Testbeam Plans:
Commissioning of Aluminum Micromegas & TPC for Proton Computed Tomography

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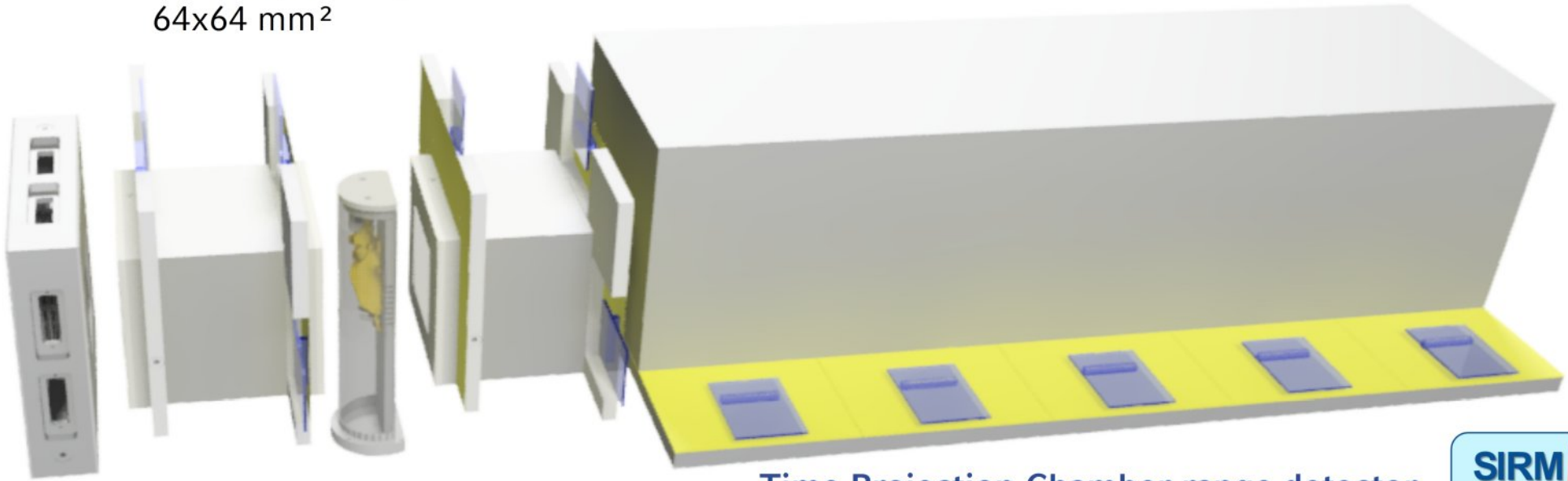
Context: Proton CT System Overview

spatial information from 2d floating strip Micromegas trackers
residual range (→ energy loss) from TPC with vertical absorbers
reference to treatment beam from 2d strip ionization chamber

4 aluminum FSM trackers
dual strips (x & y
64x64 mm²



IC: monitor
dual strip (x & y)
dual unsegmented

mouse holder
x, y, z, φ movement
sterile environment

Time Projection Chamber range detector
65 absorber foils (500µm Mylar)
8mm gaps in between

SIRMIO
2017-2021
K. Parodi
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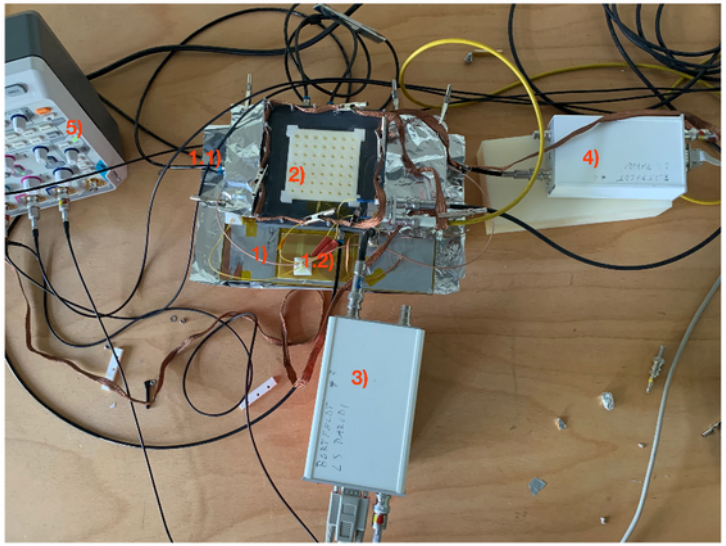
Preliminary Tests

