IC/74/76
INTERNAL REPORT
(Limited distribution)

International Atomic Energy Agency

and

United Nations Educational Scientific and Cultural Organization

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

T O P I C A L M E E T I N G

ON THE PHYSICS OF COLLIDING BEAMS

20 - 22 June 1974

(SUMMARIES AND CONTRIBUTIONS)

MIRAMARE - TRIESTE

July 1974

SUMMARY OF DATA

FROM THE SLAC-LBL MAGNETIC DETECTOR COLLABORATION AT SPEAR

B. Richter

Stanford Linear Accelerator Center, California, USA.

Presented here are some of the figures summarizing the data presented at the seminar on $e^+ - e^-$ colliding beam physics held at Trieste, 19-22 June 1974.

Fig.1 lists the collaborators in this experiment.

Fig.2 shows the comparison of the Bhabha scattering yield with the predictions of theory including the apparatus acceptance and radiative corrections.

Fig.3 tabulates the limits on a possible cut-off parameter in QED. The values of Λ correspond to form factor expansions of the form

$$F = 1 \pm \frac{q^2}{\Lambda_\pm^2} + \cdots \quad ,$$

where $\Lambda_\pm$ corresponds to a positive or negative metric.

Fig.4 defines some properties of the apparatus.

Fig.5 shows the total cross-section. The errors on the SLAC-LBL points include statistical errors, systematic effects and an allowance for the model dependence of the correction required to account for the missing angular coverage of the detector.

Fig.6 shows the same data divided by the point-like μ pair production cross-section.

Fig.7 shows the mean charged particle multiplicity. The errors on this and all subsequent figures include an allowance for the model dependence of the extrapolation to the uncovered solid angle where relevant.

Fig.8 is the observed mean charged particle momentum.

Fig.9 shows the fraction of $\sqrt{S}$ carried by charged particles.

Fig.10 shows the function $S\frac{d\sigma}{dx}$ vs. x ($x = E_h/\sqrt{S}$). If Björken scaling were true, $S\frac{d\sigma}{dx}$ should be a universal function of x. It is for $x > \frac{1}{2}$ and is not for $x < \frac{1}{2}$.

Fig.11 shows the single-particle cross-section per unit invariant phase space. In these units a kind of "hadronic" scaling is seen for $P < 1$ GeV/c.

Fig.12 shows the values of the coefficient of $\cos^2\theta$ fit to the measured angular distribution in the region $|\cos\theta| \leq 0.6$.

Fig.13 shows the fraction of π^-, K^- and $\bar{P}$ observed at $\sqrt{S} = 4.8$ GeV by a time-of-flight system.

Fig.14 shows the same data plotted as yield per unit invariant phase space vs. particle total energy.

Figs.15 and 16 show the cross-sections for "4C" and "1C" fitted events for the 4 and 6 charged particle final states.

LBL-SLAC SPEAR Magnetic Detector Collaboration

G. S. Abrams
D. D. Briggs
W. Chinowsky
C. E. Friedberg
G. Goldhaber
R. J. Hollebeek
J. A. Kadyk
G. H. Trilling
J. S. Whitaker
J. E. Zipse

J.-E. Augustin
A. M. Boyarski
M. Breidenbach
F. Bulos
J. Dakin
G. Feldman
G. E. Fischer
D. Fryberger
G. Hanson
B. Jean-Marie
R. R. Larsen
H. L. Lynch
D. Lyon
C. Morehouse
J. Paterson
M. L. Perl
T. Pun
B. Richter
R. F. Schwitters

Fig.1

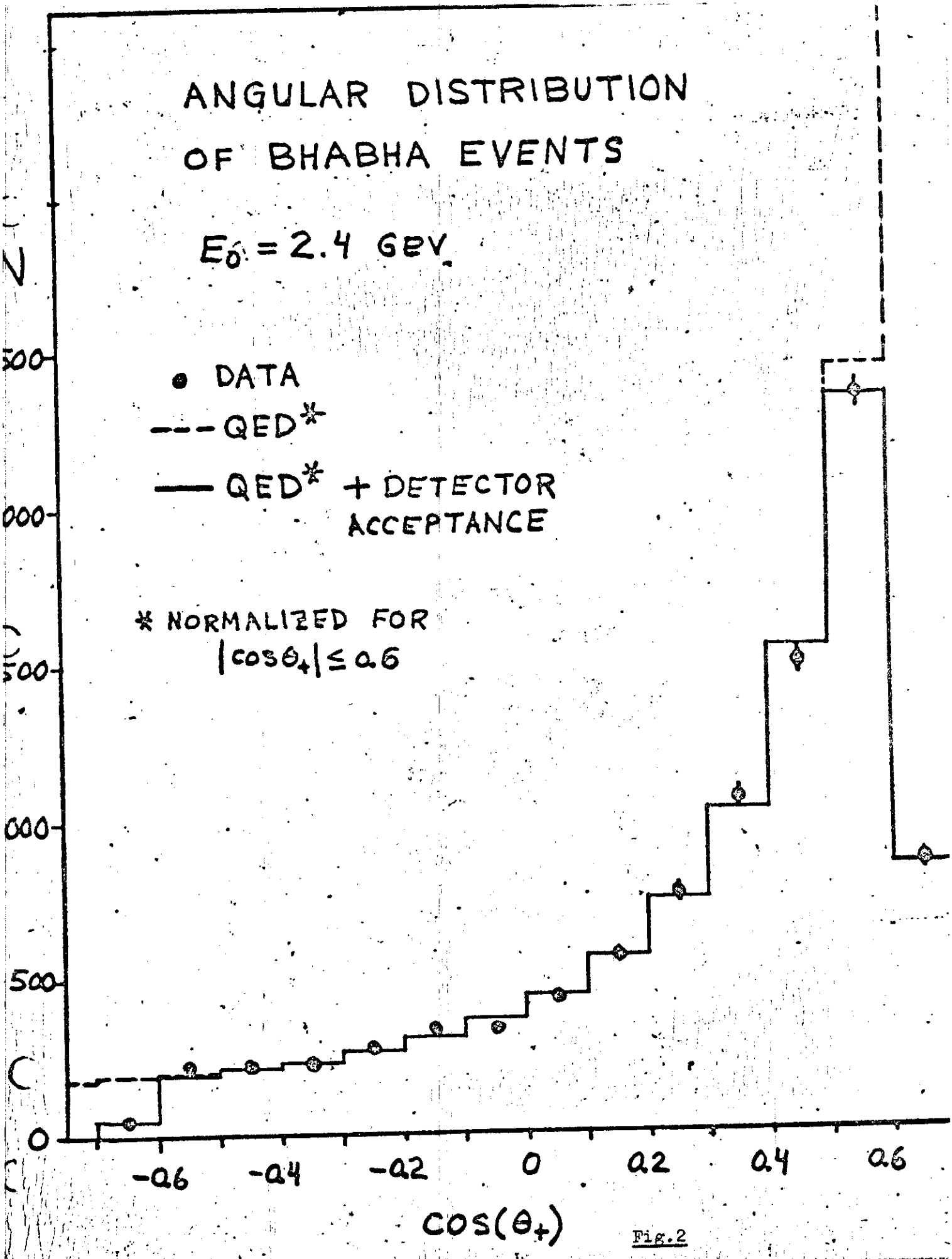

ANGULAR DISTRIBUTION
OF BHABHA EVENTS
$E_0 = 2.4$ GEV
DATA
QED*
QED* + DETECTOR ACCEPTANCE
* NORMALIZED FOR $|\cos\theta_+| \leq 0.6$
N
500
000
500
000
500
0
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
$\cos(\theta_+)$

