TRIUMF

Canada's national laboratory
for particle and nuclear physics
and accelerator-based science

TRIUMF Report

IUPAP Working Group 9

August 30, 2017

Jonathan Bagger
Director

CANADA 150
1867-2017

2018 TRIUMF's 50th Anniversary!

Strategic Goals

1. Operate safely and effectively
2. Produce world class science
3. Connect TRIUMF to the world

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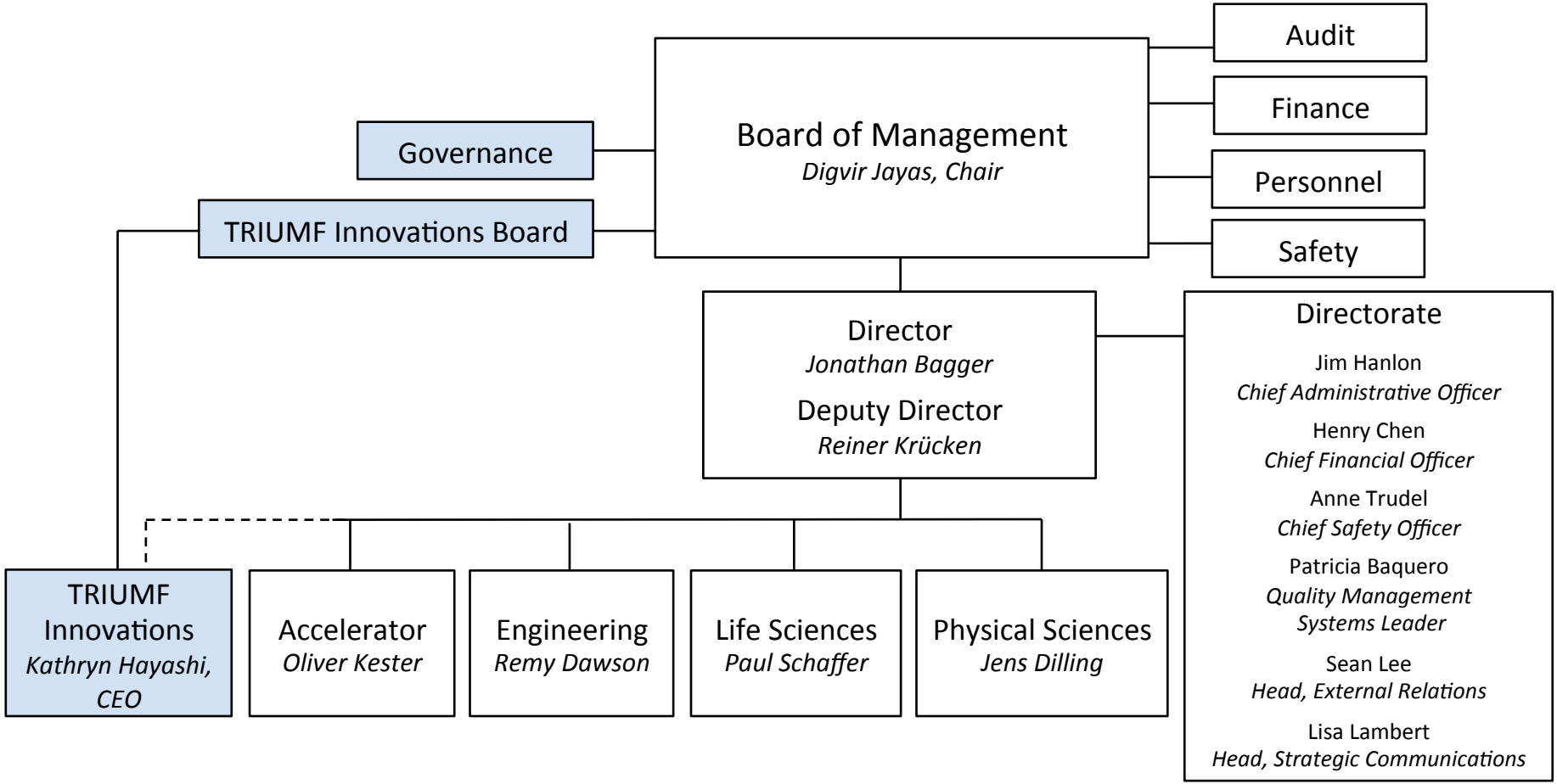
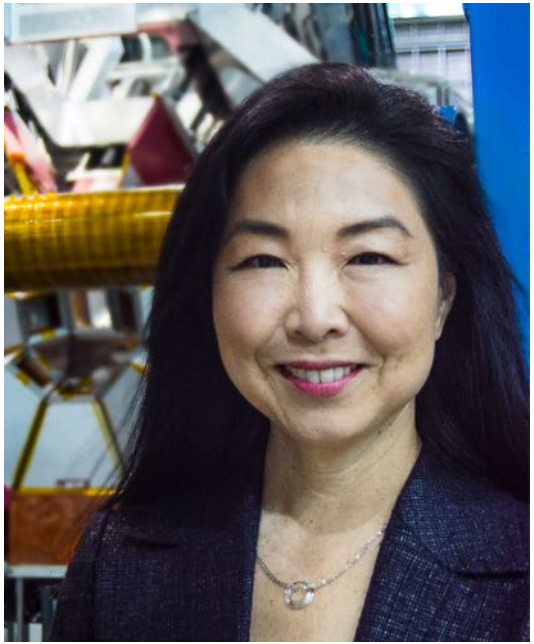
Organization





Kathryn Hayashi
CEO, TRIUMF Innovations

Karimah Es-Sabar
Chair, TRIUMF Innovations

Staffing

- Queen's University – Joint Faculty in SNOLAB Science
  - One position at Queen's, asymptotically at Queen's
  - One position at TRIUMF, asymptotically at TRIUMF
  - Initially in support of CPARC, funded by CFREF

CPARC
Canadian Particle Astrophysics Research Centre

- University of British Columbia – Joint Faculty in Quantum Matter
  - One position at TRIUMF, asymptotically at TRIUMF
  - Initially in support of CMMS

Stewart Blusson Quantum Matter Institute

CANADA FIRST RESEARCH EXCELLENCE FUND | APOGÉE CANADA FONDS D'EXCELLENCE EN RECHERCHE

Searches underway!

Staffing

- University of Tokyo – Joint Faculty in Neutrino Physics
  - One position at IPMU, asymptotically TBD
  - Held by Mark Hartz, member of T2K

東京大学
THE UNIVERSITY OF TOKYO

- University of Washington – Postdoc in Nuclear Theory
  - One joint position at TRIUMF and INT
  - MOU in preparation

UNIVERSITY of WASHINGTON

Operate Safely and Effectively

- Major push to strengthen safety, quality and project management

Strategic Goals

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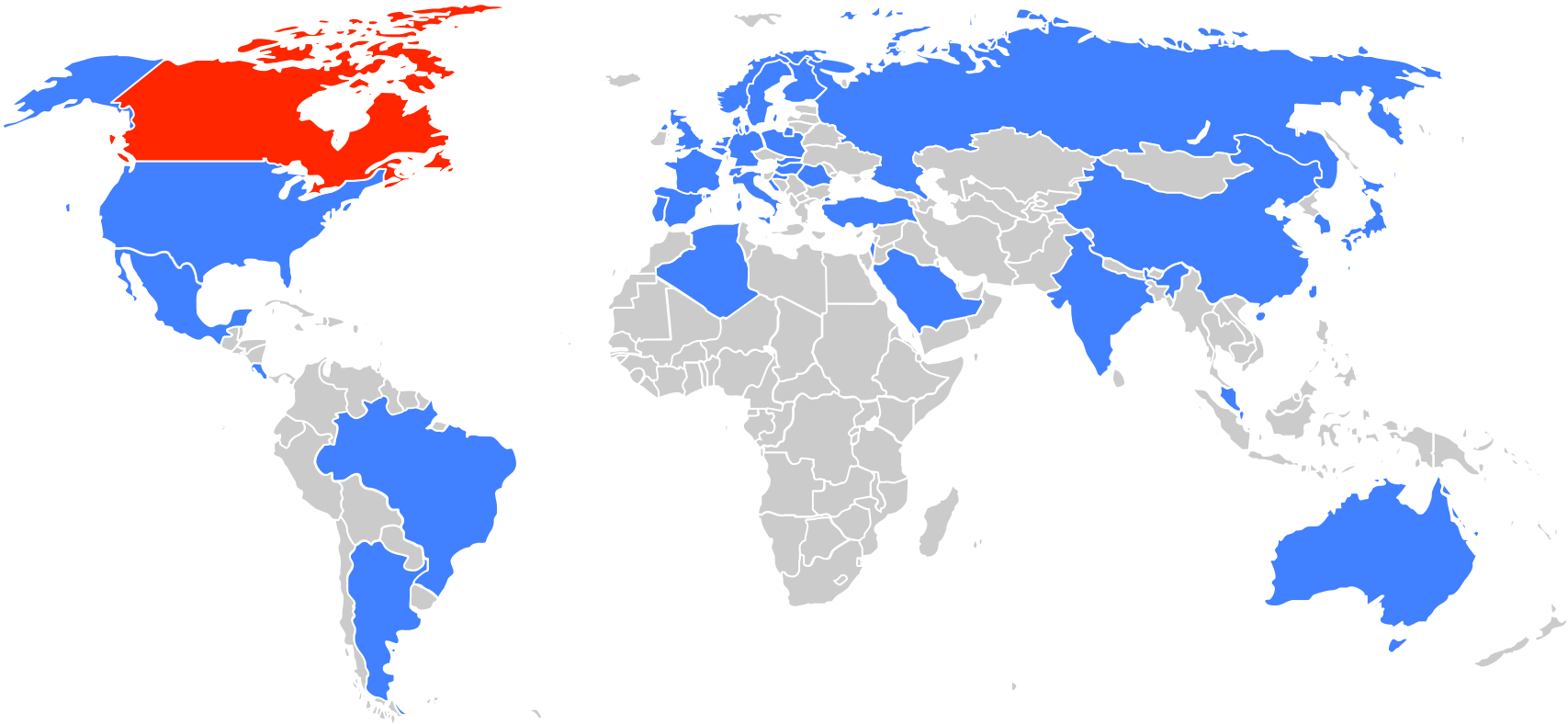
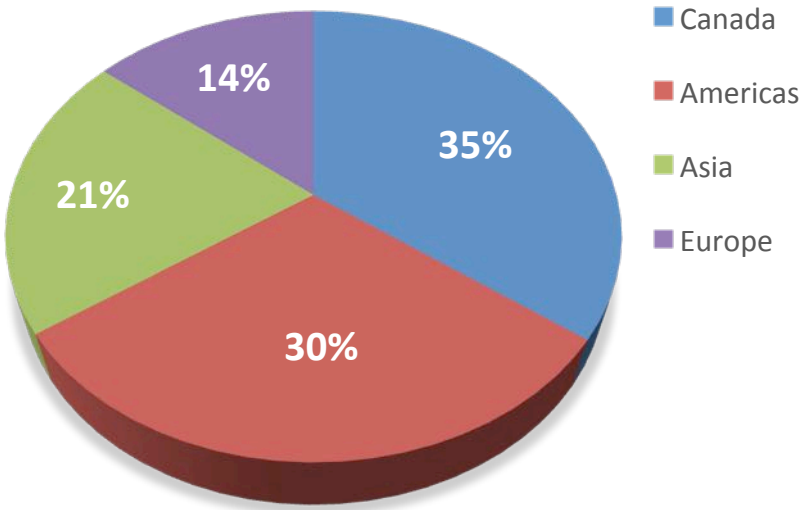
3. Connect TRIUMF to the world

