TRIUMF Physical Sciences Division

User Services Newsletter

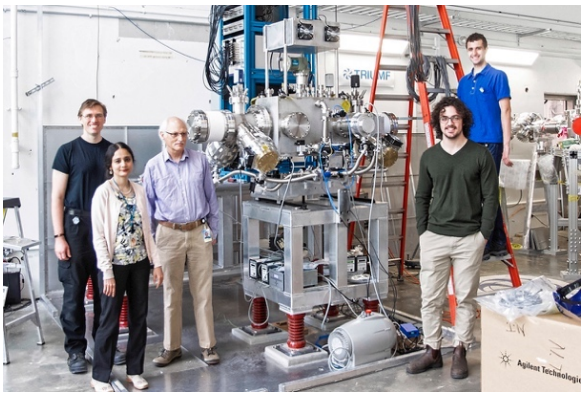
Volume 1 | No.2 November 2018

A Message from the Associate Laboratory Director - *Jens Dilling*

jdilling@triumf.ca

Dear Friends and Colleagues,

Welcome to the second newsletter from the TRIUMF Physical Sciences Division (PSD), the purpose of which is to bring you updates on major facility developments and from the Liaison Scientists of our four research and service groups: Nuclear Physics with Isotope Beams (M. Alcorta); Resonance probes, muons and beta NMR (I. McKenzie); Science Technology (T. Lindner); and Detector Test Beam with M11 (S. Yen and I. Trigger). For many of these projects we are working closely with the Accelerator Division at TRIUMF. The Liaison Scientists manage user satisfaction surveys which are completed after every experiment or service project. In this newsletter we are responding to often repeated feedback, in particular, for beam reliability at ISAC (see contribution from A. Gottberg and C. Babcock). Note that it's possible that the response to the feedback could include a 2019 schedule with reduced on-line availability to focus efforts on improved on-line reliability.



In addition, there is an update from ARIEL and CANREB (A. Garnsworthy and C. Ruiz). CANREB will commence commissioning off-line and on-line in the first half of 2019, which could lead to early science opportunities in the second half of 2019. A notice has recently been sent out for an SAP-EEC at TRIUMF in January, and one is planned for July. The July EEC hopefully will allow CANREB-based proposals to be accepted, and we will provide opportunities for beam-time requests for experiments in August and September 2019 for CANREB-based experiments. We encourage the community to coordinate early science opportunities, with focus on post-accelerated beams. There could be an opportunity for a workshop at TRIUMF if interests exist. Please let us know.

In June, together with the Helmholtz Centres (DESY, KIT, GSI, and Juelich) and industry partners D-Wave and 1Qbit, TRIUMF hosted a workshop on Data Science and Quantum Computing. Since then, we have established working groups where interested parties can sign up to participate (see mailing list here: http://lists.triumf.ca/mailman/listinfo/data_science_and_quantum_computing). TRIUMF hired a Data Scientist (W. Fedorko, wfedorko@triumf.ca) to help establish quantum computing and data science platform at TRIUMF. If interested, please feel free to reach out to him with your questions.

Cont'd on next page…

Last but not least, we were very happy and honoured to have a visit from the Canadian Prime Minister, Justin Trudeau, at TRIUMF on November 1st, to congratulate TRIUMF on its 50th anniversary and to announce the establishment of the premier centre for advanced medical isotopes research and development at TRIUMF.

If you have any questions or comments, please feel to reach out to me (jdilling@triumf.ca), the Liaison Scientists (see articles below), or to any one of our department heads:

- Nuclear Physics: Chris Ruiz, ruiz@triumf.ca
- Particle Physics: Oliver Stelzer-Chilton, stelzer-chilton@triumf.ca
- Theory: Petr Navratil, navratil@triumf.ca
- CMMS: Syd Kreitzman, syd@triumf.ca
- Science Technology: Fabrice Retiere, fretiere@triumf.ca

Nuclear Physics with Isotope Beams – *Martin Alcorta* *malcorta@triumf.ca*

After a planned delay to the start-up, Schedule 134 resulted in many successful radioactive beam experiments which resulted in excellent theses and publications. However, there were some setbacks. This was reflected in the many surveys received from the users, whom I would like to thank for their valuable feedback which highlighted areas needing improvement. Our stated policy is to flag areas of common concern and actively seek to resolve those issues wherever possible. This year we have had several criticisms related to beam delivery, most of which fall into the reliability category. The message was received loud and clear and multiple groups across divisions are actively working to resolve these issues. To this end, discussions are underway about delaying the ISAC beam schedule start-up in 2019 to address ISAC infrastructure reliability. Further information can be found in the Development Updates below.

