Materials Science and Manufacturing

Executive Director:
Dr Liesbeth Botha

CSIR/US Dept of State & Joint Services
S&T Workshop

7 September 2011

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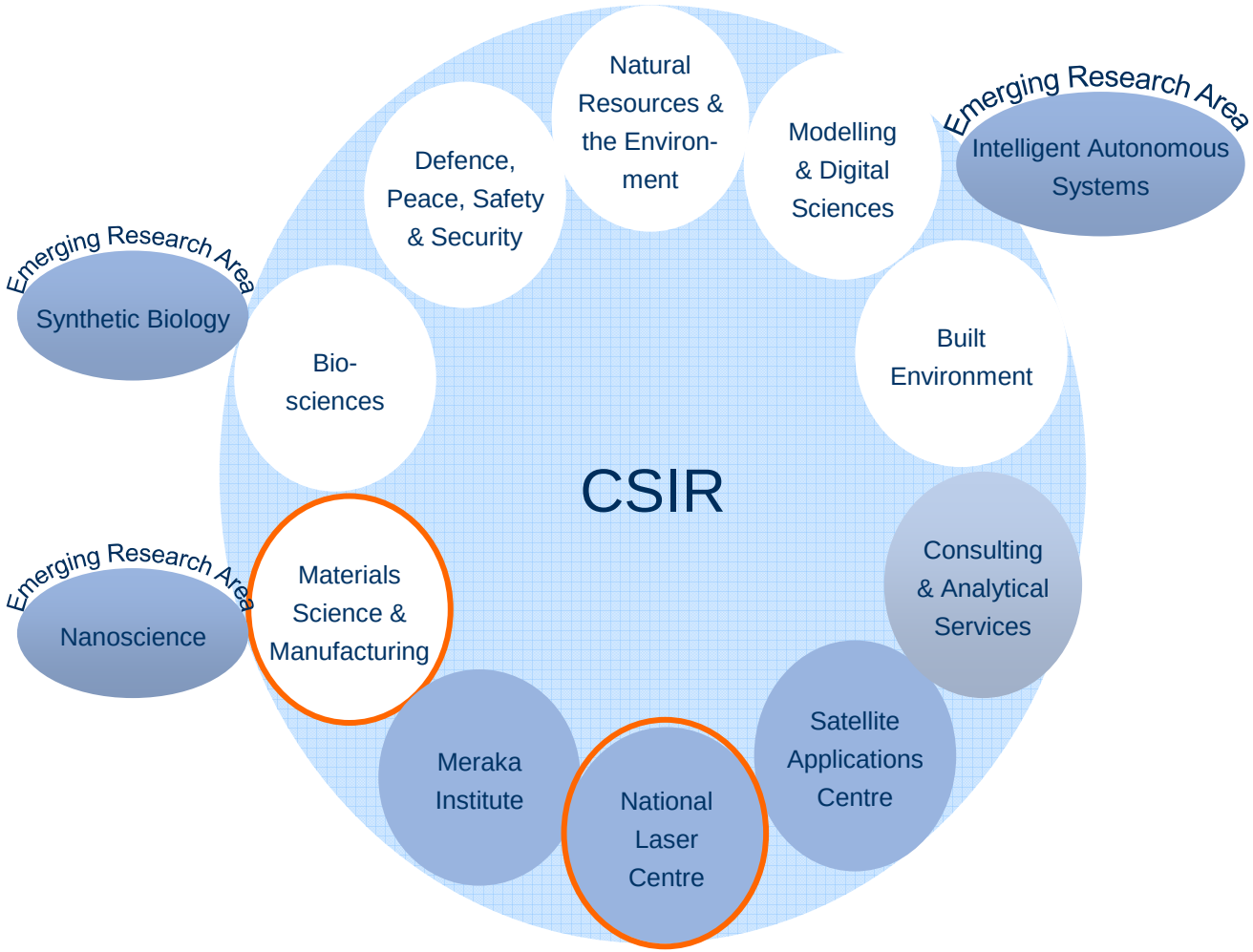
MSM position within CSIR



Materials Science & Manufacturing

Metals & Metals Processes	Polymers & Composites	Mechatronics & Micro Manufacturing	Energy & Processes	Sensor Science & Technology	Industry Support Centre (Fibres & Textiles)	National Centre For Nano-Structured Materials (NCNSM)
Primary Processes	Biomaterials	Mechatronics	Clean Coal Technologies	Smart Structures & Materials	Industry support	Advanced Engineering Materials
Powder Metallurgy Technologies	Industrial Polymers	Micro-manufacturing	Renewable Energy Technologies	Electro-optic Sensing & Imaging		Low Dimensional Systems
Advanced Casting Technologies	Nonwovens & Composites			Ultrasonics		Materials Characterisation
Engineering Design & Analysis						

Emerging Technology Areas

Nano platinum particles | Smart UAV technology | New materials for the BE | Microfluidics | Fibre metal laminates

Strategic Sector Initiatives for Growth and Impact

Aerospace | Automotive | Health | Energy | Buildings | Micro-manufacturing

Overview of Materials Research in South Africa

Dr Willie du Preez
Manager: Metals and Metals Processes
Materials Science and Manufacturing

7 September 2011

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Outline of presentation

- Introduction
- Drivers of Materials Research Since 1996
- Research Themes and Focus

