μRWELL R&D plans for 2021

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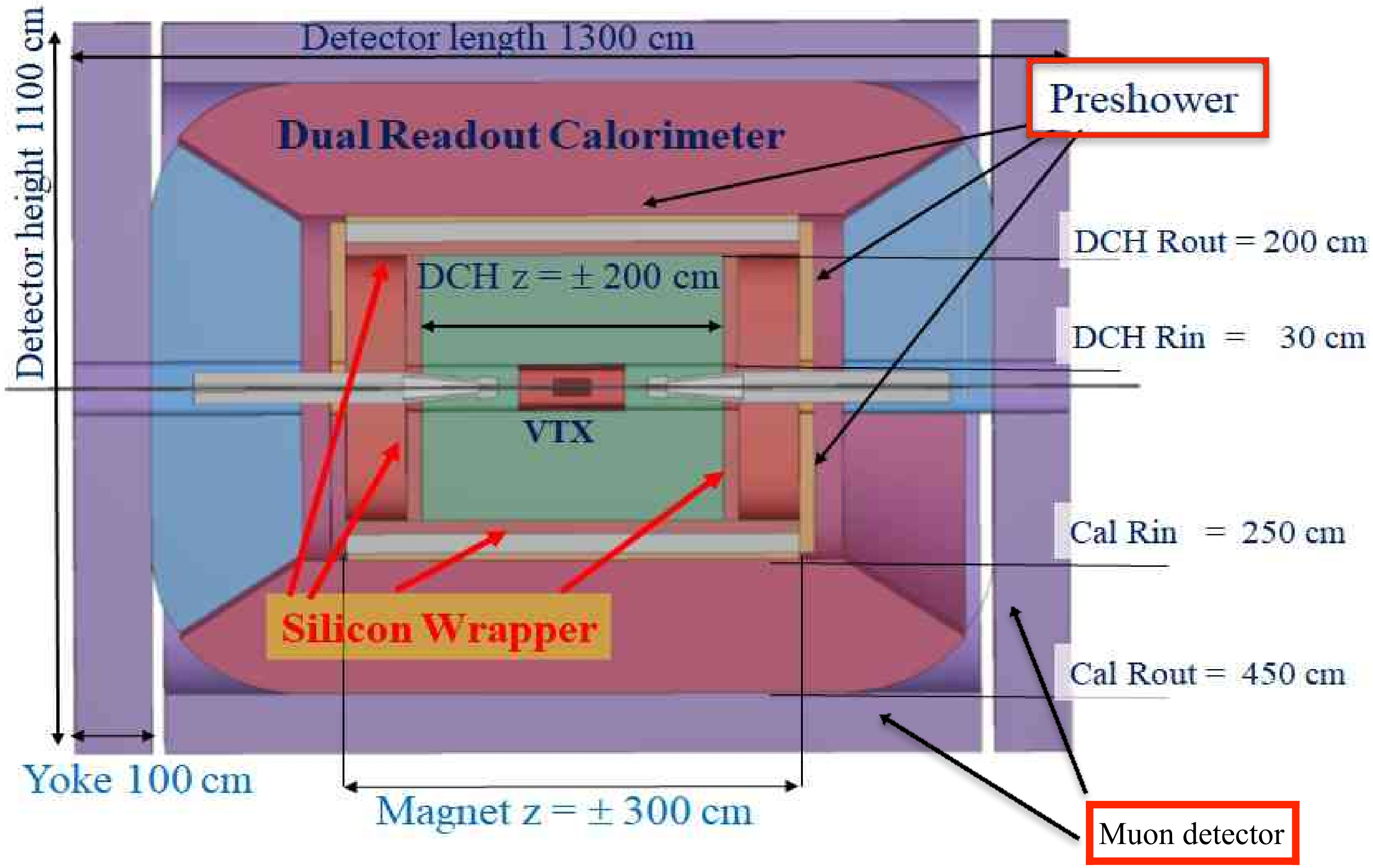
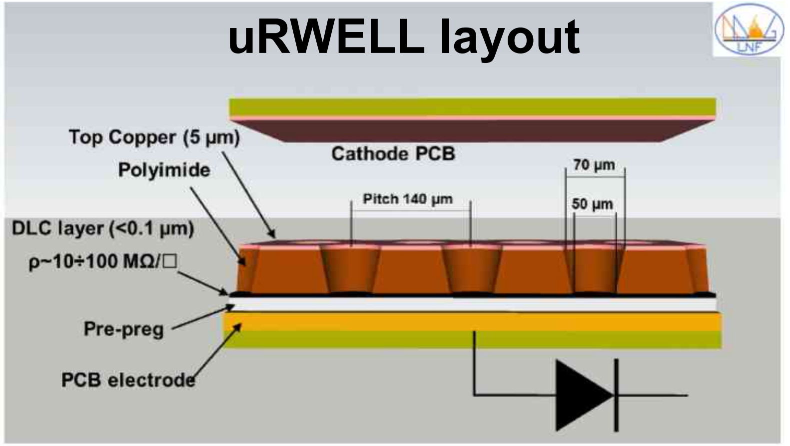
On Behalf of µRWELL R&D group

