AGENDA FOR THE OPENING OF THE CHPC CODING AND ROBOTICS WORKSHOP 1

23 March 2026

Venue: CHPC Lecture Hall

Time: 09:00 to 10:30

Programme Director: Ms. Koki Selepe (Deputy Director – Science Promotion: DSI).

1. Delegates' Introduction – 30 Minutes
2. Welcome and Introduction to CHPC (Dr Werner Janse van Rensburg – Research Manager: NICIS-CHPC) – 45 Minutes
3. Opening Remark by DSI (Ms. Koki Selepe – Deputy Director – Science Promotion: DSI) – 10 Minutes

Centre for High Performance Computing

Welcome and Introduction to the CHPC

CHPC/DSTI Coding & Robotics Workshop

Dr Werner Janse van Rensburg
(CHPC Research Manager)
wjvrensburg@csir.co.za
23 Mar 2026

Overview

- What is High Performance Computing (***HPC***)?
- ***Introduction*** to the CHPC
- CHPC ***Users*** and ***Usage***
- HPC Application ***Examples***
- CHPC ***Training*** and Development

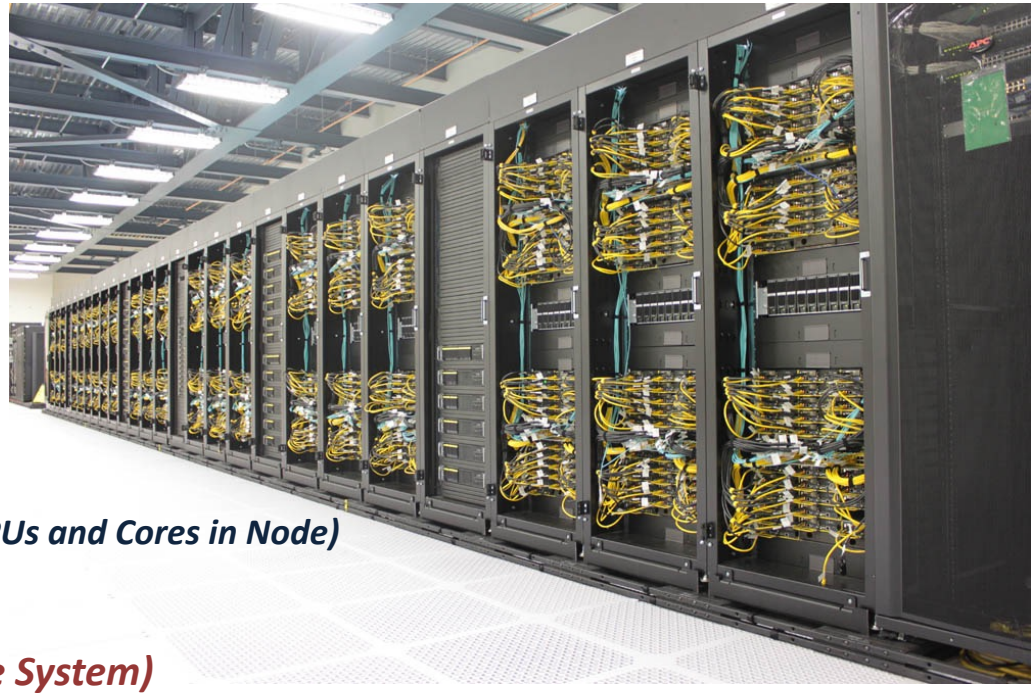
What is High Performance Computing (HPC)?

Processor(s)

Memory

Storage

Network



Desktop → HPC:

Processors (Multiple CPUs and Cores in Node)

Memory

Storage (Parallel File System)

Network (Interconnect)

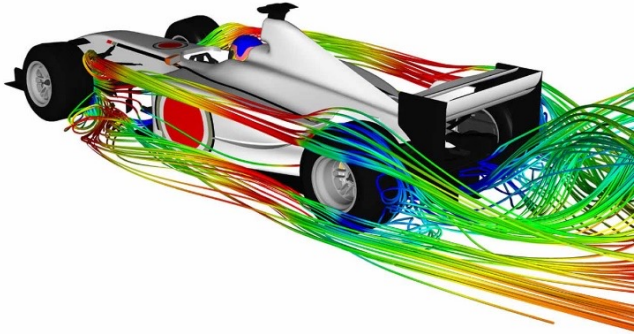
LLNL Quartz Compute Cluster

Supercomputer vs High Performance Computer…

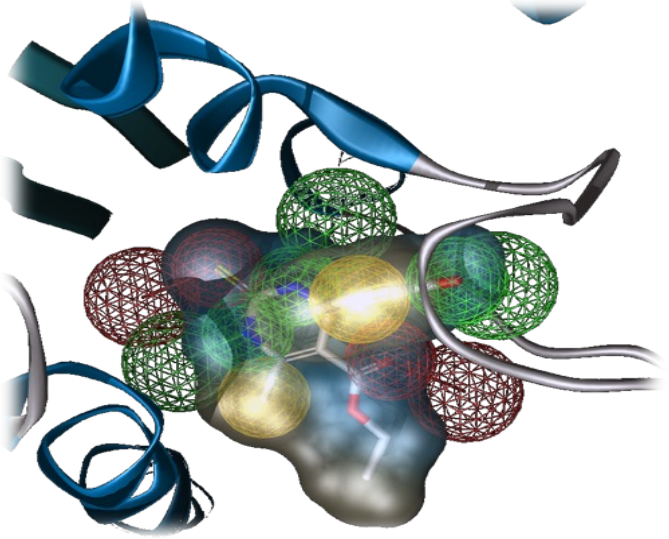
What is High Performance Computing (HPC)?

- HPC ⇒ **H**igh **P**erformance **C**omputing
- Distributed/**Parallel** computing over many **Cores** (or **CPU's**)
- **Cores** typically contained in **Nodes** (e.g. 8 cores/node) ⇒ **Cluster**
- **Serial** programs ⇒ Execution **sequentially** on **one** core at a time
- **Parallel** computing ⇒ Breaking up of serial algorithms in separate parts (threads) executed on **many** different **cores simultaneously**
- Result is significantly **higher efficiency** of calculations and simulations
- Making simulations possible that would be unrealistic on single cores
- HPC important component of most scientific and engineering research
- **Need** for **national HPC facility** in SA was recognised (more than a decade ago…)

What is High Performance Computing (HPC)?



