15 Years of SA-CERN Programme

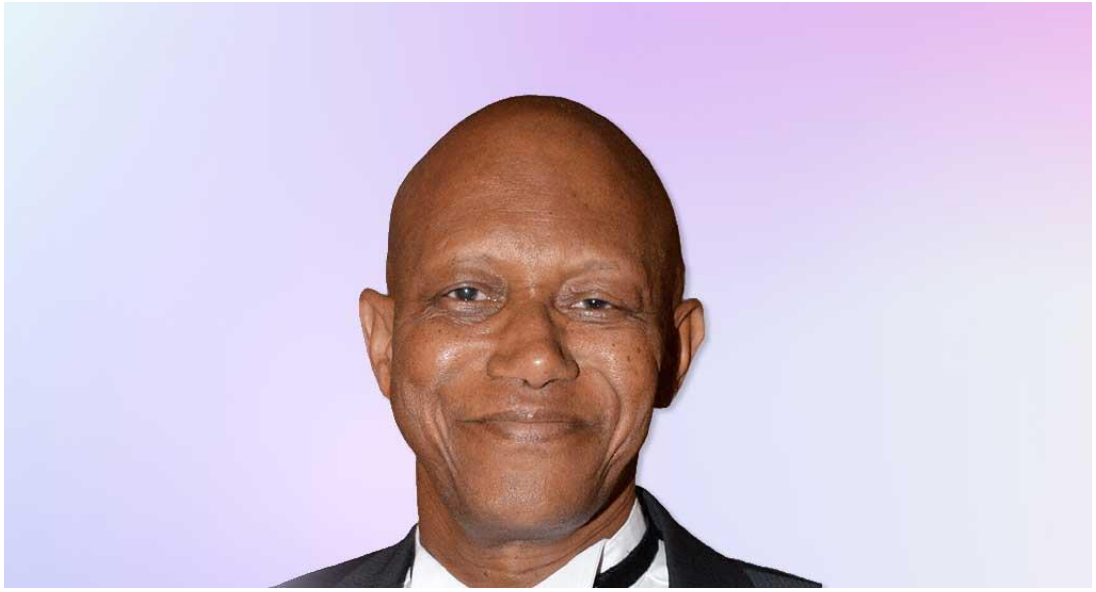
Azwinndini Muronga

20-21 January 2025,
iThemba LABS, Cape Town, South Africa

Contributors to this talk: SA-CERN Consortium members

Remembering “Madzhakandila” of SA-CERN Programme

We stand on the shoulders of trailblazers and champions

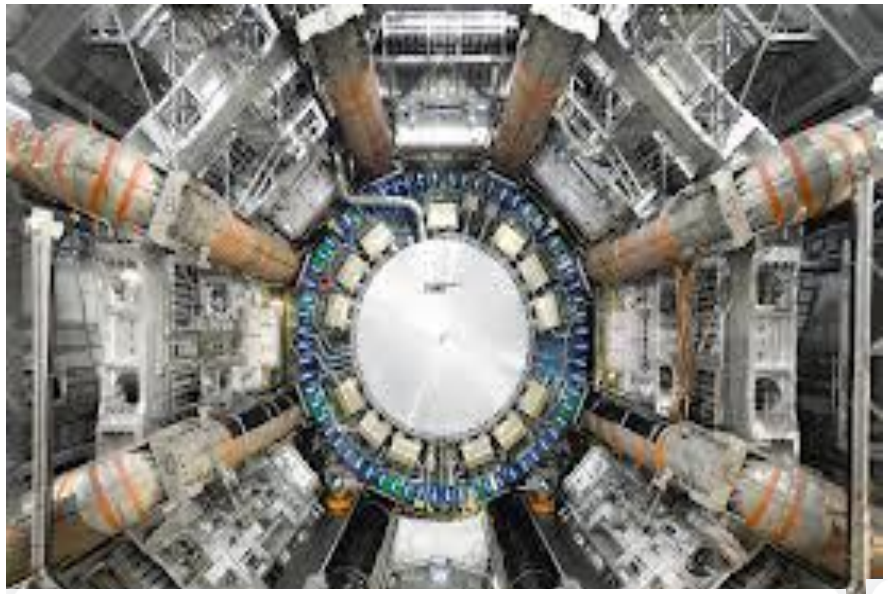


Jean Cleymans (5 August 1944—22 February 2021) was a Belgian physicist and a professor at the University of Cape Town (UCT). He made notable contributions to the area of quark-gluon plasma with focus on statistical hadronization -- Wikipedia

He was the first Chair of SA-CERN Programme

Daniel Adams (…. – 2023) was Chief Director: Basic Sciences and Infrastructure at DSTI. He spearheaded and led many initiatives that are pivotal to the National System of Innovation including national programmes such as SA-CERN, SA-JINR, NTembi, NumeRI, and the flagship research infrastructure initiative, the SA Research Infrastructure Roadmap (SARIR).

Celebration of 15 Years of SA-CERN
iThemba LABS, 20-21 January 2025



SA-ATLAS

Explores fundamental particles and forces, including the Higgs boson, through high-energy particle collisions.

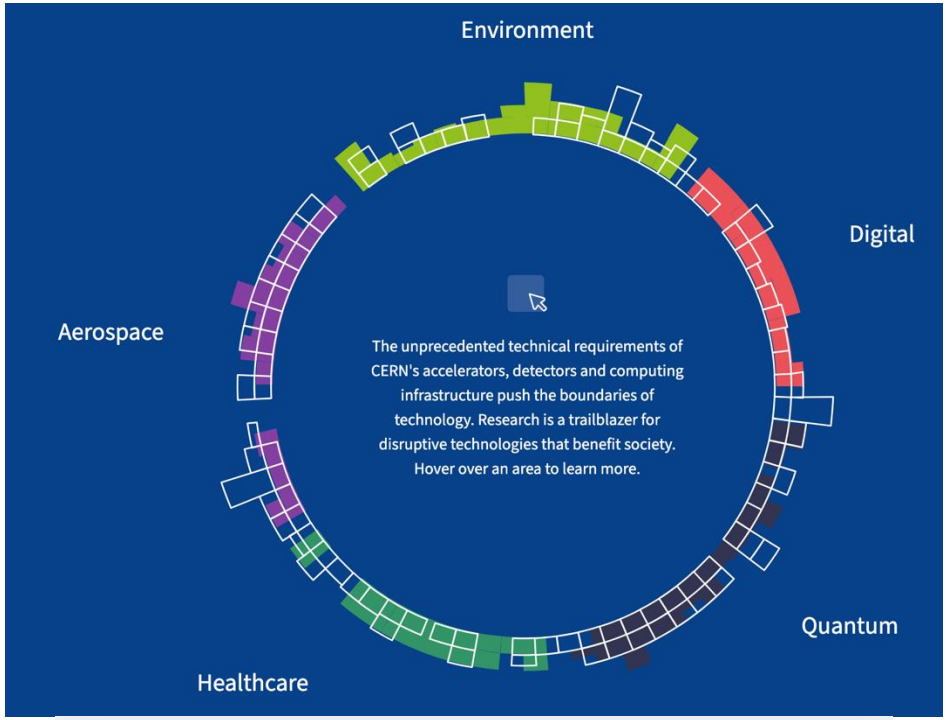
SA-ALICE

Studies quark-gluon plasma, recreating early universe conditions through high-energy heavy ion collisions.

SA-ISOLDE

producing radioactive ion beams for nuclear physics, astrophysics, and medical isotope research.

Celebration of 15 Years of SA-CERN
iThemba LABS, 20-21 January 2025



SA-TT

The SA-CERN Technology Transfer advances knowledge transfer within the research enterprise.

SA-THEORY

Which participates in the High Energy Physics and Nuclear Physics Theoretical research related to work at CERN.

Celebration of 15 Years of SA-CERN
iThemba LABS, 20-21 January 2025

International Particle Physics Outreach Group

INTERNATIONAL MASTERCLASSES
hands on particle physics

International Masterclasses

International Masterclasses 2025 will take place from 24. February - 11. April 2025

South Africa : Policy Framework

From NDP → STI White Paper → STI Decadal Plan

@governmentZA on X

https://www.gov.za/sites/default/files/gcis_document/201912/white-paper-science-technology-and-innovation.pdf

From policy- White Paper on STI

- SA-CERN programme is contributing to White Paper on STI and the STI Decadal Plan

The role of STI in South Africa's National Development Plan

The NDP sets out to address a set of core outcomes covering the following 14 focus areas: education, health, safety and security, economic growth and employment, skills development, infrastructure, rural development, human settlements, local government, environment, international relations, public sector, social protection, and nation-building and social cohesion. As will be evident from this White Paper, science, technology and innovation are key enablers that cut across all these focus areas.

Subject to conditions such as social stability, investment in STI, education and skills development, science, technology and innovation are one way of feeding a virtuous cycle of economic growth and employment in the country. It is for this reason that the NDP includes targets for PhDs and makes specific reference to the need to ensure more research, the productivity of STI investment, and the efficiency of STI institutions.

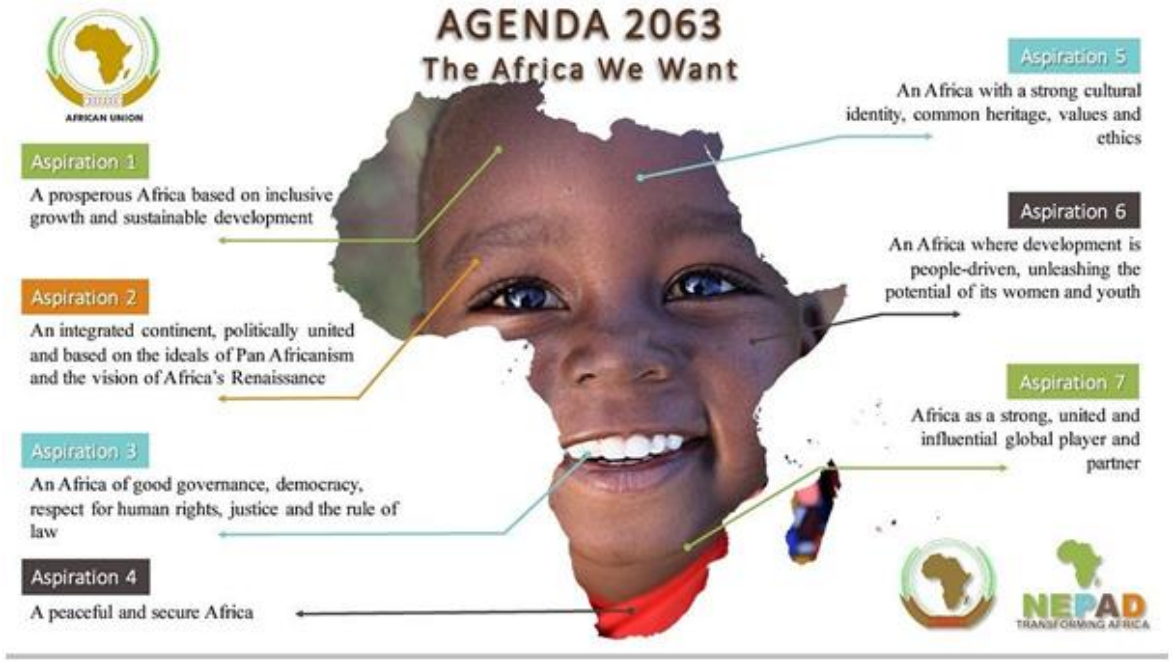
Furthermore, effective STI policies and programmes will help ensure that gains made in addressing the NDP's core outcomes will not be reversed by the impact of the Fourth Industrial Revolution, which is already fundamentally altering the nature of societies and business across the globe.

