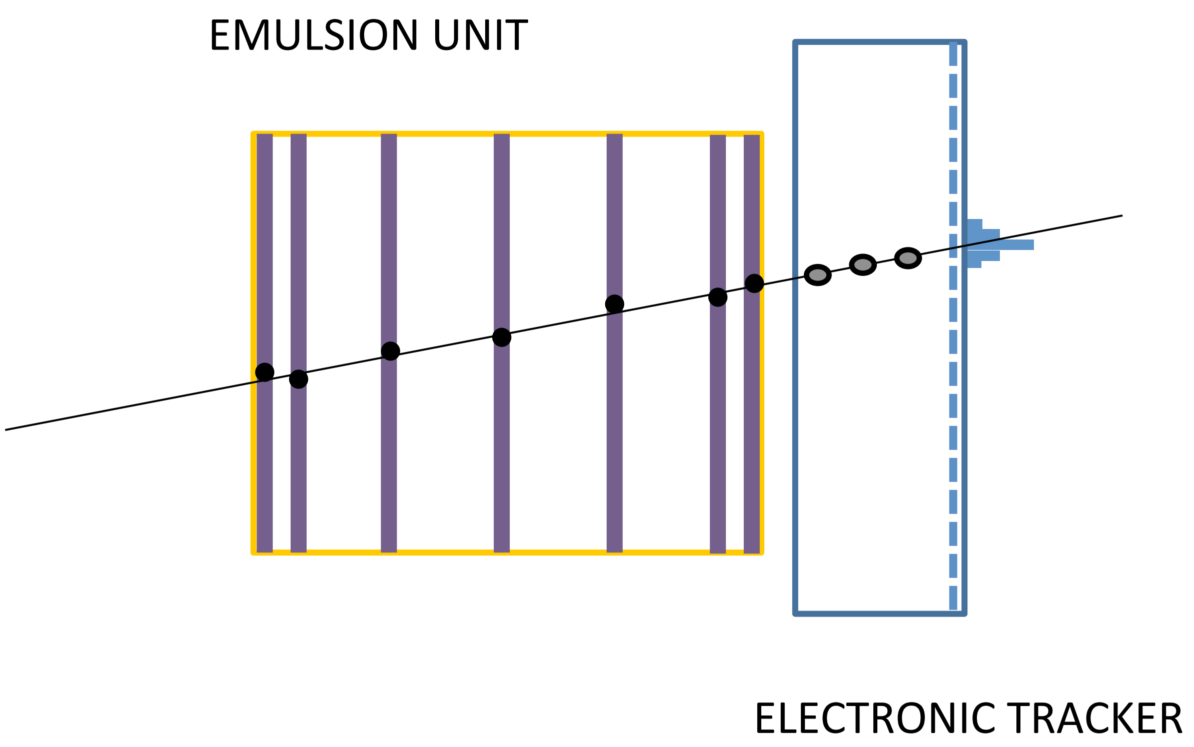
First results of micro-RWELL operated in micro-TPC mode

G. Bencivenni[a], R. De Oliveira[b], R. Farinelli[c], G. Felici[a], M. Gatta[a],
M. Giovannetti[a], L. Lavezzi[d], G. Morello[a], M. Poli Lener[a], A. Ochi[e]

a. INFN-LNF
b. CERN
c. INFN-FE
d. IHEP
e. Kobe University

Electronic tracker & Emulsion matching for SHiP experiment

The **electronic tracker should provide the time stamp** of the event finely (~1μm level) reconstructed by the emulsion unit



The matching requires for a **"good space resolution"** of the electronic detector →
$\sigma_{XY} \leq 200\mu m$
for 45°<θ<90° and B=1T.

Goal of the Beam Test

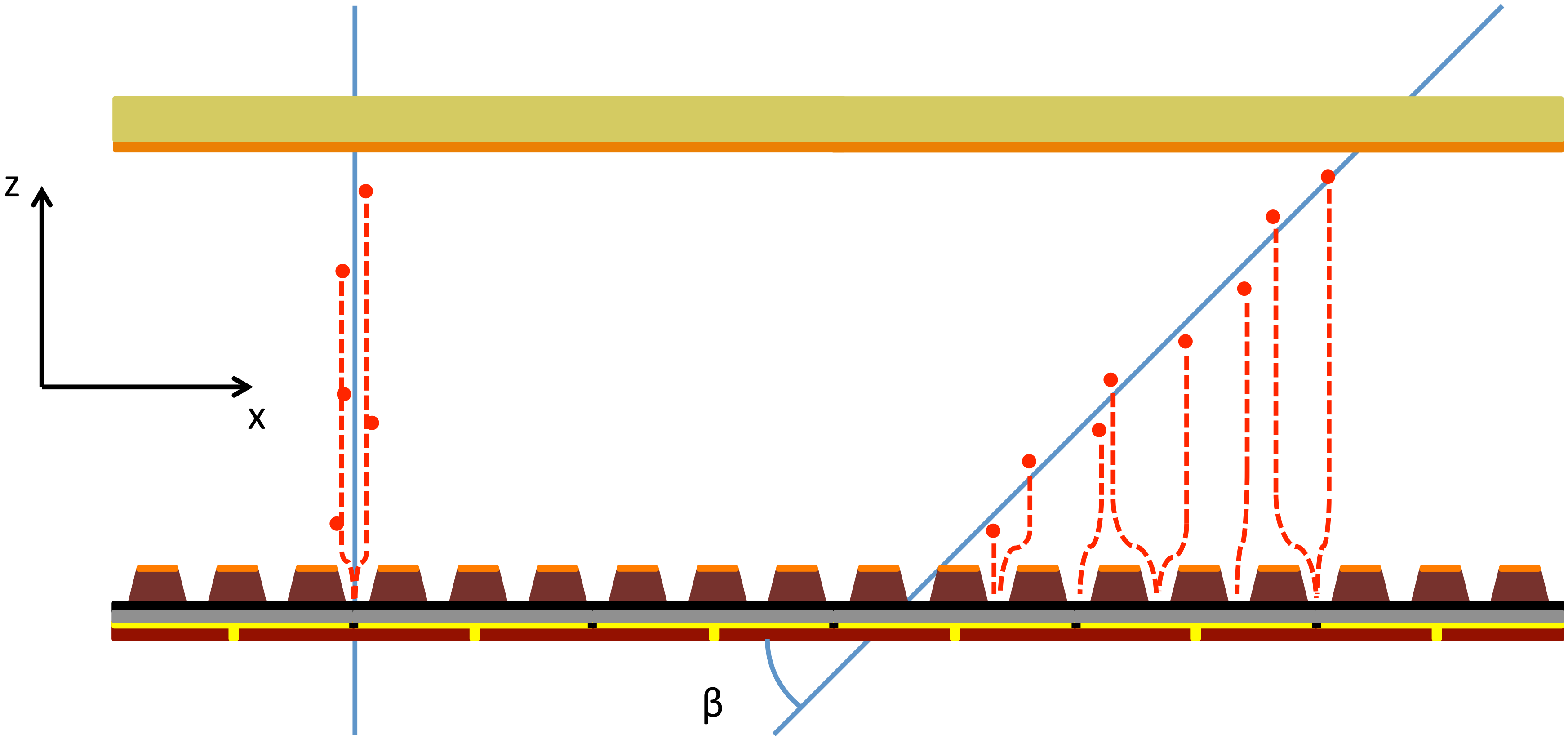
The purposes of the Beam Test:

- study of the **space resolution of the μ-RWELL** detectors vs **θ –incidence angle** of the particle

