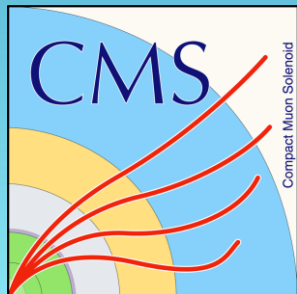


Gas Electron Multipliers for CMS experiment



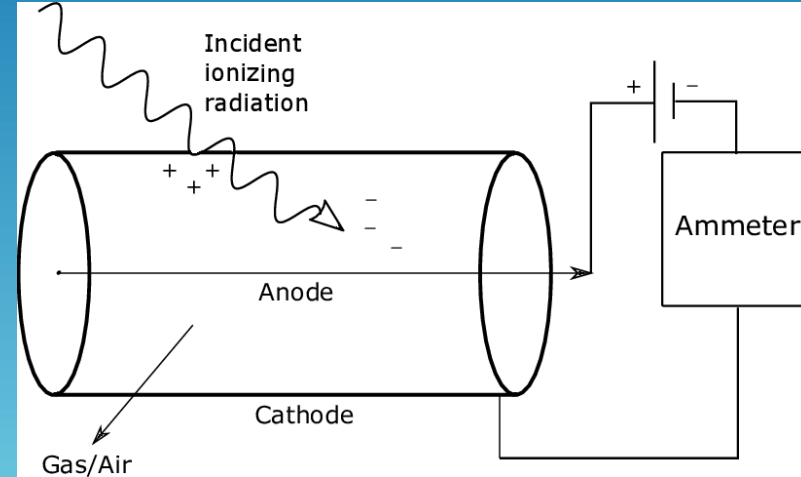
Alessandro Marini
Liceo Scientifico
"R. Donatelli"
Terni

Giulia Piaggio
Liceo Scientifico
"L. Mascheroni"
Bergamo



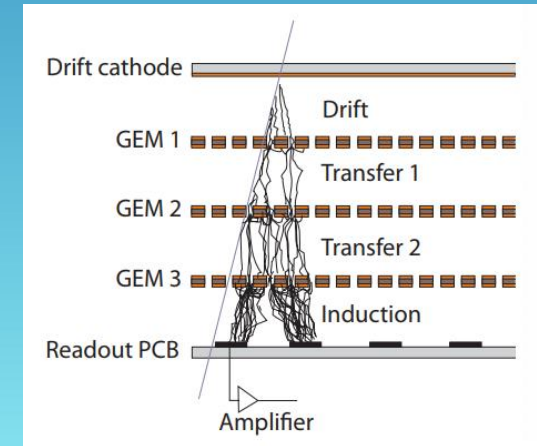
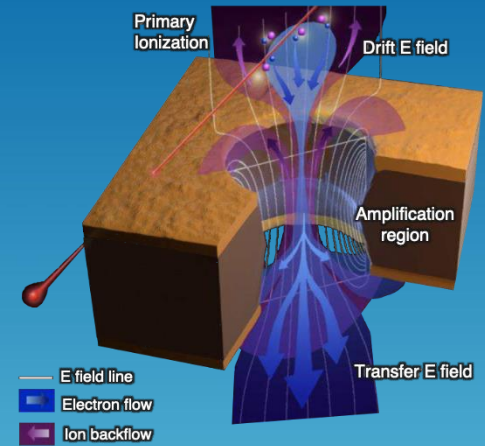
How gaseous detectors work

- Gaseous chamber with a sharp electric field
- Used to detect ionizing particles
- Ionizing particles create an electron-ion pair
- Electrons avalanche in sharp electric field creating more electron-ion pairs
- Electrons drift toward the anode and induce a signal



