

# Particle Physics @ ASFAP

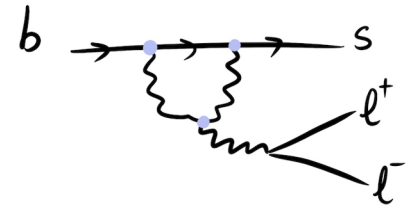
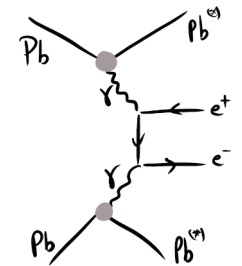
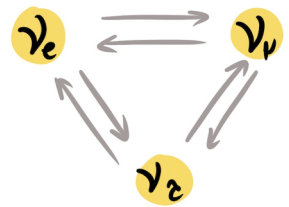
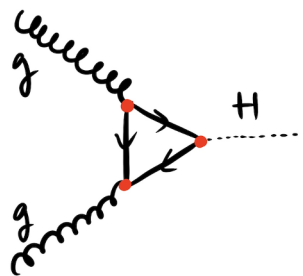
Yasmine Amhis, Zinhle Buthelezi, Mohamed Chabab,

ASFAP Community Town Hall

13.07.2021

# Standard Model of Elementary Particles

three generations of matter (fermions)			interactions / force carriers (bosons)	
I	II	III		
mass $=2.2 \text{ MeV}/c^2$ $\frac{1}{2}$ $\frac{1}{2}$ u up	mass $=1.28 \text{ GeV}/c^2$ $\frac{1}{2}$ $\frac{1}{2}$ c charm	mass $=173.1 \text{ GeV}/c^2$ $\frac{1}{2}$ $\frac{1}{2}$ t top	0 0 1 g gluon	mass $=124.97 \text{ GeV}/c^2$ 0 0 0 H higgs
QUARKS $=4.7 \text{ MeV}/c^2$ $-\frac{1}{3}$ $\frac{1}{2}$ d down	$=96 \text{ MeV}/c^2$ $-\frac{1}{3}$ $\frac{1}{2}$ s strange	$=4.18 \text{ GeV}/c^2$ $-\frac{1}{3}$ $\frac{1}{2}$ b bottom	0 0 1 γ photon	SCALAR BOSONS
$=0.511 \text{ MeV}/c^2$ -1 $\frac{1}{2}$ e electron	$=105.66 \text{ MeV}/c^2$ -1 $\frac{1}{2}$ μ muon	$=1.7768 \text{ GeV}/c^2$ -1 $\frac{1}{2}$ τ tau	$=91.19 \text{ GeV}/c^2$ 0 0 1 Z Z boson	GAUGE BOSONS VECTOR BOSONS
$<1.0 \text{ eV}/c^2$ 0 $\frac{1}{2}$ ν <sub>e</sub> electron neutrino	$<0.17 \text{ MeV}/c^2$ 0 $\frac{1}{2}$ ν <sub>μ</sub> muon neutrino	$<1.82 \text{ MeV}/c^2$ 0 $\frac{1}{2}$ ν <sub>τ</sub> tau neutrino	$=80.39 \text{ GeV}/c^2$ 0 1 W W boson	



# Particle Physics in a nutshell

## Particle physics

From Wikipedia, the free encyclopedia

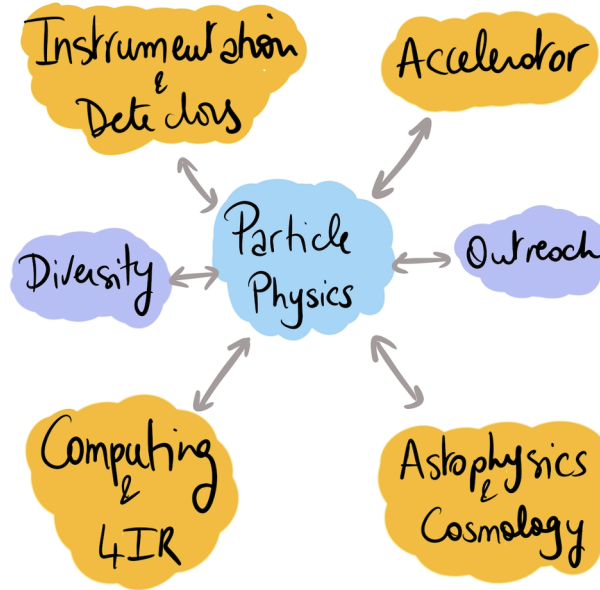
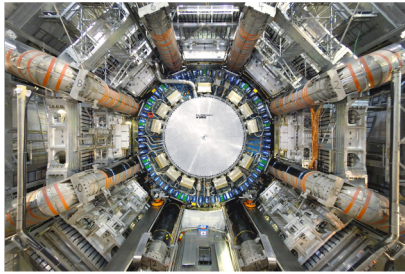
*Wikipedia!*

