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Detection of thermal neutrons using ZnS(Ag):6LiF neutron scintillator readout with WLS fibres and SiPMs

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We present the development of a multi-channel thermal neutron detection system for the application in neutron scattering experiments. The detection system is based on ZnS(Ag):6LiF scintillation screens which are readout with wavelength shifting (WLS) fibres and Silicon Photomultipliers (SiPMs). The use of SiPMs in scintillator-based neutron detectors promises several advantages such as a compact size of the detector and its insensitivity to magnetic fields.
The long emission time of the ZnS scintillator and the deficient light collection due to the poor transparency of the scintillator make it difficult to combine a high signal detection efficiency with a reasonable suppression of the SiPM dark counts. We solve this problem by optimizing the light collection from the scintillation screens [1] and by applying a dedicated signal processing algorithm to analyze the temporal distribution of the SiPM pulses [2].
We will present the design and construction of prototype detection units and will summarize the measurements demonstrating the achievement of the requirements typical for this kind of detection systems which were so far only reached with PMT- or Multianode-PMT-based systems and which are, in particular concerning the neutron absorption probability, comparable or even higher than for certain Helium-3 filled neutron detectors.

[1] J.-B.Mosset et al., Journal of Physics: Conference Series 528 (2014) 012041
[2] A.Stoykov et al., Journal of Instrumentation 9 (2014) P06015

Primary author: Dr HILDEBRANDT, Malte (Paul Scherrer Institut)

Co-authors: Dr STOYKOV, Alexey (Paul Scherrer Institut); Dr MOSSET, Jean-Baptiste (Paul Scherrer Institut); Dr SCHMLUPF, Niklaus (Paul Scherrer Institut); Mr GREUTER, Urs (Paul Scherrer Institut)

Presenter: Dr HILDEBRANDT, Malte (Paul Scherrer Institut)

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