Close Cathode Chamber: cost efficient and lightweight detector for tracking applications

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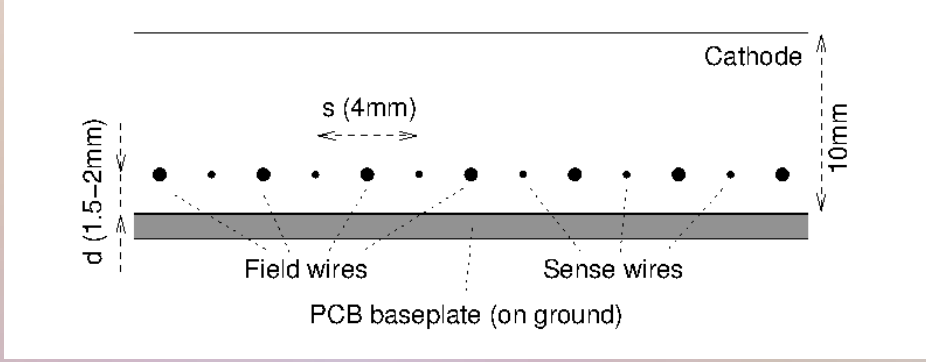
Outline

- Motivation: small material budget, economic tracking station for the ALICE VHMPID HPTD
- Asymmetric MWPC: an old idea revived
- Close Cathode Chamber:

  insensitivity to cathode planarity error
- Practical issues: large size, dead zones, …
- Applications: HPTD, cosmic muon detection
- Hybrids: photon detection, GEM QA, ...

Asymmetric MWPC outline

- An old idea revived – predecessor of MSGC-s



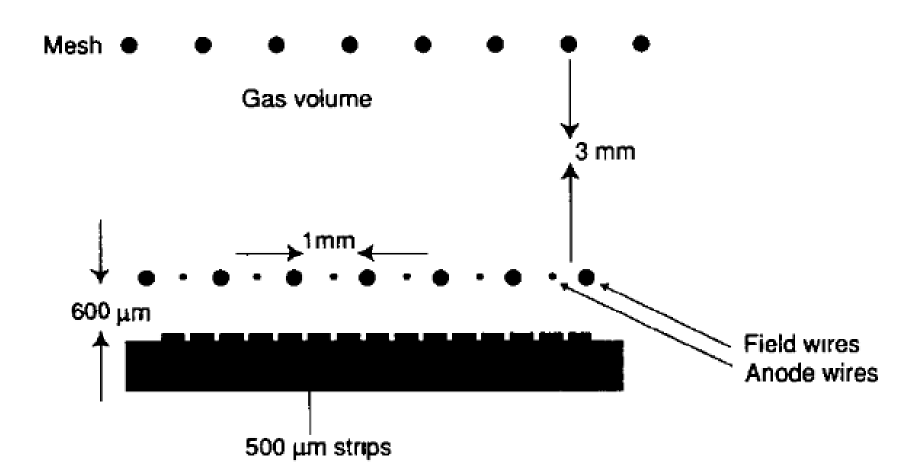
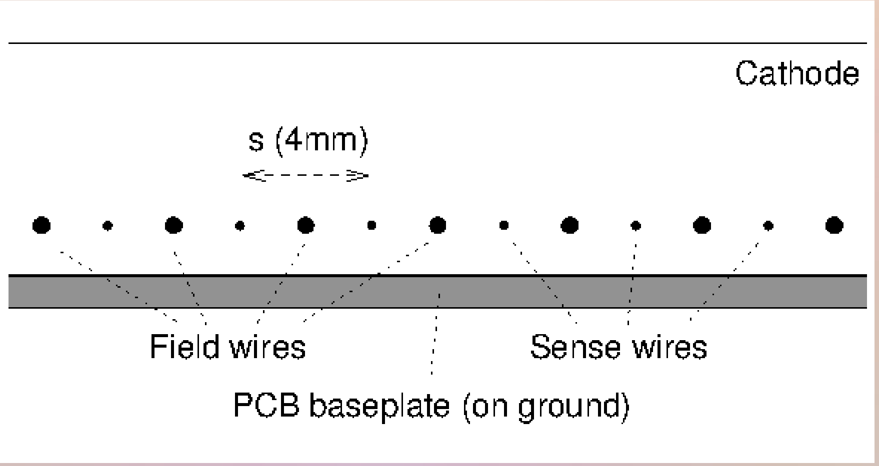


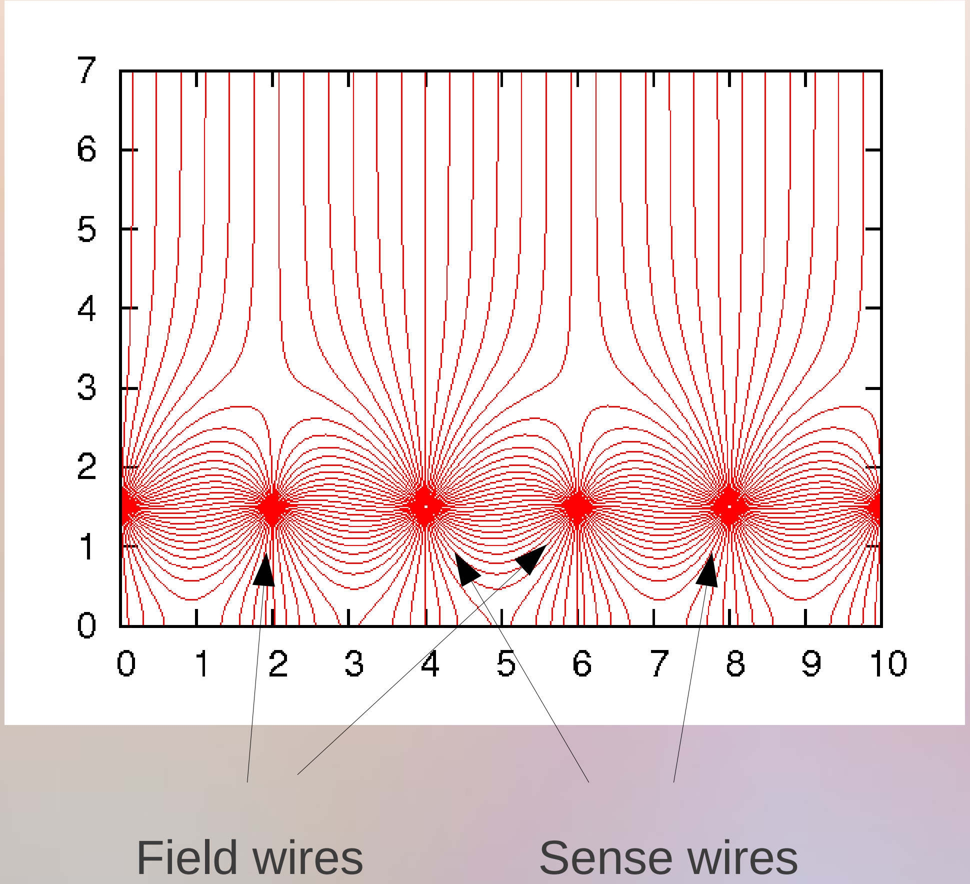
Fig. 1. Schematic of the cross-section of the asymmetric wire chamber.

