CMS activities at ENHEP - Egypt

By

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(on behalf of ENHEP)

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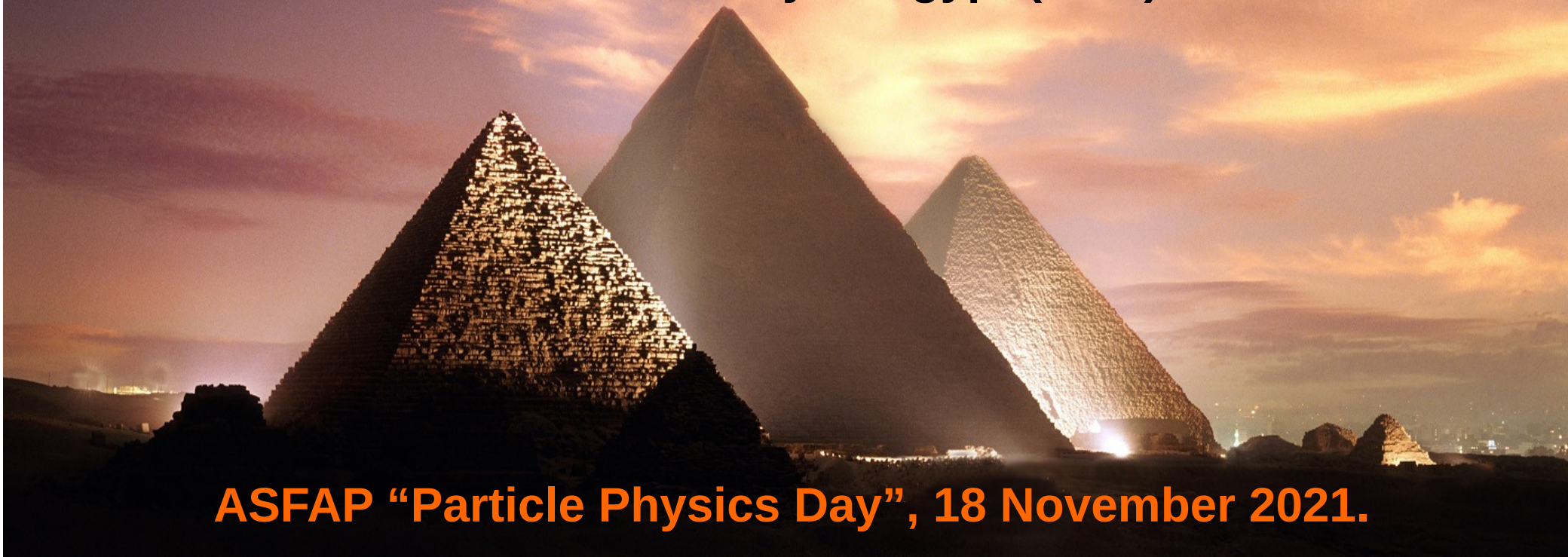


ASFAP "Particle Physics Day", 18 November 2021.

Initiation of ENHEP

- **ENHEP: the Egyptian Network of High Energy Physics is a group of Egyptytian scientists and students who work in the fileds of theoretical and experimental particle physics under the umbrella of Egyptian Academy of Science and Technology (ASRT).**
- **In 2009 Egypt became associated member state at CERN, and then joined the CMS experiment. The agreement was between CERN and ASRT.**
- **Many Egyptian (public and private) Universities have joined the research activities in CMS under the umbrella of ASRT.**

Public Universities

- **Cairo University (CU)**
- **Ain Shams University (AU)**
- **Helwan University (HU)**

Private Universities

- **The British University in Egypt (BUE)**
- **Zewail City of Science and Technology (ZC)**
- **Nile University (NU)**

