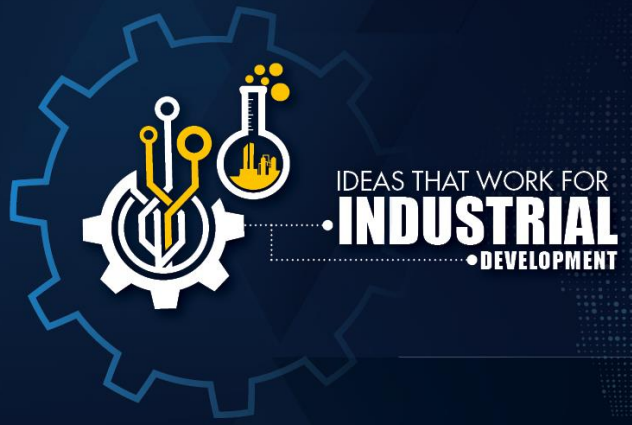


The contribution of High Performance Computing and Modelling for Industrial Development

Dr Happy Sithole and Dr Onno Ubbink

CSIR
our future through science

Strategic context

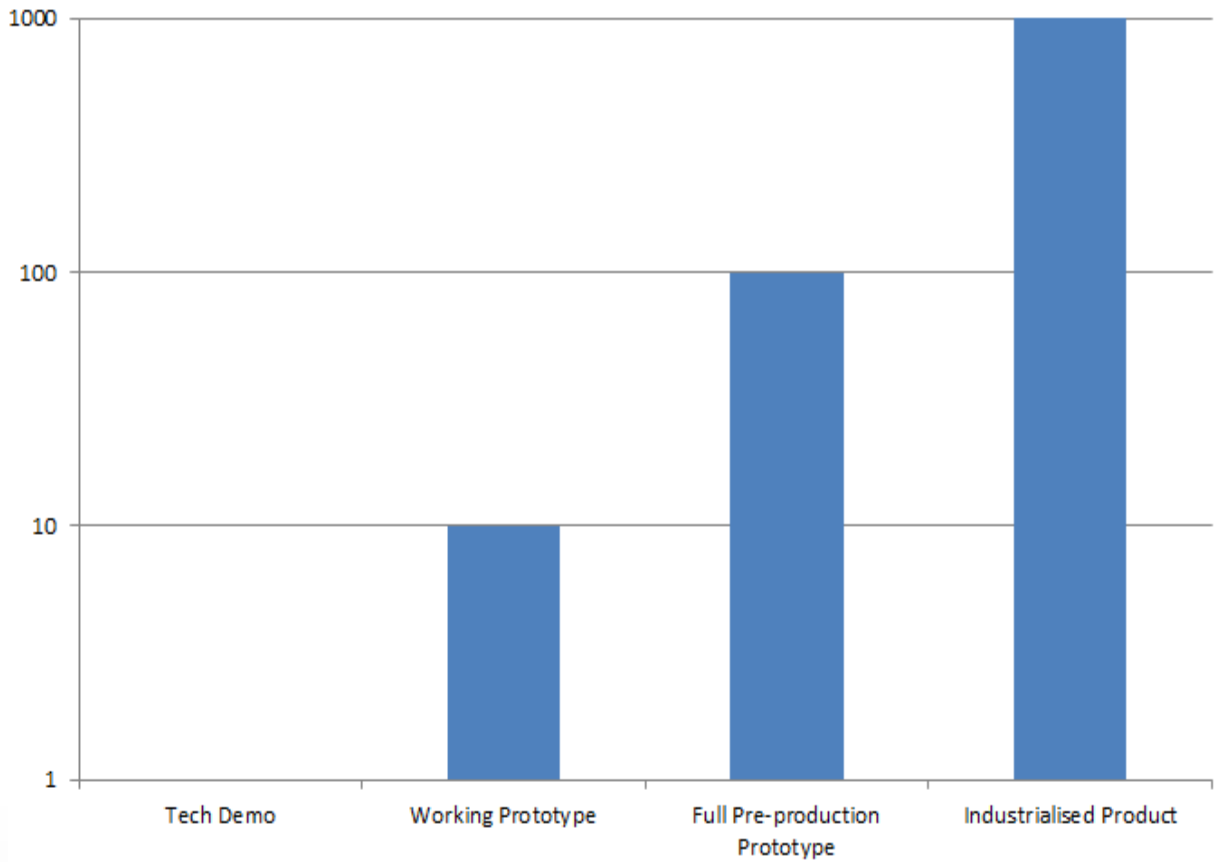
- High-performance computing (HPC) combined with machine Learning and artificial intelligence present opportunities to non-traditional industries.
- The CSIR's renewed focus on industrialisation opens up new opportunities for HPC adoption through virtual prototyping.
- Most of the developed countries have taken HPC as part of their competitiveness strategy.

Value proposition for industry

- CHPC experience of providing support to industry.
- We treat each client differently and recognise unique requirements.
- We work closely with each client to provide satisfactory solutions.
- We help to reduce the barrier for innovation through the “Virtual” Prototypes.
- Help move ideas from “Valley of Death” to realisation.
- We improve your risk management for innovation.
- Engineer for resilience.

Value proposition for industry

Resource requirement



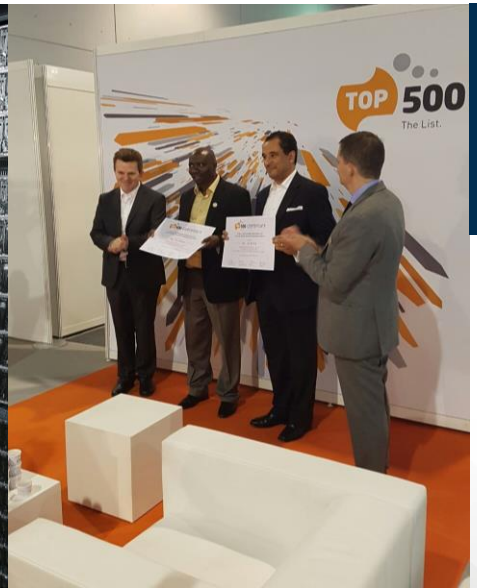
What do we offer?

