



# STATUS OF TRIUMF

TARA

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Deputy Director, Research

November 26, 2020



# COVID-19

- C19 Task Force

- Safety is paramount. Focus on public health
  - Frequent communication; close monitoring
  - Occupancy limits; daily tracking
  - Mandatory measures; required training
    - Both physical and procedural
  - Contractor screening
  - Essentially no visitors
- A few cases off site, so far no on-site transmission.



# COVID-19

- C19 Operations

- Essential isotope production proceeding apace
- Construction of ARIEL, IAMI and other projects continuing
- Research being conducted on best-effort basis
  - Papers, seminars, meetings from home
  - Remote operation of experiments
  - On-site activities only as necessary

# COVID-19

## ■ Mechanical Ventilator Milano

- Canada-Italy-US team from DarkSide DM Collaboration
- Canadian team: CNL, SNOLAB, TRIUMF and McDonald Institute; manufactured by Vexos, JMP Solutions

March 19:	Project start
May 1:	FDA Emergency Use Authorization
May 26:	Canadian Government order – 10,000 units
July 31:	Health Canada submission
September 30:	Health Canada approval
	Vexos Canadian production (800/week)



**\$267.3M core operation funding**  
+ \$25M one-time supplement  
**allows us to move forward with our Plan**

- Science and Technology
- People and Skills
- Innovation and Collaboration

**BUT: We had to significantly rebalance...**



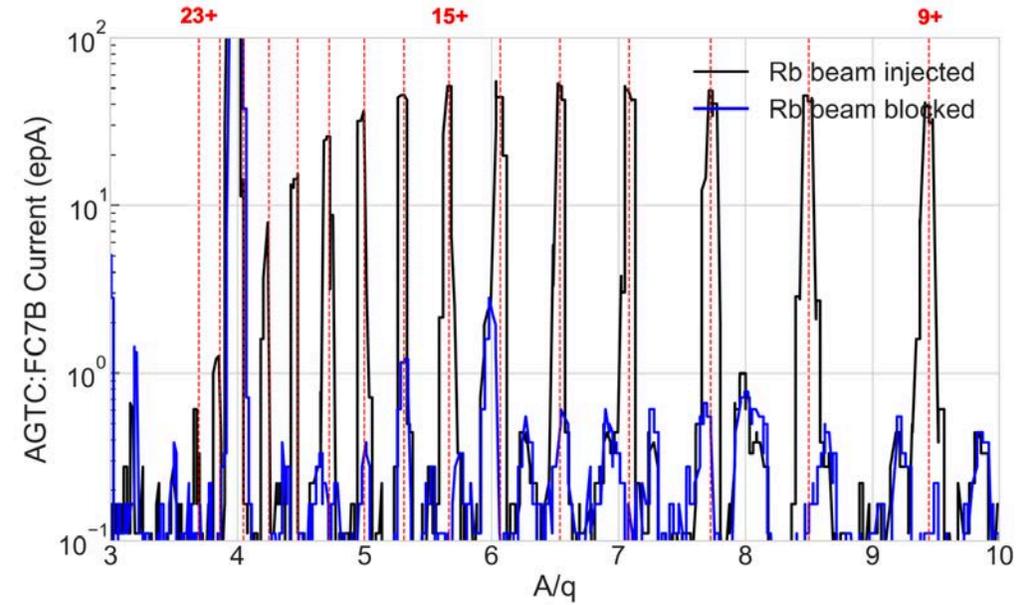
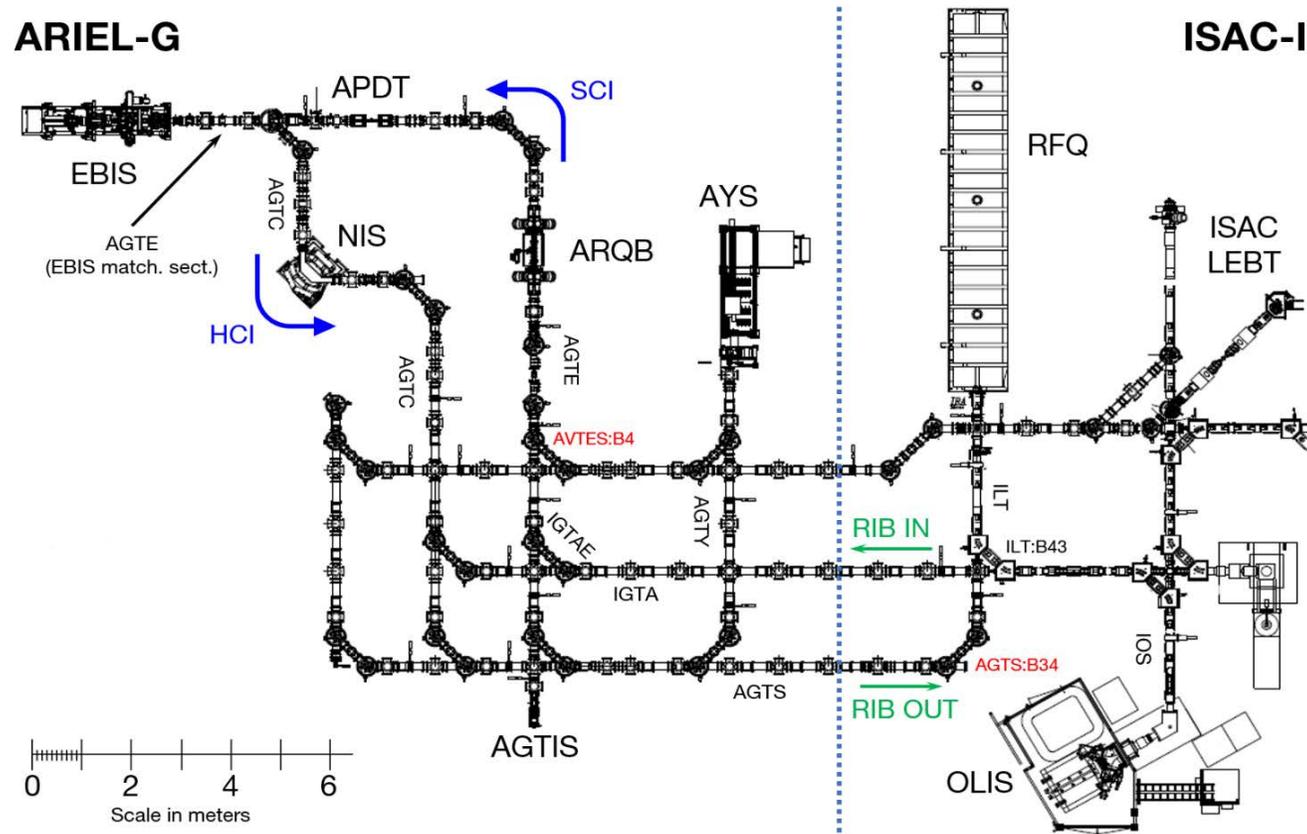
# Overall Priorities for 2020-2025

