International Society for μSR Spectroscopy

Newsletter No. 15 – December 2016

Greetings from the President of ISMS

First I would like to take this privileged moment to wish you all seasons' greetings and share a message of love for our community, hope, happiness and good health for 2017.

Also on behalf of our community I would like to take the opportunity of these festive moments to thank our instrument scientists in all facilities that with increased user base not only managed to run the facilities smoothly and efficiently and maintain them but also managed to help to improve the facilities significantly over the last year. You will see examples of those in this newsletter.

2016 was an eventful year for the world and that has affected and will affect our community.

On positive notes the publication of the ISIS impact study in 2016 showcased the social and economic impact of 30 years of ISIS facility operation. You will see the details of great activities in ISIS related to muon beams in the report by ISIS muon group. To fix M9 beam lines problems at TRIUMF, in 2016, a group of physicists and chemists across Canada have applied for an infrastructure funding that if successful, it would help them to start high momentum beam line with an improved spectrometer. As you will see in the news from JPARC, there has been significant progress for muon beam lines at JPARC in 2016. At PSI there has been significant progress in improving spectrometers.

There is also good news from incoming facility in China. With the EMuS R&D project supported by the National Natural Science Foundation (NSFC), a collaboration team from different Institute of High Energy Physics (IHEP) divisions and University of Science and Technology of China (USTC), as well a few volunteers from other institutions, has been working on the conceptual design of EMuS, and also prototyping of some key devices. In 2016, the physics design of the muon source and beamlines has been almost completed, and a paper will be published soon. Since 2009, Prof. Bangjiao Ye has been leading a

small team in USTC working on the studies from muon production, transport and moderation to μSR spectrometers. In 2016, his group focused on the design and hardware development of a μSR spectrometer prototype with 128 detector units. They are also developing a new type of spectrometer which is more suitable for low-repetition rate and high-flux EMuS. Groups of professor Bangjiao and Jingyu Tang had significant progress towards realization of EMuS. The technical designs for the muon target assembly with capture superconducting solenoids and μSR spectrometer have been completed. Our colleagues in China have been contacting some top-level Chinese scientists who showed interests in μSR applications, and their support is very important for the future construction of the EMuS.

In 2017, our colleagues in China will start the hardware development of the two prototypes, and continue to optimize the physics design. They also plan to organize a domestic workshop on μSR applications in China. We are looking forward to hearing about details of the progress on EMuS from professors Bangjiao and Jingyu Tang during our 2017 muon and beta NMR conference.

The 2017 muon and beta NMR conference website will be updated early January so I recommend you checking the website. The following notes regarding conference is provided by Jun Sugiyama:

1) The registration including Hotel reservation and abstract submission page will be open in the beginning of January, 2017.

2) The deadline of early registration and abstract will be the beginning of March, 2017.

3) The conference fee will be around 60,000 JPN, which does not include accommodation fee. Depending on our funding situation, the conference fee may be reduced.

I am looking forward to seeing you all in Sapporo in June 2017 and please don't forget to send us your nominations on Yamazaki prize.

Khashayar Ghandi

The Executive Committee of the International Society for μSR Spectroscopy

is pleased to announce the call for nominations for

The 2017 ISMS Yamazaki Prize for μSR Science

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. The 2017 prize will be awarded at a special ceremony session of the International Conference on μSR, to be held in Sapporo, Japan, in June 2017.

Nominations for the prize will be considered by the executive committee of the ISMS who may consult with experts outside the μSR community.

Nominations may be submitted by scientists as individuals or on behalf of a group. To establish a high standard it is necessary that the committee receive nominations that demonstrate a sustained, long-term impact on particular fields of science using μSR and/or on substantial development of innovative μSR-related techniques, technologies, or theories. Nominations should include a cover letter describing the motivation for the award, a brief curriculum vitae of the nominee, and a short list of major, relevant publications. At least two additional supporting letters of recommendation should be included. Nominations will be treated in confidence and will be acknowledged, but no further communication from the selection committee will be sent.

