µRWELL test beam preliminary results @ CERN-H8

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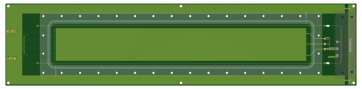
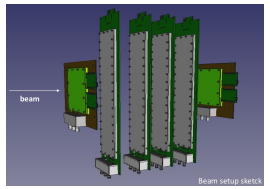
2– INFN Ferrara
3– LNF-INFN
4– INFN Bologna

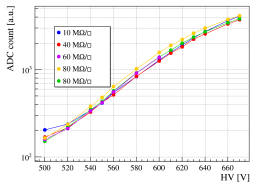
Outline



1. Design optimization and **prototype** layout



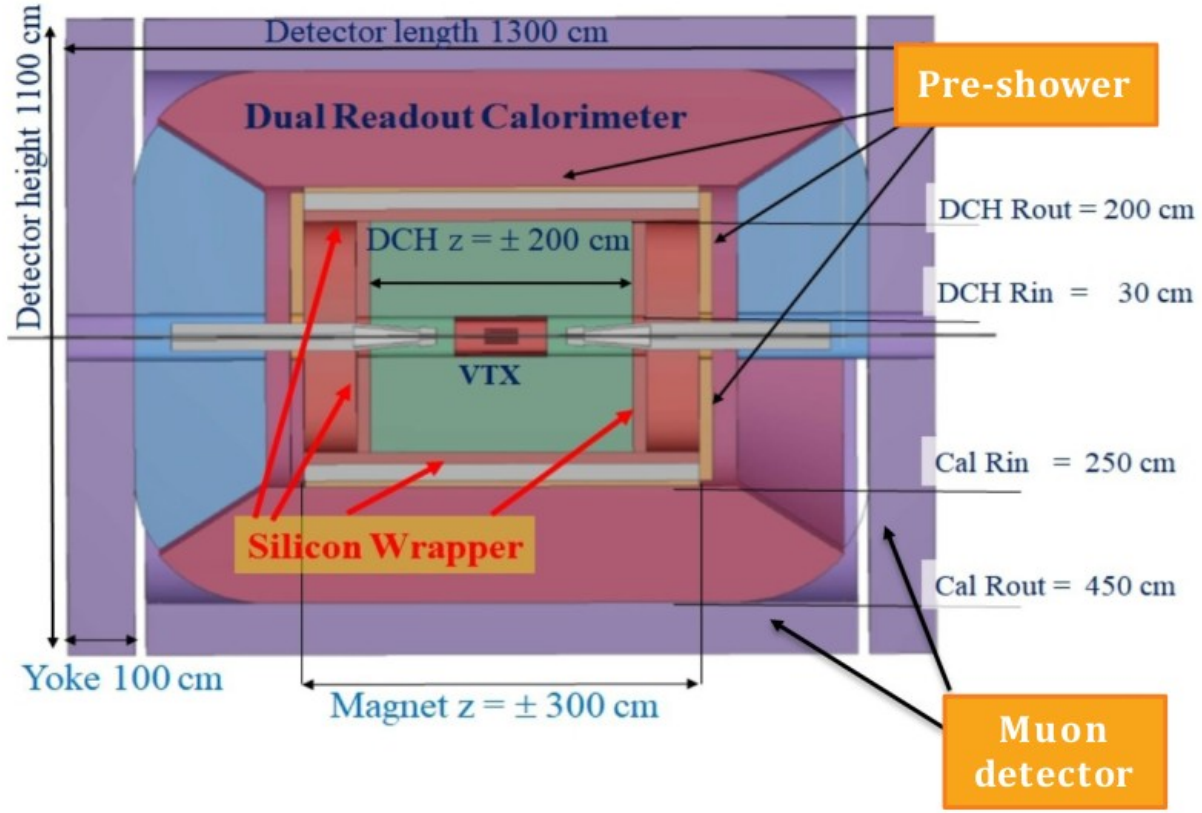
2. Test Beam **setup** and data collected



3. **Considerations** on preliminary results

IDEA pre-shower and muon system

The **IDEA detector** is a general purpose detector designed for experiments at future e^+e^- colliders (FCCee and CepC).
Pre-shower detector and the Muon system are designed to be instrumented with μ-RWELL technology.



