STUDIES OF pp AND pd INTERACTIONS WITH THE TIME OF FLIGHT SPECTROMETER AT COSY*

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First results of measurements with the Time of Flight spectrometer are shown. Reconstructed missing mass distributions of the reactions $pp \to d\pi^+$, $pp \to pp\pi^0$, and $pp \to pK^+\Lambda$ are given.

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1. Introduction

The Time of Flight spectrometer (TOF) is a detector at the external beam of COSY, which measures pp or pd reactions by detecting the velocities of charged particle tracks (For a detailed description of the detector see [1].) Using the missing mass method and the assumption of the masses of the charged particles, all reactions up to one neutral particle in the exit channel can be fully determined in all kinematic variables with an acceptance near

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to 4π. Due to this large acceptance all reactions which are allowed by a given beam momentum are recorded simultaneously:

$$\begin{array}{ll} pp \to pp & pp \to pp\gamma \\ pp \to d\pi^+ & pp \to pp\pi^0 \\ pp \to pn\pi^+ & pp \to pp\pi^+\pi^- \\ .... & \\ pp \to pp\eta(') & pp \to pK^+\Lambda \end{array}$$

2. Results

As the detector is not yet fully equipped with scintillators we have measured with a short version in order to achieve a high acceptance and with a long version which provides a good time of flight resolution and a 4π acceptance for the reactions $pp \to d\pi^+$ and $pd \to {}^3\mathrm{He}\eta$ close to threshold. (Fig. 1)

The capability of the detector for measuring all kinematically allowed reactions in one setup is shown for a beam momentum of 0.88 GeV/c (below the $pp(2\pi)$ threshold) and the short detector setup (Fig. 1).

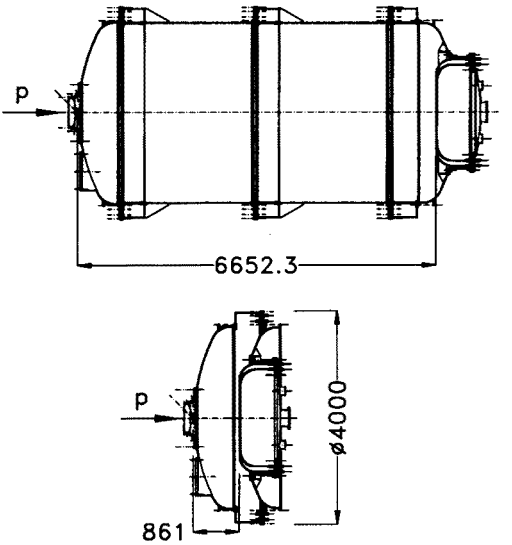

Fig. 1. Setup of the TOF–Detector. Top: Long version for measurements near kinematical thresholds. Bottom: Short version.

For each event the missing mass is calculated from the two charged track measurements (time of flight and direction) with three different mass hypotheses:

	1.0 track	2.0 track
a)	m_{proton}	$m_{\pi+}$
b)	$m_{\pi+}$	m_{proton}
c)	m_{proton}	m_{proton}

Fig. 2 shows each event plotted as a dot in a cube with the axes corresponding to the squared missing masses calculated with the hypothesis a,b, and c. The projection on the axis of the proton-proton hypothesis (and magnification) is shown in Fig. 3. A clear π^0 peak is seen.

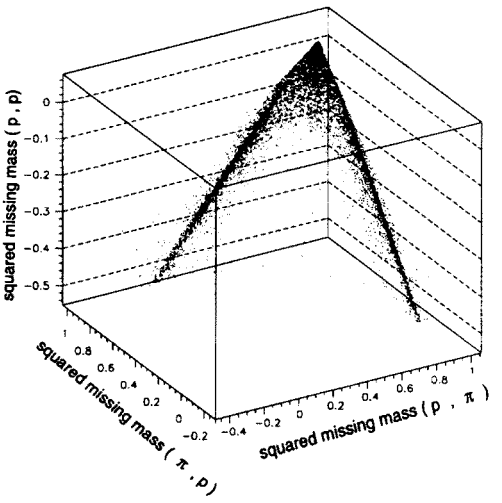

Fig. 2. Missing mass cube, beam momentum = 0.88 GeV/c. The diagonal lines are due to the reaction $pp \to d\pi^+$ broadened by events of the $pn\pi^+$ reaction. Events of the reaction $pp \to pp\pi^0$ are accumulated in the top of the distribution.

