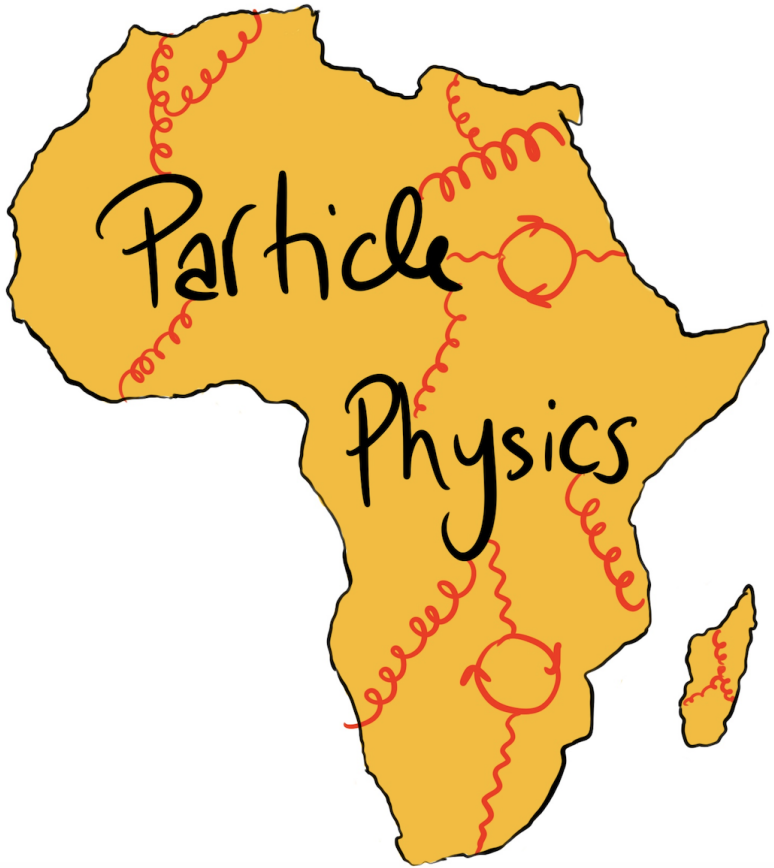
Boosting Physics in Africa within the ASFAP Strategy.: Particle physics as prototype

Mohamed Chabab
Cadi Ayyad U., Marrakech, Morocco



Outline

- ASFAP Strategy: Objectives and Structure
- Overview on Particle Physics (PP)
- Status of PP activities in Africa
- PP Working group: a summary

African Strategy for Fundamental Physics and Applications (ASFAP)

ASFAP initiative is co-founded by the Pan African and African Diaspora physicists

Mandated by African Physical Society (AfPS)

Web : https://africanphysicsstrategy.org/
Wiki : https://twiki.cern.ch/twiki/bin/view/AfricanStrategy
Twitter: https://twitter.com/StrategyAsfap

Objectives

a. Develop a Strategy to boost African education and research capabilities, improve collaborations, and inform international partners, sponsors, policymakers on the strategic directions likely to impact African development.
b. Engage African physicists and the international community in the Strategy development.
c. Release of the strategy report which will suggest the direction, with actionable items for the next decade.
d. Help to set the foundation with effective participation of African physicists in defining education and physics priorities most impactful for the continent.

ASFAP: General Structure

Committees & Conveners missions

Steering Committee (STC)

- Overall coordination
- Go-between IAC, OC, EC, W. Groups and Forums
- Final report preparation

International Advisory Committee (IAC)

- Review of progress
- Advice on scope
- Engage of International Communities and Policymakers
- Final Report Endorsement

Working Groups Conveners / Liaisons

- Encouraging and soliciting community inputs
- Preparation of the Group reports
- Liaisons have to ensure that cross-cutting topics receive proper coverage and consideration in all the relevant groups

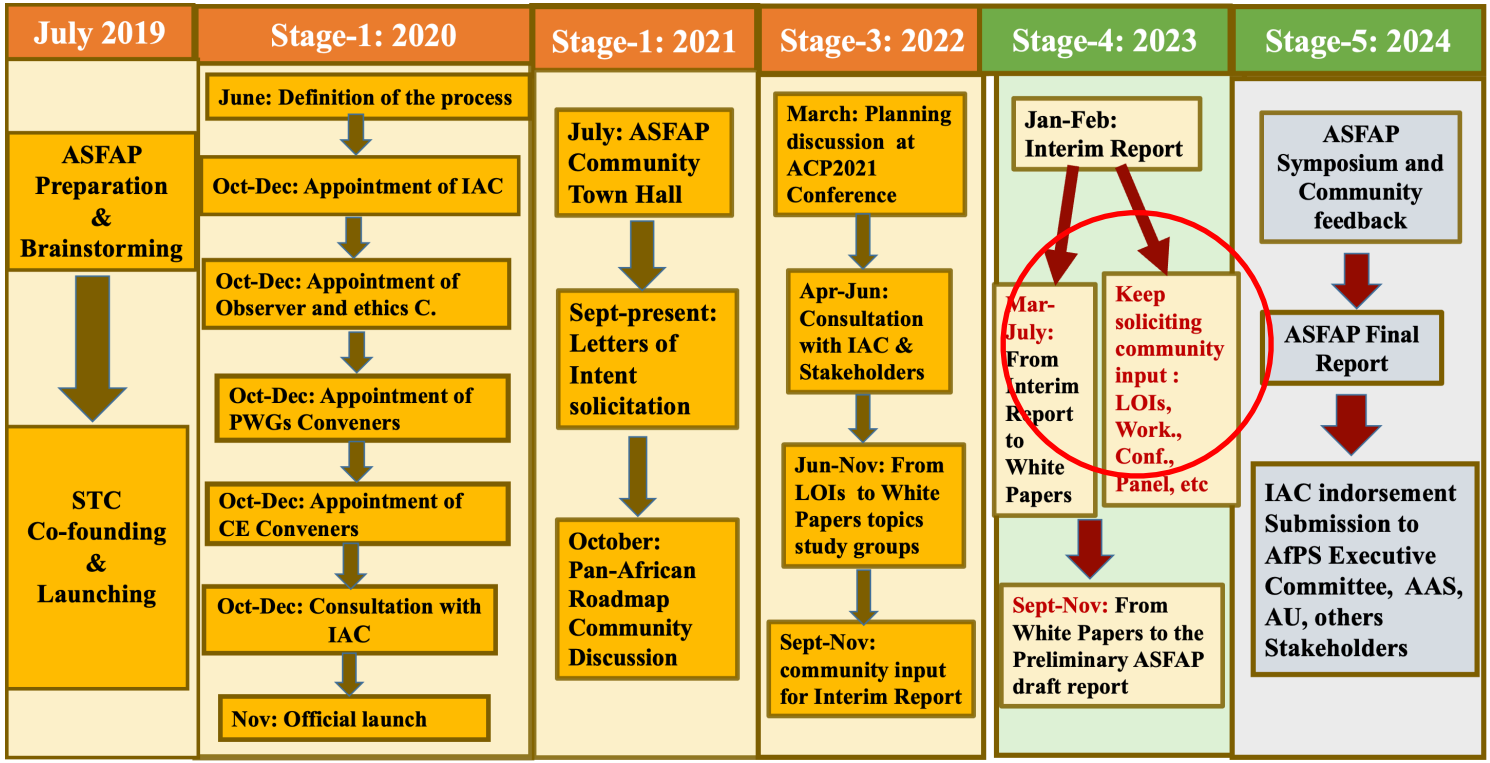
Observers Committee (OC)

