Characterization of Strip Scintillator for FDC

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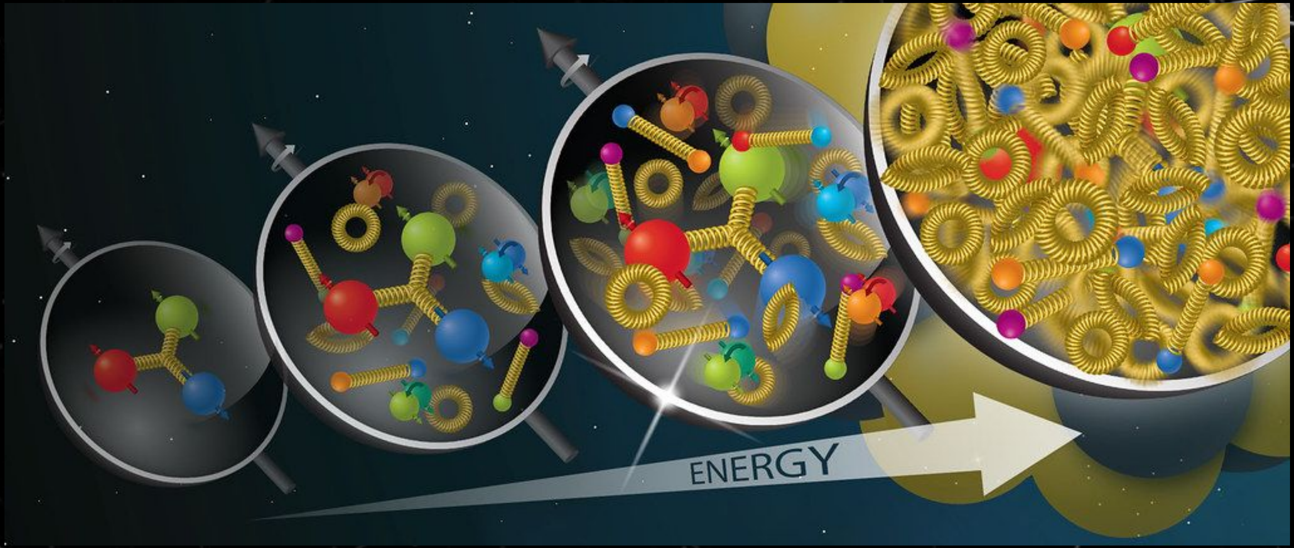
● Motivation for the FDC

Goal of EIC: Discovery of Gluon Saturation



● Pseudorapidity Coverage of the FDC

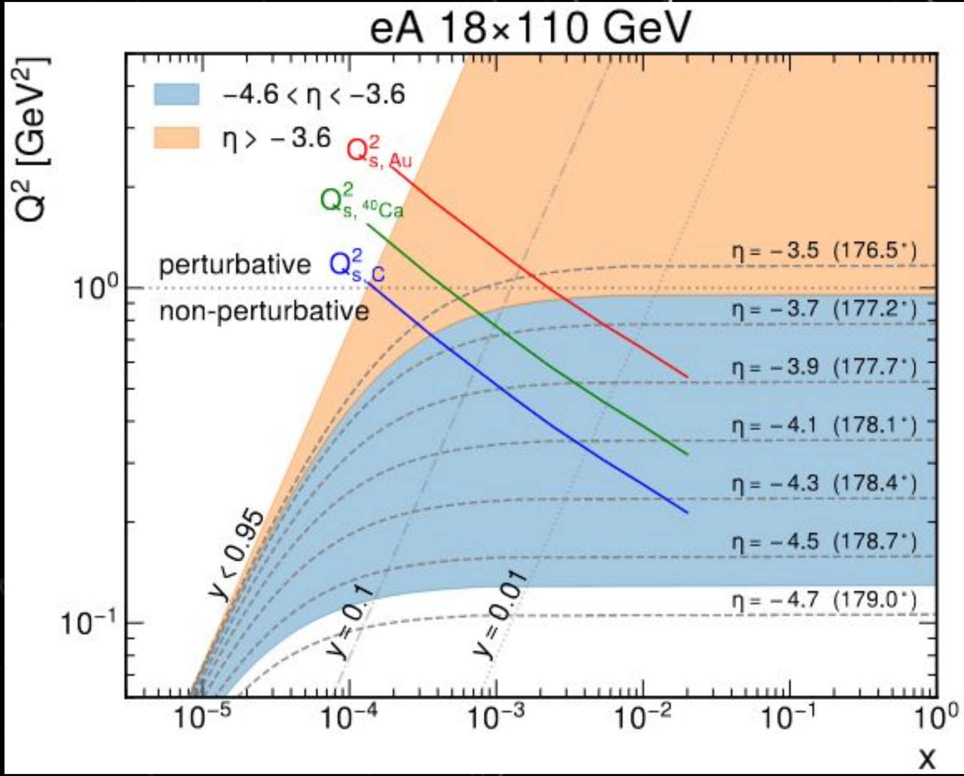
Full study requires the unfeasible region

