Summary & Highlights of CALOR 2026

Yongbin Feng (Texas Tech)

for CALOR 2026 local organizers

CPAD 2026, Seattle, Washington

October 20, 2026

Overview

- **CALOR 2026 at Santa Fe, New Mexico, five-day conference between June 1st and June 5th: https://indico.cern.ch/event/1572594/contributions/**
  - The 21st CALOR conference, now held every two years, with the first one @Fermilab in 1990
  - Around 70 participants, 17 sessions, including 45 talks + 7 posters
  - Each day has a focus: current experiments (Monday), preparation for HL-LHC (Tuesday), calorimeters @ future colliders (Wednesday), generic R&D (Thursday), and future calorimetry (Friday)

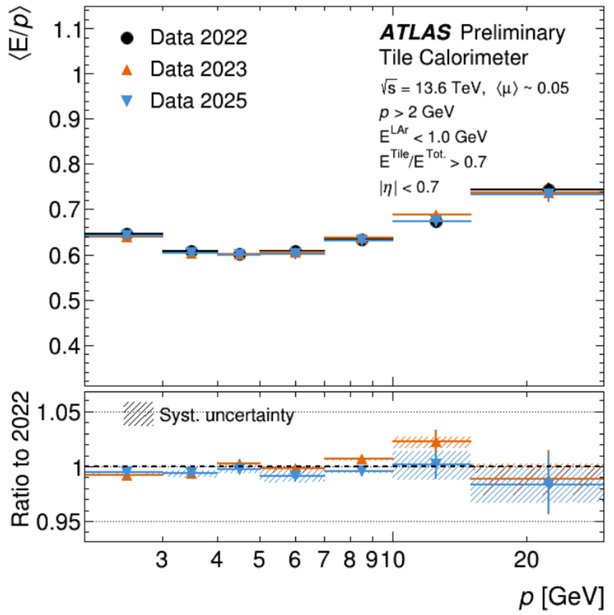


UNIVERSITY OF TEXAS ARLINGTON

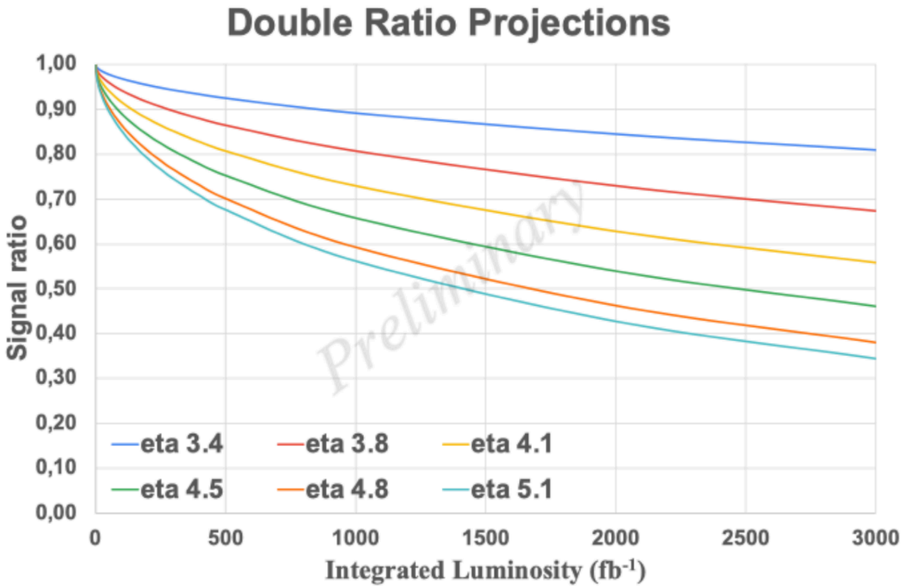
TEXAS TECH™

Current Calorimeters @ LHC

- **Three examples:**
  - ATLAS TileCal by T. Davidek.
    - Steel + scintillator sampling calorimeter for HCAL, barrel
  - CMS ECAL by B. Hirosky
    - Crystal ECAL, barrel and endcap
  - CMS HF by E. Gülmez
    - Steel + quartz-fiber Cherenkov calorimeter, forward region

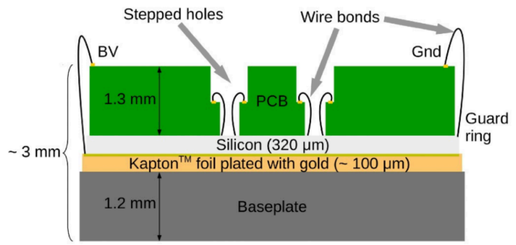


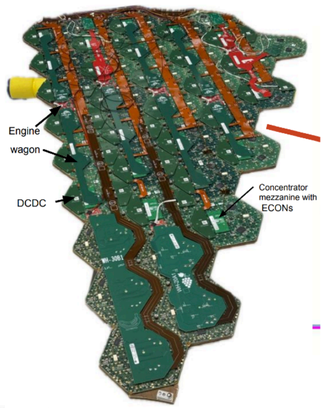
- **Focus on the experience and performance from the current experiments, and projections for HL-LHC:**
  - Excellent **efficiency** (>99%) during Run-3 data taking
  - Combined **calibration** from radiation source, laser, minimum-biased events, and/or charge injection system
  - **Stable** performance across different years during Run-3
  - Expect good performance at HL-LHC (after upgrade)

