Historical Perspective up to Higgs Discovery in Egypt

by

Reham Aly

Post-Doc Fellow – CERN semi-Fellow

Polytechnic & INFN Bari Italy - CERN

Helwan University – Cairo - Egypt

Reham.aly@cern.ch

10th anniversary of the Higgs boson discovery from Africa

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Outlines

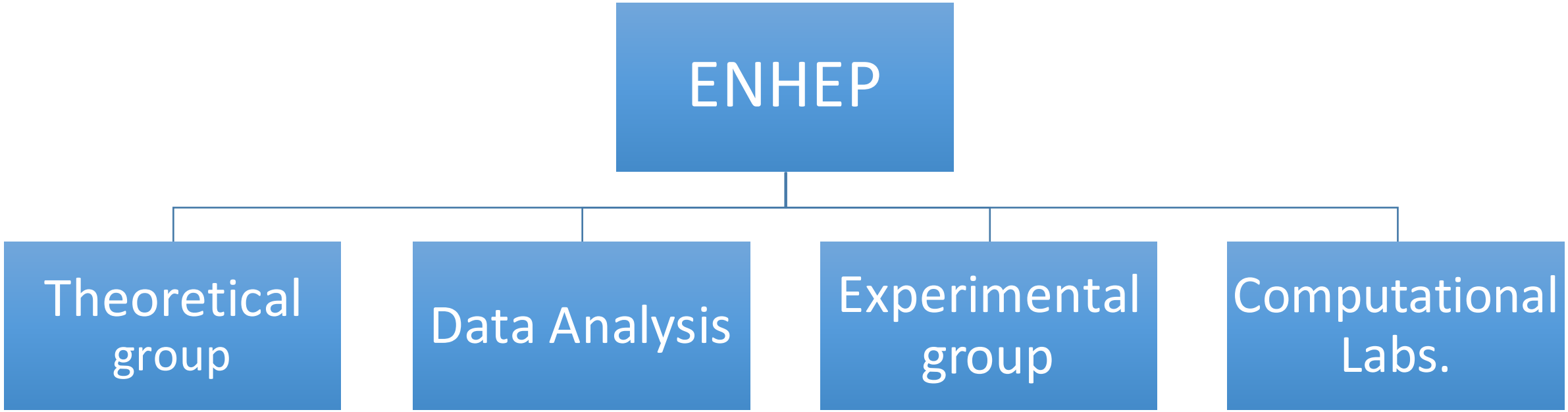
- **The initial development of HEP Experimental and Theoretical Work in Egypt**
- **Egyptian Network of High Energy Physics (ENHEP)**
- **Center of High Energy physics (CHEP-FU) in Fayoum University**
- **Egyptian schools of High Energy Physics**
- **H → ZZ → 4 leptons Analysis in a nutshell**
- **After the Higgs discovery** → Covered In the next talk by A. abdelalim

The initial development of HEP Experimental and Theoretical Work

- In September 2008, the Egyptian Network for High Energy Physics (ENHEP) has been established, as a research unit within the Academic Scientific Research and Technology (ASRT), funded by ASRT.
  - ✓ Acts as the nucleus for the scientific cooperation between the Egyptian researchers in HEP and CERN in the LHC project.
  - ✓ Promotes scientific collaboration between researchers and Egyptian academic institutions.
  - ✓ Trains young researches in Experimental and Theory of particle physics and Data analysis.
- In 2009, ASRT has signed a letter of intention that specify Egypt contribution to CMS
- In March 2010, we got the approval of the counsel meeting (Egypt is official member in CMS).

The initial development of HEP Experimental and Theoretical Work

- The Egyptian Network for High Energy Physics (**ENHEP**) is running under the umbrella of the Egyptian ministry of Higher Education and Scientific Research & the ASRT.
- **The ENHEP consists of the three groups:**



- Experts in SM & BSM physics
- SUSY, CP violation, Extra Dimensions, TeV scale B-L extension of SM, etc

- Different Universities (Cairo, BUE, Fayoum)

