ANU HEAVY ION ACCELERATOR FACILITY

Developments and major projects

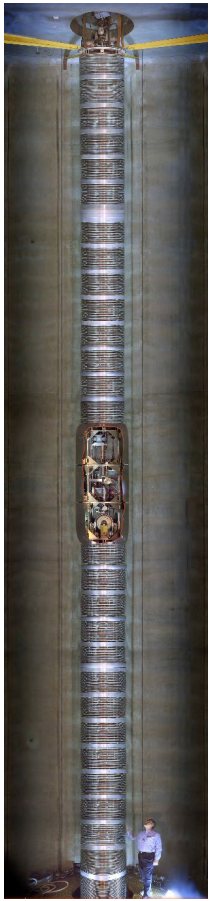
https://hiaf.anu.edu.au/

Trevor Dickinson www.trevordickinson.com

Australian National University

00 HIAF FACILITY

ANU HIAF 14UD



ANU HIAF 14UD

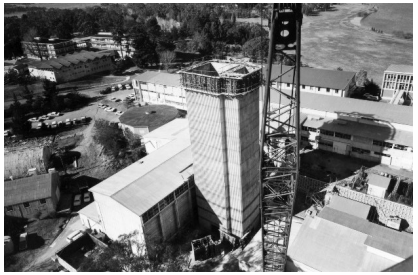
1971: pressure vessel complete

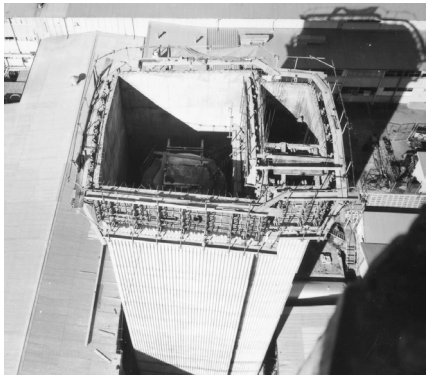
1972: 14UD assembly began

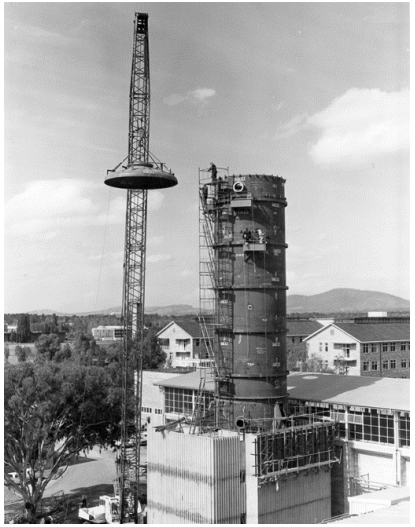
1973: first beam

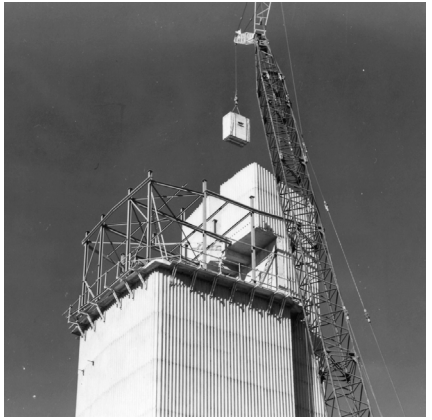
1974: first experiment

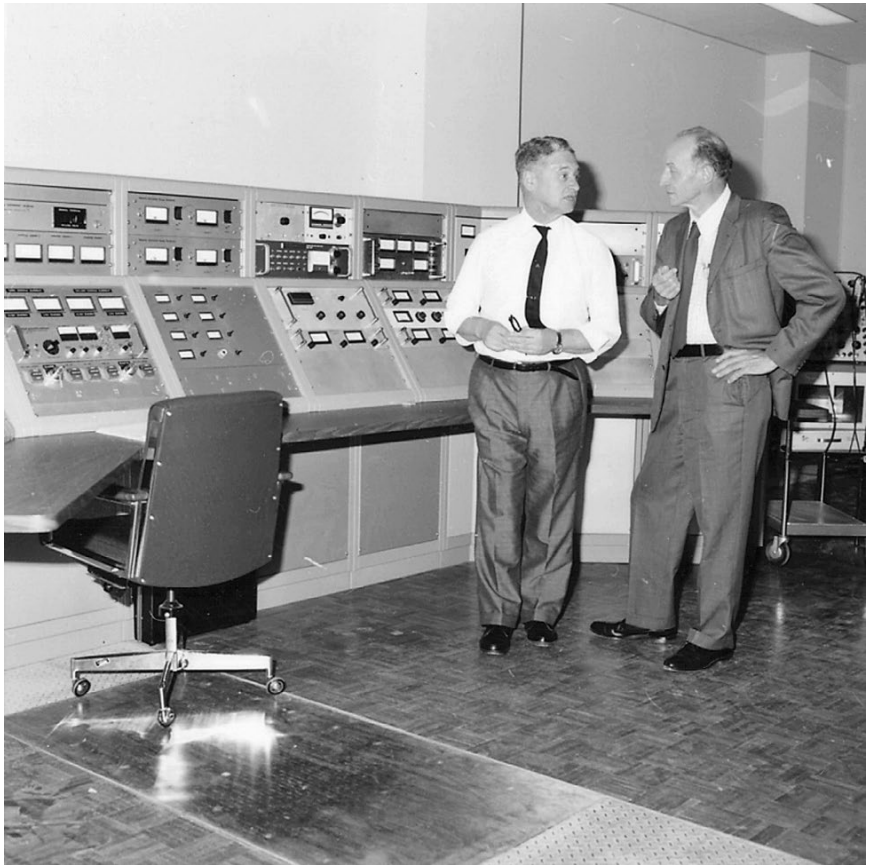
1975: acceptance tests complete











Major projects

Upgrade of ion beam injection systems

Replacement of radiation protection system

Construction of a space testing beamline to be part of NSQN

Full renewal of EPICS control systems EPICS v7, new network infrastructure

Full rewiring of major electrical distribution boards.

Move towards PLCs for control + Modbus

Replacement of SF_6 handling and storage system

Full replacement of all ceramics – design of tool-less resistor mounting system

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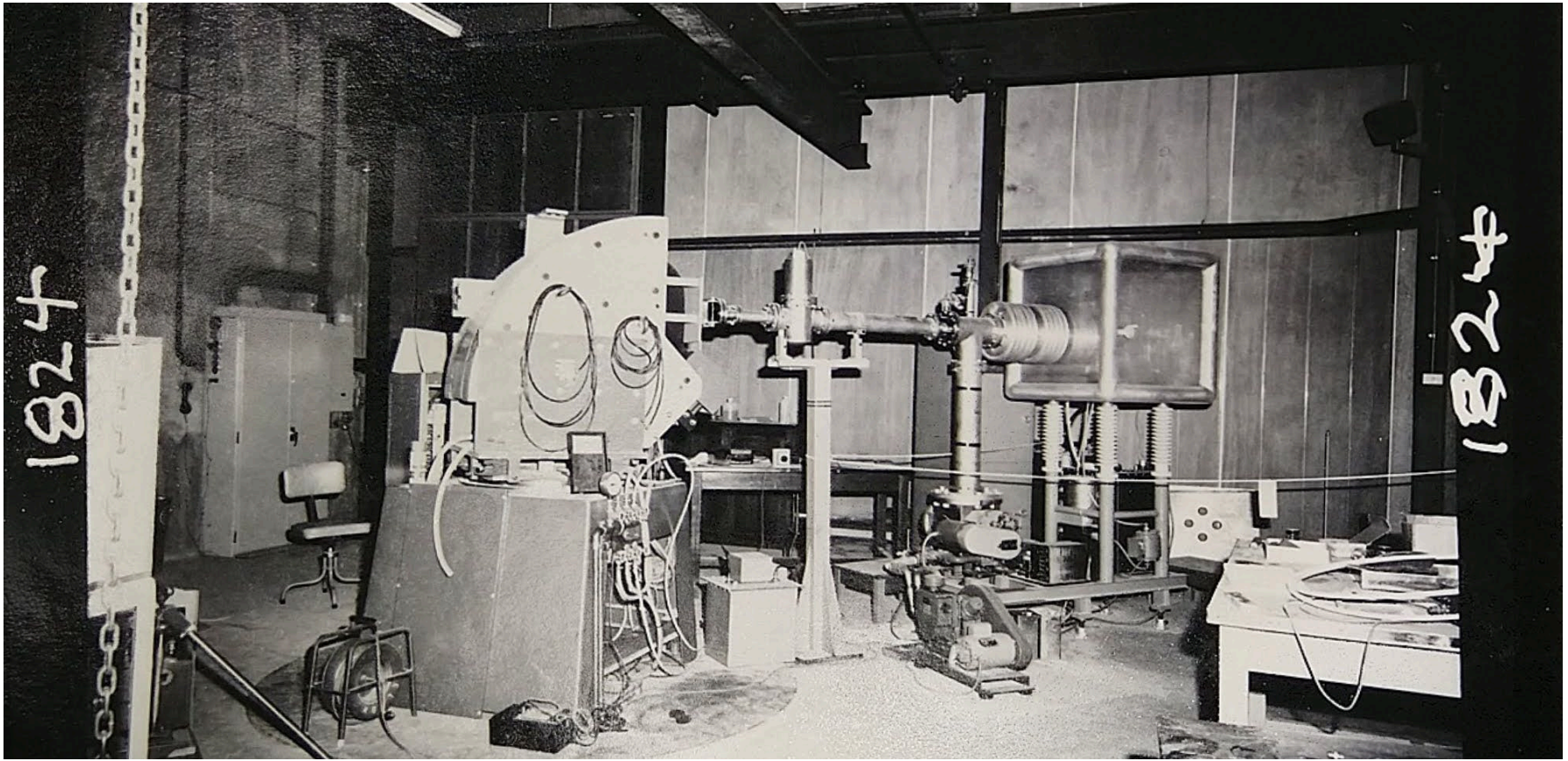
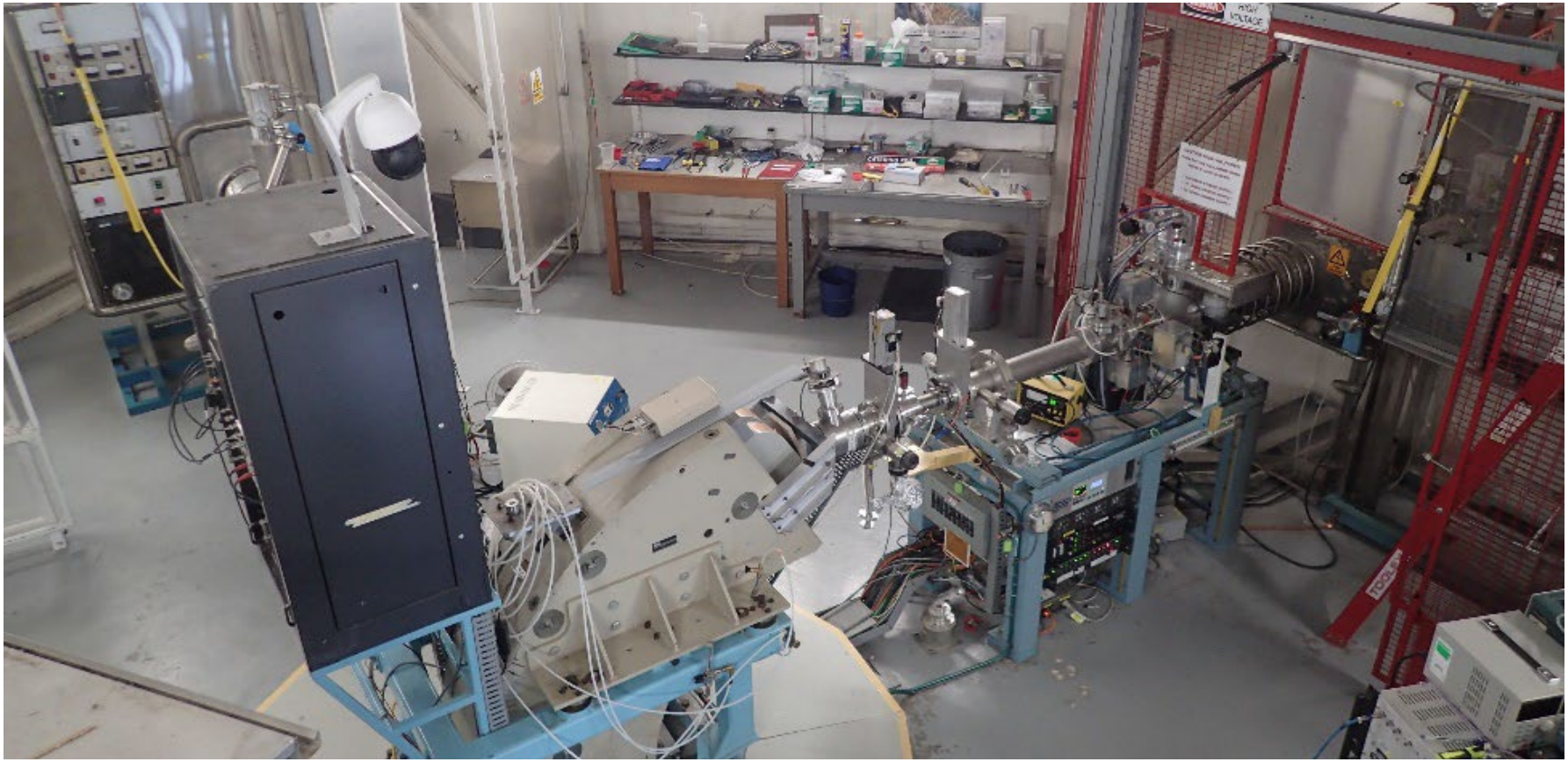
01 ION INJECTION