"No modern society has scaled the heights of social progress without science and technology … Harnessing the force of science and technology to meet South Africa's developmental needs is among the surest ways out of the current quagmire of underdevelopment … Research has shown that nations such as Japan, South Korea and Germany put science, technology and innovation in the service of their societies, with commendable results."

Kgalema Motlanthe, former President of South Africa, addressing the 2013 South African Science, Technology and Innovation Summit

Locating Physics within NDP, Africa Agenda 2063, and UN SDGs

https://www.un.org/fr/teach/SDGs



https://au-watch.org/agenda-2063/

As I have presented at ASP2024 in Marrakech

NELSON MANDELA UNIVERSITY

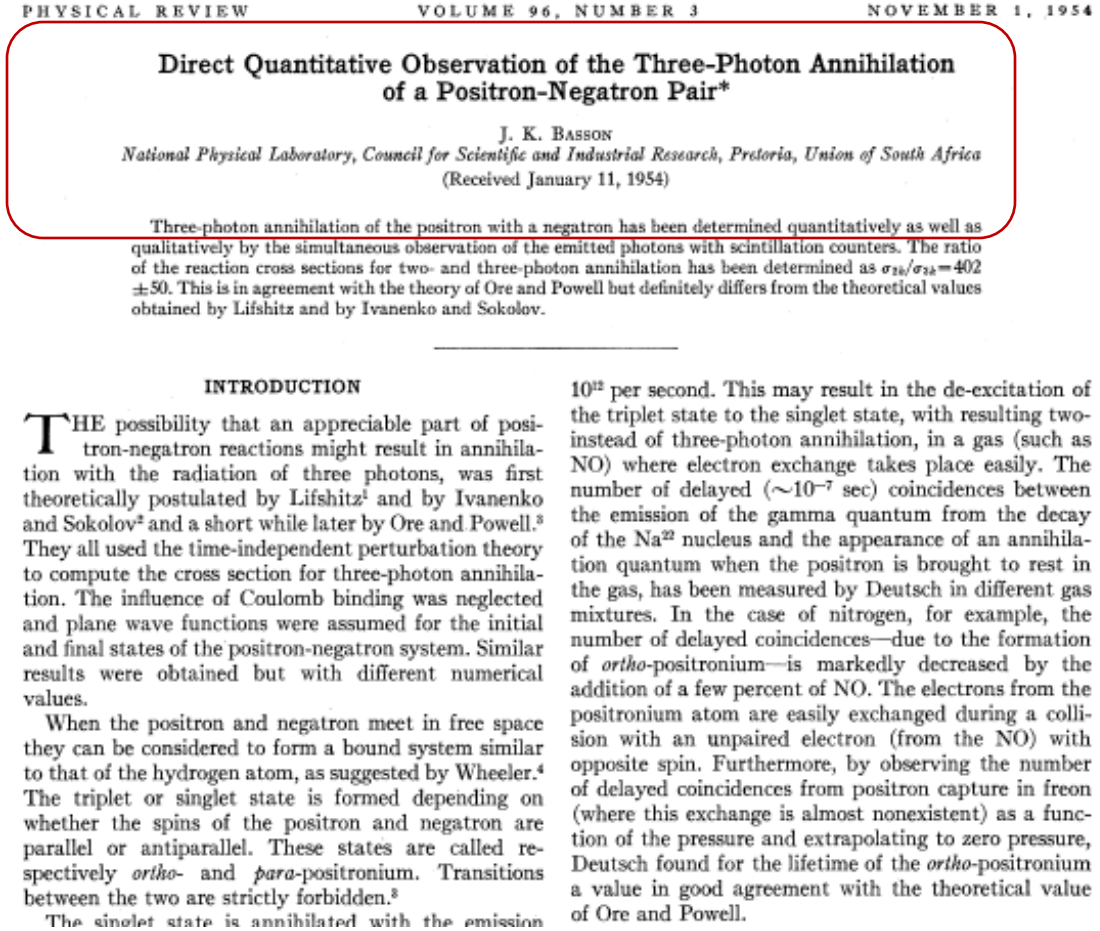
https://www.dominofoundation.org.za/national-development-plan/

Context and South Africa's history of HEP

Some prominent physicists who were educated in RSA

- Stanley Mandelstam (Dirac medal); B. Sc. Hons (Witwatersrand)
- Jonathan Dorfan [ex SLAC director]; B. Sc. (Cape Town)
- Werner Israel [Cosmologist]; B. Sc (Cape Town)
- Saul Teuklosky [Astrophysics] B. Sc Hons (Witwatersrand)
- Peter Sarnack (Maths Wolf Prize); B. Sc. Hons (Witwatersrand)
- George Ellis (FRS) – still at UCT

All the above – barring Ellis – were based abroad.



PHYSICAL REVIEW VOLUME 96, NUMBER 3 NOVEMBER 1, 1954

Direct Quantitative Observation of the Three-Photon Annihilation of a Positron-Negatron Pair*

J. K. BASSON
National Physical Laboratory, Council for Scientific and Industrial Research, Pretoria, Union of South Africa

(Received January 11, 1954)

Three-photon annihilation of the positron with a negatron has been determined quantitatively as well as qualitatively by the simultaneous observation of the emitted photons with scintillation counters. The ratio of the reaction cross sections for two- and three-photon annihilation has been determined as $\sigma_{2\gamma}/\sigma_{3\gamma}=402 \pm 50$. This is in agreement with the theory of Ore and Powell but definitely differs from the theoretical values obtained by Lifshitz and by Ivanenko and Sokolov.

INTRODUCTION

THE possibility that an appreciable part of positron-negatron reactions might result in annihilation with the radiation of three photons, was first theoretically postulated by Lifshitz[1] and by Ivanenko and Sokolov[2] and a short while later by Ore and Powell.[3] They all used the time-independent perturbation theory to compute the cross section for three-photon annihilation. The influence of Coulomb binding was neglected and plane wave functions were assumed for the initial and final states of the positron-negatron system. Similar results were obtained but with different numerical values.

When the positron and negatron meet in free space they can be considered to form a bound system similar to that of the hydrogen atom, as suggested by Wheeler.[4] The triplet or singlet state is formed depending on whether the spins of the positron and negatron are parallel or antiparallel. These states are called respectively *ortho*- and *para*-positronium. Transitions between the two are strictly forbidden.[5]

The singlet state is annihilated with the emission 10^{12} per second. This may result in the de-excitation of the triplet state to the singlet state, with resulting two- instead of three-photon annihilation, in a gas (such as NO) where electron exchange takes place easily. The number of delayed ($\sim 10^{-7}$ sec) coincidences between the emission of the gamma quantum from the decay of the Na^{22} nucleus and the appearance of an annihilation quantum when the positron is brought to rest in the gas, has been measured by Deutsch in different gas mixtures. In the case of nitrogen, for example, the number of delayed coincidences—due to the formation of *ortho*-positronium—is markedly decreased by the addition of a few percent of NO. The electrons from the positronium atom are easily exchanged during a collision with an unpaired electron (from the NO) with opposite spin. Furthermore, by observing the number of delayed coincidences from positron capture in freon (where this exchange is almost nonexistent) as a function of the pressure and extrapolating to zero pressure, Deutsch found for the lifetime of the *ortho*-positronium a value in good agreement with the theoretical value of Ore and Powell.

H SA

EVIDENCE FOR HIGH-ENERGY COSMIC-RAY NEUTRINO INTERACTIONS*

F. Reines, M. F. Crouch, T. L. Jenkins, W. R. Kropp, H. S. Gurr, and G. R. Smith

Case Institute of Technology, Cleveland, Ohio

and

J. P. F. Sellschop and B. Meyer

University of the Witwatersrand, Johannesburg, Republic of South Africa

(Received 26 July 1965)

are favored over the 3π and $\eta+2\pi$ modes, although it probably is still insufficient to account for the vast differences in decay rates between these two types of processes without introducing symmetry-breaking effects. The $\rho+2\pi$ and $\omega+2\pi$ modes are found to be comparable. For a detailed list of branching ratios, see reference 2.

[7]H. Harari, H. J. Lipkin, and S. Meshkov, Phys.

other way with equal amounts. Therefore, the statistical average of the $\rho+3\pi$ processes should not be greatly perturbed.

[8]See reference 1 for a summary of the experimental data.

[9]R. Armenteros et al., Phys. Letters 17, 170 (1465); N. Barash et. al., "Antiproton Annihilation in Hydrogen at Rest I, Reaction $\bar{p}+p\to K+\bar{K}+\pi^0$" (to be published).

EVIDENCE FOR HIGH-ENERGY COSMIC-RAY NEUTRINO INTERACTIONS*

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The flux of high-energy neutrinos from the decay of K, π, and μ mesons produced in the earth's atmosphere by the interaction of primary cosmic rays has been calculated by many authors.[1] In addition, there has been some conjecture[1] as to the much rarer primary flux of high-energy neutrinos originating outside the earth's atmosphere. We present here evidence[2] for the interactions of "natural" high-energy neutrinos obtained with a large area liquid scintillation detector (110 m^2) located at a depth of 3200 m (8800 meters of water equivalent, average $Z^2/A \simeq 5.0$) in a South African gold mine.