TRIUMF Users

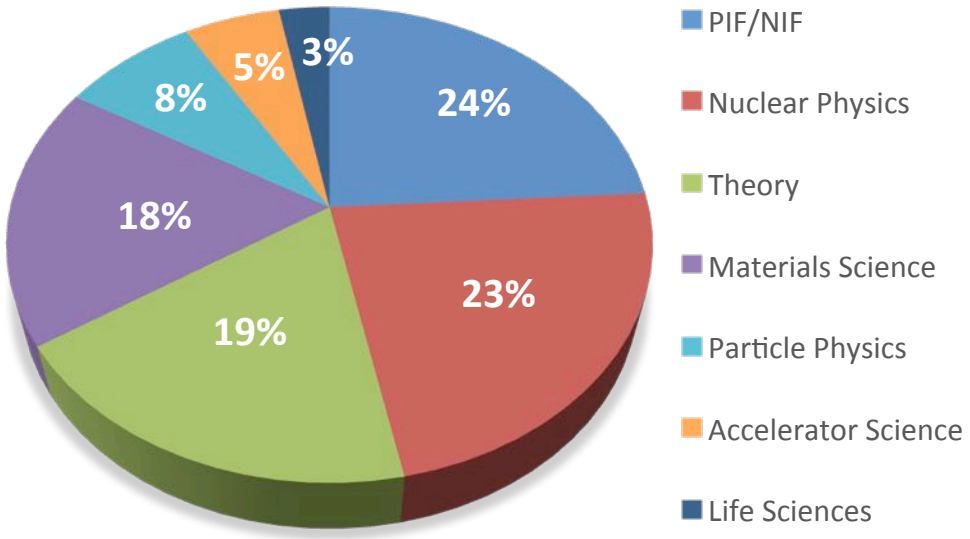


TRIUMF Users

Scientific Visitors & Users by Region (645)

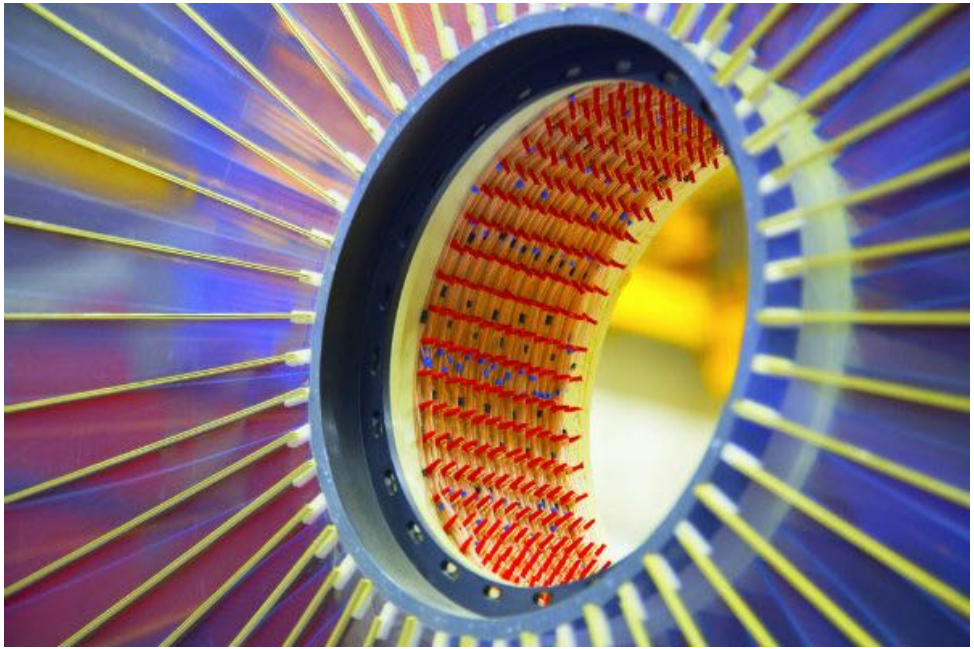


Scientific Visitors & Users by Field (645)



TRIUMF is a fully international, multidisciplinary facility!

- Three major projects currently underway
  - ARIEL II
  - UCN Facility
  - IAMI: Institute for Advanced Medical Isotopes

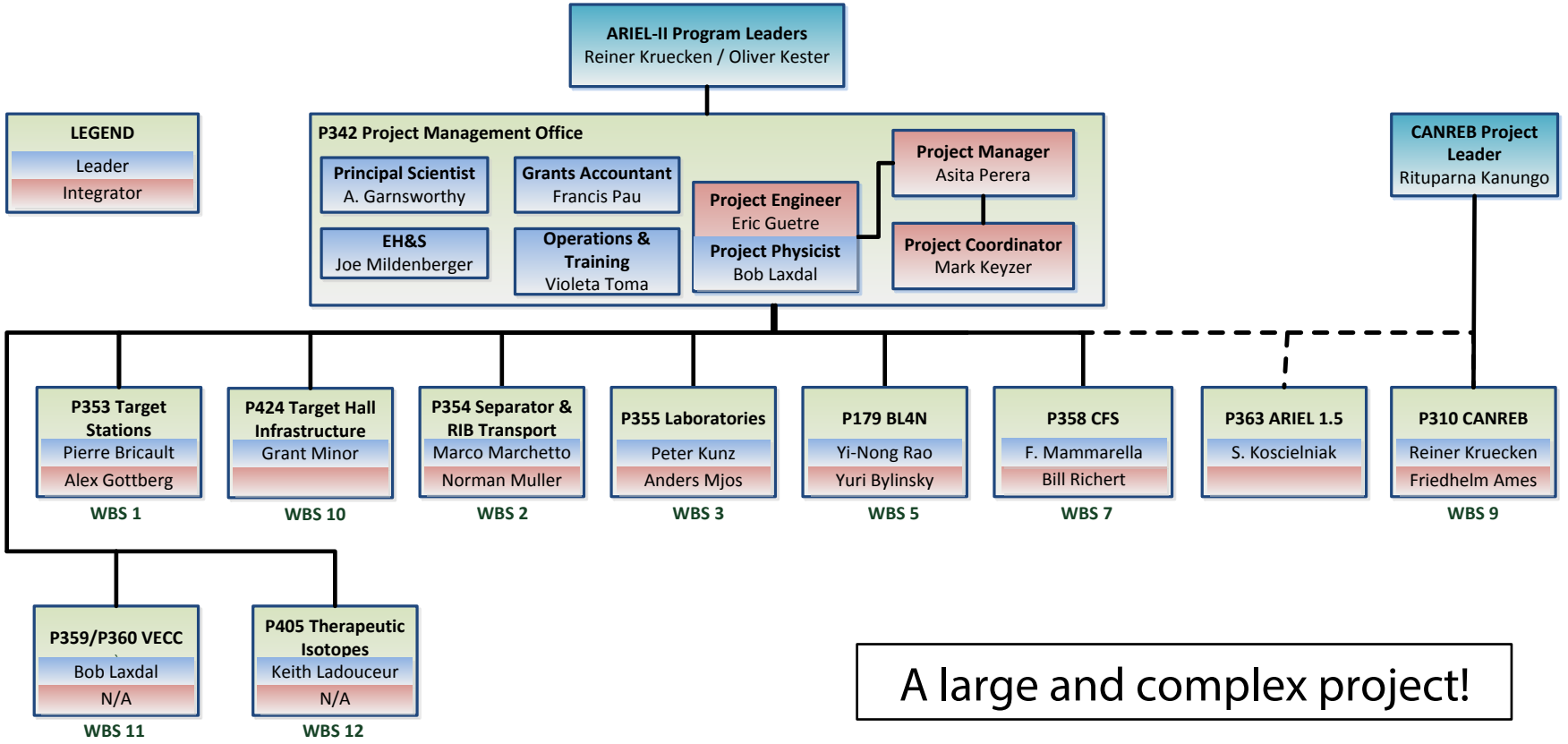


ARIEL

- ~$100M project, supported by 19 universities, led by the University of Victoria, that will triple TRIUMF's rare isotope production
- Second phase: ARIEL II, $38M CFI project. Awarded $8.7M from the BC Knowledge Development Fund – the last piece of the puzzle!
- Investment by five provinces: AB, BC, MB, ON, QC

