TRIUMF

Five-Year Plan within the 20-Year Vision - Town Hall

Physical Sciences Division

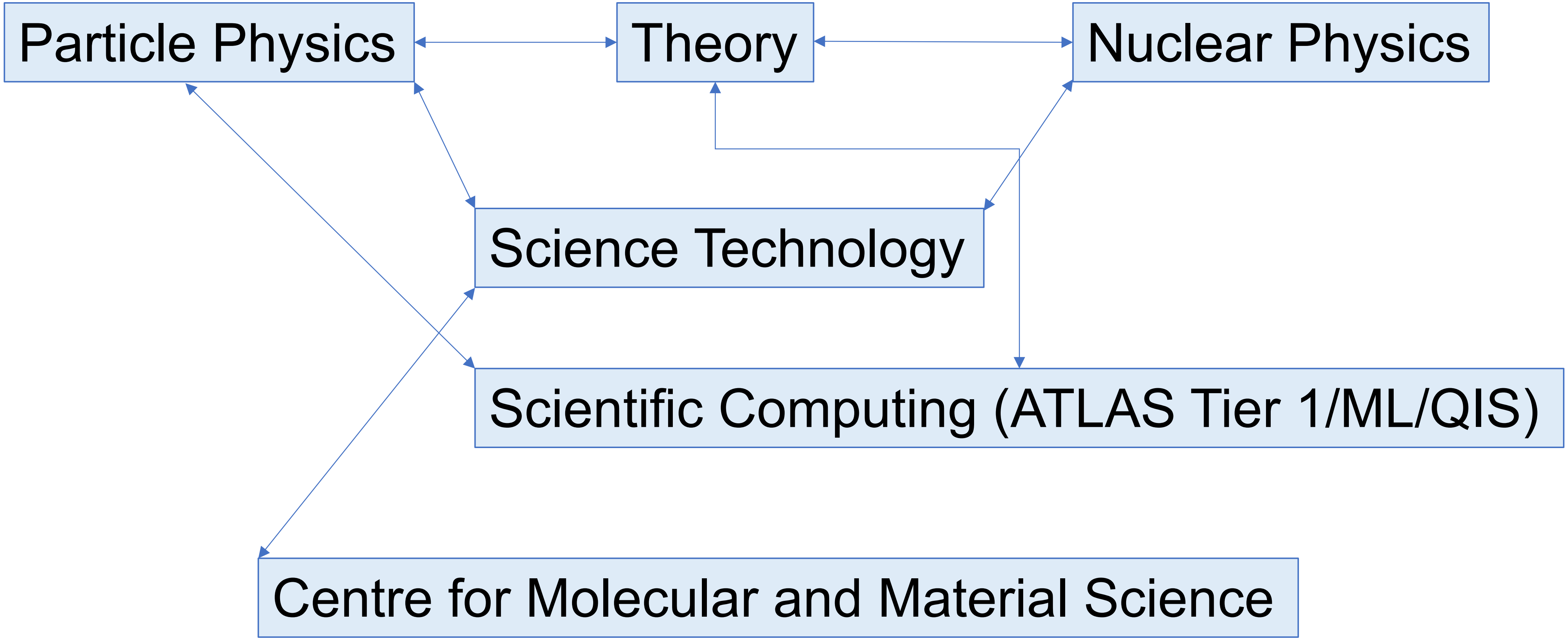
Science Week 2022

July 22, 2022,TRIUMF, Vancouver

Petr Navratil
Interim Director, Physical Sciences

2022-07-22

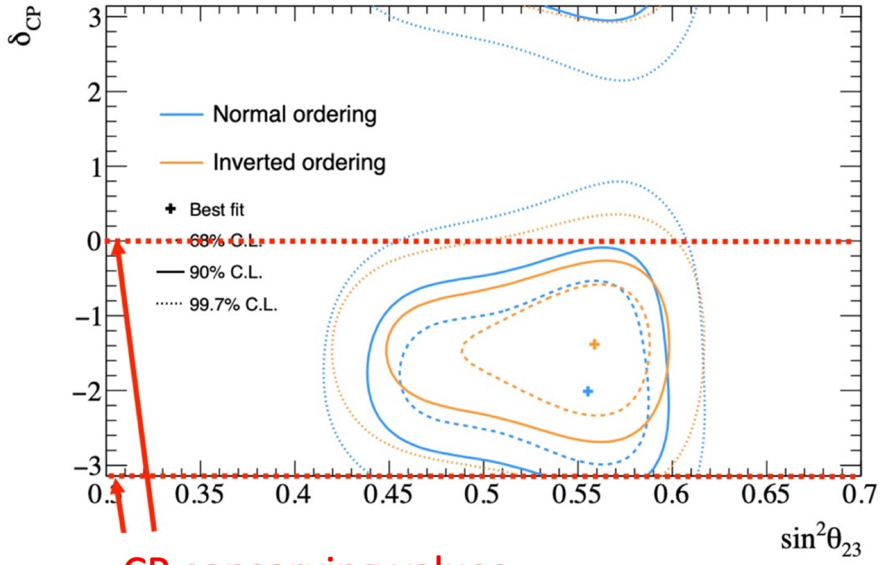
Physical Sciences Division



Planning for the next five-year period (2025-2030) … building on past accomplishments

Laser cooling of (anti)hydrogen

T2K sees a preference for CP violation (matter/antimatter asymmetry)!



CP conserving values

Planning for the next five-year period (2025-2030)
… building on past accomplishments

ATLAS collaboration published a Nature paper

@ 10-year anniversary of the Higgs boson discovery

Article

A detailed map of Higgs boson interactions by the ATLAS experiment ten years after the discovery

https://doi.org/10.1038/s41586-022-04893-w

Received: 21 March 2022

Accepted: 23 May 2022

Published online: 04 July 2022

Open access

Check for updates

The ATLAS Collaboration[1✉]

The standard model of particle physics[1–4] describes the known fundamental particles and forces that make up our Universe, with the exception of gravity. One of the central features of the standard model is a field that permeates all of space and interacts with fundamental particles[5–9]. The quantum excitation of this field, known as the Higgs field, manifests itself as the Higgs boson, the only fundamental particle with no spin. In 2012, a particle with properties consistent with the Higgs boson of the standard model was observed by the ATLAS and CMS experiments at the Large Hadron Collider at CERN[10,11]. Since then, more than 30 times as many Higgs bosons have been recorded by the ATLAS experiment, enabling much more precise measurements and new tests of the theory. Here, on the basis of this larger dataset, we combine an unprecedented number of production and decay processes of the Higgs boson to scrutinize its interactions with elementary particles. Interactions with gluons, photons, and *W* and *Z* bosons—the carriers of the strong, electromagnetic and weak forces—are studied in detail. Interactions with three third-generation matter particles (bottom (*b*) and top (*t*) quarks, and tau leptons (τ)) are well measured and indications of interactions with a second-generation particle (muons, μ) are emerging. These tests reveal that the Higgs boson discovered ten years ago is remarkably consistent with the predictions of the theory and provide stringent constraints on many models of new phenomena beyond the standard model.

PHYSICAL REVIEW C **99**, 025503 (2019)

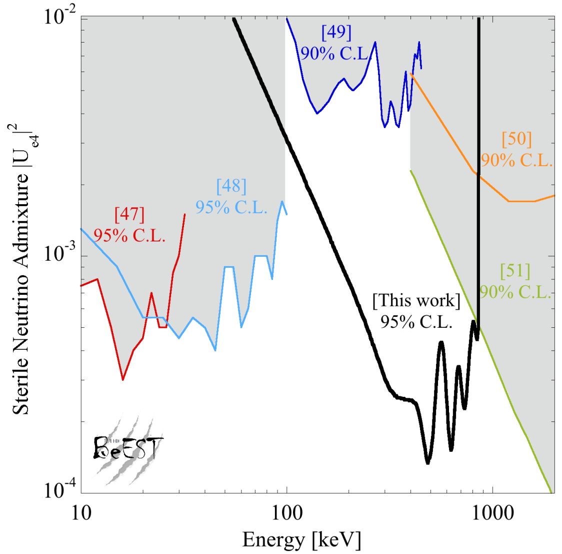
First ultracold neutrons produced at TRIUMF

S. Ahmed,[1] E. Altiere,[2] T. Andalib,[1] B. Bell,[3,4] C. P. Bidinosti,[5,1] E. Cudmore,[3,6] M. Das,[1] C. A. Davis,[3] B. Franke,[3] M. Gericke,[1] P. Giampa,[3] P. Gnyp,[3,7] S. Hansen-Romu,[1,5] K. Hatanaka,[8] T. Hayamizu,[2] B. Jamieson,[5] D. Jones,[2] S. Kawasaki,[9] T. Kikawa,[10] M. Kitaguchi,[11,12] W. Klassen,[1,5] A. Konaka,[3] E. Korkmaz,[13] F. Kuchler,[3] M. Lang,[1] L. Lee,[3,1] T. Lindner,[3,5] K. W. Madison,[2] Y. Makida,[9] J. Mammei,[1] R. Mammei,[5,1,3] J. W. Martin,[5,1] R. Matsumiya,[3] E. Miller,[2] K. Mishima,[14] T. Momose,[2] T. Okamura,[9] S. Page,[1] R. Picker,[3,15] E. Pierre,[3,8] W. D. Ramsay,[3] L. Rebenitsch,[1,5] F. Rehm,[3,7] W. Schreyer,[3,*] H. M. Shimizu,[11] S. Sidhu,[15,3] A. Sikora,[5] J. Smith,[3,2] I. Tanihata,[8] B. Thorsteinson,[5] S. Vanbergen,[3,2] W. T. H. van Oers,[3,1] and Y. X. Watanabe[9]
(TUCAN Collaboration)

PHYSICAL REVIEW LETTERS **126**, 021803 (2021)

Limits on the Existence of sub-MeV Sterile Neutrinos from the Decay of ^{7}Be in Superconducting Quantum Sensors

S. Friedrich,[1,*] G. B. Kim,[1] C. Bray,[2] R. Cantor,[3] J. Dilling,[4] S. Fretwell,[2] J. A. Hall,[3] A. Lennarz,[4,5] V. Lordi,[1] P. Machule,[4] D. McKeen,[4] X. Mougeot,[6] F. Ponce,[7,1] C. Ruiz,[4] A. Samanta,[1] W. K. Warburton,[8] and K. G. Leach[2,†]



Planning for the next five-year period (2025-2030) … building on past accomplishments

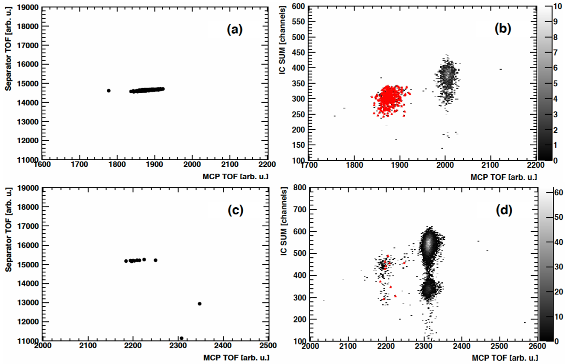
Radiative Capture on Nuclear Isomers: Direct Measurement of the $^{26m}Al(p,\gamma)^{27}Si$ Reaction

G. Lotay, A. Lennarz, C. Ruiz, C. Akers, A. A. Chen, G. Christian, D. Connolly, B. Davids, T. Davinson, J. Fallis, D. A. Hutcheon, P. Machule, L. Martin, D. J. Mountford, and A. St. J. Murphy

Phys. Rev. Lett. **128**, 042701 – Published 27 January 2022

DRAGON:
First ever isomeric beam radiative capture measurement, published in Physical Review Letters

This experiment drew upon previous work from Gammasphere, TU-Munich, TAMU to do something that hasn't ever been achieved: measuring capture on an isomer in inverse kinematics.



