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Measurement of Λ_c Polarization in photon-nucleon interactions

J. C. Anjos, C. M. Castromonte, *F.R.A. Simão

on behalf of the Fermilab E831/FOCUS Collaboration

Centro Brasileiro de Pesquisas Físicas

E-mail: simao@cbpf.br

➢ ABSTRACT

We report preliminary results of the first measurement of the polarization of Λ_c^+'s produced in interactions of high-energy photons (<E>=180 Gev) with nuclei of a segmented target of Beryllium oxyde. The results were obtained from data of the Fermilab experiment E831/FOCUS analyzing the 2-body decay of ~ 3000 Λ_c^+'s in the $\Lambda\pi$ and pK_s channels.

➢ INTRODUCTION

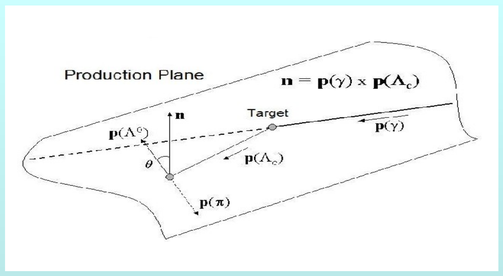
🗁 We will study the spin parameters of the charmed baryon Λ_c produced in high energy photon-nucleon interactions. For this we analyze the decay mode $\Lambda_c^+ \rightarrow \Lambda\pi$. In the weak decay of a spin1/2 particle into a spin1/2 + spin0 particles, we can write the angular distribution of the daugther fermion in the parent fermion center mass as:

🗁 ‘

🗁 $\mathbf{dN / d\cos\theta = N_0/2(1 + \alpha P \cos\theta)}$

where **P** is the Λ_c polarization which is normal to the production plane, θ is the angle between this normal and the momentum of the spin1/2 daughter particle and α is the weak decay asymmetry parameter.

🗁 In Fig. 1 we show the production plane of the decay and the θ angle.



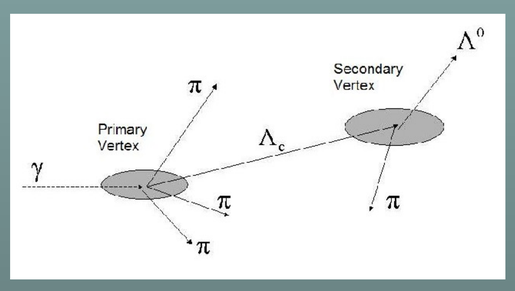
➢ FOCUS EXPERIMENT

🗁 The Spectrometer

- Located in Fermilab’s Wide Band Laboratory, upgrade of experiment E687
- Large aperture fixed target multiparticle spectrometer
- Photon beam from bremmstrahlung of 300 GeV electrons and positrons
- Segmented berylium oxide targets.
- Two systems of silicon microvertex detectors: 2 target stations + 12 planes
- High resolution separation of primary and secondary vertices
- 2 analysing magnets of opposite polarity.
- 5 stations of multiwire proportional chambers
- 3 multicell threshold Cerenkov counters identify e, π, K, p
- 2 electromagnetic calorimeters
- 1 hadron calorimeter consisting of iron and scintillating tile
- 2 muon systems: resistive plate chambers and scintillator hodoscope.

🗁 The E831/FOCUS data sample

- Collected during 1996-1997 fixed target run.
- Multiplicity trigger and loose transverse energy requirement in trigger.
- Fully reconstructed more than one million charm mesons.



