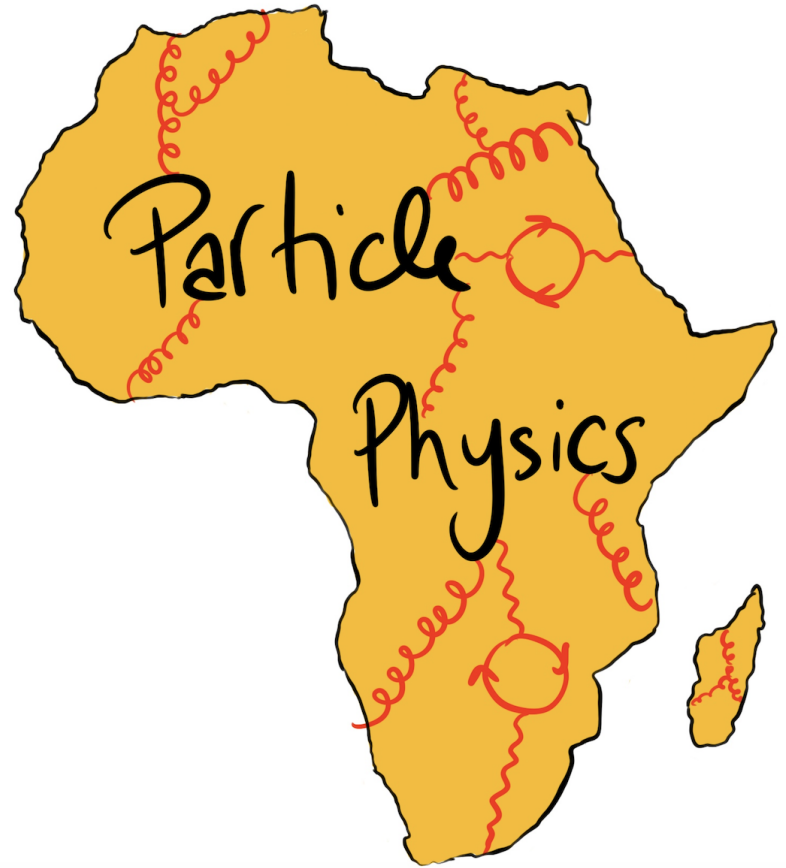


# An overview on ASFAP Particle Physics in Africa

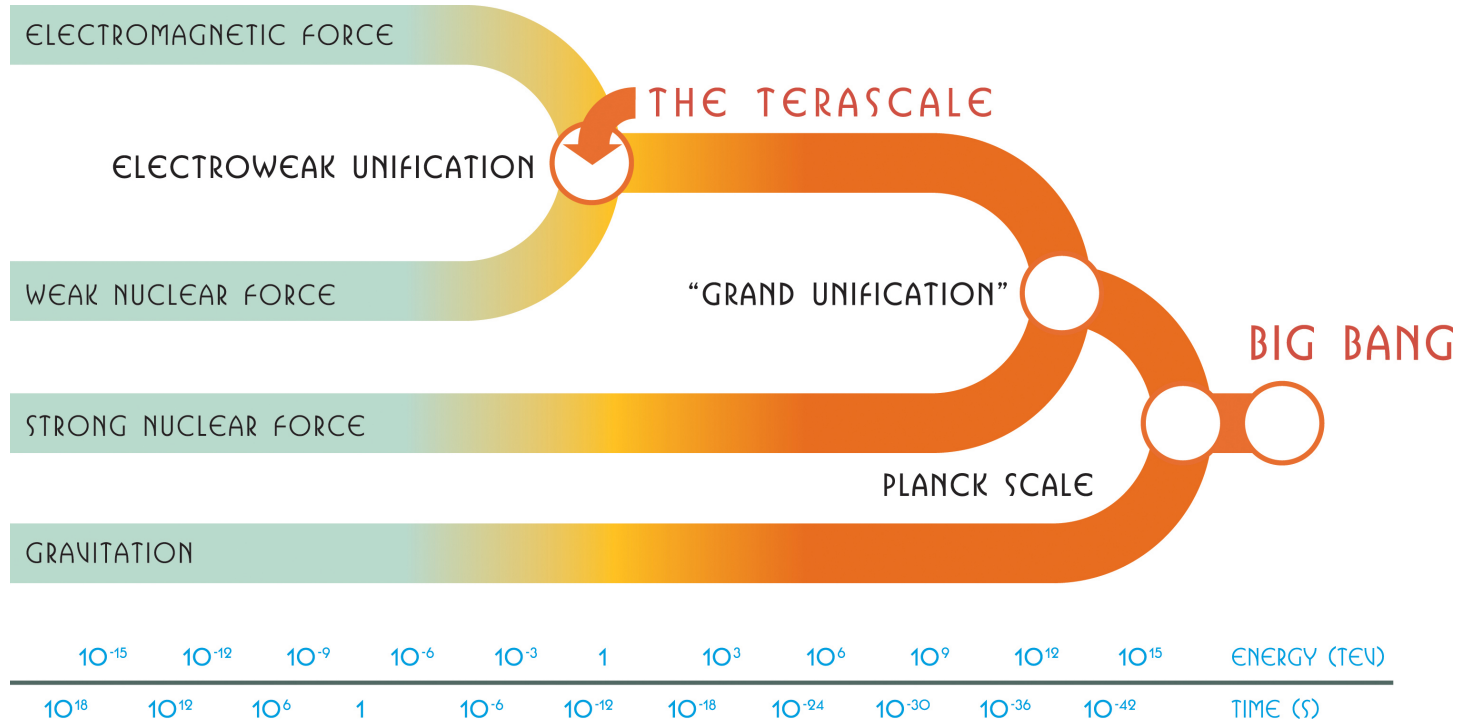
*Mohamed Chabab*



# Outline

- ❑ Preamble
- ❑ Selected Particle Physics activities in Africa
- ❑ ASFAP vision: PP Working group

# Particle physics reveals the profound connections underlying all observed phenomena..From the smallest to the largest structures in our Universe.



# Standard Model

## Standard Model of Elementary Particles

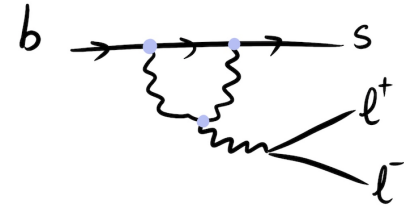
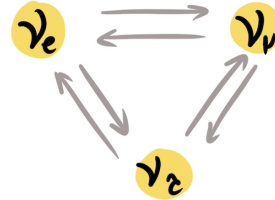
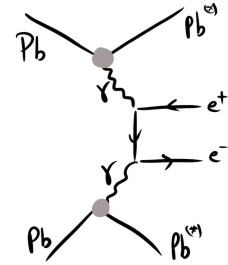
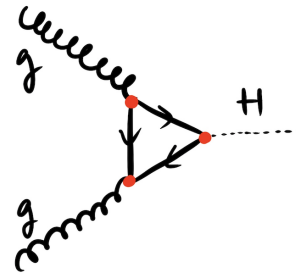
	three generations of matter (fermions)			interactions / force carriers (bosons)	
	I	II	III		
mass	=2.2 MeV/c <sup>2</sup>	=1.28 GeV/c <sup>2</sup>	=173.1 GeV/c <sup>2</sup>	0	=124.97 GeV/c <sup>2</sup>
charge	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$	0	0
spin	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	0
	<b>u</b> up	<b>c</b> charm	<b>t</b> top	<b>g</b> gluon	<b>H</b> higgs
	<b>d</b> down	<b>s</b> strange	<b>b</b> bottom	<b>γ</b> photon	
	<b>e</b> electron	<b>μ</b> muon	<b>τ</b> tau	<b>Z</b> Z boson	
	<b>ν<sub>e</sub></b> electron neutrino	<b>ν<sub>μ</sub></b> muon neutrino	<b>ν<sub>τ</sub></b> tau neutrino	<b>W</b> W boson	

