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Title: n + 11-B Gamma-Ray Production Evaluation

Author(s): Conlin, Jeremy Lloyd
Young, P. G.

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Los Alamos National Laboratory
Los Alamos, New Mexico 87545

memorandum

TO: R. Little and R. Seamon, X-6, B226 DATE: August 31, 1984

FROM: P. G. Young, T-2 PGY MAIL STOP/TELEPHONE: B243/7670

SYMBOL: T-2-M-1529

SUBJECT: n + ^{11}B GAMMA-RAY PRODUCTION EVALUATION

Group P-3 (Auchampaugh and Wender) has provided T-2 with measurements of neutron-induced gamma-ray spectra for neutron energies between 2 and 42 MeV and gamma-ray energies between ~ 1.6 and 20 MeV. To minimize delays in making this information available to X-Division, I have placed the data into ENDF/B format in as direct a manner as possible. In particular, I simply averaged the data over the five angles measured (45°, 55°, 90°, 125°, 145°), after converting to a common gamma-ray bin structure. Because the lower energy cutoff of ~ 16 MeV for the gamma rays results in significant loss of cross section at higher energies, I filled in the gamma-ray spectra at E_γ < 1.75 MeV with simple nuclear model calculations. These calculations were made with the same optical model parameters as were used for ^{15}N (page 6 of Ref. 1) and covered the incident neutron energy range of 2.5-19.5 MeV. The combined experimental and calculated gamma-ray spectra were incorporated into the existing ENDF/B-V neutron data evaluation for ^{11}B without modification of the latter. The results are stored in the Common File System under

/T2/PGY/EVAL/LAS/B11V5GR .

The first attached figure shows the total gamma-ray production cross section from the inelastic neutron threshold to 20 MeV. The new spectrum measurements (points with error bars) are compared to the theoretical calculations (histogram) for 14.5-MeV incident neutrons in the next several figures. The calculations appear to generally reproduce the measured shapes, although the magnitude of the cross section is overestimated in the calculation by 30-40%. Somewhat better agreement would be apparent if the lines in the calculated histogram were broadened. The averaged experimental spectum is shown in the next-to-final figure. These results, together with the calculated curve below E_γ = 1.75 MeV, were used for the evaluation.

It should be emphasized that this evaluation is strictly interim until the new data can be more thoroughly analyzed. In addition to incorporating gamma-ray angular effects, we need to infer the neutron inelastic cross sections from the data and attempt to reconcile that information with other independent measurements. The nuclear model calculations used to interpolate and extrapolate the data need to be better optimized to all the data available for ^{11}B. Finally, discrepancies known to exist in the neutron

data need to be addressed and corrected. The use of these data for problems when neutron transport is important is not recommended. For example, 20% errors are known to exist in the total cross section, and the total neutron emission energy at 14 MeV is too low by several factors. We anticipate completing a new evaluation during FY1985.

Bob MacFarlane processed the new evaluations using our standard procedures, and the results are available on

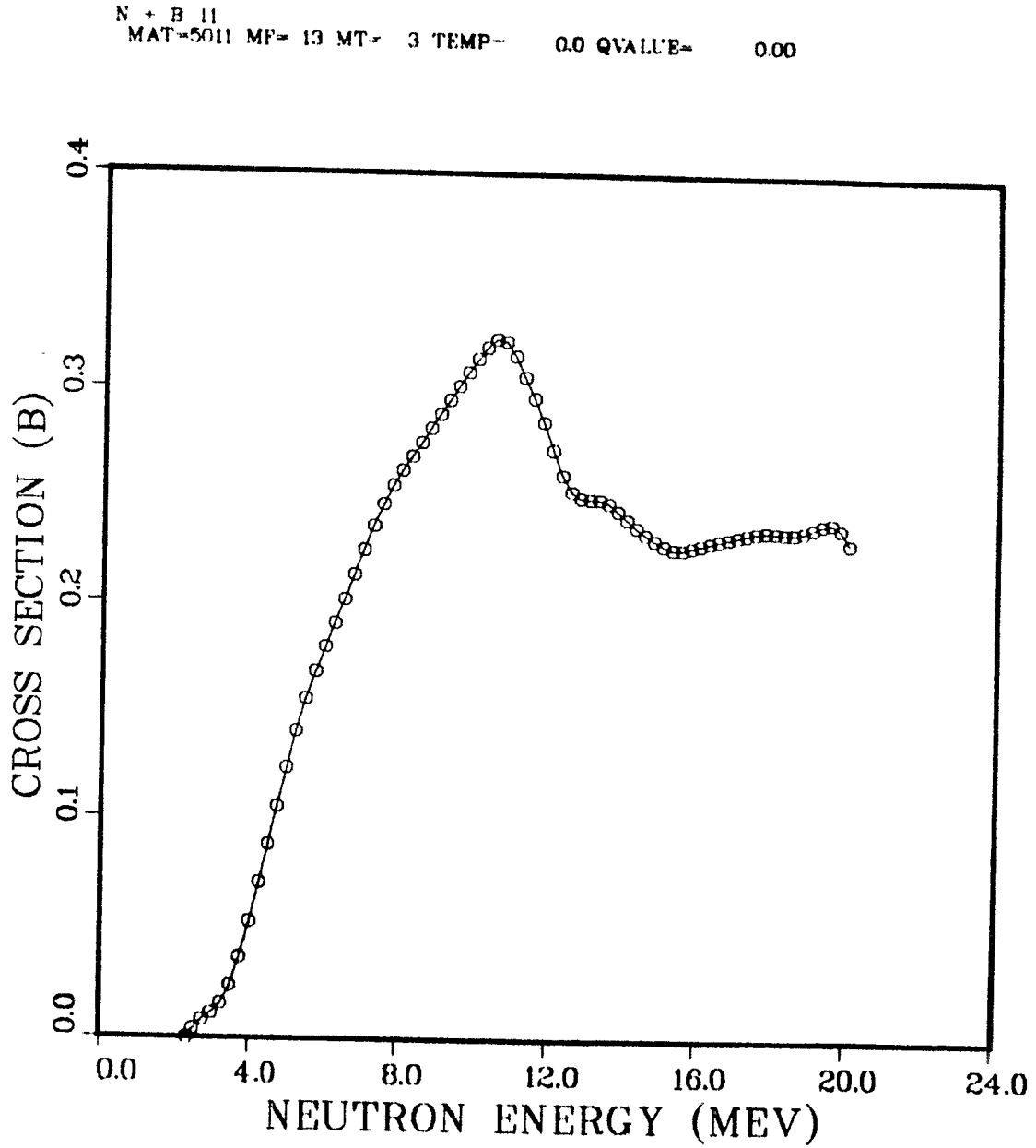
/TD30X12/GENDF/B11L
DTF/B11L
PLOTS/B11L
OUTPUT/B11L.

