UM 2025

Australian Synchrotron User Meeting

Wed 26th - Fri 28th November 2025

ANSTO

Illuminating synchrotron science!

ABSTRACT BOOK

With thanks to our sponsors

New Zealand Synchrotron Group

RAYSPEC
X-RAY SPECTROSCOPY

AVS
Australian Vacuum Services

X-SPECTRUM

AINSE
THE AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING

ANSTO

Zachary Candiloro

DAY 1

ABSTRACT 3

Scattering Approach to Understanding Protein-Nanoparticle Interactions within Ionic Liquids and Deep Eutectic Solvents

Nanoparticles have garnered attention in recent decades as strong candidates for drug delivery of many different medicines. While nanoparticle-based medicines have great customizability in their size, structure and functionality, many face limitations upon entering the human body. Protein corona are one such limitation, being a dynamic, multi-layered shell-like structure which can have profound effects on the stability, distribution, uptake, and efficacy of intravenous drug delivery, due to human serum proteins readily forming corona within biological fluids. However, the protein corona formation process is still not fully understood. In this study, we aim to use small angle X-ray scattering (SAXS) to present a comprehensive analysis of protein corona formation, including bovine serum albumin, human serum albumin and human serum, on different nanomaterials. The effect of added ionic liquids and deep eutectic solvents, which readily interact with nanoparticles and proteins, will be explored. With a focus on the cosolvents' impact on the formation of a protein corona, to decode interactions between solvents, proteins, and nanoparticles. This builds upon our previous work where we have utilised SAXS to observe the stability of serum albumin in ionic liquids and deep eutectic solvents as well as protein-nanoparticle complexes with different functionalised silica nanospheres. This work utilised SAXS to observe corona complexes in solution, successfully removing scattering contributions of free proteins, effectively isolating the information of individual nanoparticle and protein components.

Authors: Zachary Candiloro (RMIT University), Tamar Greaves (RMIT University), Hank Qi Han (RMIT University), Calum Drummond (RMIT University), Andrew Christofferson (RMIT University)

Andreas Moll

DAY 1

ABSTRACT 4

How to Train Your Data Transfer

In response to the growing scale of experimental data, the Scientific Computing team and IT have implemented a new data download service using Globus, replacing our legacy SFTP system. Globus offers a robust, secure, and high-performance platform for transferring large datasets, with features tailored to the research community, including automated synchronisation and fault tolerance. This presentation will introduce the Globus service now available at the Australian Synchrotron, highlighting its advantages over SFTP in terms of usability, scalability, and reliability. We will demonstrate how users can access their data using Globus, including authentication via institutional credentials, selecting endpoints, and managing transfers. The session will also cover best practices for data management in general and address common questions around setup and support. Our implementation of Globus aligns with international best practices, as it is already in use at international synchrotron facilities such as Diamond Light Source, NSLS-II, MAX IV, ESRF, and PSI. By adopting Globus, we aim to enhance the user experience and ensure that data from beamline experiments can be accessed quickly and securely, wherever researchers are located.

Authors: Dr Andreas Moll (Australian Synchrotron), Dr Christina Magoulas (Australian Synchrotron)

Latheesha Abeywardana

DAY 2

ABSTRACT 5

Characterization of Electrospun Core-Shell Fibres Encapsulating Iron and Vitamin A for Nutrient Deficiency using Synchrotron THz/Far Infrared

Micronutrient deficiencies affect approximately 2 billion individuals globally and are associated with various physical and cognitive ailments, particularly in developing nations. Among them, iron and vitamin A deficiencies pose significant health challenges, especially when attempting combined delivery due to adverse interactions and instability issues. This research aims to develop an innovative co-delivery system for iron and vitamin A using edible ingredients. The study uses core-shell electrospinning to stabilize and encapsulate the nutrients, mitigating potential interactions between the nutrients themselves and preventing their interaction with external factors. The efficacy of this encapsulation was assessed using Fourier-transform infrared and advanced Synchrotron THz/Far-IR spectroscopy, as well as X-ray photoelectron spectroscopy to determine the relative ratio of Fe(II) to Fe(III) within each formulation. By exploring changes in the vibrational motions of metal and organic ligands (metal-C and metal-O bonds) of the core-shell fibres as a function of increasing temperature, this study provides a fundamental understanding of how the nutrients engage with the delivery matrix, providing information that could allow us to enhance nutrient delivery. These experiments demonstrate successful incorporation of iron and vitamin A into the fibre matrix. In future work, the encapsulated fibres will undergo testing in simulated gastric environments to evaluate their digestibility and predict nutrient absorption.

Authors: Ms Latheesha Abeywardana (Deakin University), Mr Han Wang (Deakin University), Mr Liangliang Zhang (Deakin University), Dom Appadoo (Australian Synchrotron), Mrs Thambaramala V. Gamage (CSIRO), Mr Tanoj K. Singh (CSIRO), Mr Shuaifei Zhao (Deakin University), Amy Logan (CSIRO), Mr Lingxue Kong (Deakin University)

Olga Martin

DAY 1

ABSTRACT 6

Microbeam radiotherapy for the primary tumour controls distant metastasis in a preclinical triple-negative breast cancer model

Synchrotron Microbeam Radiotherapy (MRT) delivered at ultrahigh dose rates leads to extraordinary normal tissue tolerance and ablative effects on the tumour. Here, we utilised recent discoveries to explore neoadjuvant MRT treatment of a highly aggressive triple-negative 4T1.2 murine mammary carcinoma. We have already shown that MRT creates vascular permeability in tumours that can be exploited for targeted delivery of anticancer therapy. At the Australian Synchrotron, we probed MRT and/or broad beam temporal fractionation with clinically relevant systemic therapy delivered within the permeability window. MRT in combination with Doxorubicin or the anti-PD1 checkpoint inhibitor led to excellent primary tumour control and improved animal survival compared to the relevant monotherapies. Mice were generally euthanised at endpoints dictated by metastasis; the prolonged survival indicated antimetastatic activity of the local treatment. Therefore, we repeated three daily MRT fractions ± anti-PD1/PDL1 antibodies, to assess changes in metastatic burden and tumour immune cell infiltration. Microcomputed tomography of the lungs at day 6 post-treatment indicated a dramatic decrease in metastasis of irradiated animals (3-5 fold compared to unirradiated controls), with longer lasting antimetastatic responses in the combined treatment groups (4 times less metastases compared to MRT alone by day 13). The results are being confirmed by quantification of metastatic burden in the lungs and spines (genomic PCR for mCherry DNA in tumour cells). Flow cytometry revealed a significant decrease in immunosuppressive regulatory T-cells in irradiated tumours, normally abundant in the tumour microenvironment; providing a potential mechanism of the amplified antitumour immune response. Therefore, we present the use of local MRT to trigger antimetastatic activity for spontaneous metastatic disease, a novel and important application of this radiation modality.

Authors: Elette Engels (University of Wollongong), Helen Forrester (Hudson Institute of Medical Research), Mitzi Klein (Australian Synchrotron), Ms Alice Sprung (University of Melbourne), Dr Kellie Mouchemore (ONJCRI), Prof. Moeava Tehei (University of Wollongong), Prof. Stephanie Corde-Tehei (University of Wollongong), Vincent de Rover (University of Wollongong), John Paul Bustillo (University of Wollongong Australia), Dr Cheuk Ting Wu (University of Bern), Ms Kirsty Brunt (ANSTO), Matthew Cameron (CMRP University of Wollongong), Michael Lerch (University of Wollongong), Prof. Robin Anderson (ONJCRI), Prof. Valentin Djonov (University of Bern), Olga Martin (University of Wollongong)

Marian Cholewa

DAY 1

ABSTRACT 7

Application of Deep Learning-Based Methods in medical imaging

Background: Development and application of modern medical imaging techniques allows for non-invasive quantitative assessment of various biophysical parameters in human tissue. Despite its potential, modern medical imaging techniques such as Magnetic Resonans Elastography (MRE) or Positron Emission Tomography/Magnetic Resonans Imaging (PET/MRI), in comparison to conventional imaging methods like ultrasound or magnetic resonance imaging, faces several challenges, including manual evaluation through the drawing of regions of interest. Manual assessment of data is susceptible to low intra- and inter-rater reliability and is time-consuming. Moreover, exams can be affected by patient motion due to breathing or shifting. In this study, we explore the utility of deep learning-based methods for data analysis and enhancement.

Methods: Deep learning methods have gained significant attention in recent years for biomedical image analysis. We conducted an extensive literature review to identify prior work on the application of deep learning. We tested similar approaches on data collected in our laboratory, utilizing deep learning for tasks such as image enhancement and exam interpretation.

Conclusions: Deep learning proves to be a robust tool for biomedical image analysis, encompassing tasks like region of interest segmentation, image assessment, and quality enhancement. However, although deep learning shows promise in various aspects, further development is necessary for its full integration into clinical practice.

Authors: Marian Cholewa (University of Rzeszow)

ORAL

DAY 1

Xiaoning Li

ABSTRACT 9

Revealing the role of spin in Electrocatalysis through Synchrotron-Based X-ray Spectroscopy

Spin configuration plays a critical role in modulating spin-sensitive redox reactions such as the oxygen evolution reaction (OER), where spin selection rules govern the kinetics of electron transfer. In this study, we investigate the spin state evolution and electronic structure of various transition metal oxide catalysts using synchrotron-based X-ray absorption spectroscopy (XAS). By coupling experimental spectra with theoretical simulations, we reveal how the spin configurations of both transition metal and oxygen species give rise to distinct reaction pathways. The results demonstrate a strong correlation between spin alignment and catalytic activity, highlighting the crucial role of synchrotron spectroscopy in resolving spin-dependent electronic structures and deepening the mechanistic understanding of spin-regulated electrocatalysis.

Authors: Xiaoning Li (RMIT University), Prof. Tianyi Ma (RMIT University)

ORAL

Marie-Christine Zdora

DAY 3

ABSTRACT 13

Dual-sample X-ray multi-modal imaging

X-ray multi-modal imaging techniques that deliver complementary phase-contrast and dark-field signals alongside conventional attenuation have seen rapid development in recent years. These additional signals enhance sensitivity to small density differences in low-density samples and sub-resolution microstructures, making them valuable for biomedical and materials science applications. Among the available approaches, modulator-based imaging, such as grid- or speckle-based methods, is increasingly adopted at synchrotron and laboratory X-ray facilities due to its relatively simple and flexible setup. The principle of modulator-based imaging is to pattern the X-ray beam with a fine, high-visibility structure and analyse sample-induced modulations of this pattern to extract attenuation, phase-contrast, and dark-field signals. Several signal retrieval methods have been developed to process reference (modulator only) and sample (sample and modulator) image stacks. Unified Modulated Pattern Analysis (UMPA) is a particularly versatile framework, applicable to both periodic and random modulators, and adaptable to various scan geometries and experimental constraints. Building on this flexibility, we introduce a novel extension of modulator-based imaging that enables simultaneous multi-modal imaging of two samples. This is achieved by treating each sample as a modulator for the other, meaning a single acquisition can simply move the two samples past each other to collect all the information required. This approach allows extraction of all three imaging modalities for both samples, yielding six distinct images from a single scan. To our knowledge, this is the first demonstration of simultaneous multi-modal imaging of two samples within a single field of view, opening new possibilities for efficient, high-sensitivity imaging in complex sample environments.

Authors: Marie-Christine Zdora (Monash University), David Paganin (Monash University), Kaye Morgan (Monash University)

DAY 1

Danielle Martin

ABSTRACT 16

Australian Synchrotron: Facility Update and New Developments

This talk will provide an overview of ANSTO's Australian Synchrotron and new developments across the beamlines. The facility has seen many changes and updates, with new BRIGHT beamlines coming online and changes to infrastructure moving forward, including updated beamline capability. I will touch on various projects including: the AS User Portal upgrade; progress with the SXR X-Ray Nanolithography Facility (XRNF) project; the upcoming MX2 robot and goniometer upgrade; the PD Mythen III detector upgrades; alongside other facility developments that are currently underway.

Authors: Dr Danielle Martin (Australian Synchrotron), Dr Helen Brand (Australian Synchrotron), Prof. Michael James (Australian Synchrotron)

ORAL

DAY 3

Annmaree Warrender

ABSTRACT 17

Solving Structures in Solution: Updates on the BioSAXS Beamline

BioSAXS is a small angle X-ray scattering beamline dedicated to characterising the nano-scale structures of particles and biological macromolecules in solution. It is optimally designed with a high flux x-ray beam to support solution scattering experiments and facilitate time-resolved studies down to the millisecond timescale. This presentation will showcase the current capabilities of the BioSAXS beamline and how it has progressed since it came into operations in late 2023. BioSAXS supports a range of solution-SAXS experiments including static capillary measurements and samples under flow. Capillary holders are available with wide-ranging temperature control. Data acquisition plans can be readily customised for desired temperature ramps, delay times and scanning. For measurements of evolving systems or reactions, scattering can be measured over time using the flow-through capillary with a circulating pump and syringe drivers. The most used setup on BioSAXS is the Coflow Autoloader. Samples are measured under flow with a co-flowing sheath fluid through the measuring capillary to minimise beam-induced radiation damage. Samples can be measured in batch mode for high-throughput data collection, with less than 5 minutes per sample, or measured using inline size exclusion chromatography (SEC). SEC mode is useful for proteins or nucleic acid samples to ensure aggregates or oligomeric states are separated immediately prior to measuring. BioSAXS aims to provide highly automated data acquisition while retaining flexibility to support a variety of user experiments. Over time, more sample environments will be made available to users to expand experimental capability, including applying shear, magnetic fields and finer temporal-resolution.

Authors: Annmaree Warrender (Australian Synchrotron), Dr Andrew Clulow (Australian Synchrotron), Dr Lester Barnsley (ANSTO), Ashish Sethi (ANSTO)

Porun Liu

DAY 1

ABSTRACT 18

Engineering and Probing Sub-Nanoscale Active Sites for Energy Conversion Applications

This presentation examines heterogeneous electrochemical processes at electrode interfaces, with a focus on advancing clean energy conversion, storage, and utilization. A central challenge in this field is the design of high-performance inorganic electrocatalysts that can sustain robust activity under operando conditions. Addressing this challenge requires a fundamental understanding of the structural, crystalline, and electronic properties of sub-nanoscale active sites as they evolve during real-time operation. To this end, we employ advanced in-situ characterization techniques—including X-ray Absorption Spectroscopy (XAS), X-ray Diffraction (XRD), and Raman spectroscopy—to probe the dynamic behavior of transition-metal-based catalysts (Mn, Fe, Co, Ni, Cu, Ru, Bi, Ag, Ir) in essential electrochemical reaction in water, carbon dioxide electrolyzers, rechargeable zinc air batteries, hydrogen fuel cells, and biomass molecule electrochemical hydrogenation. Our investigation reveals the evolution of precursors into sub-nanoscale active catalytic states and establishes direct correlations between structural/electronic modulation and catalytic performance. In particular, the observed activity enhancements are attributed to electronic interactions with supporting substrates and the unique chemical environments engendered by sub-nanoscale architectures. These insights provide a mechanistic foundation for rationally engineering durable, high-efficiency electrocatalysts for sustainable energy applications.

Authors: Porun Liu (Griffith University)

Ben Krinkel

DAY 2

ABSTRACT 19

Exploiting rewired metabolism in cancer: a biochemical focus on malic enzyme inhibitors using structure-based drug design.

