Laboratori MPGD - INFN Bari

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ECFA-INFN early career researchers meeting
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Our activities

- At **LHC**: **CMS-GEM** upgrade and physics analyses
- **Future colliders**: **MPGD-HCAL** (hardware R&D and Muon Collider physics performance)
- **Technological transfer**: fast timing **scintillators** for medical applications

At LHC: GEM upgrade for the CMS muon system

Participation and leadership in CMS GEM upgrade (collaboration of 35 institutes)

Historically

- **Physics studies** for GEM upgrade TDR (2016)
- **Production** of triple-GEM detectors for the GE1/1 system (Bari)

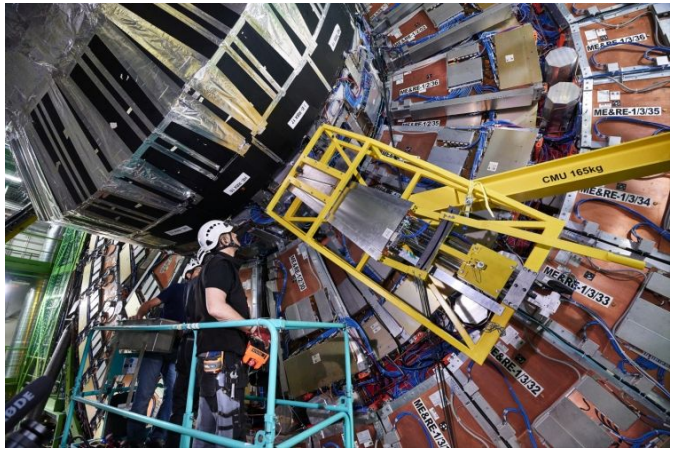
Now

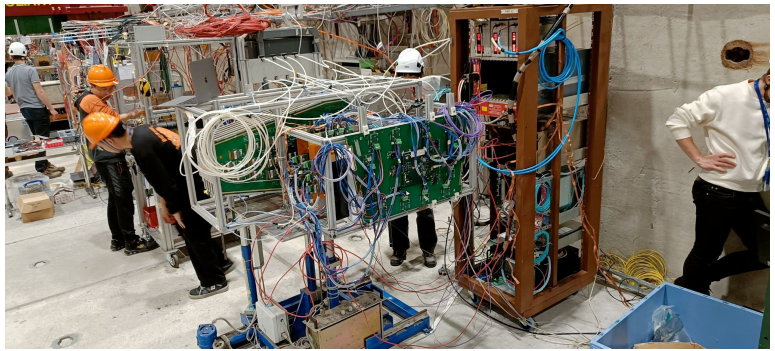
- Led **R&D and integration** for the high rate environment of the very forward ME0 station (lab Bari-CERN, test beams at SPS, GIF++)
- Responsibilities for GEM **production**, **electronics**, Run 3 **operations**, **upgrade**
- Working on ME0 **production** (30 detectors in 2025), GE1/1 **trigger** integration in Run 3, **performance** studies (e.g. timing)

Other software activities in CMS

- **Physics analysis** on Run 2 ($\tau \rightarrow 3\mu$) and Run 3 ($H \rightarrow cc$, $B_s \rightarrow 4\mu$)
- **Responsibilities**: B-physics rare decays, muon identification

