International Society for µSR Spectroscopy

Newsletter No. 14 – April 2016

Greetings from the President of ISMS

I would like to begin by thanking our research and instrument scientists and the technical staff at all facilities (JPARC, PSI RAL, and TRIUMF) who have helped our dynamic community excel in research. Based on their hard work and synergistic collaboration with other researchers in our field, we have seen, and will continue to see, the development and upgrading of all of our facilities. As you will read in the following sections, this includes significant developments at RAL, PSI and J-PARC, and, very likely, the refurbishment of M9 at TRIUMF via a grant application among several researchers at different Canadian universities and CMMS scientists. At J-PARC the Ultra Slow Muon Microscope project was launched in 2011 as a whole-community enterprise. At that time no one imagined the scale of the twists and turns the team at J-PARC would experience before reaching the first goal of ultra-slow muon (USM) beam production. In addition to the difficulties that were already anticipated during planning, the project was delayed due to the protracted influence of the Great East Japan earthquake and a series of unscheduled long-term disruptions caused by incidents in the Hadron Hall and in MLF that occurred one after another. An e-mail on February 21, 2016, from the experimenters at U1A cabin, reporting a time-of-flight peak that signalled generation of USM, prompted all the more delight among collaborators who had long awaited the news. However, collaborators were also warned that there remained much to be done before the delivery of the real first beam to the U1A experimental area. Although efforts to optimize the USM beam will continue, in parallel with user programs at D-line and surface muon beam development at S-line, this is a great achievement for our Japanese colleagues and for our community.

In addition to our four existing facilities, there is good news from the China CSNS muon source. There is some progress in the so-called EMuS (Experimental Muon Source) at CSNS. Our colleagues in China obtained a very important fund (NSFC Special Fund for Research on National Major Research Instruments) to study key technologies for an intense muon source at CSNS. With this fund, they can carry out the design of EMuS and some prototypes such as a target assembly and a µSR spectrometer in the next few years, before they obtain the construction budget. Our Chinese colleagues intend to design EMuS to serve both µSR applications and neutrino programs. To obtain very intense muon flux, a long carbon target will be placed in a high-field superconducting solenoid. A study team has been formed from different institutions in China.

Our Chinese colleagues will absolutely need support from the community for the design and future construction of their muon source. They have sent two young PhD students from USTC to attend the Muon Training School at ISIS. I am sure that our existing facilities personnel are happy to collaborate with our colleagues in China.

All these developments are the results of 1) the drive for innovation of the researchers in our community, 2) our needs as a community, 3) the aging of facilities (hence our needs for change), and 4) funding that comes or may come at any time due to changes in political parties in different countries or other socioeconomic factors that may result in a delta function of opportunities over a short period of time. If as a community we are ready to exploit these potentials, we can grow globally; otherwise, we may miss the boat.

