



Australian Government  
National Measurement Institute



## NMI STUDENT PROJECTS FOR 2015

Last updated July 2014

*Working with leading measurement scientists to resolve  
real-world measurement challenges.*

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# Foreword from *The Chief Executive*



**As NMI's Chief Executive and Australia's Chief Metrologist, I am delighted with the range of student projects that NMI has been able to make available for 2015.**

Having students join NMI – even for a short time – provides NMI with a range of benefits, including exposing a wider range of people to the role of metrology in society and its inherent benefits. Past experience has shown us that students who secure placements with us are typically high achievers who often develop a passion for metrology (the science of measurement) and become champions for good measurement wherever their careers take them. A solid grounding in measurement has proven to be useful in many industry, research, government and non-government settings, and many of these students have gone on to contribute significantly to measurement in Australia.

The projects on offer for 2015 will benefit the 'right' students as they provide an opportunity to work with some of Australia's leading measurement scientists to resolve real-world measurement challenges. Each year, our students express great satisfaction at having the chance to work on real-life issues that really matter. Next year's projects include both laboratory-based and desk-based research, but all promise to provide the right candidates with a chance to tackle a challenging and engaging aspect of measurement.

Student projects are consistent with our philosophy of engaging with measurement users and with fostering a culture that builds measurement skills and deepens the knowledge, expertise and abilities of NMI's staff.

If you are interested in doing challenging work that will extend your capabilities and encourage you to think laterally, then these projects may be for you. I encourage you to attend one of our Student Discovery Days or to contact Dr Cheryl Lim on 02 8467 3845, or email [cheryl.lim@measurement.gov.au](mailto:cheryl.lim@measurement.gov.au) for further information.

I look forward to meeting you in 2015 and welcoming you to a fruitful and productive time at our work place.

Dr Peter Fisk

Chief Executive and Chief Metrologist  
National Measurement Institute  
Department of Industry

The importance of good measurement has been recognised throughout history. Kelvin pointed out that “nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient long-continued labour in the minute sifting of numerical results”. Measurement features repeatedly in religious texts, poetry and plays. Bill Gates’ 2013 annual letter discussed how measurements have helped bring about major changes in people’s lives around the world.

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## “Through Measurement to Knowledge”

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*- Heike Kamerlingh Onnes, Nobel prizewinner and the ‘Father’ of Superconductivity.*

Measurement pervades every aspect of our lives, from grocery shopping to transport to financial transactions and health (blood tests and bionic hearing are very different, and both rely on good measurement). Industry relies on measurements for manufacturing and quality control processes, and for ensuring that parts and processes developed across the globalised economy are truly interoperable and ‘fit’ together seamlessly. Measurement supports research and development, and can help push the boundaries of the full range of sciences, and also help adapt those new scientific frontiers to more work-a-day uses in factories, office blocks, shops and homes. Even our sport and leisure activities are often supported by good measurement – we expect an Olympic pool will be 100 metres long, and that timing systems will be accurate to at least a thousandth of a second. Most of us simply assume that any underlying measurements have been done properly, when we think about it at all. However, a great deal of hard work is needed behind the scenes to ensure that everything functions the way it should.

The National Measurement Institute and its counterparts around the world play a crucial role in ensuring that the measurements we need can be done and are done to an appropriate standard.

## About NMI

The National Measurement Institute (NMI) is Australia’s peak measurement body. We are a division within the Department of Industry and contribute to the department’s aim of driving economic growth, productivity and competitiveness through delivering on our responsibilities for biological, chemical, legal and physical measurement. We:

- Undertake research and development in the areas of physical, chemical and biological measurement science. We develop and produce highly specialised biological and chemical reference materials and methods; and develop and maintain physical measurement standards, in both traditional weights and measures areas such as length and time, and newer measurement areas such as nanometrology. Matching measurement standards to the contemporary needs of researchers and industry is a major element of this work;
- Use our measurement capabilities and expertise to deliver a range of services - including sports drug, forensic drug, food and environmental testing; calibrations; training; and specialised consultancies aimed at providing individual solutions for specific measurement issues; and regulatory services such as pattern approval;
- Contribute measurement advice to policy discussions and other nationally important issues and participate in the Metre Treaty and the legal metrology (OIML) convention to support the international integration, consistency and traceability of Australian measurements. In turn, this work facilitates trade, research, science and innovation, and ultimately Australia’s productivity, prosperity and well-being; and
- Administer Australia’s Trade Measurement System and the other elements of the National Measurement Act. Our effective trade measurement system is built on applying good measurement to everyday activities and benefits all Australians by providing buyers and sellers with confidence that transactions based on measurement are fair and accurate. An estimated \$400 billion in transactions are covered each year by Australia’s trade measurement regime – including retail transactions at supermarkets and petrol stations.

## Science & Research at NMI

Science at NMI addresses the full spectrum of measurement disciplines – biological, chemical and physical. All aspects of NMI's work are underpinned by high-level research and partnerships which deliver scientific return on investment, ensure international credibility for measurements made in Australia and provide support for emerging technologies. NMI also participates in collaborative research with government, universities and industry to provide high-level measurement expertise and input to questions of national and international significance for human health, the economy and the environment.

NMI's laboratories hold a range of accreditations and certifications from NATA, the Australian National Association of Testing Authorities, including accreditation for some research and development activities. Furthermore, as a registered Research Service Provider with Innovation Australia, NMI has demonstrated its expertise, capability and capacity to undertake research and development on behalf of others.

NMI's activities include:

- Chemical analyses for organic and inorganic pollutants to meet statutory requirements, including specialised facilities for providing high accuracy reference values, low-level and speciation analysis
- Analysis of illicit drugs seizures for law enforcement agencies
- Analysis of athletes' samples to detect banned substances
- Determination of biological and chemical food contaminants, agrichemical residues, functional components and food safety indicators
- Development of new measuring instruments, systems and solutions to meet industrial and scientific needs
- Testing of instruments for type approval
- Development of new test procedures and standards for new and existing instrument types

- Development of methodologies which will support new regulations
- Measurement of nanoparticle size, size distribution and shape
- Development of nucleic acid reference methods and standards and improvement of the accuracy of current methodologies for DNA analysis.

## Students at NMI

NMI offers the following opportunities for students:

- Year 10 high school industry placements through various State Education Department programs
- Summer and winter vacation projects (for undergraduate students who have not yet completed their studies)
- A Year-In-Industry program (for undergraduate students who are interested in obtaining a year's industry experience prior to completing their final year of study)
- Internships (for students undertaking a course where this is a component)
- Co-supervision and/or placement for Honours, Masters and PhD projects
- Student scholarships partly or wholly funded by other organisations, typically offering significant levels of engagement with industry.

Most student opportunities are located at one of the four largest NMI sites: Lindfield (Sydney), North Ryde (Sydney), Port Melbourne (Melbourne) and Kensington (Perth). However, a project may occasionally be offered at one of NMI's many other locations around Australia.

Benefits of being a student at NMI include:

- The experience of working in industry
- Professional development opportunities
- Interactions with leading scientists from around the world.

## Collaboration with NMI

NMI regards partnerships with other organisations as integral to its research and essential to maximising the impact of NMI's work. These partnerships include:

- National and international scientific collaborations with universities, both in Australia and overseas, scientific research organisations such as CSIRO and other national measurement institutes from around the world.
- Development of national or international guidelines, policies and standards in conjunction with our international counterparts, Australian government bodies, technical experts, industry and community representatives
- Membership of national research associations
- Work conducted under contract for individual organisations or companies
- Co-supervision of Honours, Masters and PhD students
- Workplace training opportunities to fulfil local and international needs

- Organisation of collaborative events including conferences, workshops and seminars at the national and international level to address emerging key research fields and issues
- Encourage discussion within the scientific community through sector-based approaches in resolving measurement issues
- Lectures and technical presentations given by NMI scientists through invitations from collaborators such as universities, industry and other scientific bodies

## More Information

The projects listed in this booklet are current examples of student research opportunities; questions and discussions about other possible projects are always welcome. Interested students are encouraged to attend one of our Student Discovery Days or to contact Cheryl Lim (tel: 02 8467 3845, email: [cheryl.lim@measurement.gov.au](mailto:cheryl.lim@measurement.gov.au)) for further information.



## *Lindfield Laboratories (Sydney)*



The majority of the National Measurement Institute's work on physics and biology is conducted at its headquarters in Sydney. The building, which is owned and managed by CSIRO, has housed Australia's national standards laboratory ever since its opening in 1972. The Lindfield site also accommodates the sections responsible for the administration of the national measurement legislation and the development of procedures for regulatory and trade measurements.

Research at NMI's Lindfield laboratories in Sydney spans a wide range of topics including the development of state-of-the-art measurement methods at nano-scale to address issues of medical, environmental and industrial significance; nucleic acid reference standards and methods such as digital PCR for application to cancer diagnostics, environmental pathogen detection and gene doping detection; and development of fluid and heat-transfer models for high-flow hydrocarbon streams. Many of these activities are undertaken in partnership with universities and other research organisations in Australia and overseas. Our collaborators include the Australian National University, University of Sydney, University of Technology Sydney and University of New South Wales.

Descriptions of some of the work performed at the Lindfield laboratories can be found on the following pages, and specific examples of 2015 student project opportunities based at the Lindfield laboratories can be found on pages 19 to 29.

## *Travelling to NMI Lindfield*

NMI's Lindfield laboratories are located in Bradfield Road, West Lindfield, about 400 metres south of the Moore Avenue roundabout. The nearest train stations are Lindfield (2.8 km) and Killara (3.5 km). Bus 565 travels to the NMI Lindfield Laboratory from Lindfield, Killara and Chatswood stations. There is ample on-site parking available.

## *Examples of scientific activities at Lindfield*

### **Bioanalysis**

NMI has recently expanded our capabilities to provide measurement support for genetic testing across a range of sectors: health, food, agriculture, environment and manufacturing. Our team has a broad and complementary skill set including analytical chemistry, molecular biology and bioinformatics which we use to design and produce custom-made DNA reference materials with very high accuracy and precision. Our key technologies are digital PCR, next generation sequencing, Q-TOFMS and a novel acoustic dispensing technology which we can use to prepare reference material in formats suitable for the end-user. We promote good measurement practice using these technologies through our interactions with the national and international scientific and research community.

Examples of project topics under consideration for 2015 include:

- *DNA reference materials and reference methods for disease diagnosis*
- *Investigating factors that can affect accuracy of digital PCR*

## Mechanical, Thermal and Optical Standards



The work of this section is to take the base physical units of the SI system, such as the kilogram, metre and the Kelvin and to design and build highly specialised apparatus to convert these into the many practical measurement standards required by Australia's community and industry.

For example we take Australia's most accurate 1 kg mass standard, measured against the international prototype in Paris, and build up and down to get mass standards from mg to tonnes at the ppm level. Together with laser interferometers calibrated in terms of Australia's standards for time and used to measure the diameter of a precision machined cylinder, we can "generate" Australia's primary standard for pressure (i.e.  $P = m \cdot g / A$ ) (then used by the Bureau of Meteorology to monitor and predict our weather!)

The work of the section involves using high level engineering skills to implement physics-based apparatus to generate a wide range of standards such as sound-level, laser and ultrasound power, infra-red heat flux, gas-flow, and many others. 30 engineers, physicists and technicians work together to deliver accuracy levels amongst the best in the world, and then provides them to our community and Industry to ensure their safe and efficient operation.

As industry needs change, NMI needs to develop new apparatus, and to fully understand any deviations from the expected theoretical performance. This gives rise to a wide range of interesting projects in which we test the limits of our understanding of the engineering and the physical processes involved.

