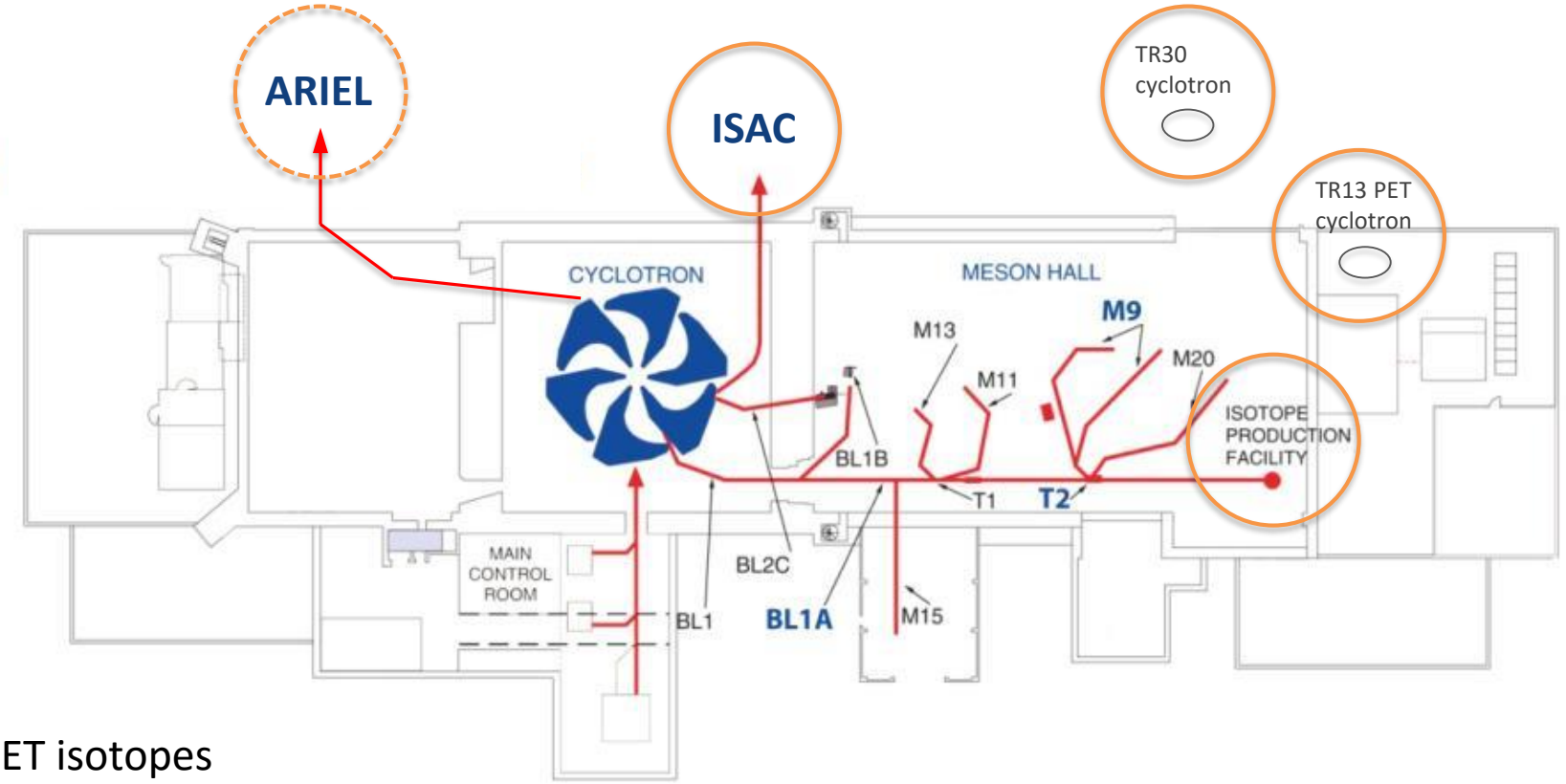
TRIUMF

Canada's National Laboratory for Particle and Nuclear Physics

Medical isotope production at TRIUMF - from imaging to treatment

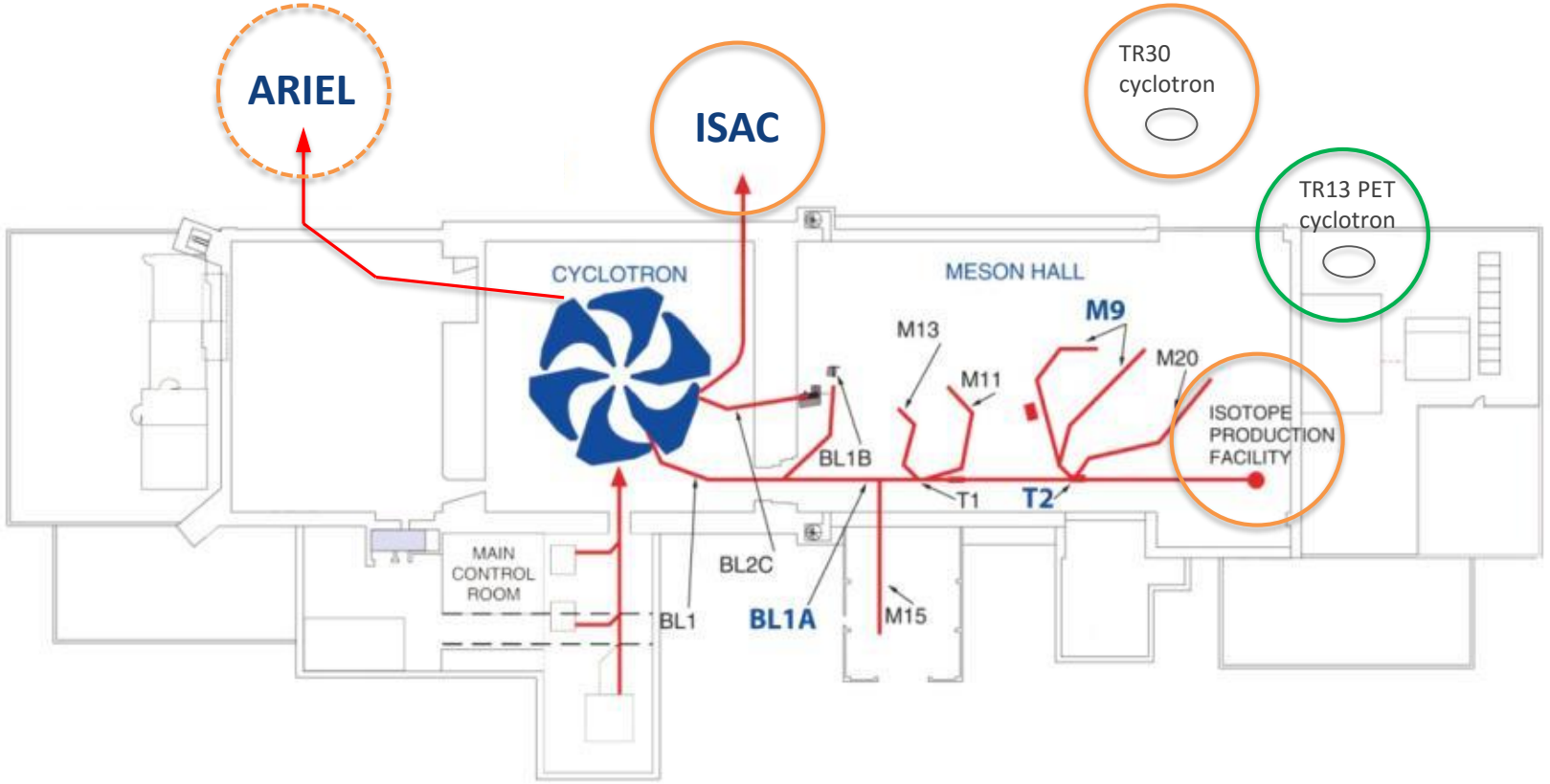
Cornelia Hoehr
Research Scientist, Life Sciences

