K-PRODUCTION EXPERIMENTS AT DISTO*

A. BRENSCHEDE

University of Gießen
for the DISTO Collaboration

IUCF Indiana, University and INFN Torino, JINR Dubna,
LNS-CEN Saclay, GSI Darmstadt, Jagellonian University and INP Krakow,
University of Gießen*, University of Frankfurt, TRIUMPF Vancouver

(Received October 9, 1996)

The planned experiments for vector meson production near threshold with the DISTO spectrometer at SATURNE are discussed. The first results for the reaction $pp \to pp\Phi$ studied via the $\Phi \to K^+K^-$ decay are presented.

PACS numbers: 13.60. Le

1. Introduction

Vector mesons are presently attracting considerable interest, because they are considered as suitable probes for in-medium effects in hot and dense hadronic matter, as it is produced in heavy ion collisions. However, the interpretation of such experiments requires the knowledge of the vector meson production cross sections in nucleon-nucleon collisions. At GSI energies (1–2 AGeV), vector meson production is subthreshold (in the nucleon-nucleon system), thus the pp cross sections are required near the production threshold. While for the ρ and ω some data is available [3], Φ production is measured only at $\sqrt{s} = 4.5$ GeV [4] and $\sqrt{s} = 6.7$ GeV [5] which is significantly above the production threshold of $\sqrt{s} = 2.9$ GeV. Therefore, we have started a program to study the reaction $pp \to pp\Phi$ via the $\Phi \to K^+K^-$ decay at $\sqrt{s} = 3.0$ GeV with the DISTO [1, 2] spectrometer at SATURNE (Saclay, France).

The $pp \to pp\Phi$ reaction is also interesting from another point of view. According to the OZI Rule [6], Φ production is strongly suppressed as compared to ω production, if the proton wave function contains no virtual $s\bar{s}$ pairs. For πp collisions, the experiments [7–10] confirm the Φ/ω-Ratio

---

* Presented at the "Meson 96" Workshop, Cracow, Poland, May 10–14, 1996.

as predicted by the OZI rule. In contrast, nucleon–nucleon collisions give higher values ([5, 4]), and for the annihilation of $p\bar{p}$ at rest the measured Φ/ω-Ratio [11] exceeds the prediction of the OZI rule by two orders of magnitude [12]. The data is compatible with an increase of the Φ/ω-Ratio with decreasing momentum transfer. In this case we can expect a rather high value near the pp threshold. A possible explanation could be a $s\bar{s}$ admixture in the proton wave function. As a consequence, the measurement of $pp \to pp\Phi$ could give information on the strangeness content of the nucleon, which is of considerable interest also in the context of the spin structure of the nucleon.

2. The DISTO spectrometer at SATURNE

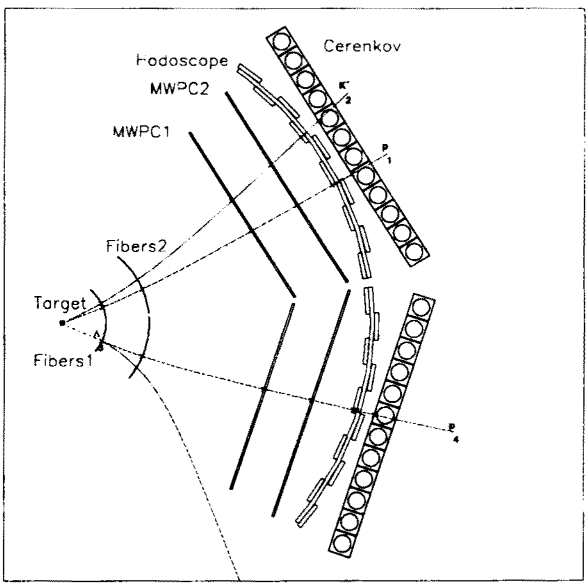

Fig. 1. Overview of the DISTO setup, top view, with a simulated Λ event. Each tracking detector is made of 3 individual planes, with a total of 3456 wires + 2880 fibers. The radius of the hodoscope is 140 cm. The vertical acceptance is ±15 degree.

The DISTO spectrometer (figure 1) is designed for an exclusive measurement of the reactions $\vec{p}p \to pK^+\Lambda$ and $\vec{p}p \to pK^+\Sigma$. It consists of a dipole magnet ($B = 1.4$ T), 2 sets of scintillating fiber detectors inside the magnetic field, 2 sets of wire chambers outside the magnetic field, a plastic scintillator hodoscope and a segmented water Cherenkov detector. The water Cherenkov detector is a powerful tool to discriminate the $\Phi \to K^+K^-$ channel against the huge background from $pp \to pp\pi^+\pi^-$, since typical kaon momenta are just above the Cherenkov threshold, where the discrimination power is largest. The data acquisition system allows to record $\approx$ 10000 events/burst.

2.1. Status of the analysis

In November 1995, $\approx 30 * 10^6$ events have been recorded with a multi-particle trigger. In the following we briefly discuss first results of the data analysis.

