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THE DEPENDENCE OF LOW MOMENTUM PARTICLE PRODUCTION ON TARGET MATERIAL AND THICKNESS

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Motivated by a need to simultaneously optimize antiproton production in Beam C1 and negative kaon flux in the LESBI and to determine the best target for neutrino (pion) production, pion and antiproton fluxes produced by 28.4 GeV/c proton incident on Al, Cu and Pt targets of various lengths at 0° and 1.4 GeV/c were made in the C1 beam while 10.5° kaon production was simultaneously measured at .870 GeV/c in the LESBI. The measurements were normalized to the secondary emission chamber (SEC) immediately upstream of the "C" target but no attempt was made to correct the measurements for beam acceptance to obtain an absolute normalization. The counter telescope which monitors targeting is of course sensitive to target material and length and is therefore not useful for normalization.

The targets used and the data obtained are given in Table I. The interaction length for Pt was obtained by interpolation using a plot (Fig. 1) of interaction lengths vs atomic number for a variety of materials taken from the "Blue Book."[1]

The 0° data obtained in C1 indicates both the pion and antiproton production saturates at less than half an interaction length whereas the 10.5° kaon data shows no clear saturation at one interaction length. This is easily understood as the result of absorption of secondary particles produced at small angles with a relatively large average amount of material between the point of production and the downstream surface of the target. Secondaries produced at 10.5° pass through comparatively little material before exiting from the side of the target in the direction of the LESBI.

1. Particle Properties Data Booklet - Particle Data Group LBL (1984).

TABLE I

ℓ	1.88" Pt	3.5" Pt	.74" Cu	2.96" Cu	5.25" Cu	5.25" Al
ℓ/ℓ_o	.522	.972	.125	.499	.886	.338
			0° Data			
π^-/SEC	67.3	60.7	55.4	103.5	156.4	124.8
$\bar{p}$/SEC	.120	.120	.0532	.159	.156	.094
			10.5° Data			
K^-/SEC	14.7	21.0/18.7	5.65	14.5	15.9	8.0
π^-/K^-	5.2	4.9/5.9	5.3	6.2	11.1	12.2

Figures 2 and 3 indicate that at 0° the Cu targets yield a greater number of both pions and antiprotons than the equivalent length of Pt. The negative pion to antiproton ratio is lower for the Pt target and is preferable for Exp. 789 whose usable antiproton flux is limited by accidentals resulting from beam pions. The 10.5° negative kaon data is shown in Fig. 4 and the π^-/K^- ratio in Fig. 5. A somewhat higher yield of K^- is obtained from Pt than from Cu but the primary benefit for kaon users arises from the shorter interaction length of Pt which allows good kaon production from a target of less than 3 inches reducing the depth of focus at the mass slit. Figure 5 indicates a marked degradation of the π^-/K^- ratio for lengths greater than 4 inches.

Conclusions

A Pt target of 2-3 inches would provide the optimum compromise for simultaneous operation. Both the $\bar{p}/\pi^-$ ratio in C1 and the π^-/K^- ratio in LESBI would benefit from a shorter target and more protons on target.

Small angle negative pion production is enhanced by the use of Cu target. The acceptance of Beam C1 is ±20 mr vertically and ± 40 mr horizontally. The narrow band neutrino horn acceptance includes the angular range of 10 mr to 140 mr and therefore a target length between $.5 < \ell/\ell_o < 1$ is called for. Cu appears to be the preferred target material to simultaneously optimize flux and depth of focus for the narrow band ν beam.