- optimization of the detector operating conditions as a function of the track incidence angles

- study of the **matching between the information of the electronic trackers and the emulsions** (in collaboration with INFN-Napoli group)

Improving space resolution: the μ-TCP mode



The use of an analogic front-end allows to associate a hit to a track using the charge centroid (CC) method. The uncertainty associated to the hit with this algorithm is dependent on the track angle: minimum for orthogonal tracks and larger as the angle increases

Improving space resolution: the μ-TCP mode

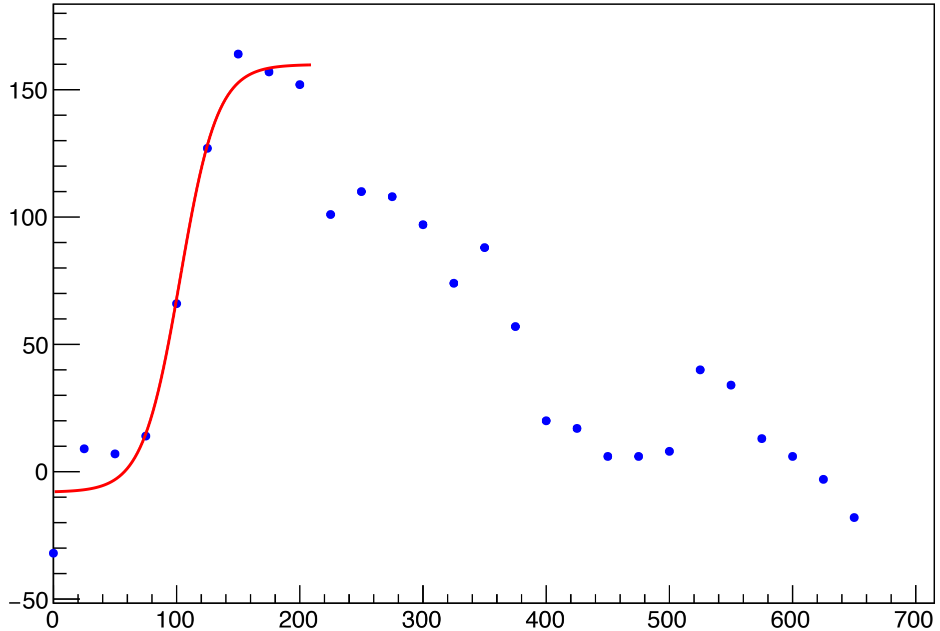
Introduced for MicroMegas by T. Alexopoulos et al., NIM **A 617** (2010) 161, it suggests a way to overcome big errors associated to sloped tracks.

Each hit is projected inside the conversion gap, where the x position is given by each strip and the $z = v_d t$

The drift velocity is provided by the Magboltz libraries.

The drift time is obtained with a fit of the charge sampled every 25 ns from each FEE channel associated to the strip.

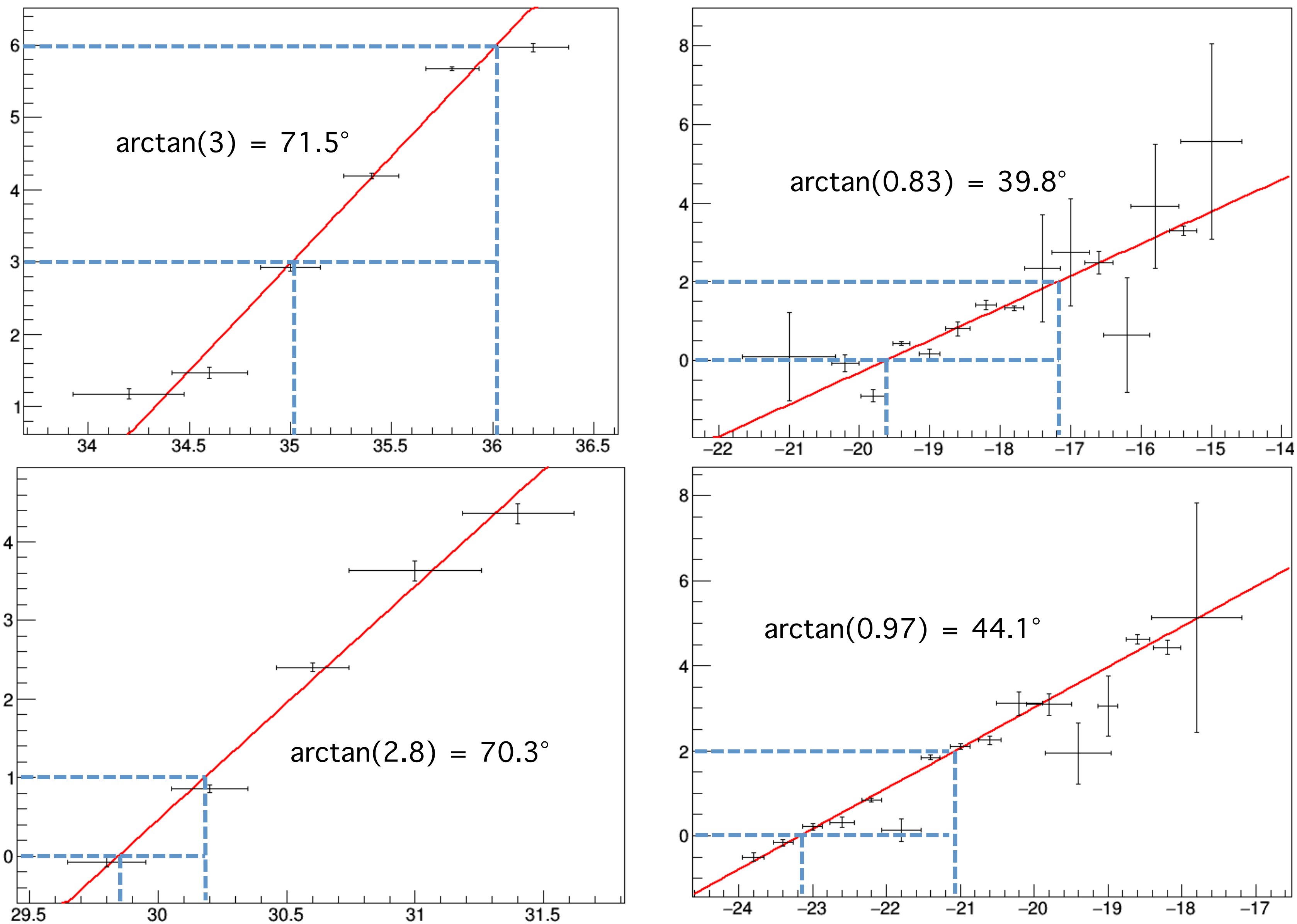
For each event we then obtain a set of projected hits that once fitted provide a track segment



Example of μ-TPC reconstruction

Here we have some examples where the tracks have an angle w.r.t. the readout plane of:

