International Society for μSR Spectroscopy

Newsletter No. 13 – February 2015

Greetings from the President of ISMS

Welcome to the first eNewsletter of 2015.

Dear colleagues, it may seem to you that your ISMS executive committee has decayed, but we are still active ☺. We have just had a wrong delay and slight coincidence issues. Please accept my apologies and my delayed greetings.

The year 2014 was one of new facilities. There are plans for new facilities in China, Korea, the United States, and Japan. In 2015, we can look forward to several new initiatives that I have described for you here:

- Your new ISMS executive committee is developing plans to strengthen the already strong worldwide standing of our μSR and β-NMR community. We plan to help the directors of our different facilities attract more government support. Such support is badly needed for some of our infrastructures. The clearest example of this is TRIUMF, where two beam lines have been on halt for almost two years mainly due to a lack of funding for necessary repairs. Our plans begin with changes to the websites of our community to make them more synergistic and complementary, with useful information for our community and the outside world. Another plan is to investigate how to make μSR and β-NMR more attractive and useful to a wider range of graduate and undergraduate students. In addition, I plan to communicate with all facility directors to see what we can do as a society to help them. I will report back to you after these conversations.

- On a brighter note, there are two confirmed meetings for our community in 2015. The first meeting took place on the 12th and 13th of January at the University of Huddersfield, UK. The EU-sponsored "Future Muon Sources" meeting examined technologies for future muon sources and novel applications of muons. The second meeting will take place on the 3rd and 4th of September and will involve the discussion of "New Applications of μSR" This EU-sponsored workshop will look at muon studies of soft matter and spectroscopy of excited states and will take place at Queen Mary, University of London.

- During our beautiful μSR conference in Switzerland last year, I was impressed by the discussions our colleagues had about muon and Li ion effects on material. These lively discussions involved the sharing of dramatically different views and are signs that our scientific community is healthy and vibrant. Close to the end of the conference, I discussed an idea with Alan Drew regarding plans to organize a conference in 2015 on "the controversial aspects of μSR and beta-

NMR". We are now working with Stephen Cottrell on those plans and you will hear more from us soon. The main goals of the conference will be to 1) have extensive discussions on the controversial issues to gain more direction and come to some conclusions, 2) to invite experts from different but related fields to contribute to the discussions, and 3) to publish a series a conference papers in that regard. We also hope to hold the meeting in an exotic location! We may have to compromise on this final wish though and piggyback the symposium on the end of QMUL conference as some of us will be there anyways and that will make funding arrangements more reasonable. Having said that, I am open to suggestions in this regard.

Khashayar Ghandi

ISMS Executive Committee

President: ***Prof. Khashayar Ghandi, Mount Allison University, Canada***
President-elect: ***Dr Thomas Prokscha, PSI, Switzerland***
Vice-president, Americas: ***Prof. Kim Chow, University of Alberta, Canada***
Vice-president, Asia: ***Prof. Koichiro Shimomura, KEK, Japan***
Vice-president, Europe, Africa: ***Dr Martin Månsson, KTH Royal Institute of Technology, Sweden***
Treasurer: ***Dr Hubertus Luetkens, PSI, Switzerland***
Secretary: ***Dr Peter Baker, ISIS, UK***

If you have comments on any aspect of the ISMS, please contact a committee member.

The 2014 ISMS Yamazaki Prize for µSR Science

Dear Friends and Colleagues,

It is with great pleasure that I announce that the winner of the 2014 Yamazaki Prize for muon science is

Professor Roberto De Renzi

Roberto De Renzi is Professor of Physics at the University of Parma and is recognised for his sustained and exceptional contributions to the development of the µSR technique to investigate solid-state physics. Roberto began his µSR career at CERN and has been a long-time user of the muon facilities at ISIS and PSI, as well as performing many pioneering NMR experiments at his lab in Parma. His work has made effective bridges between NMR and muon techniques and he is particularly well known for his work in magnetism and superconductivity.

The $3000 prize is made available by the ISMS every three years to any scientist for outstanding, sustained work in µSR science with long-term impact on scientific and/or technical µSR applications. Previous winners of the Yamazaki prize are Y.J. Uemura (2005), E. Morenzoni (2008) and J.H. Brewer (2011).

Many congratulations to Roberto.

Stephen Blundell, ISMS President 2011-2014.