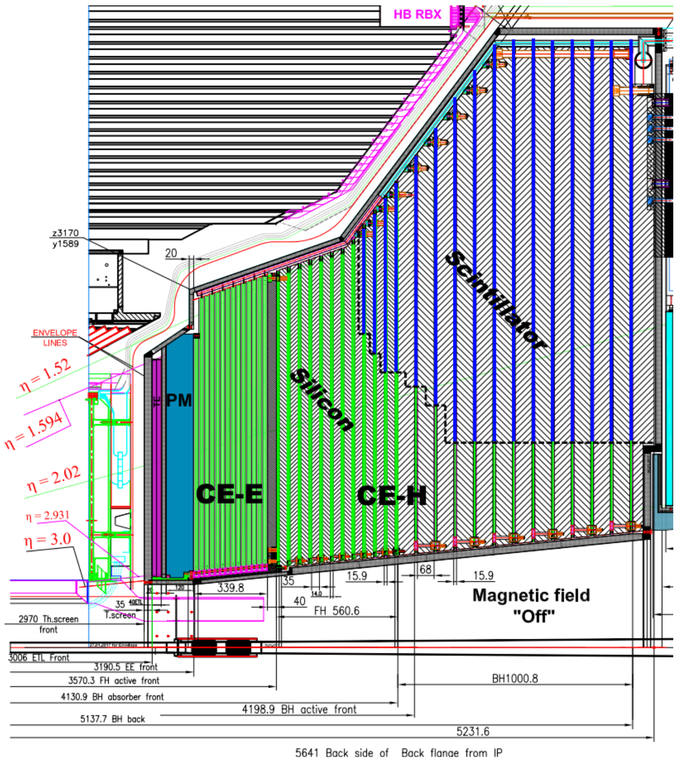


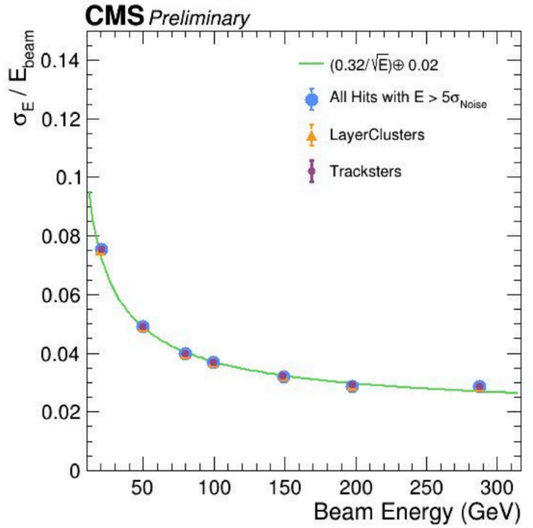
Upgrade Calorimeters for HL-LHC

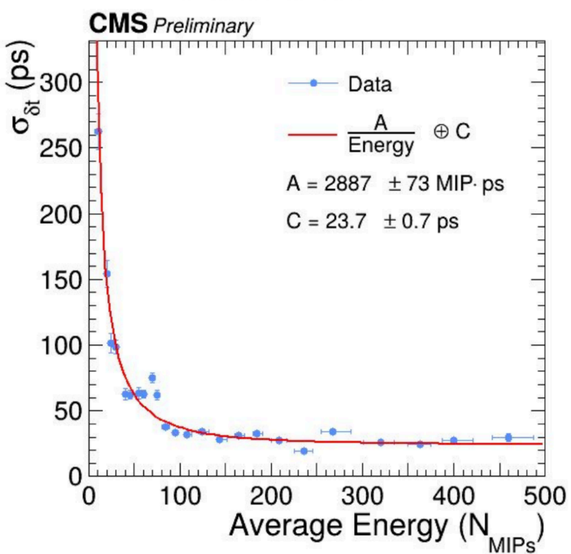
- **CMS High-Granularity Calorimeter**
  - Endcap, Silicon+absorber (Pb+Cu+CuW for ECAL, Steel+Cu+Ti for HCAL), and SiPM-on-tile+Cu+Steel at larger radius
  - **Assembly**:
    - Hybrid tape-epoxy for silicon module assembly for radiation tolerance (by C. Grieco)
    - Tile module assembly (by D. Guerrero)
    - Cassette assembly (by R. Chudasama)
  - **Software:**
    - Reconstruction algorithm: The Iterative CLustering (TICL), modular and flexible across different geometries, heterogeneous-computing friendly, uses AI/ML (by S. Ghosh)
    - Trigger primitives for online reconstruction being tested (by T. Debnath)
  - **Test beam** 2025 results (by D. Mahon)
    - MIP events used for calibration and alignment
    - Excellent energy and timing performance for EM showers





