

New Results From SELEX (E781) Experiment

Ahmet Sedat Ayan

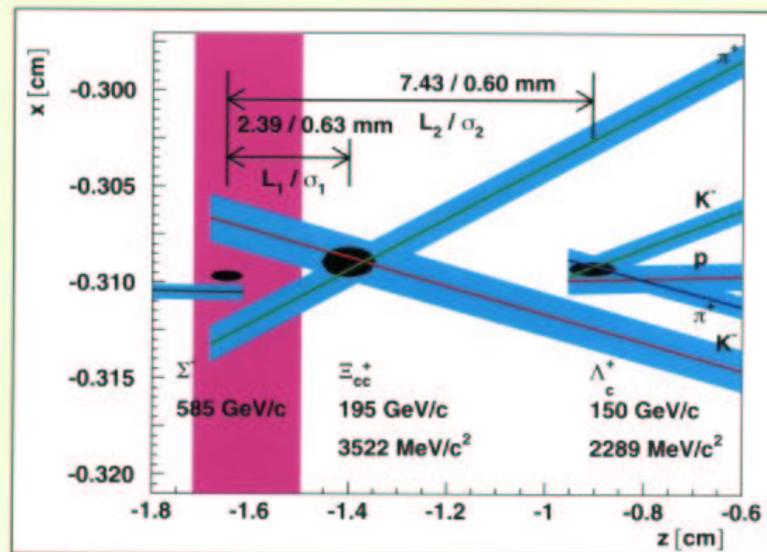
ahmet-ayan@uiowa.edu

University of Iowa
Department of Physics & Astronomy
for
the SELEX (E781) Collaboration

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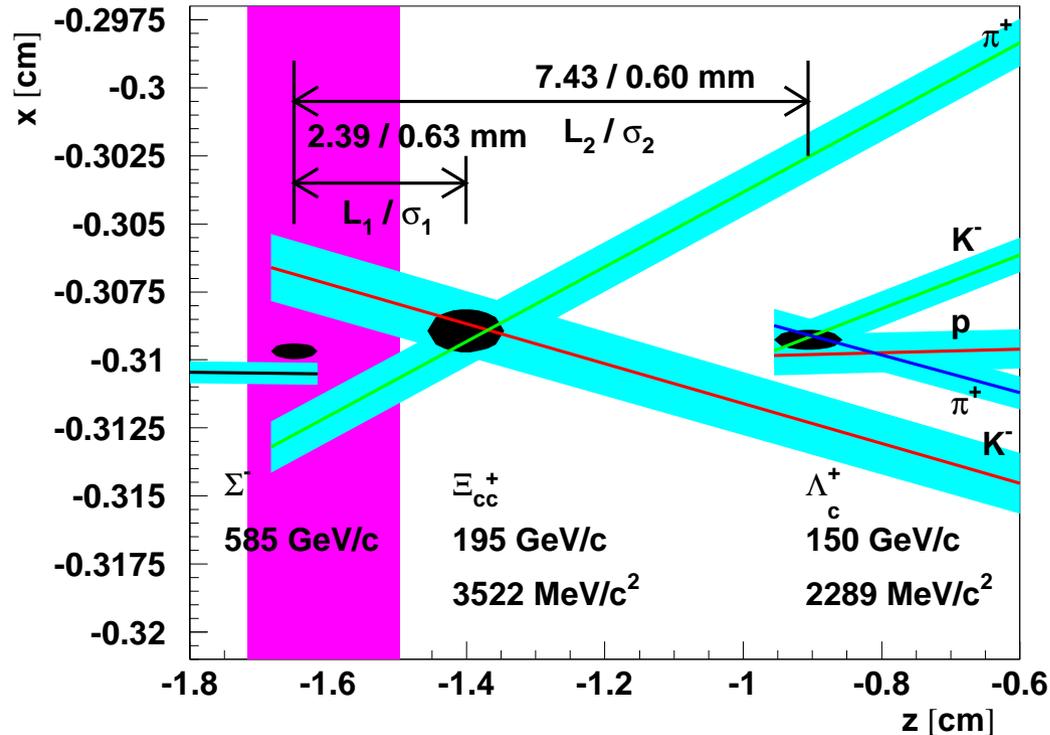
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Double-Charmed Baryons