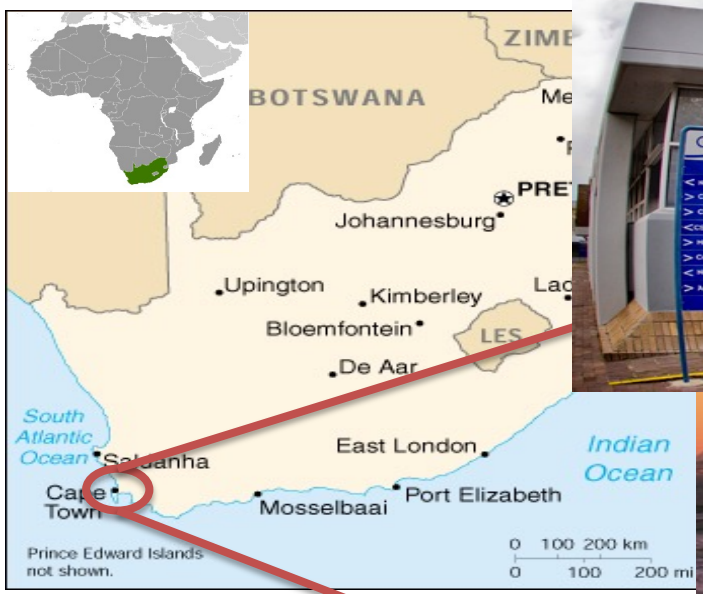
https://www.hpcwire.com/2006/05/05/high_performance_potato_chips/



Introduction to CHPC

- CHPC is **national HPC facility** funded by the SA Government
- Department of Science and Innovation (**DSI**)
- **N**ational **I**ntegrated **C**yber-**I**nfrastructure **S**ystem (**NICIS**)
- Administered by the **CSIR**
- Started operations in **June 2007** and based in Cape Town
- Until recently hosted the **largest HPC system** in **Africa**
- CHPC has total number of ~**35** employees
- CHPC has **Research**, **Technical** and **Operational** divisions

Introduction to CHPC



Introduction to CHPC

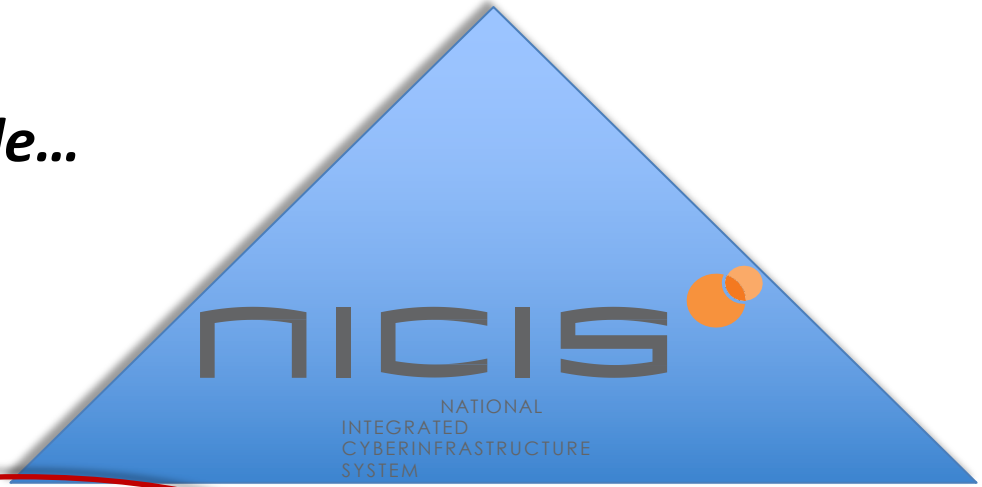
NICIS: National Integrated Cyber-Infrastructure System…

www.sanren.ac.za

SANReN
(Networking Services)

The Cyber-Infrastructure Triangle…

www.nicis.ac.za



CHPC
(Computing Services)

www.chpc.ac.za

DIRISA
(Data Services)

www.dirisa.ac.za

Introduction to CHPC

2007: IBM e1350; AMD Opteron; 2.4 GHz; 640 cores
2.5 TFlops (High Performance Linpack - HPL)

Detour: What is a Flop?

FLOP: **F**loating **P**oint **O**peration

FLOPs: **F**loating **P**oint **O**peration per **S**econd

Basic computer arithmetic

High Performance Linpack (HPL) – Solving system of linear equations

1 TFlops = 1000 GFlops = 1 million KFlops

= 1 Trillion Flops

Desktop Core i7 PC ➔ **± 0.2 TFlops**

Introduction to CHPC

2007: IBM e1350; AMD Opteron; 2.4 GHz; 640 cores
2.5 TFlops (High Performance Linpack - HPL)

2009 : Sun Constellation Cluster; 2.9/3.0 GHz; 2684 cores
27 Tflops; 480 TB Lustre File System

2008: IBM Blue Gene/P; 0.8 GHz;
4096 cores; **11.5 Tflops**

2010: GPU Cluster; 2.4 GHz; 96 cpu cores; 22 GPU's
16 Tflops; 14 TB file system

Introduction to CHPC

2007: IB… cores
2.… IPL)

2011: Tsessebe Cluster
Upgraded 2.9GHz (4032 cores)
61.6 Tflops

2009 : Sun Constellation Cluster; 2.9/3.0 GHz; 2684 cores
27 Tflops; 480 TB Lustre File System

2008: IBM Blue Gene/P; 0.8 GHz;
4096 cores; **11.5 Tflops**

2010: GPU Cluster; 2.4 GHz; 96 cpu cores; 22 GPU's
16 Tflops; 14 TB file system

Introduction to CHPC

Current Resources at the CHPC:

- Lengau cluster since **7 March 2017** (1st phase June 2016)
- Africa's 1st Petascale system ⇒ **1.029 PFlops = 1029 TFlops**

(121st on Top500* – Jun 2016)

(127th on Top 500* – Jun 2017)

CHPC Lengau Compute Cluster

Lengau: Setswana for ‘Cheetah’

Emphasis on ‘Speed’ and ‘The Fastest’…

Fastest HPC Cluster on African Continent

1.029 PFlops = 1029 TFlops

Introduction to CHPC

Resources at the CHPC: Lengau CPU Cluster

NICIS NATIONAL INTEGRATED CYBERINFRASTRUCTURE SYSTEM
CHPC

April 2016 *June 2017*

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**

Introduction to CHPC
Resources at the CHPC: GPU Cluster

- **Graphical Processor Unit (GPU) Cluster:**

  30 NVIDIA V100's

- Since **September 2018**

- Usage Demand:
  - **Transfer of Chemistry Users (MD)**
  - **Resources for Machine Learning (ML)**

Introduction to CHPC
Resources at the CHPC: Cloud

NICIS Production Cloud named: SEBOWA

Since March 2020…

- **Openstack** Cloud with Ceph storage
- **320 cores** with memory of 4GB/core
- **500 TB** of Ceph storage (2 copies)
- **100 Gbps** speed form switch split in 4

➔ each node gets 25GB network speed.