For other uses of "particle", see [Particle \(disambiguation\)](#).

**Particle physics** (also known as **high energy physics**) is a branch of [physics](#) that studies the nature of the particles that constitute [matter](#) and [radiation](#). Although the word *particle* can refer to various types of very small objects (e.g. [protons](#), gas particles, or even household dust), *particle physics* usually investigates the irreducibly smallest detectable particles and the [fundamental interactions](#) necessary to explain their behaviour.

In current understanding, these [elementary particles](#) are excitations of the [quantum fields](#) that also govern their interactions. The currently dominant theory explaining these fundamental particles and fields, along with their dynamics, is called the [Standard Model](#). Thus, modern particle physics generally investigates the Standard Model and its various possible extensions, e.g. to the newest "known" particle, the [Higgs boson](#), or even to the oldest known force field, [gravity](#).<sup>[1][2]</sup>

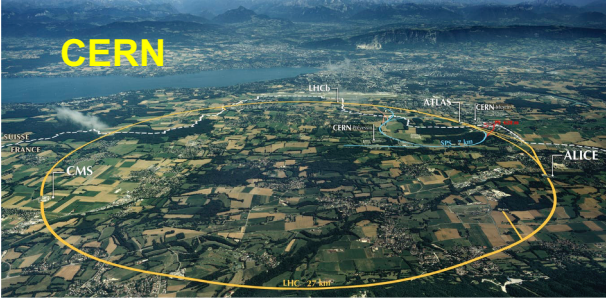
# How we position ourselves in the field of fundamental physics ?



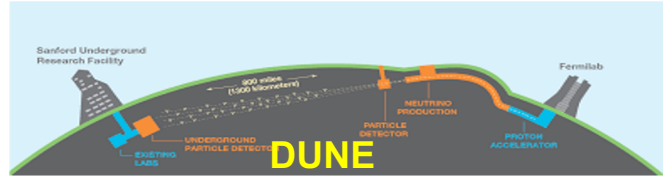
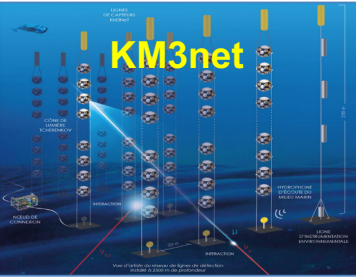
Established contact with all of the other WGs from ASFAP & discussions with individual researchers .

# Particle Physics facilities

## Colliders

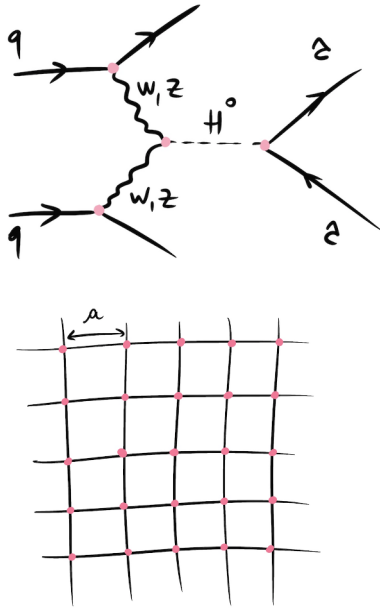


## Neutrino experiments



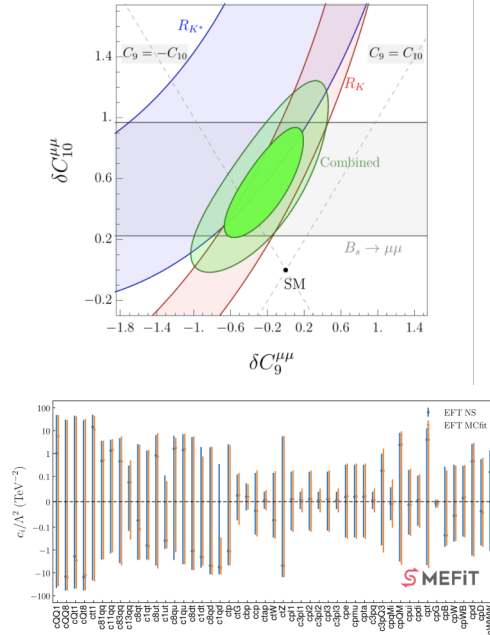
# Theoretical physics

## Predictions



Generators, Lattice QCD...

