



Virtual XFM & IRM Microscopy Workshop at the Australian Synchrotron

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Microscopy Beamlines Group Manager

Science. Ingenuity. Sustainability.

Acknowledgement of Country

*We acknowledge the people of the
Kulin and Dharawal nations,
and the various traditional nations on whose lands
we are all meeting today, and pay our respects to the
local people and Elders: past, present and emerging.*

ANSTO's Landmark Science Facilities

OPAL Research Reactor
Lucas Heights, Sydney

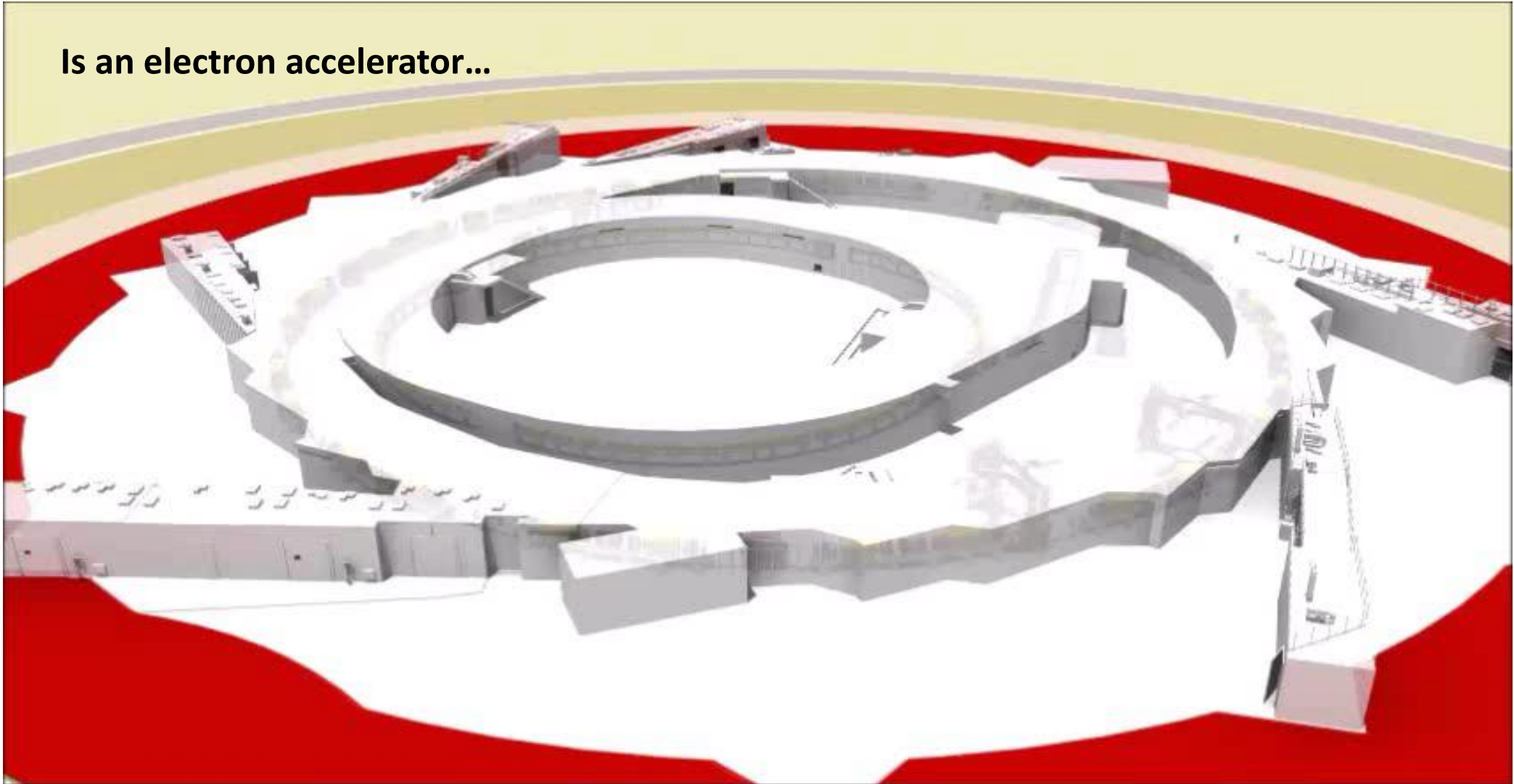


Australian Synchrotron
Clayton, Melbourne

One of ~20 International Synchrotron
facilities of similar or greater size

The Australian Synchrotron

Is an electron accelerator...



When electrons travel through magnetic fields at relativistic speeds they generate intense beams of synchrotron light (Infrared, visible and X-rays)