Nominations should be sent before 28 February 2017 to the Chair of the Selection Committee:
Prof. Khashayar Ghandi,
Mount Allison University,
Sackville,
New Brunswick,
Canada
Email: kghandi@mta.ca

Previous winners of the Yamazaki Prize: Roberto De Renzi (2014), Jess Brewer (2011), Elvezio Morenzoni (2008), and Yasutomo Uemura (2005).

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. Now the project has come to an end and we have replaced all the primary beamline quadrupole and bending magnets, plus a number of other components. Phase 1 was installed in Jan 2015, 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. Phase 2, replaced the rest of our magnets up to the point in which it splits into three, and was installed during May-Sept shutdown in 2016 (see Figure ISIS2). The new beamline layout is shown in Figure ISIS3. This has led to an increase in flux of another factor of 2, giving, in general, a factor of 4 increase from the original beamline and with no significant increase in the size of the beam spot.

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

Fig ISIS2: The installation team for the beamline upgrade, with the new beamline in the foreground.

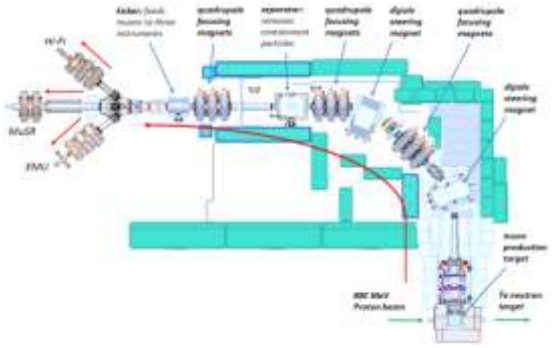


Fig ISIS3: The layout of the upgraded beamline after the full installation. The quadrupoles closest to the muon target have been replaced in the last long shutdown and the remaining quadrupoles, up to the kicker area, will be replaced in the May-September shutdown.

Cold Sample environment replacement

To improve reliability and flexibility of low temperature muon measurements, we're in the process of purchasing a number of 4He cryostats, together with dilution and 3He inserts. We anticipate a staged introduction of this new apparatus over the next three years.

Hot Oil Apparatus

HiFi now has an oil cooled/ heated sample stage which runs from -40 to +200C. The system may 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.

Muon spectroscopy e-learning

Muon spectroscopy and neutron scattering exercises and simulations of experiments are now available online for free at e-neutrons.org. The platform was developed with support from NMI3-II and features a bespoke introductory course in μ^+ spectroscopy. Further material from the muon training school will be added. If you have additional material you would like to see uploaded then please contact Peter Baker (peter.baker@stfc.ac.uk).

Muon Training School

In March 2016, we held our biennial muon spectroscopy training school. Thirty-three participants attended it with students coming from as far away as India and China. In five days, they attended 19 hours of lectures and three practical sessions on the muon beam lines. Thanks to all the students, group members and lecturers for making such a successful school.

Meetings:

We have just hosted a meeting about muon site calculation (28th Nov 2016) and will be hosting our user meeting on the 6th/7th Feb 2017. For more details please see our website (http://www.isis.stfc.ac.uk/groups/muons/muons3385.html).

And finally! The muon village

The 'muon village' is attracting visitors from all over the world following installation of a bridge to connect all muon instrument cabins directly with the instrument platform and construction of a dedicated muon user working area. Come visit!

Fig ISIS4: The new muon village

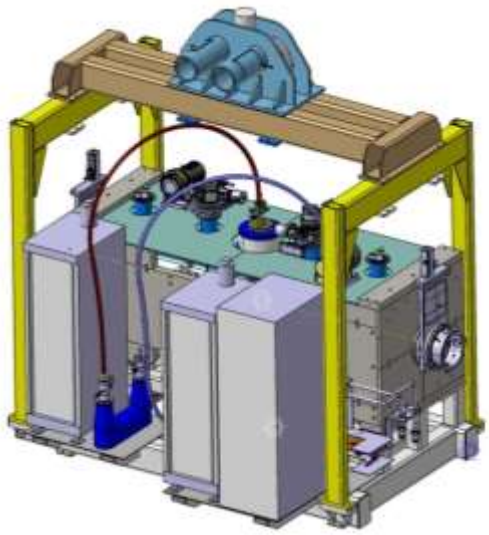
Adrian Hillier

News from PSI

In 2016 the request for beam time at the PSI µSR facility SµS reached a new summit with a total number of proposals up by more than 10% (230 proposals). This high demand puts not only an important responsibility on the SµS Scientific Committee to select the most promising proposals, but first of all a heavy load on the instrument scientists to ensure an optimum user support for external users. It is therefore rather remarkable that the same team keeps constantly improving the different instruments by adding capabilities to the existent instruments and by developing new projects to maintain the position of the SµS µSR facility. Below some of the projects are shortly presented.

