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RHO PRODUCTION AT 63 GeV/c

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Amsterdam-CERN-Cracow-Munich-Oxford-Rutherford Collaboration

ABSTRACT

From 82 000 events of the reaction

$$\pi^- p \to \pi^- \pi^+ n \text{ at } 63 \text{ GeV/c}$$

t-channel moments of the angular distribution are calculated in the mass region of the ρ-meson. Using a Regge model due to Kimel and Owens fitted to data at 17.2 GeV/c, the moments and t-distribution at 63.2 GeV/c can be predicted. We observe excellent agreement with our data.

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1. EXPERIMENTAL METHOD

During the last years a series of few-body experiments was performed at the CERN-SPS. We report here on preliminary results of a study of the reaction $\pi^- p \to \pi^- \pi^+ n$ at 63 GeV/c on a sample of 82 000 events.

The experiment was performed with a double magnet spectrometer (fig.1). Data were recorded by proportional chambers and magnetostrictive wire spark chambers. We triggered on two particles as defined by the proportional chamber P1 before the first magnet and a scintillation counter hodoscope (P2/3) after the magnet. Two Cerenkov hodoscopes distinguished pions from kaons and $\bar{p}p$-pairs.

Additional π^0's were detected by lead sandwich scintillation counters surrounding the H_2-target (F), lining the magnets (G,H) and covering the downstream end of the apparatus (P4/5).

The uncorrected $\pi\pi$ mass spectrum is shown in fig.2.

The acceptance of the apparatus is calculated by a Monte-Carlo program. Spherical harmonics moments $\langle Y_\ell^m \rangle$ are fitted to the angular distribution in the t-channel

$$\frac{d\sigma}{d\Omega} = \sum_{\ell}^{\ell_{max}} \{\langle Y_\ell^0 \rangle Y_\ell^0(\Omega) + 2 \sum_{m=1}^{m_{max}} \langle Y_\ell^m \rangle Y_\ell^m(\Omega)\}$$

using a least squares method. We restrict the fit to $\ell_{max} = 2$, $m_{max} = 2$.

The results from 13 500 events in the ρ-meson region ($0.71 < M_{\pi\pi} < 0.83$ GeV) are shown in fig.3. Compared to the data at 17.2 GeV/c (fig.4), a relative increase of $d\sigma/dt$ is observed for $\sqrt{-t} > 0.5$ GeV/c. This increase is attributed to the enhancement of natural exchange (A_2-exchange) over pion exchange contributions.

An analysis of the data at 17 GeV/c [1] has shown that the reaction $\pi^- p \to \rho^0 n$ is dominated by pion and A_2-exchange (at low and high values of $|t|$ respectively), while absorptive corrections have to be taken into account. More recently the results of a polarized target experiment [2,3] showed the need to include A_1-exchange contributions in the description of the process.

The data at 17.2 GeV/c were fitted to a Regge-model proposed by Kimel and Owens [4] which includes parametrizations for the relevant π, A_2 and A_1 exchanges plus contributions from π- and A_1-cuts.

Kimel and Owens found good agreement of the model with the data of ref. [1] and the preliminary polarized target data [2]. We repeat the fit with the final data [5] using for the trajectories the values of table 1 and obtain for the fitted parameters the results shown in table 2, where we adopt the notation of ref. [4]. The data do not discriminate well between the contributions of the A_1-pole and the A_1-cut; we therefore eliminate the A_1-cut from the fit. The fitted curves are shown in fig.4.

Due to the explicit s-dependence of the Regge-amplitudes, we get a parameter-free prediction for the data at 63 GeV/c, which is plotted in fig.3.

We observe very good agreement between the prediction and the experimental distributions; small deviations for very low $|t|$ are still under investigation.

The increase with s of the ratio of A_2- to π-exchange is described very well by the parametrization of the π- and A_2-trajectories.

The curve for $d\sigma/dt$ in fig.3 is normalized to the data points. The model predicts a calibration factor of

$$\sigma(1 \text{ produced event}) = 0.00013 \ \mu b$$

which is in agreement with our preliminary experimental estimate of

$$\sigma(1 \text{ produced event}) = 0.00009 \pm 0.00004 \ \mu b \ .$$

We intend to increase the statistics of the experiment at 63 GeV/c in order to provide more detailed information about Regge exchanges.

REFERENCES

[1] G. Grayer et al., NP B75 (1974) 189.