10 Operational Beamlines

Infrared Microscopy

Imaging and Medical Beamline

Macromolecular Crystallography

Micro-focused Crystallography

Powder Diffraction

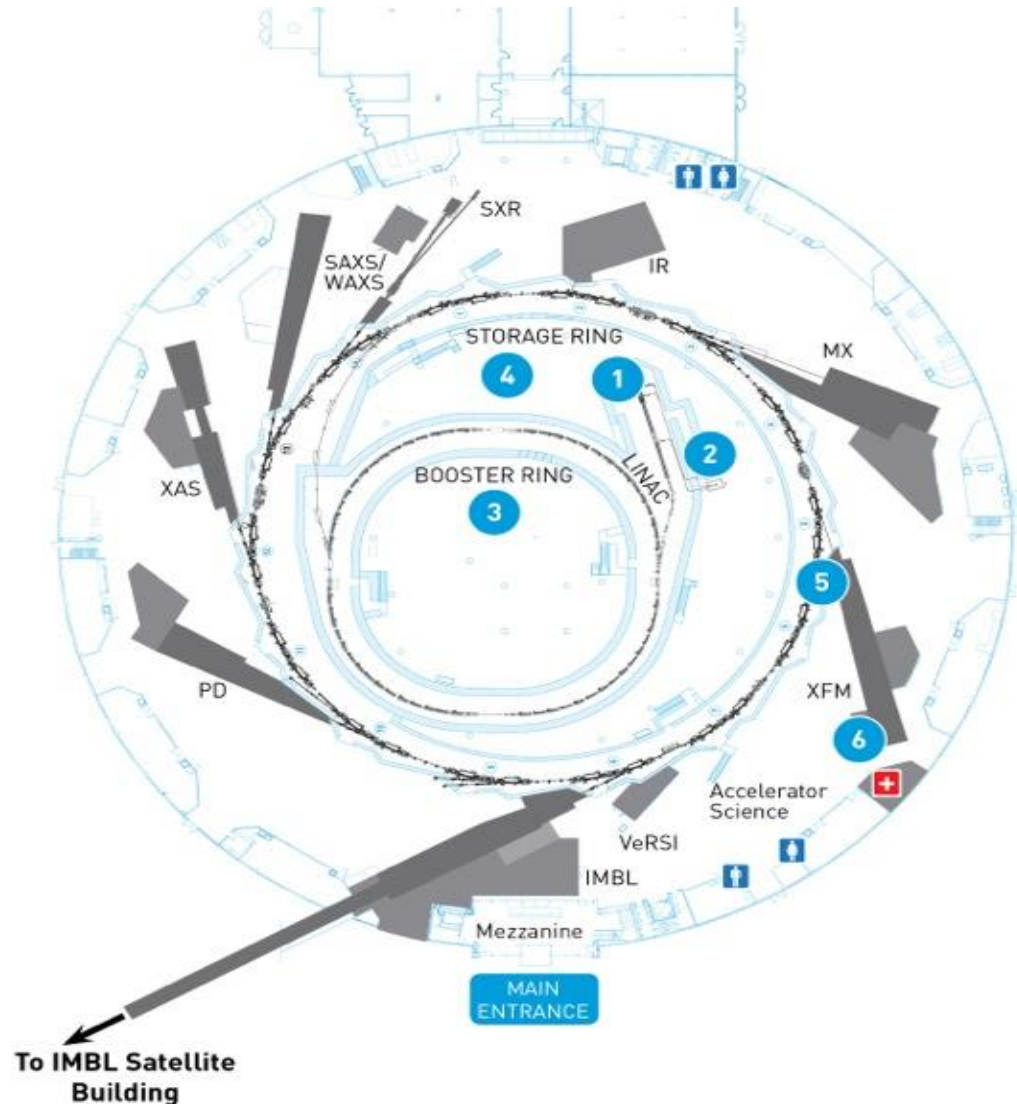
SAXS / WAXS

Soft X-ray Spectroscopy / ARPES

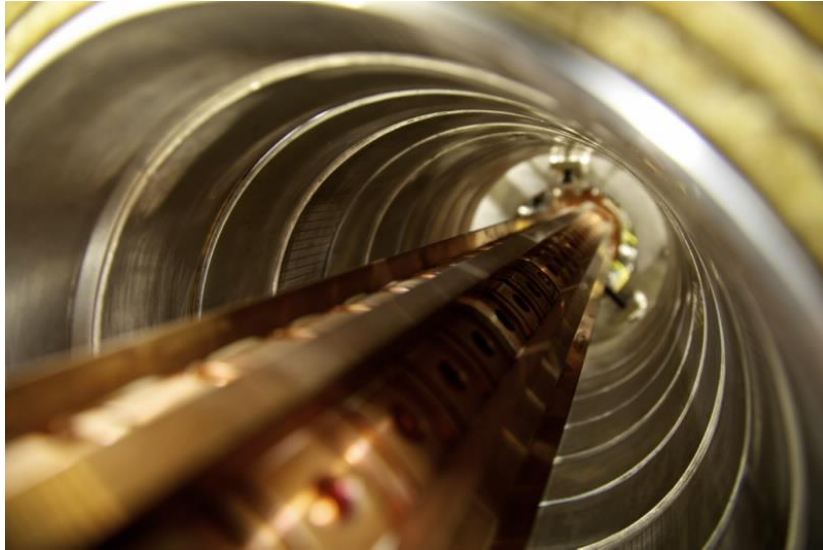
Terahertz / Far-IR Spectroscopy

X-ray Absorption Spectroscopy

X-ray Fluorescence Microscopy



The Australian Synchrotron – Accelerator Systems



Circumference: 216 m

Electron Energy: 3 Billion eV (GeV)

Electron Velocity: 99.9999985% Speed of Light

(0.7 microseconds per lap)