New Spin-Rotator for the piM3 Area

Following the complete rebuild of the GPS instrument, a new milestone is being prepared to further improve the quality of the beam of the piM3 area serving both the GPS and the LTF instruments. Based on the experience acquired during the design and construction of the spin-rotators for the DOLLY and HAL-9500 instruments, a new spin-rotator is under construction 2017 at PSI. The commissioning is foreseen during the second part of 2017. The new spin-rotator, entirely designed at PSI and built in collaboration with several Swiss companies, will allow a rotation by about 75 degrees of the muon-spin which will lead to an increase of more than 25% of the asymmetry parameter for transverse-field experiments.



New Project for the Upgrade of the GPD Detectors

The GPD decay-channel instrument is equipped with highly reliable but bulky photomultipliers-based detectors. This leads to a rather tedious procedure when changing the detectors configuration made necessary when switching from a “vertical” cryostat to a “horizontal” one. In addition, the time resolution is rather limited and the detectors configuration limits the signal/background ratio when performing µSR measurements in pressure cells.

To improve this situation a project has been started to replace the photomultipliers-based detectors with ones based on APD-technology as already implemented at PSI for the HAL-9500, LEM and GPS instruments. Based on thorough simulations, using the in-house simulation-tool *musrSim* and *musrAna* (based on Geant4), a concept of a compact and versatile detectors system has been developed. Each detector will be read by several APDs on both ends enhancing therefore time resolution. The compactness of the detectors readout will permit a higher

granularity of some positron detectors resulting in an improved S/N ratio when performing μSR experiments under pressure. The goal is to commission the new detector system at the end of the production period in 2017.

Zero-Field for the High-Field Instrument…

The high-field instrument HAL-9500 is attracting an increasing number of users. Several experiments require not only high-field data but also zero-field measurements. In order to respond to this demand the capability for true zero-field experiments will be implemented. This new setup will be sitting outside the superconducting magnet and will basically consist of a complete new set of detectors and compact coils to cancel any remaining fields at the sample position. The design is underway and the commissioning will hopefully take place prior the production period in 2017.

LEM: towards a smaller beam spot

A long term goal in the development of the low-energy muons facility is the reduction of the beam spot size on the sample. A key tool for this goal is the reliable simulation of the beam transport in the LEM beam line. To improve the reliability of the simulation, which is based on *musrSim*, the field maps of the electrostatic accelerator and of the electrostatic deflection mirror have been calculated using the finite element program *Opera*. This is a non-trivial problem due to the fact that in both devices grids of very thin tungsten wires (100 μm and 50 μm diameter) have to be modelled in a large volume of the order of 100^3 mm^3, which pushes *Opera* and today's standard computers to the limits of their capability, and a proper simplification of the problem had to be developed in order to solve the electrostatic problem. Additionally, *musrSim* has been modified by adding a Landau energy loss distribution for muons passing through the 10 nm thin carbon foil of the LEM start detector. These changes, which were realized during a summer student internship, significantly improved the agreement between experimental and simulated beam spots.

Elvezio Morenzoni Retirement & New Laboratory Head

On October 13, a special international symposium was organized at PSI in honor of Elvezio Morenzoni who reached the retirement age at the end of October. Even though Elvezio will not anymore be actively involved in the management of the Laboratory for Muon-Spin Spectroscopy, he will continue to provide his valuable expertise to the Lab as his transition toward retirement will be "of the second order".

We would like here to take the opportunity to thank Elvezio for the outstanding work accomplished at PSI, first as the project leader of the world-wide unique Low Energy Muons instrument and also for the very efficient lead of the Lab for more than 8 years.

From November 1, 2016, Alex Amato will be the new Laboratory Head.