- **ARIEL** – advance CFI project towards 2026 completion with phased science delivery
- **IAMI** – complete construction in 2022 and ramp up medical isotope production
- **TRIUMF Innovations** – seize key commercial opportunities (e.g. Ac-225)
- Utilize \$25M supplement to enhance reliability, safety, and efficiency, addressing key risks
- Deliver world-class in-house science (ISAC, CMMS, UCN, Theory, Life Science, Accelerator Science)
- Lead selected off-site particle physics activities (ATLAS/HL-LHC, Hyper-K, nEXO, ALPHA)
- Continue site and process improvements (ERP System, TCC)
- Invest into people and skills (career development, student program, outreach)

# Science & Technology – ARIEL status

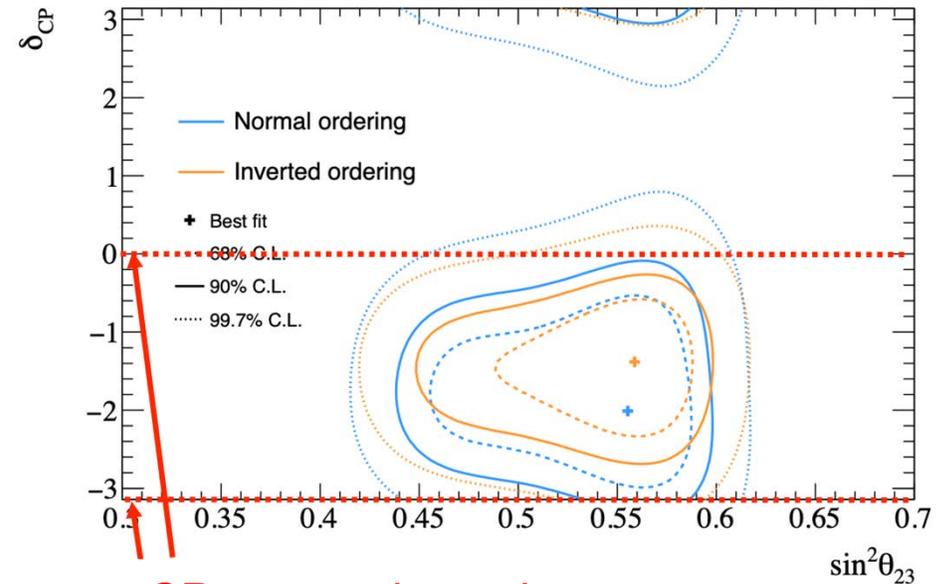
- CANREB EBIS delivered RIB to yield station; accelerated RIB in December
- COVID-19 impact:
  - Slower on-site work March-June; Vendor delays (e.g. Hot Cell)
  - Design efforts accelerated due to more work from home
- Level 1 shielding construction complete
  - Lessons learned for Levels 2 &3 scheduling, leading to extended timeline
- Currently re-baselining schedule
  - Phase 1-2 (RIB from the electron target station) delayed to late 2024
  - Overall CFI project completion timeline unchanged: late 2026
- New focus on exploiting e-linac capabilities for science
  - FLASH tumor therapy
  - Beam dump experiments: fifth force, dark photons
  - Photon nucleus cross section measurements