[2] H. Becker et al.; Paper submitted to the XVIII Int. Conf. on High Energy Physics, Tbilisi, July 1976,
and: Conference Proceedings, p.27.

[3] H. Becker et al., "Measurement of the Reaction $\pi^- p \to \rho^0 n$ on a Polarized Target"
and
H. Becker et al., "A Model Independent Partial Wave Analysis of the $\pi^+\pi^-$ System Produced at Low Momentum Transfer in the Reaction $\pi^- p_\uparrow \to \pi^-\pi^+ n$ at 17.2 GeV/c"
Papers submitted to the XIX Int. Conf. on High Energy Physics, Tokyo, 1978.

[4] J.D. Kimel and J.F. Owens, NP B122 (1977) 464.

[5] J.G.H. de Groot, Thesis Amsterdam University, April 1978.

Figure captions

Fig. 1 : Schematic plan of the spectrometer
H_2 target : H_2
Lead sandwich scintillation counters : F,G,H,P4/5
Proportional chamber : P1
Scintillation hodoscope : P2/3
Cerenkov counters : C_1,C_2
Spark chambers in ARM I
ARM II
ARM III A,B,C

Fig. 2 : Uncorrected $\pi\pi$ mass spectrum.

Fig. 3 : $d\sigma/dt$ (arbitrary units) and normalized moments of the angular distribution in the t-channel for $0.71 < M_{\pi\pi} < 0.83$ GeV/c at 63 GeV/c. Curve predicted from the fit at 17.2 GeV/c.

Fig. 4 : $d\sigma/dt$ (arbitrary units) and normalized moments of the angular distribution in the t-channel for $0.71 < M_{\pi\pi} < 0.83$ GeV/c at 17.2 GeV/c. Curve fitted with Regge model of ref. [4].

Table 1

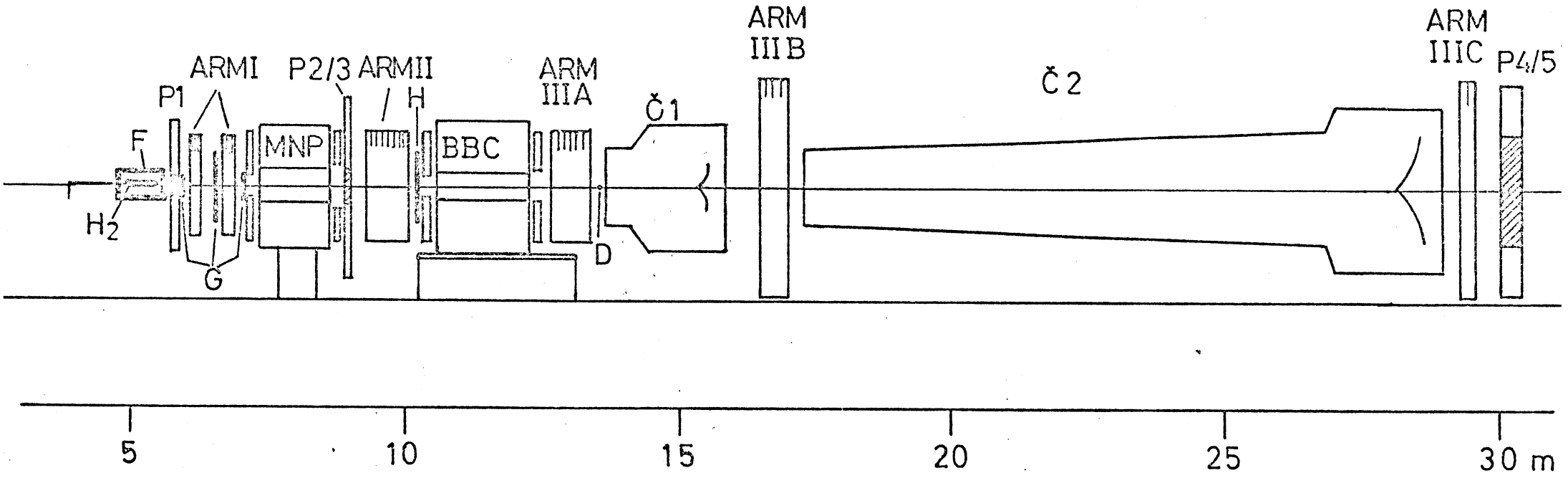
Regge Trajectories

$\alpha_\pi(t)$	$= 0.7\ (t - m_\pi^2)$
$\alpha_{A_2}(t)$	$= 0.43 + 0.74\ t$
$\alpha_{A_1}(t)$	$= -0.3 + 0.9\ t$
$\alpha_{\pi\text{-cut}}(t)$	$= 0.0 + 0.4\ t$

