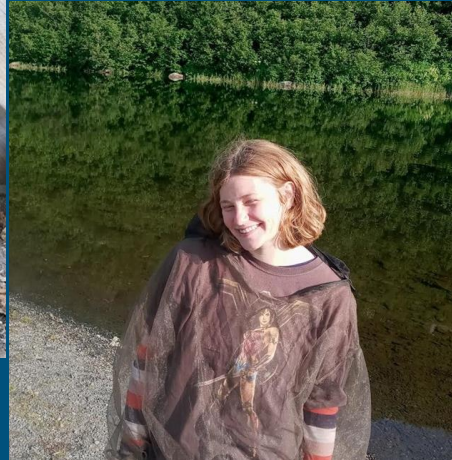
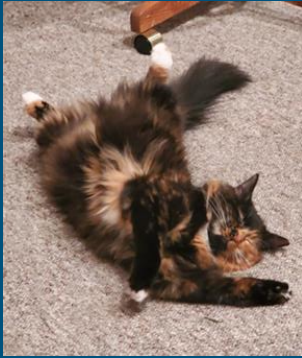




Compact Muon Solenoid (CMS) High Granularity Calorimeter (HGCal) Upgrade for End Caps: Project Introduction



Margot Lockwood
October 5th, 2022



Values: collaboration, honesty, respect for environment and others, playfulness, exploration, learning

Interests: physics (of course), biology, interdisciplinary studies, climbing, yoga, learning, adventure, poetry, art

About me

Why am I here?

- Determine if I want a career in particle physics
- See if I enjoy electrical engineering
- **Learn** skills useful in science research
- **Learn** as much as possible about CERN and particle physics
- **Learn** about living and moving abroad

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Eat croissants?

HGCAL Background

High-Luminosity (HL) LHC

HL-LHC Plan



HL LHC:

- Increase in collisions by a factor between 5 & 7 (more data in less time!)
- **More data** -> More likely to detect rare particles
- Uses less energy per amount of data



HGCAL Background

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Technical Challenges of Beam Update for Detector:

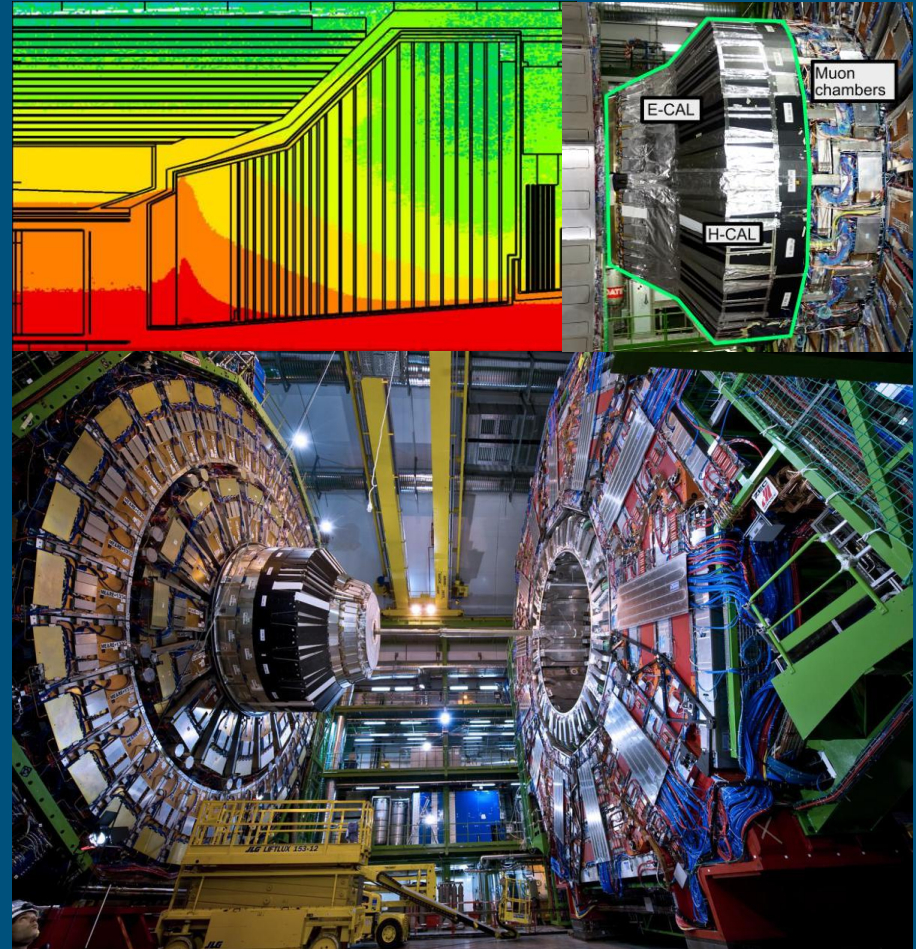
- Even harsher radiation environment (1.5MGy)
 - $LD_{50/60}$ is 2.5 Gy for reference
- More pile up events (140 on average to 200 per beam crossing)
- Cold environment (same as before)

