

AN OVERVIEW OF THE SOUTH AFRICAN ISOTOPE FACILITY (SAIF) PROJECT

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INTERNATIONAL CONFERENCE ON

ACCELERATORS FOR RESEARCH AND SUSTAINABLE DEVELOPMENT

From good practices towards socioeconomic impact



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Background

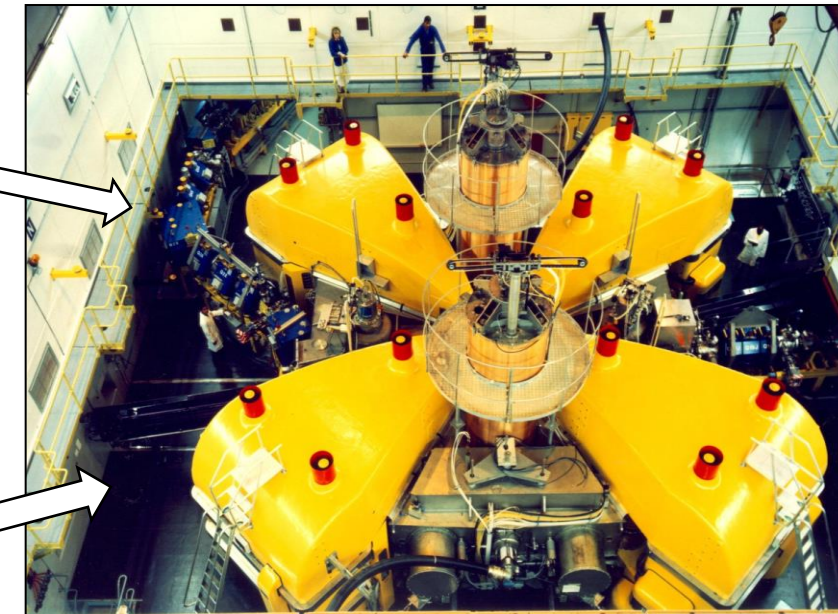
iThemba LABS is a national facility of the National Research Foundation in South Africa:

Mandate	Beam Time Allocation	
	Historically	Present Time
Sub-atomic physics research	33%	10%
Radioisotope production	33%	90%
Particle therapy – neutron/proton protocols	33%	Discontinued

Our existing facilities:

- 200 MeV separated-sector cyclotron (SSC)
- Two solid-pole injector cyclotrons (different ion sources)
- K600 spectrometer
- Experimental beam lines (Aphrodite facility, neutron beam facility, radiation biophysics facility)
- Hotlabs for chemical extraction and cGMP production of radioisotopes and radiopharmaceuticals
- 11 MeV cyclotron for F-18 production
- 3 MV Tandetron accelerator for materials science research (Cape Town)
- 6 MV Tandem accelerator for materials research and AMS (Johannesburg)