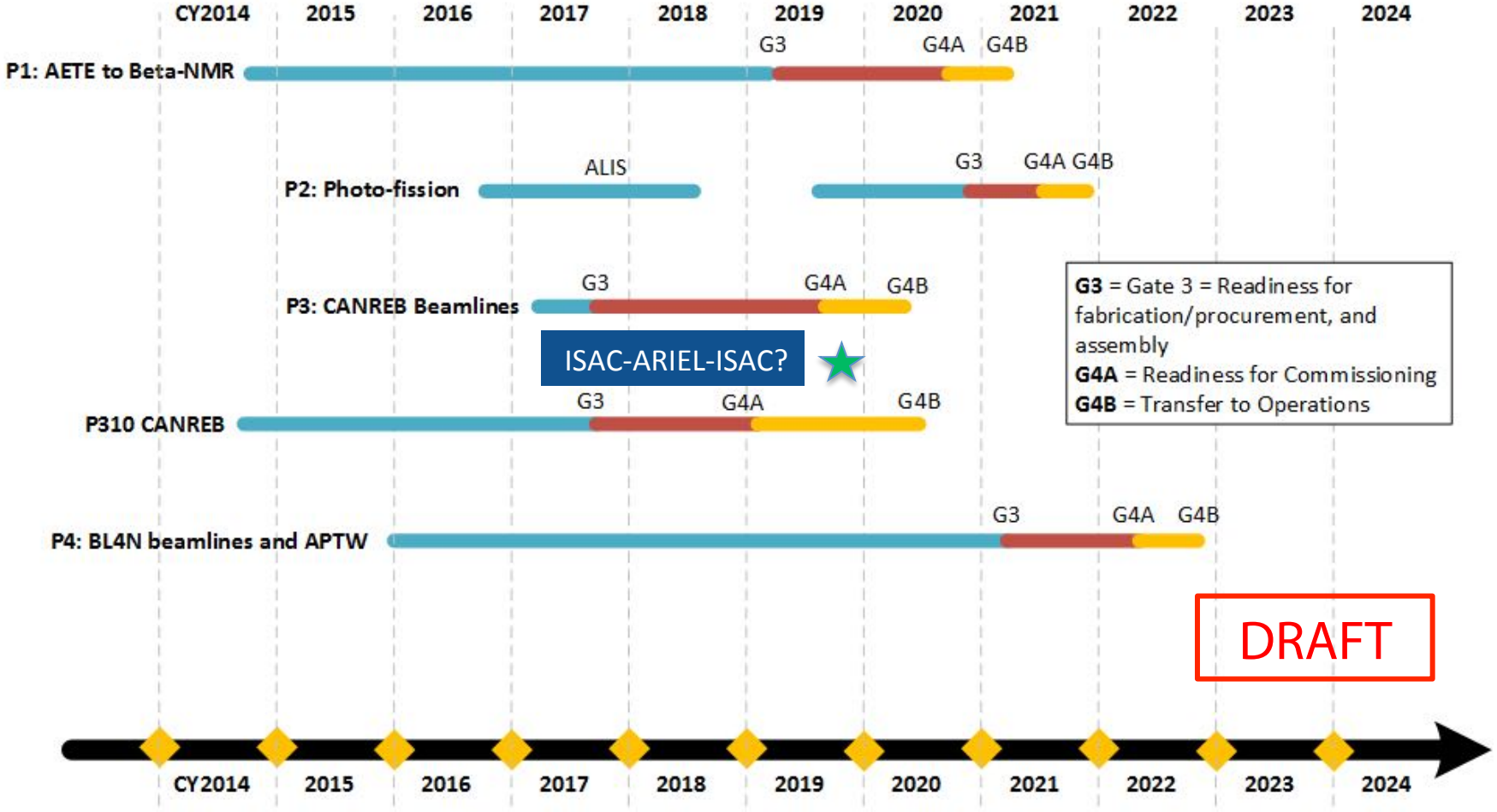
ARIEL is the future of TRIUMF

Major Projects – ARIEL II



A large and complex project!

Major Projects – ARIEL II



Milestones, as presented during ARIEL Town Hall, January 10, 2017

	Science Milestone	Month/Year
PHASE 3	First EEC approved experiments with high-mass accelerated beams from ISAC utilizing the CANREB/ARIEL EBIS charge breeder	10/2020 ★
PHASE 1	First EEC approved beta-NMR experiments with photo-produced ^{8}Li	03/2022
PHASE 2	First EEC approved experiments with photo-fission RIBs from the e-Linac	06/2022
PHASE 4	First EEC approved experiments with RIBs from ARIEL Proton target	03/2023

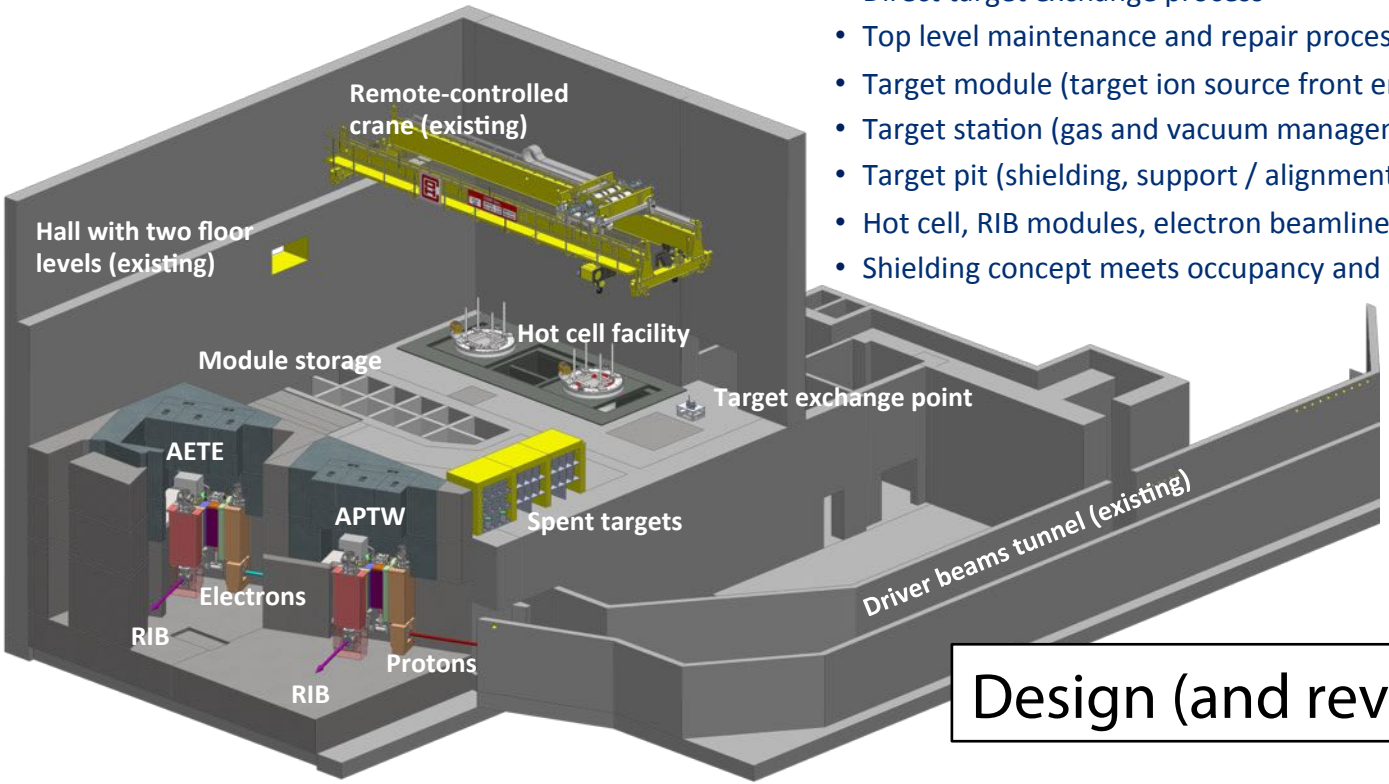
ISAC-ARIEL-ISAC in 2019?