The essential idea of the present experiment[3] is to detect the energetic muons produced in neutrino interactions in a mass of rock by means of a large area detector array imbedded in it. Backgrounds are reduced by the large overburden and by utilizing the fact that the angular distribution of the residual muons from the earth's atmosphere is strongly peaked in the vertical direction at this depth. The angular distribution of the muons produced by neutrino interactions should show a slight peaking in the horizontal direction.[4]

The detector array, shown schematically in Fig. 1, consists of two parallel vertical walls made up of 36 detector elements. The array is grouped into 6 "bays" of 6 elements each. Each detector element, Fig. 2, is a rectangular box of Lucite of wall area 3.07 m^2 containing 380 liters of a mineral-oil based liquid scintillator,[4] and is viewed at each end by two 5-in. photomultiplier tubes. The array constitutes a hodoscope which gives a rough measurement of the zenith angle of a charged particle passing through it. In addition, the event is located along the detector axis by the ratio of the photomultiplier responses at the two ends. The sum of the responses then pro-

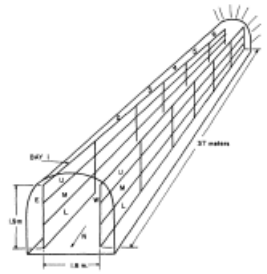
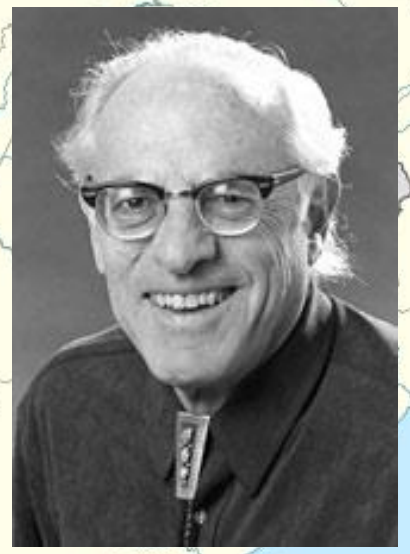
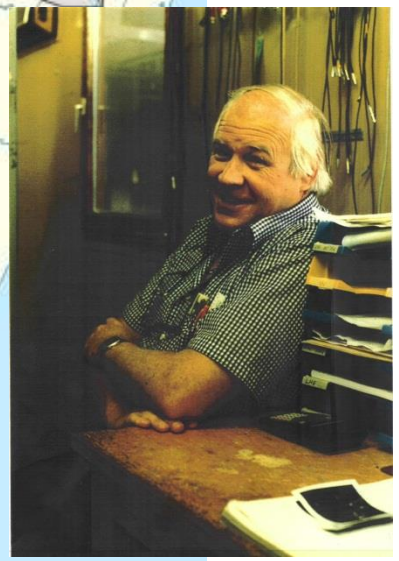


FIG. 1. Schematic of detector array.

429





Frederick Reines

Friedel Shellschop

Phys Rev Lett, 15, 429 (1965)

History of SA's contribution to frontier–level Nuclear & High Energy Physics

- The Past...
- Contributions by scientists working (or on work done) in SA
- Lower limits on electron neutrino mass at ERPM: F. Reines (Nobel Prize 1995) & J.P.F. Sellschop (Wits)
- Highly cited "Strangeness enhancement..." paper: J. Rafelski (UCT) & Muller (more than 1000 citations)
- Development of a highly successful statistical model for the description of particle production in Heavy-Ion collisions: J. Cleymans (UCT)
- Highly regarded papers in String Theory: R. de Mello Koch & J. Rodrigues (Wits)
- South Africans have built one of the most respected cyclotrons in the world (iThemba LABS)

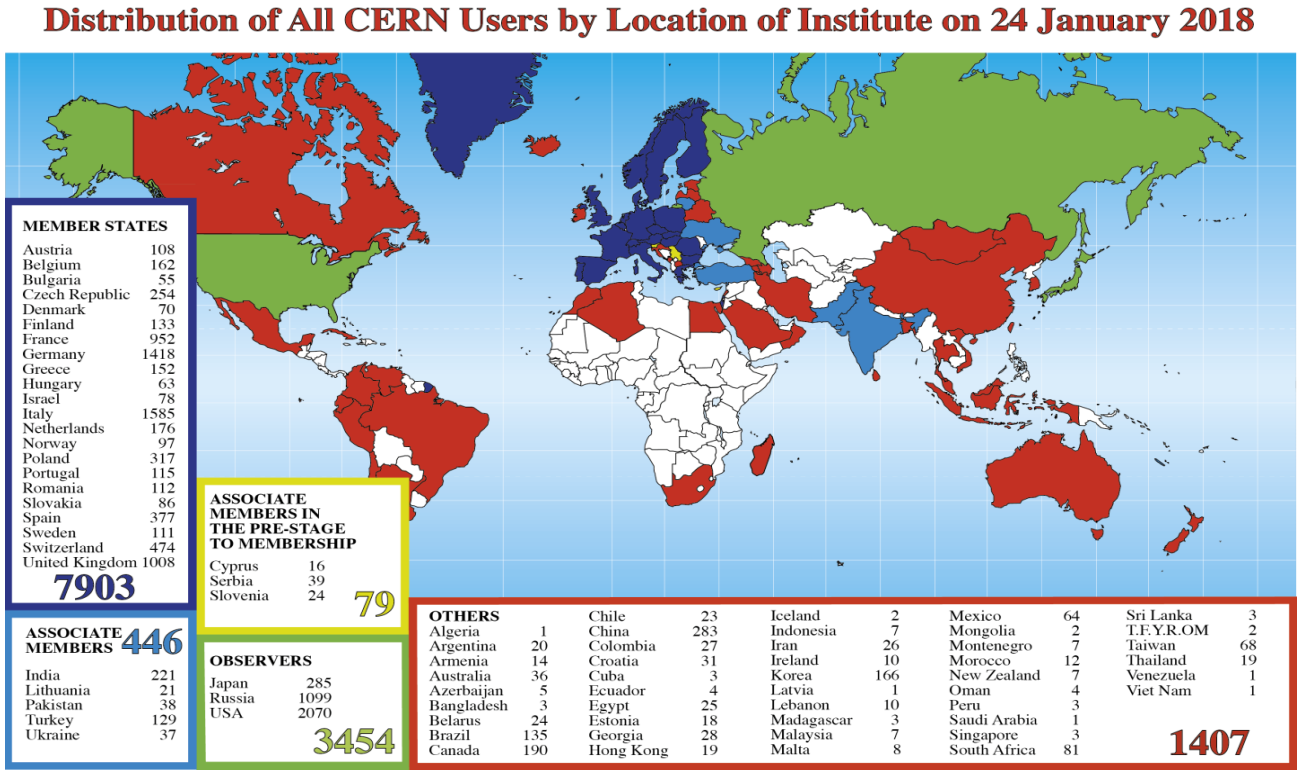
Current issues and the African context

About 0.5% of CERN users are African Nationals

Low participation of African scholars in major research labs around the world. Some examples:

- CERN users
- Users of LHC experiments

Not limited to CERN. Broader issue



Opportunity: African Youth Bulge and fast growing economies (albeit from low-base) like Asian economies of past decades.

High Energy Physics in Africa

High Energy Physics in Africa, Latin America and other developing regions

Kétévi A. Assamagan[a,*], Johan Sebastian Bonilla[b], Claudio Dib[c], Azwinndini Muronga[d], Heath B. O'Connell[e], Rogerio Rosenfeld[f], Suyog Shrestha[g]

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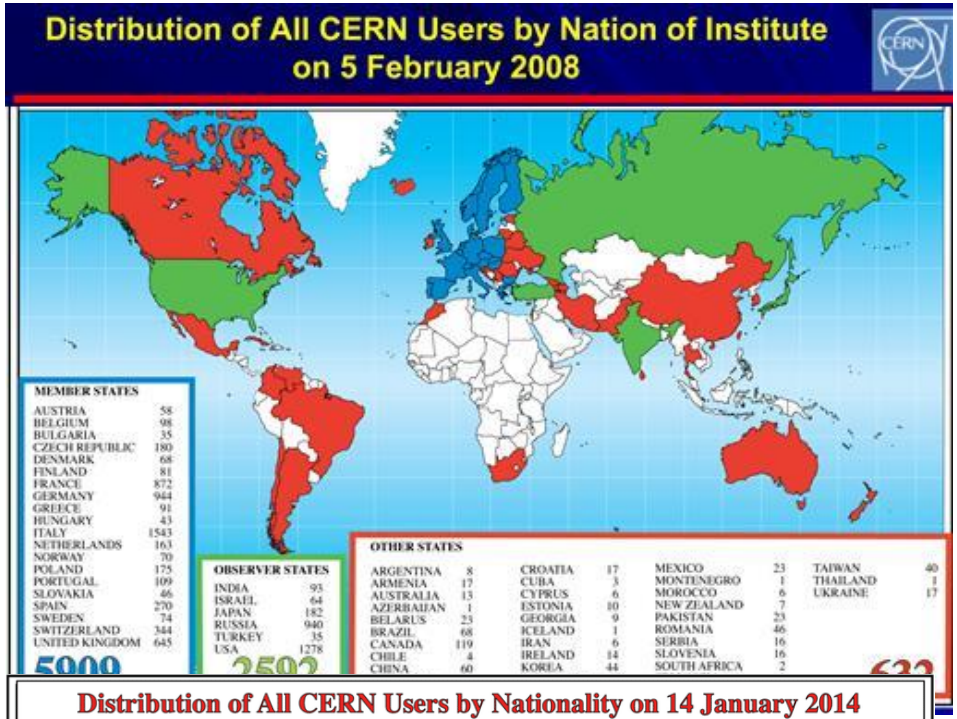
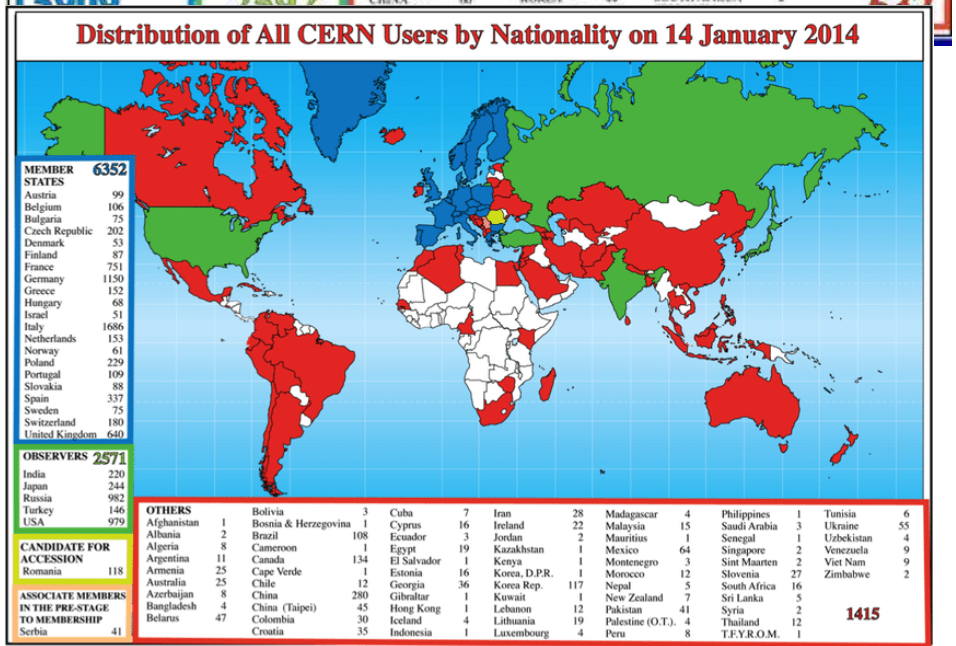
[d] *Faculty of Science, Nelson Mandela University, Gqeberha, South Africa*
[e] *Fermi National Accelerator Laboratory, USA*
[f] *Instituto de Física Teórica, UNESP and ICTP-SAIFR, Sao Paulo, Brazil*
[g] *Washington College, Chestertown, MD USA*

