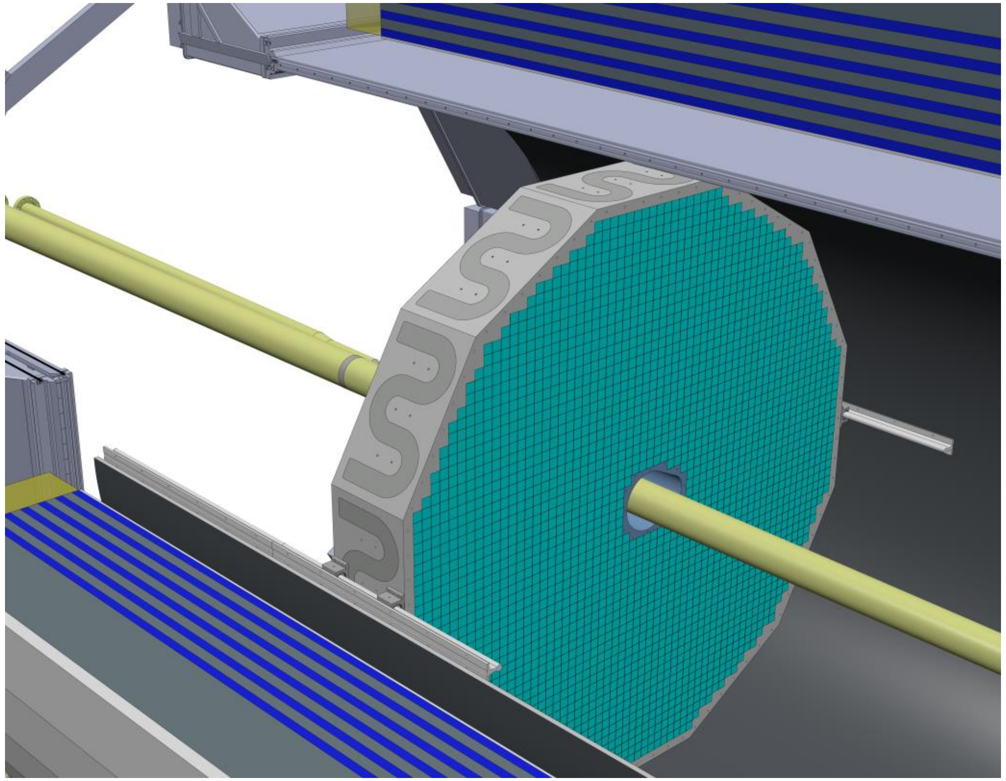


ePIC Alignment and Calibration: Calorimeter Use Case

Carlos Muñoz Camacho

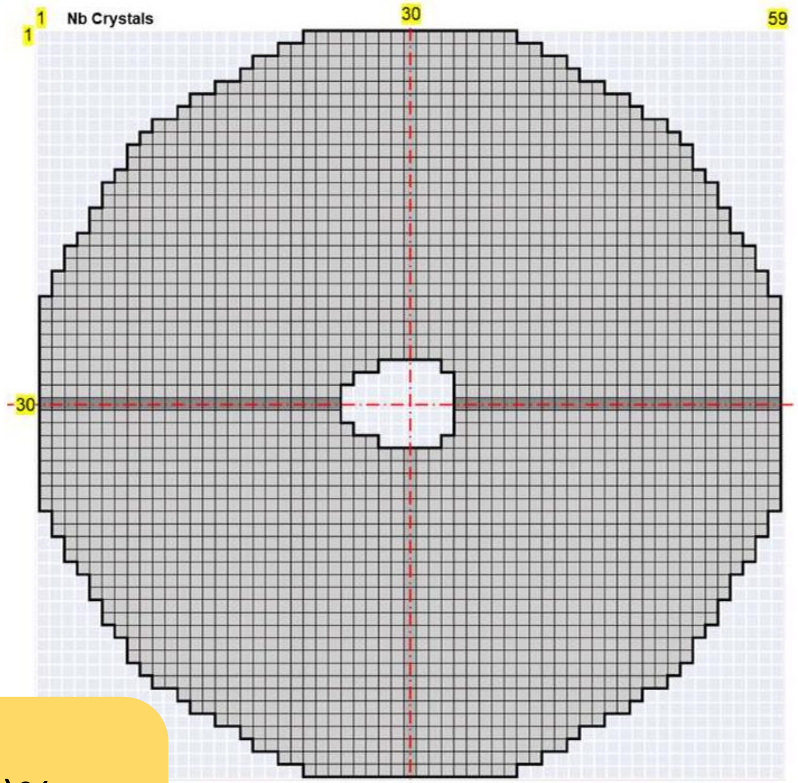
IJCLab-Orsay, CNRS/IN2P3 (France)