NIMA 648 (2011) 648.

G. Charpak, I. Crotty, Y. Giomataris, L. Ropelewski, L. Williams
NIMA 346 (1994) 506.

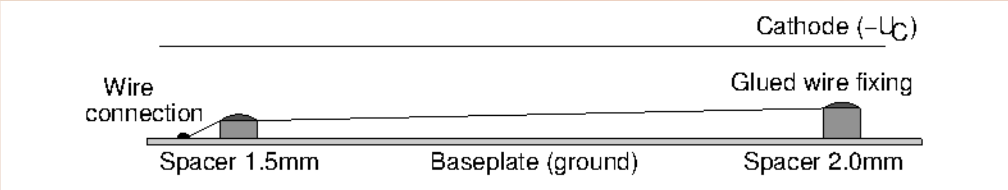
Field lines: closed among wires



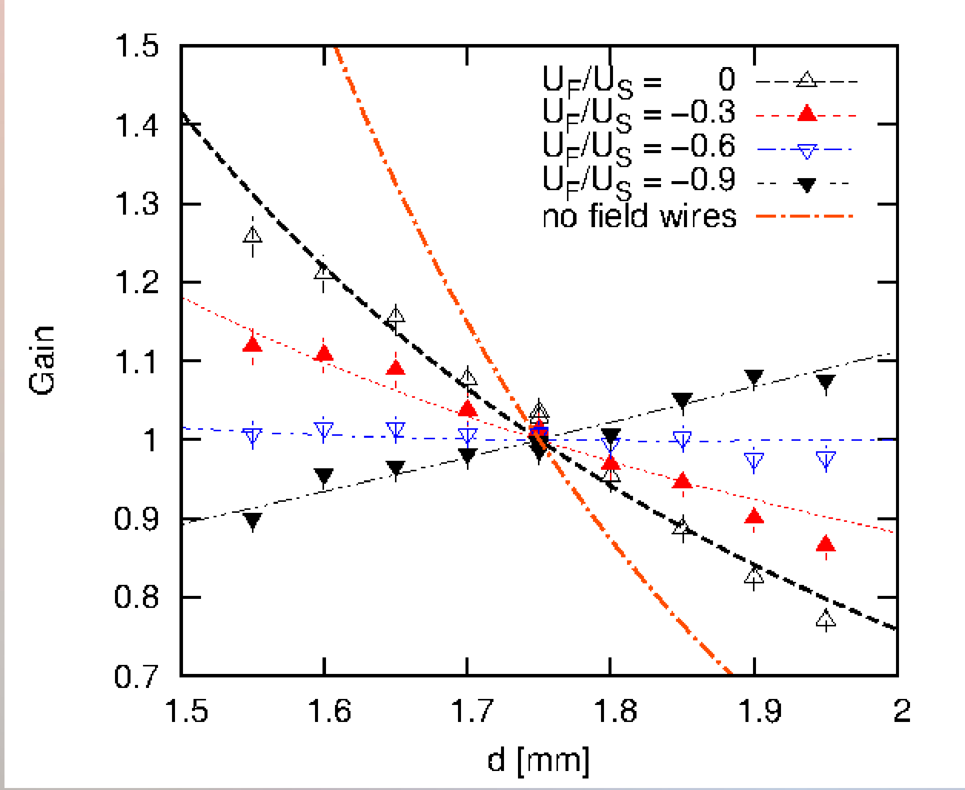


- Actually inspired by MPGD-s – amplification independent of readout structure

Gain dependence on baseplate (grounded cathode) planarity



- Direct measurement with inclined wire plane
- No dependence at given FW voltage reachable
- Note field wires on negative potential!



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Implications for advantages

- No need for a precisely flat baseplate: low material budget, simplified construction
- No sparking, unlike some MPGD-s
- One can go closer to the baseplate (“Close Cathode Chamber”) with the wires (1.5 – 0.8mm)
- Good signal coupling (60%) to segmented baseplate

but...

- … where do we pay for the reduced mechanical tolerances of the baseplate?