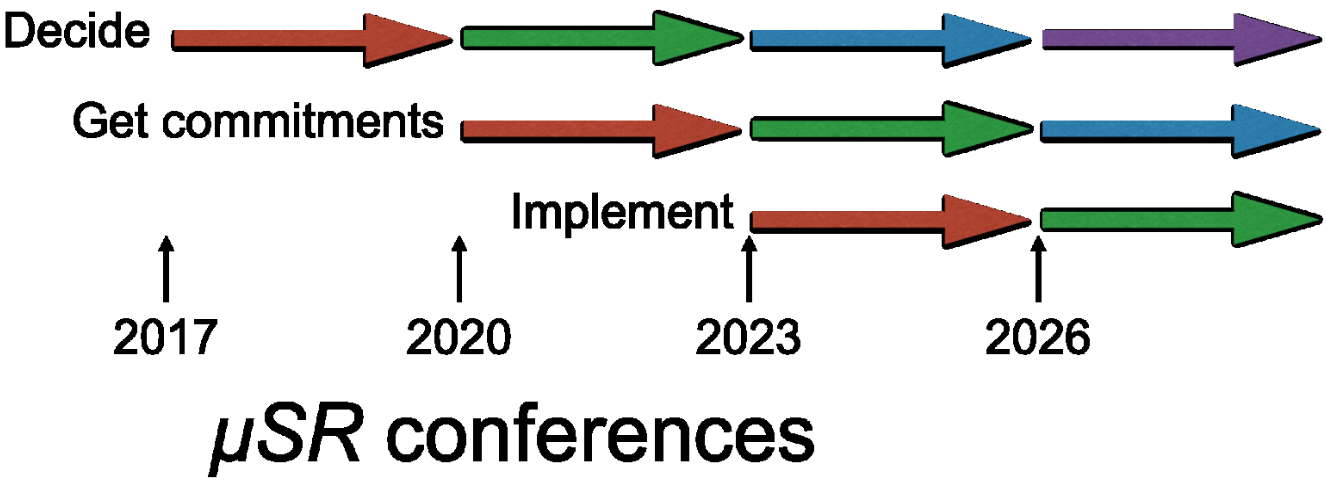

Figure 1: Major μSR Projects Cycle

To that end, I get to the initiative that I shared with you in my previous email message to the community. Despite the great knowledge base of our community and resourcefulness of our instrument/research scientists, we still need to plan to be the best scientific and sustainable community worldwide. As such, I suggested that we, as a global research-based community, develop a multiyear strategic plan for our community at the global level. Although my original idea was to plan together where we wanted to be in six years, after further discussions with the rest of the executive committee we decided that a nine-year cycle would be more reasonable. Figure 1 (credit to Jess Brewer) illustrates this idea.

I hope that with this initiative we can develop a global strategic plan that helps our community work together so that different facilities can contribute in a complementary manner and develop and deliver a number of new research support services. This could lead to Sustainable Planning for Advanced Research (SPAR) in μSR and beta NMR.

In this cycle of events at each μSR conference we will have a major milestone to meet. At the first conference, we make decisions about the next major initiatives and then we all work together to get commitments from funding agencies by the next μSR conference and to implement them by the following μSR conference.

Please email me if you are interested in joining this initiative (kghandi@triumf.ca). I would be happy to lead this and arrange some online meetings to discuss our plans. I propose that the plan includes the following sequence of steps:

1) Asking for feedback from the research community and instrument scientists of each facility on their requirements and research needs. You can provide feedback by emailing me or any of your VPs by the end of May 2016.
2) Attending cyber-infrastructure-focused meetings or emailing further suggestions to the VP of the continents with copies of email to kghandi@triumf.ca by the end of June 2016, after which the executive members will draft a document with the community's feedback.
3) Following up with a call for white papers that address the future needs of specific research disciplines and institutions after seeing the results of the initial ideas (with a deadline of end of July 2016). The executive members will discuss the wish list of the community based on the survey and white papers.

We share our progress every six months with the community in our ISMS newsletters. The ISMS newsletter also will be sent to the community every six months from now on, one in April of each year and one in October. This will lead to a document that we gradually develop for our community to review and comment. Such a dynamic document could have a strong influence on capital and operations planning for our community, regionally and globally.

We will have a meeting prior to the next μSR meeting to finalize the draft of the document and in a few meetings during the next μSR conference we will finalize the document and have that for our community as a road map for our next six years after that

When writing the white papers we need to consider that it is important that these white papers reflect a broad cross-section of input from our global research community. Different disciplines need diverse advanced research needs, which may include the following:

- planning for future spectrometers or beam lines, or new hardware on existing ones;
- planning for material characterization and preparation in our existing and forthcoming facilities;
- fundraising for facilities that need help with beam lines and instruments;
- helping launch user friendly file transfer capabilities among facilities;
- making visualization software for our results;
- broadening the frontiers of our research, such as in humanities, to which we have rarely contributed;
- expanding industrial use of our techniques.

Of course each facility needs to play a key role in spearheading many of these initiatives. When you create your white papers please address the following basic questions:

- What kinds of problems are you trying to solve?
- What kind of advanced research infrastructure could be best suited to solve these problems considering the advances in the technology?
- What quantities and types of infrastructure would be needed to meet the needs of your research community?

Please note that the intent of this initiative is for you to inform your executive of what you really need to do futuristic, world-class research in your field, not to find out what you think you can get in a status quo context.

In our last executive committee meeting we decided that at the next µSR conference we will give an award to the best white paper judged by the executive committee. The award will cover $400 towards the registration fee or accommodation for the next µSR conference. It will be named the SPAR award (please see above for definition of abbreviation). Of course, this award will not be limited to muon science. It will be awarded to the best white paper that relates to either muon science or beta-NMR or both.

