

รายงาน

Report

**Study-Visits to Equipment Centres at three Australian Universities
from 18-29 July 2011
to gain information for the best practice in running STEC at
Silpakorn University**

by

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บทสรุปสำหรับผู้บริหาร

ออสเตรเลียเน้นคุณค่าของการแบ่งปันการใช้เครื่องมือวิทยาศาสตร์และเทคโนโลยี โดยที่ Microscopy and Microanalysis Centres จากมหาวิทยาลัยหลักของชาติ 8 แห่งรวมพลังให้มีการแบ่งปันการใช้เครื่องมือวิทยาศาสตร์และเทคโนโลยี เพิ่มเติมจากการให้บริการในหน่วยงานของตน ทำให้เกิดประโยชน์สูงสุดต่อประเทศ ทำให้เกิดหน่วยงานกลางชื่อ Australian Microscopy & Microanalysis Research Facility (AMMRF) ขึ้น การร่วมมือดังกล่าวนำไปสู่การเพิ่มผลงานวิจัยของชาติ อีกทั้งเพิ่มโอกาสให้นักวิจัยเข้าถึงเครื่องมือระดับสูงและที่มีความต้องการสูงได้ เครื่องมือราคาแพงจึงถูกใช้ให้เกิดประโยชน์สูงสุด ทั้งต่อภาครัฐและเอกชน แนวปฏิบัติดังกล่าวทำให้เกิดความโปร่งใส เพราะทุกคนต้องยึดแนวปฏิบัติเดียวกัน

เป็นที่น่าประทับใจว่า นักวิจัยหลายท่านที่จัดซื้อเครื่องมือจากทุนวิจัยได้มอบเครื่องมือให้ศูนย์เครื่องมือวิทยาศาสตร์และเทคโนโลยีของแต่ละมหาวิทยาลัยเป็นผู้ดูแลด้วย การปฏิบัติดังกล่าวทำให้เกิดประโยชน์สูงสุดแก่ทุกฝ่าย โดยที่เจ้าของเครื่องมือคงสิทธิการใช้เครื่องมือในลำดับต้น ศูนย์เครื่องมือวิทยาศาสตร์และเทคโนโลยีเป็นผู้ดูแลศูนย์เครื่องมือให้อยู่ในสภาพใช้งานได้ดี นักวิจัยอื่นของประเทศมีโอกาสใช้เครื่องมือด้วย ในประเด็นความร่วมมือกับต่างประเทศนั้น AMMRF สนใจเป็นอย่างมากที่จะร่วมมือกับประเทศไทย และส่งผู้เชี่ยวชาญมาบรรยายพร้อมให้คำแนะนำด้านเครื่องมือวิทยาศาสตร์และเทคโนโลยี เราควรจะสร้างความร่วมมือกับ AMMRF เพื่อบุคลากรของเราจะได้มีโอกาสใช้เครื่องมือระดับสูงประเภทที่เราไม่มีงบประมาณเพียงพอที่จะจัดหาได้

Executive Summary

Australia as a well developed country which values sharing research facility for the real benefits for all. Each microscopy and microanalysis centres from eight major Australian universities, even though runs independently to serve each university incorporated themselves into the Australian Microscopy & Microanalysis Research Facility (AMMRF) to provide centralized equipments to the entire research community. The AMMRF demonstrates that an idea to centralize instruments is possible. This project brings about higher research productivity and higher opportunity to get in-demand and cutting-edge instruments for public. Thus, instruments in AMMRF scheme have never be left unused for a long period of time since they are used by a large number of researchers from both the government and private sectors. The scheme also enhances transparency in running research facility since everyone has to follow a set of rules and regulations.

It was impressive to observe that certain researchers once purchased major instruments from their research grants, allowed the instruments to be housed and run by centralized centres. Such practice benefits everybody. While the “real” owner has priority in using the instrument as well as having them maintained by the centre, other researchers have chances to use the equipment as well. Most of the centres in Australia, particularly the national centre (AMMRF) offered opportunities for collaboration with institutions in our country. Thailand should look more into collaborative works with the centre to gain access to high-end instruments.

