TRIUMF

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

Project Introduction and Current Status of ARIEL

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ARIEL: A two-stage Project

ARIEL – The Advanced Rare Isotope Laboratory –
will triple TRIUMF's isotope beam capacity

- Represents ~$100 million investment by federal and provincial governments; led by UVic and supported by 19 universities across Canada
- ARIEL-I was completed on time and on budget in Fall 2014
- ARIEL-II funding was approved by CFI in May 2015

  ARIEL-II has received funding from AB, MB, ON, QC (2015), BC (10/2016)

  CFI finalization process currently ongoing

  Project will be 6-year project starting shortly

  First science from ARIEL Charge Breeder with ISAC beams: 2020

- ARIEL is the highest priority project for TRIUMF
- Goal: Project execution should minimize impact on science delivery

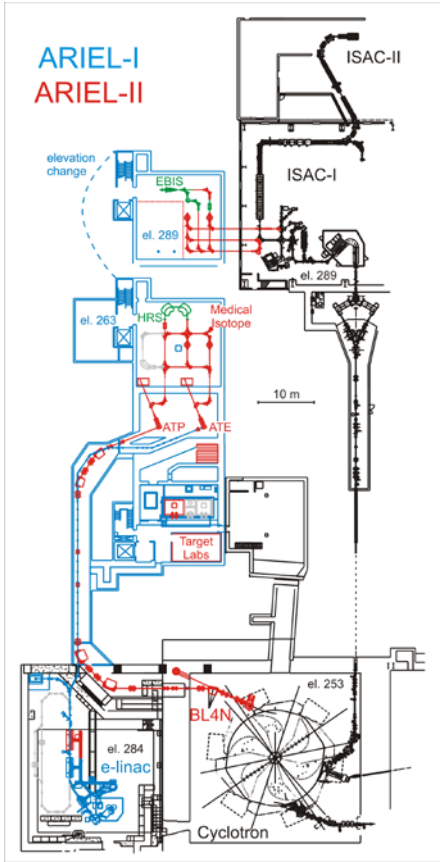
ARIEL I and II

ARIEL-I (2010-2014):

- Civil construction encompassing objectives of both ARIEL-I & II
- Electron linac up to 35 MeV, 100 kW

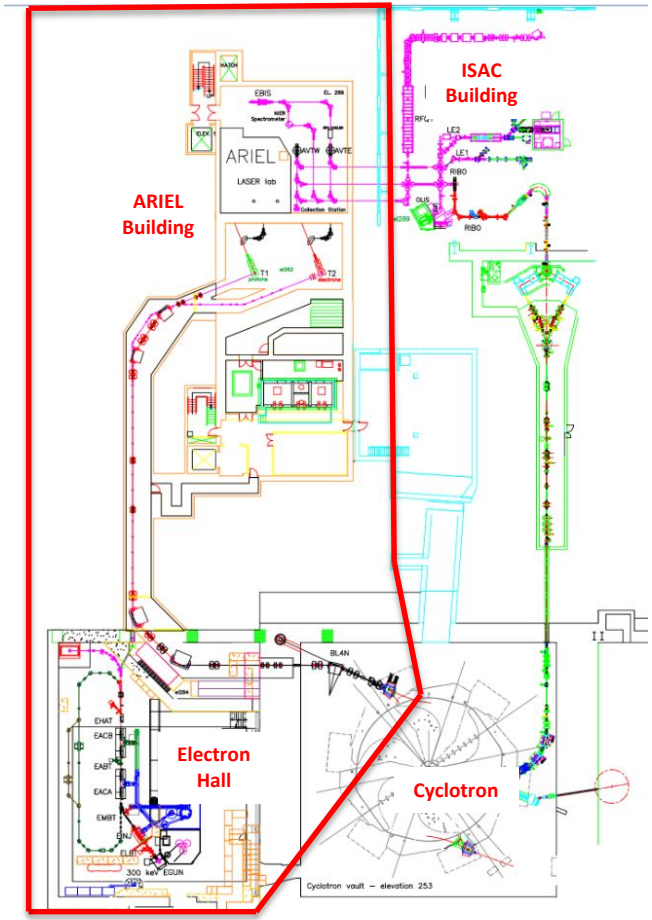
ARIEL-II (2017-2022):

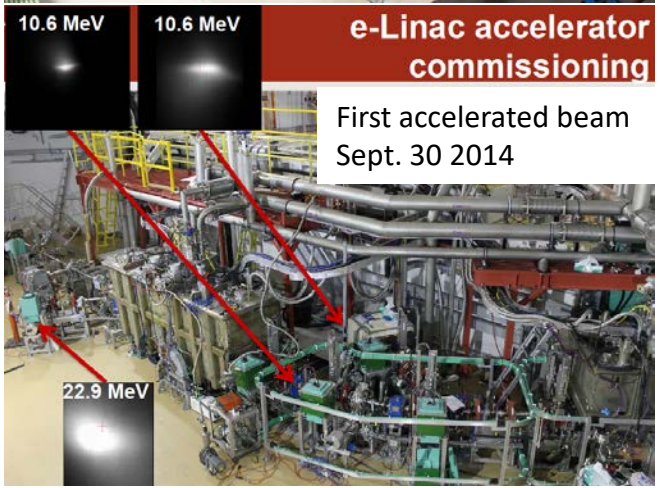
- Completion and scientific utilization of the ARIEL facility
  - RIB targets & delivery infrastructure
  - New proton beam-line
- Phased approach to bring science online
- Funding approved (C$37.5M)



