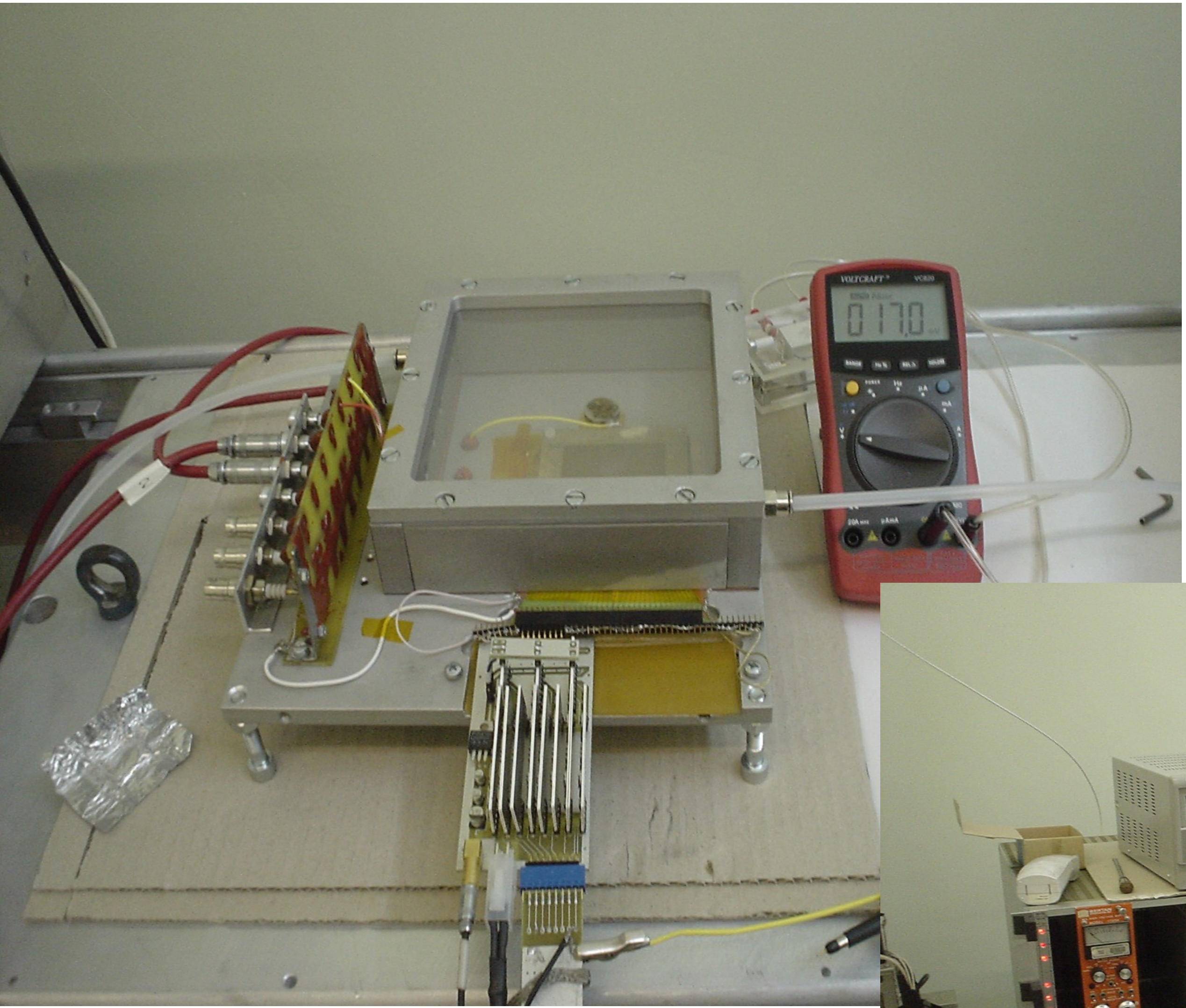
PNPI activity in MuCh

- Hit producer (Misha Ryzhinsky, separate talk)
- Thick GEM (Leonid Kudin, separate talk)

Outlook:

- Micromegas prototype tests
- Micropattern detectors: some news from CERN
- MuCh chambers: general considerations
- Integration: possible scenario

