UNIVERSITÀ
DEGLI STUDI DI BARI
ALDO MORO

Research program:

Performance studies of the GEM detectors for muon reconstruction at the CMS experiment

PhD School in Physics – XXXIV Cycle

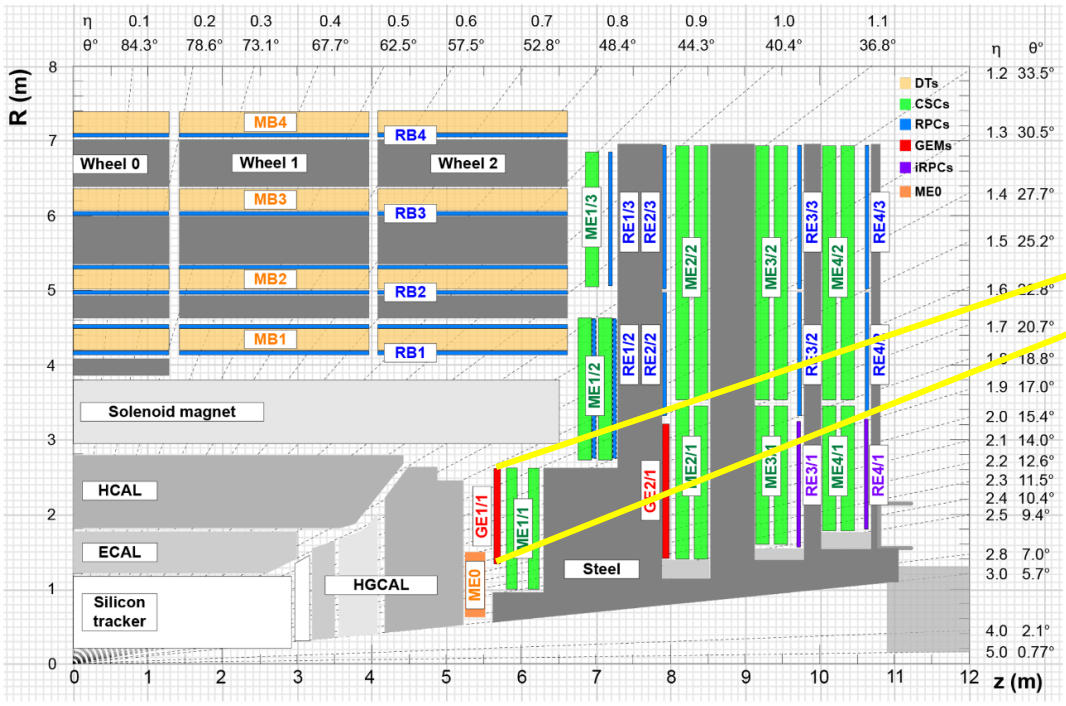
Federica Maria Simone

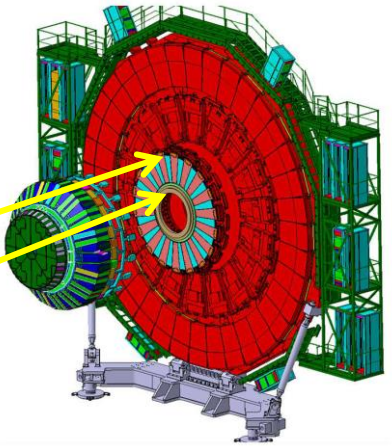
Bari, 27 Nov 2018

Outline

- The CMS upgrade:
  - The CMS muon endcap GEM upgrade: GE1/1
  - GEM installation plan
- GE1/1 performance studies at cosmic test stand
- Muon reconstruction including GE11
- Study to improve muon reconstruction
- PhD programme