The International Society for µSR Spectroscopy

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µSR2014 Conference Prizes

µSR2014 Poster Prizes

The following young scientists were awarded poster prizes for their excellent poster presentations at the conference:

1. Ichihiro Yamauchi (KEK)
   P-143/ID-78 "Anomalous ^{63}Cu Knight shift in thiospinel $CuIr_2S_4$".
2. Jean-Christophe Orain (Laboratoire de Physique des Solides, Orsay)
   P-103/ID-87 "µSR Study of a Quantum Spin Liquid Candidate : the S=1/2 Vanadium Oxyfluoride Kagome Antiferromagnet".
3. Koji Yokoyama (Queen Mary University of London)
   P-61/ID-116 "Photo-excited µSR technique under high longitudinal B-fields".
4. Andreas Knecht (PSI)
   P-55/ID-70 "Feasibility study for a new high-intensity muon beam line (HiMB) at PSI".
5. Evelyn Stilp (University of Zurich/PSI)
   P-15/ID-103 "Modifications of the Meissner screening profile due to illumination with visible light of underdoped YBCO".

ISMS Young Scientist Awards

The ISMS Executive Committee decided to award awards to the following young scientists for their excellent oral presentations at the conference:

Pietro Bonfá (University of Parma)

Rik Mengyan (Texas Tech)

An exciting new web portal for the muon community

The Neutron and Muon I3 (http://nmi3.eu/), funded by the European Union under Framework Programme 7, has recently setup companion websites to act as portals for scientists using these techniques. The aim of these sites is to provide the respective communities with a central resource for the latest news about facilities and research worldwide, while also offering an introduction to the techniques to inform and encourage new users. The muon site is now fully available at http://www.muonsources.org/ with the neutron site at http://www.neutronsources.org/. We're still adding content, but to help us develop the site in a way that best serves the muon community we'd appreciate your feedback. Ideas as to how the community might support the website to keep content current would also be welcome. Comments can be sent to us at info@muonsources.org. *Jamie Peck and Steve Cottrell* (ISIS)

News from TRIUMF

TRIUMF is actively pursuing a plan to determine the required design parameters needed to address the M9-T2 vacuum/alignment problems which have prevented the use of the beamline over the last two years. This interim course of action, which requires the realignment of the M9 front end (FE) and addressing the deterioration of services in that high radiation environment, is meant to bridge a more comprehensive long-term plan that will address more general issues related to the aging and integrity of BL1A, the primary proton beam line. It is hoped that an implementation of such an intermediate-term solution for the M9-FE will result in an operational beam line by the middle of 2016.

The CMMS and the TRIUMF detector facility is developing a new and novel SiPM-based general purpose spectrometer for a large bore 3 T magnet that will ultimately be installed in M9A after the T2-M9 leak is rectified (as above). Beta-prototypes for the detectors are in progress and we anticipate testing the front end electronics configurations in the near future. With the experience developed in this project, a program to replace all our existing PMT based spectrometers with SiPM detectors will be commenced.

We are also working to upgrade the HiTime spectrometer, which has had a long and successful history. Thanks to the good offices of Jeff Sonier and his successful equipment grant, a new 7 T magnet from American Magnetics is in its final stages of assembly. Initial tests on the magnet indicate an order of magnitude improvement in the homogeneity and field alignment as compared to the old HiTime. The new magnet is expected in the Spring of 2015 and will initially be retrofitted with the current set of detectors. To that end we hope to have the upgraded HiTime available late in the Summer 2015 beam period (Schedule 128).

Counting rooms are our home away from home and we are happy to announce there will be new counting rooms for M9 and M20. They are significantly larger than the old counting rooms and are much closer to the experimental areas. The new counting rooms are located on the B2 level of the Meson Hall and will be ready to use in the Summer 2015 beam period.

Iain McKenzie and Syd Kreitzman

News from PSI

The workhorse is dead, long live the workhorse

On Monday 1st December, 2014, an era of almost 25 years came to an end, when the GPS µSR Instrument (General Purpose Surface-Muon Instrument), located on the piM3.2 beamline of the Swiss Muon Source at the Paul Scherrer Institute (Villigen, Switzerland), was dismantled and replaced by a brand new GPS.