Ageing facility no longer compatible with modern treatment protocols



K200 Separated Sector Cyclotron

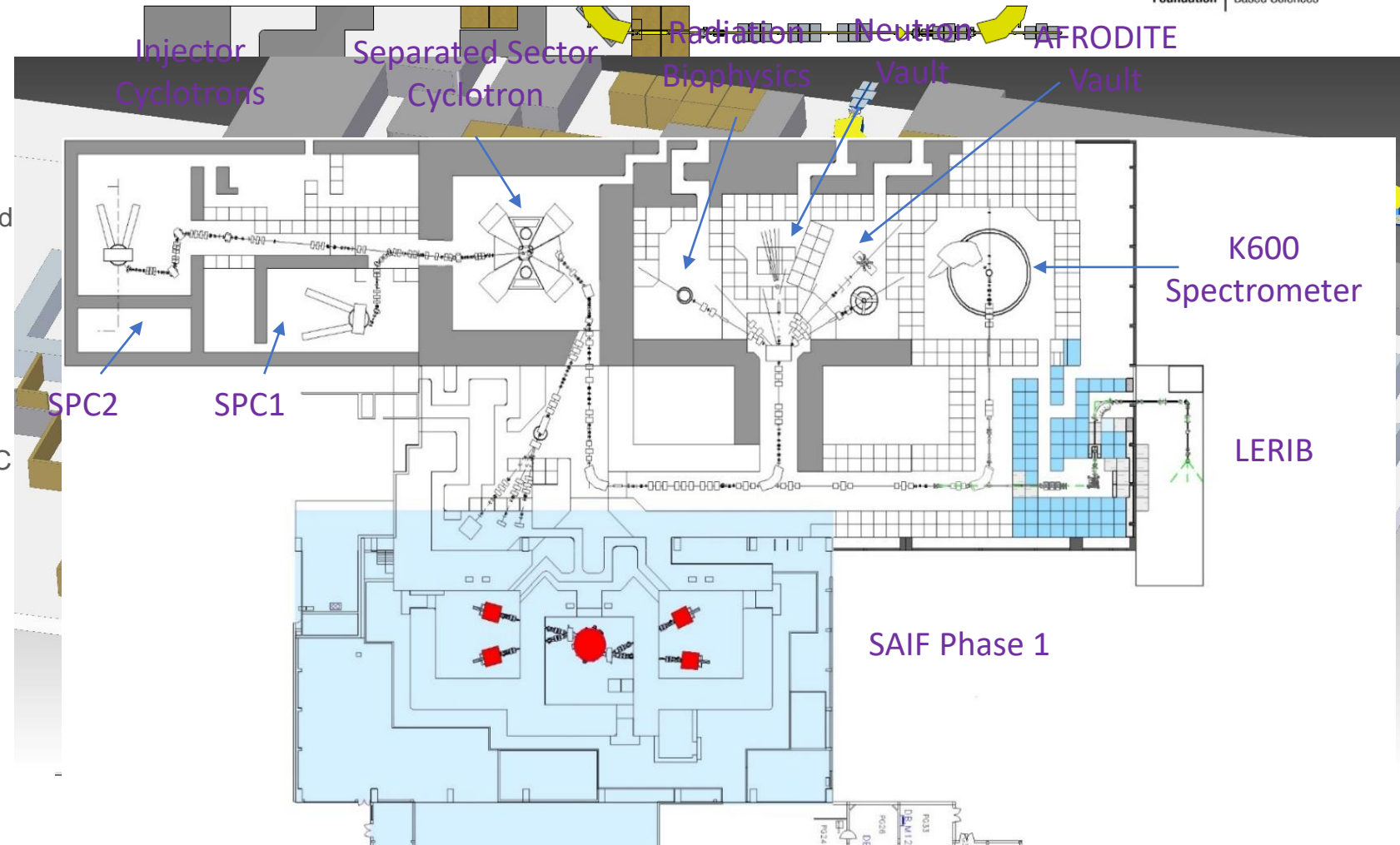
Motivation for SAIF Project

Objective = Establish a dedicated facility for radioisotope production:

- New facility to be retrofitted in 3 existing un-utilised vaults on site which realises significant savings
- Installation of a new 70MeV cyclotron and beam lines for isotope production
- Migration of the radioisotope production programme from the existing SSC to the 70MeV cyclotron;
- Increase the beam time availability at existing SSC complex for physics research

Implementation workstreams:

- 70 MeV cyclotron procurement
- New beamlines procurement
- New target stations manufacturing
- New buildings for utility services, waste disposal
- Regulatory licensing



70 MeV cyclotron

Cyclone 70P supplied by IBA Radiopharma Solutions

- Variable energy proton beams (30 – 70 MeV)
- Multicusp ion source with 10 mA of injected H⁻ current
- High-intensity proton beams up to 375 μ A per extraction port
- Dual extraction ports for simultaneous beam delivery
- 4-sector magnet of 1.6 Tesla
- Directly coupled 100 kW RF system with 2 dees (4th harmonic mode)
- 4 beam transport lines with beam diagnostics, Faraday cups and neutron shutters

