

# **ELECTRON MICROSCOPE UNIT**

## **ANNUAL REPORT**

### **2014**

#### **Permanent Staff**

**Director**

**Principal Technical Officer**

**Principal Technical Officer**

**Principal Scientific Officer**

**Chief Scientific Officer**

**Principal Scientific Officer**

**Technical officer**

**Prof B.T. Sewell**

**M. Woodward**

**M.A. Jaffer**

**Dr. B.W. Weber**

**Dr. I Shuro**

**M.E. Waldron**

**S. Karriem**

## Events and Issues

### Dr Innocent Shuro employed.

After the resignation of Dr Cummings in January 2013, Dr Shuro was appointed and took office on 1 April 2014. Dr Shuro will be in charge of Materials Science electron microscopy and will liaise closely with the Centre for Materials Engineering.

### Mr Michael Woodward employed.

Mr Woodward was hired to replace Mr Duncan and began his appointment in January 2014

### Cryo Microscopy Course

Dr Wim Busing and Dr Mathijn Vos presented a 1 week course on cryo-microscopy in February 2014

### Nova NanoSEM installed in the EMU.

The FEI Nova NanoSEM 230 was moved to the new facility in April 2014. The move was executed by Mr David Johnson from EV Optics. Vacuum issues prevented the move from being completed on time and Mr Johnson had to make a second visit to complete the alignments.

### Diffractionmeter installed in the EMU

The macromolecular X-ray diffractometer was previously housed in the Biotechnology Department at UWC. It was granted to Professor Wolf-Dieter Schubert by the NRF in 2011 and was no longer being used at UWC, as Professor Schubert has been appointed to a position in Pretoria. The NRF approved the transfer of the instrument to UCT and the appointment of Professor Sewell as PI. The diffractometer was moved from UWC and installed in the EMU in September 2014. The installation was done by Mr Woodward and the machine was running successfully by the end of September.

### Microscopy for Biologists

The Microscopy for Biologists course was held in March and attended by 22 MCB honours students. At the request of MCB, the course is becoming increasingly hands-on with fewer lectures. This year, the students were more involved with the lab work and operated the TEM and SEM under supervision.

### Crystallography course

A Crystallography course conducted by the Structural Biology Research Unit was organized by Dr Jeremy Woodward in October 2014. 14 people attended the hands-on course which used the preparation labs, the diffractometer and the computer laboratory.

### Leica equipment installed in EMU

SMM moved the high pressure freezer, Vitrobot, and both microtomes into the EMU in December 2014

### MSSA2014

The EMU hired a booth at MSSA2014 which was held at the Protea Hotel, Stellenbosch. The objective of hiring the booth was to advertise the capabilities and goals of the new facility to the electron microscopy community. Lectures were delivered emphasizing the future goals of the EMU: A centre housing nine electron beam instruments with different, but possibly overlapping, capabilities. A new and important concept is that the clients will be able monitor the analysis and visualization of their samples from remote locations and even operate the instruments remotely. This will enable the Unit to serve a more geographically dispersed clientele and the effect will be similar to that achieved by synchrotrons in Europe and America in that the optimum solution is to use a shared facility rather than to spend money on “in house” equipment.

### Power Situation

The new facility has been designed to be able to continue to function in the event of a power cut. Most of the UPS/generator system is working satisfactorily but there are a number of key issues that are being addressed at present. The circulation pumps for the cooling water were not connected and this causes immediate failure of some of the equipment and gradual failure of other equipment. The building management system that is supposed to inform P&S of problems (including power cuts) is not connected to the UPS and simply ceases to function. An oversight in the planning was that the computers in the remote control room are not connected to the UPS. This means that any active remote control sessions will terminate in the event of a blackout.

### Magnetic field cancellation

Mr. Michael Woodward has installed a magnetic field cancellation system in the three TEM rooms. It is fully operational and effective.

