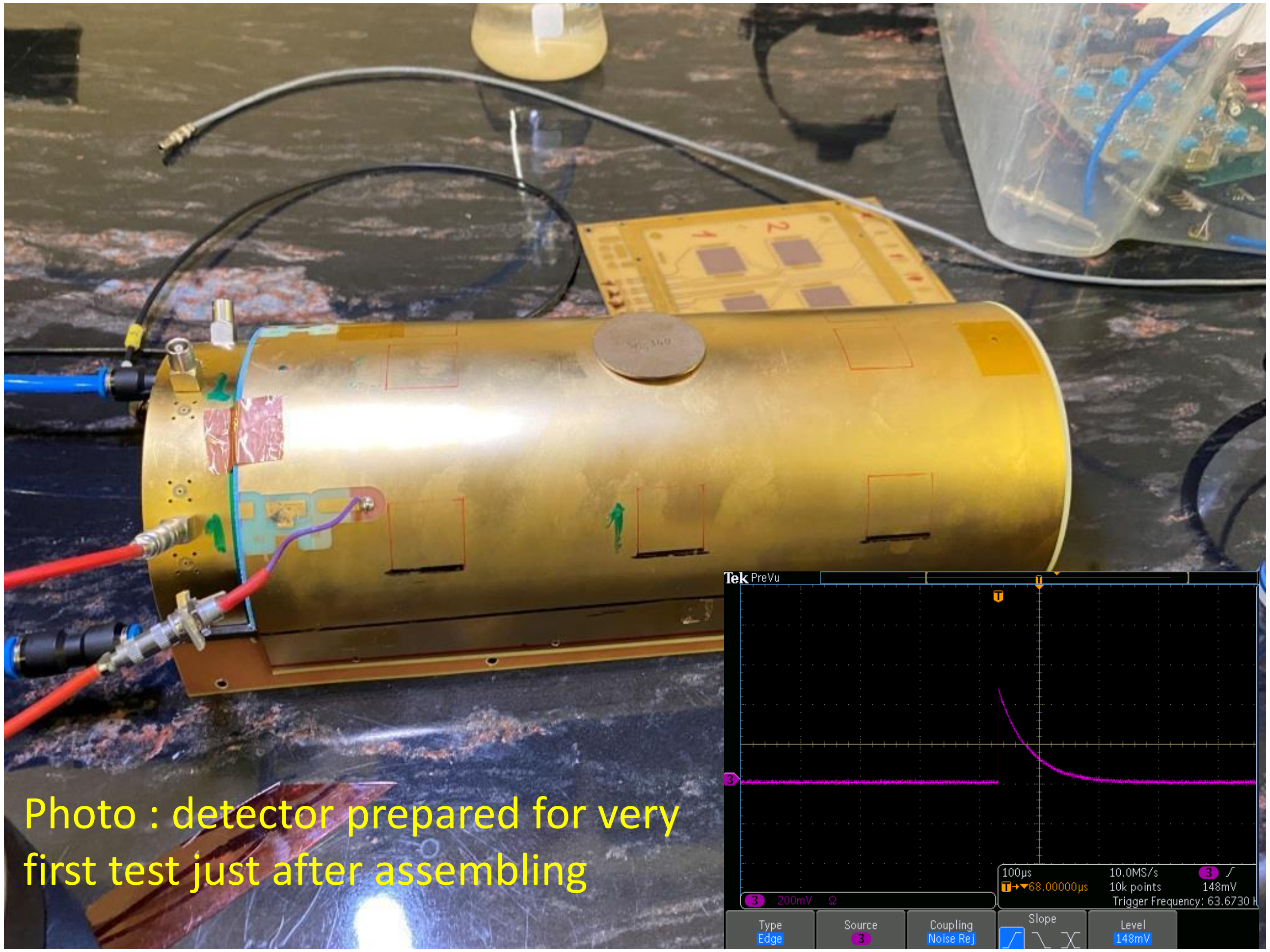
Status of Micromegas Central Tracker

Dedovich D

First prototype of Cylindrical chamber

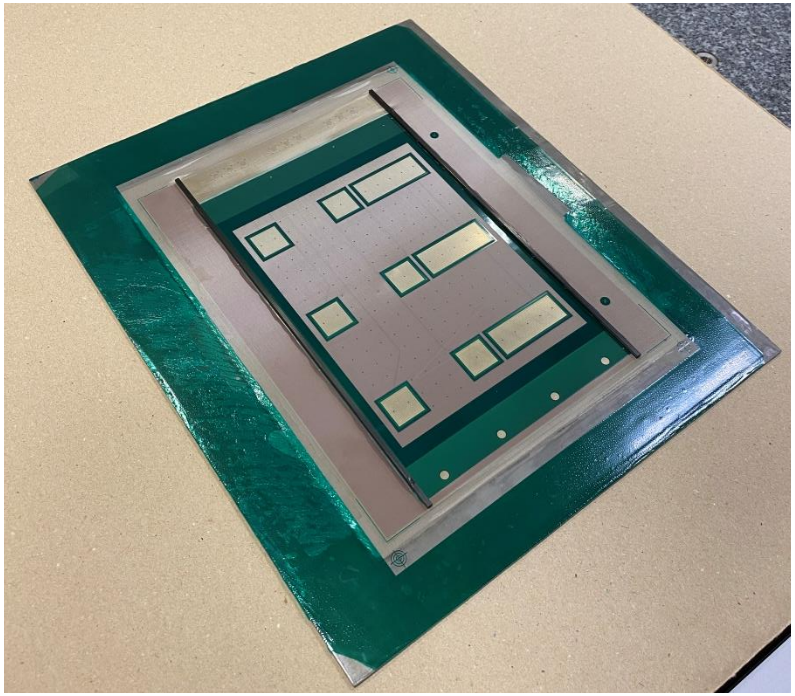


Full assembling time is 1 week

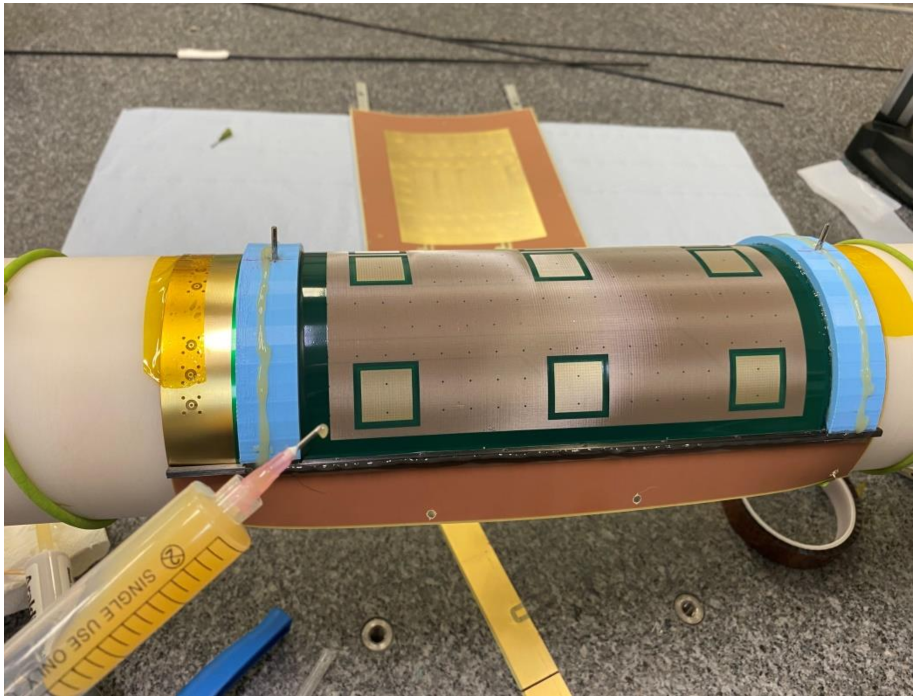
First prototype of Cylindrical chamber

Main steps of bended MM production

