



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

# Welcome to TRIUMF

Visit of the KEK Delegation

Jonathan Bagger  
Director

December 14, 2017



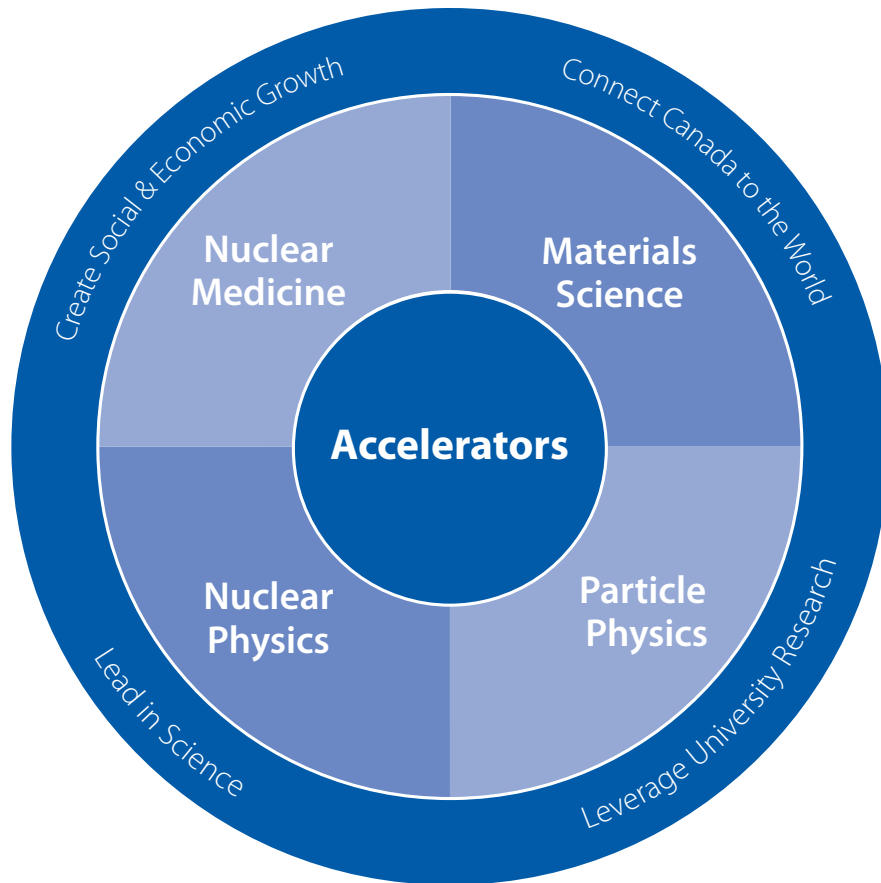


**TRIUMF has delivered nearly 50 years of science and innovation for Canada**

## HIGHLY QUALIFIED PERSONNEL

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- > **500** staff
- > **200** students & postdoctoral researchers



## KNOWLEDGE

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**86%** of Canada's subatomic physics research involves TRIUMF



