

High Performance Computing in South Africa – An Overview

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NICIS - CHPC Computer Training For DARA Project
06 – 10 May 2019, HartRAO, South Farica

AN INITIATIVE OF:



science
& technology

Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

MANAGED BY:

CSIR
our future through science

Talk Arrangement

- ❑ *Background*
- ❑ *User Community*
- ❑ *Application Research Areas*
- ❑ *Human Capital Development*
- ❑ *Resources at the CHPC*
- ❑ *CHPC Computer Training for DARA*

Background

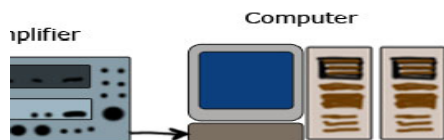
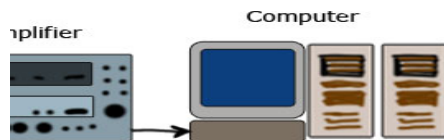
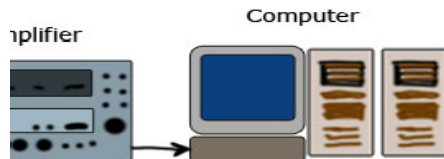
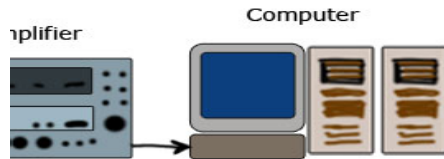


Background

- CHPC is **National HPC facility** funded by the SA - Government Department of Science and Technology (**DST**)
- Administered by the **CSIR (legal, finance, Procurement and Human resources)**
- Started operations in **June 2007 – Now about 11 yrs.**
- In 2018, the CHPC became part of NICIS of CSIR
- Currently hosts the **largest HPC system in Africa**
- CHPC has total number over **~40** employees
- CHPC has **Research, Technical** and **Operational** divisions

