The need for an integrated approach to physics/science capacity building in South Africa, SADC region, and Africa

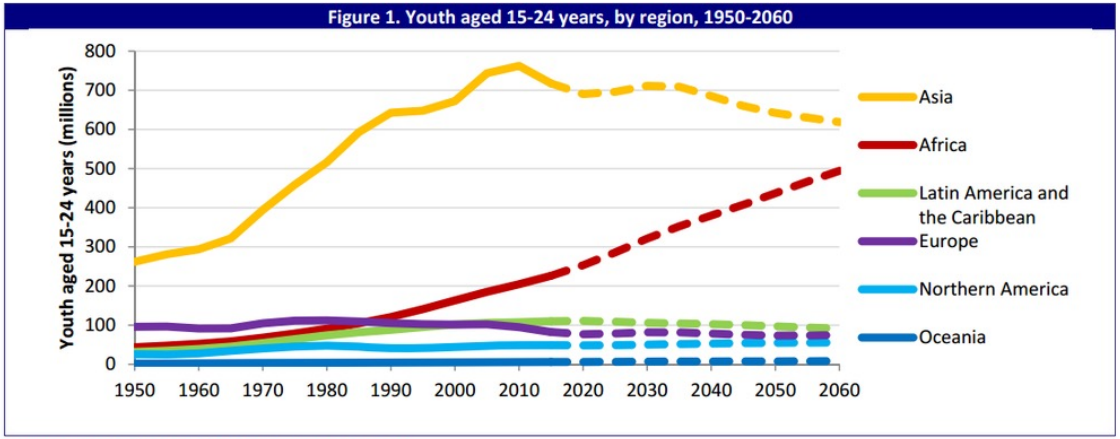
Azwinndini Muronga
Nelson Mandela University, Gqeberha, EC, South Africa

Highlights of my talk

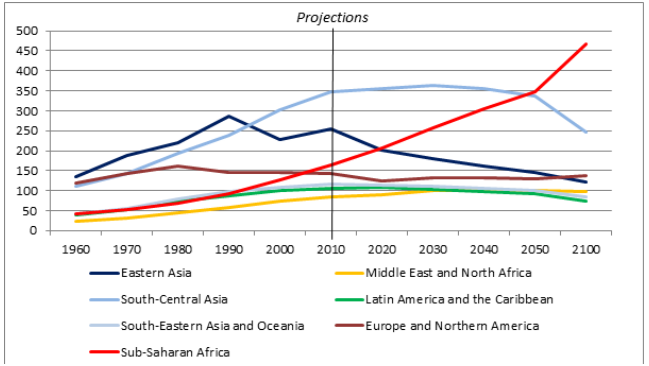
- Why should we invest in physics and science capacity building in Africa?
- What should we do to achieve our aspirations?
- There is a growing movement of physics capacity building in Africa.

Why should we care about physics/science capacity building in Africa?

The rise of Africa's Youth population



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



UNESCO: Priority Africa Flagship Programmes and Actions

- Strengthening education systems for sustainable development in Africa
- Fostering science for the sustainable management of Africa's natural resources and disaster risk reduction
- Harnessing STI and Knowledge for the Sustainable Socio-Economic Development in Africa

- Africa is positively changing at an extraordinary speed.
- But with change also comes risk.
- Rapid urbanization, growing population, youth unemployment, inequality and social exclusion, new natural resource finds and a changing climate as well as peacebuilding processes, all have the potential to place African societies under considerable strain.

https://en.unesco.org/priorityafrica/flagshipprogrammes

UNESCO: Priority Africa Flagship Programmes and Actions

- Stability and prosperity start in schools, with quality education, to teach skills for jobs, and skills for peace to all African youth. In a continent where more than 60% of the population is under 25 - empowering people means educating youth, especially girls.
- The cradle of humanity is a powerhouse of cultural diversity and the “big origin” story.
- Education is moreover about learning values for citizenship, stability, and security.
- It is about teaching the history of Africa that has shaped the world.
- It is about living together, and teaching media including ICT, STI and social networks to respond to socio-economic challenges

https://en.unesco.org/priorityafrica/flagshipprogrammes

We have challenges

- Fewer students taking mathematics and science subjects at school and university
- Fewer students who take mathematics and science subjects are succeeding
- Poor standard of teaching mathematics and science at schools
- Africanization/Decolonization of the science curriculum

Africa and the UN SDGs

Africa is expected to play a significant role in achieving the sustainable development goals.