Dark Matter  
& Cosmology

Electronics  
Radiation Testing

Molecular &  
Materials Science

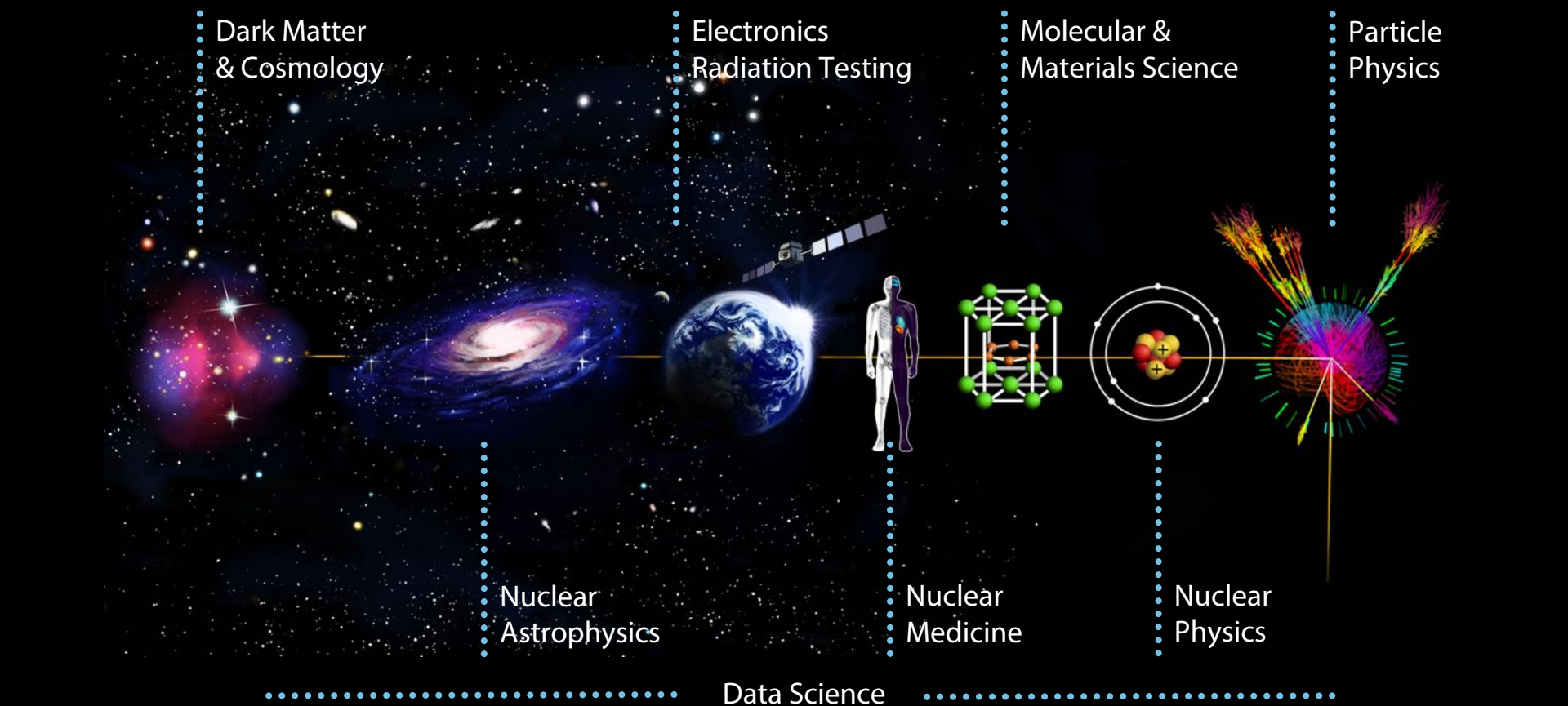
Particle  
Physics

Nuclear  
Astrophysics

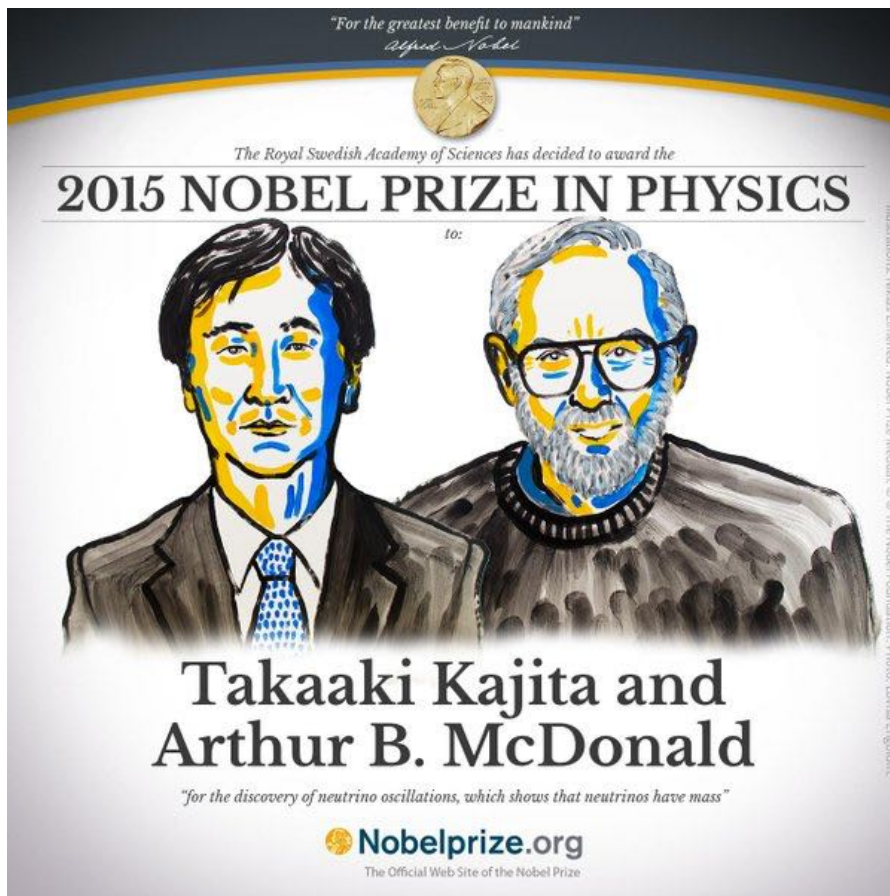
Nuclear  
Medicine

Nuclear  
Physics

Data Science







2013 Nobel Prize



2016 Breakthrough Prize



2014 John C. Polanyi Prize – ALPHA Canada  