ARIEL project components

- ARIEL-I (completed)
- ARIEL 1.5
- CANREB
- VECC MoU3
- ARIEL-II
- Therapeutic Isotopes (P405)





Reminder: ARIEL-II Phases

Phase	Major Components	Will deliver isotopes for....
1 β-NMR	Electron target for ^{8}Li production, shielding, pre separator, RIB transport to ISAC, hot cells, remote handling	materials science with β-NMR [+ light beams for Fund. Symm. (^{8}Li), Nucl. Astro. (^{10,11}C)]
2 Photofission	Actinide laboratories, Laser Ion source	photo-fission of uranium from e-Linac
3 CANREB	Beam lines to connect HRS, EBIS to ARIEL and ISAC	purified accelerated high mass beams (CANREB), Medical isotopes for imaging & treatment
4 BL4N	Proton beamline BL4N, proton target, RIB transport to ISAC	fundamental Symmetries w/ new proton beamline BL4N ➔ 3 simultaneous RIBs for users
5 HP Converter	50 MeV 500 kW eLinac 500kW HP-converter development	Full exploitation of photo-fission with full power e-Linac

ARIEL Scope changes

ARIEL scope changes:

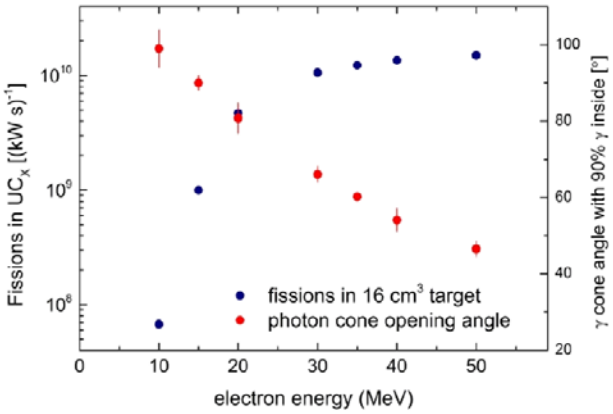
- postpone 50MeV eLinac
  → limit to E_e = 35 MeV (saturation of fission rate)

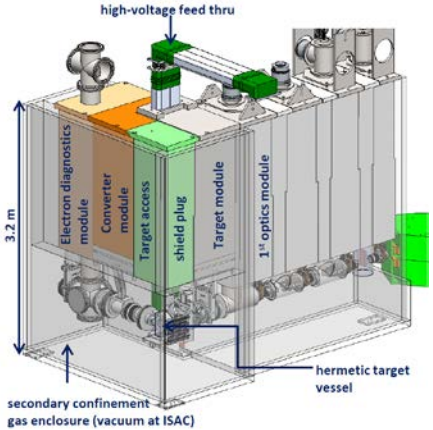
- postpone 500kW photo converter
  → limit to $P_e \leq 100$ kW (no technology for efficient use of higher power available, shielding designed for 500 kW)

Advanced target design concept:

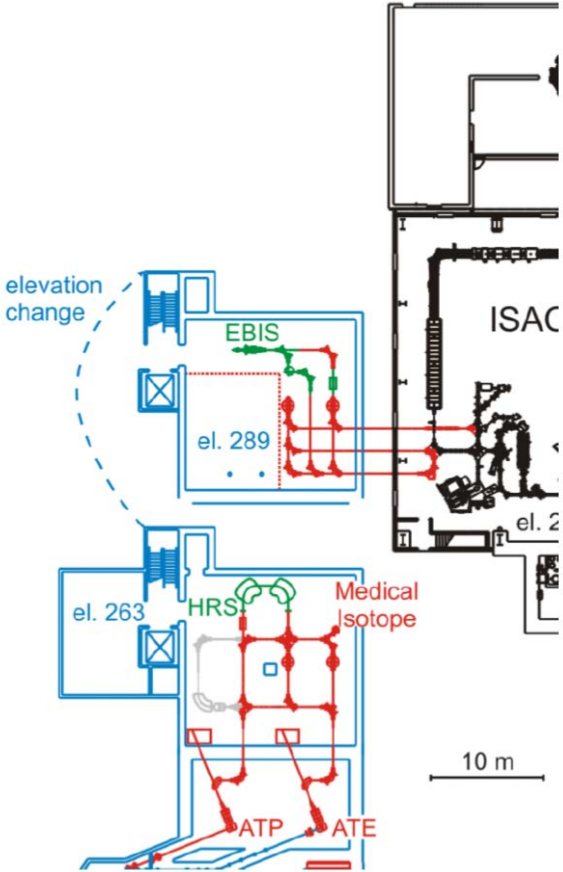
- mechanical part of target exchange in ≤ 24 h
  → higher productivity (5% overhead instead of 40% @ISAC)
  → target exchange in station not in hot cell

