PROCEEDINGS OF SCIENCE

Λ^0 Polarization as Function of the $\Lambda^0 K^+$ invariant mass in $pp \rightarrow p\Lambda^0 K^+(\pi^+\pi^-)^N, N = 1,2,3,4,5$ at 27.5 GeV

J. Félix[1,*,†], **D. C. Christian**[2], **M. D. Church**[3], **M. Forbush**[4,a], **E. E. Gottschalk**[3,b], **G. Gutierrez**[2], **E. P. Hartouni**[5,c], **S. D. Holmes**[2], **F. R. Huson**[4], **D. A. Jensen**[2], **B. C. Knapp**[3], **M. N. Kreisler**[5], **J. Uribe**[5,d], **B. J. Stern**[3,e], **M. H. L. S. Wang**[5,b], **A. Wehmann**[2], **L. R. Wiencke**[3,f], **J. T. White**[4,a]

[1]*Instituto de Fisica, Universidad de Guanajuato, León, Guanajuato, México; e-mail: felix@fisica.ugto.mx.* [2]*Fermilab, Batavia, Illinois 60510, USA.* [3]*Columbia University, Nevis Laboratories, Irvington, New York 10533, USA.* [4]*Department of Physics, Texas A&M University, College Station, Texas 77843,USA.* [5]*University of Massachusetts, Amherst, Massachusetts 01003, USA. Present affiliation:* [A]*University of California, Davis, CA 95616.* [B]*Fermilab,Batavia, Illinois 60510, USA.* [C]*Lawrence Livermore National Laboratory, Livermore CA 94550.* [D]*University of Texas, M.D. Anderson Cancer Center, Houston, TX 77030.* [E]*AT&T Research Laboratories, Murray Hill, NJ 07974.* [F]*University of Utah, Salt Lake City, UT 84112.*

The polarization of Λ^0's from the specific reactions $pp \rightarrow p\Lambda^0 K^+(\pi^+\pi^-)^N$, $N = 1,2,3,4,5$, created from 27.5 *GeV* incident protons on a liquid Hydrogen target, as function of x_F, P_T, and $M_{\Lambda^0 K^+}$, is reported. The data is from the BNL e766 experiment which collected 300×10^6 events; from those events, 1% resulted as exclusive events, from where the present analyzed data come.

International Europhysics Conference on High Energy Physics
July 21st - 27th 2005
Lisboa, Portugal

*Speaker.

†We acknowledge the assistance of the technical staff at the AGS at Brookhaven National Laboratories and the superb efforts by the staffs at the University of Massachusetts, Columbia University, and Fermilab. This work was supported in part by National Science Foundation Grants No. PHY90-14879 and No. PHY89-21320, by the Department of Energy Contracts No. DE-AC02-76CHO3000, No. DE-AS05-87ER40356 and No. W-7405-ENG-48, and by CoNaCyT of México under Grants 458100-5-4009PE and 2002-CO1-39941.

1. Introduction

Many experiments have reveal that Λ^0's from unpolarized pp inclusive and exclusive collisions, at different energies, are produced polarized[1]; and that this polarization depends on x_F, P_T, and $\Lambda^0 K^+$ invariant mass[2]. Additionally, other baryons like Ξ, Σ, etc., are produced polarized in the same experimental circumstances[3].

Some authors have proposed many theoretical ideas trying to understand that Λ^0 polarization[4]. These models lack of predictive power, and the problem of Λ^0 polarization, and in general of baryon polarization, remains as an open problem. Some experiments have been conducted to measure Λ^0 polarization, in exclusive pp collisions, trying to unveil Λ^0 polarization origin studying specific final states where Λ^0 is produced. This paper reports the results of a study of Λ^0 polarization, as function of $M_{\Lambda^0 K^+}$, in the specific final states

$$pp \to p\Lambda^0 K^+ (\pi^+\pi^-)^N, N = 1,2,3,4,5. \tag{1.1}$$

In those reactions Λ^0 is produced polarized. And this polarization is function of x_F, P_T, and $M_{\Lambda^0 K^+}$.

This sample consists of fully reconstructed pp events produced at 27.5 GeV. All final-state particles are measured and identified. Two previous measurements have been published for polarization of Λ^0 from[5]

$$pp \to p\Lambda^0 K^+ \pi^+\pi^-\pi^+\pi^-\pi^+\pi^- \tag{1.2}$$

$$pp \to p\Lambda^0 K^+ (\pi^+\pi^-)^N; N = 1,2,3,4,5. \tag{1.3}$$

at 27.5 GeV. An one measurement from[2]

$$pp \to p\Lambda^0 K^+. \tag{1.4}$$

at 800 GeV.

2. The BNL 766 Experiment and Λ^0 Data

The data for this study were recorded at the Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratories in experiment E766, described in detail elsewhere[6]. For this study 5 421, 57 455, 54 266, 16 381, and 1871 Λ^0's, for $N = 1,2,3,4,5$ respectively, satisfied selection criterium cuts reported elsewhere[5].

