The Hybrid μ-RWELL for ePIC Endcap Tracking

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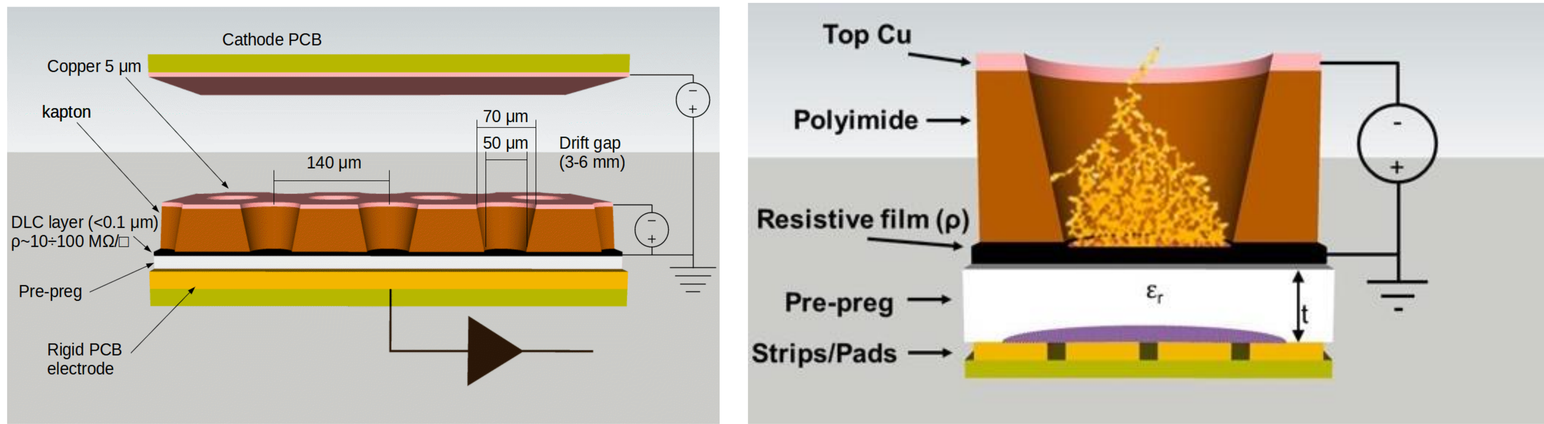
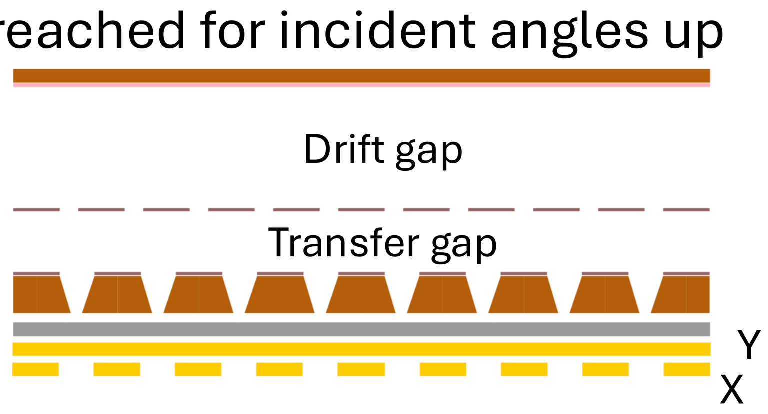
μ-RWELL

The μ-RWELL[1] is a single amplification stage **resistive MPGD** composed of:
- **PCB** cathode (gas detector gap)
- **μ-RWELL_PCB** anode (electron amplification + R/O)
  - a WELL patterned kapton foil (w/Cu-layer on top) acting as amplification stage
  - a resisitive DLC layer w/ ρ ~ 100 MΩ/☐
  - a standard readout PCB with pad/strip segmentation



