EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN–EP/89-118
14 September 1989

$B\overline{B}$ INCLUSIVE CROSS-SECTION IN 320 GeV π^- URANIUM INTERACTIONS

WA 78 Collaboration

M.G. Catanesi, M.T. Muciaccia, S. Natali, S. Nuzzo and F. Ruggieri
Università di Bari and INFN, Bari, Italy

H. Cobbaert[1] and R. Roosen
Inter-University Institute for High Energies, ULB–VUB, Brussels, Belgium

G. Carboni[2], G. Crosetti[3], M. Fidecaro, C. Gerke[4],
G. Poulard and H. Sletten
CERN, Geneva, Switzerland

M. Coupland, I.G. Roberts and P.T. Trent
Birkbeck College, London, UK

J.H. Bartley, J.E. Conboy, M.J. Esten, P. Fennel and P.F. Harrison[5]
University College, London, UK

M. De Vincenzi, S. Di Liberto, A. Frenkel, M. Iori, E. Lamanna,
G. Marini[6], G. Martellotti, A. Nigro, G. Penso, S. Petrarca,
S. Petrera, E. Petrolo, P. Pistilli[7], G. Romano[6], G. Rosa and A. Sciubba
Università di Roma and INFN, Rome, Italy

B. Alessandro, V. Bisi, D. Gamba, L. Ramello and L. Riccati
Università di Torino and INFN, Turin, Italy

(Submitted to Physics Letters B)

Present addresses:

[1] L.I.P., Universidade de Coimbra, Coimbra, Portugal
[2] INFN, Pisa, Italy
[3] INFN, Genoa, Italy
[4] DESY, Hamburg, Fed. Rep. Germany
[5] Liverpool University, UK
[6] Università di Salerno and INFN, Salerno, Italy
[7] Università di Lecce and INFN, Lecce, Italy

ABSTRACT

The inclusive cross-section for $B\overline{B}$ production by 320 GeV π^- on uranium has been measured, assuming different production models and a variable amount of $B_0 - \overline{B}_0$ mixing. A comparison of our results with those of the NA10 Collaboration is performed. The J/ψ inclusive production cross-section has also been measured in our experiment and agrees well with existing data, thus confirming the accuracy of our overall normalization.

1. Introduction

The experimental study of heavy-flavour hadroproduction and decay provides a useful test of Quantum Chromodynamics (QCD) and electroweak theory. In particular, the determination of the inclusive cross-section for beauty meson production establishes the contribution of various basic QCD subprocesses to the production mechanism. The first direct evidence of beauty hadroproduction in a fixed-target experiment was the observation of the production and decay of a $B\overline{B}$ pair in a nuclear emulsion target exposed to a 350 GeV π^- beam at the CERN Super Proton Synchrotron (SPS) [1]. Discrepant results were reported by two different experiments at the CERN Intersecting Storage Rings pp collider [2, 3]. More recently, the UA1 Collaboration [4] at the CERN $p\overline{p}$ Collider, and the NA10 Collaboration [5] in a fixed-target experiment, have measured the hadroproduction of $B\overline{B}$ pairs.

In the present paper we report the final results on inclusive $B\overline{B}$ production cross-section obtained by the WA78 Collaboration. Data were taken at the SPS with a 320 GeV π^- beam on a U target. A preliminary analysis of these data has already been published [6, 7]. For the present analysis we have improved the absolute normalization of the experiment, and measured the inclusive cross-section for J/ψ production. We compare this measurement with those obtained by other experiments with π^- beams on different target materials and at different energies, taking into account the A-dependence and energy dependence of the J/ψ production cross-section. We find very good agreement with a cross-section value extrapolated from the existing data, thus confirming the accuracy of the normalization.

Three different $B\overline{B}$ production models have been considered, including the production mechanism predicted by QCD [8], and the production model assumed by the NA10 Collaboration [5]. An analysis of our data using this model leads to a $B\overline{B}$ cross-section value which is in agreement with the NA10 result. However, an experimental distribution favours the QCD-based production mechanism rather than that assumed by NA10.

Finally the dependence of $B\overline{B}$ cross-section on the $B_0 - \overline{B}_0$ mixing parameter (χ_B) has also been investigated, and an upper limit on χ_B determined.

2. The WA78 detector

The WA78 detector was developed to detect muons coming from decays of $B\overline{B}$ pairs produced by a 320 GeV π^- beam in a U target:

$$\begin{aligned} &\pi^- + \mathrm{N} \to \mathrm{B}\overline{\mathrm{B}} + X \\ &\qquad \mathrm{B} \to \mu^+ + \overline{\mathrm{D}}(\to \mu^- + X) + X \\ &\qquad \overline{\mathrm{B}} \to \mu^- + \mathrm{D}(\to \mu^+ + X) + X. \end{aligned}$$

A detailed description of the apparatus has already been published [9]. It consists essentially of a dump calorimeter followed by a magnetic spectrometer. The calorimeter was designed to operate in a 320 GeV beam, at an intensity of $\sim 6 \times 10^6$ π^- per 2.4 s burst, with an energy resolution $\sigma(E)/E \simeq 0.6/\sqrt{E(\mathrm{GeV})}$. It was constructed so that it could be easily expanded to vary the mean density ρ. This enabled us to measure the muon background [6, 7] using the standard $1/\rho$ extrapolation method.

