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PROPOSAL FOR MEASUREMENTS OF THE POLARIZATION PARAMETER P_0 IN $\pi^{\pm}p$, pp, $\bar{p}p$, AND $K^{\pm}p$ ELASTIC SCATTERING, USING A POLARIZED TARGET

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Some of us have recently performed experiments on elastic scattering of π^-, π^+ and p from a polarized proton target, in which the polarization parameter P_0 was measured at 6.0, 8.0, 10.0 and 12.0 GeV/c. These measurements[1] show sizeable spin effects and give the sign of the polarization and its general shape as a function of the momentum transfer in the interval $-0.8 \leq t \leq -0.1$ $(\mathrm{GeV/c})^2$.

We propose to search for similar effects in K^-, K^+ and $\bar{p}$ scattering.

The present experimental data on π^+, π^- scattering up to 12.0 GeV/c does not show any appreciable energy variation of the maximum polarization (at t 0.2 $[\mathrm{GeV/c}]^2$), while for higher momentum transfers ($t \gtrsim 0.5$ $[\mathrm{GeV/c}]^2$) a strong energy dependence appears to be present. Also, there is some indication for a structure at $t \approx 0.3$ $(\mathrm{GeV/c})^2$ (see Fig.1).

In order to explore further these points, we propose to extend the previous measurements on π^-, π^+ and p scattering to higher energies($\approx$ 18 ÷ 20 GeV), to higher momentum transfers (up to ≈ 1.25 $[\mathrm{GeV/c}]^2$, thus covering the region around the second maximum - or shoulder - in the π-p angular distributions), and to better statistics.

As already stressed in a previous memorandum to the EEC[2] the above proposed experiments can only be performed on a secondary beam from the slow ejected e_3 beam. This is because of the strict requirements on high intensity for all kinds of particles, of wide range of accessible energies for both signs of charges and of small image size at the polarized target spot.

To illustrate this situation, we have calculated the number of events that can be collected per day at a few energies and for some values of t: these figures are quoted in Table 1; they were derived by using the beam intensity as estimated in Table 2, and the elastic cross-sections and the target width quoted in Table 3.

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The principle of the measurement will be the same as in the previous one, e.g. detection in coincidence of the scattered and of the recoil particles by counter hodoscopes.

However, in order to deal with the much higher intensities and to overcome the greater difficulty in measuring the direction of the incident particles, the following additions will be made:

1. two threshold and one differential Čerenkov counters will be used on the beam, for the purpose of particle identification in high background conditions;
2. the recoil proton velocity for the measurements at the smallest momentum transfers will be measured by a time-of-flight technique;
3. a large aperture magnet to analyse the momentum of the recoil proton will provide an essential improvement in background rejection, and will compensate for the loss of information on the incident particle direction which will happen if it turns out that the beam hodoscope must be abandoned.

From the rates listed in Table 1, one can derive the amount of running time which is necessary to reach any desired statistical accuracy. As a crude estimate, we believe that relevant information on the physical problems outlined above can be obtained in two weeks of setting-up and six to eight weeks of running time.

We will be ready to start with setting-up and tests of the beam and of the electronics during spring 1967. Due to the difficulties connected with the new beam, we strongly ask that some testing time be allocated to us before the spring shut-down.

REFERENCES

1) M. Borghini, G. Coignet, L. Dick, L. di Lella, P.P. Macq, A. Micholowicz and J.C. Olivier, Phys. Letters, 21, 114 (1966).

2) G. Bellettini et al, Memorandum to the EEC, May 1966.

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TABLE 1

COUNTING DATA/DAY

(over $\Delta t = 0.2t$)

Assume PS repetition rate = 2.3 sec

Number of burst/day = $\frac{24 \times 3600}{2.3}$ = 37600

We assume 20000 effective burst/day. The loss is due to polorization reversing, helium changing, magnetic tape changing etc..

Particles	p GeV/c	t = -0.25	t = -0.5	t = -0.75	t = -1.0	t = -1.25
π^-	6	74000	13400	1920	240	28
	10	30000	5400	780	96	11
	15	18000	3360	468	56	6
π^+	6	210000	44000	7800	1040	140
	10	184000	40000	6600	960	104
	15	34000	7600	1200	176	20
K^-	6	980	148	20	-	-
	10	720	108	16	-	-
K^+	6	5000	1960	576	152	37
	10	7800	3000	900	232	52
p	6	260000	44000	5400	616	66
	10	1020000	176000	22800	2640	280
	15	4400000	760000	96000	11200	1200
$\bar{p}$	5	172	17	-	-	-

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TABLE 2

BEAM INTENSITY

$$N = N_o \times E \times i \times \frac{d^3\sigma}{dn\, d\Omega\, dp} \times \Delta\Omega \times \Delta p \times f(l)$$

where

N_o = 5 10^{11} circulating protons/burst,

E = 0.4 ejection efficiency,

i = 0.63 interaction probability in the source target,

$\Delta\Omega$ = 10^{-4} sr beam solid angle at 0°,

l = 60m beam length; target to target,

f(l)= service probability after the path l.