PHYSICAL REVIEW LETTERS **123,** 197203 (2019)

Intrinsic Low-Temperature Magnetism in SmB_6

S. Gheidi,[1] K. Akintola,[1] K. S. Akella,[1] A. M. Côté,[1,2] S. R. Dunsiger,[1,3] C. Broholm,[4,5,6] W. T. Fuhrman,[7] S. R. Saha,[7] J. Paglione,[7,6] and J. E. Sonier[1,6]

PHYSICAL REVIEW X **10,** 011036 (2020)

Observation of a Charge-Neutral Muon-Polaron Complex in Antiferromagnetic Cr_2O_3

M. H. Dehn,[1,2,3,*] J. K. Shenton,[4] S. Holenstein,[5,6] Q. N. Meier,[4] D. J. Arseneau,[3] D. L. Cortie,[1,2,7,†] B. Hitti,[3] A. C. Y. Fang,[1,‡] W. A. MacFarlane,[2,3,7] R. M. L. McFadden,[2,7] G. D. Morris,[3] Z. Salman,[6] H. Luetkens,[6] N. A. Spaldin,[4] M. Fechner,[4,8] and R. F. Kiefl[1,2,3]

PHYSICAL REVIEW LETTERS **120,** 062502 (2018)

Precision Measurement of the β Asymmetry in Spin-Polarized ^{37}K Decay

B. Fenker,[1,2] A. Gorelov,[3] D. Melconian,[1,2,*] J. A. Behr,[3] M. Anholm,[3,4] D. Ashery,[5] R. S. Behling,[1,6] I. Cohen,[5] I. Craiciu,[3] G. Gwinner,[4] J. McNeil,[7,3] M. Mehlman,[1,2] K. Olchanski,[3] P. D. Shidling,[1] S. Smale,[3] and C. L. Warner[3]

PHYSICAL REVIEW LETTERS **126,** 022501 (2021)

Editors' Suggestion | Featured in Physics

***Ab Initio* Limits of Atomic Nuclei**

S. R. Stroberg,[1,2,*] J. D. Holt,[2,3,†] A. Schwenk,[4,5,6,‡] and J. Simonis[7,4,5,§]

PHYSICAL REVIEW LETTERS **120,** 062503 (2018)

Dawning of the $N = 32$ Shell Closure Seen through Precision Mass Measurements of Neutron-Rich Titanium Isotopes

E. Leistenschneider,[1,2,*] M. P. Reiter,[1,3] S. Ayet San Andrés,[3,4] B. Kootte,[1,5] J. D. Holt,[1] P. Navrátil,[1] C. Babcock,[1] C. Barbieri,[6] B. R. Barquest,[1] J. Bergmann,[3] J. Bollig,[1,7] T. Brunner,[1,8] E. Dunling,[1,9] A. Finlay,[1,2] H. Geissel,[3,4] L. Graham,[1] F. Greiner,[3] H. Hergert,[10] C. Hornung,[3] C. Jesch,[3] R. Klawitter,[1,11] Y. Lan,[1,2] D. Lascar,[1,†] K. G. Leach,[12] W. Lippert,[3] J. E. McKay,[1,13] S. F. Paul,[1,7] A. Schwenk,[11,14,15] D. Short,[1,16] J. Simonis,[17] V. Somà,[18] R. Steinbrügge,[1] S. R. Stroberg,[1,19] R. Thompson,[20] M. E. Wieser,[20] C. Will,[3] M. Yavor,[21] C. Andreoiu,[16] T. Dickel,[3,4] I. Dillmann,[1,13] G. Gwinner,[5] W. R. Plaß,[3,4] C. Scheidenberger,[3,4] A. A. Kwiatkowski,[1,13] and J. Dilling[1,2]

Selected for a Viewpoint in *Physics*
PRL **118,** 262502 (2017) PHYSICAL REVIEW LETTERS week ending 30 JUNE 2017

Nuclear Force Imprints Revealed on the Elastic Scattering of Protons with ^{10}C

A. Kumar,[1] R. Kanungo,[1*] A. Calci,[2] P. Navrátil,[2†] A. Sanetullaev,[1,2] M. Alcorta,[2] V. Bildstein,[3] G. Christian,[2] B. Davids,[2] J. Dohet-Eraly,[2,4] J. Fallis,[2] A. T. Gallant,[2] G. Hackman,[2] B. Hadinia,[3] G. Hupin,[5,6] S. Ishimoto,[7] R. Krücken,[2,8] A. T. Laffoley,[3] J. Lighthall,[2] D. Miller,[2] S. Quaglioni,[9] J. S. Randhawa,[1] E. T. Rand,[3] A. Rojas,[2] R. Roth,[10] A. Shotter,[11] J. Tanaka,[12] I. Tanihata,[12,13] and C. Unsworth[2]

5YP 2025-2030

- Divisional planning
  - Alignment with
    - TRIUMF 20-Year Vision
    - TRIUMF Goals & Objectives
  - Science from ARIEL
  - Bottom-up approach – start at departmental level
  - Discussions at the DH+D meetings
  - BAE retreat on June 13, 2022
    - Consider current effort & “blue-sky” scenario
- Discussions with the Leadership Team
- Engagement with broader community
  - Science Week, July 18-22, 2022

Deliver high-impact science

Become a hub for interdisciplinary education and training

Inspire Canadians to discover and innovate

Advanced Rare Isotope Facility (ARIEL)

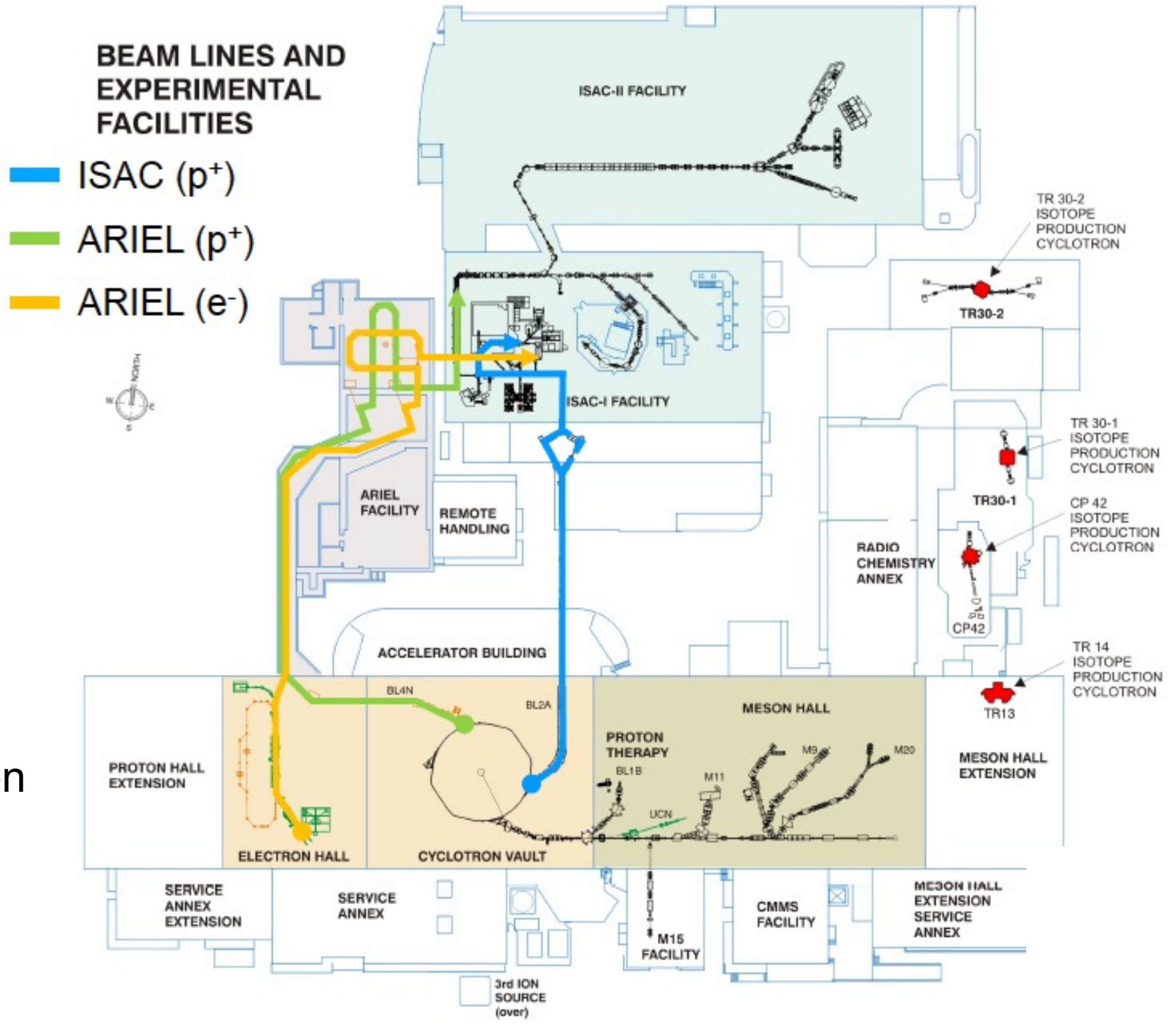
TRIUMF's flagship project

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

Let's fully utilize ARIEL capabilities and get the best scientific results from ARIEL