- Advising and conveying ideas between STC and WGs/ forums
- Review LOIs and White paper
- Help WGs in report editing

Ethics Committee (EC)

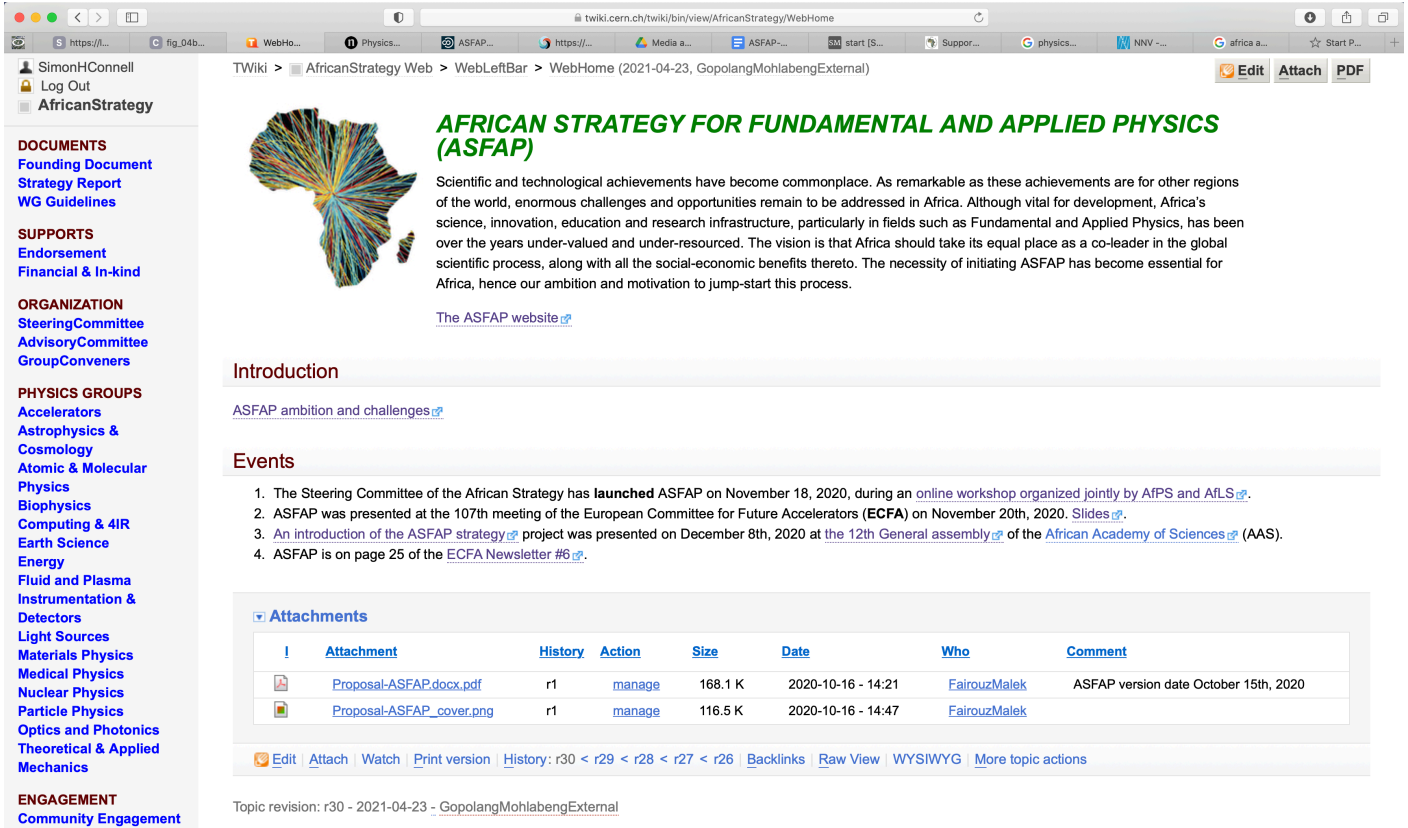
- Responsible for dissemination and maintain the Guidelines of ASFAP Code of conduct
- A subset of EC might serve as an Ombudspersons