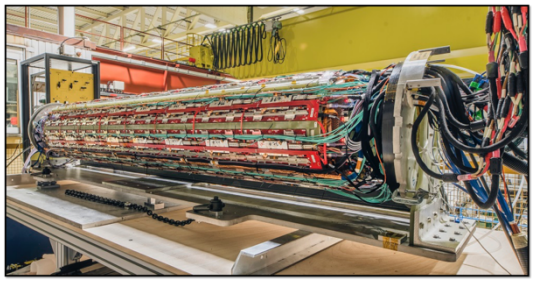
I am happy to report that we are currently reviewing applications for two new ISAC facility scientists with expertise in gamma-ray detectors and lasers/trapping who will provide long-term support for ISAC experiments. They will free up time for TRIUMF research scientists and will support external users in preparation for the increased demand expected in the ARIEL era.

Please continue to fill out the beam time satisfaction surveys. Note that the surveys will be moving to a new Office 365 forms platform in the new year. Do not hesitate to contact me for any questions related to the surveys or running experiments at ISAC.

The deadline for submission of new and continuing ISAC proposals will be Midnight (23:59), Vancouver time, Tuesday, December 11th, 2018.

Science Technology - *Thomas Lindner*

lindner@triumf.ca



The goal of the Science Technology Department is supporting the physics community in bringing to reality their projects by providing technical resources for the design, construction, and operation of experiments and other apparatus, and by supporting R&D efforts The largest project for the Science Technology Department in the last half year was the completion of the ALPHA-g radial time projection chamber (rTPC). The ALPHA-g rTPC is 2.4 m long and 0.4 m diameter, with 256 anode wires and 18432 pads and a readout with custom electronics designed and fabricated by the Science Technology Department. Surrounding the rTPC is a barrel scintillator, readout with silicon photomultipliers (SiPMs). The rTPC was built and tested at TRIUMF over the last two years and shipped to CERN in July. After a great deal of hard work from the Science Technology Department and the ALPHA collaboration, the rTPC is now ready for the first ALPHA-g commissioning and data taking run this fall.

The Science Technology Department is deploying a new tool for project management, called Project Insight. The new system will simplify the procedure for requesting SciTech resources and monitoring the status of projects. We expect that users will be able to use this new system in a couple months.

Further details on the different services provided by the department and the procedure for requesting assistance is provided on our website: http://www.triumf.ca/science-technology.

Centre for Material and Molecular Science - *Iain McKenzie*

iainmckenzie@triumf.ca

Since the last newsletter, TRIUMF has hired two new scientists, Sarah Dunsiger, and Kenji Kojima, and promoted another, Iain McKenzie, to faculty status, enabling them to do independent self-directed research. Together, they will form the core part of a team to develop a strong in-house scientific program with strong university connections (for example SFU and SBQMI at UBC).

In other good news, starting in 2019 users no longer will be charged for their liquid helium usage.

μSR

- The CMMS is currently operating with two μSR beam lines; M15 and M20. Each received approximately 130 days of delivered beam.
- We are in the process of expanding the number of beamlines and spectrometers in order to provide more capabilities for our users. A project to complete the M9A beam line and construct a new high-momentum beam line called M9H has received $10.7M from the Canada Foundation for Innovation (CFI), provincial funding agencies in B.C., Ontario, Quebec and New Brunswick and TRIUMF. M9A will focus on highly efficient sample characterization for the increasingly important broad non-expert (in μSR) user community.