GEM: gas electron multiplier

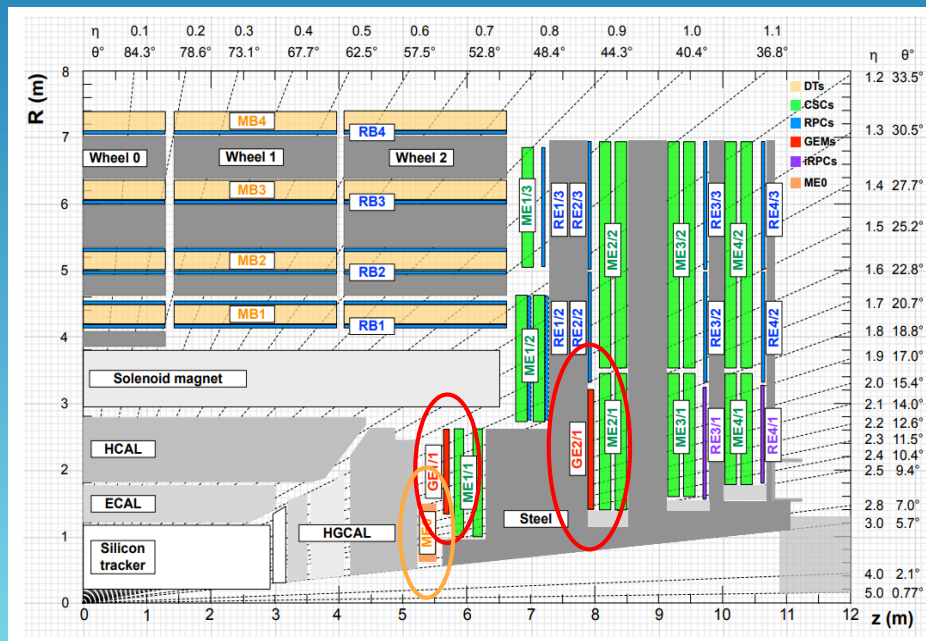
- The gas used is made of 70% Argon (ionization) and 30% CO_2 (quenching)
- Foils
 - Insulating layer with conductors on top and bottom
 - Conductors at different voltages
 - Microscopic holes which create a sharp electric field
- Electrons drift in the gaps and multiply in the foil holes
- Electron clouds induce a signal on the readout strips
- The signal is amplified and transmitted to the electronic components



GEMs in the CMS

In both end caps

- Currently functioning:
 - GE2/1 (GEM End cap second layer first ring)
 - GE1/1 (GEM End cap firstlayer first ring)
 - working alongside CSC(Cathode Strip Chamber)
- Soon to be installed: ME0 (Muon detector End cap zero)



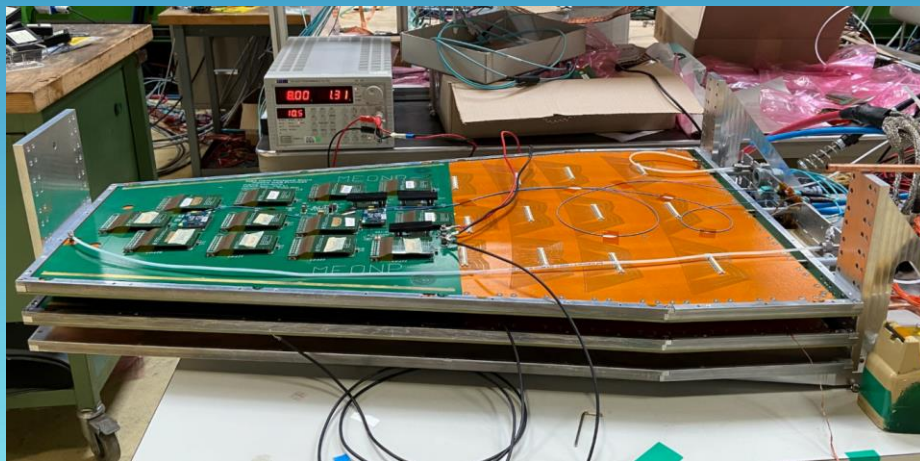
The next GEMs: GE2/1 and ME0

GE2/1:

