International Society for µSR Spectroscopy

Newsletter No. 19 – May 2021

Greetings from the President of ISMS

After so many months of uncertainty in our lives and our work there is now hope for a return to normality in the near future. Despite the effect the global pandemic has had on so many aspects of our lives, it continues to be inspiring to see the way that each of the muon facilites has adapted to allow experimental programmes to continue. The extra effort in running under Covid restrictions and especially in carrying out remote measurements is appreciated by all and will not be forgotten.

It has also been encouraging to see new developments both at the established facilities and in projects at different stages of fruition, such as progress at the EMuS facility and RCNP-MuSIC reported in this newsletter, and also the PSI HiMB and ORNL µSR proposals which were the subjects of recent online workshops that many of us attended.

I also look forward to the forthcoming meeting at TRIUMF in June and the rescheduled MuSR conference in Parma next year.

Finally, I would like to thank the committee members for their continued work for ISMS and Rick Mengyan who recently audited the society's accounts.

Best wishes and stay safe,

Tom Lancaster

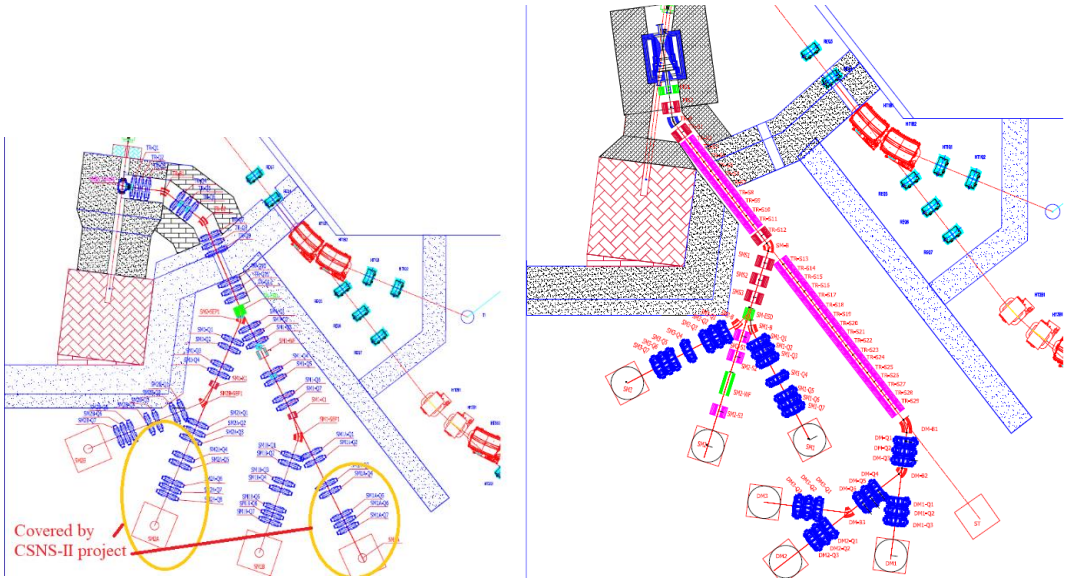
(tom.lancaster@durham.ac.uk)

The International Society for µSR Spectroscopy

c/o Peter Baker (Secretary), ISIS Facility, STFC Rutherford Appleton Laboratory, Harwell Campus, OX11 0QX, UK. Email: peter.baker@stfc.ac.uk Web: https://www.musr.org/

Progress report about the muon facility EMuS at CSNS

The application of the CSNS-II upgrading project is well in progress, which is expected to get formal approval from the National Development and Reform Commission (NDRC) in 2022. The science goals and the technical designs of EMuS were reviewed within CSNS and, the Phase-I scheme (also called as the Simplified Scheme) was confirmed to be included in the construction of CSNS-II. The Baseline Scheme of EMuS now is considered as the future upgrading. With the EMuS Phase-I, a conventional muon source with a pulsed proton beam of 25 kW, a thick graphite target, side collection, muon beamlines with room-temperature magnets, and four muon end stations to provide surface muons and negative cloud muons will be built. The science and applications will be focused on μSR techniques and muonic X-ray analysis. The Baseline Scheme aims for a more powerful muon source with superconducting capture solenoids and muon beamlines based on both superconducting solenoids and room-temperature magnets, and wider applications with more end stations. The two schemes are depicted below.