ASFAP Process Roadmap Timeline

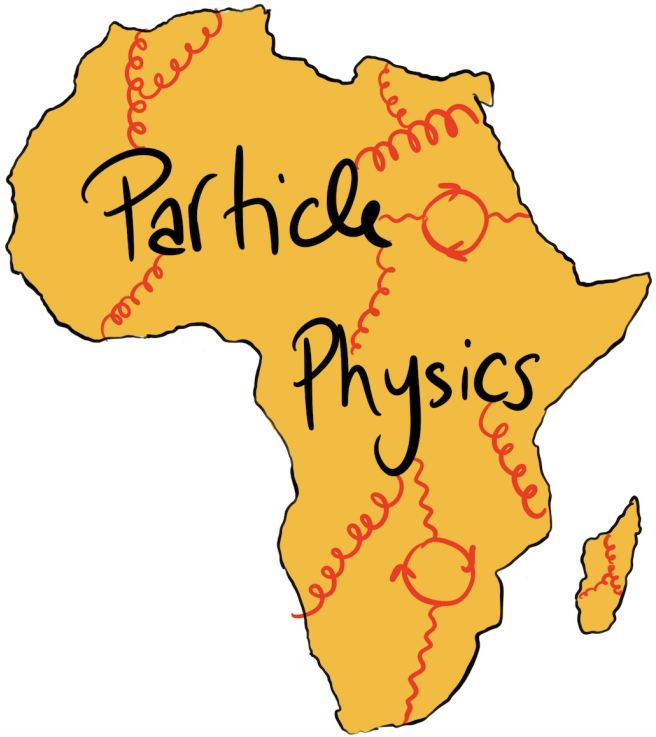


ASFAP Twiki ….activities

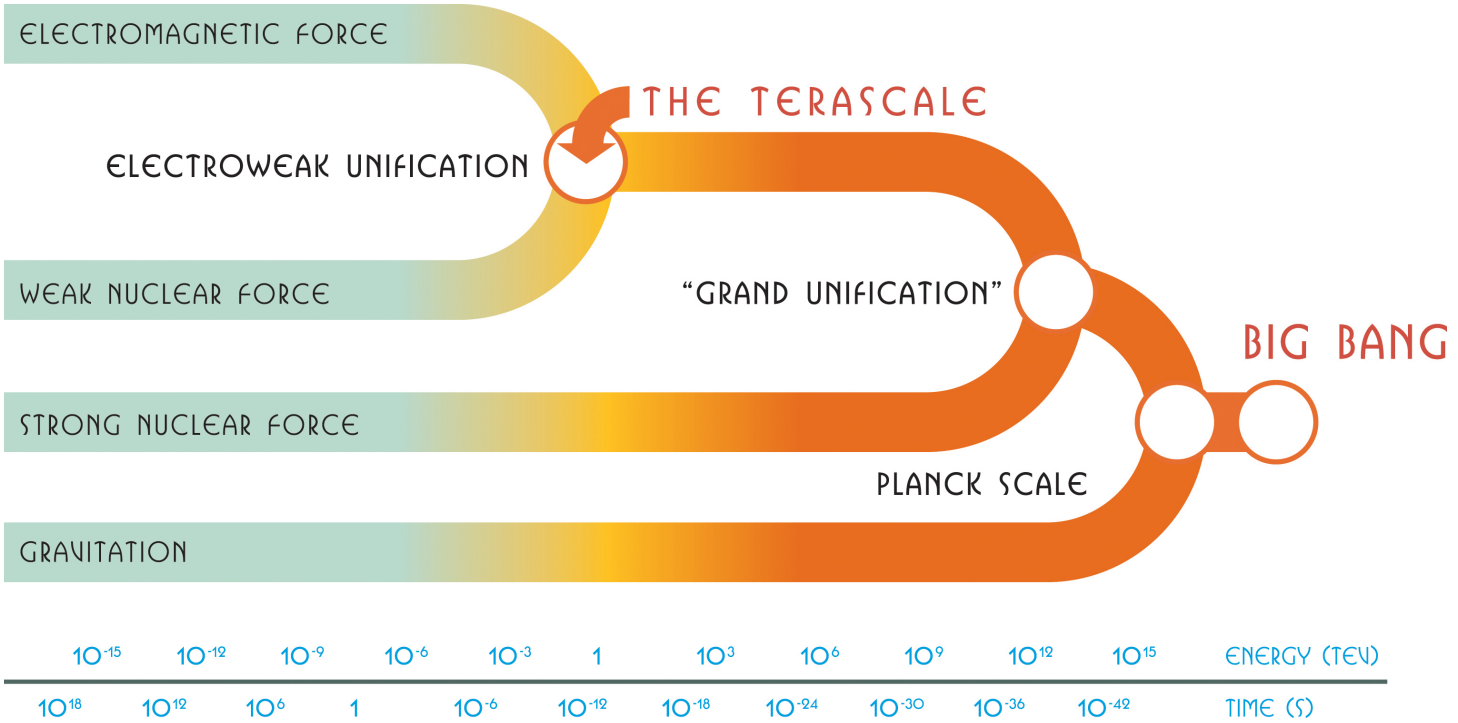
https://twiki.cern.ch/twiki/bin/view/AfricanStrategy



