Muon-S: JRA working group meeting

Villigen, February 17, 2005

The third meeting of the Muon-S JRA was held at the Paul Scherrer Institut, Villigen, Switzerland on February 17th 2005:

Working Group Meeting WP1 (Detectors) and WP2 (Simulations)

Organiser: R. Scheuermann (PSI)

Agenda:

1. Status reports on the tasks within WP1 and WP2,
2. Discussion,
3. Other business.

Attending:

- S. Cottrell (ISIS)
- D. Herlach (PSI)
- T. Lancaster (Oxford)
- E. Morenzoni (PSI)
- R. Scheuermann (PSI)
- T. Shiroka (Parma)

In this meeting participated also A. Amato, C. Baines, R. Dölling, A. Drew, D. Eshchenko, H. Luetkens,

T. Paraiso, T. Prokscha, A. Suter, A. Stoykov, S. Vongtragool and U. Zimmermann (PSI).

1. Talks presented at this meeting:

- R. Scheuermann (PSI): Status Report High Magnetic Field Project at PSI

RS presented the status of the HMF project at PSI. A commercial predesign study for a cold split pair magnet from Cryogenic LTD allowed realistic simulations performed by TL within WP2. Several different detector types have been (or will be) tested with respect to their performance in high magnetic fields (Avalanche Microchannel Photodiodes, Multichannel PMTs, Hybrid Avalanche Photodetectors).

- S. Cottrell (ISIS): Status Report High Magnetic Field Project at ISIS

SC reported on the design criteria and challenges in building a High Field spectrometer at the ISIS facility. This new instrument will be designed to offer an order of magnitude improvement in both magnetic field and count rate, configured specifically for longitudinal field experiments. Building such an instrument presents a number of challenges, particularly in the design of a highly segmented detector array that is capable of working over a wide field range.

- T. Lancaster (Univ. Oxford): Simulating the μ+SR Experiment in High Magnetic Fields

TL summarized the problematic that μSR experiments encounter in large applied magnetic fields. The field will alter the trajectories of the incoming muons and outgoing positrons and, crucially for the experiment, will evolve the spin polarization of the muons. Simulations of these effects have been carried out using Tofu (a set of in-house developed FORTRAN programs) and GEANT4 (a C++ toolkit used to simulate particle interactions with matter). Simulations of the ALC spectrometer show that the fringing field at the end of the solenoid will cause a beam spot, from a muon-beam initially directed parallel to the principal field direction, to oscillate in size at the sample position, as a function of applied field. Simulations were also carried out using a field map based on a proposed magnet design from Cryogenic Ltd. Again, oscillations in the beam spot size were found as a function of applied field. Analysis of the polarization of the muon beam at the sample position showed that, for a transverse-field geometry, a beam of radius 3 cm would be completely depolarized over the sample position below 10 T. A beam of radius 0.5 cm would, however, remain polarized over the desired field range. Muon decay has been implemented in both program packages and tests show preliminary agreement. The next stage of this project will involve full instrument simulation of the GPS and ALC spectrometers.

- T. Paraiso (PSI): Instrument Simulation with GEANT4 & FEMLAB

TP presented the main features of Geant4 toolkit and the simulation of the Low Energy μSR experiment. The chosen simulated geometry was from the trigger detector to the multiple channel detector. The muon physics (polarized decay, spin rotation in magnetic field, etc.) is now implemented in the new 7.0 release of Geant4 and tests indicate a good agreement with theoretical predictions. The Femlab finite elements solver was used to generate the inhomogeneous electric fields of the third lens and the conical anode. Using these field maps in Geant4, it has been possible to show particle trajectories, focal lengths and beam deviation were in good agreement with theoretical predictions and experimental values. Finally, the sensitive detection class in Geant4 has been shown to be suitable for low energy muon applications (e.g. the MCP counter and scintillators).

- E. Morenzoni (PSI): Position Sensitive Detectors – Advantages for μSR Spectrometers

EM pointed out the advantages of position sensitive detectors for μSR spectrometers. The position information will allow to increase the usable muon intensity at PSI by one (time-integral method) or even two orders of magnitude (time-differential method) and also to reduce the backround in the spectra significantly. A new type of experiments studying transient effects would be possible if measurements could be performed on a minutes timescale. In addition, the use of very small samples (few 100 microns for bulk, some mm for LEM) will then be possible.

- T. Shiroka (Univ. Parma): Position Sensitive Detectors using Silicon Detectors - Design Goals and Constraints

TS reported about the use of silicon detectors as position-sensitive detectors in muon spectroscopy. The peculiarities of the specific application, like the limited energy of positrons and the need for fast timing, seem to rule out many of the existing detectors. The constraints posed by muon spectroscopy indicate thin silicon pixel detectors in tandem with fast scintillating fibers as the most promising solution.

2. Further actions:

1. Magnet: evaluation of warm bore design for split coil or solenoid (RS, SC).
2. Cryostat: evaluation of horizontally operating dilution refrigerator (RS, SC).
3. Simulations (TL):

   a) Implementation of momentum bite and beam divergence.

   b) Effects of stray fields.

   c) Calculation of asymmetry at given detector geometry.

   d) Instrument simulation ALC and GPS.

   e) Simulation of different detector geometries for ALC (field dependence of baseline).

   f) User interface (TL).

4. Position sensitive detectors (TS):

   a) Simulations of PSD (Geant4).

   b) Contact to commercial suppliers.

   c) Test of PSD prototype (Si microstrip + scintillator) at ISIS (TS).

3. Other business:

Next meeting: will take place in Oxford, exact date to be agreed, but well before the μSR 2005 conference.

The WP's coordinators should discuss a contribution on the achievements obtained so far at the next μSR Conference?