75° tracks	45° tracks



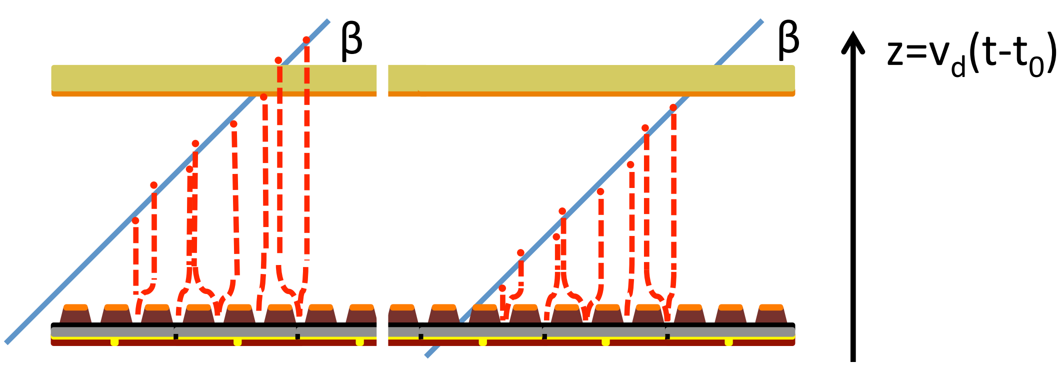
A trivial problem

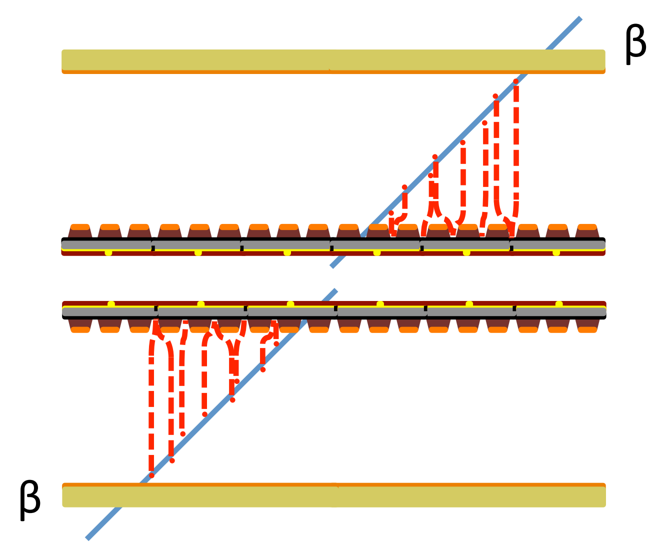
The micro-TPC mode allows to reconstruct the angular coefficient of the track segment inside the drift gap

This is just one of the parameters needed to draw a line in the plane

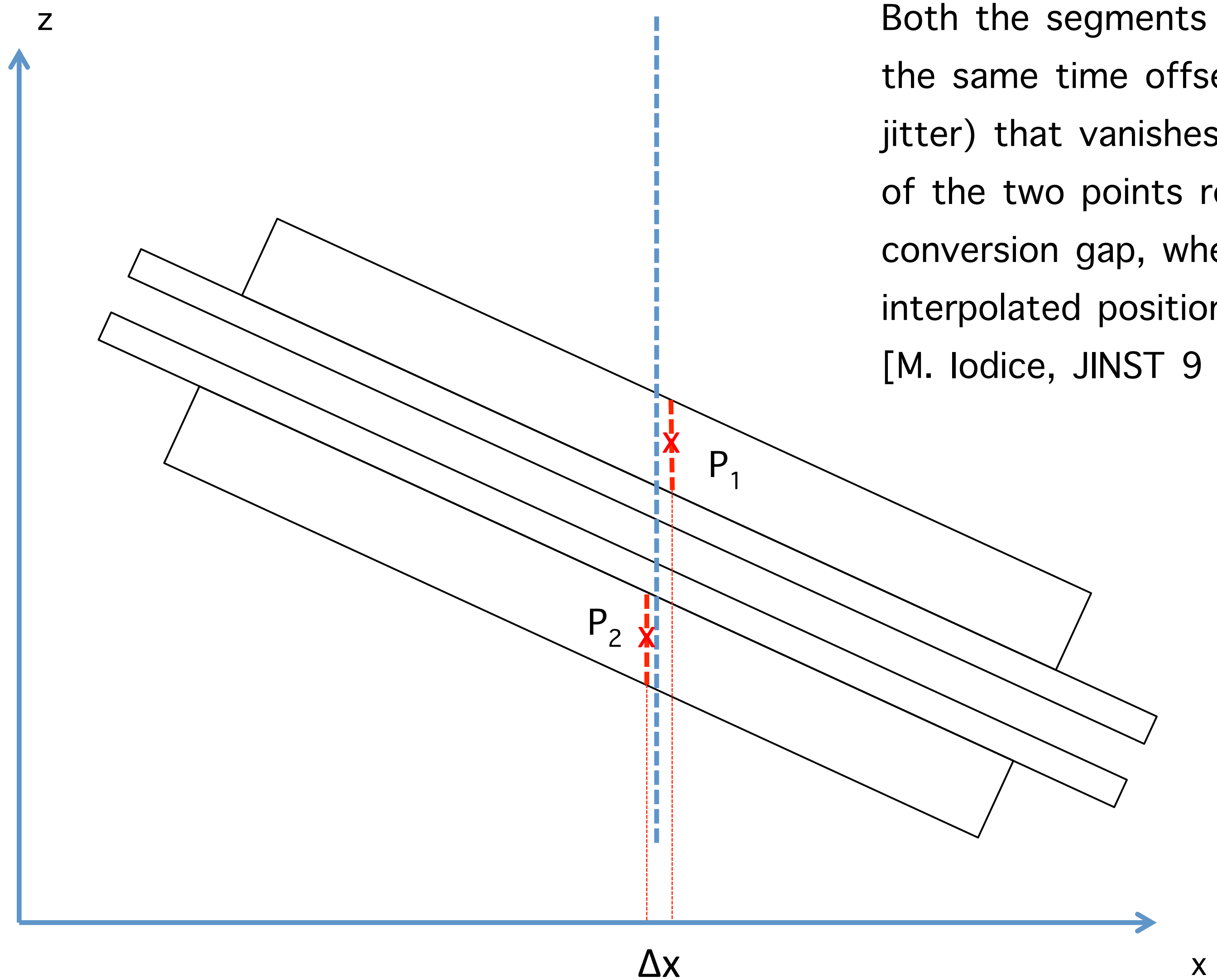
What about the intercept (depending on the T_0)?

- One method can be the use of a T_0 given in our setup by a dedicated board (as done for the measurements with emulsions, analysis still ongoing)
- But if just interested in measuring the space resolution of a detector, it is enough to compare the track segments reconstructed in two identical detectors