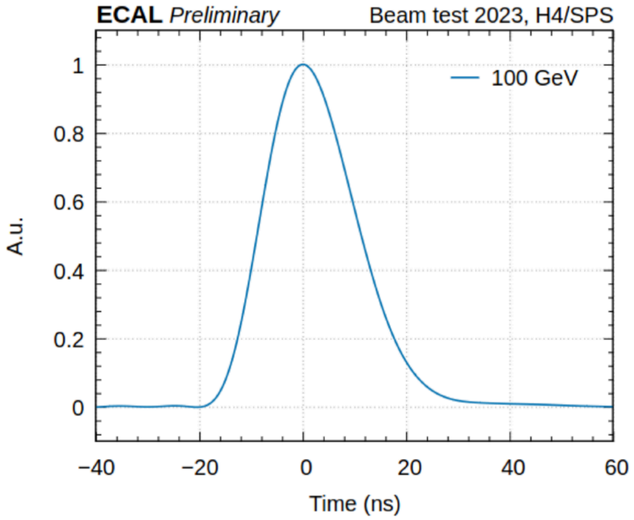


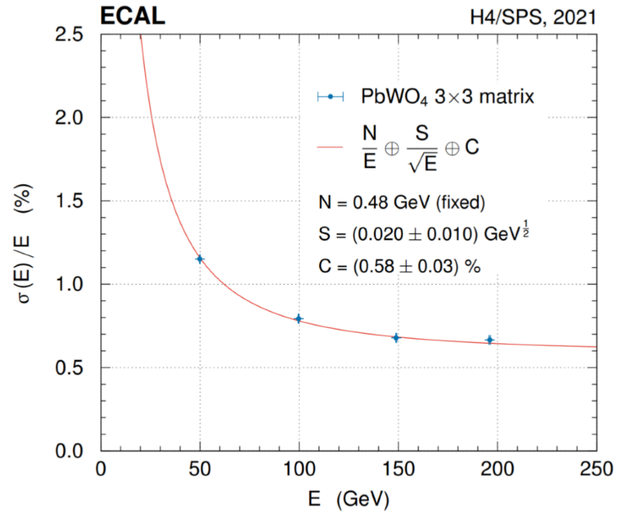


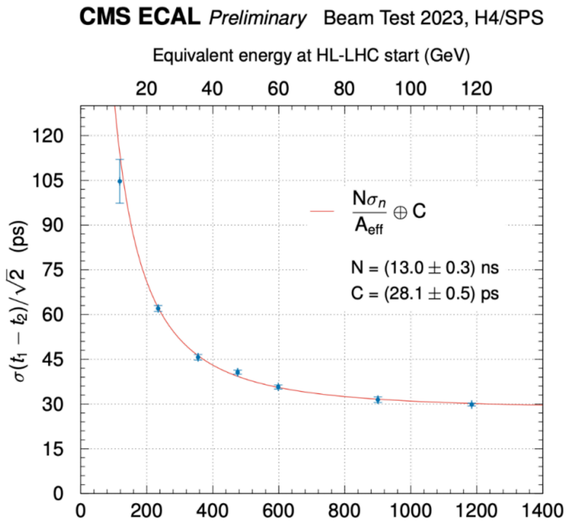


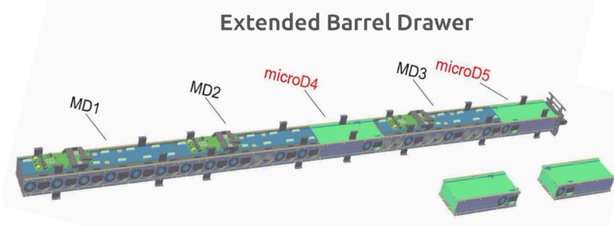
Upgrade Calorimeters for HL-LHC

- **CMS ECAL** by R. Gargiulo
  - Barrel (endcap to be replaced with HGCal), crystal + APDs stay in place, electronics fully renovated
  - Fast shaping, low noise, excellent timing and energy resolution
- **ATLAS LAr Calorimeter** by S. Menke
  - LAr+Pb for ECAL, LAr+Cu for HCAL endcap, and LAr+Cu(W) for forward
  - Detector remains unchanged, electronics upgraded for new the trigger and DAQ system and for radiation tolerance: digital trigger, precise timing information
- **ATLAS Tile Calorimeter** by M. Haviernik, S. Kandel, G. Eigen
  - New electronics and mechanical design; PMTs most exposed replaced



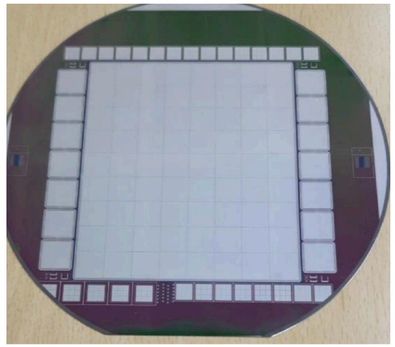


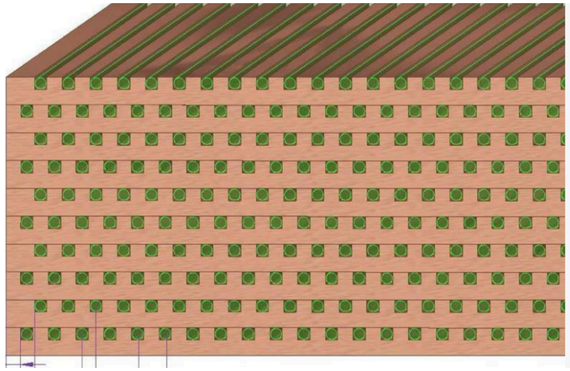




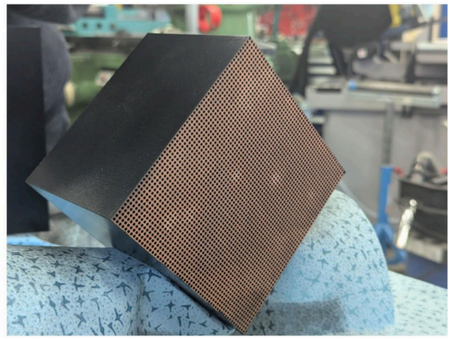
Upgrade Calorimeters for HL-LHC

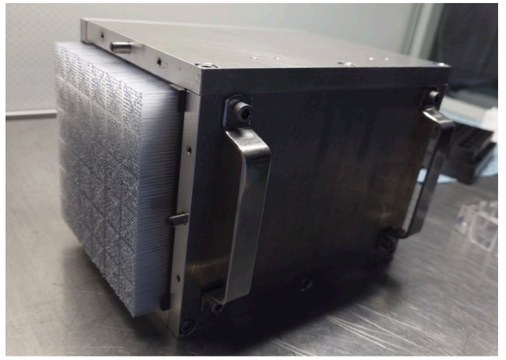
- **ALICE Forward Calorimeter (FoCal)** by H. Kano
  - New forward calorimeter: high-granularity Si+W sampling calorimeter for ECAL, and scintillating fiber + Cu + SiPM spaghetti HCAL
  - Test beam results confirmed good performance; mass production and final reviews ongoing
- **LHCb SpaCal (ECAL)** by M. Salomoni
  - In LS3, center part of ECAL becomes spaghetti calorimeters (SpaCal): scintillating fibers + W/Pb, single-sided readout
  - Energy resolution $\sigma(E)/E = 11.0\,\%/\sqrt{E} \oplus 1.2\,\%$ and timing resolution of 20ps above 40GeV
- **LHCb PicoCal (LS4 Upgrade II)** by A. Bordelius
  - SpaCal-W plastic fibers replaced with crystal (GAGG) fibers; double-sided readout and timing information with new electronics

