



Canada's National Laboratory for  
Particle and Nuclear Physics

# Progress in Ab Initio Techniques in Nuclear Physics

February 23-26, 2016

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Associate Laboratory Director TRIUMF  
- 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 Russia **USA** Korea France  
United Kingdom Austria **Japan**  
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-I  
60 keV, 1.7 AMeV

Cyclotron  
500 MeV  
350  $\mu$ A

Particle Physics  
Pienu  
Ultra Cold Neutrons

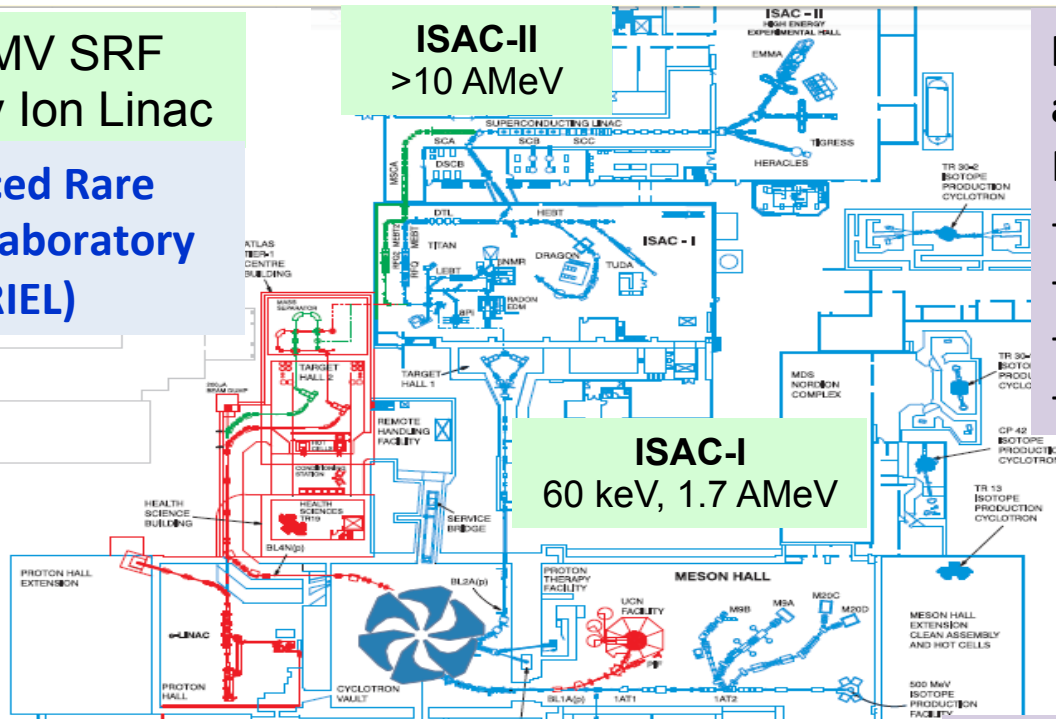
ISAC (Isotope Separator and ACcelerator)

Rare Isotope Facility

- Nuclear Structure
- Nuclear Astrophysics
- Fund. Symmetries
- CMMS ( $\beta$ NMR)

Nordion  
commercial medical  
isotope production  
3 cyclotrons

CMMS  
Centre for Molecular and  
Material Science ( $\mu$ SR)