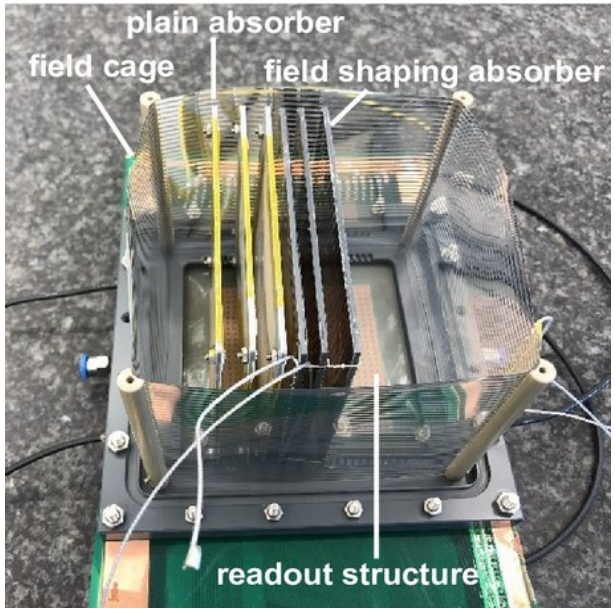
Aluminum Detector Prototype

- in-house production
- 2019: successfully tested in 22MeV proton beams with APV25 electronics
- 2020: 1 week irradiation with ^{90}Sr source
  ~ 100 tomographies → still alive



Small Time Projection Chamber Prototype

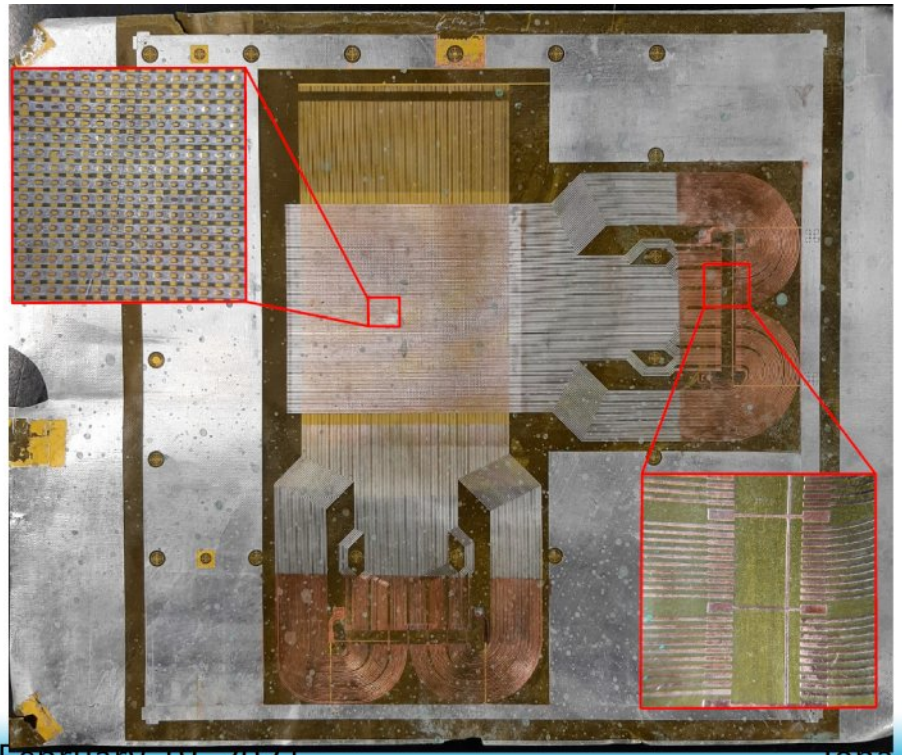
- in-house production
- full drift length, only 64 x 64 cm² readout structure
- 2019: successfully tested in 22MeV proton beams with APV25 electronics



