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Neutron detector based on ZnS:^{6}LiF scintillator readout with WLS fibers and SiPMs

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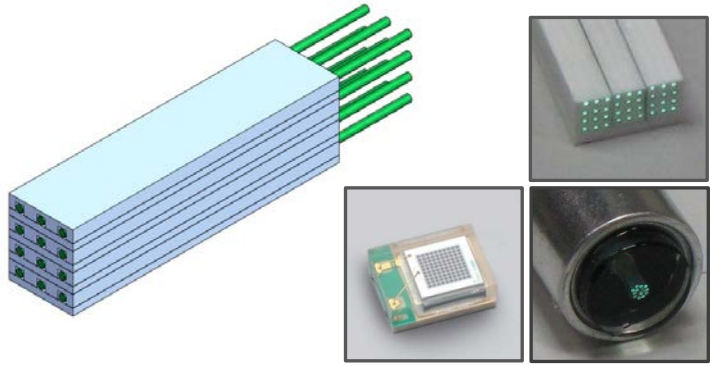
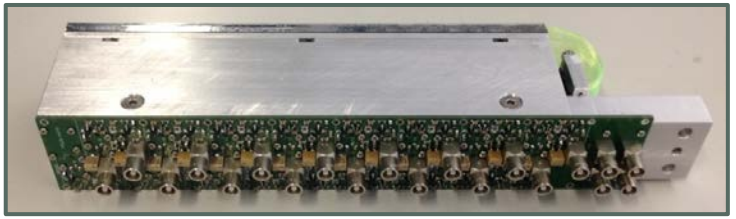
ZnS:^{6}LiF neutron detector readout with SiPMs

basic detection element

- layered machined scintillator, 2.8 mm thick
  → neutron absorption probability 75% @ 1 Å
- 12 embedded WLS fibers (0.25 mm diameter)
  → efficient, homogeneous light collection
- each detection element coupled to single SiPM
  → high single photon sensitivity



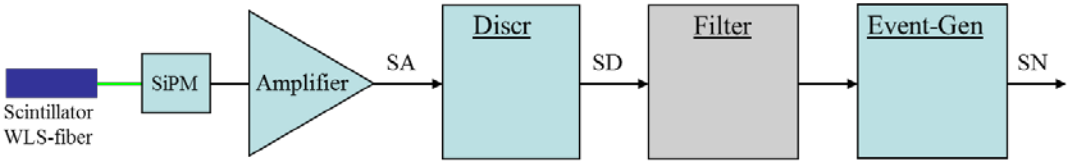


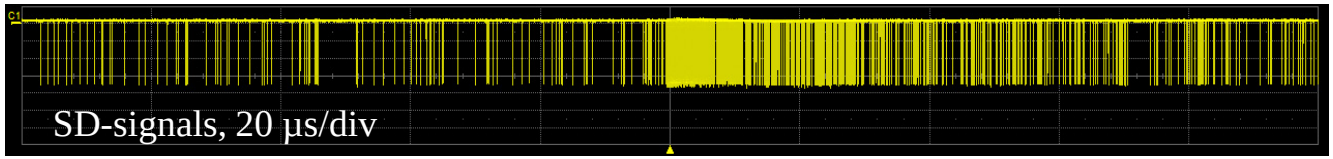
16-channel module with 1D-resolution

- 2.4 mm width, 200 mm length

signal processing system

- analysis of temporal distribution of SiPM pulses to extract neutron event from SiPM dark counts
- larger number of detected photons per neutron event required compared to PMT readout

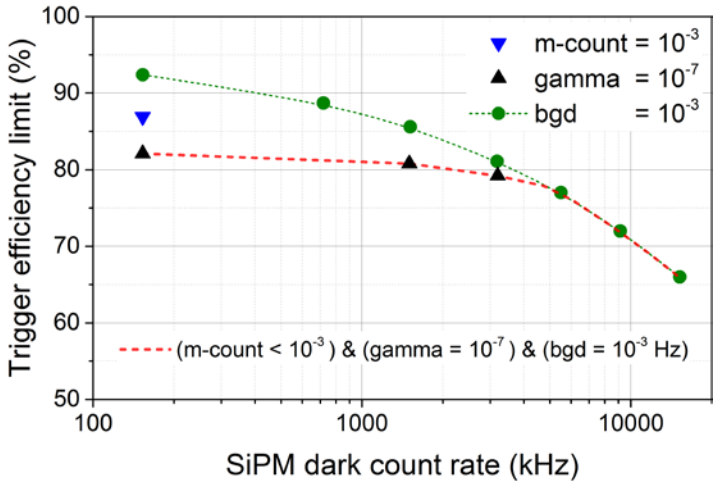


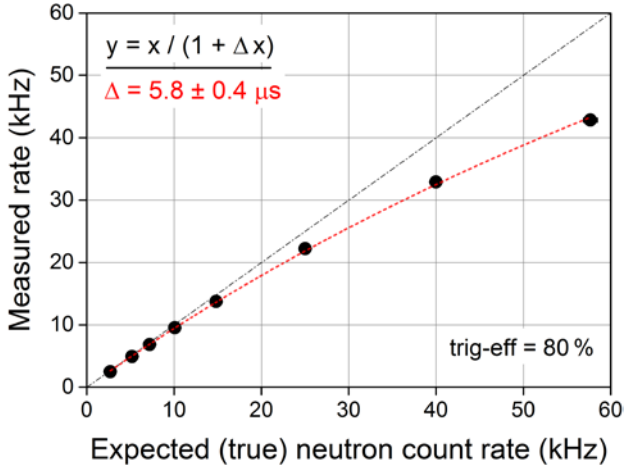


ZnS:^{6}LiF neutron detector readout with SiPMs

achieved detector performance

- 1D, gapless, individual pixel readout
- individual long pixels (2.5 mm, 200 mm)
- detection efficiency at 1 Å 60 %
  - absorption probability 75 %
  - trigger efficiency 80 %
- background count rate ≤ 10^{-3} Hz
- gamma-sensitivity (^{60}Co) ≤ 10^{-7}
- multi-count ratio ≤ 10^{-3}
- dead time ≈ 6 µs
- max. neutron count rate ≈ 50 kHz





further developments

- 2D, gapless, individual pixel readout
  size of individual pixel down to ≈ (2.5 × 2.5) mm^2

→ to do: design, construction, tools in view of large-scale production

- 2D, gapless, individual long pixels with two-side readout
  2nd coordinate via pulse-amplitude analysis, size of individual pixel ≈ (2.5 × 20) mm^2

→ to do: confirm feasibility of pulse-amplitude analysis, design, construction, tools