Beamlines and Production Sites at TRIUMF



- PET isotopes
- SPECT isotope
- α emitters

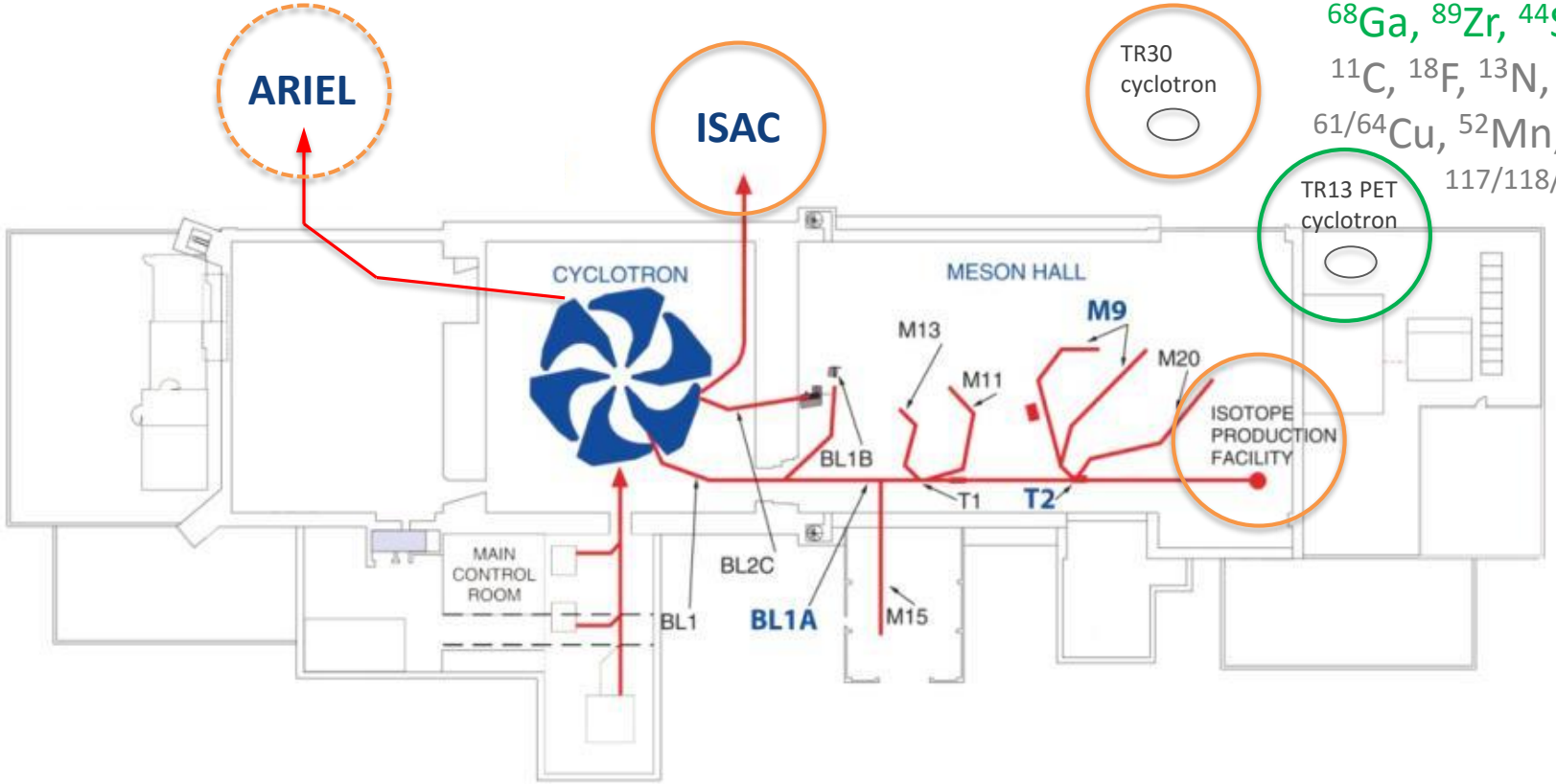
PET isotopes



Routine production of ^{11}C and ^{18}F

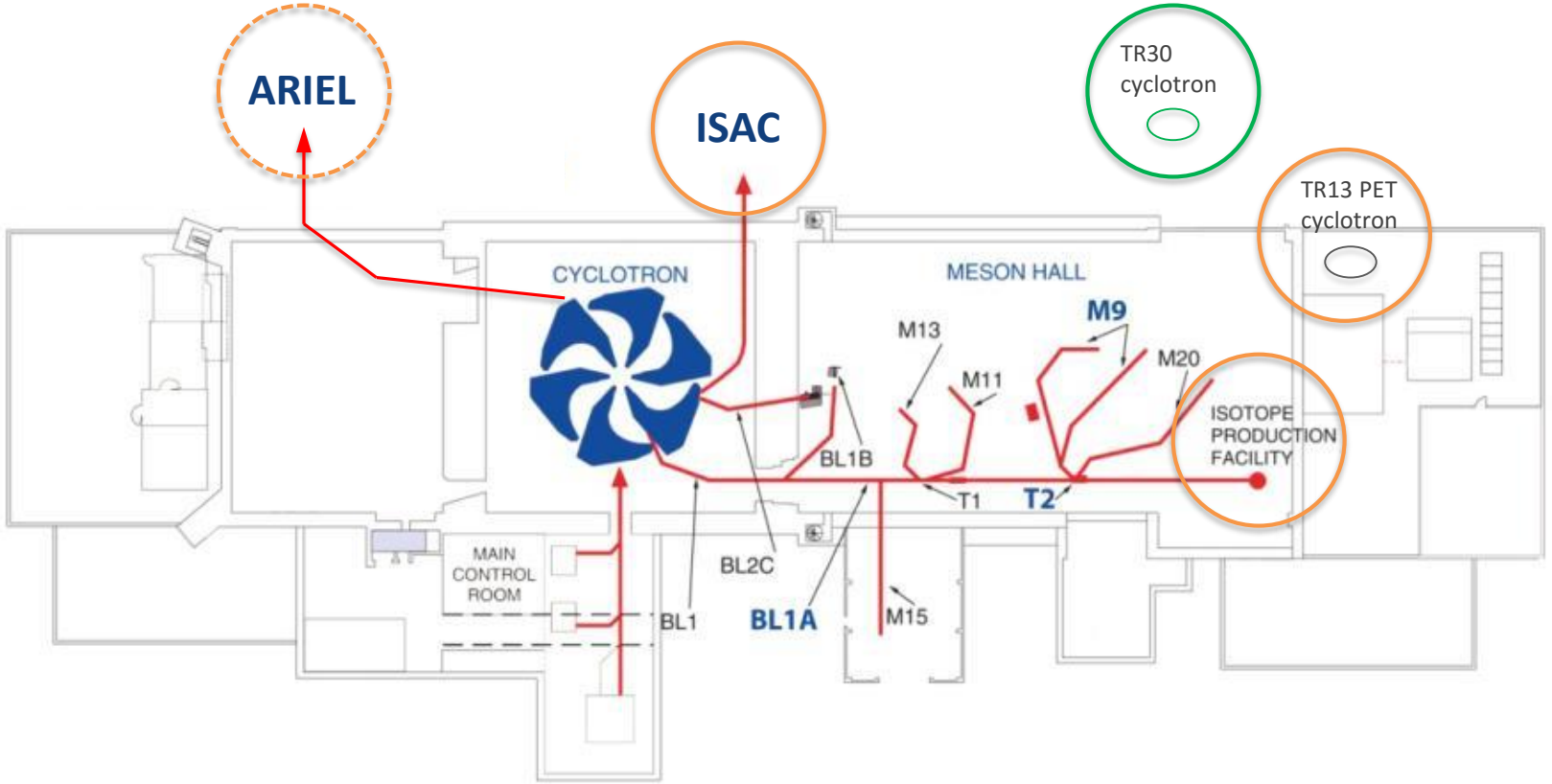
PET isotopes

^{68}Ga, ^{89}Zr, ^{44}Sc, ^{86}Y
^{11}C, ^{18}F, ^{13}N, ^{94m}Tc,
$^{61/64}Cu$, ^{52}Mn, ^{55}Co,
$^{117/118/119}Sb$,
^{192}Ir