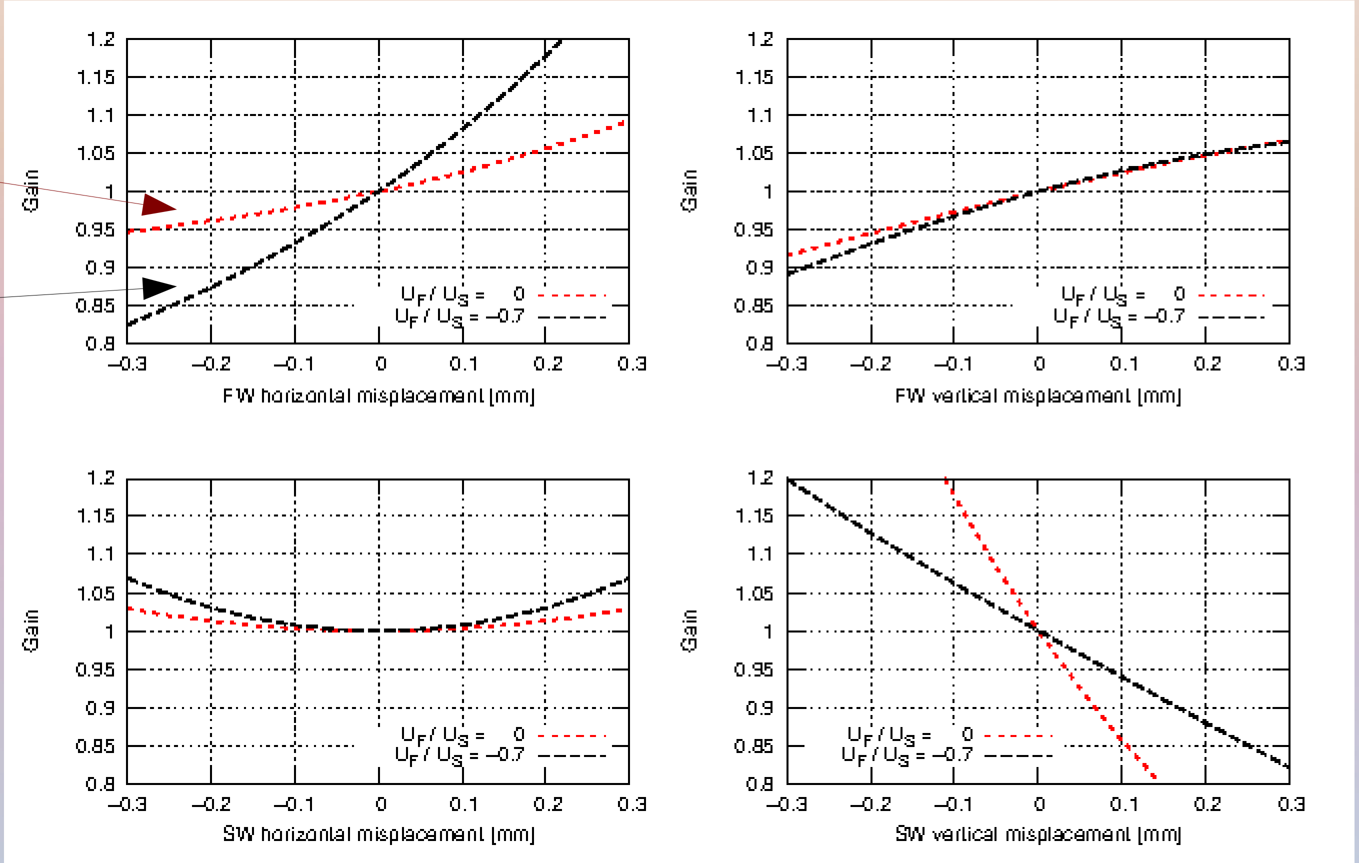
Wire positioning becomes critical

- FW horizontal and SW vertical are most sensitive

(solved by support design)

Classical

CCC



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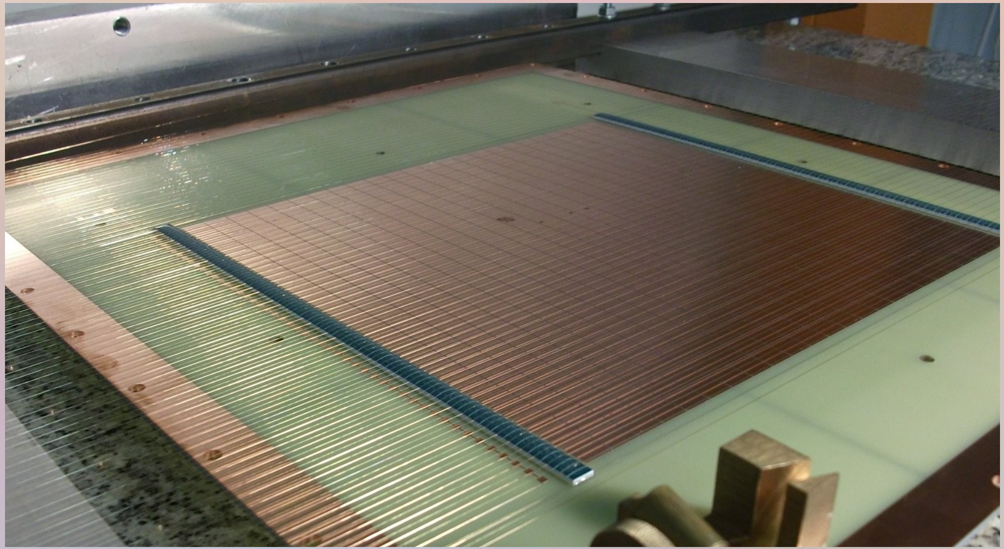
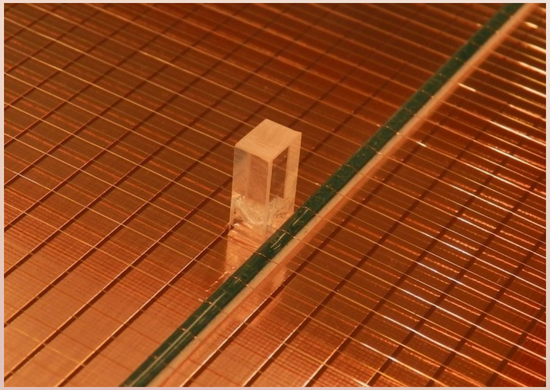
Construction: wire positioning and fixing

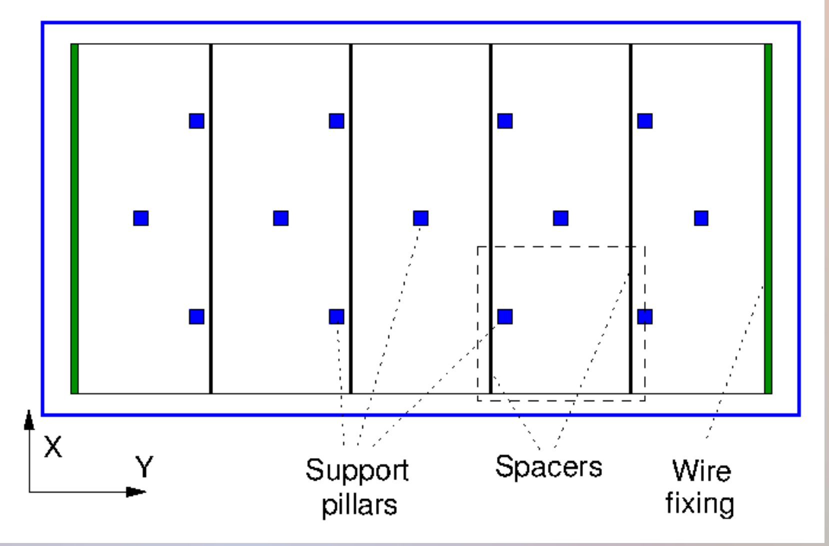
- Laser engraved plastic wire support bars
- Wire tension held by baseplate! No frame needed



Construction: towards larger sizes

- Introduction of support pillars and spacers
- 50cm by 100cm unit weighs less than 2kg!