Table 2

Fitted Parameters

β_π	$= 48.64 \pm 0.07$
c_π^0	$= 1.48 \pm 0.02$
c_π^1	$= 0.21 \pm 0.01$
β_{A_2}	$= 6.32 \pm 0.02$
c_{A_2}	$= 0.27 \pm 0.005$
$\beta_{A_1}^0$	$= 242.1 \pm 3.1$
$\beta_{A_1}^1$	$= 143.7 \pm 5.5$
$c_{A_1}^0$	$= 9.6 \pm 0.25$
$c_{A_1}^1$	$= 2.18 \pm 0.16$
$\beta_{\pi\text{-cut}}$	$= -65.3 \pm 0.25$
$c_{\pi\text{-cut}}$	$= 1.32 \pm 0.01$


ARM
III B
ARM
III C
P4/5
ARMI
P2/3
ARMII
ARM
III A
Č 1
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P1
F
H
MNP
BBC
H2
D
G
5
10
15
20
25
30 m

Fig.1

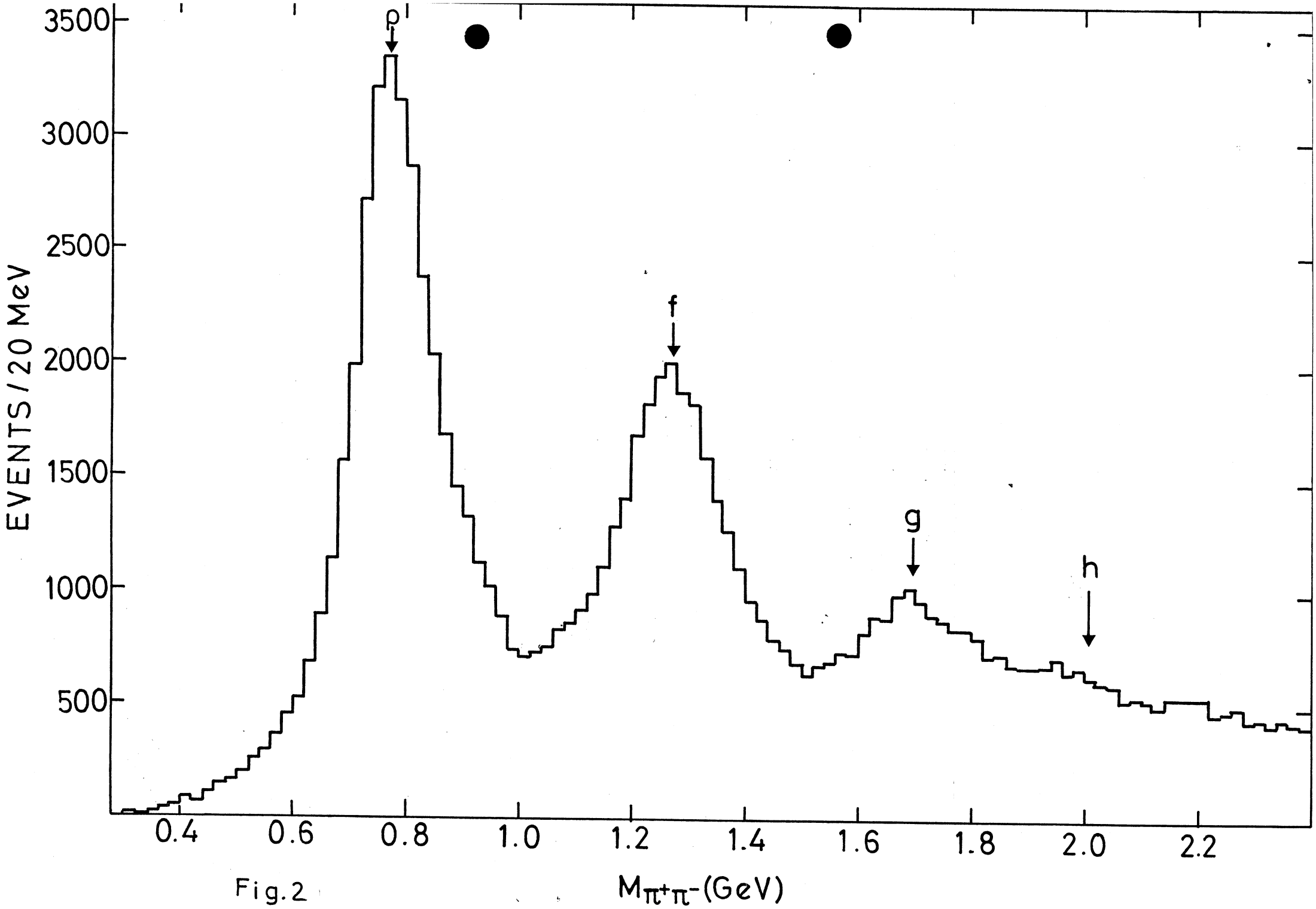
ρ
f
g
h
EVENTS / 20 MeV
3500
3000
2500
2000
1500
1000
500
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
Mπ+π-(GeV)