Beam Current: 200 mA; 1.25×10^{18} e-

Electron Beam Size ~60 microns

Vacuum Pressure: 10^{-11} mbar

Magnetic fields: up to 4 T



The Australian Synchrotron at a Glance

5000 Hours of Stored Beam; 24 hours per day, 5 or 6 days per week,

10 Operational Beamlines

1000 Experiments per annum

5,500+ User Visits

650 Journal Publications

400 New Protein Structures

150 Graduate Theses; 20 Patents

~50+ Capital Development Projects worth ~\$75M+

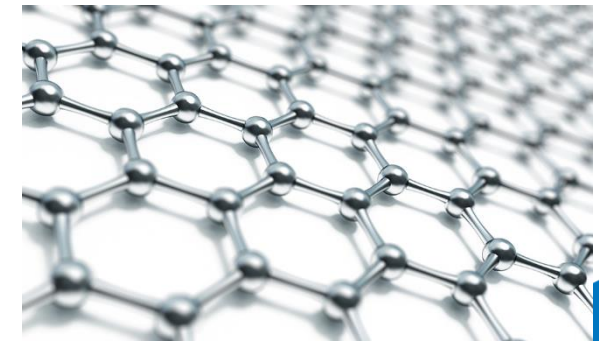
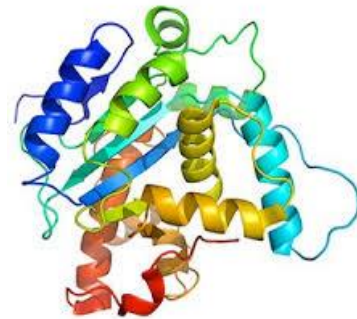
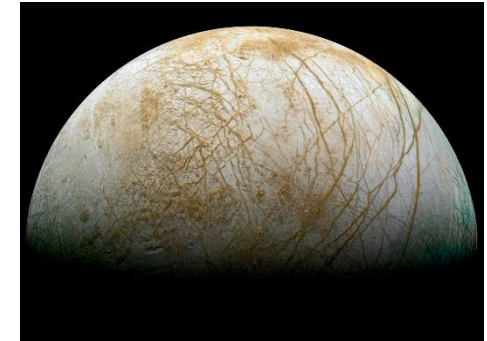
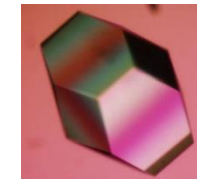
8 New BRIGTH Beamlines \$95M



A 'Typical' Synchrotron Sample

(There's no such thing...)

- From a few microns to $\sim 1 \text{ m}^2$
- A single layer of atoms up to $\sim 100 \text{ kg}$
- 10 K – 2300 °C
- Pressures up to 30,000 atmospheres
- Parts per billion
- 0.005 mg/mL

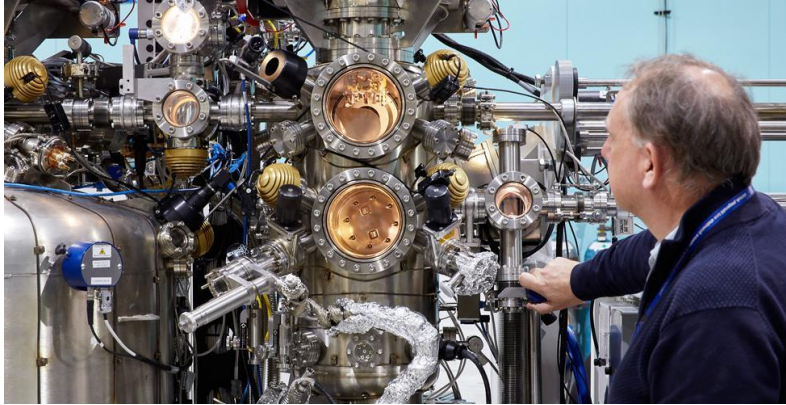




Pharmaceuticals & Health
Advanced Materials
Agriculture & Environment
Energy Technologies
Mining & Mineral Processing
Medical Imaging & Therapy
Surfaces & Coatings
Defence Technologies
Food & Nutrition
Advanced Manufacturing

650 peer-Reviewed Publications in 2020

The Australian Synchrotron User Experience



- Beam available 24 hours, 5-6 days per week
- Experiments run from a few hours to up to 6 days
- Some beamlines can run 1000's of samples per day
- Some experiments generate 100,000's datasets & up to 10 Tb
- Some experiments host up to 20 researchers per day
- 24 hr support from Accelerator Operators
- Interactive data capture & storage, analysis & processing
- On-site 50 room Guest House
- **Free Coffee !!!**