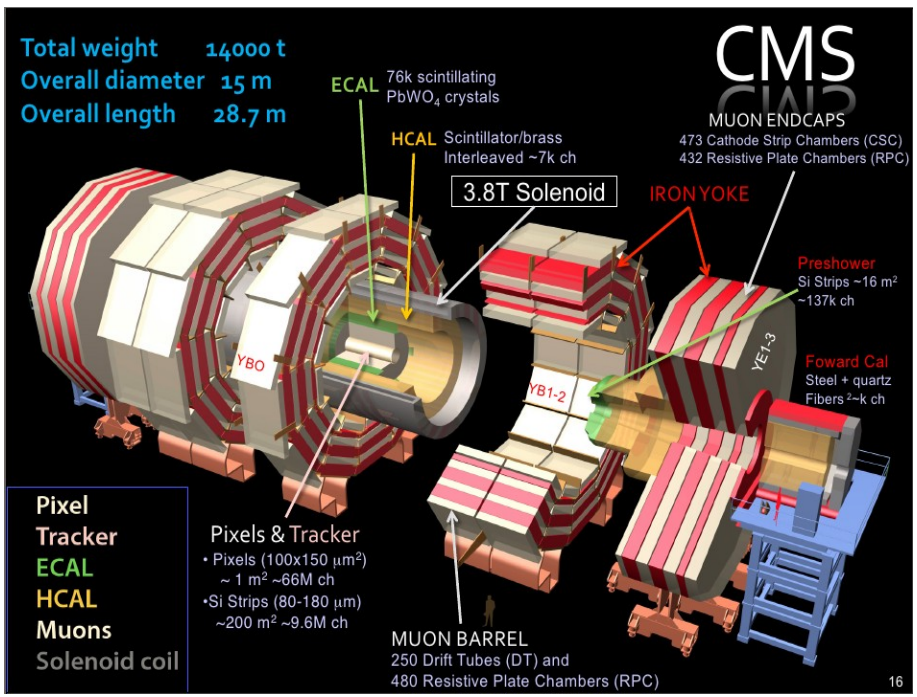
ENHEP Manpower

- **We are 9 physicists (PhD holders);**
  - **Prof. Tarek Housien (head of the ENHEP and NNS)**
  - **Prof. Shaaban Khalil (ZC)**
  - **Dr. Hassan Abdallah (CU)**
  - **Dr. Sherif Elgammal (BUE)**

  Team leaders of CMS Egypt
  - **Dr. Ali Ellithi (CU)**
  - **Dr. Ahmed Ali (ZC, HU)**
  - **Dr. Yasser Asran (BUE)**
  - **Dr. Shaimaa Abu Zied (AU).**
  - **Prof. Abdel Naser Tawfik (NU)**
- **10 PhD and Master students inside Egypt.**
- **Extra 8 PhD students who are joining PhD programs outside Egypt (at Europe).**

ENHEP research activities within CMS

- **ENHEP members are focusing on the following research activities.**
  - **Phenomenological models BSM**
  - **CMS data analysis**
  - **CMS detector R&D**



Theoretical models "BSM"

Gravity and Cosmology group:

"contact person Prof. Shaaban Khalil (ZC)"

- Alternative theories of gravity and their cosmological consequences (gauged gravity).
- Degenerate Bogdanov-Takens bifurcations in a bulk viscous cosmology.

Neutrino Group:

"contact person Prof. El-Said Lashen (ZC)"

- Texture of one equality in neutrino mass matrix.
- Lepton flavor symmetries: Phase broken μ-τ symmetry and the neutrino mass hierarchy.
- Texture of single vanishing subtrace in neutrino mass matrix.

Particle Physics:

"contact person Prof. Shaaban Khalil (ZC)"

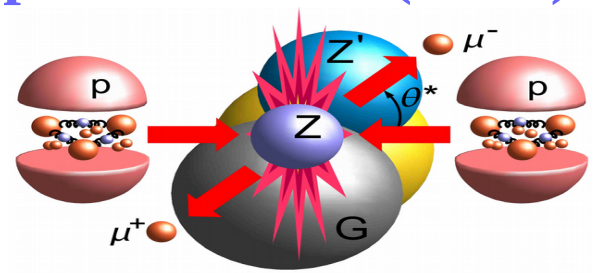
- Heavy Higgs search at the LHC.
- Left-Right models.
- SUSY Phenomenology and Leptogenesis.

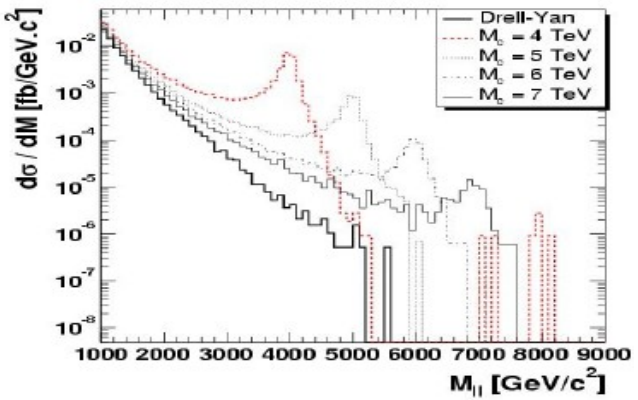
CMS data analysis "BSM"