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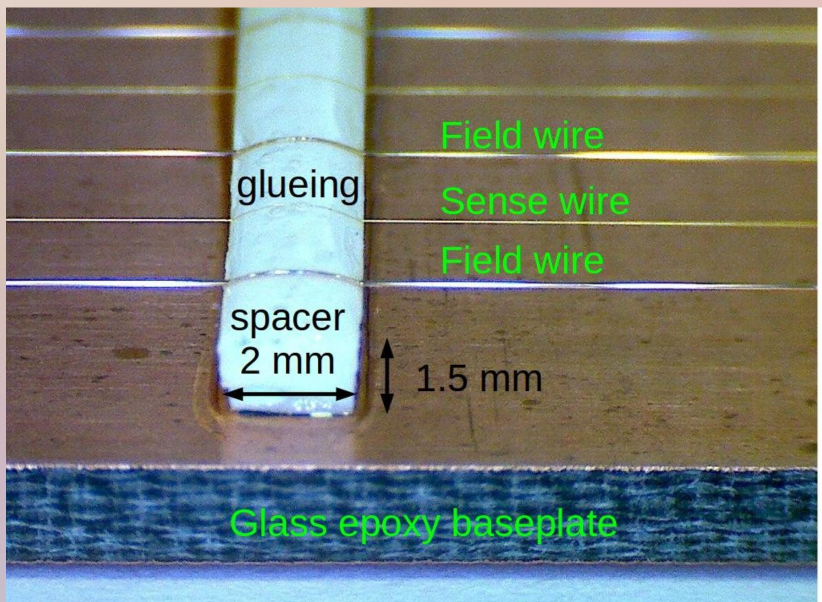
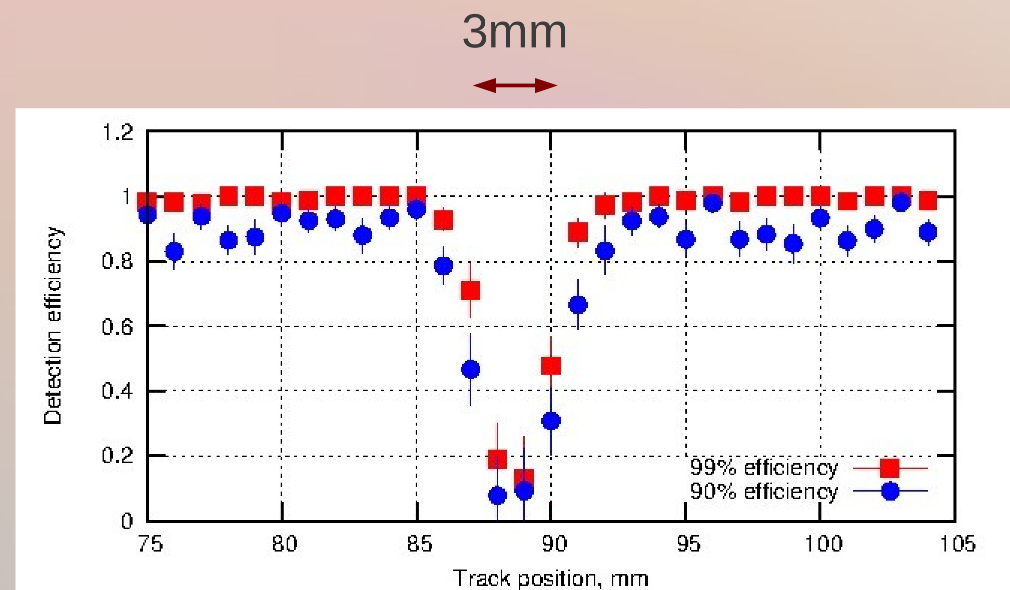
Dead zones at spacers

- Reduced width of dead zones because field lines end up on FW and not on baseplate / cathode





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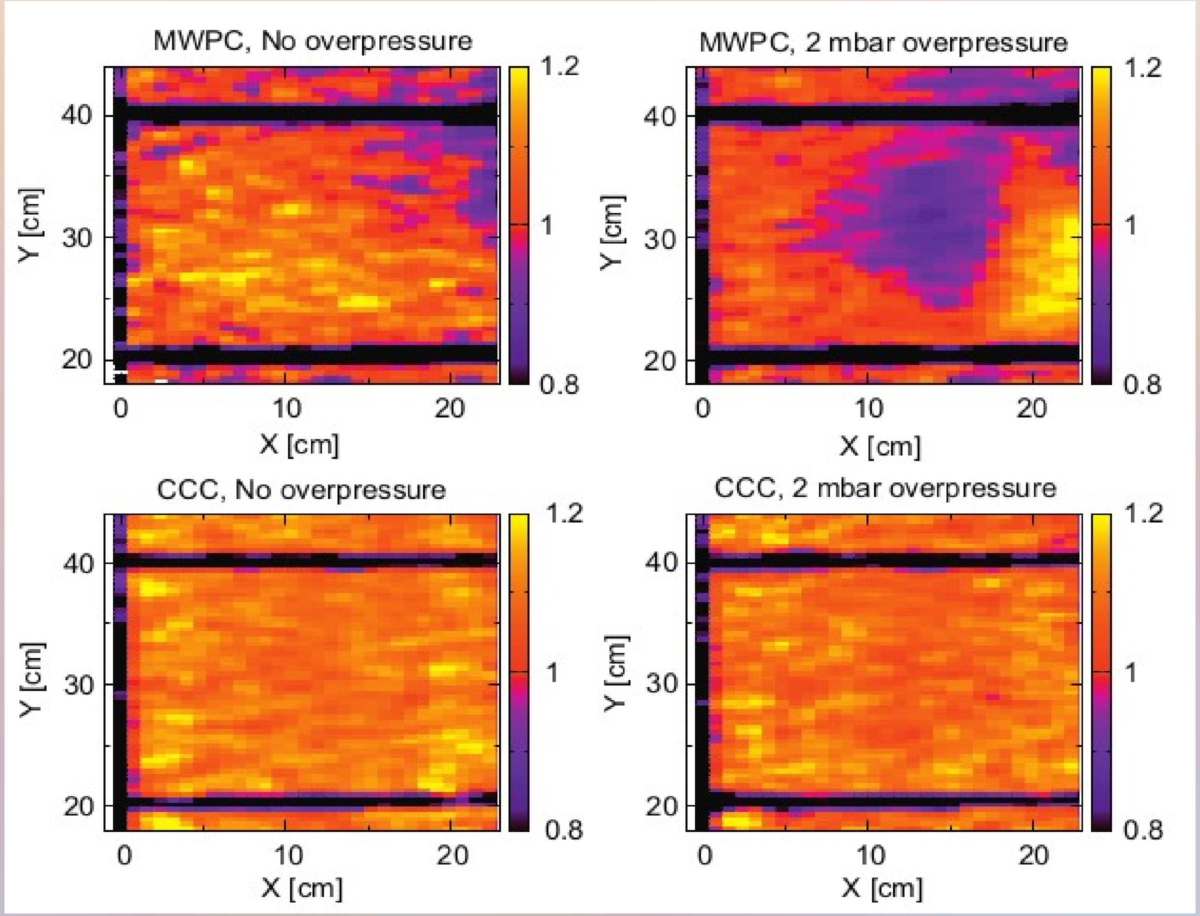
Direct demonstration of insensitivity to baseplate / cathode bulging

