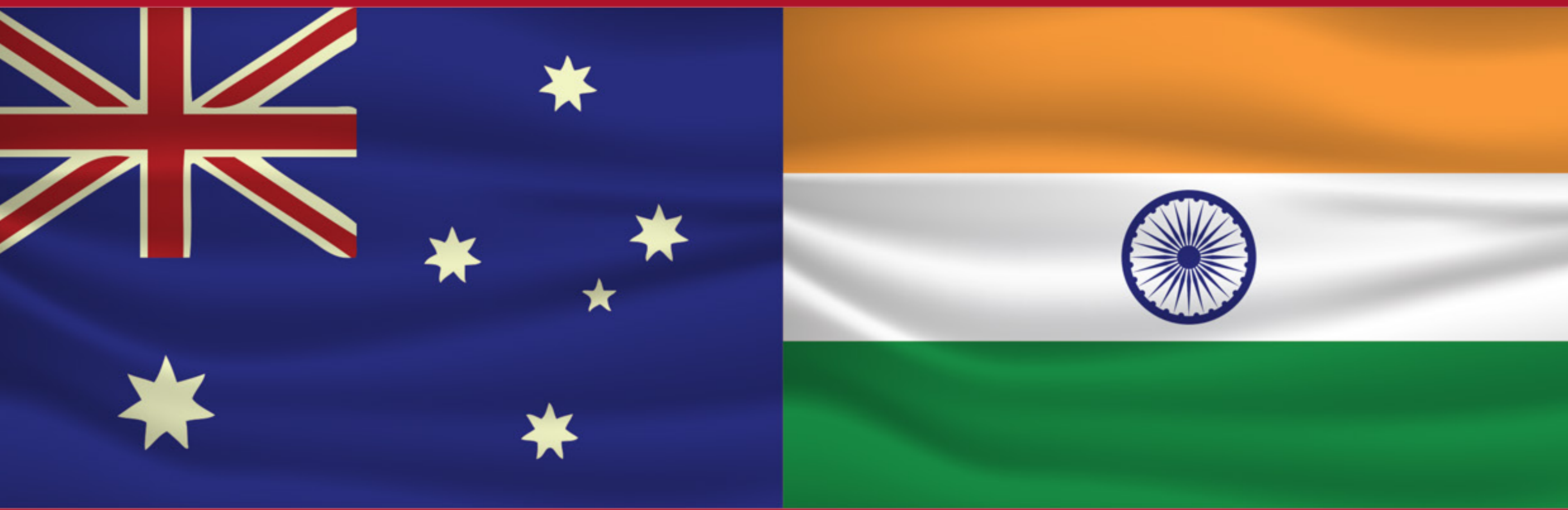
Australian Government

सत्यमेव जयते

Government of India



Australia-India Strategic Research Fund

A decade of successful collaboration

science.gov.au

ISBN: 978-1-925092-92-9

Designed by: Department of Industry, Innovation and Science

Contents

Foreword
Australia

We are pleased to be celebrating the 10th anniversary of the Australia-India Strategic Research Fund (AISRF), a program which has built strong and productive research partnerships between our two countries.

The projects showcased in this booklet highlight the range of research supported over the past decade. They are evidence of the fund's effectiveness in stimulating innovation and of the world-class work being done by Australian and Indian researchers.

The AISRF is Australia's largest fund dedicated to bilateral science collaboration. It has helped build science, technology and innovation partnerships between Australian and Indian researchers and institutions.

Australian Government investment in initiatives such as the AISRF helps to build Australia's research and innovation capacity. An important part of the program is boosting the participation of women and girls in the science, technology, engineering and mathematics (STEM) fields.

In November 2016 the Australian Government led a delegation to India, which participated in a trilateral workshop between Australia, India and the United Kingdom aimed at promoting greater gender equity in STEM. The event brought scientists, business representatives and government officials together to identify practical ways to inspire young women to study and pursue careers in STEM.

The AISRF also promotes the development of international research expertise and skills by supporting high-performing early and mid-career researchers from Australia and India to work at leading institutions in each other's countries. Establishing these foundations is important for both countries as we share a number of medium and long-term research challenges. Together, we can build the capacity to overcome them through shared knowledge and experience.

The AISRF has helped to deepen and strengthen the science relationship between Australia and India, opening opportunities for greater collaboration well into the future. We congratulate all recipients of AISRF funding on their contributions to science and look forward to the continuing development of the Australia-India relationship.

The Hon Julie Bishop MP
Minister for Foreign Affairs

Senator the Hon Arthur Sinodinos AO
Minister for Industry, Innovation and Science

Foreword
India

It is very heartening to note that the India-Australia science and technology relationship which is being formally implemented under the Australia-India Strategic Research Fund (AISRF) is celebrating its tenth anniversary. AISRF has proven itself to be a value based partnership working on the principles of 'reciprocity, co-funding and co-creation'.

Bilateral scientific and technological partnerships and alliances help in value addition to national programs as well as address and understand global issues through leveraging of complementary strengths. The objectives of the AISRF program has been carefully chosen to support joint research activities which has helped to foster new knowledge creation, deliver science based solutions to identified problems and provided opportunity for human capacity building in core sectors, and foster individual excellence for researchers through reciprocal fellowships. The AISRF has therefore effectively ensured value addition to the national science and technology priorities of both our countries.

It is very satisfying to note that the 'Grand Challenge' projects and the 'Competitive Grants' funded so far under the AISRF program has helped to enhance the quality and output of science through joint publication of high impact factor papers. Since its inception, the number of joint scientific publications co-authored by Indian and Australian researchers in peer reviewed journal has increased three folds. It has also significantly enhanced longer-term alliances between Indian and Australian researchers by linking best academic and scientific organisations. In the last three years more than 300 scientists and researchers have visited each other's country for undertaking research work under the joint projects. In addition to the significant numbers of publications, it is also very satisfying to learn that several patents and prototypes have been generated through the funded research projects under AISRF.

I understand that the AISRF is Australia's flagship investment in research collaboration with any single nation. It has certainly catapulted Australia into becoming one of India's top major research partner countries. Reflecting its success in supporting quality research partnerships, the Australia-India Strategic Research Fund has today become an important element in the broader diplomatic relationship between our two countries. India certainly values this knowledge partnership with Australia and is committed to further strengthen this to greater achievement and impact.