A. Amato

News from J-PARC

Status of muon microscope at J-PARC MUSE

We have successfully generated the Ultra Slow Muon beam for the first time at U line in J-PARC MUSE on Feb. 21, 2016, as is shown in Fig. 1. As many as 35 ultra-slow muons per second by laser resonant ionization of muonium evolved from hot tungsten (2000K) were experimentally detected by a MCP, which is higher than that developed by KEK and RAL (20 μ^+/s) at the RIKEN/RAL. In addition to highest intensity in the world, it is expected that with the improvement of quality of pulsed laser we can achieve ultra-slow muon beam with narrower energy width which will promise to improve depth resolution in the sample. Further enhancement of laser power (Lyman-α 1.7 μJ/pulse to 71 μJ/pulse and 355 nm laser ~100 mJ/pulse/cm^2 to 350 mJ/pulse/cm^2) and improving transmission efficiency of ultra-slow muon, it is expected to generate much more intense ultra-slow muon beam at experimental ports to innovate new techniques which will allow muon science to be expanded towards a variety of new nano-scientific fields.

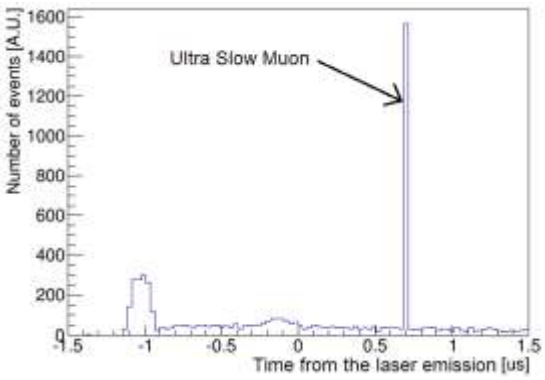


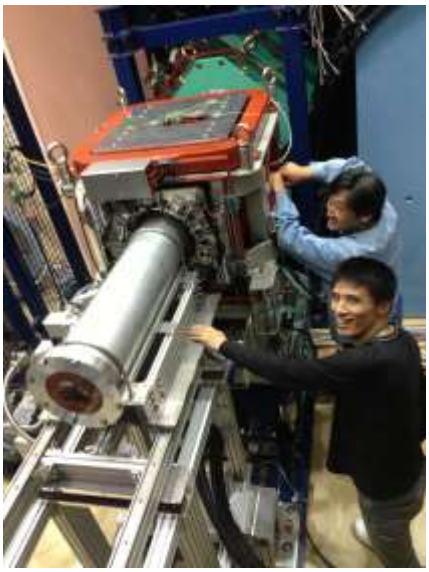
Fig. 1: Time distribution of the events measured by the MCP detector. Laser emitted at 0 ns.

Commissioning of the Surface Muon Beamline at J-PARC MUSE

The surface muon beamline (S-Line) in the experimental hall No.1 of the Materials and Life science experimental Facility (MLF) at J-PARC is designed to provide a low-energy muon beam which is mainly utilized for material and life science experiments. The main components in the beamline had been installed during the summer shutdown in 2014 as shown in Fig.2.

Fig. 2: Beamline layout of the S-Line (phase1).

Beamline commissioning was resumed after a long suspension period of summer shutdown, and a muon beam was successfully delivered to the S1 area at last on October 29, 2015. The tuning process of the muon beam accelerated by the installation of the automatic tuning program *ForTune*, which had been developed at U-line and generalized for the usage at any muon beamline described by the parameter files, and the installation of the new μSR spectrometer (Fig.3) on March 3rd, 2016. The count-rate by this spectrometer is 200M events/hour, which is the measurement with full-open slit setting and large enough specimen to stop the full beam.



K. Shimomura

Fig. 3: S1 spectrometer with the flypast chamber installed.

