

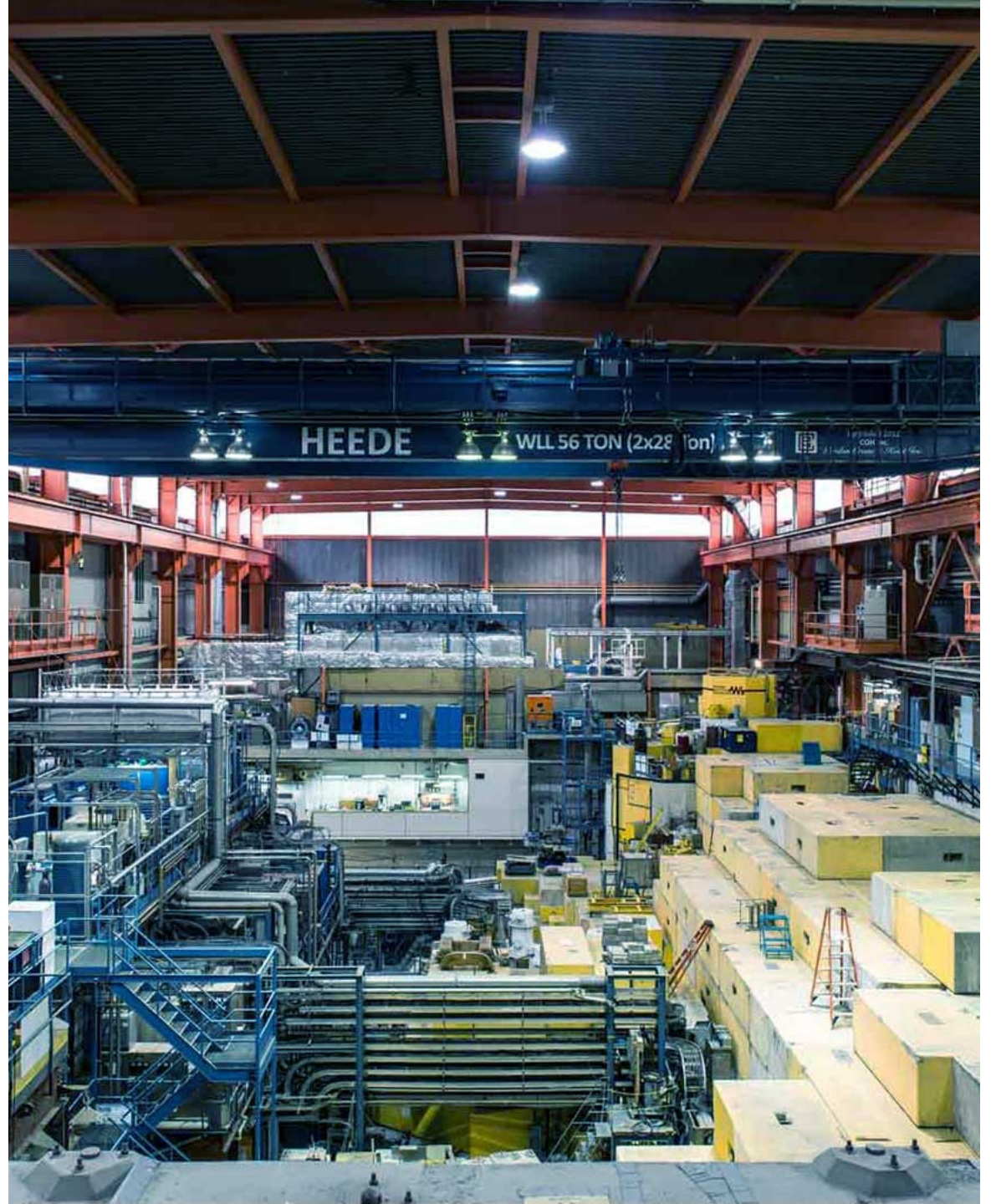


CINP-IPP Meeting TRIUMF Update

Nigel Smith

(thanks to Reiner and Sean for material)

2021-06-11



Our vision is for Canada to lead in science, discovery, and innovation, improving lives and building a better world.

TRIUMF is Canada's particle accelerator centre.

- We advance isotope science and technology, both fundamental and applied.
 - We collaborate across communities and disciplines, from nuclear and particle physics to the life and material sciences.
 - We discover and innovate, inspire and educate, creating knowledge and opportunity for all.
-
- Home to ~600 staff and students from 30 countries
 - > 200 students & post-doctoral researchers



Organisational update

New Director and CEO (from May 17th)

Many thanks to Jon Bagger and Digvir Jayas for their leadership of TRIUMF over the last few years.

TRIUMF INC.

On June 1, TRIUMF transitioned from a joint venture to an incorporated not-for-profit with charitable status.

- Board of Governors (Smaller, skills-based, comprises member University Representatives (5), UBC (1), Science Council chair (1), External (4))
- Members' Council (Enables Member Universities to retain their ownership responsibilities, comprises member universities (14)) Chair: Walter Dixon
- Science Council (Provides scientific advice and guidance to TRIUMF Board, comprises member universities (14), TRIUMF staff (5), External (5)) Chair: Corina Andreoiu



TRIUMF COVID-19 response

- Moved 85% of staff to remote work in March 2020 as Province shut down
- Maintained core crew to operate 520MeV cyclotron for medical isotope production (essential service)
- Produced PPE (face mask straps) and supported community efforts for bubble helmet, MVM and other ventilator projects
- Supported analysis of SARS-CoV-2 via cryo-electron microscope (UBC team) and computing efforts on protein folding via ATLAS-T1 computing cluster
- Ramped-up on-site project and construction work in June 2020
- Currently
 - ~45-50% of staff on-site
 - full accelerator and science operation (ISAC, MuSR, Proton Irradiations, Life Sciences) but only limited outside users (domestic only) and increased remote participation in experiments
- Response is adapted to evolving COVID situation, based on provincial guidance
- Planning under way to return to more 'normal' operations (staff + users)

Mechanical Ventilator Milano

Started in Italy by scientists from the Darkside Dark Matter collaboration in response to COVID-19 crisis and ventilator shortage (led by C. Galbiati)

Conceived as low-cost, reliable, fail-safe, and easy to operate electro-mechanical ventilator that can be produced quickly, at large scale, based on readily-available parts.

Canadian team led by Art McDonald: TRIUMF, Canadian Nuclear Laboratories, SNOLAB, McDonald Institute working with companies Vexos, JMP Solutions

March 19:

May 1:

May 26:

July 31:

September 30:

Project start

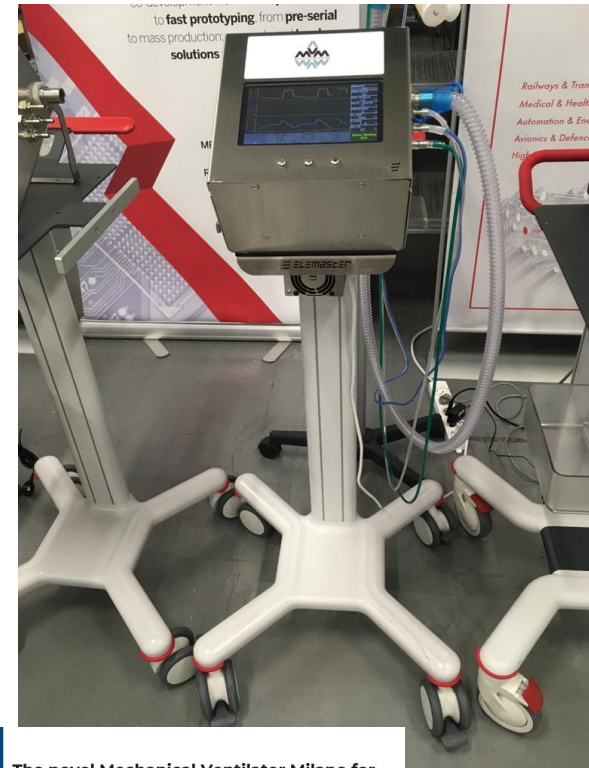
FDA Emergency Use Authorization

Canadian Government orders 10,000 units

Health Canada submission

Health Canada approval

>6,000 units produced by Vexos (Ontario) and delivered to Federal Government



The novel Mechanical Ventilator Milano for the COVID-19 pandemic

Cite as: Phys. Fluids 33, 037122 (2021); <https://doi.org/10.1063/5.0044445>
Submitted: 16 January 2021 · Accepted: 14 February 2021 · Published Online: 23 March 2021

