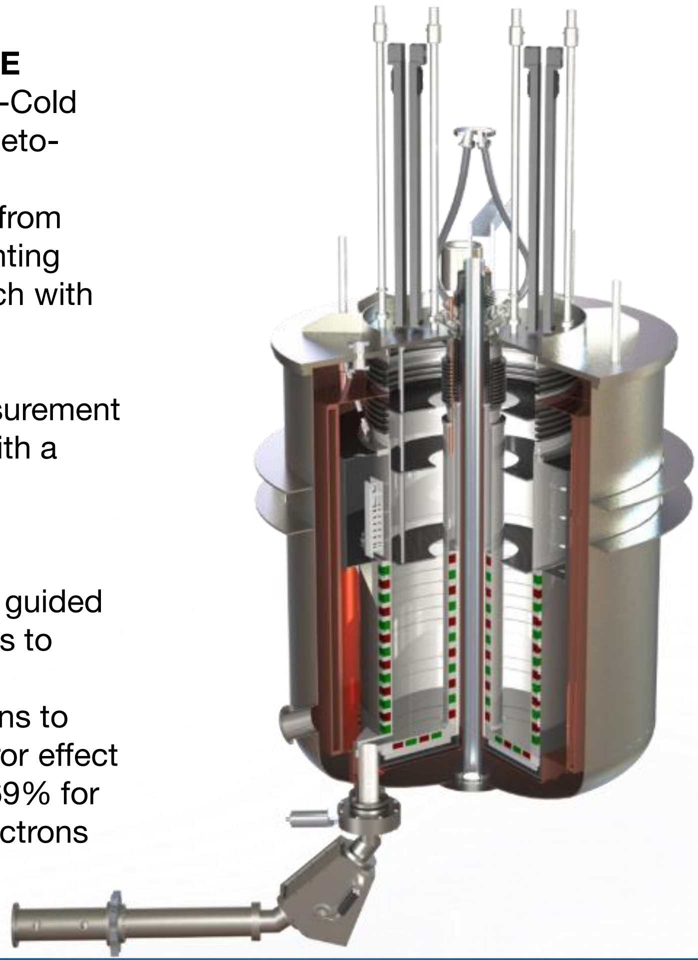
Self-Triggering Readout System for the Neutron Lifetime Experiment PENeLOPE

Basic Principles of PENeLOPE

- lossless storage of Ultra-Cold Neutrons (UCN) in magneto-gravitational trap
- neutron lifetime derived from neutron and proton counting
- new and unique approach with separate systematics
- blind analysis
- experimental goal: measurement of the neutron lifetime with a precision of 0.1 s

Proton Detection

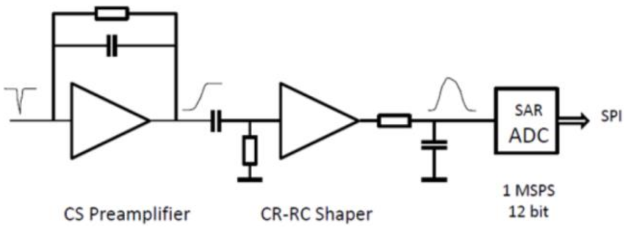
- charged decay particles guided along magnetic field lines to detector
- high voltage helps protons to overcome magnetic mirror effect
- extraction efficiency of 69% for protons and 37% for electrons feasible



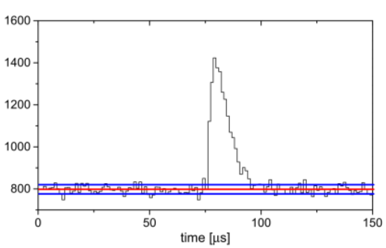
Dominic Gaisbauer

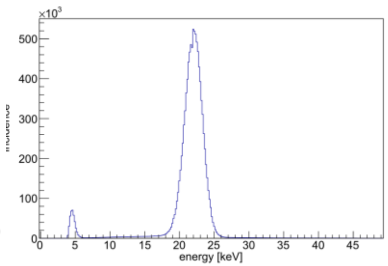
Requirements on the detector

- single proton counting
- energy from neutron decay max. 750 eV
- the whole detector setup including electronics on -30 kV electrostatic potential
- 0.6 T magnetic field due to operation close to superconducting coils
- operation at 77 Kelvin
- 10^{-8} mbar in storage volume
- 0.23 m^2 cross-sectional area has to be covered



- Charge-sensitive (CS) preamplifier
- Shaping: CR differentiator and RC integrator
- 12-bit ADC (AD7450) with $f_{\text{sample}} = 1\ \text{MHz}$





- "Real-time" pedestal calculation: Averaging over N_{avg} samples
- Calculating sigma noise over N_{avg} samples: Calculating quadratic deviation from mean value
- Signal Detection: If n_s consecutive samples > pedestal + $x_f \cdot \sigma$

Switched Enabling Protocol (SEP)

- time-division multiplexing transport layer protocol
- developed for star like optical network topology
- up to 256 slaves
- supports data transmission, slow control (IPBus) and synchronous message with determined latency

Transmission Time [µs]	Efficiency [%]
25000	99,93
10000	99,84
1000	98,42
500	96,90
100	86,20