N. Lobanov

The project

Installation of a new ion source to produce negative helium ions (ECR/RB ion source)

Installation of a new 110° electrostatic analyser (ESA)

Repositioning the existing multi-cathode MSNICS ion source to integrate with the ESA

Plus additional associated work

Installation of new safety cages around all three ion sources

Reconfiguration and upgrade of the high-voltage functional safety interlock system

Motivation

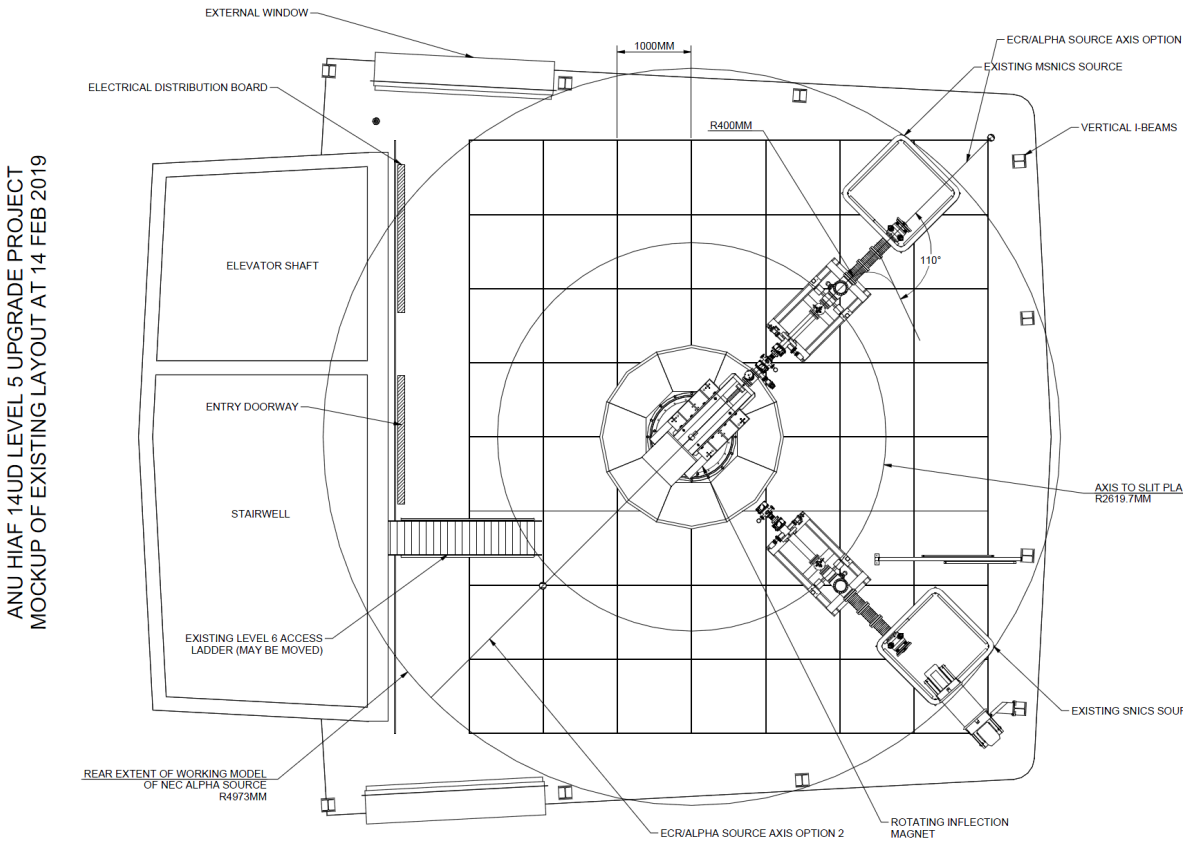
The sensitivity of AMS for heavier nuclide detection is currently constrained by high backgrounds from neighbouring isotopes due to low- and high-energy tails

Electrostatic Analyser

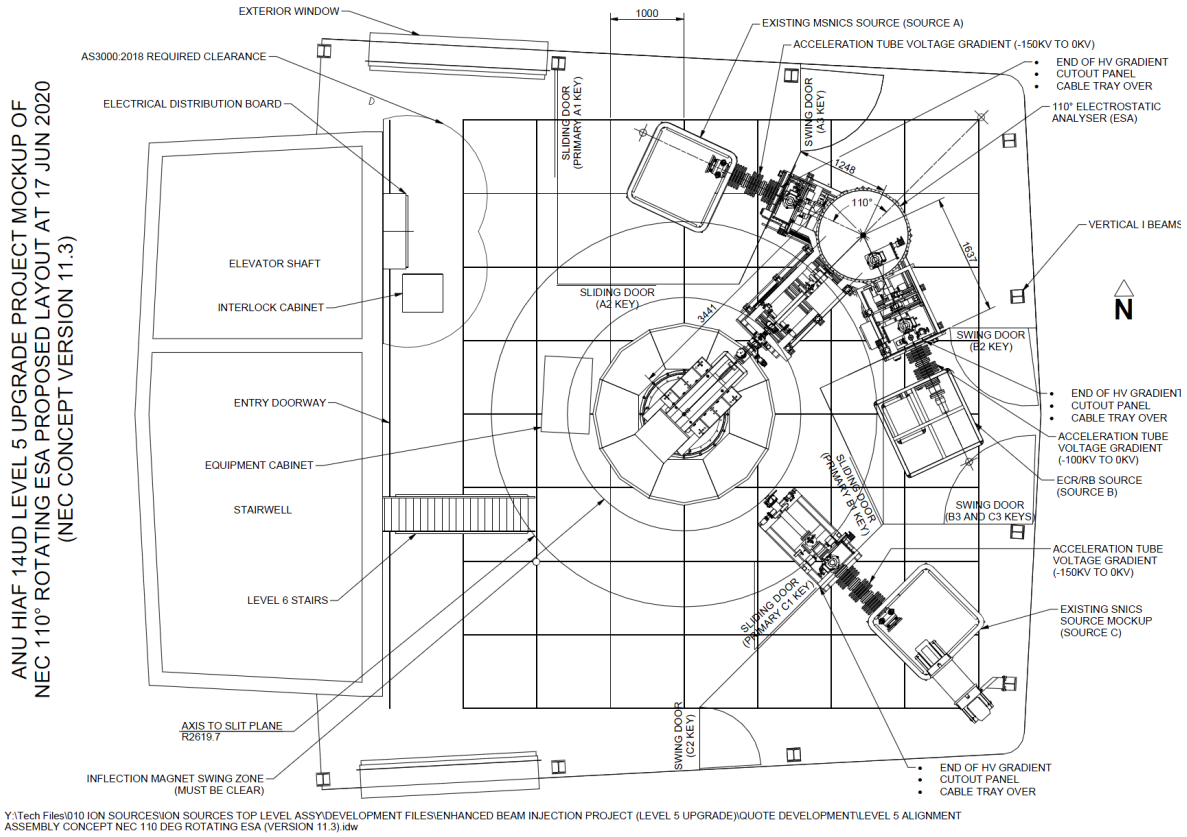
Users are demanding 3He and 4He (alpha particles) for research problems

