

# Characterization and Analysis of Silicon Sensors for use in CMS HL Upgrades

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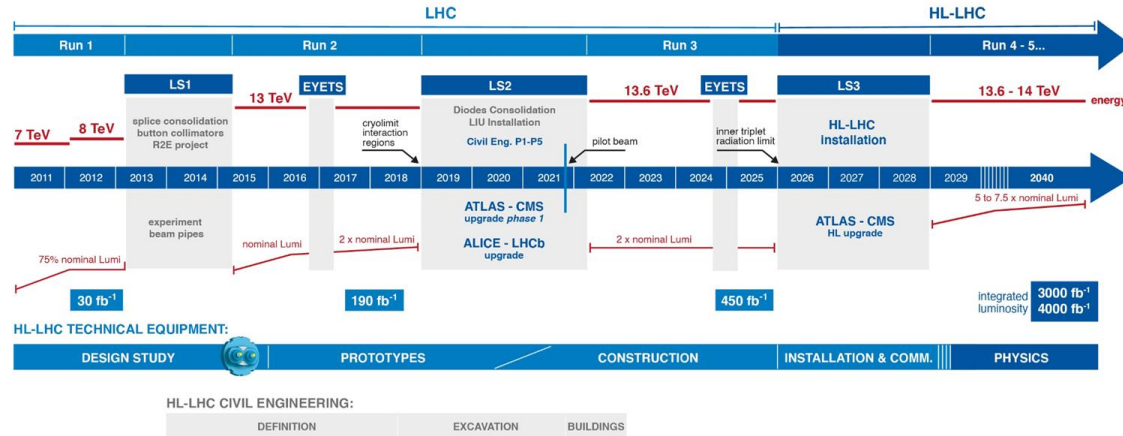
Experimental Physics - Detector Technology - Technology and Physics

University of Michigan REU Summer Student presentations

# Compact Muon Solenoid HL Upgrade

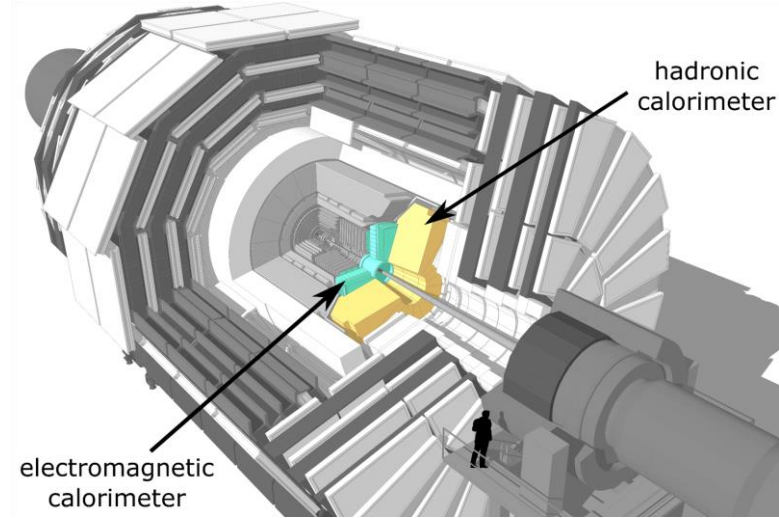


## LHC / HL-LHC Plan



### HL-LHC CIVIL ENGINEERING:

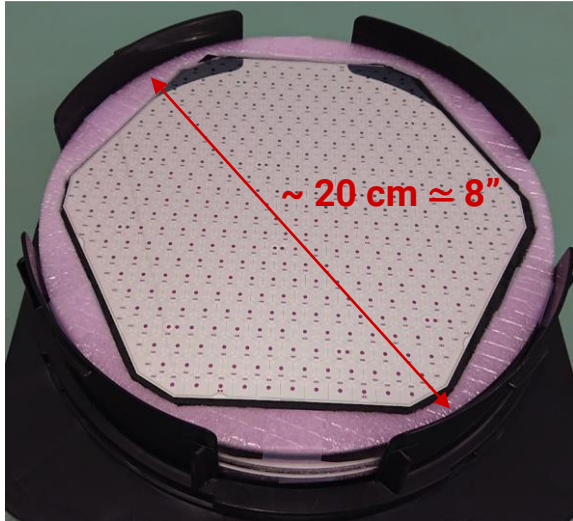
DEFINITION      EXCAVATION      BUILDINGS