A. Abba, C. Accorri, P. Agnes, A. Alessi, P. Amadio, A. Amov, F. Ardellier Desages, S. Beck, C. Bede, J. Bagger, V. Baika, G. Balgarni, A. Bayo, B. Bek, M. Becchi, D. Biagini, G. Bianchi, S. Bickel, D. Bishop, T. Boccali, A. Bombardieri, S. Bonfanti, W. M. Bonvento, M. Bouchard, M. Brevierio, S. Brice, R. Brown, J. M. Calvo-Moneda, L. Canozzi, M. Canzani, A. Capra, M. Caracciolo, M. Carlini, A. Cecconi, S. Celino, J. M. Cole, Rutz, C. Chavetto, G. Cogliati, M. Conzatti, C. Crisp, G. Croci, S. Cudmore, C. E. DeH, A. Dal Molin, M. Daley, C. Di Guardo, G. D'Avanzo, O. Davignon, M. Del Tutto, J. De Rudder, A. Devoto, P. Diaz Gomez Maqueo, F. Di Francesco, M. Dossì, E. Druzaković, C. Duma, E. Elliott, D. Fatma, C. Fernandes, F. Ferroni, G. Finocchiaro, G. Fiorillo, R. Ford, G. Fort, R. D. Fournier, D. Franco, C. Fréberg, F. Gabriele, C. Galbiati, P. Garcia-Abba, A. Gargantini, L. Giacomin, F. Giacomin, F. Giacomin, L. S. Giacomin, S. Gilletti, D. Giorgi, T. Gilma, B. Gobbi, D. Gould, F. Golf, P. Gori, G. Gortel, E. Grammelin, G. Grosso, F. Guaschi, E. Guastro, G. Hackman, T. Hadden, W. Hawkins, K. Hayashi, A. Heavey, G. Herak, N. Hessey, G. Hodshi, K. Hudson, A. Ianni, C. Ianni, V. Ippolito, C. J. James, C. Jilings, C. Kamalideh, S. Khan, E. Kim, M. King, S. King, A. Kitzner, L. Kochanska, J. Kowalewski, R. Krücken, M. Kuznetsov, S. Kuzin, M. Laflamme, G. LeBlond, L. Liu, A. Lemarié, M. Leyton, X. Li, P. Limalainen, C. Lin, T. Lindner, T. Lomonosov, P. Lu, R. Lubin, G. A. Lukhanin, G. Luo, M. MacDonald, G. Magni, R. Mahajan, S. Manzi, C. Mappelli, P. Margatak, L. Martin, S. Martin, M. Martinez, N. Massacret, P. McClurg, A. B. McDonald, E. Meazzi, R. Migallo, T. Mohyal, L. M. Tosatti, G. Monzani, C. Moretti, B. Morrison, M. Mountani, A. Muraro, P. Nagati, P. Nati, C. R. Nathe, A. J. Noble, A. Novotz, K. Ochiemak, A. Ortiz de Solerzano, F. Padellaro, M. Palomares, I. Palumbo, E. B. Parvathi, H. Papi, L. Parrozzano, S. Parrozzano, K. Patel, A. Patel, M. Palermo, C. Pellegrino, P. Pelliccione, V. Pessio, A. Pocar, A. Pope, S. Porsika, F. Pretz, O. Putignano, J. L. Raaf, C. Ratti, M. Razzi, A. Rizzato, D. Reed, J. Refsgaard, T. Reilly, A. Renahou, F. Retiere, E. Riccobene, D. Rigamonti, A. Rizzi, J. Roze, J. Romualdez, L. Russel, D. Sablone, S. Sala, D. Salomoni, P. Salvo, A. Santoni, E. Senozon, S. Santoni, C. C. Savarese, B. Scapparoni, T. Scheibel, S. Scora, M. Settimo, B. Shen, S. Shewry, A. Sher, A. Shi, P. Shrivastava, A. Shukla, B. Smith, H. J. Smith, A. Smeets, C. Soudani, P. Sriragavi, M. Suchanek, B. Sur, S. Tacchino, L. Takeuchi, M. Tardocchi, R. Tartaglia, E. Thomas, D. Trank, J. Tseng, L. Tseng, L. VanPapey, V. Vedia, B. Velho, S. Viel, A. Visiol, L. Vukob, D. Vonic, M. Wade, D. Walter, H. Wang, M. H. L. S. Wang, S. Westerdale, D. Wood, D. Yates, S. Yon, and V. Zambano

COLLECTIONS

Paper published as part of the special topic on Flow and the Virus
This paper was selected as Featured



ARTICLES YOU MAY BE INTERESTED IN

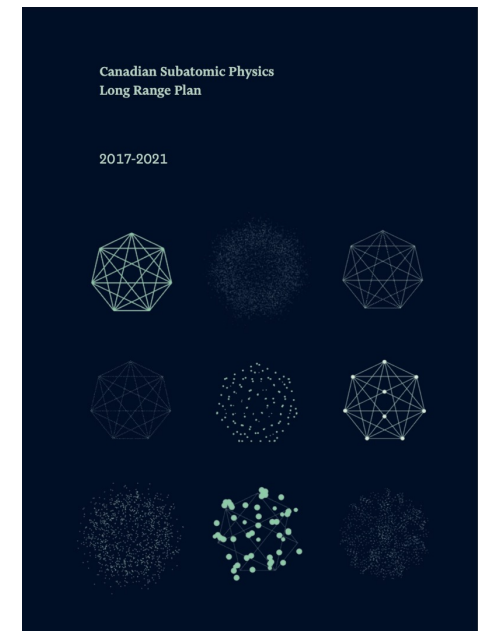
Visualizing droplet dispersal for face shields and masks with exhalation valves
Physics of Fluids 32, 091701 (2020); <https://doi.org/10.1063/5.0022968>
Visualizing the effectiveness of face masks in obstructing respiratory jets
Physics of Fluids 32, 061708 (2020); <https://doi.org/10.1063/5.0018018>

Priorities for 2020-2025

- **ARIEL** – complete CFI project in 2026 with phased science delivery
- **IAMI** – complete construction in 2022 and ramp up isotope production
- **TRIUMF Innovations** – seize key commercial opportunities
- Deliver world-class in-house science
(ISAC RIB, Materials, UCN, SAP Theory, Life Sciences, Accelerator Science)
- Lead selected off-site particle physics activities
(ATLAS/HL-LHC, T2K/Hyper-K, nEXO, ALPHA, SuperCDMS, Darkside)
- Support Canadian Subatomic Physics community aligned with LRP
- Continue infrastructure and process improvements
(Accelerator and Facility Infrastructure, TRIUMF Control Centre, Workday ERP, Cyber Security)
- Invest into people and skills
(career development, student program, outreach)