I visited equipment centres at three Australian universities. Apart from gathering information at those centres, I also learned a great deal about the management of equipments which would be relevant to the work in Thailand. Most of the centres offered opportunities for collaboration. Below is the summary of activities done during the visits.

1. Centre for Advanced Microscopy (CAM), The Australian National University (ANU)

This centre houses many types of microscopes and is also a node of The Australian Microscopy & Microanalysis Research Facility (AMMRF). CAM facilitates researchers as well as students in microscopic analysis having the following major instruments available:

- **Light Microscopes:** Zeiss Axioplan 2, Zeiss Axioskop, and Wild M400 Photomicroscope
- **Confocal Laser Scanning Microscope (LSM):** CAM has one LSM available, it is Zeiss 780 NLO confocal
- **Transmission Electron Microscopes (TEM):** There are three TEMs at the CAM. These are Hitachi H7100FA 125kV, Philips EM430 300kV and Philips CM300
- **Scanning Electron Microscopes (SEM):** Six SEMs, namely, Cambridge S360, Hitachi 4300 SE/N Schottky Field Emission, Hitachi S4500 Cold Field Emission, Hitachi S2250-N, JEOL JSM6400, and Zeiss UltraPlus analytical FESEM) which can be used for Cryo SEM , secondary electron (SE), mapping, quantitative X-ray microanalysis as well as back-scattered electron imaging (BSE).
- **Micro-CT:** This instrument uses X-Ray to construct cross-sections of a 3D-object without destroying the original specimen.
- **Atomic Force Microscope**

Each room is monitored by a closed-circuit television with a monitor situated in front of each room. Fire extinguishers and showers are checked regularly. A meeting room is well equipped with a laptop, a large LCD screen and comfortable seats. All users must be trained to use equipments properly and skillfully beforehand. To use equipments at CAM, users need to book instrument through the online system.





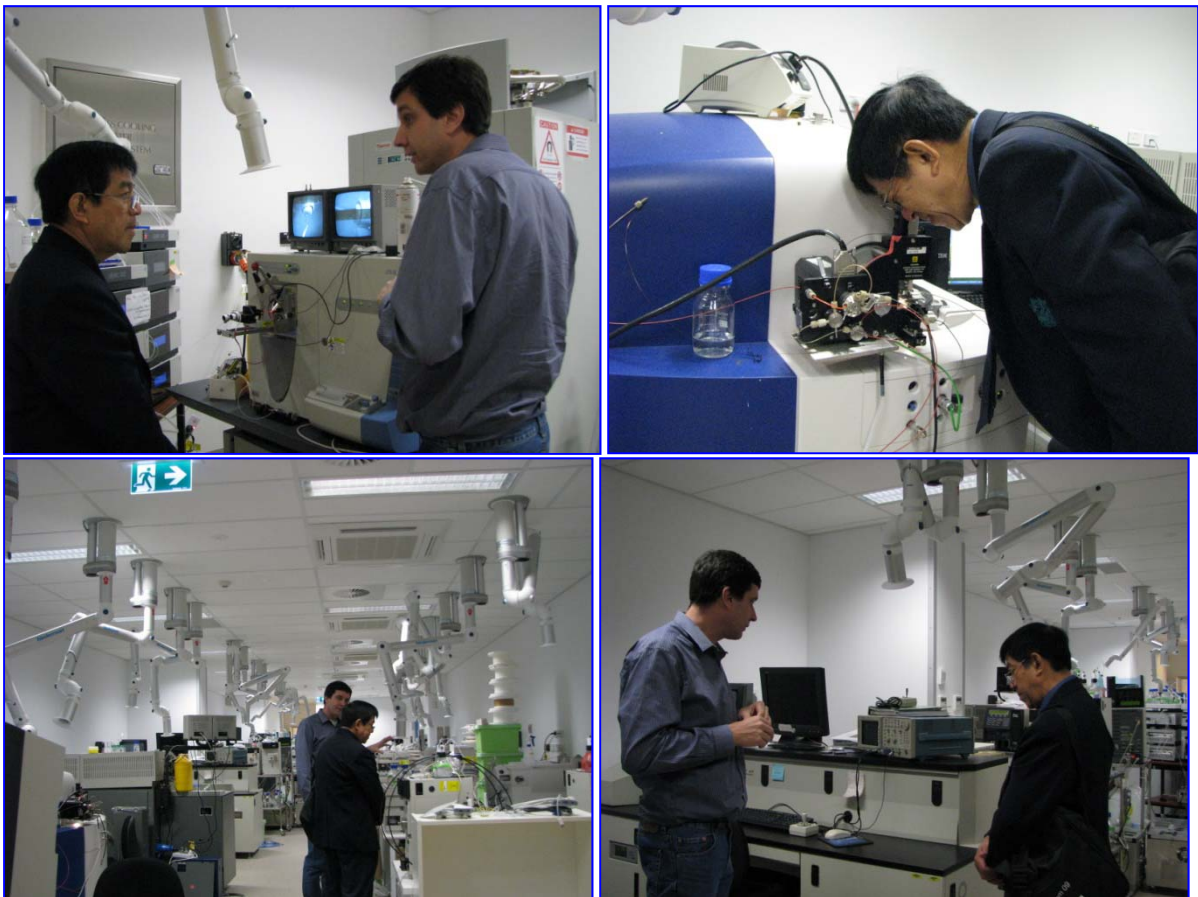
Figure 1. The visit to CAM at the Australian National University guided by Dr Paul Cooper from the Research School of Biology