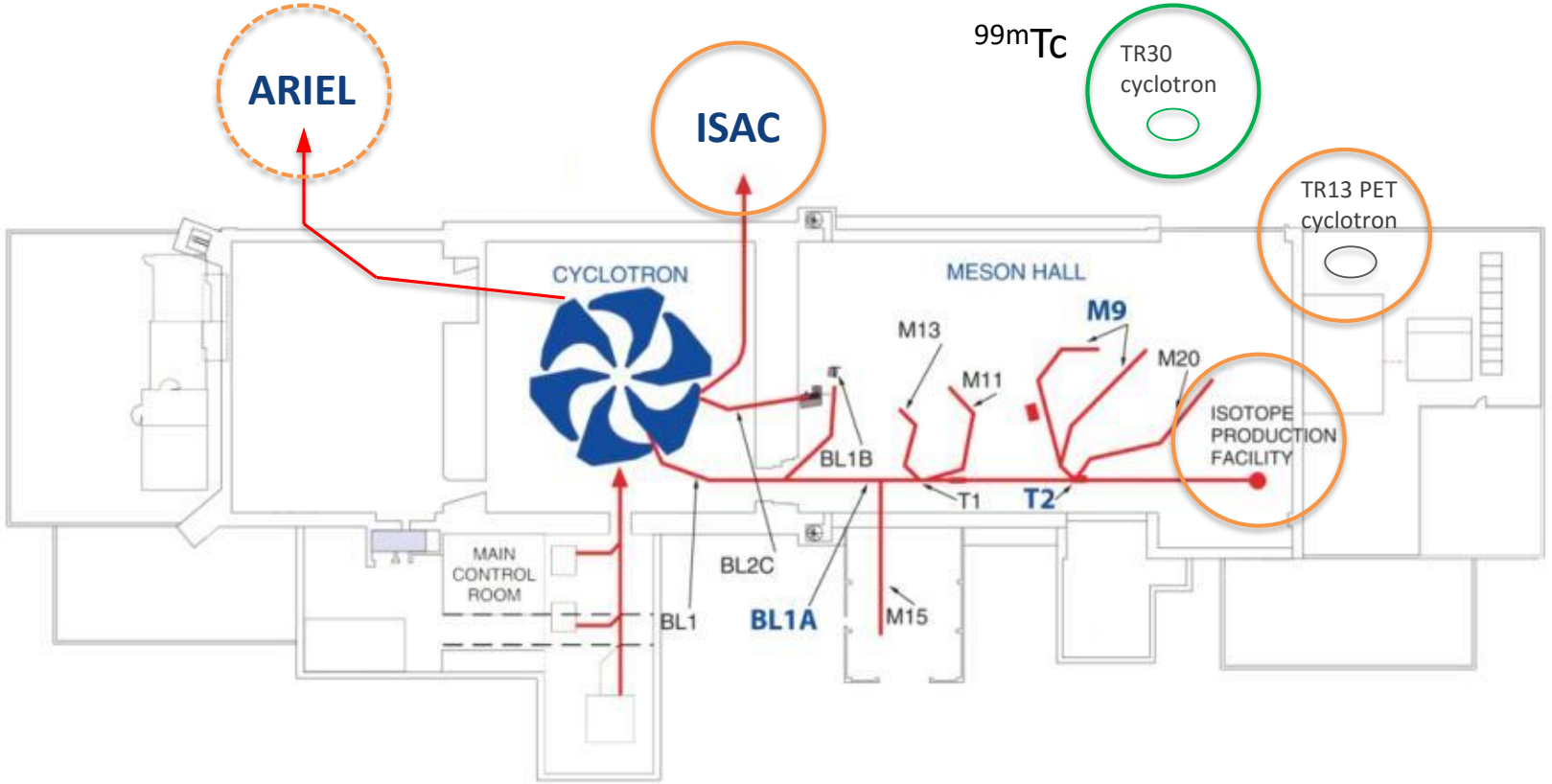


Routine production of ^{11}C and ^{18}F

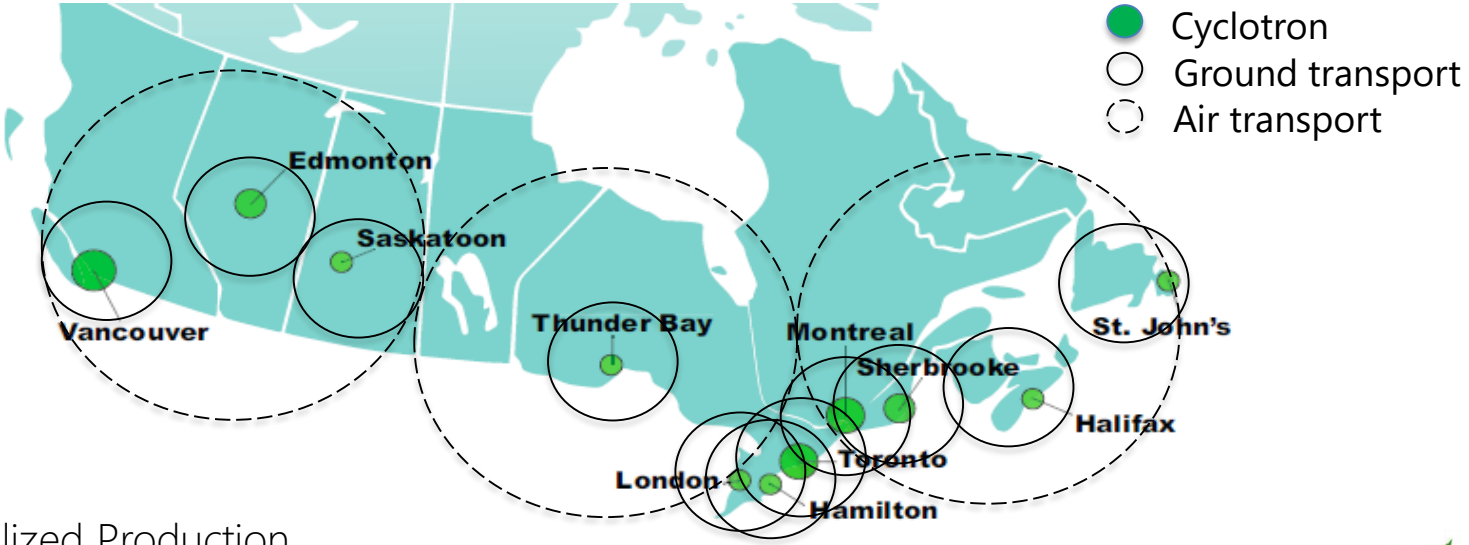
SPECT Isotope



SPECT Isotope



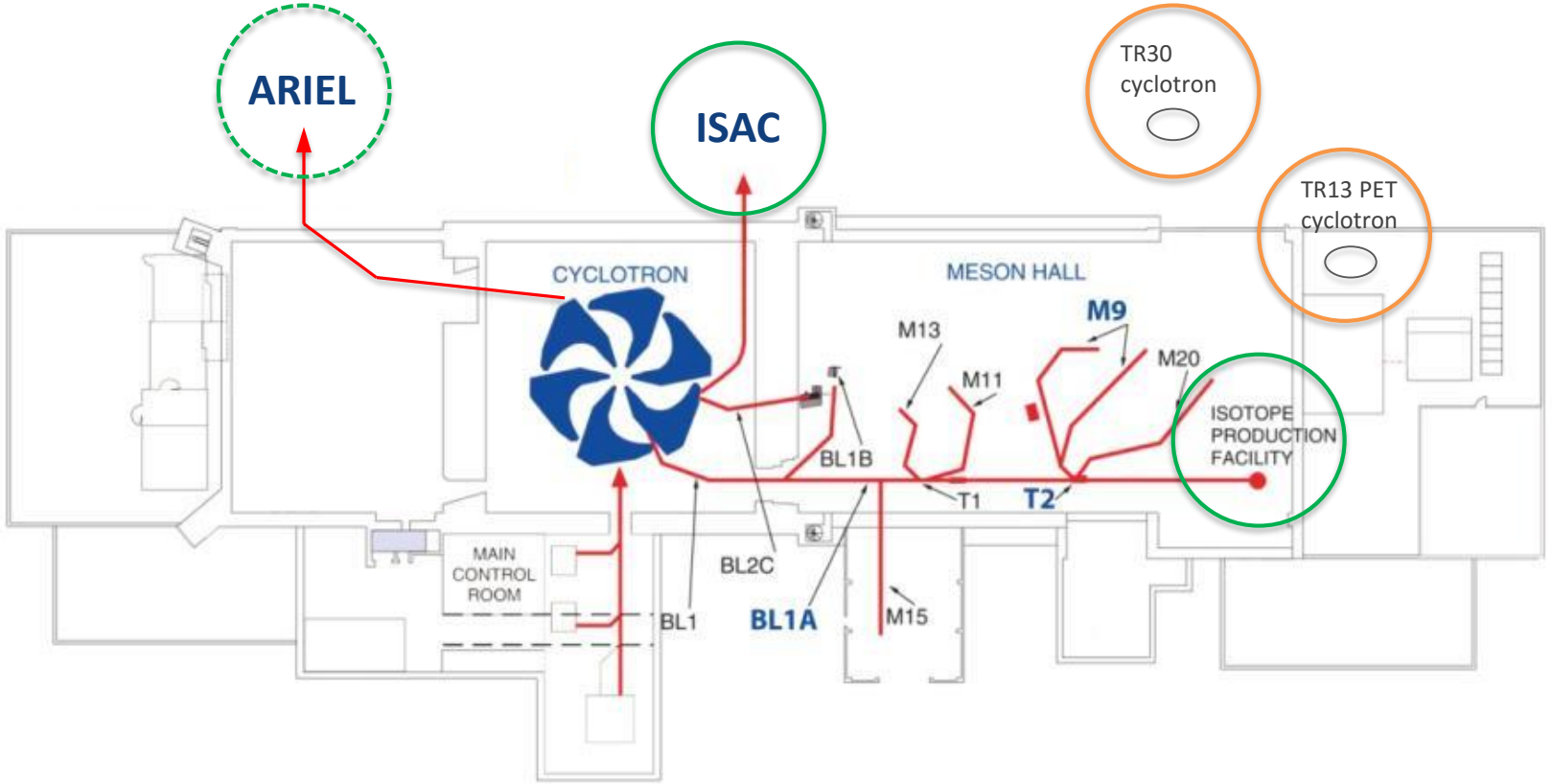
Alternative ^{99m}Tc Production



- Decentralized Production
  - ^{99m}Tc locally produced, locally used, competitively priced
  - Redundant supply to avoid widespread shortages
  - Complementary to:
    - other medical isotopes produced by cyclotrons (^{18}F)
    - other sources of ^{99m}Tc