EMuS design schemes: Phase-I (left) and Baseline (right)

The design and R&D efforts on some key technologies for EMuS, which have been supported by the National Natural Science Foundation of China, have proceeded well. The Technical Design Report (TDR) for EMuS is in the revision stage, and will be accomplished in a few months. A prototype of μSR spectrometer with 128 detector units and a target assembly prototype have been accomplished and passed the acceptance inspection. The prototype of the capture superconducting solenoid that is technically very challenging is expected to be completed in May 2021.

Jingyu Tang

On behalf of the EMuS study team

China Spallation Neutron Source (CSNS)

Institute of High Energy Physics (IHEP), CAS

News from PSI

The Covid-19 pandemic had a big impact on the planned user program in 2020. After two years with only 6 months of proton beam operation each, due to upgrades of the PSI High Intensity Proton Accelerator HIPA, 2020 should have seen a return to 8 months user operation. In addition to the December 2019 call for proposals, a 2nd call was planned for June 2020 for the period October – December. It turned out quite differently: due to the pandemic, the shutdown work of HIPA was put on halt for two months, and beam operation was resumed with more than two months delay end of July 2020. We were forced to cancel the 2nd call for proposals, and to re-schedule approved experiments to run at the end of the year. Due to the world-wide travel restrictions, only a few users could come to PSI: we counted only 20% of the normal user visits. In order to run all the approved experiments, we quickly organized a mail-in-service for samples and remote operation with additional load on PSI staff. It is thanks to the impressive commitment and flexibility of PSI and LMU staff that we could run 187 experiments during 536 experimental days of the five open instruments Dolly, GPD, GPS, HAL-9500, and LEM.

The December 2020 call for beam time in April – September 2021 has received 216 proposals, a new record for a December call! This entails high overbooking between 1.6 and 4 (at Dolly), which led to large fractions of rejected proposals, depending on the overbooking. A 2nd call has been opened with a deadline of 7th June 2021, and as it stands, we are quite confident, that 2021 will see an 8.5-month operation: the shutdown work at HIPA has been finished on time end of March, and beam operation started, as planned, on April 12th. Still, the global travel restrictions will force us to continue offering remote operation of experiments, if required.

Besides all the difficulties in access to the lab and operation of the instruments, the developments of the facility continued. For the first time, a long-term operation of the new slanted target E has been demonstrated at a proton beam current of 2.0 mA. This is particularly important for the LEM facility at the µE4 beam line, which gains 40% in low-energy muon rate, due to a corresponding increase of the surface muon rate from the larger surface of the slanted target. This allows obtaining better statistics data, or to compensate for beam losses when collimating the beam to enable LE-µSR experiments on 5x5 mm^2 samples. The design of the new 2.0-K cryostats at LEM has been delayed due to the pandemic, and we are expecting that two of the new cryostats will be available in the 2nd half of 2022. A new sample preparation chamber with transfer-under-vacuum to LEM is in development, which will allow new kinds of LE-µSR experiments on systems where a well-defined surface preparation is required.

On the high-pressure side, a collaboration between LMU and the Laboratory for Neutron and Muon Instrumentation (LIN) received funding from the Swiss National Science Foundation to develop new pressure cells with the goal to extend the available pressure range to an unprecedented level of 5 GPa, and to allow in-situ pressure adjustments. These pressure cells will be suited for use in muon and neutron instruments at PSI.

The compact positron spectrometer with SiPM readout of the new FLAME instrument is ready for use and has been successfully tested with beam in the experimental area πM3.3, where FLAME will be located. The site acceptance test of the ^{4}He cryostat with dilution fridge insert has been successfully carried out in late 2020. The delivery of the superconducting 3.5-Tesla magnet has been significantly delayed due to the pandemic. Site acceptance test is now foreseen for autumn 2021. First tests of the entire FLAME instrument, including expert user experiments, are expected at the end of 2021, and we plan to open regular user operation in 2022.