2. Mark Wainwright Analytical Centre: Bioanalytical Mass Spectrometry Facility (BMSF), The University of New South Wales (UNSW)

BMSF is one section of Mark Wainwright Analytical Centre. The facility houses advanced mass spectrometers for quantitative and qualitative analysis of proteins, peptides, biopolymers, synthetic polymers, and small molecules. The centre provides high-sensitivity GC/MS, LC/MS with various mass resolving power, MALDI instruments which are used for analyzing high-molecular weight samples, multidimension LC, and Tandem mass spectrometry (MS/MS or MSⁿ) BMSF booking management is efficiently run by AC Lab System. Users are required to register, submit their requests, and book instrument through the system. Emergency power for loads at the centre is generated by a large uninterruptible power supply (UPS).



Figure 2. Study-visit to Bioanalytical Mass Spectrometry Facility (BMSF) at The University of New South Wales where Associate Professor Dr Mark Raftery, the director of BMSF, introduced registration and booking management based on the AC Lab System.



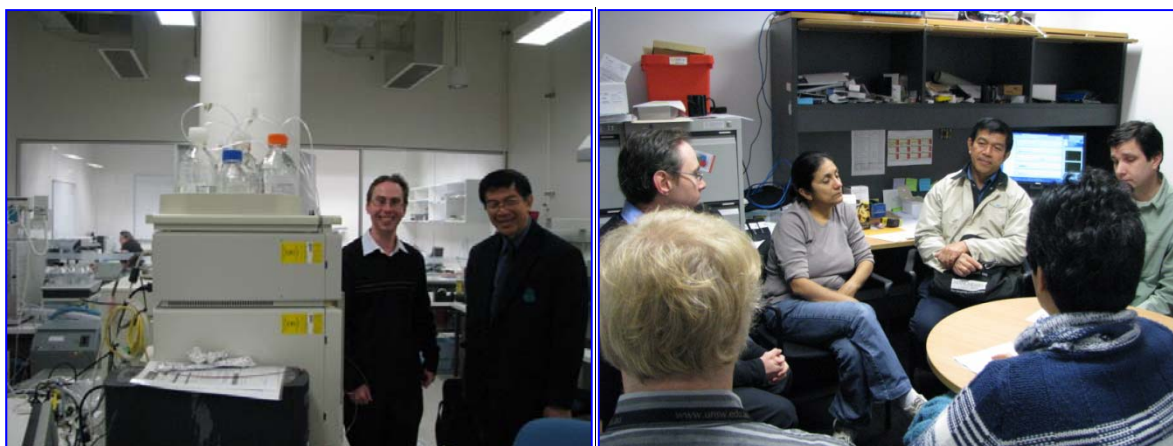


Figure 3. Associate Professor Dr Mark Raftery guided the visitors through the many mass spectrometers used in bioanalytical research. Participation at group meetings were also arranged so that visitors could observe the real running of the facility.

3. Mark Wainwright Analytical Centre: Solid State & Elemental Analysis Unit (SSEA), The University of New South Wales (UNSW)

SSEA specializes in elemental, molecular, microstructural analysis of solids. Microstructure of solids and molecular structure can be obtained from techniques such as X-Ray Diffraction, X-Ray Thin film analysis, Raman spectroscopy, Infrared spectroscopy, UV-Visible spectroscopy, and Inductively Coupled Plasma spectrometry (ICP). Surface is analyzed by X-Ray Photoelectron Spectroscopy (XPS). Elemental and molecular analysis can be done by X-Ray Fluorescence Spectroscopy (XRF), ICP-MS and ICP-OES, and Thermal Analysis. Analysis of water samples by ICP, Anion chromatography, Liquid Chromatography Organic Carbon-Nitrogen Detector (LC-OCND) for quantifying total carbon and total nitrogen, Liquid Chromatography Organic Carbon Detector (LC-OCD) for quantifying total carbon. This unit is the only place in Australia that has LC-OCD.

List of some instruments available at SSEA

ICP Laboratory

Perkin Elmer OPTIMA 7300 ICP-OES Instruments

Perkin Elmer ELAN 6100 ICP-MS and DRC2 ICP-MS

DOC-LABOR Liquid Chromatography - Trace Organic Carbon Detector (LC-OCD)

AnalytikJena NC2100S Total Carbon and Total Nitrogen Analyser

Picarro Carbon-13 Thermal Analysis System

Lachat Flow Injection Analyser

Dionex Ion Chromatography System

Milestone Microwave Digestion System

Acid Distillation Unit, Ball Mill, Centrifuge

X-Ray Fluorescence (XRF) Laboratory

PANalytical AXIOS Advanced Simultaneous WDXRF Spectrometer

PANalytical MINIPAL 4, EDXRF Spectrometer

LECO TruSpec Analyser: CN Module and S Module

LECO High Temperature NO Thermal Analysis Unit

X-Ray Diffraction (XRD) Laboratory

Philips X'pert Multipurpose X-ray Diffraction System ("MPD")

Philips PW1830 X-ray Diffraction System ("PW1830")

Philips PW1729

Philips X'pert Materials Research diffractometer ("MRD")

Bruker Kappa Apex and Enraf Nonius Single Crystal Diffractometers

Leica 165C Microscope

Thin Film Analyser - Mikropack NanoCalc 2000 UV-Vis-NIR

Data Processing Software & Databases

Surface Analysis Laboratory

XPS





Figure 4. Study-visit to Solid State & Elemental Analysis Unit (SSEA) which is a part of Mark Wainwright Analytical Centre at The University of New South Wales (UNSW) guided by Dr Dorothy Yu, Senior Technical Officer. SSEA is the only centre in Australia currently having Liquid Chromatography Organic Carbon Detector (LC-OCD)

4. Mark Wainwright Analytical Centre: Nuclear Magnetic Resonance Facility (NMRF), The University of New South Wales (UNSW)

Bruker NMR ranging from 300 MHz to 700 MHz including Bruker Avance III 300 Solid State NMR were installed at the same laboratory. Bruker EMX X Band EPR (Electron Paramagnetic Resonance spectroscopy) is provided for measuring unpaired electrons in both solid and solution state. All staffs and students must complete an induction courses before getting swipe cards to commence work on any instrument in the NMRF.