J. Beaver, H. Hupf, J Nucl Med 1971;12:739-741

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada
NSERC CRSNG
Natural Resources Canada / Ressources naturelles Canada
Canada


ARIEL
ISAC
TR30
cyclotron
TR13 PET
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CYCLOTRON
MESON HALL
M9
M13
M11
M20
ISOTOPE
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BL2C
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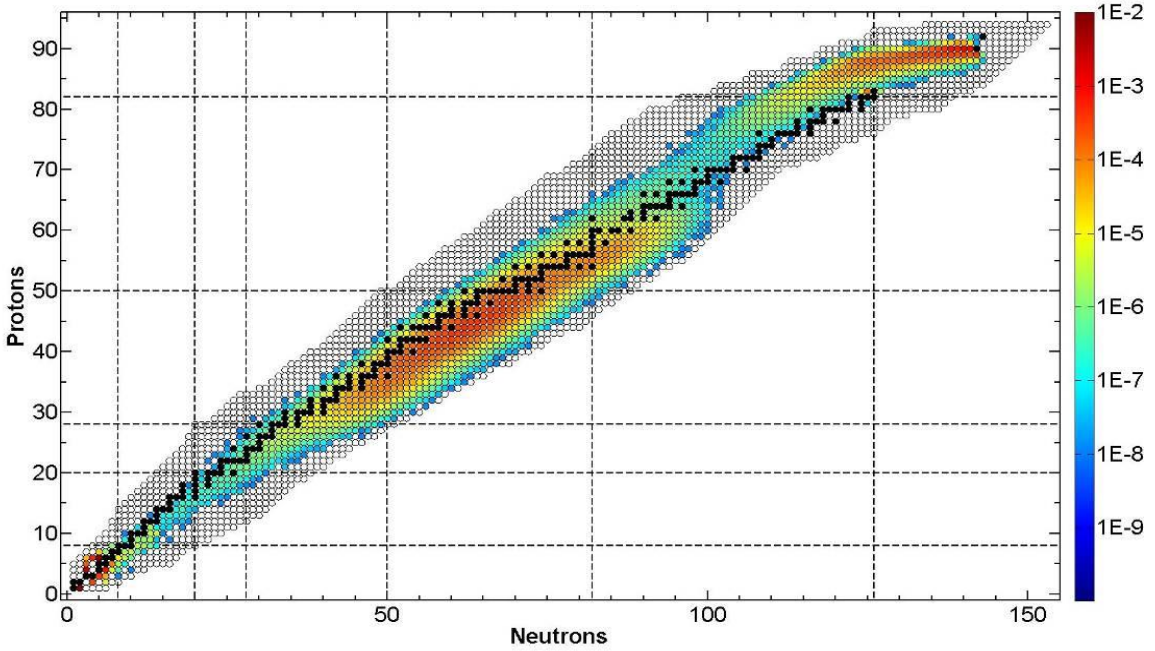
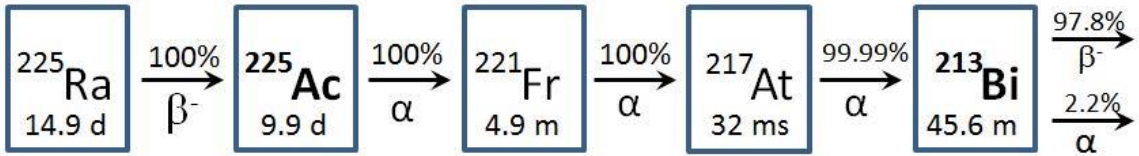
M15