Pre-shower — Oct.'21 TB

Tiles: 50x50 cm² with X-Y readout
Strip length: 50cm
Strip pitch: 0.4mm
Input FEE capacity ~ 70 pF

TOT: 330 m², 1.5×10^6 channels

Muon detector — TO BE DONE

Tiles: 50x50 cm² with X-Y readout
Strip length: 50cm
Strip pitch: 1.5mm
Input FEE capacity ~ 270 pF

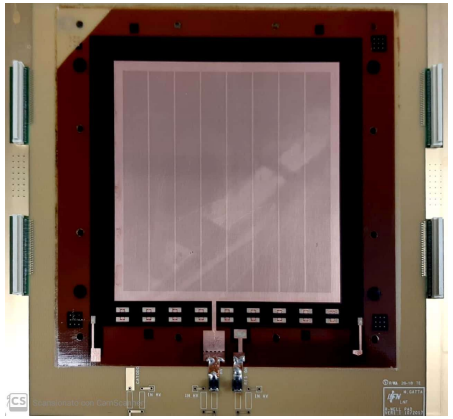
TOT: 4000 m², 5×10^6 channels

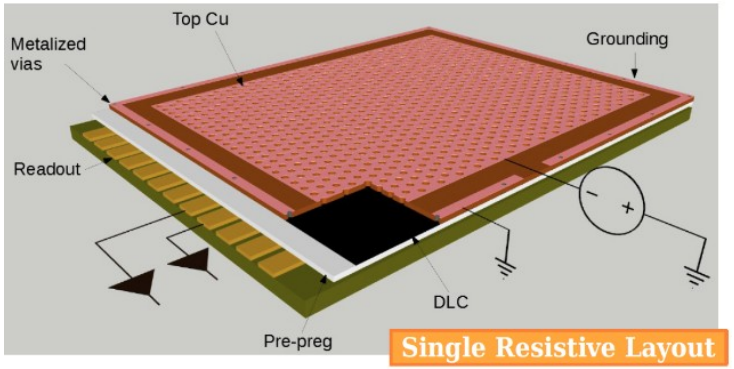
TB GOALS:

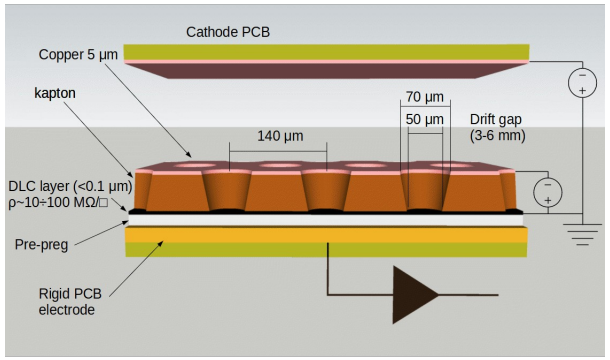
- **Charge spread measurement to optimize readout geometry** (strip pitch/width/lenght vs DLC surface resistivity).
- Tuning of μ-RWELL **resistive stage simulations.**

