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

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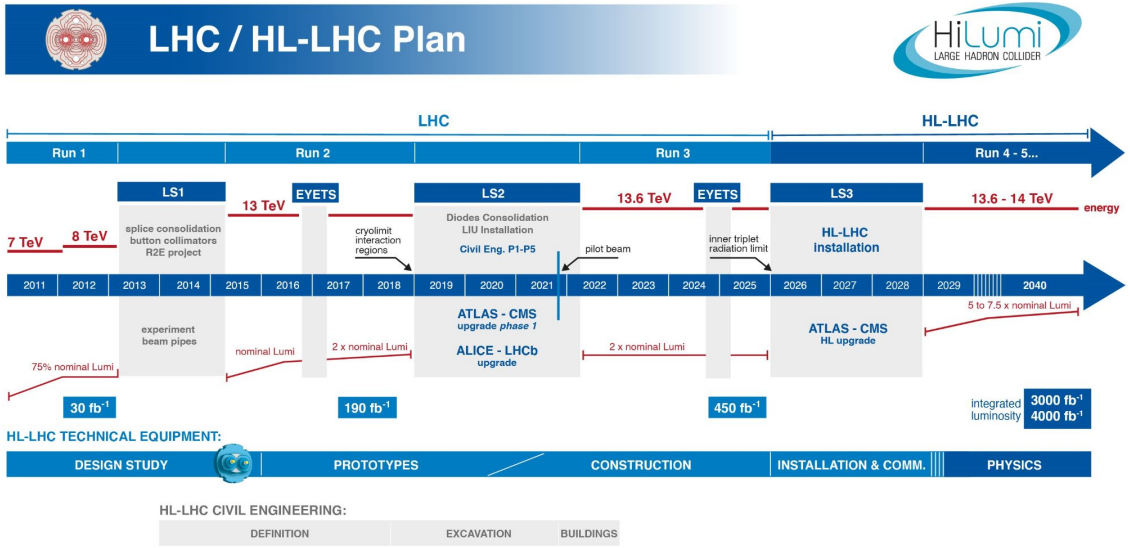
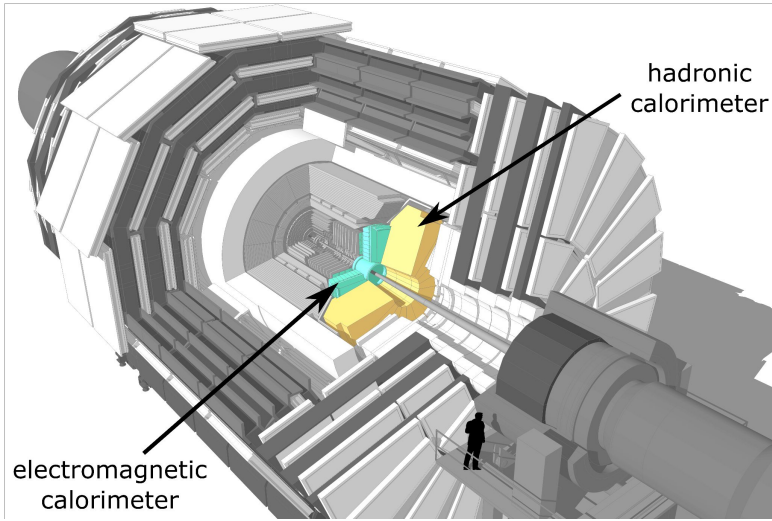
Experimental Physics - Detector Technology - Technology and Physics

University of Michigan REU Summer Student presentations

Compact Muon Solenoid HL Upgrade

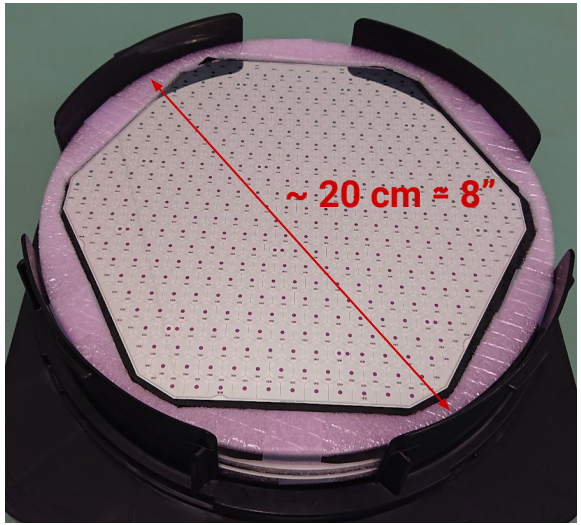


https://cds.cern.ch



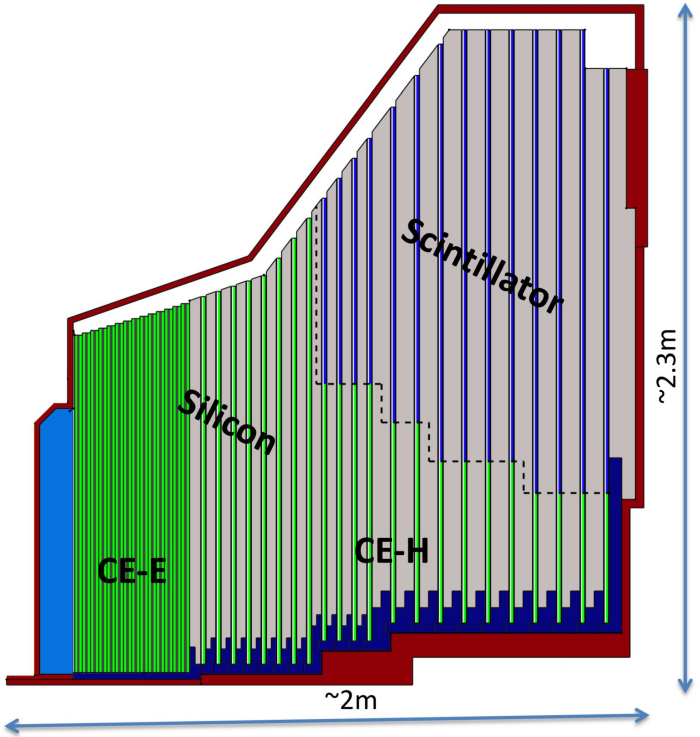
- Nearly 10x luminosity increase
- Higher event rates require faster and more radiation hard detectors
- Silicon diodes will make up a large portion of the upgraded calorimeter (HGCAL)

