

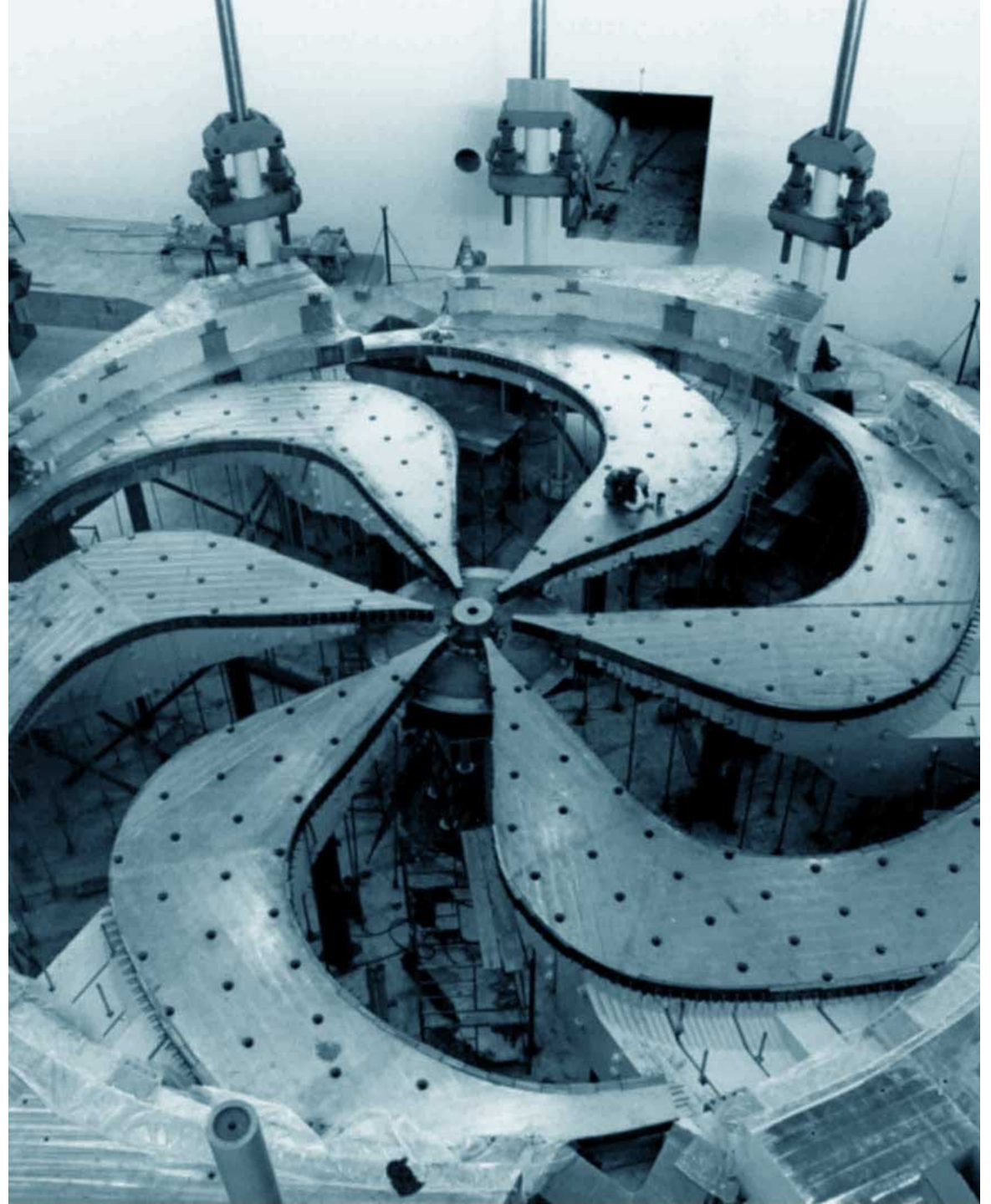
Next 5YP within the 20-year vision Summary Accelerator Division