10 Operational Beamlines

Infrared Microscopy

Imaging and Medical Beamline

Macromolecular Crystallography

Micro-focused Crystallography

Powder Diffraction

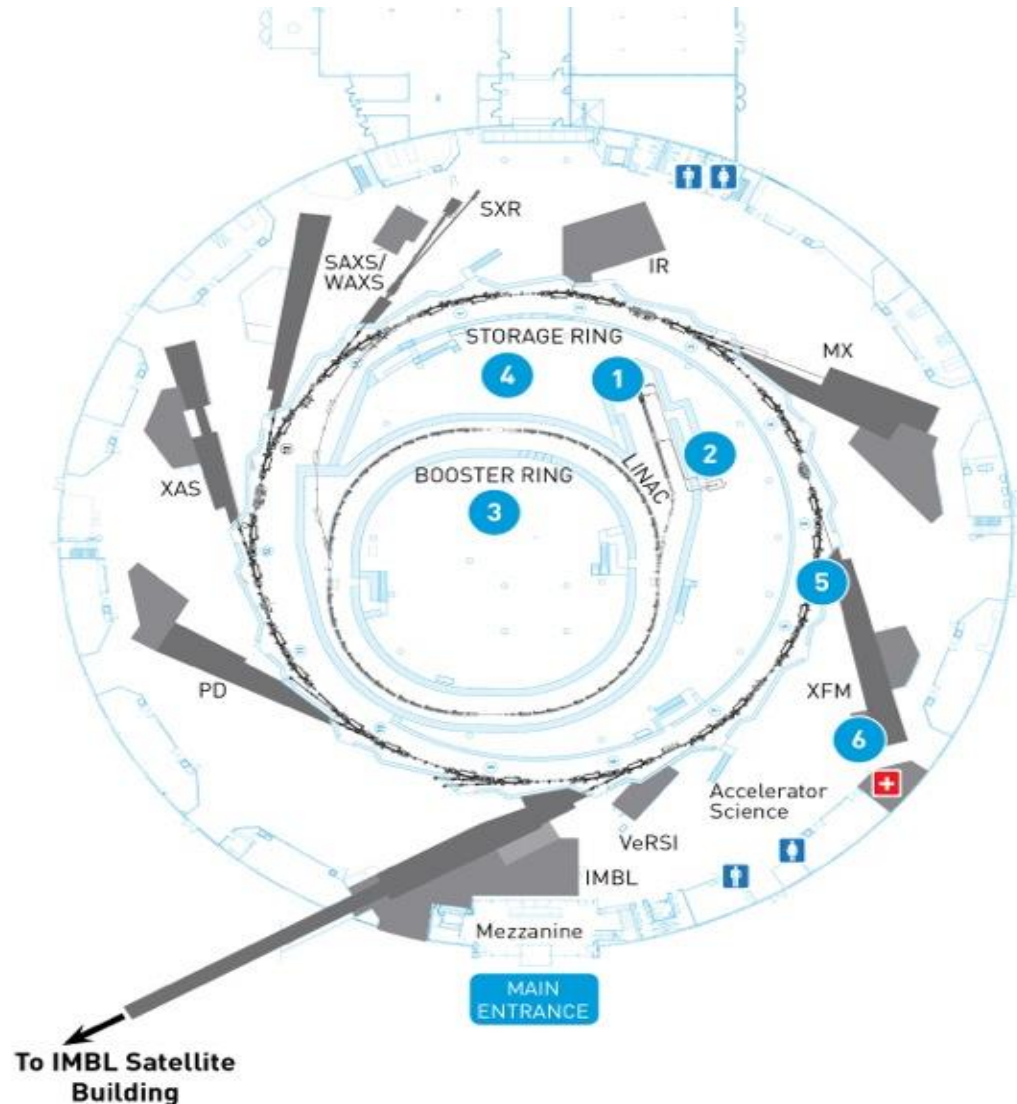
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Soft X-ray Spectroscopy / ARPES

Terahertz / Far-IR Spectroscopy

X-ray Absorption Spectroscopy

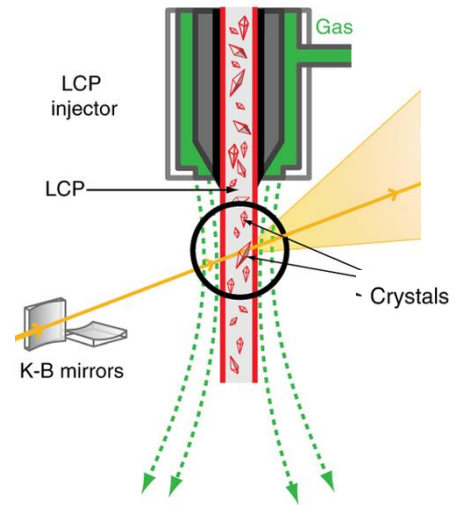
X-ray Fluorescence Microscopy



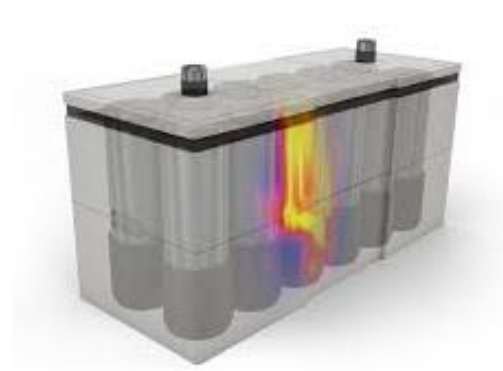
The 8 New BRIGHT Beamlines

The BRIGHT Beamlines will deliver...

