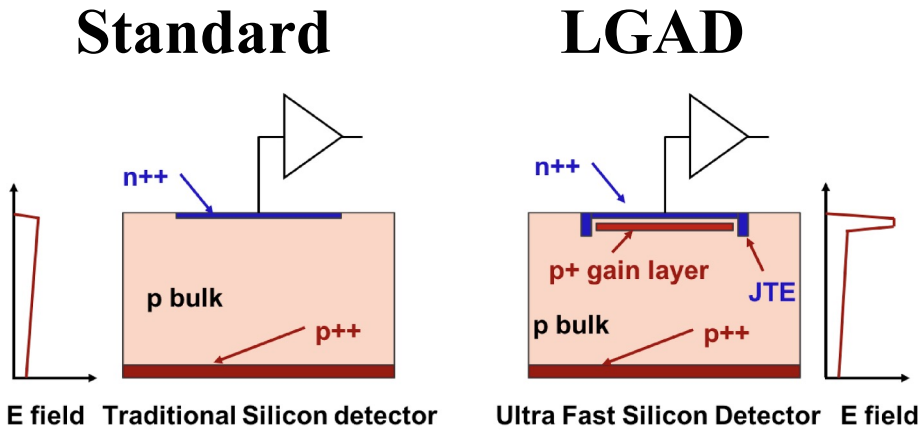
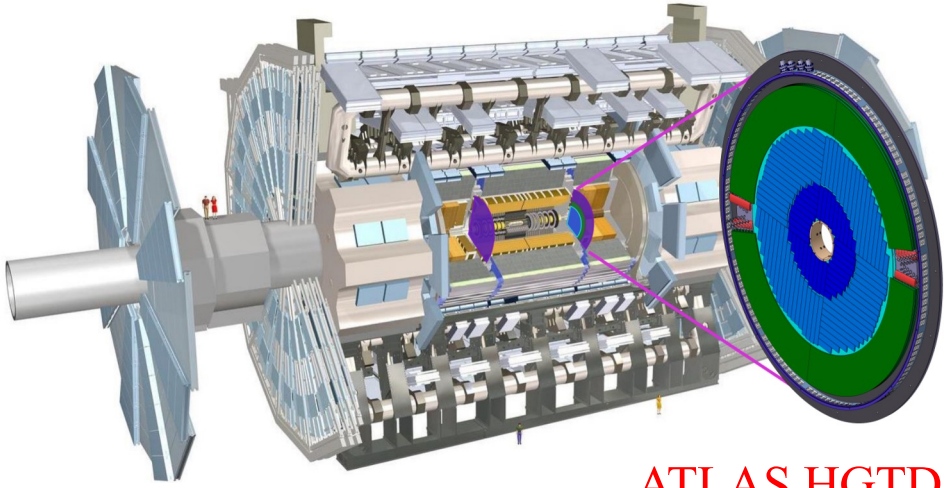
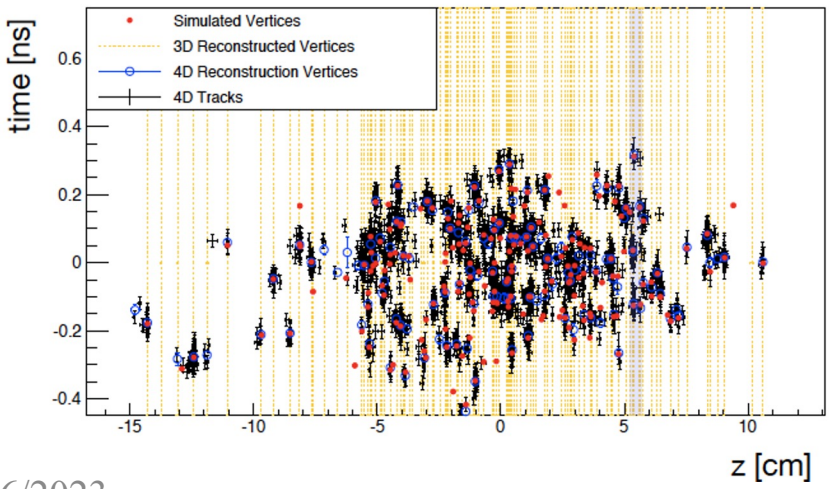
Low Gain Avalanche Diode

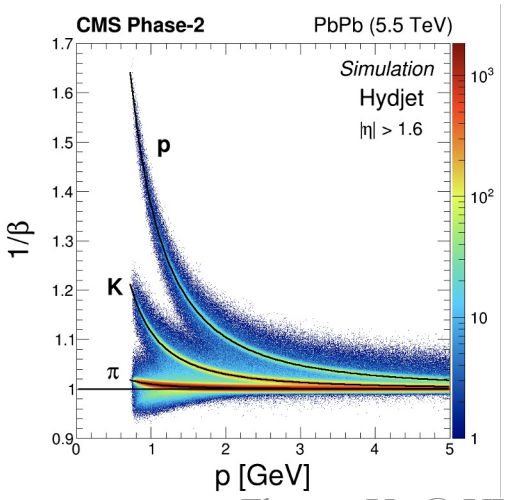
- Utilizing synergies to LGAD detectors at ATLAS (6 m^2) and CMS (14 m^2) for HL-LHC.

