ELSEVIER

Nuclear Physics B (Proc. Suppl.) 75B (1999) 16–19

NUCLEAR PHYSICS B
PROCEEDINGS
SUPPLEMENTS

First results from the Selex Collaboration

The SELEX Collaboration *
presented by M. Iori[a]

[a]Dipartimento di Fisica and INFN
Universita' di Roma La Sapienza
Rome Italy

The SELEX experiment (E781) is 3-stage magnetic spectrometer for a high statistics study of hadroproduction of charm baryons out to large x_F using 650 Gev Σ^- ,π^- and p beams. The main features of the spectrometer are: a high precision silicon vertex system ,powerful particle identification provided by TRD and RICH , forward Λ_s decay spectrometer and 3-stage lead glass photon detector. An experiment overview and description of spectrometer features are shown . Preliminary reconstructed charm states and results on Λ_c , D^+ particles and antiparticles produced by Σ^- ,π^- and p beams at $x_F > 0.3$ are presented. Asymmetry for Λ_c production is also discussed .

1. Introduction

Charm physics explores QCD phenomenology in both perturbative and nonperturbative regimes. Production dynamics studies test leading order (LO) and next to leading order (NLO) perturbative QCD. Charm lifetime measurements test models based on $\frac{1}{M_Q}$ QCD expansions. The present fixed target experiments have considerably improved the statistics but many problems remain. All experimental results are in qualitative agreement with perturbative QCD calculations but quantitative deviations from QCD are observed [1]. More experimental data, using different incident hadrons (π,p and Σ^-), help to discriminate possible different scenarios: dragging effects, fragmentation effects as well as intrinsic k_t.

2. The Selex spectrometer

The SELEX experiment at Fermilab is a 3-stage magnetic spectrometer. The 600 Gev/c Hyperon beam of negative polarity contains equal fraction of Σ and π . The positive beam is composed of 92% of protons and the rest π's. Beam particles are identified by a Transition Radiation detector (BTRD). The spectrometer was designed to study charm production in the forward hemisphere with good mass and decay vertex resolution for charm momentum in a range of 100-500 Gev/c. Fig. 1 shows the spectrometer layout. The vertex region is composed of 5 targets (2 Cu and 3 C). The total target thickess is 5% of λ_{int} for protons and the targets are separated by 1.5 cm. Downstream of the targets there are 20 silicon planes with a strip pitch of 20-25 μm disposed in X,Y,U and V views. The M1 and M2 magnets affect a momentum cut off of 2.5 Gev/c and 15 Gev/c respectively. A RICH detector, filled with Neon at room temperature and pressure, provides a single track ring radius resolution of 1.4% and 2σ K/π separation up to about 185 Gev/c. A computational filter uses tracks identified by the RICH and linked to the vertex silicon by the PWCs to make a full reconstruction of the secondary vertex. Events consistent with only a primary vertex are rejected. A Transition Radiation Detector (TRD) provides electron identification. The M3 spectrometer level is designed to aid in the reconstruction of very large momentum Λ_s.

---

*Bagazici, IHEP Beijing, Carnegie-Mellon, Moscow State , PNPI,Tel Aviv, S.L. Potosi University, CBPF, FNAL, IHEP Protvino, ITEP Moscow, MPI Heidelberg,University of Bristol, Iowa, Michigan-Flit, São Paulo, Paraíba, Rochester, Rome and Trieste

PII S0920-5632(99)00314-X

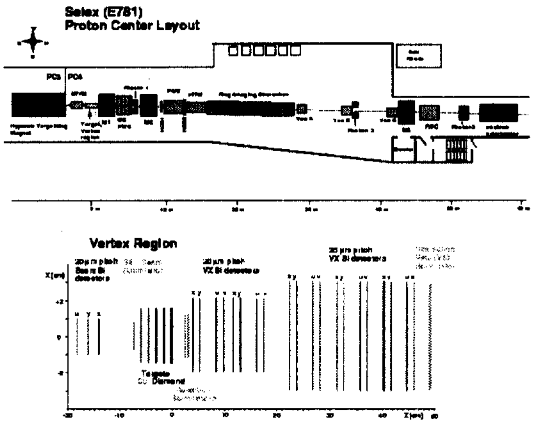

Figure 1. Spectrometer layout

3. Data set and charm selection

The data sample is described in table I. The charm trigger is very loose. It requires a valid beam track, two of opposite charge tracks to the beam with momentum > 15 Gev/c, two high momentum tracks linked to the Silicon vertex detector, and unconnected to all other tracks from the primary vertex. We triggered on about 1/3 of all the inelastic interactions. About 1/7 of them are written on the tape for a final sample of about 0.9B events. In the analysis secondary vertices were reconstructed if the χ^2 of all tracks was inconsistent with single primary vertex. The RICH detector labelled all particles above 25 Gev/c.

