

Faculty of Science

Discovering for tomorrow



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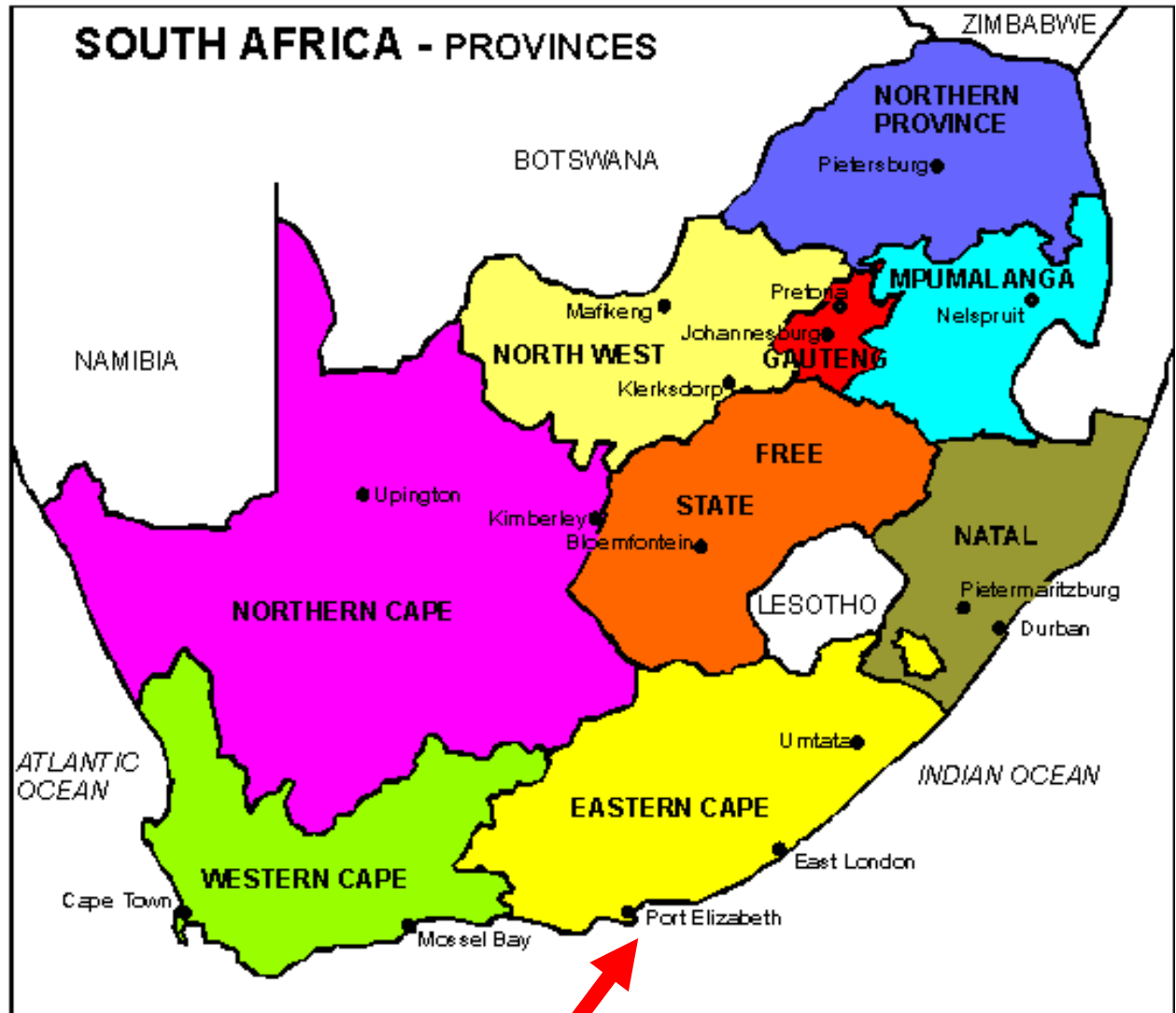
for tomorrow

