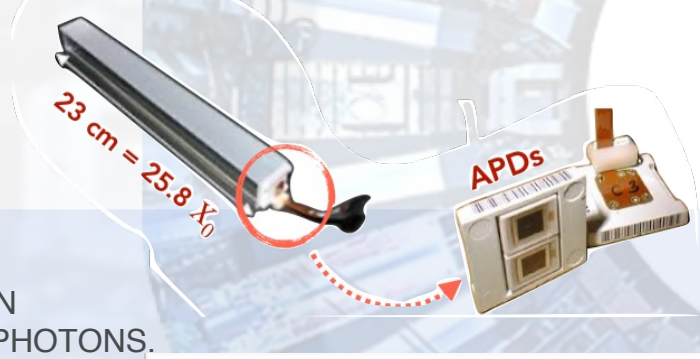
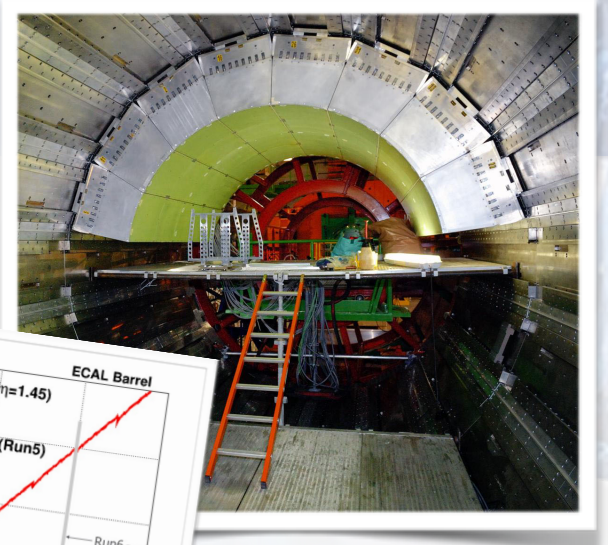
CMS ECAL UPGRADE

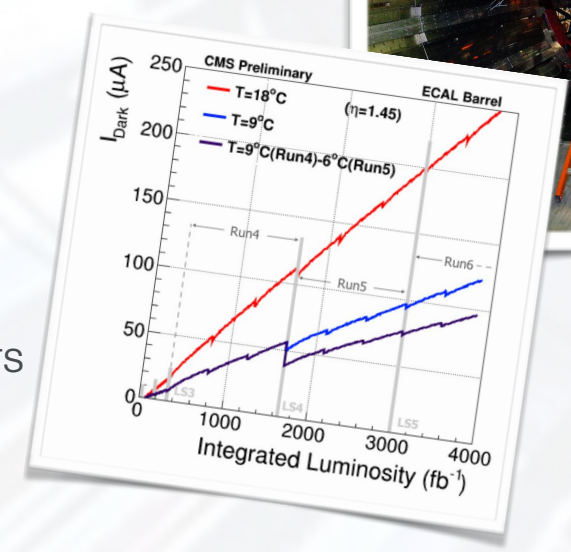


THE CMS ELECTROMAGNETIC CALORIMETER (ECAL) IS A HERMETIC, HIGH-RESOLUTION DETECTOR DESIGNED TO MEASURE THE ENERGY AND POSITION OF ELECTRONS AND PHOTONS. IT CONSISTS OF 75,848 **SCINTILLATING LEAD TUNGSTATE CRYSTALS**.
THE BARREL SECTION, WITH 61,200 CRYSTALS, IS READ OUT BY AVALANCHE PHOTODIODES (APDS) OPERATING AT A GAIN OF ABOUT 50.