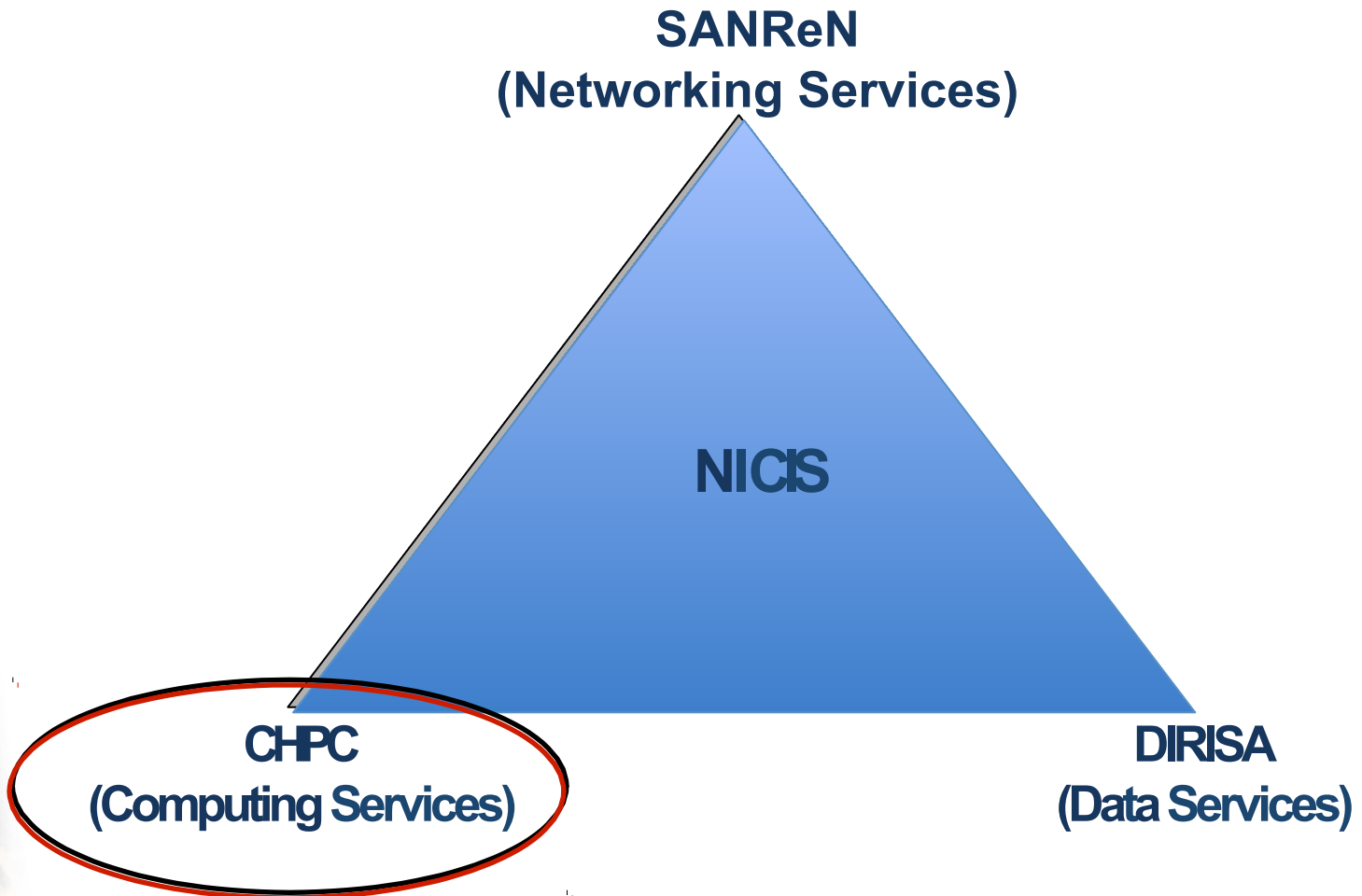
Background

What is Supercomputer?



Background

The Cyber-Infrastructure Triangle...



Background

❑ CHPC mandate:

- ⇒ Research **enabler** role via HPC
- ⇒ Provide **computational resources** to SA research community
- ⇒ Public and Private Sector Users

❑ 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**)



User Community

South Africa



User Community

Africa



- ❑ **SADC HPC Framework** agreed HPC
- ❑ Research **white papers** ⇒ Agriculture and Health