TRIUMF accelerator complex

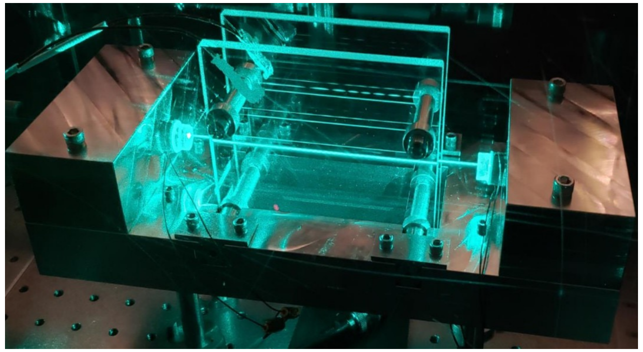


2023-2030 Strategy: Low Energy Experiments

→ Precision RIB Measurements / Fundamental Symmetries

Francium PNC Facility (Fr-PNC)

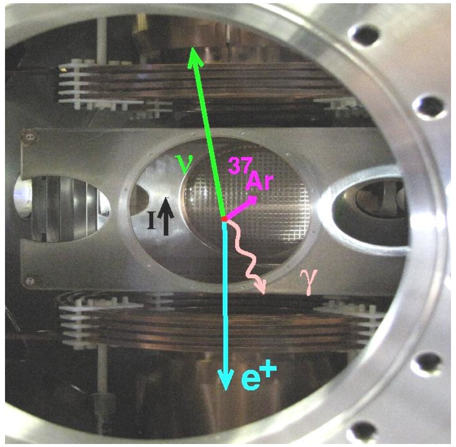
- Currently at level of E1/M1 Stark transition measurement → Sensitivity & methodology proven
- Atomic Parity-violating signal expected 2024
- APV measurement competitive with others, 2025+
  - Competitive electron-quark neutral weak coupling + nuclear anapole
- These measurements need maximum yields of $^{208-213}Fr$ → n-dependent effects



FRANCIUM UHV Power Buildup Cavity
(T. Hucko, ACOT 2021)

TRINAT (neutral atom trap) → TRINAT-γ

- Extend β-ν-γ from T-reversal symmetry breaking in ^{37}K (expected finished in current 5YP)
- Consider isospin symmetry-breaking in isospin-suppressed Fermi-GT $^{36,45,47}K$ for V_{ud}
- Develop case for time-reversal enhancement by isospin-suppressed F-GT → competitive search for Time-breaking, Parity-even isospin-breaking nucleon-nucleon interactions



TRINAT Trap

2023-2030 Strategy: Low Energy Experiments

NUCLEAR PHYSICS - ARIEL

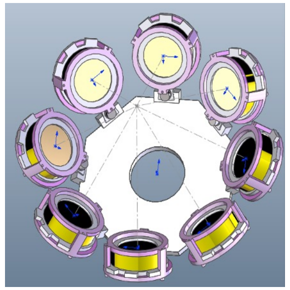
→ Decay Spectroscopy & Mass Measurements: Structure & Fund. Symmetries

GRIFFIN Decay Spectrometer

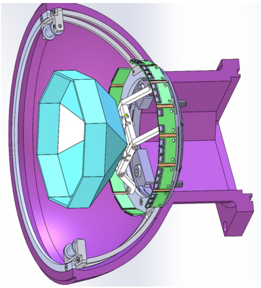
- Wide-ranging and active science program in nuclear structure, nuclear astrophysics and fundamental symmetries → continue with ISAC and further ramp up with ARIEL. → New n-rich isotopes, higher yields, cleaner beams
- New upgrades will ensure competitive edge over worldwide competition + enable new science opportunities.
  - Upgrade SCEPTAR beta-tagging array to ARIES.
  - Upgrade PACES conversion electron spectrometer to CEDAR.
  - New RCMP detector (DSSD box built by Uni. of Regina) to enable charge-particle spectroscopy (eg. β-delayed proton and alpha)

"Everything except the neutrino!"

CEDAR

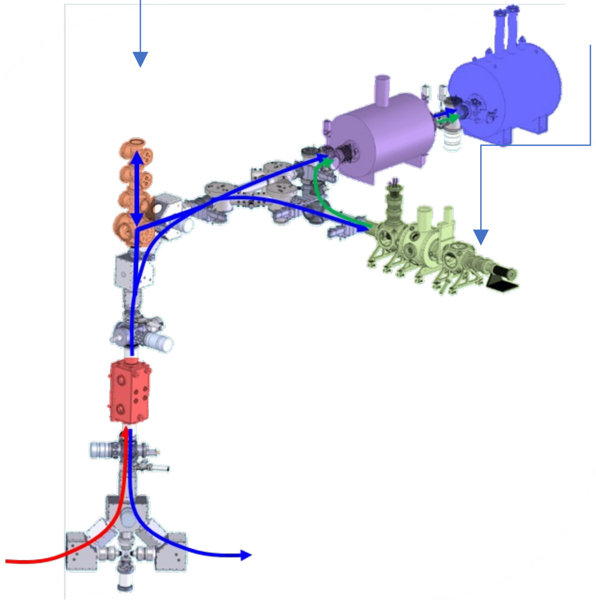


ARIES



TITAN Ion Trap Facility

- MR-TOF: 10 year + program of measuring r-process nuclei for astrophysics (masses), plus instrument of standard for measuring low intensities from ARIEL
- MPET (Penning Trap): Precision mass measurements, v. high precision (1:1E+10) of heavy superallowed β-emitters → V_{ud}



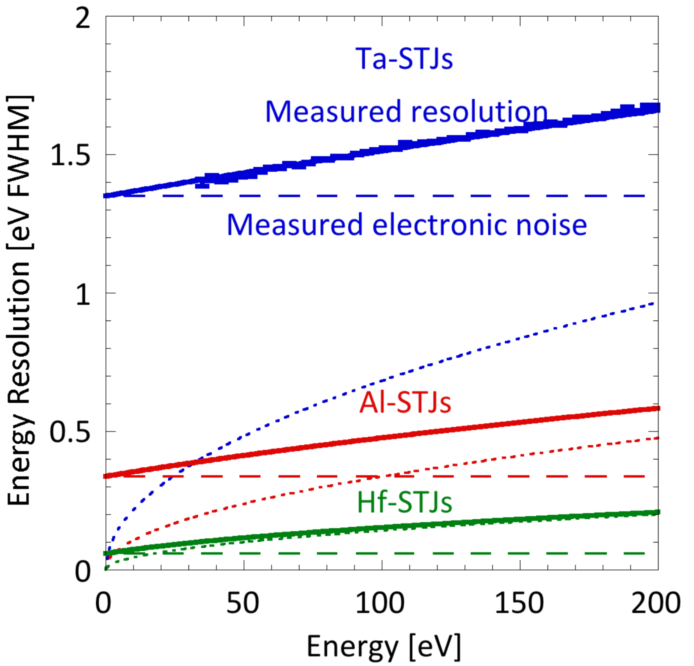
- EBIT (highly-charged ions) [5-10 year program]
  - In-trap decay spectroscopy: nuclear structure & Astro
  - Extreme UV spectroscopy → absolute charge radii of heavies (e.g. Fr, Ra) for EDMs
  - Highly-charged radioactive molecules: establishing existence → RadMol facility

2023-2030 Strategy: Low Energy Experiments

→ BeEST Sterile Neutrino Experiment

NUCLEAR PHYSICS

QUANTUM SENSING

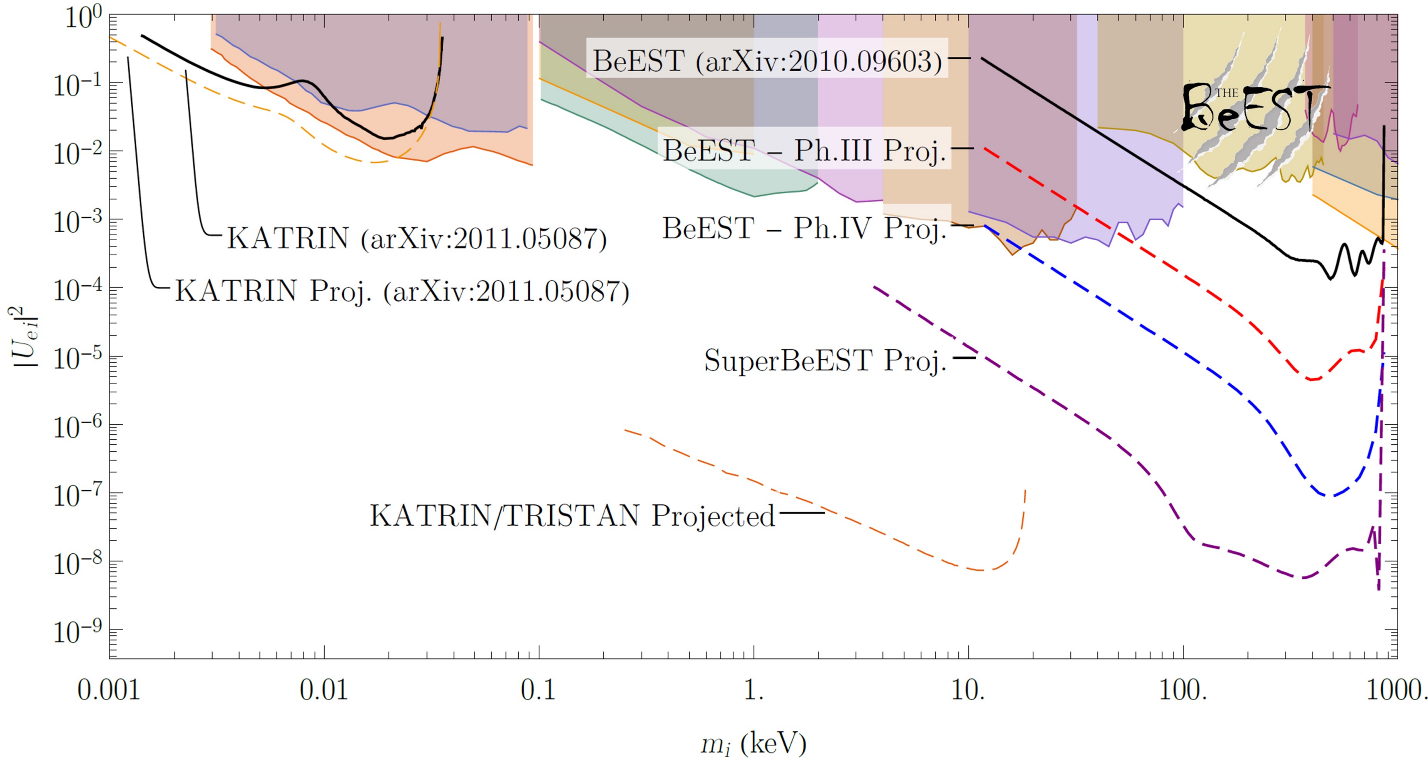


Novel experiment utilizing cutting-edge Superconducting Tunnel Junctions

Measure nuclear recoil of ^7Li during ^7Be electron capture → screen for signals of non-SM virtual mass eigenstates → eV resolution, 100s keV range