- Streamlined contracting model to fast track the process
- Experience Users can have access to CPU cycles and applications support
- Benchmarking of hardware and software and provide advice of optimal systems
- Commissioning of computing equipment, optimised for client's needs
- A complete solution for the client where there is no capacity
- A gradual on-ramp where there is need to develop capacity in long term

Leadership HPC systems

System configuration	Phase 1	Phase 2
Dell PowerEdge C6320 Servers:		
Standard Compute nodes 128GB *(64GB)* / node	1 008	**1 368**
2 x Intel Xeon E5-2690 v3 (Haswell) processors (12 Cores Each ⇒ 24 cores / node)	24 192	**32 832**
Dell PowerEdge R930 servers:		
Large Memory Compute Nodes 1024GB / node (FAT nodes)	5	**5**
4 x Intel Xeon E7-4850 v3 processors (14 Cores Each ⇒ 56 cores / node)	280	**280**
Infiniband FDR 2:1 Blocking (56 Gbps)		
Parallel Storage (Useable) PB	4	**4**
Total Number of Racks (including Compute, Login, Management and Storage Nodes)	19	**24**
Centos 7.1 with Bright Cluster Manager and Altair PBS Pro		
Total Linpack Performance (Tflop/s)	**783**	**1029**

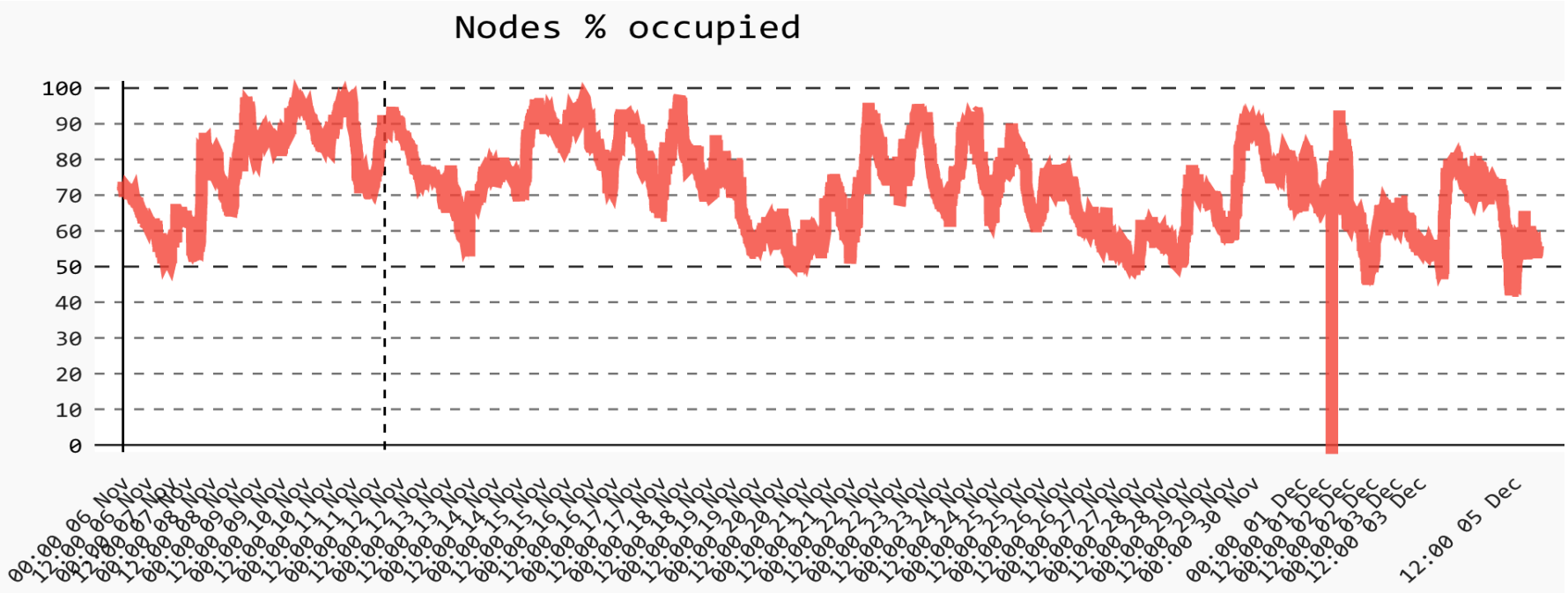
HPC Systems



- 127 on TOP500
- Awarded the fastest supercomputer in Africa

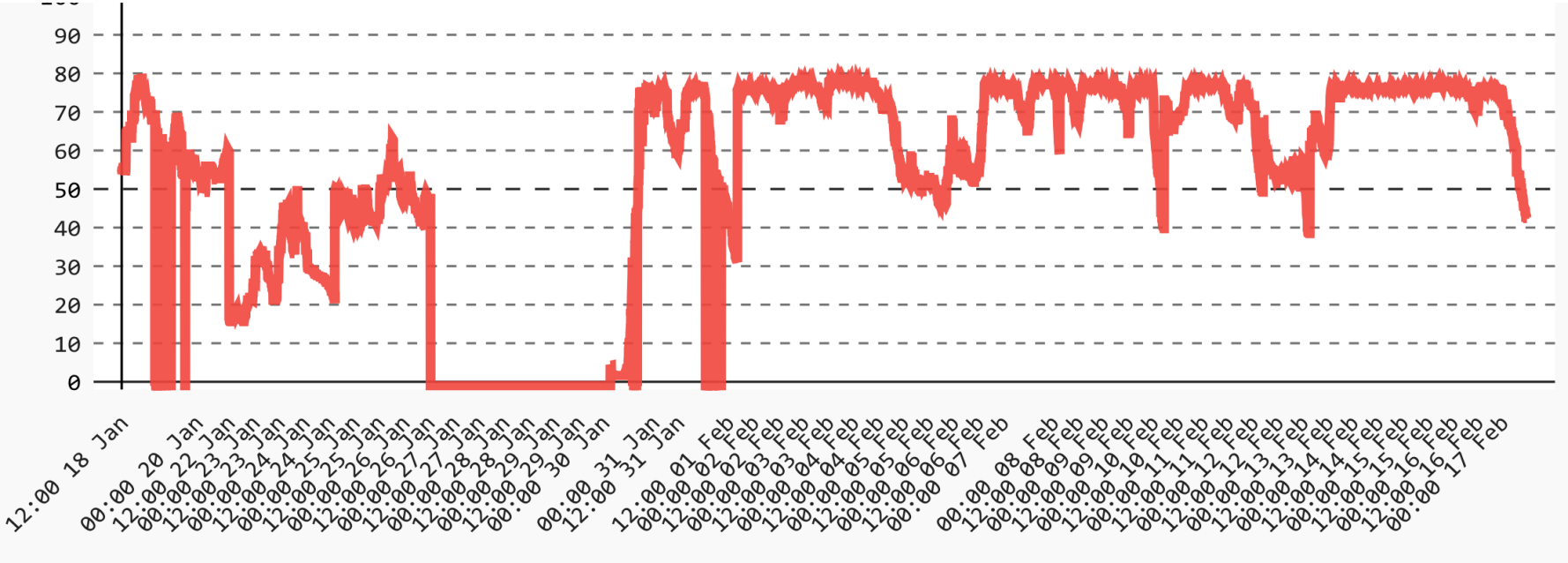
Resource utilisation

Nov/Dec 2016

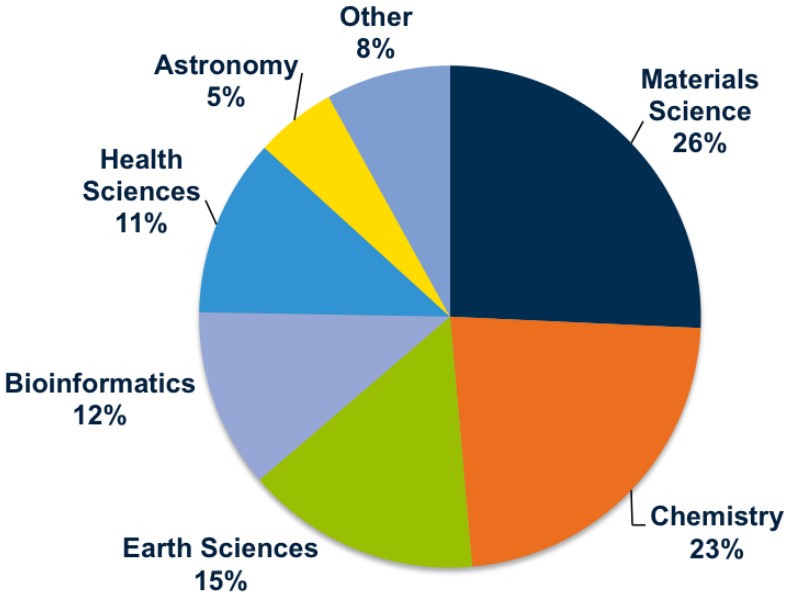


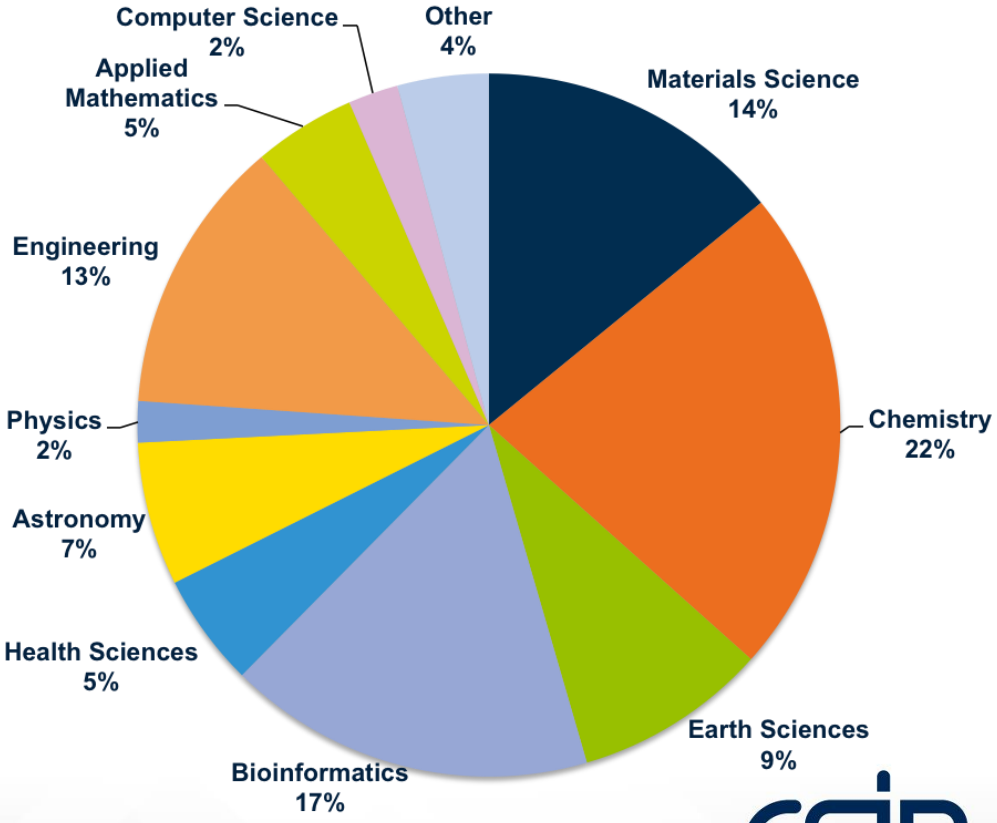
Resource utilisation

Jan/Feb 2017

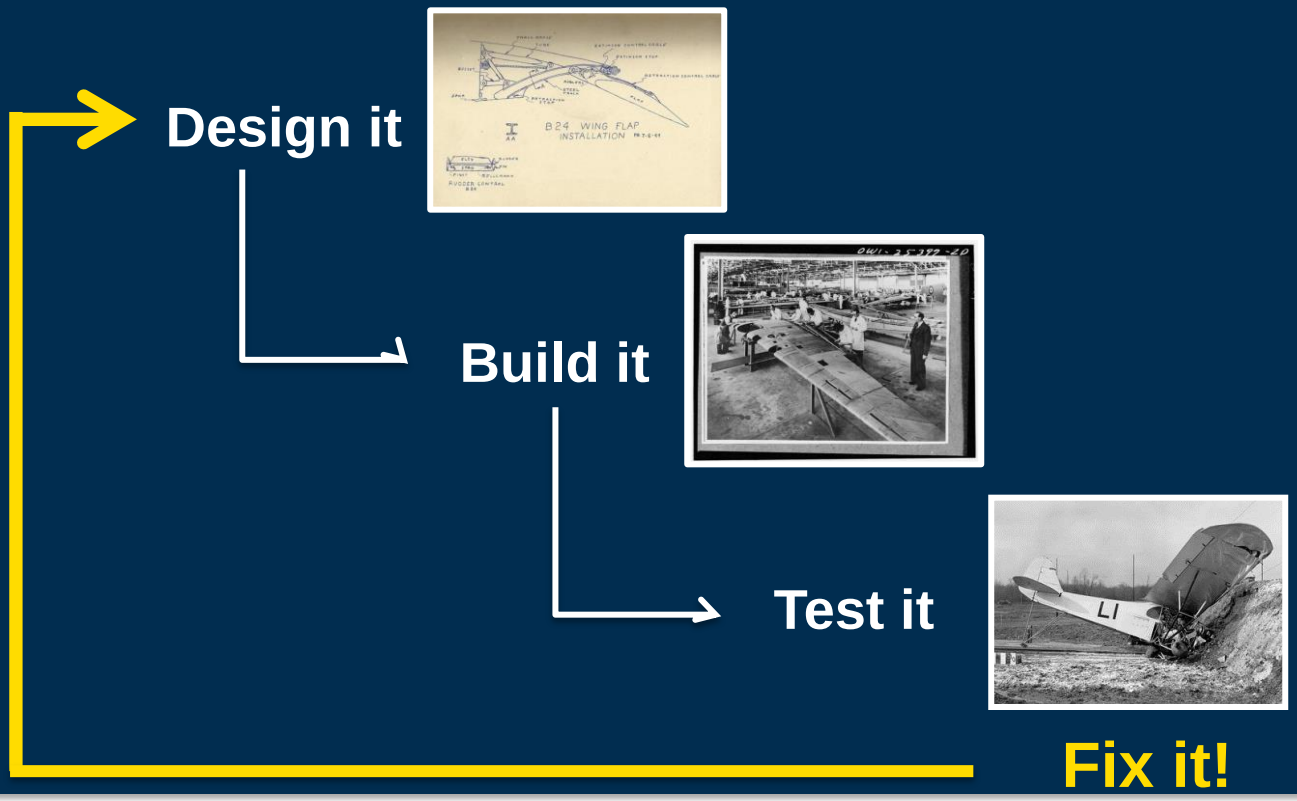


Resource utilisation by domains

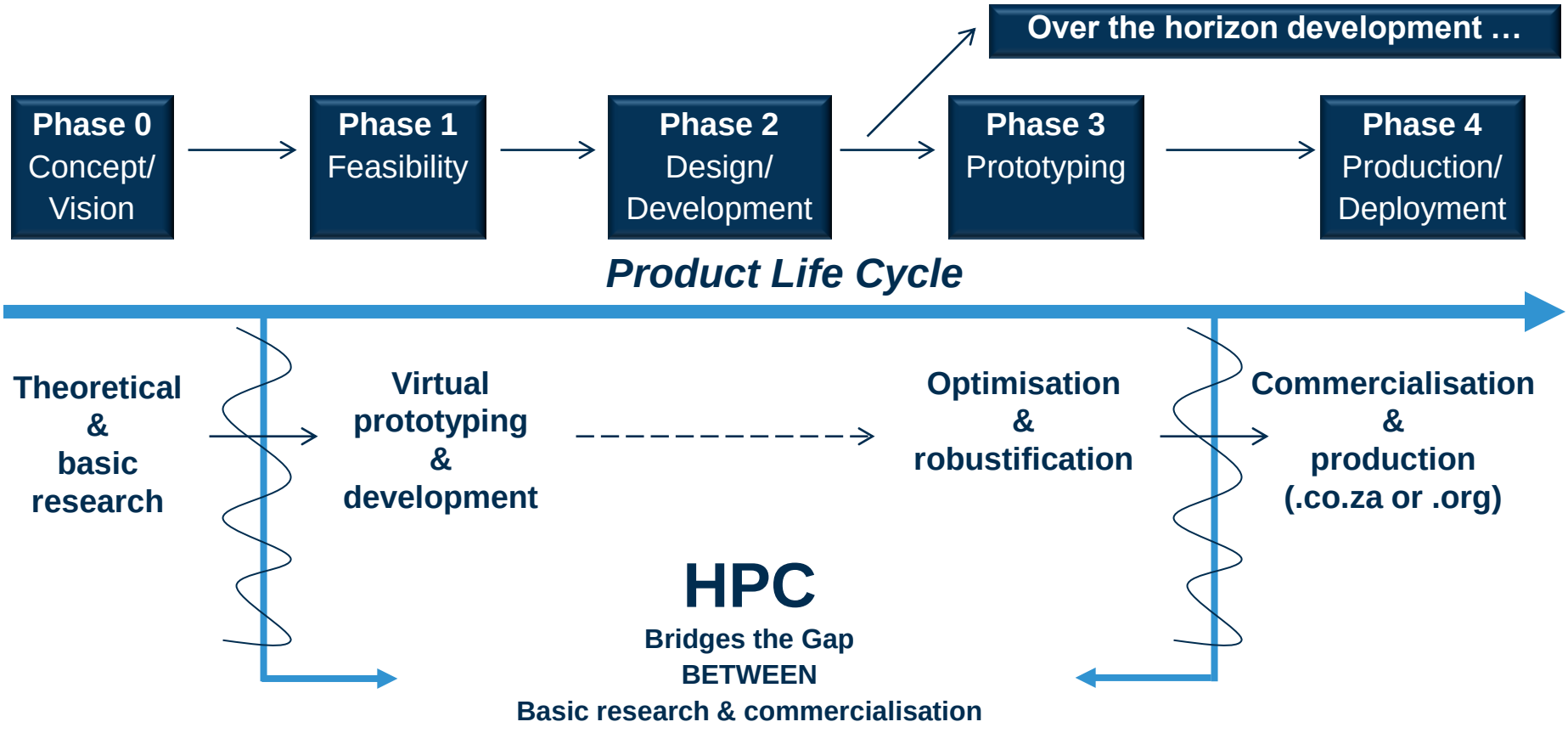




What happens during a design process?