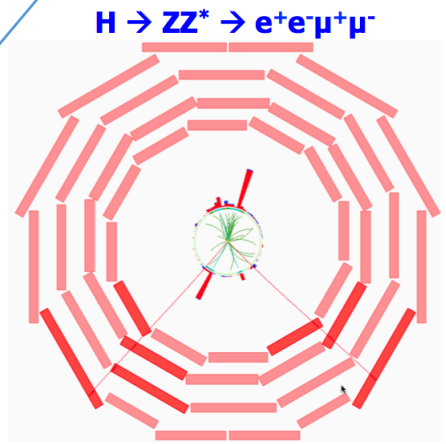
ENHEP: Data Analysis group

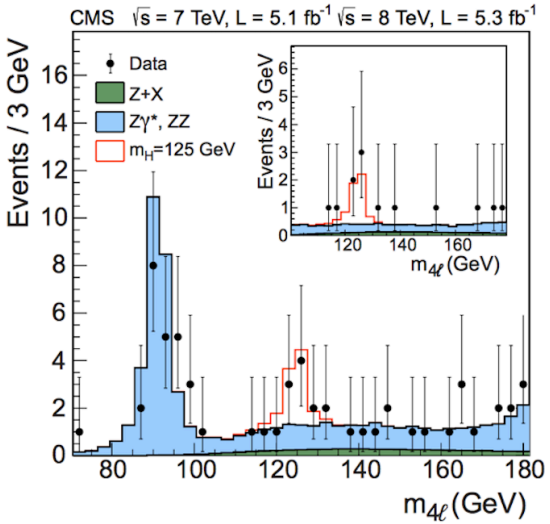
- **Data Analysis group**

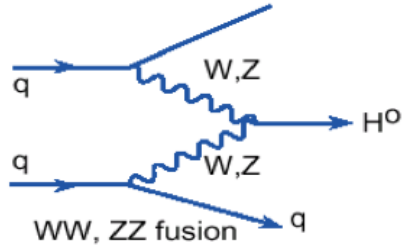
Starting analyses

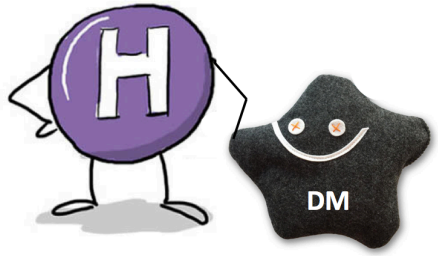
- SM Higgs Analysis (H → ZZ → 4 leptons)
- Search for Z' → (ee/μμ)
- Excited lepton analysis
- Dark Matter search
- Top quark physics
- Long lived particles
- Monopoles
- Phenomenological studies

Output: Master + PhD theses





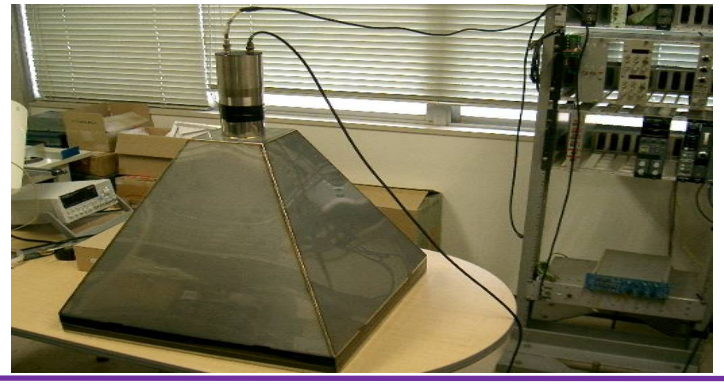




ENHEP: Experimental group

- **Experimental Particle Physics (experimental group)**
  - Established Resistive Plate Chamber Laboratory at Helwan university – Cairo
  - Setup a complete cosmic stand which enable us to test the RPC gaps as well as the complete RPC chamber.
  - Participating in new RPC chamber assembly and test in RPC Lab at CERN.
  - Participating in test beam and offline analysis.
  - Contribution in GEM physics studies as a motivation for GEM project approval in CMS
  - Contribution in the assembly of RPC and GEM detectors.