$0.1 < Q^2 < 1.0$ GeV

- ❖ Given the name “The Q^2 Gap”
- ❖ Coincides with $-4.6 < \eta < -3.6$

The limit of $\eta \approx -3.6$ is due to the Ecal Required Structure

- ❖ Ecal has a hole of ≈ 8 cm to slide into the beams



A Few-Degree Calorimeter for the Future Electron-Ion Collider

A Few-Degree Calorimeter for the future Electron-Ion Collider

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Abstract

Measuring the region $0.1 < Q^2 < 1.0$ GeV^2 is essential to support searches for gluon saturation at the future Electron-Ion Collider. Recent studies have revealed that covering this region at the highest beam energies is not feasible with current detector designs, resulting in the so-called Q^2 gap. In this work, we present a design for the Few-Degree Calorimeter (FDC), which addresses this issue. The FDC uses SiPM-on-tile technology with tungsten absorber and covers the range of $-4.6 < \eta < -3.6$. It offers fine transverse and longitudinal granularity, along with excellent time resolution, enabling standalone electron tagging. Our design represents the first concrete solution to bridge the Q^2 gap at the EIC.

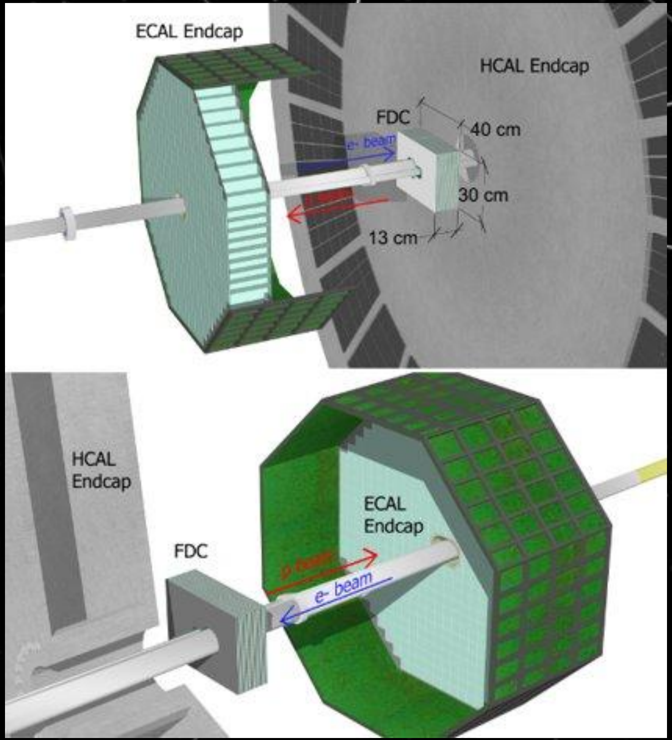
● The Few-Degree Calorimeter (FDC)

We Propose the Few-Degree Calorimeter (FDC)