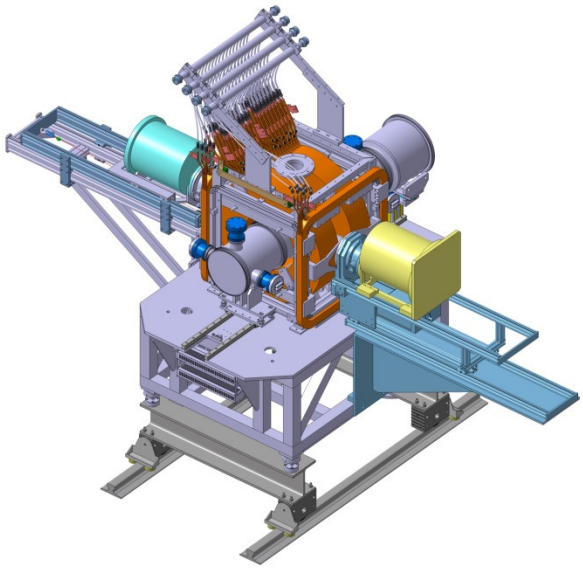

Figure 1: Schematic view of the new instrument

The old GPS instrument is very well known by different generations of µSR scientists. It was specifically designed at the beginning of the 90's by D. Herlach, U. Zimmermann and X. Donath to allow a heavy turnover coupled with a broad flexibility. During the years, its capabilities were systematically extended. A key date was for example 1996 with the introduction of novel backward and forward veto-detectors allowing one to measure extremely small samples without practically any background signal. Another major upgrade was the possibility to use the MORE ("Muons On REquest") setup to significantly extend the µSR time-window by preserving the advantage of the time-resolution typical of a "cw" muon beam. Finally in 2007, a so-called cryogenic second port was installed to allow an extremely rapid switch between different cryogenic sample environments. In addition, over the years the fast electronics was updated several times and much effort was put into the user friendliness of the control software.

Over the years more than 114'000 µSR runs were performed on the GPS instrument. Focusing only at the period 2000-2014, about 600 articles were published based on results obtained in the GPS instrument. From those about 90 papers were published in journals with an impact factor equal or higher than Physical Review Letters. But every nice story has an end, and the occurrence of a water leak in the main magnet has triggered the idea to replace the aging instrument.

The new GPS (Mark II for some of us) is retaining much of the technical solutions developed over the years for the old instrument. Hence, the geometry of the magnetic fields will be similar, though the main magnet will provide a higher field (i.e. about 8 kOe) once an adequate power supply will be installed (foreseen at the end of 2015). As before, two cryogenic ports are available for a fast turnover and the well-known Quantum flow-cryostat will be used. The main development is centered around the detectors which are now based on Avalanche Photo-Diodes (APDs). This is a by-product of the development performed in our group for the HAL-9500 High-Field instrument. In addition, the geometry of the detectors has been optimized and/or simplified by performing extended Geant4 simulations. In addition, an increased solid-angle will be covered by the detectors improving the

performance of the instrument for transverse-field experiments. This is also achieved by the use of a mobile detector, the position of which is dependent of the use of a particular cryogenic environment. The use of the APD-technology makes superfluous the long plexiglass light-guides resulting in a much more compact instrument and will hopefully lead to an increased time resolution.

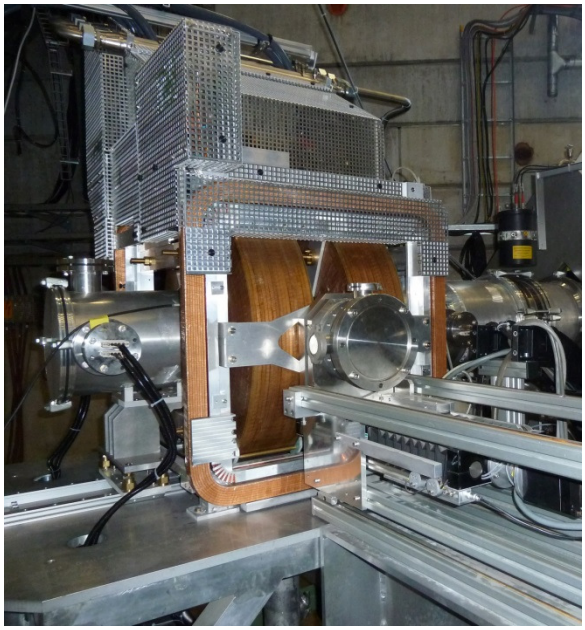

Figure 2: New GPS instrument ready for tests

The first tests performed in December 2014 were successful and a complete commissioning is expected in May 2015 and a normal users-operation with the new workhorse is expected about mid-June 2015.