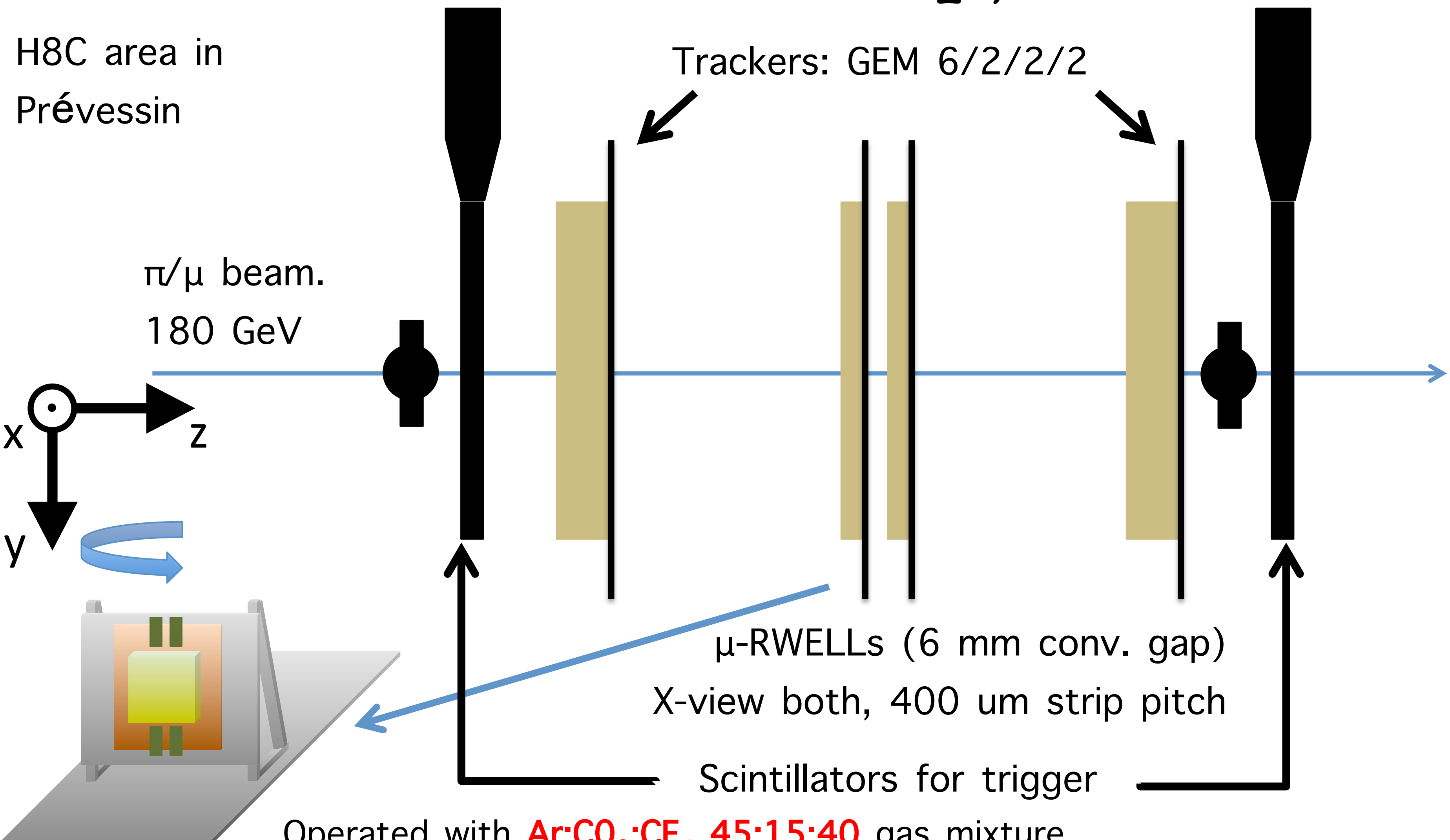


The space resolution



Both the segments are reconstructed with the same time offset (the same trigger jitter) that vanishes with the subtraction of the two points reconstructed at half conversion gap, where the error on the interpolated position is minimized
[M. Iodice, JINST 9 (2014) C01017]

The test beam setup, conf. 1



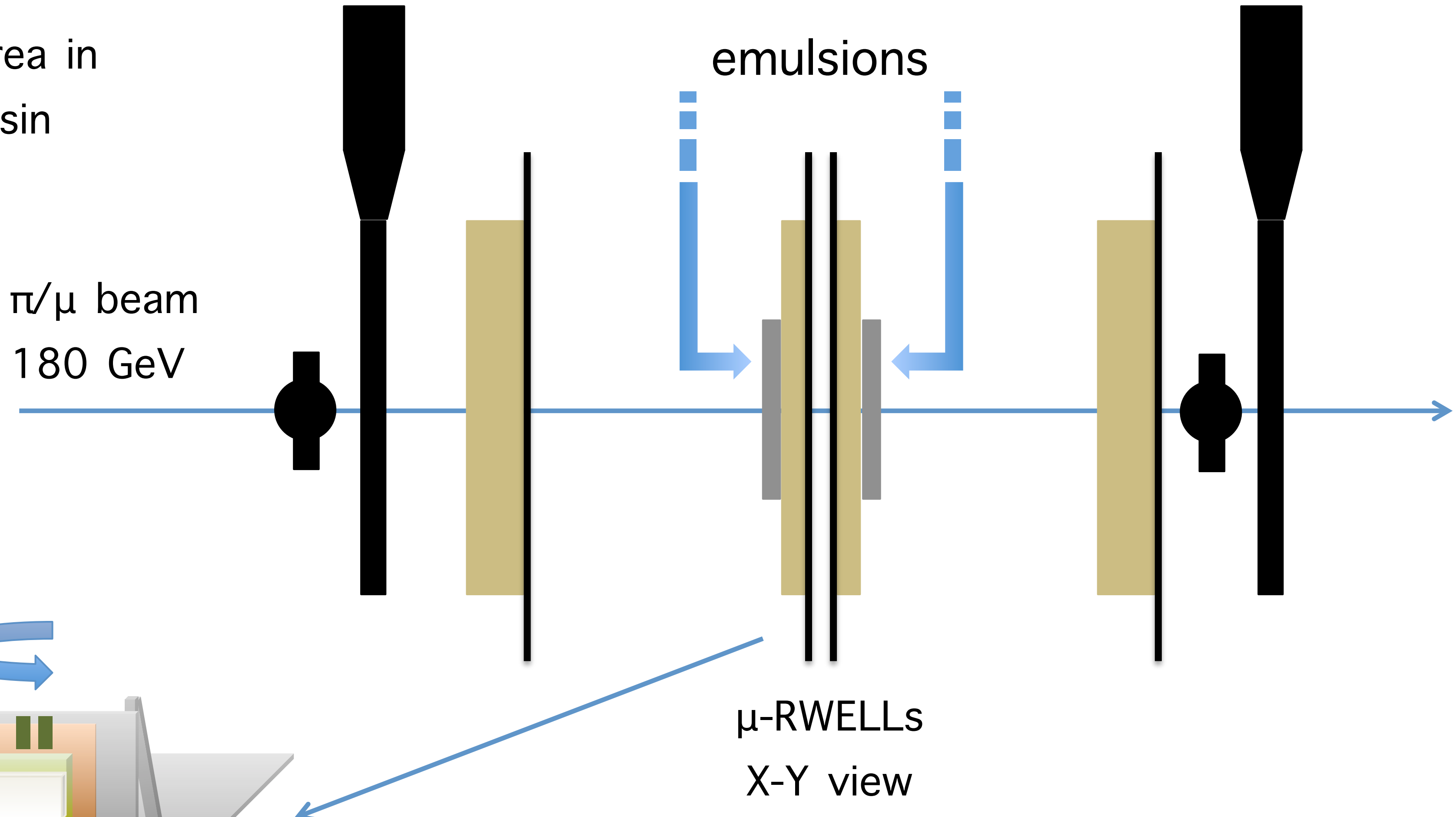
Operated with $Ar:CO_2:CF_4$ 45:15:40 gas mixture

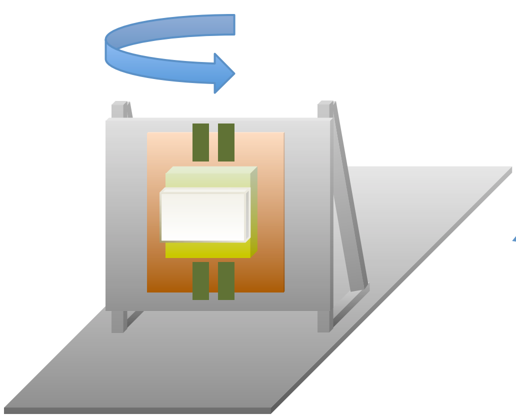
Rotatable plate

All the detectors equipped with **APV25 boards** handled by an **SRS system. A dedicated board acquiring the trigger signal provided the** T_0, differentiating the digital signal coming from the trigger