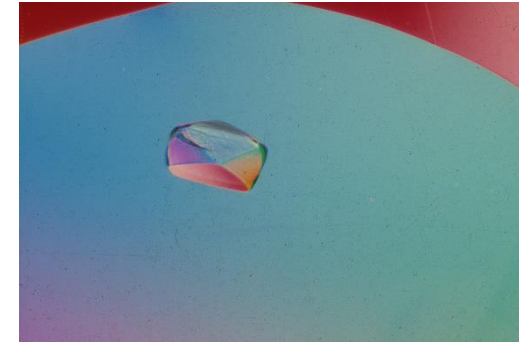
BRIGHT



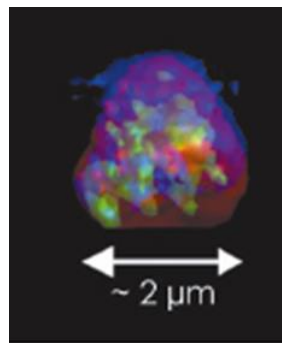
Higher Throughput



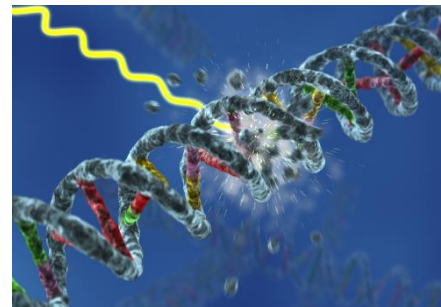
Higher Energies



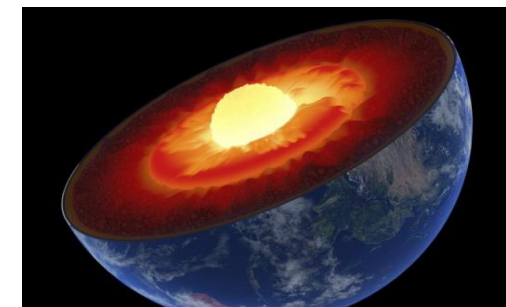
Smaller Beams



Finer
Spatial Resolution

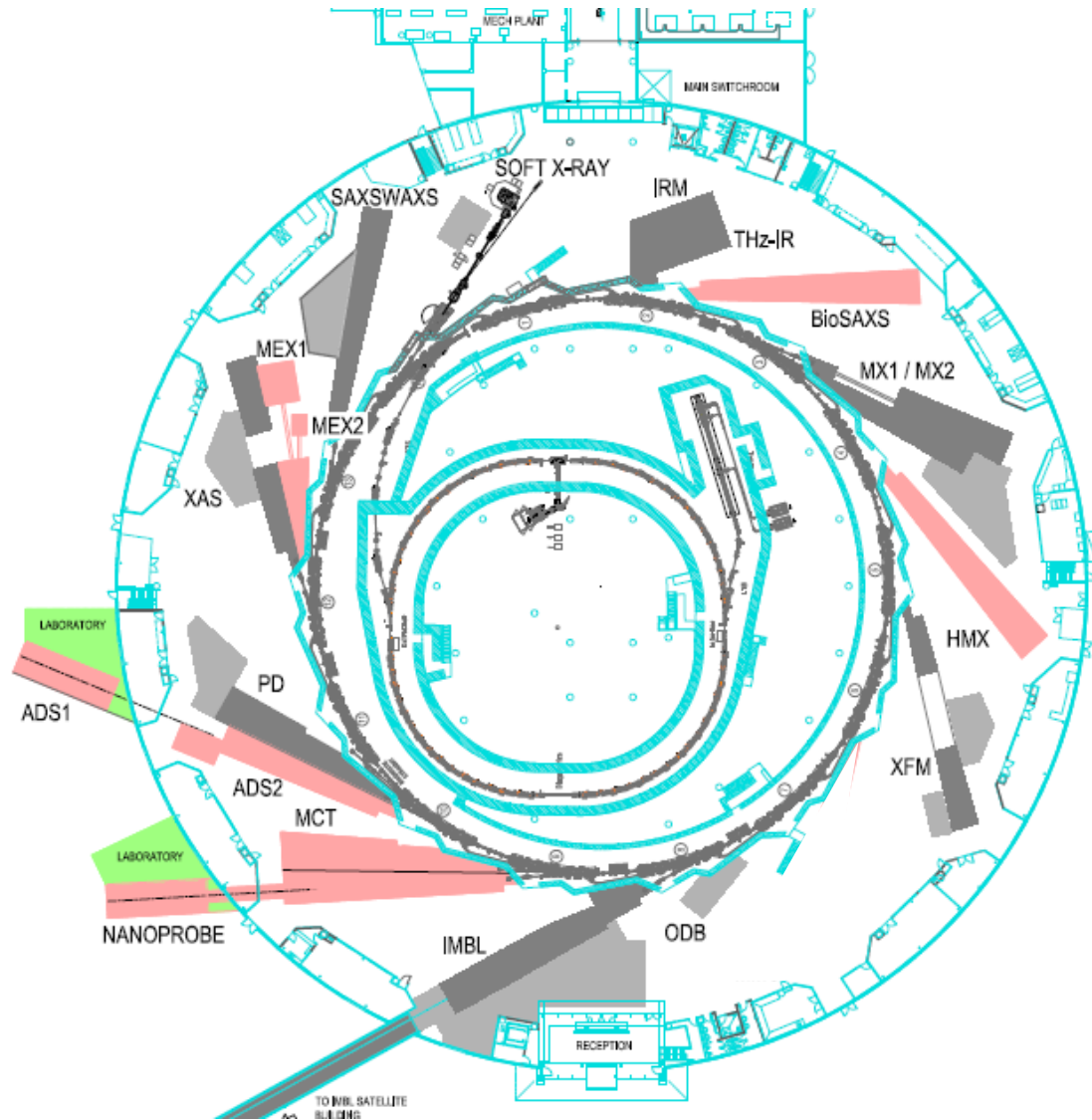


Less Damage



Extreme
Environments

The BRIGHT Beamlines

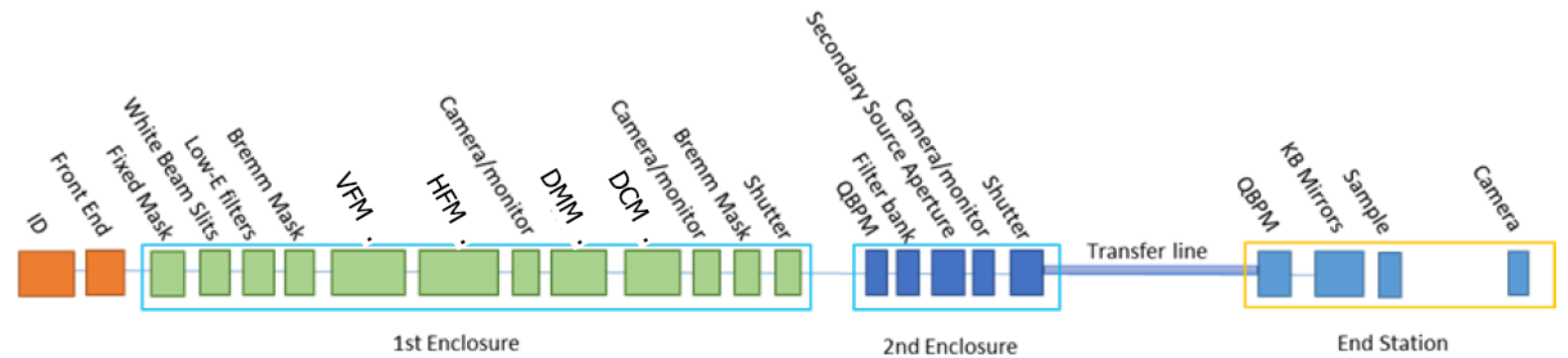
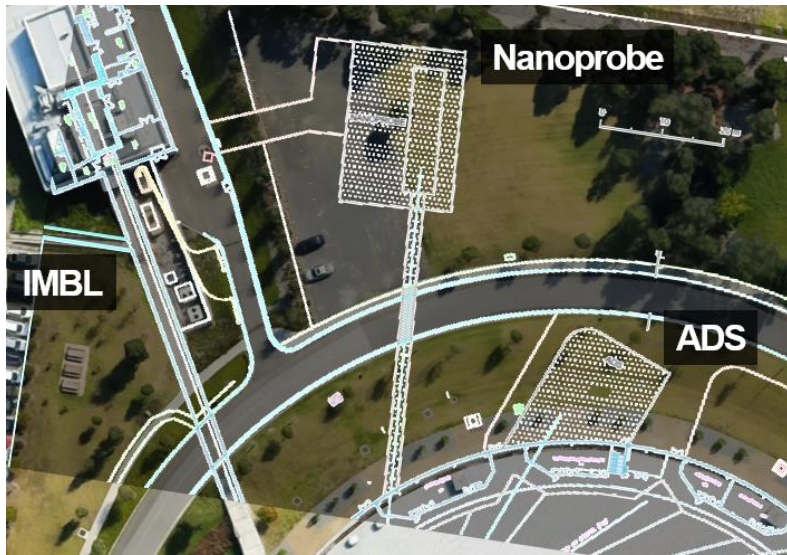