Cancer persists as a major global health burden, highlighting the urgent need for therapies that improve clinical outcomes while maintaining patient quality of life. A defining feature of many tumours is the reprogramming of cellular metabolism, notably the dysregulated production of metabolites that support survival and unchecked proliferation. Central to this metabolic shift is enhanced glutamine utilisation and upregulation of mitochondrial malic enzyme 2 (ME2), which produces pyruvate and NAD(P)H. ME2 expression is elevated in pancreatic, melanoma, and lung cancers, positioning it as a compelling yet underexplored therapeutic target. We expressed recombinant human ME1, ME2, and ME3 isoforms and characterised their enzymatic kinetics with and without NPD-389. X-ray crystallography captured molecular snapshots of NPD-389 bound to each isoform, generating a comprehensive structural dataset. Guided by these structures, we conducted a virtual screen of 12 million drug-like and fragment molecules, identifying novel inhibitory scaffolds. The efficacy of NPD-389 and these scaffolds was then robustly evaluated across eight triple-negative breast cancer cell lines. Kinetic studies revealed distinct activity and inhibition patterns, particularly highlighting unique features of the understudied ME3 isoform. The NPD-389–ME2 complex exhibited an unexpected metal-binding mode and enzyme conformation. Virtual screening uncovered new binders targeting both active and allosteric sites with isoform selectivity. In TNBC assays, NPD-389 consistently inhibited proliferation, underscoring its promise as a lead compound. These findings substantiate ME2 as a compelling anticancer target and establish a robust platform for developing isoform-selective metabolic inhibitors. Such inhibitors could serve as adjuncts to checkpoint inhibitors or chemotherapy, enhancing treatment responses and paving the way for transformative cancer therapies that improve both efficacy and patient quality of life.

Authors: Mr Ben Krinkel (University of Auckland)

Kazuhiro Nogita

DAY 2

ABSTRACT 21

In-situ synchrotron X-ray imaging of intermetallic growth and void distribution in an advanced soldering process: Overview

Understanding the nucleation and growth of Cu6Sn5 intermetallics that form between solid Cu substrates and liquid Sn-based solder alloys is essential for the development of high temperature soldering processes with improved solder joint reliability. During intermetallic growth, porosity may form and minimising or managing such porosity becomes a critical issue. This presentation delivers an overview of our recent development to observe the growth behaviour of Cu6Sn5 intermetallics by Synchrotron X-ray imaging at the SPring-8 Synchrotron BL20XU beamline. The mechanisms of porosity formation were determined and methods of manipulating the porosity distribution were formulated. Based on the results, novel soldering methods using the transient liquid phase (TLP) sintering technique are proposed to encourage non-uniform (Cu,Ni)6Sn5 intermetallic growth. This approach has the potential to distribute porosity in a controlled manner, thereby improving joint properties for applications under harsh conditions, including electronic devices exposed to high power, high current and high temperatures.

This research was conducted at the SPring-8 Synchrotron BL20XU beamline, Japan [Proposal: 2019A1149, 2019B1185, 2019B1618], and supported by the International Synchrotron Access Program [No. ISAP14935], ANSTO, Australia.

Authors: Prof. Kazuhiro Nogita (The University of Queensland), Nurul Razliana Abdul Razak (The University of Queensland), Xin Fu Tan (University of Queensland), Keith Sweatman (Nihon Superior Co., Ltd.), Dr Stuart McDonald (The University of Queensland), Prof. Hideyuki Yasuda (Kyoto University)

Roger Bourne

DAY 3

ABSTRACT 22

MCT of soft tissue at the Australian Synchrotron

Phase contrast micro CT (MCT) is gaining increasing interest for its ability to provide 3D subcellular soft tissue structural information on a par with the inherently 2D processes of traditional histology and light microscopy. Reconstruction of 3D volumes from thin section histological techniques destroys the tissue sample, introduces additional artifacts, and requires tedious and time-consuming processing of large numbers of serial sections. Since all biological structures and processes occur in a 3D space, there are fundamental advantages in non-destructive 3D tissue characterisation methods such as MCT. In magnetic resonance imaging applications for cancer assessment there is a current focus on development of diffusion-based methods that can detect the tissue microstructure changes associated with cancer development. While promising, development and optimisation of these methods remains compromised by validation methods based on 2D histology. 3D MCT may have special value in MRI validation as it can potentially provide complete microstructure information for each MRI voxel. We present results of MCT studies of human prostate and breast tissue, and correlation results with same-sample MRI microscopy and histopathology – demonstrating the capacity of MCT to provide histology-level microstructure information in a 3D format ideal for validation of MRI-based biomarker development.

Authors: Roger Bourne (University of Sydney), TImur Gureyev (the University of Melbourne), Dr Nyoman Kurniawan (University of Queensland), Dr Paul Sved (University of Sydney), Mr Adam Phipps, Dr Geoff Watson (NSW Health Pathology), Dr Satcha Foongkajornkiat (Queensland University of Technology), Prof. Rik Thompson (Queensland University of Technology), Benedicta Arhatari (Australian Synchrotron), Andrew Stevenson (Australian Synchrotron/CSIRO)

ORAL

Samantha Alloo

DAY 3

ABSTRACT 23

Shifting images between time and space to achieve X-ray phase and dark-field imaging

Novel phase and dark-field X-ray imaging methods have emerged with the advent of synchrotrons. These methods are useful in revealing structures invisible in conventional absorption imaging—phase highlights low-density features, while dark-field detects unresolved microstructure. A widely used large-scale phase and dark-field imaging method—soon to be installed at the MicroCT beamline—is grating interferometry [1]. Demonstrated almost 20 years ago, this technique is well developed, with current efforts focusing on human-sized tomography systems [2]. A key challenge, and the focus of this work, is determining the most effective method for retrieving images from grating-interferometry data. To date, retrieval has relied on measuring each pixel's intensity variation across analyser-grating steps in the presence of a sample. We introduce a fundamentally new approach [3,4], previously applied in speckle imaging [5], which yields high-quality, smooth images for small samples. To extend these advantages to larger scales, we interlace grating-interferometry data, allowing our developed methods to be applied directly [6]. We demonstrate our approach's effectiveness on mouse chest data, showing improvements over conventional methods and highlighting applications in lung-health diagnostics [7]. We anticipate implementation at the Australian Synchrotron's imaging beamlines, enabling access to richer sample information.

[1] Pfeiffer, F., et al. (2008). Nat. Mater. 7, 134-137.
[2] Viermetz, M., et al. (2022). IEEE Trans. Med. Imaging, 42(1), 220-232.
[3] Paganin, D. M., & Morgan, K. S. (2019). Sci. Rep. 9(1), 17537.
[4] Morgan, K. S., & Paganin, D. M. (2019) Sci. Rep. 9(1), 17465.
[5] Alloo, S. J., et al. (2025). Opt. Express, 33(2), 3577-3600.
[6] Beltran, M. A., et al. (2023). Optica, 10(4), 422-429.
[7] Guo, P., et al. (2024). European Radiology Experimental, 8(1), 12.

Authors: Dr Samantha Alloo (Monash University), Dr Florian Schaff (Technical University of Munich (TUM)), Prof. Kaye Morgan (Monash University)

DAY 2

Pabitraa Madhurima

ABSTRACT 24

Ultrasonic machined semi-metasurfaces on Quartz for THz Biosensing

We report the design and characterization of ultrasonically machined semi-metasurfaces on quartz substrates for terahertz (THz) biosensing. Arrays of blind square micro-wells (lateral dimension ~0.27 mm, depth ~0.27 mm, period ~0.52 mm) were fabricated directly on 1-mm thick quartz using a cost-effective ultrasonic machining process. This process avoids conventional lithography while introducing controlled surface roughness that promotes protein adsorption. The resulting structure acts as a two-dimensional grating–cavity hybrid, with the blind holes functioning as subwavelength Fabry–Pérot resonators, while the lattice periodicity provides in-plane momentum for coupling to THz modes. Finite-depth machining produces a "semi-metasurface" behavior, characterized by broadened, asymmetric resonances that remain highly sensitive to local dielectric loading. THz time-domain spectroscopy (THz-TDS) reveals sharp transmission features in the 0.45–0.65 THz range, corresponding to the first cavity resonance just below the Rayleigh diffraction edge. Partial filling of the wells with Bovine Serum Albumin (BSA) induces measurable resonance red-shifts and transmission amplitude changes, while metal coatings further improve confinement and the quality factor. By combining quartz transparency, protein-trapping micro-wells, and strong local field enhancement, this platform enables label-free in-vitro detection of protein-adsorption coverage and potential ligand binding. The method offers a scalable, low-cost route towards practical THz biosensors, bridging materials engineering and biomolecular spectroscopy.

Authors: Pabitraa Madhurima (Monash University), Prof. Raman Singh (Monash University), Santosh Panjikar (Australian Synchrotron)

Daryl Howard

DAY 3

ABSTRACT 26

The XFM Beamline for Cultural Materials Studies

The X-ray fluorescence microscopy beamline is well-suited for the analysis of cultural materials. It has the ability to quickly and non-destructively image trace elemental distributions down to micron length scales with minimal or no sample pre-treatment. A microprobe and a large area-scanning milliprobe (600mm x 1100 mm) are available for user operations. The results from several cultural heritage studies, ranging from paintings to centuries-old manuscripts and historic metallic objects, will be discussed to outline the XFM beamline's capabilities.

Authors: Daryl Howard (Australian Synchrotron)

ORAL

Andrew Stevenson

DAY 2

ABSTRACT 27

Technical details on and experiences of the MCT beamline multilayer monochromator

The micro-computed tomography (MCT) beamline was the first of the 8 new BRIGHT beamlines to become operational. One of the key X-ray optical components in the MCT photon-delivery system is a double-multilayer monochromator (DMM), used to select monochromatic X-ray beams with an energy in the range 8 to 40 keV. This DMM was the first such monochromator to be installed at the Australian Synchrotron, with all of the existing hard X-ray beamlines employing a double-crystal monochromator (DCM) based on perfect Si single crystals (all in Bragg geometry, with the exception of the Laue geometry used on IMBL). Now that MCT has been operating successfully with users for just over three years, it is timely to report on the operation and characteristics of the DMM. Some technical details and key learnings will be shared, including performance aspects related to stability, energy calibration and flux delivery. These findings are also timely given that three other BRIGHT beamlines have or will have a DMM (BioSAXS and MX3, which are both now operating; Nano, which is to follow). In addition, the existing XFM beamline has recently had a DMM installed as part of an upgrade.

Authors: Dr Andrew Stevenson (Australian Synchrotron), Benedicta Arhatari (Australian Synchrotron), Mr Adam Walsh (Australian Synchrotron)

ORAL

Michael Jones

DAY 2

ABSTRACT 28

Accurate XANES measurements on non-symmetric crystals with XBDM

Obtaining accurate XANES data on non-symmetric crystals is problematic due to the dependence on the relative orientation of the crystal with the polarisation of the X-ray beam (1-4). To overcome this the orientation of an individual crystal relative to the incident polarisation must be known and multiple orientations collected (1, 4). Recently, a multivariate analysis technique has been proposed for Fe XANES analysis (5) to reduce the error in Fe³⁺ determination by half to ~ 8%. However, this method requires a substantial known training dataset. Here, we propose a method that simultaneously combines X-ray Backscatter Diffraction Microscopy (XBDM) (6) with line or map XANES at the XFM beamline (7) to identify the crystal orientation in complex natural non-symmetric mineral samples allowing for accurate XANES data to be collected. In this presentation we discuss the pitfalls and progress of the technique.

1. M. Munoz et al. American Mineralogist 98, 1187-1197 (2013).
2. L. Masci et al. American Mineralogist 104, 403-417 (2019).
3. K. A. Evans et al. American Mineralogist 99, 443-457 (2014).
4. M. D. Dyar, J. S. Delaney, S. R. Sutton. European Journal of Mineralogy 13, 1079-1098 (2001).
5. T. Ito, S. R. Wallis, Y. Takahashi. American Mineralogist (2025).
6. C. E. Schrank, M. W. M. Jones, D. L. Howard, A. Berger, M. Herwegh. Chemical Geology 645, 121886 (2024).
7. D. L. Howard et al. Journal of Synchrotron Radiation 27, 1447-1458 (2020).

Authors: Michael Jones (Queensland University of Technology), Christoph Schrank (Queensland University of Technology), Dr Ioan Sanislav (JCU), Prof. Hugh O'Neill (Monash University), Jeremy Wykes (Australian Synchrotron), Andrew Langendam (Australian Synchrotron), Daryl Howard (Australian Synchrotron), Dr David Paterson (ANSTO), Dr Vasileios Chatzaras (The University of Sydney)

Xin Fu Tan

DAY 2

ABSTRACT 30

Deconvoluting the thermal expansion of Sn and Bi in Sn-Bi low temperature solder alloys – an in-situ heating powder diffraction study

Electronics manufacturing consumes substantial energy, heating assemblies above the melting point of solder alloys to form mechanical and electrical connections. Current generation solder alloys based on Sn-Ag-Cu systems have relatively high melting points compared to the Pb-based alloys which they have now largely replaced. The Sn-Bi system offers the only affordable alternative for lower melting-point soldering alloys that could lower energy consumption and enable the manufacture of advanced circuitry incorporating temperature-sensitive components and substrates. Thermal expansion is a critical property in solder alloys, as mismatches between solder, substrate and die can lead to mechanical failure. Unlike pure metals which typically expand linearly with increasing temperature, dilatometry studies show that the volume of Sn-Bi alloys increases to a maximum with increasing temperature, before contracting with further increases in temperature. To understand this observed phenomena, the contribution of Sn and Bi to the overall expansion of the Sn-Bi alloy is investigated by in-situ synchrotron powder X-ray diffraction (PXRD). Rietveld refinement was performed to obtain the lattice parameters and unit cell volume of Sn and Bi phases. Analysis of the obtained lattice parameters and phase diagrams indicates that the non-monotonic changes in the volume of Sn-Bi alloys with temperature arise from the combined effect of a decreasing Bi volume fraction, due to its dissolution in Sn, and corresponding changes in the unit cell volume of Sn crystals.

Authors: Xin Fu Tan (The University of Queensland), Qinfen Gu (Australian Synchrotron (ANSTO)), Dr Stuart McDonald (The University of Queensland), Mr Tetsuro Nishimura Kazuhiro Nogita (The University of Queensland)

ORAL

Ali Ghasem-Zadeh

DAY 2

ABSTRACT 32

Evaluation of Distal Radius and Tibia Bone Microstructure in Human Specimens Using Phase-Contrast Synchrotron Radiation Computed Tomography

Introduction

High-Resolution peripheral Quantitative Computed Tomography (HR-pQCT, 82 µm isotropic voxel size) provides non-invasive, in vivo assessment of bone microarchitecture, offering insights into skeletal fragility by quantifying trabecular and cortical compartments. Cortical porosity is a key determinant of bone strength and a strong predictor of fragility fractures, as even small increases disproportionately weaken cortical stiffness and bending strength by concentrating stress and facilitating crack propagation. However, accurate quantification of cortical porosity with HR-pQCT is limited by image resolution, segmentation errors, beam hardening from poly-energetic photons, and blurred edges. These technical issues can lead to underestimation of fracture risk and misclassification of individuals at high risk. To assess cortical porosity accurately, we scanned post-mortem human radii and tibiae using synchrotron radiation tomography with phase-retrieval reconstruction at 9.6 µm voxel resolution. We hypothesised that cortical porosity arising from smaller pores would be quantifiable with HR-pQCT and could be validated against synchrotron-derived attenuation and phase-contrast images.