Rank	System	Cores	Rmax (PFlop/s)	Rpeak (PFlop/s)	Power (kW)
1	**El Capitan** - HPE Cray EX255a, AMD 4th Gen EPYC 24C 1.8GHz, AMD Instinct MI300A, Slingshot-11, TOSS, HPE DOE/NNSA/LLNL United States	11,340,000	1,809.00	2,821.10	29,685
2	**Frontier** - HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11, HPE Cray OS, HPE DOE/SC/Oak Ridge National Laboratory United States	9,066,176	1,353.00	2,055.72	24,607
3	**Aurora** - HPE Cray EX - Intel Exascale Compute Blade, Xeon CPU Max 9470 52C 2.4GHz, Intel Data Center GPU Max, Slingshot-11, Intel DOE/SC/Argonne National Laboratory United States	9,264,128	1,012.00	1,980.01	38,698
4	**JUPITER Booster** - BullSequana XH3000, GH Superchip 72C 3GHz, NVIDIA GH200 Superchip, Quad-Rail NVIDIA InfiniBand NDR200, RedHat Enterprise Linux, EVIDEN EuroHPC/FZJ Germany	4,801,344	1,000.00	1,226.28	15,794
499	**ASPIRE 2A (CPU Partition)** - HPE Cray EX425, AMD EPYC 7713 64C 2GHz, Slingshot-10, HPE National Supercomputing Centre Singapore Singapore	98,304	2.58	3.11	
500	ThinkSystem HR650X, Xeon Gold 6233 24C 2.5GHz, 10G Ethernet, Lenovo Service Provider T China	67,200	2.57	5.38	

TOP500 The List.

NICIS NATIONAL INTEGRATED CYBERINFRASTRUCTURE SYSTEM CHPC

top500.org

World Top500 HPC Systems…

November 2025

NICIS
NATIONAL INTEGRATED CYBERINFRASTRUCTURE SYSTEM
CHPC

500.org

Systems...

mber 2025

500	ThinkSystem HR650X, Xeon Gold 6233 24C 2.5GHz, 10G Ethernet, Lenovo Service Provider T China	67,200	2.57	5.38

Aurora (ANL) Cray Intel Xeon
#3 Top500
1012 PFlops
9.3 Million Cores (2023)

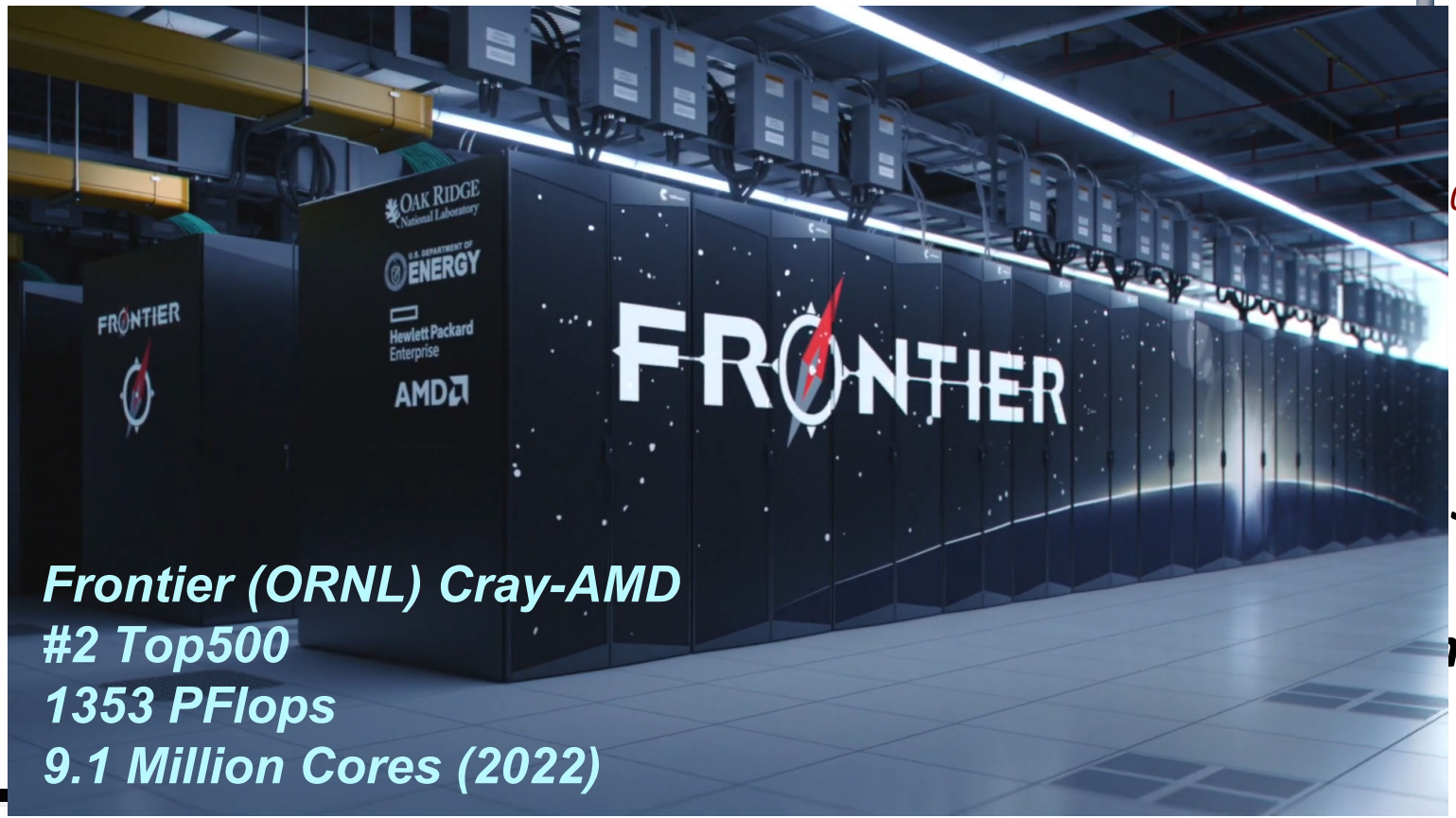
NICIS
NATIONAL INTEGRATED CYBERINFRASTRUCTURE SYSTEM
CHPC

500.org

Systems…

mber 2025

500	ThinkSystem HR650X, Xeon Gold 6233 24C 2.5GHz, 10G Ethernet, Lenovo Service Provider T China	67,200	2.57	5.38



Frontier (ORNL) Cray-AMD
#2 Top500
1353 PFlops
9.1 Million Cores (2022)

NICIS
NATIONAL INTEGRATED CYBERINFRASTRUCTURE SYSTEM
CHPC

00.org

Systems…

nber 2025

500	ThinkSystem HR650X, Xeon Gold 6233 24C 2.5GHz, 10G Ethernet, Lenovo Service Provider T China	67,200	2.57	5.38

El Capitan (LLNL) Cray-AMD
#1 Top500
1809 PFlops
11.3 Million Cores (2024)