Technology development continuum



Integrated, information-based decision making

Human, physical, virtual sensors

Bots, Actors

Archives

Information-based decisions

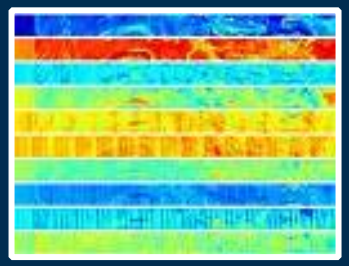
Automated provenance

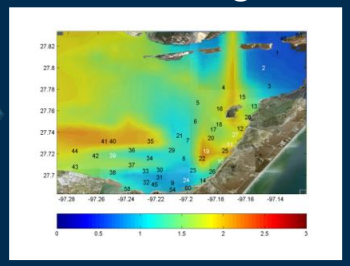
Multimodal

Modelling

Visualisation

Dashboard



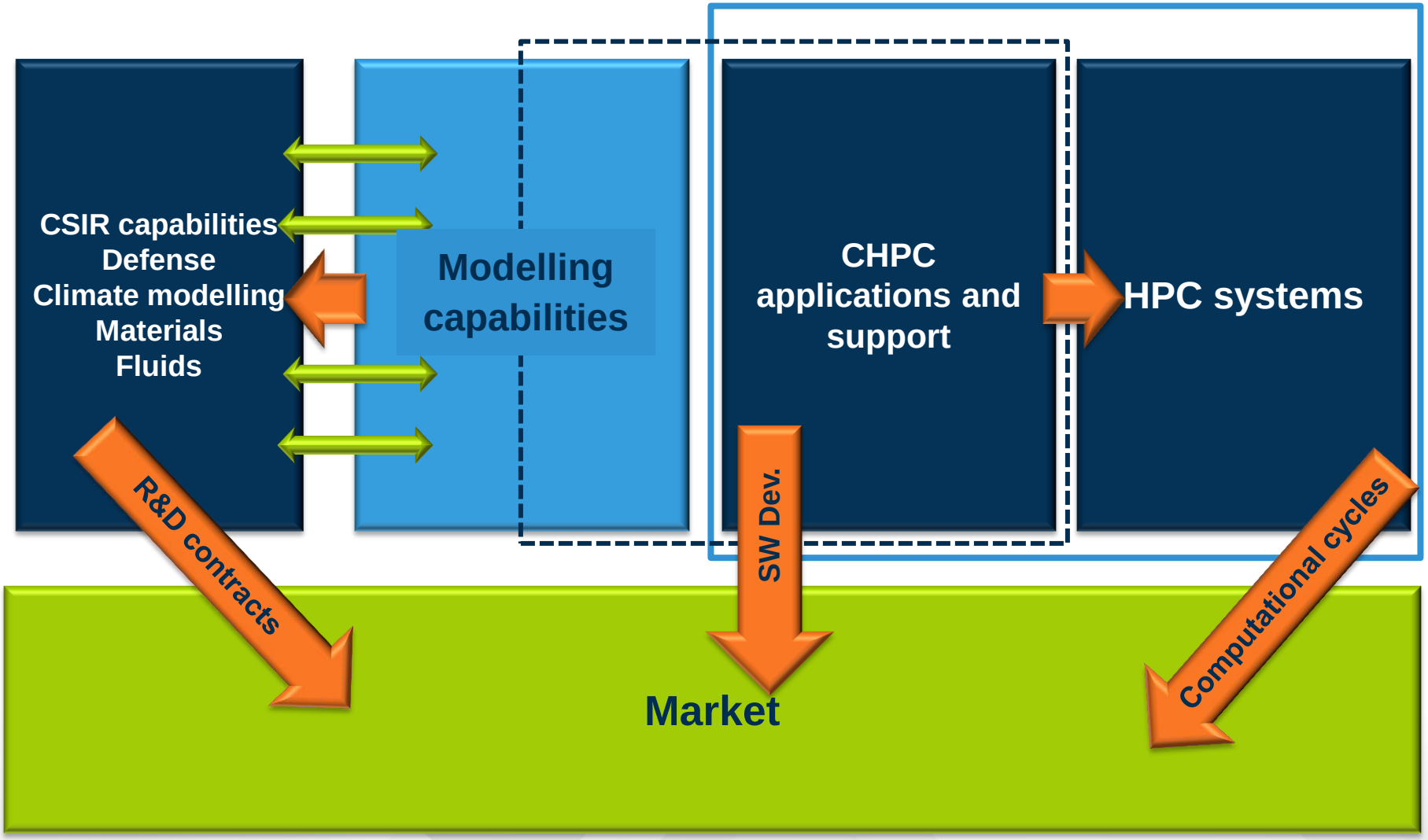


Data fusion

…Seamless computing…

Calibration

CSIR offerings



Road dynamics

AC 40 mm Asphalt

G2 150 mm Granular

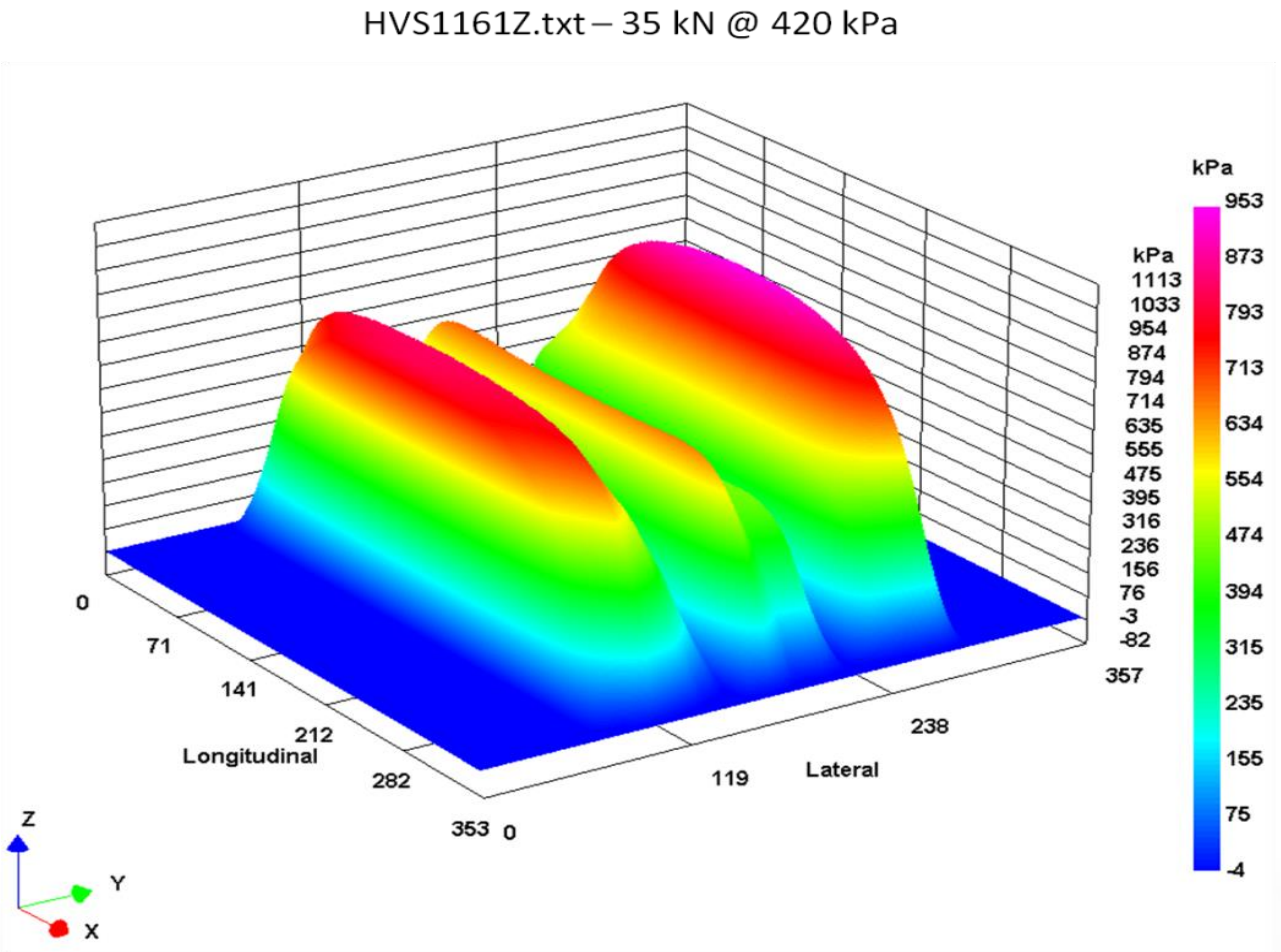
C4 150 mm Stabilized

G5 150 mm Improved

Subgrade 150 mm In

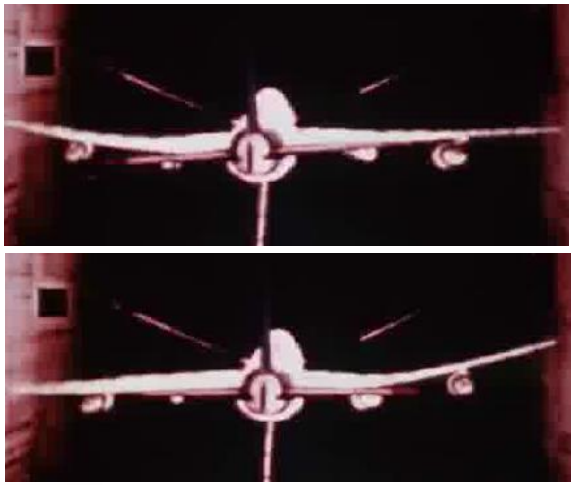
Vehicle-tyre-pavement interaction

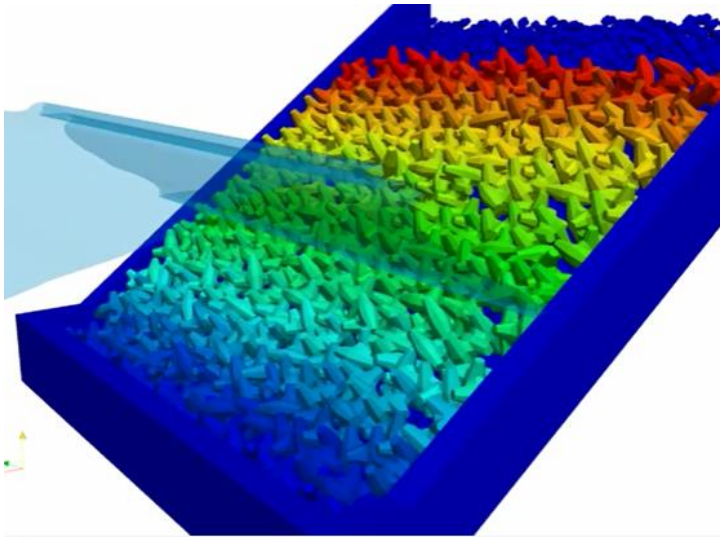
Road dynamics