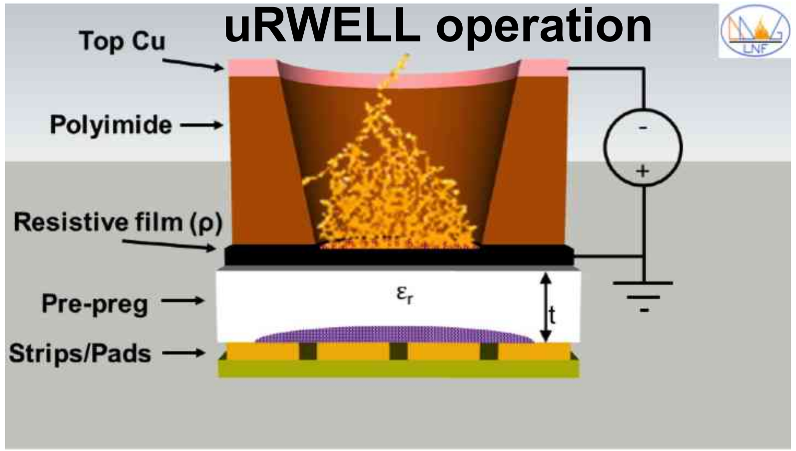
INFN BO, FE, LNF, TO

IDEA detector layout

IDEA detector is a general purpose detector designed for experiments at future e+e- colliders (FCCee CepC).





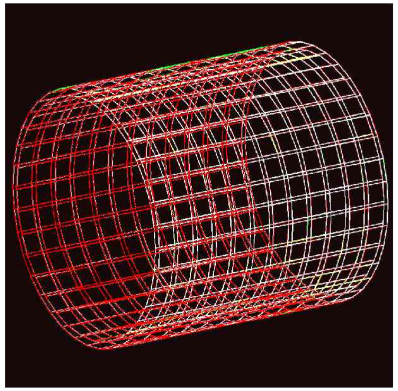


Preshower and the Muon Systems are designed with the uRWELL technology

IDEA pre-shower detector dimensions

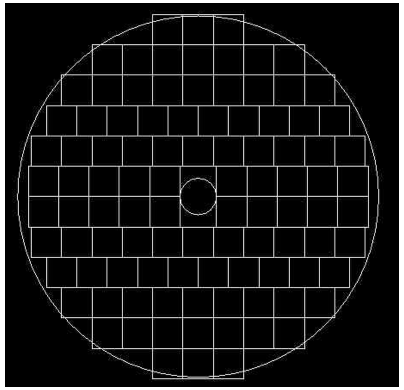
Barrel

R [mm]	Length [mm]	Thickness [mm]	pixel size [mm]	area [cm^2]	# of channels
2460	±2480	20	0.4×500	768K	384K