Spallation Reaction with 500 MeV Protons

- Hundreds of co-produced isotopes including;
- ^{225}Ra, ^{225}Ac, ^{224}Ra, ^{223}Ra, ^{213}Bi, ^{212}Pb, ^{212}Bi, $^{209/211}$At





Isotope Accelerator Program (ISAC): 50 kW ISOL Facility

Isotope production using TRIUMF's 500 MeV infrastructure

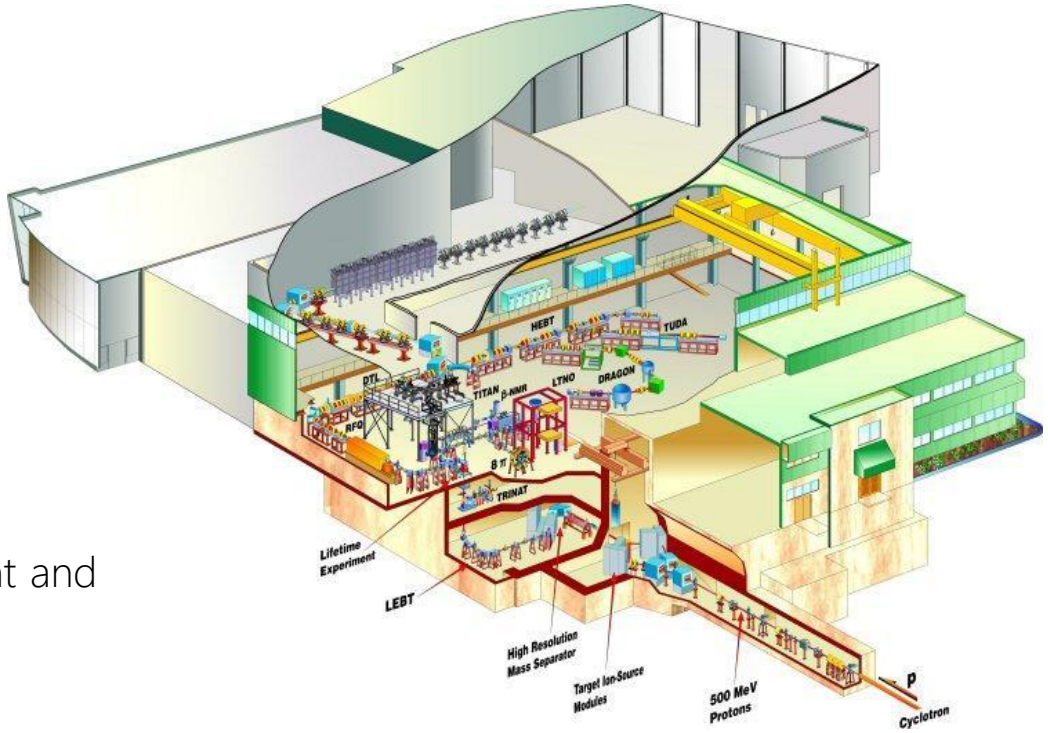
1) ISAC – ISOL (Research, Feasibility)
Low activity (kBq to MBq), high purity

2) 500 MeV – IPF (BL1A)
Intermediate activity (MBq), spallation

- Routine, independent production

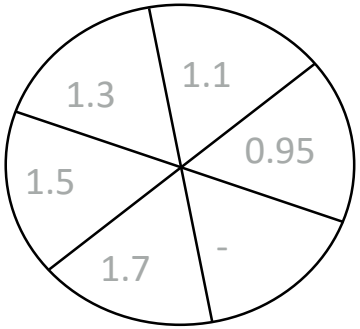
3) ARIEL/H^+
High activity (GBq), spallation