ePIC Collaboration Meeting

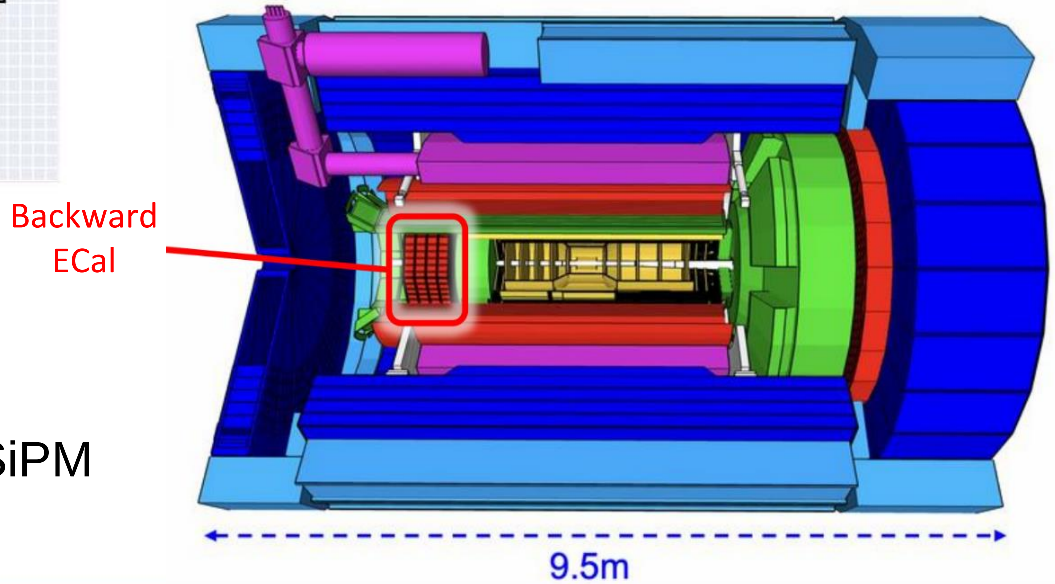
JLab, July 15 (2025)

Backward ECal in ePIC

- ~3000 PWO crystals
- SiPM readout
- Cooling
- LED monitoring



High resolution in the forward region (endcap) can only be achieved with homogeneous materials, such as crystals



Requirements:

- Energy resolution: 2%/√E + (1-3)%
- Pion suppression: 1:10^4
- Minimum detection energy: > 50 MeV

Technology choice: PWO crystals (2x2 cm^2) with high density SiPM (16 3x3 mm^2 or 4 6x6 mm^2 per crystal)

Backward ECal calibration

Will use physics processes/particles to best determine

calibration coefficients their evolution with time

- Single electrons:
  - Relies on tracker (calibration, accuracy…)
  - May not be possible for all crystals

- Neutral pion decays: $\pi^0 \to \gamma\ \gamma$
  - **Very clear signal – no need of other detectors**
  - Invariant mass of π^0 used for calibration, but non-linear procedure (2 clusters per event)

- MIPs
  - Wide signal distribution
  - Relies on simulation (or independent measurement) for absolute calibration

Calibration with π^0s

- Methods successfully used with EMCals at JLab
- Based on NIM A566 (2006) 366

Basic principle:

optimize calibration coefficient to constrain the π^0 invariant mass position and minimize its width