- pre-conditioned hermetic target vessel and target acceptance stand (TISA) to approach 95% target assembly reliability
  → higher beam delivery reliability





CANREB: ISAC+ARIEL RIB delivery systems



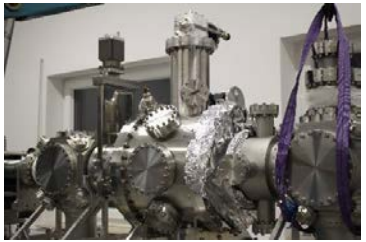
Main components of CANREB CFI project:

- high resolution mass separator M/ΔM = 20,000 for beams from ISAC and ARIEL
- charge state breeder A/q 5 -7, 100 Hz pulsed, **10-20% efficiency (available 2020 for ISAC beams!)**
  - RFQ cooler/buncher
  - EBIS charge state breeder
  - Nier spectrometer for highly charged ions

  ➔ Cleaner, more intense beams than current ISAC charge breeder
- RIB beamlines part of ARIEL-II Phase 3 project

HRS magnet poles at Buckley, NZ

RFQ pulsed drift tube



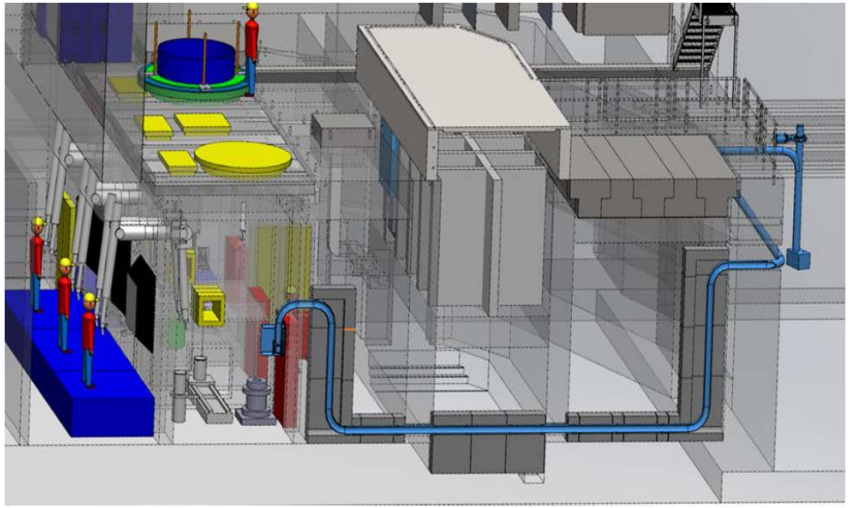