Current Status: Full Size Detector Production

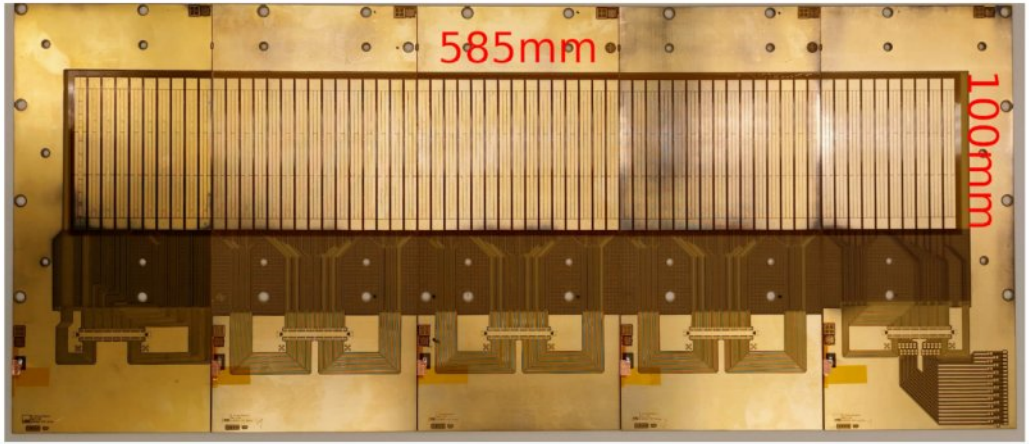
Improved Aluminum Micromegas

- improved design & production methods
- two readout PCBs ready next week,
  mechanical components few weeks → assemble



Floating Pad Time Projection Chamber

- 65 gaps, 9mm wide, 8 pads each → 5 SRS VMM FEs
- drift gap ~90mm
- readout structure: 5 individual PCBs
- pads connected to HV via screen printed Rs → done
- pillar structure → done
- individual HV stability: tested
- mechanical components ready in few weeks
  → assemble



Foreseen Setup @ Testbeam

trackers and TPC (with few absorber foils installed) on aluminum plate
→ table available?
→ material budget (within 10x10cm² < 10mm water equivalent)