- M9H will be a unique beam line with spin-rotated decay muons and high flux μ^-. This will enable users to explore a wider physical parameter space (high pressures + ultra-low temperature + high magnetic fields) than is possible with any existing beam line / spectrometer. The first step of this project is the repair of the front end of M9, which was sealed off due to a vacuum leak. A radiation-resistant quadrupole magnet has been ordered for the front end of M9 with a potential installation in an extended winter shutdown of 2019 or otherwise in 2020. Once the repairs to the front end of M9 have been completed, we will inform users once the new capabilities are enabled.
- A new 3T SiPM equipped general purpose spectrometer is being completed and should be commissioned in 2019, with experimental availability to users starting in 2020.
- There are also plans to revitalize M15 and to develop muonic X-ray analysis these have been included in the next TRIUMF 5-year-plan (2020 – 2025).

β-NMR

- In order to accommodate critical work for the ARIEL II project, the start-up of ISAC in 2018 was delayed by eight weeks. This resulted in the amount of beam time for ^{8}Li β-NMR in 2018 being reduced to 4 weeks from our typical allocation of 5 weeks. A similar reduction in beam time is anticipated in 2019. A substantial increase in beam time for β-NMR is expected in 2021, when ARIEL comes on line.
- Construction of the intermediate-field β-NMR spectrometer, which will be located downstream from the β-NQR spectrometer, began in November 2018. This spectrometer will have a maximum field of 2 kG and will be equipped with a 3He cryostat for measurements down to ~0.3 K. it is planned that this new spectrometer will be available to users in Summer 2019.

The deadline for submission of new and continuing CMMS proposals will be Midnight (23:59), Vancouver time, Tuesday, December 11th, 2018.

M11 Beam Testing – *Isabel Trigger*

itrigger@triumf.ca

The beamline M11 area is back in business. The fast pion beamline M11 first came online in 1980. A secondary beam from the BL1A T1 target was neatly steered away from the proton beamline by a septum magnet into the M11 channel, which accepted either positively- or negatively-charged pions of kinetic energy 50 to 350 MeV with a $\Delta p/p$ =5% momentum spread. That was until 2001.

In that year, the septum – which had been plagued by water leaks from its very beginning – sprung a major leak and was deemed non-repairable. Without a working septum to steer the beam into the first dipole bender, only the small fraction of particles that happen to spray into the bender end up exiting the channel. The exiting beam was reduced by many orders of magnitude in intensity, with a source not directly from the target but from the beam halo striking the edges of the beam pipe / collimators / septum, resulting in a considerable momentum spread. In practice, the much-reduced intensity made negative pion fluxes impracticably low. Still, the combination of low yet usable intensity, a mix of momenta, and a mix of positively-charged particle species (protons, pions, muons and electrons) gave M11 an entirely new vocation: the beam was perfect for testing detectors under realistic operating conditions. M11 subsequently was used to test, for example, the T2K ND280 near-detector tracker consisting of large time projection chambers and fine-grained

scintillator detectors, CsI crystals for the Belle-II calorimeter, and diamond detectors for a possible ATLAS upgrade.

When the design was made for the new ultracold neutron beamline in the former M13 area, the necessary shielding impinged on the M11 beamline, blocking the traditional achromatic beam exit. However, it was decided to use the alternate exit port on the final dipole bender, which steers the beam 30 degrees East instead of 60 degrees West, and away from UCN. By reconfiguring the shielding blocks, it was possible to carve out a new space for M11.

During the 2017-18 shutdown, Doug Preddy and the beamlines group implemented this plan, and M11 was reborn. Stan Yen, the M11 facility coordinator, then led a program to recommission M11 in time to use it for the GRIDS summer school at the beginning of August. Summer student Adrian Pikor, working with TRIUMF accelerator scientist Rick Baartman, calculated optimized magnet tunes which resulted in a factor of 14 increase in beam flux at 100 MeV/c. They then worked with Aleksey Sher to set up beam counters and test the new tunes. RPG confirmed that no neutrons or gamma backgrounds were detected outside the lockout area, and the new beamline was commissioned and usable in time for the school, with rates in the range of kHz to tens of kHz and a range of momenta from about 60-380 MeV/c.