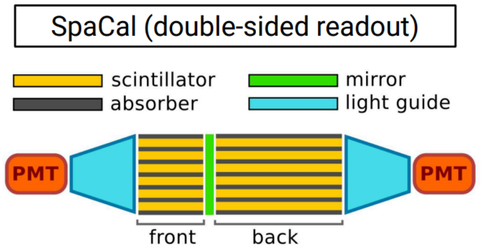


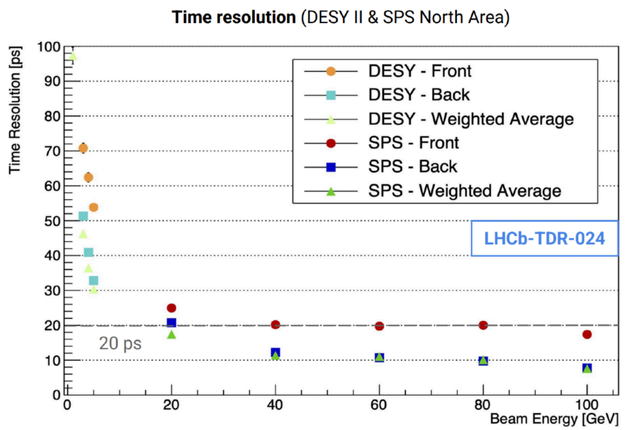


Finished absorber



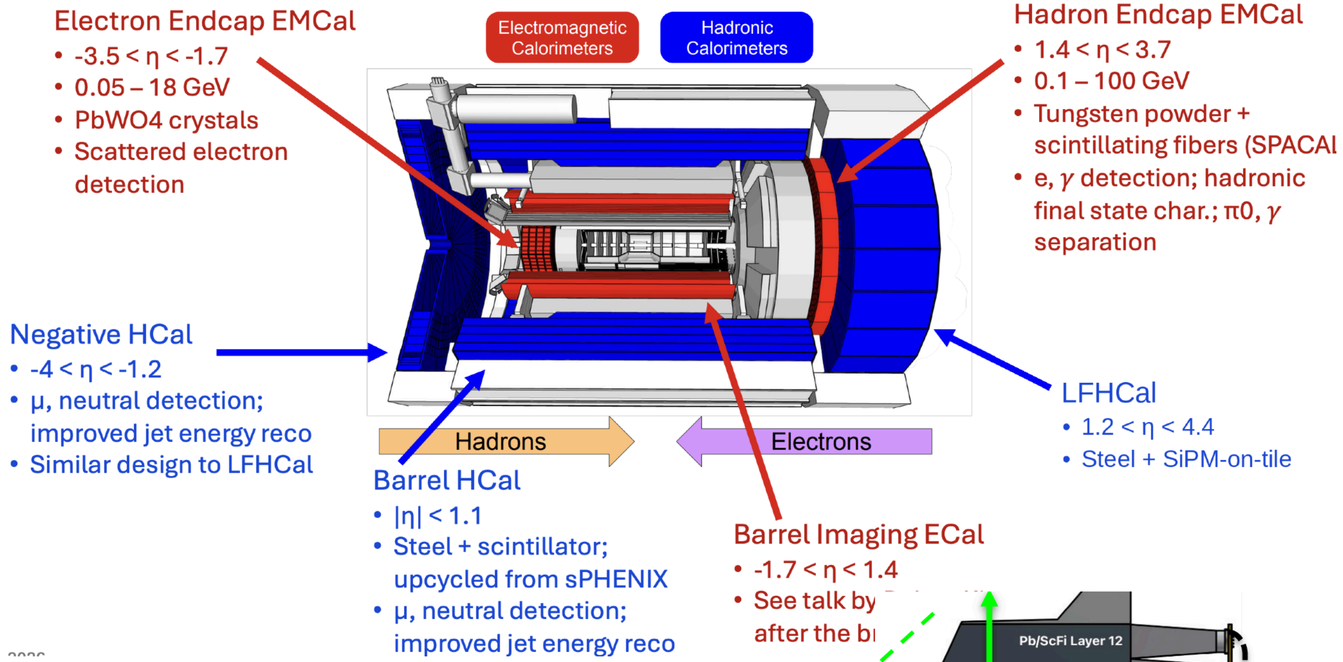


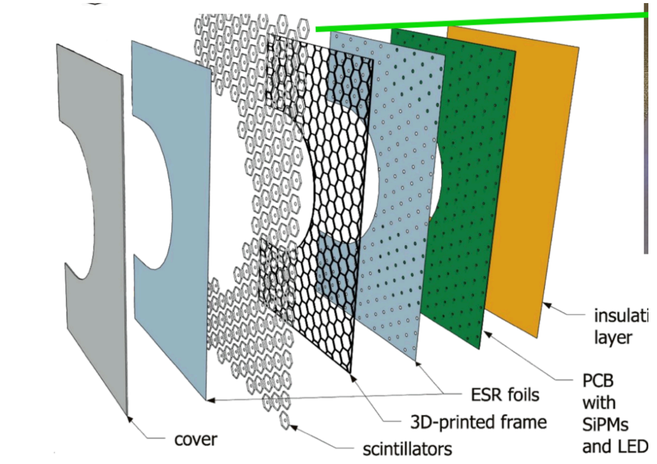


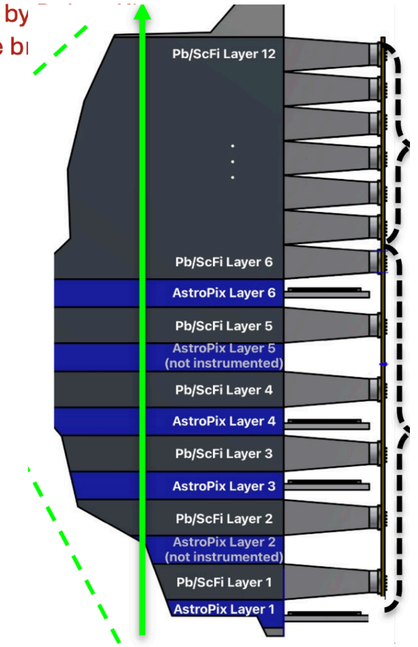


Calorimeters @ ePIC/EIC

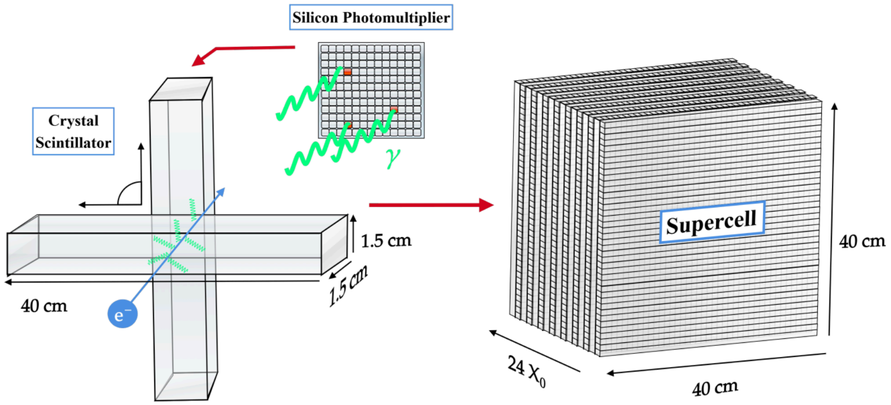
- **ePIC Longitudinally-segmented Forward HCAL (LFHCAL)** by E. Pottebaum
  - Steel + scintillator, SiPM-on-tile
  - Prototypes assembled; beam tests in 2025 and 2026. Preparation for the final design review
- **ePIC Barrel Imaging Calorimeter (BIC)** by B. Kim
  - Pb+SciFi sampling calorimeter with two-sided SiPM readout + AstroPix MAPS imaging layers
  - Pb+SciFi and AstroPix performance demonstrated; more beam tests planned for the final design review