Hybrid μ-RWELL

- GEM[2]+μ-RWELL hybrid[3] configuration has been chosen to have safe operation at a **gas gain** larger than 10 000, ensuring satisfying performances even with angled track while using a 2D R/O
- **2D strip read-out** using a "*COMPASS-like*" scheme
- 600 μm pitch corresponding to a **spatial resolution** ~150 μm (with 650 μm pitch, in 5 mm drift gap, spatial resolution better than 150 μm has been reached for incident angles up to 30° using CC and μTPC reconstruction methods combined[5])
- A drift gap larger than 3 mm allows to perform μ-TPC[6,7] reconstruction algorithm, keeping high **efficiency**



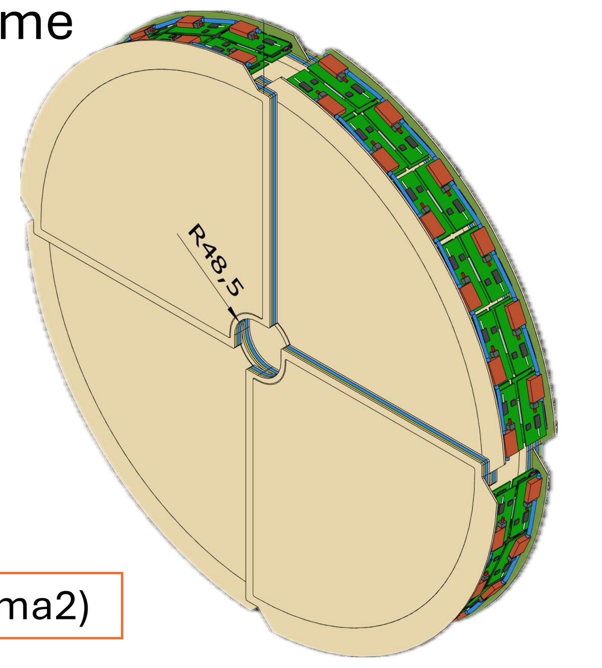
Timing with G-RWELL
Check Poster ID 46 G. Bencivenni

EIC

The **Electron Ion Collider**[4] (EIC) will be built at Brookhaven National Laboratory and is designed to study the **nucleon** and the **nuclear structure** with an unprecedented precision, shading light on confinement and on the intriguing behaviour of QCD in the non-perturbative regime

ePIC detector tracking – MPGD endcap trackers

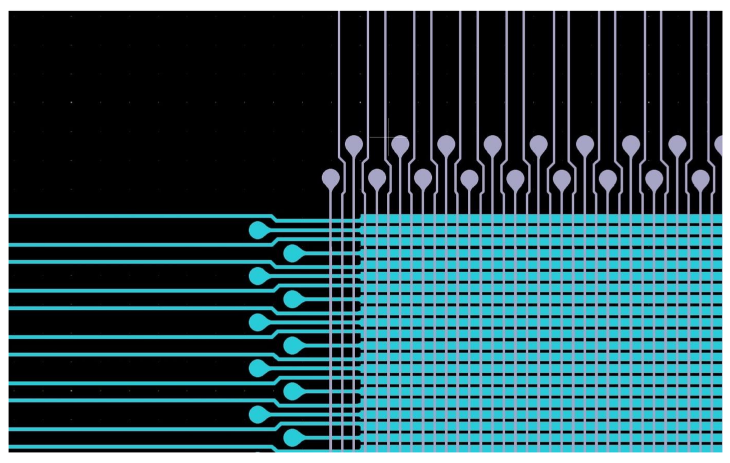
The trackers covering the area of the detector with pseudo-rapidity **|η| > 2** include the MPGD Endcap Tracker: two pairs of **Hybrid μ-RWELL disks**, one in the leptonic region and one in the hadronic region.