Endcap

R_{in} [mm]	R_{out} [mm]	z [mm]	Thickness [mm]	pixel size [mm]	area [cm^2]	# of channels
248	2440	±2460	20	0.4×500	370K	185K



IDEA's Pre-Shower detector would have in total:

- ~ **225 m2 total**
- ~ **1.5 M channel in total**

Tiles: 50x50 cm^2 with X-Y readout
Strip Length: 50 cm
Strip pitch: 0.4 mm
Input FEE capacity (Cap_{inp})~70 pF

IDEA Muon detector dimensions

Barrel

Layer	R [mm]	Length [mm]	Thickness [mm]	int. length	pixel size [mm]	area [cm^2]	# of channels
μRwell	4520	±4500	20		1.5×500	2.6M	341K
iron	4560	±4500	300	1.5			
μRwell	4880	±4500	20		1.5×500	2.8M	368K
iron	4920	±4500	300	1.5			
μRwell	5240	±5260	20		1.5×500	3.5M	462K

Endcap

Disk	R_{in} [mm]	R_{out} [mm]	z [mm]	Thickness [mm]	int. length	pixel size [mm]	area [cm^2]	# of channels
μRwell	454	5220	±4520	20		1.5×500	1.7M	227K
iron	454	5220	±4560	300	1.5			
μRwell	454	5220	±4880	20		1.5×500	1.7M	227K
iron	454	5220	±4920	300	1.5			
μRwell	454	5220	±5240	20		1.5×500	1.7M	227K

Tiles: 50x50 cm^2 with X-Y readout
Strip Length: 50 cm
Strip pitch: 1.5 mm
Input FEE capacity (Cap_{inp}) ~270 pF

IDEA's Muon detector would have in total:

~ **2800 m2 total**
~ **4M channels in total**
~ **3 stations**

2020 program on µRWELL

The 2020 program was centered mainly on the following activities:

1. construction at **ELTOS/CERN** of large size µ**RWELLs** (**Technology Transfer**)
2. *design, construction and characterisation of a* ***cylindrical*** *µ**RWELL*** *(**CREMLIN-plus** - started on 01/02/2020)*
3. *design, construction and characterisation of µRWELL to detect thermal neutrons (**ATTRACT – uRANIA**)*

