TB 2025 - CERN
Longitudinally segmented Forward HCal (LFHCal)

October 13, 2025

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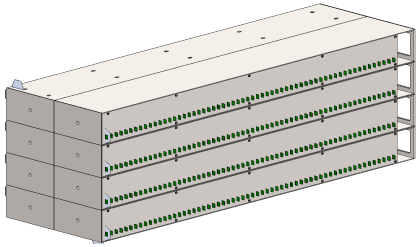
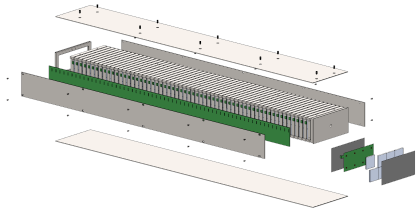
Test Beam Plans 2025 - Original Plan

Requested time: 1 week each
Main purpose: Resolution studies
Location: CERN SPS (29th Oct) & PS (19th Nov.)
Setup:

- Very similar to 2024 setup, with more modules
- 8 full 8M modules (ideally 40x40x132 cm)
- Readout with H2GCROCs
- Same setup in both areas





Main expected measurements:

- Energy resolution for hadrons and electrons
- Assessment of longitudinal/transversal leakage
- Longitudinal shower development
- Final-Flexible PCB validation & first long PCB validation

Necessary components for full setup

For the Setup at CERN

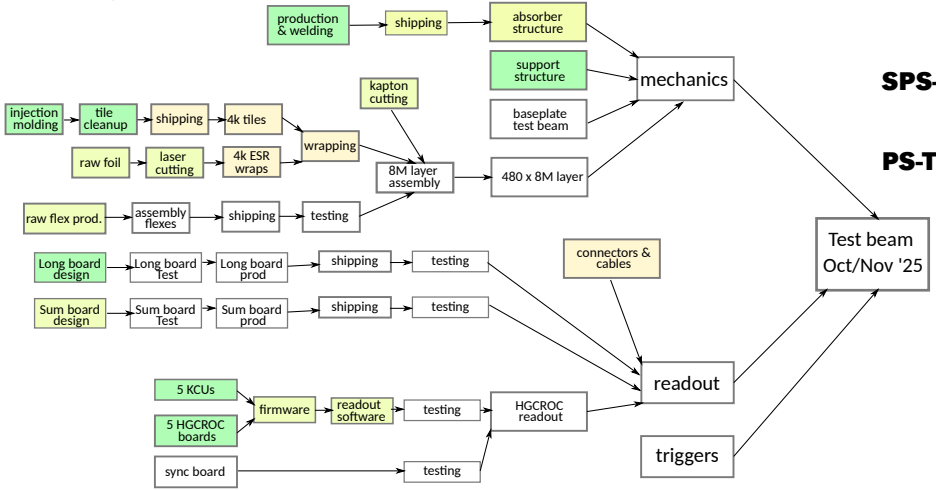
- 8 8M absorber structures + moving structures
- 480 working SiPM layers:
  - 3840 wrapped tiles
  - 480 "chocolate bars" (4x2 wrapped tiles assembled)
  - 480 flex PCBs equipped with SiPMs
- 8 long transfer boards
- 8 summing boards
- 4 (+1) HGCROC boards & 4(+1) KCUs
- Cables + mechanical structure to hold read-out boards
- Trigger paddles + supplies
- Power supplies, DAQ computer
- Readout-Software + Analysis-Software

Additional things for testing

- Switchable mini-summing board
- Shorter transfer boards
- Break-out board for long board

Each of the components necessary at CERN ideally comes with spares (i.e. 2 long boards, 2 summing boards, 20 SiPM layers ...).
Each of the more complex components should have a test productions (i.e. small sample) to verify design.

Test Beam 2025: Where were we mid September?



SPS-H4: 10/29-11/5

PS-T09: 11/19-11/26

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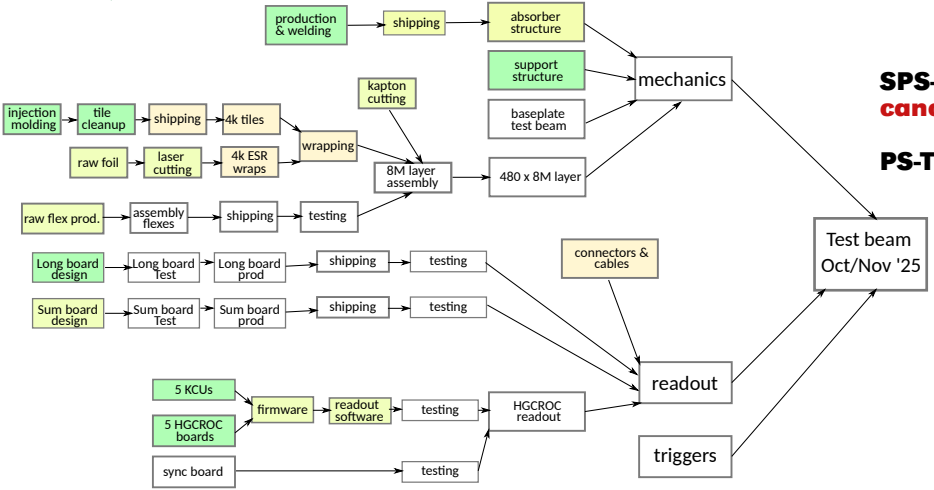