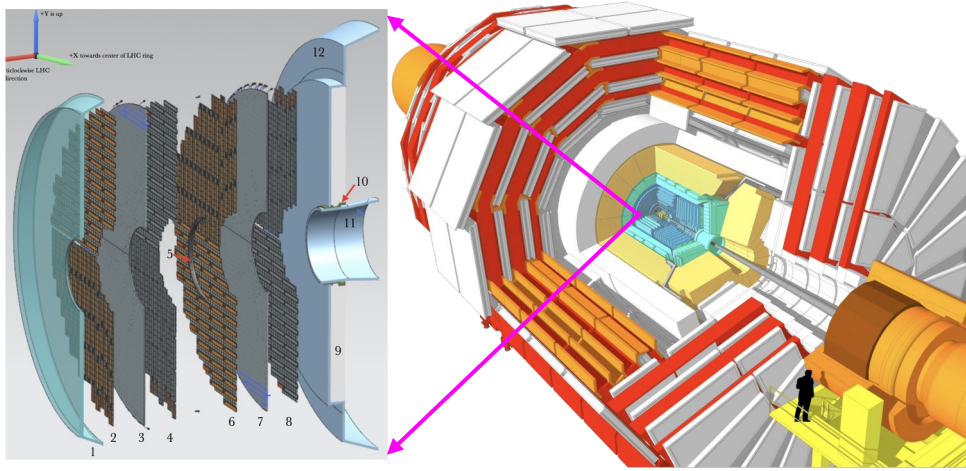




ATLAS HGTD







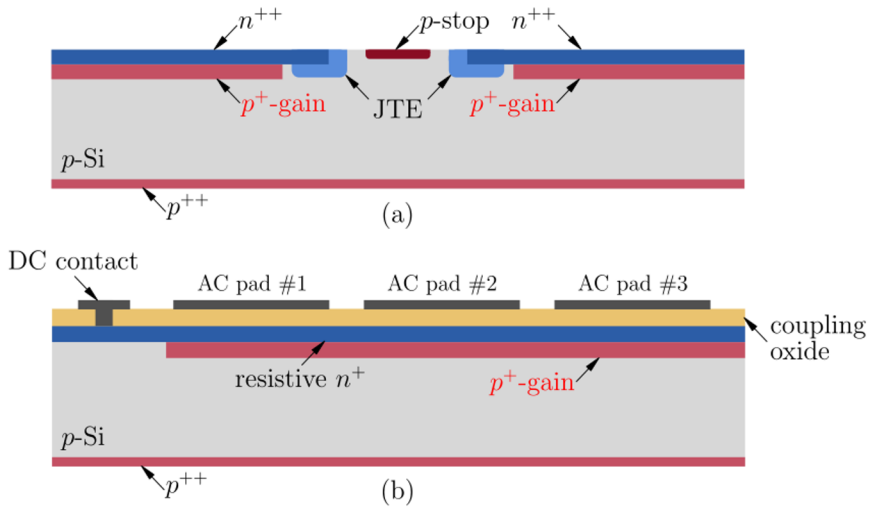
CMS ETL

AC-coupled LGAD

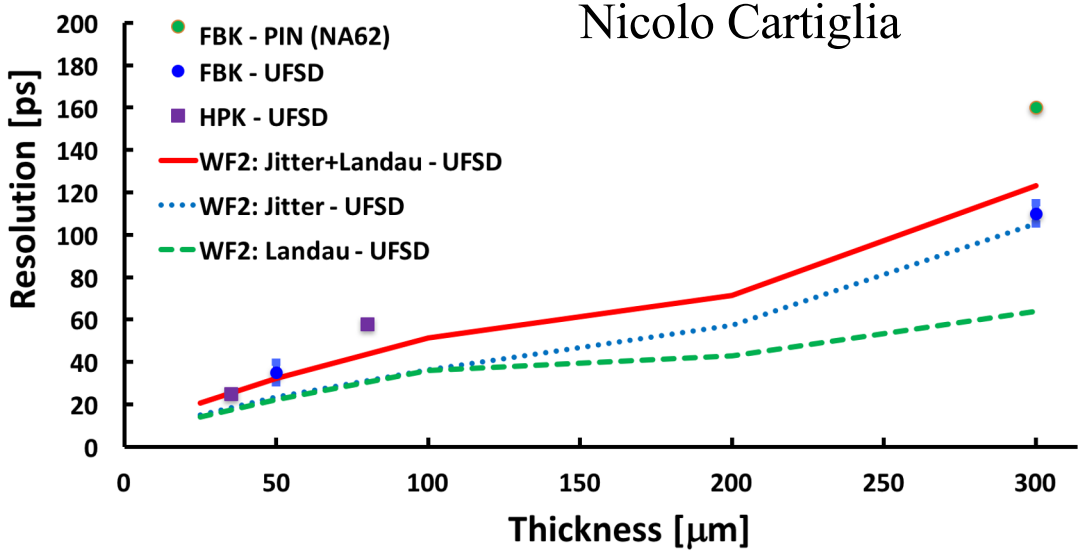
- AC-LGAD provides not only precise timing resolution, but also ~100% fill factor and much better spatial resolution than DC-LGAD.