Led by Colorado School of Mines & LLNL (Leach & Friedrich) – TRIUMF responsible for ^7Be implantation means & equipment

- Ramp up to full ^7Be intensity, best ^7Be purity, long implant times (~1 month) → ARIEL (BL4N + HRMS)
- Evolution towards 10 kilopixel Hafnium STJ arrays
- Ability to implant multiple chips under UHV in one beamtime block



2023-2030 Strategy: Medium Energy Experiments

→ Precision RIB Measurements / Nuclear Astrophysics (+ some structure)

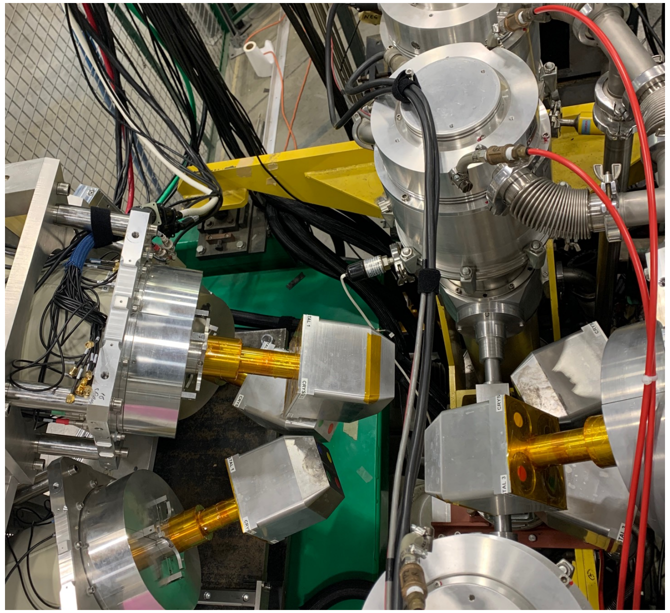
DRAGON/TUDA/SONIK

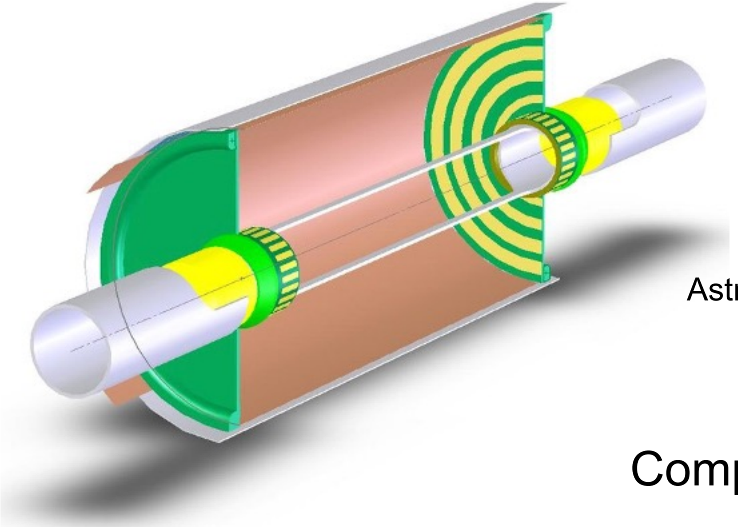
- V. high intensity stable beam experiments with RF-booster cavity
  - Direct capture, low cross-section → weakly bound halo states, astrophysics
- Long RIB runs → statistics, systematics, coverage, completeness
  - Many excited states measured in single run
- New detectors: use of GRIFFIN HPGe, Surrey $LaBr_3$ array, neutron detection at target for (α,n)
  - Eventual development of replacement array for BGO
- Competitive or unique world-standard direct measurements of radiative capture, (p,α), (α,p) + elastic scattering

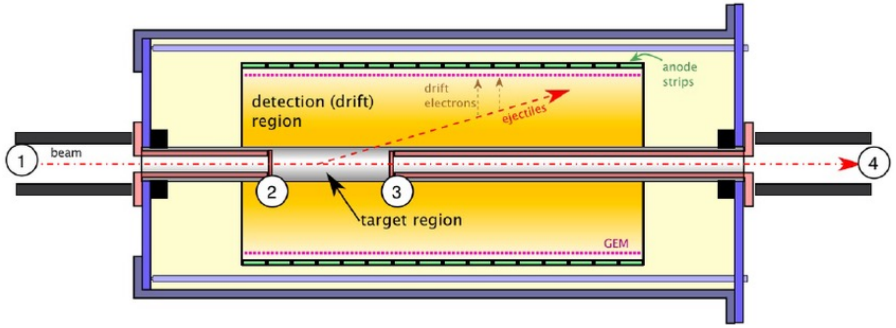
Astro TPC (formerly known as TACTIC)

- TPC for v. low cross section / high beam intensity
  - V. low energy astrophysics measurements e.g. (p,α), (α,p), (α,n) for light nuclei e.g. Big Bang Nucleosynthesis, CNO etc
  - Modified version for heavy mass
- Co-axial separated design
- New UrWELL GEM technology
- Future → flexible silicon detectors

GRIFFIN Clovers @ DRAGON







Astro TPC (York/TRIUMF)

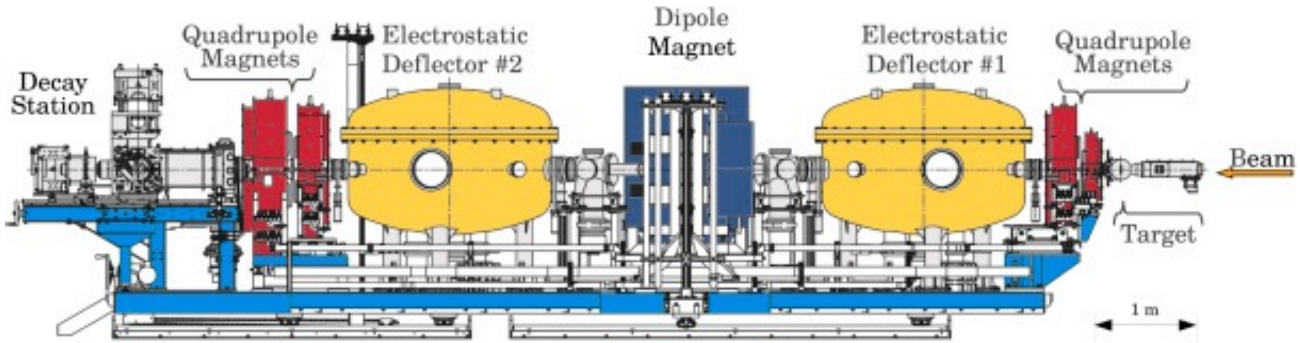
Complete "direct measurement toolkit"

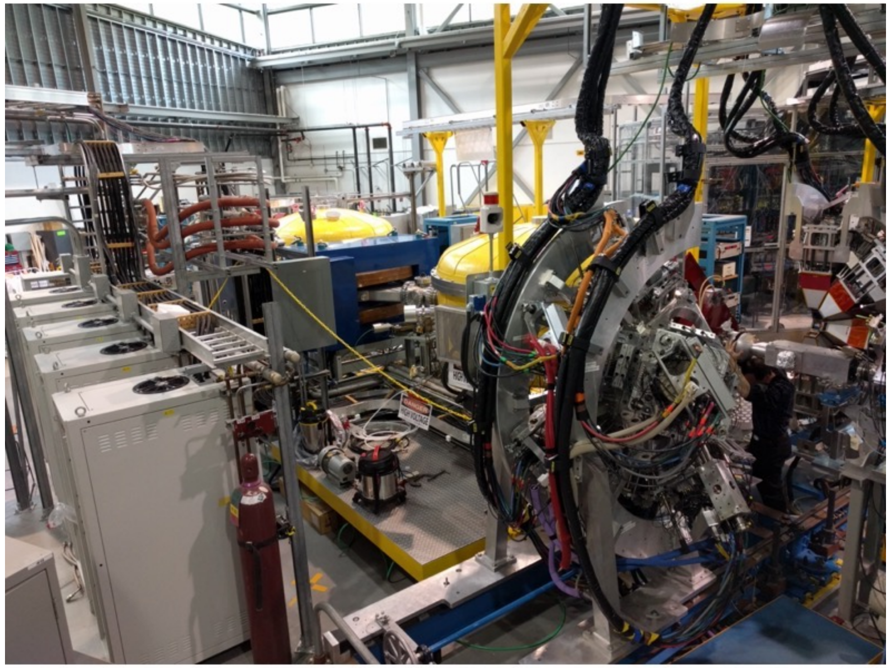
2023-2030 Strategy: High Energy Experiments

→ Pioneering & precision RIB Measurements / Nuclear Structure and Astrophysics

TIGRESS and EMMA

- Nuclear structure frontiers with RIBs:
  - Isospin: Exoticism, new magic numbers, indications of collectivity, ground states and small number of excited states
  - Precision & Sensitivity: nature of shapes and shape coexistence, microscopic origin of magic numbers, collectivity, rich excited structures and transitions
- Precision requires **high efficiency and high RIB flux** (intensity and time): highly efficient Ge detectors + recently upgraded GRIFFIN-style DAQ for ~30× the data throughput
- CANREB and ARIEL will push the frontiers of precision and sensitivity:
  - cleaner beams with lower isobaric contamination (esp. of fission products) & higher mass resolution lead to sensitivity; especially relevant for higher-mass fission peak largely unexplored by TIGRESS so far;
  - longer beam times and higher intensities will permit precise measurements





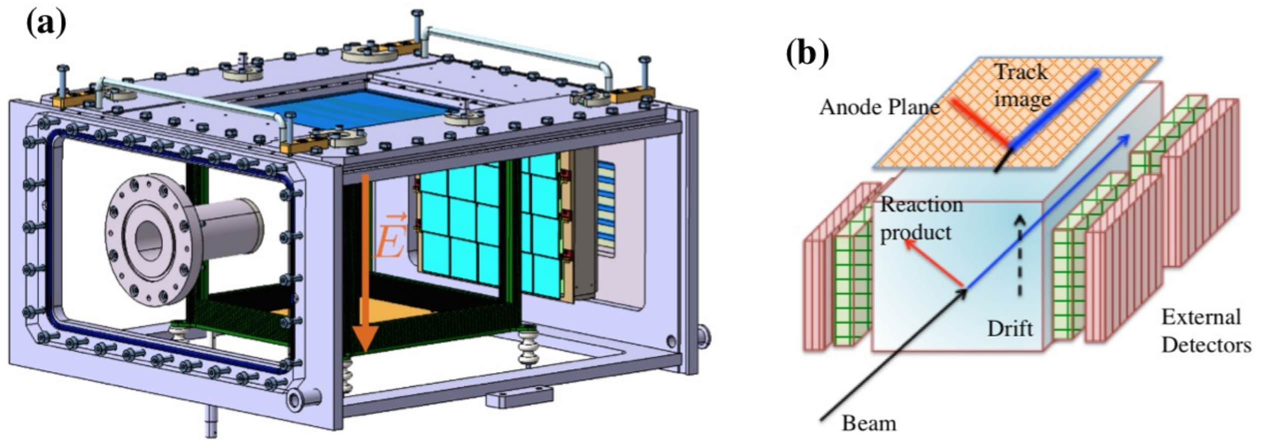
TIGRESS coupled to the EMMA recoil spectrometer target position