SPS-H4: 10/29-11/5
canceled early Sept.

PS-T09: 11/19-11/26

Clearly we were not where we needed to be on all fronts, but heroic efforts were made!
THANK YOU!

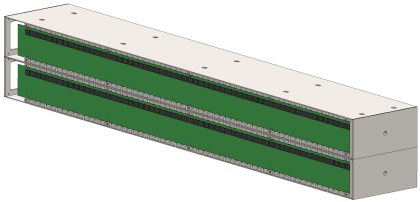
What do we have available?

- **Absorber:**
  - 8 x 8M modules at ORNL and ready to be shipped
  - Lifting and support frames available
- **Layers:**
  - 3500 tiles produced at FNAL + 1500 tiles from old production
  - Valpo + MSU cleaned & wrapped 1200 new tiles + ORNL wrapped 1200 tiles from old production $\Rightarrow$ 300 "cholocate bars" available
  - $\approx$ 70 fully assembled 2024 layers available (incl. flex boards)
  - 20 new flex boards (slighly different geometry ease of connection) - arriving this week
- **Connection & Summing electronics:**
  - 8 short long boards from 2024
  - 2 new long boards - in transit
  - 2 break-out boards - in transit
- **Readout-electronics & software:**
  - 2.5 HGCROC boards (2 will be shipped to CERN directly by Carlos)
  - 2 KCUs (trying to only 2 KCUs with 2 HGCROC boards each)
  - Standalone DAQ software exists & working - integration in RCDAQ ongoing
  - First version of analysis software also exists and is being expanded

Our modified TB proposal for PS:

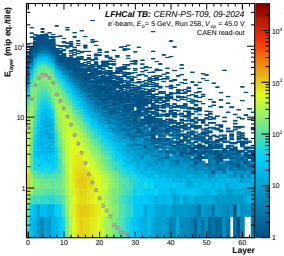
Requested time: 1 week
Main purpose: EM-response & shower development studies
Location: PS (19th Nov.)
Setup:

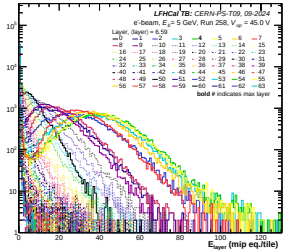
- 2 modules (20x20x132 cm)
- Readout with 8 H2GCROCs (max 512 channels)



Main expected results:

- Energy resolution electrons (should be fully contained)
- Longitudinal shower development for:
  - electrons
  - hadrons
- HGCROC dynamic range assessment, possible summing board studies
- Final-Flexible PCB validation & first long PCB testing





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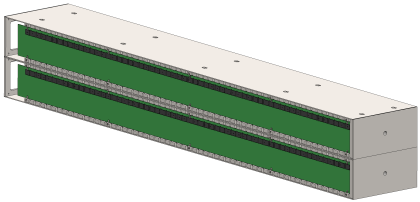

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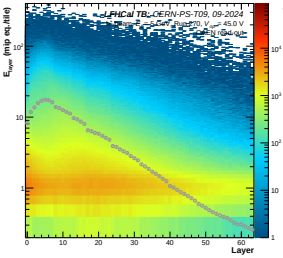
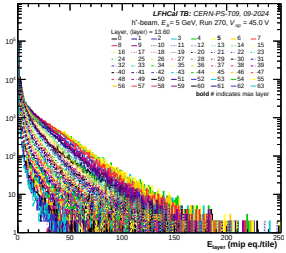
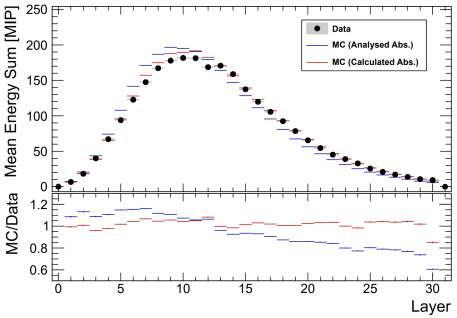
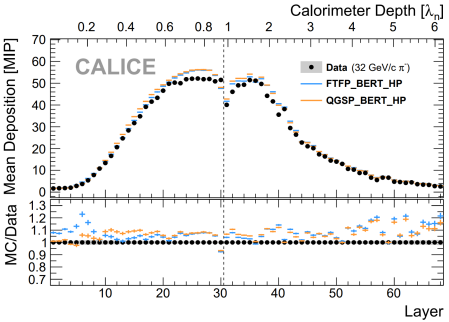