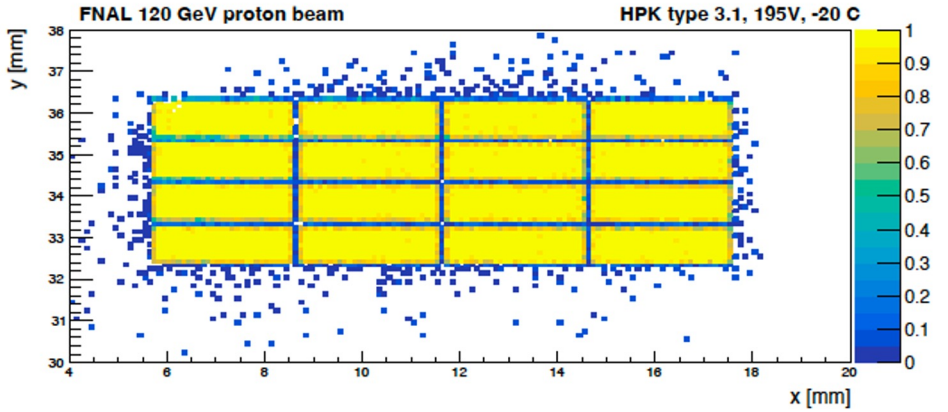
(DC-)LGAD

AC-LGAD

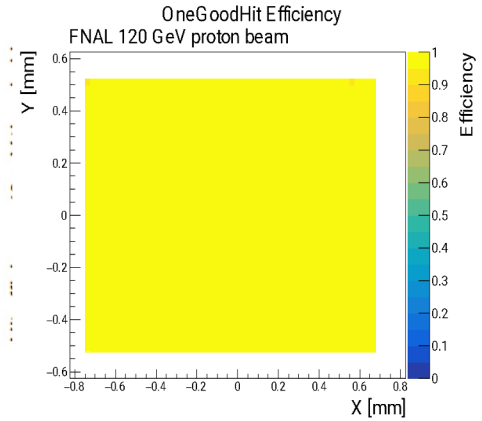


Nicolo Cartiglia

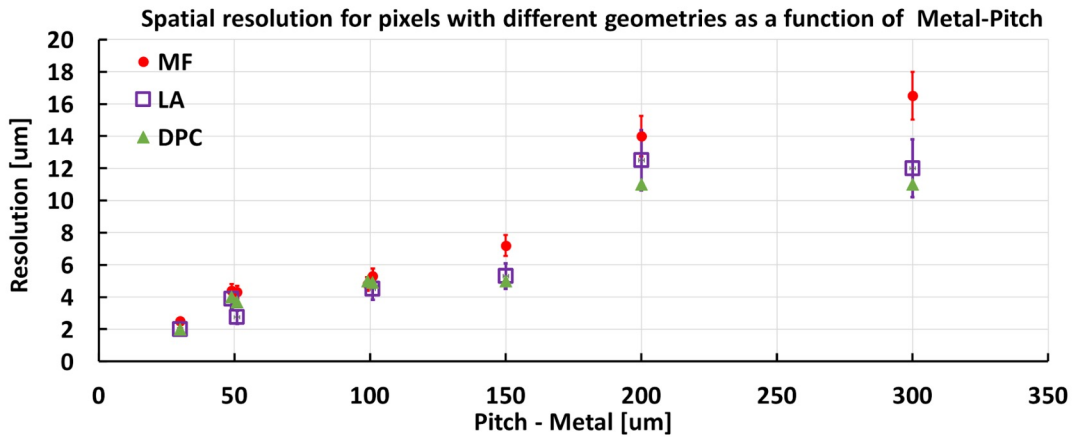




DC-LGAD



AC-LGAD



AC-LGAD Detectors for ePIC

Tracking and Vertexing:

- MAPS
- MPGD

PID:

- AC-LGAD TOF (also for tracking)
- hpDIRC
- pfRICH
- dRICH

EMCal:

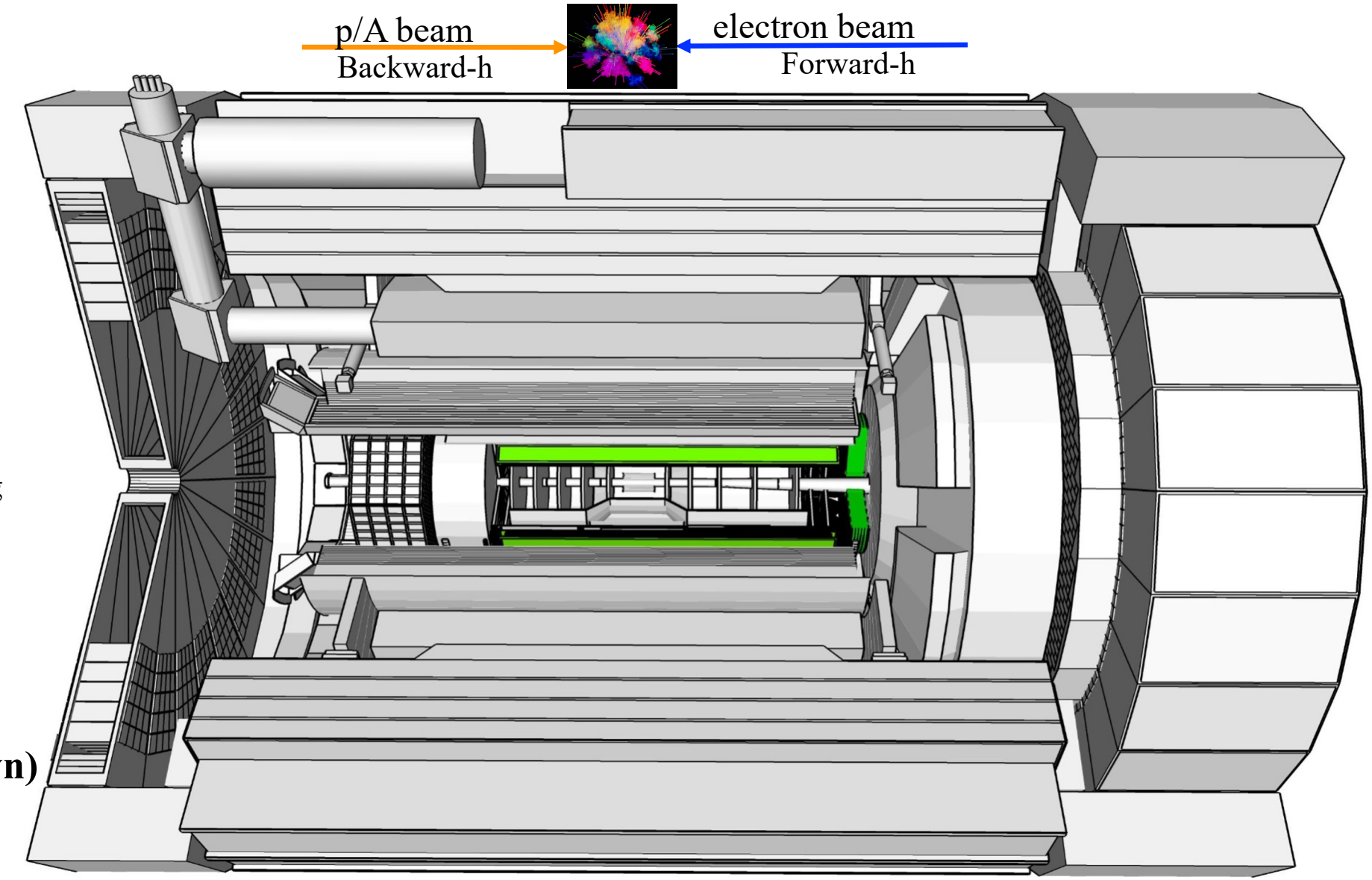
- PbWO EEMCal
- Pb/SciFi Barrel EMCal with Imaging
- W/SciFi FEMC

Hadronic Calorimeter

- Fe/Sc Backward HCAL
- Barrel HCal (sPHENIX re-use)
- Fe/Sc&W/Sc LFHCAL

Far-For/Backward (not shown)

- Roman Pots/B0 Tracker/OMD
- Zero Degree Calorimeter
- Luminosity Tracker/Calorimeter
- Low-Q^2 tagger