Fig.2

SUMMARY OF QED CUT-OFF PARAMETERS (GEV)

METHOD	FITTED PARAMETERS	DATA USED	
		$e e$	$e e + \mu\mu$
SEPARATE FORM FACTORS FOR SPACE AND TIME LIKE PHOTONS	$\Lambda_{+,-}^{SPACE}$	14 , 14	28 , 15
	$\Lambda_{+,-}^{TIME}$	10 , 17	26 , 34
SINGLE FORM FACTOR FOR SPACE OR TIME-LIKE PHOTONS	$\Lambda_{+,-}$	16 , 13	35 , 33
SEPARATE FORM FACTORS FOR e AND μ VERTICES	$\Lambda_{+,-}^{e}$	–	22 , 19
	$\Lambda_{+,-}^{\mu}$	–	14 , 16

Fig.3

Acceptance

$50° < \theta < 130°$ for Trigger

$40° < \theta \leq 140°$ for Tracking

$B = 4$ Kg

$(P_\perp)_{min} = 75$ MeV/c

$\frac{\Delta P}{P} = \pm 2\% \times P(GeV)$ with Vertex

Trigger

(Beam Pipe Ctr)(2) 2 Trig in assoc with Thru shower ctrs

Trigger rate $\approx$ 1/sec

Multihadron

2 charged non coplanar (220°)