Thomas Prokscha, Hubertus Luetkens, Alex Amato

News from RCNP-MuSIC

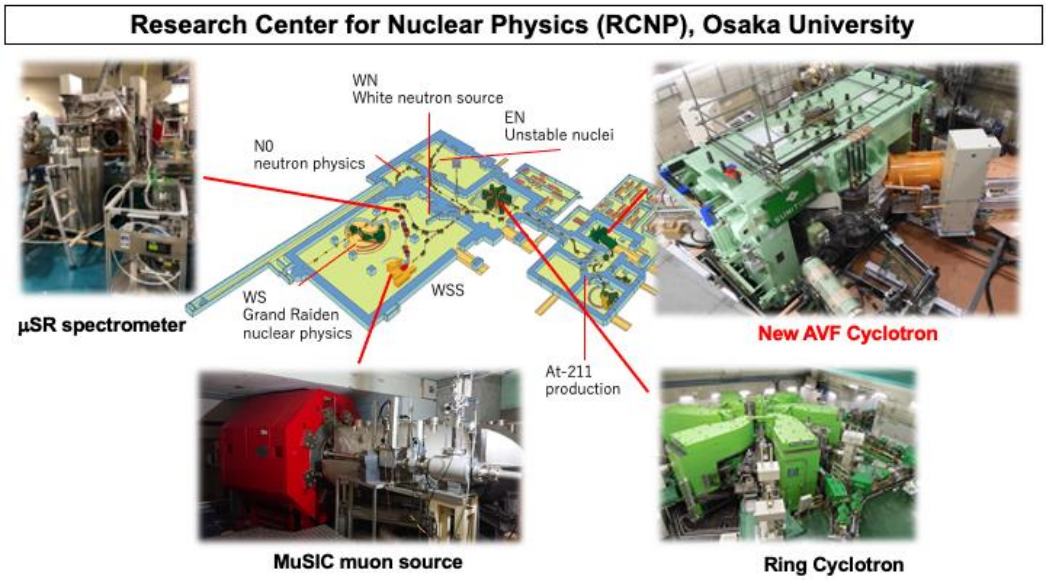
RCNP (Research Center for Nuclear Physics, Osaka University, Japan) has two cyclotron accelerators: K140 AVF (Azimuthally-Varying-Field cyclotron, 1973-) and K400 Ring cyclotron (1991-). They can accelerate a various kind of ion beams with a variable energy range. These beams are utilized for the research in nuclear physics, radiochemistry, RI production and interdisciplinary researches such as white neutron irradiation to semiconductors and muon science. Upgrade works of the AVF cyclotron and ion source has been ongoing since 2019.

Figure 1 shows a present layout of the RCNP facility, and photos of accelerators, MuSIC muon source and μSR spectrometer. For the muon production, the AVF cyclotron accelerates the proton beam up to 65 MeV and sequentially the Ring cyclotron accelerates it up to 392 MeV. This proton beam bombards a thick graphite target and produces muons and pions in the MuSIC muon source. It consists of a large solid-angle solenoid magnet to collect beams very efficiently. An intense muon beam is delivered to the μSR spectrometer. In the upgraded AVF cyclotron, the most significant changes are to employ new two Dee electrodes and to renew associated components. Emittance of an incident ion beam becomes smaller by increasing acceleration voltage. These improvements enable us to increase the 392 MeV proton beam intensity up to several mA. We expect that the muon beam intensity accordingly increases several times larger than that in 2019. In parallel, the μSR spectrometer and data taking system are improved to be more convenient for users.

The installation work is in progress although we are still in the serious situation due the covid-19 pandemic in Osaka. Reinstallation of the ion source is now in progress and then commissioning of the beam from the AVF accelerator is scheduled. After that, we will start further commissioning of the MuSIC muon beamline, especially for neutron radiation effects, heat tolerance, etc. associated with problems in increasing the muon beam. In this autumn, we expect that muon experiments will be partly resumed for users.

RCNP usually calls for new research proposals twice a year. However, feasible experiments are still limited in the MuSIC muon beamline. If you consider experiments with the MuSIC muon beam, we will appreciate to contact us in advance. (our homepage: http://www.rcnp.osaka-u.ac.jp/index_en.html)

Dai Tomono



Cyclotron accelerators and MuSIC muon source at RCNP.