Methods

Thirty-two post-mortem human radii and tibiae, fresh and dry specimens, were imaged at the Australian Synchrotron Radiation-Imaging and Medical Beamline (IMBL), using 60kV monochromatic x-ray-based tomography. Silicon amorphous detectors with voxel sizes of 9.6 and 14.6 microns have been used to create x-ray photons attenuation and phase-contrast based tomographic images.

Results

Preliminary comparison of axial images has shown higher visibility for small pores and Harversian canals in the phase contrast-based images.

Conclusion

We infer that accuracy of distal radial and distal tibial cortical porosity using HR-pQCT can be validated using synchrotron imaging as a referent gold standard.

Authors: Dr Ali Ghasem-Zadeh (The University of Melbourne), Chris Hall (Australian Synchrotron), Duncan Butler (Australian Radiation Protection and Nuclear Safety Agency), Prof. Ego Seeman (University of Melbourne)

Christoph Schrank

DAY 2

ABSTRACT 34

Differential stress and microstructure impact gypsum dehydration kinetics – insights from in-operando SAXS

Dehydration reactions are fundamental to Earth's volatile cycle, earthquake formation, and metamorphic processes. If and how tectonic stresses impact dehydration kinetics thus remains a subject of ongoing research[1,2]. This study examines how an elastic differential stress affects the dehydration kinetics of gypsum to hemihydrate and the structure of the product phase. With a novel version of the Blach cell[3] optimised for synchrotron radiation, we conducted dehydration experiments on natural alabaster in dry conditions under a constant elastic differential stress from 0.5 to 10 MPa. In-operando transmission small-angle X-ray scattering (SAXS) allowed for the real-time tracking of the dehydration progress and the evolution of nanopores with apertures between 5 and 35 nm. First, we find that a stress increase accelerates dehydration kinetics significantly, mostly through a speed-up of the nucleation step. Second, nanopore nucleation always precedes the onset of the reaction, and nanopores preferentially grow orthogonally to the maximum principal stress. Third, scanning-electron micrographs demonstrate that hemihydrate grains also form a strong shape-preferred orientation perpendicular to the maximum principal stress. Finally, the kinetic results for alabaster are briefly compared to equivalent experiments on naturally fibrous gypsum. These experiments demonstrate that tectonic stresses and rock microstructure have an important impact on the kinetics of mineral replacement reactions and the product microstructure. The geological implications will be discussed.

1 Schrank, C. E. et al. (2021), 10.1038/s43246-021-00156-9
2 Gilgannon, J. et al. (2023), 10.1130/G51612.1
3 Ji, Y. et al. (2024), https://doi.org/10.1016/j.measurement.2024.114997

Authors: Christoph Schrank (Queensland University of Technology), Dr Tomasz P. Blach (Griffith University), Yeping Ji Phung Nhu Hao Vu (UNSW), Dr Tony WANG (Queensland University of Technology), Michael Jones (QUT), Nigel Kirby (Australian Synchrotron), Prof. Klaus Regenauer-Lieb (Curtin University), Prof. Andrzej P. Radliński (Curtin University)

ORAL

Bruce Cowie

DAY 2

ABSTRACT 35

µMEX | Tender energy, scanning probe, X-ray fluorescence microscopy at MEX1

Scanning XRF µProbes provide element-specific mapping of distributions and associations within heterogeneous, complex systems, often with minimal sample preparation and destruction. µMEX offers X-ray microspectroscopy capabilities across 2.1–13.6 keV with spatial resolution unique within the facility and uncommon worldwide. The instrument enables studies of K-edges (first-row transition metals, sulphur), L-edges (rare earth elements), and M-edges (high-Z elements like uranium). Access to energies below 5 keV allows mapping of low-Z species, including chlorine and phosphorus. µMEX complements existing (XFM) and planned (NANO) scanning XRF µProbes at the Australian Synchrotron. Unlike XFM and NANO's undulator sources, MEX uses a bending magnet source. This allows users to change incident energies with relative ease, while the lower flux provides a relatively lower dose of ionisation radiation during measurement. User Operations and Early Access Round 3 2025 marked the beginning of user operations on µMEX. Early users may encounter technical glitches and missing supporting infrastructure. The MEX team is committed to iterative improvements based on user feedback and looks forward to developing this capability in collaboration with the User community. Future Development: Cryogenic Capabilities Development of cryogenic measurement conditions is planned to expand µMEX capabilities. Low-temperature environments will enable studies of radiation-sensitive samples, improve spectral resolution, and allow investigation of temperature-dependent phenomena. This capability will particularly benefit biological samples and materials requiring reduced beam damage or enhanced signal-to-noise ratios. This presentation will describe the development, present the current status and outline plans for future development.

Authors: Simon James (ANSTO Australian Synchrotron) Jeremy Wykes (Australian Synchrotron) Pria Ramkissoon (Australian Synchrotron) Dr Bruce Cowie (Australian Synchrotron,) Negin Foroughimehr (ANSTO) Letizia Sammut (Australian Synchrotron) Dr Luigi Feriani (ANSTO) Dr Melanie Hampel (ANSTO) Dr Noah Kim (ANSTO) Ben Baldwinson (Australian Synchrotron) Mr Ben Pocock (ANSTO) Dr Peter Kappen (ANSTO)

Vinodya Karunadhika

DAY 1

ABSTRACT 36

Mechanistic Insights into Early Thermal Aggregation Events of Monoclonal Antibody Formulations

Development of monoclonal antibody (mAbs) therapeutics, particularly for subcutaneous administration, often requires highly concentrated formulations. Such conditions can lead to aggregation, compromising quality, and increasing immunogenic risk. Temperature is a major concern in biopharmaceutical industry, due to its potential to trigger aggregation. Despite extensive efforts, a significant gap remains in understanding the molecular events that trigger and propagate aggregation. In this study, we aimed to elucidate the temperature-induced aggregation mechanism of mAb, using various biophysical techniques, to monitor aggregation triggered by thermal unfolding of its least stable domain. The first thermal transition, corresponding to unfolding of the CH2 domain, was detected at +60ºC by Differential Scanning Calorimetry. The hydrodynamic diameter of mAb remained relatively stable up to +55ºC, as determined by Dynamic Light Scattering, suggesting the protein retained its native conformation within this range. Above +60ºC, a significant increase in size was observed, indicating onset of aggregation, was irreversible upon cooling. Despite this unfolding event, Fourier Transform Infrared Spectroscopy and Raman Spectroscopy revealed minimal disruption to secondary structure, suggesting that early aggregation is not driven by major secondary structure loss. However, Small-Angle X-ray Scattering (SAXS) demonstrated notable tertiary structural rearrangements and formation of oligomeric species at elevated temperatures. Synchrotron size exclusion chromatography coupled SAXS further resolved these aggregates, identifying, dimers and higher-order oligomers. These findings highlight the pivotal role of unfolding of the CH2 domain in initiating aggregation and provide molecular-level insights into early events that compromise mAb stability under thermal stress. By resolving conformational changes and aggregate species using complementary biophysical techniques, this study establishes a mechanistic framework that can be utilised in understanding mAb aggregation under thermal stress.

Authors: Ms Vinodya Karunadhika (RMIT University), Mr Nimish Pradhan (RMIT University; CSL Innovation Pty Ltd; The ARC Digital Bioprocess Development Hub), Dr Annmaree Warrender (ANSTO Australian Synchrotron), Dr Dharmini Mehta (CSL Innovation Pty Ltd; The ARC Digital Bioprocess Development Hub), Dr Heidi Elmer Bodnar (CSL Innovation Pty Ltd; The ARC Digital Bioprocess Development Hub), Dr Thilini Thrimawithana (RMIT University), Prof. Sally Grass (University of Melbourne; The ARC Digital Bioprocess Development Hub), Dr Durga Dharmadana (RMIT University; The ARC Digital Bioprocess Development Hub), Prof. Celine Valery (RMIT University; UNSW; The ARC Digital Bioprocess Development Hub)

Jessica Frahn

DAY 1

ABSTRACT 38

Exploring Interfacial Characteristics of Pure Glucose Fatty Acid Esters

With increasing pressure for environmental sustainability, the food industry is seeking biodegradable and eco-friendly alternatives for product formulations. Glucose fatty acid ester emulsifiers represent a breakthrough solution, offering exceptional biodegradability whilst utilising raw materials sourced from food industry byproducts—glucose from sugarcane waste and fatty acids from dairy waste streams [1-2]. This circular approach transforms waste into valuable functional ingredients. The versatility of glucose fatty acid ester emulsifiers lies in their tuneable properties through chain length modification, enabling targeted applications across diverse formulations. Short-chain glucose-6-caprylate (G-6-C) exhibits a high hydrophilic-lipophilic balance (HLB) of 13.0 with excellent water solubility, whilst longer chain glucose-6-stearate (G-6-S) demonstrates a lower HLB of 9.0 with oil solubility. Medium chain glucose-6-laurate (G-6-L) achieves an intermediate HLB of 11.1, providing dual-phase compatibility. Profile Analysis Tensiometry determined critical micelle concentrations and adsorption kinetics for each emulsifier. G-6-C exhibited faster adsorption kinetics in aqueous phases compared to G-6-L, demonstrating clear structure-function relationships. Synchrotron small- and wide-angle X-ray scattering (SAXS/WAXS) analysis characterised micellar and crystalline structures. Chain length significantly influenced crystallinity when solubilised in solution—G-6-S showed distinct crystallisation peaks whilst G-6-C remained non-crystalline, indicating controlled structural properties through molecular design. Since lipid/emulsifier crystallisation/co-crystallisation directly influence product functionality including mouthfeel, whippability, and spreadability, the choice of appropriate emulsifier is critical for formulation success. These findings demonstrate that glucose-based fatty acid esters provide this precise control through their versatile emulsification properties, making them suitable for food emulsion applications and other industrial sectors whilst contributing to sustainable formulation development.

Authors: Jessica Frahn (University of South Australia), Marta Krasowska (University of South Australia), Anton Blencowe (The University of South Australia), David Beattie (University of South Australia), Stephanie MacWilliams (University of South Australia), Andrew Clulow (ANSTO Australian Synchrotron)

Sowbarnika Senthilkumar

DAY 2

ABSTRACT 39

Ultra-thin Films of 1-hexyl-3-methylimidazolium-based Ionic Liquids on Graphite

Ionic liquids (ILs) are molten salts with low melting points. Their distinctive characteristics, such as high thermal stability, negligible volatility, non-flammability, and high conductivity, make them ideal candidates for high-end lubrication in micro- and nanoelectromechanical devices, wind turbines, and aerospace applications. In this study, we explored the ultra-thin precursor films formed by imidazolium-based ionic liquids (ILs) on highly oriented pyrolytic graphite (HOPG). The IL series studied contained 1-hexyl-3-methylimidazolium cation paired with three different anions: bis(trifluorosulfonyl)imide, bis(fluorosulfonyl)imide, and tricyanomethamide. Understanding the physical and chemical interactions between ILs and substrates is crucial for their applications. To thoroughly understand these characteristics, we used a range of complementary techniques: Synchrotron Soft X-ray techniques: X-ray photoelectron spectroscopy, revealed the precursor film composition and also confirmed the absence of chemical interactions between the ILs and HOPG and near-edge X-ray absorption fine structure spectroscopy, determined the molecular orientation relative to the substrate. Additionally, tapping mode atomic force microscopy visualised the precursor film topography and the sessile drop contact angle measurements quantified the macroscopic wettability of the ILs on HOPG. Our findings conclusively demonstrate the formation of a two-layer patchy precursor film containing equal proportions of cations and anions, with the imidazolium ring of the cation oriented parallel to the HOPG surface.

Authors: Ms Sowbarnika Senthilkumar (University of South Australia), Marta Krasowska (University of South Australia), Anton Blencowe (University of South Australia), David Beattie (University of South Australia), Prof. Rob Atkin (The University of Western Australia), William Skinner (University of South Australia), Bruce Cowie (ANSTO), Prof. Bronwyn Hajek (University of South Australia)

Yang Cao

DAY 3

ABSTRACT 41

Enhancing Capabilities and Opportunities for Materials Research by Advanced Diffraction and Scattering Beamline at Australian Synchrotron

The Australian Synchrotron is expanding its capabilities with the introduction of two new Advanced Diffraction and Scattering beamlines (ADS-1 and ADS-2). ADS-1 is expected to be operational in 2026 and ADS-2 in 2027. The ADS beamlines offer high-energy diffraction and imaging capabilities for a range of applications in materials science and engineering. Compared with low-energy X-rays, high-energy X-rays penetrate more deeply into materials and are scattered at smaller angles. This makes them particularly suitable for: measuring samples containing high-Z elements; probing internal features of bulky samples; and performing in-situ and operando studies where samples are encapsulated within complex sample environments. ADS-1 delivers either white or monochromatic X-rays (50-150 keV) for a range of experiments, including powder diffraction, energy-dispersive diffraction, imaging and tomography. ADS-2 operates at three fixed X-ray energies: 45.3, 74.0 or 86.8 keV for powder diffraction, single crystal diffraction and total scattering experiments. In this presentation, we will introduce the new capabilities and highlight the research opportunities they offer across a range of materials applications, including battery and energy storage, mineral exploration, metallurgy, catalysis, and advanced manufacturing.

Authors: Dr Yang Cao

Peter Kappen

DAY 2

ABSTRACT 42

Updates from the Spectroscopy Group

In this session, the team will provide an overview over the capabilities of the Spectroscopy Group of beamlines, with emphasis on recent developments and science opportunities across X-ray Absorption Spectroscopy (XAS), Medium-Energy XAS 1 & 2 (MEX1 & 2), and Soft X-ray Spectroscopy (SXR). This will include updates on the micro-probe endstation at MEX1, high energy-resolution spectrometry at XAS, sample batching and scanning developments at MEX2, and under-the-hood improvements at SXR.

Authors: Peter Kappen (ANSTO)

ORAL

DAY 3

Brendan Dyett

ABSTRACT 45

Probing the Internal Structure of Lipid Nanoparticles at the Interface

Lipid nanoparticles (LNPs) have gained an increased prominence within the field of nanomedicine and drug-delivery following the success of the mRNA-vaccines and unrealized potential in future protein therapeutics. Many LNPs, including those employed within mRNA delivery, exhibit internal ordering within the nanoparticle. This internal structure can have profound impacts of the particles capability to encapsulate as well as deliver a therapeutic cargo. It is challenging, however, to elucidate this structure and even more so, changes to this structure, as these particles interact, i.e. at surfaces. Here we utilize LNPs with complex internal structures (inverse cubic, inverse hexagonal) as a model system to explore means to quantify the nanoparticle structure in-situ at solid(substrates, supported lipid bilayers)-liquid interfaces using liquid-AFM, grazing incidence x-ray scattering, total internal fluorescence and QCM-D. The results demonstrate a tandem method to determine the lattice parameter of the LNPs at the interface and simultaneously suggest that these particles display a preferred orientation at the interface. The application of these methods may further help characterize the interaction dynamics of these LNPs.

