

TRIUMF Quantum Workshop

Robert H. Lee Family Boardroom, UBC

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TRIUMF is located on the traditional, ancestral, and unceded territory of the xwməθkwəy̓əm (Musqueam) People, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site.

2024-03-10





**TRIUMF is Canada's
particle accelerator centre**

TRIUMF's Vision and Mission

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Vision

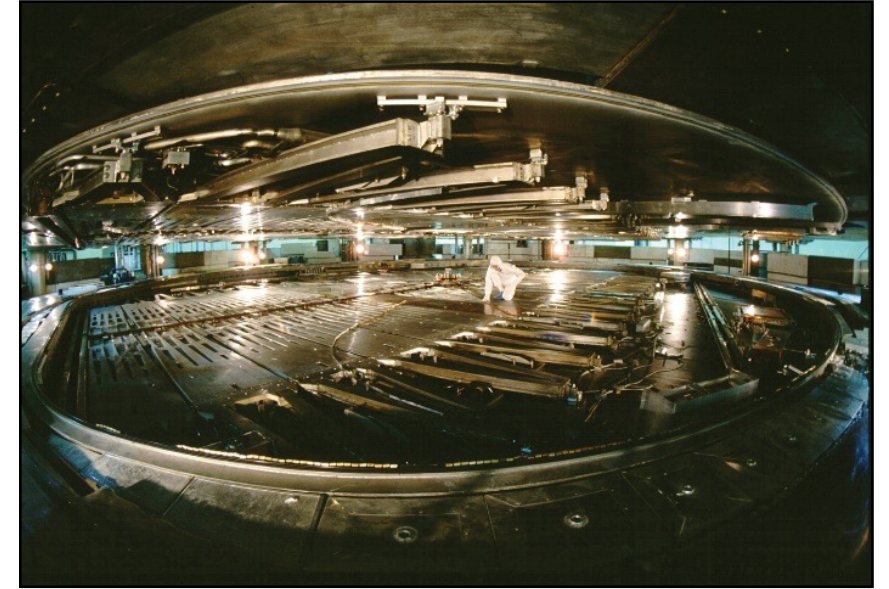
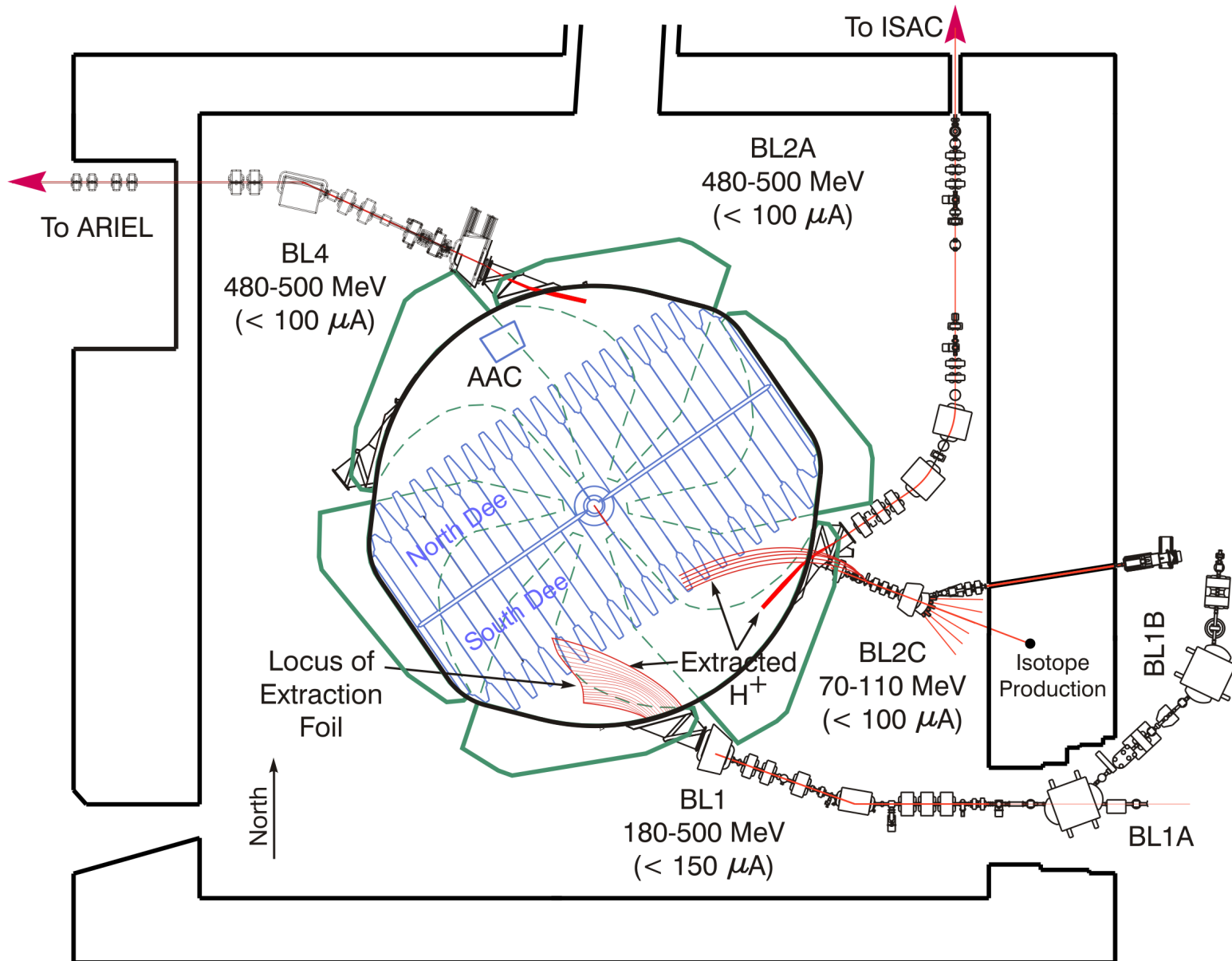
Our Vision is for Canada to lead in science, discovery, and innovation, improving lives and building a better world

