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M E M O R A N D U M

To : Members of the EEC

From : M. Albrow, S. Andersson, B. Bosnjakovic, F.C. Erné, Y. Kimura, J.P. Lagnaux, J.C. Sens and F. Udo (CERN/Holland team)

Subject: Status and request for extension of the elastic scattering experiment on polarized protons, 1-3 GeV/c

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STATUS OF THE EXPERIMENT

The experiment started in October 1968. In a first memorandum (4 Febr.,1969) to the EEC, 22 angular distributions and polarizations were reported. Including these, the status at present (May 1970) is:

K^+	16	angular distributions	and	polarizations
π^+	23	"	"	"
p	17	"	"	"
K^-	11	"	"	"
π^-	11	"	"	"
$\bar{p}$	11	"	"	"

Total 89 angular distributions and polarizations all in the range 0.85 - 2.75 GeV/c.

The status of the analysis on these data is as follows:

1) K^+ - All data have been worked out. Two rounds of phaseshift analysis have been performed: one between threshold and 1.5 GeV/c (Physics Letters 30B, 56, 1969), the other up to 1.9 GeV/c (preprint submitted to Conf.on hyperon resonances April 1970).

The common conclusion is a resonance-like behaviour of the P_3-partial wave in the region of the bump at ~ 1.25 GeV/c in the total cross section and hence the possibility of a S = + 1 resonance. In the analysis accurate partial amplitudes, of use for finite, energy sum rules, have been obtained. Data taking on K^+ has been terminated in March 1970, as it is felt that with the present apparatus no further significant information on the K^+p problem can be obtained. A final analysis, to be presented at the Kiev conference, is in preparation.

2) π^+ - All data have been worked out and a phaseshift analysis is in progress. Very strong structure is observed, both in the differential cross sections and the polarizations, between ~ 1.0 and 1.5 GeV/c. This is illustrated in Figs. 1 and 2, which show the forward slope of the DCS and the B_3 coefficient in the Legendre expansion of the polarization data. The data are complete enough to attempt an analysis of the π^+p channel (pure $I_{3/2}$) alone; this in contrast to previous analyses where the conclusions on $I = {}^3/_2$ amplitudes were largely based on I - spin decomposition in the π^-p channels.

3) p - All data have been analyzed and a publication has been prepared. The DCS data show the well established gradual increase in steepness of the forward peak, above ~ 1.8 GeV/c the well known break at t = -1 observed at high energies, becomes apparent. The polarizations drop to very small values at t ~ 0.8 - 1.0 GeV^2; similar to the 6 GeV/c data of Borghini et al. These asymptotic features thus seem to set in at as low as 2 GeV/c.

4) K^- - Part of the data have been analyzed and published (preprint, submitted to Nuclear Physics). An example is shown in Fig. 3. They are presently being interpreted in collaboration with the group of Ferro Luzzi et al. Significant structure is present in the B - coefficients near 1 GeV/c. Fig. 4 shows the B coefficients, together with an old (and certainly wrong) prediction (from a diffraction + resonance model) to illustrate what might be expected. It is our intention to devote the remainder of the available run-

ning time to K^- around 1 GeV/c, with the ultimate goal of obtaining (together with our previous experiment at 19 momenta between 1.4 and 2.4 GeV/c) partial amplitudes in a phaseshift analysis. These amplitudes can thus be examined on resonance content and serve - together with the K^+ amplitudes above - as input to finite energy sum rules.

5) π^- - Analysis in progress. No phaseshift analysis is planned.

6) $\bar{p}$ - In progress. The accuracy is limited by the very steep drop in the DCS, even at the lowest momenta.

7) High-energy features of the data - π^+, π^-, K^+, K^-, p and $\bar{p}$ DCS and POL data at 2.74 GeV/c have been used to test high-energy models (preprint, submitted to Conf. on High-Energy collisions, Stony Brook, Sept. 1969). There is limited agreement with some of these models.

REQUEST FOR PS TIME

We should like to ask for an extension of the experiment up to the shut-down in Nov./Dec. 1970. The arguments are:

1) The equipment in its present form (hodoscopes, liquid and gas Čerenkov counters, time of flight on ~ 50 scintillators, supervision by on-line computer) can handle any elastic reaction ($K^\pm$, $\pi^\pm$, $p^\pm$) over nearly the entire angular range, for incident momenta below 2.8 GeV/c, the upper limit of the q_7 beam. For positive particles, the potential of this combination of beam + detection equipment has now been fully exploited; for the negative beam this point would be reached with an extra 4 to 6 weeks of machine time.