# Science & Technology – ARIEL / CANREB



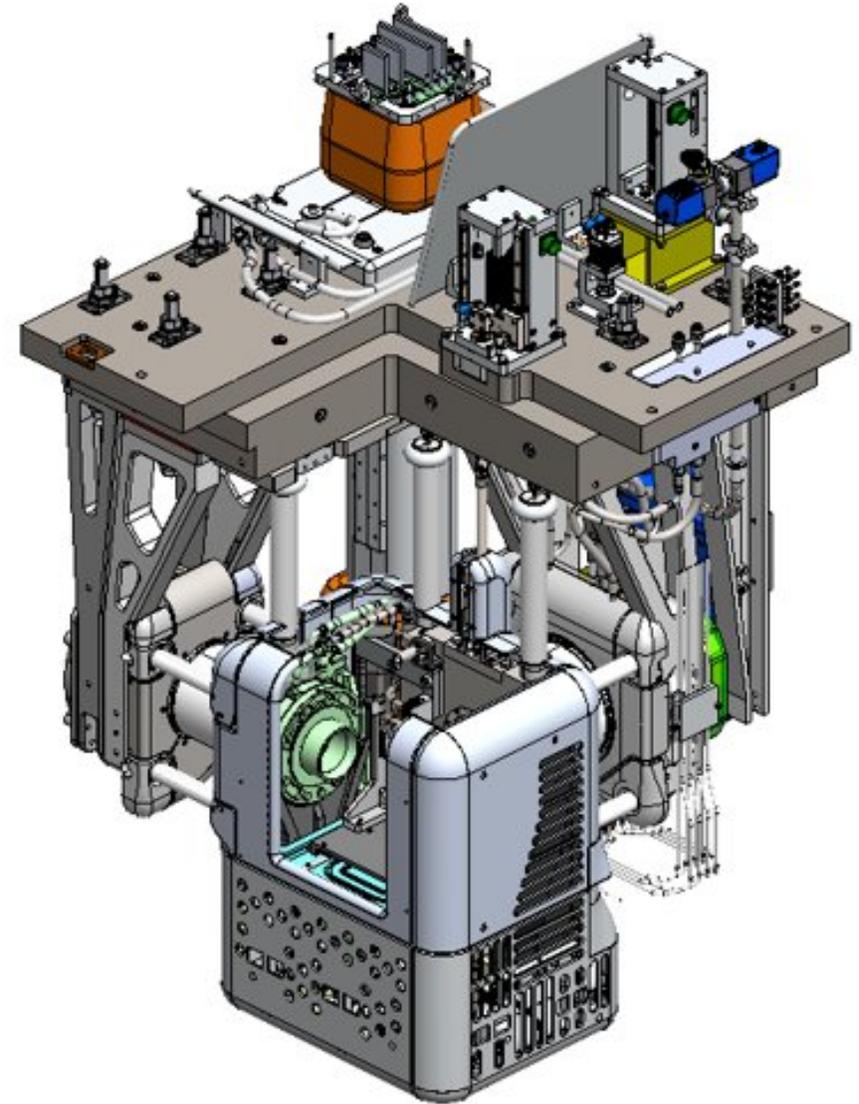
# T2K / SuperK

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



CP conserving values

# Science & Technology – ARIEL



# ARIEL Shielding

Level 4b: Removable Cap Shielding

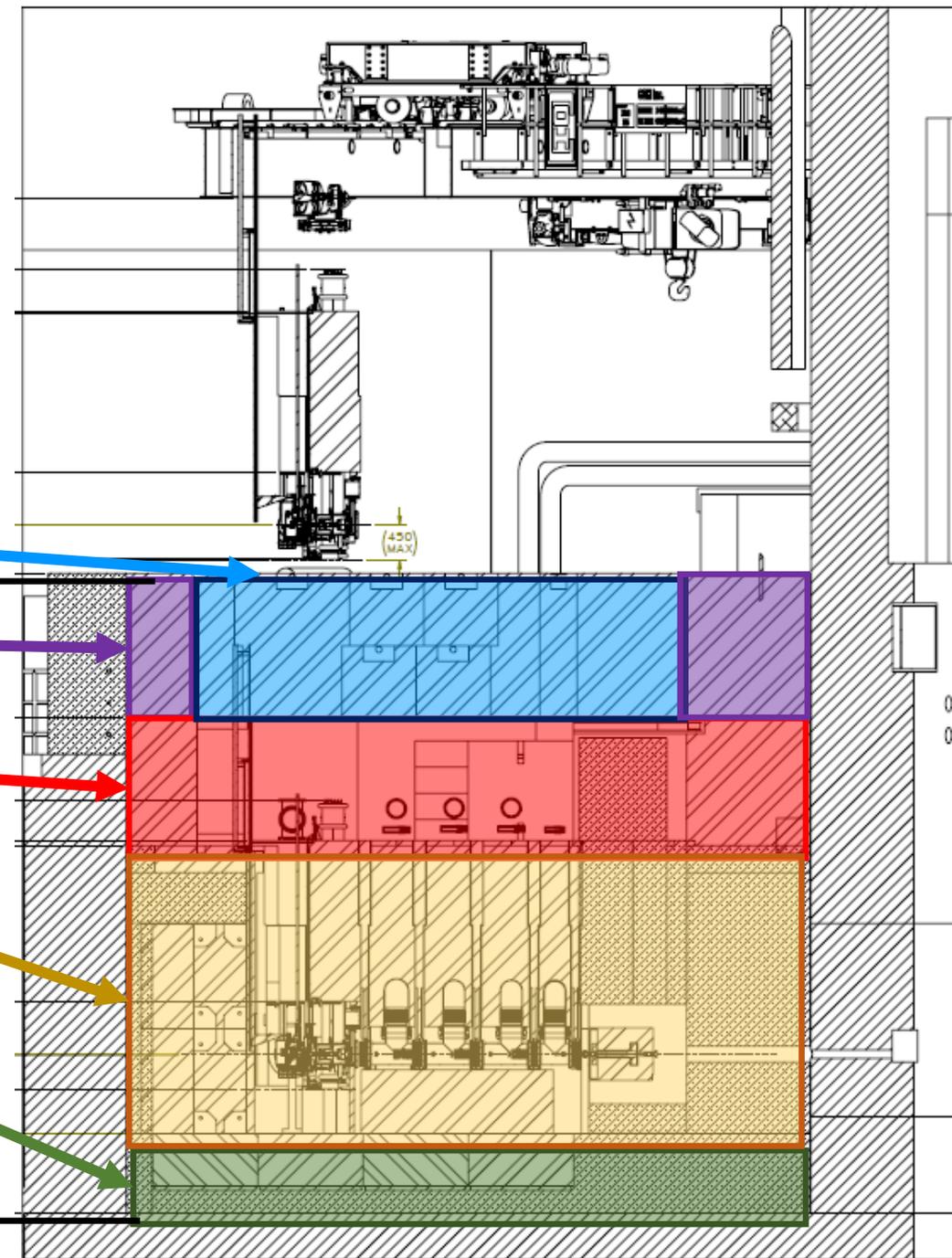
Level 4a: Fixed Cap Shielding

Level 3: Service Space

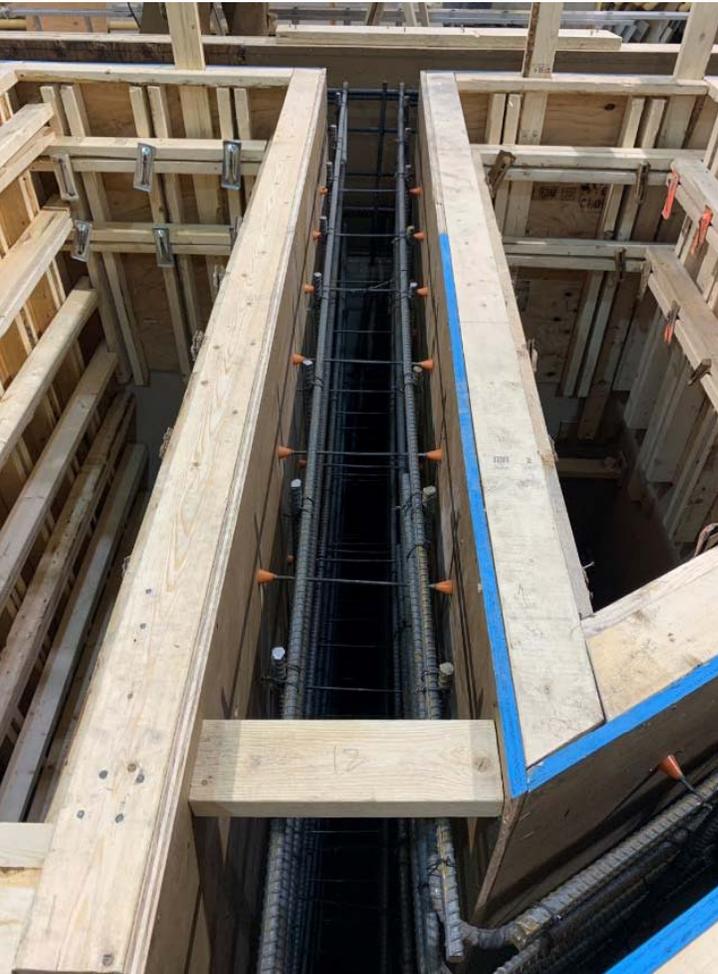
Level 2: Canyon Elevation

Level 1: Below Station

8.1m



# Science & Technology – ARIEL



# Science & Technology – Planning

- Planning underway for \$25M infrastructure projects
  - Refurbishments to the Facility
  - Site and Process Improvements
- Including ....
  - Cooling Tower ✓
  - Workday ERP implementation
  - M9 reconnected to T2, BL1A refurbishment planning
  - TRIUMF Control Centre
  - Accelerator and Beam Delivery Upgrades
  - Security System
  - Asset Management System