NICIS
NATIONAL INTEGRATED CYBERINFRASTRUCTURE SYSTEM
CHPC

rg

tems…

er 2025

500

Service Provider T
China

CHPC Mandate

- Research **Enabler** and **Accelerator** Role via HPC
- **Provisioning** of Computational Resources to:
  - South African Academic Research Community
  - African SKA and **and SADC** Partner Countries
  - Non-Academic Public and Private Sector Users (in SA)
- Research enabling role of the CHPC fourfold:
  - Access to HPC hardware **infrastructure**
  - Code/**Software** support
  - Research **domain** area support
  - Training and education initiatives (**Human Capital Development**)

CHPC Lengau Cluster Usage

(Status: 25 Feb 2026)

	All Time	6 Months
❑ Total Active* Research Programmes	**688**	**285**
❑ Total Core Hours Used (Million)	**1765**	**99**
❑ Total Active* Users	**3035**	**927**

** Active refers to usage of more >1000 compute core hours*

Resources at the CHPC: People

CHPC Support Personnel

- Dedicated Domain Specific Scientists and Engineers

  Chemistry, Materials Science, Computational Mechanics, Physics, Bioinformatics, Astronomy, Applied Mathematics, Computer Science, Earth Science, etc…

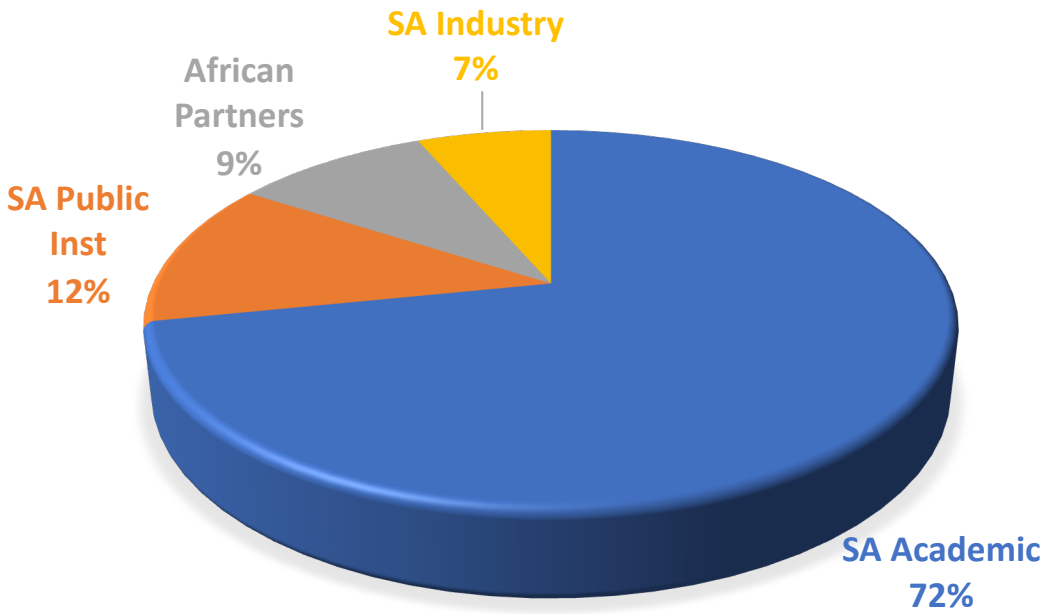
- Technical Support

- Strategic Projects Support

- Trainers

CHPC User Categories Total Active* Programmes

Lengau All Time *(Jun 2016 – 15 Aug 2024)*



 # Active Programmes

Total: 606

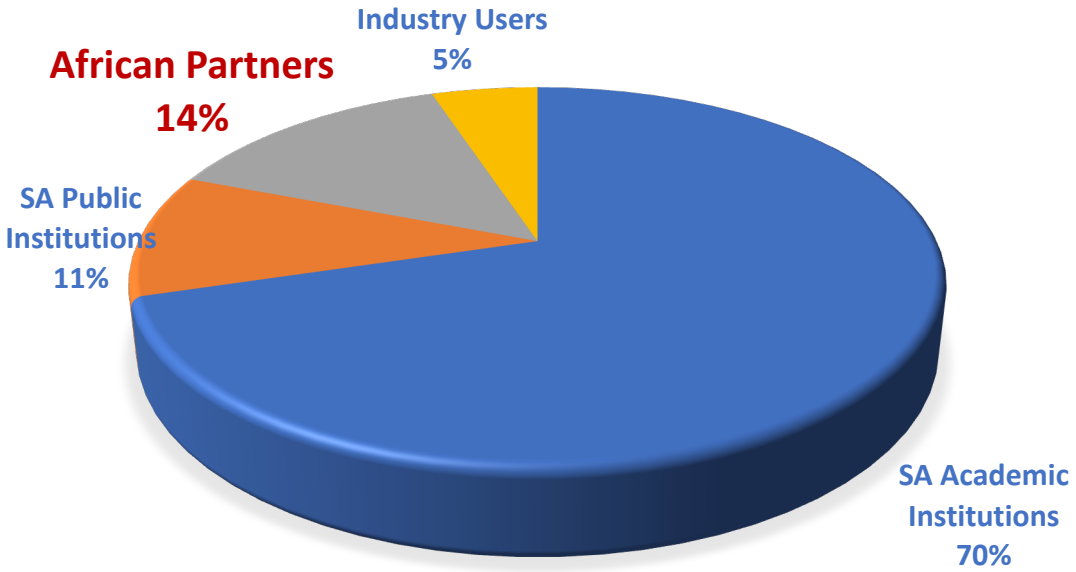
**Active refers to at least 1000 compute hours used over the relevant period.*

CHPC User Categories Total Active* Programmes

Lengau All Time (Status: 25 Feb 2026)