RPC Lab



RPC Lab

RPC Lab

CHEP-FU in Fayoum University

- In December 2019, CHEP-FU got the approval of the counsel meeting as a member of CMS experiment.
- The group has different activities and collaboration with Antwerp (Belgium), Cracow (Poland) universities & Hungary:
- Data Analysis:
  - Di-jets and tri-jets studies
  - Bose-Einstein correlations
  - Event generator with DESY
- Super Computer Lab in Fayoum University
  - 10 K Core of CPU + 60 K core of GPU
  - 2K Terabyte storage
- RPC activity
  - background studies and RPC trigger
  - Participating in test beam and offline analysis

Output: Master + PhD theses

Egyptian School on high Energy Physics

- Series of **Egyptian School on high Energy Physics**
- Held every year since 2009 up to now
  - benefit from different funding such as STDF
  - Train students & young researchers in Experimental and Theory of particle physics and Data analysis.
  - Start the connection between the students and researchers at CMS experiment

FP7 Project

  - Start connection with Higgs analysis group in Bari university – Italy as a starting point for my master thesis
  - Start connection with RPC group as a starting point for different Master thesis

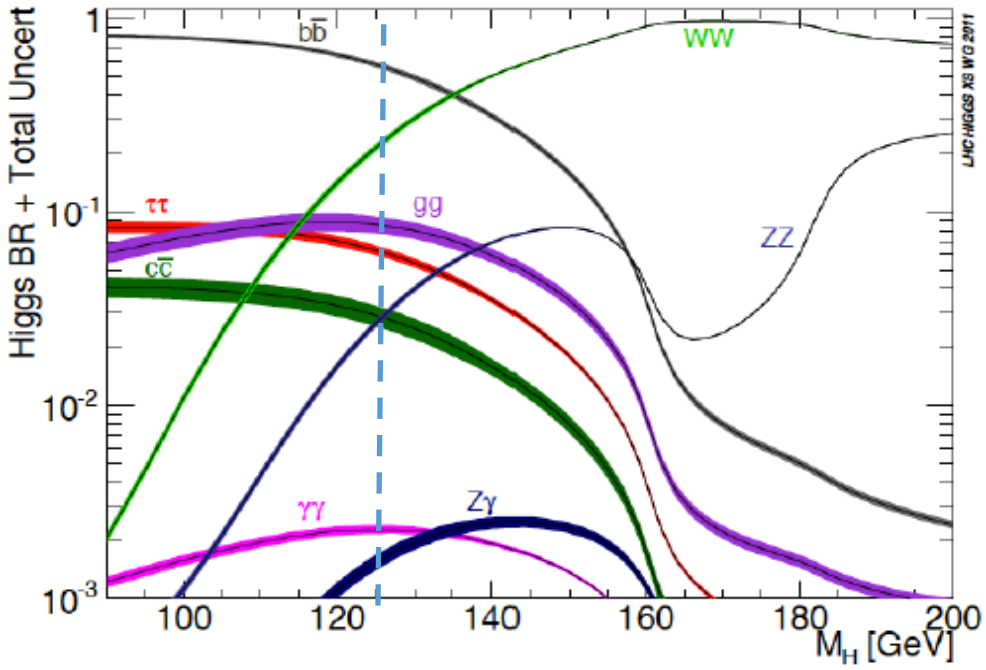
In addition: CERN Summer student program

Egyptian group @ Bari University – Italy

$H \rightarrow ZZ \rightarrow 4$ leptons Analysis in a nutshell

Master Thesis

- **Signature:**
  - 4e, 4μ , 2e2 μ final state
  - clean but extremely demanding channel for requiring the **highest possible efficiencies (lepton Reco/ID/Isolation)**
  - s x BR small ≈ few fb
- **Backgrounds:**
  Irreducible: ZZ*
- Reducible: Zbb, tt+jets, Z+light jets, WZ+jets
- **Sensitivity:** 115 < m_H < **1000** GeV
- **Data:** integrated luminosity of 5 fb^{-1} at 7 TeV in 2011, 19.8 fb^{-1} at 8 TeV in 2012
- Projection of the analysis @ 14 TeV

