HIA
HEAVY ION ACCELERATORS

SPACE IRRADIATION BEAMLINE: RADIATION TESTING CAPABILITIES

The Space Irradiation Beamline at the Heavy Ion Accelerator Facility (HIAF-SIBL), located at the Australian National University, Canberra, has been developed with the support of the Australian Space Agency. It is dedicated to charged particle radiation testing for space and offers the highest-energy heavy ion space radiation testing facility in Australia. We are proud to be a founding member of the National Space Qualification Network (NSQN), which has a $1B of space qualification infrastructure for immediate, cost-effective testing and accelerated space mission design and delivery.

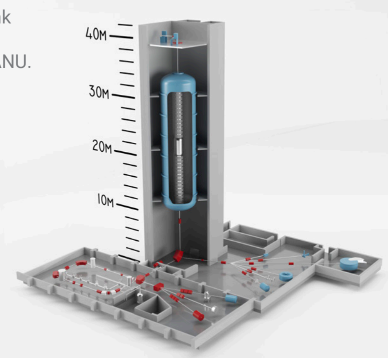

Image: 14UD Blue tank with scale, Heavy Ion Accelerator Facility, ANU.

Heavy Ion Accelerator Facility:

The Heavy Ion Accelerator Facility operates two coupled heavy ion accelerators: a 15-million-volt 14UD Tandem van de Graaff accelerator and a 6-million-volt equivalent superconducting linac booster.

The facility runs 24/7 for between 3500 and 5000 hours per year and delivers beams of nearly any element to one of 11 beam lines, one of these beamlines being dedicated to radiation testing.

HIAF-SIBL Technical capabilities:

Our capabilities are unique in Australia and rare in the world. At HIAF-SIBL we work with clients to provide tests based on their requirements. We also provide consultation and dedicated support during the testing process. The capabilities of HIAF-SIBL are as follows:

- Particle beams from protons up to 28 MeV in energy, to gold ions up to 350 MeV, with a comprehensive range of beam types and energies in between to emulate desired Linear Energy Transfer (LET) values.
- Beam intensities from 10 ions/cm^2/s up to 10^{12} ions/cm^2/s over a user-defined area (up to 40x40mm).
- You can communicate with your device electronically while it is undergoing testing via standard vacuum feedthroughs, including BNC, SMA, USB-A, RJ45 and DB 25.
- An irradiation vacuum chamber that allows the testing of large components or several test boards within a maximum size of 250x200mm.
- A silicon ΔE-E telescope (i.e 2 stacked silicon surface-barrier detectors) available for use with material/solar cell testing.

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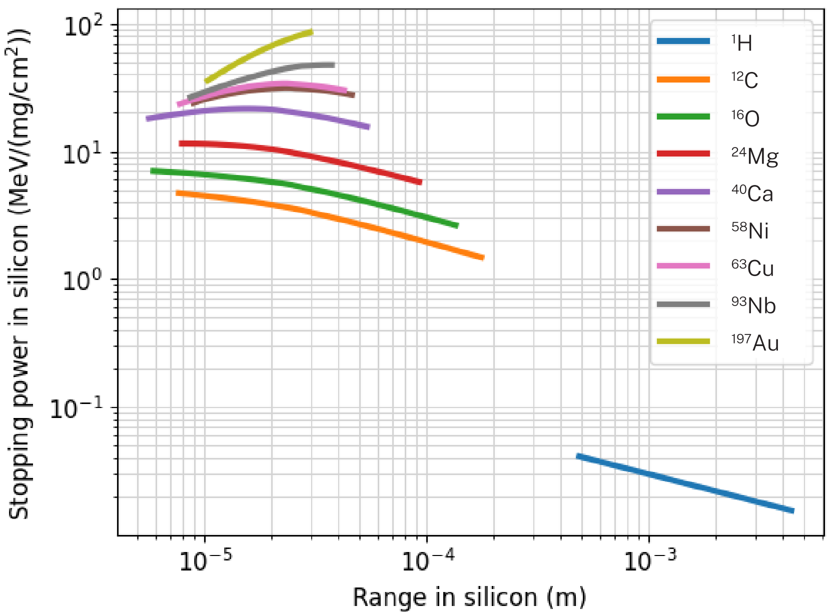
LET/energy:

The following table contains the details of the maximum energy beams available for a selection of species which can be produced by the accelerator for testing. The surface LET and range in silicon have been calculated for these beams using SRIM[1].