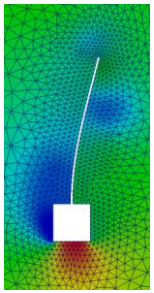


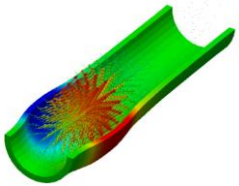
Fluid-structure interaction (FSI)

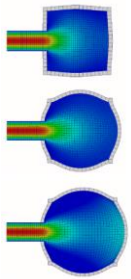
- Interaction of some movable or deformable structure with an internal or surrounding fluid flow
- a crucial consideration in the design of many engineered systems

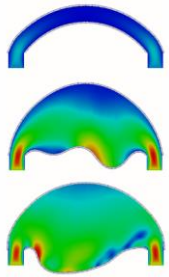






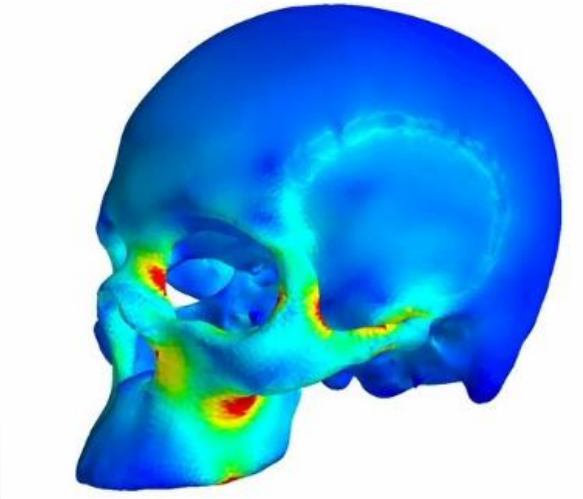




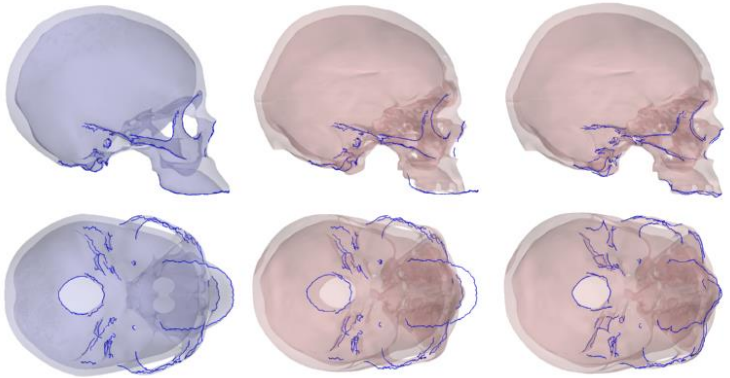


Non-rigid surface (elastic) registration

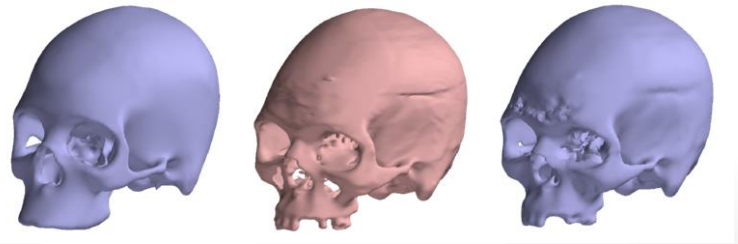
- **Process for determining the correspondence of features between images:**
  - Collected at different times
  - Captured using different imaging modalities
  - Similar objects to be compared



