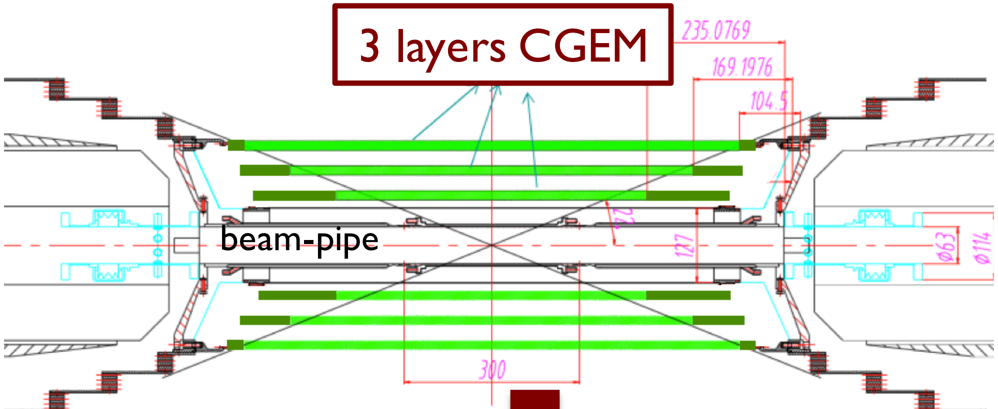
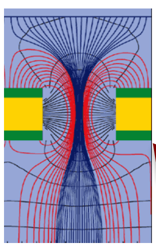
RD51 meeting

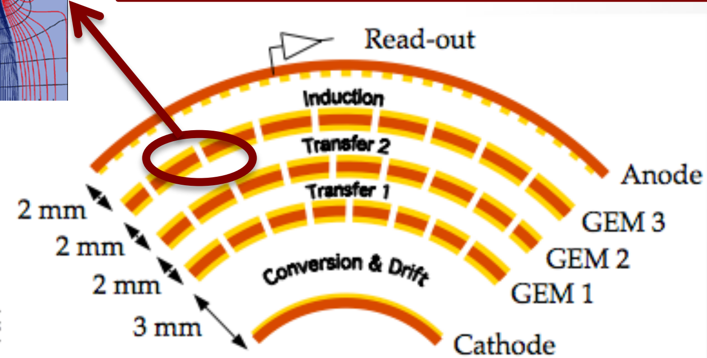
G. Cibinetto (INFN Ferrara)
on behalf of the BESIII CGEM group