Detector design

Active area: 10x10cm^2





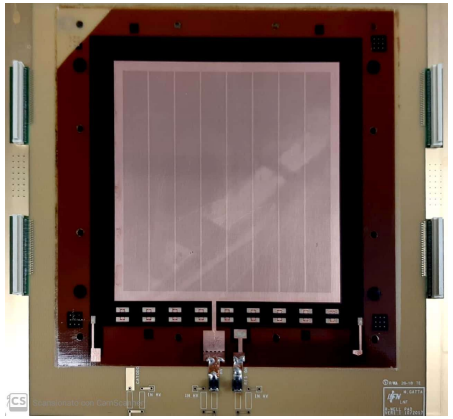


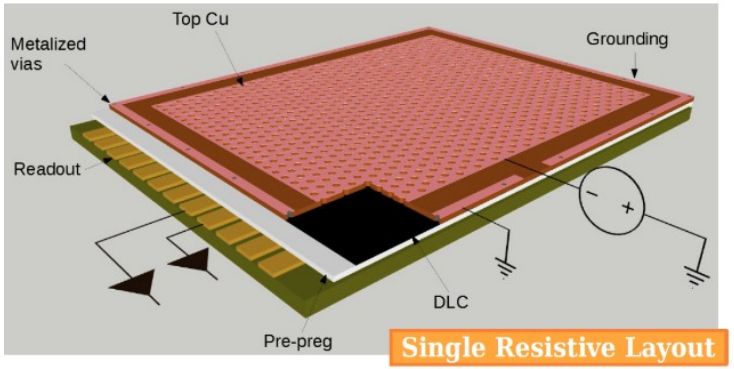
Active area: 5x40cm^2

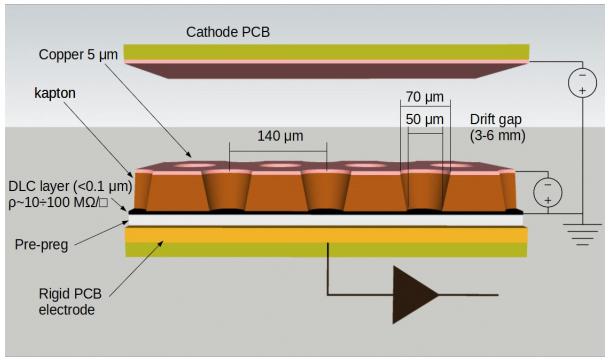
What	µ-RWELL trackers	µ-RWELL test chambers	FEE signal
Active area	10x10cm^2	5x40cm^2	
Strip pitch	400µm	400µm	
Strip length	10cm	40cm	
Strip width	300µm	150µm	**÷ 2**
Strip distance from DLC	100µm	50µm	**× 2**
Amplification WELL diameter	Standard (70µm)	Larger (to be measured)	**÷ ?**
DLC surface resistivity	30÷40MΩ/□	10÷80MΩ/□	

Detector design

Active area: 10x10cm^2







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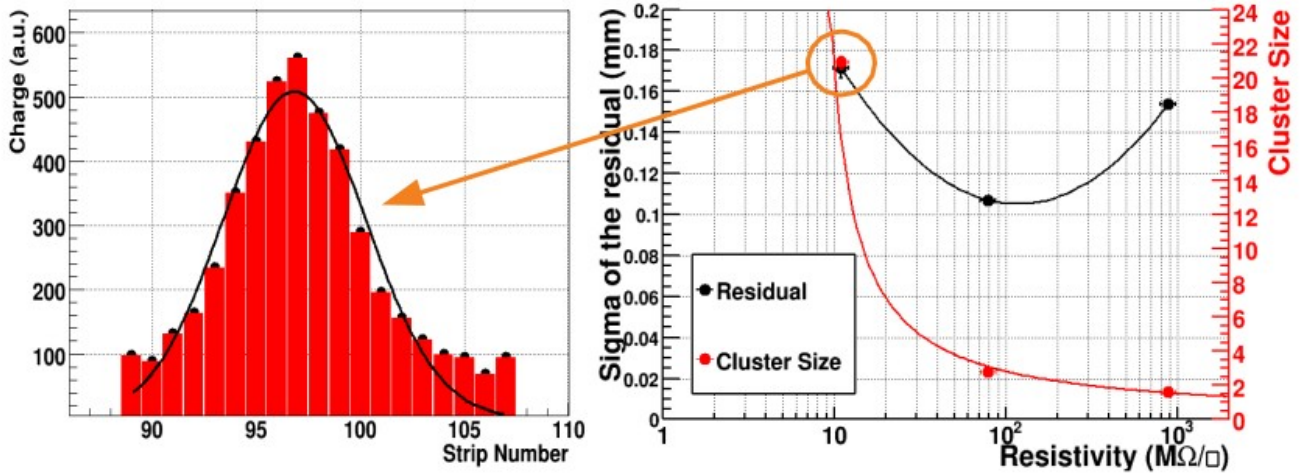
Previous resistivity scan from G. Bencivenni et al.