- Enable radiopharmaceutical development and clinical trials



Experiments underway

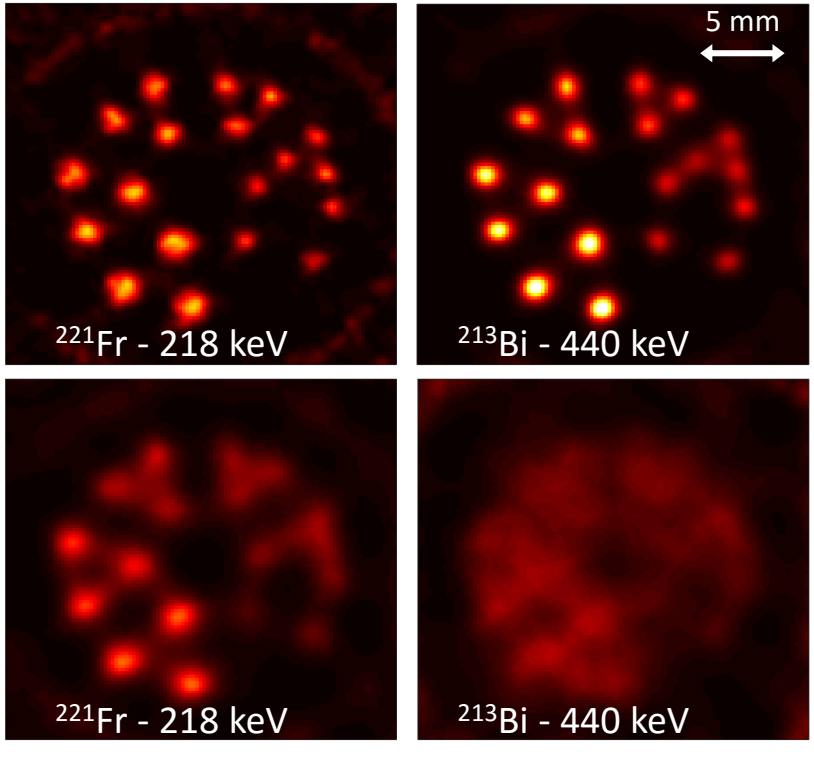
First ^{225}Ac scan

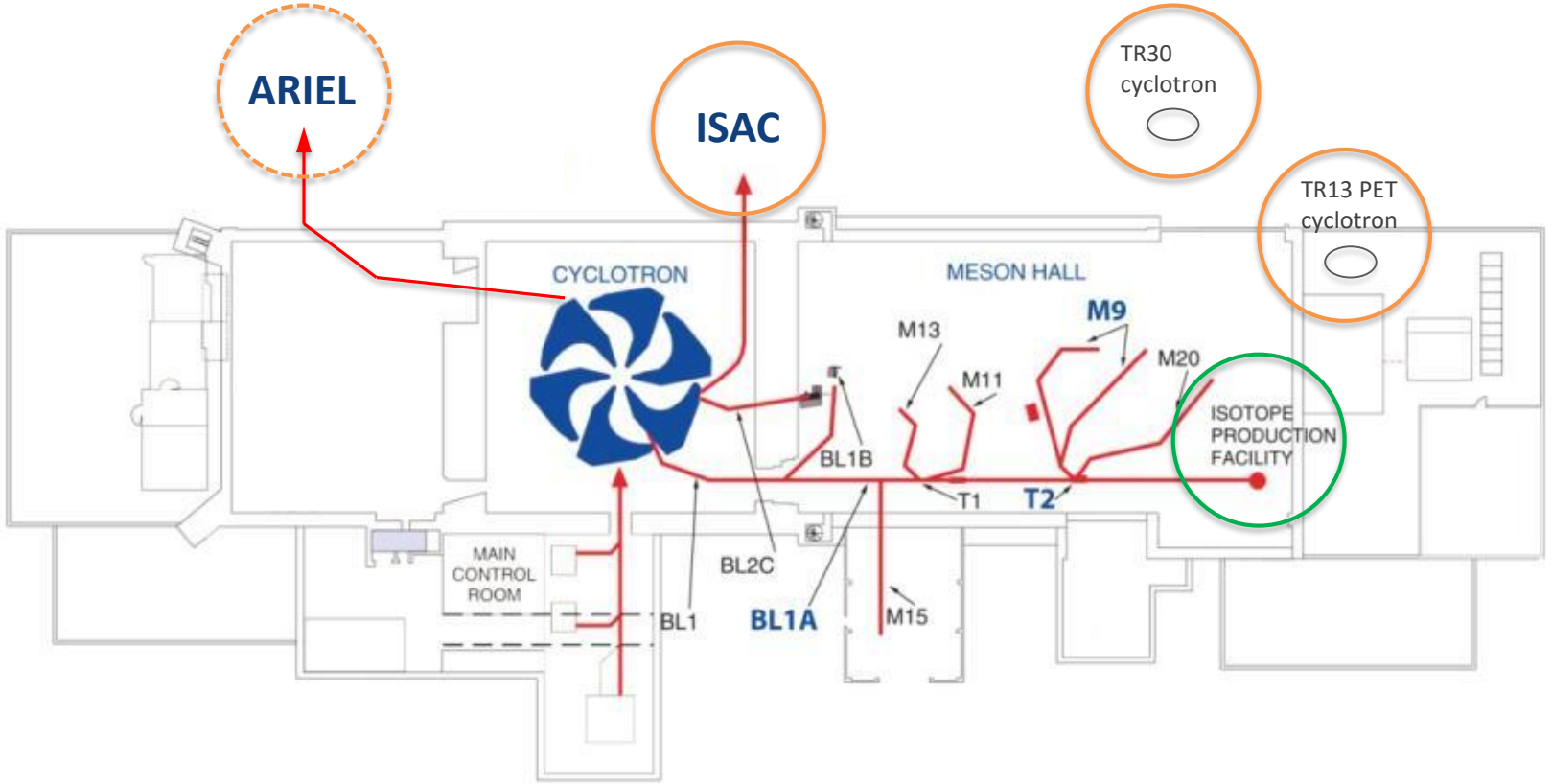


rod diameters [mm]

High Energy Collimator

High Sensitivity Collimator

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Isotope production using TRIUMF's 500 MeV infrastructure

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- Feasibility chemistry, radiolabeling

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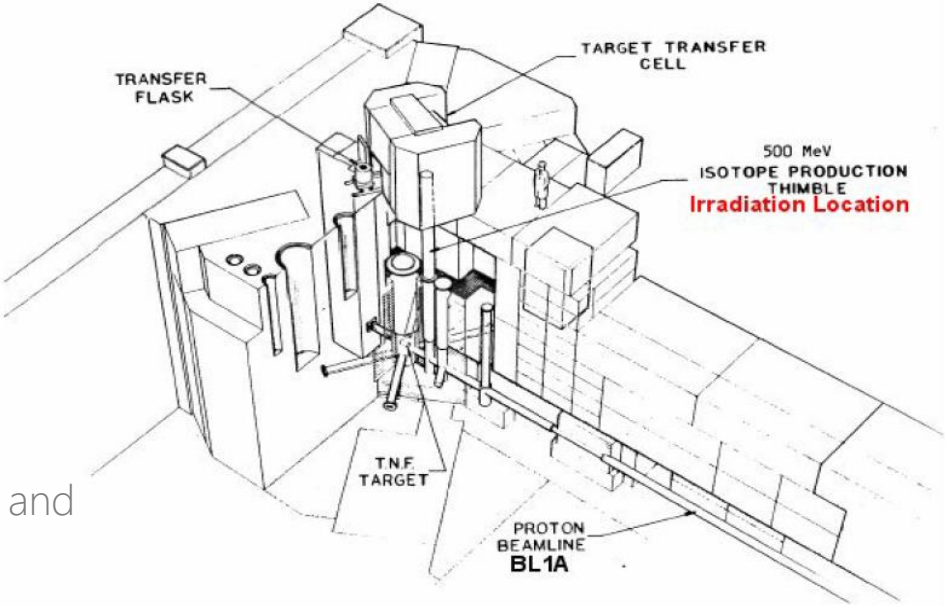


500 MeV Isotope Production Facility

^{225}Ac Production via Thorium Irradiation

- Extraction of ^{225}Ac product from Th metal has been demonstrated

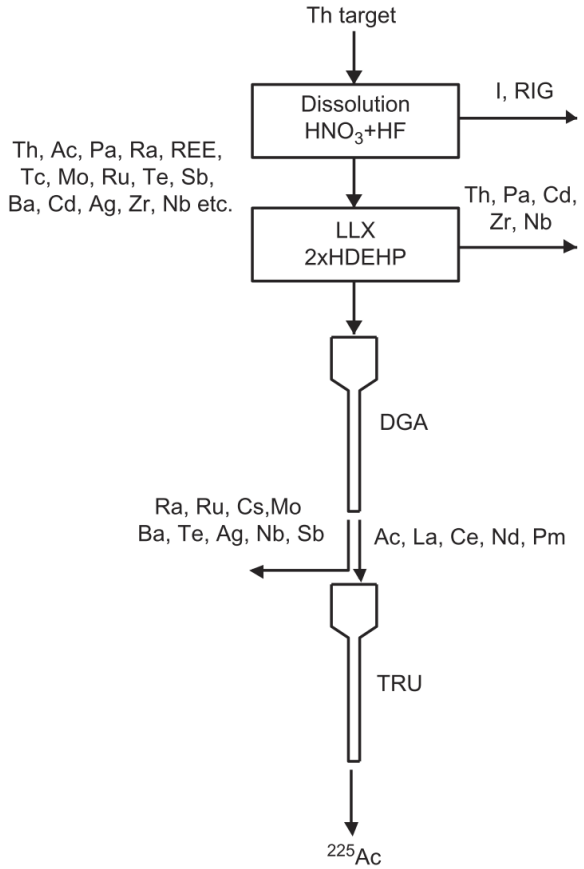
  Chemical yield: > 85%

- Directly produced Ac fraction contains toxic ^{227}Ac ($t_{1/2}$ = 22 y)

  ^{227}Ac/^{225}Ac = 0.1 - 0.2%

- Isolation of ^{225}Ac from Ra fraction could reduce ^{227}Ac impurities

V Radchenko et al. J. Chromatog. A., 2015, 1380, 55



Aliev et al., Solvent Extraction and Ion Exchange (32), 2014.