Cylindrical GEM Inner Tracker



each CGEM layer composed by a triple GEM detector with cylindrical shape





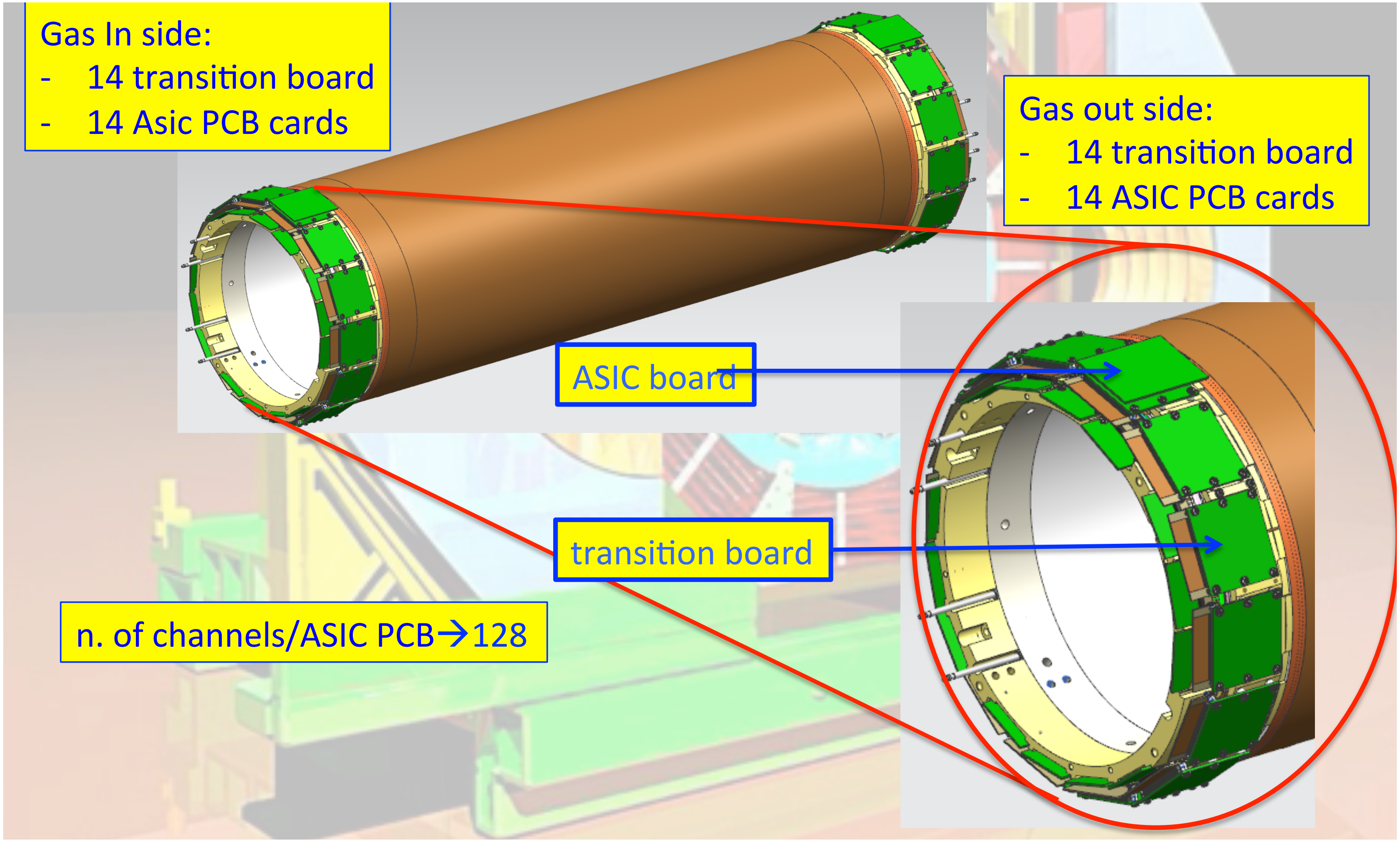
Detector requirements

- Rate capability: ~10^4 Hz/cm^2
- Spatial resolution: σ_{xy} =~130 μm : σ_z=~1 mm
- Momentum resolution:: σpt/Pt =~0.5% @1 GeV
- Efficiency = ~98%
- Material budget ≤ 1.5% of X_0 for all layers
- Coverage: 93% 4π
- Operation duration ~ 5 years

Detector peculiarities and innovations

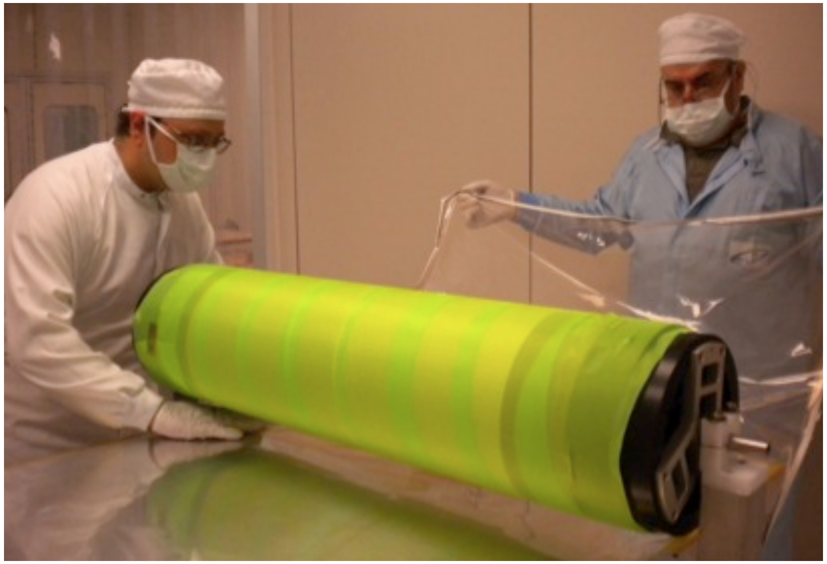
- **Rohacell** will be used in the cathode and anode structure with a substantial reduction of the thickness of the detector.
- **Analogue readout** to reach the required spatial resolution with a reasonable number of channels. A dedicated ASIC chip will be developed.
- **Anode plane with jagged strips** to limit the parasitic capacitance

