

# PROGRESS WITH A NEW RADIOISOTOPE PRODUCTION FACILITY & CONSTRUCTION OF A RADIOACTIVE BEAM FACILITY iTHEMBA LABS

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# Outline

- Current status of the accelerators
- Dedicated isotope production facility
- Facility for the production of radioactive beams

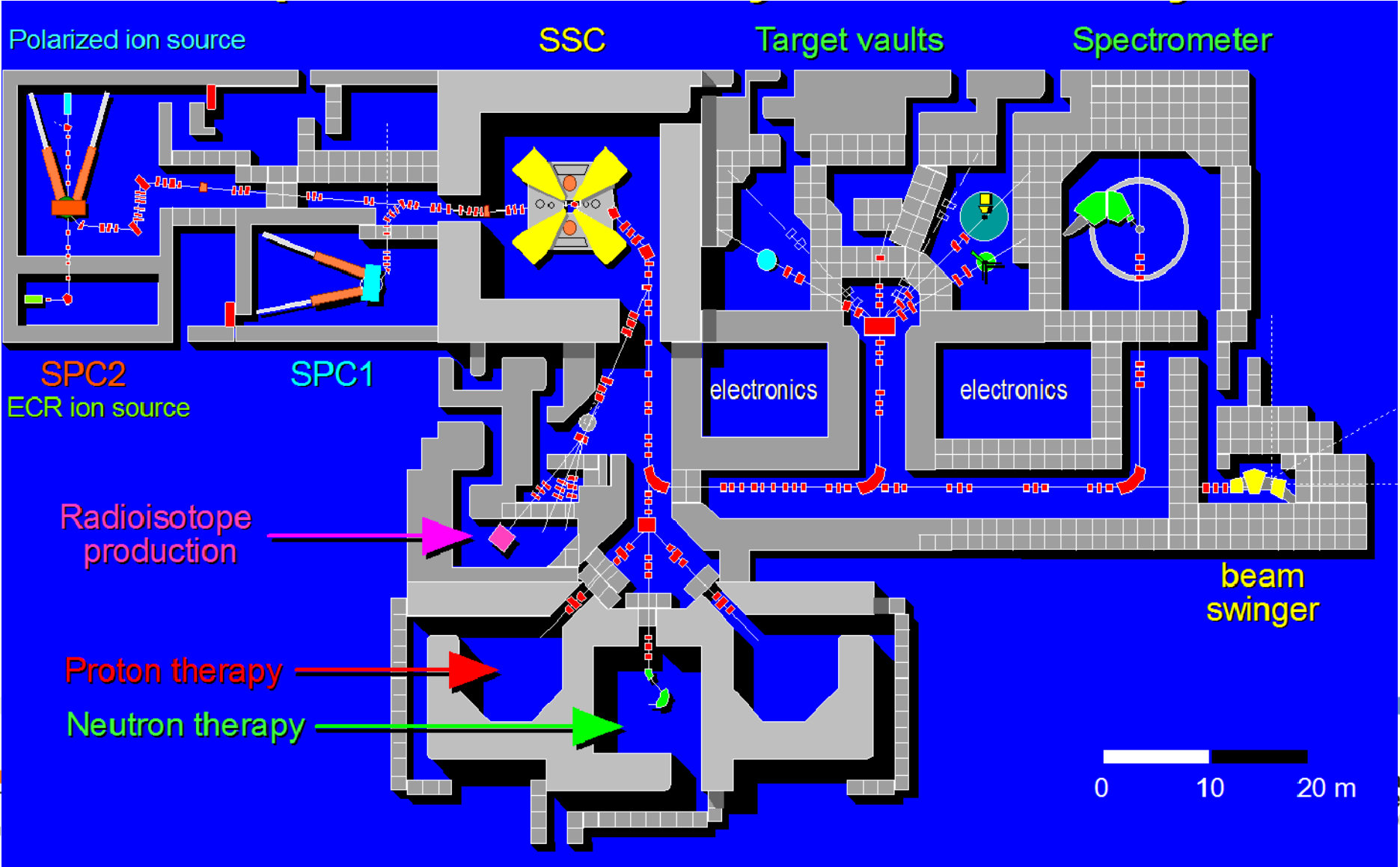


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# Layout of iThemba LABS Cyclotron Facility



# Cyclotron Beam Statistics

Year	Beam Supplied as:		% of Scheduled beam time lost due to:	
	% of Total time	% of Scheduled* time	Energy Changes	Interruptions
2013	63.0	81.2	6.2	10.7
2014	67.3	80.8	6.5	9.7
2015	64.8	78.2	7.0	12.0
2016	53.1	73.1	6.7	17.5
2017	66.7	80.2	7.0	10.3
2018	67.1	80.4	5.7	10.0
2019**	67.8	84.9	4.7	7.6

\* Scheduled time is total calendar time minus scheduled maintenance time and minus the time that the laboratory is officially closed during December