M11 provided a hands-on opportunity for GRIDS students to tune a beamline and estimate the momentum and particle composition of the beam. It is now back in business and ready to test more detectors! If you are interested in using M11 for testing, please submit a proposal to the SAP EEC, or contact Stan Yen or Isabel Trigger.

The deadline for submission of new and continuing M11 proposals will be Midnight (23:59), Vancouver time, Tuesday, December 11th, 2018.

ARIEL Update - *Adam Garnsworthy and Chris Ruiz*

garns@triumf.ca, ruiz@triumf.ca

There has been steady progress in the installation of the RIB transport beamlines and the new CANadian Rare isotope facility with Electron Beam ion source (CANREB) equipment on the ground floor of the ARIEL building, and their connection into the ISAC experimental hall. Over half of these beamlines are now aligned and under vacuum. The installation of equipment is anticipated to be completed by the end of 2018 at which point the focus will move to commissioning.

For further information, please visit the ARIEL website at: http://www.triumf.ca/ariel

CANREB Update

We would like to take this opportunity to introduce our users to the CANREB facility that will be commissioned in 2019 at TRIUMF. CANREB is a new facility, led by St. Mary's University, that will deliver pure, highly charged, rare isotope beams suitable for acceleration in order to perform experiments to investigate nuclear reactions. CANREB will complement the existing electron cyclotron resonance ion source (ECRIS)-based charge state breeder (CSB) system by providing

beams of higher purity and extending the available mass range. In the CANREB system, ions are first sent through a high-resolution mass separator, where most of the isobaric contaminants can be removed. If radioactive beam is produced at ISAC, this mass separator will be the existing ISAC mass separator. Ultimately for beams produced in ARIEL, this will be the ARIEL high-resolution separator. The ions are injected into an RFQ cooler-buncher, the bunches are injected into an EBIS (Electron Beam Ion Source) for charge state breeding, and finally the charge-bred bunches pass through a NIER spectrometer before delivery into the ISAC experimental halls.

So that users can get some idea of what the capabilities of CANREB will be, here are some technical details that are also detailed in a paper by F. Ames [*F. Ames et al., The CANREB project for charge state breeding at TRIUMF, AIP Conference Proceedings, Volume 2011, Issue 1, id.0700010 (2018)*].

CANREB beam is bunched, with a repetition time of 10 milliseconds (100 Hz). This will also allow operation with short-lived isotopes. The bunch length is initially envisaged to be about 20 microseconds. This means with these nominal settings that the experiment will receive one 20 microsecond bunch once every 10 milliseconds (100 bunches of 20μs length per second). This macroscopic time structure will be superimposed over the microstructure time structure of the ISAC-I buncher and RFQ accelerator [*Table 1 of https://www.triumf.info/wiki/exp-prog/index.php/ISAC_%28Isotope_Separator_and_ACcelerator%29*].

To guarantee the short breeding time for the entire mass range up to uranium and to have a high injection efficiency, the EBIS is designed to operate at an electron beam density of up to 20,000 A/cm^2. With the EBIS being operated at ultra-high vacuum, and no plasma wall interactions, additional contaminants induced by the charge state breeding process are expected to be significantly reduced compared with the ECRIS. Isobaric contaminants should still be expected to be present in the beam, as is the case with the ECRIS.

The total beam intensity is limited mainly by space-charge in the RFQ cooler-buncher to about 10^7 ions per bunch.

CANREB is scheduled for stable beam commissioning throughout the early months of 2019, and it is expected that during Schedule 136 significant steps in commissioning with offline and online stable and online radioactive beams will be completed. In order to do this, we will be reserving some time during the schedule for this commissioning. In the Call for Proposals for the Summer 2019 EEC meeting, we will be encouraging proposals for CANREB, and will be reserving time at the end of Schedule 136 to perform high priority experiments that utilize CANREB beam.

During the commissioning phase, the first radioactive ion beams that are likely to be investigated will be alkali and earth-alkali elements, from a variety of targets. For example, Barium, Strontium and Caesium beams are expected to be particularly suitable for production with CANREB.