Charge collected by the APV25 on the Strip readout (resistivity ~ 10 MΩ/□)

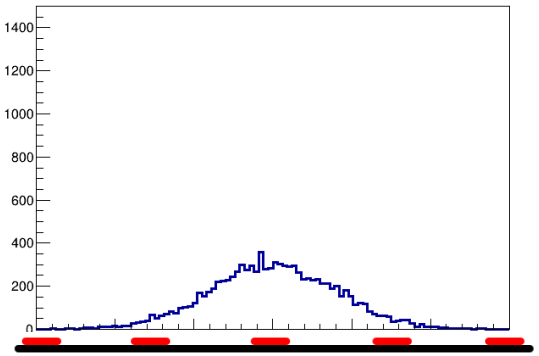
APV25 & 400 μm strip pitch →capacity = 15 pF

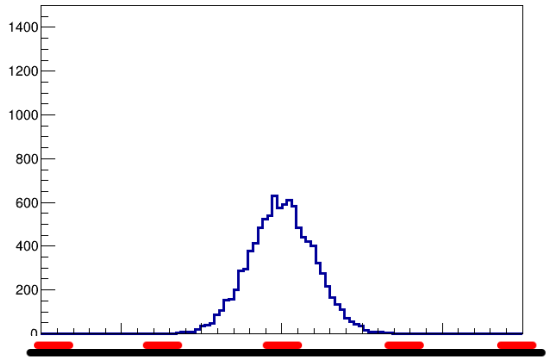


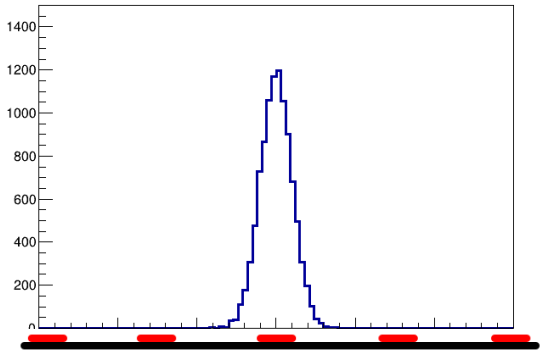
G. Bencivenni et al., NIM A 886 (2018) 36