The plot below shows the characteristic LET as a function of the range in silicon for a selection of beam species which can be produced with the accelerator. The LET and range were calculated with SRIM and cover the range of energies which can be produced by the accelerator.

Species	Max E (MeV)	Max E/A (MeV/amu)	Surface LET in Si (MeV/(mg/cm^2))	Range in Si (um)
^{1}H	28.15	28.15	0.02	4372.00
^{12}C	98.15	8.18	1.48	175.58
^{16}O	126.15	7.88	2.64	134.32
^{24}Mg	172.63	7.19	5.76	92.62
^{40}Ca	228.35	5.71	15.59	53.87
^{58}Ni	279.60	4.82	27.67	46.03
^{63}Cu	279.60	4.44	30.08	42.42
^{93}Nb	311.80	3.35	26.74	51.13
^{197}Au	349.89	1.78	85.49	29.85

1.Ziegler, J. F., Ziegler, M., & Biersack, J. (2010). SRIM – The stopping and range of ions in matter (2010). *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 268*(11–12), 1818–1823. https://doi.org/10.1016/j.nimb.2010.02.091



Flux/Fluence:

The range of available flux values is from 10 ions/cm^2/s to 10^{12} ions/cm^2/s. This can vary slightly depending on the selected beam energy to remain within the safe radiation limits of the facility.

At HIAF-SIBL there is no limit on total fluence you can test for. However, higher fluences result in longer irradiation time and will extend the time you need to test for.

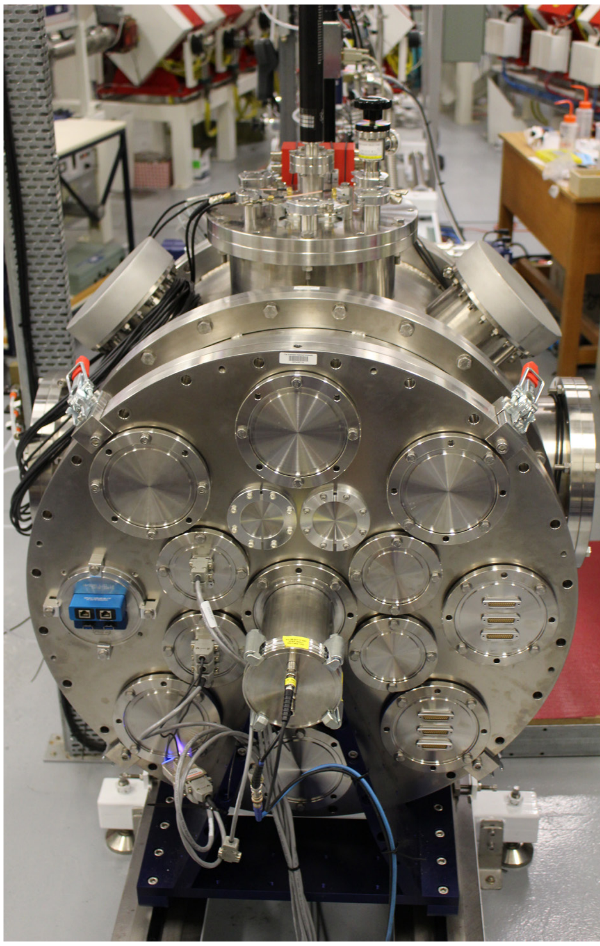


Image: Chamber, Heavy Ion Accelerator Facility, ANU.

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Test chamber:

The irradiation chamber allows the testing of large components or several test boards up to a maximum size of 250x200mm and a total possible irradiation area of 220x200mm. Positioning will be done with a translatable stage, allowing for remote controlled translation in x and y and can rotate to tilt the sample board, changing the beam's incident angle. Please note, all testing is done under vacuum.

Communication features:

Interchangeable vacuum feed-through plates are installed to provide cabling access between the sample board and the user testing system. This will allow users to communicate to and run their device while undergoing radiation testing.

A basic suite of connectors is installed to cover user needs. Depending on cabling needs, there is room for more, and plates can be custom-made.

The pre-installed plates include:

- 12 SMA coaxial female/female connectors, rated up to 18 GHz.
- 6 DSUB 25-pin male/male reversible connectors.
- 2 ethernet interface connector.
- 2 USB 3.0 type A female/female connector.
- 10 BNC connectors.