Authors: Brendan Dyett

ORAL

Denis Korneev

DAY 3

ABSTRACT 46

Correlative synchrotron-Based Micro-CT, large area SEM and FIB-SEM imaging of biological samples

Focused ion beam scanning electron microscopy (FIB-SEM) is an ultimate method to reveal the 3D-architecture of biological objects at nanometer resolution. However, the volume, which can be examined in a reasonable timeframe rarely exceeding 50×50×50 μm. Typically, such volume is enough to answer the biological question, but it is necessary to precisely target the area of interest inside the sample, which has a millimeter size. Moreover, to make it suitable for FIB-SEM, the sample should be stained with heavy metals (typically osmium), and embedded into resin. This staining makes the sample completely opaque, so light microscopy cannot be used to target the internal structures. The micro-CT technique provides a clear visualisation of the internal structures in osmicated samples, making it possible to target the areas of interest. Different resin-embedded biological samples, including zebrafish embryo, C. elegans worms, mouse oocytes, and different tissues, were visualised using the Micro-Computed Tomography beamline of the Australian Synchrotron. We optimized the imaging parameters and collected 2560×2560×2160-pixel volumes with 722 nm (magnification ×9, numerical aperture 0.28) and 361 nm (magnification ×18, numerical aperture 0.42) voxel. For some samples (zebrafish embryo and C. elegans worms) this spatial resolution made it possible to target the areas of interest for FIB-SEM immediately. For other samples (brain organoids) the structures of interest (myelinated axons) were too small to be resolved individually. Thus, we used the micro-CT data to localize the areas, which most likely contain such axons, then polished them using an ultramicrotome to visualize with large-area SEM imaging at resolution from 5 to 25 nm. The myelinated axons were detected, and then examined with FIB-SEM at 1×1×3 nm voxel.

Authors: Denis Korneev (Monash University), Dr Sergey Gorelick (Monash University), Dr Jillian Danne (Monash University), Mrs Natasha Kapoor-Kaushik (Monash University), Prof. Georg Ramm (Monash University)

Alex Harman

DAY 2

ABSTRACT 49

In-situ loaded synchrotron high-flux X-ray tomography of structural supercapacitor compression specimens

Structural supercapacitors (SSCs) offer the dual benefit of mechanical load-bearing capability and energy storage, but their complex architectures introduce new challenges for failure prediction and design optimisation. We present in-situ high-flux synchrotron X-ray tomography of SSC laminates subjected to controlled compression and shear loading. Specially designed specimens were developed to isolate these loading modes and were tested within a Deben CT5000 X-ray transparent load frame. Consultation with beamline staff during specimen design proved crucial, ensuring compatibility with the key dimensions of the X-ray source at each available magnification, and enabling continuous tomographic imaging during progressive loading to failure. Two experimental campaigns, conducted a year apart, are reported. In both cases, damage initiation, progression, and ultimate collapse were successfully captured. The second series achieved a higher acquisition rate of 30 fps, providing a more detailed view of failure dynamics, while significant improvements in specimen edge finish and reliability. Full 3D tomographic reconstruction was also performed for specimens examined prior to failure and intact specimens recovered following failure. Pre-failure scans provided valuable insights into machining quality, fibre angle distribution, and manufacturing induced defects. Looking ahead, a new detector currently being commissioned promises frame rates exceeding 1000 fps, offering the potential for unprecedented resolution of rapid failure events. The insights gained provide critical validation data for high-fidelity modelling of SSCs. By resolving the sequence of damage events and their interaction across structural domains, this work highlights the unique failure pathways introduced by multifunctionality. The program has also seeded collaboration with AFRL and UTARI, resulting in several high-impact journal publications and strengthening the transition of SSCs from laboratory concept to aerospace-relevant multifunctional structures.

Authors: Alex Harman (DSTG), Dr Mathew Joosten (Deakin University)

Tasman Harvey

DAY 1

ABSTRACT 51

Optimizing Orbit Correction in Future Australian Synchrotron Storage Rings

Accelerator storage rings for light sources and colliders are highly sensitive to magnet misalignments and field errors. These imperfections distort the orbit, which negatively impact the brightness or luminosity. Precise orbit correction plays a vital role in optimising the performance of next generation lepton accelerators. CERN's proposed e+/e- Future Circular Collider (FCC-ee) is a 91 km high energy dual lepton storage ring aimed at achieving unprecedented luminosities with energies from 45.6 GeV to 182.5 GeV per beam [1]. ANSTO is also researching a fourth generation 3 GeV light source called AS2, proposed to replace the current Australian Synchrotron when it reaches end of life [2]. Both accelerators require strong sextupoles to achieve ultra-low emittance at the pm-rad scale. The orbit offset inside these magnets strongly impacts optics distortion and ultimately accelerator performance. To correct the orbit distortion, numerical simulation toolkits developed by CERN including MAD-X, Xsuite, and Xutil, were used [3]. This presentation explores a systematic approach to linear orbit correction using Singular Value Decomposition (SVD) and how it could benefit current and next-generation storage rings. We demonstrate that the degree of correction is greater through certain magnets and discuss improvements made by considering the Beam Position Monitor (BPM) noise floor to determine a threshold for the number of singular values included in the correction.

[1] M. Benedikt et al. "Future Circular Collider Feasibility Study Report Volume 2: Accelerators, Technical Infrastructure and Safety". Ed. by M. Benedikt. Geneva: CERN, 2025.
[2] X. Zhang et al. "Preliminary lattice design for Australian Synchrotron 2.0". In: JACoW IPAC2024 (2024), TUPG10.
[3] K. Skoufaris. Xutil · GitLab. May 8, 2025. url: https://gitlab.cern.ch/kskoufar/xutil

Authors: Tasman Harvey (Swinburne University of Technology), Tessa Charles (Australian Synchrotron), Rohan Dowd (Australian Synchrotron), Jeremy Brown (Swinburne University of Technology), Nadia Zatsepin (Swinburne University of Technology)

Bernd Frerker

DAY 1

ABSTRACT 53

Improving therapeutic efficacy in microbeam radiotherapy (MRT): From unidirectional to complex treatment geometries

Radiation therapy is an important component of cancer treatment. Microbeam radiation therapy (MRT) is an experimental irradiation technique in which a synchrotron-generated X-ray beam is spatially fractionated into an array of quasi-parallel microbeams by a multislit collimator, leading to an inhomogeneous dose distribution in the target. In preclinical studies, this results in good tumor control and better tolerance for healthy tissue. Thus, MRT is the geometrically most intricate version of spatially fractionated radiotherapy (SFRT). Currently, veterinary patients are treated in unidirectional mode in a single treatment field. To irradiate larger tumours, we propose to increase the irradiation field by lateral patching of several microbeam arrays or by rotation of an array around the isocenter, in order to achieve full tumor coverage. Importantly, dose fractionation at the micrometre scale and irradiation from multiple ports, similar to the clinically already established stereotactic radiotherapy, makes dosimetry extremely challenging. Equally interesting is the correlation between spatial dose distribution and radiobiological response. To explore the latter, we have conducted in-vitro studies in human brain and lung cells at the Imaging and Medical Beamline (IMBL) of the Australian Synchrotron and at the P61A beamline of the PETRA III synchrotron on the DESY campus in Germany as part of an international collaboration project between Australian and German research groups. Our first pre-clinical data show that patching and rotating MRT arrays can be performed safely. Cells irradiated in a 3D-print of a dog's head or in 2D cell cultures only survived outside the irradiation fields. In an ongoing study, we aim to establish a quality assessment procedure for the curative, complete irradiation of primary and secondary malignant tumours.

Authors: Mr Bernd Frerker (Rostock University Medical Center), Vincent de Rover (University of Wollongong), James Cayley (University of Wollongong), Michael Lerch (University of Wollongong), Elette Engels (University of Wollongong; Australian Synchrotron/ANSTO), John Paul Bustillo (University of Wollongong), Matthew Cameron (Australian Synchrotron/ANSTO), Daniel Häusermann (Australian Synchrotron/ANSTO), Helen Forrester (Royal Melbourne Institute of Technology (RMIT) University), Olga Martin (University of Wollongong; University of Bern), Stefan Fiedler (Deutsches Elektronen-Synchrotron (DESY)), Johannes Klingenberg (Deutsches Elektronen-Synchrotron (DESY)), Guilherme Abreu Faria (Deutsches Elektronen-Synchrotron (DESY)), Abdul Malek Hamada (Rostock University Medical Center), Malin Kügele (Rostock University Medical Center), Yvonne Dzierma (Rostock University Medical Center), Frank Nüsken (Rostock University Medical Center), Guido Hildebrandt (Rostock University Medical Center), Elisabeth Schültke (Rostock University Medical Center)

ORAL

Ashkan Pakzad

DAY 1

ABSTRACT 55

Phase contrast and deep learning for X-ray dose reduction in breast cancer imaging

Breast cancer is the most diagnosed cancer in women globally, and early detection is essential for improving patient outcomes. While X-ray mammography and digital breast tomosynthesis remain the mainstays of breast cancer screening, both have limitations in diagnostic accuracy, and often cause discomfort due to the need for breast compression. Breast computed tomography is a promising alternative, but achieving adequate image quality currently necessitates relatively high radiation doses. Given the breast's high radiosensitivity, minimising the radiation dose is a priority. Phase-contrast computed tomography (PCT) has been shown to deliver higher-quality images at lower doses without the need for compression. Different supervised U-Net based models were trained on pairs of PCT scans of 27 full fresh mastectomy samples collected at 4 mGy and 24 mGy mean glandular doses (MGD) with 32 keV monochromatic X-rays. Subsequently, the trained models were applied to denoise 4 mGy MGD scans of 6 other mastectomy samples at the testing and evaluation stage. All the CT scans were collected at Imaging and Medical Beamline of the Australian Synchrotron. We show that deep learning-based denoising of 4 mGy PCT images of fresh full mastectomy samples enables at least an order of magnitude radiation dose reduction without degrading image quality. This was validated using both objective metrics, such as spatial resolution and contrast-to-noise ratio, and independently by visual assessment by radiologists and medical imaging specialists. This work was carried out in preparation for live patient PCT breast cancer imaging, initially at the Australian Synchrotron.

Authors: Ashkan Pakzad (University of Melbourne), Dr Robert Turnbull (University of Melbourne), Dr Simon Mutch (University of Melbourne), Thomas Leatham (The University of Sydney), Dr Darren Lockie (Maroondah Breastscreen), Dr Jane Fox (Monash Health), Prof. Beena Kumar (Monash Health), Daniel Hausermann (Australian Synchrotron (ANSTO)), Chris Hall (Australian Synchrotron), Anton Maksimenko (ANSTO), Dr Benedicta Arhatari (ANSTO Australian Synchrotron), Yakov Nesterets (CSIRO Manufacturing), Amir ENTEZAM (Australian Synchrotron), Dr Seyedamir Taba (University of Sydney), Prof. Patrick Brennan (University of Sydney), TImur Gureyev (University of Melbourne), Prof. Harry Quiney (University of Melbourne)

Xia Hua

DAY 2

ABSTRACT 56

In Situ Powder Diffraction Study of Hydrogen Release Mechanisms in Mg-Based Hydrides for Large-Scale Hydrogen Storage and Transportation

Magnesium (Mg)-based hydrides are potential candidates for solid-state hydrogen storage materials due to their high capacity and abundant availability. However, their slow hydrogen absorption/desorption kinetics and high desorption temperature prevent their practical application. The co-addition of lanthanum (La) and sodium (Na) to form a hypoeutectic alloy is a proven method to improve hydrogen absorption/desorption kinetics. This study further introduces trace amounts of indium (In) (0/0.2/0.5 wt.%) to the alloy Mg-La-Na alloy to investigate its role in reducing the hydrogen release temperature of the alloy. Differential scanning calorimetry (DSC) revealed that the addition of trace amounts of indium effectively reduces the dehydrogenation temperature of the Mg-5wt.%La-0.2wt.%Na alloy. To clarify the underlying mechanism, we employed in situ synchrotron powder X-ray diffraction (PXRD) to directly monitor the structural evolution during hydrogen desorption. PXRD not only identified the specific temperatures at which MgH_2 decomposes but also tracked the emergence of Mg and intermediate phases, along with quantifying their relative phase fractions as desorption progressed. Rietveld refinement indicated that In doping caused lattice expansion of Mg. This phenomenon can provide broader diffusion pathways for H atoms, which may improve the absorption/desorption kinetics. As the In concentration increased, the expansion rate gradually decreased, which may be attributed to enhanced interatomic electronegativity effects. Overall, PXRD allowed us to correlate real-time phase transformations with atomic-scale structural changes and lattice expansion of Mg.

This project is supported by the Australian Research Council (ARC) Training Centre, and the synchrotron PXRD data presented in this abstract are obtained under Proposal 23246.

Authors: Xia Hua, Xin Fu Tan (University of Queensland), Kazuhiro Nogita (The University of Queensland)

Amir Entezam

DAY 1

ABSTRACT 57

Toward Patient-Specific Dosimetry in Synchrotron Phase-Contrast Breast CT: A Monte Carlo Framework for Clinical Translation at the Australian Synchrotron

Breast Computed Tomography (BCT) enables 3D imaging without compression, improving patient comfort and visualization of breast structures, which is particularly valuable in cancer detection. Propagation-based phase-contrast BCT, available at the Imaging and Medical Beamline (IMBL) of the Australian Synchrotron, provides superior soft-tissue contrast at comparable or lower doses than conventional BCT. Accurate radiation dosimetry is essential for safe clinical translation and remains key to imaging safety and diagnostic accuracy. The standard for quantifying dose in diagnostic imaging of breast tissue is Mean glandular dose (MGD). Most Monte Carlo (MC)-based MGD estimates use simplified homogeneous phantoms, overlooking patient-specific anatomical features that critically influence dose deposition within breast. To overcome this, we developed a voxel-based MC dosimetry framework using the EGSnrc system to calculate MGD in realistic anthropomorphic breast phantoms derived from BCT images, tailored to the imaging beam properties at IMBL. MC simulations were performed on breast phantoms with varying breast density, diameter, and skin thickness across a clinically relevant energy range (28–37 keV). Our results demonstrate breast anatomy and beam energy significantly affect the MGD. Higher breast density increased MGD, whereas larger breast diameters reduced it. A 2 mm increase in skin thickness led to ~10% higher MGD. Moreover, MGDs fell with higher beam energy, though the effect was less evident in larger breasts. This voxel-based MC framework provides a robust and anatomically accurate basis for patient-specific dosimetry in synchrotron phase-contrast BCT, enabling reliable dose assessment and supporting its safe and effective implementation in upcoming clinical trials at IMBL.

