ABSTRACT

ELASTIC SCATTERING AND REACTIONS

IN THE BOMBARDMENT OF ^{14}N

BY 20 MeV DEUTERONS

by William Lucas Pickles

Reported in this thesis are differential cross sections from 10 to 170 degrees, and total cross sections for the following reactions at 20.13 MeV:

$^{14}N(d,d)^{14}N$	
$^{14}N(d,d')^{14}N^*$	EX < .14 MeV
$^{14}N(d,t)^{13}N$	EX < 8 MeV
$^{14}N(d,^3He)^{13}C$	EX < 8 MeV
$^{14}N(d,^4He)^{12}C$	EX < 13 MeV

And total reaction cross sections for the following:

$^{14}N(d,pN)$	E > 2.5 MeV
$^{14}N(d,p)$	Ex < 10 MeV
$^{14}N(d,^4He\ X)Y$	E > 2.5 MeV

The total reaction cross section for deuterons or ^{14}N is computed considering all of the above.

Also reported are differential cross sections from 15 to 50 degrees and total cross sections for the following:

$^{16}O(d,d)$
$^{16}O(d,d')^{16}O^*$ EX < 14 MeV
$^{16}O(d,^4He)^{14}N$ EX < 13 MeV

The elastic cross section $^{14}N(d,d)$, has absolute errors of less than two per cent. Optical potentials have been fit to this data using Snoopy Two. Many essentially equivalent potentials have been found. The potential with the lowest CHI-SQUARED per point (34.5) has a volume imaginary term (W_S) of 3.62 MeV and a surface imaginary term (W_D) of 2.36 MeV, with the imaginary radius parameter 1.63 fermis. Most deuteron potentials found in the literature have W_S equal to zero.

A best optical potential with $W_S = 0$ and one with $W_S = 3.62$ have been used to repeat a DWBA calculation of the cross section for $O^{16}(p,d)^{15}N$ without a major difference in the result. The Isotopic spin for many levels of ^{14}N up to 14 MeV have been assigned as zero on the basis of the $^{14}N(d,d')^{14}N^*$ measurements. The angular distributions and total cross sections in the $^{14}N(d,d')^{14}N^*$ reaction are discussed in terms of weak coupling between two 1^+ nucleons and the 2^+ and the 3^- configuration ^{12}C and between two 1^+ holes and the 3^- configuration of ^{16}O.

Experimentally, gas targets and their use in absolute cross section measurements is discussed. Time-of-flight was used to identify reaction products and is compared to the EΔE method of particle identification.

Automatic computer data processing was used extensively and is also discussed. A complete prescription for the fabrication of 3 mm silicon surface barrier detectors is presented and there is a discussion of the use of various types of detectors in time-of-flight work.

ELASTIC SCATTERING AND REACTIONS IN THE BOMBARDMENT OF ^{14}N BY 20 MeV DEUTERONS

by

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I would also like to express my deep appreciation for the patience and support of my wife, Judy.

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1. INTRODUCTION

The work presented in this thesis consists principally of the accurate measurement of the differential cross sections for elastic and inelastic scattering of 20 MeV deuterons from ^{14}N. The results are analyzed to obtain optical model parameters for $^{14}N(d,d)$ and spectroscopic information about the T = 0 states of ^{14}N.

The choice of ^{14}N resulted from a continuing interest in light nuclei at this laboratory and the energy was chosen as the minimum deuteron exit energy for which consistent spectroscopic information from the (p,d) reaction on light elements were obtained (Sn 69). Accurate proton and deuteron optical potentials are desirable in the DWBA analysis of the (p,d) reaction, because the effects of the distortion of the exit channel wave-functions have strong effects upon the calculated reaction differential cross sections.

Good proton optical potentials for energies below 50 MeV are available in the literature. Deuteron optical potentials in the energy region of 20-50 MeV are available (Mc 69, Hi 68), but the data from which they are extracted are in general less complete and less accurate than the corresponding proton data. For example, deuteron elastic scattering and/or fits at angles greater than 100 degrees

center-of-mass are rare in this energy region. The elastic deuteron cross sections presented in the work have absolute errors of less than 2% and extend in the laboratory frame from 10 degrees to 170 degrees. This data has been fit using the optical code "SNOOPY TWO" (Sc 69). Several sets of acceptable optical potentials have been found, the quality of the fit, however, especially for angles greater than 100°, is not as good as that usually obtained for proton elastic scattering. The elastic cross section and optical fits are discussed in detail in Sec. 4.1 and 4.2.

The DWBA calculations for $^{16}O(p,d)^{15}O^*$ (Ex = 6.180 MeV) performed by Snelgrove (Sn 69) have been repeated using the $^{14}N(d,d)$ parameters from this work. Peak to valley ratio of the calculated deuteron cross section oscillations is in close agreement with Snelgrove's experimental data, but the new deuteron optical potentials do not change the calculated back angle (p,d) cross section. The conclusion is that lack of agreement between Snelgrove's DWBA calculations and his back angle data was not due to inaccurate deuteron optical potentials, but more likely, resides in the form factor for the reaction as was previously suggested (Sn 69, Pr 70).

The deuteron is a particle whose isospin is zero, consequently in the (d,d') reaction only states with isospin equal to that of the ground-state should be excited.

This selection rule removes from the observed spectrum of $^{14}N(d,d')^{14}N^*$ approximately one-third of the known states below 13 MeV. This fact alone makes the (d,d') data interesting. It means that most T = 0 states in ^{14}N are well resolved in a counter experiment whose energy resolution is 45 to 70 KeV. No evidence for the excitation T = 1 states in the $^{14}N(d,d')$ reaction have been found and upper limits of cross-sections for breaking of the T = 0 selection rule for several of these states have been set. This matter is discussed in Sec. 5.1.

The spectroscopic information about ^{14}N presented in this work is derived from total reaction cross-sections and angular distributions for $^{14}N(d,d')^{14}N^*$, $^{16}O(d,d')^{16}O^*$, and $^{16}O(d,^4He)^{14}N^*$ and from DWBA analysis of the $^{14}N(d,d')^{14}N^*$.

Measurement of cross-sections with absolute error less than 2% represents a considerable experimental effort and the successful use of time-of-flight for particle identification in taking spectra represents a departure from the standard experimental procedures used in our laboratory. Consequently, Sec. 2 contains an extensive discussion of errors, experimental systems, and time-of-flight techniques.

Differential cross-sections and total reaction cross-section for the $^{14}N(d,t)$, $^{14}N(d,^3He)$, $^{14}N(d,^4HeX)Y$, $^{14}N(d,pn)Y$, and $^{14}N(d,p)$ were measured simultaneously with

the reactions previously discussed and have been used principally to construct an "anatomy" of deuteron scattering. The possible implications for deuteron optical potentials from the fact that 60% of total reaction cross-section comes from the one channel $^{14}N(d,pn)Y$ are discussed in Sec. 5.3.

2. EXPERIMENTAL

2.1 Experimental-General Discussion

The measurement of differential cross sections with small absolute errors was the primary goal of the experimental systems. The procedures are described in this section.

The following expression for differential cross section is a result of considering $\frac{d\sigma}{d\Omega}$ to be the area per nucleus which causes a particular type of scattering into unit solid angle at an angle θ with respect to the beam.

$$\frac{d\sigma(\theta)}{d\Omega} \equiv \underset{SA\to 0}{\text{Limit}} \frac{N_p}{N_T N_B SA} \quad \frac{cm^2}{sr.} \tag{2.1}$$

N_p is the number of particles scattered from a target of N_T nuclei per cm^2. N_B is the total number of incident beam particles and SA is the solid angle defined by the slit in front of the detector. Re-expressing the above equation yields

$$\frac{d\sigma(\theta)}{d\Omega} \equiv \underset{\substack{A\to 0 \\ R\to R}}{\text{Limit}} \frac{N_p}{(\bar{\rho}t)(Q/e)A/4\pi R^2} \frac{cm^2}{sr.} \tag{2.2}$$

where Q is the total charge of the beam which is incident on the target; e is the charge per beam particle. A is

the area at the detector through which a particle must pass in its free flight from the target to the detector. All defining slits have some thickness but may not in fact stop all scattered particles incident on them. Consequently, these particles may be small-angle-scattered from the surface of the hole through the defining slit. The particle undergoing rescattering of this type may enter the detector and will be kinematically down shifted in energy and/or degraded by energy loss to the slit. In summary, any absorber with a hole of area A cut through it will have an area ΔA surrounding the hole which has an opacity different from either the hole (0 opacity) or the absorber. Fortunately particles that pass through ΔA traveling from the target to the detector have a lower energy than the particles which reach the detector surface without interacting with the absorber. "Slit scattering" is the primary example of this effect. Slit scattered counts must be subtracted from N_p. A, then, is the number which is to be interpretated as the area of the clear hole in a defining absorber placed near the front surface of the detector. In expression 2.1 t is the length parallel to the incident beam in which target nuclei exist which may cause scattering into the detector. $\bar{\rho}$ is the average number density per cm^2 of target nuclei in the region t. $\bar{R}$ is the average distance from region t to the center of the defining absorber or slit at the detector.

We can now discuss the problems encountered in measuring $\bar{\rho}$ and Q. $\bar{\rho}$ must be known and remain constant during an experiment or be measured as $\frac{d\sigma}{d\Omega}$ is being measured. Usually a monitor counter serves to measure the product $\frac{\bar{\rho}tQ}{e}$ during the measurement of $\frac{d\sigma}{d\Omega}$. Solid targets melt, evaporate, pick up oil from the vacuum system and in general must be monitored during an experiment. In addition a separate experiment must be performed on the target to measure the initial $\bar{\rho}$. Errors are generated at each step. A gas target requires only that you measure the pressure and temperature of the gas contained to determine $\bar{\rho}$. For this reason gas targets were used in this experiment and are discussed in detail in Sec. 2.4.

Q is the charge of the beam incident on the target. Since the total number of particles scattered out of the beam is small, Q can be taken as the beam charge collected by stopping the beam after it has passed through the target. There are several ways errors can be committed in collecting Q. The beam is diverging when it leaves the target due to small angle scattering and you must be sure to "catch" all of it. When the beam is stopped by the material in the faraday there is a copious emission of electrons. These electrons must not escape from the collecting part of the cup. The target is also an electron emitter when beam is passing through it and these target electrons must be kept

out of the collecting cup. Having made sure the charge on the cup is due only to the beam and none of it has been lost, it must then be integrated accurately without losses. All of these considerations are discussed in Sec. 2.5.

N_p, the number of scattered particles passing "freely" through A, will, except for an error in background estimation, be too small. That is, you may miss counts, but it is highly unlikely you will make extra ones. The detector itself may fail to give the event its correct pulse height for several reasons:

1. Excitation of detector (Si) nuclei
2. Charge collection failure
3. Reactions in the detector such as (d,pn)
4. Pileup (Two scattered particles arriving within the collection time of the detector)

The electronic recording system has a processing time per event during which it will not process another event. A typical time for processing was 40 μs. This effect is called dead time and was measured using pulses from the monitor counter.

The particle identification system may fail for a number of reasons, and lose an event. In particular, when time-of-flight is used the time signal may not be generated, leaving only an energy signal. In this

experiment, events without a time signal were recorded in order to measure this type of loss.

All of the losses described above were measured during this experiment and are discussed in Secs. 2.6 and 2.7.

The ^{14}N data presented in this thesis was taken in 96 hours of continuous running and the ^{16}O in 48 hours. Particle identification was achieved with time-of-flight techniques and a 2-dimensional data taking routine "TOOTSIE" written for the XDS Sigma-7 computer by D. L. Bayer of this laboratory (Ba 69).

2.2 Beam and Beam transport

The 20 MeV beam of deuterons used in this experiment was produced by the MSU Cyclotron. Figure 2.1 shows a general view of the cyclotron and transport system. The beam extracted was normally 1 to 5 μ amps with a time resolution of less than 0.4 ns. This narrow time width was achieved in most cases by using internal phase slits, or occasionally only the beam transport system slits. Time resolution was never worse than 0.5 ns.

The beam analysis system is basically an object slit (Box 3), a 90° bending and dispersion system, and an energy defining slit (Box 5), with appropriate quadrupole and sextupole focusing (Ma 67). Also used in this experiment

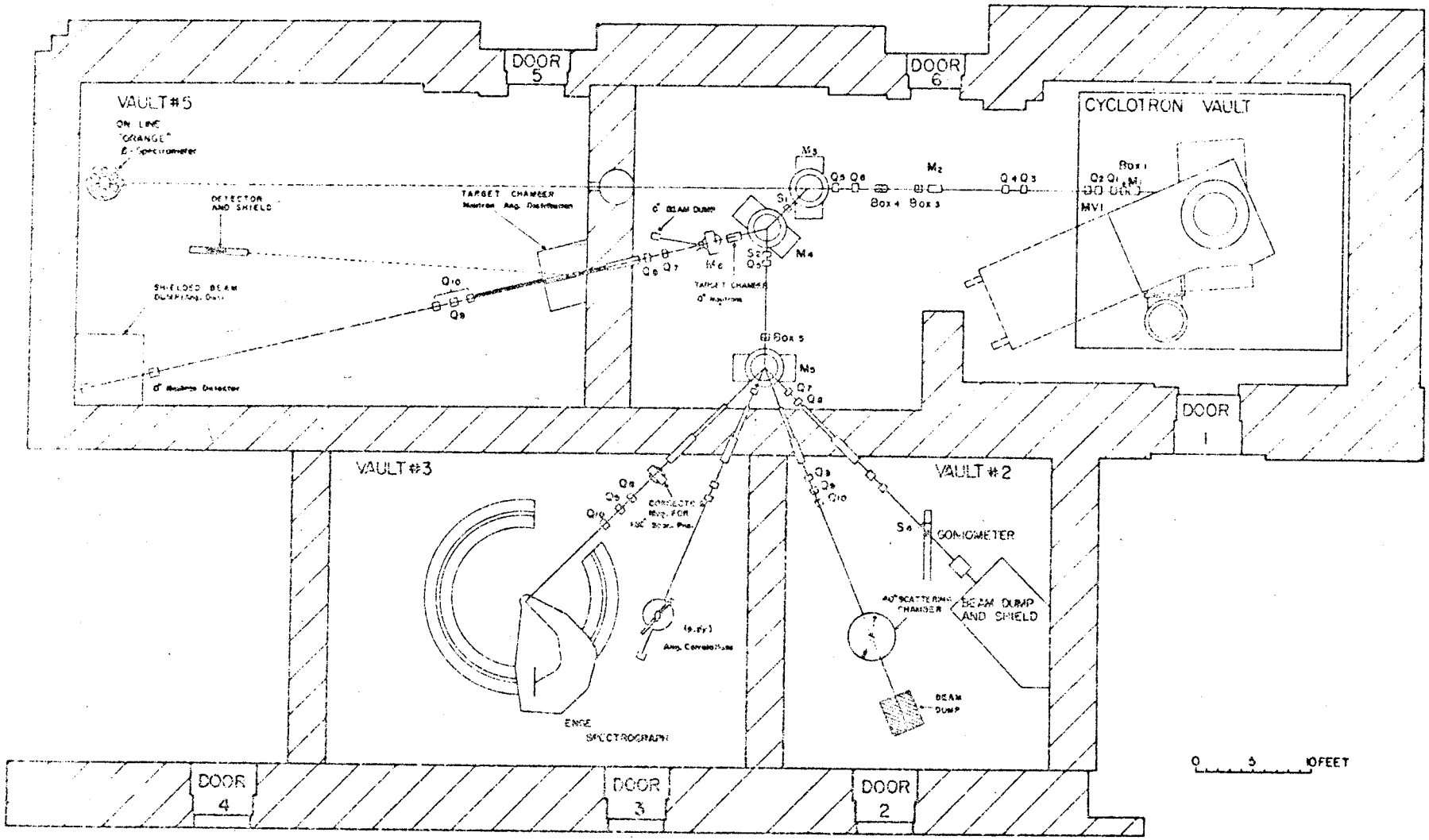


Figure 2.11 Layout of Cyclotron experimental areas as of August 1970. The new neutron angular distribution facility which is being designed will have a fixed flight path extending to the left from "Box 5" and a moveable magnet to bring the beam into Box 5 from any angle.

was a set of slits (Box 10) located immediately after the last quadrupole, a set of defining slits (Box 11) at the entrance to the scattering chamber, and magnetic steering at Box 10. All exposed beam pipe was shielded from stray magnetic fields with soft iron. The Box 10 and 11 slits and Box 10 steering magnet were used to define the zero angle for scattering and insure that it remained constant during the taking of data (Sec. 2.32).

The beam was focused at the center of the scattering chamber with a magnification of.8 of the Box 5 object. Typically the beam spot size was 0.070 inches horizontally and vertically. A maximum of 400 na was delivered to the scattering chamber; typical currents were 80 and 100 na.

2.3 Scattering Chamber and Scattering Angle Measurement

2.31 General

Figure 2.31 shows a schematic of the experimental area. Included are the last focusing elements in the beam line, the scattering chamber, and the aparatus used to define the zero scattering angle. The chamber itself was 30 inches in diameter, had one remotely moveable counter arm and one fixed arm. The detector and collimating units for counting the scattered particles were mounted on the moveable arm. The monitor counter and its collimating unit were mounted on the fixed arm. The gas cell targets and scintallator were mounted on a 1/4 inch dowel that defined the center of rotation of the moveable arm. The targets rotation and height could be controlled from the data room. A typical pressure obtained in the chamber was 10^{-5} torr.

The scattering chamber was equipped with an electrical angular readout, but this was found to reproduce measurement to only 0.2 degrees. An angular readout system which was accurate to better than 0.1 degrees and did not require constant checking was necessary. The system devised included a protractor and vernier which was read through a magnifying optical system by closed circuit T. V.

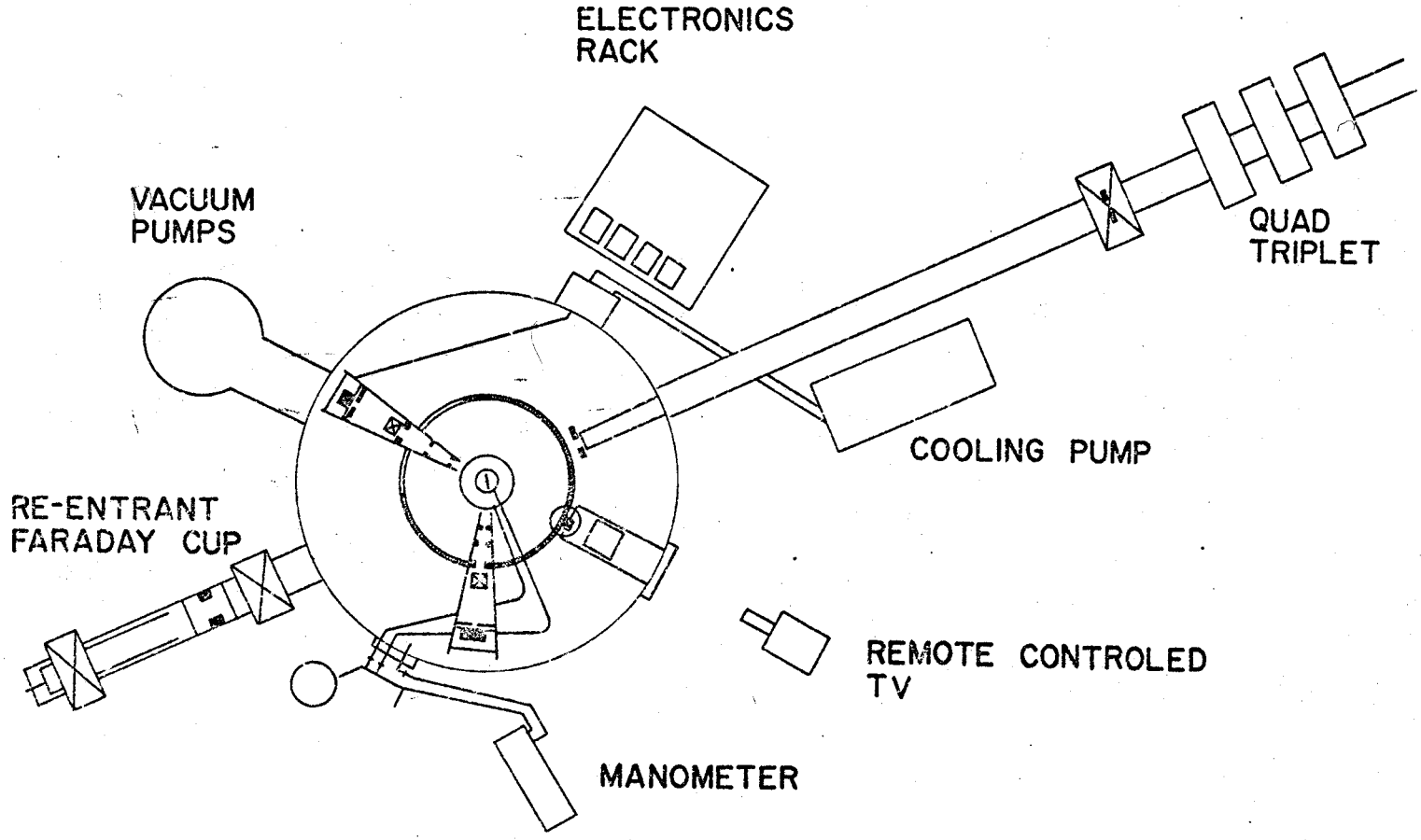


Figure 2.31 Schematic of
Experimental Area.

2.32 Angle Measurement and Errors

Figure 2.32 shows in two views, the center of the scattering chamber and the apparatus constructed to measure the angle of the moveable scattering arm with respect to the beam. An aluminum protractor 15±.001 inches in diameter and 1/4 inch thick was machined in our shop by N. R. Mercer. The angular scribe marks were cut using a dividing head with a maximum angular error of 0.015 degrees; calculated as follows:

$$\Delta\theta = 57 \times \frac{(\text{center error} + \text{scribe error})\{\text{inches}\}}{\text{Radius}\{\text{inches}\}} \quad (2.3)$$

In this case:

$$\Delta\theta = \frac{5.7 \times 2 \times 10^{-3}}{7.5} \approx 0.015 \text{ degrees}$$

A vernier was also machined to the same accuracy. The scribe marks on the protractor were cut every 0.2 degrees. This protractor was then bolted to the rotating scattering arm. The vernier was mounted on a support which was bolted to the viewing port wall. The vernier was adjustable in all directions. This whole assembly was quite massive and very stable when finally installed. The protractor was then adjusted so that its center was the actual center of rotation of the scattering arm. This was accomplished by adjusting the position of the protractor and the vernier until an equal

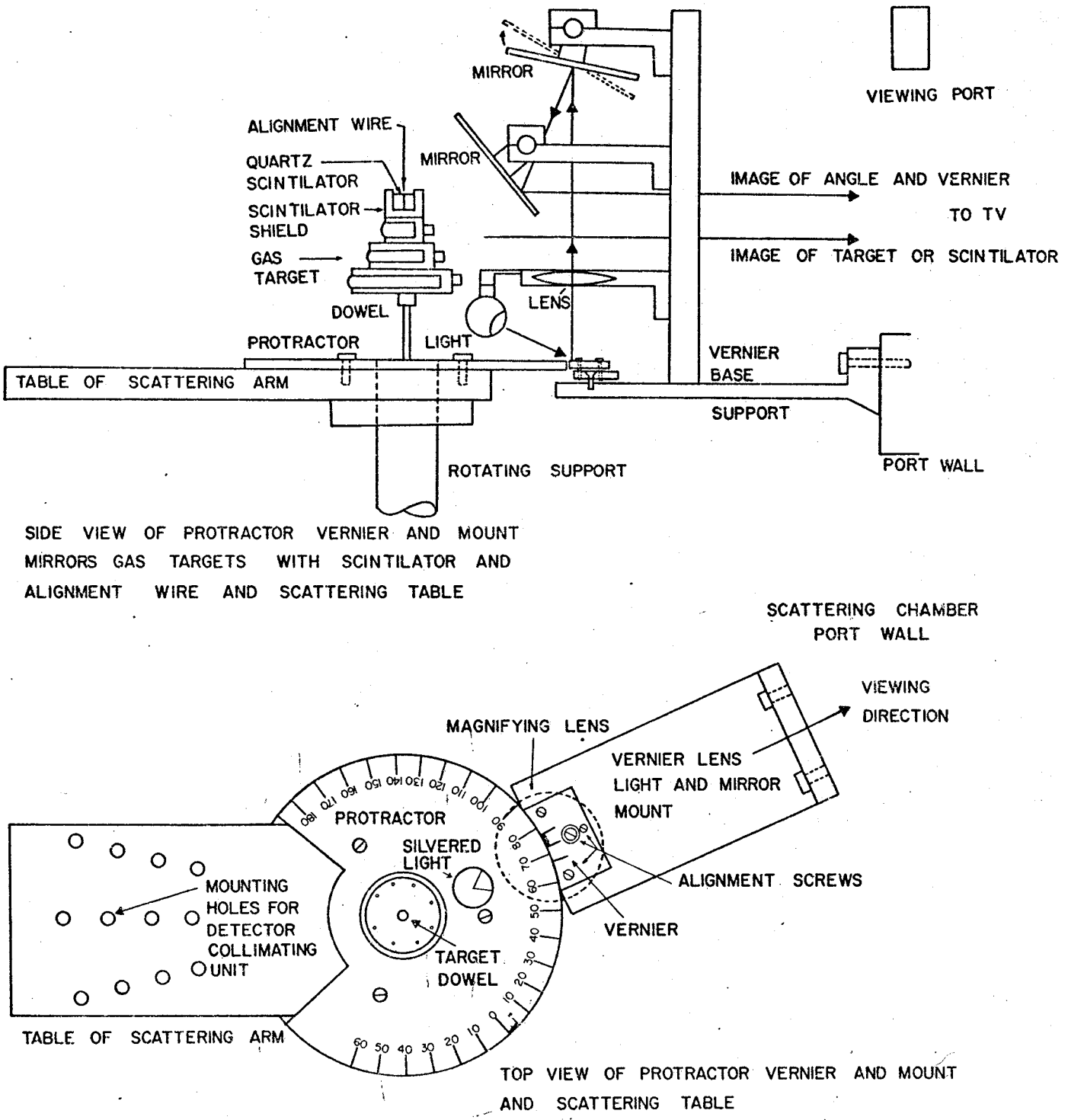


Figure 2.32 PROTRACTOR VERNIER AND OPTICAL READOUT FOR SCATTER ANGLE MEASUREMENT

distance was maintained between the edge of the protractor and the edge of the vernier for the full rotation of the protractor. The estimated centering error was 0.001 inches. Adding these errors linearly, the basic angular error of the protractor-vernier combination was approximately 0.025 degrees. The vernier marks were constructed to allow reading of angles to 0.02 degrees.

As is shown in Figure 2.32 a silvered bulb illuminated the vernier and protractor scale which was then viewed through a magnifying lens and two mirrors by a T. V. camera with a 150 mm telephoto lens. This camera had a remote focus and orientation control. Two mirrors were employed to produce a non-inverted image. The T. V. camera also provided a clear view of the target area with only a small adjustment of the camera.

The total relative angular error was 0.1 degrees and is due to the error in alignment of collimating units, the fact that there was an uncertainty of 0.020 inches in placing the beam relative to the center of rotation, and on error in determining 0 degrees. A centering error will produce an angular error $\Delta\theta$ which goes as:

$$\Delta\theta = 57 \times \frac{\Delta C}{R} \times \cos\Phi \text{ degrees} \qquad (2.32)$$

Where R is radius at which the angle θ is measured, ΔC is the centering error and Φ is the angle between the direction

of the maximum centering error and the direction at which the angle measurements were made. The collimating units for the detector had two slits 10 inches apart with rear slit 15 inches from the center of rotation of the scattering arm. Using a surveying telescope it was determined that the center of observation looking through the two slits was 0.005 inches off the center of rotation. Thus $\Delta\theta$ is equal to 0.020 degrees.

$$\Delta\theta = 57 \times \frac{5}{15} \times 10^{-3} \simeq 0.020 \text{ degrees}$$

The beam spot was typically 0.060 inches in diameter, and an error of 0.020 inches for the centroid of the beam was estimated. This results in a relative-angle uncertainty of 0.082 degrees, and it the principal source of angular error.

$$57 \times \frac{20}{14} \times 10^{-3} \simeq 0.082 \text{ degrees}$$

Combining the 3 sources of relative-angle error linearly yields a maximum error of 0.127 degrees.

$$0.082 + 0.020 + 0.025 \simeq 0.127 \text{ degrees}$$

Adding in quadrature, the error is 0.09 degrees.

2.33 Zero Angle Determination and Error

The beam direction and centering was fixed by insuring that the beam traveled in a straight line between two widely spaced slits, and passed over the center of rotation of the scattering arm.

Figure 2.33 shows these slits at boxes 10 and 11. Magnetic shielding was wrapped around the beam pipe between these two sets of slits. A small electromagnet M10 was located next to the Box 10 slit towards the cyclotron (up-stream from Box 10). Box 11 was located inside the scattering chamber 10 inches from the center and consisted of two vertical and two horizontal tantalum slits 0.125 inches thick. Charge could be collected from all four independently. Box 10 consisted of two horizontal plane slits made of aluminum with tantalum edges. The Box 10 slits were remotely moveable, while the Box 11 slits were fixed during the line up procedure.

The alignment of Box 10 and Box 11 slits was accomplished as follows: A surveying telescope was sighted through the faraday cup port, over the raised center dowel in the scattering chamber, through the Box 11 slits, through the Box 10 slits and focused on a pin at the center of the steering magnet M5. This pin and a reference surveyors target on the wall behind the telescope were used to establish the height of the beam (the optical center vertically of

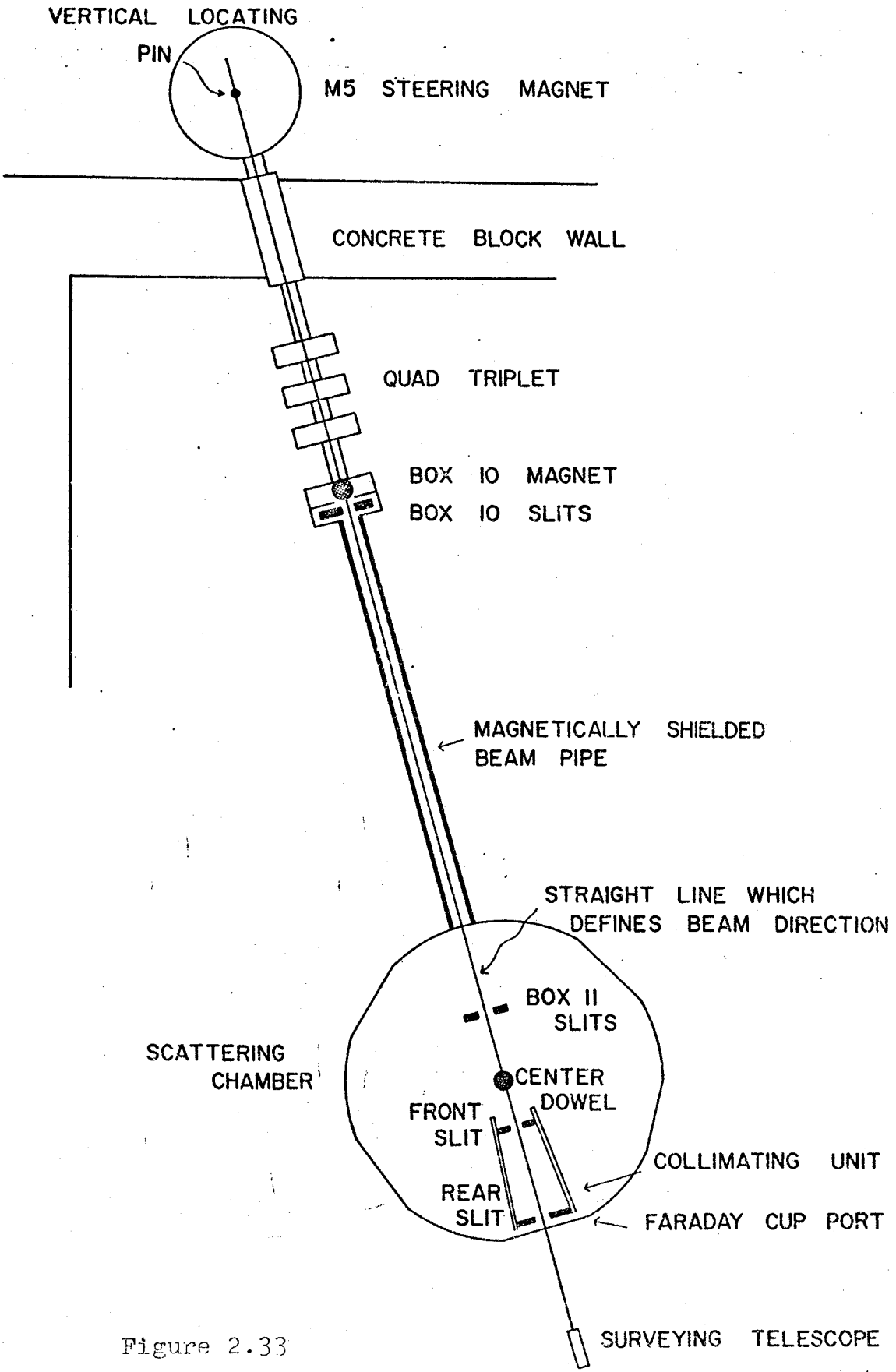


Figure 2.33

BEAM LOCATION SYSTEM

the transport system). The Box 11 slits were closed and the center of the Box 11 slits, the center of the dowel, and the telescope were made to be co-linear to ±0.002 inches. The scattering arm was rotated 360 degrees while observing the center dowel through the telescope. The center of rotation was found to be 0.002 inches off the center of the dowel and the telescope was moved so that it sighted over the center of rotation and focused on the center of Box 10. The Box 11 slits were then aligned so that each of the 4 jaws was 0.090 inches from the beam center line established by the telescope position and Box 10. The collimating units without detectors in place were then mounted on the scattering arm, raised and lowered and the arm rotated until the rear collimator was centered on the beam line. The front slit of the collimating unit was adjusted to be co-linear with the Box 10 slits, the center of rotation, the rear collimator, and telescope. The angle was then read through the optical readout system. The final result showed that the zero angle was +0.04 degrees as read on the protractor, and was reproducible.

It was at this time that the areas of the front and rear slits in the collimating units were measured using the telescope. Also, as a last step, a fine copper wire was fixed to the scintilator on top of the gas cell target. The target was mounted on the dowel and the wire was aligned with the telescope.

After the scattering chamber was closed and the beam was focused on target, the following procedure was used to put the beam on the established line.

1. Box 10 was closed and the beam was balanced on the two slits using M5.
2. Box 10 was opened to 0.5 inches full width.
3. M10 was used to sweep the beam on to first the left and then the right jaws of Box 11.
4. The current settings were recorded for M10 which provided enough deflection to left or right to deposit 1/2 of the beam on the Box 11 slits.
5. The medium current was then selected.
6. The T. V. was used to observe the beam spot and the shadow on a find copper wire on the scintillator, over the center of rotation. The shadow always equally divided the beam spot for medium current setting on M10.
7. Box 10 was closed and the balance re-checked.

This procedure initially placed the beam within 0.097 degrees of the established zero angle. This is computed as follows:

$$\Delta\theta \simeq \tan \Delta\theta = \frac{x + y}{\ell} \qquad (2.33)$$

In this case $$\Delta\theta = \frac{0.25 + 0.06}{15 \times 12}$$

$$\Delta\theta = 0.173 \times 10^{-2} \text{ radians}$$

$$\Delta\theta = 0.097 \text{ degrees}$$

where x is one half of the Box 10 full opening, y is one half of the Box 11 full opening and ℓ is the distance between them. The reason for using 1/2 the full opening is that the beam was about 1/2 the size of full opening at each slit and was taken to be uniform. All data was taken with Boxes 10 and 11 in place and monitored for a current. No current was ever observed. Then the maximum deviation of beam direction possible was 0.097 degrees. The beam was checked on the target scintallator many times and was never observed to move relative to the alignment wire.

An independent confirmation of the angular precision was obtained after the spectra were completely analyzed. The reaction p(d,d)p was observed in the proton band. A careful calculation of the energy of this peak at various angles back of 35 degrees was compared to calculated energy from "FASTKINE", the laboratory kinematics program. After adjusting for energy loss in the gas cell, the calculated and measured energies agreed to 30 KeV. In this angular region the kinematic spread for p(d,d)p is 900 KeV/deg. Thus the error in the value of the absolute scattering angle was greatly overestimated.

$$\Delta\theta \simeq \frac{30}{900} \simeq 0.033 \text{ degrees from } p(d,d)p$$

However since the angular acceptance of the detector was about 0.3 degrees quoting angular accuracies to greater than 0.1 degrees seems superfluous.

2.4 Gas Target

2.41 Design Criterion and Properties

The following properties were considered as essential in designing the gas cell target:

1. Must be leak tight.
2. Windows must not deteriorate with beam currents which allow a reasonable count rate.
3. Maintain pressure sufficient to allow a reasonable count rate.
4. Total straggling in the gas and the window should be a minimum.
5. Have pressure and temperature measurement available.
6. Have enough clear space so that no beam particles scatter from the body of the cell.
7. Easy and dependable replacement of windows.
8. Enough thermal capacity of body of the cell to prevent temperature rises of more than 0.1 degrees K. during data collection.
9. Should be easy to construct.

A cell which is as small as possible with a gas pressure great enough so that the straggling in the gas and in the window are commensurate for most exit particles will satisfy the criterion of high count rate with minimum straggling

and low beam currents. Smaller beam currents are easier to produce and prolong window life. However, the cell size does have a lower limit. This limit is imposed by the dimensions of the collimating units and the angular region over which the cell is to be used for taking data. As the collimating units rotate toward smaller angles with respect to beam direction the length along the beam from which particles can be scattered into the detector increases. At some θ the acceptance cone of the collimating slits begins to include the region of the window through which the beam passes. This angle θ is given by

$$D^2 = \frac{[t(90°) + B\tan\theta]^2}{4[\tan\theta \cos\Phi - \sin\Phi]^2} + \frac{[t(90°)]}{4} - \frac{t(90°)[t(90°) + B\tan\theta]}{2(\tan\theta \operatorname{ctn}\Phi - 1)} \qquad (2.41)$$

where D is the diameter of the inflated window, $t(90°)$ is the width of the acceptance cone at the beam where θ is 90 degrees, B is the beam spot diameter, and 2Φ is the angular width of the acceptance cone.

A simplification of 2.41 is

$$\tan\theta_{min} \approx \frac{2\, t(90°)}{D} \qquad (2.42)$$

Equation 2.42 is correct to 1 degree if Φ is less than 1 degree, B less than .1, $t(90°)$ less than .3 and D greater than .5 in the same units. As will be discussed in Section

2.61 a t(90°) of about 0.2 inches and a Φ of about 0.7 degrees was most desirable in this experiment. The following table shows the angular range of usefulness of gas cells of various diameters when t(90°) is 0.225 inches, Φ is 0.72 degrees and B is 0.080 inches.

Table 2.41 Gas cell diameter and the angular region of usefulness

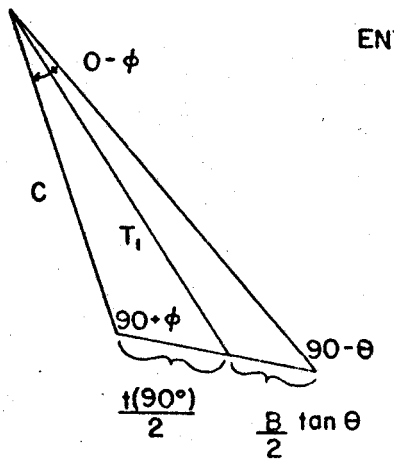
Gas Cell Diameter	Angular Region of Usefulness
0.50 inches	33° to 147°
1.0 inches	16° to 164°
2.0 inches	8.5° to 171.5°
3.0 inches	5.5° to 174.5°

where Φ = 0.72 degrees

t(90°) = 0.225 inches

B = 0.080 inches

Figure 2.41 shows how the angular regions in Table 2.41 were calculated. Notice that the volume of the beam intersected is completely determined by t(90°) and Φ. Any two slit collimating unit which results in the same t(90°) and Φ will have the same geometrical properties.



$$\frac{\frac{t(90°)}{2} + \frac{B}{2}\tan\theta}{\sin(\theta-\phi)} = \frac{C}{\sin(90-\theta)}$$

$$C = \frac{\frac{1}{2}\left[t(90°) + B\tan\theta\right]}{\tan\theta\cos\phi - \sin\phi}$$

$$T_1^2 = \frac{\frac{1}{4}\left[t(90°) + B\tan\theta\right]^2}{(\tan\theta\cos\phi - \sin\phi)^2} + \frac{t^2(90°)}{4} - \frac{1}{2}\,\frac{t(90°)\left[t(90°) + B\tan\theta\right]}{\tan\theta\cos\phi - \sin\phi}\,\sin\phi$$

T_1 = D DETERMINES ABSOLUTE MINIMUM ANGLE θ

T_1 IS THE GREATEST RADIAL DISTANCE INCLUDED IN THE INTERSECTION OF THE BEAM AND THE ACCEPTANCE CONE OF THE COLLIMATING SLITS. THIS INTERSECTION IS SHOWN ABOVE AS THE SHADED REGION.

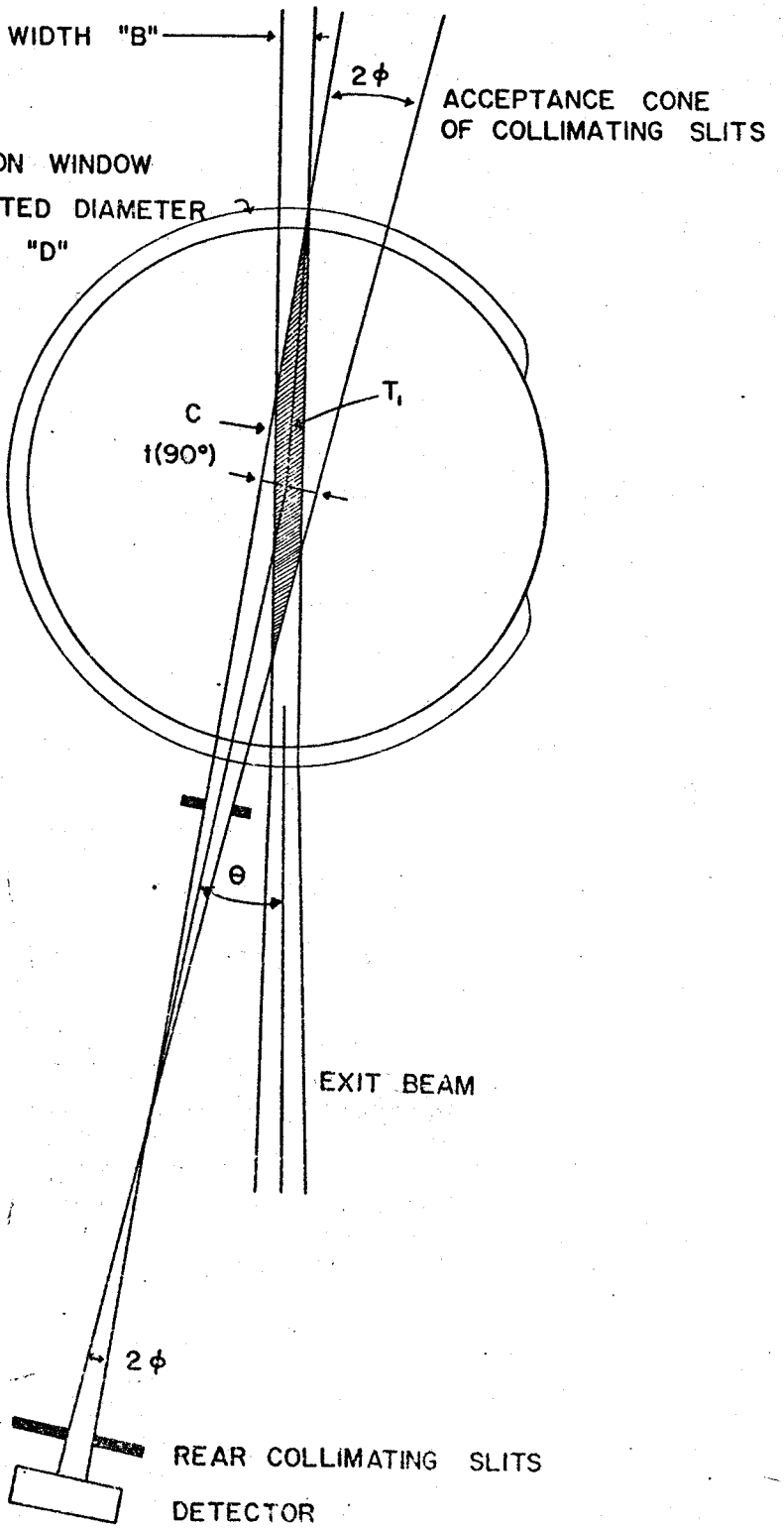


FIGURE 2.41 ANGULAR REGION OF USEFULLNESS FOR A GAS CELL TARGET

On the basis of these calculations it was decided that the gas target would be constructed so that two or three independent cells with different diameters would be available without breaking vacuum on the scattering chamber. Also, if a cell should start leaking, one would still have a spare.

If the gas cell is circular at least on the side of the beam where angular distributions are to be measured, then the mean target thickness for exit particles is the same at all angles.

Brass was chosen for the cell body because it is easy to machine, easy to solder vacuum tight gas inlet fittings to and forms a vacuum tight bond with epoxy. 0.50 mil. kapton was chosen as the window material because it can maintain a one atmosphere pressure differential, is approximately 1.7 mg/cm^3 thick and can sustain beams of 100 na for 24 hours with leaking.

2.42 Construction

It was found that kapton can be epoxied to a fresh brass surface reliably with most any good quality epoxy resin (CIBA ARALDITE 502 + 951 Hardner was used). Figure 2.42 shows three types of gas cells used. The circular cells were first turned and then milled out. The D-shaped cell allowed the mounting of a thermometer in a hole drilled in

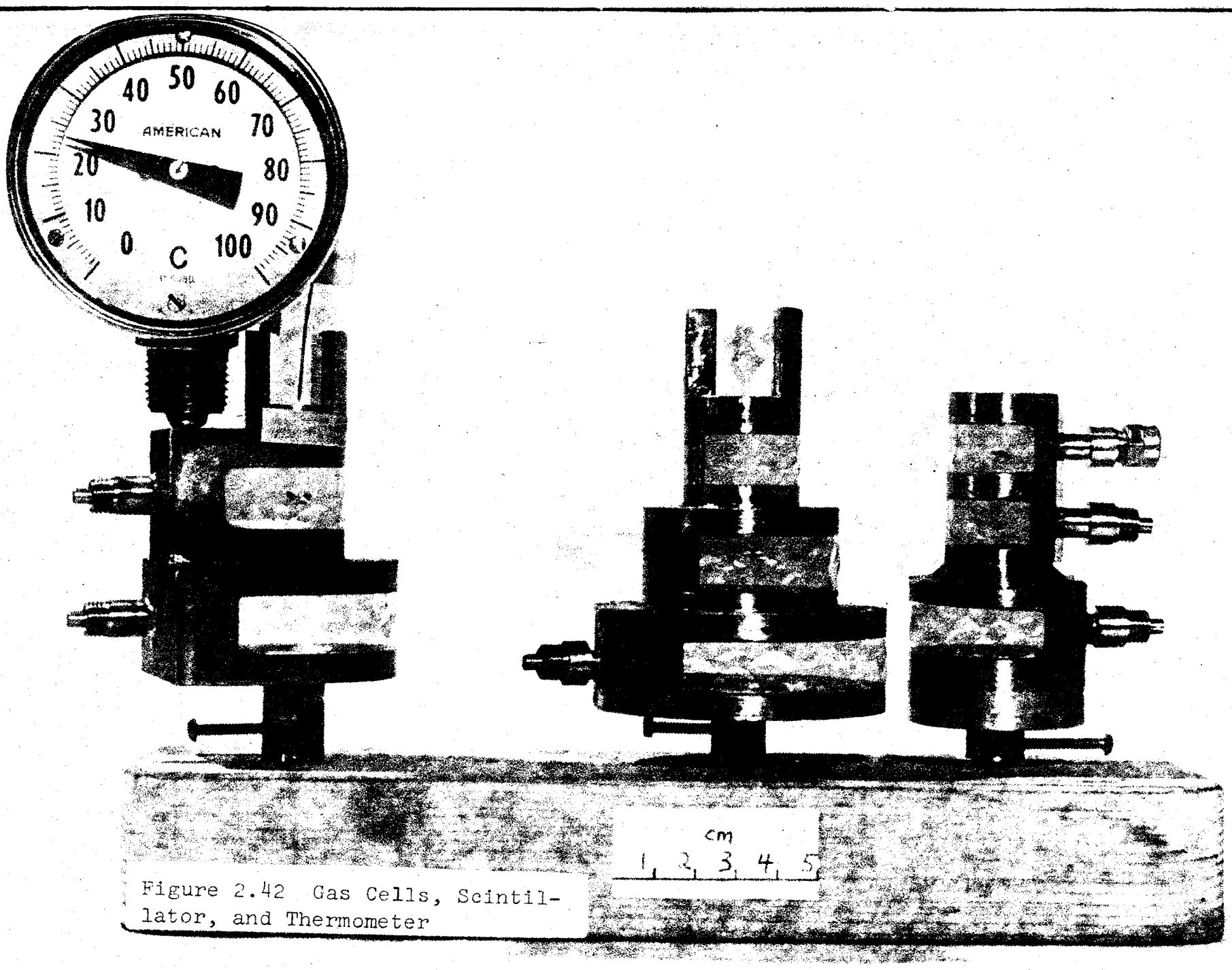


Figure 2.42 Gas Cells, Scintillator, and Thermometer

the cell body even though the effective diameter of the top cell was 1 inch. The gas inlets chosen were 1/4 inch Imperial Eastman vacuum fittings (poly flow). They were soldered into 1/4 inch holes drilled in the cell body. A brass holder for a piece of quartz scintillator was soldered to the top of the cell body. This holder was designed so that 1/4 brass walls would protect the detector while the beam was on the scintillator.

The kapton windows were epoxied to the cells as a last step. The brass was rough sanded and wiped with a clean towel before the epoxy was applied to the cell. Finger prints on the brass or the use of a solvent on the brass resulted in a bond that is not vacuum tight. The epoxy was cured at a temperature of approximately 90°F, with a heat lamp warming the cell.

2.43 Gas Manifold

The gas manifold, gas cells, and manometer are shown with their connections schematically in Figure 2.43. The manifold allowed evacuating of cells and manometer along with the scattering chamber. The cells and lines could be flushed while maintaining scattering chamber vacuum by using the roughing line shown. The port was a 1/4 inch brass disk with three inlets to the chamber as shown. The valves used were Circle Seal type 9559 B-1 MN. All connections were made with Imperial Eastman poly flow tubing.

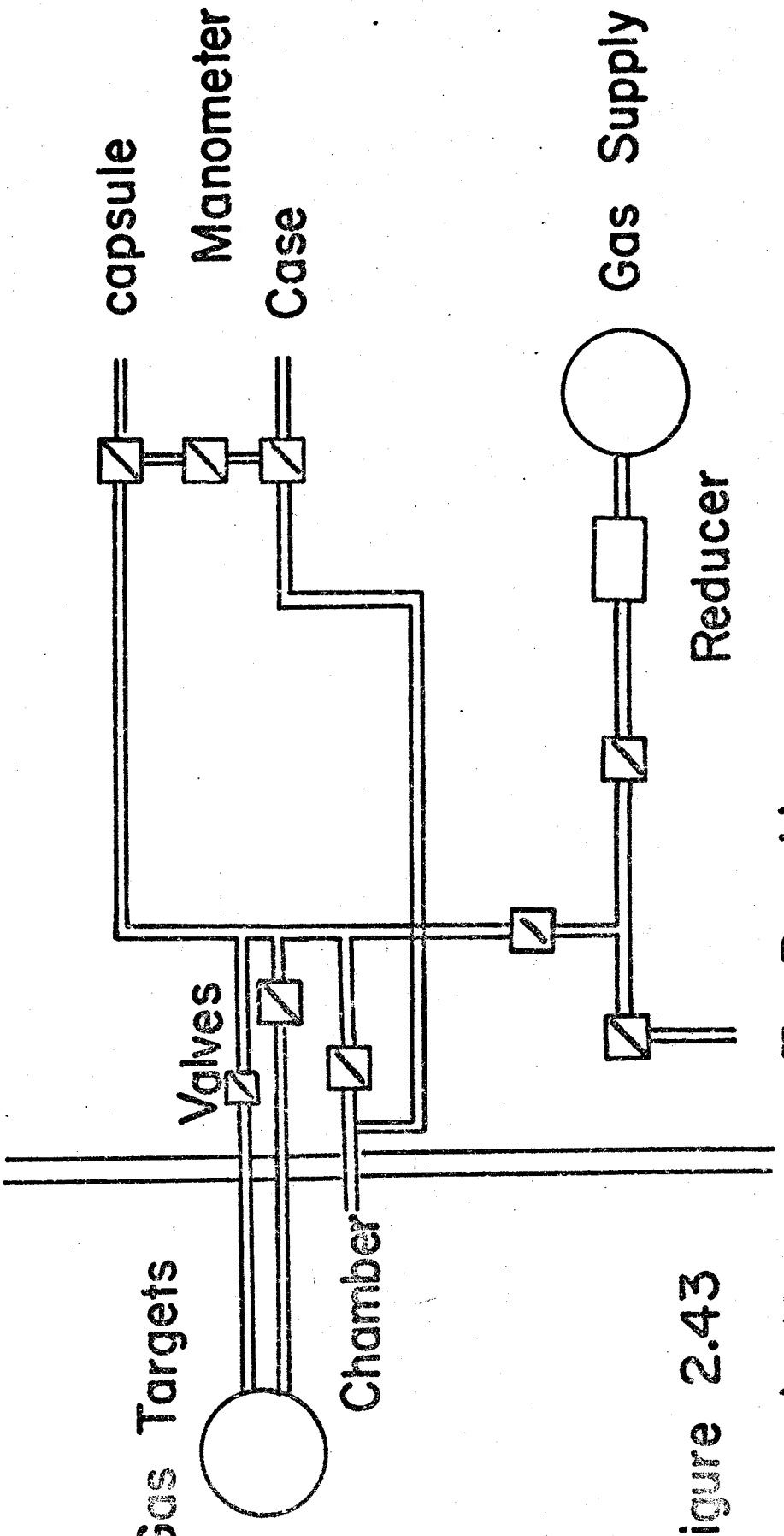


Figure 2.43

Gas Manifold

2.44 Pressure Measurement and Error

A mercury manometer was used at first and seemed most desireable because the difference in height between the two columns is a direct measure of the pressure differential. However, reading the height of the two columns is in practice very difficult. The mercury manometer was abandoned in favor of an aneroid gauge made by Wallace and Tiernan (Type FA 145PP12296). This gauge is guaranteed to be accurate to 0.03 inches of mercury absolute (traceable to the National Bureau of Standards). A H. J. Green mercury barometer with digital remote readout was calibrated by comparison to the U. S. Weather Bureau in Lansing, Michigan. This Green barometer would have made an excellent pressure measuring device but it was designed to read pressure in a limited range and only near one atmosphere. The mercury barometer was placed near the scattering chamber and the Wallace and Tiernan gauge was compared with it regularly. No difference greater than 0.01 inches between the two gauges was ever noted. No other check of the Wallace and Tiernan gauge was made. The gauge was shock mounted in a case, fitted out with Imperial Eastman fittings and a valve between the inlet and outlet, and the face of the gauge was lighted by a circular neon lamp so that the dial could be read easily by closed circuit T. V.

The reading uncertainty was 0.02 inches. Combining the reading error and the stated accuracy of the gauge linearly, we have a total error of 0.05 inches of mercury. This assumes that the pressure at the gauge was the same as that in the cell.

2.45 Beam Induced Temperature and Pressure Effects

The beam passing through the cell deposits energy, with the power dissipated in the cell generally less than 100 milliwatts. A temperature rise of less than 0.01 degrees per hour of the gas cell was calculated based on the mass of the cell and the thermal capacity of brass. The cell was in contact with the steel dowel at the center of the scattering chamber and consequently there should have been no temperature rise; in fact, no temperature rise of the gas cell was observed. The estimated reading error of the thermometer was 0.5 degrees. The thermometer was a three inch Ashcroft Bi-metal type, calibrated at zero degrees centigrade.

There is some question about what happens to the gas molecules in the target at the instant a beam burst passes through. The beam burst typically contains 10^3 particles, occurs every 50 ns and lasts 0.3 ns. Does the gas relax to complete thermal equilibrium with uniform pressure and temperature throughout the cell in between beam bursts?

Except for an occasional nuclear scattering, the beam particles will interact only with the electron clouds of the target nuclei. The maximum energy transfer to one electron from a 20 MeV deuteron is 22 KeV. Since binding energies for electrons are less than 100 eV, there should be many electrons with KeV type energies produced in the gas. This represents the generation of a "hot" plasma of electrons. The time and method for relaxation of this plasma is a question and the effect of this plasma on the local density in the gas is also a question. One knows that a pulsed spark chamber sparks, therefore the passage of one charged particle through a gas causes some electrical disturbance which in fact persists for times at least as long as 20 ns. Aside from a general interest in what happens in a gas as a function of time after the passage of a beam burst, it is important to know what $\bar{\rho}$ is like in the region of the beam so that a nuclear cross section can be obtained. The most available direct measure of $\bar{\rho}$ is in fact a cross section. During the data taking on ^{14}N a spectra was collected twice, once with a beam current of 100 na and once with a current of 10 na. The 10 na run was followed immediately by the 100 na run. The results are shown in Table 2.42.

In Table 2.42 P is the pressure, Q is the integrated charge, and (1 + DT) is the dead time correction factor. The temperature was constant.

Table 2.42 Comparison of cross sections measured with beam currents of 10 na and 100 na

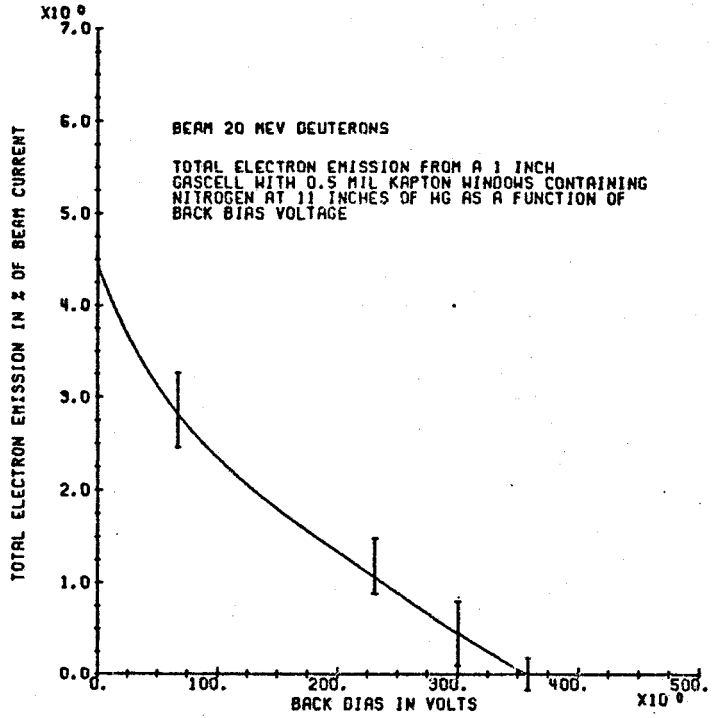
Average Current	Charge in μc	Pressure in in.Hg	$\frac{1 + DT}{PQ}$	x	Counts	=	Relative SIGMA
100 na	168.78	8.15	0.73682		29439		2169
10 na	60.81	8.18	0.20183		10815		2183

The values for SIGMA indicate that there may indeed be a 0.5% density effect, but the error in each SIGMA is about 1%. Nothing definite can be said. No correction was made to the density for the local heating effect.

2.46 Beam Induced Electron Emission from the Target

The whole question of what happens in the gas as the beam passes through stimulated our interest in measuring the total electron flux out of the target and the energy distribution of these escaping electrons. The method used was very simple. An ammeter was connected to the gas cell in series with several batteries and the gas cell was insulated from the chamber with a teflon plug. Beam was then passed through the cell and the target current was recorded as a function of beam current and target bias voltage.

The emitted electron current was found to be approximately 4% of the beam current and as shown in Figure 2.44 most electrons had energies less than 400 eV.



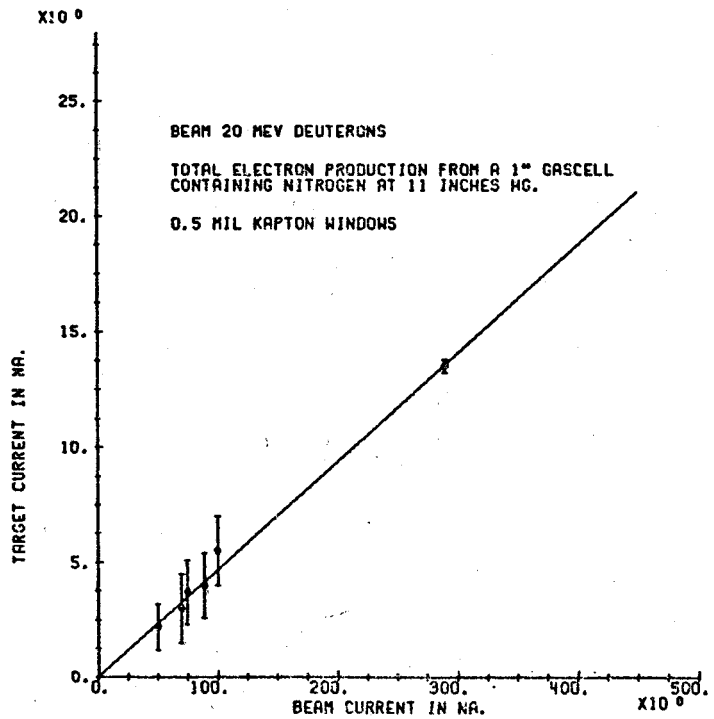


Figure 2.44 Electron Emission From Gas Targets

In any case, electron emission is not a candidate as a heat loss mechanism from gas cells. Most of the energy lost by the beam in the cell probably remains in the gas until it is conducted away by the windows and the cell body.

The maximum energy of 400 eV makes protection of the detector and faraday cup trivial. A permanent magnet of 1 gauss or greater placed in the collimating units will protect the detector from 400 eV electrons.

2.5 Beam Integration

2.51 Faraday Cup Design Criterion and Construction

The faraday cup was made from 2 short (18 inches) sections of a 4 inch aluminum beam pipe. Both ends of each section had our standard O-ring flanges. An aluminum face plate mounted on the end of one of the sections was the support for the collecting cup and also had a BNC feed-through for connecting the cup and the cable to the integrator. As shown in Figure 2.51 the collecting cup was 16 inches long, 3 inches in diameter, and was supported by three ceramic insulators. The base of the cup was 0.5 inches thick and the whole cup was made of aluminum. A nylon section of beam pipe 3 inches long with O-ring flanges on each end was inserted between the two aluminum sections. The nylon section contained an aluminum collecting ring which was 0.5 inches long, 4 inches O. D., and 3 inches I. D. A BNC feed-through was connected to this ring.

When in use these three sections of pipe were mounted on the beam exit port of the scattering chamber and two 3 Kgauss horseshoe magnets were taped on top of the metal sections; one directly over the end of the collecting cup and one in the center of the aluminum entrance section. These magnets provide a magnetic field over the interior of the pipes strong enough to "trap" 3.4 MeV electrons. Figure 2.52 shows the faraday cup mounted on the scattering chamber.

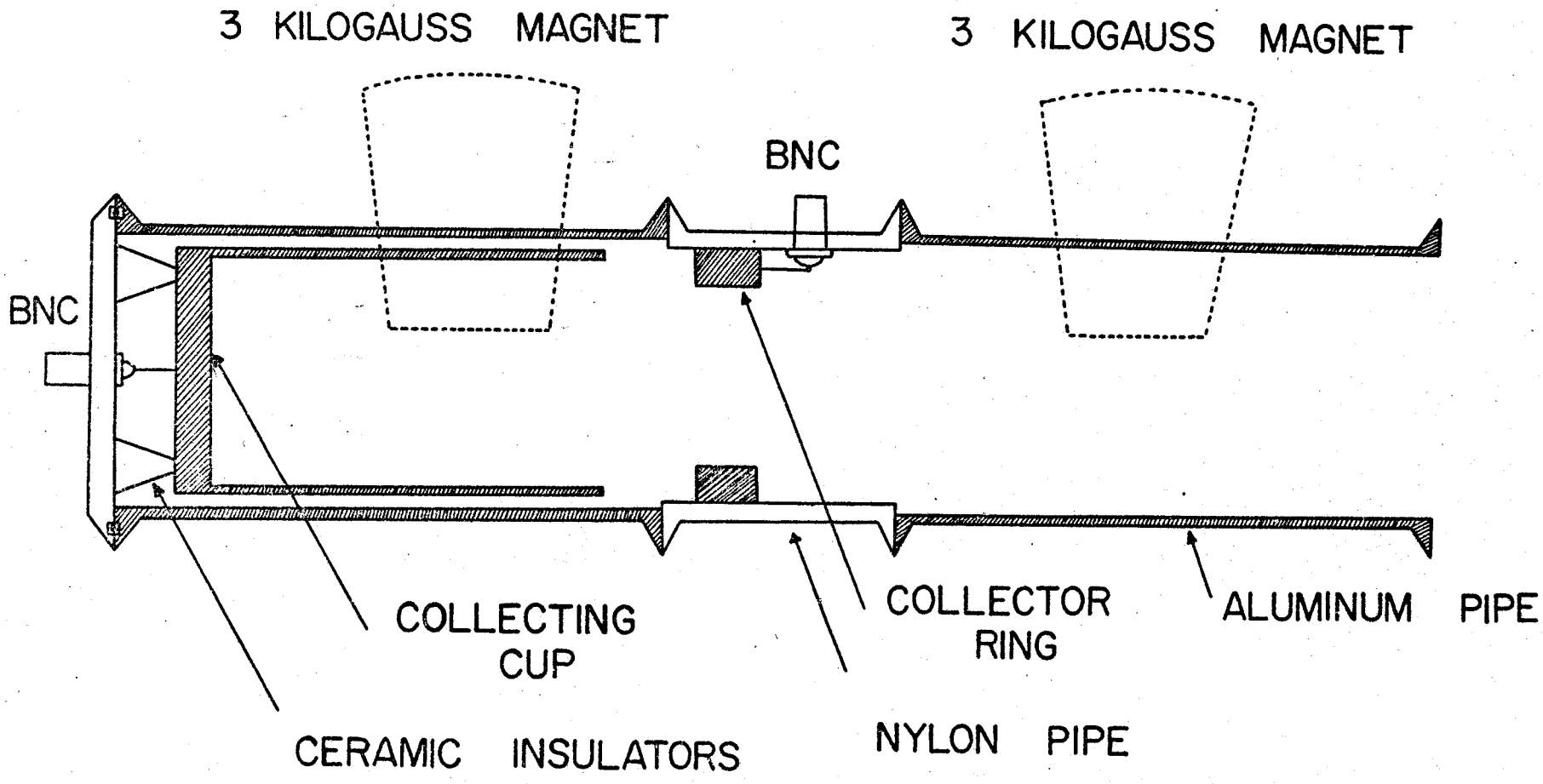


Figure 2.51 Faraday Cup Schematic

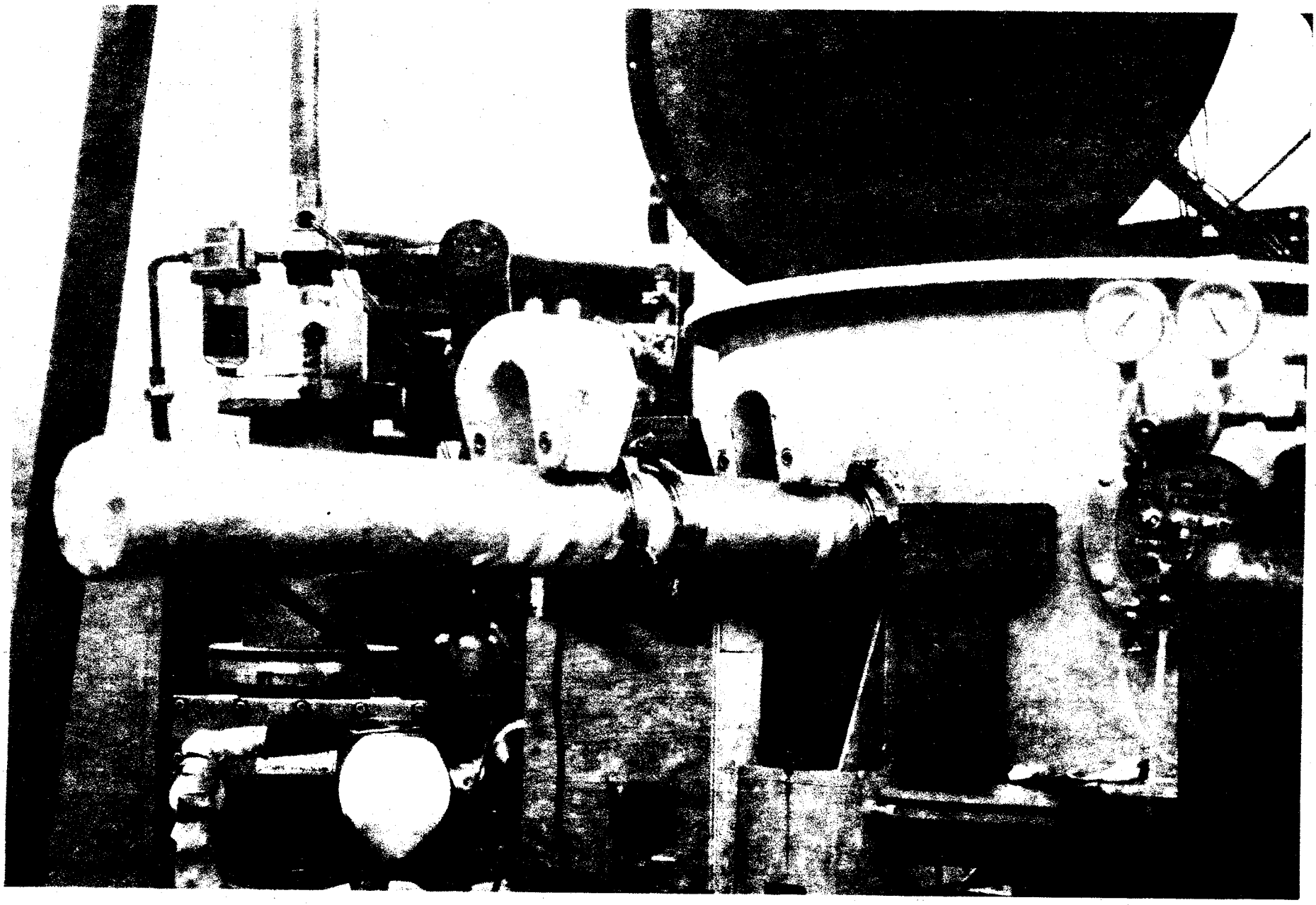


Figure 2.52 Faraday Cup Scattering Chamber and Gas Manifold

2.52 Faraday Cup Operation

The leakage resistance between the collecting cup and the case was greater than 100 meg ohms. The resistance between the case and ground was also greater than 100 meg ohms. The case and consequently the outer conductor of the co-ax were insulated from ground by the nylon section of beam pipe. The other end of the co-ax connected to the charge integrator in the data room where a ground is established by the electronics racks. Hence no D.C. ground loops are possible.

Beam current was collected with and without the magnets in place. The collected currents changed by about 7%. While this comparison was being made, current from the collector ring was monitored and was typically 4 to 6 per cent of the beam current. The collector ring current was opposite in sign to the beam current; that is, electrons were being collected. With both magnets in place a small current with the same sign as the beam was detected on the collector ring. This current was 0.7 per cent of the beam current and was probably due to broadening of the beam by the target. On the basis of these measurements, the efficiency of the charge collection was set at 0.993 ± 0.002.

2.53 Charge Integration Electronics and Calibration

An Ortec model 439 current digitizer was used in conjunction with an Ortec model 430 scaler to integrate the change collected on the faraday cup. A five volt mercury battery and a 30 meg ohm resistor were used as a current source for calibrating the digitizer. The battery voltage was measured using a standard cell and a potentiometer. The resistor was purchased with a guaranteed accuracy of 0.1%. The current digitizer input impedance is variable. It depends on the capacity of the cable connecting it with the faraday cup. The input is a virtual ground and does not make excursions away from ground greater than ±5 mv. This is why a battery voltage of 5 volts or greater must be used to calibrate the 439 if an accuracy of 0.1% absolute is to be achieved. The current source was connected directly on the digitizer input for one set of calibrations. The current source was then moved out to the experiment room and connected to the beam stop inside the faraday cup. The calibration did not change. In fact, the calibration of the 439 as supplied from Ortec was within 0.1% of the calibration we measured, so the manufacturer's settings were not changed.

The output of the 439 is a series of logic pulses. For the scale range used each logic pulse was output for

every 10^{-10} coulombs integrated. These logic pulses were fed into two Ortec 430 20 megacycle scalars. The two scalars were connected so that one was an overflow counter. The overflow scanner was slaved to the other scalar so that both could be cleared and started together.

The 439 also has an analog output which is proportional to the average current being integrated. This output was read on a meter at the cyclotron console and was used to monitor the beam while running. The current on the collector ring was also monitored at the console. The calibration of the 439 was periodically checked, but showed no change.

2.6 Scattered Particle Detection System

2.61 Collimating Units

The gas cell target is large in the sense of subtending a large solid angle as seen from the position of the detector and beam scatters from any portion of the gas or windows through which it passes. In general the only scattering of interest is that from a small region in the gas cell as shown in Figure 2.41 and again in Figure 2.61. Figure 2.61 also shows the rest of the collimating units. The side walls shield the detector from unwanted particles which originate anywhere in the plane of the beam and detector. Two baffle slits placed inside the side walls stop any particles which enter the front slit and would scatter once from side walls into the detector. The holes in these baffle slits are larger than the acceptance cone established by the front and rear slits and consequently do not enter into any geometrical properties of the collimating units. The side walls extended one inch beyond the front slit.
This reduced the amount of radiation incident on the slit and hence reduced slit scattering.

The dimensions of the collimating units were chosen (including slit openings) so that geometrical corrections to the cross section were less than 0.1% at any angle. Silverstein (Si 59) has an excellent article in which he discusses most

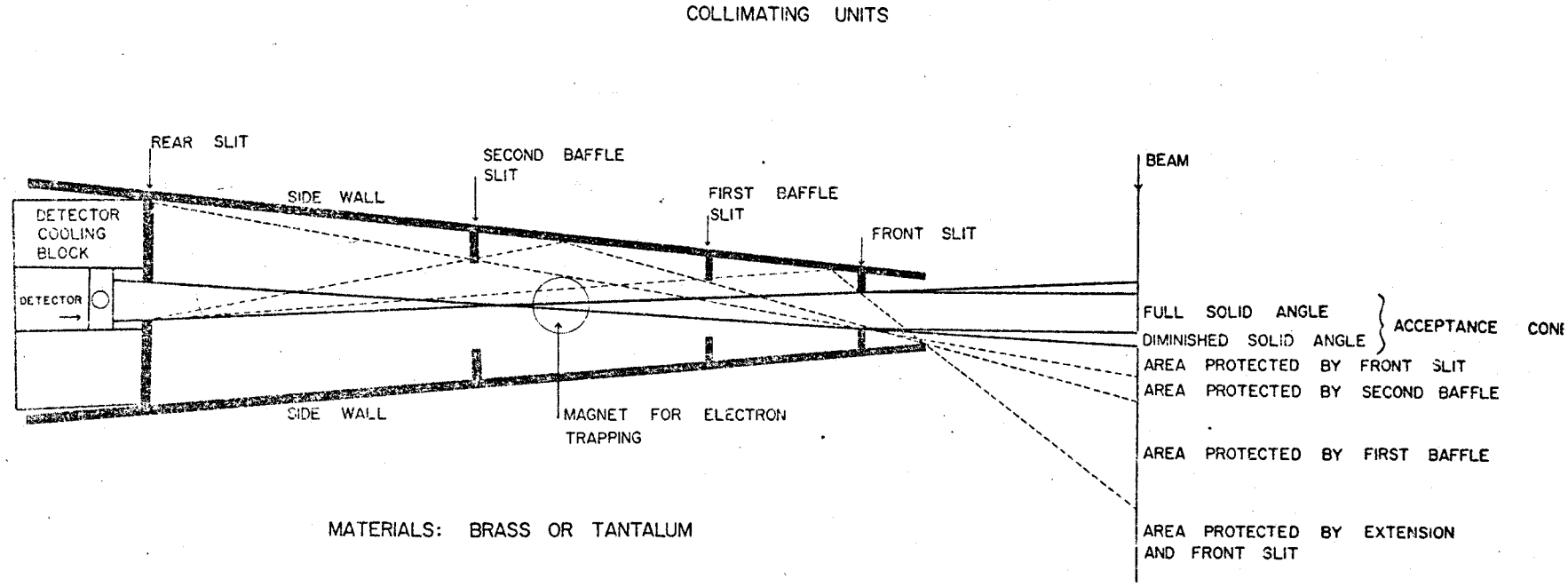

COLLIMATING UNITS
REAR SLIT
SECOND BAFFLE SLIT
FIRST BAFFLE SLIT
FRONT SLIT
SIDE WALL
DETECTOR COOLING BLOCK
DETECTOR
SIDE WALL
MAGNET FOR ELECTRON TRAPPING
MATERIALS: BRASS OR TANTALUM
BEAM
FULL SOLID ANGLE
DIMINISHED SOLID ANGLE
ACCEPTANCE CONE
AREA PROTECTED BY FRONT SLIT
AREA PROTECTED BY SECOND BAFFLE
AREA PROTECTED BY FIRST BAFFLE
AREA PROTECTED BY EXTENSION AND FRONT SLIT

Figure 2.61

of the geometrical considerations appropriate to a two slit collimating unit. The expressions appearing in his article were checked extensively by Dr. R. Atneosen of this laboratory and then Dr. R. A. Paddock wrote a program which embodies the entirety of the Silverstein calculations. The program name is "G-FACTOR".

The slit openings were approximately 0.125 inches wide and 0.255 inches wide in both slits. This width represents approximately 0.3 degrees of angular acceptance in the scattering plane. The kinematic broadening contribution to the energy resolution for this slit size was a maximum of 30 KeV. Even though the acceptance cone of the collimator had an opening of 0.7 degrees, approximately 80% of the total acceptance is contained in a smaller cone with an opening of approximately 0.3 degrees. That is, the acceptance, or differential solid angle, is not uniform across the acceptance cone. Figure 2.62 shows several examples of differential solid angles as a function of distance from the center of the gas cell.

In general a set of collimating slits gets "better" as the front slit is moved closer to the center of the gas cell, and the front slit opening gets smaller, the back slit is moved away from the gas cell, and its slit opening also gets smaller. The only undesirable effect of doing this is that the count rate decreases as the solid angle of the back

Yield = $\int d\theta \int d\theta' \, G(\theta) F(\theta, \theta')$

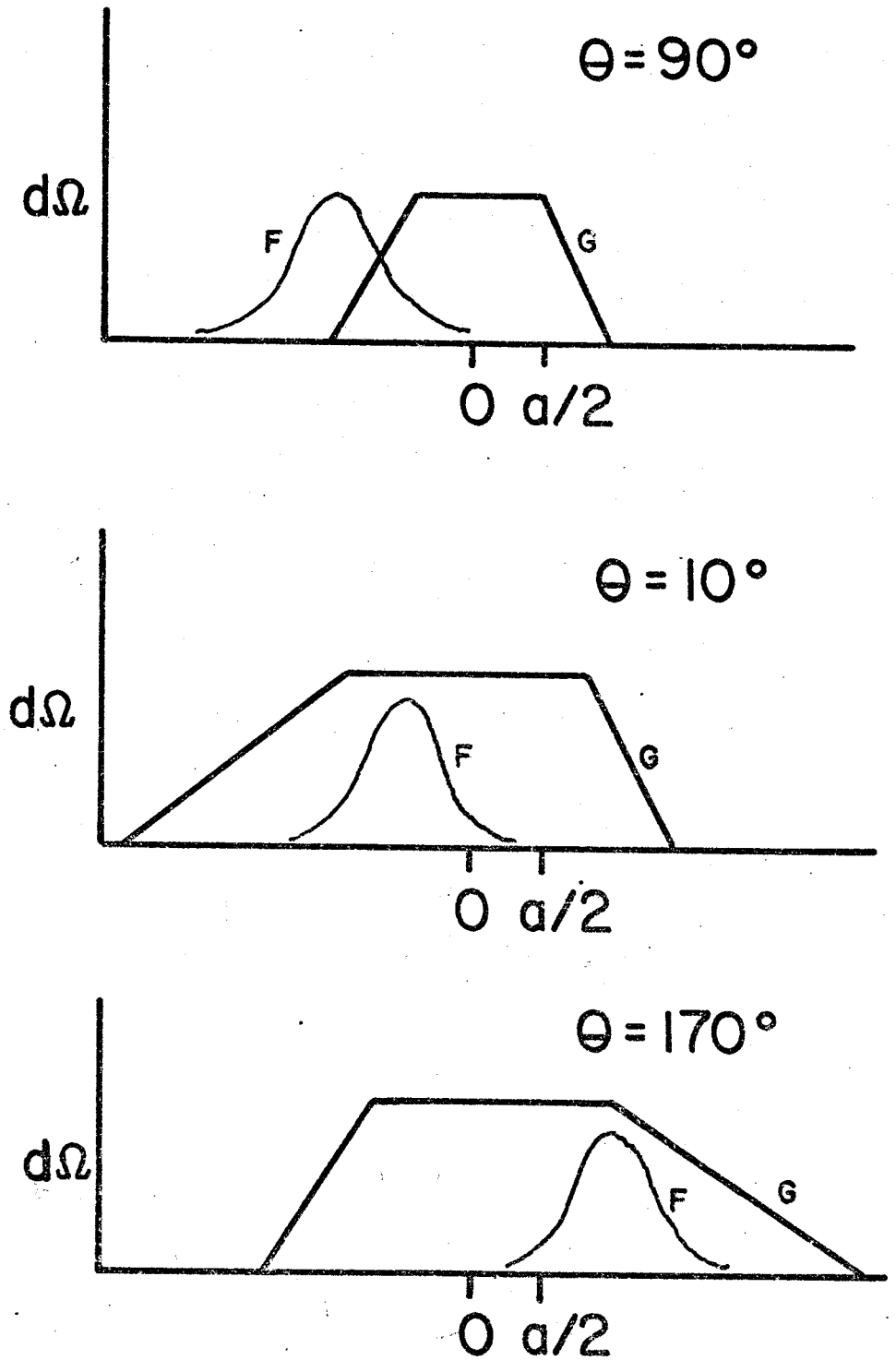


Figure 2.62 Differential solid angle as a function of distance from the center of Rotation

Figure 2.62a

Multiple Scattering Efficiency =

$$\int_{-\infty}^{+\infty} d\theta \int_{-\infty}^{+\infty} d\theta' \; e^{-\frac{(\theta - \theta')^2}{\theta^2_{rms}}} \; d\Omega(\theta')$$

considering the multiple scattering window at the beam or center of the cell.

Note that θrms for 0.5 mil Kapton is 0.16 deg.

$d\Omega(\theta')$ is trapezoidal as shown in Figure 2.62

Its full angular width is 0.7 degrees.

One expects that the multiple scattering efficiency will be different from 1 only because of the discontinuities of the trapezoid and hence is an effect appreciably less than one percent.

slit decreases. There is no reason why the front slit shouldn't be as close to the gas target as possible, except that for a fixed overall size of collimating unit, the closer it is placed to the center of rotation, the sooner the beam will strike the side walls as the unit is rotated towards zero degrees.

Figure 2.63 shows the output of "G-FACTOR" using the dimensions of the collimator used in this experiment. Silverstein's expression for cross section is

$$\frac{d\sigma}{d\Omega} = \frac{\sin\theta}{G_0}\left[1 + x + \frac{\sigma'}{\sigma}y + \frac{\sigma''}{\sigma}z\right]^{-1}\frac{N_p}{N_T N_B}$$

where x, y, z are complicated expressions involving dimensions and shapes of slits and the beam. σ' and σ'' are the first and second angular derivatives of the differential cross section. N_p, N_T, and N_B are defined in 2.1. The beam divergence of 0.4 degrees was neglected. In Figure 2.63 the calculated G is

$$G_0\left[1 + x + \frac{\sigma'}{\sigma}y + \frac{\sigma''}{\sigma}z\right]$$

and is shown for various angles, slopes, and curvatures. None of the data taken in this experiment showed $\frac{\sigma'}{\sigma}$ to be greater than 200. or $\frac{\sigma''}{\sigma}$ to be greater than 240. As a result no slope or curvature corrections were applied to the data.

Figure 2.64 is a picture of two collimating units with detector blocks in place. Also shown are the supports for

G-FACTORS FOR GAS CELL TARGETS.

GAS CELL GEOMETRY

DIST. FROM CENTER OF CELL TO REAR COLLIMATOR = 13.9400(+/- 0.0250) IN.
DIST. BETWEEN THE TWO COLLIMATORS = 10.0250(+/- 0.0050) IN.
FULL WIDTH OF FRONT SLIT = 0.1270(+/-0.0005) IN.

REAR COLLIMATOR(OBLONG)

WIDTH = 0.1215(+/- 0.0005) IN.
HEIGHT = 0.1755(+/- 0.0005) IN.

BEAM SPOT

DIAMETER = 0.1500 IN.

ZERO ORDER G-FACTOR = 4.19074E-05(+/- 0.6458 %)

ANGLE (DEG)	R1 = $\frac{\sigma'}{\sigma}$	R2 = $\frac{\sigma''}{\sigma}$	G-FACTOR (CM.)	% CHANGE
3.00	0.00000E+00	0.00000E+00	4.20966E-05	0.4515
4.00	0.00000E+00	0.00000E+00	4.20127E-05	0.2513
5.00	0.00000E+00	0.00000E+00	4.19738E-05	0.1585
6.00	0.00000E+00	0.00000E+00	4.19527E-05	0.1081
7.00	0.00000E+00	0.00000E+00	4.19400E-05	0.0777
8.00	0.00000E+00	0.00000E+00	4.19317E-05	0.0579
9.00	0.00000E+00	0.00000E+00	4.19260E-05	0.0443
10.00	0.00000E+00	0.00000E+00	4.19220E-05	0.0347
11.00	0.00000E+00	0.00000E+00	4.19190E-05	0.0276
12.00	0.00000E+00	0.00000E+00	4.19167E-05	0.0221
13.00	0.00000E+00	0.00000E+00	4.19149E-05	0.0179
14.00	0.00000E+00	0.00000E+00	4.19136E-05	0.0146
15.00	0.00000E+00	0.00000E+00	4.19124E-05	0.0119
20.00	0.00000E+00	0.00000E+00	4.19091E-05	0.0039
25.00	0.00000E+00	0.00000E+00	4.19075E-05	0.0002
30.00	0.00000E+00	0.00000E+00	4.19067E-05	0.0018
35.00	0.00000E+00	0.00000E+00	4.19062E-05	0.0030
40.00	0.00000E+00	0.00000E+00	4.19059E-05	0.0037
45.00	0.00000E+00	0.00000E+00	4.19057E-05	0.0042
50.00	0.00000E+00	0.00000E+00	4.19055E-05	0.0047
55.00	0.00000E+00	0.00000E+00	4.19054E-05	0.0050
60.00	0.00000E+00	0.00000E+00	4.19053E-05	0.0051
65.00	0.00000E+00	0.00000E+00	4.19052E-05	0.0053
70.00	0.00000E+00	0.00000E+00	4.19052E-05	0.0054
75.00	0.00000E+00	0.00000E+00	4.19051E-05	0.0055
80.00	0.00000E+00	0.00000E+00	4.19051E-05	0.0055
85.00	0.00000E+00	0.00000E+00	4.19051E-05	0.0055
90.00	0.00000E+00	0.00000E+00	4.19051E-05	0.0056
10.00	5.00000E+01	0.00000E+00	4.19392E-05	0.0757
10.00	7.50000E+01	0.00000E+00	4.19478E-05	0.0964
10.00	1.00000E+02	0.00000E+00	4.19564E-05	0.1168
10.00	1.25000E+02	0.00000E+00	4.19650E-05	0.1374
10.00	1.50000E+02	0.00000E+00	4.19736E-05	0.1580
10.00	1.75000E+02	0.00000E+00	4.19822E-05	0.1785
10.00	2.00000E+02	0.00000E+00	4.19908E-05	0.1990
10.00	0.00000E+00	5.00000E+01	4.19468E-05	0.0939
10.00	0.00000E+00	7.50000E+01	4.19592E-05	0.1235
10.00	0.00000E+00	1.00000E+02	4.19716E-05	0.1530
10.00	0.00000E+00	1.50000E+02	4.19963E-05	0.2121
10.00	1.00000E+02	1.00000E+02	4.20060E-05	0.2351

Figure 2.63 G-FACTOR Output

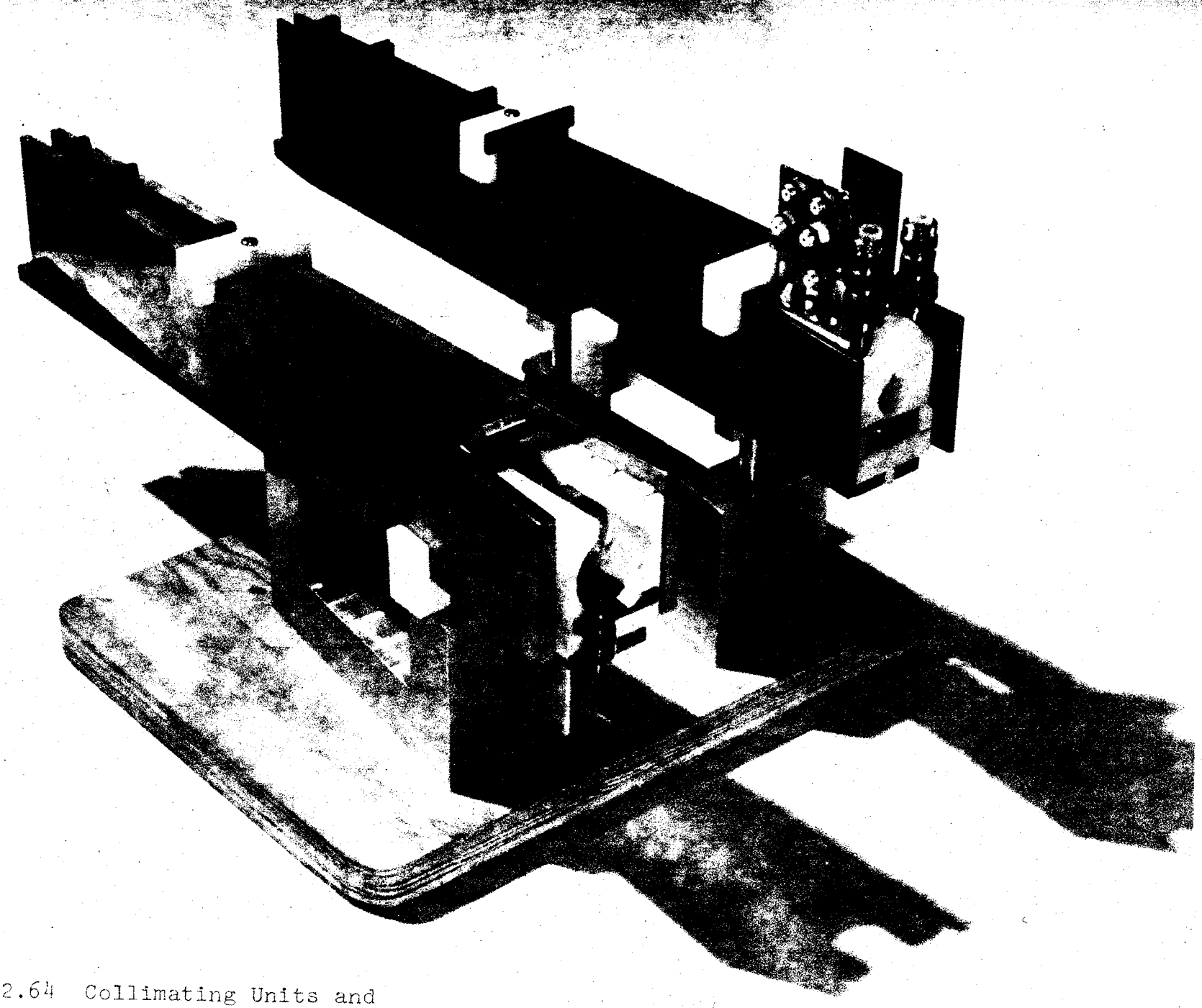


Figure 2.64 Collimating Units and
Detector Blocks

the collimating units. These supports were adjustable in height, aligned by dowels in the bottom, and had two steel tracks on which the collimators were assembled.