Update from the Centre for Molecular and Materials Science (CMMS) at TRIUMF

The Centre for Molecular and Materials Science (CMMS) at TRIUMF is organizing a virtual 2-day workshop for Thursday, June 3rd and Friday, June 4th. The motivation for this workshop is that TRIUMF is engaged in developing a 20-year vision for the laboratory and our stakeholders. There have been several areas where the community would benefit from contributions from TRIUMF, both scientifically and on technical elements. This in turn would provide the community enhanced options for studies outside of the existing program in μSR and βNMR, building new capabilities and synergies. All these ideas need to be put in context of national and international developments and competitiveness.

This workshop is designed to enable researchers, professors and scientists at Canadian institutions and facilities to present and discuss developments, and learn from ideas at other facilities and in other research areas. It will provide opportunities for coordination and identification of new concepts. The workshop will have sessions on the following topics:

Thursday, June 3rd (all times in PDT)
08:00 - 10:00 Session 1: Novel capabilities with μSR
10:30 - 12:30 Session 2: Neutron scattering (with an accelerator-based source)
13:00 - 15:00 Session 3: Polarized radioactive isotopes
15:30 - 17:30 Session 4: Muonic X-ray analysis and μ^-SR

Friday, June 4th (all times in PDT)
08:00 - 10:00 Session 5: Positron annihilation spectroscopy
10:30 - 12:30 Session 6: THz spectroscopy in Canada
13:00 - 15:00 Session 7: Synchrotron light sources
15:30 - 17:30 Session 8: μSR idea and concepts

Each session will have three 30-minute talks followed by 30 minutes for discussion. Between each session there will be a 30-minute break, where additional discussions can occur. A link to the Indico site can be found here: https://meetings.triumf.ca/indico/event/231/. We are currently confirming the last of the invited speakers and contribution titles.

While there is no registration fee, registration is **required** for attendance to this conference. **Please register by 11:59pm PST on Sunday, May 30th via the Indico site above**. All registrants will be contacted via email on Monday, May 31st with the Zoom connection information.

Any questions can be directed to the Physical Sciences Division office at sciencediv@triumf.ca

The COVID-19 pandemic resulted in the μSR beam time in 2020 being reduced by about 50% compared with a regular year. Despite this, there have been significant developments at the CMMS, and we have been able to support experiments run by both local and remote users. Remote running has been challenging but has been valuable for our users in allowing the continuation of their research programs.

We are anticipating that the amount of μSR beam time in 2021 will return to that of a normal year, which is approximately 275 days of beam delivered to M15 and M20. For the summer beam period (Schedule 140), experimenters outside of B.C. will not be allowed to visit TRIUMF. Experiments with remote users must involve collaborations with CMMS staff or local experimenters. A decision regarding visitors for the fall beam period will be made at a later date.

The new radiation-resistant quadrupole magnet doublet and the front-end of the M9 beam line were installed during the 2020-2021 winter shutdown and the M9A beam line is nearing completion. Beam delivery to M9A is anticipated at the beginning of the summer 2020 beam period and this will be followed by commissioning of the beam line. Recent technical opportunities with regards to handling SiPM/APD detectors need to be fully assessed before completing the design of the 3T spectrometer. User operations on M9A with the new, dedicated 3T spectrometer with APD detectors are anticipated for the fall 2021 beam schedule. The M9A surface muon beam line and spectrometer will be optimized for rapid sample characterization with user-friendly operation.

The M9H project is visibly proceeding in the Meson Hall, with the uncovering and removal of the old 6m-long M9B solenoid underway. Commissioning of M9H is anticipated in 2023 with user operation commencing shortly thereafter. The M9H will be a backwards muon beam line with both longitudinal AND transverse polarization. This will enable μSR measurements on materials under high pressures at higher magnetic fields than is currently possible.

A ^{3}He cryostat for the NuTime spectrometer will be ready for user operation in 2022.

Progress is being made on the construction of the new mid-field βNMR spectrometer. This spectrometer is located downstream from the present low field βNQR spectrometer and will have in-sample-plane magnetic fields of up to 0.2 T and temperatures down to 300 mK. The main components are currently being installed. The spectrometer is planned to be commissioned this summer and available for scheduled experiments in fall 2021.