<https://cds.cern.ch>

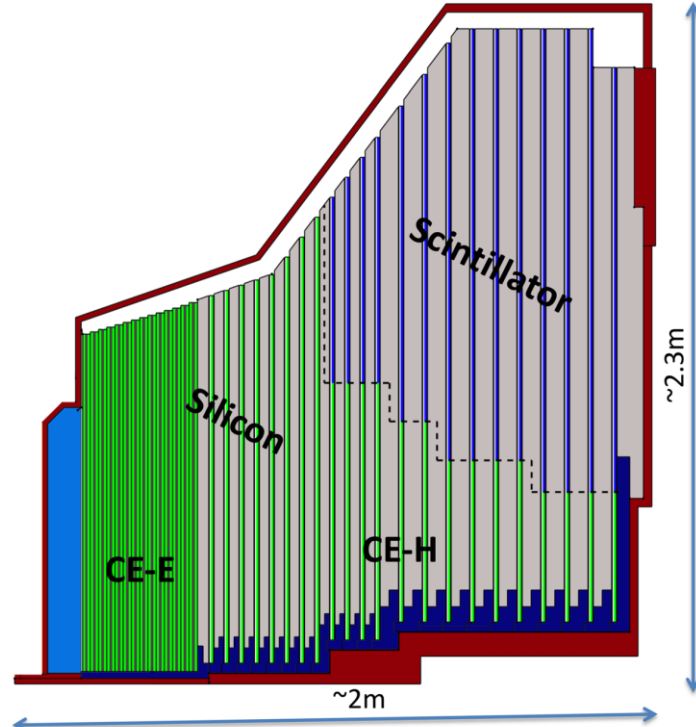
- Nearly 10x luminosity increase
- Higher event rates require faster and more radiation hard detectors
- Silicon diodes will make up a large portion of the upgraded calorimeter (HGCal)

# High Granularity Calorimeter (HGCAL)



<https://cds.cern.ch>

- Silicon sensors will have 432 or 192 channels depending on their location
- Sensors will be of varying thickness



Electromagnetic calorimeter (CE-E):

**Si**, Cu & CuW & Pb absorbers, 28 layers,  $25 X_0$  &  $\sim 1.3\lambda$

Hadronic calorimeter (CE-H):

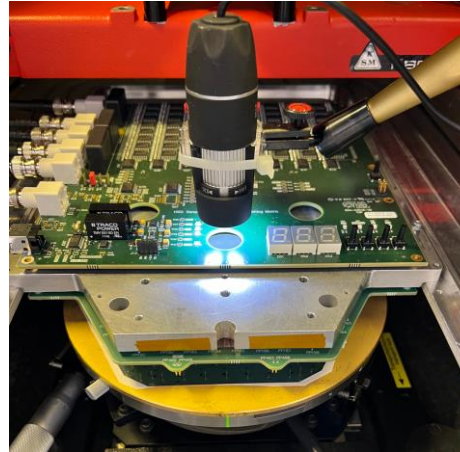
**Si** & **scintillator**, steel absorbers, 22 layers,  $\sim 8.5\lambda$

- Scintillator can't be used in the higher radiation regions
- Fully depleted silicon sensors used in both CE-E and CE-H