Oliver Kester

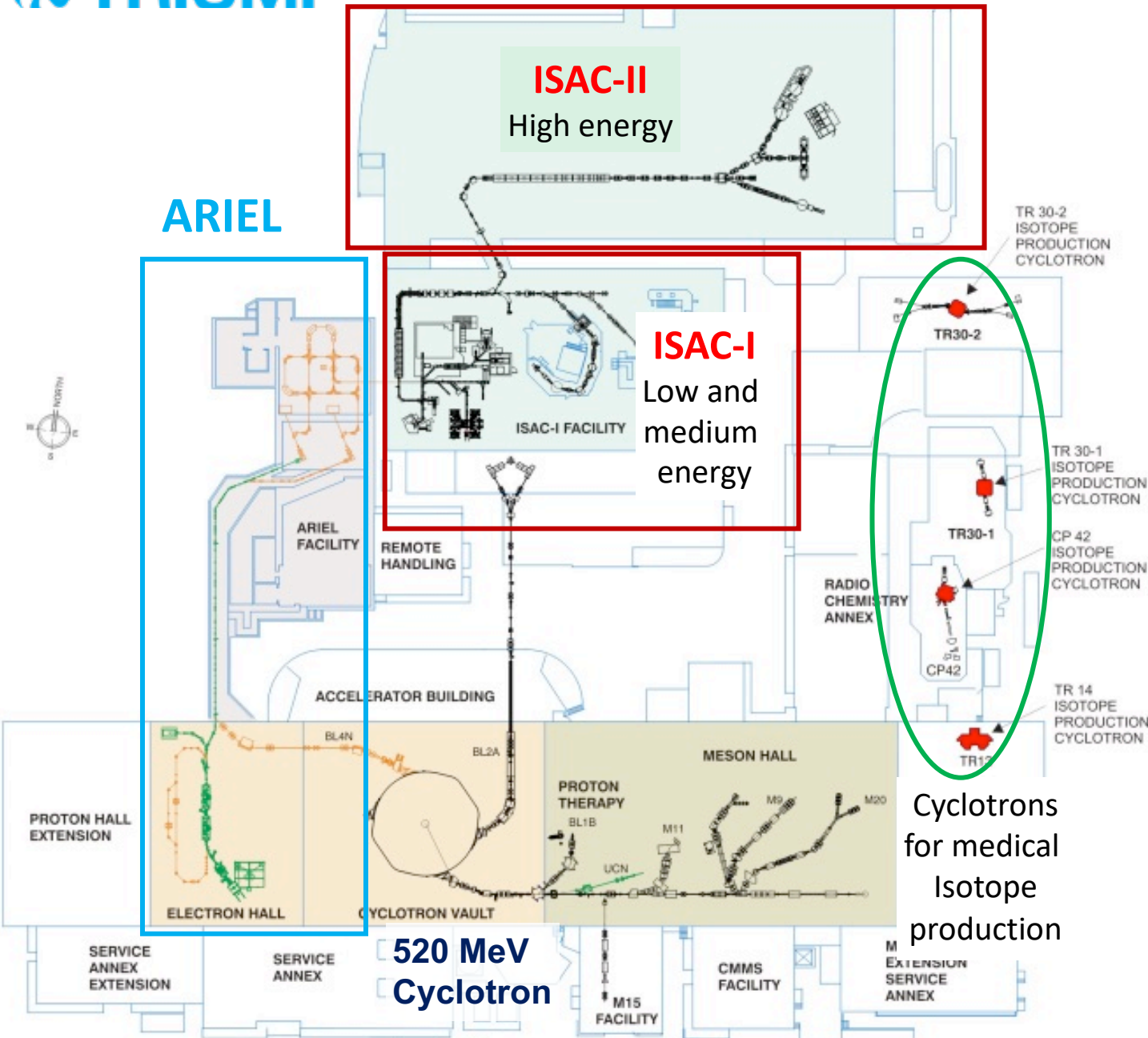
Director, Accelerator Division

TRIUMF Science week, July 22, 2022

2022-07-22



TRIUMF accelerator complex



Primary beam driver:
Cyclotron, 520 MeV, H⁻
Produces rare isotopes, neutrons and muons!

Isotope Separator and Accelerator facility - ISAC

Isotope Separator Online (ISOL) facility
ISAC-I: Normal conducting-linac, 0.15-1.8 MeV/u
ISAC-II: Superconducting-linac, 1.5-16.5 MeV/u

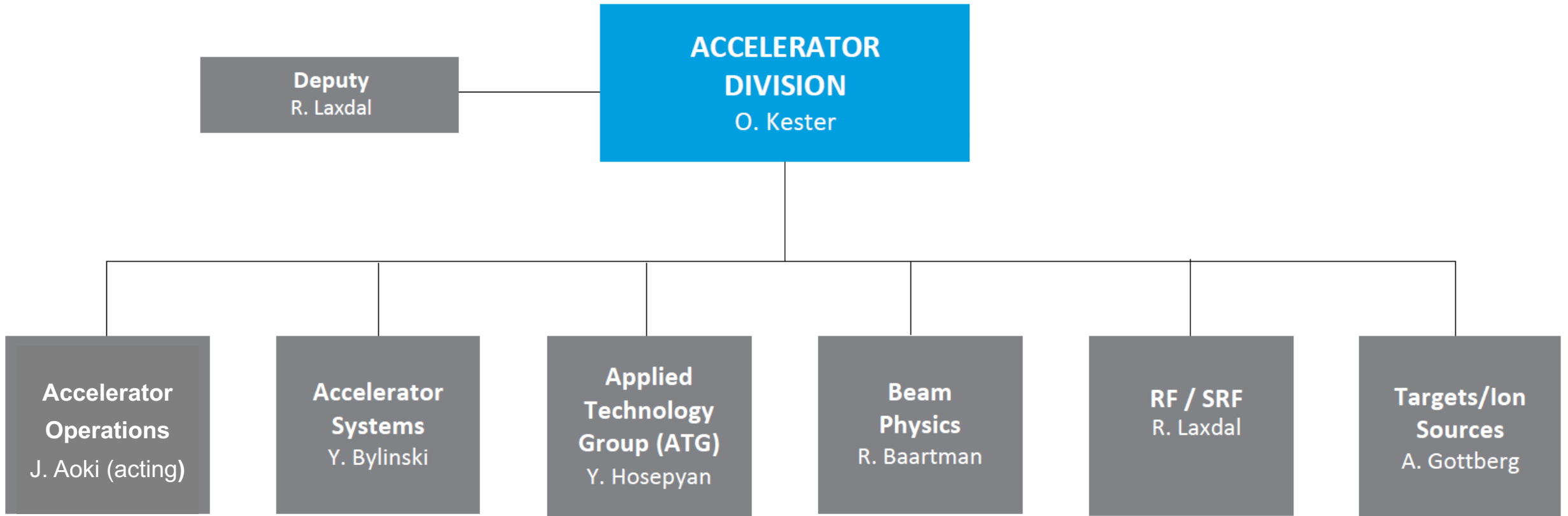
Advanced Rare Isotope Laboratory - ARIEL

Superconducting electron linac
30 MeV, 10 mA, cw

4 Cyclotrons for medical isotope production

Cyclotrons for medical Isotope production

Structure of the ACC Division



131 staff members (including post doctoral fellows) plus 30 staff from ATG
16 graduate students