The phase-I CMS muon endcap upgrade: GE1/1





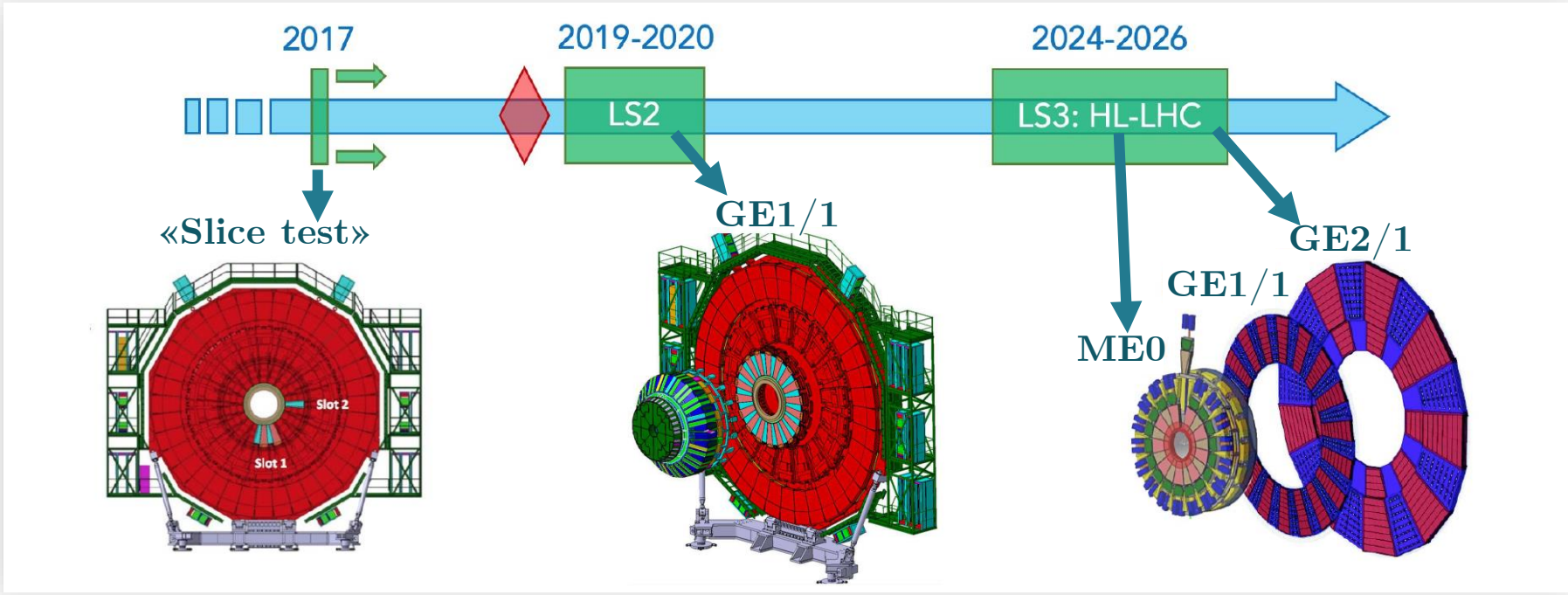
- 2 layers of triple-GEM chambers in the presently vacant positions in front of the ME1/1 CSC station
- Eta coverage $1.6 < |\eta| < 2.2$
- Installation during LS2 in 2019

Motivations:

- The endcap has high background
- The first muon station has higher B-field and lower scattering

The GE1/1 station will improve the L1 trigger and the muon momentum resolution before LS3 (new silicon tracker installation)

The CMS muon endcap upgrade: GEM installation plan

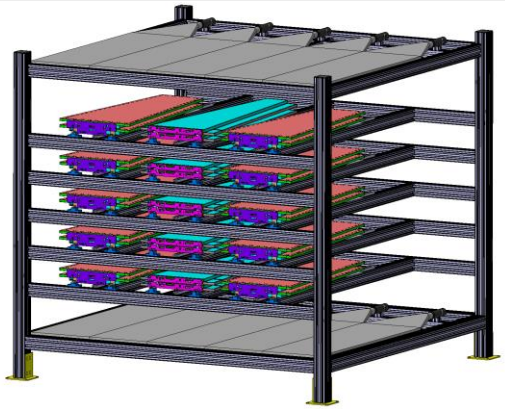


Slice Test: commissioning of 5 GE1/1 detectors in CMS	Installation of GE1/1 during Long Shutdown 2	GE2/1 & ME0 installed by end of Long Shutdown 3
1 out of 5 with final readout electronics and HV	144 detectors in two endcaps GE1/1: $1.55<\|\eta\|<2.2$	GE2/1: $1.6<\|\eta\|<2.4$ ME0: $2.0<\|\eta\|<2.8$