2) A very considerable effort has been made in March 1970 to start operating a He^3 cooling system which has increased the butanol polarization from ~ 35 to ~ 60%. Approximately 2 weeks of PS time have been lost due to failures in the initial operation of the system. As a result, only one angular distribution + polarization measurement has thus far been completed with the new cooling.

About four more distributions could be measured in the allocated PS time up to 1 August 1970. The advantages obtained with the He^3 cooling (and the efforts made to get it going) would seem to justify a more extended exploitation of this new facility in the present set-up.

3) Except for some checks with protons, we would use all of the remaining PS time for K^- (and the simultaneously taken π^- and $\bar{p}$ data) and mostly at momenta, which could not (with running times less than ~ 2 weeks/momentum) be done accurately before the installation of the He^3 cooling. Including the 4 weeks before August we would take data at 1.33, 1.17, 1.05, 1.01, 0.94, 0.89 and 0.85 GeV/c; together with the data already taken between 0.98 and 1.28 GeV/c (done partly with LMN, partly with butanol) this would cover in sufficient detail the structure-rich region between ~ 0.8 and ~ 1.3 GeV/c (see Fig. 4) and check the irregular behaviour of the Legendre coefficients obtained so far.

4) At the Lund Conference as many as 10 Λ and Σ resonances have been proposed to exist between 0.8 GeV/c (Mass 1699 MeV) and 1.3 GeV/c (1932 MeV); only half of them fit into the SU(3) multiplets. It is then obvious that polarization data will be required to constrain the analysis of the bubble chamber data in which these resonances are suspected. The present equipment can supply this information.

5) The only other potential user of the q_7 beam is the Trieste group. With this group, which has decided to adopt (with modifications) our earlier (withdrawn) proposal for backward π^+p, K^+p and $\pi^+p \rightarrow \Sigma^+K^+$ (PH I/COM-69/23, 23 May, 1969) we have arranged a transfer of the target and the beam once the present experiment is finished. We have discussed the present request for an extension; there is no objection on their part.

The proposed set of measurements (with the possible exception of the point at 0.85 GeV/c, where the rate must first be checked) can be carried out with an extension of 4 weeks of PS time, i.e. up to the presently foreseen shut-down on 15 November, 1970.