Charge distribution example

low ρ

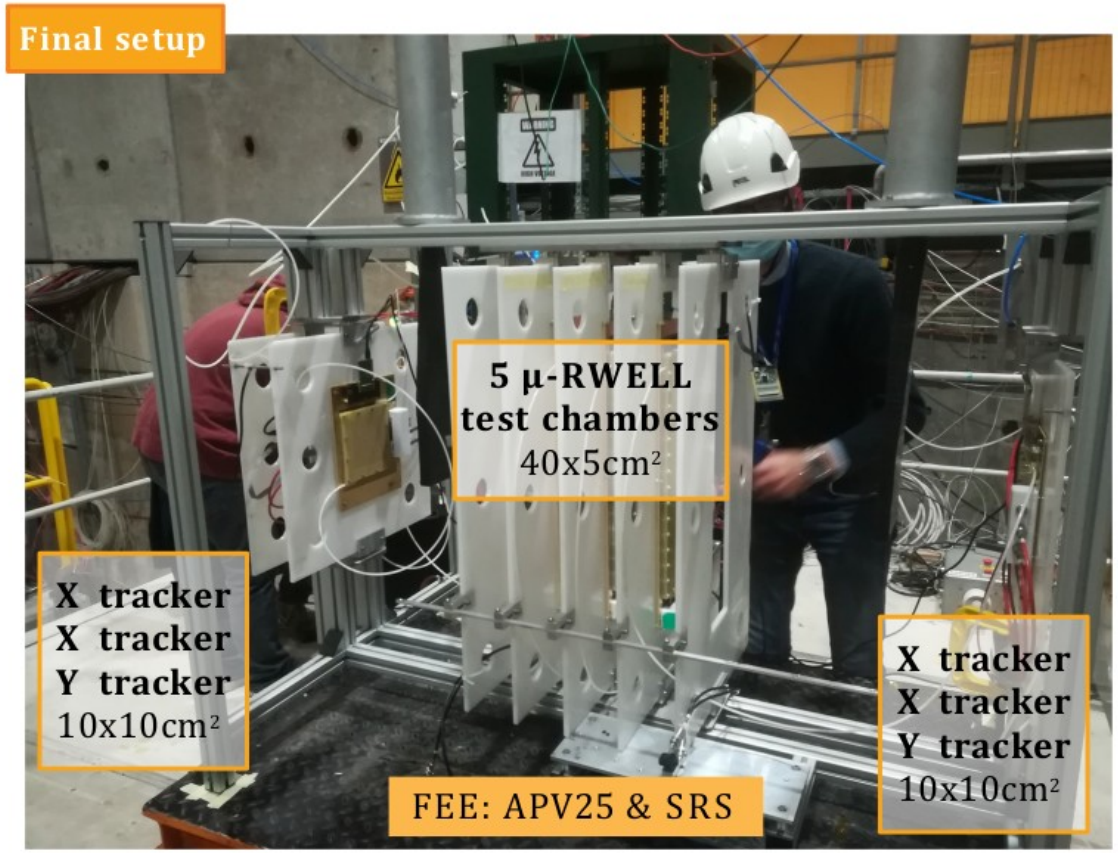






high ρ

Test beam setup



Beam setting:

SPS H8 line
secondary beam of muon or pion
in the range of 140-180 GeV/*c*

Detector setup:

5 slot available for testing chambers with beam
7 total test chamber to be tested
6 trackers (10x10 cm²)
1D readout and 400μm pitch

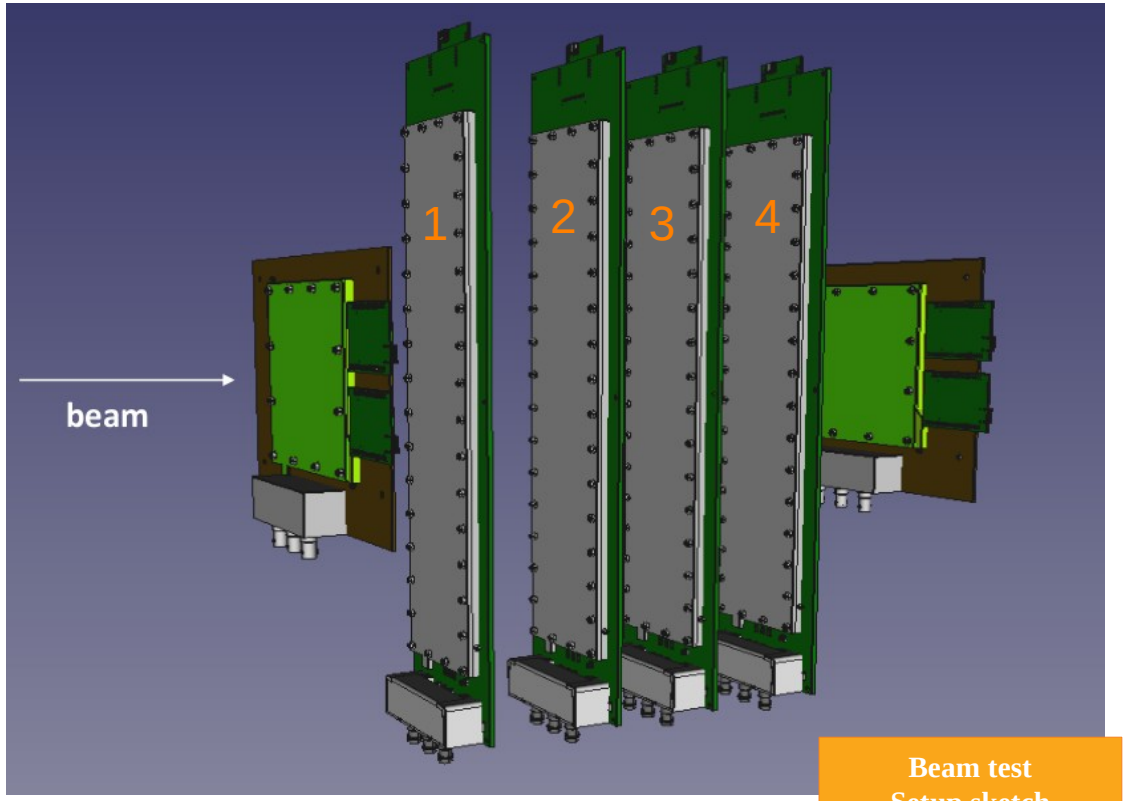
Gas mixtures:

Ar-CO_2-CF_4 (45/15/40)

FEE:

APV-25

Test beam setup



Beam test
Setup sketch

Goals:

1. the signal shape information
   (cluster charge and size)
2. detector performance
   (resolution and efficiency)

as a function of the resistivity

Analysis:

Event selection with trackers

Residual resolution measurements w/ trackers

$\Delta_{1,trk} = x_1 - x_{trk}$

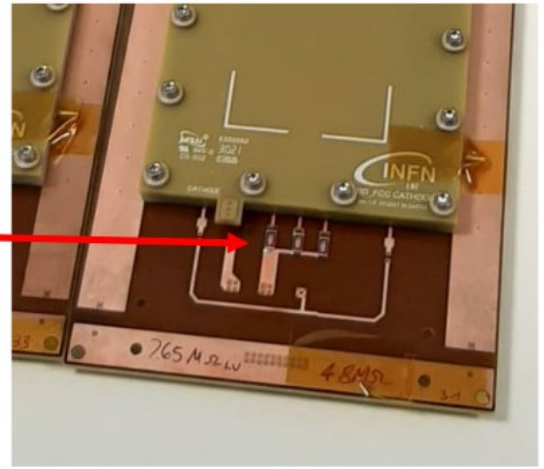
compared with a “chamber vs chamber” evaluation

$\Delta_{1,2} = x_1 - x_2$

Studies list

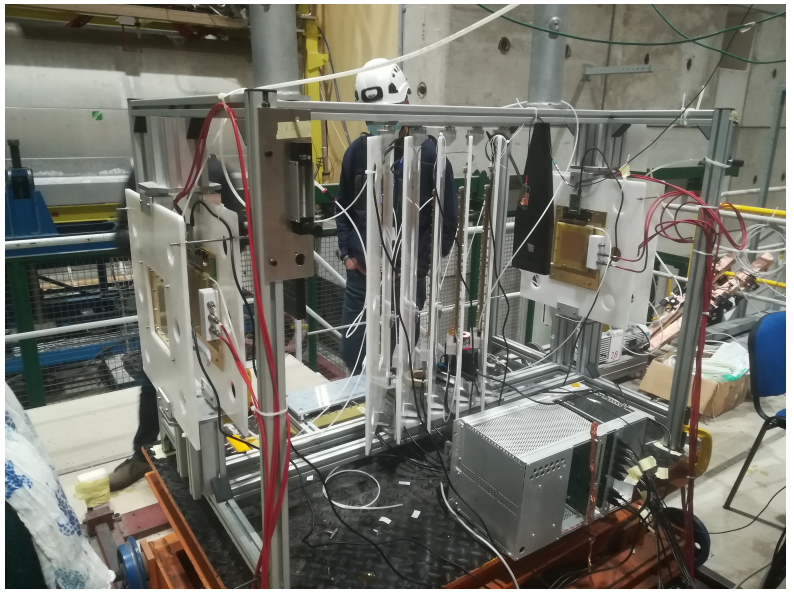
Design optimization

- Optimization S/N with different HV resistor filters setting



Detector characterization

- HV scan 0° - for trackers & test chambers (w/ muons & pions)
  -> Test chambers resistivity: [10,15,20,40,60,80,80] MΩ/□
- HV scan x angle scan (Drift field 0.5 kV/cm, w/ muons)