Mission

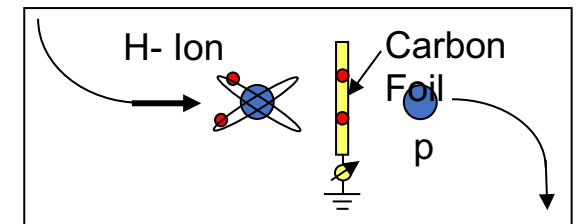
Our Mission is to serve as Canada's particle accelerator centre. We advance isotope science and technology, both fundamental and applied. We collaborate across communities and disciplines, from nuclear and particle physics to the life and material sciences. We discover and innovate, inspire and educate, creating knowledge and opportunity for all



TRIUMF's Main Cyclotron



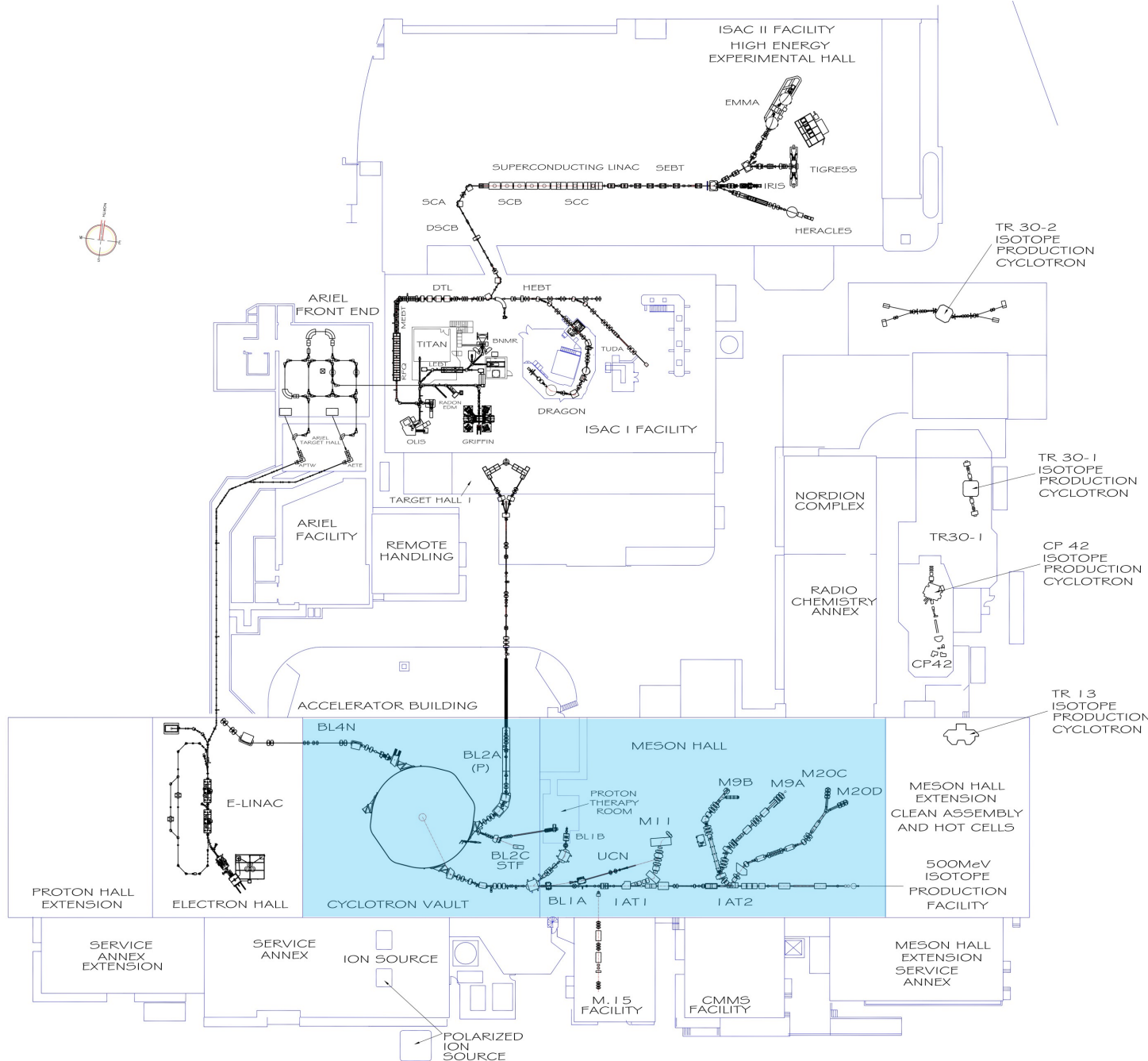
H⁻ extraction



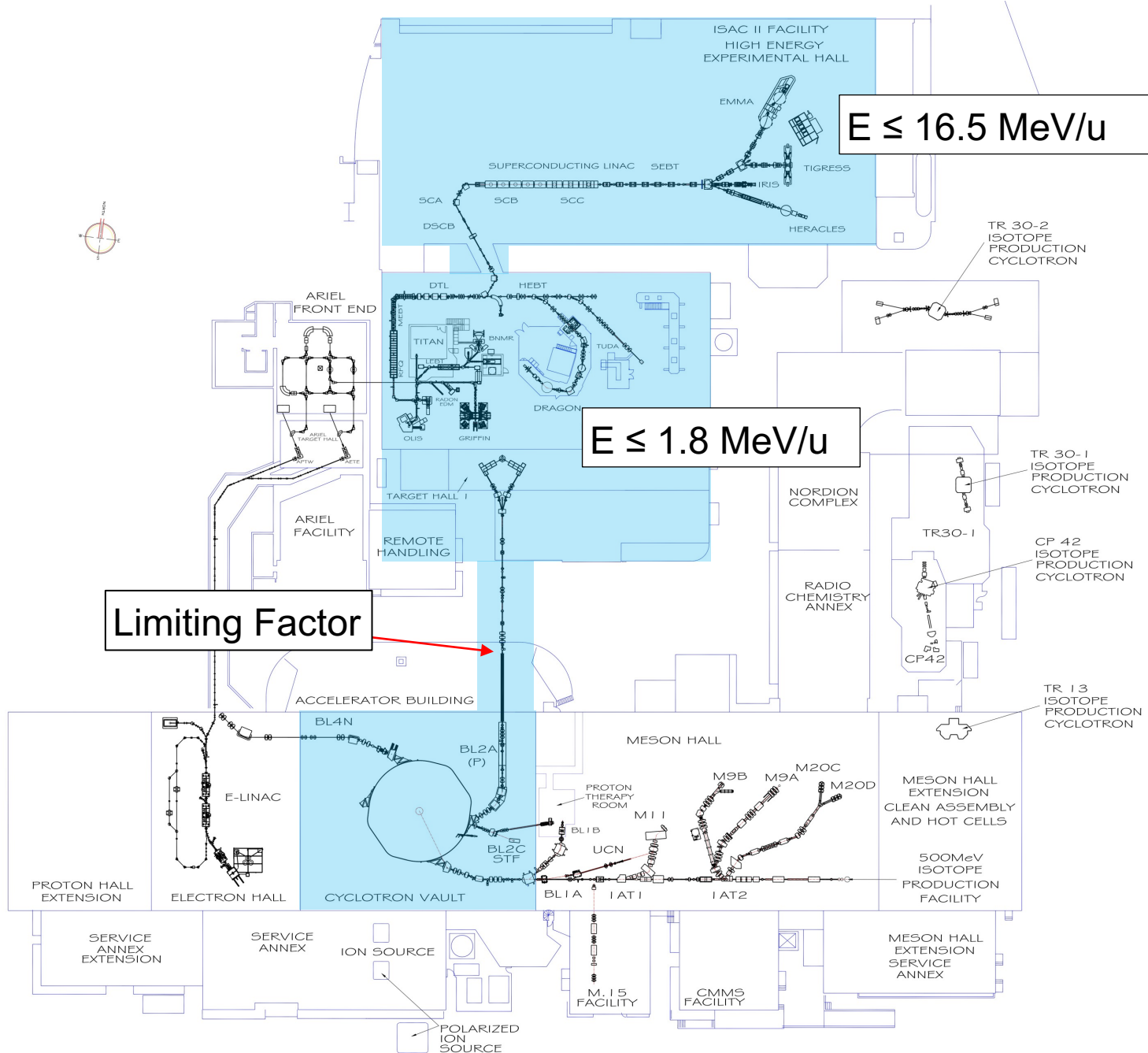
TRIUMF's Accelerators

Beamlines 1A, 1B, 2C

Materials Science μ SR
Ultra Cold Neutron Facility
Isotope Production
Irradiation Services
(Proton Therapy)