2.62 Detector Holder and Cooling Blocks

Figure 2.64 shows two types of detector holders in place in the collimating units. The holders were made of Delrin, a plastic used extensively in our beam lines. They had alignment ridges on the bottom which fit into the slot between the support tracks. The detectors were mounted in a circular hole in the plastic and held in place by plastic set screws. The cooling block was inserted into the plastic body below the detectors and was in contact with the case of the detectors.

Partial electrical shielding was provided by the collimator units themselves. Of the many styles tried, this configuration resulted in rapid cooling of detectors with low (20 pf) stray capacitance. The other designs used never achieved good cooling and low noise (capacitance) simultaneously. Much of this development work was done in co-operation with I. D. Proctor of this laboratory.

2.63 Dry Ice-Alcohol Cooling System

All detectors used in this experiment were cooled by a dry ice-alcohol system. The cooling blocks in the

detector holders were connected to Eastman poly flow tubing. These lines were run out of the scattering chamber through nylon insulated Eastman Kwik Disconnect fittings. The monitor counter and main detector were connected in series in the alcohol flow. Outside the scattering chamber, a pump circulated the cold alcohol.

Two pump designs were used; a mechanical piston type positive displacement pump, and a Bendix electric fuel pump (automobile type). Both worked well. The piston pump was made of teflon and nylon (piston and block respectively) and was submerged in the alcohol reservoir. It was driven by a 60 RPM motor via a piston rod. A complicated set of electrically activated valves was used to control the alcohol flow. The cooling tank was simply a stainless steel can with a 1/4 inch brass bottom. The heat exchanger was copper tubing that was soldered to the brass. The heating tank was a cylindrical brass pressure bomb with copper tubing inside for heat exchange. The laboratory hot water lines were connected to the bomb.

A simplified system was constructed later which used the Bendix pump. Since the fuel pump can run against a blank line, a simple "T" network was used with two electrically operated valves. This system was smaller and easier to insulate. Maintenance was also more practical. The electric fuel pump was powered by a small 12 volt supply.

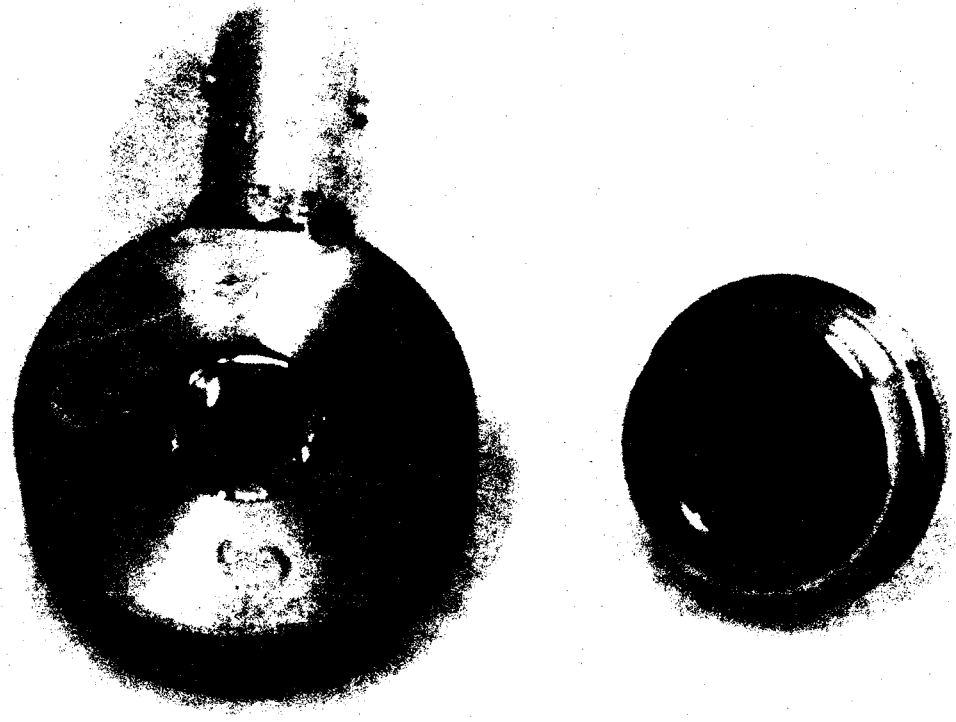
The filter elements were removed from the pump before use.

2.64 Silicon Surface Barrier Detector Fabrication

Several 3 mm blanks were cut from 55,000 ohm-cm, n-type silicon. The blanks were 1/2 inches square. These blanks were hand lapped and etched using a mixture of acids. The etched blank was then epoxied into a ceramic disc. The epoxy used preserved the n-type of the silicon surface. A guard ring of epoxy which changed the silicon surface in contact with it to p-type was applied to the front surface. The front surface was then oxidized in boiling de-ionized water for 45 minutes. A thin layer of gold was evaporated onto this freshly oxidized front surface. The back was then re-lapped and aluminum coated by evaporation. Dr. C. Gruhn advised me on the construction of these detectors. A more complete fabrication procedure is found in Appendix C. Construction of thick silicon surface barrier detectors is discussed in E. D. Klema's article (Kl 64).

Figure 2.65 shows the 3.2 mm silicon detector used in this experiment. Also shown is a 3.0 mm Lithium drifted silicon commercial Kevex detector. The 3.2 mm si detector was fully depleted at 650 volts as seen by detecting α-particles through the back of the detector, and was measured to have an intrinsic resolution of 25 KeV for 20 MeV

Figure 2.65 Detectors



M. S. U.
3.2 mm Silicon
Surface Barrier

Kevix 3 mm
Li Drifted Silicon
Surface Barrier

deuterons. When cooled, the detector could be biased up to 1200 V with no measurable (<.1 na) leakage current and no change in resolution.

2.65 EΔE Configuration Electronics

Figure 2.66 shows a block diagram of the complete EΔE electronic configuration. Two detectors are employed, and particles which are counted must stop in the second detector after having passed through the first. Different types of particles with the same total energy will leave different amounts of energy in the first detector. They then can thus be separated on the basis of their different specific ionization.

To provide a signal proportional to the total energy, charge from both detectors, D1, and D2, was collected in an ORTEC 109a charge sensitive preamp (P3). The charge from each detector was also measured separately by two more preamps (P1, P2). The resistor R across the input of the total charge permits the summing of charge in each detector and thus obtain a pulse in (P3) proportional to the total energy.

The preamp voltage pulses are fed to Ortec 440 selectable Active Filter (S1) Amplifiers. The prompt output is set to bipolar and sent to a Timing Single Analyzer, Ortec 420 (TSC), the delayed output is made unipolar and

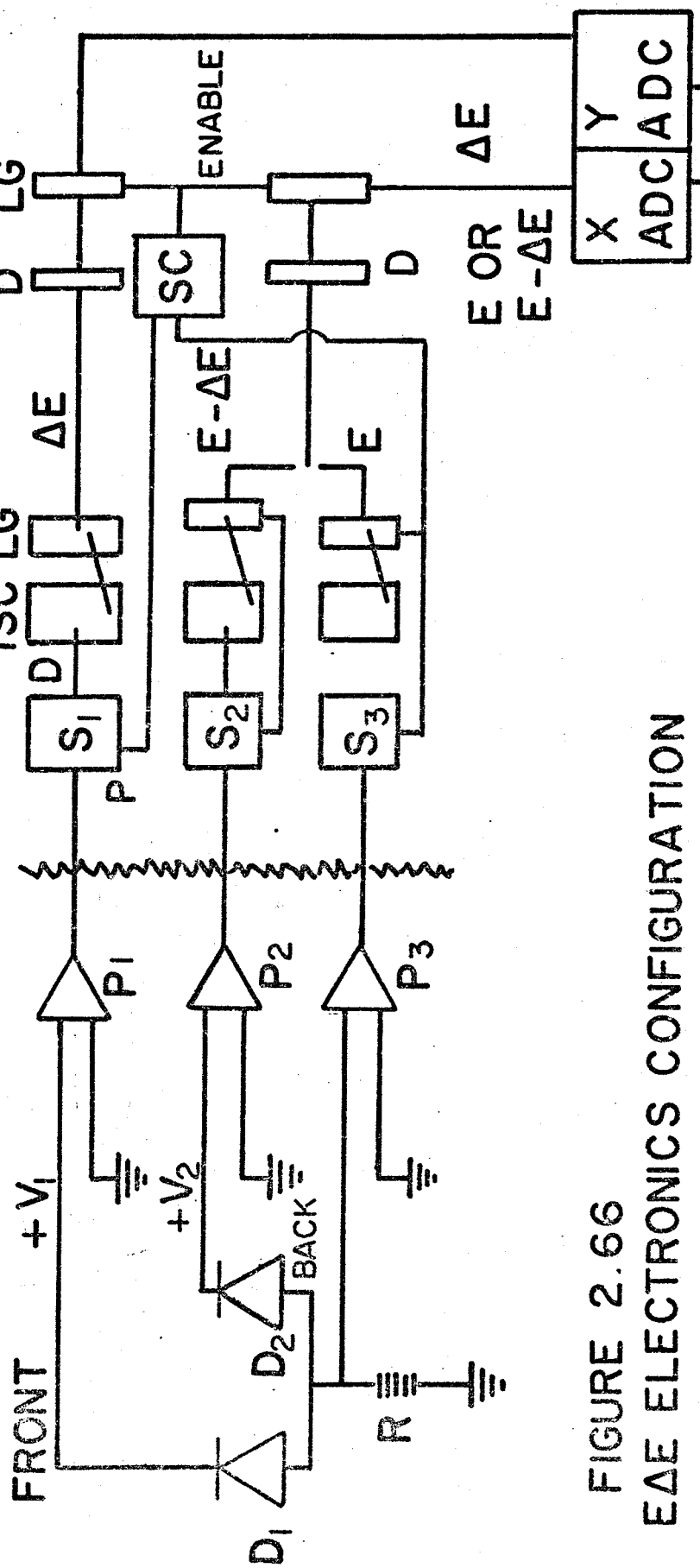


FIGURE 2.66
EΔE ELECTRONICS CONFIGURATION

sent to an Ortec 442 linear gate. If the bipolar pulse is within a set window, a logic enable pulse is sent to the linear gate and the unipolar signal is passed. This same logic pulse is sent to an Ortec 409 Slow Co-incidence module for both E and ΔE channels. If there is a co-incidence, two linear gates are opened and the E and ΔE unipolar pulses are sent to the Northern 629 ADC's. The shaping time for best resolution was 0.5 ns.

Since the 2D data routine "TOOTSIE" was available, some simplification of the typical EΔE configurations was possible. Normally the product of ΔE and E is formed and adjusted until a pulse is achieved which has a constant height for a particular type of particle, independent of energy. Then a window is set and only one particle type is collected.

In our case it is sufficient to insure that ΔE and E are in co-incidence and present them to the X and Y ADC's. The 2D display that results has bands corresponding to all the various particle types and energies which yield both an E and a ΔE pulse. The bands are not straight, but the program allows the operator to select any area of the 2D display and produce a spectrum of up to 4028 channels in the X-axis. Five such bands may be picked. Two bands can be seen in Figure 2.67 which is a photograph of the 2D scope display. The large dots which are placed by switch control

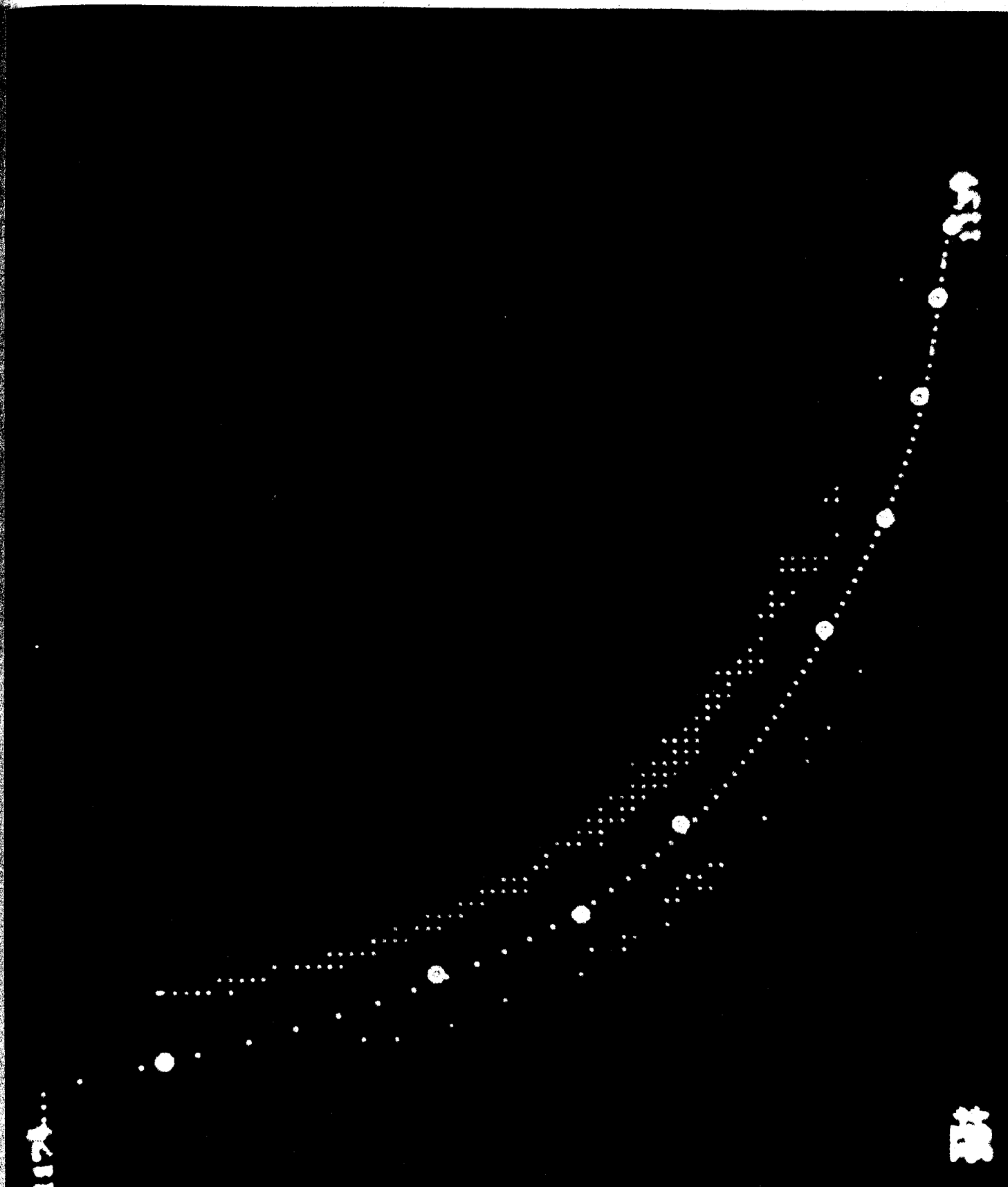


Figure 2.67 2D Display

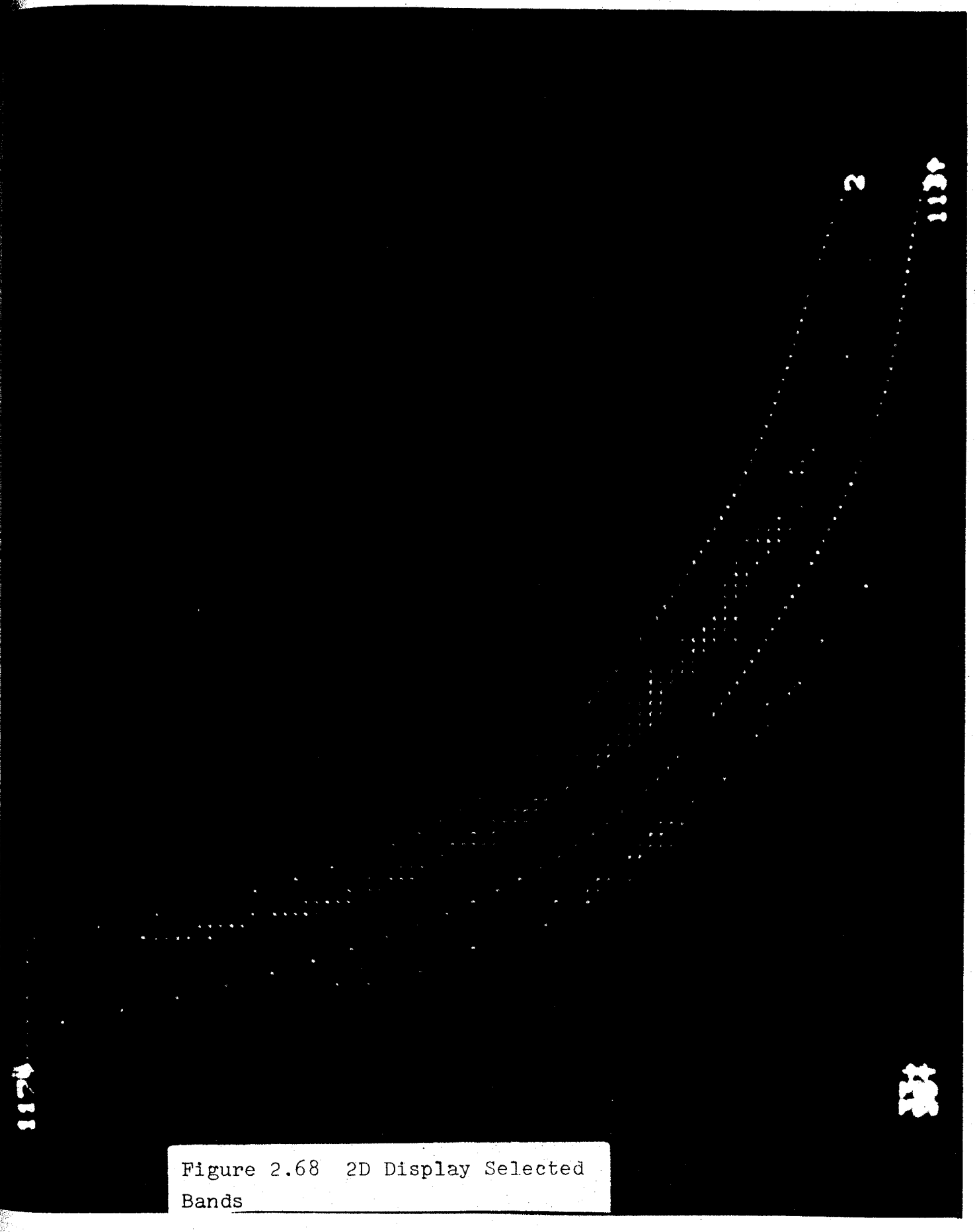


Figure 2.68 2D Display Selected Bands

and the dotted line forms one boundary of the band; it is a polynomial fit to the large dots. Figure 2.68 shows the same two bands, but now two dotted lines have been accepted by the computer. The computer will then sum all the counts within each pair of lines vertically and output spectra.

2.66 ET Configuration Electronics.

The electronics for the time of flight particle identification is shown in Figure 2.69. A single detector and preamp are used. The detector (D) charge pulse passes through the inductive pickoff of the Ortec 260 Time Pick Off (TPO) and into the preamp(P). A very sharp negative pulse is then sent to the Ortec 403A Time Pick Off Control (CU) when the slope of the charge pulse from the detector is great enough to produce an induced voltage pulse larger than the discriminator setting. This fast logic pulse is then sent through the Ortec 417 Fast Discriminator (FD) to the start of the Ortec 437A Time to Pulse Converter.

The stop pulse originates from an Ortec Zero Crossing Discriminator (ZCD) which is activated by a sine wave signal from the cyclotron dee. The stop pulse could be delayed by the Ortec 425 Nano Second Delay (NSD). The output of the TPHC, which has a pulse height proportional to (T - t) where T is an arbitrary constant less than 50 ns and t is the particle flight time from the target to detector, is fed to the Y ADC.

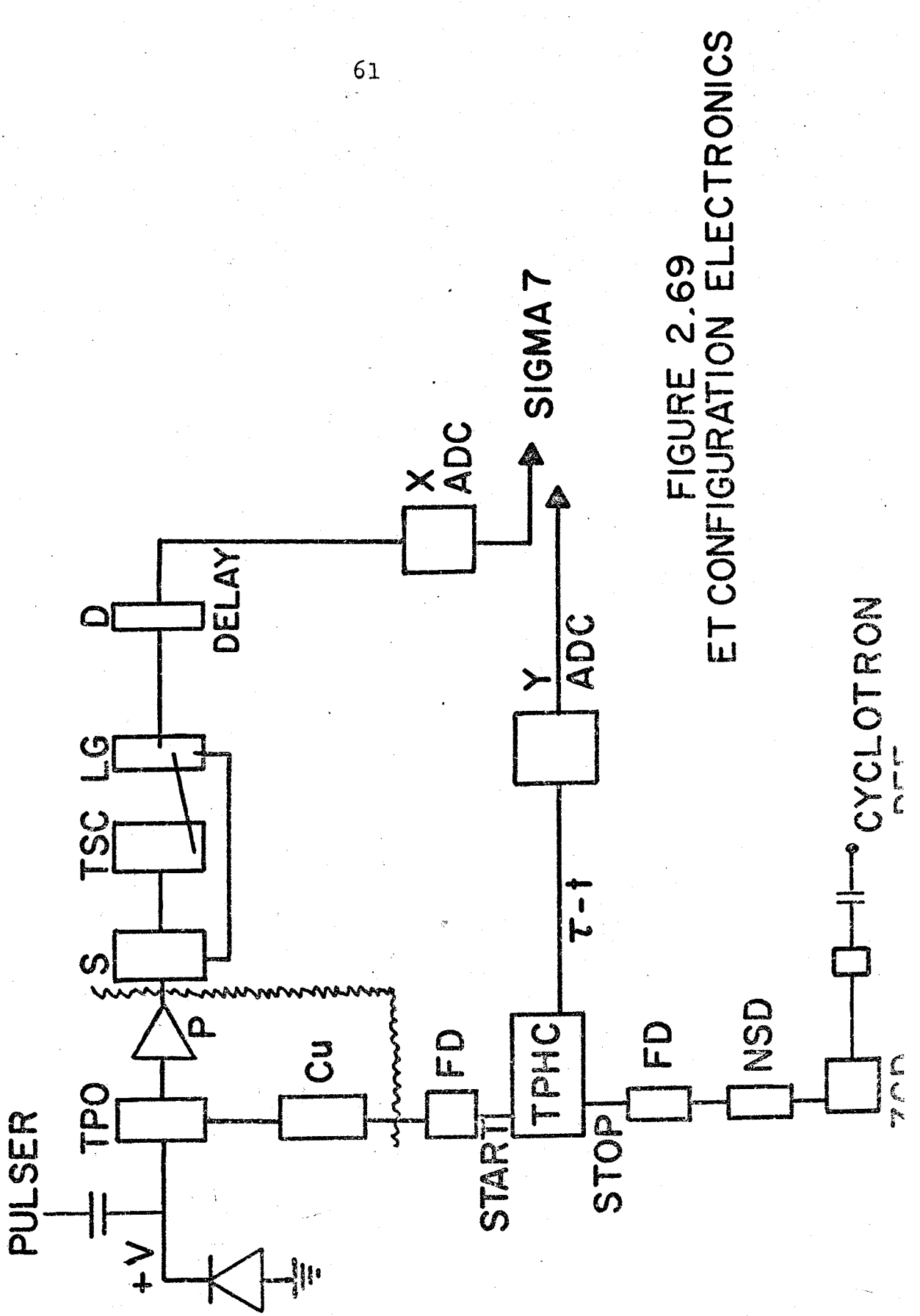


FIGURE 2.69
ET CONFIGURATION ELECTRONICS

The energy signal is passed through the same electronics as described before and delayed, then fed to the X ADC.

An Ortec pulser and charge terminator was used to inject a charge pulse into the system, so that the T pulse and the E pulse could be brought into coincidence at the ADC's. There were no external coincidence requirements on E and T, therefore an E pulse without a T would appear on the X-axis and T pulse without an E pulse would appear on the Y-axis. This was an invaluable diagnostic aid in monitoring the performance of the timing circuit.

2.7 Time of Flight Particle Identification (TOF)

2.71 Methods of Use and Evaluation

When in use the TOF system shown in Figure 2.69 was very reliable. Individual modules were found to be as reliable as the charge sensitive preamps. As mentioned in 2.45, the time resolution of the beam was no problem, and in addition there seemed to be no phase shifts in time even for the minor alterations needed to retune the cyclotron. Retuning was infrequent if the cyclotron centering was correct.

T pulses and E pulses were collected into the 2D array of "TOOTSIE". Then bands were set and spectra collected. In this case however, a pair, E and T, was not required to store in the 2D. In this way the timing circuits could be monitored and the TOF efficiency measured. If counts appear on the time axis, then the TP0 is triggering on noise or E pulses rejected at the TSC. Occasionally one of the Fast Discriminators would become defective and would break into oscillation causing a flood of T pulses.

Figure 2.71 is a section of the 2D 256 x 64 array. The vertical direction is (T - t) with a resolution of about 0.2 ns per row. The horizontal direction is energy. The four bands corresponding from top to bottom to protons, deuterons, tritons and 3He's, and alphas can be seen. The

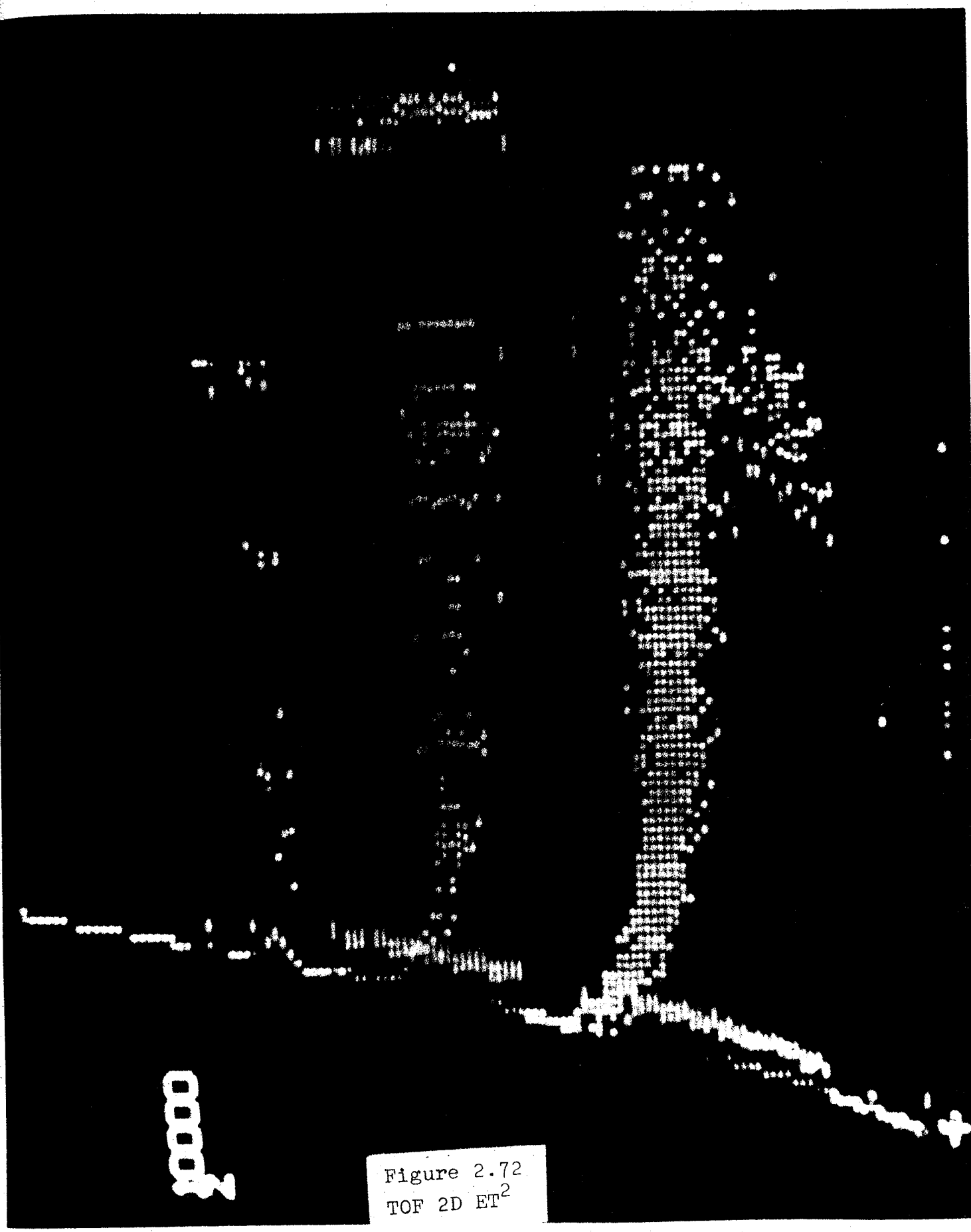


Figure 2.72
TOF 2D ET^2

Figure 2.71

TOF 2D ET

figure was made on the Sigma 7 line printer with zeros surpressed. Note that the particle identification is excellent as there are mostly zero counts in between bands. The over all timing (or mass) resolution is about 0.6 ns.

Slit scattering can be seen extending horizontally back from the elastic deuteron group near the "mass 2" label. There is also some indication of events caused by excitation of the detector nuclei, in the slit scattering band. It is particularly easy to interpret counts which appear at any location in this type of 2D display because the two axes are flight time and energy. There is a slight 0.2 ns shift in time for various peak centroids in the mass 3 band. This is a result of the difference in ionization density for 3He's and tritons in the detector.

The data displayed was taken with the M. S. U. 3.2 mm surface barrier detector. The target was ^{14}N, beam energy 20 MeV, and scattering angle 40 degrees. The lowest energy shown (left) is about 3 MeV. The spectra of the four bands are shown in Figure 2.73, plotted on a 3 cycle logrithmic scale. There is no discernable "leakage" from one spectrum into another, again reflecting the high degree of particle selection. These spectra have an energy resolution of about 50 KeV. This data was taken using the 3.2 mm detector fabricated in this laboratory. Figure 2.72 shows a display of ET^2 vs. E. The multiplication was performed in the computer. Data was not taken in this mode because the dead time is approximately 180 μs.

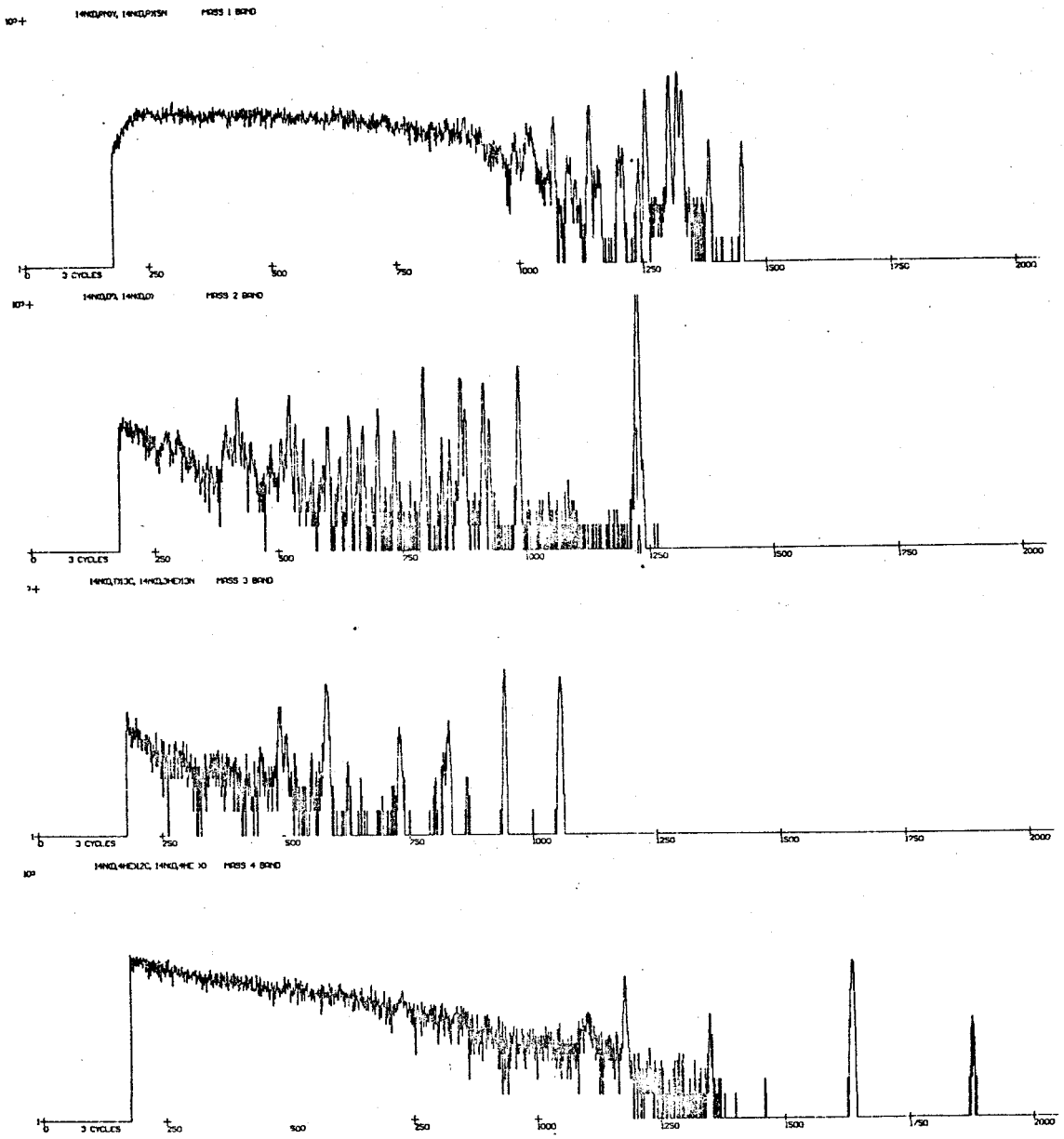


Figure 2.73

Complete Spectra

^{14}N (D,X)

2.72 System Efficiency Measurement

The TOF system does "miss" events. An E pulse can be generated without a T pulse, particularly at the lower energies. The principal contribution to this effect is noise. Since the time pick off is a slope sensitive device, random noise pulses with appreciable slopes but short duration could trigger the TPO.

The timing efficiency curves for various detectors are shown in Figure 2.74. These curves were generated from the 2D displays. The total number of events at each energy was obtained by summing in the t direction. The number of events at this energy on the axis was then divided by the summed total to obtain the probability of missing an event as a function of energy. The efficiency curves improve as one goes to detectors with smaller rise time, and smaller stray capacitance. The worst detector configuration consisted of two stacked 2 mm Ortec silicon surface barrier detectors. The best was the 3.2 mm silicon surface barrier detector made for this experiment. These efficiency curves represent the best obtained for each detector. They are considerably degraded by noise, ie, all the curves shown became much worse when the light was left on in the scattering chamber.

The systematics of TOF efficiency as a function of the RC product for the detector was worked out in cooperation with R. H. Howell of this laboratory.

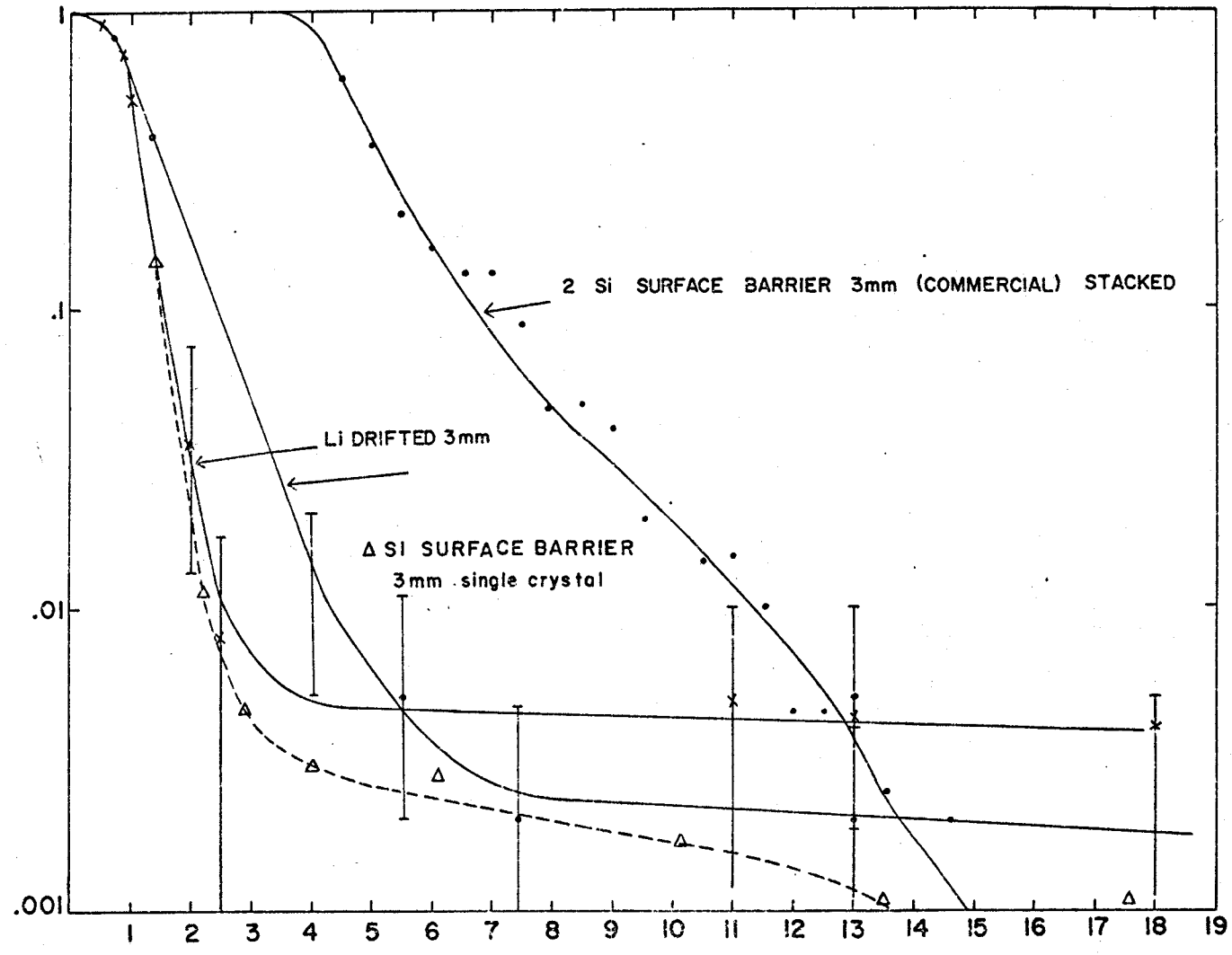

1
.1
.01
.001
2 Si SURFACE BARRIER 3mm (COMMERCIAL) STACKED
Li DRIFTED 3mm
Δ SI SURFACE BARRIER
3mm single crystal
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
EVENT ENERGY in MeV

Figure 2.74

2.73 Comparison of TOF and EΔE Cross Sections

The $^{14}N(d,d)$ elastic cross section was measured using the EΔE configuration and again using the ET electronics on a different day. On both occasions the beam energy was set at 20.58 MeV and the cm scattering angle at 78.07 degrees. The EΔE result was 1.215 mb/sr ± 0.014 mb/sr. The ET result was 1.226 mb/sr ± 0.015 mb/sr.

The two results agree to better than 1%, showing the consistency of the methods. This exercise was also a very good test of the reproducibility of the cross section measurements.

2.8 Relative Merits of TOF and EΔE Systems for Particle Identification

We have shown that for energies greater than 10 MeV, the two systems of particle identification yield the same cross section and hence are equivalent in the primary sense.

There are however many differences between the two systems. The number and type of electronics modules are different. The number and type of detectors are different. The skills learned in EΔE work are not applicable to fast timing work and probably accounts for the infrequent use of TOF.

TOF does not separate triton's and 3He's where EΔE does. TOF is best performed with one thick detector which may not exist for the energy range of interest. If two detectors are employed, EΔE will separate only those particles which leave some energy in both detectors whereas TOF will perform mass identification on all particles with energy greater than some low value (≈2 MeV). There are experiments where two detectors are a major drawback; for example, whenever the particle energy is to be measured accurately. There is always some dead layer on the back of the front detector. The energy lost in this region is not collected and introduces an energy non-linearity which is difficult to calculate or measure.

TOF does not have the same efficiency for all energies whereas EΔE does. This fact disturbs many people, but the efficiency is easily measured if one wishes to use TOF.

There also seems to be a feeling on the part of many that using fast timing electronics is touchy and difficult. This was probably true at one time, but I have not found this to be so in the present experiment. Credit must of course be given to the superb time structure of the cyclotron beam. The combination of narrow (0.3 ns) phase width and excellent phase stability, which is characteristic of the M. S. U. cyclotron, is probably not available at many laboratories. Phase widths of greater than 1.2 ns make TOF impractical for our 36" scattering chamber.

2.9 Monitor Counter

The monitor counter electronics is shown in Figure 2.91. In this experiment the monitor counter was used exclusively as a random pulse generator whose rate is proportional to the beam intensity. Large variations in count rates occur and these variations must be considered in measuring dead time.

A logic pulse generated for each monitor event is sent to both a 20 MH_Z scalar and to the Northern Four Parameter Adapter. While either an E or a T pulse is being processed (40 ns), the Northern Adapter will not pass the monitor pulse. If neither an E or a T pulse is being processed, the monitor pulse will be passed and the channel zero register in the computer will be incremented by one. One can then compare the monitor scalar value to that accumulated in channel zero. That difference is then the number of monitor events which occured while the ADC's were busy. The number of events collected by the ADC's were then multiplied by the ratio of the monitor scalar events to channel zero events. Over 20,000 monitor events were recorded for each spectrum.

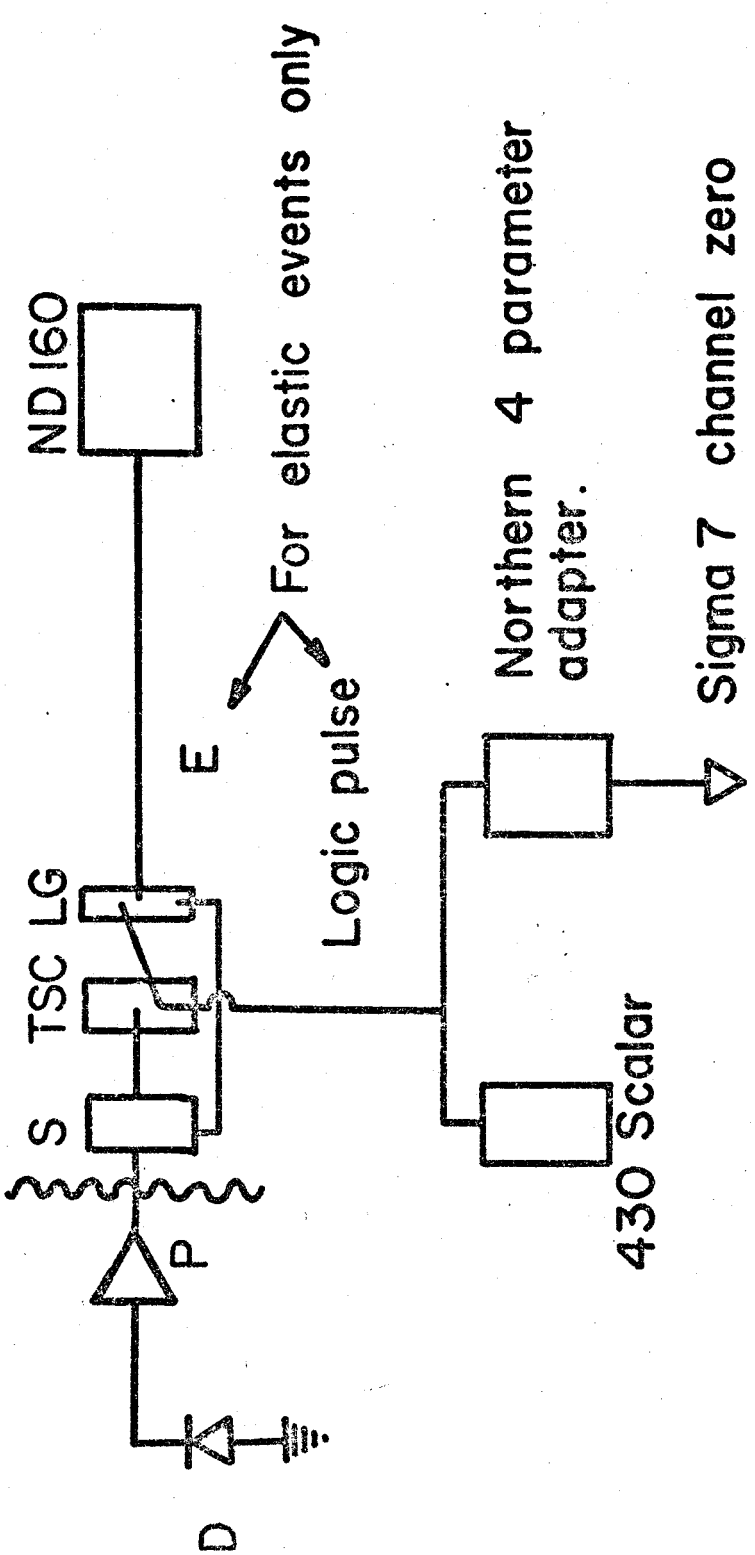


Figure 2.9 Monitor Counter and Dead Time Electronics

3. DATA COLLECTION, REDUCTION, AND ERRORS

3.1 Data Collection Method

Following the accumulation of some data into the 2D mode, the particle selecting bands were set. The beam was dumped on a valve near the cyclotron, the monitor scalar, channel zero, and the current integrator scalar were set to zero. The angle and temperature were read by remote T. V. and noted. The light in the scattering chamber was switched off and the T. V. turned to read the pressure. The initial pressure was noted, "TOOTSIE" put in the "run" mode and erased, and the valve opened to initiate the collection of spectra. When the elastic peak contained more than 10,000 counts, the valve was shut, the spectra dumped onto cards, line printer, and plotter simultaneously. The monitor scalar, channel zero, and integrator scalar were recorded, together with the final pressure and temperature. In addition the pressure was monitored during the data collection. Pile up was kept small by observing the E pulses on the oscilliscope and adjusting the beam current downward in intensity until no pulses were observed to be closer in time than 20 μs.

The beam energy was obtained from the NMR readings on M3 and M4, the analyzing magnets. The absolute error in the beam energy is obtained from a calibration procedure

involving the Enge spectrograph and known Q values for various reactions. This is discussed most completely in G. F. Trentleman's Ph. D. thesis (Tr 70). This work is also published in another article (Tr 70a).

3.2 Reduction Method: Program Picklepeak

The spectra obtained were reduced to differential cross sections and state excitation energies using the program Picklepeak. This program processed peaks automatically on the basis of the state energy and width. Background was measured at preset energy regions and then subtracted automatically. The input and output was arranged so that each angle, with its four spectra could be processed separately from cards with the output onto cards, line printer or tape. There was, however, also the option of changing a few control cards and re-processing any or all parts of the data in a tape to tape mode.

This option was used several times. Ideas for improvement or extra calculations were easy to implement and apply to the data, in whole or in part. The output to tape allows one to punch or print only what is absolutely necessary, thus reducing the expense of updating the calculations on 5000 peaks.

The input to program Picklepeak for each angle was:

1. Four 2048 "crunch" spectra
2. Charge in 10^{-10} coulombs and per cent error
3. Faraday cup normalization and per cent error
4. Temperature in degrees C. and error in degrees C.
5. Initial Pressure in inches of Hg

6. Final Pressure in inches of Hg
7. Gas cell diameter in inches
8. Scattering angle and error in degrees
9. G(θ) the g factor and its error in per cent
10. Beam energy in MeV and error in MeV
11. Detector efficiency factor and error in per cent
12. Monitor scalar
13. Channel zero
14. Masses in amu of target, projectile, and product particles for all spectra
15. Q values in MeV for all reactions to be processed.
16. Five lists of excitation energies and widths in MeV for which differential cross sections are desired (Read once only)
17. Default energy widths in MeV for each reaction
18. Energy positions and widths to be used in measuring background automatically for each band (spectra)
19. Approximate centroids of two peaks used to establish the absolute energy scales (up to 5 pairs)
20. The Q value and excitation energy in MeV of the calibration peaks.

21. (Optional) Background vs. channel number (9 pairs)--with override of automatic background subtraction
22. Any of the special purpose control cards
    a. total cross section
    b. $\frac{d\sigma}{d\Omega dE}$
    c. reactions
    d. peak strip cards
    e. automatic peak search (statistical criterion)

Internal input:

1. Complete energy loss tables for gas and kapton.
2. TOF system efficiency factor as a function of energy and error in per cent.

Subroutines:

KTQ and Kine, written by P. J. Plauger, are relativistic kinematics codes and were used as subroutines for Picklepeak.

The output of Picklepeak was prolific. 90 states per angle for 52 angles were processed to angular distributions of differential cross sections and total cross sections in the lab and center of mass. All appropriate efficiency factors and errors were applied to every piece of data. The excitation energies for all 90 states were computed.

The error in these energies was set at less than 15 KeV by comparing the distribution of the calculated energies to the known energies for some of the states. Energies and errors are found in Appendix A and B.

The expressions used in Picklepeak for calculating the differential cross section and the total error are shown in Figures 3.21 and 3.22 respectively. The output tape, which held results grouped by angle, was input to program Schuffle which produced an output tape, grouped by states, and ordered in each group by angle. That is, each group was some type of angular distribution. This output tape was then converted to cards by groups and plotted using the program Dataplot, written by D. S. Sosnoski of this laboratory. These Calcomp plots were used directly as complete figures in this thesis. Table 3.21 shows summary of errors.

Table 3.21 Summary of Errors and Efficiencies

Source	Adjustment or Efficiency	Percent Error max	min
Statistical and Background	1	30.0	0.9
Geometrical	1	0.64	0.64
Multiple Scattering	1	0.1	0.01
Faraday Cup	0.993	0.3	0.2
Charge Integration	1	0.1	0.1
Target Gas Partial Pressure	0.98 → 1	0.7	0.4
Temperature	1	0.01	0.01
Detector	0.995	0.5	0.5
Beam Energy (depends on pressure and cell diameter)	1		40 KeV
Angle	0.04 deg	.1 deg	.05 deg
Slope and Curvature	1	0.01	0.01
Time-of-Flight	0.99 → 1	1.0	0.1
Dead Time	1.5 → 1	0.5	0.01
Pile Up	1	0	0
Linear			2.49
Quadratic			1.3

$$\frac{d\sigma}{d\Omega} = \frac{10 \times SAREA \times (T + 273.16) \times Monscal \times B \times F \times \sin(THL)}{CHZERO \times CHRG \times G \times P}$$

$$B = \frac{1.602 \times 8.317 \times 29.921}{2.000 \times 1.0133 \times 6.02486}$$

$$F = FDE \times FCH \times FTOF$$

where SAREA is the number of true events in the peak

T is the temperature in degrees centigrade

Monscal is the number of events recorded by the monitor scalar

CHZERO is the number of events recorded by channel zero

THL is the Lab angle in degrees

CHRG is the beam charge collected in 10^{-10} coulombs

G is the g factor

P is the average partial pressure of the target gas

FDE is the detector efficiency

FCH is the faraday cup efficiency

FTOF is the Time of Flight efficiency

Figure 3.21 Reduction Formula

$$SIGERR = \frac{SIG \times ERSUM2}{100.0}$$

$$ERSUM2 = SQRT\left[\begin{array}{l} GERR^2 + CHRGERR^2 + PERR^2 + SINERP^2 + \\ FCHERR^2 + FDEERR^2\ TOFERR^2 + \\ AERRP^2 + TERRP^2 + DTERR^2 \end{array}\right]$$

$$SINERP = \frac{3.1416 \times THLERR \times 100.0}{Tan\ (THL) \times 180.0}$$

$$PERR = (\text{Measured Pressure error}) \times \frac{0.02}{P} \times 100.0 + 10.0\frac{(PRAW-PZERO)}{P}$$

$$DTERR = DT/SQRT(CHZERO)$$

$$AERRP = \frac{100.0 \times SQRT(SAREA1 + ACOR + AERR^2)}{SAREA}$$

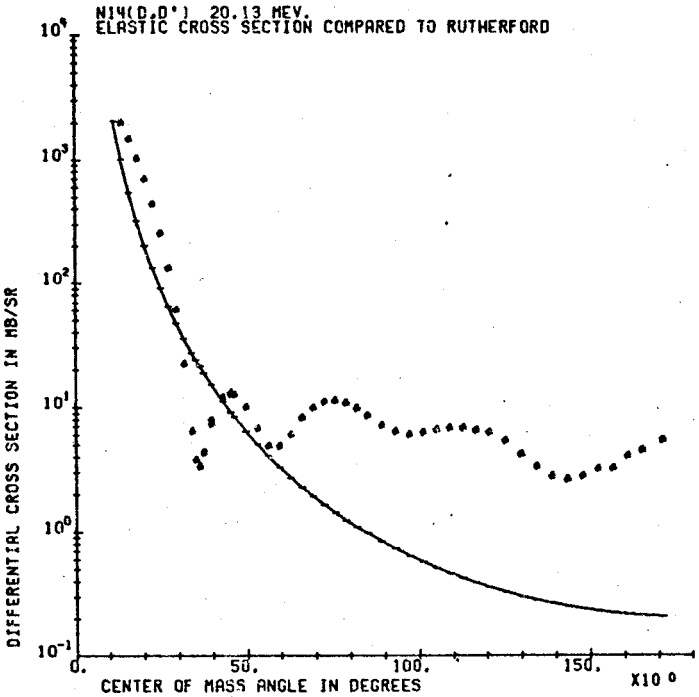
Figure 3.22 Reduction Errors

4. $^{14}N(d,d)$ ELASTIC SCATTERING

4.1 Introduction and Angular Distribution

There were two reasons why deuteron optical potentials were of interest; 1. to determine if more accurate deuteron optical potentials would affect the DWBA analysis of the $^{15}N(p,d)^{14}N$ reactions, and 2. to determine how well, and over what angular region, "standard" Wood-Saxon type optical potentials actually reproduce accurate deuteron elastic scattering data. As mentioned in the introduction, we were not able to find suitable data in the literature. This is the reason why this accurate elastic cross section measurement was undertaken.

The deuteron elastic angular distribution from ^{14}N at 20.13 MeV is shown in Figure 4.11. Also shown is the rutherford cross section. As can be seen, the principal features of the angular distribution are the very steep ascent of the cross section towards forward angles (two orders of magnitude in 10 degrees), and the extremely large back angle scattering (28 times the rutherford cross section).



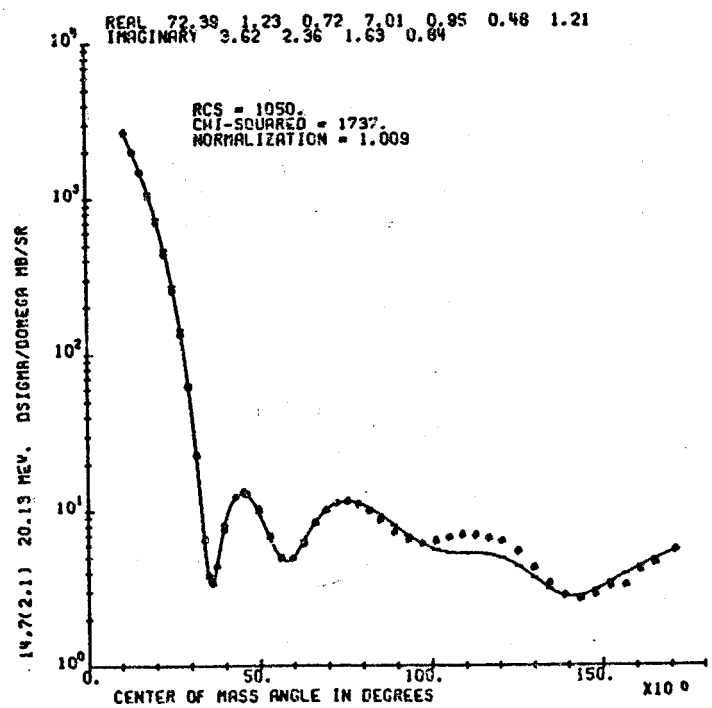


Figure 4.11 ^{14}N(d,d) Data Plus Rutherford and Data Plus Best Fit

4.2 Optical Fitting with Snoopy--Accuracy

The program used to generate the optical fits was Snoopy Two written by P. Schwandt. The M. S. U. copy of this program was updated in June 1970 from information supplied by Schwandt.

The form of the optical potentials available in Snoopy Two are as follows:

$$U(r) = U_c(r) - V(1 + e^{x})^{-1} - iW_s(1 + e^{x'})^{-1} + 4iW_D(d/dx')(1 + ex')^{-1} + U_{so}(r)$$

where $U_c(r) = Zze^2/2R_c[3 - (r/R_c)^2]$, $r \leq R_c \equiv r_c A^{1/3}$

$= Zze^2/r$, $r \geq R_c$

$$U_{so}(r) = 2V_{so}\frac{1}{r}(d/dr)(1 + e^{x''})^{-1}\vec{L}\cdot\vec{\sigma}$$

$$x = (r - r_o A^{1/3})/a_o$$

$$x' = (r - r_w A^{1/3})/a_w$$

$$x'' = (r - r_{so} A^{1/3})/a_{so}$$

For spin S = 1, two real tensor spin-orbit coupling terms are included:

$$U_{TR}(r) = -V_{TR} f(r, r_{TR}, a_{TR})[(\vec{S}\cdot\vec{r})^2/r^2 - 2/3]$$

$$U_{TL}(r) = -V_{TL} f(r, r_{TL}, a_{TL})[(\vec{L}\cdot\vec{S})^2 + (\vec{L}\cdot\vec{S})/2 - 2\vec{L}^2/3]$$

with the following shape factor options:

1. $f(x) = e^{-x^2}$
2. $f(x) = 4(d/dx)\ (1 + e^{x})^{-1}$
3. $f(x) = r(d/dr)\ [\frac{1}{r}(d/dr)\ (1 + e^{x})^{-1}$
4. $f(x)$ is inputted as function of r,
   where $x \equiv (r - r_T A^{1/3})a_T$.

In the first of these tensor couplings, U_{TR}, the matrix elements off-diagonal in L are ignored.

An excellent description of the calculations and search procedures performed by Snoopy Two, including the description of input parameters and general operation of the code is contained in the publication by Schwandt (Sc 69). The code was checked in three ways:

1. Various potential parameter sets were used by Schwandt at Indiana on their computer to calculate $^{14}N(D,D)$ at 20.13 MeV. His results were sent to us and compared with identical calculations on the Sigma 7 using our version of the code. Schwandt's results were reproduced exactly.

2. Identical deuteron parameters were used in calculations using Julie, the DWBA code from ORNL (BA 62), and Snoopy Two and the two codes were forced to compute with the same values of L_{max}, the highest orbital angular momentum partial wave. Several values of L_{max} between 8 to 16 were used. The cross sections were calculated at identical angles and agreed to better than one per cent.

3. A set of deuteron parameters was chosen as a starting point. Snoopy was allowed to search until CHI-SQUARED was minimized. The two parameters, AMPEN and CBHEX, which control matching and integration procedures in Snoopy Two, were changed and searching process repeated. The minimum CHI-SQUARED achieved was plotted as a function of CBHEX with AMPEN fixed by the value of CBHEX. The results are shown in Figure 4.21 where it is seen that CHI-SQUARED descends sharply to a long plateau region. The code must be operated in this region to be accurate. For this work CBHEX was taken as 10^{-3}.

The definition of CHI-SQUARED in Snoopy Two as used for the elastic scattering is:

$$\text{CHI-SQUARED} \equiv \sum_{i=1}^{N} \left[\frac{(\sigma_i \text{calc} - \sigma_i \text{exp})}{\Delta\sigma_i \text{exp}} \right]^2$$

Our version of Snoopy was also modified by myself and D. Sosnoski for various types of punch output to make it compatible with the Dataplot program.

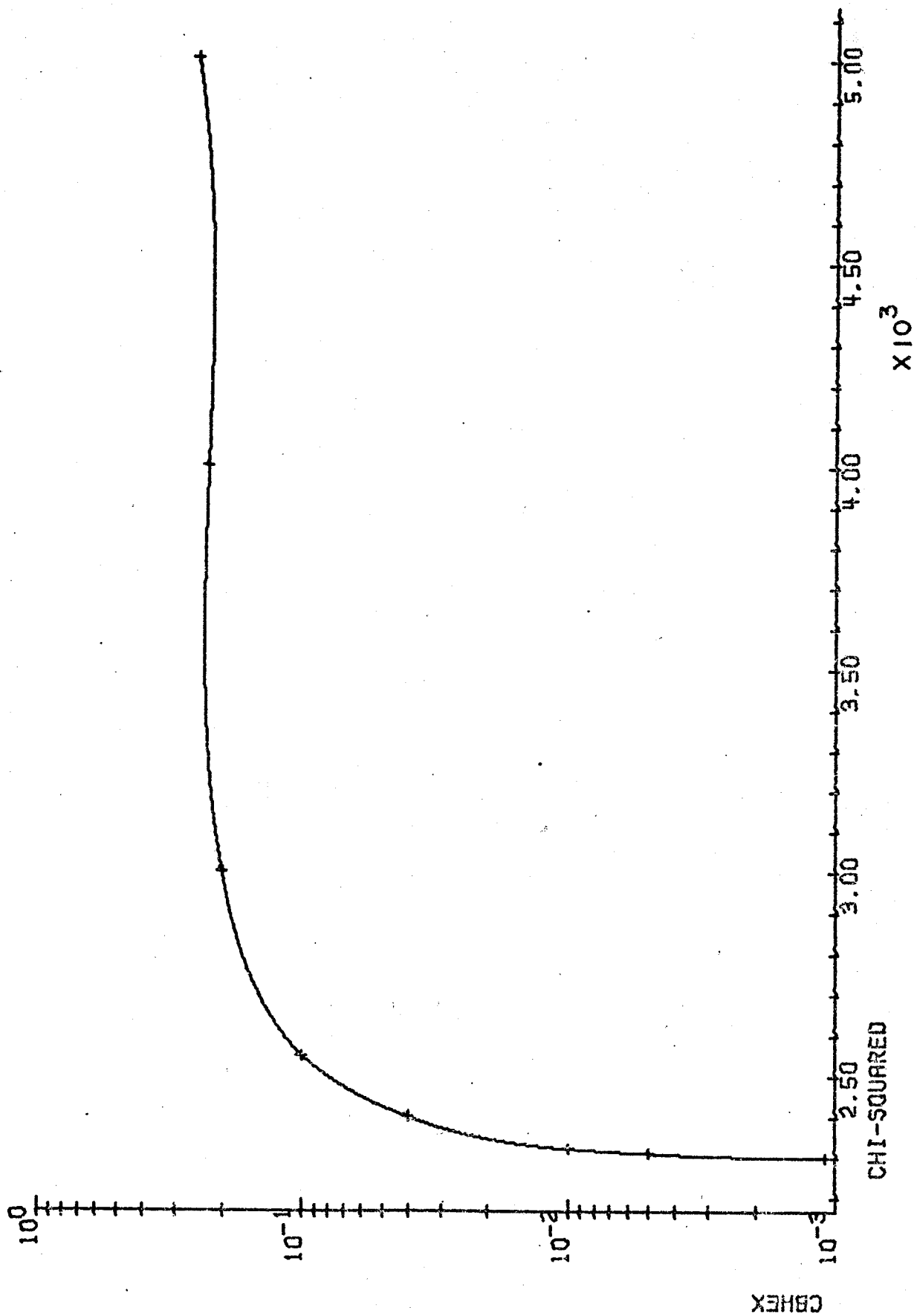


Figure 4.21 Matching Accuracy for SNOOPY TWO

4.3 Discussion of Results

As can be seen in Figures 4.31 and 4.32 a number of different sets of potential parameters give fits with CHI-SQUARED's of about 2000. This number is the total CHI-SQUARED. The average CHI-SQUARED per point is obtained by dividing the total CHI-SQUARED by 52.

A total CHI-SQUARED of 1750 is the lowest we have been able to achieve. This corresponds to an average CHI-SQUARED per point of 34. In an overall way the fits are reasonable. However, whenever the two peaks around 80 deg. and 120 deg. begin to be fit in the correct ratio, the fit becomes too large near the top of the peak at 20 deg. When the forward angle data is fit very well, the two back angle peaks at 80 and 120 degrees are fit poorly. Some parameter sets were found that reproduced the observed shoulder near 160° and had approximately the proper ratio of heights near 80 and 120 deg., but the phase of the oscillation near 140 degrees and the height near 20 degrees was considerably off. The feeling one develops is that the standard potentials being used to fit the data are not quite right.

Initially an attempt was made to fit this deuteron data using zero volume absorbtion and five of the best sets of parameters are shown in Figure 4.31. Considerable improvement in X^2 was achieved by allowing a large volume

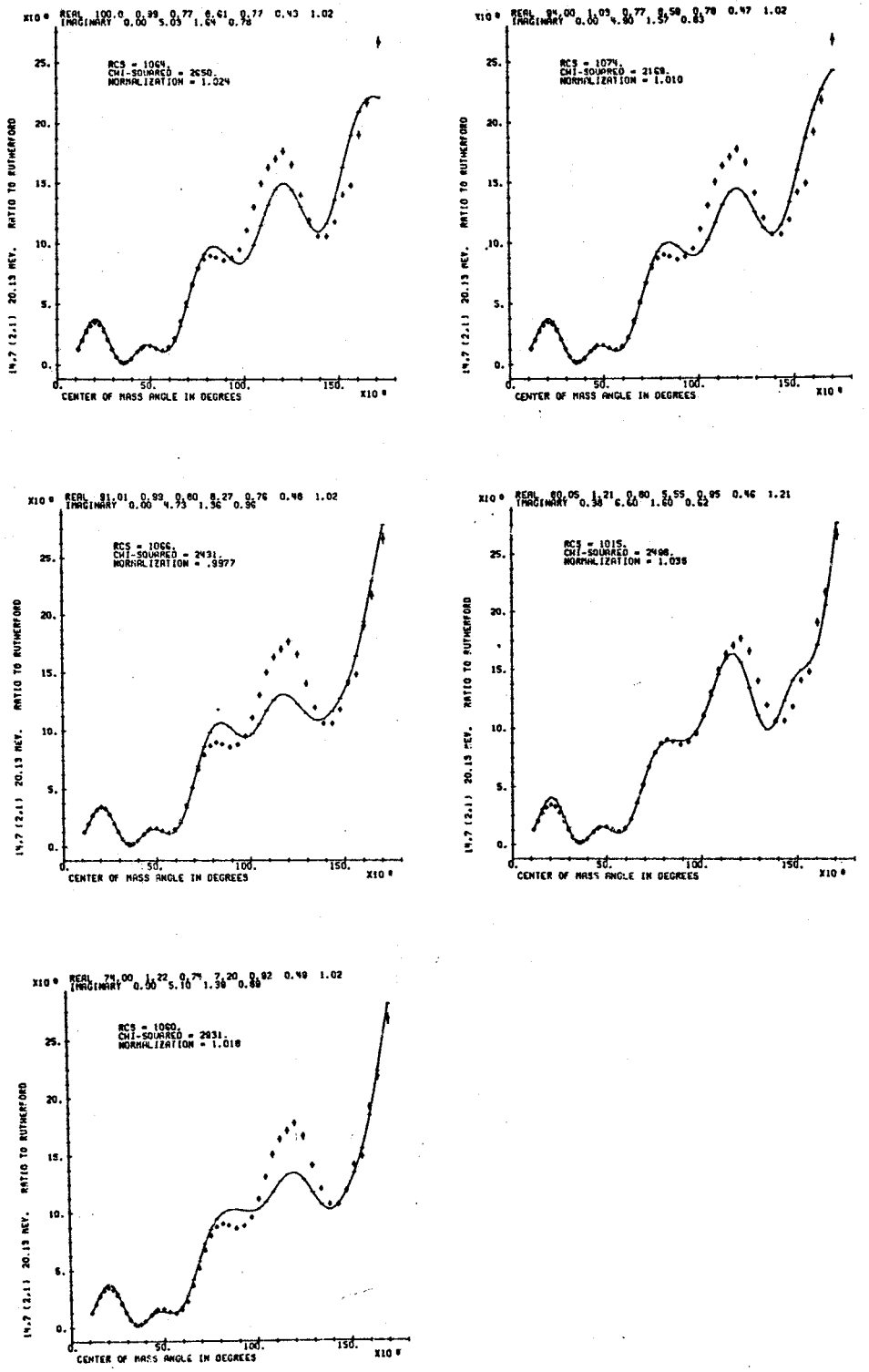


Figure 4.31 $^{14}N(d,d)$ Optical Model Fits (small W_s)

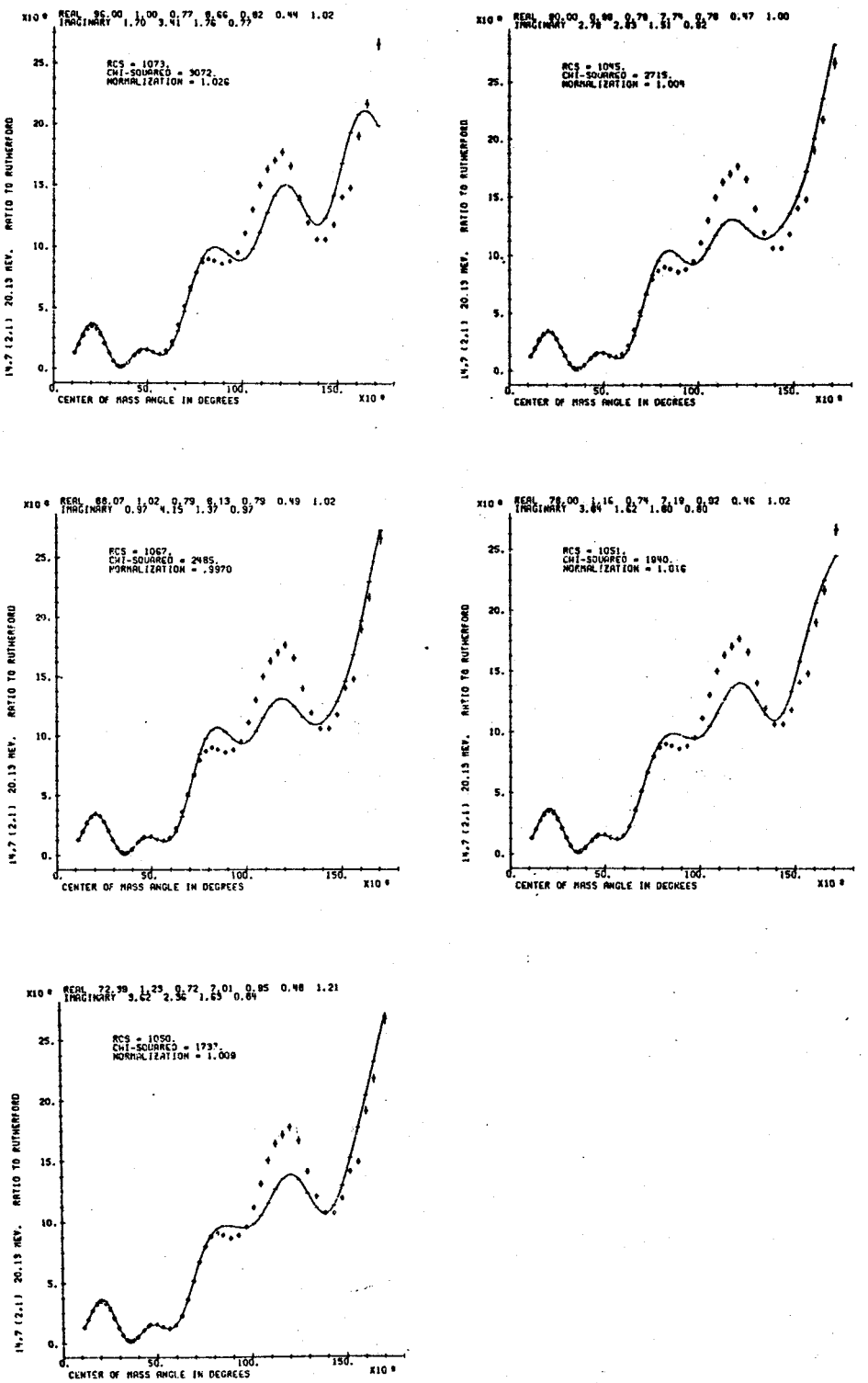


Figure 4.32 $^{14}N(d,d)$ Optical Model Fits (large W_s)

absorbtion and reducing the surface absorbtion. The implications of this are unclear. Five of this type of parameter set are shown in Figure 4.32. The order of the parameters shown is

V RO AO VSO RSO ASO

WS WD RW AW

No Tensor potential terms were available in our code.

Clearly the deuteron, being so loosely bound, will interact to some degree with nuclei as two separate particles. Attempts to handle the deuteron scattering problem in this way have been made by many authors (Jo 70, Ra 67, Di 65, Ce 62, Ce 65, Be 65, Gi 66). The goal set in this work was to analyze the accurate deuteron data as carefully as possible using a well established code which treats the deuteron as a single entity. Having completed this and not being completely satisfied with the fits, we feel it probably is necessary to re-formulate deuteron scattering theory. Rawitscher (Ra 67) and Testoni (Te 66) discuss the contribution of the deuteron break-up to the optical potential. No publicly available codes exist at this time for performing deuteron elastic scattering calculations which explicitly account for the loosely bound structure of the deuteron.

Table 4.31 is a summary of the ten potentials shown in Figures 4.31 and 4.32.

TABLE 4.31 SUMMARY OF OPTICAL POTENTIALS

RCS = TOTAL REACTION CROSS SECTION
NORM = NORMALIZATION

V	RO	AO	WS	WD	RW	AW	VSO	RSO	ASO	RC	RCS	NORM	CHI-SQ
72.30	1.23	0.72	3.62	2.36	1.63	0.84	7.01	0.95	0.48	1.21	1050.0	1.0090	1737.0
78.00	1.16	0.74	3.84	1.62	1.80	0.80	7.19	0.92	0.46	1.02	1051.0	1.0160	1940.0
88.07	1.02	0.79	0.97	4.15	1.37	0.97	8.13	0.79	0.49	1.02	1067.0	0.9970	2485.0
90.00	0.99	0.79	2.78	2.83	1.51	0.92	7.74	0.78	0.47	1.00	1045.0	1.0040	2715.0
96.00	1.00	0.77	1.70	3.41	1.76	0.77	8.66	0.82	0.44	1.02	1073.0	1.0260	3072.0
94.00	1.03	0.77	0.00	4.90	1.57	0.83	8.59	0.78	0.47	1.02	1074.0	1.0100	2169.0
91.01	0.99	0.80	0.00	4.73	1.36	0.96	8.27	0.76	0.48	1.02	1066.0	0.9977	2431.0
80.05	1.21	0.80	0.38	6.60	1.60	0.62	8.55	0.95	0.46	1.21	1015.0	1.0380	2498.0
100.00	0.99	0.77	0.00	5.03	1.64	0.78	8.61	0.77	0.43	1.02	1064.0	1.0240	2650.0
74.00	1.32	0.74	0.00	5.10	1.39	0.89	7.20	0.92	0.49	1.02	1060.0	1.0180	2931.0

4.4 Total Reaction Cross Section

Total reaction cross sections for the following seven reactions have been measured in this experiment.

1.	$^{14}N(D,D')$	75.8 ± 14 mb	Ex < 15 MeV
2.	$^{14}N(D,T)$	14.8 ± 1.2 mb	Ex < 18 MeV
3.	$^{14}N(D,3He)$	17.5 ± 1.3 mb	Ex < 8 MeV
4.	$^{14}N(D,\alpha)$	15.0 ± 2.4 mb	Ex < 14 MeV
5.	$^{14}N(D,\alpha Y)X$	193.8 ± 6.4 mb	E > 3 MeV
6.	$^{14}N(D,PN)$	546.3 ± 15 mb	E > 3 MeV
7.	$^{14}N(D,P)$	49.6 ± 6.0 mb	E < 10 MeV

The seven angular distributions used to calculate these numbers are shown in Figure 4.41. The sum of the above reaction cross sections is approximately 910 mb. This measured reaction cross section is about 10% lower than the reaction cross section calculated by Snoopy. As can be seen in Figures 4.31 and 4.32 the reaction cross section is about 1 barn, as calculated for all the parameter sets. The reaction cross section is not proportional to the imaginary volume integral.

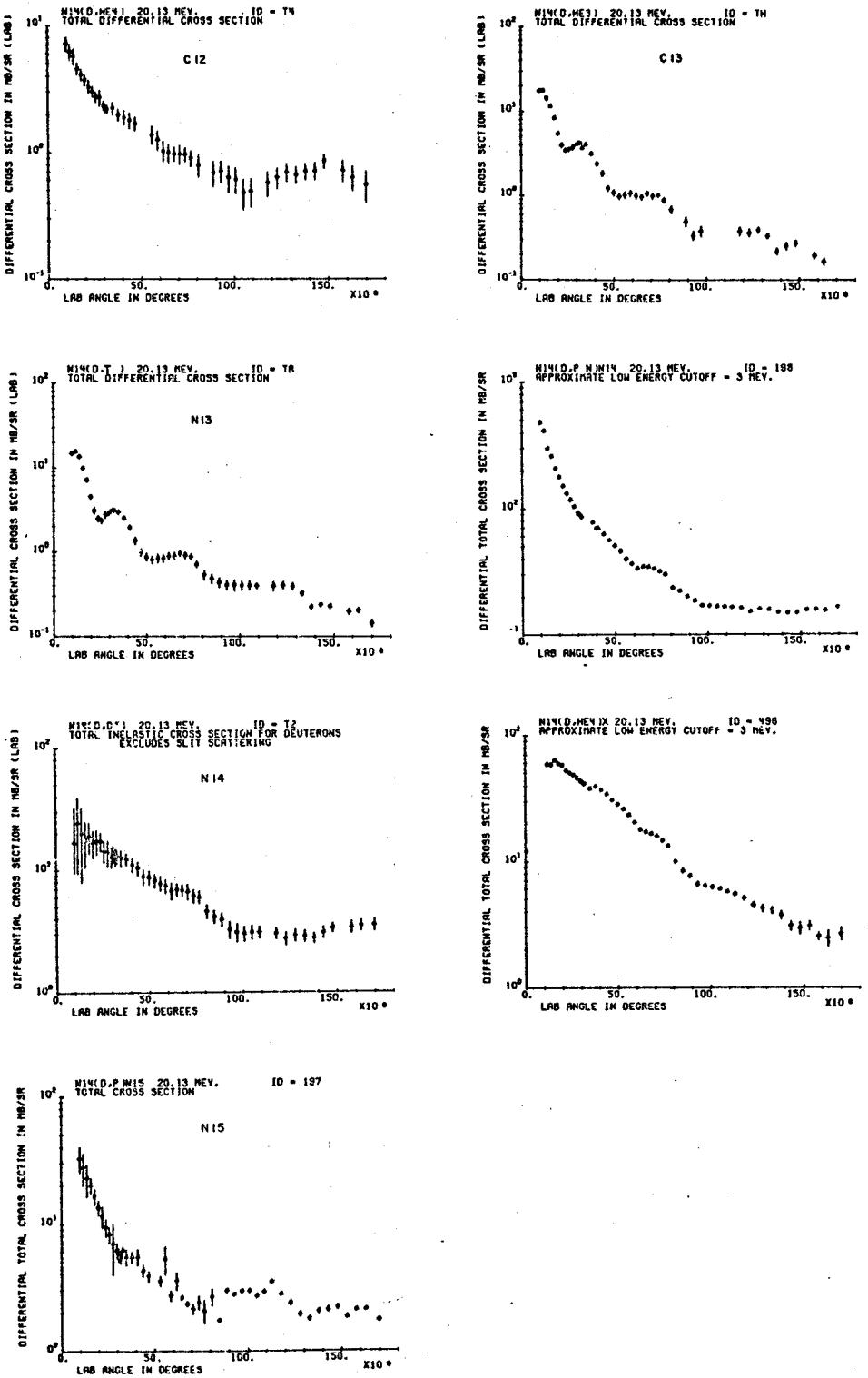
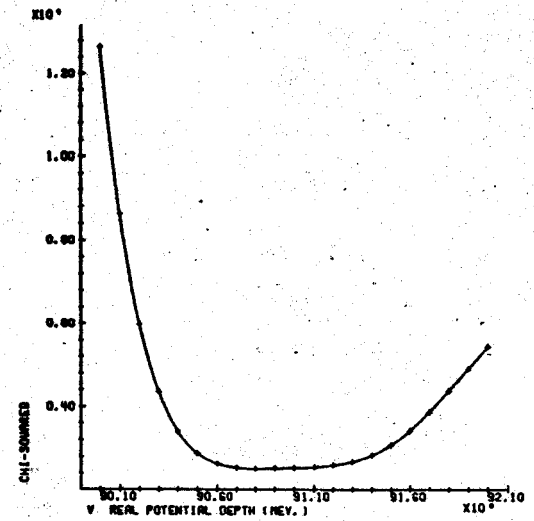


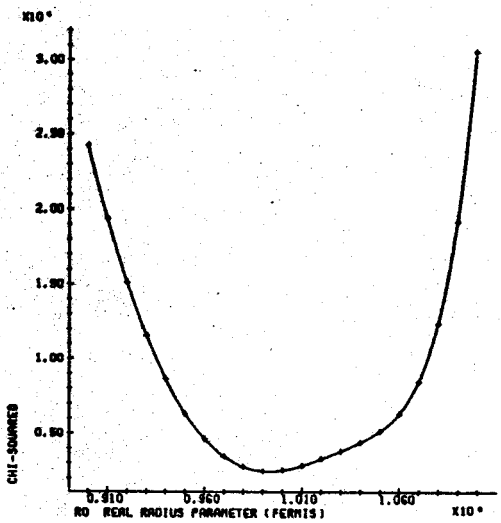
Figure 4.41 Total Cross Section
For Each Reaction Product

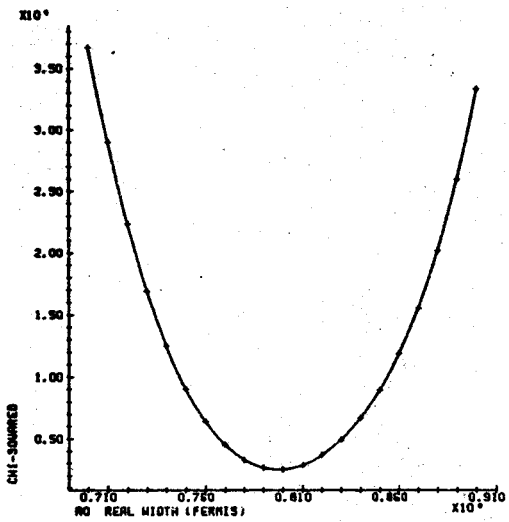
4.5 Shape of X^2 Space

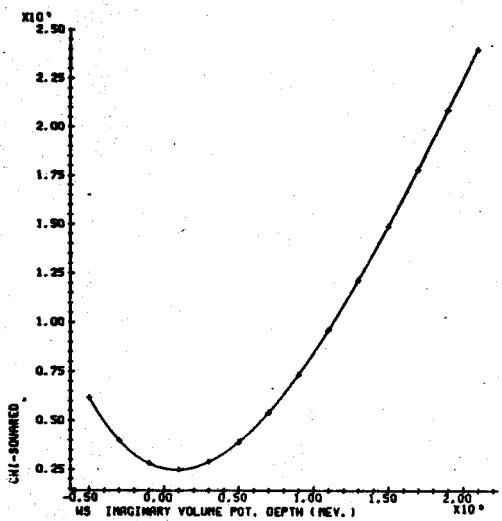
As a check of probably "goodness" of each parameter in the potential, cuts were computed in X^2 space along each parameter axis, in order to measure the sensitivity of the fit to that parameter. Figure 4.51 shows the results for the best parameter set which has WS equal to zero. Figure 4.52 shows results using the best WS > 0 fit.

V has a noticeable flat bottom in the plots of X^2 vs. V for both potentials. In the first set WD is "soft" as are both WD and WS in the second set.









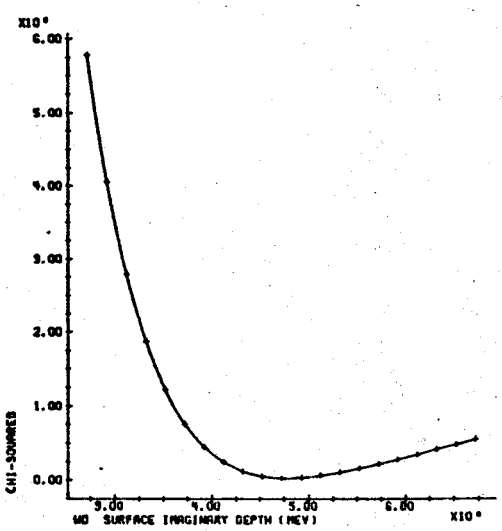
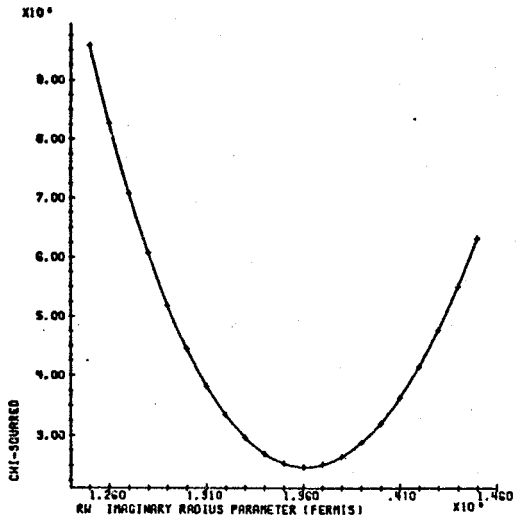
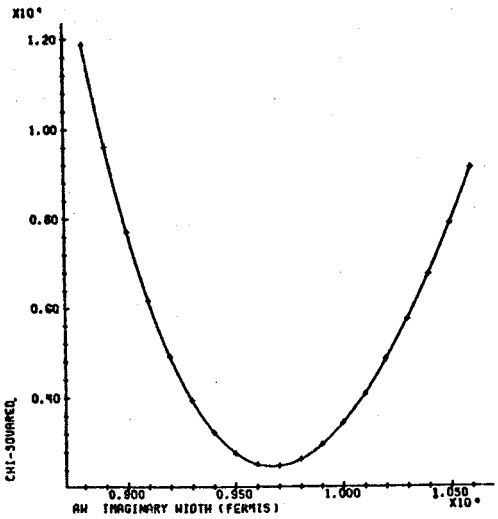
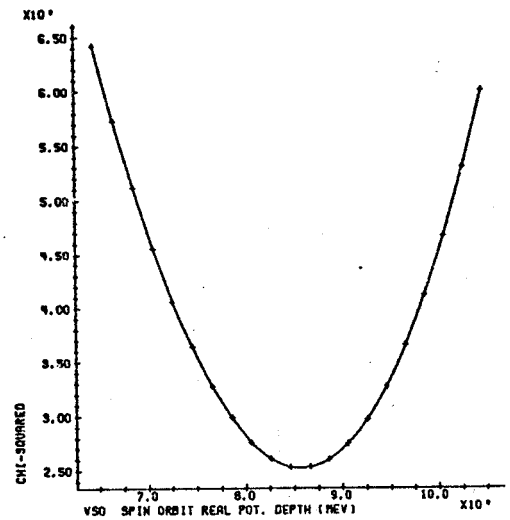
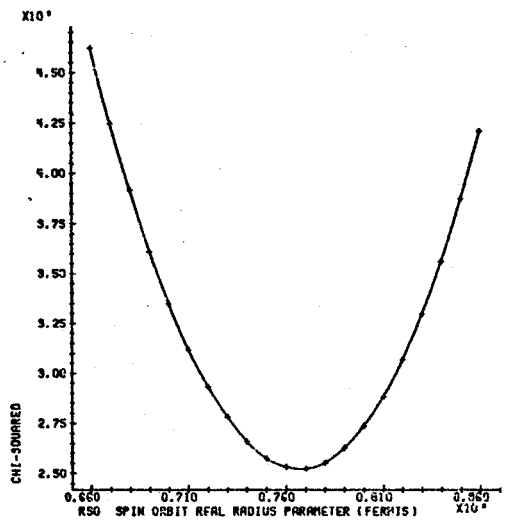


Figure 4.51 CHI-SQUARED Surface No W_s









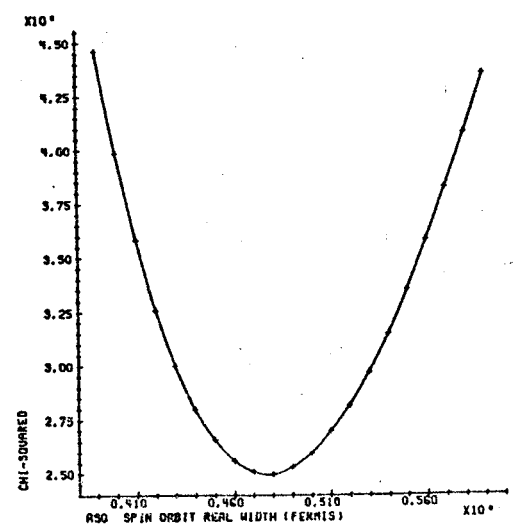
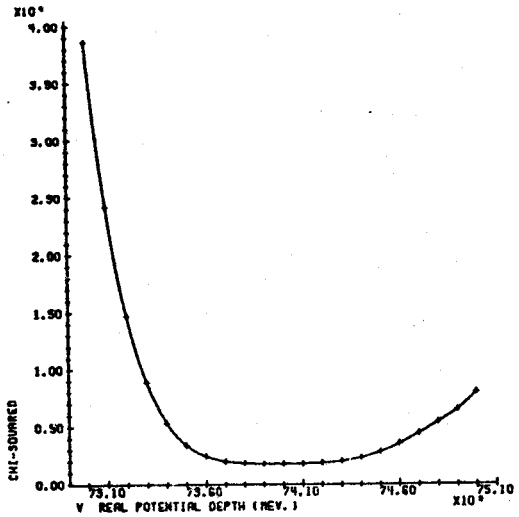
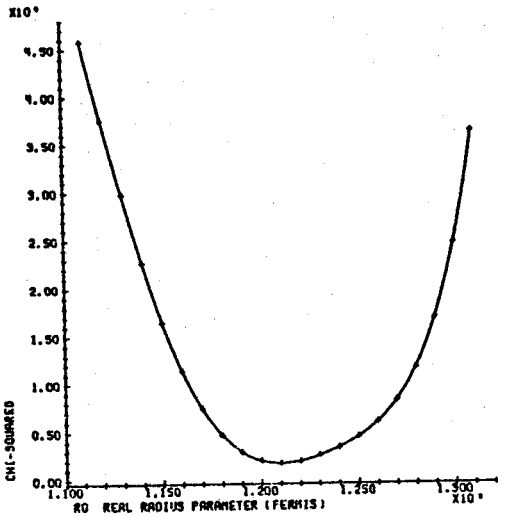
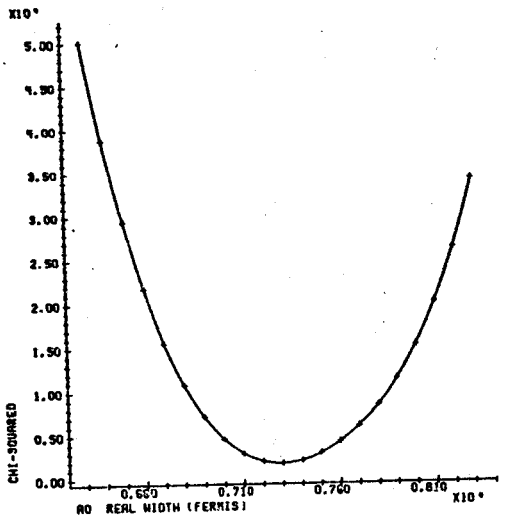
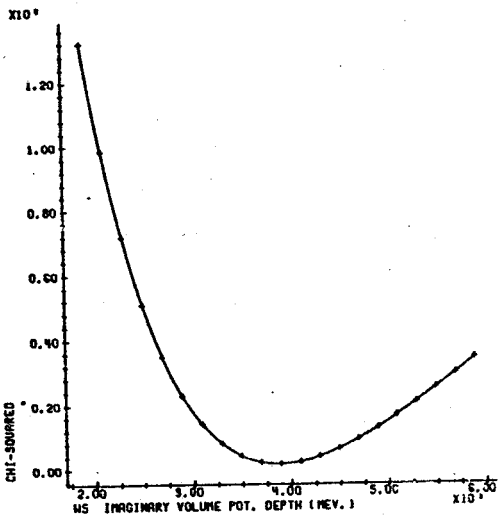


Figure 4.51a CHI-SQUARED Surface No W_S









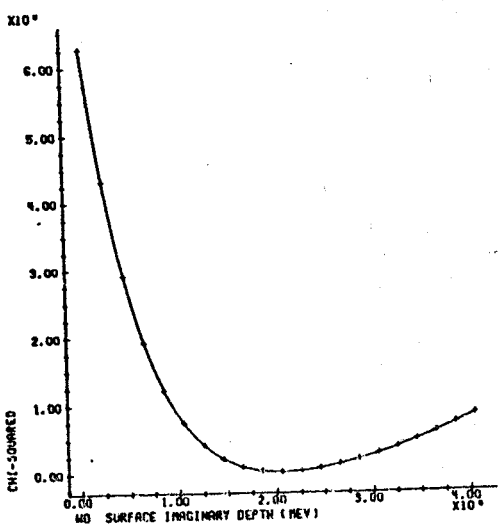
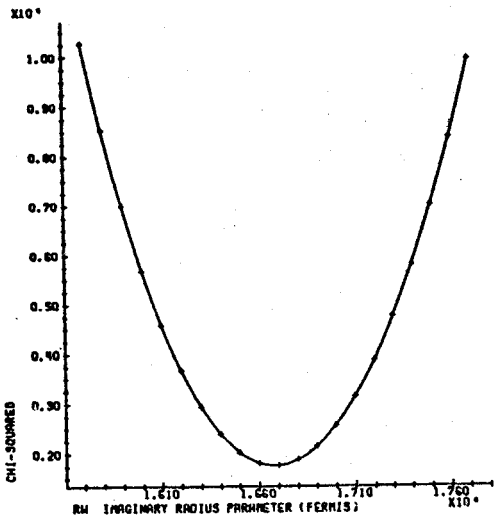
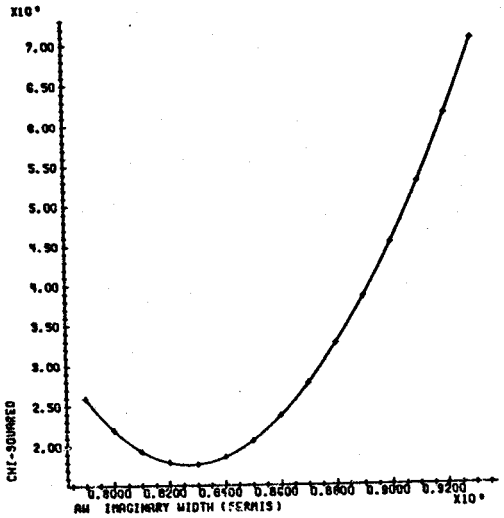
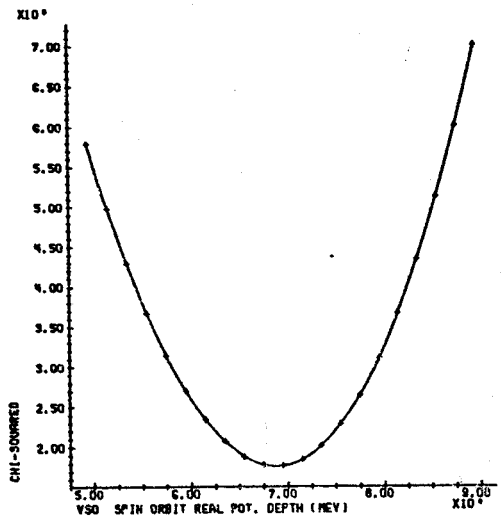
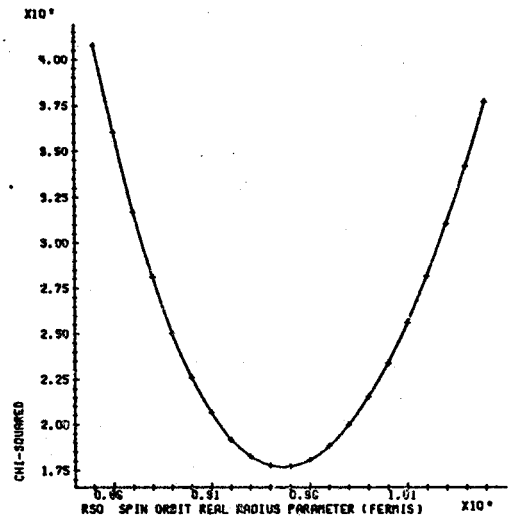


Figure 4.52 CHI-SQUARED Surface With W_s









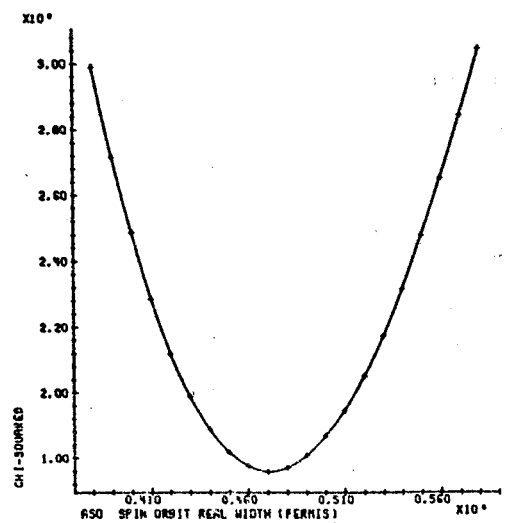


Figure 4.52a CHI-SQUARED Surface With W_s

4.6 Recalculation of $^{16}O(p,d)^{15}O^*$ (Ex = 6.18)

One of the motivations for the present work was the result of the analysis by Snelgrove (Sn 69) of the $^{16}O(p,d)^{15}O$ reaction. As indicated in the introduction, the (p,d) reaction cross sections for the principal transitions corresponding to the pick up of a p 1/2 and of a p 3/2 neutron from the ^{16}O target show, in the calculation, a back angle yield far in excess of the experimental observation. As was interpreted then (Pr 70, Sn 69) this effect could be traced to an excessive contribution to the (p,d) reaction from the nuclear interior. The problem was handled by using truncation and damping of the nuclear interior. The interest here was to see if some of the effect could be explained by inaccuracy of the optical potential used in the DWBA (p,d) calculation.