New ion (alpha) source

Existing layout

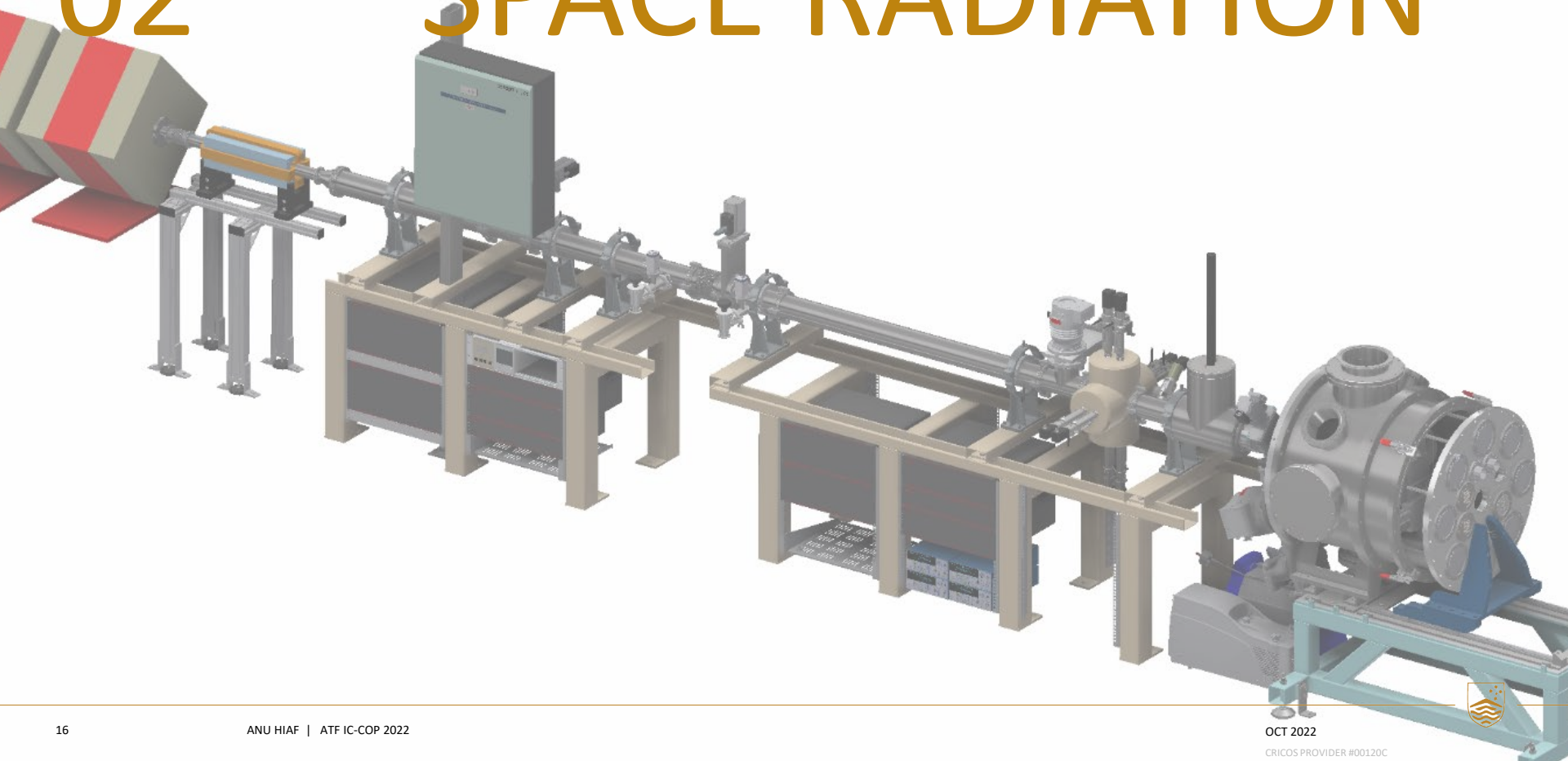


Planned layout



National Electrostatics Corporation

02 SPACE RADIATION



National Space Qualification Network

Funded by the Australian Space Agency

Industry predominantly private civil space led

Currently payload deployment is focused on

- rapid deployment of small form factor in LEO
- towards larger satellites over the next 10 years.

University and industry partnership bringing together a number of space testing capabilities

Australian National University

- National Space Test Facility (Mt Stromlo)
- Heavy Ion Accelerator Facility

Australian Nuclear Science and Technology Organisation (ANSTO)

University of Wollongong

Steritech

Saber Astronautics

Nova Systems

Launching April 2023

Access to industry and emerging enterprises

https://www.nsqn.org/

HIAF NSQN capabilities

Will deliver ion beams ranging from protons (up to 29 MeV) to Uranium (up to 385 MeV)

Single event effect (SEE) testing

Trigger single event effects (SEE) with protons and heavy ions with a focus on specific de-capped components

Proton total ionising dose (TID) testing

Displacement damage (DD) testing

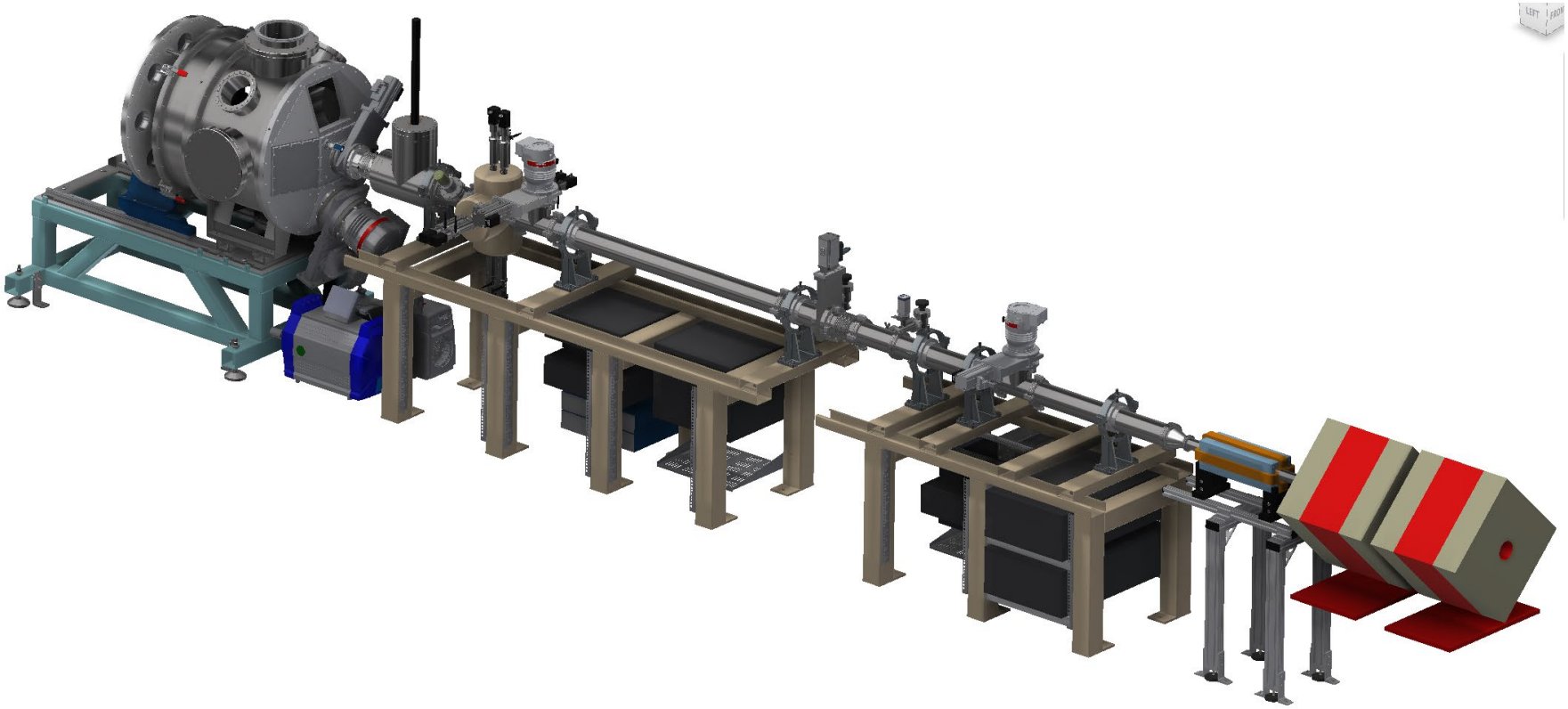
Typically done with protons and will irradiate devices with the highest energy protons available at HIAF

Radiobiology studies

A radiobiology capability is a longer-term goal, with a prototype multi-sample stage complete (Oliver Hubbard)

Comparable existing facilities at the Brookhaven Tandem (USA) and RADEF at Jyvaskala (Finland)