<https://fiveyearplan.triumf.ca/>



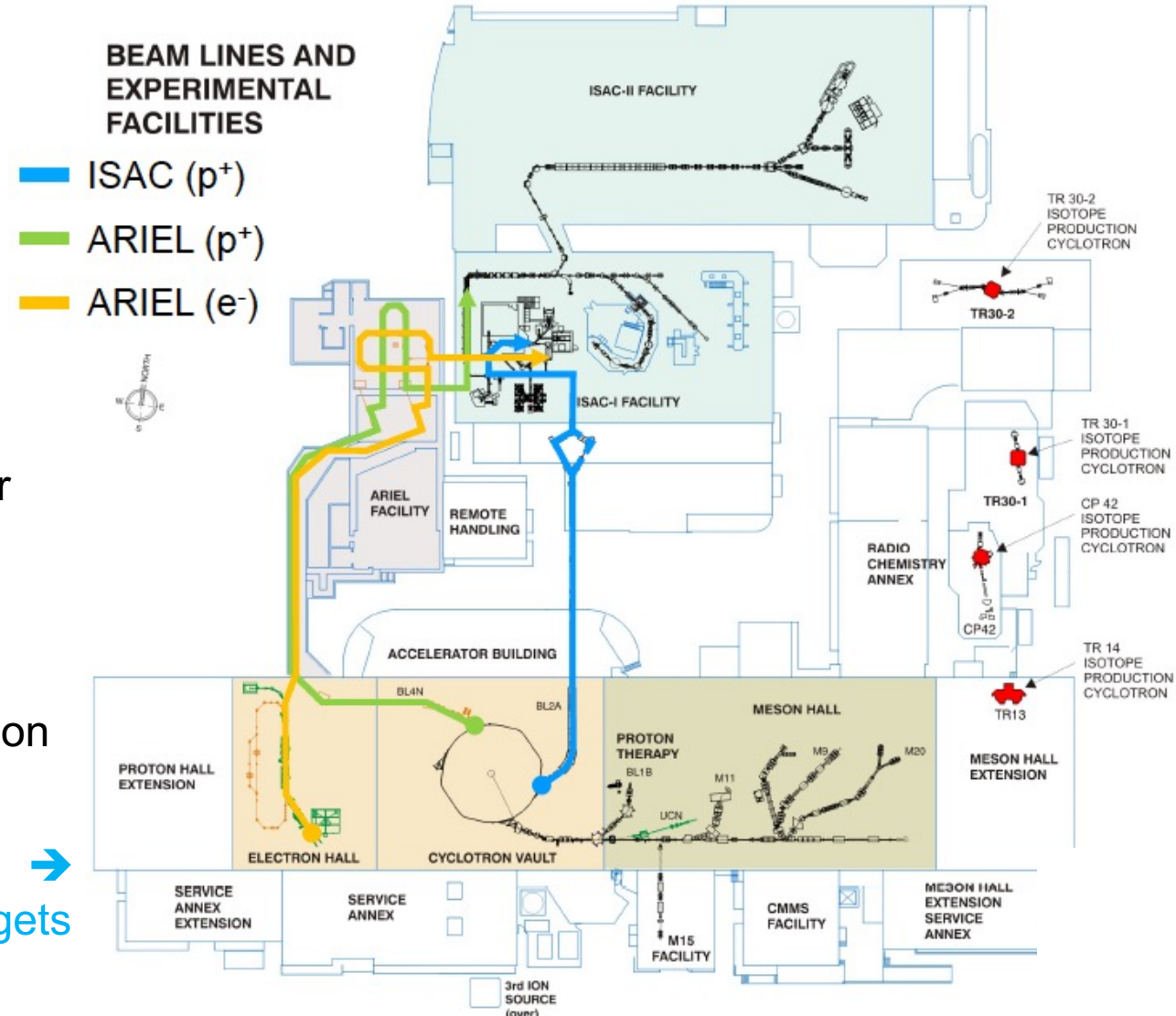
Advanced Rare Isotope Facility (ARIEL)

TRIUMF's flagship project

Substantially expands RIB capabilities:

- Simultaneous RIB production from 3 targets
 - 50 kW existing ISAC proton target
 - 50 kW new ARIEL proton target
 - 100 kW new ARIEL electron target
- More beam hours for science
- Multi-user capability with more and new isotopes for
 - Nuclear Physics (Structure, Nucl. Astro, Fund. Sym.)
 - Materials Science, Life Sciences
- Project completion in 2026 with phased implementation, interleaving science with construction
- Schedule re-baselined accounting for delays due to CVOID and added complexity (targets, shielding), → final completion date unchanged but production targets delayed to 2025/26

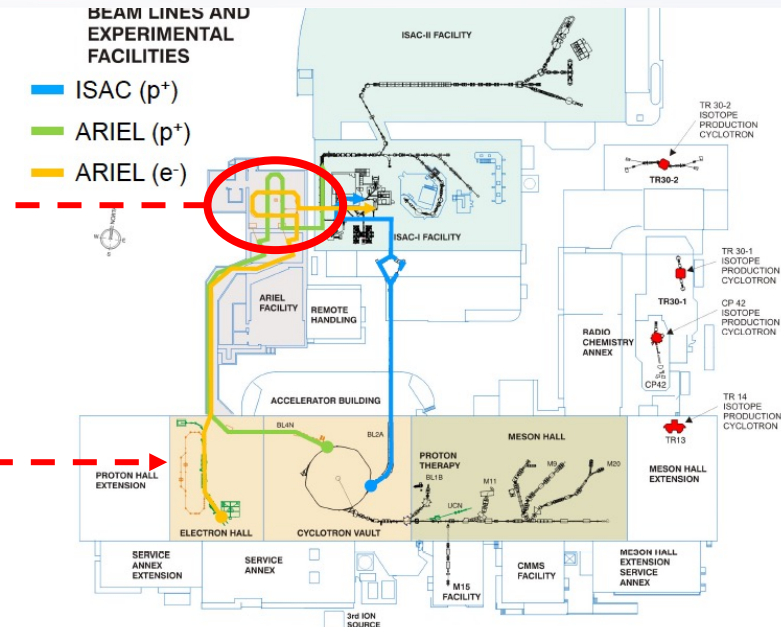
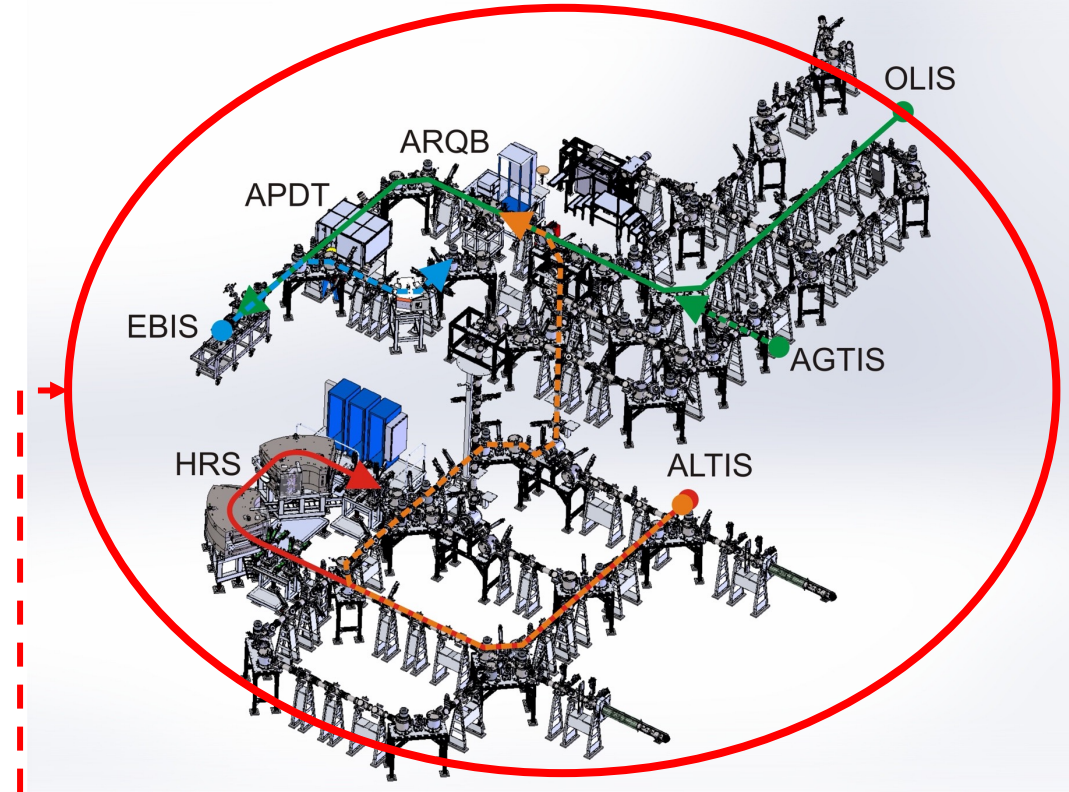
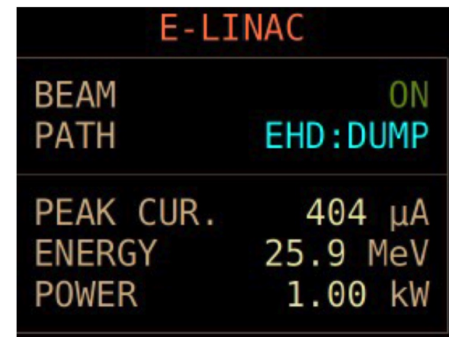
TRIUMF accelerator complex