HGCAL Background

HGCAL Current Status

What does HG-LHC mean for the CMS Detector?

- Better electronics are needed
- Better resolution 2d->5d
- 20-ps timing precision over 600 m² of detector required
- Radiation and cold hardy electronics required



HGCAL Background

HGCAL Upgrade Overview

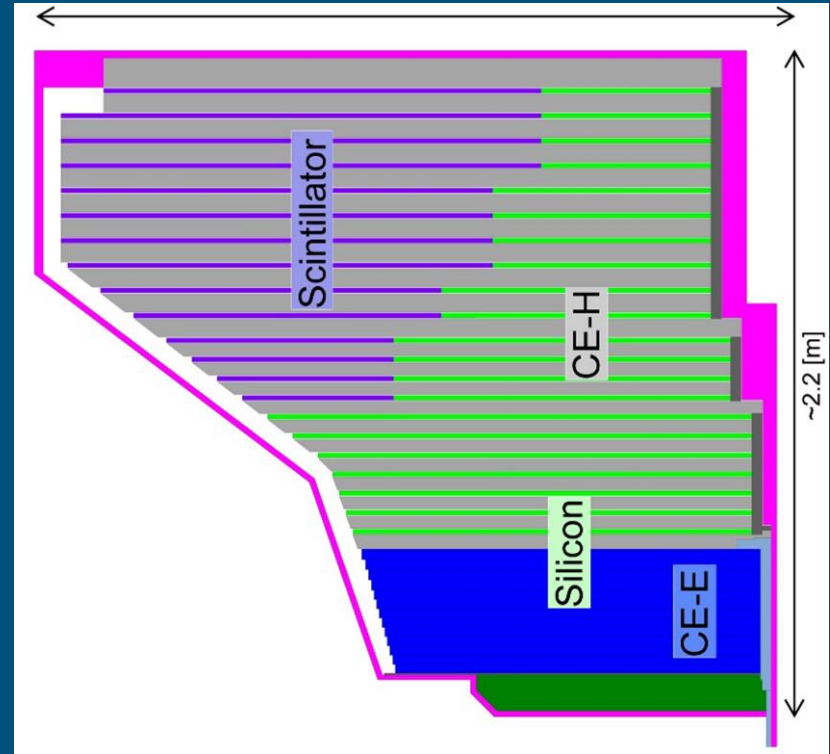
Upgrade will enhance particle identification, energy resolution, and pileup rejection

Electromagnetic Section (CE-E)

