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LETTER OF INTENT TO MEASURE LARGE ANGLE π-p ELASTIC SCATTERING

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With a straight forward modification of our E-290 equipment in the M6 beam line, we will be able to make a significant measurement of large angle scattering of pions, kaons and anti-protons on hydrogen at ~200 GeV/c. Previous large angle data from Fermilab[1] (E7) extends only to $-t \approx 2$ for pions. We believe that we can obtain data beyond $-t$ of 5 $(\mathrm{GeV/c})^2$.

In Fig. 1 we show our proposed layout. The only change from E-290 is to move the recoil magnet and detectors from backward to forward angles, entailing a few days of rigging.

We estimate that we can measure cross sections smaller than those of E7 by over a factor of 50, so this is an appropriate second generation experiment; we should be able to reach cross sections of $\sim 1.5 \times 10^{-33}\ \mathrm{cm}^2/(\mathrm{GeV/c})^2$.

A. <u>Signal</u>

(i) we use a 40" liquid hydrogen target (E7 had 12").

(ii) we will be able to use at least $\sim 3 \times 10^6$ particles/pulse (E7 used $\sim 5 \times 10^5$). We hope in fact to use more than that, and expect to take data with no PWC's in the direct beam.

(iii) we propose to run ~200 hours at each polarity (E7 used ~70 hours).

(iv) we will use proportional chambers and a "tight" triggering scheme, and so should not have the 30% deadtime of E7, who used spark chambers and a "loose" trigger. (We also will not trigger on events with $-t \lesssim 1$.)

We arrive at an identical estimate for our sensitivity by scaling the conditions (beam intensity, acceptance, etc.) of the 14 and 23 GeV BNL experiment.[2,3]

B. Background

(i) we will have momentum analysis on both outgoing particles, whereas E7 momentum analysed only the forward particle. This gives us another constraint in the analysis. In addition it reduces the number of particles hitting the recoil arm trigger counters, possibly causing false triggers.

(ii) our trigger is very selective. In the forward arm, coincidences are made between a counter in hodoscope α and a corresponding counter in hodoscope β, cutting down the momentum acceptance for triggers in this arm. An appropriate matrix of coincidences is made between the forward (α, β) hodoscopes and the recoil hodoscope to trigger preferentially on elastic events.

Previous experience[2,3,4] at AGS energies has shown that these restrictive triggers give a large reduction in background. E7

had signal to background of 1 to 1[5] at $-t \approx 2$; we believe that our reductions in background will enable us to measure to $-t \approx 5$. (See also Appendix)

Physics

Figure 2 shows existing data at 23[2] and 200[1] GeV/c for $\pi^- p$ elastic scattering; our expected sensitivity at ~200 GeV/c ($\sim 1.5 \times 10^{-33}$ $cm^2/(GeV/c)^2$) is also shown. If the differential cross section at 200 GeV/c is similar to that at 23 GeV/c, we should be able to measure to $-t \approx 5$ for $\pi^- p$. For kaons and antiprotons, we would expect to measure to $-t \approx 2$, a factor of 2 further than present data. The results should enable the following questions to be answered.

1) The $\pi^- p$ data at 23 GeV/c has an abrupt change of slope at $-t = 3$; is this still present at 200 GeV/c? (We observe in large angle pp scattering at ISR energies that there is also a change of slope at large t).

2) Do new diffraction-type phenomena appear at higher momentum? As an example, the $-t = 1.4$ dip in pp elastic scattering only becomes apparent above 100 GeV/c.

3) All measured meson-proton cross sections appear to be equal around $-t = 1$ with no momentum dependence between 14 and 200 GeV/c[1,3] - see Fig. 3. This says that all meson proton collisions behave similarly at small impact parameters, whereas they do not do so at large impact parameters. Is this true at even larger values of -t?

4) There is always the hope that large t collisions, which probe the interaction at small distances, might reveal some effects of a constituent nature of the hadrons. An example is of course the cross section becoming flat at some t value, indicating a hard constituent of the hadron.

We estimate that 400 hours of running and 100 hours of set up should enable us to make measurements for both polarities to the accuracy noted above. We could take this data at the completion of E-290, sometime in late 1977.

REFERENCES

[1] C. W. Akerlof, et al., Phys. Lett. 59B, 197, (1975), Phys. Rev. Lett. 35, 1406 (1975), University of Michigan, UM HE-76-6 (to be published).

[2] P. Cornillon, et al., Phys. Rev. Lett. 30, 403 (1973).

[3] R. Rubinstein, et al., Phys. Rev. Lett. 30, 1010 (1973).