EBIS at MPIK Heidelberg

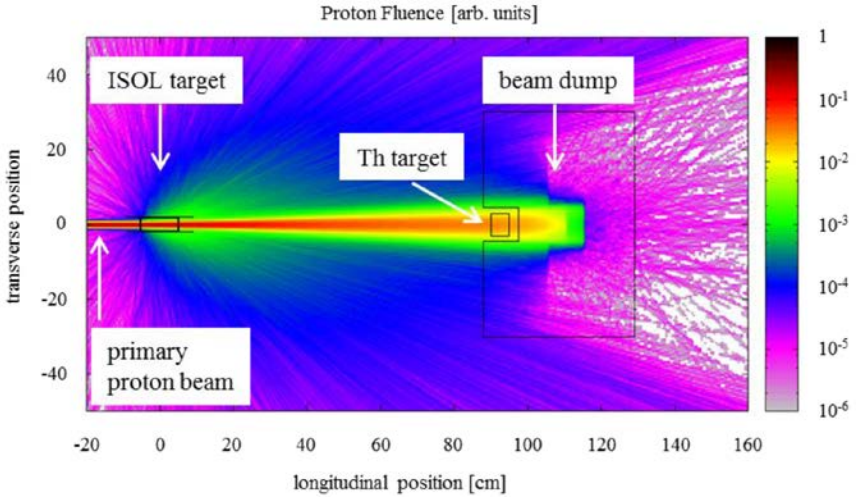
➔ Friedhelm Ames

New Project Proposal for Therapeutic Isotopes

500 MeV – ARIEL/H^+
- High activity (GBq), spallation
- Enable radiopharmaceutical development and clinical trials

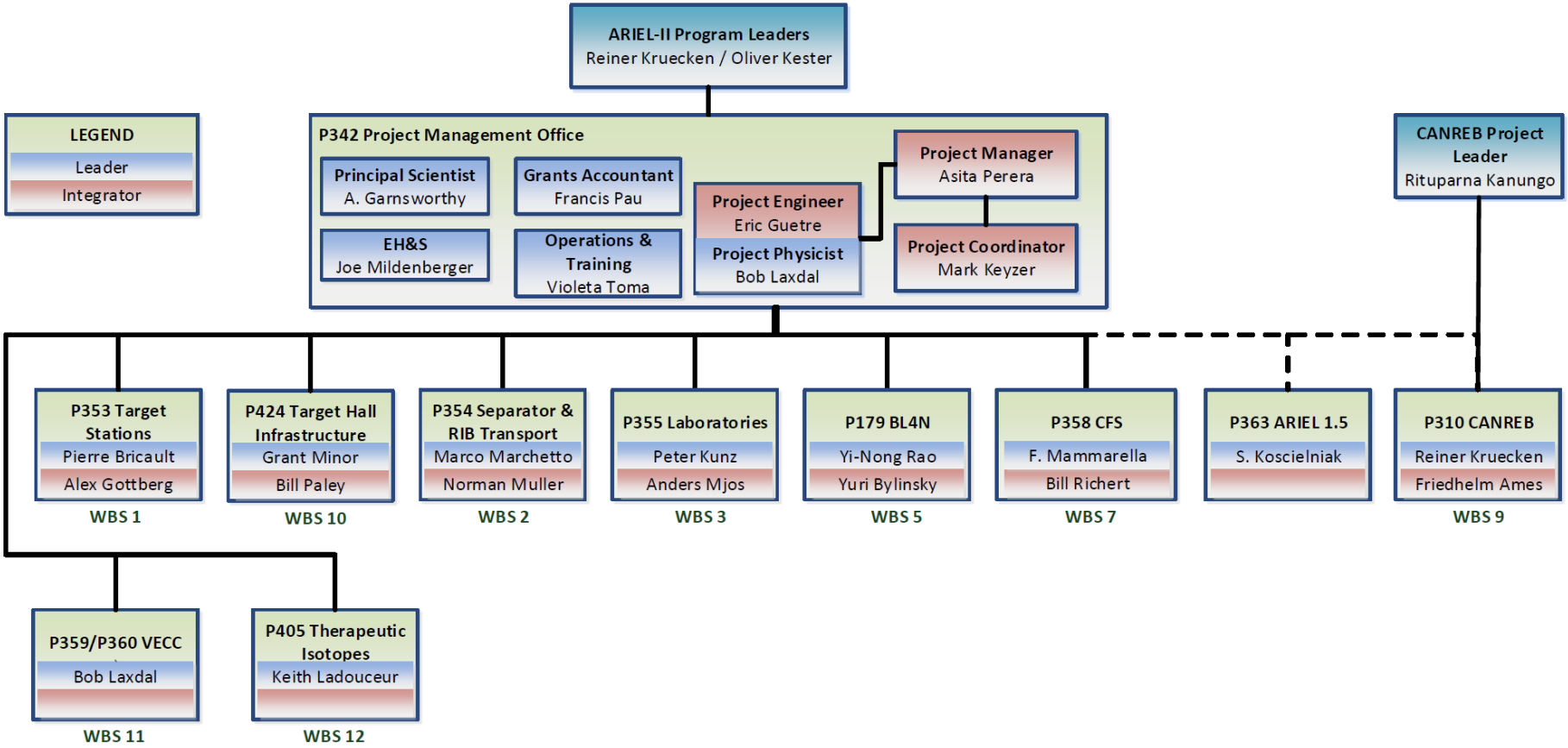
Future direction: Commercial production
- Details in breakout session





Timeline and Status:
- $9.9M CFI Application submitted (UBC)
- Funding announcement: June 2017
- If successful, roll project into ARIEL-II

Organization



ARIEL is divided geographically

#1 RIB delivery

#2 ARIEL target stations & infrastructure

#3 Driver beam lines

P355 – Laboratories ($1.3M)

P424 – Target Hall Infrastructure ($10.6M)

P310 – CANREB ($3.4M)

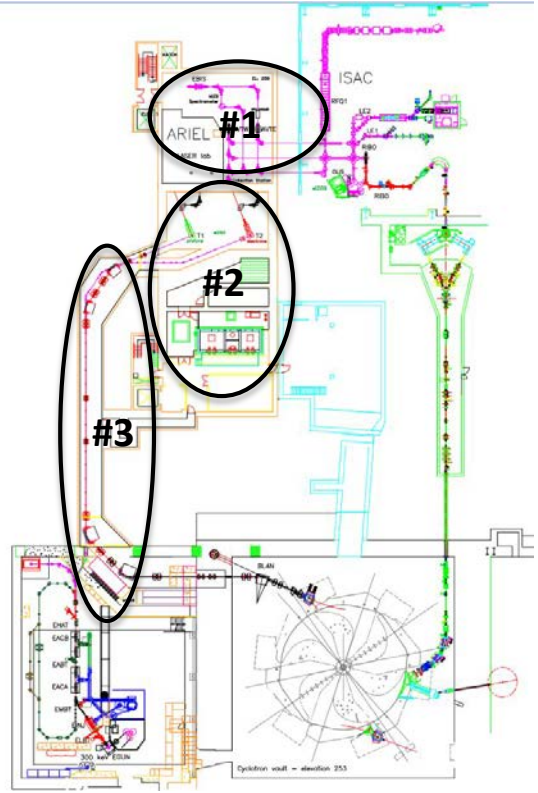
P354 – Beamlines ($7M)