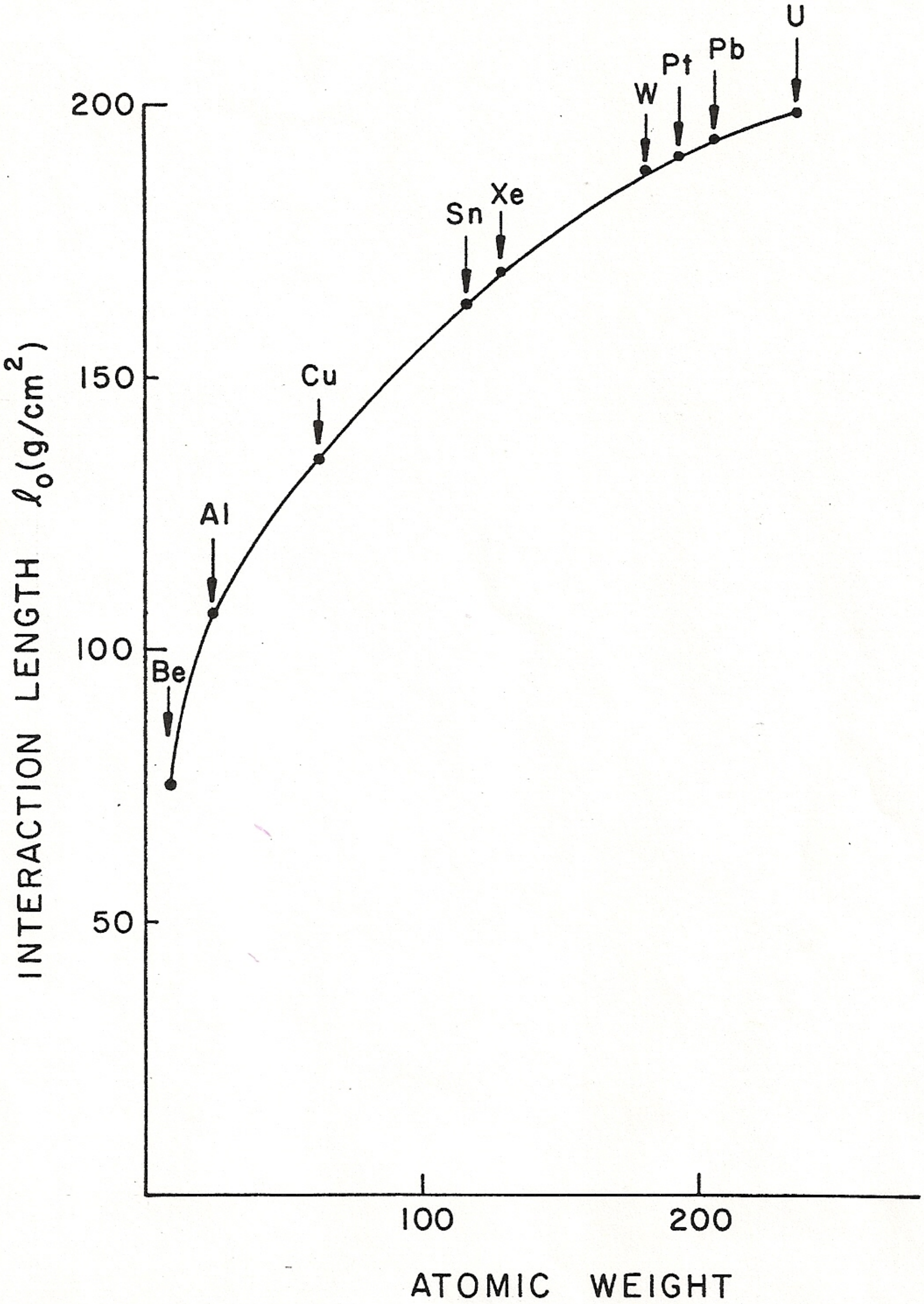

Figure 1. The dependence of interaction length ℓ_o on atomic weight.