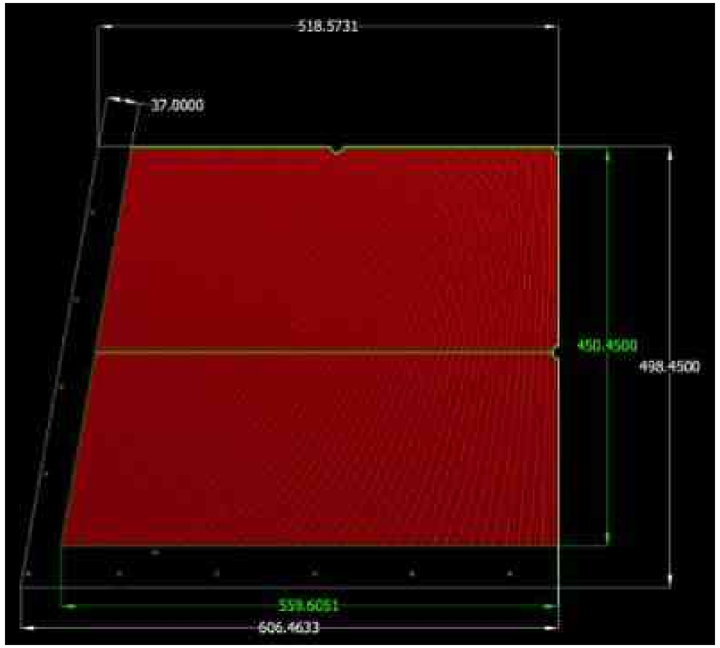
2021 program on μRWELL

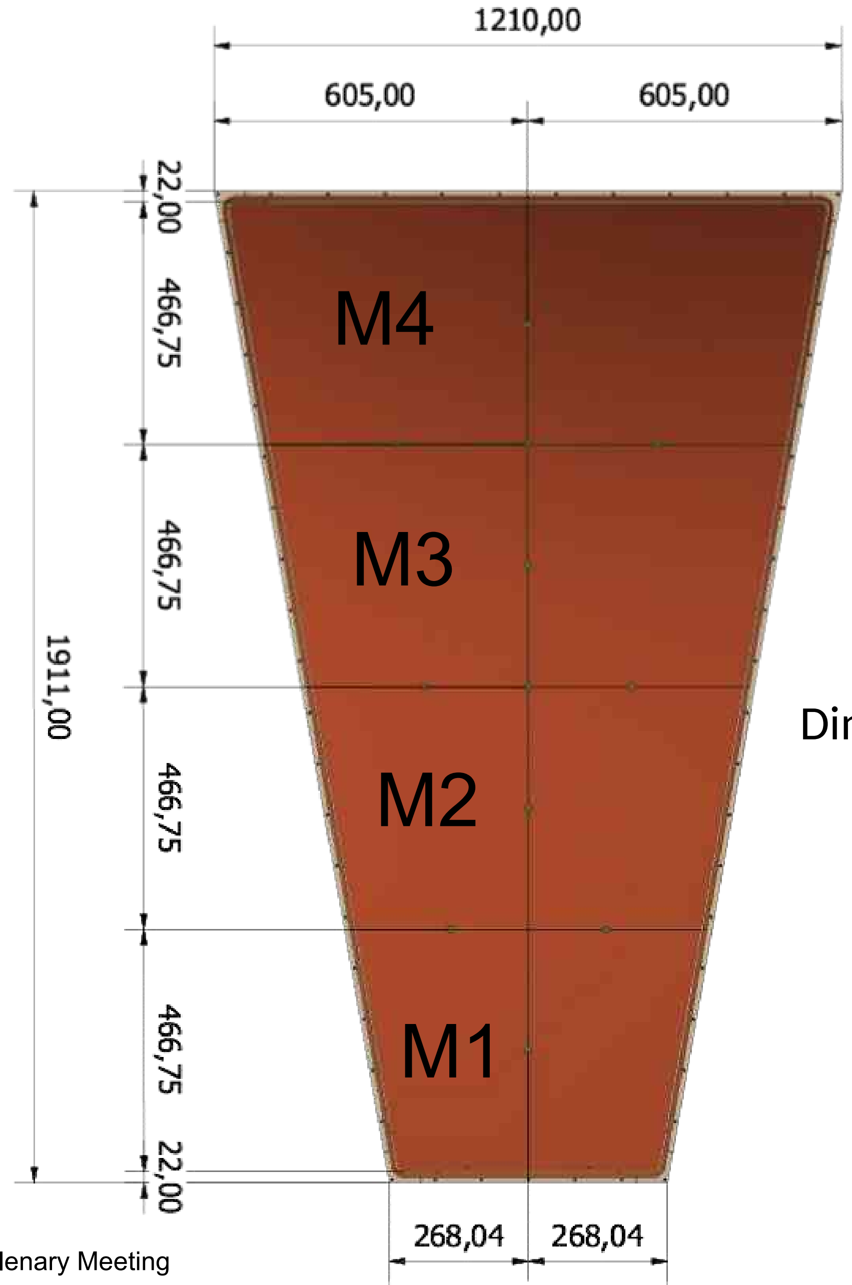
The 2021 program is centered mainly on the following activities:

1. test of large size μ**RWELLs** with TIGER-GEMROC readout
2. *optimization studies on DLC resistivity and pitch size for the IDEA pre-shower and muon chamber (**AIDAinnova**)*

Large area µRWELL with TIGER readout

Size: 606.5 x 498.5 x 1 mm
Active area: 559.6 - 480 (w) x 450 (h) mm
373 radial strips
strip pitch 1.29 - 1.5 mm
strip length ~ 22 cm