[4] D. P. Owen, et al., Phys. Rev. 181, 1794 (1969).

[5] D. Jovanovic - Private Communication.

APPENDIX

Predicting inelastic backgrounds in two-arm spectrometer elastic scattering experiments is notoriously difficult. Processes that could cause such background, such as $\pi p \rightarrow \pi p \pi^{o}$, must be at an extreme of their phase space if they are to simulate elastic scattering within the experimental resolution. Estimating such extremely low probability configurations is difficult.

A better way of estimating backgrounds is by comparison with similar experiments. E177 (J. Orear) is measuring pp elastic scattering to larger values of t and smaller cross sections than we are proposing. In our range, πp and pp elastic scattering cross sections should be approximately the same, based on preliminary results from E177 and assuming 200 Gev πp data continue to be similar to 23 Gev data. There is no reason to believe that inelastic scattering should be very different in the two interactions. The experimental arrangement of E177 is similar to ours, with two magnetic spectrometers. They have somewhat higher bending power, but a looser trigger and no chambers in front of their magnets. Even out to-t of 10 $(GeV/c)^2$, nowhere is their background more than ~ 5% of the elastic signal. (C. Hojvat - private communication). Based on this, we believe that we should not have background problems over the range of our experiment.

FIG 1A TARGET AREA

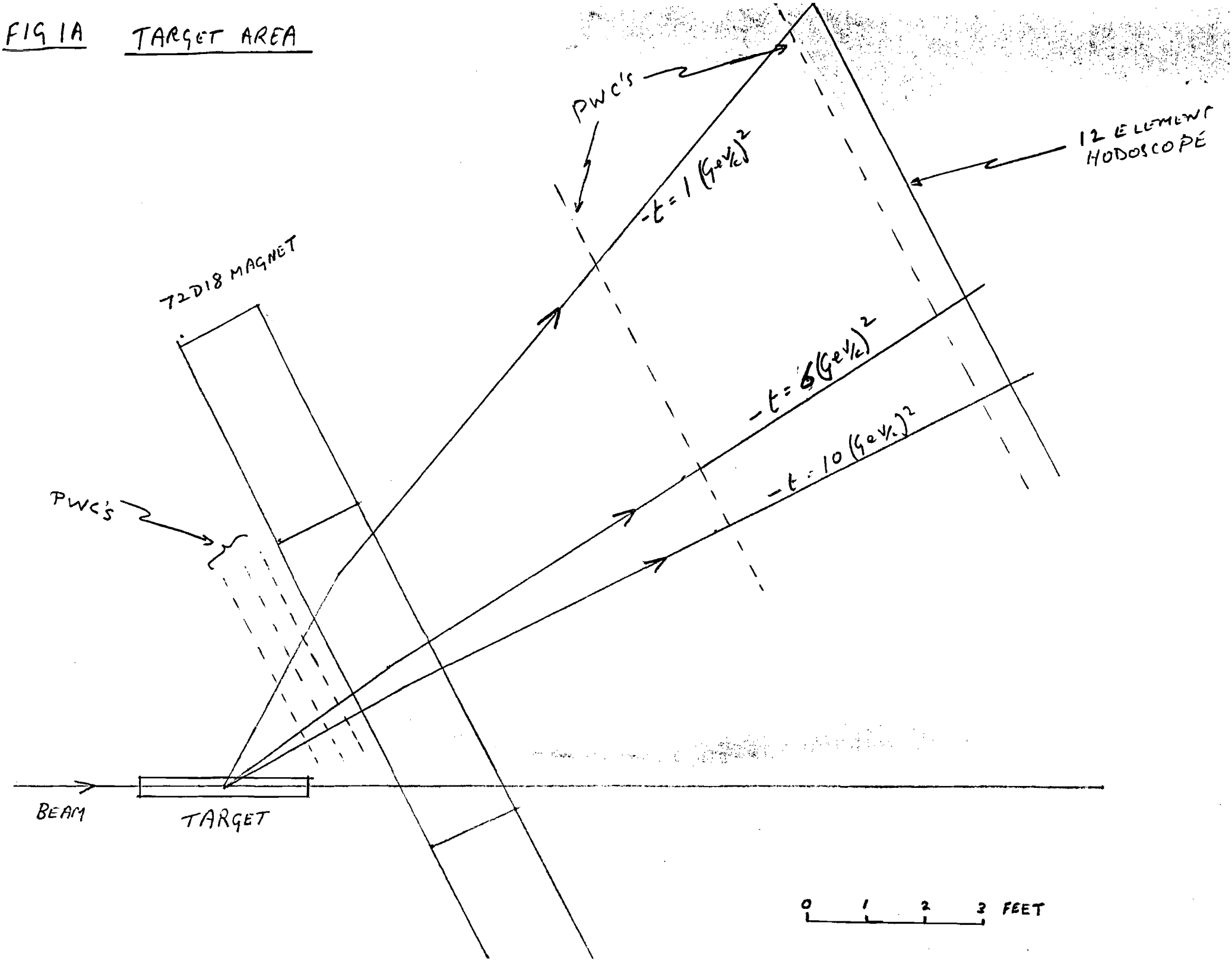
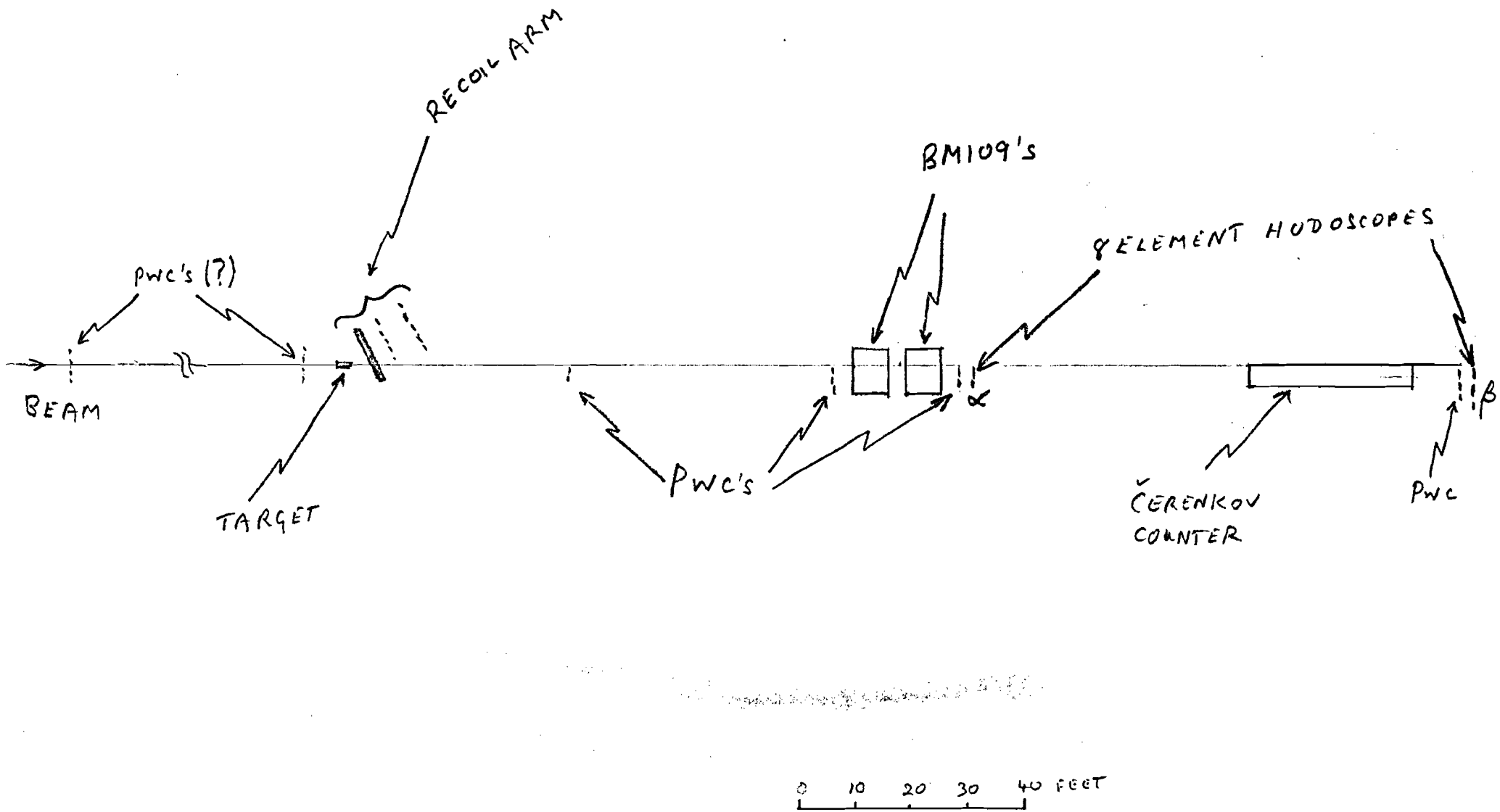