MM module (anode PCB + mesh) before bending



MM module bended on assembling table before cathode gluing

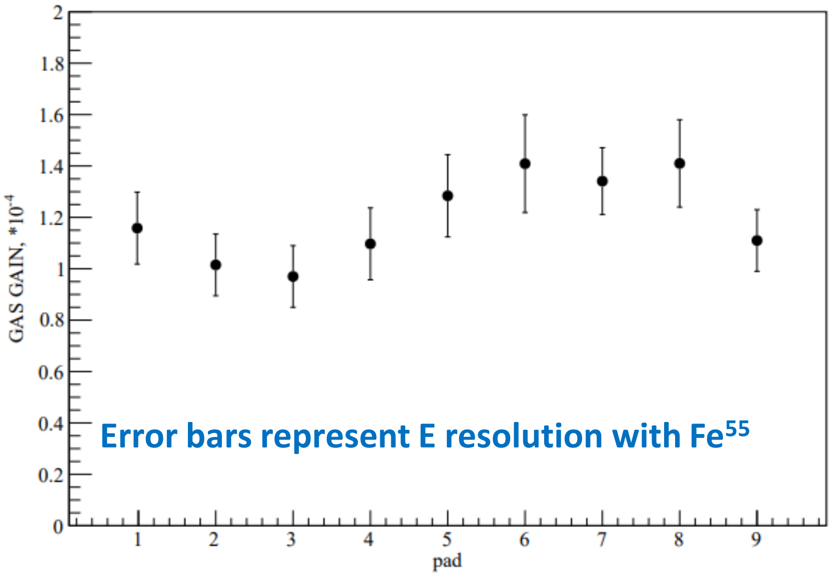


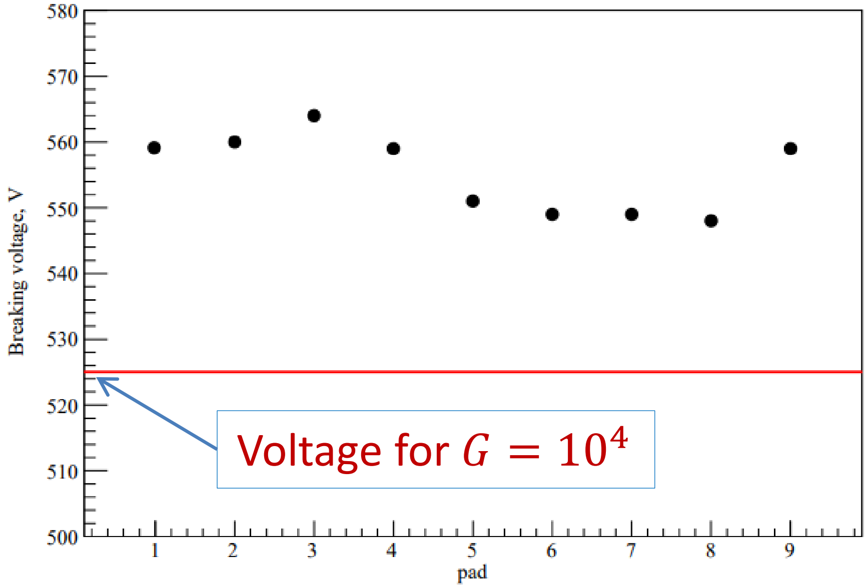
Signal electrodes shaped as 9 pad to check gain (⟺ gap) uniformity after bending

First prototype of Cylindrical chamber

Maun task of 1st prototype is to check the assembling method and detector uniformity after bending

Gas gain (left) and breaking voltage as a function of pad number



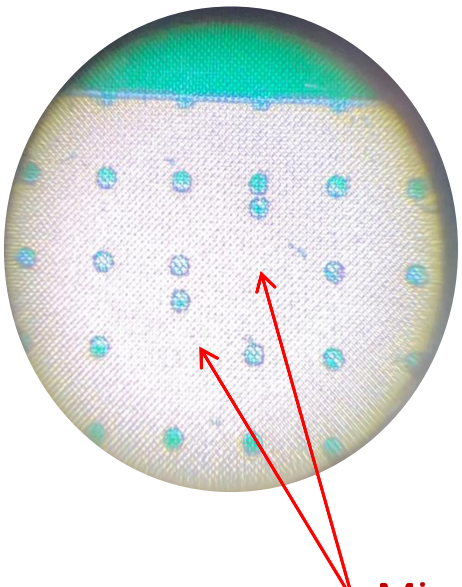


- Stable operation with gas gain $G = 10^4$
- Gain spread may be explained by 3μ amplification gap variations