The spectrometer consists of a 1.5 T superconducting magnet equipped with drift and multiwire proportional chambers, which enabled us to measure the direction and momenta of the muons filtered by the calorimeter dump with a resolution $\Delta p/p \simeq 6 \times 10^{-4}\ p$ (GeV/c).

3. Trigger and event selection

Owing to the large mass difference between beauty and charm mesons, muons produced by B-meson decay (either directly or via the B → D → μ decay chain) have larger transverse momentum (p_T), and are accompanied by more energetic neutrinos than those produced by the background of charm decays. The trigger and event selection procedures were therefore designed to select events with high-p_T muons and large missing energy.

The missing energy (E_miss) is calculated by comparing the beam energy (E_beam) with the sum of the energy deposited in the calorimeter (E_cal) and the energy of the outgoing muons (E_μ) measured in the spectrometer: $E_\mathrm{miss} = E_\mathrm{beam} - E_\mathrm{cal} - \sum E_\mu$. The total leptonic energy (E_lept) and the total visible energy (E_vis) are given by $E_\mathrm{lept} = E_\mathrm{miss} + \sum E_\mu$ and $E_\mathrm{vis} = E_\mathrm{cal} + \sum E_\mu$.

The trigger system [9] accepted events with at least two muons in the spectrometer; one muon was required to exit from the calorimeter at a radius greater than 5 cm, to reduce the background of low-p_T events. A second-level trigger required that the calorimeter energy E_cal be less than 280 GeV. With this trigger 2.2×10^7 events were recorded on tape, corresponding to 5.5×10^{11} effective beam interactions. The final data sample analysed here contains 4356 like-sign dimuons and 1582 three-muon events. It is slightly different from that already presented in Refs. [6, 7] since additional cuts have now been applied which improve the signal-to-background ratio by rejecting beam halo muons and hadron punch-through.

We select as $B\overline{B}$ candidates the like-sign dimuon events with $E_{\rm vis} < 300$ GeV, $p_{\rm Ttot}$ $(= \sum p_{\rm T}) > 2.7$ GeV/c, and $E_{\rm lept} > 100$ GeV. There are 68 such events, with an expected background of 5.2 events. The three-muon sample contains 11 candidates with $E_{\rm vis} < 270$ GeV and $p_{\rm Ttot} > 3$ GeV/c, for which the expected background is 1.1 events. The backgrounds were calculated [6, 7] by combining single-muon events taken with a special trigger, either in pairs to produce the like-sign background, or with opposite-sign events to produce the three-muon background.

The track-reconstruction efficiency has been determined by processing Monte Carlo generated events. We estimate this efficiency to be $(85 \pm 5)\%$ for like-sign or opposite-sign dimuon events and $(60 \pm 10)\%$ for three-muon events, with little dependence on details of the production model.

4. J/ψ cross-section and normalization

To verify the absolute normalization of the $B\overline{B}$ cross-section we have also measured the J/ψ inclusive cross-section. The comparison of this result with those already obtained by other experiments using π^- beams provides a useful check on our analysis procedure. For this measurement we collected a sample of $\sim$ 6400 opposite-sign dimuons with a dedicated trigger which does not require any cut on $E_{\rm cal}$. This trigger was activated during one machine burst out of every twenty, so the data for J/ψ and $B\overline{B}$ were taken during the same experimental runs.

In Fig. 1a we show the experimental effective mass spectrum of the opposite-sign dimuon sample, fitted with a Gaussian plus an exponential distribution to extract the J/ψ contribution. To reduce the Drell–Yan background, only events with $2.7 \leq m(\mu^+\mu^-) \leq 4$ GeV/c^2 have been retained. For these $\sim$ 2700 events we show in Figs. 1b and c, respectively, the $x_{\rm F}$ distributions of the dimuons and the $p_{\rm T}$ distribution of the muons. These two distributions are in quite good agreement with the Monte Carlo predictions shown on the same figures, which have been calculated using the $x_{\rm F}$ and $p_{\rm T}$ distributions reported by the NA3 Collaboration [10].

The measured inclusive cross-section for J/ψ production, in the kinematical region $x_{\rm F} \geq 0$, is

$$\mathrm{BR} \times \sigma(\pi^- + \mathrm{U} \rightarrow \mathrm{J}/\psi + X) = 1.52 \pm 0.17 \ \mu\mathrm{b},$$

where BR $\simeq 0.069$ is the branching ratio for the decay $\mathrm{J}/\psi \rightarrow \mu^+\mu^-$. The quoted error is a quadratic combination of the statistical and systematic ones. The normalization is done using the beam scalers and a total inelastic π^-U cross-section of 1654 ± 110 mb [11]. To compare our value of the J/ψ inclusive cross-section with the results obtained by other experiments performed with π^- beams, we parametrize the J/ψ inclusive production cross-section ($x_{\mathrm{F}} \geq 0$) as

$$\sigma(\pi^- + \mathrm{A} \to \mathrm{J}/\psi + X) = \sigma_0(\sqrt{s}) \cdot A^{\alpha},$$

where A is the atomic number of the target. In Fig. 2 we plot the values of σ_0 as a function of $\sqrt{s}$, obtained by different experiments [12]*), including the present one, assuming $\alpha = 0.87$ [13]. The curve is a fit to all the points except ours, calculated (apart from a multiplicative factor) using the lowest order QCD formula [15] for J/ψ inclusive production on an isoscalar target and the partonic, scaling violating, distribution functions for the π^-, given by Owens [16] (set 1). This curve, extrapolated to our value of $\sqrt{s}$ = 24.5 GeV, predicts a value of $\sigma_0 \simeq 183 \pm 5$ nb, which is in very good agreement with our experimental value of $\sigma_0 \simeq 189 \pm 21$ nb. If we leave α as a free parameter of the fit we obtain $\alpha = 0.90 \pm 0.02$. In this case the fitting curve extrapolated to our value of $\sqrt{s}$ predicts $\sigma_0 = 161 \pm 4$ nb, while our experimental value becomes $\sigma_0 = 160 \pm 18$ nb which is still in a quite good agreement with the extrapolated one. The quoted errors on σ_0 include the statistical and the systematic ones, combined in quadrature.