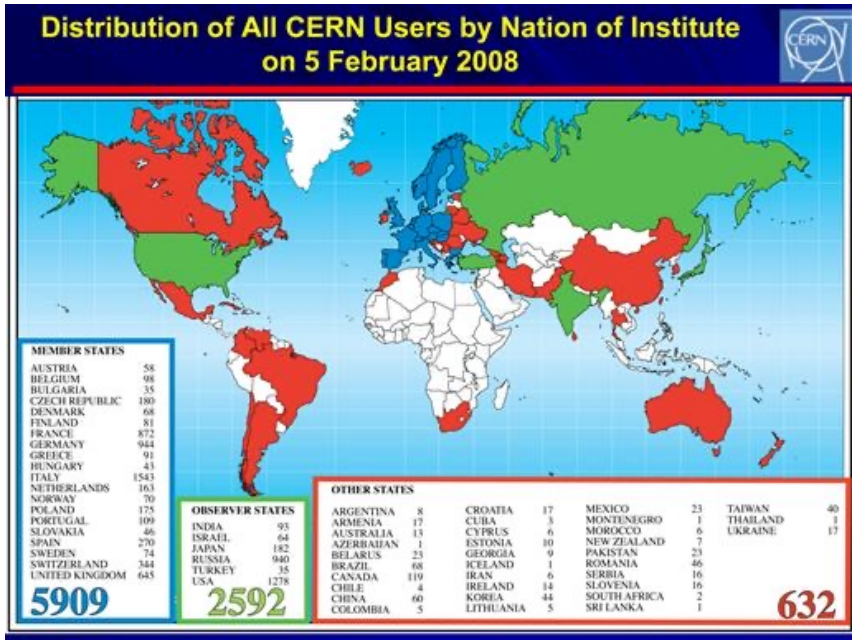
IUPAP Centenary YEARS 1922 - 2022

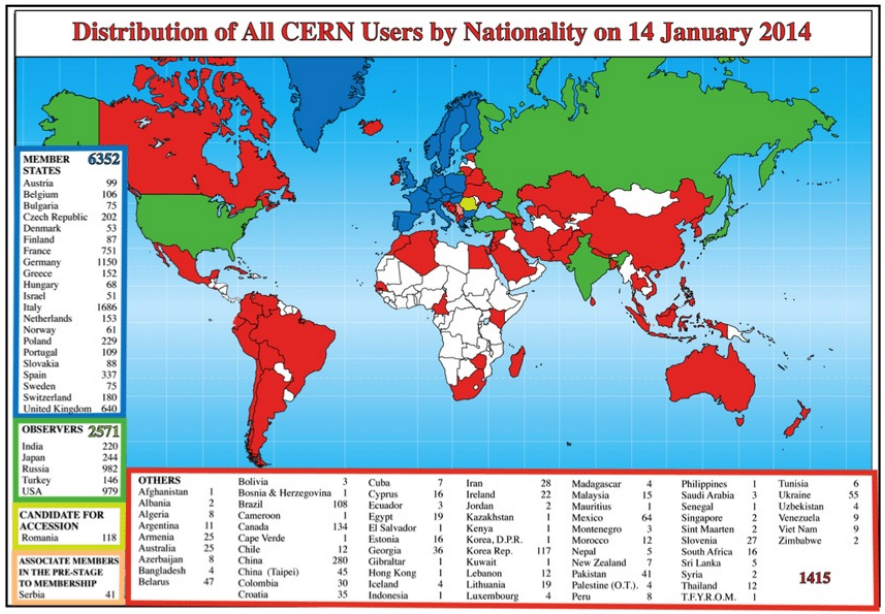
United Nations Educational, Scientific and Cultural Organization