## Nanometrology

Nanotechnologies rely on our ability to characterise, understand and manipulate matter at the nanometre scale. As the technologies evolve, nanomaterials such as nanoparticles find ever widening applications, for example in nanomedicine, energy generation and storage, smart buildings, environmental remediation and in an increasing number and variety of consumer products.

NMI's nanometrology team develops and maintains measurement tools, standards and expertise for nanotechnologies. In our scanning probe microscopy laboratory, we develop unique atomic force microscopy instrumentation and methodology that link measurements of the dimensions of nanoscale objects to Australia's primary length standard. This traceability ensures that measurements are comparable to each other and give industry, researchers and regulators confidence in the accuracy of results.

NMI's nanoparticle characterisation laboratory provides a unique combination of state-of-the-art equipment, including light scattering, microscopy, sedimentation, particle tracking and fractionation instruments. Accurate measurements of the properties of nanomaterials support industry, researchers, regulators and the community so they can better understand the behaviour of these materials, develop novel applications and ensure that such developments are responsible, safe and sustainable.

Examples of project topics under consideration for 2015 include:

- *Develop an error mapping model for 3D stage motion in NMI's metrological scanning probe microscope (mSPM), implemented in software to correct the measured mSPM data.*
- *Develop flexible real-time communication between different mSPM system components, e.g., the mSPM controller and phasemeter.*
- *Integrate an advanced translation stage into an atomic force microscope.*
- *Quantify the influence of polydispersity of nanoparticle suspensions on the average particle size and on the particle size distribution measured in light scattering experiments.*

- *Quantify the influence of particle shape on the particle size and particle size distribution measured in sedimentation and light scattering experiments.*
- *Automate image analysis of optical, electron and atomic force microscopy images.*
- *Analyse real-time particle tracking video microscopy data.*

These topics are indicative and can be tailored to individual student background and interests.

Projects in this area may be suited to students with a wide range of backgrounds, including Science, Physics, Chemistry, Nanotechnology, Chemical Engineering, Electrical Engineering; Software engineering and Mechanical Engineering.

## *North Ryde Laboratories (Sydney)*



The National Measurement Institute's Sydney chemistry laboratories moved from their previous location in Pymble to new purpose-built premises in North Ryde at the end of June 2012. The Australian Astronomical Observatory is co-located in the same building.

NMI chemical laboratories deliver world-class measurement services including activities of national significance in environmental testing, illicit drug analysis and sports drugs testing. Research activities and service delivery have been enhanced by the increased space, new technology and infrastructure available to our teams in this new state-of-the-art facility. The laboratories collaborate extensively with both industry and academia, and have hosted students from various local universities including University of Sydney, University of New

South Wales, Macquarie University and University of Technology Sydney.

Descriptions of some of the work performed at the North Ryde laboratories can be found on the following pages, and specific examples of 2015 student project opportunities based at the North Ryde laboratories can be found on pages 30 to 40.

## *Travelling to NMI North Ryde*

The North Ryde laboratories are located at 105 Delhi Road, just east of the intersection with Julius Avenue East, and 700 m from the North Ryde train station on the suburban Northern Line. Alternatively the bus stop at the intersection of Delhi Road and Julius Avenue East is serviced by Sydney Buses service 545 which runs between the Chatswood Bus Interchange (stand L) and the Macquarie Centre/Macquarie University Bus Interchange (stand B). If driving to NMI North Ryde, please note that vehicular entry to the site from Delhi Road is only legal for west-bound traffic.

## *Examples of scientific activities at North Ryde*



### **Australian Sports Drug Testing Laboratory (ASDTL)**

The ASDTL is the only laboratory in the Oceania region accredited by the World Anti-Doping Agency (WADA) to carry out doping control analysis in human sport and as such performs virtually all of the sports drug testing carried out in Australia and New Zealand. ASDTL complies with the requirements of ISO/IEC 17025:2005 and is accredited by NATA. Drug testing is not just carried out at major sporting

events but is a year round activity with the analysis of some 8000 samples per year from a range of amateur and professional sports.

Our research program aims to improve analytical techniques used in our laboratory and to investigate new forms of doping which are currently undetectable. We receive funding from the WADA, the Department of Health Anti-Doping Research Program and the US Partnership for Clean Competition.

Examples of project topics under consideration for 2015 include:

- Detection of designer drugs in urine and blood samples by metabolomics
- Identification of new peptide hormone analogue products using LC-MS/HRMS
- Quantitative LC-MS/MS method for glucocorticosteroids and their metabolites in urine
- Expansion of isotope ratio mass spectrometry applications for improved doping control
- Improved doping control of exogenous anabolic androgenic steroids through the analysis of low level, long term metabolites
- Multi residue analysis for the detection of peptide hormones in urine and plasma
- Development of reusable columns for enzyme hydrolysis (eg beta-glucuronidase, Protease XIV, PNGase F, Neuraminidase)
- Application of nanoparticles in the extraction and concentration of peptide hormones
- Review of supplement products available on the Australian market to determine prevalence of banned substances
- Estimation of measurement uncertainty for threshold substances

Projects in this area could be especially suited to students with a background in Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management and/or Measurement Uncertainty.

### Analytical Services

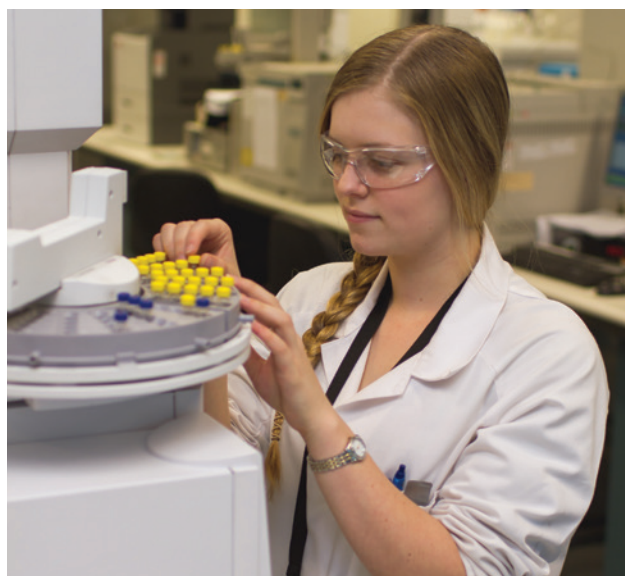
NMI's Analytical Services Branch in Sydney provides world-class measurement services in the areas of environmental, pharmaceutical, agricultural, food and clandestine laboratory testing.

Examples of project topics under consideration for 2015 include:

- Low levels of volatile organic compounds by purge and trap GCMS
- Evaluation of Different Methods for Determination of Inorganic Arsenic in Food and Environmental Samples
- Investigation of emerging organic contaminants in environmental waters
- Alternative Sampling methods – indoor air quality
- Analysis of Sulfur-containing inorganic anions by 2D-IC

Honours, Masters and PhD students with backgrounds in analytical chemistry, environmental chemistry and/or organic/inorganic chemistry would be especially welcome.

### Chemical Reference Materials



The Chemical Reference Materials team is accredited to ISO guide 34 by the National Association Testing Authorities (NATA) to certify pure substance calibration standards in the fields of sports doping control, forensics, environmental and food testing. The group comprises a synthesis team dedicated to the preparation of steroid metabolites and other analytes of interest, not commercially available. Certification of all calibration standards involves confirmation of identity using spectroscopy, and assignment of purity using traditional analytical techniques. NMI calibration standards are sold to Australian and laboratories worldwide, underpinning high quality chemical measurement.

Our research program aims to investigate improved synthesis procedures to important analytes of interest and new techniques for the purity assessment.

Examples of project topics under consideration for 2015 include:

- The improved synthesis of 4-hydroxytestosterone, a key metabolite in the detection of formestane abuse by athletes.
- The synthesis of 5 $\beta$ -androst-1-en-3 $\alpha$ -ol-17-one, a key metabolite in the detection of boldenone abuse by athletes.
- The synthesis of key degradation products of 2-alkylamino-1-phenyl-propan-1-ones, in support of improved purity determination.
- Production of deuterated internal standards for key steroid metabolites identified in human urine, one such example being 5 $\beta$ -androst-1-en-17 $\beta$ -ol-3-one, a key metabolite in the detection of boldenone abuse by athletes.

Projects in this area could be especially suited to students with a background in Organic or Analytical Chemistry, or Statistics.

#### The Ultra-Trace Unit

The Ultra-Trace Unit was originally established in 2000 to help fulfil Australian Government obligations as a signatory of the United Nations Environment Programme's Stockholm Convention on Persistent Organic Pollutants (POPs). As Australia's first NATA accredited provider of analytical services for ultra-trace level testing of dioxins, furans and dioxin-like PCBs, we also assisted in a comprehensive study of background levels of dioxin-like compounds in the Australian environment as part of the National Dioxin Program.

Our commercial work routinely focuses on different environmental and industrial matrices such as soils, sediments, water and stack emission samples; however we also test a wide variety of foodstuffs and biota. Projects related to residue analysis are also conducted.

In accordance with the expanding scope of the Stockholm Convention, we continue to develop our analytical capability to determine other POPs and contaminants of emerging concern, including polybrominated diphenyl ethers (PBDEs), perfluorinated compounds (PFCs) and short-chain chlorinated paraffins (SCCPs).

Examples of project topics under consideration for 2015 include:

- Validate a method for Hexabromocyclododecane (HBCD), a newly listed Stockholm Convention chemical in soil, water and biota.
- Develop a GC-MS-MS technique for the analysis of Polybrominated diphenyl ethers (PBDEs), a family of commercial chemicals listed in the Stockholm Convention.
- Optimisation of an analytical method for determination of short-chain chlorinated paraffins

Projects in this area could be especially suited to students with skills in Analytical Chemistry, Chemistry, Quality Management and/or Measurement Uncertainty.

## *Port Melbourne Laboratories (Melbourne)*



The primary focus of the National Measurement Institute's Melbourne laboratories is to serve the food sector through excellence and innovation in chemical and microbiological analysis and research. In addition, a small team specialises in engineering metrology with particular focus on industrial applications, such as calibration of roundness and angle standards. The laboratories have strong and long-standing collaborations with Victoria University, RMIT, University of New South Wales, University of Sydney, University of Western Australia, Melbourne University, Deakin University, James Cook University and Northern Melbourne Institute of Technology.

An outline of the work conducted at the Port Melbourne laboratories is given on the next page and some specific examples of 2015 student project opportunities can be found on pages 40 to 43.

## *Travelling to NMI Port Melbourne*

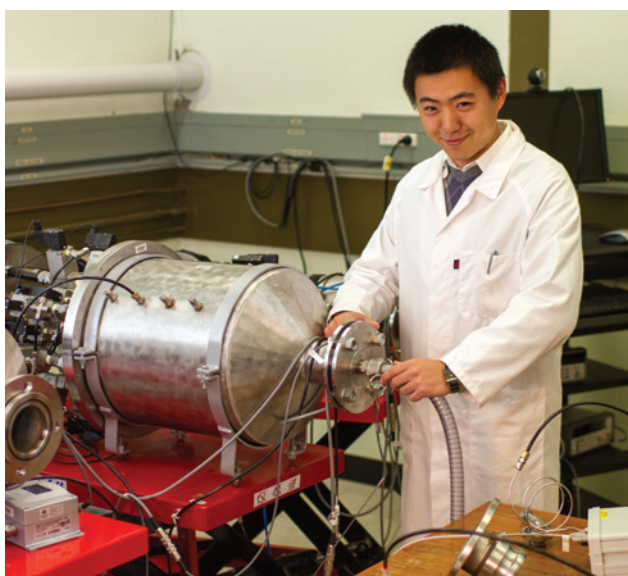
NMI's Port Melbourne laboratories are located at 1/153 Bertie Street, Port Melbourne, in the cul-de-sac section of Bertie Street just past the intersection with Fennell Street. The laboratories are a 7 minute walk from the bus stop (Bus Route 235) at the intersection of Raglan Street and Williamstown Road or a 10 minute walk from the Raglan Street stop (stop 127) on the 109 tram line. Those travelling by car can enter Bertie Street via either Williamstown Road or Fennell Street (off Ingles Street).