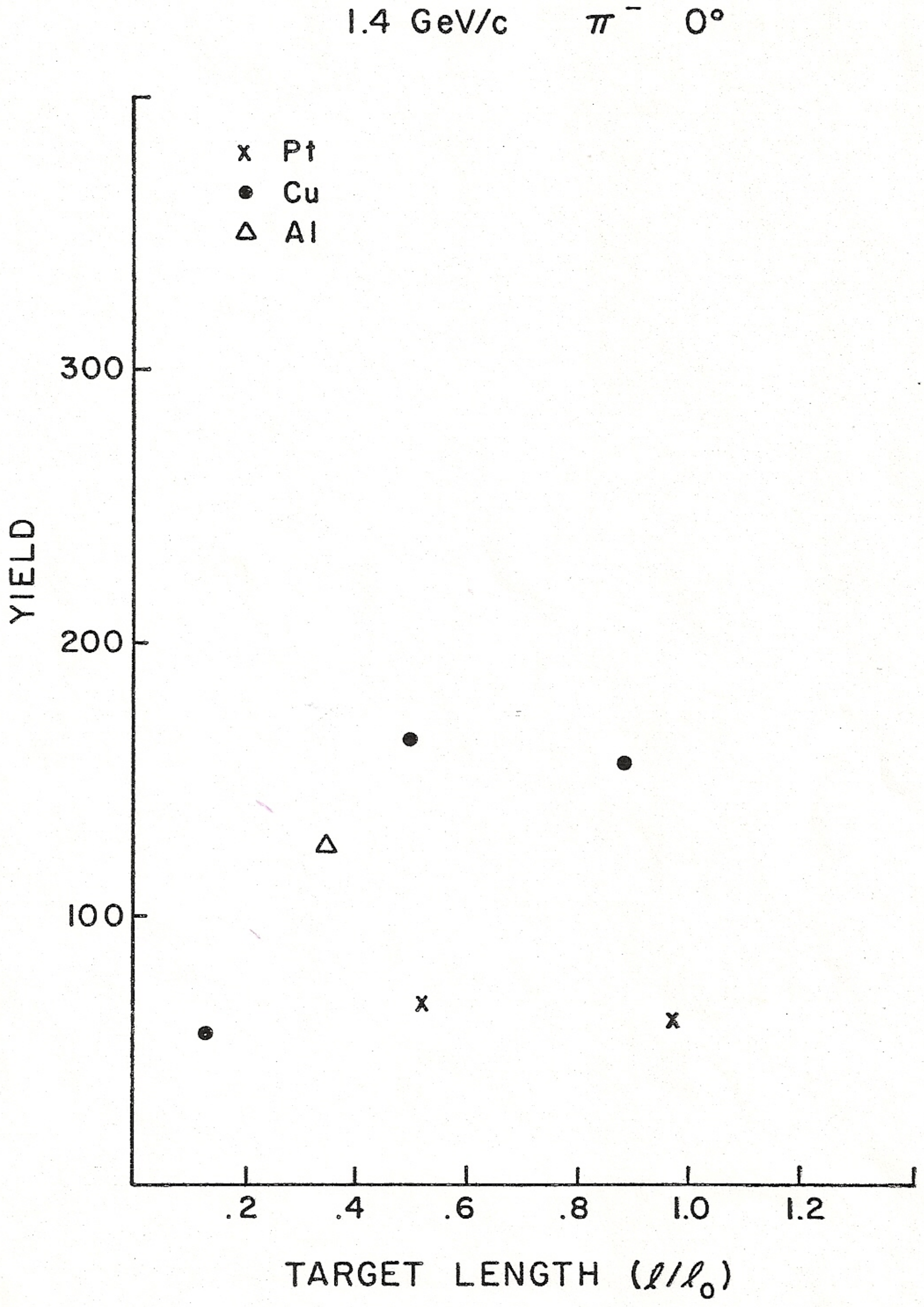

Figure 2. The yield or number of π^- per SEC count at 0° and 1.4 GeV/c vs. target length/interaction length.

