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

Adapted Neutron optics for new science and new Boron based neutron detectors.

Networking and Joint Research Development Activities

Leading beneficiary: ICMA-CSIC

Partners: University of Zaragoza

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

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

1. State of the Art

We propose to participate at several levels; i) neutron optics adapted for new instruments developments for extreme conditions research, ii) new ideas for Boron based neutron detectors, iii) organization of thematic neutron schools.

i) Neutron optics adapted for new instruments developments for extreme conditions research

Neutron diffraction has unique capabilities for scientific research under extreme conditions, mainly in two large areas: crystallography/geosciences and magnetism/solid-state physics. The growing interest in these fields is attested by the quantity and quality of publications, by the number of experiments proposed at the different neutron sources and by the new instrumentation projects under development all around the world. The Spanish scientific community and the ILL are currently involved in the construction of a CRG "eXtreme conditions Diffractometer (XtremeD)" for both single crystals and powders, operating at high pressures (up to 50 GPa) and high magnetic fields (up to 17 Tesla). However a lot of developments need to be done in order to be able to focus the neutron beam in the small volumes necessary to reach high pressure of high magnetic fields.

ii) New materials for 10-Boron based neutron detectors.

It is highly necessary the design of new neutron detectors based in alternatif technologies to the 3He and with similar or comparable specfications (i.e. uniform eficiency around 80%@4.5A in all the active detection area and good discrimination of signal to noise coming from fast neutrons or gammas).

The main problem to overpass this is the scarcity of stable “neutron conversors”, with high isotopic aboundance or easy enrichment. For the moment 157Gd, 3He, 10B and 6Li are the more suitable candidates for this from which 157Gd cis excluded due to the unfavourable separation. Therefore new generation detectors should be based on 10B or 6Li.

Regarding the solid 10B detectors they are mainly based in deposition of multilayers of $10B_4C$ in Al. However new research must be done in order to find new materials the could be the alternatif to the tipical $10B_4C$.

iii) Organization of thematic neutron schools.

Since the last NMI3 project the ICMA team is participating in the organization of neutron scattering schools on specific topics. (Molecular, magnetism, biotechnology and biosciences, magnetic structures, extreme conditions, etc.…). This activity should continue.

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

Neutron optics adapted for new instruments developments for extreme conditions research and new ideas for Boron based neutron detectors are two topics that need to be tackle in a european context because all the existing and new creation neutron sources will need these new technologies.

The planned new developments on neutron optics and neutron detection would be to

- foresight studies for common new high performance instrumentation, methods, concepts and/or technologies , including the testing of components, subsystems, materials, techniques and dedicated software

- development of final prototype for key enabling technologies and implementation plans for transfer of knowledge from prototypes to new facilities

Science under extreme conditions generally implies a (very) high pressure applied to the sample, possibly combined with other extreme parameters such as high or low temperatures, high magnetic fields, extreme chemical environments, among others. The interest on scientific problems related to the behaviour of matter under such extreme conditions has experienced an important increase over the last few years, and the scientists dedicated to such studies constitute one of the most active communities nowadays [1]. Neutron diffraction has unique capabilities for this kind of research and the interest for this technique is attested by the number of experiments proposed at the different neutron sources, by the new instrumentation projects under development all around the world and by the quantity and quality of the publications issued from this field. It is essentially to continue to develop this at a European level to provide a shared resource that is competitive globally.

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

High Pressure and high magnetic field communities, materials science communities, nuclear physic community.

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

This initiative is related to the Spanish national project: *Spanish Initiatives on Neutron Scattering (SpINS-ILL)*, the aim of which is to encourage and promote the use of neutron techniques in the scientific community.

Just within Spain there are over 200 Scientists who are working with high pressure develpements and they are in contact with us.

We are participating at national level in a project to develop new materials as alternative to the 10B4C for neutron detectors.

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

Progress in condensed matter physics, solid-state chemistry and geosciences depends on the understanding of fundamental properties of materials under extreme conditions. Areas of new science that could be done with new neutron optics adapted for instruments developments for extreme conditions research. In the article “XtremeD: a new diffractometer for high pressure and magnetics fields at ILL” a short revision is done. Furthermore, in the study of compounds relevant to molecular biology the use of moderate pressures is achieving great interest.

The combination of high pressures and magnetic field opens new avenues in the study of condensed matter properties and neutron diffraction must play a central role in these studies.

References

[1] “Extreme Conditions” ESRF news 51 (2009)..
[2] XtremeD - a new neutron diffractometer for high pressures and magnetic fields at ILL developed by Spain Alberto Rodriguez-Velamazan, J.; Campo, Javier; Rodriguez-Carvajal, Juan; et al.
Edited by: Gorria, P; Blanco, JA
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Book Series: Journal of Physics Conference Series Volume: 325 Article Number: 012010 Published: 2011

[3] The challenging optics of XtremeD - a neutron diffractometer for high pressures and magnetic fields at ILL developed by Spain
By: Alberto Rodriguez-Velamazan, J.; Noguera, Pedro
Edited by: Gorria, P; Blanco, JA
5TH MEETING OF THE SPANISH NEUTRON SCATTERING ASSOCIATION Book Series: Journal of Physics Conference Series Volume: 325 Article Number: 012022 Published: 2011

[4] Recent Advances in Crystallography Crystallography Under Extreme Conditions: State of the Art and Perspectives, Legrand Vincent http://dx.doi.org/10.5772/48608