

Muon JRA (WP 17) and Muon Outreach (WP 2) Update

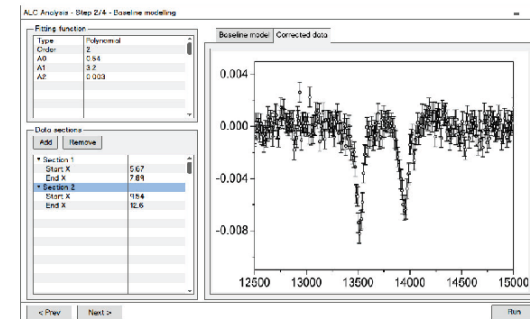
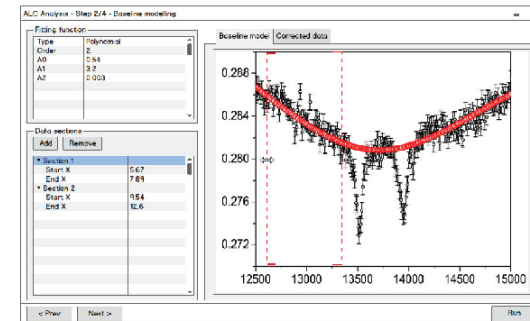
Muon JRA

Task 17.2: Software development for data analysis

Good progress made with this task ...

- Document specifying routines for efficient analysis of high field experiments complete (D17.1)
- Document discussing the potential for integrating simulation with analysis software complete (D17.3)
- Work to develop examples started – due M36 (D17.2) and M48 (D17.4)

Analysis of ALC data and integration of the Quantum simulation code being worked on



Task 17.3: Concept studies for future muon sources

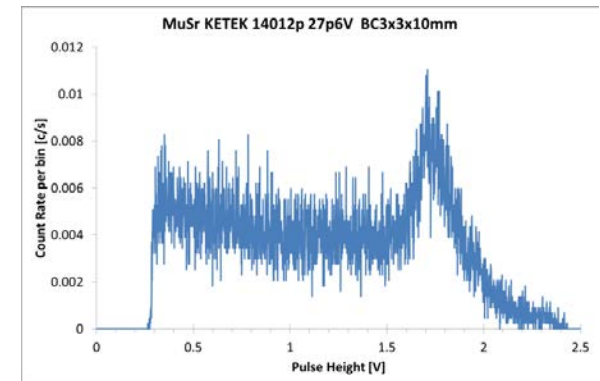
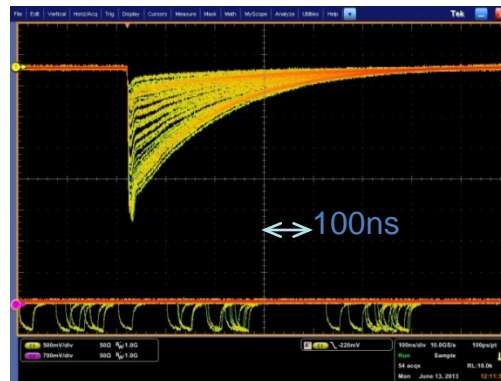
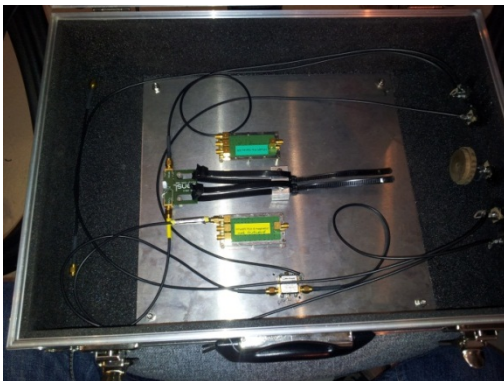
Falls into second half of JRA, but preliminary work started ...

- Elvezio Morenzoni (PSI) will lead an area of work looking at muon micro-beams
- Bob Cywinski (Huddersfield) and ISIS will focus on muon target technologies and consider options for future high intensity muon sources

Task 17.4: Detector technologies for Pulsed Muon Sources

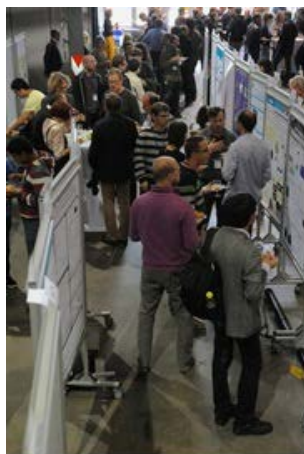
Good progress made with this task ...