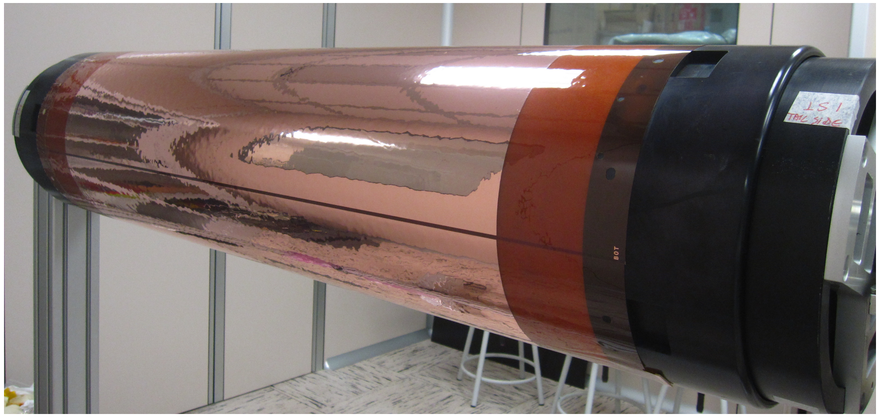
The first cylindrical prototype



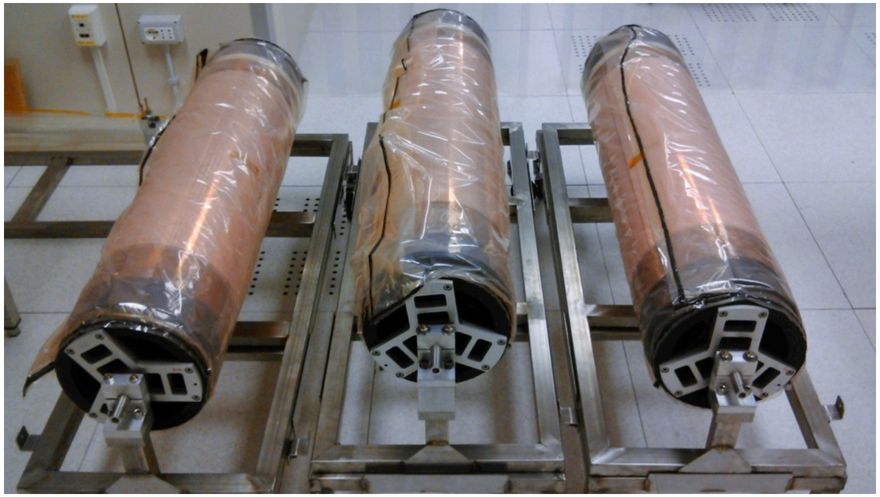
Prototype assembly

Cathode, with Rohacell-based structure, has been assembled.
Mechanical stress tests done on irradiated cathode prototypes up to 10 Mrad.





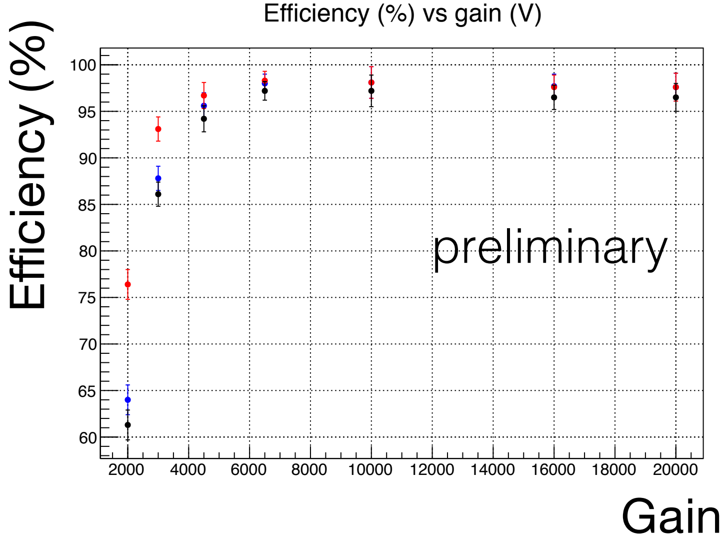
Three cylindrical GEM also ready.
Anode plane just arrived from CERN: aim to finalize the detector early next year.