ANU HIAF contact: lauren.bezzina@anu.edu.au



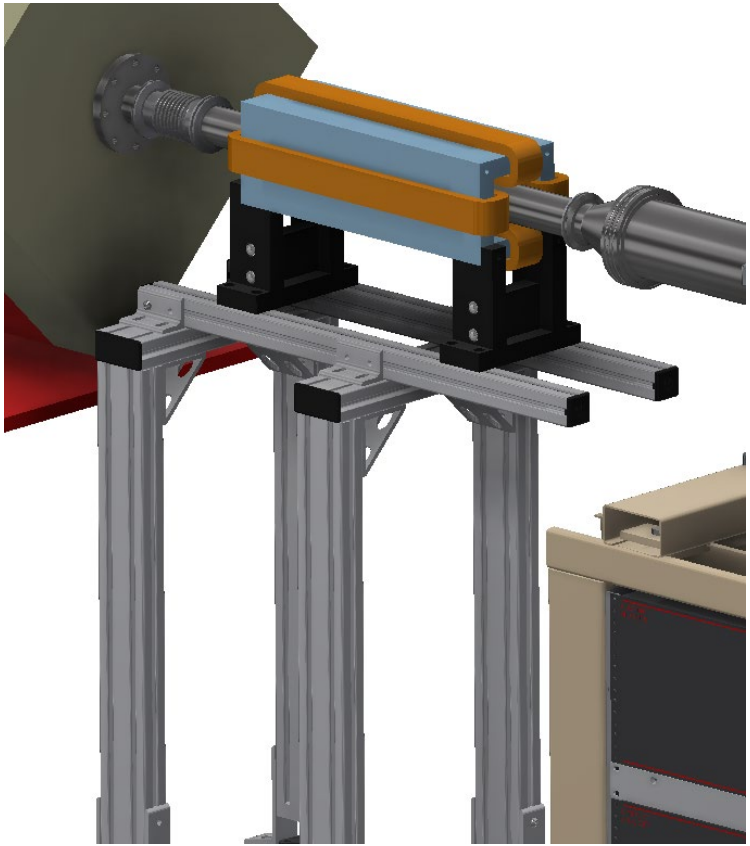
Ion Beam Scanning System

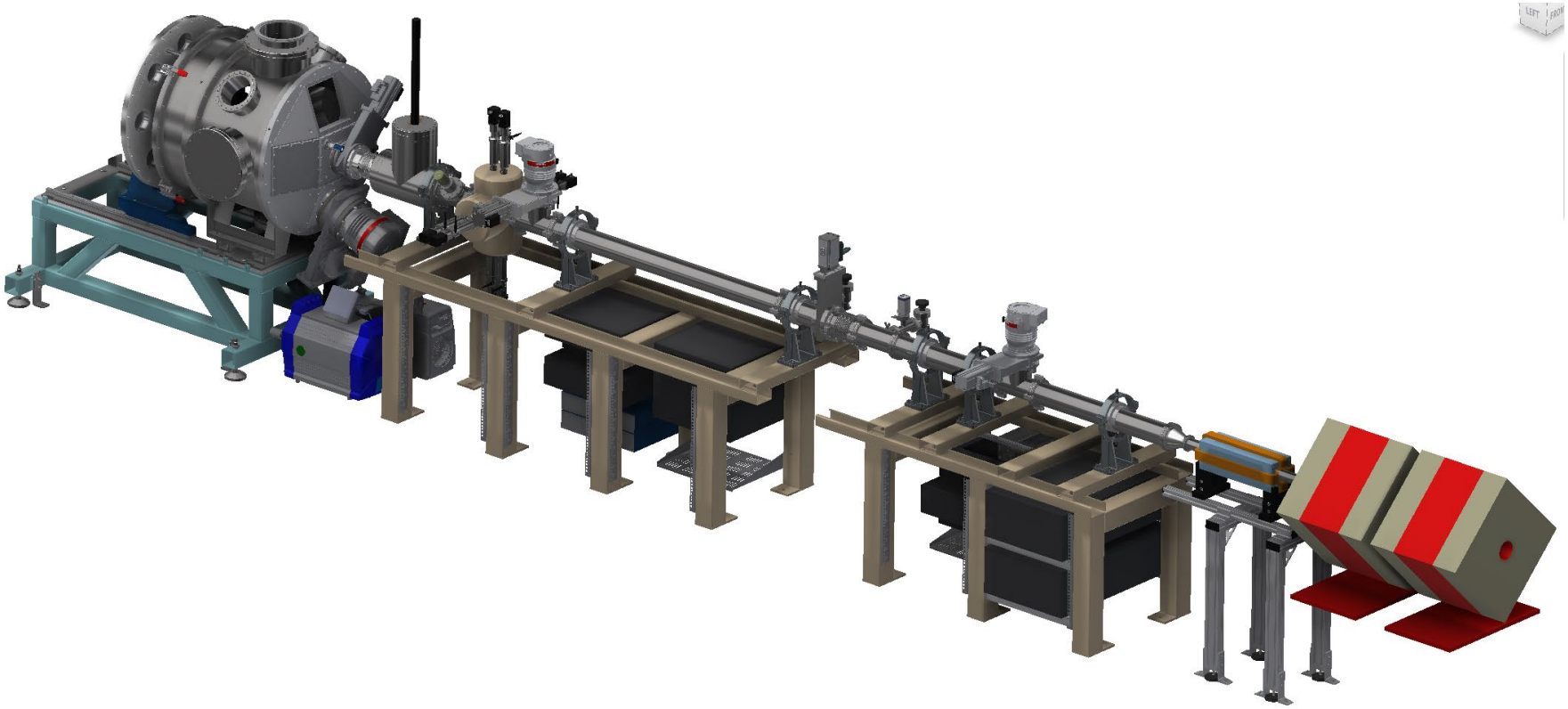
Manufactured by Buckley Systems (New Zealand)

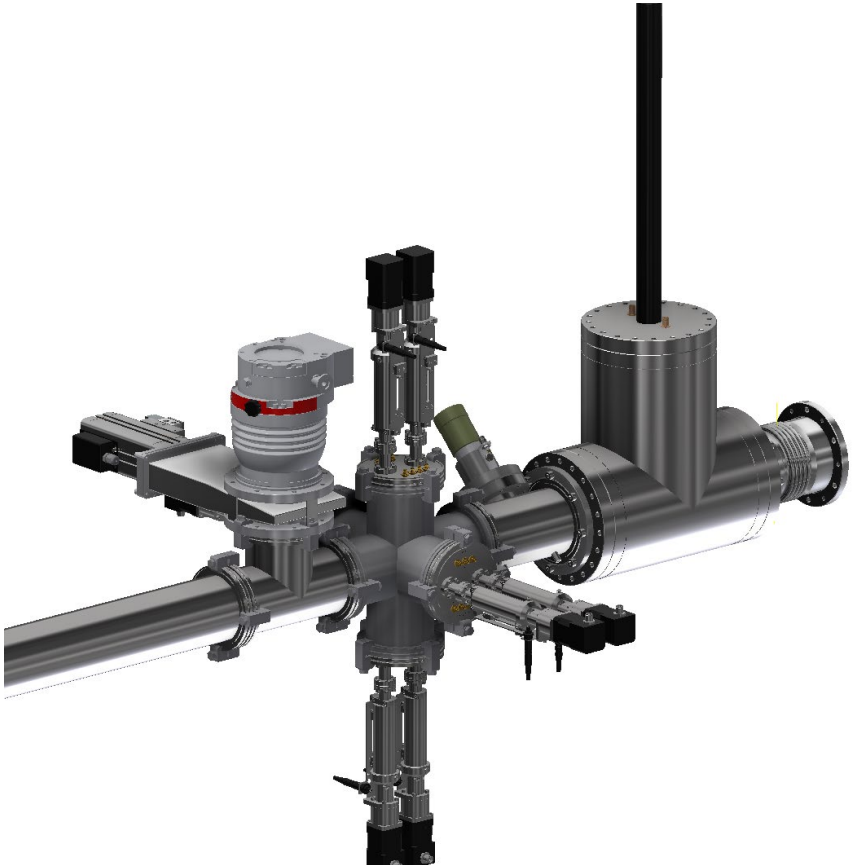
Enables variable scan frequencies and patterns to control uniformity

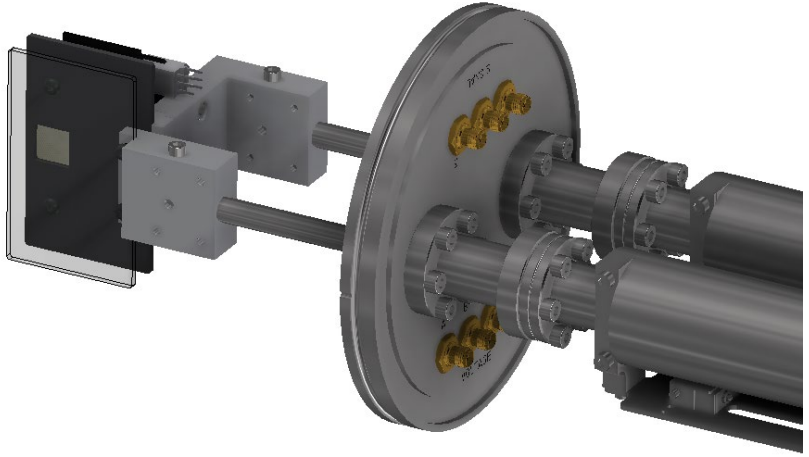
Deflect most energetic heaviest ion beams over a path length of 4m

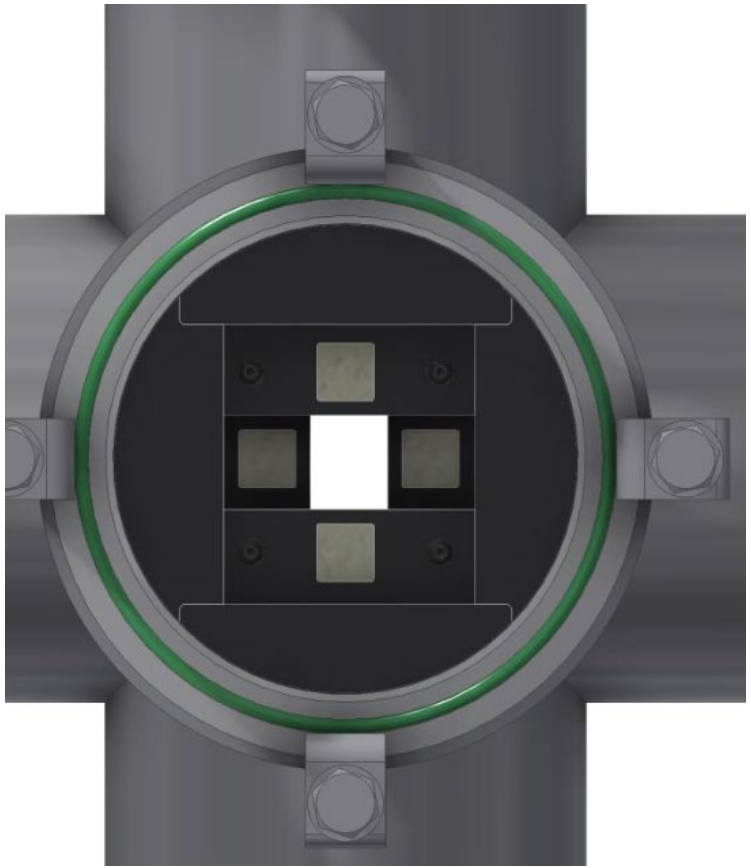
With a maximum scan range of 70mm × 70mm on the beam defining slits











Beam Characterisation

Will measure the flux of the incident ion beam in real time to ensure a known and homogenous irradiation of the DUT.