The Hon Dr Harsh Vardhan
Minister for Science and Technology, and Earth Sciences

Australia-India Strategic Research Fund Overview

Australia and India have a long history of political, economic, cultural and sporting ties. Both countries lie within a region that continues to present challenges as it undergoes immense change.

Over the past 10 years, our two nations have set out to face some of these challenges together through the Australia-India Strategic Research Fund (AISRF), Australia's largest fund dedicated to bilateral science collaboration. The AISRF supports scientists in Australia and India to work together on cutting-edge research to find solutions to a broad range of key challenges.

The Australian and Indian governments established the program in 2006. Recognising the contribution it has made to strengthening the relationship between our countries and to the world's scientific knowledge base, both governments agreed to extend the fund in 2009 and again in 2014. Since its establishment, the two governments have committed more than $100 million (Rs 500 crore) to the AISRF and the program has supported some 300 collaborative activities, including joint projects, workshops, and fellowships.

The AISRF is run by the Australian Government's Department of Industry, Innovation and Science, supported by the Department of Foreign Affairs and Trade, in conjunction with two Indian Government departments—the Department of Science and Technology and the Department of Biotechnology. The program currently supports Collaborative Research Projects, Targeted Workshops, and Early and Mid-Career Researcher Fellowships.

The AISRF has received thousands of applications for funding, with each funding round targeting different areas of national priority for both countries. The fund has supported research collaboration across more than 20 different mutual priority areas, including: agriculture; astronomy and astrophysics; biomedical devices and implants; clean energy technologies; food and water security; information and communication technology; marine sciences; nanotechnology; stem cells; and vaccines.

The fund's Collaborative Research Projects typically run for up to three years and Australian grants in different rounds have ranged from $200,000 to $1 million each, with a Grand Challenge component offering up to $3 million each for projects of significant scale and ambition. The Government of India funds Indian research partners on a matching effort basis. In recent years, applicants have been encouraged to collaborate not only with other scientists but also with industry and other end-users, such as hospitals, to maximise the potential for research projects to lead to commercialisation and other real-life, tangible outcomes.

Under its Targeted Workshops component, the AISRF helps leading researchers to meet and collaborate, with a focus on developing solutions to a particular key issue or challenge facing both nations.

The AISRF supports high-performing young researchers to undertake early and mid-career fellowships in India, and the Government of India provides reciprocal support for fellows from India to travel and undertake research in Australia.

Early and mid-career researchers, senior visiting fellows and eminent senior researchers from both countries have helped to build the strong research partnership which now exists between Australia and India, and have helped to facilitate long-term science, technology and innovation collaboration between the two countries.

The AISRF has built a solid foundation for developing and strengthening knowledge collaboration between Australia and India into the future.

Women in STEMM

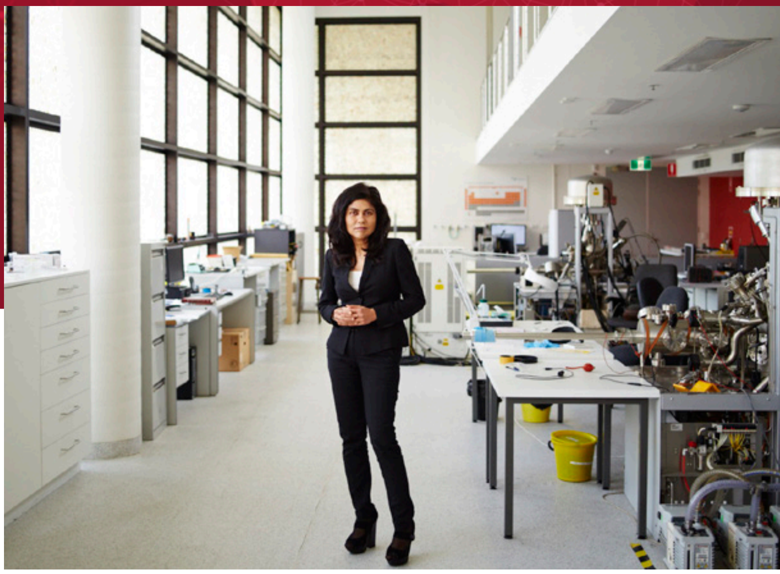
Women in STEMM Workshop

Since its inception the AISRF has supported collaborative workshops involving Australian and Indian researchers. These workshops – which often involve participation by government officials and policy makers, and representatives from other countries – are focused on key science priority areas such as nanotechnology, marine science, biomedical devices and renewable energy. The workshops, which are alternately hosted in Australia and India, are an important vehicle for the exchange of ideas and provide a basis for future collaboration on a range of challenges.

The most recent workshop was held in New Delhi, India in November 2016, with the theme of Women in STEMM (science, technology, engineering, mathematics and medicine).

The AISRF provided funding to the Australian Academy of Science (AAS) to organise the workshop on the basis of their experience promoting gender equality through the Science in Australia Gender Equity (SAGE) initiative, and in recognition of the AAS' strong ties with their Indian and, in this case, UK counterparts. The Academy was able to draw on this experience and their international connections to attract some of Australia, India and the United Kingdom's best advocates for gender equity in STEMM.

Like many other countries, Australia and India face significant challenges in attracting women to STEMM studies and retaining them in STEMM careers – as researchers, innovators, entrepreneurs and leaders. While some of these challenges differ across countries, many of them arise from the 'culture' of STEMM disciplines and institutions – which means they need to be addressed through both national and international action.



Professor Sahajwalla in her lab

A keynote speaker at the workshop was University of New South Wales (UNSW) **Scientia Professor Veena Sahajwalla**, a leading researcher and pioneering innovator, as well as a former AISRF project manager.

Professor Sahajwalla is one of Australia's most prized and successful scientists. She is an Australian Research Council (ARC) Laureate Professor and the Director of the Centre for Sustainable Materials Research and Technology (SMaRT). She is researching new solutions for potentially toxic waste stockpiles in Australia and worldwide, along with discovering green manufacturing pathways which will deliver innovations that transform waste into value-added materials. She was an AISRF grant recipient for her project to develop a novel approach for processing hazardous electronic waste and more recently was a member of the AISRF Advisory Panel. She is also a passionate advocate for gender equity in STEMM: at UNSW, Professor Sahajwalla established the Science 50:50 program to help support young girls and young women in Australia to pursue education and careers in STEMM fields.

The recent workshop identified several opportunities for future collaboration between Australia, India and the UK to address the many challenges around gender equity in STEMM, and showed there is a clear opportunity for Australia to become a regional leader on this issue. Professor Sahajwalla and other women leaders and role models in the Australian science system will have an important role in the actions arising from the workshop.