P353 – Target Stations ($9M)

P363 – e-linac completion ($0.5M)

P179 – BL4N ($4.5M)

P358 – CFS ($3.3M)



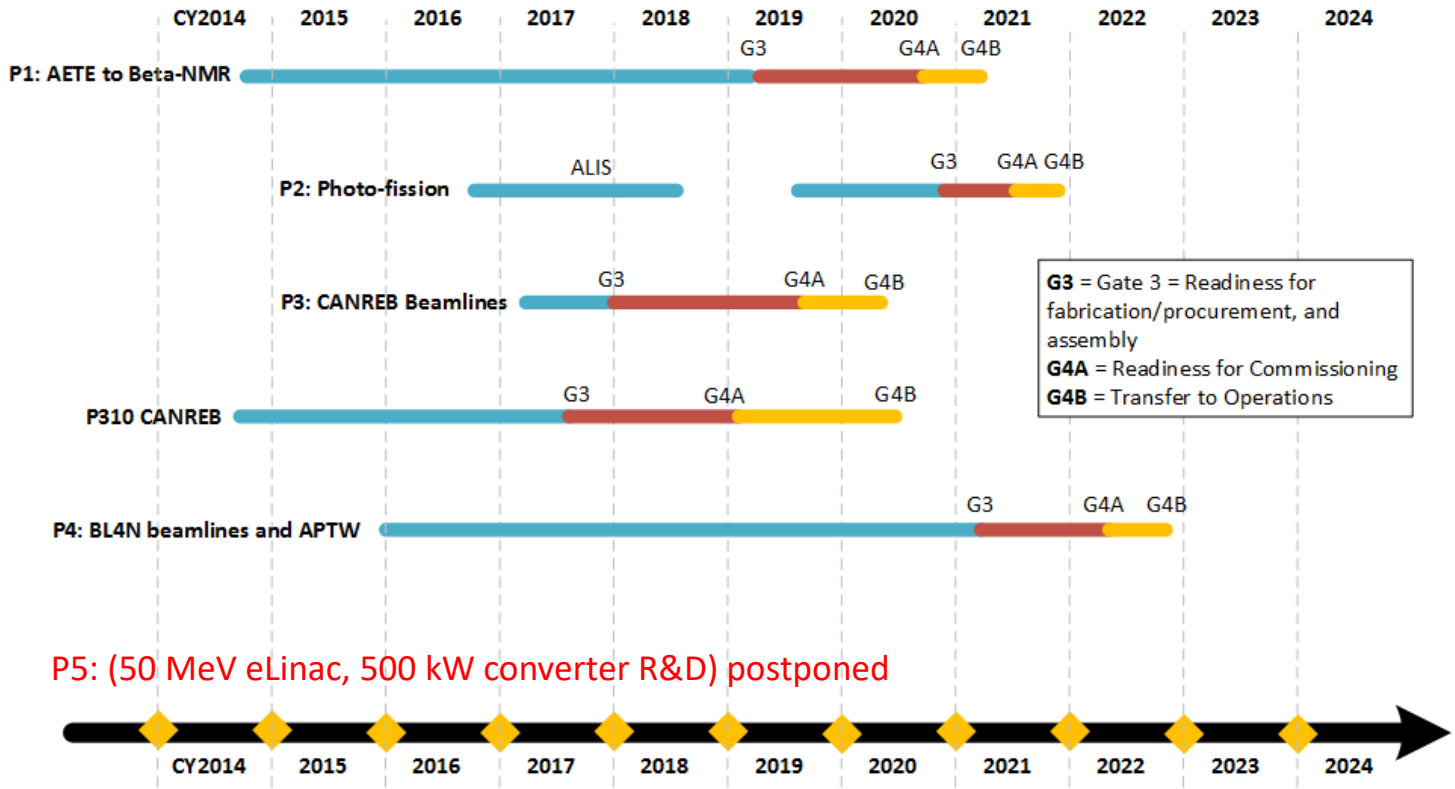
Least risk: complete asap

AETE is new tech: higher risk

Depends on target stations

ARIEL-II schedule

Baselined deterministic Schedule



ARIEL: Science enabling milestones

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 ^{8}Li	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