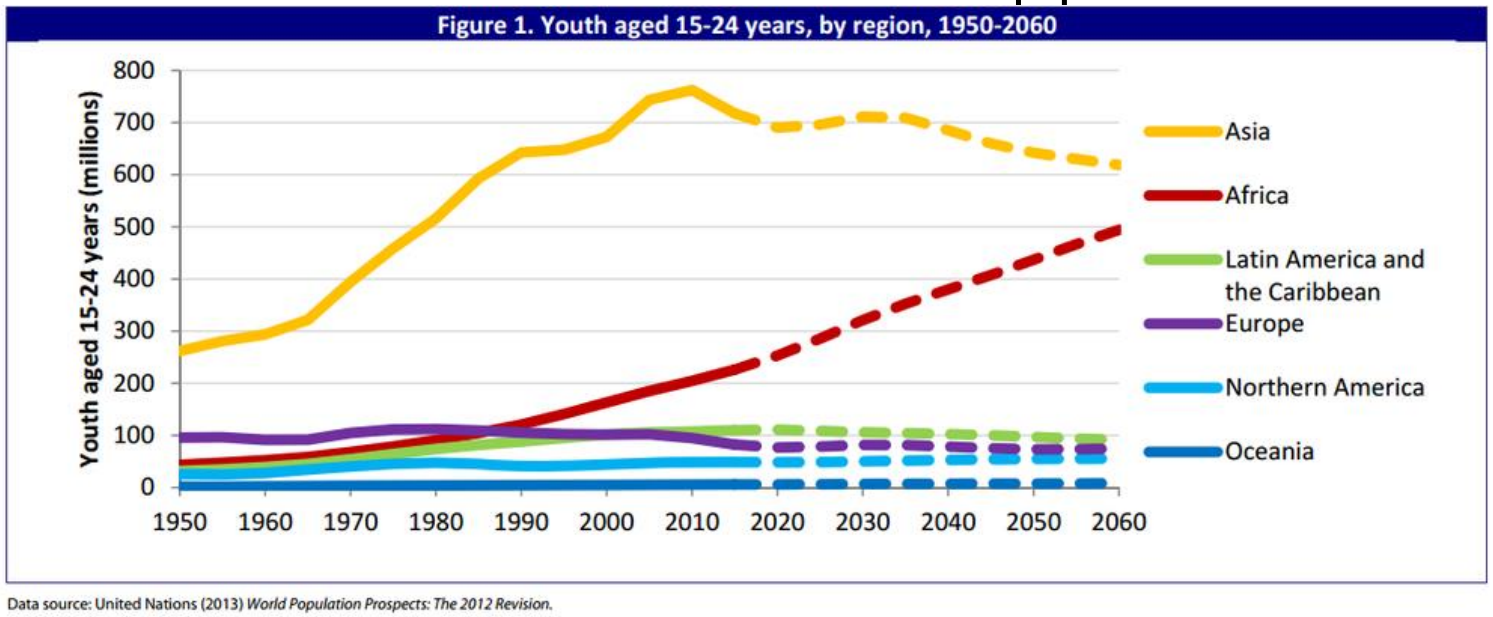
Abstract

We summarize the current status of high energy physics (HEP) in Africa, Latin America, and other developing regions.

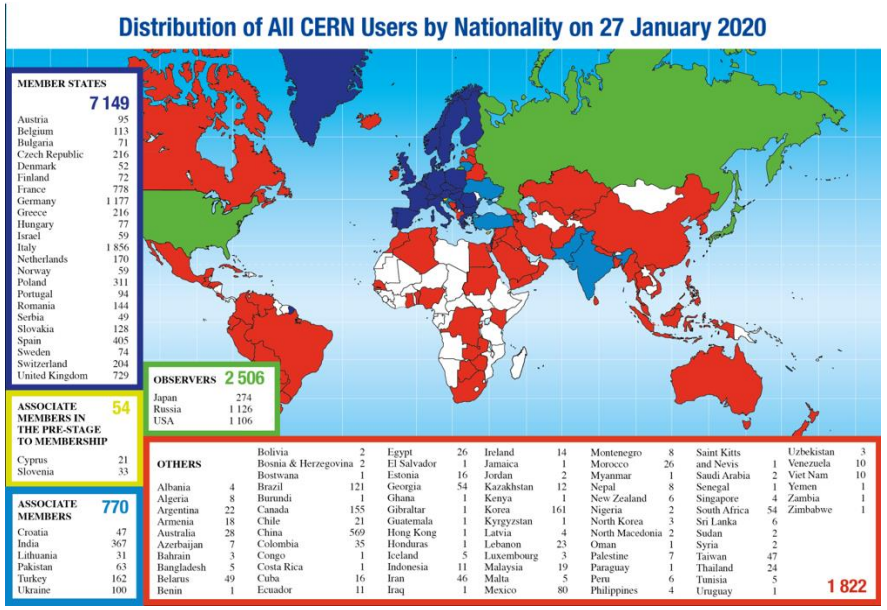




The rise of Africa's Youth population – Challenges and opportunities



Data source: United Nations (2013) *World Population Prospects: The 2012 Revision.*

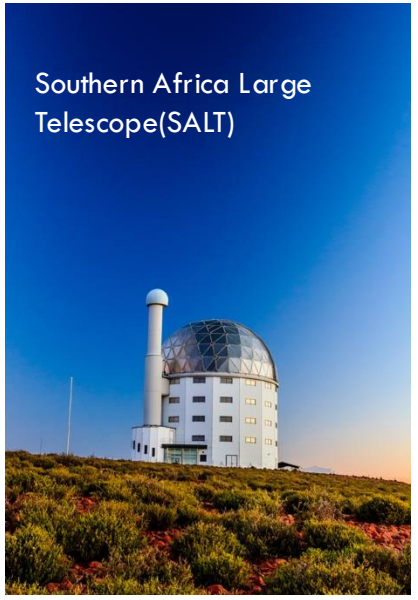


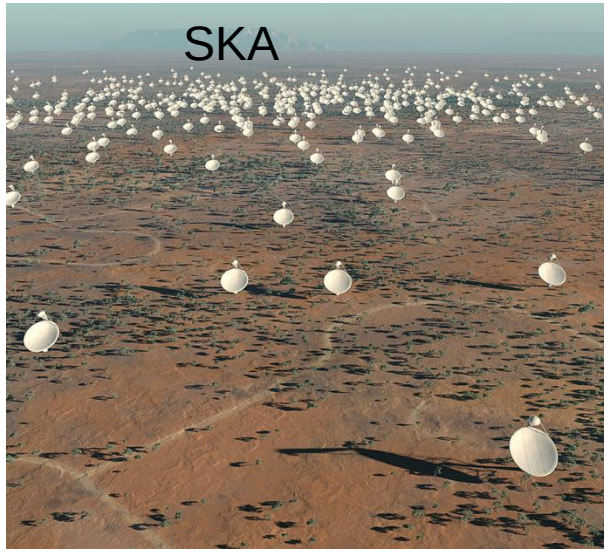
- Major research research facilities coming to Africa

- SKA - The largest radio astronomy observatory to be (co-) hosted by South Africa (70%) and Australia (30%) : meaning that two Global/Geographical South nations will be at the heart of managing and driving the project; and this will need a large African STEM workforce

- Africa and in particular Southern Africa has geographic advantage in astronomy research (besides point of human origins)

- In Africa the diversity challenge is both local and global.





South African Science at external Large Scale International Facilities

Astronomy : SARAO, SALT, MeerKAT, SKA, ….

Nuclear : iThemba, …

Other : NITheCS, CHPC, SA HEIs and Research Councils, SANSA

HEP/Nuclear : CERN, JINR,GSI,

Interdisciplinary : Synchrotrons

Astronomy : HESS, CTA, LIGO

SA OFFICIALS AT CERN

1992: Signing of first Co-operation Agreement by FRD (NRF) President R Arndt and CERN D-G Nobel Laureate Prof C Rubbia

2005: Visit by Minister of Science of Technology Mr Mangena

2011: Visit by Minister of Science of Technology Mrs G. N. Pandor

Minister of S &T : M. Kubayi-Ngubane

May 15 2018

Background: UCT-ALICE to UCT-CERN

- UCT joins ALICE (November 2001)
- UCT-CERN Research Centre (August 2003)
- SA-CERN (15 December 2008)
  - ALICE: UCT and iThemba LABS
- MoU – Muons & Grid Computing (21 March 2011)
- Wits joins ALICE (March 2014)
- CHPC signs MoU: computing for ALICE&ATLAS (April 2015)

10 Issues CAPE ARGUS, WEDNESDAY, MAY 1, 2002 Dates Looking for that someone special? Call Dateline on 082 232 5300. How is the rand holding up? SEE PAGE 12

SCIENCE

City boffins join Alice for a Big Bang

The University of Cape Town is among key sites in a world computer linkup on the Net that aims to recreate the beginning of the universe. Education Reporter **Jeanne van der Merwe** reports

A GIANT project, involving UCT and spearheaded by the world's largest nuclear physics research centre, seeks to to recreate the first few microseconds after the Big Bang and create pre-atomic "particle soup".

It will take about a thousand scientists from 28 countries, representing 78 institutes, several years to complete the experiment, led by the European Organisation for Nuclear Research (Cern) near Geneva, Switzerland.

The team of eight University of Cape Town physicists, led by world-class A-rated nuclear physicist Professor Jean Cleymans, is the only representative of Africa and the Southern Hemisphere to take part in the project.

And the Cape Town scientists will also be helping create the next generation of the World Wide Web.

Dubbed Alice (short for "A Large Ion Collider Experiment"), the experiment seeks to recreate a kind of the "particle soup" that existed for a few fractions of a second after the Big Bang (the moment the universe started) while it was still too hot for atoms to be formed.

The experiments themselves will be done at Cern, but in order to analyse the mass of data generated when millions upon millions of atoms collide, they need thousands of scientists and enormous computer capacity.

Cleymans, one of the world's leading thinkers in the field of nuclear physics, explained: "With this experiment we are trying to get as close as we can to the Big Bang. We can never get to the Big Bang itself, because that only happened once and can never happen again.