5. B$\overline{\mathrm{B}}$ production and decay

A Monte Carlo study of B$\overline{\mathrm{B}}$ production and decay indicates that the acceptance of our experiment is largely determined by the two-dimensional x_{F} distribution ($x_{\mathrm{F}1}, x_{\mathrm{F}2}$) of the B and $\overline{\mathrm{B}}$, which results from the assumed production model. We have calculated the inclusive B$\overline{\mathrm{B}}$ cross-section using three different models:

a) QCD model

We use a parametrization of the lowest order QCD prediction of the differential cross-section due to Berger [17]:

$$\frac{\mathrm{d}^3\sigma}{\mathrm{d}x_{\mathrm{F}1}\,\mathrm{d}x_{\mathrm{F}2}\,\mathrm{d}p_{\mathrm{T}}^2} = \frac{\mathrm{d}^2\sigma}{\mathrm{d}x_{\mathrm{F}1}\,\mathrm{d}x_{\mathrm{F}2}} \exp\left(-\frac{p_{\mathrm{T}}^2}{B}\right),$$

where $x_{\mathrm{F}1}$ and $x_{\mathrm{F}2}$ are the Feynman x_{F} of the b and $\overline{\mathrm{b}}$ quark and p_{T} their transverse momentum. At our energy the average p_{T} value is expected to be [8] $\langle p_{\mathrm{T}} \rangle \simeq 2.32$ GeV/c, which corresponds to $B \simeq 6.9$ (GeV/c)^2 in the above formula. The two-dimensional

---

*) Data on hydrogen targets have not been included since the parametrization $\sigma = \sigma_0 A^{\alpha}$ does not apply for $A = 1$ [13, 14].

distribution $d^2\sigma/dx_{F1}\, dx_{F2}$ is represented as a scatter plot in Fig. 3a. From this distribution (used directly to evaluate our overall acceptance for $B\overline{B}$ events) we compute the differential cross-section for production of a single b-quark, and find it can be represented by the formula

$$\frac{d\sigma}{dx_F} \propto \exp\left[- \frac{(x_F - 0.09)^2}{A_\pi^2} \right],$$

with $A_\pi^2 \simeq 0.3$*). Smearing due to the b-quark fragmentation into physical particles has been folded in with these QCD calculations when generating the parameters of B and $\overline{B}$ mesons.

b) Modified QCD model

To show the sensitivity of our results to the mean value of x_F, we have also investigated a model using the same p_T distributions as in model (a), but with the x_F distribution shifted from $\langle x_F \rangle = 0.09$ to 0.05.

c) NA10 model

To compare our results with those obtained by the NA10 Collaboration [5], we have calculated our acceptance using the production model assumed by that experiment. According to that model, the $B\overline{B}$ pair is the sole decay product of an intermediate mass M, which is centrally produced with a cross-section

$$\frac{d^2\sigma}{dx_F\, dp_T} \propto (1 - |x_F|)^3 \;\; p_T \;\; \exp\,(-2p_T)$$

$$\frac{d\sigma}{dM} \propto \; \exp\,[-(M - M_0)^2/(2\delta^2)], \qquad (M \geq 2m_B)$$

where M_0 is the mass of the Υ''' resonance, m_B is the mass of the B meson, and δ is a parameter which depends [18] on the c.m. energy $\sqrt{s}$. In Fig. 3b we show, for this production model, the scatter plot (x_{F1}, x_{F2}) of the B and $\overline{B}$ x_F.

The quite different behaviour of the (x_{F1}, x_{F2}) distributions which are compared with the relative acceptance of our apparatus in Figs. 3a and b, explain why the cross-sections obtained using the QCD or the NA10 model are significantly different, as we will see in the next section.

The B and $\overline{B}$ decays were simulated using the Lund Monte Carlo [19]. The effective semileptonic branching ratios for B and D decay were 11.6% and 10.4% respectively, when averaged over the different flavours (u, d, s) of the mesons. The slight difference of these

---

*) In Eq. (1) of Ref. [7] the mean value $\langle x_F \rangle$ of this distribution was erroneously reported to be 0.05 instead of 0.09.

values from those assumed in our previous analysis [6, 7] leads to an increase of the $\mathrm{B\overline{B}}$ cross-section of ~ 15% with respect to that reported in Ref. [7].