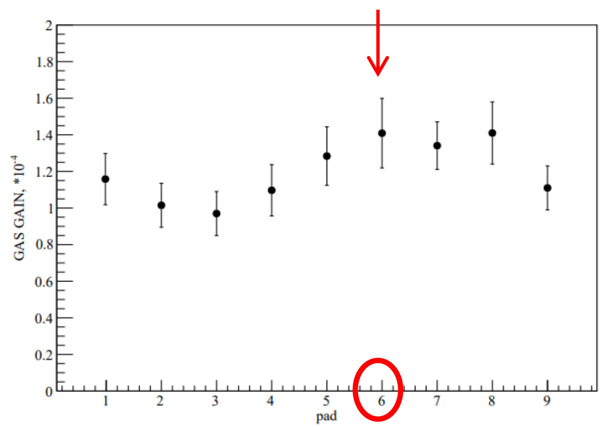
First prototype of Cylindrical chamber

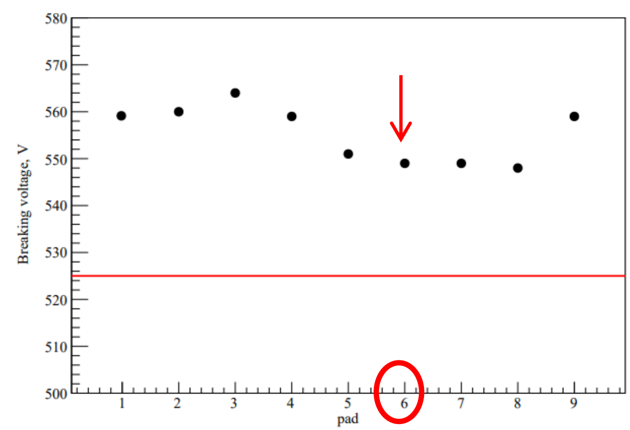
Broken pillars effect test

- Broken pillar is common problem for mass production
- Cylindrical MM must have a lot very small pillars (0.2 mm diameter, 1 mm pitch), pillar damage is quite probable
- 2 pillars was shifted on signal pad #6
- **No crucial effect is observed**



Missing pillars

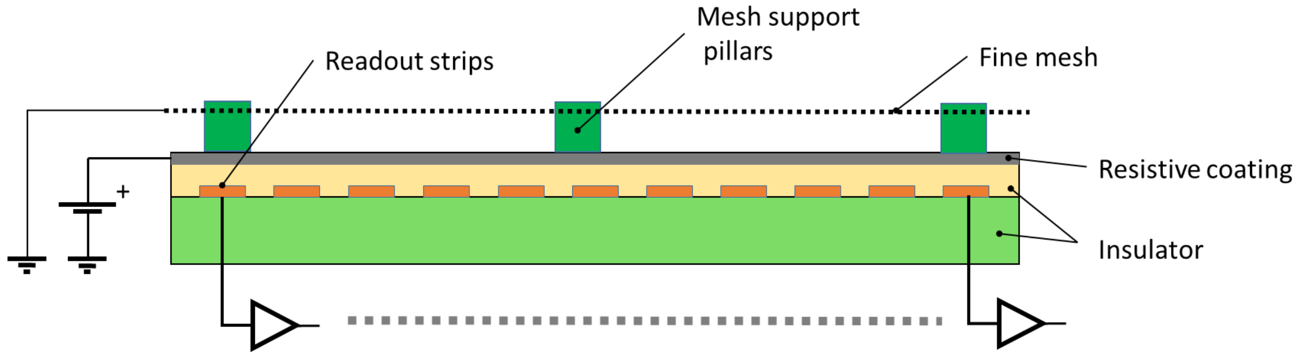




DLC degradation test

Why degradation test is needed?