List of equipments in the NMRF

Bruker Avance III 700 MHz	Bruker Avance III 300 MHz
Bruker Avance III 600 MHz	Bruker Avance III 300 MHz Solid State
Bruker Avance III 500 MHz	Bruker DPX 300 MHz
Bruker Avance III 400 MHz	Bruker EMX X-Band ESR Spectrometer



Figure 5. Dr Donald Thomas, NMRF Scientific Officer, guided visitors to NMRF: NMR 700 MHz, the highest frequency NMR available at the NMRF, is shown at the bottom left-hand corner.

5. **Mark Wainwright Analytical Centre: Electron Microscope Unit (EMU), The University of New South Wales (UNSW)**

EMU at The University of New South Wales is one of the major university-based microscopy and microanalysis centres of the AMMRF. EMU provides variety of microscopy and analysis facilities, for instance, TEM, SEM, and Focused Ion Beam (FIB) which can be used for nanomilling very thin (~100nm) sections, Atomic Force Microscope (AFM) which helps investigate surface at nano level, Electron Probe Microanalyser (EPMA), X-Ray Microcomputed Tomography, and Scanning Probe Microscope (SPM). Electrical power supply and gas system in the laboratory are professionally well-planned. Safety spectacles must be worn upon entering chemical and preparation rooms.