(Led by TRIUMF's Makoto Fujiwara)



2015 NSERC Brockhouse Prize – Cyclotron  
Produced Tc-99m (Led by TRIUMF's Paul Schaffer)

## In 2016, TRIUMF....



Provided more than **27,000** informal science experiences to the public



Trained **219** highly qualified personnel



Produced more than **1.9M** medical isotope patient doses

## Resulting in....



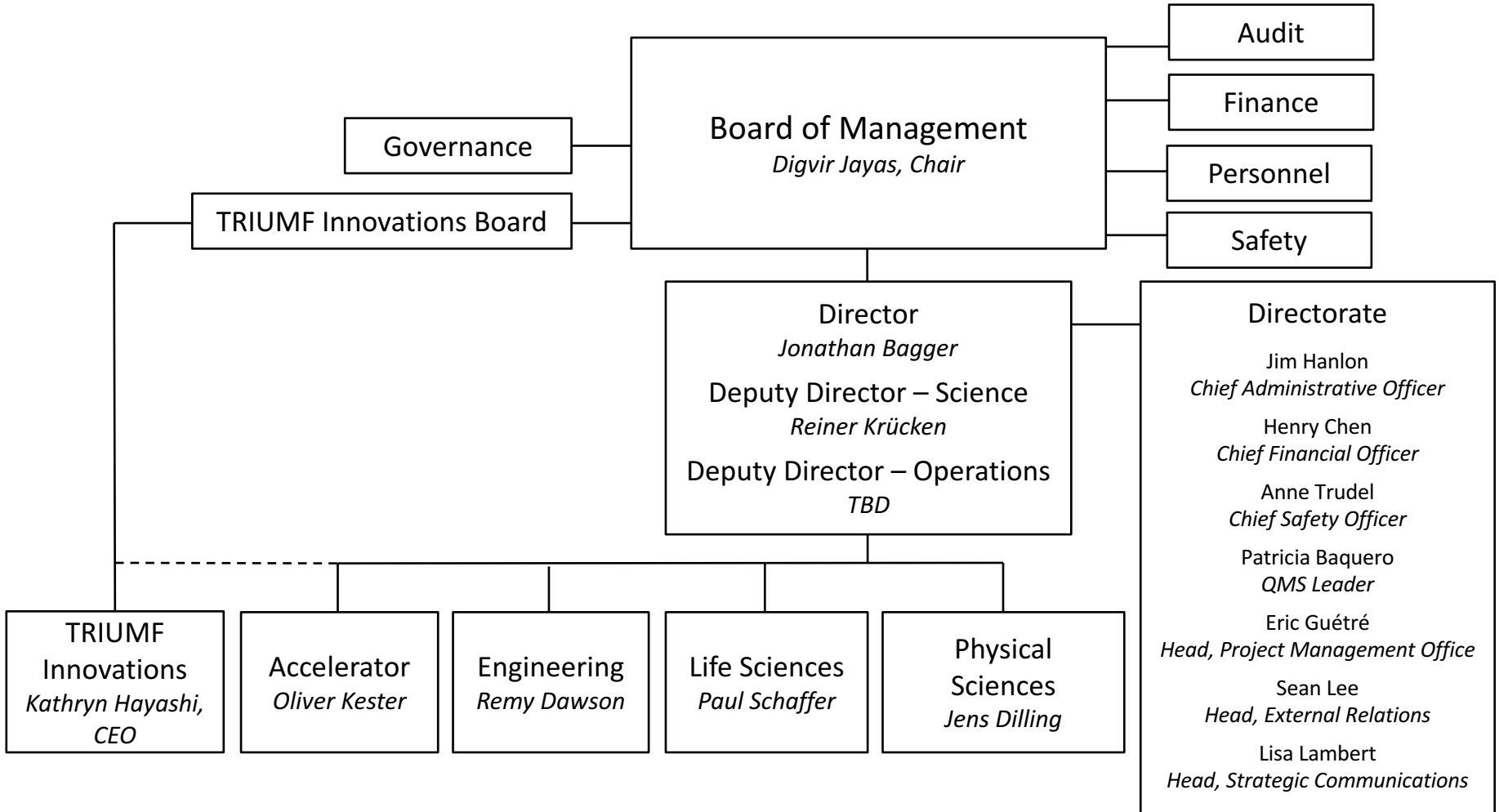
**321** published scientific papers



**104** commercial agreements



**\$4.1M** in commercial revenues





In FY16/17 TRIUMF's total funding was \$74.4M

## Core Operations

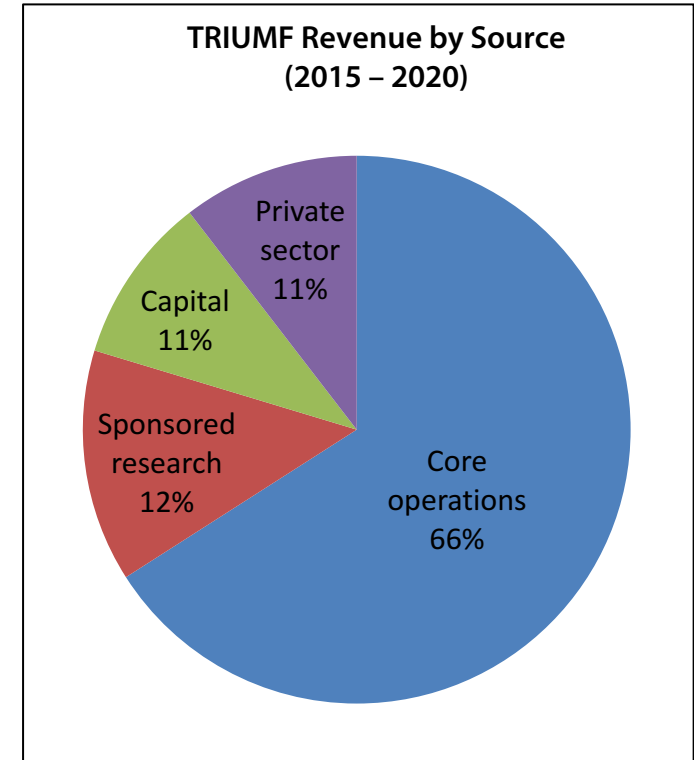
- Federal government via NRC (\$269.5M for 2015 – 2020)