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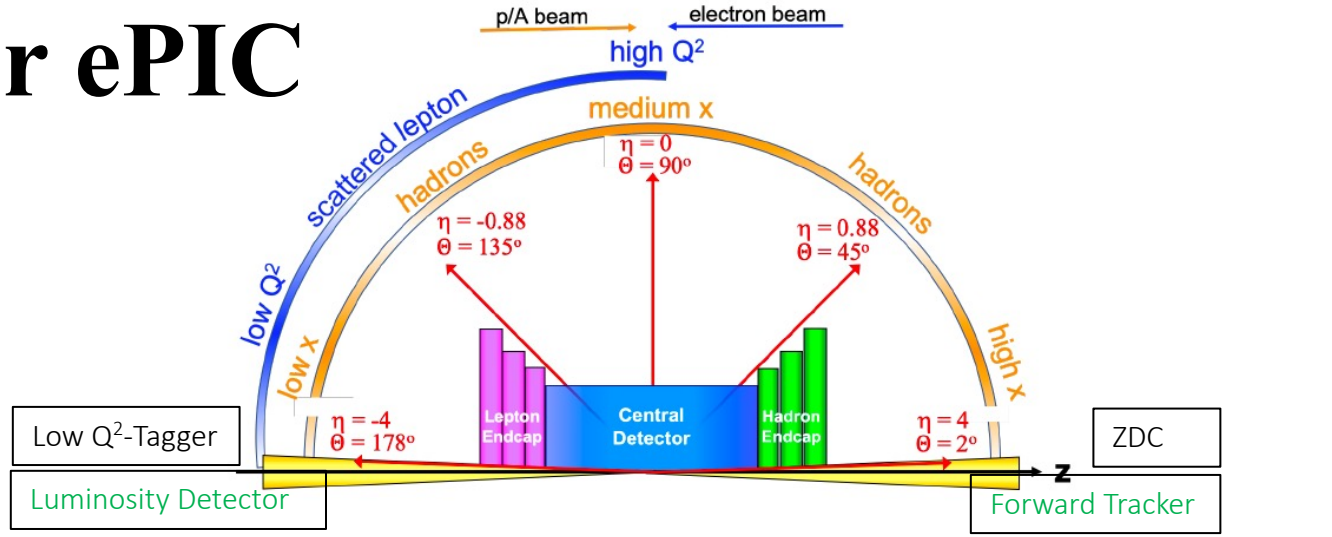
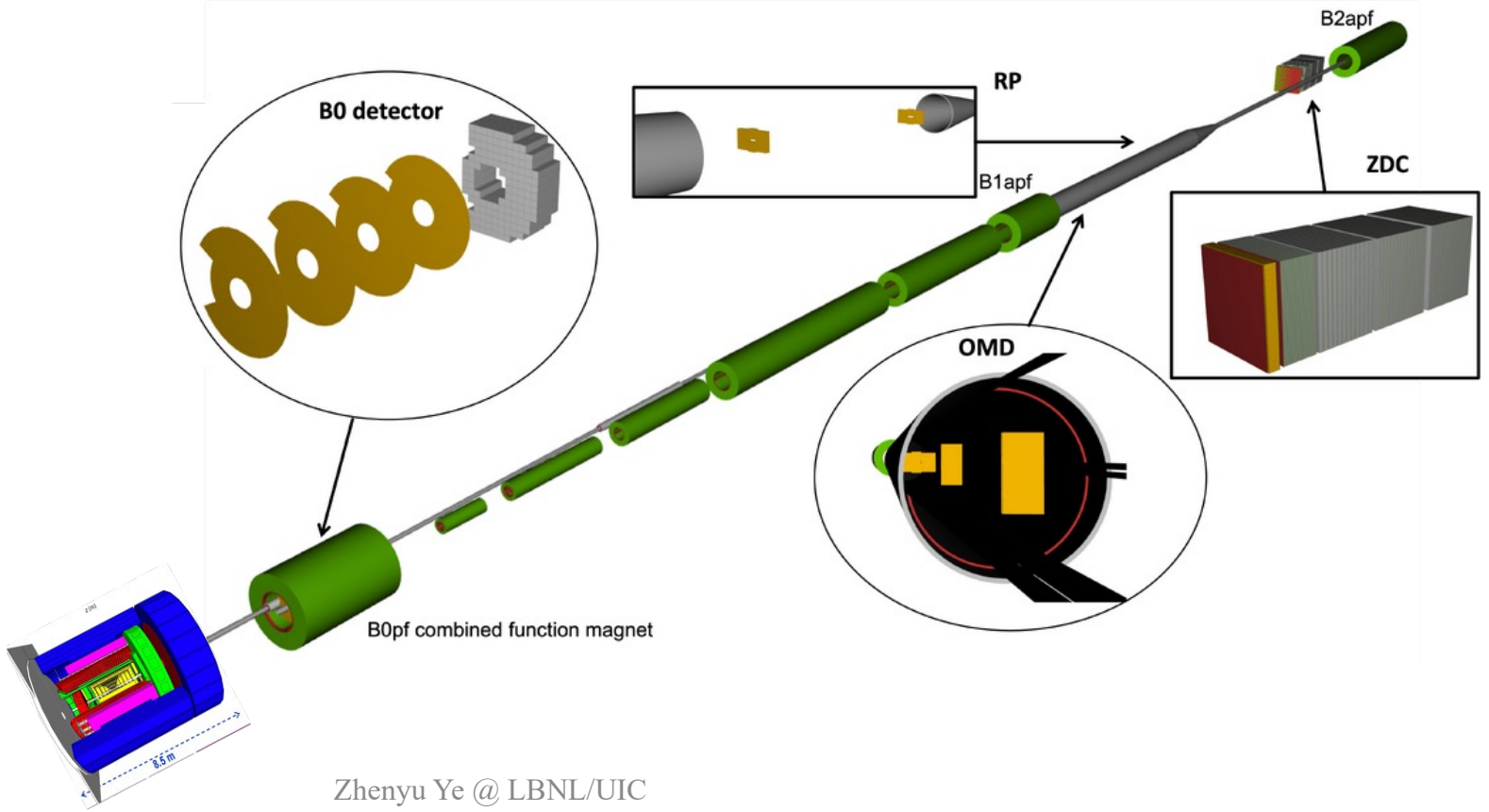
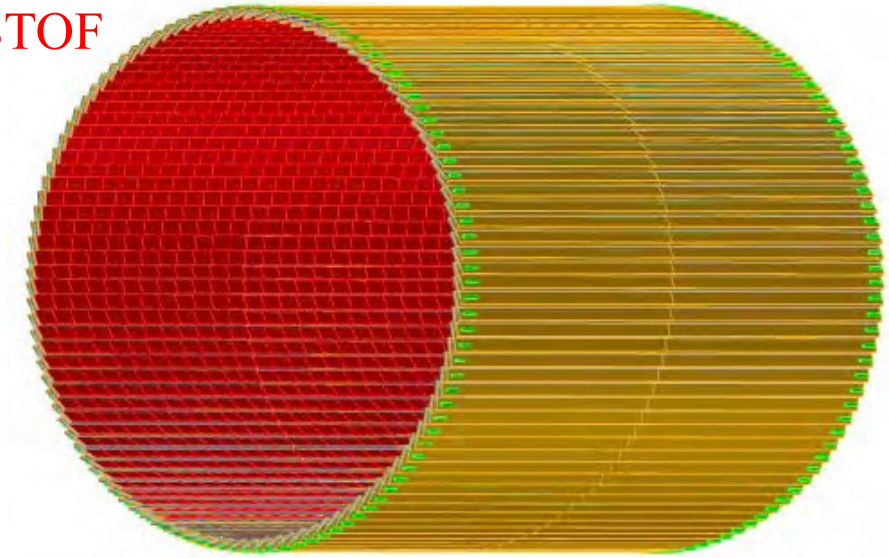