Khashayar Ghandi

ISMS Executive Committee

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

The International Society for µSR Spectroscopy

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News from TRIUMF

There have been considerable developments at the TRIUMF Centre for Molecular and Materials Science (CMMS) and these will significantly benefit the user community.

The most important development is the removal of the user fee of $125 per 12-hour shift of beam time due to a contribution from TRIUMF management. This is a tremendous vote of confidence by TRIUMF in the μSR and β-NMR program and it removed a substantial barrier for people doing experiments at CMMS. The helium recovery system and liquefier have been running for approximately year and has been an outstanding success. It has reduced the costs of running μSR and β-NMR experiments and has given us a secure supply of clean liquid helium, something that wasn't true in the past and that had caused the cancellation of several experiments. There is still a charge of $1.75/L of liquid helium to cover the operating costs of the liquefier.

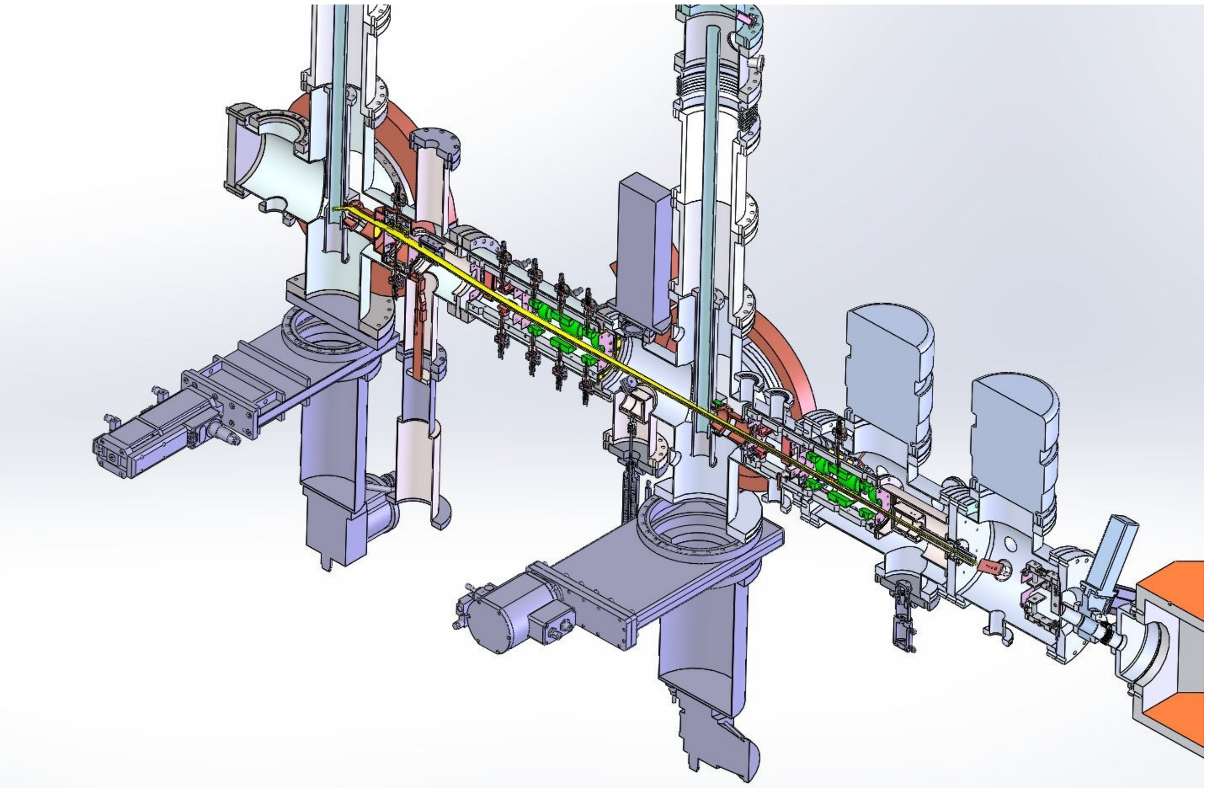
The HiTime spectrometer has been upgraded with the purchase of a new magnet from American Magnetics and we are now calling it NuTime. The "Nu" of NuTime isn't the Greek letter but is a Yiddish word equivalent to English words like "so?" or "well?," and can be used all by itself to mean "What's new?" The magnetic field homogeneity is greatly improved over HiTime with 1.3 ppm over a disc of ± 2.5 mm in the z-direction and ± 5 mm in the x- and y-directions. NuTime is currently fitted with PMTs but our plan is to refit the spectrometer with SiPM, which should greatly improve the time resolution. We are currently applying for funds to acquire a helium-3 cryostat for NuTime.

