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The angular distributions of photomesons produced in hydrogen have previously been measured adequately only in a range of angles from 40° to 180° c.m.[1,2] A recent paper by Moravcsik[3] points out that in such a restricted angular range it is quite possible to analyze the angular distributions by a polynomial including terms up to $\cos^2 \theta$, representing S- and P-wave production only. However, the basic Chew-Low theory of photoproduction contains a term $\frac{\epsilon \cdot q \, \sigma \cdot (K - q)}{q_0 K - q \cdot K}$, where K and ϵ are the photon momentum and polarization; q, q_0 the momentum and energy of the meson, and σ the nucleon spin.[4] This term arises from the interaction of the meson current with the incident photon, and because of the denominator, mixes in higher angular momentum states. The effect of this term should be most noticeable in the shape of the distribution at forward angles and in forward-backward asymmetry.

In this experiment we have measured the relative angular distributions for the yield of positive pions produced by 260 ± 5-Mev gamma rays. Figure 1 shows the experimental arrangement. The target is a 2-inch liquid hydrogen vessel with thin Mylar walls (0.015 in). The mesons were detected by their characteristic π-μ decay in a six-counter telescope whose complexity was dictated by the need to cope with the heavy electron and γ-ray background. Mesons are partially identified by a coincidence 1 + 3 + 4 - 2 - 6, where 2 is a Lucite Cerenkov counter that is insensitive to pions in the energy band detected by the telescope. This energy band is determined by selecting a carbon absorber that requires the pion to stop and decay in the fifth detector, where it is identified by a delayed coincidence with the μ-meson pulse. A lead scatterer 1.5 cm thick placed halfway down the channel helped materially to reduce the accidental counts due to electrons. Since the amount of material

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in the path of the meson is quite large, absolute measurements of cross sections by this method would be impractical. However, for measurements of the relative yield, in the restricted angular range where our measurements were made, the change in efficiency of the telescope can be readily estimated.

The angular distributions, measured in a range from 0° to 53° c.m. and normalized to the CalTech magnet data,[2] are shown in Fig. 2. The experimental points have been corrected for the relative change in efficiency of the counter telescope as a function of angle; the largest correction, between the 0° point and the 53° point, amounted to less than 6%. The solid line is a least-squares fit to an expression of the form

$$\sum_{n=0}^{4} \frac{A_n (\cos\theta)^n}{(1 - V/c \cos\theta)^2},$$

where V is the velocity of the meson in the c.m. system. The dashed line is a theoretical curve taken from the Chew-Low theory, including some recoil terms, as evaluated by Moravcsik.[3] The table below compares the least-squares coefficients with those obtained from theory, when the total cross sections are normalized to 2π in both cases.

	A_0	A_1	A_2	A_3	A_4
Theory	0.56	-1.03	0.38	0.18	-0.083
Experiment	0.57	-1.03	0.36	0.15	-0.04

These measurements are being continued for higher-energy photons on hydrogen and deuterium.

We would like to acknowledge the help and encouragement received from Professor A. C. Helmholz, and thank the crew of the synchrotron for providing us with a steady beam.

References

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2. Walker, Teasdale, Peterson, and Vette, Phys. Rev. 99, 210 (1955).

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Figures

Fig. 1. Experimental arrangement.

Fig. 2. Differential cross section for photoproduction of positive pions from hydrogen for a photon energy of 260 Mev.