Authors: Dr Amir ENTEZAM (Australian Synchrotron), Dr Ashkan Pakzad (The University of Melbourne), Dr Anton Maksimenko (Australian Synchrotron), Dr Christopher Hall (Australian Synchrotron), Dr Matthew John Cameron (Australian Synchrotron), Dr Adam Round (Australian Synchrotron), Dr Yakov Nesterets (Commonwealth Scientific and Industrial Research Organisation), Dr Benedicta Arhatari (Australian Synchrotron), Dr Patrick Brennan (The University of Sydney), Dr Daniel Häusermann (Australian Synchrotron), Dr Timur Gureyev (The University of Melbourne), Prof. Harry Quiney (The University of Melbourne)

Marjana Yeasmin

DAY 2

ABSTRACT 58

In situ foliar transformation of selenium nanoparticles during photosynthesis - evidence from μ-XANES and proteomics

Selenium is an essential micronutrient known for its role in maintaining human health. Foliar-applied selenium nano particles (SeNP)-enriched have application in controlling plant growth, photosynthesis, nutrient content, and stress responses. However, little is known about how SeNP interact with crops and transforms within photosynthesising tissue. In this study, we investigated the time-dependent response of wheat (Triticum aestivum L.) to foliar applied SeNP, transformations over time within leaf tissues, SeNP uptake and translocation-related genes expression, photosynthesis and the proteomics profile of SeNP-enriched wheat using confocal microscopy, Orbitrap mass spectrometry, X-ray fluorescence microscopy (μ-XRF) imaging, X-ray absorption near edge spectroscopy (μ-XANES). Foliar-applied SeNP were located adjacent to chloroplasts and reduced reactive oxygen species accumulation by 50%, including the superoxide anion and hydrogen peroxide. The μ-XRF demonstrated little short movement of SeNP. Furthermore, speciation of Se in SeNP applied leaves showed that organic species of Se were rapidly developed, accounting for >90% of Se in the area of application. The ex-situ proteomics identified 1,541 proteins, out of which 78 showed significant overexpression in plants treated with SeNP. These differently expressed proteins (DEPs), which are strongly associated with biological processes, especially photosynthesis, increased threefold in SeNP-treated leaves compared to the untreated plant. Additionally, an 11-fold increase in protein involved in the detoxification of superoxide radicals illustrates their crucial role in mitigating oxidative stress. The findings of the study show that SeNP treatment effectively enhances proteomic traits of wheat, boosting photosynthesis pathways and strengthening plant defence mechanisms.

Authors: Marjana Yeasmin, Dane Lamb, Jacob Netherton, Prof. Ajayan Vinu

Usman Faryad

DAY 2

ABSTRACT 59

Thermal Transformation of Iron-Arsenic Minerals Under Realistic Bushfire Scenarios

Climate change is predicted to increase the frequency and spatial extent of bushfires globally, raising concerns about their impact on contaminant cycling. Arsenic (As), a redox-sensitive metalloid, is of particular concern as fire-driven thermal processes can accelerate redox reactions and destabilise iron-As minerals, influencing As mobility and risk. However, previous studies have simulated extreme fire conditions, and the geochemical response of arsenite-bearing iron minerals under low-to-moderate bushfires remains poorly resolved. To investigate this, we simulated low-to-moderate bushfires (100–350°C, 45 minutes) on tooeleite ($Fe_6(AsO_3)_4SO_4(OH)_4 \cdot 4H_2O$), with and without natural organic matter (5% C w/w citric acid and Humic acid). Lab-based XRD and synchrotron Powder Diffraction (PD), alongside TEM, Raman, and FTIR analyses showed crystallinity loss from 175°C, progressing to amorphisation at 350°C. Mössbauer spectroscopy confirmed structural collapse, with broad doublets (QS 1.05 mm/s) inconsistent with previously documented nano-crystalline Fe phases, such as ferrihydrite and amorphous ferric arsenate. Between 6–9% Fe(II) was observed which indicating partial reduction. Arsenic K-edge XANES revealed extensive As(III) oxidation at 350°C, but this was inhibited by humic acid, which produced 8% As(II) upon heating, suggesting previously undocumented fire-induced reductive pathways. Iron K-edge and As K-edge EXAFS confirmed the collapsed mineral structure, whilst sulfur (S) K-edge XANES indicated formation of more tightly coordinated S-O-Fe(III) bonds. These findings indicate that bushfire heating drives complex Fe-As-S transformations, breaking down crystalline phases and producing novel nano-crystalline phases. Organic matter critically appears to modulate these pathways, highlighting its role in As mobility in fire-affected contaminated soils and naturally enriched environments.

Authors: Mr Usman Faryad (RMIT University), Dr Marjana Yeasmin (RMIT University), Dr Dane Lamb (RMIT University), Dr Sepide Abbasi (ANSTO), Dr Andrew Grigg (ETH Zurich), Prof. Angelia Seyfferth (University of Delaware), Dr Suzie Reichman (University of Melbourne), Prof. Ruben Kretzschmar (ETH Zurich)

Emma Gobes

DAY 1

ABSTRACT 62

Using Micro-Computed Tomography to analyse Fibre Orientation and Its Influence on Mechanical Performance in Moulded Fibre Materials

Moulded fibre is a unique fibre-based material with low density and high grammage compared to conventional paper products, offering a sustainable alternative to single use plastic materials. Despite experiencing significant uptake as a packaging material, its mechanical performance is generally sub-par compared to plastic materials and conventional paper products at a similar grammage. In addition, the relationship between fibre orientation, microstructure, and mechanical performance in moulded fibre remains poorly understood. In this study, the Synchrotron Micro-Computed Tomography (MCT) beamline was used to image the three-dimensional fibre orientation and microstructure of moulded fibre samples produced under different manufacturing conditions. Complimentary testing of mechanical properties was undertaken to understand how fibre orientation and microstructure are linked with mechanical performance and can be manipulated using mould design. Our results demonstrate that mould design can alter the mechanical performance of moulded fibre products. This work provides a systematic evaluation of moulded fibre microstructure at Synchrotron resolution, bridging material science with industrial manufacturing practices. The findings contribute to the development of moulded fibre as a sustainable material alternative by enabling industry to design products with improved performance. This integration of Synchrotron imaging, materials engineering, and mechanical testing provides a framework for advancing fibre-based products in packaging and beyond.

Authors: Ms Emma Gobes (New Zealand Institute for Bioeconomy Science Limited and Massey University), Dr Kelly Wade (New Zealand Institute for Bioeconomy Science Limited), Dr Eli Gray-Stuart (Massey University), Dr Kate Parker (New Zealand Institute for Bioeconomy Science Limited), Prof. John Bronlund (Massey University)

KEYNOTE

Jun Wang

DAY 1

ABSTRACT 63

Probing grain growth via in-situ Synchrotron/lab dynamic Laue

The grain size significantly impacts the properties of metallic materials. It is often tailored via thermal processing, during which normal or abnormal grain growth occurs. Significant gaps remain in our understanding of the dynamic nature of the grain growth kinetics at the individual grain level. Our recently modified dynamic in-situ transmission Laue diffraction technique (with a beam size larger than the grain size) offers the opportunity to study 'rapid' changes in structure, such as intermittent plasticity and thermally induced grain growth/shrinkage at the grain scale in the bulk samples. Using this technique, we first demonstrate a seemingly erratic grain rotation in Mg alloy AZ91 annealed (with grain growing from 60 to 80 μm) at 500 °C using the Synchrotron Micro-CT beamline. This erratic rotation is not entirely erratic; it follows distinct segments characterized by a common rotation axis and a common disconnection-mediated shear coupling factor. We then show an abnormal grain growth (the abnormal grain grows to over 400 μm while the other grains remain at 4 μm – unchanged from the as-deposited microstructure) in an additive friction stir deposition (AFSD, a new solid-state 3D printing technology with the potential to transform metal scrap into high-value parts) processed Mg alloy AZ31, annealed at 450 and 500 °C, performed using a lab liquid metal X-ray source. The abnormal grain displayed a different texture compared to the initial bulk texture pre-annealing, and exhibited three distinctive stages: incubation, rapid growth, and slow growth.

Authors: Dr Jun Wang (Deakin University), Mrs Yu Chen (Deakin University), Prof. Ross Marceau (Deakin University), Dr Runguang Li (Deakin University), Prof. Scott Barnett (Deakin University), Andrew Stevenson (Australian Synchrotron/ CSIRO), Peter Lynch (Deakin University), Prof. Matthew Barnett (Deakin University)

ORAL - STUDENT

DAY 1

James Cayley

ABSTRACT 65

Benchmarking the PEER beamline for very high-energy electron radiotherapy studies

Ultra-high dose-rate, very high-energy electrons (VHEE, electrons with energy greater than 50 MeV) are of increasing interest to the field of radiotherapy, due to their ability to penetrate deeply into tissue and reach tumours that are out of reach to clinical electrons of lower energies. The Pulsed Energetic Electrons for Research (PEER) linac at ANSTO Australian Synchrotron delivers 100 MeV electrons and is capable of blisteringly high dose-rates. In excess of 10^8 Gy/s, orders of magnitude above the 40 Gy/s required for the FLASH effect, PEER enables the combination of deep penetration and normal tissue sparing. Previous efforts showed the MOSkin detector, a promising candidate for FLASH dosimetry, was able to accurately measure the dose at PEER, delivered as a single 200 ns pulse. With suitable dosimetry and diagnostics established, in-vitro biological investigations have been conducted to investigate cell survival curves as a benchmarking exercise, compared to 2 Gy/s, 73 keV synchrotron x-rays at the Imaging and Medical Beamline. The results are also compared to those of other international groups. Further, mice cadavers have been used to investigate the ability to target and irradiate specific locations of live animals, and to confirm the combination of PEER with IMBL animal husbandry facilities. To allow irradiation of larger targets (the PEER beam is approx. 2.5 mm FWHM), Monte Carlo studies are being used to develop a beam flattening foil while minimising radiative losses and preserving dose-rates.

Authors: James Cayley (University of Wollongong), Elette Engels (University of Wollongong), Tessa Charles (Australian Synchrotron), Mr Paul Bennetto (ANSTO Australian Synchrotron), Ms Kirsty Brunt (ANSTO), Ms Chelsey Skee (University of Wollongong), Mr Kiarn Roughley (University of Wollongong), Ms Sarah Koschny (University of Wollongong), Ms Marie Wegner, Ms Elisabetta Gargioni (UKE Hamburg), Elisabeth Schultke (Rostock University Medical Center), Prof. Moeava Tehei (University of Wollongong), Anatoly Rozenfeld (University Of Wollongong), Eugene Tan (Australian Synchrotron - ANSTO), Michael Lerch (University of Wollongong)

Branwen Hastings

DAY 2

ABSTRACT 66

Investigation of the Structural Expansion of a Skyrmion-Hosting Material upon Dual-Doping

Magnetic skyrmions are topologically protected spin structures that can be manipulated by various external stimuli with minimal energy input, making them attractive for future spintronic applications.[1] Skyrmion hosting materials have been proposed as solutions for many current global issues, especially around energy consumption and usage, with the potential to provide more energy-efficient memory devices with quicker storage and retrieval of information.[2] Cu_2OSeO_3 was the first insulating multiferroic material observed to host magnetic skyrmions under specific conditions.[3] It possesses a magnetic structure with both ferromagnetic and antiferromagnetic superexchange interactions and has a 3-up 1-down ferrimagnetic arrangement of Cu^{2+} ions.[4] Competition between Heisenberg exchange and Dzyaloshinskii–Moriya interactions induces canting of the Cu^{2+} spins, which under specific conditions stabilises skyrmion textures. Previous research has focused on doping the magnetic (Cu^{2+}) or non-magnetic (Se^{4+}) sites individually, observing changes to the skyrmion formation conditions through X-ray, neutron and magnetisation techniques.[5–7] Upon doping, the distance between spins changes with the expansion of the unit cell and the magnitude of the spin changes with Zn. The current project aims to investigate the effects of doping both metal sites simultaneously, $(Cu_{1-x}Zn_x)_2O(Se_{1-y}Te_y)O_3$, allowing for a further understanding of the formation of skyrmions, and to understand the underlying quantum-mechanical processes behind the complex spin and charge interactions.

Overall, upon doping, the Cu-Cu interactions lengthen, resulting in changes to the interaction strengths, with disruption to both the vector products of the spins. High-resolution variable temperature synchrotron pXRD data, collected at the Australian Synchrotron, show a structural anomaly of Cu-Cu interactions lengthening upon cooling of the system at similar temperatures where magnetic structures form, which is consistent upon single and dual-doping.

Authors: Branwen Hastings (Univeristy of Auckland), Marco Vas (University of Auckland), Dr Marcus Giansiracusa (University of Melbourne), Clemens Ulrich (The University of New South Wales), Samuel Yick (University of Auckland), Elliot Gilbert (ANSTO), Tilo Soehnel (The University of Auckland)

Zhou Chen

DAY 2

ABSTRACT 67

Self-Assembled Ion Transport Channels in Block Copolymer Electrolytes for Dendrite-Free All-Solid-State Sodium Batteries

Sodium metal batteries are a promising low-cost alternative to lithium-based systems, offering abundant raw materials and high energy density. However, their development is hindered by challenges such as dendrite growth and interfacial instability, which compromise safety and cycling performance. To address these issues, we report a new class of fluorinated, ion conducting block copolymer electrolytes designed to self-assemble into well-defined ion transport channels. These block copolymers, composed of perfluoropolyether (PFPE) segments and charged polyethylene oxide (PEO) blocks, self-assemble into a variety of nanostructures. A three-dimensional interconnected body-centered cubic (BCC) morphology forms across a broad PFPE volume fraction range ($f_{PFPE} \approx 0.15$-0.30). Among the observed morphologies, the BCC phase stands out for its superior performance, enabling high ion conductivity (up to 1.42×10^{-4} S cm^{-1} at 80°C) and forming robust electrode/electrolyte interfaces that support stable cycling in symmetric sodium cells for over 5000 h at 0.1 mA cm^{-2}. Furthermore, in full-cell configurations using $Na_3V_2(PO_4)_3$ (NVP) cathodes, the block copolymer-based sodium metal battery retains >91% of its initial capacity after 1000 cycles at 0.5 C and a high Coulombic efficiency at >99.8%. This study highlights the potential of morphological control through block copolymer design to overcome key limitations in sodium metal batteries and presents a viable path toward safe, high-performance, and sustainable energy storage technologies.

Authors: Zhou Chen (University of Queensland), Zhuojing Yang, Dr Xiao Tan, Yiqing Wang, Xiaoen Wang, Prof. Bin Luo, Maria Forsyth, Prof. Craig Hawker, Debra Searles, Cheng Zhang

ORAL

DAY 3

Michelle Croughan

ABSTRACT 68

Which dark-field imaging technique is best for me? Comparing a family of approaches at MicroCT

X-ray imaging has evolved beyond conventional absorption-based imaging. For example, dark-field imaging shows unresolved microstructures within a sample, such as powders, pores or fibres, due to how they scatter the x-ray beam. This scattering can be measured in many ways: either by analysing how the x-ray intensity changes across different propagation angles (analyser-based imaging or grating interferometry), or by observing a decrease in image visibility (propagation-based, speckle-based, or grid-based imaging). This talk focuses on the latter family of techniques. Two samples were imaged at the MicroCT Beamline using these different imaging setups and different analysis algorithms: dual-energy propagation [1], single-grid (isotropic [2] and directional [3]), single-speckle [4], and multi-speckle [5]. These algorithms vary in the number of required data sets and their computational strategies – operating either globally on entire images or locally within sub-image-sized analysis windows. These dark-field methods will be compared to highlight their strengths and limitations, while also demonstrating an agreement in the extracted dark-field signal. This suite of complementary techniques is characterised in a summary table, allowing non-expert users to easily identify the optimal technique for their experiments.

[1] Ahlers, J. N., et al. (2024). Optica, 11(8), 1182–1191.
[2] How, Y. Y. & Morgan, K. S. (2022). Optics Express, 30(7), 10899–10918.
[3] Croughan, M.C., et al. (2023). Optics Express, 31(7), 11578-11597.
[4] Beltran, M. A., et al. (2023). Optica, 10(4), 422–429.
[5] Alloo, S. J., et al. (2023). Scientific Reports, 13(1), 5424.