ARIEL Progress



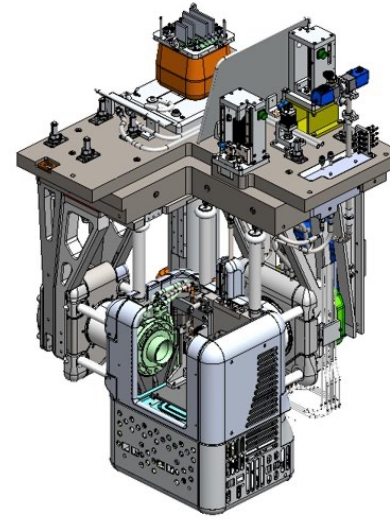
- CANREB EBIS charge breeder delivered $^{59}\text{Cu}^{19+}$ beam to IRIS experiment
- CANREB High Resolution Separator demonstrates resolution of 10,000 w/o higher-order corrections
- e-Linac has reached intermediate milestones of 30 MeV, 1 kW (on the way to 100kW)



ARIEL Progress

- Hot Cell factory acceptance completed in France
- Target Module design maturing
- Layer 2 (of 4) of Target Hall shielding progressing

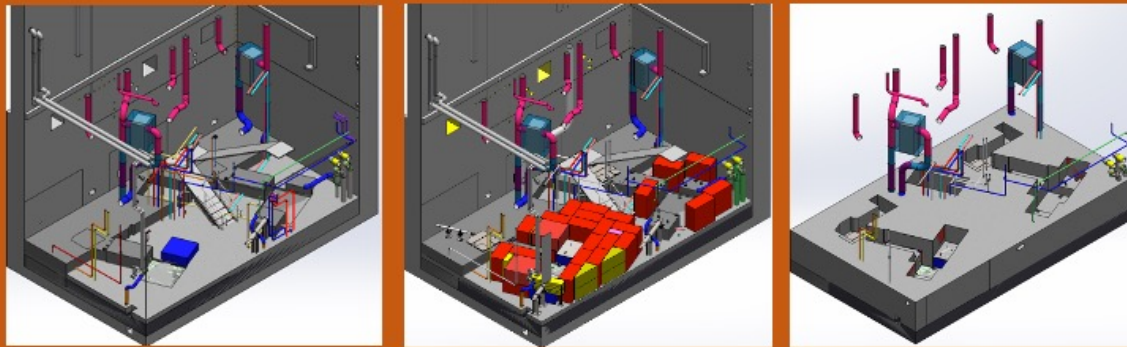
Electron Target



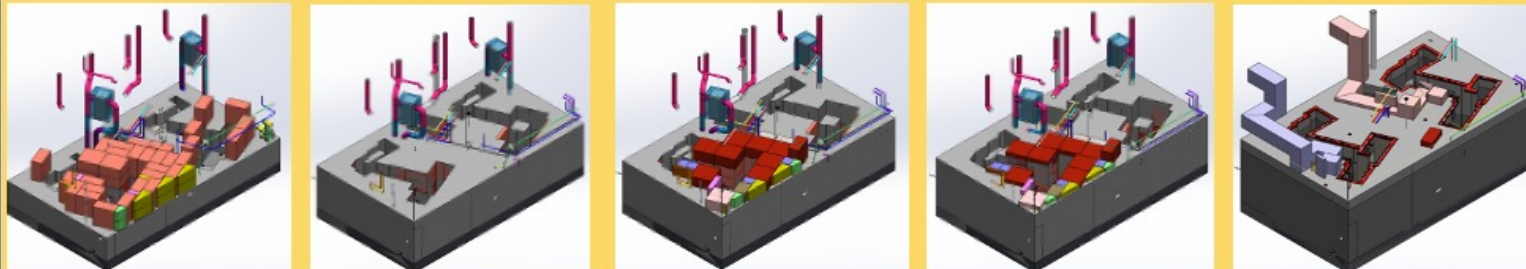
Hot Cell



L2A



L2B



Institute for Advanced Medical Isotopes (IAMI)

- IAMI is a ~C\$50M facility supported by the Government of Canada, the Province of British Columbia, BC Cancer, and UBC
- Home to a TR24 medical cyclotron and a GMP hot-cell complex, IAMI will serve as a global centre for medical research and radiopharmaceutical development
- Funding was announced by PM Justin Trudeau on November 1, 2018
- Construction under way with completion planned for 2022