QUARKS

LEPTONS

SCALAR BOSONS

GAUGE BOSONS  
VECTOR BOSONS



# Standard Model Framework

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



# New York Times, July 5, 2012



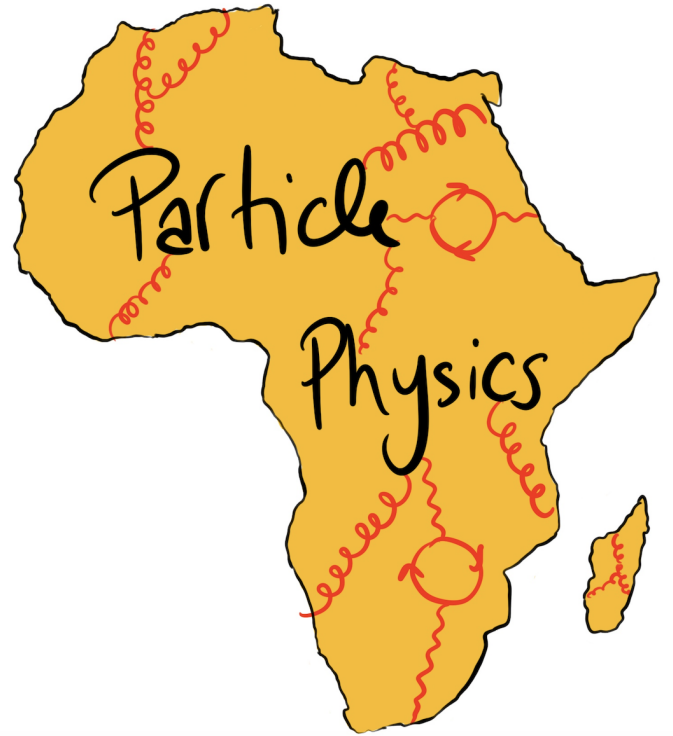
**Englert - Higgs**

## *Physicists Find Elusive Particle Seen as Key to Universe*



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

*Selected PP activities in Africa*



# Presence at CERN

## Non-Member States, Territories and Regions Collaborating with CERN

Albania	Algeria	Argentina	Armenia	Australia	Azerbaijan
Bahrain	Bangladesh	Belarus	Bolivia	Brazil	Canada
Chile	China	Colombia	Costa Rica	Cuba	Ecuador
Egypt	Georgia	Ghana	Hong Kong	Iceland	Indonesia
Iran	Ireland	Jordan	Kazakhstan	Korea	Kuwait
Latvia	Lebanon	Madagascar	Malaysia	Malta	Mexico
Mongolia	Montenegro	Morocco	Mozambique	Nepal	New Zealand
North Macedonia	Oman	Palestine	Paraguay	Peru	Philippines
Qatar	Rwanda	Saudi Arabia	Singapore	South Africa	Sri Lanka
Taiwan	Thailand	Tunisia	United Arab Emirates	Uzbekistan	Vietnam

**Involvement in experiments either full members or associate:**

ATLAS

CMS

Alice

**Training opportunities for example in LHCb.**

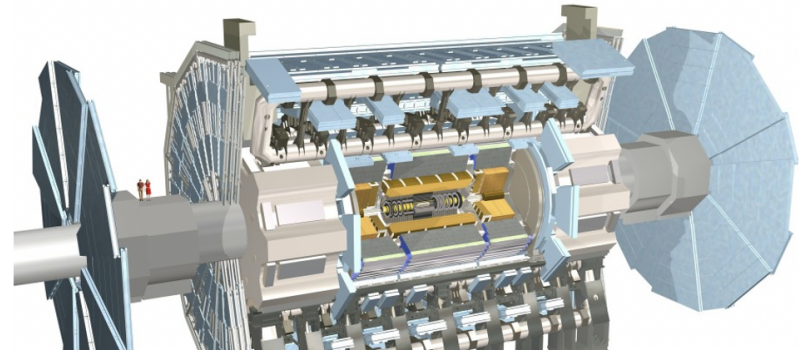
**Computing Tier 3 WLCG**



# Particle Physics in Morocco : History



- 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 Saadi University, Tangier**
  - **Mascir**



# 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



# South Africa

## SA-CERN programme

### ATLAS, ALICE, ISOLDE, CERN



science & innovation

Department:  
Science and Innovation  
REPUBLIC OF SOUTH AFRICA



iThemba LABS  
Laboratory for Accelerator Based Sciences



NELSON MANDELA  
UNIVERSITY



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

Slides courtesy of Simon Connell, UJ

- SA has a long history in High Energy Physics, eg : 1<sup>st</sup> 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