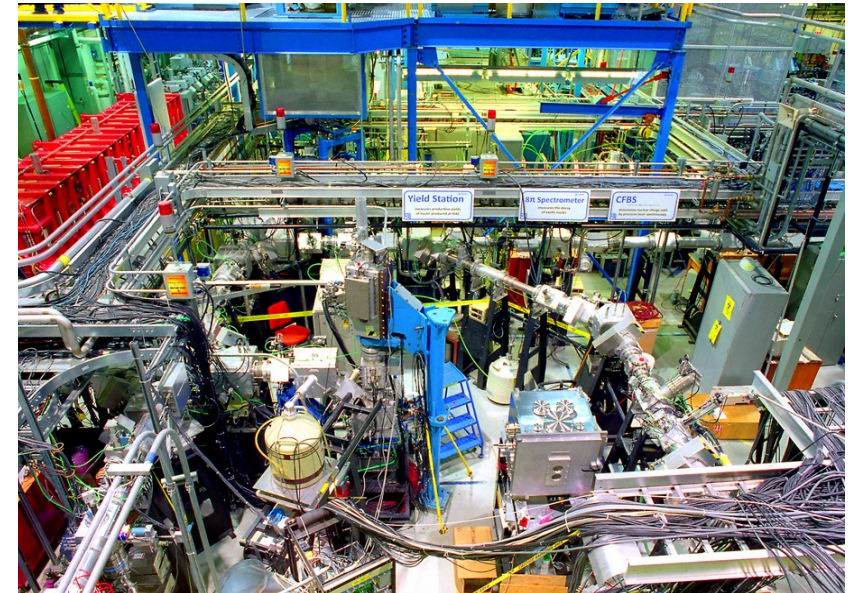


TRIUMF's Accelerators



■ Beamline 2A

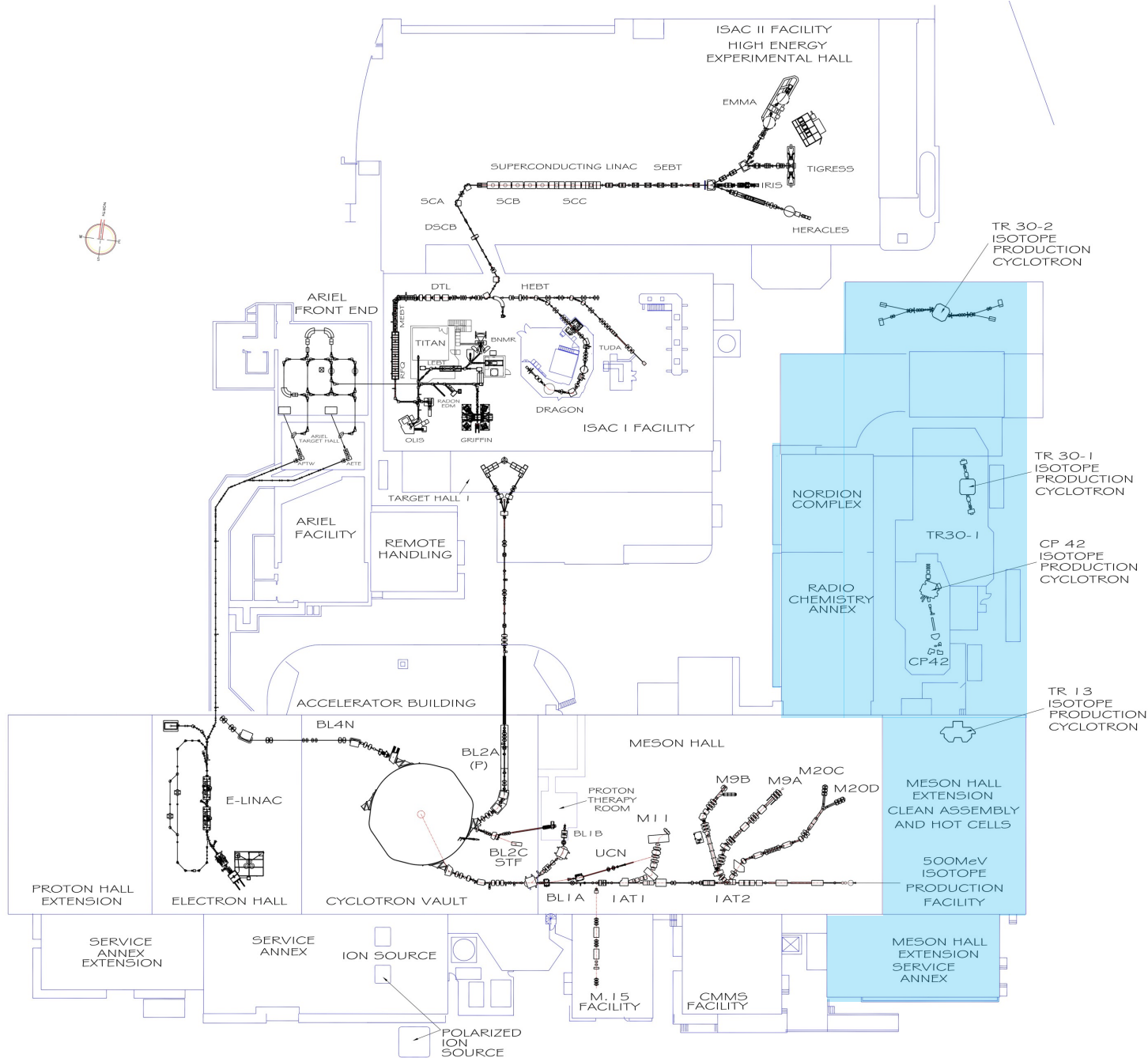
- ISAC I Facility
- ISAC II Facility
 - Nuclear Astrophysics
 - Nuclear Structure
 - Electroweak Physics
 - Materials Science β NMR