\*\* Statistics for 2019 is up until 17 September 2019



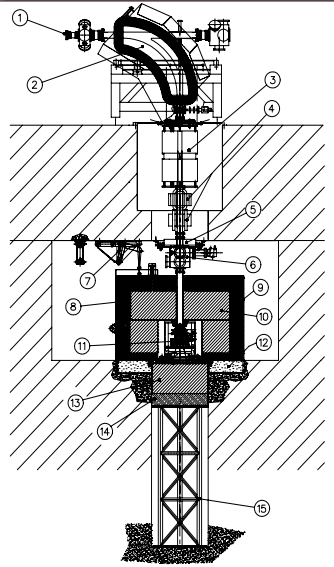
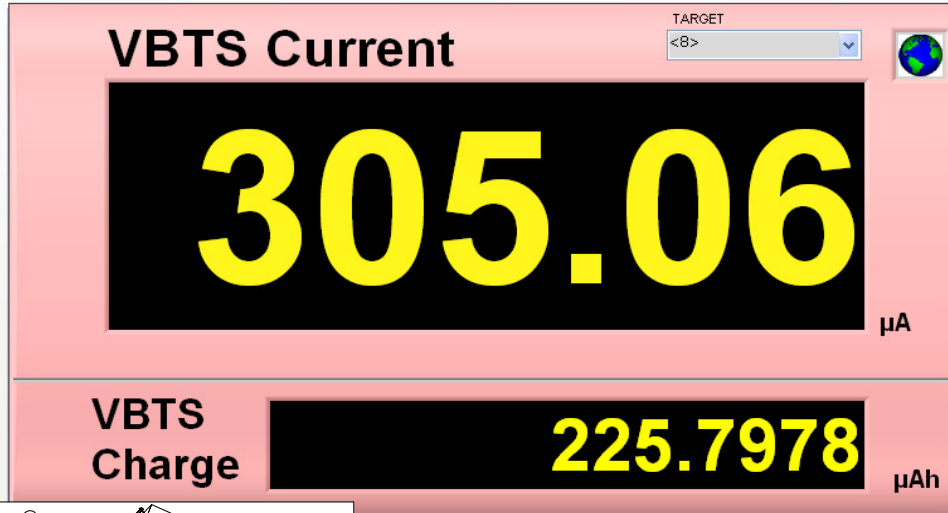
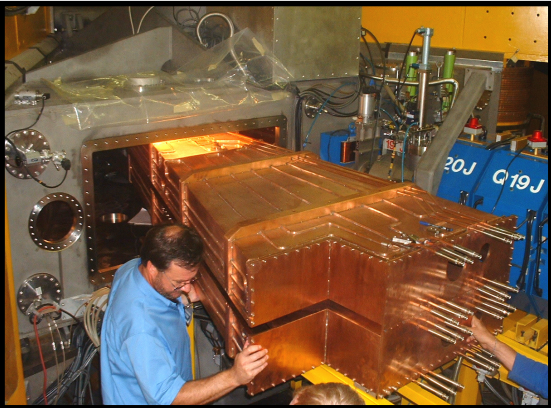
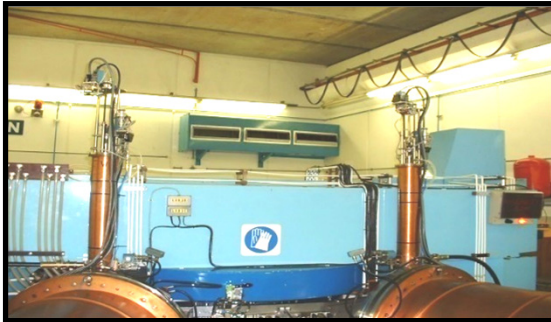
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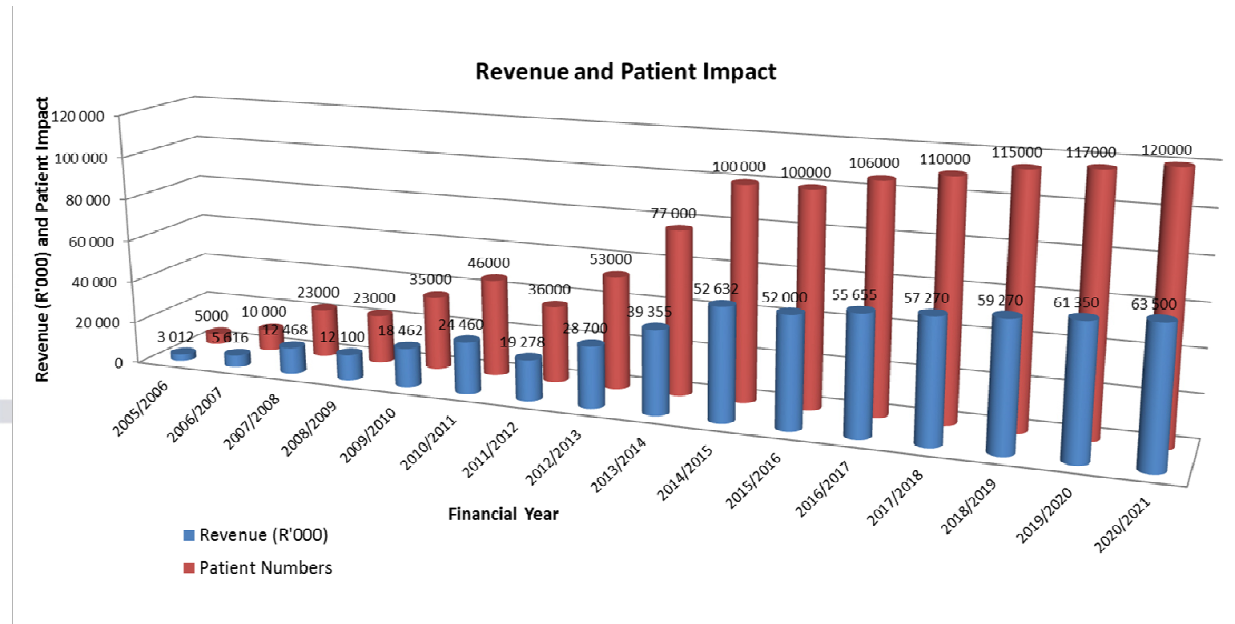
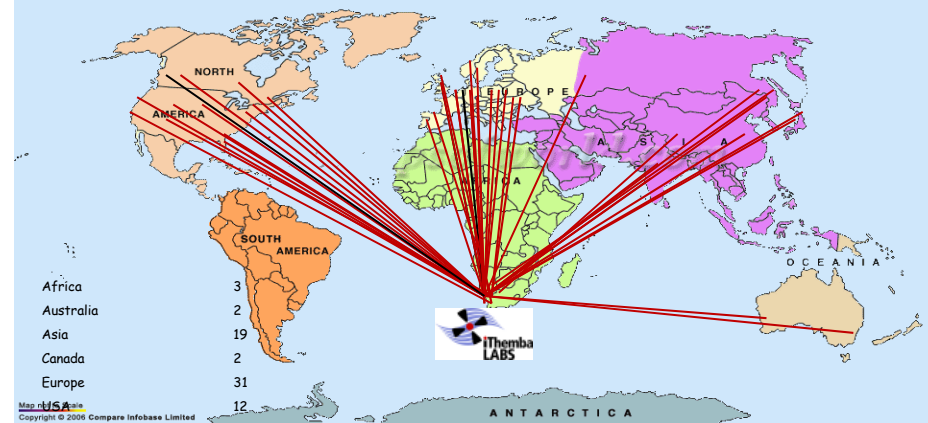
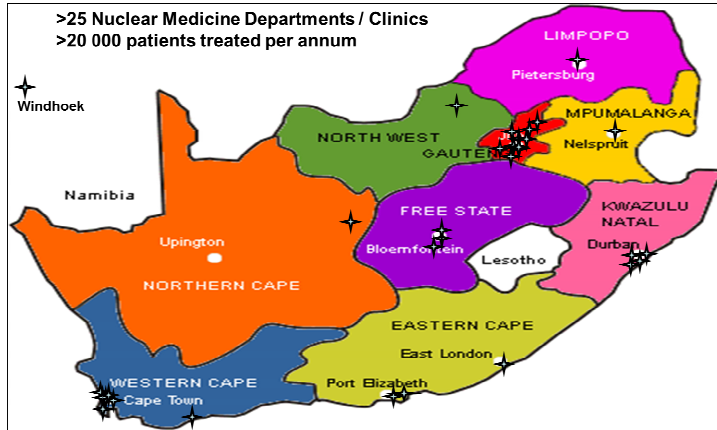
  
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# iThemba LABS: World Leader in Accelerator Produced Radioisotopes for Medicine



# 2017 marks 30 years of operation of the Separated Sector Cyclotron



SSC supported science has resulted in globally relevant research & has impacted the needs of society over 3 decades

- 2300 patients treated with neutron & proton therapy
- Rare isotopes for early detection & treatment of certain cancers & other ailments:  
more than 900 000 patients



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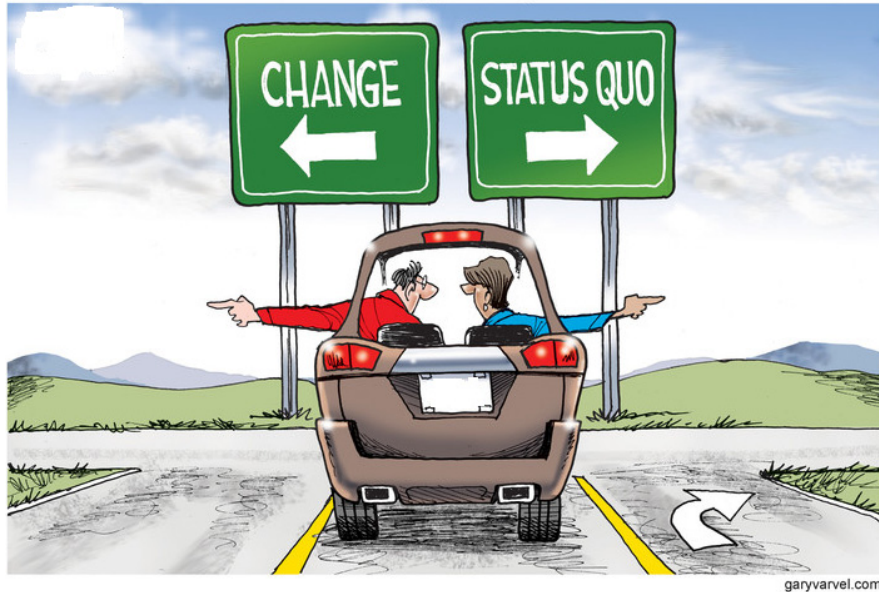
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# The challenges place *iThemba LABS* at a cross roads



The Facility was faced with two options:

1. Maintaining the status quo.
2. Embark on a sustainable & globally competitive research facility through research infrastructure renewal.