Introduction

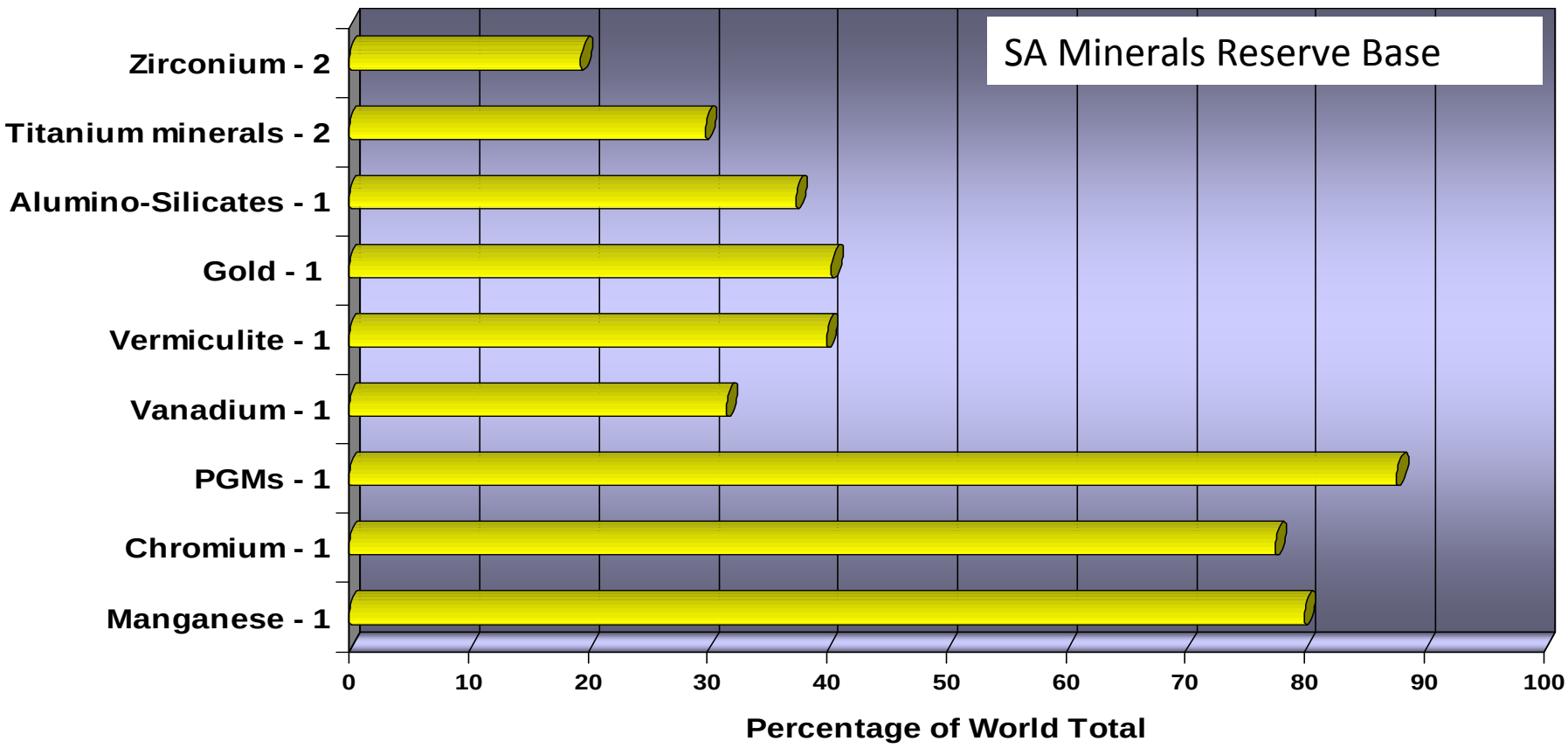
- Only a selection of materials research in South Africa
- Manufacturing related materials research
- Research aligned with national priorities
- Included in our Materials Science sessions:
- Batteries
- Polymers
- Nanocomposites and nano-metal matrix composites
- Piezoelectric materials
- Light metals
- Laser processing of materials

Drivers of Materials Research Since 1996

- 1996 White Paper on Science and Technology (S&T)
- 1999 Manufacturing/Materials & Mining and Metallurgy Foresight Studies
- 2002 National R&D Strategy by the DST

  Relevant S&T Missions:
  - Advanced manufacturing
  - Astronomy
  - Resource-based industries
- 2002 Integrated Manufacturing Strategy by the **dti**
- 2002/3 Development and approval of the Advanced Manufacturing Technology Strategy (AMTS)
- 2004 – Establishment of implementation initiatives

Drivers of Materials Research (continued)



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Drivers of Materials Research (continued)

- 2005: The Advanced Metals Initiative was established and championed by DST through its Resource-Based Industries mission

- 4 Pillars of the AMI:
  - Light Metals Development Network (LMDN)
    - Aluminium, Titanium, Magnesium: Led by CSIR
  - Precious Metals Development Network (PMDN)
    - Platinum Group Metals & Gold: Led by Mintek
  - New Metals Development Network (NMDN)
    - Zirconium, Hafnium, Niobium, Tantalum: Led by Necsa
  - Ferrous & Base Metals Development Network (F&BMDN)
    - Steels, Base Metals: Led by Mintek

Drivers of Materials Research (continued)

- 2007: DST publishes South Africa's 10 Year Innovation Plan
- Grand Challenges:

  (A mechanism to create focus and develop a research agenda with specific national outcomes)

  1. Farmer to Pharma value chain to strengthen the bio-economy;
  2. Space science & technology;
  3. Energy security;
  4. Global-change science (climate change); and
  5. Human and social dynamics
- Centres of Competence
  - To close gaps along the technology development value chain
  - To provide support for technology and systems integration
  - To develop production capabilities
  - To develop productive human capacity
  - To facilitate the commercialisation of R&D outcomes

Drivers of Materials Research (continued)

- 2007: The **dti** publishes the National Industrial Policy Framework (NIPF) and Industrial Policy Action Plan (IPAP)
- 2010: Updated Industrial Policy Action Plan (IPAP2)
  - Advanced Manufacturing
    - Advanced Materials: Titanium, Nano-materials, Natural fibre composites, high performance composites
    - Plastics for the plastic conversion industry

- 2005: Aerospace Industry Strategy (the **dti**)
- 2010: Aerospace Sector Development Plan (the **dti** and DST)
  - Subsector: Advanced Materials and Manufacturing
    - Lightweight materials: metals and composites

Drivers of Materials Research (continued)

- Energy crisis in South Africa – need for renewed focus on energy research, especially renewables
  - Battery technology research
  - Fuel cell R&D

- 2006: CSIR establishes a Nanotechnology ERA
- 2007: CSIR and DST establishes the National Centre for Nano-Structured Materials (NCNSM)