# Science & Technology – Planning

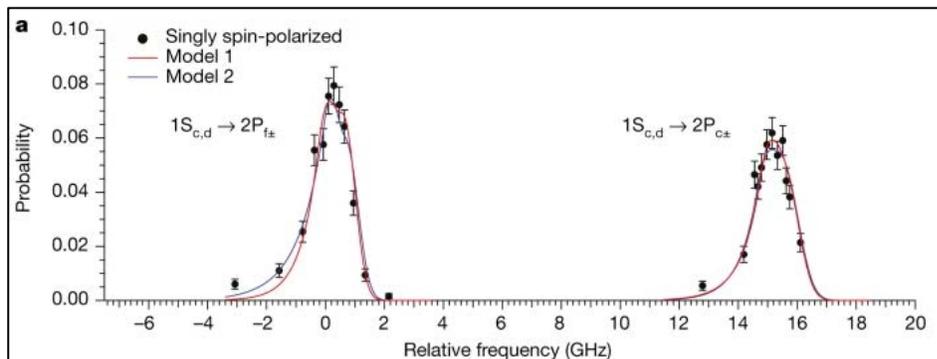
- Building a laboratory to last....
  - Incorporating TRIUMF
    - CRA charitable status achieved ✓
    - On track for April 1, 2021
  - Enlarging our network
    - University of Waterloo is our 21<sup>st</sup> Member! ✓
      - Institute for Quantum Computing
      - Perimeter Institute



UNIVERSITY OF  
**WATERLOO**

# ALPHA

- “Confinement of antihydrogen for 1000 seconds,” TRIUMF-led ALPHA paper from 2011, high-lighted by Nature Physics as a “sweet fifteen” favourite!
- Fine structure measurement in antihydrogen confirmed key aspects of QED in antimatter sector



Check for updates editorial

## Sweet fifteen

As *Nature Physics* turns fifteen, we celebrate some of our favourite papers.

How quickly times change. The last time we looked back at our previous achievements, in 2015, we were ten! We will readily admit that nothing could quite have prepared us for the turbulent five years that we have experienced since: Brexit, Trump and the COVID-19 pandemic, to name but three prominent developments on the world stage, have all tested our naive faith in the inexorable development of our collective wellbeing.

The polarizing emotions surrounding these events have made us aware of a whole new facet of the human condition; one that, as the expert rationalizers that we are, we initially struggled to identify and come to terms with. In short: we are now teenagers, and life is more complicated than we thought.

That being said, during this time we have also been lucky to witness a number of memorable scientific discoveries. LIGO's observation of gravitational waves, the first image of a black hole obtained by the Event Horizon Telescope Collaboration, and the discovery of superconductivity in bilayer graphene would all be worthy additions to Jorge Cham's "Top 10 physics discoveries of the past decade". It remains an exciting time as any to be a physicist.

And it is with this spirit that we have decided to mark the 15-year anniversary of *Nature Physics*. All the editors of the journal — past and present — have weighed in with their thoughts in a Feature highlighting their favourite papers from our back catalogue.

Our selection naturally reflects the breadth of our different interests as editors: for example, our launching editor, Alison Wright, focuses on our so-called front half, which under her tenure came to be a vibrant venue covering all manner of topics at the intersection between physics, art and society. Our newest recruit Richard Brierley, on the other hand, reminisces about a quantum simulation paper that inspired him as a young graduate student.

Other results that we dwell on admiringly include a 15-minute-long confinement of antihydrogen, electrons arranged in a fractal structure, and a laboratory model recreating a Parker spiral — the spiralling magnetic structure arising from the interaction between the Sun's magnetic field and the solar wind.

We celebrate these results not only for the beautiful phenomena that they represent but also — and this is in keeping with 150 years of tradition at *Nature* — for the incredible feats of human ingenuity that made them observable in the first place. Indeed, if there is one recurring theme in the history of physics, it is the human touch that each discovery seems keen to share.

Our 15-year anniversary cover contains (clockwise from top left): image created by quantum imaging, self-assembly of green-fluorescent-protein-active *Escherichia coli* bacteria, a quantum gas microscopy image, and self-assembly of polystyrene beads. Credit: Hugo Defienne and Daniele Faccio, University of Glasgow (top left); Serim Ilday, Bilkent University - UNAM (top right and bottom left); Immanuel Bloch, Max Planck Institute of Quantum Optics (bottom right)

antihydrogen, electrons arranged in a fractal structure, and a laboratory model recreating a Parker spiral — the spiralling magnetic structure arising from the interaction between the Sun's magnetic field and the solar wind.

nature

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Article | Open Access | Published: 19 February 2020