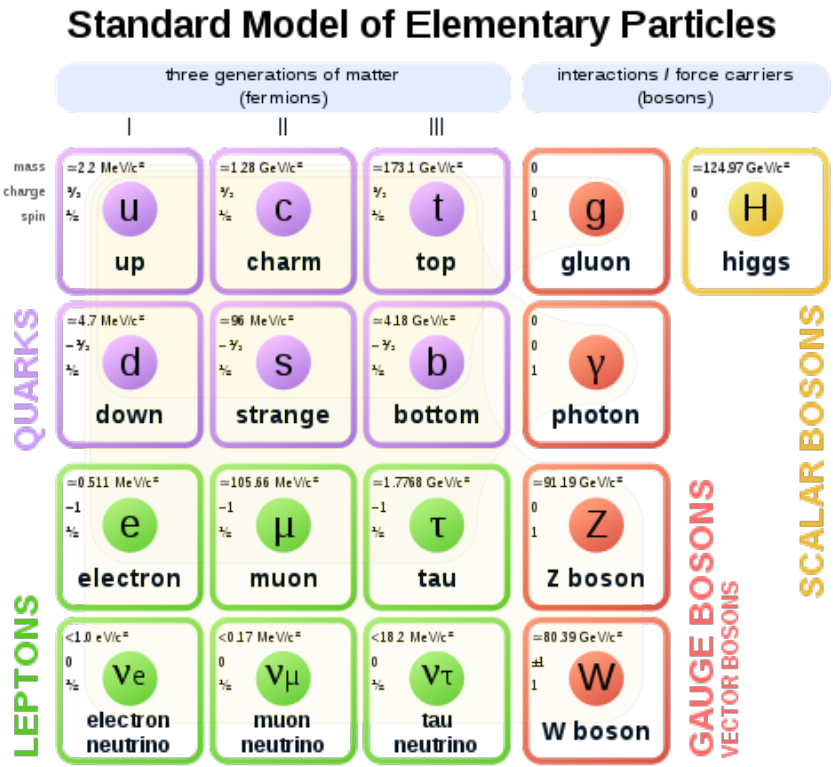
Brief Overview

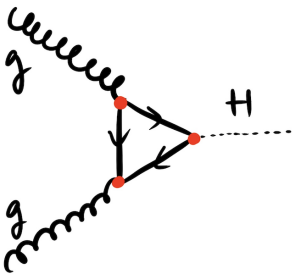


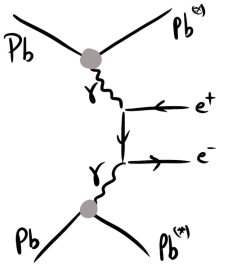
Particle physics reveals the profound connections underlying all observed phenomena..from the smallest to the largest structure in our Universe.

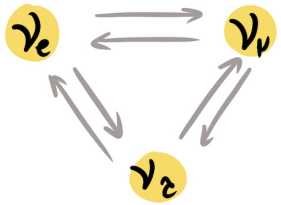


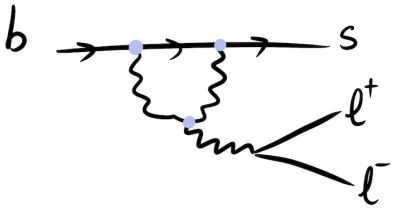
Particle Physics in a nutshell : The Standard Model











The Standard Model Framework

Particle physics has a *Standard Model* of particles and their interactions: GSW

New York Times, July 5, 2012

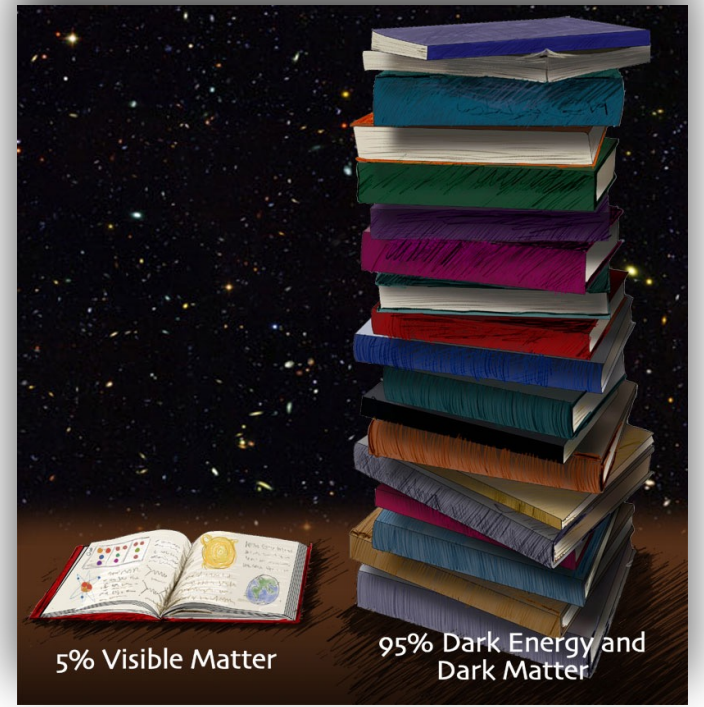
Physicists Find Elusive Particle Seen as the Key to Universe

POOL PHOTO BY DENIS BALIBOUSE

Physicists in Geneva applauded the discovery of a subatomic particle that looks like the Higgs boson.

SM cannot be complete

- Neutrino masses
- The pattern of fermion masses
- Dark matter/Dark energy



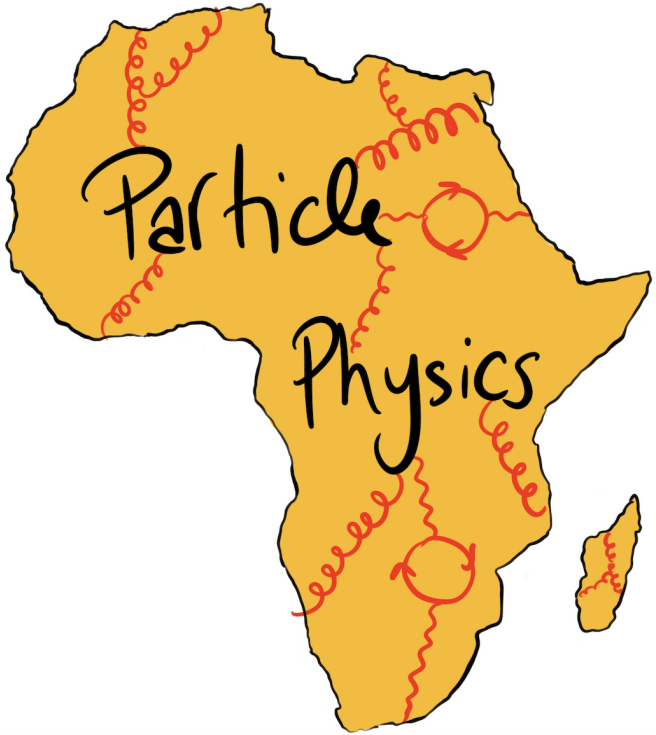
95% of the mass of the universe is dark matter and dark energy :
Not explained by the Higgs boson !