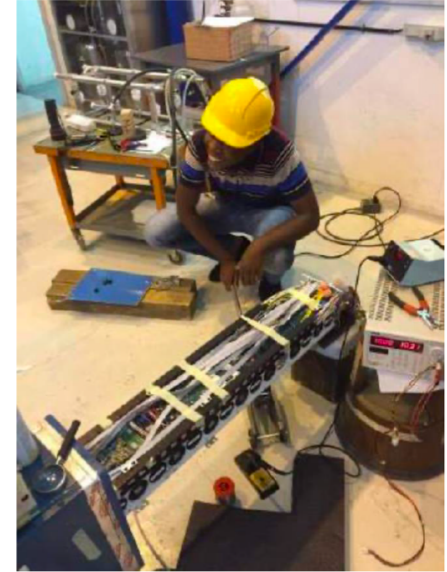
# SA participates in Physics, Upgrade activities, Engineering, Outreach



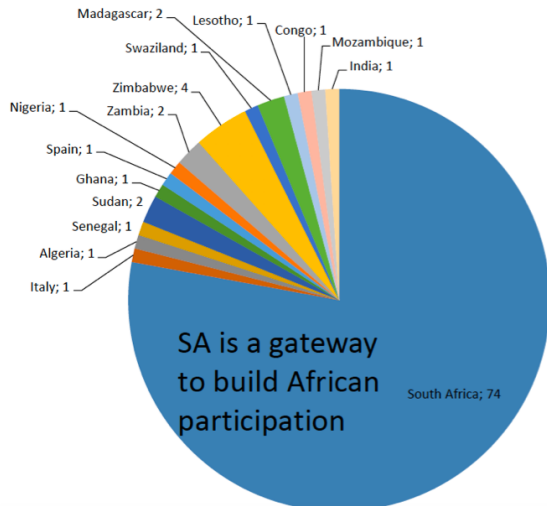
Some of the SA-CERN group



Staff and students at ALICE



Testing modules developed in SA for ATLAS



Staff and students at ISOLDE



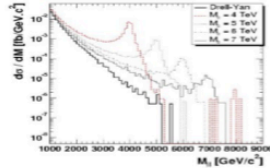
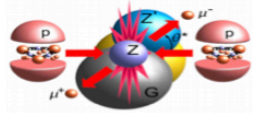
*Slides courtesy of Simon Connell, UJ*

# CMS @ Egypt

- 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  $b \rightarrow s l^+ l^-$  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

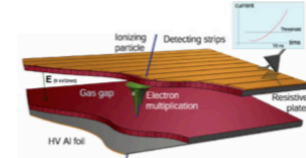
<https://inspirehep.net/literature/1853941>

- 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)

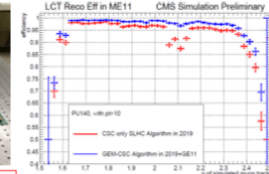
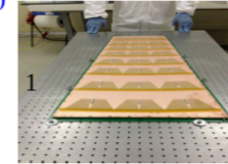


Egyptian groups participate in  
 \* Assembling of RPC detector  
 \* Efficiency tests

- Gas Electron Multiplier (GEM)

- Dr. Ahmed Abdelalim (ZC)
- Dr. Shima Abuzeid (AU)
- Dr. Hassan Abdalla (CU)
- Salwa Mohamed (AU)
- Mohamed Elhoseny (CU)
- Aya Beshr (AU)
- Basma Elmahdy (BUE)

contact person



### 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

- Search for mono-Z' + DM:

contact person Dr. Sherif Elgammal (BUE)

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

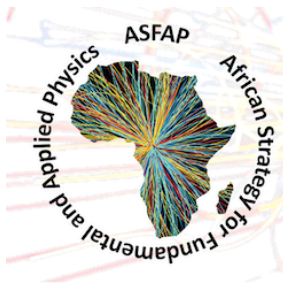
- Search for mono-Higgs + DM:

contact person Dr. Sherif Elgammal (BUE)