- ❑ CHPC resources to **African students**

- ❑ **HPC Ecosystems*** Project ⇒

Botswana, Zambia, Namibia,
Madagascar, Mauritius, Kenya,

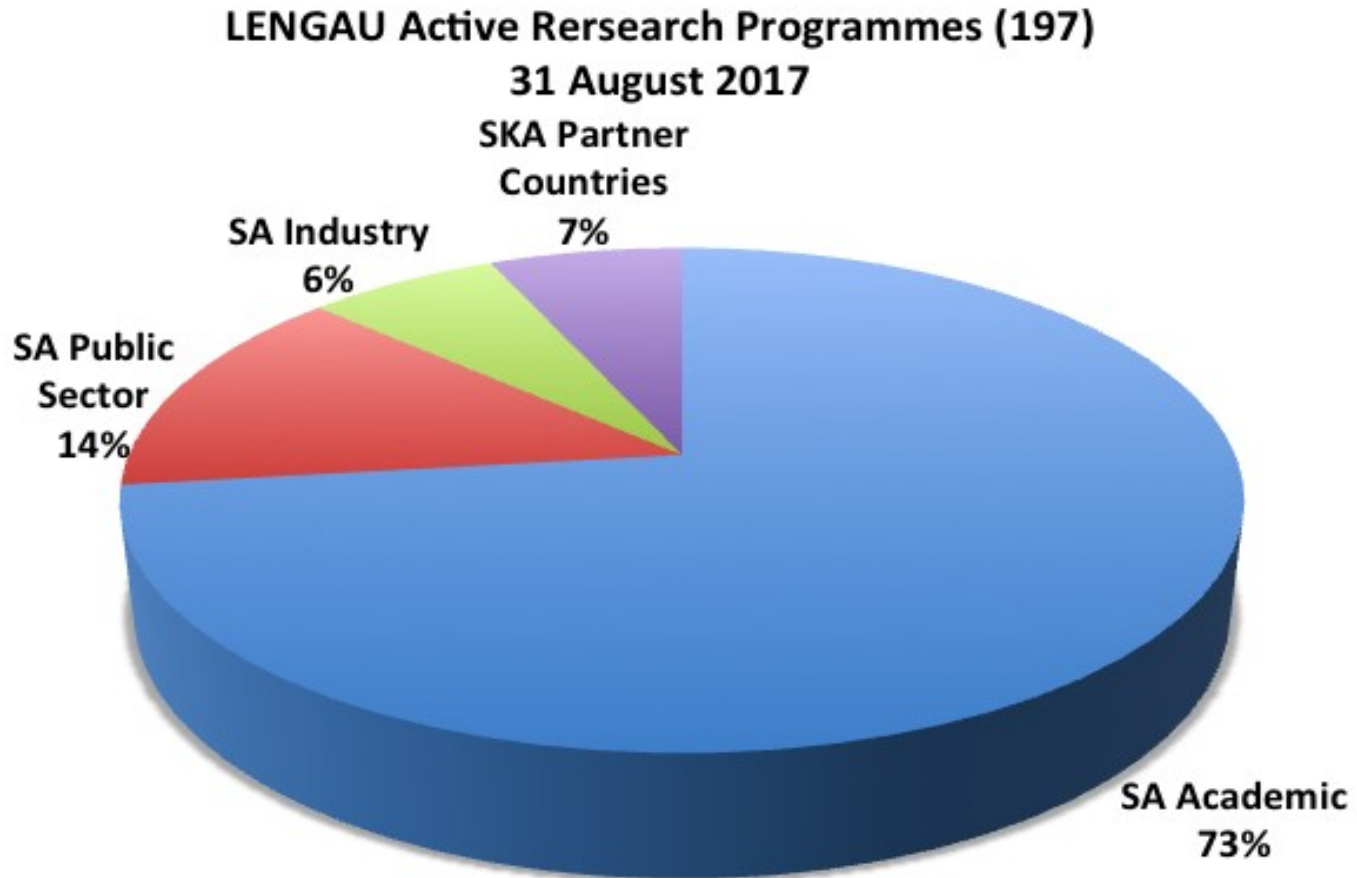
- ❑ Mozambique and Ghana

In collaboration with SKA, assist the
African partners through the **SKA**

Readiness Program*



Who is using the CHPC?



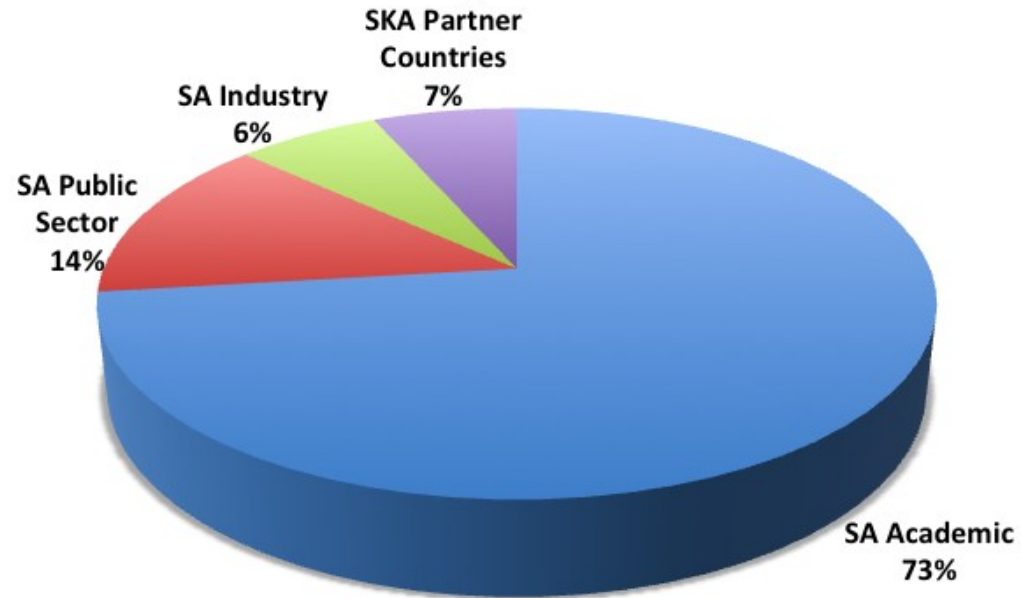
CHPC Utilisation

African Partner Countries:

- **Namibia:** 2 (UNAM)
- **Kenya:** 6 Pwani, Eldoret, Maseno, Moi, MMUST, Rongo).
- **Ghana:** 4(KNUST, Univ Ghana)
- **Mozambique:** 1 (UEM)