The test beam setup, conf. 2

H8C area in Prévessin

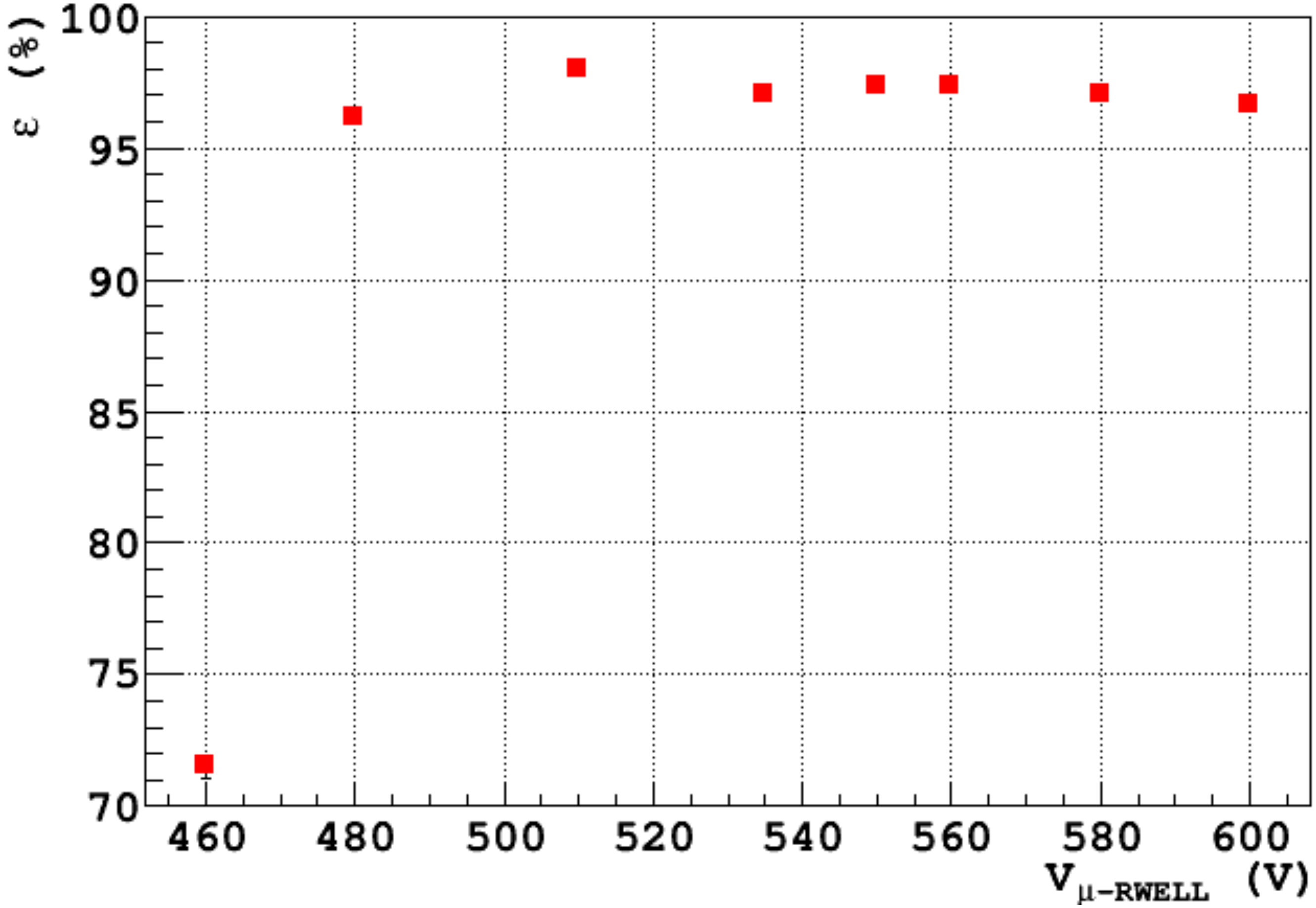




Rotatable plate

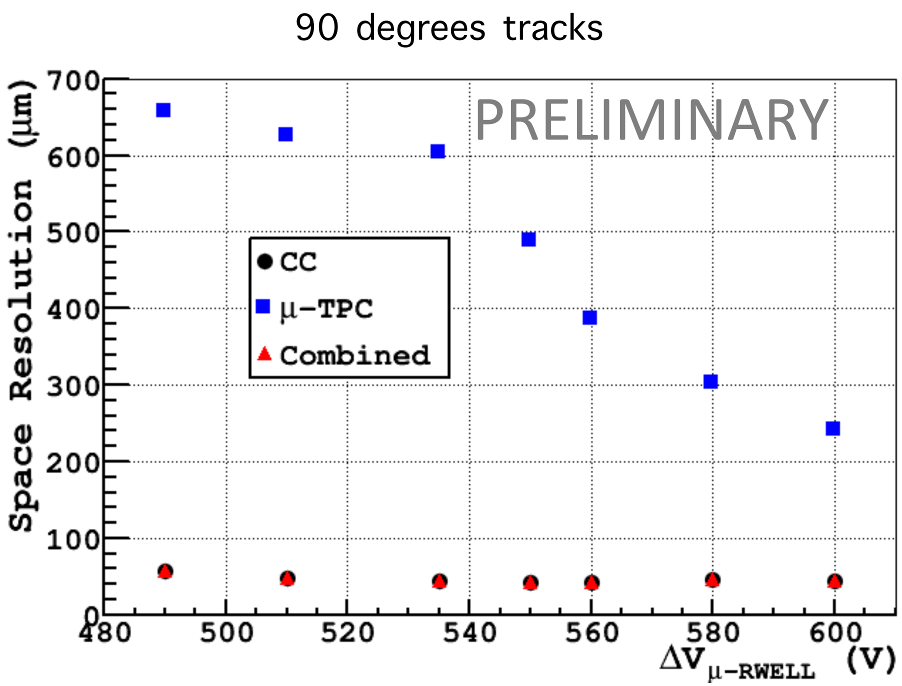
3 data taking campaign with angle scan from 90° to 45° in seven steps