We ask that all users fill in the user survey at for every experiment they complete. This is the best way for our experimenters to alert the CMMS group regarding things that worked and that didn't work during your experiments. We will use this feedback to help us improve the facility. Issues that have been highlighted include problems with temperature controllers and the auto-run program. CMMS staff have been working on these issues. https://forms.office.com/Pages/ResponsePage.aspx?id=EDUFwrOceUai049ELgO1h5fLuBhjcm1GhoMy7RNYkRJUQ0I2VVpXTVRSOVE1Sk9BSVNTMFU0WkxLRSQlQCN0PWcu

Iain McKenzie, Syd Kreitzman, and Gerald Morris

ISMS Executive Committee

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Webmaster: ***Thomas Prokscha, PSI, Switzerland***
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If you have comments on any aspect of the ISMS, please contact a committee member.

News from RIKEN-RAL

The RIKEN-RAL Muon Facility is operational following the ISIS beam time schedules. The large refurbishment plan of the beam line toward 2022 is on-going with support of the ISIS engineering group and old components will be replaced to achieve stable and sustainable operational conditions well into the future. Sharing of cryostats with the ISIS muon beamlines has been started with support by the ISIS cryogenic team. At this moment, due to Covid, it is not easy for users to come to ISIS physically, and mail-order experiments are being carried out under remote operation from RIKEN/Japan. The ISIS instrumental scientists are supporting RIKEN experiments.

The RIKEN-RAL Muon Facility celebrated 30-Years of operations in 2020. More than 30 video messages (and a song!) were sent from users who enjoyed the muon science at RIKEN-RAL. Those messages have been released through the ISIS home page. https://www.isis.stfc.ac.uk/Pages/30-years-RIKEN-ISIS.aspx.

After the ISIS long-shut down, we are planning to continue to operate the RIKEN-RAL under better experimental conditions and the call for proposals will be open again at some time in 2022.

Isao Watanabe

News from ISIS

ISIS is now seeking its next phase of new instruments and significant instrument developments: a portfolio of projects that has been called the Endeavour programme. This includes a significant upgrade to the MuSR instrument intended to increase both its counting rate and time resolution by more than an order of magnitude. Endeavour will see the ISIS instrument suite developed to meet current and future challenges in areas such as Materials for the Future; Smart, Flexible and Clean Energy Technologies; Advanced Manufacturing and Biosciences and Healthcare. A series of talks to showcase the scientific capabilities of the proposed Endeavour instruments is planned for July 2021. More information can be found at:
https://www.isis.stfc.ac.uk/Pages/News21_EndeavourMeetings.aspx.

We would like to thank all those who attended the 'virtual' Muon Site Calculation Meeting, held 4th Sept 2020, and all the speakers who contributed to the day. This event continued the very successful series of meetings previously organised to discuss computational techniques for μSR. This particular meeting was organised within the framework of a two-year grant from the Ada Lovelace Centre whose main purpose is the development of a sustainable software platform for the various computational tools used for muon spectroscopy.

ISIS ended its March 2020 cycle slightly early as the UK went into its first lockdown. The following cycle was postponed and steady operation has been possible since September and will continue until the ISIS Long Shutdown begins in June. Almost all experiments have been done with remote users posting their samples and controlling the instruments over the web.

From the beginning of July 2021, the facility will go into a long shutdown for the refurbishment of the first target station target (TS1), the replacement of one of the linear accelerator tanks, and significant refurbishment of the RIKEN-RAL beamlines. While TS1 will be off until autumn 2022, the second target station (TS2) will have some running at the beginning of that year. The next call for proposals for the muon instruments will be around April 2022 (TS2 is likely to have an earlier call in late 2021). Full up-to-date information please visit the ISIS website: https://www.isis.stfc.ac.uk/Pages/Apply-for-beamtime.aspx.

Finally, the International Advanced School in Muon Spectroscopy, organised jointly with PSI and Oxford in 2019, is being turned into a book, which should be published later this year. Look out for *Muon Spectroscopy: An Introduction* (eds. Blundell, De Renzi, Lancaster, Pratt, OUP, 2021)!