Research Themes and Focus

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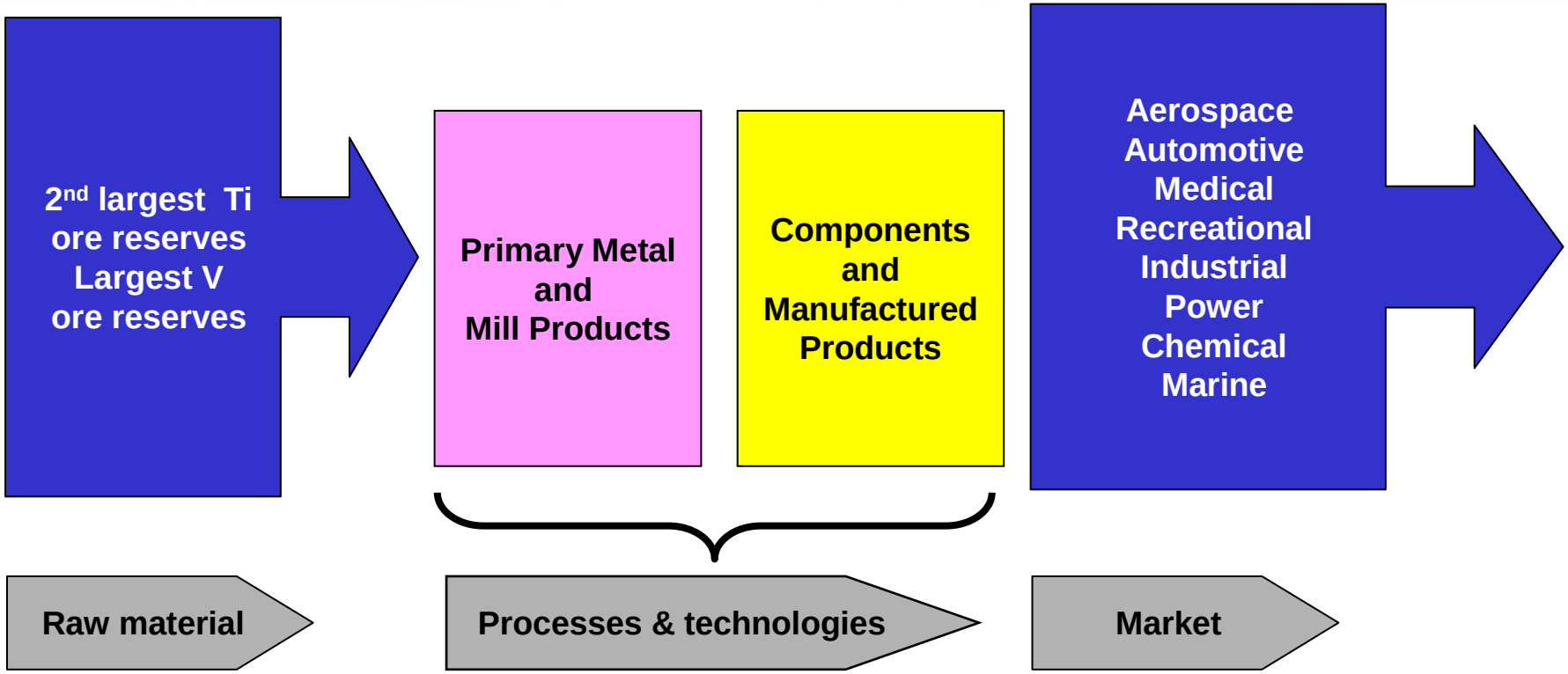
South African Industrial Opportunity with Titanium



The Titanium Centre of Competence integrates and coordinates R&D and commercialisation across the value chain

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Titanium Centre of Competence Collaborators