+ // 3 charged

Normalization — Bhabha

eff $\approx$ 65%

Fig.4

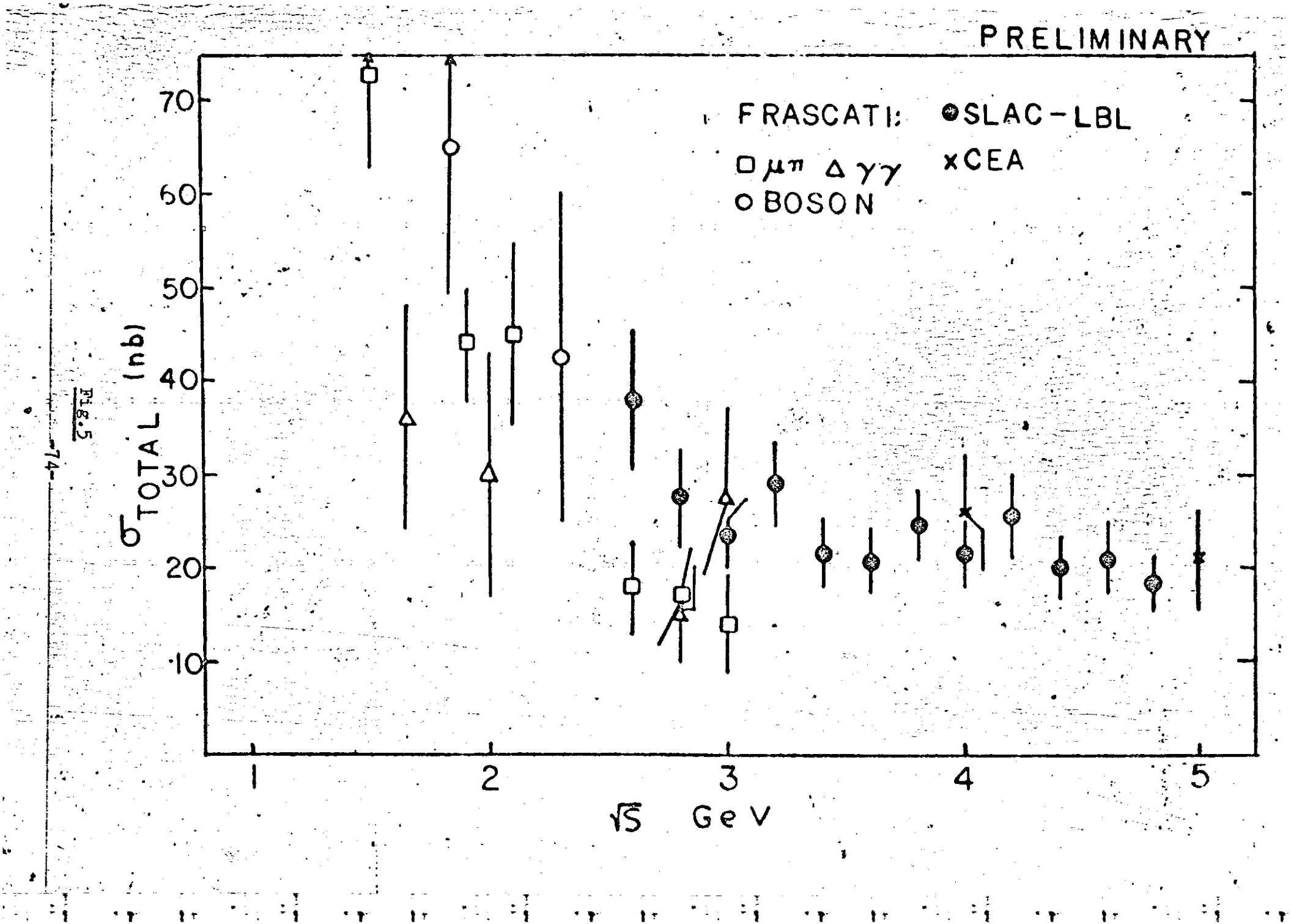

PRELIMINARY
FRASCATI:
□ μπ Δ γγ
○ BOSON
● SLAC-LBL
× CEA
σ TOTAL (nb)
70
60
50
40
30
20
10
1
2
3
4
5
√S GeV

Fig.5

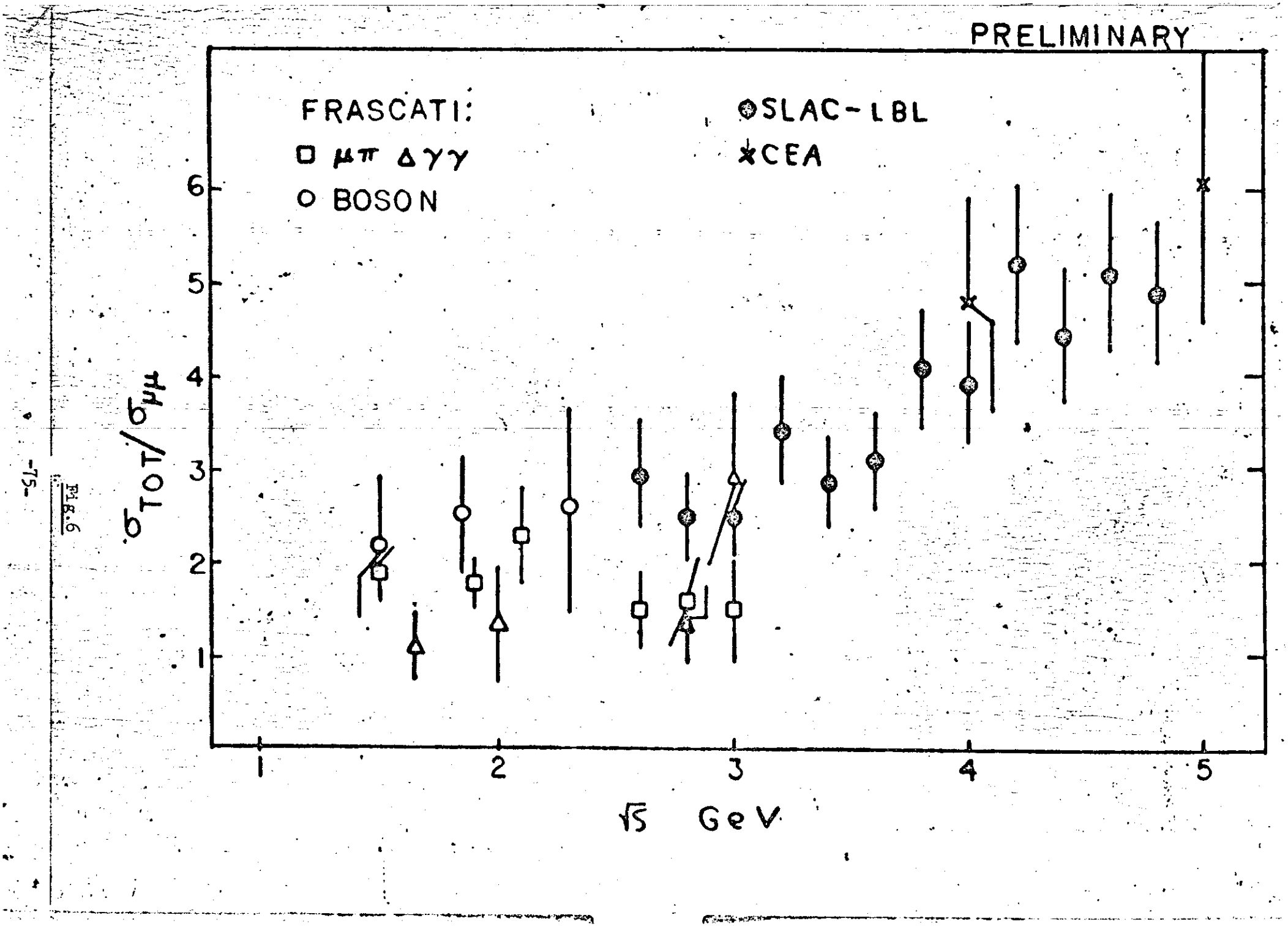

PRELIMINARY
FRASCATI:
□ μπ Δγγ
○ BOSON
⊙SLAC-LBL
✱CEA
$\sigma_{TOT}/\sigma_{\mu\mu}$
1
2
3
4
5
6
1
2
3
4
5
√s GeV