Delegates at the Women in STEMM workshop

Dr Kiran Mazumdar Shaw delivering the keynote address at the Women in STEMM workshop in New Delhi

Women in STEMM

Dr Howard in the field in Palwa District just outside Delhi

Early Career Researcher Fellowships

Dr Natasha Howard has a background in both Social Geography and Population Health and is a current Research Fellow at the Sansom Institute for Health Research, University of South Australia. Her research interests seek to understand built and socio-cultural environmental determinants (i.e. place-based factors) and their relevance for addressing social and health challenges in dynamic contexts. Notably, she has concentrated on assessing spatial health data systems to incorporate stakeholder, workforce, and community perspectives in their application and interpretation of health issues that are a priority amongst vulnerable and marginalised populations.

Dr Howard was awarded a 2012-13 AISRF Early Career Research Fellowship through the Australian Academy of Science and spent three months at the International Clinical Epidemiology Network (INCLEN) Trust, based in New Delhi. The Fellowship aimed to gain a greater understanding on current Indian research activities exploring the relationship between built and socio-cultural environments and health conditions with the goal of identifying opportunities for cross-country place-health comparisons.

During the fellowship, an assessment was undertaken of constructed built environmental features which were being integrated into a large-scale, comprehensive system known as the SOMAARTH Demographic Development and Environmental Surveillance Site (DDESS). The SOMAARTH DDESS will enable the monitoring and surveillance of demographic and health changes (e.g. diabetes, obesity) in a rural region of Haryana (Palwal District) which is experiencing rapid urbanisation.

Dr Howard's work during her AISRF fellowship broadened her research interests in the field of global indigenous health and she gained valuable practical experiences through undertaking field-based research in rural Indian villages. She found both living and working in New Delhi a challenging yet rewarding experience. The fellowship allowed for a unique cultural insight into the data collections and more broadly the international research community through this intensive three-month visit.

Women in STEMM

Dr Neeti Sanan-Mishra: more resilient rice

Dr Neeti Sanan-Mishra is the Group Leader at the International Centre for Genetic Engineering and Biotechnology, New Delhi. She has a background in Life Sciences. Her current research interests seek to understand the small RNA mediated regulatory networks involved in controlling the rice plant's development when stressed by high temperature, salinity and drought. She has adopted a multi pronged strategy using bioinformatics alongside traditional molecular biology and biochemical approaches to identify and analyse these genetic regulators.

In 2013 Dr Sanan-Mishra was awarded an Australia-India Strategic Research Fund grant to address the issue of crop productivity at high temperatures. This issue is a challenge for sustainable plant and food production in our changing environment. If her research is successful it could increase crop yields at higher temperatures and decrease the ever expanding demand for land devoted to food production.

The research of Dr Sanan-Mishra and her team has already led to the discovery of novel high temperature responsive microRNAs and the genetic networks which they control. Their research continues in an effort to characterise the role of these microRNAs in rice crops' growth at high temperatures. At the same time Dr Sanan-Mishra's Australian partners at the Queensland University of Technology are studying the effects of temperature on Arabidopsis, a close relative of cabbage, mustard and canola. Together both teams hope to enable the development of novel genetic tools which will help to mitigate the effects of climate change on important crops.

Women in STEMM

Professor Veena Choudhary: processing hazardous electronic waste

Professor Veena Choudhary is a distinguished professor at the Indian Institute of Technology, New Delhi. She has made significant contributions to the fields of Polymer Science and Engineering and has been recognised through the award of the Alexander Von Humboldt Fellowship in Germany (1985-86), the Indo-US Science and Technology Fellowship (1991-92), and a visiting professorship to Sweden (2000-2001).

In 2012 Professor Choudhary and a multi-disciplinary team from India and Australia were awarded an Australia-India Strategic Research Fund grant to explore new approaches for the processing of hazardous electronic waste. The project focusses on recycling electronic printed circuit boards which are ubiquitous in electronic devices. The team aimed to develop innovative and environmentally sustainable methods for processing hazardous e-waste to recover valuable metals and reduce the toxic emissions and environmental pollution associated with existing processes. The environmental footprint of electronic waste could be significantly reduced with improved recycling that prevents hazardous emissions and allows the economic recovery of a large part of contained metals.

This project is in its final stages and has seen significant improvements in the recovery of a variety of valuable materials including metals, carbons, and polymer-rich fractions from e-waste. These materials can be recycled into various products and minimise the further exploitation of natural resources. The project has also reduced the amount of pollutants and toxins released during processing, making the process more environmentally friendly and significantly enhancing the safety of operations for workers. Further optimization is currently underway to maximise metal recovery from complex e-waste with sound recycling economics, determine safe e-waste management practices, and develop a mature technology ready for commercialisation.

Case Study

Reducing the burden of injury in Australia and India

The team from the Australia India Trauma Systems Collaboration

A person dies from traumatic injuries as a result of a road accident every four minutes in India. In Australia, over 1200 deaths were caused by road accidents in 2015. By 2020, it is expected that traumatic injury will represent the third greatest disease burden worldwide. For every death as a result of trauma, many more are seriously injured or permanently disabled.

Many of these deaths and disabilities are avoidable. Improvements in trauma care and rehabilitation can dramatically reduce the disease burden of traumatic injury. Often it is simple improvements which allow injured people to recover and lead normal productive lives.

Australia-India Strategic Research Fund

Since 2003, Professor Mark Fitzgerald and his team at the National Trauma Research Institute (a department of Alfred Health and partnership with Monash University) have been investigating how to improve systems of trauma care and patient outcomes in Australia. They have enjoyed considerable success. **In Victoria, where they are based, their innovations have helped contribute to a 50 per cent reduction in the mortality rate from traumatic injury between 2001 and 2011.**

There is always room for improvement and a desire to refine their systems further led the National Trauma Research Institute (NTRI) to seek out a collaboration with the All India Institute of Medical Science (AIIMS). This collaboration allows the researchers to identify which improvements to systems and technologies work best much faster than is possible in Australia as a result of India's ability to rapidly iterate and adopt new technology combined with its huge population.

Together the NTRI and AIIMS are investigating the effects in India of a number of innovations in systems of trauma care and rehabilitation. These include: **a mobile app for ambulances which allows them to pre-warn hospitals about severely injured patients before they arrive**; the introduction of an Australian system to reduce errors during resuscitation; a mobile app to improve post-trauma rehabilitation; and developing better data collection to improve care underpinned by the first multi-site trauma registry in India. The most successful innovations will be brought back to Australia, or offered internationally.