Δp = momentum bite, corresponding to $\frac{\Delta p}{p}$ = 1%,

n = $N_o$xi = number of interactions.

$\frac{d^3\sigma}{dn\, d\Omega\, dp}$ = differential cross-section per interaction, per steradian and per GeV/c.

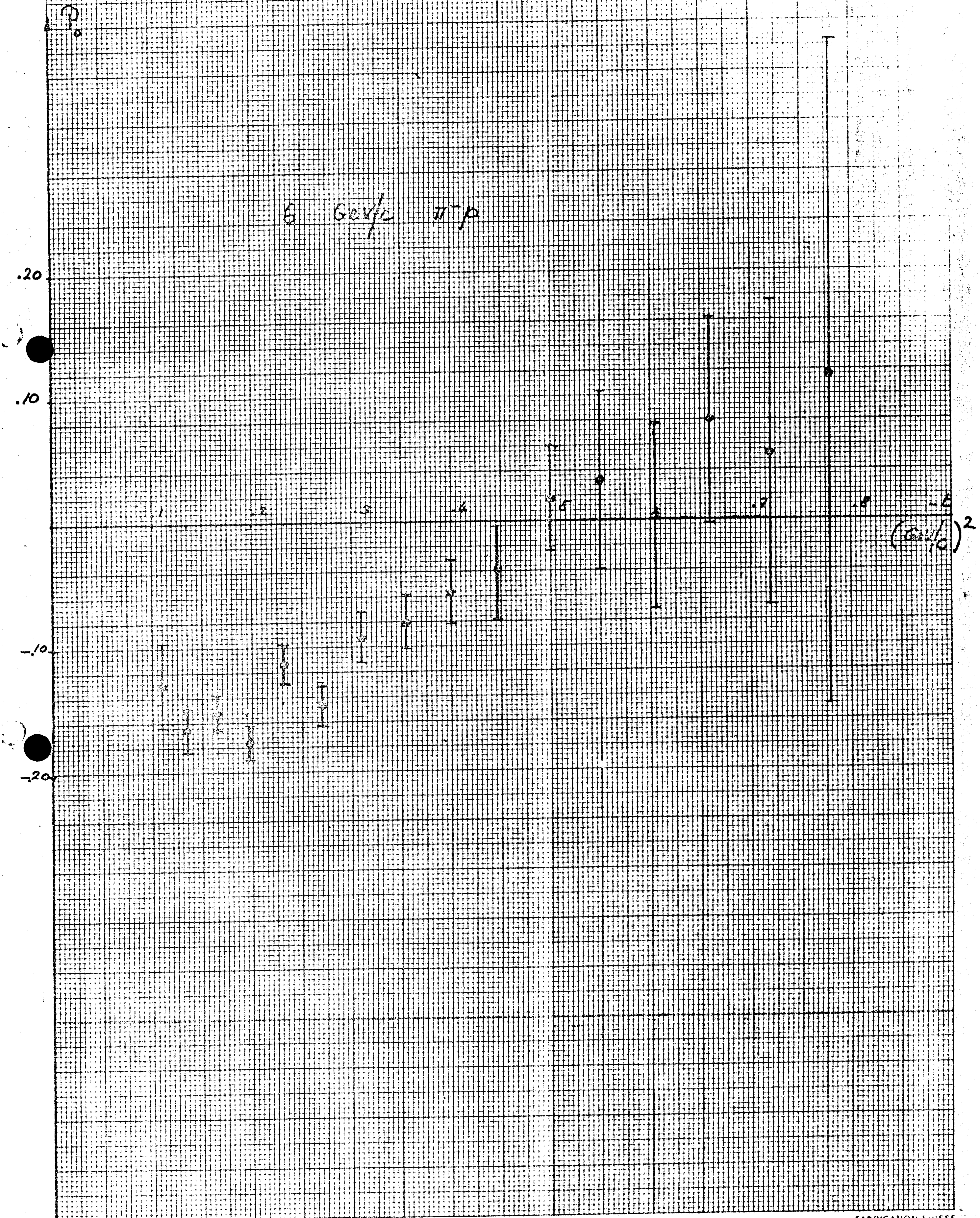
p GeV/c	particle	$\frac{d^3\sigma}{dn\, d\Omega\, dp}$	f(l)	N
6 10 15	π^-	0.8 0.22 9 10^{-2}	0.83 0.9 0.93	10^6 5 10^5 3.1 10^5
6 10 15	π^+	2.3 1.23 0.28	0.83 0.9 0.93	2.9 10^6 2.8 10^6 5.3 10^5
6 10 15	K^-	2 10^{-1} 1.1 10^{-1} 1.3 10^{-2}	0.26 0.45 0.56	7.8 10^4 1.2 10^5 2.7 10^4
6 10 15	K^+	6 10^{-2} 1.5 10^{-2} 1.6 10^{-2}	0.26 0.45 0.56	2.3 10^4 1.7 10^4 3.4 10^3
6 10 15	P	1.3 3.1 9.0	1 1 1	2 10^6 7.8 10^6 3.4 10^7
6 10 15	P^-	7.2 10^{-3} 1.4 10^{-3} 2.3 10^{-5}	1 1 1	1.08 10^4 3.5 10^3 8.6 10^1