IYBSSD2022
International Year Basic Sciences for Sustainable Development

Africa will have continental events on IYBSSD and IUPAP Centenary celebrations

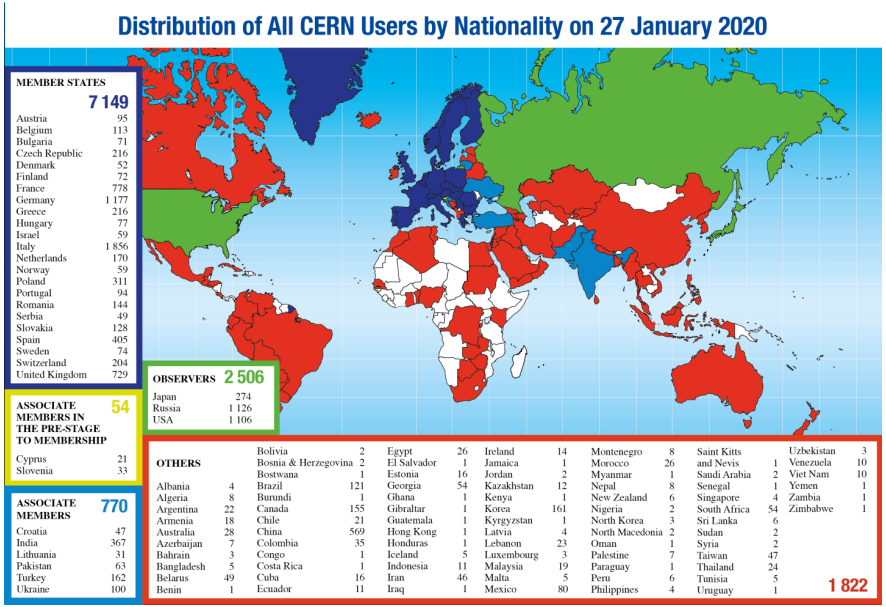
High Energy Physics in Africa





Africa's participation in international HEP

- Africa's participation in international HEP facilities remains extremely low.

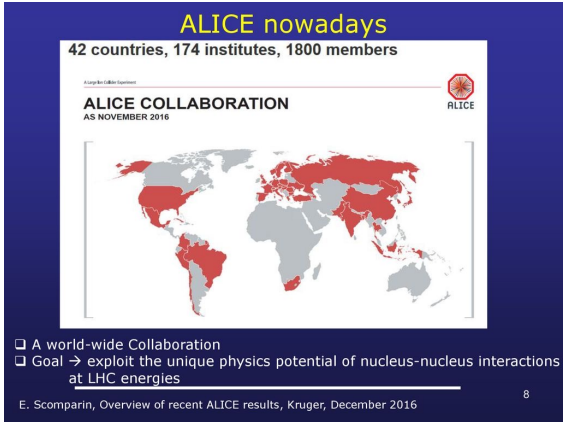


About 1.1% of CERN users are African Nationals

Not limited to CERN, a broader issue

Africa's participation in international HEP

- About 43 countries with one African country
- About 178 institutes of which 2 are from South Africa
- Over 1900 members of which 5 are from South Africa



South Africa
SA-CERN programme
ATLAS, ALICE, ISOLDE, CERN, Theory

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences | University of Cape Town | University of Johannesburg | University of KwaZulu-Natal | Nelson Mandela University | DUT Durban University of Technology | University of the Western Cape | Cape Peninsula University of Technology | University of the Witwatersrand, Johannesburg | University of Zululand | UNISA University of South Africa

Participating institutions : 1 National Facility (iThemba LABS) and 10 Universities

	ATLAS	ALICE	ISOLDE	Theory	Total
PhD	6	5	6	8	25
MSc	19	2	7	15	43
Accad Staff	7	6	6	7	26
Tech Staff	3				3
Post Docs	5	2	2	2	8

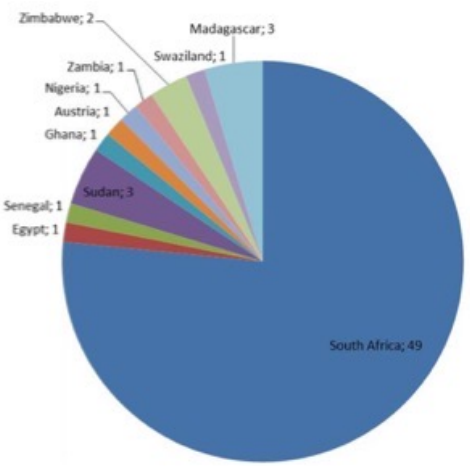
2017 numbers, increasing trajectory

- SA has a long history in High Energy Physics, eg : 1st neutrino discovered and studied in nature 1965
  - Long history at CERN, BNL, JLAB, JINR, others
  - Also a long history of theoretical contributions
- **SA-CERN Co-operation Agreement 1992**
- Now formal participation at CERN and JINR

Most HEP now in the SA-CERN and JINR Programmes

Decades of "ad hoc" participation

- ALICE since 2001
- ATLAS since 2010
- ISOLDE since 2017
- Theory
- JINR since 2005



Courtesy of Simon Connell

Change the World

Africa participation at ICHEP

Summary and Outlook

- Introduction
- Happy 50th birthday Standard Model!
- ICHEP 2018
- Thoughts for the future

- **Broad and exciting conference**
  - Experiment, phenomenology, theory, astro-particle, accelerator, detector, computing, education, diversity, applications
  - 1119 participants (213 women, 906 men)
  - 835 parallel talks in 16 sections
  - 41 plenary talks
  - 2 award lectures
  - 6 satellite meetings
  - 2 public lectures
  - 226 posters (3 award talks)
  - Director's panel
- ***Not*** **a detailed/complete summary**