The researchers are particularly hopeful that the pre hospital warning app can be adapted to the Australian ambulance setting, and that the rehabilitation app will help improve patient outcomes, particularly in regional Australia.

Australian Team Leader:
Professor Mark Fitzgerald
National Trauma Research Institute

Indian Team Leader:
Professor Mahesh Chandra Misra
JPN Apex Trauma Centre, AIIMS

Case Study

Better detection of tuberculosis

CSIRO's point-of-care TB diagnostic tool

Tuberculosis (TB) is one of the top ten causes of death globally. Right now more than two billion people worldwide are infected with the highly contagious bacteria that causes TB. While TB is effectively controlled in Australia, many of our near neighbours struggle with high rates of the disease. Limited resources and the difficulties of diagnosis and care are hindering efforts to bring TB under control in disadvantaged, rural and remote communities in countries like India, Papua New Guinea and Indonesia.

Accurate diagnosis is critical to controlling TB but the current diagnostic tests for TB are expensive, slow and rely on access to centralised laboratories. In India alone, the World Health Organisation estimates that in 2014 up to 25 per cent of TB cases went undiagnosed and untreated. Roughly a quarter of all TB cases worldwide occur in India. The development of simple, cheap and portable diagnostic tests would improve detection rates and could help to break the transmission cycle of the disease.

Australia-India Strategic Research Fund

A team at Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), led by Doctor Scott Martin, has been **working to develop a portable point of care diagnostic tool to detect TB from urine samples without the need for laboratory analysis**. This tool uses chemiresistor sensors; a proven fluid analysis technology that international research has shown can diagnose cancer from breath samples and identify hydrocarbons in seawater. The sensors are inexpensive and easy to fabricate and miniaturise. However, more work needs to be done to adapt the technology for TB diagnosis.

The sensors and a data analysis algorithm have to be optimised so they can correctly identify the metabolic 'fingerprint' of TB from a urine sample. To achieve this, researchers need to test large numbers of TB samples. However, because TB is controlled in Australia, there is no domestic sample collection for Dr Martin's team to access. So, with support from the Australia-India Strategic Research Fund, the CSIRO has teamed up with India's Institute of Microbial Technology in Chandigarh to tackle the issue.

CSIRO sends its sensors to India's Institute of Microbial Technology, who use them to analyse infected and healthy samples from their collection. The institute then sends the test result data back to CSIRO to optimise the device.

While it is early days, preliminary results are promising. They suggest that, with optimisation, the sensors could soon be reliably diagnosing TB.

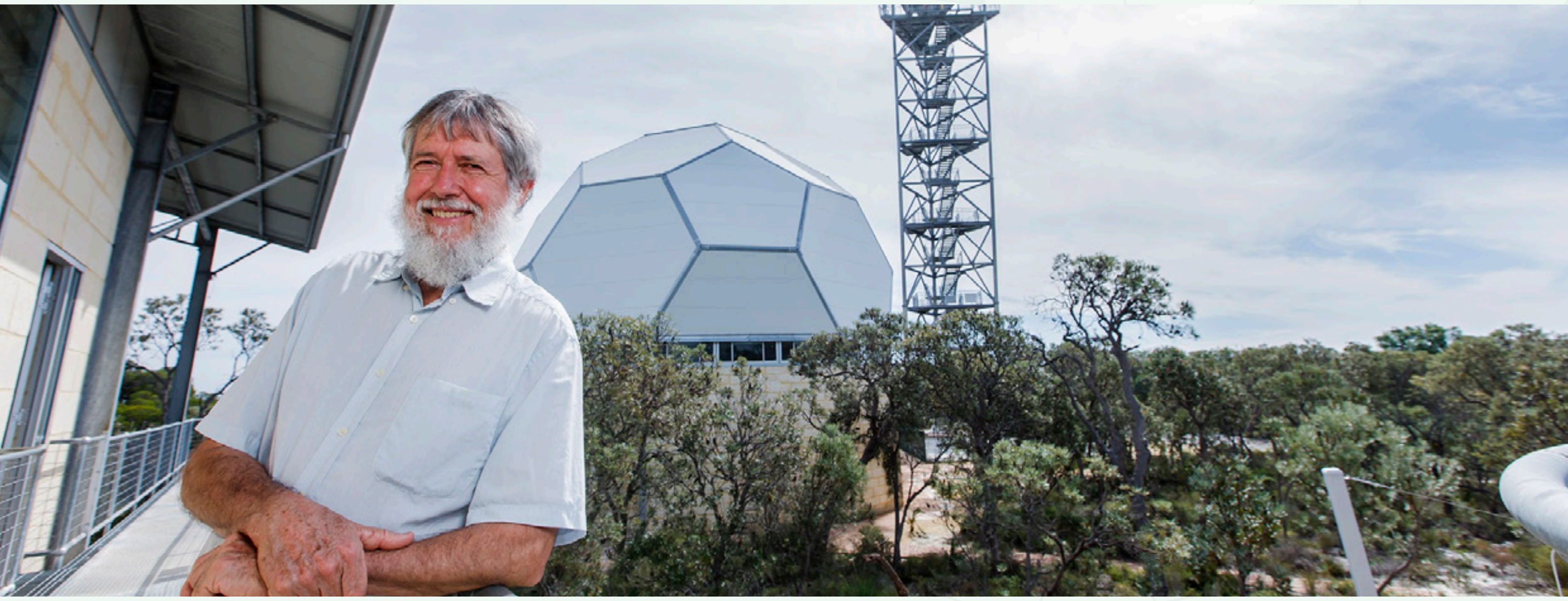
CSIRO has also been working with Axxin, an Australian biomedical company, to design and produce a portable device to house the chemiresistor sensors for use in the field. These devices are relatively cheap and should allow the technology, once perfected, to be deployed for point of care TB diagnosis in resource-limited countries to control and prevent TB in India and the region.

Australian Team Leader:
Dr Scott Martin
CSIRO

Indian Team Leader:
Dr Ashwani Kumar
Institute of Microbial Technology

Case Study

Collaboration on gravitational wave astronomy



David Blair at the Gravity Discovery Centre, Gingin WA

The detection of gravitational waves is one of the biggest scientific achievements of modern physics. The September 2015 discovery of these waves will allow scientists to expand our knowledge of the universe and everything in it.