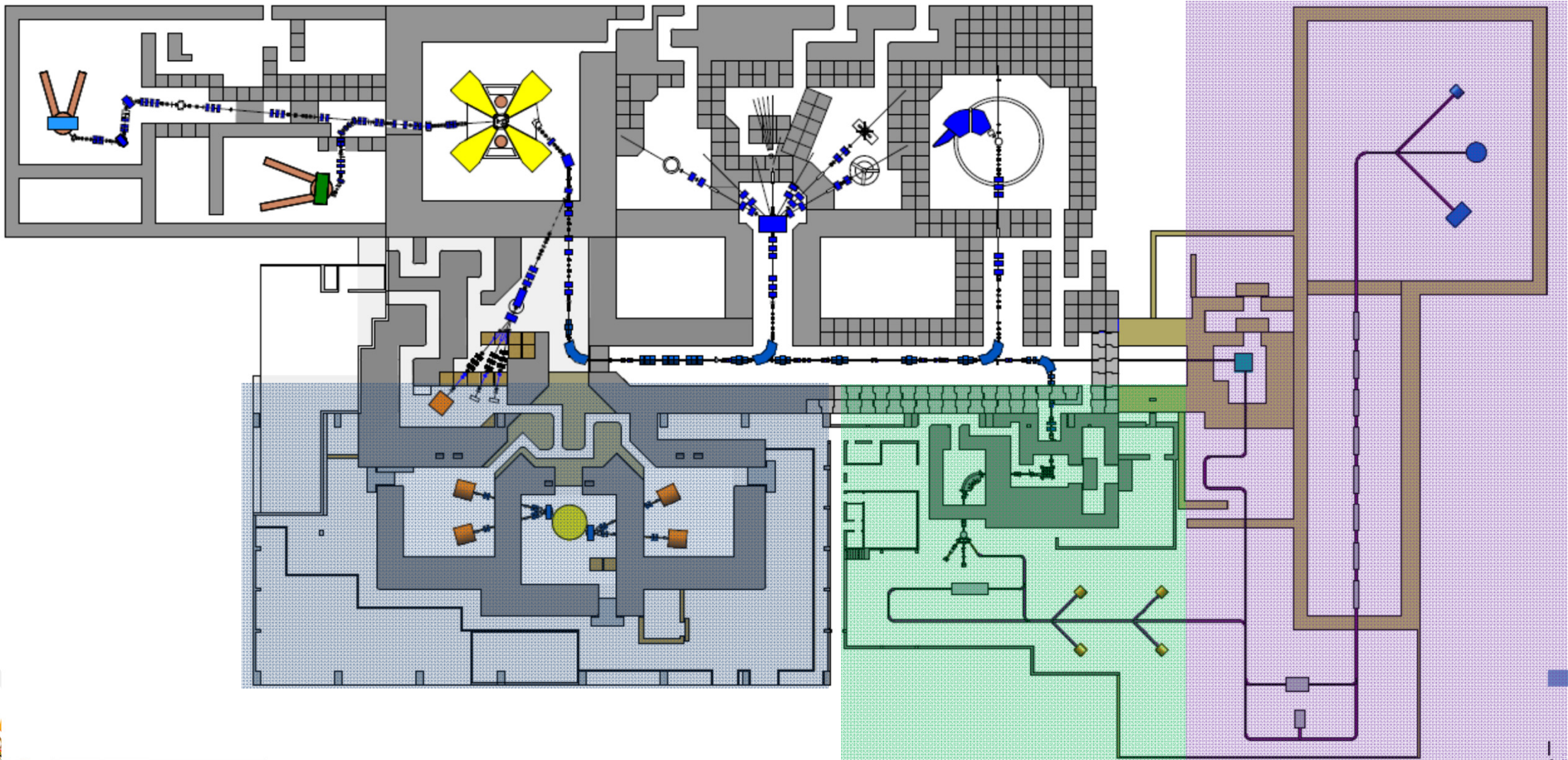


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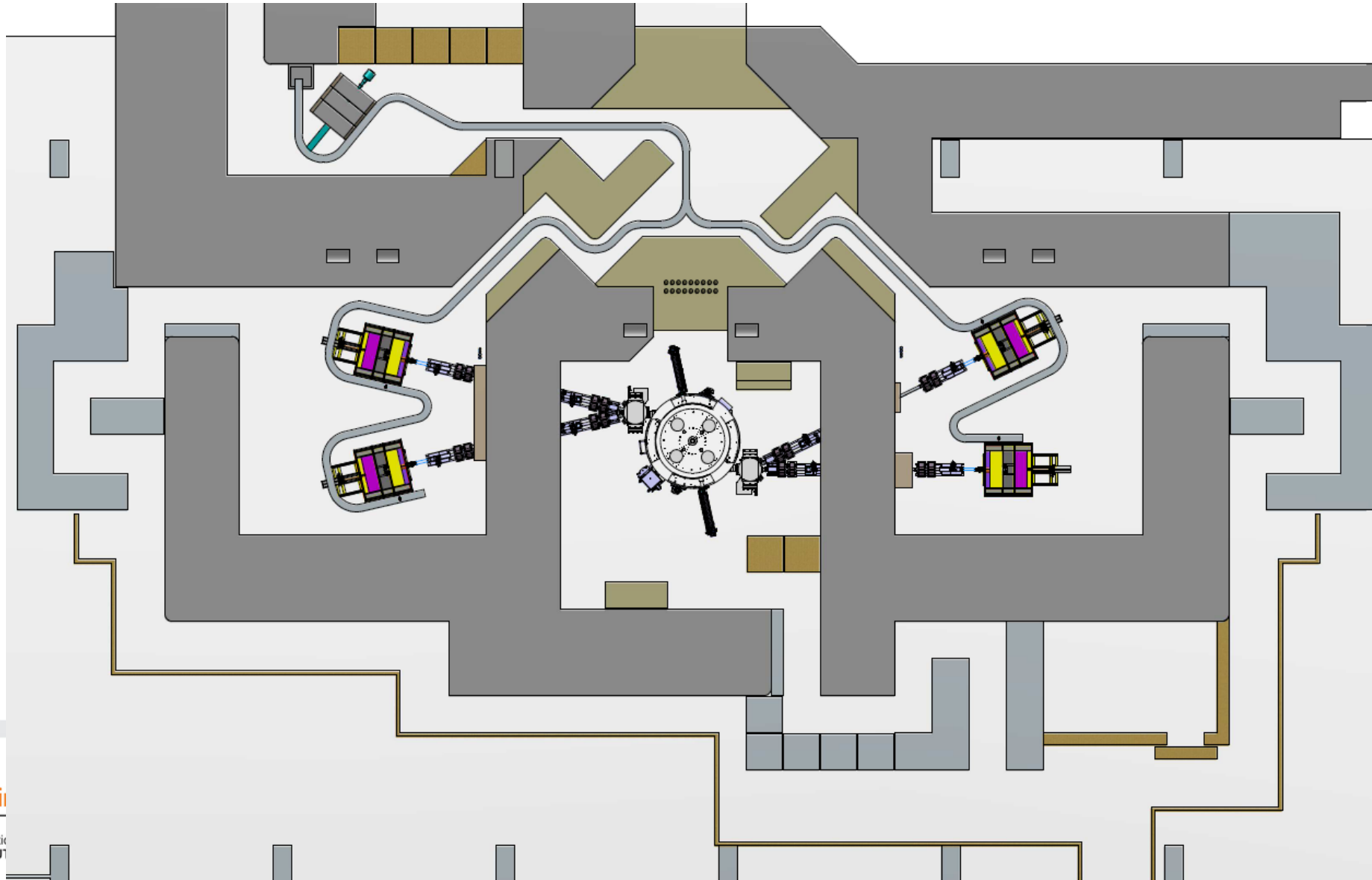
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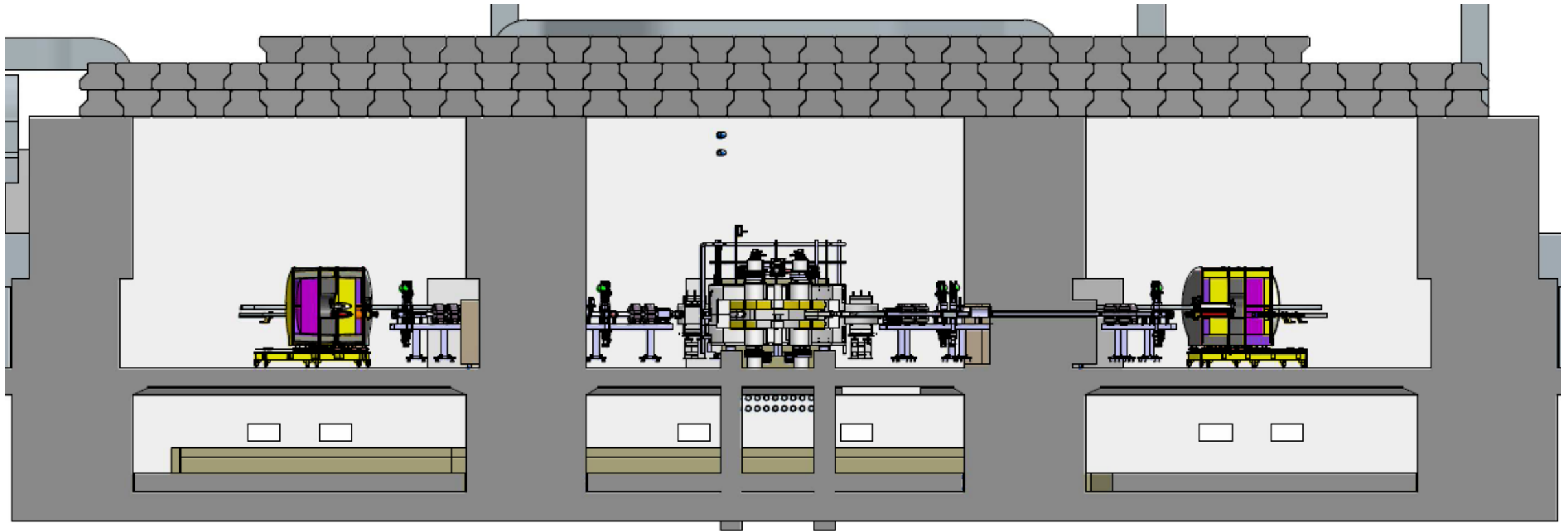
# South African Isotope Facility (SAIF)



# Accelerator Centre