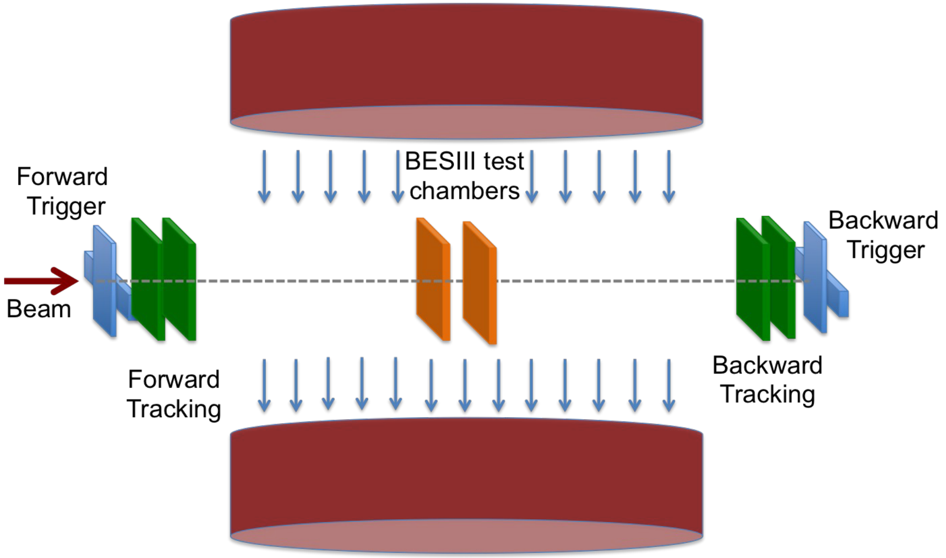


Data analysis of Test Beam

In a first beam test (end of 2014) we studied the performance of the detector without magnetic field and Ar/Isobutane (90:10) mixture:

- efficiency plateau starting at gain ~6000
- efficiency in the plateau region ~97%
- space resolution ~90 microns





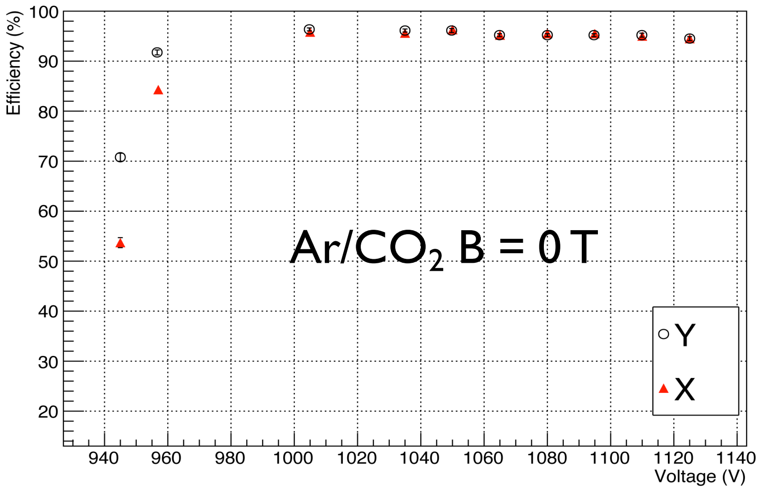
We are currently analyzing the data of the June 2015 test beam,

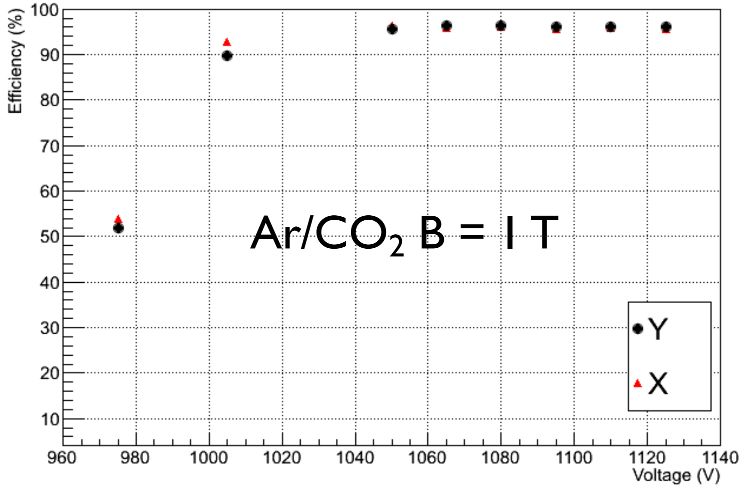
- performance of the detector in magnetic field
- tested different anode configurations (not shown here)