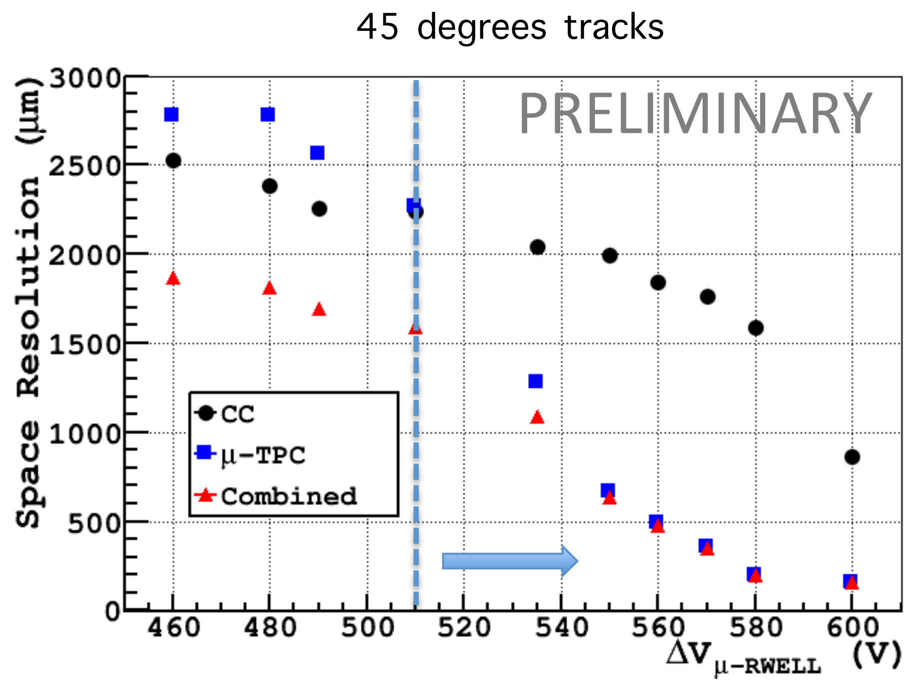
Preliminary efficiency



Tracking efficiency within ±5σ from the expected position

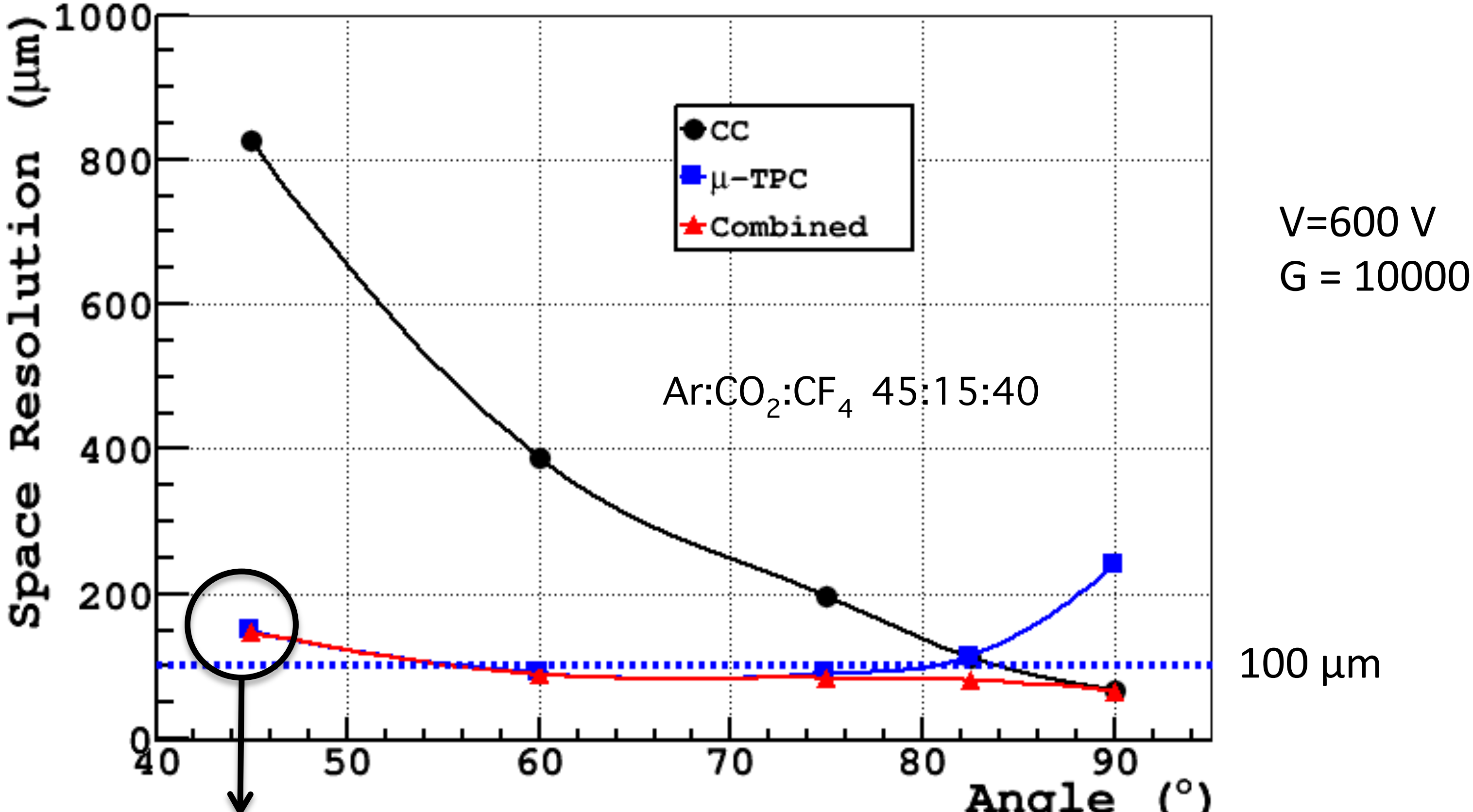
First results





Space resolution as a function of the HV, with pion beam. We show the comparison between the two reconstruction methods and their combination, obtained weighting the different σ with the height of the corresponding gaussian

First results



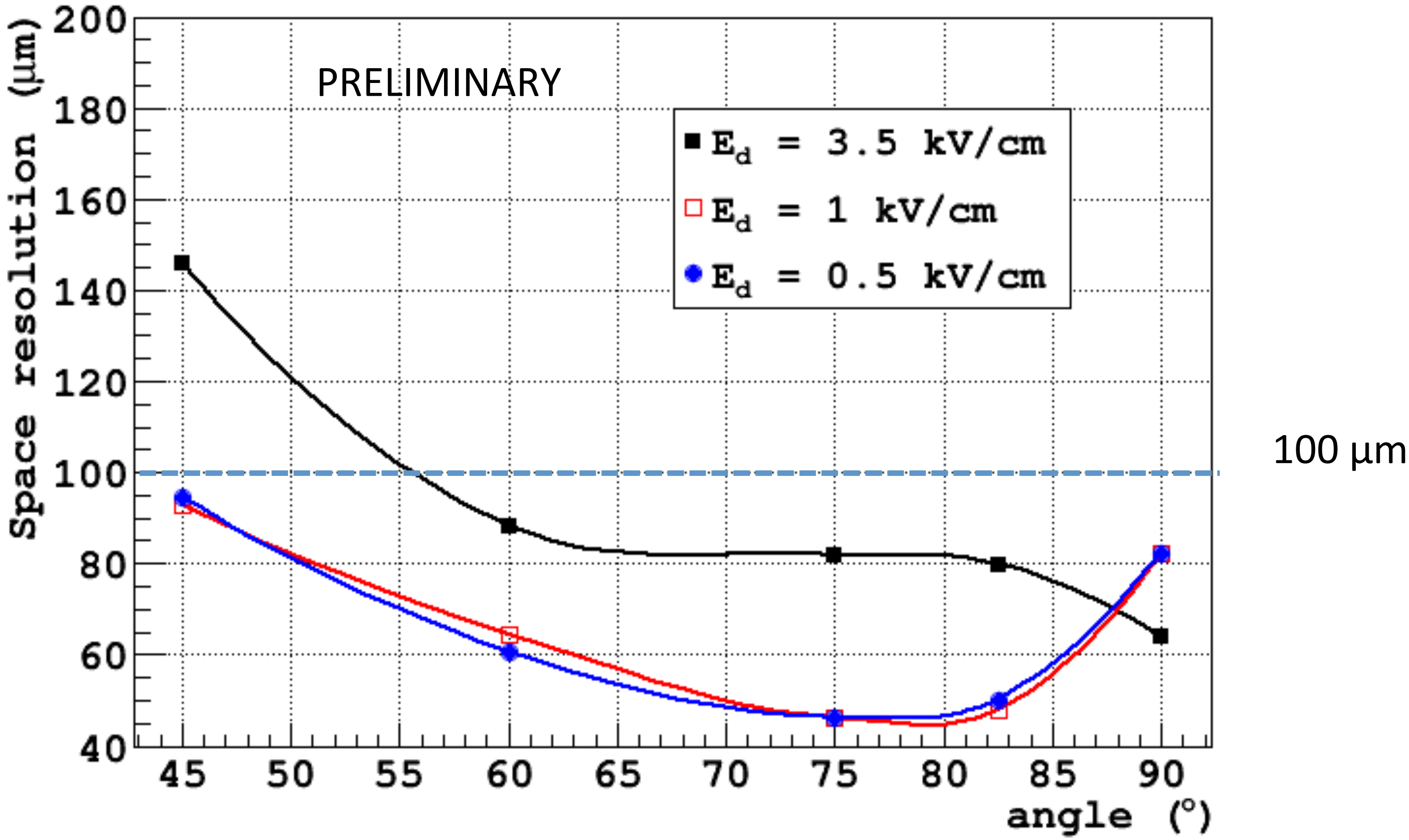
To be understood: analysis is ongoing

Space resolution as a function of the angle, at E_{drift}=3.5 kV/cm, with muon beam. The combination of the two methods makes the space resolution to be independent of the track incident angle.