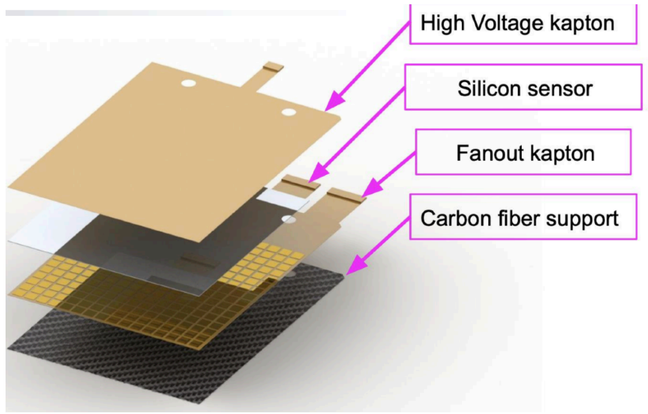




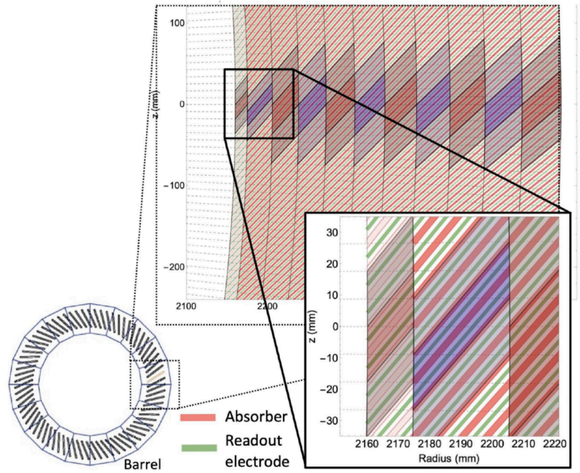
Calorimeters @ Future Colliders



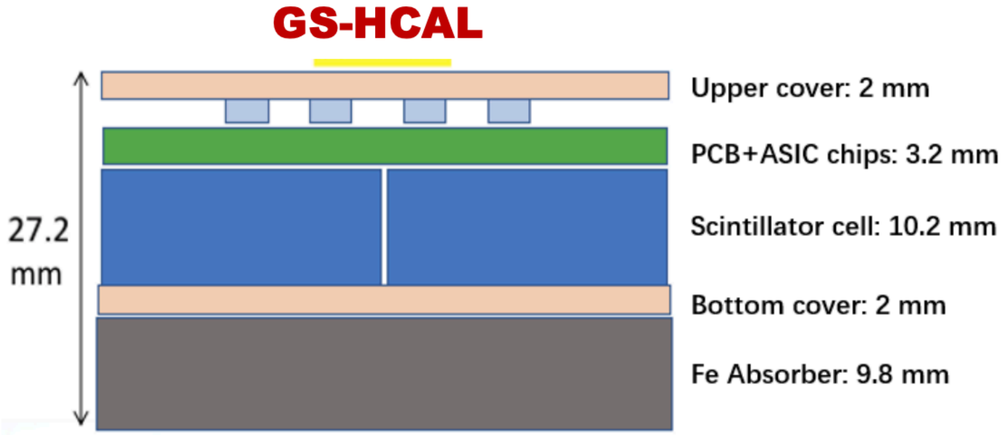
High-granularity crystal ECAL (by J. Rolph)



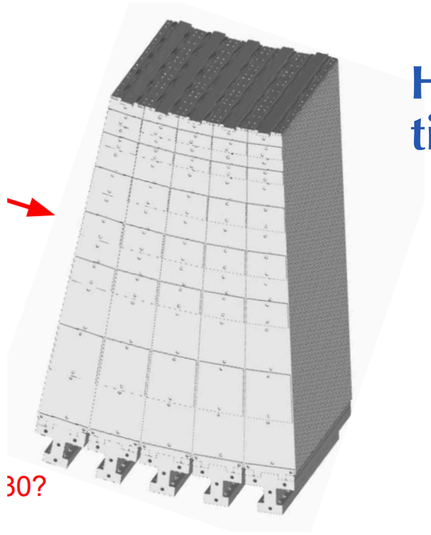
High-granularity Si-W ECAL (by R. Poeschl)



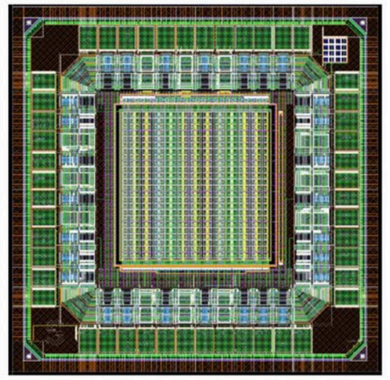
High-granularity Noble Liquid Calorimeter (by J. Faltova)



High-granularity glass-scintillator HCAL (by Y. Heng)



High-granularity scintillation tile HCAL (by M. Soldani)