Numerology, conventions and standards

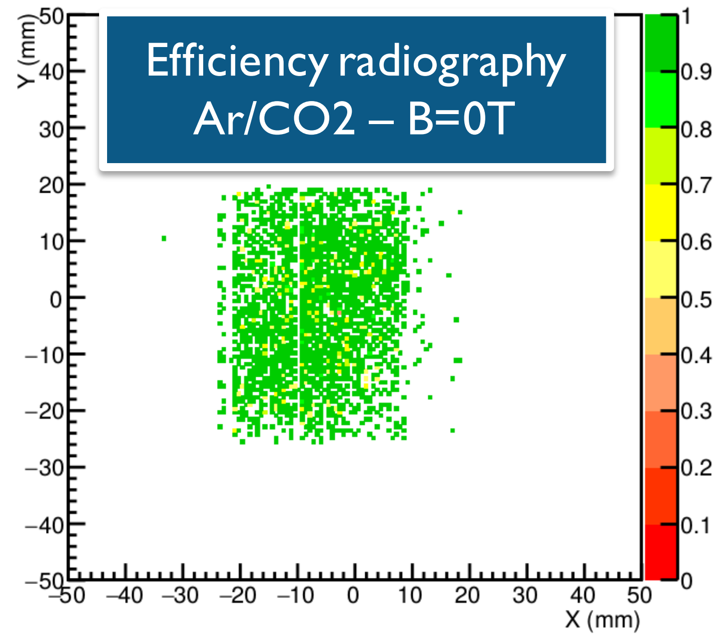
- BESIII standard configuration
  - strip pitch 650 micron
  - fields:
    - drift = 1.5 kV/cm
    - transfer 1 = transfer 2 = 3 kV/cm
    - induction = 5 kV/cm
  - gain ~10k
  - orientation during TB: Y is the bending coordinate
  - gas mixture: Ar/CO_2 (70:30), alternatively Ar/Isobutane (90:10)
  - readout electronics: APV25

Efficiency with Ar/CO_2 gas mixture

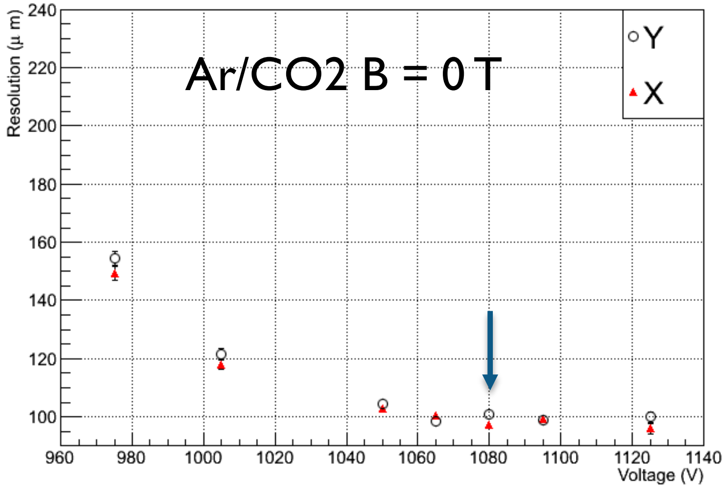


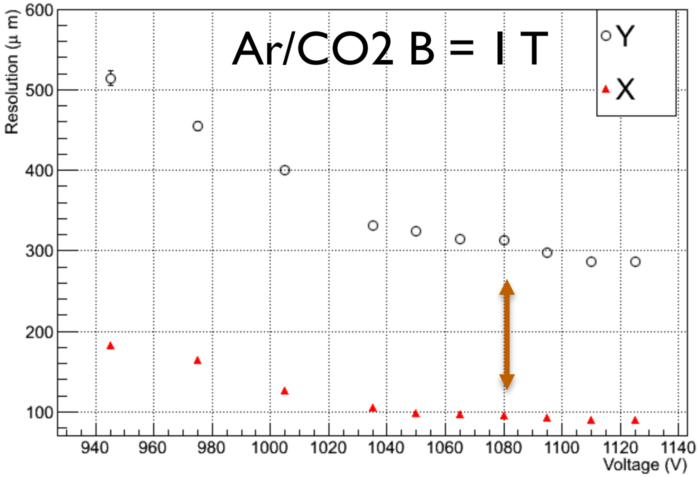


- Efficiency: clusters associated to tracks found by the external tracking.
- Magnetic field doesn't affect much the efficiency of the detector: plateau starts slightly at higher gain.
- 2D efficiency maps done to look for possible detector issues.
- Similar behavior with Ar/Isobutane has mixture