- 4 Modules (GEM chambers) constitute a single layer
- Built an early version now in the experiment, while the others are being built in the lab

ME0:

- 6 layers of GEM Chambers assembled into a stack
- These chambers will be closer to the beam pipe, which means higher rate and special electronics and materials required
- Prototype chambers are being built in the lab



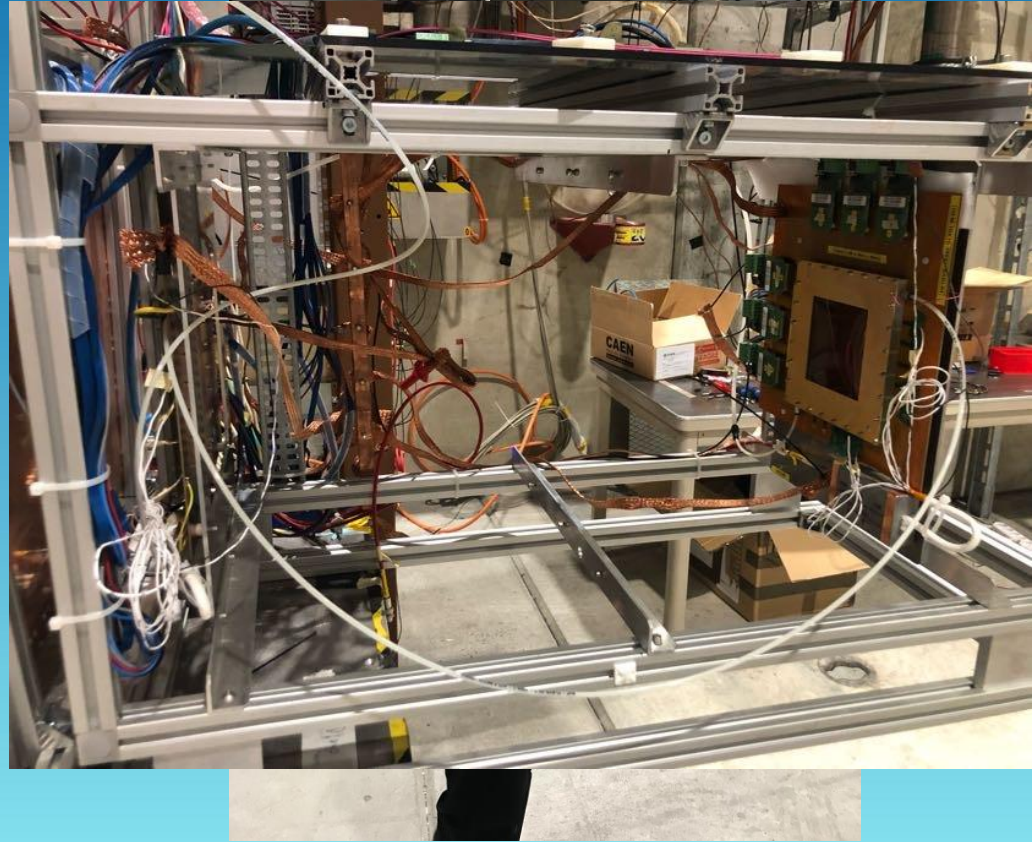
Tuesday 24/05

- First meeting with supervisors
- Learning about GEMs
- GEM lab visit



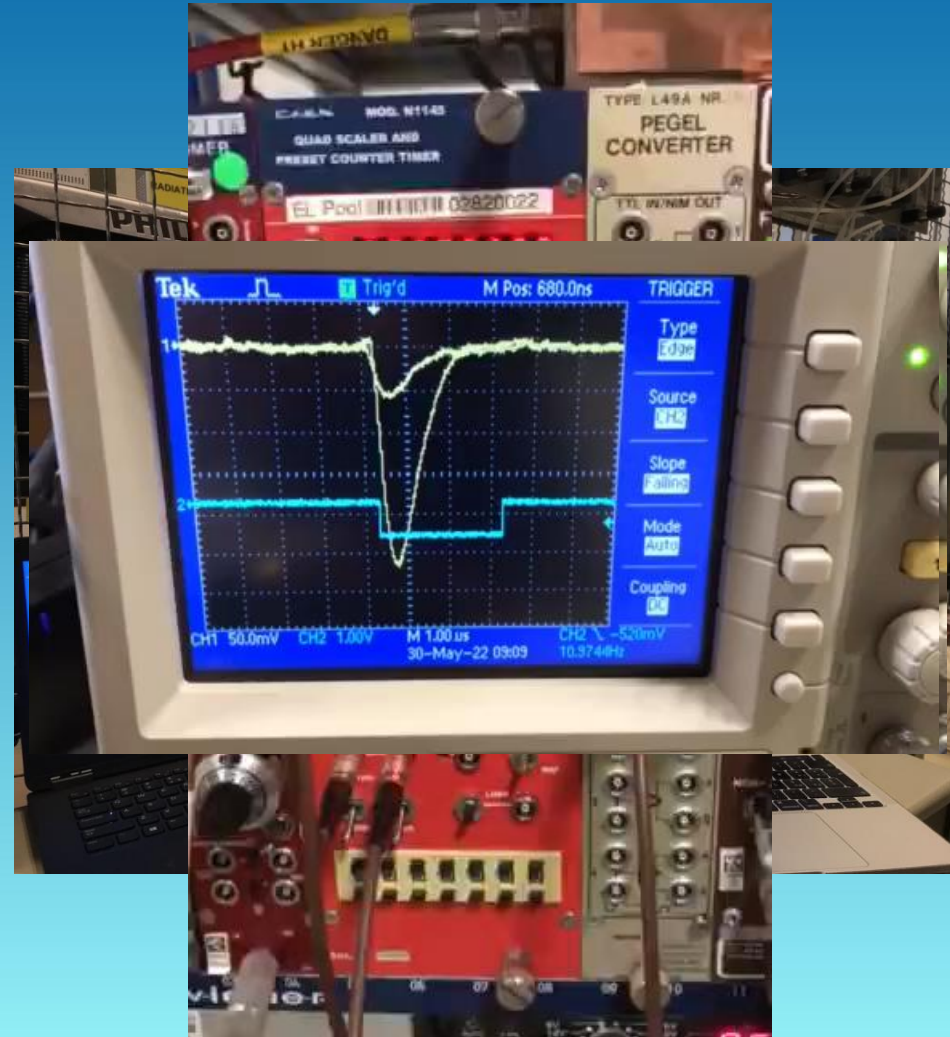
Wednesday 25/05

- Test beam visit
- GEM testing