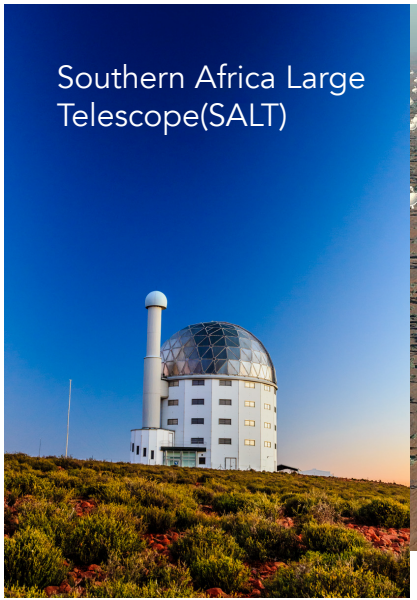
- Asia/Pacific: 560
- Europe: 414
- N/S America: 137
- Africa: 8
- Antarctica: 0

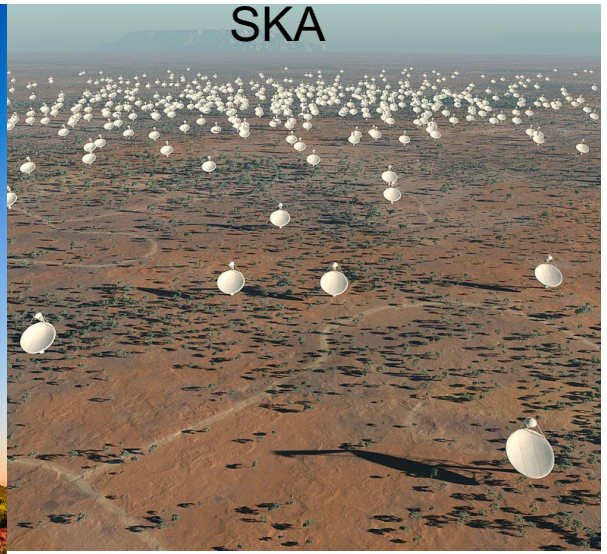
Africa is fertile with possibilities

Why is physics/science capacity building in Africa important?

- 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.

Multi-messenger Astronomy





SKA science and the birth of multi-messenger astronomy

The Astrophysical Journal Letters, 848:L12 (59pp), 2017 October 20 https://doi.org/10.3847/2041-8213/aa91c9

OPEN ACCESS

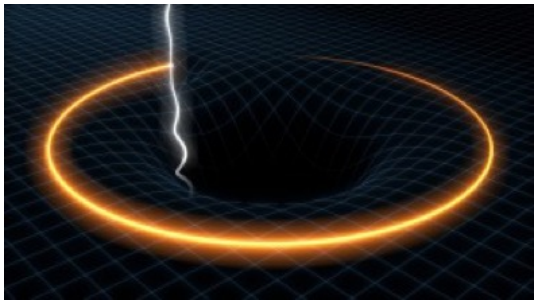
Multi-messenger Observations of a Binary Neutron Star Merger

LIGO Scientific Collaboration and Virgo Collaboration, Fermi GBM, INTEGRAL, IceCube Collaboration, AstroSat Cadmium Zinc

A comparison between SALT/SAAO observations and kilonova models for AT 2017gfo: the first electromagnetic counterpart of a gravitational wave transient – GW170817

Buckley et al.

McCully et al.



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Physics capacity building in South Africa

- Public Engagement with Science
- Learners and educators support programmes
  - SAIP Outreach activities for learners and Teacher Development programs
  - SAPhO
- Student support programmes
  - Hot and Dense Matter School & Workshop
  - NITheCS Summer Study & Research Programme – aka “NITheCS Internship”

Rural capacity building

- Science engagement in primary and secondary schooling education system
- Going from province to province visiting schools and HEIs
- Talking about wonders of nuclear physics, particle physics, astrophysics, and cosmology
- Science Centres in SA have transformed into training Centres for STEM learners and educators

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…has challenges in Africa

- Science engagement in in rural schools, in open spaces and under trees
- These challenges require local solutions that are implemented globally
- No time to wait for luxury infrastructure

Capacity building through educator training

- 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

Physics for Africa
SAPhO

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

Physics for Africa
SAPhO

- Excellence through South African Physics Olympiad
- SAIP's Physics Olympiad produced some of the top matric learners in SA


Don’t prepare students for something. Prepare them for anything.
@E_Sheninger
Image credit: kidoovation.com/

Capacity building at universities

- Annual Hot and Dense Matter in Heavy Ion Collisions and Astrophysics (HDM) school and workshop
- The school curriculum covers introductory topics including mathematical physics, computational physics, nuclear physics, particle physics, astrophysics and cosmology
- The HEPP Workshop series - The topics to be covered will be high-energy theory and phenomenology (heavy ions, pp, ep, ee collisions), ATLAS physics and ALICE physics.
- National Institute for Theoretical and Computational Sciences (NITheCS) Internship Programme. The NMU-NITheCS internship programme is a 4 weeks+ programme in topics spanning nuclear and particle physics, astrophysics and cosmology

NMU-NITheCS Internship 2022

A special year – 12 years on

It is always intensive!