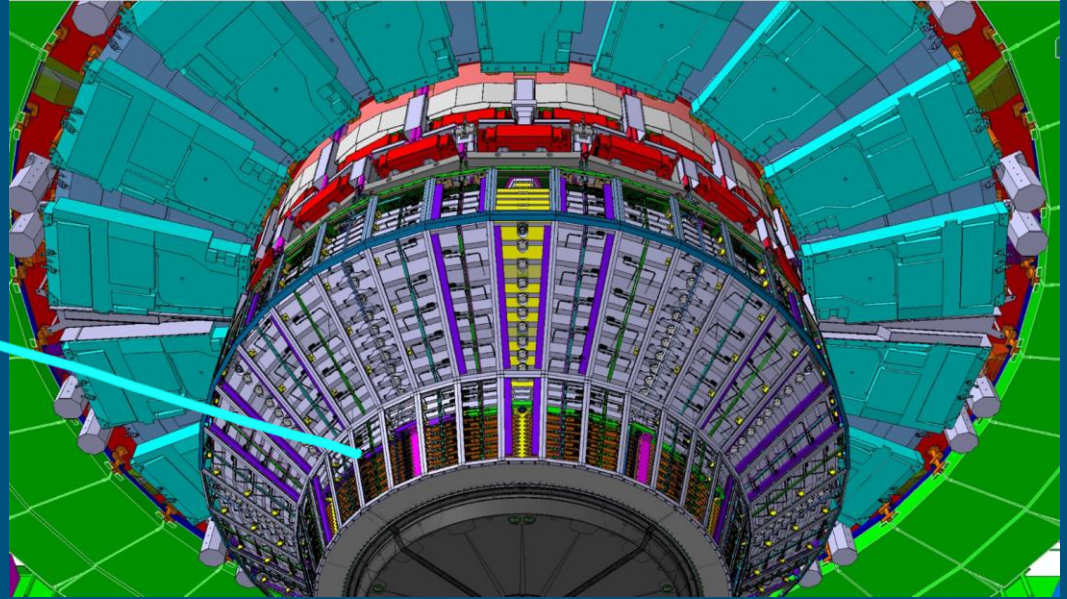
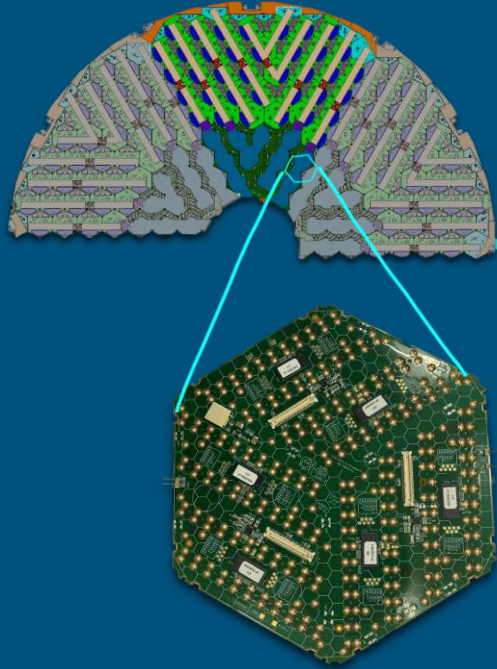
- Hexagonal silicon sensors!
- 6M silicon pads (620 m²)
- 26 layers

Hadronic Section (CE-H)