13 Research Programmes at CHPC

LENGAU Active Research Programmes (197)
31 August 2017

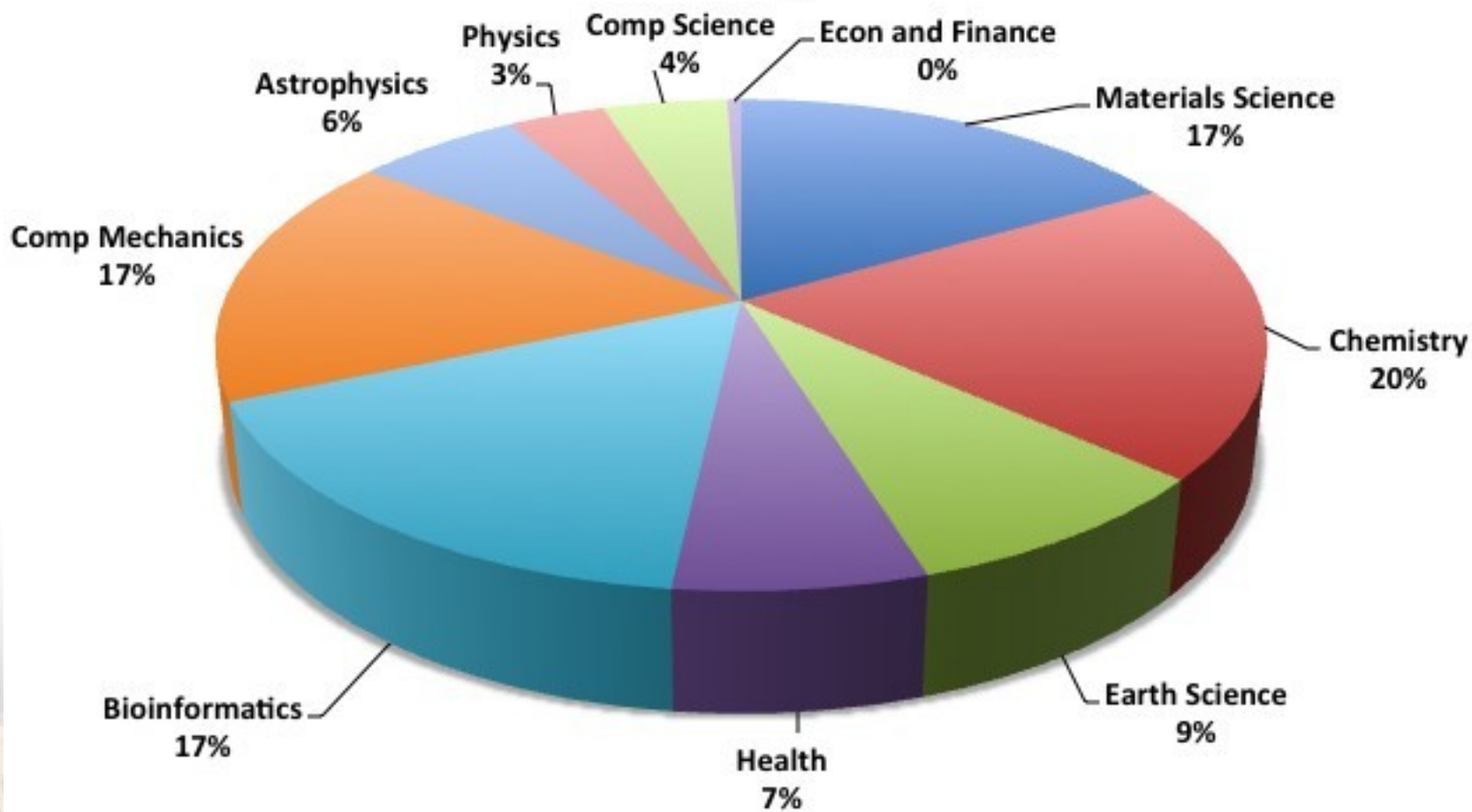


Who is using the CHPC?

Research Programme Number Distribution - LENGAU

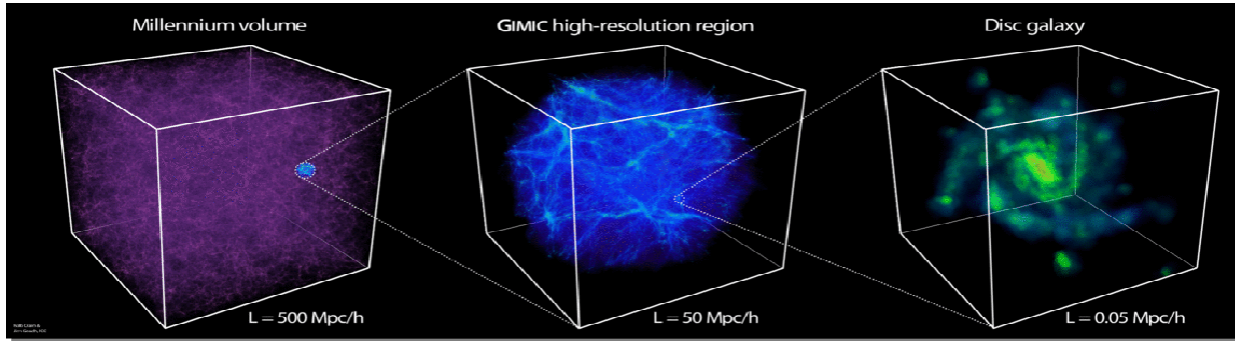
31 August 2017

Total Research Programmes: 197



Application Research Areas

Astronomy/Cosmology



Astronomy/Cosmology (Universe/Galaxy Evolution)