Status of C70 manufacturing & installation

- Factory acceptance tests completed in Belgium in July 2021
- Delivered to port of Cape Town in December 2021
- Installed into the vault in April 2022

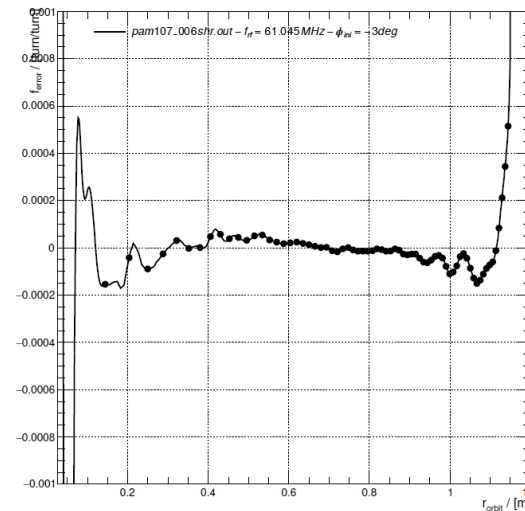
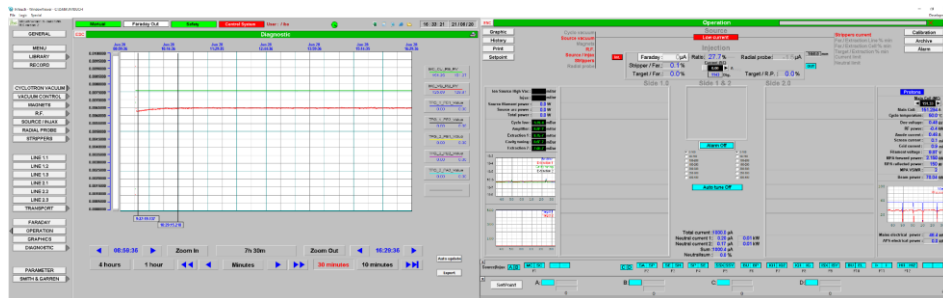


Figure 7: CYCLONE@70p, PAM107 project, H⁻: The frequency error $\Delta f/f$ as



Installation of C70 cyclotron and beam transport lines



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Installation of C70 cyclotron and beam transport lines



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Installation of C70 cyclotron and beam transport lines