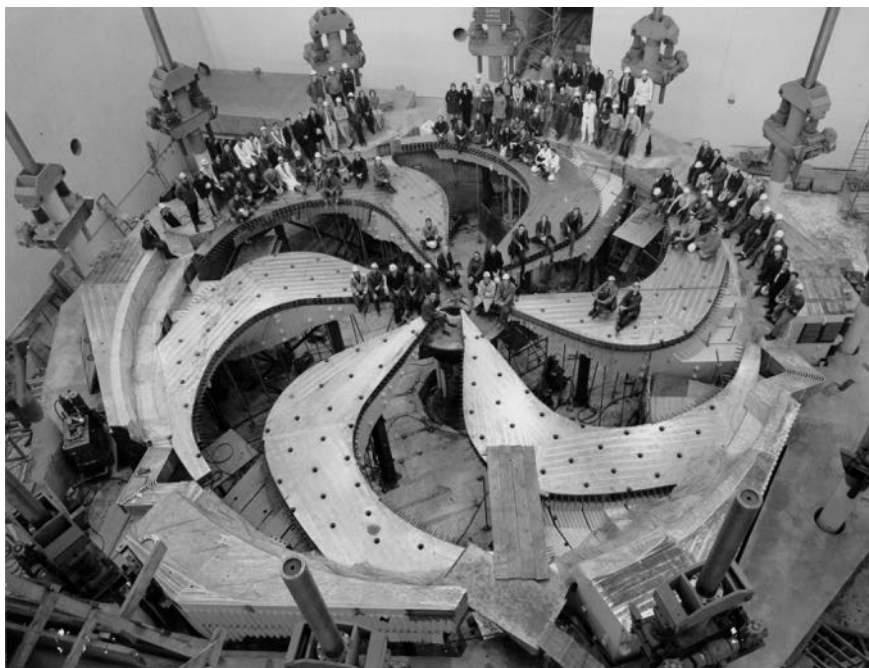
## Capital Expenses and Sponsored Research

- Provincial governments
- Federal government (i.e. Canada Foundation for Innovation, Tri-Council Agencies, NRCan, WD)
- International collaborations

