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A scintillator hodoscope for experiments at proton storage rings

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Abstract

A versatile scintillator hodoscope with two dimensional position sensitivity and good time resolution has been installed at the CELSIUS ion storage ring of the The Svedberg Laboratory. It is designed to be easily inserted into a package of range-measuring hodoscopes. We report on resolution and efficiency features that have been studied with reaction products from stored protons of energies 1360 and 1450 MeV impinging on a proton or deuteron pellet target. Among first applications are reconstructions of missing masses in pp reactions and of neutrons in η meson production via $pd \rightarrow pn\eta p_s$ with a spectator proton p_s.

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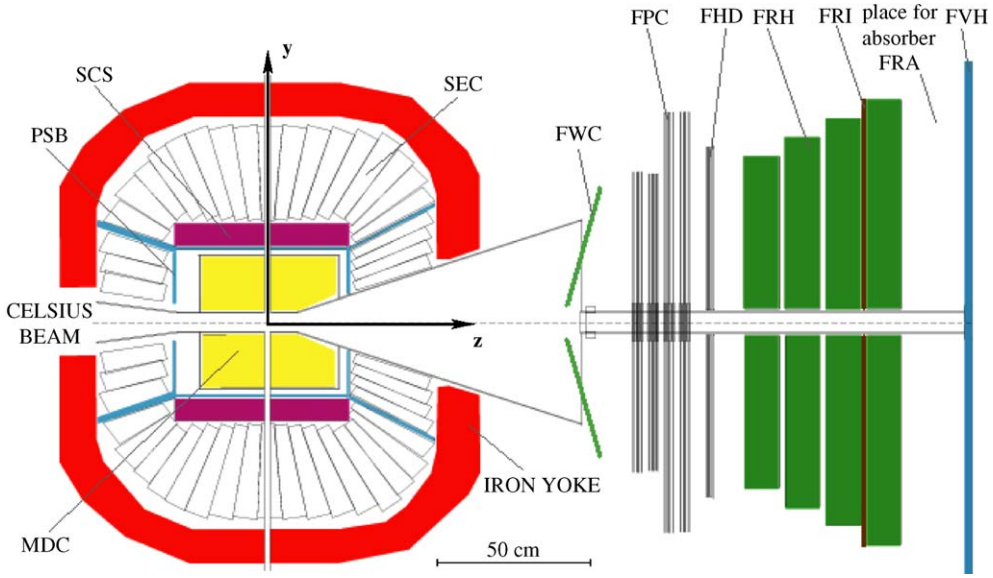

Fig. 1. The WASA detector: schematic view of a cut along the beam line.

1. Introduction

Light meson (π, η, K) production in nucleon–nucleon interactions and the study of their rare decay modes is intensively pursued at light ion storage rings like CELSIUS [1] or COSY [2]. In order to achieve adequate luminosities and count rates, internal targets are used in conjunction with detectors of 4π acceptance in the center of mass system. Detector systems typically comprise a central detector for neutral and charged decay products, and a forward range detector for momentum and missing mass analysis on the outgoing baryons. Range hodoscopes (e.g. FRH in Fig. 1) are massive multilayer devices with limited inherent time and spatial resolution; they are therefore supplemented with additional layers in front of them (FPC, FHD in Fig. 1) that provide high resolution and absorb little energy. The flexibility of such hodoscopes could be enhanced if it were possible to adjust the high-resolution layers to the range of the baryons by implementing them at the optimum intermediate position between two adjacent range layers. A thin two-layer hodoscope called FRI serving this purpose in the CELSIUS-WASA experiment [1,3] is described in this paper.

In Section 2 we present the concept of FRI supplementing the forward range hodoscope of the WASA setup; Section 3 is devoted to its implementation and the resolution values obtained. Some first applications are given in Section 4, followed by a summary.

2. Hodoscope concept and realization

The cylindrically symmetric WASA detector [1] is shown in Fig. 1 in a cut view along the beam line. The hydrogen pellet generator sends its string of pellets in $-y$ direction at $z = 0$ through the CELSIUS beam. The interaction region is surrounded by the central detector for charged meson and γ detection with the mini drift chamber (MDC) inside of the solenoid of $B = 1\,\mathrm{T}$ field strength and the electromagnetic 4π calorimeter (SEC). The forward going charged baryons penetrate through the forward range hodoscope FRH (thickness 44 cm of plastic scintillator) or are stopped in it (for protons if $T_p \leqslant 300\,\mathrm{MeV}$).

The geometrical constraints imposed upon FRI were: (i) A gap of at most 3 cm width available for insertion, while keeping full angular coverage of the range hodoscope (maximum diameter 144 cm);