- QCD predicts the existence of baryons with one, two or three charm quarks.
- Many models predict a rich spectrum of radial and orbital excitations ^a.
- Double-charmed, $J = 1/2$ baryons:
 - $\Xi_{cc}^+(ccd)$, $\Xi_{cc}^{++}(ccu)$, $\Omega_{cc}^+(ccs)$
 - Almost all models predict a mass range of $3500 - 3700 MeV/c^2$ for the double charm level for $J = 1/2$

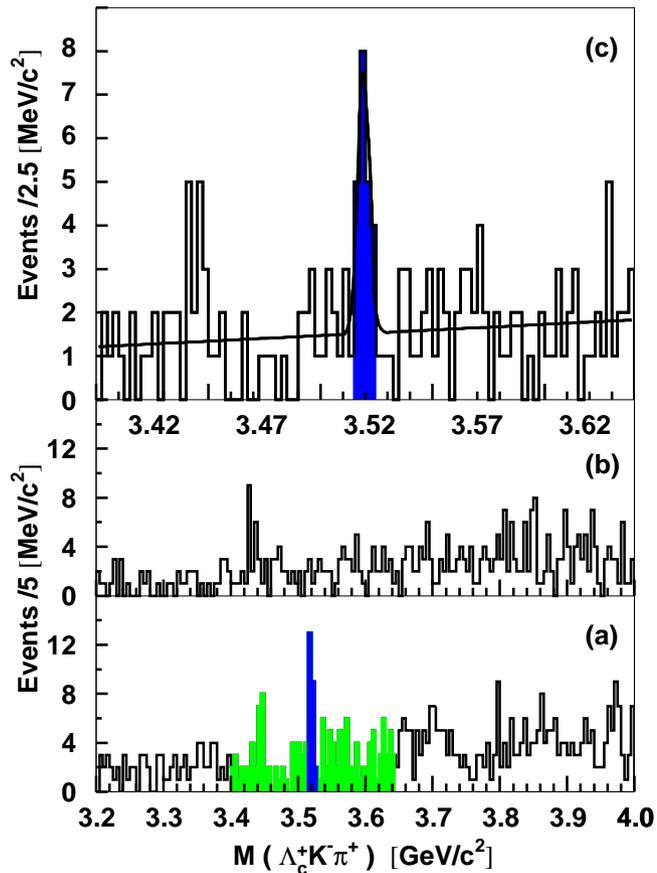
^aFleck et al., Prog. Theo. Phys., **82,760-774**

First Observation of $\Xi_{cc}^+(ccd)$ Baryon



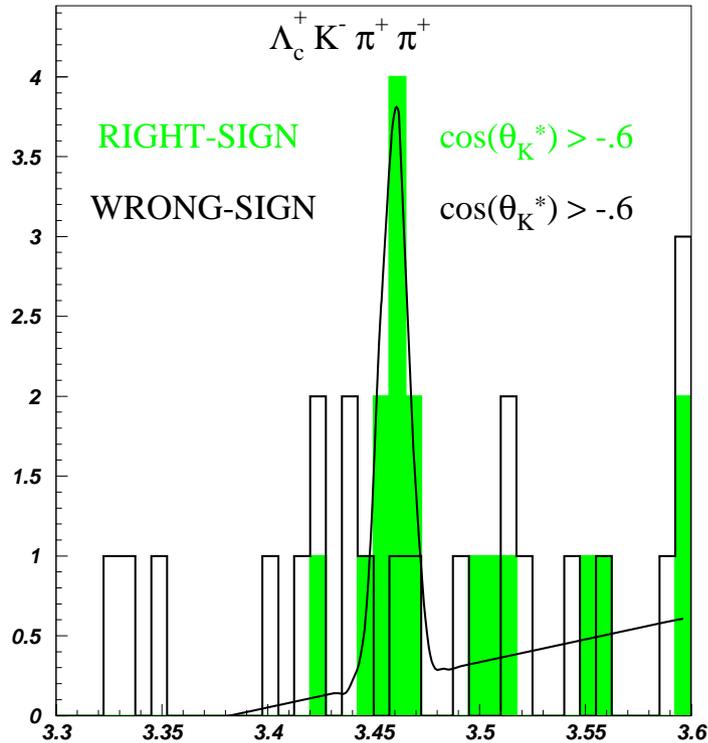
A candidate event shown with production target, 1σ track error corridors and vertex error ellipses. Three additional found tracks which form the primary vertex with the beam track are not shown.