TRIUMF's Accelerators

■ Nuclear Medicine

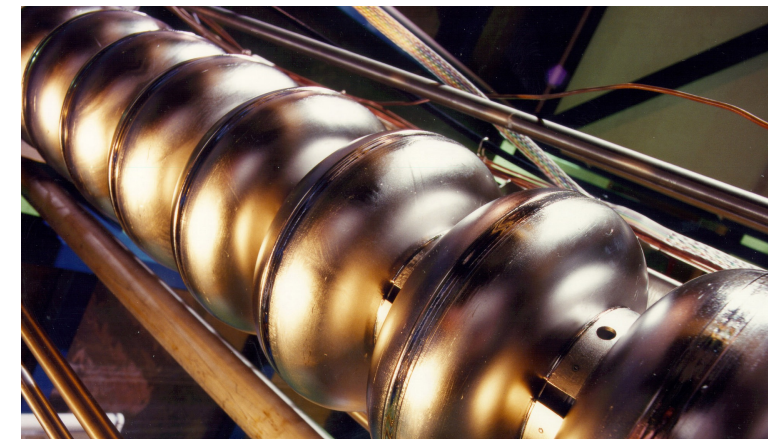
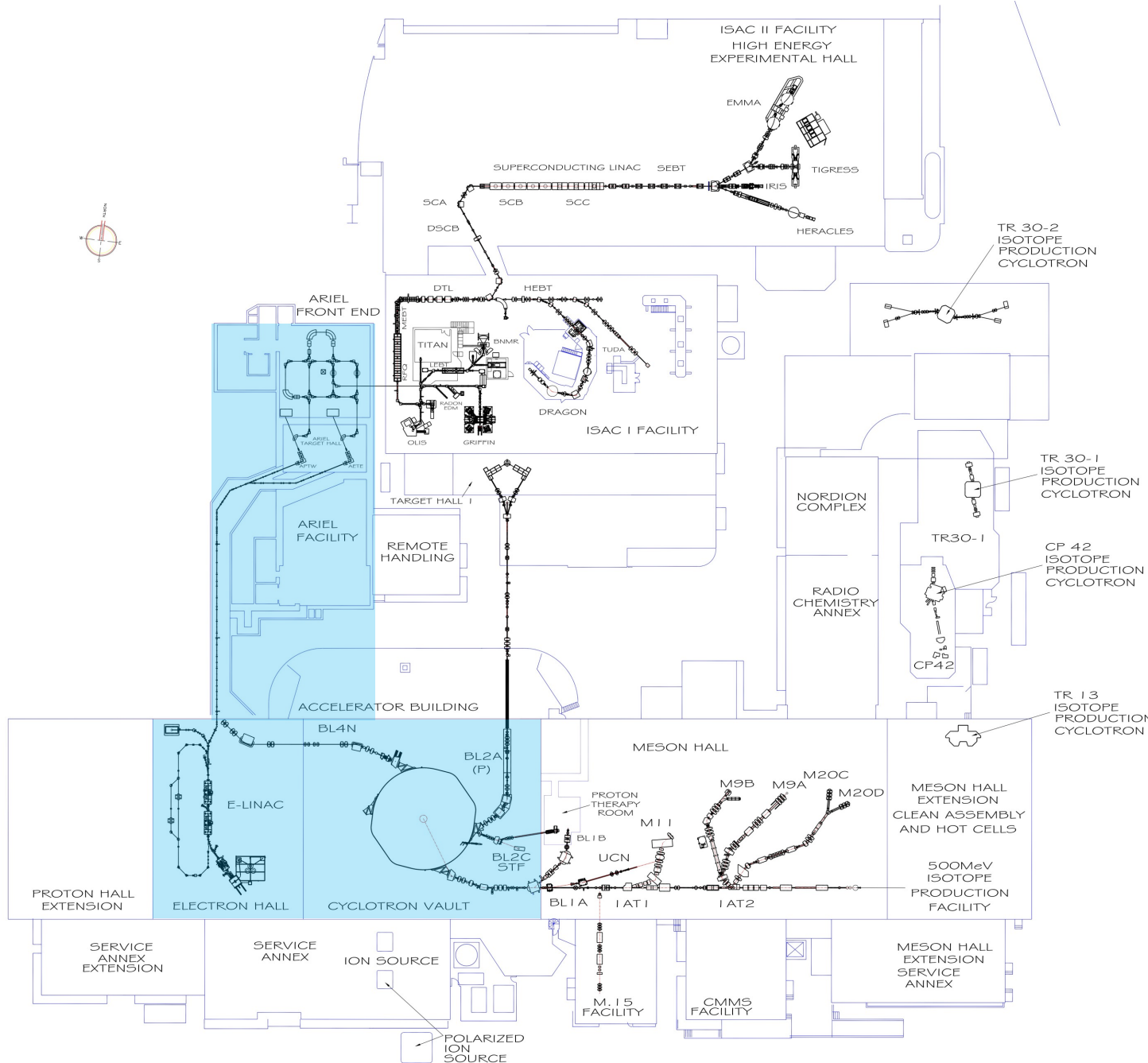
- Five H⁻ medical cyclotrons (including new IAMI TR 24)
 - Isotope production and R&D
- Radiochemistry
 - BWXT
 - ~2M doses annually
 - UBC
 - Centre for Brain Health
- New **IAMI Facility**



TRIUMF's Accelerators

■ ARIEL

- Multi-user, multi-disciplinary RIB Facility
- Intense, clean RIB beams into ISAC experiments
 - New 30 MeV 300 kW superconducting CW electron linac
 - New electron beamline and 100 kW target station
 - New 50 kW proton beamline and target station



Workshop goals

- **Formulate a quantum strategy for TRIUMF**
- What research at TRIUMF is aligned with Canada's National Quantum Strategy
- What "quantum-enabled" science done at TRIUMF
- Identify synergies among groups at TRIUMF on quantum-related activities
- Future directions related to quantum science that TRIUMF should consider pursuing