## *Examples of scientific activities at Port Melbourne*

### **Technical and Development Innovation (TDI)**

TDI Port Melbourne has been involved in collaborative research for over 20 years and currently has a number of collaborative research projects leading to Honours, Masters and PhD degrees with Australian universities in partnership with industry and government. TDI is very active in the areas of food residues, functional foods, food allergens, composition, speciation and contamination of foods. Our measurement capabilities include GC and LC MS/MS, LC QTOF MS, LC Ion Trap MS, GC-FID, GC-ECD/NPD/FPD/MS, ICP-OES, ICP-MS, UV/Vis spectroscopy, HPLC-PDA/RI/FLD and CE, PCR, Bioanalyzer technologies, cellular research and bioassay techniques. Substantial capabilities also exist in classical chemistry techniques, particularly in the area of food proximate measurements (fat, moisture, protein, ash).

### **Mechanical, Thermal and Optical Standards**



The work of this section is to take the base physical units of the SI system, such as the kilogram, metre and the Kelvin and to design and build highly specialised apparatus to convert these into the many practical measurement standards required by Australia's community and industry.

For example we take Australia's most accurate 1 kg mass standard, measured against the international prototype in Paris, and build-up and down to get mass standards from mg to tonnes at the ppm level. Together with laser interferometers calibrated in terms of Australia's standards for time and used to measure the diameter of a precision machined cylinder, we can "generate" Australia's primary standard for pressure (i.e.  $P = m \cdot g / A$ ) (then used by the Bureau of Meteorology to monitor and predict our weather!)

The work of the section involves using high level engineering skills to implement physics-based apparatus to generate a wide range of standards such as sound-level, laser and ultrasound power, infra-red heat flux, gas-flow, and many others. 30 engineers, physicists and technicians work together to deliver accuracy levels amongst the best in the world, and then provides them to our community and Industry to ensure their safe and efficient operation.

As industry needs change, NMI needs to develop new apparatus, and to fully understand any deviations from the expected theoretical performance. This gives rise to a wide range of interesting projects in which we test the limits of our understanding of the engineering and the physical processes involved.

## *Kensington Laboratories (Perth)*



The National Measurement Institute's Perth-based chemistry laboratories serve the environmental and resource sectors through provision of the highest quality chemical analytical service delivery and research activities. The laboratories frequently collaborate with key Western Australian stakeholders and research organisations such as Curtin University, the University of Western Australia, the CSIRO, the Water Corporation of WA, the WA Department of Water and other WA State Government Departments, as well as several major resource and exploration companies.

Since 2006, the laboratories have been housed in the Australian Research Resources Centre (ARRC) at 26 Dick Perry Avenue, Kensington. The ARRC is jointly operated by CSIRO and Curtin University of Technology and houses many other affiliates and centres of expertise as a petroleum and minerals research hub for the South-East Asian region.

An outline of the work conducted at the Kensington laboratories is given in the next column, including examples of potential project topics for interested students.

## *Travelling to NMI Kensington*

NMI's Kensington laboratories are located in the Australian Resources Research Centre (ARRC) complex at the intersection of Dick Perry Avenue and Kent Street in Technology Park. Buses 33, 35 and 72 take about 30 mins to travel from St Georges Terrace in the CBD to the ARRC building. Ample on-site parking is available.

## *Examples of scientific activities at Kensington*

### **Technical and Development Innovation (TDI)**

NMI in Kensington has been involved in a number of collaborative research projects with both government and private organisations over many years. The laboratory is accredited by NATA (National Association of Testing Authorities) for its R&D activities. The NMI works closely with universities in Perth, such as Curtin University, and the University of Western Australia (UWA), providing lectures, work experience placements, and advice for undergraduate and post graduate students. NMI Kensington has experience in environmental testing of waters and soils, and testing of agricultural products and expertise in the rapid development and validation of methods to an accreditable standard within a commercial, customer focussed organisation.

Our student projects can be associated with a wide range of resource industries (oil and gas, minerals, water, agriculture). Current interests include:

- Australian native plants for drought proofing foraging supply and for bioremediation of hydrocarbon spillages
- Use of geosequestration for storage of captured CO<sub>2</sub>
- Investigation of water holding times as a method validation requirement in the ISO/IEC 17025 International Laboratory Standard.

Projects may be especially suited to students with a background in Analytical Chemistry, Environmental Chemistry, Quality Management and Food Safety Systems, Organic Chemistry or Inorganic Chemistry.

# List of Indicative Project Topics for 2015

The topics listed below and described in the following pages are some of the projects under consideration by NMI for 2015. Further details can be obtained from the technical contact listed in the relevant project description. Enquiries regarding alternative topics are very welcome and can be directed in the first instance to Cheryl Lim, ph: 02 8467 3845, email: [cheryl.lim@measurement.gov.au](mailto:cheryl.lim@measurement.gov.au)

Project Title	Duration/ Student Level	NMI Location	NMI Section	Examples of Suitable Student Courses/ Background	Page No
DNA reference materials and reference methods for disease diagnosis	6 months to 3 years (3rd year, Honours, Masters, PhD)	Lindfield (NSW)	Bioanalysis	Molecular biology, chemistry, biochemistry, statistics, bioinformatics	19
Investigating factors that can affect accuracy of digital PCR	6 months to 3 years (3rd year, Honours, Masters, PhD)	Lindfield (NSW)	Bioanalysis	Molecular biology, chemistry, biochemistry, statistics, bioinformatics	19
Mapping 3D motion in an ultra-accurate atomic force microscope	3 months to 1 year (3rd year, Honours, Masters)	Lindfield (NSW)	Nanometrology	Software Engineering, ICT, Electrical Engineering, Science, Physics, Nanotechnology, Mechanical Engineering  Desirable: Programming and software development skills; experience with Mathematica, LabVIEW	20
Integration of scanning and interferometry system components in an ultra-accurate atomic force microscope	3 months to 1 year (3rd year, Honours, Masters)	Lindfield (NSW)	Nanometrology	Software Engineering, ICT, Electrical Engineering, Science, Physics, Nanotechnology  Desirable: Programming and software development skills; experience with LabVIEW, LabVIEW RT, LabVIEW FPGA	21

Project Title	Duration/ Student Level	NMI Location	NMI Section	Examples of Suitable Student Courses/ Background	Page No
Advanced translation stage for atomic force microscopy	3 months to 1 year (3rd year, Honours, Masters)	Lindfield (NSW)	Nanometrology	Mechanical Engineering, Electrical Engineering, Software Engineering, ICT, Science, Physics, Nanotechnology  Desirable: Mechanical design, programming and software development skills; experience with SolidWorks, LabVIEW, Igor	22
Accurate nanoparticle sizing – the influence of size polydispersity	3 months to 1 year (3rd year, Honours, Masters)	Lindfield (NSW)	Nanometrology	Science, Physics, Chemistry, Nanotechnology, Chemical Engineering	23
Automated image analysis for optical, electron and atomic force microscopy	3 months to 1 year (3rd year, Honours, Masters)	Lindfield (NSW)	Nanometrology	Software Engineering, ICT, Electrical Engineering, Science, Physics, Nanotechnology  Desirable: Programming and software development skills; experience with ImageJ, Javascript, Java, R	24
Processing particle tracks	3 to 6 months (3rd year, Honours, Masters)	Lindfield (NSW)	Nanometrology	Software Engineering, ICT, Electrical Engineering, Science, Physics, Nanotechnology  Desirable: Skills in statistics, scripting, and workflow automation and experience with MS Office and VBA.	25
Sampling algorithms for precision measurements in Phasor Measurement Units (PMUs)	6 months (final year undergraduate)	Lindfield (NSW)	Electricity	Signal processing, Statistics and Probability	26

Project Title	Duration/ Student Level	NMI Location	NMI Section	Examples of Suitable Student Courses/ Background	Page No
Data mining: Analysis of flow-meter calibrations to assess real-world stability	3 months (3rd year)	Lindfield (NSW)	Mechanical, Thermal & Optical Standards	Computing, Statistics, Mechanical Engineering	26
Transient flow effects in Coriolis flow meters used for CNG in the transport industry	3 months (3rd year)	Lindfield (NSW)	Mechanical, Thermal & Optical Standards	Mechanical Engineering	27
Development of a palladium-carbide reference melting temperature standard	3 to 6 months (3rd year, Honours)	Lindfield (NSW)	Mechanical, Thermal & Optical Standards	Mechanical Engineering, Metallurgy, Physics, Heat Transfer	27
Development of a new traceable high-power laser calorimeter reference standards (various projects)	3 months to 3 years (3rd year, Honours, Masters, PhD)	Lindfield (NSW)	Mechanical, Thermal & Optical Standards	Physics, Mechanical Engineering, Heat Transfer, Optics, Laser Physics	28
Development of new PVTt gas flow reference standard (various projects)	3 months to 3 years (3rd year, Honours, Masters, PhD)	Lindfield (NSW)	Mechanical, Thermal & Optical Standards	Physics, Mechanical Engineering, Heat Transfer, Thermodynamics	28
Modelling anomalous resonances in rotary gas flow-meters	3 to 6 months (3rd year, Honours)	Lindfield (NSW)	Mechanical, Thermal & Optical Standards	Physics, Mechanical Engineering, Heat Transfer, Thermodynamics	29
Ultra high precision gauge pressure measurement for the wind power industry	3 months to 3 years (3rd year, Honours, Masters, PhD)	Lindfield (NSW)	Mechanical, Thermal & Optical Standards	Physics, Mechanical Engineering, Thermodynamics	29
Improved analytical methods for the screening of Endogenous Anabolic Androgenic Steroids	1 year (Hons, Masters)	North Ryde (NSW)	Australian Sports Drug Testing Laboratory	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty	30
Detection of ethyl glucuronide and ethylsulfate as indicators of alcohol abuse	1 year (Hons, Masters)	North Ryde (NSW)	Australian Sports Drug Testing Laboratory	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty	31

Project Title	Duration/ Student Level	NMI Location	NMI Section	Examples of Suitable Student Courses/ Background	Page No
Survey on Australian supplements	1 year (Honours, Masters) – part of project  3 year (PhD) – complete project	North Ryde (NSW)	Australian Sports Drug Testing Laboratory	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty	32
Validation of Carbohydrate Moieties of recombinant and natural erythropoietin by LCMSMS	1 year (Honours, Masters) – part of project	North Ryde (NSW)	Australian Sports Drug Testing Laboratory	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty	33
Proof of concept for the detection of clandestine compounds in urine samples using metabolomics	1 year (Honours, Masters) – part of project  3 year (PhD) – complete project	North Ryde (NSW)	Australian Sports Drug Testing Laboratory	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty	34
Development of reusable columns for enzyme hydrolysis (e.g. beta-glucuronidase, Protease XIV, PNGase F, Neuraminidase)	1 year (Honours, Masters)	North Ryde (NSW)	Australian Sports Drug Testing Laboratory	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty	35
Alternative Sampling methods – indoor air quality	1 year (Honours, Masters)	North Ryde (NSW)	NMI Air Laboratory	Analytical Chemistry, Environmental Chemistry, Organic Chemistry	36
Investigation of emerging contaminants in environmental waters	1-3 years (Honours, Masters, PhD)	North Ryde (NSW)	Analytical Services	Analytical Chemistry, Environmental Chemistry, Organic Chemistry	37
Evaluation of Different Methods for Determination of Arsenic, Mercury, Selenium and Chromium Species in Food and Environmental Samples	1-3 years (Honours, Masters, PhD)	North Ryde (NSW)	Analytical Services	Analytical Chemistry, Environmental Chemistry, Inorganic Chemistry	37
Low levels of volatile organic compounds by purge and trap GCMS	1 year (Honours, Masters)	North Ryde (NSW)	Analytical Services	Analytical Chemistry, Environmental Chemistry, Inorganic Chemistry	38