The β-NMR and β-NQR spectrometers continue to be very productive given the 5 weeks of beam per year. We are planning to increase this to 15 weeks for beam per year in 2019 with the completion of the first stage of the ARIEL project. The majority of the experiments were done using lithium-8 but we are developing new isotopes as probes. In December 2015 we successfully polarized magnesium-31, which has a spin of 1/2, and plan to use this with a spectrometer brought from ISOLDE at CERN by CMMS' newest member, Dr. Monika Stachura, to study biologically relevant materials in solution. Another β-NMR spectrometer is being developed for downstream of the existing β-NQR spectrometer. The new spectrometer will have a maximum magnetic field of 2.2 kG parallel to the surface and will be equipped with a helium-3 cryostat to allow measurements between 300 mK and 300 K. This will be used to measure magnetic field penetration profiles in Nb cavity materials that are relevant to advanced SRF research.

In May 2015 CMMS hosted the 4th Super-PIRE REIMEI Workshop on Frontiers of Condensed Matter Physics (http://phys.columbia.edu/fcmp/). This workshop consisted of 29 leading researchers in condensed matter physics giving lectures on state-of-the-art work and three days of training sessions on the CMMS beamlines. The workshop was organized by Tomo Uemura and was an outstanding success.

For the past 5 years the only muon beamlines available at CMMS were M15 and M20. The vacuum leaks at the front end of M9 have meant it had to be blanked off to protect the other beamlines and has deprived the user community of a unique resource. The vacuum leak was caused by motion of the beamline due to swelling of supporting blocks. In 2015 we measured the amount the beamline components have shifted and have developed a plan to correct for the misalignment, which should be well underway by 2017. This will allow us to begin experiments on M9A, which is a high intensity surface muon beamline that will have a permanently installed spectrometer with a 3 T magnet. M9A is being designed as a user-friendly beamline that will be optimized for sample characterization and high-throughput. We are currently preparing an application to the Canadian Foundation for Innovation to upgrade the high momentum M9B beamline, which will be renamed M9H. We plan to replace the existing 6 m-long decay solenoid with a persistent solenoid that should greatly improve reliability. We also plan to take advantage of the fact that M9H will be the only high momentum beamline with transverse polarization and we will develop a new spectrometer with a maximum field of 4 T and compatible with a dilution refrigerator that will allow studies of materials under pressure at much higher fields and lower temperatures than is currently possible.

Iain McKenzie and Syd Kreitzman



News from PSI

In 2015, the request for beam time at the PSI µSR facility SµS remained at a very high level with a total of 207 proposals. Parallel to the very intense user program several instruments have been upgraded with the aim to either improve their reliability and overall performance, or to extend the accessible parameter range for the µSR experiments.

The workhorse is back

The new GPS spectrometer has been successfully commissioned in December 2014 and May 2015 and completed its first successful year of user operation. By making use of muons and positrons detectors made of plastic scintillators and read out by Geiger-mode Avalanche Photodiodes (APD), the time resolution of the complete instrument could be improved to about 160 ps compared to 800 ps in the old GPS. Accordingly, frequencies of up to 1.8 GHz have been measured on a quartz crystal. In addition, the width of the prompt peak has been drastically reduced which now allows to obtain good data already about 1 ns after muon implantation. The new compact design with detectors left and right relative to the sample increased the solid angle for transverse field experiments by 50%. In addition higher magnetic fields of up to 0.8 T will be available for the experiments after installation of a new power supply early 2017. The user experiments in 2015 already profited from the enhanced overall performance of this new instrument.