With a beam momentum of 2.75 GeV/c and a special set of start counters for triggering on the delayed decay of the Λ the reaction $pp \to pK^+\Lambda$ has been studied with the short detector setup. Fig. 4 shows the reconstructed missing mass of preselected events. With about 50 reconstructed events of this type the existing world wide data set is exceeded.

In order to measure $pp \to d\pi^+$ [2] and $pd \to^3 \text{He}\eta$ close to threshold a 6.6 m long version of the Time of Flight spectrometer was built. Two angular distributions of $pp \to d\pi^+$ with beam momenta of 0.80 GeV/c and 0.835 GeV/c were measured (Fig. 5). The data of $pd \to^3 \text{He}\eta$ with a beam momentum of 1.6 GeV/c will be analyzed in the near future.

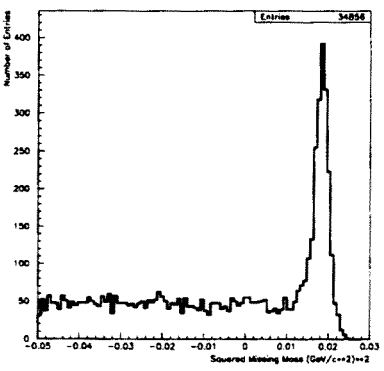

Fig.3

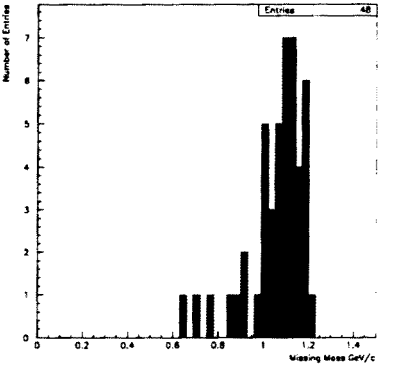

Fig.4

Fig.3 Squared missing mass distribution, hypothesis of both tracks to be protons, beam momentum = 0.88 GeV/c.

Fig.4 Missing mass distribution of reconstructed events using only the four-momentum of the prompt particles (p and K^+), the Λ decay particles (p and π^-) are not yet used (beam momentum: 2.75 GeV/c).

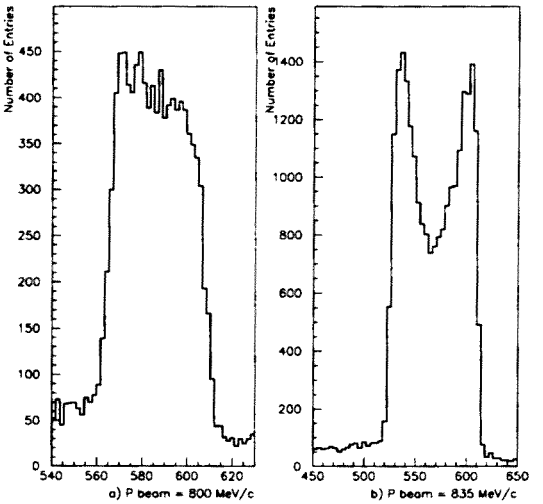

Fig.5 Time of flight distribution of deuterons from the reaction $pp \to d\pi^+$ for two beam momenta: 0.80 GeV/c and 0.835 GeV/c.

3. Conclusion

All above discussed data are preliminary results of ongoing analyses. They show that the principle of the non-magnetic spectrometer works. The $pK\Lambda$ measurement will be repeated with the expectation of getting a factor of more than 100 for lower statistical errors.

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