The plot of the (n,γ) matrix is attached as the final figure.

Ref: 1. E. D. Arthur, "Applied Nuclear Data Research and Development Semiannual Progress Report: October 1, 1982-March 31, 1983, " LA-9841-PR (1983).

Encs: 9 Figures

Distribution:
J. Gordon, X-2, B220
G. Auchampaugh, P-3, D449
S. Wender, P-3, D449
R. MacFarlane, T-2, B243
E. Arthur, T-2, B243
T-2 Files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CROSS SECTION (B)
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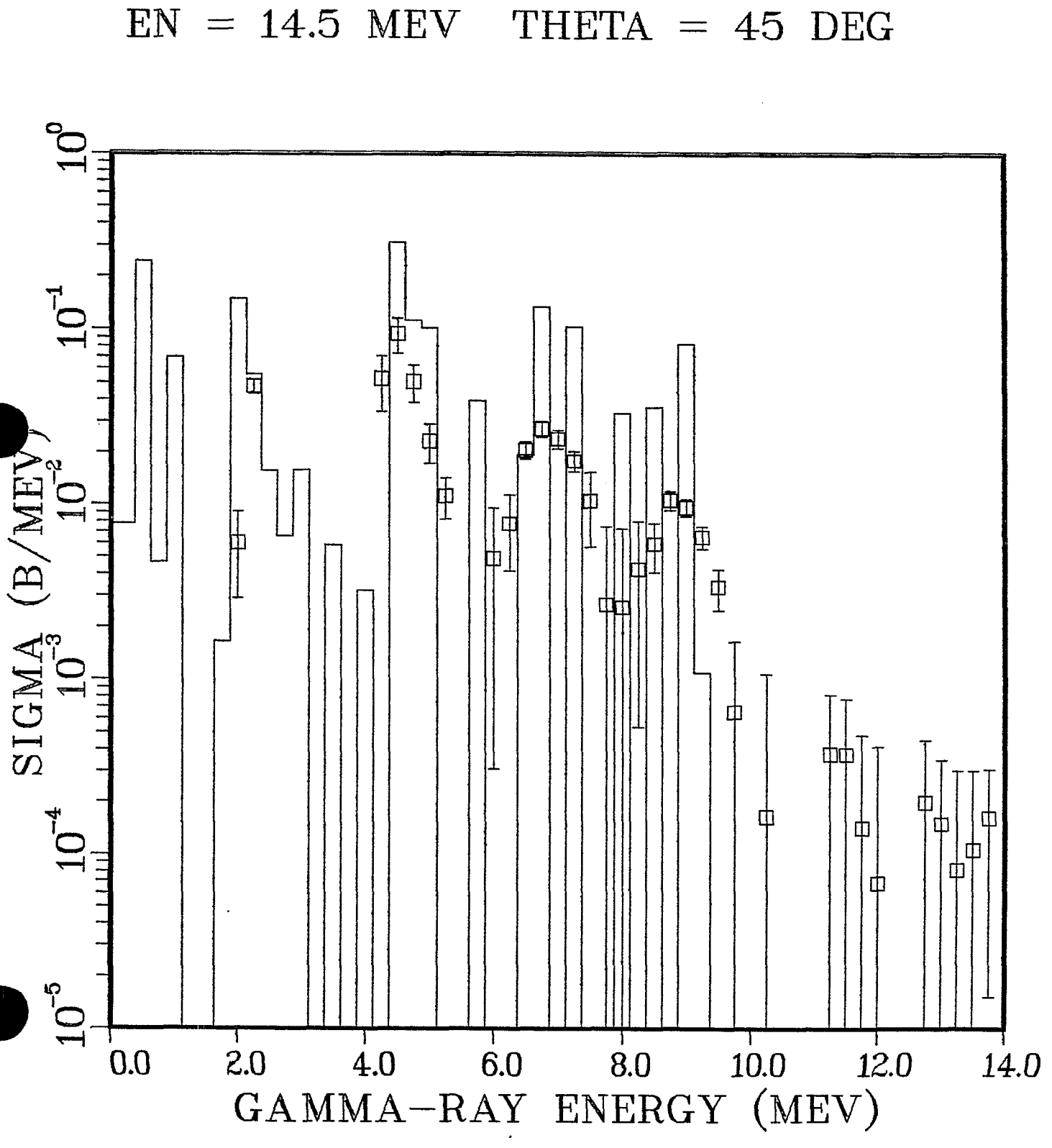
0.1
0.2
0.3
0.4
0.0
4.0
8.0
12.0
16.0
20.0
24.0
NEUTRON ENERGY (MEV)