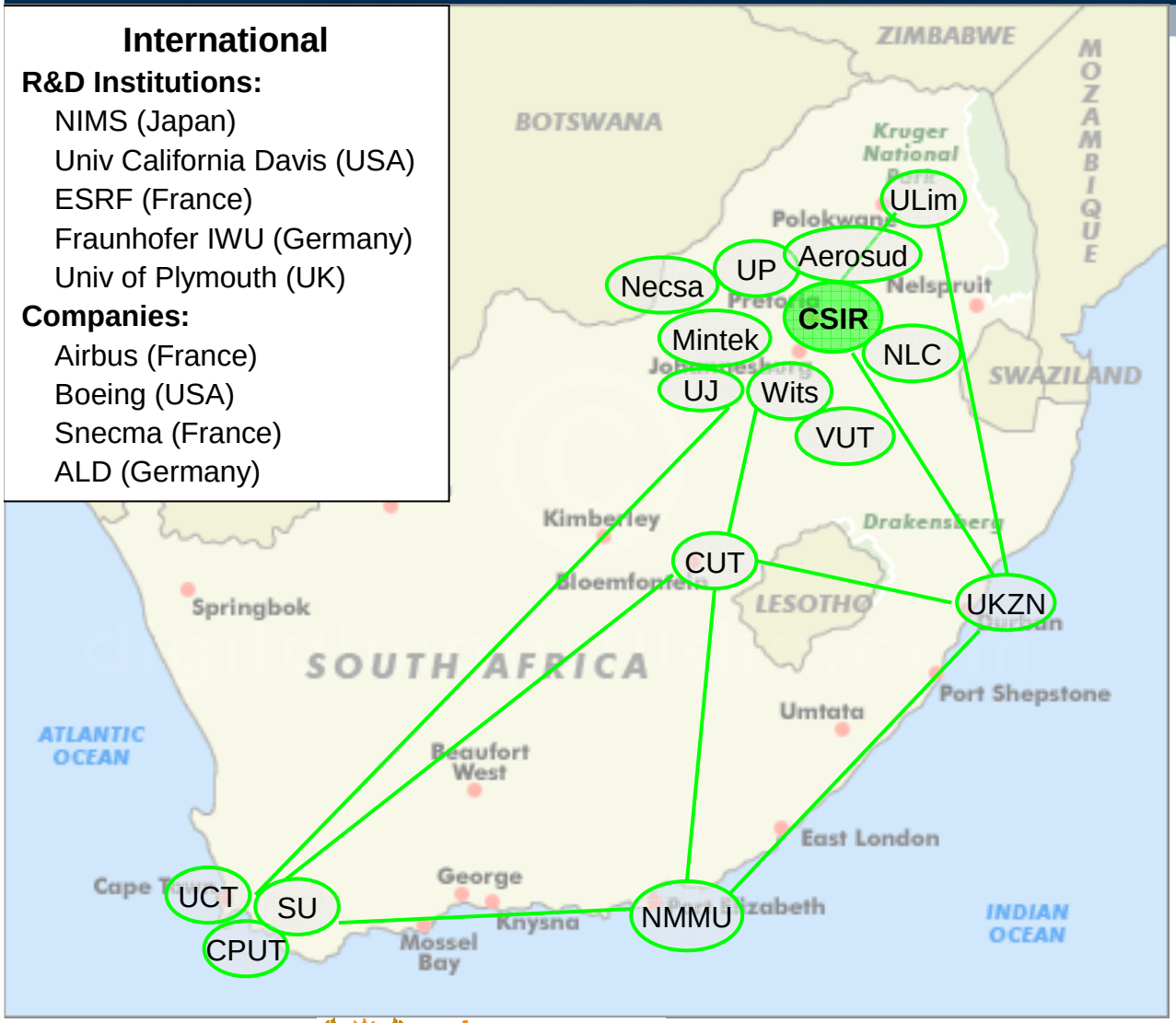
International

R&D Institutions:

- NIMS (Japan)
- Univ California Davis (USA)
- ESRF (France)
- Fraunhofer IWU (Germany)
- Univ of Plymouth (UK)

Companies:

- Airbus (France)
- Boeing (USA)
- Snecma (France)
- ALD (Germany)



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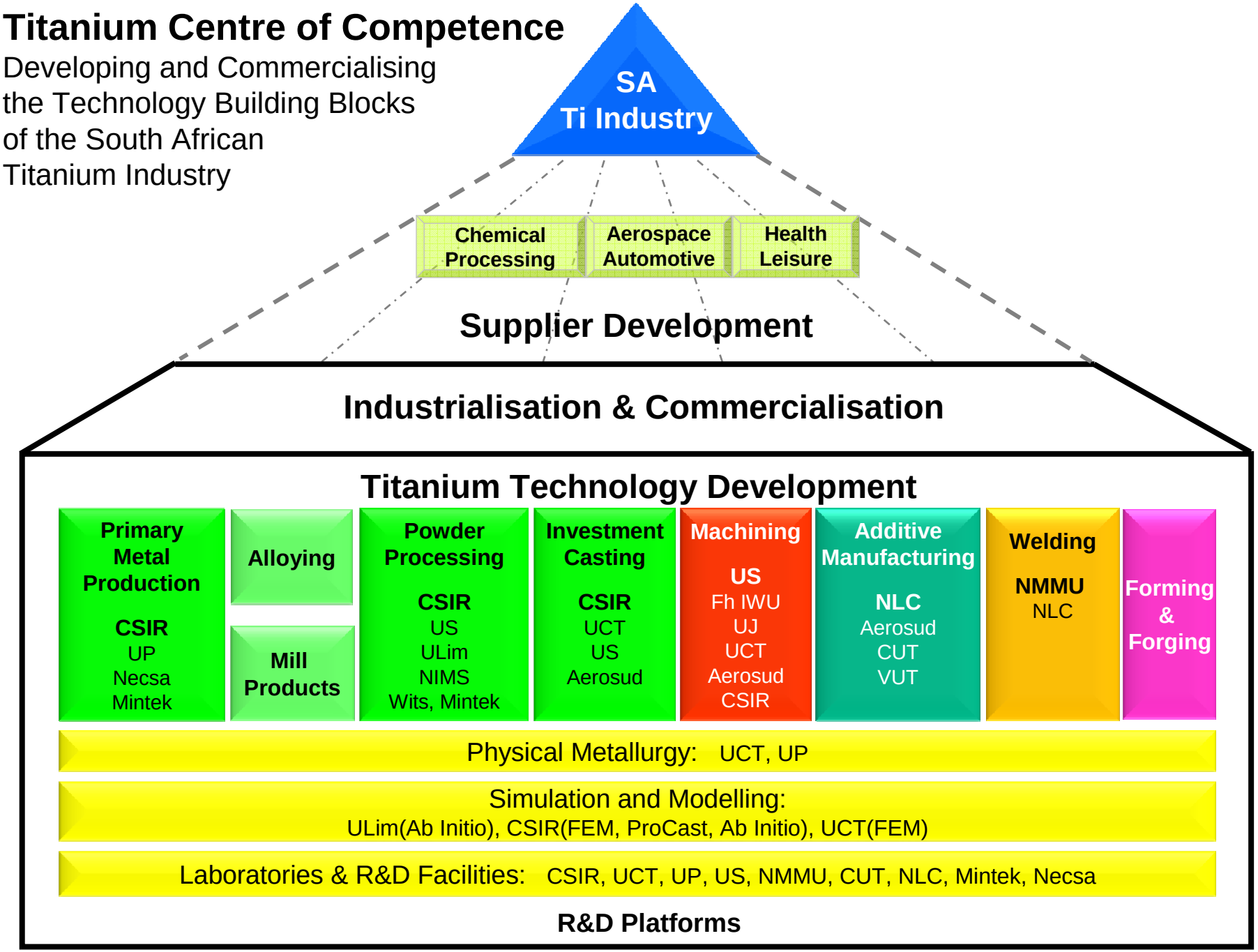
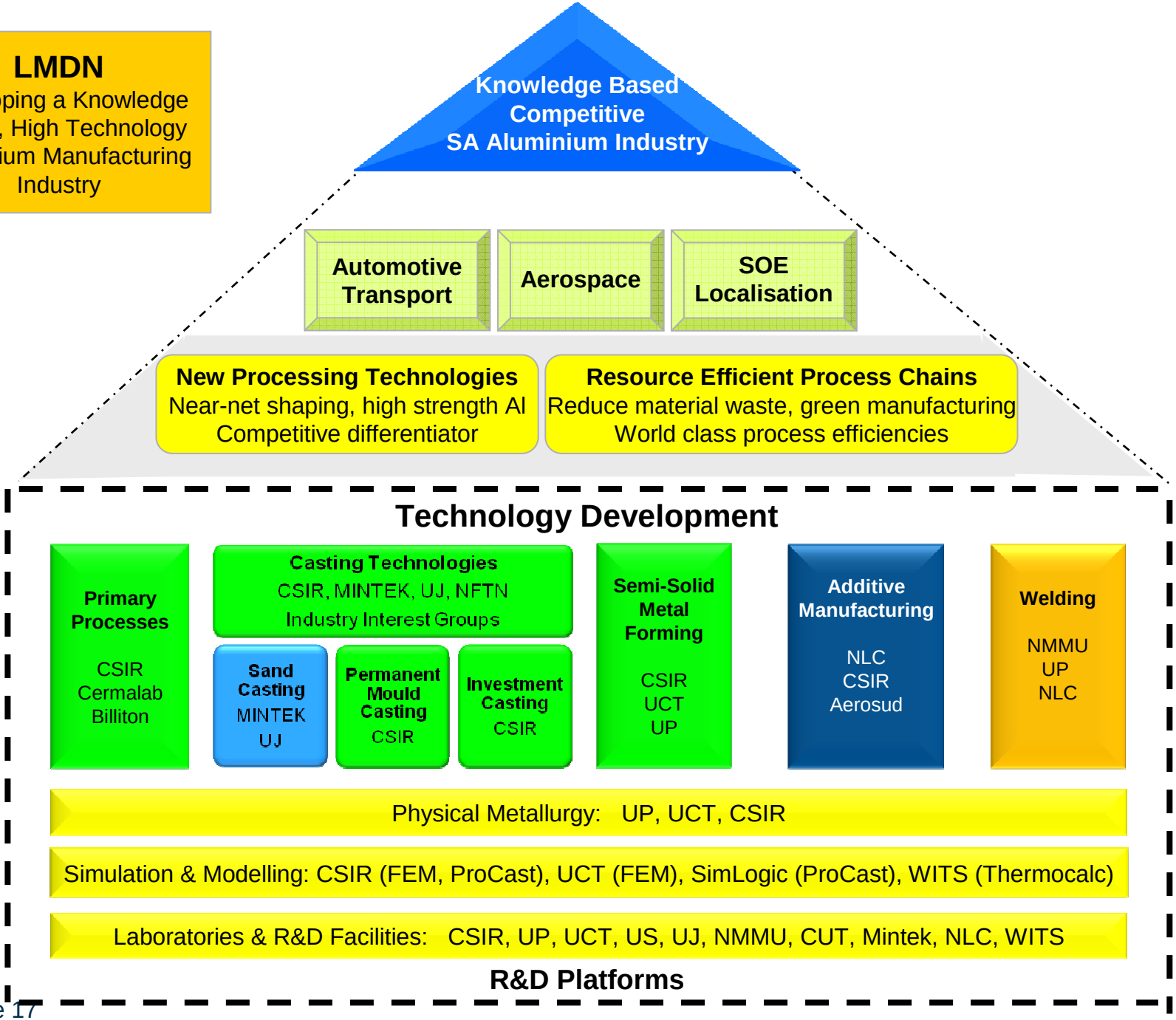
Titanium Centre of Competence

