

# A New Method for HL- LHC CMS MTD Upgrade

Development of an Innovative Method to  
Characterize the Sensitive Elements of the BTL  
Detector

# Who is speaking?

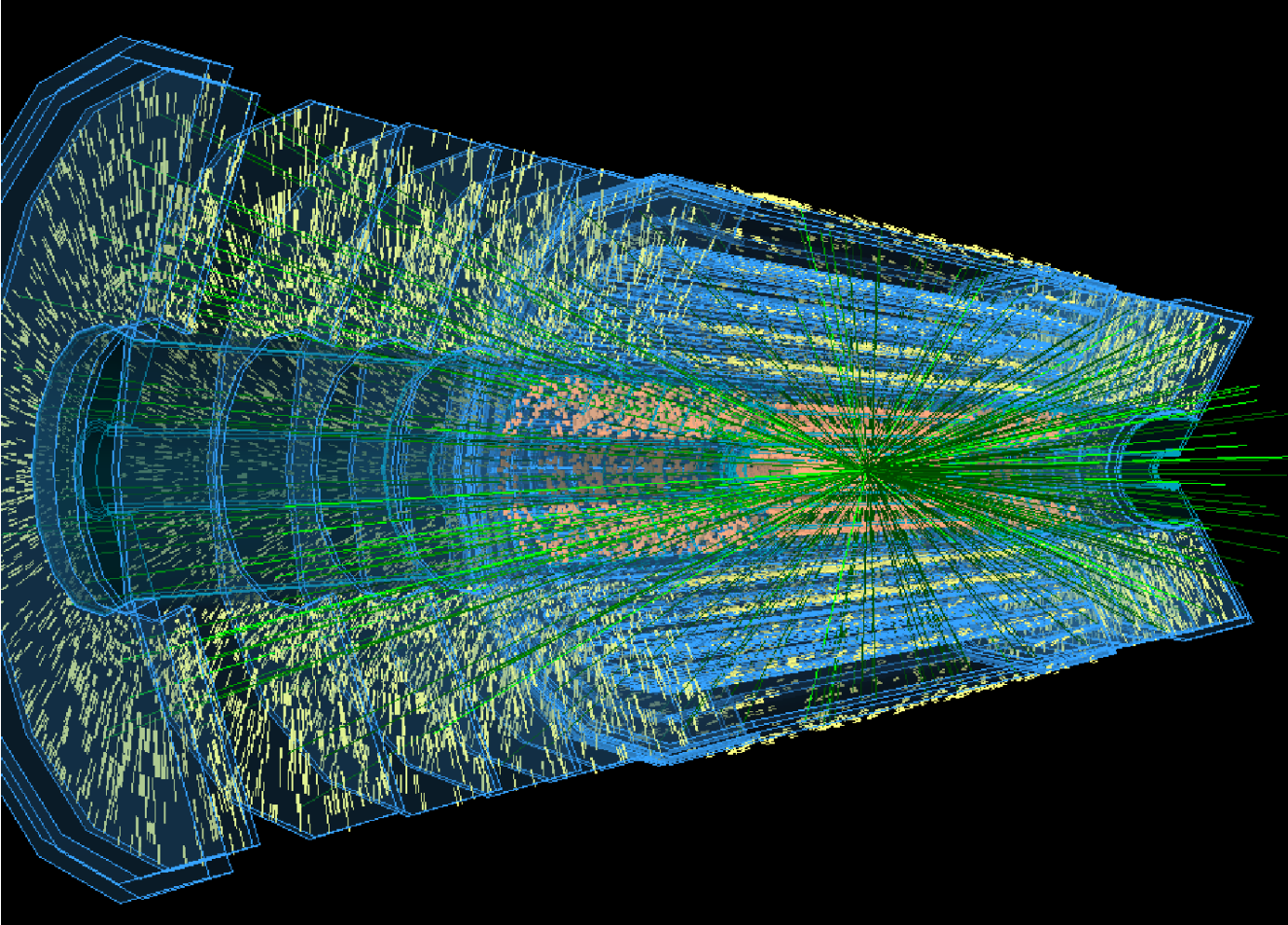
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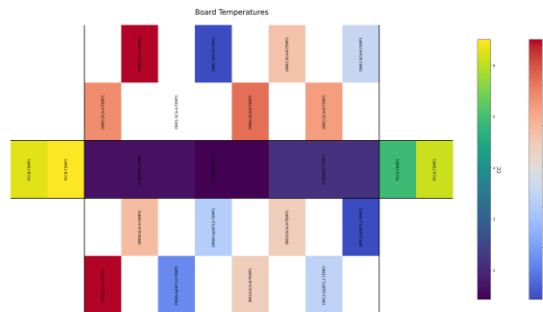
- Over the past three months, I have been working on the research presented in my Bachelor's thesis, focusing on the characterization of sensitive elements in the BTL detector for the CMS experiment.
- I aspire to pursue a career in high-energy particle physics.
- Curious by nature – always full of questions.

# HL-LHC & CMS Detector Upgrade



- The **High-Luminosity LHC (HL-LHC)**, planned for 2030, will boost both **instantaneous and integrated luminosity**: more particles interactions.
- Main goals: **more precise Higgs boson studies** and an **extended search for new physics**.
- This upgrade presents challenges for the **CMS detector**:
  - ~**200 interactions** per bunch crossing (pileup) and **increased radiation** and **higher data** throughput requirements
- To address this, the **MIP Timing Detector (MTD)** is introduced:
  - Provides **tens-of-picosecond time resolution** and **helps associate tracks** to the correct primary vertex, improving event reconstruction

# The New Method



- Sensitive elements: **LYSO:Ce crystals** and Silicon Photomultipliers (**SiPMs**)  
The crystals emit light when crossed by particles;  
SiPMs detect this light, and the **TOFHIR electronics** read both time and energy signals.