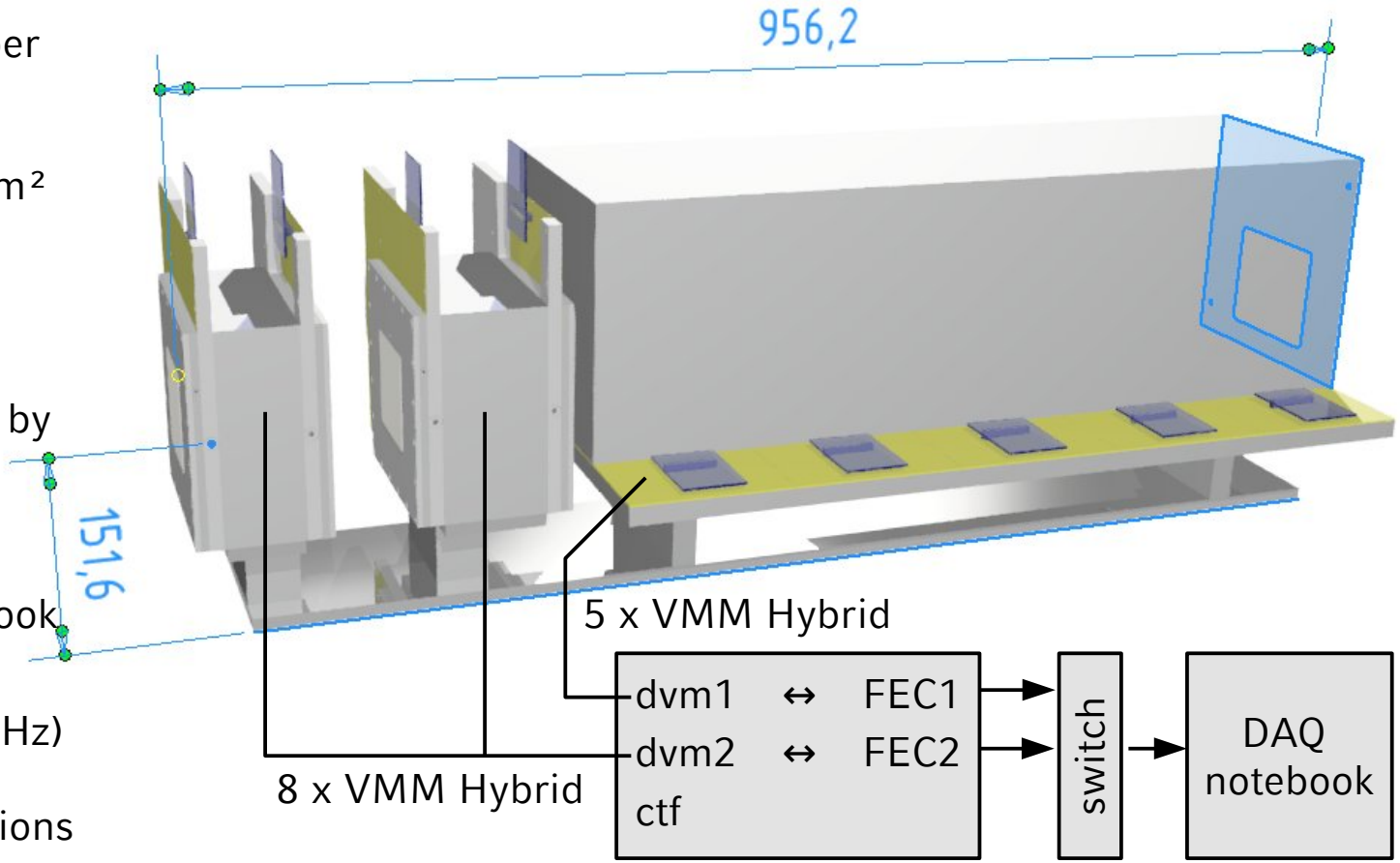
DAQ: 13 VMM hybrids + SRS
→ DAQ notebook close to setup

HV: iseg SHQ supplies, controlled by SC computer close to setup

gas: premixed Ne:CF_4 80:20

space in control room: one notebook

beam:
- several days low rate (10 – 100kHz)
- few days high rate (1 – 5 MHz)
- muons preferred but fine with pions



Summary

full size aluminum Micromegas trackers and Time Projection Chamber production

- readout structures: ready (next week for MM)
- mechanical components: ready in few weeks → then assemble
- test MMs and TPC with cosmics during spring

test beam goals (autumn)

- commission MM and TPC & find optimum HV parameters
- test new VMM SRS in real beam
- measure relative detector alignment & rotation
- determine optimum spatial resolution (for HE & straight tracks)
- investigate high-rate capability and find limit

any position for parasitic running fine (no magnetic field)

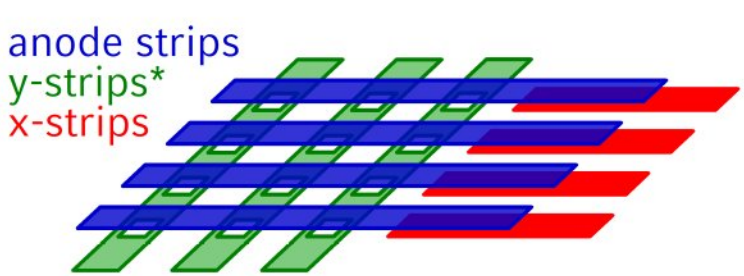
Thank you!