Introductory lectures, group discussions, calculating, computing, presenting, scientific report/paper writing

2022 NMU-NITheCS Internship Programme was unique

- **Activity Report on the Seventh African School of Fundamental Physics and Applications (ASP2022)**
- Kétévi A. Assamagan, Bobby Acharya, Kenneth Cecire, Christine Darve, Fernando Ferroni, Julia Ann Gray, Azwinndini Muronga – https://arxiv.org/pdf/2302.13940.pdf

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The 7th Biennial African School of Fundamental Physics and Applications
28 November - 9 December 2022

SOUTH AFRICAN INSTITUTE OF PHYSICS

UNIVERSITY WORLD NEWS
Africa Edition

UPAP Centenary YEARS 1922 - 2022

UNESCO United Nations Educational, Scientific and Cultural Organization

IYBSSD2022 International Year Basic Sciences for Sustainable Development

al Edition Africa Edition Asia Hub SDGs Hub Transformative Leadership Special Reports Partner

in us on **Facebook**
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SOUTH AFRICA

Institute focuses on training high-level problem solvers

Heather Dugmore 13 June 2023

LinkedIn Tweet Share

A total of 36 interns, the largest-ever number of final-year BSc, honours and masters students from South Africa's rural areas and historically disadvantaged universities, have submitted projects for

NELSO e the World

2023/2024 Programme

Lookout for:

1. NITheCS Internship call
2. NMU-NITheCS Summer Study & Research Pogramme call – applied through NITheCS call
3. SA-JINR Theory Workshop call – integration with the summer study & research programme in Gqeberha, Nov/Dec 2023

Physics capacity building in Africa

- The African School of Fundamental Physics and Applications (ASP)
- The African Conference on Fundamental Physics and Applications (ACP)
- The African Strategy on Fundamental & Applied Physics (ASFAP)

The African School of Fundamental Physics and Applications a.k.a. the African School of Physics (ASP) Assessment of impact

https://www.africanschoolofphysics.org/

Dr. Kétévi A. Assamagan
on behalf of the ASP-IOC , IAC and LOC

ketevi@bnl.gov

Physicist at

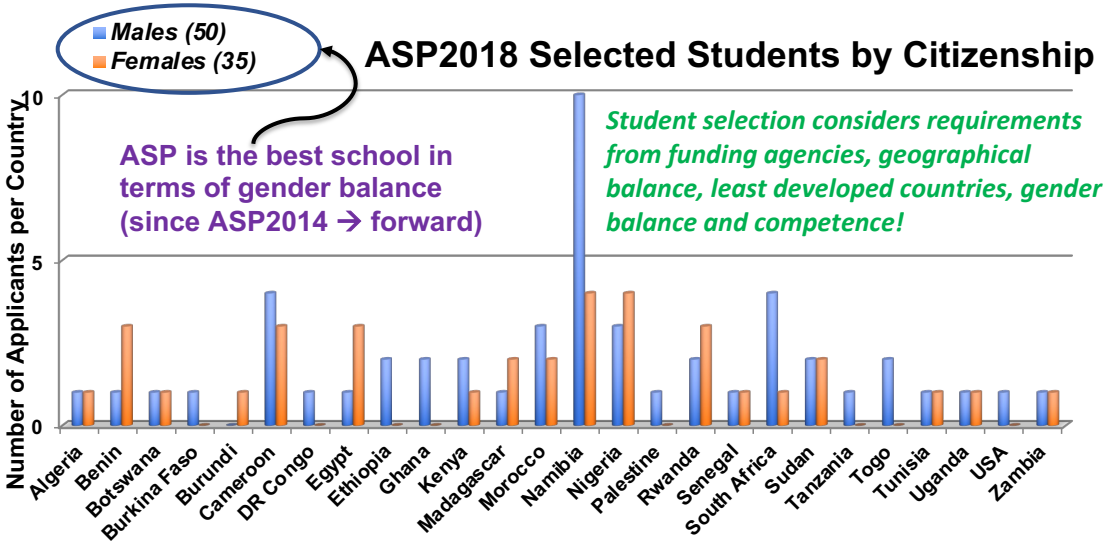
Brookhaven National Laboratory (USA)