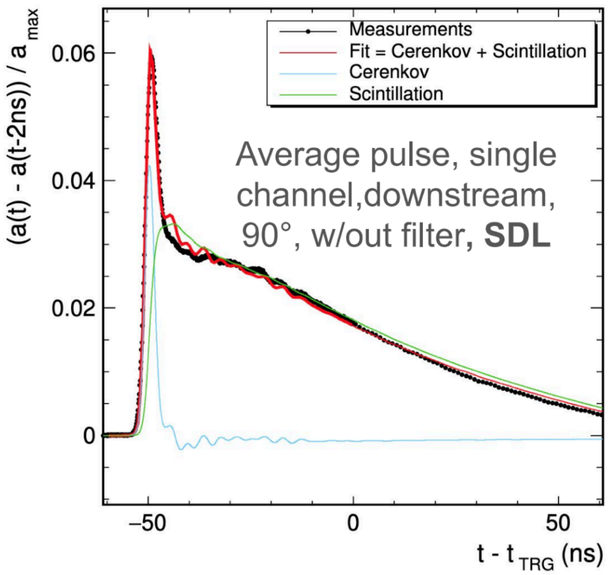


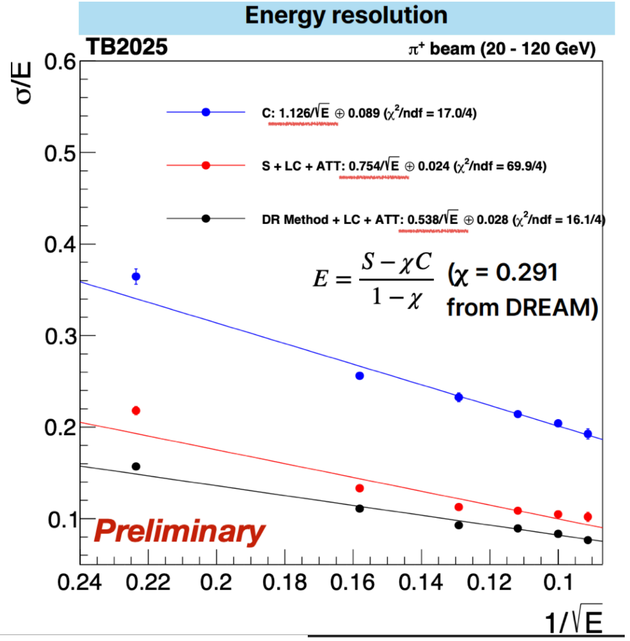
Layout for WP1.2 2022

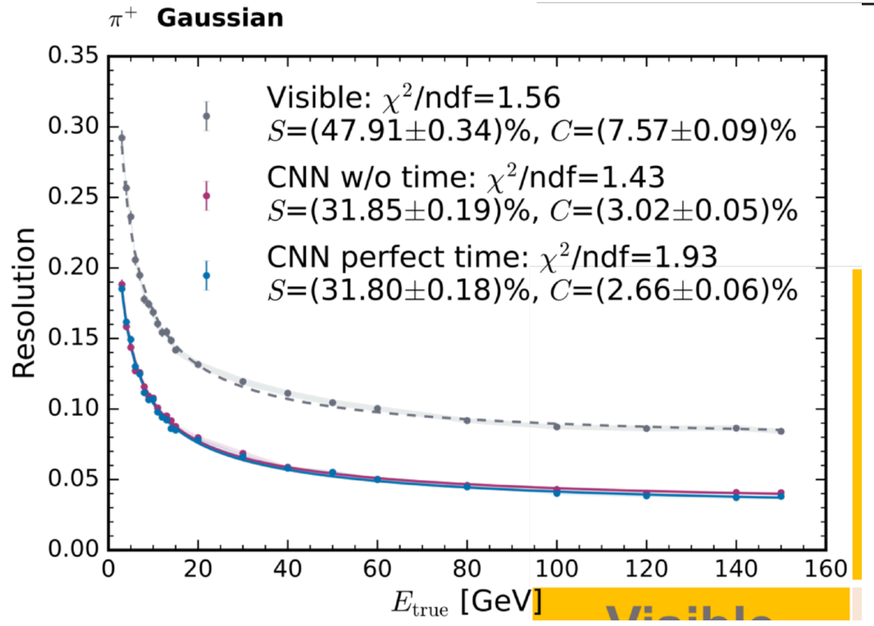
MAPS ECAL (by J. Brau)

Calorimeters @ Future Colliders

- **Dual-readout calorimeters (by A. Pareti, K. Lee, G. Cummings, Y. Feng, W. Jin)**
  - Crystal ECAL + fiber HCAL
  - ECAL: testing different crystals; waveform analysis for ECAL to separate C vs S
  - HCAL: testing absorbers, fibers, and readout; also exploring timing information
- **Algorithms:**
  - 5D calorimetry information for particle flow: particle ID, software compensation, reduced confusion, jet energy resolution and identification
  - 5D calorimetry and PF by R. Poeschl
  - π^0 vs photon separation by Y. Lee