Figure 1.

Figure 2.


EN = 14.5 MEV THETA = 45 DEG
SIGMA (B/MEV)
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10^-1
10^-2
10^-3
10^-4
10^-5
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2.0
4.0
6.0
8.0
10.0
12.0
14.0
GAMMA-RAY ENERGY (MEV)

Figure 3.

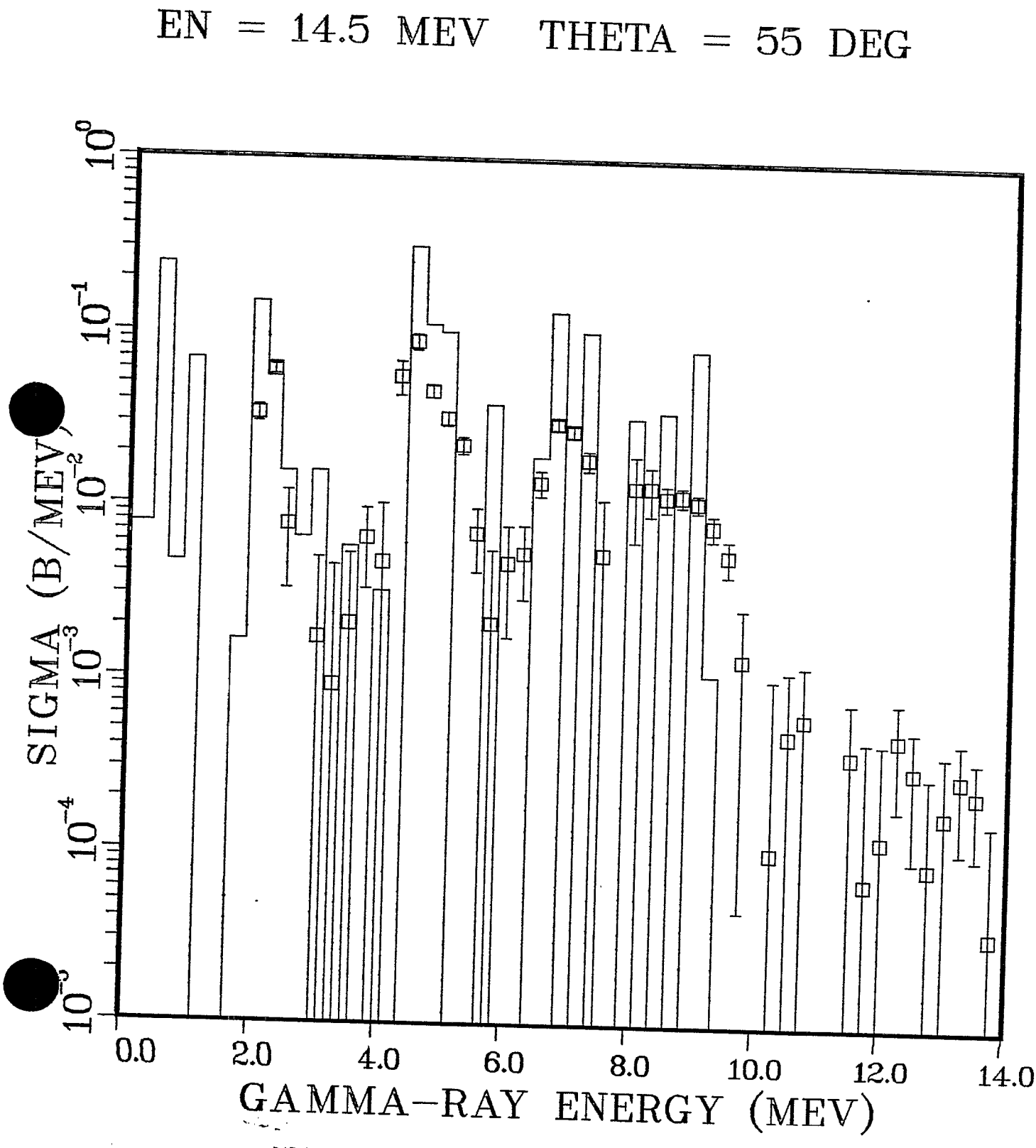

EN = 14.5 MEV THETA = 55 DEG
SIGMA (B/MEV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
GAMMA-RAY ENERGY (MEV)

Figure 4.