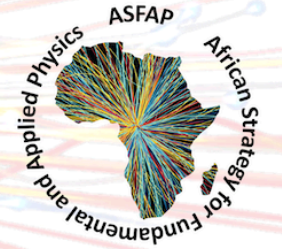
<https://link.springer.com/article/10.1007%2FJHEP03%282020%29025>

- Search for mono-Z + DM:

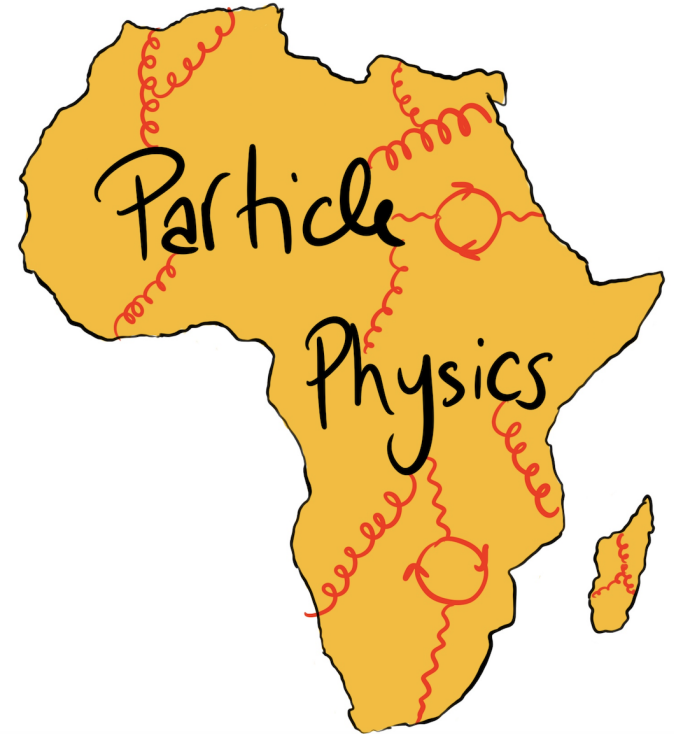
contact person Prof. Shaaban Khalil (ZC)



## African Strategy for Fundamental and Applied Physics



*ASFAP vision: PP Working group*



# Challenges of PP research in Africa

- Gaps in human capital
- Infrastructural deficits
- Weaker support systems for research
- Barriers to international mobility and collaboration.
- Small presence of African developing 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 potential factor for development.

However, despite these challenges, Africa has produced a vibrant research PP communities 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.****



# Particle Physics Conveners



Yasmine Amhis (France)



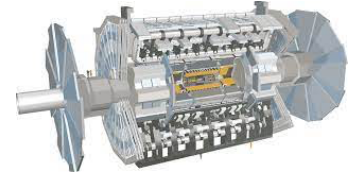
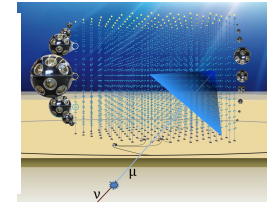
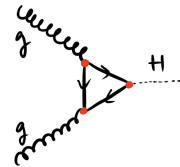
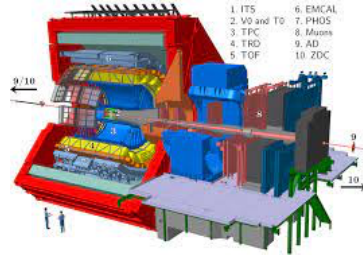
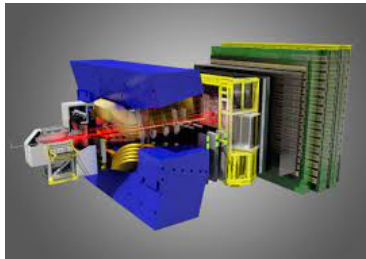
Zinhle Buthelzi (SA)



Mohamed Chabab (Morocco)