Placed between the Ecal crystal and the backward Hcal

Covers the region of particles missed by Ecal in region around the beampipes

Uses SiPM-on-Tile Technology

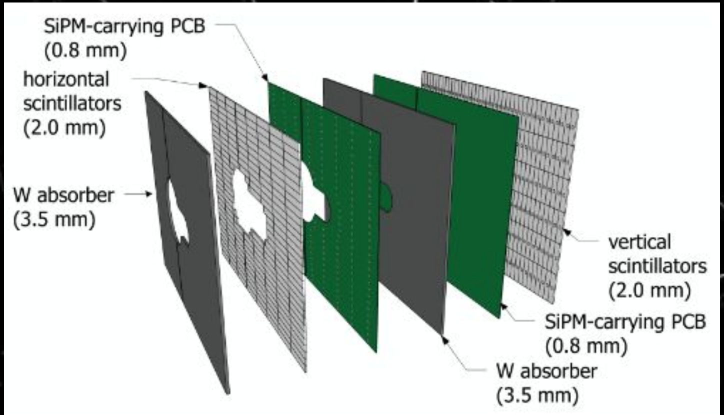


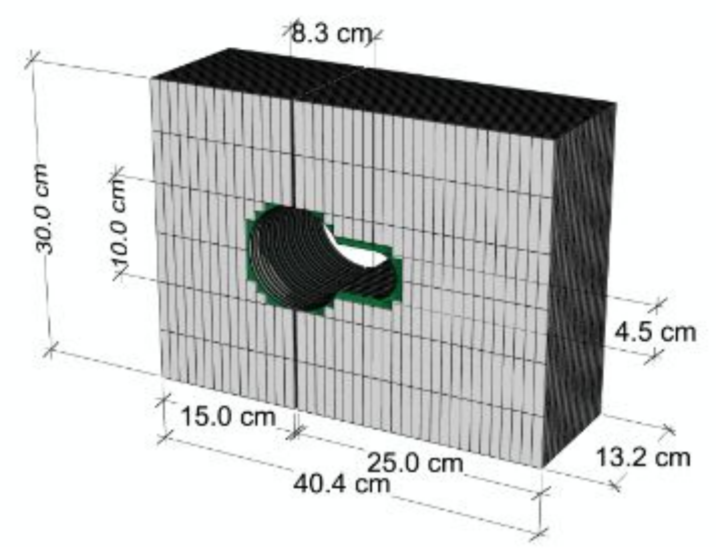
● Structure of the FDC

Layers of the FDC

- ❖ Tungsten layer
- ❖ Scintillators (Horizontal and Vertical Var.)
- ❖ Reflective foil
- ❖ SiPM-carrying PCB

With 2 sections to slide out left and right



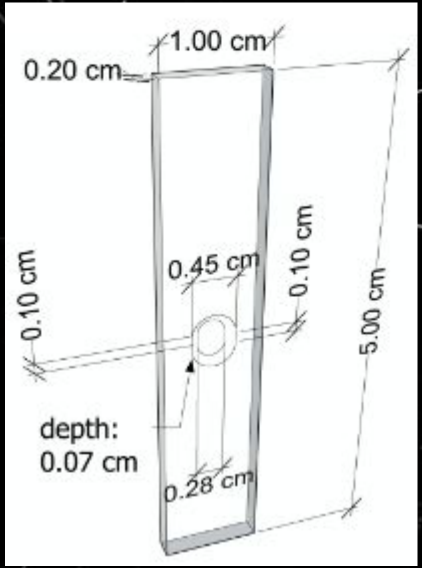


● The Scintillators Strips

Dimpled Scintillators
❖ Air-Coupled SiPM

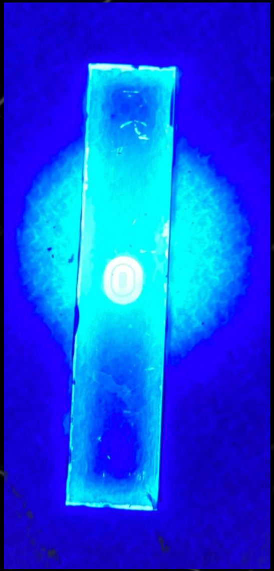
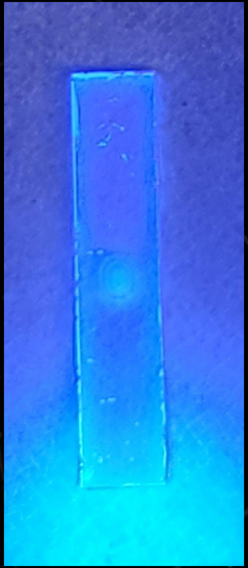
Emits light when by a particle ionizes the material
❖ Light is readout by SiPM