(Courtesy Cress and Cunnaman)



First MeerKAT dish: March 2014

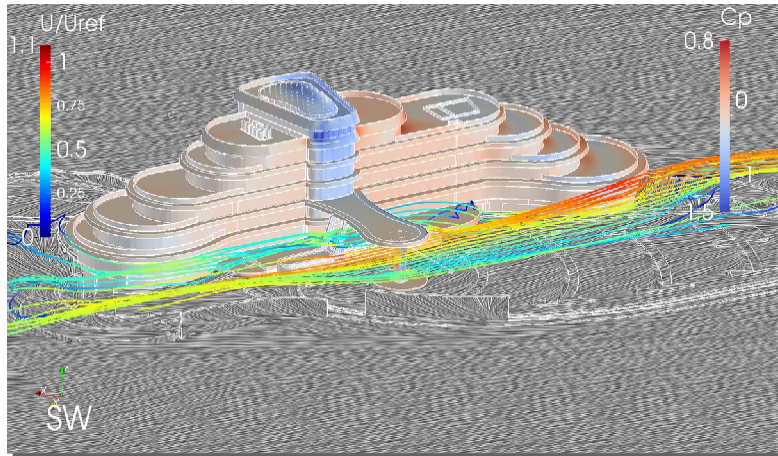
Artist's Impression of SKA Dishes

(SDPO/TDP/DRAO/Swinburne Astronomy Productions)



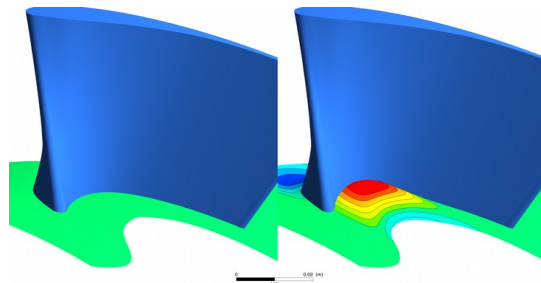
Application Research Areas

Computational Mechanics

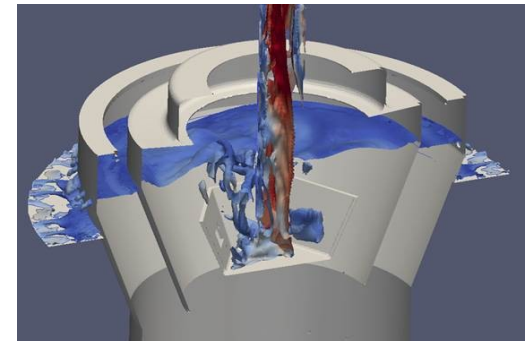


Building aerodynamics (ECLM)

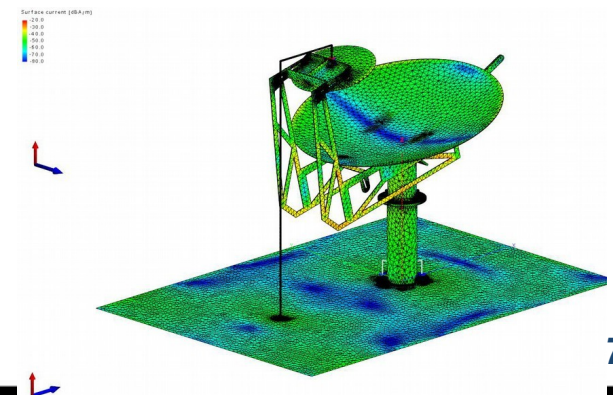
Turbine blade design (UCT):



Elutriator Design (De Beers Marinen)