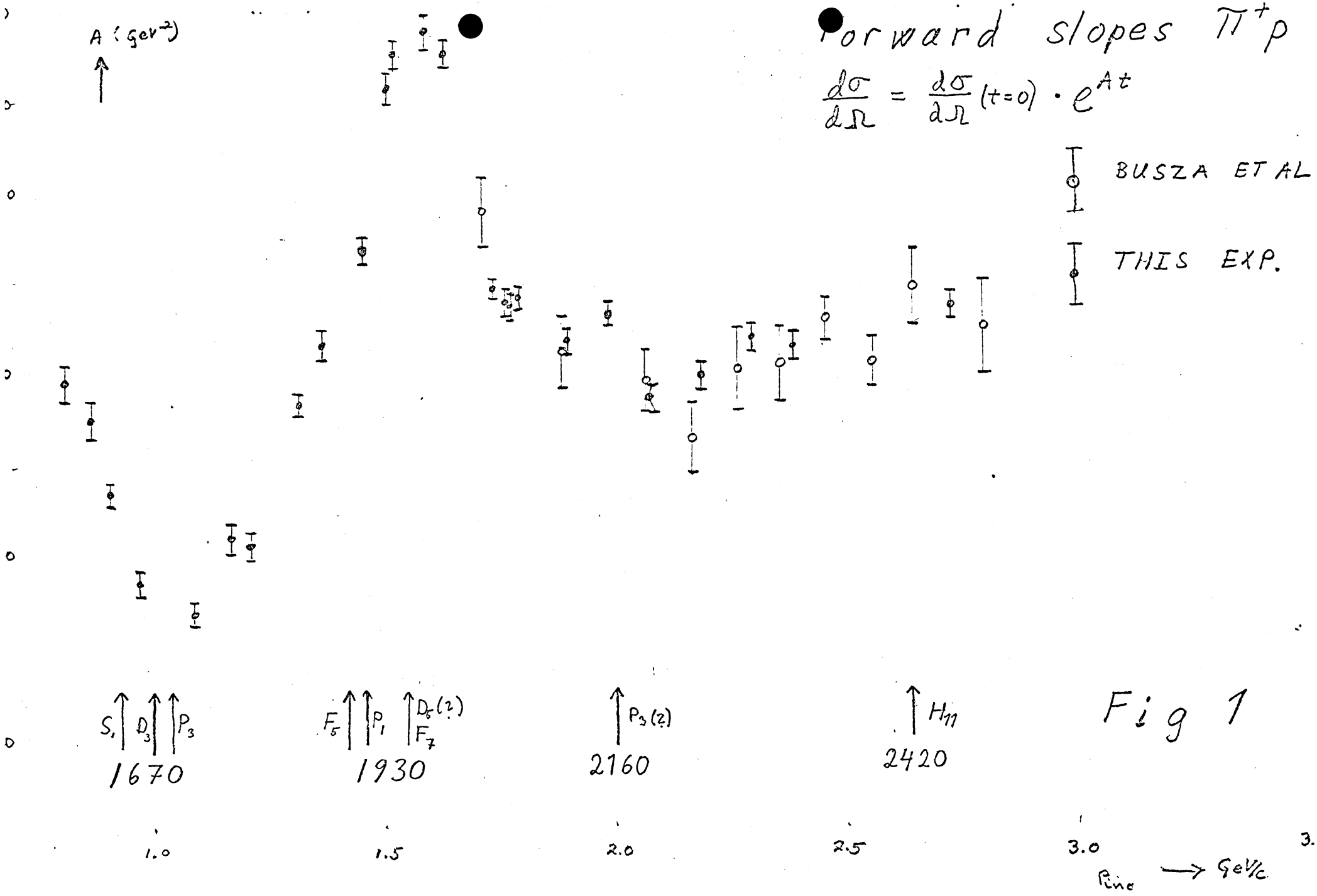

Forward slopes $\pi^+ p$
$\frac{d\sigma}{d\Omega} = \frac{d\sigma}{d\Omega}(t=0) \cdot e^{At}$
BUSZA ET AL
THIS EXP.
A (GeV^{-2})
S_1 D_3 P_3
1670
F_5 P_1 $D_5(?)$ F_7
1930
$P_3(?)$
2160
H_{11}
2420
1.0
1.5
2.0
2.5
3.0
Pinc → GeV/c

Fig 1

$$\pi^+ p \rightarrow \pi^+ p$$

$$p \frac{d\sigma}{d\Omega} = \frac{1}{k^2} \sum_{l=1}^{L} B_l \, P_l^1(\cos\theta^{*+})$$