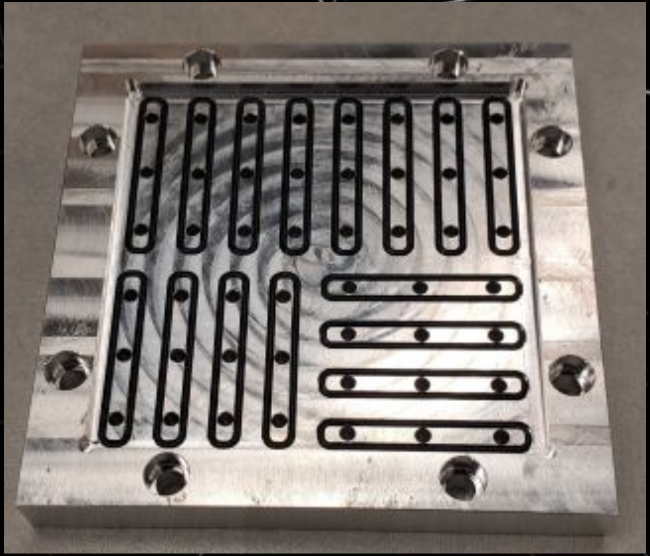
Reflective Foil Layer
❖ Maximizing light-yield



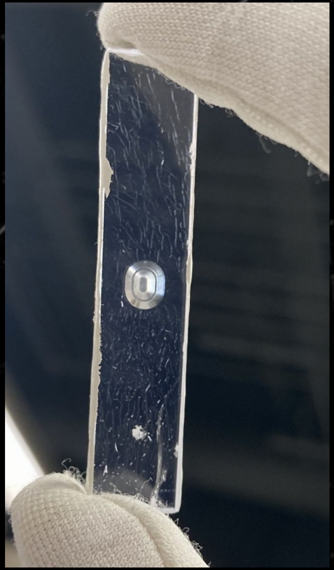
- # The Scintillator Dimple

Scintillators are covered from all sides except the dimple



- Annealing Scintillators




Heated for 4 hours at 80°C

Removes Crazings

- 3D printed frame

Isolates cells to avoid optical crosstalk