First Observation of $\Xi_{cc}^+(ccd)$ Baryon



- $\Xi_{cc}^+ \rightarrow \Lambda_c^+ K^- \pi^+$
- An excess of 15.9 events over an 6.1 ± 0.5 events of expected background seen at a mass of $3519 \pm 1 \text{ MeV}/c^2$ (Fig.(c))
- Wrong-sign invariant mass distribution for $\Lambda_c^+ K^- \pi^+$ shown in Fig.(b).
- No significant excess!

Evidence For $\Xi_{cc}^{++}(ccu)$ Baryon (i)



- $\Lambda_c^+ K^- \pi^+ \pi^+$ invariant mass shown. Ξ_{cc}^{++} candidate at $3460 \text{ MeV}/c^2$.

- Ξ_{cc}^+ 's iso-doublet partner with $Q = 2$?

- Wrong-Sign topological modes are:

- $Q = 2 : \Lambda_c^+ K^+ \pi^- \pi^+$

- $Q = 0 : \Lambda_c^+ K^- \pi^+ \pi^-$
 $: \Lambda_c^+ K^+ \pi^- \pi^-$

Evidence For $\Xi_{cc}^{++}(ccu)$ Baryon (ii)

- (ccd) state seen with the same S/N and same events in three different independent analyses in SELEX.
- (ccu) state has a Poisson significance of 0.8×10^{-6} in single-bin probability with the angle cut. For no-angle cut, its Poisson single-bin probability is 1.1×10^{-4} , 140x higher (7.2 event excess for average background level of 1.8 events).
- SELEX analysis continues to understand these decay modes and to look for other possible decay channels.
- More results are expected this summer.