Project Title	Duration/ Student Level	NMI Location	NMI Section	Examples of Suitable Student Courses/ Background	Page No
Analysis of Sulphur-containing inorganic anions by 2D-IC	1 year (Honours, Masters)	North Ryde (NSW)	Analytical Services	Analytical Chemistry, Environmental Chemistry, Inorganic Chemistry	38
Persistent Organic Pollutants in Australian fauna and marine mammals	6 months or longer (Honours, Masters)	North Ryde (NSW)	Ultra-Trace Unit	Veterinary science, toxicology, analytical chemistry	39
Hexabromocyclododecane (HBCD) method development	6 months or longer (Honours, Masters)	North Ryde (NSW)	Ultra-Trace Unit	Analytical Chemistry	39
XML report development	3 months or longer (Honours, Masters)	North Ryde (NSW)	Ultra-Trace Unit	Computer Science / Programming	40
Finite element modelling of primary pressure standards	3-6 months (Honours Engineering)	Port Melbourne (Vic)	Mechanical, Thermal & Optical Standards	Finite Element Analysis, Mechanical Engineering, Solidworks, ANSYS, Software Development	40
Marine biotoxin determination and method development	1-3 years (Honours, Masters, PhD)	Port Melbourne (Vic)	Technical Development & Innovation	Analytical Chemistry, Biochemistry	41
Olive oil authentication and the effects of storage on oil classification	1-3 years (Honours, Masters, PhD)	Port Melbourne (Vic)	Technical Development & Innovation	Analytical Chemistry	41
Production of Maillard reaction products based on allergenic proteins and their reaction with reducing sugars	1-3 years (Honours, Masters, PhD)	Port Melbourne (Vic)	Technical Development & Innovation	Analytical Chemistry, Biochemistry, Proteomics	42
Chemical and physical migration from recycled and paper-based food contact materials (food packaging)	1-3 years (Honours, Masters, PhD)	Port Melbourne (Vic)	Technical Development & Innovation	Chemistry, Polymer & Packaging Science, Food Science	42
Confirmatory techniques for food allergen measurements	1-3 years (Honours, Masters, PhD)	Port Melbourne (Vic)	Technical Development & Innovation	Immuno-chemistry, Biochemistry, Proteomics, Food Safety, Food Science, Health	43

## Detailed Project Descriptions

<b>Project Title:</b>	DNA reference materials and reference methods for disease diagnosis
Project Duration and Student Level:	6 months to 3 years (3rd year, Honours, Masters, PhD)
NMI Location	Lindfield
NMI Section	Bioanalysis Group
NMI Contact	Kerry Emslie
Email contact	Kerry.emslie@measurement.gov.au
Background Information and Context:	DNA reference materials are required in many areas of genetic testing to enable diagnostic laboratories to monitor the performance of routine test methods.
Project Description:	Using state-of-the-art molecular biology and mass spectrometry techniques, this project involves preparation and characterisation of a reference material for use by routine diagnostic laboratories.
Examples of Relevant Student Courses/Skills	Molecular biology, chemistry, biochemistry, statistics, bioinformatics

<b>Project Title:</b>	Investigating factors that can affect accuracy of digital PCR
Project Duration and Student Level:	6 months to 3 years (3rd year, Honours, Masters, PhD)
NMI Location	Lindfield
NMI Section	Bioanalysis Group
NMI Contact	Kerry Emslie
Email contact	Kerry.emslie@measurement.gov.au
Background Information and Context:	Digital PCR is a relatively new technique for accurately quantifying specific DNA sequences and is being used by national measurement institutes to certify DNA reference materials.
Project Description:	This project will investigate factors that can influence the accuracy of digital PCR and will use complementary techniques to verify digital PCR accuracy.
Examples of Relevant Student Courses/Skills	Molecular biology, chemistry, biochemistry, statistics, bioinformatics

<b>Project Title:</b>	Mapping 3D motion in an ultra-accurate atomic force microscope
Project Duration and Student Level:	3 months to 1 year (3rd year, Honours, Masters)
NMI Location	Lindfield, NSW
NMI Section	Nanometrology
NMI Contact	Bakir Babic
Email contact	bakir.babic@measurement.gov.au
Background Information and Context:	<p>Nanotechnology relies on our ability to characterise, understand and manipulate matter at the nanometre scale. The Atomic Force Microscope (AFM) is an enabling tool for all of these fundamental tasks.</p> <p>NMI's scanning probe microscopy laboratory develops and maintains unique state-of-the-art AFM instrumentation and methodology for measurements of dimensions of nanoscale objects that are traceable to the SI metre. This traceability ensures that measurements are comparable to each other and give industry and researchers confidence in the accuracy of the results.</p> <p>The requirements for ultimate accuracy of nanoscale measurements place very high demands on the performance of the AFM instrumentation, and NMI is developing unique solutions to meet these demands, including an ultra-stable metrological Scanning Probe Microscope (mSPM).</p>
Project Description:	<p>Develop and implement a software error mapping model for the three-dimensional motion of the sample translation stage in NMI's mSPM.</p> <p>Apply the model to displacement data obtained by laser interferometry to correct the motion stage errors and to determine the contribution of stage motion and alignment to the uncertainty of mSPM length measurements.</p>
Examples of Relevant Student Courses/Skills	<p>Software Engineering, ICT, Electrical Engineering, Science, Physics, Nanotechnology, Mechanical Engineering</p> <p>Desirable: Programming and software development skills; experience with Mathematica, LabVIEW</p>

<b>Project Title:</b>	Integration of scanning and interferometry system components in an ultra-accurate atomic force microscope
Project Duration and Student Level:	3 months to 1 year (3rd year, Honours, Masters)
NMI Location	Lindfield, NSW
NMI Section	Nanometrology
NMI Contact	Bakir Babic
Email contact	bakir.babic@measurement.gov.au
Background Information and Context:	<p>Nanotechnology relies on our ability to characterise, understand and manipulate matter at the nanometre scale. The Atomic Force Microscope (AFM) is an enabling tool for all of these fundamental tasks.</p> <p>NMI's scanning probe microscopy laboratory develops and maintains unique state-of-the-art AFM instrumentation and methodology for measurements of dimensions of nanoscale objects that are traceable to the SI metre. This traceability ensures that measurements are comparable to each other and give industry and researchers confidence in the accuracy of the results.</p> <p>The requirements for ultimate accuracy of nanoscale measurements place very high demands on the performance of the AFM instrumentation, and NMI is developing unique solutions to meet these demands, including an ultra-stable metrological Scanning Probe Microscope (mSPM).</p>
Project Description:	<p>Develop flexible real-time communication between system components of NMI's metrological scanning probe microscope (mSPM).</p> <p>Specifically, integrate the AFM controller and its functionality for scanning and force sensing with the interferometric position measurement implemented as all-digital phasemeters on a real-time FPGA platform by establishing accurate and reliable signal synchronisation.</p> <p>Utilise this synchronisation functionality to generate mSPM data sets that lend themselves to automated post-processing.</p>
Examples of Relevant Student Courses/Skills	<p>Software Engineering, ICT, Electrical Engineering, Science, Physics, Nanotechnology</p> <p>Desirable: Programming and software development skills; experience with LabVIEW, LabVIEW RT, LabVIEW FPGA</p>

<b>Project Title:</b>	Advanced translation stage for atomic force microscopy
Project Duration and Student Level:	3 months to 1 year (3rd year, Honours, Masters)
NMI Location	Lindfield, NSW
NMI Section	Nanometrology
NMI Contact	Malcolm Lawn
Email contact	malcolm.lawn@measurement.gov.au
Background Information and Context:	<p>Nanotechnology relies on our ability to characterise, understand and manipulate matter at the nanometre scale. The atomic force microscope (AFM) is an enabling tool for all of these fundamental tasks.</p> <p>NMI's scanning probe microscopy laboratory develops and maintains unique state-of-the-art AFM instrumentation and methodology for measurements of dimensions of nanoscale objects that are traceable to the SI metre. This traceability ensures that measurements are comparable to each other and give industry and researchers confidence in the accuracy of the results.</p> <p>The requirements for ultimate accuracy of nanoscale measurements place very high demands on the performance of AFM instrumentation, and NMI is developing unique solutions to meet these demands, including an ultra-stable metrological scanning probe microscope (mSPM).</p>
Project Description:	<p>Design mechanical components for the integration of an advanced two-dimensional flexure translation stage into NMI's atomic force microscope (AFM).</p> <p>Develop a software interface between the AFM and stage controllers to provide functionality for both scanning and position measurement utilising the new stage.</p> <p>(Note: Depending on the duration and scope of the internship and on the level of experience of the student, the internship may only involve one of the duties listed above.)</p>
Examples of Relevant Student Courses/Skills	<p>Mechanical Engineering, Electrical Engineering, Software Engineering, ICT, Science, Physics, Nanotechnology</p> <p>Desirable: Mechanical design, programming and software development skills; experience with SolidWorks, LabVIEW, Igor</p>

<b>Project Title:</b>	Accurate nanoparticle sizing - the influence of size polydispersity
Project Duration and Student Level:	3 months to 1 year (3rd year, Honours, Masters)
NMI Location	Lindfield, NSW
NMI Section	Nanometrology
NMI Contact	Åsa Jämting, Victoria Coleman
Email contact	asa.jamting@measurement.gov.au, victoria.coleman@measurement.gov.au
Background Information and Context:	<p>Nanomaterials such as nanoparticles find ever widening applications, for example in nanomedicine, energy generation and storage, smart buildings, environmental remediation and in an increasing number and variety of consumer products.</p> <p>Nanoparticle properties such as particle size distribution, particle concentration and surface chemistry determine how such materials interact with their environment. These interactions in turn determine the particles' efficacy as well as their fate and effect in the environment and in biological systems. Accurate measurements of the properties of nanomaterials are therefore critical so that industry, researchers, regulators and the community can understand the behaviour of these materials, develop novel applications and ensure that such developments are responsible, safe and sustainable.</p> <p>NMI's nanoparticle characterisation laboratory develops and maintains measurement tools, standards and expertise for nanomaterials. It provides a unique combination of state-of-the-art equipment including light scattering, microscopy, sedimentation, particle tracking, and fractionation instruments.</p>
Project Description:	<p>Quantify the influence of size polydispersity of nanoparticle suspensions on the particle size distribution and average particle size measured in light scattering experiments.</p> <p>Compare particle size measurement results obtained for different test suspensions using dynamic and static light scattering and particle tracking analysis.</p>
Examples of Relevant Student Courses/Skills	Science, Physics, Chemistry, Nanotechnology, Chemical Engineering