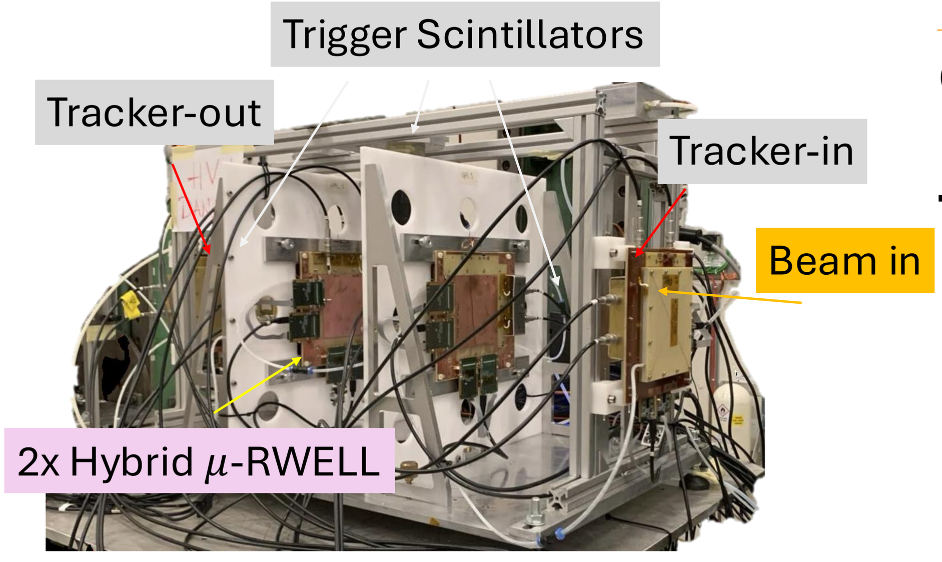


Thanks to Stefano Gramigna (INFN Roma2)

Detector Under Test

- Active area 100x100 mm[2]
- Readout *à la COMPASS* 2D
  - Bottom strip pitch 400 μm, width 300 μm
  - Top strip pitch 400 μm, width 60 μm
- 6 mm drift gap
- 3 mm transfer gap





Test Beam @PS T10 November 2024

Gas mixture:
$Ar:CO_2:CF_4$ 45:15:40
Tracking:
hybrid GEM+μ-RWELL with 2D R/O and μ-RWELL with 2D R/O
Detectors Under Test:
2 hybrid G-RWELL with 2D R/O

Preliminary results HV scan

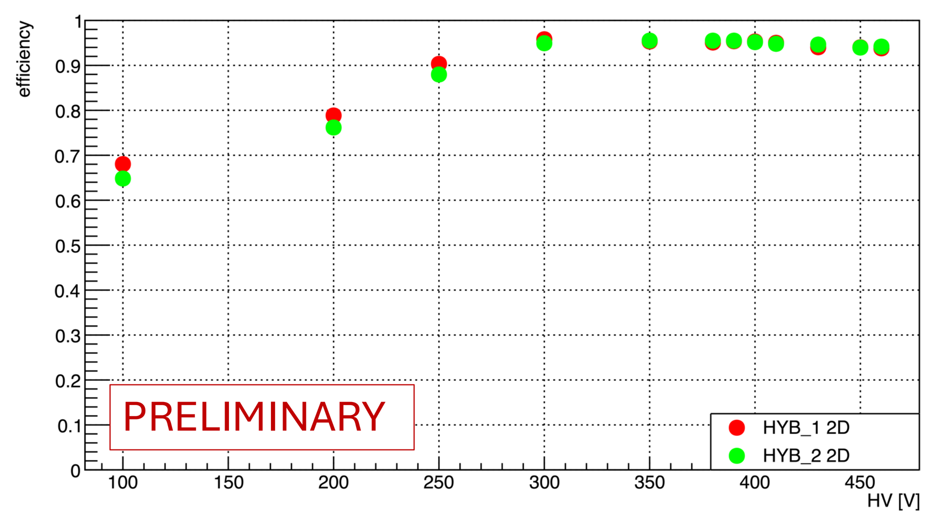
The hybrids' μ-RWELL voltage is set to have gain ~ 1500 (ΔV_{WELL}= 550 V)
The efficiency 2D is performed with a tracking system and requires both the strips along X and Y to fire

