SIEF Special Research Program: Synchrotron Science

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The SIEF Special Research Program: Synchrotron Science (SIEF SRP-01) (the SRP) over the past four years has been a vital element of the broader funding of access to the Australian Synchrotron (AS) by the Australian and New Zealand research community. Together with ANSTO, the Victorian state government, New Zealand, and the Australian Research Council (ARC) through its Special Research Initiative (SRI), SIEF has contributed significantly to the national innovation system by providing access to the AS for a range of projects based on merit-based beamtime allocation.

In 2012, CSIRO, acting on behalf of the Commonwealth Publicly Funded Research Agencies (PFRAs), coordinated a response to an invitation by the Science and Industry Endowment Fund (SIEF) for a proposal to the Special Research Program providing for continued access by scientists of the PFRAs to the Australian Synchrotron in the four year period to 30 September 2016, in order to carry out research that is aligned with the SIEF Strategic Objectives. Five PFRAs participated in the proposal:

- ANSTO
- CSIRO
- The Defence Science and Technology Organisation (DSTO), now Defence Science and Technology Group (DST Group)
- Geoscience Australia (GA)
- The National Measurement Institute (NMI)

CSIRO is the Administering Organisation. The SRP was formally established in September 2012 with back-to-back funding agreements between SIEF and CSIRO, CSIRO and the other participating PFRAs, and CSIRO and Synchrotron Light Source Australia, a wholly owned subsidiary of ANSTO and incoming Operator of the Australian Synchrotron.

The Australian Synchrotron

The Australian Synchrotron is one of Australia's landmark research facilities: in 2015-16 more than 5,400 researcher visits took place from right around Australia and internationally, performing around 1,000 separate synchrotron-powered experiments; additionally, industry clients made use of more than 1,100 beamline hours.

The Australian Synchrotron's team maintained beam availability at record levels in 2015-16, delivering better than 99.2 per cent up-time. In so doing, they consolidated the Australian Synchrotron's position as one of the world's most reliable modern accelerators. Such consistent operations are vitally important to research clients from universities, public science agencies, medical research institutes and across industry.

Under an international best practice "juste retour" process, access was allocated through merit-based peer-review while maintaining proportionality to contributed funding by the different partners over the lifetime of the funding period. Oversubscription for beamline access occurred across the entire Funding Period, with the demand for time on many beamlines far outstripping the available supply. This long-term oversubscription is one of the underpinning arguments for expanding the number and range of beamlines into the future.

Overall publications for the AS over the funding period exceeded 1750, with 263 resulting from SIEF funded access – it is expected that the time delay between experiment and publication will result in additional publications after the funding period. Greater than 30% of total AS users over the funding period were early career researchers (ECR), with over 25% of SIEF funded users classified as ECRs.

Governance and management arrangements, set up early in the funding period, have proven sound, with no significant issues being raised at the regular Funders Committee meetings. All Key Performance Indicators have been met. An overall assessment of the success of the Program has been that it has performed well in delivering access to the Australian Synchrotron by the PFRAs over the full term of the funding period, as demonstrated by the number of successful proposals. Furthermore, the successful projects demonstrate strong alignment with the conduct of Research in the fields of natural or applied science and its practical application, for the national benefit, and assisting industry, furthering the interests of the Australian community or contributing to the achievement of national objectives. In particular, a high level of collaboration across multiple organisations is evident by the number of co-proposers and co-authored publications.

On December 7 2015 as part of its National Innovation and Science Agenda the Commonwealth announced that, as part of the Australian Synchrotron becoming a federal government facility as a platform of ANSTO, it would provide $520 million in operations funding for the Australian Synchrotron over the next ten years, thus signalling that operations of the facility will be maintained at world class standard for the longer term.