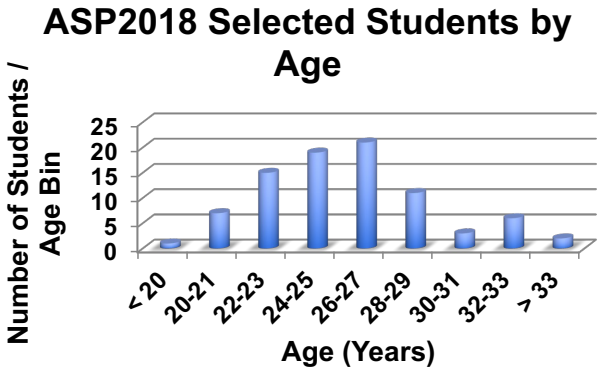
African School of Fundamental Physics and Applications

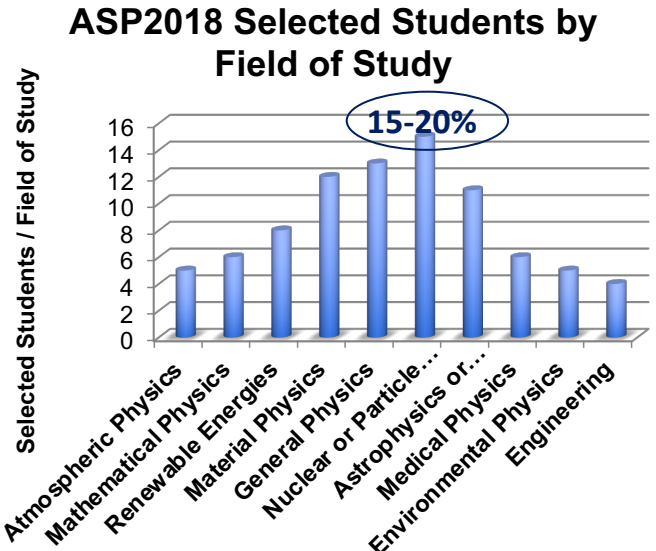
- Also known as “The African School of Physics”
- Acronym: ASP; Logo: as above
- https://www.africanschoolofphysics.org
- Organized biennially in different African countries since 2010 by an International Organizing Committee (IOC), ASP-IOC@CERN.CH

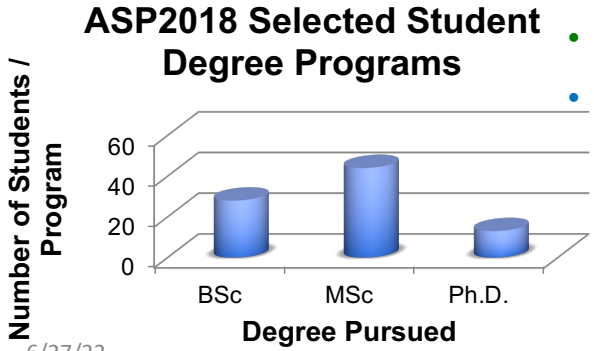
ASP	Host Country	Applicants	Students	Mentorship	Teachers	Pupils	Conference
2010	South Africa	125	65	Continuously, even when there is no formal school			
2012	Ghana	138	50				
2014	Senegal	330	70				
2016	Rwanda	429	75	Program formalized in 2016. Runs continuously	20	150	
2018	Namibia	523	85		63	> 1200	+60
2020	Morocco						
2021	Online	N/A	94				+649