- Micromegas is vulnerable to discharge due to high-ionization track
- In hadron accelerator environment high ionization due to slow proton or neutron interaction is typical



- High-resistive anode used to localize discharge (DLC, diamond like carbon in our case)
- DLC thickness is about 0.1μ, it may be damaged by discharge

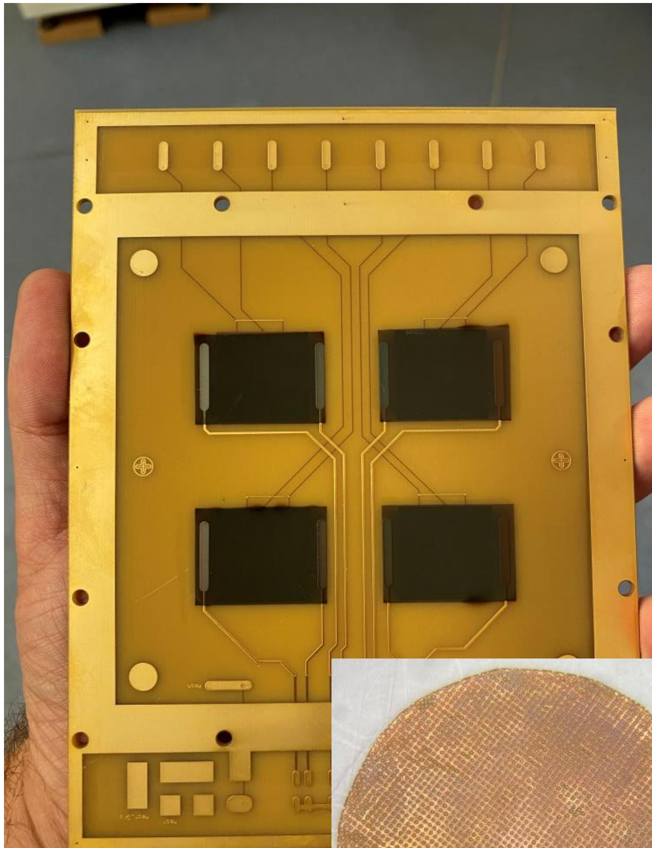
DLC degradation test

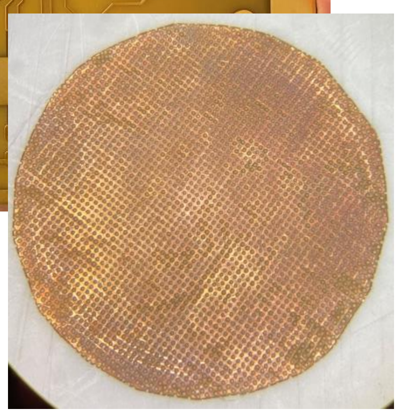
How we study the degradation?

Control Fe^{55} spectrum #1 → Operation under α-source $R_{\blacksquare}$ control → Control Fe^{55} spectrum #2

- How can degradation be manifested ?
  - Increasing of the DLC resistance
  - Worsening of energy resolution
  - Substantial changes of amplitude