ISMS Executive Committee

President: ***Prof. Khashayar Ghandi, Mount Allison University, Canada***
President-elect: ***Dr Thomas Prokscha, PSI, Switzerland***
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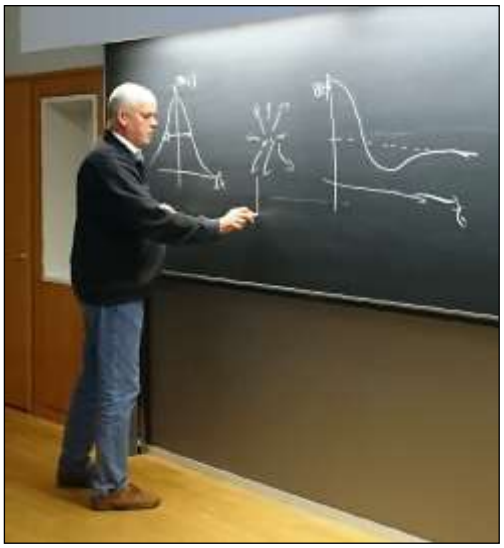
If you have comments on any aspect of the ISMS, please contact a committee member.

Sweden has traditionally been a very strong supporter and contributor to the μ+SR community. Scientists from both Uppsala University and KTH Royal Institute of Technology were highly involved in especially the early developments of the technique at CERN and later also at ISIS. At this moment previously unprecedented investments in large-scale research infrastructures are being made in Sweden. This includes both the recent inauguration of the new Max IV synchrotron facility as well as the parallel developments and construction of the European Spallation Source (ESS) in Lund. To fully take advantage of such investments the Swedish Government and funding agencies are currently allocating targeted funding to strengthen especially the use of neutron scattering techniques in Swedish universities and industry, but also to create links and synergies with the much stronger Swedish X-ray user community. Within this drive the Swedish Research Council (VR) has reinforced the contracts with existing neutron sources, including ISIS in UK and ILL in France. This will ensure beamtime access for Swedish users to primarily neutron experiments, but also in the case of ISIS, muons. Another large investment is made by the Swedish Foundation for Strategic Research (SSF) that currently investing 120 million SEK (and potentially another 100 MSEK) into a national graduate school in neutron scattering (www.SwedNess.se). Within this school up to 40 fully funded PhD students will be employed and educated in order to rebuild a new generation of Swedish neutron scatterers. The call for the first 10 PhD positions has recently opened now in December 2016.

Unfortunately there are no planned Swedish investments into the muon related research and the Swedish μ+SR community has slowly declined leaving zero remaining active Swedish muon users up until the end of 2014. On the initiative from me, the current ISMS Vice President (Europe), Martin Månsson, an action to revive the Swedish muon community has begun. Initially it started out as a local drive where close collaborators at KTH Royal Institute of Technology and Uppsala University got involved in μ+SR projects together with me and my collaborators at ISIS, PSI and TRIUMF. As a result there are now 4 active muon users in Sweden, which now are preparing to submit their own project applications. More recently, this muon action is aimed to be included also into a bigger picture of Swedish activity around science at large-scale facilities. The initial goal is to include μ+SR as a complimentary technique within the growing Swedish community in neutron scattering and synchrotron radiation techniques. As

the current Director of Studies for SwedNess, I will be in a good position to include the awareness, basic knowledge and advantages of μ^+SR into the neutron curriculum and consequently the future experimental toolbox of a new generation of Swedish researchers at both universities as well as in industry. As a first step in this direction I have managed to get the interest from the **Materials Research Platform** at KTH (http://www.kth.se/materials), which is the hub for all materials research performed at KTH in Stockholm. In an internal call for funding they agreed that muon-based techniques could be of high interest to materials researchers and that actions to support competence should be performed. Consequently, they allocated targeted funding of 150'000 SEK to organize a muon workshop at KTH in the autumn of 2016.



Professor Daniel Andreica from the Babes-Bolyai University in Cluj-Napoca, Romania explains the Kubo-Toyabe function.

