



Canada's National Laboratory for
Particle and Nuclear Physics

Progress in Ab Initio Techniques in Nuclear Physics

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- Physical Sciences Division





TRIUMF was founded in 1968 and has delivered nearly 50 years of science and innovation for Canada, and is engaging the World.

Both: experiments and theory.

HIGHLY QUALIFIED PERSONNEL



350 staff

150 students & post-doctoral researchers



500+ scientist & student researcher visits per year

KNOWLEDGE

86% of Canada's subatomic physics research involves TRIUMF



INTERNATIONAL ENGAGEMENT

50+ international agreements & partnerships

China Italy Switzerland
Israel USA Korea France
Russia India Japan
United Kingdom Austria Germany



BUSINESS

\$1B in economic activity in last decade



**40 MV SRF
Heavy Ion Linac**

**Advanced Rare
Isotope Laboratory
(ARIEL)**

**ISAC-II
>10 AMeV**

**ISAC (Isotope Separator
and ACcelerator)**

Rare Isotope Facility

- Nuclear Structure
- Nuclear Astrophysics
- Fund. Symmetries
- CMMS (β NMR)

**ISAC-I
60 keV, 1.7 AMeV**

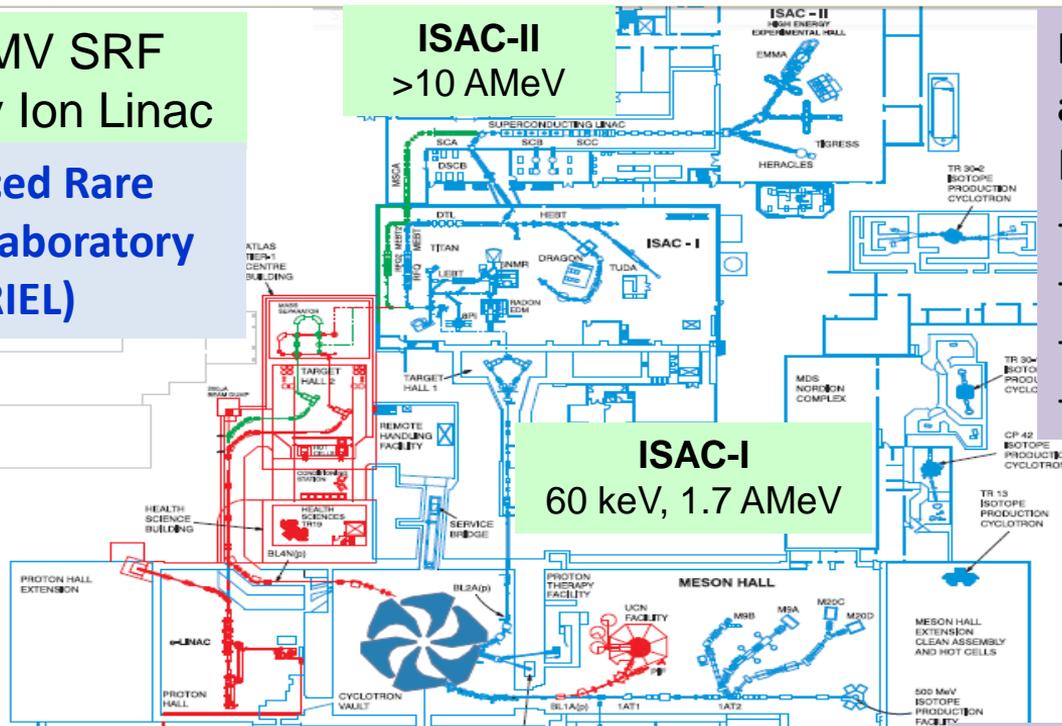
Nordion

commercial medical
isotope production
3 cyclotrons

Cyclotron
500 MeV
350 μ A

Particle Physics
Pienu
Ultra Cold Neutrons

CMMS
Centre for Molecular and
Material Science (μ SR)