## Private Sector

- Industrial partnerships
- Royalties, commercial revenue & interest



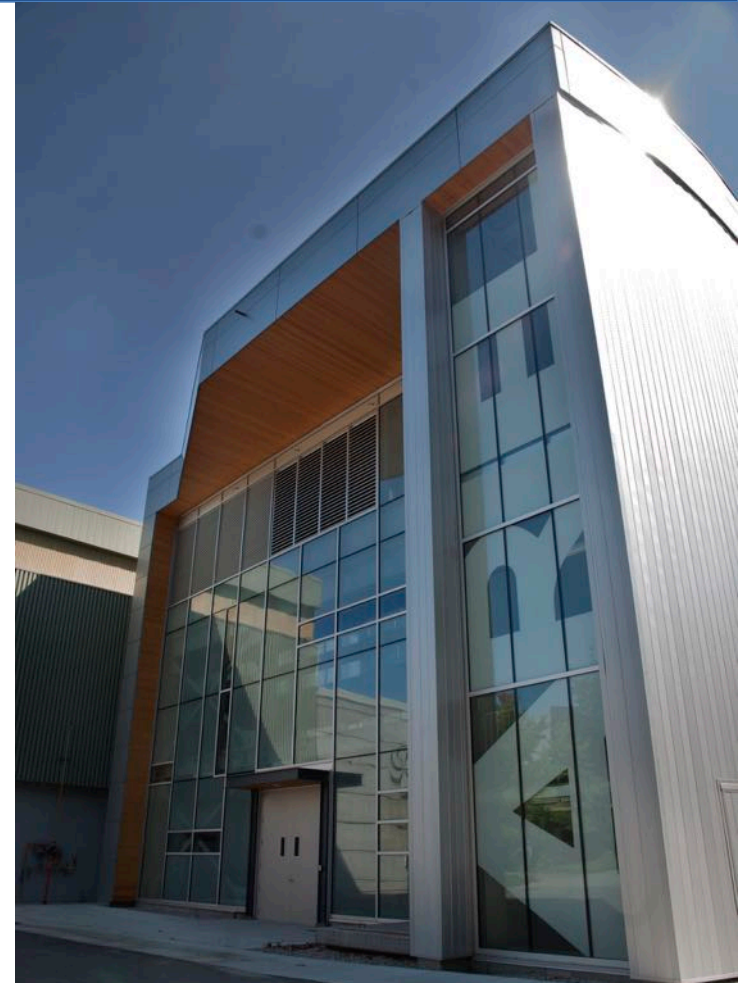


## TRIUMF is home to the world's largest cyclotron

- Celebrated the 40<sup>th</sup> anniversary of commissioning in 2016
- Designated *IEEE Historical Engineering Milestone* in 2011

## Advanced Rare Isotope Laboratory (ARIEL)

- Uses state-of-the-art, made-in-Canada super-conducting RF accelerator technology
- Represents ~\$100 million investment by federal and five provincial governments (BC, AB, MB, ON, QC); supported by a total of 21 university partners from across Canada
- Project in two phases: ARIEL I completed in Fall 2014; ARIEL II is fully funded as of October 2016



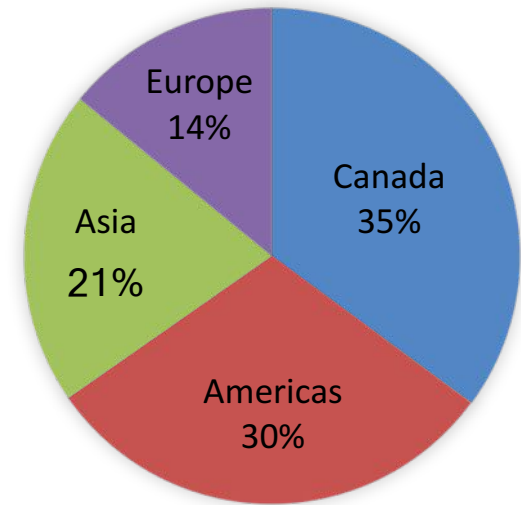


From 2013-16, TRIUMF hosted users from over 35 countries

TRIUMF has agreements with over 50 international organizations, including Japan, the United States, Germany, India, Israel and France

- In August 2013, TRIUMF and the Variable Energy Cyclotron Centre (VECC) of Kolkata, India signed a \$10.4M agreement to collaborate on research
- TRIUMF serves as a launchpad for Canadian contributions to major international laboratories, including CERN (Europe) and J-PARC and KEK (Japan)
- Japan has the second most number of foreign users to TRIUMF, behind the United States

2016 Scientific Visitors & Users by Region (645)











**TRIUMF**  
I N N O V A T I O N S

TRIUMF Innovations is responsible for managing the laboratory's commercial activities by:

- Connecting TRIUMF researchers and technologies to the world via industry partnerships, licensing, and start-up companies
- Providing streamlined pathways for businesses to access TRIUMF infrastructure and expertise
- Developing business opportunities for applied physics-based technologies from the TRIUMF network
- Training the next generation of science-driven entrepreneurs

TRIUMF has a long and successful history working with a variety of industry partners



Since 2010, TRIUMF has launched five spin-off companies that cover a wide breadth of sectors