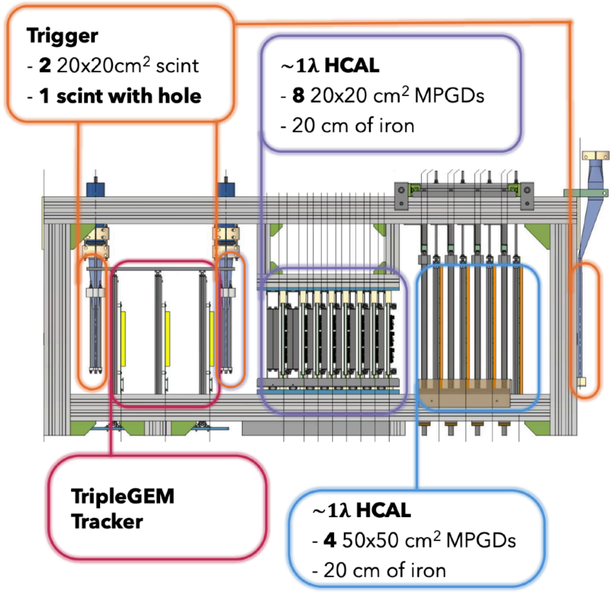


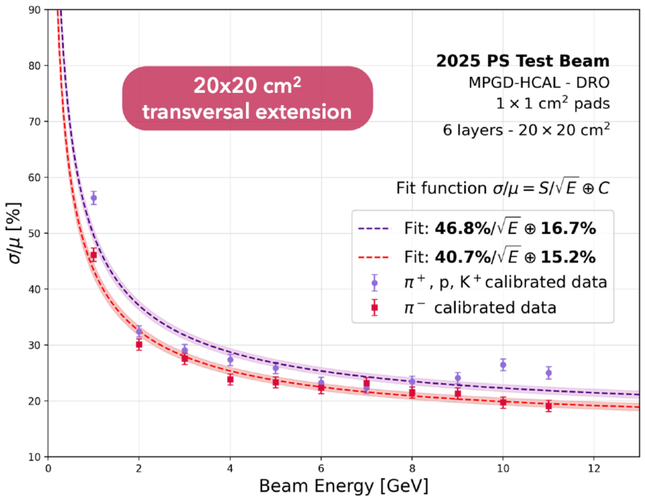


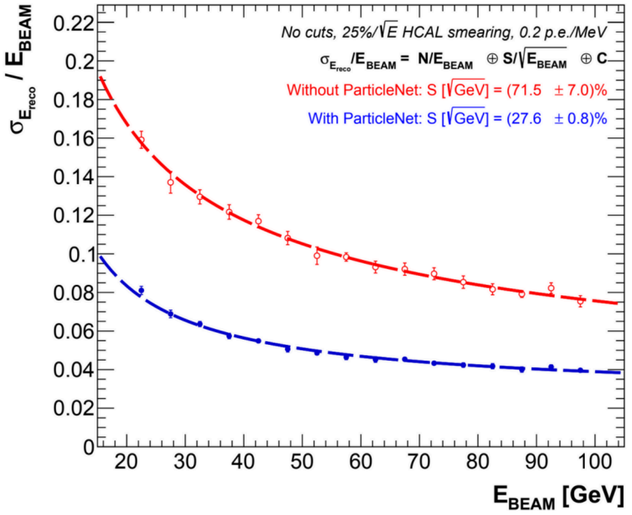


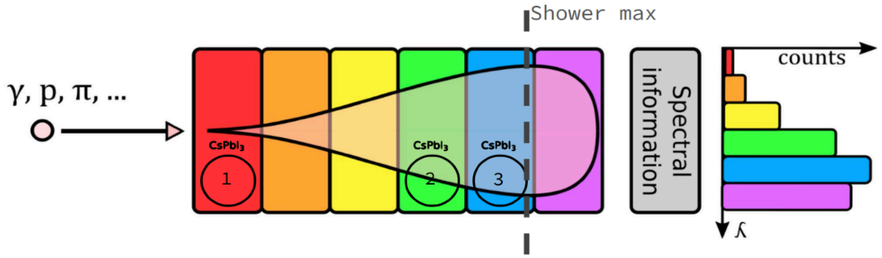
More R&D

- **MAGiCAL: Sampling hadron calorimeter based on Resistive Micro Pattern Gaseous Detectors (MPGD)** by L. Generoso
  - MPGDs (sensors) + Iron (absorber) + Semi-digital readout
- **CRILIN @ e^+e^- colliders** by R. Gargiulo
  - Crystal+SiPMs, ~20ps timing
  - Software compensation with AI/ML by measuring shower shapes
- **Chromatic calorimeter using nanocomposite scintillators** by M. Salomoni



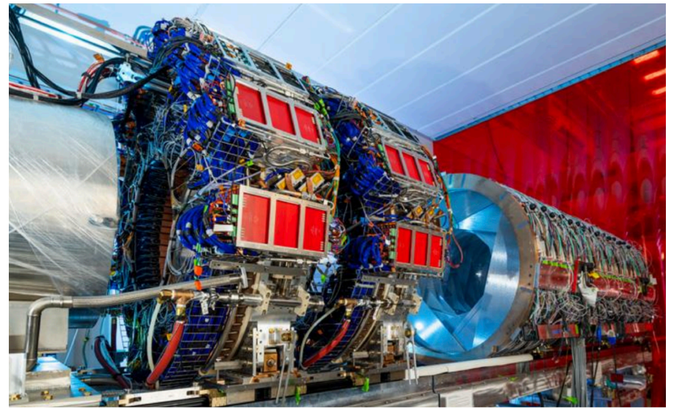




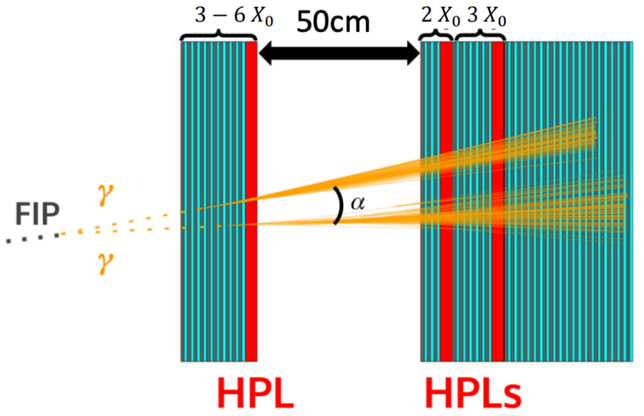


Beyond Colliders

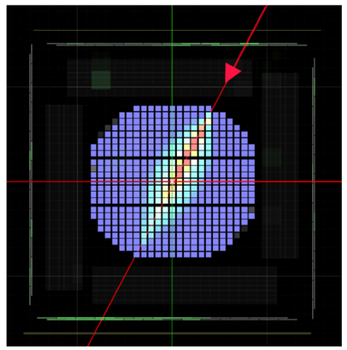
- **ECAL @ Mu2e experiment** by L. Crescimbeni
  - CsI crystal + SiPM readout
  - Used for PID, seeded track finder, and trigger
  - System installed and first results look good: expect <100ps timing resolution and ~6% energy resolution at 100MeV

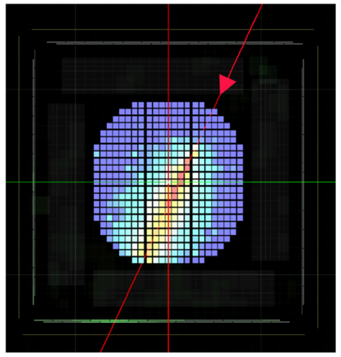


- **High-granularity pointing ECAL @ SHiP** by S. Ritter
  - Sampling ECAL: plastic scintillator strips + lead absorber + SiPM readout
  - Need excellent pointing resolution to reconstruct the decay vertex of neutral particles