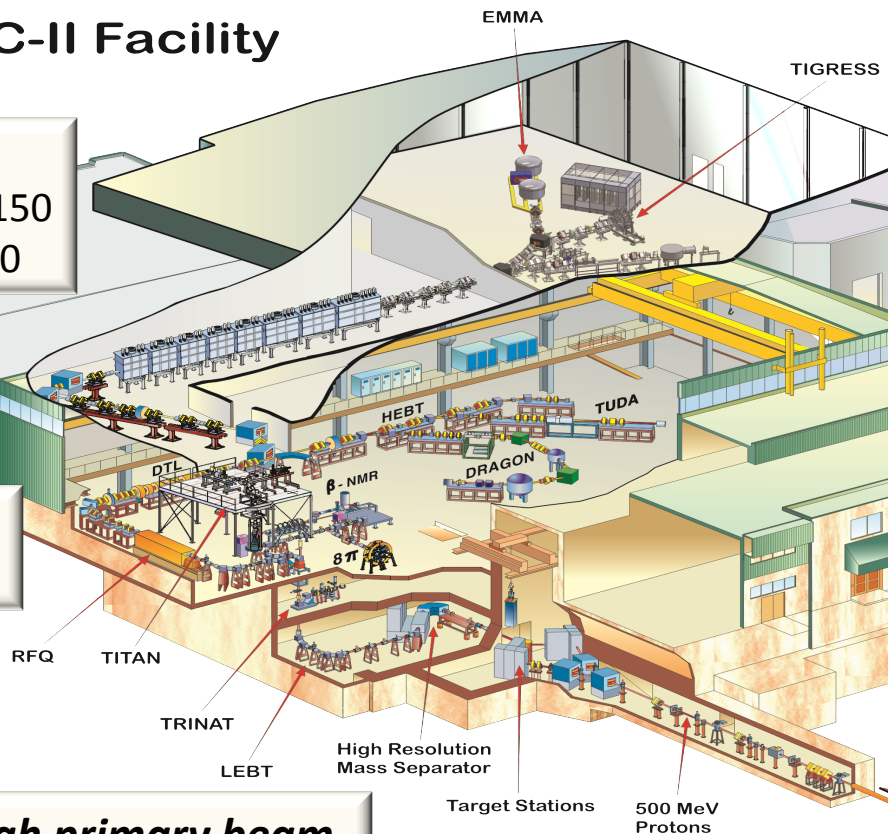
## ISAC-I and ISAC-II Facility

### ISAC II:

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

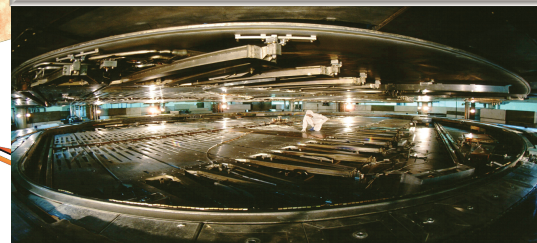
### ISAC I:

60 keV & 1.7 AMeV



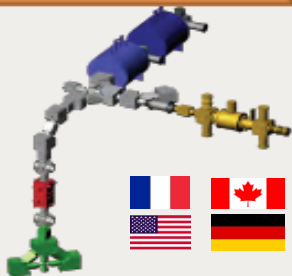
### Programs in

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

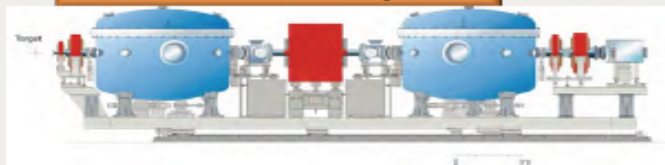


ISOL facility with **high primary beam intensity** (100  $\mu$ A, 500 MeV, p)