<b>Project Title:</b>	Automated image analysis for optical, electron and atomic force microscopy
Project Duration and Student Level:	3 months to 1 year (3rd year, Honours, Masters)
NMI Location	Lindfield, NSW
NMI Section	Nanometrology
NMI Contact	Victoria Coleman
Email contact	victoria.coleman@measurement.gov.au
Background Information and Context:	<p>Nanotechnology relies on our ability to characterise, understand and manipulate matter at the nanometre scale. Microscopy is an indispensable tool for the characterisation of nanomaterials, and NMI uses optical, electron and atomic force microscopy techniques to determine a number of important properties of such materials, such as the particle size distribution and the agglomeration state.</p> <p>In addition to the complexity (and associated high costs) of the required equipment, the use of microscopy for measuring the properties of particulate materials is also hampered by image analysis which is often cumbersome, laborious and slow (and therefore expensive). As a consequence, the number of particles analysed for a given sample may be limited, with undesirable consequences for the statistical relevance of the results. Therefore, even partial automation of image analysis has the potential to improve the accuracy of microscopy results and to reduce the associated costs.</p>
Project Description:	<p>Develop algorithms, macros and scripts to automate the work and data flow in the analysis of microscopy images.</p> <p>Specifically, address challenges related to automated image analysis including normalisation, thresholding and binarisation of the images, segmentation, generation of appropriate statistics, reporting and documentation, and data management.</p>
Examples of Relevant Student Courses/Skills	<p>Software Engineering, ICT, Electrical Engineering, Science, Physics, Nanotechnology</p> <p>Desirable: Programming and software development skills; experience with ImageJ, Javascript, Java, R</p>

<b>Project Title:</b>	Processing particle tracks
Project Duration and Student Level:	3 to 6 months (3rd year, Honours, Masters)
NMI Location	Lindfield, NSW
NMI Section	Nanometrology
NMI Contact	Åsa Jamting
Email contact	asa.jamting@measurement.gov.au
Background Information and Context:	<p>Nanotechnology relies on our ability to characterise, understand and manipulate matter at the nanometre scale.</p> <p>Video microscopy is a powerful technique for determining important properties of nanomaterials such as the particle size distribution and the agglomeration state. Examples include on-line imaging of particles moving past an optical microscopy system or dynamic particle tracking analysis (PTA) where the Brownian motion of the particles is analysed to determine their sizes.</p> <p>The comprehensive analysis of the results from such measurements involves post-processing and statistical analysis. Some of the challenges that have to be addressed include generation of appropriate statistics, reporting and documentation, and data management.</p>
Project Description:	<p>Development of algorithms, macros and scripts to automate the work and data flow in the analysis of real-time particle tracking video microscopy data.</p> <p>Specifically, address challenges related to generation of appropriate statistics, reporting and documentation, and data management.</p>
Examples of Relevant Student Courses/Skills	<p>Software Engineering, ICT, Electrical Engineering, Science, Physics, Nanotechnology</p> <p>Desirable: Skills in statistics, scripting, and workflow automation and experience with MS Office and VBA.</p>

<b>Project Title:</b>	Sampling Algorithms for Precision Measurements in Phasor Measurement Units (PMUs)
Project Duration and Student Level:	6 months (3rd year, 4th year/Honours)
NMI Location	Lindfield, NSW
NMI Section	Electricity
NMI Contact	Dimitrios Georgakopoulos
Email contact	dimitrios.georgakopoulos@measurement.gov.au
Background Information and Context:	<p>A Phasor Measurement Unit (PMU) is a device that captures the dynamic conditions of a power network by measuring voltage and current phasors (rotating vectors), frequency and rate of change of frequency in real time. The timing of the PMU is derived from a GPS clock, which enables synchronizing the measurements made by different PMUs at a number of different locations. Measurements made by PMUs are essential to ensure stability and reliability of power networks.</p> <p>The National Measurement Institute (NMI) has facilities for precision measurements of current and voltage harmonics and frequency. NMI is currently expanding its capabilities into the measurement of the rate of change of frequency for the calibration of PMUs.</p>
Project Description:	<p>The main tasks of the project are:</p> <ul style="list-style-type: none"> <li>■ Compile a number of existing sampling algorithms for the measurement of electrical quantities.</li> <li>■ Compare the algorithms theoretically and experimentally using state-of-the-art hardware available at NMI.</li> <li>■ Investigate different approaches to the sampling of signals containing harmonics for precision electrical measurements.</li> <li>■ Analyse the quantization error introduced by the analogue-to-digital conversion of the sampled waveforms.</li> <li>■ Investigate the calibration requirements for the sampling system.</li> <li>■ Write software for integrating the individual measurement modules to a calibration system and the testing of a commercial PMU.</li> </ul>
Examples of Relevant Student Courses/Skills	Signal processing, Statistics and Probability

<b>Project Title:</b>	Data mining: Analysis of flow-meter calibrations to assess real-world stability
Project Duration and Student Level:	Suitable for a 3rd year computing student project.
NMI Location	Lindfield, NSW
NMI Section	Mechanical, Thermal and Optical Standards: Londonderry Flow Facility
NMI Contact	Simon Dignan
Email contact	Simon.Dignan@measurement.gov.au
Background Information and Context:	<p>Flow metering systems are used extensively in the Australian economy, from fuel dispensing systems at a service station to large scale pipeline metering at fuel production plants.</p> <p>The cost and time take for the calibrations required to ensure the accuracy of LPG fuel metering in Australia is directly related to the stability of the flowmetering technologies in use. The NMI Londonderry Flow Facility underpins the accuracy of Australia's liquid transport fuel systems, and has calibrated and recalibrated several hundred flow LPG meters over many years. This provides NMI with an invaluable resource to objectively assess the long term performance of these meters.</p>
Project Description:	<p>This project involves developing automated data mining techniques to extract data from past calibration records and to quality check, group and analyse the data. A second phase is to develop statistical models for meter drift and instability to be used to develop objectively based recalibration guidelines for Australian Industry.</p>
Examples of Relevant Student Courses/Skills	Computing, Statistics, Mechanical Engineering

<b>Project Title:</b>	Transient flow effects in Coriolis flow meters used for CNG in the transport industry
Project Duration and Student Level:	Suitable for a 3 month 3rd year project.
NMI Location	Lindfield, NSW (please note that most of the work will be performed at NMI's Londonderry Flow Facility near Penrith, Sydney)
NMI Section	Mechanical, Thermal and Optical Standards: Londonderry Flow Facility
NMI Contact	Simon Dignan
Email contact	Simon.Dignan@measurement.gov.au
Background Information and Context:	CNG is a low-greenhouse emission, low-cost transport fuel which is now rapidly being adopted in Australia. The metering of this fuel (essential methane at 200 atmospheres), from tanker to service station to bus or car is performed using Coriolis flow meters, and NMI's Londonderry Flow facility has recently commissioned a high pressure CNG gas metering facility designed characterise the performance of these meters. Although these meters are known to be highly accurate for continuous flows, their performance to the rapid start-stop flows encountered in real-world use is not well known.
Project Description:	Work directly with NMI technical experts to develop and perform experiments and collect data to assess the effects of flow-transients on high pressure Coriolis flow meters. The project will include a literature review, and should ideally result in a formal publication on the findings.  This project provides the opportunity for a student to work on a project relevant to the rapidly growing gas industry.
Examples of Relevant Student Courses/Skills	Mechanical Engineering

<b>Project Title:</b>	Development of a Palladium-Carbide reference melting temperature standard
Project Duration and Student Level:	Suitable for a 3 month 3rd year project or a 3-6 month science/engineering honours project.
NMI Location	Lindfield
NMI Section	Mechanical, Thermal and Optical Standards: Temperature Standards
NMI Contact	Ferdouse Jahan
Email contact	Ferdouse.Jahan@measurement.gov.au
Background Information and Context:	The melting points of pure materials are used as secondary reference standards, as they can provide highly repeatable temperatures for the calibration of precision temperature sensors. However, until recently the use of re-usable crucibles was limited to the melting point of copper (1084°C) due to the chemical interaction between the material and the holding crucible. At present thermocouples are calibrated at 1555°C by melting a small sample of pure Palladium wire wrapped over the tip of the thermocouple. This is both destructive of the expensive reference material and shortens the thermocouple by 1-2 cm for each calibration: a significant issue for many users. NMI is implementing a new series of reference standards exploiting this crucible-reference interaction as metal-carbide eutectic points. These will form the basis of a new temperature reference for calibrations in Australia over the range to 1600°C.
Project Description:	Work with NMI staff to design miniature graphite crucibles and develop techniques for achieving an optimal palladium-carbide eutectic ingot by systematically experimenting with filling techniques, annealing and heat-treatment sequences. The project will involve working with NMI scientific staff to design and implement experiments to help guide the way to solving a number of challenging practical problems such as the high viscosity of the eutectic mix limiting mixing and anomalous heat-transfer. Time permitting, the project will also involve designing and conducting experiments to explore unresolved metallurgical issues arising from the non-equilibrium conditions.  As an honours project, a publication on the results is expected.
Examples of Relevant Student Courses/Skills	Mechanical Engineering, Metallurgy, Physics, Heat Transfer

<b>Project Title:</b>	Development of a new traceable high-power laser calorimeter reference standard
Project Duration and Student Level:	Various projects are available for this area, from 3 month 3rd year student level to a PhD level physics or engineering project.
NMI Location	Lindfield
NMI Section	Mechanical, Thermal and Optical Standards: Optics Project
NMI Contact	Peter Manson
Email contact	Peter.Manson@measurement.gov.au
Background Information and Context:	Lasers are now ubiquitous in Research, Industry, Medicine and the home. NMI is responsible for the reference standards used by laboratories to accurately measure the beam power (CW) or energy (pulsed) of laser sources. For low powers this is achieved by using various attenuation techniques to link to the primary reference standard for optical power in Australia, the cryogenic radiometer. However the linkage to this sub-mW reference becomes increasingly poorer at very high powers, such as the increasingly common >100 W lasers. An alternative traceability, accurately measuring the heat rise of a water cooled absorber or calorimeter, is now under development.
Project Description:	The project will compare the results of high power laser calibrations obtained using the conventional attenuation methods with those based on direct thermal measurements of a new water cooled calorimeter. Ideally all the laser power will end up in the cooling fluid, but in reality convection, re-radiation and stray conduction will all play a part, Assessing and quantifying the anomalous heat transfer processes within the calorimeter will allow estimation of the accuracy of this new instrument as a reference standard for high-power laser calibration.
Examples of Relevant Student Courses/Skills	Physics, Mechanical Engineering, Heat Transfer, Optics, Laser Physics

<b>Project Title:</b>	Development of new PVTt gas flow reference standard
Project Duration and Student Level:	Various projects are available from 3 month 3rd year student level to a PhD level engineering project.
NMI Location	Lindfield
NMI Section	Mechanical, Thermal and Optical Standards: Gas Flow Standards
NMI Contact	Khaled Chahine
Email contact	Khaled.Chahine@measurement.gov.au
Background Information and Context:	NMI maintains facilities for the calibration of gas-flow meters underpinning the reliable and accurate transfer of billions of dollars of natural gas per year. To meet rising industry demand for improved accuracy and range of flows, NMI is establishing a new primary standard for the calibration of sonic-nozzle gas flow standards. The PVTt facility (Pressure, Volume, Temperature, Time) consists of 1m <sup>3</sup> of special collection tanks with mK temperature stability, and volume known at the ppm level. Together with high accuracy pressure sensors and flow control systems this facility is planned to improve the accuracy of gas flow standards from 0.13% to 0.02%.
Project Description:	<p>This project has opportunities for several possible student projects.</p> <ul style="list-style-type: none"> <li>■ Developing the mechatronics and software to integrate valves and sensors into automated control and data logging systems to understand the transient and non-equilibrium flow issues expected to dominate the overall system uncertainty.</li> <li>■ Development of the flow and thermodynamic models for millisecond transient flows during valve switching and performing measurements to validate these models.</li> </ul>
Examples of Relevant Student Courses/Skills	Physics, Mechanical Engineering, Heat Transfer, Thermodynamics