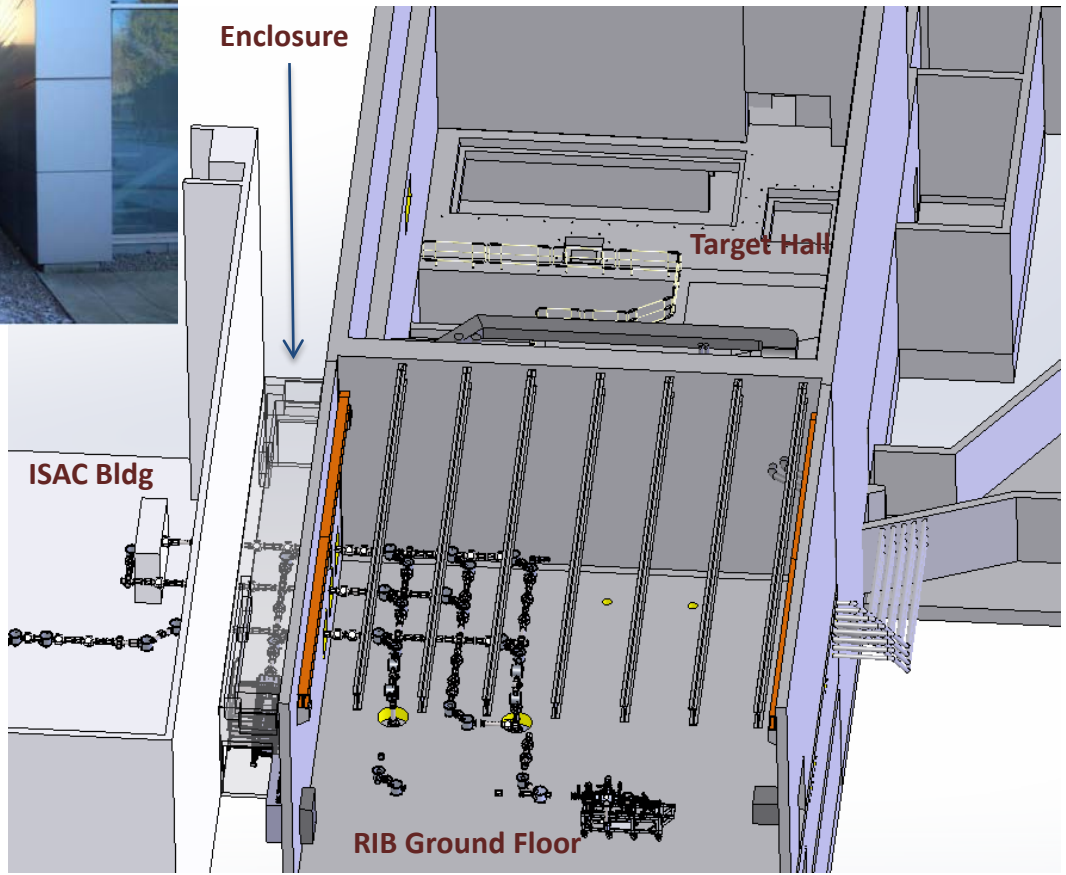
→ More RIB hours, cleaner n-rich RIBs

→ 3 parallel RIBs

- Dates based on Monte Carlo analysis of schedule
- Current best estimates but with high confidence
- Efforts under way to accelerate schedule