## Interpretations

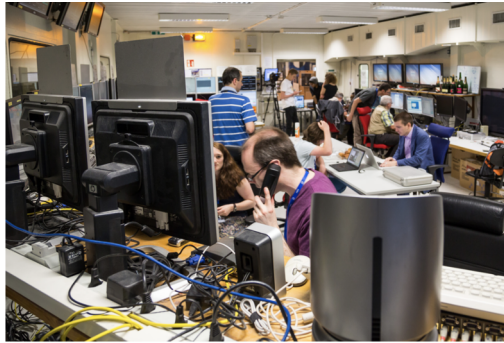


EFTs, CKM, PMNS...

## Model Building



# Typical operating structure (CERN)



**Operations/Shifts  
for data taking**

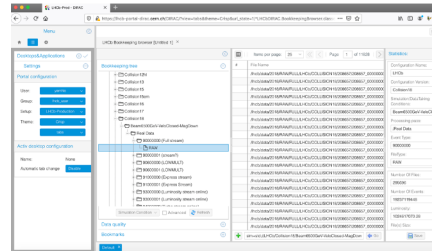


**On site training**



**Brainstorming**

**Large international  
collaborations**



**Remote access to data**

# Particle Physics conveners



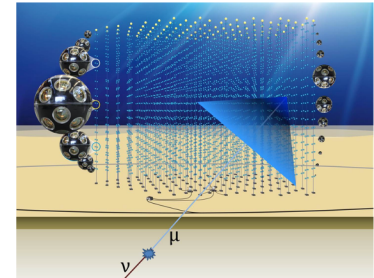
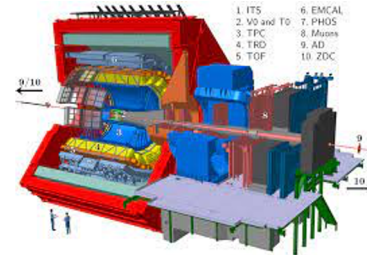
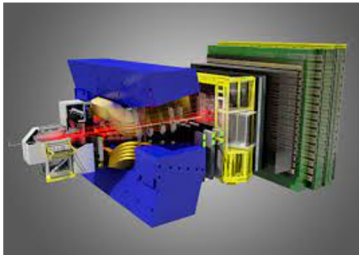
**Yasmine Amhis**



**Zinhle Buthelzi**



**Mohamed Chabab**



# Our role

**Contribute to building a network of Particle Physicists in Africa.**

**Start by making a survey of the ongoing activities and collaborations in Africa for both Experimental and Theoretical physics.**

**Address the possibilities of evolution and expansion of these involvements in the next few years.**

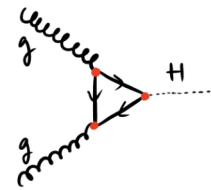




# Proposed subgroups

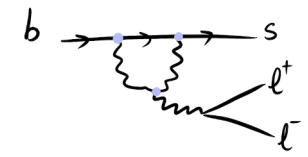
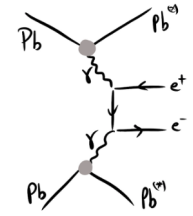
- **subWG I “Fundamental constituents & forces” :**

- Higgs physics.
- Electroweak and BSM physics.
- Direct searches.



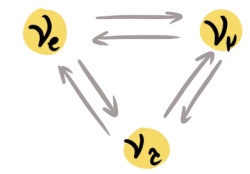
- **subWG II “Symmetries and composite structures”:**

- 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:** For subWG I, II and III we would like to have two conveners, an experimentalist and a theorist.