CENTRE FOR HIGH RESOLUTION TRANSMISSION ELECTRON MICROSCOPY



Prof. Mike Lee - CHRTEM Manager
Prof. Jan Neethling - CHRTEM Director

South Africa - Port Elizabeth



NMMU and CHRTEM



NMMU South Campus



CHRTEM



Proclaimed Nature reserve

Launch of HRTEM Centre, 11 Oct 2011: Switching on of HRTEM by Minister Blade Nzimande



The Centre (CHRTEM)

- The focal point of CHRTEM is the atomic resolution double Cs (aberration) corrected transmission electron microscope - JEOL ARM 200F
- The director of the Centre, Prof Jan Neethling, who is an internationally recognized EM expert and is well known within the European EM fraternity
- The creation of the centre was made possible by the vision and funding from the DST and NRF with support from the NMMU VC, Prof Derrick Swartz as well as the DHET and other partners.
- The centre (CHRTEM) is housed in a custom built building which satisfies all the environmental operating conditions to achieve maximum performance of the ARM 200F

The Investment

- The total investment for the CHRTEM is approximately R 130+ million (€ 12.5 million)
- Building R 30 million (NMMU and DHET)
- Microscopes R 90 million (DST and NRF)
- Auxiliary equipment R 10+ million (NRF and THRIP)

FUNDING PARTNERS



Board at the entrance
foyer in the CHRTEM
building

The Building

- Design was based on a ten year business plan
- Two sections
 - Section A consisting of four microscope laboratories
 - Section B -administration, offices, training centre and sample preparation
 - Accommodation for 10 staff, 4 visiting scientists and 24 postgraduate (postdoc) students



Building Design Parameters

- Two year planning and design process 2008-2009
- Design influenced by a number of EM site designs and site visits in Europe
- Tender and building process commenced in January 2010 (site handover June 2010), instrument installation April 2011, building completion in July 2011
- Official opening in October 2011
- Environmental parameters (based on ARM) for microscope labs:
 - Vibrations
 - Magnetic fields
 - Temperature and humidity control
 - Air flow