Holds scintillators in place and defines layer

Designed on Sketchup

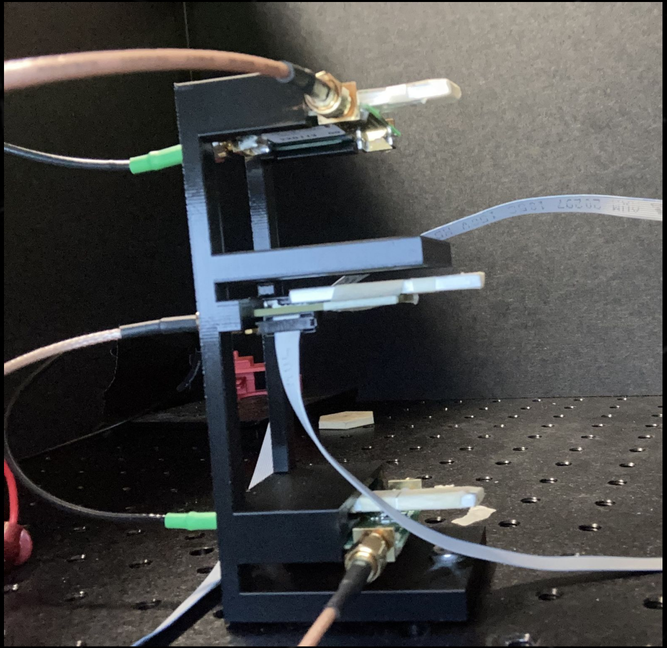
- # The ESR Foil

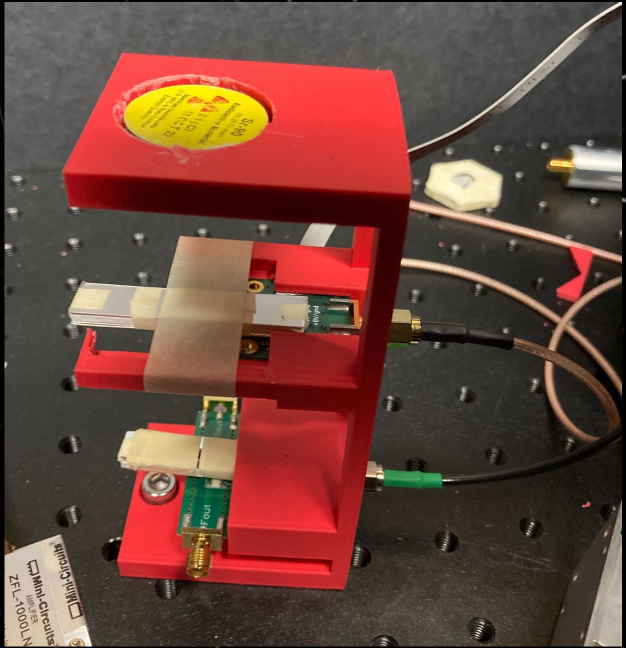
Fits to cover all scintillators in a layer

Designed to fit SiPM to avoid any escaping light particles

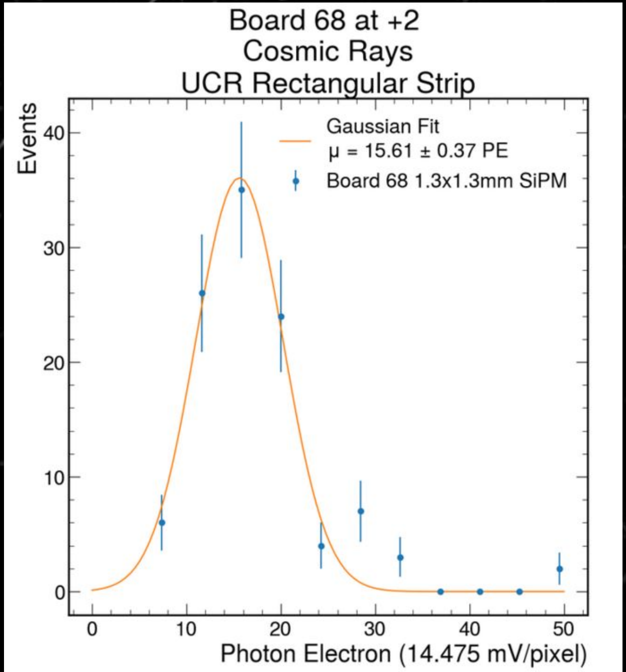
Done by CNC laser and designed one Fusion360