"But if we collide different ions together at high enough speed, we might make them 'melt' into one, making the different atom nuclei indistinguishable and recreate that condition of quark gluon plasma ('particle soup') that probably existed a microsecond or so after the Big Bang, long before atoms started defining themselves in electrons, protons and neutrons."

In the experiments, scientists will use a Cern accelerator 26km in circumference to collide lead ions (lead atoms with an electric charge) at a fraction slower than light speed.

To ascertain whether they succeeded in making the quark gluon plasma, they have to track the paths of millions upon millions of subatomic particles generated by the atoms' collisions in the accelerator. This is why they need a completely new kind of computer "grid" with enough collective brainpower to receive and process all information.

This revolutionary "data grid" is similar to the World Wide Web, but it can run programmes collectively instead of merely exchanging data files as the current Web does.

The project will cost more than R650 million, funded mostly by western European countries, with substantial contributions from Japan, the United States and India.

Team member Zebion Vilakazi, a UCT lecturer who has done postdoctoral studies at Cern, said Cleymans's expertise on nuclear physics was one of the main reasons why the university had been asked to join the programme.

"Jean Cleymans has been actively involved in this field for more than 20 years and he is regarded as one of the leading authorities in the world."

The UCT team's job within the experiment is to design a way of selecting the data most relevant to the experiment.

"The experiment simply creates too much data, and there are certain events within the experiment that are more important than others. We are finding a way of streamlining the information and selecting only the most useful events. For that we need a computer programme that can make thousands of decisions a second. This is crucial for the success of the project, because if you lose one track of an important ion, you could lose a valuable part of the experiment, and finding it again would be like finding a needle in a haystack."

Cleymans said it was a seminal moment for South African science to collaborate in such a comprehensive programme.

"In the past we have not been able to participate in this kind of project, particularly due to sanctions and the political situation. It also doesn't happen often that such a large number of researchers from one department takes part in a programme – currently we have about a third of the physics department's staff working on this, and we would like to get more students on board."

He said the fact this was the biggest and most expensive physics experiment currently in the world could lead to pitfalls.

"With so many researchers on one project, sociology does come into play. There are a lot of big egos involved, and the whole enterprise has to be co-ordinated very well."

Cleymans said a data grid in Cape Town would enable scientists to investigate how well the computer system worked over a long distance.

UCT joined the Alice collaboration last November, and Cleymans estimated that the group would be ready for computer test runs by September.

The Department of Arts, Culture, Science and Technology has approved a R200 000 donation for the project, and UCT's research committee has approved funding for 20 computers to be used in the international data grid.

Pinball wizards: UCT physics professor Jean Cleymans and colleague Zebion Vilakazi with an electronic image of subatomic particles while they are colliding in an accelerator.

THE CAPE ARGUS (1ST MAY 2002)

THE SA-CERN PROGRAMME JOURNEY

The

Trailblazers

“Madzhakandila”

The Launch of SA-CERN Programme

The South Africa CERN Programme

The main aim of the SA–CERN programme is to make the facilities at CERN available to South African researchers, engineers, technicians and students.

SA-CERN sub-programs:
SA-ALICE, SA-ATLAS, SA-ISOLDE, and SA-THEORY

10 Years of SA-CERN Celebration
November 19-21, 2018

From UCT-CERN to SA-CERN

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Telephone +27-21-650-4062
e-mail cleymans@qgp.phy.uct.ac.za
Professor Jean Cleymans
Director UCT-CERN Research Centre

May 4, 2007

Minister M. Mangena
Department of Science and Technology
Pretoria
via
Dr. P. Mjwara
Director General
Department of Science and Technology
Pretoria
via
Professor C. de la Rey
Deputy Vice-Chancellor
University of Cape Town

To the Honourable Minister of Science and Technology,

Re: Collaboration between South Africa
and the European Centre for Nuclear Research (CERN)

For many years several physicists have been making use of the facilities at CERN, located in Geneva, Switzerland, taking part in high quality research projects. The support for these projects has always been on an ad-hoc basis. After much discussion with colleagues, it has been suggested that a formal proposal be made to coordinate the research being done by South African scientists at CERN and to have funding for this at the level of around 5 000 000.00 Rands. The project would be based at iThemba LABS since all groups have regularly contact meetings there. This would provide a major boost for research in nuclear and particle physics in South Africa and would provide support for many activities related to nuclear physics in the country. We kindly ask the Minister to support this proposal.

Yours sincerely,

Jean Cleymans
for:
Krish Bharuth-Ram (UKZN) Simon H. Connell (Wits)
S. Karataglidis (Rhodes) Z.Z. Vilakazi (iThemba LABS)

June 30 2005

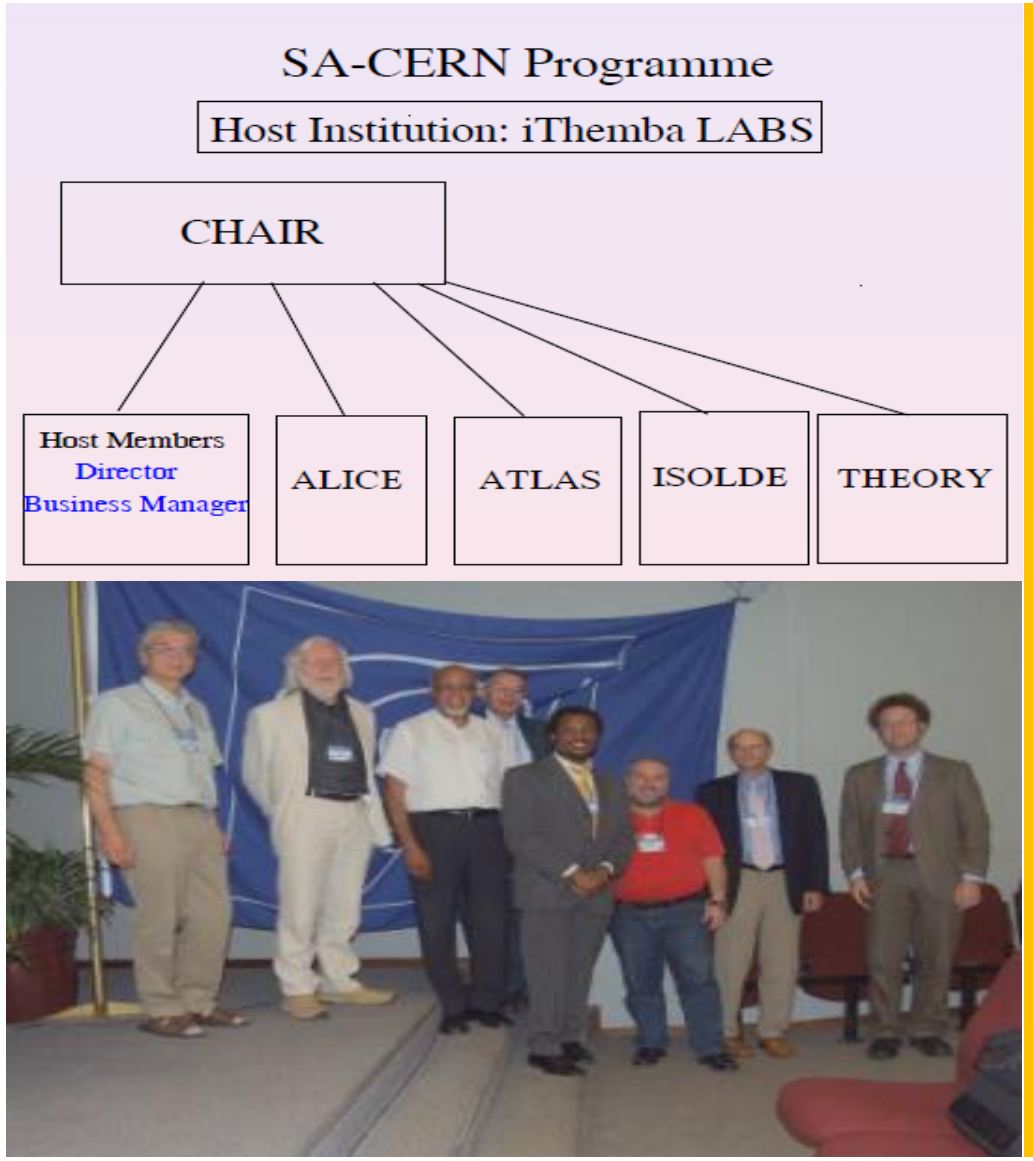
July 20 2007

The SA-CERN Programme

1. Started as a consortium of researchers who had long standing research program with CERN

2. Modelled along the Australian, Indian and Brazilian programs.
   - Allows for central point of coordination and resource allocation.
3. Agreement was that iThemba LABS would act as a neutral institutional hosts for the SA-CERN program:

Has been recognised by the ministry as an exemplar for other multi-lateral collaborations: SA-JINR



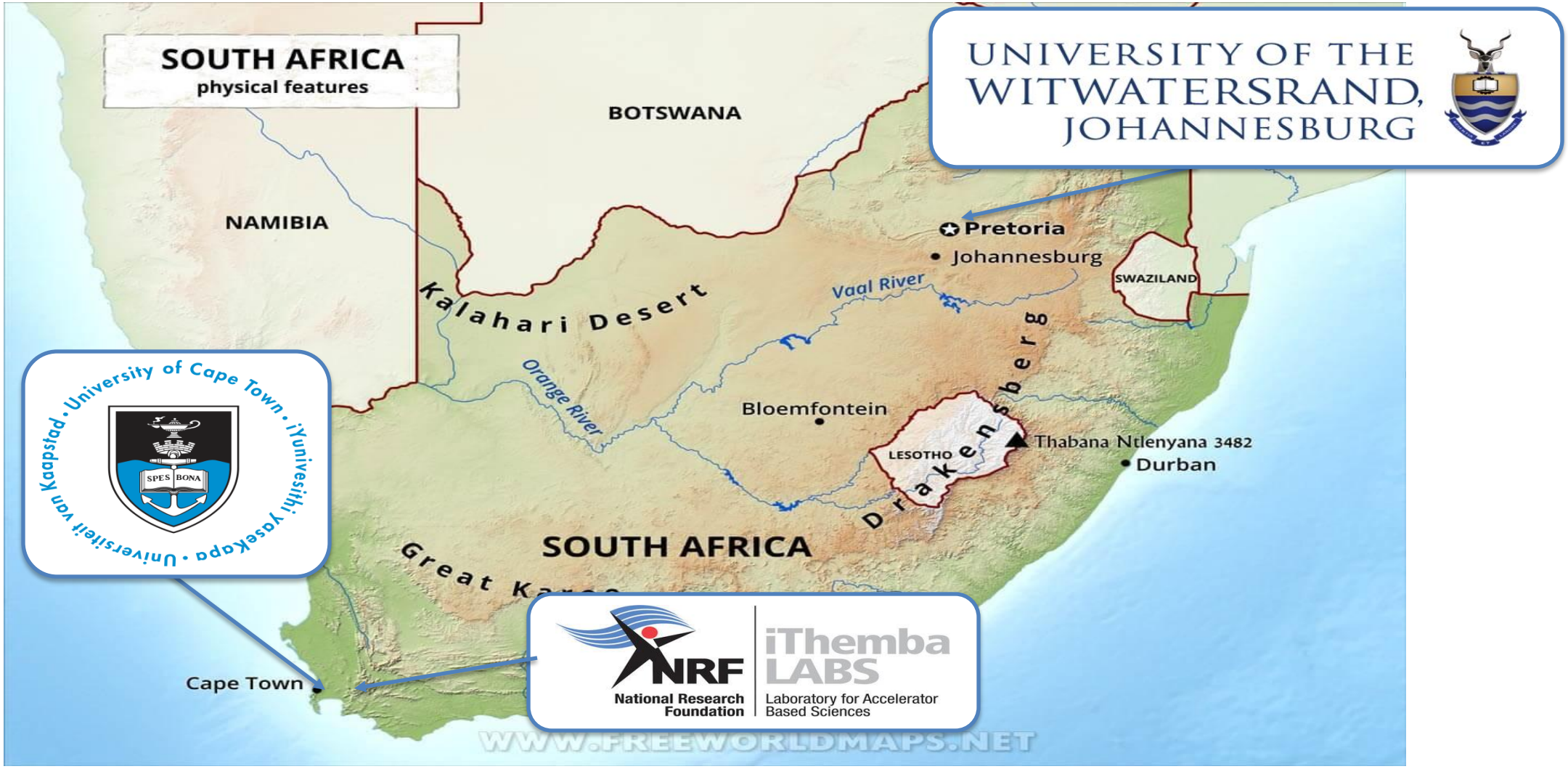
Host of the National SA-CERN Programme: iThemba LABS