 # Active Programmes

Total: 688



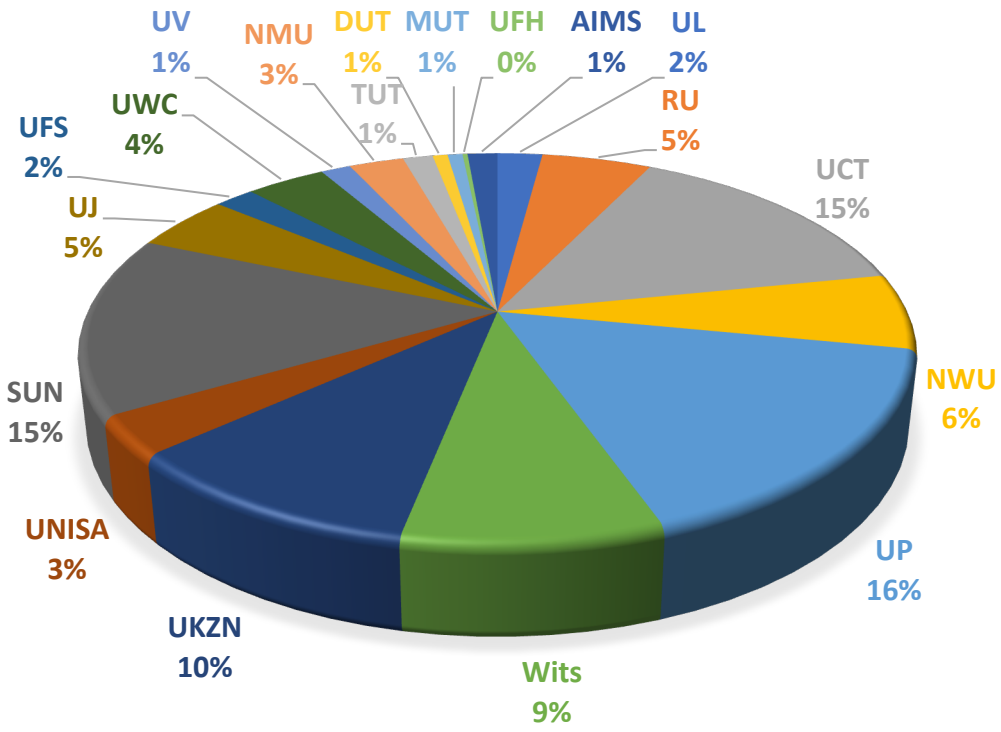
**Active refers to at least 1000 compute hours used over the relevant period.*

CHPC Use: SA Universities Total Active* Programmes

Lengau All Time (Status: 25 Feb 2026)

 # Active Programmes

Total: 482



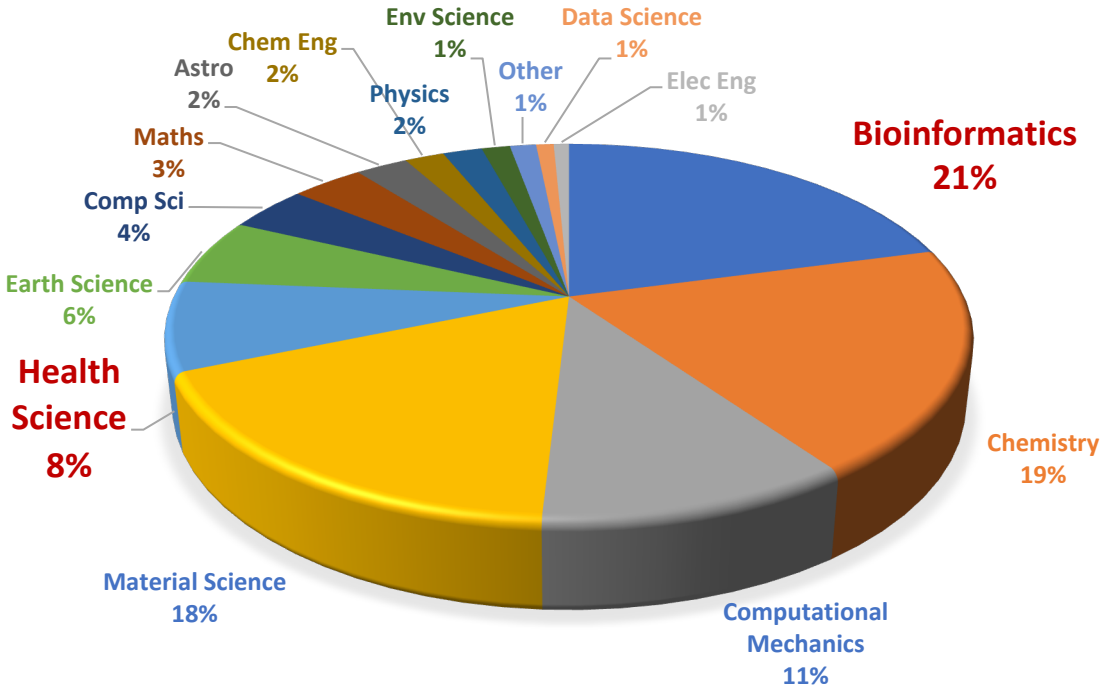
**Active refers to at least 1000 compute hours used over the relevant period.*

CHPC Use: Disciplines Total Active* Programmes

Lengau All Time (Status: 25 Feb 2026)

 # Active Programmes

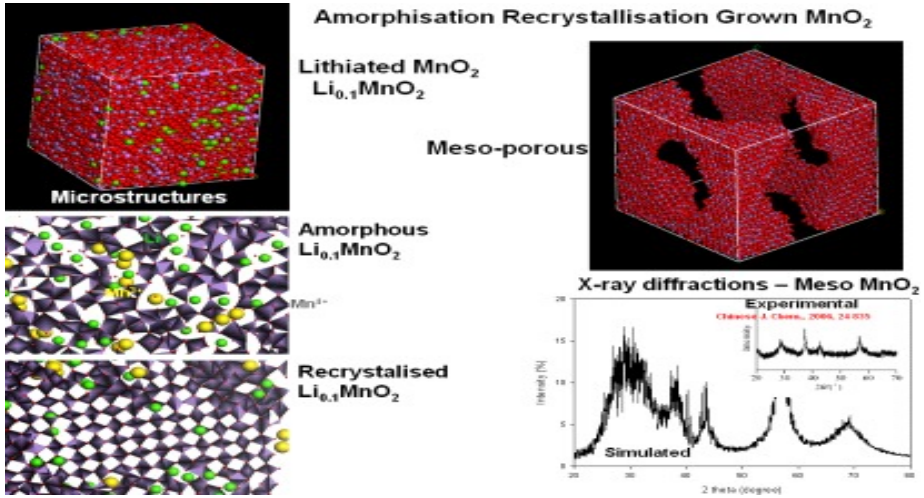
Total: 688



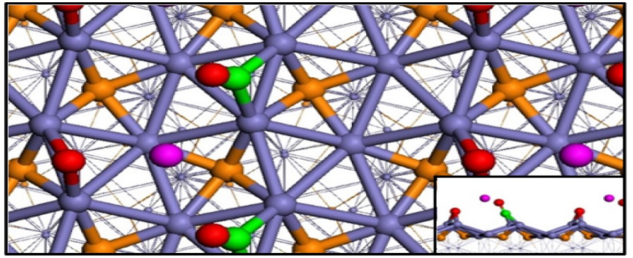
**Active refers to at least 1000 compute hours used over the relevant period.*