## Investigation of the fine structure of antihydrogen

The ALPHA Collaboration

*Nature* 578, 375–380(2020) | Cite this article

23k Accesses | 4 Citations | 364 Altmetric | Metrics

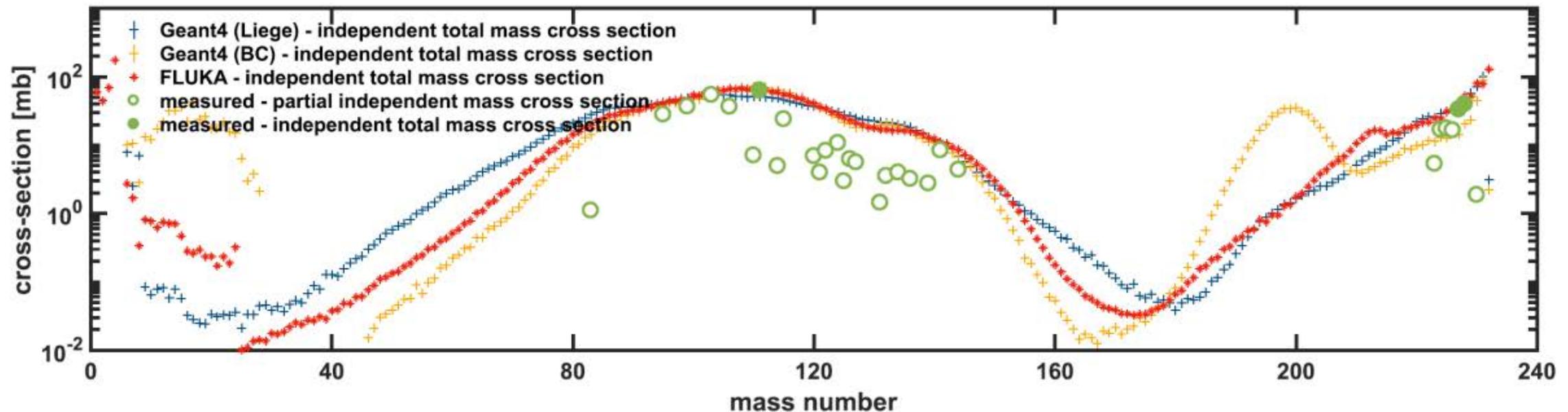
### Abstract

At the historic Shelter Island Conference on the Foundations of Quantum Mechanics in 1947, Willis Lamb reported an unexpected feature in the fine structure of atomic hydrogen: a separation of the  $2S_{1/2}$  and  $2P_{1/2}$  states<sup>1</sup>. The observation of this separation, now known as the Lamb shift, marked an important event in the evolution of modern physics, inspiring others to develop the theory of quantum

# $^{225}\text{Ac}$ Production

Nuclide production cross sections from irradiation of thorium by 438 MeV protons and a comparison to FLUKA and GEANT4 simulations

Andrew K. H. Robertson, Peter Kunz, Cornelia Hoehr, and Paul Schaffer  
Phys. Rev. C **102**, 044613 – Published 19 October 2020



# $^{225}\text{Ac}$ Radiopharmaceutical Development

Chemistry  
A European Journal

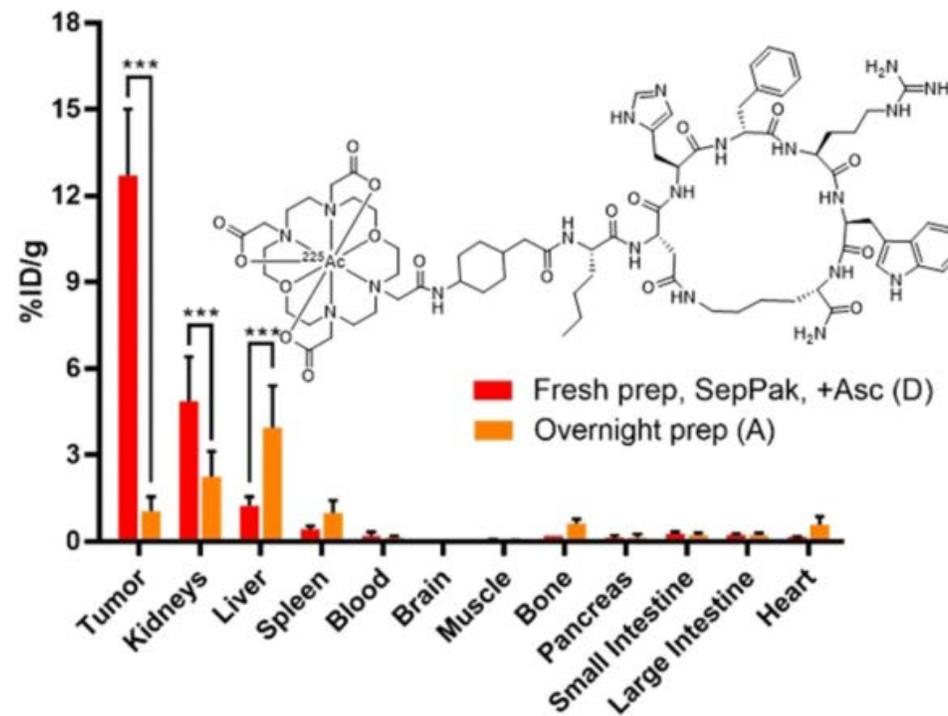
Chemistry  
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European Chemical  
Societies Publishing