List of major equipments at the EMU

JOEL 1400 TEM

FEI QUANTA 200 ESEM

Skyscan 1072 X-Ray Micro-CT

Hitachi S900 FESEM

Ultramicrotome

Philips CM200 FEGTEM

FEI Tecnai G2 TEM

Zeiss Auriga FIB SEM

JOEL 8500F Hyperprobe EPMA

Veeco/DI Multimode SPM

Veeco/DI Dimension 3000 SPM

JOEL 5400MK II SPM

Hitachi S3400-I SEM

AFM

FEI xP200 FIB

FEI Nova NanoSEM 230



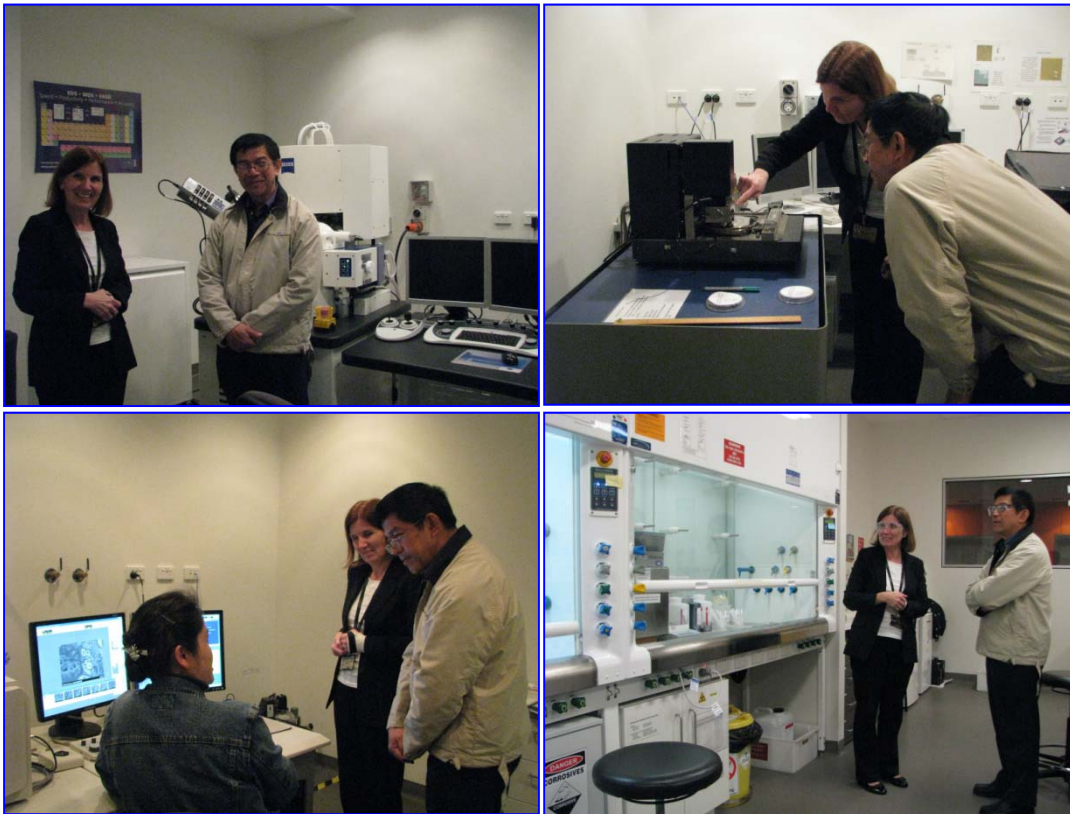


Figure 6. Associate Professor Marion Stevens-Kalceff, Deputy Director of Electron Microscope Unit (also Associate Professor at School of Physics) introduced EMU to visitors and guided through the laboratories. Comprehensive service of EMU has continuously benefited staffs, students as well as researchers from private sectors.

6. Mark Wainwright Analytical Centre: Biological Resources Imaging Laboratory (BRIL), The University of New South Wales (UNSW)