- All dates based on Monte Carlo analysis of schedule
- Current best estimates
- Efforts under way to accelerate schedule

Continuous discussions with user community

Major Projects – ARIEL II

Targets



Concepts finalized:

- Operational model
- Direct target exchange process
- Top level maintenance and repair processes
- Target module (target ion source front end, high voltage path, shielding)
- Target station (gas and vacuum management, module interfaces)
- Target pit (shielding, support / alignment structure, main services voids)
- Hot cell, RIB modules, electron beamline
- Shielding concept meets occupancy and dose rate requirements

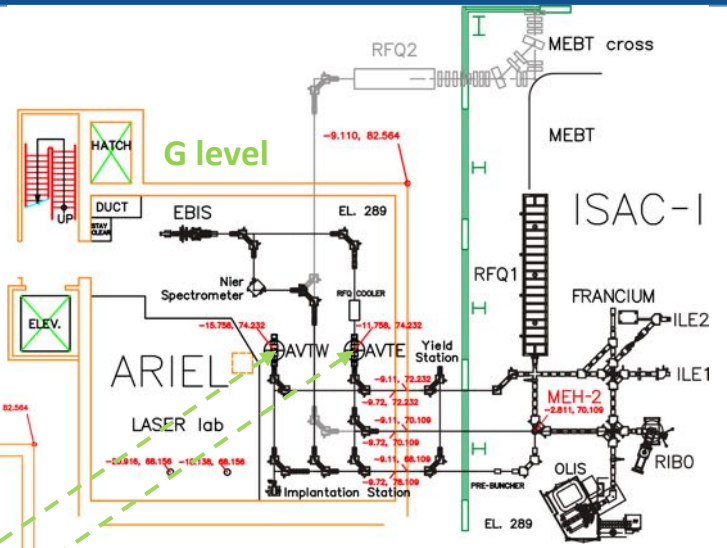
Design (and reviews) underway!

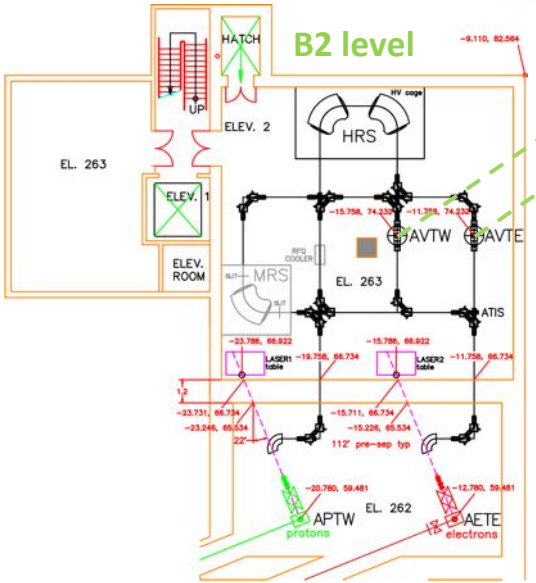
Major Projects – ARIEL II

RIB Transport

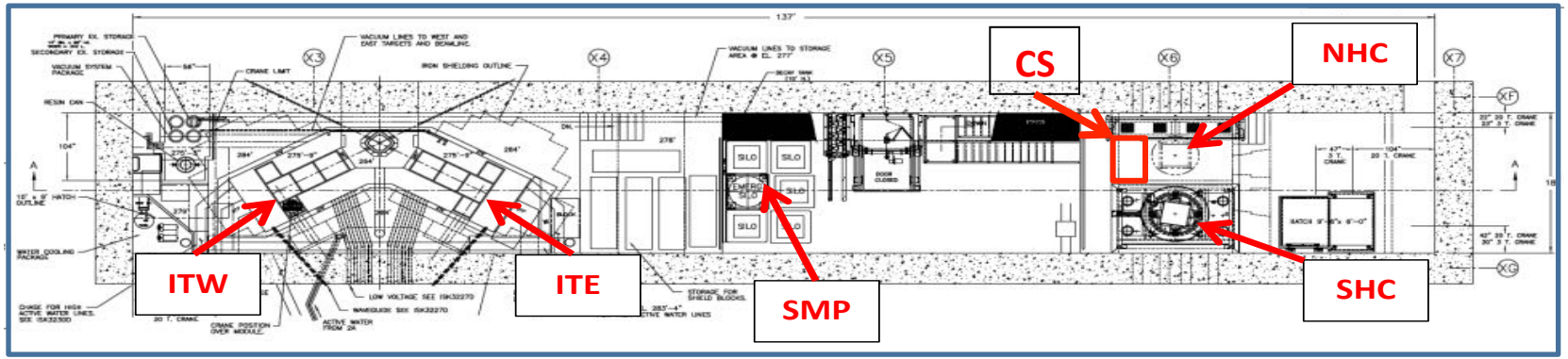
Status:

- HRS magnet finished
- Prototype section installed
  - Vendors qualified
  - Design validated





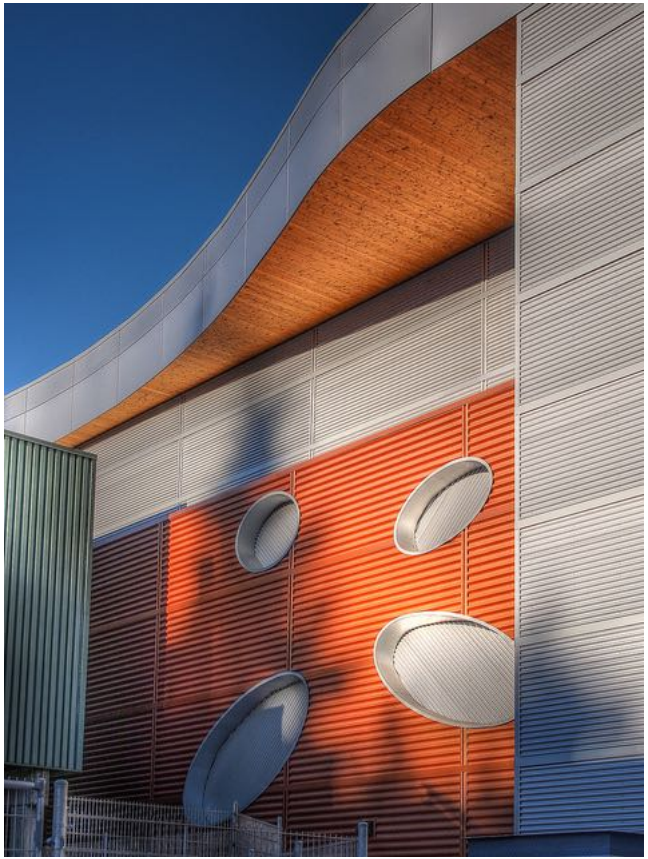
Major Projects – ISAC Upgrades



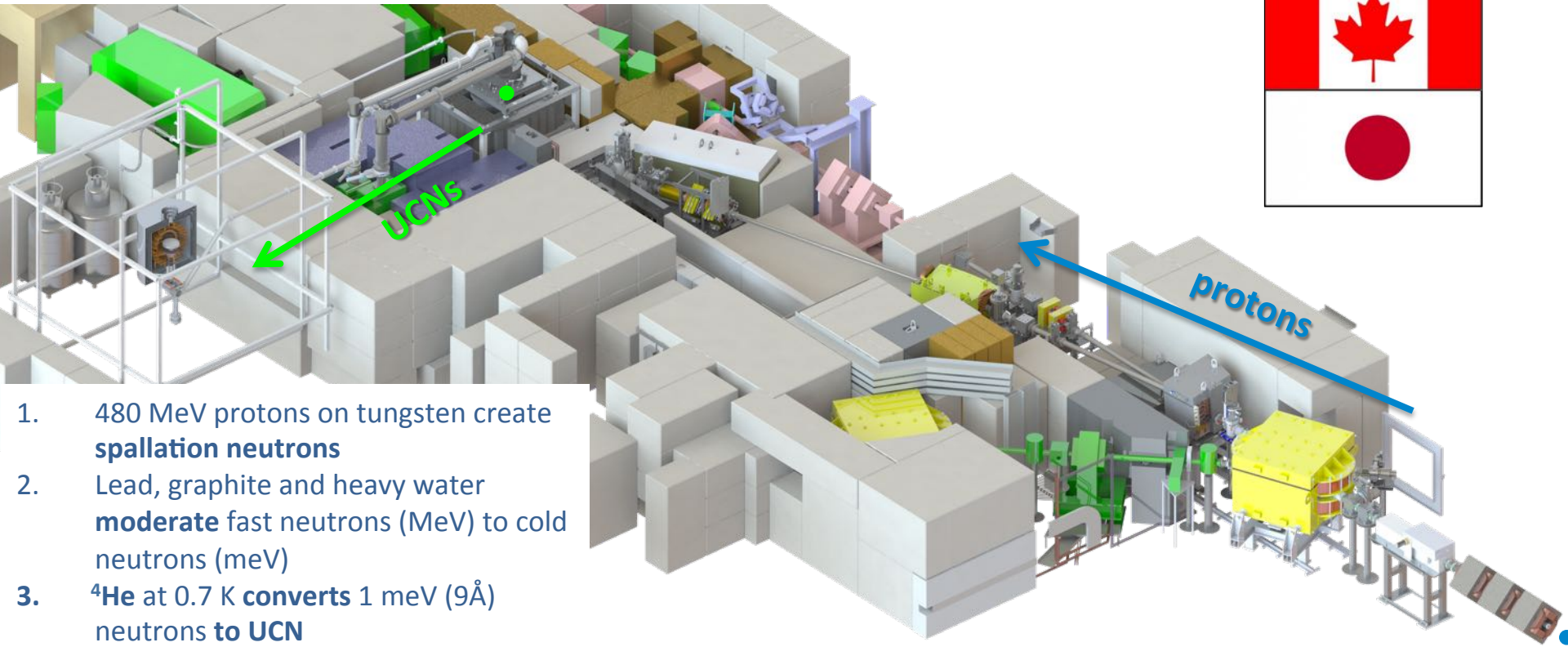
Infrastructure upgrades to ISAC as well as ARIEL. New Target Module will add redundancy. Refurbished Target Modules will add reliability. Safe Module Parking and North Hot Cell will speed work by removing bottlenecks