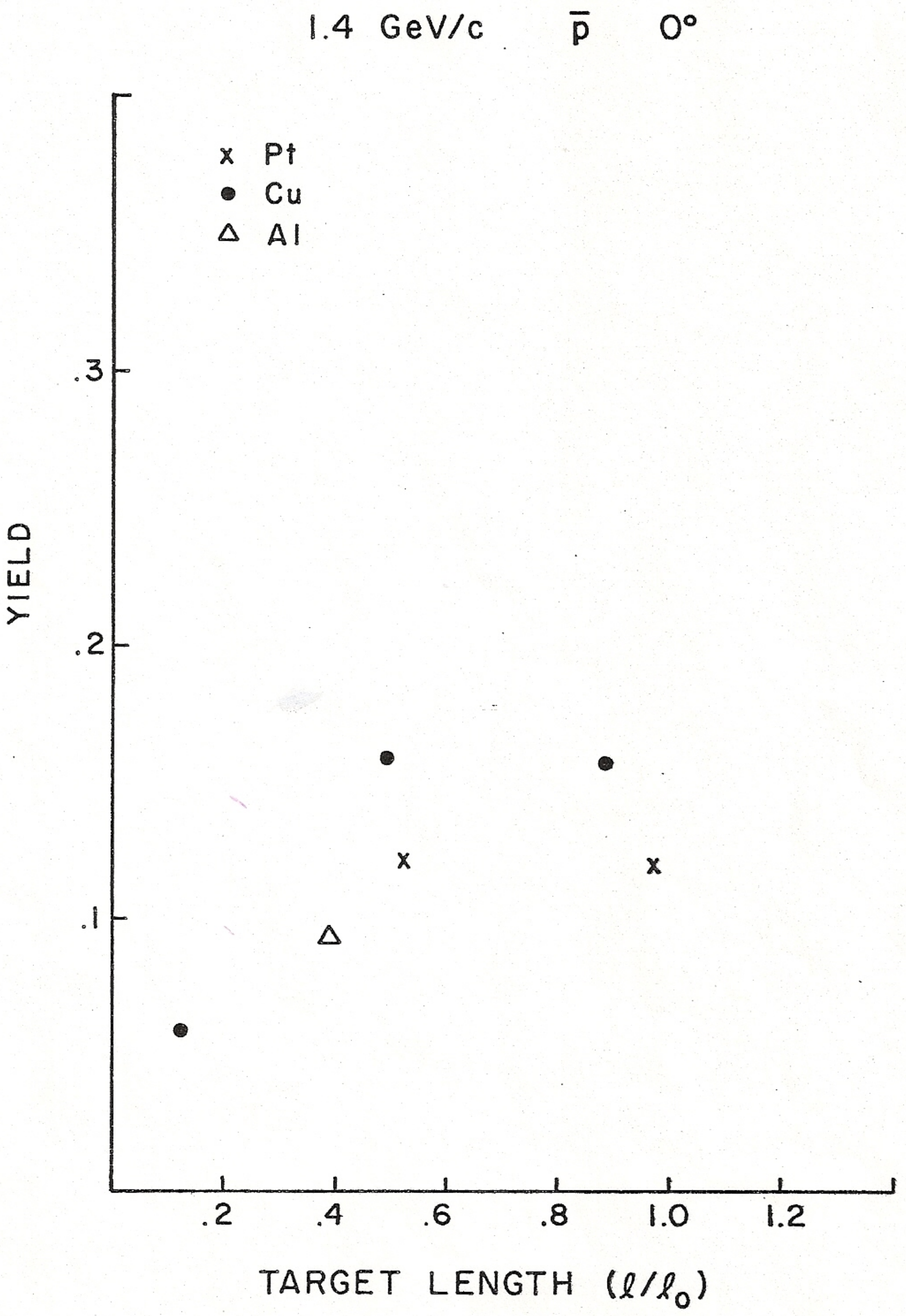

Figure 3. The yield or number of $\bar{p}$ per SEC count at 0° and 1.4 GeV/c vs. target length/interaction length.