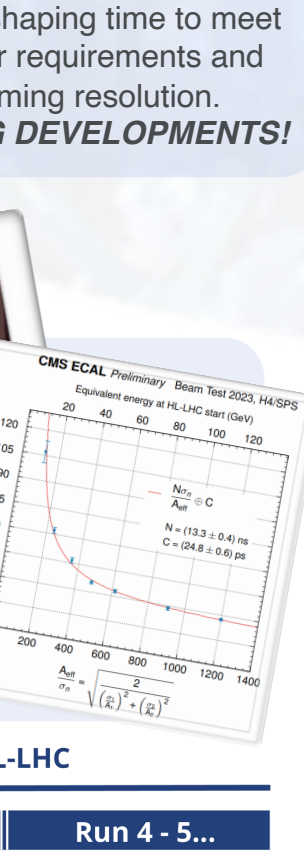
CHALLENGES for HL-LHC

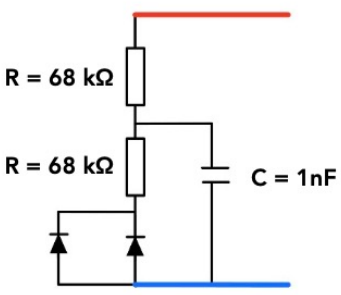
RADIATION DAMAGE (CRYSTALS, APDS, ELECTRONICS)
HIGHER PILEUP (200 COLLISIONS/EVENT)
INCREASED DARK CURRENT IN APDS
HIGH DATA RATES AND TRIGGER REQUIREMENTS



ELECTRONICS UPGRADE

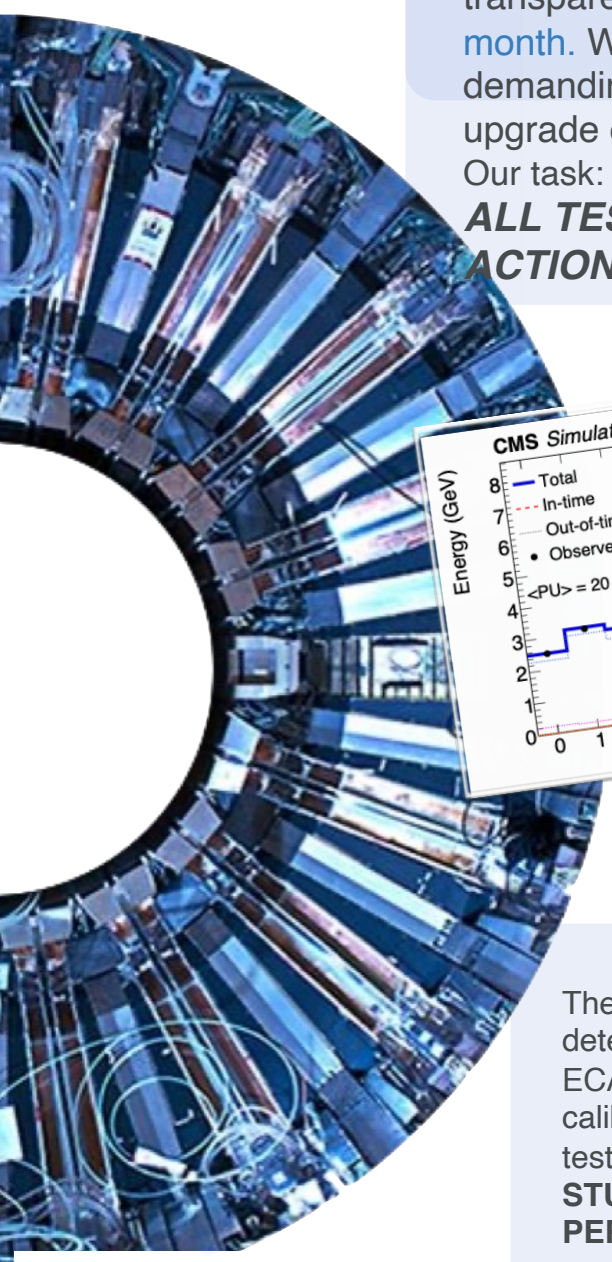
NEW FRONT-END ELECTRONICS WITH LOW-NOISE AMPLIFIERS
DIGITIZATION AT 160 MHZ WITH HIGH DYNAMIC RANGE
NEW HIGH VOLTAGE SYSTEM FOR APDS
IMPROVED CALIBRATION & MONITORING SYSTEMS
ENHANCED TIMING CAPABILITIES FOR PRECISION MEASUREMENTS