DLC degradation test



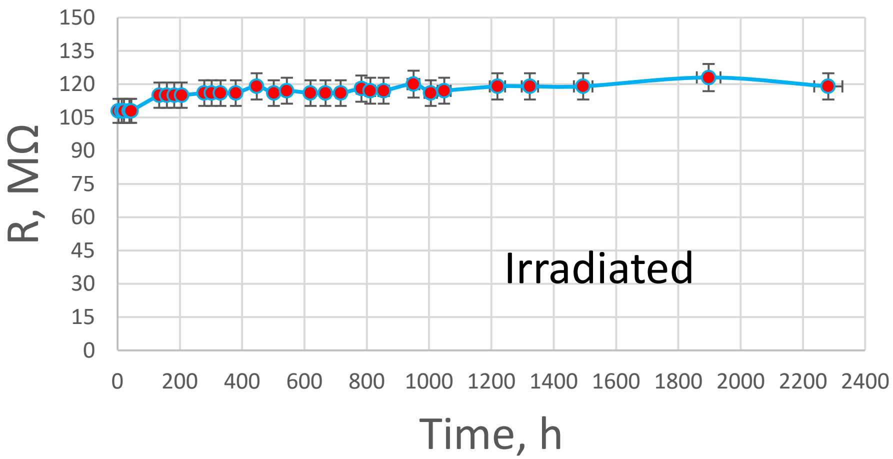


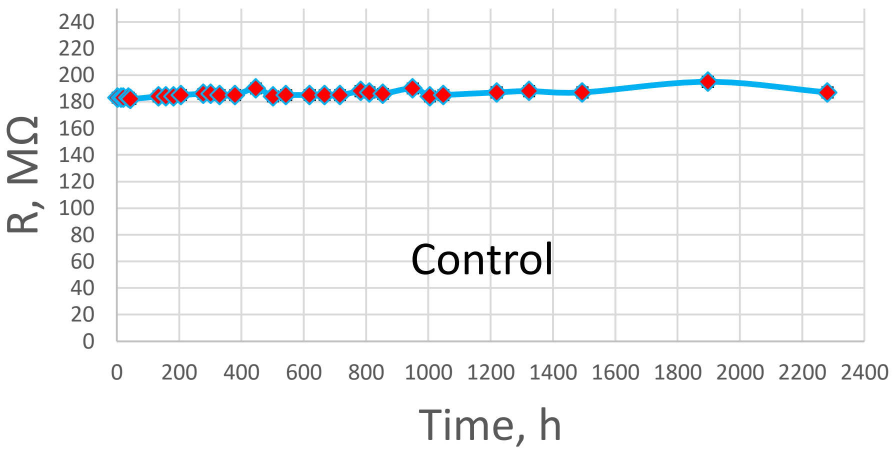
- Special chamber was produced with 4 independent active regions with the possibility to measure resistance without detector disassembling
- 2 chamber operate ~4 months, 2 pads was irradiated by α-source, 2 used as a control one
- Multichannel collimator limit the track angle within $\mp 30^{o}$

DLC degradation test

No significant signs of degradation is observed

The sheet resistance of DLC coating for irradiated and control sample





Total discharge number $\sim 9 \times 10^8$,
equivalent of 7 Hz/cm^2 for 2 years of operation

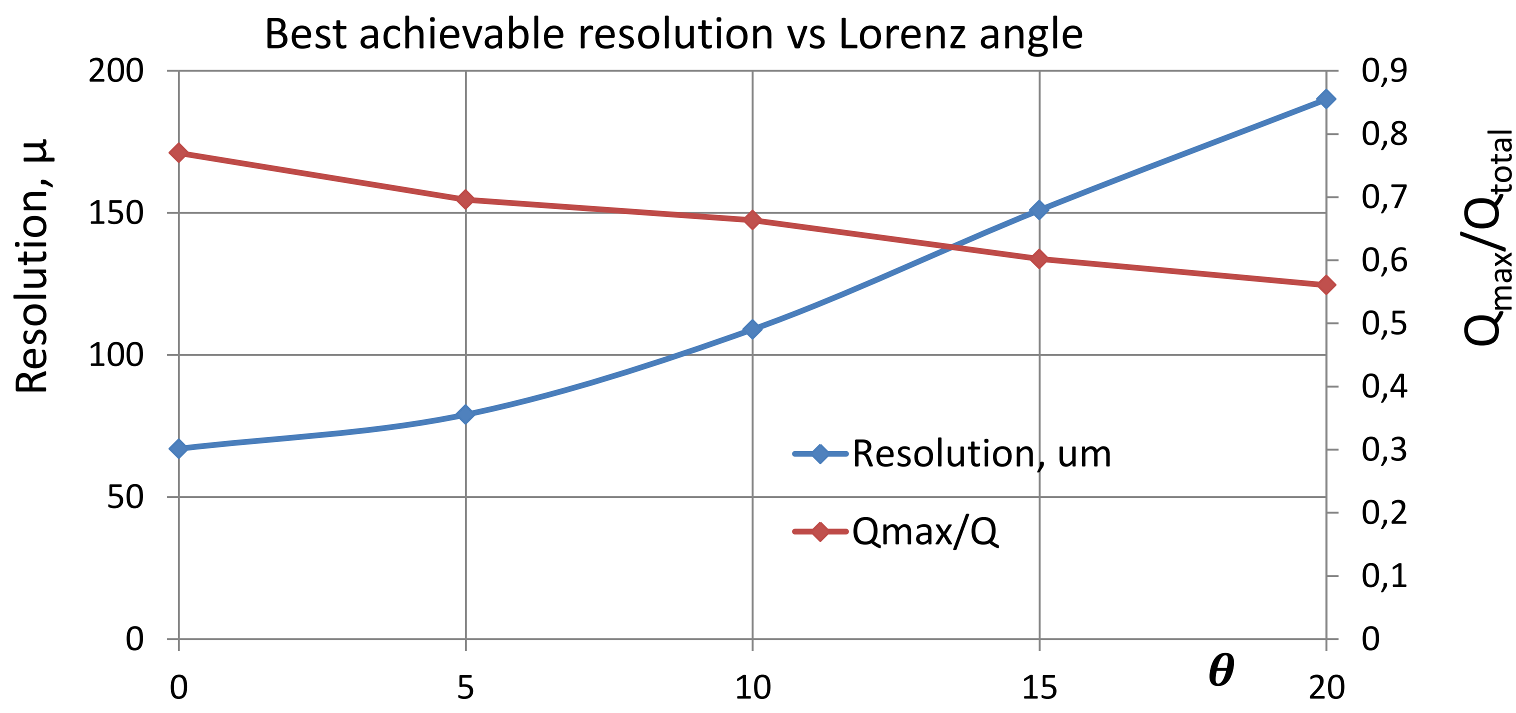
Simulation of detector performance
with different gas mixtures