Particle discrimination.

The correlation of Cherenkov light versus momentum shows separate lines for each particle mass and allows to determine the particle type. Figure 2 shows the correlation obtained at DISTO, indicating a separation of protons and pions. Kaons are not visible in this inclusive plot, because the cross section for kaon production is too small. However, by selecting the regions where kaons are expected, the background for the $\Phi \to K^+K^-$ channel can be reduced drastically. Additional particle discrimination is possible by energy loss and time of flight in the hodoscope, which so far has not been used in the analysis.

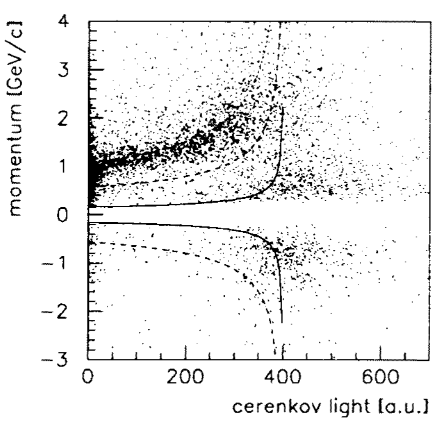

Fig. 2. Correlation between particle momentum and light output from the Cerenkov detectors. Negative momentum indicates negatively charged particles. The lines corresponds to the calculated correlations, dotted line to protons, dashed lines to kaons and solid lines to pions.

Reconstruction of 2-body decays

Due to the low detector efficiencies obtained in the November run, the analysis has to be restricted to 2-particle correlations. However, this allows to look for various particles with 2-body decay channels like Λ, K_s and ϕ as well as the pp missing mass analysis, which is a means to search for particles like ω, η' or ϕ. As an example, the $\pi^+\pi^-$ invariant mass distribution is shown in figure 3, where a signal from $K_s \to \pi^+\pi^-$ decay is visible. A significant signal from the $\phi \to K^+K^-$ channel could not yet be established.

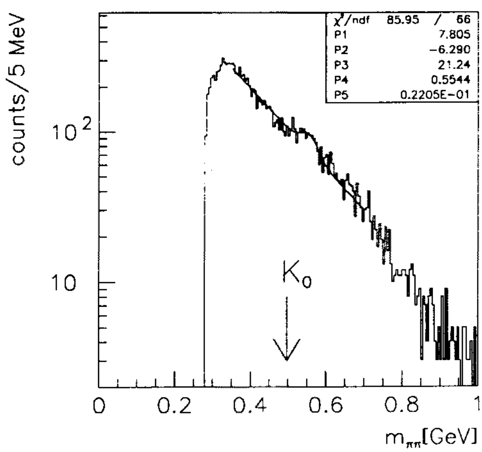

Fig. 3. Invariant mass distribution for $\pi^+\pi^-$-pairs measured at 2.85 GeV. The bump near 500 MeV corresponds to the $K_s \to \pi^+\pi^-$ decay with a yield which is compatible with the known cross section.

3. Summary and outlook

To interpret the heavy ion experiments, the knowledge of nucleon–nucleon cross sections for vector meson production near threshold is required. The DISTO spectrometer at SATURNE (Saclay) will be used to measure the cross section of the reaction $pp \to pp\Phi$, which is of particular interest also with respect to the question of the strangeness content of the nucleon.

In June 96, DISTO collected data with significantly improved wire-chamber performance. A high statistics run will follow in July.

This work was supported in part by Gesellschaft für Schwerionenforschung (GSI) and by Deutsches Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie (BMBF) under contract No 06 GI 174 I.

REFERENCES

[1] R. Bertini, *Nucl. Phys.* **A585**, 265c (1995).
[2] A. Maggiora, *Nuclear Physics News* Vol.5, No.4, 23 (1995).
[3] M.W. Arenton *et al.*, *Phys. Rev.* **D25**, 22 (1982).
[4] V. Blobel *et al.*, *Phys. Lett.* **B59**, 88 (1975).
[5] R. Baldi *et al.*, *Phys. Lett.* **B68**, 381 (1977).
[6] S. Okuba *Phys. Lett.* **B5**, 165 (1965); G. Zweig, CERN Report No. 8419/TH412 (1964) unpublished; I. Iuzuka, *Prog. Theor. Phys. Suppl.* **37-38**, 21 (1966).
[7] M. Abolins *et al.*, *Phys. Rev. Lett.* **11**, 381 (1963).
[8] D. Ayres *et al.*, *Phys. Rev. Lett.* **32**, 1463 (1974).
[9] D. Cohen *et al.*, *Phys. Rev. Lett.* **38**, 269 (1977).
[10] P.L. Woodworth *et al.*, *Phys. Lett.* **B65**, 89 (1976).
[11] M.A. Faessler *et al.*, *Proc. NAN-93 Conference* Moscow, 1993; *Phys. At. Nucl.* **57**, 1693 (1994).
[12] J. Ellis *et al.*, Preprint CERN-TH.7326/94.