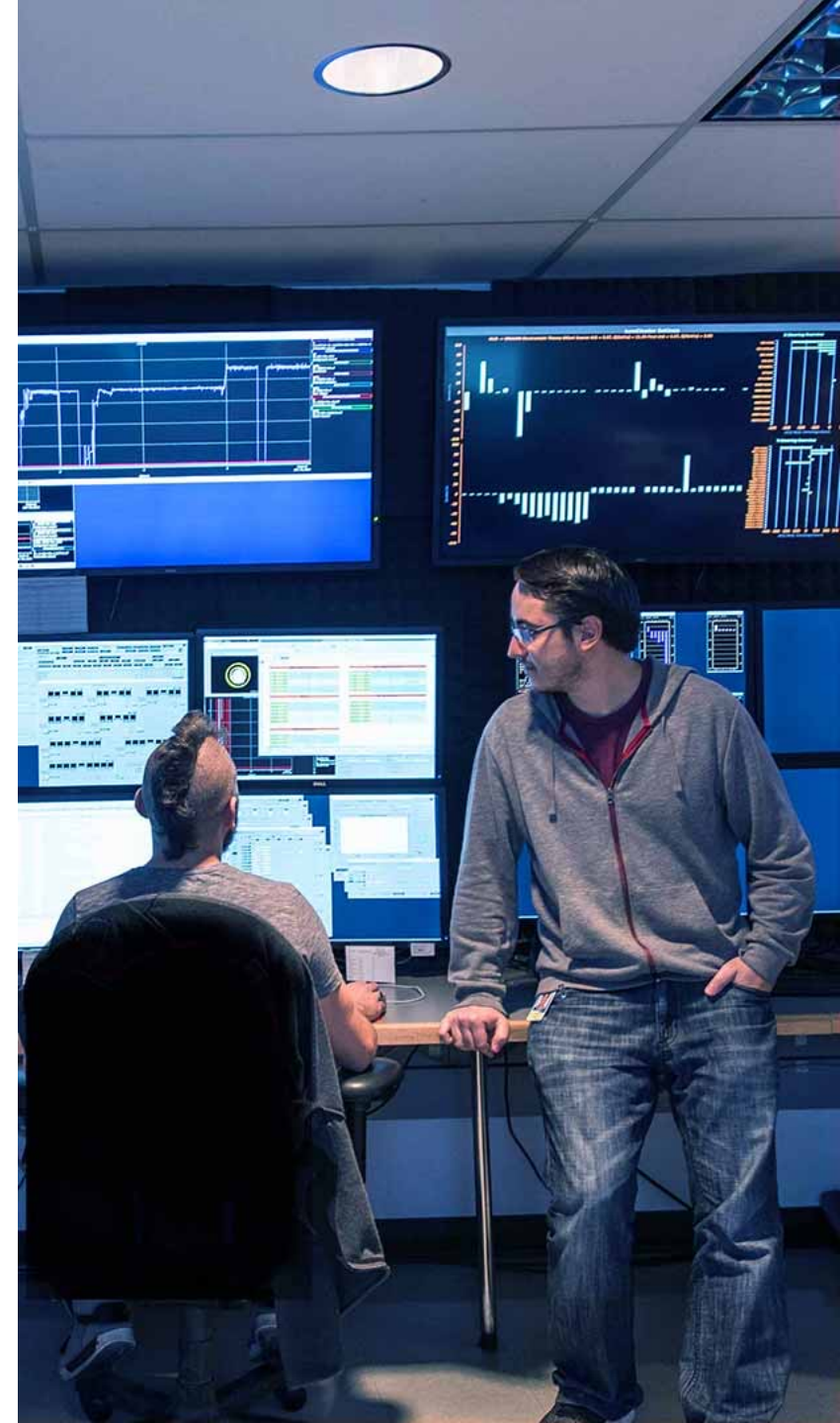
TRIUMF Accelerator Development and Research

Three main areas of activities:

- Operation, refurbishment and upgrade of the TRIUMF accelerator complex
- Domestic and international accelerator projects
- Accelerator research and development

based on three pillars of excellence in

- beam physics and instrumentation
- secondary particle production
- SRF/RF technologies and research



20-Year Vision

Five themes make up the foundation of the 20-Year Vision document. The Accelerator Division vision links to all themes:

- 1. A global leader in discovery science, delivering breakthroughs that unlock the deepest mysteries of the universe:**
Strengthening Canada's leadership in groundbreaking particle and nuclear physics
- 2. A world-class accelerator centre driving use-inspired research – from the life sciences to quantum and green technologies:**
Leveraging our unique infrastructure to pursue research in Canada that will change the world
- 3. An inclusive multidisciplinary talent incubator, attracting and developing the best people from around the world:**
Producing Canada's future science leaders and innovators
- 4. A leader in a flourishing national Big Science ecosystem:**
Catalyzing the success and growth of Canada's network of major research facilities
- 5. A national innovation hub translating discovery science into health and sustainability solutions:**
Responding nimbly to complex societal challenges for the benefit of Canadians