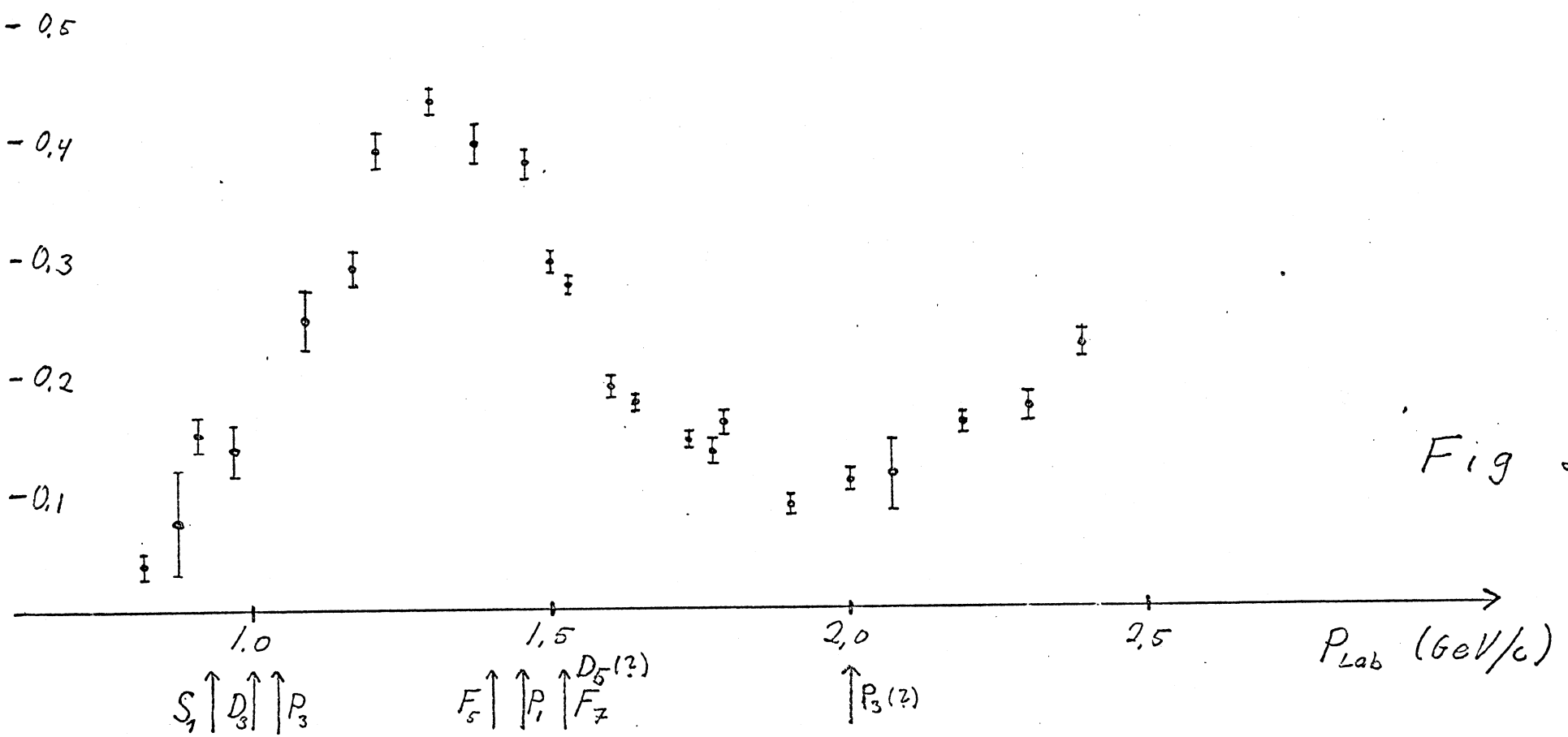
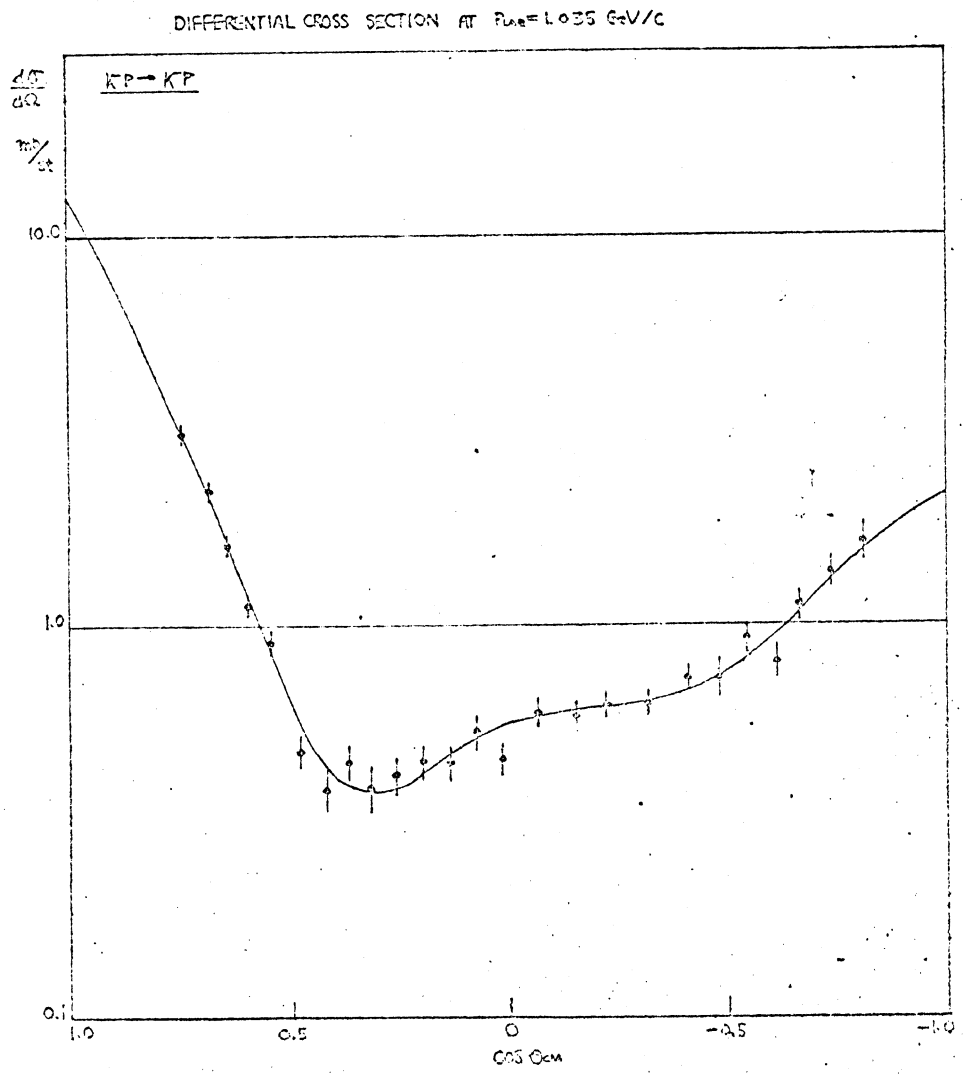