<b>Project Title:</b>	Modelling anomalous resonances in rotary gas flow-meters
Project Duration and Student Level:	Projects are available from 3 month 3rd year student level to an honours level 3-6 month project
NMI Location	Lindfield
NMI Section	Mechanical, Thermal and Optical Standards: Gas Flow Standards
NMI Contact	Khaled Chahine
Email contact	Khaled.Chahine@measurement.gov.au
Background Information and Context:	NMI maintains facilities for the calibration of gas-flow meters underpinning the reliable and accurate transfer of billions of dollars of natural gas per year. During calibration of rotary flow meters, anomalous resonances can develop between the mechanical inertia of the rotating meter parts, the adiabatic and non-adiabatic compressibility of the gas stored in the system and the operation of the sonic-nozzles controlling the gas flow. These resonances or the actions taken to mitigate them, can limit the accuracy of meter calibrations.
Project Description:	<p>In this project, the student will develop appropriate models to describe the resonance frequencies and growth rates to and design experiments to validate and test the model. Using the model, optimal mitigation strategies will be developed and tested.</p> <p>It is expected that this work will be published as a paper.</p> <p>The project provides the opportunity for the student to work on a project of relevance to the fast growing gas industry.</p>
Examples of Relevant Student Courses/Skills	Physics, Mechanical Engineering, Heat Transfer, Thermodynamics

<b>Project Title:</b>	Ultra high precision gauge pressure measurement for the wind power industry.
Project Duration and Student Level:	Honours level 3-6 month project. Extension to a PhD project may also be possible depending on the findings.
NMI Location	Lindfield
NMI Section	Mechanical, Thermal and Optical Standards: Pressure Standards
NMI Contact	John Man
Email contact	John.Man@measurement.gov.au
Background Information and Context:	In the rapidly growing area of wind-turbine renewable energy, the accurate measurement of air speed is essential. NMI provides reference standards to accredited laboratories for them to use to test instrumentation for this important industry. These labs need to measure pressure differences with an accuracy below 0.1 Pa (i.e. better than 1 ppm of atmospheric pressure). NMI is establishing a new facility for differential gauge pressure, a twin-pressure-balance. At present, instabilities in the interaction between the piston's mass, trapped air volume, heat exchange between the adiabatically expanding air and the piston, and the rotating piston inertia lead to anomalous instabilities that limit the performance of the new standard.
Project Description:	<p>In this project, the student will develop appropriate models to describe the decay of forced and naturally occurring oscillations of the system, and test these models on the experimental apparatus. Using the model the student will devise and test appropriate mitigation strategies.</p> <p>Ideally this work will be published as a paper.</p>
Examples of Relevant Student Courses/Skills	Physics, Mechanical Engineering, Thermodynamics

<b>Project Title:</b>	Improved analytical methods for the screening of Endogenous Anabolic Androgenic Steroids
Project Duration and Student Level:	1 year (Honours, Masters)
NMI Location	North Ryde
NMI Section	Australian Sports Drug Testing Laboratory (ASDTL)
NMI Contact	Catrin Goebel
Email contact	Catrin.Goebel@measurement.gov.au
Background Information and Context:	<p>The ASDTL is the only laboratory in the Oceania region accredited by the World Anti-Doping Agency (WADA) to carry out doping control analysis in human sport and as such performs virtually all of the sports drug testing carried out in Australia and New Zealand. ASDTL complies with the requirements of ISO/IEC 17025:2005 and is accredited by NATA. Drug testing is not just carried out at major sporting events but is a year round activity with the analysis of some 8000 samples per year from a range of amateur and professional sports.</p> <p>Our research program aims to improve analytical techniques used in our laboratory and to investigate new forms of doping which are currently undetectable. We receive funding from the WADA, the Department of Health's Anti-Doping Research Program and the US Partnership for Clean Competition.</p>
Project Description:	Recent research has demonstrated the improved effectiveness of the athlete steroid biological passport when alternative steroid metabolites are included into routine analytical procedures. However, their implementation into routine steroid profiling is not trivial as their concentrations are generally quite low (less than 50 ng/mL) and stable isotopically labelled internal standards are not available. As such, improved instrument capabilities are required for their successful analysis. This project aims to implement the best identified alternative steroid metabolites into routine screening at ASDTL and to investigate new instrumental technology available to improve their analysis for their future potential implementation into the athlete steroid biological passport.
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty

<b>Project Title:</b>	Detection of ethyl glucuronide and ethylsulfate as indicators of alcohol abuse
Project Duration and Student Level:	1 year (Honours, Masters)
NMI Location	North Ryde
North Ryde	Australian Sports Drug Testing Laboratory (ASDTL)
NMI Contact	Catrin Goebel
Email contact	Catrin.Goebel@measurement.gov.au
Background Information and Context:	<p>The ASDTL is the only laboratory in the Oceania region accredited by the World Anti-Doping Agency (WADA) to carry out doping control analysis in human sport and as such performs virtually all of the sports drug testing carried out in Australia and New Zealand. ASDTL complies with the requirements of ISO/IEC 17025:2005 and is accredited by NATA. Drug testing is not just carried out at major sporting events but is a year round activity with the analysis of some 8000 samples per year from a range of amateur and professional sports.</p> <p>Our research program aims to improve analytical techniques used in our laboratory and to investigate new forms of doping which are currently undetectable. We receive funding from the WADA, the Department of Health's Anti-Doping Research Program and the US Partnership for Clean Competition.</p>
Project Description:	<p>The project aims to develop and fully validate methods for ethyl glucuronide and ethylsulfate for estimation of concentration in line with new requirements for the WADA Endogenous Anabolic Androgenic Steroids Technical Document.</p> <p>The testosterone to epitestosterone ratio (T/E) can be elevated by the effects of alcohol use. Currently elevated T/E ratios are investigated by isotope ratio mass spectrometry, where the result is negative it is not known whether the T/E ratio may have been influenced by alcohol consumption. To ensure that any such affected T/E ratios are not included in an athlete's biological passport profiling data the quantitative measurement of the alcohol metabolites is required.</p>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty

<b>Project Title:</b>	Survey on Australian supplements
Project Duration and Student Level:	1 year (Honours, Masters) – part of project 3 year (PhD) – complete project
NMI Location	North Ryde
NMI Section	Australian Sports Drug Testing Laboratory (ASDTL)
NMI Contact	Catrin Goebel
Email contact	Catrin.Goebel@measurement.gov.au
Background Information and Context:	<p>The ASDTL is the only laboratory in the Oceania region accredited by the World Anti-Doping Agency (WADA) to carry out doping control analysis in human sport and as such performs virtually all of the sports drug testing carried out in Australia and New Zealand. ASDTL complies with the requirements of ISO/IEC 17025:2005 and is accredited by NATA. Drug testing is not just carried out at major sporting events but is a year round activity with the analysis of some 8000 samples per year from a range of amateur and professional sports.</p> <p>Our research program aims to improve analytical techniques used in our laboratory and to investigate new forms of doping which are currently undetectable. We receive funding from the WADA, the Department of Health's Anti-Doping Research Program and the US Partnership for Clean Competition.</p>
Project Description:	<p>There continues to be a significant numbers of adverse analytical findings being reported where the athlete is claiming this is due to contents of supplements they have been using.</p> <p>Several new designer stimulants for example have been identified recently and identification of such new substance is a priority research area for anti-doping testing.</p> <p>The survey involves considerable work identifying the contents of each material via sophisticated analytical techniques such as NMR. It is expected the survey would include at least 300 products which would be from Australia and overseas sources.</p>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty

<b>Project Title:</b>	Validation of Carbohydrate Moieties of recombinant and natural erythropoietin by LCMSMS
Project Duration and Student Level:	1 year (Honours, Masters) – part of project
NMI Location	North Ryde
NMI Section	Australian Sports Drug Testing Laboratory (ASDTL)
NMI Contact	Catrin Goebel
Email contact	Catrin.Goebel@measurement.gov.au
Background Information and Context:	<p>The ASDTL is the only laboratory in the Oceania region accredited by the World Anti-Doping Agency (WADA) to carry out doping control analysis in human sport and as such performs virtually all of the sports drug testing carried out in Australia and New Zealand. ASDTL complies with the requirements of ISO/IEC 17025:2005 and is accredited by NATA. Drug testing is not just carried out at major sporting events but is a year round activity with the analysis of some 8000 samples per year from a range of amateur and professional sports.</p> <p>Our research program aims to improve analytical techniques used in our laboratory and to investigate new forms of doping which are currently undetectable. We receive funding from the WADA, the Department of Health's Anti-Doping Research Program and the US Partnership for Clean Competition.</p>
Project Description:	<p>Glycoprotein hormones and their recombinant counterparts are abused by athletes seeking to gain a competitive edge in sports. The predicament that anti-doping laboratories face is that these hormones are naturally produced in the body and the distinction against their recombinant analogues is not possible based on conventional immunoassays. However, most peptide hormones undergo post translational modification, i.e. glycosylation, and there are significant differences in the nature of the attached carbohydrates between natural and recombinant hormones. The current gel-based method for the detection of doping with erythropoietin (EPO) relies on glycosylation variation and permits the differentiation between natural and recombinant EPO.</p> <p>Initial investigations have been carried out to examine utilising this principle to determine the differences in glycan isoforms using a liquid chromatography tandem mass spectrometry (LC-MSMS) platform. These trials have utilised recombinant EPO preparations. The concept which was applied involved digesting the recombinant EPO glycoproteins to reduce the length of the protein to single amino acids or shortened peptides, this allowed for more effective enzymatic carbohydrate cleavage to release the glycans. To allow more effective mass spectrometry analysis the glycans were labelled with a derivatisation reagent and then analysed on a LC-MSMS by a multiple reaction monitoring method.</p> <p>The effectiveness of using liquid chromatography with mass spectrometry as a technique for the detection of recombinant EPO through labelled glycan analysis has thus been demonstrated in this preliminary work by the investigators. The method now requires workflow optimisation to reduce sample preparation time and increase overall recovery. This will be followed by full validation of the resulting method using spiked samples, excretion studies and a number of athletes' samples that contain low and high levels of glycoprotein hormones.</p> <p>The developed method, when fully validated, will be immediately useful for confirmation purposes for samples which are within its limit of detection. This will be a major step forward for the anti-doping community's ability to use widely accepted mass spectrometry technology as a confirmation for recombinant EPO rather than the IEF-gel methodology.</p>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty

<b>Project Title:</b>	Proof of concept for the detection of clandestine compounds in urine samples using metabolomics
Project Duration and Student Level:	1 year (Honours, Masters) – part of project 3 year (PhD) – complete project
NMI Location	North Ryde
NMI Section	Australian Sports Drug Testing Laboratory (ASDTL)
NMI Contact	Catrin Goebel
Email contact	Catrin.Goebel@measurement.gov.au
Background Information and Context:	<p>The ASDTL is the only laboratory in the Oceania region accredited by the World Anti-Doping Agency (WADA) to carry out doping control analysis in human sport and as such performs virtually all of the sports drug testing carried out in Australia and New Zealand. ASDTL complies with the requirements of ISO/IEC 17025:2005 and is accredited by NATA. Drug testing is not just carried out at major sporting events but is a year round activity with the analysis of some 8000 samples per year from a range of amateur and professional sports.</p> <p>Our research program aims to improve analytical techniques used in our laboratory and to investigate new forms of doping which are currently undetectable. We receive funding from the WADA, the Department of Health's Anti-Doping Research Program and the US Partnership for Clean Competition.</p>
Project Description:	<p>Detection of all performance enhancing drugs is essential to help maintain an environment in which drug free athletes can compete fairly. The modern athlete however is becoming more and more advanced in their efforts to avoid detection by anti-doping laboratories. This became evident in the BALCO conspiracy where compounds were made specifically to circumvent detection by laboratories for the athletes to gain an unfair competitive advantage. The current methods available to WADA laboratories are largely based on the detection of known compounds. A method which laboratories can use to detect new and previously unknown compounds - clandestine compounds is required. The project will apply advanced mass spectrometry and computing technology to develop a database for comparison to athlete samples. The comparison of an athlete's sample to the database will enable the detection of clandestine compounds such as new "designer" steroids. These clandestine compounds which are detected will undergo further analysis for identification purposes and thus will be able to be classified as either a prohibited substance or not. The developed database and techniques will be made available to all WADA laboratories.</p>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty

<b>Project Title:</b>	Development of reusable columns for enzyme hydrolysis (eg beta-glucuronidase, Protease XIV, PNGase F, Neuraminidase)
Project Duration and Student Level:	1 year (Honours, Masters)
NMI Location	North Ryde
NMI Section	Australian Sports Drug Testing Laboratory (ASDTL)
NMI Contact	Catrin Goebel
Email contact	Catrin.Goebel@measurement.gov.au
Background Information and Context:	<p>The ASDTL is the only laboratory in the Oceania region accredited by the World Anti-Doping Agency (WADA) to carry out doping control analysis in human sport and as such performs virtually all of the sports drug testing carried out in Australia and New Zealand. ASDTL complies with the requirements of ISO/IEC 17025:2005 and is accredited by NATA. Drug testing is not just carried out at major sporting events but is a year round activity with the analysis of some 8000 samples per year from a range of amateur and professional sports.</p> <p>Our research program aims to improve analytical techniques used in our laboratory and to investigate new forms of doping which are currently undetectable. We receive funding from the WADA, the Department of Health's Anti-Doping Research Program and the US Partnership for Clean Competition.</p>
Project Description:	<p>In proteomics it is frequently necessary to quickly carry out enzyme reactions such as proteolysis on small sample volumes. This has been done by immobilising enzymes such as trypsin on small columns or pipette tips. The solution to be reacted is poured onto the column and the reaction is complete within a few minutes. If such columns were available with enzymes used by the anti-doping community such as with b-glucuronidase it would significantly reduce the time taken for existing methodology. Unfortunately such columns are not available commercially.</p> <p>It is proposed to collaborate with a commercial company with a view to determining whether it is possible to use immobilised enzymes for our routine screening procedure. This will require us to purchase a small number of prototype columns and evaluate them using our routine methods. Modifications to the columns may be made depending on the results obtained. Should the development of the columns be successful we would then purchase sufficient columns to validate the new methodology. Included in the validation would be a thorough investigation of the robustness of the columns.</p> <p>This project has the potential to significantly reduce the time taken for sample preparation in all WADA laboratories and reduce cost of testing processes.</p>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Chemistry, Biochemistry, Statistics, Quality Management, Measurement Uncertainty

<b>Project Title:</b>	Alternative Sampling methods - indoor air quality
Project Duration and Student Level:	1 year Honours/Masters
NMI Location	North Ryde, NSW
NMI Section	NMI Air Laboratory
NMI Contact	Danny Slee Gavin Stevenson
Email contact	danny.slee@measurement.gov.au gavin.stevenson@measurement.gov.au
Background Information and Context:	<p>There is substantial information available on the measurement and evaluation of indoor air contaminants in industrial settings, in which air samples have usually been collected using either a sorbent tube with pump or an evacuated canister with flow regulator. However, these methodologies are not always sensitive enough to allow for the quantification of contamination at environmental levels. Air levels of contamination measured in the indoor air of residences and business buildings are generally much lower than the concentrations associated with occupational exposure in an industrial setting. The indoor air investigator should consider these differences in sensitivity when making decisions regarding monitoring and the design of an indoor air-sampling plan will vary with the objectives of the study.</p> <p>Considerations include developing a list of target compounds and parameters to be analysed, determining the required sampling duration, choosing a sampling and analytical method and detection capability consistent with the study objectives, establishing representative sampling conditions, and ensuring that adequate quality assurance and quality control practices are in place throughout the sampling and analytical process.</p>
Project Description:	<p>The aim of this project would be to investigate and validate the use of passive diffusion devices for the characterisation of longer-term (up to three weeks) average concentrations of volatile organic compounds (VOCs). These simple sampling devices may be more practical than other methods from a cost and logistical viewpoint for routine, longer-term indoor air sampling. To date, commercially available passive devices containing charcoal as the absorbent medium are used qualitatively to determine VOC 'hotspots' in industrial settings. As with active time-weighted samples, the chemicals are first desorbed from the badge's sampling medium and then are analysed using gas chromatography-mass spectrometry techniques. There are several recognised potential problems with these types of passive samplers which include effects of higher humidity, back diffusion off the sampling medium, interferences between compounds and high blank values for benzene, styrene and sometimes toluene. Further development with the application of these types of samplers to environmental level indoor air VOC characterisation should address these issues.</p>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Environmental Chemistry, Organic Chemistry

<b>Project Title:</b>	Investigation of emerging contaminants in environmental waters
Project Duration and Student Level:	1 -3 year Honours/Masters/PhD
NMI Location	North Ryde, NSW
NMI Section	Analytical Services
NMI Contact	Danny Slee
Email contact	danny.slee@measurement.gov.au
Background Information and Context:	A wide range of chemicals commonly found in water are now considered to be emerging contaminants, due to their potential for significant impact on human health and the environment. These emerging contaminants are usually detected in environmental waters at concentrations ranging from trace to ppb levels. Most existing toxicity data are based on tests performed on single compounds and for short-term exposure. Therefore, the focus of current research has moved to understand the fate and effects of mixture of compounds, their metabolites and/or transformation by-products, as hydrolysis, photolysis and biotic transformations may lead to the formation of more toxic and persistent contaminants. The development of a sensitive multi-residue analytical method for the generalised and non-targeted screening of trace organic contaminants in complex environmental waters is needed.
Project Description:	<p>Emerging contaminants, such as pharmaceuticals, personal care products and pesticides, have been detected in a wide variety of environmental water samples including surface water, groundwater and sewage flows. At present pre-targeted screening of emerging contaminants can be performed using triple-quadrupole MS, however this technique cannot achieve sufficiently accurate mass measurement to be used for post- and non-targeted screening. Ultra-high performance liquid chromatography (UHPLC) coupled with hybrid quadrupole time-of-flight mass spectrometry (QTOF/MS) has been identified as a preferred technique for qualitative and quantitative testing and non-targeted screening of organic pollutants.</p> <p>This project would address development and validation of methods to permit generalised extraction of a wide range of compounds from different types of waters, and development and validation of QTOF/MS methods in elucidating the emerging contaminants and/or their metabolites and transformation by-products in an aquatic environment.</p>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Environmental Chemistry, Organic Chemistry

<b>Project Title:</b>	Evaluation of Different Methods for Determination of Arsenic, Mercury, Selenium and Chromium species in Food and Environmental Samples
Project Duration and Student Level:	1 year Honours/Masters/PhD
NMI Location	North Ryde, NSW
NMI Section	Analytical Services
NMI Contact	Michael Wu
Email contact	michael.wu@measurement.gov.au
Background Information and Context:	It is recognized that total element concentration determination does not provide adequate information to understand the effects observed in the environment and in living systems. The toxicity, bioavailability, physiological and metabolic processes, the mobility and fate are greatly dependant on the specific chemical form of the element. Therefore the speciation of different arsenic, mercury, chromium and selenium species is of essential importance to be determined accurately.
Project Description:	This project seeks to address current analytical limitations through the development of a reliable and accurate method for routine analysis of arsenic, mercury, chromium and selenium species by using a liquid chromatography technique for separation and ICP-MS for determination.
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Environmental Chemistry, Inorganic Chemistry

<b>Project Title:</b>	Low levels of volatile organic compounds by purge and trap GCMS
Project Duration and Student Level:	1 year Honours/Masters/PhD
NMI Location	North Ryde, NSW
North Ryde, NSW	Analytical Services
NMI Contact	Danny Slee
Email contact	danny.slee@measurement.gov.au
Background Information and Context:	The method used for the analysis of volatile organic compounds (VOC) in water and soil matrices is a purge-and-trap (P&T) gas chromatography (GC)/ mass spectrometry (MS). As the method should encompass a wide range of matrices with an extensive range of concentration limits, it is necessary to have an analytical system that is sensitive enough for the lower restrictions and robust enough for the higher concentrations of VOC components. NMI has recently purchased a new combination P&T concentrator/autosampler which is capable of sampling multiple matrices, and aims to improve the methodology for analysis of VOC.
Project Description:	<p>There is a continuous need to improve the methodologies, in particular detection limits and time efficiency, in environmental testing laboratories. NMI aims to achieve the following:</p> <ul style="list-style-type: none"> <li>■ Establish the Linear calibrations and Method Detection Limits (MDLs) for most common traps and trap settings</li> <li>■ Evaluate capabilities and limitations for determination of VOC in soil matrices</li> <li>■ Evaluate the autosampler's carryover reduction options</li> <li>■ Validate an improved methodology</li> <li>■ Submit for NATA accreditation</li> </ul>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Environmental Chemistry, Organic Chemistry

<b>Project Title:</b>	Analysis of Sulphur-containing inorganic anions by 2D-IC
Project Duration and Student Level:	1 year Honours/Masters/PhD
NMI Location	North Ryde, NSW
NMI Section	Analytical Services
NMI Contact	Michael Wu
Email contact	michael.wu@measurement.gov.au
Background Information and Context:	Sulphur-containing inorganic anions e.g sulphite (SO <sub>3</sub> <sup>2-</sup> ), sulphate (SO <sub>4</sub> <sup>2-</sup> ), thiocyanate (SCN <sup>-</sup> ), thiosulfate (S <sub>2</sub> O <sub>3</sub> <sup>2-</sup> ) are commonly encountered in soil sediments, hot springs, and lake waters. They are also frequently used in many industrial applications. Their speciation and quantitation are very important to the understanding of those processes.
Project Description:	<p>Many sulphur-containing species, due to their redox chemistry, can readily react with each other, decompose over time, or be oxidized in the presence of air. They are also very sensitive to the pH of the solution, which would affect the distribution of the species with time. All these factors make the determination of the sulphur-containing anions a very exciting task.</p> <p>The project would aim to develop a method to separate and quantify sulphur-containing anions by suppressed ion chromatography; test the reliability, repeatability and sensitivity of the method to ensure the development of an analytically sound product for soil and water matrices; and submit the method for NATA accreditation.</p>
Examples of Relevant Student Courses/Skills	Analytical Chemistry, Environmental Chemistry, Organic/Inorganic Chemistry

<b>Project Title:</b>	Persistent Organic Pollutants in Australian fauna and marine mammals
Project Duration and Student Level:	6 months or longer Honours or Masters
NMI Location	North Ryde, NSW
NMI Section	Ultra trace laboratory
NMI Contact	Gavin Stevenson
Email contact	<a href="mailto:gavin.stevenson@measurement.gov.au">gavin.stevenson@measurement.gov.au</a>
Background Information and Context:	<p>Persistent Organic Pollutants (POPs) are either unintentional by-products or industrial chemicals that exhibit toxicity and are exceptionally persistence in the environment. These compounds bioaccumulate in the food chain and can cause reproductive and development issues in animals and humans.</p> <p>The Ultra trace laboratory was originally established in 2000 to help fulfil Australian Government obligations as a signatory of the United Nations Environment Programme's Stockholm Convention on POPs.</p> <p>Past studies have included Dioxins and PCBs in Sydney Harbour fish, PBDEs in Tasmanian Devils, and POPs in Ibis.</p>
Project Description:	The project can focus on an impacted population (like Sydney fish) or be a survey of POPs contamination (like Ibis across 2 states). Animal samples (blood/fat/flesh/eggs) are collected by the student in the field and analysed at NMI. Training on the analytical and data processing techniques will be provided in the laboratory. Students will require access and permissions to obtain animal samples.
Examples of Relevant Student Courses/Skills	Veterinarians, Toxicologists, Analytical chemists