3. Λ^0 Polarization and Results

This study of Λ^0 polarization explores the dependence of the polarization on the kinematic variables P_T, x_F and $M_{\Lambda^0 K^+}$ in the final states represented by Eq. (1.1). The way these variables are defined and the way Λ^0 polarization is measured are explained elsewhere[5].

To improve the statistical power of polarization measurements, Λ^0 polarization from both hemispheres are summed properly. The results of Λ^0 polarization are in Figure 1, as function of $M_{\Lambda^0 K^+}$. This Λ^0 polarization behavior has been observed previously in other reactions[2].

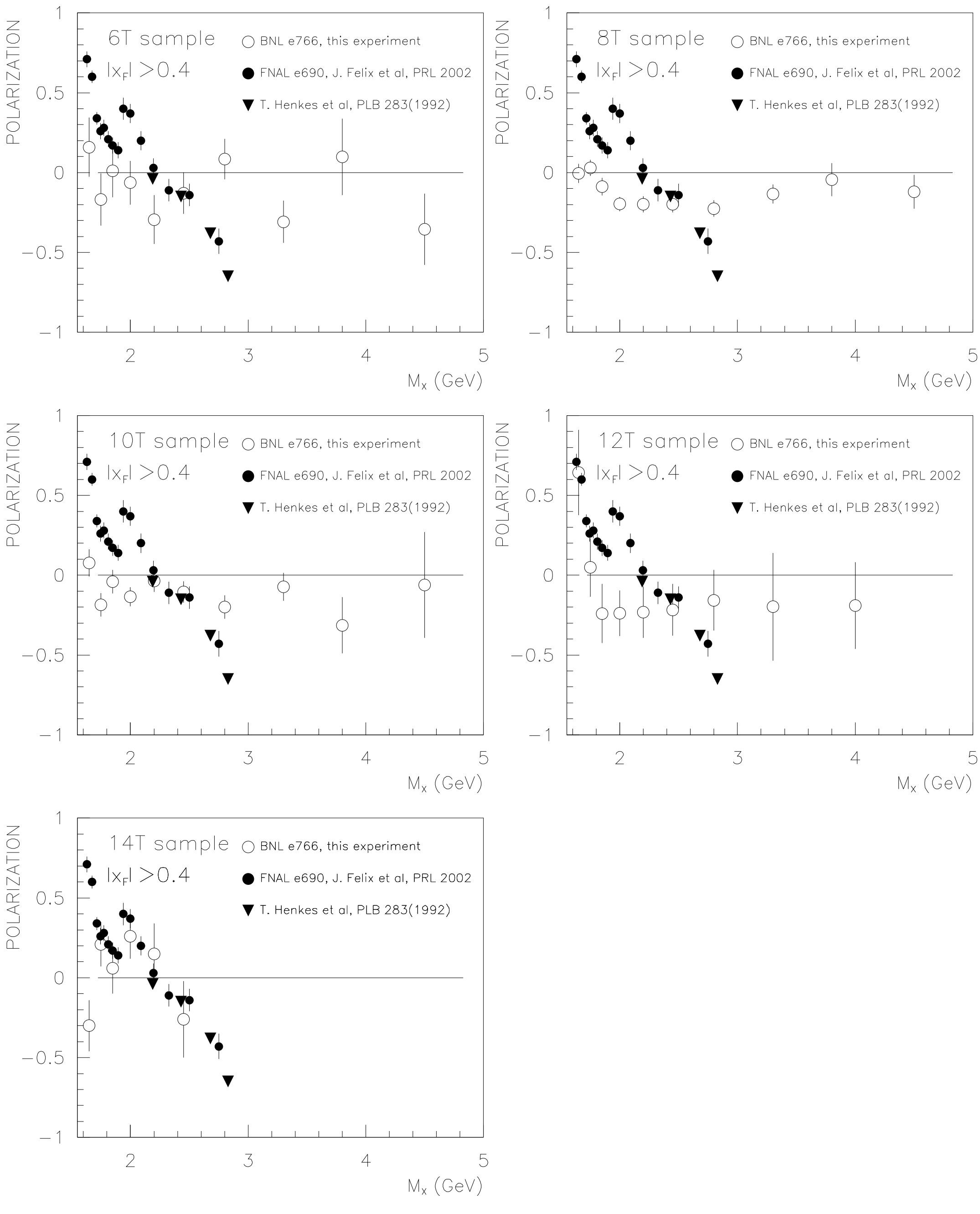

Figure 1: Λ^0 Polarization as function of the $M_{\Lambda^0 K^+}$ invariant mass. Open circles, this experiment; filled ones, Reference 2 (J. Félix *et al*); filled triangles, Reference 2 (T. Henkes *et al*).