HPC Applications: Materials

Materials Science / Chemistry / Health

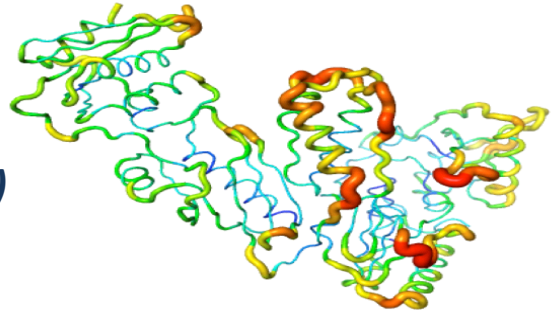


Energy Storage – Battery Development (Materials Science)

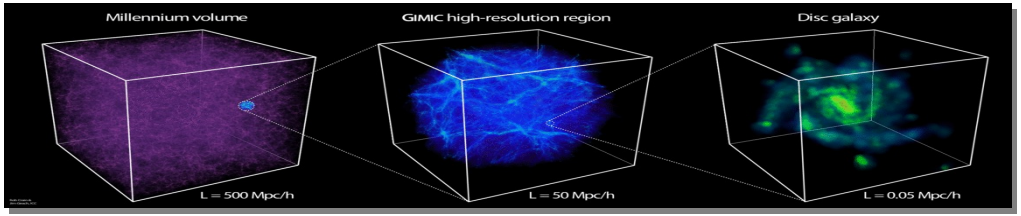


Computational Catalysis (Comp Chem / Materials Science)

Drug-Design Molecular Modelling (Computational Chemistry)



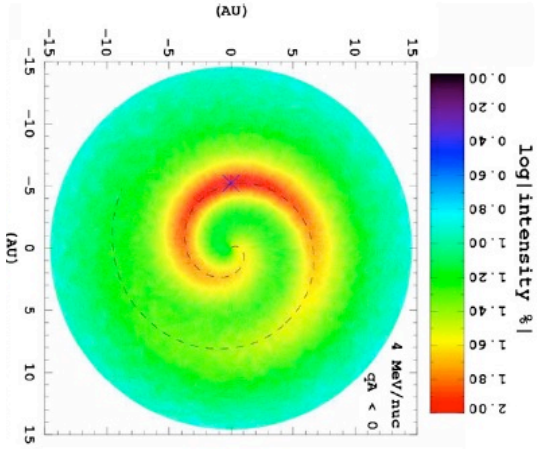
HPC Applications: Astronomy

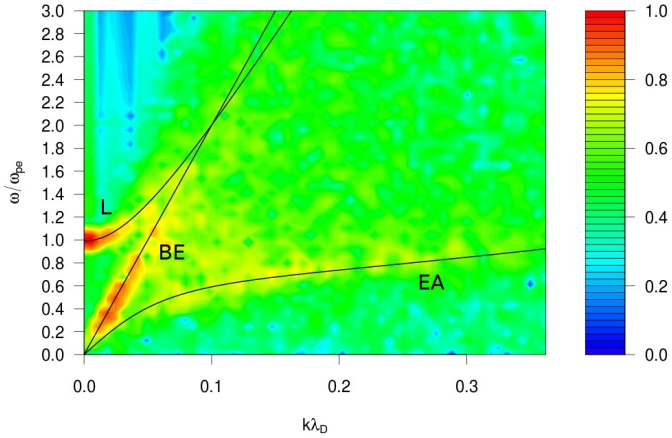


Astronomy/Cosmology (Universe/Galaxy Evolution)

(Courtesy Cress and Cunnama)

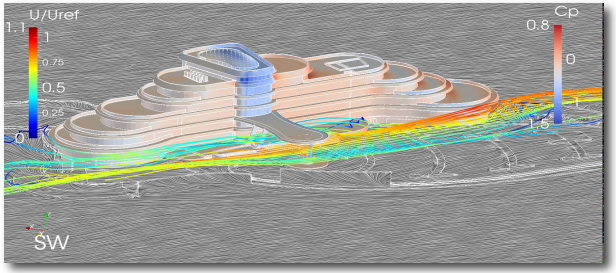
Electron intensities –
Jupiter rel to Sun (NWU)



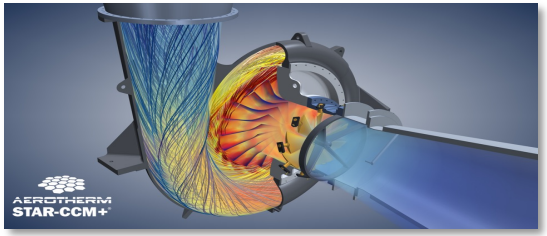


HPC Applications: Engineering

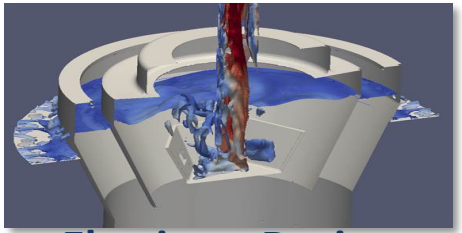
Computational Mechanics / Engineering



Building aerodynamics
(ECI-JV)

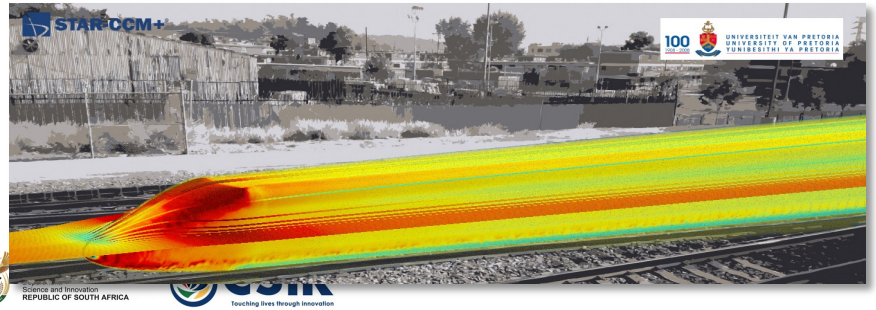


Centrifugal Steam Compressor
(Aerotherm)

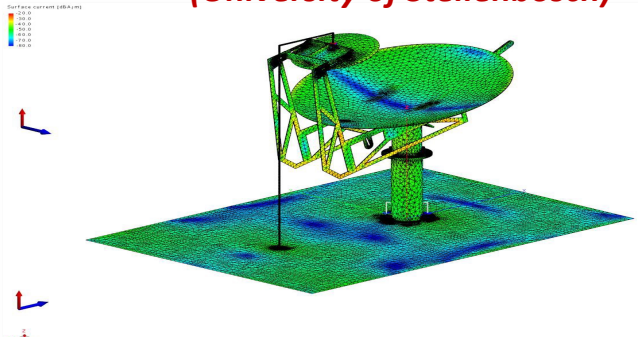


Elutriator Design
(De Beers Marine)

High-speed Train Design *(UP)*:



Radio-Astronomy Dish Design
(University of Stellenbosch)