A. Amato, H. Luetkens, M. Elender, A. Stoykov, D. Graf, U. Greuter, K. Sedlak and A. Raselli

musrfit in the bucket

musrfit - an open source data analysis framework for time differential μSR - has moved to bitbucket.org. This allows users from around the world simple access and the opportunity to feedback errors, or to suggest new features. The documentation link stays at PSI:
http://lmu.web.psi.ch/musrfit/user/MUSR/WebHome.html,
whereas the software repository and issue tracker can be found here: https://bitbucket.org/muonspin/musrfit

News from ISIS

Primary muon beamline upgrade

We are currently in the middle of a long shutdown and have had no muons since June 2014. The ISIS proton beam is due to be restarted in March 2015. You might think that we will have had a nice relaxing time, but far from it! Our time has been spent on a large project, namely the Primary Muon beamline upgrade. This replaces all the beamline quadrupole magnets – many over 40 years old - together with other components. This will keep the ISIS muon beamlines up and running for many more years.

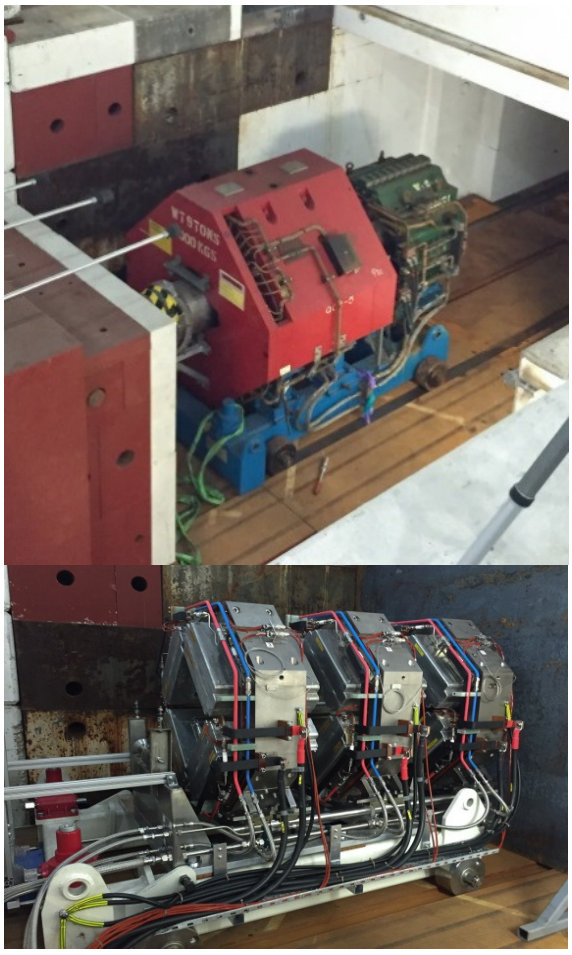

Figure 3: Old (top) and new (bottom) going out/in respectively.

We have redesigned the muon optic by replacing doublets with triplets and moving our first triplet closer to the muon target. When fully installed this new design should give an increase in flux of at least two. This initial installation, the first three quadrupoles, is complete with the installation of the rest scheduled for 2016.

Photo-excited µSR

In addition to the beamline upgrade Dr Alan Drew (Queen Mary University London) has funding to develop research into photo-excited MuSR at ISIS. This European Research Council funded project, named MuSES, involves installing a high-power laser system on HiFi. Understanding fundamental physics of photo-excited states using muons will be the priority. However, the project will also apply the technique to different organic materials to understand electron dynamics, including excitonic and biological processes. The laser system is now installed and the first experiments have taken place.

