Progress Report on the Retardation Spectrometer aSPECT

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From summer 2005 to winter 2006, the retardation spectrometer aSPECT has been set up for the first time at the cold neutron beam line MEPHISTO at the new research reactor FRM-II (shown in Fig. 1). Protons from neutron decay in the decay volume of the spectrometer are guided by a strong magnetic field towards a proton detector (a custom-designed segmented PIN diode). Between decay volume and detector, a cylindrical retarding electrode provides a variable electrostatic barrier potential U. The inserted diagram in Fig. 1 shows the pulse height spectrum of the proton detector for different barrier voltages. The left peak is due to electronic noise. The right peak is the proton peak. The number of protons which are able to pass the electrostatic barrier decreases as the barrier voltage U is ramped up. If we subtract the background and integrate the count rate below the proton peak for different settings of the barrier potential, we can compute the proton spectrum.

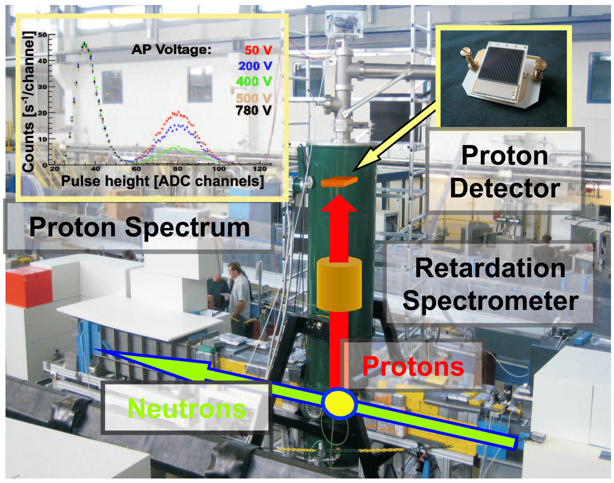

Fig. 1: Setup of the spectrometer aSPECT at the beamline MEPHISTO. Details can be found in [1].

Preliminary results were already published in [2]. The present status of the data analysis is:

The separation between proton and electronic noise peak is not good. Still, it is better than previously shown [2,3], as we learnt how to extract the pulse height information from the recorded pulse shape.

The proton count rate shows non-statistical fluctuations. They don't depend on the voltage of the analyzing plane. Drifts in the electronic noise are visible, but their size is too small to explain the proton count rate fluctuations. The probable origin are ions which are produced in the acceleration potential just below the detector.

To get a reasonable separation of proton peak and electronic noise a high acceleration voltage (up to 32 kV) was needed. In combination with the high magnetic field this proved to be difficult; we lost a lot of beam time and detectors due to high voltage discharges.

The magnetic field was measured offline. Our present setup is iron-free, still we see a small amount of hysteresis due to the superconductor itself.

For the next beam time, the experiment has to move to the beam line PF1B at the Institut Laue-Langevin. For that, an anti-magnetic screen has been built and tested successfully. Further improvements are the use of an online calibration source, and an in situ-magnetometer based on NMR. A new silicon drift detector (manufactured by the MPI Halbleiterlabor in cooperation with PNSensor GmbH) was successfully tested [4]: The resulting proton spectrum is shown in Fig. 2. Here, the proton peak is better separated from the electronic noise. In addition, the much lower acceleration voltage of 14–16 kV for the protons will help to solve the high voltage problems.

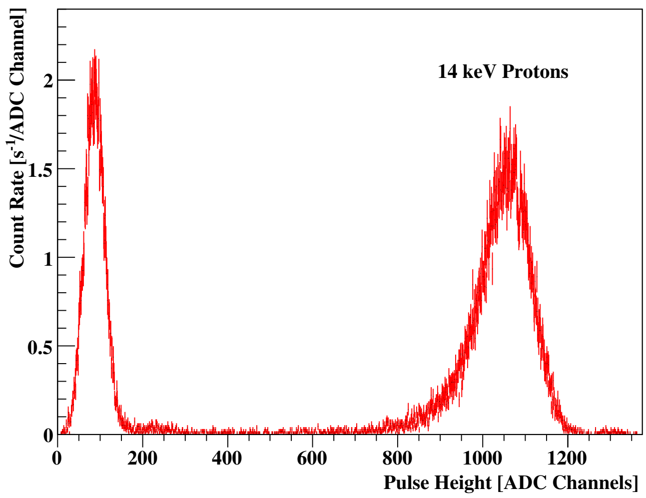

Fig. 2: Pulseheight Spectrum of the new silicon drift detector

This project is funded by BMBF under contract number 06MZ170 and 06MT196; by the European Commission under Contract No. 506065, by this lab and by the University of Mainz.

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