2D neutron detector based on ZnS:^{6}LiF scintillator readout with WLS fibres and SiPMs

Leading beneficiary: PSI, Detector Group (LTP/NUM)

Partners: potentially: ISIS, Detector Laboratory

Estimated budget (in person months, other direct cost) and tentative distribution per partner

48 PM, other direct costs: 500 kEuro (only development) + 200kEuro hardware

Abstract of your innovative activity: *(please make sure that you mention the following points)*

1. State of the Art:

   In current applications neutron detectors based on ZnS:^{6}LiF scintillators are read-out by light guides or wavelength sifting (WLS) fibres and photomultiplier tubes (PMTs). In case of single anode PMTs dedicated channel coding schemes are applied in order to restrict the total number of PMTs and thereby the granularity of the coding scheme might limit the spatial resolution and the overall counting rate. Even in case of multi-anode PMTs the costs per channel are still an issue and might limit the number of channels. In any case PMTs are not suitable to be operated in magnetic fields.

   Currently PSI is developing a 1D neutron detector based on ZnS:^{6}LiF scintillators readout by WLS fibres and SiPMs for an upgrade of the strain-scanning diffractometer POLDI at SINQ/PSI.
   SiPMs are insensitive to magnetic field and used for the first time in such a detector system.

2. What is new? Why should it be done on a European consortium level (synergies)?

   The new approach is to use SiPM instead of conventional PMTs also for 2D neutron detectors as SiPMs are insensitive to magnetic fields and much smaller than PMTs. In addition, the price per SiPM is not a limiting factor anymore and in case of 2D detectors each "pixel" could be equipped with its own SiPM avoiding any coding schemes and leading to an improved rate capability and an improved spatial resolution.

   A potential partner in this development is ISIS as this lab has a long experience in using ZnS:^{6}LiF scintillators. On the other hand PSI has a long and well established experience using SiPM in different types of detectors and is currently developing a 1D neutron detector with ZnS:^{6}LiF, WLS fibres and SiPMs. Combining the knowledge of this two partners is essential in this project.

3. How could your activity be connected with other methods and techniques (outside the neutrons community)?

SiPMs are also used in detectors for μSR or particle physics experiments. The development e.g. of a signal processing system to suppress the intrinsic dark count rate of SiPMs might have impact also in these fields.

4. Is there any link with national initiatives/projects (e.g. national data initiatives, but also European roadmaps etc)?

   The development of this kind of 2D neutron detector will be of interest for many applications in neutron scattering, like strain scanning or powder and single diffractometers, especially as the low costs allows to cover an extended scattering angle, which is necessary to compensate the lower efficiency compared to Helium-3 detectors.

5. How is the user community involved in your activity? Benefit for the user (evt. for any specific science community?)

   ZnS:^{6}LiF scintillators readout by WLS fibres and SiPMs are a good candidate to act as a replacement of ^{3}He detectors in certain cases. In particular in applications with the need of large area detectors all users will benefit in spite of the ongoing ^{3}He crisis. SiPM’s are insensitive to magnetic fields (in contrast to photomultipliers), essential for many leading-edge experiments. This technology not only allows an easier maintenance (modular units can be combined due to the lack of a pressure vessel), but also standardized detector set-ups.