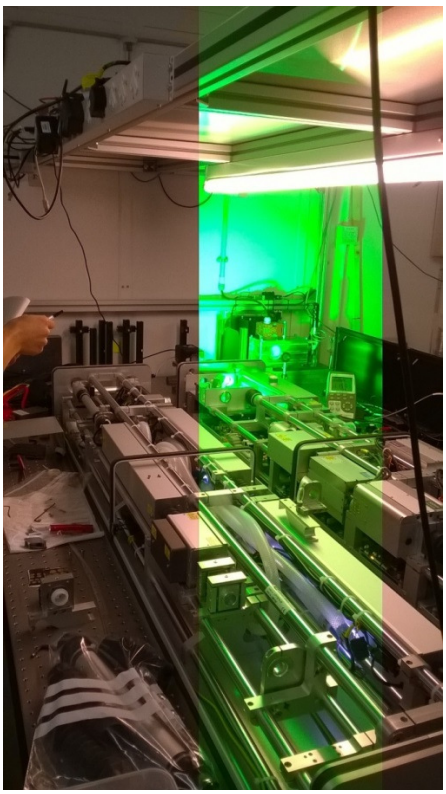

Figure 4: The new laser on HiFi in action.

MANTID for muons

The development of codes running under the Mantid framework for the analysis of muon data continues. An interface focused on time domain analysis is now included as part of the Mantid distribution and is available on all the instruments. Recent updates have included batch fitting of datasets, modules for Fourier/Maximum Entropy analysis and shortly simultaneous fitting of multiple groups and runs with shared parameters. Improvements have been made to the analysis of Radio Frequency and Avoided Level Crossing experiments in which a single interface guiding users through the process of reduction and analysis of these datasets.

Recent meetings

There have been two meetings recently, firstly a meeting at the British Radio Spectroscopy Group Christmas meeting held at the IOP in London. The subject was the complementary between NMR and μSR. It brought the latest results of the μSR science to a potential new community. In addition, we recently held an interesting meeting in Huddersfield, UK on Future Muon sources. This meeting was a bringing together of two communities in which new ideas for future muon sources were discussed.

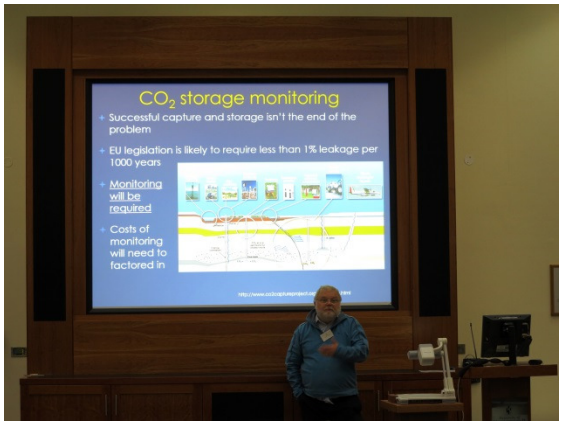

Figure 5: Jon Gluyas (Durham University) explains how muon tomography can be applied.

Forthcoming meetings

On 19th May 2015, a muon site calculation workshop will be held, adjacent to the general neutron and muon user meeting at the Hinkley Island Hotel in Leicestershire, UK. This will be the 5th in the series and provides an excellent opportunity to discuss new ideas and current thinking in determining the muon site. In addition, there will be a three day meeting on "New Applications of μSR: Studies of Soft Matter and Spectroscopy of Excited States" in London (3rd-4th Sept. 2015). For more information on these meetings, please keep an eye out for announcements.

Adrian Hillier

News from J-PARC

New rotating target for muon production

The current muon fixed target will break down in less than 1 year by 1-MW proton beam on the simulation. To extend the lifetime, the developments of the muon rotating target, in which the radiation damage is distributed to a wider area, had been started since 2008 in parallel with the proton beam operation. A horizontal shaft, which is a rotation axis of the rotating target, is parallel to the proton beam line. Because a motor device of the rotating target must be located 2.4 m above the beam line level due to high radiation, the rotating motion is transmitted into the horizontal shaft through a vertical long shaft and a pair of bevel gears. The rotating body is composed of a graphite wheel, a wheel support, and the horizontal shaft supported by two horizontal bearings. The two bearings are attached to a cooling jacket in which water piping is embedded. The rotation speed of the rotating target could be determined from the evaluation of the maximum temperature gradients inside the graphite. Consequently, it was determined to be 15 rounds per a minute.

When the rotating target method is applied, the lifetime of graphite will be more than 30 years. Then, the lifetime of bearing will have a dominant influence on the lifetime of the muon target. The bearings of the rotating target are located in high vacuum of 10-4 Pa, at high temperature of 390 Kelvins, and under high radiation dose of 100 MGy/year. Though disulfide molybdenum or silver is generally used in these conditions, the sintered compact of disulfide tungsten is used for our target.