Snelgrove's Julie calculations (Sn 69) for the 6.18 MeV state of ^{15}O were repeated using the two best deuteron optical parameter sets discussed in Sec. 4.3. The resulting angular distributions are compared to Snelgrove's result in Figures 4.61 and 4.62. As can be seen the principal effect of the calculated cross section not falling off as rapidly with angle as the data remains, so that we must conclude that the effect is not attributable to any distortion effect in the deuteron waves.

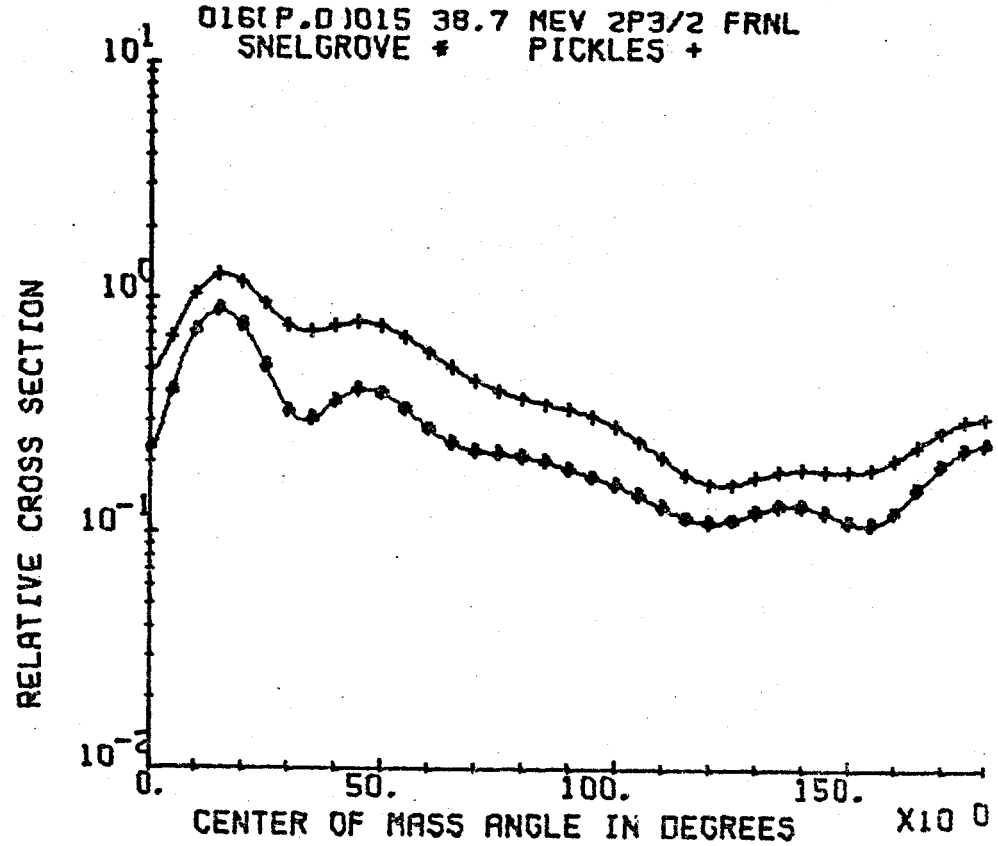
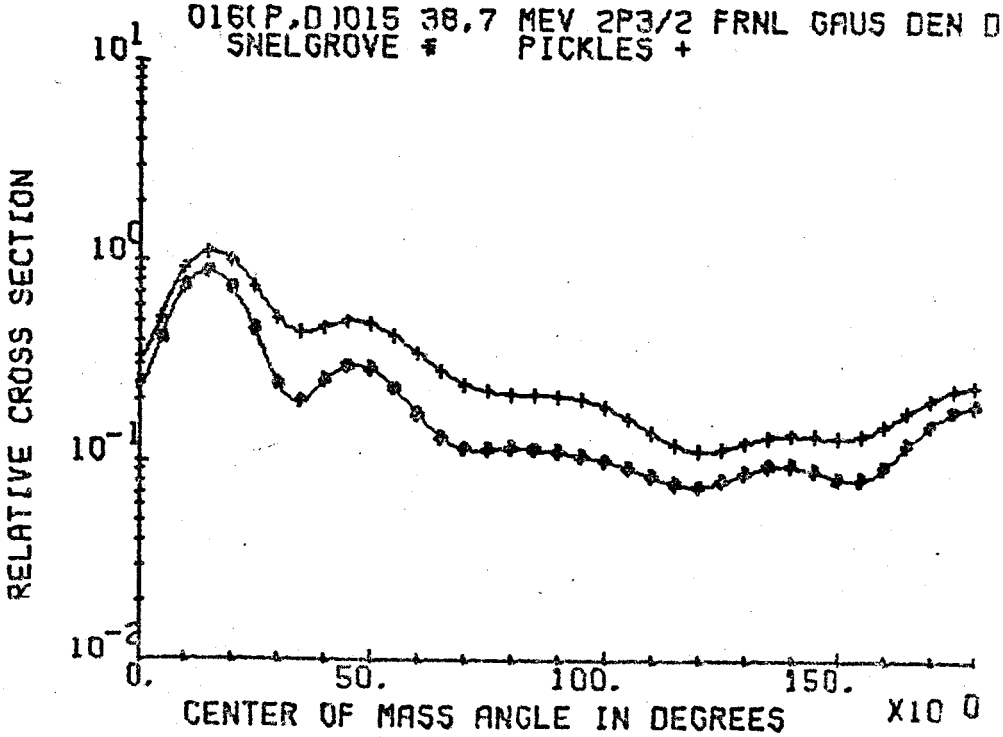


FIGURE 4.61 REFITTING 16O(P,D) WITHOUT WS



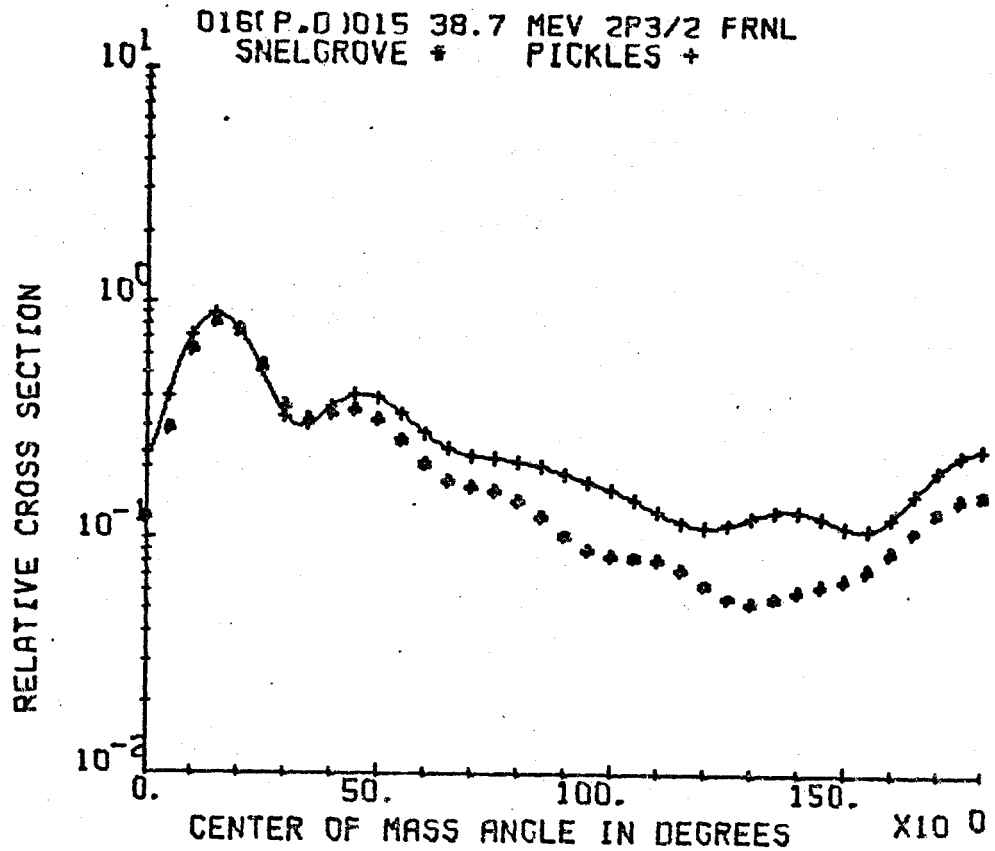
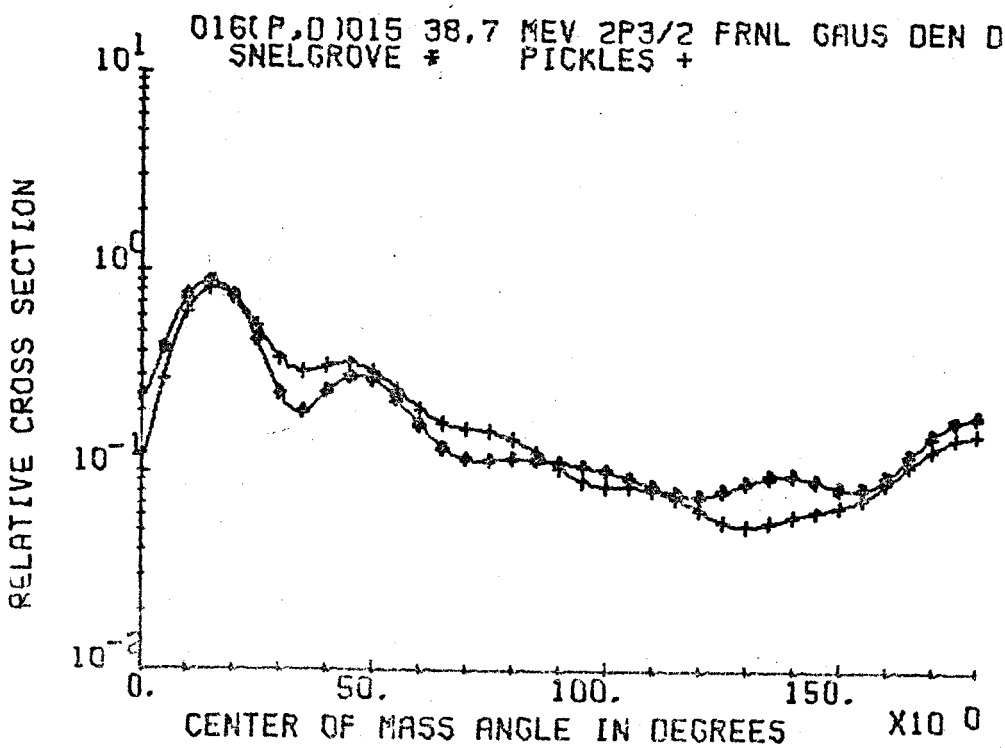


FIGURE 4.62 REFITTING 16O(P,O) WITH WS



5. INELASTIC SCATTERING AND REACTIONS

5.1 Total Reaction Cross Sections

Total reaction cross sections were computed from the angular distributions f(θ) using the expression:

$$2\pi \int_0^{\pi} f(\theta) \sin(\theta)\, d\theta \qquad (5.1)$$

The integration was done in a simple point by point manner. The accuracy was checked by integrating f(θ)'s known to be better than 0.5 per cent. This error was computed for a 5 degree step size. The total reaction cross section is found with the corresponding angular distribution in the Appendices A and B.

The two functions f(0) and f(180) were taken to be f(10) and f(170) respectively.

5.2 Inelastic Scattering.

Angular distributions of differential cross sections, reaction cross sections and energies for many final states resulting from a deuteron beam incident on ^{14}N and ^{16}O are reported in this work. These final states can be grouped into those resulting from zero, one, and two particle transfer. The understanding provided by the simple shell model configuration for A equal 12 through 16 nuclei will be explored in relation to this data.

5.21 Inelastic Deuteron Scattering

Inelastic scattering is known to selectively excite collective states with relatively large cross sections. A collective state in the shell model is a state whose wave function is a mixture of many pure shell model wave functions with comparable amplitudes. The more "collective" the state is, the greater is the number of basis wave functions which are necessary to express the wave function of the state. In ^{16}O and ^{12}C the principal example of this type of level is the 3^- at 6.13 MeV in ^{16}O and the 2^+ at 4.44 MeV in ^{12}C. Angular distribution for the reaction $^{16}O(d,d')$ were measured from 15 to 50 degrees. These angular distributions were then integrated to produce the spectrum of total cross sections shown in Figure 5.21. The 6.13 MeV $(3^-,0)$ state in ^{16}O is excited five times more strongly

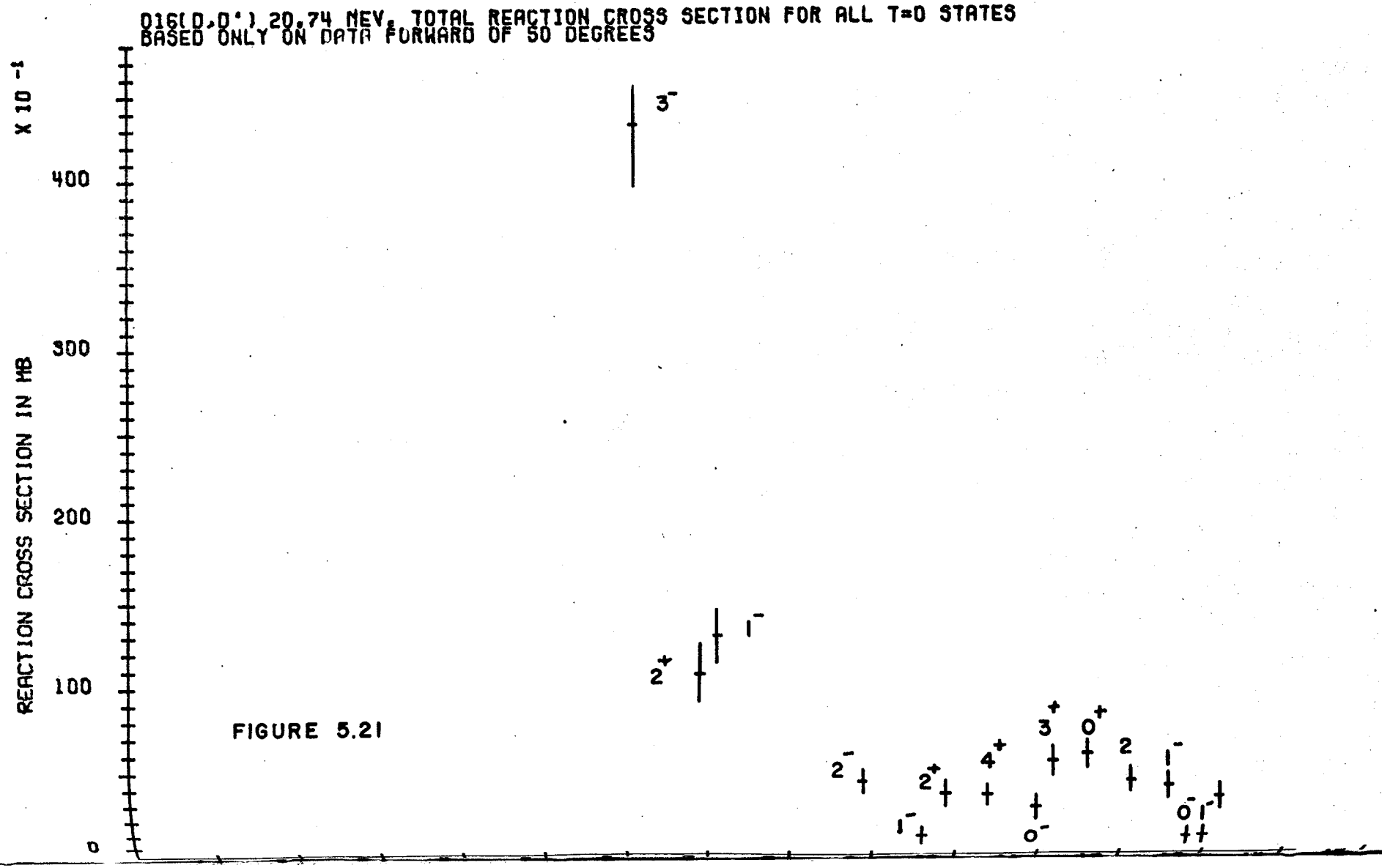

O16(D,D') 20.74 MEV, TOTAL REACTION CROSS SECTION FOR ALL T=0 STATES
BASED ONLY ON DATA FORWARD OF 50 DEGREES
REACTION CROSS SECTION IN MB
X 10 -1
400
300
200
100
0
3⁻
2⁺
1⁻
2⁻
2⁺
1⁻
4⁺
0⁻
3⁺
0⁺
2
1⁻
0⁻
1⁻

FIGURE 5.21

than the 6.916 MeV $(2^+,0)$ and the 7.115 $(1^-,0)$. The 3^- is excited ten times more strongly than all other states.

In a weak coupling picture one might expect to see principally states of 1^+, 2^+, and 3^+, and 2^-, 3^-, 4^- in ^{14}N. A glance at the spectrum of Figure 5.22 does indeed show the high level of excitation of such states. Clearly, these states must be somewhat collective, but since ^{14}N is rather well described by the shell model (Tr 63), it is that picture which will be used in the discussion. Table 5.21 showing the dominate shell model configurations and calculated state admixtures for ^{14}N is from True's article (Tr 63).

Another feature of deuteron inelastic scattering which is different from proton, ^3He, and triton inelastic scattering is the fact that only states in the target nucleus with the same Isospin as the ground state can be excited if T is to be conserved. The same is true for inelastic scattering of alpha-particles since both the deuteron and alpha-particles have Isospin equal to zero in their lowest energy states. One cannot measure T directly. It is usually inferred from experiments, such as the inelastic scattering data described here.

If all the data agree with a consistent set of T assignments the use of T as a quantum number is justified. The extent to which the system of nucleons in ^{14}N is

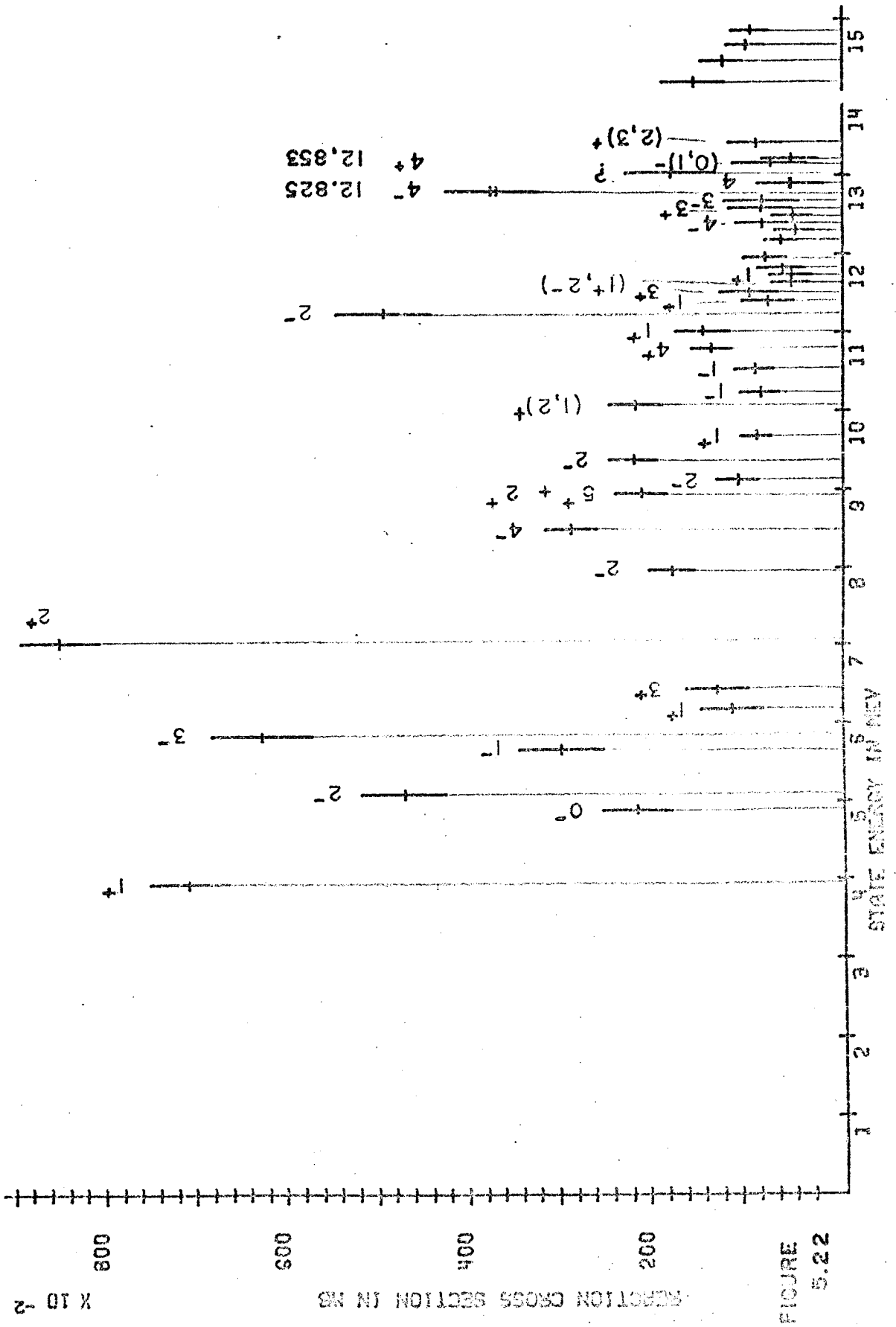

N14(D,D') 20.13 MEV. TOTAL CROSS SECTION FOR ALL T=0 STATES
REACTION CROSS SECTION IN MB
X 10 -2
800
600
400
200
STATE ENERGY IN MEV
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1+
0-
2-
1-
3-
2+
3+
1+
2-
5+ + 2+
4-
2-
2-
1+
(1,2)+
1-
1-
4+
1+
3+ (1+,2-)
1+
2-
4-
3-=3+
?
(0,1)-
(2,3)+
4- 12.825
4+ 12.853
FIGURE 5.22

Figure 5.21

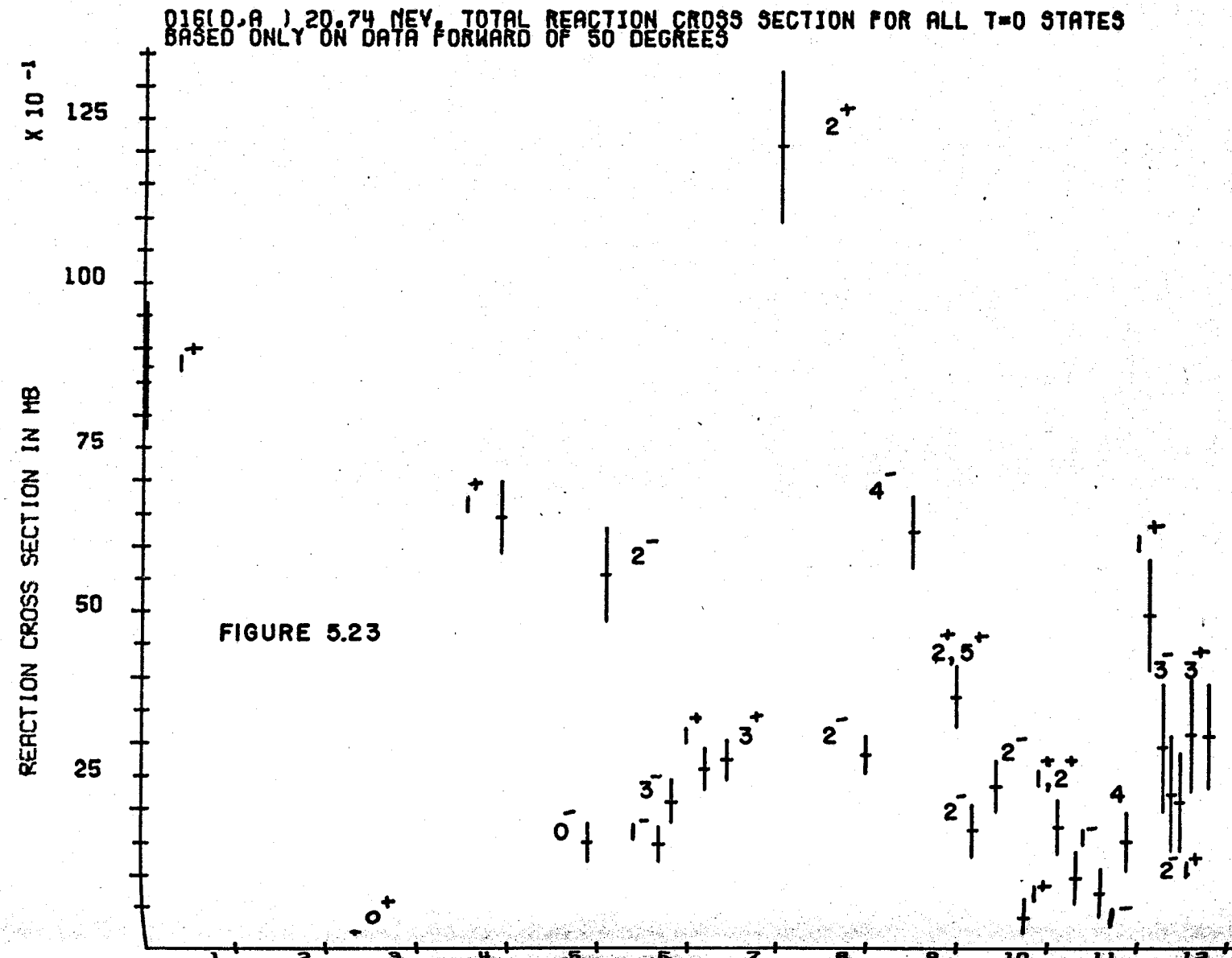
Energy levels, dominant configuration(s), and eigenfunctions for N^{14} with $\nu_p = 0.32$ F^{-2}, $\nu_{n,d} = 0.27$ F^{-2}, and $\alpha = 1.6$.[a]

Energy (MeV)	Dominant configuration(s)	Eigenfunctions					
$J^\pi, T = 0^-, 0$		$p_{1/2}s_{1/2}$					
3.31	$p_{1/2}s_{1/2}$	1.000					
$J^\pi, T = 0^+, 1$		$p_{1/2}^2$	$s_{1/2}^2$	$d_{5/2}^2$	$d_{3/2}^2$		
2.94	$p_{1/2}^2$	−0.9501	0.1219	0.2635	0.1139		
8.46	$s_{1/2}^2$	−0.2056	−0.9360	−0.2754	−0.0760		
10.93	$d_{5/2}^2$	−0.2262	0.3278	−0.9063	−0.1414		
20.86	$d_{3/2}^2$						
$J^\pi, T = 0^-, 1$		$p_{1/2}s_{1/2}$					
8.37	$p_{1/2}s_{1/2}$	1.000					
$J^\pi, T = 1^+, 0$		$p_{1/2}^2$	$s_{1/2}^2$	$d_{5/2}^2$	$s_{1/2}d_{3/2}$	$d_{3/2}d_{5/2}$	$d_{3/2}^2$
0	$p_{1/2}^2$	0.9666	0.0643	0.1839	0.1012	0.0105	−0.1318
6.34	$s_{1/2}^2$	0.1303	−0.8732	−0.3268	0.0201	−0.3308	0.0628
9.92	$d_{5/2}^2$	0.1346	0.4713	−0.7157	−0.0398	−0.4357	0.1103
12.24	$s_{1/2}d_{3/2}$	0.1483	−0.0759	−0.2193	−0.8379	0.4505	0.1378
14.75	$d_{3/2}d_{5/2}$						
20.57	$d_{3/2}^2$						
$J^\pi, T = 1^-, 0$		$p_{1/2}s_{1/2}$	$p_{1/2}d_{3/2}$				
4.90	$p_{1/2}s_{1/2}$	0.9931	0.1175				
12.07	$p_{1/2}d_{3/2}$	0.1175	−0.9931				
$J^\pi, T = 1^+, 1$		$s_{1/2}d_{3/2}$	$d_{3/2}d_{5/2}$				
16.58	$s_{1/2}d_{3/2}$						
17.55	$d_{3/2}d_{5/2}$						
$J^\pi, T = 1^-, 1$		$p_{1/2}s_{1/2}$	$p_{1/2}d_{3/2}$				
7.26	$p_{1/2}s_{1/2}$	−0.9945	0.1050				
12.27	$p_{1/2}d_{3/2}$	−0.1050	−0.9945				
$J^\pi, T = 2^+, 0$		$s_{1/2}d_{5/2}$	$s_{1/2}d_{3/2}$	$d_{3/2}d_{5/2}$			
9.45	$s_{1/2}d_{5/2}$	−0.8729	0.3935	0.2885			
14.28	$d_{3/2}d_{5/2}$						
15.90	$s_{1/2}d_{3/2} + d_{3/2}d_{5/2}$						
$J^\pi, T = 2^-, 0$		$p_{1/2}d_{5/2}$	$p_{1/2}d_{3/2}$				
4.83	$p_{1/2}d_{5/2}$	0.9829	0.1842				
7.89	$p_{1/2}d_{3/2}$	0.1842	−0.9829				
$J^\pi, T = 2^+, 1$		$s_{1/2}d_{5/2}$	$d_{5/2}^2$	$s_{1/2}d_{3/2}$	$d_{3/2}d_{5/2}$	$d_{3/2}^2$	
10.12	$s_{1/2}d_{5/2}$	−0.8981	−0.3599	−0.2219	0.1003	−0.0675	
12.31	$d_{5/2}^2$	−0.3857	0.9163	0.0171	−0.0920	0.0535	
15.90	$s_{1/2}d_{3/2}$						
17.22	$d_{3/2}d_{5/2}$						
21.65	$d_{3/2}^2$						
$J^\pi, T = 2^-, 1$		$p_{1/2}d_{5/2}$	$p_{1/2}d_{3/2}$				
9.25	$p_{1/2}d_{5/2}$	−0.9997	0.0260				
13.71	$p_{1/2}d_{3/2}$	−0.0260	−0.9997				
$J^\pi, T = 3^+, 0$		$s_{1/2}d_{5/2}$	$d_{5/2}^2$	$d_{3/2}d_{5/2}$	$d_{3/2}^2$		
7.61	$s_{1/2}d_{5/2}$	−0.8969	−0.4082	−0.1673	0.0312		
11.60	$d_{5/2}^2$	−0.4307	0.8919	0.1203	−0.0675		
15.76	$d_{3/2}d_{5/2}$						
19.46	$d_{3/2}^2$						
$J^\pi, T = 3^-, 0$		$p_{1/2}d_{5/2}$					
5.60	$p_{1/2}d_{5/2}$	1.000					
$J^\pi, T = 3^+, 1$		$s_{1/2}d_{5/2}$	$d_{3/2}d_{5/2}$				
12.07	$s_{1/2}d_{5/2}$	1.000	0				
17.55	$d_{3/2}d_{5/2}$						
$J^\pi, T = 3^-, 1$		$p_{1/2}d_{5/2}$					
7.71	$p_{1/2}d_{5/2}$	1.000					
$J^\pi, T = 4^+, 0$		$d_{3/2}d_{5/2}$					
13.82	$d_{3/2}d_{5/2}$	1.000					
$J^\pi, T = 4^+, 1$		$d_{5/2}^2$	$d_{3/2}d_{5/2}$				
12.33	$d_{5/2}^2$	−0.9636	0.2674				
15.95	$d_{3/2}d_{5/2}$						
$J^\pi, T = 5^+, 0$		$d_{5/2}^2$					
9.32	$d_{5/2}^2$	1.000					

[a] The wave functions have been given only for the levels below 14 MeV.

correctly characterized by T is reflected by the degree to which T = 1 states in ^{14}N are not excited by deuteron inelastic scattering. No evidence was in fact seen for the excitation of any well established T = 1 states. B. G. Harvey (Ha 66) et al report the reaction $^{14}N(\alpha,\alpha')$. They did not observe any T = 1 states, but their resolution (300 KeV) was good enough to made any firm T assignments. The first excited state of ^{14}N is at 2.313 MeV and has $(J^{\pi},T) = 0^{+},1$. This state can be described predominantly by a shell model configuration of $(p_2^1)^2$ (see Table 5.21). It differs from the ground state of ^{14}N in that this $(p_2^1)^2$ system could exist for two neutrons as well as for two protons, and thus cannot have T = 0. Even without the Isospin forbidden nature of the transition, the cross section for this state would be expected to be small. Thus the fact that it is not observed is a poor test of isospin conservation. A better test is the lack of excitation of this state in spectrum of the $^{16}O(d,\alpha)^{14}N$. This spectrum was measured in this experiment and is shown in Figure 5.23a. Figure 5.23 is the total cross sections for the states observed.

The minimum total reaction cross section we could have measured for the 2.313 MeV state via the (d,d') reaction, based upon the minimum cross section measured at each angle, was 10 μb. Since the total uncertainty was 19 μb, we have


O16(D,A) 20.74 MEV, TOTAL REACTION CROSS SECTION FOR ALL T=0 STATES
BASED ONLY ON DATA FORWARD OF 50 DEGREES
X 10 -1
125
100
75
50
25
REACTION CROSS SECTION IN MB
FIGURE 5.23
0+
1+
1+
2-
0-
1-
3-
1+
3+
4-
2-
2+
2,5+
2-
2-
1+
1,2+
4
1-
1-
1+
1+
3-
3+
2-
1+

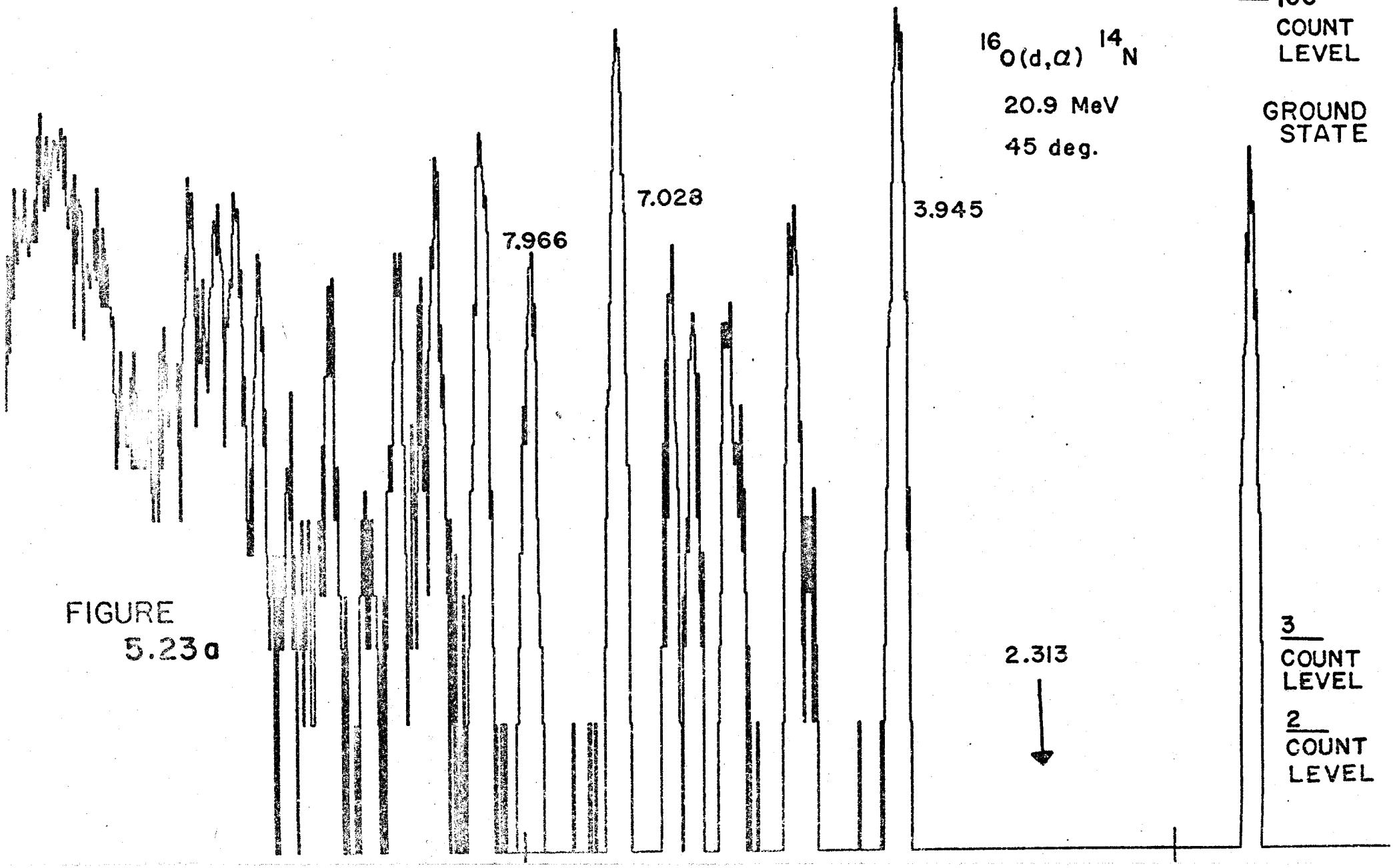

$^{16}O(d,\alpha)\ ^{14}N$
20.9 MeV
45 deg.
100 COUNT LEVEL
GROUND STATE
7.966
7.028
3.945
2.313
3 COUNT LEVEL
2 COUNT LEVEL

FIGURE 5.23a

$$\sigma\ 2.311 = 10\ \mu b \pm \begin{matrix} 19\ \mu b \\ 10\ \mu b \end{matrix}$$

This represented the lowest upper limit set for any of the T = 1 states of ^{14}N.

The energy and T for each state in ^{14}N is compared in Table 5.22, a 1969 compilation of A = 14 energy level properties (Az 69). On the basis of the present experiment, many levels in ^{14}N are assigned T = 0 as shown in Table 5.22. The level at 11.24 MeV is reassigned and given T = 0. Also included in Table 5.22 are the spins and parities of the levels. Table 5.23 shows dominant calculated shell model configurations (Tr 63).

As seen in Table 5.23 the dominant configuration of the 4.913 MeV $(0^-,0)$ and the 5.691 MeV $(1^-,0^-)$ states in ^{14}N is $P_2^1 S_2^1$. These two states should have similar angular distributions. As can be seen from Figure 5.24 the angular distributions are almost identical and the ratio of the total cross sections is approximately 1.5:1 (refer to Figure 5.22 for the total cross sections for all T = 0 states in ^{14}N).

There are two states at 5.834 MeV $(3^-,0)$ and 5.106 MeV $(2^-,0)$ whose dominant configurations are both $P_2^1 d_2^5$ (Tr 63). The total cross sections for these states would be expected to have a ratio of 7:5 in the weak coupling of $(1^+ \times 3^-)$. In this case we observed 6.4:4.8 which would appear to confirm the weak coupling picture except that the 4^- of the

Table 5.22 Energy Levels of ^{14}N

From Present Work			From (Aj 69)	
Ex in ^{14}N MeV	T	σ in mb	Ex in ^{14}N (MeV ± KeV)	J^{π},T
0	0		0	1^+,0
--	--	* <10 μb	2.31281 ± 0.06	0^+,1
3.945	0	7.4 ± .4	3.9447 ± 1.2	1^+,0
4.903	0	2.1 ± .4	4.9134 ± 2.4	0^-,0
5.105	0	4.7 ± .5	5.10587 ± 0.18	2^-,0
5.678	0	3.0 ± .5	5.691 ± 3	1^-,0
5.834	0	6.3 ± .6	5.834 ± 3	3^-,0
6.202	0	1.1 ± .3	6.1976 ± 2.0	1^+,0
6.448	0	1.2 ± .3	6.4436 ± 1.6	3^+,0
7.928	0	8.5 ± .4	7.028 ± 1	2^+,0
7.968	0	1.7 ± .2	7.966 ± 1	2^-,0
--	--		8.061 ± 2	1^-,1
8.488	0	8.5 ± .3	8.489 ± 3	4^-,0
--	--		8.617 ± 3	0^+,1
--	--		8.80 ± 50	0^-,1
--	--		8.907 ± 3	3^-,1
8.962	0	2.1 ± .2	8.963 ± 3	5^+,0
Unresolvable			8.979 ± 4	2^+,(0)
9.138	0	1.0 ± .2	9.129 ± 2	2^-,0
--	--		9.172 ± 1.5	2^+,1
9.389	0	2.2 ± .2	9.388 ± 4	2^-,0
--	--		9.508 ± 3	2^-,1

Table 5.22 Continued

From Present Work			From (Aj 69)	
Ex in ^{14}N MeV	T	σ in mb	Ex in ^{14}N (MeV ± KeV)	J^{π},T
9.701	0	0.8 ± .2	9.702 ± 4	1^+
10.075	0	2.1 ± .3	10.09 ± 10	$(1,2)^+$
10.250	0	0.8 ± .2	10.228 ± 10	$1^{(-)},0$
--	--		10.432 ± 7	$2^+,1$
10.550	0	0.8 ± .2	10.56 ± 10	1^-
10.815	0	1.3 ± .2	10.81 ± 18	$4^+,0$
11.035	0	1.4 ± .3	11.04 ± 32	$1^+,0$
Unresolvable			11.05	
11.239	0	5.0 ± .5	11.24 ± 19	$3^-,1$
--	--		11.30	$2^-,0$
11.413	0	0.7 ± .3	11.40 ± 18	$1^+,0$
11.521	0	0.9 ± .3	11.51 ± 30	3^+
11.660	0	0.4 ± .3	11.66 ± 40	$(1^+,2^-)$
11.753	0	0.4 ± .2	11.75	1^+
11.838	0	0.5 ± .2	11.81	
11.981	0	0.7 ± .2	11.95 ± 30	
12.20		0.5 ± .2	12.24	
12.32		0.5 ± .2	12.29	
12.41	0	0.7 ± .3	12.414 ± 6	4^-
12.51		0.4 ± .2	12.47 ± 10	
--	--		12.503 ± 9	
12.61	0	0.8 ± .3	12.608 ± 7	3^+

Table 5.22 Continued

From Present Work			From (Aj 69)	
Ex in ^{14}N MeV	T	σ in mb	Ex in ^{14}N (MeV ± KeV)	J^{π},T
12.69	0	0.7 ± .4	12.689 ± 4	3^-
Unresolvable			12.793 ± 6	4^+
12.81	0	3.7 ± .5	12.825 ± 7	4^-
			12.853 ± 15	
12.92		0.5 ± .4	12.942 ± 7	4
13.04	0	1.9 ± .5	13.05 ± 20	T=0
13.18		0.7 ± .4	13.164 ± 8	$(0,1)^-$
13.24		0.5 ± .3	13.23 ± 10	
13.43	0	0.9 ± .3	13.3	
			13.66 ± 10	$(2,3)^+$
			13.71 ± 10	
			13.75 ± 10	1^+,1
13.98	0	0.3 ± .1	14.04	
14.19	0	1.5 ± .3	14.17	
14.47	0	1.2 ± .2	14.40	
14.68	0	1.0 ± .2	14.70	
14.87		0.8 ± .2	14.84	
			15.0	

Table 5.23 Energy levels and dominant configurations for N^{14} with $v_p = v_{s,d} = 0.3\ F^{-2}$ and $\alpha = 1.6$ (Tr 63).

J^π,T	Energy (MeV)	Dominant configuration(s)
0^-,0	2.96	$p_{1/2}s_{1/2}$
0^+,1	2.72	$p_{1/2}^2$
	7.91	$s_{1/2}^2$
	10.49	$d_{5/2}^2$
	20.54	$d_{3/2}^2$
0^-,1	8.12	$p_{1/2}s_{1/2}$
1^+,0	0	$p_{1/2}^2$
	5.54	$s_{1/2}^2$
	9.34	$s_{1/2}^2 + d_{5/2}^2 + d_{3/2}d_{5/2}$
	11.44	$s_{1/2}d_{3/2}$
	14.28	$d_{5/2}^2 + s_{1/2}d_{3/2} + d_{3/2}d_{5/2}$
	20.16	$d_{3/2}^2$
1^-,0	4.58	$p_{1/2}s_{1/2}$
	11.78	$p_{1/2}d_{3/2}$
1^+,1	16.32	$s_{1/2}d_{3/2}$
	17.30	$d_{3/2}d_{5/2}$
1^-,1	6.99	$p_{1/2}s_{1/2}$
	12.00	$p_{1/2}d_{3/2}$
2^+,0	8.71	$s_{1/2}d_{5/2}$
	13.82	$d_{3/2}d_{5/2} + s_{1/2}d_{5/2} + s_{1/2}d_{3/2}$
	15.45	$s_{1/2}d_{3/2} + d_{3/2}d_{5/2}$
2^-,0	4.50	$p_{1/2}d_{5/2}$
	7.53	$p_{1/2}d_{3/2}$
2^+,1	9.57	$s_{1/2}d_{5/2}$
	11.95	$d_{5/2}^2$
	15.59	$s_{1/2}d_{3/2}$
	16.93	$d_{3/2}d_{5/2}$
	21.36	$d_{3/2}^2$

Table 5.23 continued

$2^-,1$	8.99	$p_{1/2}d_{5/2}$
	13.45	$p_{1/2}d_{3/2}$
$3^+,0$	6.77	$s_{1/2}d_{5/2}$
	11.10	$d_{5/2}^2$
	15.21	$d_{3/2}d_{5/2}$
	18.98	$d_{3/2}^2$
$3^-,0$	5.28	$p_{1/2}d_{5/2}$
$3^+,1$	11.82	$s_{1/2}d_{5/2}$
	17.30	$d_{3/2}d_{5/2}$
$3^-,1$	7.43	$p_{1/2}d_{5/2}$
$4^+,0$	13.10	$d_{3/2}d_{5/2}$
$4^+,1$	11.94	$d_{5/2}^2$
	15.54	$d_{3/2}d_{5/2}$
$5^+,0$	8.60	$d_{5/2}^2$

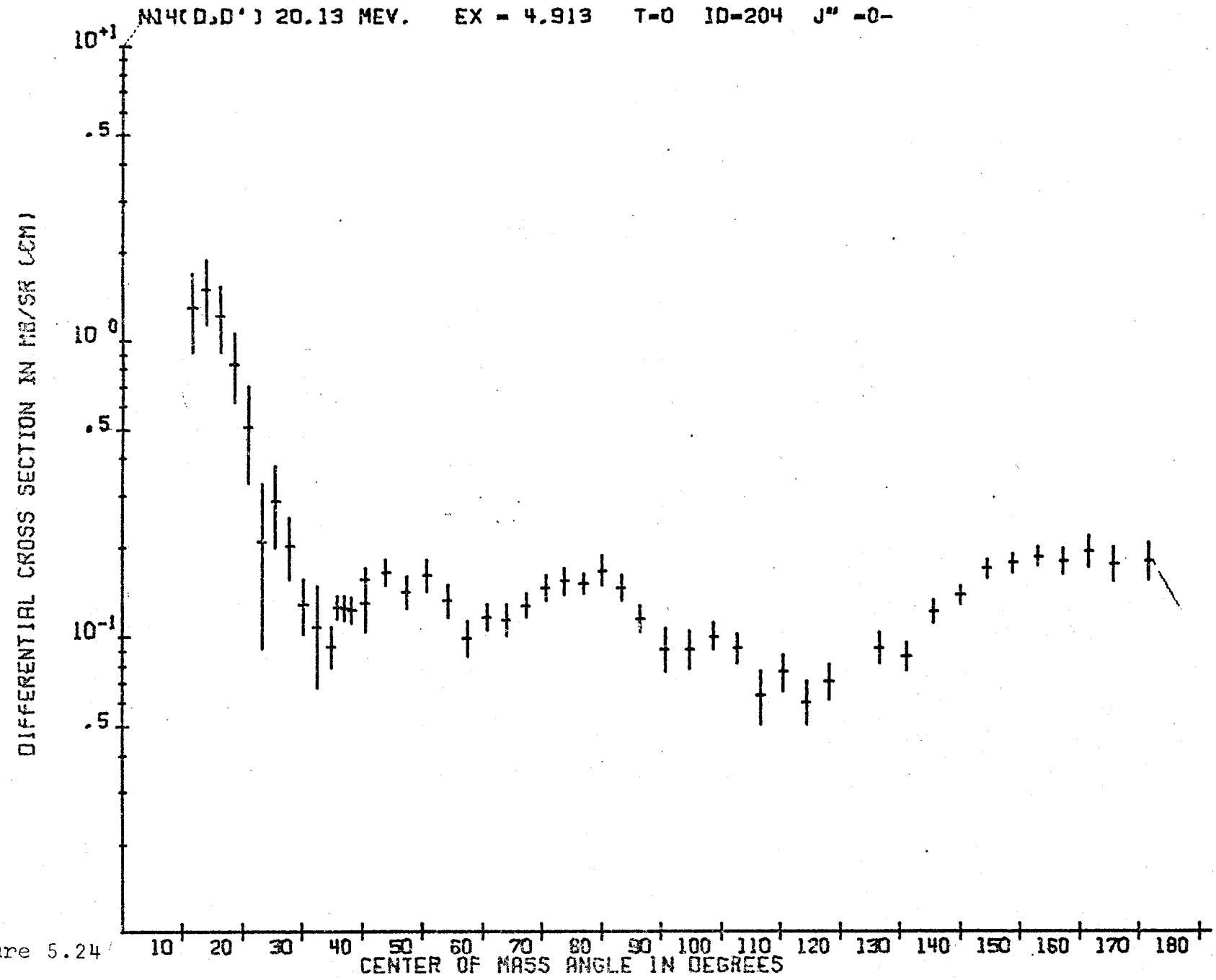

N14(D,D') 20.13 MEV. EX = 4.913 T=0 ID=204 J" =0-
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
10+1
.5
10 0
.5
10-1
.5
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.24

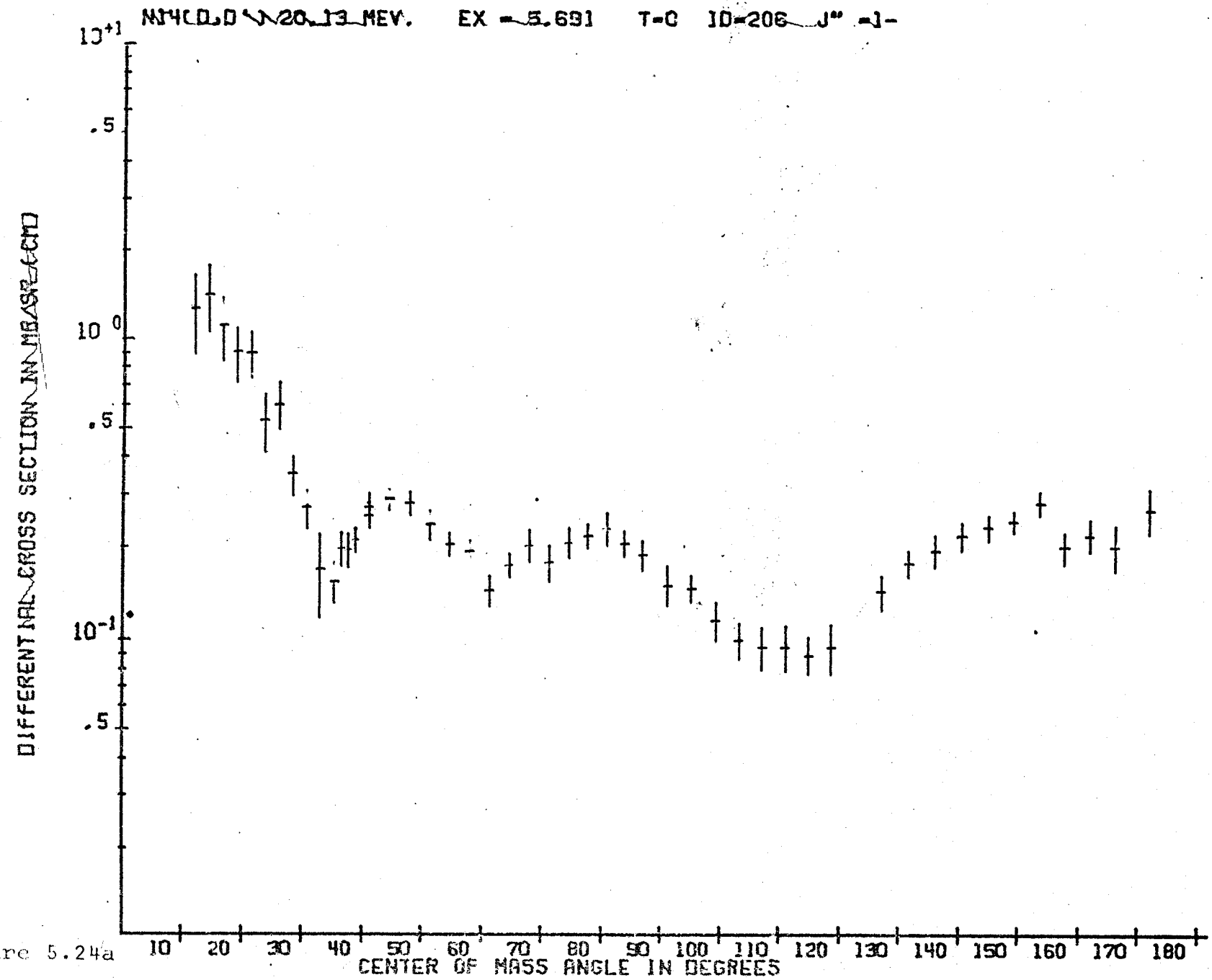

NI4(D,D')N20.13 MEV. EX =5.691 T=0 ID=206 J" =1-
DIFFERENTIAL CROSS SECTION IN MB/SR/CM
10+1
.5
10 0
.5
10-1
.5
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.24a

of the group is much too weak. The angular distributions again are identical as seen in Figure 5.25.

The $(1^+,0)$ state at 3.945 MeV and the 7.028 $(2^+,0)$ state are as discussed by True, core excitation states primarily. Their angular distribution and strengths are similar as can be seen in Figure 5.26.

Two states at higher energy are excited very strongly. These are the 11.24 MeV 2^- and the 12.825 MeV 4^-. The strong excitation of these two states (Figure 5.22) is possibly interpretated as weak coupling of the two 1^+ nucleons to the 9.64 MeV 3^- configuration of ^{12}C. These two states are also strongly excited in the (α,α') reaction (Ha 66).

The angular distributions of the rest of the states observed have very little structure and are probably excited by compound mechanisms. These angular distributions are shown in Figure 5.27 and following.

5.22 One Nucleon Transfer

The one nucleon transfer reactions reported here are $^{14}N(D,t)^{13}N$ and $^{14}N(D,^3He)^{13}C$. The total reaction cross sections for the states observed are shown in Figures 5.28 and 5.29. ^{13}N and ^{13}C are mirror nuclei and hence we should see a very similar state structure and relative excitation strength. Comparison of the two figures shows that this is indeed the case.

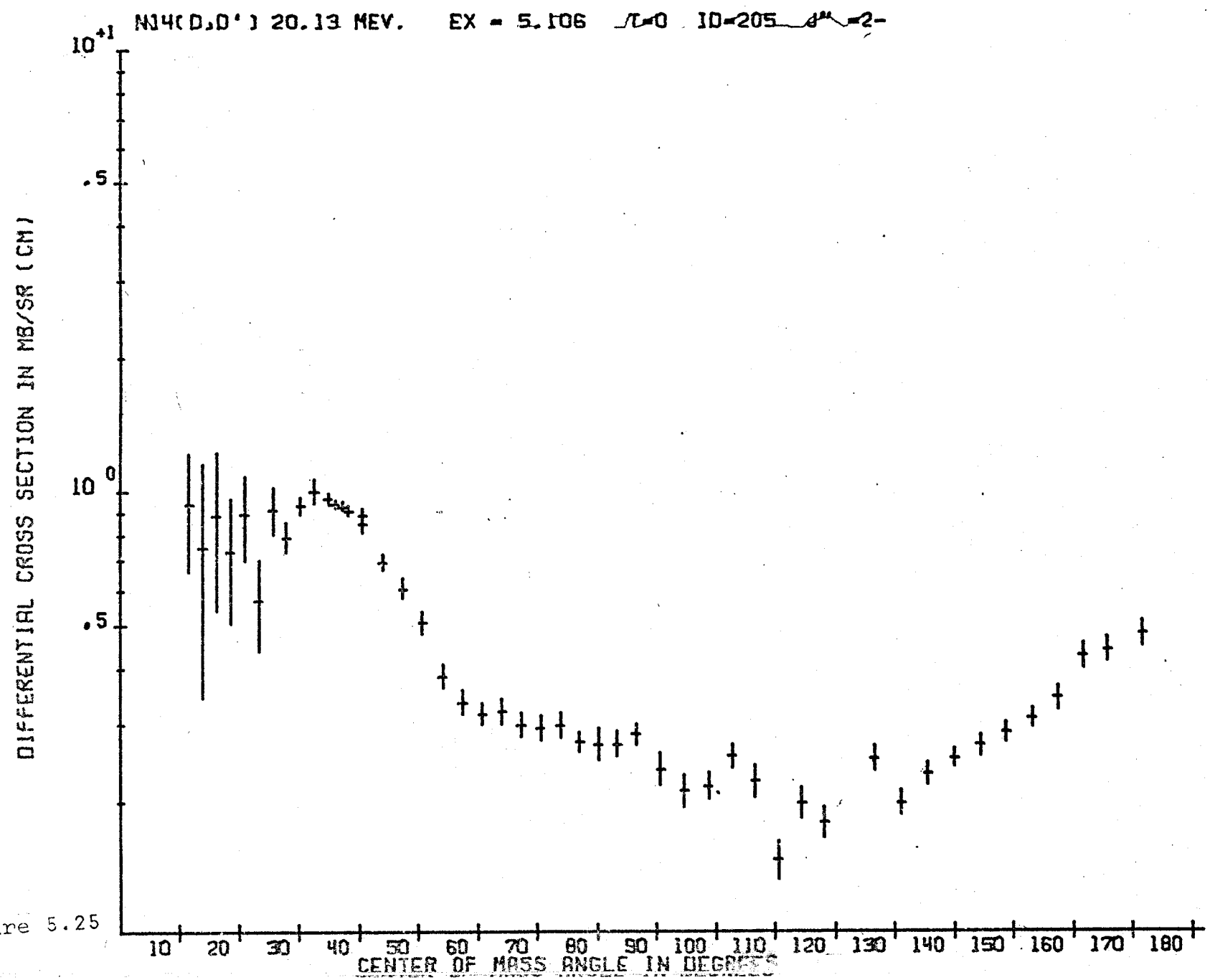

N14(D,D') 20.13 MEV. EX = 5.106 T=0 ID=205 J^π=2-
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
10+1
.5
10 0
.5
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.25

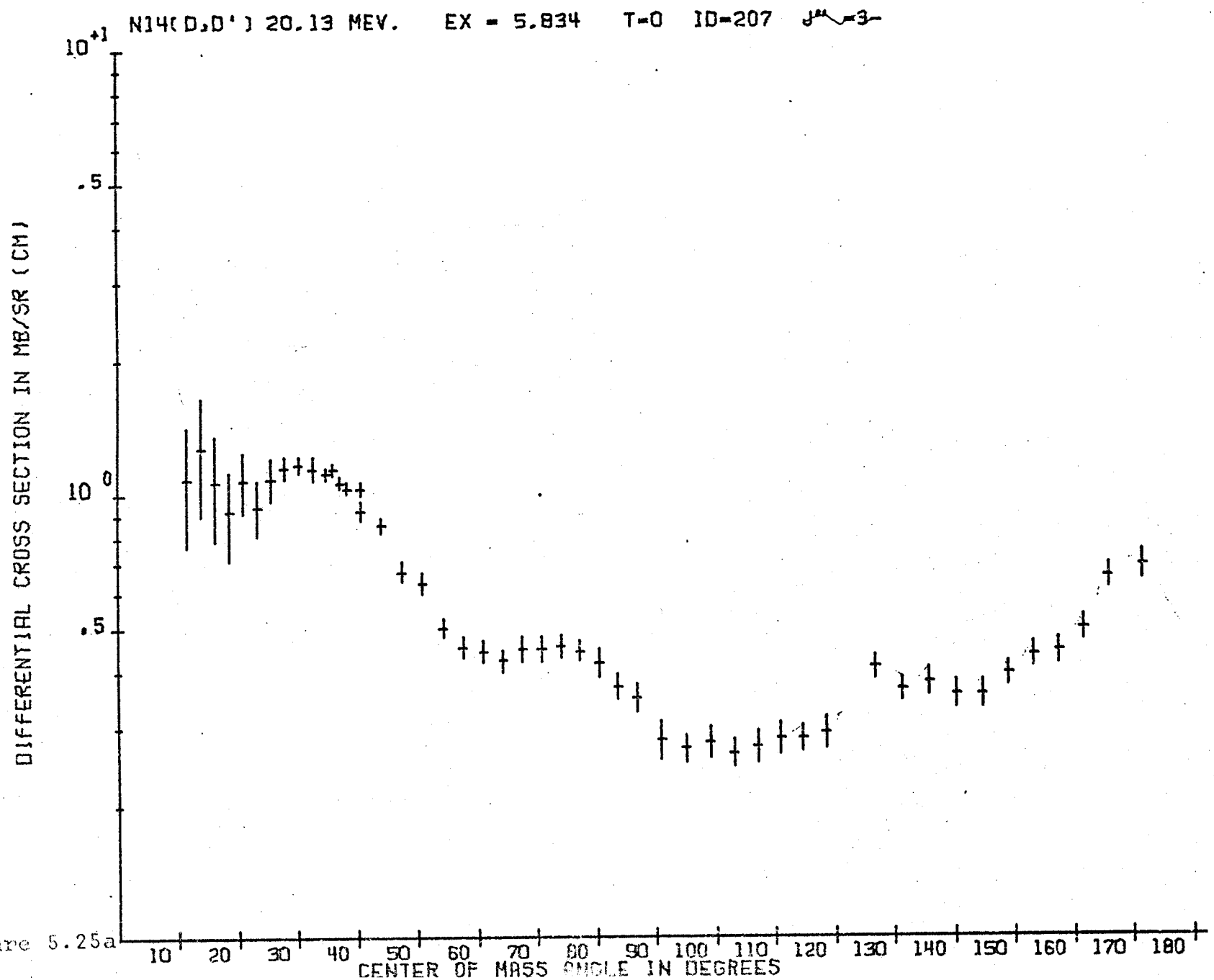

N14(D,D') 20.13 MEV. EX = 5.834 T=0 ID=207 J^π=3-
10^+1
.5
10^0
.5
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.25a

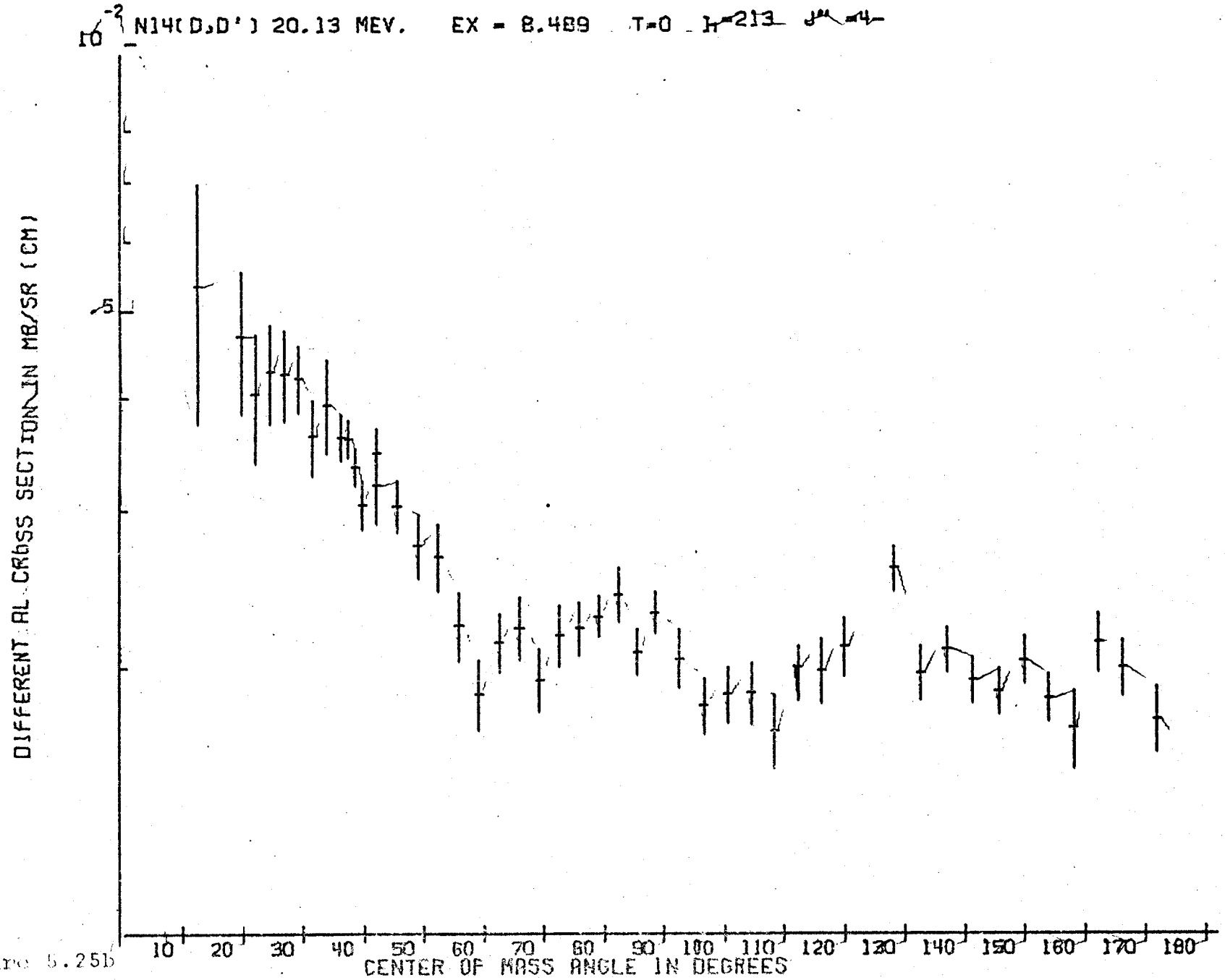

10^-2
N14(D,D') 20.13 MEV. EX = 8.489 T=0 H=213
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
5
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.25b

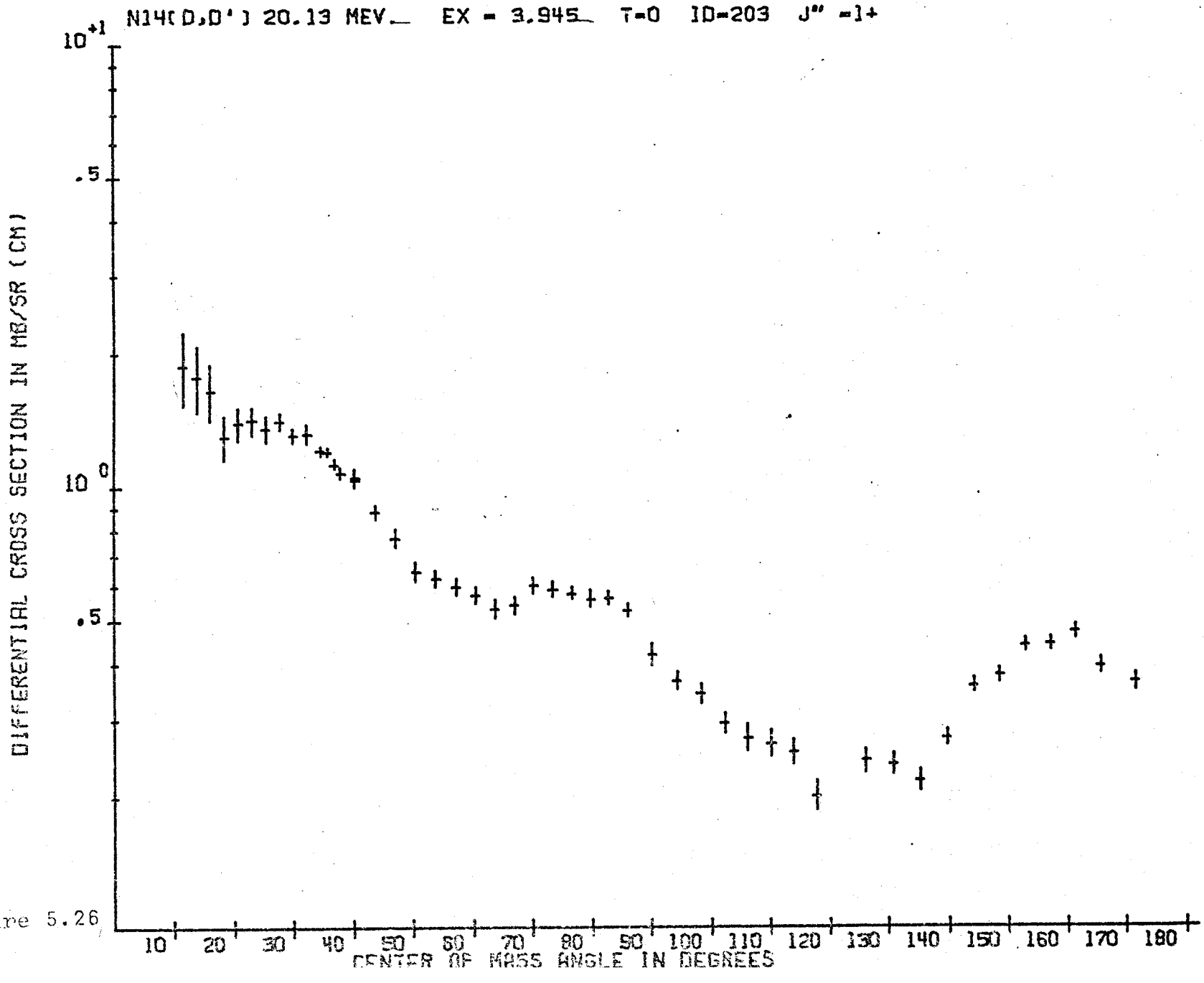

N14(D,D') 20.13 MEV EX = 3.945 T=0 ID=203 J" =1+
10+1
.5
10 0
.5
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.26

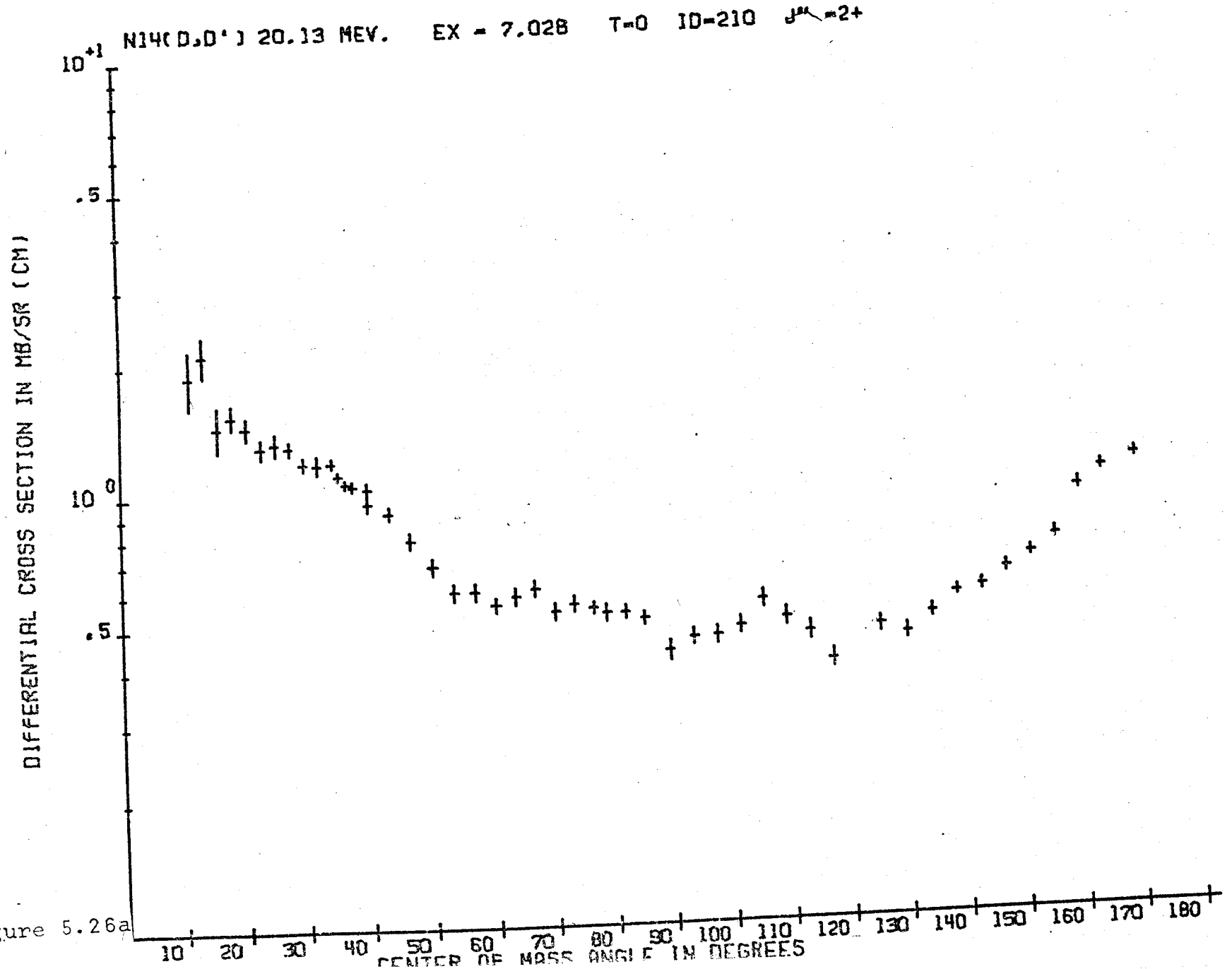

N14(D,D') 20.13 MEV. EX = 7.028 T=0 ID=210 J^π=2+
10+1
.5
10 0
.5
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.26a

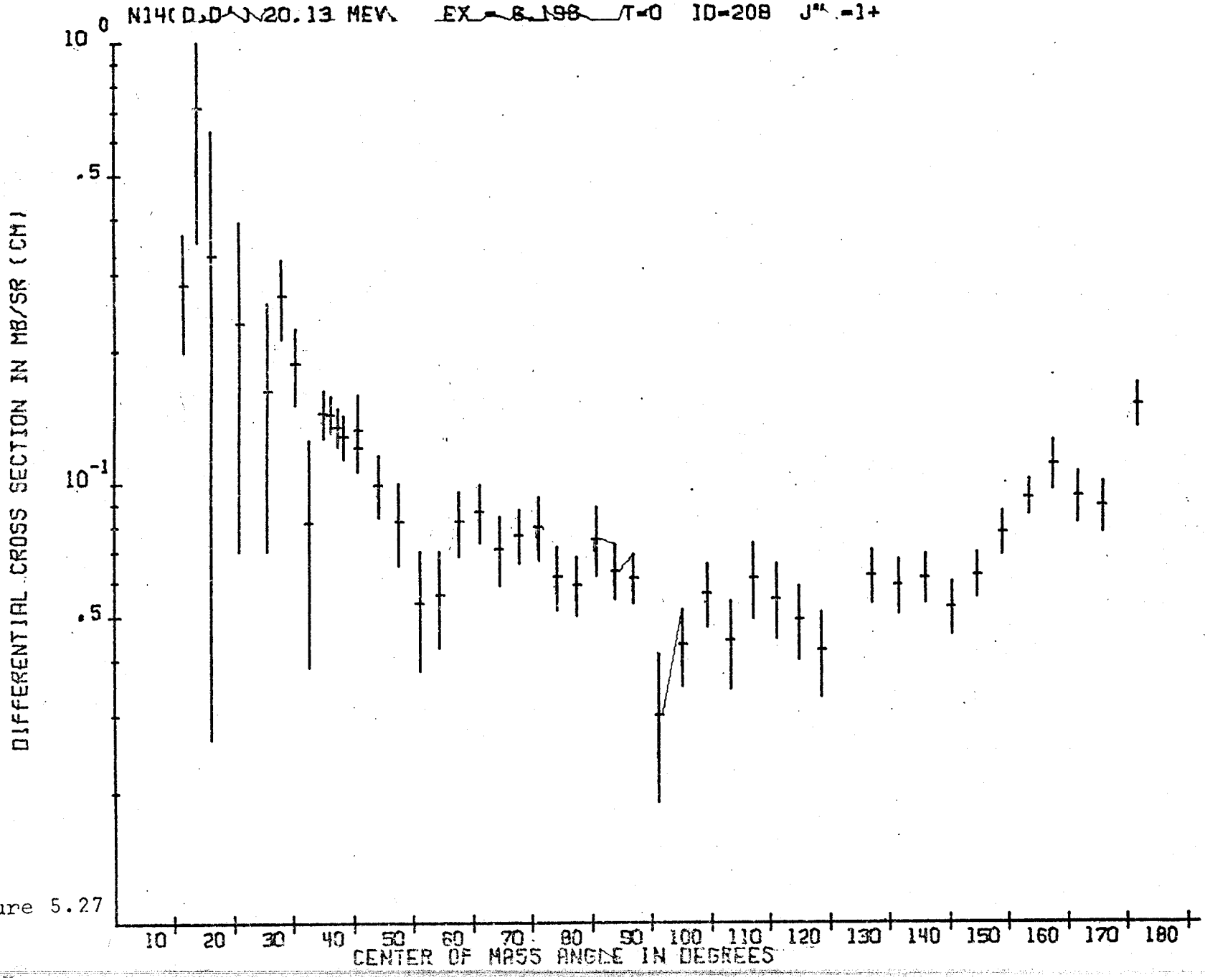

N14(D,D)N 20.13 MEV EX = 8.198 T=0 ID=208 J^π =1+
10^0
.5
10^-1
.5
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.27

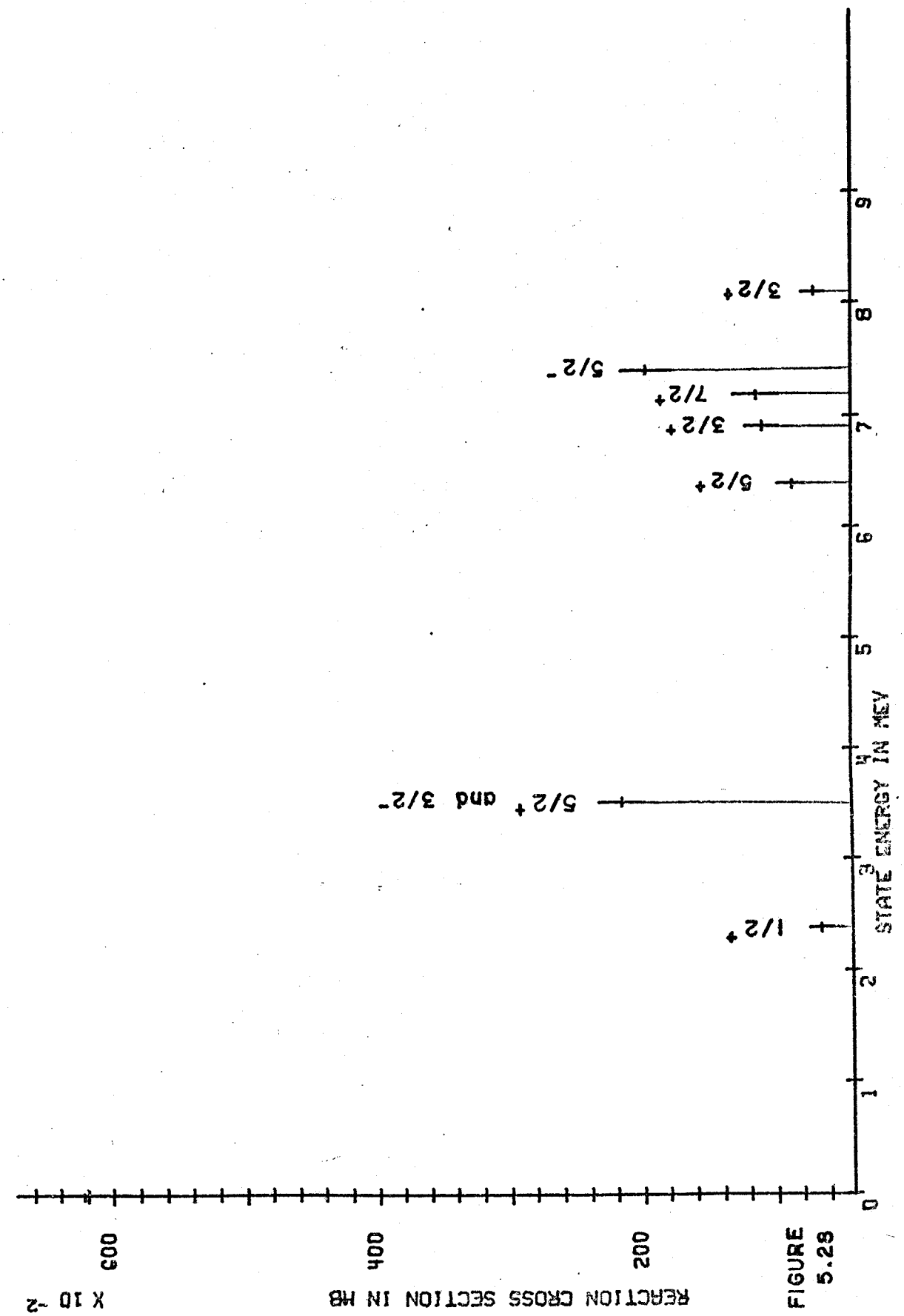

N14(D,T) 20.13 MEV. TOTAL CROSS SECTION FOR ALL STATES
REACTION CROSS SECTION IN MB
X 10 -2
600
400
200
0
1
2
3
4
5
6
7
8
9
STATE ENERGY IN MEV
1/2+
5/2+ and 3/2-
5/2+
3/2+
7/2+
5/2-
3/2+

FIGURE 5.28

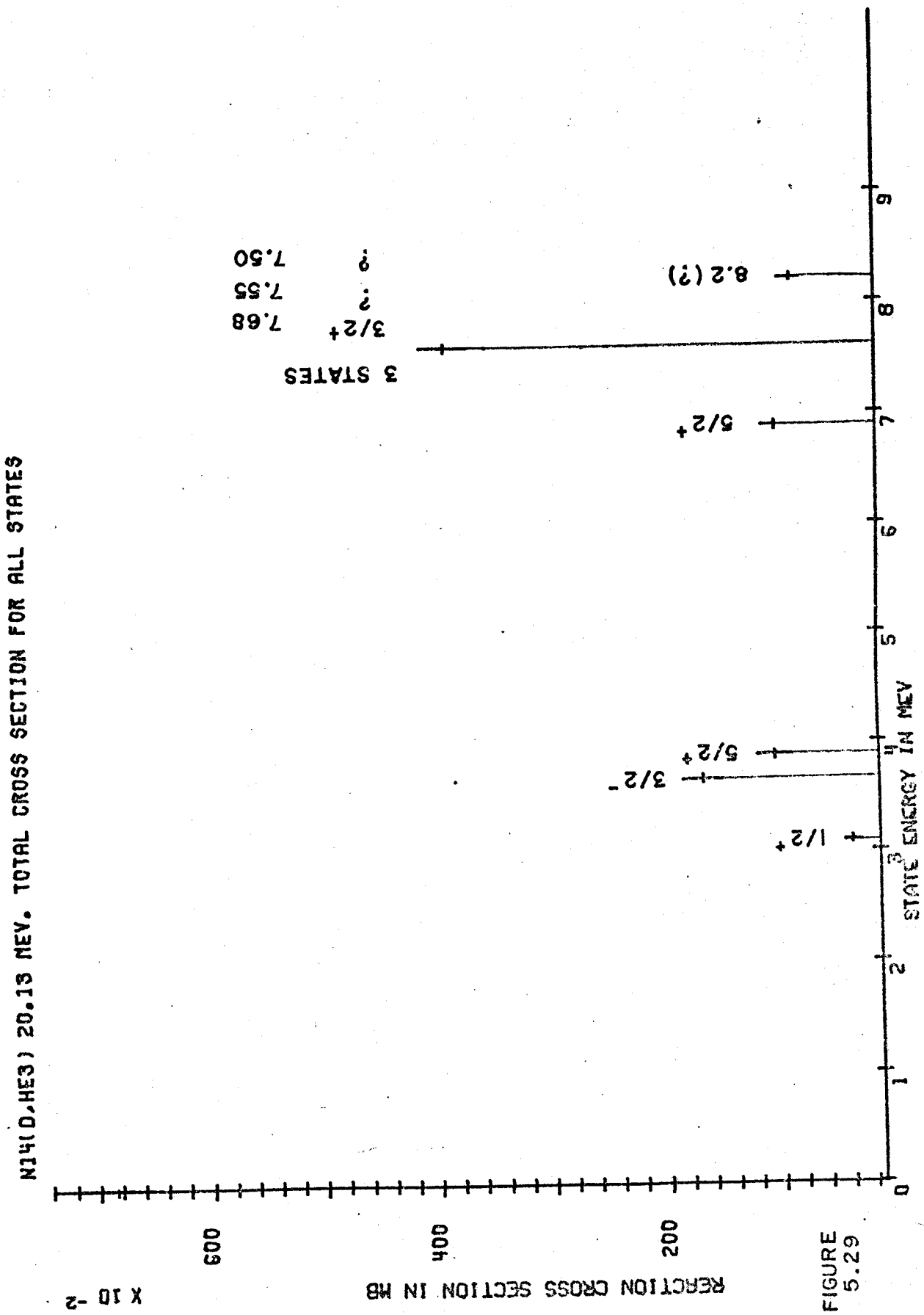

N14(D,HE3) 20.13 MEV. TOTAL CROSS SECTION FOR ALL STATES
X 10 -2
REACTION CROSS SECTION IN MB
600
400
200
0
1
2
3
4
5
6
7
8
9
STATE ENERGY IN MEV
1/2+
3/2-
5/2+
5/2+
3 STATES
3/2+ 7.68
? 7.55
? 7.50
8.2 (?)

FIGURE 5.29

Low lying states observed in these one nucleon pick up reactions should be made by removal of a $P_{\frac{1}{2}}$ particle and hence should be negative parity states. These states $1/2^-$, $3/2^-$ can be seen as strongly excited. However weak $1/2^+$ and $5/2^+$ states can also be seen. These could be formed in a firect pick up reaction if the ground state of ^{14}N has some admixture of 2s - 1d shell ($2s_{\frac{1}{2}}$, $d_{\frac{5}{2}}$,$d_{\frac{3}{2}}$) to the dominant s^4p^{10} configuration. These positive parity states could also be excited through the formation of a compound nucleus (^{16}O), and this process probably contributes to the cross section at these energies. As they are observed here, it is clear from their angular distribution (Figure 5.210) that a considerable contribution from direct process is involved, thus indicating the presence of higher shell admixture. This agrees with previously reported results on the $^{14}N(p,d)^{13}N$ reaction (Ko 67) where spectroscopic factors for the reaction were extracted.