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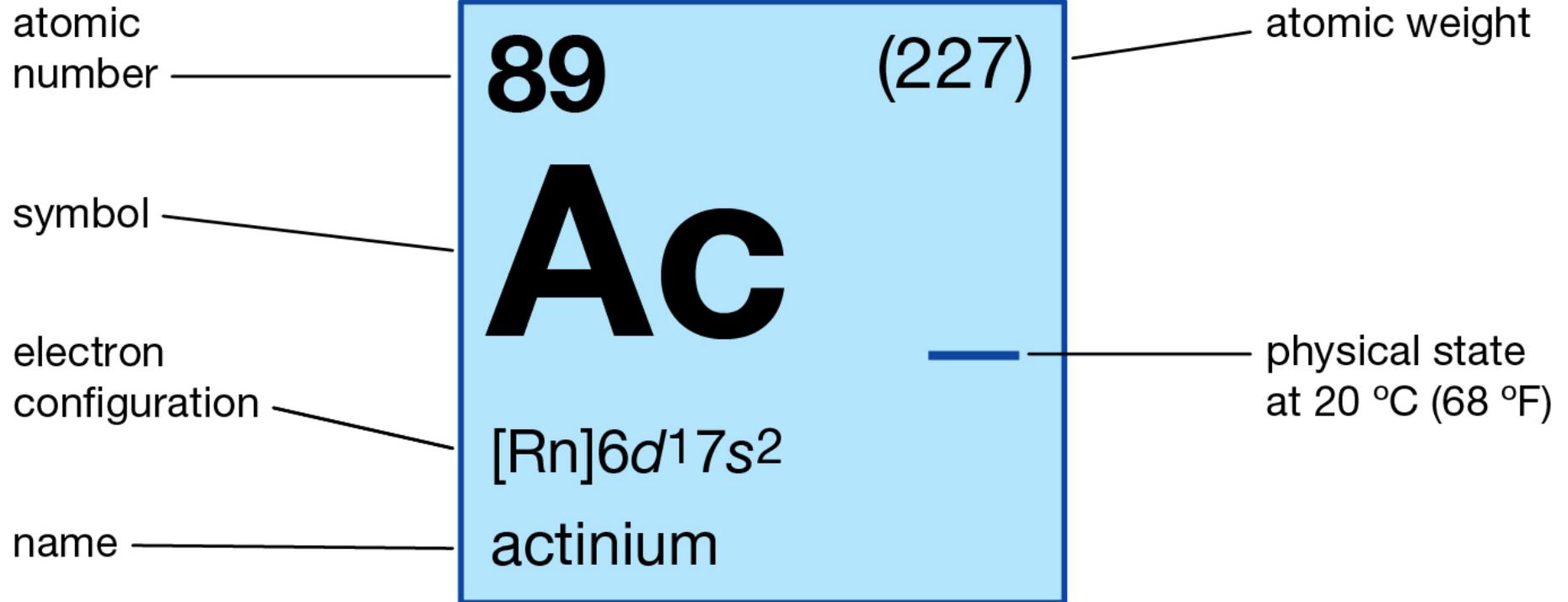
## Synthesis and Evaluation of a Macrocyclic Actinium-225 Chelator, Quality Control and In Vivo Evaluation of $^{225}\text{Ac}$ -crown- $\alpha$ MSH Peptide

Dr. Hua Yang, Dr. Chengcheng Zhang, Dr. Zheliang Yuan, Dr. Cristina Rodriguez-Rodriguez, Andrew Robertson, Dr. Valery Radchenko, Randy Perron, Denise Gendron, Dr. Patrick Causey, Dr. Feng Gao [✉](#), Dr. François Bénard [✉](#), Dr. Paul Schaffer [✉](#) ... [See fewer authors](#) [^](#)

- Novel chelator design and synthesis
- Rapid, ambient temperature labeling
- Targeted radiopharmaceutical preclinical studies underway