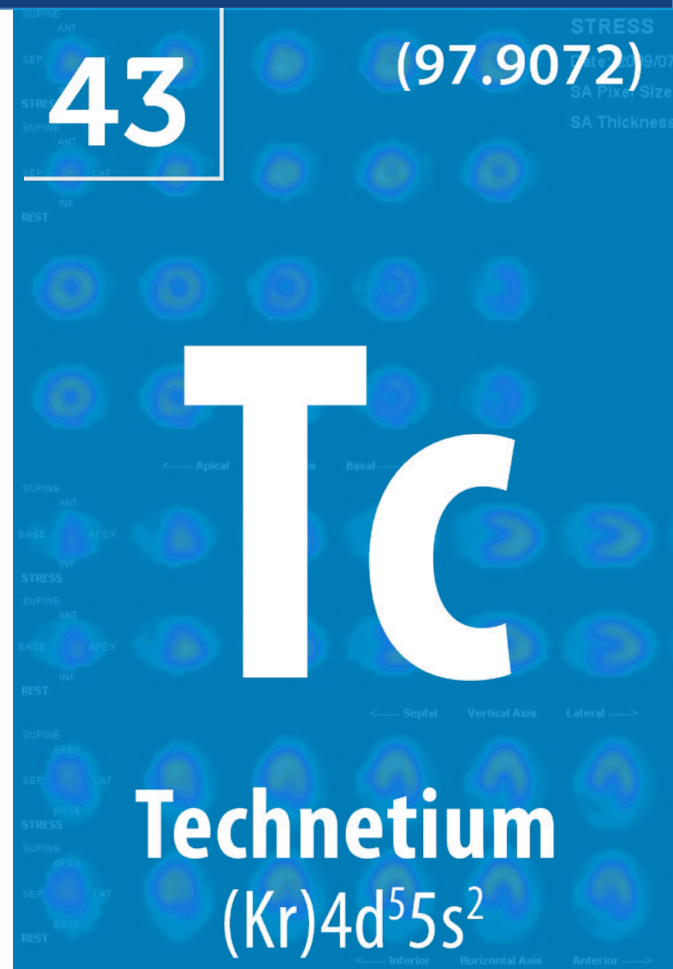
Company	Sector	Product Offering
ARTMS Products Inc.	Life Sciences	Novel targets and accessories for medical cyclotrons to produce medical isotopes for clinical use
CRM Geotomography	Mining	Geophysical mineral exploration technology that can detect, locate, and characterize ore bodies without the need for test bores
Frontier Sonde	Oil & Gas	Well-logging tool that uses neutron probes to detect residual oil deposits
IKOMED	Medical Devices	Microshutters that reduce radiation exposure during medical procedures
Micromatter	Advanced Manufacturing	Specialized foils and calibration standards for research and industrial applications



TRIUMF is well positioned to assist in solving problems of global importance

One example of this is the leadership role we are playing in the development of alternative isotope production technologies

Problem: Tc-99m is one of the world's most important diagnostic radioisotopes, and the NRU Reactor at Chalk River – which supplied much of Canada's supply – has ceased production



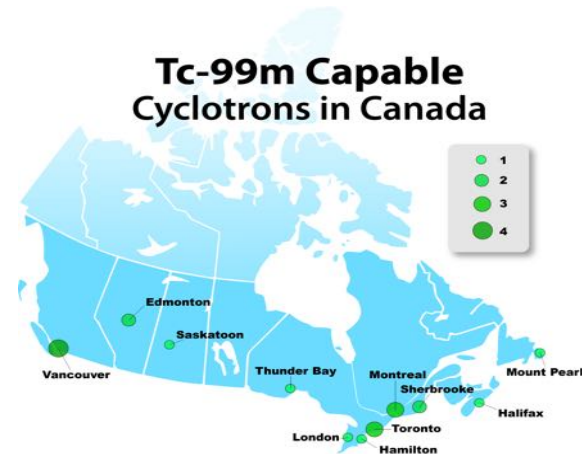
Solution: A TRIUMF-led consortium developed an innovative method to produce Tc-99m using medical cyclotrons

The consortium included:

- TRIUMF (Vancouver, BC)
- BC Cancer Agency (Vancouver, BC)
- University of British Columbia (Vancouver, BC)
- Centre for Probe Development and Commercialization (Hamilton, ON)
- Lawson Health Research Institute (London, ON)

Project status:

- Health Canada approved clinical trials are complete and the New Drug Submission is being prepared
- The technology is being commercialized by ARTMS Products Inc. which has received support from an international investor and is close to securing VC funding
- Interest in this technology is growing and ARTMS recently completed its first sales to European customers



Building on the cluster of expertise that exists in Vancouver, TRIUMF, UBC, BC Cancer Agency, and SFU are proposing **the Institute for Advanced Medical Isotopes (IAMI)**