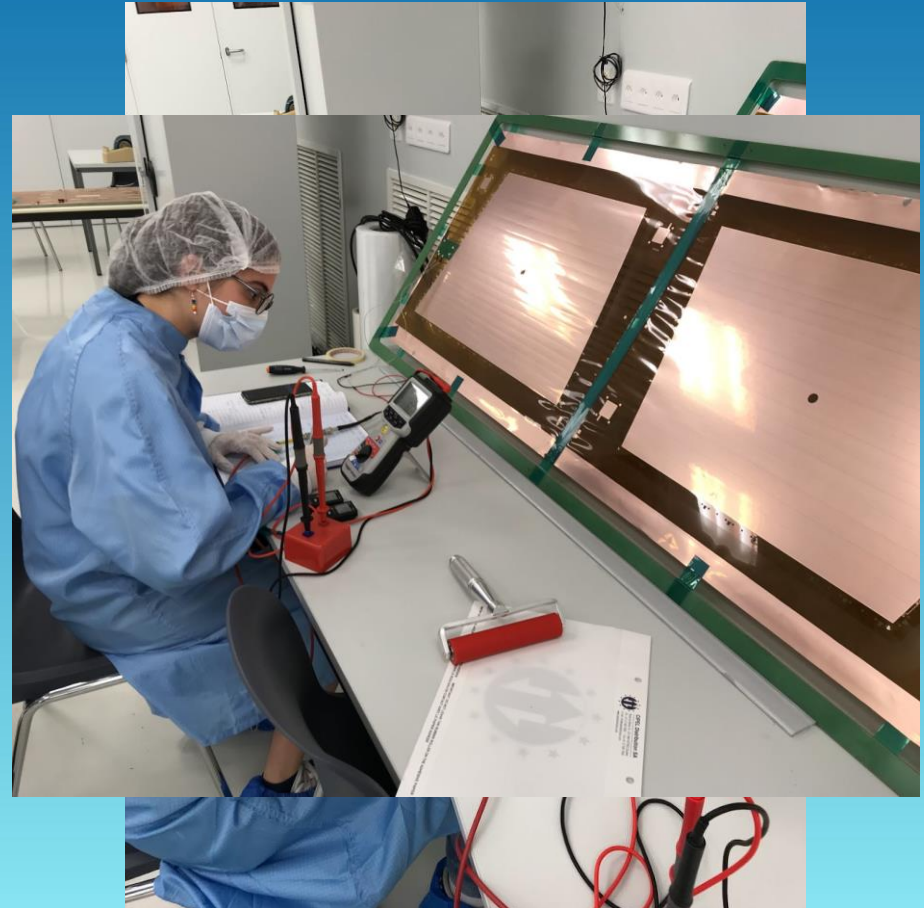
Monday 30/05

- GEM calibration
 - Events measured varying the voltage
 - Use of X-ray guns



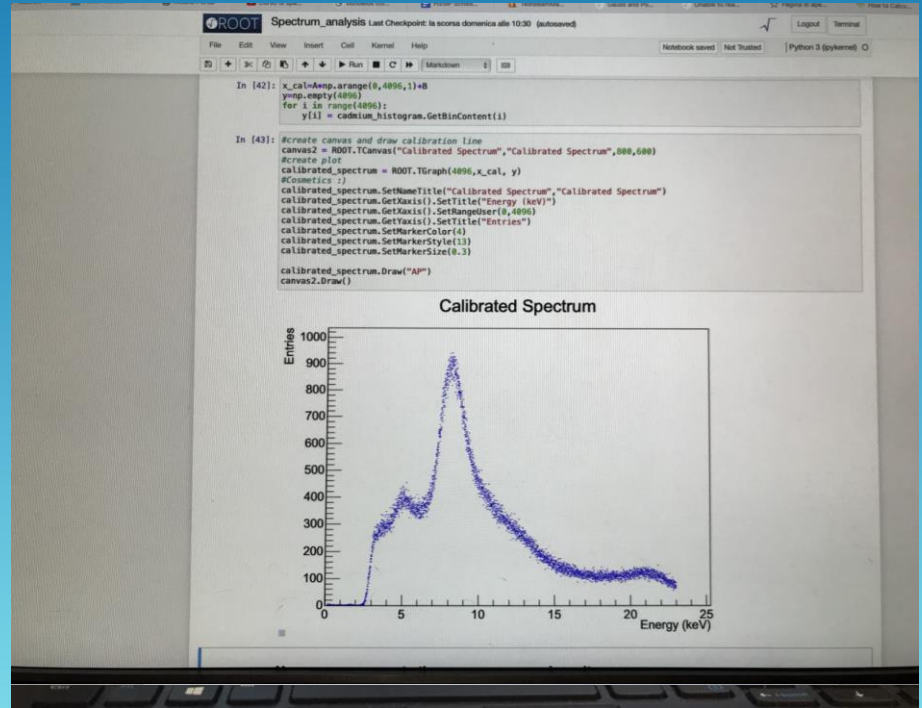
Monday 30/05

- Clean room work
 - GEM foils cleaning with electrostatic roller
 - Quality control
 - Resistance testing