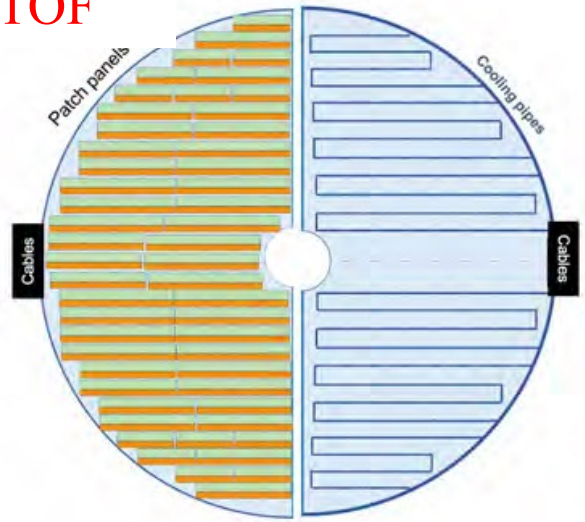


ePIC AC-LGAD Detector Requirements (Current)

BTOF



FTOF



Roman Pots

	Area (m^2)	Channel size (mm^2)	# of Channels	Timing Resolution	Spatial resolution	Material budget
Barrel TOF	10	0.5*10	2.4M	35 ps	30 μm in $r \cdot \varphi$	0.01 X_0
Forward TOF	1.4	0.5*0.5	5.6M	25 ps	30 μm in x and y	0.05 X_0
B0 tracker	0.07	0.5*0.5	0.28M	30 ps	20 μm in x and y	0.05 X_0
RPs/OMD	0.14/0.08	0.5*0.5	0.56M/0.32M	30 ps	140 μm in x and y	no strict req.
Lumi Tracker						