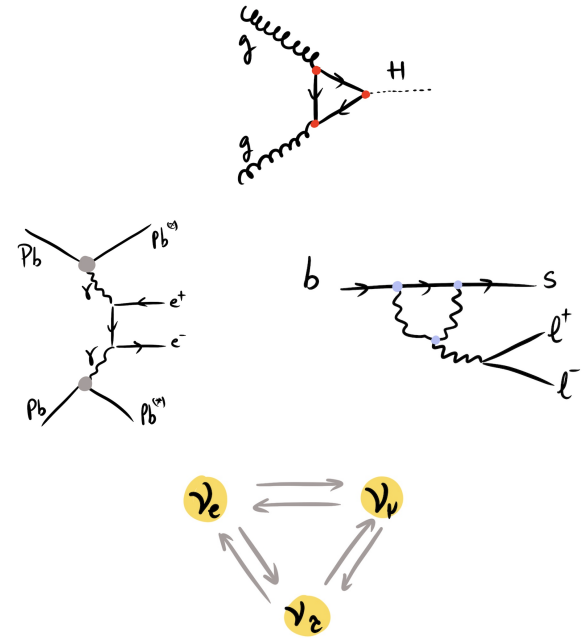
James Keaveney (SA)

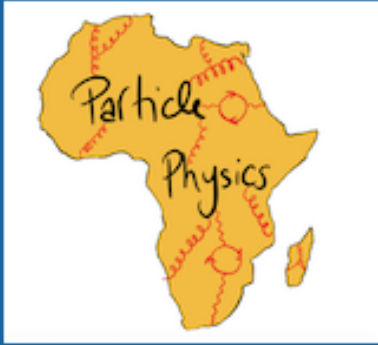


# Proposed subgroups:

- **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” .**

**Note:** Two conveners for each, an experimentalist and a theorist.

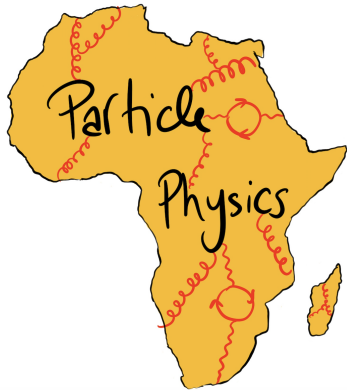




## First ASFAP Particle Physics Day

18 November 2021  
Online  
Europe/Paris timezone

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



## Second ASFAP Particle Physics Day PhD' students and postdocs

27 May 2022  
Online

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

# LoIs related to Particle Physics

- [Searching for subtle signs of new physics via novel top quark measurements](#) (*University of Cape Town (RSA) and IFIC Valencia ATLAS groups that commenced in 2020*), Concerns the electroweak couplings of the top quark as they pertain to the search for new physics and comprises analyses of data within the ATLAS collaboration and reinterpretation of published LHC data outside experimental collaborations. The aim is to highlight the importance of a thematic long-term research programme in enriching the African particle physics community and maximising its impact on the field's most prominent research questions.
- [Searches for heavy resonances decaying to top quarks with the ATLAS detector at LHC](#) (*Mohammed V University, Morocco*), A search for new resonances that decay into top-quark pairs ( $t\bar{t}$  invariant mass distribution) using data collected in 2015 to 2018 by the ATLAS experiment in pp collisions at  $\sqrt{s} = 13$  TeV at the LHC.
- [Jet energy scale and resolution in the High-Granularity Timing Detector in ATLAS upgrades at HL-LHC](#) (*Mohammed V University, Morocco*), Large increase of pileup is one of the main experimental challenges for the High Luminosity-Large Hadron Collider (HL-LHC) physics program. HL-LHC is expected to start in 2027 and will provide an integrated luminosity of 3000 fb<sup>-1</sup> in ten years, a factor 10 more than what will be collected by 2023. A powerful new way to address this challenge is to exploit the time spread of the interactions to distinguish between collisions occurring very close in space but well separated in time. A High-Granularity Timing Detector (HGTD, low-gain avalanche detector technology), is proposed for the ATLAS Phase-II upgrade. The impact of HGTD in reducing pileup track contamination in the jets reconstruction in the forward region is investigated
- [Higgs portal vector dark matter interpretation: review of Effective Field Theory approach and ultraviolet complete models](#) (*Mohammed V University (Morocco), BNL (USA), University of Johannesburg (RSA)*):- The Higgs portal-vector dark matter interpretation of the spin-independent dark-matter nucleon elastic scattering cross section, using the invisible Higgs decay width measured at the LHC, is presented. The Effective Field Theory approach and ultraviolet complete models have been used and details description are discussed. Hence, the inclusion of these theoretical scenarios in LHC public results in comparison with direct detection results is proposed. We investigate the dark matter in the sub-GeV mass range as well.