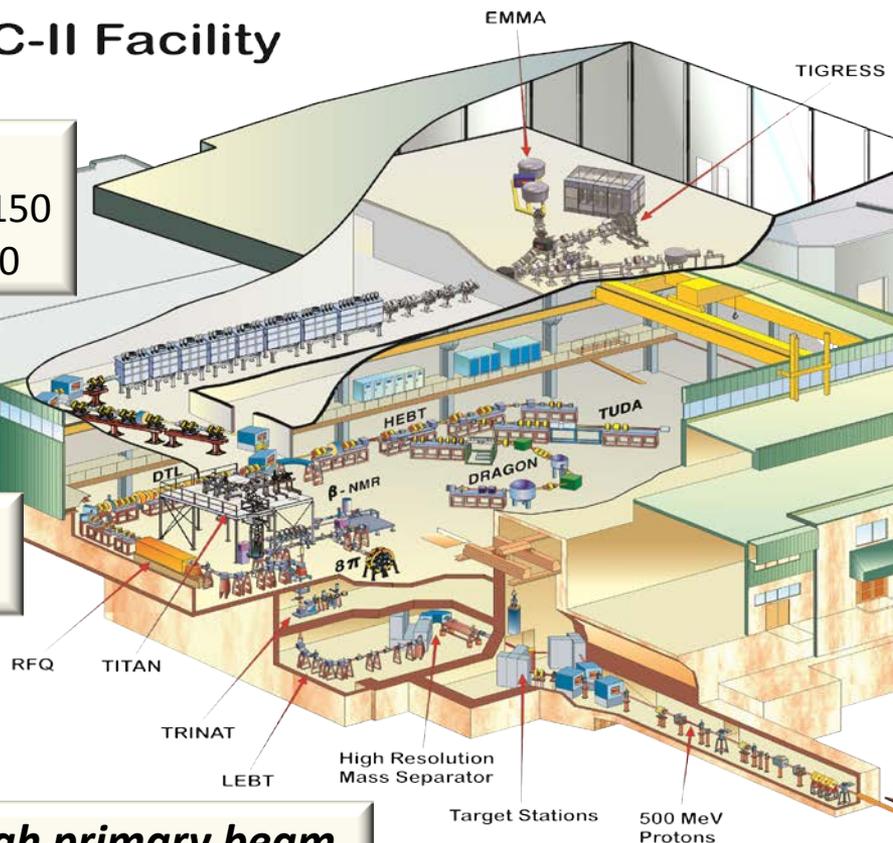
ISAC-I and ISAC-II Facility

ISAC II:

- 10 AMeV for $A < 150$
- 16 AMeV for $A < 30$

ISAC I:

60 keV & 1.7 AMeV



Programs in

- Nuclear Structure & Dynamics
- Nuclear Astrophysics
- Electroweak Interaction Studies
- **Material Science**
- 16 permanent experiments

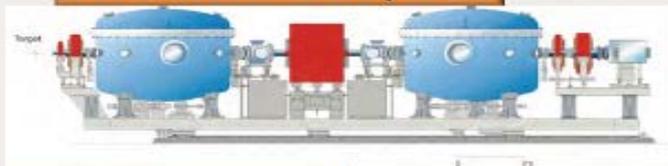


ISOL facility with **high primary beam intensity** (100 μ A, 500 MeV, p)

TITAN Penning Trap facility



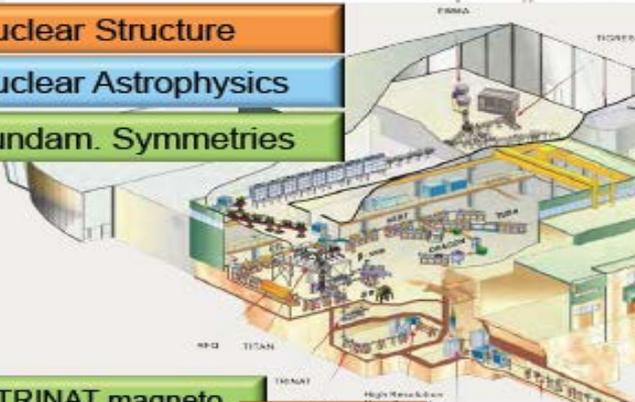
EMMA recoil mass analyzer



Nuclear Structure

Nuclear Astrophysics

Fundam. Symmetries



MTV Mott scattering drift chamber



TIGRESS in-beam gamma-ray spectrometer



Laser polarizer line



IRIS solid hydrogen reaction set-up



Francium trapping facility

TRINAT magneto optical trap



DESCANT



GRIFFIN



TUDA reaction setup



DRAGON recoil separator



The **Advanced Rare IsotopE** Laboratory will triple TRIUMF's isotope beam capacity

