New Q3D Focal Plane Detector with Cathode-strip Readout Became Operational ◇

H.-F. Wirth, H. Angerer, T. von Egidy, Y. Eisermann, G. Graw, and R. Hertenberger

A new proportional counter for the Q3D focal plane is designed to detect light ions like p,d,t,α with a position resolution of better than 0.1 mm, good particle identification and high count rate. It is based on the prototype detector of J. Ott et al. [1]. The working principle is shown in Fig. 1. The particles hit the focal plane at an incoming angle of 40-50 degrees. These particles ionize the isobutane (500 mbar) inside the detector. The electrons generated between the two cathode foils drift to one of the two anode wires and produce a charge avalanche. This avalanche induces a positive charge on the etched cathode strips of the second foil.

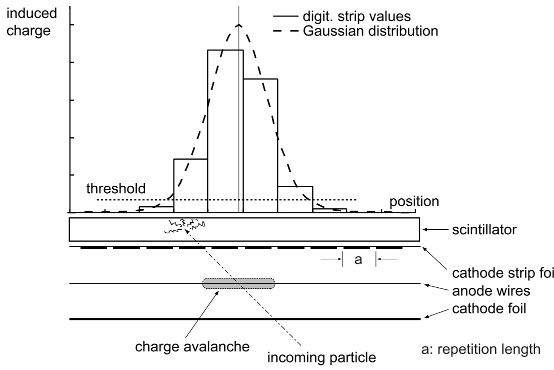

Fig. 1: Working principle of the cathode strip detector. The repetition length a is 3.5 mm.

The cathode strip foil has a pattern of 272 strips each 3 mm broad with an etched gap of 0.5 mm. 255 strips are connected to their individual preamplifiers, shapers and peak-heigth detection modules. The induced charge of one event is digitized and read out together with the address of the strip with the lowest number whose signal is above an adjustable threshold. Only events on 3-7 adjacent strips (above threshold) are recognized by an ASIC (application specific integrated circuit) and sent to the marabou data acquistion. By multiplexing the number of ADCs is reduced to 8. The charge histograms of the events are fitted with a Gaussian distribution in the replay, while the online specta are simply generated with the center of gravity method. The deadtime of the data acquisition is 150 μs for one event which results in possible count rates in the kHz range at reasonable deadtime. Fig. 2 shows a schematic cut through the detector. The strips are connected to printed circuit boards with 12 preamplifiers each, alternately mounted above and under the strip foil. The active length of the detector is 89 cm. This straigth length is not yet critical with respect to the curvature of the focal plane [2]. The detector has two anode wires to get a vertical position information to set the correct heigth in the detector chamber. The particles are stopped in a 7 mm thick plastic scintillator (NE-104). The photomultiplier signals together with the wire signals allow the particle identification.

Fig. 3 shows a white spectrum of elastically scattered deuterons of 22 MeV (on a 0.5 mm thick Al target).

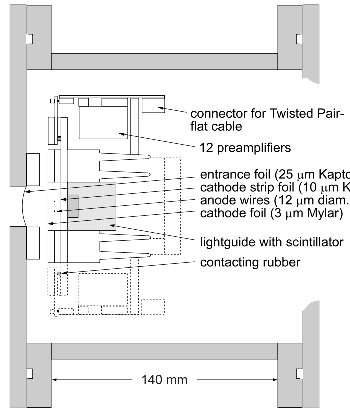

Fig. 2: Schematic cut through the detector. The 10 mm thick aluminium housing measures 190x250x1600 mm^3.

After the replay with the Gaussian fit no structure of the strip foil remains, which is also proven by Fourier analysis of the white spectra. The position determination is not disturbed by artificial periodic effects of the foil structure.

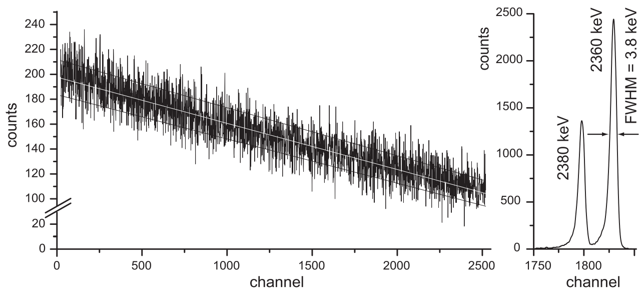

Fig. 3: Spectra measured with the detector. The left one is a so called white spectrum of elastically scattered deuterons. The white line is a linear fit, the two black lines are each 1 σ away. χ^2 of the fit is 1.2. The number of channels is 10 times the number of strips, this means one strip is related to 10 channels. The right one is a part of the proton spectrum of the reaction ^{128}Te($\vec{\mathrm{d}}$,p)^{129}Te at 22°, E_{d}=22 MeV, pol.=−1. The FWHM is 3.8 keV.

The detector has proven its operationability in several experiments. The group of A. Krasznahorkay has measured ^{235}U(d,pf) at 12.5 MeV deuteron energy for 8 days [3]. The so far best energy resolution of 3.8 keV was achieved in a ^{128}Te($\vec{\mathrm{d}}$,p) measurement [4,5] with 18 MeV deuterons (see Fig. 3). This resolution is limited due to target thickness, the stability of the Tandem and the Q3D and is not limited by the detector. The particle identification works satisfactory.

References

[1] J. Ott, H. Angerer, T. von Egidy, R. Georgii, and W. Schauer, Nucl. Instr. Meth. **A367** (1995) 280
[2] M. Löffler, H.J. Scheerer, and H. Vonach, Nucl. Instr. Meth. **111** (1973) 1
[3] P. Thirolf, A. Krasznahorkay *et al.*, this report, p.15
[4] R. Hertenberger *et al.*, this report, p.70
[5] H.-F. Wirth, Ph.D. thesis, TU München, 2001

◇ Supported by the DFG under IIC4-Eg 25/4-1.