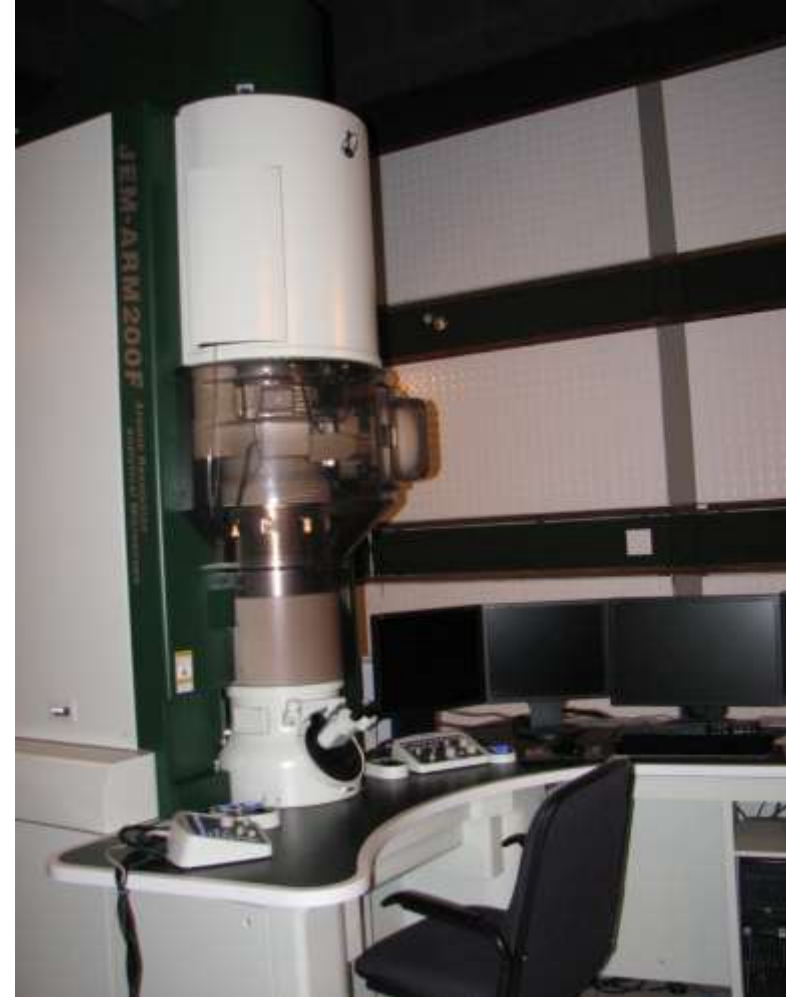
The Microscopes

- Instrument selection using a very stringent evaluation process - score sheet and a national selection panel (NRF)
 - JEOL ARM 200F Transmission Electron Microscope (TEM)
 - JEOL JEM 2100 TEM
 - FEI Helios NanoLab 650 Dual Beam FIBSEM
 - Other Instruments
 - JEOL 7001F FEGSEM
 - CSM Nano-indenter/AFM
 - PHILIPS CM20 TEM



JEOL JEM-ARM200F

- Double Cs aberration corrected TEM with Schottky source
- STEM resolution 0.08nm
- TEM point resolution 0.11nm and lattice resolution 0.10nm
- Auxiliary
 - Oxford Xmax80 EDS
 - Gatan Quantum GIF - EFTEM, EELS and spectrum imaging
 - Orius SC1000 CCD camera



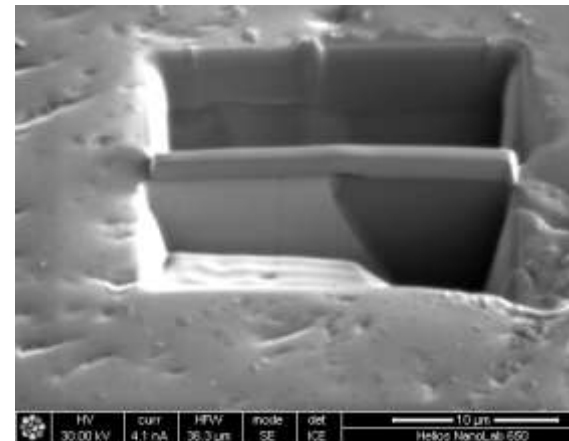
JEOL JEM-2100

- LaB_6 source
- TEM Point resolution 0.23nm
- TEM Image resolution 0.14nm
- STEM and Diffraction
- Auxiliary
 - Oxford Xmax80 EDS
 - Gatan Quantum GIF - EFTEM, EELS and spectrum imaging
 - Orius SC1000 CCD camera



FEI HELIOS NanoLab 650 - Dual beam FIB

- Electron imaging resolution 0.8nm
- Ion beam imaging resolution 4.5nm
- Omniprobe sample manipulators
- Gas Injection system
- Plasma cleaner



JEOL JSM-7001F

- Field emission (FEG) source
- SEM Image Resolution 1.2nm
- Oxford EDS SDD Xmax20 system
- Oxford WDS four crystal system
- Oxford HKL EBSD - high resolution camera



SAMPLE PREPARATION

- **Five laboratories**
 - Polishing laboratory
 - Chemical Laboratory
 - Ion Milling Laboratory
 - Plasma Cleaning
 - Microscope Lab: Nano-indenter/AFM, CM20



Sample Preparation - milling and coating

- Five Gatan 691 PIPS
 - LV gentle mill plus camera
 - Low temperature
- Iridium/gold coater
- Carbon coater
- JEOL Cross section polisher
- Light Microscopes with digital camera