6. Results

In Table 1 we give the $\mathrm{B\overline{B}}$ inclusive cross-sections on nucleon obtained for the three production models considered and for different values of the mixing parameter χ_B [20]. A linear A-dependence of the cross-section has been assumed. Results from like-sign and three-muon samples have been combined. The normalization is done analogously to that of the J/ψ cross-section, using the beam scalers and the total inelastic π^-U cross-section. The cross-section value for model (a) with $\chi_B = 0.2$ is ~ 55% higher than that already reported in Ref. [7], which was obtained with the same assumptions. This difference is due in part (~ 25%) to the new absolute normalization of our experiment, in part (~ 15%) to the different effective branching ratio assumed for the semileptonic B and D decays, and in part (~ 15%) to a revised version of the Monte Carlo calculations on acceptance and track reconstruction efficiency*).

The cross-sections obtained using model (c), which have been calculated for $\chi_B =$ 0 and 0.2, are higher by a factor of ~ 4 compared with that of model (a). They range between ~ 10 and ~ 20 nb, and are therefore compatible with the 14^{+7}_{-6} nb reported by the NA10 Collaboration [5]. We conclude that both experiments are in agreement, the difference between their numerical results being due to the different production mechanism assumed in each analysis. In Fig. 4 we compare our experimental E_{lept} distribution with those expected from models (a) (QCD) and (b) (NA10). In spite of the limited statistics, we observe a better agreement with model (a). The average value of E_{lept} is 177 GeV for model (a) and 163 GeV for model (b), to be compared with 179 ± 10 for the experimental data. This favours our QCD-based $\mathrm{B\overline{B}}$ cross-section values rather than that reported by the NA10 Collaboration [5].

In Ref. [7] an attempt was made to extract the value of the mixing parameter (χ_B) by comparing the cross-sections obtained from the three-muon and like-sign samples. However, using the latest values of the acceptance and taking into account the statistical

---

*) The experimental set-up has been simulated with two independent Monte Carlo calculations. Their results, which agree within ± 6%, have been averaged and taken with a ± 10% systematic error. We found that the acceptance and track reconstruction efficiency used in Ref. [7] were systematically overestimated for the three-muon sample, while those for the like-sign dimuons are practically unchanged.

and systematic uncertainties, no significant determination of χ_B can be obtained with this method.

An estimate of χ_B can be deduced from the distribution of the like-sign dimuon sample in the ($p_{\rm Tmin}, p_{\rm Tmax}$) plane, $p_{\rm Tmin}$ and $p_{\rm Tmax}$ being respectively the minimum and maximum $p_{\rm T}$ of the two muons. In the absence of mixing these events come from a B ($\overline{\rm B}$) and a D ($\overline{\rm D}$) decay. If mixing is present, a fraction of these events come directly from the decay of the resulting BB or $\overline{\rm B}\,\overline{\rm B}$ pair and therefore have a different ($p_{\rm Tmin}, p_{\rm Tmax}$) distribution. A study of dimuon pairs from the three-muon beauty sample suggests that the variable $F_{\rm T} = p_{\rm Tmin} + 0.4 p_{\rm Tmax}$ can be used to discriminate efficiently between mixed and unmixed events. A fit to this distribution, and the number of $\rm B\overline{B}$ candidates in the three-muon sample indicates that $\sim$ 10% of like-sign detected events decay following $\rm B_0 - \overline{B}_0$ mixing. At 90% confidence level (CL) this corresponds to an upper limit of $\chi_B \leq 0.15$. A comparison of this value with the result on $\rm B_d$ mixing from $\rm e^+e^-$ machines cannot be performed since our data sample contains an unknown mixture of $\rm B_u$, $\rm B_d$, and $\rm B_s$ mesons. It is in broad agreement with the upper limit of 0.12 (at 90% CL) reported by MARK II [21] and 0.121±0.047 reported by UA1 [22] for data samples which also contained mixtures of $\rm B_u$, $\rm B_d$, and $\rm B_s$. Our result is expected to depend on the $\rm B\overline{B}$ production model and in particular on the assumed $p_{\rm T}$ distribution. We conclude that our data are consistent with the presence of mixed events, but do not allow us to give an accurate and model-independent value of χ_B.

7. Conclusions

We have reported final results on the inclusive $\rm B\overline{B}$ production cross-section measured in π^-U interactions at $\sqrt{s} = 24.5$ GeV. Different $\rm B\overline{B}$ production models and $\rm B_0 - \overline{B}_0$ mixing parameters have been considered.

With respect to our preliminary results [6, 7] several improvements in data analysis have been performed. In particular, the J/ψ inclusive cross-section has been measured in our apparatus. The very good agreement of this result with those obtained by other collaborations gives us confidence in the absolute normalization of our experiment.

A comparison with the results obtained by the NA10 Collaboration shows that the higher $\rm B\overline{B}$ cross-section obtained by that experiment is very probably due to the particular production model they assumed. In spite of the limited statistics, our total leptonic energy spectrum shows a better agreement with the prediction of a QCD-based production model than with that of the NA10 model.

Finally, we compare our results [production model (a)] with the theoretical QCD predictions, which are indeterminate by a factor of $\sim$ 2 or more, owing to the choice of b-quark mass and of evolution scale. Assuming a b-quark mass of 5 GeV the theoretical estimates range from ~ 1 to ~ 3 nb per nucleon in a lowest order calculation [8, 17] and from ~ 1.6 to ~ 4.6 nb per nucleon if next-to-leading QCD corrections are also considered [23]. We conclude that, within the experimental and theoretical uncertainties, QCD describes the main features of the $B\overline{B}$ hadroproduction, from the present c.m. energy up to that explored at the CERN $p\overline{p}$ Collider [4].