FIGURE 1B


RECOIL ARM
BM109's
γ ELEMENT HODOSCOPES
PWC's (?)
BEAM
TARGET
PWC's
α
β
ČERENKOV COUNTER
PWC
0 10 20 30 40 FEET

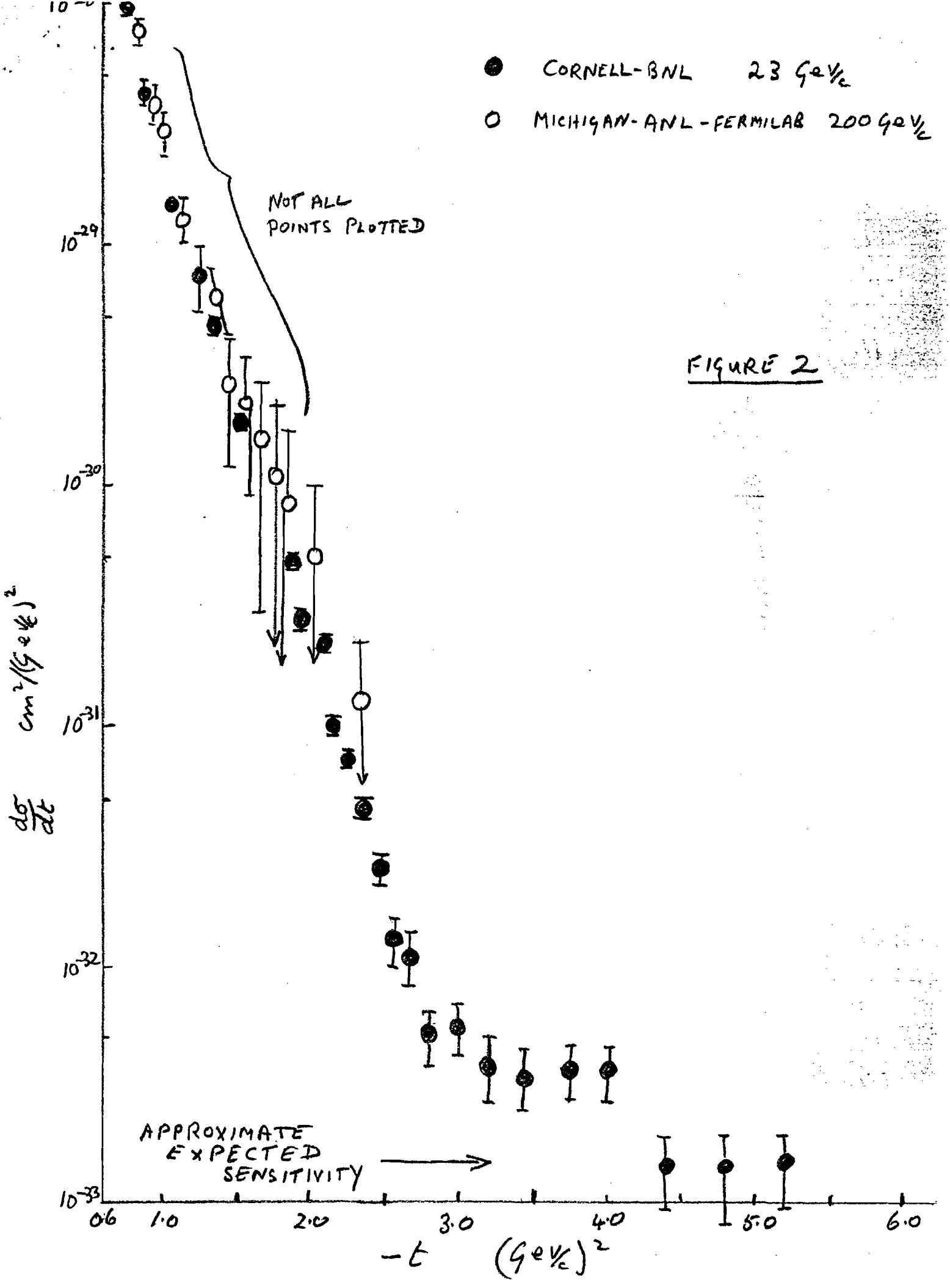

CORNELL-BNL 23 GeV/c
MICHIGAN-ANL-FERMILAB 200 GeV/c
NOT ALL POINTS PLOTTED
APPROXIMATE EXPECTED SENSITIVITY
$\frac{d\sigma}{dt}$ cm²/(GeV/c)²
10^{-29}
10^{-30}
10^{-31}
10^{-32}
10^{-33}
0.6
1.0
2.0
3.0
4.0
5.0
6.0
$-t$ (GeV/c)²