- Gain first operational experience
- Integration in CMS DAQ and services

GE1/1 performance studies at cosmic test stand

- 144 single detectors built and validated by end of December
- Ready to be coupled in 72 GE11 chambers by February 2019
- Final stage of qualification of GE11 detectors before installation
  - Full configuration of front-end electronics, ENC measurement
  - Active channel fraction per detector
  - Detector muon efficiency vs HV

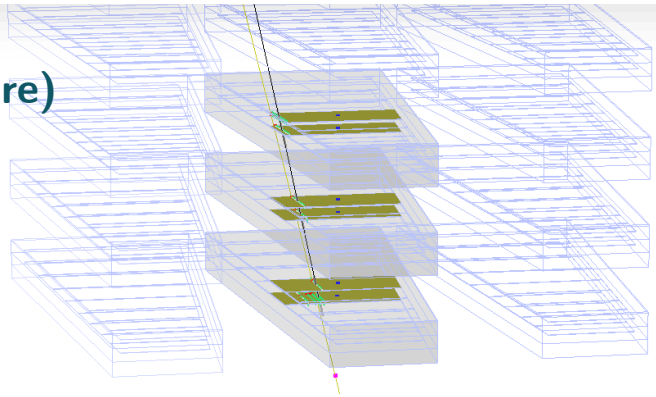


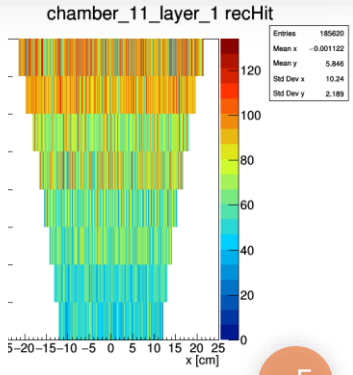
The test stand at CERN 904 lab:

- 15 GE11 chambers
- Cosmic trigger w/scintillators
- Gas system (Ar/CO_2 70/30)
- Cooling system
- HV and LV suppliers
- Back electronics (setting up ongoing!)

Analysis framework (in CMS software)

Performs: - Seeding
- Track reconstruction
- Cluster size studies
- Detector Efficiency





