X-RAY AND NEUTRON RADIOGRAHPHY / TOMOGRAPHY
@ Necsa: A SUCCESS STORY

Dr Frikkie de Beer
CHIEF SCIENTIST: Rad/Tom
Success is no accident. It is hard work, perseverance, learning, studying, sacrifice, and MOST of all, love of what you are doing.

-Pele
Allan McLeod Cormack

- South African-born American physicist who, with Godfrey Hounsfield, was awarded the 1979 Nobel Prize for Physiology or Medicine.
- For helping to invent CAT scan X-ray technology.
Me
31 years

Kobus Hoffman
9 years

Lunga Bam
11 years

Robert Nshimirimana
10 years
SUCCESS IN THE ESTABLISHMENT OF:

► A Neutron CT & X-CT capability
NEUTRON CT FACILITY @ Necsa

OPERATIONAL FROM 1975 – 2013 (Thermal N)
- 1975: Film
- 1996: Digital
- 2003: Tomography

SAFARI-1 reactor wall
Shielding
Beam stop / door
Fig. 12(c): A neutron tomogram of the critical component of a helicopter engine lubricator.

Fig. 12(d): A cutted into neutron tomogram of a of a helicopter engine lubricator revealing the blockage.
Operational 2021
- Fast neutrons
- Thermal Neutrons
- Gamma-rays
- Dynamic imaging
- FOV: 350 x 350 mm²

NDIFF: Operational  
NRAD: Upgrade Phase
SUCCESS IN THE ESTABLISHMENT OF:

► A Neutron CT & X-CT capability
► A Micro-focus XCT capability (1 / 4 for Academia)
µXCT FACILITY @ Necsa

COMMISSIONED IN July 2011
SUCCESS IN THE ESTABLISHMENT OF:

► A Neutron CT & X-CT capability
► A Micro-focus XCT capability (1 / 4 for Academia)
► A Sustainable USER program
Discuss Proposals

Submit Proposals Online
radtomnecsa@gmail.com

Evaluation of Proposals

Beam time allocation

OUTPUT

Upgrade to Hons, MSc, PhD
Peer reviewed Paper
Conference

Scanning @ Necsa
Beam time Analytical time
2019 Calendar

Period 1

Period 2

Period 3

215 days beam time available per annum
**POST GRAD STUDENTS & RESEARCHERS**

- Beam time Rates (Subject to change):
  - **Normal:**

<table>
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<tr>
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<th>Once off Registration Fee per Project</th>
<th>Cost per day</th>
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<tr>
<td>Researchers &amp; Post Graduate Students</td>
<td>R1000</td>
<td>R500</td>
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- Beam time on special request is available on Saturday’s and Sunday’s:

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  ► A Sustainable USER program

■ SUCCESS OF HUMAN CAPITAL DEVELOPMENT
  ► Necsa Employees (Instrument Scientists)
CAPACITY BUILDING:
• 3 x MSc
• 1 x PhD (2 currently unrolled & Submitted)

RECOGNITION: NATIONAL
• 1 x DSI-NRF C3 rated researcher:
• 2 x Associated Researchers @ HEI
• 1 x Lecturer for Honors & MSc
• 1 x Host of National Conference (IMGRAD)

RECOGNITION: INTERNATIONAL
• 1 x Board Member of Scientific Society (President)
• Reviewing Beam line proposals / Peer reviewed Journals
• 1 x Host of International Conference
• IAEA : TC; CRP; Specialist; Host of Scientific mission.
SUCCESS IN THE ESTABLISHMENT OF:

► A Neutron CT & X-CT capability
► A Micro-focus XCT capability (1 / 4 for Academia)
► A Sustainable USER program

SUCCESS OF HUMAN CAPITAL DEVELOPMENT

► Necsa Employees (Instrument Scientists)
► Number of scientific visitors to Necsa’s CT Labs (Local & Intl)

2017: 438
2018: 389
2019: 412
SUCCESS IN THE ESTABLISHMENT OF:
► A Neutron CT & X-CT capability
► A Micro-focus XCT capability (1 / 4 for Academia)
► A Sustainable USER program

SUCCESS OF HUMAN CAPITAL DEVELOPMENT
► Necsa Employees (Instrument Scientists)
► Number of scientific visitors to Necsa’s CT Labs (Local & Intl)
► Number of Proposals submitted

2017: 38
2018: 42
2019: 39
■ SUCCESS IN THE ESTABLISHMENT OF:
  ► A Neutron CT & X-CT capability
  ► A Micro-focus XCT capability (1 / 4 for Academia)
  ► A Sustainable USER program