Some highlights resulting from access provided by the SIEF Synchrotron Science program

Synchrotron science is extraordinarily diverse: bright x-ray beams - much brighter than be achieved in any other way - can be used in many ways to study many types of sample and phenomena, from proteins to paintings, from nanostructures to engine casings. X-rays passing through complex structures provide detailed 3D images; x-rays causing atoms to emit characteristic signature wavelengths - fluorescence - allow detailed analysis of chemical composition at microscopic scales; x-rays bending in their passage - diffraction - allows the structures and shapes of crystals and molecules to be determined. Each of many different techniques has a dedicated beamline with special, often unique, instrumentation and dedicated specialist staff, enabling studies across natural science and industrial technology. In the last four years SIEF has supported a wide range of such studies. Here are just some examples:

Maia detector for X-ray Fluorescence Microscopy to detect gold

In support of Australia's mineral exploration industry, CSIRO and the Australian Synchrotron have continued the development of the innovative Maia detector for X-ray Fluorescence Microscopy (XFM) for the detailed chemical mapping and analysis of mineral samples. XFM is used across a wide range of geology and geochemical disciplines to study ore deposition and improved technologies for mineral processing. One such study captured international attention recently with the discovery that some species of desert eucalypts and acacias concentrate traces of economically important metals, especially gold, in their leaves as a by-product of their deep-rooted search for water and nutrients in hostile environments. With newspaper headlines proclaiming **'Gold in Gum Leaves'** the significance of this may not have been appreciated. Australia is an old, old landscape, with much of its geology covered by deep layers of ancient sediment. Unlike other continents stripped by ice sheets in comparatively recent times, mineral exploration in many parts of Australia is made more difficult and expensive because of the nature of this deep cover. By demonstrating that nano-particles of gold sequestrated in leaves by desert plants are actually signatures of deeply buried ore bodies, and not, for example wind-blown dust particles, Mel Lintern and colleagues at CSIRO have used the synchrotron to open a whole new field of bio-geological mineral exploration technology.

> *See some of the article headliners here:*
>
> *CSIRO:*
> Gold in gum leaves
>
> *ABC:*
> Finding gold in gum trees an old prospector's trick
>
> *Australian Geographic:*
> Gold stored in gum leaves: a 'Eureka moment'

X-ray diffraction to develop cancer therapeutics

Synchrotrons around the world are vital workhorses for the study of important biochemicals and the development of new pharmaceuticals. The Australian Synchrotron is no different, with several beamlines dedicated to the efficient analysis of proteins and other molecules using x-ray diffraction to determine the precise structure from purified and crystallised samples. Operating in concert with CSIRO's Collaborative Crystallisation Centre, the Cooperative Research Centre for Cancer Therapeutics (CRC-CTx) has developed a compound that binds to and inhibits *arginine methyltransferase 5 (PRMT5)* proteins which are implicated in both cancer and non-cancer blood disorders affecting millions of people. This compound is now licenced through Australian company Bionomics Lts to MSD, an Australian arm of the multinational drug company Merck. High levels of PRMT5 are found in mantle cell lymphoma, chronic lymphocytic leukaemia, melanoma, lung and breast cancers and are linked to low survival rates. PRMT5 inhibitors also have application potential in treating non-cancer blood disorders such as sickle cell disease and beta thalassemia by initiating genes involved in the development of blood.

Nanoscale investigation of casein micelles for better milk practices

A team from the CSIRO's Food and Nutrition group has used the Australian Synchrotron to gain a first-time look at the nanostructure of casein micelles, a protein structure found within components of cow's milk, to identify how it can be manipulated for more efficient milk processing practices and better quality milk products. This research was conducted in partnership with the Victorian Government Department of Economic Development, Jobs, Transport and Resources. Investigating micellar behaviour at the nanoscale through the Australian Synchrotron was crucial to the research team's efforts to devise improvements for Australia's milk processing industry.

By better understanding micelle formation in cow's milk, researchers can improve how milk is processed into different products and stored to maintain quality. This is particularly important to support the milk export industry that transports products such as milk powder and cheese to growing Asian markets.