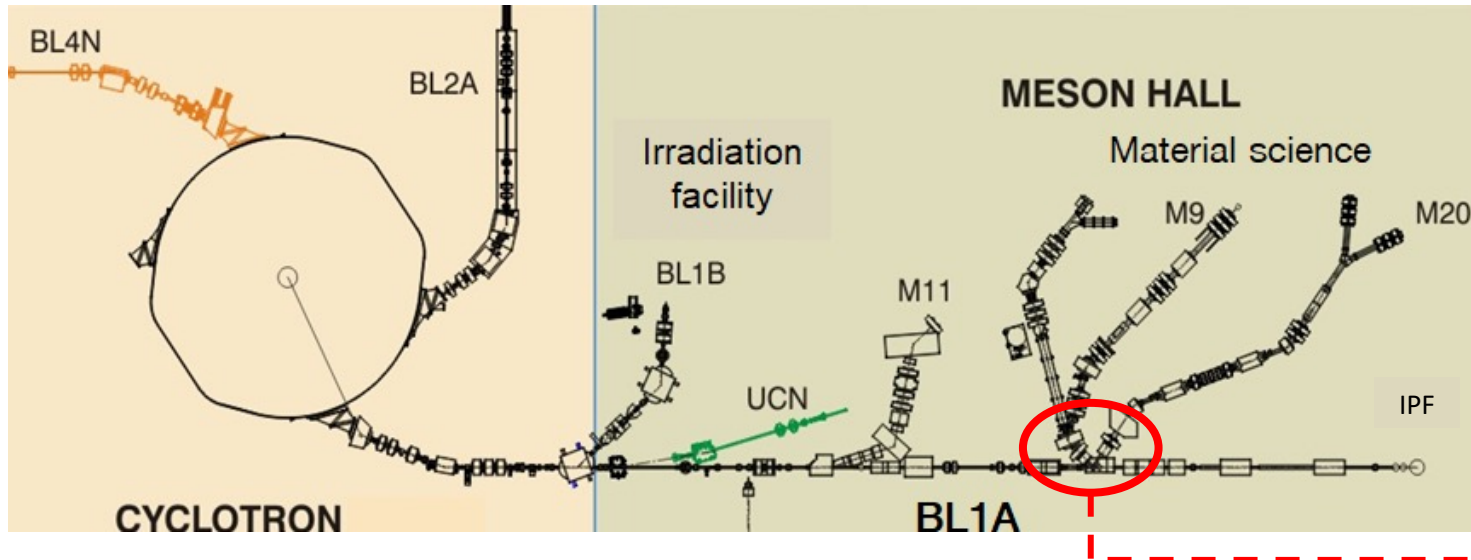
Infrastructure Improvements

Cooling Tower replacement

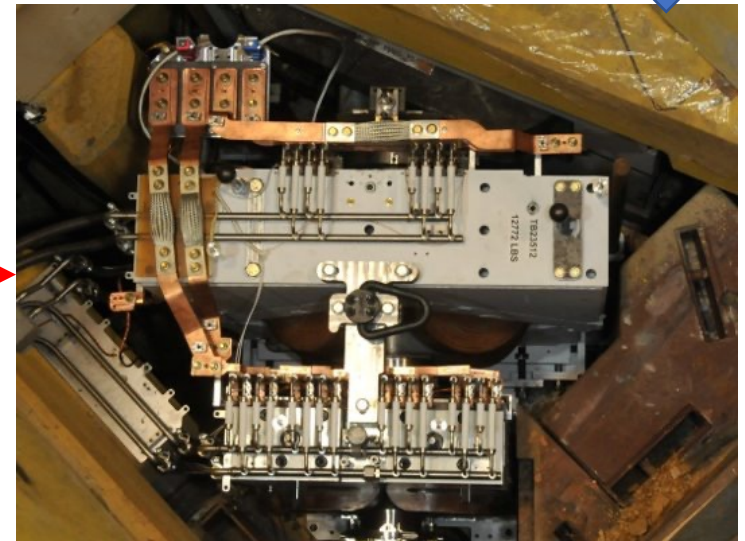


BL1A upgrade project

- Planning underway for major upgrade project to restore reliable operation while optimizing beam dynamics (to be funded)
 - New beam configuration
 - New magnets, power supplies, diagnostics, collimators
 - New remote handling technologies
- Enable radioisotope production (α -emitters) and μ SR programme



M9/T2 connection restored



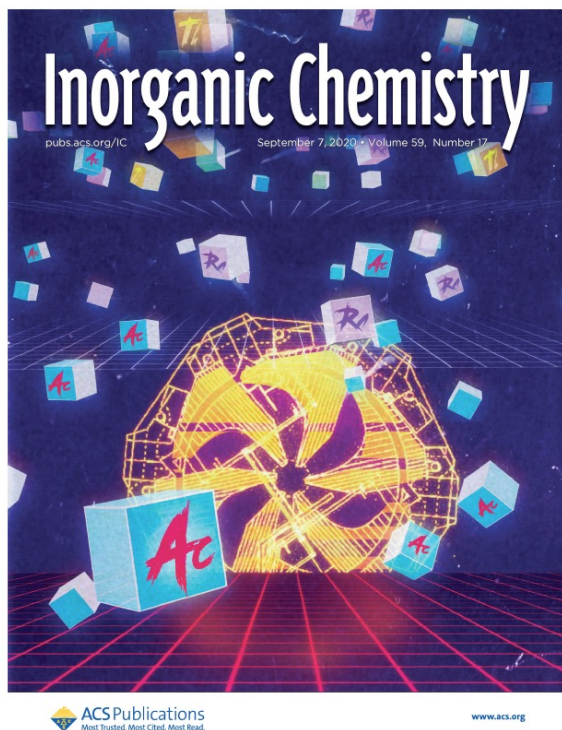
Selected Research Highlights



^{225}Ac production

Therapeutic Isotope Production

- Cover publication for Inorganic Chemistry
- Additional coverage in Physical Review C



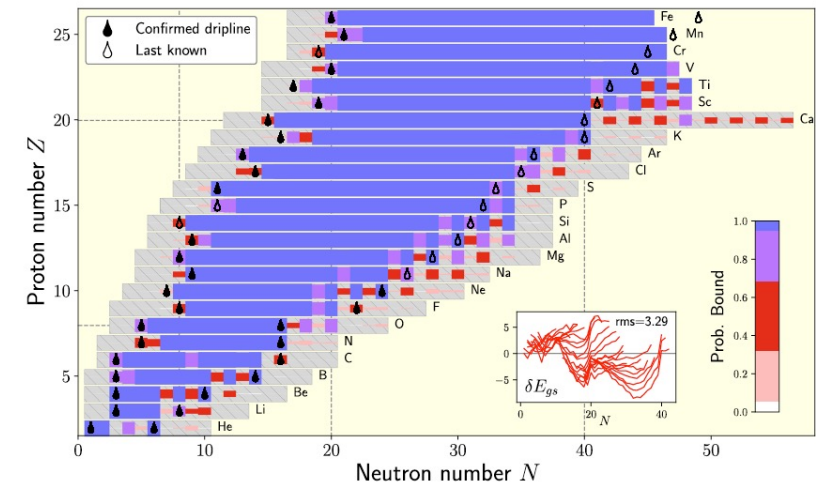
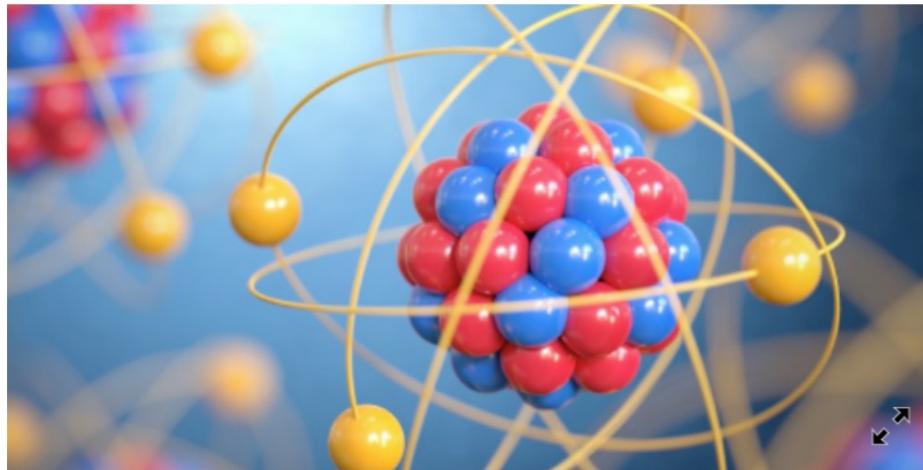
- Irradiation/spallation of ^{232}Th @ 500 MeV to produce a variety of isotopes (see above)
- Ac isolated from complex mixture, purified & used internally/shipped to end user
- Emerging Opportunities:
 - Isolation of ^{233}Pa and ^{228}Th from Th spallation waste;
 - Various auger emitters; novel PET isotopes (^{135}La)

Robertson et al. Inorg. Chem 2020, 59, 12156
Robertson et al. Phys. Rev. C 2020, 120, 044613

Ab-initio Nuclear Theory

Defining the Limit of Existence – prediction of drip-lines using first-principles calculations

- Break-through publication in Physical Review Letters



Featured in Physics

Editors' Suggestion

Ab Initio Limits of Atomic Nuclei

S. R. Stroberg, J. D. Holt, A. Schwenk, and J. Simonis
Phys. Rev. Lett. **126**, 022501 – Published 12 January 2021

PhysiCS See synopsis: [Predicting the Limits of Atomic Nuclei](#)