Efficiency study at 0°
Cluster association performed for a window 2 mm x 2 mm
In plateau (eff ~ 96%) @ gain 5200 (ΔV_{GEM} ~ 300 V)

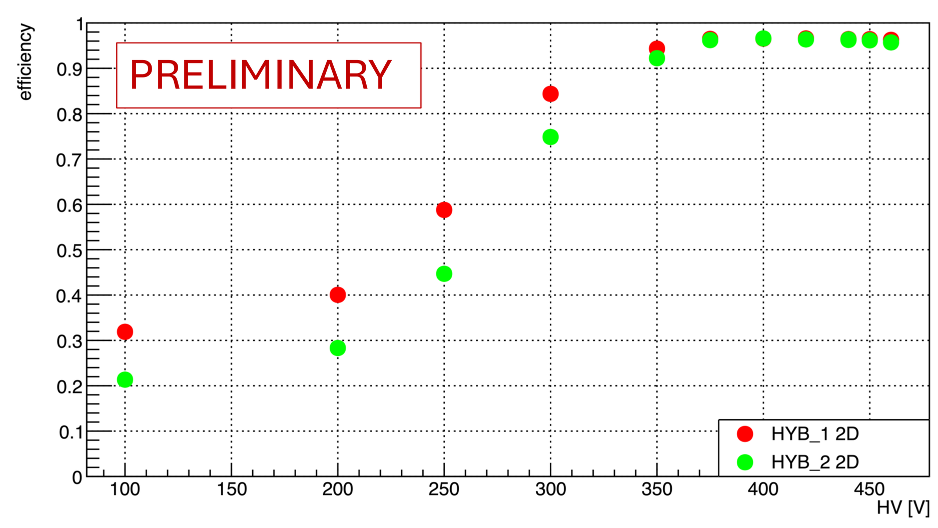
Efficiency study at 30°
Cluster association performed for a window 4 mm x 4 mm
In plateau (eff ~ 96%) @ gain 15000 (ΔV_{GEM} ~400 V)

$$\varepsilon_{2D} = \frac{\#\ tracks\ with\ associated\ cluster\ on\ the\ DUT}{\#\ tracks\ passing\ trought\ the\ DUT}$$

HV scan at 0°

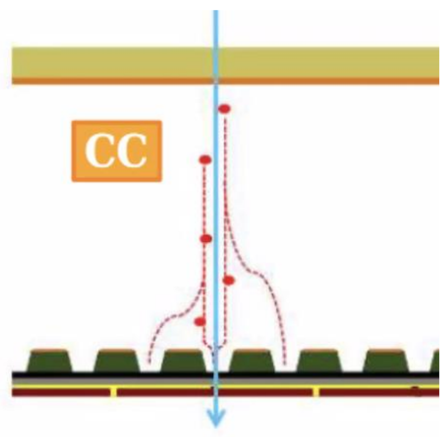


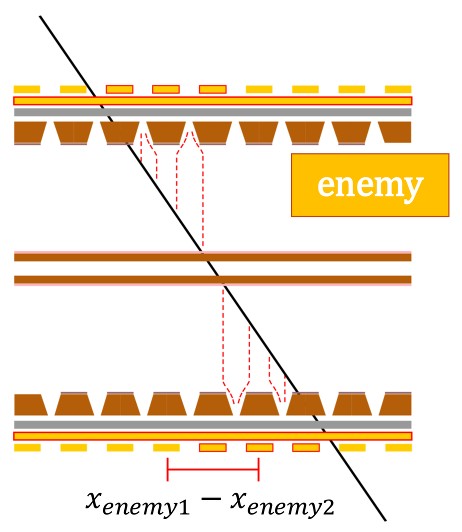
HV scan at 30°



Spatial resolution study at 0°

Charge Centroid method is currently used as the first step of spatial resolution study