- Uses state-of-the-art, made-in-Canada superconducting electron linear accelerator technology; targets are designed to allow medical isotopes to be extracted alongside the experimental program
- Represents ~\$100 million investment by federal and provincial governments; supported by 19 university partners from across Canada
- Project to occur in two phases:
 - ARIEL-I completed in Fall 2014;
 - ARIEL-II funded by Canada Foundation of Innovation, funding now secured.
- Will provide more and new isotopes



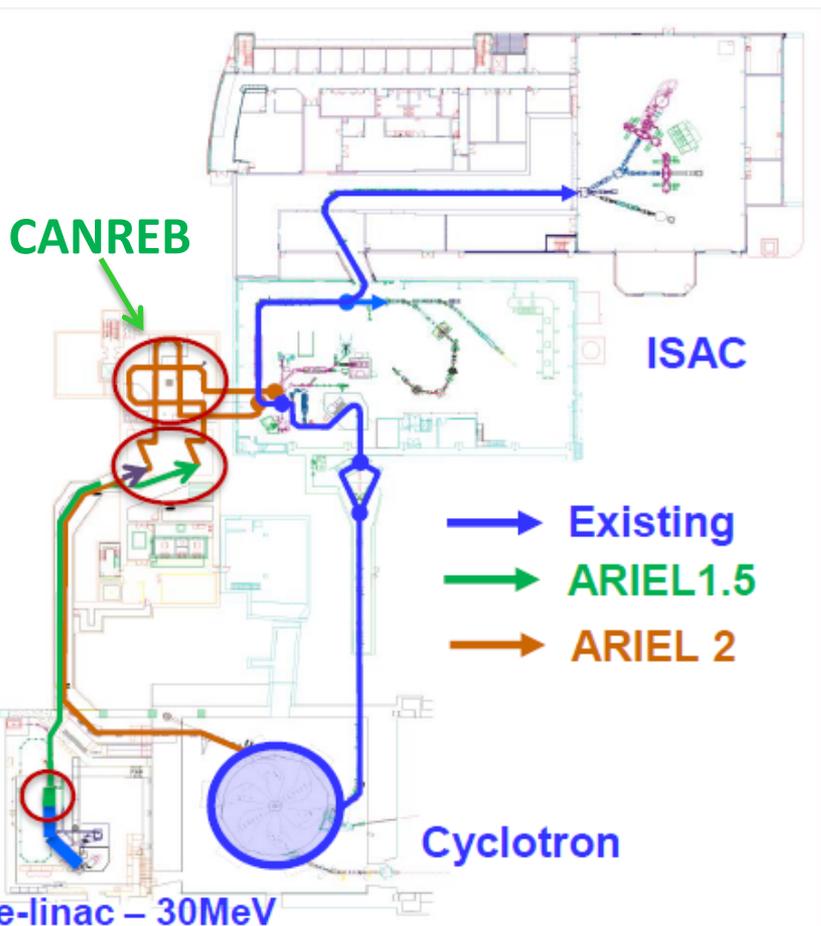
ISOTOPES

- **What we can do at ARIEL:**
- **isotopes for characterizing new materials:**
 - ^8Li as a sensitive probe for interfaces
- **medical isotopes for nuclear imaging and tumor treatment:**
 - alpha-emitters like ^{211}At
- **isotopes for developing and refining theory for nuclear physics**
 - Proton- and electron-induced rare isotopes at the extremes
- **isotopes as laboratories to search for new symmetries in nature**
 - Heavy proton-induced isotopes, like Fr, Rn and some light electron-induced isotopes: Li
- **isotopes: how and where the heavy elements were produced in the universe**
 - Very neutron rich isotopes from photo-fission
- **Triple the available beam time: more time for beam developments**