Authors: Samantha Alloo, Ying Ying How, Jannis Ahlers (Monash University), David Paganin (Monash University), Michelle Croughan (Monash University), Kaye Morgan (Monash University)

Vaishnavi Krishnamurthi

DAY 1

ABSTRACT 69

Structure-property relationship in liquid metal alloys

Liquid metals represent an exciting new frontier in chemistry. While room temperature liquid metals (RT LMs) remain fluid at ambient conditions and have significant potential in electronic, catalytic, and biomedical applications, alloys such as GaCu, GaZn and GaBi, which do not exist at RT, have implications ranging from fundamental science to industrial applications. However, their complete utilisation is limited by the lack of analytical techniques capable of elucidating their bulk-liquid chemical processes. The primary challenge in studying these systems is their metallic bonds, which make them opaque to most traditional solvent characterisation techniques and prevent atomic-level insights. Investigating the nanoscale structures of bulk liquid metals can provide valuable information on their properties and potential applications in various LM applications. Neutron scattering techniques like small angle neutron scattering (SANS) have advanced considerably in recent years, now capable of resolving atomic structures, clusters, and covalent associations within soft matter systems. This talk will highlight the various investigations carried out on liquid metals and alloys, including gallium, gallium-based eutectic and hypo/hyper eutectic alloys with In, Sn, Cu, Zn and Bi as the dopants at varying concentrations to probe the nanoscale structures of these systems and develop structure-property relationships for RTLM systems using SANS. Using a defined shape model at a length scale between 6 Å and 1570 Å, crucial knowledge of particle-particle interaction and its effect on the atomic structure is obtained, which will help develop the fundamental understanding of solvation dynamics in liquid metals and alloys.

Authors: Vaishnavi Krishnamurthi (RMIT University), Jitendra Mata (ANSTO), Prof. Torben Daeneke (RMIT University), Dr Aaron Elbourne (RMIT University)

ORAL

Pablo Mota Santiago

DAY 2

ABSTRACT 70

A first look at materials science research at the SAXS/WAXS beamline

Small-angle and wide-angle X-ray scattering (SAXS/WAXS) are widely used techniques for accessing the organization of materials at the angstrom to hundreds of nanometres length scale. There is a reciprocal relationship between the scattered angle and the length scales probed in the sample interior. As a result, the scattering intensities relate to the structures and the distribution of subcomponents within the volume elements of bulk materials or deposited at surfaces. The SAXS/WAXS beamline at Australian Synchrotron, ANSTO can be used to probe the structure of a broad range of materials, such as polymers, nanocomposites, metal alloy precipitates, etc. The beamline boasts a one cubic metre in-vacuum chamber providing almost negligible background for detection of vacuum-compatible weakly scattering systems. The beamline also has the capability to provide information of structures deposited at the surface thanks due to its grazing incidence operational mode. This presentation will highlight current projects under development at the SAXS/WAXS beamline. These developments will support faster better data quality (replacement of old slits), faster data acquisition, data visualisation and reduction (new beamline library, use of jupyterlab and new general scan framework), and new experimental setups (blade and spin coating grazing incidence, tensile testing). Together, these advances are strengthening support for materials science research across diverse applications.

Authors: Pablo Mota Santiago (Australian Synchrotron), Valerie Mitchell (University of Melbourne), Dr Luke Giles (ANSTO), Ashish Sethi (ANSTO), Nigel Kirby (Australian Synchrotron)

Hao Yin

DAY 2

ABSTRACT 72

Tracking long-term flavonoid accumulation in Antarctic moss leaves non-destructively through synchrotron-based infrared microspectroscopy

Antarctic vegetation is restricted to non-vascular plants dominated by mosses. One important mechanism to cope with abiotic stress is the synthesis of flavonoids. However, traditional destructive bulk extraction methods require large amounts of scarce Antarctic material and fail to capture the fine-scale spatial and temporal distribution of compounds. In this study, we used synchrotron-based infrared microspectroscopy on individual leaves of Antarctic moss Ceratodon purpureus, collected from various sites in the Windmill Islands, East Antarctica. This approach enabled us to generate non-destructive chemical distribution maps in single moss leaves. By combining IRM with radiocarbon dating, we revealed the long-term dynamics of compound accumulation at high temporal and spatial resolution. Our results show that structural polysaccharides and flavonoids are the primary compounds preserved in moss leaves over time. Polysaccharides were predominantly localised in the costa, consistent with their structural role, whereas flavonoids were concentrated in the lamina. Two distinct distribution patterns were identified along the leaf axis: “diffuse” and “zoned”, which were strongly associated with microenvironmental water availability. This study presents the first high-resolution chemical distribution maps of Antarctic moss leaves at the single-leaf scale. Our findings reveal links between compound accumulation, microenvironment, and climate factors, highlighting their potential as long-term proxies for climate change.

Authors: Mrs Hao Yin (University of Wollongong), Dr Melinda Waterman (University of Wollongong), Mr Yifan Wu (University of Wollongong), Dr Annaleise Klein (Australian Synchrotron), Prof. Sharon Robinson (University of Wollongong)

Yu Chen

DAY 1

ABSTRACT 73

Towards observation of 3D microstructure in real time

Real-time observation of 3D grain microstructure evolution in polycrystalline materials under external stimuli is desired for a more accurate understanding of the microstructure-property relationship. However, available 3D diffraction techniques, such as diffraction contrast tomography, 3D XRD, or differential-aperture X-ray microscopy (with a beam size smaller than the grain size), require time-consuming sample rotation or raster scans, which prevent them from tracking microstructural changes in real-time. Therefore, we proposed a new technique to address this limitation. It is an extension of our recently developed real-time Synchrotron transmission X-ray Laue diffraction (with a beam size larger than the grain size) combined with the X-ray tracing method for locating grain positions and an energy scan of a new detector to resolve indexing challenges. At the Micro-CT beamline, we focused on initial energy scan verification and ray tracing. A polychromatic X-ray beam (4-70 keV) with a beam size of $180 \times 110\ \mu m^2$ passes through an 800 μm thick Mg alloy sample. The energy scan (without sample rotation or raster scanning) was performed using an EIGER2 R 1M hybrid-photon-counting detector with an energy step size of 0.5 keV from 4 keV to 70 keV. This helped resolve the energy for each Laue reflection and verified the indexation results for 26 grains obtained from the XMAS software. We are currently developing an algorithm to automate our indexation process since the diffraction angle and energy of each reflection are known. Based on this verified indexation, we constructed the 3D grain map of the sample using the ray tracing approach.

Authors: Mrs Yu Chen (Deakin University), Jun Wang (Deakin University), Sitarama Raju Kada, Andrew Stevenson (Australian Synchrotron), Prof. Matthew Barnett (Deakin University), Peter Lynch (Deakin University)

Christian Arzberger

DAY 1

ABSTRACT 75

Optimizing Microbeam Radiation Therapy Through Temporal Fractionation in Non-Small Cell Lung Cancer

Background: Microbeam Radiotherapy (MRT) is a preclinical X-ray technique delivering spatially fractionated, ultra-high doses that spare normal tissue while preserving tumor control. This could enable dose escalation in radiosensitive organs such as the lung, where pneumonitis and fibrosis currently limit efficacy. We investigated the impact of temporally fractionated MRT over three consecutive days on lung cancer cells in vitro in Munich and healthy mouse lungs in vivo in Melbourne.

Methods: A549 (human) and LLC (murine) cells, as well as C57BL/6 mice, received MRT or conventional broad-beam (BB) irradiation, either as a single fraction or three fractions spaced 24 h apart. Flow cytometry was used to assess cell cycle and cell death in vitro. Lung fibrosis in vivo is monitored by computer tomography (CT) and serum TGF-β.

Results: MRT induced a significant stronger G2/M arrest after the first fraction, enhancing sensitivity to subsequent doses, while BB caused only modest arrest. Three-fraction MRT showed enhanced apoptosis and immunogenic-cell death with high externalization of calreticulin, while BB predominantly caused necrosis with lower apoptotic induction in all radiation regimens. CT monitoring of irradiated mouse lungs is ongoing; data will be available in November.

Conclusion: Temporally fractionated MRT enhances tumour cell killing and immunogenicity compared to single-fraction MRT or BB in vitro. Our ongoing in vivo study will determine whether this approach can optimise lung cancer radiotherapy by improving efficacy while reducing toxicity.

Authors: Christian Arzberger, Dr Mariaelvy Bianchini (Technical University of Munich), Prof. Stefan Bartzsch (Technical University of Munich), Dr Mabroor Ahmed (Technical University of Munich), Mitzi Klein (Australian Synchrotron), Matthew Cameron (Australian Synchrotron/ANSTO), Ms Kirsty Brunt (ANSTO), Daniel Hausermann (Australian Synchrotron (ANSTO)), Dr Susanne Raulefs (Technical University of Munich), Prof. Stephanie E. Combs (Technical University of Munich), Thomas E. Schmid Technical University of Munich), Dr Kim Kraus (Technical University of Munich)

ORAL

Zhang Tian

DAY 2

ABSTRACT 77

A Solid-Gas-Aqueous Reaction Cell for In Situ Transmission X-Ray Diffraction of Cement Carbonation

The in-situ X-ray diffraction (XRD) measurements on cement slurry carbonation reaction is challenging due to complex interplay of liquid, gas and solid phase materials. We present an exploratory, purpose-built bubbling reaction cell designed to do flat-plate transmission mode XRD. This setup has been utilized to study the carbonation kinetics of CO2 bubbling in cement slurry under various conditions by means of in-situ synchrotron powder X-ray diffraction experiments. Alongside the experimental setup, we will discuss the in-situ XRD data analysis based on Rietveld refinement method, especially for quantitative phase analysis, which are essential for handling the complexities of measurements in aqueous environments. The development of this bubbling reactor prototype shows promise for extending in-situ XRD studies to a wider range of aqueous and slurry-based materials.

Authors: Dr Zhang Tian (Monash X-ray Platform), Ms Ziyu Chen (Monash X-ray Platform), Dr Ian Madsen (Monash X-ray Platform), Jisheng Ma (Monash University), Yuxiang Wu (Monash University), Dr Suming Zhu (Monash X-ray Platform)

Lucy Costello

DAY 1

ABSTRACT 79

From Dim to Detail: Comparative Lung Imaging with CT, MRI, and PC-CT

Lung cancer is the leading cause of cancer death in Australia. It is the fifth most common cancer diagnosed and is responsible for almost one in five cancer deaths. Currently, the path for a patient to be diagnosed is a chest X-ray to look for obvious abnormalities, followed by a chest Computed Tomography (CT) scan to gain a better understanding of the pathology. Unfortunately, a medical CT does not provide sufficient information to properly visualise early-stage tumours, often resulting in a poor prognosis for the patient. Because of this, the idea of "zooming-in" to a suspicious area of a patient and taking a Region-of-Interest (ROI) image was formed. We couple this with Phase Contrast (PC) which looks at how the x-rays are refracted (or how they have shifted in phase) to get more information or contrast from the patient's soft tissue. The lungs create strong phase contrast effects which means that the once-apparently homogenous soft tissue, as observed in a conventional medical image (X-ray and CT), is now revealed with greater visible detail. In this project we show a comparison between current clinical imaging techniques (CT and MRI) and phase-contrast CT using large animal tissue observing simulated tumours. We also show the first Human lung pathology images utilising the Region-of-Interest technique we have developed using the Imaging and Medical Beamline (IMBL), while also demonstrating the contrast of dose across both clinical and phase-contrast images. With the sensitivity and spatial resolution of ROI PC-CT, lung cancer patient prognosis could be improved in the future.

Authors: Lucy Costello (Monash University), Martin Donnelley (University of Adelaide), Ronan Smith (University of Adelaide), Michelle Croughan (Monash University), Marcus Kitchen (Monash University), Kaye Morgan (Monash University), Daniel Hausermann (Australian Synchrotron (ANSTO)), Yakov Nesterets (CSIRO Manufacturing), Lorenzo D'Amico (Monash University), Dom Jurkschat (Monash University)

Lucrezia Guarneri

DAY 1

ABSTRACT 80

Designing Lipid Nanocarriers for Polyphenol Delivery in Neurodegenerative Disease

Cubosomes are lipid-based nanoparticles with internal bicontinuous cubic structures that offer a versatile platform for delivering neuroprotective polyphenols in Alzheimer's disease therapy. However, the incorporation of bioactives can profoundly alter nanoparticle structure and stability. In this study, we encapsulated a range of neuroprotective polyphenols and observed that each induced distinct effects on phase behavior and lattice parameters. Among these, pentagalloyl glucose (PGG) showed the most promising combination of encapsulation and structural compatibility. To gain mechanistic insight, we applied small-angle X-ray scattering (SAXS) and small-angle neutron scattering (SANS) to study PGG-loaded cubosomes, with and without cholesterol. SAXS revealed polyphenol-specific shifts in cubic phase transitions, while SANS with contrast variation provided unique information on core–shell nanoparticle structure. Polyphenols were shown to uniquely reshape cubosome nanostructure, with PGG emerging as a promising candidate. By combining SAXS and SANS, we demonstrate how bioactive–lipid interactions modulate core–shell organization, providing design rules for engineering biomimetic nanocarriers for polyphenol delivery in neurodegenerative disease.

Authors: Ms Lucrezia Guarneri, Liliana de Campo (ANSTO), Charlotte Conn (RMIT), Andrew Clulow (ANSTO Australian Synchrotron), Leonie van 't Hag (Monash University)

ORAL

DAY 3

Molong Han

ABSTRACT 82

Mid-Infrared Coded Aperture Holography

Mid-infrared (MIR) coded aperture holography combines the principles of incoherent digital holography with coded aperture imaging to enable advanced multidimensional imaging. This presentation introduces the fundamentals of coded aperture holography, recent progress in reconstruction algorithms, and evolving applications across 2D, 3D, spectral, and temporal domains. We highlight developments such as incoherent holography without two-beam interference, nonlinear deconvolution methods, and phase retrieval approaches that extend the capabilities of MIR holographic microscopy. Applications include synchrotron-based infrared holographic imaging, phase imaging of biological samples, and birefringence mapping. These advances demonstrate the potential of coded aperture holography to achieve high-resolution, depth-extended imaging in complex environments, opening new opportunities in biomedical imaging, material characterization, and applied optics.

Authors: Molong Han, Dr Daniel Smith (University of Tartu), Dr Soon NG Hock (Swinburne University), Prof. Joseph Rosen (Ben Gurion University Israel), Dr Pimm Vongsvivut (Infrared Microspectroscopy (IRM) beamline - ANSTO), Prof. Saulius Juodkazis (Swinburne University), Prof. Vijayakumar Anand (University of Tartu)

ORAL

Darmanin Connie

DAY 2

ABSTRACT 84

Protic ionic liquids as stable carrier media for seral protein crystallography

Continuous liquid sample delivery systems, such as Gas Dynamic Virtual Nozzles (GDVNs), are essential for serial protein crystallography at synchrotrons and X-ray Free Electron Lasers (XFELs)1,2. By replenishing the sample stream, GDVNs enable high-throughput and time-resolved molecular imaging. Despite their widespread use, these devices face challenges in efficient sample delivery. In particular, the reliance on high concentrations of polyethylene glycol (PEG) to prevent ice formation, together with salts in protein buffers, can cause nozzle clogging, stream instabilities, and even detector damage. These problems arise because such buffers are prone to dehydration and 'salting out' under experimental conditions. To address these limitations, we investigated the use of Protic Ionic Liquids (PILs) as novel, non-volatile carrier media for serial crystallography. PILs exhibit high proton mobility and tuneable physicochemical properties that make them attractive alternatives to conventional buffers. Here we studied the behaviour of protein crystals in PILs and assessed their jetting performance using GDVNs. Crystal quality and stability were examined using small- and wide-angle X-ray scattering (SAXS/WAXS), optical microscopy, and injector-based tests. SAXS/WAXS measurements at the Australian Synchrotron confirmed protein crystal integrity and diffraction quality when suspended in PIL matrices. Three types of PILs—ethylammonium acetate (EtAA), ethylammonium formate (EtAF), and ethylammonium glycolate (EAG)—were tested. All three maintained stable, high-quality, crystals over extended periods. Overall, PILs show strong potential as a novel serial crystallography injection media. Their low volatility is particularly advantageous for in-vacuo structure determination, offering a promising pathway to more effective sample delivery at synchrotron and XFEL facilities.