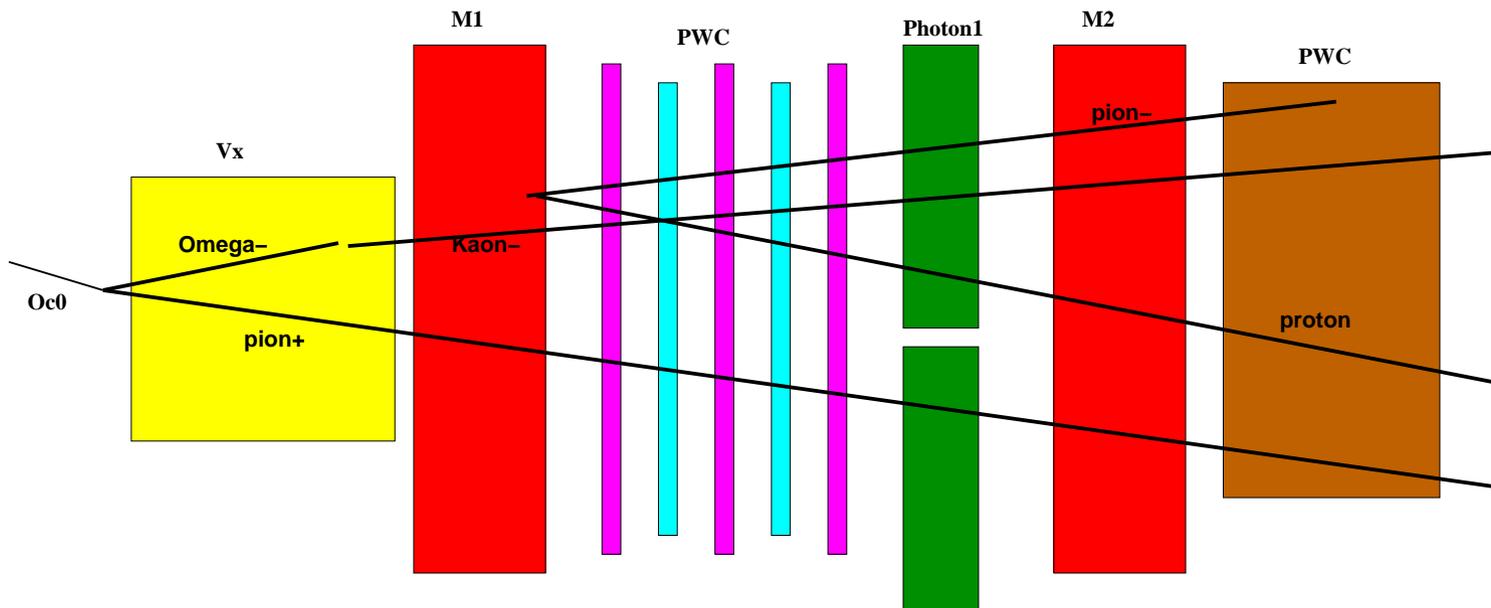
$\Omega_c^0(ssc)$ Charmed Baryon Search

- FOCUS(E831) recently reported results on Ω_c^0 for two decay modes ^a
 - 38 ± 9 events for $\Xi^- K^- \pi^+ \pi^+$
 - 23 ± 7 events for $\Omega^- \pi^+$with a mass of $2697.5 \text{ GeV}/c^2$
- SELEX(E781) has Ω_c^0 candidate events in two decay modes:
 - 47 ± 14 events for $\Omega^- \pi^- \pi^+ \pi^+$
 - 40 ± 12 events for $\Omega^- \pi^+$

^aTalk given by E. Vaandering at Beach 2002 Meeting , Vancouver,BC

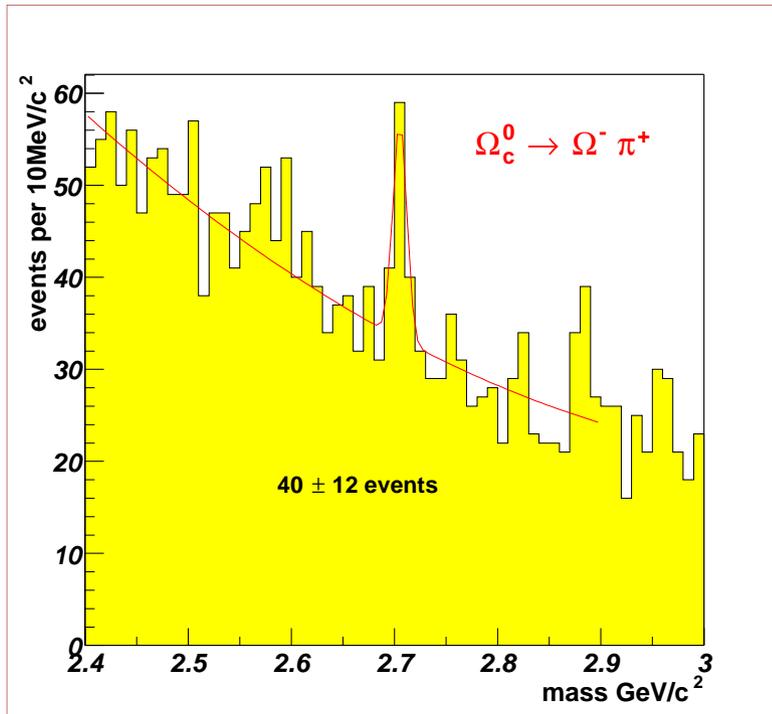
$\Omega_c^0(ssc)$ Search Strategy

- We look for M1+M2 spectrometer tracks and extrapolate them back upstream to look for a kink with a vertex segment (Vx)