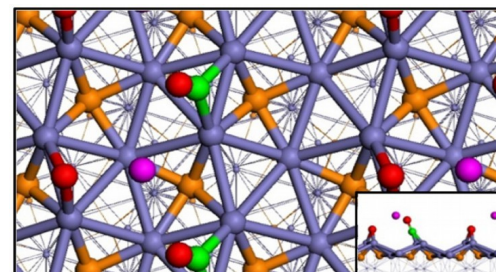
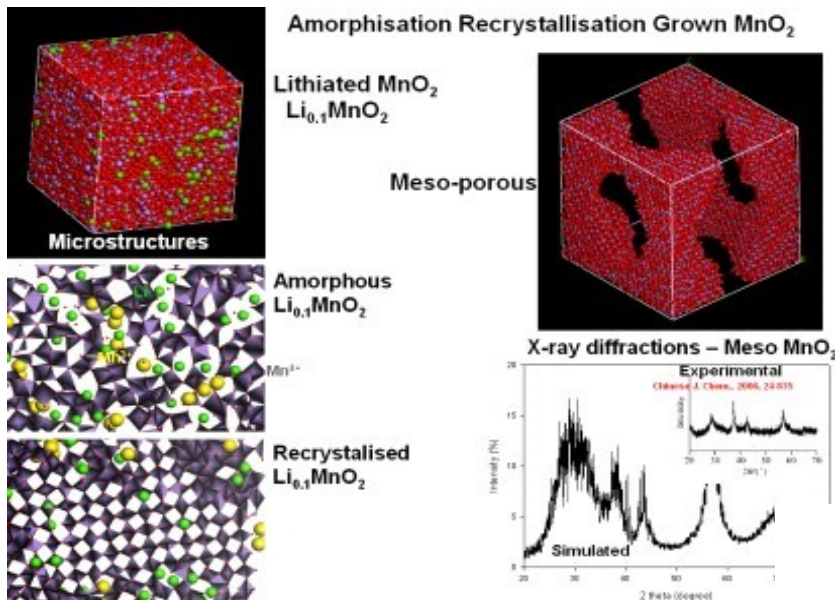


Radio-Astronomy Dish Design (University of Stellenbosch)



Application Research Areas

Materials Science/ Chemistry

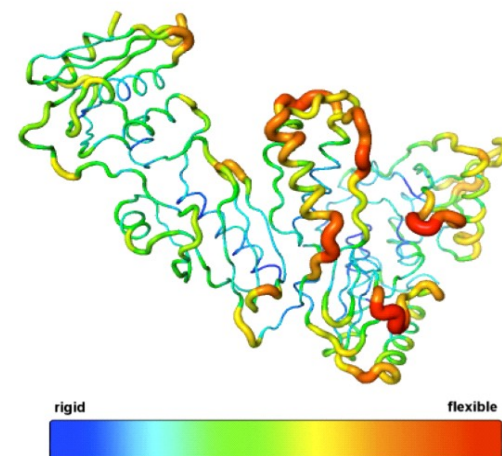


Computational Catalysis (Comp Chem/ Materials Science)

**Energy Storage – Battery Development
(Materials Science)**

Drug- Design (Molecular Modeling)

