First Observation of K^- and ϕ meson at ANKE

M. Hartmann and Y. Maeda

The first physics experiment with the new detection system for negatively charged ejectiles at ANKE [1] is ϕ-meson production in pp collisions [2, 3] at beam energies 2.65 GeV and 2.7 GeV by detecting the K^+K^- decay mode. These energies correspond to excess energies of 18 MeV and 35 MeV (see arrows in the upper part of Fig. 1 a)). I.e. the result will cover similar excess energies as the ω-data from SPES-III [4] and recent TOF [5] experiments shown in the lower part of Fig. 1 a). In addition to the understanding of the reaction $pp \to pp\phi$ near threshold, the data will thus provide information on the deviation from the cross-section ratio $R_{\mathrm{OZI}} = \sigma_\phi/\sigma_\omega = \tan^2\alpha_v = 4.2\times10^{-3}$ given by the the Okubo-Zweig-Iizuka (OZI) rule with the ideal ϕ-ω mixing angle α_v.

In Spring 2002 a first week of beam time - out of four approved weeks [2] - has been carried out at a beam energy of 2.7 GeV. Prior to this beam time the final commissioning of the negative detection system was performed during the measurement of $a_0^+(980)$ production [6] at 2.83 GeV. Also, a comparable number of ϕ events could be collected at this higher energy. At a similar energy (T_p=2.85 GeV) the DISTO collaboration [7] has measured the ϕ cross section, the only existing result close to the threshold.

For analyzing the data a new software development has been started, which implements the full ANKE spectrometer [8] in a ROOT [9] environment. The positive and negative detection systems are already implemented in the new analysis framework and implementation of the forward detector is nearly finished. For a efficient background suppression, a full event reconstruction with one detected proton in the forward detector is necessary.

To achieve an estimate about the collected yield of ϕ-mesons without a third detected particle - one proton in forward - the range telescopes of the positive detection system at ANKE were used. In these telescopes K^+ events can be selected by using energy loss information in the ΔE counters and a signal of delayed decay products of the stopped kaons in the VETO counters [10, 11]. This is possible with a small background contribution but has the disadvantage that only about 13% of the muons from K^+ decay reach the VETO counter. The coincident K^- meson can be selected from the time of flight difference in Fig. 1 b) using all pos. and neg. STOP counter combinations, which were calibrated with the help of $\pi^+\pi^-$ pairs before [1]. The peak around zero is mainly due to K^+K^- pairs while the strong enhancement between -6 and -1.8 ns are $K^+\pi^-$ pairs. Selecting the K^+K^- pairs around zero one can deduce the invariant K^+K^- mass as plotted in Fig. 1 c). A peak in the mass region of ϕ mesons with the expected mass resolution $\leq$10 MeV FWHM is clearly visible. The spectrum contains 70% of the statistics at 2.7 GeV collected in 5 days. Considering this fact and the K^+ detection efficiency, totally around 750 ϕ-events exist in the data. Out of these approximately one third of the events should have a coincident proton in the forward system. Three additional weeks of available beamtime for the ϕ production in pp collisions at the lower energy 2.65 GeV will be taken in the winter 2003/04.

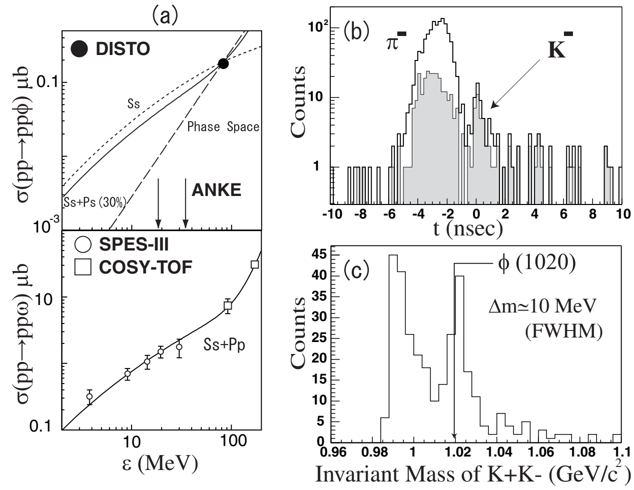

Fig. 1: a) Existing data for ϕ and ω production in pp collisions near threshold. The lines in the figures show the calculations using the energy dependence of specific partial wave amplitudes. The letters Ss, Ps, Pp indicate angular momentum of final protons (capital letters) and mesons (small letters). b) Time difference of the time of flight from the target to the neg. STOP counters once calculated using time calibration and secondly calculated from the momentum of the K^- candidate. The shadowed region shows the effect of the Čerenkov counters, which decrease the π^- events by a factor 5 without reducing the K^- yield. In c) the spectrum of the invariant K^+K^- mass is plotted.

The spectrum in Fig. 1 c) implies that ϕ meson production can also be studied in proton-nucleus reactions at ANKE by detecting only two particles in the negative and positive detection system [12, 13].

References:

[1] M. Hartmann et al., Annual report 2002: "Status and Calibration of the New Detection System for Negatively Charged Ejectiles at ANKE";
[2] M. Hartmann et al., COSY Proposal No. 104;
[3] M. Hartmann et al., Annual report 2001: "Investigation ϕ-meson production in pp and pn collisions at ANKE";
[4] F. Hibou et al., Phys. Rev. Lett. 83 (1999) p. 492;
[5] S. Abd El-Samad et al., Phys. Lett. B552 (2001) p. 16;
[6] V. Kleber et al., Annual report 2002: "Investigation of a_0^+ resonance production in the reaction $pp\to dK^+\overline{K^0}$ at ANKE";
[7] F. Balestra et al., Phy. Rev. C63 (2001);
[8] V. Hejny, M. Hartmann, A. Mussgiller, Annual report 2002: "RootSorter: A new Analysis Framework for ANKE";
[9] http://root.cern.ch, CERN;
[10] S. Barsov et al, NIM A462 (2001) p. 364;
[11] M. Büscher et al., NIM A481 (2002) p. 378-396;
[12] H. Müller et al., COSY Proposal No. 21;
[13] Update of COSY Proposal No. 21 in preparation;