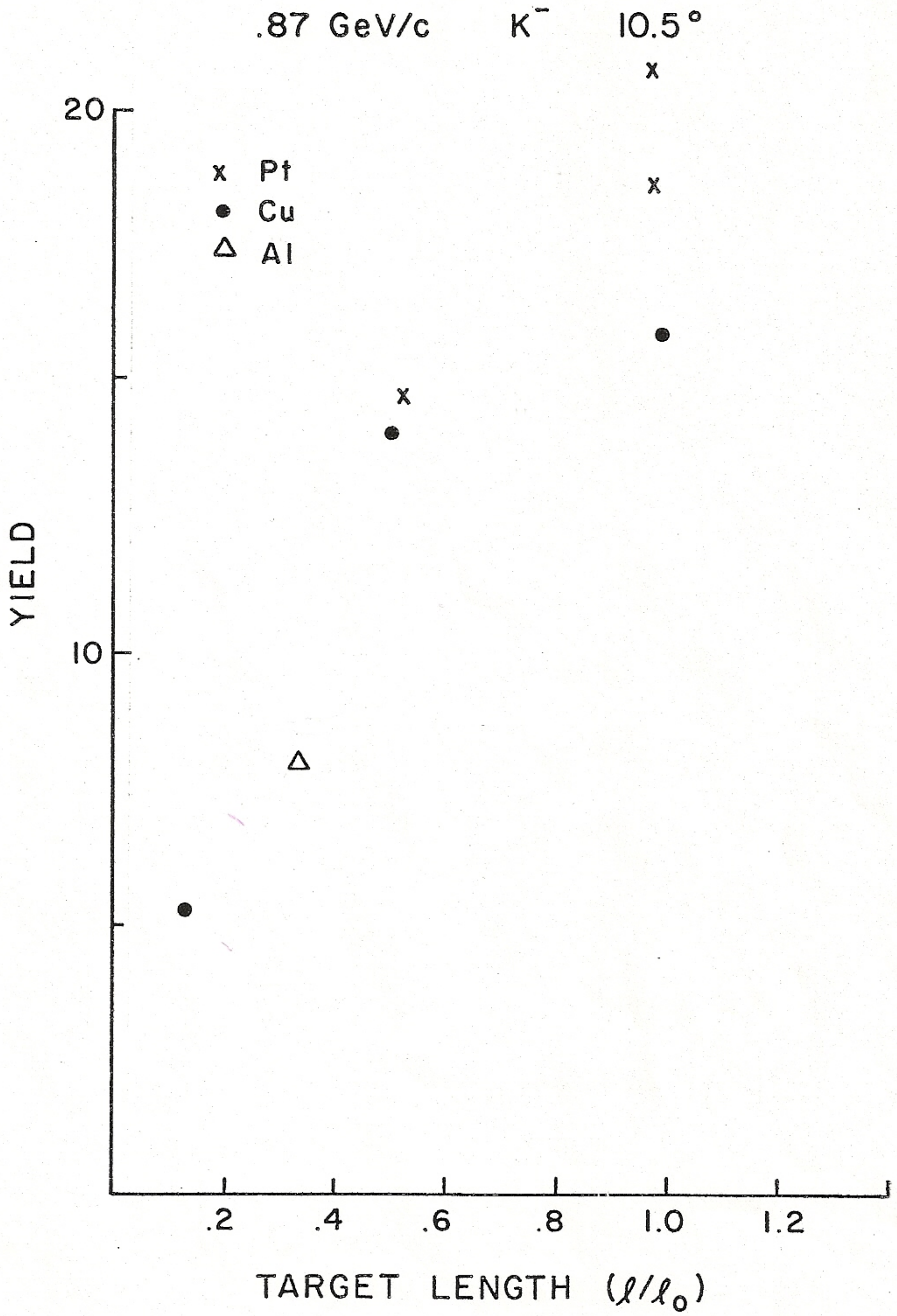

Figure 4. The yield or number of K^- per SEC count at 10.5° and .87 GeV/c per SEC count vs. target length/interaction length.