References

[1] J.P. Albanese et al., Phys. Lett. **158B** (1985) 186.

[2] M. Basile et al., Lett. Nuovo Cimento **31** (1981) 97 and Nuovo Cimento **68A** (1982) 289.

[3] D. Drijard et al., Phys. Lett. **108B** (1982) 361.

[4] C. Albajar et al., Phys. Lett. **186B** (1987) 237.

[5] P. Bordalo et al., Z. Phys. **C39** (1988) 7.

[6] M.G. Catanesi et al., Phys. Lett. **187B** (1987) 431.

[7] M.G. Catanesi et al., Phys. Lett. **202B** (1988) 453.

[8] E.L. Berger, Proc. Topical Seminar on Heavy Flavours, Nucl. Phys. B (Proc. Supp.) **1B** (1988) 425 and Proc. of the 24th Int. Conf. on High Energy Physics, Munich, 1988 (Springer, Berlin, 1989), p. 987.

[9] M.G. Catanesi et al., Nucl. Instrum. Methods **A253** (1987) 222.

[10] J. Badier et al., Z. Phys. **C20** (1983) 101.

[11] A.S. Carroll et al., Phys. Lett. **80B** (1979) 319.

[12] The experimental points reported in the figure are from the following references:
J. LeBritton et al., Phys. Lett. **81B** (1979) 401.
Yu.B. Bushnin et al., Phys Lett. **72B** (1977) 269.
M.J. Corden et al., Phys. Lett. **68B** (1977) 96 and **96B** (1980) 411.
Yu.M. Antipov et al., Phys. Lett. **72B** (1977) 278.
S. Katsanevas et al., Phys Rev. Lett. **60** (1988) 2121.
M.A. Abolins et al., Phys. Lett. **82B** (1979) 145.
K.J. Anderson et al., Phys. Rev. Lett. **42** (1979) 944.
J. Badier et al., Z. Phys. **C20** (1983) 101.

[13] S. Katsanevas et al., Phys. Rev. Lett. **60** (1988) 2121.

[14] H. Cobbaert, ULB–VUB Thesis, Brussels, April 1989.

[15] V. Barger et al., Z. Phys. **C6** (1980) 169.

[16] J.F. Owens, Phys. Rev. **D30** (1984) 943.

[17] E.L. Berger, Phys. Rev. **D37** (1988) 1810.

[18] H. G. Fisher and W.M. Geist, Z. Phys. **C19** (1983) 159.

[19] The Lund Monte Carlo programs, CERN pool programs long write-up, April 1987.

[20] P.J. Franzini, Phys. Rep. **173** (1989) 1.

[21] T. Schaad et al., Phys. Lett. **160B** (1985) 188.

[22] C. Albajar et al., Phys. Lett. **186B** (1987) 247.

[23] G. Altarelli et al., Nucl. Phys. **B308** (1988) 724.

Table 1: Inclusive $B\overline{B}$ cross-section for different production models and $B_0 - \overline{B}_0$ mixing parameters χ_B (see text). In column 2 the average x_F of beauty particles is reported for the three models. The cross-sections, expressed in nb per nucleon, have been calculated assuming a linear A-dependence. The quoted errors are statistical and systematic respectively, the latter being due to uncertainties on acceptance, track reconstruction efficiency, absolute normalization, and the semileptonic branching ratio of B and D decay.

Production model	$\langle x_F \rangle$	χ_B		
		0	0.1	0.2
a)	0.09	4.8 ± 0.6 ± 1.5	3.6 ± 0.4 ± 1.1	3.1 ± 0.4 ± 1
b)	0.05	6.2 ± 0.8 ± 1.9	4.5 ± 0.6 ± 1.4	3.7 ± 0.5 ± 1.1
c)	0	18.6 ± 2.3 ± 5.5	–	11.6 ± 1.3 ± 3.5

Figure captions

Fig. 1: a): Experimental invariant mass distribution of the opposite-sign dimuons. The J/ψ signal is obtained by fitting the data with a Gaussian plus an exponential background.

b): Experimental x_F distribution of the opposite-sign dimuons.

c): Experimental p_T distribution of each muon of the opposite-sign dimuons.

In (b) and (c) the curves are Monte Carlo predictions, normalized to the data. To reduce the Drell–Yan background, only events with $2.7 \leq m(\mu^+\mu^-) \leq 4$ GeV/c^2 have been retained.

Fig. 2: Comparison of our present result on σ_0 for J/ψ production (see text) with the previous ones obtained with π^- beams at different c.m. energies $\sqrt{s}$. Statistical and systematic errors, combined in quadrature, are shown. The curve is a fit to all the points except ours, calculated (apart from a multiplicative factor) using the lowest order QCD formula for J/ψ inclusive production. The quite good agreement of our results with this fit confirms the accuracy of our overall normalization.

Fig. 3: Two-dimensional distribution of the Feynman x_F of the produced beauty particles: a) in the QCD model; b) in the NA10 model. The inner (outer) solid line encloses the region where the acceptance of our experiments is greater than 50% (10%) of its maximum value.

Fig. 4: Experimental distribution of the leptonic energy (E_{lept}) compared with the prediction of the QCD model (curve a) and NA10 model (curve b).