backup

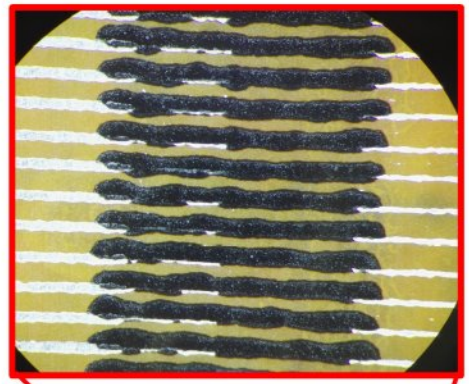
backup: In-house Production: Aluminum Floating Strip Micromegas

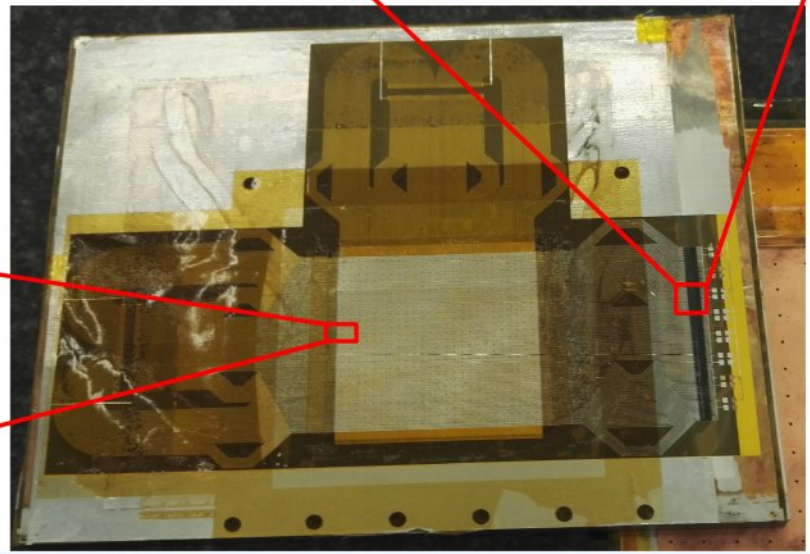
12µm Al anode strips &
y-readout- strips (direct coupling) on
32µm Kapton & glue
→ x-readout strips outside active area
→ 0.15 X_0 per detector (70% from mesh)

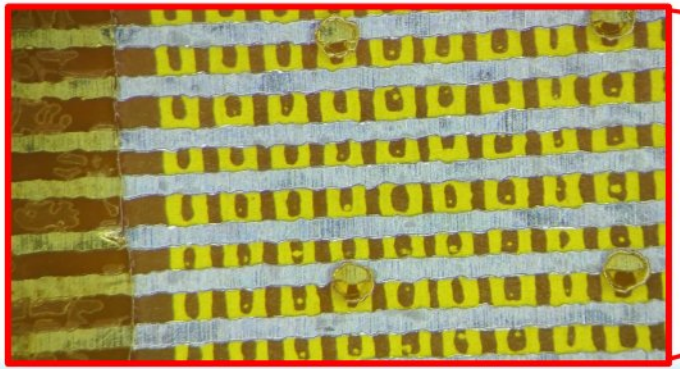
LMU PCB workshop: laminator, UV exposure unit
detector lab: solder resist spray, development, chemical & electroplating, etching, stripping, curing, mesh stretching, screen printing