Fig.6

MEAN CHARGED MULTIPLICITY

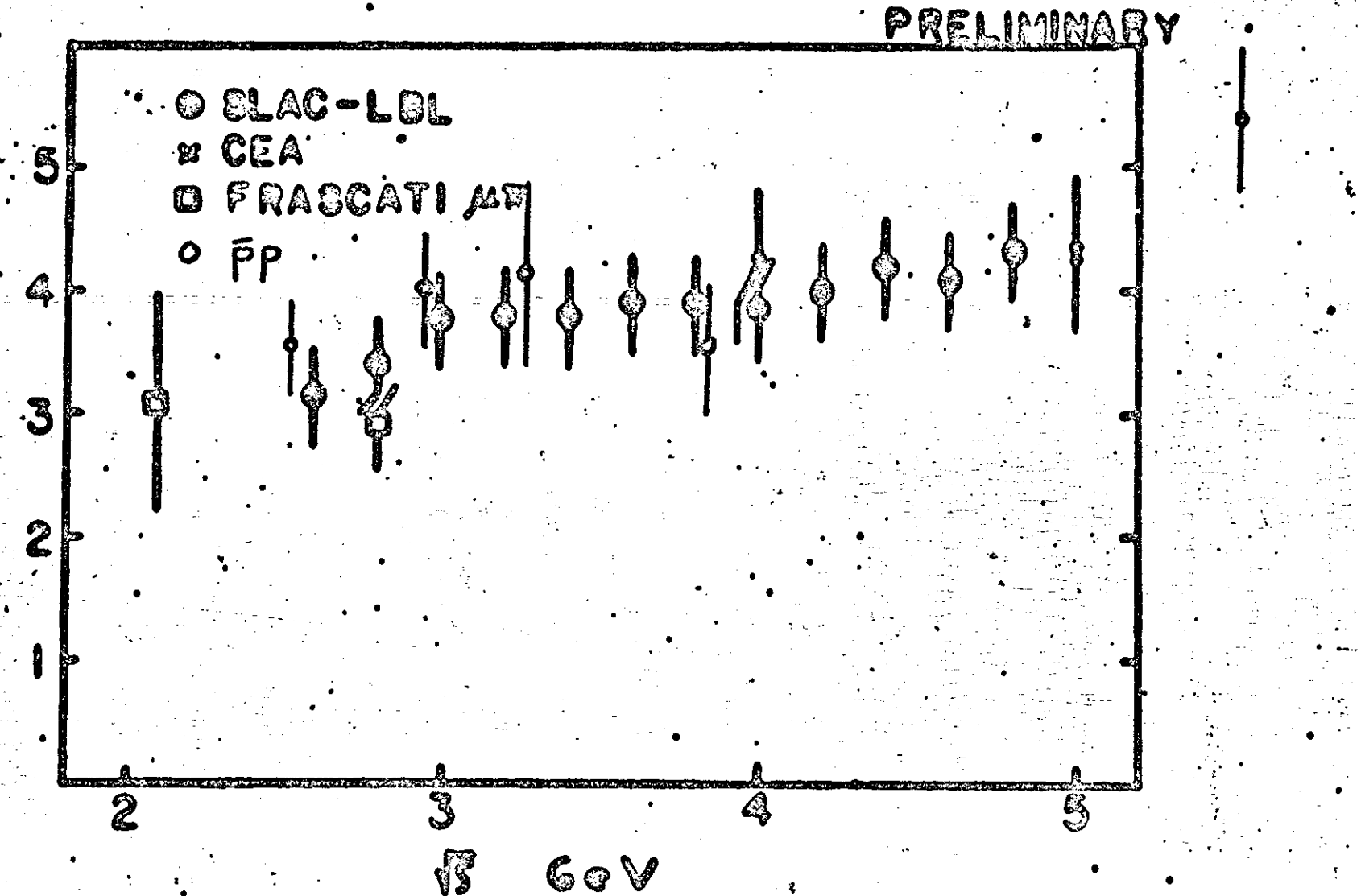
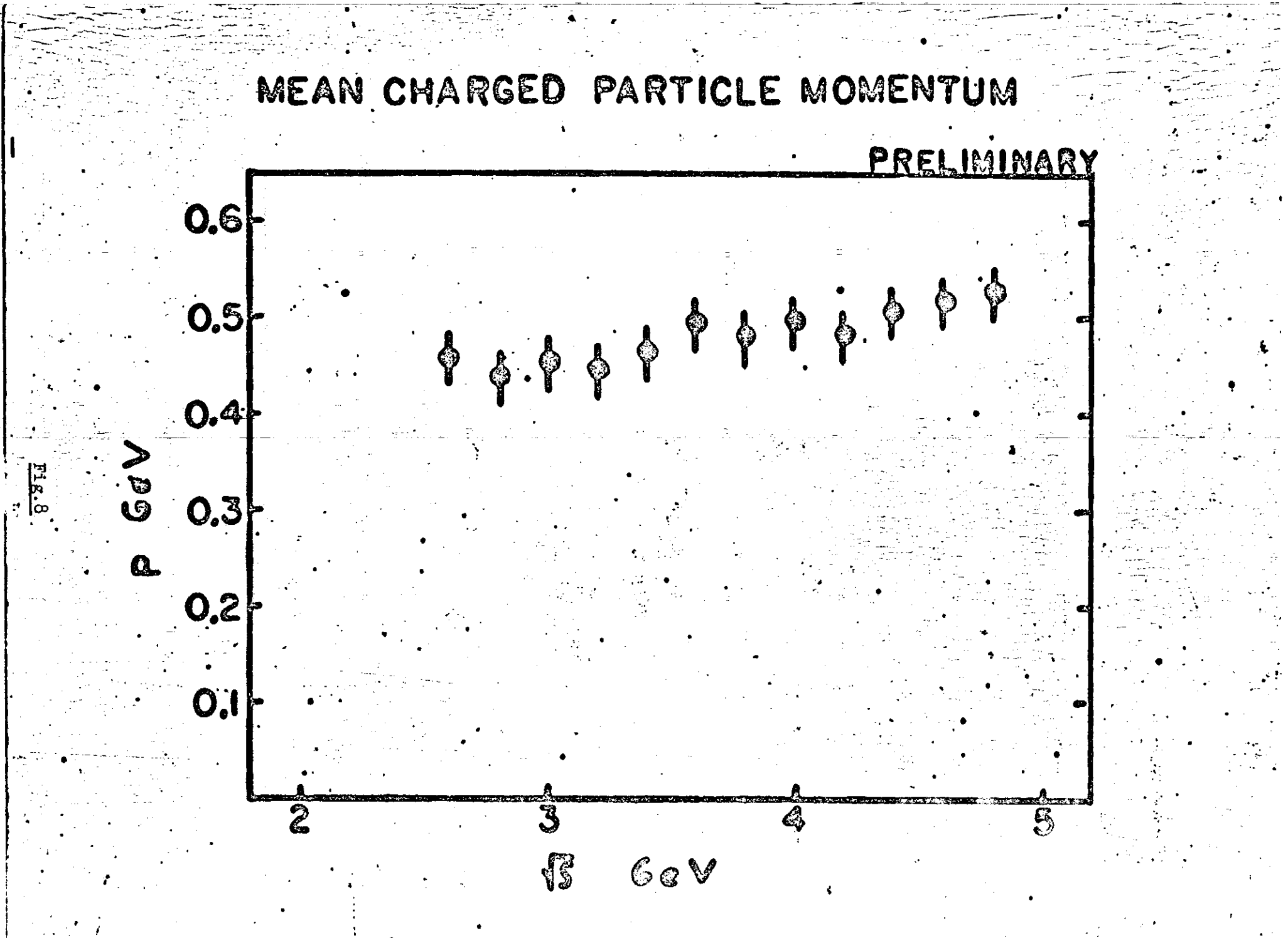


