A threshold Čerenkov counter for the COSY–11 facility

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Recently the COSY–11 collaboration [Bra96] has measured the production of Λ and Σ^0 hyperons at equivalent excess energies up to 13 MeV [Sew99]. Now the program of studying the associated strangeness production in $pp \to pK^+\Lambda(\Sigma^0)$ reactions is extended to higher excess energies, up to 60 MeV [Pro99].

In reactions of this type one of the main difficulties is to identify short-lived K^+ by the time of flight method. Positively charged kaons do not reach the S3 detector and merely only 30% pass through S1 (Fig. 1). Therefore one has to use the time of flight measurement between the target and S1. The start time for the kaons is calculated by tracking back the proton, registered in S1 and S3, through the known dipole magnetic field to the target position. The stop signal is provided by the scintillator arrangement S1. This procedure allows to determine the four momentum vectors of the proton and K^+, while the unobserved neutral hyperon has to be identified by the misssing mass method.

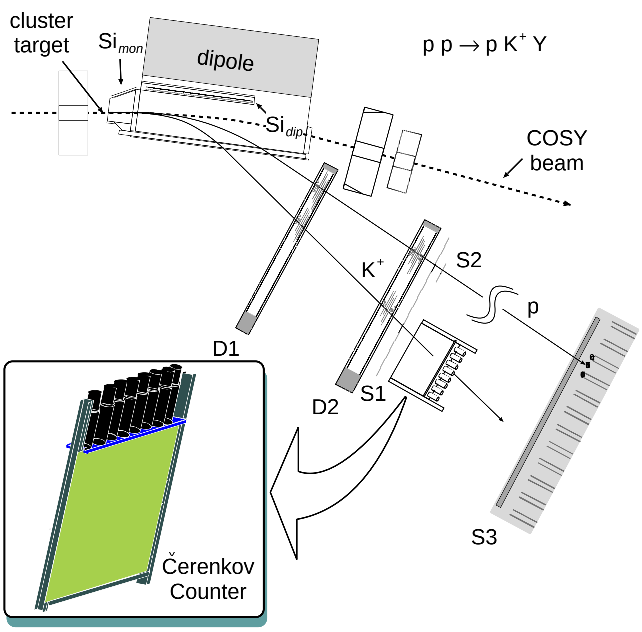

Figure 1: Schematic view of the COSY–11 detection setup showing the position of the Čerenkov counter.

For a clean event selection a reduction of background orginating from the misidentification of a pion as a kaon is crucial. Pions and kaons with the same momentum can be distinguished by their velocity. For example in case of the reaction $pp \to pK^+\Sigma^0$ at a proton beam momentum of 2.576 GeV/c one has $< \beta_{\pi^+} > = 0.975$ and $< \beta_{K^+} > = 0.720$. For a better identification of the kaons a threshold Čerenkov counter has been installed at the COSY–11 experimental setup. As an active medium pure water was chosen. The container of the Čerenkov counter has been built in the Institute of Physics, University of Silesia in Katowice (Poland). It

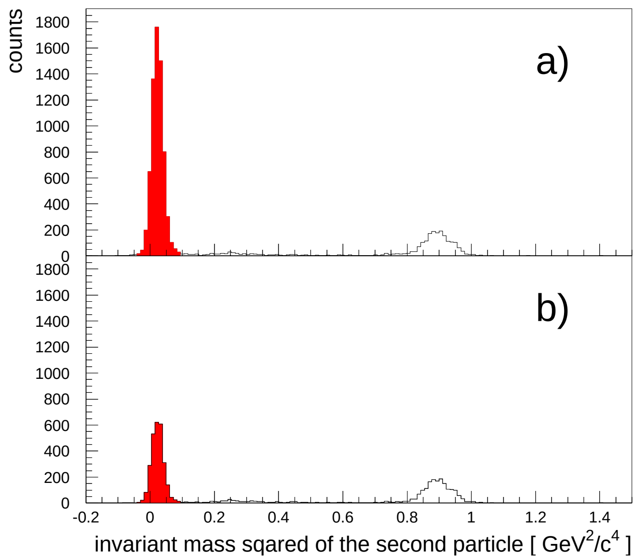

Figure 2: Spectra of the invariant mass squared of the second particle for the events without a) and with the use of a veto signal by the Čerenkov counter b).

has a rectangular shape with dimensions 85x85x5 cm^3. As inner reflecting layers 2.5 mm thick chrome-plated steel plates (type H17) have been used. In the upper part eight photomultipliers readout the volume. The detector can be inclined with respect to the direction of incoming particles (see Fig. 1), which allows to optimize the conditions of reflection of the Čerenkov light inside the radiator. Additionally in front of the radiator a lead degrader is installed, since the maximum β value of the outgoing K^+ can exceed the threshold β value for water. The degrader thickness can be adjusted according to the given beam momentum.

The new Čerenkov detector has been used for the first time during measurements of the reactions $pp \to pK^+\Lambda$ and $pp \to pK^+\Sigma^0$ in July 2000. Figure 2 shows preliminary spectra of the invariant mass squared obtained from the particle identification procedure without a) and with b) including the information from the Čerenkov counter. Using the Čerenkov detector as a veto results in a reduction of the pion background by a factor of three without loosing kaon yield.

References

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[Pro99] COSY Proposal No. 87 (1999) and No. 87.1 (2000).

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