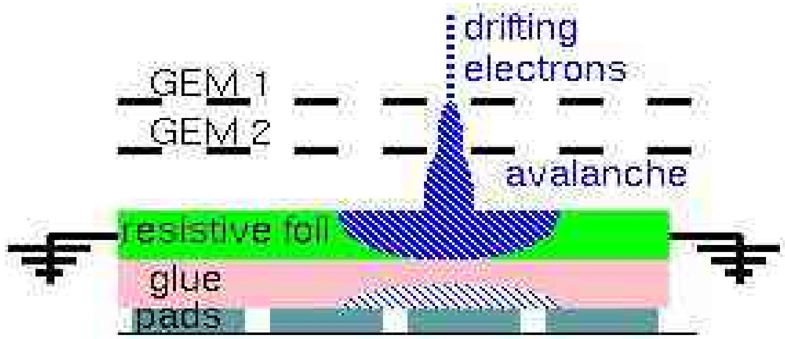
Dimensions in mm

Large area µRWELL with TIGER readout

- Build a large µRWELL detector and equip it with a Tiger-based readout
  - Would be a very valid test of an IDEA-dimension µRWELL detector equipped with a custom-made ASIC
  - The TIGER chip was developed by TO and FE for GEM detectors in the frame of BESIII
- We could then test the M4 with the Tiger with the large cosmic rays telescope (Bologna), with sources (Ferrara) and with a X-ray gun (LNF) before bringing the whole setup onto a test beam sometime in 2021
- In parallel perform simulation studies, with special emphasis on Long Lived Particles, to justify the interest of having a performing tracker in the muon detection system rather than a simple tagger and optimise the detector consequently.
  - This task is foreseen by the IDEA group and will receive special consideration.

Example: Charge dispersion in a GEM- TPC with a resistive anode

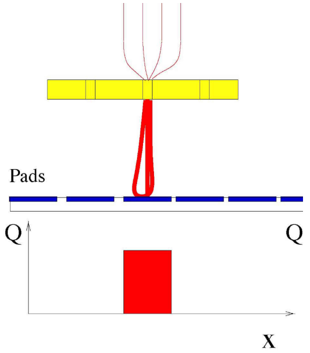
Modified GEM anode with a high resistivity film bonded to a readout plane with an insulating spacer