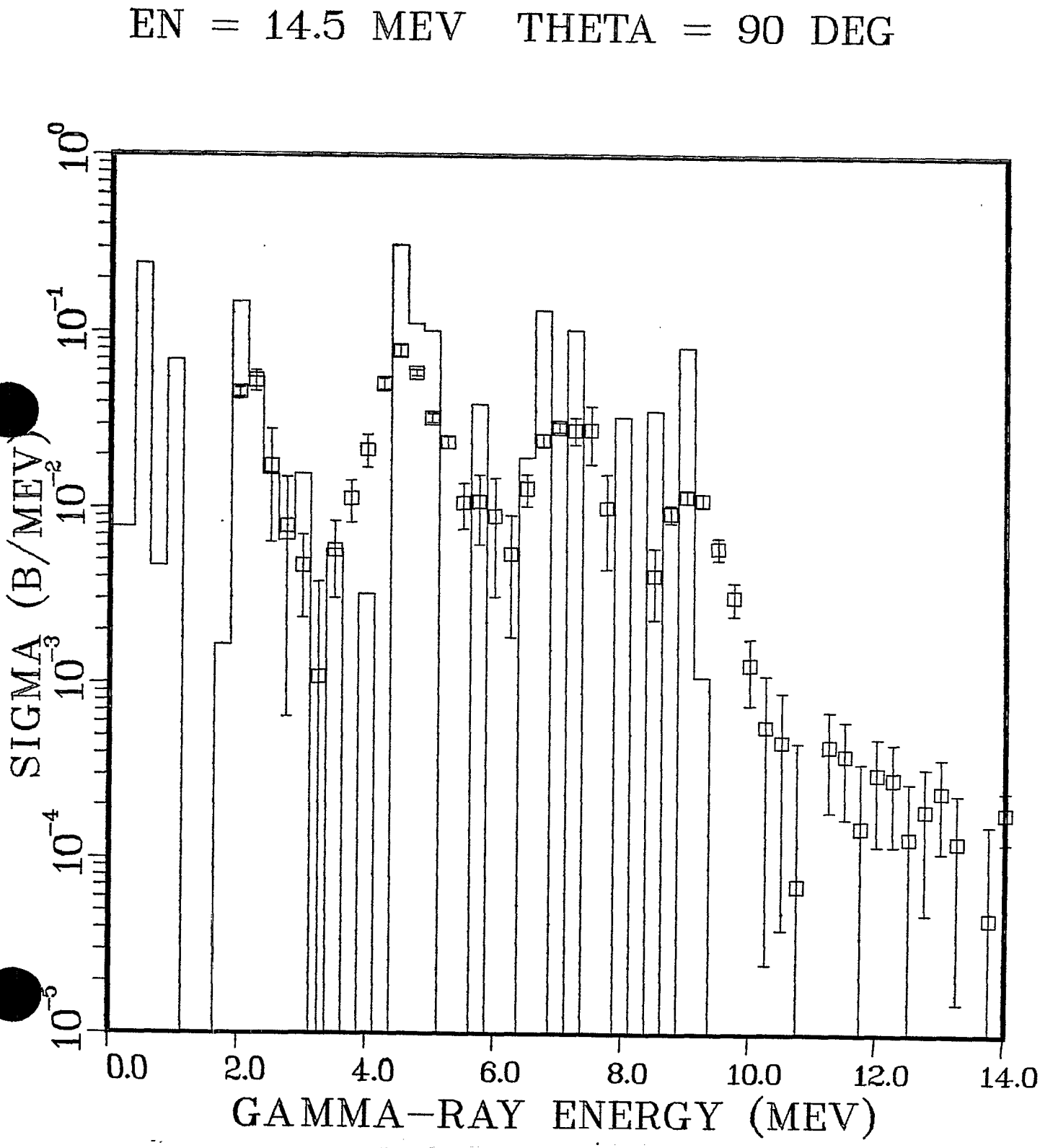
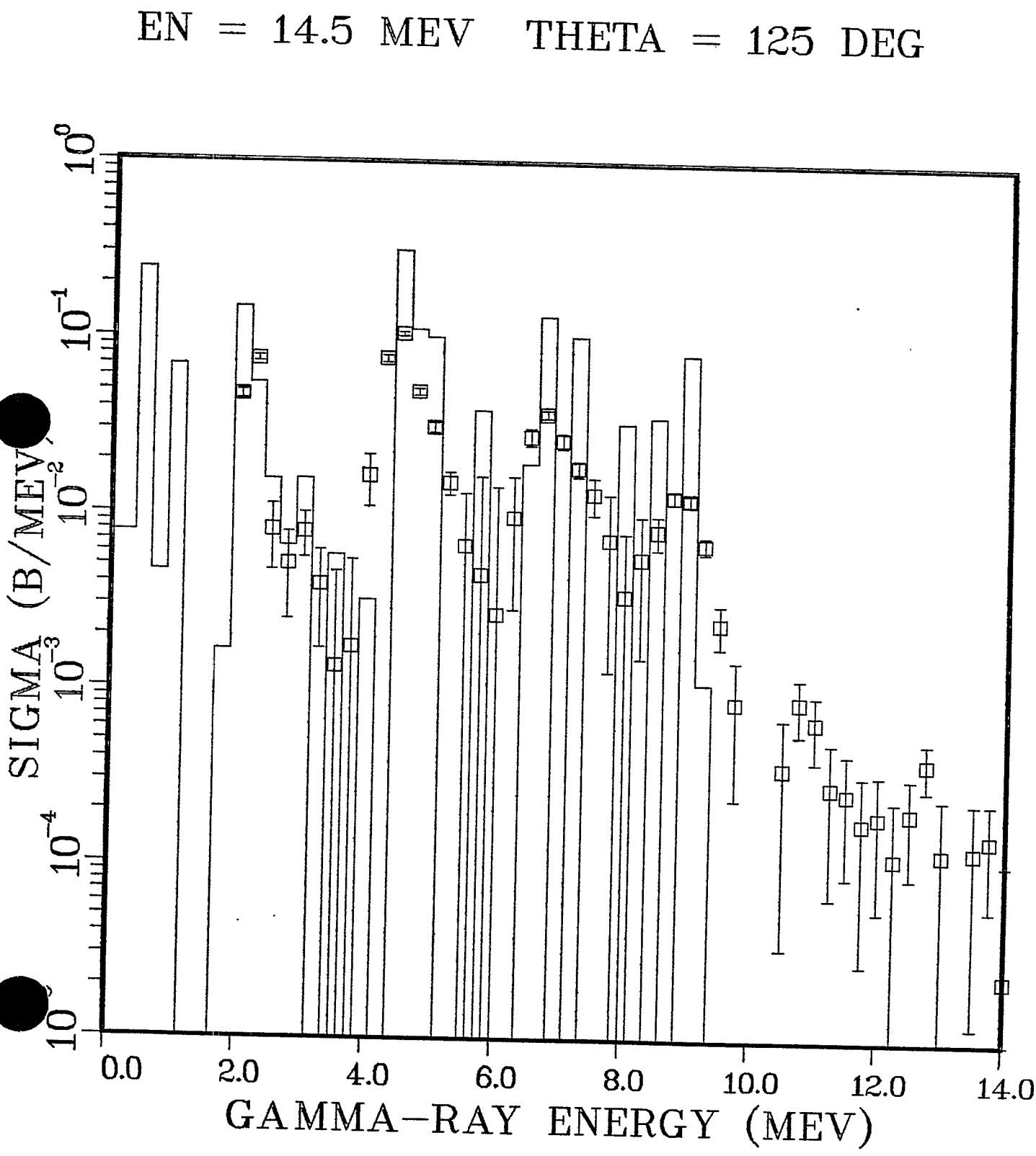