But what are gravitational waves and how do we measure them?

Gravitational waves are ripples in space-time caused by the movement of heavy objects, such as planets, stars, and black-holes, in space. The heavier the object the larger the ripples produced. If a heavy object moves very fast, for example, when a black-hole orbits another black-hole, the ripples will be large enough to be detected by an instrument on earth called a Laser Interferometer Gravitational-wave Observatory or LIGO.

A LIGO is the most sensitive optical instrument ever made. It detects gravitational waves by measuring movements as small as 10 millionths of the width of an atom. Their extreme sensitivity is essential when trying to detect the effects of gravitational waves. The technology and materials used in the LIGO are some of the most advanced in the world and they don't come cheap.

Australian Team Leader:
Professor David Blair
University of Western Australia

Indian Team Leader:
Professor Bala Iyer
Raman Research Institute

Australia-India Strategic Research Fund

The detection of gravitational waves was a multinational effort only made possible by the dedicated collaboration of international partners. Two of those partners were Professor David Blair from the University of Western Australia, and Professor Bala Iyer from the Raman Research Institute in Bangalore, India. The Australian team's expertise in advanced interferometers complemented the Indian team's strengths in data analytics, orbital dynamics and precision instruments. The Australia-India Strategic Research Fund provided the support to bring their complementary expertise together.

The project successfully raised interest and awareness of gravitational wave studies in our region and helped establish the groundwork for India to succeed in its bid to build a LIGO in India. It also showcased Australia's research capability in this field and sparked interest in the construction of an Australian LIGO.

Multi-national collaboration was vital to the discovery of gravitational waves. Australia-India Strategic Research Fund support has helped to enable that international collaboration and will continue to contribute to further discoveries in this field.

Case Study

Next-generation radio telescope to uncover more about the origins of the universe

A tile of MWA sensors

In the remote shire of Murchison in central Western Australia, a next-generation radio telescope, **the Murchison Widefield Array (MWA), is helping scientists to 'go back in time' and discover more about the origins of our universe.** The telescope hunts for explosive and variable objects in the Milky Way, such as black holes and exploding stars, and makes new measurements of solar bursts throughout their journey from the surface of the Sun to the Earth and on to the outer solar system.

Australia-India Strategic Research Fund

The MWA project is a multi-national effort involving hundreds of scientists working in 17 organisations throughout Australia, India, the United States, New Zealand and Canada. The MWA project has already delivered a highly versatile telescope that went from initial construction to full operation in just 18 months and the Australia-India Strategic Research Fund helped to support a critical part of that: the collaboration between Professor Steven Tingay's Curtin University team and Professor Avinash Deshpande's team at the Raman Research Institute (RRI) in India.

Professor Deshpande's group designed the digital receivers that feature the broad frequency coverage and agile frequency switching capabilities that have allowed scientists to observe astrophysical sources at entirely new frequencies. "The technologies developed by RRI have been essential to the success of the MWA," said MWA Director Dr Randall Wayth. Detecting such faint radio waves, the MWA can collect up to 20 terabytes of data every day.

The receivers form the first part of the MWA's digital signal path, which ends in a digital correlator developed by the radio astronomy group at Curtin University. Here the MWA operations and engineering teams manage the deployment, integration and commissioning of the MWA.

Unlike traditional dish telescopes, the MWA is made up of 128 small array 'tiles' spread over nine square kilometres, a unique design that provides an extremely wide field of view and enables large parts of the sky to be surveyed quickly. This design allows the MWA to track space debris and help to prevent collisions with valuable satellites. The MWA's success was also instrumental in Australia being chosen as one of the sites for the multi-billion dollar Square Kilometre Array project.

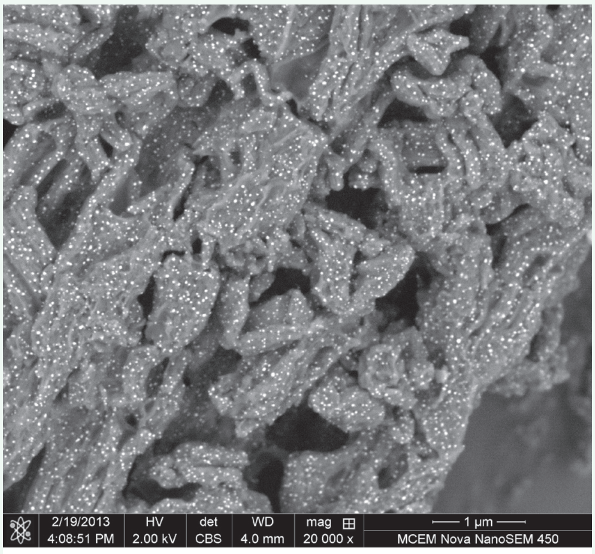
Building on this successful collaboration, the Australian and international teams are now embarking on a program to double the size of the MWA to 256 tiles and to develop the next generation of MWA hardware driving the development of new technologies. The future looks bright for the MWA.

Australian Team Leader:
Professor Steven Tingay
Curtin University

Indian Team Leader:
Professor Avinash Deshpande
Raman Research Institute

Case Study

Nanotechnology innovation in biofuels production



Microscopic view of the new nanocomposite catalyst

Nanotechnology is changing what is possible across a range of industries. We are already benefiting from innovations based on our ability to structure matter at the molecular level, from ever faster and smaller computers to antibacterial clothing.

Nanotechnology is also transforming what can be achieved by chemical catalysts—materials that facilitate chemical reactions by making them faster and less energy-intensive. By combining traditional catalysts with special nanocomposite support structures, new catalysts can be made which are more efficient and more active. These new nanocomposite catalysts can improve a range of industrial processes we rely on every day, allowing us to make more, from less, and faster.

The production of liquid transport fuels (petrol and diesel) from natural gas, coal and biomass relies on the catalyst dependent Fischer-Tropsch process. Current Fischer-Tropsch reactors are energy intensive and only economically viable in large refineries. New highly active catalysts will make refineries more efficient and allow the miniaturisation of Fischer-Tropsch reactors. Miniaturised reactors could enable the production of fuel in remote or otherwise inaccessible locations in Australia and India.