Instruments are kept in closed area where pressure is controlled. The air entering laboratories is filtered to prevent harmful microbes from gaining an access. The same is done for air which exit the laboratories. Autoclaved costumes must be worn while working in the BRIL. Laboratory animals are supplied by germ-free suppliers. To bring one own animals to the BRIL, animals have to be first checked by certified companies. Laboratory animals are housed and fed in temperature-controlled rooms and checked for their well-beings each day.

Major equipments available at the BIF

DM IL	Axio Observer X.1 SD & TIRF
TCS SP5	Elyra
Microtime200	Fluoview FV1000
Atomic Force Microscope	Nanoenabler
Axio Examiner	Nuance

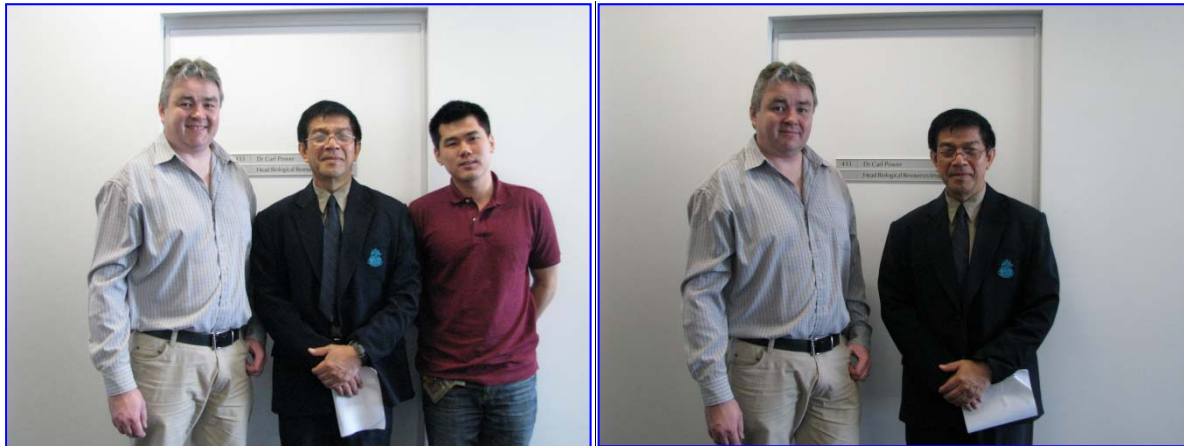


Figure 7. Study-visit to Biological Resources Imaging Laboratory (BRIL), The University of New South Wales was guided by Dr Carl Power, head of BRIL.