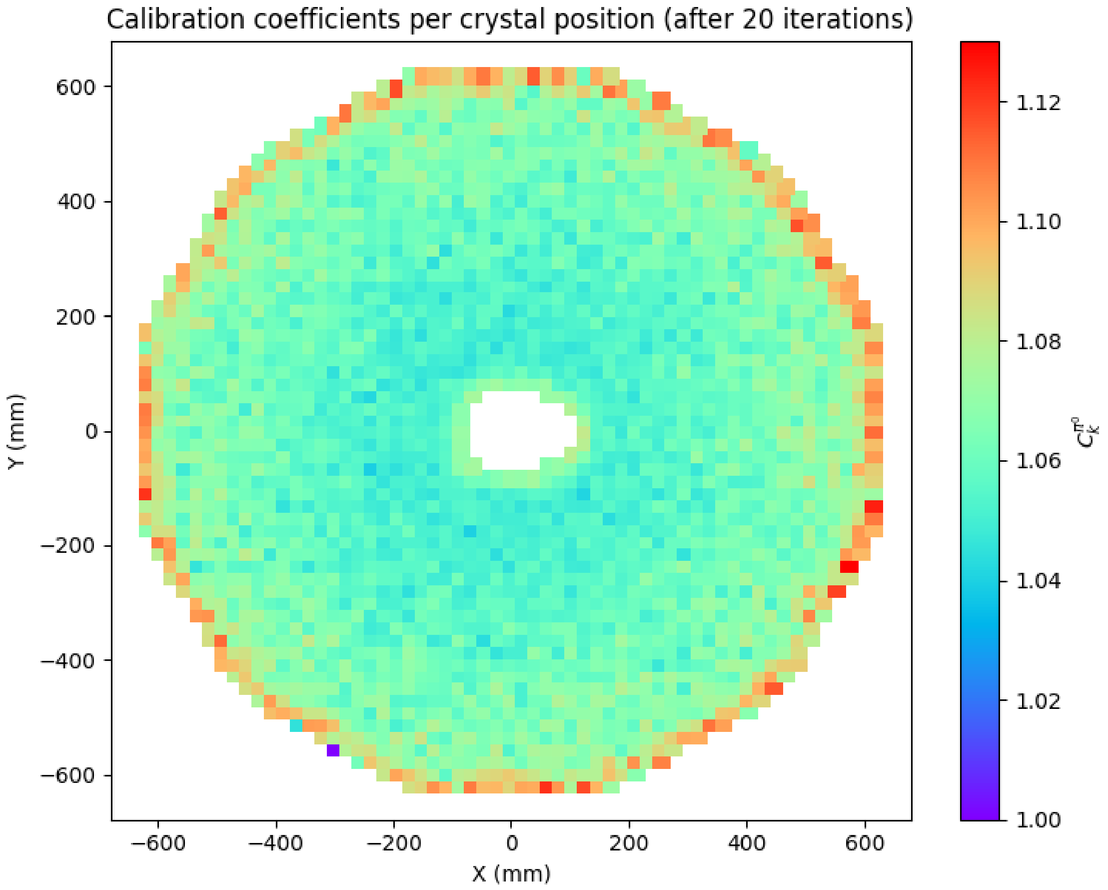
$$F = \boxed{\sum_{i=1}^{N_{events}} (m_i^2 - m_0^2)^2} + \boxed{2\lambda \sum_{i=1}^{N_{events}} (m_i^2 - m_0^2)}$$