→ Pioneering & precision RIB Measurements

IRIS

- Nuclear structure frontiers with RIBs:
  - Exploit CANREB increase in charge breeding efficiency
  - Shell evolution in heavier nuclei
  - *r*-process nucleosynthesis studies
  - $^{28}Al(p,\alpha)$ studies for core-collapse supernovae

→ IRIS is always operating right at edge of possible RIB intensities → needs operational optimization and full capabilities of ARIEL/CANREB



EXACT-TPC

- Active target, allowing for ^4He or ^3He targets
  - With ARIEL, can measure $^{136,137}Sn(\alpha,\alpha')$ to search for resonances just above *n* threshold
  - Ideal tool to search for isoscale monopole resonance as well
- Complementary to IRIS transfer reactions (*d*,*p*) (*p*,*d*) (*d*,*t*) to get knowledge of neutron orbitals, EXACT e.g. allows for (^3He,*d*) for proton orbitals to looks for changes in nuclear shells in heavy nuclei
- Two nucleon transfer for pairing correlations using (^3He,*p*) to study proton-neutron pairing in nuclei.
- Astro: *rp*, *r* process. Indirect measurements for proton capture in ^{23}Al;. ^{35}K, ^{59}Cu, ^{61}Ga
- Thick target to measure excitation spectrum across various energies for resonant capture reactions

"We envision that for a major part of the experiments the proposed EXACT-TPC and the IRIS facility will be operated simultaneously with the TPC being located behind IRIS in the same beamline."

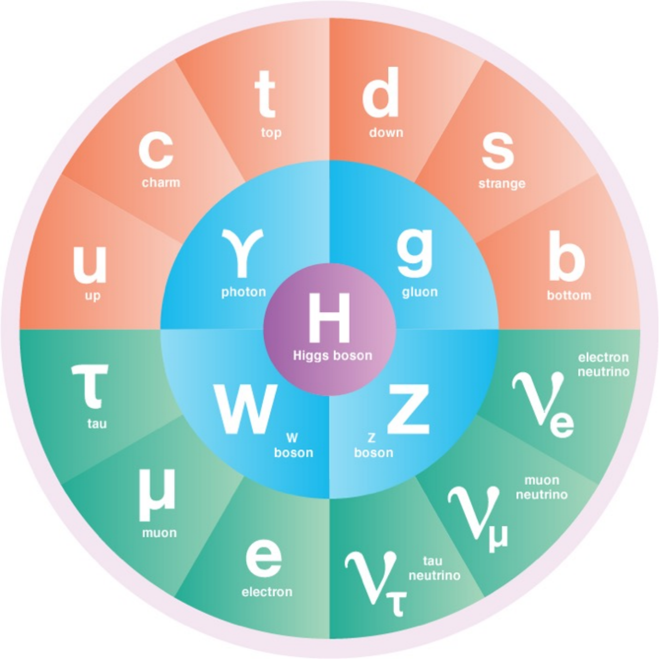
← EXACT TPC

The departments of **Particle Physics**, **Science & Technology** and **Scientific Computing** address the areas:

- High Energy Frontier
- Neutrinos and Dark Matter
- Precision Tests of Fundamental Interactions

Lead in Scientific Discovery through **focus projects**

- Projects where we are involved in all areas
  - detector design/construction, operations, data analysis
- Ensure critical mass is established
- Maintain leadership in all areas
- Current experiments
  - ATLAS, T2K/Hyper-K, ALPHA, TUCAN, SuperCDMS
- New experiments expected to reach that point in the future
  - DarkLight, nEXO, PIONEER



Enable Particle Physics in Canada and Abroad

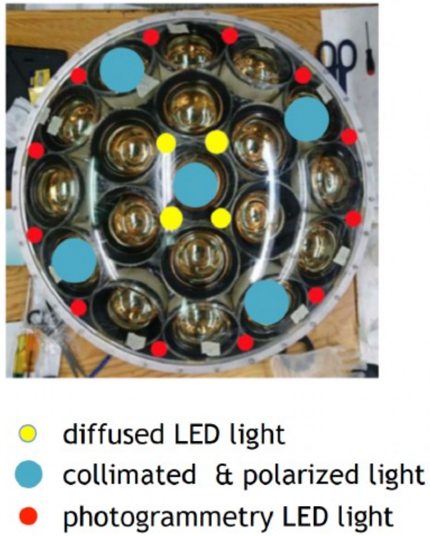
- TRIUMF is part of a **network of laboratories and partner institutions**
- Leverage TRIUMF key expertise in accelerator, computing, detector and DAQ technologies
  - Unique expertise in e.g. cryomodules, SiPM, TPC, gaseous detectors, DAQ, etc…
  - Support for Accelerator and Engineering, Science Technology and Computing are crucial

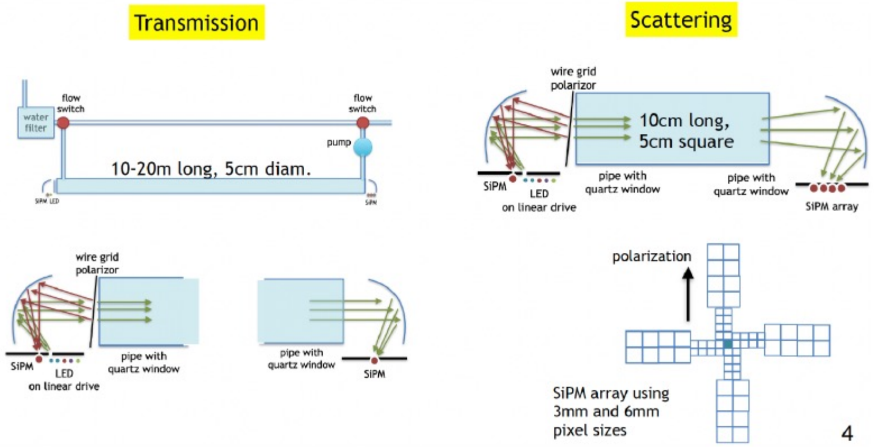
- SNOLAB: detector, facility and DAQ systems through Science and Technology involvement
  -> SuperCDMS, nEXO, ARGO, DEAP, SNO+
- CERN: In kind contributions to LHC and HL-LHC,
  share in detector upgrades -> ATLAS, ALPHA
- KEK/J-PARC: beam monitoring accelerator contributions
  share in detector upgrades -> T2K/Hyper-K
- Gran Sasso: DAQ systems -> DarkSide
- Future involvement
  - Ocean Networks Canada: -> P-One
  - Future Collider

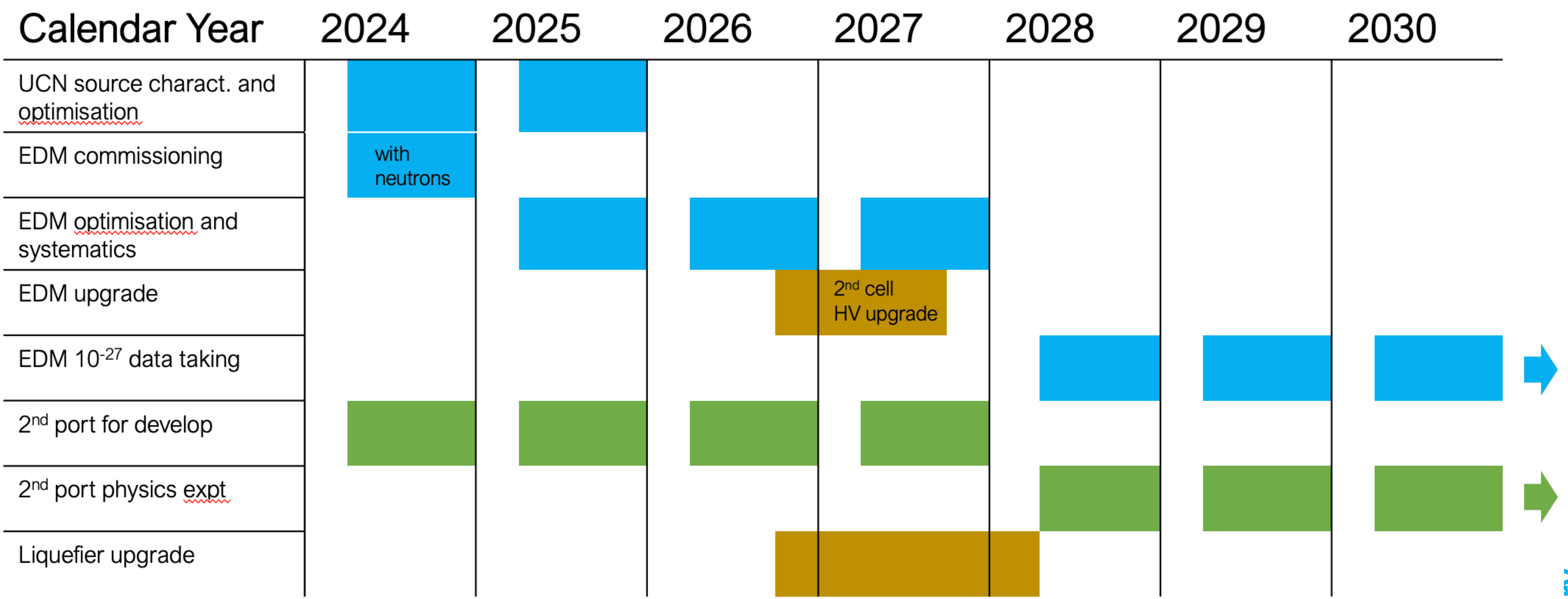
Hyper-K Detector Contributions

- Plan contributions to Hyper-K detector funded through CFI-IF 2023 competition
- 200 mPMT modules used for calibration
  - Some PMTs are replaced by pulsed LED light injection system for water/PMT response calibration
- Photogrammetry system will be built for HK as well
- Ex-situ light attenuation and scattering measurement devices to be built
  - See Akira's talk for more details