Fig 2


DIFFERENTIAL CROSS SECTION AT Plab = 1.035 GeV/c
K⁻P → K⁻P
dσ/dΩ
mb/sr
10.0
1.0
0.1
1.0
0.5
0
-0.5
-1.0
COS Θcm

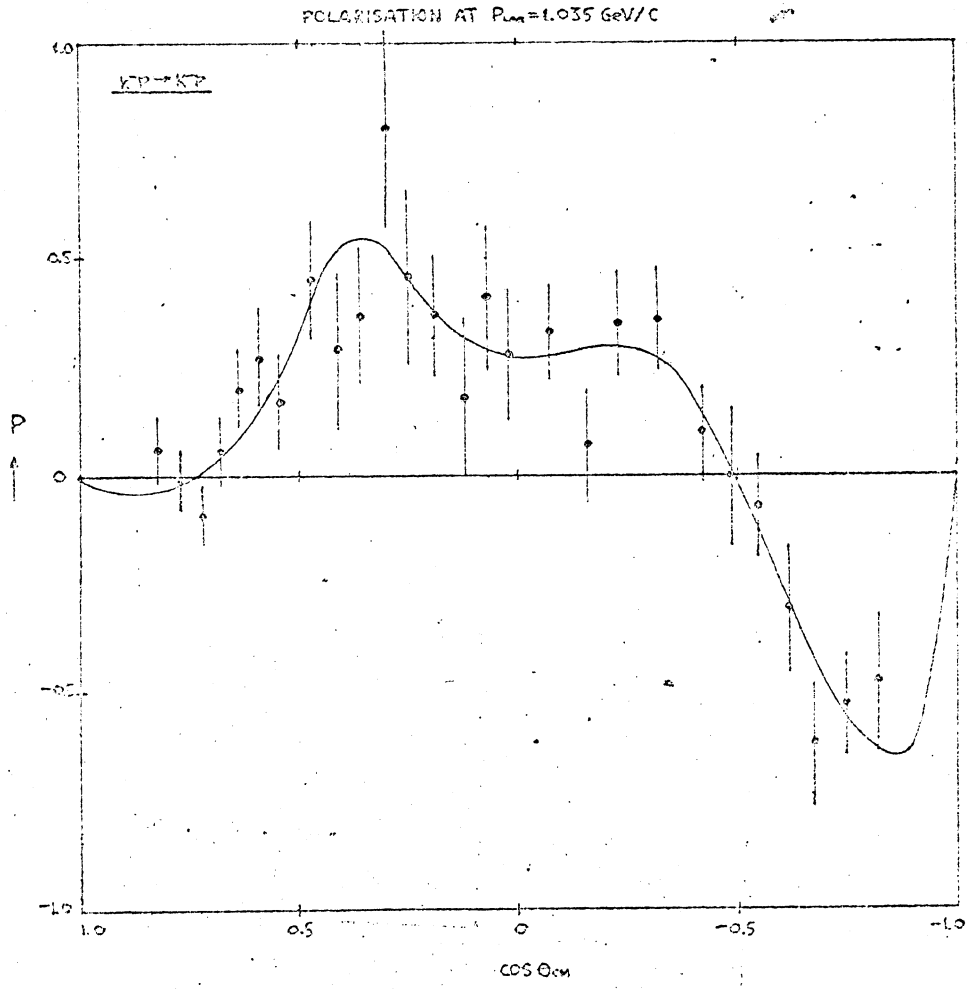
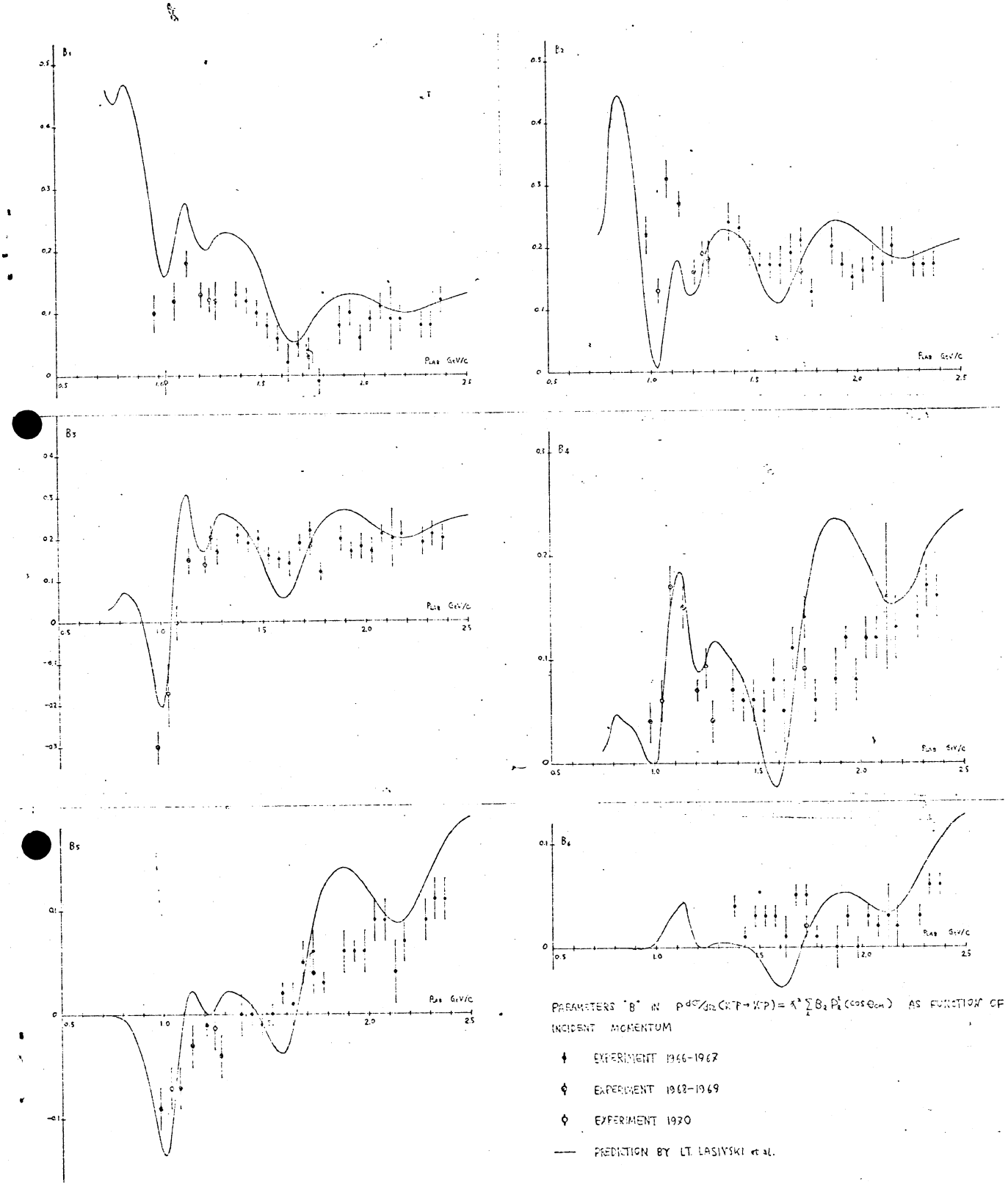

POLARISATION AT Plab = 1.035 GeV/c
K⁻P → K⁻P
P
1.0
0.5
0
-0.5
-1.0
1.0
0.5
0
-0.5
-1.0
COS Θcm

Fig. 3.



PARAMETERS "B" IN $P\frac{d\sigma}{d\Omega}(K^-P \to K^0P) = \lambda^2 \sum_L B_L P_L^1(\cos\Theta_{cm})$ AS FUNCTION OF INCIDENT MOMENTUM

- EXPERIMENT 1966-1967
- EXPERIMENT 1968-1969
- EXPERIMENT 1970
- PREDICTION BY LT. LASINSKI et al.

Fig. 4.