Australia-India Strategic Research Fund

A team at the CSIRO, led by Dr Ken Chiang, has been busy developing new nanocomposite catalysts. But they needed help to test the new catalysts' real-world performance. So they partnered with the Indian Institute of Petroleum (IIP) with funding support from the Australia-India Strategic Research Fund. The project brought together CSIRO's state of the art nanotechnology capabilities and the IIP's fuel testing expertise with the aim of developing industry-ready nanocomposite catalysts.

The IIP has put the CSIRO's new nanocomposite catalysts through a series of practical tests, aiding the transformation of bio oils. The new nanocomposite catalysts are performing well, successfully producing more fuel from bio oil than a standard catalyst. The CSIRO team has also developed an optimised procedure for manufacturing their nanocomposite catalysts.

Relative to earlier techniques the new catalyst synthesis procedure is 20 times more efficient, and eliminates toxic by-products. This allows production of the catalysts to be scaled up, reducing their cost and opening the door to commercialisation.

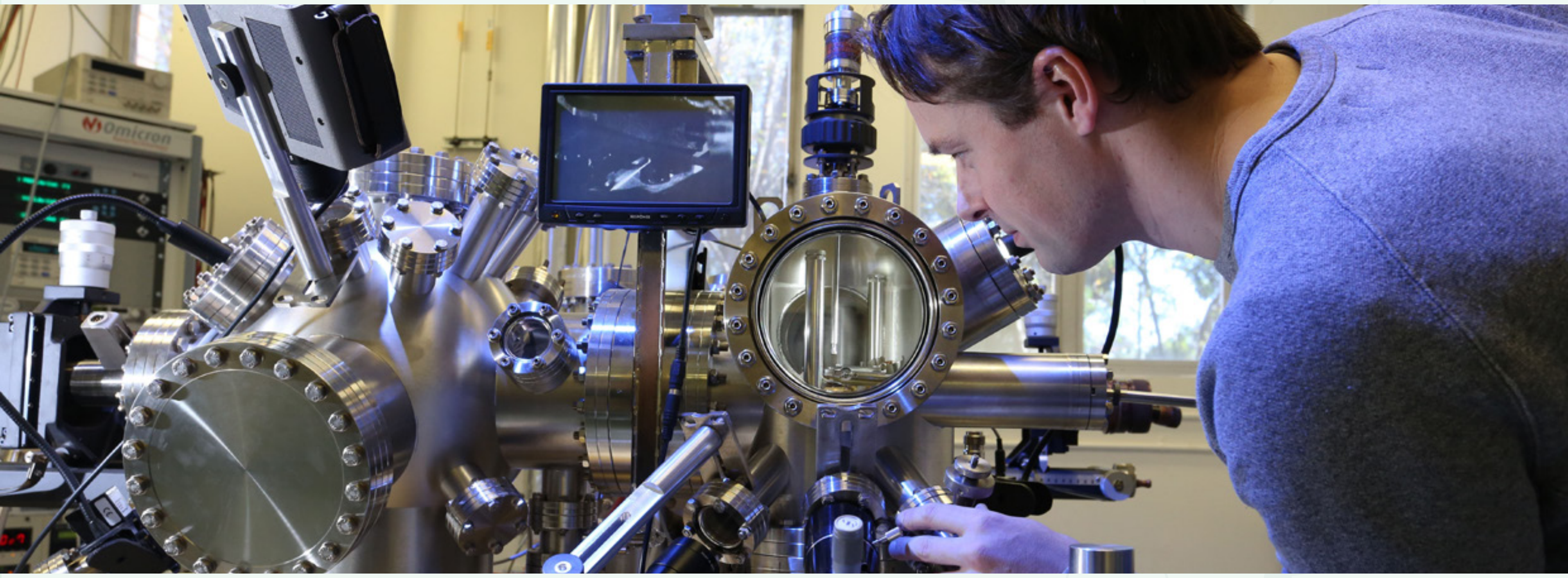
Through the practical testing it has been discovered that the nanocomposite catalysts are also effective for a number of other chemical reactions, including the conversion of carbon dioxide into methanol. The CSIRO is exploring opportunities with commercial partners to bring their nanocomposite catalysts to industry.

Australian Team Leader:
Dr Ken Chiang
CSIRO

Indian Team Leader:
Dr Nagabhatla Viswanadham
Indian Institute of Petroleum

Case Study

Noise in quantum electronics



Researcher, Joris Keizer, using a scanning tunnelling microscope to fabricate silicon devices with atomic precision

Particles at the atomic and sub-atomic level don't play by the normal rules of physics. They follow their own mind-bending laws, which we call quantum physics. These tiny particles can 'tunnel' through other particles, be in multiple states at the same time and can get spookily entangled over distances.

Quantum computing aims to use the unique and sometimes quirky properties of quantum physics to solve complex problems in finance, medicine, weather forecasting and physics, much faster than traditional computers can. To get there we must be able to precisely and predictably manipulate material at the quantum scale. However, quantum scale electronic devices are traditionally plagued by high levels of noise, or unintended and uncontrolled environmental interference. **Understanding and controlling noise has become critical for the development of quantum computers** and the continued miniaturisation of traditional computers.

Australia-India Strategic Research Fund

Professor Michelle Simmons and her team at the Centre for Quantum Computing in the University of New South Wales are working to develop a quantum computer. They are currently the only group in the world fabricating and optimising quantum electronic devices using silicon and germanium.

Professor Simmons believes that international collaboration is essential for their world leading science. So she and her team, with support from the Australia-India Strategic Research Fund, are working with the Indian Institute of Science to tackle the problem of noise. Their collaboration combines Australia's state-of-the-art fabrication facilities and India's ultrasensitive noise measurement apparatus – with great results.

Professor Simmons says "Our Indian partners were able to look at the devices we made and could tell us what the issues were that made a particular device behave badly. As a consequence, we could change our fabrication process to get our devices working better."

Outcomes from the collaboration so far have included: the discovery of a new state of matter; the development of new techniques for the production of atomic scale germanium and silicon transistors; and the repeated production of quantum electronic devices with the lowest levels of electrical noise to date.

Over the next five years, the team is planning to produce a 10-qubit quantum integrated circuit device.

International cooperation is accelerating Australian and Indian efforts to produce a scalable quantum computer, and the rest of the world is watching closely.