Beam size defining

Eight Tantalum slits capable of defining beam profile from millimetre profiles up to 40 x 40 mm

Fluence counting / dose mapping

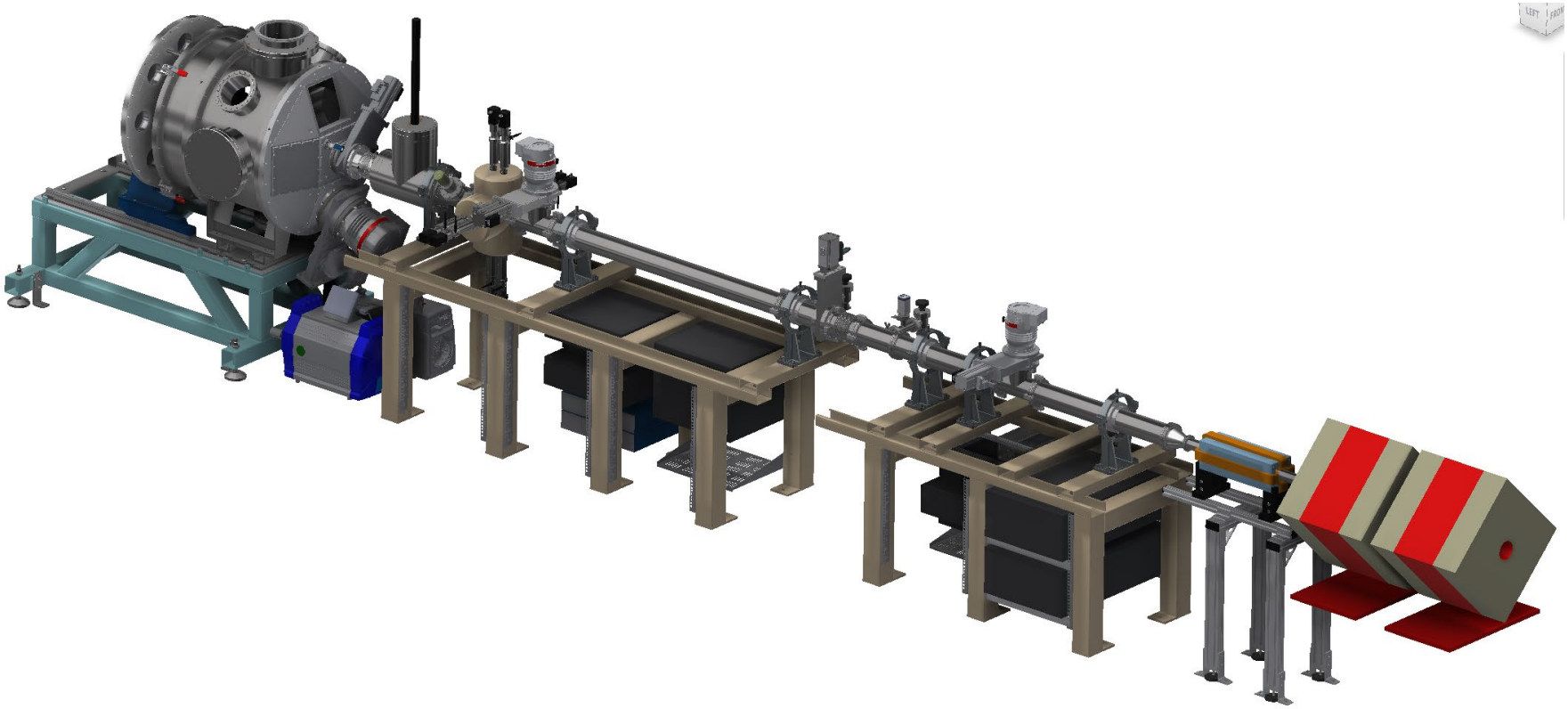
Monitoring of beam flux over 12 orders of magnitude

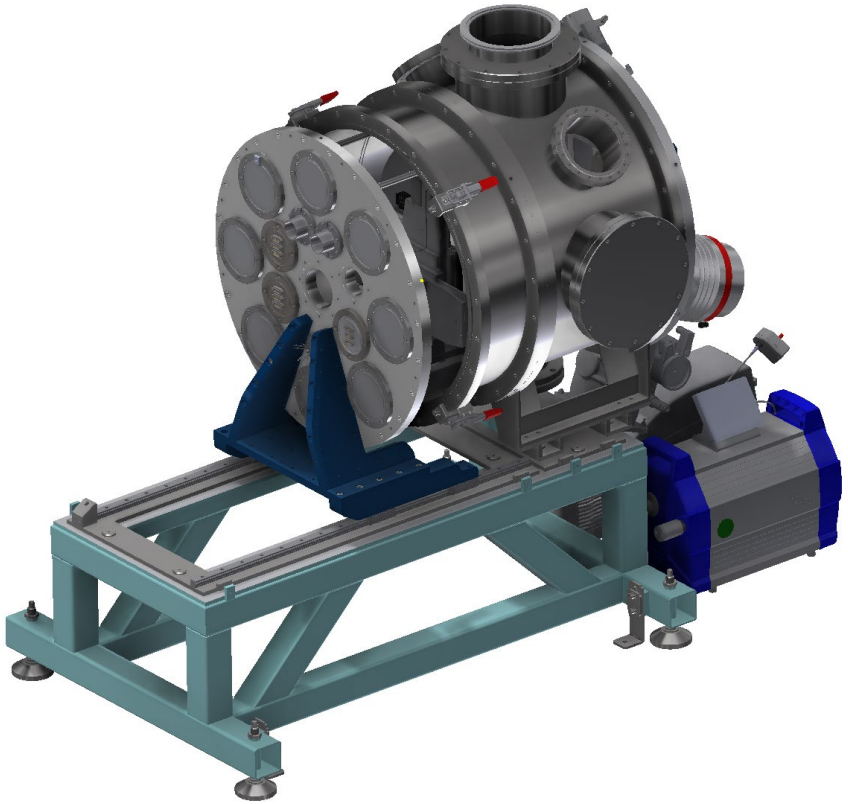
Two modes of operation:

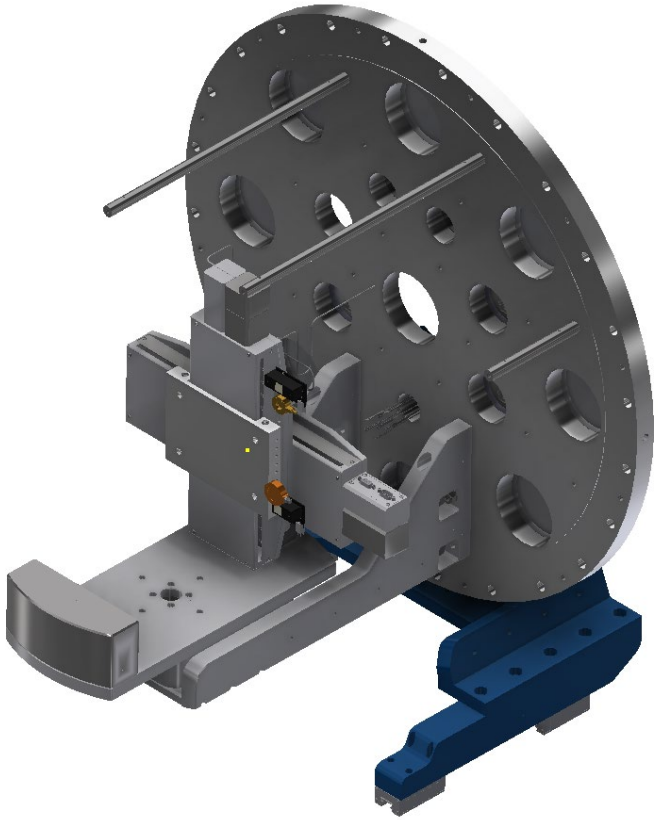
- Low intensity mode –real time flux monitoring (envisage to be 90% of users test requirements) -particle counting with plastic scintillator & SiPMreadouts
- High intensity mode (DD or TID test cases) –beam current measurement from intermediate faraday cups measurements and current measurement of beam profile monitor

Uniformity sanity checking

Overlapping plastic scintillators mounted on slits provide real time sanity checks of beam uniformity –coupled with florescent imaging screens in irradiation chamber







Irradiation Chamber

Will provide users a translatable stage to carry DUTs and other diagnostic instruments that:

Can be controlled remotely with linear motion (X-Y) and rotation about up to 90 degrees (increases the LET – linear energy transfer)

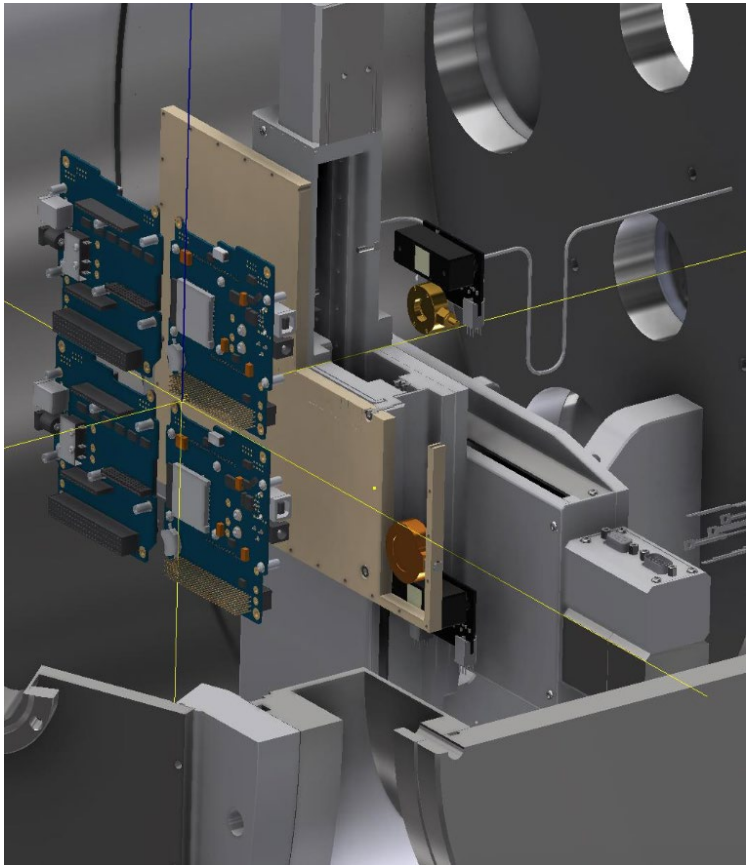
User precision control of selecting area of DUT

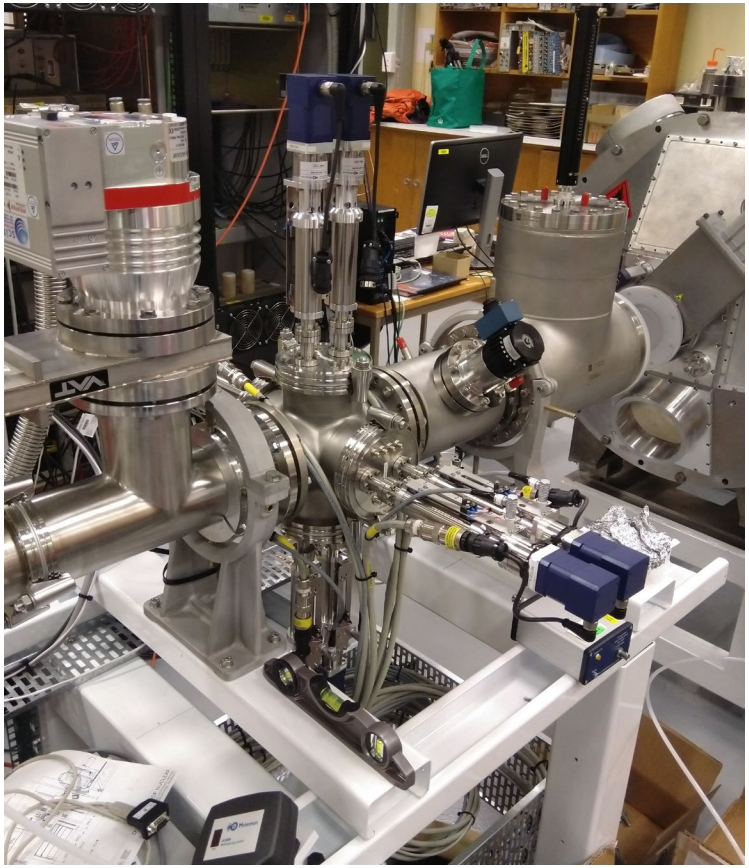
Will allow a minimum area of X-250 mm x Y-200 mm to be moved into the beam path (the scannable area)