Fig. 7

Fig.8


MEAN CHARGED PARTICLE MOMENTUM
PRELIMINARY
0.6
0.5
0.4
0.3
0.2
0.1
p GeV
2
3
4
5
√s GeV

CHARGED ENERGY / TOTAL ENERGY IF ALL CHARGED PARTICLES HAVE PION MASS

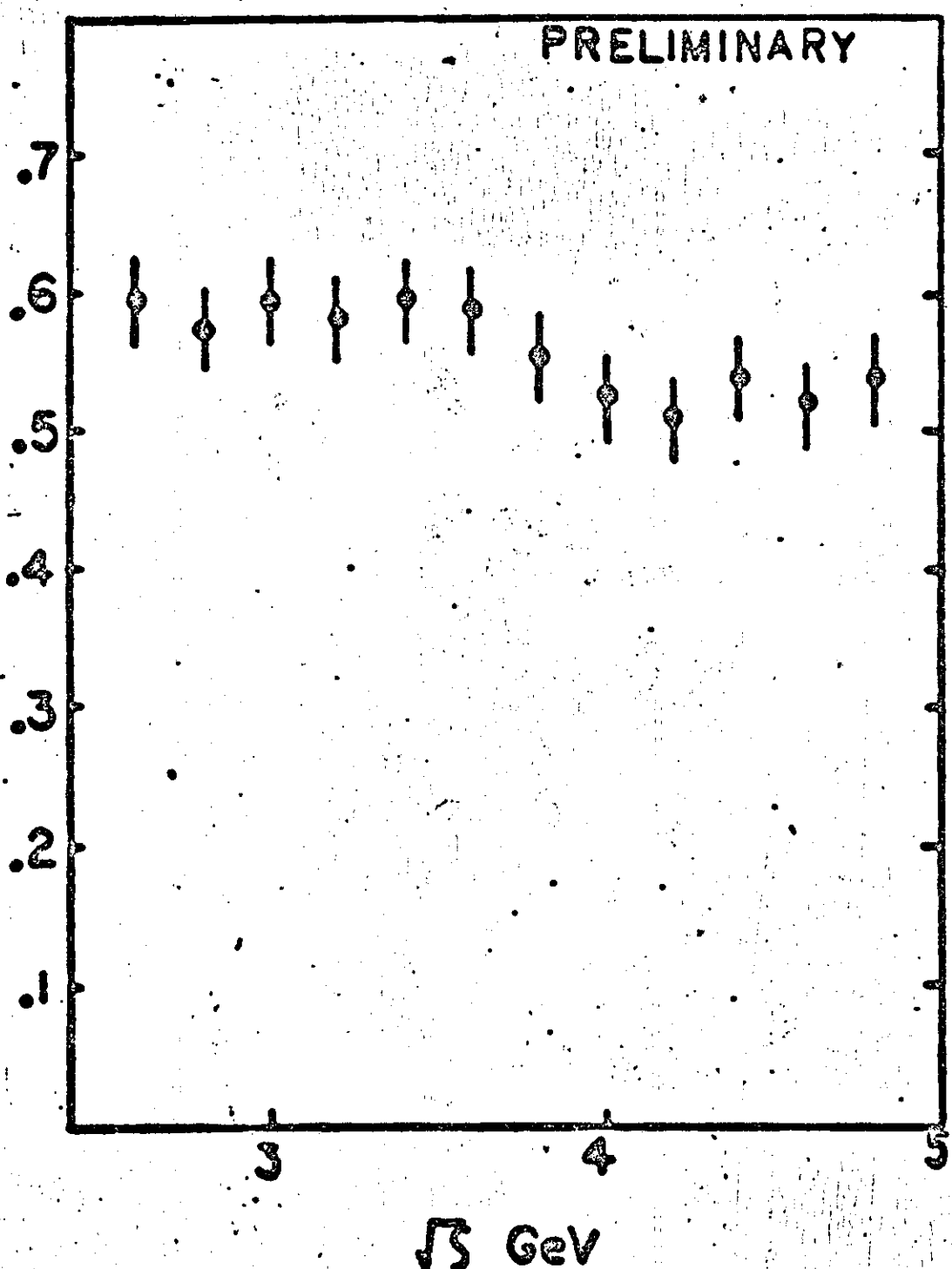


Fig.9

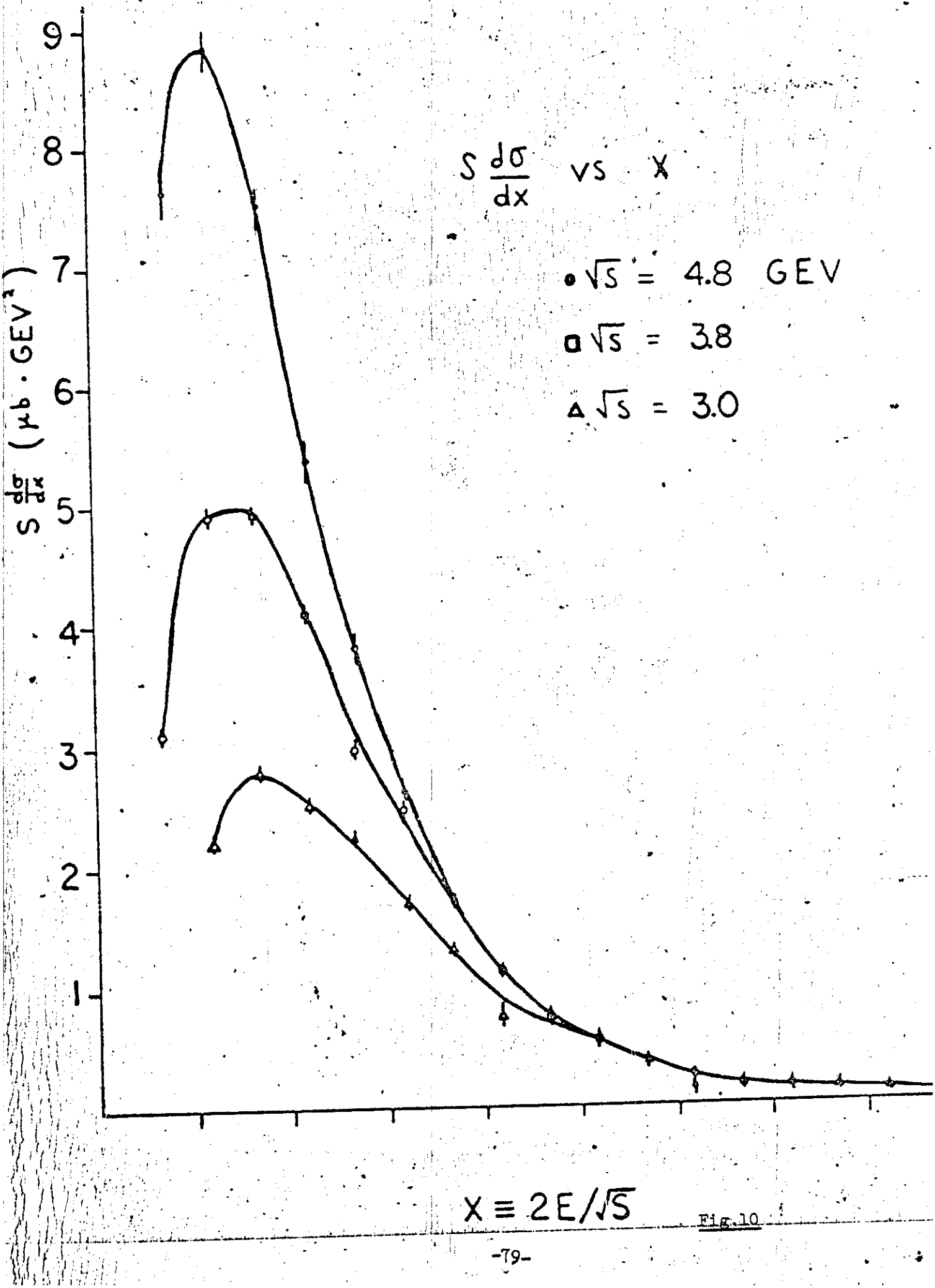

$S\frac{d\sigma}{dx}$ vs X
• $\sqrt{s}$ = 4.8 GEV
□ $\sqrt{s}$ = 3.8
△ $\sqrt{s}$ = 3.0
$S\frac{d\sigma}{dx}$ ($\mu b \cdot GEV^2$)
1
2
3
4
5
6
7
8
9
$X \equiv 2E/\sqrt{s}$