First results

The μ-TPC algorithm depends on the electrons drift velocity.

Further measurements have been done for different electric field.

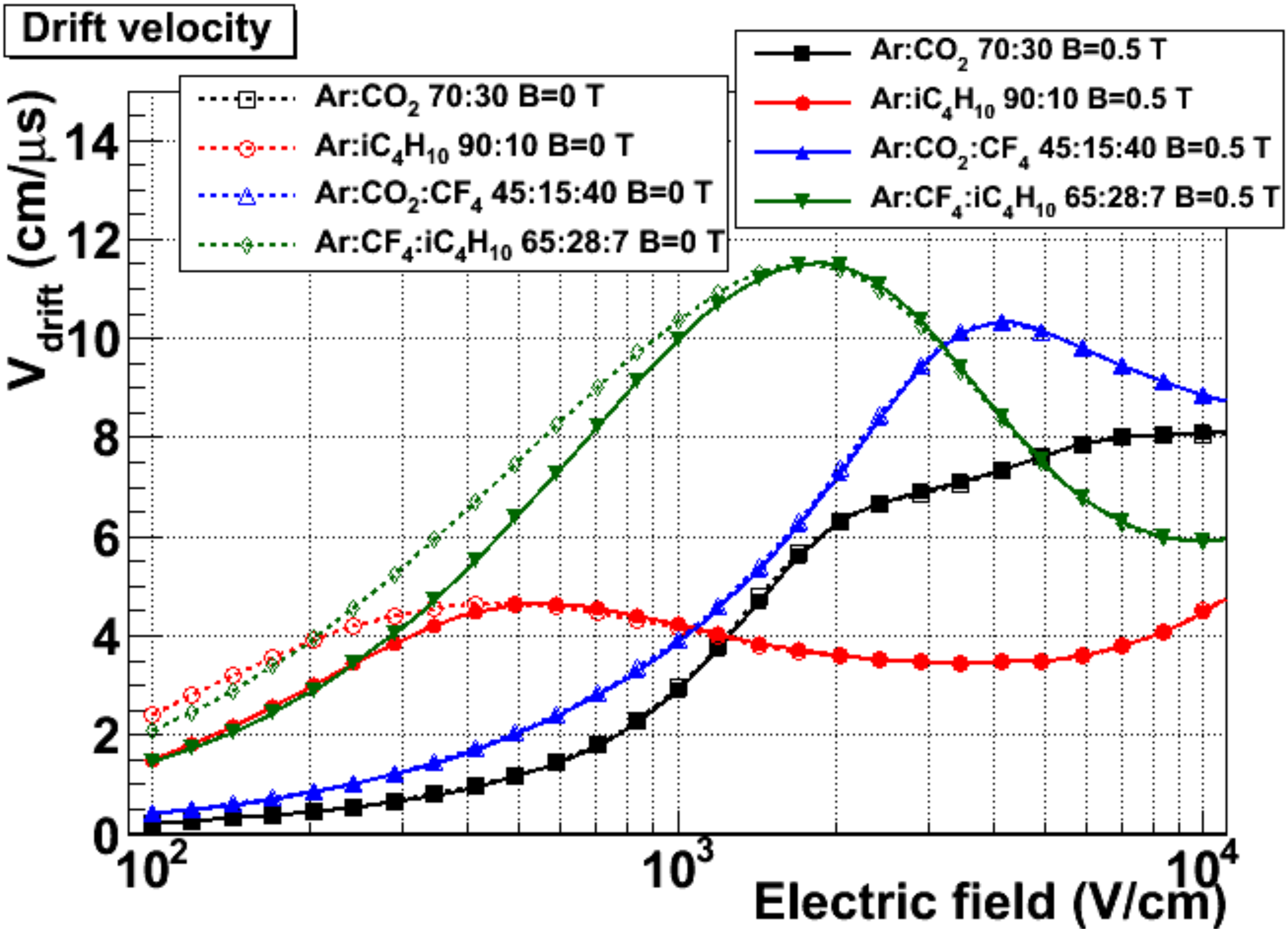


Combination of uTPC and CC methods for different drift fields

Values below 100 μm are reached with E_d=0.5, 1 kV/cm

Conclusions

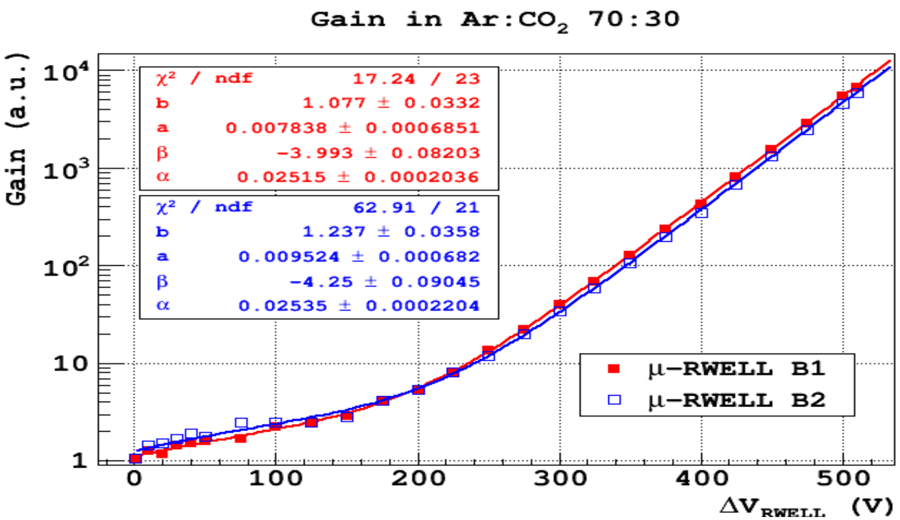
- For the first time the μ-TPC algorithm has been applied to μ-RWELL detectors
- This algorithm seems to be very effective in order to reduce the uncertainties of the reconstruction for sloped tracks (but also for tracks in magnetic field)
- Low values of drift velocities seem helpful for an improvement of the space resolution
- Still an open issue: why does the σ get worse at $\beta=45°$?
- But this is the first test beam, further measurements are mandatory