The ***Swedish Muon Meeting*** was conducted over 2 days on 5-6 September, 2016 at the main campus of KTH Royal Institute of Technology, Stockholm, Sweden. I was myself the main organizer and chair of the meeting. During this gathering we had a series of topical lectures, which first gave an introduction to the μ^+SR technique and then showed its strengths/capabilities in a wide range of scientific areas. The focus was on materials related research, including materials science, solid state physics and chemistry, magnetism, surfaces and interfaces as well as organic materials. The speakers were all invited from a series of well renowned academic institutions as well industry and were all world-leading experts in their particular field. In detail the meeting was opened by an **Introductory Lecture to μ^+SR** by *Prof. Roberto De Renzi from University of Parma in Italy*, followed by a series of topical lectures including:

- **Muons for Magnetism & Superconductivity**
  Prof. Stephen Blundell, University of Oxford, UK
- **Low-energy μ^+SR:** Thin Films, Interfaces & Photo-induced Effects
  Dr. Thomas Prokscha, Paul Scherrer Institute, Switzerland
- **Muons for Energy Materials & Industry:** Batteries, Hydrogen Storage & Permanent Magnets
  Dr. Jun Sugiyama, Toyota Central Research & Development Labs., Inc., Japan
- **μ^+SR under extreme conditions:** High Pressures and Magnetic Fields
  Prof. Daniel Andreica, Babes-Bolyai University, Romania
- **Swedish μ^+SR Traditions:** A Historical Perspective
  Prof. Erik. B. Karlsson Uppsala University, Sweden
- **Complementarity of Muons & Neutrons:** Spin Glasses, Spin Liquids and Spin Ices
  Dr. Sarah Dunsiger, Ohio State University, USA
- **An overview of the photo-μ^+SR capabilities on the HiFI spectrometer**
  Dr. Alan Drew, Queen Mary University London, UK
- **Muons for Compositional Analysis**

Prof. Kenya Kubo, International Christian University, Japan

- **Muons for Photovoltaics & Semiconductors**
  As. Prof. Helena Vieira Alberto, University of Coimbra, Portugal

In addition to this *dream team,* Dr. Stephen Cottrell of ISIS muon facility was also invited to give a talk on "*Exploiting Radio Frequency Techniques with Muons*". Unfortunately he could not participate due to a velocipede misadventure. Even though I am informed that he is already back spinning muons in Oxfordshire, at the time of the meeting we all sent him our best wishes for a speedy and full recovery!

Some of the attending participants of the Swedish Muon Meeting
For a full list of participants visit the meeting webpage at: www.musr.se/KTH

Outcome of the Meeting

In total there were more than 40 participants joining the Swedish Muon Meeting. A majority of the participants came from a wide range of KTH institutions. However, we were very pleased to also welcome researchers that joined from other Swedish institutions including Uppsala University, Chalmers University of Technology, the Nordic Institute for Theoretical Physics (Nordita) and Gothenburg University. We were especially pleased to welcome some local muon heroes including *(left to right)* Lars-Olov Norlin (KTH), Ola Hartmann (Uppsala University), Suzy Lidström (Royal Swedish Academy of Sciences) and Erik Karlsson (Uppsala University). Unfortunately another member of this muon spinning team, *Roger Wäppling*, could not join our meeting but we all send him our warmest greetings.

During the lectures and seminars several potential collaborations and ideas for new research projects were initiated. On a direct short term perspective the meeting has resulted in the writing and submission of a couple of new μ^+SR beamtime proposals at both PSI and ISIS. Further, a couple of potential technical developments are currently being discussed and a few potential projects related to the β-NMR facility at TRIUMF are planned. Such initiative will most likely lead to another handful of beamtime proposals for the next calls. Finally, there was a spark of interest at especially KTH for using negative muons as a tool to perform compositional analysis. Here discussions are currently being conducted to possibly have another mini-workshop organized by, once again, the KTH Materials platform. In all cases mentioned, the projects involve Swedish teams that previously never used muon techniques in their research. My hope is that this initial boost will help to form new scientific projects directly linked to the unique capabilities of μ^+SR, but also give already established Swedish research projects a competitive edge by incorporating the technique(s) into their experimental toolbox.

Welcome back to Stockholm in the future !!!

Hope to see you all in Sapporo, June 2017…
… *Merry Christmas & Happy New Year !!!*

Asst. Prof. Martin Månsson
ISMS Vice President (Europe & Africa)

Further information and downloads

A longer report from the Swedish Muon Meeting is currently being prepared and will be published on the webpage of the KTH Materials Platform within a near future. For a full list of participants, program, book of abstract as well as to download the slides of all the talks + meeting photos, please visit the webpage of the Swedish Muon Meeting: www.musr.se/KTH

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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.