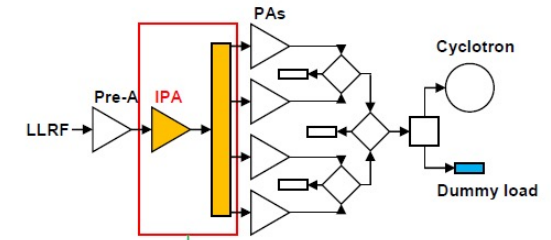
Topics to be addressed in the next 5YP

The 5-year plan 2025-2030 must address

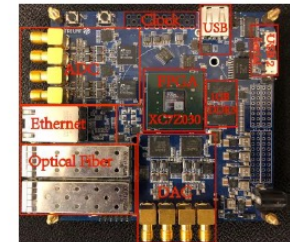
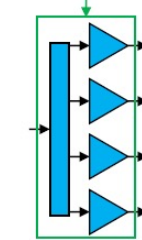
- the operation and refurbishment / upgrade of the accelerator complex
 - the ARIEL completion and transition to standard operation
 - an engagement in domestic and international collaborations (CANS, HL-LHC etc.)
- Prioritization ongoing
- Driver accelerators (cyclotron, e-linac) and the according primary beam lines (BL1A and BL4N) including improvements required for our business partners like BWXT
 - TCC – TRIUMF Control Center (combines Driver and RIB control room, exploiting modern beam tuning techniques and controls technologies)
 - Towards the operation of the Advanced Rare Isotope Laboratory (ARIEL completion and commissioning, ISAC target infrastructure, target module refurbishment, labs and ISAC accelerators)
 - External projects and collaboration (HL-LHC/CERN, SCK-CEN, VECC, CANS, DarkLight)
 - Research and education (Beam physics, high power accelerators – cyclotrons, linacs, colliders, SRF research and Targets and Ion Sources / Remote Handling)

Driver accelerators

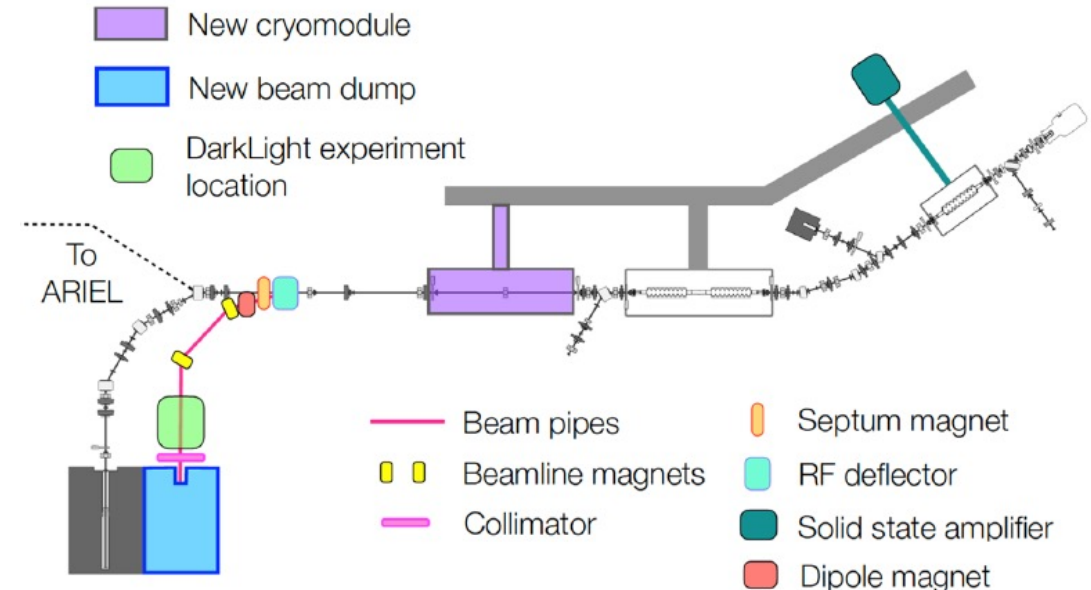
- Continue cyclotron refurbishment RF system (SSA and digital LLRF)
- Towards reduced cyclotron maintenance time (lid-up only every second year)
- E-linac towards high reliability and 100 kW beam power → for ARIEL operation
 - R&D on particulate contamination, Plasma cleaning
 - Support irradiation projects (FLASH, materials etc.)
 - Search beyond the Standard Model – DarkLight (50 MeV, new beam dump, RF separator)
 - Intense THz and IR radiation
- Primary beam lines (BL1A and BL4N)
 - Major BL1A refurbishments require RH priorities → Meson hall RH systems refurb, including hot cell, T1/T2 target transfer flask
 - Continuation of RH controls refurbishment
 - Develop and install RH waste management and reduction infrastructure