TITAN Penning Trap facility



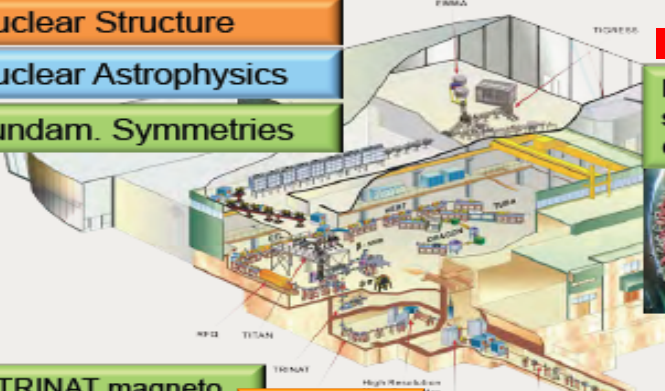
EMMA recoil mass analyzer



Nuclear Structure

Nuclear Astrophysics

Fundam. Symmetries



TIGRESS in-beam gamma-ray spectrometer



MTV Mott scattering drift chamber



IRIS solid hydrogen reaction set-up



Laser polarizer line



Francium trapping facility



TRINAT magneto optical trap



DESCANT



GRIFFIN



TUDA reaction setup



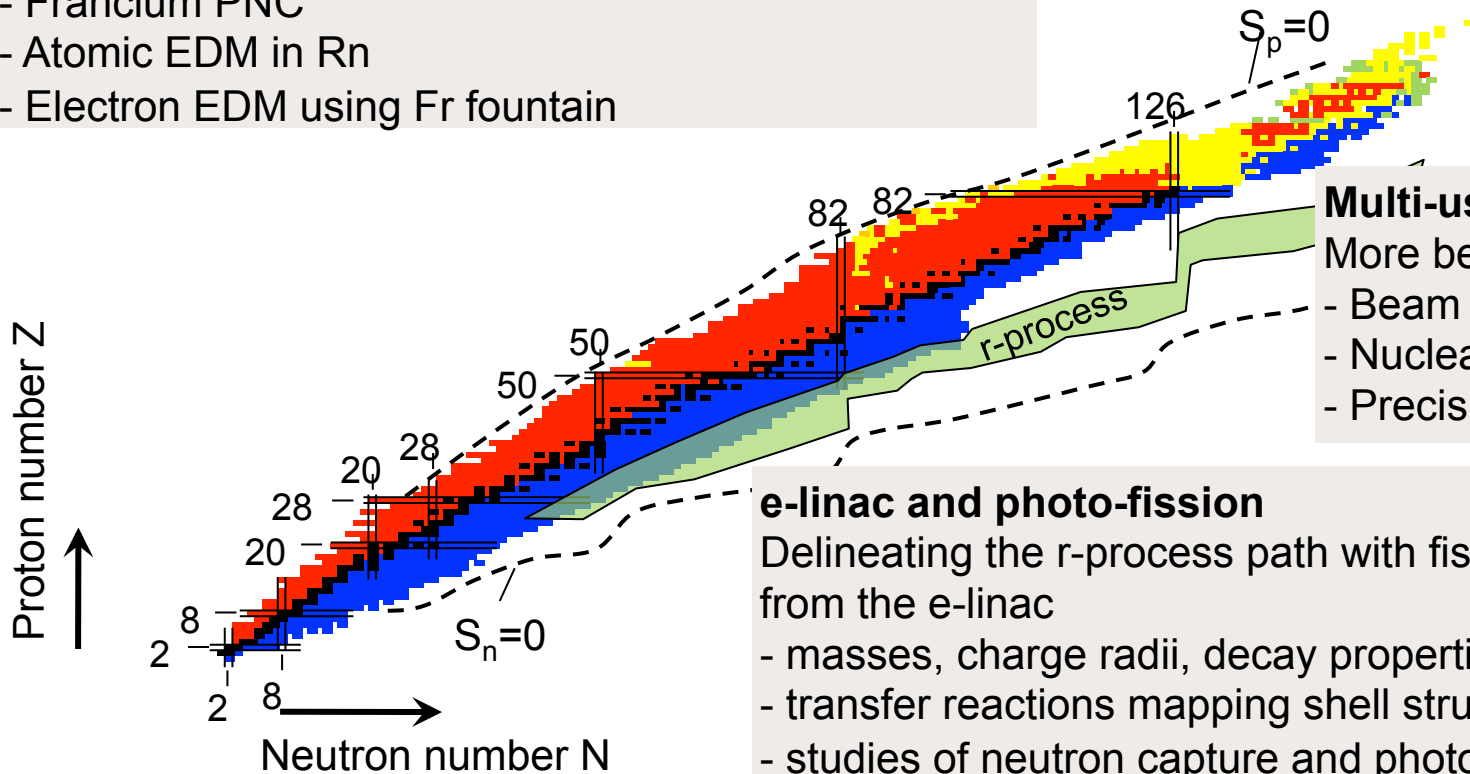
DRAGON recoil separator



## Actinide proton beam-line:

High intensity, clean beams for electroweak precision experiments using hundreds of days of beam per year