- 240k plastic scintillator tubes replaces lead tungsten crystals
- 21 layers



HGCAL Background Hexagon Sensor

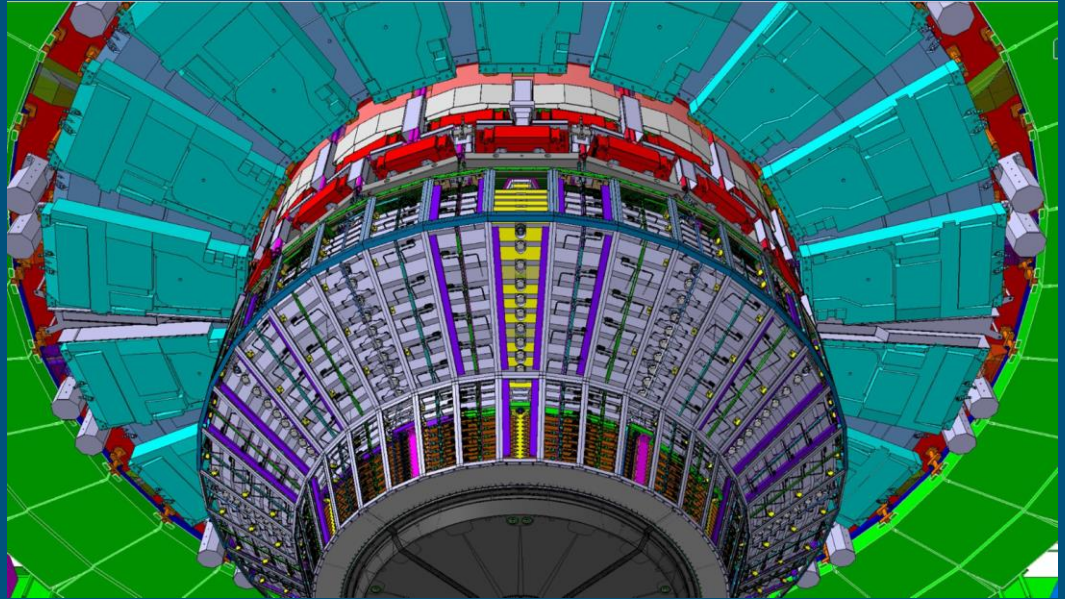


HGCAL Background

HGCAL Current Status

Full integration is underway
(Lots of little things coming together)

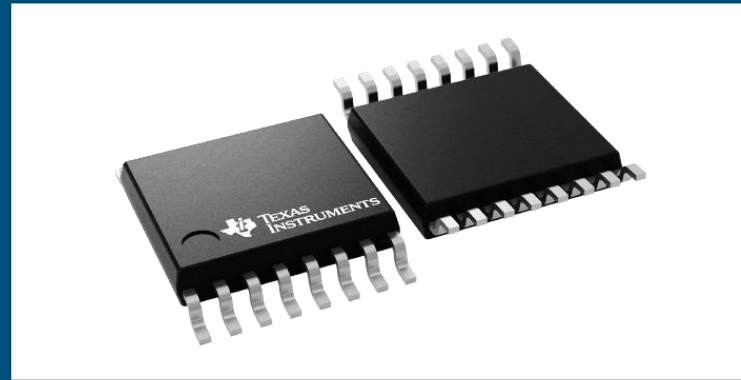
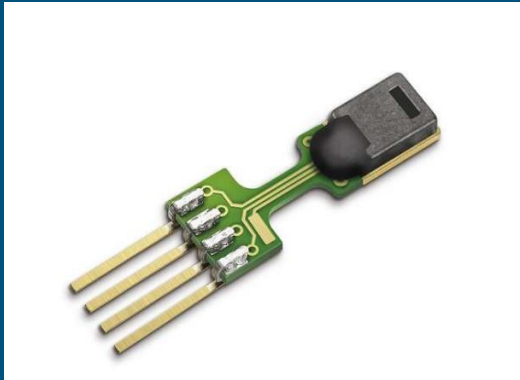
Front end back end communication, trigger system, all components need to work together to communicate, debugging, slow-control being prototyped...



What am I doing?