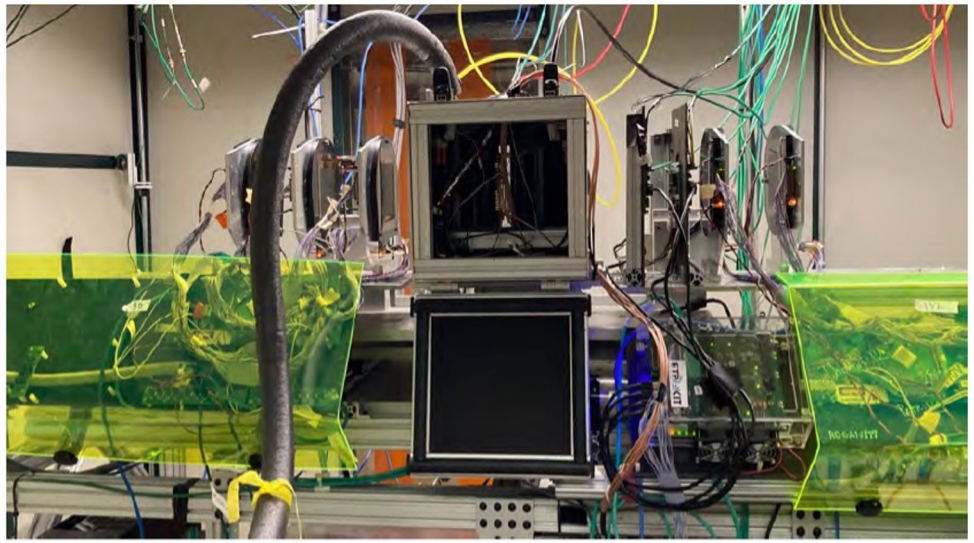
Requirements on timing and spatial resolutions and material budget are still being evaluated and are subject to change as the design matures, and we will continue to explore common designs for these detectors where possible to reduce cost and risk.

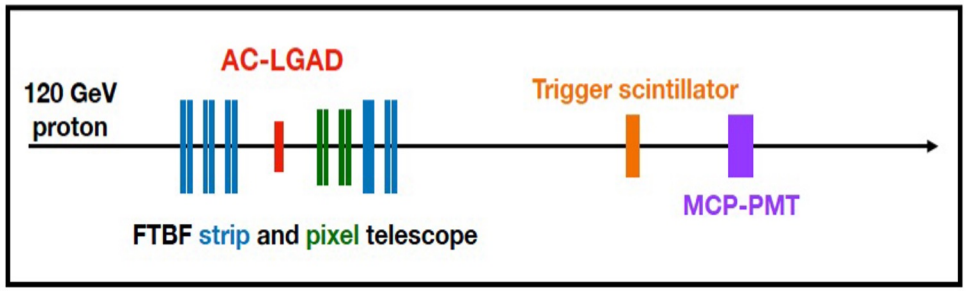
AC-LGAD Sensor

- Sensors with different configurations produced by BNL-IO and HPK, and tested with 120GeV protons
- Prototype strip sensors with ~35 ps time resolution and <15 um spatial resolution (more in the next talk).
- Prototype pixel sensors with ~20 ps time resolution and ~20* um spatial resolution.

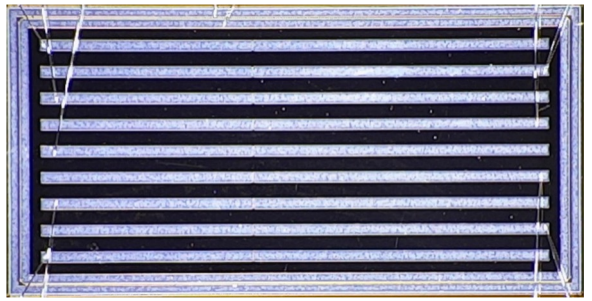
* ~50 um under metal electrodes. To be improved