Fig. 10

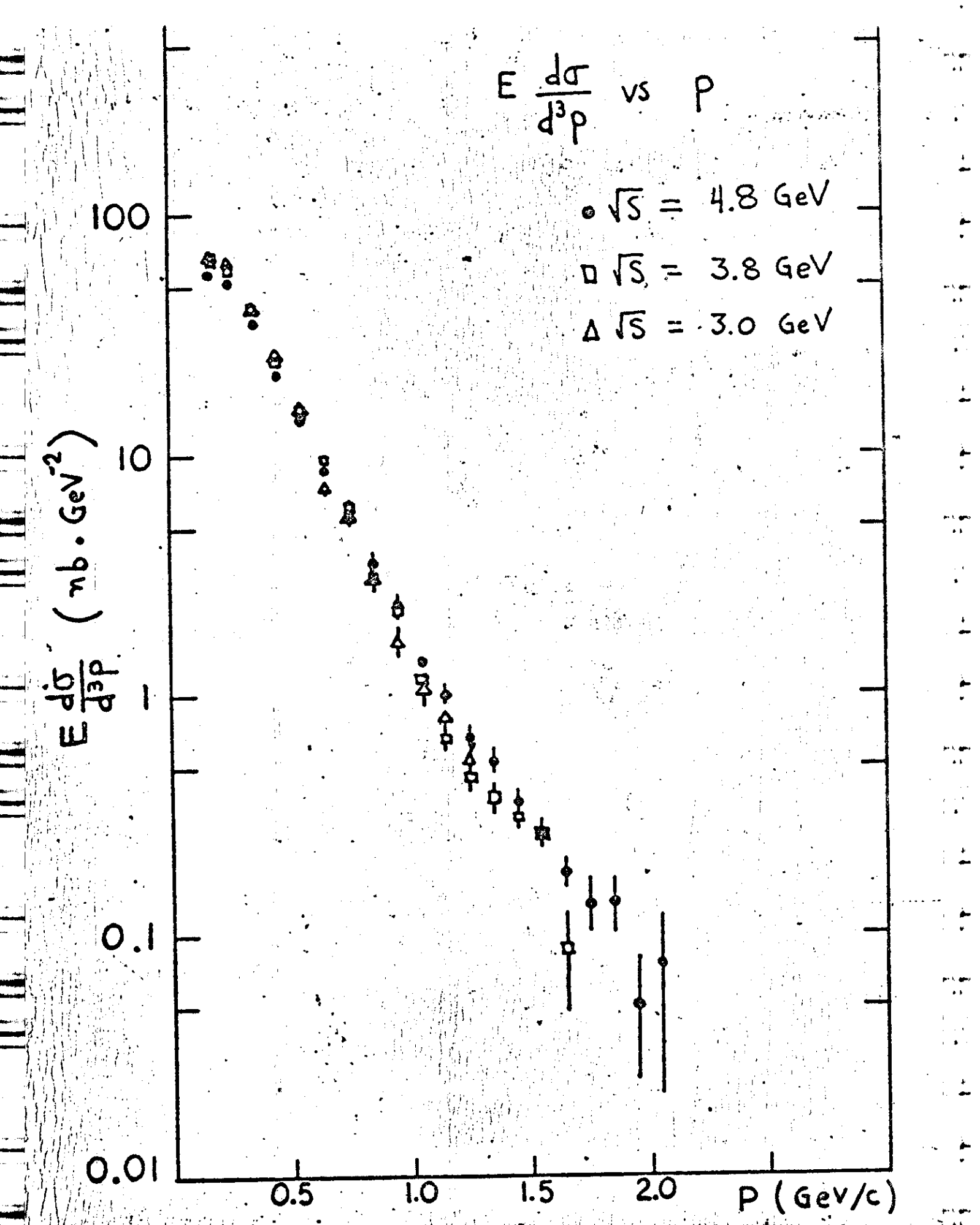

$E\frac{d\sigma}{d^3p}$ vs P
$\sqrt{s}$ = 4.8 GeV
$\sqrt{s}$ = 3.8 GeV
$\sqrt{s}$ = 3.0 GeV
$E\frac{d\sigma}{d^3p}$ (nb · GeV^{-2})
100
10
1
0.1
0.01
0.5
1.0
1.5
2.0
P (GeV/c)

Fig.11

α	$0 < X < .45$	$.45 \leq X < .9$
$\sqrt{S} = 4.8$	$.25 \pm .10$	$.2 \pm .2$
$\sqrt{S} = 3.8$	$.18 \pm .11$	$.0 \pm .4$
$\sqrt{S} = 3.0$	$.0 \pm .17$	$.2 \pm .4$