for Exotic Isotopes (ACE Isotopes)



# Side view of the 70 MeV Facility



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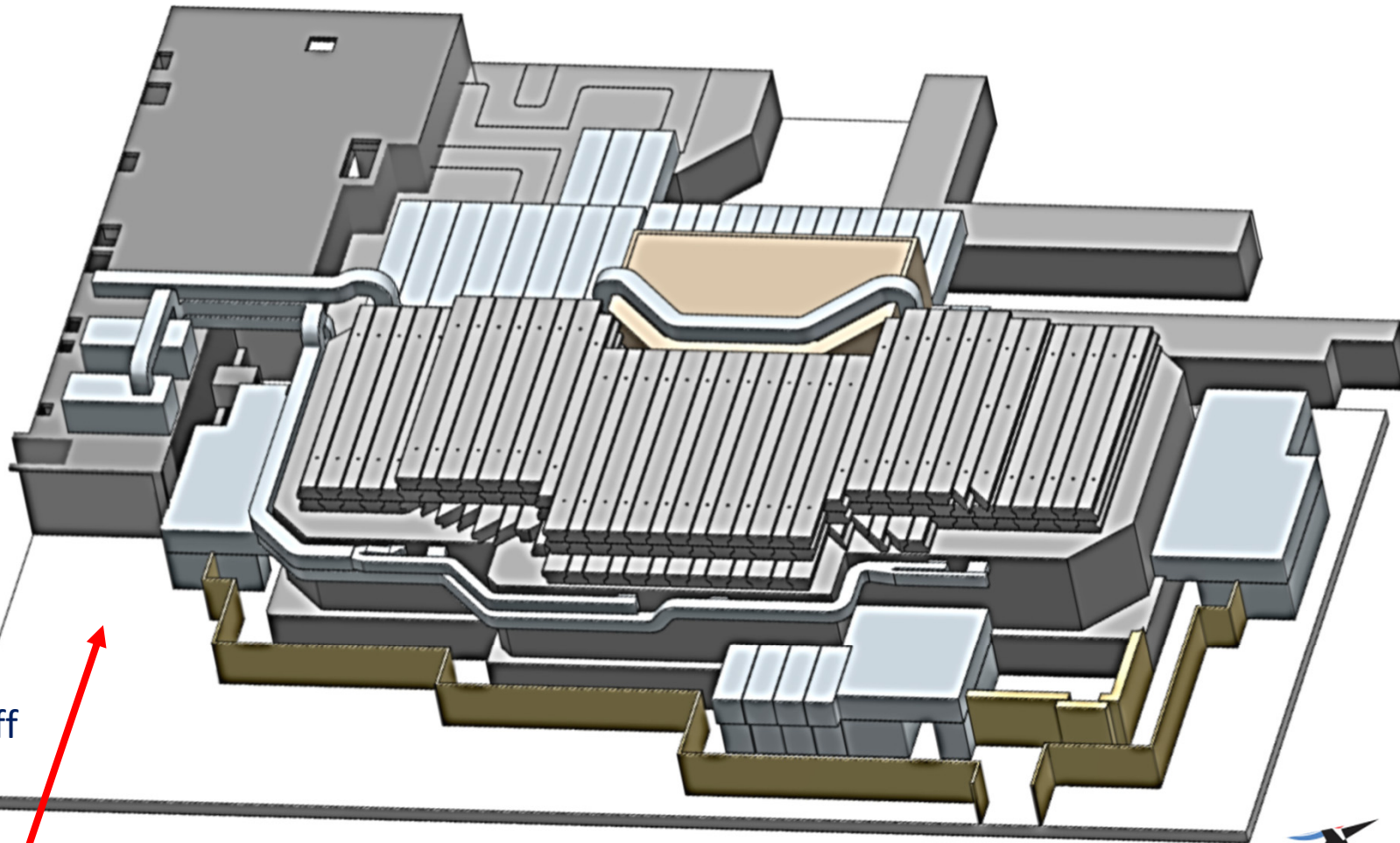
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# Cyclotron & Isotope Production Vaults of the 70 MeV Facility