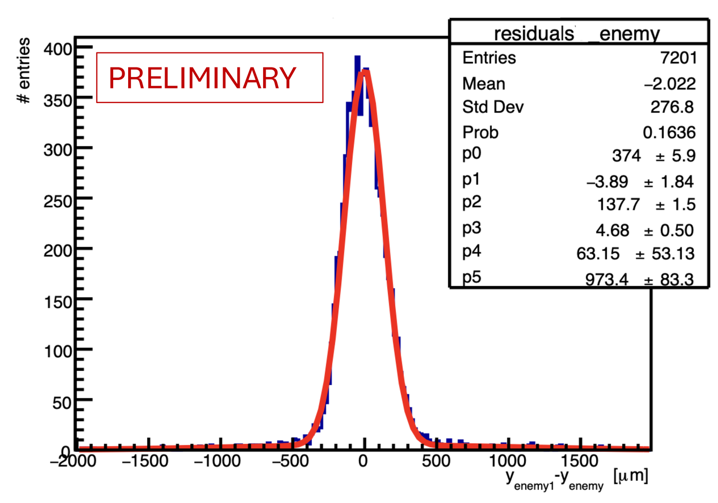


The "**enemy**" method evaluates the residual from the distance between the cluster centers detected by the two adjacent DUTs

Preliminary results HV scan at 0°

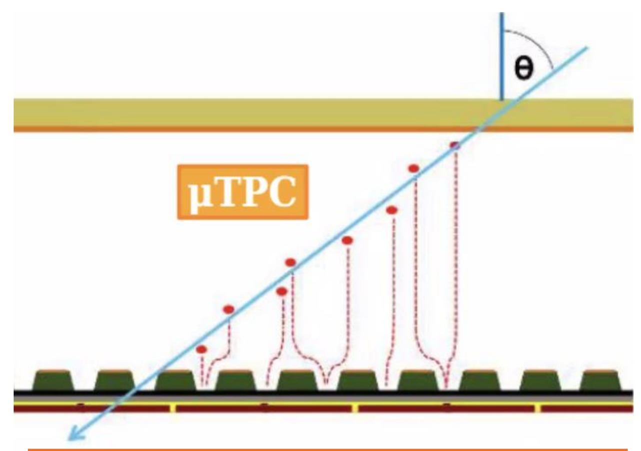
In plateau (eff ~ 96%) :
- ΔV_{GEM} ~430 V
- ΔV_{WELL}= 550 V