VALUES FOR FIT WITH $1 + \alpha \cos^2\theta$

Fig.12

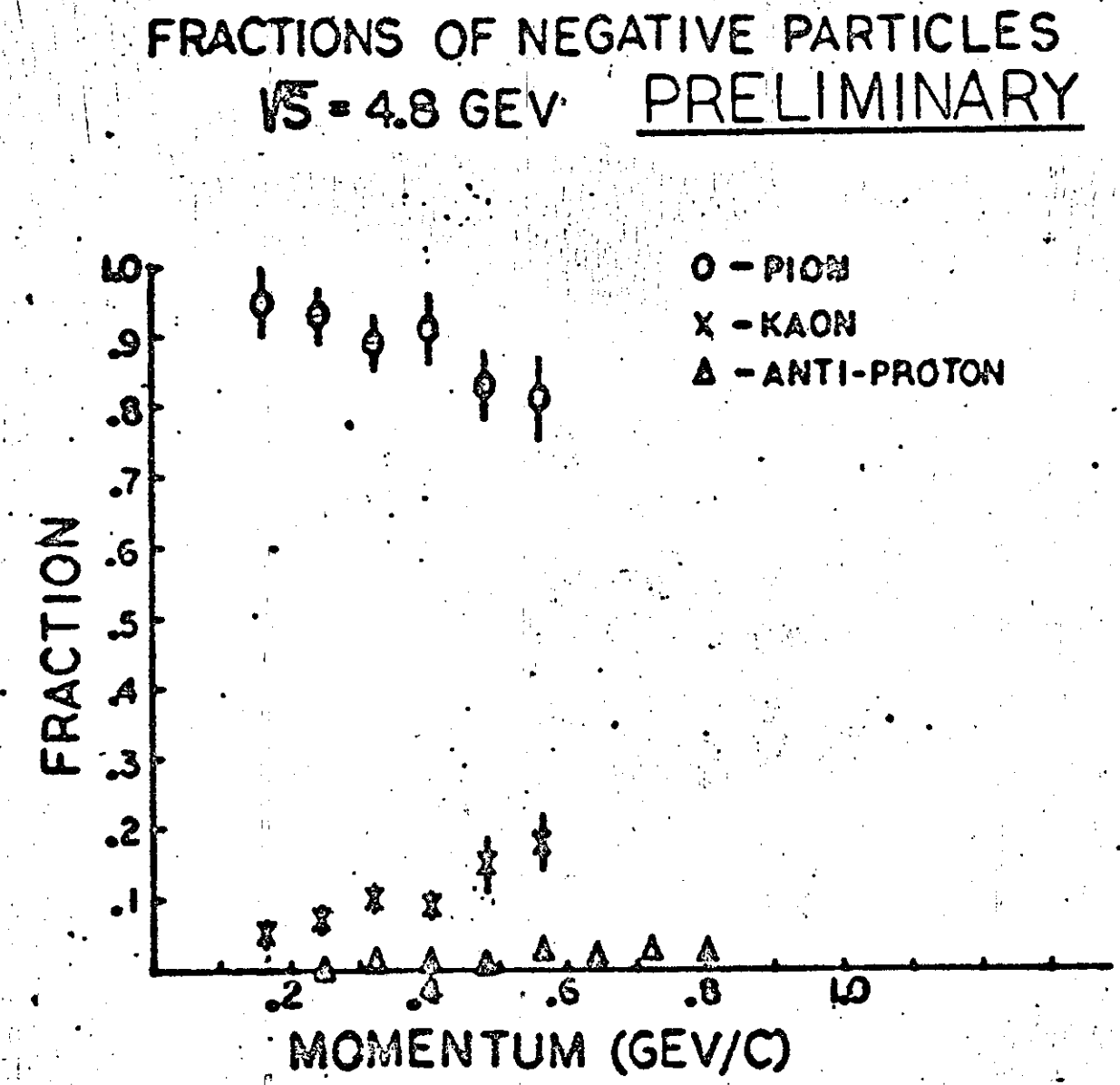

FRACTIONS OF NEGATIVE PARTICLES
√S = 4.8 GEV PRELIMINARY
O - PION
X - KAON
Δ - ANTI-PROTON
FRACTION
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.2
.4
.6
.8
1.0
MOMENTUM (GEV/C)

Fig.13

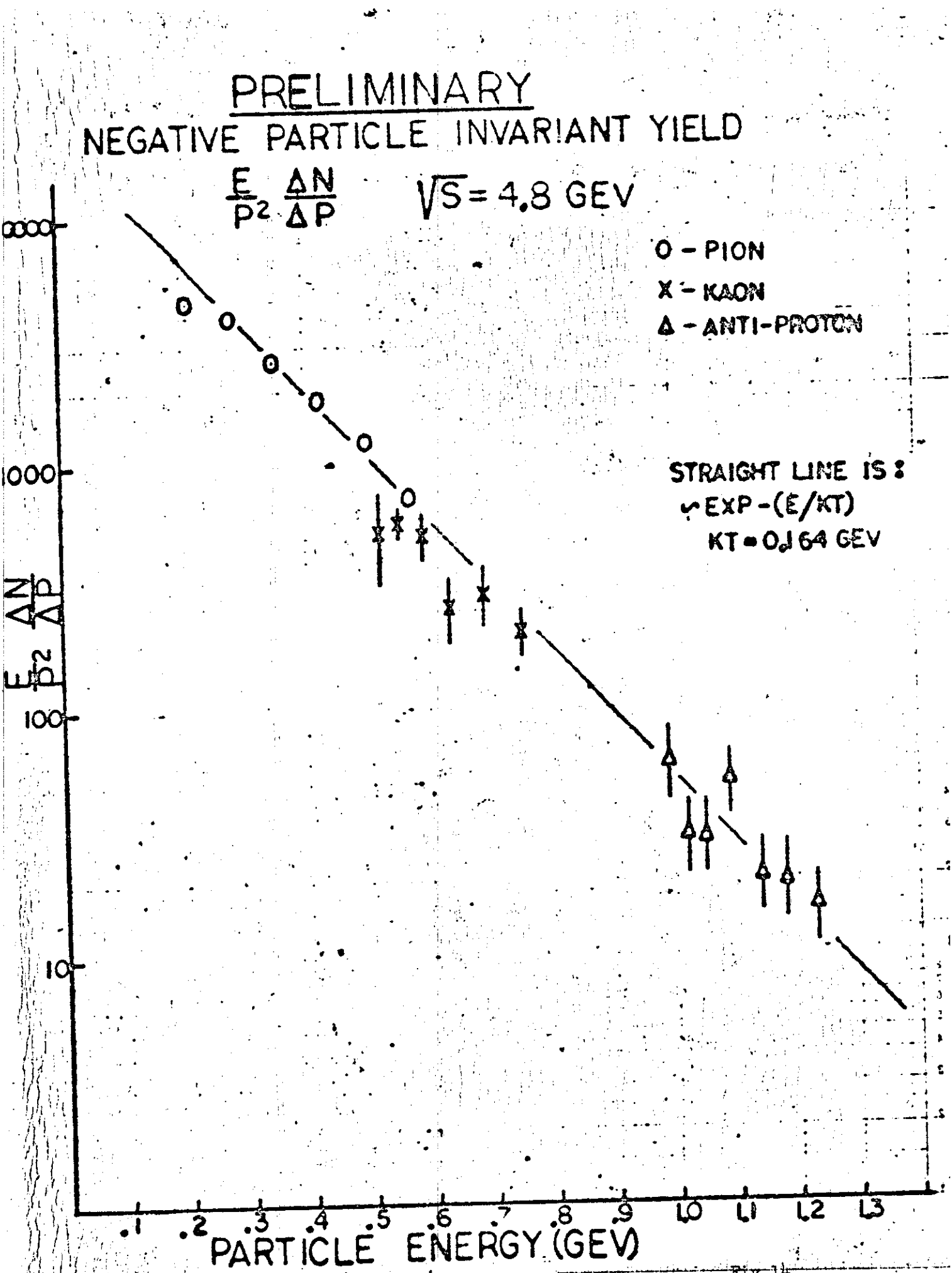

PRELIMINARY
NEGATIVE PARTICLE INVARIANT YIELD
$\frac{E}{P^2}\frac{\Delta N}{\Delta P}$ $\sqrt{S}$ = 4.8 GEV
O - PION
X - KAON
Δ - ANTI-PROTON
STRAIGHT LINE IS:
~ EXP - (E/KT)
KT = 0.164 GEV
$E\frac{\Delta N}{\Delta P}$
$\frac{1}{P^2}$
1000
100
10
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
PARTICLE ENERGY (GEV)