Cooler DOLLY

For the second part of beamtime in 2015 at the DOLLY spectrometer, a new ^{3}He insert has been successfully put into operation. This user-friendly new sample environment equipment dramatically extends the accessible temperature range of the instrument, with a lowest temperature of 0.24 K. A special arrangement of beam windows and sample mounting has been developed for this ^{3}He insert to be able to use a veto detector system. This therefore conserves the very low background conditions of the instrument for small samples down to ~3x3 mm^2.

LEM running in pulsed mode

In the past, the accessible field range for longitudinal and transverse field µSR studies on the LEM spectrometer was restricted due to the formation of Penning traps for ions in the sample region where the electric field of the last focusing lens and the experimental magnetic field overlap. With the help of a new high voltage power supply and the development of an "on/off" measurement mode, the high voltage of the electrostatic lens can now be pulsed, effectively evacuating the Penning traps periodically. The pulsing rate is 100 Hz with a duty cycle of 90%, reducing the counting rate only by 10% during the high voltage "off" time. This allows applying magnetic fields up to the maximum value of 3400 G while maintaining a narrow beamspot. In addition, the new "on/off" mode has been successfully tested for LE-µSR experiments with external stimuli, including electric fields, radio frequency or light.

Up to 50 fold speed-up in µSR data fitting

With the improvements in detector technologies, it is now possible to achieve higher time resolution, often at the expense of higher detector segmentation. This leads to substantially larger data sets that need to be handled by the analysis software, causing a dramatic increase in the required minimization times for fitting. Traditionally, a reduction of the data size was obtained by transforming to a rotating reference frame (RRF). A major disadvantage of this transformation is a loss of precision. For example, at 9 T with a 10 ms time window, the estimated error on fit parameters increases by a factor of about 3. In addition artifacts such as ghost-lines and line-shape deformations are introduced into the data. Within the musrfit framework we worked out a brute force GPU solution which brings down the fitting times from ~30 min to 45 s for HAL-9500 spectra at 9 T, without introducing the above mentioned drawbacks of RFF transformations. Currently, only HAL-9500 TF-μSR data can be analyzed with GPU support (CUDA, openCL), but full GPU support for all data will be implemented into musrfit very soon, such that all applications of the software can benefit from the 30-50 times speed-up. This will be especially valuable for time consuming global fits, as well as for the elaborated analysis of some LE-μSR experiments.

T. Prokscha

STOP PRESS: ISIS Muon Spectroscopy Training School 2016

News from ISIS

Primary Beamline Upgrade:

A few years ago we started the project to upgrade the primary muon ISIS beamline. The beamlines have been almost untouched since their installation in the mid-1980's, with many components now showing signs of age. In the end, we will replace all the primary beamline quadrupole and bending magnets, plus a number of other components. Phase 1 has been installed, with the replacement of the first three quadrupoles closest to our target (see Fig. ISIS1). This has led to a typical increase in flux of 2 across all the instruments.

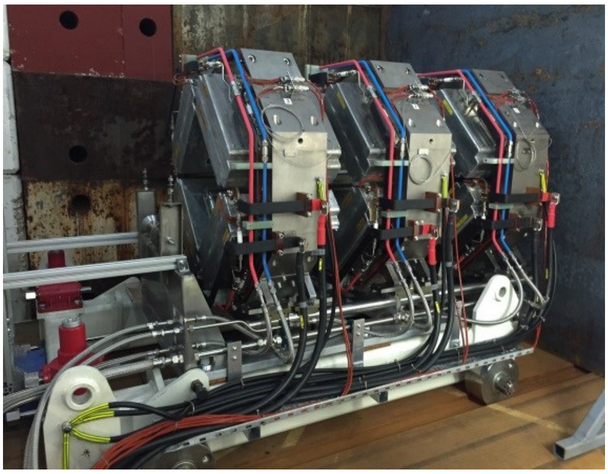


Fig ISIS1: The new quadrupoles (radiation hard) closest to our target shortly before installation. These magnets were made in house.

Phase 2, which will replace the rest of our magnets up to the point in which it splits into three, will be installed during May-Sept shutdown in 2016. The new beamline layout is shown in Figure ISIS2.