ASP2018 Students Profile







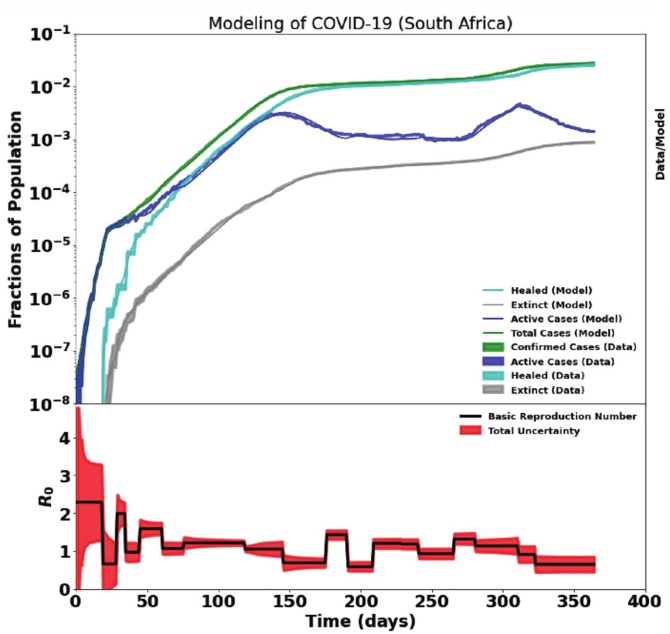


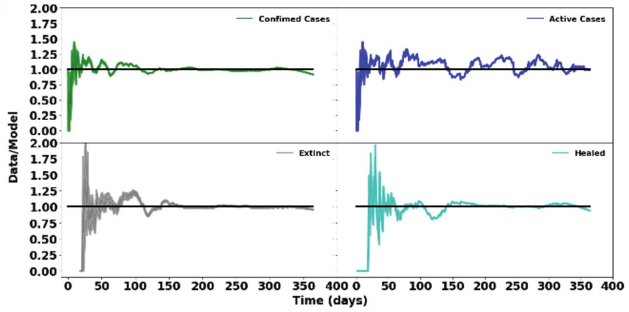
- 523 Applications
- Total Selected: 85
- There were 30 good students on the waiting list
  - Selections constrained by budget and logistics
  - Replace early declinations

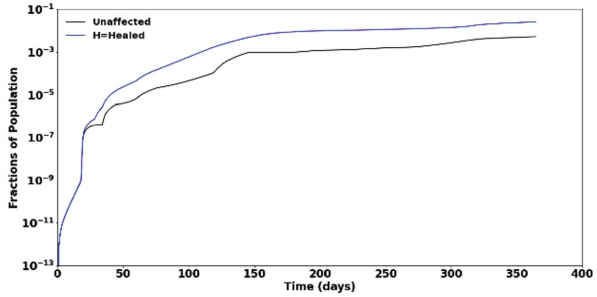
ASP Mentorship during COVID-19 Pandemic

APS alumni learned about

- Analysis tools in C++ and Python
- Understanding their data
- Modeling, goodness of fit
- Statistical analysis
- Uncertainties (statistical, systematic)
- Estimation of basic reproduction number R_0
- Giving scientific talks
- Writing a paper and responding referees comments







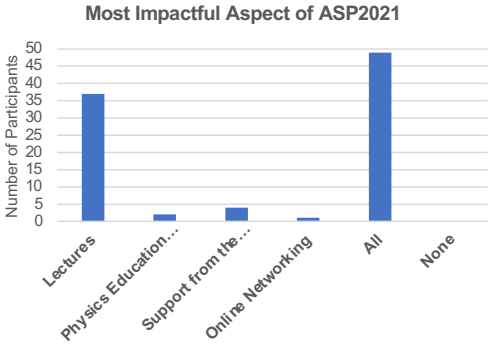
First 12 months of COVID-19 data of 10 countries analyzed
> 50% of all COVID-19 cases in Africa were analyzed by 13 African students

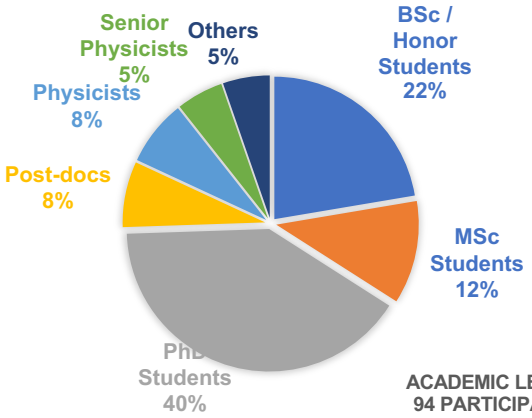
Study published in the Scientific African
https://doi.org/10.1016/j.sciaf.2021.e00987

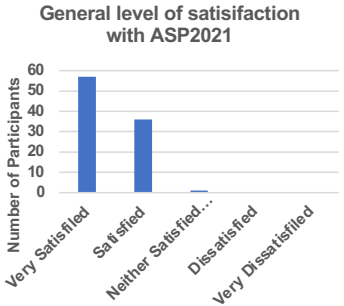
See the talk by Toivo S. Mabote (Mozambique, ASP2020 alumnus)
On Friday, March 11, 2022

ASP2021, July 19-30, 2021; online school

- **ASP2020-Morocco**
  - Cancelled because of COVID-19
  - A 2-week online version organized as ASP2021







Participant group photo, March 11, 2022

The international HEP community is welcome to participate and co-create the future of Africa's HEPA community

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The 7th Biennial African School of Fundamental Physics and Applications

28 November - 9 December 2022

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K. Assamagan (BNL)
A. Dabrowski (CERN)
C. Darve (ESS)
J. Ellis (King's College London)
F. Ferroni (GSSI-INFN)
S. Muanza (CNRS-IN2P3)