<b>Project Title:</b>	Hexabromocyclododecane (HBCD) method development
Project Duration and Student Level:	6 months or longer Honours or Masters
NMI Location	North Ryde, NSW
NMI Section	Ultra trace laboratory
NMI Contact	Gavin Stevenson
Email contact	<a href="mailto:gavin.stevenson@measurement.gov.au">gavin.stevenson@measurement.gov.au</a>
Background Information and Context:	<p>Persistent Organic Pollutants (POPs) are either unintentional by-products or industrial chemicals that exhibit toxicity and exceptional persistence in the environment. These compounds bioaccumulate in the food chain and can cause reproductive and development issues in animals and humans.</p> <p>HBCD, a flame retardant used in the construction industry, was recently added to the Stockholm convention. NMI wants to develop analytical methods in a range of environmental matrices for this compound.</p>
Project Description:	Development of laboratory and LCMS instrumental techniques for the detection of HBCD in environmental matrices, for example biota, water and soil. The laboratory has an existing method for air samples that would form the basis of the development.
Examples of Relevant Student Courses/Skills	Analytical chemists

<b>Project Title:</b>	XML report development
Project Duration and Student Level:	3 months or longer Honours
NMI Location	North Ryde, NSW
NMI Section	Ultra trace laboratory
NMI Contact	Gavin Stevenson
Email contact	<a href="mailto:gavin.stevenson@measurement.gov.au">gavin.stevenson@measurement.gov.au</a>
Background Information and Context:	The Ultra trace laboratory uses sophisticated instruments to conduct chemical measurements, and spends considerable time processing the data into an Excel format suitable for end users. Recent upgrades to software have allowed the data to be exported via XML format, and NMI needs to write reports to convert the XML data into end user reports.
Project Description:	Write XML based reports to recreate the current Analytical Certificates issued by the laboratory using Excel. This should be relatively straight forward to a student with the right skills, but will require review against existing certificates.
Examples of Relevant Student Courses/Skills	Computer Science, Programming

<b>Project Title:</b>	Finite Element Modelling of Primary Pressure standards
Project Duration and Student Level:	Suitable for a 3- 6 months honours level engineering student project
NMI Location	Port Melbourne
NMI Section	Mechanical, Thermal and Optical Standards: High Pressure Project
NMI Contact	Neville Owen
Email contact	<a href="mailto:Neville.owen@measurement.gov.au">Neville.owen@measurement.gov.au</a>
Background Information and Context:	NMI maintains Australia's primary standards for pressure: used in just about every facet of industry including manufacturing, safety, health and environment. To meet the ever increasing demands of Australian industry, NMI need to improve the accuracy of our primary standards for this area, which are based on very accurate piston/cylinder systems.
Project Description:	Primary pressure standard or piston cylinder units (PCUs) are calibrated measuring their exact 3 dimensional shape using advanced length metrology techniques, and developing and validating finite element models to self consistently predict both the mechanical distortion under high pressure, and the flow of gas or liquid in the gap between piston and cylinder. This project requires using modelling and engineering design programs like Solidworks, ANSYS and similar to conduct Finite Element Analysis (FEA) on a PCU to find effective area dependent on pressure profile in the PCU gap. Other parameters include piston fall rate and PCU distortion coefficient. The model needs to be refined against measurement parameters and validated against existing solutions. Further work includes assisting dimensional measurement staff to optimise measured data and prepare the modelling packages to conduct routine PCU analysis. This work has a target uncertainty around 0.001% and relies on dimensional data with a resolution of tens of nanometres.
Examples of Relevant Student Courses/Skills	Finite Element Analysis, Mechanical Engineering, Solidworks, ANSYS, Software development.

<b>Project Title:</b>	Marine biotoxin determination and method development
Project Duration and Student Level:	1-3 years, Honours, Masters or PhD
NMI Location	Port Melbourne
NMI Section	Technical Development & Innovation
NMI Contact	Katherine Stockham
Email contact	Katherine.Stockham@measurement.gov.au
Background Information and Context:	Under specific environmental conditions, harmful algal blooms occur and marine biotoxins are produced. These toxins accumulate in seafood, particularly bivalve molluscs such as mussels, oysters and scallops, and can be extremely harmful and even fatal to humans when eaten. Both water and fat soluble marine biotoxins survive the cooking process and are classified by the symptoms they induce, namely paralytic, neurotoxic, amnesic and/or diarrhetic shellfish toxin.
Project Description:	The main classes of toxins being studied currently are saxitoxins (responsible for paralysis, suffocation and death). Method development and baseline data collection is needed for amnesic, diarrhetic and neurotoxic shellfish toxins in mussels, oysters and scallops being produced domestically. Liquid Chromatography with tandem mass spectrometry (LC/MS/MS) will be used for this research work.
Examples of Relevant Student Courses/Skills	Analytical chemistry, biochemistry

<b>Project Title:</b>	Olive oil authentication and the effects of storage on oil classification
Project Duration and Student Level:	1-3 years, Honours, Masters or PhD
NMI Location	Port Melbourne
NMI Section	Technical Development & Innovation
NMI Contact	Katherine Stockham
Email contact	Katherine.Stockham@measurement.gov.au
Background Information and Context:	Australia produced around 20 million litres of olive oil last year, and the industry is growing steadily. Much of this olive oil is for export, and needs to meet specific authenticity and quality criteria which is related to olive oil grading. There are many different parameters involved in olive oil authenticity, and storage and transport conditions are thought to have significant influence. For example, extended transport in warm conditions can affect the oxidation of oil, which in turn can exhibit a rancid aroma when opened. Taste and aroma are affected, and there is concern over what other parameters will change and how this affects the oil grading (authenticity) and quality over time.
Project Description:	This project aims to use international standard methods for the authentication of Australian olive oils, which exhibit unique phytochemical properties. Furthermore, the effect of storage time and temperature will be investigated to understand how olive oil quality and classification may be affected by these processes commonly used in the industry.
Examples of Relevant Student Courses/Skills	Analytical chemistry

<b>Project Title:</b>	Production of Maillard reaction products based on allergenic proteins and their reaction with reducing sugars
Project Duration and Student Level:	1-3 years, Honours, Masters or PhD
NMI Location	Port Melbourne
NMI Section	Technical Development & Innovation
NMI Contact	Katherine Stockham
Email contact	Katherine.Stockham@measurement.gov.au
Background Information and Context:	Digestive disorders (including food intolerance) and food allergy are becoming major and ongoing issues in Australia, affecting the health of 1 in 20 children and 1 in 50 adults currently. Egg and shellfish are among the more predominant allergens, while functional bowel disease (irritable bowel syndrome) affects around 1 in 5 Australians. Often patients exhibit more than one complaint, and food allergy and food intolerance are seen in the same patient. For these reasons, novel research is being conducted into understanding the links between the sugar-protein interactions during digestion.
Project Description:	This research focuses on Maillard reaction products, produced from allergenic proteins and reducing sugars. The sugars studied are classified as FODMAPs, fermentable oligosaccharides, disaccharides, monosaccharides and polyols. FODMAPs have been identified as key factors in functional bowel disorder, and diets excluding these sugars are most commonly prescribed in the treatment of FBD. Allergenic proteins of shellfish and egg will undergo simulated digestion in combination with a range of FODMAPs to produce MRPs. This study will be used in conjunction with further studies to determine the reproducibility, allergenicity and overall impact on FBD.
Examples of Relevant Student Courses/Skills	Analytical chemistry, biochemistry, proteomics

<b>Project Title:</b>	Chemical and physical migration from recycled and paper-based food contact materials (food packaging)
Project Duration and Student Level:	1-3 years, Honours, Masters or PhD
NMI Location	Port Melbourne
NMI Section	Technical Development & Innovation
NMI Contact	Katherine Stockham
Email contact	Katherine.Stockham@measurement.gov.au
Background Information and Context:	A wide range of food packaging is used in Australia, both locally and internationally sourced. Over the last decade, there has been a shift in packaging requirements and innovation, such that active packaging and environmentally conscious packaging are highly sought after. Active packing often has antimicrobial or gas barrier properties to prolong the shelf life of food products, and recyclable materials are increasingly used. In order to ensure that packaging intended for contact with food is safe, the Australian Standard 2070-1999 sets out a guideline for testing requirements of food packaging. These guidelines relate to the total amount of material that can migrate out of packaging into food, as well as migration of specific chemicals and plasticisers. Recycled paper products have many additional chemicals available to migrate, and plasticisers in inks and dyes are prevalent. For these reasons, research is being conducted at NMI into chemical and physical (overall) migration from emerging forms of food packaging.
Project Description:	This project aims to investigate and validate methods for migration testing of recycled paper-based food contact materials and emerging forms of active packaging. The research will include undertaking simulations on food contact materials to simulate acidic, fatty, aqueous, alcoholic and dry foods. Contact time, temperature and surface area will be recorded and specialised equipment used. Physical migration is determined by gravimetry and chemical migration by GC-MS and LC-MS screening.
Examples of Relevant Student Courses/Skills	Chemistry, polymer and packaging science, food science

<b>Project Title:</b>	Confirmatory Techniques for Food Allergen analysis
Project Duration and Student Level:	1-3 years, Honours, Masters or PhD
NMI Location	Port Melbourne
NMI Section	Food Allergen Research
NMI Contact	Dean Clarke
Email contact	dean.clarke@measurement.gov.au
Background Information and Context:	<p>For those with severe, life threatening food allergies, it is essential to be able to obtain accurate and reliable information about all the major and minor components in a food. Food allergies (or hypersensitivities) are a significant and increasing problem in industrialised countries and reportedly affect up to 2% of adults and 6% of children. Many allergen proteins may be present in foods or used in food production without the consumer being aware. Food manufacturers have a legal and moral responsibility to produce safe food. Accurate and legible labelling is essential information for allergic consumers if they are to comply with their strict avoidance diets and therefore food labelling is important in preventing food allergy.</p> <p>In Australia, the routine approach to measuring allergen proteins for food labelling is to use immunological based techniques (ELISAs or Lateral Flow devices). These techniques are preferred for routine use due to their cost effectiveness, ease of use and availability for a range of target allergen proteins. Immunologically derived results are often in dispute due to unexpected component concentrations, lack of validation data for specific food types, conflicting results from different kits and variable extractability or detection in complex matrices. Results derived from these immunological affinity-based techniques would be greatly assisted by robust confirmatory techniques.</p> <p>Mass spectrometry is contributing significant data on composition and structure and has become the predominant technology for peptide and protein identification. By precise measurement of protein molecular masses, mass spectrometry techniques are able to unambiguously identify allergen proteins.</p>
Project Description:	The aim of this project will be to identify, using mass spectrometry, unique small proteins or peptides that upon detection indicate unequivocally the presence of allergen proteins or peptides. Species of origin and specific protein identification will be compared to public databases and reference materials where available. Whole and digested proteins will be investigated.
Examples of Relevant Student Courses/Skills	Immuno-chemistry, Biochemistry, Proteomics, Food Safety, Food Science, Health

# Contact Information for Major Research Locations

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info@measurement.gov.au  
ABN 74 599 608 295

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Bradfield Road  
West Lindfield NSW 2070  
Telephone: 61 2 8467 3600

Sydney

105 Delhi Rd  
North Ryde NSW 2113  
Telephone: 61 2 9449 0111

Sydney

Flow Measurement Facility  
919 Londonderry Rd  
Londonderry, NSW 2753  
Telephone: 61 2 8467 3514

Melbourne

1/153 Bertie Street  
Port Melbourne VIC 3207  
Telephone: 61 3 9644 4888

Perth

Australian Resources Research Centre  
26 Dick Perry Ave  
Kensington WA 6151  
Telephone: 61 8 9368 8400