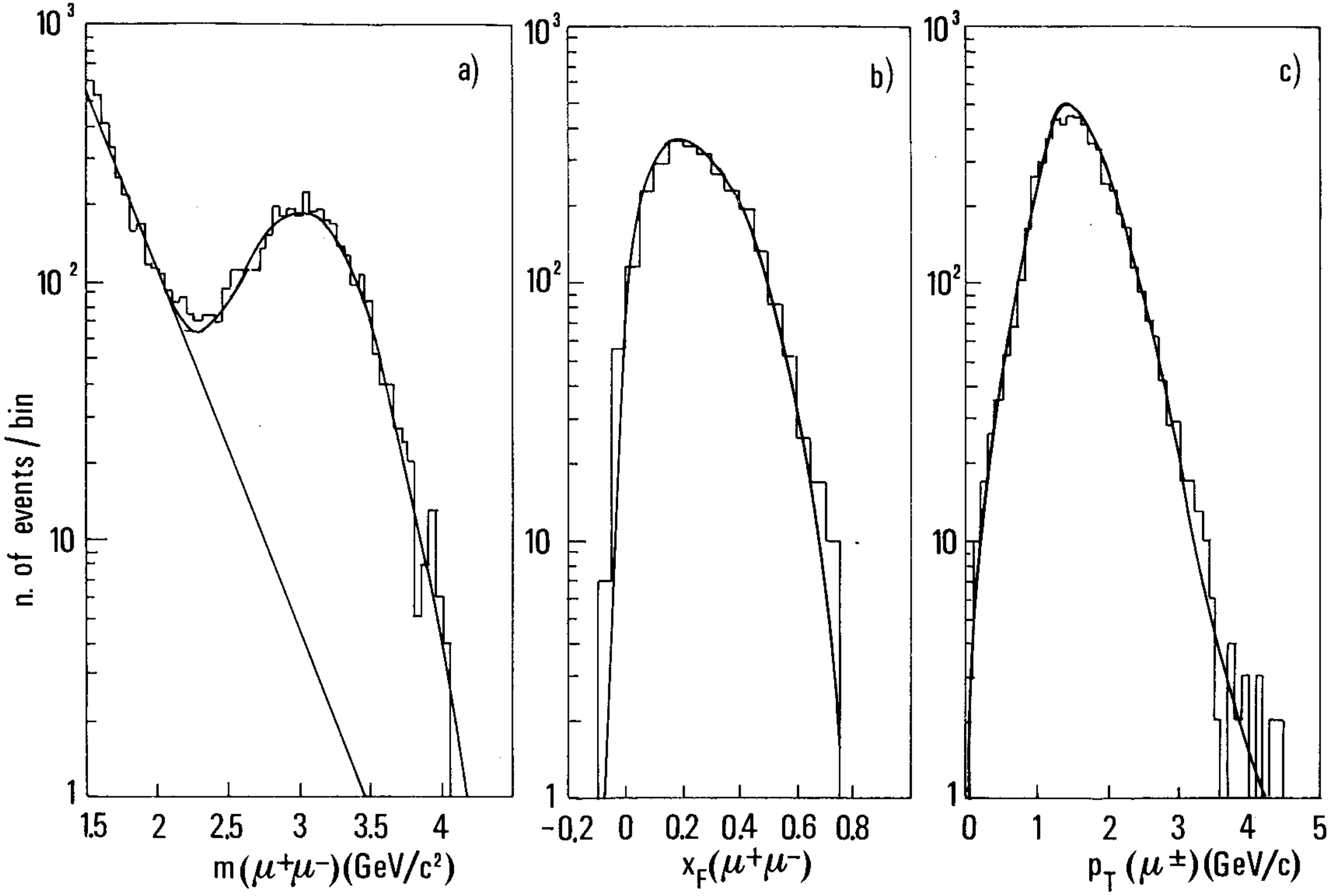
a)
b)
c)
n. of events / bin
10^3
10^2
10
1
1.5
2
2.5
3
3.5
4
$m(\mu^+\mu^-)(\mathrm{GeV}/c^2)$
−0.2
0
0.2
0.4
0.6
0.8
$x_F(\mu^+\mu^-)$
0
1
2
3
4
5
$p_T(\mu^\pm)(\mathrm{GeV}/c)$