Beam Development Update – *Carla Babcock and Alex Gottberg*

cbabcock@triumf.ca, gottberg@triumf.ca

In the last newsletter we reported on the rich variety of target and ion source development projects ongoing at ISAC, as well as on ISAC target operation statistics - all are making significant progress and in particular, we successfully operated of a nanometric target material, an electrospun carbon fibre matrix with embedded dispersed SiC particles (<100 nm). Here we would like to take the opportunity to demonstrate our commitment to ongoing ISAC infrastructure campaigns that aim to unlock higher operational reliability and new capabilities that users are demanding (via for example the satisfaction surveys).

The 2018 shutdown and subsequent months provided advantages for ISAC as well as ARIEL. During this time, quick electrical connections have been installed on both target stations, increasing the reliability of the connections and reducing the time required for personnel to couple and de-couple a target module during the target exchange by almost a factor two, an important milestone towards a faster target turnover at ISAC. Additionally, changes were made to both the target conditioning procedure and the target assembly design, which have prevented any electrical shorts of the ISAC target extraction electrodes in 2018, a failure mode that frequently reduced beam intensity in past years. Last but not least, the 2018 shutdown and the reduction of UCX targets in fall 2017 enabled the development of a faster and more sustainable production method for UCX targets. Consequently, we are happy to lift the limitation on the number of UCX targets for ISAC, effective 2019.

After the 2019 shutdown, routine radioisotope beam delivery will resume after allowing the required time to accommodate ISAC infrastructure upgrades. The plan is to use that time to address issues arising from the ageing ISAC TMs, which will continue until adequate resources can be marshalled.

Users know that the target module high voltage bias limitations are causing significant restrictions to some experiments, especially in the medium and high energy areas. Mitigation measures are in place, such as the installation and successful operation of the newly developed ISAC RF booster, which allows the addition of up to 8 keV to the beam energy while maintaining reasonable transmission rates. These measures allow ISAC to continue to deliver beam while the team is working on implementing solutions to the module HV limitations.

In 2018, only two target modules (TMs), TM2 (< 30 kV) and TM4 (< 40 kV), have been in operation. TM2 and TM4 have gone through partial refurbishments in 2015 and 2013, respectively, and show signs of fatigue, compromising performance beyond the high voltage integrity. Thanks to the amazing efficiency of the team, and especially Anders Mjøs, Keith Ng and Chad Fisher, we are in the process of manufacturing and assembling parts in order to exchange the source trays on both TM2 and TM4 during the 2019 shutdown. A source tray carries all critical electrical, fluid, gas and high voltage services to the target, making it the most complex and vulnerable subassembly of the ISAC target module. Initiatives are underway to complete a full TM3 refurbishment to bring it back into operational rotation.

Having three modules supporting ISAC operations will be a substantial improvement in reliability for users. In order to support effective and uninterrupted ISAC operation, a study of

