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Digital pulse processing of proton detector signals for the spectrometer aSPECT

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The retardation spectrometer aSPECT was designed to measure the electron-antineutrino angular correlation a in free-neutron decay with high accuracy. This coefficient allows to determine the ratio of the weak coupling constants. In aSPECT, it is extracted from the proton recoil spectrum. After selection by a retardation potential, protons are accelerated to typically ˜15keV and deposit up to 10keV in the active volume of a silicon drift detector. The threshold for proton detection must be as low as possible in order to detect also protons depositing very little energy. One challenge is the presence of decay electrons with energies of several hundreds of keV. They can precede coincident protons by a few microseconds only. The quite different energy ranges have to be handled by the same acquisition system, with good resolution for the proton signal and without saturation for the electron signal and proton loss.

We have employed two solutions: a non-linear analog shaper with digital pulse processing of the shaped signal and direct digital pulse processing of the preamplifier signal. The non-linear shaper reduces the amplification for higher signals. Therefore, a moderate resolution in the ADC is sufficient. However, spectra are more difficult to calibrate and saturation effects in the preamplifier may be invisible. Direct processing of the preamplifier signal requires a much higher resolution of the pulse processing ADC which became available only recently. In the 2013 beamtime at the Institut Laue-Langevin, a 14 bit ADC has been tested.

We present and compare both solutions.

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