BRIGHT Program: ~\$95M

Start construction of two new beamlines P.A.

- Medium Energy XAS 1 & 2
- Micro-Computed Tomography
- Biological SAXS
- Advanced Diffraction and Scattering 1 & 2
- High Performance Macromolecular Crystallography
- X-ray Fluorescence Nanoprobe

BRIGHT Progress - X-ray Fluorescence Nanoprobe



Cryogenic Permanent-Magnet Undulator

Beamline Length – ~110 m

DMM: ~5 keV – 20 keV; broadband – *Mapping*

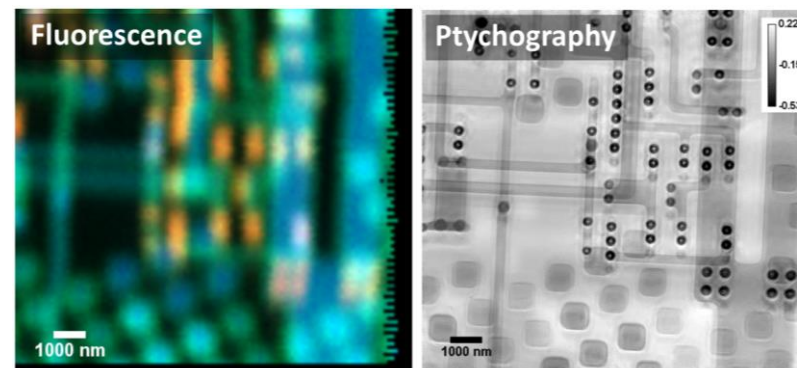
1e 8 ph/s (photons per second) - 60 nm focus at 10 keV