1. S Holmes, et.al Nature Communications 13 (1), 4708 (2022)
2. S Holmes, et.al Acta Cryst 77, C849 (2023)

Authors: Dr Darmanin Connie (LaTrobe University), Prof. Brian Abbey (La Trobe University), Mr Andrew Formosa (La Trobe University), Dr Kenny Liu (RMIT), Mr Stefan Paporakis (RMIT), Dr Qi Han (RMIT), Mr Stuart Brown (RMIT), Prof. Tamar Greaves (RMIT), Dr Katrina Doerner (European XFEL)

ORAL

DAY 3

Daryl Howard

ABSTRACT 85

Seamless acceleration towards megapixels per minute – and update from the XFM Beamline

The XFM beamline is a hard x-ray microprobe capable of fast elemental mapping of a diverse range of samples for elements from Silicon to Plutonium. Since accepting first light in 2008, the beamline has cemented itself as a world-leading instrument for rapid elemental mapping in a wide variety of disciplines with vastly different sample requirements. It has also coupled this rapid mapping with correlated techniques, including XANES mapping and ptychography, enabling a more complete understanding of many systems. The last few years has seen the XFM beamline complete several upgrades that have seen its capabilities expand. This includes the installation of our Dual Multilayer Monochromator (DMM), enabling a 10-20x uplift in flux at the sample, and the integration of a new SDD detector into the beamline operations. These upgrades have allowed our multimodal techniques to grow to include collecting microdiffraction and micro-SAXS/WAXS data with correlated fluorescence. We have also had significant work on data pipelines at the beamline, with our Fluorescence Tomography pipeline being delivered for users. Here we will present an update of the beamline, the outcomes of these upgrades and some of the challenges this has presented. We shall also update the community on the state of our correlated techniques and other advances we have made in improving the user experience.

Authors: Andrew Langendam (Australian Synchrotron), David Paterson (ANSTO), Daryl Howard (Australian Synchrotron)

DAY 1

Christopher Hill

ABSTRACT 86

Examining fundamental interactions between chitosan and sol-gel silica toward sustainable materials using SAXS and SANS

Chitosan and silica are two materials that have seen increased examination in the journey for viable alternatives to petrochemical materials [1]. These form the basis for a method of microcapsule synthesis in which chitosan is used to stabilise an oil-in-water emulsion, while an oil-miscible silica precursor is premixed in the oil phase and undergoes a sol-gel process at the interface to form a stable silica capsule shell [2]. Our work examines the formation of silica–chitosan hybrid materials from two precursors, tetraethyl orthosilicate (TEOS) and tetramethyl orthosilicate (TMOS), in both aqueous bulk systems and at the oil-water interface. We have used spatially resolved synchrotron small-angle x-ray scattering (SAXS) to examine the structures formed in bulk and at interfaces. Complementary contrast variation small-angle neutron scattering (SANS) enabled separation of scattering signals from chitosan and silica structures. We have found that the geometry of the silica structures formed is influenced largely by the precursor used, with TMOS based structures forming nanoplatelet-like structures, while TEOS forms ellipsoidal structures, with aqueous conditions affecting particle size. These findings will be used to design the next generation of chitosan-silica hybrid materials for controlled capsule formulation.

[1] C. Carbone, I. Navarro-Arrebola, L. Liggieri, F. Ortega, R. G. Rubio and E. Guzmán, Journal of Molecular Liquids 2025, 425, 127273.
[2] M. Ali, S. P. Meaney, M. J. Abedin, P. Holt, M. Majumder and R. F. Tabor, Journal of Colloid and Interface Science 2019, 552, 528-539.

Authors: Christopher Hill (Monash University), Andrew Clulow (ANSTO Australian Synchrotron), Anna Sokolova (ANSTO), Rico Tabor (Monash University)

Bernt Johannessen

DAY 1

ABSTRACT 87

Standing Still to Measure Even Faster: Fixed Energy XAS

Addressing the challenges of carbon utilisation, sustainable energy storage, and low-emission technologies requires advanced characterisation tools to design and optimise new materials. At the Australian Synchrotron at ANSTO, these efforts are advanced through partnerships with universities and national research centres, including the ARC Centre of Excellence for Green Electrochemical Transformation of Carbon Dioxide (GETCO2). Such collaborations are accelerating the development of next-generation materials while aligning with Australia's Net Zero Plan and the Future Made in Australia initiative. ANSTO continues to support high-impact, collaborative research across academia and industry. The X-ray Absorption Spectroscopy (XAS) Beamline plays a central role in this effort, supporting *in operando* experiments that are essential for probing catalytic and electrochemical processes in real time [1, 2]. Recent developments include the implementation of fast (slew) scanning, which has reduced sample-to-data turnaround by a factor of three and enabled up to 100-fold faster acquisition rates. This is transformative for dynamic *in operando* studies. Building on this foundation, new fixed-energy scanning capabilities have been introduced, offering further flexibility for time-resolved and kinetic measurements.

We welcome users to explore these new capabilities in their future experiments at the XAS Beamline.

1. Y. Fan, X. Wang, G. Bo, X. Xu, K. W. See, B. Johannessen, W. K. Pang, Adv. Sci. 2025, 12, 2414480.
2. B. V. Kerr, H. J. King, C. F. Garibello, P. R. Dissanayake, A. N. Simonov, B. Johannessen, D. S. Eldridge, R. K. Hocking, Energy Fuels 2022, 36, 2369.

Authors: Ben Baldwinson (Australian Synchrotron), Melanie Hampel (Australian Synchrotron), Dr Noah Kim (ANSTO), Letizia Sammut (Australian Synchrotron), Jessica Hamilton (Australian Synchrotron (ANSTO)), Dr Sepide Abbasi (ANSTO), Britt Kerr (ANSTO), Bernt Johannessen (Australian Synchrotron)

Cailin Diedericks

DAY 1

ABSTRACT 89

Optimising Lung Aeration using External Negative Pressures in Near-Term Rabbit Kittens.

Introduction: Respiratory distress in term infants is primarily caused by elevated airway liquid at birth. As liquid is cleared from the airways into lung tissue, the lungs become oedematous. However, elevated liquid increases the degree of oedema, impairing respiratory function. Previous research demonstrated that external negative pressures (-6 cmH2O) improve lung aeration, and we hypothesise that optimal levels of external negative pressure will vary with the volume of airway liquid.

Methods and Results: Rabbit kittens (30/32d) were randomised to Control or Elevated Liquid (EL) groups. Control kittens had lung liquid drained, simulating volumes after vaginal delivery. EL kittens had lung liquid drained and 30 mL/kg liquid returned, simulating volumes after caesarean section. Kittens were transferred into a water-filled plethysmograph and external pressures adjusted to 0 cmH2O (Control n=7; EL n=6), -3 cmH2O (Control n=7; EL n=8), -6 cmH2O (Control n=6; EL n=7), or -9 cmH2O (Control n=6; EL n=7). Kittens were ventilated with a tidal volume of 8 mL/kg. Phase-contrast X-ray imaging measured lung aeration (functional residual capacity; FRC). In Control kittens, FRC levels increased with external negative pressure levels, but were similar in external -6 and -9 cmH2O (31.6±0.9 vs 39.0±1.3 mL/kg). In EL kittens, FRC increased with the levels of external negative pressure (0 cmH2O, 7.6±2.0; -3 cmH2O, 15.1±1.3; -6 cmH2O, 22.1±1.6; -9 cmH2O, 28.3±3.1 mL/kg; $P \leq 0.05$).

Conclusion: Optimal lung inflation (FRC≈30 mL/kg) was achieved with external -6 cmH2O in Control kittens, whereas external -9 cmH2O caused over-inflation (FRC≈40 mL/kg). In EL kittens, optimal lung aeration was achieved with external 9 cmH2O.

Authors: Cailin Diedericks (Hudson Institute of Medical Research), Dr Kelly Crossley (Hudson Institute of Medical Research), Dom Jurkschat (Monash University), Dr Indya Davies (Hudson Institute of Medical Research), Ms Paige Riddington (Hudson Institute of Medical Research), Prof. Arjan te Pas (Leiden University Medical Centre), Marcus Kitchen (Monash University), Stuart Hooper (Monash University)

Rufus Mart Ceasar Ramos

DAY 1

ABSTRACT 90

Probing the Dispersion Behaviour of $Ti_3C_2T_x$ MXene Nanosheets Using X-ray Scattering

A thorough understanding of the dispersion behaviour of $Ti_3C_2T_x$ MXenes is essential for their effective integration into advanced functional systems, including fiber spinning, spray coating, and printable electronics. Despite the growing interest in MXenes, a key challenge remains in elucidating their structural evolution in liquid media. The nanosheets exhibit complex stacking, spacing, and aggregation tendencies that strongly influence both their processability and ultimate performance in device applications. To address this challenge, we employ a combination of Small-Angle X-ray Scattering (SAXS) and Wide-Angle X-ray Scattering (WAXS) to probe the structural organization and interparticle interactions of $Ti_3C_2T_x$ MXene sheets dispersed in different solvents. Our approach enables direct characterization of the nanosheets under realistic conditions, capturing dynamic changes in colloidal arrangements. By systematically analyzing variations in scattering profiles with respect to concentration and the presence of different ion intercalants, we uncover key parameters that govern colloidal stability and exfoliation quality. In particular, the results reveal how ion species and dispersion conditions dictate interlayer distances and degree of aggregation, thereby providing critical insights into optimizing dispersion protocols. This study highlights the utility of synchrotron-based scattering methods as powerful tools for probing nanosheet organization in situ. Beyond fundamental understanding, the findings establish design principles for tailoring MXene dispersions to specific processing routes, ultimately advancing their deployment in scalable, high-performance technologies.

Authors: Mr Rufus Mart Ceasar Ramos (Deakin University), Dr Peter Lynch (Deakin University), Dr Ken Aldren Usman (Deakin University), Dr Si Qin (Deakin University), Dr Joselito Razal (Hong Kong Polytechnic University), Ms Kim Sisican (Deakin University), Ms Rochelle Ibabao (Deakin University), Mr Kevinilo Perez (Deakin University)

ORAL

DAY 1

Rosalie Hocking

ABSTRACT 93

Following Redox Chemistry Across Space and Time- Insight from Xr-rays from Molecular to Macro

One of the greatest challenges of the 21st century will be securing cheap and renewable sources of energy. One of the most promising approaches to this challenge is to design catalysts from earth-abundant materials capable of implementing key chemical reactions, including splitting water into hydrogen and oxygen ($H_2O \rightarrow 2H^+ + O_2$); and both the oxidation ($H_2 \rightarrow 2H^+$) and reduction ($2H^+ \rightarrow H_2$) of hydrogen among many others. In studying catalysts, we often focus on the “nature of the active site” which for classical heterogeneous catalysts works well- but not all catalysts work by surface sorption processes alone. In some systems, it is increasingly realised that processes of precipitation and reformation may actually be key to how the catalysts work. In this talk, we explore how X-ray experiments can be used to probe systems over different timescales. Utilising underlying electrochemical change coupled to single wavelength x-ray absorption we can separate the different timescales of deposition and oxidative electrochemical processes. Using X-ray imaging we can follow the movement of redox process through mm-μm of deposited material. The redox events between substrate and catalyst and the speed of these processes appear to play a key role in both engineering product selectivity and catalyst stability. We examine how the events after catalysis may be key for understanding both the active events of catalysis as well as mechanisms of decomposition. Key for modern and ancient catalyst design alike.

Authors: Prof. Alexandr Simonov (Monash), Britt Kerr (ANSTO), Dr Chad Stone (Swinburne University of Technology), Darcy Simondson-Tammer (Monash University), Dr Peter Mahon (Swinburne), Rosalie Hocking (Swinburne University of Technology)

ORAL

Stewart Walker

DAY 3

ABSTRACT 95

Two for the price of one - double Illumination at the Australian Synchrotron

This presentation will overview the analysis of different materials undertaken in a number of investigations at the FAR-IR beam line at the Australian Synchrotron including, semen, fingerprint reagents, drugs, explosives, blood and bruises. The FAR-IR beam line provided much higher intensity light and finer resolution than a standard University based instrument. Our initial studies used polyethylene and/or polytetrafluoroethylene pressed disk pellets in a cryogen-cooled cryostat. Following this we used the diamond windowed cells for liquids. Our most recent research has utilised the out-of-vacuum diamond window to analyse powders, liquids and solids. This enabled temperature, humidity and gaseous environment to be realistic to human bodies. We have initiated research using a combined FAR-IR beam from beneath and an UV-Vis detector above to investigate interconversion of oxy-haemoglobin to de-oxy-haemoglobin and, also investigate carboxy-haemoglobin and haemoglobin breakdown products – biliverdin and bilirubin (that gives bruises their green and orangey-brown colour, respectively). This “double illumination” at the FAR-IR beam line of the Australian Synchrotron gives us, and other researchers, a unique approach to obtain twice as much information from the same sample. We studied transitions that are important in identifying a bruise and the relative ages of bruises. The information from these studies provides essential information for a range of forensic and medical investigations. Although this proof-of-concept has been used for a specific area of investigation, the new technique of double illumination from below and above a sample can be applied to other areas of investigation. Thereby, we can get two for the price of one.

Authors: Stewart Walker (Flinders University)

ORAL - STUDENT

DAY 1

Olivia Mejías

ABSTRACT 97

Unravelling indium cycling in mine waste: insights from the combined application of high-energy synchrotron XFM and XAS

Indium (In), a critical metal for the energy transition, is attracting international attention due to supply constraints. Mine waste represents a potential sustainable source, yet its deportment and cycling in these environments remain poorly understood. This study presents a microanalytical investigation of In cycling in mine waste from the Baal Gammon Cu–Sn deposit (Queensland, Australia) and adjacent stream sediments. SEM-based automated mineralogy (MapsMin), LA-ICP-MS, synchrotron-based XFM and XAS (XANES), and microbial identification were applied to resolve In occurrence, deportment, and incorporation mechanisms across hypogene, supergene, surficial, and biogenic phases. In-bearing hypogene assemblages were dominated by chalcopyrite, sphalerite, and kësterite–stannite. In(III) incorporation occurred mainly through coupled substitution with Cu^{+} and Ag^{+} into Zn^{2+} sites, with additional occurrences in micro-inclusions, lamellae, and exsolved textures at sulphide–sulphide and sulphide–oxide interfaces. Within supergene assemblages, In(III) was sequestered in colloform goethite, indicating strong retention under acidic, oxidising conditions via substitution into Fe^{3+} sites. In the enrichment zone, XANES detected minor In(I), possibly reflecting reducing conditions but remaining within model uncertainty. Sediments hosted In(III) in cassiterite, suggesting long-term immobilisation and resistant transport pathways. Biogenic precipitates showed In co-localisation with bacterially mediated schwertmannite, zykaite, and natrojarosite, while XANES confirmed its persistence in the In(III) state without microbial redox modification. This study highlights the role of biogeochemical processes in controlling In cycling. High-energy synchrotron XFM, including a double multilayer monochromator (DMM), combined with XAS, proved essential for resolving trace-level In distribution and oxidation state in complex Sn-rich mine waste, informing biomining and recovery strategies.