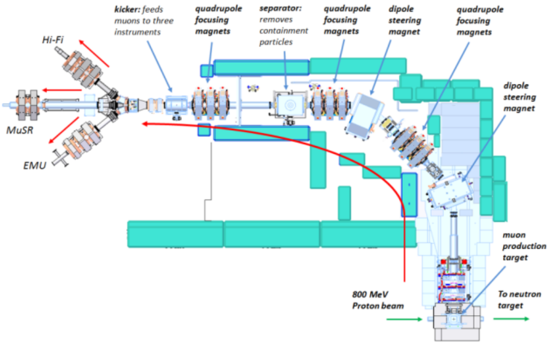


Fig ISIS2: The layout of the upgraded beamline after the full installation.

New magnet for MUSR

After the failure of the MuSR magnet a few years ago, we have been using a magnet given to ISIS by PSI, initially it was envisaged that this magnet would be setup for an offline RF coil test facility. The new magnet has just been successfully installed and commissioned. This should increase the field available on MuSR to 6kG, once the new power supply has been installed. In addition, after a summer student had conducted careful simulations, a new beam snout has been installed which improves the data coming from the MuSR instrument.

Sample environment

The liquid handling facilities currently available for users have been expanded and improved. This now includes a Perspex argon-filled glove box for handling liquids in an oxygen free environment and a metal liquid handling rig for degassing solvents, which has been recently refurbished. There is also an easy to clean, glass, liquid handling rig available for degassing solvents that may contaminate the metal rig.

On HiFi, we now have an oil cooled/heated sample stage which runs from -40 to +200C. Sample mounting is compatible with the CCR.

The upper picture is the argon box for handling liquids in an oxygen-free environment. The lower picture is the refurbished metal liquid handling rig.

It will be preferred over the CCR for experiments near room temperature, where frequent sample changes are required (no defrosting), and where external wiring or liquid pipework has to be connected to the sample cell.

Bigger and Better Support labs

The 'old' muon sample preparation lab has been replaced with a new and much larger lab which now includes a much more equipment and a separate wet chemistry lab.

Developing and Integrating Simulation and Analysis

The development of codes running under the Mantid framework for the analysis of muon data continues, with improvements in the ALC data reductions and the time differential interfaces, and now the QUANTUM program is available. The improvements in time differential analysis include batch fitting, simultaneous fitting of multiple groups and Maximum entropy analysis.

Staff News:

We are pleased to announce that we have recruited two new instrument scientists to the group. The first is a joint position with RIKEN (Adam Berlie from ANU) and the other is on MuSR (Pabitra Biswas from PSI).

Meetings

Last September, as part of the outreach JRA for NMI3 a meeting on **New Applications of µSR: Studies of Soft Matter and Spectroscopy of Excited States** was held.

Adrian Hillier

News from RIKEN/RAL

The RIKEN-RAL Muon Facility celebrated two significant milestones recently. 25 years ago, the first agreement between RIKEN and RAL for construction and operation of the facility was signed. 20 years ago, the facility was officially inaugurated by the then RIKEN President Prof Arima. To mark these events, celebrations were held at RAL last year and, recently, at RIKEN, attended by many Japanese and international scientists who have worked at the facility over the years. The Facility is notable not just for its contributions to muon science and technology in a wide variety of ways, but also for the significant collaborations it has enabled: between the UK and Japan, and between RIKEN and many Japanese universities and institutions, and more widely to universities in Malaysia, Indonesia and Korea. The current agreement between RIKEN and RAL governing the facility ends in 2018, and discussions are currently underway regarding the future operations of the facility after this time.

Current science activities at the RIKEN-RAL Muon Facility include full exploitation of the new Chronus high data rate muon spectrometer (alongside the Argus instrument which has been in place for many years); continued development of a low energy muon source; development of elemental analysis using negative muons; exploration of chip irradiation tests using muons; and plans for experiments focused on fundamental studies of the proton radius.

Philip King

Celebrating the RIKEN-RAL Muon Facility. Cutting the cake, from right to left: Katsu Ishida, Eiko Torikai, Ken Nagamine, Isao Watanabe, Robert McGreevy, Philip King.

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Post-doctoral researcher job opportunity at ISIS

The EU, under the Horizon 2020 programme, is funding a project (SINE2020) seeking to stimulate new science and innovation with neutrons and muons. A postdoctoral research assistant is required to work on this project, with a particular focus on developing novel sample environment for applying radio-frequency techniques to muonium chemistry. For further details see http://www.topcareer.jobs/Vacancy/irc221488_6341.aspx.

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.