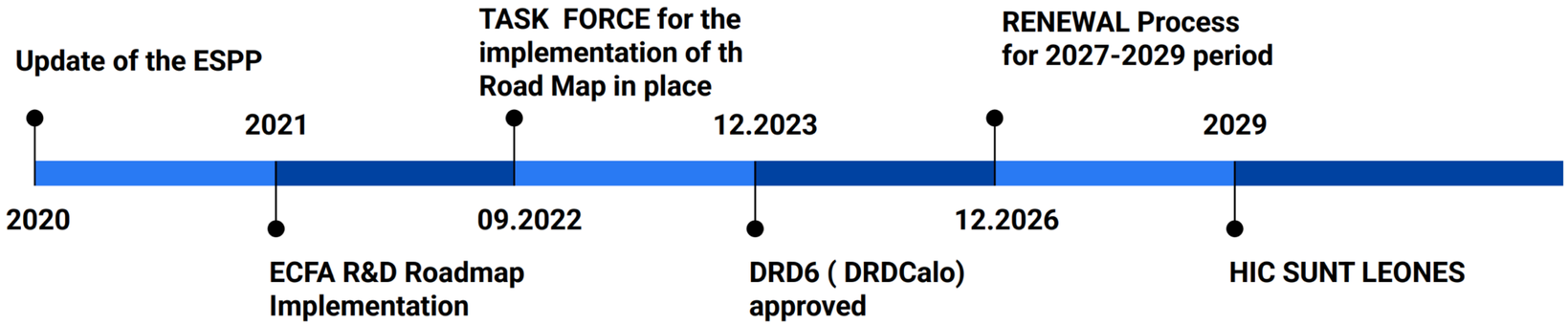
- **HERD calorimeter** by P. Betti
  - LYSO crystals + photodiodes on the China Space Station (~2029), for high energy cosmic rays (High Energy cosmic Radiation Detection)

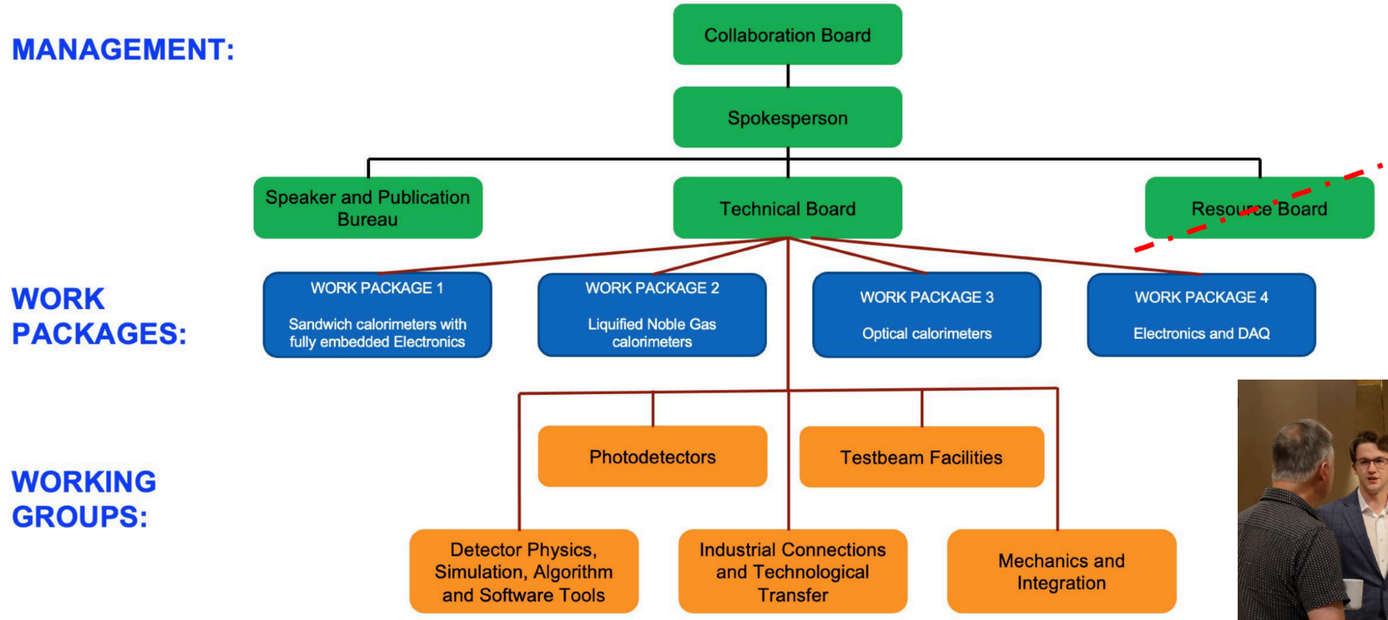




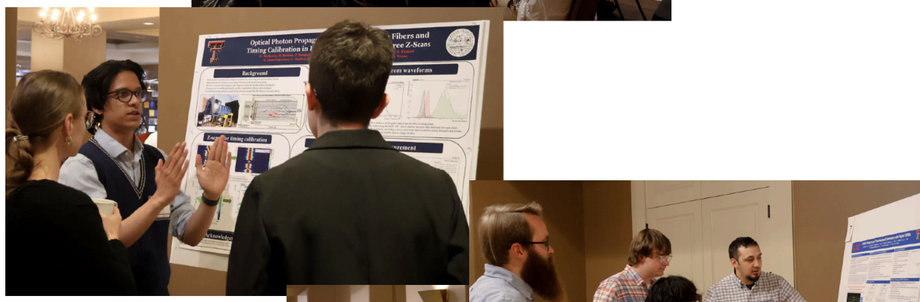
Collaborations and Interactions

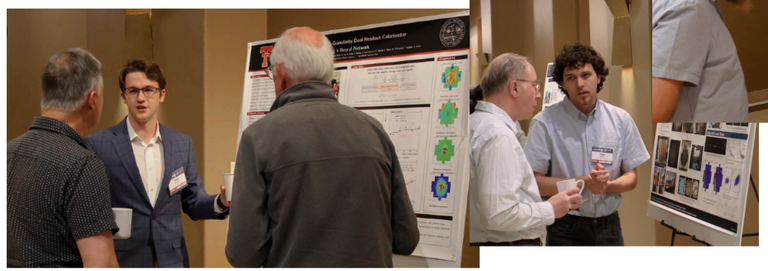
- DRDCalo meeting, and overview and highlights of DRDCalo











Summary

- **Run-3 is finishing**
  - LHC calorimeters stayed above 99% efficient, with aging effects measured and corrected at (sub)percent level
- **HL-LHC upgrades are in production**
  - ASICs are made, boards and modules are being built, and installation runs 2027-2029
- **ePIC for EIC is coming**
  - Forward SiPM-on-tile HCAL, barrel Pb/SciFi + MAPS imaging calorimeter
  - Many synergies between NP and HEP, especially on detector/calorimeter
- **Calorimeters for future colliders and experiments are maturing**
- **Timing is now a “standard” observable**
  - Per-hit timing information for clustering, and per-shower information for particle and higher-level reconstruction
- **AI/ML and new materials widen the design space**
  - GNN/CNN reconstruction, scintillating glass, oriented crystals, etc.

CALOR 2026, Santa Fe