### The appointment of an eResearch consultant

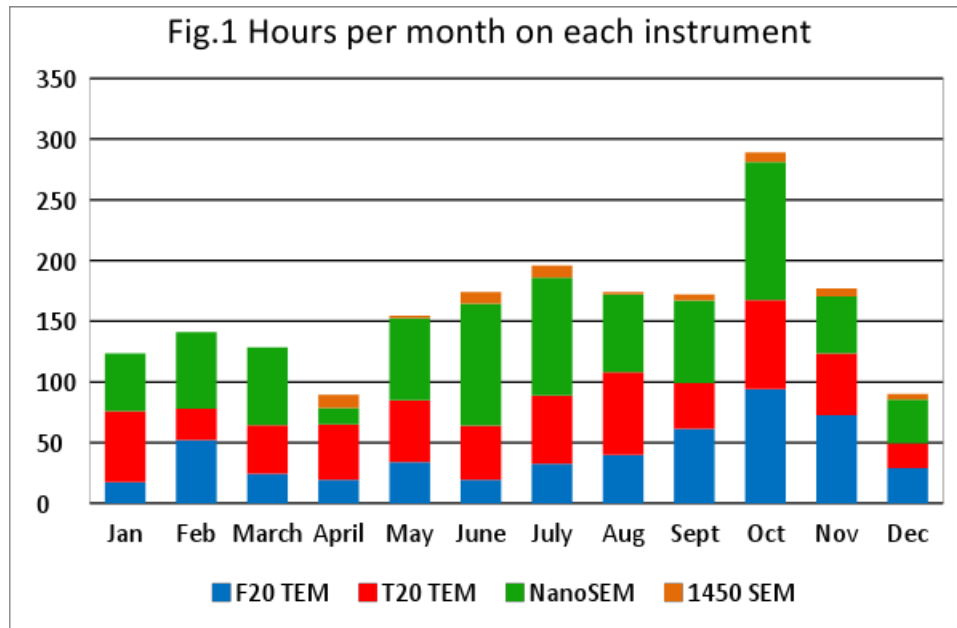
Dr. Jason van Rooyen has been appointed – initially for a period of two years – to put the computer systems for EM data management, processing and remote control in place. A further need that has been identified is the need for a computerized booking and user management system.

### Health and Safety

Mr. Sean Karriem has been appointed safety officer of the new facility. He has identified that the oxygen detectors that were “signed off” by Properties and Services have never been connected and that they have been installed at the incorrect height. A number of other safety procedures that were designed into the initial plans cannot be implemented in the building “as built” and Mr. Karriem is currently looking into alternatives.

## Instrument use in 2014

221 people made use of the microscopy services of the EMU in 2014, for a combined total of 1819 hours. Fig 1 shows the number of hours per month on each instrument.



### FEI Tecnai F20 FEGTEM

200kV field emission gun (FEG) high resolution TEM,  
Cryo facilities,  
Electron Tomography  
Gatan digital camera

The F20 operated reliably all year with no significant problems. This instrument was used for a total of 496.5 hours in 2014 by 66 people

### FEI Tecnai 20 TEM

200 kV LaB6 electron source  
Cryo Facilities  
Electron Tomography  
An Energy Filtered TEM (EFTEM)  
Gatan digital camera

The T20 operated reliably all year with no significant problems. This instrument was used for a total of 572 hours in 2014 by 76 people

### FEI Nova NanoSEM

Field Emission Gun (FEG) high resolution SEM,  
Backscatter detector,  
EDS detector

EBSD system  
STEM detector  
Low vac capabilities

The Nova NanoSEM was moved successfully into the EMU in April 2014. There were a few issues with software and vacuum which were sorted out by Mr. Woodward and Mr. Johnson (who supervised the move). The SEM was not available for use for 3 weeks in April. The new environment has resulted in better resolution (1.8nm) and an ongoing problem with the EBSD mapping software has been resolved now the SEM is on a stable platform.

In December, the EBSD detector end switch malfunctioned and the detector would not insert, the detector has been returned to Oxford for repair.

The Nova NanoSEM was used for a total of 781.5 hours in 2014 by 139 people. This excludes approximately 70 EBSD runs which vary in length from 2 to 18 hours.

#### Zeiss 1450 SEM

Tungsten electron source  
Backscatter detector  
EDS system

This instrument is operating as a tungsten filament SEM and has been mainly used by civil engineering students studying concrete.

The Zeiss1450 was used for a total of 58.5 hours in 2014 by 15 people.

## Users of the Unit

A total of 221 people used the Unit in 2014, from 61 different departments, institutes or companies. Table 1 shows the top 20 departments, institutes and companies who used the electron microscopes during 2014.