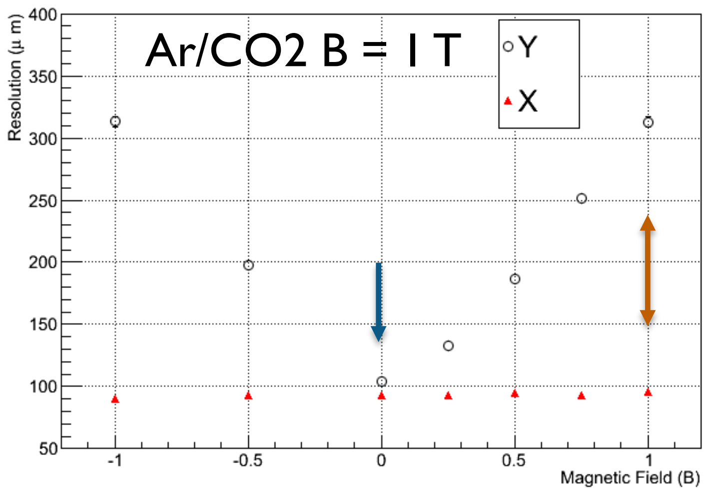
Space resolution



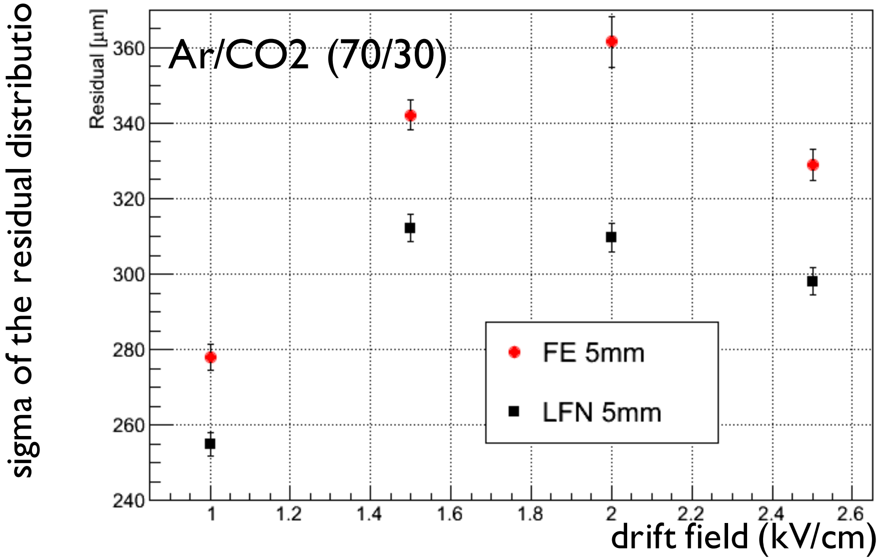


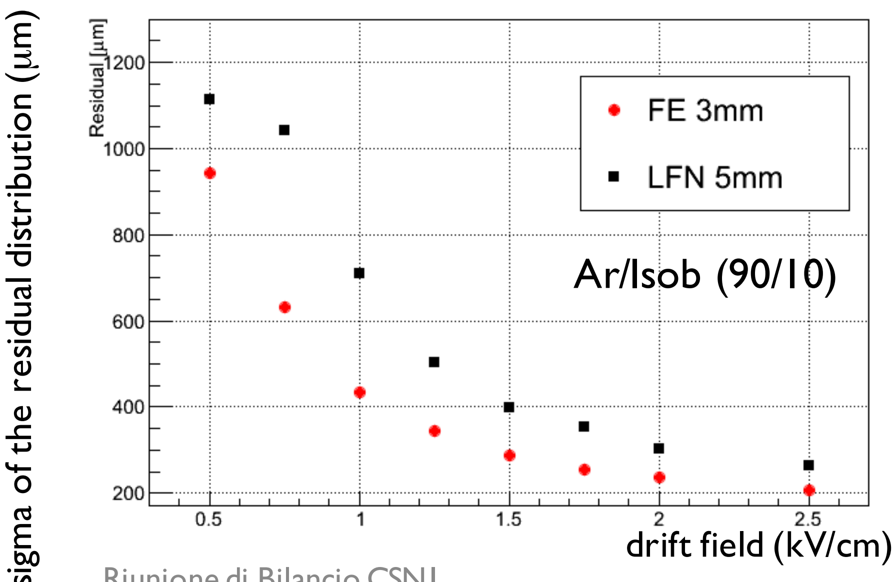
Space resolution is less than 100 microns with no magnetic field and increases linearly with the B value up to ~300 um at 1 Tesla.

A scan of the drift field (see next slide) has been done to understand if it could be improved.