Further studies

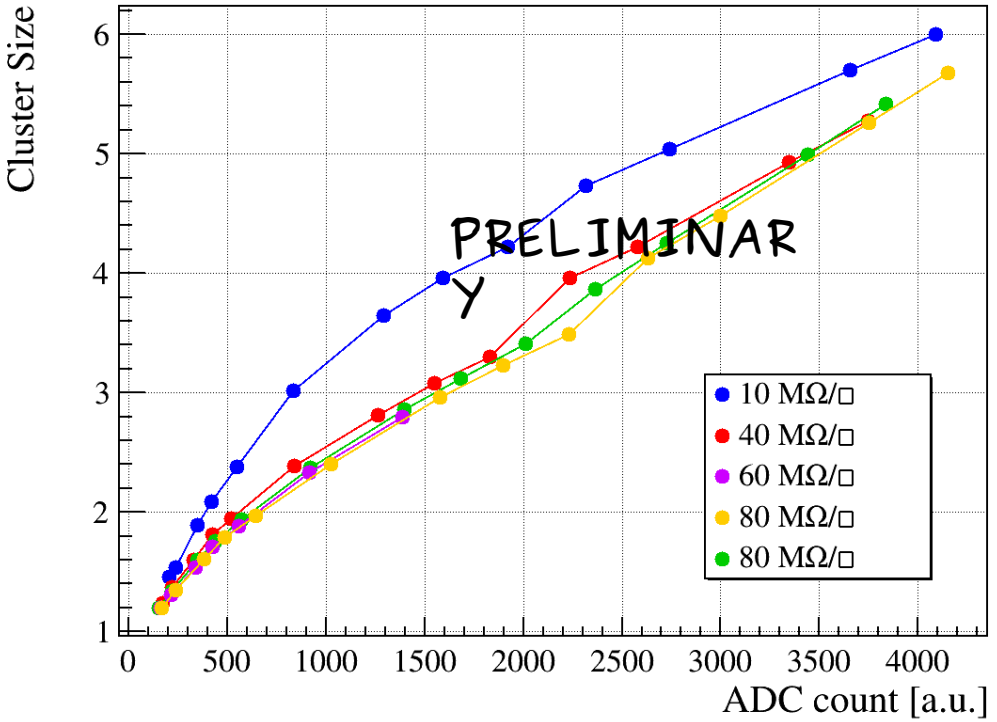
- HV scan 40° for test chambers (with muons)
- Angle scan [0,10,20,30,40]° test chambers
- Drift field scan 0° - [0.01, 0.05, 0.1, 0.5, 1, 2, 3, 3.5, 4, 5] kV/cm

About 200 runs to be analized

Preliminary results: cluster size

Higher cluster size found for 10MΩ/□ proto with some consideration with respect to G. Bencivenni et al. NIM A886(2018) 36

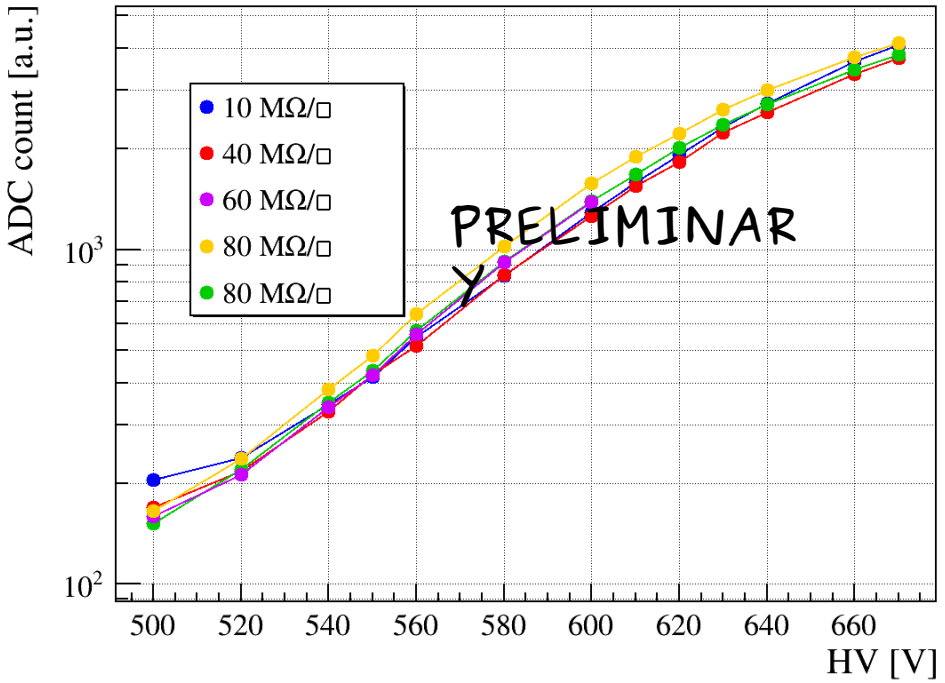
A flat behaviour is observed in the 40-80 MΩ/□ range.