Table 1. Names of top 20 departments or companies:

		Hour s			Hours
1	Chemical Engineering	375.5	11	180 degrees engineering	43.5
2	Molecular and Cell Biology	160	12	Department of Environmental Affairs	38
3	Materials Engineering	129.5	13	Physics	34
4	Structural Biology	112	14	Chemistry	28
5	Polymer Science, University of Stellenbosch	97	15	Medical Virology	27.5
6	CPUT	85	16	Archaeology	25
7	Stellenbosch Nanofibre Company	76	17	Mechanical Engineering	19.5
8	WITS	72	18	UWC	19.5
9	Cardio Vascular Research	54	19	Civil Engineering	12.5
10	Ithemba Labs	44.5	20	Patterson & Cooke	12.5

## Publications by users of the Unit in 2014

Adriaenssens, E., Van Zyl, L., De Maayer, P., Rubagotti, E., Kirby, B., Tuffin, M. and Cowan, D. Metagenomic analysis of the viral community in Namib Desert hypoliths. *Lett Appl Microbiol* . 2014. doi: 10.1111/lam.12380.

Ayanda, O.S., Mthembu, N.L., Oputo, O.U., Akinsoji, O.S., Bissa, M-L.T.L. and Le Roux, S. Remediation of cadmium (II) from simulated seawater: Kinetics, equilibrium and thermodynamic studies. *Chem Sci Rev Lett*. 2014, 3(10), 183-193

Ayanda, OS, Fatoki, O.S., Adekola, F.A. and Ximba, B.J. Removal of tributyltin from shipyard process wastewater by fly ash, activated carbon and fly ash/activated carbon composite: adsorption model and kinetics. (wileyonlinelibrary.com) *J Chem Technol Biotechnol* 2014; 88: 2201–2208

Cawthra, H., Bateman, M., Carr, A., Compton, J. and Holmes, P. Understanding Late Quaternary change at the land–ocean interface: a synthesis of the evolution of the Wilderness coastline, South Africa. *Quaternary Science Reviews*, 2014, 99 210-223

Chowdhury, M. R., Fester, V. G., and Kale, G. M. Growth kinetics evaluation of hydrothermally synthesised  $\beta$ -FeOOH nanorods. *Journal of crystal growth*, 2014. 387, 57-65.

Galvao, B., Weber, B., Rafudeen, M., Ferreira, E., Patrick, S. and Abratt, V. Identification of a Collagen Type I Adhesin of *Bacteroides fragilis*. *PLoS One* , 2014, v9 (3) e91141

Khumalo, Z., Topic, M., Comrie, C., Blumenthal, M., Pineda-Vargas, C., Bucher, R and Kisslinger, K. Effect of annealing on phase sequence and their composition in the Pt-coated Mo system. *Nuclear Instruments & Methods in Physics Research Section B-Beam Interactions with Materials and Atoms*. 2014, 338 8-12

Mannl, U., van den Berg, C., Magunje, B., Harting, M., Britton, D., Jones, S., van Staden, E and Scriba, M. Nanoparticle composites for printed Electronics. *Nanotechnology*, 2014, 25(9) 094004.

Theka, T., Rodgers, A. and O'Ryan, C. Variability in kidney stone incidence between black and white South Africans: AGT pro11leu polymorphism is not a factor. *Journal of Endourology* .2014, v28 (5) 577-581

van den Berg, C., Topic, M., Magunje, B., Britton, D. and Harting, M. Structural and electrical characteristics of printed silver and palladium nanoparticle networks. *Journal of the Southern African Institute of Mining and Metallurgy*, 2014, 114 (2) 145-149

Woodward, J., and Wepf, R. Macromolecular 3D SEM reconstruction strategies: Signal to noise ratio and resolution. *Ultramicroscopy*, 2014, 201 43-49.

Zablocki, O., van Zy, L.I, Adriaenssens,E., Tuffin, M.,Cary, C and Cowan, D. Metagenomic characterization of distinct Antarctic soil viral communities. *Applied and Environmental Microbiology*. 2014. doi: 10.1128/AEM.01525-14.

Students graduating in 2014 who have used the EMU in the course of their studies:

Name	Degree	University	Department	Race	Gender
Ambele, M	PhD	UCT	Chemistry	B	M
Cawthra, H	PhD	UCT	Geology	W	F
Chonco, Z	PhD	UCT	Chem Eng	B	F
Chowdhury, M	D Tech	CPUT	Chem Eng	C	M
Dace, H	MSc	UCT	MCB	W	M
Finkelstein, L	MSc	UCT	CME	W	M
Jonah, E	PhD	UCT	Physics	B	M
Meyer, N	MSc	UCT	Chem Eng	W	F
Molokwane, T	MSc	UCT	CME	B	M
van der Meer, P	MSc	UCT	CME	W	M
Zhou, Y	MSc	UCT	Chem Eng	W	M

## Teaching and training in 2014

Training courses are individually designed according to the perceived needs of each trainee and trainees are not certified.