TABLE III

HIGH ENERGY DIFFERENTIAL CROSS-SECTIONS

Target: 45 mm long, LMN cristal; $\Delta\phi = \pm 20°$

	Beam momentum (GeV/c)	Number of elastic events vs. t per incident particle, in a t interval of 0.05 $(GeV/c)^2$
π^-	6 10 15	4.0 3.5 3.1 } 10^{-5} exp (9.5 t)
π^+	6 10 15	3.3 3.0 2.8 } 10^{-5} exp (8.8 t)
K^-	≥ 5	2.8 10^{-5} exp (10.3 t)
K^+	≥ 5	1.6 10^{-5} exp (6.5 t)
p	≥ 5	7.6 10^{-5} exp (9.8 t)
$\bar{p}$	5 10	1.5 1.1 } 10^{-5} exp (12. t)



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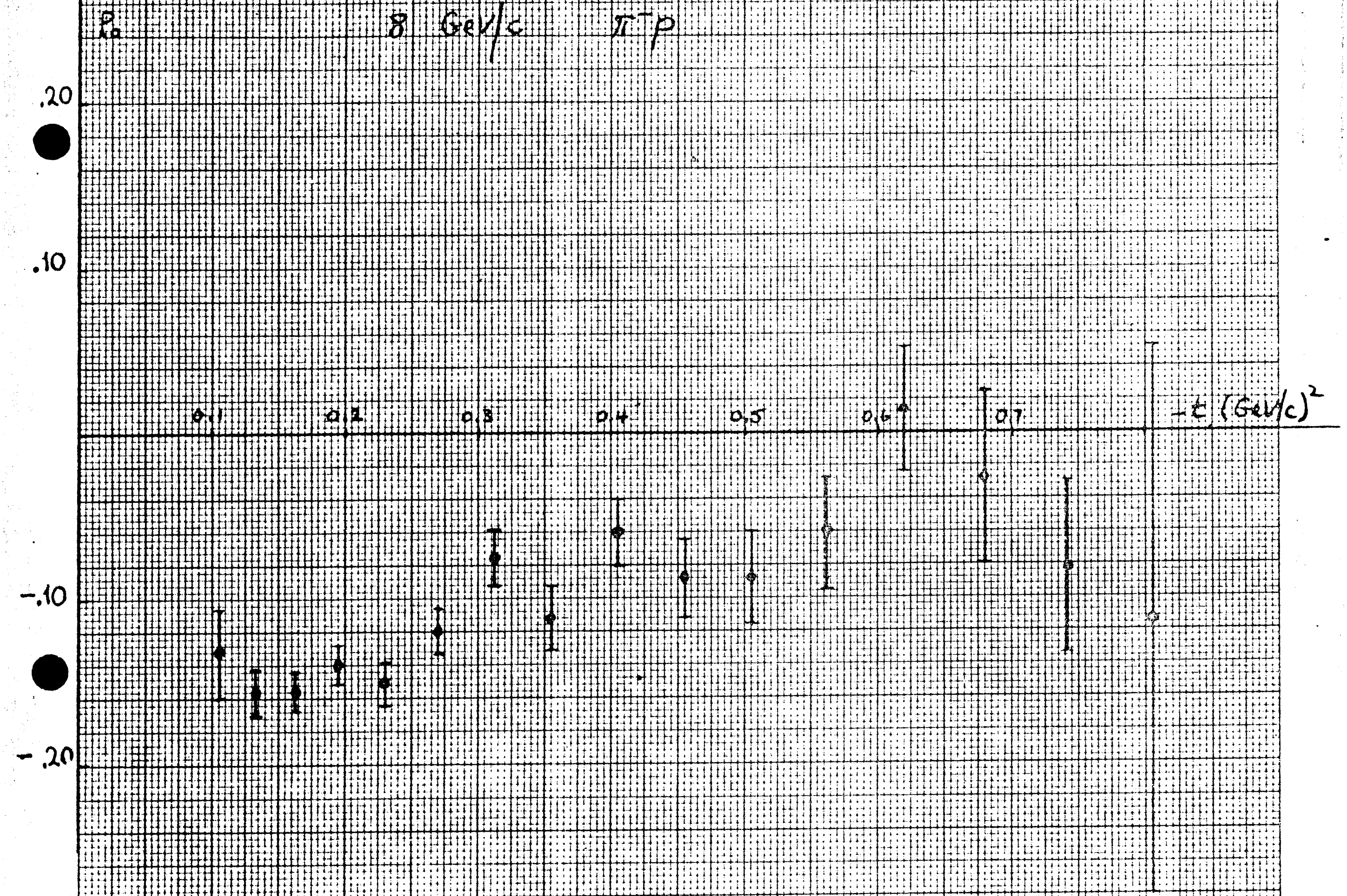
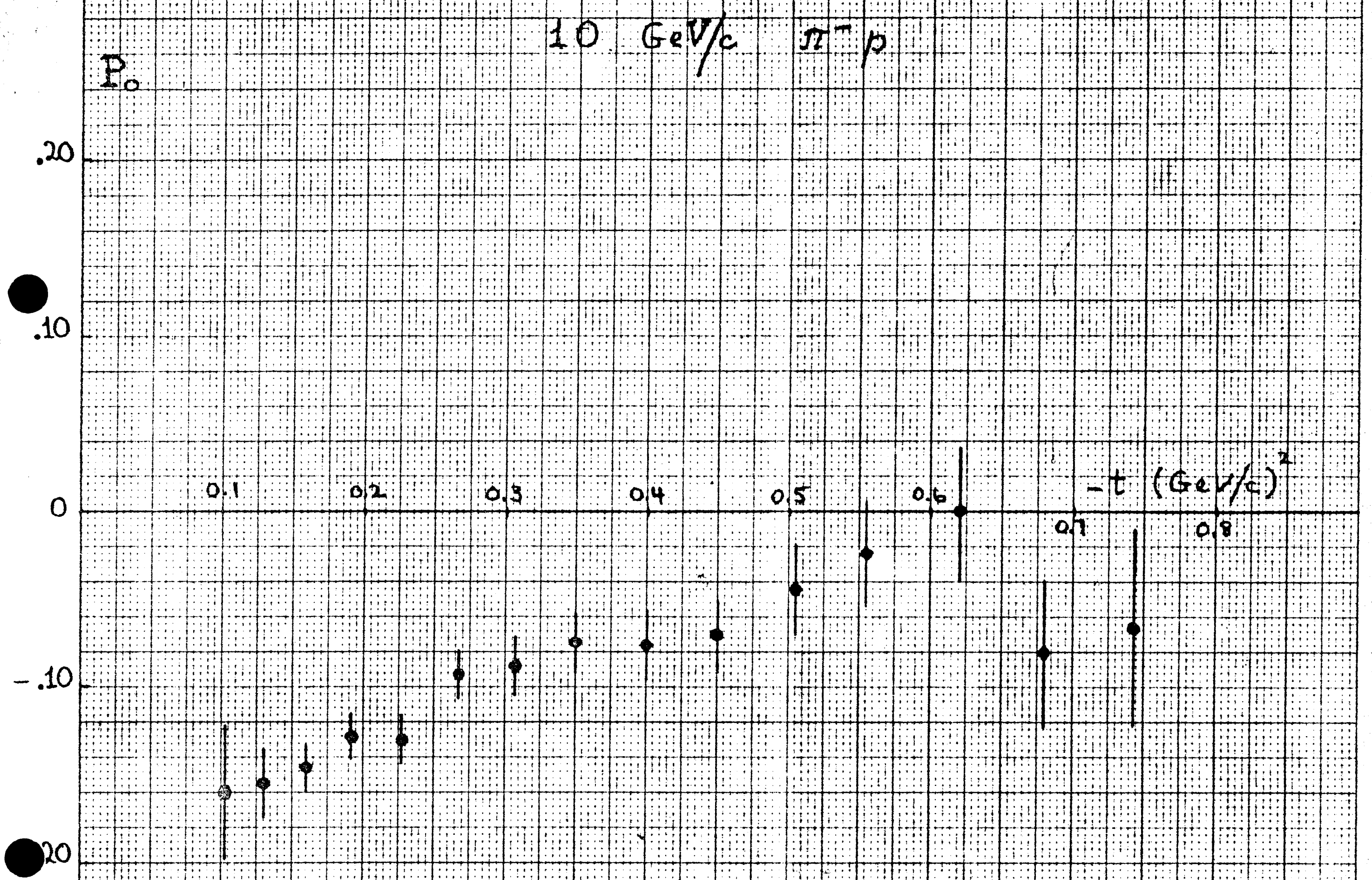


P_o
8 GeV/c
$\pi^- p$
.20
.10
-.10
-.20
0.1
0.2
0.3
0.4
0.5
0.6
0.7
$-t$ $(GeV/c)^2$



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