TITLE and type of activity (Networking, Joint Research development):

Next generation 2D-PSD ^{3}He-gas-detectors for neutron powder and single crystal diffractometers: Delivering hardware and integrated data reduction software

Leading beneficiary: ILL Grenoble (Detector Group)

Partners: FRM2, TU Munich (Detektor- & Elektroniklabor),
SINQ, PSI Villigen (Gas Detector Group/Laboratory for Neutron Scattering)

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

Abstract of your innovative activity:

New experiments at existing and new neutrons sources eager for big high-efficient area detectors with good resolution and low gamma sensitivity. Consequently, three leading European neutron sources (ILL, FRM2 and SINQ) agreed to jointly develop the next generation 2-dimensional position sensitive detector (2D-PSD). In each research centre, instruments have been identified to use this new detector along with its new data acquisition software: ExtremD@ILL, PUMA@FRM2 and DMC-2@SINQ. A minimum of three exactly identical 2D-PSD ^{3}He-gas detectors with a radius of ~750mm, a horizontal acceptance angle of ~160° (2θ) and an active height of ~300mm will be build. The 2D resolution will be <1.5mm horizontally and ~5mm vertically with a detection efficiency >95% for λ=2.5Å. The detector and data acquisition software will be suited for powder diffraction as well as single crystal diffraction. Additionally, the standardization of the detector and software allows for the development of standardized beam optics, for example polarization analysis in the form of radial collimator super-mirrors. The compact design optimizes the ^{3}He volume. The project is structured in a pre-phase to build a proto-type necessary to verify all specifications and allow for eventual optimisation. Subsequently, we will manufacture the first three units in the production phase. Other neutron research centres around the world are welcomed for input on the specifications, as this may lead to the production of further 2D-PSDs based on a standardized design meeting the specifications for numerous instruments.

The project includes the development and implementation of the whole work package including electronics with standard interfaces for data readout and control at the different research centres as well as software for data reduction: A ready-to-use detector system.

1. State of the Art

   ^{3}He-gas detectors remain unmatched in respect of efficiency, resolution and noise-free charge amplification. The D19 detector of ILL has proven its maturity during several years of operation. Making a compact gas detector based on this design with a high resolution and a low dead volume will compensate the only disadvantage: using expensive (but available) ^{3}He

detection gas. In order to address tomorrow's scientific questions the efficient use of neutrons has to be optimised with the move to cover and resolve a larger solid angle. To retrieve the information from the increased detector coverage the new data acquisition software will allow basic data output for standard data evaluation software as well as the possibility for future or specialized software to use the full information of the 2D data (off-Bragg scattering). The standardized design allows the implementation and test of specialized components, for instance for polarization analysis.

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

   We intend to improve the D19 design in three respects: Improving reliability and service interventions by simplifying the design, building modern electronics based on present components available and develop state of the art data acquisition software. Modular extensions once developed could be used by all fielding research centres. The collaboration of three European research centres, ILL, TU Munich and SINQ, will distribute the developing cost to more fabricated units as well as simplifying maintenance and updates. It is also expected that others institutions will order further units on a contractual basis. As the market is limited, only a European collaboration can form a critical mass.

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

   Using specialized companies to build big vacuum chambers for a common design is a key point, which could be done by a specialized SME or a spin-off company. Already in the first production phase, we will make efforts to collaborate with future partners interested in a licensed production.

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

   The first target of this project is to build three 2D-PSD detectors for XtremeD@ILL , PUMA@FRM2 and DMC-2@SINQ instruments already in operation or in a late design stage. The development of these high efficiency detectors will be of interest in the mid-time planning for powder instruments at ESS, even if ESS is presently developing Boron based detectors.

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

   ILL, FRM2 and SINQ and their respective user community will benefit directly, as these new 2D-PSD detectors will open new research fields such as in-situ measurements for "fast" processes as well as investigations on magnetic superstructures of single crystals and improve the performance of the instrument quantitatively by the extended spacial coverage as well as qualitatively by the 2D resolution. As the standardized detector will consist of modular sub-units, this allows implementing special instrument options to

tailor the instrument to specific science cases, with the possibility to exchange these options between the research centres. Furthermore, the standardization of key components - for example the acquisition software - will reduce the training time for users and maximize the science output.