- Main characteristics are space resolution and amplitude, both degrade fast with increasing of Lorentz angle
- For most of mixtures increasing of drift field reduce the Lorentz angle, but the same time reduce charge collection efficiency
- Our aim is to find best compromise
- Why we need this data now?
  - Estimate acceptable noise level of FE and detector efficiency
  - Some mixtures apply special requirement on gas system and experimental set-up (particularly the flammable one)

Simulation of detector performance

Lorentz angle effect

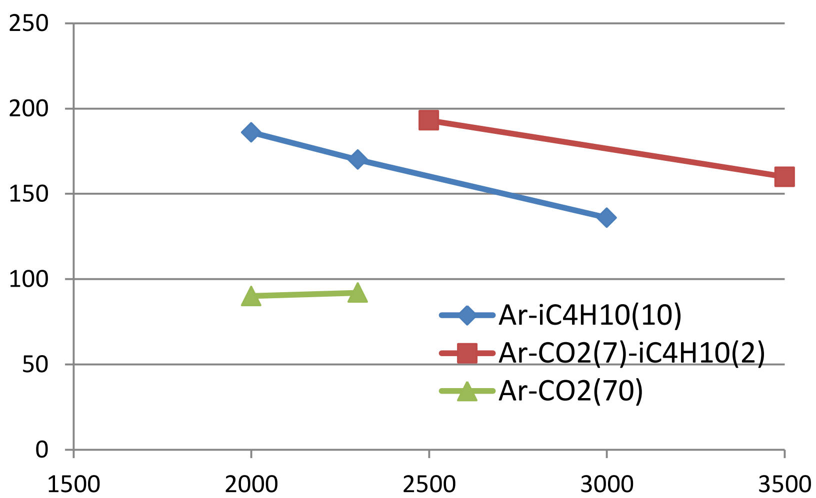
From the detector response point perpendicular track with non zero Lorentz angle is equivalent to inclined track