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

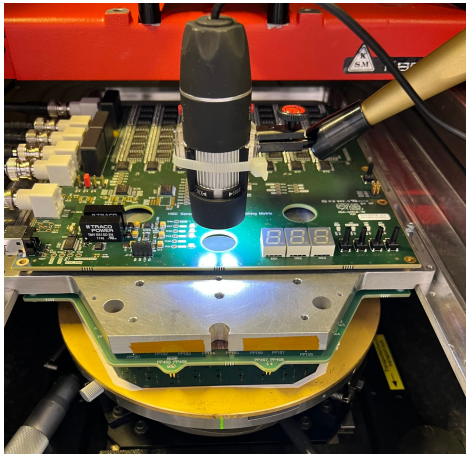


Electromagnetic calorimeter (**CE-E**):
Si, Cu & CuW & Pb absorbers, 28 layers, 25 X_0 & ~1.3λ
Hadronic calorimeter (**CE-H**):
Si & **scintillator**, steel absorbers, 22 layers, ~8.5λ

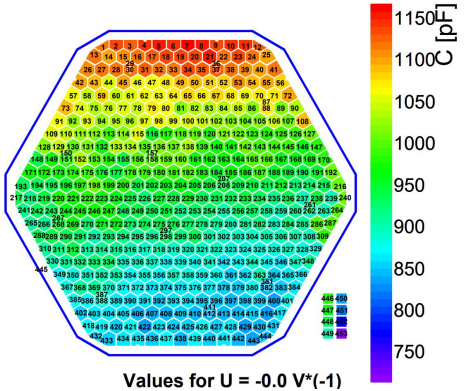
- Scintillator can’t be used in the higher radiation regions
- Fully depleted silicon sensors used in both CE-E and CE-H

IV and CV Characterization

Optical inspection of sensors to ensure integrity of key components

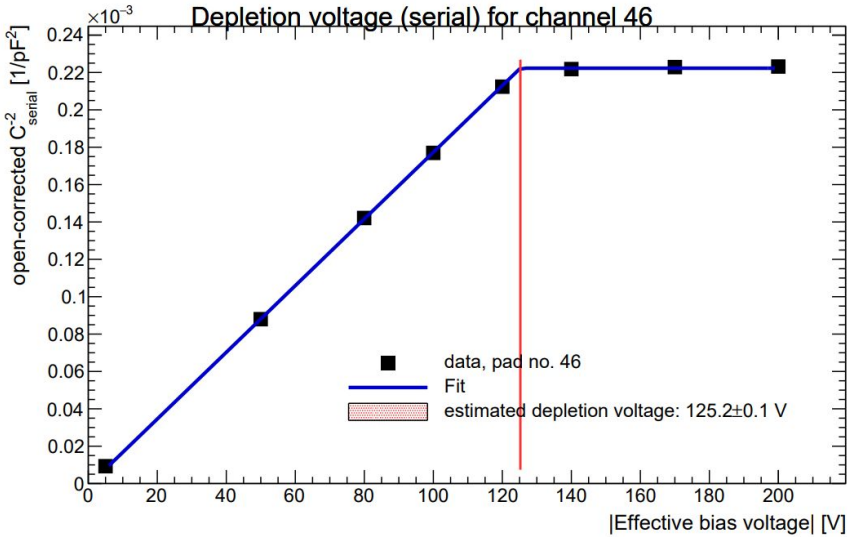


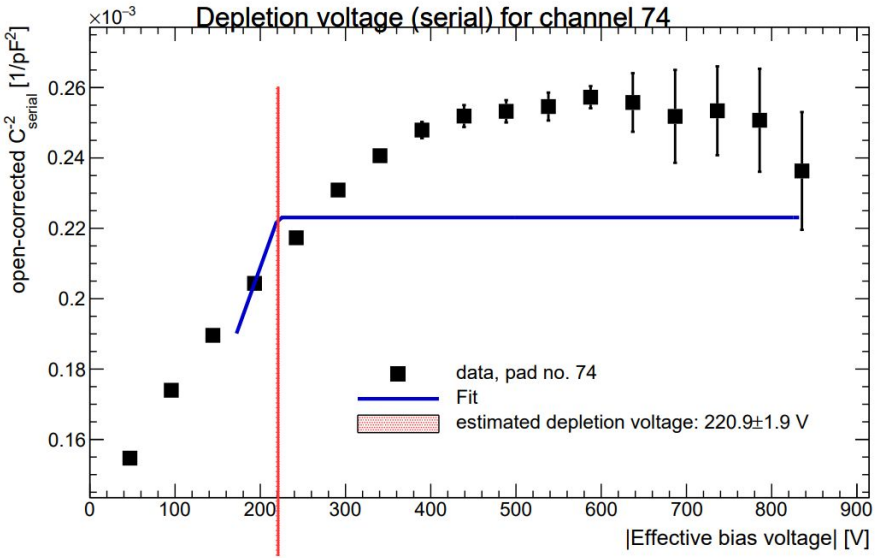
Electrical testing performed by probe card run with labview program



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