Fig.2

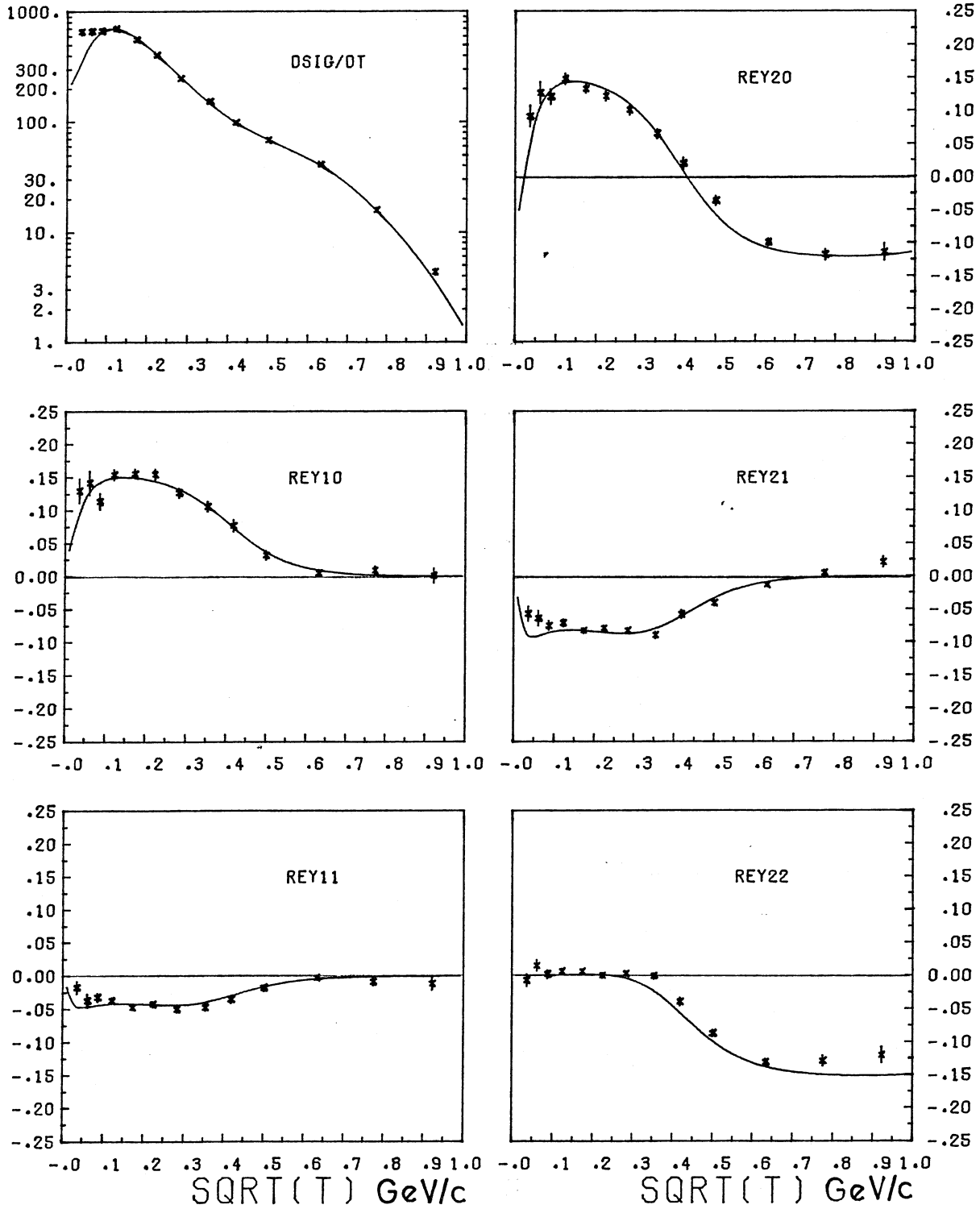
63 GeV/c
DSIG/DT
REY20
REY10
REY21
REY11
REY22
SQRT(T) GeV/c
SQRT(T) GeV/c