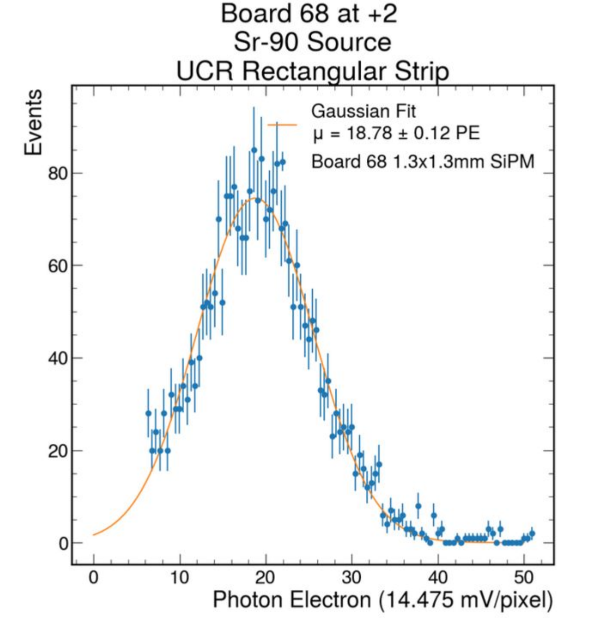
- Testing Scintillators





- Testing Scintillators





- # Granularity of the Strip Scintillator

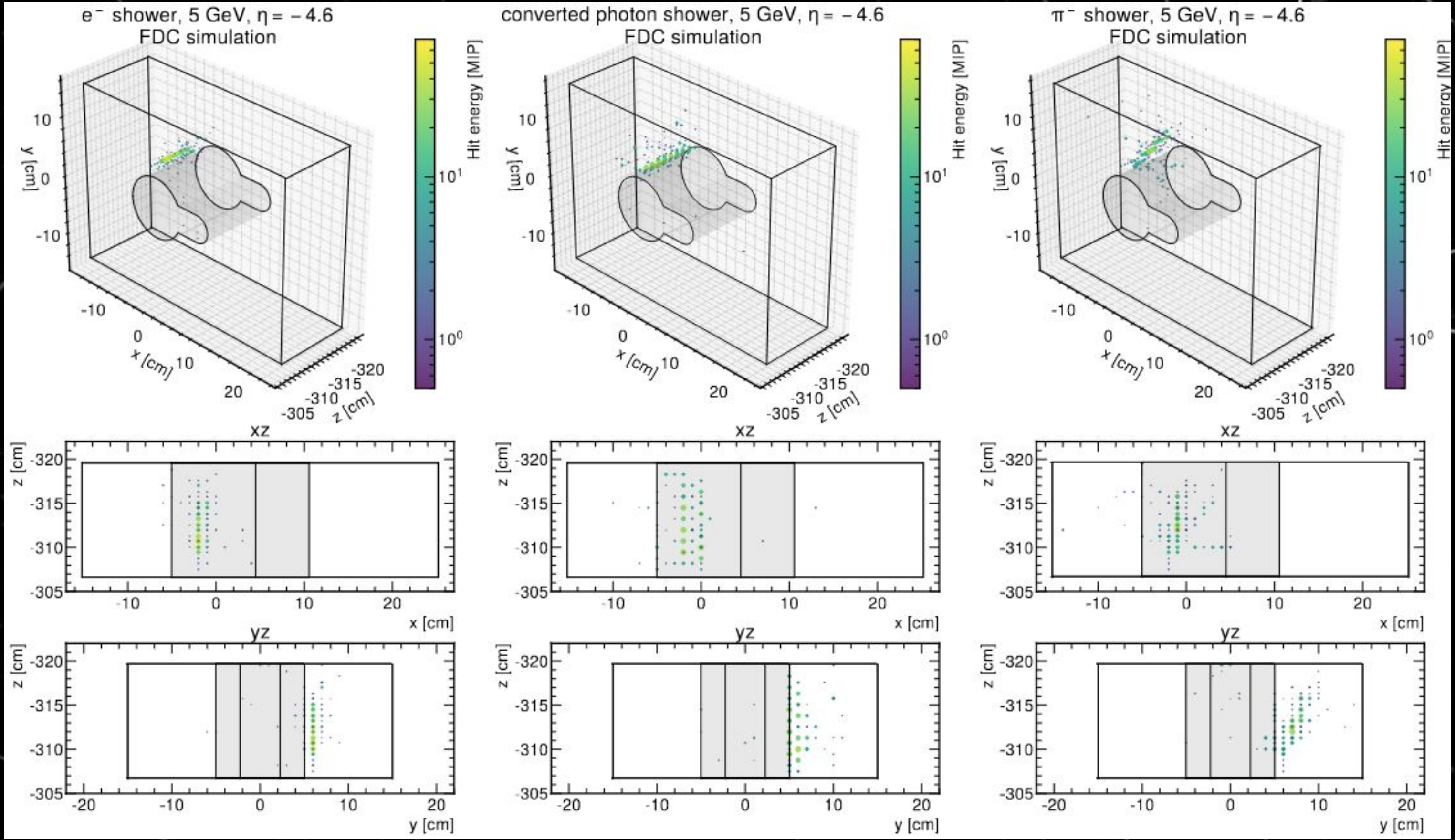
Horizontal and Vertical orientation of each layer