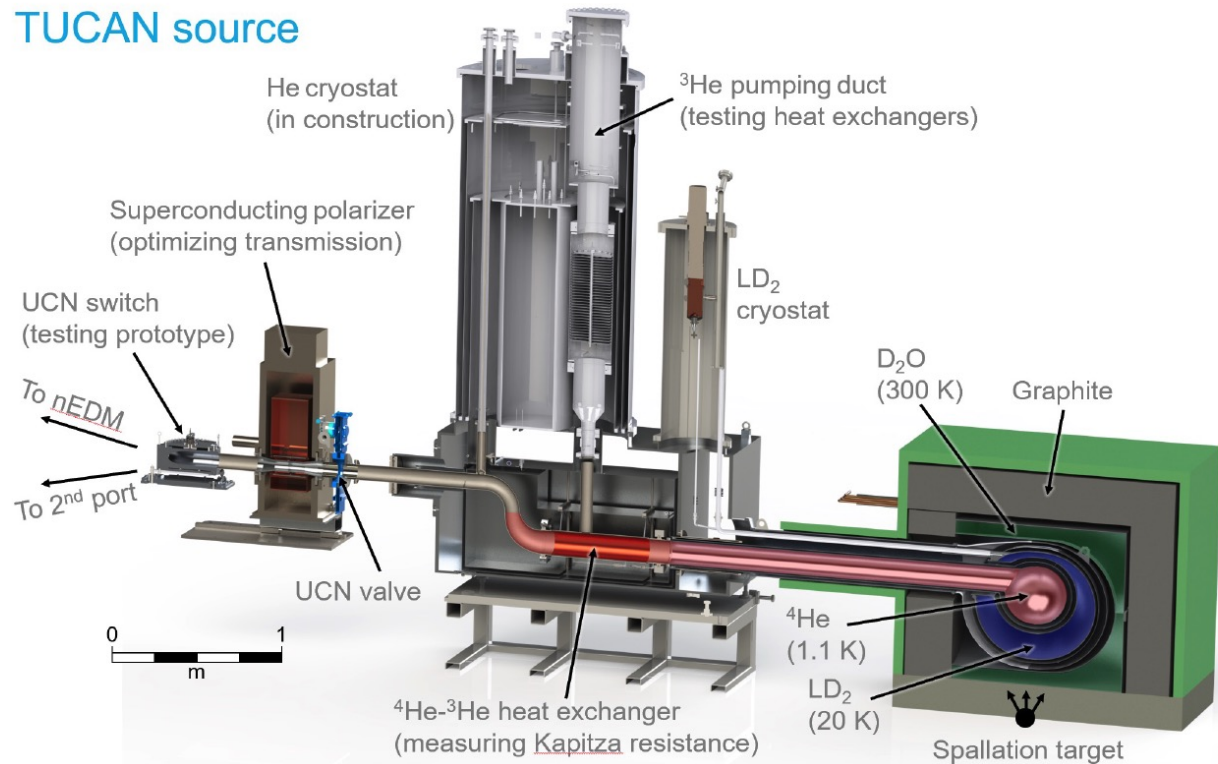
- *ab initio* predictions of drip lines highlighted as Editor's suggestion and Featured in Physics
- First principles nuclear theory applied to predict drip lines from helium to iron
- Masses of ~700 nuclei predicted using chiral nucleon-nucleon and three-nucleon interactions as input

TRIUMF UltraCold Advanced Neutron Source and EDM experiment

UCN source

- Aiming at world-record UCN yield (experiments are statistics limited)
- Spallation neutron production
- Heavy water and deuterium moderators
- Superfluid helium-4 converter at ≈ 1.1 K
- UCN are extracted to two experimental ports: nEDM & user facility

TUCAN source



Progress:

2020:

- Validated UCN-vessel coating at LANL
- Core moderator vessel machined

2021:

- Cryostat tests in Japan completed
- Prototype source uninstalled
- Shielding prepared for new source

Plans:

2021:

- Installation of cryostats for new source
- **Start of cryogenic commissioning**

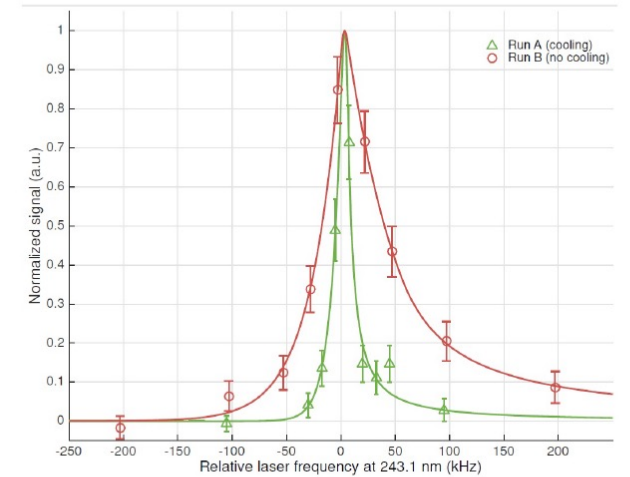
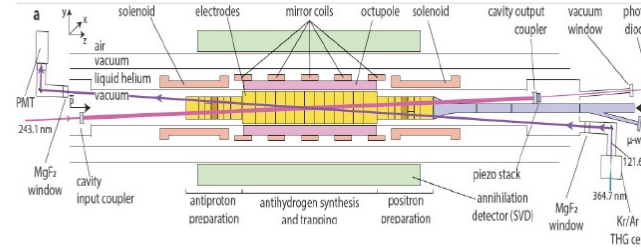
2022:

- Installation of moderators
- **First UCN production with new source**

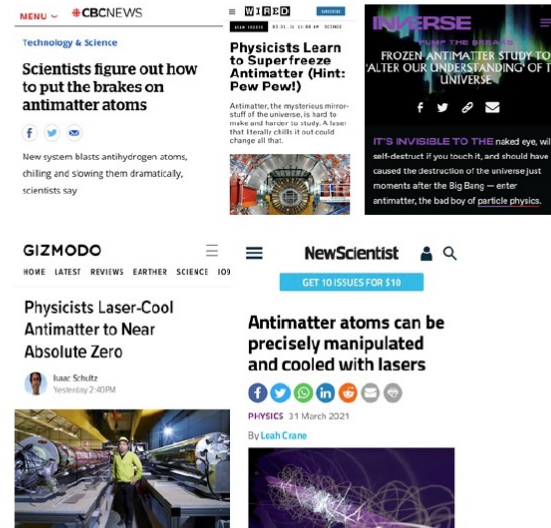
ALPHA

Antimatter - First laser cooling of antihydrogen atoms

- Cover publication for Nature – April 2021

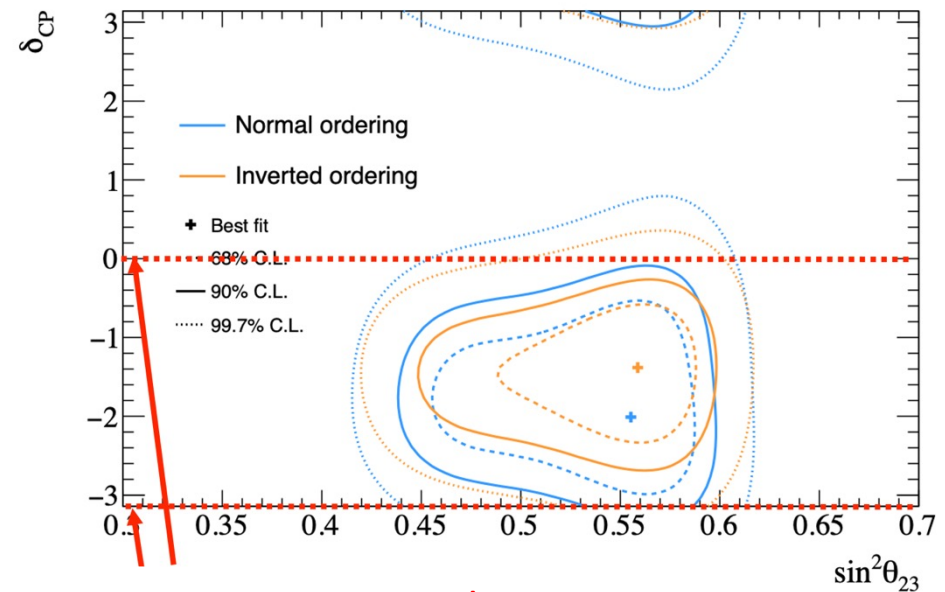


- Break-through achievement
- ALPHA collaboration achieves a world-first: laser cooling
- TRIUMF lead effort (and TRIUMF-built apparatus)