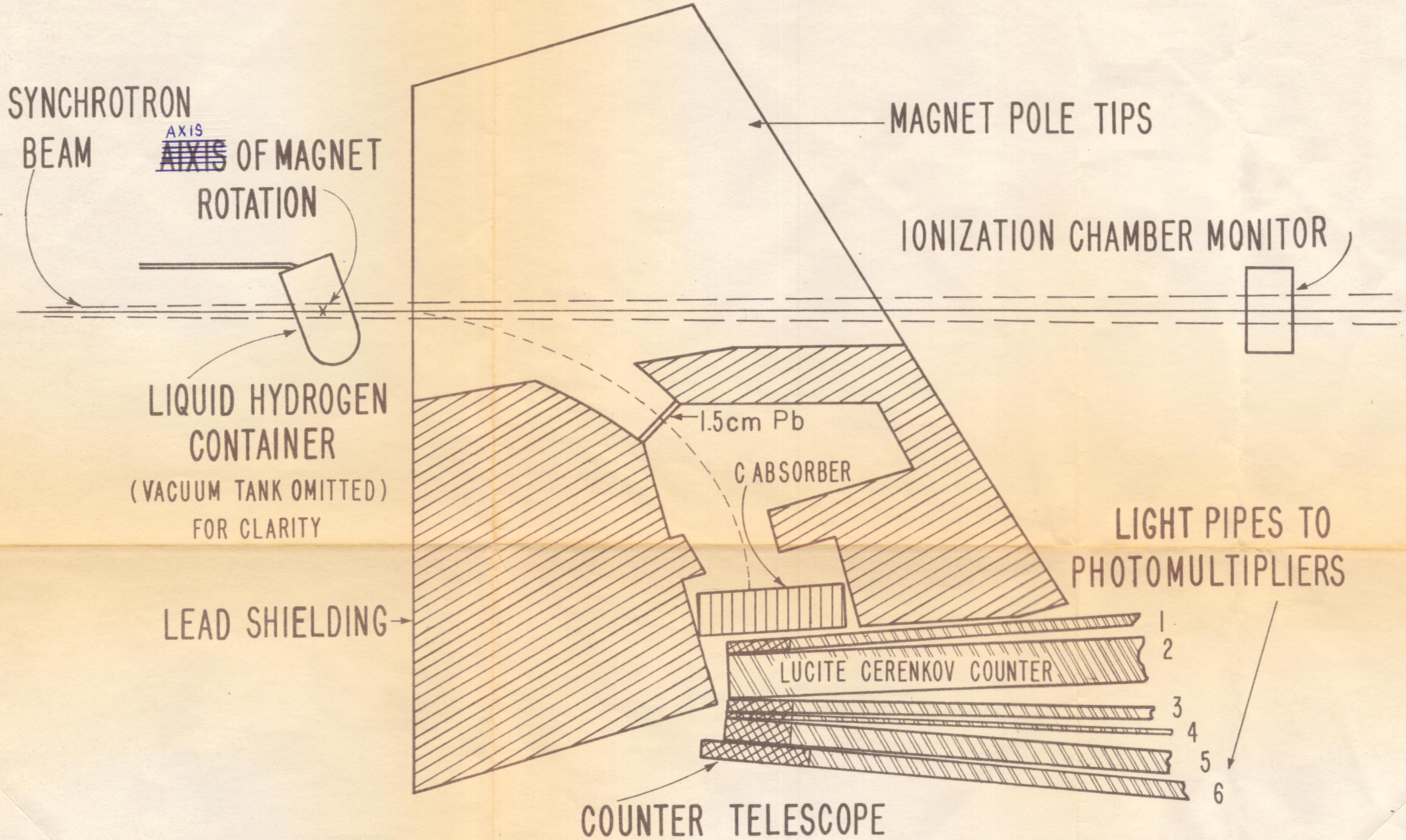

Fig. 1

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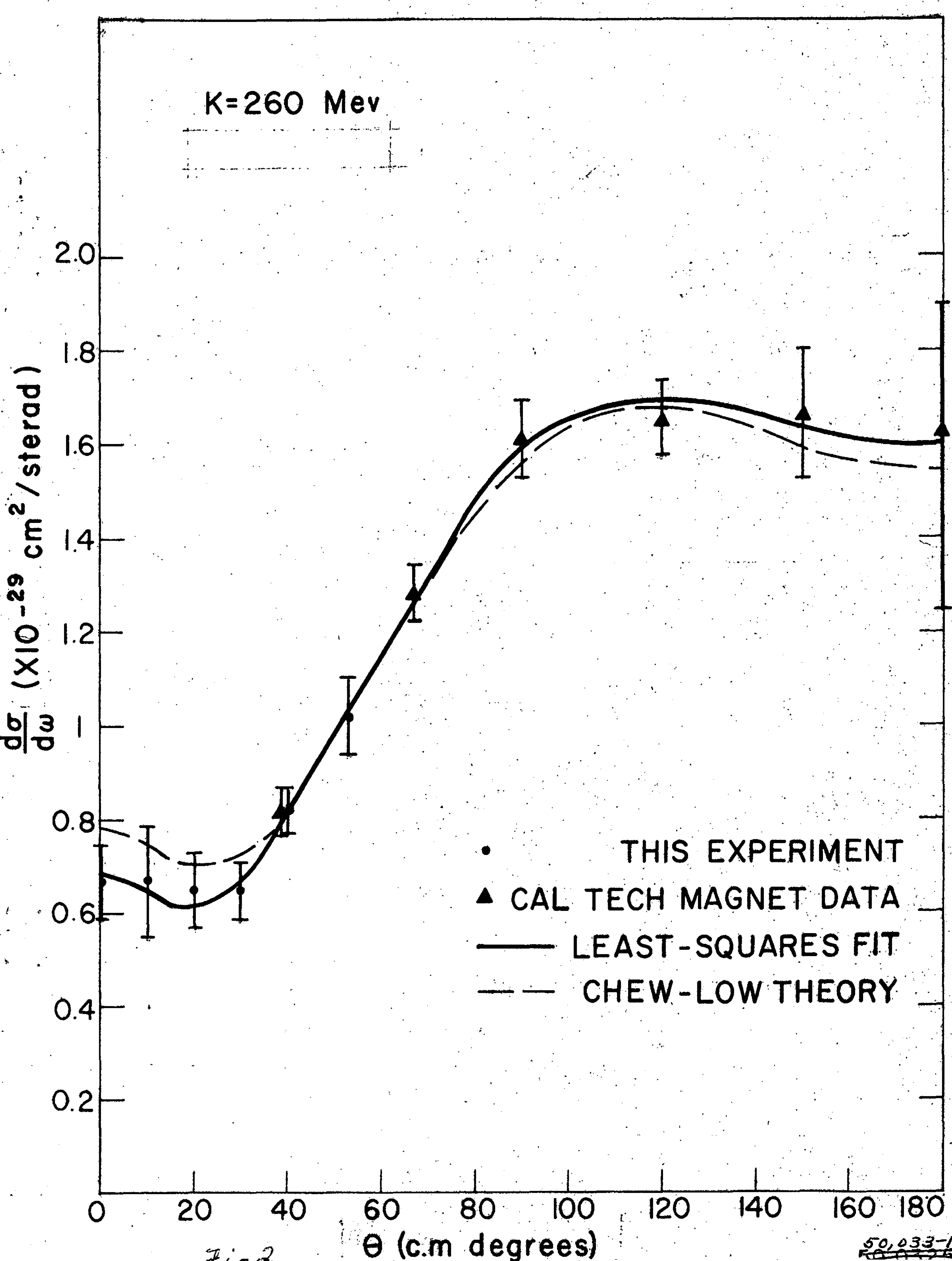

K=260 Mev
$\frac{d\sigma}{d\omega}$ (X10^{-29} cm^2/sterad)
2.0
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
20
40
60
80
100
120
140
160
180
θ (c.m degrees)
THIS EXPERIMENT
CAL TECH MAGNET DATA
LEAST-SQUARES FIT
CHEW-LOW THEORY

Fig 2

50,033-1