Australian Team Leader:
Professor Michelle Simmons
University of New South Wales

Indian Team Leader:
Professor Arindam Ghosh
Indian Institute of Science

Case Study

New drugs to help fight the diabetes pandemic

280 Australians develop diabetes every day.
That's one person every 5 minutes.

In Australia, diabetes is among the leading causes of illness, disability, amputations and death. It causes long-term damage to young and old, and costs the economy billions every year. Approximately one third of the estimated 1.7 million Australians with the disease are unaware that they have it. Although diabetes has often been considered a disease of western society, in India more than 100 million people will suffer from diabetes by 2030. **Diabetes is preventable, but once established it has no cure.**

The most common form of diabetes is type 2, a progressive condition in which high blood sugar occurs because the body becomes resistant to the effects of insulin or loses its ability to produce enough insulin. Current therapies for type 2 diabetes are not targeted, which means that treatment can have limited effectiveness and cause unwanted side effects.

"280 Australians develop diabetes every day."

Australian Team Leader:
Professor Matthew Cooper
Institute for Molecular Bioscience
The University of Queensland

Indian Team Leader:
Professor V Jayathirtha Rao
Indian Institute of Chemical Technology

Australia-India Strategic Research Fund

Scientists are only just beginning to understand the role inflammation may play in the development of chronic diseases such as diabetes. It is thought that inflammation of the pancreas caused by the immune system may lead to insulin resistance and ultimately type 2 diabetes. With support from the Australia-India Strategic Research Fund, Professor Matthew Cooper and his team at The University of Queensland's Institute for Molecular Bioscience are working with the Indian Institute of Chemical Technology to identify potential new anti-inflammatory therapies for type 2 diabetes.

"Diabetes is preventable, but once established it has no cure."

Together they have been synthesising new molecules that can block a key driver of immune cell inflammation, called the 'inflammasome'. Inflammasomes are protein complexes in our immune system that trigger the release of molecules that exacerbate inflammation, leading to deposits of toxic 'amyloid' (protein fragments) in the pancreas, having damaging effects. **The two teams are working on a series of early stage molecules which can potentially stop this inflammatory process** in immune cells.

They also hope to test the effect of 'tracer' molecules in type 2 diabetes models to see if they can halt the death of insulin-producing cells and ultimately stop the progression of diabetes. Their aim is to develop a suite of these 'tracer' molecules which could be used to visualise inflammation in the body in real time and to better identify the effect of inflammation in the pancreas.

Case Study

A new frontier in HIV/AIDS vaccine research

HIV, or human immunodeficiency virus, remains a global epidemic with millions of people infected worldwide. An estimated 27,000 people in Australia and 1.9 million in India are living with the disease.

Research has led to many advances in treatment, which have improved and extended people's lives, but an effective vaccine and cure remain elusive.

That may change with the help of 'Elite Controllers', people infected with HIV who are able to naturally control the infection in their blood with Antibody-Dependent Cellular Cytotoxicity (ADCC) antibodies. These specialised antibodies are a normal part of the body's immune system. They identify and destroy infected cells by bonding to specific markers on a cell wall, then signal for the body's immune system to attack.

However, Elite Controllers' ADCC antibodies seem to be able to identify and destroy HIV infected cells where most people's ADCC antibodies cannot. Researchers hope that a better understanding of Elite Controllers' ADCC antibodies and the chemical markers of HIV that they target will lead to immunotherapies capable of curing HIV and fast track the development of an effective vaccine.

Australia and India both have world-class scientists studying Elite Controllers' ADCC antibodies, looking for a game changing discovery in the fight against HIV.

Australian Team Leader:
Professor Stephen Kent
University of Melbourne

Indian Team Leader:
Dr Madhuri Thakar
National AIDS Research Institute

Australia-India Strategic Research Fund

Australia and India both have world-class scientists studying Elite Controllers' ADCC antibodies, looking for a game changing discovery in the fight against HIV. By collaborating, these scientists are able to pool their resources, technologies and ideas to make advances that neither could readily achieve alone.

With the support of the Australia-India Strategic Research Fund, Australian researchers at the University of Melbourne, led by Professor Stephen Kent, are teaming up with their Indian counterparts at the National AIDS Research Institute (NARI) in Pune, India, to study Elite Controllers and their ADCC antibodies.

Professor Kent and his team have been working with 22 Elite Controllers in Melbourne and Sydney to identify which ADCC antibodies are most potent. Their colleagues at NARI have also been working with HIV infected people who naturally control HIV.

Together, the two research teams are identifying the specific B cells in the immune system that make these ADCC antibodies. Once the B cells are identified, the researchers will be able to synthesise these potent antibodies. This will be an important step towards new therapies being developed and the realisation of a cure for HIV. Both teams are hopeful that, as their research progresses, it will create knowledge that will have a real impact on HIV worldwide.

Case Study

A new hepatitis C vaccine

Researchers at the University of Adelaide, beside an ELIspot machine used to measure vaccinated animals' immune response

Hepatitis C afflicts an estimated 150 million people worldwide. It is a viral infection of the liver which often presents as a chronic disease. It persists for decades and can cause great harm to infected individuals, including cirrhosis and liver cancer. There are 12 million people in India infected with hepatitis C and 300,000 Australians. In Australia another 10,000 people are infected each year. Treatment can cost up to $70,000 per person and Australia's health system spends approximately $252 million each year on the disease.

At present there is no effective vaccine for hepatitis C. As a result our ability to control the disease's spread through at-risk populations is limited. An effective vaccine could prevent tens of thousands of new infections each year, provide an alternative treatment option for those already infected, and save the Australian and Indian health systems millions of dollars.

Australian Team Leader:
Professor Eric Gowans
University of Adelaide

Assoc Professor Joseph Torresi
University of Melbourne

Indian Team Leader:
Prof Saumitra Das
Indian Institute of Science

Australia-India Strategic Research Fund

A team of Australian scientists, based at the University of Adelaide and led by Professor Eric Gowans, is working towards that goal. To help them achieve it, they have teamed up with Indian researchers at the Indian Institute of Science. With the help of the Australia-India Strategic Research Fund they are working to get a vaccine ready for clinical trials. **Their plan is to collaborate to develop two distinct types of vaccination** and then combine them into a single 'cocktail' vaccine capable of providing immunity against all known strains of hepatitis C.

The first type of vaccination relies on synthesised virus like particles which mimic the hepatitis C virus. These particles can't cause an infection but are close enough to hepatitis C to train the immune system to generate free floating antibodies to neutralise the real virus.