Developing and Commercialising the Technology Building Blocks of the South African Titanium Industry



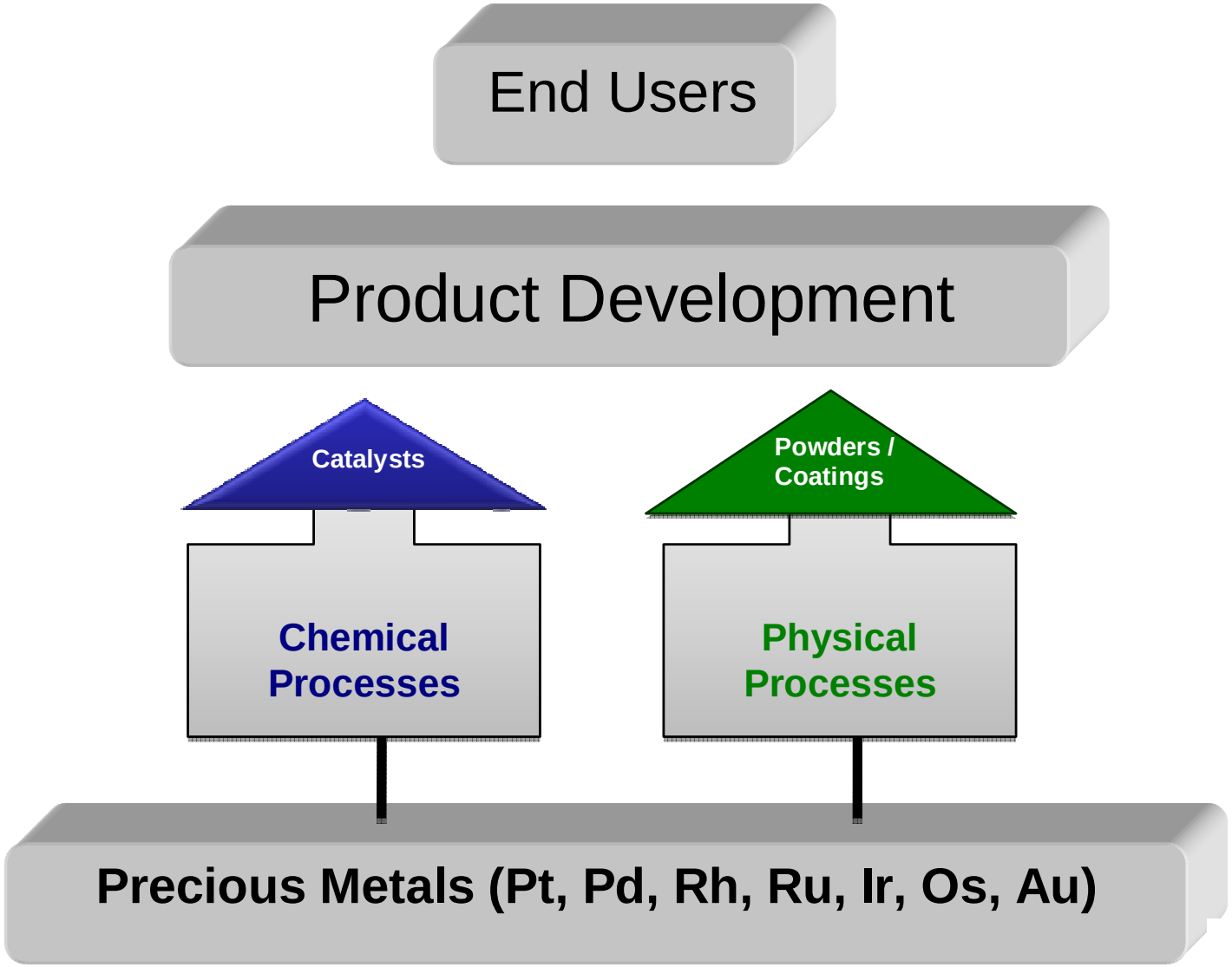
LMDN
Developing a Knowledge Based, High Technology Aluminium Manufacturing Industry