Preliminary results: Cluster Charge

Good gain uniformity among prototypes.

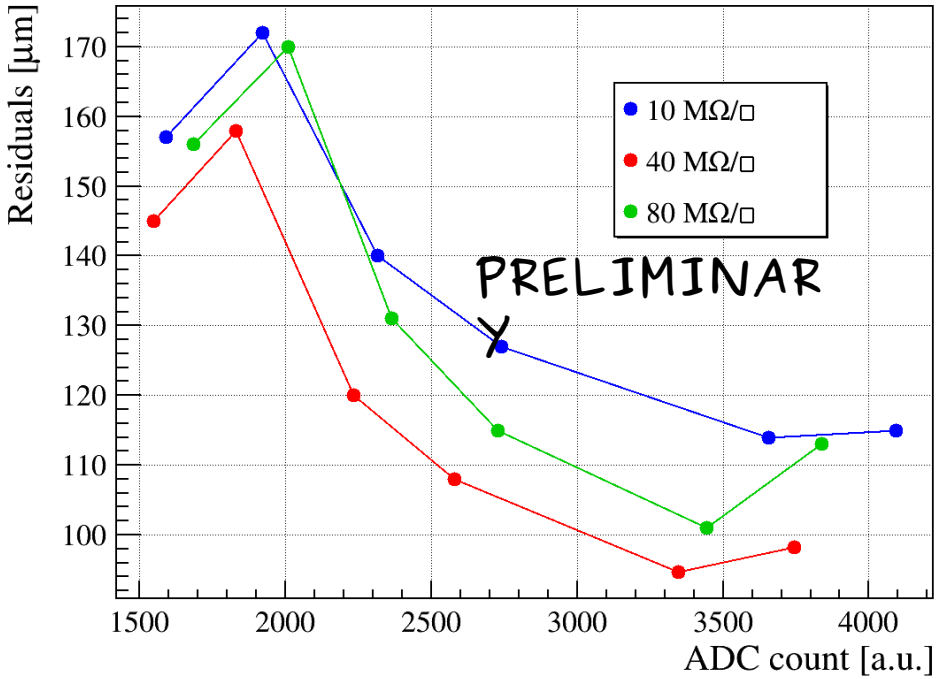
Lower charge with respect to 10x10cm^2 μ-RWELL due to larger amplification holes



Preliminary results: Residuals

A reasonable behavior is observed for different gain and resistivity.

Tracking contribution not yet subtracted



Next steps

Zero Step:
Software ricostruzione e dati su macchina @ FE ✓
Debug codice ricostruzione e accesso

Riccardo

First Step:
Analisi a zero gradi in CC (*)
- ADC counts vs HV
- Spread charge vs resistivity
- Risoluzione spaziale vs resistivity (B&B / with tracking)
- Efficienza overall & micro-settori

Matteo, Erika, Riccardo

To be concluded before Vienna Conf.

Second Step:
Analisi in uTPC:
- ADC counts vs HV
- Spread charge vs resistivity
- Risoluzione spaziale vs resistivity (B&B / with tracking)
- Efficienza overall & micro-settori

Isabella, Lia Riccardo

Checks @ LNF:
- Rimisurare resistività
- Misura piedistallo APV con diversi schemi di resistenza filtro HV:
  a) 100kΩ, 1 MΩ, 10 MΩ,
  b) 3 settori vs unico settore con e senza resistenza
- Misura di guadagno di alcune test chambers (10, 40, 80MΩ/□)
- Misura del massimo HV su test chambers

Matteo, Marco

Conclusions

The R&D on the detector design for the pre-shower and the muon system of IDEA is on going.

First 5x40cm^2 active area prototypes with different resistivity have been produced and tested @ CERN H8

The resistivity range betwenn 10-80 MΩ/□ will be characterized to extract both signal information and detector performance.

The analysis results will be used to improve the detector design and to tune the ongoing μRWELL resistive stage simulation

Thank You