CC + enemy Resolution 110 μm

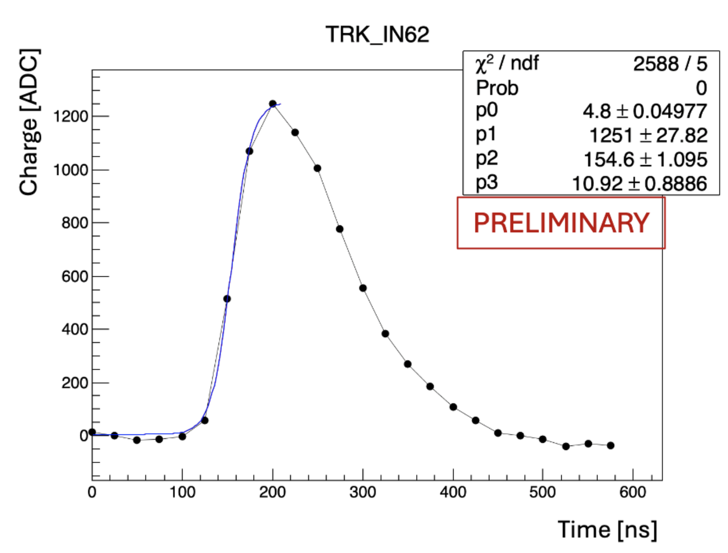


Spatial resolution study at 30°

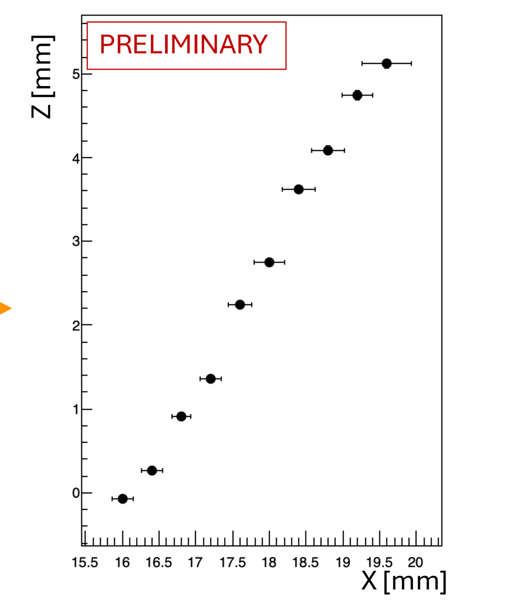
The "**μTPC**" method: time of the hit on the strip is used with the drift velocity in the gap, to perform μTPC and select the position along z in the gas gap in which the particle passed



Thanks to Riccardo Farinelli (INFN Bologna)



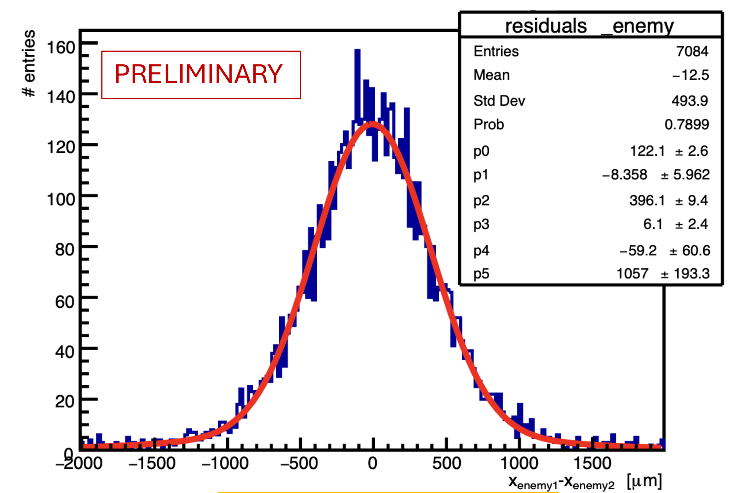
$Z = v_d\ t$



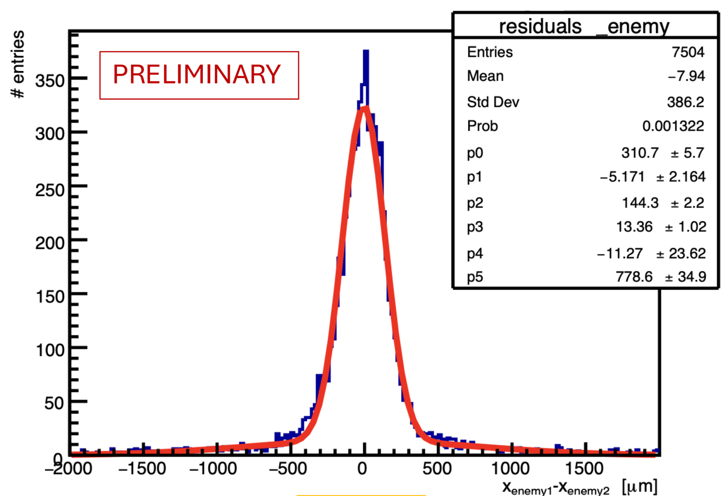
Preliminary results HV scan at 30°

In plateau (eff ~ 96%) :
- ΔV_{GEM} ~460 V
- ΔV_{WELL}= 550 V

CC + enemy Resolution: 270 μm
μTPC + enemy Resolution: 150 μm



Charge Centroid



μTPC

[1]G.Bencivenni et al. https://doi.org/10.1088/1748-0221/10/02/P02008
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