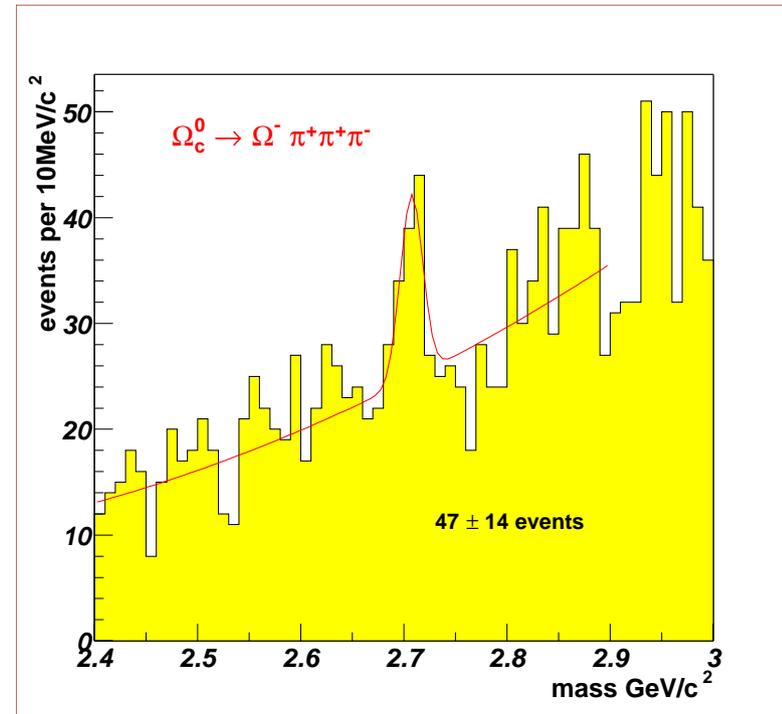


A cartoon representation of a $\Omega_c^0 \rightarrow \Omega^- \pi^+$ event

$\Omega_c^0(ssc)$ Charmed Baryon Search



$\Omega_c^0 \rightarrow \Omega^- \pi^+$ mode :
 40 ± 12 events.



$\Omega_c^0 \rightarrow \Omega^- \pi^- \pi^+ \pi^-$ mode :
 47 ± 14 events.

$\Omega_c^0(ssc)$ Charmed Baryon Search

- We anticipate to reduce the background.
- Our Analysis Goals:
 - We want to measure:
 - the Ω_c^0 *mass* and currently are working on systematics.
 - the *Relative Branching Ratio* for $\Omega^- \pi^- \pi^+ \pi^+$ and $\Omega^- \pi^+$ modes and are working on the systematics.
 - the *Lifetime*.

Production Asymmetry of D_s from Σ^- and π^- Beam

The first detailed measurement of D_s by a hyperon beam ^a.
(For an earlier study, see WA89 publication ^b).

- The production of D_s^- relative to D_s^+ as a function of x_f with $600\text{GeV}/c$ Σ^- beam measured in the interval $0.15 < x_f < 0.7$.
- Proposed theoretical models to explain charm hadroproduction in the framework of non-perturbative hadronization:
 - Color-drag string model ^c: Pronounced at high x_f , independent of p_t .
 - Intrinsic charm model ^d: Manifest itself at low p_t and larger x_f .

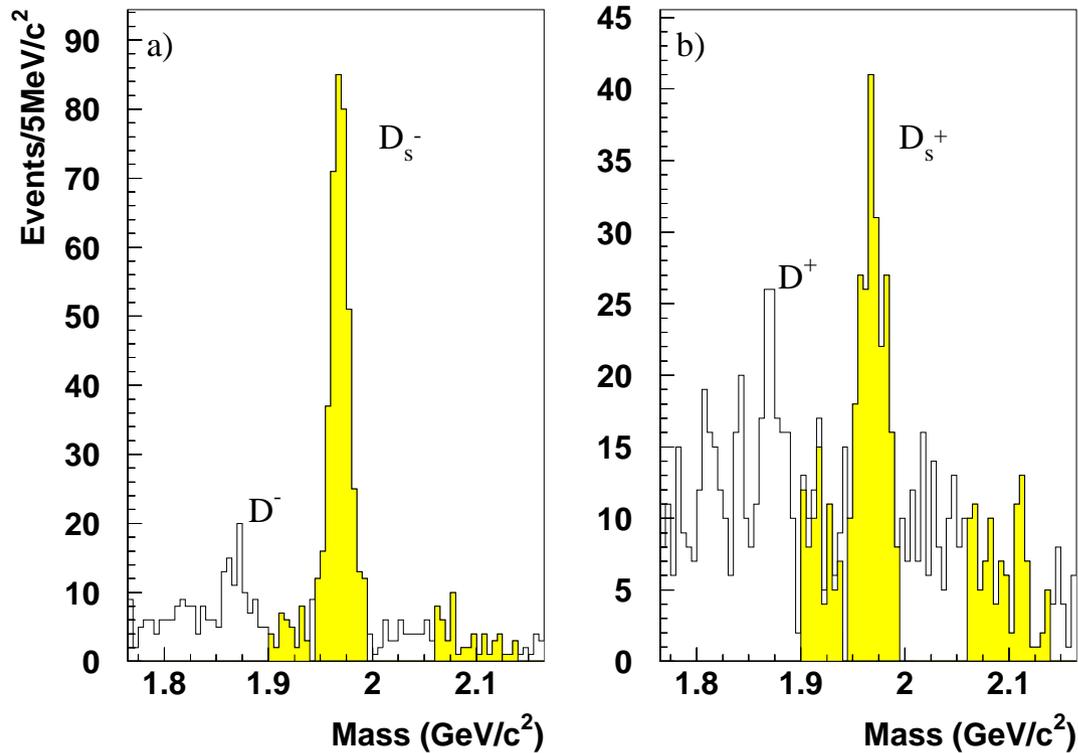
^aPublication *in Press* by Phys. Lett. B