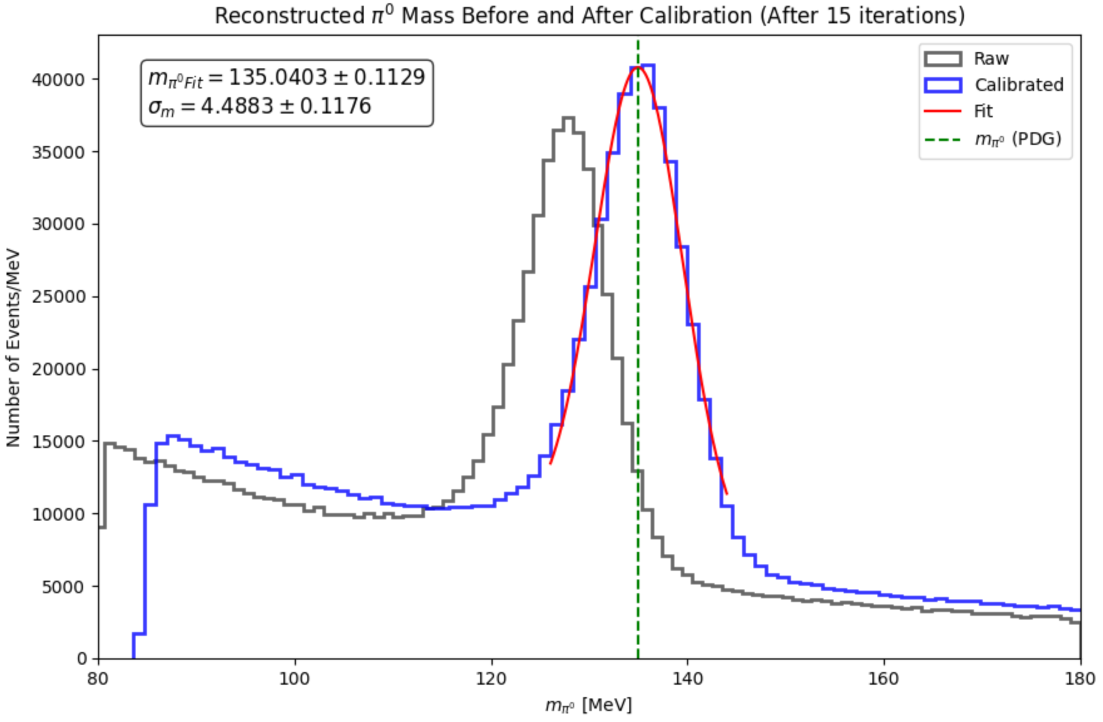
resolution term to optimize

constraint $\langle m_i^2 \rangle = m_0^2$

$m_0 = M_\pi = 0.1349766$ GeV
m_i: reconstructed $M_{\gamma\gamma}$
λ: Lagrange multiplier