■ SUCCESS OF HUMAN CAPITAL DEVELOPMENT
  ► Necsa Employees (Instrument Scientists)
  ► Number of scientific visitors to Necsa’s CT Labs (Local & Intl)
  ► Number of Proposals submitted
  ► Number of Peer reviewed papers (Aware of)
  ► Number of higher educational degrees (Aware of)
SUCCESS IN THE ESTABLISHMENT OF:
- A Neutron CT & X-CT capability
- A Micro-focus XCT capability (1 / 4 for Academia)
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SUCCESS OF HUMAN CAPITAL DEVELOPMENT
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- Number of Peer reviewed papers (Aware of)
- Number of higher educational degrees (Aware of)

SUCCESS IN # OF SCIENTIFIC FIELDS SERVED
- Number of scientific fields
SCIENTIFIC FIELDS

SCIENTIFIC AREAS

- Palaeontology, 22%
- System, 12%
- Engineering, 16%
- Geological, 9%
- Petro-Physics, 2%
- Archaeology, 8%
- Metallurgy, 3%
- NDT, 1%
- Nuclear, 1%
- Hydrogen, 1%
- Zoology, 6%
- Dentistry, 1%
- Anatomy, 8%
FUEL CELLS

- Management of Water in an electrolyzer.

Channel Size: 2 mm x 2 mm

Hydrogen outlet

Cross over
Water: Black

Hydrogen: White

Water supply IN

Experiments @ NIST, USA

www.necsa.co.za
SCIENTIFIC FIELDS

SECTOR
- BIOSCIENCES

FIELD
- HUMANITY
- ZOOLOGY

SUB-FIELD
- ANATOMY
- DENTISTRY
- ANIMALS
- PLANTS

OUTPUT
- Peer reviewed papers: 7
- Honours: 4
- MSc: 2
- PhD: 2
- MSc: 1
- Peer reviewed papers: 2
- Chapter book: 2
- PhD: 1
The use of digital imaging is the way of the future for teaching and research at Higher Education Institutions.
(2019 – 2021)
This project is the first of its kind to amalgamate a large digital archive of microfocus scanning (Micro-
XCT), Lodox Statscan, and CBCT scans from known deceased South African and comparative specimens and to make them internationally accessible.

The use of digital imaging is the way of the future for teaching and research at Higher Education Institutions.
HERITAGE STUDIES

ARCHAEOLOGY

4 PhD

PALAEOSCIENCES

41 Peer reviewed papers

1 MSc

0 PhD

1 MSc

0 Honours

1 Chapter book

4 PhD
Fossils: Neutrons vs. X-RAYS

Fossilized bone: Hydroxyapatite $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$
CT INVESTIGATIONS

Palaeosciences
Fossil materials in dense Breccia matrix

Materials in:
- Nuclear Sector
- Energy Sector
- Aircraft Industry
- Motor Industry
- Civil Eng
- Geosciences
- Archaeology
- Palaeosciences
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<tr>
<th>SECTOR</th>
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<td>MATERIAL SCIENCE</td>
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<td>CIVIL</td>
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<td>METALLURGICAL</td>
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<td>NUCLEAR</td>
<td>6 Honours</td>
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<td></td>
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<td>1 MSc</td>
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<td></td>
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<td>2 Peer reviewed paper</td>
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<td>5 Honours</td>
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OPTIMISE PROCESSES

PBMR Fuel Sphere
6 cm diameter
Carbon matrix
20000 Triso particles
TRISO PARTICLES (1mm diameter) QUANTIFICATION

Sample:
1mm diameter TRISO fuel kernel

Parameters:
Cr - target
X-ray: 40kV ; 30mA
Time = 12 min

Equipment:
Micro-focus X-ray system & A-Si detector
University Ghent; Belgium

35 micron: Low dens. C

35 micron: SiC

135 micron: 35 micron high dens & 100 micron low dens
EVOLUTION OF X-RAY TOMO
State owned Company

In terms of Section 13 of the Nuclear Energy Act, No. 46 of 1999, Necsa is mandated to:

- Undertake and promote research and development (R & D) in the field of nuclear energy and radiation sciences and technology and, subject to the Safeguards Agreement, to make these generally available.
- Process source material, …. and nuclear material; and
- Co-operate with any person or institution in matters falling within these functions, subject to the approval of the Minister.
Questions?