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Low Threshold Proton-Recoil Detectors for nELBE *

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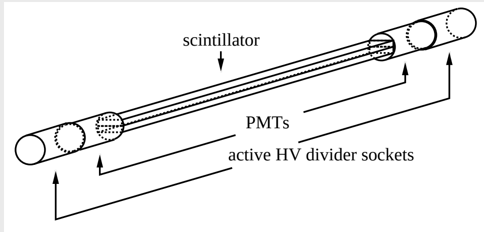
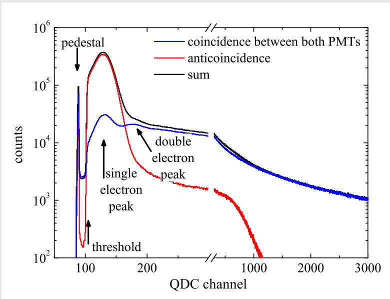
The Scintillation Detectors

- material: plastic scintillator EJ-200 (equivalent to BC-408 or Pilot F)
- dimensions of the scintillator stripes: 1000 x 42 x 11 mm³
- two types: consisting of one or two stripes, respectively
- readout: - by two photomultiplier tubes (PMT) Hamamatsu R2059-01
  - one PMT at each end
- electronics: - one multi hit, multi event TDC CAEN V1190A
  - two multi event QDCs CAEN V792
  - dedicated, inhouse developed CFDs
  - listmode data acquisition via VME bus by CES RIO3 Power PC
- trigger threshold: just below the single electron peak (SEP)



The detector layout.



QDC spectrum of one PMT under different conditions concerning the other PMT of the same detector illustrating the SEP and the trigger threshold.

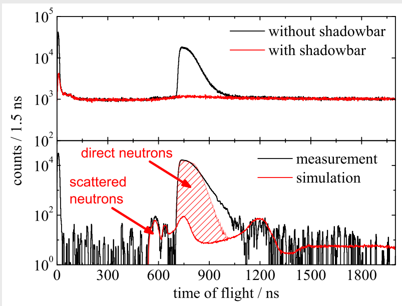
The detectors in a transport frame.

The Efficiency Calibration

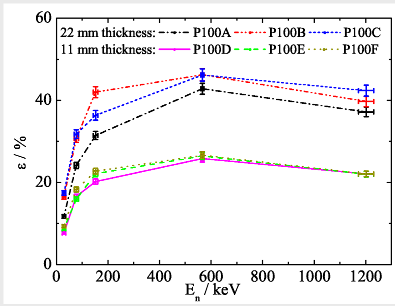
- efficiency calibration done at PTB Braunschweig [1]
- low background conditions due to huge experimental hall (24 x 30 x 14 m³)
- quasi monoenergetic neutron beams produced via (p,n) reactions on ^{7}Li or ^{3}H with E_n=24, 73, 150, 560 and 1200 keV
- flux monitored with well-calibrated recoil proton proportional counters
- neutron flux distribution simulated with Monte-Carlo code TARGET
- background measured using a PE shadow bar

Results:

- efficiencies of more than 10 % for neutrons with kinetic energies of only 24 keV
- quite constant efficiency at energies above 150 keV
- detection threshold quite well reproducable because trigger threshold is set relative to the SEP



Upper panel: Measured time-of-flight spectrum at E_n=73 keV with and without the PE shadow bar.
Lower panel: Background subtracted spectrum for comparison with the simulated neutron spectrum.

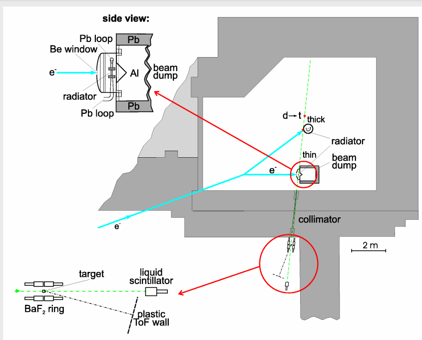


Measured efficiencies.

[1] R. Beyer, E. Grosse, et al., Nucl. Instr. Meth. A, in press, DOI:10.1016/j.nima.2007.02.096.

The Neutron-Time-of-Flight Source nELBE

- ELBE Electron beam: up to 50 MeV, average current 1 mA, pulse length Δt < 10 ps, micropulse repetition rate 13 MHz/2^n
- future: SRF injector 500 kHz / 1mA or smaller rate with reduced beam current
- short flight path to use high repetition rates: 4.0 m
- liquid lead radiator will produce intense neutron flux while dissipating high thermal load
- neutron intensity: $1.5 \cdot 10^7$ cm^{-2} s^{-1}
- neutron energy range: 100 keV < E_n < 6 MeV (energy range similar to a fast reactor)
- neutron energy resolution: ΔE/E < 1 % at 4.0 m flight path
- detectors to be used:
  – Proton-recoil detector for neutron flux measurements
  – Calorimeter consisting of 42 BaF_2 crystals for (n,γ)-measurements



Experimental Setup at nELBE.

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