RF schematic

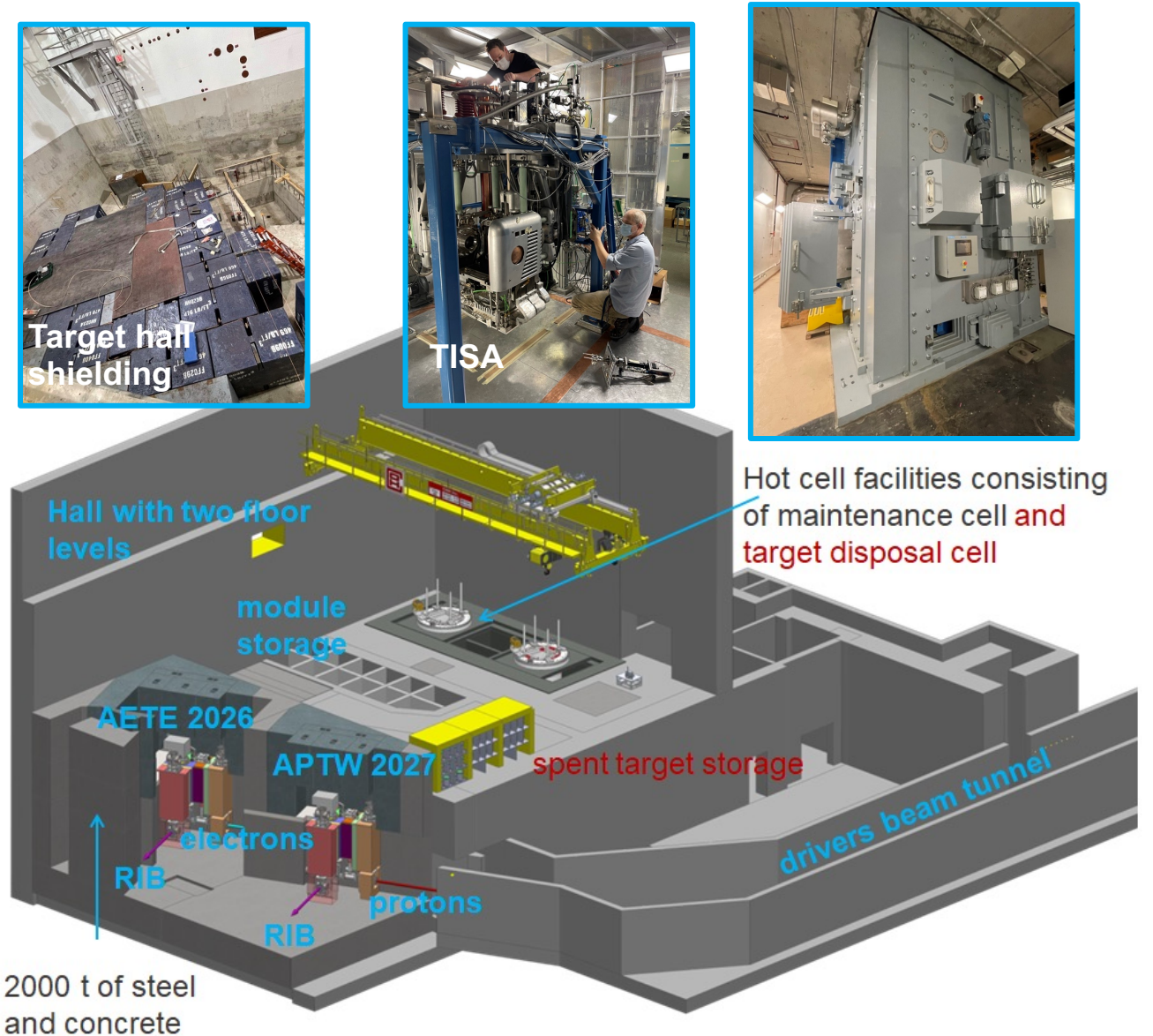


Digital LLRF board



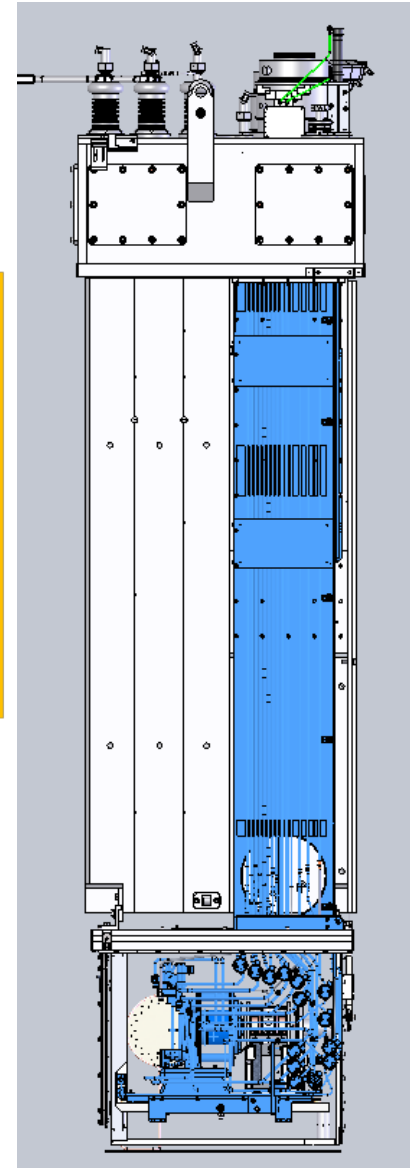
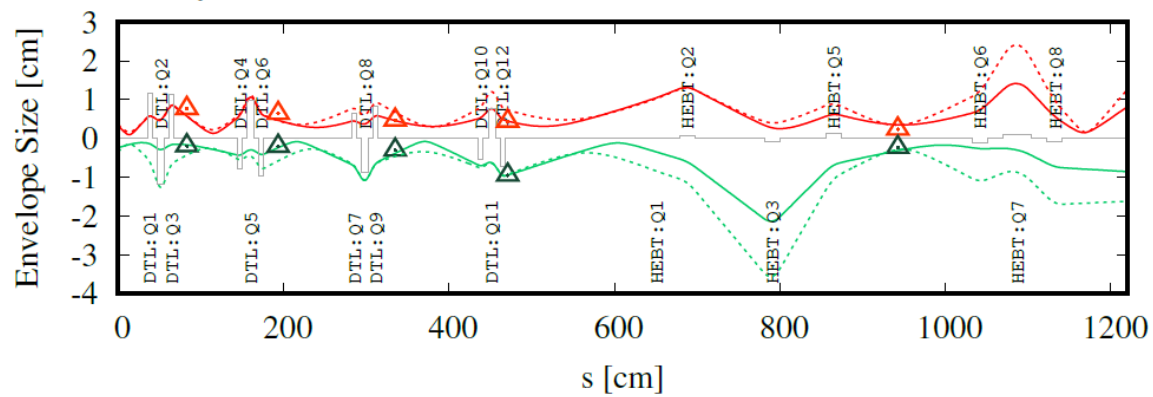
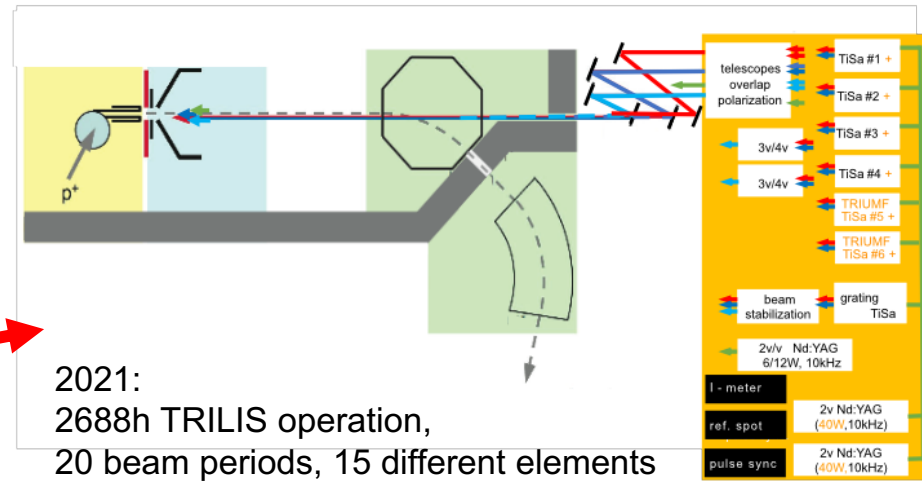
ARIEL completion and transition into Operation