Experimental High Energy Physics

The forefront of experimental particle physics research takes place at CERN, in Geneva. Experimental Particle physicists participates in several experiments : ***ATLAS CMS, ALICE, LHCb,***…

- The primary objective of the ***ATLAS and CMS*** experiments is to uncover new fundamental constituents of matter and their interactions.
- ***ALICE*** experiment is mainly focused on understanding the state of matter known as the Quark-Gluon Plasma.
- ***LHCb*** is dedicated to provide insight into the matter-antimatter asymmetries.

Status of PP activities in Africa



Presence @ CERN

Involvement in experiments either full members or associate:

ATLAS

CMS

Alice

Training opportunities for example in LHCb.

Computing Tier 3 WLCG

Evolution of the level of participation and implication up to institutional collaborator.

Major collaborations

ASFAP — African Strategy for Fundamental and Applied Physics

ATLAS EXPERIMENT

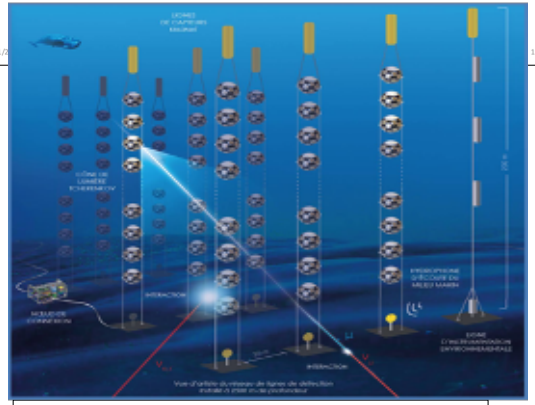
SAHAL YACOOB

ATLAS@UCT

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

ATLAS Activities in Morocco

D. Benchekroun
Hassan II University of Casablanca
On behalf the ATLAS Moroccan Group

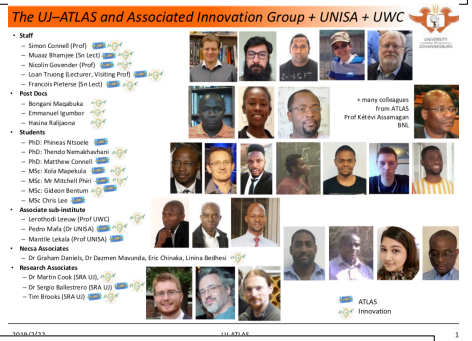


South Africa Activities in ALICE

ALICE

Zinhle Buthelezi,
for SA-ALICE

First ASFAP Particle Physics Day,
African Strategy for Fundamental Physics & Applications
18 November 2021



Egypt

By

Sherif Elgammal
(on behalf of ENHEP)

Centre for Theoretical Physics (CTP)
British University in Egypt (BUE)

HEP in Madagascar

D. Rabetiarivony,
on behalf of the
Institute of High Energy Physics of Madagascar, Univ. Antananarivo (MG)

DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

First ASFAP Particle Physics Day

DEEP UNDERGROUND NEUTRINO EXPERIMENT
and
UNIVERSITY OF ANTANANARIVO
MADAGASCAR

Nov.18th 2021

KM3net@Morocco

Laza Rakotondravohitra PhD
Universite d'Antananarivo
GenesisCare USA/ Duke University Medical Center

Contribution to ATLAS Computing in Algeria

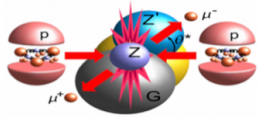
Ecole Nationale Supérieure d'Informatique (ESI)

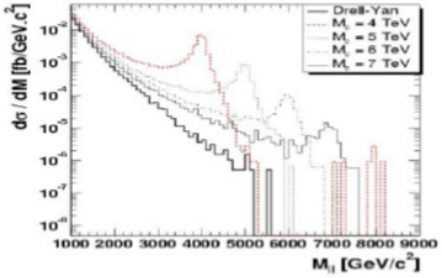
ESI ECOLE NATIONALE SUPÉRIEURE D'INFORMATIQUE

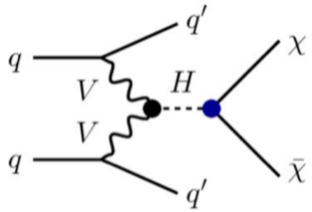
A few highlights

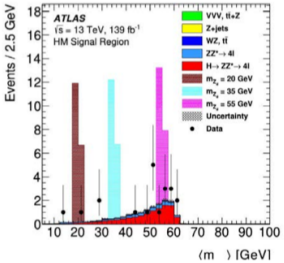
Physics analyses

Z prime models (BSM)