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

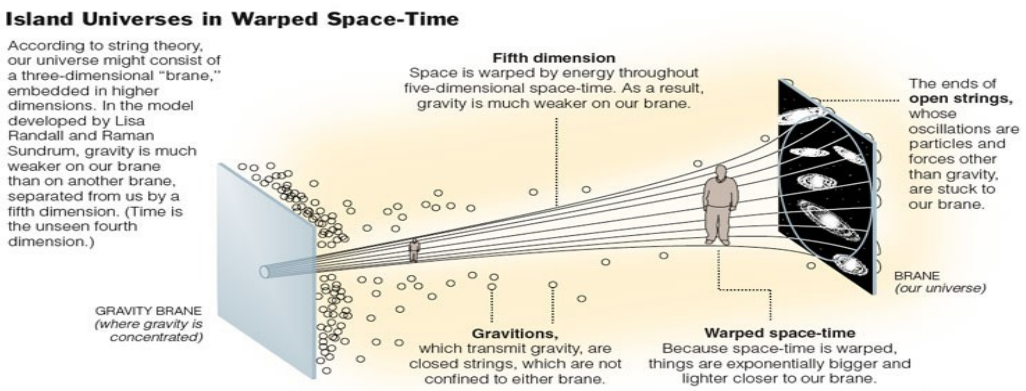
"contact person Dr. Sherif Elgammal (BUE)"

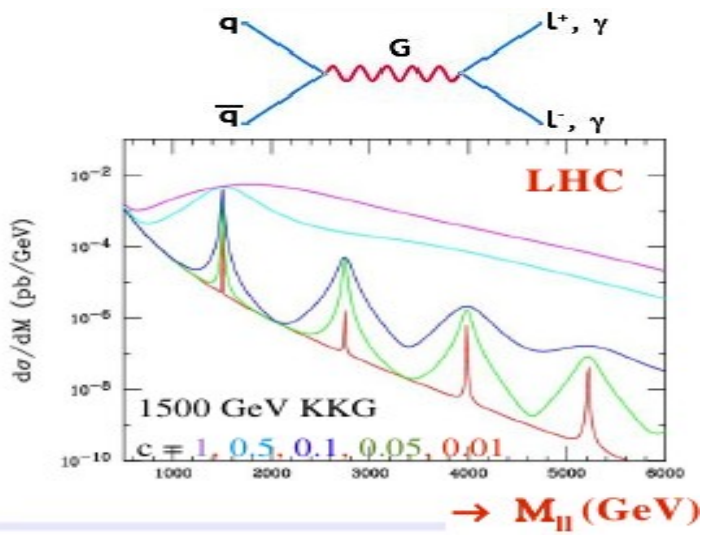
- Z prime models (BSM)





- Kaluza Klien excitation from Extra-dimensions





CMS data analysis "BSM"

- **Searching for new physics with bbl$^{\pm}$l^{-} contact interaction**

"contact person Dr. Sherif Elgammal (BUE)"

- **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

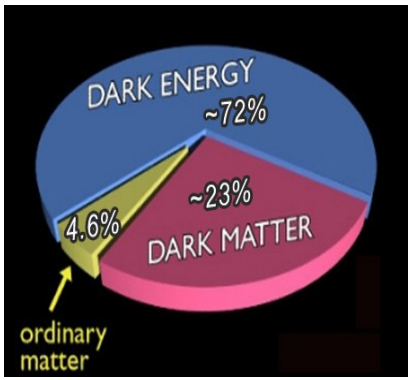
- **ATLAS published this analysis in**

  https://inspirehep.net/literature/1853941

- **Work still on going using CMS run 2**

CMS data analysis “BSM”

- **Search for Dark Matter (DM) using CMS data**



- 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)”**

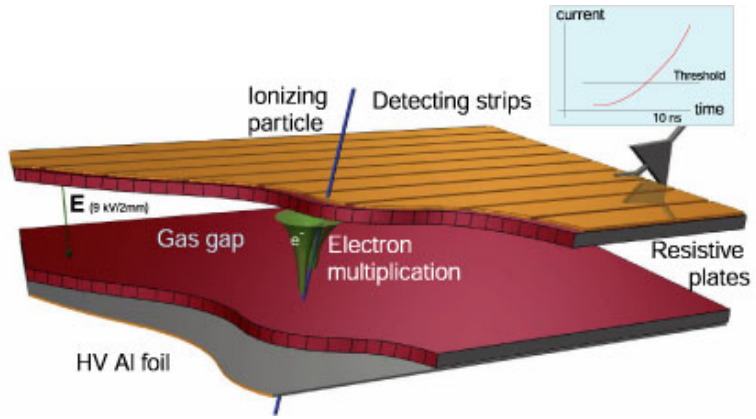
  https://link.springer.com/article/10.1007%2FJHEP03%282020%29025