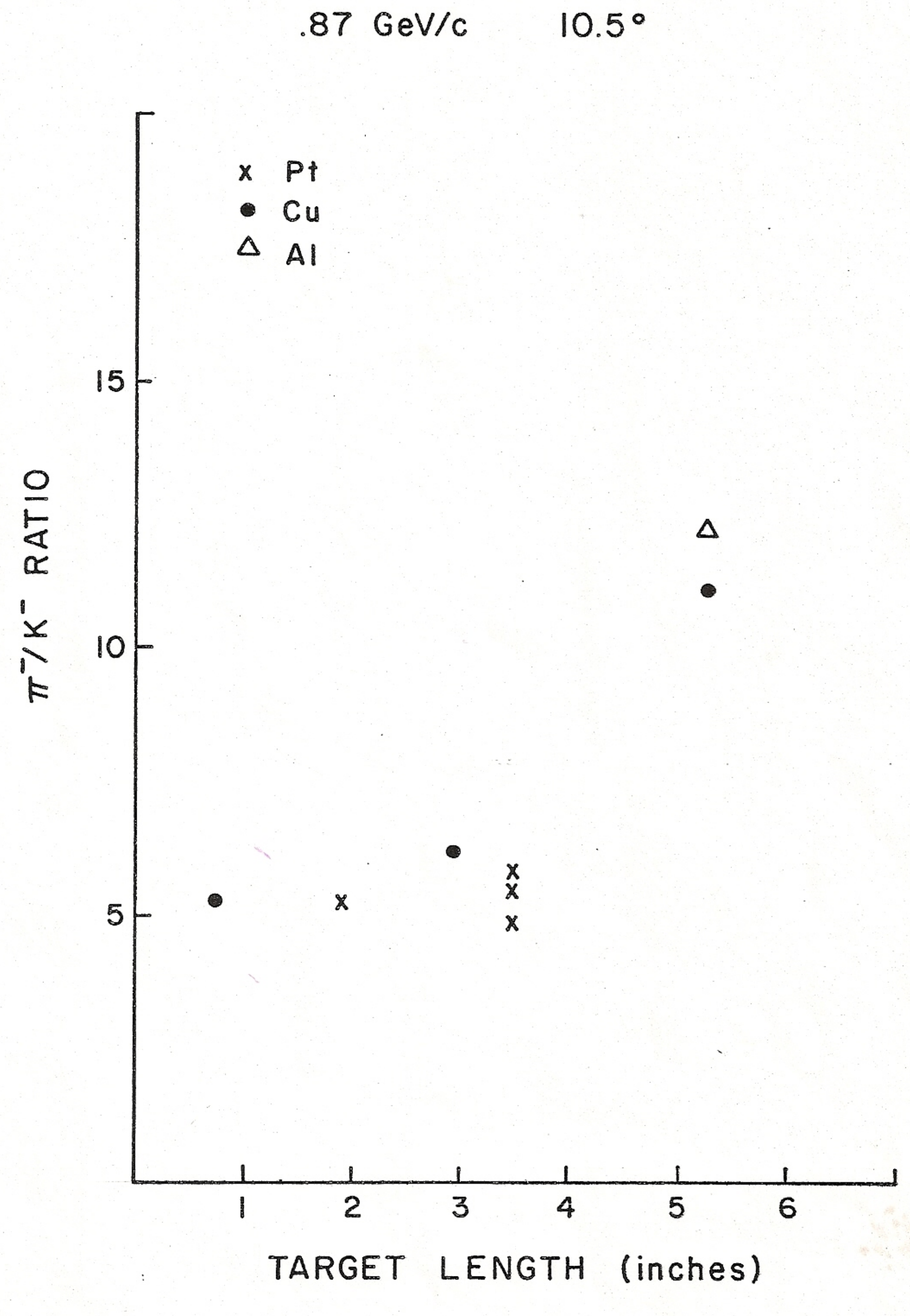

Figure 5. The π^-/K^- ratio vs. target length in the LESBI at 10.5° and .87 GeV/c.