EN = 14.5 MEV THETA = 90 DEG
SIGMA (B/MEV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
GAMMA-RAY ENERGY (MEV)

Figure 5.


EN = 14.5 MEV THETA = 125 DEG
SIGMA (B/MEV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
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2.0
4.0
6.0
8.0
10.0
12.0
14.0
GAMMA-RAY ENERGY (MEV)

Figure 6.

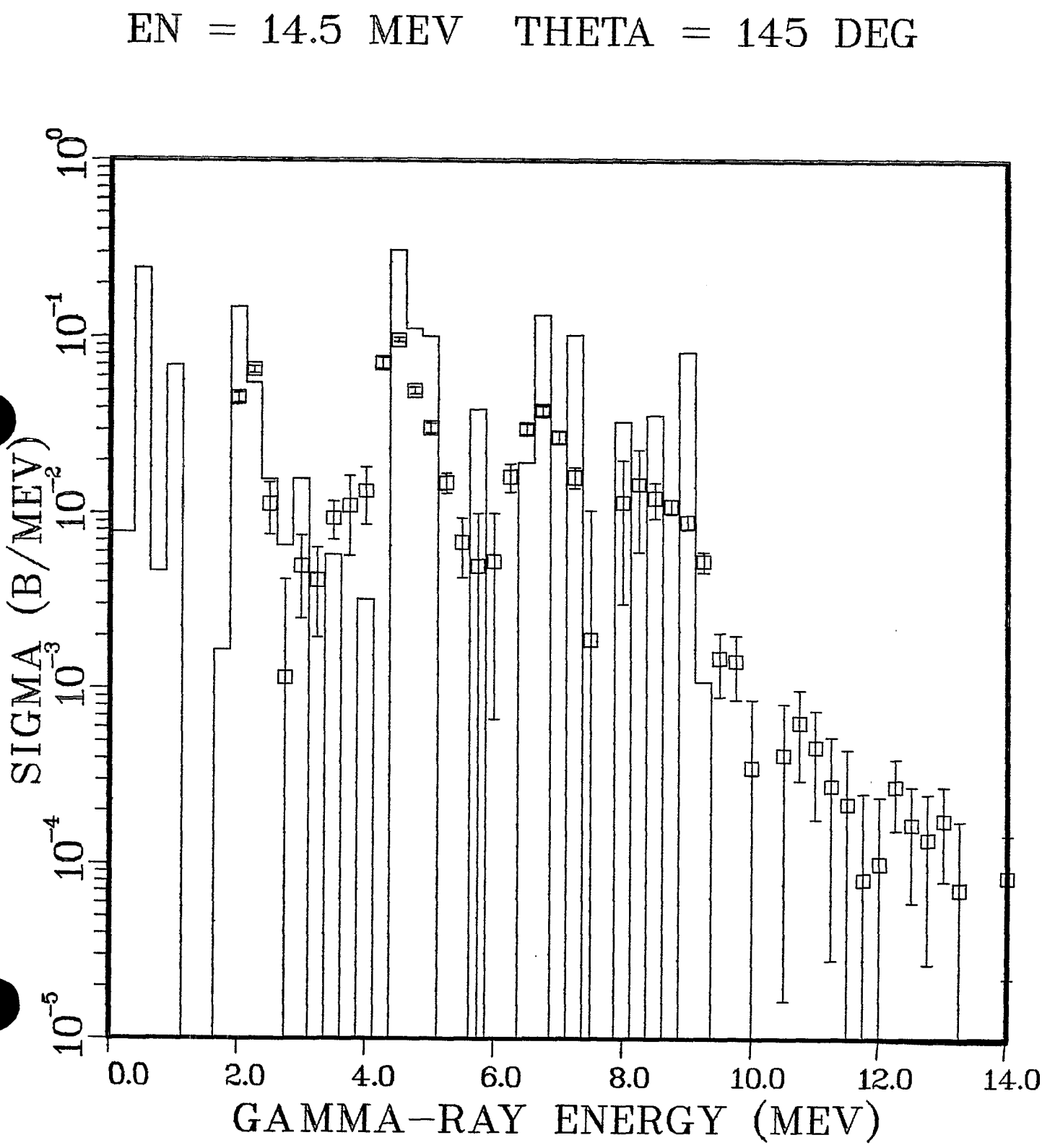

EN = 14.5 MEV THETA = 145 DEG
SIGMA (B/MEV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
GAMMA-RAY ENERGY (MEV)

Figure 7.