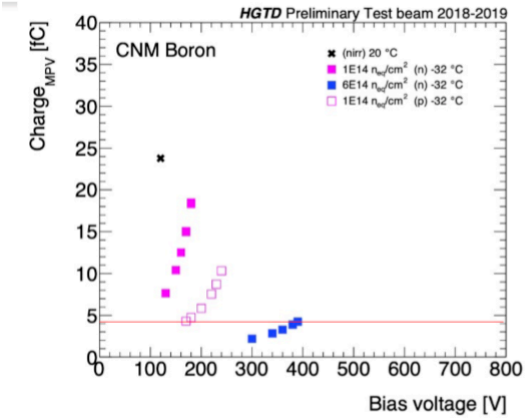




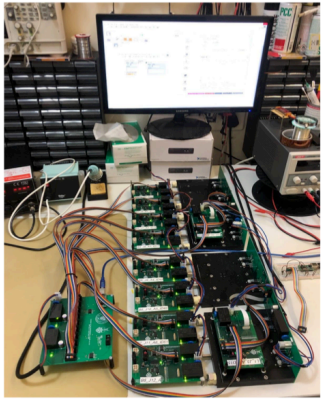




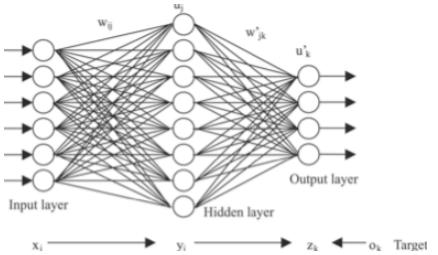
Beam tests



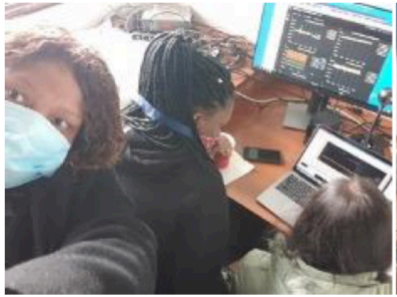
Electronics development

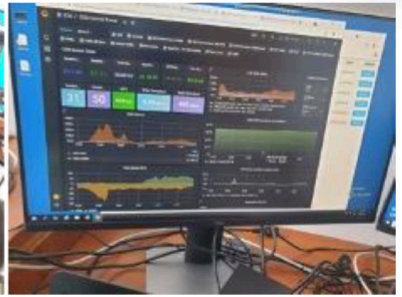


Machine learning



Remote operations





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

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

	ATLAS	ALICE	ISOLDE	Theory	Total
PhD	6	5	6	8	25
MSc	19	4	7	15	45
Accad Staff	8	6	6	7	27
Tech Staff	3	2	4		9
Post Docs	5	2	2	2	11

2020 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

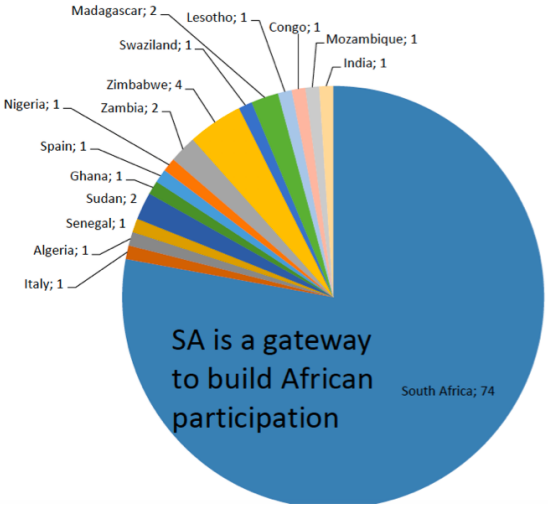
Decades of "ad hoc" participation

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

Slides courtesy of Simon Connell, UJ

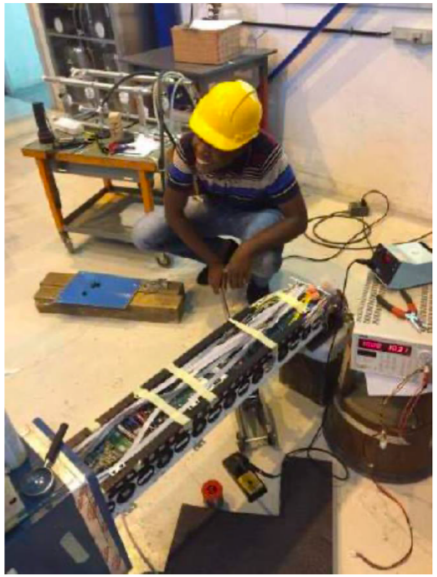
SA participates in Physics, Upgrade activities, Engineering, Outreach

Some of the SA-CERN group



Staff and students at ALICE

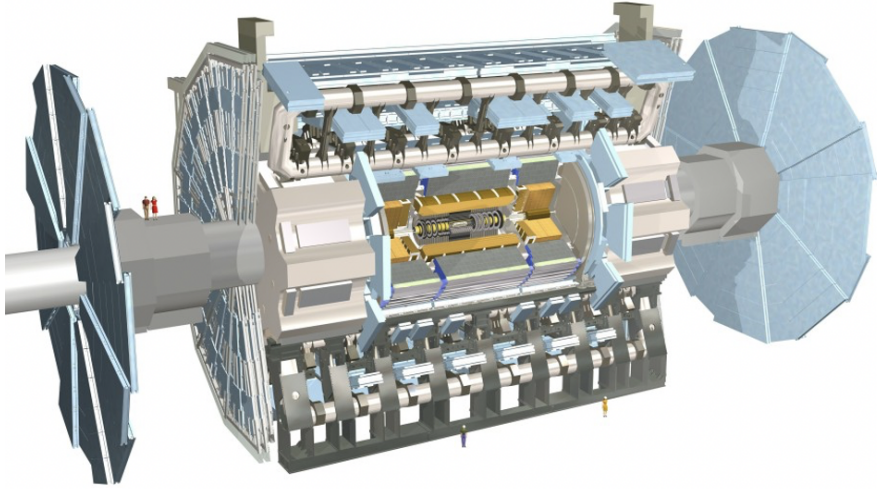
Staff and students at ISOLDE



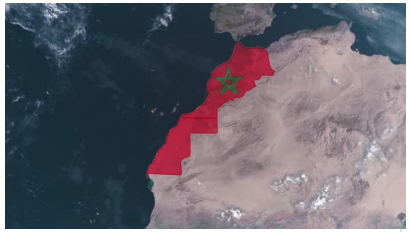
Testing modules developed in SA for ATLAS

Slides courtesy of Simon Connell, UJ

- Morocco has an internationally high-quality research in theoretical and experimental high-energy physics
- Morocco started its research in experimental particle physics with CERN in **1996** as a member of the ATLAS collaboration
- The scientific collaboration with CERN was boosted thanks to the foundation of the High Energy Physics framework (**RUPHE**)
- **RUPHE is formed of 5 Universities:**
  - Hassan II University in Casablanca;
  - Mohammed V University in Rabat;
  - Cadi Ayyad University in Marrakech;
  - Mohammed 1st University in Oujda;
  - Ibn-Tofail University in Kenitra
  - **AbdelMalek Saidi University, Tanger**



ATLAS Morocco group at a glance



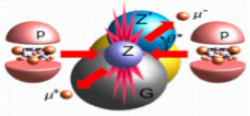
- **Current ATLAS People :**
- **52 members:**
  - **20 physicists**
  - **32 PhD Students**
  - **12 defended PhD thesis**
- **Research Program includes the topics:**
- **1) Physics analyses:**
  - Measurements: Standard Model (SM) and Higgs
  - Searches: Beyond the SM and Exotic new physics
  - Higgs boson and dark matter
- **2) Detector performance:**
  - Jets & Missing Transverse Energy reconstruction
  - Lepton reconstruction
- **3) Detector Operation:**
  - Inner detector Offline Commissioning,
  - Performance & Optimization
- **4) Upgrade:**
  - ATLAS High Granularity Timing Detector
- **5) Computing:**
  - Grid Data Processing & Analysis
  - Deep Machine Learning
  - High Performance Computing
- **4) Theory and Phenomenology**
  - **Multi Higgs models building**
  - **Colliders Phenomenology**