Authors: Olivia Mejías (The University of Queensland), Jessica Hamilton (Monash University), Daryl Howard (Australian Synchrotron), Thomas Ray Jones (CSIRO), Anita Parbhakar-Fox (Sustainable Minerals Institute)

ORAL

Dom Appadoo

DAY 3

ABSTRACT 98

Update on the Capabilities at the THz Beamline: from Environmental to Energy applications

THz synchrotron spectroscopy has become an increasingly important tool in the identification and quantification of molecular species, as it is well established that synchrotron radiation offers a considerable S/N advantage over conventional thermal sources. The brightness advantage is perfectly suited for high-resolution gas-phase spectroscopy where spectral features have narrow line-widths, and at the Australian Synchrotron, this advantage is limited to energies lying below 1500 cm-1; on the other hand, a flux advantage is observed for energies below 350 cm-1 which facilitates the study of homogeneous condensed-phase samples. The THz/Far-IR beamline at the Australian Synchrotron is a multi-disciplinary facility catering for a diverse research community both at national and international levels, and offering a suite of instruments to accommodate the requirements: the THz beamline is equipped with multipass gas-cells operating from room temperature down to cryogenic temperatures; it is also equipped with cryostats and an ATR to study condensed-phase samples. In this paper, some gas phase as well as some condensed phase applications and capabilities of the THz/Far-IR beamline will be presented.

Authors: Dom Appadoo (Australian Synchrotron)

ORAL

DAY 2

Qinfen Gu

ABSTRACT 99

Zero-Emission NO_2 Capture Using Divalent Metal-Exchanged Zeolites for Clean Air Technologies

The transition to hydrogen and biofuel energy systems, while reducing carbon emissions, paradoxically sustains large-scale nitrogen oxide (NOx) pollution due to high-temperature combustion. Among NOx species, nitrogen dioxide (NO_2) poses severe health risks, yet existing ambient-temperature adsorbents inevitably generate toxic nitric oxide (NO) as a by-product. In this work, we introduce divalent metal cation-exchanged LTA zeolites that achieve complete NO_2 capture with zero NO release under both dry and humid conditions. Exemplified by Ca^{2+}- and Mn^{2+}-exchanged zeolites, these materials combine high NO_2 uptake capacity, rapid adsorption kinetics, and excellent regenerability with unprecedented zero-emission performance. Mechanistic insights from spectroscopy and density functional theory reveal that divalent cations suppress NO formation by stabilizing nitrous acid intermediates and preventing their decomposition. Demonstrating practical viability, we integrate these zeolites into a wearable respirator, creating a “zero-NOx shield” that exceeds industrial safety standards. This study not only establishes a scalable platform for ambient NO_2 abatement but also redefines adsorption chemistry in zeolites, paving the way for transformative clean air technologies across industrial, urban, and indoor environments.

Authors: Dr Zeyu Tao (City University of Hongkong), Qinfen Gu (Australian Synchrotron (ANSTO)), Huanting Wang (Monash university), Prof. Jin Shang (City University of Hong Kong)

ORAL

Alison Edwards

DAY 2

ABSTRACT 101

Quantum Crystallography, Chemical Crystallography in the 21st Century

From its inception, the KOALA single-crystal Laue neutron Diffractometer at ACNS, ANSTO has been used in validation of nuclear positions determined in what are now termed quantum crystallographic studies. Several groups intersecting at the long-standing UWA collaboration between Mark Spackman and Dylan Jayatilaka (but now distributed across the globe) amongst others now pursue a range of differing strategies seeking to exploit the fact that it is the distribution of electrons in a crystal which give rise to the diffraction pattern. It ought therefore to be possible to extract from the diffraction pattern the distribution of electrons about the nuclear positions which can be precisely determined by neutron diffraction. Critical to extracting the electronic distributions is accessing high resolution X-ray diffraction data - something for which Synchrotrons are particularly useful. The nature of the diffractometer and detector available is vitally important to the suitability of data collected for use in Quantum Crystallographic modelling and the demands that this will place on institutions and the available crystallographic infrastructure into the future are considerable. KOALA is viewed as a key instrument in the validation of these approaches, and we are seeking to provide a framework for crystallographers to compare the diverse approaches under development, and also to encourage the sharing of raw data collected at high resolution at home lab and synchrotron sources where the published structure is a fit for purpose conventional independent atom model but which may support a quantum approach to modelling.

Authors: Alison Edwards (ANSTO)

Hank Qi Han

DAY 2

ABSTRACT 102

A Five-Year Journey Connecting Chemistry and Biology through Synchrotron Science

Chemical interactions are governed by ions, solvents, and molecular forces, which control nanoscale organisation, self-assembly, and colloidal behaviour in biological and soft-matter systems. Over the past five years, my work has focused on understanding how chemical interactions shape biological structure and function, using synchrotron science as the central platform. Since 2020, I have led over twelve awarded small-angle X-ray scattering (SAXS) proposals and participated in more than thirty synchrotron experiments, spanning crystallography, solution and solid scattering, autoloader and co-flow SAXS, size-exclusion chromatography SAXS, and time-resolved studies.

Through macromolecular crystallography MX2 beamtimes, it resulted in the deposition of seven lysozyme structures, which provides new insight into integrating scattering and crystallography workflows across beamlines. Using SAXS in combination with complementary in-solution techniques, it was demonstrated how SAXS can characterise proteins, nanoparticles, solid nanomaterials, membranes, metal organic framework (MOF)-based systems, and soft assemblies in different environments. This work are related to the colloid and interfacial chemistry with complex biological and pharmaceutical systems.

A major component of my work is method development. I have expanded the use of high-throughput SAXS pipelines, automated analysis workflows, and tailored protocols for studying protein aggregation, nanoparticle assembly, hydrogel evolution, and nanomaterials under different conditions. These tools now support collaborative programs with researchers at UNSW, Sydney, Adelaide, Deakin, and RMIT, especially working with multiple beamline scientists.
This talk will highlight how solvent environments, ionic liquids, and nanoengineered surfaces drive nanoscale organisation in proteins, hybrid materials, and functional nanostructures, drawing on insights from more than twenty interconnected synchrotron projects. I will also outline ongoing studies using BioSAXS to probe dynamic self-assembly. Together, these advances demonstrate a unique trajectory connecting chemistry and biology through synchrotron-enabled discovery.

Authors: Hank Qi Han (RMIT University)

Samantha Alloo

DAY 2

ABSTRACT 107

Decoding the Flow of Speckles to Unlock Multimodal X-ray Images

In X-ray imaging, spatially random intensity patterns—termed speckles—enable the capture of attenuation, phase, and dark-field images, collectively termed multimodal images [1,2]. These images reveal dense, transparent, and unresolved sample structures, respectively, and together provide richer structural information than any single image alone. Speckle-based X-ray imaging is an appealing multimodal technique because its setup is simple and flexible, requiring only a random mask, such as sandpaper. To retrieve multimodal images, the three contrast mechanisms encoded in the imaging data must be separated. My research focuses on this step: developing novel multimodal image retrieval algorithms for speckle-based X-ray imaging. Specifically, I have been exploring how the principle of energy conservation and flow can help decode X-ray speckle measurements to generate multimodal images. The approach is founded on the Fokker–Planck equation, which describes how X-ray speckles transform as they propagate from a sample to a detector. In this presentation, I will discuss the details of the Fokker–Planck equation and how it can be applied to speckle-based X-ray imaging [3-6]. I will also present several supporting imaging tools developed alongside this work, including a method for fully quantitative object characterisation [7].

[1] Morgan, K. S., Paganin, D. M., & Siu, K. K. (2012). Appl. Phys. Lett., 100(12).
[2] Bérujon, S., et al. (2012). Phys. Rev. Lett., 108(15), 158102.
[3] Pavlov, K. M., et al. (2020). J. Opt., 22(12), 125604.
[4] Alloo, S. J., et al. (2022). J. Med. Imaging, 9(3), 031502.
[5] Alloo, S. J., et al. (2023). Sci. Rep., 13, 5424.
[6] Alloo, S. J., et al. (2025). Opt. Express, 33(2), 3577–3600.
[7] Alloo, S. J., et al. (2022). Opt. Lett., 47(8), 1945–1948.

Authors: Dr Samantha Alloo (Monash University)

Kaye Morgan

DAY 1

ABSTRACT 110

Advancing medical imaging with patterned x-ray light

X-ray light allows us to look inside the body, enabling non-invasive medical care and medical research that our ancestors only dreamed of. Synchrotron x-ray light allows us to image at unprecedented speed and resolution, capturing the dynamics of the body in detail. The coherent light provided by the synchrotron also allows us to play tricks that reveal how the body has refracted and scattered x-rays, revealing weakly attenuating organs like the brain in 'phase' images and unresolved microstructure like the lung air sacs in 'dark-field' images. In this presentation, I will describe how medical research questions have motivated the development of novel methods for high-speed x-ray phase and dark-field imaging. In particular, we have created techniques where the x-ray illumination is patterned by placing a precision grating, geological sieve, or even a piece of sandpaper in the beam path. Using a similar principle to facial recognition technology in mobile phones, we can track how the pattern is distorted to extract a phase image. In addition, any local blurring of the pattern indicates that porous, granular or fibrous structures in the body have scattered the x-ray light, revealing the location and potentially also the size/material of those structures. Using mathematics that describes the movement of pollen grains on lake, we can describe and decipher how the patterned light is distorted and diffused. These new imaging methods have allowed us to better understand how the body works, test the effectiveness of new treatments and innovate methods for treatment delivery. We are now looking at how this imaging can be employed in hospitals, from the histological scale to whole-chest imaging.

Authors: Kaye Morgan (Monash University)

POSTERS

ID #	Title	Presenter
10	In Situ XANES Study of PFAS Impacted Soils Filled with Aqueous and Non-Aqueous Phases	Anand Kumar, Bin Qian
11	X-ray absorption study on borophene based single atom catalysts	Ruichang Xue
12	X-ray Imaging of Cyclic Loading-Induced Microstructural Alterations in Reservoir Rocks: Implications for Underground Hydrogen Storage	Chamila Nanayakkara
15	Assessing airway mucus viscosity with phase-contrast X-ray imaging based in-vivo active-microrheology	Ronan Smith
20	Hot Chips on IMBL	Chris Hall
25	Micro-Computed Tomography beamline: Data Acquisition and Processing Pipeline	Benedicta Arhatari
29	MEX1: Update and new capabilities	Jeremy Wykes, Pria Ramkissoon
31	Charting Marine Organosulfur Metabolism: Discovery of a Homotaurine Breakdown Pathway	Helen Barber
33	Crystal orientation mapping with XBDM	Michael Jones
37	Altered Osteocyte Lacunar Morphology and Density in a Mouse Model of Chronic Kidney Disease Using Synchrotron Radiation Micro-CT	Ali Ghasem-Zadeh
40	Acetic Acid-Induced Interactions in Shale Caprock: Implications for Underground Hydrogen Storage Integrity	Pramod Dilshan
43	Latest Developments and Updates on the Medium Energy X-ray Absorption Spectroscopy Beamline (MEX2)	Negin Foroughimehr

ID #	Title	Presenter
44	An update from the XAS beamline team	Britt Kerr
47	Polycrystalline Microstructural Imaging Capabilities of the ADS Beamlines	Louise McGuiggan
48	Current status and future developments on the SXR beamline	Lars Thomsen
50	BioSAXS - The Future of Solution Scattering at the Australian Synchrotron	Annmaree Warrender
52	Trialling the CrystalChip at MX3 by the Monash Macromolecular Crystallisation Platform	Geoffrey Kong
54	Evidence of metallic samarium at the samarium nitride surface	Anton Tadich
60	Chiral Epoxides in Astrochemistry: Structure and Spectroscopy of Propylene Oxide and Vinyl Oxirane	Afnan Alasmari
61	Tracking Bound Water Changes Following Porcine Cornea Exposure to 26 GHz Radiation with Attenuated Total Reflection Spectroscopy Utilizing Synchrotron Sourced THz Radiation	Zoltan Vilagosh
64	Evaluating Radiation Dose in Anthropomorphic Breast Phantoms for Synchrotron Phase-Contrast CT- A Simulation-Based Study	Tavjot Kaur Matharu
71	Large synchrotron minibeam fields in 3B: A Pilot Study	Vincent de Rover
76	Investigation of the Uptake of Lyotropic Liquid Crystalline Nanoparticles by Eukaryotic and Bacterial Cells Following Exposure to Synchrotron-Sourced Terahertz Radiation	Zoltan Vilagosh
78	Progressive Damage Mechanisms in Fibre-Reinforced Concrete under Multiple Impact	Zeng Ding

POSTERS

ID #	Title	Presenter
81	Humidity-Driven Structure Evolution in Triple Ionic–Electronic Conducting Perovskites	Desheng Feng
83	From Lab to Synchrotron: Unravelling Structures of Functional crystals	Ruoming Tian
88	Cyclic-peptide binding screening at the Australian Synchrotron: Integrating Crystallographic and BioSAXS Approaches	Yogesh Khandokar
92	Laboratory-Based XAS/XES Access for young researchers	Xun Geng
96	Synthesis and Characterisation of Binuclear Gold-based drugs for the effective treatment of cancer	Arthur Hentschel
103	Structural kinetics in aqueous Aluminum fumarate/Ag MOF composites via time-resolved in situ WAXS	Nandish Hosadoddi Srikantamurthy
105	Use of AI for the Low Dose Mammography and Other CT Experiments on IMBL	Anton Maksimenko
106	How to Train Your Data Transfer	Andreas Moll, Christina Magoulas
108	Micro-CT Imaging at the Australian Synchrotron: High-Resolution Applications in Scientific Research	Ruwini S K Ekanayake
109	Direct Synthesis of Lead-Halide Perovskite Microwires via a Pipette-Combined AFM, with Enhanced Structural Stability by Parylene-C Encapsulation and Synchrotron IR Spectroscopy	Sangmin An
111	Major Upgrade of the SAXS/WAXS Beamline Software System	Nigel Kirby, Stephen Mudie, Christina Magoulas
112	Probing Nanoscale Structural Perturbation in WS2 monolayer via eXplainable Artificial Intelligence	Suh HyeongChan

POSTERS

ID #	Title	Presenter
113	The nanoscale structural perturbations in two-dimensional semiconductor	Dong Hyeon Kim
114	Phase Engineering Induced Au Intercalation Driving Modulation of Charge Carrier Behavior in TMDCs	Dohyeon Lee
115	Nanospectroscopy imaging of hyperbolic phonon polaritons in hBN	Ji Hong Kim
116	Artificial Intelligence Driven Noise Reduction for Reliable and Rapid Spectral Analysis	Seung Yoon Han
117	Explainable Artificial Intelligence Prediction of Tip Geometry for Pre-Assessment of Tip-Enhanced Raman Spectroscopy Performance	Dong-Joon Yi