- Electron target station completion and online in 2026
Proton target station completion in 2027
→ BL4N completion
- Will required a ramp up in operation to take full advantage of ARIEL over the next 5YP
→ 9000+ hours, 3 simultaneous exotic RIBs:
- Offline target acceptance stand – TISA completion
- Target production laboratories
- Target decay storage vault
- Resonant laser ion source for proton target station
- APTW proton beam raster system



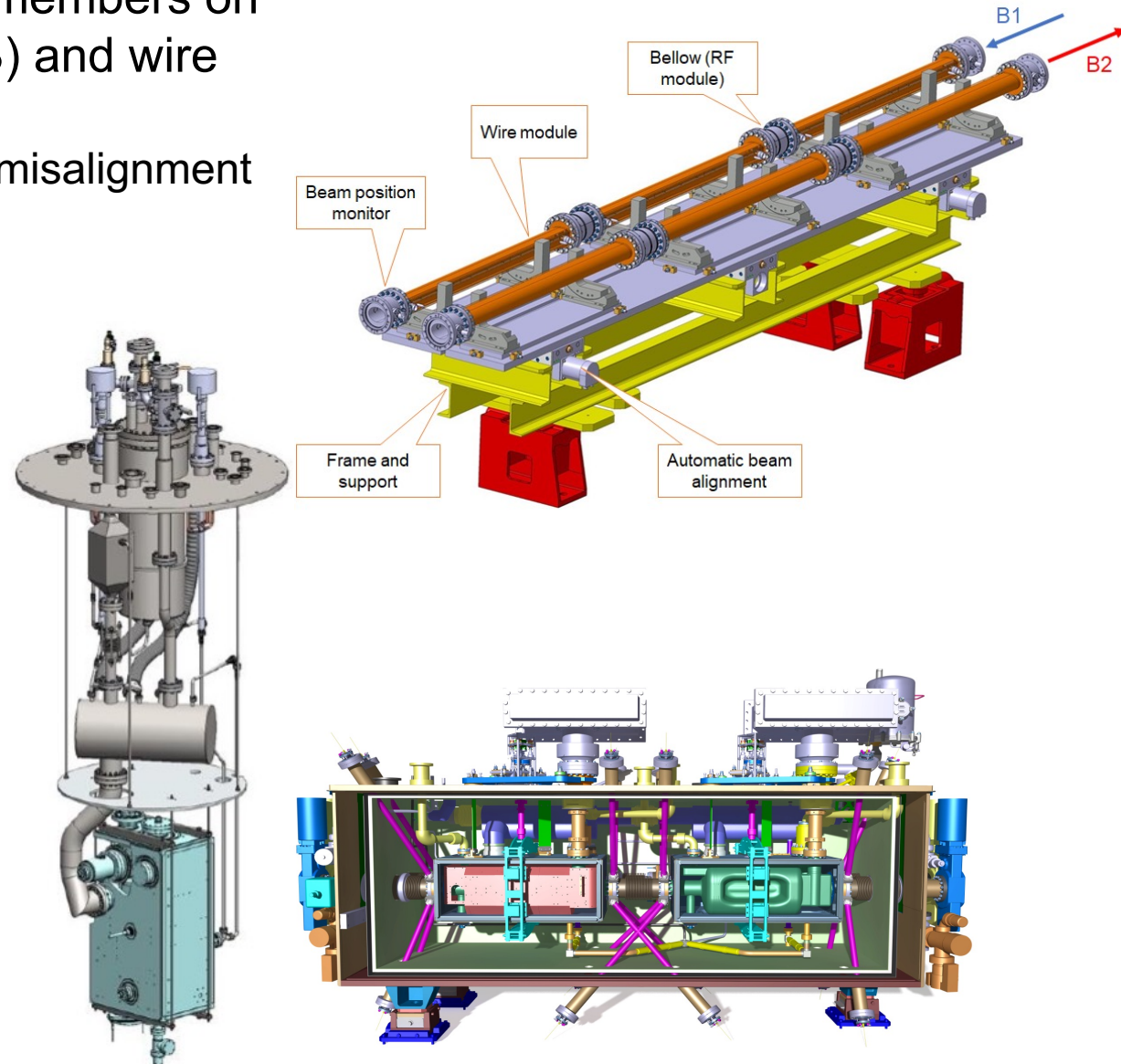
ISAC in the next 5YP

- Full roll-out of regular target module refurbishment program (all major components except shielding)
- Target production and conditioning systems renewal → labs
- Electrical and mechanical systems refurbishment and procurement of critical spares
- Laser Ion Source beam development: 2 elements/y (increasingly difficult)
- Allow for more complex setups and ALIS & TRILIS parallel operation
- From the ISAC Linacs towards generalized usage of model-based tuning and machine learning across TRIUMF.