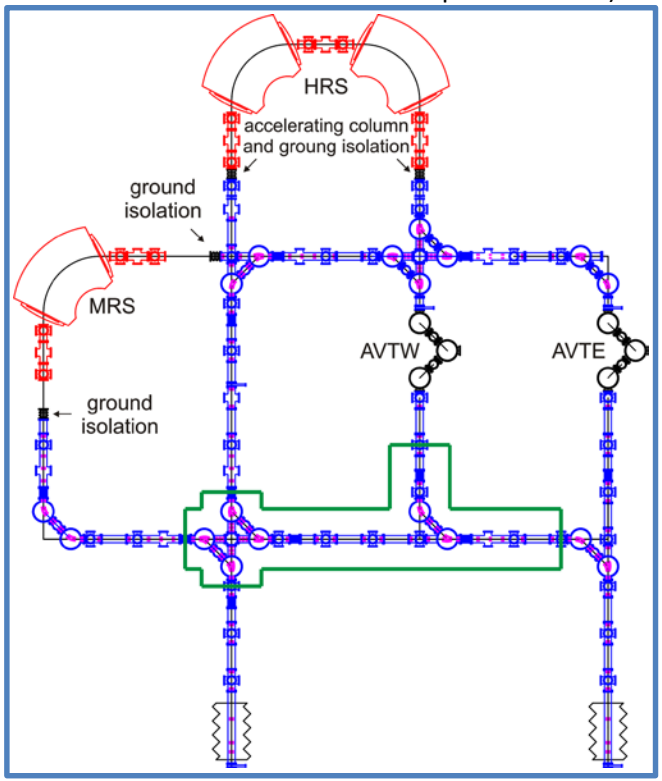
➔ Eric Guetre

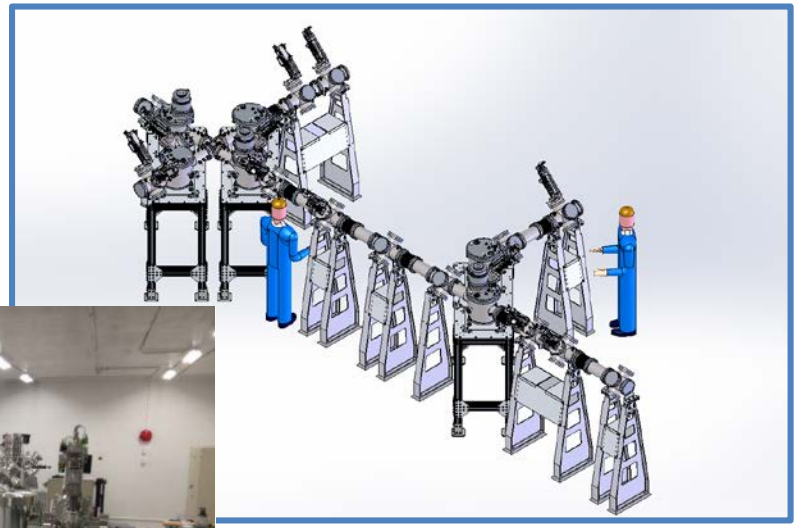
View of ARIEL



RIB Transport Prototype

Plan view of B2 level “Mass Separator Room)





Assembled & evaluated 2016

Purchase of all RIB Transport components initiated

RIB hours per year in the ARIEL era

Week	Exchange
1	ITE
2	APTW
3	AETE
4	ITW
5	APTW
6	AETE
7	ITE
8	APTW
9	AETE
10	ITW
11	APTW

Target exchange schedule

Target Area	Wks/year	RIB sched	RIB deliv
ITW/ITE	35	3780	3024
APTW	35	3640	2803
AETE	43	4472	3443
Totals			**9270**

RIB hours per year

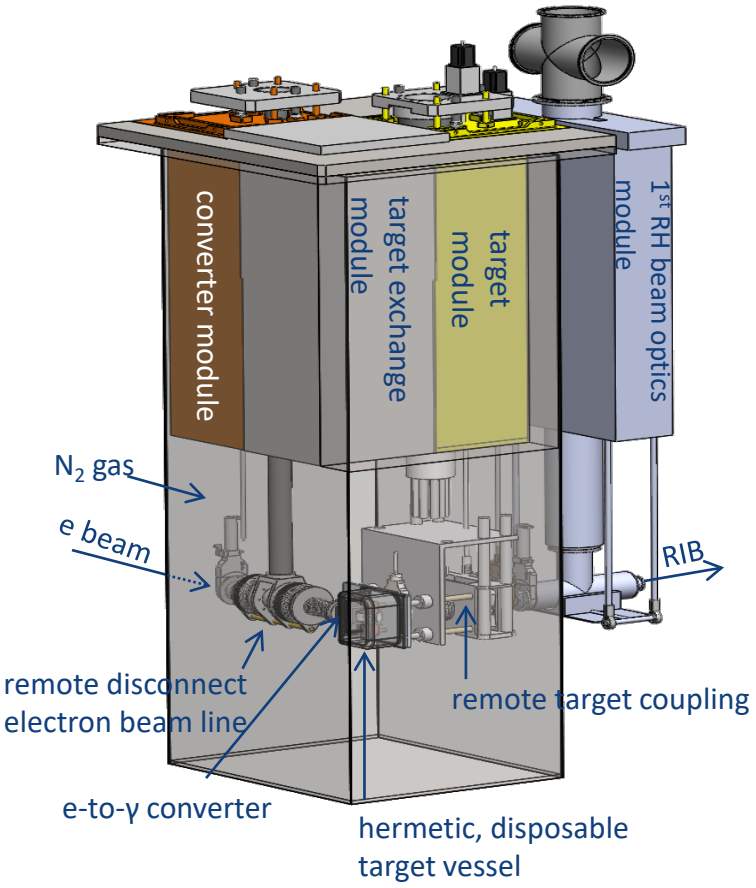
ITE/W	APTW	AETE
12	12	14

Targets per year

Source: TRI-DN-15-16 ARIEL Operational model (Bob Laxdal)