- Francium PNC
- Atomic EDM in Rn
- Electron EDM using Fr fountain



## Multi-user operations:

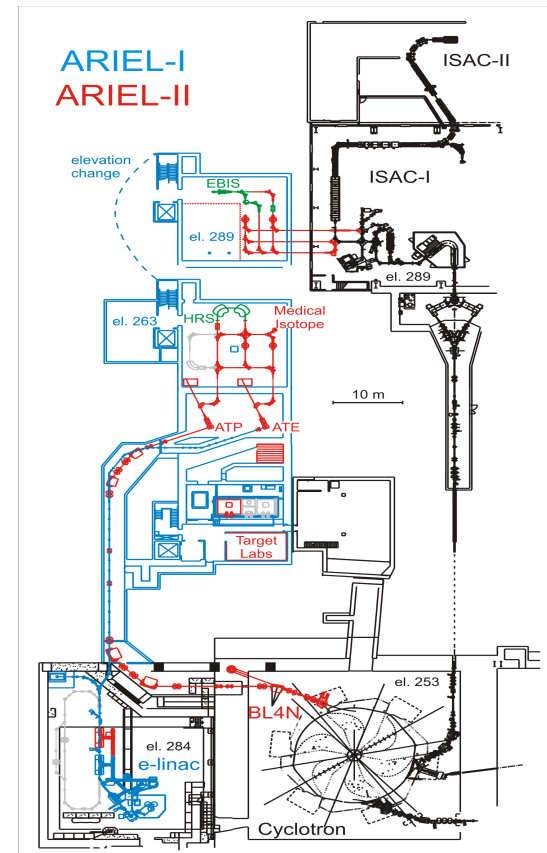
- More beam time for
- Beam development
  - Nuclear astrophysics
  - Precision experiments

## e-linac and photo-fission

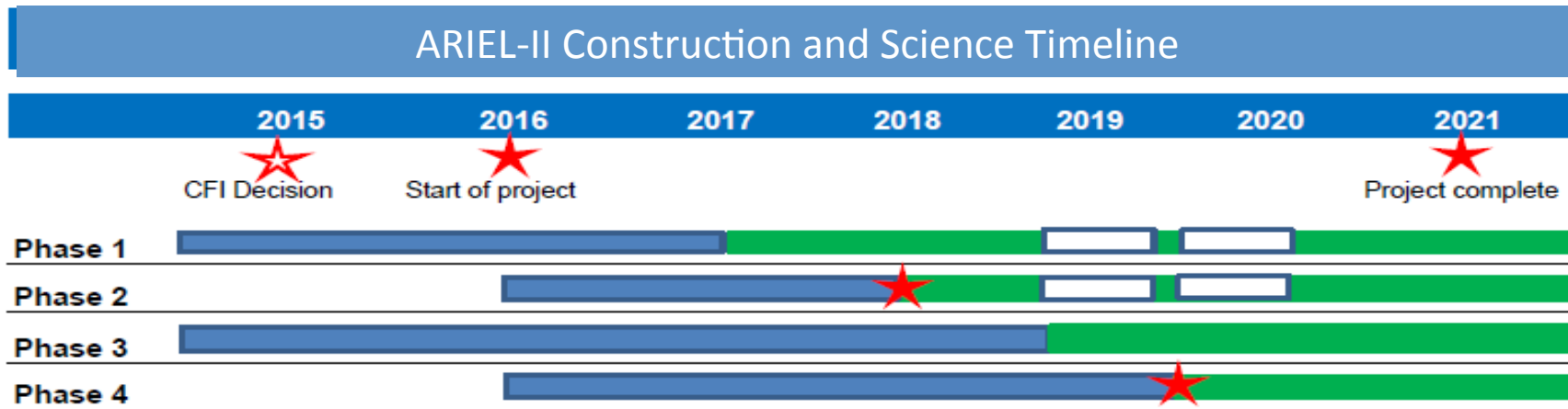
Delineating the r-process path with fission fragment beams from the e-linac

- masses, charge radii, decay properties
- transfer reactions mapping shell structure
- studies of neutron capture and photo dissociation rates

- **ARIEL-I (2010-2014):**
  - Civil construction to encompass objectives of both ARIEL-I & II
  - Electron linac up to 25 MeV, 50 kW
  
- **ARIEL-II (2016-2021):**
  - Completion and scientific utilization of the ARIEL facility
    - RIB targets & delivery infrastructure
    - New proton beamline
    - High power electron linac (36 MeV, 100kW)
  - Phased approach to bring science online
  - Fully funded







Phase	Will deliver isotopes for....
1	Materials science with $\beta$ -NMR + light beams for Fund. Symm. ( $^8\text{Li}$ )
2	Photo-fission of uranium from e-Linac
3	Purified accelerated high mass beams (CANREB), Medical isotopes for imaging & treatment
4	Fundamental Symmetries w/ new proton beamline (BL4N) ❖ <b>Three simultaneous rare isotope beams delivered to users</b>



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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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