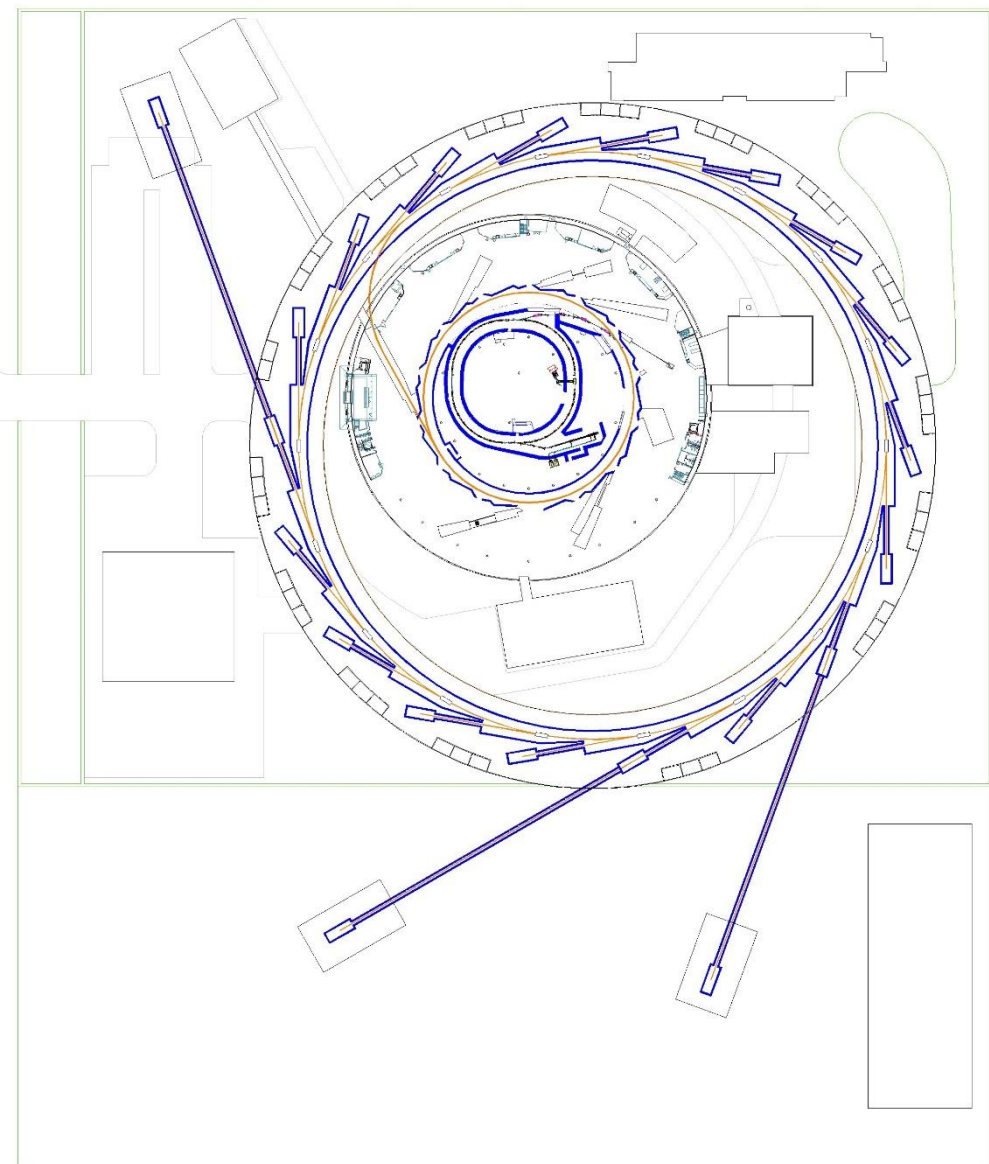
1e10 ph/s into a 100 nm focus at 10 keV

DCM 5.6 keV – 20 keV, monochromatic – *Spectroscopy*

Scanning X-ray Diffraction Microscopy - 15 nm resolution

X-ray Fluorescence Nanoprobe
Conceptual Design Completed
Undulator installed – late 2022
Satellite Building Completed – 2023
1st light – late 2023
Commissioning – mid 2024
1st Users – July 2024

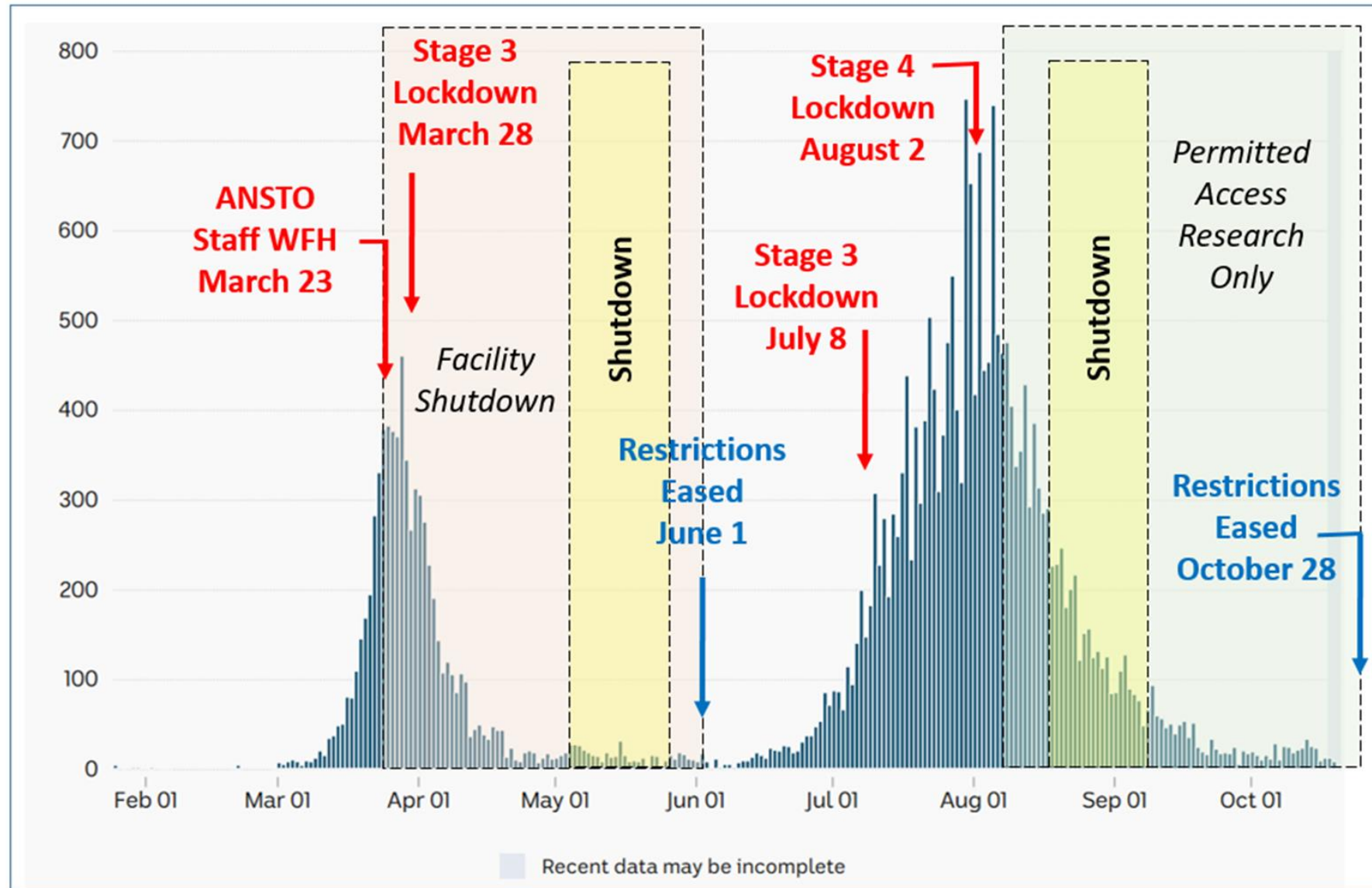




In 2021...