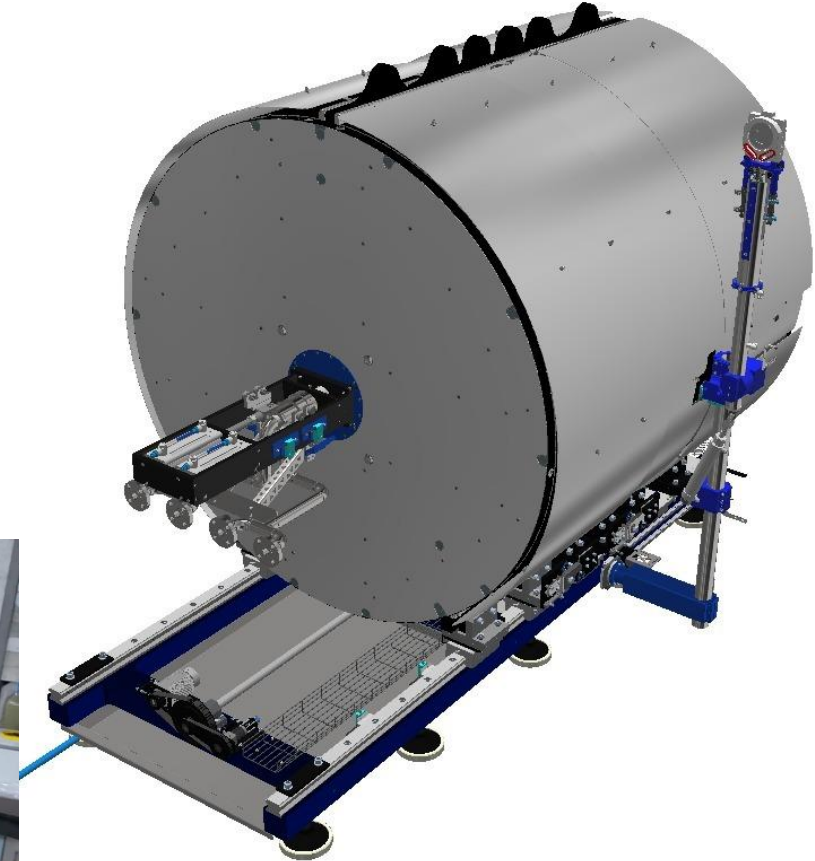
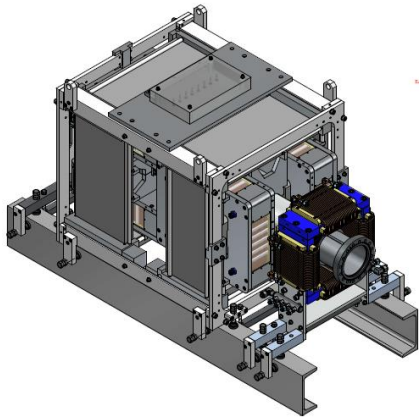
Target Systems

In-house design of target station

- Provide local radiation shielding (steel, lead, borated wax)
- Accommodate solid targets of Sr and Ga in tandem
- Water-cooled target capsules (up to 26 kW heat removal)
- Helium-cooled vacuum window
- Robotic transfer of target from target stations to chemical processing facility

In-house design of sweeper / steerer magnets*:

- H-type dipole magnets 90° phase difference to sweep the beam in a circular pattern to provide heat dissipation to the vacuum window and target capsule



* Subject of poster session CN-301-175 by J. Mira

Infrastructure

Construction works in progress, entailing the following:

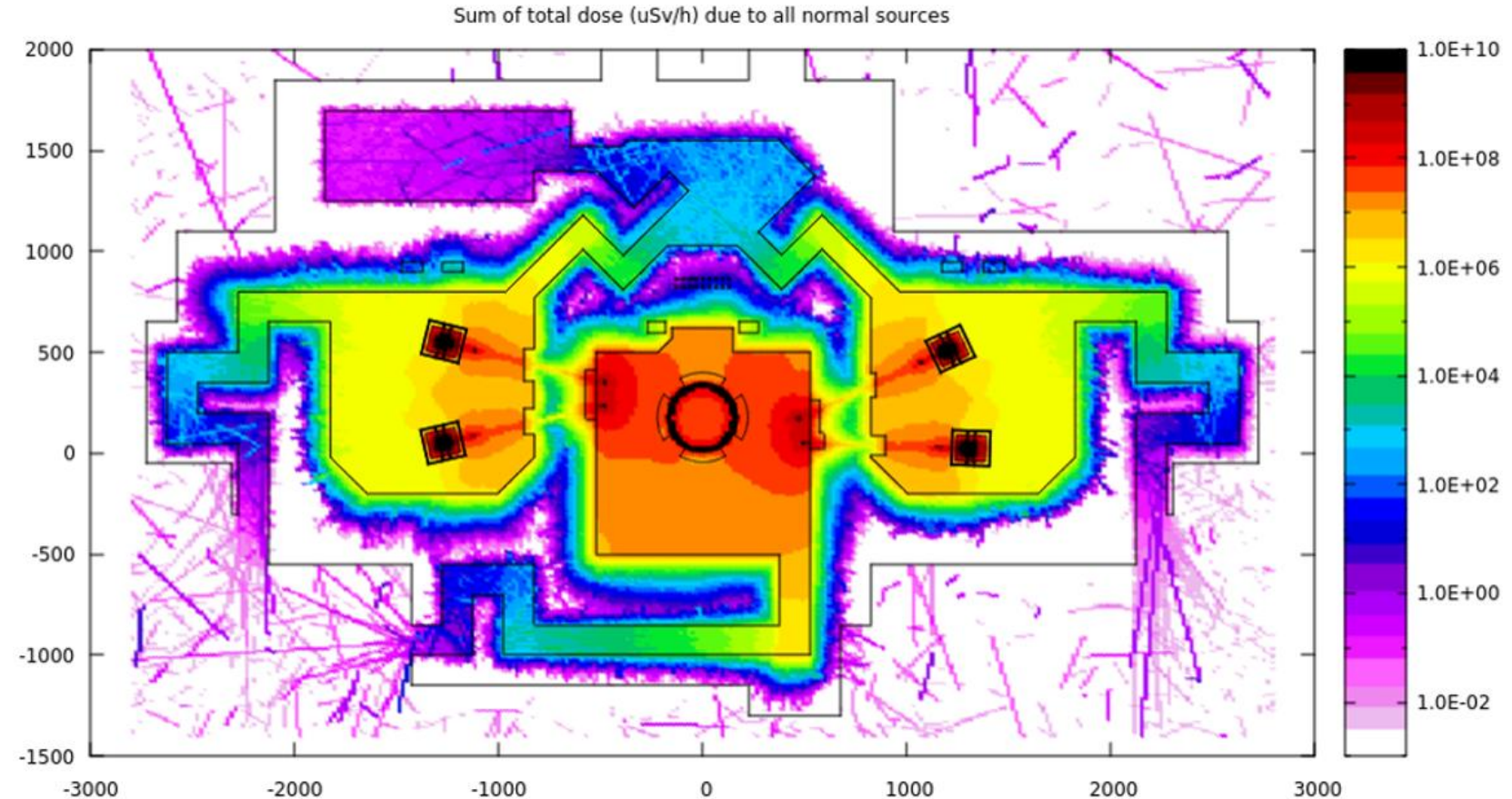
- Structural modifications to cyclotron vault and 2x target vaults
- Facilities to house power supplies, electronics and control rooms
- Mechanical plant room for central water cooling plant
- Electrical plant room for power distribution and RUPS
- Radioactive waste storage facility (processing & storage of solid & liquid wastes)
- HVAC for specified air changes and pressure cascades in controlled areas
- Cyclotron and beam transport line cooling systems
- Target cooling systems
- Supervisory control systems for vault clearance and safety interlocking



Infrastructure

Vault Modifications – Verification of Design for Radiation Shielding*:

- Worst case fluence to dose conversion factors used (FLUKA option EWT74) based on data sets from ICRP74
- Acceptable Radiation Levels:
 - Unrestricted blue areas (ground level outside vaults): $< 2.5 \mu\text{Sv/h}$
 - Restricted blue areas (on roof): $< 15 \mu\text{Sv/h}$



* Subject of poster session CN-301-178 by H. Barnard

iThemba LABS: South African Isotope Facility



Remaining work:

Activity	Estimated completion date
C70 cyclotron: Final assembly of mechanical/electrical systems	Jun 2022
Commission central services (HVAC, cooling systems, electrical power)	Jul 2022
C70 cyclotron: RF start	Aug 2022
C70 cyclotron: First beam extraction	Oct 2022
Complete radioactive waste handling facility	Oct 2022
Install 2x target stations	Oct 2022
C70 cyclotron: Beam transport line commissioning	Nov 2022
C70 cyclotron: Site acceptance testing	Feb 2023
Complete regulatory licensing process	Mar 2023



Thank you

Acknowledgements

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National Research Foundation

IBA Radiopharma Solutions

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