*: pattern inspired by F. Klitzner, LMU Munich

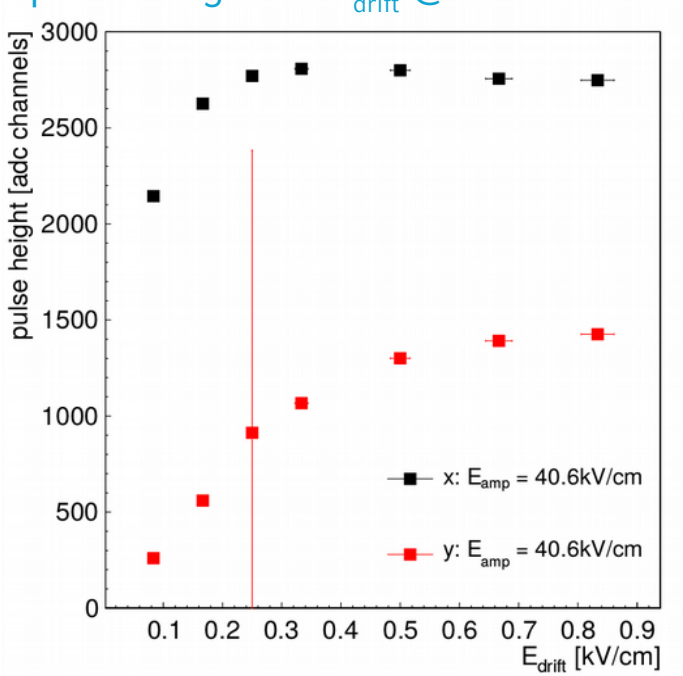




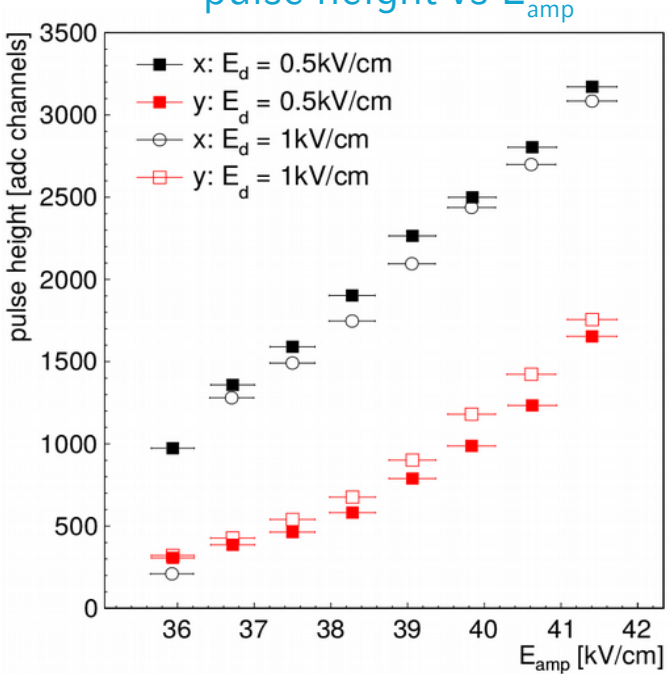


backup: Aluminum Micromegas: Pulse Height vs Voltages @ 22MeV Protons

pulse height vs E_{drift} @ 40.6kV/cm



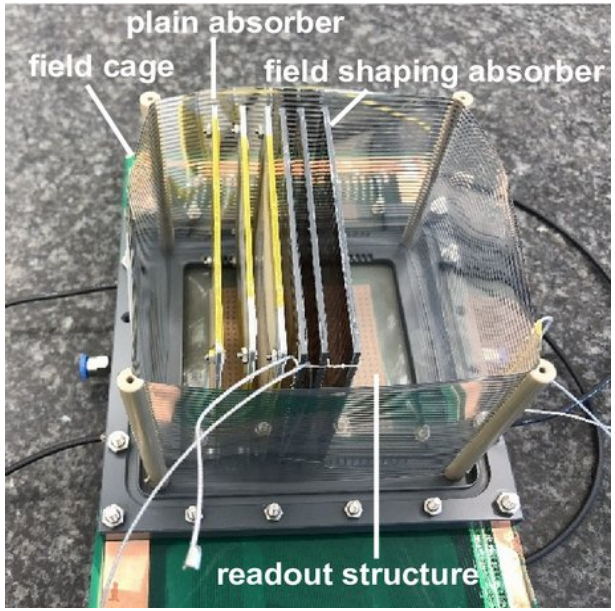
pulse height vs E_{amp}

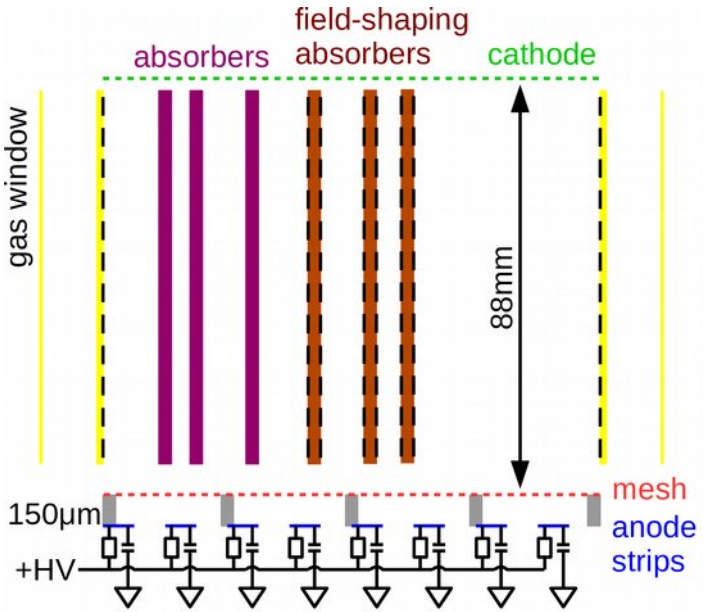


x: typical transparency behavior
y: influence of electron drift velocity → bi-polar signal

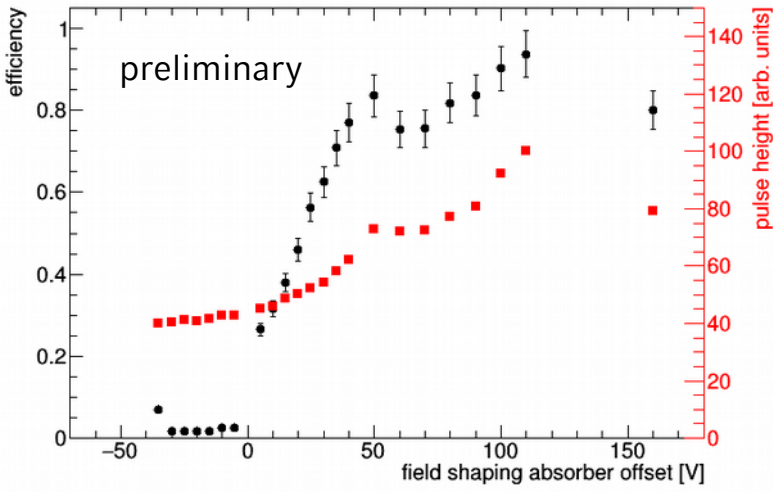
pulse height ratio y/x ~ 0.5 → well usable

backup: Range Time Projection Chamber: Prototype Tests



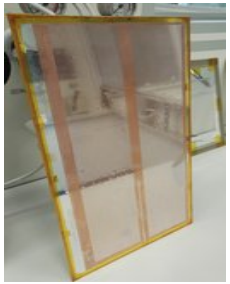


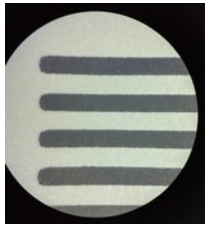
variation of absorber offset voltage
@ 54mm electron drift distance



- 88mm drift region
- 64x64mm² strip Micromegas readout structure
- 50µm Mylar field cage
- absorbers: 3 field-shaping, 4 plain (PTFE or Mylar)

recent beam tests @ 22MeV & 75MeV p
→ understand concept





1mm strips
1mm gap