- Need to **characterize parameters** of SiPMs

**Current method** to characterize **not applicable post-installation** → No external photon source available

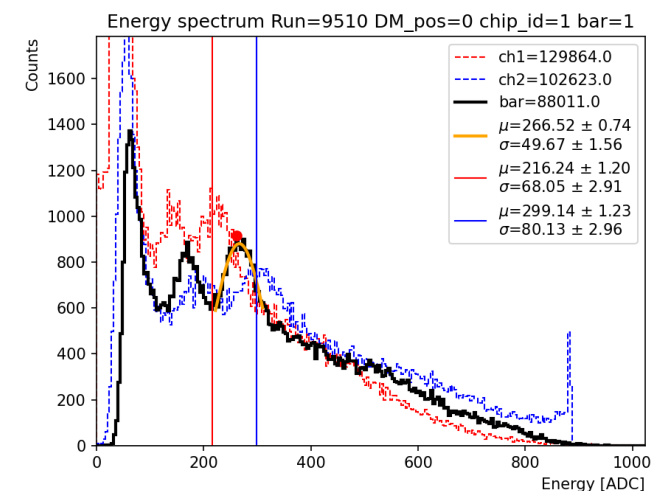
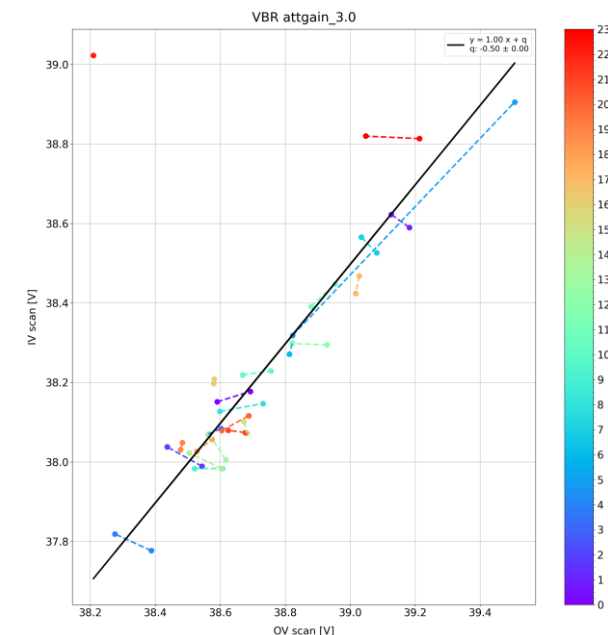
**New approach:** Use **intrinsic radioactivity** of LYSO:Ce (beta decay) as a source of photons to estimate SiPMs

- **Energy response** modeled as a function of **SiPM parameters**:

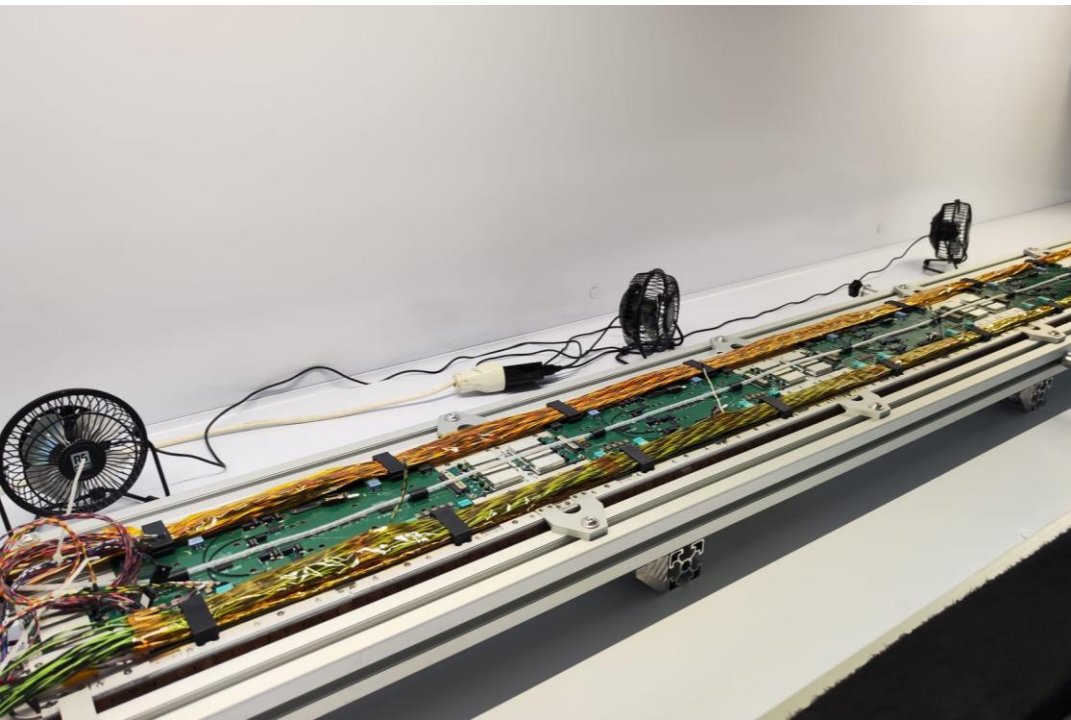
**Peak Extraction** from the LYSO spectrum

**Parameter Extraction:** fitting data from LYSO and **optimizing TOFHIR electronics**

**Temperature Stability** confirmed across conditions







# What I learned

- Don't Be Afraid To:
  - Ask for help
  - Be judged
  - Make mistakes
- Be creative in finding new solutions
- Seek collaboration, not selfish glory
- No satisfaction comes from what is easy
- There is still much work to be done in physics.  
The future is in our hands.