T2K

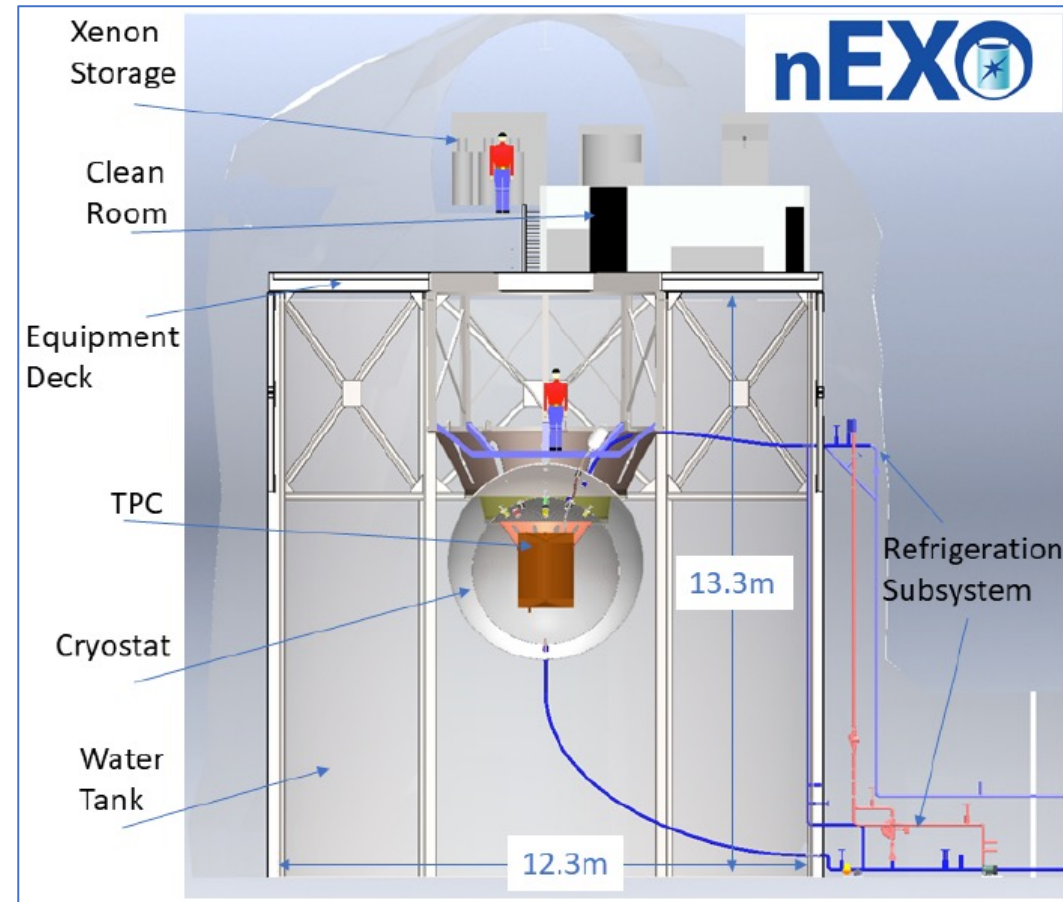
- T2K results with data through 2018 published as cover article in Nature.
- Results updated with data through 2020 were presented at Neutrino 2020
- T2K sees a preference for CP violation (matter/antimatter asymmetry)!



CP conserving values

nEXO

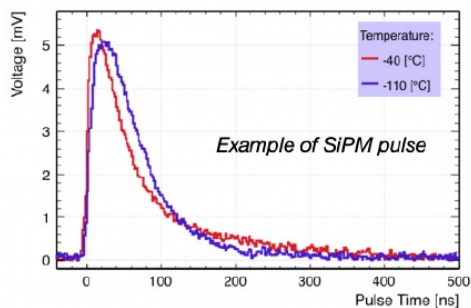
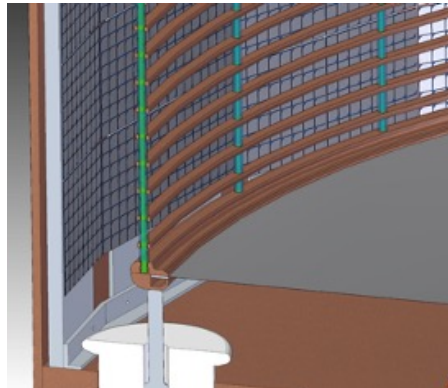
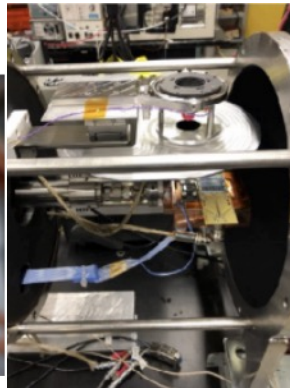
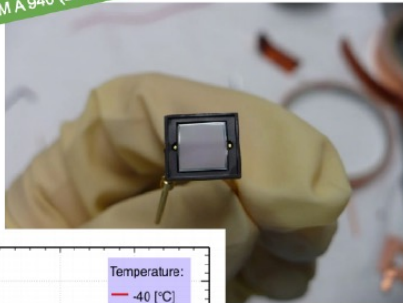
- Next-generation liquid-Xe TPC
- 5-tonne enriched in ^{136}Xe at $\sim 90\%$
- Designed to go beyond $T_{1/2} \sim 10^{28}$ years (new sensitivity study)
- Preferred location: SNOLAB Cryopit
- UBC/TRIUMF led CFI project conditionally approved
 - pending outcome of US DOE Portfolio review
 - R&D and construction infrastructure at TRIUMF, SNOLAB, McGill, Carleton, Sherbrooke



Silicon PhotoMultiplier Testing

Hamamatsu VUV4 MPPC

NIM A 940 (2019)