**Workshop on Future Synchrotron
Science &
BRIGHT-II Suite of Beamlines**

COVID-19 and the Australian Synchrotron in 2020

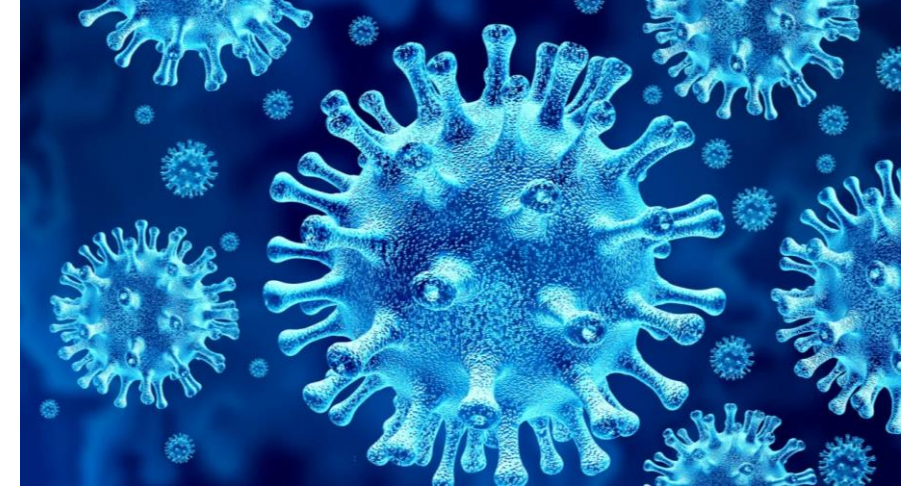


Operations & Outputs: 2020

Hours of Stored Beam:	~3700	(normally 5000)
Machine Availability:	98.5%	
Beamtime Delivered:	75%	
New Users:	612	
User Visits:	3500	
Journal Publications: AS Beamlines:	650	(32% JIF > 7)
Journal Publications: ISAP / Other Staff:	37 / 19	
PDB Structures:	480	
Patents:	18	

The COVID-19 Rapid Access Program

In March, the Australian Synchrotron established a *Rapid Access Program* to support research into the detection and treatment of the SARS-CoV-2 virus and COVID-19.



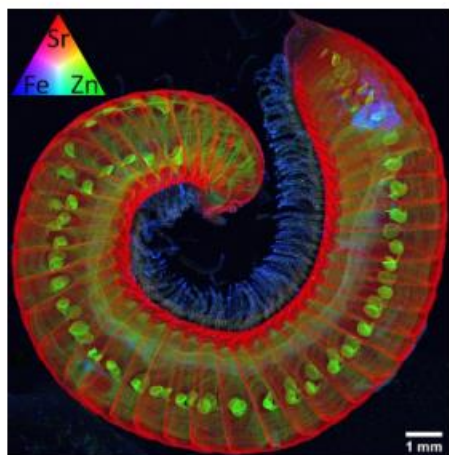
Program operated during lockdown restrictions.

More than 40 COVID-19 related experiments have been undertaken by domestic and international research institutes and companies.

Macromolecular Crystallography; X-ray Fluorescence Microscopy;
X-ray Absorption Spectroscopy; Soft X-ray Spectroscopy,
Infrared Microscopy.

Synchrotron Wiki

Welcome to the XFM beamline



The X-ray fluorescence microscopy beamline (XFM) is a hard X-ray beamline at the Australian Synchrotron and specializes in the spatially resolved detection of elements at the micrometre length scale, XANES imaging, large area elemental mapping and ptychography.

Click on the link for information regarding applications for beam time: [Access information](#).

Meet the team

We are happy to help with your questions regarding the beamline and what it can do for your science. You can contact us all at as-xfm@ansto.gov.au or see the team members [here](#).



Welcome!

The infrared microscopy beamline analyses a diverse range of samples for chemical and structural information; from bone to meteorites to electrochemical cells to plant material to cheese to paint, the possibilities seem almost endless!

There are predominantly two reasons to utilise synchrotron-FTIR microscopy:

1. To gain spatially resolved information about a sample through raster mapping (point-by-point measurements of individual spectra that are stitched together)
2. To acquire single point spectra on samples which are too small for laboratory-based instruments

Next round

- 2022-1: User beamtime late January to early May 2022
- Call for proposals opens mid-August 2021
- Call for proposals closes mid-September 2021

Timetable

■ Today XFM

- XFM Beamline & Capabilities - [David Paterson & Daryl Howard](#)
- Advanced XFM methods & Nanoprobe beamline - [Cameron Kewish](#)

- Sample preparation XFM / IRM studies in biology - [Mark Hackett](#)
- XRF analysis using GeoPIXE - [Chris Ryan](#)

- Geology: Life on the edge & secrets of magmatic sulfide systems
[Louise Schoneveld, Siyu Hu & Steve Barnes](#)
- **Discussion Session: Sample Preparation**

Timetable

■ **Tomorrow** **IRM**

- IRM Beamline & Capabilities – [Mark Tobin](#)
- Macro-ATR capabilities for high-resolution surface characterisation
[Jitraporn \(Pimm\) Vongsvivut](#)
- Measuring bone composition in health & disease - [Martha Blank & Natalie Sims](#)

- Synchrotron IRM to explore fingerprint chemistry- [Rhiannon Boseley](#)
- sFTIRM from archaeological human bone - [Justyna Miskiewicz](#)
- Soil carbon research from past, present and future - [Han Weng](#)

- **Discussion session: Future capabilities of the IRM beamline**
- SynchrotronIR nanoscopy for materials and life sciences - [Andreas Huber](#)
- How to apply for beamtime – [Annaleise Klien](#)