All data reported here resulted from a preliminary pass through the data, using a production code optimized for speed and not for efficiency. The simulated reconstruction efficiency of any charmed state is constant at about 40% for $x_F > 0.3$.

3.1. Charm performance

The requirements to study charm physics and to reduce the background are:

good decay vertex resolution and mass resolution and particle identification.

The vertex algorithm provides an average longitudinal error, σ_z on the primary and secondary vertex of 170 μm and 600μm respectively. Their combination, σ is equal to 650 μm. In the Λ_c sample, the average momentum is 220 Gev/c, corresponding to a time resolution of 20 fs.

To reduce the background we only keep charm candidates that decay over a longitudinal distance greater than at least $z_{min} = 8\sigma$

The RICH detector gives, as shown in fig. 2, a good separation $\frac{\pi}{K}$ for track momentum of 100 Gev/c corresponding to the average momentum of decay tracks (p,K).

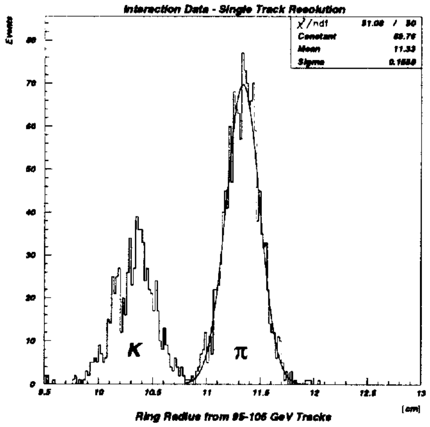

Figure 2. K and π ring radius from 95-105 Gev/c tracks

The mass resolution is constant versus the momentum. Fig. 3 shows the $D^0 \to K^- + \pi^+$ mass resolution is < 10 Mev/c at all momenta.

4. Charm and anticharm asymmetry

To lowest order QCD, charm and anticharm quarks are produced symmetrically in hadroproduction. Next to Leading Order (NLO) introduces small (1%) asymmetries in quark momenta due to interference between contributing amplidutes. In this connection the ACCMOR exper-

beam type	p (Gev/c)	interactions 10^9	events 10^6
Σ^-/π^- 50%-50%	600	4.2	182
Σ^-/π^- 93%-7%	600	9.6	566
p/π^+ 92%-8%	550	2.4	99
Total		16.2	847

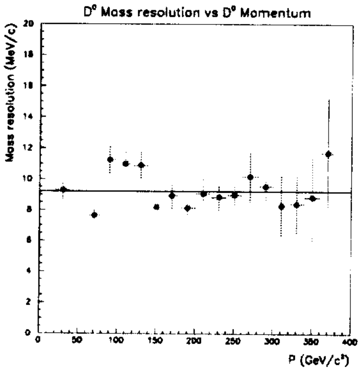

Figure 3. $D^0 \to \pi^+ + K^-$ mass resolution

iment does not find distinction between leading and nonleading charm meson and charm baryons produced in a 200 Gev/c pion beam and a 250 Gev/c proton beam [2].

However E769 has observed a Λ_c asymmetry integrated over $x_F > 0$ for a 250 Gev/c proton beam and in the same experiment has mesured D meson asymmetry for a 250 Gev/c pion beam [3].

The WA89 experiment has studied charm particles produced by a Σ^- 340 Gev/c beam. Considerable production asymmetry between D^-, D^+ and ${\Lambda_c}^+$,$\overline{\Lambda_c}^-$ was observed[4].

Recently the WA92 and E791 experiment show charm meson asymmetry in a 350 Gev/c pion beam [5] and a 500 Gev/c pion beam [7] respectively.

These experiments show a modest asymmetry for D mesons produced by pion beam that grows with x_F . Baryon studies with small statistics suggest large Λ_c asymmetry.

The observed asymmetry can be explained by a recombination of charm quark antiquarks with the beam valence quarks or by different processes like in the intrinsic charm and in the quark-gluon string model [6].

In the SELEX experiment the negative beam particles have a valence quark in common with ${\Lambda_c}^+, D^-, {D_s}^-$ (d or s quark) or with D^0 (u quark).

The proton beam has two valence quarks in common with ${\Lambda_c}^+$ (u and d quarks) and one quark with D^- (d quark). The π data show comparable particle-antiparticle yields both for charm mesons and charm baryons. The observed D meson asymmetry is consistent with previous experiment.