Beam characteristics and dosimetry:

By using a rastering magnet, we can change the beam spot from 1x1mm up to 70x70mm for uniform irradiation. After the magnet, the beam passes through two 40x40mm slits allowing the beam spot to range between 1x1mm area and a 40x40mm area. With the moving test stage, the total possible irradiation area is 220x200mm.

For low flux monitoring we use the combination of scintillators and SIPMs while for high flux monitoring, we make use of a beam profile monitor.

Detectors:

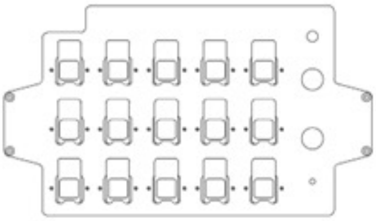
We have a silicon ΔE-E telescope (i.e. 2 stacked silicon surface-barrier detectors) available for testing which is compatible for use with our material samples mount.

Mount availability:

We have two existing mounting setups for use; a 20x20mm sample plate designed for material and solar cell samples, and a pinboard plate designed for electronic components.

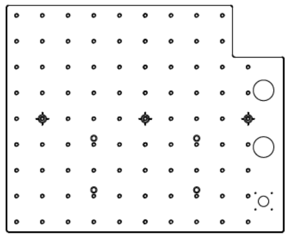
Material samples mount:

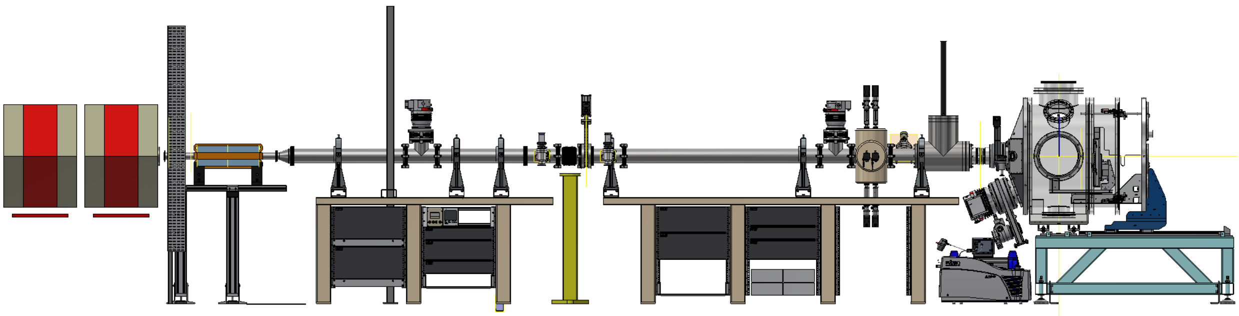
Consists of a mounting plate designed to fit fifteen 20x20mm samples attached to the chamber stage. The attachment has a gap between the moving stage and the mount to allow space for our detector.



Electronics mount:

Acts like a pinboard with 25mm grid spacings of M4 threaded holes to attach boards and components for testing. This mount is incompatible with the use of energy detectors.





Fees:

The daily cost of testing varies from $3,000 to $12,000 depending on the user category. Each day of beam time represents 16 hours of operation and dedicated support from our physicists and technical staff.

In addition to daily fees, industry users will be charged an initial one-off setup/consultation fee $2,500 irrespective of the number of days for testing. This fee recognises that users will require assistance in designing/framing their experiments and the design or manufacture of new mounting, or modification of existing mounting. Please request our detailed pricing guide for more information and case studies.

Please note the HIAF-SIBL does not provide a formal radiation certification but will help you understand the performance of your device or shielding material in a space-like radiation environment, to inform the next steps in reducing risks to your mission.

How do I arrange testing?

For enquiries about testing, a tour of the facility or more information, contact our User Engagement Team userengagement.hiaf@anu.edu.au.
Our team can give you a tour, discuss your requirements and proposed tests, and guide you through the booking process.

Image: Heavy Ion Accelerator Facility, ANU.

ABOUT US

The Space Irradiation Beamline is enabled by the Heavy Ion Accelerators (HIA) project funded through the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS). We are proud to be a founding member of the National Space Qualification Network (NSQN), which has a $1B of space qualification infrastructure for immediate, cost-effective testing and accelerated space mission design and delivery. Our capabilities are unique in Australia and rare in the world. We can emulate the space radiation environment to test your equipment under the most damaging ionising radiation conditions equivalent to those expected in orbit. Such testing presents the opportunity to reduce the risk of project failure as well as lower the cost and complexity of space missions.

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