# Actinium



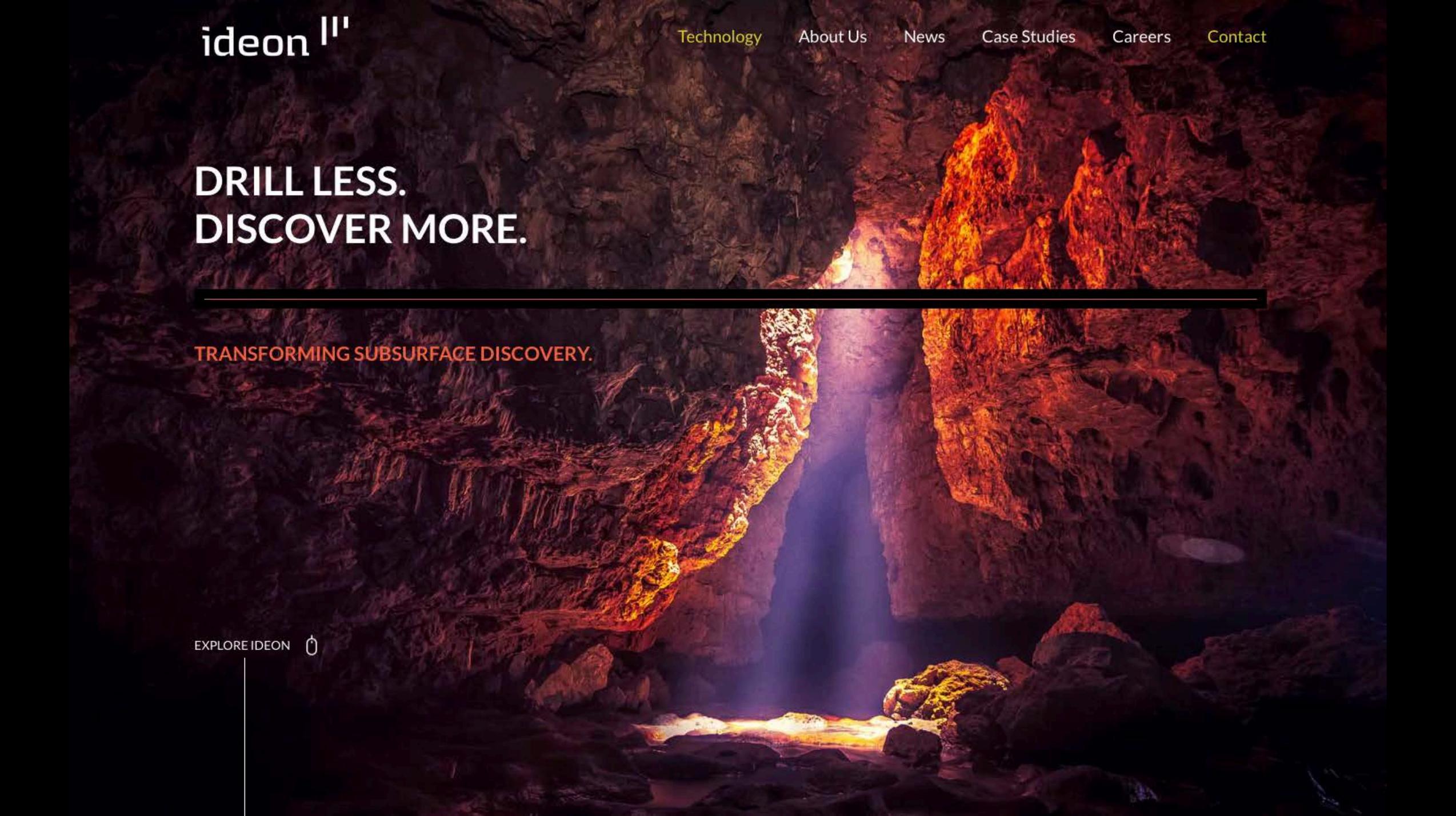
 Actinide elements       Solid

( ) indicates the mass of the longest-lived isotope.

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EXPLORE IDEON 





# Revolutionizing Nuclear Medicine

We are global leaders in developing novel technology and products that enable our partners to produce the world's most-used diagnostic isotopes including:

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(Ga-68)

**QUANTM-89**

(Zr-89)

**QUANTM-99**

(Tc-99m)

**QUANTM-64**

(Cu-64)

Secured US\$19M in Series A funding



**TRIUMPH**

20-Year Vision



## Purpose of the TRIUMF 20-year Vision

- **To articulate TRIUMF's ambitions for future accomplishments** with respect to Science & Technology, People & Skills, and Innovation & Collaboration.
- **To describe the long-term facilities development, consistent with TRIUMF's Vision, Mission, and its Strategic Plan,** allowing TRIUMF to update its facilities plan so that all future developments are consistent with the updated Master Plan.
- **To involve and inform TRIUMF's community and stakeholders,** providing clarity and a better understanding of the developments proposed at TRIUMF so that stakeholders have meaningful information to base their planning on and to engage us about their plans.

## Phases of the TRIUMF 20-year Vision development

- **Phase 1: Visioning and listening** (Fall 2020 – Spring 2021)  
A broad spectrum of stakeholders will be engaged through various means to capture the full diversity of ideas and perspectives of our community.
- **Phase 2: Convergence on vision framework** (Spring 2021 – Summer 2021)  
Based on the input received, the high-level pillars of the vision and supporting elements will be developed and refined through consultations.
- **Phase 3: Finalization** (Summer 2021 – Winter 2021)  
The 20-year Vision document will be drafted, refined, and the final version approved by the TRIUMF Board.

# Science & Technology – Planning

- Twenty-year visioning process underway!

In context of Canadian and international planning exercises

- Nuclear Physics
- Particle Physics
- Fundamental Physics with AMO Techniques
- Life Sciences
- Probes for Quantum Materials and Biomolecules
- Quantum Technologies
- Scientific Computing
- Emerging Trends in Convergence Research
- Accelerator Sciences and Facilities
- TRIUMF Site Development
- People and Skills
- Innovation and Collaboration



**Thank You!**  
**Merci!**

[www.triumf.ca](http://www.triumf.ca)

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