Precious Metals Development Network Objective

The objective of the PMDN is to help South Africa to retain some of the precious metals value matrix by identifying, research, develop and promote new technology and applications that will expand the local technical capacity, impact positively on human resource development, and create the potential to establish local benefication industries.

MINTEK
Specialists in mineral and metallurgical technology



MINTEK
Specialists in mineral and metallurgical technology

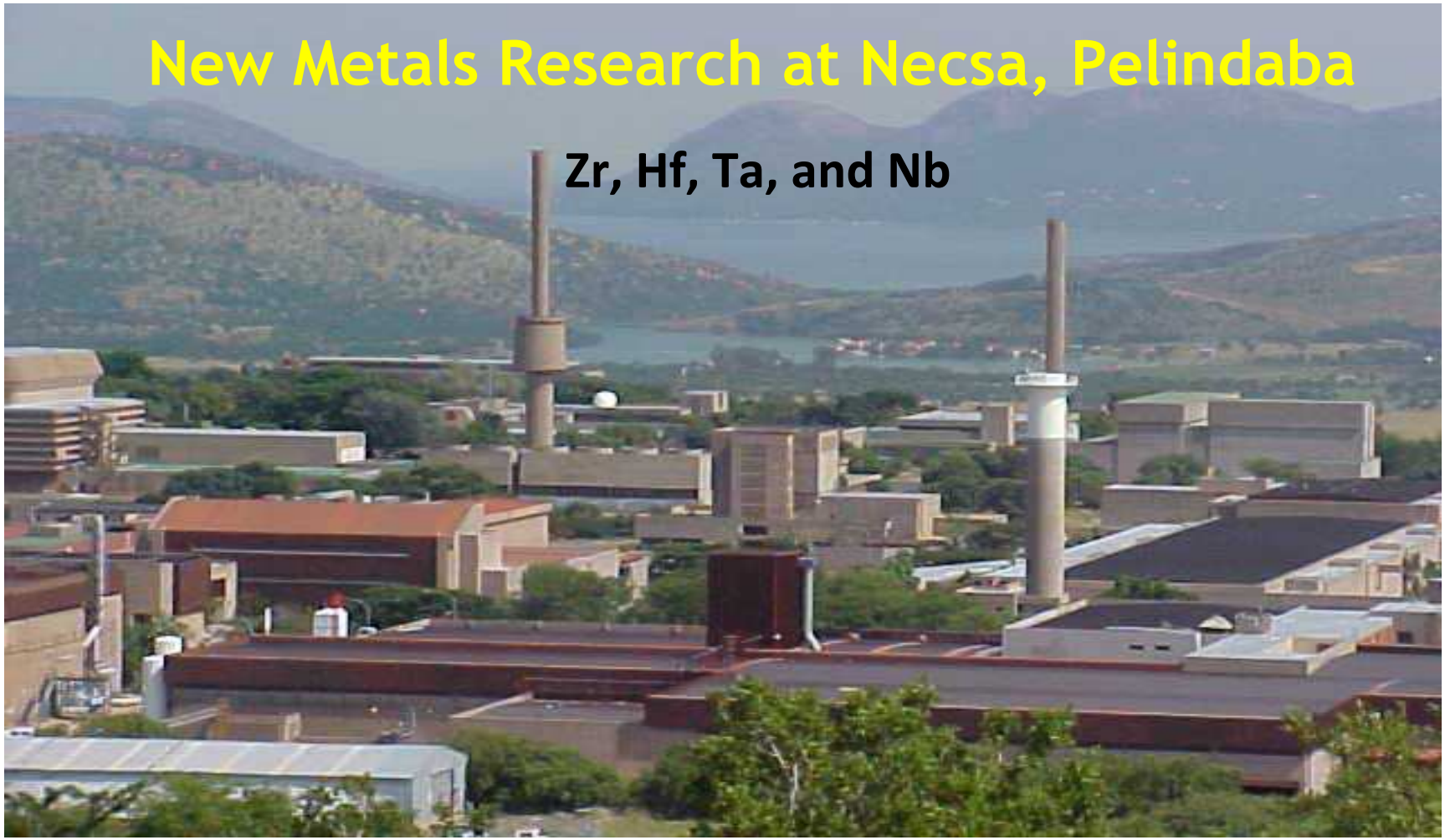
Catalysis & Powder / Coatings

- Precious Metals' Catalysts R&D for Chemical Processing Reactions
- Scale Up of Precious Metals Catalysts
- Powder Metallurgy – Gas Atomising of Precious Metals
- High Temperature Oxidation Resistant Coatings