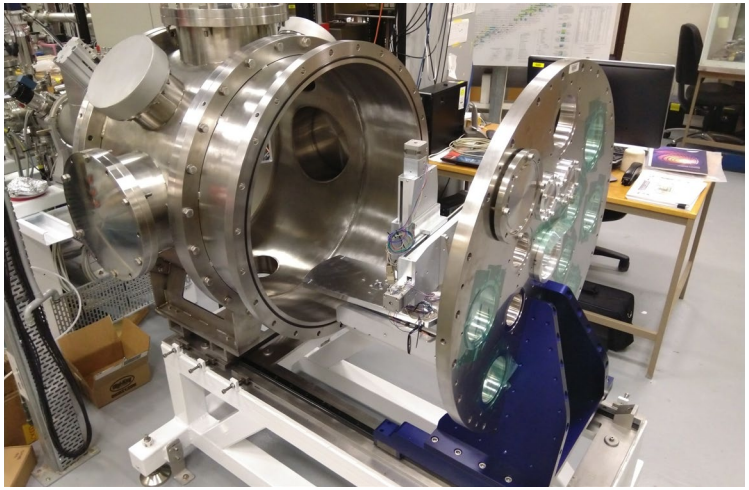
Will provide a wide range of user high vacuum feedthrough for I/O, power etc.

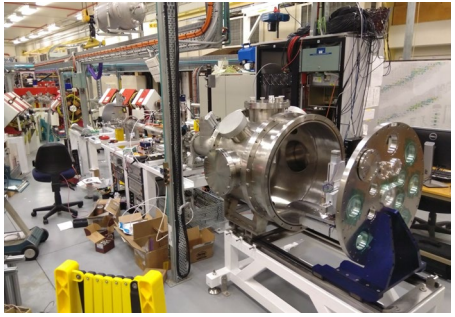
Will host energy degrading to further reduce beam intensity and/or energy reduction

Will host beam diagnostics instruments such as energy detectors, flux monitors and beam imaging screens

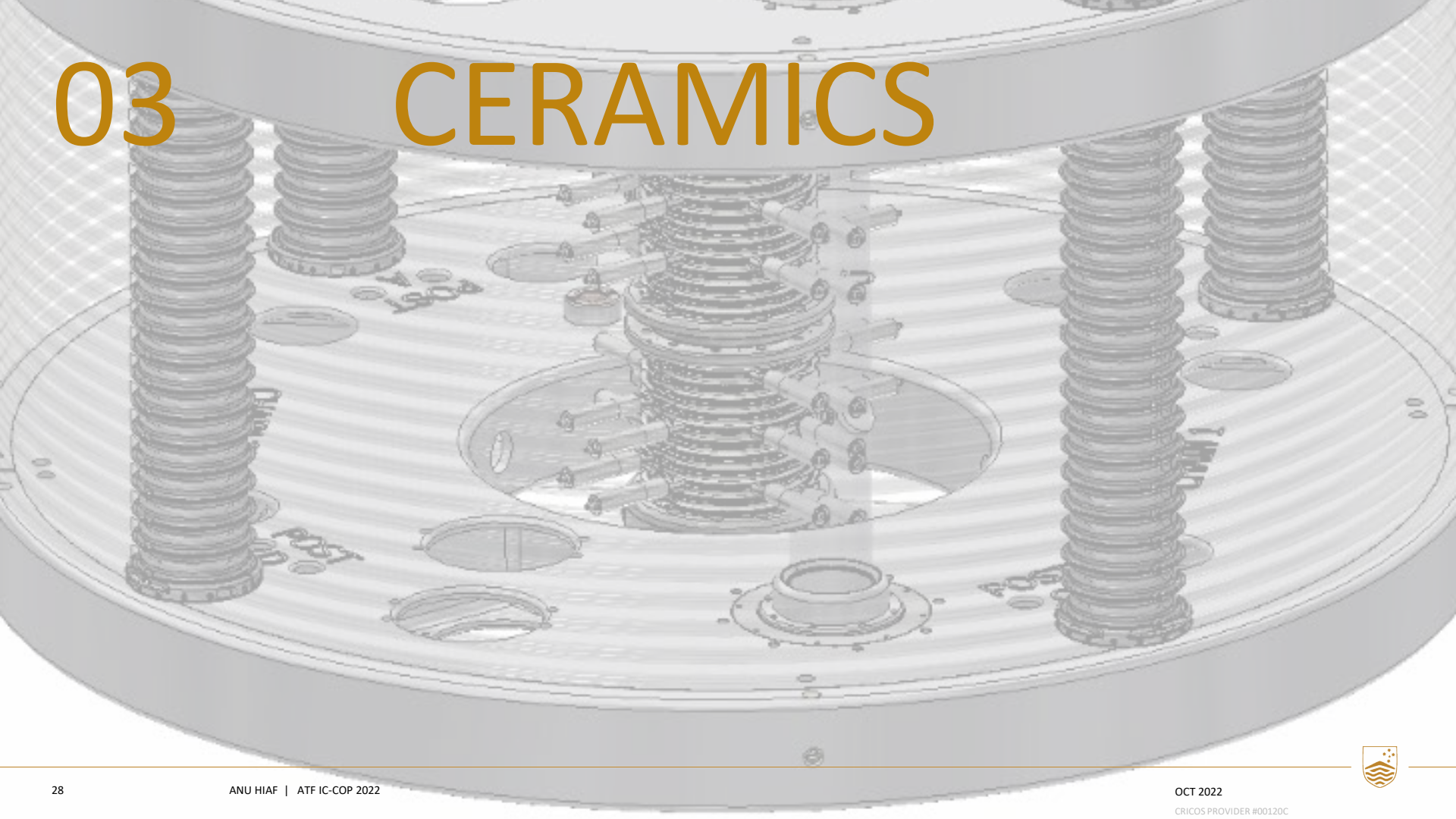


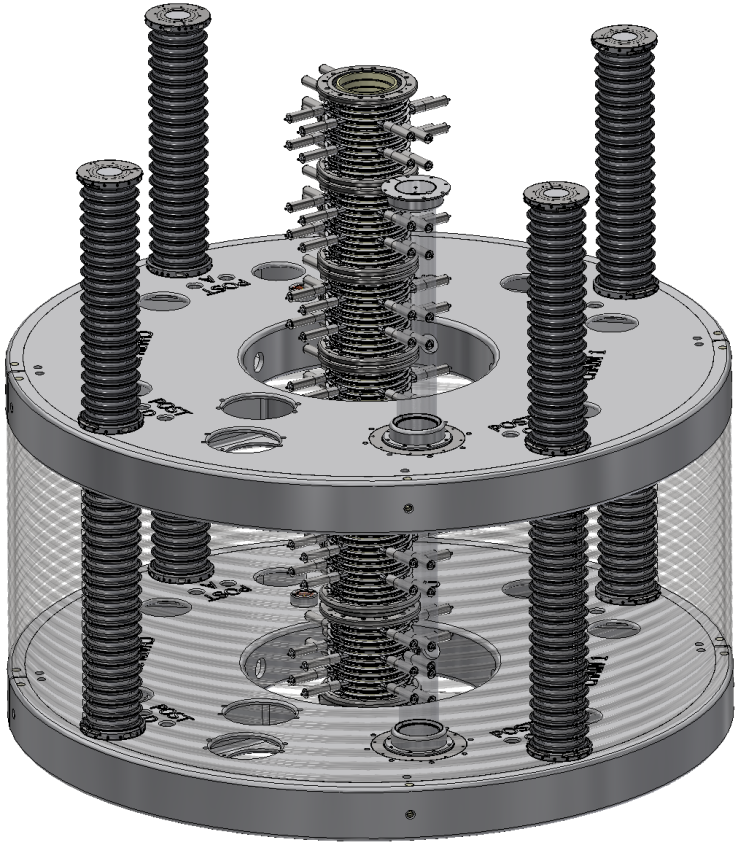


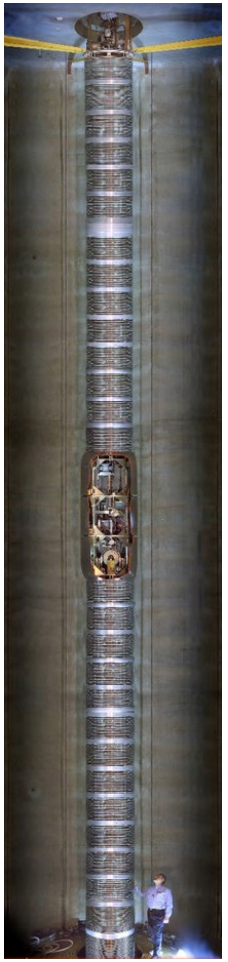




03 CERAMICS







14UD voltage records

Conditioned to 14.8MV in 1983 (with corona points)