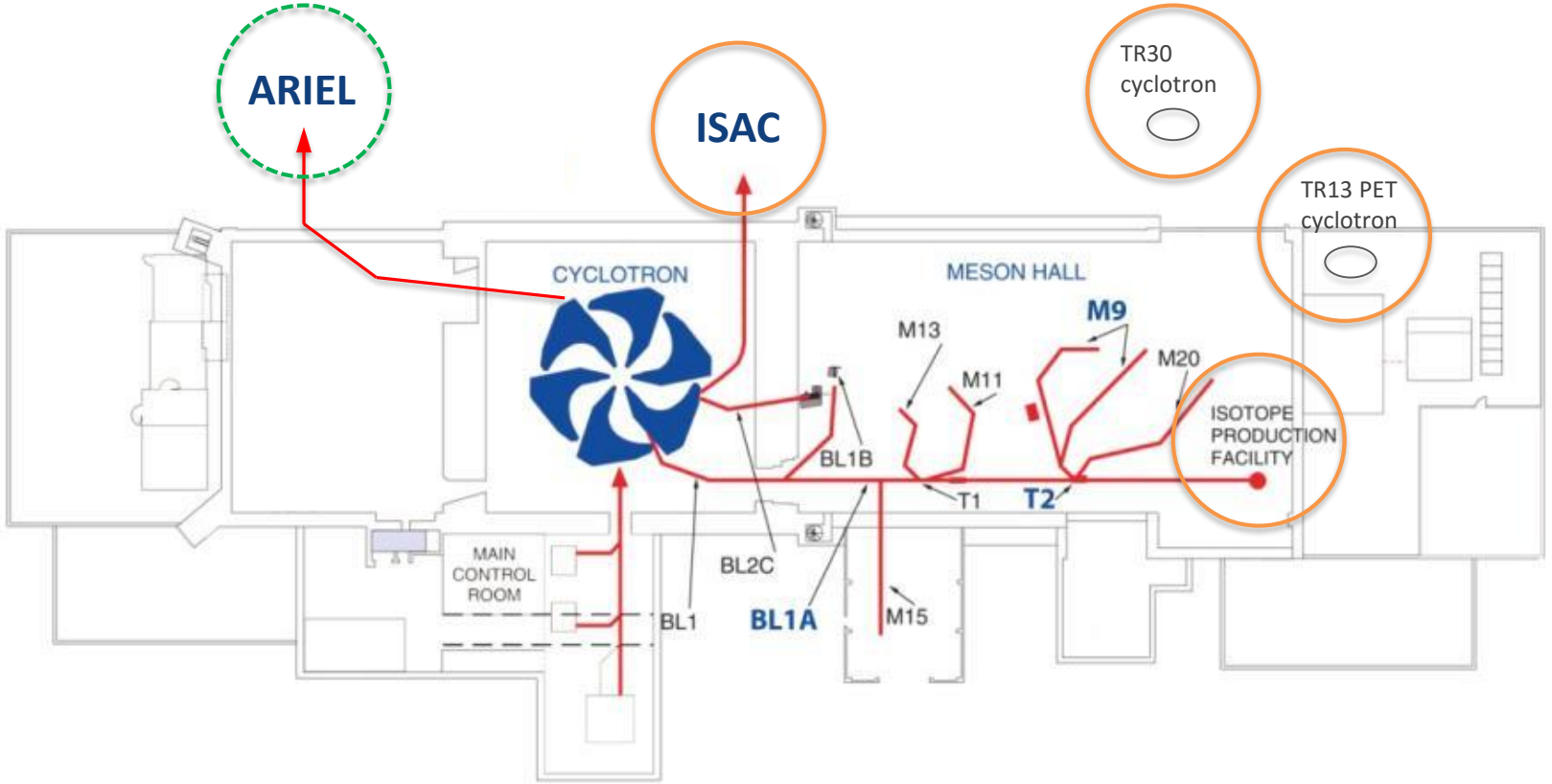
Primary vs Secondary ^{225}Ac

Process steps:
1) Th Irradiation
2) Ra/Ac separation 1 week EOB – gives primary Ac fraction
3) Recovered Ra allowed to sit for 17.5 days
4) Ra/Ac separation – gives secondary Ac fraction

First run with Th oxide 2016
First run with Th Dec 2017

Primary Ac Fraction			
days from Ra/Ac isolation	0	1	5
Ac-225 [MBq]	**42.2**	**39.4**	**29.9**
Ac-228/Ac-225 [%]	0.039	0.003	0.000
Ac-227/Ac-225 [%]	0.185	0.198	0.261
Ac-226/Ac-225 [%]	16.020	9.740	1.330

Secondary Ac Fraction		
days from Ra/Ac isolation	0	2
Ac-225 [MBq]	**2.2**	**1.9**
Ac-228/Ac-225 [%]	0.882	0.003
Ac-227/Ac-225 [%]	9.951E-09	9.949E-09
Ac-226/Ac-225 [%]	0.000	0.000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Isotope Accelerator Program: ARIEL Parasitic Target Station