Why is this important? - Physics





- We can learn a lot about simulation from longitudinal showers of e^- and hadrons
- e^-: Quality of readout & modeling in simulations
- h: Quality of hadron shower models

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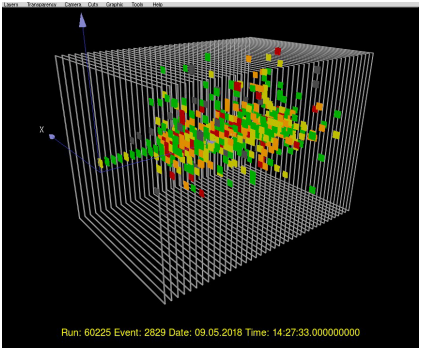

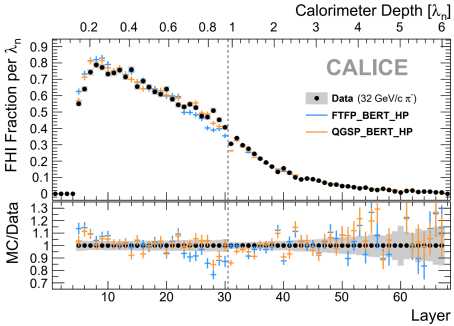

- High granularity enables reconstruction of first interaction
- This is well described in MC & easy to extract MC truth

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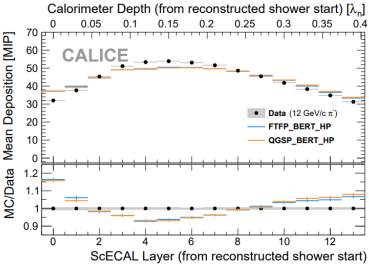

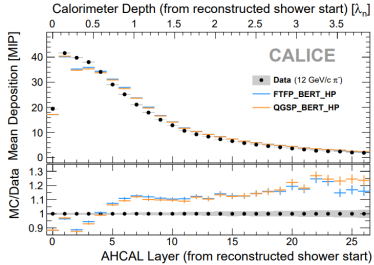

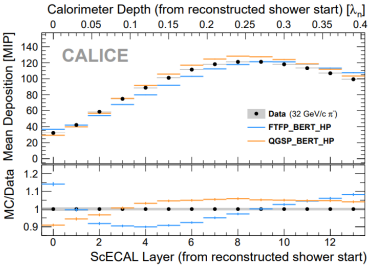

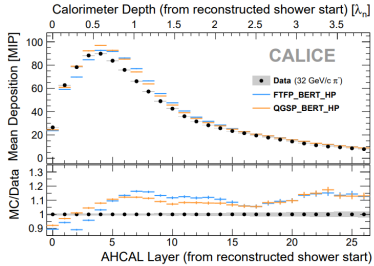

- Longitudinal profile from shower start gives more detailed look into shower model

Necessary components for 2 module setup

- 2 8M absorber structures + moving structures
- 70 working SiPM layers:
  - 960 wrapped tiles
  - 120 "chocolate bars" (4x2 wrapped tiles assembled)
  - 90 flex PCBs equipped with SiPMs *20 new flex PCBs from prototype production + 70 old (fully compatible)*
  - This is enough for both electron resolution and longitudinal hadron profiles
- 4 (+1) HGCROC boards & 4(+1) KCUs
- Cables + mechanical structure to hold read-out boards
- Trigger paddles + supplies *New DRS4 based scintillator+SiPM triggers available, but limited to 500Hz*
- Power supplies, DAQ computer
- Readout-Software + Analysis-Software

Improvements over last beam time

- **Temperature Readout**
  - Raspberry Pi 3b+ temperature logger
  - Based on DS18B20 sensors (thanks to Martin Purschke!)
  - Built and validated by UTK undergrad student
  - Easy to integrate into rcdaq
- **HGCROC/KCU synchronization**
  - New firmware reads 4 HGCROCs/KCU (up from 2)
  - Reduces number of KCUs to be synchronized, improves synchronization efficiency
  - rcdaq integration