Fig. 1

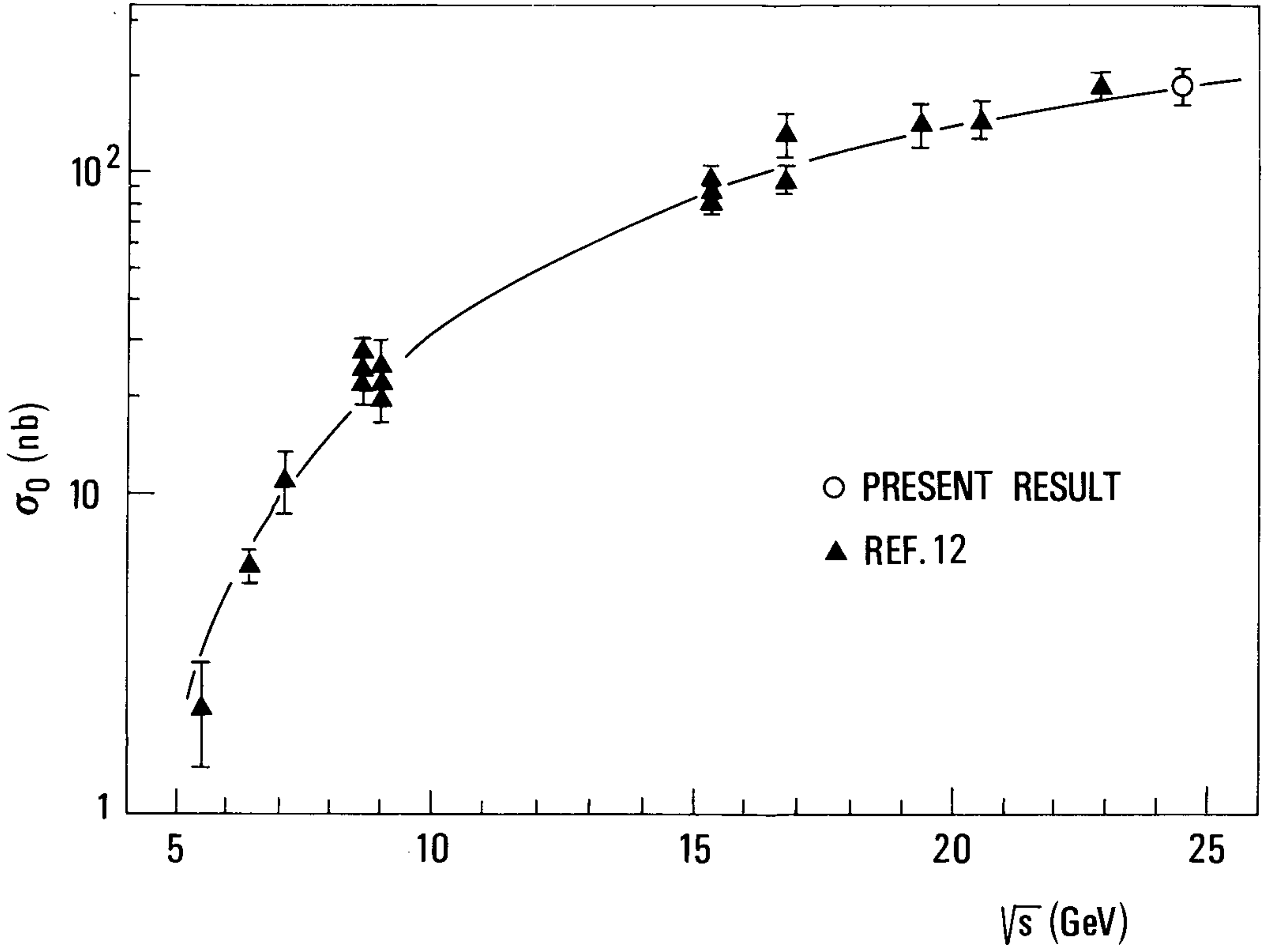

Fig. 2

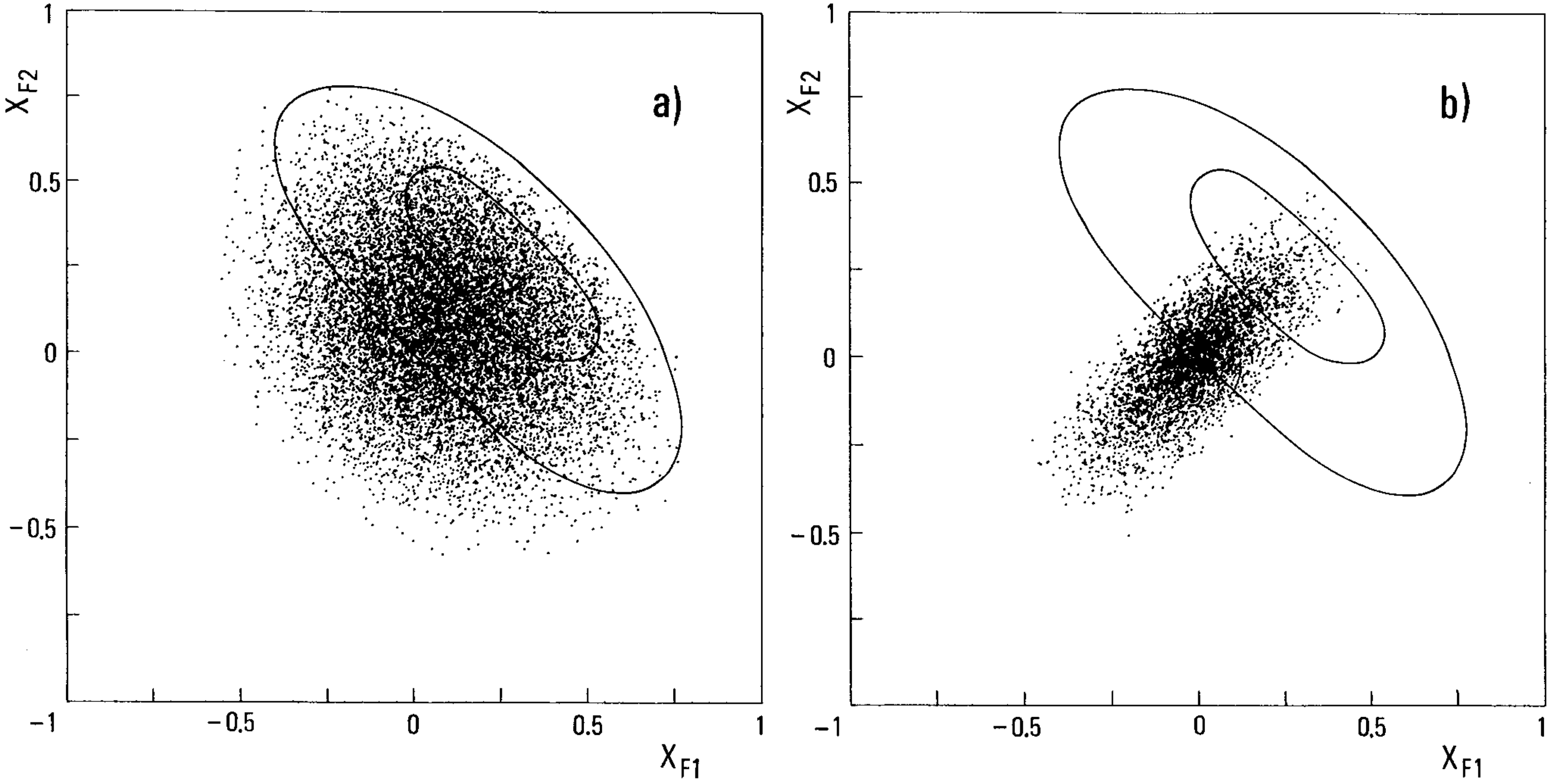

Fig. 3