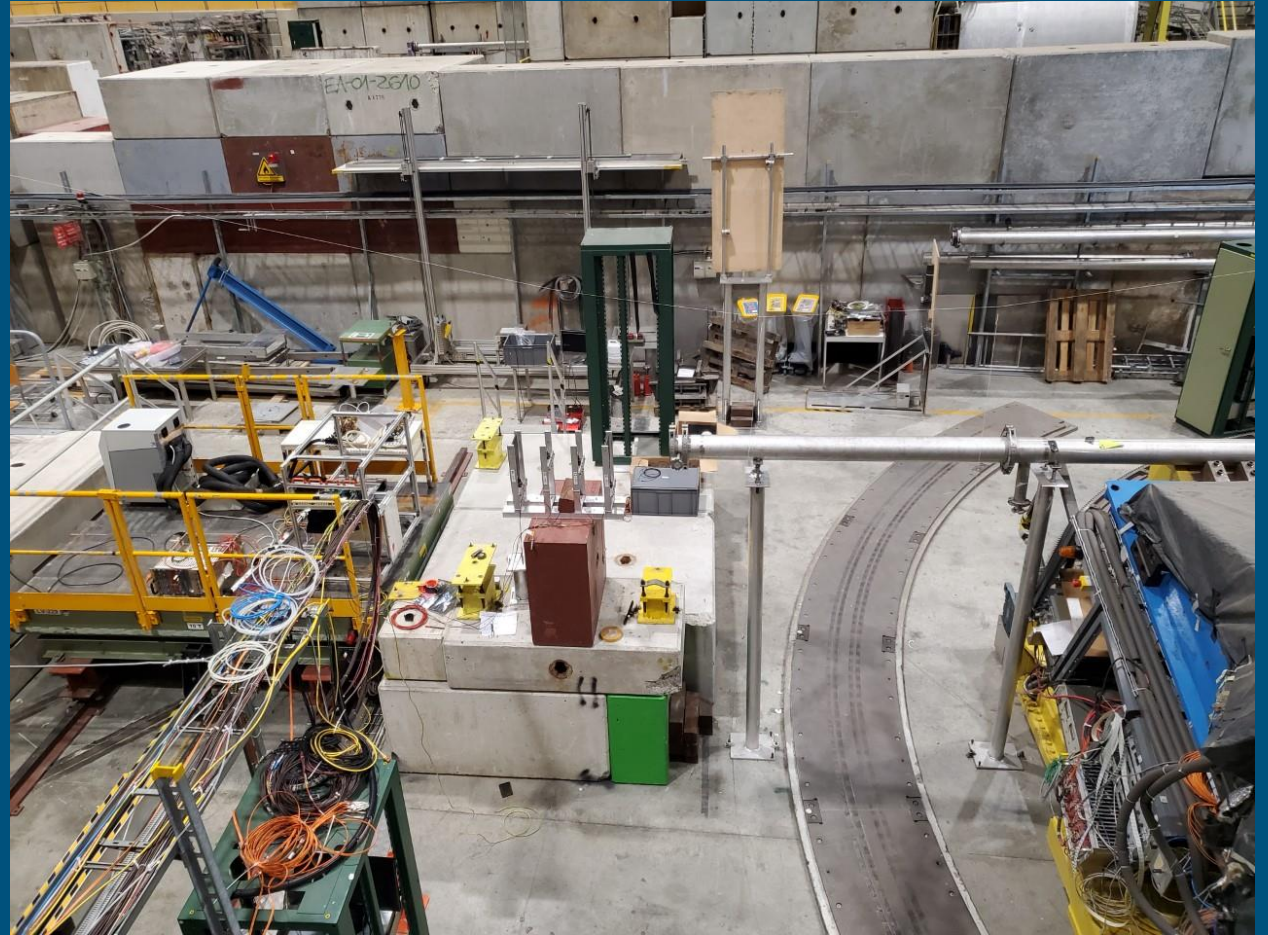
I²C Protocol

1. Temperature and Humidity Sensor for beam test
 - a. arduinos, (micro)soldering, pin mapping (reverse engineering PCB), learning acronyms, learning basics relating to electrical engineering, and I²C protocol
2. Help take data this next week during beam test (starting today!)
3. Use I²C protocol for digital to analog readout for Trophy V3



Beam Test!

Image of the test beam pipe and electronics being tested (set up still in progress)



Thank you

Merci!



Questions?

Sources:

High-Luminosity LHC. CERN. (n.d.). Retrieved October 4, 2022, from <https://home.cern/resources/faqs/high-luminosity-lhc>

Christophe Ochando and CMS Collaboration 2017 J. Phys.: Conf. Ser. 928 012025