Of the five dominant transitions to negative parity states only three are observed ($1/2^-$, $3/2^-$, $5/2^-$). The other two, $1/2^-$ and $3/2^-$ are at a higher excitation energy, 8.93 and 11.80 MeV respectively (Ko 67).

The other one particle transfer reactions possible are (d,p) and (d,n) stripping. Neutrons were not detected in this experiment. The only data extracted for the (d,p) reaction was the total reaction cross section angular distribution

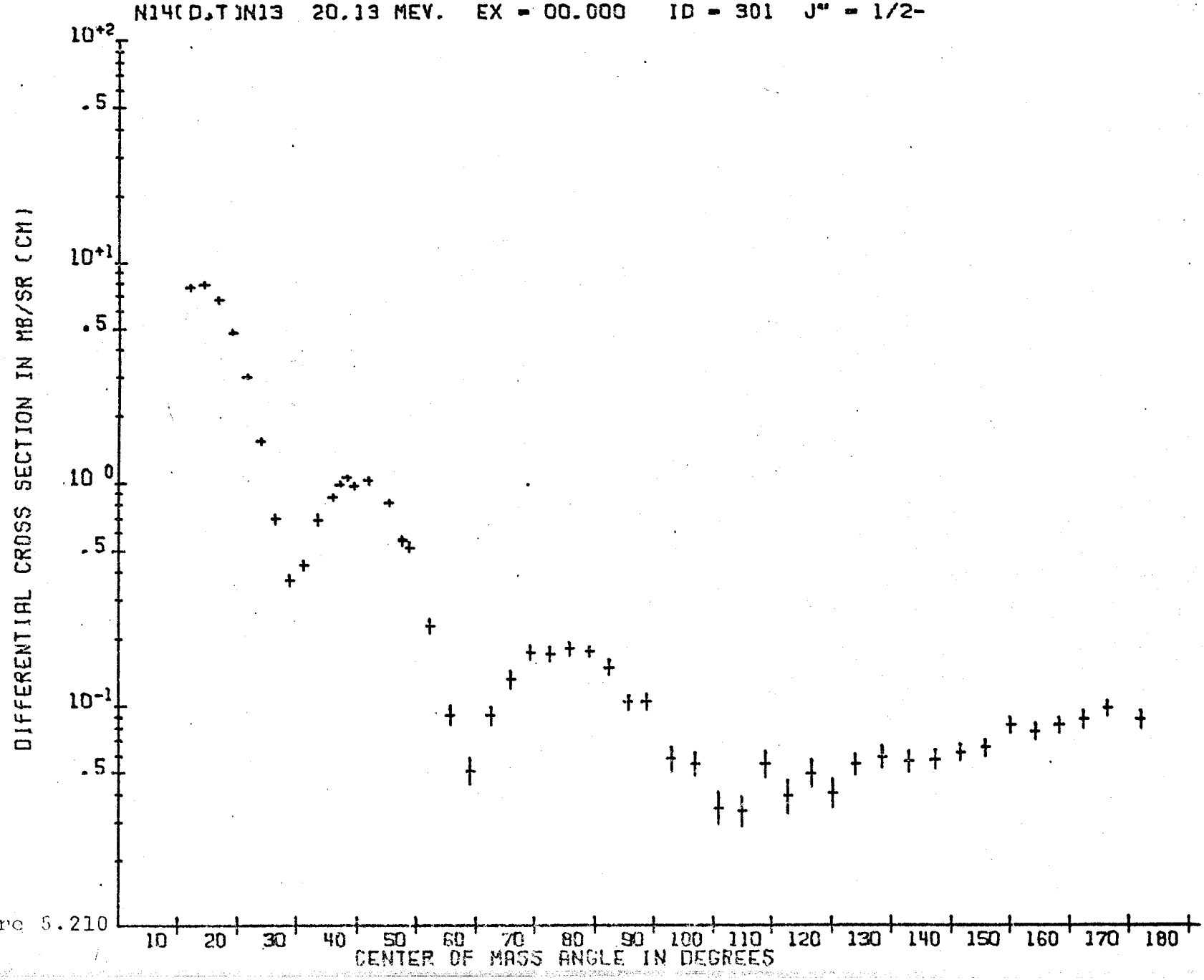

N14(D,T)N13 20.13 MEV. EX = 00.000 ID = 301 J" = 1/2-
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
10+2
.5
10+1
.5
10 0
.5
10-1
.5
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.210

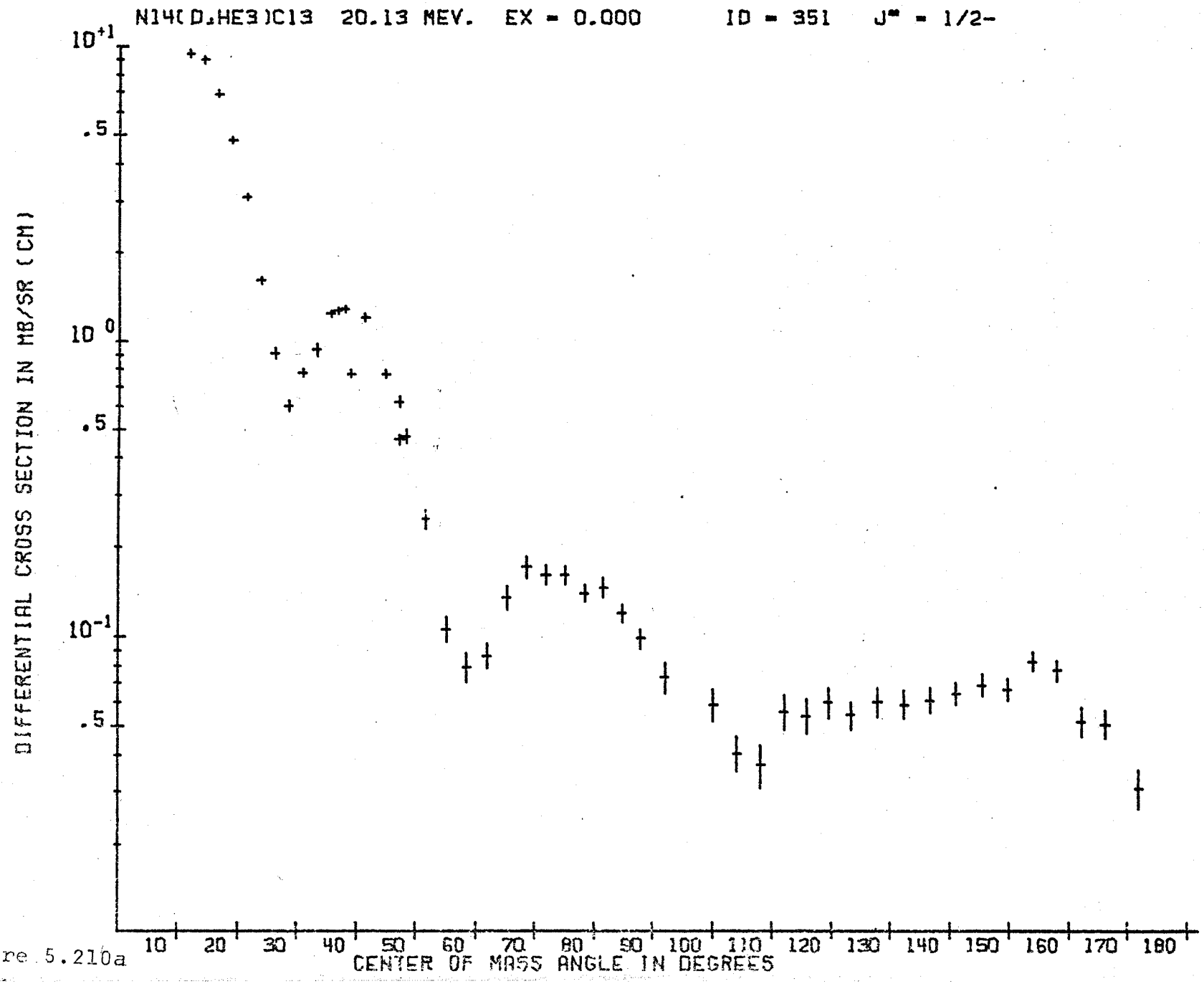


Figure 5.210a

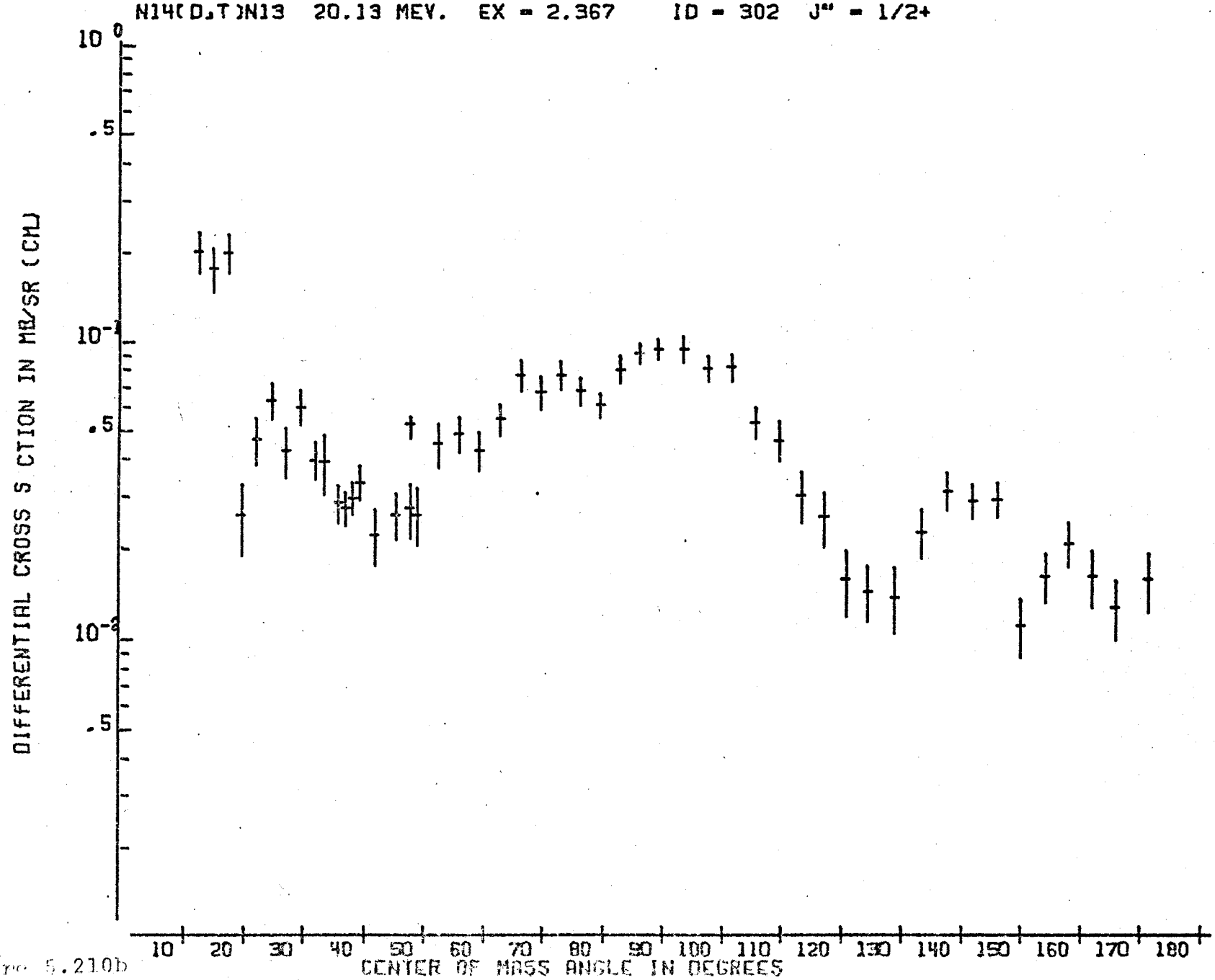


Figure 5.210b

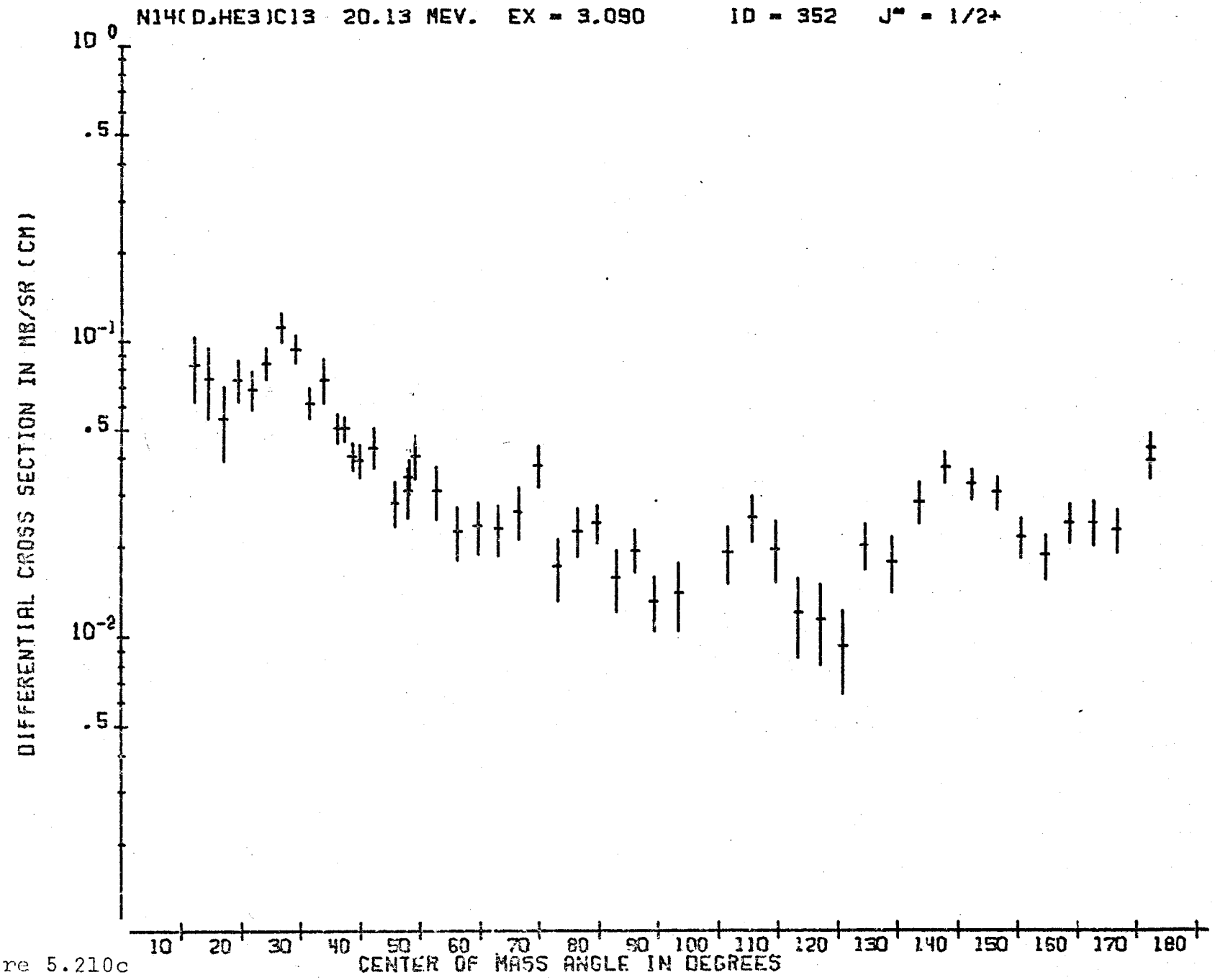


Figure 5.210c

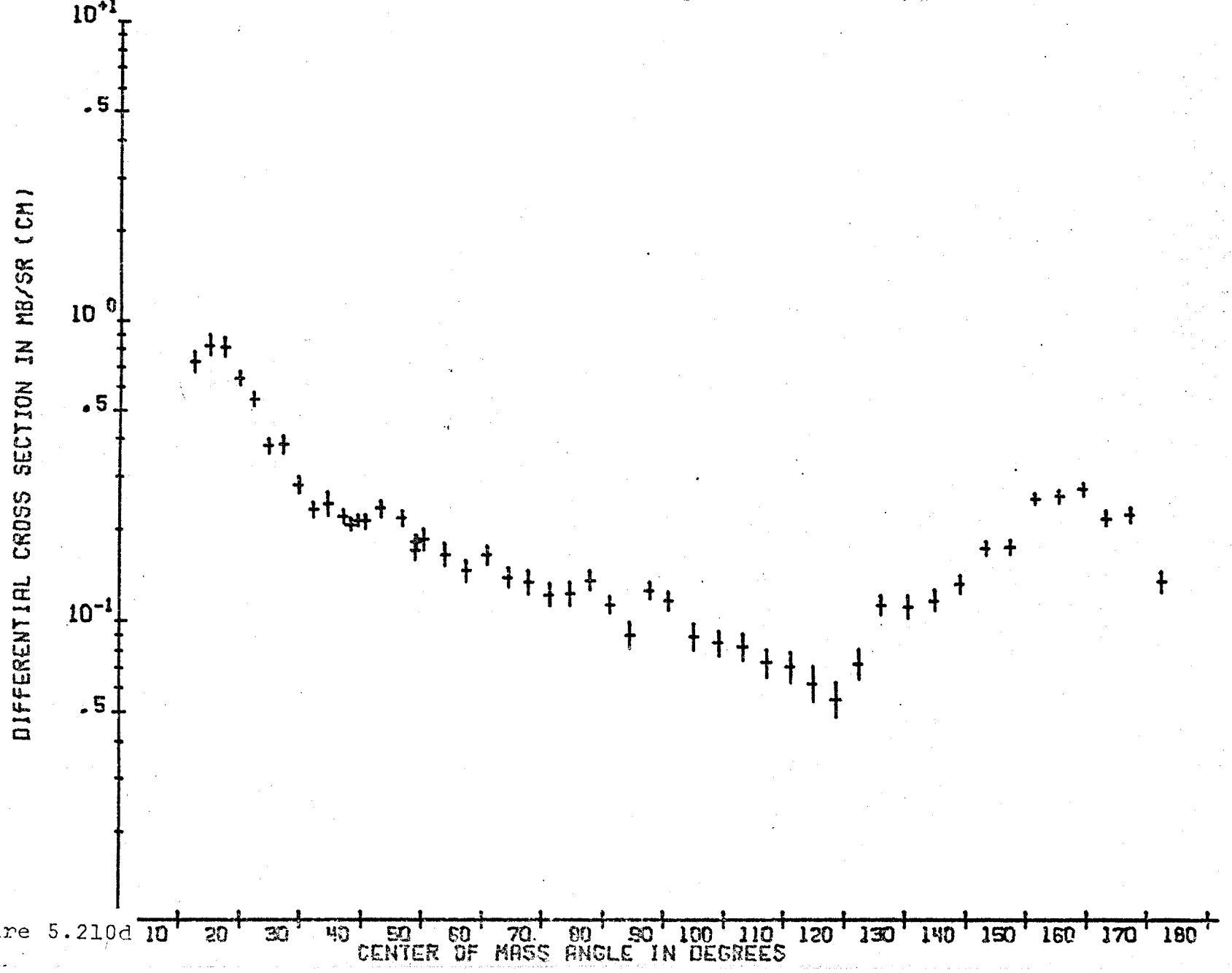


Figure 5.210d

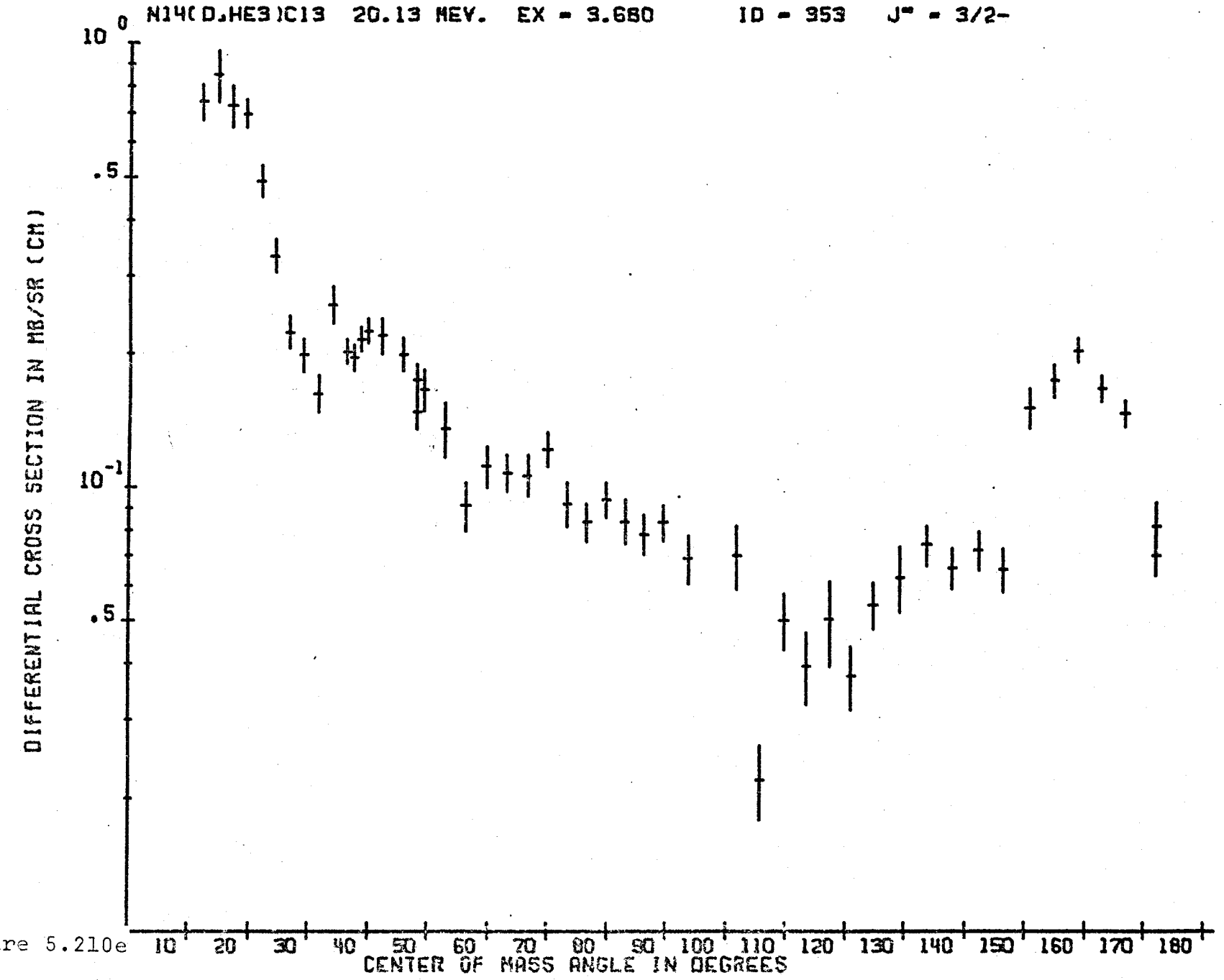


Figure 5.210e

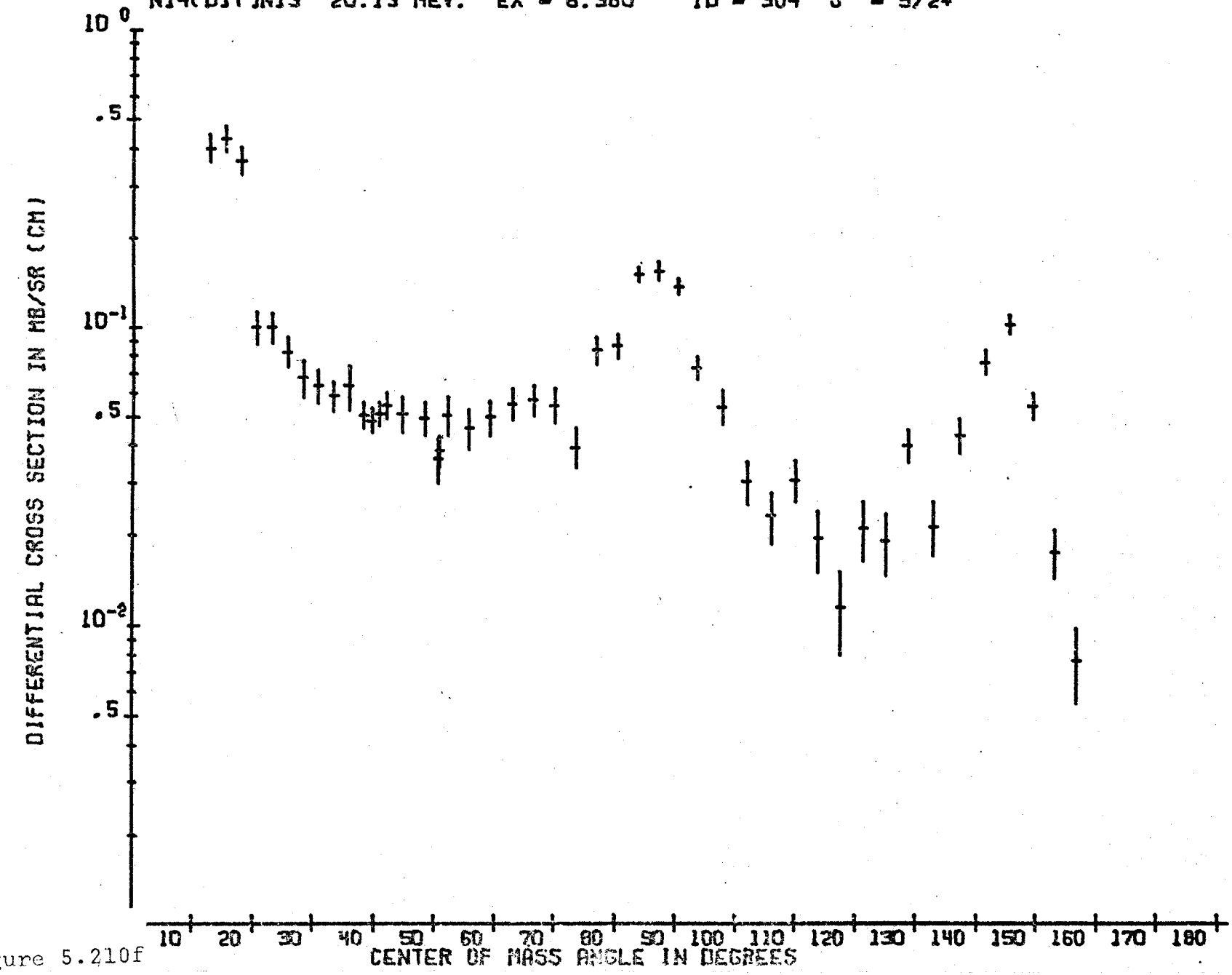


Figure 5.210f

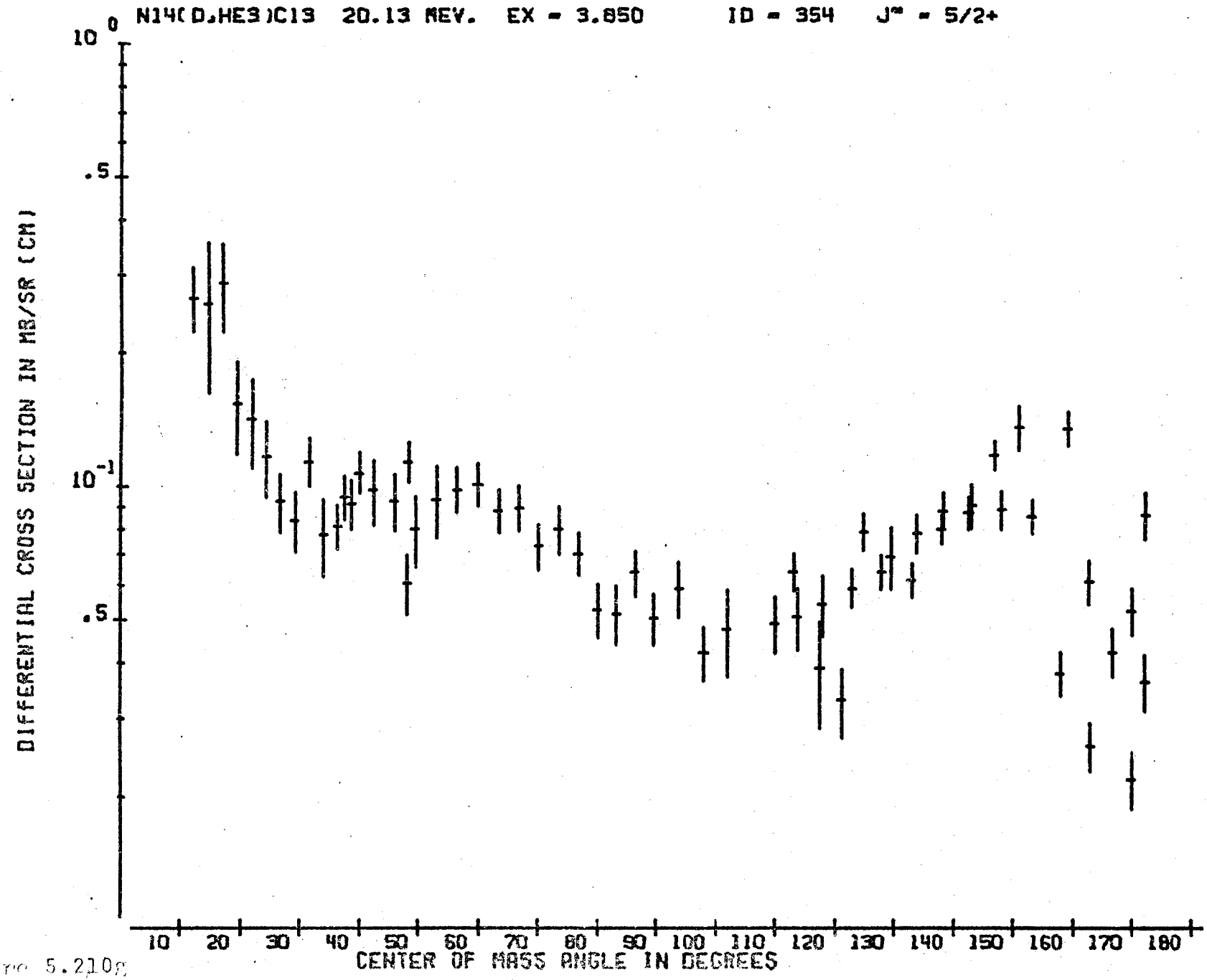

N14(D,HE3)C13 20.13 MEV. EX = 3.850 ID = 354 J^π = 5/2+
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
10^0
.5
10^-1
.5
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
CENTER OF MASS ANGLE IN DEGREES

Figure 5.21a

and the total cross sections since very good spectroscopic information is already available from high resolution (d,p) work.

5.23 Two Particle Pick Up

The (d,α) reaction is the only two particle pick up reaction present in this data. Figure 5.211 shows the total cross section for the first ten states of ^{12}C. The ground state 0^+ is formed by picking up the $2P^-$ nucleons. The strongly excited 2^+ at 4.4 MeV results from picking up two nucleons from the P^- shell. The angular distributions for each of the states excited by this reaction are shown in Figure 5.211. Since the lowest T = 1 state in ^{12}C is above 15 MeV, the isospin selection rule does not inhibit any state in the range of energy where data was measured.

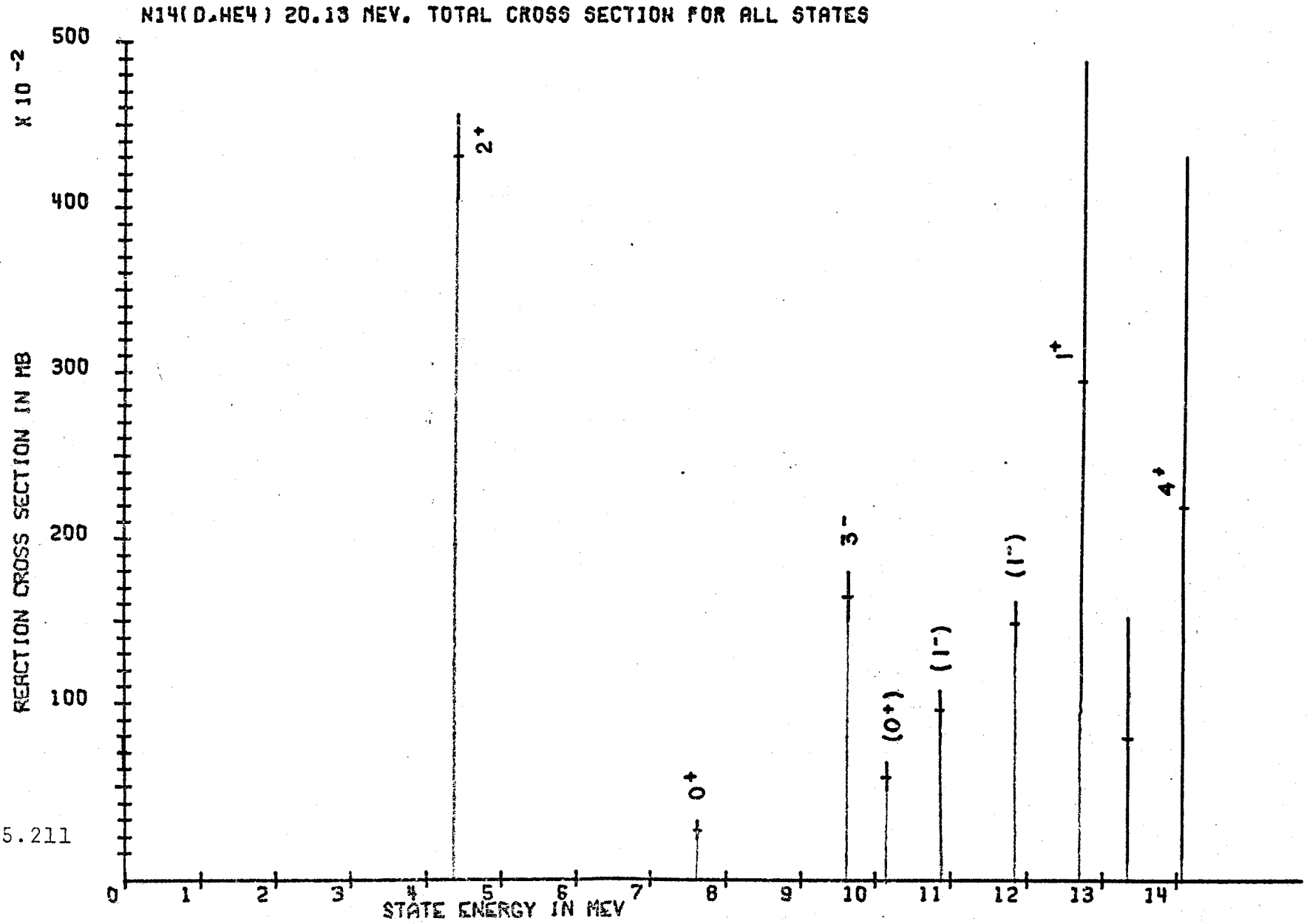

N14(D,HE4) 20.13 MEV. TOTAL CROSS SECTION FOR ALL STATES
REACTION CROSS SECTION IN MB
X 10 -2
500
400
300
200
100
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
STATE ENERGY IN MEV
2+
0+
3-
(0+)
(1-)
(1-)
1+
4+

Figure 5.211

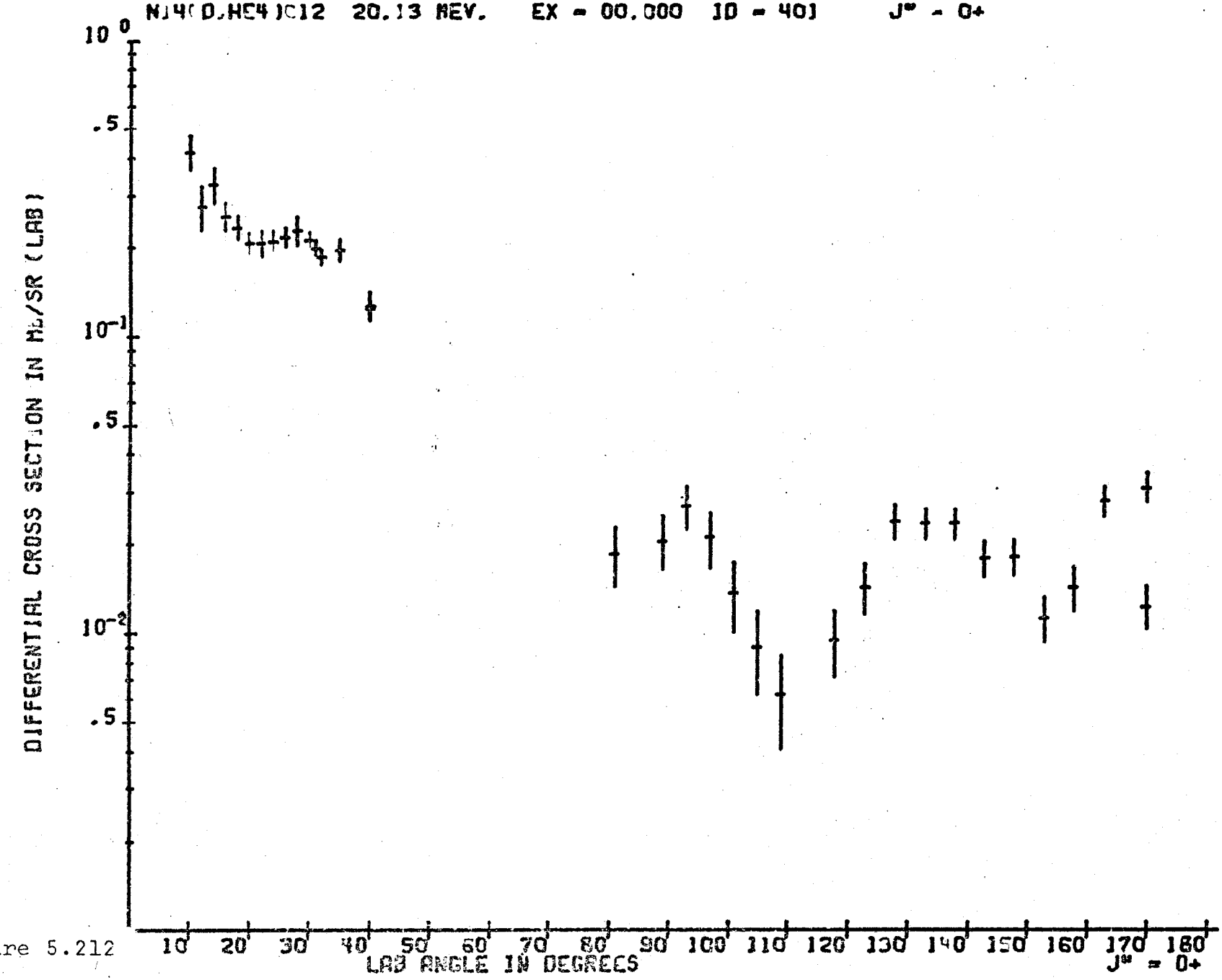

N14(D,HE4)C12 20.13 MEV. EX = 00.000 ID = 401 J* = 0+
DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
10 0
.5
10-1
.5
10-2
.5
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
LAB ANGLE IN DEGREES
J* = 0+

Figure 5.212

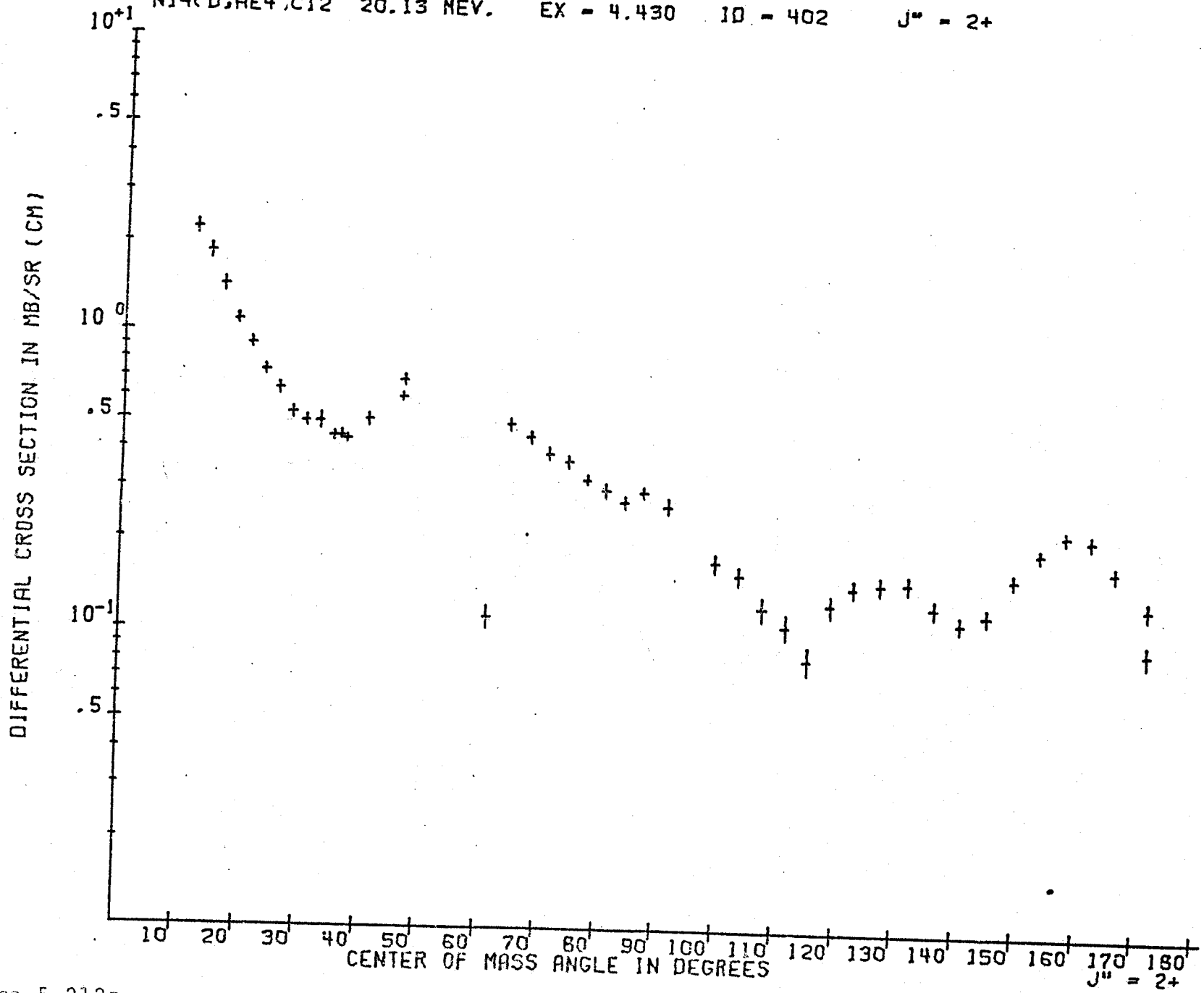


Figure 5.212a

Figure 5.212b

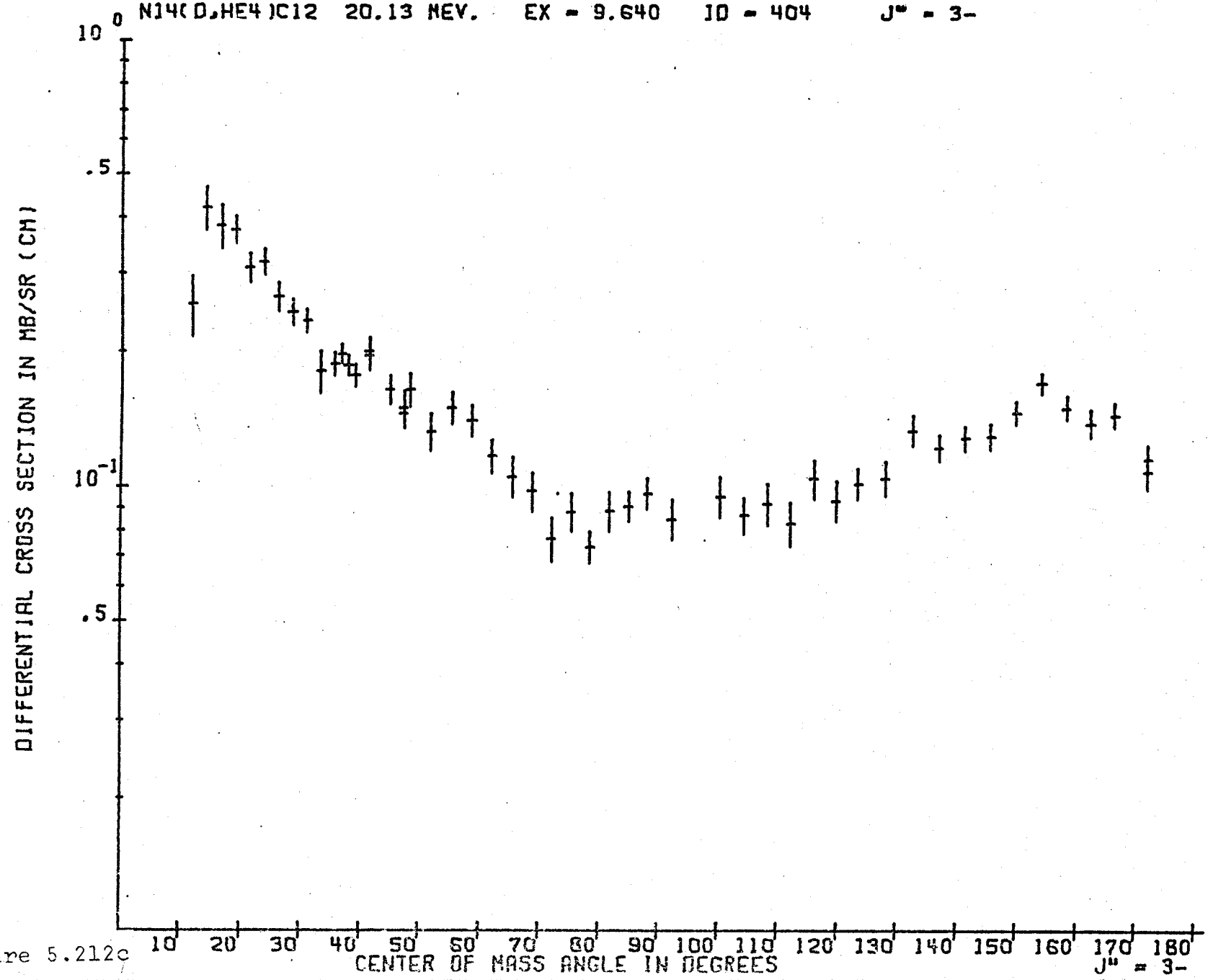


Figure 5.212c

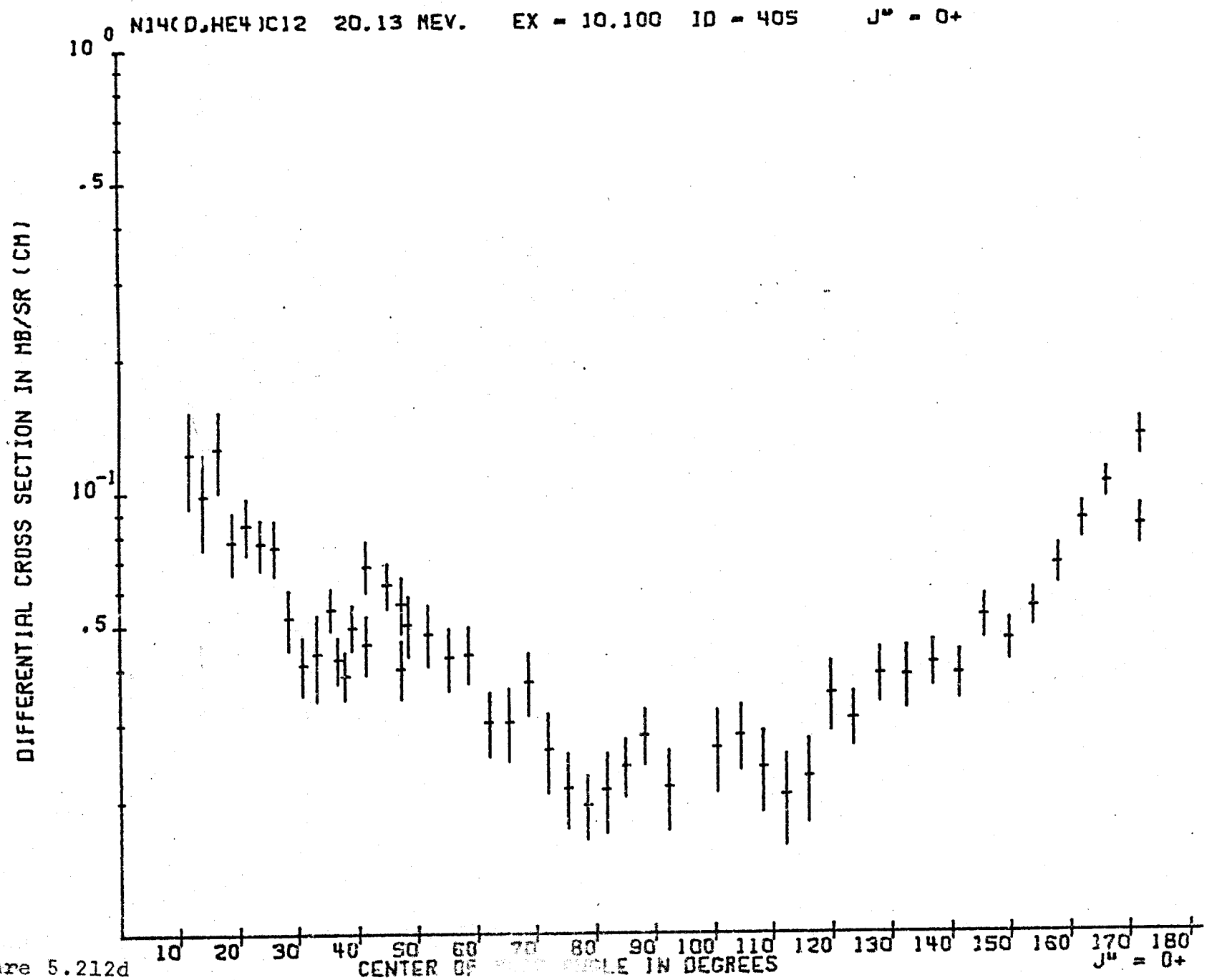


Figure 5.212d

6. CONCLUSION

We have found that a wide range of optical potentials will give essentially the same quality fit to the deuteron elastic scattering at 20 MeV. The best fit required a large imaginary volume term with a reduced imaginary surface term. The average value of CHI-SQUARED achieved by this set of parameters is larger than what is generally obtained for highly accurate and complete proton elastic scattering data. This reflects in part the high accuracy of the experimental data, and demonstrates the difficulties in the optical model representation of elastic scattering as applied in this investigation. Nevertheless the agreement is remarkable in view of the simplicity of the model.

The extensive deuteron inelastic data allowed the assignment of isospin for many of the highly excited states in ^{14}N. The other reactions measured contributed primarily to the measurement of the total reaction cross section.

The inelastic scattering also provided confirmation of theoretical descriptions of the levels of ^{14}N. Similar investigations performed systematically on other nuclei should reveal a more complete picture of the complex phenomena of nuclear interactions.

APPENDICES

APPENDIX A

Tabulation of Differential Cross Sections and Total Reaction Cross Sections at 20.13 MeV ^{14}N Target

The following pages contain listings of angular distributions, reaction cross sections, and total reaction cross sections for all the processes recorded with ^{14}N as the target. Each page has as a function of center-of-mass angle, the center-of-mass differential cross section in mb/sr, and the total error in mb/sr. The lab differential cross section and error are on the reverse side of the page, listed as a function of lab angle. The excitation energy of the state and error in MeV, spin, parity, isotopic spin, reaction cross section and error in mb appear with each angular distribution. The reaction cross section was computed from the angular distribution using

$$= 2\pi \int_0^{180} f(\theta)\sin\theta \, d\theta \quad \text{(see Sec. 4.4)}$$

The excitation energies and errors are computed separately on the basis of angles forward of 90°, backward from 90°, and all angles.

APPENDIX A.1

$^{14}N(d,d)$

N14(D,D) 20.13 MEV. EX = 0.000 T=0 ID=201 J = 1+

AVERAGE ENERGY = 0.0001+- 0.0001 THETA < 90
AVERAGE ENERGY = -0.0007+- 0.0007 THETA > 90
AVERAGE ENERGY = -0.0002+- 0.0003 ALL ANGLES
REACTION CROSS SECTION = 1.213E+03 +- 0.577E+02
INTEGRATION LENGTH = 2.967 + 0.099 + 0.075 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.684E+03	5.706E+01
11.40	2.684E+03	5.706E+01
13.68	2.009E+03	2.733E+01
15.97	1.485E+03	1.919E+01
18.25	1.031E+03	1.273E+01
20.52	7.014E+02	8.630E+00
22.80	4.387E+02	5.138E+00
25.07	2.554E+02	8.199E+00
27.34	1.330E+02	1.529E+00
29.60	6.125E+01	7.133E-01
31.86	2.257E+01	3.361E-01
34.12	6.547E+00	9.660E-02
35.24	3.873E+00	6.129E-02
36.37	3.400E+00	5.509E-02
37.49	4.385E+00	7.156E-02
39.73	8.010E+00	1.270E-01
39.73	7.464E+00	1.231E-01
43.08	1.216E+01	1.649E-01
46.42	1.282E+01	1.853E-01
49.74	1.018E+01	1.578E-01
53.05	6.836E+00	1.098E-01
56.34	4.951E+00	8.773E-02
59.61	4.939E+00	8.383E-02
62.86	6.136E+00	1.053E-01
66.10	8.349E+00	1.294E-01
69.31	1.005E+01	1.393E-01
69.31	1.005E+01	1.393E-01
72.51	1.119E+01	1.533E-01
75.68	1.149E+01	1.459E-01
78.84	1.098E+01	1.547E-01
81.97	9.975E+00	1.312E-01
85.08	8.679E+00	1.196E-01
89.19	7.284E+00	1.176E-01
93.26	6.484E+00	1.036E-01
97.29	6.145E+00	1.026E-01
101.28	6.352E+00	1.010E-01
105.23	6.704E+00	1.129E-01
109.14	6.963E+00	1.177E-01
113.01	6.899E+00	1.154E-01
116.84	6.617E+00	1.085E-01
125.31	5.450E+00	9.136E-02
129.94	4.256E+00	6.767E-02
134.52	3.396E+00	5.430E-02
139.04	2.824E+00	4.477E-02
143.53	2.671E+00	4.370E-02
147.96	2.832E+00	4.578E-02
152.37	3.236E+00	5.103E-02
156.73	3.289E+00	5.240E-02
161.07	4.111E+00	6.668E-02
165.39	4.580E+00	7.163E-02
171.41	5.512E+00	9.648E-02
180.00	5.512E+00	9.648E-02

APPENDIX A.2

$^{14}N(d,d')^{14}N^*$ EX < 15 MeV

N14(D,D') 20.13 MEV. EX = 3.945 T=0 ID=203 J =1+

AVERAGE ENERGY = 3.9430+- 0.0006 THETA < 90
AVERAGE ENERGY = 3.9483+- 0.0007 THETA > 90
AVERAGE ENERGY = 3.9451+- 0.0006 ALL ANGLES
REACTION CROSS SECTION = 7.060E+00 +- 0.431E+00
INTEGRATION LENGTH = 2.967 + 0.101 + 0.073 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.674E+00	3.517E-01
11.59	1.874E+00	3.517E-01
13.91	1.771E+00	3.087E-01
16.23	1.649E+00	2.415E-01
18.55	1.299E+00	1.514E-01
20.87	1.392E+00	1.226E-01
23.18	1.412E+00	1.016E-01
25.49	1.354E+00	9.143E-02
27.79	1.405E+00	5.936E-02
30.09	1.308E+00	4.735E-02
32.38	1.319E+00	6.874E-02
34.67	1.204E+00	3.353E-02
36.81	1.198E+00	2.916E-02
38.95	1.124E+00	2.748E-02
41.09	1.076E+00	3.058E-02
42.37	1.040E+00	3.665E-02
42.37	1.054E+00	4.180E-02
43.77	8.808E-01	3.190E-02
47.15	7.677E-01	3.498E-02
50.52	6.445E-01	3.377E-02
53.86	6.220E-01	2.774E-02
57.19	5.944E-01	2.671E-02
60.50	5.684E-01	2.412E-02
63.79	5.289E-01	2.609E-02
67.06	5.397E-01	2.492E-02
70.30	5.997E-01	2.660E-02
70.30	5.997E-01	2.660E-02
73.53	5.875E-01	2.407E-02
76.72	5.746E-01	1.978E-02
79.90	5.587E-01	2.497E-02
83.05	5.609E-01	1.952E-02
86.18	5.250E-01	1.933E-02
90.30	4.177E-01	2.331E-02
94.38	3.645E-01	1.906E-02
98.42	3.398E-01	1.917E-02
102.40	2.916E-01	1.639E-02
106.35	2.710E-01	2.005E-02
110.24	2.634E-01	1.840E-02
114.09	2.517E-01	1.732E-02
117.90	2.000E-01	1.576E-02
126.30	2.399E-01	1.521E-02
130.88	2.353E-01	1.372E-02
135.40	2.162E-01	1.216E-02
139.86	2.709E-01	1.196E-02
144.27	3.543E-01	1.362E-02
148.64	3.729E-01	1.448E-02
152.96	4.350E-01	1.571E-02
157.24	4.389E-01	1.711E-02
161.49	4.679E-01	1.863E-02
165.72	3.918E-01	1.644E-02
171.60	3.605E-01	1.755E-02
180.00	3.605E-01	1.755E-02

N14(D,D') 20.13 MEV. EX = 4.913 T=0 ID=204 J =0+

AVERAGE ENERGY = 4.9011+- 0.0015 THETA < 90
AVERAGE ENERGY = 4.9060+- 0.0019 THETA > 90
AVERAGE ENERGY = 4.9030+- 0.0012 ALL ANGLES
REACTION CROSS SECTION = 2.133E+00 +- 0.380E+00
INTEGRATION LENGTH = 2.967 + 0.102 + 0.073 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.296E+00	5.174E-01
11.65	1.296E+00	5.174E-01
13.98	1.495E+00	3.728E-01
16.32	1.216E+00	3.139E-01
18.65	8.320E-01	2.205E-01
20.97	5.117E-01	1.840E-01
23.30	2.085E-01	1.175E-01
25.62	2.869E-01	8.936E-02
27.93	2.035E-01	4.862E-02
30.24	1.288E-01	2.769E-02
32.54	1.077E-01	4.064E-02
34.85	9.298E-02	1.484E-02
35.99	1.260E-01	1.187E-02
37.14	1.246E-01	1.188E-02
38.28	1.231E-01	1.249E-02
40.57	1.561E-01	1.499E-02
40.57	1.304E-01	2.665E-02
43.98	1.651E-01	1.746E-02
47.38	1.414E-01	1.871E-02
50.76	1.609E-01	2.139E-02
54.12	1.329E-01	1.696E-02
57.46	9.898E-02	1.357E-02
60.78	1.161E-01	1.183E-02
64.08	1.145E-01	1.463E-02
67.36	1.273E-01	1.249E-02
70.61	1.462E-01	1.472E-02
70.61	1.462E-01	1.472E-02
73.84	1.540E-01	1.608E-02
77.05	1.506E-01	1.181E-02
80.23	1.676E-01	2.004E-02
83.39	1.462E-01	1.519E-02
86.52	1.150E-01	1.189E-02
90.65	9.094E-02	1.540E-02
94.73	9.098E-02	1.395E-02
98.77	1.006E-01	1.107E-02
102.76	9.164E-02	1.115E-02
106.70	6.331E-02	1.326E-02
110.58	7.603E-02	1.108E-02
114.44	6.032E-02	1.030E-02
118.23	7.071E-02	1.003E-02
126.61	9.226E-02	1.149E-02
131.18	8.621E-02	9.673E-03
135.68	1.216E-01	1.120E-02
140.12	1.381E-01	1.047E-02
144.51	1.696E-01	1.316E-02
148.85	1.772E-01	1.339E-02
153.14	1.866E-01	1.387E-02
157.40	1.802E-01	1.833E-02
161.62	1.950E-01	2.464E-02
165.82	1.766E-01	2.290E-02
171.66	1.808E-01	2.703E-02
180.00	1.808E-01	2.703E-02

STOP

N14(D,D') 20.13 MEV. EX = 5.106 T=0 ID=205 J =2-

AVERAGE ENERGY = 5.1038+- 0.0008 THETA < 90
AVERAGE ENERGY = 5.1068+- 0.0012 THETA > 90
AVERAGE ENERGY = 5.1050+- 0.0007 ALL ANGLES
REACTION CROSS SECTION = 4.701E+00 +- 0.471E+00
INTEGRATION LENGTH = 2.967 + 0.102 + 0.073 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	9.376E-01	5.884E-01
11.66	9.376E-01	5.884E-01
14.00	7.501E-01	4.086E-01
16.34	8.820E-01	3.431E-01
18.67	7.345E-01	2.323E-01
21.00	8.907E-01	1.957E-01
23.32	5.674E-01	1.335E-01
25.65	9.106E-01	1.117E-01
27.96	7.902E-01	6.144E-02
30.28	9.281E-01	4.147E-02
32.58	1.001E+00	6.429E-02
34.88	9.618E-01	3.088E-02
36.03	9.344E-01	2.599E-02
37.18	9.262E-01	2.550E-02
38.32	9.038E-01	2.843E-02
40.61	8.830E-01	3.372E-02
40.61	8.466E-01	4.326E-02
44.03	6.920E-01	2.985E-02
47.43	6.044E-01	3.215E-02
50.81	5.057E-01	3.206E-02
54.18	3.825E-01	2.448E-02
57.52	3.337E-01	2.137E-02
60.84	3.153E-01	1.837E-02
64.15	3.194E-01	2.216E-02
67.42	2.975E-01	1.868E-02
70.68	2.921E-01	1.988E-02
70.68	2.921E-01	1.988E-02
70.68	2.921E-01	1.988E-02
73.91	2.964E-01	2.031E-02
77.12	2.716E-01	1.472E-02
80.30	2.689E-01	2.337E-02
83.46	2.692E-01	1.815E-02
86.59	2.834E-01	1.629E-02
90.72	2.363E-01	2.071E-02
94.81	2.107E-01	1.797E-02
98.85	2.161E-01	1.566E-02
102.84	2.526E-01	1.644E-02
106.78	2.217E-01	1.944E-02
110.67	1.472E-01	1.471E-02
114.51	1.981E-01	1.627E-02
118.31	1.789E-01	1.469E-02
126.68	2.492E-01	1.663E-02
131.24	1.978E-01	1.365E-02
135.74	2.306E-01	1.407E-02
140.17	2.503E-01	1.312E-02
144.56	2.674E-01	1.528E-02
148.89	2.863E-01	1.593E-02
153.19	3.081E-01	1.629E-02
157.44	3.418E-01	2.228E-02
161.65	4.250E-01	2.883E-02
165.84	4.399E-01	2.763E-02
171.67	4.770E-01	3.232E-02
180.00	4.770E-01	3.232E-02

N14(D,D') 20.13 MEV. EX = 5.691 T=0 ID=206 J =1-

AVERAGE ENERGY = 5.6798+- 0.0014 THETA < 90
AVERAGE ENERGY = 5.6749+- 0.0018 THETA > 90
AVERAGE ENERGY = 5.6779+- 0.0012 ALL ANGLES
REACTION CROSS SECTION = 2.965E+00 +- 0.465E+00
INTEGRATION LENGTH = 2.967 + 0.102 + 0.072 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.262E+00	5.283E-01
11.70	1.262E+00	5.283E-01
14.05	1.412E+00	3.537E-01
16.39	1.109E+00	2.678E-01
18.73	9.047E-01	1.887E-01
21.07	8.946E-01	1.543E-01
23.40	5.329E-01	1.173E-01
25.73	6.028E-01	1.085E-01
28.06	3.506E-01	5.283E-02
30.38	2.704E-01	3.859E-02
32.69	1.683E-01	5.272E-02
35.00	1.535E-01	2.356E-02
36.15	1.984E-01	2.593E-02
37.31	1.964E-01	2.507E-02
38.45	2.116E-01	1.922E-02
40.75	2.556E-01	2.509E-02
40.74	2.723E-01	3.188E-02
44.17	2.899E-01	2.270E-02
47.58	2.795E-01	2.603E-02
50.98	2.381E-01	2.685E-02
54.35	2.053E-01	1.868E-02
57.70	1.934E-01	1.916E-02
61.03	1.432E-01	1.706E-02
64.34	1.743E-01	1.615E-02
67.63	2.024E-01	2.531E-02
70.89	1.780E-01	2.550E-02
70.89	1.780E-01	2.550E-02
74.13	2.080E-01	2.327E-02
77.34	2.180E-01	2.037E-02
80.53	2.312E-01	2.770E-02
83.69	2.114E-01	2.188E-02
86.82	1.932E-01	2.258E-02
90.96	1.535E-01	2.416E-02
95.04	1.502E-01	1.564E-02
99.08	1.169E-01	1.775E-02
103.07	1.003E-01	1.386E-02
107.00	9.453E-02	1.587E-02
110.90	9.490E-02	1.723E-02
114.74	8.917E-02	1.319E-02
118.53	9.455E-02	1.793E-02
126.89	1.458E-01	2.002E-02
131.44	1.815E-01	1.890E-02
135.92	2.015E-01	2.521E-02
140.35	2.248E-01	2.338E-02
144.72	2.401E-01	2.369E-02
149.03	2.516E-01	2.128E-02
153.31	2.891E-01	2.586E-02
157.54	2.062E-01	2.536E-02
161.74	2.267E-01	2.859E-02
165.91	2.073E-01	3.667E-02
171.71	2.761E-01	4.743E-02
180.00	2.761E-01	4.743E-02

N14(D,D') 20.13 MEV. EX = 5.834 T=0 ID=207 J. =3-

AVERAGE ENERGY = 5.8348+- 0.0013 THETA < 90
AVERAGE ENERGY = 5.8339+- 0.0018 THETA > 90
AVERAGE ENERGY = 5.8344+- 0.0011 ALL ANGLES
REACTION CROSS SECTION = 6.267E+00 +- 0.553E+00
INTEGRATION LENGTH = 2.967 + 0.102 + 0.072 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.085E+00	5.799E-01
11.72	1.085E+00	5.799E-01
14.07	1.265E+00	3.771E-01
16.41	1.071E+00	2.863E-01
18.75	9.145E-01	2.072E-01
21.09	1.078E+00	1.706E-01
23.43	9.390E-01	1.322E-01
25.76	1.085E+00	1.187E-01
28.08	1.150E+00	6.748E-02
30.41	1.164E+00	5.053E-02
32.72	1.139E+00	7.299E-02
35.03	1.114E+00	3.719E-02
36.19	1.137E+00	3.637E-02
37.34	1.062E+00	3.464E-02
38.49	1.033E+00	3.297E-02
40.78	1.030E+00	4.067E-02
40.78	9.185E-01	4.556E-02
44.21	8.534E-01	3.395E-02
47.62	6.687E-01	3.588E-02
51.02	6.299E-01	3.688E-02
54.39	5.005E-01	2.670E-02
57.75	4.513E-01	2.610E-02
61.08	4.429E-01	2.453E-02
64.39	4.216E-01	2.395E-02
67.68	4.473E-01	3.039E-02
70.94	4.483E-01	3.168E-02
70.94	4.483E-01	3.168E-02
74.19	4.545E-01	2.846E-02
77.40	4.431E-01	2.402E-02
80.59	4.178E-01	3.191E-02
83.75	3.684E-01	2.477E-02
86.88	3.474E-01	2.562E-02
91.02	2.798E-01	2.833E-02
95.11	2.677E-01	1.928E-02
99.15	2.763E-01	2.219E-02
103.13	2.615E-01	1.860E-02
107.07	2.702E-01	2.216E-02
110.96	2.824E-01	2.324E-02
114.80	2.820E-01	1.998E-02
118.59	2.906E-01	2.356E-02
126.95	4.073E-01	2.562E-02
131.49	3.631E-01	2.266E-02
135.97	3.772E-01	2.789E-02
140.39	3.543E-01	2.541E-02
144.76	3.532E-01	2.540E-02
149.08	3.924E-01	2.358E-02
153.34	4.319E-01	2.785E-02
157.57	4.423E-01	3.011E-02
161.77	4.970E-01	3.322E-02
165.93	6.491E-01	4.209E-02
171.73	6.875E-01	5.255E-02
180.00	6.875E-01	5.255E-02

N14(D,D') 20.13 MEV. EX = 6.198 T=0 ID=208 J. =1+

AVERAGE ENERGY = 6.2016+- 0.0009 THETA < 90
AVERAGE ENERGY = 6.2018+- 0.0045 THETA > 90
AVERAGE ENERGY = 6.2017+- 0.0019 ALL ANGLES
REACTION CROSS SECTION = 1.080E+00 +- 0.336E+00
INTEGRATION LENGTH = 2.967 + 0.102 + 0.072 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.822E-01	5.251E-01
11.74	2.822E-01	5.251E-01
14.10	7.163E-01	3.638E-01
16.45	3.289E-01	3.026E-01
21.14	2.312E-01	1.610E-01
25.82	1.629E-01	9.248E-02
28.15	2.670E-01	5.502E-02
30.48	1.874E-01	3.752E-02
32.80	8.176E-02	4.365E-02
35.11	1.443E-01	1.782E-02
36.27	1.433E-01	1.397E-02
37.42	1.341E-01	1.314E-02
38.58	1.275E-01	1.471E-02
40.88	1.210E-01	1.451E-02
40.88	1.326E-01	2.635E-02
44.31	9.938E-02	1.600E-02
47.73	8.240E-02	1.770E-02
51.13	5.384E-02	1.648E-02
54.52	5.619E-02	1.403E-02
57.87	8.207E-02	1.374E-02
61.22	8.641E-02	1.291E-02
64.53	7.144E-02	1.285E-02
67.82	7.662E-02	1.072E-02
71.09	7.983E-02	1.311E-02
74.33	6.154E-02	9.966E-03
74.33	6.154E-02	9.966E-03
77.55	5.897E-02	9.090E-03
80.74	7.486E-02	1.345E-02
83.91	6.362E-02	9.025E-03
87.05	6.129E-02	8.064E-03
91.19	2.992E-02	1.107E-02
95.28	4.325E-02	8.641E-03
99.32	5.654E-02	9.330E-03
103.30	4.413E-02	1.015E-02
107.24	6.121E-02	1.207E-02
111.12	5.505E-02	1.083E-02
114.96	4.926E-02	9.519E-03
118.74	4.191E-02	9.279E-03
127.09	6.215E-02	8.677E-03
131.63	5.881E-02	8.339E-03
136.10	6.125E-02	7.781E-03
140.52	5.259E-02	7.284E-03
144.87	6.216E-02	7.372E-03
149.17	7.761E-02	8.763E-03
153.43	9.333E-02	8.730E-03
157.64	1.107E-01	1.414E-02
161.83	9.355E-02	1.262E-02
165.98	8.892E-02	1.180E-02
171.75	1.508E-01	1.766E-02
180.00	1.508E-01	1.766E-02

N14(D,D') 20.13 MEV. EX = 6.444 T=0 ID=209 J =3+

AVERAGE ENERGY = 6.4482+- 0.0007 THETA < 90
AVERAGE ENERGY = 6.4476+- 0.0011 THETA > 90
AVERAGE ENERGY = 6.4479+- 0.0006 ALL ANGLES
REACTION CROSS SECTION = 1.245E+00 +- 0.344E+00
INTEGRATION LENGTH = 2.967 + 0.103 + 0.072 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.973E-01	5.383E-01
11.76	2.973E-01	5.383E-01
14.12	3.786E-01	3.556E-01
16.48	3.442E-01	2.985E-01
21.18	2.094E-01	1.630E-01
25.86	1.017E-01	8.662E-02
28.20	2.239E-01	5.438E-02
32.85	3.528E-02	4.025E-02
35.17	8.251E-02	1.591E-02
36.33	9.801E-02	1.312E-02
37.48	9.904E-02	1.210E-02
38.64	9.092E-02	1.398E-02
40.94	9.660E-02	1.354E-02
40.94	9.844E-02	2.435E-02
44.38	9.714E-02	1.558E-02
47.80	1.055E-01	1.811E-02
51.21	6.400E-02	1.629E-02
54.60	9.556E-02	1.514E-02
57.96	8.324E-02	1.353E-02
61.30	9.497E-02	1.301E-02
64.62	1.050E-01	1.427E-02
67.92	8.658E-02	1.122E-02
71.19	1.066E-01	1.386E-02
74.44	8.920E-02	1.120E-02
74.44	8.920E-02	1.120E-02
77.66	7.785E-02	9.581E-03
80.85	8.851E-02	1.330E-02
84.02	8.383E-02	9.243E-03
87.15	8.420E-02	8.690E-03
91.30	7.038E-02	1.223E-02
95.38	6.230E-02	9.268E-03
99.42	6.787E-02	9.651E-03
103.41	6.287E-02	1.072E-02
107.35	6.657E-02	1.225E-02
111.24	5.938E-02	1.106E-02
115.07	6.396E-02	1.000E-02
118.85	5.834E-02	1.001E-02
127.19	9.108E-02	9.829E-03
131.73	8.999E-02	9.620E-03
136.19	8.575E-02	8.524E-03
140.60	1.037E-01	8.711E-03
144.94	1.208E-01	9.078E-03
149.24	1.200E-01	9.839E-03
153.49	1.258E-01	9.670E-03
157.70	1.077E-01	1.409E-02
161.87	1.192E-01	1.332E-02
166.01	1.410E-01	1.316E-02
171.77	1.571E-01	1.814E-02
180.00	1.571E-01	1.814E-02

N14(D,D') 20.13 MEV. EX = 7.028 T=0 ID=210 J =2+

AVERAGE ENERGY = 7.0274+- 0.0004 THETA < 90
AVERAGE ENERGY = 7.0283+- 0.0002 THETA > 90
AVERAGE ENERGY = 7.0277+- 0.0003 ALL ANGLES
REACTION CROSS SECTION = 8.487E+00 +- 0.439E+00
INTEGRATION LENGTH = 2.967 + 0.103 + 0.071 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.893E+00	2.893E-01
11.81	1.893E+00	2.893E-01
14.18	2.122E+00	2.285E-01
16.54	1.443E+00	1.749E-01
18.90	1.536E+00	1.025E-01
21.26	1.447E+00	8.980E-02
23.61	1.295E+00	7.430E-02
25.96	1.324E+00	7.961E-02
28.31	1.293E+00	5.309E-02
30.65	1.190E+00	4.540E-02
32.98	1.184E+00	6.247E-02
35.31	1.191E+00	3.258E-02
36.47	1.111E+00	2.786E-02
37.63	1.064E+00	2.657E-02
38.79	1.053E+00	3.047E-02
41.10	1.037E+00	3.635E-02
41.10	9.590E-01	4.088E-02
44.55	9.091E-01	3.164E-02
47.99	7.904E-01	3.475E-02
51.41	6.847E-01	3.285E-02
54.80	5.972E-01	2.727E-02
58.18	5.973E-01	2.647E-02
61.53	5.556E-01	2.367E-02
64.86	5.610E-01	2.718E-02
68.16	6.025E-01	2.659E-02
71.44	5.320E-01	2.508E-02
71.44	5.320E-01	2.508E-02
71.44	5.320E-01	2.508E-02
74.69	5.541E-01	2.313E-02
77.92	5.399E-01	1.876E-02
81.12	5.244E-01	2.378E-02
84.29	5.246E-01	1.872E-02
87.43	5.060E-01	1.849E-02
91.58	4.250E-01	2.185E-02
95.67	4.550E-01	2.049E-02
99.71	4.578E-01	2.156E-02
103.70	4.779E-01	2.137E-02
107.63	5.480E-01	2.612E-02
111.51	4.960E-01	2.468E-02
115.34	4.595E-01	2.310E-02
119.12	3.942E-01	2.050E-02
127.44	4.667E-01	2.029E-02
131.96	4.466E-01	1.922E-02
136.41	4.921E-01	1.810E-02
140.80	5.452E-01	1.756E-02
145.13	5.595E-01	1.800E-02
149.41	6.109E-01	1.942E-02
153.64	6.581E-01	2.007E-02
157.82	7.182E-01	2.341E-02
161.97	9.266E-01	2.800E-02
166.09	1.017E+00	2.797E-02
171.82	1.074E+00	3.197E-02
180.00	1.074E+00	3.197E-02

N14(D,D') 20.13 MEV. EX = 7.966 T=0 ID=211 J =2-

AVERAGE ENERGY = 7.9682+- 0.0007 THETA < 90
AVERAGE ENERGY = 7.9683+- 0.0010 THETA > 90
AVERAGE ENERGY = 7.9682+- 0.0006 ALL ANGLES
REACTION CROSS SECTION = 1.732E+00 +- 0.249E+00
INTEGRATION LENGTH = 2.946 + 0.125 + 0.071 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.275E-01	1.967E-01
14.28	2.275E-01	1.967E-01
19.04	3.151E-01	8.468E-02
21.42	2.560E-01	7.334E-02
23.79	2.552E-01	5.855E-02
26.16	2.316E-01	5.183E-02
28.52	2.514E-01	3.573E-02
30.87	2.140E-01	3.589E-02
33.22	1.944E-01	4.059E-02
35.57	1.490E-01	1.669E-02
36.73	1.646E-01	1.351E-02
37.90	1.417E-01	1.241E-02
39.07	1.482E-01	1.561E-02
41.39	1.588E-01	1.563E-02
41.39	1.416E-01	2.643E-02
44.87	1.213E-01	1.568E-02
48.32	1.232E-01	1.824E-02
51.76	1.183E-01	1.828E-02
55.17	1.091E-01	1.656E-02
58.57	1.259E-01	1.479E-02
61.94	1.515E-01	1.427E-02
65.28	1.400E-01	1.542E-02
68.60	1.380E-01	1.370E-02
71.89	1.255E-01	1.490E-02
75.16	1.394E-01	1.266E-02
75.16	1.394E-01	1.266E-02
75.16	1.394E-01	1.266E-02
78.40	1.509E-01	1.082E-02
81.60	1.555E-01	1.446E-02
84.78	1.422E-01	1.075E-02
87.93	1.335E-01	9.945E-03
92.09	1.275E-01	1.317E-02
96.18	1.054E-01	1.043E-02
100.22	8.568E-02	9.729E-03
104.21	6.483E-02	1.055E-02
108.14	7.335E-02	1.277E-02
112.01	8.729E-02	1.223E-02
115.84	7.592E-02	1.122E-02
119.61	1.075E-01	1.234E-02
127.89	1.457E-01	1.141E-02
132.39	1.515E-01	1.211E-02
136.82	1.461E-01	1.033E-02
141.18	1.310E-01	9.520E-03
145.48	1.266E-01	9.381E-03
149.72	1.213E-01	1.008E-02
153.91	1.455E-01	9.871E-03
158.06	1.197E-01	1.531E-02
162.16	1.699E-01	1.437E-02
166.24	1.834E-01	1.340E-02
171.91	1.385E-01	1.329E-02
180.00	1.385E-01	1.329E-02

N14(D,D') 20.13 MEV. EX = 8.489 T=0 ID=213 J =4-

AVERAGE ENERGY = 8.4895+- 0.0007 THETA < 90
AVERAGE ENERGY = 8.4867+- 0.4467 THETA > 90
AVERAGE ENERGY = 8.4883+- 0.1806 ALL ANGLES
REACTION CROSS SECTION = 2.842E+00 +- 0.286E+00
INTEGRATION LENGTH = 2.967 + 0.104 + 0.070 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	6.000E-03	3.000E-03
11.95	5.323E-03	2.743E-01
19.13	4.673E-01	8.543E-02
21.51	4.029E-01	6.604E-02
23.90	4.266E-01	5.402E-02
26.27	4.241E-01	4.967E-02
28.65	4.191E-01	3.651E-02
31.01	3.610E-01	3.492E-02
33.37	3.920E-01	4.703E-02
35.72	3.603E-01	2.147E-02
38.09	3.584E-01	1.710E-02
40.07	3.336E-01	1.604E-02
39.24	3.026E-01	1.892E-02
41.57	3.464E-01	2.156E-02
41.57	3.186E-01	3.118E-02
45.06	3.020E-01	2.003E-02
48.53	2.729E-01	2.284E-02
51.98	2.650E-01	2.269E-02
55.41	2.215E-01	1.983E-02
58.81	1.862E-01	1.671E-02
62.19	2.121E-01	1.607E-02
65.54	2.206E-01	1.815E-02
68.87	1.928E-01	1.556E-02
72.17	2.163E-01	1.751E-02
75.45	2.201E-01	1.501E-02
75.45	2.201E-01	1.501E-02
75.45	2.201E-01	1.501E-02
78.69	2.271E-01	1.246E-02
81.91	2.401E-01	1.689E-02
85.09	2.075E-01	1.233E-02
88.24	2.303E-01	1.247E-02
92.40	2.045E-01	1.547E-02
96.50	1.811E-01	1.302E-02
100.54	1.863E-01	1.364E-02
104.52	1.870E-01	1.485E-02
108.46	1.698E-01	1.623E-02
112.33	1.947E-01	1.647E-02
116.15	1.934E-01	1.591E-02
119.91	2.057E-01	1.554E-02
128.18	2.515E-01	1.476E-02
132.66	1.923E-01	1.343E-02
137.07	2.040E-01	1.194E-02
141.41	1.887E-01	1.105E-02
145.69	1.833E-01	1.098E-02
149.91	1.986E-01	1.199E-02
154.07	1.802E-01	1.087E-02
158.20	1.665E-01	1.674E-02
162.28	2.077E-01	1.568E-02
166.33	1.947E-01	1.391E-02
171.97	1.706E-01	1.437E-02
180.00	2.000E-03	1.000E-03

N14(D,D') 20.13 MEV. EX = 8.489 T=0 ID=213 J =4-

AVERAGE ENERGY = 8.4891+- 0.0006 THETA < 90
AVERAGE ENERGY = 8.4869+- 0.0009 THETA > 90
AVERAGE ENERGY = 8.4883+- 0.0005 ALL ANGLES
REACTION CROSS SECTION = 2.856E+00 +- 0.288E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.638E-03	3.936E-01
9.96	7.638E-03	3.936E-01
15.96	6.647E-01	1.215E-01
17.96	5.711E-01	9.357E-02
19.96	6.022E-01	7.623E-02
21.96	5.959E-01	6.977E-02
23.96	5.859E-01	5.103E-02
25.96	5.019E-01	4.853E-02
27.96	5.418E-01	6.499E-02
29.96	4.950E-01	2.949E-02
30.96	4.907E-01	2.341E-02
31.96	4.552E-01	2.188E-02
32.96	4.115E-01	2.572E-02
34.96	4.677E-01	2.908E-02
34.96	4.301E-01	4.207E-02
37.96	4.030E-01	2.672E-02
40.96	3.597E-01	3.009E-02
43.96	3.447E-01	2.950E-02
46.96	2.840E-01	2.541E-02
49.96	2.352E-01	2.110E-02
52.96	2.638E-01	1.998E-02
55.96	2.699E-01	2.220E-02
58.96	2.320E-01	1.871E-02
61.96	2.556E-01	2.068E-02
64.96	2.554E-01	1.741E-02
64.96	2.554E-01	1.741E-02

ABCISSA	ORDINATE	ERROR
64.96	2.554E-01	1.741E-02
67.96	2.586E-01	1.418E-02
70.96	2.682E-01	1.885E-02
73.96	2.272E-01	1.349E-02
76.96	2.472E-01	1.337E-02
80.96	2.135E-01	1.614E-02
84.96	1.839E-01	1.321E-02
88.96	1.838E-01	1.345E-02
92.96	1.793E-01	1.423E-02
96.96	1.582E-01	1.511E-02
100.96	1.763E-01	1.490E-02
104.96	1.702E-01	1.399E-02
108.96	1.760E-01	1.328E-02
117.96	2.024E-01	1.187E-02
122.96	1.499E-01	1.046E-02
127.96	1.542E-01	9.023E-03
132.96	1.386E-01	8.115E-03
137.96	1.311E-01	7.847E-03
142.96	1.386E-01	8.365E-03
147.96	1.231E-01	7.422E-03
152.96	1.116E-01	1.121E-02
157.96	1.370E-01	1.034E-02
162.96	1.268E-01	9.058E-03
169.96	1.097E-01	9.240E-03
180.00	1.097E-01	9.240E-03

N14(D,O1) 20.13 MEV. SUM OF(8.963,5+) AND (8.979,2+) ID = 217

AVERAGE ENERGY = 8.9633+- 0.0007 THETA < 90
AVERAGE ENERGY = 8.9603+- 0.0013 THETA > 90
AVERAGE ENERGY = 8.9620+- 0.0007 ALL ANGLES
REACTION CROSS SECTION = 2.062E+00 +- 0.287E+00
INTEGRATION LENGTH = 2.946 + 0.126 + 0.070 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.569E-01	2.142E-01
14.41	2.569E-01	2.142E-01
19.21	1.789E-01	8.498E-02
21.61	2.372E-01	6.954E-02
24.00	2.516E-01	6.249E-02
26.39	3.011E-01	5.107E-02
28.77	2.714E-01	3.530E-02
31.15	1.828E-01	4.195E-02
33.51	2.381E-01	5.229E-02
35.88	2.342E-01	2.937E-02
37.06	1.963E-01	1.837E-02
38.23	1.934E-01	1.577E-02
39.41	1.821E-01	1.694E-02
41.75	1.956E-01	1.980E-02
41.75	1.807E-01	2.905E-02
45.25	1.867E-01	1.649E-02
47.73	1.914E-01	1.976E-02
52.20	1.787E-01	2.196E-02
53.64	1.909E-01	2.010E-02
55.05	1.938E-01	1.754E-02
56.44	1.839E-01	1.858E-02
65.81	1.825E-01	1.669E-02
71.14	1.875E-01	1.550E-02
72.45	1.641E-01	1.680E-02
73.73	1.576E-01	1.338E-02
75.73	1.576E-01	1.338E-02

ABCISSA	ORDINATE	ERROR
75.73	1.576E-01	1.338E-02
78.98	1.699E-01	1.250E-02
82.21	1.590E-01	1.599E-02
85.40	1.452E-01	1.276E-02
88.55	1.463E-01	1.071E-02
92.72	1.197E-01	1.241E-02
96.81	1.321E-01	1.177E-02
100.86	1.263E-01	1.191E-02
104.84	1.264E-01	1.494E-02
108.77	1.398E-01	1.518E-02
112.64	1.175E-01	1.655E-02
116.45	1.263E-01	1.430E-02
120.21	1.165E-01	1.419E-02
128.45	1.522E-01	1.217E-02
132.92	1.557E-01	1.502E-02
137.31	1.407E-01	1.177E-02
141.64	1.479E-01	1.334E-02
145.90	1.341E-01	1.520E-02
150.10	1.396E-01	1.640E-02
154.24	1.507E-01	1.322E-02
158.34	1.129E-01	1.961E-02
162.40	1.370E-01	1.800E-02
166.42	1.392E-01	1.735E-02
172.02	1.226E-01	2.014E-02
180.00	1.226E-01	2.014E-02

N14(D,D') 20.13 MEV. SUM OF(8.963,5+) AND (8.979,2+) ID = 217

AVERAGE ENERGY = 8.9632+- 0.0007 THETA < 90
AVERAGE ENERGY = 8.9599+- 0.0014 THETA > 90
AVERAGE ENERGY = 8.9620+- 0.0007 ALL ANGLES
REACTION CROSS SECTION = 2.062E+00 +- 0.286E+00
INTEGRATION LENGTH = 2.950 + 0.104 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.710E-01	3.095E-01
11.96	3.710E-01	3.095E-01
15.96	2.567E-01	1.219E-01
17.96	3.248E-01	9.937E-02
19.96	3.581E-01	8.892E-02
21.96	4.266E-01	7.233E-02
23.96	3.826E-01	4.974E-02
25.96	2.646E-01	5.879E-02
27.96	3.275E-01	7.282E-02
29.96	3.298E-01	4.065E-02
30.96	2.716E-01	2.534E-02
31.96	2.659E-01	2.168E-02
32.96	2.495E-01	2.320E-02
34.96	2.661E-01	2.692E-02
34.96	2.457E-01	3.953E-02
37.96	2.509E-01	2.215E-02
40.96	2.539E-01	2.620E-02
43.96	2.300E-01	2.873E-02
46.96	2.463E-01	2.592E-02
49.96	2.463E-01	2.228E-02
52.96	2.300E-01	1.947E-02
55.96	2.244E-01	2.051E-02
58.96	2.265E-01	1.872E-02
61.96	1.947E-01	1.992E-02
64.96	1.836E-01	1.552E-02
64.96	1.836E-01	1.552E-02
64.96	1.836E-01	1.552E-02
67.96	1.941E-01	1.426E-02
70.96	1.781E-01	1.790E-02
73.96	1.593E-01	1.399E-02
76.96	1.572E-01	1.150E-02
80.96	1.251E-01	1.296E-02
84.96	1.341E-01	1.194E-02
88.96	1.245E-01	1.173E-02
92.96	1.210E-01	1.429E-02
96.96	1.299E-01	1.410E-02
100.96	1.061E-01	1.493E-02
104.96	1.107E-01	1.252E-02
108.96	9.918E-02	1.207E-02
117.96	1.216E-01	9.725E-03
122.96	1.204E-01	1.160E-02
127.96	1.054E-01	8.818E-03
132.96	1.076E-01	9.697E-03
137.96	9.489E-02	1.075E-02
142.96	9.638E-02	1.132E-02
147.96	1.017E-01	8.925E-03
152.96	7.476E-02	1.298E-02
157.96	8.924E-02	1.172E-02
162.96	8.948E-02	1.115E-02
169.96	7.783E-02	1.278E-02
180.00	7.783E-02	1.278E-02

N14(D,D') 20.13 MEV. EX = 9.139 T=0 ID=219 J =2-

AVERAGE ENERGY = 9.1390+- 0.0021 THETA < 90
AVERAGE ENERGY = 9.1360+- 0.0030 THETA > 90
AVERAGE ENERGY = 9.1377+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 1.015E+00 +- 0.225E+00
INTEGRATION LENGTH = 2.304 + 0.168 + 0.069 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.761E-01	8.291E-02
19.25	1.761E-01	8.291E-02
21.65	1.517E-01	7.580E-02
24.05	1.505E-01	5.464E-02
26.44	1.720E-01	4.282E-02
28.82	1.386E-01	2.925E-02
31.20	1.100E-01	3.985E-02
33.58	1.325E-01	4.598E-02
35.94	1.096E-01	2.636E-02
37.12	8.831E-02	1.599E-02
38.30	6.612E-02	1.264E-02
39.47	5.404E-02	1.426E-02
41.82	6.399E-02	1.593E-02
41.81	4.719E-02	2.627E-02
45.32	7.272E-02	1.301E-02
46.81	7.260E-02	1.514E-02
52.28	9.907E-02	1.946E-02
55.72	6.810E-02	1.689E-02
56.14	7.071E-02	1.367E-02
62.54	6.753E-02	1.201E-02
65.91	4.913E-02	1.125E-02
69.24	6.187E-02	1.053E-02
72.55	7.191E-02	1.351E-02
75.84	6.682E-02	1.014E-02
75.84	6.682E-02	1.014E-02
79.10	6.236E-02	9.652E-03
82.31	5.830E-02	1.307E-02
85.51	7.063E-02	1.249E-02
88.67	5.488E-02	8.750E-03
92.83	6.034E-02	1.150E-02
96.93	4.758E-02	8.571E-03
100.98	7.201E-02	9.364E-03
104.96	6.602E-02	1.327E-02
108.89	2.983E-02	1.034E-02
112.76	5.412E-02	1.468E-02
116.56	3.289E-02	9.859E-03
120.32	5.381E-02	1.290E-02
128.56	7.940E-02	9.161E-03
133.03	7.911E-02	1.540E-02
137.40	8.761E-02	1.072E-02
141.72	8.646E-02	1.202E-02
145.98	8.907E-02	1.562E-02
150.17	9.161E-02	1.636E-02
154.31	1.134E-01	1.355E-02
158.40	7.676E-02	1.993E-02
162.45	9.480E-02	2.508E-02
166.46	1.384E-01	2.353E-02
172.05	1.444E-01	2.392E-02
180.00	1.444E-01	2.392E-02