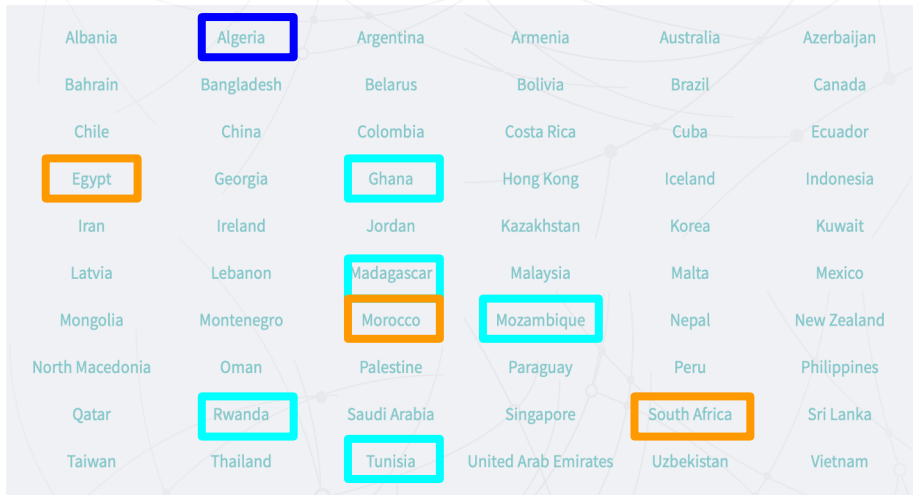
# Ongoing survey of activities -- CERN

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

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

# Ongoing survey of activities -- CERN

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



Involvement in experiments either full members or associate:

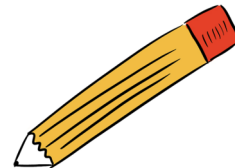
ATLAS  
CMS  
Alice

Training opportunities for example in LHCb.  
Computing Tier 3 WLCG

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

Next steps: extend survey to other facilities.

# Theoretical physics



## Topics covered :

- Standard Model Physics.
- Physics Beyond the Standard Model
- General relativity, Quantum Gravity
- Dark matter.
- Etc.

arXiv:2103.04262v2 [hep-ex] 27 May 2021

**Search for dark matter production in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations**

S. Ezzamel<sup>1</sup> and M. A. Lodi<sup>2</sup>  
 1. Physics Department, The College of Science, King Fahd University of Petroleum & Minerals, Dhahran 31021, Saudi Arabia  
 2. Physics Department, King Fahd University of Petroleum & Minerals, Dhahran 31021, Saudi Arabia

The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations. The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations. The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations.

**1. INTRODUCTION**

One of the interesting new questions in particle physics is the existence of dark matter. The dark matter is a form of matter that does not interact with light and is not made of atoms. It is thought to be made of particles that do not interact with light and is not made of atoms. It is thought to be made of particles that do not interact with light and is not made of atoms.

**2. CONCLUSIONS**

The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations. The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations.

**BOUNDARIES OF THE SCALE OF NONLOCALITY FROM DARK MATTER PRODUCTION AT THE LHC: A NEW EXPERIMENTAL CONSTRAINT**

MORIMARIE DELIA RIZZI  
 Laboratoire de Physique Théorique, Faculté de Sciences de la Nature et de la Vie, Université de Bourgogne, Dijon, France

**SUMMARY**

The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations. The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations.

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arXiv:2010.07837v1 [hep-th] 15 Oct 2020

FRSAC-TR/09-0145, UQAR-TR/78-2782

**On Universal Constants of Ads Black Holes from Hawking-Page Phase Transition**

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 1. Département de Physique, Faculté des Sciences de la Nature et de l'Environnement, UQAR, Québec, Québec, Canada  
 2. Física Teórica, Dept. de Física, Univ. de Murcia, Campus de Espinardo, 30100 Murcia, Spain  
 \*Hibernation, CERN, CH-1211 Geneva 23, Switzerland

October 16, 2020

**Abstract**

We investigate the thermodynamic properties of the Hawking-Page phase transition of Ads black holes. We present evidence for the existence of two universal constants associated with the Hawking-Page (HP) and minimum black hole thermodynamic transition points. These constants are defined by  $C_1 = \frac{S_{HP}}{A_{HP}}$  and  $C_2 = \frac{M_{HP}}{A_{HP}}$ , where  $S_{HP}$  and  $M_{HP}$  are the entropy and mass of the HP transition point, respectively. We show that these constants are universal for all Ads black holes, regardless of the dimensionality of the spacetime. We also discuss the implications of these constants for the study of black hole thermodynamics.