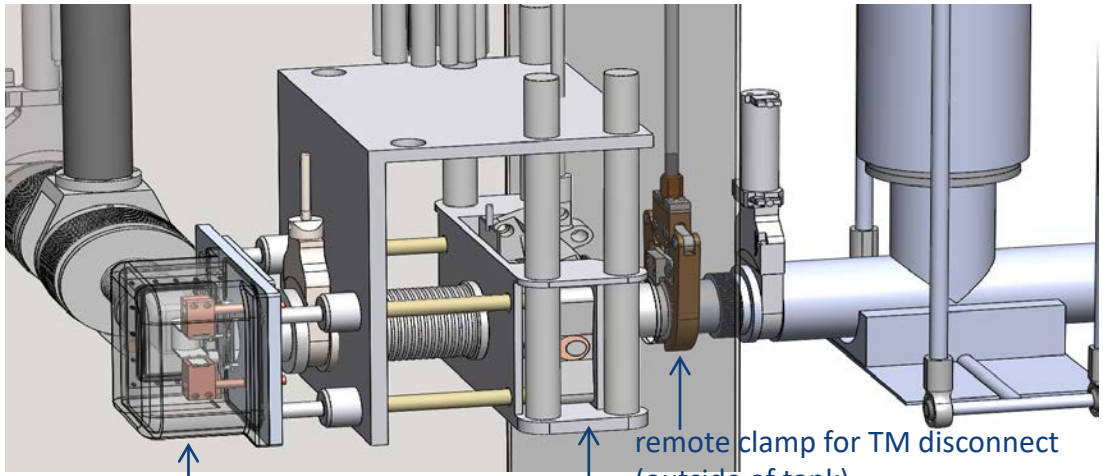
➔ Bob Laxdal

Electron Target Module Concept



Target exchange possible in
1. target station using crane
2. hot cell using tele-manipulators

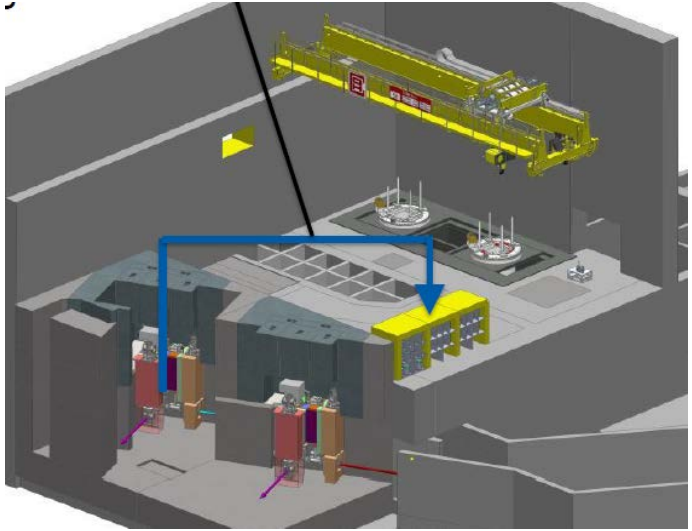
- All modules maintainable in hot cell
- Infrastructure for 13 disposable target vessels per year
- 2 target modules at start (1 for β-NMR, 1 for development + backup)

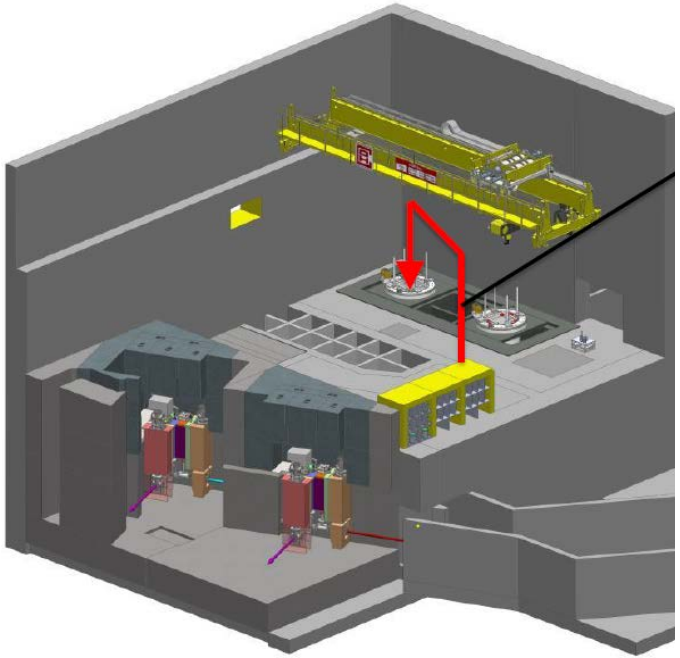


➔ Alexander Gottberg

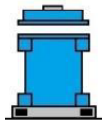
Spent target disposal strategy

1) Target vessel to storage vault





2) After ~2 yrs, target vessel to hot cell for separation & packaging



3) Packaged waste shipped to Chalk River

Summary of Project Status

- ARIEL-II funding has been approved by CFI and Provinces
- Design and resource planning efforts are in full swing ➔ Eric Guetre
- Schedule for CFI Project ARIEL-II has been baselined
- Budget finalization process with UVic & CFI ongoing
- More details in the forthcoming talks today

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Thank you!
Merci!

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