- This is the first workshop of an envisioned series on the topic



TRIUMF's strength – quantum sensing technologies development and applications, quantum material research, quantum-enabled science, HQP training

Short-term objectives

- Draft a brief document outlining the current vision of TRIUMF's quantum strategy
- Prepare an accompanying presentation
 - Both will be evolving documents
- Take advantage of new funding opportunities (standing objective)
 - For example, call for proposals to strengthen Canada's quantum research and innovation capacity in quantum sensing announced in January:

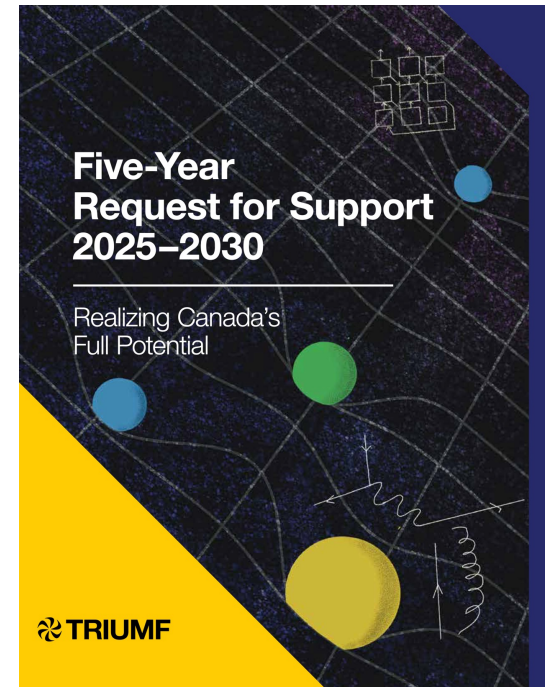
NSERC and the NRC launch a collaborative funding opportunity to advance the industrial readiness of quantum sensing technologies.

Applications accepted until June 14, 2024.



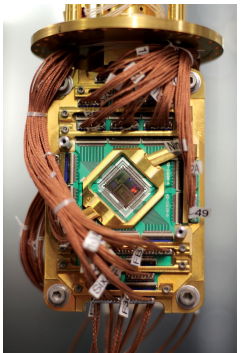
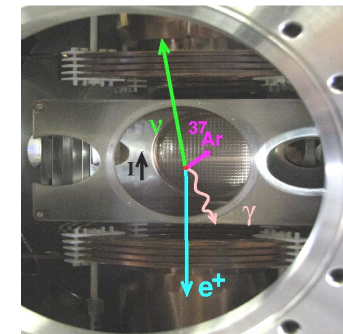
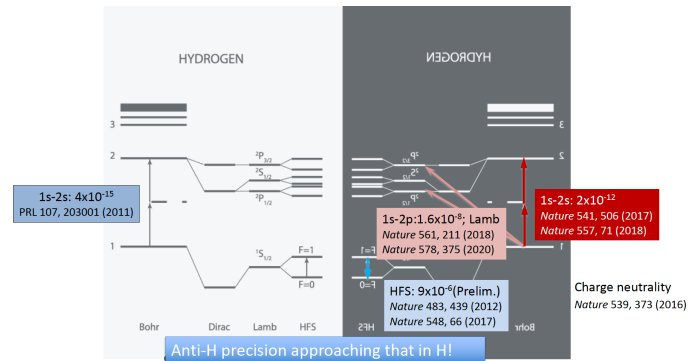
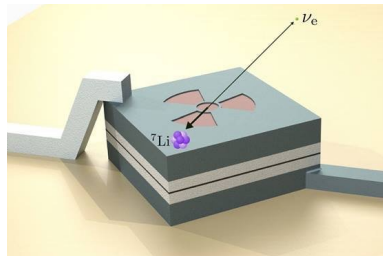
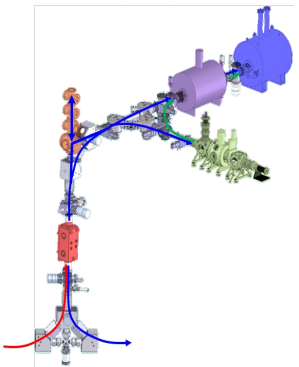
Steps taken in the past couple of years

- Established quantum & precision forum
 - Hosting regular seminars and discussions
- Drafted plans to establish
 - Quantum Science and Precision Physics Centre
 - New capabilities - hiring of experts in the areas not currently readily available (optical frequency metrology, next-generation cryostat R&D, advanced magnet development, and quantum materials characterization)
 - Detector Centre
 - AI Centre
 - Included in TRIUMF's Five Year Request for Support 2025-2030