Entrance with truck to off load cyclotron

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# IBA Cyclone<sup>®</sup> 70P

Isochrones cyclotron with 4 sectors

RF: 61 MHz

Harmonic number 4

Mean Acceleration Voltage: 55 kV

Max magnetic field : 1.6 T

Max kinetic energy/n: 30 - 70 MeV

Total beam current of 750  $\mu$ A proton beam

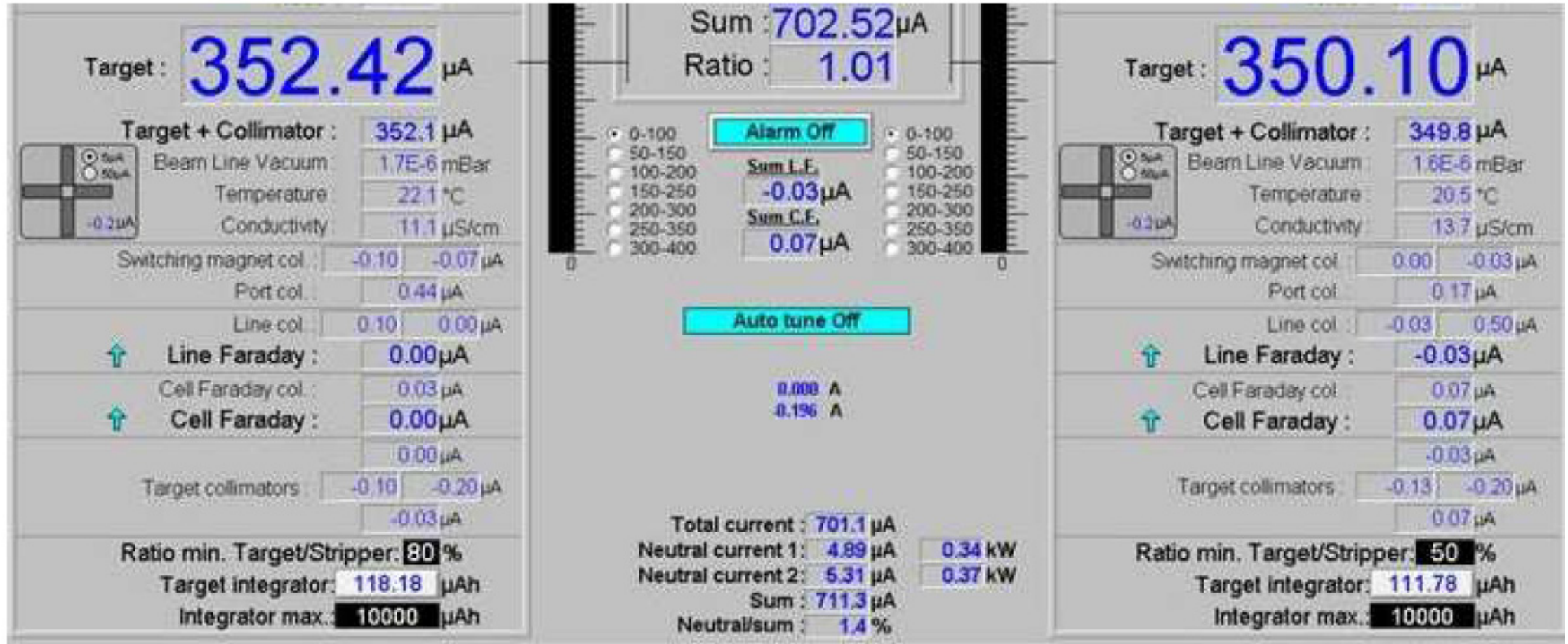


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# IBA Cyclone 70P first full beam extraction (dual beam)