**Keywords:** Ads black holes, Universal constants, Hawking-Page phase transition.

**Black hole stability under odd-parity perturbations in Horowitz gravity**

Agustín González<sup>1</sup>, Roberto Emparan<sup>1</sup>, Horacio El-Emir<sup>1</sup>, Juan Carlos González  
 1. Department of Physics, Princeton University, Princeton, NJ 08542, USA  
 2. Institute of Physics, University of Amsterdam, Science Park 904, Amsterdam, The Netherlands

**Abstract**

The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations. The authors present the possible kinematic features for the production of dark matter particles in association with the  $Z$  bosons at the LHC in pp collisions at  $\sqrt{s} = 13$  TeV using Monte Carlo simulations.

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$$L_{\text{Yukawa}} = -(\gamma_e)_{ij} \bar{L}_i \phi R_{Rj} - (\gamma_d)_{ij} \bar{Q}_i \phi R_{Rj} - (\gamma_u)_{ij} \bar{Q}_i \tilde{\phi} U_{Rj} + \text{h.c.},$$

# Where to find us ?

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

NAME	AFFILIATION	EMAIL	Gender	African origin/Diaspora
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Prof. Mohamed Chabab <a href="#">ChababBio</a>	Cadi Ayyad U, Morocco	mchabab[at]uca.ma	M	Morocco

## Observers Committee members

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

# Conclusion

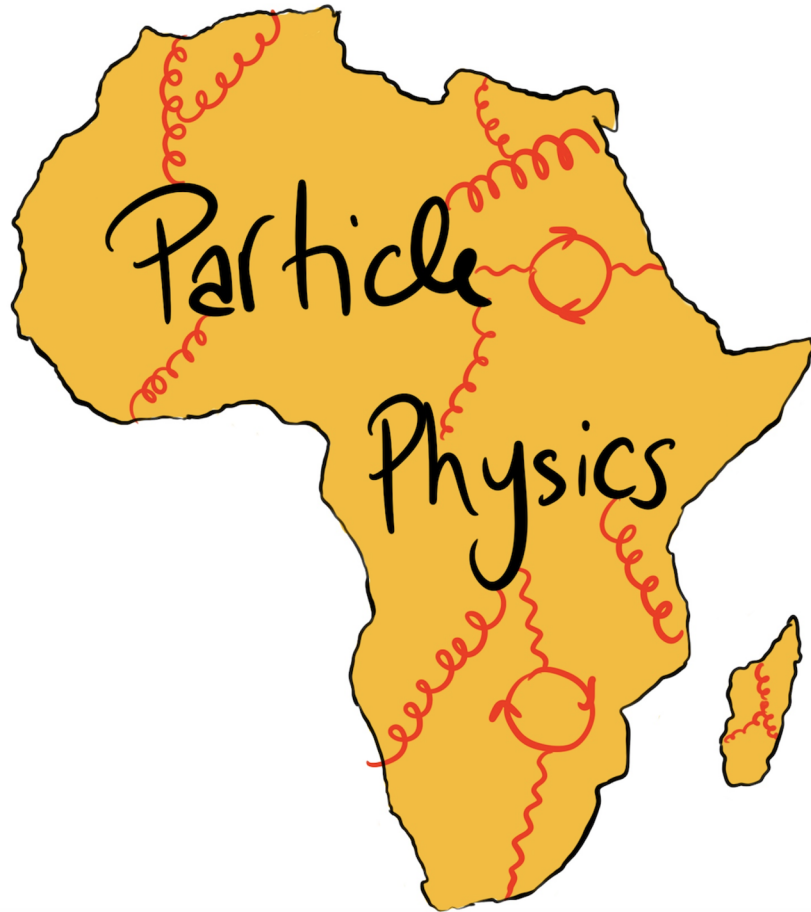
**Agreed on a structure for the subWGs and opened a call for nominations.**

**Started a survey of the activities with CERN. This work will be extended to other facilities and to Theoretical Physics.**