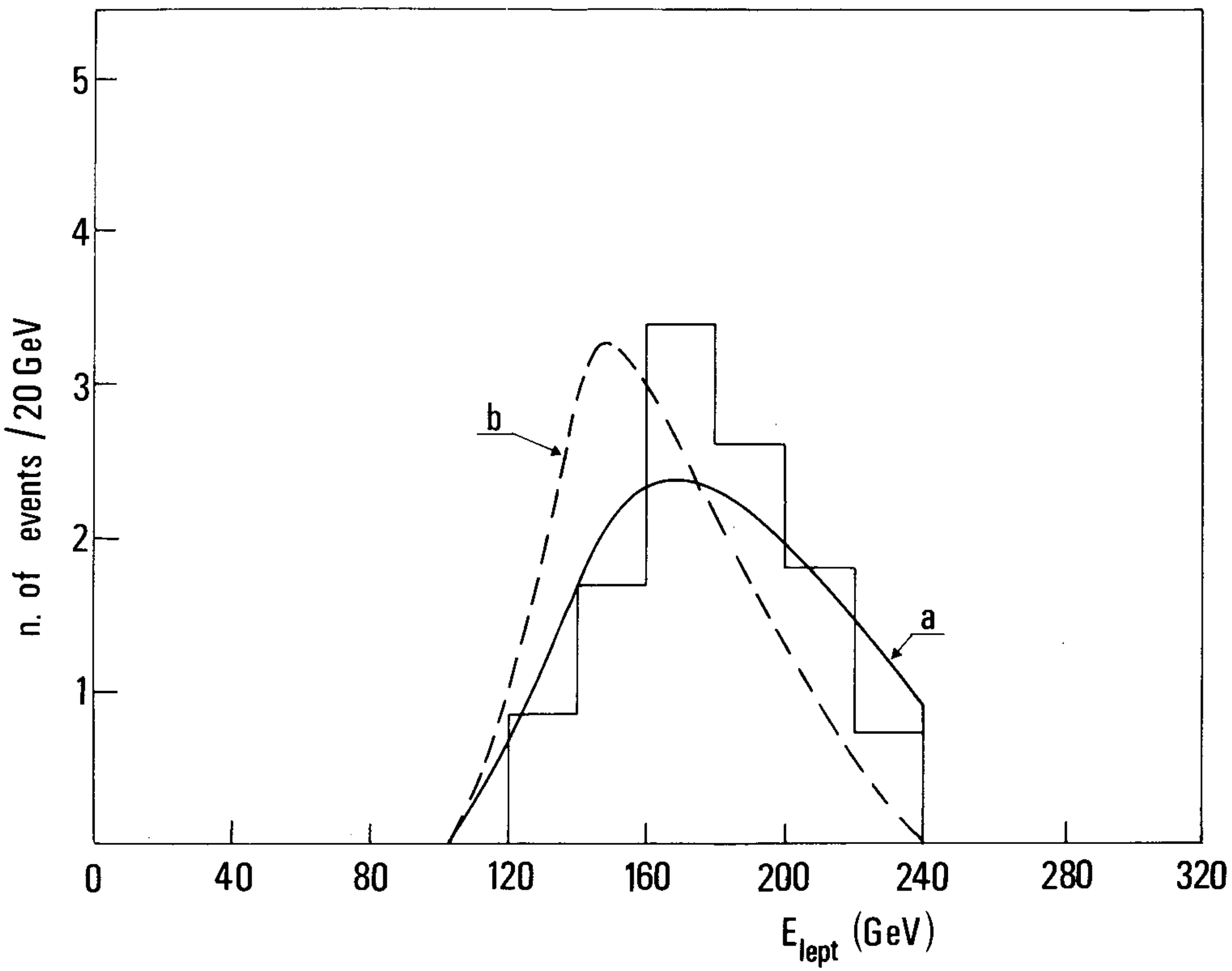
5
4
3
2
1
n. of events / 20 GeV
b
a
0
40
80
120
160
200
240
280
320
E_{lept} (GeV)

Fig. 4