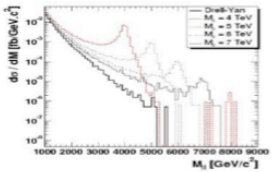
Egypt @ CMS

- Search for new heavy resonant and non-resonant phenomena in dilepton channels

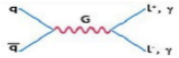
"contact person Dr. Sherif Elgammal (BUE)"

  - Z prime models (BSM)





  - Kaluza Klien excitation from Extra-dimensions



  - To explain b->s l^+ l^- anomalies at the LHC

https://arxiv.org/abs/1805.11402

  - High pt correlated tests of lepton universality in lepton(s) + jet(s) processes; EFT analysis

https://arxiv.org/abs/2005.06457

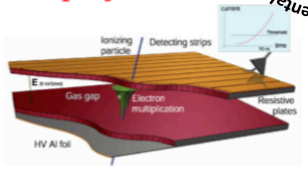
  - ATLAS published this analysis in

https://inspirehep.net/literature/1853941

  - Work still on going using CMS run 2

Egypt involved in the following CMS R&D projects

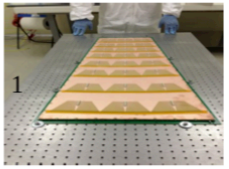
- Resistive Plate Chamber (RPC)
  - Prof. Elsayed Salama (BUE)
  - Dr. Yasser Assran (BUE) contact person
  - Shereen Aly (HU)
  - Asmaa Fawzi (HU)
  - Fatma Abdelkawy (AU)
  - Tahany Elhussieny (AU)

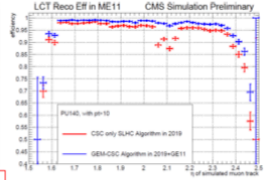


Egyptian groups participate in
* Assembling of RPC detector
* Efficiency tests

- Gas Electron Multiplier (GEM)
  - Dr. Ahmed Abdelalim (ZC)
  - Dr. Shimaa Abuzeid (AU)

contact person - Dr. Hassan Abdalla (CU)
  - Salwa Mohamed (AU)
  - Mohamed Elhoseny (CU)
  - Aya Beshr (AU)
  - Basma Elmahdy (BUE)





Advantage of GEM
* Combine triggering and tracking functions.
* Enhance and optimize the readout (eta,phi) granularity by improve rate capability.

Egyptian groups participate in
* Simulation of GEM detector
* Efficiency tests

9

- Search for mono-Z' + DM: "contact person Dr. Sherif Elgammal (BUE)"

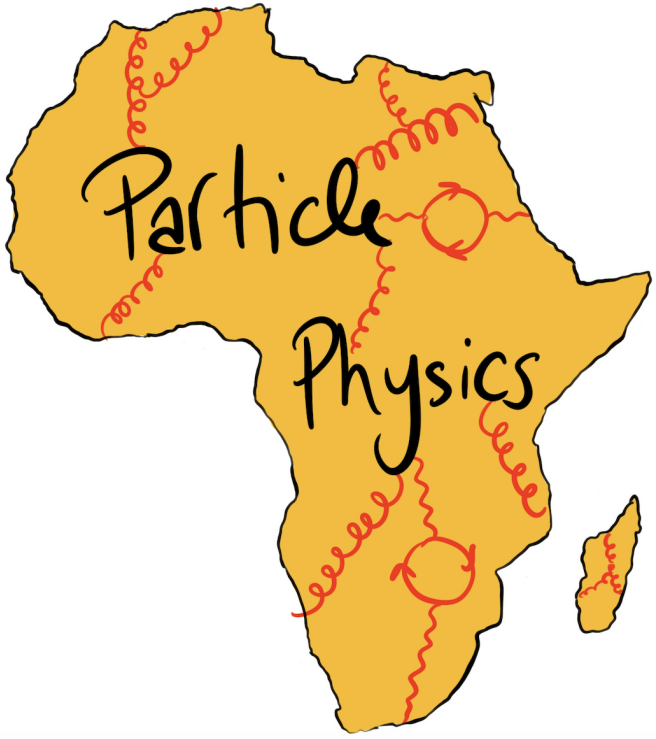
https://arxiv.org/pdf/2013.04326.pdf

- Search for mono-Higgs + DM: "contact person Dr. Sherif Elgammal (BUE)"

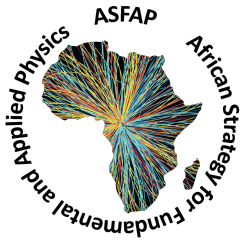
https://link.springer.com/article/10.1007%2FJHEP03%282020%29025

- Search for mono-Z + DM: "contact person Prof. Shaaban Khalil (ZC)"

PP Working group



Challenges of PP research in Africa

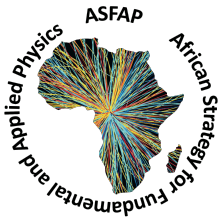


- Gaps in human capital
- Infrastructure deficits
- Weaker supporting systems for research
- Barriers to international mobility
- Small presence of African countries in world wide PP community
- Scientific collaboration among African countries is still below expectations

These factors have limited the contributions of the physics community to translate skills and expertise to a factor of development

However, despite these challenges, Africa has produced a vibrant research community with enormous potential

ASFAP: Scope of PP-WG



Define the particle physics community's direction for the current decade
Identify and prioritize the actions / activities in the coming years.

- Contribute to building a network of Particle Physicists in Africa.
- Push forward the ongoing activities and foster cooperations between African researchers for both Experimental and Theoretical physics.
- Address the possibilities of evolution and expansion of these involvements and drive future endeavors.
- Collect scientific inputs from African PP community: written contributions (LoI):
- Provide a shared roadmap for the field: White paper.