Tuesday 31/05

- GEM calibration
 - Buffed copper fluorescence
 - Copper Fluorescence
 - Cadmium decay energy
- Data interpolation



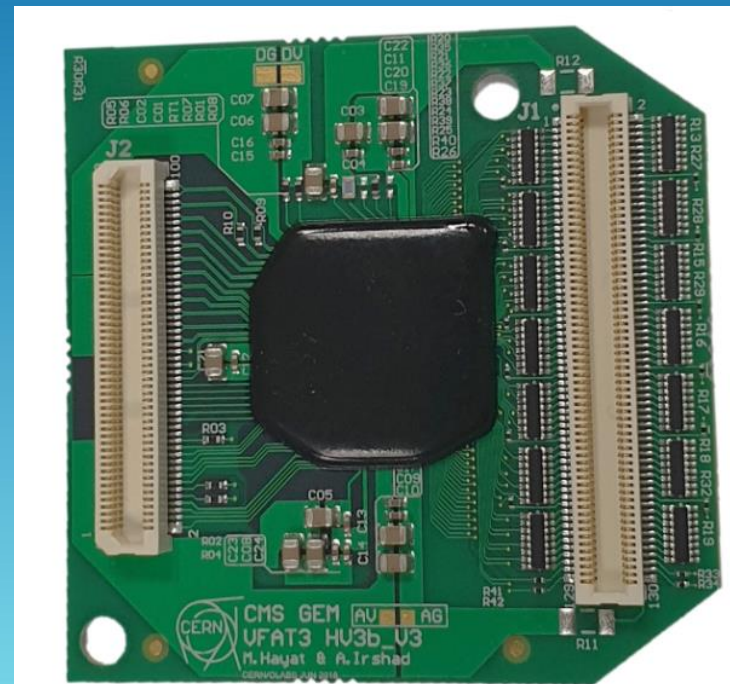
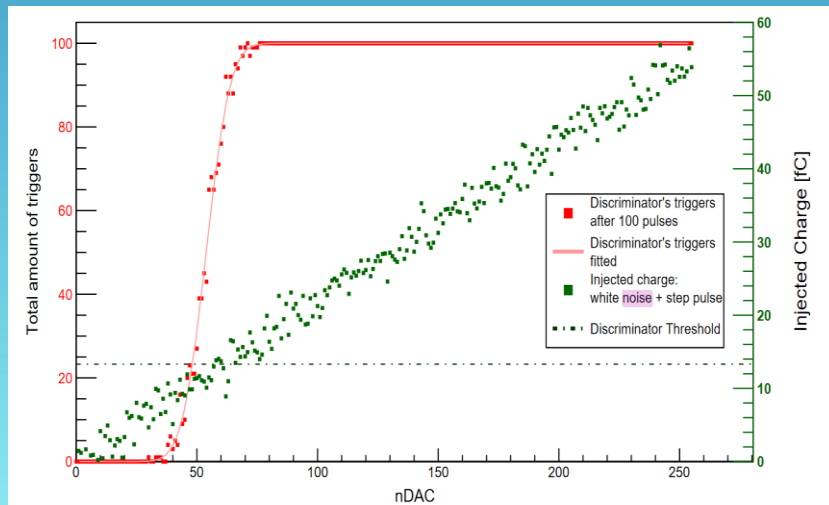
Wednesday 1/06

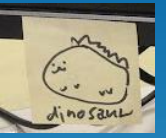
- The brain of CMS: CMS Control Room
- See GEMs operating
- Learn about CSC



Thursday 2/06

- VFAT recalibration to get a uniform response to electrical signals





Special thanks to our supervisors:

Giovanni Mocellin and **Brendan Regnery**,
Department of Physics **University of
California, Davis**