Wall thickness 1+0.5mm

- MWPC-like

- CCC-like



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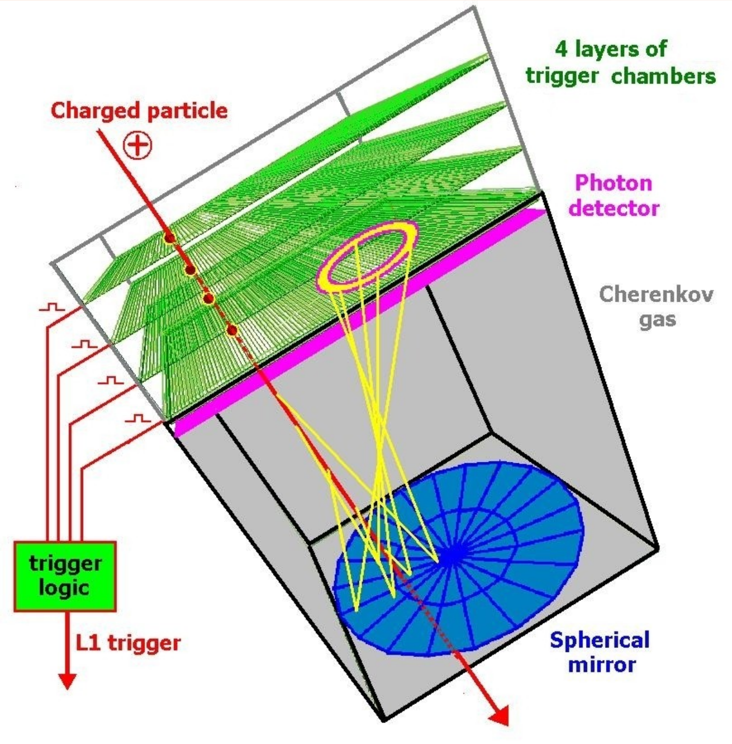
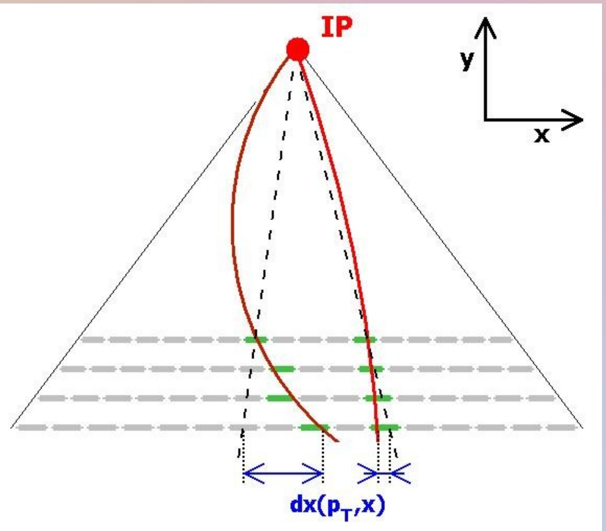
Proposed application: HPTD

- Component of ALICE VHMPID upgrade project
- CCC proposed as trigger (L0, L1) and tracking
- VHMPID postponed to LS3 in favour of more concentrated upgrades





NIMA 639 (2011) 274.
Nucl.Phys. Proc. Supp. 197 (2009) 296

CERN PS beam test

- Various HPTD elements for performance validation

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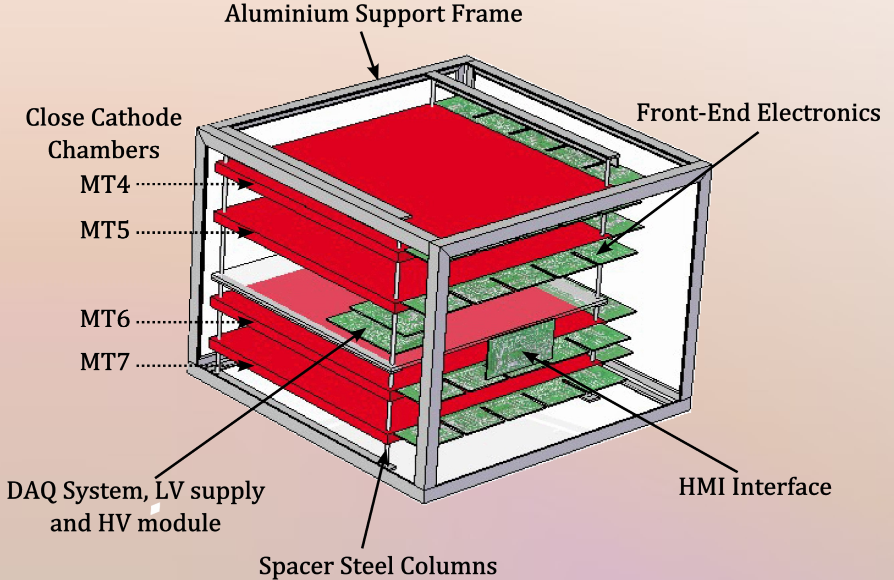
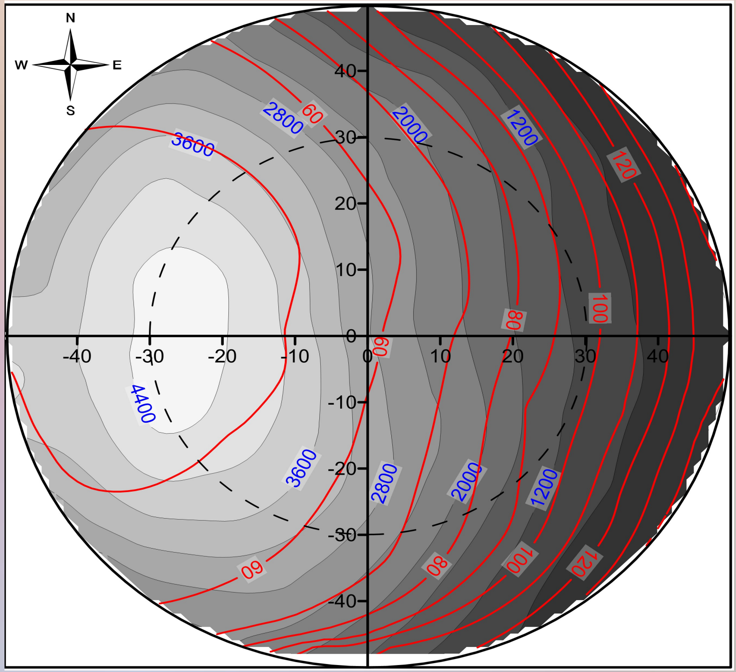
Application as cosmic muon tracking

- Two dimensional readout (pads and FW), triggering on summed SW signal – standalone system