^bAdamovich et al. Eur. Phys. J. C8,593,(1999)

^cNorrbin et al. Eur. Phys. J. C17,137 (2000)

^dVogt et al. Nucl. Phys. B478, 311 (1996)

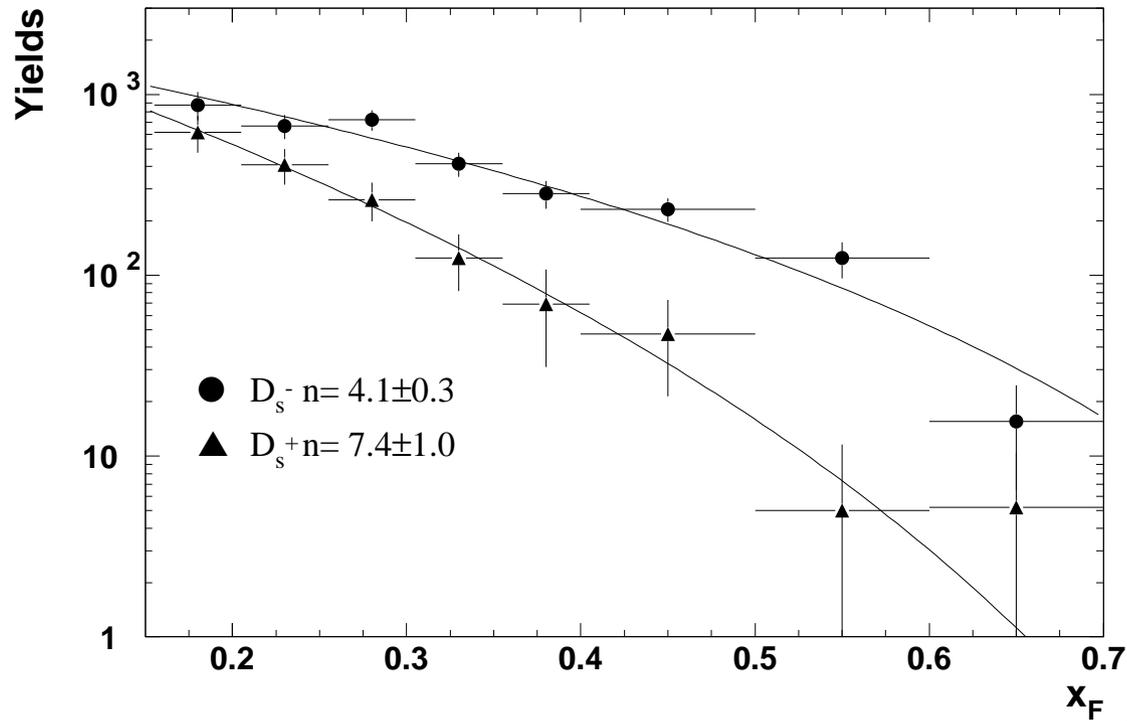
Mass Distributions



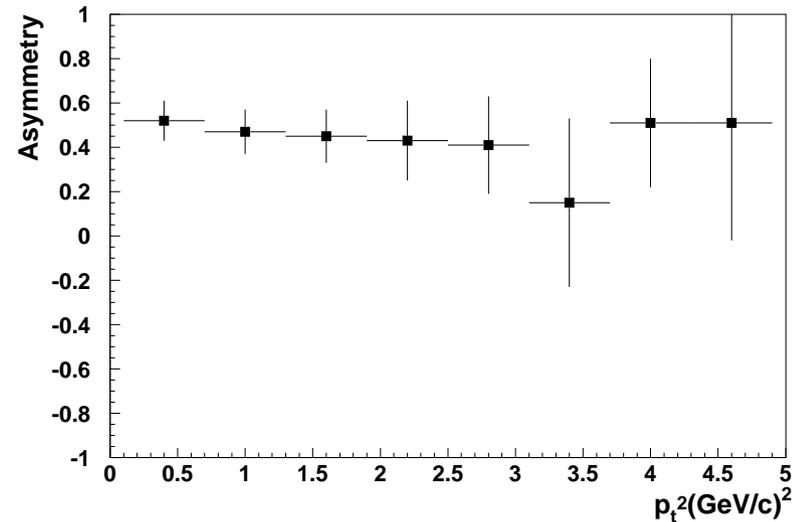
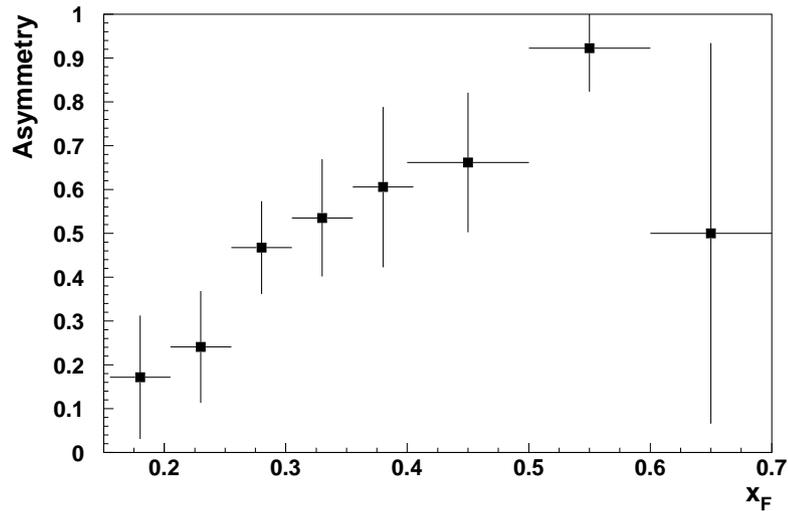
- Events selection:
 - Longitudinal separation between primary and secondary vertexes has to be $L/\sigma > 9$
 - Two Kaons required to be in the RICH \implies **LOW Background!**

X_f Distributions

- Acceptance corrected x_f distributions for D_s^- and D_s^+ from Σ^- beam.
- Simulation studies show that the D_s^- and D_s^+ acceptances are identical within simulation statistics.
- Fits of the yields to $(1 - x_f)^n$ for each charge state are plotted and the n-values listed.



Production Asymmetry



- Production asymmetry for Σ^- beam data as a function of x_f .
- Production asymmetry for Σ^- beam data as a function of p_t^2 .
- Yields obtained from resonant (KK^* and $\phi\pi$) events were used to calculate the asymmetry.

Conclusions:

- $\Sigma^- (dds)$ beam data show a *strong* production asymmetry favoring $D_s^- (\bar{c}s)$ production.
- The integrated charge asymmetries with $600\text{GeV}/c \Sigma^-$ found to be 0.53 ± 0.06 .
- The integrated charge asymmetries with π^- beam to be $0.06 \pm 0.11 \implies$ Consistent with zero asymmetry since neither D_s^- nor D_s^+ is a leading particle.
- Results show that Σ^- beam fragments play a role in the production of D_s as suggested by the leading quark model.
- SELEX results favors color-drag model over intrinsic charm model.

Recent SELEX Publications

- First Observation of the Doubly Charmed Baryon Ξ_{cc}^+ , Phys. Rev. Lett., **89 (2002),112001**
- Production Asymmetry of D_s from $600\text{GeV}/c$ Σ^- and π^- beam, Phys. Lett. B, In press.
- Hadronic Production of Λ_c from $600\text{ GeV}/c$ π^- , Σ^- and Proton Beams, Phys. Lett. **B528(2002)49**
- First Measurement of $\pi^- e \rightarrow \pi^- e \gamma$ Pion Virtual Compton Scattering, Phys. Rev. **C66(2002) 034613**