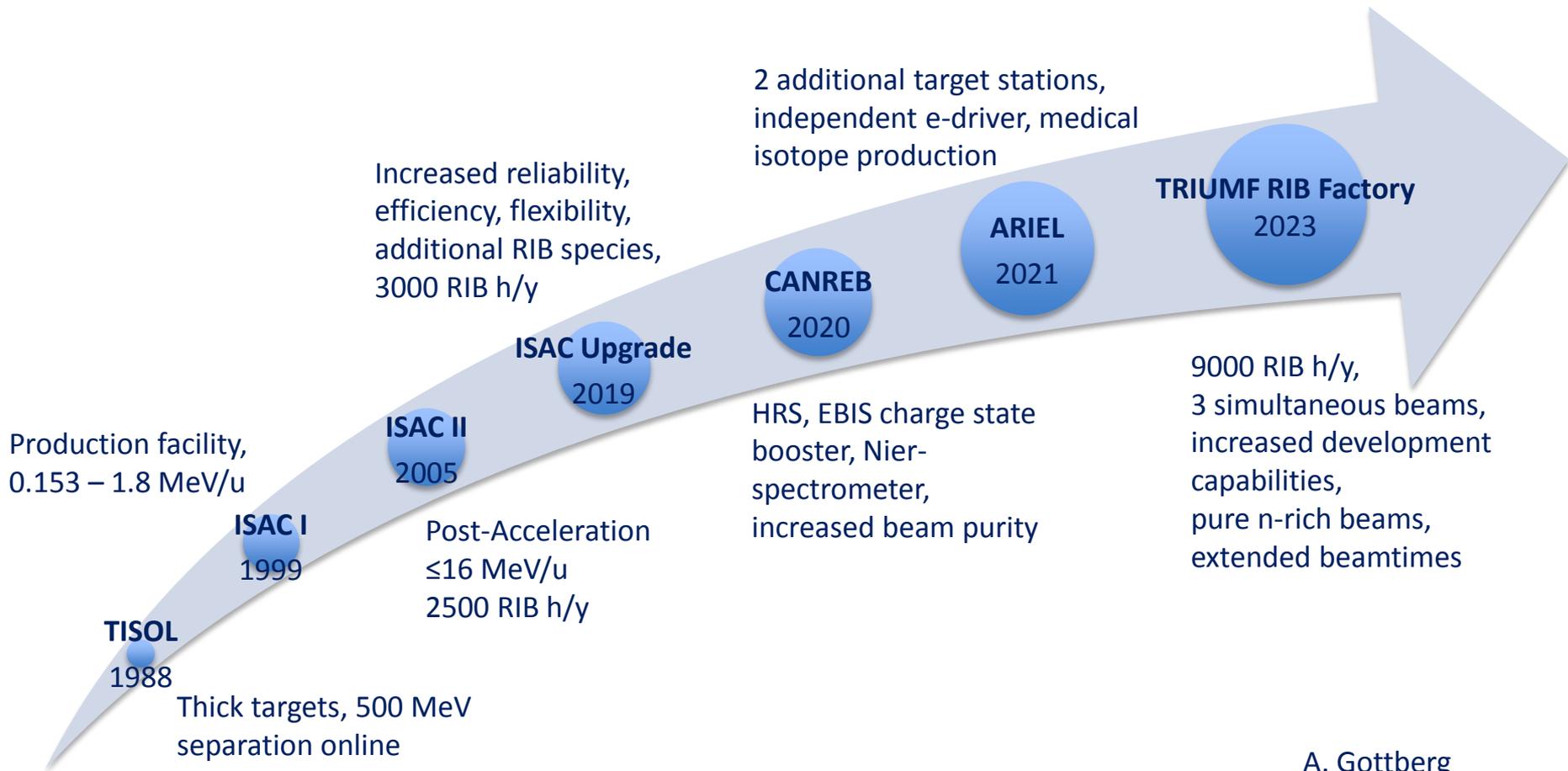


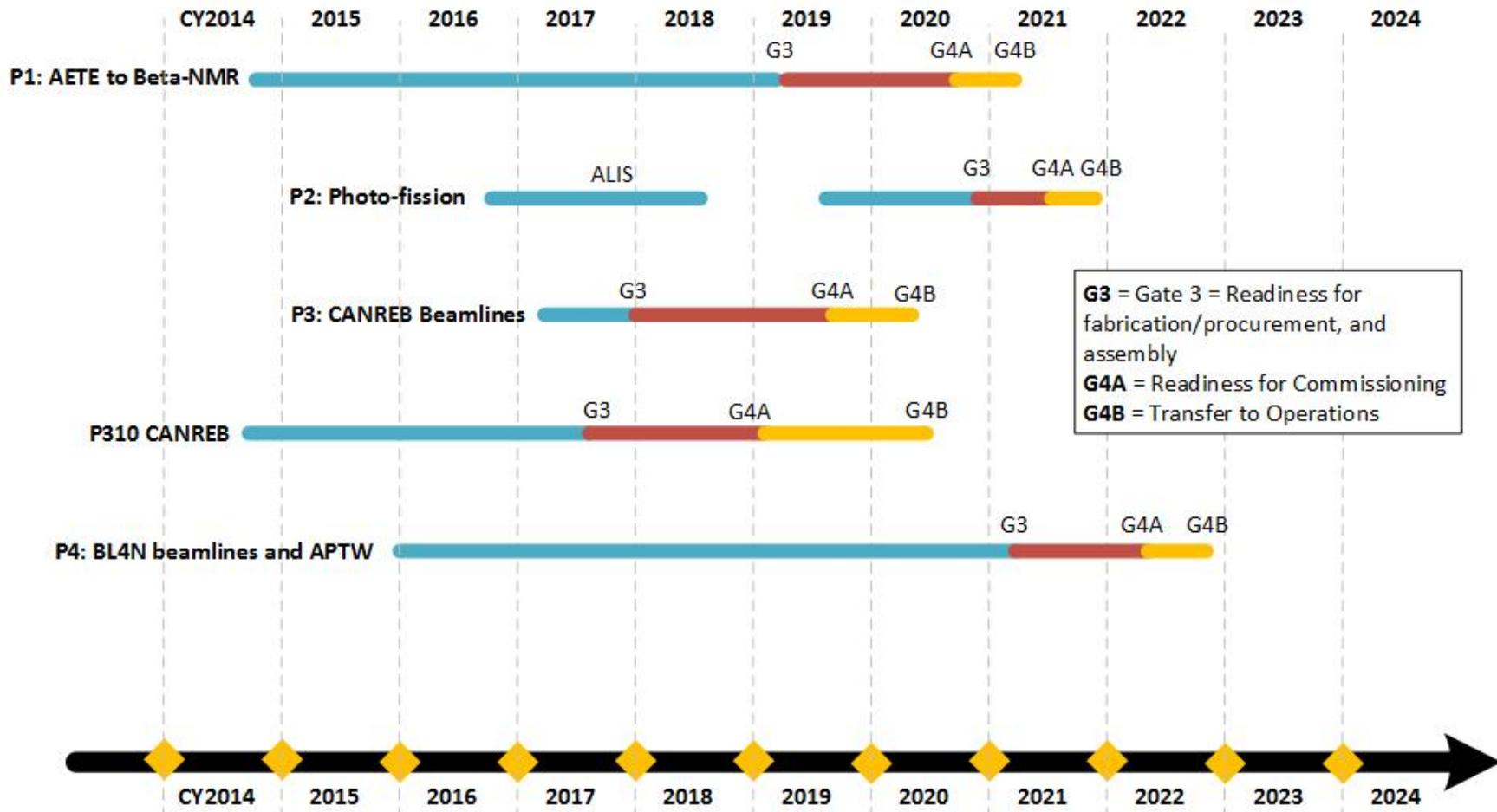


ADVANCED RARE ISOTOPE LABORATORY



- **ARIEL 1.5**
 - Complete beamline to ARIEL electron target station – parts in hand - integrate to the ARIEL2 schedule
 - Complete e-Linac to final 30MeV (ACMuno->ACMduo)
- **ARIEL 2**
 - Target ion source
 - Target hall infrastructure – hot cell design
 - Low energy beam transport (with CANREB) – detailed design of beamline completed
prototype beam line under construction
- **CANREB**
 - High resolution separator
 - Beam preparation with RFQ and EBIS





Year	Science exploitation
2020	ISAC-CANREB-ISAC beams
2022	ARIEL beam (Li-8)
2022	ARIEL photo-fission beams to ISAC
2023	ARIEL spallation beams to ISAC

**Towards day-1
experiments of ARIEL**



Science enabling milestone	Month/Year
First EEC approved experiments with high-mass accelerated beams from ISAC utilizing the CANREB/ARIEL EBIS charge breeder	10/2020
First EEC approved beta-NMR experiments with photo-produced ^8Li	03/2022
First EEC approved experiments with photo-fission RIBs from the e-Linac	06/2022
First EEC approved experiments with RIBs from ARIEL Proton target	03/2023



Higher intensity,
cleaner high-mass
accelerated beams



More RIB hours,
cleaner n-rich RIBs



3 parallel RIBs



Canada's national laboratory for
particle and nuclear physics

Laboratoire national canadien
pour la recherche en physique
nucléaire et en physique des
particules

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

Welcome to TRIUMF

and enjoy the workshop.

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