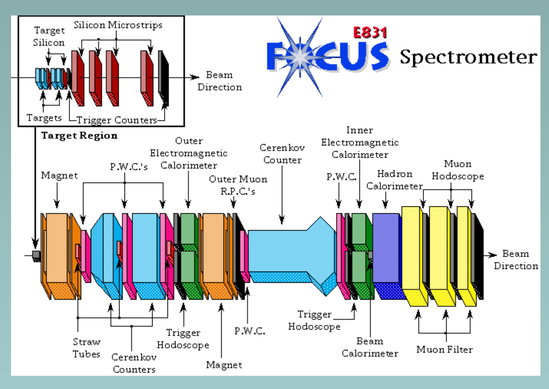
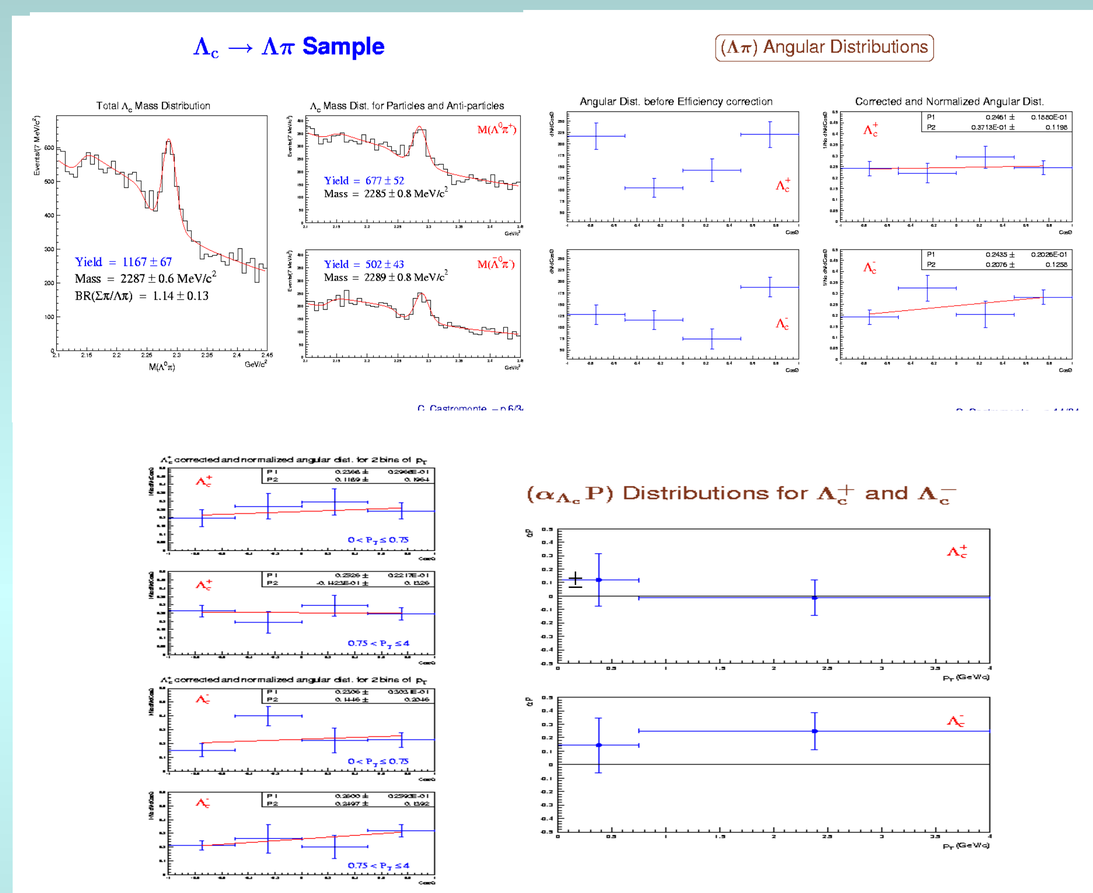
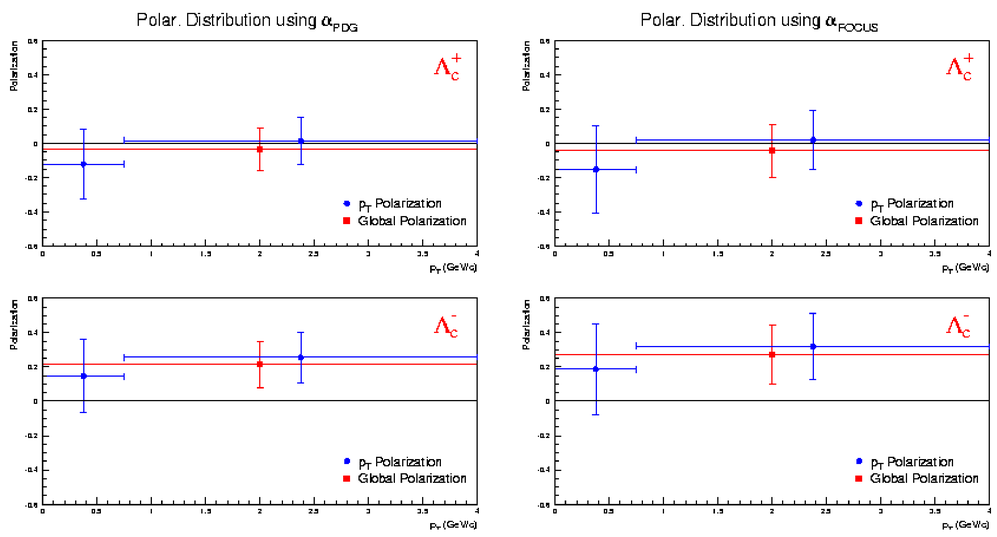
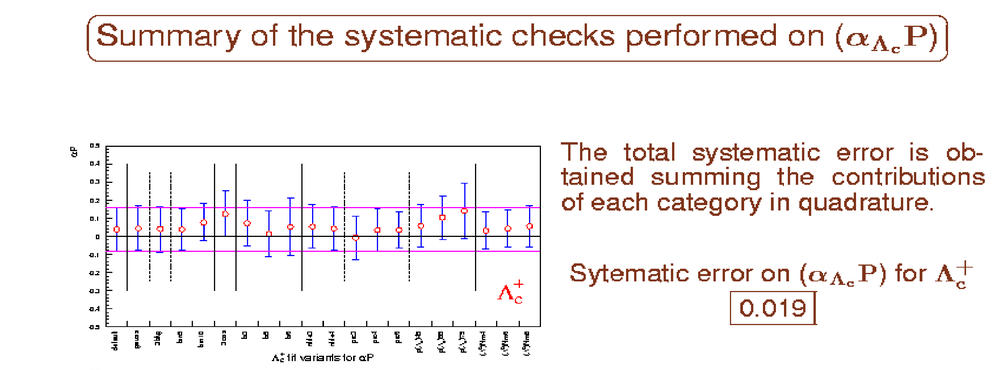