National coordinators are elected.
Chairman is elected by the national coordinators.

Launch of the SA-CERN consortium December 2008.

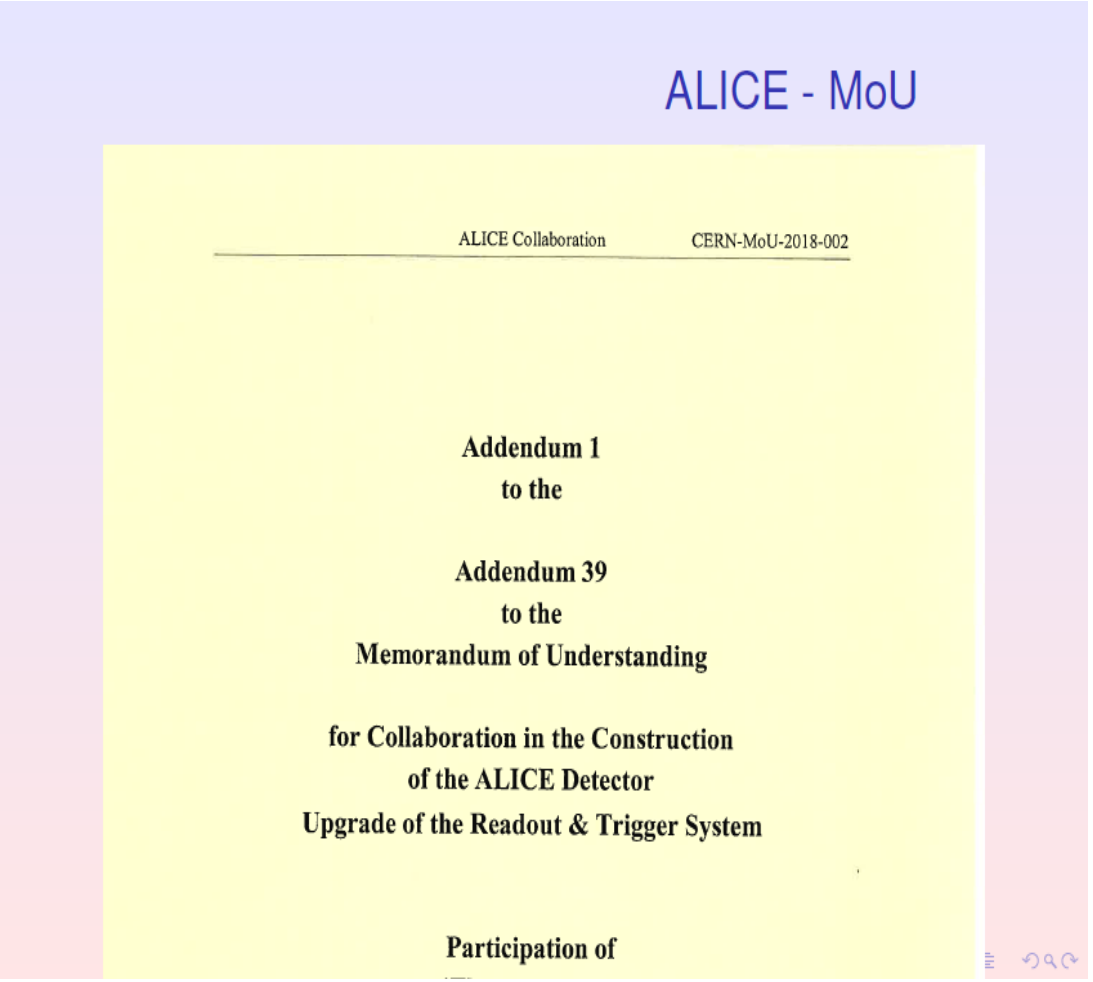
NRF National Research Foundation 25 iThemba LABS Laboratory for Accelerator Based Sciences

ALICE in South Africa



ALICE

- Principal Scientists:
  - Zinhle Buthelezi (iThemba LABS),
  - Siegfried Förtsch (iThemba LABS),
  - Zeblon Vilakazi (WITS)



SA at ALICE

European Laboratory for Particle Physics

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ALICE MATTERS

A Large Ion Collider Experiment

ALICE

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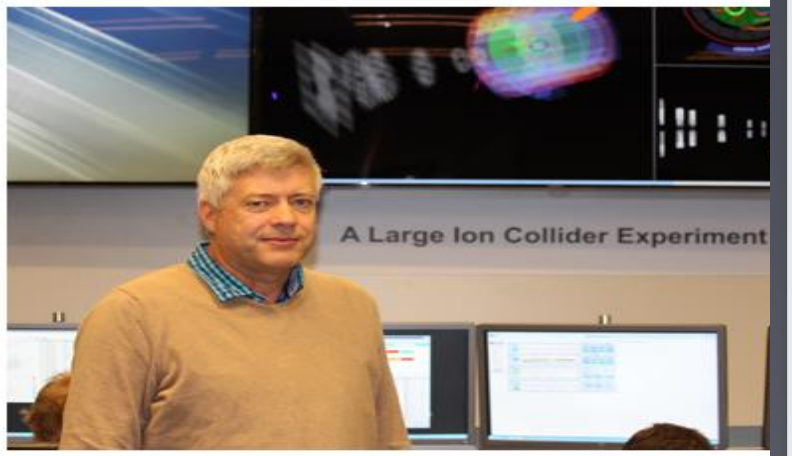
Focus on: Siegfried Förtsch

by Iva Raynova. Published: 28 February 2016

The new run coordinator of ALICE



Siegfried was born in Germany but raised in South Africa. While still in high
the idea to study medicine: *"I wanted to study science and to help others at t*
When he got to University though, he fell in love with physics: *"We had*
inspirational physics lecturers at university, especially on the theory side.
interest in physics became stronger and stronger and eventually overrode al

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Home | Issues | About

Focus on Edith Zinhle Buthelezi

by Virginia Greco. Published: 11 June 2018

Edith Zinhle Buthelezi, who is a senior scientist at iThemba LABS, Somerset West, South Africa, has been the ALICE Run Manager for some of the latest weeks and has also participated on behalf of the Collaboration in a ***Facebook live event*** *organized by CERN and held on May 30th. We spoke to her to know more about her career path and scientific interests.*

Edith is a member of the ALICE Collaboration since 2007 and is involved in the muon spectrometer activities and its upgrade. A nice and cheerful person, she is very enthusiastic about her job and her involvement in ALICE. The path that led her into high-energy nuclear physics and CERN, though, was not straightforward but presented some twists and turns.

When she was a youngster, Edith was convinced that she wanted to be a medical doctor. So, when the time came, she enrolled for a medical degree in Cape Town. But, after some time, she realized that she was rather interested in natural sciences, so she dropped

Recent Comments

Congratulations !
on: **Focus on Marco van Leeuwen**
1 year 6 months ago

Farewell Paolo
on: **Paolo Giubellino's end-of-mandate message**
1 year 10 months ago

Great Event
on: **Happy 30th birthday, heavy-ion physics!**
1 year 11 months ago

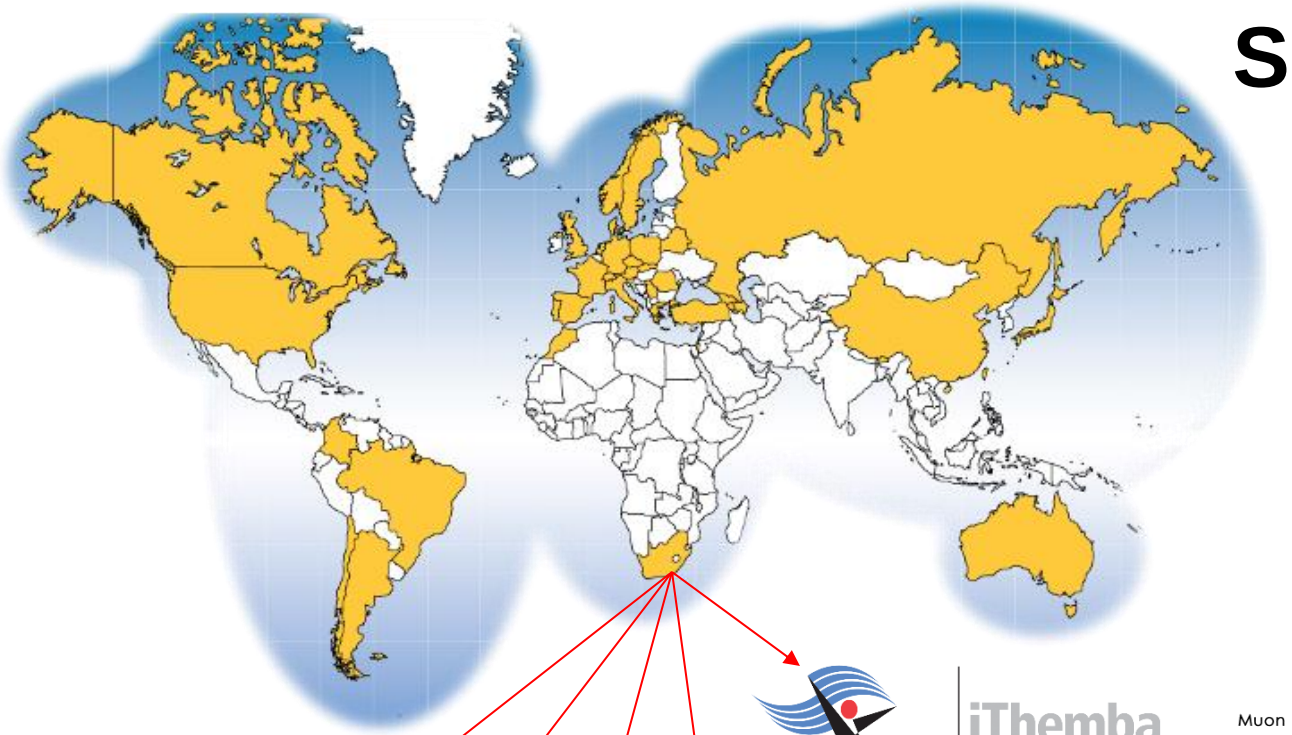
Hadron-nucleus collisions
on: **Exciting times for ALICE: the new heavy-ion run is starting**
2 years 6 days ago