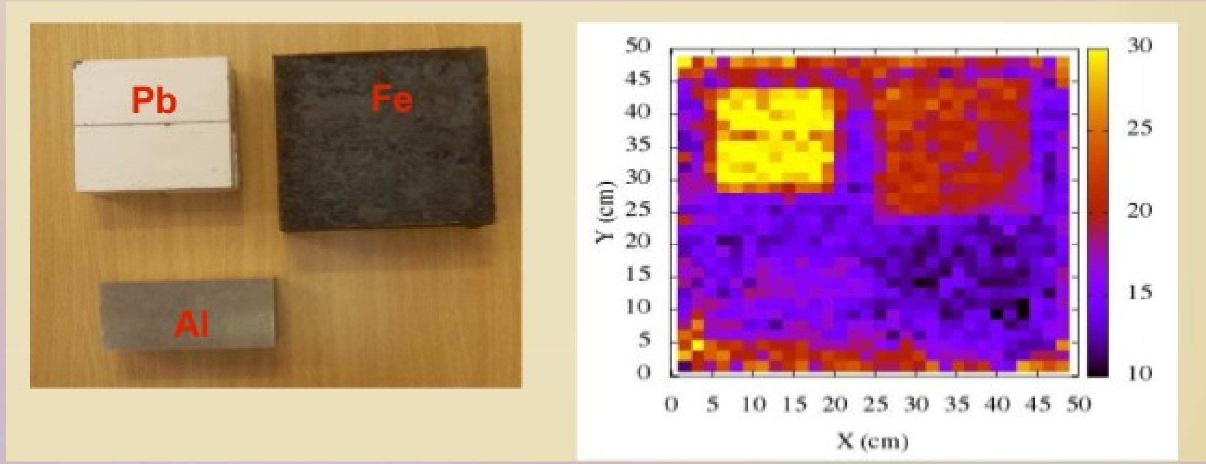




NIM A 689 (2012) 60-69
Adv. HEP (2013) 560192

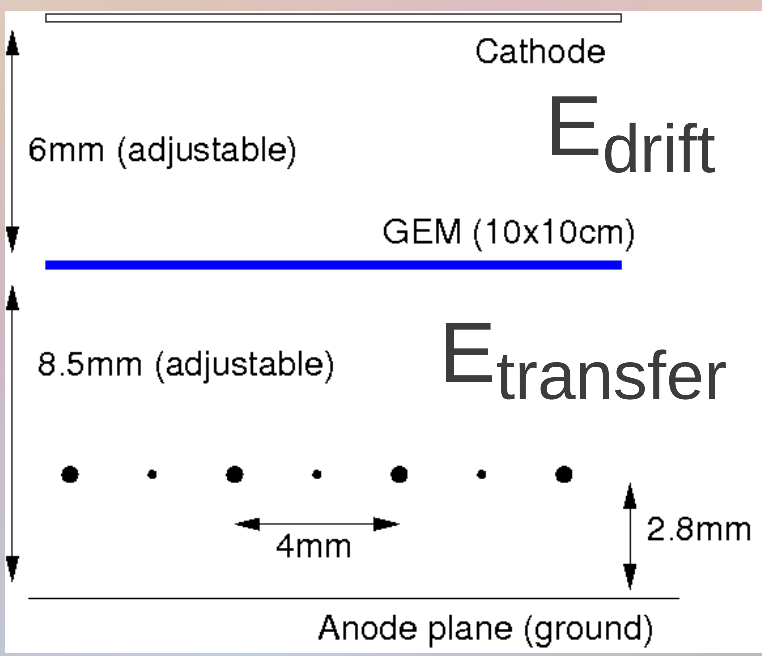
Tomographic cosmic tracking station

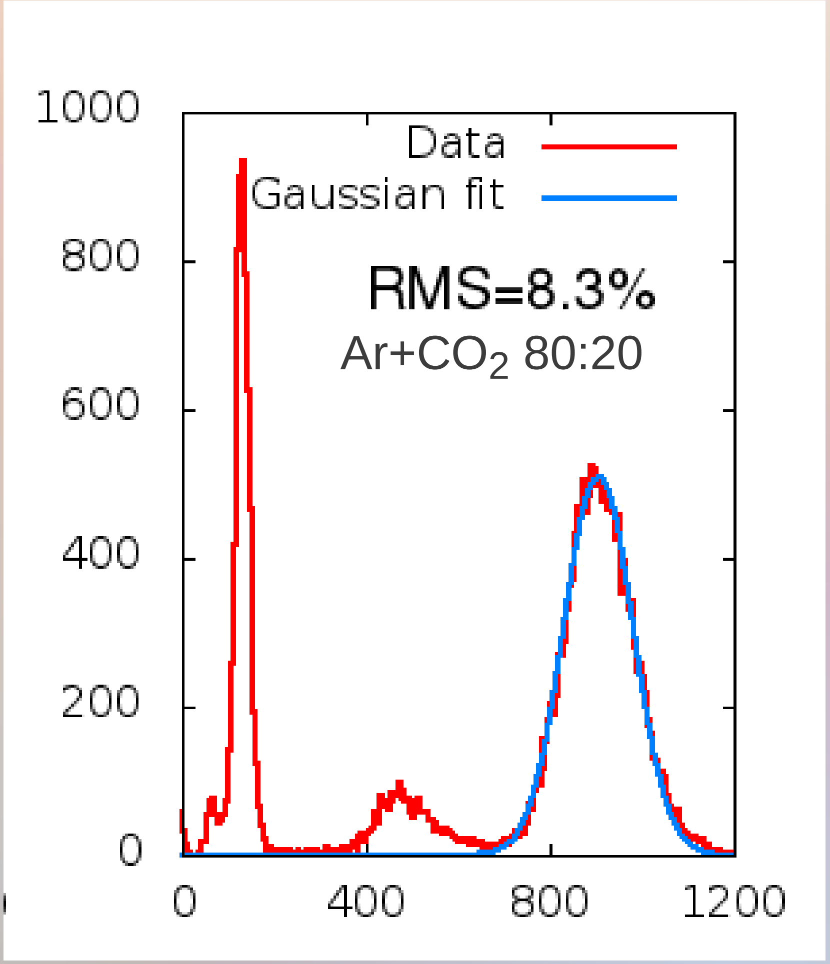
- Multiple scattering strength map for various samples



Hybrid: GEM + CCC for R&D and QA purposes

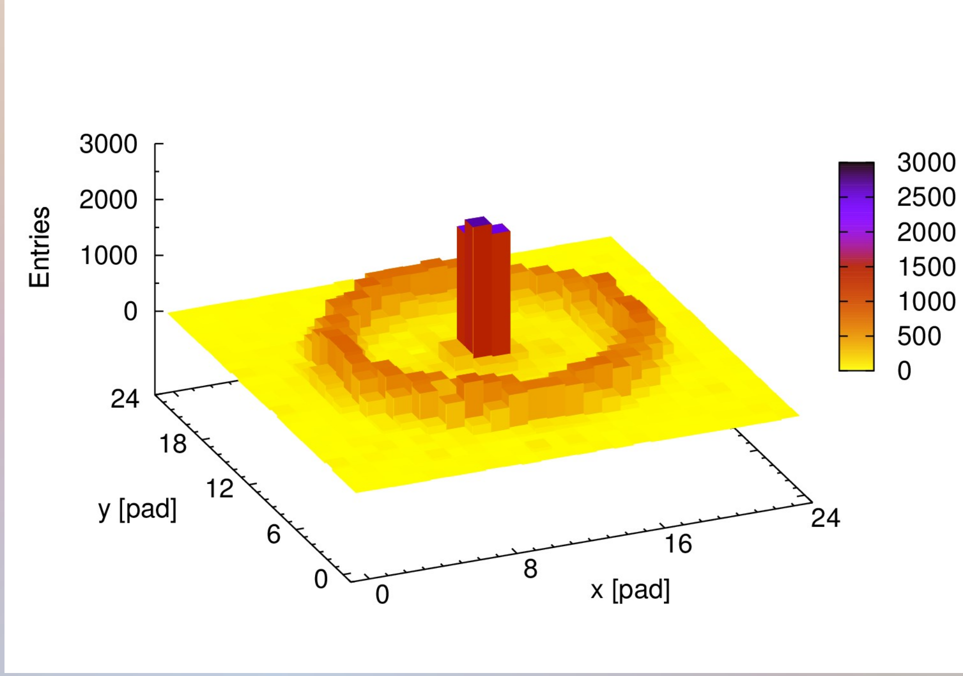
- Old concept with MWPC
- Possibility of testing single GEM layers