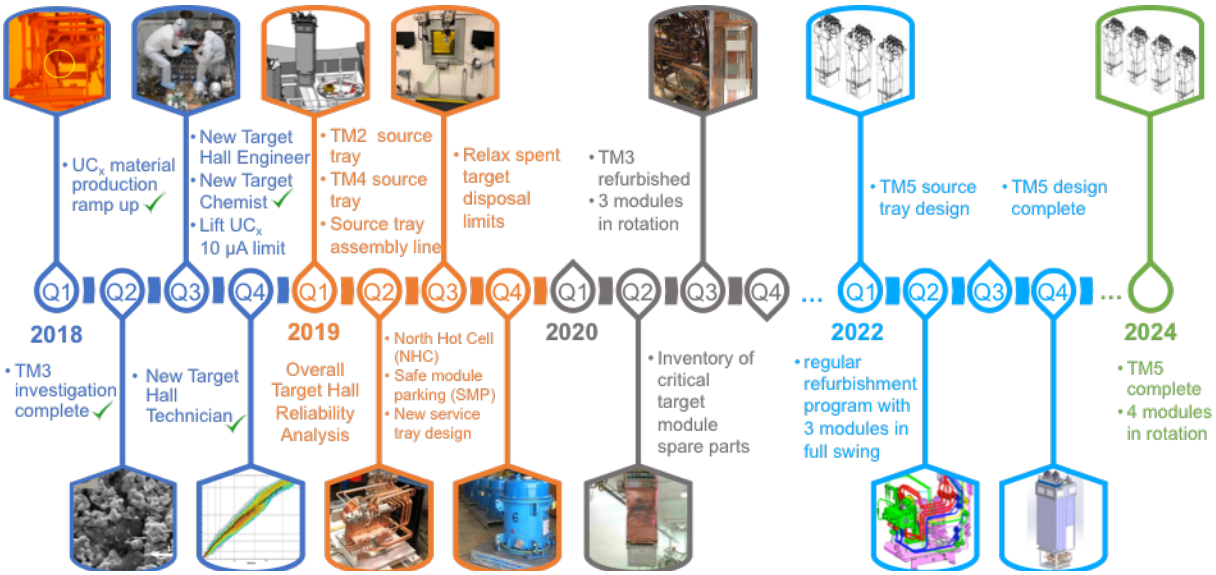
the ISAC operational cycle indicates that four target modules will be required. This allows one TM to be refurbished while the others are either operating or acting as a spare. The refurbishment phase is a necessary step given that the average time between component failures calls for a TM refurbishment every 4-6 years. In order to meet a four-TM operational cycle, we are preparing for the construction of a new target module, TM5, once the ARIEL development project ramps down.

Besides the replacement of the source trays, which is a major endeavour requiring remote handling infrastructure and involving experts from many groups at TRIUMF, ISAC will use the 2019 shutdown to gear up for the next running period. Various target module components will be replaced, and general annual maintenance will be performed to achieve better reliability and less downtime in the coming year. One important milestone to be addressed in that period is the current disposal chain for the irradiated targets at TRIUMF. At the moment shipments to Canadian National Laboratories in Chalk River are on hold until the inner target transport enclosure has been redesigned and recertified. Thanks to the dedication of the entire team, new areas for temporary storage of the irradiated units have been prepared at ISAC in order to avoid impact to the users. The 30 irradiated targets currently stored (nominal storage capacity is 24) have to be re-packaged and prepared for shipment during the shutdown to create space for the targets that will be used in the 2019 running period.

ISAC continues to improve the yields and variety of isotopes available across the nuclear chart, however the team would prefer to limit the 2019 experimental campaign to UCX, SiC and Ta targets in combination with surface ion sources. Other combinations will be scheduled at a reduced rate and a maximum of 8 targets will be scheduled in the 2019 running period.

There is an intense ongoing discussion regarding the possibility of reduced online operation if required to accomplish our goals in 2019 and provide greater reliability for users.

The timeline below summarizes our plans to address the highest priority ISAC target system actions, in order to increase reliability and expand capabilities for the RIB science program. We will report on progress and changes to this schedule on a regular basis in this Newsletter.



TRIUMF Users Group Update - *Ania Kwiatkowski*

tug@triumf.ca

The TRIUMF Users Executive Committee (TUEC) is engaged on behalf of users on a number of activities related to the TRIUMF Five Year Plan 2020-2025, including a recent representation to the Advisory Committee on TRIUMF (ACOT).

A subcommittee is reviewing and updating the charter and bylaws. Changes include modernizing language and practices. In addition, the term user will be considered and possibly redefined. Any user interested in assisting may volunteer by contacting us by email at tug@triumf.ca .

The recent TUEC election took place Oct 11 – Nov 1, 2018. Results are being tabulated and will be announced soon. We thank the outgoing members for their service:

- Kyle Leach (Colorado School of Mines), Past Chair
- Monika Stachura (TRIUMF)
- Beatrice Franke (TRIUMF)

If you are not yet a member of the TRIUMF Users Group, please sign up via the mailing list at: http://lists.triumf.ca/mailman/listinfo/triumf-user

---

END

If you have any questions or concerns regarding the contents of this newsletter, please contact Marcello Pavan - Academic, University and User Engagement at marcello@triumf.ca; or Allayne McGowan - PSD Administrative Assistant, at sciencediv@triumf.ca