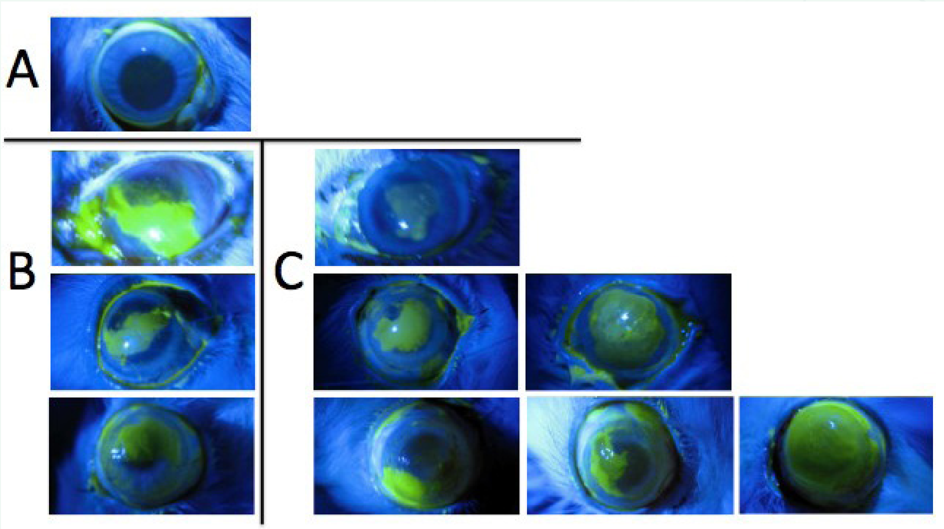
The second type of vaccination is an emerging method which extracts sections of the virus' DNA and then uses the DNA to create a protein profile of the virus. The immune system remembers the protein profile and is then able to use it to identify and destroy cells infected with hepatitis C.

The initial results are promising. The teams have successfully refined the method for producing virus-like particles which mimic hepatitis C and have demonstrated that the DNA vaccination method can generate immunity in small and large animal models. The next step is to check that both types of vaccination continue to work in larger animal models.

Should the results hold up on the larger animal models, the intent is to bring together both techniques into a final 'cocktail' vaccine. That cocktail vaccine will then undergo preliminary safety tests before continuing to human clinical trials. If those trials are successful, then Australia and India will have another tool to help them combat the spread of hepatitis C.

Case Study

An advanced therapy for ocular surface disease



The successful transplantation of lens cultured cells helping repair a rabbit's damaged cornea

The cornea, the transparent front part of the eye, plays a vital role in our sight. It allows light to enter the eye and accounts for nearly two-thirds of the eye's total refractive power. Clear vision and a healthy cornea rely on the integrity of the cornea's outermost layer, the corneal epithelium. Critical to maintaining the integrity of the corneal epithelium are the limbal stem cells (LSCs) at the edge of the cornea. These LSCs help in normal tissue homeostasis and repair. When they are depleted by injury or disease, it can lead to limbal stem cell deficiency where nearby tissue grows over the surface of the cornea resulting in corneal opacity, severe pain, discomfort, and eventually blindness.

There are treatments for limbal stem cell deficiency which transplant corneal epithelial sheets grown on a human amniotic membrane matrix. However, the scarcity of amniotic membranes, and the need for expensive donor screening and cold storage mean the availability of these treatments is limited. Researchers from India's LV Prasad Eye Institute and the Centre for Eye Research Australia have collaborated to develop techniques to lower the costs and increase the availability of treatments for limbal stem cell deficiency.

Australia-India Strategic Research Fund

Their project aimed to produce therapeutic contact lenses which could grow and deliver corneal epithelial cells to treat ocular surface diseases. To do this they had to coat contact lenses with novel plasma polymer coatings which could support the growth of human corneal epithelial cells. Their coating technique allows exact control over thickness and results in a safe clean therapeutic product. They then conducted pre-clinical transplantation studies on rabbit models which demonstrated that the cells grown on 100% AA-based plasma polymer contact lenses can be successfully transferred to the corneal surface for regenerative applications. Work towards human trials continues at the LV Prasad Eye Institute in Hyderabad. The clinical translation of such a technology will offer patients around the world an animal product free,, affordable stem cell treatment for limbal stem cell deficiency.

Indian Team Leader:
Dr Virender Sangwan,
LV Prasad Eye Institute

Australian Team Leader:
Dr Mark Daniell,
Centre for Eye Research, Australia

Case Study

Kafirin: sorghum's multipurpose protein

Indian and Australian researchers at the Curtin University of Technology sorghum farm

Sorghum is an important grain crop in both Australia and India, with production amounting to approximately 2.2 and 5.5 million MT per annum in each country respectively. For centuries sorghum has been used as food, and distilled into ethanol but researchers are discovering that sorghum can be used for much more. Sorghum is a major source of the celiac safe protein kafirin which has excellent plastifiable characteristics and is insoluble in acidic conditions. These properties give kafirin a wide variety of potential uses as an edible and sustainable plastic which could displace a number of products and materials derived from petrochemicals.

Australia-India Strategic Research Fund

A team of scientists from the Institute of Chemical Technology (ICT), Mumbai and Curtin University of Technology, Perth have been investigating Sorghum's kafirin potential. They have already identified the Indian and Australian sorghum varieties with naturally high levels of kafirin and developed a new process for extracting kafirin from sorghum. Their new process yields high purity kafirin which was not previously available.

They have begun to demonstrate some of the uses of kafirin. The high purity kafirin has been successfully used to create packaging films, edible coating for fruits, pharmaceutical beadlets as carrier for nutraceuticals and medicines. Further, kafirin has been evaluated as a coating of gelatine capsules to make them useful for the sustained or delayed release of pharmaceutical medicines. The team have also successfully developed a new generation kafirin-based bio-absorbent for complete water decontamination in rural areas. This would bring significant health benefits to disadvantaged populations by preventing the various infections and diseases caused by dirty water. The researchers envision that this new bio-absorbent could be used to decontaminate drinking water with a tea-bag like product.

More work remains to be done. The team is working to increase the scale of their technology. They have already achieved modest success by scaling their lab prototypes for the extraction and purification of kafirin up to pilot scale production rates of one kilogram a day, while retaining their high levels of purity. The next step is to achieve the production of kafirin at a commercial scale.

The commercial application of this research has the potential to revolutionise how we use, and value, the sorghum crop in India and Australia.

Australian Team Leader:
Dr Ranjeet Utikar,
Curtin University of Technology

Indian Team Leader:
Dr Sandeep B. Kale
Institute of Chemical Technology

Break-out group discussion at the Women in STEMM workshop science.gov.au