# Where to find us?

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

NAME	AFFILIATION	EMAIL	Gender	African origin/Diaspora
Dr. Yasmine Amhis <a href="#">YaBio</a>	CNRS-IN2P3, France	yasmine.sara.amhis[at]cern.ch	F	Algeria
Ass. Prof. Zinhle Buthelezi	iThemba LABS/WITS	edith.zinhle.buthelezi[at]cern.ch	F	South Africa
Prof. Mohamed Chabab <a href="#">ChababBio</a>	Cadi Ayyad U, Morocco	mchabab[at]uca.ma	M	Morocco

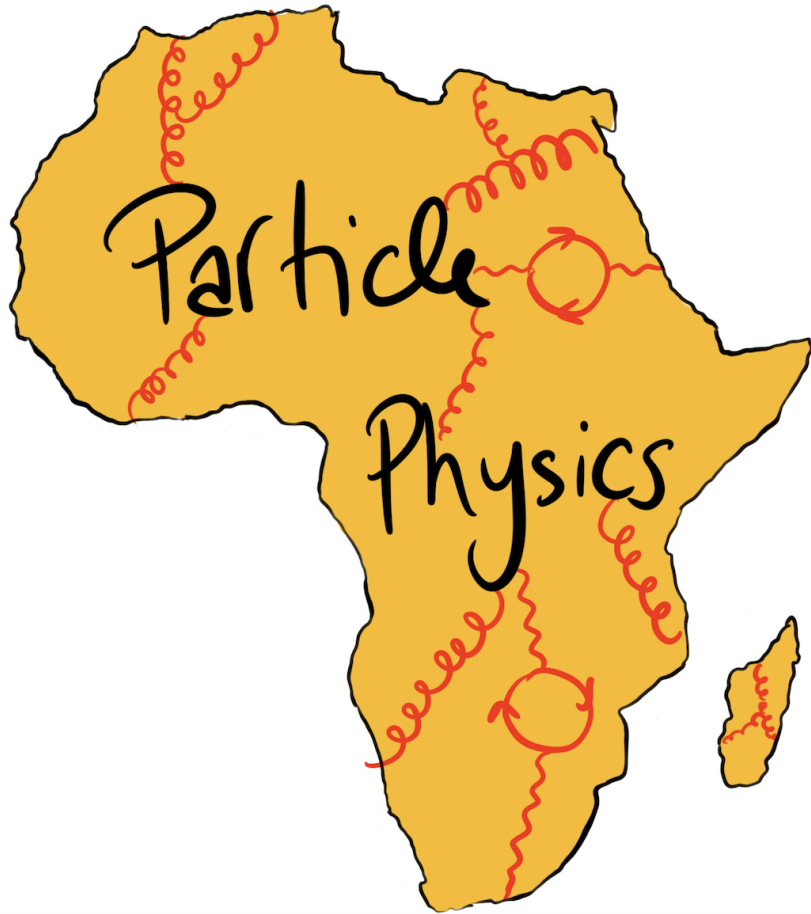
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Dr. Samira Hassani	CEA, France	Samira.Hassani[at]cern.ch	F
Prof. Peter Jenni	Freiburg University and CERN	peter.jenni[at]cern.ch	M
Dr. Claire Lee	Fermilab, USA	claire.lee[at]cern.ch	F
Dr. María Moreno Llácer	IFIC, CSIC-University of Valencia, Spain	maria.moreno.llacer[at]cern.ch	F
Dr. Lydia Roos	LPNHE, CNRS and Sorbonne Université, Paris, France	lroos[at]lpnhe.in2p3.fr	F
Dr. Gopolang Mohlabeng	Queen's University	gopolang.mohlabeng[at]queensu.ca	M

## Other members

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Prof. Farida Fassi	Mohammed V University in Rabat	farida.fassi[at]cern.ch	F

**Please reach us if you are interested !**



*Thank you*