The following people were trained on the EMU's instruments in 2014:

Name	University/Institute	Department
<b>Nova NanoSEM</b>		
Cain, V	UCT	CME
Conradie, D	UCT	SAT
de Villiers, J	UCT	CVRU
Fawsey, M	UCT	Physics
Magidi, L	UCT	CME
Mandava, N	UCT	SASOL labs
Moffet, A	UCT	Archaeology
Mokoena, M	UCT	Chemistry
Senzani, S	WITS	CBTBR
Seumangle, N	UCT	CME
Shuro, I	UCT	EMU
<b>Zeiss 1450</b>		
Chivavava, J	UCT	Chemical Engineering
Hohlig, B	UCT	Civil Engineering
Shuro, I	UCT	EMU
Voornveldt, J	UCT	CVRU
<b>F20 TEM</b>		
Dollie, E	Red Cross Hospital	Dept of Histopathology
Hendricks, U	UCT	Chemical Engineering
Ilchev, A	US	Polymer Science
Moolman, B	US	Biochemistry
Nergaard, M	Norway University	Chemical Engineering
Shuro, I	UCT	EMU
<b>T20 TEM</b>		
Barnabas, A	Ithemba Labs	Materials Research Grp
Els, H	UCT	MCB
Galvao, B	UCT	MCB
Minnis-Ndimba, R	Ithemba Labs	Materials Research Grp
Shuro, I	UCT	EMU
Venter, R	UCT	MCB

### Educational visits:

Bishops: 5 Post Matric – Feb 2014

Chesterhouse College Gr11 – March 2014



First Year Science Students – June 2014

Science teachers information programme – November 2014

**EM Unit finances 2014**

Purpose of each account:

Operating: This is the annual operating budget received from the University

Services: This is income from users outside UCT (mainly from University of Stellenbosch, CPUT, UWC and industry). Expenditure from this account includes specific maintenance items for the microscopes such as new HT boards.

Consumables: Items such as chemicals and lab consumables are bought from this account and sold to users

Maintenance: This is internal income from UCT users. Expenditure from this account includes general microscope repair and maintenance such as liquid nitrogen and nitrogen gases.

EMU finances, 2014	Operating 000516	Services 001258	Consumables 000933	Maintenance 000995
Summary (- number indicates credit to the account)				
Opening Balance	-10 957.00	-891 250	-27 293	-333 495
Income	-33 953.00	-437 570	-59 244	-534 552
Expenditure	29 506.00	1 002 321	19 079	280 364
<b>Closing balance</b>	<b>-15 404.00</b>	<b>-326 499</b>	<b>-67 458</b>	<b>-587 683</b>
<b>Income</b>				
Operating Grant	33 953.00			
Internal recoveries				534 552
External recoveries		437 750		
Sales revenue			59 244	
<b>Total</b>	<b>33 953.00</b>	<b>437 750</b>	<b>59 244</b>	<b>534 552</b>
<b>Expenditure</b>				
Tel, Postage, Fax		22 551		2 843
PC Consumables	925.00	3 886		19 323
PC components		13 623		13 228
Transfer to investment account		300 000		
Printing		11 404		925
Stationery		889		
Travel		129 209		2 116
Conferences	23 500.00	20 008		
Contribution to Diffractometer		250 000		
Building repairs and maintenance		37 697		5 183
Utilities (Gases)				71 903
General Operating		21 610	17 717	94 627
Repair and Maintenance		43 557		28 030
Equipment		1 030		
Assets		26 722		42 150
Entertainment & Functions				36
Utilities rental	5 081.00	4 862	1 362	
Staffing costs and bursaries		114 855		
books		418		
<b>Total</b>	<b>29 506.00</b>	<b>1 002 321</b>	<b>19 079</b>	<b>280 364</b>
<b>Investment accounts</b>				
	Balance			
EMU investment account 1	1 378 897.00			
EMU investment account 2	46 630.00			

## Appendix 1

UCT projects carried out on the EMU instruments in 2014:

Student	PI	Project	Technique
<b>Archaeology</b>			
Moffet, A	Chirikure, S	“Phalaborwa where the hammer is heard” Metal production and regional political economy	SEM
<b>Cardiovascular Research</b>			
Conradie, D		Silanized stent posts	SEM
Du Toit, J	Bezuidenhout, D	Electro spun vascular grafts	SEM
Voornveldt, J	Bezuidenhout, D	Electro spun vascular grafts	SEM
<b>Chemical Engineering</b>			
Allie-Ebrahim, T and Soloman, U	Van Steen, E	Determining lateral interactions on platinum supported catalysts	TEM
Brighton, M	Harrison, S	Use of position emission particle tracking (PEPT) in the study of Bioreactors	TEM
Brosius, R		Pt (Pd) TiO <sub>2</sub>	SEM
Ceylon, C	Claeys, M	Sintering of Co/Al <sub>2</sub> O <sub>3</sub> Catalysts	TEM
De Beer, M	Van Steen, E	Deposition of Pt/Au/Co on SiO <sub>2</sub> for Fischer-Tropsch synthesis	TEM
Durgaprasad	Harrison, S	VP-BPV	SEM
Dlamini, B and Vidima, S	Rodriguez, M	In situ investigation of calcium carbonate scaling in a test cell	SEM
Dube, V	Lewis, A	Study of reaction kinetics for selective removal of NiS and CoS from a system of Co-Ni-Mn	SEM
Epstein, B and Mazvidza, E	Schwanitz, B	Comparison of ink preparation techniques for the polymer electrolyte fuel cell catalyst layer	TEM/SEM
Fortune, A	Conrad, O	Continuous Pt surface catalyst for PEFC	TEM
Furst, M	Fischer, N	Synthesis of iron catalysts	TEM
Gangen, T	van Steen, E	Preparation of Pt/Pd core shell catalyst	TEM/SEM
Hettel, B	Claeys, M	Co <sub>2</sub> Hydrogenation to substitute natural gas components	TEM
Hendricks, U	Lewis, A	Measurement and modelling of Pd salt precipitation with the objective of developing techniques to model crystallization kinetics in sparingly soluble systems	TEM
Hlabangana, N	Levecque, P	Influence of particle size and morphology of Pt <sub>3</sub> Co	TEM

Jackson, C	Conrad, O	Preparation of and characterization of PtRu/C catalysts for DMFC	TEM/SEM
Jacobs, C	Levecque, P	Continuous Pt surface catalyst for PEFC	TEM
Kunene, A	van Steen, E	Pt/Au as a promoter for supported cobalt catalysts	TEM/SEM
Khasu, M	Conrad, O	Synthesis of water gas shift reaction catalysts	SEM/TEM
Khoza, T	Blair, S	Evaluation of metal nitrides and borides as an alternative electrocatalyst support material for ORR	TEM/SEM
Kotze, H	Fischer, N & Claeys, M	Synthesis of Co <sub>3</sub> O <sub>4</sub> particles	TEM
Legrande, C	Hussain, N	Metal gas diffusion layers	SEM
Letaba, G		Catalytic properties of Pt-based bimetallic catalysts	TEM
Lubhelwana, S	Claeys, M	Controlled size synthesis of Co allotropes	TEM
Moyo, T	Petersen, F	A Comparative electrochemical and leach study of the dissolution of chalcopyrite in ammoniacal solutions	SEM
Nyathi, T	Claeys, M	Crytallite size-effects of Co <sub>3</sub> O <sub>4</sub> catalysts on the preferential oxidation of CO in H <sub>2</sub> -rich gases	TEM
Petersen, A	Van Steen, E	Cobalt support interaction	TEM
Schwanitz, B	Levecque, P	Confidential Nanofiber characterization	SEM
September, C	Levecque, P	Preparation and characterisation of electrocatalyst using electrospun nanofibers as novel support structures.	SEM
Sewsunker, C	Claeys, M	Synthesis of Rh and Fe model catalysts	SEM/TEM
Wiese, J		Effects of different grinding media on particle shape	SEM
Wolf, M	Claeys, M	Phase transformations in Fischer-Tropsch Co catalysts	TEM
Xalabile, P	Fletcher, J	Development of PdZn catalyst for reforming of methanol	SEM
<b>Chemistry</b>			
Combrink, J	Egan, T	Synthetic Hemozoin ( $\beta$ -Hematin) Crystals	TEM
Fakier, S	Rodgers, A	Investigation of IP6 ingestion on CaOx urolithiansis in different South African population groups	SEM