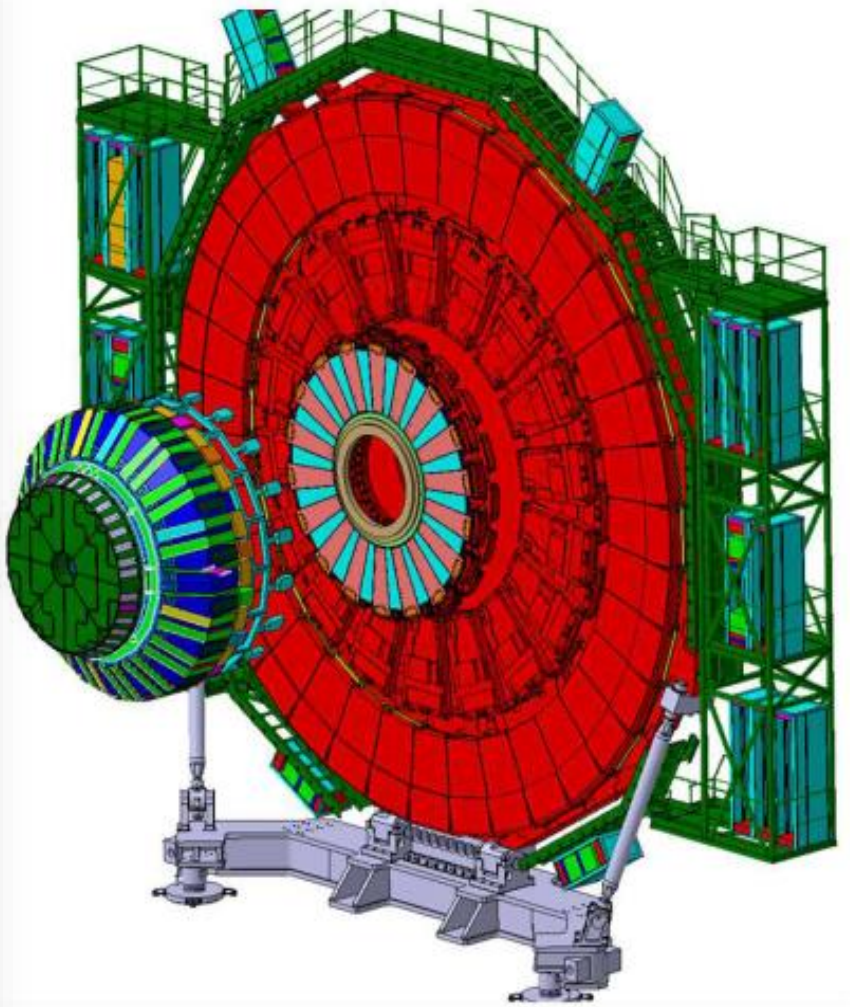
Performance of GE1/1 with cosmic muons

Time line of my studies:

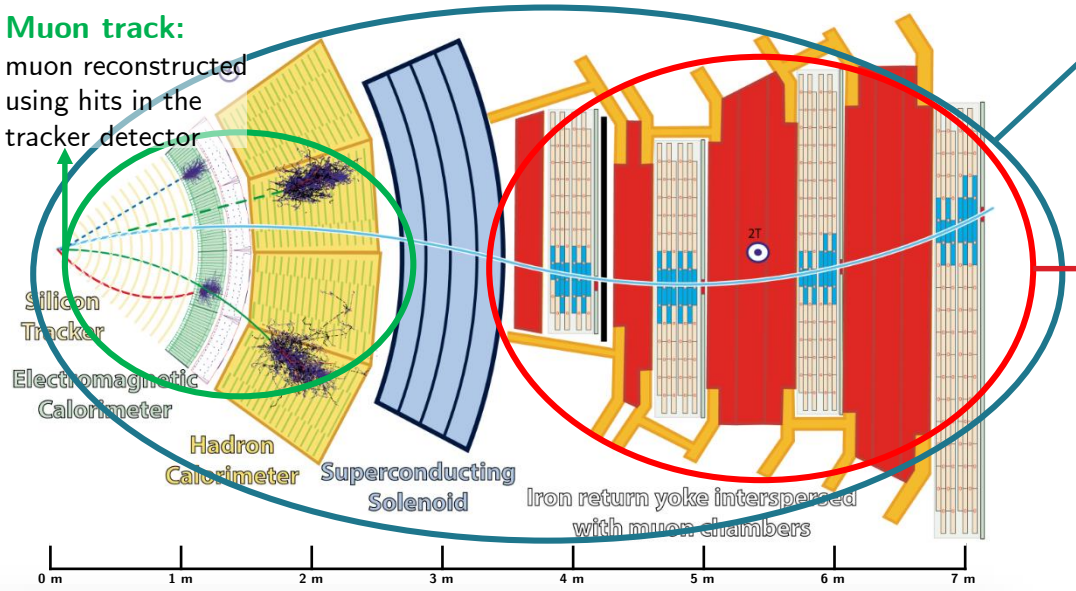
- 2019:
  - Muon reconstruction algorithm development with simulation
  - Local cosmic run after the chamber installation
- 2020:
  - Global cosmic run with all CMS
- 2021:
  - Global cosmic run at 4 Tesla

My objectives:

Develop the local and global cosmic muon reconstruction algorithms and use these reconstructed muons to measure the detector performance



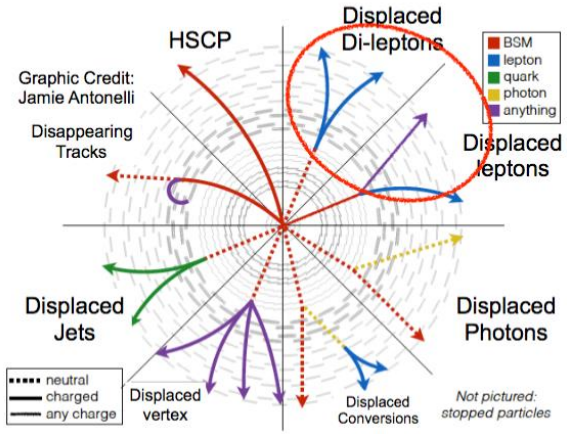
Muon reconstruction including GE1/1



Global Muon: muon reconstructed combining track and standAlone muon

StandAlone Muon: muon reconstructed using information inside the muon system. Note: The standard SA algorithm includes a vertex constraint.