Congratulations
on: **Federico Antinori elected as the next ALICE Spokesperson**
2 years 6 months ago

Archive

October 2018 (7)
September 2018 (5)
August 2018 (5)
July 2018 (6)
June 2018 (6)
May 2018 (8)
April 2018 (4)
March 2018 (6)
February 2018 (7)
December 2017 (7)
November 2017 (9)

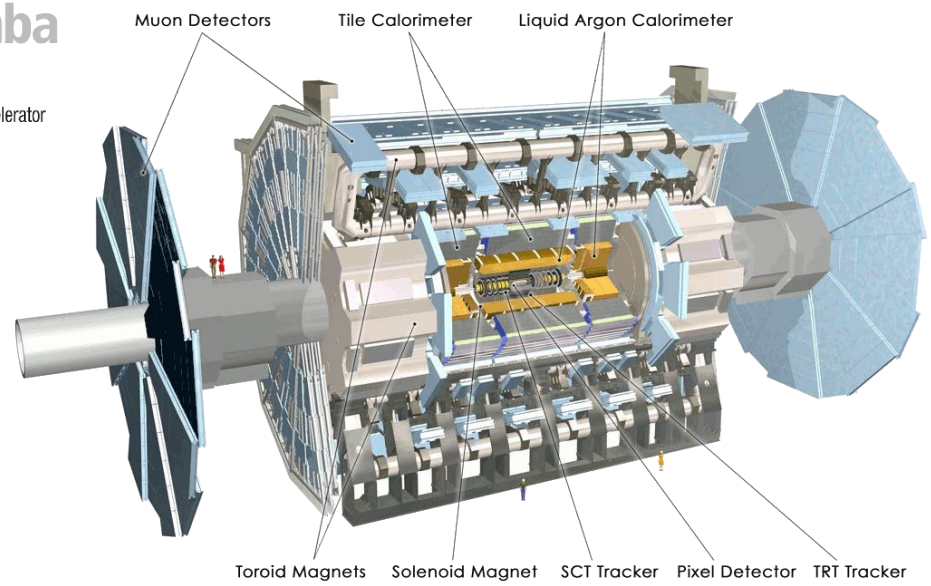
SA@ATLAS



NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

UNIVERSITY OF JOHANNESBURG

UNIVERSITY OF ZULULAND

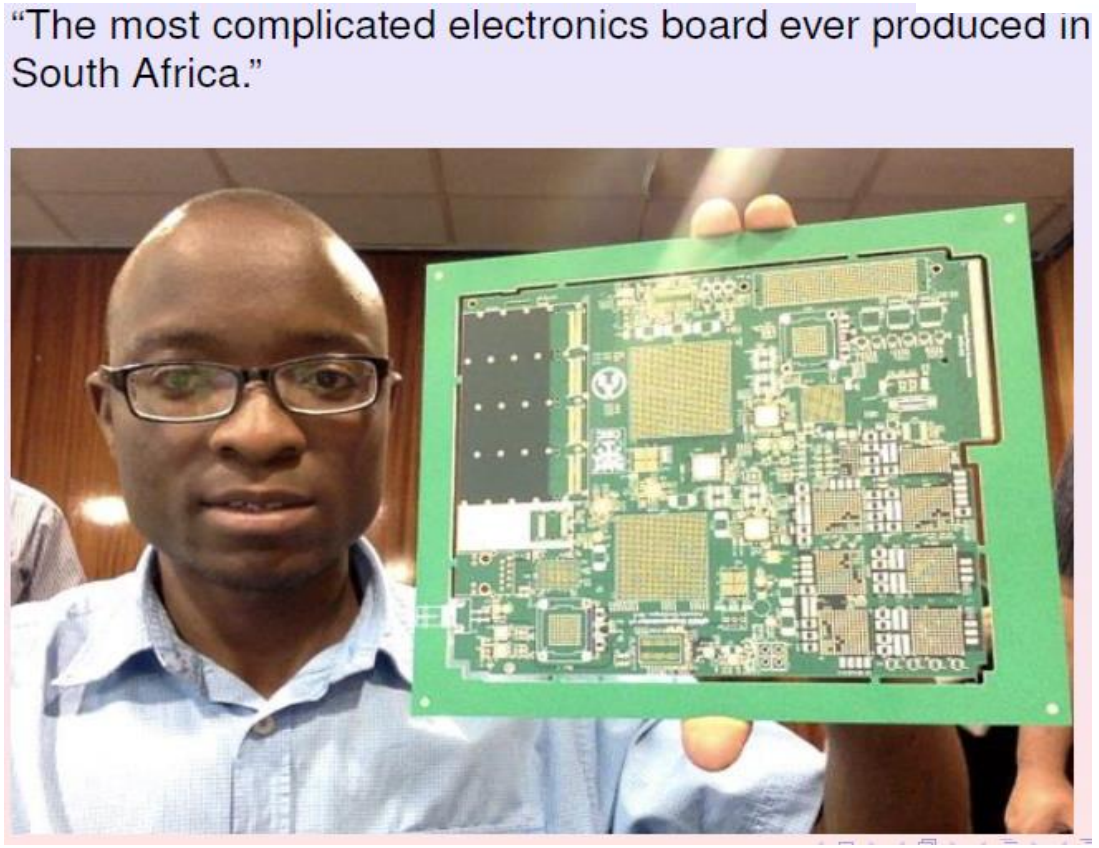


ATLAS

Showing the Minister the most complex board made in South Africa by Trax based on an ATLAS design. Impact on local industry commended.

SA-Atlas Highlights

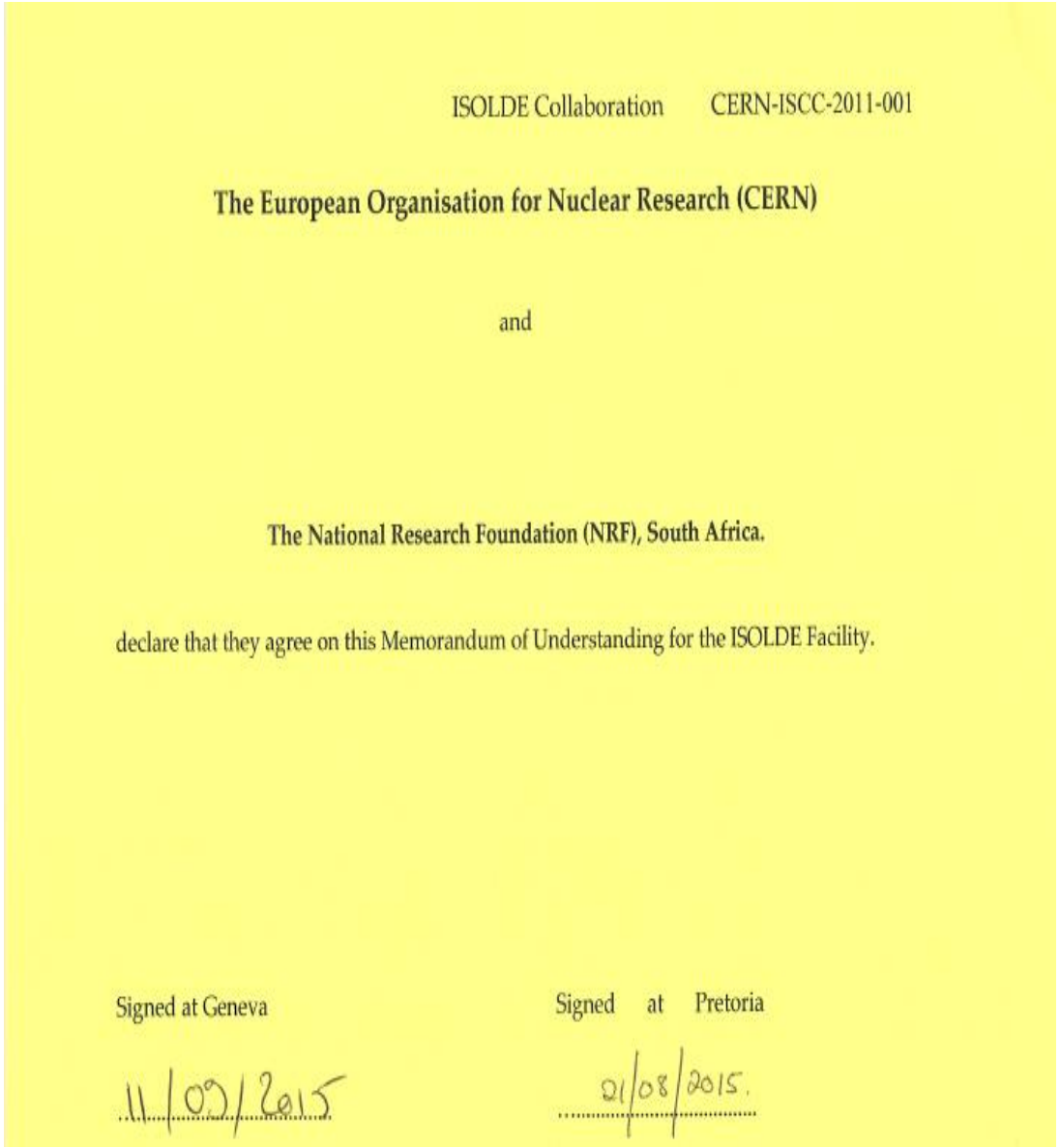
- Principal Investigators
  - James Keaveney (UCT), Deepak Kar (Wits), Bruce Mellado (Wits), Simon Connell (UJ)



ISOLDE

Principal Scientists:

- **Krish Bharuth-Ram** (KwaZulu-Natal and Durban U. of Technology)
- Hillary Masenda & Deena Naidoo (Witwatersrand),
- Nico Orce & S. Trambak (Western Cape)
- Mathis Wiedeking (iThemba LABS), Christine Steenkamp (Stellenbosch)
- Christine Steenkamp (SU)
- Sifiso Ntshangase (UniZulu)
- Rob Bark, Peter Jones (iTL)



ISOLDE Collaboration CERN-ISCC-2011-001

The European Organisation for Nuclear Research (CERN)

and

The National Research Foundation (NRF), South Africa.

declare that they agree on this Memorandum of Understanding for the ISOLDE Facility.