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

Egypt involved in the following CMS R&D projects

Resistive Plate Chamber (RPC)

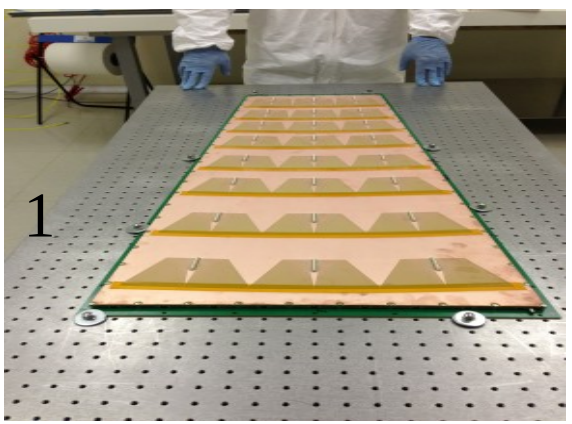
- Prof. Elsayed Salama (BUE)
- Dr. Yasser Assran (BUE) contact person
- Shereen Aly (HU)
- Asmaa Fawzi (HU)
- Fatma Abdelkawy (AU)
- Tahany Elhussieny (AU)

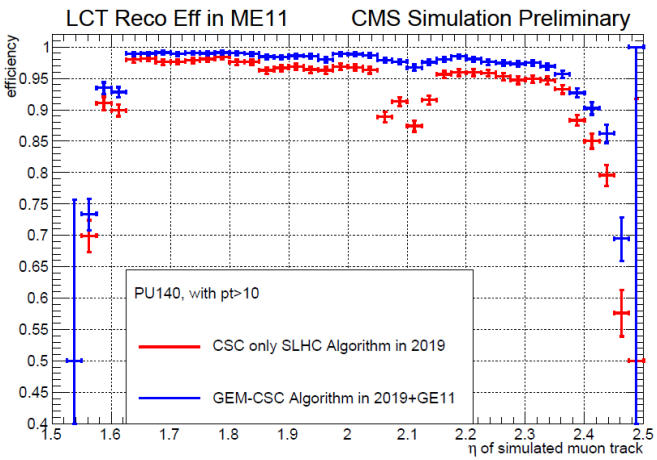


Egyptian groups participate in
* Assembling of RPC detector
* Efficiency tests

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)