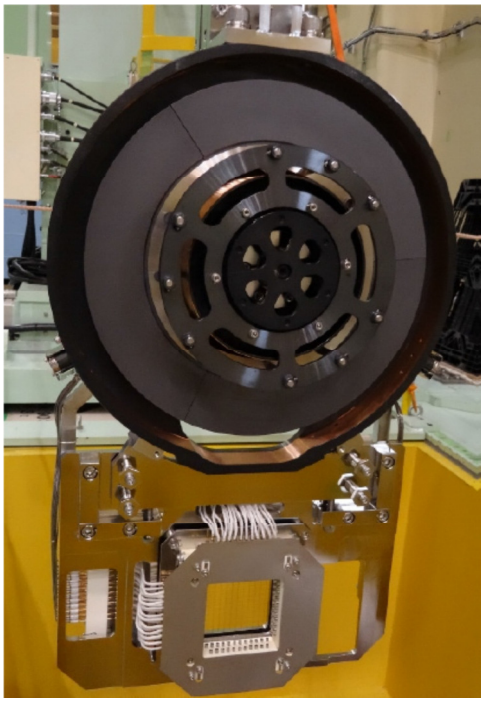

Figure 6: Picture of the muon rotating target and the multi-wired profile monitor. The monitor can measure the beam profile on the target position. They will be moved by up-down motion system.

Safety reviews by relative experts inside and outside J-PARC were conducted twice and the reviews validated installation of the muon rotating target. The muon rotating target was installed in September of 2014. Figure 6 shows a picture of the muon rotating target and the multi-wired profile monitor. Since the installation, the rotating target has been working properly.

New muon beam line dedicated for surface muon (S-line)

The construction of the surface muon beam line (S-Line) in the experimental hall No.1 of the Materials and Life science experimental Facility (MLF) building has been started. In the last year, the main beam line components to direct the muon beam toward the S1 experimental area, one of the planned four experimental areas, have been manufactured, as seen in Fig. 7. The basic design of the Q

triplet magnets (the magnet bore size of 300 mm in diameter; the magnetic pole length of 300 mm) is the same as that of Q triplet, which was installed in the D-Line in the experimental hall No. 2. In addition to this, the magnet support is detachable between the upper and lower parts, in order to make re-installation in the beam line after alignment easy. Refurbishment of the bending magnet SB2, which had been previously used in the D-Line as DB3. The septum magnet to provide the beam toward the S1 and S2 experimental areas was newly designed and fabricated.

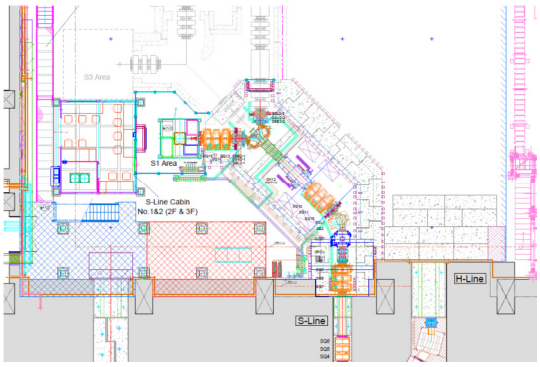

Figure 7: Beamline layout of the S-Line (phase1).

The DC separator (SSEP) was manufactured, being similarly designed to that installed in the D-Line (DSEP); the electrode is 300 mm in width, 500 mm in length, the gap length is 200 mm, and the maximum applied high-voltage is ±250 kV, respectively. However, the HV feed-through was entirely modified. In the case of DSEP, HV is supplied through a ceramic insulator. In spite of the designed value of ±250 kV, the operational voltage is limited about ±190 kV because of HV trips. On the other hand, in the case of the DC separator installed in the U-Line, the HV stack, which is designed to generate a HV of ±400 kV by using a Cockcroft-Walton HV circuit, is directly attached to the vacuum chamber. This avoids that the metallic part at HV is exposed under atmospheric environment, preventing from HV trips due to an environmental reason. Therefore, we decided to use the U-Line style HV power supply (PS) for SSEP. It is also noted that the connecting flange at the vacuum chamber is common with that of DSEP. If the PS of SSEP turns out to be operating successfully, possible upgrade of PS's for DSEP might be considered in the near future.