Computational Chemistry

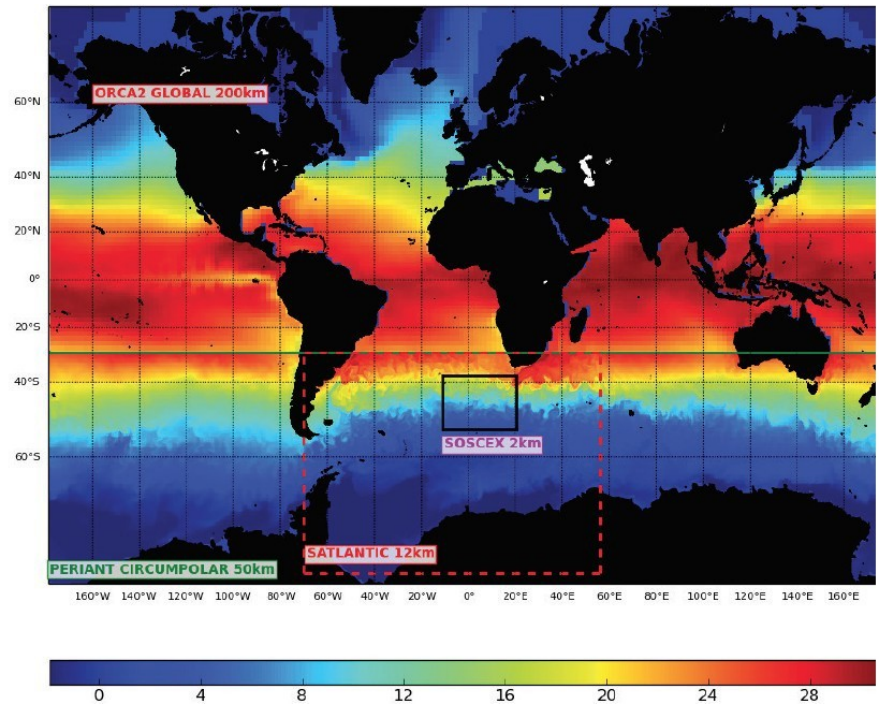


Application Research Areas

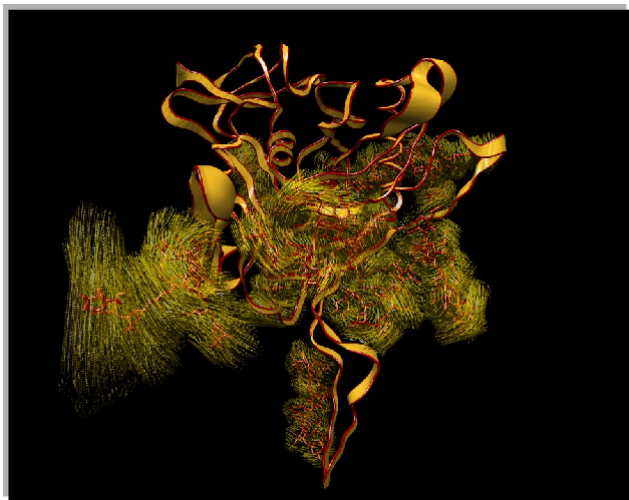
Climate Modelling / Weather



- ❑ African based
- ❑ VRESM Southern Oceans



Application Research Areas



Bioinformatics

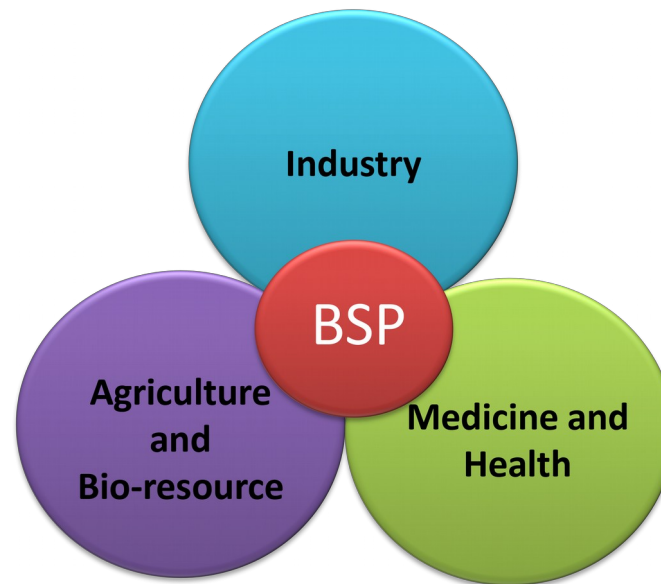
(Example of simulated movement of HIV-1 gp120 protein and attached sugar chains)

Proteomics, Genome sequencing, etc.

(Image courtesy Natasha Wood, SANBI, UWCn)



- ⇒ Coordinated National **Bioinformatics** Support
- ⇒ Enable research application in – Omics technologies (biotechnology, health, agriculture, etc. for bioeconomy)



www.bsp.ac.za

Application Research Areas

High Energy Physics/ CERN

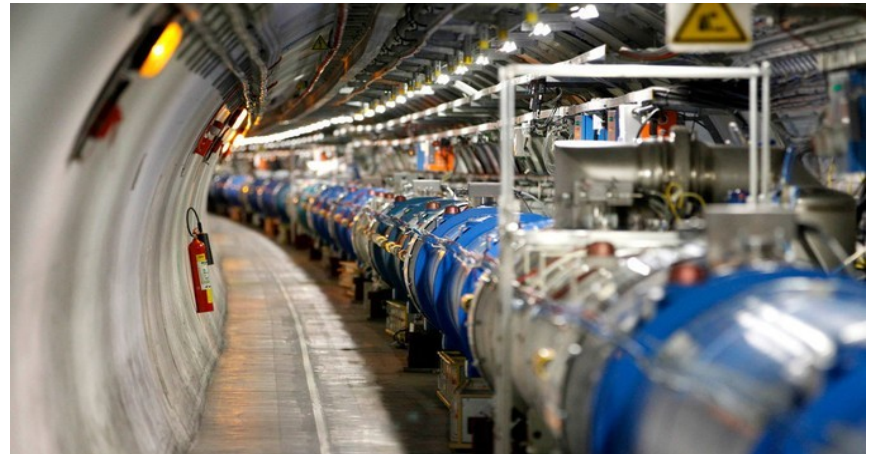
- ❑ **HPC Cluster for GRID computing** – CERN Alice + Atlas Experiments
- ❑ **CHPC is Tier 2 facility** by CERN – SNow 1 of 155 Tier 2 sites in world
- ❑ Infrastructure important **test-bed**

for **SKA related activities**



Inside Large Hadron Collider (LHC) – CERN

(Pierre Albouy, Reuters)



