First Results with the Retardation Spectrometer *a*SPECT

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1. Scientific Background

With the *a*SPECT spectrometer we will measure the proton spectrum in the decay of the free neutron. For kinematic reasons its shape depends on the angular correlation coefficient a between the momenta of neutrino and electron.

Several reasons make the measurement important: A better knowledge of the correlation coefficient a sheds new light on the problem of the possible violation of the unitarity of the Cabbibo-Kobayashi-Maskawa matrix [1]. Secondly, our proposed measurements can give better limits on the existence of scalar or tensor currents [2], which are proposed by models with leptoquarks or charged higgs particles.

2. Experimental Setup

*a*SPECT is a retardation spectrometer which measures the countrate of protons from neutron decay with kinetic energies above a variable electrostatic barrier U. The spectrometer has been set up at the cold neutron beam line MEPHISTO at the new neutron source FRM-II which is presently the strongest cold neutron beam of the world. Its measured neutron capture flux of 2×10^{10} cm^{-2}s^{-1} translates into a neutron decay rate of about 700 s^{-1} in the decay volume of the spectrometer. From there, the decay protons are guided by a strong magnetic field towards a proton detector. The detector is a segmented PIN diode. Between decay volume and detector, an electrode provides the electrostatic barrier potential U. Details of the spectrometer were published in Ref. [3].

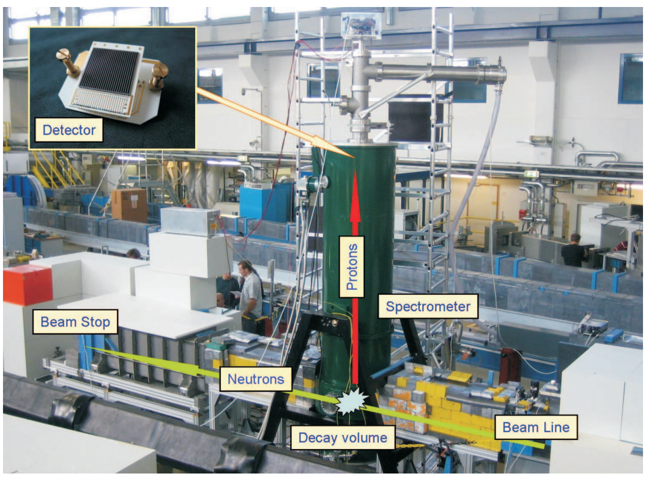

Fig. 1: Setup of the spectrometer *a*SPECT at the beamline MEPHISTO.

3. Present Status

The pulseheight spectrum of the proton detector is shown in Fig. 2. Besides a thermal noise peak around channel 30 the proton peak is visible at about channel 60. At the detector, all the protons have about the same energy due to an acceleration voltage of 30 keV. The number of protons which are able to pass the analyzing plane decreases as the analyzing plane voltage is ramped up. The measurement at $U = 800$ V can be used as a background measurement, since the endpoint of the proton spectrum is at about 750 eV. The background below the proton peak is smaller than 1:10.

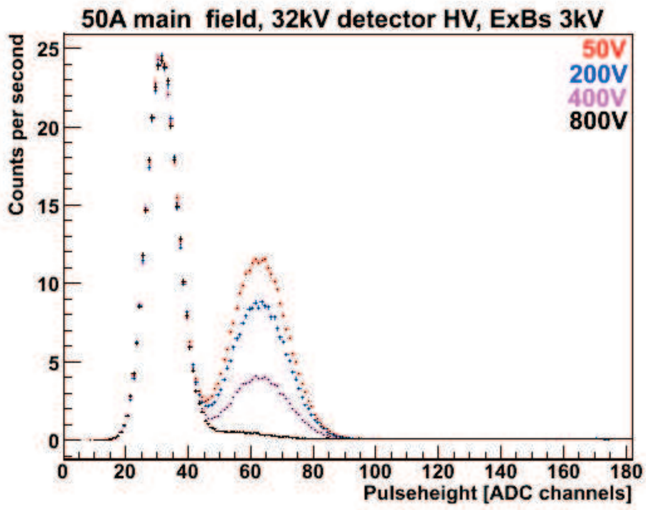

Fig. 2: Pulseheight Spectrum of the Proton Detector at different barrier voltages U.

If we integrate the count rate below the proton peak for different settings of the barrier potential, we can compute the proton spectrum. It is as predicted by the Standard Model using the presently accepted value for the correlation coefficient a. But so far, we have little statistics in our spectrum. Problems with the high voltage stability and with the stability of the thermal noise peak remain to be solved before the final data taking can take place.

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References

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