SIDIS simulation at 18x275 GeV

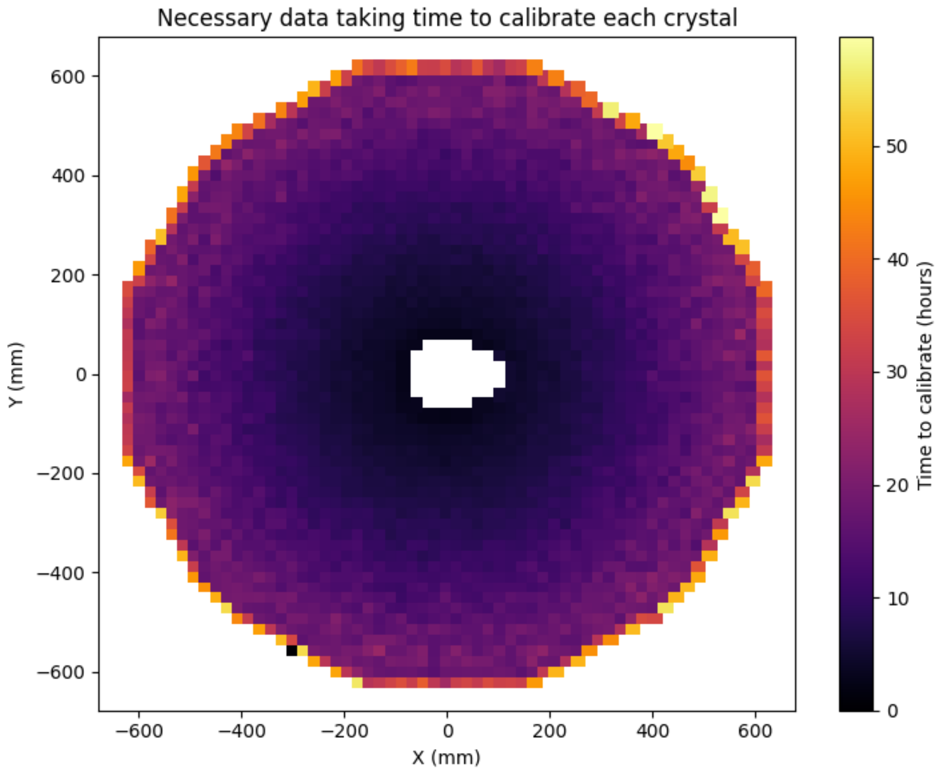




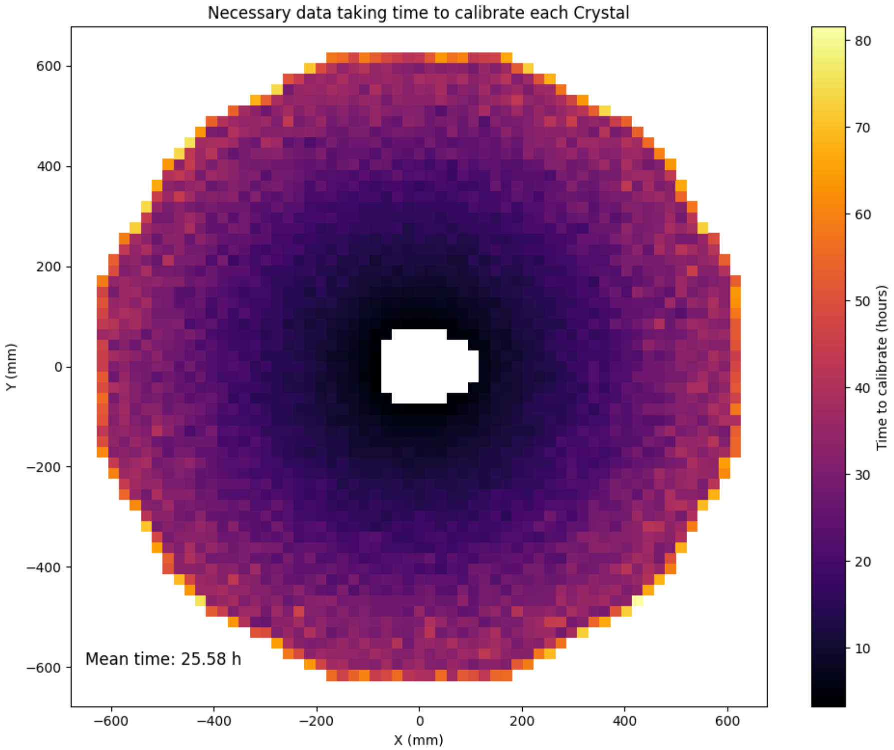
Analysis by Axel Perez Ruiz (IJCLab)

Calibration with π^0s: time required

- Number of hours needed for 1000 events/crystal
- SIDIS simulation



18x275 GeV



5x41 GeV

Analysis by Axel Perez Ruiz (IJCLab)