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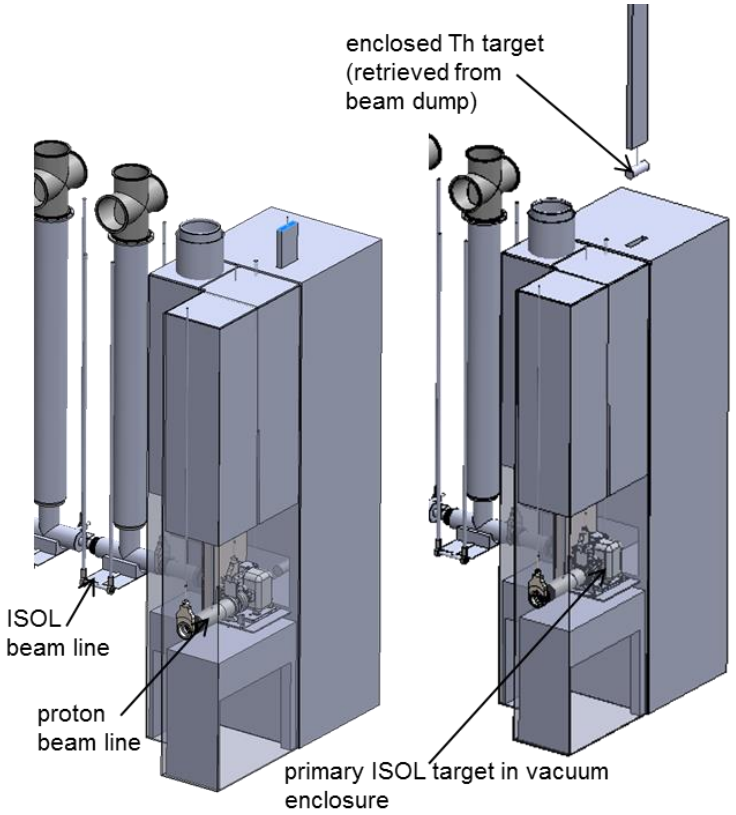
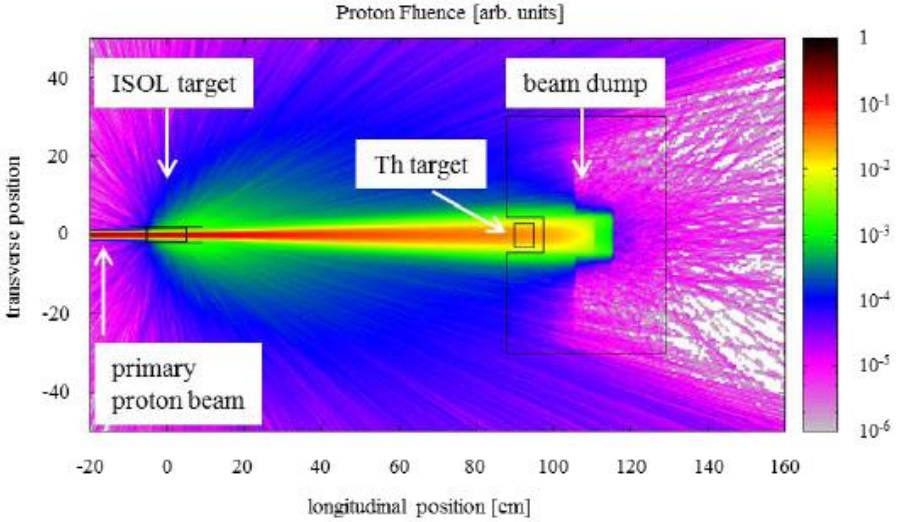
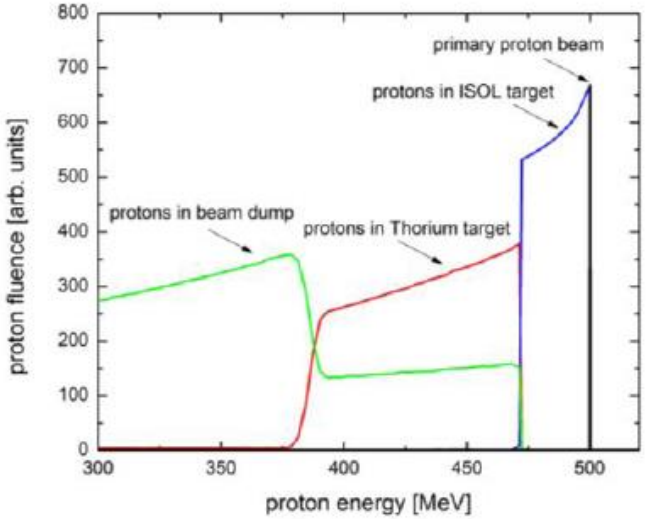


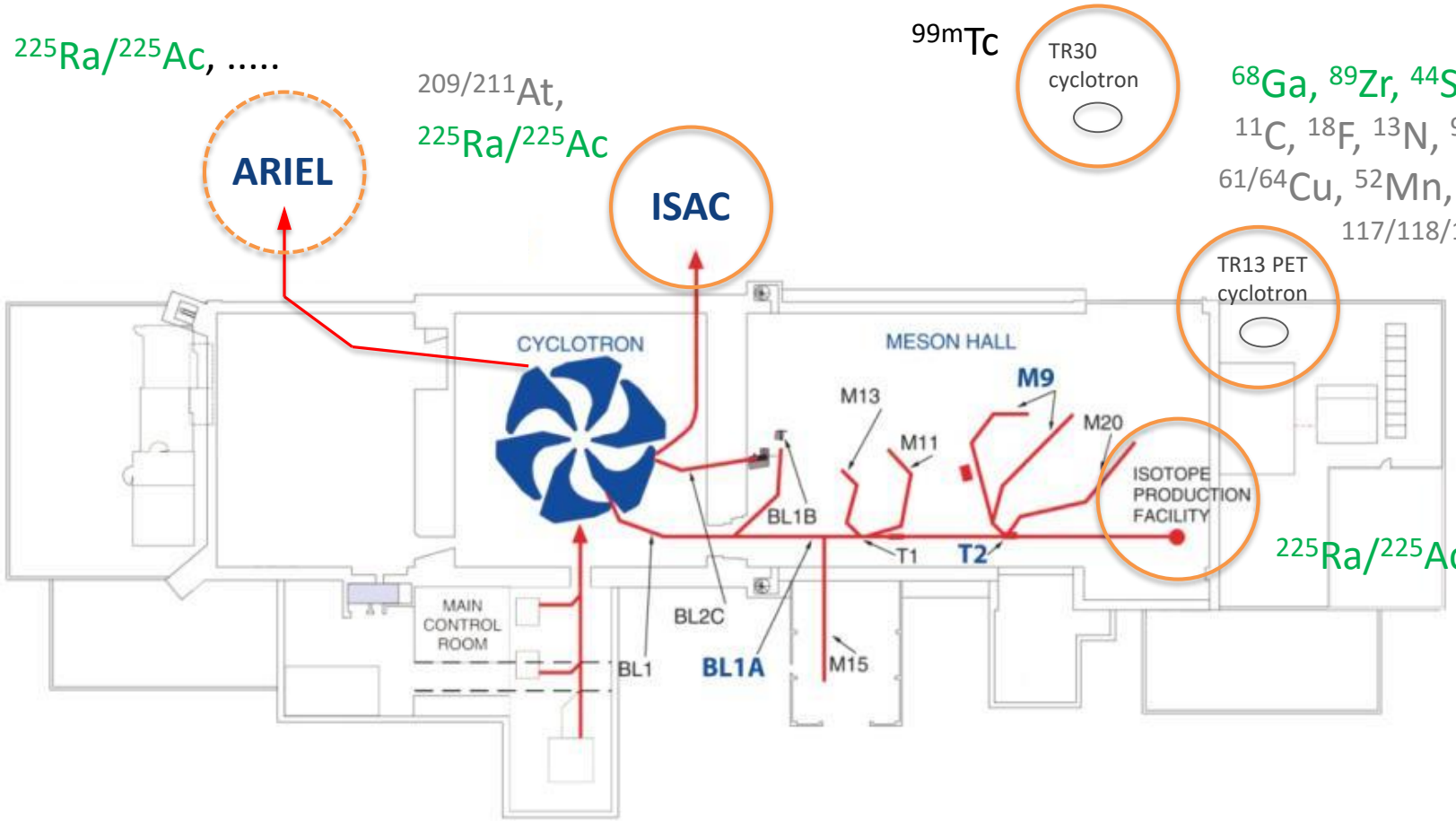
Proposed ARIEL Parasitic Target Station - CFI

- 400 mCi (15 GBq) ^{225}Ac per target (FLUKA; A. Gottberg)
- Irradiation schedule decoupled from science target
- ARIEL Proton Station commissioning scheduled for 2021
- $9.8M for infrastructure





Summary


225Ra/225Ac, ...
ARIEL
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Thank you!
Merci!

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