Sample Preparation - Cutting and polishing

- Precision grinding and polishing machines (x 6)
- Dedicated polishing machines for grit sizes 30 down to 0.05 micron
- Wire sectioning saws
- Diamond disc cutter
- Diamond wire blade saw



CHRTEM STAFF

Prof Jan Neethling	Director: Centre for HRTEM
Prof Mike Lee	Centre Manager/Training Coordinator
Mr William Goosen	SEM Operator
Dr Tina Heiligers	Project Coordinator/FIBSEM Operator
Ms Marisa Kolver	Administrator
Ms Tanya Liebenberg	Laboratory Assistant/Sample Preparation
Mr Jacques O'Connell	Scientist/ Engineer
Dr Jaco Olivier	Scientist/TEM Operator
*Dr Nabom Hashe	Operator- Physics Department

STUDENTS AND RESEARCH PROJECTS

Student	Degree	Dissertation	Status
Justin Downey	PhD	Degradation of Graphite with Silicon Implantation and Palladium Deposits	In Progress 2013
Arno Janse van Vuuren	PhD	Radiation Damage in ZrN Irradiated with Swift Heavy Ions of Fission Fragment Energies	In Progress 2014
Colani Masina	PhD	Structural analysis of synthetic ferrihydrite and the mechanism of Phase Transformation under reduction environment to α -Fe	In Progress 2014
Ettienne Minnaar	MSc	Microstructural and Analytical Characterization of Plasma Dissociated Zircon (PDZ)	In Progress 2012
Jacques O'Connell	PhD	The role of Ru in Ag migration through SiC in TRISO fuel	In Progress 2013
Dr Jaco Olivier	PhD	The role of palladium in the migration of silver in silicon carbide	Complete 2011

NMMU Collaboration

- **DST Nanophotonics chair (Prof J R Botha) - OMVPE and optical sensors**
 - Nanophosphors
 - Semiconductor quantum wells and dots
 - Infrared detector devices
 - One MSc, 6 PhD students and a post doc student
- **Earth Sciences - training and minerals research**
- **Biochemistry, zoology, botany and chemistry - training and research**

RSA Collaboration

- **SASOL Technology**
 - Catalysts
- **NECSA**
 - Nuclear materials
- **Element Six**
 - Diamond materials
- **Pebble Bed Modular reactor Project (PBMR) - now housed at NECSA**
- **Materials Engineering - University of Cape Town**
- **DST Centre of Excellence in strong materials - University of Witwatersrand**
- **DST/Mintek Nano-technology Innovation Centre**
- **University of the Free State - Geology**

International Collaboration

- Oxford University - UK
- CIME - EPFL Switzerland
- RWTH Aachen University - Germany
- Max Planck Institute, Stuttgart - Germany
- Joint Institute for Nuclear Research, Dubna - Russia
- Idaho National Laboratory - USA
- European Commission Joint Research Centre, Karlsruhe Germany