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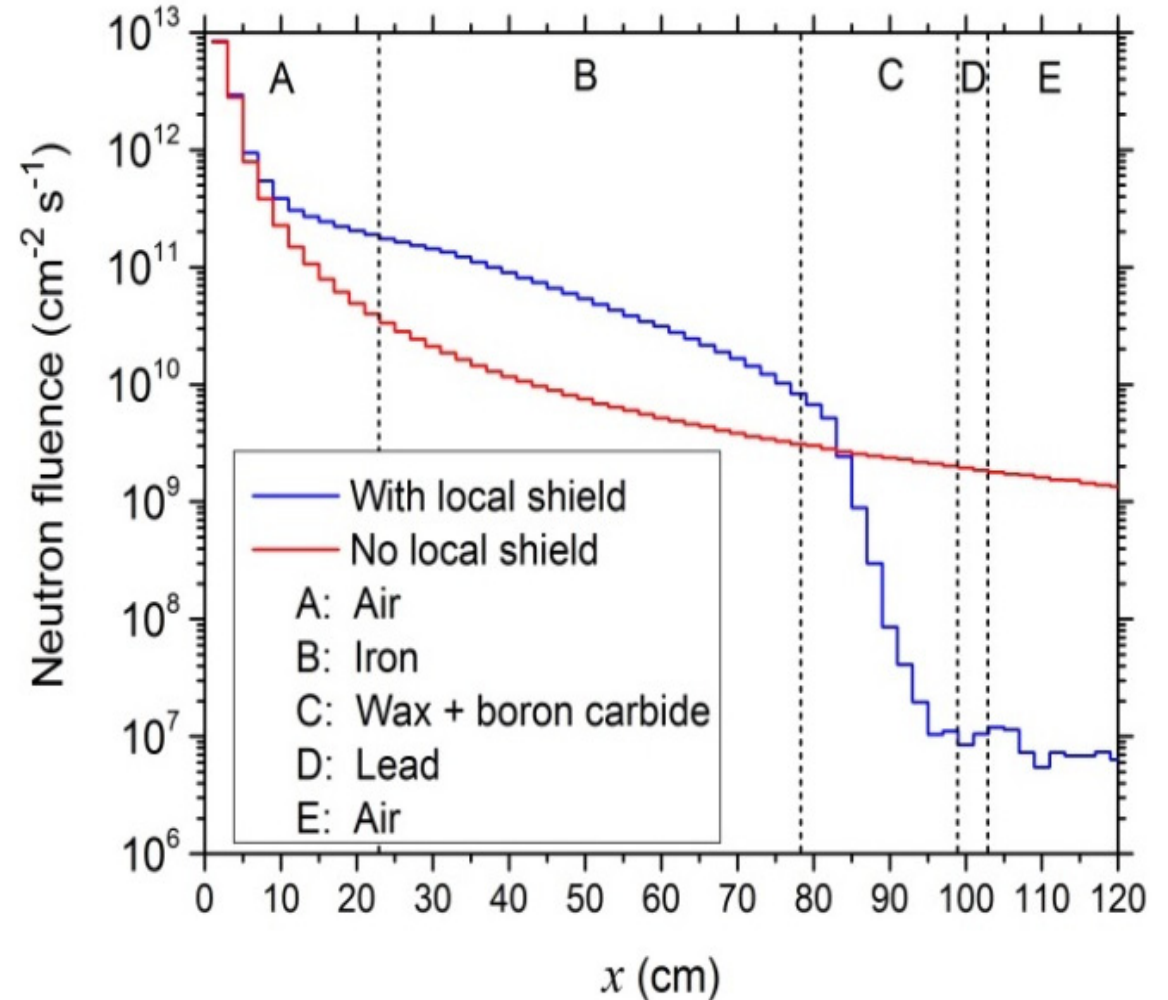
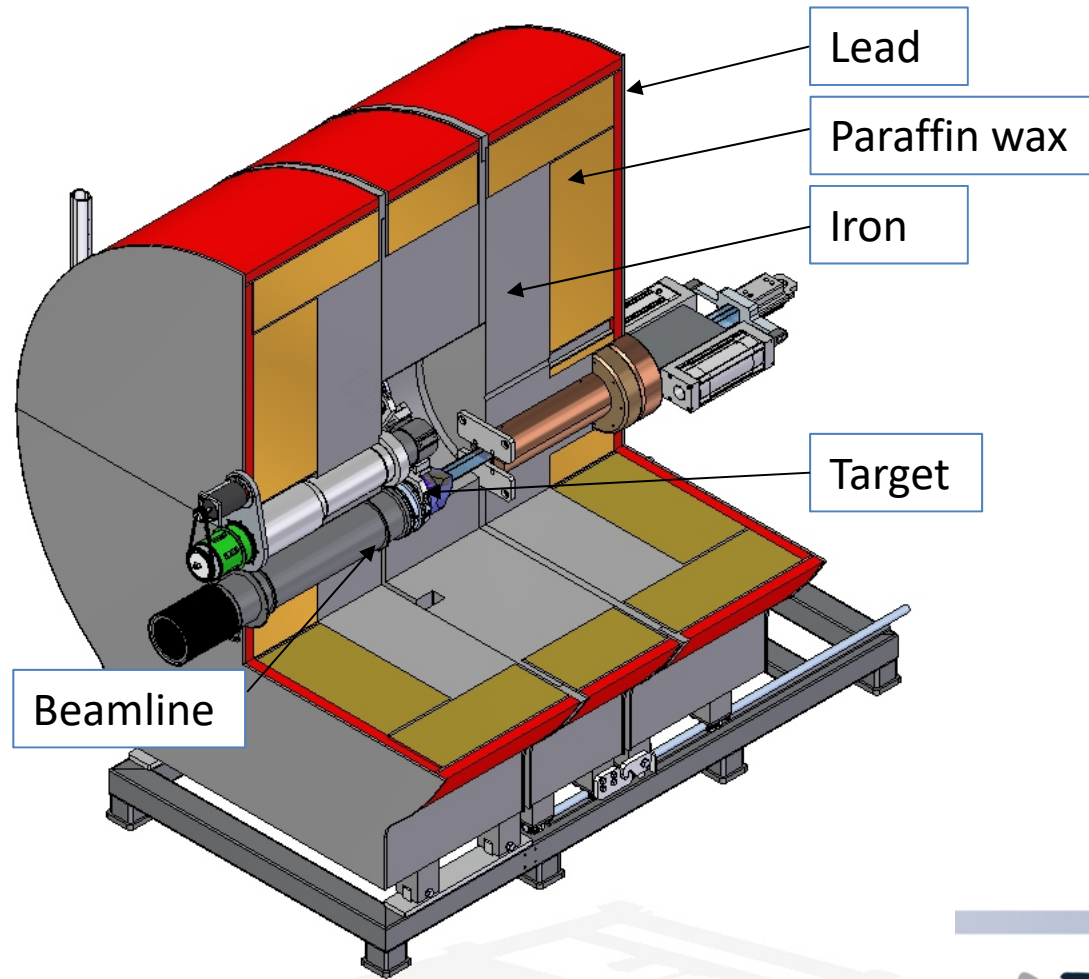


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# Design of the Isotope Production Target Station



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# Ferrite Sweeper Magnets for sweeping the beam on the target

- Sweep frequency 1000 Hz maximum
- Maximum sweep radius will be varied during bombardment up to 20 mm



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# Current Radionuclides routine production list

Radionuclide	Half-Life (days/years)	Nuclear Reaction	Product	Main Use
$^{82}\text{Sr}$	25 days	$\text{Rb}(p,xn)^{82}\text{Sr}$	Produced as a radionuclide	Used to manufacture $^{82}\text{Sr}/^{82}\text{Rb}$ generators
$^{68}\text{Ge}$	271 days	$\text{Ga}(p,xn)^{68}\text{Ge}$	Produced as a radionuclide	Used to manufacture $^{68}\text{Ge}/^{68}\text{Ga}$ generators or used for calibration of gamma camera's or PET CT scanners
$^{88}\text{Y}$	106.6 days	$\text{Sr}(p,xn)^{88}\text{Y}$	Produced as a radionuclide	Non –medical application
$^{109}\text{Cd}$	453 days	$\text{Ag}(p,xn)^{109}\text{Cd}$	Produced as a radionuclide	Non-medical application
$^{22}\text{Na}$	2.602 years	$\text{Mg}(p,n)^{22}\text{Na}$	Produced as a radionuclide	Positron Annihilation Studies



# Current Radiopharmaceuticals routine production list

Radionuclide	Half-Life (hours)	Nuclear Reaction	Radiopharmaceutical Product	Main Use
$^{18}\text{F}$	1.83	$^{15}\text{O}(\text{p},\text{n})^{18}\text{F}$	$^{18}\text{F}$ -FDG	Glucose metabolic studies
$^{67}\text{Ga}$	78.3	$\text{Zn}(\text{p},\text{xn})^{67}\text{Ga}$ $\text{Ge}(\text{p},\text{x})^{67}\text{Ga}$	$^{67}\text{Ga}$ -citrate	Localization of certain tumours and inflammatory regions
$^{81}\text{Rb}/^{81\text{m}}\text{Kr}$	4.58	$\text{Kr}(\text{p},\text{xn})^{81}\text{Rb}$	$^{81}\text{Rb}/^{81\text{m}}\text{Kr}$ generator	Lung ventilation studies
$^{123}\text{I}$	13.2	$^{127}\text{I}(\text{p},5\text{n})^{123}\text{Xe} \rightarrow ^{123}\text{I}$	$^{123}\text{I}$ -sodium iodide $^{123}\text{I}$ -MIBG	Thyroid studies Localization of certain tumours such as neuroblastoma, pheochromocytoma