Mokoena, M	Rodgers, A	Investigation of the in vivo effects of antioxidant dietary agents on oxalate kidney stone disease	SEM
Viljoen, A	Bourne, S	Supramolecular Gels	TEM
<b>Civil Engineering</b>			
Hoehlig, B	Beushausen, H	Investigation into properties of bi-cement layers	SEM
Kiliswa, M	Alexander, M	The influence of sewer parameters on the deterioration of concrete sewer pipes	SEM
Nganga, G	Alexander, M	Material characterization of cements	SEM
<b>CME</b>			
Cain, V			SEM
Matthews, R	Knutsen, R	Primary water stress corrosion cracking studies of structural materials in pressurised water nuclear reactors	SEM
Mhleko, S	Sonderegger, B	Investigation of the damage evolution in creep exposed pressure pipes	SEM
Makhah, W	George, S	Techniques to monitor crack growth during fatigue testing	SEM
Netshithethe, T	George, S	Modification of Ti-6Al-4V for antimicrobial integration for orthopaedic devices	SEM
Sibanda, M	Sonderegger, B	Design of ferritic/Martensitic creep resistant steel	SEM
Shangase, P	George, S	A model to determine an impact of corrosion on concrete water mains	SEM
<b>Geological Science</b>			
Cawthra, H	Compton, J	The marine geology of Mossel Bay	SEM
Oosthuizen, M	Compton, J	Phosphate diagenesis	SEM
<b>Human Biology</b>			
Meketane, K		Properties of human hair	TEM/SEM
<b>Marine Science</b>			
Landschoff, J	Griffiths, C	Reproduction biology of brittle starfish	SEM
<b>Molecular and Cell Biology</b>			
K Cooper,	Farrant, J	Biochemical, genetic, physiological and cellular research in desiccation plants.	SEM/TEM
Galvao, B	Abratt, V	Identification of protein components of <i>Bacteroides fragilis</i> fimbriae	TEM
Huddy, S		Production of horseradish peroxidase in <i>Nicotiana benthamiana</i> .	TEM
Hattingh, A	Meyer, P	Creation of plant expressed bluetongue virus	TEM
Van Zyl, A		HPV vaccine development	TEM

<b>Mechanical Engineering</b>			
Airey, K-A	Kuppuswamy, R	Resharpener of PCD/PCBN tool/insert supplied by Ford SA with a development of force controlled grinding technology.	SEM
Floweday, G		Corrosion failure investigation of a synthetic wax drum	SEM
Lepodise, K	Kuppuswamy, R	Micro-machine design and development for stent processing	SEM
Makah, W	Kuppuswamy, R	Techniques to monitor crack growth during fatigue testing	SEM
Mandavha, U	Woolard, C	Effect of fuel composition on the amount of deposits formed in a flow reactor	SEM
Raphefo, K	Kuppuswamy, R	Value addition of aerolap-polishing	SEM
Swartz, J	Kuppuswamy, R	Minimum quantity lubrication	SEM
Sibomro, S	Kuppuswamy, R	High speed pocket machining in Ti <sub>6</sub> Al <sub>4</sub> V	SEM
Volschenk, G	Langdon, G	The response of Al and Glass fiber FML's to blast loading	SEM
Waite, J	Kuppuswamy, R	Predicting wear on PCD inserts	SEM
<b>Medical Biochemistry</b>			
Hendricks, N	Blackburn, J	Hand held biosensor for detecting pathogens via surface enhanced RAMAN scattering	SEM/TEM
<b>Medical Virology</b>			
Offerman, K	Douglass, N	Characterization of novel avipoxviruses	TEM
Williamson A-L		Generation of a recombinant lumpy skin disease virus expressing rift valley fever virus immunogenic genes	TEM
<b>Oceanography</b>			
Du Plessis, G		Capsivector project	SEM
Truter, P		Chemical composition of lead weights	SEM
<b>Physics</b>			
Fawsey, M	Blumenthal, M	The photocatalytic production of hydrogen gas	SEM/TEM
Ojdanic, M	Blumenthal, M	Hydrogen production using solar energy	SEM
Unugibe, D	Britton, D, Harting, M	TEM of titanium dioxide nanoparticles produced by flame spray pyrolysis	SEM/TEM
<b>Structural Biology</b>			

Broadley, S	Sewell, T	Purification and co-crystallisation of Plasmodium falciparum HGXPRT with a chalcone inhibitor	TEM
Kianja, J	Sewell, T	The thermostability of the nitrile hydratase from Geobacillus pallidus.	TEM
Mulelu, A	Sewell, T	Factors involved in the oligomerization of the cyanide dihydratase from <i>Bacillus Pumulus</i> .	TEM