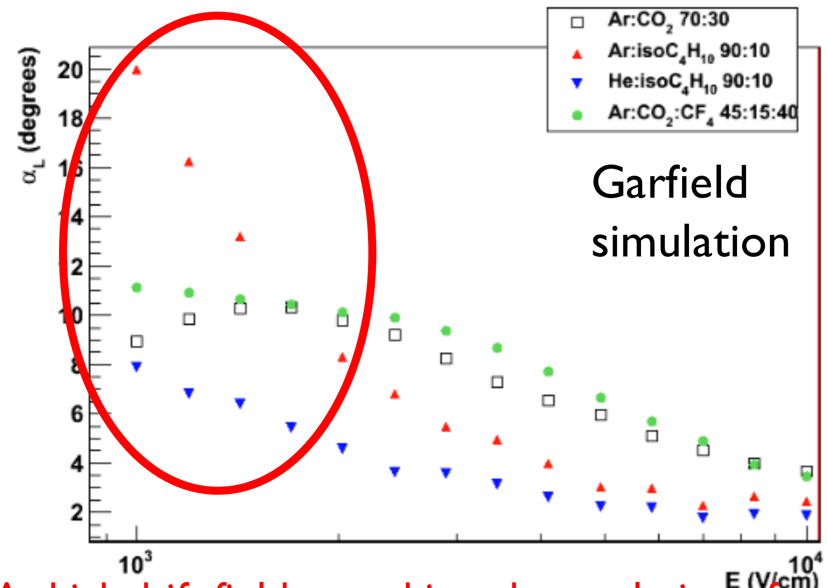


Spatial resolution in the drift field scan





The behavior of the resolution copy the Lorentz angle for each gas mixture.



At high drift field, we achieved a resolution of about 200 microns with Ar/Isobutane (90:10) with 650 micron strip pitch!

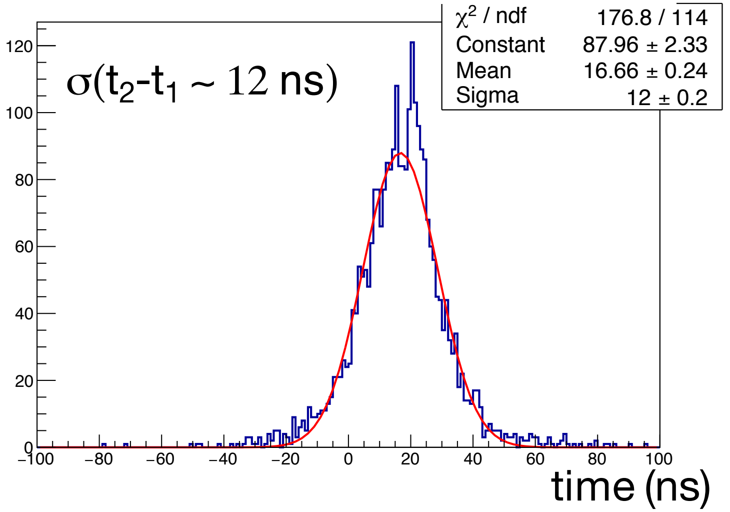
Efficiency not affected by drift field variation in the range we studied.

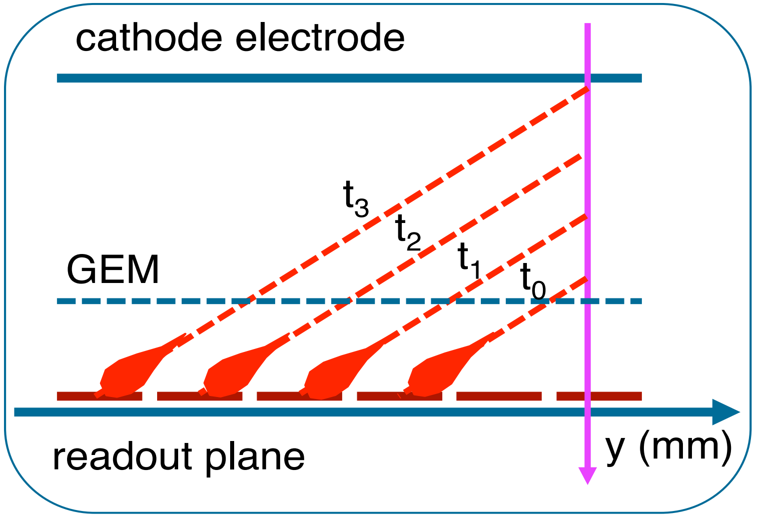
To improve… → see next slide

μTPC readout for a GEM detector

- The time information can be used to improve the spatial resolution with B field.