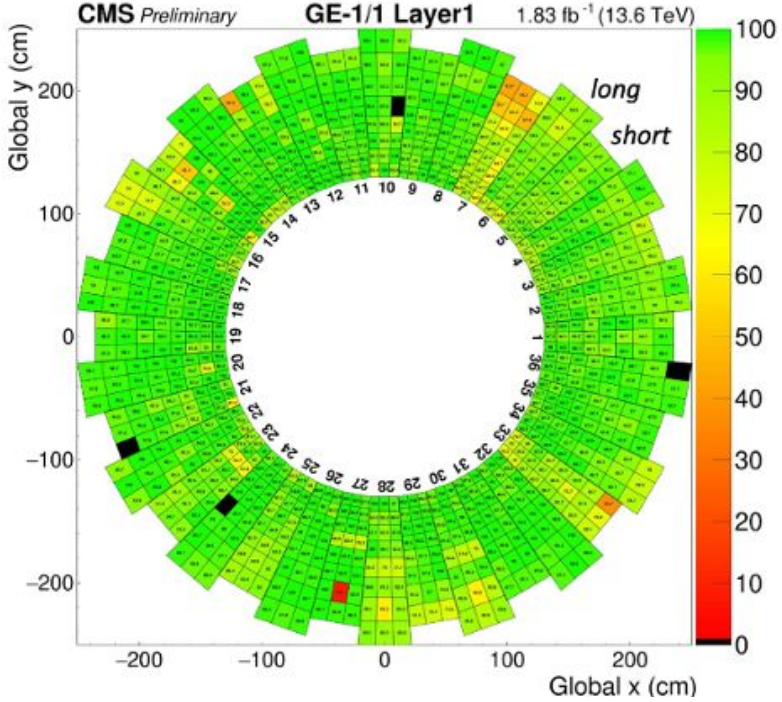
Installation of GE1/1 detector in CMS





Stack of ME0 detectors in SPS test beam

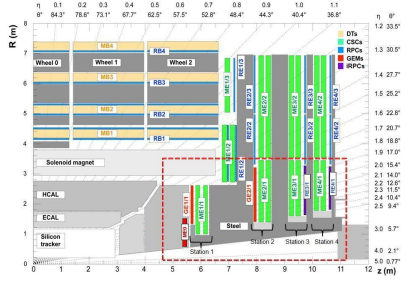
CMS GEM: highlights

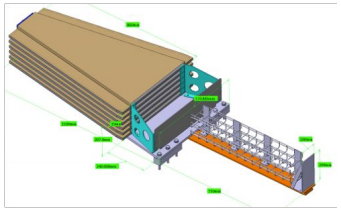


Efficiency snapshot of GE1/1 wheel in CMS during Run 3

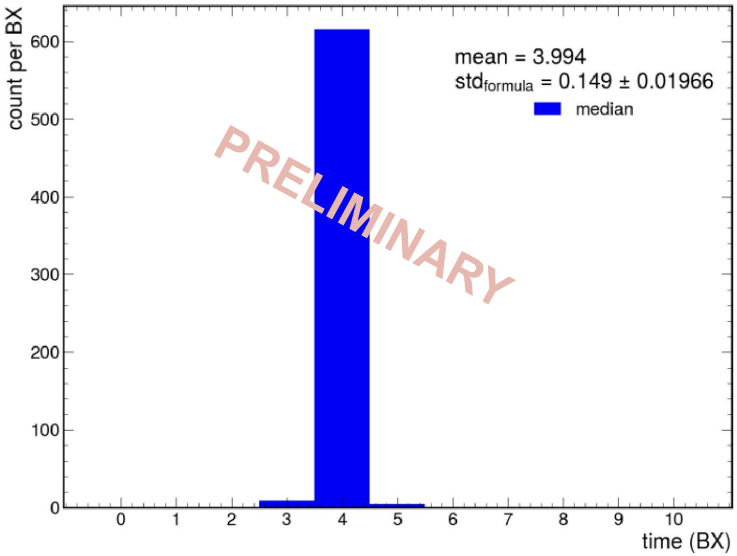
Average efficiency > 95% (10% faulty detector or electronics)

Level-1 trigger integration ongoing





ME0 is made of **stacks** of six triple-GEM detectors



ME0 segment timing with 6-layer stack measured with cosmics

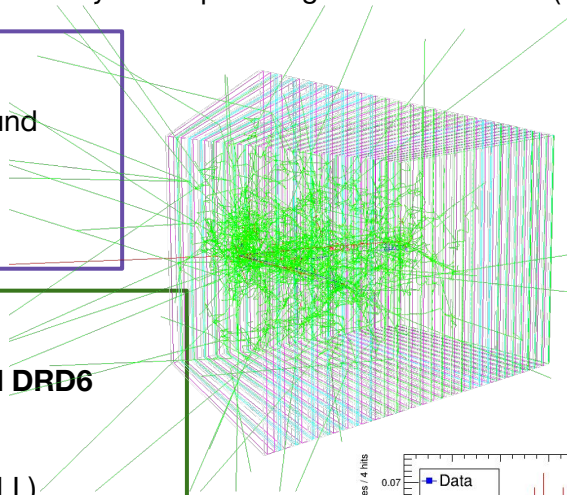
Excellent BX identification (3.75 ns)

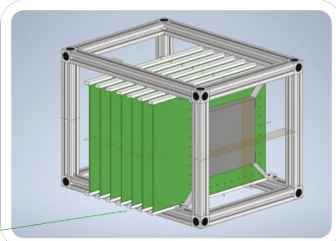
At future colliders: muon collider HCAL

R&D and performance studies on a sampling hadronic calorimeter read out by micro-pattern gaseous detectors (MPGD)

Detector and physics performance in Muon Collider software

- Simulated detector response w/ and w/o beam-induced background
- Ongoing threshold optimization for semi-digital readout
- To be tested in physics case (H→cc)



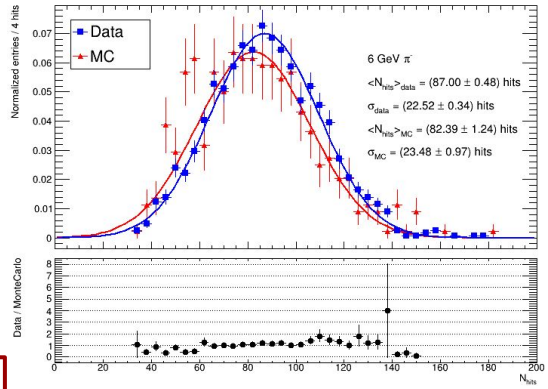


Calorimeter cell in simulation and mechanics of cell prototype

Hardware activities: prototype production, testing, integration

- Activity started with RD51 **common project**, now with **DRD1 and DRD6**

  INFN (Bari, Frascati, Roma 3, Napoli), Weizmann institute
- **Produced 12 MPGD prototypes** (MicroMegas, μ-RWELL, RPWELL)
- Tested with **muons at SPS** (2023, 2024): **good efficiency, space resolution**
- **HCAL prototype built** with 8 layers (iron + MPGD)
  - Containment for ~10 GeV pions
  - Tested with 1-11 GeV pions at PS (2023): **excellent data-MC agreement, ongoing energy resolution analysis**



6-GeV pion shower: MC vs test beam data

Plans (PRIN-PNRR): building 50×50 cm^2 prototypes, testing with Crilin (Muon collider HCAL)