**Looking forward to hearing back from you !**

**Special thanks to our observers for their input and feedback.**







# 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



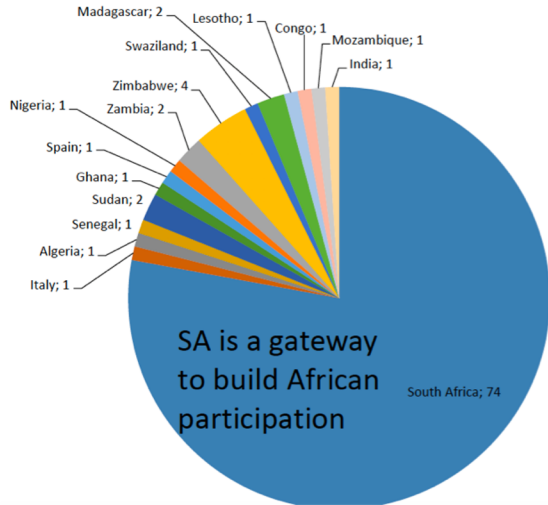
Some of the SA-CERN group



Staff and students at ALICE



Testing modules developed in SA for ATLAS



Staff and students at ISOLDE

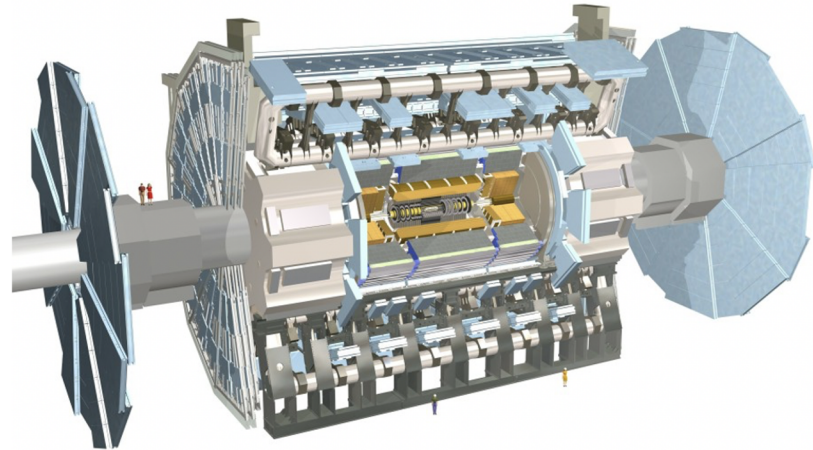


Slides courtesy of Simon Connell, UJ

# 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



# 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



## CALICE Collaboration Calorimeters for Linear Collider Experiments

- Performance of the ILD detector concept: Si-W ELM Calorimeter
- Higgs mass measurement at the International Linear Collider (ILC) in the  $ee \rightarrow ZH \rightarrow ee X$  channel



# KM3NeT Collaboration Search for Neutrino



- **ARCA** : Detection of high energy neutrinos of cosmic origin
- **ORCA**: detector dedicated to the determination of the mass hierarchy of neutrinos.

## **KM3NeT/Morocco: 3 Moroccan Universities are full members**

- **Univ. Mohammed V, Rabat**
- **Univ. Mohammed I, Oujda**
- **Univ. Cadi Ayyad, Marrakech**

## **Members:**

- **12 Physicists**
- **4 PhD Students**
- **1 defended PhD thesis**



**Research Program includes the topics:**

- Search for Magnetic monopole
- Search for nuclearite
- Neutrino light curves from core collapse Supernovae

**Contribution to the construction of KM3NeT telescopes:**

- DOM integration in Rabat and Oujda Sites.

# Egypt

The ENHEP PhD theses:

Ahmed Abdelalim, Search for excited electron production using Di-electron + photon signature and search for new heavy neutral gauge boson using Di-electron signature with ATLAS at  $V_s = \text{TeV}$  (2011).

Shimaa Abu Zeid, Search for top quark Flavour Changing Neutral Coupling with the CMS Experiment at the LHC (2018).

Yasser Assran, Study and operational characteristics of RPC FOR THE CMS experiment at LHC (2012).

Mohammed Attia, A Study of Charged Particle Production in Proton-Proton Collisions at LHC (2007).

Sherif Elgammal, Detection of high energy electrons in the CMS detector at the LHC (2009).

Mai Elsayy, Search for Magnetic Monopoles in the CMS experiment at the Large Hadron Collider (2020).

Ahmed Lotfy, Study of Correlations in p-p Collisions at LHC (2017).