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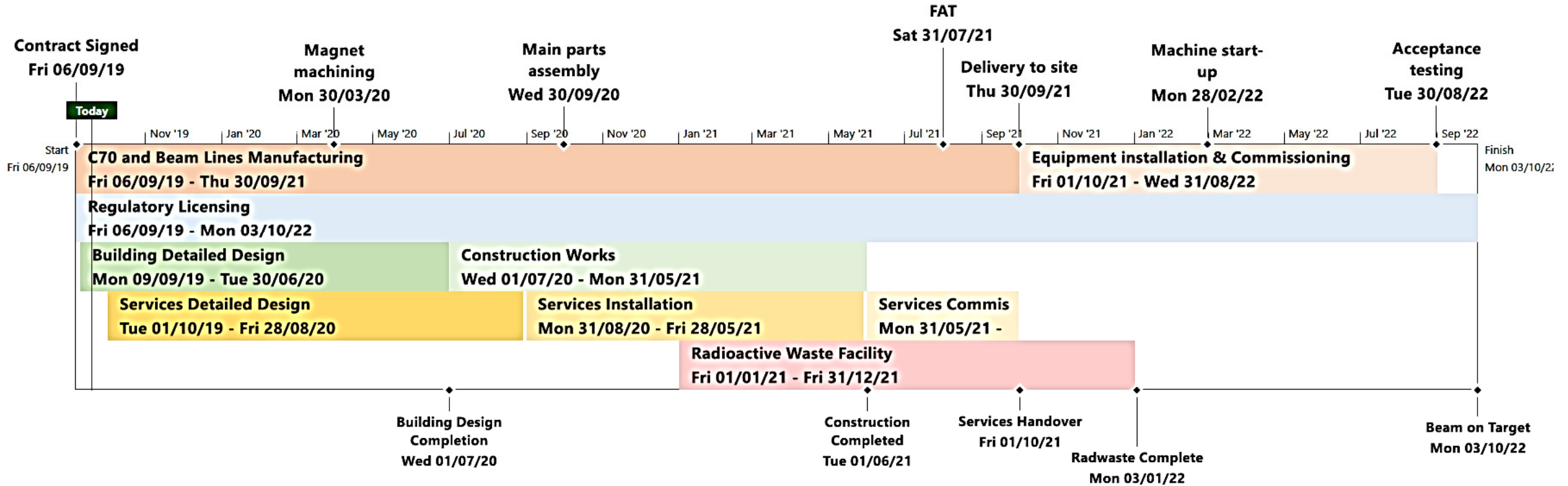
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# Time scale for project



# Target Ion Source Test Stand for radioactive beam facility



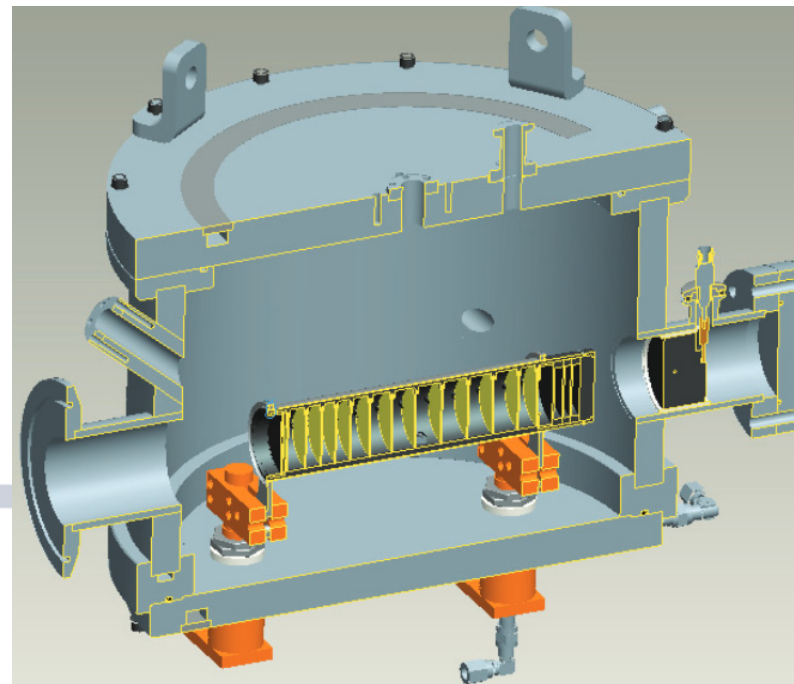
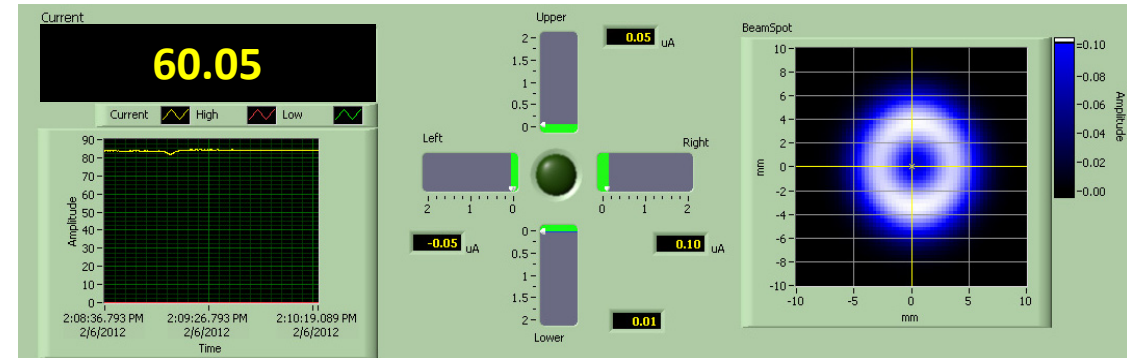
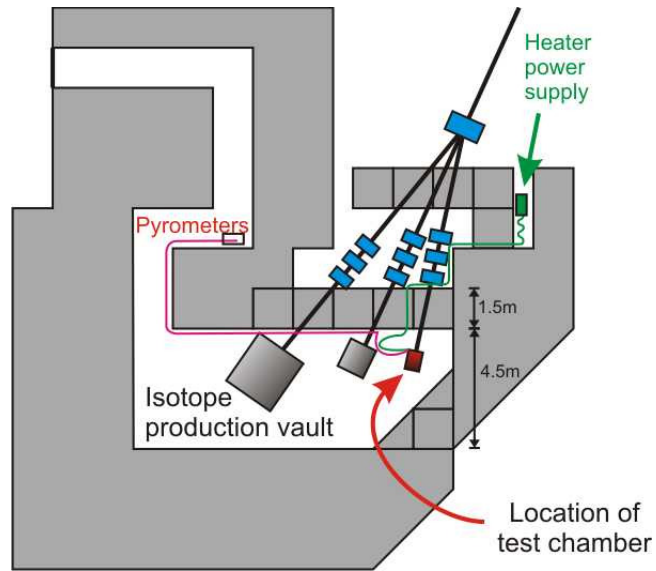
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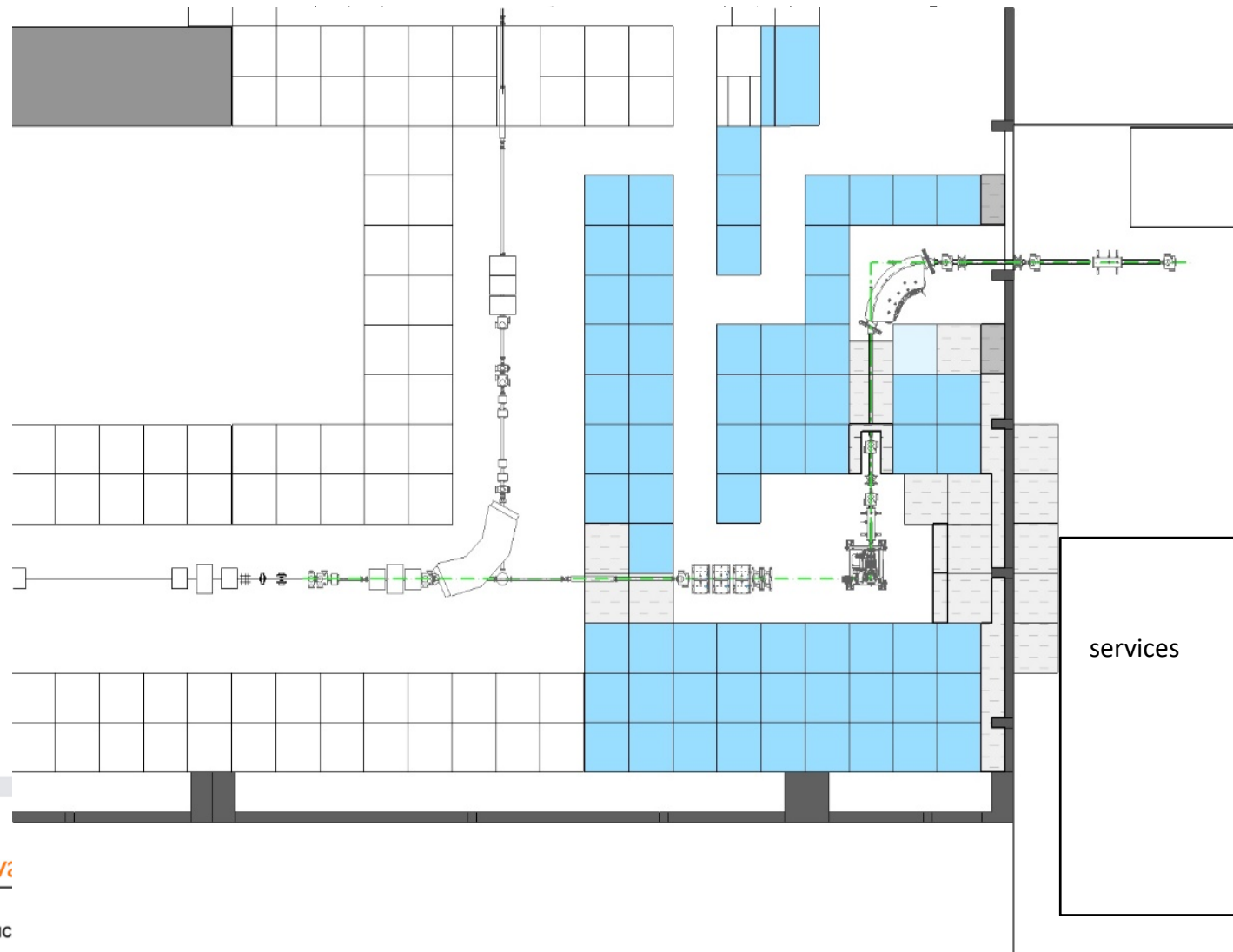
# Online test with silicon carbide discs, 60 micro ampere, 66 MeV proton beam