Prompt muon coming from electroweak boson decay (W, Z, H)



Displaced muon coming from exotic particles decay: dedicated reconstruction needed

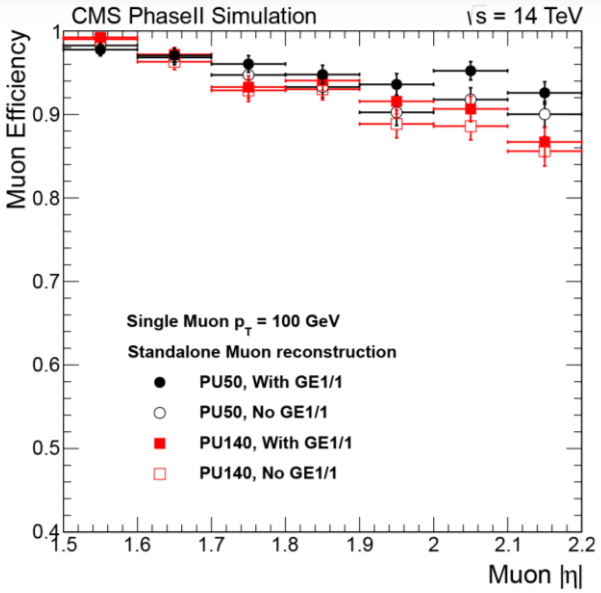
Inclusion of GE11 station in the muon reconstruction can improve both the **Standalone** and the **Global Muon performance**.

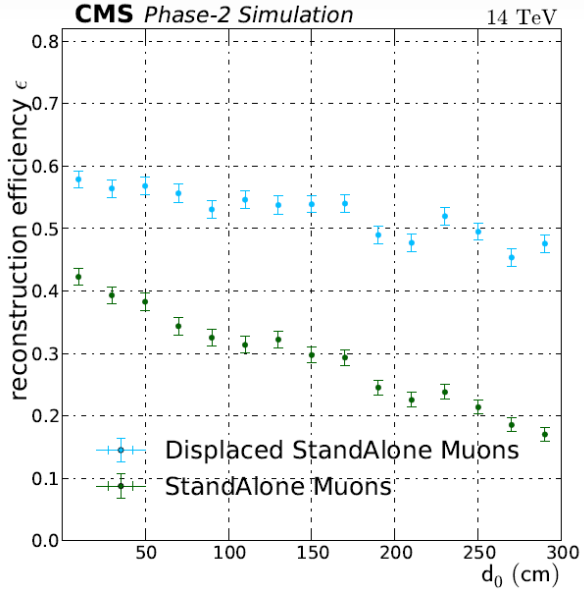
The new high precision coordinate measurements in GE11 station allows for **new algorithms** to reconstruct **displaced muons**.

Study to improve muon reconstruction

My objectives:

- Extend and optimize preliminary studies [1] on muon reconstruction, taking into account realistic geometry and background particle rate.
- After the installation of GE1/1, I will study the improvement in muon reconstruction efficiency (both prompt and displaced).
- Study of the performance of the muon reconstruction with first pp-collision data (Run3)





[1] A. Colaleo et al., CMS Technical Design Report for the Muon Endcap GEM Upgrade, https://cds.cern.ch/record/2021453, 2015

First year programme:

- Data analysis to study the performance of the GEM detectors with cosmic muons in dedicated test stand before installation:
  - muon reconstruction and detector efficiency measurement
- Local muon reconstruction algorithm implementation
- Performance measurements using cosmics recontructed in CMS

Second and third year programme:

- Global muon reconstruction algorithm implementation
- Performance of the muon reconstruction with first pp-collisions
- Performance of the GE1/1 detector with cosmic muons