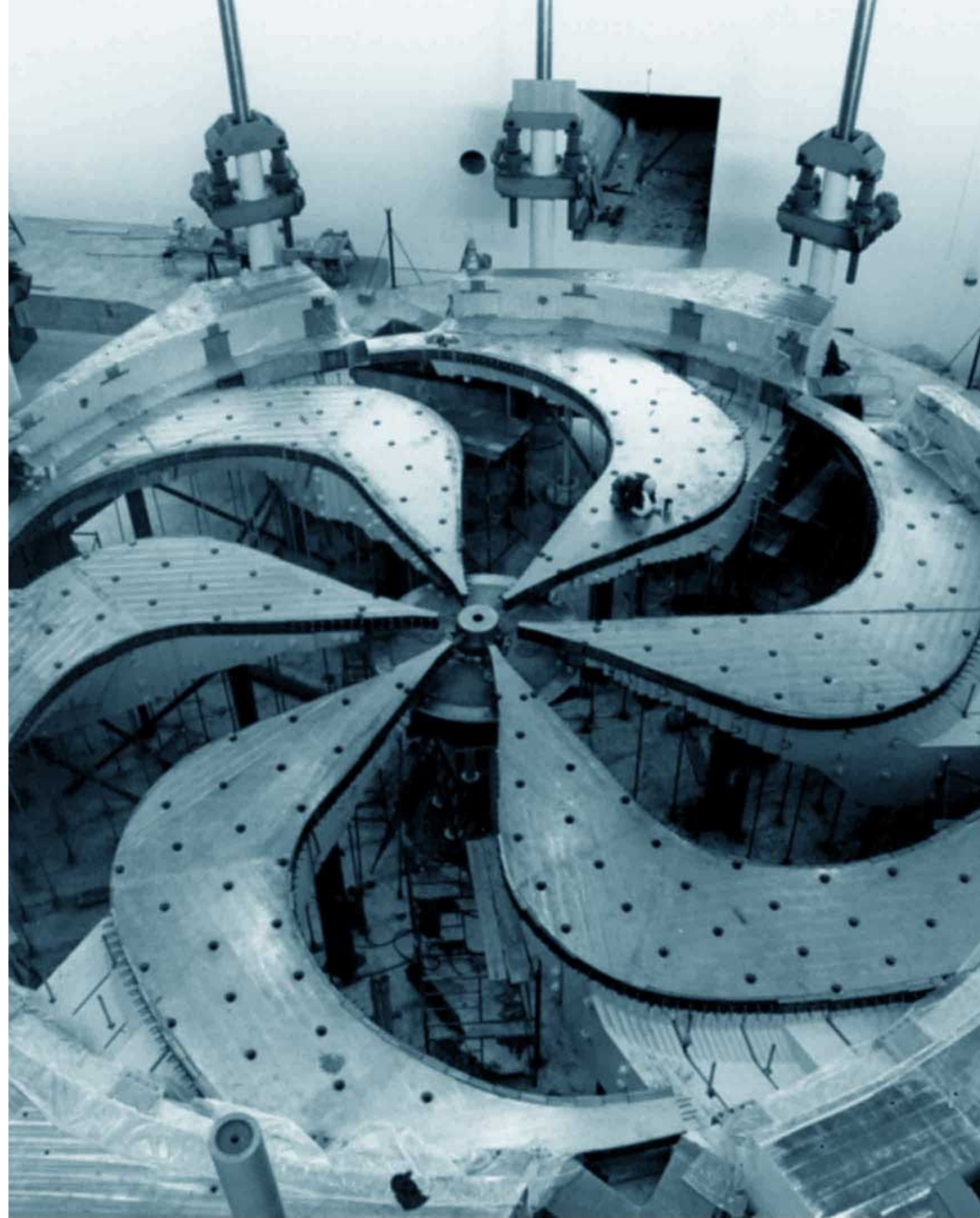


- 5 m² SiPM photodetector on TPC barrel
- SiPM testing in vacuum at LXe temps
- CW VUV light source with monochromator
- Improvements in pumping/ baking to eliminate residual water film

Requirement	Hamamatsu VUV4	FBK HD3
Photo-Detection Efficiency (>15%)	19 ± 3%	27 ± 5%
Correlated Avalanches (<0.2 @ >3V OV)	0.15 @ 3V	0.17 @ 3V
Dark Counts (<50 Hz/mm ²)	0.2 Hz/mm ² @ 4V	0.2 Hz/mm ² @ 4V

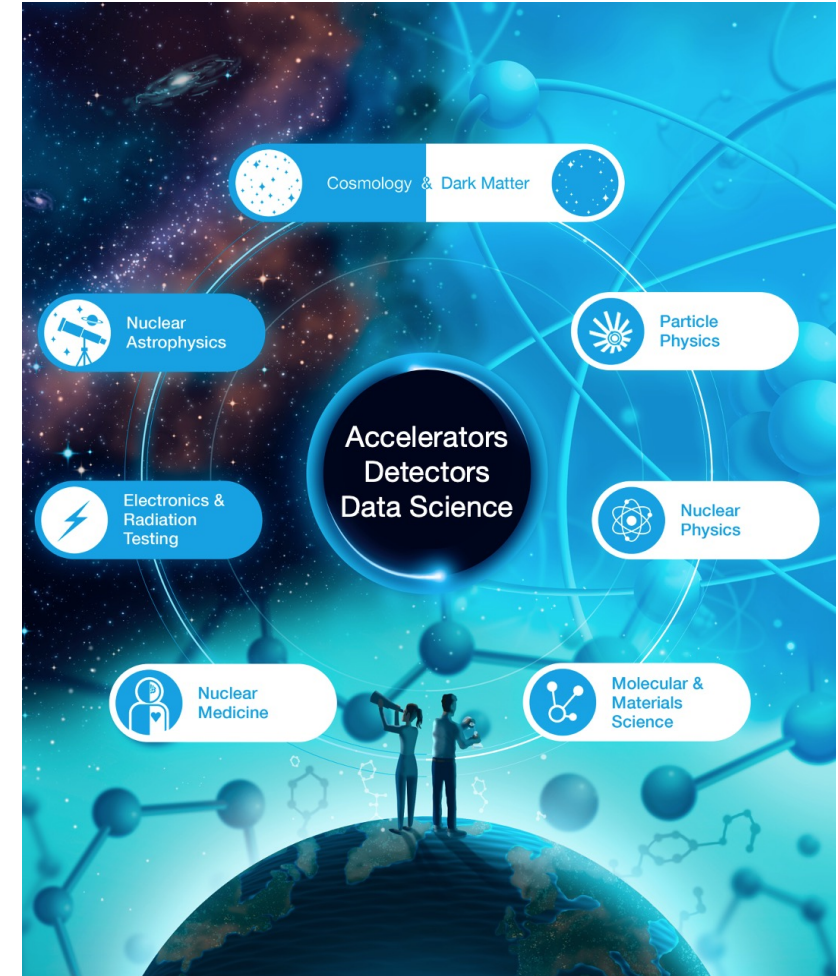
20-Year Vision

2021-06-11



20-year Vision for TRIUMF

- Rolling 20-year Vision, to be updated every 5 years
- The 20-year Vision will
 - articulate TRIUMF's long-term ambitions and overall direction
 - guide the development of the next 5-Year Plan (2022-23),
 - guide the long-term facility development
- Phased development
 - **Visioning and listening (Fall 2020 – Spring 2021)**
 - Stakeholder and community engagement
 - **Convergence on vision framework (Summer - Fall 2021)**
 - Development and refinement through consultations
 - **Finalization (Fall – Winter 2021)**
 - Final 20-year Vision document approved by TRIUMF Board



Phase I - Visioning and Listening

Topical Groups

- Nuclear Physics
- Particle Physics
- Fundamental Physics with AMO techniques
- Life Sciences
- Probes for Quantum Materials and Biomolecules
- Quantum Technologies (detectors, sensors, traps, etc.)
- Scientific Computing
- Emerging trends in Convergence Research
- Accelerator Sciences and Facilities
- TRIUMF Site Development
- People and Skills
- Innovation & Collaboration

Consultation on draft Pillars of 20-year vision during TRIUMF Science Week 2021 (Aug. 16-20)

20-year Vision Phase 1 status

Topicals Groups are meeting and consulting

Community Consultations

- ThoughtExchange Ideation Platform
- Survey with specific questions of Topical Groups

Steering Committee Meeting April 8

- Encouraged even broader stakeholder engagement

Topical Groups will deliver

- 5-pager answering the guiding questions
- Topical Vision Summaries



Guiding Questions

- What is TRIUMF today?
- What trends and changes will shape TRIUMF's future?
- What will TRIUMF be?
- What will TRIUMF have accomplished?
- What will TRIUMF be doing and what will TRIUMF not be doing anymore?
- What will TRIUMF look like?

Summary

- TRIUMF governance structure in evolution
- Delivering on the goals laid out in Strategic Plan 2020-2025
 - Advance its major platforms ARIEL, IAMI, TRIUMF Innovations
 - Invest into infrastructure and process renewal
 - Deliver and support world-class science
 - Investing into people and skills
- Long term challenge for TRIUMF
 - Sustainable operation of with ramp up of ARIEL and IAMI requires higher core funding level
 - Five-year planning exercise starts next year
- 20-year Vision Development
 - TRIUMF is developing a 20-year vision to position the lab for sustainable long-term future

Q&A