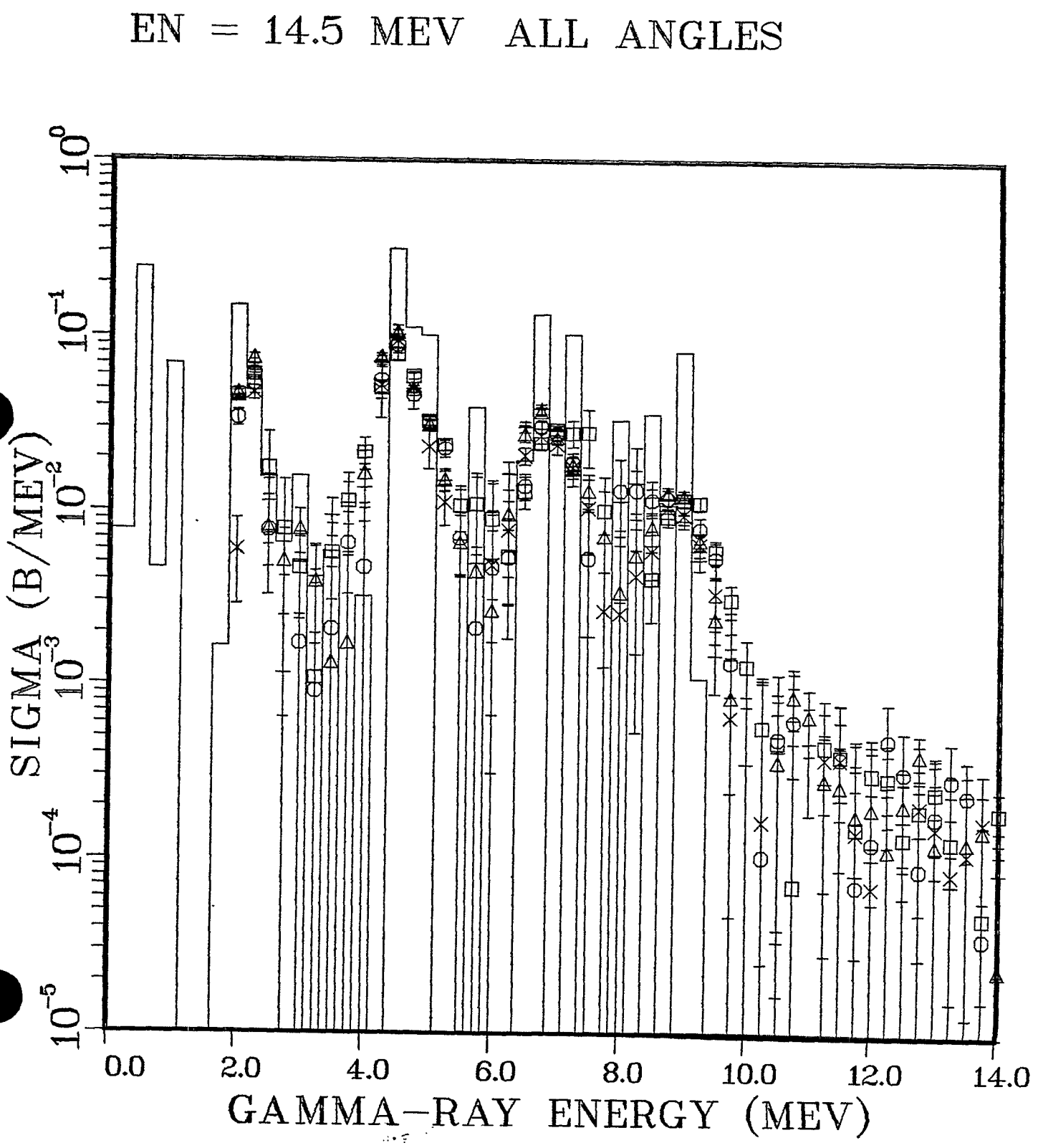

EN = 14.5 MEV ALL ANGLES
SIGMA (B/MEV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
GAMMA-RAY ENERGY (MEV)

Figure 8.