1-2 days of data should be sufficient

ALLEN4EIC:
A Real-Time Data Processing Framework for the ePIC Detector

Letter of Intent to the
Hadron Physics call in Horizon Europe

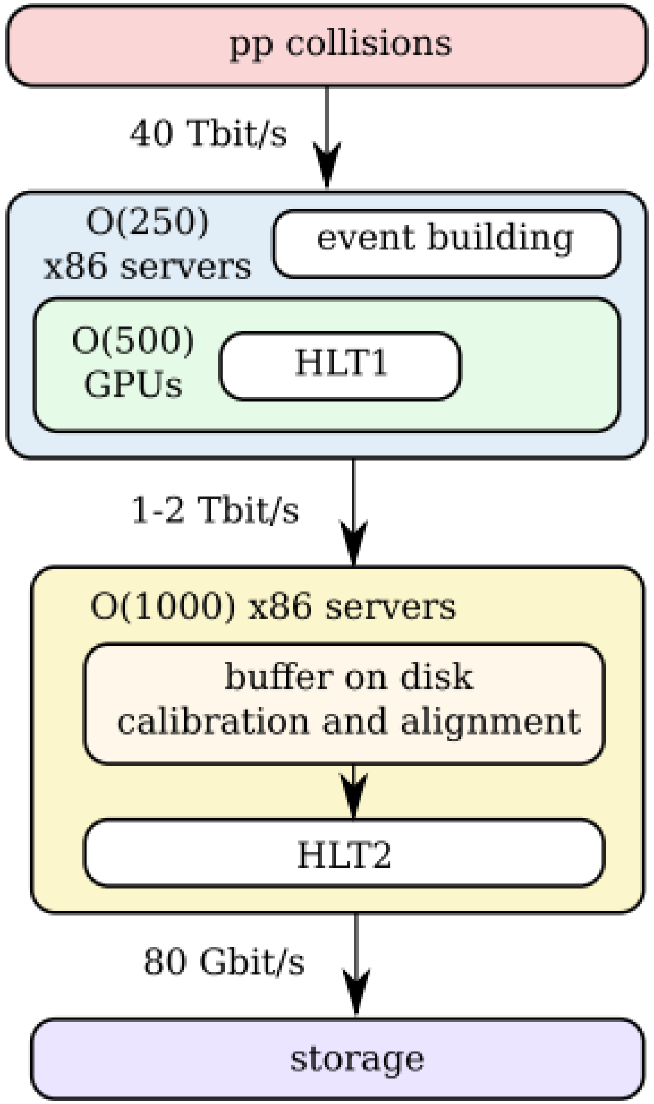
Vladimir Gligorov, LPNHE

Carlos Muñoz Camacho, IJCLab

Nantes, Jul 1-2 (2025)

Allen Framework: Proven at the LHCb Experiment

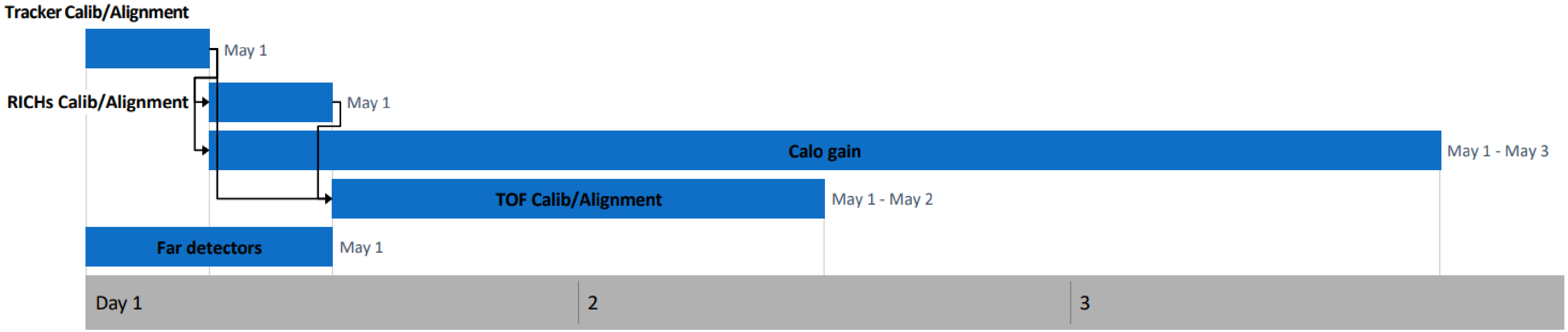
- Developed for GPU-based high-level triggering at LHCb.
- Processes 30 million events/sec using commodity GPUs.
- Cross-platform (x86, CUDA, ARM); Python + C++/CUDA.
- Includes monitoring, high energy-efficiency.