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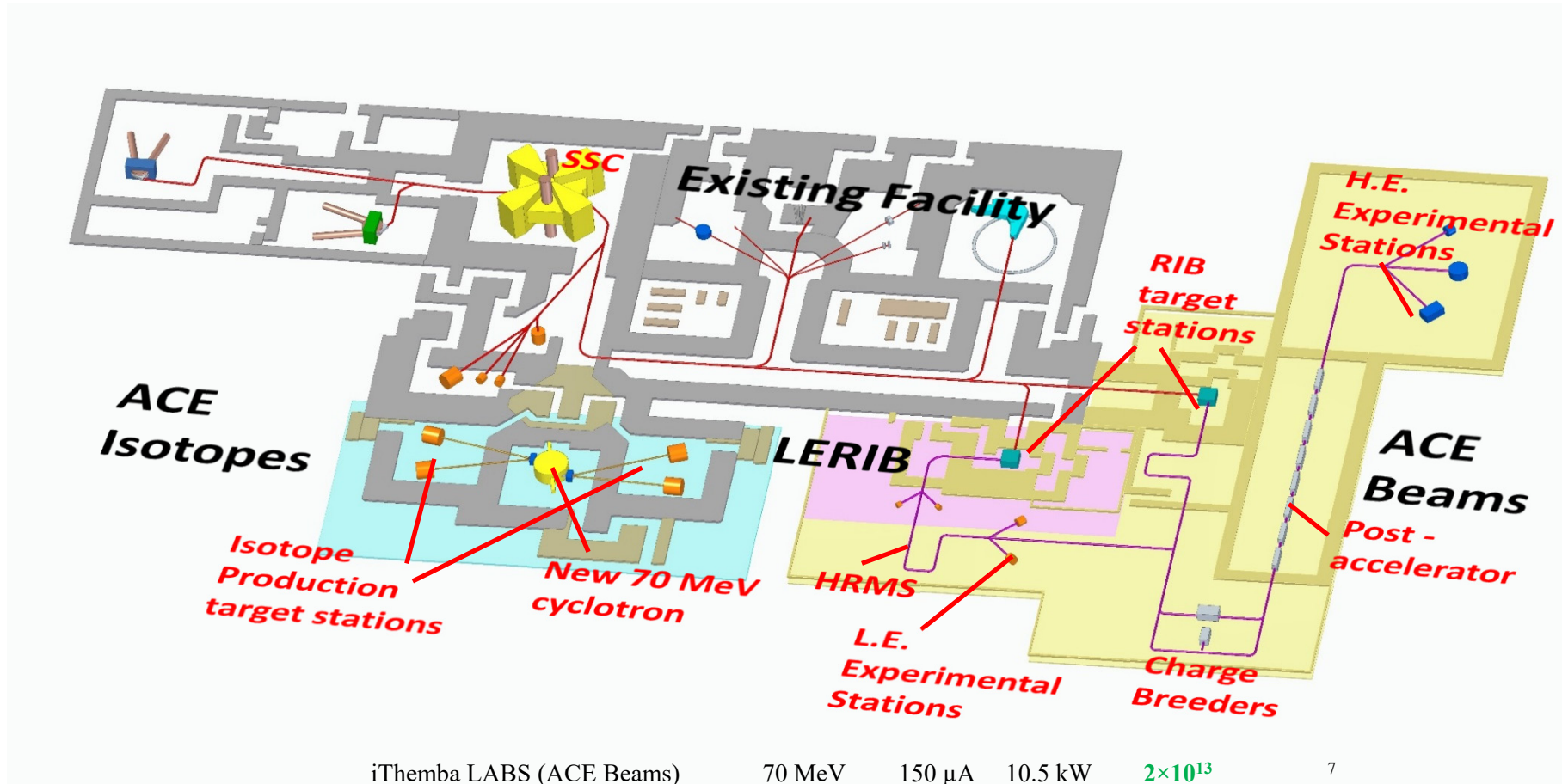
# Phase zero being built with using test-facility and LERIB parts



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# South African Isotope Facility (SAIF)



iThemba LABS (ACE Beams)	70 MeV	150 $\mu$ A	10.5 kW	$2 \times 10^{13}$	7
iThemba LABS (LERIB)	66 MeV	50 $\mu$ A	3.3 kW	$6.7 \times 10^{12}$	



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# Thank You



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