- Design document for APD test system complete (D17.8)
System assembled and being used for on-beam evaluation
- Design document for prototype array (D17.8, part 2) anticipated M24
Evaluation of array (D17.9) after the ISIS long shutdown (M36 onwards)



Outreach: Developing the Muon User Community

- High field developments reported on the web (D2.13)
- Leaflets describing high field applications produced (D2.14)
- Workshop on Function Materials held at PSI (part of JUM@P '13) (D2.15)
- Workshop on Soft Matter and ISIS User Meeting planned for 2015 (D20.16)



Muon Level Crossing Resonance Spectroscopy
An application of a novel magnetic resonance technique

Muons provide a valuable probe of the atomic-level properties of materials. Unique information can be obtained using the technique of Level Crossing Resonance (LCR).

LCR can be used to:

- determine free radical structures by measurement of muon hyperfine coupling constants
- investigate the reactions, molecular dynamics and local environment of free radicals
- study spin dynamics in magnetic systems
- determine muon sites, for example in semiconductors

This leaflet provides examples of how the LCR technique can be used.

High Time Resolution Muon Spectroscopy
Exploiting a novel magnetic resonance technique

Muons provide a very sensitive probe of the atomic-level properties of materials. High field muon techniques are being developed by the European facilities, the high time resolution available at the μSR facilities unique opportunities to be investigated.

Examples of how high time resolution muon spectroscopy can be used for novel measurements include:

- tracking superconductive vortex states and length scales
- studying magnetic systems such as spin liquids and low dimensional magnetism
- Characterising hydrogen impurities in semiconductors
- Investigating quantum fluctuations in high spin molecules.

A quick introduction to the muon technique

Muon spin resonance spectroscopy is less well known than other spin spectroscopy techniques such as NMR and EPR, but it provides researchers with an important tool that can be used to study a wide range of problems in physics and chemistry.

The muon technique involves implanting spin polarised positive muons into a material. Muons are short-lived particles, decaying after an average lifetime of 2.2 μs to produce positrons. The decay direction which emerges from a sample after muon implantation can be detected, providing information about the muon's behaviour inside the material.

Particularly about how the muon polarisation changes under the sample. This, in turn, enables us to deduce information about the atomic-level properties of the material.

Muons are very sensitive probes of magnetic systems, often detecting effects that are too weak to be seen by other methods. They also have a wide variety of other applications – for example, in studies of superconductors, magnetic materials, molecular systems and chemical reactions, spent battery materials and a variety of organic systems. In some studies, the positive muon can be thought of as being like a light proton (muons have a mass of one ninth of the proton mass) and muons will sometimes pick up an electron to form a hydrogen called muonium (μH). By following muon behaviour inside a material one can learn about positron and hydrogen behaviour. This is important in understanding materials, atomic conductors and hydrogen storage materials and insulating materials.

References on the muon technique include:

- Muon spin rotation, relaxation and resonance spectroscopy in condensed matter. *Journal of Physics: Condensed Matter* 16 (1904), 1901-1912.
- Spin-polarised muons in condensed matter. *Journal of Physics: Condensed Matter* 16 (1904), 1913-1917.
- The Muon Spin Rotation in Solids. *Journal of Physics: Condensed Matter* 16 (1904), 1919-1921.

Developing muonsources.org ...

- Website up and running
- 'Snag list' to address
- Feedback from the μ SR community (Facilities)
- Role of the ISMS?
- Go Live!



The screenshot shows the homepage of muonsources.org. At the top right is a search bar. Below it is the site title 'Muonsources.org' with the tagline 'Your entry into the neutron world'. A navigation menu includes 'Home', 'News', 'Science with Muons', 'Muon centres', 'Resources', 'ISMS', and 'Calendar'. The main content area features a 'Welcome to Muonsources.org' section, a 'Get in touch' section, and a 'Mailing list' section. A large image of a group of people is displayed, with a 'Frontiers of muon spectroscopy' article snippet to its right. Below this are two news items: 'Frontiers of muon spectroscopy - symposium and user meeting' and 'Call for proposals for μ SR experiments at the SpS'. The PSI logo is visible at the bottom of the second news item.

Future activities ...

- Next JRA meeting is planned to coincide with the 13th International μ SR Conference (June 2014)
- Conference gives us the opportunity to publicise JRA work
- Outreach workshop on Soft Matter planned early 2015
- Continue to report JRA and Outreach activities and deliverables using the NMI3 website