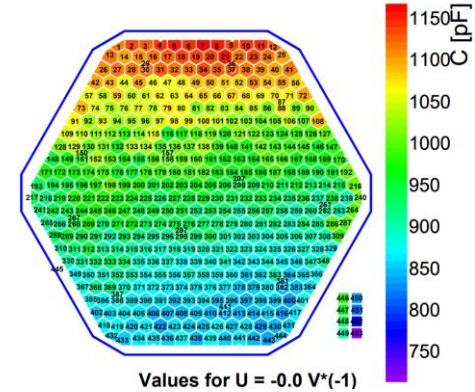
# IV and CV Characterization



Optical inspection of sensors to ensure integrity of key components

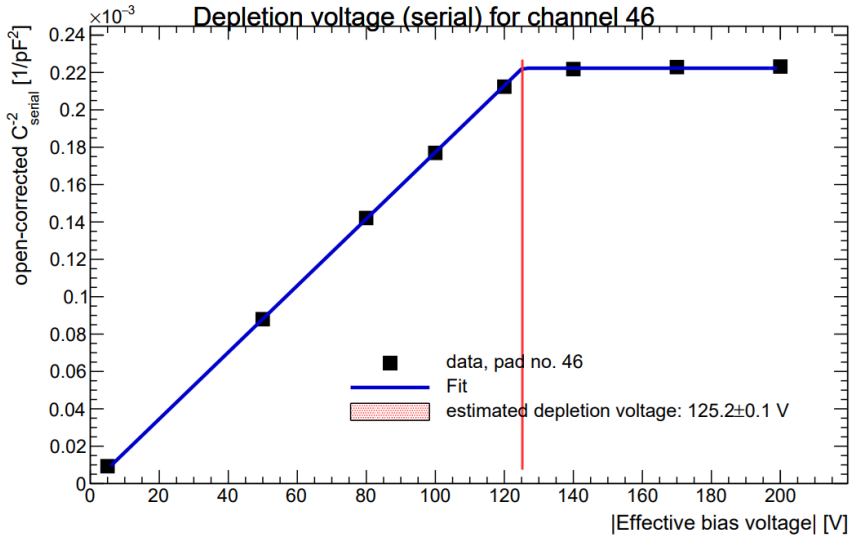


Electrical testing performed by probe card run with labview program

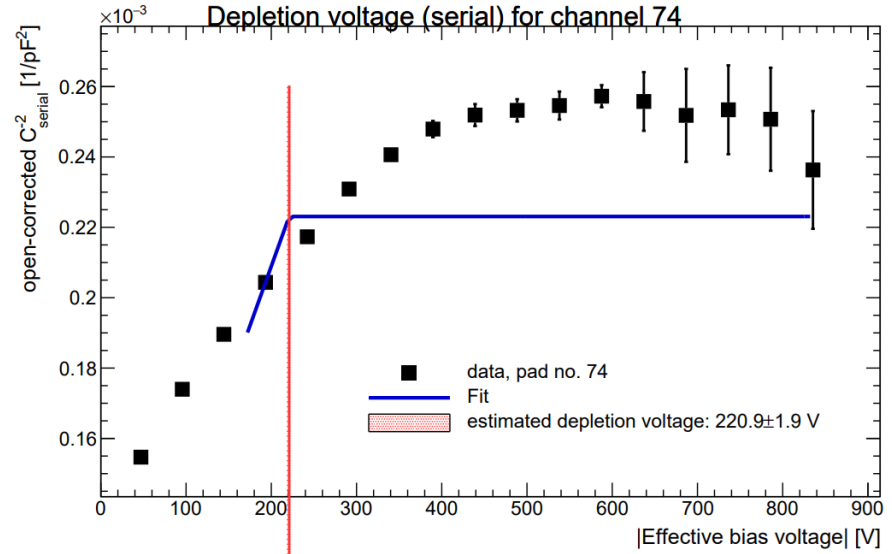


Example of CV output data

# Extracting Depletion Voltage from CV Data



- Well behaved pre-irradiated data is easy to fit



- Post irradiation data can get much more messy which causes current fitting model to fail