Allen replaces hardware triggers using GPUs and high-performance software. It’s portable, open-source, and energy-efficient. Perfect candidate for EIC-style real-time computing.

Adapting Allen for the ePIC Detector

- At ePIC: Allen shifts from trigger filter to real-time reconstruction tool.
- First use: calibration for the backward EM calorimeter.
- Will support ePIC data model, geometry, streaming architecture.
- Built on AllenCore (modular version, expected Q1 2026).

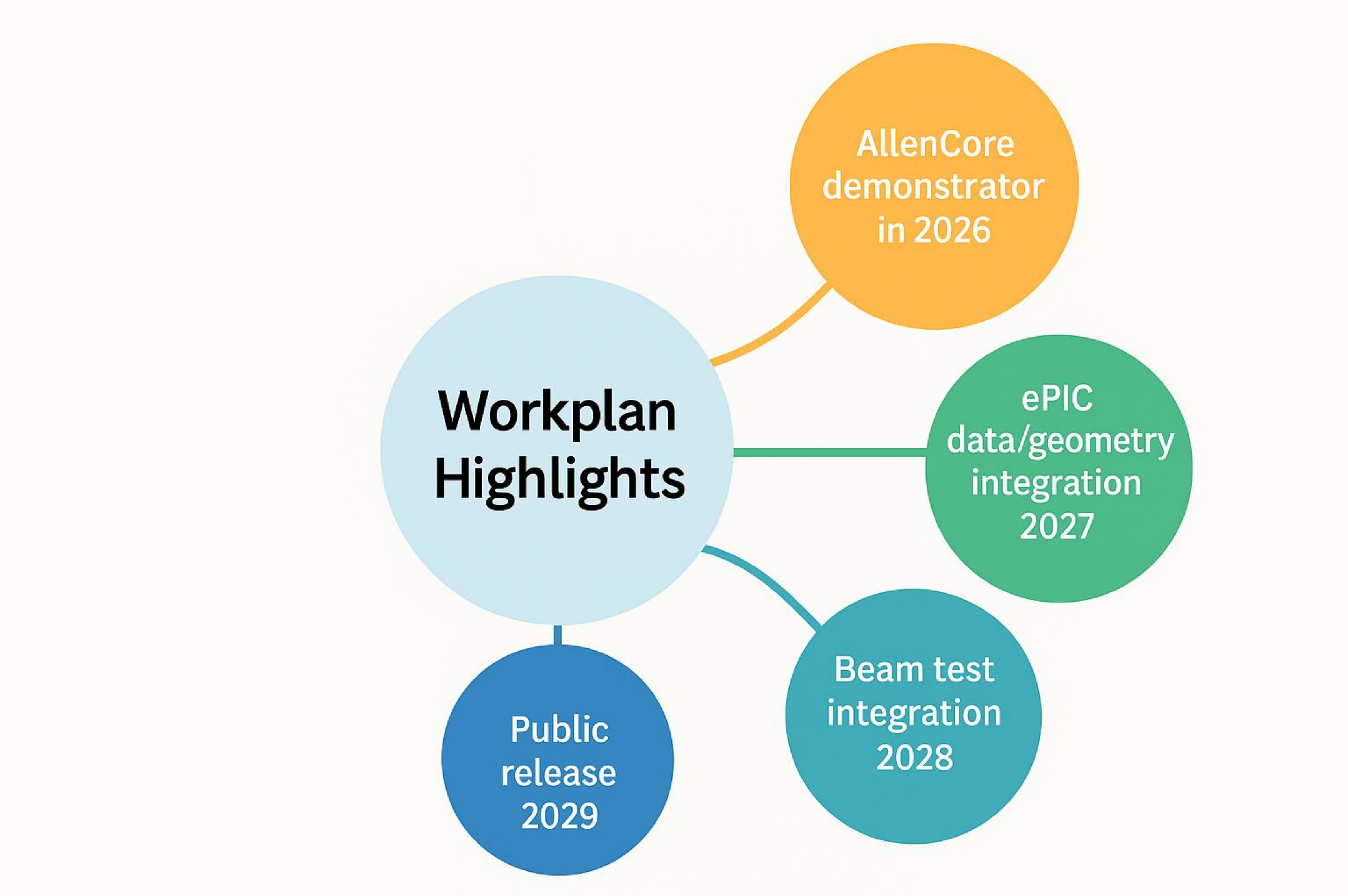


At ePIC, Allen will operate downstream, not just filtering but reconstructing and calibrating in real time, a new mode of use, but one Allen is well-suited for.