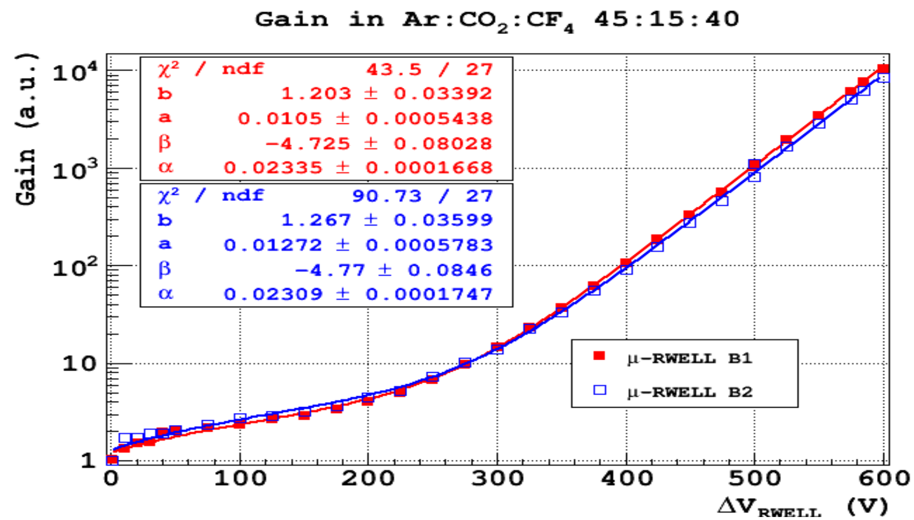


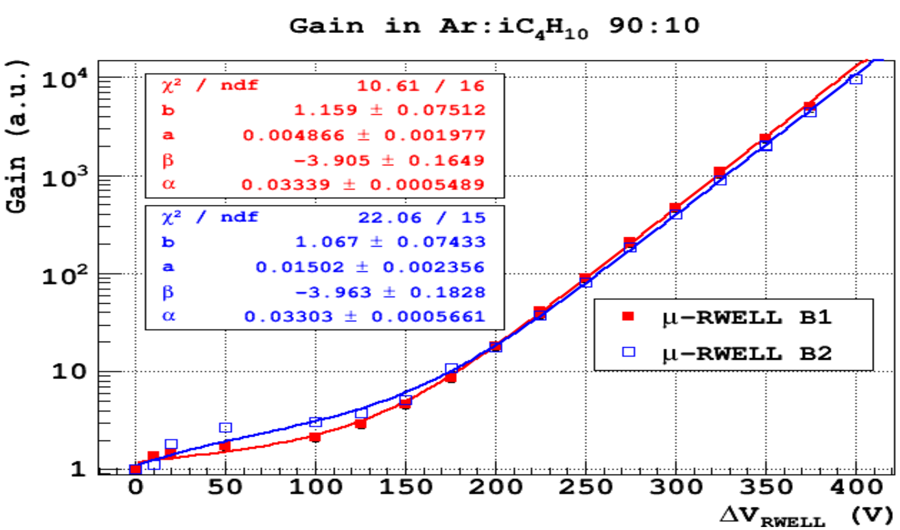
Drift velocity
Ar:CO2 70:30 B=0 T
Ar:iC4H10 90:10 B=0 T
Ar:CO2:CF4 45:15:40 B=0 T
Ar:CF4:iC4H10 65:28:7 B=0 T
Ar:CO2 70:30 B=0.5 T
Ar:iC4H10 90:10 B=0.5 T
Ar:CO2:CF4 45:15:40 B=0.5 T
Ar:CF4:iC4H10 65:28:7 B=0.5 T
Vdrift (cm/μs)
0
2
4
6
8
10
12
14
10^2
10^3
10^4
Electric field (V/cm)

X-ray measurements

Two prototypes with the **double resistive layer scheme** (ρ=40 MΩ/☐) have been completed last Summer; the detectors have been tested with a 5.9 keV X-rays flux **(local irradiation)**.

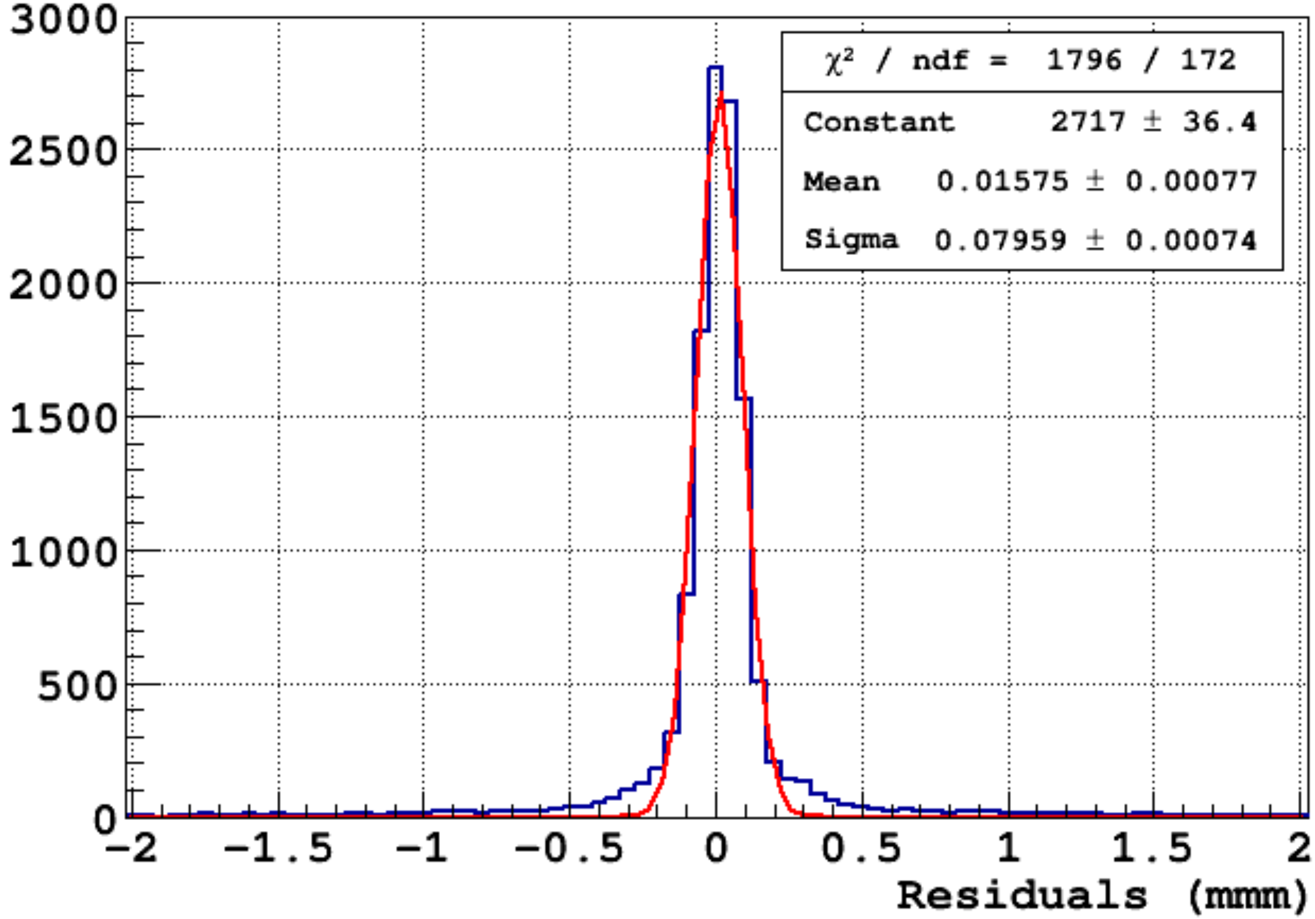






Measurement performed in current mode.
Gain measured up to 10000.
Similar behavior for the two chambers.

Examples of residuals



E_d= 3.5 kV/cm V=600 V (G=10000)