Updated Concept

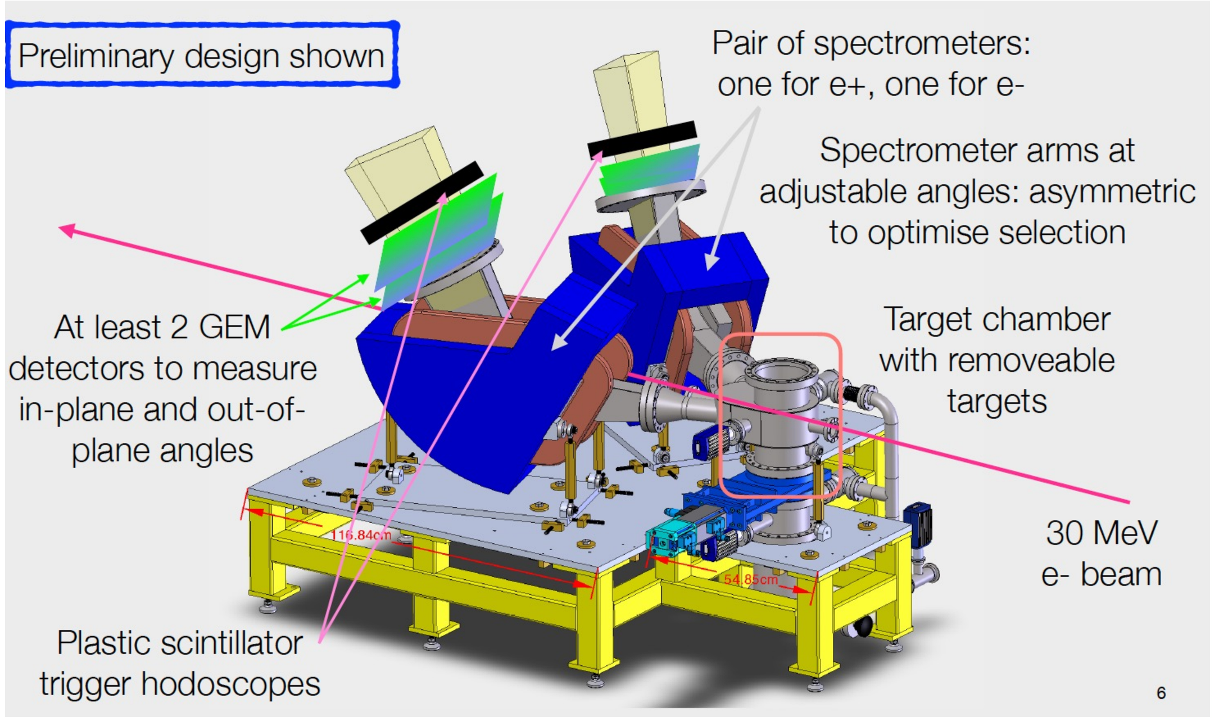




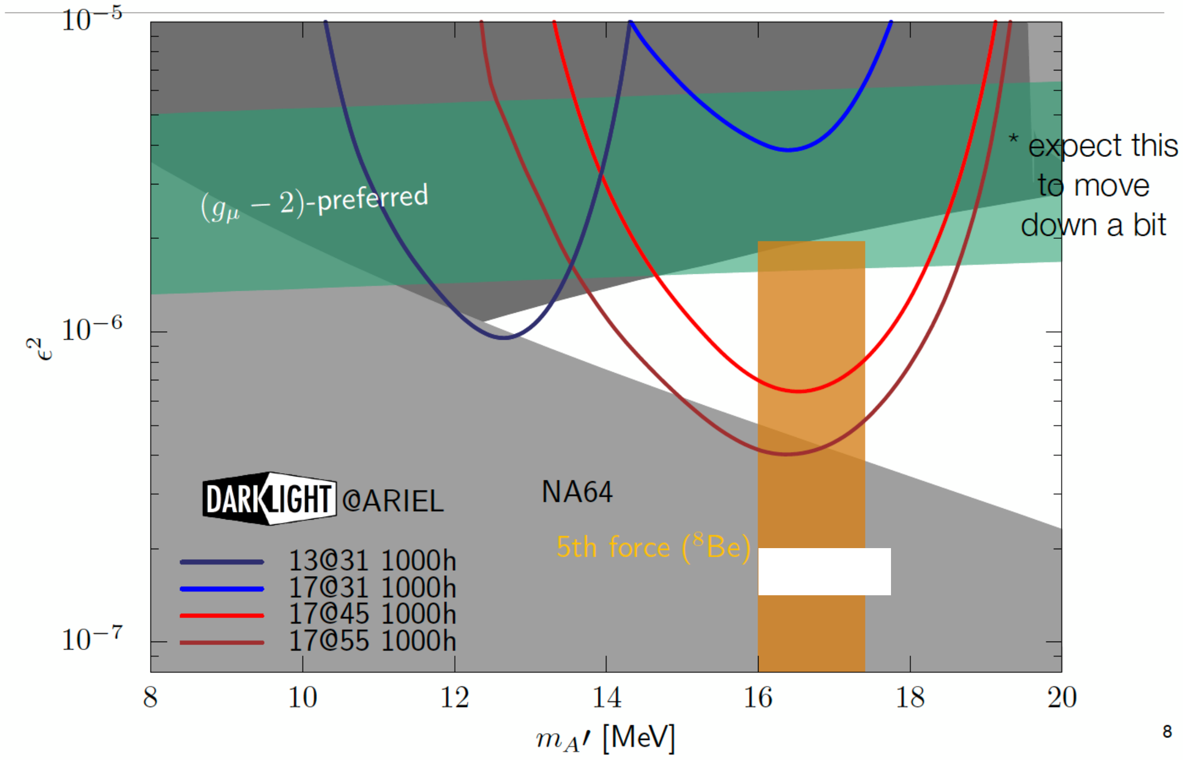

Calendar Year
2024
2025
2026
2027
2028
2029
2030
UCN source charact. and optimisation
EDM commissioning
with neutrons
EDM optimisation and systematics
EDM upgrade
2nd cell HV upgrade
EDM 10-27 data taking
2nd port for develop
2nd port physics expt
Liquefier upgrade

DarkLight

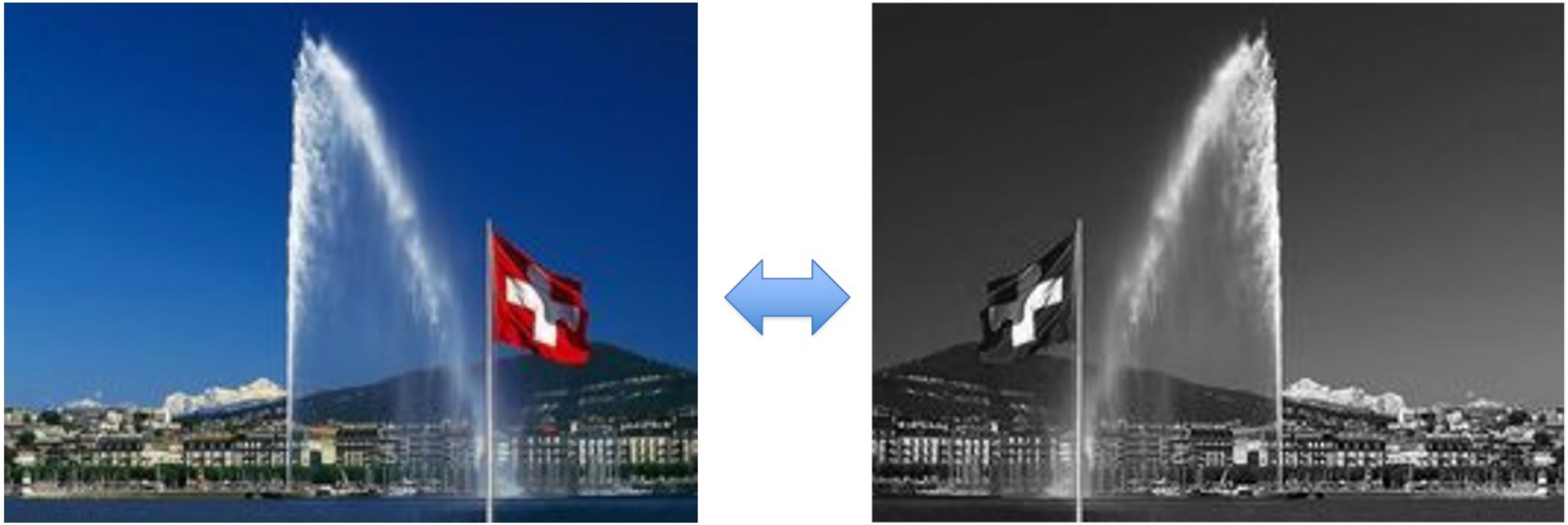
Experiment overview



Sensitivity at 30 and 50 MeV accelerators



ALPHA - HAICU



Objective: to make precision hydrogen–antihydrogen comparison
in the same apparatus
→ Need to improve both anti-H and H techniques!

CMMS

20 Year Vision

- A world-class accelerator centre driving use-inspired research—from the life sciences to quantum and green technologies
- A national innovation hub translating discovery science into health and sustainability solutions
- An inclusive multidisciplinary talent incubator, attracting and developing the best people from around the world

CMMS

- Advance Quantum Technologies:
- Enable green technology solutions:
- Engage with new complimentary initiatives:
- i.e. THz, CANS (Accelerator based neutrons)

5 Year Plan

- Realize the experimental capabilities of new muon and βNMR beamline infrastructure / beamtime.
- Establish new detector technologies, inclusive of increasing experimental automation.
- Proactively engage user groups: collaborations, outreach, new applications

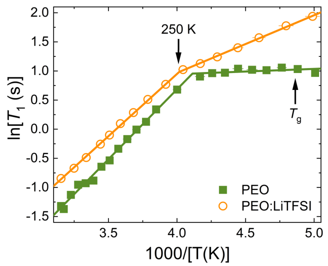
CMMS

New TRIUMF vision items … match new facility capabilities, i.e.