A Monte Carlo analysis is used to study possible systematic effects, caused by finite acceptance and finite resolution, that might bias the Λ^0 polarization measurements. The Monte Carlo sample is generated with unpolarized Λ^0's using a model for reactions (1) that faithfully reproduces all kinematic distributions. This sample of events is subjected to the same analysis programs and cuts used for the data. The measured polarization for this Monte Carlo sample, which is generated with zero polarization, is found to be consistent with zero as function of x_F, P_T, and $M_{\Lambda^0 K^+}$.

In a second analysis that makes a direct comparison to data, Monte Carlo events are weighted by $(1+\alpha \wp cos\theta)$ with $\wp$ measured, for each bin of $M_{\Lambda^0 K^+}$. The Λ^0 polarization in the Monte Carlo is in good agreement with the data, all the χ^2/dof between data and Monte Carlo distributions are close to 1. The $cos\theta$ distributions are not quite linear, due to detector acceptance, these acceptance induced variations in $cos\theta$ are reproduced by the Monte Carlo.

Λ^0 polarization in reactions (1.1) depends on x_F, P_T, $M_{\Lambda^0 K^+}$; this polarization is different from that determined in $pp \rightarrow p\Lambda^0 K^+$, at 800 GeV[2]. Therefore, provide that there is energy enough in the reaction to create Λ^0, its polarization is independent of the beam energy.

References

[1] K. Heller *et al*, Phys. Lett. **B68**, 480(1977). G. Bunce *et al*, Phys. Lett. **B86**, 386(1979).

[2] T. Henkes *et al*, Phys. Lett. B283, 155(1992). J. Félix *et al*, Phys. Rev. Lett. 88, 061801-4(2002).

[3] J. Duryea *et al*, Phys. Rev. Lett. 67, 1193(1991). R. Rameika *et al*, Phys. Rev. **D33**, 3172(1986). C. Wilkinson *et al*, Phys. Rev. Lett. 58, 855(1987). B. Lundberg *et al*, Phys. Rev. **D40**, 39(1989). F. Lomanno *et al*, Phys. Rev. Lett. 43, 1905(1979). S. Erhan *et al*, Phys. Lett. **B82**, 301(1979). F. Abe *et al*, Phys. Rev. Lett. 50, 1102(1983). K. Raychaudhuri *et al*, Phys. Lett. **B90**, 319(1980). K. Heller *et al*, Phys. Rev. Lett. 41, 607(1978). F. Abe *et al*, J. of the Phys. S. of Japan. 52, 4107(1983). P. Aahlin *et al*, Lettere al Nuovo Cimento 21, 236(1978). A. M. Smith *et al*, Phys. Lett. **B185**, 209(1987). V. Blobel *et al*, Nuclear Physics **B122**, 429(1977).

[4] T. A. DeGrand *et al*, Phys. Rev. **D24**, 2419(1981). B. Andersson *et al*, Phys. Lett. **B85**, 417(1979). J. Szweed *et al*, Phys. Lett. **B105**, 403(1981). K. J. M. Moriarty *et al*, Lett. Nuovo Cimento 17, 366(1976). S. M. Troshin and N. E. Tyurin, Sov. J. Nucl. Phys. 38, 4(1983). J. Soffer and N.E. Törnqvist, Phys. Rev. Lett. 68, 907(1992). Y. Hama and T. Kodama, Phys. Rev. **D48**, 3116(1993). R. Barni *et al*, Phys. Lett. **B296**, 251(1992). W. G. D. Dharmaratna and G. R. Goldstein, Phys. Rev. **D53**, 1073(1996). W. G. D. Dharmaratna and G. R. Goldstein, Phys. Rev. **D41**, 1731(1990). S. M. Troshin and N. E. Tyurin, Phys. Rev. **D55**, 1265(1997). L. Zuo-Tang and C. Boros, Phys. Rev. Lett. 79, 3608(1997).

[5] J. Félix *et al*, Phys. Rev. Lett. 76, 22(1996). J. Félix, Ph.D. thesis, Universidad de Guanajuato, México, 1(1994). J. Félix *et al*, Phys. Rev. Lett. 82, 5213(1999).

[6] J. Uribe *et al*, Phys. Rev. D49, 4373(1994). E. P. Hartouni *et al*, Nucl. Inst. Meth. A317, 161(1992). E. P. Hartouni *et al*, Phys. Rev. Lett. 72, 1322(1994). E. E. Gottschalk *et al*, Phys. Rev. D53, 4756(1996). D. C. Christian *et al*, Nucl. Instr. and Meth. A345, 62(1994). B. C. Knapp and W. Sippach, IEEE Trans. on Nucl. Sci. NS 27, 578(1980). E. P. Hartouni *et al*, IEEE Trans. on Nucl. Sci. NS 36, 1480(1989). B. C. Knapp, Nucl. Instrum. Methods **A289**, 561(1980).

PoS(HEP2005)122