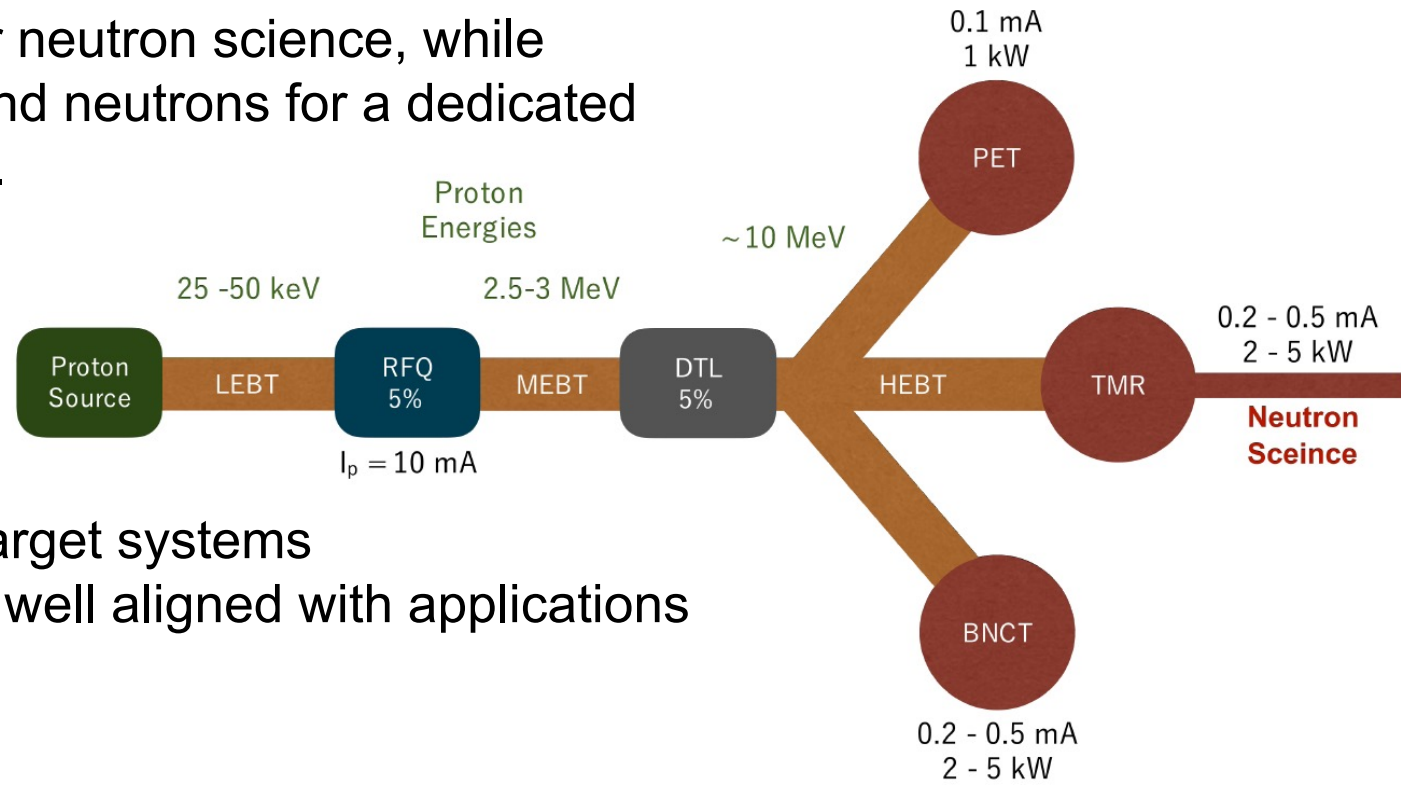
Example international: Collaboration with CERN

- Beam simulation studies by beam physics group members on the theory for both long-range beam-beam (LRBB) and wire correctors in the HL-LHC
 - Effect on the closed orbit of the LHC coming from a misalignment of wire correctors
- Wire correctors are planned in locations on both sides of the interaction point to compensate LRBB effects
 - TRIUMF is asked to engage on wire corrector for HL-LHC in the next 5YP – P530
- TRIUMF will receive 10 dressed RF Dipole resonators from US-AUP re-qualify and assemble each pair of RFDs into five hermetic strings.
 - TRIUMF to assemble hermetic strings into five cryomodules
 - Cryomodule production and delivery will continue in the next 5YP period



Example domestic: PC-CANS

- TRIUMF is collaborating with the University of Windsor and the Canadian neutron scattering community towards an accelerator-based neutron facility (D. Maharaj's talk on Monday, CDR PC-CANS: [PC-CANS CDR Circulated Proposal-v5.1.pdf](#))
- Collaboration has conceptualized a stageable prototype CANS facility, PC-CANS, based on linac technology.
- PC-CANS will allow competitive rates for neutron science, while simultaneously producing F18 for PET and neutrons for a dedicated BNCT research and development facility.
- The PC-CANS prototype will be the first CANS in Canada and the first for BNCT in North America.
- The project will augment and solidify TRIUMF core competence in linac and target systems and the proton accelerator technology is well aligned with applications