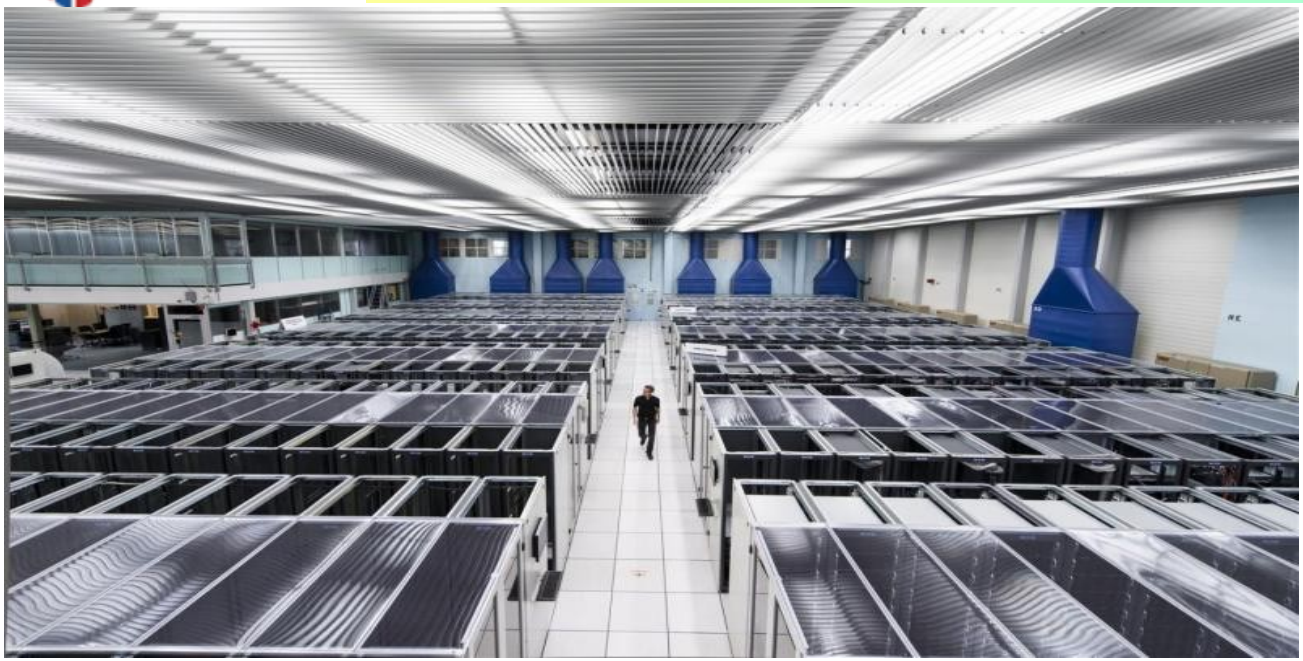




Advantage of GEM
* Combine triggering and tracking functions.
* Enhance and optimize the readout (eta,phi) granularity by improve rate capability.

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

ENHEP computing centres & GRID



We have 3 High performance computing labs in Egypt

[1] HPCL at the center for theoretical physics (BUE)

[2] HPCL at the center for fundamental physics (ZC).

[3] Advanced computer center at El-Shekh Zaied (CU).

HPCL at the centre for theoretical physics (BUE)

High performance computing labs (HPCL) at BUE

- **is a High-Performance Computing (HPC) cluster administered and run by CTP@BUE.**
- **It is used for research conducted by CTP and open to other BUE staff and entities associated with the BUE.**
- **NUT comprises of 320 CPUs and 3072 GPUs divided into six nodes, connected via Gigabit switch and running CentOS-7 Linux and Slurm resource manager.**
- **Its total storage capacity is 38 Tbytes.**

Specifications:

- **The NUT cluster comprises 320** CPUs distributed among six Dell Precision 7820 Workstation nodes as follows:
- Nodes are endowed with Intel Xeon CPU's (at 3.20GHz).
- Each node has 32GB RAM.
- Each node comes with dual GPU (256 core each) - NVIDIA QUADRO P400, 2GB .
- The cluster is attached to Dell PowerEdge T630 Tower server with total 38Tbytes of NFS storage.
- It is connected through a Gigabit local network.

Education & summer schools

* The school is one of the main activities of the Egyptian Network of High Energy Physics (ENHEP)

* It was established in September 2008 under the patronage of the Minister of Higher Education & Scientific Research, and the president of the Academy of Scientific Research and Technology (ASRT).

* It acts as a nucleus for the scientific cooperation between Egyptian experts in the areas of high energy physics and CERN in the LHC project.

Events:

- The 7TH school on high energy physics, at Ain Shams University, January 2019. https://indico.cern.ch/event/731987/
- The 6TH school on high energy physics, at the British University in Egypt, December 2016. https://indico.cern.ch/event/581306/
- The 5TH school on high energy physics, at Zewail City of Science and Technology, November 2015. https://indico.cern.ch/event/453690/
- The 4TH school on high energy physics, at the British University in Egypt, December 2014. https://indico.cern.ch/event/308134/

* The goal of the school is to give extensive courses on the basic topics of
theoretical,
computational,
experimental particle physics
for Egyptian as well as regional graduate students.

* The prospective outcome of the school is to train qualified members capable of joining the Egyptian national project related to the CMS experiment at the Large Hadron Collider (LHC) in CERN.

Output of RPC and GEM

Egyptian groups participated in

- Number of publications in both RPC and GEM: 60 papers
- Number of students working in these projects are:

3 PhD student (RPC)

1 PhD student (GEM)

2 MSc Students (RPC)

3 MSc student (GEM)

Output of Data analysis (AN)

List of recent analysis notes:

S. Elgammal, et. al., "Search for High Mass Di-Electron Resonances with the Full Run 2 Dataset", CMS AN2019/101.
S. Elgammal, et. al., "Search for high-mass resonances in the di-electron final state with 2018 data", CMS AN-2018/253.
S. Elgammal, et. al., "Search for high-mass resonances in the di-electron final state with 2017 data", CMS AN-2018/021.
S. Elgammal, et. al., "Combination of Diboson searches with 2016 data", CMS AN-2018/055.
S. Elgammal, et. al., "Combination of H + MET searches for dark matter using 2016 data", CMS AN-2018/102.
S. Elgammal, et. al., "Combination of the 8 TeV and 13 TeV Z' to Dilepton Limits", CMS AN-2016/138.
S. Elgammal, et. al., "Search for High-Mass Resonances Decaying to Muon Pairs in pp Collisions at sqrt(s) = 13 TeV with the full 2016 data set of 37 fb and combination with 2015 result", CMS AN-2016/391.
S. Elgammal, et. al., "Search for high mass di-electron resonances with the full 2016 data", CMS AN-2016/404.
S. Elgammal, et. al., "Non-resonant Excesses in the Dilepton Mass Spectra ", CMS AN-2016/466.
S. Elgammal, et. al., "Search for Dark Matter produced in association with a Higgs boson in the four-lepton final state at √s = 13 TeV", CMS AN-2016/328.
S. Elgammal, et. al., "Dielectron resonance search in Run 2 at √s = 13 TeV pp collisions", CMS AN-2015/222.
S. Elgammal, et. al., "Search for High-Mass Resonances Decaying to Muon Pairs in pp Collisions at √s = 13 TeV", CMS AN-2015/223.

Output of Data analysis (papers)

Number of publications is about 100 papers / year.

Selected papers

- **S. Elgammal, M. A. Louka, A. Y. Ellithi and M. T. Hussein. Search for dark matter production in association with the Z' boson at the LHC in pp collisions at √s = 8 TeV using Monte Carlo simulations. Chinese Physics C, Vol. 45, No. 8 (2021) 083001 DOI:10.1088/16741137/ac061c.**
- **The CMS collaboration, Search for resonant and nonresonant new phenomena in high-mass dilepton final states at \sqrt{s} = 13 TeV. JHEP 07 (2021) 208, arXiv: 2103.02708 [hep-ex].**
- **The CMS Collaboration, Search for dark matter particles produced in association with the Higgs boson in proton-proton collisions at √ s = 13 TeV. JHEP 03 (2020) 25 .**
- **The CMS collaboration, Search for contact interactions and large extra dimensions in the dilepton mass spectra from proton-proton collisions at √s= 13 TeV. JHEP 04 (2019) 114, arXiv:1812.10443v2 [hep-ex] .**
- **The CMS collaboration, Search for high-mass resonances in dilepton final states in proton-proton collisions at √s =13 TeV. JHEP (2018) 2018:120.**

Output of GEM (papers)

Recent publications.

*Performance of a triple-GEM demonstrator in pp collisions at the CMS detector, Journal of Instrumentation 16(11):P11014, DOI:10.1088/1748-0221/16/11/P11014.

* Interstrip capacitances of the readout board used in large triple-GEM detectors for the CMS Muon Upgrade, Journal of Instrumentation 15(12):P12019-P12019, DOI:10.1088/1748-0221/15/12/P12019.

* Triple-GEM discharge probability studies at CHARM: simulations and experimental results, Journal of Instrumentation 15(10):P10013-P10013, DOI:10.1088/1748-0221/15/10/P10013.

* Two years' test of a temperature sensing system based on fibre Bragg grating technology for the CMS GE1/1 detectors, Journal of Physics Conference Series 1561:012006, DOI:10.1088/1742-6596/1561/1/012006.

* Performance of prototype GE1／1 chambers for the CMS muon spectrometer upgrade, Nuclear Instruments and Methods in Physics Research Section A Accelerators Spectrometers Detectors and Associated Equipment 972:164104, DOI:10.1016/j.nima.2020.164104.

* Layout and assembly technique of the GEM chambers for the upgrade of the CMS first muon endcap station, Nuclear Instruments and Methods in Physics Research Section A Accelerators Spectrometers Detectors and Associated Equipment 918(11), DOI:10.1016/j.nima.2018.11.061.

Summary

High lights

- **Egypt has become an associated member at CERN since 2009.**
- **ENHEP participated in CMS experiment research activities in fields (theory, data analysis and detector R & D).**
- **In data analysis; we are participating in the search for BSM models in order to search for DM and Extra-dimensions.**
- **In CMS detector R & D; we are participating in assembling and testing the RPC & GEM detectors.**
- **More than 100 CMS papers are signed by ENHEP members per year and published in international journals, which in turn increases the rank of Egyptian Universities.**
- **We are open to collaborate with other African institutes which are also member at CERN in many aspects related to particle and computaional physics.**
- **We propose to you, as a nucleolus for our collaboration, organizing the 1st African CMS data Analysis school (CMSDAS) at Cairo.**