African Strategy for
Fundamental and Applied Physics

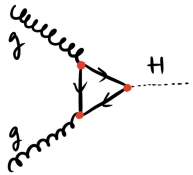
Particle Physics Conveners

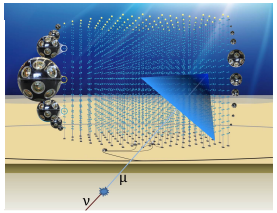
Mohamed Chabab (Morocco)

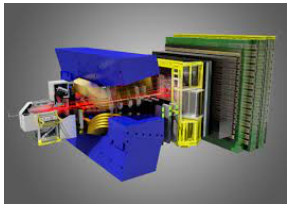
Yasmine Amhis (France)

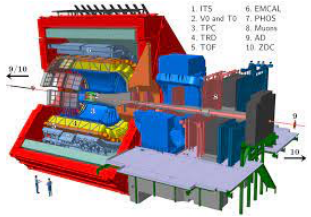
Zinhle Buthelzi (SA)

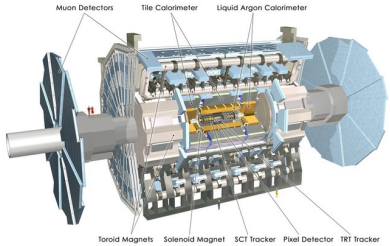
James Keaveney (SA)





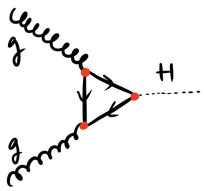


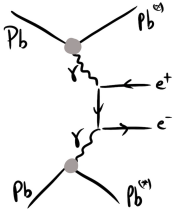


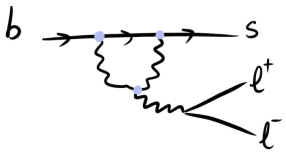


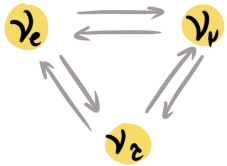
Subgroups:

- **subWG I “Fundamental constituents & forces”** :
  - Higgs physics.
  - Electroweak and BSM physics.
  - Direct searches.
- **subWG II “Symmetries and composite structures”:**
  - Flavour physics, CP violation.
  - Strong interaction, hadron physics, heavy ions.
  - Indirect searches.
  - nEDM.
- **subWG III “Light messengers” :**
  - Neutrino Physics : neutrino parameters, CP violation, BSM.
- **subWG IV “Infrastructures”**





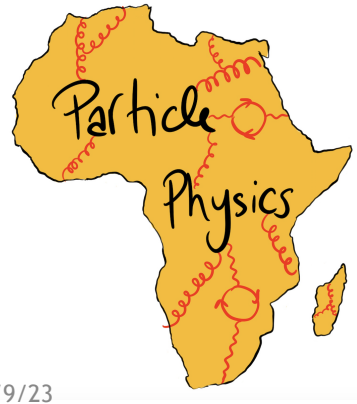




First ASFAP Particle Physics Day

18 November 2021
Online
Europe/Paris timezone

https://indico.cern.ch/event/1080353/



Second ASFAP Particle Physics Day

PhD' students and postdocs

31 March 2022
Online

https://indico.cern.ch/event/1126310/

Where to find us?

https://twiki.cern.ch/twiki/bin/view/AfricanStrategy/AfParticlePhysics

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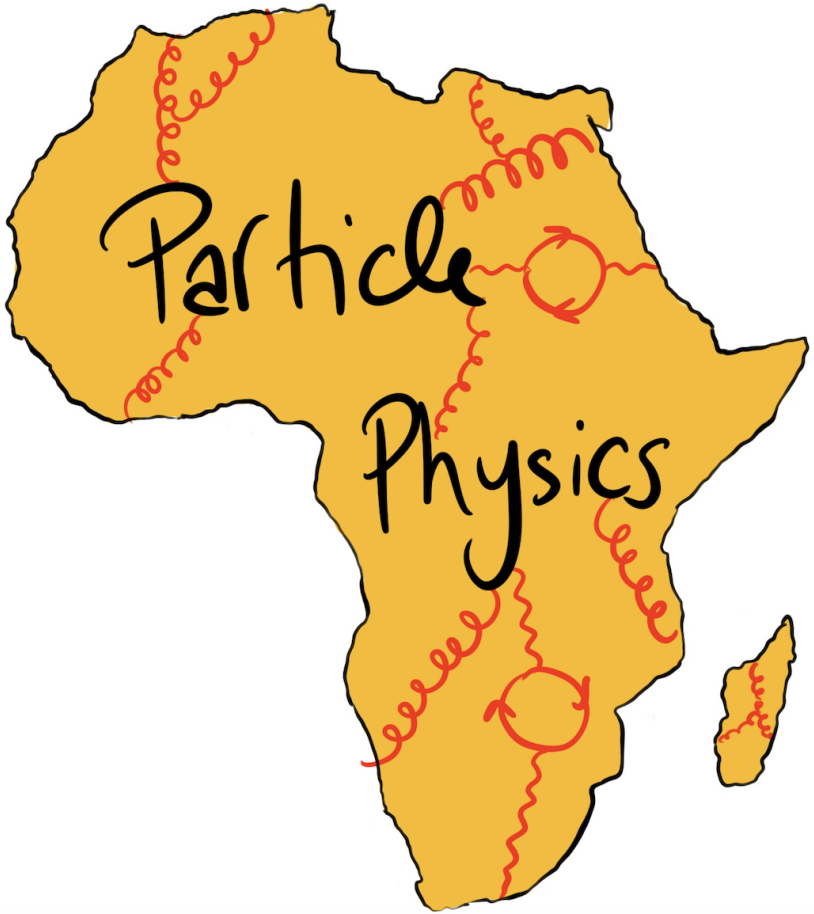
Please reach us if you are interested !



ASFAP
African Strategy for Fundamental and Applied Physics

Thank you