N14(D,D') 20.13 MEV. EX = 9.129 T=0 ID=219 J =2-

AVERAGE ENERGY = 9.1383+- 0.0019 THETA < 90
AVERAGE ENERGY = 9.1367+- 0.0034 THETA > 90
AVERAGE ENERGY = 9.1377+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 1.014E+00 +- 0.225E+00
INTEGRATION LENGTH = 2.915 + 0.139 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.536E-01	1.194E-01
15.96	2.536E-01	1.194E-01
17.96	2.176E-01	1.087E-01
19.96	2.150E-01	7.803E-02
21.96	2.446E-01	6.087E-02
23.96	1.960E-01	4.135E-02
25.96	1.547E-01	5.603E-02
27.96	1.852E-01	6.426E-02
29.96	1.523E-01	3.661E-02
30.96	1.222E-01	2.213E-02
31.96	9.119E-02	1.742E-02
32.96	7.424E-02	1.959E-02
34.96	8.727E-02	2.171E-02
34.96	6.435E-02	3.581E-02
37.96	9.799E-02	1.752E-02
40.96	9.659E-02	2.014E-02
43.96	1.300E-01	2.553E-02
46.96	8.806E-02	2.183E-02
49.96	9.004E-02	1.740E-02
52.96	8.461E-02	1.504E-02
55.96	6.053E-02	1.385E-02
58.96	7.489E-02	1.273E-02
61.96	8.545E-02	1.605E-02
64.96	7.792E-02	1.181E-02
64.96	7.792E-02	1.181E-02

ABCISSA	ORDINATE	ERROR
67.96	7.132E-02	1.103E-02
70.96	6.535E-02	1.463E-02
73.96	7.756E-02	1.371E-02
76.96	5.901E-02	9.402E-03
80.96	6.305E-02	1.201E-02
84.96	4.829E-02	8.694E-03
88.96	7.096E-02	9.221E-03
92.96	6.315E-02	1.269E-02
96.96	2.769E-02	9.590E-03
100.96	4.877E-02	1.321E-02
104.96	2.878E-02	8.620E-03
108.96	4.572E-02	1.095E-02
117.96	6.331E-02	7.300E-03
122.96	6.099E-02	1.186E-02
127.96	6.544E-02	8.003E-03
132.96	6.267E-02	8.707E-03
137.96	6.280E-02	1.101E-02
142.96	6.298E-02	1.125E-02
147.96	7.620E-02	9.103E-03
152.96	5.057E-02	1.313E-02
157.96	6.141E-02	1.624E-02
162.96	8.844E-02	1.503E-02
169.96	9.106E-02	1.508E-02
180.00	9.106E-02	1.508E-02

N14(D,D') 20.13 MEV. EX = 9.388 T=0 ID=221 J. =2-

AVERAGE ENERGY = 9.3895+- 0.0009 THETA < 90
AVERAGE ENERGY = 9.3875+- 0.0014 THETA > 90
AVERAGE ENERGY = 9.3886+- 0.0008 ALL ANGLES
REACTION CROSS SECTION = 2.150E+00 +- 0.262E+00
INTEGRATION LENGTH = 2.946 + 0.126 + 0.069 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.672E-01	1.908E-01
14.48	3.672E-01	1.908E-01
18.30	3.232E-01	7.029E-02
21.70	2.554E-01	6.774E-02
24.10	3.224E-01	4.743E-02
26.50	3.355E-01	4.262E-02
28.89	3.040E-01	2.939E-02
31.28	2.556E-01	2.650E-02
33.66	3.032E-01	4.267E-02
36.03	2.290E-01	2.109E-02
37.22	2.354E-01	1.657E-02
38.39	2.218E-01	1.412E-02
39.57	1.954E-01	1.711E-02
41.93	2.332E-01	1.914E-02
41.93	1.773E-01	2.785E-02
43.44	2.182E-01	1.782E-02
44.94	2.266E-01	2.141E-02
46.41	2.338E-01	2.100E-02
47.86	2.111E-01	1.979E-02
49.28	2.054E-01	1.727E-02
50.69	1.901E-01	1.595E-02
52.05	1.444E-01	1.572E-02
53.41	1.587E-01	1.442E-02
54.72	1.501E-01	1.579E-02
76.01	1.334E-01	1.220E-02
76.01	1.334E-01	1.220E-02

ABCISSA	ORDINATE	ERROR
76.01	1.334E-01	1.220E-02
79.27	1.431E-01	1.036E-02
82.49	1.618E-01	1.459E-02
85.69	1.267E-01	1.106E-02
88.85	1.501E-01	1.065E-02
93.01	1.471E-01	1.394E-02
97.12	1.273E-01	1.112E-02
101.17	1.386E-01	1.157E-02
105.15	1.410E-01	1.357E-02
109.07	1.185E-01	1.387E-02
112.94	1.127E-01	1.366E-02
116.75	9.071E-02	1.178E-02
120.49	7.777E-02	1.148E-02
128.72	1.207E-01	1.004E-02
133.18	1.201E-01	1.298E-02
137.55	1.349E-01	1.019E-02
141.86	1.268E-01	9.654E-03
146.10	1.475E-01	1.088E-02
150.28	1.612E-01	1.198E-02
154.40	1.703E-01	1.127E-02
158.48	1.502E-01	1.974E-02
162.52	1.905E-01	2.346E-02
166.52	1.791E-01	2.140E-02
172.07	1.602E-01	2.231E-02
180.00	1.602E-01	2.231E-02

N14(D,D') 20.13 MEV. EX = 9.388 T=0 ID=221 J =2-

AVERAGE ENERGY = 9.3891+- 0.0008 THETA < 90
AVERAGE ENERGY = 9.3877+- 0.0017 THETA > 90
AVERAGE ENERGY = 9.3886+- 0.0008 ALL ANGLES
REACTION CROSS SECTION = 2.150E+00 +- 0.262E+00
INTEGRATION LENGTH = 2.950 + 0.104 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.348E-01	2.781E-01
11.96	5.348E-01	2.781E-01
15.96	4.677E-01	1.017E-01
17.96	3.681E-01	9.762E-02
19.96	4.627E-01	6.805E-02
21.96	4.792E-01	6.086E-02
23.96	4.319E-01	4.174E-02
25.96	3.611E-01	3.743E-02
27.96	4.258E-01	5.991E-02
29.96	3.195E-01	2.941E-02
30.96	3.273E-01	2.304E-02
31.96	3.073E-01	1.955E-02
32.96	2.697E-01	2.360E-02
34.96	3.195E-01	2.621E-02
34.96	2.428E-01	3.813E-02
37.96	2.953E-01	2.415E-02
40.96	3.027E-01	2.858E-02
43.96	3.080E-01	2.765E-02
46.96	2.740E-01	2.567E-02
49.96	2.624E-01	2.205E-02
52.96	2.390E-01	2.004E-02
55.96	1.724E-01	1.940E-02
58.96	1.926E-01	1.749E-02
61.96	1.788E-01	1.879E-02
64.96	1.559E-01	1.424E-02
64.96	1.559E-01	1.424E-02
64.96	1.559E-01	1.424E-02
67.96	1.639E-01	1.186E-02
70.96	1.817E-01	1.637E-02
73.96	1.393E-01	1.215E-02
76.96	1.615E-01	1.145E-02
80.96	1.538E-01	1.456E-02
84.96	1.291E-01	1.128E-02
88.96	1.365E-01	1.138E-02
92.96	1.348E-01	1.296E-02
96.96	1.098E-01	1.285E-02
100.96	1.014E-01	1.228E-02
104.96	7.916E-02	1.027E-02
108.96	6.588E-02	9.721E-03
117.96	9.586E-02	7.965E-03
122.96	9.215E-02	9.957E-03
127.96	1.003E-01	7.566E-03
132.96	9.137E-02	6.956E-03
137.96	1.034E-01	7.625E-03
142.96	1.101E-01	8.176E-03
147.96	1.136E-01	7.521E-03
152.96	9.830E-02	1.291E-02
157.96	1.225E-01	1.508E-02
162.96	1.136E-01	1.357E-02
169.96	1.003E-01	1.396E-02
180.00	1.003E-01	1.396E-02

N14(D,D') 20.13 MEV. EX = 9.702 T=0 ID=223 J =1+

AVERAGE ENERGY = 9.7041+- 0.0012 THETA < 90
AVERAGE ENERGY = 9.6966+- 0.0020 THETA > 90
AVERAGE ENERGY = 9.7009+- 0.0012 ALL ANGLES
REACTION CROSS SECTION = 8.017E-01 +- 0.172E+00
INTEGRATION LENGTH = 2.883 + 0.190 + 0.069 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.949E-01	4.841E-02
21.78	1.949E-01	4.841E-02
24.19	1.550E-01	3.977E-02
26.59	1.384E-01	3.730E-02
28.99	1.295E-01	2.575E-02
31.38	1.086E-01	2.269E-02
33.77	1.307E-01	3.957E-02
36.15	7.193E-02	1.921E-02
37.34	1.056E-01	1.507E-02
38.52	8.806E-02	1.159E-02
39.71	4.782E-02	1.407E-02
42.06	4.407E-02	1.302E-02
42.06	3.926E-02	2.487E-02
45.59	6.601E-02	1.388E-02
49.09	7.244E-02	1.630E-02
52.57	8.274E-02	1.552E-02
56.04	6.483E-02	1.586E-02
59.47	8.641E-02	1.348E-02
62.88	7.957E-02	1.213E-02
66.26	6.197E-02	1.258E-02
69.61	9.331E-02	1.145E-02
72.93	5.237E-02	1.209E-02
76.23	4.921E-02	8.904E-03
79.49	3.699E-02	6.857E-03
79.49	3.699E-02	6.857E-03
82.72	3.687E-02	9.663E-03
85.92	4.096E-02	7.296E-03
89.09	3.578E-02	5.641E-03
93.25	4.580E-02	7.978E-03
97.35	2.818E-02	5.807E-03
101.42	2.966E-02	5.476E-03
105.40	2.025E-02	9.759E-03
109.32	3.504E-02	1.068E-02
113.17	1.707E-02	8.922E-03
116.97	2.795E-02	8.990E-03
120.71	1.466E-02	7.422E-03
128.94	5.639E-02	6.780E-03
133.37	3.265E-02	8.078E-03
137.74	3.967E-02	6.516E-03
142.03	5.545E-02	7.846E-03
146.26	6.152E-02	8.020E-03
150.42	4.651E-02	8.657E-03
154.53	5.669E-02	7.169E-03
158.58	3.373E-02	1.740E-02
162.60	4.690E-02	1.396E-02
166.58	4.883E-02	1.352E-02
172.12	9.272E-02	1.808E-02
180.00	9.272E-02	1.808E-02

N14(D,D') 20.13 MEV. EX = 9.702 T=0 ID=223 J. =1+

AVERAGE ENERGY = 9.7037+- 0.0012 THETA < 90
AVERAGE ENERGY = 9.6964+- 0.0022 THETA > 90
AVERAGE ENERGY = 9.7011+- 0.0012 ALL ANGLES
REACTION CROSS SECTION = 6.702E-01 +- 0.209E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.640E-03	3.643E-01
9.96	7.640E-03	3.643E-01
15.96	1.378E-01	1.010E-01
17.96	2.827E-01	7.020E-02
19.96	2.239E-01	5.744E-02
21.96	1.990E-01	5.360E-02
23.96	1.851E-01	3.680E-02
25.96	1.544E-01	3.224E-02
27.96	1.847E-01	5.588E-02
29.96	1.009E-01	2.695E-02
30.96	1.476E-01	2.107E-02
31.96	1.227E-01	1.614E-02
32.96	6.639E-02	1.952E-02
34.96	6.071E-02	1.792E-02
34.96	5.408E-02	3.425E-02
37.96	8.982E-02	1.887E-02
40.96	9.724E-02	2.187E-02
43.96	1.095E-01	2.053E-02
46.96	8.454E-02	2.067E-02
49.96	1.109E-01	1.729E-02
52.96	1.004E-01	1.530E-02
55.96	7.684E-02	1.559E-02
58.96	1.014E-01	1.393E-02
61.96	6.284E-02	1.443E-02
64.96	5.765E-02	1.042E-02
64.96	5.765E-02	1.042E-02
64.96	5.765E-02	1.042E-02
67.96	4.247E-02	7.868E-03
70.96	4.147E-02	1.086E-02
73.96	4.509E-02	8.026E-03
76.96	3.854E-02	6.072E-03
80.96	4.790E-02	8.337E-03
84.96	2.860E-02	5.889E-03
88.96	2.919E-02	5.385E-03
92.96	1.932E-02	9.305E-03
96.96	3.241E-02	9.872E-03
100.96	1.532E-02	7.997E-03
104.96	2.431E-02	7.815E-03
108.96	1.238E-02	6.260E-03
117.96	4.454E-02	5.352E-03
122.96	2.491E-02	6.161E-03
127.96	2.928E-02	4.806E-03
132.96	3.968E-02	5.613E-03
137.96	4.277E-02	5.574E-03
142.96	3.150E-02	5.861E-03
147.96	3.750E-02	4.741E-03
152.96	2.186E-02	1.128E-02
157.96	2.987E-02	8.889E-03
162.96	3.068E-02	8.493E-03
169.96	5.744E-02	1.120E-02
180.00	5.744E-02	1.120E-02

N14(D,D') 20.13 MEV. EX = 10.09 T=0* ID=224 J =1+ BR 2+

AVERAGE ENERGY = 10.0794+- 0.0008 THETA < 90
AVERAGE ENERGY = 10.0673+- 0.5299 THETA > 90
AVERAGE ENERGY = 10.0746+- 0.2099 ALL ANGLES
REACTION CROSS SECTION = 2.126E+00 +- 0.297E+00
INTEGRATION LENGTH = 2.946 + 0.127 + 0.068 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.000E-01	2.000E-01
14.59	3.028E-01	2.227E-01
17.02	3.507E-01	1.853E-01
19.45	3.221E-01	1.003E-01
21.87	3.339E-01	5.350E-02
24.29	3.982E-01	6.366E-02
26.71	3.663E-01	5.807E-02
29.12	3.507E-01	3.864E-02
31.52	2.745E-01	4.166E-02
33.91	3.011E-01	4.902E-02
36.30	2.600E-01	3.046E-02
37.49	2.811E-01	2.829E-02
38.68	2.487E-01	2.366E-02
39.87	2.334E-01	1.906E-02
42.24	2.243E-01	2.253E-02
42.23	2.125E-01	2.830E-02
45.77	2.041E-01	1.799E-02
49.29	1.717E-01	1.802E-02
52.79	1.796E-01	2.029E-02
56.26	1.502E-01	2.021E-02
59.70	1.610E-01	1.809E-02
63.13	1.464E-01	1.507E-02
66.51	1.346E-01	1.485E-02
69.88	1.322E-01	1.641E-02
73.20	1.351E-01	1.656E-02
76.20	1.351E-01	1.656E-02

ABCISSA	ORDINATE	ERROR
76.51	1.290E-01	1.288E-02
79.78	1.273E-01	1.051E-02
83.02	1.577E-01	1.630E-02
86.22	1.491E-01	1.172E-02
89.39	1.548E-01	1.114E-02
93.56	1.452E-01	1.431E-02
97.67	1.340E-01	1.182E-02
101.72	1.350E-01	1.187E-02
105.69	1.132E-01	1.521E-02
109.61	9.722E-02	1.525E-02
113.47	8.057E-02	1.163E-02
117.28	8.094E-02	1.543E-02
121.01	6.660E-02	1.042E-02
129.20	1.306E-01	1.071E-02
133.63	1.558E-01	1.400E-02
137.98	1.696E-01	1.492E-02
142.26	1.928E-01	1.479E-02
146.46	2.072E-01	1.338E-02
150.61	2.163E-01	1.769E-02
154.69	2.481E-01	1.843E-02
158.72	1.642E-01	2.459E-02
162.71	2.258E-01	2.562E-02
166.67	1.974E-01	1.996E-02
172.16	1.462E-01	1.651E-02
180.00	1.000E-01	5.000E-02

N14(D,D') 20.13 MEV. EX = 10.09 T=0* ID=224 J = 1+ OR 2+

AVERAGE ENERGY = 10.0792+- 0.0007 THETA < 90
AVERAGE ENERGY = 10.0656+- 0.0021 THETA > 90
AVERAGE ENERGY = 10.0747+- 0.0013 ALL ANGLES
REACTION CROSS SECTION = 2.030E+00 +- 0.298E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.641E-03	4.052E-01
9.96	7.641E-03	4.052E-01
11.96	4.479E-01	3.293E-01
13.96	5.170E-01	2.731E-01
15.96	4.731E-01	1.473E-01
17.96	4.885E-01	7.824E-02
19.96	5.799E-01	9.268E-02
21.96	5.308E-01	3.413E-02
23.96	5.055E-01	5.567E-02
25.96	3.934E-01	5.967E-02
27.96	4.286E-01	6.986E-02
29.96	3.677E-01	4.304E-02
30.96	3.960E-01	3.984E-02
31.96	3.491E-01	3.320E-02
32.96	3.263E-01	2.663E-02
34.96	3.112E-01	3.124E-02
34.96	2.948E-01	3.924E-02
37.96	2.796E-01	2.464E-02
40.96	2.320E-01	2.435E-02
43.96	2.392E-01	2.701E-02
46.96	1.970E-01	2.650E-02
49.96	2.077E-01	2.333E-02
52.96	1.857E-01	1.911E-02
55.96	1.677E-01	1.996E-02
58.96	1.616E-01	2.006E-02
61.96	1.620E-01	1.985E-02
61.96	1.620E-01	1.985E-02

ABCISSA	ORDINATE	ERROR
61.96	1.620E-01	1.985E-02
64.96	1.516E-01	1.513E-02
67.96	1.466E-01	1.209E-02
70.96	1.778E-01	1.836E-02
73.96	1.645E-01	1.291E-02
76.96	1.669E-01	1.201E-02
80.96	1.519E-01	1.496E-02
84.96	1.359E-01	1.199E-02
88.96	1.328E-01	1.166E-02
92.96	1.079E-01	1.447E-02
96.96	8.972E-02	1.406E-02
100.96	7.204E-02	1.039E-02
104.96	7.011E-02	1.336E-02
108.96	5.593E-02	8.743E-03
117.96	1.025E-01	8.403E-03
122.96	1.179E-01	1.059E-02
127.96	1.241E-01	1.091E-02
132.96	1.367E-01	1.048E-02
137.96	1.426E-01	9.207E-03
142.96	1.448E-01	1.184E-02
147.96	1.622E-01	1.205E-02
152.96	1.052E-01	1.574E-02
157.96	1.421E-01	1.612E-02
162.96	1.225E-01	1.238E-02
169.96	8.952E-02	1.010E-02
180.00	8.952E-02	1.010E-02

N14(D,D') 20.13 MEV. EX = 10.228 T=0 ID=225 J = 1-*

AVERAGE ENERGY = 10.2495+- 0.0020 THETA < 90
AVERAGE ENERGY = 10.2573+- 0.5399 THETA > 90
AVERAGE ENERGY = 10.2527+- 0.2278 ALL ANGLES
REACTION CROSS SECTION = 7.607E-01 +- 0.213E+00
INTEGRATION LENGTH = 2.882 + 0.191 + 0.068 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.000E-01	1.000E-01
21.92	1.160E-01	4.800E-02
24.34	1.260E-01	5.754E-02
26.76	1.292E-01	5.165E-02
29.18	1.098E-01	3.359E-02
31.58	6.346E-02	2.813E-02
33.93	6.810E-02	4.552E-02
36.38	4.777E-02	2.721E-02
37.57	8.589E-02	2.670E-02
38.77	6.735E-02	2.243E-02
39.95	5.307E-02	1.565E-02
42.32	6.024E-02	1.902E-02
43.31	3.052E-02	2.519E-02
45.86	5.564E-02	1.387E-02
47.40	5.656E-02	1.356E-02
52.68	6.106E-02	1.607E-02
56.35	3.419E-02	1.722E-02
58.81	6.783E-02	1.540E-02
63.23	4.293E-02	1.185E-02
65.65	4.573E-02	1.271E-02
70.00	4.119E-02	1.303E-02
73.33	3.282E-02	1.245E-02
76.64	3.976E-02	9.662E-03
79.92	4.320E-02	8.057E-03
79.92	4.320E-02	8.057E-03
83.16	2.967E-02	1.193E-02
86.37	3.416E-02	8.564E-03
89.53	4.590E-02	7.513E-03
93.71	6.727E-02	1.098E-02
97.83	5.983E-02	8.639E-03
101.87	5.479E-02	7.989E-03
105.85	3.620E-02	1.341E-02
109.78	4.431E-02	1.324E-02
113.65	1.810E-02	8.125E-03
117.44	3.080E-02	1.364E-02
121.16	2.434E-02	7.836E-03
129.35	3.827E-02	7.436E-03
133.77	4.330E-02	1.037E-02
138.11	4.678E-02	1.411E-02
142.37	5.055E-02	1.433E-02
146.56	6.477E-02	1.183E-02
150.70	6.152E-02	1.755E-02
154.77	7.187E-02	2.100E-02
158.80	5.697E-02	2.622E-02
162.77	1.038E-01	2.627E-02
166.72	9.340E-02	2.139E-02
172.20	1.127E-01	1.791E-02
180.00	1.000E-01	5.000E-02

N14(D,D') 20.13 MEV. EX = 10.228 T=0 ID=225 J = 1-*

AVERAGE ENERGY = 10.2520+- 0.0018 THETA < 90
AVERAGE ENERGY = 10.2577+- 0.0023 THETA > 90
AVERAGE ENERGY = 10.2539+- 0.0015 ALL ANGLES
REACTION CROSS SECTION = 6.417E-01 +- 0.259E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.642E-03	3.806E-01
9.96	7.642E-03	3.806E-01
11.96	2.352E-01	3.095E-01
13.96	8.536E-02	2.544E-01
15.96	8.150E-02	1.375E-01
17.96	1.704E-01	7.049E-02
19.96	1.842E-01	8.411E-02
21.96	1.880E-01	7.513E-02
23.96	1.589E-01	4.859E-02
25.96	9.128E-02	5.482E-02
27.96	9.731E-02	6.501E-02
29.96	6.780E-02	3.860E-02
30.96	1.215E-01	3.774E-02
31.96	9.490E-02	3.167E-02
32.96	7.448E-02	2.195E-02
34.96	8.386E-02	2.646E-02
34.96	4.247E-02	3.504E-02
37.96	7.647E-02	1.905E-02
40.96	7.670E-02	1.837E-02
43.96	8.155E-02	2.145E-02
46.96	4.495E-02	2.271E-02
49.96	8.773E-02	1.991E-02
52.96	5.457E-02	1.504E-02
55.96	5.711E-02	1.587E-02
58.96	5.046E-02	1.595E-02
61.96	3.871E-02	1.495E-02
61.96	3.871E-02	1.495E-02
61.96	3.871E-02	1.495E-02
64.96	4.681E-02	1.137E-02
67.96	4.982E-02	9.284E-03
70.96	3.348E-02	1.345E-02
73.96	3.771E-02	9.447E-03
76.96	4.953E-02	8.103E-03
80.96	7.041E-02	1.148E-02
84.96	6.069E-02	8.757E-03
88.96	5.384E-02	7.844E-03
92.96	3.445E-02	1.275E-02
96.96	4.083E-02	1.219E-02
100.96	1.614E-02	7.243E-03
104.96	2.662E-02	1.178E-02
108.96	2.038E-02	6.558E-03
117.96	2.992E-02	5.809E-03
122.96	3.264E-02	7.813E-03
127.96	3.409E-02	1.027E-02
132.96	3.566E-02	1.011E-02
137.96	4.435E-02	8.093E-03
142.96	4.097E-02	1.168E-02
147.96	4.672E-02	1.365E-02
152.96	3.752E-02	1.668E-02
157.96	6.486E-02	1.641E-02
162.96	5.753E-02	1.317E-02
169.96	6.837E-02	1.087E-02
180.00	6.837E-02	1.087E-02

N14(D,D') 20.13 MEV. EX = 10.56 T=0 ID=227 J = 1-

AVERAGE ENERGY = 10.5497+- 0.0020 THETA < 90
AVERAGE ENERGY = 10.5406+- 0.5548 THETA > 90
AVERAGE ENERGY = 10.5458+- 0.2344 ALL ANGLES
REACTION CROSS SECTION = 8.242E-01 +- 0.218E+00
INTEGRATION LENGTH = 2.882 + 0.192 + 0.068 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.000E-01	1.000E-01
22.00	1.414E-01	5.437E-02
24.43	1.373E-01	5.527E-02
26.86	1.766E-01	5.622E-02
29.29	1.574E-01	3.700E-02
31.70	6.619E-02	3.734E-02
34.11	6.722E-02	4.406E-02
36.51	4.637E-02	3.134E-02
37.71	9.436E-02	2.533E-02
38.91	1.096E-01	2.214E-02
40.10	3.642E-02	1.814E-02
42.48	4.891E-02	1.815E-02
42.47	2.134E-02	2.848E-02
46.03	6.128E-02	1.922E-02
49.57	5.660E-02	1.278E-02
53.06	7.501E-02	1.561E-02
56.57	3.601E-02	1.752E-02
60.02	4.449E-02	1.478E-02
63.47	5.905E-02	1.294E-02
66.86	5.649E-02	1.459E-02
70.23	7.164E-02	1.288E-02
73.56	4.520E-02	1.509E-02
76.89	6.336E-02	1.161E-02
80.17	5.714E-02	9.819E-03
83.17	5.714E-02	9.819E-03

ABCISSA	ORDINATE	ERROR
80.17	5.714E-02	8.819E-03
83.41	5.117E-02	1.233E-02
86.63	4.966E-02	1.014E-02
89.78	6.370E-02	7.002E-03
93.97	5.088E-02	7.156E-03
98.09	4.765E-02	7.366E-03
102.13	5.850E-02	7.843E-03
106.12	1.884E-02	1.309E-02
110.01	3.622E-02	1.106E-02
113.88	1.908E-02	1.025E-02
117.67	1.728E-02	9.561E-03
121.43	1.456E-02	7.904E-03
129.54	5.320E-02	8.256E-03
133.99	4.564E-02	1.369E-02
138.31	5.036E-02	1.103E-02
142.56	6.541E-02	1.404E-02
146.74	7.223E-02	1.484E-02
150.86	6.674E-02	1.506E-02
154.92	1.049E-01	1.831E-02
158.91	4.686E-02	2.551E-02
162.87	7.561E-02	1.954E-02
166.80	1.014E-01	1.992E-02
172.24	1.047E-01	2.102E-02
180.00	1.000E-01	5.000E-02

N14(D,D') 20.13 MEV. EX = 10.56 T=0 ID=227 J = 1-

AVERAGE ENERGY = 10.5498+- 0.0018 THETA < 90
AVERAGE ENERGY = 10.5411+- 0.0050 THETA > 90
AVERAGE ENERGY = 10.5469+- 0.0021 ALL ANGLES
REACTION CROSS SECTION = 6.998E-01 +- 0.279E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.643E-03	4.883E-01
9.96	7.643E-03	4.883E-01
11.96	2.282E-01	3.710E-01
13.96	6.658E-03	2.777E-01
15.96	1.670E-01	1.387E-01
17.96	2.092E-01	2.040E-02
19.96	2.023E-01	8.136E-02
21.96	2.588E-01	8.236E-02
23.96	2.294E-01	5.391E-02
25.96	9.440E-02	5.406E-02
27.96	9.672E-02	6.336E-02
29.96	6.625E-02	4.476E-02
30.96	1.343E-01	3.604E-02
31.96	1.554E-01	3.138E-02
32.96	5.144E-02	2.561E-02
34.96	6.853E-02	2.541E-02
34.96	2.989E-02	2.987E-02
37.96	8.472E-02	2.656E-02
40.96	7.718E-02	2.559E-02
43.96	1.007E-01	2.094E-02
46.96	4.760E-02	2.315E-02
49.96	5.783E-02	1.920E-02
52.96	7.545E-02	1.652E-02
55.96	7.084E-02	1.829E-02
58.96	8.812E-02	1.579E-02
61.96	5.449E-02	1.818E-02
61.96	5.449E-02	1.818E-02

ABCISSA	ORDINATE	ERROR
61.96	5.449E-02	1.818E-02
64.96	7.480E-02	1.378E-02
67.96	6.605E-02	1.019E-02
70.96	5.786E-02	1.393E-02
73.96	5.491E-02	1.121E-02
76.96	6.882E-02	7.558E-03
80.96	5.328E-02	7.487E-03
84.96	4.832E-02	7.485E-03
88.96	5.744E-02	7.695E-03
92.96	1.790E-02	1.243E-02
96.96	3.331E-02	1.017E-02
100.96	1.698E-02	9.113E-03
104.96	1.488E-02	8.230E-03
108.96	1.213E-02	6.583E-03
117.96	4.139E-02	6.419E-03
122.96	3.418E-02	1.025E-02
127.96	3.642E-02	7.973E-03
132.96	4.577E-02	9.818E-03
137.96	4.901E-02	1.006E-02
142.96	4.403E-02	9.933E-03
147.96	6.749E-02	1.178E-02
152.96	2.951E-02	1.606E-02
157.96	4.673E-02	1.208E-02
162.96	6.175E-02	1.212E-02
169.96	6.276E-02	1.260E-02
180.00	6.276E-02	1.260E-02

N14(D,D') 20.13 MEV. EX = 10.81 T=0 ID=228 J = 4+

AVERAGE ENERGY = 10.8154+- 0.0013 THETA < 90
AVERAGE ENERGY = 10.8122+- 0.5406 THETA > 90
AVERAGE ENERGY = 10.8139+- 0.2458 ALL ANGLES
REACTION CROSS SECTION = 1.292E+00 +- 0.227E+00
INTEGRATION LENGTH = 2.860 + 0.214 + 0.067 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.000E-01	5.000E-02
24.82	1.458E-01	5.730E-02
28.96	1.458E-01	6.182E-02
29.39	1.491E-01	4.051E-02
31.81	7.766E-02	3.771E-02
34.23	7.013E-02	4.359E-02
36.64	8.422E-02	3.719E-02
37.84	1.379E-01	3.121E-02
39.04	1.046E-01	2.674E-02
40.24	8.690E-02	1.871E-02
42.63	7.547E-02	1.670E-02
43.82	6.447E-02	2.682E-02
45.19	1.153E-01	2.090E-02
46.73	1.186E-01	1.965E-02
53.35	1.162E-01	1.657E-02
55.75	1.041E-01	1.890E-02
59.22	1.257E-01	1.630E-02
62.67	1.198E-01	1.511E-02
67.06	1.073E-01	1.594E-02
70.46	1.189E-01	1.300E-02
73.80	8.710E-02	1.759E-02
77.12	1.048E-01	1.158E-02
80.41	1.109E-01	1.067E-02
80.41	1.109E-01	1.067E-02

ABCISSA	ORDINATE	ERROR
83.66	1.161E-01	1.503E-02
86.87	9.520E-02	1.114E-02
90.05	1.098E-01	9.705E-03
94.25	8.769E-02	9.109E-03
98.35	9.184E-02	1.026E-02
102.40	8.419E-02	9.257E-03
106.38	5.089E-02	1.246E-02
110.30	5.077E-02	1.066E-02
114.15	5.328E-02	1.120E-02
117.94	4.440E-02	1.197E-02
121.65	4.236E-02	8.544E-03
129.81	1.261E-01	1.085E-02
134.21	1.191E-01	1.732E-02
138.52	1.264E-01	1.165E-02
142.75	1.208E-01	1.247E-02
146.91	1.183E-01	1.408E-02
151.02	1.176E-01	1.520E-02
155.05	1.337E-01	1.461E-02
159.03	9.336E-02	2.381E-02
162.97	1.148E-01	1.999E-02
166.87	1.125E-01	2.000E-02
172.28	9.320E-02	2.256E-02
180.00	1.000E-01	5.000E-02

N14(D,D') 20.13 MEV. EX = 10.81 T=0 ID=228 J = 4+

AVERAGE ENERGY = 10.8157+- 0.0011 THETA < 90
AVERAGE ENERGY = 10.8120+- 0.0011 THETA > 90
AVERAGE ENERGY = 10.8144+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 1.213E+00 +- 0.303E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.643E-03	5.346E-01
9.96	7.643E-03	5.346E-01
11.96	1.301E-01	3.804E-01
13.96	6.658E-03	2.951E-01
15.96	6.454E-02	1.406E-01
17.96	2.630E-01	1.121E-01
19.96	2.162E-01	8.493E-02
21.96	2.151E-01	9.117E-02
23.96	2.188E-01	5.940E-02
25.96	1.132E-01	5.494E-02
27.96	1.015E-01	6.300E-02
29.96	1.211E-01	5.345E-02
30.96	1.974E-01	4.468E-02
31.96	1.493E-01	3.814E-02
32.96	1.235E-01	2.657E-02
34.96	1.064E-01	2.352E-02
34.96	9.085E-02	3.777E-02
37.96	1.604E-01	2.905E-02
40.96	1.543E-01	2.699E-02
43.96	1.569E-01	2.236E-02
46.96	1.382E-01	2.510E-02
49.96	1.642E-01	2.127E-02
52.96	1.537E-01	1.938E-02
55.96	1.350E-01	2.005E-02
58.96	1.462E-01	1.603E-02
61.96	1.053E-01	2.125E-02
61.96	1.053E-01	2.125E-02
61.96	1.053E-01	2.125E-02
64.96	1.242E-01	1.366E-02
67.96	1.285E-01	1.235E-02
70.96	1.315E-01	1.702E-02
73.96	1.054E-01	1.232E-02
76.96	1.188E-01	1.049E-02
80.96	9.186E-02	9.534E-03
84.96	9.312E-02	1.040E-02
88.96	8.258E-02	9.073E-03
92.96	4.828E-02	1.181E-02
96.96	4.658E-02	9.768E-03
100.96	4.726E-02	9.928E-03
104.96	3.809E-02	1.026E-02
108.96	3.517E-02	7.089E-03
117.96	9.745E-02	8.380E-03
122.96	8.864E-02	1.288E-02
127.96	9.070E-02	8.358E-03
132.96	8.382E-02	8.650E-03
137.96	7.955E-02	9.470E-03
142.96	7.685E-02	9.929E-03
147.96	8.518E-02	9.302E-03
152.96	5.818E-02	1.484E-02
157.96	7.019E-02	1.222E-02
162.96	6.772E-02	1.204E-02
169.96	5.531E-02	1.339E-02
180.00	5.531E-02	1.339E-02

N14(D,D') 20.13 MEV. EX = (11.04 AND 11.05) T = 0 J =1+ , ID=229

AVERAGE ENERGY = 11.0413+- 0.0010 THETA < 90
AVERAGE ENERGY = 11.0263+- 0.0022 THETA > 90
AVERAGE ENERGY = 11.0349+- 0.0016 ALL ANGLES
REACTION CROSS SECTION = 1.386E+00 +- 0.297E+00
INTEGRATION LENGTH = 2.924 + 0.150 + 0.067 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.227E-01	1.826E-01
17.24	2.227E-01	1.826E-01
19.69	2.103E-01	1.008E-01
22.14	2.408E-01	8.956E-02
24.60	2.095E-01	5.558E-02
27.04	2.022E-01	5.644E-02
29.48	2.062E-01	5.345E-02
31.91	1.531E-01	3.859E-02
34.34	1.190E-01	4.574E-02
36.75	1.081E-01	3.819E-02
37.96	1.433E-01	3.973E-02
39.16	1.344E-01	3.557E-02
40.36	1.200E-01	1.906E-02
41.56	1.392E-01	2.612E-02
42.75	1.340E-01	2.862E-02
46.33	1.196E-01	2.216E-02
49.89	1.299E-01	2.112E-02
53.42	1.459E-01	1.833E-02
56.93	1.161E-01	1.998E-02
60.39	1.368E-01	1.524E-02
63.86	1.165E-01	1.720E-02
67.26	1.281E-01	1.531E-02
70.66	1.300E-01	1.360E-02
74.01	1.230E-01	1.723E-02
77.33	1.064E-01	1.307E-02
77.33	1.064E-01	1.307E-02
77.33	1.064E-01	1.307E-02
80.62	9.900E-02	1.277E-02
83.87	9.501E-02	1.978E-02
87.10	8.683E-02	1.353E-02
90.27	1.057E-01	1.639E-02
94.46	8.487E-02	1.010E-02
98.57	5.406E-02	1.176E-02
102.63	7.970E-02	9.351E-03
106.60	6.057E-02	1.635E-02
110.53	4.764E-02	1.299E-02
114.37	4.411E-02	9.449E-03
118.16	4.841E-02	1.411E-02
121.87	3.634E-02	9.032E-03
130.00	1.044E-01	1.105E-02
134.40	1.152E-01	1.783E-02
138.70	1.202E-01	1.633E-02
142.92	1.332E-01	1.660E-02
147.05	1.108E-01	1.720E-02
151.15	1.026E-01	2.063E-02
155.16	1.201E-01	1.518E-02
159.13	6.618E-02	2.097E-02
163.04	7.372E-02	1.975E-02
166.93	6.668E-02	1.602E-02
172.32	7.157E-02	1.704E-02
180.00	7.157E-02	1.704E-02

N14(D,D') 20.13 MEV. EX = (11.04 AND 11.05) T = 0 J =1+ , ID=229

AVERAGE ENERGY = 11.0398+- 0.0011 THETA < 90
AVERAGE ENERGY = 11.0246+- 0.0025 THETA > 90
AVERAGE ENERGY = 11.0347+- 0.0016 ALL ANGLES
REACTION CROSS SECTION = 1.288E+00 +- 0.326E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.644E-03	5.594E-01
9.96	7.644E-03	5.594E-01
11.96	1.477E-01	3.717E-01
13.96	3.364E-01	2.758E-01
15.96	3.165E-01	1.516E-01
17.96	3.608E-01	1.252E-01
19.96	3.125E-01	8.287E-02
21.96	3.000E-01	8.370E-02
23.96	3.042E-01	7.882E-02
25.96	2.245E-01	5.655E-02
27.96	1.734E-01	6.657E-02
29.96	1.563E-01	5.518E-02
30.96	2.063E-01	5.719E-02
31.96	1.928E-01	5.099E-02
32.96	1.714E-01	2.720E-02
34.96	1.973E-01	3.699E-02
34.96	1.898E-01	4.051E-02
37.96	1.672E-01	3.096E-02
40.96	1.789E-01	2.908E-02
42.96	1.978E-01	2.553E-02
46.96	1.549E-01	2.665E-02
49.96	1.794E-01	1.999E-02
52.96	1.501E-01	2.214E-02
55.96	1.619E-01	1.932E-02
58.96	1.610E-01	1.683E-02
61.96	1.491E-01	2.088E-02
61.96	1.491E-01	2.088E-02
61.96	1.491E-01	2.088E-02
64.96	1.263E-01	1.551E-02
67.96	1.149E-01	1.481E-02
70.96	1.078E-01	2.243E-02
73.96	9.627E-02	1.499E-02
76.96	1.144E-01	1.772E-02
80.96	8.894E-02	1.058E-02
84.96	5.480E-02	1.191E-02
88.96	7.811E-02	9.157E-03
92.96	5.738E-02	1.548E-02
96.96	4.361E-02	1.188E-02
100.96	3.903E-02	8.354E-03
104.96	4.140E-02	1.206E-02
108.96	3.006E-02	7.465E-03
117.96	8.027E-02	8.494E-03
122.96	8.519E-02	1.318E-02
127.96	8.575E-02	1.164E-02
132.96	9.177E-02	1.144E-02
137.96	7.399E-02	1.148E-02
142.96	6.652E-02	1.337E-02
147.96	7.592E-02	9.587E-03
152.96	4.089E-02	1.295E-02
157.96	4.470E-02	1.197E-02
162.96	3.981E-02	9.564E-03
169.96	4.210E-02	1.002E-02
180.00	4.210E-02	1.002E-02

N14(D,D') 20.13 MEV. EX = 11.240 T=0 ID=232 J' = 3-

AVERAGE ENERGY = 11.2451+- 0.0009 THETA < 90
AVERAGE ENERGY = 11.2305+- 0.5615 THETA > 90
AVERAGE ENERGY = 11.2390+- 0.2342 ALL ANGLES
REACTION CROSS SECTION = 4.899E+00 +- 0.519E+00
INTEGRATION LENGTH = 2.946 + 0.129 + 0.067 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
9.00	1.900E+00	5.000E-01
14.82	1.088E+00	3.353E-01
17.29	9.352E-01	2.563E-01
19.75	9.429E-01	1.372E-01
22.21	8.704E-01	1.135E-01
24.67	8.511E-01	8.077E-02
27.12	7.419E-01	8.058E-02
29.57	7.823E-01	8.082E-02
32.01	6.648E-01	5.832E-02
34.44	5.387E-01	7.774E-02
36.86	5.618E-01	6.260E-02
39.27	5.562E-01	6.686E-02
41.68	5.625E-01	3.604E-02
42.88	5.693E-01	4.748E-02
43.87	5.552E-01	4.733E-02
46.46	5.148E-01	3.723E-02
50.03	4.463E-01	3.227E-02
53.57	4.701E-01	3.542E-02
57.08	4.554E-01	3.231E-02
60.56	4.519E-01	2.952E-02
64.02	4.660E-01	3.107E-02
67.44	4.417E-01	2.877E-02
70.84	4.006E-01	2.672E-02
74.20	3.894E-01	2.637E-02
74.20	3.894E-01	2.637E-02
77.53	3.918E-01	2.484E-02
80.83	3.667E-01	2.056E-02
84.08	3.677E-01	3.160E-02
87.30	3.621E-01	2.457E-02
90.49	3.449E-01	2.390E-02
94.68	2.714E-01	1.974E-02
98.79	2.560E-01	2.011E-02
102.85	2.430E-01	1.691E-02
106.83	1.912E-01	2.623E-02
110.75	1.898E-01	2.373E-02
114.60	1.903E-01	1.806E-02
118.37	1.661E-01	2.504E-02
122.08	1.518E-01	1.753E-02
130.20	2.857E-01	1.880E-02
134.59	2.652E-01	2.278E-02
138.87	3.091E-01	2.448E-02
143.07	2.638E-01	2.450E-02
147.21	2.044E-01	2.788E-02
151.28	1.637E-01	2.438E-02
155.28	1.696E-01	1.964E-02
159.22	9.922E-02	2.677E-02
163.12	1.027E-01	2.088E-02
166.99	8.667E-02	1.806E-02
172.36	6.575E-02	1.592E-02
180.00	6.000E-02	6.000E-02

N14(D,D') 20.13 MEV. EX = 11.240 T=0 ID=232 J = 3-

AVERAGE ENERGY = 11.2440+- 0.0009 THETA < 90
AVERAGE ENERGY = 11.2287+- 0.0036 THETA > 90
AVERAGE ENERGY = 11.2390+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 4.675E+00 +- 0.511E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.393E+00	7.034E-01
9.96	1.393E+00	7.034E-01
11.96	1.660E+00	5.114E-01
13.96	1.422E+00	3.896E-01
15.96	1.428E+00	2.076E-01
17.96	1.312E+00	1.711E-01
19.96	1.277E+00	1.211E-01
21.96	1.107E+00	1.202E-01
23.96	1.160E+00	1.198E-01
25.96	9.799E-01	8.593E-02
27.96	7.688E-01	1.138E-01
29.96	8.165E-01	9.093E-02
30.96	8.601E-01	8.906E-02
31.96	8.019E-01	8.194E-02
32.96	8.076E-01	5.172E-02
34.96	8.107E-01	6.757E-02
34.96	7.902E-01	6.733E-02
37.96	7.230E-01	5.225E-02
40.96	6.176E-01	4.463E-02
43.96	6.404E-01	4.823E-02
46.96	6.102E-01	4.327E-02
49.96	5.948E-01	3.883E-02
52.96	6.022E-01	4.012E-02
55.96	5.598E-01	3.643E-02
58.96	4.975E-01	3.315E-02
61.96	4.735E-01	3.204E-02
61.96	4.735E-01	3.204E-02
64.96	4.661E-01	2.952E-02
67.96	4.265E-01	2.390E-02
70.96	4.180E-01	3.589E-02
73.96	4.020E-01	2.725E-02
76.96	3.737E-01	2.587E-02
80.96	2.845E-01	2.068E-02
84.96	2.594E-01	2.037E-02
88.96	2.380E-01	1.655E-02
92.96	1.808E-01	2.480E-02
96.96	1.734E-01	2.166E-02
100.96	1.679E-01	1.593E-02
104.96	1.416E-01	2.133E-02
108.96	1.251E-01	1.443E-02
117.96	2.186E-01	1.438E-02
122.96	1.950E-01	1.674E-02
127.96	2.190E-01	1.734E-02
132.96	1.806E-01	1.677E-02
137.96	1.354E-01	1.846E-02
142.96	1.053E-01	1.567E-02
147.96	1.063E-01	1.230E-02
152.96	6.080E-02	1.640E-02
157.96	6.174E-02	1.254E-02
162.96	5.129E-02	1.069E-02
169.96	3.832E-02	9.275E-03
180.00	3.832E-02	9.275E-03

N14(D,D') 20.13 MEV; EX = 11.40 T=0 ID=233 J = 1+

AVERAGE ENERGY = 11.4128+- 0.0011 THETA < 90
AVERAGE ENERGY = 11.4136+- 0.5707 THETA > 90
AVERAGE ENERGY = 11.4131+- 0.2536 ALL ANGLES
REACTION CROSS SECTION = 6.709E-01 +- 0.282E+00
INTEGRATION LENGTH = 2.881 + 0.194 + 0.066 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER-OF-MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
20.00	6.000E-02	4.000E-02
22.27	1.365E-01	8.848E-02
24.73	1.084E-01	6.408E-02
27.19	1.007E-01	5.823E-02
29.64	1.407E-01	6.181E-02
32.09	6.941E-02	4.653E-02
34.52	6.518E-02	5.295E-02
36.95	6.799E-02	5.970E-02
39.16	9.527E-02	5.385E-02
39.37	8.651E-02	4.711E-02
40.57	8.175E-02	2.876E-02
42.99	5.083E-02	3.449E-02
42.98	6.510E-02	3.049E-02
44.57	8.482E-02	2.305E-02
50.15	6.966E-02	1.840E-02
55.69	7.334E-02	2.638E-02
57.21	6.535E-02	2.289E-02
60.70	7.089E-02	1.879E-02
64.16	7.023E-02	1.969E-02
67.60	6.305E-02	2.209E-02
71.00	6.414E-02	1.952E-02
74.37	5.891E-02	1.909E-02
77.71	4.124E-02	1.228E-02
81.01	5.054E-02	1.836E-02
81.01	5.058E-02	1.836E-02

ABCISSA	ORDINATE	ERROR
81.01	5.038E-02	1.836E-02
84.28	5.098E-02	2.204E-02
87.50	5.080E-02	1.651E-02
90.68	5.134E-02	1.594E-02
94.87	3.823E-02	1.436E-02
98.99	3.161E-02	1.393E-02
103.05	3.029E-02	8.319E-03
107.04	2.525E-02	1.332E-02
110.94	3.085E-02	1.257E-02
114.80	2.436E-02	1.361E-02
118.55	2.320E-02	1.602E-02
122.26	3.375E-02	1.194E-02
130.38	5.106E-02	1.567E-02
134.75	4.110E-02	1.274E-02
139.04	4.842E-02	1.644E-02
143.23	4.028E-02	1.531E-02
147.34	3.142E-02	1.729E-02
151.41	2.707E-02	1.224E-02
155.39	2.370E-02	9.677E-03
159.32	9.969E-03	1.549E-02
163.21	1.685E-02	7.838E-03
167.05	1.700E-02	8.239E-03
172.39	7.631E-03	6.874E-03
180.00	2.000E-02	2.000E-02

N14(D,D') 20.13 MEV. EX = 11.51 T=0 ID=234 J = 3+*

AVERAGE ENERGY = 11.5246+- 0.0011 THETA < 90
AVERAGE ENERGY = 11.5171+- 0.0018 THETA > 90
AVERAGE ENERGY = 11.5215+- 0.0011 ALL ANGLES
REACTION CROSS SECTION = 8.799E-01 +- 0.313E+00
INTEGRATION LENGTH = 2.967 + 0.108 + 0.066 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
9.09	4.953E-03	3.422E-01
12.40	4.953E-03	3.422E-01
14.89	3.717E-02	1.677E-01
17.37	1.407E-01	1.468E-01
19.84	1.106E-01	1.114E-01
22.31	1.443E-01	6.623E-02
24.78	1.602E-01	6.548E-02
27.24	1.382E-01	5.756E-02
29.70	1.587E-01	5.086E-02
32.14	8.968E-02	5.043E-02
34.58	1.106E-01	5.570E-02
37.02	8.881E-02	4.935E-02
39.23	1.154E-01	4.199E-02
39.44	1.172E-01	3.766E-02
42.64	1.288E-01	2.605E-02
45.06	1.139E-01	2.348E-02
48.06	1.009E-01	3.298E-02
48.65	1.347E-01	1.887E-02
50.23	1.053E-01	2.175E-02
53.78	1.078E-01	2.084E-02
57.30	1.061E-01	2.128E-02
60.80	9.539E-02	2.203E-02
64.28	9.224E-02	1.379E-02
67.70	9.748E-02	2.034E-02
71.11	8.696E-02	1.768E-02
74.48	7.619E-02	1.862E-02
74.48	7.619E-02	1.863E-02
77.82	7.388E-02	1.283E-02
81.12	7.297E-02	1.789E-02
84.39	6.836E-02	1.742E-02
87.61	7.470E-02	1.307E-02
90.80	7.180E-02	1.327E-02
95.00	4.755E-02	1.147E-02
99.11	5.270E-02	1.108E-02
103.17	3.765E-02	8.072E-03
107.16	3.328E-02	1.158E-02
111.07	3.618E-02	9.475E-03
114.91	3.465E-02	1.488E-02
118.67	2.661E-02	8.697E-03
122.38	3.519E-02	1.021E-02
130.47	6.462E-02	1.251E-02
134.85	6.714E-02	1.585E-02
139.12	7.103E-02	1.522E-02
143.31	7.098E-02	1.544E-02
147.42	4.889E-02	9.943E-03
151.48	4.168E-02	1.108E-02
155.45	3.145E-02	8.177E-03
159.37	5.895E-04	1.403E-02
163.26	4.144E-03	8.594E-03
167.09	8.352E-03	7.287E-03
172.41	4.456E-03	6.850E-03
180.00	4.456E-03	6.850E-03

N14(D,D') 20.13 MEV. EX = 11.51 T=0 ID=234 J = 3+*

AVERAGE ENERGY = 11.5236+- 0.0011 THETA < 90
AVERAGE ENERGY = 11.5173+- 0.0022 THETA > 90
AVERAGE ENERGY = 11.5215+- 0.0011 ALL ANGLES
REACTION CROSS SECTION = 8.800E-01 +- 0.313E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.646E-03	5.282E-01
3.96	7.646E-03	5.282E-01
11.96	1.342E-01	2.581E-01
13.96	2.158E-01	2.250E-01
15.96	1.689E-01	1.700E-01
17.96	2.193E-01	1.006E-01
19.96	2.424E-01	9.901E-02
21.96	2.003E-01	8.655E-02
23.96	2.373E-01	7.603E-02
25.96	1.332E-01	7.490E-02
27.96	1.632E-01	3.215E-02
29.96	1.301E-01	7.225E-02
30.96	1.683E-01	6.122E-02
31.96	1.702E-01	5.468E-02
33.96	1.663E-01	3.766E-02
34.96	1.634E-01	4.800E-02
34.96	1.447E-01	4.726E-02
37.96	1.764E-01	2.666E-02
40.96	1.466E-01	3.028E-02
42.96	1.478E-01	2.855E-02
46.96	1.430E-01	2.866E-02
49.96	1.263E-01	2.914E-02
52.96	1.198E-01	1.790E-02
55.96	1.241E-01	2.587E-02
61.96	9.300E-02	2.273E-02
64.96	9.416E-02	1.530E-02
67.96	8.513E-02	2.085E-02
70.96	7.788E-02	1.983E-02
73.96	8.307E-02	1.452E-02
76.96	7.789E-02	1.438E-02
80.96	4.987E-02	1.202E-02
84.96	5.339E-02	1.121E-02
88.96	3.683E-02	7.889E-03
92.96	3.142E-02	1.093E-02
96.96	3.297E-02	8.626E-03
100.96	3.047E-02	1.308E-02
104.96	2.259E-02	7.376E-03
108.96	2.884E-02	8.360E-03
117.96	4.909E-02	9.495E-03
122.96	4.898E-02	1.156E-02
127.96	4.988E-02	1.068E-02
132.96	4.809E-02	1.045E-02
137.96	3.204E-02	6.512E-03
142.96	2.648E-02	7.034E-03
147.96	1.945E-02	5.056E-03
152.96	3.562E-04	8.473E-03
157.96	2.453E-03	5.086E-03
162.96	4.864E-03	4.243E-03

N14(D,D') 20.13 MEV. EX = 11.66 T=0 ID=235 J = (1+,2-)

AVERAGE ENERGY = 11.6600+- 0.0011 THETA < 90
AVERAGE ENERGY = 11.6601+- 0.7288 THETA > 90
AVERAGE ENERGY = 11.6600+- 0.2915 ALL ANGLES
REACTION CROSS SECTION = 4.205E-01 +- 0.209E+00
INTEGRATION LENGTH = 2.711 + 0.217 + 0.213 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.000E-02	5.000E-02
24.83	5.302E-02	5.215E-02
27.30	5.088E-02	4.926E-02
29.76	8.232E-02	4.591E-02
32.21	2.599E-02	4.738E-02
34.66	2.820E-02	5.380E-02
37.10	3.609E-02	4.601E-02
39.31	3.500E-02	3.869E-02
39.53	4.065E-02	3.150E-02
43.73	5.245E-02	2.328E-02
43.16	2.680E-02	2.277E-02
43.14	1.642E-02	2.741E-02
46.76	2.633E-02	1.639E-02
50.33	1.861E-02	1.198E-02
53.90	3.308E-02	1.872E-02
57.42	1.694E-02	1.472E-02
60.92	4.338E-02	2.354E-02
64.41	3.724E-02	1.273E-02
67.84	4.463E-02	1.366E-02
71.26	4.594E-02	1.477E-02
74.63	2.609E-02	1.515E-02
74.63	2.609E-02	1.515E-02
77.97	4.443E-02	1.554E-02
81.28	4.193E-02	1.613E-02
84.55	4.803E-02	1.260E-02
87.78	3.769E-02	1.105E-02
90.97	4.850E-02	1.023E-02
95.15	2.890E-02	1.068E-02
99.29	2.920E-02	6.346E-03
103.35	2.573E-02	1.040E-02
107.34	5.359E-03	9.479E-03
111.24	1.867E-02	8.140E-03
115.08	2.160E-02	1.210E-02
118.85	1.519E-02	6.178E-03
122.56	9.604E-03	8.696E-03
130.63	2.866E-02	6.487E-03
134.98	2.759E-02	1.076E-02
139.26	3.283E-02	1.372E-02
143.43	3.465E-02	1.369E-02
147.53	2.181E-02	7.610E-03
151.57	1.451E-02	7.384E-03
155.54	1.467E-02	7.427E-03
180.00	2.000E-02	2.000E-02

N14(D,D') 20.13 MEV. EX = 11.66 T=0 ID=235 J = (1+,2-)

AVERAGE ENERGY = 11.6597+- 0.0010 THETA < 90
AVERAGE ENERGY = 11.6581+- 0.0021 THETA > 90
AVERAGE ENERGY = 11.6591+- 0.0010 ALL ANGLES
REACTION CROSS SECTION = 3.707E-01 +- 0.277E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.646E-03	5.177E-01
9.96	7.646E-03	5.177E-01
11.96	9.901E-02	2.926E-01
13.96	8.362E-02	2.284E-01
15.96	4.240E-02	1.446E-01
17.96	7.445E-02	9.436E-02
19.96	8.059E-02	7.919E-02
21.96	7.685E-02	7.437E-02
23.96	1.236E-01	6.891E-02
25.96	3.677E-02	7.064E-02
27.96	4.178E-02	7.966E-02
29.96	5.306E-02	6.761E-02
30.96	5.124E-02	5.661E-02
31.96	7.241E-02	4.591E-02
32.96	7.614E-02	3.233E-02
34.96	3.858E-02	3.276E-02
34.96	2.363E-02	3.940E-02
37.96	3.736E-02	2.324E-02
40.96	2.600E-02	1.673E-02
43.96	4.550E-02	2.581E-02
46.96	2.289E-02	1.989E-02
49.96	5.757E-02	3.123E-02
52.96	4.850E-02	1.657E-02
55.96	5.696E-02	1.742E-02
58.96	5.742E-02	1.845E-02
61.96	3.191E-02	1.852E-02
61.96	3.191E-02	1.852E-02
61.96	3.191E-02	1.852E-02
64.96	5.313E-02	1.857E-02
67.96	4.899E-02	1.884E-02
70.96	5.479E-02	1.437E-02
73.96	4.195E-02	1.229E-02
76.96	5.264E-02	1.109E-02
80.96	3.031E-02	1.119E-02
84.96	2.958E-02	6.422E-03
88.96	2.515E-02	1.016E-02
92.96	5.053E-03	8.931E-03
96.96	1.698E-02	7.399E-03
100.96	1.895E-02	1.061E-02
104.96	1.286E-02	5.227E-03
108.96	7.847E-03	7.099E-03
117.96	2.168E-02	4.904E-03
122.96	2.005E-02	7.813E-03
127.96	2.294E-02	9.581E-03
132.96	2.335E-02	9.225E-03
137.96	1.422E-02	4.957E-03
142.96	9.164E-03	4.661E-03
147.96	9.011E-03	4.561E-03
152.96	3.563E-04	6.695E-03
157.96	4.517E-04	3.501E-03
162.96	2.150E-03	3.715E-03
169.96	4.477E-04	2.580E-03
180.00	4.477E-04	2.580E-03

N14(D,D') 20.13 MEV. EX = 11.75 T=0 ID=236 J = 1+

AVERAGE ENERGY = 11.7531+- 0.0009 THETA < 90
AVERAGE ENERGY = 11.7521+- 0.8394 THETA > 90
AVERAGE ENERGY = 11.7527+- 0.2938 ALL ANGLES
REACTION CROSS SECTION = 4.223E-01 +- 0.240E+00
INTEGRATION LENGTH = 2.685 + 0.174 + 0.283 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.000E-02	2.000E-02
19.92	1.930E-02	2.798E-02
22.40	6.721E-02	5.999E-02
24.87	5.471E-02	6.212E-02
27.34	6.435E-02	5.620E-02
29.81	5.583E-02	4.958E-02
32.26	4.096E-02	4.730E-02
34.71	2.530E-02	3.429E-02
37.16	3.077E-02	4.664E-02
39.37	4.684E-02	4.413E-02
39.58	4.055E-02	4.084E-02
40.80	4.822E-02	2.311E-02
43.22	2.258E-02	2.264E-02
43.22	4.441E-02	2.803E-02
46.82	4.761E-02	1.941E-02
50.41	3.144E-02	1.303E-02
53.97	4.405E-02	2.348E-02
57.51	5.215E-02	1.785E-02
61.01	5.789E-02	2.012E-02
64.49	4.456E-02	1.837E-02
67.94	2.760E-02	1.369E-02
67.94	2.760E-02	1.369E-02

ABCISSA	ORDINATE	ERROR
71.35	3.457E-02	1.360E-02
74.73	3.842E-02	1.599E-02
78.08	3.839E-02	1.680E-02
81.38	3.427E-02	1.698E-02
84.66	4.134E-02	1.319E-02
87.89	3.314E-02	1.130E-02
91.09	3.730E-02	1.319E-02
95.27	2.517E-02	1.051E-02
99.41	1.947E-02	6.289E-03
103.46	1.839E-02	1.264E-02
107.44	1.310E-02	9.324E-03
111.36	2.614E-02	1.026E-02
115.18	1.163E-02	1.148E-02
118.97	1.428E-02	1.320E-02
122.67	2.197E-02	1.282E-02
130.73	3.296E-02	1.144E-02
135.09	2.036E-02	7.265E-03
139.34	2.598E-02	1.124E-02
143.51	2.077E-02	1.347E-02
147.61	1.508E-02	6.428E-03
180.00	2.000E-02	2.000E-02

N14(D,D') 20.13 MEV. EX = 11.75 T=0 ID=236 J = 1+

AVERAGE ENERGY = 11.7530+- 0.0008 THETA < 90
AVERAGE ENERGY = 11.7504+- 0.0016 THETA > 90
AVERAGE ENERGY = 11.7521+- 0.0008 ALL ANGLES
REACTION CROSS SECTION = 3.721E-01 +- 0.284E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.647E-03	4.676E-01
9.96	7.647E-03	4.676E-01
11.96	7.848E-03	3.088E-01
13.96	7.267E-02	2.259E-01
15.96	2.969E-02	1.353E-01
17.96	1.029E-01	9.183E-02
19.96	8.336E-02	9.462E-02
21.96	9.748E-02	8.511E-02
23.96	8.408E-02	7.464E-02
25.96	6.127E-02	7.072E-02
27.96	3.757E-02	5.090E-02
29.96	4.536E-02	6.873E-02
30.96	6.878E-02	6.476E-02
31.96	5.928E-02	5.966E-02
32.96	7.020E-02	3.362E-02
34.96	3.258E-02	3.266E-02
34.96	6.408E-02	4.043E-02
37.96	6.771E-02	2.759E-02
40.96	4.404E-02	1.824E-02
43.96	6.071E-02	3.233E-02
46.96	7.064E-02	2.417E-02
49.96	7.699E-02	2.674E-02
52.96	5.813E-02	2.395E-02
55.96	3.529E-02	1.749E-02
58.96	4.328E-02	1.701E-02
61.96	4.705E-02	1.957E-02
61.96	4.705E-02	1.957E-02

ABCISSA	ORDINATE	ERROR
61.96	4.705E-02	1.957E-02
64.96	4.596E-02	2.009E-02
67.96	4.008E-02	1.984E-02
70.96	4.720E-02	1.505E-02
73.96	3.692E-02	1.258E-02
76.96	4.051E-02	1.432E-02
80.96	2.641E-02	1.102E-02
84.96	1.972E-02	6.364E-03
88.96	1.797E-02	1.234E-02
92.96	1.235E-02	8.779E-03
96.96	2.375E-02	9.311E-03
100.96	1.019E-02	1.006E-02
104.96	1.207E-02	1.115E-02
108.96	1.792E-02	1.045E-02
117.96	2.487E-02	8.628E-03
122.96	1.474E-02	5.257E-03
127.96	1.810E-02	7.828E-03
132.96	1.395E-02	9.037E-03
137.96	9.791E-03	4.170E-03
142.96	5.146E-03	3.921E-03
147.96	3.938E-03	2.936E-03
152.96	3.564E-04	5.608E-03
157.96	4.518E-04	2.810E-03
162.96	3.870E-04	2.236E-03
169.96	4.478E-04	1.901E-03
180.00	4.478E-04	1.901E-03

N14(D,D') 20.13 MEV. EX = 11.81 T=0 ID=237 J =

AVERAGE ENERGY = 11.8387+- 0.0007 THETA < 90
AVERAGE ENERGY = 11.8372+- 0.8455 THETA > 90
AVERAGE ENERGY = 11.8382+- 0.2887 ALL ANGLES
REACTION CROSS SECTION = 5.243E-01 +- 0.268E+00
INTEGRATION LENGTH = 2.707 + 0.152 + 0.282 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
6.00	7.000E-02	4.000E-02
17.46	6.018E-02	1.559E-01
19.94	6.967E-02	3.727E-02
22.43	5.443E-02	7.249E-02
24.91	5.736E-02	6.131E-02
27.38	6.170E-02	5.822E-02
29.85	7.905E-02	5.331E-02
32.31	4.978E-02	4.369E-02
34.76	3.209E-02	3.306E-02
37.20	3.939E-02	4.500E-02
39.63	5.567E-02	4.092E-02
42.04	5.788E-02	4.087E-02
44.46	5.691E-02	2.455E-02
46.86	4.215E-02	2.323E-02
49.25	3.003E-02	2.766E-02
51.63	6.468E-02	1.873E-02
54.00	7.379E-02	2.081E-02
56.36	5.023E-02	1.883E-02
58.71	3.197E-02	1.731E-02
61.05	3.832E-02	1.456E-02
63.38	5.994E-02	2.085E-02
65.70	4.036E-02	1.452E-02
68.03	4.036E-02	1.452E-02

ABCISSA	ORDINATE	ERROR
68.03	4.036E-02	1.452E-02
71.44	5.247E-02	1.517E-02
74.83	4.232E-02	1.906E-02
78.18	3.039E-02	1.393E-02
81.49	3.823E-02	1.546E-02
84.76	3.882E-02	1.600E-02
87.99	3.297E-02	1.076E-02
91.19	4.181E-02	1.390E-02
95.39	3.356E-02	8.605E-03
99.51	3.652E-02	9.121E-03
103.55	2.760E-02	8.926E-03
107.56	2.750E-02	1.208E-02
111.46	3.432E-02	1.272E-02
115.30	2.757E-02	1.025E-02
119.06	2.091E-02	1.842E-02
122.76	1.683E-02	1.216E-02
130.82	4.152E-02	1.328E-02
135.18	3.697E-02	8.830E-03
139.43	4.831E-02	1.067E-02
143.60	3.224E-02	1.161E-02
147.69	2.452E-02	7.551E-03
180.00	2.000E-02	2.000E-02

N14(D,D') 20.13 MEV. EX = 11.81 T=0 ID=237 J =

AVERAGE ENERGY = 11.8385+- 0.0007 THETA < 90
AVERAGE ENERGY = 11.8392+- 0.0018 THETA > 90
AVERAGE ENERGY = 11.8387+- 0.0007 ALL ANGLES
REACTION CROSS SECTION = 4.676E-01 +- 0.291E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.647E-03	4.632E-01
9.96	7.647E-03	4.632E-01
11.96	9.347E-02	3.290E-01
13.96	9.321E-02	2.415E-01
15.96	1.075E-01	1.500E-01
17.96	8.359E-02	1.113E-01
19.96	8.763E-02	9.363E-02
21.96	9.372E-02	8.841E-02
23.96	1.194E-01	8.046E-02
25.96	7.466E-02	6.550E-02
27.96	4.779E-02	4.921E-02
29.96	5.820E-02	6.647E-02
30.96	8.195E-02	6.020E-02
31.96	8.482E-02	5.986E-02
32.96	8.306E-02	3.581E-02
34.96	6.098E-02	3.360E-02
34.96	4.343E-02	3.999E-02
37.96	9.221E-02	2.669E-02
40.96	1.036E-01	2.921E-02
43.96	6.938E-02	2.599E-02
46.96	4.339E-02	2.348E-02
49.96	5.107E-02	1.938E-02
52.96	7.834E-02	2.724E-02
55.96	5.169E-02	1.852E-02
58.96	6.579E-02	1.901E-02
61.96	5.190E-02	2.336E-02
61.96	5.190E-02	2.336E-02
61.96	5.190E-02	2.336E-02
64.96	3.642E-02	1.669E-02
67.96	4.476E-02	1.809E-02
70.96	4.436E-02	1.827E-02
73.96	3.675E-02	1.198E-02
76.96	4.542E-02	1.508E-02
80.96	3.521E-02	9.020E-03
84.96	3.698E-02	9.228E-03
88.96	2.696E-02	8.711E-03
92.96	2.590E-02	1.137E-02
96.96	3.116E-02	1.154E-02
100.96	2.413E-02	8.963E-03
104.96	1.764E-02	1.553E-02
108.96	1.370E-02	9.893E-03
117.96	3.125E-02	9.986E-03
122.96	2.670E-02	6.372E-03
127.96	3.355E-02	7.401E-03
132.96	2.157E-02	7.766E-03
137.96	1.586E-02	4.879E-03
142.96	9.464E-03	6.232E-03
147.96	5.772E-03	2.431E-03
152.96	3.565E-04	5.297E-03
157.96	4.519E-04	3.248E-03
162.96	3.871E-04	2.320E-03
169.96	4.479E-04	4.031E-04
180.00	4.479E-04	4.031E-04

N14(D,D') 20.13 MEV. EX = 11.950 T=0 ID=238 J =

AVERAGE ENERGY = 11.9769+- 0.0015 THETA < 90
AVERAGE ENERGY = 11.9881+- 0.9222 THETA > 90
AVERAGE ENERGY = 11.9805+- 0.2995 ALL ANGLES
REACTION CROSS SECTION = 7.048E-01 +- 0.242E+00
INTEGRATION LENGTH = 2.694 + 0.131 + 0.316 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.000E-02	5.000E-02
15.00	2.141E-01	1.802E-01
17.50	1.476E-01	1.277E-01
22.49	1.014E-01	5.692E-02
24.97	5.665E-02	3.794E-02
27.45	8.324E-02	4.061E-02
29.92	9.640E-02	3.710E-02
32.39	3.443E-02	3.044E-02
34.85	6.109E-02	3.826E-02
37.29	4.038E-02	3.349E-02
38.52	6.271E-02	2.859E-02
39.74	5.676E-02	2.411E-02
40.94	8.167E-02	2.190E-02
43.38	4.537E-02	1.856E-02
45.38	2.912E-02	2.631E-02
47.00	6.353E-02	1.507E-02
50.60	6.765E-02	1.895E-02
54.17	7.386E-02	1.532E-02
57.72	4.536E-02	1.859E-02
61.24	5.310E-02	1.262E-02
64.73	6.271E-02	1.645E-02
64.73	6.271E-02	1.645E-02
68.16	4.866E-02	1.370E-02
71.58	4.418E-02	1.320E-02
74.97	3.660E-02	1.787E-02
78.34	3.907E-02	1.038E-02
81.64	5.766E-02	1.214E-02
84.92	6.076E-02	1.499E-02
88.17	5.114E-02	9.254E-03
91.37	5.420E-02	8.157E-03
95.57	5.220E-02	7.938E-03
99.71	3.653E-02	6.809E-03
103.78	3.407E-02	5.914E-03
107.75	3.172E-02	1.221E-02
111.67	2.462E-02	1.433E-02
115.50	3.308E-02	1.090E-02
119.25	2.820E-02	1.216E-02
122.95	3.660E-02	1.303E-02
131.00	5.534E-02	9.703E-03
135.34	3.710E-02	8.532E-03
139.57	4.691E-02	1.012E-02
143.74	4.823E-02	9.143E-03
180.00	5.000E-02	5.000E-02

N14(D,D') 20.13 MEV. EX = 11.950 T=0 ID=238 J =

AVERAGE ENERGY = 11.9785+- 0.0015 THETA < 90
AVERAGE ENERGY = 11.9909+- 0.0028 THETA > 90
AVERAGE ENERGY = 11.9825+- 0.0016 ALL ANGLES
REACTION CROSS SECTION = 5.715E-01 +- 0.244E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.648E-03	3.634E-01
9.96	7.648E-03	3.634E-01
11.96	3.345E-01	2.815E-01
13.96	2.299E-01	1.989E-01
15.96	2.775E-03	1.168E-01
17.96	1.565E-01	8.781E-02
19.96	8.696E-02	5.822E-02
21.96	1.271E-01	6.197E-02
23.96	1.462E-01	5.624E-02
25.96	5.189E-02	4.586E-02
27.96	9.138E-02	5.721E-02
29.96	5.992E-02	4.967E-02
30.96	9.269E-02	4.224E-02
31.96	8.652E-02	3.548E-02
32.96	1.197E-01	3.206E-02
34.96	6.589E-02	2.694E-02
34.96	4.229E-02	3.818E-02
37.96	9.094E-02	2.156E-02
40.96	9.534E-02	2.669E-02
43.96	1.024E-01	2.131E-02
46.96	6.178E-02	2.524E-02
49.96	7.099E-02	1.686E-02
52.96	8.221E-02	2.155E-02
55.96	6.246E-02	1.757E-02
58.96	5.851E-02	1.657E-02
61.96	4.497E-02	2.193E-02
61.96	4.497E-02	2.193E-02
61.96	4.497E-02	2.193E-02
64.96	4.692E-02	1.245E-02
67.96	6.760E-02	1.422E-02
70.96	6.951E-02	1.713E-02
73.96	5.704E-02	1.031E-02
76.96	5.892E-02	8.860E-03
80.96	5.478E-02	8.322E-03
84.96	3.698E-02	6.886E-03
88.96	3.325E-02	5.766E-03
92.96	2.983E-02	1.147E-02
96.96	2.231E-02	1.297E-02
100.96	2.888E-02	9.509E-03
104.96	2.373E-02	1.022E-02
108.96	2.969E-02	1.056E-02
117.96	4.147E-02	7.266E-03
122.96	2.665E-02	6.125E-03
127.96	3.240E-02	6.982E-03
132.96	3.206E-02	6.076E-03
137.96	9.922E-03	5.188E-03
142.96	4.010E-03	6.395E-03
147.96	8.723E-03	3.252E-03
152.96	3.566E-04	9.673E-03
157.96	4.520E-04	5.554E-03
162.96	3.873E-04	4.325E-03
169.96	4.481E-04	4.679E-03
180.00	4.481E-04	4.679E-03

N14(D,D') 20.13 MEV. EX = 12.24 T=0 ID=239 J =

AVERAGE ENERGY = 12.2035+- 0.0013 THETA < 90
AVERAGE ENERGY = 12.1935+- 0.9380 THETA > 90
AVERAGE ENERGY = 12.2000+- 0.3211 ALL ANGLES
REACTION CROSS SECTION = 5.350E-01 +- 0.177E+00
INTEGRATION LENGTH = 2.630 + 0.197 + 0.315 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.000E-02	4.000E-02
22.57	4.628E-02	4.275E-02
25.07	5.649E-02	4.014E-02
27.56	5.094E-02	3.438E-02
30.04	4.766E-02	3.080E-02
32.52	3.380E-02	2.773E-02
35.00	3.051E-02	3.834E-02
37.45	2.405E-02	2.537E-02
38.68	4.910E-02	2.274E-02
39.89	4.413E-02	1.849E-02
41.11	7.009E-02	2.113E-02
43.56	3.630E-02	1.763E-02
43.55	2.201E-02	2.044E-02
47.20	5.740E-02	1.305E-02
50.80	6.053E-02	1.546E-02
54.38	4.471E-02	1.105E-02
57.95	3.287E-02	1.683E-02
61.46	5.255E-02	1.559E-02
64.97	5.305E-02	1.254E-02
68.43	4.234E-02	1.209E-02
68.43	4.234E-02	1.209E-02
71.88	4.529E-02	1.309E-02
75.27	4.219E-02	1.357E-02
78.62	3.915E-02	9.688E-03
81.95	4.267E-02	8.081E-03
85.22	3.901E-02	1.032E-02
88.47	4.831E-02	9.226E-03
91.65	7.020E-02	9.252E-03
95.87	3.169E-02	6.126E-03
99.99	4.224E-02	6.722E-03
104.05	5.072E-02	9.428E-03
108.04	3.394E-02	1.161E-02
111.92	2.404E-02	1.216E-02
115.75	2.168E-02	8.652E-03
119.53	2.274E-02	8.543E-03
123.22	1.797E-02	1.441E-02
131.26	3.002E-02	7.874E-03
135.56	2.756E-02	6.967E-03
139.82	4.210E-02	6.820E-03
143.94	2.867E-02	8.379E-03
180.00	3.000E-02	3.000E-02

N14(D,D') 20.13 MEV. EX = 12.24 T=0 ID=239 J =

AVERAGE ENERGY = 12.2025+- 0.0012 THETA < 90
AVERAGE ENERGY = 12.1903+- 0.0025 THETA > 90
AVERAGE ENERGY = 12.1985+- 0.0014 ALL ANGLES
REACTION CROSS SECTION = 4.520E-01 +- 0.214E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.649E-03	3.285E-01
9.96	7.649E-03	3.285E-01
11.96	7.850E-03	2.256E-01
13.96	8.832E-02	1.794E-01
15.96	2.775E-03	9.954E-02
17.96	7.195E-02	6.644E-02
19.96	8.741E-02	6.209E-02
21.96	7.835E-02	5.286E-02
23.96	7.285E-02	4.707E-02
25.96	5.132E-02	4.207E-02
27.96	4.600E-02	5.778E-02
29.96	3.596E-02	3.790E-02
30.96	7.311E-02	3.385E-02
31.96	6.541E-02	2.737E-02
32.96	1.034E-01	3.115E-02
34.96	5.310E-02	2.578E-02
34.96	3.218E-02	2.987E-02
37.96	8.272E-02	1.880E-02
40.96	8.584E-02	2.192E-02
43.96	6.234E-02	1.540E-02
46.96	4.502E-02	2.304E-02
49.96	7.061E-02	2.093E-02
52.96	6.992E-02	1.650E-02
55.96	5.461E-02	1.558E-02
58.96	5.716E-02	1.650E-02
61.96	5.204E-02	1.673E-02
61.96	5.204E-02	1.673E-02
61.96	5.204E-02	1.673E-02
64.96	4.716E-02	1.166E-02
67.96	5.017E-02	9.493E-03
70.96	4.472E-02	1.182E-02
73.96	5.398E-02	1.030E-02
76.96	7.639E-02	1.006E-02
80.96	3.327E-02	6.425E-03
84.96	4.275E-02	6.795E-03
88.96	4.944E-02	9.182E-03
92.96	3.186E-02	1.089E-02
96.96	2.173E-02	1.099E-02
100.96	1.887E-02	7.524E-03
104.96	1.905E-02	7.152E-03
108.96	1.451E-02	1.162E-02
117.96	2.234E-02	5.854E-03
122.96	1.966E-02	4.967E-03
127.96	2.680E-02	4.663E-03
132.96	1.889E-02	5.518E-03
137.96	5.874E-03	3.437E-03
142.96	2.458E-03	3.760E-03
147.96	5.626E-03	2.771E-03
152.96	3.568E-04	7.544E-03
157.96	4.523E-04	4.532E-03
162.96	3.875E-04	3.491E-03
169.96	4.483E-04	3.884E-03
180.00	4.483E-04	3.884E-03

N14(D,D') 20.13 MEV. EX = 12.29 T=0 ID=240 J =

AVERAGE ENERGY = 12.3204+- 0.0010 THETA < 90
AVERAGE ENERGY = 12.3214+- 0.9478 THETA > 90
AVERAGE ENERGY = 12.3207+- 0.3242 ALL ANGLES
REACTION CROSS SECTION = 3.824E-01 +- 0.216E+00
INTEGRATION LENGTH = 2.631 + 0.197 + 0.314 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.000E-02	2.000E-02
22.62	3.662E-02	5.306E-02
25.13	3.911E-02	4.759E-02
27.62	2.278E-02	4.130E-02
30.11	5.444E-02	4.512E-02
32.59	2.797E-02	3.699E-02
35.06	1.034E-02	4.656E-02
37.53	9.697E-03	3.006E-02
38.76	2.847E-02	3.443E-02
39.99	2.551E-02	3.119E-02
41.21	4.305E-02	2.552E-02
43.66	2.595E-02	2.670E-02
46.65	2.664E-02	2.641E-02
47.29	3.302E-02	1.622E-02
50.91	4.481E-02	2.087E-02
54.49	3.503E-02	1.153E-02
58.07	4.194E-02	2.161E-02
61.61	3.417E-02	1.928E-02
65.11	4.084E-02	1.703E-02
68.57	4.393E-02	1.820E-02
72.01	3.171E-02	1.819E-02
75.41	2.961E-02	1.736E-02
78.78	4.331E-02	1.415E-02
82.09	3.095E-02	1.078E-02
85.39	3.534E-02	1.422E-02
88.62	3.069E-02	1.433E-02
91.82	5.382E-02	1.177E-02
96.05	2.610E-02	8.186E-03
100.19	3.251E-02	1.176E-02
104.24	2.308E-02	1.116E-02
108.22	1.856E-02	1.371E-02
112.14	3.150E-02	1.547E-02
115.95	1.565E-02	6.686E-03
119.72	2.281E-02	1.204E-02
123.37	9.533E-03	1.171E-02
131.41	2.153E-02	1.041E-02
135.73	1.403E-02	6.112E-03
139.95	1.886E-02	7.849E-03
144.07	1.703E-02	8.597E-03
180.00	1.000E-02	1.000E-02

N14(D,D') 20.13 MEV. EX = 12.29 T=0 ID=240 J =

AVERAGE ENERGY = 12.3204+- 0.0009 THETA < 90
AVERAGE ENERGY = 12.3191+- 0.0026 THETA > 90
AVERAGE ENERGY = 12.3199+- 0.0010 ALL ANGLES
REACTION CROSS SECTION = 3.319E-01 +- 0.263E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.649E-03	3.869E-01
9.96	7.649E-03	3.869E-01
11.96	7.850E-03	2.874E-01
13.96	6.663E-03	2.396E-01
15.96	2.776E-03	1.166E-01
17.96	5.719E-02	8.283E-02
19.96	6.077E-02	7.392E-02
21.96	3.517E-02	6.375E-02
23.96	8.356E-02	6.923E-02
25.96	4.264E-02	5.635E-02
27.96	1.563E-02	7.040E-02
29.96	1.456E-02	4.510E-02
30.96	4.257E-02	5.144E-02
31.96	3.797E-02	4.639E-02
32.96	6.377E-02	3.787E-02
34.96	3.811E-02	3.920E-02
34.96	4.203E-02	3.874E-02
37.96	4.774E-02	2.344E-02
40.96	6.378E-02	2.968E-02
43.96	4.899E-02	1.612E-02
46.96	5.763E-02	2.966E-02
49.96	4.607E-02	2.597E-02
52.96	5.397E-02	2.247E-02
55.96	5.680E-02	2.352E-02
58.96	4.010E-02	2.298E-02
61.96	3.659E-02	2.144E-02
61.96	3.659E-02	2.144E-02

ABCISSA	ORDINATE	ERROR
61.96	3.659E-02	2.144E-02
64.96	5.226E-02	1.707E-02
67.96	3.644E-02	1.268E-02
70.96	4.057E-02	1.631E-02
73.96	3.432E-02	1.601E-02
76.96	5.860E-02	1.280E-02
80.96	2.740E-02	8.587E-03
84.96	3.289E-02	1.188E-02
88.96	2.248E-02	1.086E-02
92.96	1.740E-02	1.284E-02
96.96	2.842E-02	1.394E-02
100.96	1.359E-02	5.800E-03
104.96	1.906E-02	1.005E-02
108.96	7.673E-03	9.417E-03
117.96	1.596E-02	7.712E-03
122.96	9.953E-03	4.335E-03
127.96	1.284E-02	5.341E-03
132.96	1.116E-02	5.628E-03
137.96	3.177E-03	3.051E-03
142.96	2.793E-03	3.368E-03
147.96	1.539E-03	2.100E-03
152.96	3.569E-04	4.570E-03
157.96	4.524E-04	4.071E-04
162.96	3.876E-04	2.022E-03
169.96	4.484E-04	2.783E-03
180.00	4.484E-04	2.783E-03

N14(D,D') 20.13 MEV. EX = 12.41 T=0 ID=241 J = 4-

AVERAGE ENERGY = 12.4109+- 0.0007 THETA < 90
AVERAGE ENERGY = 12.4074+- 0.9544 THETA > 90
AVERAGE ENERGY = 12.4097+- 0.3102 ALL ANGLES
REACTION CROSS SECTION = 7.377E-01 +- 0.283E+00
INTEGRATION LENGTH = 2.675 + 0.154 + 0.313 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.000E-01	1.000E-01
17.65	9.634E-02	1.751E-01
20.16	4.238E-02	8.298E-02
22.66	1.108E-01	5.029E-02
25.18	1.109E-01	5.225E-02
27.67	1.053E-01	4.956E-02
30.17	1.160E-01	4.697E-02
32.65	8.682E-02	4.517E-02
35.13	6.716E-02	4.406E-02
37.59	7.678E-02	3.797E-02
38.83	8.082E-02	4.315E-02
40.06	9.506E-02	4.295E-02
41.29	8.663E-02	2.961E-02
43.73	7.308E-02	3.489E-02
45.72	6.853E-02	3.115E-02
47.37	9.815E-02	2.022E-02
51.00	8.241E-02	2.638E-02
54.59	7.686E-02	1.634E-02
58.16	8.282E-02	2.309E-02
61.71	7.151E-02	1.975E-02
65.21	6.670E-02	1.831E-02
65.21	6.670E-02	1.831E-02

ABCISSA	ORDINATE	ERROR
68.68	9.309E-02	2.254E-02
72.12	8.435E-02	1.850E-02
75.53	6.519E-02	2.075E-02
78.89	7.150E-02	1.689E-02
82.21	7.669E-02	1.430E-02
85.51	5.597E-02	1.789E-02
88.75	6.961E-02	1.449E-02
91.97	6.798E-02	1.295E-02
96.18	5.219E-02	9.575E-03
100.30	5.122E-02	1.172E-02
104.37	4.711E-02	1.291E-02
108.35	3.856E-02	1.503E-02
112.24	4.012E-02	1.577E-02
116.08	2.022E-02	6.390E-03
119.82	2.004E-02	1.154E-02
123.51	1.724E-02	7.885E-03
131.52	2.419E-02	9.782E-03
135.54	2.269E-02	9.032E-03
140.05	2.321E-02	9.463E-03
144.17	2.136E-02	9.290E-03
180.00	1.000E-02	1.000E-02

N14(D,D') 20.13 MEV. EX = 12.41 T=0 ID=241 J = 4-

AVERAGE ENERGY = 12.4107+- 0.0007 THETA < 90
AVERAGE ENERGY = 12.4092+- 0.0014 THETA > 90
AVERAGE ENERGY = 12.4102+- 0.0007 ALL ANGLES
REACTION CROSS SECTION = 6.807E-01 +- 0.290E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.650E-03	3.746E-01
9.96	7.650E-03	3.746E-01
11.96	3.091E-01	3.944E-01
13.96	1.524E-01	2.769E-01
15.96	6.673E-02	1.305E-01
17.96	1.736E-01	7.878E-02
19.96	1.729E-01	8.146E-02
21.96	1.632E-01	7.680E-02
23.96	1.786E-01	7.231E-02
25.96	1.328E-01	6.905E-02
27.96	1.019E-01	6.684E-02
29.96	1.156E-01	5.714E-02
30.96	1.212E-01	6.467E-02
31.96	1.419E-01	6.410E-02
32.96	1.287E-01	4.397E-02
34.96	1.076E-01	5.135E-02
34.96	1.009E-01	4.582E-02
37.96	1.423E-01	2.931E-02
40.96	1.176E-01	3.762E-02
43.96	1.078E-01	2.293E-02
46.96	1.223E-01	3.178E-02
49.96	9.660E-02	2.666E-02
52.96	8.629E-02	2.422E-02
55.96	1.206E-01	2.918E-02
58.96	1.069E-01	2.342E-02
61.96	8.069E-02	2.566E-02
61.96	8.069E-02	2.566E-02
61.96	8.069E-02	2.566E-02
64.96	8.640E-02	2.039E-02
67.96	9.062E-02	1.684E-02
70.96	6.431E-02	2.053E-02
73.96	7.790E-02	1.620E-02
76.96	7.406E-02	1.409E-02
80.96	5.481E-02	1.004E-02
84.96	5.180E-02	1.184E-02
88.96	4.586E-02	1.256E-02
92.96	3.612E-02	1.407E-02
96.96	3.616E-02	1.420E-02
100.96	1.753E-02	5.534E-03
104.96	1.671E-02	9.619E-03
108.96	1.384E-02	6.326E-03
117.96	1.788E-02	7.223E-03
122.96	1.605E-02	6.383E-03
127.96	1.574E-02	6.413E-03
132.96	1.393E-02	6.055E-03
137.96	3.157E-03	2.778E-03
142.96	3.485E-04	2.827E-03
147.96	3.537E-04	1.680E-03
152.96	3.570E-04	4.664E-03
157.96	4.526E-04	2.856E-03
162.96	3.877E-04	2.266E-03
169.96	4.486E-04	2.598E-03
180.00	4.486E-04	2.598E-03

N14(D,D') 20.13 MEV. EX = 12.47 T=0 ID=242 J =

AVERAGE ENERGY = 12.5076+- 0.0011 THETA < 90
AVERAGE ENERGY = 12.5099+- 1.0425 THETA > 90
AVERAGE ENERGY = 12.5083+- 0.3475 ALL ANGLES
REACTION CROSS SECTION = 4.117E-01 +- 0.223E+00
INTEGRATION LENGTH = 2.574 + 0.220 + 0.347 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.000E-02	5.000E-02
25.22	2.520E-02	4.468E-02
27.73	2.542E-02	5.485E-02
30.22	4.274E-02	3.985E-02
32.71	1.691E-02	4.852E-02
35.19	1.619E-02	3.342E-02
37.67	2.664E-02	4.020E-02
40.15	4.180E-02	3.883E-02
42.63	2.763E-02	4.119E-02
45.11	5.764E-02	3.160E-02
47.59	2.932E-02	3.909E-02
50.07	1.725E-02	3.016E-02
52.56	5.285E-02	2.922E-02
55.04	3.691E-02	2.105E-02
57.52	5.328E-02	1.641E-02
60.00	3.754E-02	2.035E-02
62.48	4.651E-02	2.034E-02
64.96	4.314E-02	1.595E-02
67.44	4.517E-02	1.950E-02
69.93	4.517E-02	1.950E-02

ABCISSA	ORDINATE	ERROR
72.24	3.298E-02	1.499E-02
75.65	2.414E-02	1.587E-02
79.02	4.096E-02	1.335E-02
82.36	4.316E-02	1.583E-02
85.66	4.392E-02	2.160E-02
88.92	3.972E-02	1.966E-02
92.10	5.550E-02	1.472E-02
96.33	3.169E-02	1.080E-02
100.46	2.847E-02	1.017E-02
104.53	3.328E-02	1.931E-02
108.50	3.295E-02	1.386E-02
112.40	2.704E-02	9.986E-03
116.24	1.881E-02	8.932E-03
119.99	9.481E-03	6.037E-03
123.65	7.337E-03	7.445E-03
131.67	1.388E-02	6.999E-03
135.97	1.211E-02	8.308E-03
140.18	1.958E-02	6.945E-03
180.00	7.000E-03	7.000E-03

N14(D,D') 20.13 MEV. EX = 12.47 T=0 ID=242 J =

AVERAGE ENERGY = 12.5077+- 0.0009 THETA < 90
AVERAGE ENERGY = 12.5051+- 0.0034 THETA > 90
AVERAGE ENERGY = 12.5068+- 0.0013 ALL ANGLES
REACTION CROSS SECTION = 3.594E-01 +- 0.274E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.650E-03	3.656E-01
9.96	7.650E-03	3.656E-01
11.96	9.701E-02	3.405E-01
13.96	6.664E-03	1.947E-01
15.96	2.776E-03	1.482E-01
17.96	8.405E-02	8.836E-02
19.96	3.943E-02	6.987E-02
21.96	3.956E-02	8.531E-02
23.96	6.606E-02	6.157E-02
25.96	2.595E-02	7.442E-02
27.96	2.466E-02	5.087E-02
29.96	4.025E-02	6.071E-02
30.96	6.290E-02	5.840E-02
31.96	4.139E-02	6.165E-02
32.96	8.594E-02	4.709E-02
34.96	4.331E-02	5.772E-02
34.96	2.549E-02	4.453E-02
37.96	7.689E-02	3.231E-02
40.96	5.284E-02	3.010E-02
43.96	7.494E-02	2.306E-02
46.96	5.184E-02	2.809E-02
49.96	6.299E-02	2.752E-02
52.96	5.722E-02	2.114E-02
55.96	5.864E-02	2.529E-02
58.96	4.186E-02	1.900E-02
61.96	2.993E-02	1.966E-02
61.96	2.993E-02	1.966E-02
61.96	2.993E-02	1.966E-02
64.96	4.957E-02	1.614E-02
67.96	5.094E-02	1.866E-02
70.96	5.051E-02	2.482E-02
73.96	4.449E-02	2.200E-02
76.96	6.049E-02	1.603E-02
80.96	3.328E-02	1.133E-02
84.96	2.878E-02	1.027E-02
88.96	3.238E-02	1.877E-02
92.96	3.084E-02	1.296E-02
96.96	2.433E-02	8.977E-03
100.96	1.628E-02	7.721E-03
104.96	7.889E-03	5.019E-03
108.96	5.875E-03	5.957E-03
117.96	1.022E-02	5.147E-03
122.96	8.527E-03	5.847E-03
127.96	1.322E-02	4.685E-03
132.96	9.776E-03	5.457E-03
137.96	2.440E-03	3.320E-03
142.96	3.486E-04	2.981E-03
147.96	3.538E-04	2.010E-03
152.96	3.571E-04	3.994E-03
157.96	4.527E-04	4.074E-04
162.96	3.878E-04	2.240E-03
169.96	4.487E-04	4.039E-04
180.00	4.487E-04	4.039E-04