A Strong, Cross-Institutional Consortium

- IJCLab – ePIC adaptation & calorimetry
- LPNHE & CPPM – Allen developers (LHCb)
- INFN Genova – Streaming readout expertise
- CERN – AllenCore support
- Jefferson Lab – Integration and test at EIC

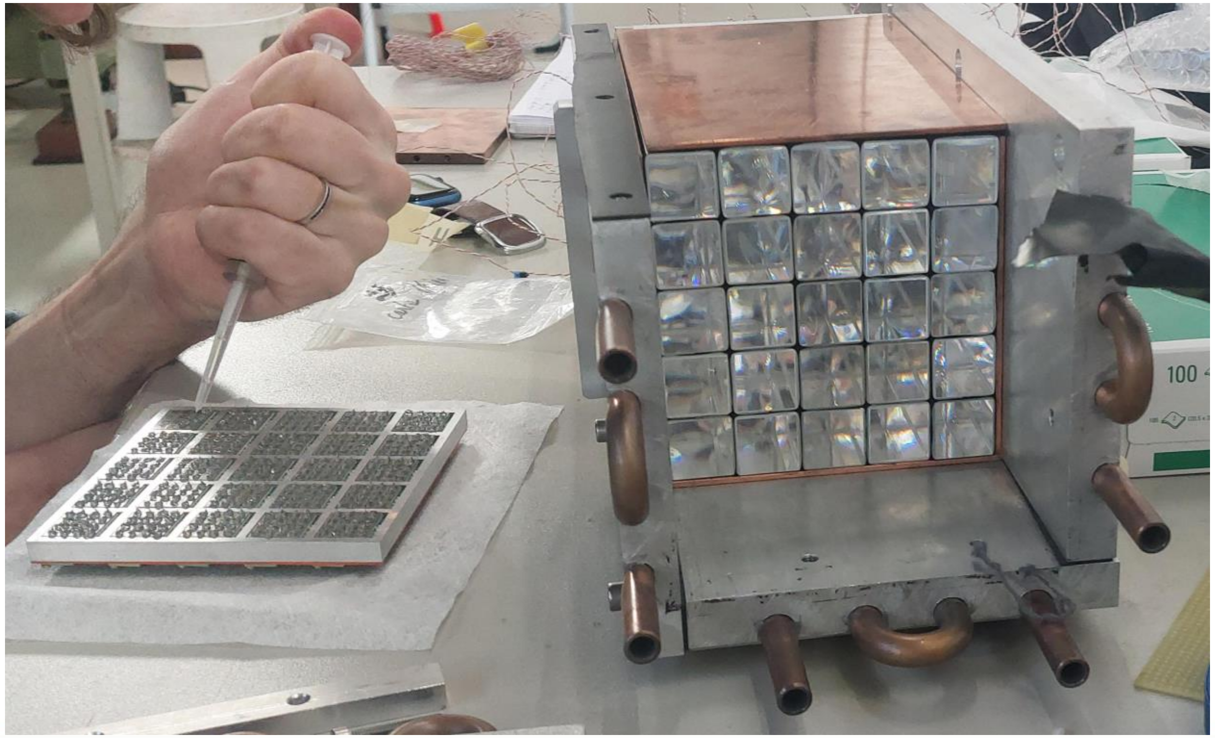
Work Plan Highlights



Backup

5x5 PWO prototype with 16 SiPMs per crystal

- 25 PWO crystals from CRYTUR
- SiPM readout
- Cooling and temp control



SiPMs: Hamamatsu S14160-3015PS
(3x3 mm^2; 15μm pixel size)