For both baryon beams (Σ^-, p) there is a difference in leading-nonleading production integrated over $x_F > 0.3$, of charm mesons and charm baryons. In particular they show asymmetric particle-antiparticle yields for ${\Lambda_c}^+$ and symmetric yields for D mesons. Fig. 4 shows these results consistent with the WA89 experiment, using a Σ^- 340 Gev/c beam and E769.

Fig. 5 shows the Λ_c^+ x_F dependence for different beams. There is a clear evidence that more leading Λ_c^+ are produced at high x_F in Σ, p beams than in the π beam.

5. SUMMARY

The SELEX experiment explores the large x_F region using different beams. The present results show new features in charm production that complement the experiments using a lower energy beam (200-350 Gev/c). Futher analysis will ex-

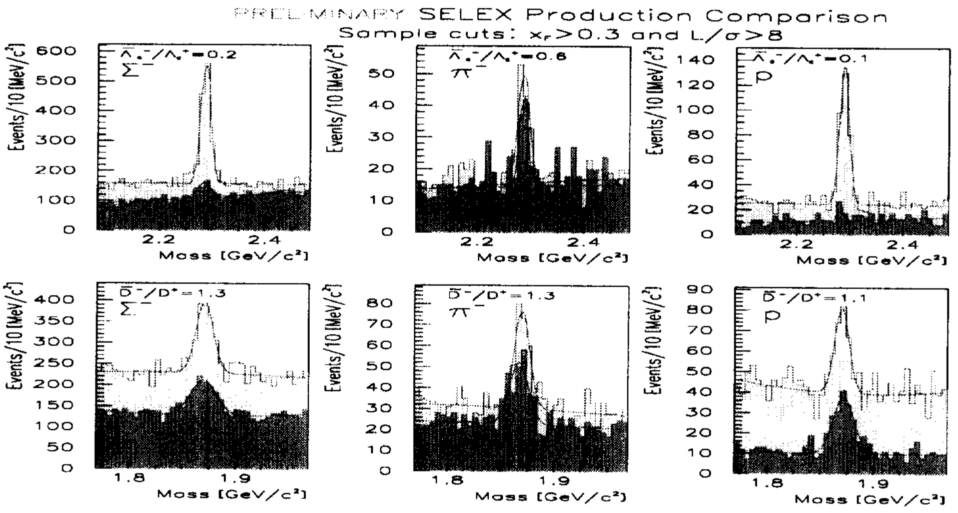

Figure 5. Charm baryon and meson asymmetry integrated over $x_F > 0.3$ for different beams

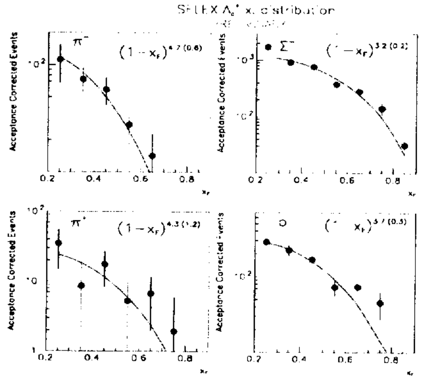

Figure 4. $\Lambda_c{}^+$ x_F dependence for different beams

tend the x_F coverage down to about 0.1. Also other charm baryon states are being analyzed and all these results will be reported later.

REFERENCES

1. S.Frixione,M. Mangano, P. Nason and G. Ridolfi "Heavy quark production" in Heavy Flavour II", A. J. Buras and M. Lindner eds. World Scientific Publishing Singapore 1997
2. ACCMOR-NA32 S. Barlag et al. Z. Phys. C39 (1988) 451; ibid C49 (1991) 555; Phys Lett. B257 (1991) 519
3. E769 - G.A. Alves et al. Phys. Rev. Lett 77 (1996) 2388-2392
4. WA89 - M.I. Adamovich et al. CERN-EP/98-41
5. WA92 - M.I. Adamovich et al., Phys. Lett. B348 (1995) 256; ibid 77 (1996) 2388-2392
6. T. Gutierrez and R. Vogt hep-ph/9808213; G.H. Arakelyan hep-ph/9711276 (1997); A.K.Likhoded and S.R. Slabospitsky Preprint of IHEP97-66 Protvino 1997 he-ph/9710476
7. E791 - E. M. Aitala et al. Phys Lett. B411 (1997) 230; ibid B403 (1997) 185;ibid B371 (1996) 157