MINTEK
Specialists in mineral and metallurgical technology

New Metals Research at Necsa, Pelindaba

Zr, Hf, Ta, and Nb



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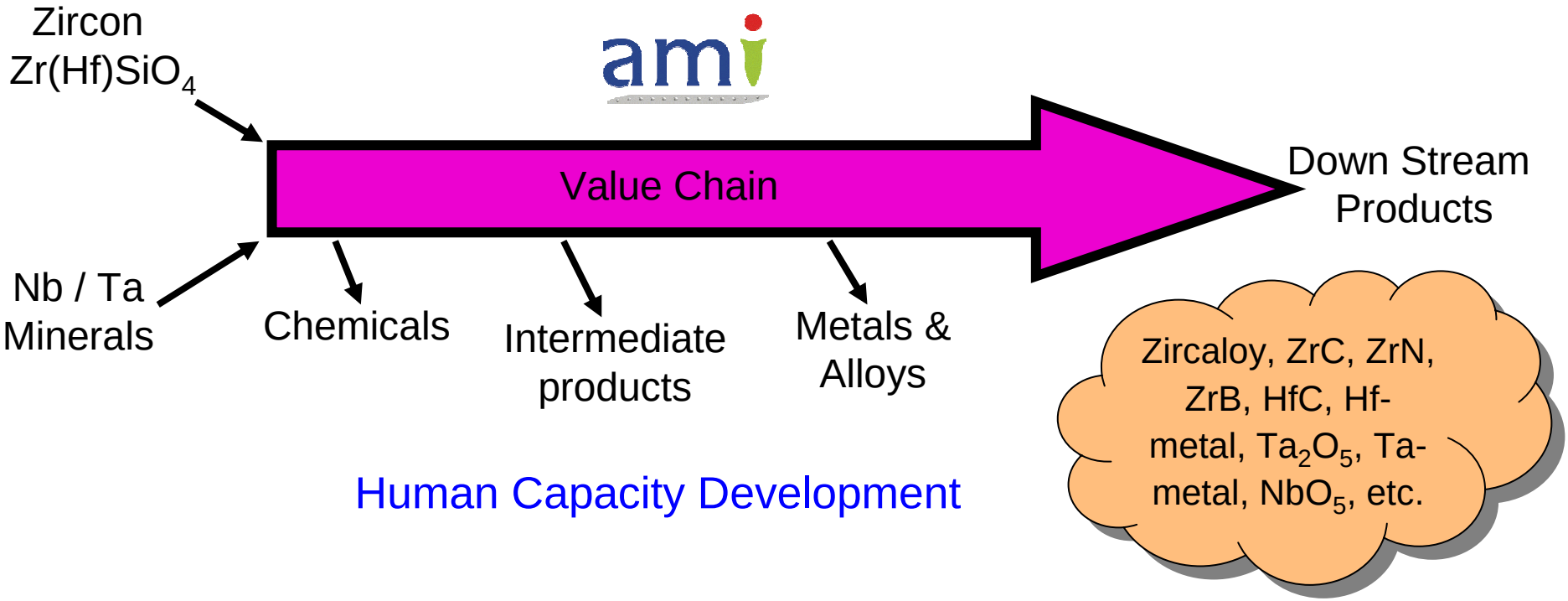
The New Metals Development Network
Main Objective

To beneficiate the minerals of Zr, Hf, Ta and Nb across the whole value chain:



Human Capacity Development

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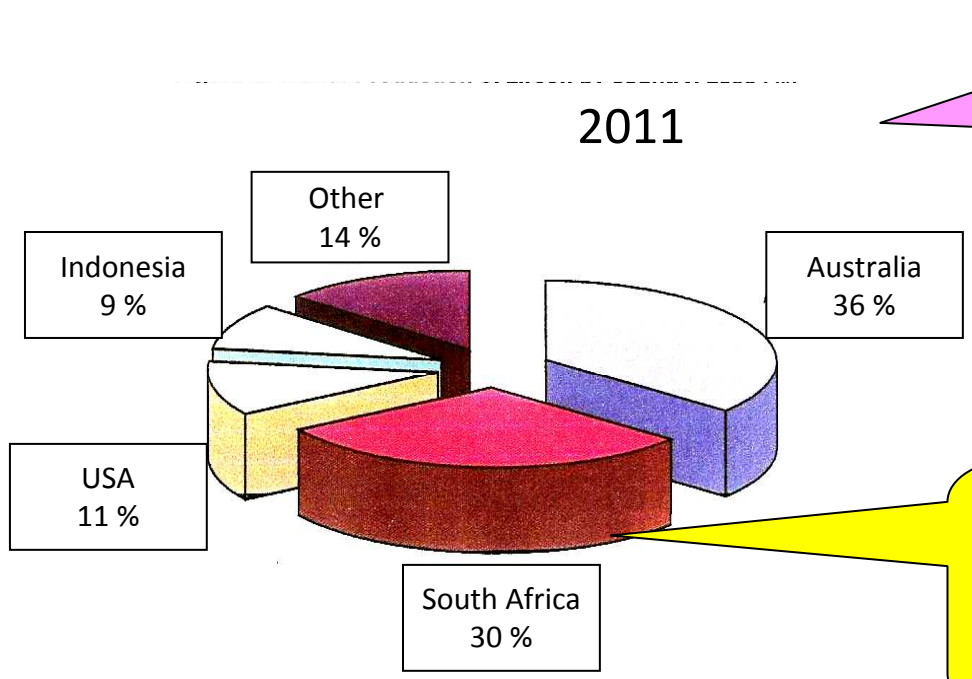
World Production of Zircon



World production: *ca.* 1 100 000 tonnes per annum

South Africa is the second largest producer in the world

Less than 5 % beneficiated locally

Source: Roskill 2011

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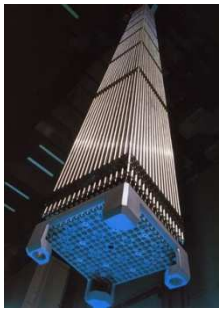
The value adding chain