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N. Hashe (Nelson Mandela University
A. Muronga (Nelson Mandela Univers
R. Mosia (Nelson Mandela University)
S. Ngesi (Nelson Mandela University)
A. Tabalaza (Nelson Mandela Univers
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ASFAP African Strategy for Fundamental and Applied Physics

NELSON MANDELA UNIVERSITY

SOUTH AFRICAN INSTITUTE OF PHYSICS

Date:
4-8 July 2022

ANNUAL CONFERENCE OF THE SOUTH AFRICAN INSTITUTE OF PHYSICS (SAIP 2022)

Virtual Conference

Activity Report on the Seventh African School of Fundamental Physics and Applications (ASP2022)
Kétévi A. Assamagan, Bobby Acharya, Kenneth Cecire, Christine Darve, Fernando Ferroni, Julia Ann Gray, Azwinndini Muronga

Integration is important

Heather Dugmore and Gillian McAinsh, Shaping the Future of Science for Soci-ety — supplement with articles on ASP2022,
https://news.mandela.ac.za/news/media/Store/documents/2023/Science%20Supplement/Shaping-the-Future-of-Science-for-Society.pdf

Activity Report on the Seventh African School of Fundament
Physics and Applications (ASP2022)

Kétévi A. Assamagan[a,*], Bobby Acharya[b], Kenneth Cecire[c], Christine Darve[d], Fer
Ferroni[e], Julia Ann Gray[f], Azwinndini Muronga[g]

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[b]*ICTP, Italy, and King's College London, UK*
[c]*University of Notre Dame, USA*
[d]*European Spallation Source, Sweden*
[e]*INFN-GSSI, Italy*
[f]*ASP International Advisory Committee, Switzerland*
[g]*Nelson Mandela University, South Africa*

Abstract

The African School of Fundamental Physics and Applications, also known as the
School of Physics (ASP), was initiated in 2010, as a three-week biennial event
additional training in fundamental and applied physics to Africa
of three-year university education. Since its inception, ASP h
than a school. ASP has become a series of activities and events
physics as an engine for development in Africa. We report on
Physics, ASP2022, organized at Nelson Mandela University, on N
2022. ASP2022 included programs for university students, hig
school pupils.

Keywords: The African School of Physics, ASP, ASP2022

1. Introduction

The African School of Physics is a collection of activities to
of African students. One activity is a three-week biennial e
African countries—this event consists of a 2-week intensive sc
one-week African Conference on Fundamental and Applied Phy
host country of the next biennial event is selected two and hal
a bidding process. In December 2019, South Africa was sele
countries, to host the seventh edition of ASP at Nelson Mar
Gqeberha. ASP2022 was originally planned in July 2022, for
with the South African Institute of Physics annual meeting; how
to travel restrictions and uncertainties resulting from the COV

*Contact

Figure 3: Engagement with high school pupils during ASP2022.

Figure 4: ASP forum for discussion with policymakers on capacity development and retention in Africa.

Figure 2: High school teachers during ASP2022.

Change the World

Report of the Notre Dame Contribution to the African School of Fundamental Physics and Applications 2022 in Gqeberha, South Africa
Kenneth Cecire, Shane Wood

NELSON MANDELA UNIVERSITY

The 3rd African Conference on Fundamental and Applied Physics

25-29 September 2023

What should we do to build physics/science capacity in Africa?

Lessons from Snowmass 2021

- These Snowmass contributed papers are of particular interest in today's talk
- I strongly recommend anyone interested in the topics of Diversity & Inclusion, Public Engagement and Public Education, and Physics Education, to study these white papers and their recommendations.

- Why should the U.S. care about high energy physics in Africa and Latin America? arXiv:2203.10060
- The Necessity of International Particle Physics Opportunities for American Education arXiv:2203.09336
- The need for structural changes to create impactful public engagement in US particle physics arXiv:2203.08916
- Building a Culture of Equitable Access and Success for Marginalized Members in Today's Particle Physics Community
- arXiv:2206.01849

Cultural and structural change at all levels within the international HEP community and its stakeholders is necessary for an equitable access and success of Africa's HEP community.

Cultural and Structural Changes needed within our community

- Engage with other African communities in a mutual beneficial way,
- Measure the impact by the success of African scholars and students,
- Measure the success by the return of African scholars and students to develop programs in Africa,
- Science Engagement should be treated in the same footing as Teaching and Research
- Physics/Science Education Scholarship should be recognized just like any other physics/science research

- We need a clear collective dream
- We need to look beyond SA borders
- We need to strengthen the SADC and Sub-Sahara region to contribute to the continental efforts.
- SAIP Office is coordinating the efforts already – they need the support of the community
- See Brian Masara's talk