Major Projects – ARIEL II

- Now that funding is secured, ARIEL II can proceed at full bore
- ARIEL will transform TRIUMF. With it, ISAC will realize its full potential
- TRIUMF is on track to become an isotope factory with a focus on excellence, quality, consistency, reliability, and the user experience

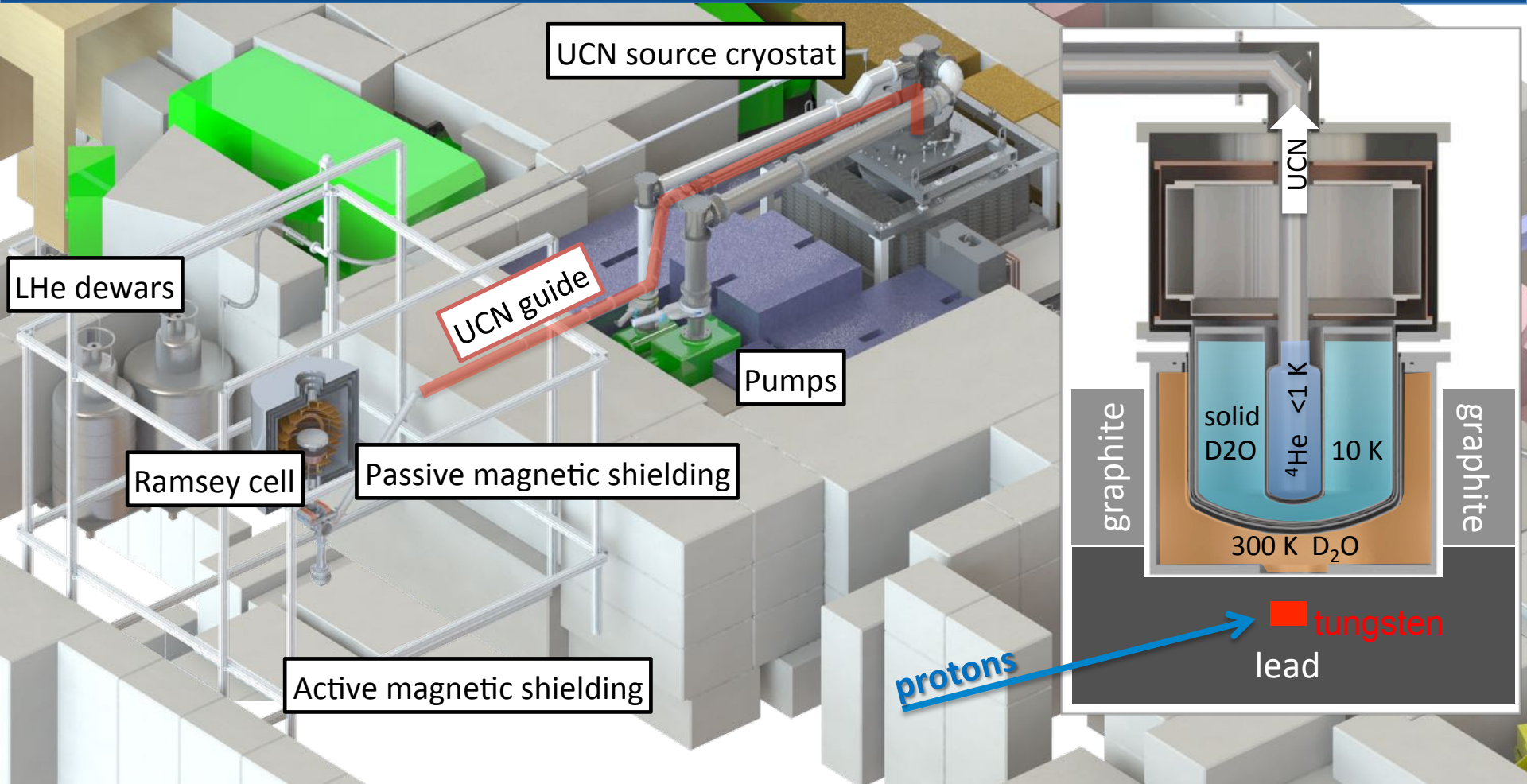


Major Projects – Ultra Cold Neutron Facility



1. 480 MeV protons on tungsten create **spallation neutrons**
2. Lead, graphite and heavy water **moderate** fast neutrons (MeV) to cold neutrons (meV)
3. ^{4}**He** at 0.7 K **converts** 1 meV (9Å) neutrons **to UCN**
4. **Material guides** transport UCN to experiments

Major Projects – Ultra Cold Neutron Facility



Major Projects – Ultra Cold Neutron Facility

UCN Status

- First proton injection (Nov. 2016)
- First beam on target and neutron production (Nov. 2016)
- First cold neutron production (Nov. 2016)
- Vertical source installed (Spring 2017)
- First ultra cold neutrons – coming soon!

Future Plan

- High intensity horizontal source
- Neutron EDM experiment
- Second port?

Major Projects – IAMI

- IAMI – Institute for Advanced Medical Isotopes – will build on TRIUMF's long history in the field of medical isotopes
- Today, TRIUMF produces 2M doses of medical isotopes per year in partnership with Nordion
- A tremendous success story: A public-private partnership that returns value to TRIUMF, to Canada and the world

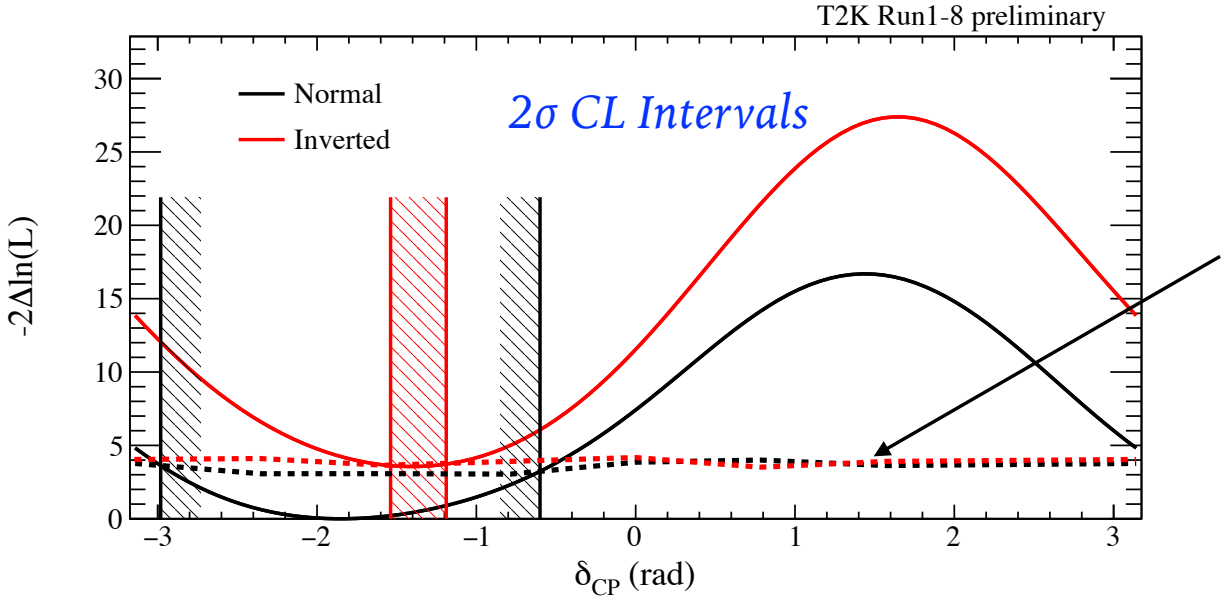
Major Projects – IAMI

- IAMI will house a TR24 cyclotron and GMP laboratories to position TRIUMF life sciences for the 21st century
  - Producing isotopes for clinical use at UBC Hospital and the BC Cancer Agency
  - Producing isotopes and tracers for biomedical research and drug development, including both diagnostics and therapeutics

Major Projects – IAMI

- IAMI is moving ahead – TR-24 has arrived!
- IAMI facility schematic design is complete
- Work continues on planning governance and operations, and in seeking private-sector partners. Lots of interest…
- 2/3 of the funding is secured!

