

Muon Joint Research Activity and Access Funding to stimulate high field measurements

Leading beneficiary: EU Researchers

Partners: PSI and ISIS, with a number of University groups (to be confirmed)

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

PDRAs requested at both PSI and ISIS (each 36 person months) and a PDRA (24 person months) for a University partner developing DFT simulation codes

Abstract of your innovative activity:

Funding for Access is proposed. It's suggested that funding is restricted to groups using the novel High Field muon facilities recently developed at both PSI and ISIS, with a focus of helping new users' exploit these unique spectrometers in their research.

A **Joint Research Activity for Muons** is proposed that aims to develop the following Task Areas:

- **The development of software methods for improved muon data analysis**

The purpose of this task will be to investigate the role of simulation techniques for providing unique information for muon data analysis. Work will focus particularly on the application of DFT methods both to estimate hyperfine couplings of muoniated radicals and to determine the muon site and charge state, an area now attracting research worldwide, and is likely to involve both software development and workshops. A number of University groups have expressed an interest of working in this area, and a broad collaboration supported by this JRA is envisaged. Applications of the DFT codes are being developed in many science areas, and links to communities, including neutron scattering and magnetic resonance, are envisaged. Methods developed during this task will be made available to users through analysis codes supported by the facilities, and the work is likely to contribute to the international Mantid project.

- **GPU and MIC technologies for muon data analysis and instrument simulations**

The arrival of the Geiger-mode avalanche photodiodes (APDs) allow much more compact μ SR spectrometers with unmatched time resolution, typically at the cost of a higher segmentation of the detector systems. Together this results in much larger data sets, which in turn leads to very time consuming fits. On current workstations such fits can easily need hours for some instruments or for global fits. Similar problems arise for instrument simulations based on Geant, and therefore do not allow very systematic instrument simulations within a reasonable time, which often would be beneficial for the improvement of the instruments. Recent progress in GPU

technologies brought “high performance computing” to the workstation at an affordable price. Very recently Intel introduced MIC (Many Integrated Core Architecture) which will directly compete with GPU’s with some very promising features compared to them. The goal of this task will be to make these new technologies available for data analysis packages and investigate their implementation into instrument simulations. Expected speedups range between a factor of 10 to 100 at much lower costs than cluster computing can offer. In these developments we will directly profit from synergies with the accelerator division at PSI where these technologies are also considered for the study of beam dynamics.

- **An evaluation of new source technologies for future high intensity muon sources**

Novel muon techniques currently being developed and used by the community, such as low energy μ SR and the application of pulsed stimuli, would benefit greatly from an enhanced muon flux. The aim of this task is to consider how future high intensity sources might be realised. In particular, a recent idea of extracting muons from existing spallation targets will be explored, with simulations being used to evaluate the polarisation and utility of beams produced using this method. A wider view will also be taken, examining target and accelerator technologies, and considering how a future high intensity muon source might be realised within the current ESFRI roadmap.

- **The study of emerging detector technologies and their suitability for μ SR experiments**

Novel detector technologies based on Geiger-mode avalanche photodiodes (APDs) were developed during Framework Programme 7, proving crucial for the constructing a compact field-insensitive fast timing array required for the PSI high field instrument. The capability of commercial APDs has, however, advanced rapidly in recent years, with new devices promising a significant performance improvement particularly for fast timing applications. Furthermore, alternative technologies, such as the Micro Channel Plate (MCP), are becoming available that merit evaluation and comparison with APDs. The aim of this task is to evaluate emerging detector technologies to ensure future muon instrument arrays continue to be state of the art. Because of the contrasting requirements of the PSI and ISIS sources, collaborative work between the facilities is essential to this project if a proper overview is to be obtained. Collaboration with neutron detector groups at the facilities is anticipated, ensuring a broad contribution from results obtained from this work.

- **The development of e-Learning material for scientists new to the muon technique**

Both ISIS and PSI run regular muon and condensed matter schools that are designed to introduce young researchers to muon spectroscopic techniques. The aim of this task will be the development e-Learning material designed both to support the curriculum taught during these schools and, importantly, provide an on-line learning resource for muon spectroscopy that is

continuously available to the community. The material is likely to include lectures, supporting review articles and sample data for analysis. Codes to enable students to complete simulated muon experiments may also be developed, building on the Geant4-based simulations developed during Framework Programmes 6 and 7.

- **Promoting Joint Activities between PSI and ISIS muon sources**

The PSI and ISIS muon sources are complementary; the beam structure of the S μ S making it ideally suited to applications requiring fast timing, while ISIS allows low background time differential data to be captured at high data rates. Together, the sources offer European researchers access to the full range of μ SR spectroscopic methods, including state of the art low energy experiments and novel techniques requiring beam synchronous stimuli. To make users aware of the latest facility developments and make best use of available resources, joint PSI/ISIS User meetings are planned for this task. These are likely to have a topical science theme and may be arranged to coincide with neutron and X-ray user meetings to encourage synergy with these communities.