Charged particle veto detector for a kaonic deuterium measurement at DAΦNE

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Introduction

SIDDHARTA-2's aim is to perform a precise measurement of kaonic deuterium to determine X-ray transitions to the ground state (1s-level), such as to determine its shift and width induced by the presence of the strong interaction [1]. The analysis of the combined measurements of kaonic deuterium and kaonic hydrogen (already measured by SIDDHARTA [2]) will allow the extraction of the isospin-dependent antikaon-nucleon scattering lengths which are fundamental inputs of low-energy QCD effective theories.

Experimental Setup

Using the theoretical estimates for K^-d yields, which are one order of magnitude below the measured K^-p yields, an upgrade and optimisation of the SIDDHARTA apparatus is essential. An enhancement by at least one order of magnitude of the signal to background ratio is required for SIDDHARTA. Therefore, an active charged particle anticoincidence-veto-2 system is under construction, since each real X-ray signal from K^-d K_α transitions is accompanied by charged particles like protons and pions from final kaon absorption. We cannot veto all potential signals which are in coincidence with these particles, but we rather have to look at the positional correlation between SDDs and charged particle hits. Clearly, it is advantageous to detect the charged particle position as close as possible to the SDD cell to obtain a good signature of whether the events might origin from the SDDs or not.
The basic layout of the detector is shown in Fig.1. It is planned to use tiles made out of small organic scintillators with sizes of 50 x 12 x 5 mm^3, attached to one Silicon Photo-Multiplier (SiPM) with a sensitive area of 4 x 4 mm^2, which are shown in Fig.2. The main reasons for choosing organic scintillators are their fast response (short rise- and decay-times) and their high light yield. As detector SiPMs are chosen because SiPMs provide advantageous properties such as good timing, compactness and high photon detection efficiency (PDE).
We will present in detail the detector setup and discuss the first results of the test measurement.

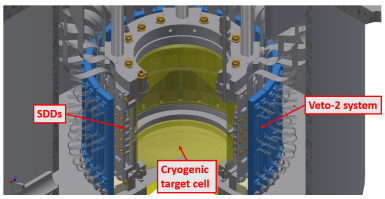

Figure 1: Setup of SIDDHARTA-2

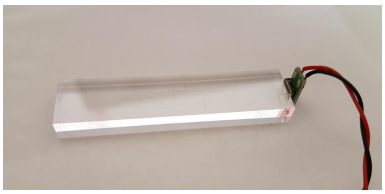

Figure 2: Scintillator tile with SiPM

[1] H. Shi *et al.*, Journal of Physics: Conf. Series **800** (2017) 012007.
[2] M. Bazzi *et al.* (SIDDHARTA collaboration), Phys. Lett. B **704** (2011) 113.