Selective feature registration

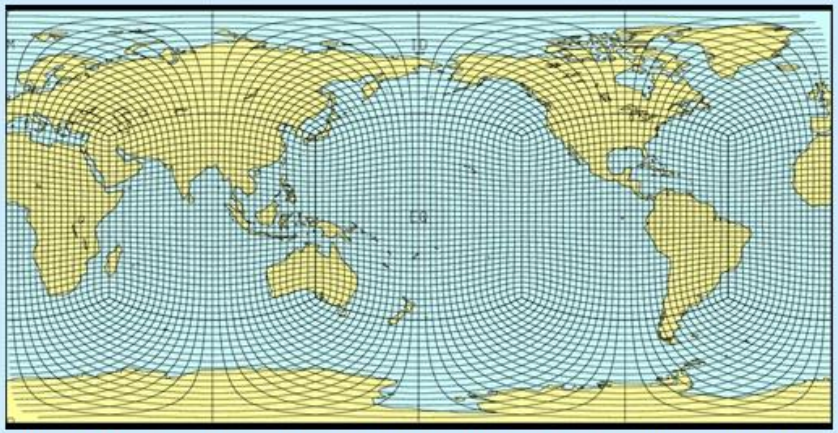


Generic and target shape

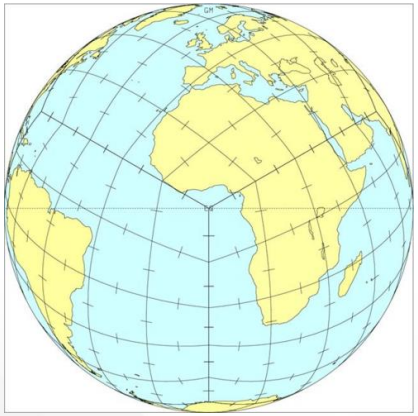


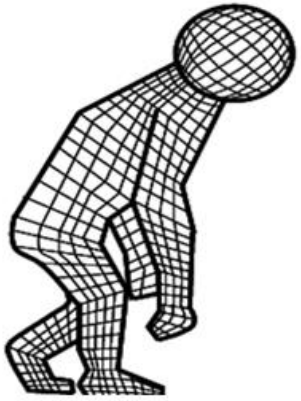
Variable-resolution Earth System Model (VRESM)

- As demonstrated by CCAM (world's first cubic atmospheric model), the cubic grid approach provides considerable advantages in numerical efficiency; this numerical efficiency allows finer resolution, longer simulations and more ensemble members
- VRESM inherits CCAM's reversible staggering grid that provides the model with its excellent wave-dispersive properties
- VRESM also inherits CCAM's extensive range of atmospheric physical parameterisations for radiation, clouds, convection, boundary turbulence, aerosols, etc.



Plot of the cubic grid used by both VCAM and PCOM. The common grid simplifies coupling and improves efficiency for eddy permitting/resolving spatial scales