Human Capital Development

- CHPC National Meeting
- Dedicated CHPC Training events
 - Introductory Programming School (Linux and Python)
 - Winter School in Parallel Programming (University of Pretoria in July 2019)
 - Student Cluster Competition (SCC)
 - HPC Ecosystems Project (HPC Systems deployment in Africa)
 - Computer Training for DARA
 - Computer Hardware and Software for School learners (Disassembling and Assembling a Computer and coding using SCRATCH)

CHPC National Conference

2018 CHPC National Conference:

→ **Cape Town, South Africa,**

December 2018

www.chpcconf.co.za

2019 CHPC Conference (TBC)

→ **Johannesburg, South Africa,**

December 2019

www.chpcconf.co.za

Student Cluster Competition

Training undergraduate students in HPC

Three stage program:

(1) Winter school: **22 Teams**

(2) CHPC National Meeting: **10 Teams**

(3) ISC: **1 Team** representing SA

ISC' 17 and 18
Runner-Up **MOST**

ISC'13 Champions



Leipzig

ISC'14 Champions



Leipzig

ISC'15 Runner-Up



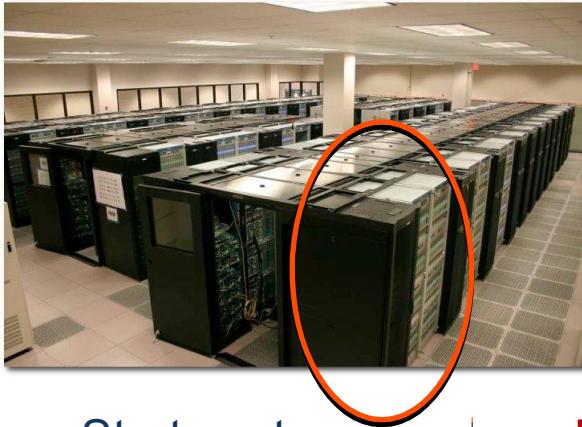
Frankfurt

ISC'16 Champions



Frankfurt

HPC Ecosystem Project



HPC Systems Repurposing



- Strategy to **repurpose HPC's systems** for **local compute** or training needs.
- **HPC Ecosystem initiative** ⇒ Provide mid-range **HPC's systems** to **universities**
- One of **key** strategic **initiatives** of the CHPC
- CHPC initiated the **RANGER Project** – Support to institutions/ universities
 - ⇒ **Do not have** HPC facilities
 - ⇒ Need of HPC resources for **learning**

Computer Training for DARA

CHPC – DARA Partnership

- DARA is UK (University of Leeds) HCD initiative focusing in Radio Astronomy for SKA readiness/AVN countries in Africa (<https://www.dara-project.org/>)
- DARA is mainly funded by Newtown Funding and NRF contribution from SA site
- CHPC Introduced Computer Training to DARA project in 2017
- 2.5 Days Linux Command line and 2,5 Python Programming for Science and Engineering.

Computer Training for DARA **CHPC**



- **20 Students** were trained at EMU, in Maputo, Mozambique (Nov. 2017).
- **12 Students** were trained in KUT, Nairobi, Kenya (Nov. 2017).
- **13 Students** were trained at IOGA, Madagascar (February 2018)
- **19 cohort** of students from Namibia/Botswana and Zambia were trained at HartRAO, South Africa (March 2018).
- 20 Students attended HPC training for Astronomers and Meteorologists in Ghana – June 2018**

Computer Training for DARA

- 20 Students from Kenya and Ghana where trained at Ghana

Space Science and Technology Institute (GSSTI), in Accra, Ghana: 29

April to 03 May 2019.



Supercomputer at CHPC

- ❑ **First phase of Lengau** (Cheetah) launched on **7 June 2016**
- ❑ **783 Tfiop/s** (121st on Top500)
- ❑ **Upgraded Lengau** released on **7 March 2017**
 - ❑ Africa's 1st Petascale system ⇒ **1.029 Pfiop/s**



Supercomputer at CHPC

System Configuration	Phase 1 March 2016:	Phase 2: March 2017:
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 \Rightarrow 24 cores / node)	24 192	32 832
Dell PiowerEdge R930 servers:		
Large Memory Compute Nodes 1024GB / node (FAT nodes)	5	5
4 x Intel Xeon E7-4850 v3 processors (14 Cores Each \Rightarrow 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



Acknowledgement

Funding from UK and SA Newton Funds to support CHPC computer Training for DARA Project (Prof Melvin Hoare from UL and Dr Alet de Witt from SARAQ) .

AND

CHPC support under the DST Big Data initiatives

Thank You for Listening...

***For more information, visit
CHPC:***

www.chpc.ac.za

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