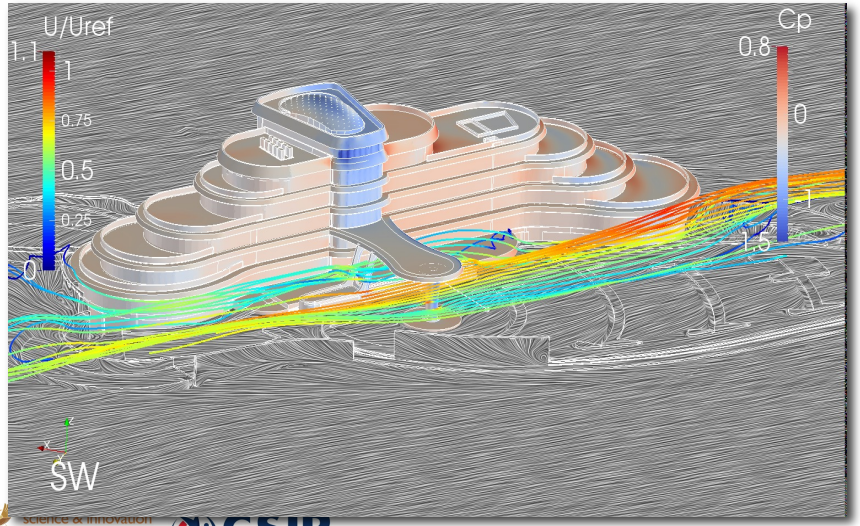


HPC Applications: Engineering

CASE STUDY

Computational Mechanics: ECI-JV: Architecture

- ECI-JV provides engineering, procurement and **construction services** Eastern Cape province in South Africa
- CHPC approached for evaluation of **building designs** in Port Elizabeth



Building aerodynamics (Eastern Cape Infrastructure-JV)

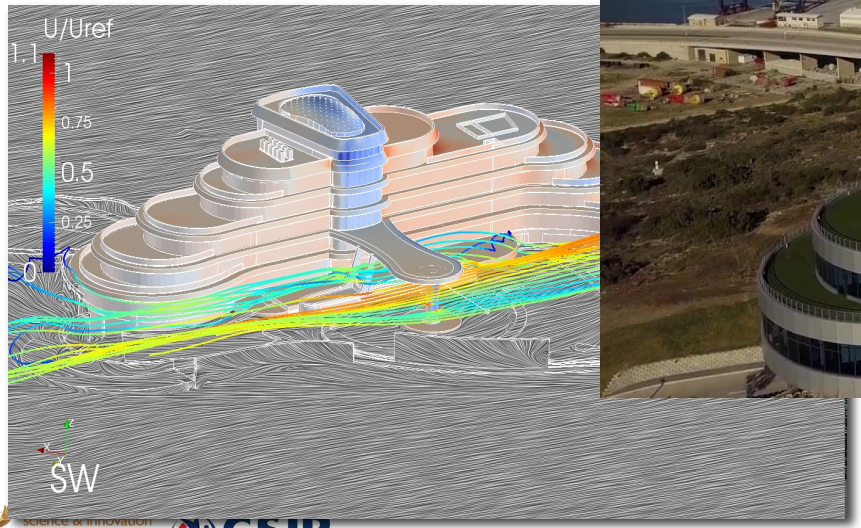
- Example of **full consultation** and CFD (OpenFOAM) **analyses perfomed for the client**
- Resulted in **design modifications** and re-orientations of the eMendi Building…

Courtesy: Dr Charles Crosby (CHPC)

HPC Applications: Engineering

CASE STUDY

Computational Mechanics: ECI-JV: Architecture



eMendi Building Completed in June 2017 at Port of Ngqura – https://www.youtube.com/watch?v=EGItgLSO-y4

Building Aerodynamics (Eastern Cape Infrastructure-JV)

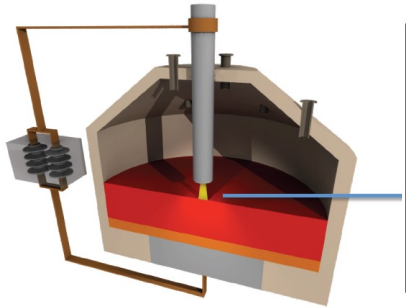
HPC Applications: Engineering

CASE STUDY

Mintek: Pyrometallurgy

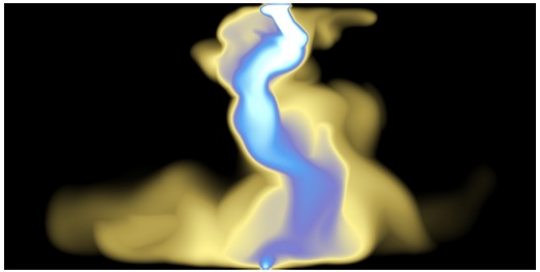
- DC Furnace **Plasma Arc electric smelting** simulations
- **CFD** and Magnetohydrodynamics (**MHD**) simulations
- Resulted in **patent** for Mintek on **arc detection technology**
- **Fully dependent** on **CHPC** for HPC resource requirments

MINTEK
A global leader in mineral and metallurgical innovation



Cross-section of DC Furnace Showing Plasma Arc (photo)

Photographic Image



Simulated

Courtesy: Dr Quinn Reynolds (Mintek)

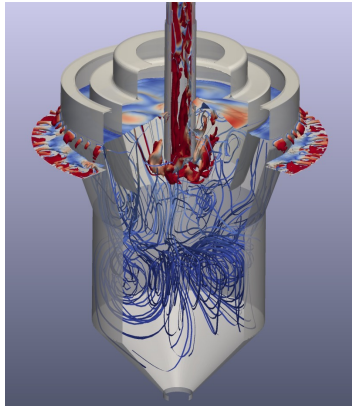
HPC Applications: Engineering

CASE STUDY

De Beers Marine: Diamond Mining

- Mining of **diamonds from seabed** west coast of SA and Namibia
- Advanced **technologies** required **for seperation** of diamonds by wet screening, grinding and deagglomeration
- Dependent on CHPC for **CFD** evaluations of **dewatering** sub-system **designs**
- Resulted in effective **decision making** for technology implementations