IAMI is a multidisciplinary R&D facility will work across five key areas:

- Medical isotope production
- Clinical imaging
- Radiopharmaceutical development
- Accelerated drug development
- Cancer therapies



“The Institute for Advanced Medical Isotopes is the single most transformative capital project for the future of UBC Medicine”

Dr. Dermot Kelleher  
Dean, Faculty of Medicine,  
University of British Columbia

#### IAMI Founding Partners



## IAMI will reduce the risk of medical isotope shortages in Canada

- IAMI will help ensure Tc-99m supply security by support a large scale demonstration of ARTMS' made-in-Canada technology
- IAMI will also produce a reliable supply of other isotopes (i.e. F-18 and C-11) for research and use by our clinical partners





Boston



A \* STAR

Singapore  
Bioimaging Consortium

Singapore

**Karolinska  
Institutet**

Stockholm

Imanova  
Centre for Imaging Sciences

London

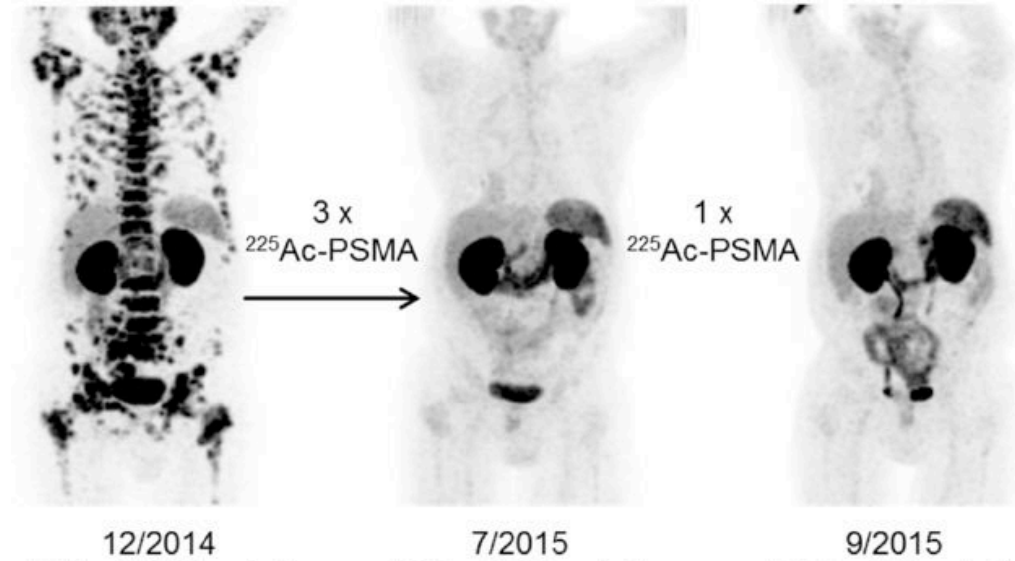
IAMI will add Vancouver to a short list of international centres using isotopes to accelerate drug development

**Vancouver**



# IAMI will produce powerful new isotopes with the potential to treat cancer

- This image shows a prostate cancer patient before and after treatment with next-generation isotope therapy
- Development has stalled because of a global lack of supply of the isotope
- IAMI will solve this problem and position Canada as a world leader in this rapidly emerging market



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

TRIUMF has a long and productive history of scientific collaboration with Japan. This relationship continues to flourish and deliver benefit for both nations

TRIUMF looks forward to exploring new opportunities with KEK and to expanding collaboration in areas such as:

- Subatomic Physics
- Materials Science
- Accelerator Applications





Canada's national laboratory  
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TRIUMF: Alberta | British Columbia | Calgary |  
Carleton | Guelph | McGill | Manitoba | McMaster |  
Montréal | Northern British Columbia | Queen's |  
Regina | Saint Mary's | Simon Fraser | Sherbrooke |  
Toronto | Victoria Western | Winnipeg | York

ありがとう!  
Thank you!  
Merci!

Follow us at TRIUMFLab