Signed at Geneva 11/09/2015

Signed at Pretoria 21/08/2015.

Theory

Principal Scientists:

- **A Cornell** (UJ), S Karataglidis (UJ), A Muronga (NMU), WA Horowitz , A Pershier & H Weigert (UCT) , Dawit Worku (CPUT), Isobel Kolbe (Wits), Mawande Lushozi (UCT)

SA-CERN Consortium

Achievements and Impact

Research outputs

- Over the past 15 years the SA-CERN programme has been very productive in publishing scientific results in highly reputable journals.
- Collaborating with thousand of other scientists from around the globe means that the published work is of the highest standard.
- Such good standards are transferred back into our own internal review systems such as the NRF review system
- Our students are also trained from such system requiring rigour and quality work.
- During the past 5 years we went through COVID-19. Some of our researchers made their knowledge and innovation skills available to fight the spread of COVID-19.

Knowledge and Technical skills

- Students and emerging researchers acquire hands-on skills through involvement in large international experimental teams – electronics, high performance computing, coding, AI and machine learning
- They gain and generate new knowledge necessary for knowledge-based economy and for basic sciences and mathematics education
- They also learn soft skills – communication, writing , teamwork, and leadership
- Knowledge and Technology transfer into local research institutions and industry – AI/ML, electronics, engineering, and good international practices – some of CERN's R&D has been developed here in SA over the past 20 years.
- In 2023 a new pillar in SA-CERN programme was launched – the Technology Transfer pillar

Knowledge and Technical skills

- At the heart of technology and innovation is fundamental research.
- Without fundamental research there will be no transformative technology to transfer.
- Fundamental science opens new avenues for broad societal impact in addition to scientific impact.
- The TT pillar of SA-CERN is established with 6 technology transfer projects that stems from the research conducted at CERN.
- Currently the SA-CERN Programme has an investment of R30 M from DSTI.
- The programme has about 70 PG students in addition to several Postdocs. This is a successful programme in terms of student supervision and mentoring of early career researchers.

High Performance computing

Centre for High Performance Computing CHPC

WORLDWIDE LHC COMPUTING GRID COLLABORATION

CERN-C-RRB-2005-01/Rev. 1

15 April 2015

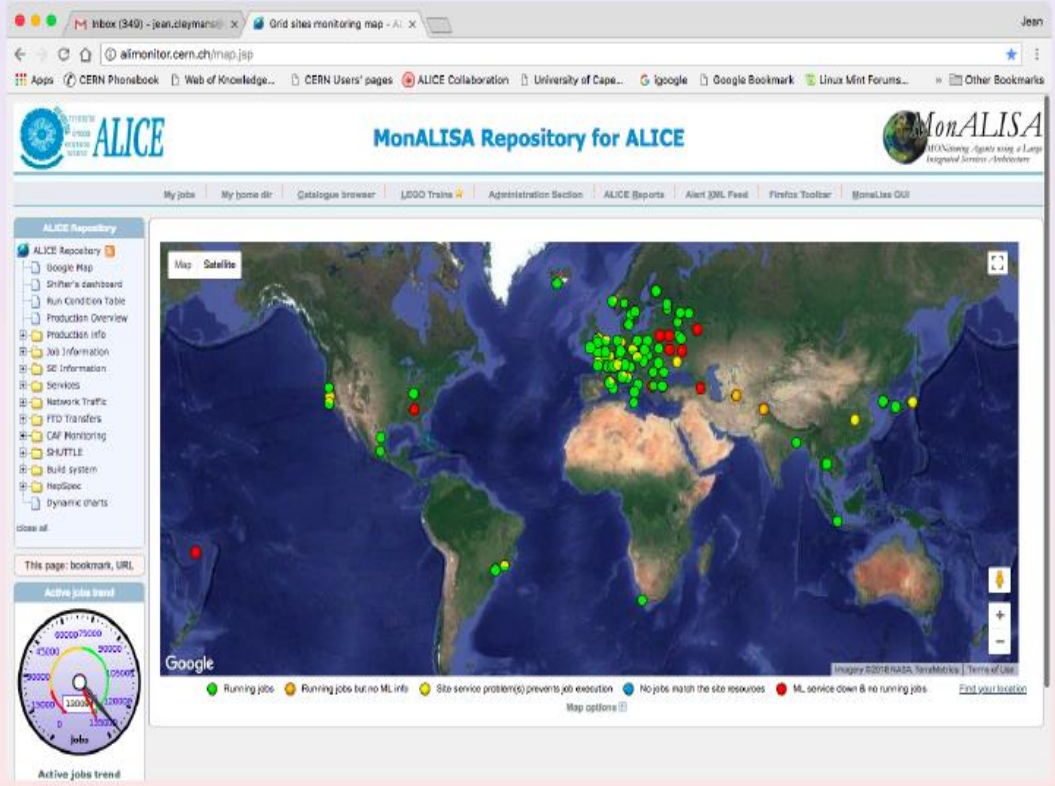
Memorandum of Understanding

for Collaboration in the Deployment and Exploitation of the Worldwide LHC Computing Grid

between

The EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ("CERN")

Centre for High Performance Computing



Outreach

International masterclass April 2014

- **“Looking for Strange Particles in ALICE”**
  - Organized by SA-ALICE and iThemba LABS
  - 24 students from 6 schools
  - International video discussion with Cairo, Geneva &Warsaw

2015: CERN Beamline for Schools Competition

St. John’s College and Barnato Park High School team

Simon H. Connell (University of Johannesburg)

THE BIENNIAL AFRICAN SCHOOL OF FUNDAMENTAL PHYSICS AND APPLICATIONS (ASP)

Activity report on the African School of Physics, November 28 – December 9, 2022

Figure 3: Engagement with high school pupils during ASP2022.

Figure 1: Interactions between students and lecturers during ASP2022.

http://www.africanschoolofphysics.org/

Early interventions in primary and secondary schools – from Limpopo via Soweto to Eastern Cape

South African Institute of Physics (SAIP) Outreach Programmes. SA-CERN physicists are also part of SAIP.

Going from province to province visiting schools and HEIs

Talking about careers in nuclear physics, particle physics, astrophysics, and cosmology

Physics for Africa

- Africa engaging with Physics

Teachers in STEM education

Programmes for STEM educators

Training teachers has ripple Effects – as evidenced by schools which improved their results

SAIP has an educators development programme which has been very successful

The programme is now rolled to the provinces and neighbouring African countries

WiPiSA Lunch Seminars at SA institutions

Hot and Dense Matter in Heavy Ion Collisions and Astrophysics - for university students

Annual Hot and Dense Matter in Heavy Ion Collisions and Astrophysics (HDM) school and workshop

The HDM schools are aimed at students who just finished their BSc up to PhD level

The school curriculum covers introductory topics including mathematical physics, computational physics, nuclear physics, particle physics, astrophysics and cosmology

These schools are mainly hosted by rural universities in order to attract students from these universities

We also partner with visiting academics - e.g., LHC in Kruger

Training future researchers in NPAC

The National Institute for Theoretical Physics (NIThePP) Internship Programme

NIThePP Associates submit research topics

Students apply and indicate which topic of their interest

NIThePP Associates select suitable students

I have worked with an average of 7 students/year
for the past 8 years with 95% coming from rural universities

Students work over summer on topics cutting through
NPAC

Publication: Star
Date: Tuesday, January 09, 2018
Page: 9

THEY DID IT: Final-year BSc and maths and physics postgraduate students on the National Institute of Theoretical Physics Internship Programme last month, photographed in the New Science Building at Nelson Mandela University. Like these students, matriculants who achieve in maths and science have the opportunity to pursue undergraduate and postgraduate degrees and join the global science community.
BACK, FROM LEFT: Mphamela Enos Baloyi (University of Limpopo), Precious Matodzi Mabidi (University of Limpopo), Sindisiwe Xhakaza (University of Johannesburg), Ndivhuwo Ndou (University of Venda)
COUCH FROM LEFT TO RIGHT: Thabani Ngcobo (University of KZN), Shifhiwa Khorommbi (University of Limpopo), John Tshegofatso Tshipi (University of Pretoria)
FRONT: Rudzani Foster Nemusunda (University of Venda), Tsebo Kibe (University of Stellenbosch)

Far more can excel in maths, science

International Masterclasses, Beamline for Schools, HEPP Workshops, MINuS, MatSci, …

Africa got talent
SAPhO

- Excellence through South African Physics Olympiad
- Establishing and nurturing talent

Africa got talent
SAPhO

- Excellence through South African Physics Olympiad
- Establishing and nurturing talent

One of the many we inspired

Ms Nkateko Baloyi with Azwinndini Muronga at the 10 Year Celebration of SA-CERN

We salute the youth of Africa

Dear Prof. Azwinndini Muronga,

This is Nkateko, I spoke to you earlier about how you inspired me to study Physics.

In 2008, you gave an outreach presentation about your work in the Mopani District. I was on e of the grade 9 learners chosen to attend the outreach from Zivuko Senior Secondary School.

I have a BSc degree in Chemistry and Physics(University of Limpopo). After completing my BSc at UL, i joined the NASSP programme (extended programme) at UCT and I completed my Bsc Astrophysics and Space Science Hons last year.

I'm currently registered with Wits, MSc eScience (Data Science) and I'm working on the searc h for new bosons using machine learning techniques supervised by Prof Bruce Mellado.

Kind Regards,
Nkateko Baloyi

Listen to the voice of reason

“What counts in life is not the mere fact that we have lived. It is what difference we have made to the lives of others that will determine the significance of the life we lead.”
– Nelson Mandela,
90th birthday celebration of Walter Sisulu, Walter Sisulu Hall, Johannesburg, 18 May 2002

Special Mention

- ✓John Ellis
- ✓Paolo Giubellino
- ✓Peter Jenni

Long-term visitors and champions :
Volker Lindenstruth, Florent Staley, Peter Steinberg, S. Chattophadyay, K. Assamangan

CERN Internatonal office, collaboration spokespersons and others who have supported this initiative.

All our Continental and international partners and collaborators

Thank you

- ✓DSTI
- ✓NRF
- ✓iThemba LABS
- ✓Research institutions
- ✓CERN

For the support over more han 15 years