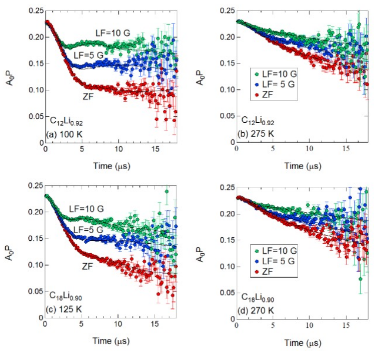
- M9H : ➔ new quantum materials / sustainability / battery research;
- M9A : ➔ hydrogen storage / new quantum materials;
- Increased βNMR beam-time (15 weeks vs 5) and/or experimental capacity :

➔ quantum materials / battery research

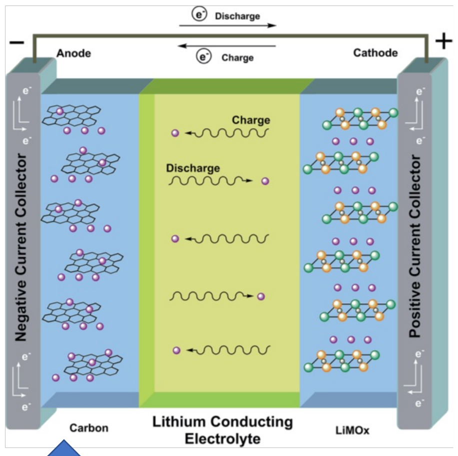
$^{8}Li^{+}$ β-NMR



μSR

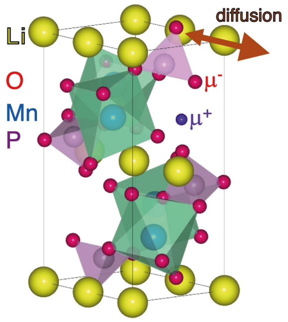


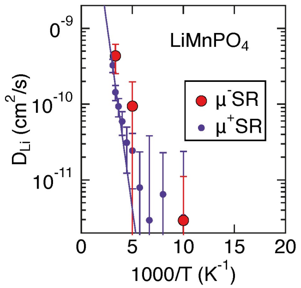
Electrolyte



Anode

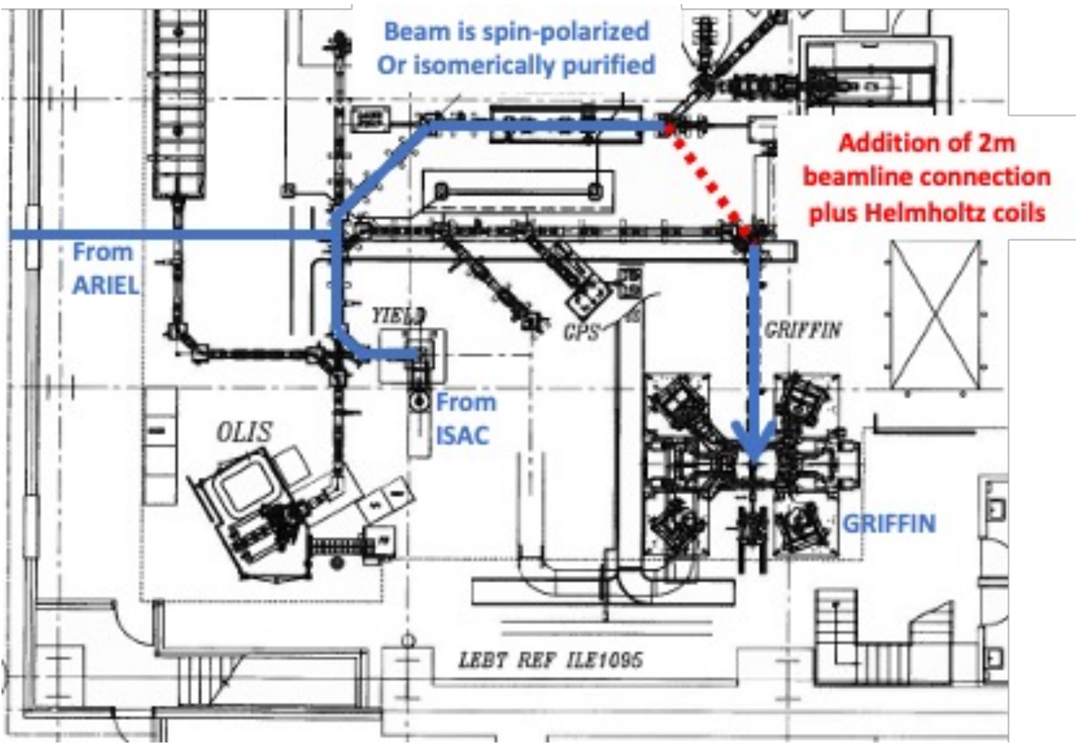
Cathode





Delivery of spin-polarized beams to GRIFFIN

NEW INITIATIVES - ARIEL



Decay spectroscopy with β-γ and γ-γ coincidences of spin-polarized beams:

- High initial polarization can improve sensitivity over PAC by ~ 10
- gamma-tagged beta asymmetry for firm assignment of spins, parities;
- isospin mixing measurements relevant to V_{ud};
- searches for time-reversal breaking

Decay spectroscopy of Isomerically pure beams by resonant photoionization:

- Detailed nuclear structure investigations in regions such as ^{132}Sn with important implications for nuclear astrophysics

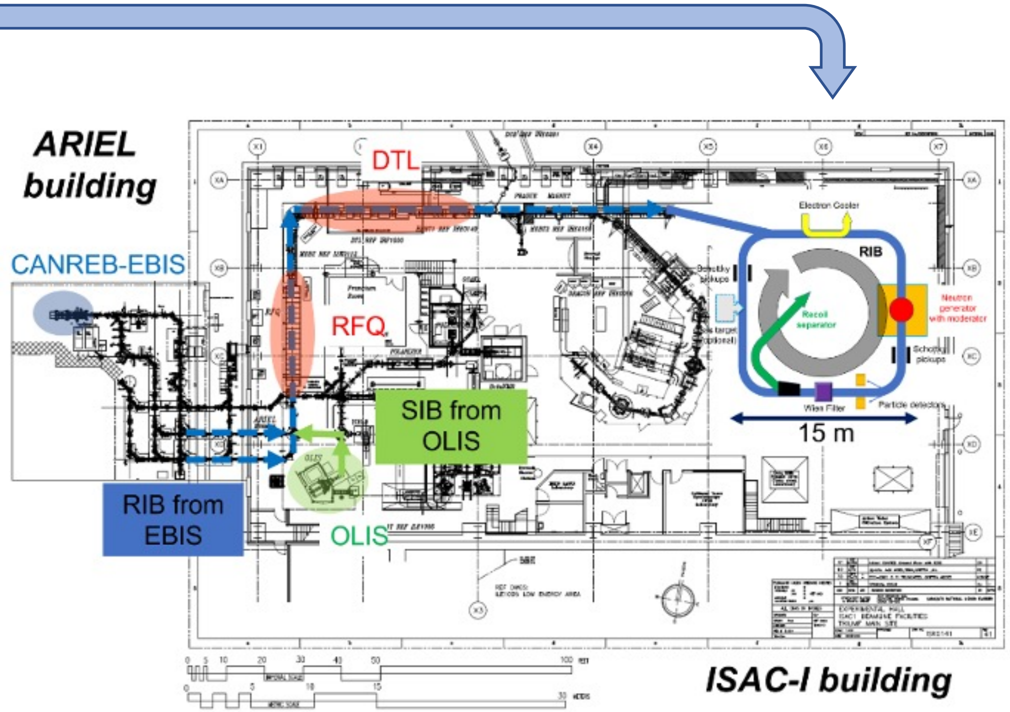
Needs: development of high-power photoionization laser for last step

A new 2-meter section of beamline (<$200k) is needed to join the Polarizer beamline to the GRIFFIN gamma-ray spectrometer.

- Simplest beamline enables delivery of nuclear spin-polarized or isomerically-purified beams of alkali ions or other J^{atomic}=0 species.
- Addition of Helmholtz coils greatly enhances the range of beams by enabling non-zero atomic spins.

TRIUMF Storage Ring (TRISR)

- TRISR – a storage ring for neutron capture on radioactive nuclei
  - Direct measurement in inverse kinematics
  - Coupled to ISAC radioactive beam facility
  - High-flux neutron generator – “neutron target” that intersects with orbiting ion beam
  - Nuclear astrophysics applications – r-process

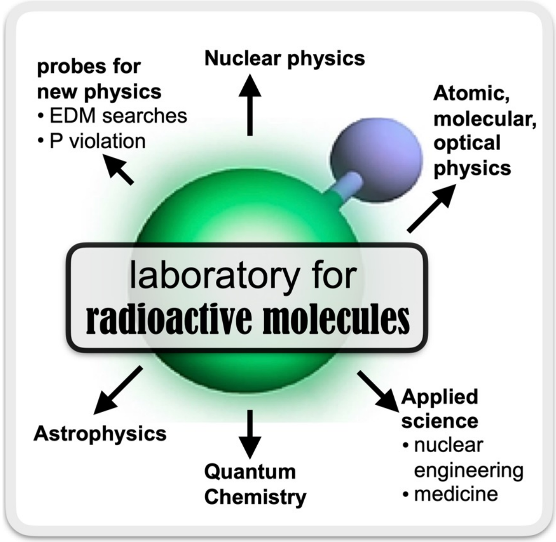


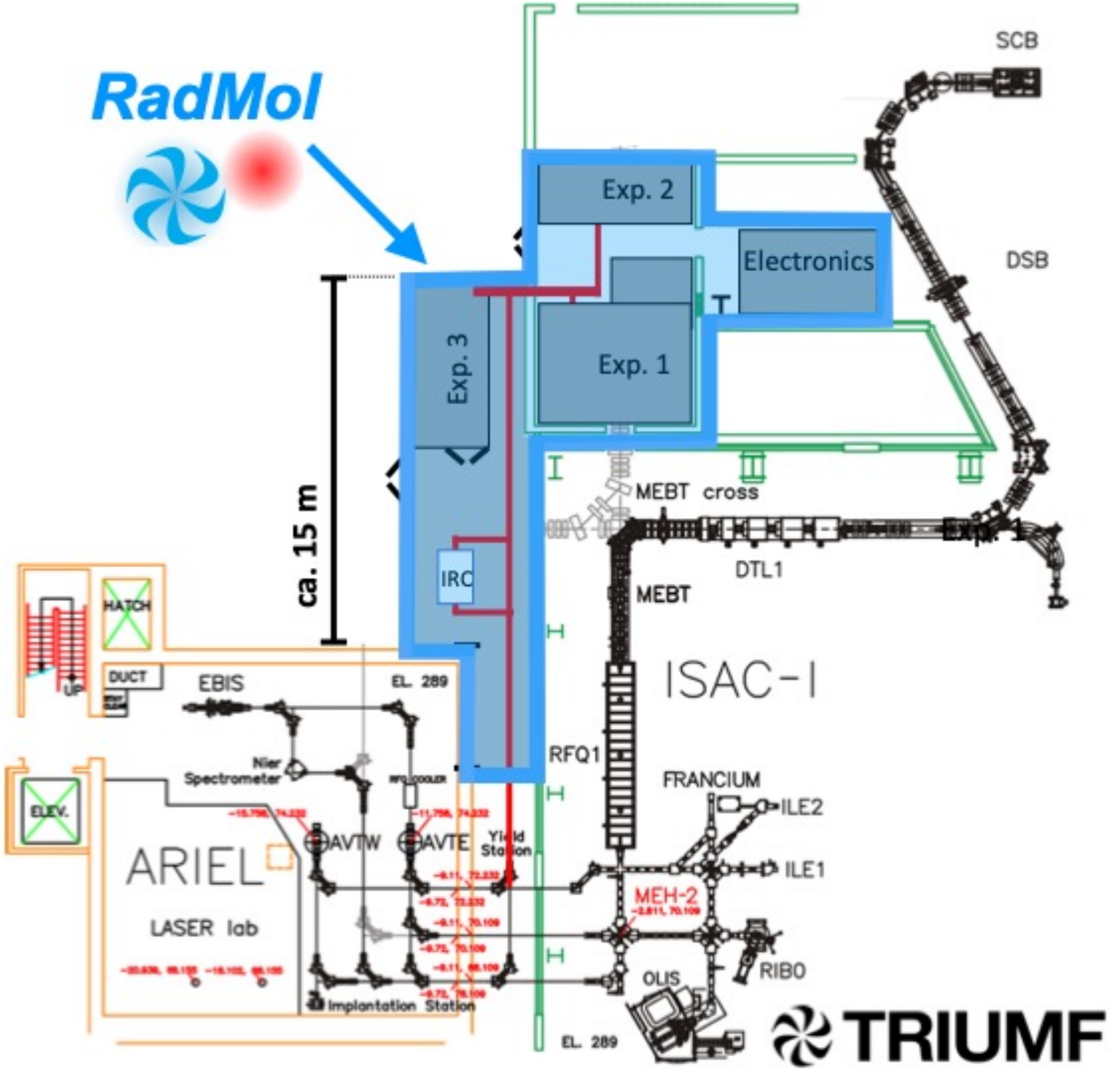
Centre for Precision Measurement & Quantum Sensing* [*name TBD]