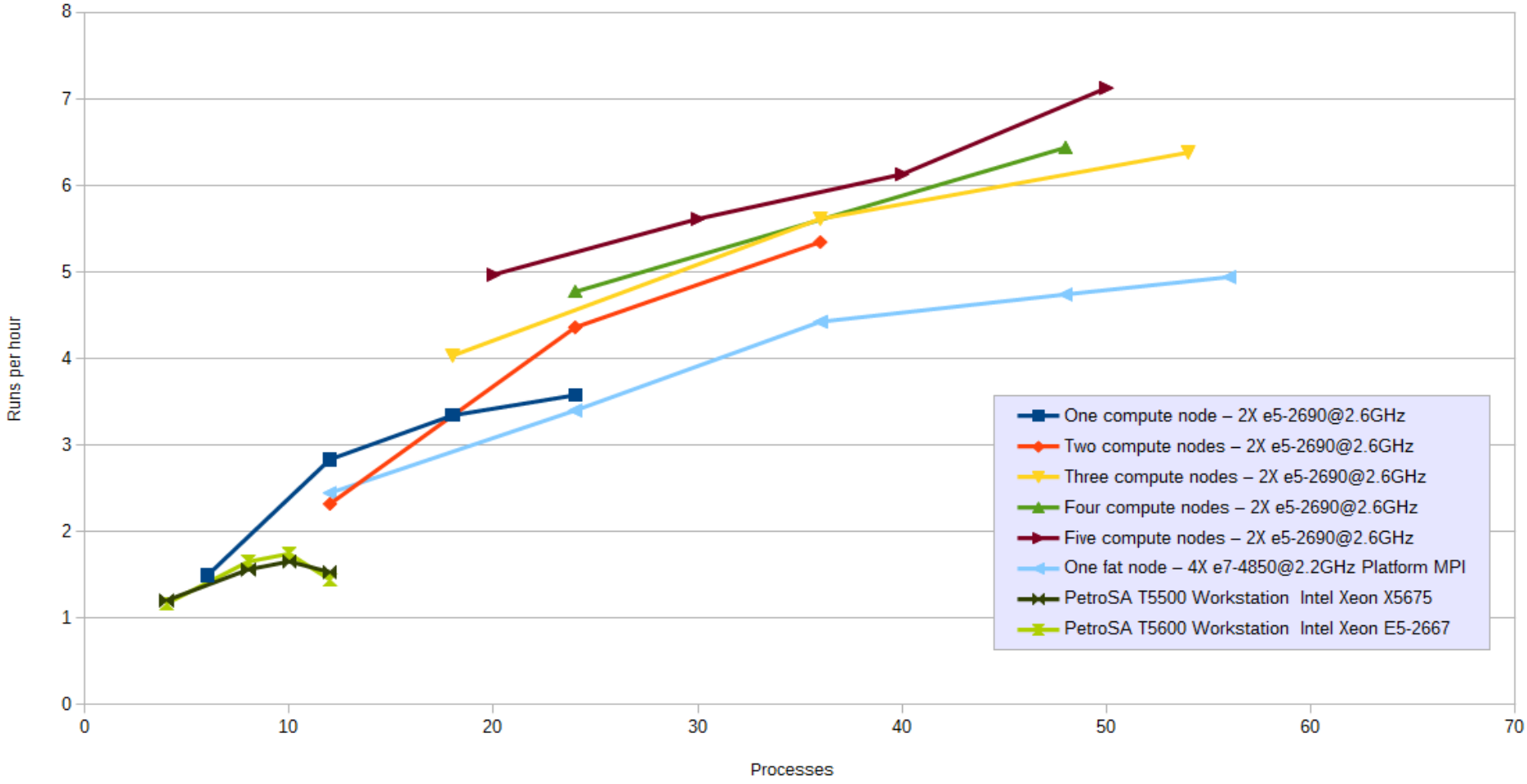


Industry partners

Proof of concept and realisation of value

PetroSA Eclipse Benchmark Case

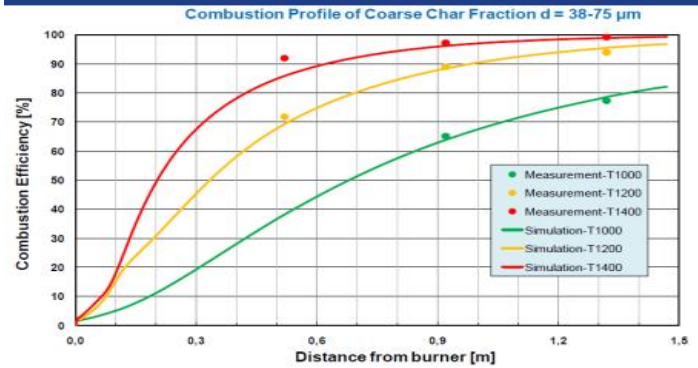
Dimensions 149X118X128 – 2.25 Million Cells

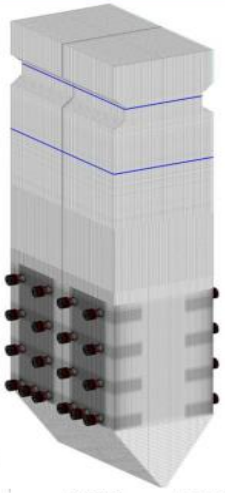


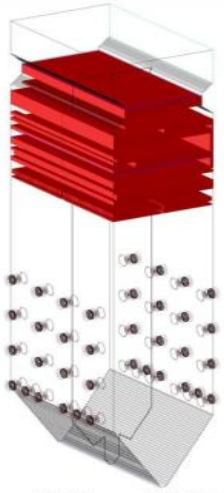
In-house skills: CPU and Code

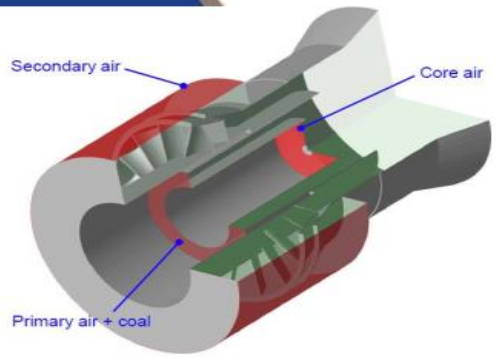
Combustion CFD Modelling

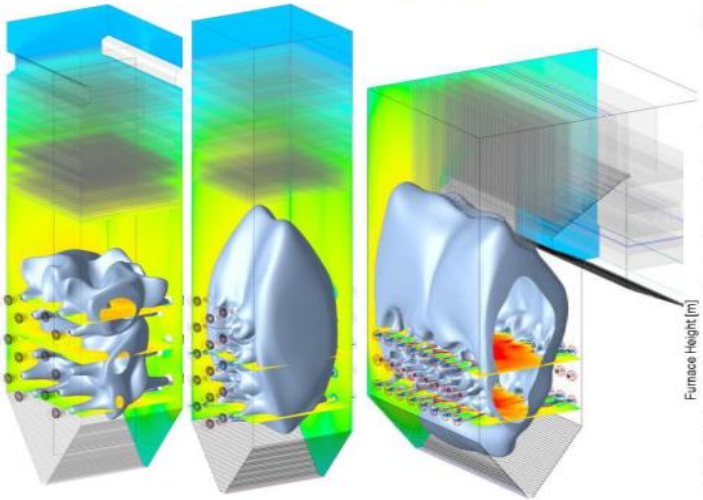
Eskom

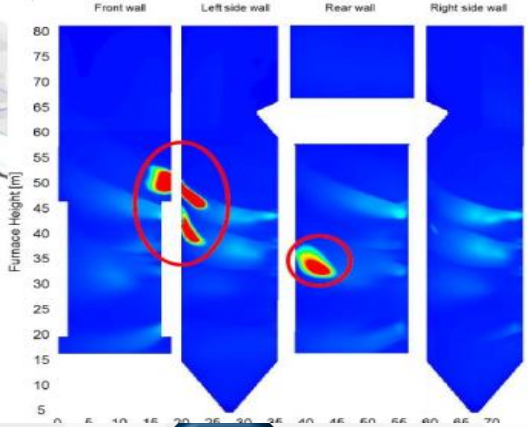


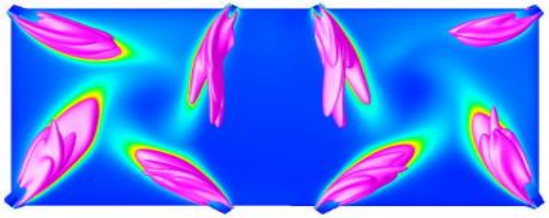


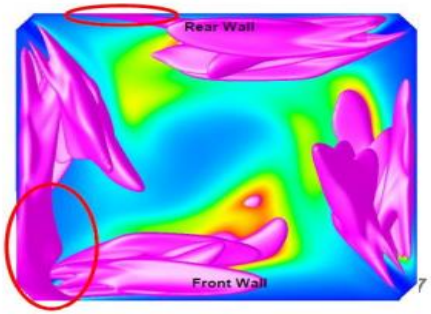












IDEAS THAT WORK FOR INDUSTRIAL DEVELOPMENT

Thank You

CSIR

our future through science