- ❖ High Granularity
- ❖ 10x10 mm^2 granularity

Provides Information of position

The scintillators are painted white on the sides, and covered with foil to maximize light yield

- ❖ Removes noise signals



e⁻ shower, 5 GeV, η = −4.6
FDC simulation
converted photon shower, 5 GeV, η = −4.6
FDC simulation
π⁻ shower, 5 GeV, η = −4.6
FDC simulation
Hit energy [MIP]
x [cm]
y [cm]
z [cm]
xz
yz

● SiPM PCB

Provides a Readout for the particles

Consists of pixels, each having multiple photodiodes

- ❖ SiPM is provided a voltage to put the diode at its limit
- ❖ “Overspills” when light strikes the diodes letting electrons through to provide readout

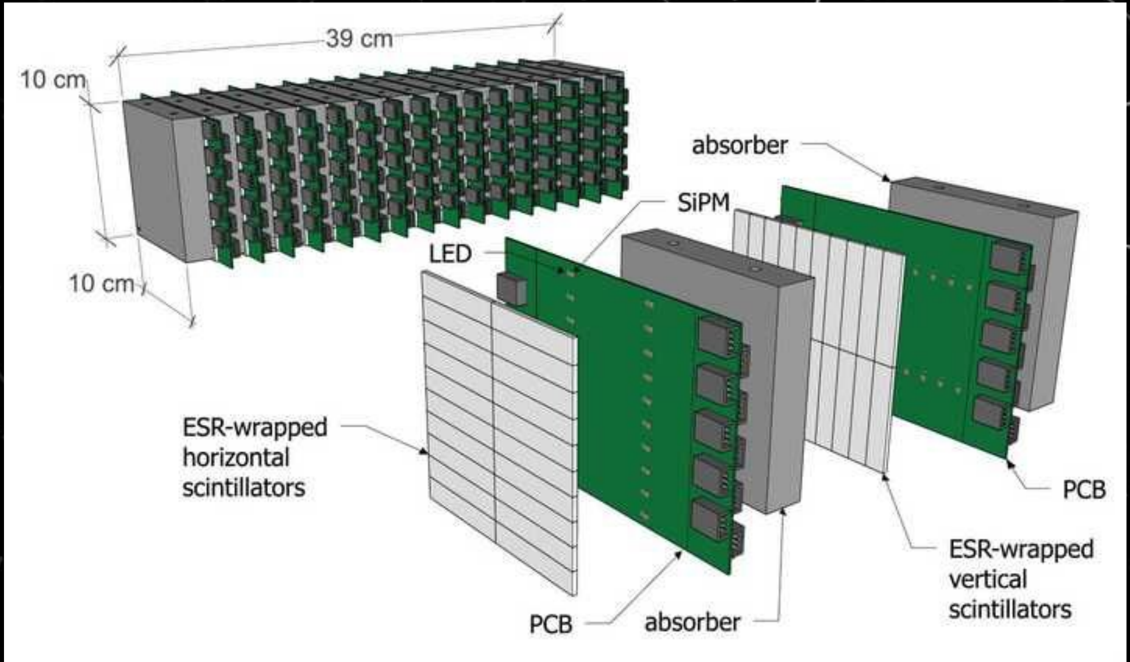
This provides information of energy and time of particle that was detected after the collision

● Prototype

Total of 16 layers

Planning to assemble and test with beam at lab setting

Next Step Goal:
Visualizing showers of different particles



● Conclusions

❖ This designs “bridges” the Q^2 gap to the EIC

❖ It covers $-4.6 < \eta < -3.6$ enabling studies of perturbative QCD and gluon-saturation regime

❖ It provides high granularity of 10 x 10 mm^2 5D shower measurements position, time, and energy