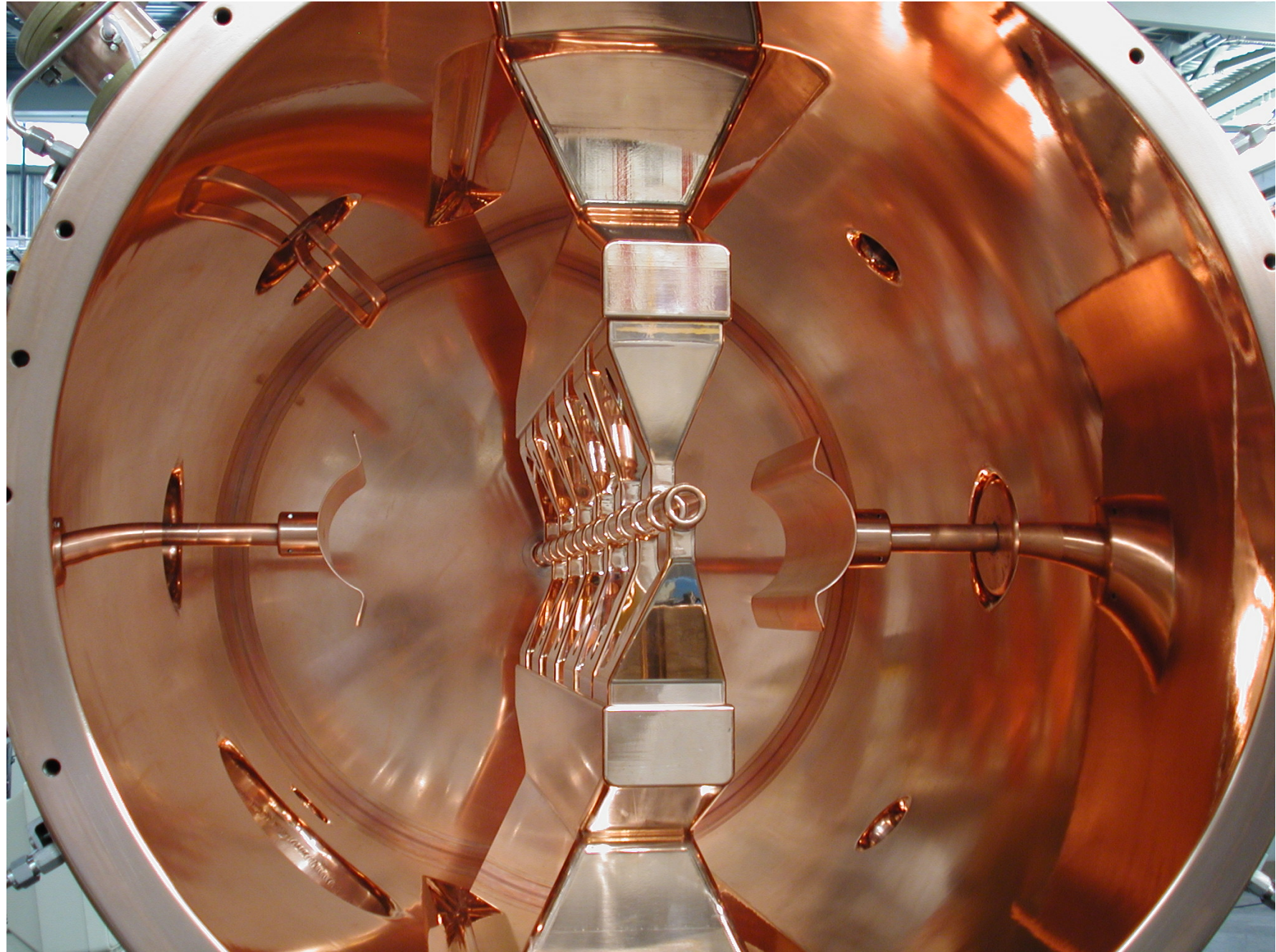
Staffing towards the ARIEL operation era

- Basis for the staffing decision towards the ARIEL operation era is the Operational model for ARIEL (Document-129655).
→ Factory model, where the three RIB target areas are each scheduled in three-week cycles with each cycle starting on a subsequent week.
- The operational model analysis includes an estimation of the extra effort required to commission, operate, develop and maintain a significantly expanded facility, over and above the present effort.
- From this analysis we identified additional hires, taking the gain of efficiency into account
(TCC, advances beam tuning, IT tools, refurbished equipment)

Thank you

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Additional slides

ACC division mission statement

- The TRIUMF accelerator division safely operates the TRIUMF accelerator complex with high performance and availability. We develop and implement new accelerator facilities and related technologies to support world class science nationally and internationally.
- We lead accelerator physics research in Canada and foster TRIUMF's position at the forefront of accelerator science. We advance our core competencies and transfer our knowledge to industry for the benefit of society.
- We leverage infrastructure and expertise to provide world class training of HQP in accelerator physics and engineering.

Our 20-year Vision for TRIUMF Accelerator Science and Facilities

Isotope Valley

With ISAC+ARIEL+IAMI we will greatly expand our capabilities, and establish TRIUMF as a leading global center for isotope research.

Isotopes for physical science

Isotopes for life science

Isotopes to cure Canadians

Canadian Hub

We are Canada's centre of excellence in accelerator-related science and technology.

We centralize knowledge, and diffuse it through training, counsel, and collaborations.

With our always evolving expertise we remain a leader in Canada's transformation to a knowledge based economy.

Big Science — Big Tech

International collaborations are key to contribute to the most significant discoveries, attract talents, and maintain cutting-edge expertise.

We support international projects by leveraging our core knowledge and engaging Canadian industry.

We build on our strengths to serve science and invent life-changing technologies.

Driver accelerators:

- Cyclotron refurbishment and upgrades (RF, controls, etc.)
- e-linac towards full performance
- beam lines (BL1A – CFI project), BL4N completion for APTW

TCC – TRIUMF Control Center (combines Driver and RIB control room)

RIB facilities:

- ARIEL completion and commissioning
- ISAC target hall consolidation, target module refurbishment, labs, ISAC accelerators
- Target ion sources, RILIS

Research and education:

- HLA, model coupled beam tuning, machine learning
- High power beams – e-linac, HL-LHC, EIC
- Cyclotron technology (injection, beam loss reduction, SC cyclotron)
- SRF research - plasma conditioning, degassing furnace, particulate migration

External projects:

- CERN HL-LHC and TIS
- SCK-CEN and Raon – TIS and post acceleration technologies
- CANS, DarkLight and FLASH irradiation