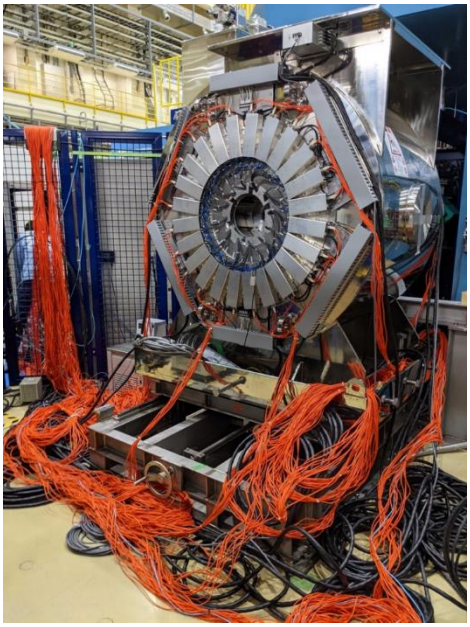
Adrian Hillier

News from J-PARC

From April to May 2020, J-PARC was shut down due to COVID-19 measures with 13 days of beamtime cancelled. It was decided to stop accepting proposals in the first half of 2021 and carry over the proposals accepted in the second half of 2020 until the shutdown in the summer of 2021. However, due to the rapid increase in the number of infected people in the fourth wave over the past month or two, travel from overseas continues to be difficult. It has been instructed to designate On-site Participants on the member list for the second half of 2021.

At the D-line, the project on elemental analysis of archaeological materials using muonic X-ray is progressing well. The research on Japanese swords using neutrons and muons was featured in a TV program, and the research on elemental analysis of the contents of reagent bottles owned by Ogata Koan, a doctor, scientist, and educator of the Edo period, was recently covered in several national newspapers.

Meanwhile, at the S-line, preparations for the muonium 1s-2s resonance experiment by a group at Okayama University are underway. The new beam branch, which will be operated as the S2 area, has been equipped with equipment for the resonance experiment and a booth for laser equipment, and



is waiting for the day when the beam will be delivered. However, the government offices are still working from home due to COVID-19, and the permitting schedule is generally behind schedule. The beam commissioning using the high field μSR spectrometer CYCLOPS has started in the S1 area.

The year 2020 was the 40th anniversary of the start of pulsed neutron and muon experiments at KEK Tsukuba, and a commemorative symposium was held (unfortunately online) in December 2020.

The lecture is in Japanese, but is available on YouTube.

https://www.youtube.com/playlist?list=PLRiEphFk2yG8q3aVL6HpZoA3LQDRA7SAx

Photo: High field muSR spectrometer CYCLOPS. The counter is consisting of 3008ch. scintillators and SiPMs.

Akihiro Koda

Progress report on a μSR facility in the US

In the past several years, there has been a concerted effort to assess the scientific and technical feasibility of constructing a new μSR facility in the United States. In September 2016, a workshop was held at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee to engage the μSR community and discuss the potential for a future muon facility. This timing coincided with ongoing plans to upgrade the Spallation Neutron Source (SNS) at ORNL in order to increase the beam power and construct a second neutron target station. At that workshop, participants discussed the foundation for a novel μSR facility that could use laser stripping to divert a small fraction of the SNS proton beam towards a μSR target facility. Since then, ORNL staff and partners have worked on developing a preliminary design and refining the possible beam parameters of such a facility.

In order to understand the scientific needs of the μSR community, a second workshop was held virtually February 1-2, 2021. This workshop featured 7 plenary speakers from various μSR research areas, who discussed the current state of μSR research and their vision for the future directions and needs. There were also 4 breakout sessions that discussed different scientific opportunities, instrumentation developments and complementary capabilities for a potential future muon source co-located with the brightest neutron source in the US. Finally, there were presentations on the current state of the preliminary design of the ORNL μSR facility, and the plans for future work to continue to refine this concept. The workshop had 215 registered participants from around the world, and a peak of 123 simultaneous attendees.

Due to the high power of the SNS accelerator and the novel use of laser stripping, the current design of the ORNL μSR facility is predicted to support 4 initial beamlines with a surface muon flux greater than $7x10^8$ μ^+/sec. The participants noted that this high muon flux would be most useful for generating low-energy muon beams to undertake new scientific opportunities. The next step of the project involves pursuing funding to develop a more complete conceptual design that addresses the scientific needs highlighted at the workshop. This will include continuing effort to update and engage the μSR community.