Fig.3

17.2 GeV/c

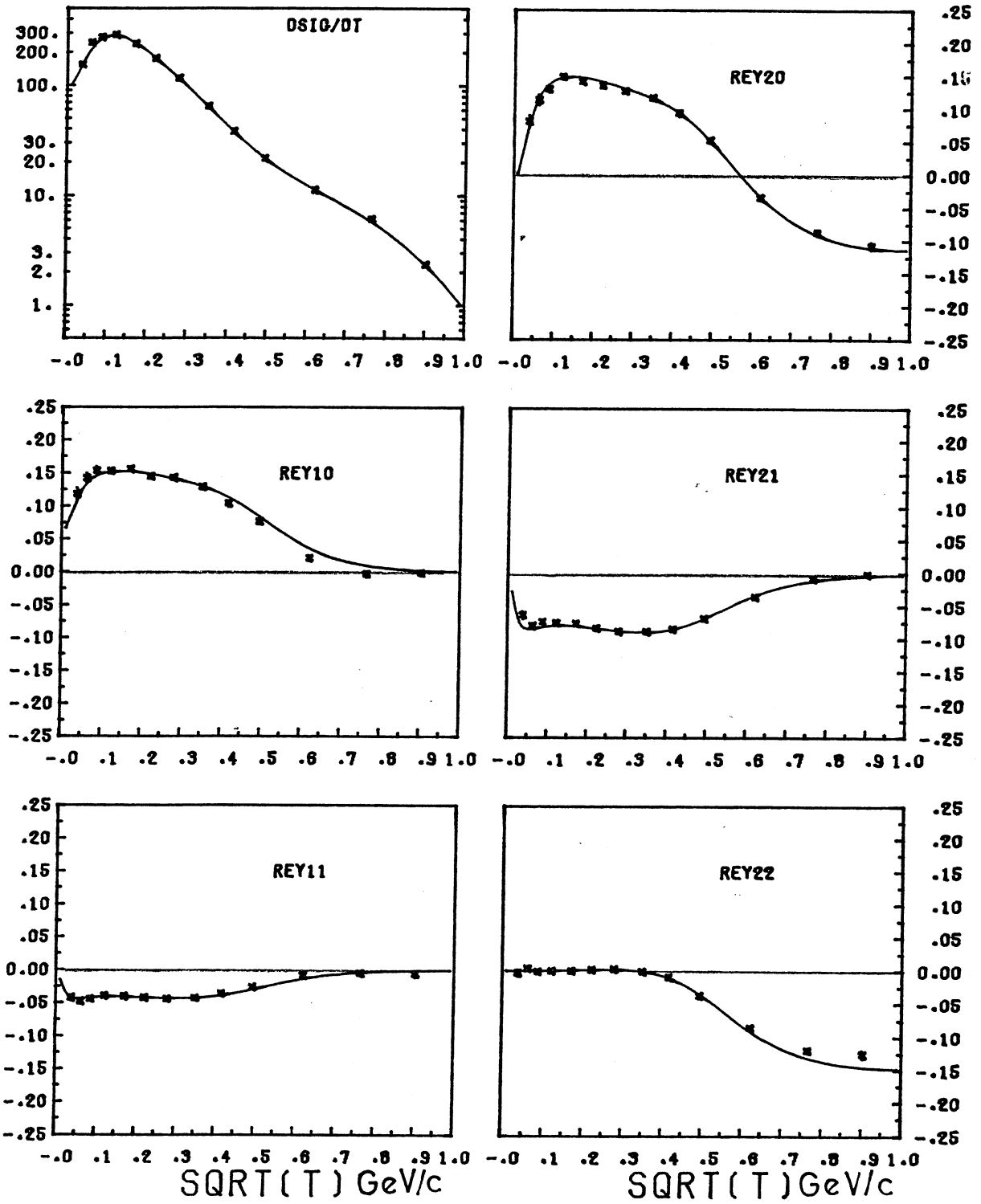

Fig. 4