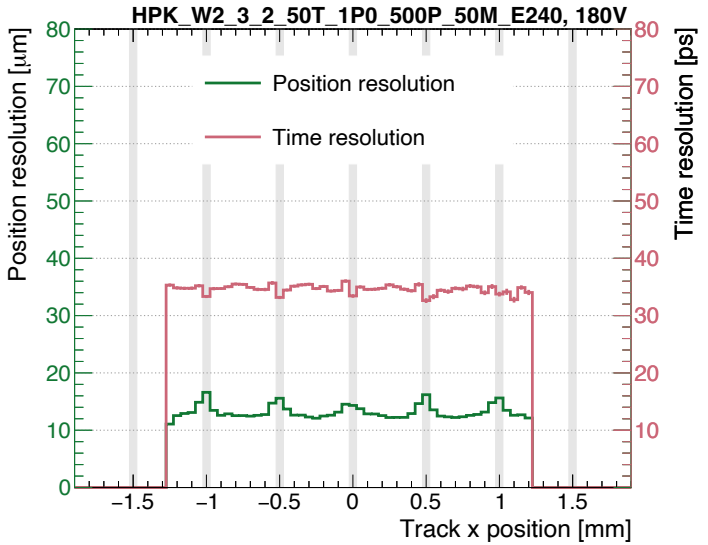
Fermilab Test Beam Setup



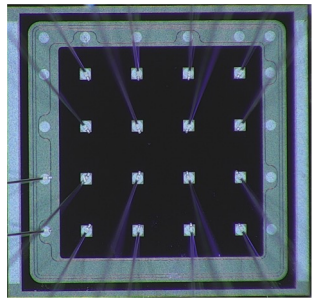


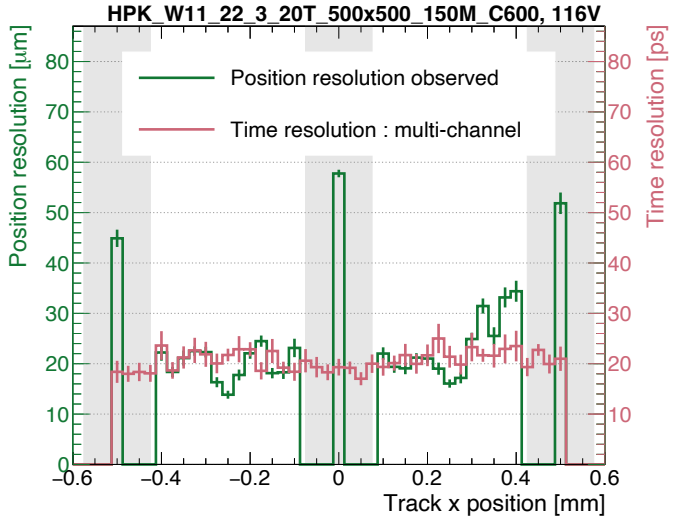
HPK Strip Sensor (4.5x10 mm²)





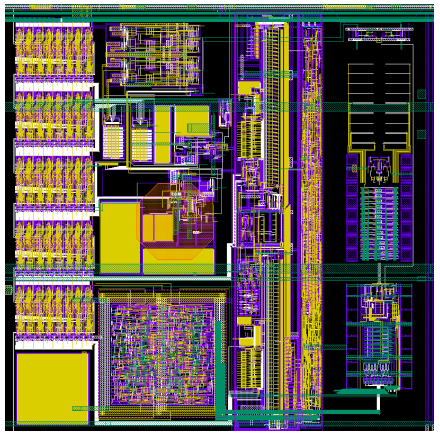
HPK Pixel Sensor (2x2 mm²)





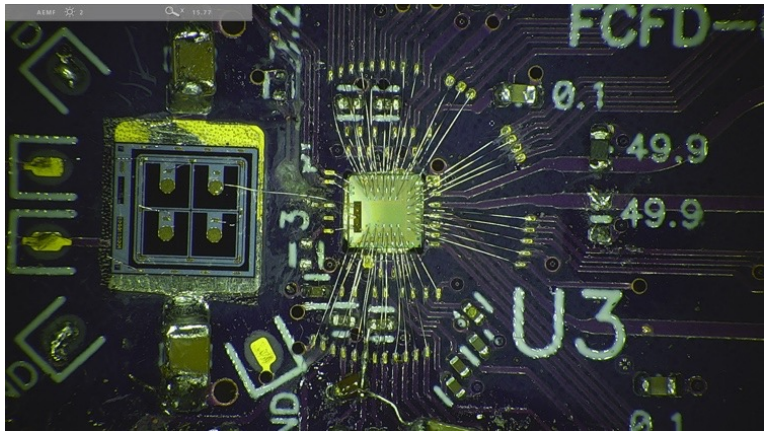
Frontend Readout ASIC

- **R&D Goals**
  - 15-20 ps jitter with minimal (1-2 mW/ch) power consumption, match AC LGAD sensors for ePIC.
- **Plan**
  - Utilize the design and experience in ASICs for fast-timing detectors from ATLAS and CMS, and investigate common ASIC design and development for TOF and FF.



EICROC by Omega/IJCLab/Irfu/AGH

- Preamp, discri. taken from ATLAS ALTIROC
- I2C slow control taken from CMS HGCROC
- TOA TDC adapted by IRFU Saclay
- ADC adapted to 8bits by AGH Krakow
- Digital readout: FIFO depth8 (200 ns)



FCFD by Fermilab (more in the next talk)

- Adapt the Constant Fraction Discriminator (CFD) principle in a pixel paired with a TDC, one time measurement gives the final answer.
- Charge injection consistent with simulations: ~30 ps at 5 fC, and <10 ps at 30 fC
- Tested with laser, beta source and beam

AC-LGAD Workfest

- **Jan 9:**
  - **Requirement and Design**
  - **AC-LGAD sensor**
  - **Frontend ASIC**
  - **Readout electronics**
  - **Dinner 7pm at Goat & Vine, 195 Remington Blvd, Bolingbrook, IL 60440. Please email me if interested.**
- **Jan 10**
  - **Detector Module**
  - **Mechanical structure and cooling**
- **Jan 10&11**
  - **EICROC0 Demonstration (several sessions) organized by**

    Alessandro Tricoli Alessandro.Tricoli@cern.ch

    Prithwish Tribedy ptribedy@bnl.gov