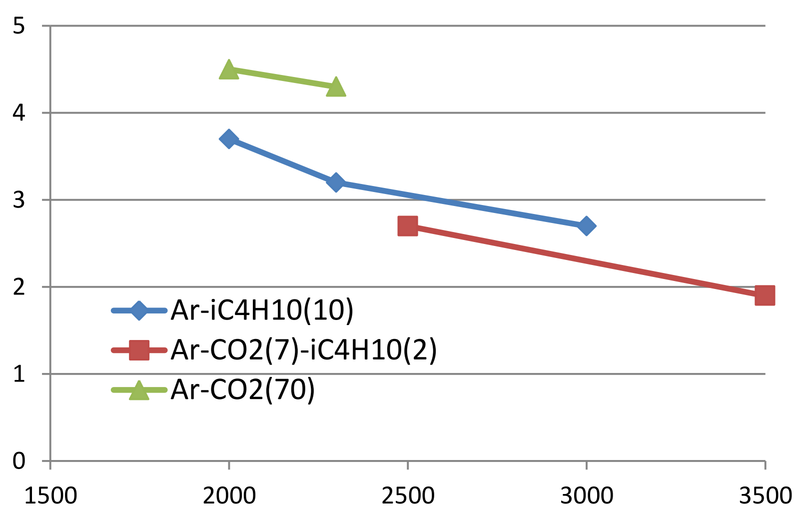


Simulation of detector performance

with different gas mixtures

- Garfield simulation was done for 4 mixtures:AriC4H10(10%) $ArCO_2(7\%)iC_4H_{10}(2\%)$,$ArCO_2(70\%)$,$ArCO_2(7\%)$.
- Gas gain was normalized to real data with safety factor 0.5





For reference: VMM noise with similar strip size is slightly bellow 0.5 fC RMS (ATLAS)

Simulation of detector performance

with different gas mixtures

- According the simulation, ArCO2 mixture with CO2 fraction about 70% provide the best detector performance

- Space resolution ~100μ and efficiency above 95% at 4 fC threshold with noise level about 0.5 fC RMS imay be reached

- **The test without magnetic field will not reveal real detector performance**

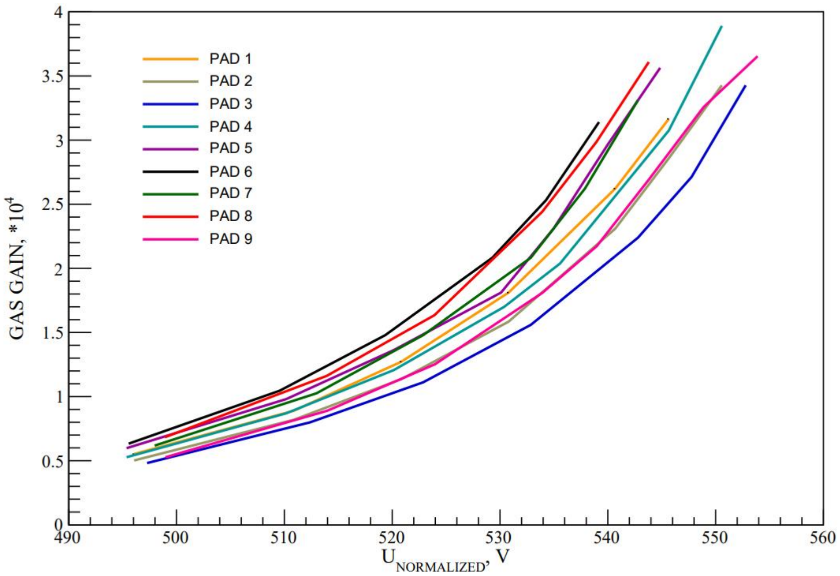
Future plans

- 2 chambers will be sent to CERN this week.
  - Compare performance of chambers with different pillar structure. We need PCB with very small pillar pitch (1mm , while the standard value >5mm)
  - Compare resolution with .4 and .6 mm pitch
- We plan produce new prototype before end of this year
  - Realistic strips structure, realistic dead area size, fixation & alignment elements, integrated cables, but ½ active area length
- 2 more iteration before mass production

Backup slides

First prototype of Cylindrical chamber

Gain variations vs gap variation



Gain vs voltage G(U) plots

$$G = e^{\alpha(E)d}$$

$$d \to d + \Delta d$$

$$G_0 \to e^{\alpha\left(E_0 * \frac{d-\Delta d}{d}\right) * (d+\Delta d)} = e^{\alpha(E') * d * \frac{d+\Delta d}{d}}$$

$$G_0 \to \left[G(U_0 \frac{d - \Delta d}{d})\right]^{\frac{d+\Delta d}{d}}$$