Travis Williams

The Spallation Neutron Source facility as it appears today. The central laboratory and office building is in the foreground, with the neutron target station in the center of the picture. The linear accelerator is at the top. The empty space to the right is allocated for the planned second neutron target station, and the proposed μSR facility could be placed beside the water tower at the top of the picture, as indicated. (https://neutrons.ornl.gov/sns)

ISMS Audit

As the external auditor for the International Society for μSR Spectroscopy (ISMS) and consistent with the ISMS constitution, I requested a report of the ISMS accounting information from Dr. Hubertus Luetkens (ISMS treasurer) on 01 Feb 2021 to complete the annual account audit. I promptly received a detailed summary of the incoming and outgoing money from the ISMS account starting from Jan 2002 through 31 Jan 2021 as well as the official account statement from PSI. After a detailed review of these data, I find no questionable charges or credits; all activity is appropriate for ISMS business and matches the current budget.
The next external audit will occur in January 2022.
I thank and commend the treasurer for his diligence and the entire Executive Committee for such responsible accounting and reporting.
Should there be any questions, comments or suggestions regarding the external audit, please do not hesitate to contact me.

Rick (P.W.) Mengyan

UPDATE: MuSR-2020 Parma, Italy

We are pleased to announce new dates for the 15th International Conference on Muon Spin Rotation, which will be hosted by Parma, Italy, 29 August 2022 to 2 September 2022 The meeting will be preceded by a Student Day on 28th August 2022. We anticipate opening registration early in the New Year. More news will follow.

Roberto De Renzi and Adrian Hillier

MRM2021 symposium "Novel Functions in Advanced Materials Probed by Spin Polarized Quantum Beams"

We are pleased to announce that MATERIALS RESEARCH MEETING 2021 (MRM2021) will be held on December 13-17, 2021 in Yokohama, Japan. https://mrm2021.jmru.org/

MRM2021 is intended to offer a venue to materials researchers from different disciplines to discuss recent scientific developments and applications of advanced materials. Intensive discussions among participants with different backgrounds are expected to bring innovative ideas and strategic development for next-generation materials research.

MRM2021 consists of plenary sessions, clusters, and symposia. Each cluster consists of multiple symposia, which will have a joint session (cluster session) during the meeting period. As SYMPOSIUM A-3, Science with Spin Polarized Quantum Beams (Muon, Neutron, Positron, etc.) will be discussed as following,

SYMPOSIUM A-3
Novel Functions in Advanced Materials Probed by Spin Polarized Quantum Beams
SCOPE
Elucidation of local state in advanced materials is key issue for functional material studies. Aiming to reveal new aspects of novel function of advanced materials, spin polarized quantum beams, such as muons, neutrons, positrons and ions, are quite powerful tools. This symposium will provide for academic and industrial researchers in diverse research fields to discuss and exchange new findings and ideas in utilizing and developing the cutting-edge spin polarized quantum beams.

Topics
Functional Materials, Thin films and multilayers,
Strongly correlated systems, Semiconductor, Spintronics,
Soft Matter, Battery, Catalysis,Novel imaging and New techniques

Cluster Keynote Speakers
Yasutomo J. Uemura(Columbia University)
Gerbrand Ceder(UC Berkeley)
Surya R. Kalidindi(Georgia Institute of Technology)

Organizers
Toshiya Otomo(High Energy Accelerator Research Organization (KEK))
Tadashi Adachi(Sophia University)

Wataru Higemoto(Japan Atomic Energy Agency)
Kazuki Ohishi(Comprehensive Research Organization for Science and Society (CROSS))
Javier Campo(Aragón Nanoscience and Materials Institute, CSIC-University of Zaragoza)
Ross Stewart(ISIS Pulsed Neutron and Muon Source, Rutherford Appleton Laboratory)
Lei Shu(Department of Physics, Fudan University)
Martin Månsson(Docent Applied Physics, KTH Royal Institute of Technology)

https://mrm2021.jmru.org/program/symposium/A/A-3

MRM2021 abstract submission is now open for the technical symposium. All abstracts must be submitted online. The submission deadline is May 31, 2021.

MRM2021 will take place as a face-to-face meeting, and all events will be held at the venue in Yokohama. Authors who have submitted abstracts will be asked to deliver in-person presentations (oral or poster) of their work; however, they can present online (both oral and poster) if they cannot travel in December due to COVID-19. All meeting attendees will be able to participate in the meeting in-person and online.

The organizers welcome participants interested in materials research and anticipate an exciting and fruitful discussion. We are looking forward to seeing you in Yokohama (or online) on December 2021.

On behalf of the A-3 Organizing Committee

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