Fig.1: The E831/FOCUS Spectrometer.







C. Castromonte – p.18/34

➢ DATA ANALYSIS

🗁 Event Selection Criteria

Λ^0 selection:

$1.10 < m(\Lambda 0) < 1.125$ GeV/c2

Requirements on Cerenkov ID on proton:

$\Delta W(Kp) > 0$; $\Delta W(\pi p) > 4$

Vee πcon > -6

Λ_c selection:

Production and decay vertices well separated ($L/\sigma > 3$)

Goodness-of-fit requirements on vertices:

Confidence level primary vertex CLP > 1%.

secondary vertex CLS > 2%

$2.15 < m(\Lambda c) < 2.45$ GeV/c2

Λc momentum > 45 GeV/c

π momentum $10 < p(\pi) < 70$ GeV/c

Requirement on Cerenkov ID : πcon > - 5

After applying the final cuts ,we obtain **677±52** and **502±43** events for particle and anti-particle respectively.

🗁 Fitting the Data

Fitting the Λ_c^+ mass histograms

- Fit Λ_c signal with 2 normalized Gaussians with common mean and different widths
- Fit background with a 3rd order polynome for each bin of $\mathbf{p_T}$.

- Fit the $\Lambda_c^+ \rightarrow \Sigma(\Lambda\gamma)\,\pi$ reflection, using shapes from Monte Carlo ($\Sigma\,\pi$) mass distributions fitted with spline functions..

➢ SYSTEMATIC EFFECTS

We consider the following sources of systematic errors:

- Detachment of vertices $\mathbf{L/\sigma} > 3$, 5 and 6
- Effect of bin widths (5 and 10 MeV/c2)
- Pion identification πcon > -6, -4 and -3
- Λc momentum: $p(\Lambda c) > 40$, 55, 75 GeV/c
- Effect of dividing cosq in 3 bins instead of 4;
- Taking 1Gaussian instead of 2 for signal
- Effect of background shape: 2nd order polynomial.

➢ RESULTS AND CONCLUSIONS

•We have studied the polarization of Λ_c^+ using the decay channels $\Lambda_c^+ \rightarrow \Lambda^0\,\pi^+$ and $\Lambda_c^+ \rightarrow p\,K^0_s$ and charge conjugate ones. We measure the product αP of the asymmetry parameter and taking the value of α from PDG and FOCUS , we determine the polarization.

•Then our results are:

$\forall \alpha P = -0.033 \pm 0.120 \pm 0.019$ for Λ_c^+

$\forall \alpha P = 0.211 \pm 0.125 \pm 0.037$ for Λ_c^-

• Because we have low statistics and large errors the polarization is compatible with zero within 1σ and show a slight dependence of the polarization on tranverse momentum.

•The branching ratio measured

•$BR = \Gamma(\Lambda_c^+ \rightarrow \Lambda^0\,\pi^+) / \Gamma(\Lambda_c^+ \rightarrow \Sigma^0\,\pi^+) = 1.14 \pm 0.13$

•is in good agreement with the PDG value

•$BR_{PDG} = 1.10 \pm 0.70$

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