Results – T2K



critical $\Delta\chi^2$ values for 2σ confidence level

Hint of CP violation: $\delta_{CP} = 0, \pi$ excluded at 2σ

Results – ALPHA

First laser spectroscopy on anti-H

M. Ahmadi et al., Nature 541 (2017)

LETTER

OPEN

doi:10.1038/nature21040

Observation of the 1S–2S transition in trapped antihydrogen

M. Ahmadi[1], B. X. R. Alves[2], C. J. Baker[3], W. Bertsche[4,5], E. Butler[6], A. Capra[7], C. Carruth[8], C. L. Cesar[9], M. Charlton[3], S. Cohen[10], R. Collister[7], S. Eriksson[3], A. Evans[11], N. Evetts[12], J. Fajans[8], T. Friesen[2], M. C. Fujiwara[7], D. R. Gill[7], A. Gutierrez[13], J. S. Hangst[2], W. N. Hardy[12], M. E. Hayden[14], C. A. Isaac[3], A. Ishida[15], M. A. Johnson[4,5], S. A. Jones[3], S. Jonsell[16], L. Kurchaninov[7], N. Madsen[3], M. Mathers[17], D. Maxwell[3], J. T. K. McKenna[7], S. Menary[17], J. M. Michan[7,18], T. Momose[12], J. J. Munich[14], P. Nolan[1], K. Olchanski[7], A. Olin[7,19], P. Pusa[1], C. Ø. Rasmussen[2], F. Robicheaux[20], R. L. Sacramento[9], M. Sameed[3], E. Sarid[21], D. M. Silveira[9], S. Stracka[22], G. Stutter[2], C. So[11], T. D. Tharp[23], J. E. Thompson[17], R. I. Thompson[11], D. P. van der Werf[3,24] & J. S. Wurtele[8]

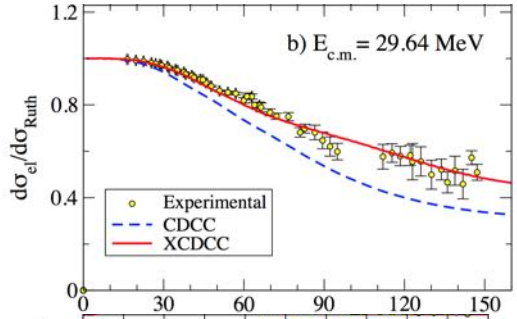
- First demonstration:
  - Precision already 2×10^{-10}
    $\Delta f \sim 400$ kHz
  - Sensitive to antiproton internal structure at 20% level
- Major Canadian contributions
  - Cryostat with laser access
    - TRIUMF/Calgary
  - Annihilation detection
    - TRIUMF
  - Magnetometry
    - SFU/UBC
  - Laser cooling development
    - UBC/TRIUMF
  - Operation & Run Coordination

Results – TIGRESS

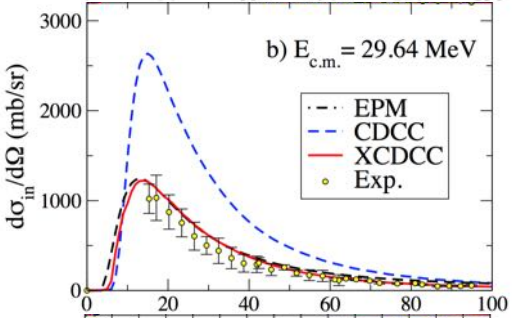
- Exclusive measurement of halo nucleus ^{11}Be scattering from high-Z target
- Differential cross sections understood if excited ^{10}Be core structure is taken into account
- Possible at TRIUMF-ISAC because of
  - Intense ^{11}Be from ISAC-TRILIS, high-quality acceleration with ISAC-II
  - TIGRESS experimental infrastructure capable of coupling to dedicated external detectors

V. Pesudo et al, Phys. Rev. Lett. 118, 152502 (2017)

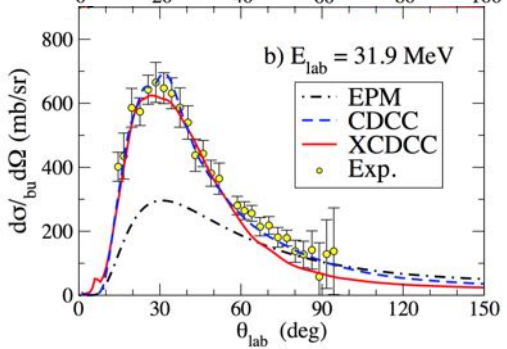
Elastic
-> ^{11}Be



Inelastic
-> ^{11}Be*
-> ^{11}Be+γ



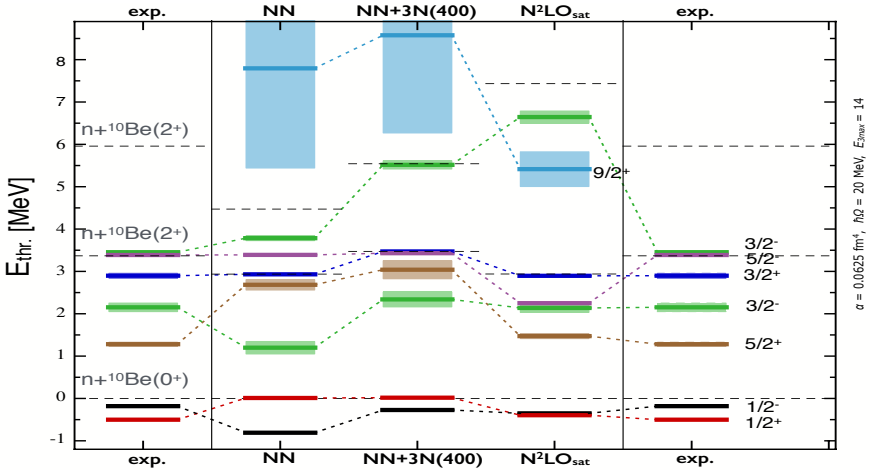
Breakup
-> ^{10}Be(+n)



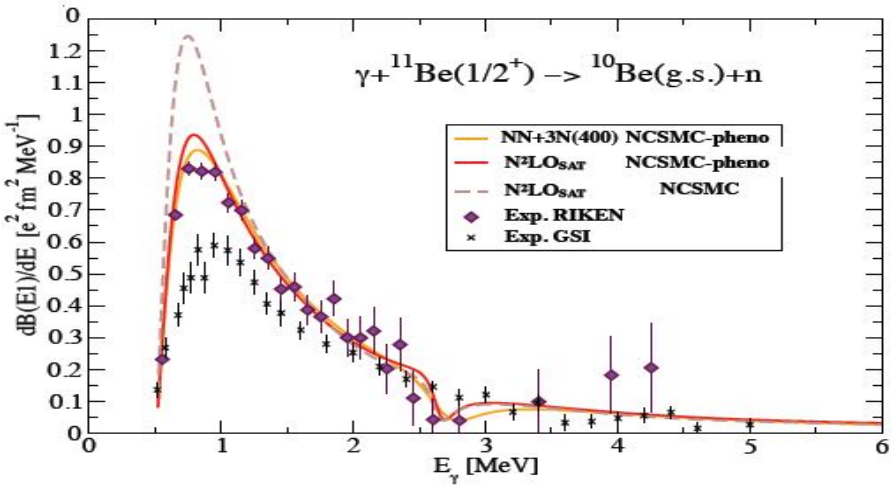
Results – Theory

First-principles study of ^{11}Be. *Ab initio* calculations demonstrate:

Contributions from chiral nuclear forces



Discrimination between conflicting photo-dissociation experiments



PRL 117, 242501 (2016) PHYSICAL REVIEW LETTERS week ending 9 DECEMBER 2016

Can *Ab Initio* Theory Explain the Phenomenon of Parity Inversion in ^{11}Be?

Angelo Calci,[1,*] Petr Navrátil,[1,†] Robert Roth,[2] Jérémy Dohet-Eraly,[1,‡] Sofia Quaglioni,[3] and Guillaume Hupin[4,5]

[1]*TRIUMF, 4004 Wesbrook Mall, Vancouver, British Columbia V6T 2A3, Canada*

Also ^{6}He

PRL 117, 222501 (2016) PHYSICAL REVIEW LETTERS week ending 25 NOVEMBER 2016

How Many-Body Correlations and α Clustering Shape ^{6}He

Carolina Romero-Redondo,[1,*] Sofia Quaglioni,[1,†] Petr Navrátil,[2,‡] and Guillaume Hupin[3,§]

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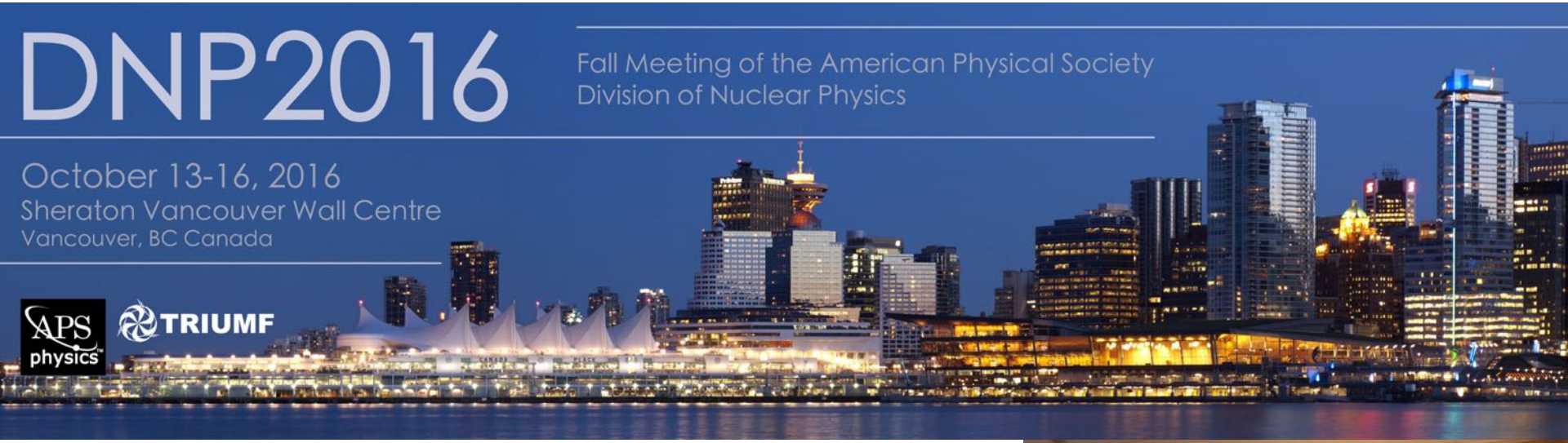


American Physical Society DNP Annual Meeting held in Vancouver

- 668 registered participants
- 168 undergraduate students!