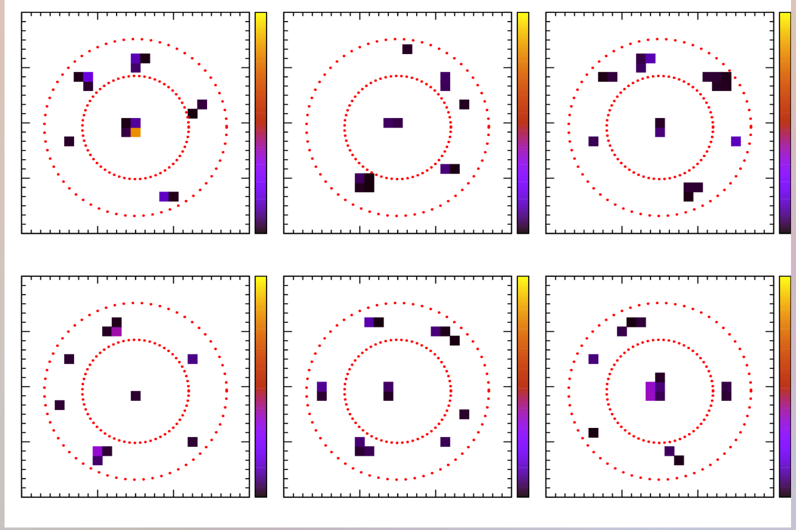




TCPD hybrid: TGEM + CCC for UV detection

- Complete Cherenkov ring with 20cm TGEM
- Note it has advantages from both worlds: high detection efficiency without sparks





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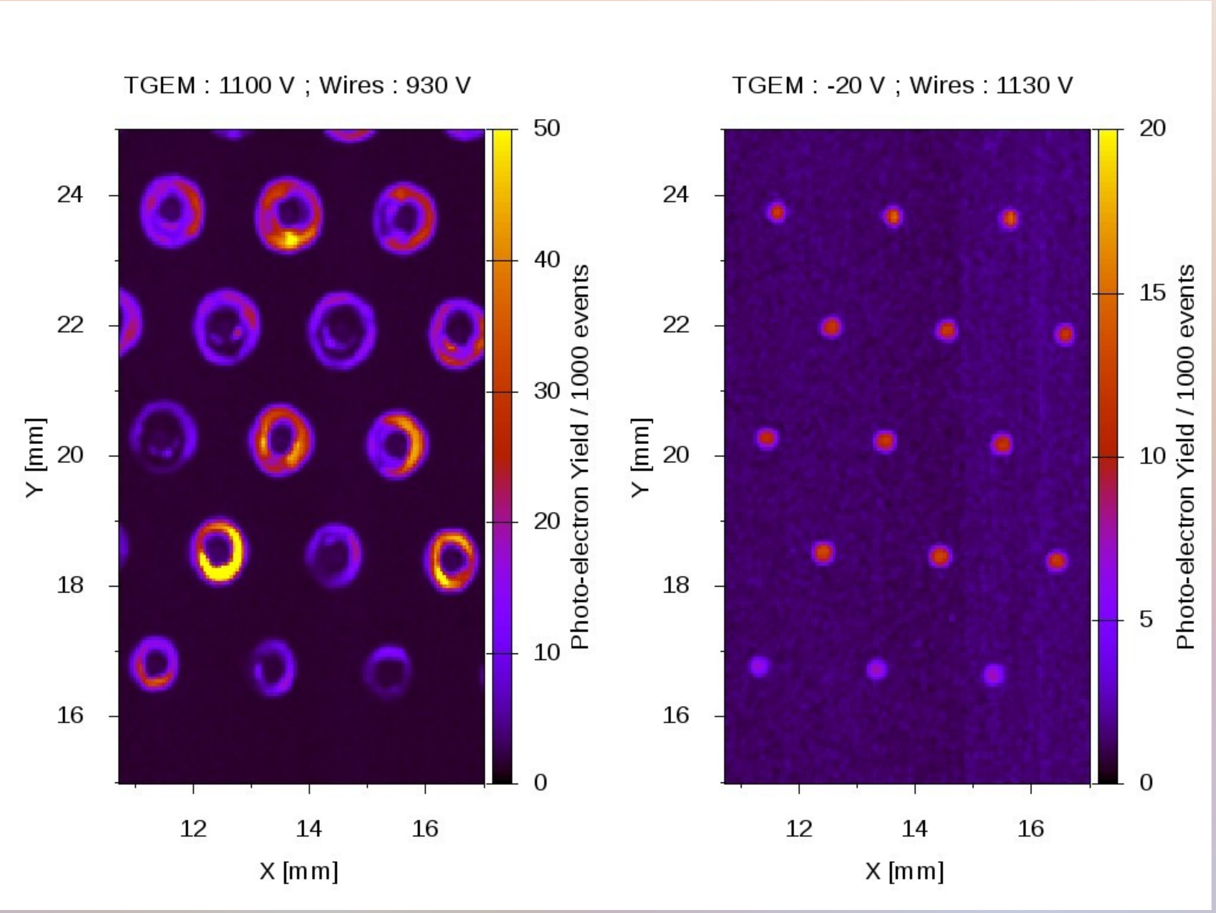
TGEM high resolution UV sensitivity scanning (Leopard)

- CCC as booster stage for TGEM
- Sensitive to single electrons by itself!
  (see right panel)