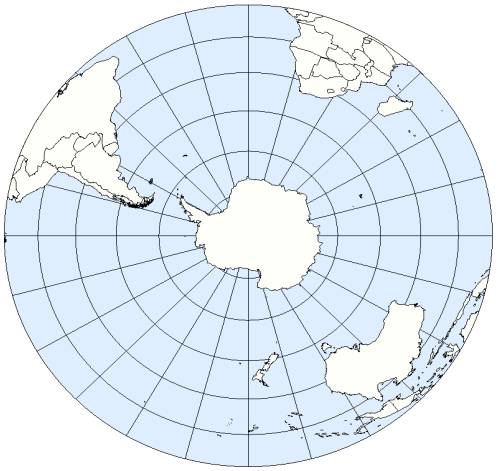
SS Nujoma – Mining Vessel

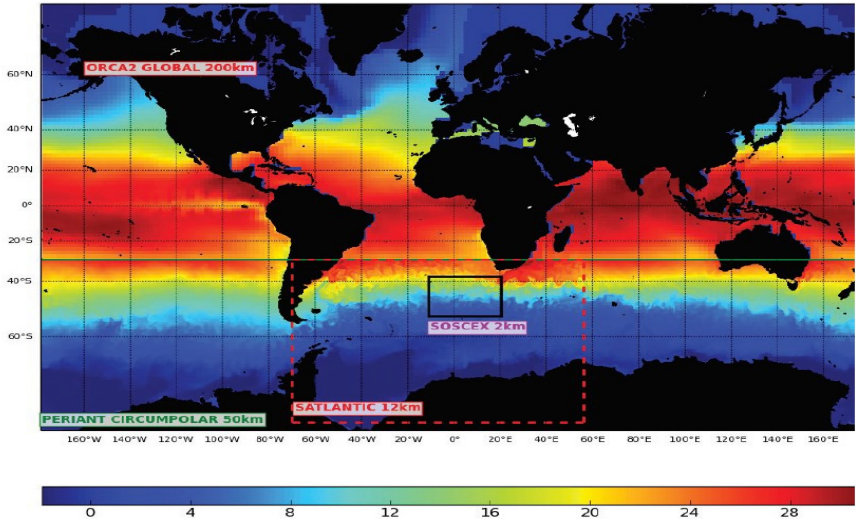


Courtesy: Mr Imraan Parker (De Beers Marine)

HPC Applications: Earth Sciences

Climate Modelling / Weather





- **African based Variable Resolution Earth Systems Model (VRESM)**
- **Southern Oceans, Atmosphere** and **Terrestrial** dynamics in existing models
- Will form **unique contribution** to next global and regional climate assessment of IPCC through Assessment Report Six **(AR6)**

HPC Applications: Earth Sciences

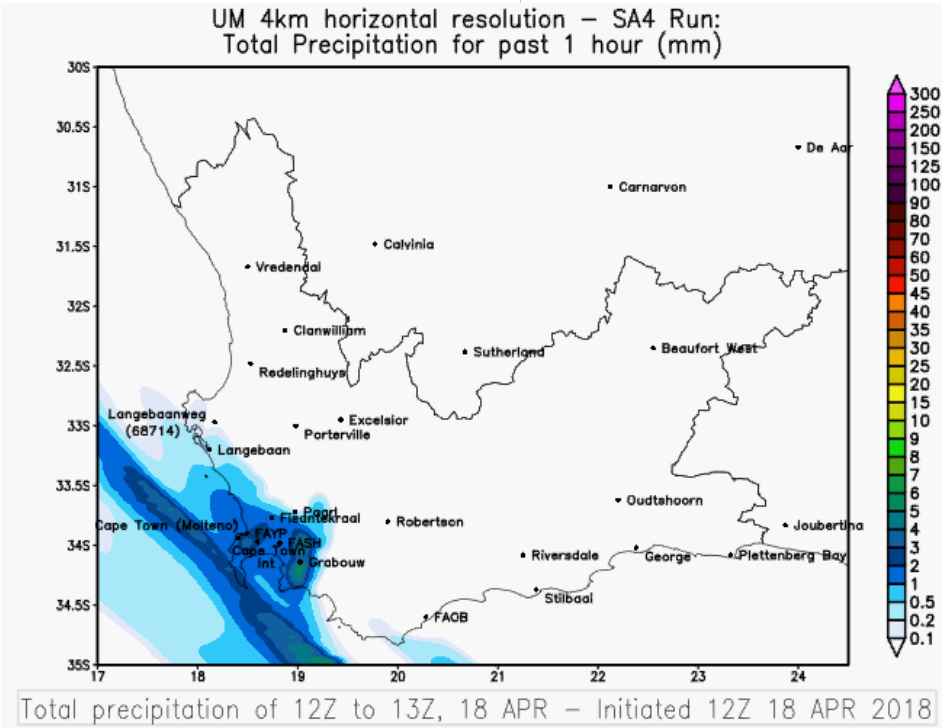
CASE STUDY

Weather Prediction

South African Weather Service (SAWS)

CHPC-SAWS MoU:

- ❑ CHPC is ***Fail-Over Facility***
- ❑ All ***SAWS Research*** done at CHPC



1st UM forecast which ran operationally on the CHPC in April 2018 (Dr S Landman)

CHPC Training and Development Initiatives

- Dedicated CHPC Training events
  - Introductory Programming/Coding School (Summer School)
  - Winter School in High Performance Computing
  - Student Cluster Competition (SCC)*
  - HPC Ecosystems Project*
  - Domain specific workshops / Ad Hoc Training
- CHPC National Conference
- SKA Readiness program
- Women in HPC (WHPC) Program
- **Outreach Programmes, e.g. CHPC Hardware and Coding Workshop**

Why this Coding and Robotics Workshop?

Acknowledgements:

- Department of Science, Technology and Innovation (DSTI)

  Ms Koki Selepe

- CHPC Trainers and Organisers

  Mr Mthetho Sovara*, Ms Zama Mtshali, Mr Binyamin Barsch,

  Ms Nomlie Mfuphi, Mr Ntlharhi Baloyi, Ms Cynthia Mukhanu,

  Mr Sam Mathekga, Mr Mfundo Mdwadube, Mt Vuyo Mfidi,

  Mr Matsobane Mpyana, Mr Bryan Johnston, Mr Thuso Bogopa

  Ms Funeka Mafani

- You the Trainees: The Expectations are High!

Thank You !

Background:

DSI Hardware, Coding and Robotics Programme…

PROGRAMME FOR THE CHPC CODING AND ROBOTICS WORKSHOP

23 – 27 March 2026

Time	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
08:45 - 9:00	Registration	Registration	Registration	Registration	Registration
9:00 -10:30	Opening: Computer Hardware and Coding for DSI Workshop 10	Scratch Coding Session 3	Robotics Practical Session 1	Microbit Session 1	Microbit Session 3
10:30 - 11:00			**Tea Break**		
11:00 - 13:00	Scratch Coding Session 1	Scratch Coding Session 4	Robotics Practical 2	Microbit Session 2	Microbit Session 4
13:00- 14:00			**Lunch**		
14:00 -15:00	CHPC Facility Tour	Scratch Coding Session 5	Robotics Practical Session 3	{codeclub} Session 1	Feedback and Closing
15:30 - 16:00			**Tea Break**		
16:00 - 17:00	Scratch Coding Session 2	Scratch Coding 6	Robotics Practical Session 4	{codeclub} Session 2	Departure