N14(D,D') 20.13 MEV. EX = 12.608 T=0 ID=244 J = 3+

AVERAGE ENERGY = 12.6116+- 0.0011 THETA < 90
AVERAGE ENERGY = 12.6094+- 0.9007 THETA > 90
AVERAGE ENERGY = 12.6108+- 0.2933 ALL ANGLES
REACTION CROSS SECTION = 7.558E-01 +- 0.347E+00
INTEGRATION LENGTH = 2.756 + 0.110 + 0.276 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.000E-02	5.000E-02
12.65	4.764E-03	2.499E-01
15.19	5.287E-02	1.813E-01
17.72	9.087E-02	1.475E-01
20.24	5.225E-02	1.041E-01
22.76	1.095E-01	6.926E-02
25.27	6.550E-02	3.879E-02
27.79	7.989E-02	6.070E-02
30.23	7.175E-02	4.044E-02
32.79	1.002E-01	6.838E-02
35.28	8.965E-02	6.076E-02
37.76	6.999E-02	5.853E-02
38.99	8.037E-02	5.349E-02
40.22	1.109E-01	6.514E-02
41.44	1.111E-01	3.507E-02
43.91	9.715E-02	5.769E-02
43.90	8.493E-02	3.429E-02
47.56	1.119E-01	2.952E-02
51.19	6.948E-02	2.596E-02
54.81	9.406E-02	2.470E-02
58.39	9.883E-02	3.309E-02
61.93	8.686E-02	2.608E-02
65.46	7.195E-02	2.085E-02
65.46	7.195E-02	2.085E-02
68.95	7.641E-02	2.300E-02
72.38	7.538E-02	1.991E-02
75.81	7.158E-02	2.378E-02
79.17	6.271E-02	1.547E-02
82.52	8.175E-02	2.457E-02
85.80	8.043E-02	2.337E-02
89.05	8.861E-02	3.129E-02
92.28	9.567E-02	2.438E-02
96.49	7.922E-02	1.888E-02
100.61	5.777E-02	1.402E-02
104.67	6.568E-02	2.181E-02
108.66	5.944E-02	1.535E-02
112.58	4.429E-02	1.719E-02
116.38	2.599E-02	1.293E-02
120.14	1.716E-02	9.260E-03
123.81	1.839E-02	8.788E-03
131.80	1.829E-02	5.305E-03
136.08	1.490E-02	8.085E-03
140.29	2.164E-02	7.060E-03
144.40	1.672E-02	8.518E-03
148.41	2.767E-03	6.294E-03
180.00	1.000E-02	1.000E-02

N14(D,D') 20.13 MEV. EX = 12.608 T=0 ID=244 J = 3+

AVERAGE ENERGY = 12.6112+- 0.0010 THETA < 90
AVERAGE ENERGY = 12.6062+- 0.0020 THETA > 90
AVERAGE ENERGY = 12.6096+- 0.0010 ALL ANGLES
REACTION CROSS SECTION = 7.339E-01 +- 0.341E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.651E-03	4.013E-01
9.96	7.651E-03	4.013E-01
11.96	8.462E-02	2.901E-01
13.96	1.449E-01	2.352E-01
15.96	8.295E-02	1.652E-01
17.96	1.729E-01	1.094E-01
19.96	1.029E-01	6.091E-02
21.96	1.248E-01	9.479E-02
23.96	1.113E-01	6.270E-02
25.96	1.544E-01	1.053E-01
27.96	1.371E-01	9.290E-02
29.96	1.062E-01	8.876E-02
30.96	1.214E-01	8.077E-02
31.96	1.668E-01	9.791E-02
32.96	1.662E-01	5.245E-02
34.96	1.441E-01	8.551E-02
34.96	1.259E-01	5.078E-02
37.96	1.633E-01	4.306E-02
40.96	9.976E-02	3.725E-02
43.96	1.327E-01	3.483E-02
46.96	1.369E-01	4.579E-02
49.96	1.175E-01	3.538E-02
52.96	9.570E-02	2.771E-02
55.96	9.945E-02	2.992E-02
58.96	9.588E-02	2.530E-02
61.96	8.693E-02	2.951E-02
61.96	8.893E-02	2.951E-02
61.96	8.893E-02	2.951E-02
64.96	7.601E-02	1.874E-02
67.96	9.662E-02	2.902E-02
70.96	9.261E-02	2.688E-02
73.96	9.932E-02	3.503E-02
76.96	1.043E-01	2.656E-02
80.96	8.321E-02	1.981E-02
84.96	5.840E-02	1.416E-02
88.96	6.386E-02	2.119E-02
92.96	5.556E-02	1.433E-02
96.96	3.979E-02	1.542E-02
100.96	2.245E-02	1.116E-02
104.96	1.425E-02	7.680E-03
108.96	1.468E-02	7.010E-03
117.96	1.341E-02	3.888E-03
122.96	1.045E-02	5.668E-03
127.96	1.455E-02	4.742E-03
132.96	1.079E-02	5.495E-03
137.96	1.722E-03	3.914E-03
142.96	3.487E-04	3.056E-03
147.96	3.539E-04	1.978E-03
152.96	3.572E-04	3.214E-04
157.96	4.528E-04	3.297E-03
162.96	3.879E-04	3.491E-04
169.96	4.489E-04	4.040E-04
180.00	4.489E-04	4.040E-04

N14(D,D') 20.13 MEV. EX = 12.689 T=0 ID=245 J = 3-

AVERAGE ENERGY = 12.6958+- 0.0008 THETA < 90
AVERAGE ENERGY = 12.6928+- 2.1155 THETA > 90
AVERAGE ENERGY = 12.6953+- 0.3627 ALL ANGLES
REACTION CROSS SECTION = 7.384E-01 +- 0.413E+00
INTEGRATION LENGTH = 2.444 + 0.111 + 0.587 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.000E-02	5.000E-02
12.68	4.746E-03	2.793E-01
15.22	4.886E-03	1.602E-01
17.75	5.684E-02	1.709E-01
20.28	4.784E-02	9.673E-02
22.80	8.718E-02	6.919E-02
25.32	1.153E-01	5.566E-02
27.84	8.042E-02	5.441E-02
30.34	1.071E-01	4.517E-02
32.84	7.084E-02	6.299E-02
35.34	6.958E-02	7.727E-02
37.82	7.880E-02	6.936E-02
39.06	7.328E-02	6.039E-02
40.29	8.467E-02	6.613E-02
41.52	1.061E-01	3.120E-02
43.98	7.659E-02	5.723E-02
43.97	7.578E-02	3.416E-02
47.64	7.891E-02	2.508E-02
51.28	9.342E-02	3.275E-02
51.28	9.342E-02	3.275E-02
51.28	9.342E-02	3.275E-02
54.90	7.953E-02	3.340E-02
58.48	8.788E-02	3.346E-02
62.04	9.652E-02	2.963E-02
65.56	8.789E-02	2.844E-02
69.05	8.804E-02	2.036E-02
72.50	1.014E-01	2.792E-02
75.92	5.679E-02	2.794E-02
79.29	7.307E-02	2.289E-02
82.63	8.889E-02	2.746E-02
85.94	9.912E-02	3.280E-02
89.19	1.087E-01	3.123E-02
92.40	6.678E-02	2.841E-02
96.62	6.431E-02	2.813E-02
100.75	6.593E-02	1.568E-02
104.81	6.573E-02	2.011E-02
108.81	4.902E-02	1.572E-02
112.70	2.493E-02	1.975E-02
180.00	5.000E-03	5.000E-03

N14(D,D') 20.13 MEv. EX = 12.689 T=0 ID=245 J = 3-

AVERAGE ENERGY = 12.6952+- 0.0008 THETA < 90
AVERAGE ENERGY = 12.6892+- 0.0014 THETA > 90
AVERAGE ENERGY = 12.6932+- 0.0008 ALL ANGLES
REACTION CROSS SECTION = 7.072E-01 +- 0.376E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.651E-03	4.502E-01
9.96	7.651E-03	4.502E-01
11.96	7.652E-03	2.573E-01
13.96	9.100E-02	2.735E-01
15.96	7.621E-02	1.540E-01
17.96	1.382E-01	1.096E-01
19.96	1.819E-01	8.773E-02
21.96	1.261E-01	8.525E-02
23.96	1.667E-01	7.029E-02
25.96	1.095E-01	9.734E-02
27.96	1.068E-01	1.185E-01
29.96	1.199E-01	1.055E-01
30.96	1.110E-01	9.146E-02
31.96	1.277E-01	9.970E-02
32.96	1.593E-01	4.680E-02
34.96	1.139E-01	8.506E-02
34.96	1.126E-01	5.075E-02
37.96	1.155E-01	3.670E-02
40.96	1.345E-01	4.713E-02
43.96	1.125E-01	4.722E-02
46.96	1.220E-01	4.642E-02
49.96	1.314E-01	4.029E-02
52.96	1.171E-01	3.787E-02
55.96	1.148E-01	2.652E-02
58.96	1.293E-01	3.555E-02
61.96	7.066E-02	3.474E-02
61.96	7.066E-02	3.474E-02

ABCISSA	ORDINATE	ERROR
61.96	7.066E-02	3.474E-02
64.96	8.869E-02	2.776E-02
67.96	1.052E-01	3.246E-02
70.96	1.142E-01	3.777E-02
73.96	1.219E-01	3.500E-02
76.96	7.285E-02	3.097E-02
80.96	6.756E-02	2.952E-02
84.96	6.663E-02	1.583E-02
88.96	6.387E-02	1.952E-02
92.96	4.577E-02	1.467E-02
96.96	2.237E-02	1.771E-02
100.96	1.413E-02	1.209E-02
104.96	1.114E-02	9.448E-03
108.96	1.024E-02	5.103E-03
117.96	5.750E-03	2.710E-03
122.96	1.047E-02	4.391E-03
127.96	1.202E-02	6.078E-03
132.96	7.328E-03	5.532E-03
137.96	3.485E-04	3.316E-03
142.96	3.488E-04	1.974E-03
147.96	3.540E-04	3.185E-04
152.96	3.573E-04	3.571E-03
157.96	4.530E-04	4.076E-04
162.96	3.881E-04	3.492E-04
169.96	4.490E-04	4.042E-04
180.00	4.490E-04	4.042E-04

N14(D,D') 20.13 MEV. EX = 12.825 T=0 ID=247 J = 4-

AVERAGE ENERGY = 12.8158+- 0.0013 THETA < 90
AVERAGE ENERGY = 12.8070+- 0.9852 THETA > 90
AVERAGE ENERGY = 12.8130+- 0.3051 ALL ANGLES
REACTION CROSS SECTION = 3.651E+00 +- 0.479E+00
INTEGRATION LENGTH = 2.722 + 0.111 + 0.309 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.000E-01	2.000E-01
12.71	6.158E-01	3.544E-01
15.26	7.393E-01	2.363E-01
17.80	7.338E-01	2.175E-01
20.33	6.945E-01	1.297E-01
22.86	5.992E-01	8.090E-02
25.39	6.391E-01	7.881E-02
27.91	5.319E-01	7.094E-02
30.42	5.502E-01	6.440E-02
32.93	5.103E-01	6.877E-02
35.42	4.059E-01	7.235E-02
37.91	4.331E-01	7.323E-02
39.15	4.136E-01	5.866E-02
40.39	4.238E-01	5.687E-02
41.63	4.401E-01	4.085E-02
44.09	4.293E-01	6.166E-02
44.08	4.429E-01	5.193E-02
47.76	4.668E-01	3.187E-02
51.41	4.347E-01	4.356E-02
55.04	4.487E-01	4.869E-02
58.63	4.159E-01	3.436E-02
62.19	4.437E-01	3.805E-02
62.19	4.437E-01	3.805E-02
65.73	4.361E-01	3.497E-02
69.21	3.951E-01	3.122E-02
72.68	3.645E-01	3.407E-02
76.08	3.215E-01	3.745E-02
79.47	3.570E-01	2.938E-02
82.81	3.791E-01	2.678E-02
86.11	3.820E-01	4.566E-02
89.37	3.737E-01	3.431E-02
92.59	3.739E-01	3.167E-02
96.80	2.899E-01	3.346E-02
100.95	2.932E-01	2.399E-02
105.01	2.919E-01	2.722E-02
108.98	2.116E-01	2.728E-02
112.90	1.743E-01	2.565E-02
116.71	1.017E-01	1.956E-02
120.46	5.053E-02	1.438E-02
124.12	5.132E-02	1.005E-02
132.08	4.127E-02	6.602E-03
136.37	4.094E-02	9.462E-03
140.56	4.091E-02	9.191E-03
144.62	2.986E-02	9.192E-03
180.00	1.000E-02	1.000E-02

N14(D,D') 20.13 MEV. EX = 12.825 T=0 ID=247 J. = 4-

AVERAGE ENERGY = 12.8148+- 0.0012 THETA < 90
AVERAGE ENERGY = 12.8075+- 0.0030 THETA > 90
AVERAGE ENERGY = 12.8124+- 0.0014 ALL ANGLES
REACTION CROSS SECTION = 3.711E+00 +- 0.488E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	9.982E-01	5.744E-01
9.96	9.982E-01	5.744E-01
11.96	1.195E+00	3.819E-01
13.96	1.181E+00	3.500E-01
15.96	1.112E+00	2.076E-01
17.96	9.548E-01	1.289E-01
19.96	1.013E+00	1.249E-01
21.96	8.378E-01	1.117E-01
23.96	8.609E-01	1.007E-01
25.96	7.927E-01	1.068E-01
27.96	6.256E-01	1.114E-01
29.96	6.621E-01	1.119E-01
30.96	6.294E-01	8.922E-02
31.96	6.420E-01	8.610E-02
32.96	6.636E-01	6.156E-02
34.96	6.411E-01	9.203E-02
34.96	6.611E-01	7.747E-02
37.96	6.591E-01	4.681E-02
40.96	6.284E-01	6.293E-02
43.96	6.373E-01	6.910E-02
46.96	5.796E-01	4.784E-02
49.96	6.060E-01	5.192E-02
52.96	5.331E-01	4.672E-02
55.96	5.167E-01	4.078E-02
58.96	4.657E-01	4.349E-02
61.96	4.009E-01	4.665E-02
61.96	4.009E-01	4.665E-02

ABCISSA	ORDINATE	ERROR
61.96	4.009E-01	4.665E-02
64.96	4.342E-01	3.570E-02
67.96	4.492E-01	3.171E-02
70.96	4.408E-01	5.264E-02
73.96	4.195E-01	3.848E-02
76.96	4.082E-01	3.454E-02
80.96	3.045E-01	3.513E-02
84.96	2.962E-01	2.421E-02
88.96	2.834E-01	2.640E-02
92.96	1.973E-01	2.542E-02
96.96	1.561E-01	2.295E-02
100.96	8.747E-02	1.681E-02
104.96	4.173E-02	1.187E-02
108.96	4.073E-02	7.972E-03
117.96	3.004E-02	4.802E-03
122.96	2.846E-02	6.572E-03
127.96	2.722E-02	6.110E-03
132.96	1.908E-02	5.870E-03
137.96	3.487E-04	3.971E-03
142.96	3.489E-04	3.345E-03
147.96	3.542E-04	1.932E-03
152.96	3.574E-04	6.682E-03
157.96	4.532E-04	4.078E-04
162.96	3.882E-04	3.494E-04
169.96	4.492E-04	4.043E-04
180.00	4.492E-04	4.043E-04

STAP

N14(D,D') 20.13 MEV. EX = 12.942 T=0 ID=249 J = 4

AVERAGE ENERGY = 12.9207+- 0.0009 THETA < 90
AVERAGE ENERGY = 12.9147+- 0.0015 THETA > 90
AVERAGE ENERGY = 12.9190+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 4.587E-01 +- 0.359E+00
INTEGRATION LENGTH = 2.665 + 0.134 + 0.343 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.299E-02	2.017E-01
15.30	5.299E-02	2.017E-01
17.84	7.599E-02	1.546E-01
20.38	4.160E-02	9.896E-02
22.92	5.058E-02	6.757E-02
25.45	7.483E-02	5.827E-02
27.98	4.587E-02	5.569E-02
30.49	7.086E-02	5.241E-02
33.00	4.067E-02	5.857E-02
35.51	3.459E-02	4.584E-02
38.01	4.853E-02	6.080E-02
39.24	4.537E-02	6.114E-02
40.49	4.880E-02	4.990E-02
41.72	6.269E-02	3.822E-02
44.20	5.139E-02	5.469E-02
44.19	4.702E-02	3.871E-02
47.88	5.689E-02	2.413E-02
51.53	5.864E-02	2.775E-02
55.16	6.596E-02	3.333E-02
58.77	6.598E-02	3.355E-02
62.33	5.374E-02	2.549E-02
62.33	5.374E-02	2.549E-02
65.87	5.195E-02	2.746E-02
69.37	5.793E-02	2.664E-02
72.83	4.593E-02	2.273E-02
76.25	5.814E-02	3.011E-02
79.64	3.655E-02	2.076E-02
82.99	5.567E-02	2.445E-02
86.29	5.126E-02	4.130E-02
89.55	5.394E-02	2.855E-02
92.77	4.014E-02	3.482E-02
96.99	3.728E-02	2.045E-02
101.14	3.096E-02	1.941E-02
105.20	3.711E-02	2.573E-02
109.18	2.412E-02	1.922E-02
113.06	1.924E-02	1.594E-02
116.90	1.481E-02	1.129E-02
120.61	3.121E-03	6.143E-03
124.30	2.369E-03	4.215E-03
132.26	2.647E-03	3.057E-03
140.70	4.806E-03	5.557E-03
180.00	4.806E-03	5.557E-03

N14(D,D') 20.13 MEV. . EX = 12.942 T=0 ID=249 J = 4

AVERAGE ENERGY = 12.9202+- 0.0008 THETA < 90
AVERAGE ENERGY = 12.9127+- 0.0010 THETA > 90
AVERAGE ENERGY = 12.9177+- 0.0008 ALL ANGLES
REACTION CROSS SECTION = 4.293E-01 +- 0.363E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.652E-03	4.309E-01
9.96	7.652E-03	4.309E-01
11.96	8.601E-02	3.273E-01
13.96	1.229E-01	2.498E-01
15.96	6.692E-02	1.592E-01
17.96	8.098E-02	1.081E-01
19.96	1.191E-01	9.270E-02
21.96	7.260E-02	8.810E-02
23.96	1.118E-01	6.232E-02
25.96	6.344E-02	9.131E-02
27.96	5.354E-02	7.092E-02
29.96	7.452E-02	9.331E-02
30.96	7.009E-02	9.337E-02
31.96	7.424E-02	7.586E-02
32.96	9.491E-02	5.792E-02
34.96	7.706E-02	8.196E-02
34.96	7.049E-02	5.799E-02
37.96	8.396E-02	3.559E-02
40.96	8.508E-02	4.023E-02
43.96	9.400E-02	4.746E-02
46.96	9.226E-02	4.687E-02
49.96	7.362E-02	3.489E-02
52.96	6.966E-02	3.679E-02
55.96	7.595E-02	3.490E-02
58.96	5.682E-02	2.909E-02
61.96	7.266E-02	3.759E-02
61.96	7.266E-02	3.759E-02

ABCISSA	ORDINATE	ERROR
61.96	7.266E-02	3.759E-02
64.96	4.454E-02	2.528E-02
67.96	6.608E-02	2.899E-02
70.96	5.922E-02	4.767E-02
73.96	6.061E-02	3.205E-02
76.96	4.385E-02	3.800E-02
80.96	3.918E-02	2.147E-02
84.96	3.127E-02	1.958E-02
88.96	3.600E-02	2.494E-02
92.96	2.247E-02	1.789E-02
96.96	1.720E-02	1.424E-02
100.96	1.270E-02	9.679E-03
104.96	2.572E-03	5.058E-03
108.96	1.874E-03	3.332E-03
117.96	1.918E-03	2.213E-03
122.96	5.577E-04	3.816E-03
127.96	3.180E-03	3.674E-03
132.96	7.251E-04	2.320E-03
137.96	3.488E-04	3.138E-04
142.96	3.491E-04	3.140E-04
147.96	3.543E-04	3.188E-04
152.96	3.576E-04	3.218E-04
157.96	4.534E-04	4.080E-04
162.96	3.884E-04	3.495E-04
169.96	4.494E-04	4.045E-04
180.00	4.494E-04	4.045E-04

STOP

N14(D,D') 20.13 MEV. EX = 13.05 T=0 ID=250 J =

AVERAGE ENERGY = 13.0490+- 0.0013 THETA < 90
AVERAGE ENERGY = 13.0406+- 0.0038 THETA > 90
AVERAGE ENERGY = 13.0464+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 1.913E+00 +- 0.501E+00
INTEGRATION LENGTH = 2.666 + 0.134 + 0.342 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.658E-01	2.688E-01
15.34	2.658E-01	2.688E-01
17.90	1.594E-01	1.964E-01
22.99	2.301E-01	1.215E-01
25.52	2.039E-01	9.019E-02
28.06	2.208E-01	7.719E-02
30.58	2.004E-01	6.831E-02
33.10	1.859E-01	8.573E-02
39.36	1.933E-01	8.777E-02
40.62	2.229E-01	7.369E-02
41.84	2.360E-01	6.033E-02
44.34	2.358E-01	7.229E-02
44.32	2.067E-01	5.868E-02
48.01	2.171E-01	3.908E-02
51.68	2.334E-01	4.735E-02
55.31	2.184E-01	3.293E-02
58.93	1.912E-01	4.630E-02
62.50	1.926E-01	3.803E-02
66.03	2.063E-01	3.967E-02
66.03	2.063E-01	3.967E-02
69.56	1.806E-01	3.620E-02
73.05	2.147E-01	3.607E-02
76.48	1.770E-01	4.336E-02
79.86	1.966E-01	3.196E-02
83.22	2.176E-01	3.654E-02
86.51	2.501E-01	4.491E-02
89.79	2.462E-01	3.570E-02
92.98	2.249E-01	3.639E-02
97.22	1.864E-01	1.872E-02
101.37	1.737E-01	2.234E-02
105.44	1.533E-01	2.702E-02
113.31	6.874E-02	1.789E-02
117.11	3.001E-02	1.412E-02
120.87	2.185E-02	9.769E-03
124.50	1.943E-02	6.554E-03
132.47	1.421E-02	4.446E-03
136.69	1.105E-02	1.274E-02
140.85	2.732E-02	9.069E-03
180.00	2.732E-02	9.069E-03

N14(D,D') 20.13 MEV. . EX = 13.05 T=0 ID=250 J =

AVERAGE ENERGY = 13.0490+- 0.0012 THETA < 90
AVERAGE ENERGY = 13.0337+- 0.0050 THETA > 90
AVERAGE ENERGY = 13.0440+- 0.0021 ALL ANGLES
REACTION CROSS SECTION = 1.733E+00 +- 0.492E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.653E-03	5.151E-01
9.96	7.653E-03	5.151E-01
11.96	4.339E-01	4.388E-01
13.96	2.593E-01	3.194E-01
15.96	2.785E-01	2.198E-01
17.96	3.705E-01	1.955E-01
19.96	3.263E-01	1.443E-01
21.96	3.513E-01	1.228E-01
23.96	3.166E-01	1.079E-01
25.96	2.916E-01	1.344E-01
27.96	2.530E-01	1.607E-01
29.96	2.656E-01	1.296E-01
30.96	2.970E-01	1.348E-01
31.96	3.409E-01	1.127E-01
32.96	3.590E-01	9.173E-02
34.96	3.556E-01	1.089E-01
34.96	3.115E-01	8.837E-02
37.96	3.219E-01	5.791E-02
40.96	3.402E-01	6.897E-02
43.96	3.125E-01	4.709E-02
46.96	2.684E-01	6.495E-02
49.96	2.648E-01	5.225E-02
52.96	2.775E-01	5.331E-02
55.96	2.376E-01	4.758E-02
58.96	2.759E-01	4.630E-02
61.96	2.219E-01	5.429E-02
61.96	2.219E-01	5.429E-02
61.96	2.219E-01	5.429E-02
64.96	2.401E-01	3.899E-02
67.96	2.588E-01	4.342E-02
70.96	2.894E-01	5.191E-02
73.96	2.770E-01	4.012E-02
76.96	2.458E-01	3.973E-02
80.96	1.959E-01	1.965E-02
84.96	1.753E-01	2.253E-02
88.96	1.485E-01	2.616E-02
92.96	7.992E-02	1.930E-02
96.96	6.131E-02	1.594E-02
100.96	2.568E-02	1.207E-02
104.96	1.793E-02	8.009E-03
108.96	1.531E-02	5.160E-03
117.96	1.023E-02	3.199E-03
122.96	7.600E-03	8.758E-03
127.96	1.797E-02	5.961E-03
132.96	3.583E-03	5.400E-03
137.96	3.489E-04	4.366E-03
142.96	3.492E-04	4.740E-03
147.96	3.545E-04	3.189E-04
152.96	3.578E-04	3.220E-04
157.96	4.536E-04	4.082E-04
162.96	3.886E-04	3.497E-04
169.96	4.497E-04	4.047E-04
180.00	4.497E-04	4.047E-04

N14(D,D') 20.13 MEV. EX = 13.164 T=0 ID=251 J = (0,1)-

AVERAGE ENERGY = 13.1768+- 0.0007 THETA < 90
AVERAGE ENERGY = 13.1817+- 0.0020 THETA > 90
AVERAGE ENERGY = 13.1783+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 7.108E-01 +- 0.402E+00
INTEGRATION LENGTH = 2.668 + 0.134 + 0.339 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.520E-01	1.793E-01
15.39	1.520E-01	1.793E-01
17.95	1.126E-01	1.547E-01
20.50	8.309E-02	1.131E-01
23.06	1.309E-01	1.041E-01
25.61	1.387E-01	8.252E-02
28.14	1.435E-01	8.039E-02
30.68	1.804E-01	8.271E-02
33.21	1.472E-01	8.253E-02
35.73	1.451E-01	1.011E-01
38.23	1.248E-01	8.136E-02
39.48	1.132E-01	7.480E-02
40.73	9.629E-02	7.416E-02
41.97	1.412E-01	5.970E-02
44.47	5.054E-02	7.006E-02
44.45	1.043E-01	4.625E-02
48.16	1.073E-01	3.664E-02
51.83	9.456E-02	5.048E-02
55.48	7.008E-02	2.762E-02
59.10	6.882E-02	3.421E-02
62.68	7.880E-02	3.077E-02
62.68	7.880E-02	3.077E-02

ABCISSA	ORDINATE	ERROR
62.68	7.880E-02	3.077E-02
66.24	7.943E-02	3.624E-02
69.76	7.749E-02	4.224E-02
73.25	6.071E-02	2.560E-02
76.68	4.299E-02	3.917E-02
80.08	6.029E-02	3.000E-02
83.44	6.443E-02	3.169E-02
86.75	4.689E-02	2.526E-02
90.02	5.490E-02	3.257E-02
93.24	8.020E-02	3.015E-02
97.48	4.381E-02	1.371E-02
101.62	4.814E-02	1.826E-02
105.68	3.069E-02	1.323E-02
109.68	1.845E-02	1.193E-02
113.57	2.559E-02	1.350E-02
117.36	3.040E-03	5.645E-03
121.12	1.698E-03	3.526E-03
124.75	3.288E-03	3.681E-03
132.71	1.788E-03	2.966E-03
141.10	3.445E-03	3.827E-03
180.00	3.445E-03	3.827E-03

N14(D,D') 20.13 MEV. . EX = 13.164 T=0 ID=251 J = (0,1)-

AVERAGE ENERGY = 13.1770+- 0.0006 THETA < 90
AVERAGE ENERGY = 13.1853+- 0.0015 THETA > 90
AVERAGE ENERGY = 13.1797+- 0.0008 ALL ANGLES
REACTION CROSS SECTION = 6.477E-01 +- 0.401E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.654E-03	3.520E-01
9.96	7.654E-03	3.520E-01
11.96	2.497E-01	2.945E-01
13.96	1.842E-01	2.531E-01
15.96	1.353E-01	1.841E-01
17.96	2.119E-01	1.685E-01
19.96	2.233E-01	1.329E-01
21.96	2.296E-01	1.286E-01
23.96	2.669E-01	1.314E-01
25.96	2.322E-01	1.301E-01
27.96	2.272E-01	1.581E-01
29.96	1.936E-01	1.262E-01
30.96	1.749E-01	1.155E-01
31.96	1.480E-01	1.140E-01
32.96	2.161E-01	9.126E-02
34.96	7.659E-02	1.061E-01
34.96	1.580E-01	7.000E-02
37.96	1.599E-01	5.457E-02
40.96	1.385E-01	7.388E-02
43.96	1.008E-01	3.969E-02
46.96	9.701E-02	4.819E-02
49.96	1.088E-01	4.244E-02
52.96	1.073E-01	4.890E-02
55.96	1.023E-01	5.570E-02
58.96	7.823E-02	3.296E-02
61.96	5.402E-02	4.917E-02
61.96	5.402E-02	4.917E-02
61.96	5.402E-02	4.917E-02
64.96	7.382E-02	3.670E-02
67.96	7.678E-02	3.772E-02
70.96	5.434E-02	2.925E-02
73.96	6.184E-02	3.665E-02
76.96	8.773E-02	3.295E-02
80.96	4.605E-02	1.440E-02
84.96	4.858E-02	1.840E-02
88.96	2.971E-02	1.279E-02
92.96	1.712E-02	1.106E-02
96.96	2.276E-02	1.199E-02
100.96	2.593E-03	4.811E-03
104.96	1.388E-03	2.879E-03
108.96	2.579E-03	2.884E-03
117.96	1.280E-03	2.120E-03
122.96	5.582E-04	4.357E-03
127.96	2.245E-03	2.491E-03
132.96	3.443E-04	1.282E-03
137.96	3.491E-04	3.141E-04
142.96	3.494E-04	3.144E-04
147.96	3.547E-04	3.191E-04
152.96	3.580E-04	3.221E-04
157.96	4.539E-04	4.084E-04
162.96	3.888E-04	3.499E-04
169.96	4.500E-04	4.050E-04
180.00	4.500E-04	4.050E-04

N14(D,D') 20.13 MEV. EX = 13.23 T=0 ID=252 J =

AVERAGE ENERGY = 13.2373+- 0.0010 THETA < 90
AVERAGE ENERGY = 13.2392+- 0.0025 THETA > 90
AVERAGE ENERGY = 13.2379+- 0.0011 ALL ANGLES
REACTION CROSS SECTION = 4.593E-01 +- 0.296E+00
INTEGRATION LENGTH = 2.668 + 0.135 + 0.339 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	6.831E-02	1.589E-01
15.42	6.831E-02	1.589E-01
17.98	4.483E-02	1.492E-01
20.54	6.853E-02	8.294E-02
23.09	8.180E-02	5.942E-02
25.65	5.222E-02	5.524E-02
28.19	5.367E-02	5.533E-02
30.73	8.914E-02	6.462E-02
33.26	4.215E-02	5.314E-02
35.78	4.696E-02	5.661E-02
38.30	5.285E-02	5.359E-02
39.55	2.964E-02	4.083E-02
40.79	6.797E-02	4.693E-02
42.03	7.085E-02	5.014E-02
44.53	6.735E-02	5.473E-02
44.52	6.072E-02	3.340E-02
48.23	7.257E-02	3.092E-02
51.91	5.519E-02	3.472E-02
55.57	6.808E-02	2.493E-02
59.13	5.276E-02	2.665E-02
62.78	5.630E-02	1.709E-02
62.78	5.630E-02	1.709E-02
66.33	6.478E-02	2.964E-02
69.84	5.685E-02	3.355E-02
73.34	5.585E-02	1.656E-02
76.77	3.784E-02	2.298E-02
80.19	5.171E-02	1.991E-02
83.54	4.118E-02	1.696E-02
86.85	5.470E-02	1.788E-02
90.13	5.373E-02	2.130E-02
93.36	5.477E-02	2.218E-02
97.59	3.915E-02	1.439E-02
101.75	2.938E-02	1.395E-02
105.81	1.489E-02	8.328E-03
109.79	1.031E-02	9.124E-03
113.68	1.447E-02	9.358E-03
117.51	2.729E-03	4.959E-03
121.21	1.115E-03	4.095E-03
124.90	3.023E-03	3.246E-03
132.75	1.790E-03	2.969E-03
137.02	2.619E-03	5.315E-03
141.18	1.878E-03	2.798E-03
180.00	1.878E-03	2.798E-03

N14(D,D') 20.13 MEV.. EX = 13.23 T=0 ID=252 J =

AVERAGE ENERGY = 13.2378+- 0.0010 THETA < 90
AVERAGE ENERGY = 13.2389+- 0.0020 THETA > 90
AVERAGE ENERGY = 13.2381+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 4.463E-01 +- 0.313E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.654E-03	3.609E-01
9.96	7.654E-03	3.609E-01
11.96	1.126E-01	2.620E-01
13.96	7.360E-02	2.448E-01
15.96	1.119E-01	1.354E-01
21.96	8.613E-02	8.876E-02
23.96	1.421E-01	1.030E-01
25.96	6.671E-02	8.407E-02
27.96	7.372E-02	8.881E-02
29.96	8.226E-02	8.335E-02
30.96	4.693E-02	6.323E-02
31.96	1.048E-01	7.231E-02
32.96	1.086E-01	7.684E-02
37.96	1.084E-01	4.615E-02
40.96	8.101E-02	5.093E-02
43.96	9.612E-02	3.590E-02
46.96	7.452E-02	3.762E-02
49.96	7.788E-02	2.362E-02
52.96	8.764E-02	4.006E-02
55.96	7.514E-02	4.431E-02
58.96	7.207E-02	2.135E-02
61.96	4.761E-02	2.888E-02
64.96	6.339E-02	2.438E-02
67.96	4.911E-02	2.021E-02
67.96	4.911E-02	2.021E-02

ABCISSA	ORDINATE	ERROR
70.96	6.345E-02	2.072E-02
73.96	6.056E-02	2.398E-02
76.96	5.994E-02	2.424E-02
80.96	4.116E-02	1.511E-02
84.96	2.964E-02	1.406E-02
88.96	1.441E-02	8.049E-03
92.96	9.557E-03	8.452E-03
96.96	1.286E-02	8.308E-03
100.96	2.324E-03	4.218E-03
104.96	9.099E-04	3.339E-03
108.96	2.364E-03	2.536E-03
117.96	1.280E-03	2.121E-03
122.96	1.782E-03	3.614E-03
127.96	1.220E-03	1.816E-03
132.96	3.443E-04	3.097E-04
137.96	3.492E-04	3.142E-04
34.96	9.219E-02	5.067E-02
142.96	3.495E-04	3.144E-04
147.96	3.547E-04	3.192E-04
152.96	3.581E-04	3.222E-04
157.96	4.540E-04	4.086E-04
162.96	3.889E-04	3.500E-04
169.96	4.501E-04	4.051E-04
180.00	4.501E-04	4.051E-04

N14(D,D') 20.13 MEV. EX = 13.3 T=0 ID=253 J =

AVERAGE ENERGY = 13.4218+- 0.0022 THETA < 90
AVERAGE ENERGY = 13.4367+- 0.0082 THETA > 90
AVERAGE ENERGY = 13.4252+- 0.0026 ALL ANGLES
REACTION CROSS SECTION = 9.231E-01 +- 0.282E+00
INTEGRATION LENGTH = 2.597 + 0.135 + 0.409 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.699E-01	1.958E-01
15.48	1.699E-01	1.958E-01
18.07	8.052E-02	1.605E-01
20.64	3.682E-02	8.287E-02
23.20	5.455E-02	4.790E-02
25.76	7.350E-02	4.733E-02
28.32	7.149E-02	4.242E-02
30.87	7.990E-02	3.774E-02
33.42	4.291E-02	4.390E-02
35.96	2.774E-02	4.780E-02
38.48	3.003E-02	3.804E-02
39.72	1.967E-02	2.794E-02
41.00	2.482E-02	3.006E-02
42.21	1.010E-01	4.115E-02
44.74	6.343E-02	3.654E-02
44.72	7.707E-02	3.776E-02
48.44	1.118E-01	2.501E-02
52.13	1.372E-01	2.765E-02
55.82	1.389E-01	2.357E-02
55.82	1.389E-01	2.357E-02

ABCISSA	ORDINATE	ERROR
55.82	1.389E-01	2.357E-02
59.44	8.034E-02	2.504E-02
63.06	1.166E-01	1.984E-02
66.62	1.283E-01	2.153E-02
70.18	1.127E-01	2.112E-02
73.70	1.213E-01	1.820E-02
77.14	8.367E-02	2.066E-02
80.55	1.093E-01	1.443E-02
83.90	1.336E-01	1.197E-02
87.24	1.161E-01	1.749E-02
90.52	1.043E-01	1.361E-02
93.77	1.286E-01	1.253E-02
97.98	8.578E-02	1.114E-02
102.14	7.763E-02	9.867E-03
106.20	5.411E-02	9.681E-03
110.18	2.371E-02	1.653E-02
114.18	1.542E-02	1.203E-02
133.09	1.175E-02	3.389E-03
180.00	1.175E-02	3.389E-03

N14(D,D') 20.13 MEV. . EX = 13.3 T=0 ID=253 J =

AVERAGE ENERGY = 13.4238+- 0.0019 THETA < 90
AVERAGE ENERGY = 13.4429+- 0.0063 THETA > 90
AVERAGE ENERGY = 13.4300+- 0.0028 ALL ANGLES
REACTION CROSS SECTION = 8.071E-01 +- 0.289E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.656E-03	4.346E-01
9.96	7.656E-03	4.346E-01
11.96	2.824E-01	3.253E-01
13.96	1.335E-01	2.659E-01
15.96	6.070E-02	1.366E-01
17.96	8.942E-02	7.849E-02
19.96	1.197E-01	7.707E-02
21.96	1.158E-01	6.866E-02
23.96	1.285E-01	6.066E-02
25.96	6.849E-02	7.003E-02
27.96	4.394E-02	7.567E-02
29.96	4.713E-02	5.969E-02
30.96	3.071E-02	4.359E-02
31.96	3.862E-02	4.674E-02
32.96	1.560E-01	6.354E-02
34.96	9.713E-02	5.592E-02
34.96	1.179E-01	5.774E-02
37.96	1.682E-01	3.762E-02
40.96	2.028E-01	4.083E-02
43.96	2.016E-01	3.419E-02
46.96	1.142E-01	3.558E-02
49.96	1.623E-01	2.760E-02
52.96	1.746E-01	2.927E-02
55.96	1.499E-01	2.806E-02
58.96	1.574E-01	2.359E-02
61.96	1.058E-01	2.609E-02
61.96	1.058E-01	2.609E-02
61.96	1.058E-01	2.609E-02
64.96	1.345E-01	1.774E-02
67.96	1.599E-01	1.431E-02
70.96	1.350E-01	2.032E-02
73.96	1.177E-01	1.535E-02
76.96	1.409E-01	1.372E-02
80.96	9.019E-02	1.170E-02
84.96	7.825E-02	9.936E-03
88.96	5.225E-02	9.339E-03
92.96	2.193E-02	1.527E-02
96.96	1.363E-02	1.063E-02
100.96	3.997E-03	9.529E-03
104.96	9.103E-04	8.427E-03
108.96	7.880E-04	4.665E-03
117.96	8.323E-03	2.398E-03
122.96	5.586E-04	7.794E-03
127.96	4.386E-04	3.447E-03
132.96	3.446E-04	6.428E-03
137.96	3.496E-04	3.145E-04
142.96	3.499E-04	3.148E-04
147.96	3.551E-04	3.195E-04
152.96	3.585E-04	3.226E-04
157.96	4.545E-04	4.090E-04
162.96	3.894E-04	3.505E-04
169.96	4.506E-04	4.056E-04
180.00	4.506E-04	4.056E-04

** UNDERFLOW ON NUMERIC FIELD READ AT LOCATION 00041 IN SUBROUTINE LOAD ENTRY **
** UNDERFLOW ON NUMERIC FIELD READ AT LOCATION 00049 IN SUBROUTINE LOAD ENTRY **
N14(D,D') 20.13 MEV. EX = 14.04 T=0 ID=257 J =

AVERAGE ENERGY = 13.9864+- 0.0010 THETA < 90
AVERAGE ENERGY = 13.9727+- 3.4932 THETA > 90
AVERAGE ENERGY = 13.9843+- 0.5379 ALL ANGLES
REACTION CROSS SECTION = 3.668E-01 +- 0.125E+00
INTEGRATION LENGTH = 2.267 + 0.206 + 0.668 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.557E-02	3.332E-02
23.60	4.557E-02	3.332E-02
26.21	4.221E-02	2.350E-02
28.81	4.788E-02	3.061E-02
31.40	4.715E-02	2.473E-02
33.13	1.166E-02	2.577E-02
40.40	2.000E-02	1.960E-02
41.68	2.009E-02	1.988E-02
42.94	2.528E-02	1.883E-02
43.50	3.814E-02	1.697E-02
45.47	3.958E-02	2.101E-02
49.26	5.478E-02	1.272E-02
53.00	4.340E-02	1.410E-02
56.72	6.409E-02	1.059E-02
56.72	6.409E-02	1.059E-02
60.41	6.085E-02	1.492E-02
64.07	5.786E-02	1.344E-02
67.68	4.006E-02	1.179E-02
71.24	5.990E-02	1.464E-02
74.79	3.332E-02	9.329E-03
78.27	4.184E-02	8.376E-03
81.73	3.879E-02	9.601E-03
85.11	4.156E-02	7.568E-03
88.47	6.014E-02	1.553E-02
91.76	5.467E-02	8.666E-03
95.00	4.278E-02	6.687E-03
99.23	1.680E-02	4.856E-03
103.40	9.848E-03	3.286E-03
180.00	0.000E+00	0.000E+00

N14(D,D') 20.13 MEV. EX = 14.04 T=0 ID=257 J =

AVERAGE ENERGY = 13.9848+- 0.0013 THETA < 90
AVERAGE ENERGY = 13.9641+- 0.0013 THETA > 90
AVERAGE ENERGY = 13.9800+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 3.271E-01 +- 0.147E+00
INTEGRATION LENGTH = 2.688 + 0.087 + 0.367 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.660E-03	1.953E-01
9.96	7.660E-03	1.953E-01
11.96	7.555E-02	1.412E-01
13.96	9.115E-02	1.586E-01
15.96	3.169E-02	8.765E-02
17.96	7.717E-02	5.641E-02
19.96	7.109E-02	3.956E-02
21.96	8.008E-02	5.116E-02
23.96	7.825E-02	4.102E-02
25.96	2.171E-02	3.385E-02
27.96	4.999E-02	5.500E-02
29.96	1.887E-02	4.165E-02
30.96	3.218E-02	3.152E-02
31.96	3.216E-02	3.180E-02
32.96	4.024E-02	2.996E-02
34.96	6.009E-02	2.672E-02
34.96	6.230E-02	3.304E-02
37.96	8.474E-02	1.966E-02
40.96	6.586E-02	2.138E-02
43.96	9.531E-02	1.574E-02
46.96	8.855E-02	2.169E-02
49.96	8.230E-02	1.911E-02
52.96	5.563E-02	1.635E-02
52.96	5.563E-02	1.635E-02
55.96	8.108E-02	1.979E-02
58.96	4.393E-02	1.229E-02
61.96	5.365E-02	1.073E-02
64.96	4.833E-02	1.195E-02
67.96	5.025E-02	9.139E-03
70.96	7.052E-02	1.819E-02
73.96	6.210E-02	9.832E-03
76.96	4.703E-02	7.344E-03
80.96	1.767E-02	5.101E-03
84.96	9.898E-03	3.299E-03
88.96	1.804E-03	1.275E-03
92.96	7.531E-04	4.858E-03
96.96	9.671E-04	8.696E-04
100.96	9.870E-04	3.215E-03
104.96	9.121E-04	8.202E-04
108.96	7.896E-04	7.100E-04
117.96	6.418E-04	5.772E-04
122.96	5.600E-04	5.037E-04
127.96	4.398E-04	3.956E-04
132.96	3.455E-04	3.108E-04
137.96	3.505E-04	3.153E-04
180.00	3.505E-04	3.153E-04

N14(D,D') 20.13 MEV. EX = 14.17 T=0 ID=258 J =

AVERAGE ENERGY = 14.2022+- 0.0012 THETA < 90
AVERAGE ENERGY = 14.1656+- 0.0128 THETA > 90
AVERAGE ENERGY = 14.1966+- 0.0036 ALL ANGLES
REACTION CROSS SECTION = 1.557E+00 +- 0.359E+00
INTEGRATION LENGTH = 2.397 + 0.115 + 0.629 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.604E-01	2.660E-01
13.23	1.604E-01	2.660E-01
15.87	3.973E-01	2.445E-01
18.52	3.171E-01	2.159E-01
21.15	1.897E-01	1.160E-01
23.78	2.281E-01	7.487E-02
26.41	2.244E-01	5.583E-02
29.04	2.120E-01	6.809E-02
31.62	1.700E-01	5.286E-02
34.23	1.171E-01	6.256E-02
36.83	2.289E-01	7.376E-02
39.41	1.857E-01	5.423E-02
40.71	1.460E-01	4.698E-02
41.99	1.189E-01	4.697E-02
43.25	1.833E-01	5.154E-02
45.82	1.962E-01	5.089E-02
48.79	2.416E-01	5.161E-02
49.61	2.700E-01	3.253E-02
49.61	2.700E-01	3.253E-02

ABCISSA	ORDINATE	ERROR
49.61	2.700E-01	3.253E-02
53.37	2.766E-01	3.826E-02
57.13	2.432E-01	3.004E-02
60.85	2.178E-01	3.631E-02
64.53	2.284E-01	3.067E-02
68.13	2.217E-01	2.851E-02
71.73	2.371E-01	3.587E-02
75.27	1.700E-01	2.712E-02
78.79	1.541E-01	2.167E-02
82.25	1.887E-01	2.084E-02
85.66	1.892E-01	1.888E-02
89.02	1.862E-01	3.066E-02
92.33	1.386E-01	1.623E-02
95.55	1.271E-01	1.097E-02
99.76	3.828E-02	6.628E-03
103.92	1.480E-02	3.863E-03
107.90	1.131E-02	3.271E-03
180.00	1.131E-02	3.271E-03

N14(D,D') 20.13 MEV. EX = 14.17 T=0 ID=258 J =

AVERAGE ENERGY = 14.1966+- 0.0030 THETA < 90
AVERAGE ENERGY = 14.1735+- 0.0178 THETA > 90
AVERAGE ENERGY = 14.1917+- 0.0047 ALL ANGLES
REACTION CROSS SECTION = 1.482E+00 +- 0.350E+00
INTEGRATION LENGTH = 2.644 + 0.087 + 0.411 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.811E-01	4.660E-01
9.96	2.811E-01	4.660E-01
11.96	6.939E-01	4.269E-01
13.96	5.512E-01	3.752E-01
15.96	3.281E-01	2.006E-01
17.96	3.921E-01	1.286E-01
19.96	3.834E-01	9.534E-02
21.96	3.599E-01	1.155E-01
23.96	2.860E-01	8.887E-02
25.96	1.955E-01	1.043E-01
27.96	3.786E-01	1.220E-01
29.96	2.059E-01	8.876E-02
30.96	2.381E-01	7.658E-02
31.96	1.928E-01	7.615E-02
32.96	2.954E-01	8.301E-02
34.96	3.129E-01	8.111E-02
34.96	3.648E-01	8.216E-02
37.96	4.227E-01	5.089E-02
40.96	4.245E-01	5.867E-02
43.96	3.657E-01	4.512E-02
46.96	3.204E-01	5.338E-02
49.96	3.281E-01	4.402E-02
49.96	3.281E-01	4.402E-02
52.96	3.104E-01	3.988E-02
55.96	3.236E-01	4.889E-02
58.96	2.257E-01	3.596E-02
61.96	1.988E-01	2.793E-02
64.96	2.364E-01	2.608E-02
67.96	2.298E-01	2.291E-02
70.96	2.191E-01	3.603E-02
73.96	1.578E-01	1.846E-02
76.96	1.399E-01	1.207E-02
80.96	4.027E-02	6.963E-03
84.96	1.486E-02	3.873E-03
88.96	1.083E-02	3.128E-03
92.96	7.535E-04	1.288E-02
96.96	9.680E-04	8.704E-04
100.96	9.880E-04	8.884E-04
104.96	9.130E-04	8.210E-04
108.96	7.904E-04	7.108E-04
117.96	6.420E-04	6.415E-04
122.96	5.608E-04	5.044E-04
127.96	4.404E-04	3.961E-04
132.96	3.461E-04	3.113E-04
180.00	3.461E-04	3.113E-04

N14(D,D') 20.13 MEV. EX = 14.40 T=0 ID=259 J =

AVERAGE ENERGY = 14.4733+- 0.0012 THETA < 90
AVERAGE ENERGY = 14.4595+- 0.0082 THETA > 90
AVERAGE ENERGY = 14.4715+- 0.0019 ALL ANGLES
REACTION CROSS SECTION = 1.202E+00 +- 0.235E+00
INTEGRATION LENGTH = 2.368 + 0.117 + 0.657 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.194E-01	1.666E-01
13.36	3.194E-01	1.666E-01
16.03	3.290E-01	1.717E-01
18.70	2.365E-01	1.303E-01
21.37	1.870E-01	7.048E-02
24.03	2.248E-01	4.578E-02
26.68	2.117E-01	3.657E-02
29.33	2.077E-01	4.209E-02
31.96	2.035E-01	3.132E-02
34.59	1.667E-01	4.367E-02
37.22	1.950E-01	4.486E-02
39.82	1.265E-01	2.942E-02
41.12	1.806E-01	2.952E-02
42.40	1.290E-01	3.026E-02
43.67	1.717E-01	3.431E-02
46.28	1.857E-01	3.519E-02
46.27	1.966E-01	3.317E-02
46.27	1.966E-01	3.317E-02
50.12	2.337E-01	2.263E-02
53.92	2.339E-01	2.701E-02
57.70	2.004E-01	2.390E-02
61.46	1.789E-01	2.436E-02
65.18	1.859E-01	2.005E-02
68.82	1.399E-01	1.853E-02
72.43	1.452E-01	2.294E-02
76.00	9.166E-02	1.775E-02
79.55	9.403E-02	1.500E-02
83.01	1.227E-01	1.293E-02
86.44	1.175E-01	1.245E-02
89.83	7.445E-02	1.593E-02
93.14	5.299E-02	8.460E-03
96.39	3.427E-02	4.957E-03
100.71	6.544E-03	2.476E-03
104.77	4.950E-03	2.022E-03
180.00	4.950E-03	2.022E-03

N14(D,D') 20.13 MEV. EX = 14.40 T=0 ID=259 J =

AVERAGE ENERGY = 14.4716+- 0.0015 THETA < 90
AVERAGE ENERGY = 14.4804+- 0.0014 THETA > 90
AVERAGE ENERGY = 14.4732+- 0.0014 ALL ANGLES
REACTION CROSS SECTION = 1.170E+00 +- 0.229E+00
INTEGRATION LENGTH = 2.557 + 0.087 + 0.498 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.712E-01	2.979E-01
9.96	5.712E-01	2.979E-01
11.96	5.855E-01	3.054E-01
13.96	4.193E-01	2.310E-01
15.96	3.299E-01	1.243E-01
17.96	3.943E-01	8.025E-02
19.96	3.689E-01	6.370E-02
21.96	3.592E-01	7.276E-02
23.96	3.491E-01	5.370E-02
25.96	2.836E-01	7.422E-02
27.96	3.288E-01	7.557E-02
29.96	2.111E-01	4.906E-02
30.96	2.999E-01	4.898E-02
31.96	2.128E-01	4.991E-02
32.96	2.815E-01	5.621E-02
34.96	3.012E-01	5.705E-02
34.96	3.188E-01	5.374E-02
37.96	3.720E-01	3.600E-02
40.96	3.648E-01	4.209E-02
43.96	3.058E-01	3.644E-02
46.96	2.669E-01	3.632E-02
46.96	2.669E-01	3.632E-02
49.96	2.708E-01	2.917E-02
52.96	1.984E-01	2.625E-02
55.96	2.004E-01	3.162E-02
58.96	1.229E-01	2.379E-02
61.96	1.224E-01	1.952E-02
64.96	1.549E-01	1.630E-02
67.96	1.436E-01	1.520E-02
70.96	8.803E-02	1.881E-02
73.96	6.055E-02	9.655E-03
76.96	3.780E-02	5.462E-03
80.96	6.882E-03	2.600E-03
84.96	4.957E-03	2.023E-03
88.96	9.039E-04	8.127E-04
92.96	7.546E-04	6.785E-04
96.96	9.692E-04	8.714E-04
100.96	9.893E-04	8.896E-04
104.96	9.144E-04	8.222E-04
108.96	7.917E-04	7.119E-04
117.96	6.438E-04	5.790E-04
122.96	5.619E-04	5.054E-04
180.00	5.619E-04	5.054E-04

N14(D,D') 20.13 MEV. EX = 14.70 T=0 ID=260 J =

AVERAGE ENERGY = 14.6788+- 0.0032 THETA < 90
AVERAGE ENERGY = 14.6825+- 0.0008 THETA > 90
AVERAGE ENERGY = 14.6793+- 0.0028 ALL ANGLES
REACTION CROSS SECTION = 9.121E-01 +- 0.210E+00
INTEGRATION LENGTH = 2.435 + 0.087 + 0.620 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.634E-01	3.147E-01
9.96	3.634E-01	3.147E-01
11.96	7.994E-01	2.512E-01
13.96	3.765E-01	1.949E-01
15.96	3.160E-01	1.489E-01
17.96	3.304E-01	7.168E-02
19.96	3.657E-01	6.914E-02
21.96	3.698E-01	6.915E-02
23.96	3.231E-01	6.410E-02
25.96	2.683E-01	7.568E-02
27.96	3.660E-01	8.382E-02
29.96	2.155E-01	5.987E-02
30.96	2.331E-01	5.102E-02
31.96	2.063E-01	6.664E-02
32.96	2.372E-01	5.247E-02
34.96	2.460E-01	5.068E-02
34.96	2.431E-01	4.865E-02
37.96	2.914E-01	3.261E-02
40.96	2.926E-01	4.069E-02
43.96	3.051E-01	3.470E-02
43.96	3.051E-01	3.470E-02
46.96	2.360E-01	3.053E-02
49.96	1.963E-01	2.707E-02
52.96	1.583E-01	2.630E-02
55.96	1.192E-01	2.176E-02
58.96	6.467E-02	1.310E-02
61.96	7.839E-02	2.047E-02
64.96	7.698E-02	1.266E-02
67.96	6.806E-02	7.936E-03
70.96	4.495E-02	9.449E-03
73.96	2.002E-02	5.801E-03
76.96	1.736E-02	3.777E-03
80.96	9.836E-04	9.825E-04
84.96	8.270E-04	7.435E-04
88.96	9.048E-04	8.134E-04
92.96	7.554E-04	6.792E-04
96.96	9.703E-04	8.724E-04
100.96	9.905E-04	8.906E-04
104.96	9.156E-04	8.233E-04
108.96	7.928E-04	7.129E-04
180.00	7.928E-04	7.129E-04

N14(D,D') 20.13 MEV. EX = 14.70 T=0 ID=260 J =

AVERAGE ENERGY = 14.6829+- 0.0013 THETA < 90
AVERAGE ENERGY = 14.6693+- 0.0121 THETA > 90
AVERAGE ENERGY = 14.6815+- 0.0020 ALL ANGLES
REACTION CROSS SECTION = 1.045E+00 +- 0.230E+00
INTEGRATION LENGTH = 2.300 + 0.118 + 0.724 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.994E-01	1.727E-01
13.49	1.994E-01	1.727E-01
16.18	4.409E-01	1.386E-01
18.88	2.085E-01	1.079E-01
21.56	1.760E-01	8.296E-02
24.24	1.652E-01	4.020E-02
26.91	2.065E-01	3.906E-02
29.60	2.101E-01	3.931E-02
32.24	1.853E-01	3.578E-02
34.90	1.552E-01	4.380E-02
37.54	2.137E-01	4.899E-02
40.17	1.271E-01	3.535E-02
41.48	1.382E-01	3.028E-02
42.80	1.230E-01	3.977E-02
44.07	1.424E-01	3.152E-02
46.71	1.493E-01	3.077E-02
46.71	1.493E-01	3.077E-02
46.67	1.477E-01	2.959E-02
50.54	1.805E-01	2.022E-02
54.37	1.852E-01	2.577E-02
58.17	1.975E-01	2.247E-02
61.95	1.564E-01	2.025E-02
65.67	1.334E-01	1.842E-02
69.36	1.105E-01	1.838E-02
73.02	8.556E-02	1.564E-02
76.65	4.778E-02	9.692E-03
80.18	5.975E-02	1.562E-02
83.71	6.057E-02	9.977E-03
87.10	5.539E-02	6.467E-03
90.45	3.787E-02	7.971E-03
93.90	1.746E-02	5.067E-03
97.03	1.572E-02	3.424E-03
180.00	1.572E-02	3.424E-03

N14(D,D') 20.13 MEV. EX = 14.84 T=0 ID=261 J =

AVERAGE ENERGY = 14.8658+- 0.0014 THETA < 90
AVERAGE ENERGY = 14.8623+- 0.0121 THETA > 90
AVERAGE ENERGY = 14.8654+- 0.0018 ALL ANGLES
REACTION CROSS SECTION = 9.004E-01 +- 0.210E+00
INTEGRATION LENGTH = 2.305 + 0.119 + 0.718 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.093E-01	1.601E-01
13.60	2.093E-01	1.601E-01
16.38	2.540E-01	1.260E-01
19.05	2.665E-01	1.016E-01
21.76	1.994E-01	7.891E-02
24.45	2.195E-01	4.003E-02
27.15	2.484E-01	4.008E-02
29.86	1.937E-01	3.704E-02
32.54	2.189E-01	3.562E-02
35.20	1.723E-01	4.212E-02
37.84	2.055E-01	4.819E-02
40.50	1.488E-01	3.502E-02
41.83	1.528E-01	3.011E-02
43.16	1.150E-01	3.854E-02
44.44	1.428E-01	3.150E-02
47.07	1.636E-01	3.084E-02
47.07	1.636E-01	3.084E-02

ABCISSA	ORDINATE	ERROR
47.07	1.959E-01	3.013E-02
50.96	2.225E-01	2.082E-02
54.83	2.263E-01	2.638E-02
58.67	2.026E-01	2.230E-02
62.47	1.364E-01	1.969E-02
66.22	1.090E-01	1.769E-02
69.91	7.035E-02	1.741E-02
73.59	5.084E-02	1.444E-02
77.20	2.552E-02	8.270E-03
80.73	2.674E-02	1.380E-02
84.28	2.524E-02	8.137E-03
87.76	2.908E-02	5.195E-03
91.20	1.426E-02	6.115E-03
94.60	5.533E-03	4.209E-03
97.74	4.488E-03	2.314E-03
180.00	4.488E-03	2.314E-03

STOP

N14(D,D') 20.13 MEV. EX = 14.84 T=0 ID=261 J =

AVERAGE ENERGY = 14.8659+- 0.0015 THETA < 90
AVERAGE ENERGY = 14.8736+- 0.0018 THETA > 90
AVERAGE ENERGY = 14.8669+- 0.0014 ALL ANGLES
REACTION CROSS SECTION = 8.696E-01 +- 0.203E+00
INTEGRATION LENGTH = 2.435 + 0.087 + 0.620 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.878E-01	2.965E-01
9.96	3.878E-01	2.965E-01
11.96	4.691E-01	2.326E-01
13.96	4.699E-01	1.866E-01
15.96	3.641E-01	1.440E-01
17.96	3.980E-01	7.255E-02
19.96	4.473E-01	7.215E-02
21.96	3.465E-01	6.623E-02
23.96	3.882E-01	6.314E-02
25.96	3.027E-01	7.393E-02
27.96	3.570E-01	8.368E-02
29.96	2.559E-01	6.021E-02
30.96	2.616E-01	5.149E-02
31.96	1.958E-01	6.557E-02
32.96	2.413E-01	5.319E-02
34.96	2.732E-01	5.145E-02
34.96	3.270E-01	5.026E-02
37.96	3.641E-01	3.404E-02
40.96	3.525E-01	4.220E-02
43.96	3.172E-01	3.488E-02
43.96	3.172E-01	3.488E-02

ABCISSA	ORDINATE	ERROR
46.96	2.083E-01	3.004E-02
49.96	1.621E-01	2.630E-02
52.96	1.018E-01	2.517E-02
55.96	7.148E-02	2.028E-02
58.96	3.481E-02	1.126E-02
61.96	3.531E-02	1.820E-02
64.96	3.225E-02	1.039E-02
67.96	3.591E-02	6.408E-03
70.96	1.700E-02	7.280E-03
73.96	6.359E-03	4.831E-03
76.96	4.965E-03	2.557E-03
80.96	9.849E-04	8.854E-04
84.96	8.278E-04	7.442E-04
88.96	9.057E-04	8.142E-04
92.96	7.562E-04	6.799E-04
96.96	9.715E-04	8.735E-04
100.96	9.918E-04	8.918E-04
104.96	9.169E-04	8.245E-04
108.96	7.941E-04	7.140E-04
180.00	7.941E-04	7.140E-04

STOP

*N14(D,D') 20.13 MEV. ID = T2
*TOTAL INELASTIC CROSS SECTION FOR DEUTERONS

AVERAGE ENERGY = 0.0000+- 0.0000 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.0000 THETA > 90
AVERAGE ENERGY = 0.0000+- 0.0000 ALL ANGLES
REACTION CROSS SECTION = 7.586E+01 +- 0.137E+02
INTEGRATION LENGTH = 2.906 + 0.087 + 0.149 = 3.142

* EXCLUDES SLIT SCATTERING
$DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)

ABCISSA	ORDINATE	ERROR
0.00	1.667E+01	1.556E+01
9.96	1.667E+01	1.556E+01
11.96	2.437E+01	1.513E+01
13.96	2.000E+01	1.219E+01
15.96	1.754E+01	7.190E+00
17.96	1.895E+01	5.402E+00
19.96	1.676E+01	4.319E+00
21.96	1.726E+01	4.003E+00
23.96	1.722E+01	3.086E+00
25.96	1.426E+01	2.948E+00
27.96	1.398E+01	3.398E+00
29.96	1.286E+01	2.512E+00
30.96	1.348E+01	2.234E+00
31.96	1.277E+01	2.140E+00
32.96	1.294E+01	1.751E+00
34.96	1.249E+01	2.008E+00
37.96	1.221E+01	1.377E+00
40.96	1.105E+01	1.508E+00
43.96	1.035E+01	1.384E+00
46.96	8.852E+00	1.342E+00
49.96	8.724E+00	1.172E+00
52.96	8.232E+00	1.096E+00
55.96	7.772E+00	1.105E+00
58.96	7.386E+00	9.635E-01
61.96	6.767E+00	1.059E+00
61.96	6.767E+00	1.059E+00
61.96	6.767E+00	1.059E+00
64.96	6.892E+00	8.361E-01
67.96	6.818E+00	7.762E-01
70.96	6.650E+00	9.835E-01
73.96	6.130E+00	7.665E-01
76.96	5.972E+00	6.970E-01
80.96	4.571E+00	6.150E-01
84.96	4.135E+00	5.107E-01
88.96	3.917E+00	5.149E-01
92.96	3.254E+00	5.457E-01
96.96	3.078E+00	5.276E-01
100.96	3.008E+00	4.402E-01
104.96	3.085E+00	4.089E-01
108.96	3.093E+00	3.593E-01
117.96	3.020E+00	3.188E-01
122.96	2.743E+00	3.425E-01
127.96	2.899E+00	3.252E-01
132.96	2.859E+00	3.154E-01
137.96	2.766E+00	2.793E-01
142.96	3.079E+00	3.409E-01
147.96	3.339E+00	3.047E-01
169.96	3.543E+00	4.050E-01
157.96	3.393E+00	3.860E-01
162.96	3.501E+00	3.692E-01
180.00	3.501E+00	3.692E-01

STOP

APPENDIX A.3

$^{14}N(d,d')^{14}N$ T = 1

N14(D,D') 20.13 MEV. . EX = 2.313 T=1 ID=202 J =0+
  UNCERTAINTY IN DIFFERENCE BETWEEN PEAK AREA AN AVERAGE ENERGY = 2.3217+- 0.0025 THETA < 90
                                                  AVERAGE ENERGY = 2.3133+- 0.0065 THETA > 90
                                                  AVERAGE ENERGY = 2.3186+- 0.0029 ALL ANGLES
UNERTAINTY AND 1 COUNT MIN IN MB/SR   REACTION CROSS SECTION = 3.165E-02 +- 0.235E+00
CENTER OF MASS ANGLE IN DEGREES   INTEGRATION LENGTH = 2.967 + 0.100 + 0.074 = 3.142

ABCISSA	ORDINATE	ERROR
6.00	5.738E-03	3.795E-01
11.50	5.738E-03	3.795E-01
13.81	5.900E-03	3.042E-01
16.11	1.042E-01	2.378E-01
18.41	2.097E-03	1.493E-01
20.71	1.755E-03	1.231E-01
23.00	1.430E-03	8.644E-02
25.30	1.659E-03	7.660E-02
27.58	1.190E-03	4.836E-02
29.86	9.533E-04	3.359E-02
32.14	2.323E-03	3.888E-02
34.42	5.982E-03	1.312E-02
35.55	1.022E-02	7.556E-03
36.69	5.031E-04	7.030E-03
37.82	3.762E-03	6.994E-03
40.08	1.130E-03	8.499E-03
41.07	1.257E-03	1.475E-02
43.45	9.278E-04	1.111E-02
45.82	1.298E-03	1.334E-02
50.16	1.335E-03	1.640E-02
53.49	3.412E-03	8.928E-03
56.80	1.005E-03	8.651E-03
60.09	3.001E-03	6.878E-03
63.37	1.119E-03	7.296E-03
66.61	2.152E-03	4.812E-03
69.84	4.647E-03	9.082E-03
69.84	4.647E-03	9.082E-03

ABCISSA	ORDINATE	ERROR
69.84	4.647E-03	9.082E-03
73.06	8.158E-04	7.989E-03
76.25	5.285E-04	7.243E-03
79.41	9.001E-04	9.772E-03
82.55	5.394E-04	6.982E-03
85.66	6.979E-03	7.051E-03
89.79	9.393E-04	1.240E-02
93.88	8.063E-04	7.542E-03
97.89	9.009E-04	7.484E-03
101.89	7.685E-04	4.964E-03
105.84	4.002E-03	1.107E-02
109.73	1.051E-03	6.957E-03
113.59	3.151E-03	6.321E-03
117.42	8.775E-04	8.336E-03
125.85	3.075E-03	7.197E-03
130.45	1.743E-03	4.508E-03
134.99	5.356E-04	5.234E-03
139.49	4.299E-04	3.623E-03
143.92	1.155E-03	2.733E-03
148.33	4.530E-04	3.931E-03
152.69	1.733E-03	4.334E-03
157.01	2.072E-03	4.340E-03
161.29	1.785E-03	2.856E-03
165.57	5.307E-04	5.256E-03
171.51	6.200E-04	6.689E-03
180.00	6.200E-04	6.689E-03

N14(D,D') 20.13 MEV. EX = 2.313 T=1 ID=202 J =0+
  UNCERTAINTY IN DIFFERENCE BETWEEN PEAK AREA AN AVERAGE ENERGY = 2.3219+- 0.0026 THETA < 90
                                                  AVERAGE ENERGY = 2.3119+- 0.0069 THETA > 90
                                                  AVERAGE ENERGY = 2.3186+- 0.0029 ALL ANGLES
UNERTAINTY AND 1 COUNT MIN IN MB/SR   REACTION CROSS SECTION = 3.165E-02 +- 0.235E+00
LAB ANGLE IN DEGREES   INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

ABCISSA	ORDINATE	ERROR
0.00	7.631E-03	5.046E-01
9.96	7.631E-03	5.046E-01
11.96	7.831E-03	4.046E-01
13.96	1.379E-01	3.148E-01
15.96	2.769E-03	1.972E-01
17.96	2.311E-03	1.621E-01
19.96	1.877E-03	1.134E-01
21.96	2.170E-03	1.002E-01
23.96	1.550E-03	6.299E-02
25.96	1.236E-03	4.356E-02
27.96	2.999E-03	5.018E-02
29.96	7.686E-03	1.695E-02
30.96	1.310E-02	9.679E-03
31.96	6.430E-04	8.983E-03
32.96	4.795E-03	8.812E-03
34.96	1.432E-03	1.077E-02
34.96	1.593E-03	1.869E-02
37.96	1.165E-03	1.395E-02
40.96	1.614E-03	1.659E-02
43.96	1.643E-03	2.017E-02
46.96	4.153E-03	1.086E-02
49.96	1.209E-03	1.040E-02
52.96	3.566E-03	8.170E-03
55.96	1.313E-03	8.556E-03
58.96	2.492E-03	5.568E-03
61.96	5.306E-03	1.037E-02
61.96	5.306E-03	1.037E-02

ABCISSA	ORDINATE	ERROR
61.96	5.306E-03	1.037E-02
64.96	9.185E-04	8.990E-03
67.96	5.864E-04	8.033E-03
70.96	9.838E-04	1.068E-02
73.96	5.806E-04	7.511E-03
76.96	7.395E-03	7.468E-03
80.96	9.745E-04	1.285E-02
84.96	8.186E-04	7.653E-03
88.96	8.950E-04	7.431E-03
92.96	7.467E-04	4.821E-03
96.96	3.804E-03	1.051E-02
100.96	9.778E-04	6.466E-03
104.96	2.867E-03	5.750E-03
108.96	7.814E-04	7.419E-03
117.96	2.614E-03	6.116E-03
122.96	1.446E-03	3.738E-03
127.96	4.341E-04	4.240E-03
132.96	3.409E-04	2.872E-03
137.96	8.980E-04	2.124E-03
142.96	3.457E-04	2.999E-03
147.96	1.301E-03	3.253E-03
152.96	1.534E-03	3.211E-03
157.96	1.306E-03	2.090E-03
162.96	3.843E-04	3.805E-03
169.96	4.446E-04	4.796E-03
180.00	4.446E-04	4.796E-03

STOP

APPENDIX A.4

$^{14}N(d,t)^{13}N$ EX < 8 MeV

N14(D,T)N13 20.13 MEV. EX = 00.000 ID = 301 J = 1/2-

AVERAGE ENERGY = -0.0158+- 0.0021 THETA < 90
AVERAGE ENERGY = -0.0056+- 0.0012 THETA > 90
AVERAGE ENERGY = -0.0119+- 0.0015 ALL ANGLES
REACTION CROSS SECTION = 6.246E+00 +- 0.362E+00
INTEGRATION LENGTH = 2.919 + 0.105 + 0.118 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.683E+00	2.585E-01
12.05	7.683E+00	2.585E-01
14.47	7.867E+00	2.318E-01
16.88	6.766E+00	1.964E-01
19.28	4.780E+00	1.124E-01
21.69	3.020E+00	7.887E-02
24.09	1.550E+00	4.853E-02
26.49	6.923E-01	3.931E-02
28.88	3.693E-01	2.050E-02
31.26	4.303E-01	1.999E-02
33.64	6.686E-01	3.910E-02
36.01	8.599E-01	2.476E-02
37.19	9.914E-01	2.439E-02
38.37	1.054E+00	2.483E-02
39.55	9.679E-01	2.681E-02
41.91	1.023E+00	3.444E-02
45.42	8.180E-01	2.788E-02
47.76	5.574E-01	1.998E-02
47.71	5.524E-01	2.600E-02
48.91	5.177E-01	2.560E-02
52.39	2.285E-01	1.706E-02
55.83	9.111E-02	9.348E-03
59.26	5.113E-02	6.979E-03
62.66	9.089E-02	8.719E-03
66.03	1.319E-01	1.193E-02
69.38	1.747E-01	1.334E-02
69.38	1.747E-01	1.334E-02
72.69	1.719E-01	1.296E-02
75.99	1.809E-01	1.209E-02
79.24	1.752E-01	9.662E-03
82.46	1.491E-01	1.155E-02
85.66	1.041E-01	7.507E-03
88.82	1.046E-01	7.820E-03
92.99	5.783E-02	7.375E-03
97.09	5.488E-02	6.685E-03
101.13	3.455E-02	5.619E-03
105.12	3.362E-02	5.142E-03
109.05	5.482E-02	7.558E-03
112.91	3.916E-02	6.543E-03
116.71	4.969E-02	7.197E-03
120.47	4.060E-02	6.140E-03
124.16	5.467E-02	5.801E-03
128.70	5.913E-02	6.913E-03
133.15	5.624E-02	6.394E-03
137.53	5.726E-02	5.815E-03
141.84	6.149E-02	5.432E-03
146.08	6.461E-02	5.687E-03
150.26	8.149E-02	6.482E-03
154.39	7.673E-02	6.405E-03
158.46	8.169E-02	6.709E-03
162.50	8.647E-02	7.827E-03
166.50	9.685E-02	7.744E-03
180.00	9.685E-02	7.744E-03

N14(D,T)N13 20.13 MEV. EX = 00.000 ID = 301 J = 1/2-

AVERAGE ENERGY = -0.0151+- 0.0020 THETA < 90
AVERAGE ENERGY = -0.0052+- 0.0012 THETA > 90
AVERAGE ENERGY = -0.0118+- 0.0015 ALL ANGLES
REACTION CROSS SECTION = 6.231E+00 +- 0.360E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.120E+01	3.770E-01
9.96	1.120E+01	3.770E-01
11.96	1.144E+01	3.371E-01
13.96	9.813E+00	2.842E-01
15.96	6.907E+00	1.623E-01
17.96	4.348E+00	1.135E-01
19.96	2.221E+00	6.954E-02
21.96	9.677E-01	5.606E-02
23.96	5.241E-01	2.909E-02
25.96	6.072E-01	2.820E-02
27.96	9.659E-01	5.483E-02
29.96	1.198E+00	3.449E-02
30.96	1.377E+00	3.386E-02
31.96	1.459E+00	3.435E-02
32.96	1.335E+00	3.496E-02
34.96	1.401E+00	4.712E-02
37.96	1.106E+00	3.769E-02
39.96	7.475E-01	2.678E-02
39.96	7.395E-01	3.479E-02
40.96	6.909E-01	3.414E-02
43.96	3.008E-01	2.244E-02
46.96	1.182E-01	1.212E-02
49.96	6.529E-02	8.906E-03
52.96	1.142E-01	1.095E-02
55.96	1.629E-01	1.472E-02
58.96	2.119E-01	1.617E-02
61.96	2.047E-01	1.542E-02
61.96	2.047E-01	1.542E-02

ABCISSA	ORDINATE	ERROR
61.96	2.047E-01	1.542E-02
64.96	2.113E-01	1.411E-02
67.96	2.006E-01	1.106E-02
70.96	1.673E-01	1.295E-02
73.96	1.144E-01	8.245E-03
76.96	1.125E-01	8.408E-03
80.96	6.045E-02	7.704E-03
84.96	5.569E-02	6.780E-03
88.96	3.403E-02	5.530E-03
92.96	3.213E-02	4.910E-03
96.96	5.083E-02	7.003E-03
100.96	3.522E-02	5.882E-03
104.96	4.338E-02	6.279E-03
108.96	3.441E-02	5.200E-03
112.96	4.500E-02	4.772E-03
117.96	4.699E-02	5.489E-03
122.96	4.319E-02	4.908E-03
127.96	4.259E-02	4.322E-03
132.96	4.436E-02	3.917E-03
137.96	4.532E-02	3.987E-03
142.96	5.572E-02	4.430E-03
147.96	5.127E-02	4.278E-03
152.96	5.352E-02	4.394E-03
157.96	5.570E-02	5.041E-03
162.96	6.156E-02	4.922E-03
169.96	5.431E-02	4.979E-03
180.00	5.431E-02	4.979E-03

N14(D,T)N13 20.13 MEV. EX = 2.367 ID = 302 J' = 1/2+

AVERAGE ENERGY = 2.3705+- 0.0021 THETA < 90
AVERAGE ENERGY = 2.4137+- 0.0056 THETA > 90
AVERAGE ENERGY = 2.3886+- 0.0041 ALL ANGLES
REACTION CROSS SECTION = 6.624E-01 +- 0.885E-01
INTEGRATION LENGTH = 2.967 + 0.107 + 0.067 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.022E-01	3.225E-02
12.27	2.022E-01	3.225E-02
14.73	1.768E-01	3.042E-02
17.18	1.993E-01	2.982E-02
22.08	4.656E-02	8.520E-03
24.52	6.334E-02	8.988E-03
26.96	4.270E-02	8.046E-03
29.39	6.028E-02	8.013E-03
31.81	3.990E-02	5.837E-03
34.23	3.937E-02	9.043E-03
36.64	2.653E-02	4.129E-03
37.84	2.743E-02	3.614E-03
39.04	2.976E-02	3.677E-03
40.23	3.345E-02	4.566E-03
42.63	2.236E-02	4.774E-03
46.19	2.599E-02	4.676E-03
48.56	5.010E-02	5.695E-03
48.48	2.596E-02	5.421E-03
49.74	2.474E-02	5.404E-03
53.26	4.262E-02	7.218E-03
56.75	4.635E-02	6.573E-03
60.22	4.076E-02	6.160E-03
63.66	5.181E-02	6.500E-03
67.07	7.308E-02	8.770E-03
70.46	6.379E-02	7.943E-03
73.81	7.283E-02	8.331E-03
73.81	7.283E-02	8.331E-03
77.13	6.443E-02	7.107E-03
80.42	5.775E-02	5.446E-03
83.67	7.648E-02	8.197E-03
86.90	8.660E-02	6.811E-03
90.08	8.930E-02	7.199E-03
94.27	8.940E-02	9.185E-03
98.38	7.679E-02	7.930E-03
102.45	7.766E-02	8.474E-03
106.43	5.046E-02	6.336E-03
110.36	4.397E-02	6.805E-03
114.20	2.872E-02	5.643E-03
118.00	2.427E-02	5.069E-03
121.70	1.509E-02	3.778E-03
125.34	1.370E-02	2.927E-03
129.80	1.316E-02	3.293E-03
134.23	2.161E-02	4.020E-03
138.53	2.971E-02	4.256E-03
142.78	2.759E-02	3.700E-03
146.93	2.783E-02	3.799E-03
151.03	1.061E-02	2.376E-03
155.06	1.547E-02	2.928E-03
159.04	1.994E-02	3.378E-03
162.98	1.546E-02	3.378E-03
166.88	1.217E-02	2.796E-03
172.29	1.505E-02	3.373E-03
180.00	1.505E-02	3.373E-03

N14(D,T)N13 20.13 MEV. EX = 2.367 ID = 302 J = 1/2+

AVERAGE ENERGY = 2.3757+- 0.0031 THETA < 90
AVERAGE ENERGY = 2.4138+- 0.0068 THETA > 90
AVERAGE ENERGY = 2.3886+- 0.0041 ALL ANGLES
REACTION CROSS SECTION = 6.620E-01 +- 0.884E-01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.054E-01	4.871E-02
9.96	3.054E-01	4.871E-02
11.96	2.664E-01	4.582E-02
13.96	2.993E-01	4.477E-02
17.96	6.936E-02	1.269E-02
19.96	9.391E-02	1.332E-02
21.96	6.297E-02	1.186E-02
23.96	8.841E-02	1.175E-02
25.96	5.815E-02	8.503E-03
27.96	5.701E-02	1.309E-02
29.96	4.102E-02	5.934E-03
30.96	3.930E-02	5.175E-03
31.96	4.247E-02	5.245E-03
32.96	4.753E-02	6.484E-03
34.96	3.152E-02	6.726E-03
37.96	3.614E-02	6.499E-03
39.96	6.902E-02	7.842E-03
39.96	3.567E-02	7.444E-03
40.96	3.391E-02	7.405E-03
43.96	5.755E-02	9.740E-03
46.96	6.157E-02	8.726E-03
49.96	5.322E-02	8.038E-03
52.96	6.646E-02	8.332E-03
55.96	9.198E-02	1.103E-02
58.96	7.874E-02	9.797E-03
61.96	8.808E-02	1.007E-02
61.96	8.808E-02	1.007E-02
64.96	7.630E-02	8.410E-03
67.96	6.691E-02	6.305E-03
70.96	8.666E-02	9.280E-03
73.96	9.590E-02	7.537E-03
76.96	9.660E-02	7.781E-03
80.96	9.366E-02	9.614E-03
84.96	7.786E-02	8.034E-03
88.96	7.617E-02	8.304E-03
92.96	4.785E-02	6.004E-03
96.96	4.031E-02	6.234E-03
100.96	2.546E-02	4.999E-03
104.96	2.080E-02	4.342E-03
108.96	1.252E-02	3.132E-03
112.96	1.101E-02	2.350E-03
117.96	1.017E-02	2.544E-03
122.96	1.607E-02	2.988E-03
127.96	2.131E-02	3.052E-03
132.96	1.913E-02	2.564E-03
137.96	1.870E-02	2.552E-03
142.96	6.930E-03	1.551E-03
147.96	9.845E-03	1.863E-03
152.96	1.242E-02	2.103E-03
157.96	9.445E-03	2.064E-03
162.96	7.320E-03	1.681E-03
169.96	8.915E-03	1.998E-03
180.00	8.915E-03	1.998E-03

N14(D,T)N13 20.13 MEV. EX = 3.510 ID = 303 J = 3/2-

AVERAGE ENERGY = 3.5098+- 0.0015 THETA < 90
AVERAGE ENERGY = 3.5158+- 0.0034 THETA > 90
AVERAGE ENERGY = 3.5122+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 2.161E+00 +- 0.169E+00
INTEGRATION LENGTH = 2.967 + 0.108 + 0.066 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.277E-01	6.199E-02
12.40	7.277E-01	6.199E-02
14.88	8.253E-01	6.581E-02
17.36	8.116E-01	6.027E-02
19.84	6.409E-01	3.503E-02
22.31	5.464E-01	2.962E-02
24.77	3.789E-01	2.215E-02
27.24	3.841E-01	2.658E-02
29.69	2.812E-01	1.737E-02
32.14	2.333E-01	1.418E-02
34.58	2.441E-01	2.245E-02
37.01	2.212E-01	1.162E-02
38.23	2.082E-01	1.009E-02
39.44	2.140E-01	1.001E-02
40.65	2.130E-01	1.160E-02
43.06	2.349E-01	1.552E-02
46.66	2.177E-01	1.359E-02
49.06	1.820E-01	1.088E-02
48.93	1.713E-01	1.393E-02
50.24	1.855E-01	1.480E-02
53.79	1.655E-01	1.420E-02
57.32	1.462E-01	1.166E-02
60.81	1.645E-01	1.239E-02
64.29	1.391E-01	1.065E-02
67.71	1.342E-01	1.186E-02
71.12	1.224E-01	1.099E-02
74.49	1.228E-01	1.080E-02
74.49	1.228E-01	1.080E-02

ABCISSA	ORDINATE	ERROR
74.49	1.228E-01	1.080E-02
77.83	1.356E-01	1.033E-02
81.13	1.132E-01	7.652E-03
84.40	8.991E-02	8.874E-03
87.62	1.255E-01	8.223E-03
90.82	1.163E-01	8.233E-03
95.01	8.934E-02	9.180E-03
99.13	8.498E-02	8.354E-03
103.18	8.249E-02	8.751E-03
107.17	7.290E-02	7.651E-03
111.08	7.063E-02	8.671E-03
114.92	6.241E-02	8.375E-03
118.70	5.546E-02	7.722E-03
122.40	7.264E-02	8.382E-03
126.05	1.132E-01	8.585E-03
130.50	1.122E-01	9.804E-03
134.86	1.171E-01	9.523E-03
139.12	1.326E-01	9.187E-03
143.31	1.740E-01	9.574E-03
147.41	1.760E-01	9.855E-03
151.48	2.550E-01	1.216E-02
155.46	2.596E-01	1.254E-02
159.38	2.741E-01	1.312E-02
163.26	2.198E-01	1.321E-02
167.09	2.250E-01	1.255E-02
172.41	1.353E-01	1.046E-02
180.00	1.353E-01	1.046E-02

N14(D,T)N13 20.13 MEV. EX = 3.510 ID = 303 J = 3/2-

AVERAGE ENERGY = 3.5098+- 0.0013 THETA < 90
AVERAGE ENERGY = 3.5172+- 0.0041 THETA > 90
AVERAGE ENERGY = 3.5122+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 2.160E+00 +- 0.169E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.123E+00	9.561E-02
9.96	1.123E+00	9.561E-02
11.96	1.270E+00	1.012E-01
13.96	1.244E+00	9.236E-02
15.96	9.782E-01	5.345E-02
17.96	8.302E-01	4.499E-02
19.96	5.730E-01	3.348E-02
21.96	5.778E-01	3.996E-02
23.96	4.204E-01	2.597E-02
25.96	3.465E-01	2.105E-02
27.96	3.602E-01	3.310E-02
29.96	3.239E-01	1.700E-02
30.96	3.036E-01	1.471E-02
31.96	3.109E-01	1.453E-02
32.96	3.082E-01	1.678E-02
34.96	3.368E-01	2.225E-02
37.96	3.079E-01	1.921E-02
39.96	2.549E-01	1.524E-02
39.96	2.389E-01	1.942E-02
40.96	2.585E-01	2.060E-02
43.96	2.270E-01	1.946E-02
46.96	1.971E-01	1.571E-02
49.96	2.178E-01	1.639E-02
52.96	1.807E-01	1.383E-02
55.96	1.709E-01	1.509E-02
58.96	1.527E-01	1.369E-02
61.96	1.499E-01	1.317E-02
61.96	1.499E-01	1.317E-02
61.96	1.499E-01	1.317E-02
64.96	1.619E-01	1.232E-02
67.96	1.321E-01	8.921E-03
70.96	1.025E-01	1.010E-02
73.96	1.395E-01	9.136E-03
76.96	1.262E-01	8.923E-03
80.96	9.369E-02	9.619E-03
84.96	8.609E-02	8.456E-03
88.96	8.068E-02	8.552E-03
92.96	6.882E-02	7.217E-03
96.96	6.434E-02	7.893E-03
100.96	5.486E-02	7.356E-03
104.96	4.706E-02	6.547E-03
108.96	5.952E-02	6.862E-03
112.96	8.963E-02	6.790E-03
117.96	8.521E-02	7.438E-03
122.96	8.541E-02	6.942E-03
127.96	9.315E-02	6.448E-03
132.96	1.179E-01	6.484E-03
137.96	1.154E-01	6.459E-03
142.96	1.619E-01	7.722E-03
147.96	1.605E-01	7.746E-03
152.96	1.655E-01	7.918E-03
157.96	1.301E-01	7.816E-03
162.96	1.311E-01	7.307E-03
169.96	7.762E-02	6.002E-03
180.00	7.762E-02	6.002E-03

N14(D,T)N13 20.13 MEV. EX = 6.380 ID = 304 J = 5/2+

AVERAGE ENERGY = 6.3799+- 0.0008 THETA < 90
AVERAGE ENERGY = 6.3829+- 0.0020 THETA > 90
AVERAGE ENERGY = 6.3810+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 8.711E-01 +- 0.102E+00
INTEGRATION LENGTH = 2.828 + 0.112 + 0.202 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.009E-01	4.383E-02
12.86	4.009E-01	4.383E-02
15.44	4.318E-01	4.565E-02
18.01	3.640E-01	3.866E-02
20.57	9.991E-02	1.307E-02
23.13	9.942E-02	1.195E-02
25.69	8.239E-02	9.827E-03
28.24	6.750E-02	9.790E-03
30.78	6.312E-02	7.862E-03
33.31	5.854E-02	6.798E-03
35.84	6.297E-02	1.098E-02
38.35	5.043E-02	5.287E-03
39.61	4.646E-02	4.631E-03
40.86	5.083E-02	4.636E-03
42.11	5.441E-02	5.613E-03
44.60	5.086E-02	6.944E-03
48.31	4.909E-02	6.207E-03
50.81	3.624E-02	4.797E-03
50.51	3.595E-02	6.178E-03
52.00	5.052E-02	7.463E-03
55.66	4.558E-02	7.229E-03
59.29	4.962E-02	6.595E-03
62.89	5.503E-02	6.959E-03
66.44	5.675E-02	6.627E-03
69.97	5.463E-02	7.392E-03
69.97	5.463E-02	7.392E-03
73.45	3.942E-02	6.099E-03
76.90	8.365E-02	8.764E-03
80.30	8.628E-02	8.107E-03
83.67	1.507E-01	8.786E-03
87.00	1.546E-01	1.160E-02
90.27	1.373E-01	8.575E-03
93.51	7.263E-02	6.454E-03
97.73	5.393E-02	7.113E-03
101.89	3.013E-02	4.968E-03
105.94	2.322E-02	4.653E-03
109.92	3.074E-02	5.002E-03
113.82	1.952E-02	4.608E-03
117.63	1.155E-02	3.656E-03
121.34	2.116E-02	4.862E-03
124.98	1.910E-02	4.390E-03
128.56	4.023E-02	5.223E-03
132.90	2.150E-02	4.399E-03
137.16	4.352E-02	6.003E-03
141.27	7.625E-02	7.240E-03
145.31	1.025E-01	7.655E-03
149.24	5.437E-02	5.685E-03
153.10	1.761E-02	3.278E-03
156.87	7.638E-03	2.207E-03
180.00	7.638E-03	2.207E-03

N14(D,T)N13 20.13 MEV. EX.= 6.380 ID = 304 J = 5/2+

AVERAGE ENERGY = 6.3811+- 0.0009 THETA < 90
AVERAGE ENERGY = 6.3809+- 0.0022 THETA > 90
AVERAGE ENERGY = 6.3810+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 8.708E-01 +- 0.102E+00
INTEGRATION LENGTH = 2.775 + 0.087 + 0.280 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	6.649E-01	7.268E-02
9.96	6.649E-01	7.268E-02
11.96	7.138E-01	7.545E-02
13.96	5.992E-01	6.363E-02
15.96	1.636E-01	2.139E-02
17.96	1.620E-01	1.946E-02
19.96	1.335E-01	1.592E-02
21.96	1.087E-01	1.576E-02
23.96	1.009E-01	1.257E-02
25.96	9.289E-02	1.077E-02
27.96	9.913E-02	1.728E-02
29.96	7.870E-02	8.247E-03
30.96	7.529E-02	7.190E-03
31.96	7.859E-02	7.163E-03
32.96	8.372E-02	8.631E-03
34.96	7.747E-02	1.057E-02
37.96	7.354E-02	9.293E-03
38.96	5.670E-02	7.102E-03
39.96	5.278E-02	9.065E-03
40.96	7.438E-02	1.099E-02
43.96	6.585E-02	1.043E-02
46.96	7.028E-02	9.333E-03
49.96	7.631E-02	9.642E-03
52.96	7.695E-02	8.978E-03
55.96	7.237E-02	9.783E-03
58.96	5.095E-02	7.876E-03
61.96	1.054E-01	1.103E-02
64.96	1.059E-01	9.939E-03
67.96	1.799E-01	1.048E-02
70.96	1.795E-01	1.346E-02
73.96	1.549E-01	9.661E-03
76.96	7.952E-02	7.059E-03
80.96	5.670E-02	7.470E-03
84.96	3.039E-02	5.005E-03
88.96	2.245E-02	4.495E-03
92.96	2.848E-02	4.630E-03
96.96	1.732E-02	4.085E-03
100.96	9.818E-03	3.104E-03
104.96	1.723E-02	3.957E-03
108.96	1.491E-02	3.424E-03
112.96	3.012E-02	3.907E-03
117.96	1.530E-02	3.128E-03
122.96	2.948E-02	4.063E-03
127.96	4.933E-02	4.681E-03
132.96	6.344E-02	4.736E-03
137.96	3.234E-02	3.380E-03
142.96	1.009E-02	1.878E-03
147.96	4.238E-03	1.224E-03
180.00	4.238E-03	1.224E-03

N14(D,T)N13 20.13 MEV. EX.= 6.910 ID = 305 J = 3/2+

AVERAGE ENERGY = 6.9101+- 0.0021 THETA < 90
AVERAGE ENERGY = 6.8873+- 0.0082 THETA > 90
AVERAGE ENERGY = 6.9026+- 0.0036 ALL ANGLES
REACTION CROSS SECTION = 1.073E+00 +- 0.129E+00
INTEGRATION LENGTH = 2.729 + 0.113 + 0.299 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.357E-01	2.495E-02
12.98	1.357E-01	2.495E-02
15.53	9.784E-02	2.139E-02
18.17	1.193E-01	2.184E-02
20.77	8.977E-02	1.227E-02
23.35	1.046E-01	1.215E-02
25.92	1.061E-01	1.108E-02
28.49	9.426E-02	1.226E-02
31.06	8.499E-02	9.835E-03
33.62	7.521E-02	8.555E-03
36.15	1.015E-01	1.398E-02
38.70	5.342E-02	5.402E-03
39.97	6.834E-02	7.520E-03
41.23	5.209E-02	4.659E-03
42.48	8.601E-02	7.310E-03
44.99	5.013E-02	6.906E-03
46.73	5.608E-02	6.636E-03
51.25	9.430E-02	9.204E-03
50.91	7.204E-02	1.015E-02
52.45	7.152E-02	8.904E-03
56.14	6.749E-02	8.745E-03
59.79	4.559E-02	6.514E-03
63.42	3.886E-02	7.239E-03
63.42	3.886E-02	7.239E-03
63.42	3.886E-02	7.239E-03
67.00	4.250E-02	5.897E-03
70.56	4.132E-02	6.468E-03
74.04	2.606E-02	5.021E-03
77.52	4.061E-02	6.645E-03
80.93	3.802E-02	5.547E-03
84.31	5.094E-02	5.595E-03
87.64	3.893E-02	5.758E-03
90.93	4.942E-02	5.182E-03
94.15	4.104E-02	5.115E-03
98.37	4.185E-02	6.531E-03
102.51	5.792E-02	7.333E-03
106.58	7.177E-02	8.694E-03
110.56	9.434E-02	9.176E-03
114.48	1.092E-01	1.150E-02
118.33	8.515E-02	1.063E-02
122.07	4.511E-02	1.152E-02
129.24	8.658E-02	9.909E-03
133.52	1.314E-01	1.560E-02
137.70	2.134E-01	1.521E-02
141.77	2.081E-01	1.410E-02
145.74	1.114E-01	8.165E-03
180.00	1.114E-01	8.165E-03