Nuclear fuel assembly

Zircon sand

Carbo-chlorination

Zircon
800 USD/t

Purification

$ZrCl_4$ impure
4000 USD/t

Reduction

Nuclear-grade $ZrCl_4$

Alloying

Nuclear-grade Zr metal sponge

60 – 80 000 USD/t

Manufacturing

Zircaloy 2 and 4
200 000 USD/t

Semis:
tubes, bars, sheets

Nuclear fuel assemblies
> 500 000 USD/t

27 tonnes Zircaloy per nuclear reactor

USD 5,4 million per reactor

Nuclear fuel assembly
27 tonnes final Zircaloy components

USD 13,5 million per reactor

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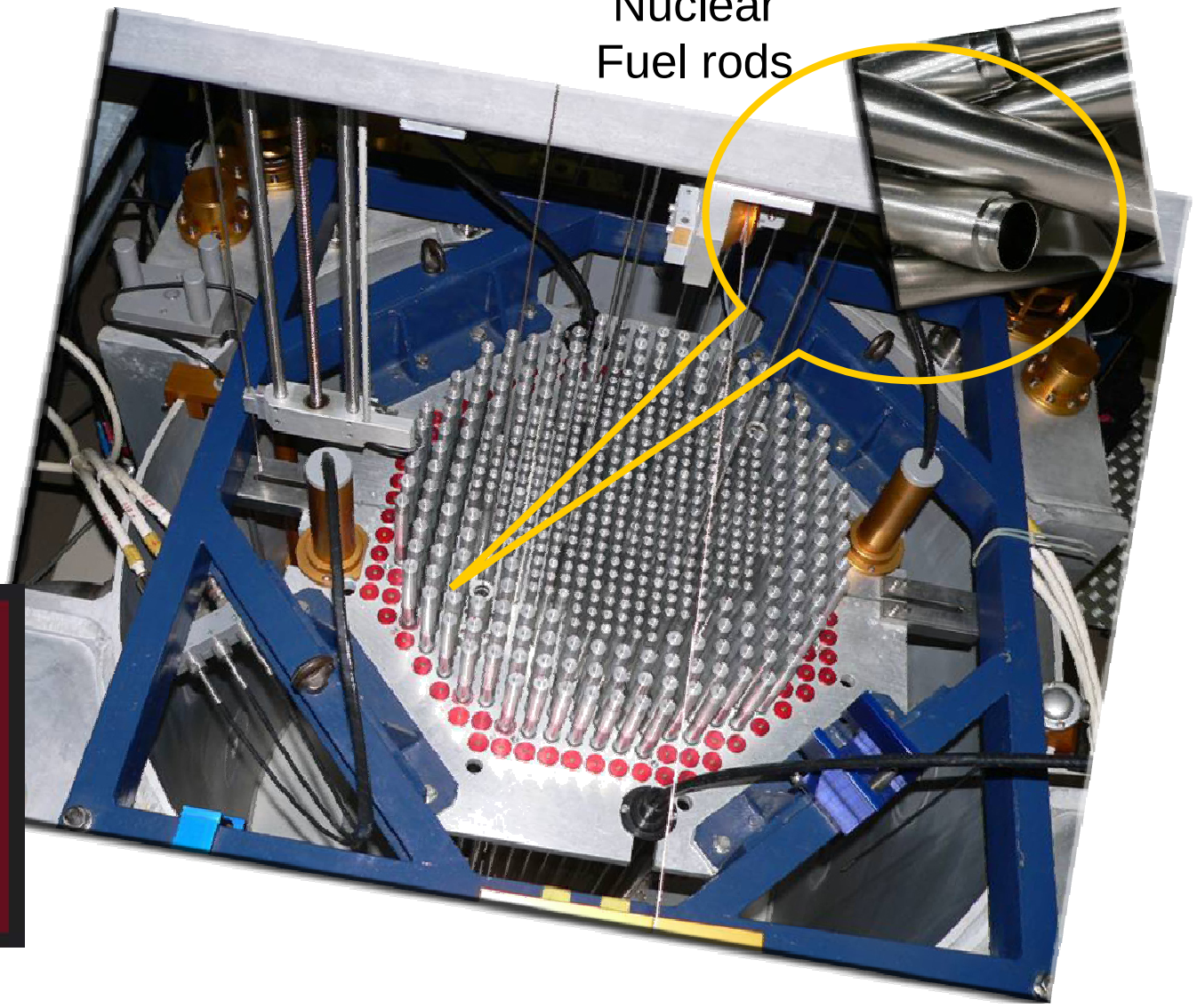
Zircaloy as cladding material for nuclear fuel rods



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A typical 2400 MW PWR reactor uses 2 400 km of fuel cladding tubing and 22 km of thimble tubing in its initial fuel loading, equivalent to approximately 27 t of Zircaloy-4, thereafter, replenished with an average of 10 t per year.

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Ceramic Applications of New Metals in Aerospace

- ZrB_2 - Refractory ceramic for hypersonic flight or rocket propulsion systems (very high temperature resistant)
- ZrN - Refractory ceramic for high wear resistance on turbo blades
- Yttria-stabilised zirconia – Thermal barrier coatings on gas and jet turbine engines
- Coatings on turbo blades – High wear resistance
- Hafnium Carbide – Structural material in high temperature aerospace applications

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Biocomposites

BioAERO

- **Product Focus:** Interior panels for commercial aircraft
- **Present Investments:** NATFIBIO – 2009 - 2011
- **Typical Products:**

Overhead luggage bin

Aircraft window panels

- Natural fibre reinforced phenolic panels successfully screened at Airbus
- Mechanical characteristics under variable environmental conditions being determined
- 1 patent
- 1 technology demonstrator completed, 1 in progress

Conclusions

- Materials research in South Africa has been directed quite strongly over the past two decades to align with national priorities
- There is a growing expectation from funders is that researchers should be able to indicate the impact of their research towards strengthening and growing the South African economy
- CSIR, in collaboration with the DST, plays an important role in leading major national R&D initiatives

Thank You

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