- We propose creation of a new Centre for Precision Measurement & Quantum Sensing* at TRIUMF
  - One of the new initiatives in the TRIUMF Five Year Plan 2025 – 2030
  - A focal point for atomic, molecular, quantum sensing activities at TRIUMF, currently spread across departments and divisions
  - Primary interest in fundamental physics, but will also explore societal applications
  - Serves the TRIUMF and Canadian community
  - Connects to the international efforts
  - Synergies with other initiatives; Detector, CMMS, Computing, Theory, Training Centres
- National & International Context
  - Worldwide interest in applications of AMO/Quantum techniques for fundamental physics, e.g. at FNAL, CERN, KEK, UK QTFP
  - Lack of fundamental physics perspective in the current Canadian Quantum Strategy discussions — A gap in Canadian research ecosystem

Future Radioactive Molecule (RadMol) Laboratory

- Radioactive molecules as novel precision probes for fundamental physics
- Initial physics program:
  - Octuple-deformed nuclei incorporated into polar molecules ⇒ unmatched sensitivity for nuclear EDM
  - Access nuclear anapole moments via diatomic molecules
- Provision for expansions into other fields





Vision of the Detector Centre / Platform

NEW INITIATIVES

- Support operational excellence
  - Nurture and develop state-of-the-art detector technologies
    - The first TPC in an experiment (TRIUMF E104)
      - leads to new projects: Hermes TRD, E787 DC, Babar DC, T2K TPC, ALPHAg, TACTIC, …
    - The first SiPM in an experiment (T2K FGD)
      - leads to new projects: μSR, nEXO/ARGO, environmental monitoring…
  - Facilities for construction, calibration, and testing
    - Scintillator shop, ATLAS wire bonding facility, clean rooms, MHESA
    - M11, PIF/NIF, PTF, PHARR
- Training HQP opportunities
  - Coop/summer student program, TRISEP/GRID, Master class, Kirkness program
- Facilitate detector developments across the laboratory and Canada
  - TRIUMF to become a detector centre like CERN
  - Nuclear/Particle, CMMS, Accelerator (diagnostics),
  - Applications (TRIUMF innovations): Life Science, green technologies, space science
- Complementary to CFI funding projects

Establishment of Theory & Education Centres

- ***Ab Initio* Nuclear Theory Centre** Strengthen TRIUMF nuclear *ab initio* program
  - Require additional nuclear theorist with associated postdoc position
    - Quantum many-body theory (in the future quantum computing?)
    - Intersection of nuclear and quantum chemistry *ab initio* theory
    - Increasing reach to heavy nuclei – connection to r-process modeling, Radioactive Molecules
  - Increase synergy with ARIEL program and the newly proposed AMO/Precision/Quantum centre
  - **Build on existing strength → bigger impact**
- **TRIUMF Workshop/Visitor/Education Centre**
  - Model based on very successful centres such as the Institute for Nuclear Theory (INT)
  - Host multiple in-house workshop and collaboration programs year-round – **cover all lab topics**!
  - Program proposals would be submitted externally and reviewed by an evaluation committee
  - True workshop format: office space for participants, 2-week timeline, limited presentations.
  - Allow extended student and scientist visits from member universities/expand outreach

New Building

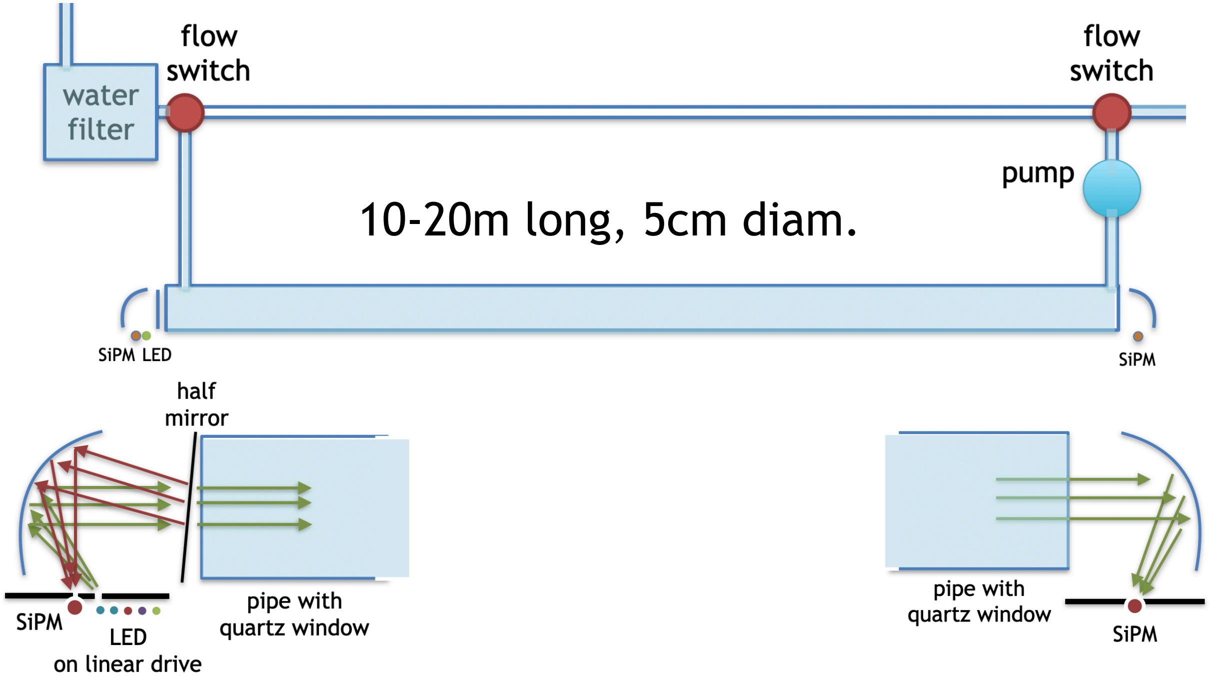
Blue sky scenario

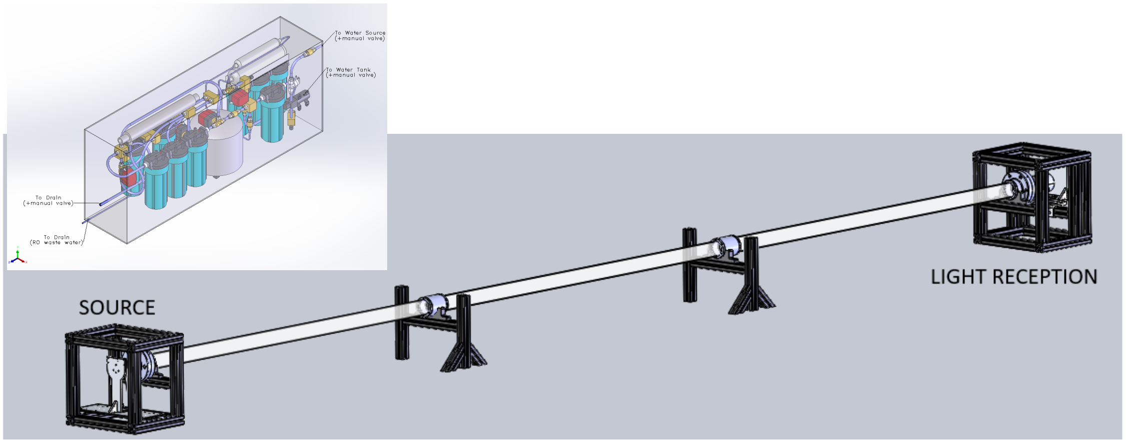
- Space is one of the limiting factors for growth at TRIUMF, both experimental and office space
- Pitch a new building with benefits to BC for a **New Research Center or Platform** that is too large for a single university
  - Five-Year plan + federal matching?
  - With university using Strategic Investment Funds?
- Several possibilities to make this appealing to BC and Canada
  - Societal benefits / green technology / sustainability
    - Use detectors for e.g., water and air quality monitoring
    - Connect to technology transfer and commercialization
  - Training and learning center
    - On-the-job training in cutting-edge research environment
    - Work integrated learning, in collaboration with e.g. BCIT, SFU, UBC – TRIUMF as a satellite training center
  - Develop next generation leaders and EDI
    - Workshop and conference space and an outreach & teaching center with interdisciplinary programs

Example IAMI + office space

Possible model:
Building + basic infrastructure & technical core expertise *supplemented by* Project specific CFI requests that add specialized equipment + key expertise

Water monitoring project – based on technology developed for the SuperK detector





- In-line continuous monitoring of the water
- Pulsed LED light through 10-20m sample water
  - 230 - 700nm
  - parabolic mirror focus
  - Relative measurement by SiPM at source/reception
- Relative to purified water
  - ultra-pure (RO)
  - particle filter (MF,NF)
  - ion exchange resins
  - UV steriliser (organic)

Objectives of the Science Week focused on the 5YP 2025-2030 preparation

Inform about the research done at TRIUMF and PSD

Identify connections between different research activities and departments

Get feedback and input from the TRIUMF community

Facilitate an enhancement of the science output

Input for the 5YP 2025-2030 document

TRIUMF

Thank you
Merci

Discovery,
accelerated