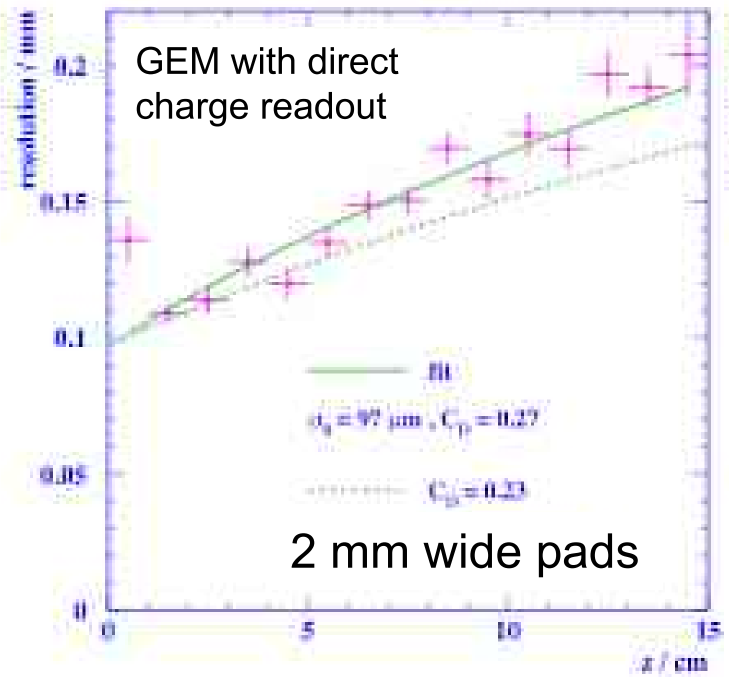


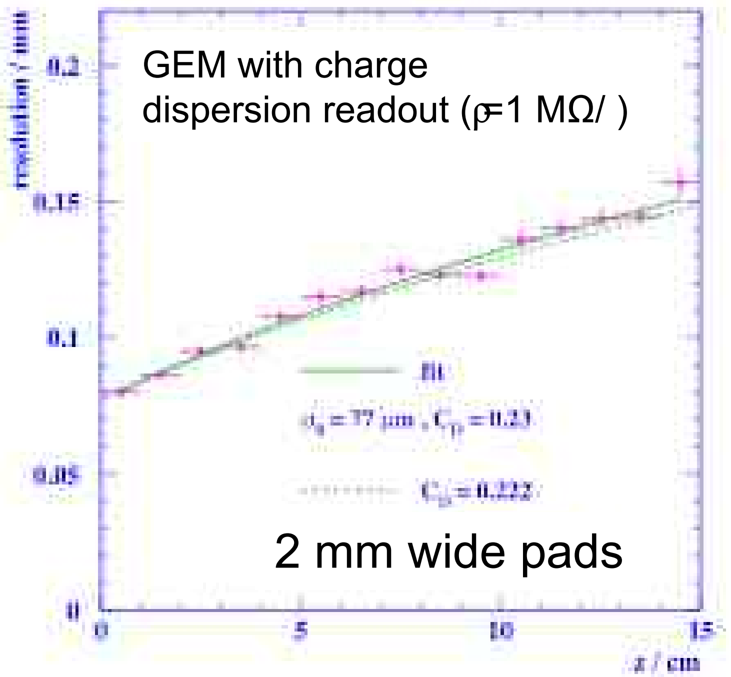
R.K.Carnegie et.al.,
NIM A538 (2005) 372

K. Boudjemline et.al.,
NIM A574 (2007) 22

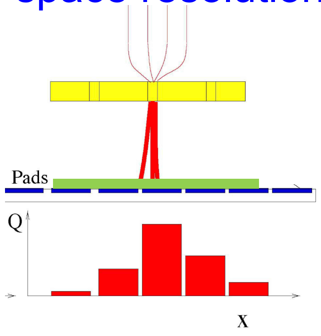
Pad width would limits MPGD TPC space resolution







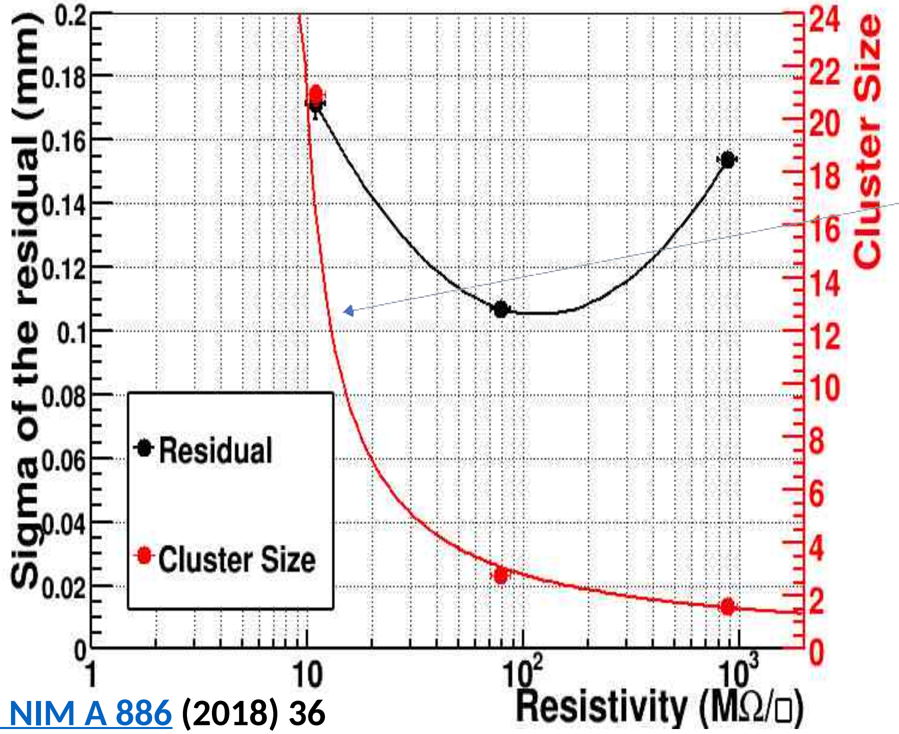
Resistive layer increase charge distribution increasing MPGD TPC space resolution