Fig. 14

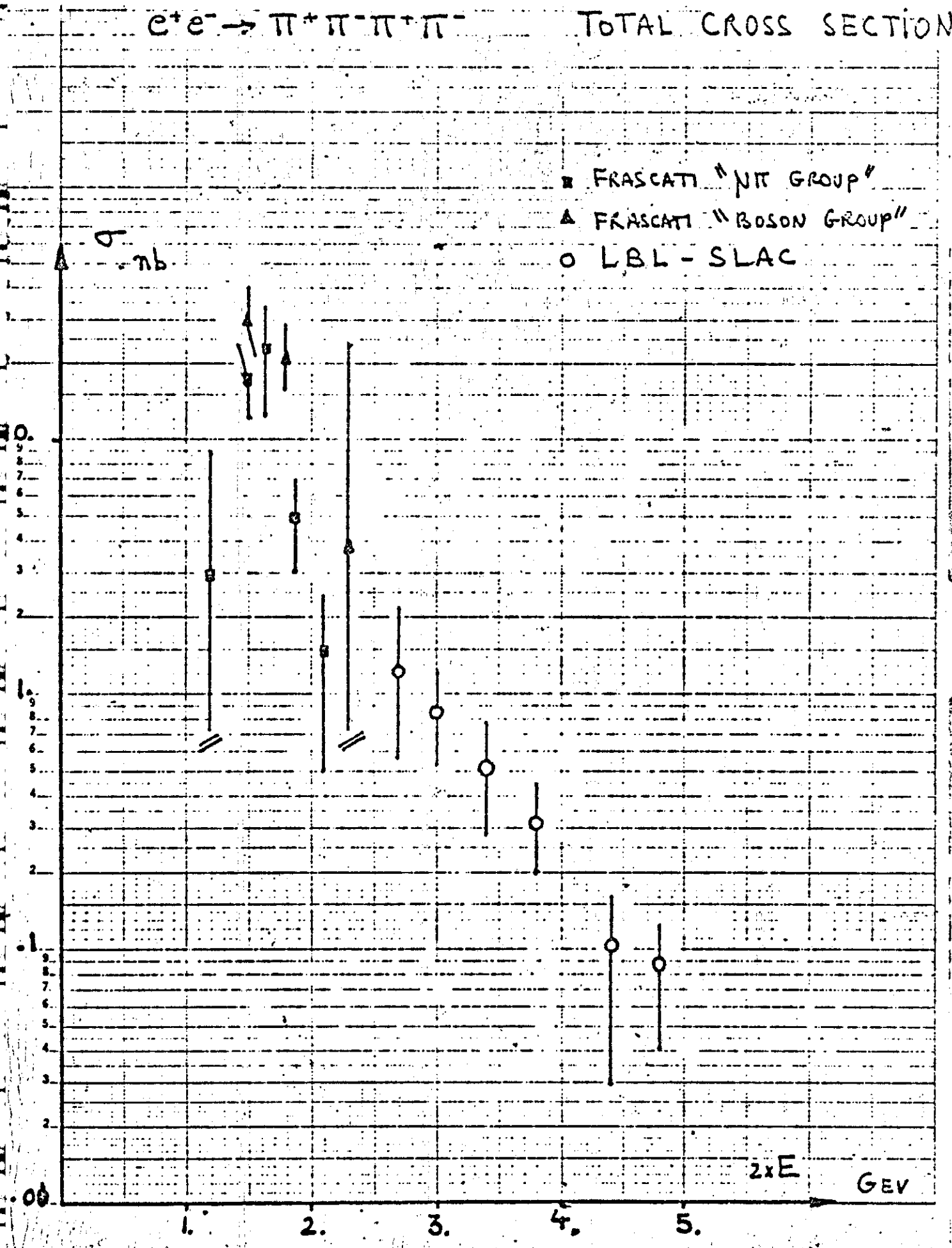

$e^+e^- \to \pi^+\pi^-\pi^+\pi^-$ TOTAL CROSS SECTION
FRASCATI "NπI GROUP"
FRASCATI "BOSON GROUP"
LBL - SLAC
σ nb
2xE GEV
1.
2.
3.
4.
5.

Fig.15

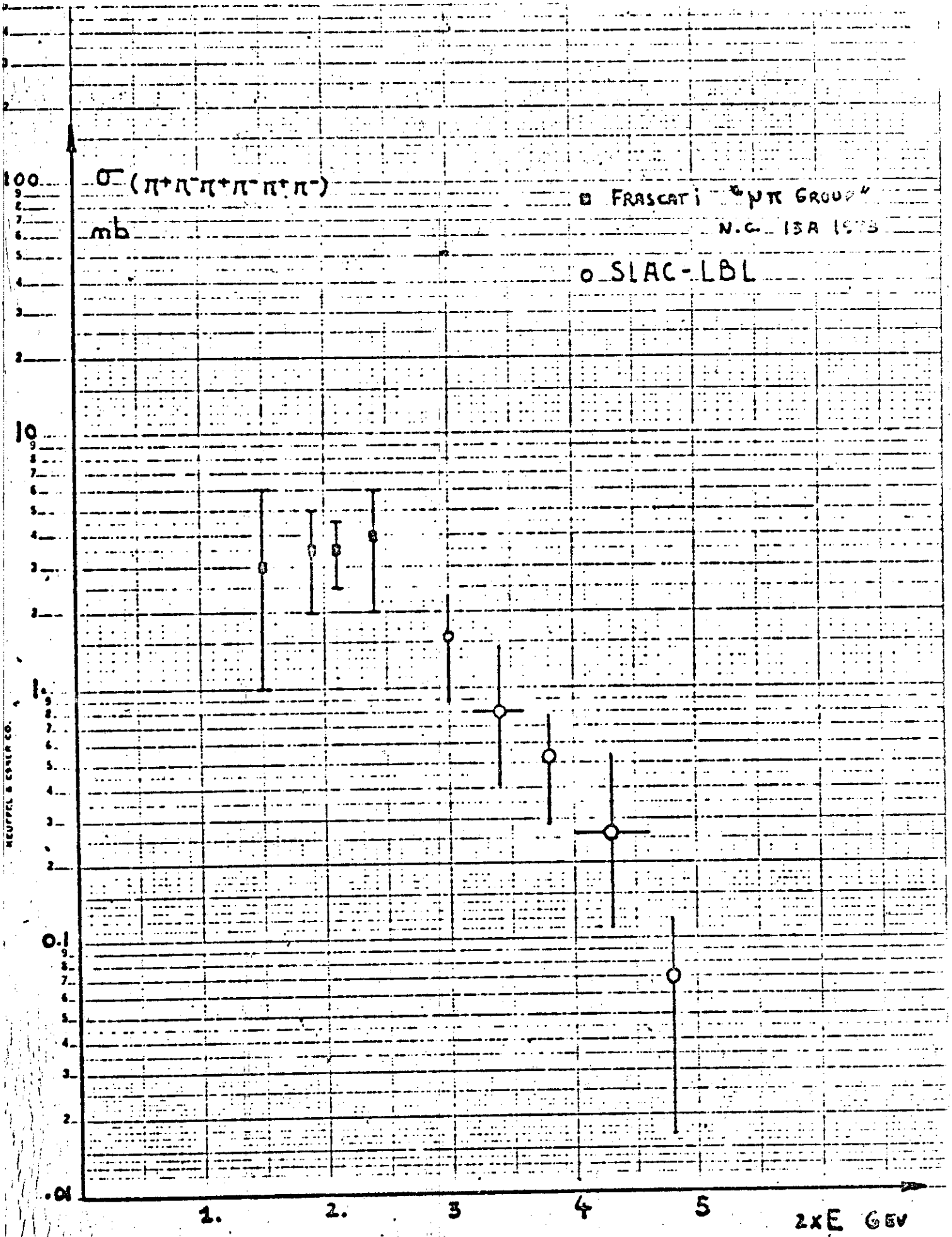

σ (π⁺π⁻π⁺π⁻π⁺π⁻)
mb
100
10
1.
0.1
0.01
1.
2.
3
4
5
2xE GeV
□ FRASCATI "μπ GROUP"
N.C. ISR 1973
○ SLAC-LBL
KEUFFEL & ESSER CO.

Fig.16