N14(D,T)N13 20.13 MEV. EX = 6.910 ID = 305 J = 3/2+

AVERAGE ENERGY = 6.9051+- 0.0029 THETA < 90
AVERAGE ENERGY = 6.8936+- 0.0120 THETA > 90
AVERAGE ENERGY = 6.9026+- 0.0036 ALL ANGLES
REACTION CROSS SECTION = 1.096E+00 +- 0.132E+00
INTEGRATION LENGTH = 2.644 + 0.087 + 0.411 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.293E-01	4.215E-02
9.96	2.293E-01	4.215E-02
11.96	1.647E-01	3.601E-02
13.96	1.998E-01	3.656E-02
15.96	1.498E-01	2.046E-02
17.96	1.736E-01	2.016E-02
19.96	1.749E-01	1.825E-02
21.96	1.544E-01	2.006E-02
23.96	1.382E-01	1.599E-02
25.96	1.214E-01	1.380E-02
27.96	1.622E-01	2.235E-02
29.96	8.470E-02	8.561E-03
30.96	1.079E-01	1.186E-02
31.96	8.183E-02	7.313E-03
32.96	1.375E-01	1.141E-02
34.96	7.748E-02	1.067E-02
37.96	8.523E-02	1.008E-02
39.96	1.418E-01	1.383E-02
39.96	1.071E-01	1.509E-02
40.96	1.067E-01	1.328E-02
43.96	9.880E-02	1.279E-02
46.96	6.537E-02	9.331E-03
49.96	5.452E-02	1.015E-02
49.96	5.452E-02	1.015E-02
49.96	5.452E-02	1.015E-02
52.96	5.825E-02	8.076E-03
55.96	5.528E-02	8.646E-03
58.96	3.398E-02	6.541E-03
61.96	5.157E-02	8.431E-03
64.96	4.698E-02	6.846E-03
67.96	6.117E-02	6.711E-03
70.96	4.540E-02	6.708E-03
73.96	5.592E-02	5.857E-03
76.96	4.502E-02	5.605E-03
80.96	4.401E-02	6.861E-03
84.96	5.834E-02	7.379E-03
88.96	6.918E-02	8.371E-03
92.96	8.698E-02	8.451E-03
96.96	9.628E-02	1.012E-02
100.96	7.172E-02	8.940E-03
104.96	3.631E-02	9.261E-03
112.96	6.380E-02	7.296E-03
117.96	9.189E-02	1.090E-02
122.96	1.419E-01	1.011E-02
127.96	1.320E-01	8.933E-03
132.96	6.761E-02	4.951E-03
180.00	6.761E-02	4.951E-03

N14(D,T)N13 20.13 MEV. EX = 7.180 ID = 306 J = 7/2+

AVERAGE ENERGY = 7.1849+- 0.0016 THETA < 90
AVERAGE ENERGY = 7.1734+- 0.0034 THETA > 90
AVERAGE ENERGY = 7.1821+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 1.247E+00 +- 0.198E+00
INTEGRATION LENGTH = 2.525 + 0.114 + 0.503 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.703E-01	2.822E-02
13.05	1.703E-01	2.822E-02
15.66	1.570E-01	2.740E-02
18.28	1.690E-01	4.071E-02
20.87	2.010E-01	4.063E-02
23.46	2.281E-01	3.534E-02
26.06	1.686E-01	2.699E-02
28.64	1.840E-01	3.223E-02
31.22	2.308E-01	2.882E-02
33.78	1.978E-01	3.218E-02
36.33	2.029E-01	2.970E-02
38.89	1.995E-01	2.291E-02
40.16	2.058E-01	2.973E-02
41.42	1.867E-01	2.260E-02
42.69	1.829E-01	1.605E-02
45.23	1.647E-01	2.454E-02
48.98	1.501E-01	1.520E-02
51.51	2.064E-01	3.186E-02
51.12	1.535E-01	2.010E-02
52.71	1.344E-01	1.486E-02
52.71	1.344E-01	1.486E-02
56.41	1.061E-01	1.345E-02
60.08	8.714E-02	1.008E-02
63.71	8.412E-02	1.212E-02
67.31	6.941E-02	8.199E-03
70.87	6.754E-02	1.131E-02
74.39	7.502E-02	1.006E-02
77.87	6.829E-02	1.066E-02
81.30	8.914E-02	1.211E-02
84.70	9.081E-02	1.481E-02
88.03	9.288E-02	1.026E-02
91.32	8.687E-02	9.508E-03
94.56	7.077E-02	8.870E-03
98.82	6.697E-02	1.088E-02
102.99	4.983E-02	1.039E-02
107.04	5.233E-02	8.990E-03
111.00	4.898E-02	8.024E-03
114.90	4.610E-02	1.219E-02
118.68	4.572E-02	8.717E-03
122.38	4.876E-02	1.265E-02
180.00	4.876E-02	1.265E-02

N14(D,T)N13 20.13 MEV. EX = 7.180 ID = 306 J = 7/2+

AVERAGE ENERGY = 7.1841+- 0.0015 THETA < 90
AVERAGE ENERGY = 7.1666+- 0.0031 THETA > 90
AVERAGE ENERGY = 7.1819+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 1.136E+00 +- 0.173E+00
INTEGRATION LENGTH = 2.435 + 0.087 + 0.620 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.905E-01	4.814E-02
9.96	2.905E-01	4.814E-02
11.96	2.668E-01	4.655E-02
13.96	2.864E-01	6.897E-02
15.96	3.384E-01	6.840E-02
17.96	3.820E-01	5.916E-02
19.96	3.141E-01	4.493E-02
21.96	3.044E-01	5.330E-02
23.96	3.790E-01	4.729E-02
25.96	3.221E-01	5.239E-02
27.96	3.275E-01	4.791E-02
29.96	3.192E-01	3.663E-02
30.96	3.277E-01	4.731E-02
31.96	2.958E-01	3.578E-02
32.96	2.883E-01	2.528E-02
34.96	2.569E-01	3.826E-02
37.96	2.300E-01	2.327E-02
39.96	3.129E-01	4.825E-02
39.96	2.298E-01	3.008E-02
40.96	2.022E-01	2.233E-02
43.96	1.565E-01	1.982E-02
43.96	1.565E-01	1.982E-02
46.96	1.258E-01	1.455E-02
49.96	1.188E-01	1.709E-02
52.96	9.571E-02	1.129E-02
55.96	9.084E-02	1.520E-02
58.96	9.832E-02	1.317E-02
61.96	8.712E-02	1.358E-02
64.96	1.106E-01	1.501E-02
67.96	1.094E-01	1.782E-02
70.96	1.086E-01	1.198E-02
73.96	9.847E-02	1.077E-02
76.96	7.772E-02	9.731E-03
80.96	7.043E-02	1.143E-02
84.96	5.014E-02	1.044E-02
88.96	5.033E-02	8.637E-03
92.96	4.501E-02	7.366E-03
96.96	4.045E-02	1.068E-02
100.96	3.833E-02	7.300E-03
104.96	3.904E-02	1.012E-02
108.96	1.729E-02	3.773E-03
180.00	1.729E-02	3.773E-03

N14(D,T)N13 20.13 MEV. EX = 7.400 ID = 307 J = 5/2-

AVERAGE ENERGY = 7.3982+- 0.0019 THETA < 90
AVERAGE ENERGY = 7.4053+- 0.0103 THETA > 90
AVERAGE ENERGY = 7.4001+- 0.0031 ALL ANGLES
REACTION CROSS SECTION = 1.958E+00 +- 0.183E+00
INTEGRATION LENGTH = 2.698 + 0.114 + 0.329 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.885E-01	4.795E-02
13.11	4.885E-01	4.795E-02
15.73	7.499E-01	5.966E-02
18.35	5.968E-01	5.800E-02
20.95	6.018E-01	4.834E-02
23.56	5.308E-01	4.103E-02
26.16	4.338E-01	3.188E-02
28.75	3.994E-01	3.519E-02
31.34	3.757E-01	2.826E-02
33.92	3.557E-01	3.073E-02
36.49	3.454E-01	3.266E-02
39.05	3.776E-01	2.502E-02
40.32	3.673E-01	2.635E-02
41.60	3.922E-01	2.454E-02
42.87	4.032E-01	1.884E-02
45.41	3.611E-01	2.776E-02
49.18	3.323E-01	1.902E-02
51.71	2.075E-01	2.686E-02
51.31	3.001E-01	2.067E-02
52.93	2.970E-01	1.959E-02
56.64	2.264E-01	1.783E-02
56.64	2.264E-01	1.783E-02
60.33	1.877E-01	1.324E-02
63.98	1.425E-01	1.194E-02
67.61	1.081E-01	9.363E-03
71.13	1.062E-01	1.231E-02
74.67	1.199E-01	1.157E-02
78.16	1.155E-01	1.118E-02
81.60	1.170E-01	1.198E-02
84.99	1.335E-01	1.351E-02
88.35	1.374E-01	1.200E-02
91.65	1.360E-01	1.022E-02
94.91	1.078E-01	9.080E-03
99.14	7.442E-02	1.007E-02
103.31	8.014E-02	9.970E-03
107.41	7.305E-02	8.789E-03
111.41	5.570E-02	7.227E-03
115.24	5.619E-02	1.031E-02
119.07	3.184E-02	6.255E-03
122.81	2.742E-02	5.726E-03
126.43	2.902E-02	5.499E-03
142.32	1.269E-02	4.115E-03
180.00	1.269E-02	4.115E-03

N14(D,T)N13 20.13 MEV. EX = 7.400 I_D = 307 J = 5/2-

AVERAGE ENERGY = 7.3983+- 0.0017 THETA < 90
AVERAGE ENERGY = 7.4105+- 0.0188 THETA > 90
AVERAGE ENERGY = 7.4001+- 0.0031 ALL ANGLES
REACTION CROSS SECTION = 1.960E+00 +- 0.184E+00
INTEGRATION LENGTH = 2.601 + 0.087 + 0.454 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	8.410E-01	8.253E-02
5.96	8.410E-01	8.253E-02
11.96	1.287E+00	1.023E-01
13.96	1.019E+00	9.900E-02
15.96	1.021E+00	8.199E-02
17.96	8.961E-01	6.924E-02
19.96	7.280E-01	5.347E-02
21.96	6.655E-01	5.861E-02
23.96	6.214E-01	4.672E-02
25.96	5.836E-01	5.040E-02
27.96	5.620E-01	5.310E-02
29.96	6.085E-01	4.029E-02
30.96	5.390E-01	4.223E-02
31.96	6.258E-01	3.912E-02
32.96	6.401E-01	2.988E-02
34.96	5.985E-01	4.356E-02
37.96	5.127E-01	2.932E-02
39.96	3.165E-01	4.093E-02
39.96	4.520E-01	3.112E-02
40.96	4.497E-01	2.965E-02
43.96	3.360E-01	2.644E-02
43.96	3.360E-01	2.644E-02
46.96	2.726E-01	1.922E-02
49.96	2.024E-01	1.693E-02
52.96	1.498E-01	1.297E-02
55.96	1.435E-01	1.662E-02
58.96	1.578E-01	1.521E-02
61.96	1.479E-01	1.430E-02
64.96	1.456E-01	1.488E-02
67.96	1.612E-01	1.629E-02
70.96	1.609E-01	1.405E-02
73.96	1.544E-01	1.159E-02
76.96	1.185E-01	9.970E-03
80.96	7.828E-02	1.057E-02
84.96	8.057E-02	1.001E-02
88.96	7.013E-02	8.428E-03
92.96	5.102E-02	6.613E-03
96.96	4.913E-02	9.001E-03
100.96	2.654E-02	5.210E-03
104.96	2.180E-02	4.548E-03
108.96	2.201E-02	4.168E-03
127.96	7.873E-03	2.551E-03
180.00	7.873E-03	2.551E-03

N14(D,T)N13 20.13 MEV. EX = 8.100 I_D = 308 J = 3/2+

AVERAGE ENERGY = 8.1044+- 0.0033 THETA < 90
AVERAGE ENERGY = 8.0875+- 0.0135 THETA > 90
AVERAGE ENERGY = 8.0997+- 0.0047 ALL ANGLES
REACTION CROSS SECTION = 7.007E-01 +- 0.874E-01
INTEGRATION LENGTH = 2.596 + 0.116 + 0.429 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.250E-01	2.337E-02
13.31	1.250E-01	2.337E-02
15.97	1.022E-01	2.135E-02
18.63	1.137E-01	2.081E-02
21.27	1.381E-01	1.491E-02
23.93	1.358E-01	1.356E-02
26.56	1.459E-01	1.273E-02
29.20	1.370E-01	1.328E-02
31.82	1.297E-01	1.099E-02
34.43	1.411E-01	1.032E-02
37.05	1.313E-01	1.544E-02
39.64	1.463E-01	8.859E-03
40.94	1.220E-01	7.225E-03
42.24	1.290E-01	7.273E-03
43.54	1.406E-01	8.861E-03
46.10	1.096E-01	9.960E-03
49.95	9.890E-02	8.615E-03
52.55	1.031E-01	7.726E-03
51.94	9.809E-02	1.002E-02
53.76	8.342E-02	9.373E-03
57.55	7.588E-02	9.111E-03
57.55	7.588E-02	9.111E-03
61.24	5.073E-02	6.520E-03
64.92	5.357E-02	6.725E-03
68.59	4.571E-02	5.829E-03
72.16	3.644E-02	5.926E-03
75.75	4.090E-02	6.117E-03
79.24	4.510E-02	6.335E-03
82.72	2.858E-02	4.589E-03
86.17	3.959E-02	4.398E-03
89.54	5.106E-02	6.568E-03
92.85	5.570E-02	5.381E-03
96.09	5.041E-02	5.353E-03
100.39	3.352E-02	5.605E-03
104.57	4.517E-02	6.122E-03
108.64	3.492E-02	5.760E-03
112.63	5.218E-02	6.615E-03
116.50	5.592E-02	7.949E-03
120.30	3.243E-02	6.260E-03
123.93	3.149E-02	6.078E-03
127.41	1.482E-02	3.968E-03
130.84	5.678E-03	2.009E-03
180.00	5.678E-03	2.009E-03

N14(D,T)N13 20.13 MEV. EX = 8.100 ID = 308 J = 3/2+

AVERAGE ENERGY = 8.1037+- 0.0028 THETA < 90
AVERAGE ENERGY = 8.0772+- 0.0228 THETA > 90
AVERAGE ENERGY = 8.0997+- 0.0047 ALL ANGLES
REACTION CROSS SECTION = 7.061E-01 +- 0.885E-01
INTEGRATION LENGTH = 2.470 + 0.087 + 0.585 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (L_AB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.218E-01	4.145E-02
9.96	2.218E-01	4.145E-02
11.96	1.805E-01	3.772E-02
13.96	1.999E-01	3.658E-02
15.96	2.415E-01	2.606E-02
17.96	2.363E-01	2.358E-02
19.96	2.522E-01	2.199E-02
21.96	2.350E-01	2.277E-02
23.96	2.207E-01	1.869E-02
25.96	2.380E-01	1.739E-02
27.96	2.195E-01	2.580E-02
29.96	2.423E-01	1.466E-02
30.96	2.010E-01	1.189E-02
31.96	2.115E-01	1.191E-02
32.96	2.293E-01	1.444E-02
34.96	1.766E-01	1.604E-02
37.96	1.566E-01	1.363E-02
39.96	1.614E-01	1.208E-02
39.96	1.507E-01	1.539E-02
40.96	1.295E-01	1.454E-02
43.96	1.154E-01	1.384E-02
43.96	1.154E-01	1.384E-02
46.96	7.529E-02	9.669E-03
49.96	7.761E-02	9.732E-03
52.96	6.455E-02	8.223E-03
55.96	5.006E-02	8.134E-03
58.96	5.466E-02	8.166E-03
61.96	5.851E-02	8.209E-03
64.96	3.596E-02	5.768E-03
67.96	4.828E-02	5.358E-03
70.96	6.027E-02	7.744E-03
73.96	6.357E-02	6.134E-03
76.96	5.557E-02	5.894E-03
80.96	3.526E-02	5.888E-03
84.96	4.526E-02	6.126E-03
88.96	3.330E-02	5.487E-03
92.96	4.732E-02	5.992E-03
96.96	4.823E-02	6.848E-03
100.96	2.658E-02	5.124E-03
104.96	2.456E-02	4.735E-03
108.96	1.102E-02	2.947E-03
112.96	4.027E-03	1.424E-03
180.00	4.027E-03	1.424E-03

*N14(D,E') 20.13 MEV. ID = TR
*TOTAL DIFFERENTIAL CROSS SECTION

AVERAGE ENERGY = 0.0000+- 0.0000 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.0000 THETA > 90
AVERAGE ENERGY = 0.0000+- 0.0000 ALL ANGLES
REACTION CROSS SECTION = 1.483E+01 +- 0.126E+01
INTEGRATION LENGTH = 2.906 + 0.087 + 0.149 = 3.142

$DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.488E+01	8.082E-01
3.96	1.488E+01	8.082E-01
11.96	1.559E+01	7.822E-01
13.96	1.366E+01	7.266E-01
15.96	9.838E+00	4.445E-01
17.96	7.097E+00	3.628E-01
19.96	4.491E+00	2.709E-01
21.96	3.096E+00	2.794E-01
23.96	2.493E+00	2.081E-01
25.96	2.370E+00	2.025E-01
27.96	2.753E+00	2.675E-01
29.96	2.897E+00	1.658E-01
30.96	3.021E+00	1.742E-01
31.96	3.106E+00	1.554E-01
32.96	3.069E+00	1.499E-01
34.96	2.956E+00	1.952E-01
37.96	2.508E+00	1.490E-01
40.96	1.546E+00	1.529E-01
43.96	1.358E+00	1.350E-01
46.96	9.862E-01	9.865E-02
49.96	8.659E-01	9.687E-02
52.96	8.067E-01	8.265E-02
55.96	8.378E-01	9.922E-02
58.96	8.391E-01	9.062E-02
61.96	8.932E-01	9.421E-02
61.96	8.932E-01	9.421E-02
61.96	8.932E-01	9.421E-02
64.96	8.945E-01	8.729E-02
67.96	9.597E-01	8.295E-02
70.96	9.112E-01	8.627E-02
73.96	8.772E-01	6.893E-02
76.96	7.116E-01	6.337E-02
80.96	5.325E-01	6.916E-02
84.96	4.843E-01	6.223E-02
88.96	4.363E-01	5.780E-02
92.96	4.076E-01	5.118E-02
96.96	4.069E-01	6.187E-02
100.96	4.005E-01	4.791E-02
104.96	4.002E-01	4.978E-02
108.96	3.999E-01	3.245E-02
117.96	3.958E-01	5.284E-02
122.96	4.058E-01	4.234E-02
127.96	3.921E-01	3.797E-02
132.96	3.248E-01	2.539E-02
137.96	2.219E-01	1.913E-02
142.96	2.361E-01	1.684E-02
147.96	2.272E-01	1.639E-02
169.96	1.426E-01	1.459E-02
157.96	1.975E-01	1.678E-02
162.96	2.031E-01	1.582E-02
180.00	2.031E-01	1.582E-02

APPENDIX A.5

$^{14}N(d,^{3}He)$ EX < 8 MeV

N14(D,HE3)C13 20.13 MEV. EX = 0.000

ID = 351 J = 1/2-

AVERAGE ENERGY = -0.0138+- 0.0038 THETA < 90
AVERAGE ENERGY = -0.0096+- 0.0037 THETA > 90
AVERAGE ENERGY = -0.0122+- 0.0028 ALL ANGLES
REACTION CROSS SECTION = 6.885E+00 +- 0.397E+00
INTEGRATION LENGTH = 2.967 + 0.104 + 0.071 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	9.382E+00	3.000E-01
11.90	9.382E+00	3.000E-01
14.28	8.994E+00	2.538E-01
16.66	6.908E+00	2.007E-01
19.04	4.796E+00	1.135E-01
21.42	3.083E+00	8.057E-02
23.79	1.602E+00	4.994E-02
26.15	9.037E-01	3.890E-02
28.51	5.994E-01	2.673E-02
30.87	7.775E-01	2.775E-02
33.22	9.340E-01	4.632E-02
35.56	1.238E+00	3.087E-02
36.73	1.267E+00	2.850E-02
37.90	1.285E+00	2.823E-02
39.05	7.729E-01	2.384E-02
41.39	1.197E+00	3.789E-02
44.85	7.708E-01	2.724E-02
47.17	4.609E-01	1.820E-02
47.16	6.218E-01	2.792E-02
48.31	4.725E-01	2.463E-02
51.75	2.493E-01	1.800E-02
55.16	1.063E-01	1.019E-02
58.55	7.894E-02	8.756E-03
61.92	8.642E-02	8.564E-03
65.27	1.359E-01	1.219E-02
68.60	1.718E-01	1.331E-02
65.60	1.718E-01	1.331E-02
71.89	1.622E-01	1.265E-02
75.16	1.612E-01	1.145E-02
78.39	1.405E-01	8.652E-03
81.59	1.466E-01	1.149E-02
84.78	1.201E-01	8.095E-03
87.93	9.865E-02	7.602E-03
92.07	7.286E-02	8.293E-03
100.22	5.891E-02	7.338E-03
104.21	4.043E-02	5.626E-03
108.13	3.694E-02	6.172E-03
112.01	5.598E-02	7.790E-03
115.83	5.418E-02	7.469E-03
119.60	5.999E-02	7.418E-03
123.31	5.431E-02	5.731E-03
127.88	6.029E-02	6.910E-03
132.38	5.917E-02	6.484E-03
136.81	6.093E-02	5.923E-03
141.17	6.438E-02	5.482E-03
145.47	6.888E-02	5.785E-03
149.72	6.665E-02	5.758E-03
153.91	8.277E-02	6.542E-03
158.05	7.725E-02	6.405E-03
162.16	5.172E-02	5.922E-03
166.24	5.068E-02	5.466E-03
171.91	3.071E-02	4.599E-03
180.00	3.071E-02	4.599E-03

N14(D,HE3)C13 20.13 MEV. EX = 00.000

ID = 351 J = 1/2-

AVERAGE ENERGY = -0.0155+- 0.0038 THETA < 90

AVERAGE ENERGY = -0.0064+- 0.0041 THETA > 90

AVERAGE ENERGY = -0.0124+- 0.0030 ALL ANGLES

REACTION CROSS SECTION = 6.843E+00 +- 0.396E+00

INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.334E+01	4.264E-01
9.96	1.334E+01	4.264E-01
11.96	1.276E+01	3.600E-01
13.96	9.771E+00	2.839E-01
15.96	6.762E+00	1.600E-01
17.96	4.330E+00	1.132E-01
19.96	2.241E+00	6.986E-02
21.96	1.259E+00	5.416E-02
23.96	8.309E-01	3.705E-02
25.96	1.072E+00	3.825E-02
27.96	1.281E+00	6.349E-02
29.96	1.687E+00	4.205E-02
30.96	1.721E+00	3.870E-02
31.96	1.740E+00	3.821E-02
32.96	1.042E+00	3.214E-02
34.96	9.401E-01	3.983E-02
34.96	1.604E+00	5.074E-02
37.96	1.021E+00	3.605E-02
39.96	6.058E-01	2.391E-02
39.96	8.168E-01	3.666E-02
40.96	6.181E-01	3.221E-02
43.96	3.220E-01	2.323E-02
46.96	1.354E-01	1.298E-02
49.96	9.912E-02	1.099E-02
52.96	1.069E-01	1.059E-02
55.96	1.654E-01	1.483E-02
58.96	2.058E-01	1.593E-02
58.96	2.058E-01	1.593E-02
61.96	1.909E-01	1.488E-02
64.96	1.865E-01	1.323E-02
67.96	1.595E-01	9.817E-03
70.96	1.633E-01	1.279E-02
73.96	1.312E-01	8.842E-03
76.96	1.057E-01	8.142E-03
80.96	7.602E-02	8.646E-03
88.96	5.818E-02	7.243E-03
92.96	3.884E-02	5.401E-03
96.96	3.451E-02	5.762E-03
100.96	5.086E-02	7.073E-03
104.96	4.788E-02	6.597E-03
108.96	5.159E-02	6.375E-03
112.96	4.547E-02	4.796E-03
117.96	4.886E-02	5.597E-03
122.96	4.648E-02	5.091E-03
127.96	4.647E-02	4.515E-03
132.96	4.774E-02	4.063E-03
137.96	4.978E-02	4.179E-03
142.96	4.704E-02	4.062E-03
147.96	5.720E-02	4.520E-03
152.96	5.241E-02	4.344E-03
157.96	3.456E-02	3.956E-03
162.96	3.345E-02	3.607E-03
169.96	2.002E-02	2.997E-03
169.96	3.642E-02	3.736E-03
180.00	3.642E-02	3.736E-03

N14(D,HE3)C13 20.13 MEV. EX = 3.090

ID = 352 J = 1/2+

AVERAGE ENERGY = 3.0793+- 0.0033 THETA < 90
AVERAGE ENERGY = 3.1210+- 0.0063 THETA > 90
AVERAGE ENERGY = 3.0957+- 0.0043 ALL ANGLES
REACTION CROSS SECTION = 3.697E-01 +- 0.652E-01
INTEGRATION LENGTH = 2.967 + 0.106 + 0.069 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	8.276E-02	2.076E-02
12.12	8.276E-02	2.076E-02
14.55	7.454E-02	1.995E-02
16.97	5.442E-02	1.573E-02
19.40	7.388E-02	1.186E-02
21.82	6.827E-02	1.045E-02
24.23	8.420E-02	1.049E-02
26.64	1.114E-01	1.301E-02
29.05	9.402E-02	1.013E-02
31.45	6.155E-02	7.336E-03
33.83	7.407E-02	1.255E-02
36.22	5.035E-02	5.554E-03
37.41	5.020E-02	4.952E-03
38.59	4.049E-02	4.338E-03
39.77	3.919E-02	4.993E-03
42.15	4.353E-02	6.733E-03
45.66	2.819E-02	4.917E-03
48.03	3.465E-02	4.772E-03
47.96	3.101E-02	5.977E-03
49.17	4.078E-02	7.007E-03
52.66	3.097E-02	6.202E-03
56.13	2.260E-02	4.620E-03
59.57	2.350E-02	4.707E-03
62.99	2.298E-02	4.350E-03
66.37	2.643E-02	5.293E-03
69.73	3.772E-02	6.133E-03
73.04	1.720E-02	4.058E-03
73.04	1.720E-02	4.058E-03
76.36	2.271E-02	4.224E-03
79.62	2.399E-02	3.509E-03
82.86	1.574E-02	3.714E-03
86.04	1.951E-02	3.215E-03
89.21	1.312E-02	2.741E-03
93.41	1.398E-02	3.614E-03
101.54	1.912E-02	4.178E-03
105.60	2.509E-02	4.446E-03
109.46	1.973E-02	4.532E-03
113.35	1.203E-02	3.629E-03
117.11	1.145E-02	3.456E-03
120.88	9.295E-03	2.941E-03
124.55	2.021E-02	3.527E-03
129.07	1.775E-02	3.791E-03
133.52	2.843E-02	4.563E-03
137.87	3.727E-02	4.712E-03
142.15	3.260E-02	3.969E-03
146.36	3.051E-02	3.921E-03
150.52	2.159E-02	3.340E-03
154.61	1.869E-02	3.166E-03
158.65	2.421E-02	3.661E-03
162.66	2.413E-02	4.147E-03
166.63	2.282E-02	3.762E-03
172.14	3.908E-02	5.349E-03
172.13	4.318E-02	5.166E-03
180.00	4.318E-02	5.166E-03

N14(D,HE3)C13 20.13 MEV. EX = 3.090

ID = 352 J = 1/2+

AVERAGE ENERGY = 3.0800+- 0.0033 THETA < 90
AVERAGE ENERGY = 3.1243+- 0.0062 THETA > 90
AVERAGE ENERGY = 3.0957+- 0.0043 ALL ANGLES
REACTION CROSS SECTION = 3.696E-01 +- 0.652E-01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.221E-01	3.064E-02
3.96	1.221E-01	3.064E-02
11.96	1.097E-01	2.934E-02
13.96	7.979E-02	2.305E-02
15.96	1.080E-01	1.734E-02
17.96	9.940E-02	1.520E-02
19.96	1.221E-01	1.520E-02
21.96	1.607E-01	1.876E-02
23.96	1.349E-01	1.454E-02
25.96	8.782E-02	1.046E-02
27.96	1.050E-01	1.778E-02
29.96	7.090E-02	7.817E-03
30.96	7.045E-02	6.946E-03
31.96	5.661E-02	6.062E-03
32.96	5.456E-02	6.949E-03
34.96	6.017E-02	9.301E-03
37.96	3.847E-02	6.705E-03
39.96	4.689E-02	6.455E-03
39.96	4.186E-02	8.065E-03
40.96	5.489E-02	9.426E-03
43.96	4.109E-02	8.225E-03
46.96	2.955E-02	6.035E-03
49.96	3.023E-02	6.051E-03
52.96	2.907E-02	5.498E-03
55.96	3.284E-02	6.573E-03
58.96	4.602E-02	7.477E-03
61.96	2.058E-02	4.852E-03
61.96	2.058E-02	4.852E-03

ABCISSA	ORDINATE	ERROR
61.96	2.058E-02	4.852E-03
64.96	2.665E-02	4.954E-03
67.96	2.758E-02	4.031E-03
70.96	1.772E-02	4.178E-03
73.96	2.150E-02	3.539E-03
76.96	1.415E-02	2.952E-03
80.96	1.463E-02	3.778E-03
88.96	1.881E-02	4.107E-03
92.96	2.392E-02	4.234E-03
96.96	1.823E-02	4.184E-03
100.96	1.077E-02	3.246E-03
104.96	9.944E-03	2.999E-03
108.96	7.822E-03	2.474E-03
112.96	1.650E-02	2.878E-03
117.96	1.397E-02	2.982E-03
122.96	2.160E-02	3.464E-03
127.96	2.739E-02	3.460E-03
132.96	2.321E-02	2.824E-03
137.96	2.111E-02	2.711E-03
142.96	1.454E-02	2.248E-03
147.96	1.230E-02	2.082E-03
152.96	1.560E-02	2.358E-03
157.96	1.528E-02	2.625E-03
162.96	1.424E-02	2.347E-03
169.96	2.405E-02	3.291E-03
169.96	2.668E-02	3.192E-03
180.00	2.668E-02	3.192E-03

N14(D,HE3)C13 20.13 MEV. EX = 3.680

ID = 353 J = 3/2-

AVERAGE ENERGY = 3.6748+- 0.0019 THETA < 90
AVERAGE ENERGY = 3.6562+- 0.0075 THETA > 90
AVERAGE ENERGY = 3.6675+- 0.0034 ALL ANGLES
REACTION CROSS SECTION = 1.668E+00 +- 0.178E+00
INTEGRATION LENGTH = 2.967 + 0.106 + 0.068 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.389E-01	6.853E-02
12.17	7.389E-01	6.853E-02
14.61	8.499E-01	1.126E-01
17.05	7.236E-01	7.905E-02
19.49	6.951E-01	4.899E-02
21.91	4.897E-01	4.013E-02
24.34	3.328E-01	2.853E-02
26.76	2.239E-01	1.991E-02
29.17	1.983E-01	1.706E-02
31.58	1.626E-01	1.580E-02
33.98	2.583E-01	2.492E-02
36.37	2.017E-01	1.275E-02
37.57	1.955E-01	1.313E-02
38.76	2.156E-01	1.431E-02
39.94	2.252E-01	1.461E-02
42.32	2.192E-01	2.025E-02
45.86	1.994E-01	1.665E-02
48.22	1.474E-01	1.301E-02
48.15	1.746E-01	1.496E-02
49.33	1.656E-01	1.775E-02
52.88	1.354E-01	1.876E-02
56.36	9.082E-02	1.135E-02
59.81	1.113E-01	1.170E-02
63.23	1.078E-01	1.065E-02
66.63	1.063E-01	1.144E-02
69.99	1.216E-01	1.122E-02
73.33	9.139E-02	1.051E-02
73.33	9.139E-02	1.051E-02
73.33	9.139E-02	1.051E-02
76.64	8.353E-02	8.457E-03
79.91	9.365E-02	8.638E-03
83.16	8.376E-02	9.641E-03
86.35	7.844E-02	8.031E-03
89.52	8.321E-02	8.014E-03
93.71	6.896E-02	8.877E-03
101.86	7.019E-02	1.149E-02
105.79	2.198E-02	4.162E-03
109.76	4.997E-02	7.238E-03
113.61	3.948E-02	7.372E-03
117.42	5.021E-02	1.109E-02
121.15	3.736E-02	6.212E-03
124.83	5.421E-02	6.583E-03
129.33	6.255E-02	1.084E-02
133.76	7.418E-02	7.742E-03
138.09	6.561E-02	7.240E-03
142.37	7.211E-02	7.105E-03
146.56	6.519E-02	7.358E-03
150.70	1.513E-01	1.582E-02
154.76	1.740E-01	1.465E-02
158.78	2.037E-01	1.373E-02
162.75	1.671E-01	1.133E-02
166.70	1.465E-01	9.802E-03
172.18	7.024E-02	7.389E-03
172.17	8.184E-02	1.032E-02
180.00	8.184E-02	1.032E-02

N14(D,HE3)C13 20.13 MEV. EX = 3.680

ID = 353 J = 3/2-

AVERAGE ENERGY = 3.6747+- 0.0018 THETA < 90
AVERAGE ENERGY = 3.6544+- 0.0082 THETA > 90
AVERAGE ENERGY = 3.6675+- 0.0034 ALL ANGLES
REACTION CROSS SECTION = 1.668E+00 +- 0.178E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.099E+00	1.019E-01
9.96	1.099E+00	1.019E-01
11.96	1.261E+00	1.670E-01
13.96	1.071E+00	1.169E-01
15.96	1.025E+00	7.221E-02
17.96	7.190E-01	5.891E-02
19.96	4.864E-01	4.169E-02
21.96	3.257E-01	2.895E-02
23.96	2.869E-01	2.467E-02
25.96	2.338E-01	2.271E-02
27.96	3.690E-01	3.559E-02
29.96	2.862E-01	1.808E-02
30.96	2.764E-01	1.856E-02
31.96	3.037E-01	2.015E-02
32.96	3.160E-01	2.048E-02
34.96	3.052E-01	2.817E-02
37.96	2.740E-01	2.286E-02
38.96	2.008E-01	1.771E-02
39.96	2.372E-01	2.031E-02
40.96	2.244E-01	2.405E-02
43.96	1.808E-01	2.504E-02
46.96	1.194E-01	1.492E-02
49.96	1.439E-01	1.512E-02
52.96	1.371E-01	1.353E-02
55.96	1.327E-01	1.427E-02
58.96	1.490E-01	1.373E-02
61.96	1.098E-01	1.262E-02
61.96	1.098E-01	1.262E-02
61.96	1.098E-01	1.262E-02
64.96	9.834E-02	9.949E-03
67.96	1.080E-01	9.952E-03
70.96	9.452E-02	1.087E-02
73.96	8.658E-02	8.858E-03
76.96	8.981E-02	8.643E-03
80.96	7.217E-02	9.284E-03
88.96	6.898E-02	1.128E-02
92.96	2.093E-02	3.960E-03
96.96	4.606E-02	6.665E-03
100.96	3.524E-02	6.575E-03
104.96	4.340E-02	9.577E-03
108.96	3.129E-02	5.200E-03
112.96	4.402E-02	5.342E-03
117.96	4.892E-02	8.468E-03
122.96	5.595E-02	5.837E-03
127.96	4.783E-02	5.275E-03
132.96	5.088E-02	5.011E-03
137.96	4.465E-02	5.038E-03
142.96	1.008E-01	1.054E-02
147.96	1.132E-01	9.523E-03
152.96	1.293E-01	8.744E-03
157.96	1.047E-01	7.096E-03
162.96	9.048E-02	6.053E-03
169.96	4.276E-02	4.498E-03
169.96	5.000E-02	6.302E-03
180.00	5.000E-02	6.302E-03

N14(D,HE3)C13 20.13 MEV. EX = 3.850

ID = 354 J = 5/2+

AVERAGE ENERGY = 3.8590+- 0.0016 THETA < 90
AVERAGE ENERGY = 3.9033+- 0.0067 THETA > 90
AVERAGE ENERGY = 3.8758+- 0.0042 ALL ANGLES
REACTION CROSS SECTION = 1.039E+00 +- 0.150E+00
INTEGRATION LENGTH = 2.967 + 0.106 + 0.068 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.660E-01	4.524E-02
12.19	2.660E-01	4.524E-02
14.64	2.580E-01	9.685E-02
17.08	2.869E-01	6.475E-02
19.51	1.537E-01	3.614E-02
21.94	1.413E-01	3.200E-02
24.37	1.166E-01	2.282E-02
26.79	9.233E-02	1.393E-02
29.21	8.342E-02	1.278E-02
31.62	1.133E-01	1.431E-02
34.02	7.751E-02	1.528E-02
36.42	8.109E-02	9.250E-03
37.62	9.416E-02	1.096E-02
38.81	9.113E-02	1.196E-02
40.00	1.070E-01	1.159E-02
42.38	9.755E-02	1.672E-02
45.92	9.227E-02	1.350E-02
48.29	1.134E-01	1.207E-02
48.20	6.037E-02	9.485E-03
49.45	7.964E-02	1.448E-02
52.96	9.333E-02	1.726E-02
56.44	9.810E-02	1.164E-02
59.89	1.008E-01	1.125E-02
63.32	8.805E-02	9.828E-03
66.72	8.930E-02	1.060E-02
70.08	7.305E-02	8.754E-03
70.08	7.305E-02	8.754E-03

ABCISSA	ORDINATE	ERROR
73.42	7.986E-02	9.957E-03
76.73	7.018E-02	7.797E-03
80.00	5.238E-02	7.268E-03
83.24	5.144E-02	8.011E-03
86.45	6.366E-02	7.511E-03
89.63	5.014E-02	6.693E-03
93.80	5.870E-02	8.310E-03
97.99	4.201E-02	5.846E-03
101.97	4.742E-02	1.053E-02
109.89	4.899E-02	7.170E-03
113.74	5.053E-02	8.168E-03
117.54	3.877E-02	1.054E-02
121.26	3.276E-02	5.858E-03
124.93	7.902E-02	7.698E-03
129.43	6.922E-02	1.111E-02
133.86	7.811E-02	7.945E-03
138.20	8.801E-02	8.154E-03
142.47	8.700E-02	7.635E-03
146.65	1.173E-01	9.064E-03
150.76	1.357E-01	1.560E-02
158.84	1.349E-01	1.218E-02
162.82	6.071E-02	7.006E-03
166.75	4.208E-02	5.318E-03
172.21	3.611E-02	5.392E-03
172.19	8.606E-02	1.050E-02
180.00	8.606E-02	1.050E-02

N14(D,HE3)C13 20.13 MEV. EX = 3.850

ID = 354 J = 5/2+

AVERAGE ENERGY = 3.8629+- 0.0040 THETA < 90
AVERAGE ENERGY = 3.9029+- 0.0044 THETA > 90
AVERAGE ENERGY = 3.8762+- 0.0041 ALL ANGLES
REACTION CROSS SECTION = 1.039E+00 +- 0.150E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.970E-01	6.751E-02
9.96	3.970E-01	6.751E-02
11.96	3.839E-01	1.441E-01
13.96	4.256E-01	9.604E-02
15.96	2.271E-01	5.342E-02
17.96	2.081E-01	4.710E-02
19.96	1.709E-01	3.343E-02
21.96	1.346E-01	2.030E-02
23.96	1.210E-01	1.852E-02
25.96	1.633E-01	2.062E-02
27.96	1.110E-01	2.187E-02
29.96	1.153E-01	1.315E-02
30.96	1.335E-01	1.552E-02
31.96	1.287E-01	1.687E-02
32.96	1.505E-01	1.630E-02
34.96	1.361E-01	2.331E-02
37.96	1.271E-01	1.858E-02
39.96	1.548E-01	1.648E-02
39.96	8.218E-02	1.291E-02
40.96	1.082E-01	1.967E-02
43.96	1.249E-01	2.310E-02
46.96	1.293E-01	1.533E-02
49.96	1.306E-01	1.457E-02
52.96	1.121E-01	1.251E-02
55.96	1.117E-01	1.325E-02
58.96	8.963E-02	1.073E-02
61.96	9.608E-02	1.197E-02
61.96	9.608E-02	1.197E-02
61.96	9.608E-02	1.197E-02
64.96	8.272E-02	9.183E-03
67.96	6.045E-02	8.381E-03
70.96	5.809E-02	9.040E-03
73.96	7.031E-02	8.290E-03
76.96	5.413E-02	7.220E-03
80.96	6.145E-02	8.692E-03
84.96	4.261E-02	5.925E-03
88.96	4.659E-02	1.034E-02
96.96	4.510E-02	6.596E-03
100.96	4.503E-02	7.275E-03
104.96	3.346E-02	9.090E-03
108.96	2.738E-02	4.894E-03
112.96	6.404E-02	6.234E-03
117.96	5.400E-02	8.662E-03
122.96	5.873E-02	5.970E-03
127.96	6.392E-02	5.918E-03
132.96	6.113E-02	5.361E-03
137.96	7.997E-02	6.175E-03
142.96	9.005E-02	1.035E-02
147.96	8.821E-02	9.018E-03
152.96	8.548E-02	7.716E-03
157.96	3.776E-02	4.357E-03
162.96	2.580E-02	3.260E-03
169.96	2.183E-02	3.259E-03
169.96	5.226E-02	6.374E-03
180.00	5.226E-02	6.374E-03

N14(D,HE3)C13 20.13 MEV. EX = 6.870

ID = 355 J = 5/2+

AVERAGE ENERGY = 6.8723+- 0.0016 THETA < 90

AVERAGE ENERGY = 6.8926+- 0.0108 THETA > 90

AVERAGE ENERGY = 6.8790+- 0.0039 ALL ANGLES

REACTION CROSS SECTION = 1.014E+00 +- 0.109E+00

INTEGRATION LENGTH = 2.753 + 0.110 + 0.279 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.692E-01	2.882E-02
12.55	1.692E-01	2.882E-02
15.07	1.592E-01	2.823E-02
17.57	1.611E-01	2.622E-02
20.03	1.543E-01	1.665E-02
22.53	1.502E-01	1.506E-02
25.07	1.409E-01	1.318E-02
27.57	1.101E-01	1.253E-02
30.05	1.187E-01	1.106E-02
32.53	1.068E-01	9.405E-03
35.00	1.075E-01	1.468E-02
37.46	9.602E-02	7.483E-03
38.68	8.693E-02	6.360E-03
39.91	7.682E-02	5.834E-03
41.13	7.873E-02	6.903E-03
43.57	6.173E-02	7.805E-03
47.21	6.535E-02	7.361E-03
49.63	6.016E-02	6.140E-02
49.45	5.576E-02	7.833E-03
50.82	5.806E-02	8.153E-03
54.41	7.073E-02	9.163E-03
57.97	4.316E-02	6.246E-03
61.61	7.020E-02	7.984E-03
65.00	5.046E-02	6.331E-03
65.00	5.046E-02	6.331E-03

ABCISSA	ORDINATE	ERROR
65.00	5.046E-02	6.331E-03
68.46	6.521E-02	8.182E-03
71.89	7.010E-02	8.241E-03
75.28	6.494E-02	7.790E-03
78.66	6.336E-02	6.990E-03
81.96	7.243E-02	6.070E-03
85.28	6.101E-02	7.273E-03
88.49	6.507E-02	5.867E-03
91.69	7.525E-02	6.584E-03
95.93	5.488E-02	7.175E-03
100.06	1.865E-02	3.895E-03
104.09	5.798E-02	7.339E-03
108.09	1.212E-01	9.946E-03
112.03	2.873E-02	5.541E-03
115.85	2.932E-02	5.762E-03
119.60	3.246E-02	5.941E-03
123.31	2.917E-02	5.340E-03
126.91	7.611E-02	7.076E-03
131.32	7.537E-02	8.097E-03
135.63	1.785E-01	1.197E-02
139.25	2.837E-01	1.385E-02
143.95	2.271E-01	1.119E-02
147.99	3.325E-02	4.276E-03
180.00	3.325E-02	4.276E-03

N14(D,HE3)C13 20.13 MEV. EX = 6.870 ID = 355 J = 5/2+

AVERAGE ENERGY = 6.8739+- 0.0019 THETA < 90
AVERAGE ENERGY = 6.8951+- 0.0145 THETA > 90
AVERAGE ENERGY = 6.8790+- 0.0039 ALL ANGLES
REACTION CROSS SECTION = 1.018E+00 +- 0.109E+00
INTEGRATION LENGTH = 2.688 + 0.087 + 0.367 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.673E-01	4.554E-02
9.96	2.673E-01	4.554E-02
11.96	2.509E-01	4.447E-02
13.96	2.528E-01	4.114E-02
15.96	2.411E-01	2.602E-02
17.96	2.336E-01	2.342E-02
19.96	2.180E-01	2.039E-02
21.96	1.695E-01	1.928E-02
23.96	1.816E-01	1.690E-02
25.96	1.622E-01	1.428E-02
27.96	1.621E-01	2.212E-02
29.96	1.436E-01	1.119E-02
30.96	1.295E-01	9.468E-03
31.96	1.139E-01	8.649E-03
32.96	1.163E-01	1.019E-02
34.96	9.032E-02	1.141E-02
37.96	9.566E-02	1.061E-02
39.96	8.589E-02	8.759E-03
39.96	7.913E-02	1.111E-02
40.96	8.241E-02	1.156E-02
43.96	9.871E-02	1.278E-02
46.96	5.914E-02	8.554E-03
49.96	9.441E-02	1.073E-02
52.96	6.650E-02	8.338E-03
52.96	6.650E-02	8.338E-03
52.96	6.650E-02	8.338E-03
55.96	8.415E-02	1.055E-02
58.96	8.849E-02	1.039E-02
61.96	8.013E-02	9.603E-03
64.96	7.636E-02	8.417E-03
67.96	8.517E-02	7.131E-03
70.96	6.998E-02	8.335E-03
73.96	7.271E-02	6.551E-03
76.96	8.190E-02	7.159E-03
80.96	5.761E-02	7.526E-03
84.96	1.887E-02	3.937E-03
88.96	5.651E-02	7.146E-03
92.96	1.138E-01	9.325E-03
96.96	2.594E-02	4.999E-03
100.96	2.549E-02	5.005E-03
104.96	2.717E-02	4.968E-03
108.96	2.351E-02	4.299E-03
112.96	5.913E-02	5.493E-03
117.96	5.601E-02	6.012E-03
122.96	1.271E-01	8.519E-03
127.96	1.939E-01	9.457E-03
132.96	1.495E-01	7.362E-03
137.96	2.116E-02	2.720E-03
180.00	2.116E-02	2.720E-03

N14(D,HE3)C13 20.13 MEV. EX = 7.580

ID = 356 J = 3/2+

AVERAGE ENERGY = 7.5670+- 0.0032 THETA < 90
AVERAGE ENERGY = 7.6096+- 0.0125 THETA > 90
AVERAGE ENERGY = 7.5791+- 0.0050 ALL ANGLES
REACTION CROSS SECTION = 4.253E+00 +- 0.250E+00
INTEGRATION LENGTH = 2.648 + 0.110 + 0.383 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.183E+00	7.909E-02
12.66	1.183E+00	7.909E-02
15.20	1.427E+00	8.768E-02
17.73	1.417E+00	7.901E-02
20.26	1.215E+00	4.849E-02
22.77	1.084E+00	4.206E-02
25.29	8.305E-01	3.300E-02
27.81	6.975E-01	3.216E-02
30.31	6.652E-01	2.687E-02
32.81	6.949E-01	2.488E-02
35.29	6.257E-01	3.572E-02
37.77	6.882E-01	2.110E-02
39.01	7.369E-01	1.988E-02
40.24	7.248E-01	1.931E-02
41.48	7.859E-01	2.307E-02
43.94	7.889E-01	2.848E-02
47.60	6.617E-01	2.405E-02
50.05	6.096E-01	2.032E-02
49.81	6.064E-01	2.648E-02
51.25	5.349E-01	2.517E-02
54.87	4.494E-01	2.338E-02
58.45	3.296E-01	1.748E-02
58.45	3.296E-01	1.748E-02
62.02	2.750E-01	1.593E-02
65.54	2.567E-01	1.443E-02
69.02	2.715E-01	1.682E-02
72.45	2.581E-01	1.594E-02
75.87	2.809E-01	1.633E-02
79.25	2.799E-01	1.491E-02
82.56	3.717E-01	1.423E-02
85.89	3.586E-01	1.799E-02
89.11	3.368E-01	1.378E-02
92.33	2.897E-01	1.324E-02
96.58	2.204E-01	1.457E-02
100.78	1.186E-01	9.919E-03
104.78	1.246E-01	1.084E-02
108.75	5.691E-02	6.791E-03
112.71	1.168E-01	1.128E-02
116.53	1.024E-01	1.087E-02
120.28	7.439E-02	9.072E-03
123.94	2.954E-02	5.406E-03
127.54	2.723E-01	1.383E-02
131.88	2.071E-01	1.371E-02
136.13	7.136E-02	7.569E-03
180.00	7.136E-02	7.569E-03

N14(D,HE3)C13 20.13 MEV. EX = 7.580 ID = 356 J = 3/2+

AVERAGE ENERGY = 7.5711+- 0.0040 THETA < 90
AVERAGE ENERGY = 7.5943+- 0.0275 THETA > 90
AVERAGE ENERGY = 7.5759+- 0.0065 ALL ANGLES
REACTION CROSS SECTION = 4.088E+00 +- 0.231E+00
INTEGRATION LENGTH = 2.601 + 0.087 + 0.454 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.902E+00	1.272E-01
9.96	1.902E+00	1.272E-01
11.96	2.384E+00	1.405E-01
13.96	2.263E+00	1.262E-01
15.96	1.932E+00	7.706E-02
17.96	1.714E+00	6.648E-02
19.96	1.306E+00	5.189E-02
21.96	1.091E+00	5.028E-02
23.96	1.034E+00	4.173E-02
25.96	1.072E+00	3.836E-02
27.96	9.579E-01	5.466E-02
29.96	1.045E+00	3.202E-02
30.96	1.114E+00	3.003E-02
31.96	1.091E+00	2.904E-02
32.96	1.178E+00	3.455E-02
34.96	1.141E+00	4.226E-02
37.96	9.673E-01	3.513E-02
39.96	8.821E-01	2.939E-02
39.96	8.706E-01	3.799E-02
40.96	7.693E-01	3.618E-02
43.96	6.352E-01	3.302E-02
46.96	4.572E-01	2.423E-02
49.96	3.741E-01	2.165E-02
49.96	3.741E-01	2.165E-02
49.96	3.741E-01	2.165E-02
52.96	3.420E-01	1.920E-02
55.96	3.538E-01	2.190E-02
58.96	3.286E-01	2.028E-02
61.96	3.492E-01	2.029E-02
64.96	3.396E-01	1.807E-02
67.96	4.395E-01	1.681E-02
70.96	4.131E-01	2.070E-02
73.96	3.776E-01	1.544E-02
76.96	3.160E-01	1.443E-02
80.96	2.315E-01	1.529E-02
84.96	1.198E-01	1.001E-02
88.96	1.211E-01	1.052E-02
92.96	5.317E-02	6.338E-03
96.96	1.048E-01	1.011E-02
100.96	8.828E-02	9.365E-03
104.96	6.162E-02	7.508E-03
108.96	2.352E-02	4.302E-03
112.96	2.086E-01	1.059E-02
117.96	1.516E-01	1.003E-02
122.96	4.999E-02	5.298E-03
127.96	1.046E-02	2.138E-03
180.00	1.046E-02	2.138E-03

N 4(D,HE3)C13 20.13 MEV. EX = 8.200

ID = 357 J = 3/2+

AVERAGE ENERGY = 8.2236+- 0.0034 THETA < 90

AVERAGE ENERGY = 8.2026+- 0.0101 THETA > 90

AVERAGE ENERGY = 8.2183+- 0.0040 ALL ANGLES

REACTION CROSS SECTION = 9.814E-01 +- 0.115E+00

INTEGRATION LENGTH = 2.577 + 0.112 + 0.453 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.586E-01	2.742E-02
12.78	1.586E-01	2.742E-02
15.33	1.346E-01	2.551E-02
17.88	1.435E-01	2.432E-02
20.44	9.596E-02	1.288E-02
22.98	8.626E-02	1.119E-02
25.54	7.626E-02	9.502E-03
28.07	6.552E-02	9.488E-03
30.59	7.955E-02	8.886E-03
33.11	6.313E-02	7.094E-03
35.63	9.450E-02	1.354E-02
38.12	6.428E-02	6.011E-03
39.36	6.400E-02	5.361E-03
40.61	5.221E-02	4.724E-03
41.85	8.855E-02	7.222E-03
44.34	4.851E-02	6.814E-03
48.04	5.584E-02	6.654E-03
50.49	9.555E-02	7.651E-03
50.24	4.372E-02	6.845E-03
51.71	6.981E-02	8.827E-03
55.36	5.859E-02	8.229E-03
55.36	5.859E-02	8.229E-03
58.94	5.443E-02	6.938E-03
62.51	4.667E-02	6.431E-03
66.06	4.712E-02	6.056E-03
69.58	4.999E-02	7.092E-03
73.09	5.284E-02	7.086E-03
76.50	7.401E-02	8.258E-03
79.91	7.759E-02	7.696E-03
83.24	8.449E-02	6.533E-03
86.57	1.014E-01	9.368E-03
89.83	1.635E-01	9.392E-03
93.03	1.454E-01	9.219E-03
97.26	1.190E-01	1.062E-02
101.39	5.611E-02	6.791E-03
105.42	8.337E-02	8.850E-03
109.44	6.608E-02	7.346E-03
113.26	6.143E-02	8.175E-03
117.14	4.474E-02	7.188E-03
120.87	5.524E-02	7.845E-03
124.54	4.085E-02	6.403E-03
128.05	4.371E-02	5.413E-03
180.00	4.371E-02	5.413E-03

N14(D,HE3)C13 20.13 MEV. EX = 8.200 ID = 357 J = 3/2+

AVERAGE ENERGY = 8.2225+- 0.0031 THETA < 90
AVERAGE ENERGY = 8.1945+- 0.0144 THETA > 90
AVERAGE ENERGY = 8.2183+- 0.0040 ALL ANGLES
REACTION CROSS SECTION = 1.015E+00 +- 0.120E+00
INTEGRATION LENGTH = 2.470 + 0.087 + 0.585 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.598E-01	4.489E-02
9.96	2.598E-01	4.489E-02
11.96	2.196E-01	4.160E-02
13.96	2.330E-01	3.949E-02
15.96	1.553E-01	2.083E-02
17.96	1.388E-01	1.800E-02
19.96	1.222E-01	1.522E-02
21.96	1.043E-01	1.510E-02
23.96	1.258E-01	1.404E-02
25.96	9.906E-02	1.113E-02
27.96	1.472E-01	2.108E-02
29.96	9.921E-02	9.272E-03
30.96	9.834E-02	8.233E-03
31.96	7.986E-02	7.221E-03
32.96	1.348E-01	1.099E-02
34.96	7.315E-02	1.027E-02
37.96	8.287E-02	9.868E-03
39.96	1.400E-01	1.122E-02
39.96	6.364E-02	9.958E-03
40.96	1.018E-01	1.287E-02
43.96	8.394E-02	1.178E-02
43.96	8.394E-02	1.178E-02
46.96	7.643E-02	9.735E-03
49.96	6.418E-02	8.837E-03
52.96	6.342E-02	8.143E-03
55.96	6.578E-02	9.323E-03
58.96	6.793E-02	9.101E-03
61.96	9.278E-02	1.034E-02
64.96	9.482E-02	9.396E-03
67.96	1.005E-01	7.765E-03
70.96	1.174E-01	1.083E-02
73.96	1.839E-01	1.056E-02
76.96	1.590E-01	1.007E-02
80.96	1.251E-01	1.115E-02
84.96	5.665E-02	6.849E-03
88.96	8.080E-02	8.568E-03
92.96	6.143E-02	6.822E-03
96.96	5.482E-02	7.288E-03
100.96	3.827E-02	6.143E-03
104.96	4.533E-02	6.433E-03
108.96	3.217E-02	5.037E-03
112.96	3.311E-02	4.097E-03
180.00	3.311E-02	4.097E-03

N14(D,HE3)C13 20.13 MEV. EX = 8.850

I_D = 358 J = 1/2

AVERAGE ENERGY = 8.8467+- 0.0044 THETA < 90
AVERAGE ENERGY = 8.8496+- 0.0077 THETA > 90
AVERAGE ENERGY = 8.8473+- 0.0038 ALL ANGLES
REACTION CROSS SECTION = 2.095E+00 +- 0.174E+00
INTEGRATION LENGTH = 2.419 + 0.180 + 0.542 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	6.917E-01	3.512E-02
20.66	6.917E-01	3.518E-02
23.23	5.932E-01	2.986E-02
25.79	5.020E-01	2.478E-02
28.35	4.702E-01	2.570E-02
30.90	4.639E-01	2.231E-02
33.45	4.292E-01	1.888E-02
35.98	4.074E-01	2.816E-02
38.50	4.242E-01	1.592E-02
39.75	4.317E-01	1.449E-02
41.01	4.381E-01	1.432E-02
42.25	4.533E-01	1.680E-02
44.76	4.390E-01	2.083E-02
48.46	3.775E-01	1.759E-02
50.99	1.551E-01	9.739E-03
50.69	3.721E-01	2.022E-02
52.16	3.203E-01	1.903E-02
55.82	2.564E-01	1.728E-02
55.82	2.564E-01	1.728E-02

STOP

ABCISSA	ORDINATE	ERROR
55.82	2.564E-01	1.728E-02
59.46	1.595E-01	1.189E-02
63.07	1.157E-01	1.012E-02
66.66	9.241E-02	8.463E-03
70.23	5.935E-02	7.691E-03
73.72	7.480E-02	8.406E-03
77.16	4.984E-02	6.741E-03
80.60	4.937E-02	6.103E-03
83.96	7.073E-02	5.951E-03
87.26	5.005E-02	6.542E-03
90.56	6.342E-02	5.768E-03
93.79	5.908E-02	5.810E-03
98.01	3.998E-02	6.118E-03
102.20	4.320E-02	5.959E-03
106.25	4.001E-02	6.123E-03
114.09	5.546E-02	7.800E-03
117.87	2.898E-02	5.808E-03
180.00	2.898E-02	5.808E-03

N14(D,HE3)C13 20.13 MEV. EX = 8.850 I_D = 358 J = 1/2

AVERAGE ENERGY = 8.8486+- 0.0039 THETA < 90
AVERAGE ENERGY = 8.8270+- 0.0061 THETA > 90
AVERAGE ENERGY = 8.8473+- 0.0038 ALL ANGLES
REACTION CROSS SECTION = 2.133E+00 +- 0.181E+00
INTEGRATION LENGTH = 2.313 + 0.139 + 0.690 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (L_AB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.143E+00	5.810E-02
15.96	1.143E+00	5.810E-02
17.96	9.745E-01	4.903E-02
19.96	8.198E-01	4.045E-02
21.96	7.631E-01	4.168E-02
23.96	7.795E-01	3.591E-02
25.96	6.862E-01	3.017E-02
27.96	6.459E-01	4.462E-02
29.96	6.664E-01	2.500E-02
30.96	6.750E-01	2.265E-02
31.96	6.816E-01	2.226E-02
32.96	7.015E-01	2.598E-02
34.96	6.729E-01	3.191E-02
37.96	5.685E-01	2.647E-02
38.96	2.313E-01	1.451E-02
39.96	5.496E-01	2.984E-02
40.96	4.738E-01	2.813E-02
43.96	3.721E-01	2.506E-02
43.96	3.721E-01	2.506E-02
43.96	3.721E-01	2.506E-02
46.96	2.269E-01	1.690E-02
49.96	1.611E-01	1.407E-02
52.96	1.258E-01	1.152E-02
55.96	7.896E-02	1.022E-02
58.96	9.707E-02	1.090E-02
61.96	6.302E-02	8.515E-03
64.96	6.078E-02	7.507E-03
67.96	8.468E-02	7.117E-03
70.96	5.821E-02	7.601E-03
73.96	7.163E-02	6.508E-03
76.96	6.474E-02	6.359E-03
80.96	4.204E-02	6.426E-03
84.96	4.354E-02	5.999E-03
88.96	3.863E-02	5.905E-03
96.96	4.908E-02	6.896E-03
100.96	2.455E-02	4.916E-03
180.00	2.455E-02	4.916E-03

STOP

*N14(D,HE3) 20.13 MEV. ID = TH
*TOTAL DIFFERENTIAL CROSS SECTION

AVERAGE ENERGY = 0.0000+- 0.0000 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.0000 THETA > 90
AVERAGE ENERGY = 0.0000+- 0.0000 ALL ANGLES
REACTION CROSS SECTION = 1.750E+01 +- 0.134E+01
INTEGRATION LENGTH = 2.906 + 0.087 + 0.149 = 3.142

$DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
 LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.771E+01	8.947E-01
8.96	1.771E+01	8.947E-01
11.96	1.777E+01	9.839E-01
13.96	1.447E+01	7.767E-01
15.96	1.159E+01	4.850E-01
17.96	8.418E+00	3.913E-01
19.96	5.487E+00	2.881E-01
21.96	4.007E+00	2.794E-01
23.96	3.494E+00	2.034E-01
25.96	3.576E+00	1.860E-01
27.96	3.779E+00	2.812E-01
29.96	4.114E+00	1.586E-01
30.96	4.218E+00	1.501E-01
31.96	4.195E+00	1.485E-01
32.96	3.694E+00	1.576E-01
34.96	4.083E+00	2.074E-01
37.96	3.175E+00	1.663E-01
40.96	2.433E+00	1.741E-01
43.96	1.859E+00	1.622E-01
46.96	1.233E+00	1.087E-01
49.96	1.098E+00	1.020E-01
52.96	9.829E-01	8.932E-02
52.96	9.829E-01	8.932E-02
55.96	1.025E+00	1.009E-01
58.96	1.072E+00	9.854E-02
61.96	1.003E+00	9.307E-02
64.96	9.657E-01	8.071E-02
67.96	1.065E+00	7.100E-02
70.96	9.923E-01	8.435E-02
73.96	1.016E+00	6.858E-02
76.96	8.854E-01	6.497E-02
80.96	6.805E-01	7.079E-02
88.96	4.896E-01	6.511E-02
92.96	3.383E-01	4.234E-02
96.96	3.785E-01	5.251E-02
117.96	3.765E-01	4.360E-02
122.96	3.610E-01	3.518E-02
127.96	3.908E-01	3.155E-02
132.96	3.332E-01	2.524E-02
137.96	2.174E-01	2.145E-02
142.96	2.531E-01	2.782E-02
147.96	2.716E-01	2.578E-02
157.96	1.928E-01	1.844E-02
162.96	1.644E-01	1.561E-02
180.00	1.644E-01	1.561E-02

APPENDIX A.6

$^{14}N(d,^{4}He)$ EX < 14 MeV

N14(D,HE4)C12 20.13 MEV.   EX = 00.000 ID = 401 J = 0+

AVERAGE ENERGY = -0.0191+- 0.0028 THETA < 90
AVERAGE ENERGY = -0.0308+- 0.0119 THETA > 90
AVERAGE ENERGY = -0.0255+- 0.0067 ALL ANGLES
REACTION CROSS SECTION = 7.011E-01 +- 0.902E-01
INTEGRATION LENGTH = 2.967 + 0.101 + 0.073 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.101E-01	4.232E-02
11.60	3.101E-01	4.232E-02
13.93	2.029E-01	3.440E-02
16.25	2.417E-01	3.466E-02
18.57	1.695E-01	1.990E-02
20.89	1.742E-01	1.746E-02
23.20	1.547E-01	1.485E-02
25.51	1.550E-01	1.600E-02
27.82	1.580E-01	1.371E-02
30.12	1.641E-01	1.253E-02
32.41	1.737E-01	2.001E-02
34.71	1.616E-01	1.043E-02
35.85	1.524E-01	9.047E-03
36.99	1.427E-01	8.540E-03
40.41	1.535E-01	1.312E-02
46.06	9.786E-02	8.327E-03
46.11	1.003E-01	1.113E-02
90.35	1.760E-02	4.089E-03
98.49	2.073E-02	4.329E-03
98.49	2.073E-02	4.329E-03

ABCISSA	ORDINATE	ERROR
98.49	2.073E-02	4.329E-03
102.48	2.771E-02	4.630E-03
106.42	2.226E-02	4.752E-03
110.31	1.479E-02	3.956E-03
114.16	9.987E-03	3.160E-03
117.96	7.071E-03	2.501E-03
126.36	1.131E-02	2.925E-03
130.94	1.755E-02	3.447E-03
135.46	2.988E-02	4.039E-03
139.91	3.012E-02	3.638E-03
144.32	3.075E-02	3.742E-03
148.68	2.399E-02	3.336E-03
152.99	2.477E-02	3.444E-03
157.26	1.561E-02	2.764E-03
161.51	2.004E-02	3.549E-03
165.73	3.956E-02	4.652E-03
171.61	4.435E-02	5.337E-03
171.62	1.771E-02	3.094E-03
180.00	1.771E-02	3.094E-03

N14(D,HE4)C12 20.13 MEV. EX = 4.430 ID = 402 J = 2+

AVERAGE ENERGY = 4.4231+- 0.0055 THETA < 90
AVERAGE ENERGY = 4.4139+- 0.0080 THETA > 90
AVERAGE ENERGY = 4.4190+- 0.0047 ALL ANGLES
REACTION CROSS SECTION = 4.305E+00 +- 0.256E+00
INTEGRATION LENGTH = 2.967 + 0.102 + 0.072 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.228E+00	1.205E-01
11.73	2.228E+00	1.205E-01
14.08	1.849E+00	1.054E-01
16.43	1.429E+00	8.503E-02
18.78	1.093E+00	4.881E-02
21.12	9.085E-01	4.070E-02
23.46	7.380E-01	3.299E-02
25.79	6.378E-01	3.273E-02
28.12	5.310E-01	2.536E-02
30.45	5.001E-01	2.212E-02
32.77	4.998E-01	3.390E-02
35.08	4.460E-01	1.757E-02
36.24	4.496E-01	1.587E-02
37.39	4.371E-01	1.529E-02
40.84	5.094E-01	2.418E-02
45.55	6.068E-01	2.129E-02
46.59	6.903E-01	2.976E-02
61.16	1.134E-01	9.901E-03
64.46	4.970E-01	2.390E-02
67.77	4.517E-01	2.204E-02
71.03	3.989E-01	2.016E-02
74.28	3.748E-01	1.779E-02
77.49	3.283E-01	1.354E-02
80.68	3.042E-01	1.677E-02
80.68	3.042E-01	1.677E-02

ABCISSA	ORDINATE	ERROR
80.68	3.042E-01	1.677E-02
83.85	2.767E-01	1.252E-02
86.99	2.988E-01	1.352E-02
91.10	2.694E-01	1.617E-02
99.25	1.752E-01	1.274E-02
103.23	1.600E-01	1.127E-02
107.17	1.241E-01	1.133E-02
111.06	1.086E-01	1.083E-02
114.89	8.370E-02	9.239E-03
118.68	1.279E-01	1.080E-02
122.42	1.471E-01	9.445E-03
127.03	1.510E-01	1.091E-02
131.57	1.526E-01	1.035E-02
136.05	1.269E-01	8.482E-03
140.47	1.134E-01	7.204E-03
144.82	1.204E-01	7.568E-03
149.13	1.605E-01	8.865E-03
153.39	1.953E-01	9.981E-03
157.61	2.259E-01	1.091E-02
161.79	2.194E-01	1.213E-02
165.95	1.716E-01	9.984E-03
171.74	9.158E-02	7.845E-03
171.75	1.295E-01	8.677E-03
180.00	1.295E-01	8.677E-03

N14(D,HE4)C12 20.13 MEV. EX = 00.000 ID = 401 J = 0+

AVERAGE ENERGY = -0.0244+- 0.0069 THETA < 90
AVERAGE ENERGY = -0.0266+- 0.0116 THETA > 90
AVERAGE ENERGY = -0.0255+- 0.0067 ALL ANGLES
REACTION CROSS SECTION = 7.065E-01 +- 0.905E-01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.194E-01	5.724E-02
9.96	4.194E-01	5.724E-02
11.96	2.739E-01	4.644E-02
13.96	3.255E-01	4.667E-02
15.96	2.545E-01	2.671E-02
17.96	2.332E-01	2.337E-02
19.96	2.063E-01	1.981E-02
21.96	2.060E-01	2.126E-02
23.96	2.091E-01	1.814E-02
25.96	2.162E-01	1.651E-02
27.96	2.277E-01	2.623E-02
29.96	2.108E-01	1.359E-02
30.96	1.982E-01	1.176E-02
31.96	1.851E-01	1.107E-02
34.96	1.960E-01	1.686E-02
39.96	1.237E-01	1.052E-02
39.96	1.270E-01	1.409E-02
80.96	1.850E-02	4.246E-03
88.96	2.056E-02	4.292E-03
88.96	2.056E-02	4.292E-03
88.96	2.056E-02	4.292E-03
92.96	2.686E-02	4.484E-03
96.96	2.107E-02	4.495E-03
100.96	1.367E-02	3.656E-03
104.96	9.022E-03	2.853E-03
108.96	6.244E-03	2.208E-03
117.96	9.505E-03	2.456E-03
122.96	1.437E-02	2.820E-03
127.96	2.385E-02	3.223E-03
132.96	2.349E-02	2.837E-03
137.96	2.347E-02	2.855E-03
142.96	1.795E-02	2.496E-03
147.96	1.822E-02	2.532E-03
152.96	1.131E-02	2.003E-03
157.96	1.434E-02	2.539E-03
162.96	2.802E-02	3.294E-03
169.96	3.108E-02	3.739E-03
169.96	1.237E-02	2.160E-03
180.00	1.237E-02	2.160E-03

N14(D,HE4)C12 20.13 MEV. EX = 4.430 ID = 402 J = 2+

AVERAGE ENERGY = 4.4197+- 0.0063 THETA < 90
AVERAGE ENERGY = 4.4181+- 0.0070 THETA > 90
AVERAGE ENERGY = 4.4190+- 0.0047 ALL ANGLES
REACTION CROSS SECTION = 4.308E+00 +- 0.256E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.081E+00	1.666E-01
9.96	3.081E+00	1.666E-01
11.96	2.551E+00	1.454E-01
13.96	1.966E+00	1.170E-01
15.96	1.500E+00	6.696E-02
17.96	1.242E+00	5.564E-02
19.96	1.006E+00	4.494E-02
21.96	8.654E-01	4.440E-02
23.96	7.173E-01	3.425E-02
25.96	6.722E-01	2.973E-02
27.96	6.683E-01	4.532E-02
29.96	5.931E-01	2.336E-02
31.96	5.962E-01	2.104E-02
33.96	5.777E-01	2.020E-02
35.96	6.669E-01	3.164E-02
39.96	7.804E-01	2.736E-02
43.96	8.891E-01	3.831E-02
50.96	1.379E-01	1.204E-02
55.96	5.957E-01	2.863E-02
58.96	5.334E-01	2.601E-02
61.96	4.637E-01	2.342E-02
64.96	4.286E-01	2.034E-02
67.96	3.692E-01	1.522E-02
70.96	3.362E-01	1.852E-02
70.96	3.362E-01	1.852E-02

ABCISSA	ORDINATE	ERROR
70.96	3.362E-01	1.852E-02
73.96	3.006E-01	1.359E-02
76.96	3.188E-01	1.442E-02
80.96	2.804E-01	1.682E-02
88.96	1.735E-01	1.260E-02
92.96	1.545E-01	1.087E-02
96.96	1.168E-01	1.066E-02
100.96	9.965E-02	9.928E-03
104.96	7.490E-02	8.262E-03
108.96	1.116E-01	9.421E-03
112.96	1.253E-01	8.042E-03
117.96	1.249E-01	9.017E-03
122.96	1.227E-01	8.319E-03
127.96	9.933E-02	6.634E-03
132.96	8.651E-02	5.494E-03
137.96	8.977E-02	5.639E-03
142.96	1.171E-01	6.467E-03
147.96	1.398E-01	7.144E-03
152.96	1.591E-01	7.683E-03
157.96	1.524E-01	8.423E-03
162.96	1.179E-01	6.858E-03
169.96	6.218E-02	5.326E-03
169.96	8.773E-02	5.875E-03
180.00	8.773E-02	5.875E-03

N14(D,HE4)C12 20.13 MEV. EX = 7.660 ID = 403 J = 0+

AVERAGE ENERGY = 7.6223+- 0.0090 THETA < 90
AVERAGE ENERGY = 7.6542+- 0.0058 THETA > 90
AVERAGE ENERGY = 7.6341+- 0.0065 ALL ANGLES
REACTION CROSS SECTION = 2.318E-01 +- 0.513E-01
INTEGRATION LENGTH = 2.967 + 0.103 + 0.071 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.244E-01	2.608E-02
11.85	1.244E-01	2.608E-02
14.22	3.895E-02	1.473E-02
16.59	4.737E-02	1.499E-02
18.96	2.572E-02	7.141E-03
21.33	1.657E-02	5.245E-03
23.69	9.462E-03	3.578E-03
26.05	1.099E-02	4.154E-03
28.39	1.240E-02	3.740E-03
30.74	2.167E-02	4.430E-03
33.08	2.423E-02	7.310E-03
35.41	1.704E-02	3.284E-03
36.59	1.957E-02	3.140E-03
37.75	2.486E-02	3.457E-03
38.89	1.773E-02	3.417E-03
41.21	1.797E-02	4.642E-03
41.23	2.259E-02	4.934E-03
44.67	1.417E-02	3.545E-03
46.98	1.354E-02	3.031E-03
47.02	8.296E-03	3.137E-03
46.12	7.445E-03	3.041E-03
51.57	1.023E-02	3.617E-03
54.95	1.165E-02	3.366E-03
58.33	1.935E-02	4.331E-03
61.69	1.938E-02	4.047E-03
65.02	1.641E-02	4.470E-03
68.35	9.130E-03	3.045E-03
68.35	9.130E-03	3.045E-03
68.35	9.130E-03	3.045E-03
71.64	9.741E-03	3.082E-03
74.90	7.168E-03	2.390E-03
78.12	5.695E-03	1.718E-03
81.33	1.327E-02	3.429E-03
84.51	1.383E-02	2.716E-03
87.66	1.033E-02	2.438E-03
99.94	9.049E-03	2.864E-03
103.92	9.309E-03	2.689E-03
107.85	1.637E-02	4.097E-03
111.73	2.359E-02	5.038E-03
115.55	2.137E-02	4.670E-03
119.32	2.531E-02	4.793E-03
123.05	1.780E-02	3.257E-03
127.64	1.322E-02	3.211E-03
132.14	6.990E-03	2.212E-03
136.59	1.525E-02	2.938E-03
140.96	2.232E-02	3.196E-03
145.28	2.510E-02	3.457E-03
149.54	2.374E-02	3.401E-03
153.75	2.208E-02	3.337E-03
157.91	1.494E-02	2.779E-03
162.05	1.990E-02	3.639E-03
166.15	3.679E-02	4.618E-03
171.86	4.109E-02	5.292E-03
171.87	5.639E-02	5.727E-03
180.00	5.639E-02	5.727E-03

N14(D,HE4)C12 20.13 MEV. EX = 7.660 ID = 403 J = 0+

AVERAGE ENERGY = 7.6241+- 0.0089 THETA < 90
AVERAGE ENERGY = 7.6526+- 0.0060 THETA > 90
AVERAGE ENERGY = 7.6341+- 0.0065 ALL ANGLES
REACTION CROSS SECTION = 2.318E-01 +- 0.513E-01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.754E-01	3.676E-02
9.96	1.754E-01	3.676E-02
11.96	5.479E-02	2.072E-02
13.96	6.644E-02	2.102E-02
15.96	3.598E-02	9.986E-03
17.96	2.310E-02	7.308E-03
19.96	1.313E-02	4.965E-03
21.96	1.518E-02	5.740E-03
23.96	1.704E-02	5.141E-03
25.96	2.066E-02	6.061E-03
27.96	3.297E-02	9.944E-03
29.96	2.305E-02	4.440E-03
30.96	2.639E-02	4.234E-03
31.96	3.342E-02	4.646E-03
32.96	2.374E-02	4.573E-03
34.96	2.389E-02	6.170E-03
34.96	3.006E-02	6.564E-03
37.96	1.863E-02	4.660E-03
39.96	1.768E-02	3.955E-03
39.96	1.084E-02	4.099E-03
40.96	9.678E-03	3.951E-03
43.96	1.314E-02	4.645E-03
46.96	1.476E-02	4.261E-03
49.96	2.416E-02	5.406E-03
52.96	2.385E-02	4.977E-03
55.96	2.231E-02	5.413E-03
58.96	1.089E-02	3.629E-03
58.96	1.089E-02	3.629E-03

ABCISSA	ORDINATE	ERROR
58.96	1.089E-02	3.629E-03
61.96	1.142E-02	3.612E-03
64.96	8.262E-03	2.754E-03
67.96	6.447E-03	1.944E-03
70.96	1.475E-02	3.809E-03
73.96	1.509E-02	2.962E-03
76.96	1.106E-02	2.607E-03
88.96	8.945E-03	2.829E-03
92.96	8.956E-03	2.586E-03
96.96	1.533E-02	3.833E-03
100.96	2.150E-02	4.588E-03
104.96	1.896E-02	4.140E-03
108.96	2.187E-02	4.138E-03
112.96	1.498E-02	2.739E-03
117.96	1.078E-02	2.616E-03
122.96	5.529E-03	1.748E-03
127.96	1.171E-02	2.256E-03
132.96	1.669E-02	2.390E-03
137.96	1.831E-02	2.520E-03
142.96	1.693E-02	2.424E-03
147.96	1.543E-02	2.330E-03
152.96	1.026E-02	1.908E-03
157.96	1.345E-02	2.460E-03
162.96	2.458E-02	3.085E-03
169.96	2.710E-02	3.491E-03
169.96	3.713E-02	3.771E-03
180.00	3.713E-02	3.771E-03

N14(D,HE4)C12 20.13 MEV. EX = 9.640 ID = 404 J = 3-

AVERAGE ENERGY = 9.6203+- 0.0055 THETA < 90
AVERAGE ENERGY = 9.6112+- 0.0047 THETA > 90
AVERAGE ENERGY = 9.6168+- 0.0039 ALL ANGLES
REACTION CROSS SECTION = 1.647E+00 +- 0.145E+00
INTEGRATION LENGTH = 2.967 + 0.104 + 0.070 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.561E-01	4.065E-02
11.93	2.561E-01	4.065E-02
14.32	4.226E-01	4.881E-02
16.71	3.830E-01	4.359E-02
19.10	3.767E-01	2.758E-02
21.48	3.090E-01	2.302E-02
23.86	3.174E-01	2.094E-02
26.23	2.649E-01	2.053E-02
28.60	2.446E-01	1.704E-02
30.96	2.345E-01	1.479E-02
33.31	1.805E-01	1.991E-02
35.66	1.870E-01	1.105E-02
36.84	1.978E-01	1.042E-02
38.01	1.861E-01	9.867E-03
39.17	1.771E-01	1.095E-02
41.50	1.965E-01	1.542E-02
41.51	1.999E-01	1.476E-02
44.98	1.646E-01	1.215E-02
47.30	1.453E-01	1.052E-02
47.33	1.501E-01	1.337E-02
48.44	1.645E-01	1.436E-02
51.90	1.329E-01	1.304E-02
55.31	1.500E-01	1.245E-02
58.71	1.409E-01	1.172E-02
62.08	1.170E-01	9.999E-03
65.44	1.053E-01	1.070E-02
68.78	9.771E-02	9.975E-03
68.78	9.771E-02	9.975E-03
72.07	7.648E-02	8.850E-03
75.34	8.793E-02	8.398E-03
78.58	7.317E-02	6.211E-03
81.79	8.812E-02	8.863E-03
84.98	9.016E-02	6.984E-03
88.14	9.679E-02	7.609E-03
92.27	8.492E-02	8.955E-03
100.43	9.516E-02	9.738E-03
104.41	8.635E-02	8.293E-03
108.34	9.144E-02	9.750E-03
112.20	8.302E-02	9.571E-03
116.04	1.045E-01	1.047E-02
119.80	9.296E-02	9.663E-03
123.51	1.018E-01	7.924E-03
128.06	1.045E-01	9.185E-03
132.56	1.337E-01	1.044E-02
136.97	1.225E-01	8.539E-03
141.32	1.285E-01	8.295E-03
145.60	1.294E-01	8.682E-03
149.83	1.464E-01	8.754E-03
154.01	1.707E-01	9.520E-03
158.14	1.497E-01	9.731E-03
162.23	1.386E-01	1.001E-02
166.29	1.449E-01	9.386E-03
171.94	1.079E-01	9.396E-03
171.95	1.156E-01	8.550E-03
180.00	1.156E-01	8.550E-03

N14(D,HE4)C12 20.13 MEV. EX = 9.640 ID = 404 J = 3-

AVERAGE ENERGY = 9.6197+- 0.0053 THETA < 90
AVERAGE ENERGY = 9.6115+- 0.0049 THETA > 90
AVERAGE ENERGY = 9.6168+- 0.0039 ALL ANGLES
REACTION CROSS SECTION = 1.647E+00 +- 0.145E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.661E-01	5.810E-02
9.96	3.661E-01	5.810E-02
11.96	6.028E-01	6.960E-02
13.96	5.448E-01	6.200E-02
15.96	5.342E-01	3.909E-02
17.96	4.366E-01	3.252E-02
19.96	4.466E-01	2.946E-02
21.96	3.710E-01	2.875E-02
23.96	3.409E-01	2.374E-02
25.96	3.251E-01	2.050E-02
27.96	2.488E-01	2.743E-02
29.96	2.561E-01	1.513E-02
30.96	2.701E-01	1.422E-02
31.96	2.533E-01	1.342E-02
32.96	2.401E-01	1.484E-02
34.96	2.644E-01	2.074E-02
34.96	2.691E-01	1.987E-02
37.96	2.190E-01	1.616E-02
39.96	1.918E-01	1.388E-02
39.96	1.983E-01	1.765E-02
40.96	2.162E-01	1.887E-02
43.96	1.724E-01	1.691E-02
46.96	1.919E-01	1.592E-02
49.96	1.776E-01	1.476E-02
52.96	1.452E-01	1.240E-02
55.96	1.286E-01	1.305E-02
58.96	1.174E-01	1.197E-02
58.96	1.174E-01	1.197E-02

ABCISSA	ORDINATE	ERROR
61.96	9.026E-02	1.044E-02
64.96	1.019E-01	9.728E-03
67.96	8.324E-02	7.061E-03
70.96	9.835E-02	9.885E-03
73.96	9.867E-02	7.638E-03
76.96	1.038E-01	8.157E-03
80.96	8.864E-02	9.341E-03
88.96	9.394E-02	9.606E-03
92.96	8.286E-02	7.951E-03
96.96	8.528E-02	9.087E-03
100.96	7.526E-02	8.671E-03
104.96	9.209E-02	9.220E-03
108.96	7.967E-02	8.277E-03
112.96	8.490E-02	6.605E-03
117.96	8.434E-02	7.407E-03
122.96	1.045E-01	8.152E-03
127.96	9.287E-02	6.472E-03
132.96	9.474E-02	6.111E-03
137.96	9.293E-02	6.231E-03
142.96	1.026E-01	6.134E-03
147.96	1.171E-01	6.531E-03
152.96	1.009E-01	6.553E-03
157.96	9.195E-02	6.635E-03
162.96	9.489E-02	6.147E-03
169.96	6.978E-02	6.075E-03
169.96	7.465E-02	5.520E-03
180.00	7.465E-02	5.520E-03

N14(D,αE4)C12 20.13 MEV. EX = 10.100 ID = 405 J = 0+

AVERAGE ENERGY = 10.1418+- 0.0036 THETA < 90
AVERAGE ENERGY = 10.1500+- 0.0075 THETA > 90
AVERAGE ENERGY = 10.1449+- 0.0037 ALL ANGLES
REACTION CROSS SECTION = 5.158E-01 +- 0.819E-01
INTEGRATION LENGTH = 2.967 + 0.104 + 0.070 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.222E-01	3.016E-02
11.96	1.222E-01	3.016E-02
14.35	9.840E-02	2.386E-02
16.75	1.256E-01	2.596E-02
19.14	7.778E-02	1.249E-02
21.52	8.470E-02	1.223E-02
23.90	7.708E-02	1.025E-02
26.28	7.564E-02	1.095E-02
28.65	5.207E-02	8.311E-03
31.02	4.067E-02	6.299E-03
33.38	4.335E-02	9.705E-03
35.73	5.466E-02	5.986E-03
36.91	4.199E-02	5.200E-03
38.08	3.861E-02	4.887E-03
39.25	4.977E-02	5.840E-03
41.58	6.841E-02	9.085E-03
41.59	4.557E-02	7.046E-03
43.07	6.195E-02	7.431E-03
47.38	4.006E-02	6.169E-03
47.41	5.612E-02	8.123E-03
48.54	5.017E-02	7.947E-03
51.99	4.797E-02	7.798E-03
55.43	4.218E-02	6.993E-03
58.82	4.303E-02	6.430E-03
62.21	3.001E-02	5.089E-03
65.57	3.002E-02	5.682E-03
68.88	3.721E-02	6.130E-03
68.88	3.721E-02	6.130E-03
72.20	2.609E-02	5.386E-03
75.47	2.135E-02	4.116E-03
78.72	1.955E-02	3.220E-03
81.93	2.113E-02	4.318E-03
85.12	2.385E-02	3.564E-03
88.27	2.805E-02	4.179E-03
92.42	2.146E-02	4.481E-03
100.55	2.629E-02	5.597E-03
104.56	2.803E-02	4.747E-03
108.46	2.365E-02	4.940E-03
112.36	2.052E-02	4.836E-03
116.18	2.258E-02	4.930E-03
119.93	3.471E-02	6.276E-03
123.64	3.062E-02	4.345E-03
128.20	3.864E-02	5.595E-03
132.66	3.833E-02	6.320E-03
137.08	4.080E-02	4.993E-03
141.42	3.854E-02	5.080E-03
145.70	5.222E-02	6.082E-03
149.92	4.609E-02	5.027E-03
154.08	5.445E-02	5.344E-03
158.21	6.820E-02	7.090E-03
162.28	8.571E-02	7.959E-03
166.34	1.034E-01	7.926E-03
171.97	1.321E-01	1.280E-02
171.98	8.366E-02	8.842E-03
180.00	8.366E-02	8.842E-03

N14(D,HE4)C12 20.13 MEV. EX = 10.100 ID = 405 J = 0+

AVERAGE ENERGY = 10.1428+- 0.0043 THETA < 90
AVERAGE ENERGY = 10.1532+- 0.0078 THETA > 90
AVERAGE ENERGY = 10.1464+- 0.0040 ALL ANGLES
REACTION CROSS SECTION = 5.545E-01 +- 0.839E-01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.754E-01	4.330E-02
9.96	1.754E-01	4.330E-02
11.96	1.409E-01	3.417E-02
13.96	1.794E-01	3.706E-02
15.96	1.107E-01	1.777E-02
17.96	1.201E-01	1.734E-02
19.96	1.088E-01	1.446E-02
21.96	1.063E-01	1.538E-02
23.96	7.283E-02	1.162E-02
25.96	5.686E-02	8.759E-03
27.96	5.996E-02	1.342E-02
29.96	7.512E-02	8.224E-03
30.96	5.753E-02	7.122E-03
31.96	5.271E-02	6.670E-03
32.96	6.771E-02	7.942E-03
34.96	9.238E-02	1.226E-02
34.96	6.155E-02	9.513E-03
37.96	8.270E-02	9.915E-03
39.96	5.304E-02	8.163E-03
39.96	7.437E-02	1.076E-02
40.96	6.614E-02	1.047E-02
43.96	6.241E-02	1.014E-02
46.96	5.412E-02	8.968E-03
49.96	5.437E-02	8.121E-03
52.96	3.734E-02	6.318E-03
55.96	3.675E-02	6.952E-03
58.96	4.477E-02	7.371E-03
58.96	4.477E-02	7.371E-03

ABCISSA	ORDINATE	ERROR
61.96	3.085E-02	6.364E-03
64.96	2.479E-02	4.775E-03
67.96	2.228E-02	3.666E-03
70.96	2.360E-02	4.822E-03
73.96	2.612E-02	3.901E-03
76.96	3.011E-02	4.482E-03
84.96	8.020E-02	8.147E-03
88.96	2.595E-02	5.519E-03
92.96	2.687E-02	4.548E-03
96.96	2.204E-02	4.599E-03
100.96	1.857E-02	4.374E-03
104.96	1.986E-02	4.333E-03
108.96	2.968E-02	5.363E-03
112.96	2.547E-02	3.612E-03
117.96	3.108E-02	4.498E-03
122.96	2.986E-02	4.922E-03
127.96	3.081E-02	3.769E-03
132.96	2.829E-02	3.727E-03
137.96	3.731E-02	4.344E-03
142.96	3.214E-02	3.505E-03
147.96	3.717E-02	3.647E-03
152.96	4.565E-02	4.745E-03
157.96	5.652E-02	5.247E-03
162.96	6.724E-02	5.155E-03
169.96	8.490E-02	8.222E-03
169.96	5.365E-02	5.670E-03
180.00	5.365E-02	5.670E-03

N14(D,HE4)C12 20.13 MEV. EX = 10.840 ID = 406 J = 1-

AVERAGE ENERGY = 10.8472+- 0.0030 THETA < 90
AVERAGE ENERGY = 10.8562+- 0.0050 THETA > 90
AVERAGE ENERGY = 10.8506+- 0.0028 ALL ANGLES
REACTION CROSS SECTION = 9.596E-01 +- 0.109E+00
INTEGRATION LENGTH = 2.967 + 0.105 + 0.070 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.013E-01	4.041E-02
11.39	3.013E-01	4.041E-02
14.39	2.718E-01	3.861E-02
16.79	2.684E-01	3.541E-02
19.19	2.282E-01	2.119E-02
21.58	1.912E-01	1.775E-02
23.97	1.705E-01	1.514E-02
26.35	1.259E-01	1.397E-02
28.73	1.389E-01	1.247E-02
31.10	1.114E-01	9.997E-03
33.47	1.186E-01	1.604E-02
35.83	8.777E-02	7.425E-03
37.01	9.342E-02	6.849E-03
38.18	9.839E-02	6.869E-03
39.36	9.006E-02	7.668E-03
41.70	8.215E-02	9.853E-03
41.70	8.441E-02	9.477E-03
45.19	9.816E-02	9.290E-03
47.51	4.986E-02	5.779E-03
47.54	7.801E-02	9.567E-03
48.67	7.554E-02	9.625E-03
52.14	5.908E-02	8.639E-03
53.56	7.737E-02	8.635E-03
58.98	5.906E-02	7.526E-03
62.36	6.066E-02	7.128E-03
65.73	5.345E-02	7.579E-03
68.06	5.415E-02	7.392E-03
69.06	5.415E-02	7.392E-03

ABCISSA	ORDINATE	ERROR
72.37	6.074E-02	7.674E-03
75.65	5.130E-02	6.387E-03
78.90	5.239E-02	5.218E-03
82.11	4.307E-02	6.170E-03
85.31	4.658E-02	4.991E-03
88.47	4.118E-02	4.874E-03
92.62	4.477E-02	6.482E-03
100.77	4.174E-02	6.173E-03
104.76	4.911E-02	6.213E-03
108.70	4.740E-02	7.011E-03
112.56	4.113E-02	6.690E-03
116.36	4.014E-02	6.444E-03
120.12	5.223E-02	6.946E-03
123.82	5.484E-02	5.786E-03
128.38	4.673E-02	6.110E-03
132.84	7.422E-02	7.315E-03
137.24	7.626E-02	6.682E-03
141.57	8.455E-02	6.343E-03
145.83	8.274E-02	6.403E-03
150.04	7.684E-02	6.243E-03
154.19	9.731E-02	7.170E-03
158.29	9.852E-02	7.319E-03
162.36	1.338E-01	9.689E-03
166.40	1.506E-01	9.629E-03
172.00	1.528E-01	1.162E-02
172.01	1.622E-01	1.068E-02
180.00	1.622E-01	1.068E-02