Space resolution with u-RWELL: orthogonal tracks

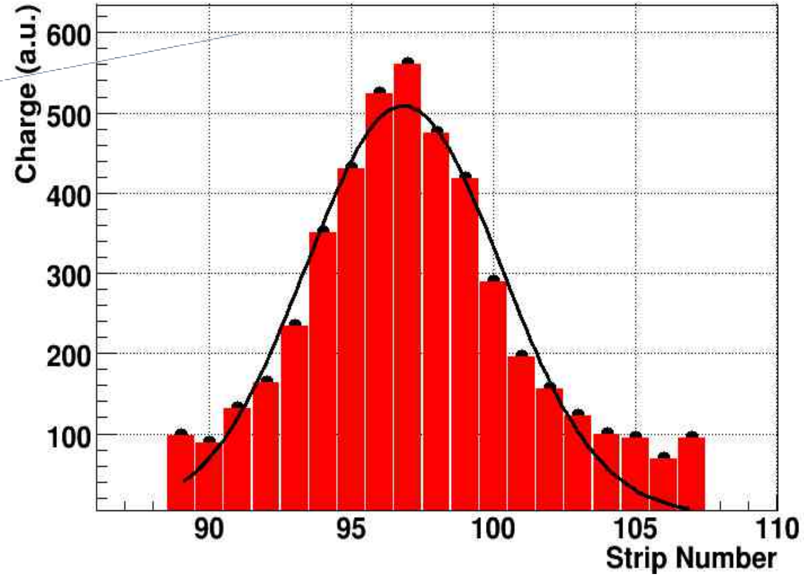
Centroid analisys

APV & 400 um strip pitch & Cinp=15 pF



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

Charge collected by the APV on the strip readout (resistivity 10 MΩ/)



The use of **low resistivity increases the charge spread** (cluster size) on the readout strips and then **σ is worsening.**

At **high resistivity** the **charge spread is too small (Cl_size → 1)** then the Charge Centroid method becomes no more effective **(σ → pitch/√12).**

Resistivity and pitch size optimizazion

Built and test 10 µRWELL detectors low-rate configuration with active are of 50x16 cm^2

N.5 µRWELL for the Pre-shower

Strip pitch 0.4 mm, strip length 50 cm (C_{inp}~70 pF)

- N.5 for the Muon detector

Strip pitch 1 mm, strip length 50 cm (C_{inp}~180 pF)

The proposal measures the charge distribution for 5 resistivity on the DLC 10-20-50-100-200 MOhm/square.

Hardware and software simulations will test different pitch sizes: i.e. 0.4-0.8-1.2 mm for the pre-shower configuration and 1-2-3 mm for the muon chamber configurations.

The characterization of these configurations will be performed with a test beam with APV electronics at SPS-CERN

2022-2024 program on µRWELL

- Define the best resistivity of the DLC for both µRWELL fundamental tiles
  - Build 50x50 cm^2 prototypes for preshower and muon system
    - Both prototypes with bi-dimensional readout
  - Develop a custom-made ASIC for the µRWELLs, with the experience obtained from the TIGER
  - Optimise the engineering mass construction process together with industry (Eltos)
  - Test and validate µRWELL prototypes in the lab with cosmic rays
  - Test and validate µRWELL prototypes with custom-made electronics in test beams
- Develop a new reconstruction algorithm, ML-based, to improve the resolution for tracks impinging at an angle far from 90^0

Several of the points above are already contained in AIDAinnova

- AIDAinnova will mostly provide contracts for young collaborators
- Assume that CSN1 will cover material and equipment costs

Thanks