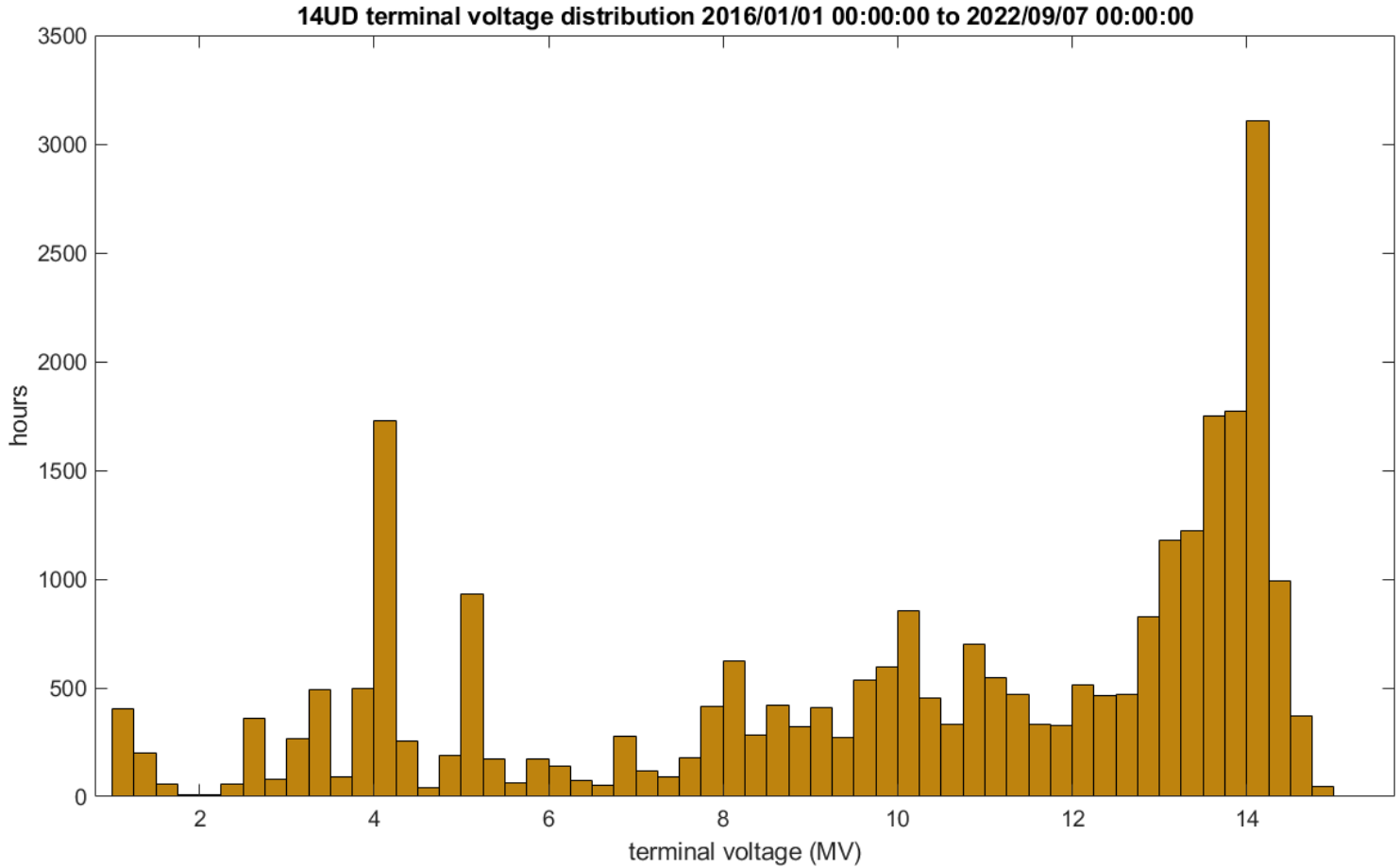
Upgrade to “compressed geometry” and resistors in around 1990

Conditioned to 16.7 MV

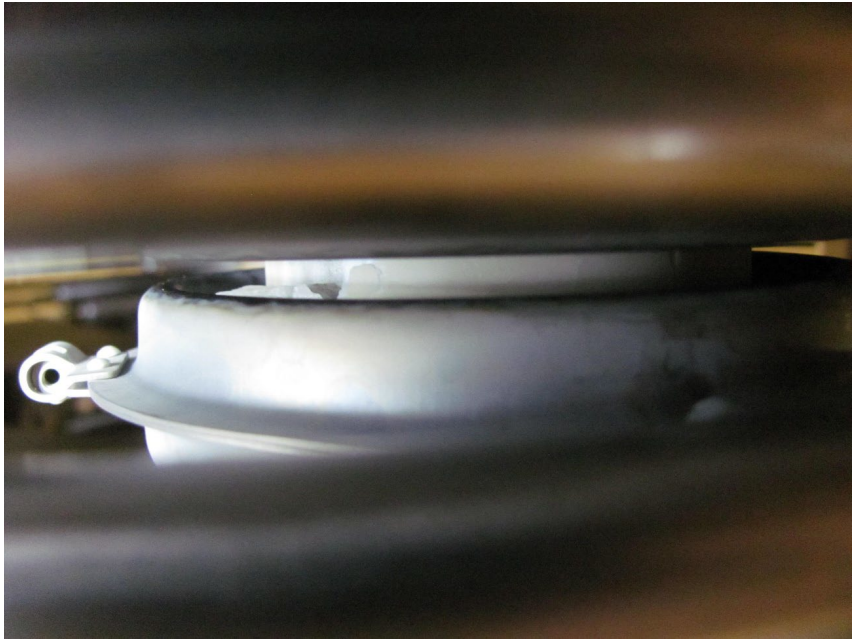
Experiments at 15.5 MV

Now at 14.3 MV max for experiments

OCT 2022



Ceramic insulators



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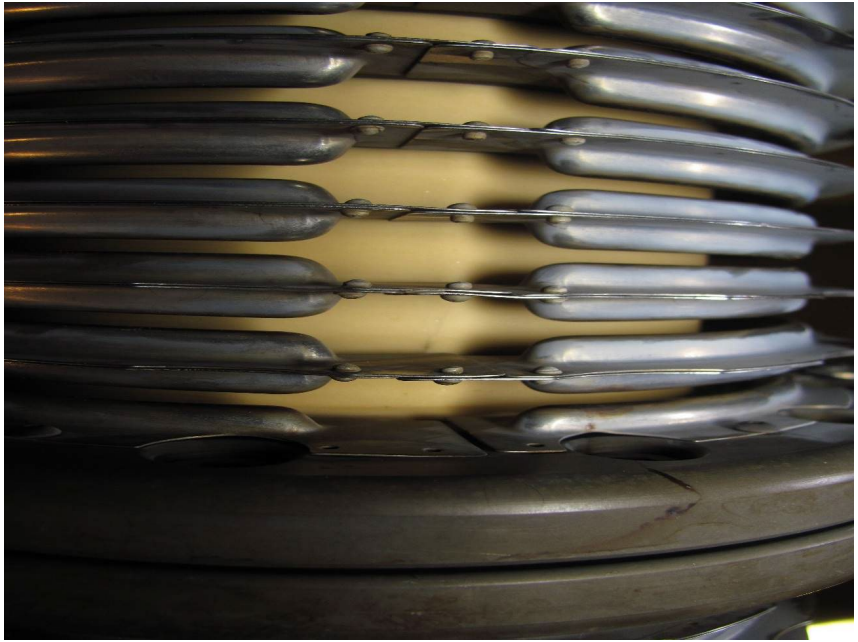
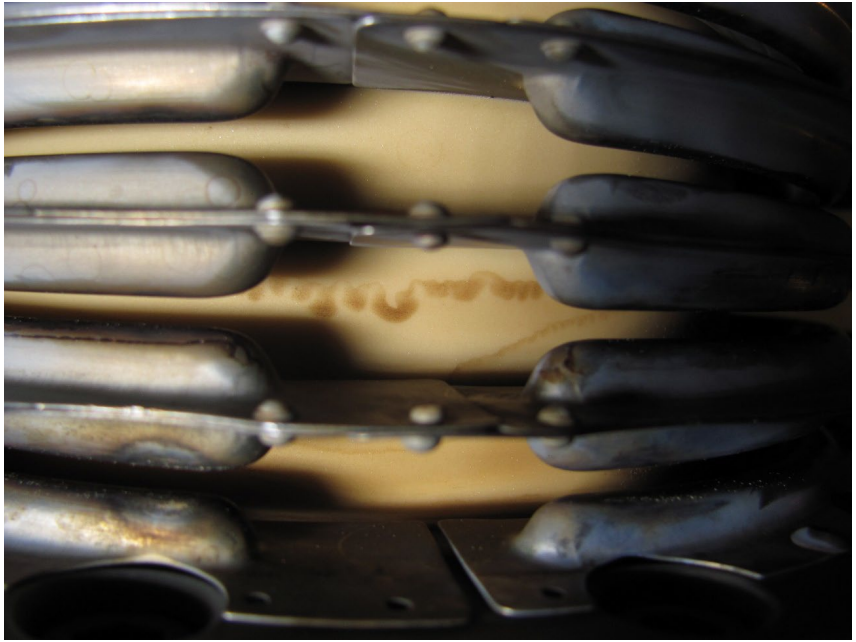
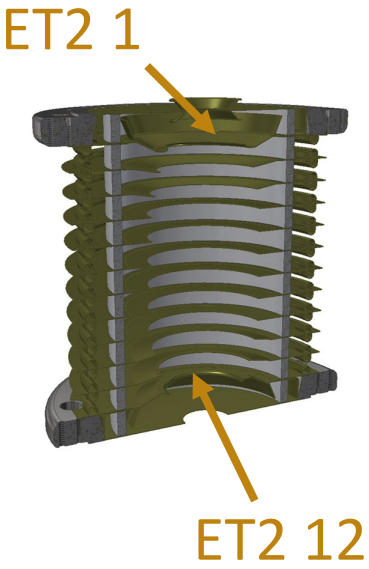
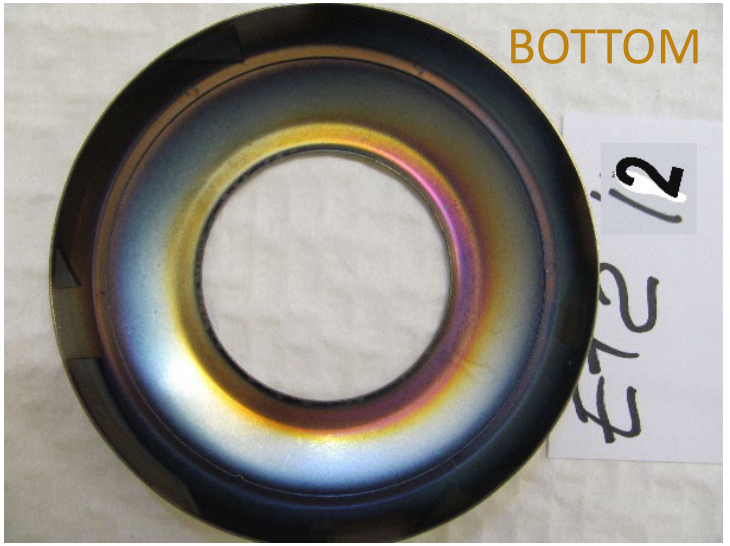