7. The Australian Centre for Microscopy & Microanalysis (ACMM) and The Australian Microscopy & Microanalysis Research Facility (AMMRF), The University of Sydney (USYD)

The AMMRF, under The Commonwealth's National Collaborative Research Infrastructure Strategy (NCRIS), was initiated in 2007 as a result of a collaboration between microscopy and microanalysis centres of 8 Australian universities, the linked laboratories and the linked centres. This scheme helps maximize using microscopic and microanalysis equipments for the maximum benefits to research community. Each university node hosts overlapping and complementary equipments. Researchers can apply for the Travel and Access Program (TAP) Grant to access the AMMRF instruments around Australia. Online-training tools with virtual lessons, and technique finder can be accessed at the site.

ACMM at the University of Sydney is a part of the AMMRF. The centre operates in a similar pattern to other AMMRF university nodes. Apart from providing extensive range of microscopy and microanalysis instruments, ACMM also welcomes people from any fields to enroll in courses ranging from Certificate to Diploma and to Master.

Example of instruments at the ACMM

Light and Laser Microscope: Leica SP5 II confocal and multiphoton microscope, Olympus BX61 Motorized System Microscope (SIS), Nikon Eclipse E800 Fluorescence Microscope (SensiCam), etc.

Scanning Probes: Ntegra Near-Field Scanning Optical Microscope (NSOM) and PicoSPM from Molecular Imaging

Scanning Electron Microscope: FEI Quanta 200 3D, Philips XL 30 CP, Zeiss ULTRA *plus* and Intellection Quemsan

Transmission Electron Microscope: JEOL 3000F, JEOL 2200FS, JEOL 2100, JEOL 1400, VGSTEM HB601, Philips CM12, and Philips CM120 Biofilter

Atom Probe: Imago Local Electrode Atom Probe, and Imago Wide-Field-Of-View Laser Atom Probe (LEAP3000)

X-Ray: Xradia MicroXCT-400 Micro-Computed Tomography, Xradia NanoXCT-100 Nano-Computed Tomography, Skyscan 1072 Micro-Computed Tomography, XRD Siemens D5000, and XRD Shimadzu S6000

Spectroscopy: Secondary Neutral Mass Spectrometer (SNMS)

Image Visualization and Data Analysis

Telemicroscopy

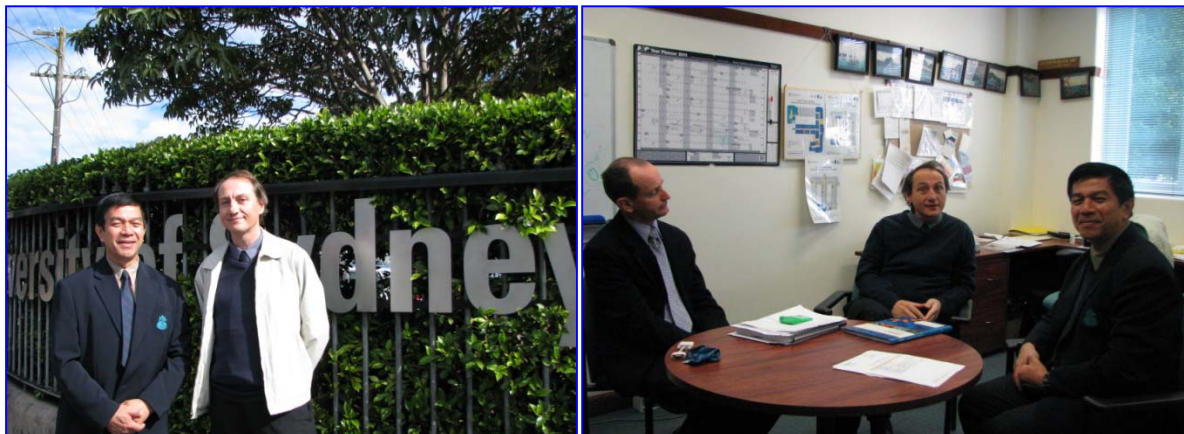


Figure 8. Visit to the Australian Microscopy & Microanalysis Research Facility (AMMRF), The University of Sydney. Professor Simon P. Ringer, AMMRF Executive Director & CEO, discussed possibilities to adapt AMMRF model for running scientific equipments centres elsewhere.