TRIUMF JINA-CEE CINP ICPN University of Victoria ARC

Viva l'Italia

June 30, 2017 – H.E. Sergio Mattarella, President of Italy, visited TRIUMF

The 2017 Federal Budget contained proposals supported by TRIUMF

- Commitment to develop a federal science infrastructure strategy
- Impact Canada Fund: New "challenge-based" funding program to fund research into issues of national importance
- Innovative Solutions Canada: An SBIR-like procurement program to build capacity

The Fundamental Science Review released by blue ribbon panel

Recommendations:

- Improve federal coordination and oversight
- Increase funding – especially for investigator-led research grants
- Strengthen support and planning for major research facilities

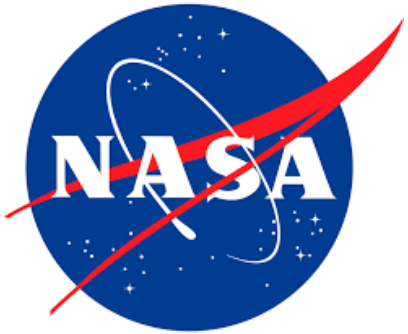
What will it mean for TRIUMF?

TRIUMF

INNOVATIONS

- TRIUMF's business-facing arm
- Deeply integrated into TRIUMF
- Links science and technology to tangible business opportunities

Commercial Partners



BC Trade Missions

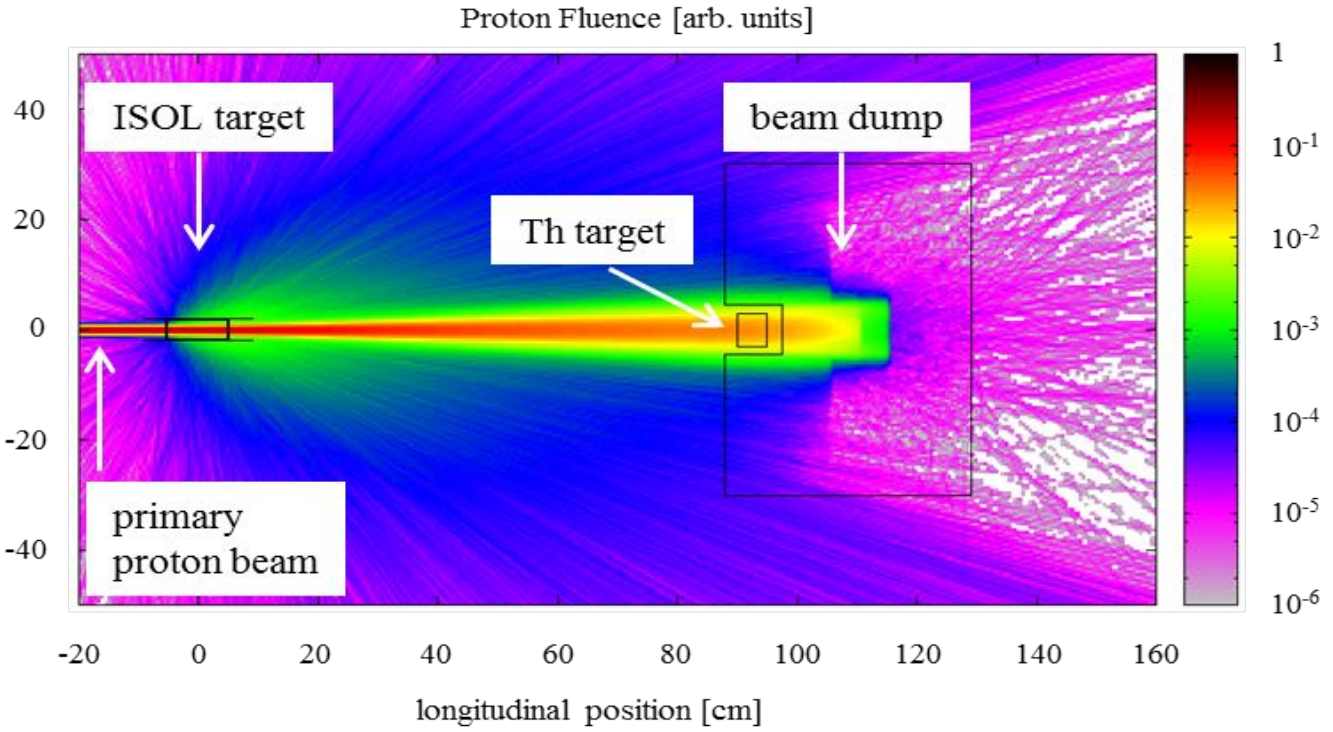
ARTMS Products, Inc

- A TRIUMF spin-off company devoted to Tc-99m production using medical cyclotrons
- IAMI will supply Tc-99m to British Columbia using ARTMS technology
- About to receive its first infusion of venture capital