Quantum Science and Precision Physics at TRIUMF

- Many experiments and activities at TRIUMF fall under the Quantum Science and Precision Physics umbrella
 - Quantum material research - μ SR, β NMR – new beamlines (M9A, M9H), renovated M15
 - Precision quantum techniques - TUCAN, TITAN, Francium trapping, TRINAT, ALPHA, RILIS
 - New flagship experiments - RadMol, HAICU, nEXO, PIONEER
 - Experiments utilizing novel quantum sensing technologies – BeEST
 - Quantum computing – D-wave annealer for Quantum - Assisted ML simulation of ATLAS calorimeter
 - Development of single-photon detection techniques – Science Technology dept



Agenda

08:45	→ 09:15	Breakfast	30m
09:15	→ 10:40	Overview	
09:15		Introduction	15m
		Speaker: Petr Navratil (TRIUMF)	
09:30		Canada's National Quantum Strategy	30m
		Speaker: Michael Rosenblatt (Innovation, Science and Economic Development Canada)	
10:00		Quantum science and precision physics centre	15m
		Speaker: Chloé Malbrunot (TRIUMF)	
10:15		AI Centre	10m
		Speaker: Wojciech Fedorko (TRIUMF)	
10:25		Detector Centre	15m
		Speaker: Fabrice Retiere (TRIUMF)	
10:40	→ 11:00	Coffee Break and Discussion	20m
11:00	→ 12:00	Fundamental science: Part 1	
11:00		Quantum science centres across Canada and around the world	15m
		Speaker: Iain McKenzie (TRIUMF)	
11:15		Quantum sensing applications in particle physics	15m
		Speaker: Pietro Giampa (TRIUMF)	
11:30		Quantum sensing in fundamental physics	15m
		Speaker: Makoto Fujiwara (TRIUMF)	
11:45		Quantum computing applications	15m
		Speaker: Wojciech Fedorko (TRIUMF)	
12:00	→ 12:15	Discussion	15m
12:15	→ 13:00	Fundamental science: Part 2	
12:15		The BeEST and SALER - Experiments with rare isotopes in quantum sensors	15m
		Speaker: Chris Ruiz (TRIUMF)	
12:30		Towards quantum sensing with (anti)hydrogen: HAICU at TRIUMF and ALPHA at CERN	15m
		Speaker: Andrea Capra (TRIUMF)	
12:45		Very precise quantum sensing to search for the electric dipole moment of the neutron	15m
		Speaker: Ruediger Picker (TRIUMF)	
13:00	→ 13:45	Lunch	45m

13:45	→ 14:15	Fundamental science: Part 3	
13:45		TRINAT+CIPI -> Phys Rev A quantum optics publication: a cautionary tale	15m
		Speaker: John Behr (TRIUMF)	
14:00		Quantum control of radioactive molecules to probe physics beyond the Standard Model	15m
		Speaker: Kia Boon Ng (TRIUMF)	
		TRIUMF_QSW_2024...	
14:15	→ 14:30	Discussion	15m
14:30	→ 15:15	Use inspired science: Part 1	
14:30		Quantum opportunities with single photon detector	15m
		Speaker: Harry Lewis (TRIUMF)	
14:45		μSR and β-NMR as quantum sensors	10m
		Speaker: Iain McKenzie (TRIUMF)	
14:55		Quantum materials	10m
		Speaker: Kenji Kojima (TRIUMF)	
15:05		Beta-NMR quantum annealing connection	10m
		Speaker: Sydney Kreitzman (TRIUMF)	
15:15	→ 15:30	Coffee break and informal discussion	15m
15:30	→ 16:00	Use inspired science: Part 2	
15:30		TRIUMF THz project	15m
		Speaker: Victor Verzilov (TRIUMF)	
15:45		Quantum applications of laser ion source, polarized beams, and collinear fast beam laser spectroscopy (remote from South Korea 12/2/2024 07:45)	15m
		Speaker: Jens Lassen (TRIUMF Canada's particle accelerator centre)	
16:00	→ 16:40	Discussion - training of HQP in quantum-related fields and future directions	40m
16:40	→ 17:00	Summary	20m

Thank you!
Merci!

Thanks to the organizers:

Iain McKenzie, Oliver Stelzer-Chilton,
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Stephan Malbrunot-Ettenauer,
Wojtek Fedorko