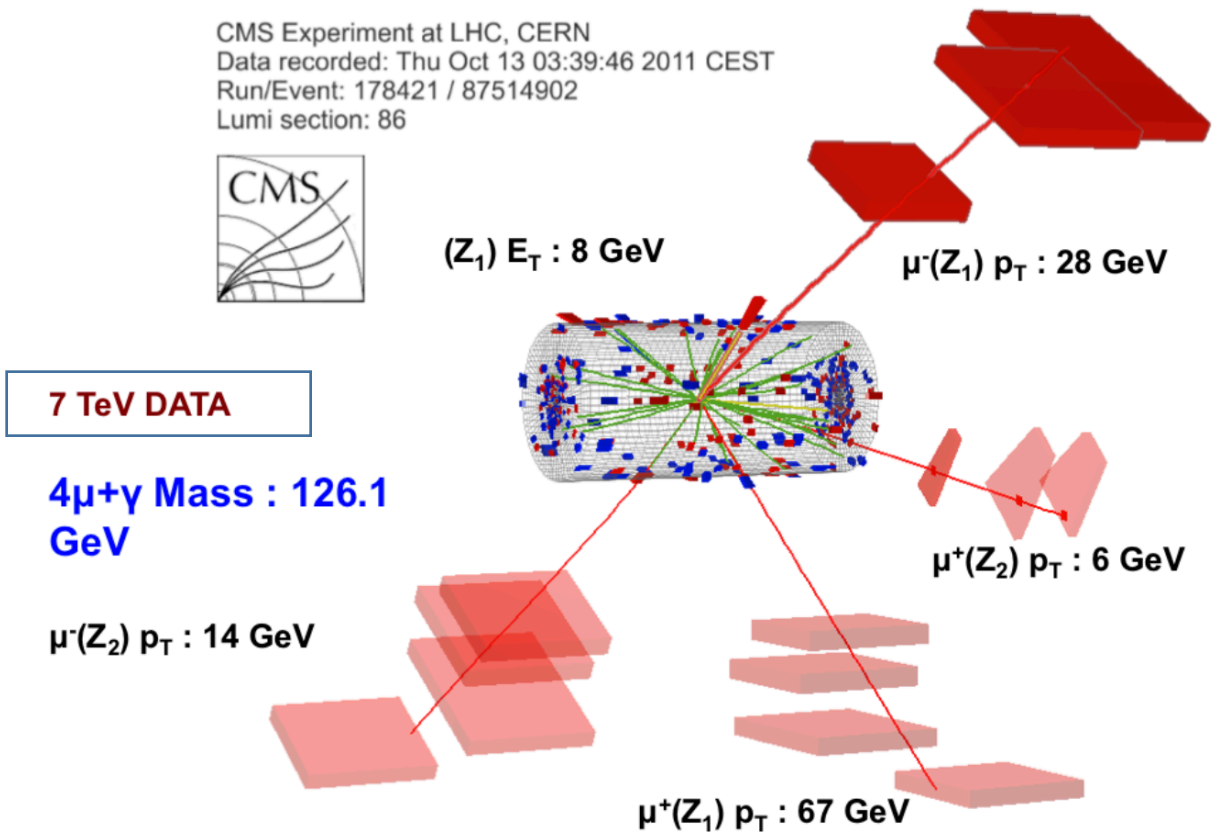


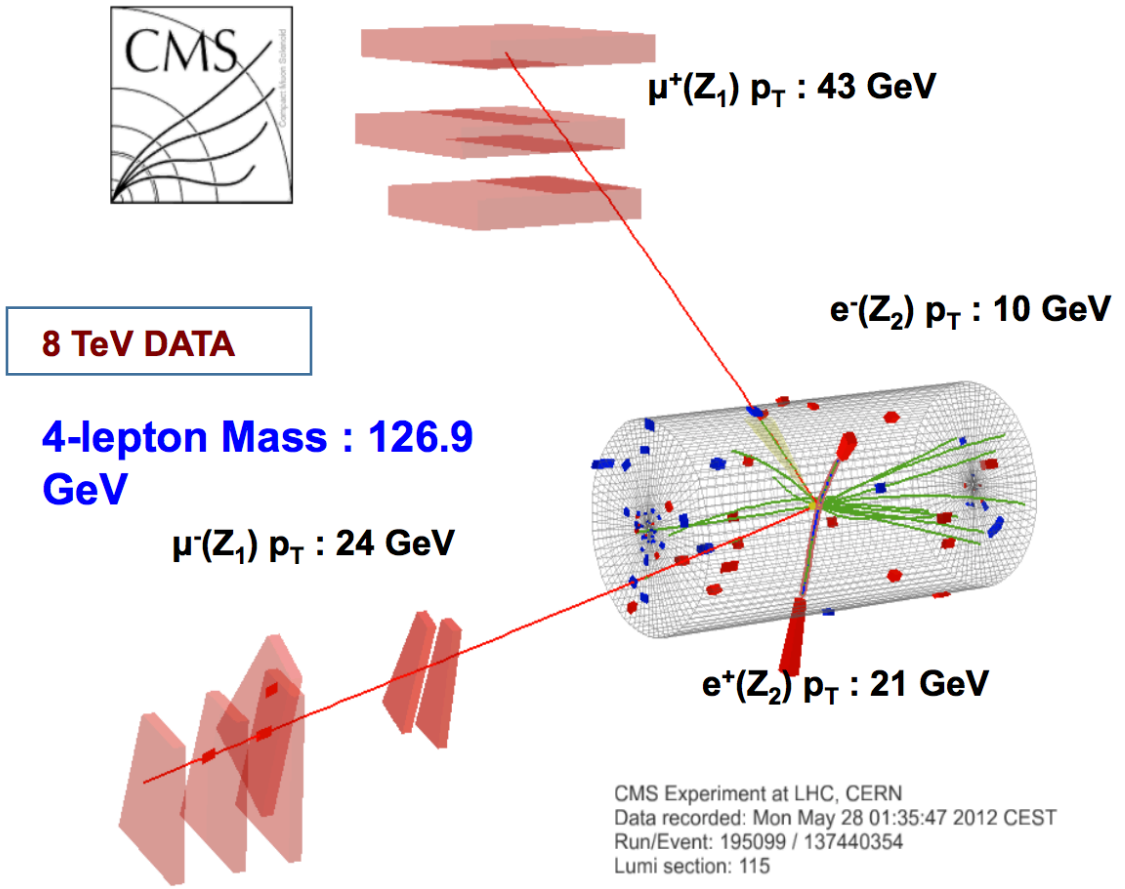
At m_H = 125 GeV:

- H(bb) = 57.8%
- H(WW) = 21.4%
- H(gg) = 8.19%
- H(ττ) = 6.27%
- H(ZZ) = 2.62%
- H(cc) = 2.89%
- H(γγ) = 0.23%
- H(Zγ) = 0.15 %
- H(μμ) = 0.02%

Clean Channel

H → ZZ → 4 leptons Analysis in a nutshell



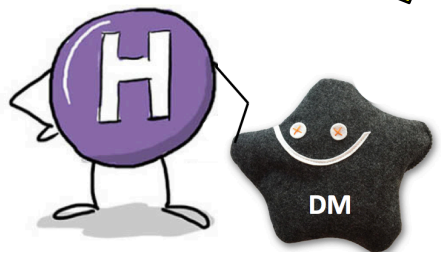


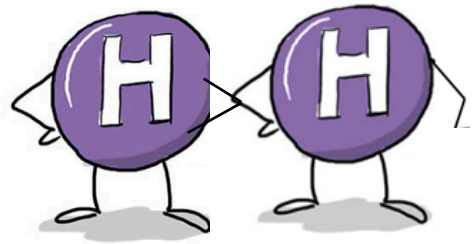
After Higgs Discovery ……

Covered In the next talk by A. abdelalim

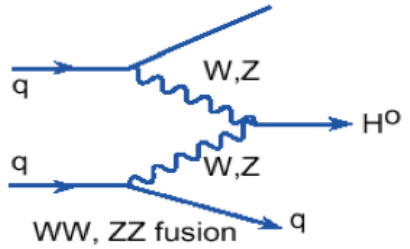
- Discovery of the Higgs boson has opened a new portal for different searches:

1. Search for Dark Matter (DM) Candidate produced in association with Higgs boson where Higgs boson is used as a tag for the analysis "Mono-H signature" H+ Missing Energy (MET)
   - Exploit the knowledge we have in H→ZZ→4l analysis
2. Search for Double Higgs boson production which help in the measurement of the Higgs self coupling
3. Vector Boson Fusion (VBF) analysis: to make a measurement of the Higgs VBF production XS using Neural Network
   - Allow Direct probe of the coupling between vector bosons and the Higgs boson and, hence, directly probes the electroweak sector of the SM.





4. Future Circular Collider (FCC-ee) activity
   - Studying benchmark physics processes in order to allow studying/optimization of detector designs
   - ZH analysis promising probe for precise Higgs sector measurements
   - Contribution in R&D for tracking wire chamber
   - Contributing in test beam analysis for wire chamber at CERN.




THANK YOU!