FIGURE 2

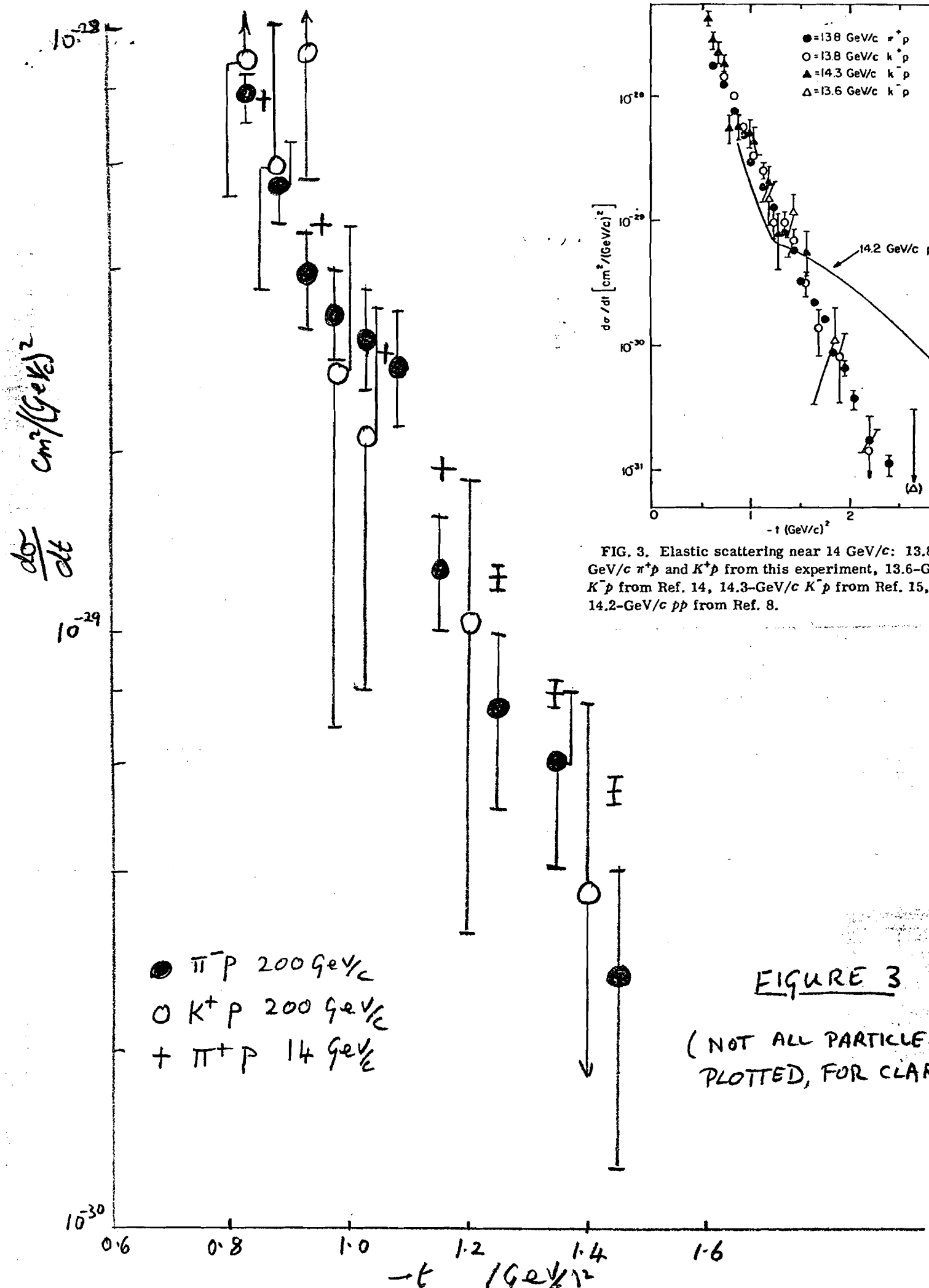


FIG. 3. Elastic scattering near 14 GeV/c: 13.8-GeV/c π^+p and K^+p from this experiment, 13.6-GeV/c K^-p from Ref. 14, 14.3-GeV/c K^-p from Ref. 15, and 14.2-GeV/c pp from Ref. 8.

FIGURE 3

(NOT ALL PARTICLES PLOTTED, FOR CLARITY)