Electrode surface condition





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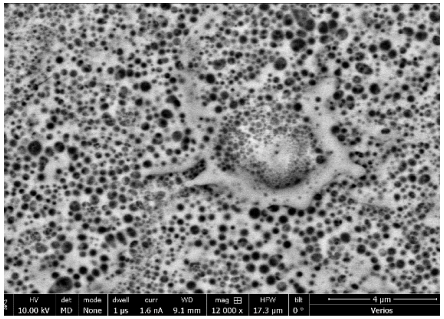
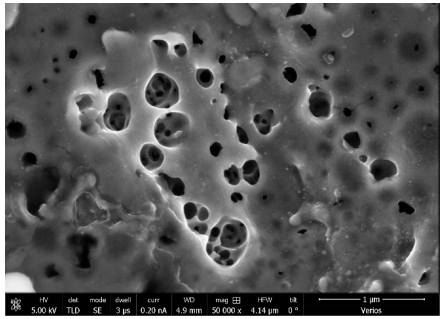
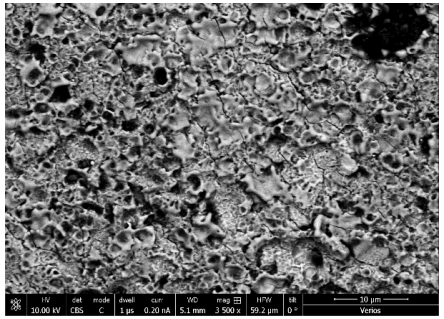
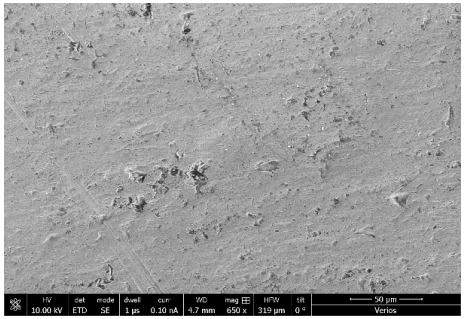


Porosity

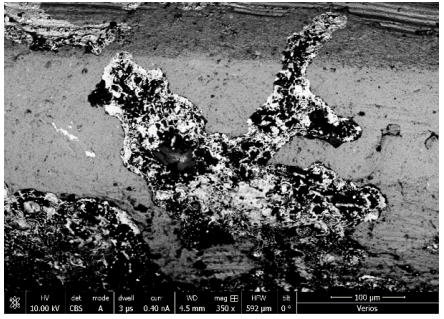




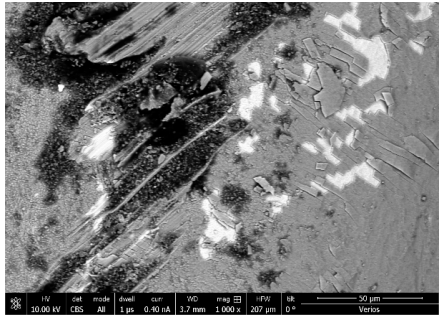
Recrystallization



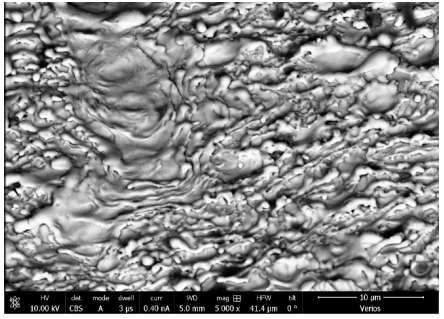
Unused Ti



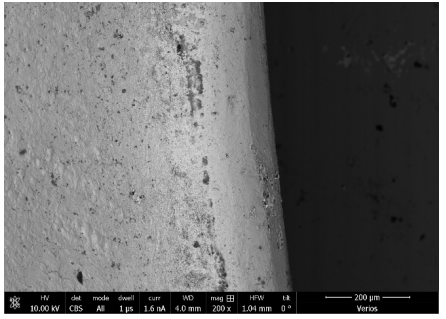
Metal vaporisation



Layer build-up



Melting



Electrode edge

Electrode surface condition

SEM EDX on used electrodes

oxygen 20 – 40%

carbon 10 – 20%

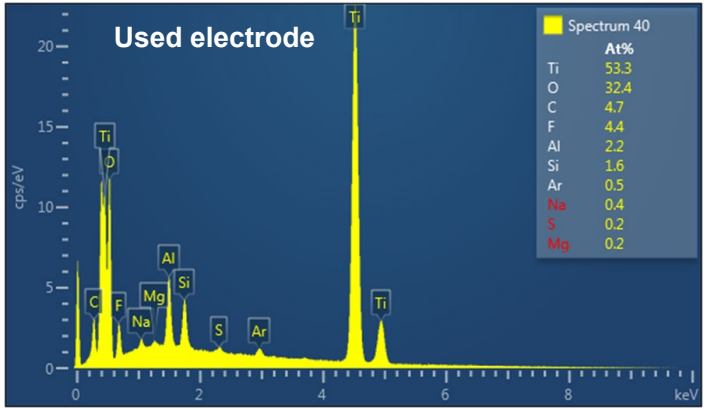
fluorine 3 – 7%

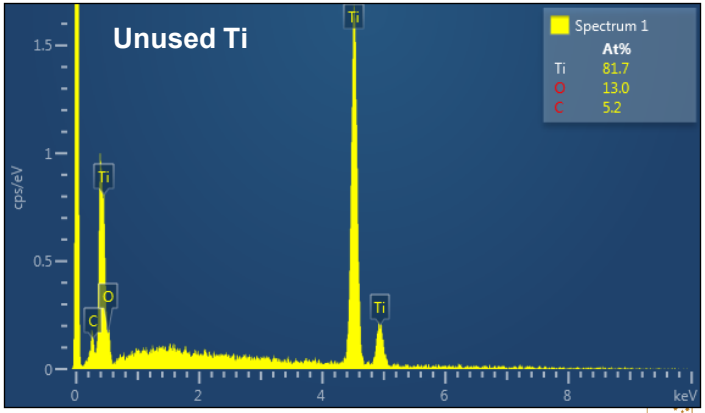
aluminium 1 – 3%

Unused Ti

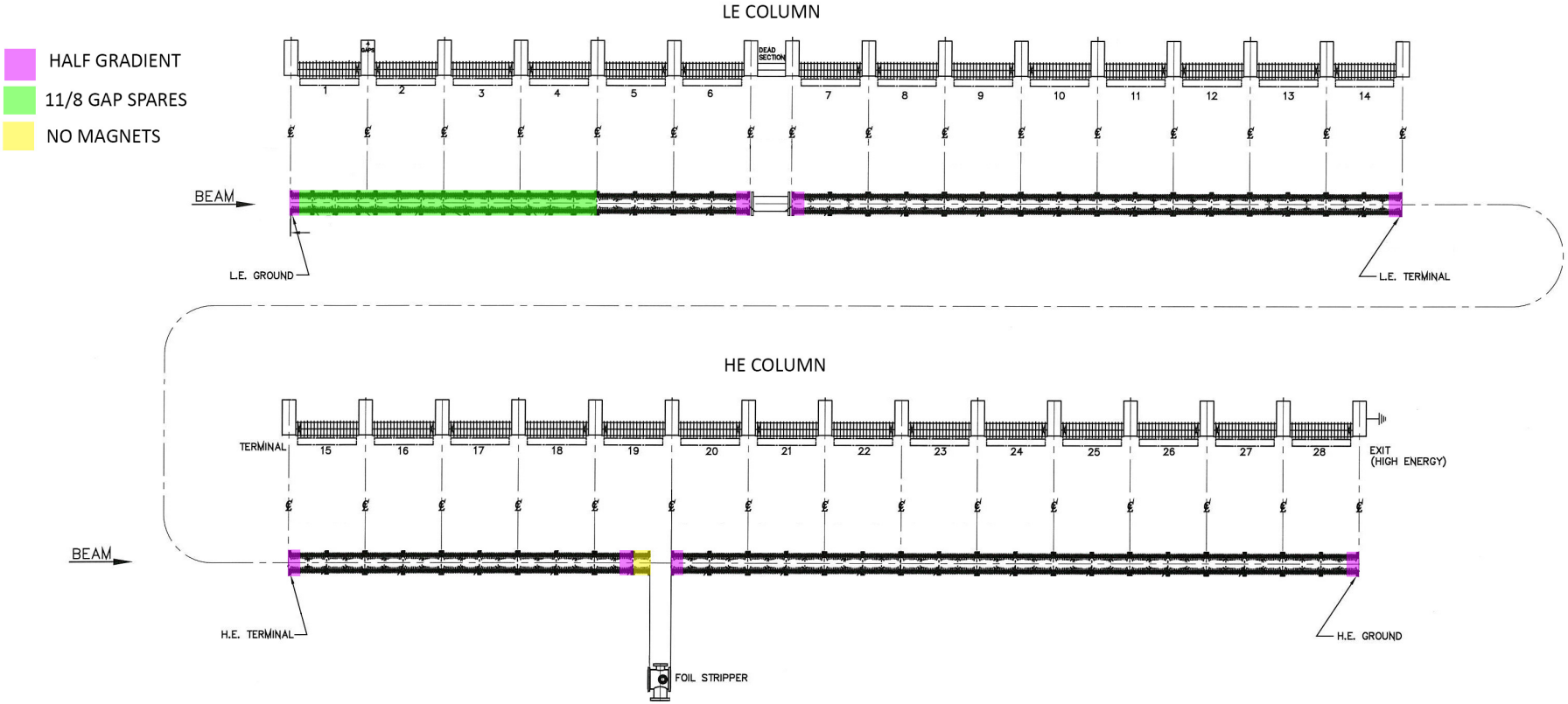
oxygen 10 – 15%

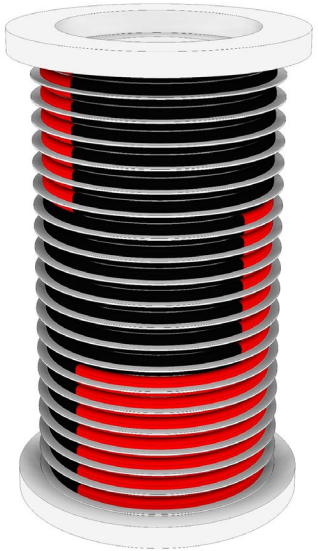
carbon 3 – 6%



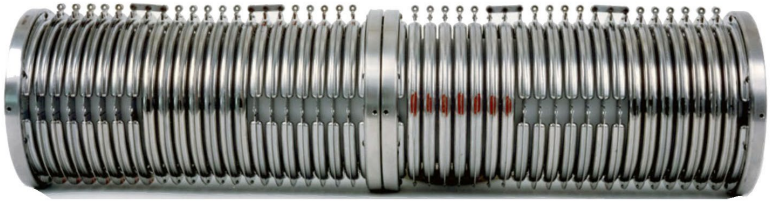


NEC Proposal





T. Tunningley



NEC

Additional informaiton

Notthoff et al. High Voltage Upgrade of the 14UD Tandem Accelerator HIAT 2022

Linardakis et al. High Voltage Performance Degradation of the 14UD Tandem Accelerator HIAT 2018

Development of tool-less resistor mounting

National Electrostatics Corp.

THANK YOU

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