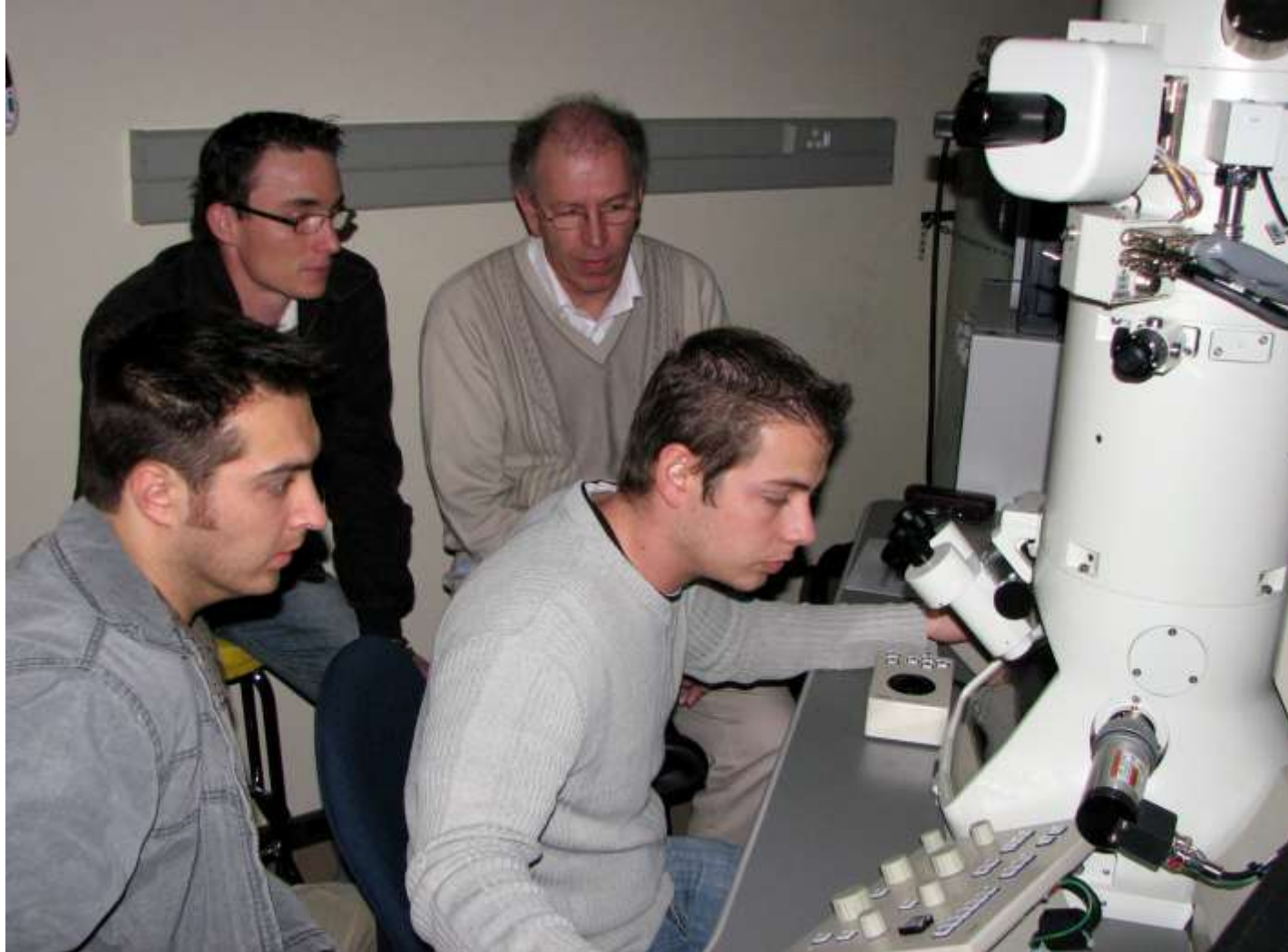
CHRTEM and South Africa

- All HRTEM Centre staff are occupied full time with supervising/managing and operation of instruments
- All CHRTEM postgraduate students attached to the centre are directly using EM as a primary tool and are either staff, EM operators and/or trainers with 3-5 years of day-to-day "hands-on" experience
- All CHRTEM postgraduate students have a high level of theory and practical skills - crystallography, X-ray diffraction, EM and defect solid state physics
- This level of theory and experience is not necessarily true for all EM operators in South Africa

NEED FOR COLLABORATION

- Staff/postgraduate shortage does not allow for extended and effective formal training programs for students from other South African institutions
- Require a critical mass of postdoctoral students and visiting professors/lecturers/ researchers - need for collaboration
- Intermediate and advanced training courses are required. Need to determine the entry level and prerequisites (experience and theory) for candidates
- Training programs with emphasis on “hands-on” approach (3:1)
- Special areas of interest are EELS and tomography

Training - Space restrictions



Conclusion

THANK YOU FOR YOUR ATTENTION