artms

tia
2017 TECHNOLOGY IMPACT AWARDS
JUNE 22, 2017 | 5:00PM | VANCOUVER CONVENTION CENTRE WEST

Exciting Opportunity: ARIEL Symbiotic Target



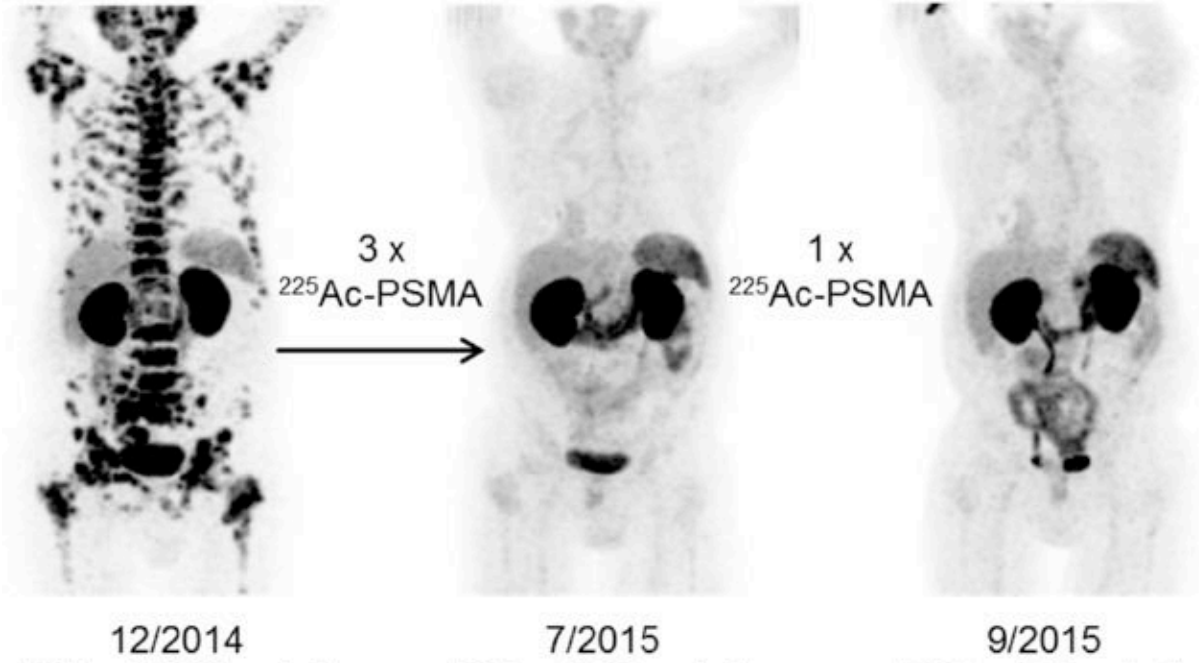
Canadian Nuclear Laboratories

Laboratoires Nucléaires Canadiens

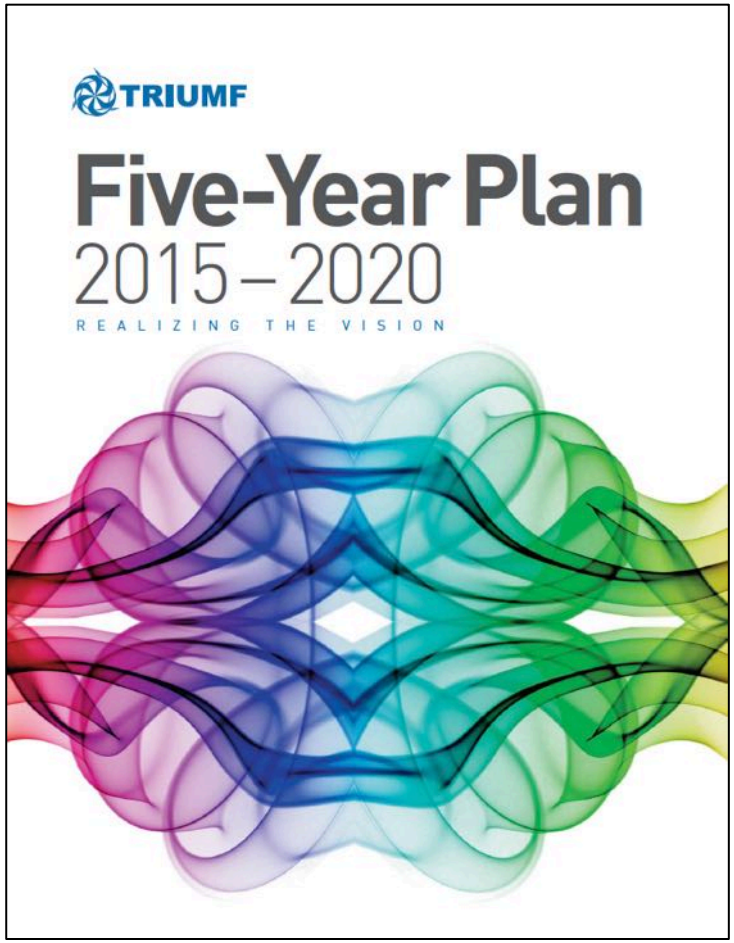
U.S. DEPARTMENT OF ENERGY

Prostate cancer patient before and after treatment with ^{225}Ac-PSMA

C Kratochwil, et al, J Nuc Med (2016) doi:10.2967/jnumed.116.178673

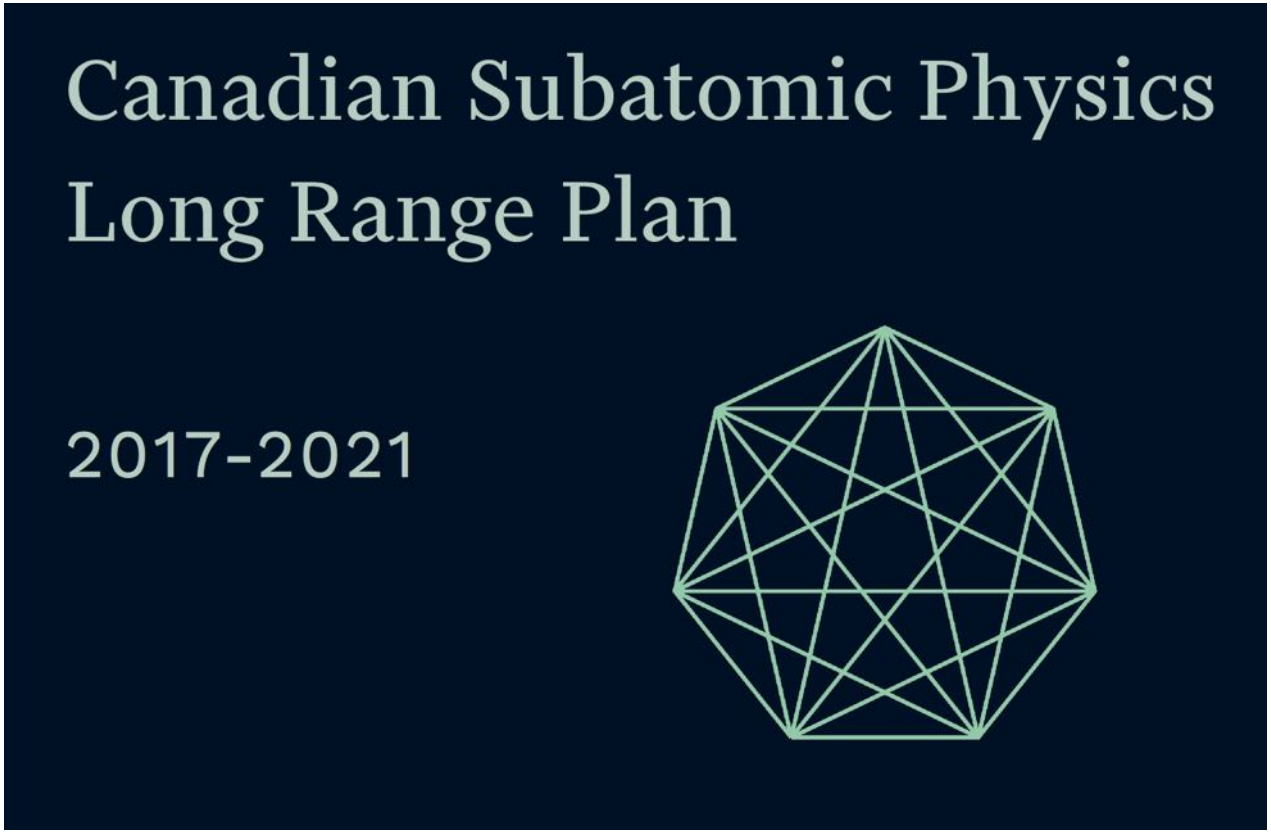


Right now, progress is limited by isotope supply



Five-Year Plan 2020-2025

Boundary condition: consistent with SAP Long Range Plan



Five-Year Plan 2020-2025

- **Purpose:**
  - Articulate TRIUMF's vision and mission
  - Communicate goals and priorities for 2020-2025 & beyond
  - Lay out an action plan, including a high level budget
  - Secure base funding for operations
- **Audience:**
  - Community
  - International Peer Review Committee
  - NRC
  - Government of Canada
- **Timeline:**
  - Consultation and internal planning through 2017
  - Main elements to be defined in Spring 2018
  - Report to be released in September 2018

- **Consultation:**
  - **Internal strategic planning exercises**
    - Divisional and institutional
  - **Broad community consultation**
    - Science Week, July 10-14
    - Submissions to PPAC, TRIUMF's Policy and Planning Advisory Committee
- **Governance:**
  - **Executive Committee** drives planning
  - **Steering Committee** oversees the process
  - **PPAC** evaluates projects and commitments
  - **ACOT** reviews main elements of the plan
  - **Board of Management** approves the plan

Charge and Members

- Oversee the consultation process and solicit input from the relevant stakeholder communities
- Provide critical feedback on the priorities and initiatives, ensuring that they align with stakeholder interests
- Act as review panel for the final plan and the associated communications strategy

Name	Title	Institution
Jonathan Bagger	Director	TRIUMF
David Castle	Vice President Research	University of Victoria, Vice Chair TRIUMF Board
Rod Clark	Division Deputy	Lawrence Berkeley Lab, former SAP-EEC Chair
Robert Dunlop	Former ADM (retired)	(Industry Canada)
Kathryn Hayashi	President and CEO	TRIUMF Innovations
Ritu Kanungo	Professor	Saint Mary's University
Oliver Kester	ALD - Accelerator Division	TRIUMF
Suzanne Lapi	Associate Professor	University of Alabama, Birmingham
Kyle Leach	Assistant Professor	Colorado School of Mines, TUEC Chair
Graeme Luke	Professor and Chair	McMaster University
Scott Oser	Professor	University of British Columbia
Nigel Smith	Director	SNOLAB
Brigitte Vachon	Associate Professor	McGill University
Michelle Wong	Director, Research	University of British Columbia

Charge

- Articulate TRIUMF's value to stakeholders
    - Evaluate proposals submitted to TRIUMF
        - Nuclear Physics
        - Particle Physics
        - Molecular and Materials Science
        - Life Sciences
        - Accelerator Science
    - Identify priorities for ongoing activities and new initiatives
- Answer key questions
    - What are the strengths and weaknesses of the current areas of activity?
    - What are potential new areas of activity?
    - Which of the ongoing activities should be increased?
    - Which of the ongoing activities should eliminated?

Members

- Corina Andreoiu (SFU)
- Jean-Francois Arguin (Montréal)
- David Asgeirsson (TRIUMF Innovations)
- Sampa Bhadra (York)
- Paul Garrett (Guelph)
- Darren Grant (Alberta)
- Brigitte Guerrin (Sherbrooke)
- Garth Huber (Regina)
- Hae Young Kee (Toronto)
- Bob Kowalewski (UVic) - Chair
- Alison Lister (UBC)
- Andrew MacFarlane (UBC)
- Juliette Mammei (Manitoba)
- Tony Noble (Queen's)
- Rachid Ouyed (Calgary)
- Frank Prato (Western)
- Jeff Quilliam (Sherbrooke)
- Ralf Schirmacher (Calgary)
- Jeff Sonier (SFU)
- Vesna Sossi (UBC)
- Hiro Tanaka (Toronto)
- Manuela Vincter (Carleton)

Five-Year Plan – Structure and Timeline

January 11, 2017	ARIEL Town Hall
May 26, 2017	Call for PPAC Proposals
July 10-14, 2017	Science Week
October 16, 2017	PPAC deadline
Fall 2017	PPAC review of proposals
Winter 17/18	Formulation of plan
Winter 2018	Consultation on plan
Spring 2018	ACOT review / Board approval
September 2018	Release of FYP 2020-2025
Fall 2018	International Peer Review
Fall 2018	Lobbying push in Ottawa

- Five-Year Plan 2020-25 will contain
  - A high-level summary for Ministers
  - A 20 page strategic plan for Analysts
  - A 50 page implementation plan for ACOT, Peer Review Committee

- Additional background on a new TRIUMF website
  - Facility information
  - Science highlights 2013-2018
  - CVs of Research Scientists

Plan will go public in September 2018

Communication and promotion will be done with 50th Anniversary Celebration in 2018

http://www.triumf.ca/FYP2020-25


TRIUMF