In the experimental hall No.1, the construction of the PS yard and the user cabins were completed, together with the plumbing works serving cooling water to the PS's. The PS yard consists of 3 floors. The upper deck is at 10 m above the floor level, which is the tallest structure constructed in the experimental hall No.1. The middle deck at the H-Line exit is connected to the mezzanine at the neutron experimental area. Nevertheless, the emergency stair between the upper and middle decks was installed. It is important to provide more than one evacuation route in case of emergency.

Shortly after constructing the PS yard, the concrete shields of the beam line were installed. The shielding door and the beam stopper of the S1 experimental area, as well as the beam blocker in the S-Line beam line, were also placed, which are both essential for MLF operation, even though the muon beam is still not available at the S-Line. On the other hand, the new μSR spectrometer, which will be installed in the S1 area, as well as the equipment for data acquisition including the network data storage.

The beam line components were installed during the shutdown period in FY2014. The beam commissioning will be started in the end of FY 2014.

Koichiro Shimomura

News from RIKEN/RAL

The RIKEN-RAL muon facility is based at the ISIS Neutron and Muon Source. It produced its first muons in 1994 and was officially inaugurated in 1995 – so this year marks 20 years of facility operations. A very Happy Birthday to the RIKEN-RAL Muon Facility!

The facility consists of four experimental ports which support a diverse range of science. Port 2 houses the Argus μSR spectrometer which has been used for many years for condensed matter and molecular science. Argus has now been joined by Chronus, located on Port 4 of the facility. Chronus is an advanced muon spectrometer which has over 600 detector elements to take full advantage of the high data rates available at a pulsed muon source. It offers longitudinal and transverse fields, and a flexible space for sample environment. Chronus has recently been commissioned and is now running experiments. Both Argus and Chronus will soon be using data acquisition systems based on the ISIS standard, so that ISIS users will have a similar experience on any muon instrument in the ISIS hall.

Muon catalysed fusion research on Port 1 of the RIKEN-RAL Muon Facility has been productive and successful, and yielded excellent new insights into the fusion process. The research has been ongoing since the creation of the facility, but will no longer be carried out at the facility and some of the equipment is about to be removed. This will make space for a new experiment, to measure the radius of the proton, which will be installed during 2015.

Port 3 of the RIKEN-RAL facility is dedicated to developing a laser-ionisation method for producing low energy muons for surface and interface studies, as well as fundamental measurements such as muon g-2. This year will see big changes to the apparatus, including installation of a room temperature muon production target, simplified transport line for the low energy muons and a higher power laser. We are looking forward to the enhanced low energy muon yield expected from these changes.

RIKEN-RAL has also seen new experiments performed this year. This includes using muons to study single event upsets in microelectronic devices, and using negative muons for elemental analysis. Both of these areas will continue to be developed during this year.

The RIKEN-RAL muon facility welcomes users from anywhere in the world. Applications for beamtime can be made through either the ISIS or the RIKEN-RAL calls for proposals.

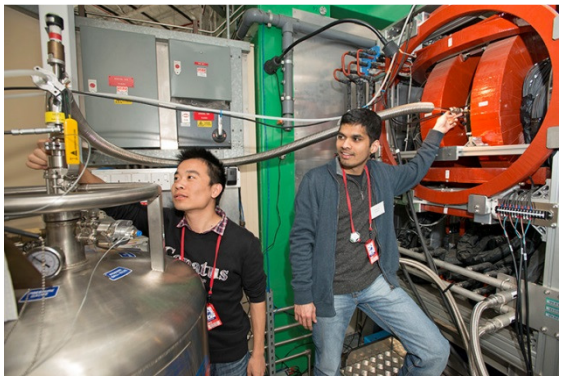

Figure 8: Students on the ISIS muon training course learning using Chronus at the RIKEN-RAL muon facility.

Philip King

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ISMS – Sverige is born

Sweden was once a country with very active users and developers within the field of μ^+SR. However, lately the regrowth of a new generation of Swedish muon rotators has not been going too well. In order to spread the knowledge and usefulness of μ^+SR as an experimental tool within a broad scientific area, a new online home for ISMS – Sverige has opened at: http://www.musr.se.

Martin Månsson

Comments on this newsletter?

The ISMS newsletter will be distributed periodically to inform the μSR community of ISMS activities, and to provide other information and news of interest to community members. We would welcome comments and thoughts on the content and distribution method – please email the ISMS Secretary, Peter Baker, at peter.baker@stfc.ac.uk if you have suggestions.