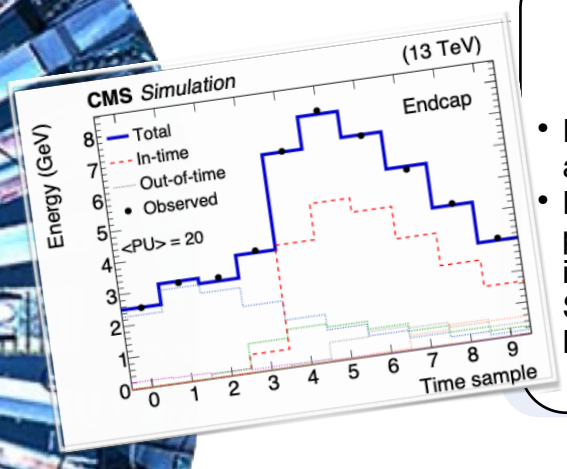




HV SYSTEM

ECAL's excellent energy resolution requires stable high voltage, temperature, and transparency, each contributing <0.2%. The HV system must stay within 60 mV over a month. With HL-LHC, APD dark current will rise from ~5 μA to ~200 μA per capsule, demanding an upgrade. In collaboration with CAEN, the Rome group is leading the upgrade of the HV system.
Our task: calibrate, test, and validate the new boards to ensure top performance.
ALL TESTS ARE CARRIED OUT IN OUR ROME LAB — COME AND SEE IT IN ACTION!





STANDARD MULTIFIT

- Extracts energy in a 5x5 crystal matrix
- Handles moderate pileup (up to ~50 interactions). Sampling at 40 MHz

HL-LHC MULTIFIT

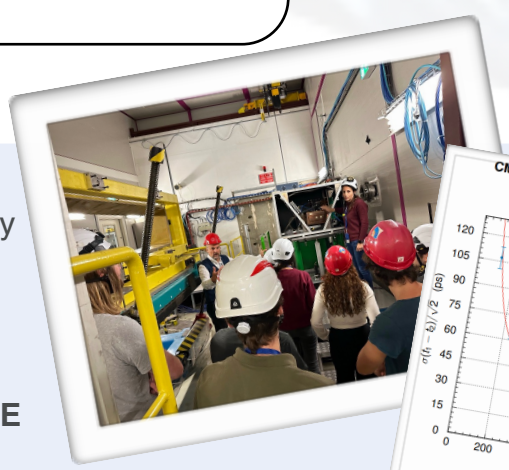
- Can extract energy, timing, discriminate APDs background for each crystal
- Optimized for extreme pileup (**~200 int / BX**)
- Works with upgraded electronics at **160MHz** sampling
- Ensure ECAL maintains high energy resolution in HL-LHC conditions

AMPLITUDE reconstruction

Reduced shaping time to meet new trigger requirements and enhance timing resolution.
ONGOING DEVELOPMENTS!

TEST BEAMS @ CERN

The ECAL test beam campaigns are a unique opportunity to study detector performance under controlled conditions. By exposing ECAL modules to well-known particle beams, we can validate calibration strategies, measure timing and energy resolution, and test upgrades for the HL-LHC.
STUDIES OF BOTH HARDWARE BEHAVIOR AND SOFTWARE PERFORMANCE, AND HOW THEY INTERACT



Large Hadron Collider (LHC) — HL-LHC

Run 1		LS1		Run 2				LS2		Run 3			LS3	Run 4 - 5...		
7 TeV	8 TeV			13 TeV						13/14 TeV						
2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	...2038

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Join CMS for your thesis! Contact us!