Figure 9. Ellie Kable, ACMM Laboratory Manager, guided the visitors to instruments at the ACMM.

Table 1 Instruments available at some university nodes in the AMMRF scheme

Hosts	Instruments	Number of instruments
ACMM, The University of Sydney	Atom Probes	2
	TEM	6
	STEM	1
	FIB, SEM	1
	SEM	2
	FESEM	1
	Confocal microscope	5
	Optical microscope	6
	XRD	2
	Micro-CT	3
	SPM	1
	NSOM	1
UMT	2	
EMU, The University of New South Wales	TEM	2
	SEM	5
	Microanalysis System	1
	FIB	1
	ESEM	1
	FIB, SEM	1
	EPMA	1
	AFM	1
	SPM	1
	Micro-CT	1
	UMT	2
CAM, The Australian National University	TEM	2
	SEM	6
	Micro-CT	1
	AFM	1

Conclusion

1. **An exemplar for a successful national research facility:** Australia as a well developed country thus values sharing research facility for the real benefits of the country. Each microscopy and microanalysis centres from the eight Australian universities incorporated into the AMMRF to provide centralized equipments to the entire research community. The AMMRF demonstrates that an idea to centralize instruments is possible. This project brings about higher research productivity and higher opportunity to get in-demand and cutting-edge instruments for public. Thus, instruments in AMMRF scheme will never be left unused for a long period of time since they are used by a large number of researchers from both the government and private sectors. The scheme also enhances transparency in running research facility since everyone has to follow a set of rules and regulations.
2. **Equipments centres are designed professionally:** It is evident that equipment centres have good electrical and gas outlets plans. Instruments in the same category are grouped in the same place. There are black-yellow stripes on floors to separate working areas from warning areas.
3. **All students have their rights to run instrument:** This is a good point of equipment centres in Australia. Students and staffs have equal right. They must go through training programs prior to gaining rights to the use of any equipment. Users are categorized into three levels of proficiency as the followings:
 - Level 1:** Users are still required to operate instruments under supervision during office hours
 - Level 2:** Users are allowed to operate instruments alone during office hours
 - Level 3:** Users gained enough proficiency and are allowed to operate instruments alone 24 hoursThrough the training courses, students gain understanding on principles behind the instrument they are working on. They know how to operate instruments themselves and become more skillful. Experiences and knowledge they accumulate while working will be useful for their future careers. This practice also reduces the time which technical officers or scientists need to spend on analyzing samples for everyone, but use the time more effectively in training new users. If all users operate instruments correctly, instrument will last longer and that helps the government safe money in the long run. Training courses can start from simple procedures, thus opening opportunity for people from other fields to experience modern technology of microscopy and create their required works. A number of artists came to use SEM for their art works.

4. **Safety is a priority:** Key cards are used when enter and exit laboratories. First aid kits and showers are provided in case of an accident. Smoke detectors are installed in equipment rooms. Fire extinguishers and an evacuation plan are prepared in case of fire. People working in laboratory need to dress appropriately to reduce risk of accidents. The requirement for goggles and lab coats is a good example.

5. **Online management system:** Staff and users can access an online system to book instruments, register training programs, and learn how to use equipments via virtual lessons. Technique finder on the AMMRF website can help researchers find the most appropriate methods for their work.

6. **Data backup:** Researchers can feel secure that all data and images are kept in a system for future uses.

7. **Brainstorm group meeting:** A group meeting of members at equipment centres is arranged on a regular basis to share problems, idea, and solutions for the development of an equipment centre.