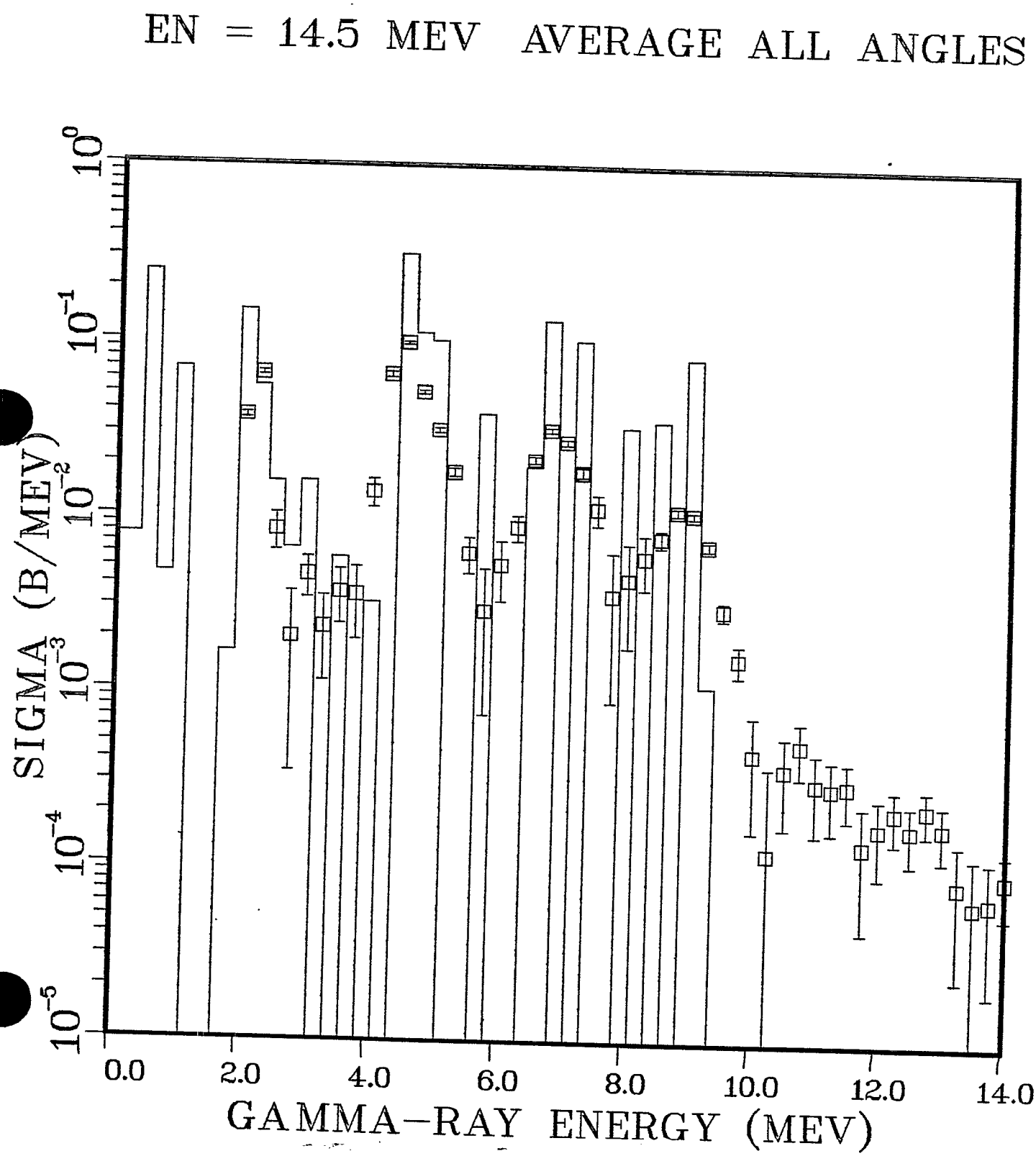
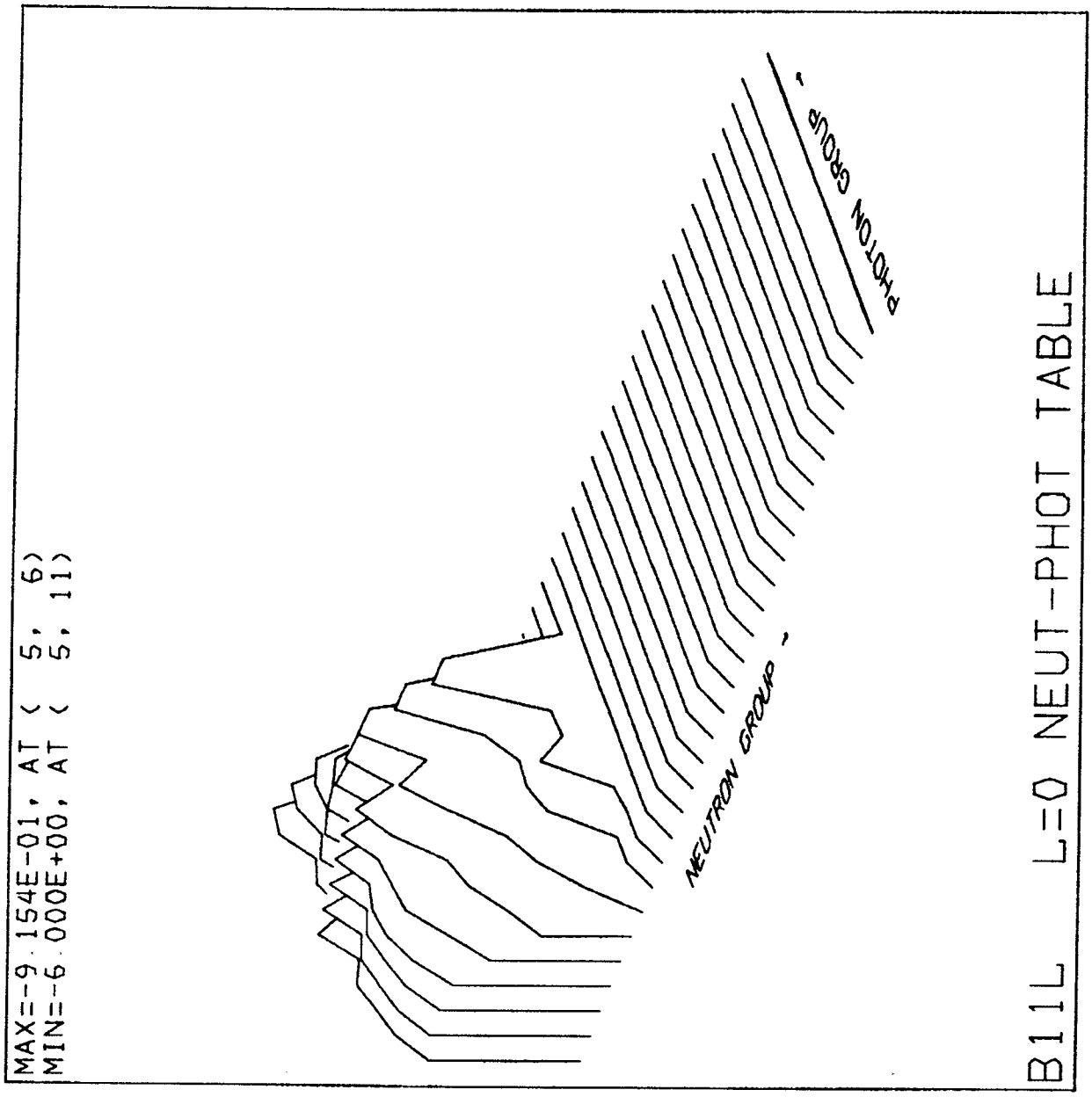

EN = 14.5 MEV AVERAGE ALL ANGLES
SIGMA (B/MEV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
GAMMA-RAY ENERGY (MEV)

Figure 9.


B11L L=0 NEUT-PHOT TABLE
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MIN=-6.000E+00, AT (5, 11)
NEUTRON GROUP
PHOTON GROUP