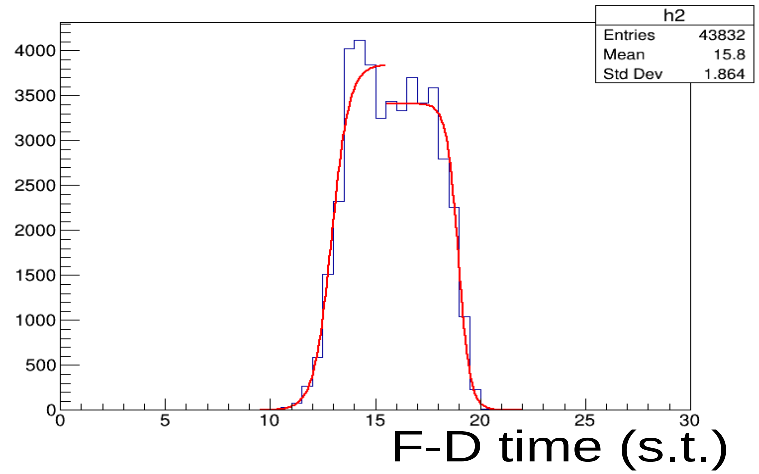
difference from t_2 and t_1





drift velocity (Ar/Isob 90:10)

- from sim.: 3.77 cm/us
- from data: 3.58 cm/us



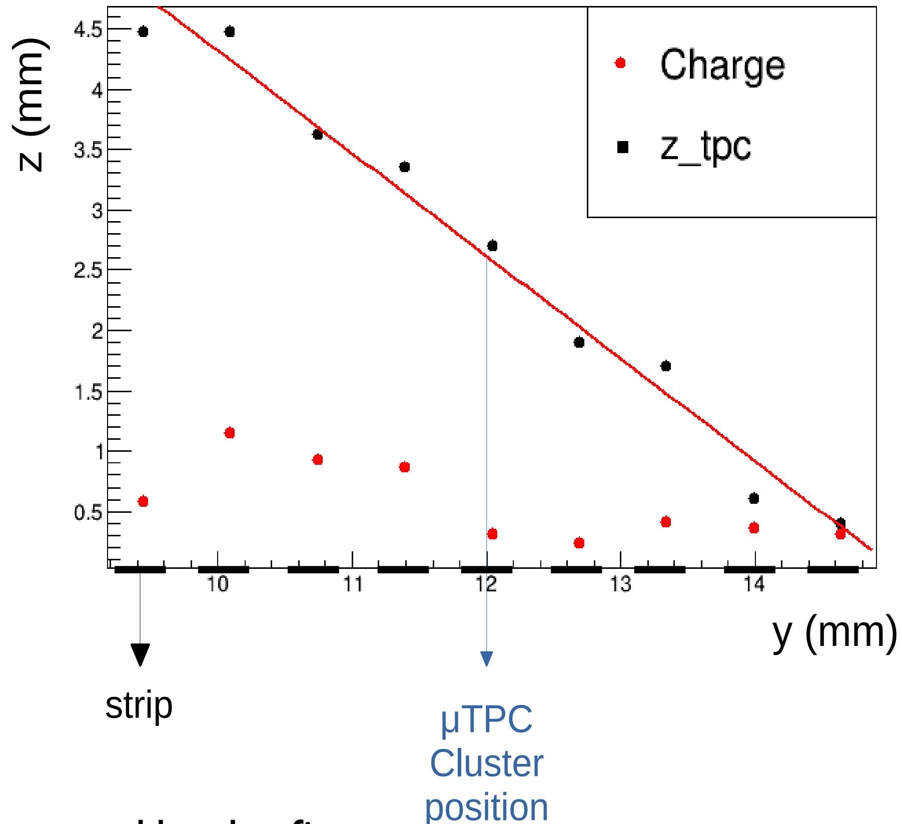
- The electron drift velocity can be extracted by the hit time distribution and its consistent with simulations.
- The track can be reconstructed from the drift velocity measurement.

μTPC readout studies

- The drift time from the point where the electron is generated and G1 can be measured as: t_FD – t_init
- It is possible to associate a point inside the conversion gap using the drift velocity:
- z_tpc = v_drift * (t_FD – t_init)
- An error of 0,65/sqrt(12) is associated at each strip position

→ A linear fit is perform

- μTPC cluster position can be measured as the position at half-gap



The incident angle of the particle can be extracted by the fit:

- real, from setup: 45°
- measurement from uTPC: 46°

Conclusions and plan for future

- Two TB have been done so far with RD51 to test planar prototype in the magnetic field.
- Very good performance have been found with both Ar/CO_2 and Ar/Isobutane gas mixture.
- Need to complete the analysis of the latest TB (e.g. performance of the new jagged anode).
- Need to finalize the implementation of the micrTPC readout in order to push the performance even further.
- Our first cylindrical prototype is under final assembly and we need to test with beam next year.
- An additional test beam with planar prototype may be needed if the microTPC readout preliminary studies show good results.