NIMA 694 (2012) 16, see talk by G. Hamar on Monday

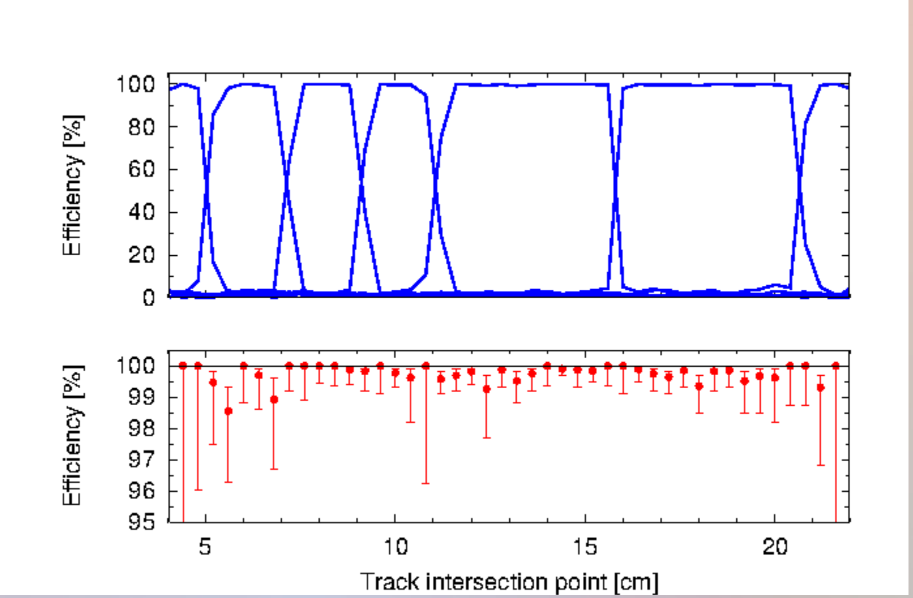
Conclusions

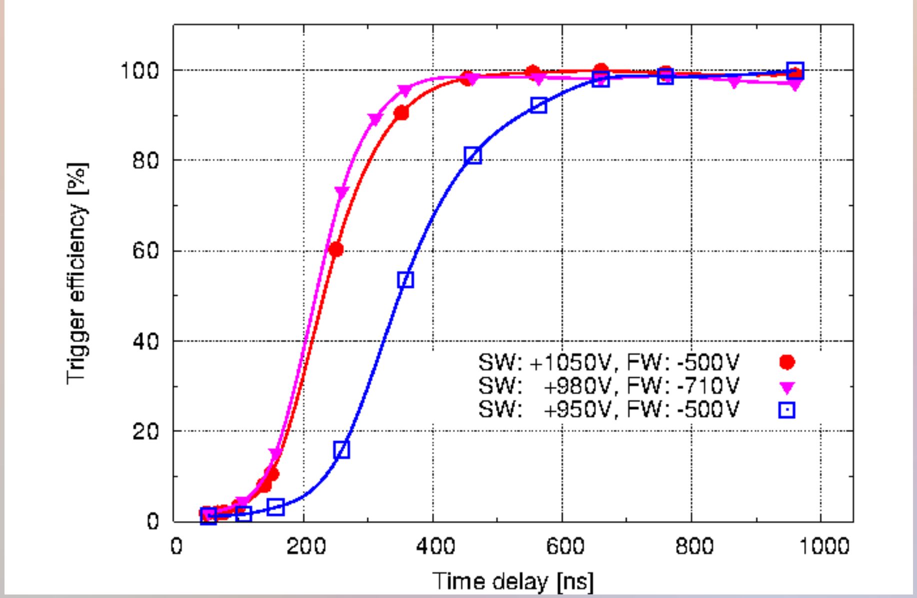
- CCC concept: some features of MPGD-s help improving the classical MWPC-s
- Low material budget, easy and cheap construction
- Mechanical resistance enables out-of-the-lab applications
- Proved to be an efficient gain booster in MPGD hybrids, both as detector and as R&D tool

Backup slides

Efficiency and timing

- Full efficiency; wire groups for rough position information
- Trigger formation time compatible with expectation and fulfilling ALICE L0 requirement



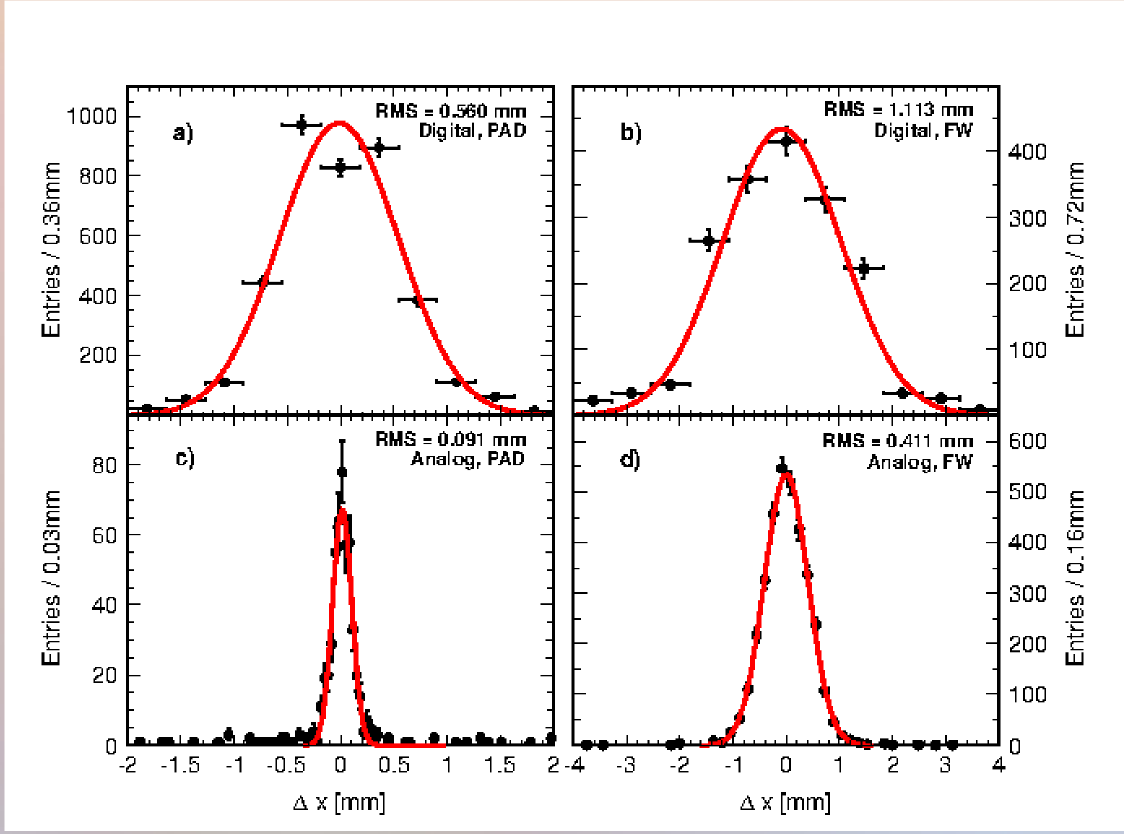


Position resolution

- “Discriminated” or “Analog” readout mode
- Note that analog readout of FW does make sense

Discriminated →

Analog →



2mm strips (pads)
4mm wire spacing
Gassiplex readout