N14(D,HE4)C12 20.13 MEV. EX = 10.840 ID = 406 J = 1-

AVERAGE ENERGY = 10.8471+- 0.0029 THETA < 90
AVERAGE ENERGY = 10.8573+- 0.0053 THETA > 90
AVERAGE ENERGY = 10.8506+- 0.0028 ALL ANGLES
REACTION CROSS SECTION = 9.595E-01 +- 0.109E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.348E-01	5.832E-02
9.96	4.348E-01	5.832E-02
11.96	3.914E-01	5.560E-02
13.96	3.854E-01	5.083E-02
15.96	3.266E-01	3.033E-02
17.96	2.726E-01	2.531E-02
19.96	2.421E-01	2.149E-02
21.96	1.779E-01	1.974E-02
23.96	1.953E-01	1.752E-02
25.96	1.557E-01	1.397E-02
27.96	1.649E-01	2.230E-02
29.96	1.212E-01	1.025E-02
30.96	1.286E-01	9.425E-03
31.96	1.350E-01	9.420E-03
32.96	1.231E-01	1.048E-02
34.96	1.115E-01	1.337E-02
34.96	1.145E-01	1.285E-02
37.96	1.316E-01	1.245E-02
39.96	6.630E-02	7.681E-03
39.96	1.038E-01	1.273E-02
40.96	1.000E-01	1.274E-02
43.96	7.720E-02	1.128E-02
46.96	9.964E-02	1.111E-02
49.96	7.492E-02	9.541E-03
52.96	7.573E-02	8.893E-03
55.96	6.563E-02	9.301E-03
58.96	6.534E-02	8.913E-03
58.96	6.534E-02	8.913E-03
61.96	7.199E-02	9.089E-03
64.96	5.968E-02	7.425E-03
67.96	5.980E-02	5.951E-03
70.96	4.819E-02	6.900E-03
73.96	5.108E-02	5.470E-03
76.96	4.424E-02	5.233E-03
80.96	4.676E-02	6.766E-03
88.96	4.116E-02	6.082E-03
92.96	4.703E-02	5.946E-03
96.96	4.408E-02	6.515E-03
100.96	3.715E-02	6.037E-03
104.96	3.521E-02	5.650E-03
108.96	4.453E-02	5.918E-03
112.96	4.545E-02	4.793E-03
117.96	3.742E-02	4.890E-03
122.96	5.752E-02	5.667E-03
127.96	5.729E-02	5.018E-03
132.96	6.169E-02	4.626E-03
137.96	5.874E-02	4.544E-03
142.96	5.323E-02	4.323E-03
147.96	6.594E-02	4.857E-03
152.96	6.548E-02	4.863E-03
157.96	8.748E-02	6.336E-03
162.96	9.721E-02	6.213E-03
169.96	9.735E-02	7.405E-03
169.96	1.032E-01	6.789E-03
180.00	1.032E-01	6.789E-03

N14(D,HE4)C12 20.13 MEV. EX = 11.830 ID = 407 J = 1-

AVERAGE ENERGY = 11.8458+- 0.0033 THETA < 90
AVERAGE ENERGY = 11.8558+- 0.0032 THETA > 90
AVERAGE ENERGY = 11.8497+- 0.0024 ALL ANGLES
REACTION CROSS SECTION = 1.481E+00 +- 0.135E+00
INTEGRATION LENGTH = 2.967 + 0.105 + 0.069 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.410E-01	3.590E-02
12.04	2.410E-01	3.590E-02
14.46	2.102E-01	3.378E-02
16.86	1.836E-01	2.912E-02
19.27	2.091E-01	2.019E-02
21.67	1.896E-01	1.761E-02
24.07	1.443E-01	1.386E-02
26.46	1.798E-01	1.667E-02
28.86	1.695E-01	1.374E-02
31.23	1.649E-01	1.216E-02
33.61	1.605E-01	1.862E-02
35.98	1.429E-01	9.489E-03
37.17	1.484E-01	8.652E-03
38.34	1.340E-01	8.021E-03
39.52	1.514E-01	9.957E-03
41.87	1.446E-01	1.306E-02
41.87	1.257E-01	1.155E-02
45.38	1.260E-01	1.051E-02
47.71	9.773E-02	8.092E-03
47.72	1.099E-01	1.134E-02
48.87	1.429E-01	1.323E-02
52.34	1.100E-01	1.178E-02
55.79	1.244E-01	1.095E-02
59.20	1.137E-01	1.045E-02
62.60	1.166E-01	9.893E-03
65.97	1.117E-01	1.097E-02
69.32	1.118E-01	1.063E-02
72.63	8.932E-02	9.302E-03
72.63	8.932E-02	9.302E-03
72.63	8.932E-02	9.302E-03
75.92	8.811E-02	8.379E-03
79.18	8.913E-02	6.824E-03
82.41	1.026E-01	9.549E-03
85.60	6.974E-02	6.118E-03
88.77	9.883E-02	7.593E-03
92.92	8.110E-02	8.745E-03
97.03	5.161E-02	6.478E-03
101.07	9.355E-02	9.281E-03
105.05	7.965E-02	7.940E-03
108.98	9.194E-02	9.804E-03
112.85	9.557E-02	1.025E-02
116.66	6.615E-02	8.305E-03
120.40	7.644E-02	8.438E-03
124.10	9.577E-02	7.705E-03
128.63	1.092E-01	9.423E-03
133.10	7.983E-02	7.619E-03
137.48	1.113E-01	8.132E-03
141.79	1.245E-01	7.766E-03
146.04	1.249E-01	7.942E-03
150.22	1.685E-01	9.381E-03
154.35	1.969E-01	1.036E-02
158.43	1.989E-01	1.057E-02
162.47	2.035E-01	1.210E-02
166.48	2.280E-01	1.202E-02
172.06	2.461E-01	1.364E-02
172.06	2.802E-01	1.358E-02
180.00	2.802E-01	1.358E-02

N14(D,HE4)C12 20.13 MEV. EX = 11.830 ID = 407 J = 1-

AVERAGE ENERGY = 11.8468+- 0.0031 THETA < 90
AVERAGE ENERGY = 11.8554+- 0.0035 THETA > 90
AVERAGE ENERGY = 11.8497+- 0.0024 ALL ANGLES
REACTION CROSS SECTION = 1.481E+00 +- 0.135E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.509E-01	5.226E-02
9.96	3.509E-01	5.226E-02
11.96	3.053E-01	4.906E-02
13.96	2.658E-01	4.216E-02
15.96	3.017E-01	2.913E-02
17.96	2.726E-01	2.531E-02
19.96	2.064E-01	1.982E-02
21.96	2.560E-01	2.374E-02
23.96	2.402E-01	1.947E-02
25.96	2.324E-01	1.713E-02
27.96	2.249E-01	2.607E-02
29.96	1.989E-01	1.320E-02
30.96	2.058E-01	1.200E-02
31.96	1.851E-01	1.108E-02
32.96	2.084E-01	1.370E-02
34.96	1.975E-01	1.784E-02
34.96	1.718E-01	1.578E-02
37.96	1.701E-01	1.418E-02
39.96	1.308E-01	1.083E-02
39.96	1.472E-01	1.518E-02
40.96	1.904E-01	1.763E-02
43.96	1.445E-01	1.547E-02
46.96	1.612E-01	1.417E-02
49.96	1.450E-01	1.332E-02
52.96	1.463E-01	1.241E-02
55.96	1.378E-01	1.352E-02
58.96	1.355E-01	1.288E-02
61.96	1.063E-01	1.106E-02
61.96	1.063E-01	1.106E-02
61.96	1.063E-01	1.106E-02
64.96	1.028E-01	9.774E-03
67.96	1.020E-01	7.805E-03
70.96	1.151E-01	1.070E-02
73.96	7.663E-02	6.717E-03
76.96	1.063E-01	8.162E-03
80.96	8.477E-02	9.133E-03
84.96	5.238E-02	6.570E-03
88.96	9.217E-02	9.137E-03
92.96	7.616E-02	7.586E-03
96.96	8.530E-02	9.089E-03
100.96	8.604E-02	9.220E-03
104.96	5.780E-02	7.251E-03
108.96	6.485E-02	7.155E-03
112.96	7.893E-02	6.346E-03
117.96	8.691E-02	7.495E-03
122.96	6.141E-02	5.857E-03
127.96	8.292E-02	6.055E-03
132.96	9.000E-02	5.612E-03
137.96	8.778E-02	5.580E-03
142.96	1.155E-01	6.428E-03
147.96	1.319E-01	6.940E-03
152.96	1.306E-01	6.941E-03
157.96	1.315E-01	7.813E-03
162.96	1.453E-01	7.659E-03
169.96	1.547E-01	8.578E-03
169.96	1.760E-01	8.532E-03
180.00	1.760E-01	8.532E-03

N14(D,HE4)C12 20.13 MEV. EX = 12.710 ID = 408 J = 1+

AVERAGE ENERGY = 12.7009+- 0.0038 THETA < 90
AVERAGE ENERGY = 12.7182+- 0.0026 THETA > 90
AVERAGE ENERGY = 12.7077+- 0.0028 ALL ANGLES
REACTION CROSS SECTION = 2.950E+00 +- 0.193E+01
INTEGRATION LENGTH = 2.967 + 0.106 + 0.069 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.180E+00	2.731E-01
12.09	1.180E+00	2.731E-01
14.51	9.741E-01	2.872E-01
16.93	8.662E-01	3.020E-01
19.35	7.063E-01	2.975E-01
21.76	6.549E-01	2.660E-01
24.17	6.786E-01	2.397E-01
26.57	5.698E-01	2.335E-01
28.96	4.758E-01	2.182E-01
31.36	4.454E-01	2.158E-01
33.74	4.264E-01	1.924E-01
36.12	3.507E-01	1.934E-01
37.31	3.613E-01	1.783E-01
38.49	3.522E-01	1.879E-01
39.66	3.396E-01	1.879E-01
42.02	3.082E-01	2.060E-01
42.03	3.560E-01	1.758E-01
45.54	3.183E-01	1.894E-01
47.89	2.017E-01	1.453E-01
47.90	3.052E-01	1.629E-01
49.05	3.840E-01	1.568E-01
52.53	3.467E-01	1.666E-01
55.98	2.428E-01	1.642E-01
59.41	2.376E-01	1.676E-01
62.82	1.440E-01	1.440E-01
66.20	1.351E-01	1.351E-01
69.56	1.174E-01	1.174E-01
72.89	1.139E-01	1.139E-01
72.89	1.139E-01	1.139E-01
72.89	1.139E-01	1.139E-01
76.18	1.231E-01	1.231E-01
79.44	1.645E-01	1.296E-01
82.67	1.540E-01	1.361E-01
85.88	1.750E-01	1.072E-01
89.03	1.524E-01	1.299E-01
93.20	1.174E-01	1.174E-01
97.31	1.129E-01	1.129E-01
101.35	1.173E-01	1.173E-01
105.33	2.112E-01	1.173E-01
109.26	1.512E-01	1.424E-01
113.12	1.460E-01	1.455E-01
116.93	1.057E-01	1.057E-01
120.67	6.014E-02	4.127E-02
124.37	1.275E-01	1.275E-01
128.89	1.075E-01	1.075E-01
133.33	1.585E-01	1.504E-01
137.69	1.471E-01	1.471E-01
141.99	1.431E-01	1.431E-01
146.22	1.641E-01	1.641E-01
150.39	1.371E-01	1.371E-01
154.50	2.659E-01	2.542E-01
158.56	2.561E-01	2.561E-01
162.58	1.469E-01	1.469E-01
166.57	4.815E-01	4.723E-01
172.10	4.409E-01	4.366E-01
172.11	2.007E-01	2.007E-01
180.00	2.007E-01	2.007E-01

N14(D,HE4)C12 20.13 MEV. EX = 12.710 ID = 408 J = 1+

AVERAGE ENERGY = 12.7016+- 0.0036 THETA < 90
AVERAGE ENERGY = 12.7197+- 0.0027 THETA > 90
AVERAGE ENERGY = 12.7077+- 0.0028 ALL ANGLES
REACTION CROSS SECTION = 2.950E+00 +- 0.193E+01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.731E+00	4.006E-01
9.96	1.731E+00	4.006E-01
11.96	1.426E+00	4.202E-01
13.96	1.264E+00	4.406E-01
15.96	1.027E+00	4.325E-01
17.96	9.485E-01	3.852E-01
19.96	9.785E-01	3.455E-01
21.96	8.176E-01	3.351E-01
23.96	6.791E-01	3.114E-01
25.96	6.321E-01	3.061E-01
27.96	6.016E-01	2.712E-01
29.96	4.914E-01	2.709E-01
30.96	5.045E-01	2.489E-01
31.96	4.901E-01	2.614E-01
32.96	4.705E-01	2.602E-01
34.96	4.238E-01	2.831E-01
34.96	4.898E-01	2.418E-01
37.96	4.323E-01	2.571E-01
39.96	2.717E-01	1.956E-01
39.96	4.112E-01	2.193E-01
40.96	5.147E-01	2.101E-01
43.96	4.583E-01	2.201E-01
46.96	3.162E-01	2.137E-01
49.96	3.046E-01	2.147E-01
52.96	1.816E-01	1.814E-01
55.96	1.674E-01	1.673E-01
58.96	1.428E-01	1.427E-01
61.96	1.360E-01	1.359E-01
61.96	1.360E-01	1.359E-01
61.96	1.360E-01	1.359E-01
64.96	1.442E-01	1.441E-01
67.96	1.888E-01	1.486E-01
70.96	1.731E-01	1.529E-01
73.96	1.926E-01	1.179E-01
76.96	1.641E-01	1.398E-01
80.96	1.228E-01	1.227E-01
84.96	1.146E-01	1.145E-01
88.96	1.154E-01	1.154E-01
92.96	2.016E-01	1.119E-01
96.96	1.399E-01	1.317E-01
100.96	1.310E-01	1.304E-01
104.96	9.204E-02	9.198E-02
108.96	5.079E-02	3.483E-02
112.96	1.045E-01	1.044E-01
117.96	8.502E-02	8.496E-02
122.96	1.211E-01	1.149E-01
127.96	1.087E-01	1.087E-01
132.96	1.026E-01	1.025E-01
137.96	1.143E-01	1.142E-01
142.96	9.302E-02	9.298E-02
147.96	1.763E-01	1.684E-01
152.96	1.663E-01	1.663E-01
157.96	9.382E-02	9.379E-02
162.96	3.033E-01	2.974E-01
169.96	2.739E-01	2.713E-01
169.96	1.247E-01	1.247E-01
180.00	1.247E-01	1.247E-01

N14(D,HE4)C12 20.13 MEV. EX = 13.340 ID = 409

AVERAGE ENERGY = 13.3486+- 0.0012 THETA < 90
AVERAGE ENERGY = 13.3488+- 0.0015 THETA > 90
AVERAGE ENERGY = 13.3486+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 7.860E-01 +- 0.730E+00
INTEGRATION LENGTH = 2.967 + 0.106 + 0.069 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	8.785E-02	8.785E-02
12.13	8.785E-02	8.785E-02
14.56	7.976E-02	7.976E-02
16.98	1.404E-01	1.082E-01
19.41	1.041E-01	9.797E-02
21.83	9.196E-02	9.196E-02
24.24	7.892E-02	7.892E-02
26.65	1.097E-01	1.009E-01
29.05	8.853E-02	8.132E-02
31.45	7.622E-02	7.595E-02
33.84	6.342E-02	6.342E-02
36.23	7.332E-02	7.215E-02
37.42	6.462E-02	6.462E-02
38.61	5.883E-02	5.232E-02
39.79	4.923E-02	4.923E-02
42.15	5.992E-02	5.992E-02
42.15	5.799E-02	5.799E-02
45.69	5.289E-02	5.289E-02
48.03	5.749E-02	5.711E-02
48.03	7.671E-02	6.115E-02
49.20	7.546E-02	6.064E-02
52.69	6.309E-02	6.309E-02
56.15	6.303E-02	6.303E-02
59.59	5.447E-02	5.447E-02
63.01	4.920E-02	4.920E-02
66.39	6.547E-02	5.554E-02
69.75	4.760E-02	4.711E-02
73.08	3.628E-02	3.628E-02
73.08	3.628E-02	3.628E-02
73.08	3.628E-02	3.628E-02
76.38	4.538E-02	4.538E-02
79.64	4.487E-02	4.487E-02
82.88	4.368E-02	4.368E-02
86.08	5.901E-02	4.906E-02
89.25	5.473E-02	4.850E-02
93.42	5.682E-02	4.715E-02
97.53	6.858E-02	6.858E-02
101.58	6.278E-02	6.053E-02
105.56	5.327E-02	5.041E-02
109.48	5.811E-02	5.713E-02
113.34	5.461E-02	4.976E-02
117.14	4.059E-02	3.394E-02
120.87	3.343E-02	1.229E-02
124.56	4.651E-02	4.651E-02
129.08	5.563E-02	5.563E-02
133.52	5.390E-02	4.946E-02
137.87	5.673E-02	5.673E-02
142.16	6.131E-02	6.131E-02
146.37	9.699E-02	8.333E-02
150.52	8.886E-02	8.886E-02
154.61	8.485E-02	8.485E-02
158.66	8.246E-02	8.246E-02
162.66	1.035E-01	1.035E-01
166.63	1.059E-01	1.059E-01
172.14	1.431E-01	1.431E-01
172.14	1.092E-01	1.092E-01
180.00	1.092E-01	1.092E-01

N14(D,HE4)C12 20.13 MEV. EX = 13.340 ID = 409

AVERAGE ENERGY = 13.3488+- 0.0011 THETA < 90
AVERAGE ENERGY = 13.3484+- 0.0016 THETA > 90
AVERAGE ENERGY = 13.3486+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 7.861E-01 +- 0.730E+00
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.297E-01	1.297E-01
9.96	1.297E-01	1.297E-01
11.96	1.175E-01	1.174E-01
13.96	2.060E-01	1.587E-01
15.96	1.523E-01	1.433E-01
17.96	1.340E-01	1.340E-01
19.96	1.145E-01	1.145E-01
21.96	1.584E-01	1.455E-01
23.96	1.271E-01	1.167E-01
25.96	1.088E-01	1.084E-01
27.96	8.995E-02	8.992E-02
29.96	1.033E-01	1.016E-01
30.96	9.072E-02	9.068E-02
31.96	8.230E-02	7.316E-02
32.96	6.860E-02	6.857E-02
34.96	8.284E-02	8.280E-02
34.96	8.018E-02	8.014E-02
37.96	7.223E-02	7.219E-02
39.96	7.781E-02	7.726E-02
39.96	1.038E-01	8.272E-02
40.96	1.017E-01	8.165E-02
43.96	8.378E-02	8.374E-02
46.96	8.244E-02	8.239E-02
49.96	7.010E-02	7.006E-02
52.96	6.225E-02	6.221E-02
55.96	8.140E-02	6.901E-02
58.96	5.809E-02	5.746E-02
61.96	4.343E-02	4.340E-02
61.96	4.343E-02	4.340E-02
61.96	4.343E-02	4.340E-02
64.96	5.327E-02	5.323E-02
67.96	5.160E-02	5.156E-02
70.96	4.919E-02	4.915E-02
73.96	6.503E-02	5.402E-02
76.96	5.900E-02	5.225E-02
80.96	5.944E-02	4.928E-02
84.96	6.958E-02	6.953E-02
88.96	6.176E-02	5.949E-02
92.96	5.078E-02	4.802E-02
96.96	5.368E-02	5.274E-02
100.96	4.889E-02	4.452E-02
104.96	3.523E-02	2.943E-02
108.96	2.813E-02	1.034E-02
112.96	3.798E-02	3.795E-02
117.96	4.378E-02	4.375E-02
122.96	4.095E-02	3.756E-02
127.96	4.169E-02	4.166E-02
132.96	4.365E-02	4.363E-02
137.96	6.707E-02	5.760E-02
142.96	5.983E-02	5.981E-02
147.96	5.580E-02	5.578E-02
152.96	5.312E-02	5.310E-02
157.96	6.553E-02	6.552E-02
162.96	6.613E-02	6.611E-02
169.96	8.807E-02	8.806E-02
169.96	6.720E-02	6.719E-02
180.00	6.720E-02	6.719E-02

N14(D,HE4)C12 20.13 MEV. EX = 14.080 ID = 410 J = 4+

AVERAGE ENERGY = 14.0756+- 0.0021 THETA < 90
AVERAGE ENERGY = 14.0871+- 0.0026 THETA > 90
AVERAGE ENERGY = 14.0801+- 0.0018 ALL ANGLES
REACTION CROSS SECTION = 2.187E+00 +- 0.212E+01
INTEGRATION LENGTH = 2.967 + 0.106 + 0.068 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.246E-01	3.246E-01
12.17	3.246E-01	3.246E-01
14.61	3.435E-01	3.435E-01
17.05	4.680E-01	4.645E-01
19.48	3.357E-01	3.357E-01
21.91	3.903E-01	3.903E-01
24.33	3.600E-01	3.600E-01
26.75	3.512E-01	3.512E-01
29.16	4.017E-01	3.570E-01
31.57	3.062E-01	3.062E-01
33.97	3.552E-01	3.306E-01
36.36	2.733E-01	2.733E-01
37.56	1.699E-01	1.899E-01
38.75	2.053E-01	2.053E-01
39.93	1.656E-01	1.656E-01
42.30	1.226E-01	1.226E-01
42.31	1.779E-01	1.779E-01
45.85	1.162E-01	1.162E-01
48.20	1.038E-01	1.038E-01
48.20	1.645E-01	1.645E-01
49.37	1.268E-01	1.268E-01
52.87	6.767E-02	6.767E-02
56.34	2.050E-01	2.050E-01
59.79	1.548E-01	1.548E-01
63.22	1.484E-01	1.484E-01
66.61	1.841E-01	1.841E-01
69.98	1.650E-01	1.650E-01
73.31	1.037E-01	1.037E-01
73.31	1.037E-01	1.037E-01
73.31	1.037E-01	1.037E-01
76.62	1.155E-01	1.155E-01
79.89	1.262E-01	1.262E-01
83.13	1.491E-01	1.491E-01
86.34	1.831E-01	1.831E-01
89.51	1.151E-01	1.151E-01
93.68	1.136E-01	1.136E-01
97.81	2.316E-01	2.316E-01
101.84	1.230E-01	1.230E-01
105.82	9.326E-02	9.326E-02
109.75	1.123E-01	1.123E-01
113.61	1.468E-01	1.468E-01
117.40	8.567E-02	8.567E-02
121.13	9.981E-02	4.591E-02
124.81	1.184E-01	1.184E-01
129.32	1.352E-01	1.352E-01
133.74	1.579E-01	1.579E-01
138.08	2.629E-01	2.629E-01
142.35	2.327E-01	2.327E-01
146.55	2.618E-01	2.618E-01
150.68	2.545E-01	2.545E-01
154.75	2.412E-01	2.412E-01
158.78	1.498E-01	1.498E-01
162.76	1.332E-01	1.332E-01
166.71	9.959E-02	9.959E-02
172.19	4.927E-02	4.927E-02
172.19	2.550E-01	2.550E-01
180.00	2.550E-01	2.550E-01

N14(D,HE4)C12 20.13 MEV. EX = 14.080 ID = 410 J = 4+

AVERAGE ENERGY = 14.0764+- 0.0022 THETA < 90
AVERAGE ENERGY = 14.0875+- 0.0024 THETA > 90
AVERAGE ENERGY = 14.0801+- 0.0018 ALL ANGLES
REACTION CROSS SECTION = 2.187E+00 +- 0.211E+01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.828E-01	4.827E-01
9.96	4.828E-01	4.827E-01
11.96	5.097E-01	5.096E-01
13.96	6.921E-01	6.869E-01
15.96	4.947E-01	4.946E-01
17.96	5.727E-01	5.725E-01
19.96	5.260E-01	5.258E-01
21.96	5.105E-01	5.103E-01
23.96	5.807E-01	5.159E-01
25.96	4.400E-01	4.399E-01
27.96	5.072E-01	4.718E-01
29.96	3.875E-01	3.874E-01
30.96	2.684E-01	2.683E-01
31.96	2.890E-01	2.889E-01
32.96	2.322E-01	2.321E-01
34.96	1.705E-01	1.704E-01
34.96	2.476E-01	2.475E-01
37.96	1.596E-01	1.595E-01
39.96	1.413E-01	1.412E-01
39.96	2.239E-01	2.238E-01
40.96	1.718E-01	1.717E-01
43.96	9.036E-02	9.031E-02
46.96	2.695E-01	2.693E-01
49.96	2.001E-01	2.000E-01
52.96	1.887E-01	1.885E-01
55.96	2.298E-01	2.296E-01
58.96	2.021E-01	2.020E-01
61.96	1.246E-01	1.245E-01
61.96	1.246E-01	1.245E-01
61.96	1.246E-01	1.245E-01
64.96	1.359E-01	1.358E-01
67.96	1.454E-01	1.453E-01
70.96	1.682E-01	1.681E-01
73.96	2.021E-01	2.019E-01
76.96	1.242E-01	1.241E-01
80.96	1.189E-01	1.188E-01
84.96	2.350E-01	2.348E-01
88.96	1.208E-01	1.207E-01
92.96	8.877E-02	8.871E-02
96.96	1.035E-01	1.035E-01
100.96	1.311E-01	1.310E-01
104.96	7.408E-02	7.402E-02
108.96	8.363E-02	3.844E-02
112.96	9.618E-02	9.611E-02
117.96	1.058E-01	1.057E-01
122.96	1.192E-01	1.191E-01
127.96	1.917E-01	1.916E-01
132.96	1.643E-01	1.643E-01
137.96	1.794E-01	1.794E-01
142.96	1.697E-01	1.697E-01
147.96	1.570E-01	1.569E-01
152.96	9.546E-02	9.543E-02
157.96	8.336E-02	8.334E-02
162.96	6.144E-02	6.143E-02
169.96	2.997E-02	2.997E-02
169.96	1.551E-01	1.551E-01
180.00	1.551E-01	1.551E-01

STOP

*N14(D,HE4) 20.13 MEV. ID = T4
*TOTAL DIFFERENTIAL CROSS SECTION

AVERAGE ENERGY = 0.0000+- 0.0000 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.0000 THETA > 90
AVERAGE ENERGY = 0.0000+- 0.0000 ALL ANGLES
REACTION CROSS SECTION = 1.503E+01 +- 0.238E+01
INTEGRATION LENGTH = 2.906 + 0.087 + 0.149 = 3.142

$DIFFERENTIAL CROSS SECTION IN MB/SR (LAB)
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.224E+00	9.554E-01
9.96	7.224E+00	9.554E-01
11.96	6.264E+00	9.173E-01
13.96	5.741E+00	8.338E-01
15.96	4.588E+00	5.142E-01
17.96	4.124E+00	4.408E-01
19.96	3.735E+00	3.791E-01
21.96	3.328E+00	4.168E-01
23.96	3.054E+00	3.178E-01
25.96	2.762E+00	2.768E-01
27.96	2.739E+00	4.150E-01
29.96	2.358E+00	2.140E-01
30.96	2.256E+00	1.905E-01
31.96	2.211E+00	1.802E-01
34.96	2.249E+00	2.667E-01
37.96	2.000E+00	2.216E-01
40.96	1.900E+00	2.510E-01
43.96	1.800E+00	2.649E-01
46.96	1.700E+00	2.177E-01
55.96	1.397E+00	2.338E-01
58.96	1.267E+00	2.222E-01
61.96	1.036E+00	1.999E-01
64.96	1.007E+00	1.753E-01
64.96	1.007E+00	1.753E-01
64.96	1.007E+00	1.753E-01
67.96	9.778E-01	1.364E-01
70.96	9.786E-01	1.760E-01
73.96	9.741E-01	1.279E-01
76.96	9.096E-01	1.370E-01
80.96	7.959E-01	1.674E-01
88.96	6.934E-01	1.623E-01
92.96	7.143E-01	1.383E-01
96.96	6.344E-01	1.535E-01
100.96	6.149E-01	1.473E-01
104.96	4.803E-01	1.328E-01
108.96	4.937E-01	1.274E-01
117.96	5.764E-01	1.309E-01
122.96	6.367E-01	1.230E-01
127.96	6.997E-01	1.143E-01
132.96	6.687E-01	1.055E-01
137.96	7.117E-01	1.113E-01
142.96	7.186E-01	1.150E-01
147.96	8.592E-01	1.160E-01
169.96	5.580E-01	1.572E-01
157.96	7.252E-01	1.443E-01
162.96	6.373E-01	1.435E-01
180.00	6.373E-01	1.435E-01

APPENDIX A.7

$^{14}N(d,^{4}He + X)Y$

$^{14}N(d,p)^{15}N$

$^{14}N(d,pn)Y$

*N14(D,P N)N14 20.13 MEV. ID = 198
*APPROXIMATE LOW ENERGY CUTOFF = 3 MEV.

AVERAGE ENERGY = 18.9534+- 0.0582 THETA < 90
AVERAGE ENERGY = 18.5907+- 0.0551 THETA > 90
AVERAGE ENERGY = 18.8250+- 0.0502 ALL ANGLES
REACTION CROSS SECTION = 5.463E+02 +- 0.150E+02
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

$DIFFERENTIAL TOTAL CROSS SECTION IN MB/SR
 LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.778E+02	1.290E+01
9.96	4.778E+02	1.290E+01
11.96	4.106E+02	9.830E+00
13.96	2.969E+02	7.872E+00
15.96	2.580E+02	4.373E+00
17.96	2.074E+02	3.570E+00
19.96	1.764E+02	2.897E+00
21.96	1.497E+02	2.864E+00
23.96	1.304E+02	2.216E+00
25.96	1.165E+02	1.863E+00
27.96	1.027E+02	3.281E+00
29.96	9.160E+01	1.371E+00
30.96	8.879E+01	1.224E+00
31.96	8.508E+01	1.170E+00
37.96	7.675E+01	1.061E+00
38.96	6.911E+01	8.612E-01
40.96	6.893E+01	1.153E+00
43.96	6.213E+01	9.030E-01
46.96	5.552E+01	7.627E-01
49.96	5.038E+01	7.121E-01
52.96	4.565E+01	6.361E-01
55.96	3.960E+01	1.409E+00
58.96	3.621E+01	6.740E-01
61.96	3.333E+01	6.992E-01
64.96	3.444E+01	4.407E-01
64.96	3.444E+01	4.407E-01

ABCISSA	ORDINATE	ERROR
67.96	3.422E+01	4.293E-01
70.96	3.319E+01	4.629E-01
73.96	3.154E+01	4.853E-01
76.96	2.983E+01	5.707E-01
80.96	2.338E+01	5.043E-01
84.96	2.204E+01	2.963E-01
88.96	1.983E+01	2.892E-01
92.96	1.848E+01	2.642E-01
96.96	1.683E+01	2.606E-01
100.96	1.673E+01	2.375E-01
104.96	1.655E+01	2.132E-01
108.96	1.645E+01	1.854E-01
112.96	1.634E+01	2.333E-01
117.96	1.611E+01	2.402E-01
122.96	1.505E+01	2.187E-01
127.96	1.578E+01	2.117E-01
132.96	1.560E+01	2.004E-01
137.96	1.484E+01	2.096E-01
142.96	1.469E+01	2.082E-01
147.96	1.477E+01	2.117E-01
152.96	1.549E+01	1.976E-01
157.96	1.565E+01	2.090E-01
162.96	1.532E+01	2.094E-01
169.96	1.636E+01	2.608E-01
180.00	1.636E+01	2.608E-01

*N14(D,HE4) 20.13 MEV. ID = 498
*APPROXIMATE LOW ENERGY CUTOFF = 3 MEV.

AVERAGE ENERGY = 21.9587+- 0.1689 THETA < 90
AVERAGE ENERGY = 17.2145+- 0.3546 THETA > 90
AVERAGE ENERGY = 20.2784+- 0.3808 ALL ANGLES
REACTION CROSS SECTION = 1.938E+02 +- 0.645E+01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

$DIFFERENTIAL TOTAL CROSS SECTION IN MB/SR
LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	6.137E+01	2.669E+00
9.96	6.137E+01	2.669E+00
11.96	5.885E+01	2.212E+00
13.96	5.849E+01	2.196E+00
15.96	6.306E+01	1.768E+00
17.96	5.935E+01	1.734E+00
19.96	5.780E+01	1.688E+00
21.96	5.261E+01	1.502E+00
23.96	5.035E+01	1.413E+00
25.96	4.849E+01	1.229E+00
27.96	4.576E+01	1.278E+00
29.96	4.335E+01	1.019E+00
30.96	4.226E+01	9.157E-01
31.96	4.134E+01	9.153E-01
34.96	3.788E+01	8.746E-01
37.96	3.931E+01	7.578E-01
40.96	3.690E+01	8.298E-01
43.96	3.434E+01	7.037E-01
46.96	3.082E+01	7.019E-01
49.96	2.840E+01	6.199E-01
52.96	2.600E+01	4.941E-01
55.96	2.341E+01	5.045E-01
58.96	2.049E+01	4.424E-01
61.96	1.788E+01	3.477E-01
64.96	1.714E+01	3.617E-01
64.96	1.714E+01	3.617E-01
67.96	1.658E+01	3.948E-01
70.96	1.591E+01	4.057E-01
73.96	1.463E+01	4.384E-01
76.96	1.322E+01	2.561E-01
80.96	9.983E+00	3.312E-01
84.96	8.429E+00	3.738E-01
88.96	7.661E+00	2.673E-01
92.96	6.573E+00	3.096E-01
96.96	6.400E+00	2.643E-01
100.96	6.250E+00	2.764E-01
104.96	6.000E+00	1.823E-01
108.96	5.750E+00	1.486E-01
112.96	5.502E+00	2.190E-01
117.96	5.103E+00	2.099E-01
122.96	4.511E+00	2.506E-01
127.96	4.244E+00	3.074E-01
132.96	4.073E+00	2.735E-01
137.96	3.758E+00	2.992E-01
142.96	3.081E+00	2.673E-01
147.96	2.955E+00	3.368E-01
152.96	3.091E+00	2.666E-01
157.96	2.546E+00	1.831E-01
162.96	2.464E+00	3.677E-01
169.96	2.668E+00	3.088E-01
180.00	2.668E+00	3.088E-01

*N14(D,P)N15 20.13 MEV. ID = 197
*TOTAL CROSS SECTION

AVERAGE ENERGY = 12.1845+- 0.1372 THETA < 90
AVERAGE ENERGY = 10.2994+- 0.1432 THETA > 90
AVERAGE ENERGY = 11.5168+- 0.1701 ALL ANGLES
REACTION CROSS SECTION = 4.957E+01 +- 0.599E+01
INTEGRATION LENGTH = 2.967 + 0.087 + 0.088 = 3.142

$DIFFERENTIAL TOTAL CROSS SECTION IN MB/SR
 LAB ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.249E+01	7.680E+00
9.96	3.249E+01	7.680E+00
11.96	2.771E+01	7.856E+00
13.96	2.282E+01	6.666E+00
15.96	2.009E+01	2.790E+00
17.96	1.636E+01	2.328E+00
19.96	1.340E+01	1.891E+00
21.96	1.144E+01	2.180E+00
23.96	9.379E+00	1.559E+00
25.96	8.222E+00	1.244E+00
27.96	6.941E+00	3.003E+00
29.96	6.133E+00	8.596E-01
30.96	5.665E+00	6.826E-01
31.96	5.450E+00	6.484E-01
32.96	6.165E+00	4.505E-01
34.96	5.457E+00	8.040E-01
37.96	5.446E+00	5.907E-01
40.96	5.485E+00	8.143E-01
43.96	4.276E+00	5.019E-01
46.96	3.867E+00	3.776E-01
52.96	3.541E+00	3.192E-01
55.96	5.279E+00	1.317E+00
58.96	2.724E+00	2.504E-01
61.96	3.566E+00	5.759E-01
64.96	2.616E+00	1.078E-01
64.96	2.616E+00	1.078E-01

ABCISSA	ORDINATE	ERROR
67.96	2.337E+00	1.255E-01
70.96	2.142E+00	2.033E-01
73.96	2.401E+00	2.938E-01
76.96	2.066E+00	4.321E-01
80.96	2.654E+00	3.941E-01
84.96	1.742E+00	4.269E-02
88.96	2.970E+00	1.087E-01
92.96	2.774E+00	9.306E-02
96.96	2.939E+00	1.147E-01
100.96	2.951E+00	1.167E-01
104.96	2.695E+00	1.076E-01
108.96	2.912E+00	9.769E-02
112.96	3.480E+00	7.716E-02
117.96	2.781E+00	8.312E-02
122.96	2.378E+00	1.187E-01
127.96	1.942E+00	9.351E-02
132.96	1.791E+00	7.465E-02
137.96	2.050E+00	1.090E-01
142.96	2.105E+00	1.092E-01
147.96	2.199E+00	1.111E-01
152.96	1.856E+00	4.783E-02
157.96	2.104E+00	5.889E-02
162.96	2.117E+00	5.359E-02
169.96	1.750E+00	5.786E-02
180.00	1.750E+00	5.786E-02

STOP

APPENDIX B

Tabulation of Differential Cross Sections and Total Reaction Cross Sections at 20.9 MeV ^{16}O Target

The following pages contain listings of angular distributions, reaction cross sections, and total reaction cross sections for all the processes recorded with ^{14}N as the target. Each page has as a function of center-of-mass angle, the center-of-mass differential cross section in mb/sr, and the total error in mb/sr. The lab differential cross section and error are on the reverse side of the page, listed as a function of lab angle. The excitation energy of the state and error in MeV, spin, parity, isotopic spin, reaction cross section and error in mb appear with each angular distribution. The reaction cross section was computed from the angular distribution using

$$= 2\pi \int_0^{180} f(\theta)\sin\theta \, d\theta \quad \text{(see Sec. 4.4)}$$

The excitation energies and errors are computed separately on the basis of angles forward of 90°, backward from 90°, and all angles.

APPENDIX B.1

$^{16}O(d,d')$ EX < 15 MeV

816(D,D') 20.7 MEV. EX = 00.100 ID = 201 J = 0+

AVERAGE ENERGY = 0.1411+- 0.0070 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.0108 THETA > 90
AVERAGE ENERGY = 0.1411+- 0.0074 ALL ANGLES
REACTION CROSS SECTION = 2.121E+03 +- 0.257E+03
INTEGRATION LENGTH = 1.922 + 0.132 + 1.087 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.707E+03	5.672E+02
15.15	4.707E+03	5.672E+02
15.11	1.430E+03	1.777E+01
17.71	5.159E+02	6.171E+00
20.16	5.090E+02	5.953E+00
20.16	4.126E+02	4.831E+00
22.78	1.689E+02	1.989E+00
25.20	7.232E+01	8.953E-01
25.20	7.246E+01	8.587E-01
27.83	1.294E+01	2.095E-01
29.04	4.771E+00	8.800E-02
30.25	1.719E+00	4.374E-02
32.87	7.596E+00	1.103E-01
35.29	1.553E+01	2.061E-01
39.32	1.975E+01	2.745E-01
45.37	1.220E+01	1.753E-01
55.43	6.798E+00	9.018E-02
180.00	6.798E+00	9.018E-02

STOP

816(D,D') 20.7 MEV. EX = 06.122 ID = 202 J = 3-

AVERAGE ENERGY = 6.1211+- 0.0003 THETA < 90
AVERAGE ENERGY = 0.0000+- 7.4666 THETA > 90
AVERAGE ENERGY = 6.1211+- 0.0003 ALL ANGLES
REACTION CROSS SECTION = 4.324E+01 +- 0.363E+01
INTEGRATION LENGTH = 1.923 + 0.132 + 1.086 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.712E+01	5.972E+00
15.18	4.712E+01	5.972E+00
15.14	7.613E+00	3.747E-01
17.75	7.250E+00	2.390E-01
20.19	7.229E+00	2.061E-01
20.19	7.113E+00	1.586E-01
22.82	5.779E+00	1.423E-01
25.25	7.018E+00	1.671E-01
25.25	6.989E+00	1.380E-01
27.68	6.884E+00	1.434E-01
29.09	6.553E+00	1.156E-01
30.30	6.462E+00	1.066E-01
32.93	5.912E+00	9.341E-02
35.35	5.115E+00	9.160E-02
35.39	3.632E+00	9.220E-02
45.44	2.654E+00	6.972E-02
55.52	1.751E+00	3.496E-02
180.00	1.751E+00	3.496E-02

816(D,D') 20.7 MEV. EX = 06.916 ID = 204 J = 2+

AVERAGE ENERGY = 6.9072+- 0.0014 THETA < 90
AVERAGE ENERGY = 0.0000+- 7.8172 THETA > 90
AVERAGE ENERGY = 6.9072+- 0.0015 ALL ANGLES
REACTION CROSS SECTION = 1.073E+01 +- 0.135E+01
INTEGRATION LENGTH = 1.923 + 0.132 + 1.086 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.527E+01	2.623E+00
15.18	1.527E+01	2.623E+00
15.14	2.724E+00	4.104E-01
17.75	2.502E+00	2.226E-01
20.20	2.326E+00	1.680E-01
20.20	2.405E+00	1.526E-01
22.83	1.519E+00	1.110E-01
25.26	1.741E+00	1.154E-01
25.26	1.674E+00	8.799E-02
27.89	1.085E+00	6.657E-02
29.10	9.376E-01	6.502E-02
30.31	8.139E-01	3.640E-02
32.94	5.280E-01	2.808E-02
35.36	3.328E-01	2.942E-02
39.40	4.169E-01	4.493E-02
45.46	5.448E-01	3.965E-02
55.54	3.361E-01	1.795E-02
180.00	3.361E-01	1.795E-02

O16(D,D') 20.7 MEV. EX = 07.115 ID = 205 J = 1-

AVERAGE ENERGY = 7.1187+- 0.0009 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.6374 THETA > 90
AVERAGE ENERGY = 7.1187+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 1.299E+01 +- 0.156E+01
INTEGRATION LENGTH = 1.923 + 0.132 + 1.086 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.890E+01	2.942E+00
15.18	1.890E+01	2.942E+00
15.14	2.906E+00	3.851E-01
17.75	2.627E+00	2.187E-01
20.20	2.327E+00	1.662E-01
20.20	2.216E+00	1.485E-01
22.83	1.457E+00	1.090E-01
25.26	1.540E+00	1.107E-01
25.26	1.435E+00	8.377E-02
27.89	1.061E+00	6.601E-02
29.10	9.855E-01	6.476E-02
30.31	9.988E-01	3.925E-02
32.94	7.994E-01	3.185E-02
35.37	6.029E-01	3.361E-02
39.41	4.526E-01	4.468E-02
45.46	2.921E-01	3.447E-02
55.54	4.389E-01	1.927E-02
180.00	4.389E-01	1.927E-02

816(D,D') 20.7 MEV. EX = 08.871 ID = 206 J = 2-

AVERAGE ENERGY = 8.8711+- 0.0014 THETA < 90
AVERAGE ENERGY = 0.0000+- 8.6946 THETA > 90
AVERAGE ENERGY = 8.8711+- 0.0014 ALL ANGLES
REACTION CROSS SECTION = 4.324E+00 +- 0.673E+00
INTEGRATION LENGTH = 1.923 + 0.133 + 1.086 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.253E+00	1.350E+00
15.20	3.253E+00	1.350E+00
15.16	8.171E-01	2.280E-01
17.77	6.550E-01	1.481E-01
20.22	7.673E-01	1.184E-01
20.22	5.287E-01	1.008E-01
22.85	5.736E-01	7.028E-02
25.28	7.892E-01	8.917E-02
25.28	7.226E-01	6.686E-02
27.91	7.536E-01	7.591E-02
29.13	7.434E-01	4.943E-02
30.34	6.222E-01	3.746E-02
32.97	6.113E-01	3.035E-02
35.40	4.987E-01	3.304E-02
39.44	3.195E-01	4.632E-02
45.50	2.795E-01	3.705E-02
55.58	2.440E-01	1.502E-02
180.00	2.440E-01	1.502E-02

816(D,D') 20.7 MEV. EX = 09.590 ID = 207 J = 1-

AVERAGE ENERGY = 9.5807+- 0.0016 THETA < 90
AVERAGE ENERGY = 0.0000+- 2.1600 THETA > 90
AVERAGE ENERGY = 9.5807+- 0.0020 ALL ANGLES
REACTION CROSS SECTION = 8.359E-01 +- 0.575E+00
INTEGRATION LENGTH = 1.923 + 0.133 + 1.086 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.344E+00	1.509E+00
15.20	1.344E+00	1.509E+00
15.16	3.092E-01	2.519E-01
17.78	6.130E-02	1.620E-01
20.23	5.372E-02	1.230E-01
20.23	1.316E-03	1.114E-01
22.86	1.334E-01	7.153E-02
25.29	1.067E-01	8.978E-02
25.29	2.781E-02	5.666E-02
27.92	5.683E-02	7.817E-02
29.14	9.644E-02	5.332E-02
30.35	1.241E-01	4.461E-02
32.98	6.647E-02	2.799E-02
35.41	2.710E-02	2.965E-02
39.45	1.522E-03	3.919E-02
45.51	1.246E-03	3.435E-02
55.60	2.540E-02	1.444E-02
180.00	2.540E-02	1.444E-02

816(D,D') 20.7 MEV. EX = 09.847 ID = 208 J = 2+

AVERAGE ENERGY = 9.8596+- 0.0016 THETA < 90
AVERAGE ENERGY = 0.0000+- 7.1013 THETA > 90
AVERAGE ENERGY = 9.8596+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 3.566E+00 +- 0.739E+00
INTEGRATION LENGTH = 1.923 + 0.133 + 1.086 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.768E+00	1.550E+00
15.21	4.768E+00	1.550E+00
15.17	8.266E-01	2.554E-01
17.78	4.401E-01	1.572E-01
20.23	3.452E-01	1.218E-01
20.23	4.650E-01	1.090E-01
22.86	3.347E-01	7.203E-02
25.30	3.221E-01	9.245E-02
25.30	2.598E-01	5.710E-02
27.93	1.972E-01	7.941E-02
29.14	3.287E-01	5.609E-02
30.36	3.253E-01	4.833E-02
32.99	2.290E-01	3.187E-02
35.42	1.470E-01	3.217E-02
39.46	1.051E-01	4.060E-02
45.52	6.501E-02	3.510E-02
55.61	1.494E-01	1.681E-02
180.00	1.494E-01	1.681E-02

816(D,D') 20.7 MEV. EX = 10.353 ID = 209 J = 4+

AVERAGE ENERGY = 10.3634+- 0.0018 THETA < 90
AVERAGE ENERGY = 0.0000+- 7.3918 THETA > 90
AVERAGE ENERGY = 10.3634+- 0.0018 ALL ANGLES
REACTION CROSS SECTION = 3.513E+00 +- 0.599E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.580E+00	1.069E+00
15.21	2.580E+00	1.069E+00
15.17	2.175E-01	1.952E-01
17.79	2.043E-01	1.349E-01
20.24	1.493E-01	1.136E-01
20.24	2.792E-01	8.212E-02
22.87	2.666E-01	5.915E-02
25.30	1.488E-01	8.289E-02
25.30	2.136E-01	5.074E-02
27.94	2.206E-01	6.883E-02
29.15	2.704E-01	4.624E-02
30.37	3.188E-01	4.208E-02
33.00	2.355E-01	3.108E-02
35.43	1.933E-01	3.100E-02
39.47	2.142E-01	4.593E-02
45.54	1.965E-01	3.830E-02
55.63	2.417E-01	1.685E-02
180.00	2.417E-01	1.685E-02

816(D,D') 20.7 MEV. EX = 10.950 ID = 210 J = 0-

AVERAGE ENERGY = 10.9521+- 0.0018 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.0120 THETA > 90
AVERAGE ENERGY = 10.9521+- 0.0018 ALL ANGLES
REACTION CROSS SECTION = 2.699E+00 +- 0.707E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.810E+00	1.373E+00
15.22	4.810E+00	1.373E+00
15.18	3.760E-01	2.450E-01
17.79	3.013E-01	1.648E-01
20.25	3.213E-01	1.209E-01
20.25	5.080E-01	1.581E-01
22.88	1.891E-01	6.790E-02
25.31	1.620E-01	9.182E-02
25.31	1.895E-01	5.632E-02
27.95	1.223E-01	6.601E-02
29.16	2.481E-01	7.700E-02
30.38	2.244E-01	5.735E-02
33.01	2.024E-01	4.471E-02
35.44	1.202E-01	3.692E-02
39.49	8.424E-02	4.618E-02
45.55	5.953E-02	4.369E-02
55.65	5.484E-02	2.085E-02
180.00	5.484E-02	2.085E-02

816(D,D') 20.7 MEV. EX = 11.150 ID = 211 J = 0+

AVERAGE ENERGY = 11.1544+- 0.0031 THETA < 90
AVERAGE ENERGY = 0.0000+- 3.9437 THETA > 90
AVERAGE ENERGY = 11.1544+- 0.0034 ALL ANGLES
REACTION CROSS SECTION = 5.492E+00 +- 0.818E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.711E+00	1.344E+00
15.22	4.711E+00	1.344E+00
15.18	5.950E-01	2.460E-01
17.80	4.416E-01	1.598E-01
20.25	4.366E-01	1.181E-01
20.25	2.243E-01	1.538E-01
22.88	3.901E-01	6.634E-02
25.32	4.415E-01	8.969E-02
25.32	4.582E-01	5.842E-02
27.95	4.368E-01	6.725E-02
29.17	4.681E-01	7.585E-02
30.38	4.565E-01	5.661E-02
33.02	5.033E-01	4.734E-02
35.44	3.752E-01	4.071E-02
39.49	3.895E-01	4.998E-02
45.56	3.813E-01	4.729E-02
55.65	3.281E-01	2.436E-02
180.00	3.281E-01	2.436E-02

816(D,D') 20.7 MEV. EX = 11.580 ID = 213 J = 0+

AVERAGE ENERGY = 11.5699+- 0.0020 THETA < 90
AVERAGE ENERGY = 0.0000+- 3.7492 THETA > 90
AVERAGE ENERGY = 11.5699+- 0.0021 ALL ANGLES
REACTION CROSS SECTION = 5.872E+00 +- 0.828E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	8.162E+00	1.360E+00
15.22	8.162E+00	1.360E+00
15.18	8.334E-01	2.029E-01
17.80	8.171E-01	1.317E-01
20.26	5.714E-01	1.167E-01
20.25	5.729E-01	8.308E-02
22.89	4.070E-01	6.154E-02
25.33	4.347E-01	8.412E-02
25.33	4.371E-01	5.006E-02
27.96	3.730E-01	6.749E-02
29.18	3.731E-01	4.950E-02
30.39	4.238E-01	4.702E-02
33.03	4.087E-01	3.905E-02
35.46	2.236E-01	3.479E-02
39.50	3.008E-01	4.853E-02
45.57	3.067E-01	4.140E-02
55.67	2.154E-01	1.923E-02
180.00	2.154E-01	1.923E-02

O16(D,D') 20.7 MEV. EX = 12.090 ID = 215 J =

AVERAGE ENERGY = 12.0983+- 0.0026 THETA < 90
AVERAGE ENERGY = 0.0000+- 6.1923 THETA > 90
AVERAGE ENERGY = 12.0983+- 0.0026 ALL ANGLES
REACTION CROSS SECTION = 4.355E+00 +- 0.736E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	6.809E+00	1.237E+00
15.23	6.809E+00	1.237E+00
15.19	5.800E-01	1.912E-01
17.81	5.653E-01	1.294E-01
20.26	3.747E-01	1.103E-01
20.26	4.922E-01	7.921E-02
22.90	3.114E-01	6.079E-02
25.34	3.214E-01	8.250E-02
25.34	3.377E-01	5.211E-02
27.97	2.449E-01	6.766E-02
29.19	2.468E-01	4.893E-02
30.41	2.375E-01	4.364E-02
33.04	2.153E-01	3.930E-02
35.47	1.591E-01	3.387E-02
39.52	1.245E-01	4.897E-02
45.59	1.368E-01	3.921E-02
55.69	1.387E-01	1.931E-02
180.00	1.387E-01	1.931E-02

816(D,D') 20.7 MEV. EX = 12.530 ID = 217 J =

AVERAGE ENERGY = 12.5447+- 0.0033 THETA < 90
AVERAGE ENERGY = 0.0000+- 7.2516 THETA > 90
AVERAGE ENERGY = 12.5447+- 0.0033 ALL ANGLES
REACTION CROSS SECTION = 4.002E+00 +- 0.751E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.560E+00	1.326E+00
15.24	4.560E+00	1.326E+00
15.20	3.668E-01	1.926E-01
17.82	4.039E-01	1.565E-01
20.27	3.443E-01	1.146E-01
20.27	5.151E-01	9.634E-02
22.91	3.355E-01	6.970E-02
25.35	3.906E-01	1.063E-01
25.35	4.929E-01	6.133E-02
27.98	4.241E-01	9.224E-02
29.20	4.591E-01	7.111E-02
30.42	5.254E-01	6.209E-02
33.05	4.938E-01	6.111E-02
35.48	4.404E-01	4.745E-02
39.54	3.447E-01	6.157E-02
45.61	3.423E-01	5.456E-02
55.71	1.607E-01	2.211E-02
180.00	1.607E-01	2.211E-02

816(D,D') 20.7 MEV. EX = 12.790 ID = 218 J =

AVERAGE ENERGY = 12.7747+- 0.0016 THETA < 90
AVERAGE ENERGY = 0.0000+- 3.4306 THETA > 90
AVERAGE ENERGY = 12.7747+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 7.107E-01 +- 0.607E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.433E+00	1.334E+00
15.24	1.433E+00	1.334E+00
15.20	4.338E-03	1.788E-01
17.82	2.092E-03	1.689E-01
20.28	2.419E-03	1.117E-01
20.28	5.645E-02	1.115E-01
22.92	1.354E-03	6.268E-02
25.35	2.215E-03	9.081E-02
25.35	5.754E-02	6.129E-02
27.99	3.679E-02	9.257E-02
29.21	7.335E-02	6.971E-02
30.42	6.678E-02	6.459E-02
33.06	7.341E-04	5.920E-02
35.49	1.415E-02	3.776E-02
39.54	1.518E-03	5.499E-02
45.62	1.243E-03	4.751E-02
55.72	1.256E-02	2.230E-02
180.00	1.256E-02	2.230E-02

B16(D,D') 20.7 MEV. EX = 12.970 ID = 219 J =

AVERAGE ENERGY = 12.9720+- 0.0016 THETA < 90
AVERAGE ENERGY = 0.0000+- 8.3247 THETA > 90
AVERAGE ENERGY = 12.9720+- 0.0016 ALL ANGLES
REACTION CROSS SECTION = 8.083E-01 +- 0.624E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.139E+00	1.270E+00
15.24	1.139E+00	1.270E+00
15.20	4.537E-03	1.802E-01
17.82	6.065E-02	1.755E-01
20.23	2.419E-03	1.119E-01
20.28	1.004E-01	1.092E-01
22.92	3.832E-02	6.595E-02
25.36	2.214E-03	8.644E-02
25.36	4.633E-02	6.577E-02
27.99	1.839E-03	6.839E-02
29.21	5.387E-02	7.175E-02
30.43	5.684E-02	6.046E-02
33.07	2.859E-02	5.165E-02
38.50	5.421E-02	3.780E-02
39.55	4.014E-02	5.501E-02
45.62	4.140E-02	3.778E-02
55.73	3.158E-02	2.914E-02
180.00	3.158E-02	2.914E-02

B16(D,D') 20.7 MEV. EX = 13.100 ID = 220 J =

AVERAGE ENERGY = 13.1577+- 0.0012 THETA < 90
AVERAGE ENERGY = 0.0000+- 3.1856 THETA > 90
AVERAGE ENERGY = 13.1577+- 0.0012 ALL ANGLES
REACTION CROSS SECTION = 3.323E+00 +- 0.722E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.400E+00	1.211E+00
15.25	3.400E+00	1.211E+00
15.21	1.956E-01	2.010E-01
17.83	3.617E-01	1.533E-01
20.28	2.405E-01	1.194E-01
20.28	3.236E-01	9.685E-02
22.92	2.870E-01	6.830E-02
25.36	2.418E-01	1.011E-01
25.36	3.605E-01	6.720E-02
28.00	3.539E-01	7.154E-02
29.22	3.249E-01	7.109E-02
30.43	3.563E-01	5.821E-02
33.07	3.061E-01	5.413E-02
35.51	3.263E-01	4.544E-02
38.56	2.888E-01	6.387E-02
45.63	3.042E-01	4.436E-02
58.74	1.562E-01	2.829E-02
180.00	1.562E-01	2.829E-02

APPENDIX B.2

$^{16}O(d,^{4}He)^{14}N$ EX < 15 MeV

816(D,A) 20.74 MEV. EX = 00.000 ID = 401 T = 0 J = 1+

AVERAGE ENERGY = 0.0456+- 0.0025 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.0020 THETA > 90
AVERAGE ENERGY = 0.0456+- 0.0025 ALL ANGLES
REACTION CROSS SECTION = 8.735E+00 +- 0.948E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.326E+01	1.668E+00
15.21	1.326E+01	1.668E+00
15.17	2.202E+00	1.015E-01
17.79	1.745E+00	6.385E-02
20.24	1.402E+00	6.046E-02
20.24	1.270E+00	4.340E-02
22.87	7.209E-01	3.232E-02
25.30	5.630E-01	3.587E-02
25.31	5.867E-01	2.803E-02
27.94	4.124E-01	2.792E-02
29.15	3.823E-01	2.018E-02
30.37	3.865E-01	1.915E-02
33.00	4.209E-01	1.815E-02
35.43	4.743E-01	2.193E-02
39.47	4.616E-01	2.694E-02
45.54	3.841E-01	2.220E-02
55.63	2.655E-01	1.127E-02
180.00	2.655E-01	1.127E-02

816(D,A) 20.74 MEV. EX = 02.313 ID = 402 T = 0 J = 0+

AVERAGE ENERGY = 2.3461+- 0.0217 THETA < 90
AVERAGE ENERGY = 0.0000+- 5.4103 THETA > 90
AVERAGE ENERGY = 2.3461+- 0.0217 ALL ANGLES
REACTION CROSS SECTION = 6.995E-02 +- 0.271E-01
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.381E-01	5.159E-02
15.22	1.381E-01	5.159E-02
15.18	4.338E-02	1.373E-02
17.80	1.673E-02	5.920E-03
20.25	1.693E-02	6.403E-03
20.25	5.247E-03	2.624E-03
22.89	6.768E-03	3.028E-03
25.32	6.642E-03	3.835E-03
25.32	8.661E-03	3.351E-03
27.96	1.839E-03	1.839E-03
29.17	1.320E-02	3.665E-03
30.39	1.804E-03	1.276E-03
33.02	3.669E-03	1.641E-03
35.45	9.592E-04	8.634E-04
39.50	1.517E-03	1.375E-02
45.57	3.726E-03	2.152E-03
55.66	4.490E-04	4.041E-04
180.00	4.490E-04	4.041E-04

B16(D,A) 20.74 MEV. EX = 03.945 ID = 403 T = 0 J = 1+

AVERAGE ENERGY = 3.9442+- 0.0002 THETA < 90
AVERAGE ENERGY = 0.0000+- 5.5551 THETA > 90
AVERAGE ENERGY = 3.9442+- 0.0002 ALL ANGLES
REACTION CROSS SECTION = 6.434E+00 +- 0.542E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	5.019E+00	6.725E-01
15.23	5.019E+00	6.725E-01
15.19	7.064E-01	5.601E-02
17.81	9.027E-01	4.473E-02
20.26	1.356E+00	5.934E-02
20.26	1.287E+00	4.370E-02
22.90	1.291E+00	4.434E-02
25.34	1.414E+00	5.809E-02
25.34	1.424E+00	4.530E-02
27.97	1.016E+00	4.462E-02
29.19	8.788E-01	3.146E-02
30.41	7.490E-01	2.724E-02
33.04	5.521E-01	2.097E-02
35.47	4.600E-01	2.157E-02
39.52	8.470E-01	4.429E-02
45.59	9.595E-01	3.589E-02
55.69	3.034E-01	1.210E-02
180.00	3.034E-01	1.210E-02

816(D,A) 20.74 MEV. EX = 04.913 ID = 404 T = 0 J = 0-

AVERAGE ENERGY = 4.9127+- 0.0022 THETA < 90
AVERAGE ENERGY = 0.0000+- 4.3049 THETA > 90
AVERAGE ENERGY = 4.9127+- 0.0025 ALL ANGLES
REACTION CROSS SECTION = 1.507E+00 +- 0.281E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.241E+00	5.316E-01
15.24	2.241E+00	5.316E-01
15.20	4.894E-01	7.985E-02
17.82	3.696E-01	5.566E-02
20.27	3.574E-01	5.263E-02
20.27	3.012E-01	3.957E-02
22.91	2.325E-01	2.417E-02
25.35	3.360E-01	2.965E-02
25.35	3.059E-01	2.507E-02
27.98	2.755E-01	2.602E-02
29.20	2.688E-01	2.016E-02
30.42	2.586E-01	1.675E-02
33.05	2.242E-01	1.496E-02
35.48	2.050E-01	1.712E-02
39.54	8.467E-02	3.723E-02
45.61	8.437E-02	1.517E-02
55.71	2.692E-02	6.794E-03
180.00	2.692E-02	6.794E-03

816(D,A) 20.74 MEV. EX = 05.106 ID = 405 T = 0 J = 2-

AVERAGE ENERGY = 5.1031+- 0.0011 THETA < 90
AVERAGE ENERGY = 0.0000+- 6.0610 THETA > 90
AVERAGE ENERGY = 5.1031+- 0.0011 ALL ANGLES
REACTION CROSS SECTION = 5.562E+00 +- 0.706E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.085 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	9.548E+00	1.288E+00
15.24	9.548E+00	1.288E+00
15.20	1.498E+00	1.051E-01
17.82	1.077E+00	6.870E-02
20.27	8.838E-01	6.425E-02
20.27	6.927E-01	4.616E-02
22.91	3.811E-01	2.823E-02
25.35	2.608E-01	2.659E-02
25.35	2.768E-01	2.427E-02
27.99	1.946E-01	2.296E-02
29.20	1.815E-01	1.768E-02
30.42	1.675E-01	1.393E-02
33.06	1.788E-01	1.372E-02
35.49	2.442E-01	1.824E-02
39.54	2.826E-01	4.192E-02
45.61	3.089E-01	2.276E-02
55.71	1.180E-01	9.406E-03
180.00	1.180E-01	9.406E-03

B16(D,A) 20.74 MEV. EX = 05.691 ID = 406 T = 0 J = 1-

AVERAGE ENERGY = 5.6971+- 0.0017 THETA < 90
AVERAGE ENERGY = 0.0000+- 2.6041 THETA > 90
AVERAGE ENERGY = 5.6971+- 0.0019 ALL ANGLES
REACTION CROSS SECTION = 1.489E+00 +- 0.257E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	9.302E-01	2.181E-01
15.24	9.302E-01	2.181E-01
15.20	1.948E-01	4.203E-02
17.82	2.233E-01	3.478E-02
20.28	2.583E-01	4.212E-02
20.28	2.696E-01	4.721E-02
22.92	2.634E-01	2.987E-02
25.35	3.315E-01	4.127E-02
25.35	3.234E-01	3.873E-02
27.99	3.359E-01	3.110E-02
29.21	3.274E-01	3.827E-02
30.43	2.683E-01	2.976E-02
33.06	2.117E-01	2.287E-02
35.50	1.494E-01	1.734E-02
39.55	8.514E-02	2.790E-02
45.62	1.191E-01	2.654E-02
55.73	8.835E-02	1.529E-02
180.00	8.835E-02	1.529E-02

816(D,A) 20.74 MEV. EX = 05.234 ID = 407 T = 0 J = 3-

AVERAGE ENERGY = 5.8306+- 0.0011 THETA < 90
AVERAGE ENERGY = 0.0000+- 4.0939 THETA > 90
AVERAGE ENERGY = 5.8306+- 0.0012 ALL ANGLES
REACTION CROSS SECTION = 2.131E+00 +- 0.317E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.843E+00	3.163E-01
15.24	1.843E+00	3.163E-01
15.20	2.813E-01	4.634E-02
17.82	3.339E-01	3.806E-02
20.28	3.500E-01	4.475E-02
20.28	3.507E-01	4.838E-02
22.92	2.445E-01	2.942E-02
25.36	3.137E-01	4.077E-02
25.36	3.410E-01	3.904E-02
27.99	2.863E-01	2.953E-02
29.21	2.473E-01	3.711E-02
30.43	1.837E-01	2.837E-02
33.07	1.538E-01	2.239E-02
35.50	1.656E-01	1.779E-02
39.55	1.494E-01	2.980E-02
45.62	1.538E-01	2.736E-02
55.73	1.157E-01	1.570E-02
180.00	1.157E-01	1.570E-02

816(D,A) 20.74 MEV. EX = 06.198 ID = 408 T = 0 J = 1+

AVERAGE ENERGY = 6.1920+- 0.0009 THETA < 90
AVERAGE ENERGY = 0.0000+- 8.3780 THETA > 90
AVERAGE ENERGY = 6.1920+- 0.0009 ALL ANGLES
REACTION CROSS SECTION = 2.614E+00 +- 0.306E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.876E+00	4.133E-01
15.25	2.876E+00	4.133E-01
15.20	4.543E-01	4.490E-02
17.83	5.341E-01	3.424E-02
20.28	4.705E-01	3.489E-02
20.28	4.383E-01	2.463E-02
22.92	3.929E-01	2.409E-02
25.36	4.285E-01	3.145E-02
25.36	4.534E-01	2.459E-02
28.00	3.761E-01	2.666E-02
29.22	2.908E-01	1.774E-02
30.43	2.970E-01	1.854E-02
33.07	2.299E-01	1.392E-02
35.50	2.441E-01	1.577E-02
39.56	1.853E-01	3.437E-02
45.63	1.872E-01	1.556E-02
55.74	1.063E-01	8.558E-03
180.00	1.063E-01	8.558E-03

816(D,A) 20.74 MEV. EX = 06.444 ID = 409 T = 0 J = 3+

AVERAGE ENERGY = 6.4391+- 0.0020 THETA < 90
AVERAGE ENERGY = 0.0000+- 1.4993 THETA > 90
AVERAGE ENERGY = 6.4391+- 0.0020 ALL ANGLES
REACTION CROSS SECTION = 2.761E+00 +- 0.298E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.221E+00	3.332E-01
15.25	2.221E+00	3.332E-01
15.21	3.850E-01	4.131E-02
17.83	3.046E-01	2.580E-02
20.29	2.702E-01	2.672E-02
20.29	2.001E-01	1.656E-02
22.93	1.674E-01	1.609E-02
25.36	1.855E-01	2.082E-02
25.36	2.057E-01	1.668E-02
28.00	2.018E-01	1.945E-02
29.22	2.077E-01	1.501E-02
30.44	1.746E-01	1.505E-02
33.07	2.167E-01	1.354E-02
35.51	2.431E-01	1.574E-02
39.56	1.659E-01	3.474E-02
45.63	2.157E-01	1.669E-02
55.74	1.699E-01	1.019E-02
180.00	1.699E-01	1.019E-02

816(D,A) 20.74 MEV. EX = 07.028 ID = 410 T = 0 J = 2+

AVERAGE ENERGY = 7.0164+- 0.0013 THETA < 90
AVERAGE ENERGY = 0.0000+- 9.1962 THETA > 90
AVERAGE ENERGY = 7.0164+- 0.0013 ALL ANGLES
REACTION CROSS SECTION = 1.209E+01 +- 0.115E+01
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.483E+01	1.858E+00
15.25	1.483E+01	1.858E+00
15.21	2.404E+00	1.062E-01
17.83	2.686E+00	8.137E-02
20.29	2.493E+00	8.277E-02
20.29	2.567E+00	6.592E-02
22.93	2.034E+00	5.740E-02
25.37	1.945E+00	6.904E-02
25.37	2.074E+00	5.712E-02
28.01	1.516E+00	5.532E-02
29.23	1.251E+00	3.831E-02
30.44	1.104E+00	3.377E-02
33.08	7.472E-01	2.473E-02
35.52	5.557E-01	2.467E-02
39.57	5.538E-01	3.964E-02
45.65	8.490E-01	3.360E-02
56.75	4.469E-01	1.492E-02
180.00	4.469E-01	1.492E-02

O16(D,A) 20.74 MEV. EX = 07.966 ID = 411 T = 0 J = 2-

AVERAGE ENERGY = 7.9640+- 0.0017 THETA < 90
AVERAGE ENERGY = 0.0000+- 3.4093 THETA > 90
AVERAGE ENERGY = 7.9640+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 2.825E+00 +- 0.323E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.044E+00	4.322E-01
15.26	3.044E+00	4.322E-01
15.22	5.444E-01	4.897E-02
17.84	3.771E-01	2.839E-02
20.30	3.060E-01	2.739E-02
20.30	2.264E-01	3.104E-02
22.94	2.427E-01	1.831E-02
25.38	1.962E-01	4.090E-02
25.38	2.112E-01	2.764E-02
28.02	2.529E-01	2.171E-02
29.24	2.034E-01	1.453E-02
30.46	2.077E-01	1.385E-02
33.10	2.089E-01	1.647E-02
35.53	1.838E-01	2.215E-02
39.59	1.979E-01	4.275E-02
45.67	2.700E-01	1.850E-02
55.78	1.299E-01	7.754E-03
180.00	1.299E-01	7.754E-03

816(D,A) 20.74 MEV. EX = 08.489 ID = 413 T = 0 J = 4-

AVERAGE ENERGY = 8.4852+- 0.0024 THETA < 90
AVERAGE ENERGY = 0.0000+- 2.0801 THETA > 90
AVERAGE ENERGY = 8.4852+- 0.0025 ALL ANGLES
REACTION CROSS SECTION = 6.234E+00 +- 0.536E+00
INTEGRATION LENGTH = 1.924 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.976E+00	5.682E-01
15.26	3.976E+00	5.682E-01
15.22	6.650E-01	5.423E-02
17.85	5.935E-01	3.586E-02
20.31	5.432E-01	4.323E-02
20.31	4.560E-01	3.951E-02
22.95	4.500E-01	2.556E-02
25.39	5.396E-01	5.880E-02
25.39	5.867E-01	3.859E-02
28.03	6.777E-01	3.602E-02
29.25	7.193E-01	2.819E-02
30.47	8.149E-01	2.908E-02
33.11	7.606E-01	3.018E-02
35.54	7.617E-01	3.519E-02
39.60	5.786E-01	4.962E-02
45.68	5.609E-01	2.699E-02
55.79	3.981E-01	1.474E-02
180.00	3.981E-01	1.474E-02

816(D,A) 20.74 MEV. EX = 08.971 ID = 417 T = 0 J = KQ,IQ

AVERAGE ENERGY = 8.9538+- 0.0023 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.2278 THETA > 90
AVERAGE ENERGY = 8.9538+- 0.0023 ALL ANGLES
REACTION CROSS SECTION = 3.715E+00 +- 0.467E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.439E+00	5.258E-01
15.27	2.439E+00	5.258E-01
15.23	5.007E-01	6.374E-02
17.85	4.608E-01	6.375E-02
20.31	3.708E-01	4.834E-02
20.31	2.827E-01	5.052E-02
22.96	2.621E-01	3.300E-02
25.40	2.225E-01	5.477E-02
25.40	2.668E-01	4.655E-02
28.04	3.058E-01	3.247E-02
29.26	2.797E-01	3.312E-02
30.48	3.104E-01	2.863E-02
33.12	2.938E-01	2.804E-02
35.55	3.167E-01	3.415E-02
39.61	3.432E-01	5.217E-02
45.69	3.760E-01	3.673E-02
55.81	2.409E-01	1.894E-02
180.00	2.409E-01	1.894E-02

O16(D,A) 20.74 MEV. EX = 09.129 ID = 419 T = 0 J = 2-

AVERAGE ENERGY = 9.1405+- 0.0018 THETA < 90
AVERAGE ENERGY = 0.0000+- 3.4847 THETA > 90
AVERAGE ENERGY = 9.1405+- 0.0018 ALL ANGLES
REACTION CROSS SECTION = 1.698E+00 +- 0.385E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.850E+00	4.997E-01
15.27	1.850E+00	4.997E-01
15.23	3.443E-01	8.682E-02
17.85	2.930E-01	6.536E-02
20.31	2.743E-01	4.652E-02
20.31	2.266E-01	5.388E-02
22.96	1.568E-01	3.082E-02
25.40	1.401E-01	5.320E-02
25.40	1.922E-01	4.465E-02
28.04	2.014E-01	3.358E-02
29.26	2.101E-01	3.521E-02
30.48	1.683E-01	2.715E-02
33.12	1.522E-01	2.531E-02
35.56	1.799E-01	2.957E-02
39.61	6.455E-02	4.475E-02
45.69	1.344E-01	3.554E-02
55.81	7.478E-02	1.939E-02
180.00	7.478E-02	1.939E-02

816(D,A) 20.74 MEV. EX = 09.388 ID = 421 T = 0 J = 2-

AVERAGE ENERGY = 9.3959+- 0.0024 THETA < 90
AVERAGE ENERGY = 0.0000+- 8.2848 THETA > 90
AVERAGE ENERGY = 9.3959+- 0.0024 ALL ANGLES
REACTION CROSS SECTION = 2.373E+00 +- 0.380E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.960E+00	4.786E-01
15.27	1.960E+00	4.786E-01
15.23	4.116E-01	8.097E-02
17.86	3.619E-01	5.325E-02
20.32	4.428E-01	5.596E-02
20.32	3.982E-01	4.567E-02
22.96	2.879E-01	3.211E-02
25.40	3.012E-01	6.545E-02
25.40	4.368E-01	3.696E-02
28.04	3.715E-01	2.934E-02
29.26	3.860E-01	3.242E-02
30.48	3.358E-01	3.064E-02
33.12	2.749E-01	2.779E-02
35.56	2.272E-01	2.898E-02
39.62	1.603E-01	4.246E-02
45.70	2.243E-01	3.271E-02
55.82	1.224E-01	1.657E-02
180.00	1.224E-01	1.657E-02

816(D,A) 20.74 MEV. EX = 09.702 ID = 423 T = 0 J = 1+

AVERAGE ENERGY = 9.7198+- 0.0019 THETA < 90
AVERAGE ENERGY = 0.0000+- 4.5173 THETA > 90
AVERAGE ENERGY = 9.7198+- 0.0019 ALL ANGLES
REACTION CROSS SECTION = 3.492E-01 +- 0.295E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.084 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.940E-01	4.482E-01
15.27	1.940E-01	4.482E-01
15.23	8.488E-02	9.958E-02
17.86	1.338E-01	6.023E-02
20.32	8.934E-02	5.550E-02
20.32	2.987E-02	4.272E-02
22.97	3.800E-02	3.588E-02
25.41	2.202E-03	6.195E-02
25.41	7.018E-02	3.675E-02
28.05	1.323E-01	2.480E-02
29.27	6.909E-02	3.505E-02
30.49	4.711E-02	3.716E-02
33.13	3.271E-02	2.760E-02
35.57	5.117E-02	3.185E-02
39.63	2.071E-02	4.175E-02
45.71	1.826E-02	3.230E-02
55.83	2.191E-02	1.722E-02
180.00	2.191E-02	1.722E-02

θ16(D,A) 20.74 MEV. EX = 10.090 ID = 424 T = 0 J = (U,I)Q

AVERAGE ENERGY = 10.0720+- 0.0017 THETA < 90
AVERAGE ENERGY = 0.0000+- 1.4653 THETA > 90
AVERAGE ENERGY = 10.0720+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 1.759E+00 +- 0.403E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.428E+00	5.598E-01
15.28	1.428E+00	5.598E-01
15.24	3.432E-01	1.179E-01
17.86	2.661E-01	8.462E-02
20.33	3.245E-01	6.858E-02
20.33	2.288E-01	4.695E-02
22.97	1.872E-01	4.226E-02
25.41	2.030E-01	7.213E-02
25.41	2.860E-01	4.542E-02
28.06	2.136E-01	3.915E-02
29.28	1.430E-01	4.155E-02
30.50	1.649E-01	4.963E-02
33.14	1.537E-01	3.561E-02
35.57	1.640E-01	3.636E-02
39.63	1.047E-01	3.873E-02
45.72	1.292E-01	3.788E-02
55.84	1.001E-01	1.864E-02
180.00	1.001E-01	1.864E-02

816(D,A) 20.74 MEV. EX = 10.228 ID = 425 T = 0 J = UN-E

AVERAGE ENERGY = 10.2753+- 0.0013 THETA < 90
AVERAGE ENERGY = 0.0000+- 5.5140 THETA > 90
AVERAGE ENERGY = 10.2753+- 0.0013 ALL ANGLES
REACTION CROSS SECTION = 9.769E-01 +- 0.394E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	1.478E+00	6.149E-01
15.28	1.478E+00	6.149E-01
16.24	1.255E-01	1.152E-01
17.87	1.829E-01	8.525E-02
20.33	1.762E-01	8.256E-02
20.33	1.165E-01	5.209E-02
22.97	8.325E-02	4.255E-02
25.42	1.096E-01	8.195E-02
28.42	1.470E-01	4.097E-02
28.06	1.210E-01	4.103E-02
29.23	1.236E-01	4.109E-02
30.50	9.119E-02	4.684E-02
33.14	8.265E-02	3.815E-02
35.59	8.243E-02	3.771E-02
39.64	1.510E-03	4.402E-02
45.72	1.722E-02	3.909E-02
55.84	2.940E-02	1.835E-02
180.00	2.940E-02	1.835E-02

816(D,A) 20.74 MEV. EX = 10.560 ID = 427 T = 0 J = 1-

AVERAGE ENERGY = 10.5461+- 0.0015 THETA < 90
AVERAGE ENERGY = 0.0000+- 1.4502 THETA > 90
AVERAGE ENERGY = 10.5461+- 0.0016 ALL ANGLES
REACTION CROSS SECTION = 7.342E-01 +- 0.377E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	7.673E-01	5.752E-01
15.28	7.673E-01	5.752E-01
15.24	7.303E-02	1.177E-01
17.87	1.253E-01	7.415E-02
20.33	1.899E-01	7.348E-02
20.33	1.005E-01	5.699E-02
22.98	3.366E-02	4.527E-02
25.42	2.201E-03	7.021E-02
25.42	1.228E-01	3.822E-02
28.06	9.518E-02	4.964E-02
28.29	1.198E-01	4.223E-02
30.51	5.844E-02	3.904E-02
33.15	6.976E-02	3.272E-02
35.59	7.757E-02	3.938E-02
38.65	3.623E-02	5.337E-02
45.73	1.236E-03	3.878E-02
55.85	3.803E-02	1.952E-02
180.00	3.803E-02	1.952E-02

816(D,A) 20.74 MEV. EX = 10.810 ID = 428 T = 0 J = 4+

AVERAGE ENERGY = 10.8272+- 0.0015 THETA < 90
AVERAGE ENERGY = 0.0000+- 7.2889 THETA > 90
AVERAGE ENERGY = 10.8272+- 0.0016 ALL ANGLES
REACTION CROSS SECTION = 1.530E+00 +- 0.444E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	6.741E-01	5.900E-01
15.29	6.741E-01	5.900E-01
15.24	1.629E-01	1.462E-01
17.87	1.584E-01	8.703E-02
20.34	2.679E-01	6.349E-02
20.34	1.909E-01	5.402E-02
22.98	1.274E-01	4.705E-02
25.43	1.090E-01	5.747E-02
25.43	2.293E-01	4.461E-02
28.07	1.926E-01	6.595E-02
29.29	1.828E-01	4.801E-02
30.51	2.035E-01	4.277E-02
33.15	2.096E-01	3.943E-02
35.59	2.325E-01	4.454E-02
39.65	2.112E-01	5.895E-02
45.74	1.460E-01	4.362E-02
55.86	1.043E-01	2.472E-02
180.00	1.043E-01	2.472E-02

O16(D,A) 20.74 MEV. EX = 11.045 ID = 429 T = 0 J = 1+

AVERAGE ENERGY = 11.0679+- 0.0023 THETA < 90
AVERAGE ENERGY = 0.0000+- 2.5006 THETA > 90
AVERAGE ENERGY = 11.0679+- 0.0023 ALL ANGLES
REACTION CROSS SECTION = 4.956E+00 +- 0.850E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	4.520E+00	1.075E+00
15.29	4.520E+00	1.075E+00
15.25	8.416E-01	1.983E-01
17.88	1.036E+00	1.472E-01
20.34	1.160E+00	1.059E-01
20.34	9.634E-01	1.006E-01
22.99	6.929E-01	7.816E-02
25.43	8.639E-01	9.017E-02
25.43	9.309E-01	7.454E-02
28.07	7.671E-01	9.230E-02
29.30	5.682E-01	9.107E-02
30.52	5.956E-01	7.581E-02
33.16	4.984E-01	5.886E-02
35.60	4.108E-01	5.682E-02
39.66	3.021E-01	6.863E-02
45.75	2.895E-01	5.800E-02
55.87	2.471E-01	4.049E-02
180.00	2.471E-01	4.049E-02

816(D,A) 20.74 MEV. EX = 11.240 ID = 431 T = 0 J = 3-

AVERAGE ENERGY = 11.2196+- 0.0011 THETA < 90
AVERAGE ENERGY = 0.0000+- 5.8660 THETA > 90
AVERAGE ENERGY = 11.2196+- 0.0011 ALL ANGLES
REACTION CROSS SECTION = 2.943E+00 +- 0.944E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.439E+00	1.372E+00
15.29	3.439E+00	1.372E+00
15.25	7.197E-01	2.208E-01
17.88	5.145E-01	2.113E-01
20.34	5.087E-01	1.529E-01
20.34	3.806E-01	1.343E-01
22.99	2.455E-01	8.711E-02
25.43	2.052E-01	9.674E-02
25.43	3.068E-01	8.044E-02
28.08	2.724E-01	9.286E-02
29.30	2.412E-01	1.019E-01
30.52	2.221E-01	8.696E-02
33.16	1.773E-01	8.015E-02
35.60	2.117E-01	7.941E-02
39.66	2.709E-01	9.696E-02
45.75	1.691E-01	7.219E-02
55.88	1.226E-01	5.116E-02
180.00	1.226E-01	5.116E-02

016(D,A) 20.74 MEV. EX = 11.300 ID = 432 T = 0 J = 2-

AVERAGE ENERGY = 11.3170+- 0.0010 THETA < 90
AVERAGE ENERGY = 0.0000+- 8.0971 THETA > 90
AVERAGE ENERGY = 11.3170+- 0.0010 ALL ANGLES
REACTION CROSS SECTION = 2.252E+00 +- 0.856E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	2.633E+00	1.420E+00
15.29	2.633E+00	1.420E+00
15.25	4.022E-01	1.994E-01
17.88	4.430E-01	2.143E-01
20.34	3.333E-01	1.440E-01
20.34	3.456E-01	1.221E-01
22.99	1.502E-01	6.590E-02
25.43	1.576E-01	9.093E-02
25.43	1.727E-01	7.300E-02
28.08	1.188E-01	8.032E-02
29.30	1.630E-01	9.157E-02
30.52	1.428E-01	7.083E-02
33.17	1.569E-01	8.344E-02
35.60	1.928E-01	8.647E-02
39.67	1.513E-01	8.597E-02
45.75	1.536E-01	5.982E-02
55.83	9.577E-02	4.264E-02
180.00	9.577E-02	4.264E-02

816(D,A) 20.74 MEV. EX = 11.400 ID = 433 T = 0 J = 1+

AVERAGE ENERGY = 11.4113+- 0.0012 THETA < 90
AVERAGE ENERGY = 0.0000+- 0.1425 THETA > 90
AVERAGE ENERGY = 11.4113+- 0.0012 ALL ANGLES
REACTION CROSS SECTION = 2.133E+00 +- 0.724E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.125E+00	1.172E+00
15.29	3.125E+00	1.172E+00
15.25	4.496E-01	2.271E-01
17.38	4.316E-01	1.704E-01
20.35	3.137E-01	1.243E-01
20.35	2.943E-01	1.150E-01
22.99	1.579E-01	6.692E-02
25.44	1.944E-01	8.469E-02
25.44	1.988E-01	8.718E-02
28.08	1.216E-01	7.804E-02
29.30	1.243E-01	8.346E-02
30.52	1.181E-01	7.625E-02
33.17	1.211E-01	6.545E-02
35.61	1.333E-01	7.091E-02
39.67	1.144E-01	6.242E-02
45.76	8.259E-02	4.637E-02
55.88	6.740E-02	3.356E-02
180.00	6.740E-02	3.356E-02

816(D,A) 20.74 MEV. EX = 11.510 ID = 434 T = 0 J = 3+

AVERAGE ENERGY = 11.5332+- 0.0011 THETA < 90
AVERAGE ENERGY = 0.0000+- 2.9870 THETA > 90
AVERAGE ENERGY = 11.5332+- 0.0011 ALL ANGLES
REACTION CROSS SECTION = 3.132E+00 +- 0.846E+00
INTEGRATION LENGTH = 1.925 + 0.133 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.481E+00	1.213E+00
15.29	3.481E+00	1.213E+00
15.25	4.706E-01	2.460E-01
17.83	5.213E-01	1.423E-01
20.35	4.651E-01	1.285E-01
20.35	5.203E-01	1.204E-01
23.00	3.789E-01	8.793E-02
25.44	2.974E-01	9.452E-02
25.44	4.320E-01	1.029E-01
28.03	3.273E-01	8.544E-02
29.31	2.796E-01	9.053E-02
30.53	2.816E-01	8.466E-02
33.17	2.813E-01	7.087E-02
35.61	2.855E-01	7.105E-02
35.67	2.149E-01	6.543E-02
45.76	2.320E-01	6.813E-02
55.89	1.324E-01	4.345E-02
180.00	1.324E-01	4.345E-02

816(D,A) 20.74 MEV. EX = 11.660 ID = 435 T = 0 J = NUQ,I-E

AVERAGE ENERGY = 11.7255+- 0.0017 THETA < 90
AVERAGE ENERGY = 0.0000+- 7.4053 THETA > 90
AVERAGE ENERGY = 11.7255+- 0.0017 ALL ANGLES
REACTION CROSS SECTION = 3.116E+00 +- 0.778E+00
INTEGRATION LENGTH = 1.925 + 0.134 + 1.083 = 3.142

DIFFERENTIAL CROSS SECTION IN MB/SR (CM)
CENTER OF MASS ANGLE IN DEGREES

ABCISSA	ORDINATE	ERROR
0.00	3.972E+00	1.113E+00
15.30	3.972E+00	1.113E+00
15.26	3.904E-01	2.078E-01
17.83	4.789E-01	1.173E-01
20.35	5.711E-01	1.029E-01
20.35	4.431E-01	9.243E-02
23.00	2.269E-01	7.886E-02
25.44	2.612E-01	9.838E-02
25.44	3.137E-01	7.634E-02
28.09	1.639E-01	8.044E-02
28.31	3.347E-01	8.488E-02
30.53	2.464E-01	6.768E-02
33.18	2.336E-01	6.003E-02
35.62	2.635E-01	5.890E-02
38.68	1.961E-01	6.121E-02
45.77	1.511E-01	6.590E-02
55.90	1.206E-01	3.719E-02
180.00	1.206E-01	3.719E-02

```
616(D,A) 20.74 MEV.  EX = 12.827  ID = 447  T = 0  J = 4-
                                        AVERAGE ENERGY = 12.9097+- 0.0028 THETA < 90
                                        AVERAGE ENERGY =  0.0000+- 6.7972 THETA > 90
                                        AVERAGE ENERGY = 12.9097+- 0.0028 ALL ANGLES
DIFFERENTIAL CROSS SECTION IN MB/SR (CM)  REACTION CROSS SECTION =  2.761E+01 +-  0.308E+01
CENTER OF MASS ANGLE IN DEGREES           INTEGRATION LENGTH = 1.925 + 0.134 + 1.083 = 3.142

   ABCISSA  ORDINATE     ERROR
      0.00 2.407E+01 3.887E+00
     15.31 2.407E+01 3.887E+00
     15.27 3.208E+00 4.104E-01
     17.99 3.670E+00 3.564E-01
     20.37 3.688E+00 3.597E-01
     20.37 3.447E+00 2.442E-01
     23.02 2.109E+00 2.460E-01
     25.47 2.590E+00 3.306E-01
     25.47 2.972E+00 2.251E-01
     28.12 2.783E+00 2.727E-01
     28.34 2.187E+00 2.055E-01
     30.56 2.536E+00 1.824E-01
     33.21 2.333E+00 1.627E-01
     35.65 2.009E+00 1.845E-01
     39.72 2.101E+00 2.250E-01
     45.81 2.066E+00 1.895E-01
     55.95 1.533E+00 8.962E-02
    180.00 1.533E+00 8.962E-02
 STOP
```

APPENDIX C

Procedure for Silicon Surface Barrier Detector Preparation

1. Crystal Specification

   1.1 The resistivity and reverse bias of a pn junction determines the thickness (W in microns) of the charge depleted region.

$$W(\mu) = 0.5 \sqrt{\rho\{\text{ohmcm}\}\ V\{\text{volts}\}}$$

   This means that one desires a high resistivity in order to fabricate thick detectors that operate at relatively low bias.

   1.2 The carrier life time should be greater than 10^{-3} sec.

   1.3 Uniformity

2. Sample Preparation

   2.1 Cut sample from N type stock at any angle to thickness W + 500 microns and to desired shape with a diamond saw.

   2.2 Lap sample to remove all saw cut damage as determined by visual inspection

   Lapping Procedure:

   2.21 600 grit then rinse with H_2O

   2.22 1000 grit then rinse with H_2O

   2.23 Use 6 micron diamond wheel (use special diamond lubricant)

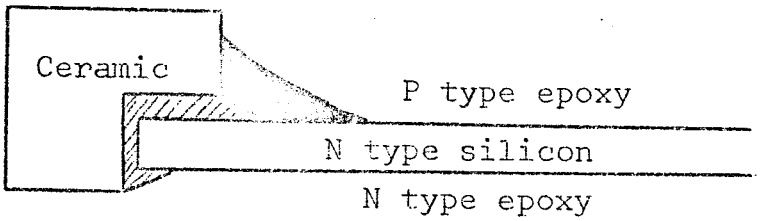
2.3 Degrease sample with cotton swabs and trichloroethylene, methyl alcohol, and a 30 second etch using $1HF + 3HNO_3$. Rinse sample completely in H_2O. (Option: not to etch one surface).

2.4 Etch sample in CP-4(3HF, $5HNO_3$, 3HCOOH) for 90 seconds; then rinse with H_2O in ion-meter until a reading of less than 10^{-6} NaCl ion count equivalent is obtained. Dry sample with N_2.

2.5 Epoxy sample in a ceramic holding ring (rings are machined from lavite and baked at 1400° F). Use Ciba 502 Epoxy mixed 10:1 with Ciba Hardner type 951. Allow to harden in dry atmosphere for 24 hours.

2.6 Etch mounted sample (option: leave one surface etched) in CP-4 for 30 seconds. Rinse with H_2O in ionometer until reading less than 10^{-6} NaCl equivalent is obtained.

2.7 Lay down an epoxy ring which tapers the surface of the detector to the holder wall. See figure:



with Ciba 502 epoxy + 1% iodine by weight mixed with Epoxylite no. 204 B Hardner

2.8 Evaporate gold and aluminum contacts.

LIST OF REFERENCES

Ba 62 R. H. Bassel, R. M. Drisko, and G. R. Satchler, ORNL 3240

Ba 69 D. L. Bayer, Bulletin of APS Series II Vol. 14 Num 12 (1969) 1243

Be 65 G. Bencze and E. Pietarinen, Phys. Letters 19 (1965) 586

Cl 62 C. F. Clements, Phy. Rev. 128 (1962) 2724

Cl 65 C. F. Clement, Nucl. Phys. 66 (1965) 241

Di 65 J. K. Dickens and F. G. Percy, Phys. Rev. 138 (1965) B 1083

Gi 66 F. P. Gibson and A. K. Kerman, Phys. Rev. 145 (1966) 758

Ha 66 B. G. Harvey, et al, Phy. Rev. 146 (1966) 712

Hi 68 F. Hinterberger, et al, Nucl. Phy. A115 (1968) 570

Jo 70 R. C. Johnson, PJR Soper, PRC 1 (1970) 976

Kl 64 E. D. Klema, Nucl. Inst. and Meth. 26 (1964) 205

Ma 67 G. H. MacKenzie, E. Kashy, M. M. Gordon, and H. G. Blosser, IEEE Transactions on Nuclear Science, NS-14 3 (1967) 353

Mc 69 F. K. McGowan, W. T. Miller, H. J. Kim and W. Hyatt, Nuclear Data Tables A6 (1969) 353

Pr 70 B. M Preedom, J. L. Snelgrove, and E. Kashy, Phys. Rev. C1 (1970) 1132

Sc 69 P. Schwandt, CU Cyclotron Program Utilization Report (1969)

Si 59 Silverstein, Nucl. Inst. and Meth. 4 (1959) 53

Sn 69 J. L. Snelgrove and E. Kashy, Phys. Rev. 187 (1969) 1246

Sn 69a J. L. Snelgrove and E. Kashy, Phys. Rev. 187 (1969) 1259

Tr 63 W. W. True, PR 130 (1963) 1530

Tr 70 G. F. Trentelman, PhD Thesis, M.S.U. (1970)

Tr 70a G. F. Trentelman and E. Kashy, Nucl. Instr. and Meth., to be published