Micromegas prototype tests

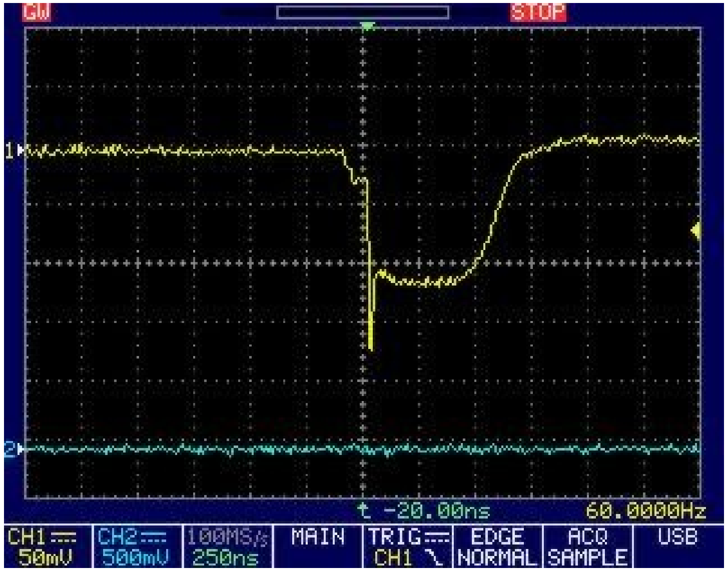


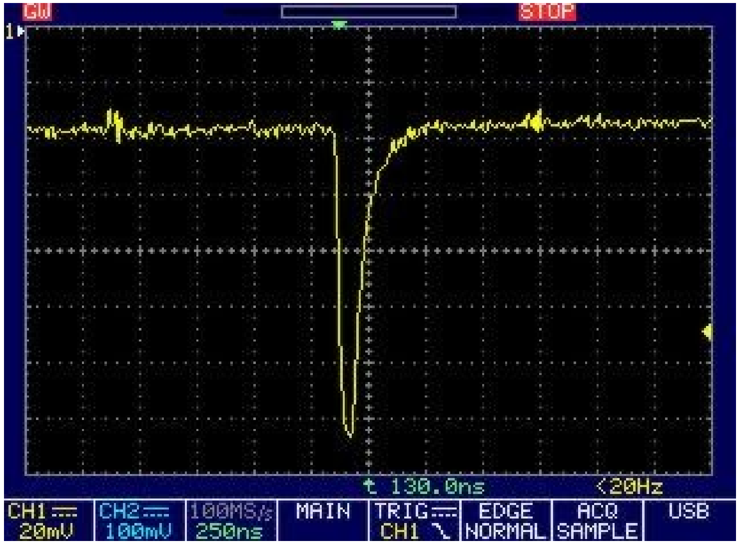
It is a-priori known that MM can work in MuCh environment

Goals:
- To lean how to work with the device
- To see the signal shapes
- To study basic properties

Ionization gap = 3 mm

Anode charge distribution in case of Micromegas ($ArCO_2$, 80:20)



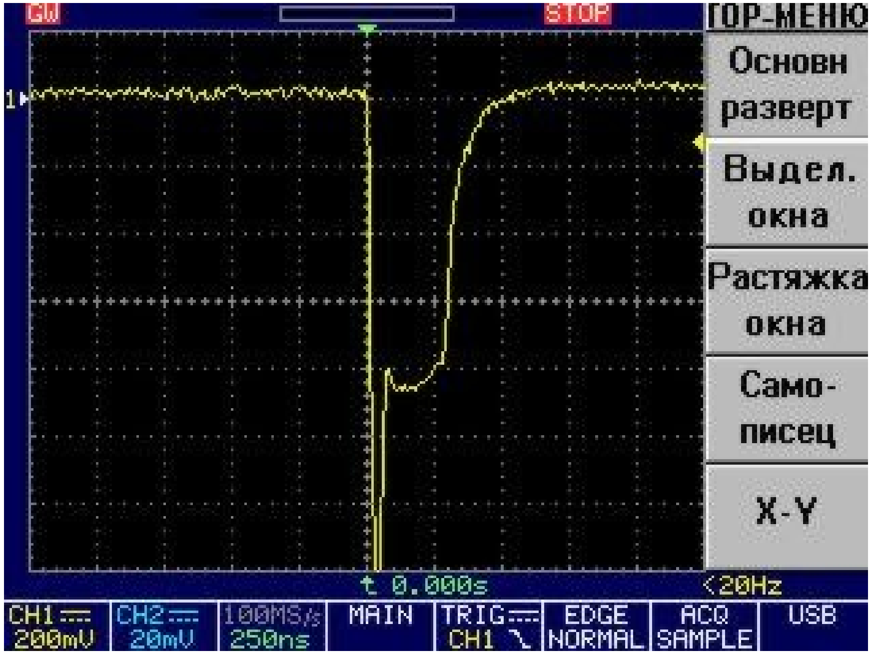


Wide strip zone, 100 microns gap

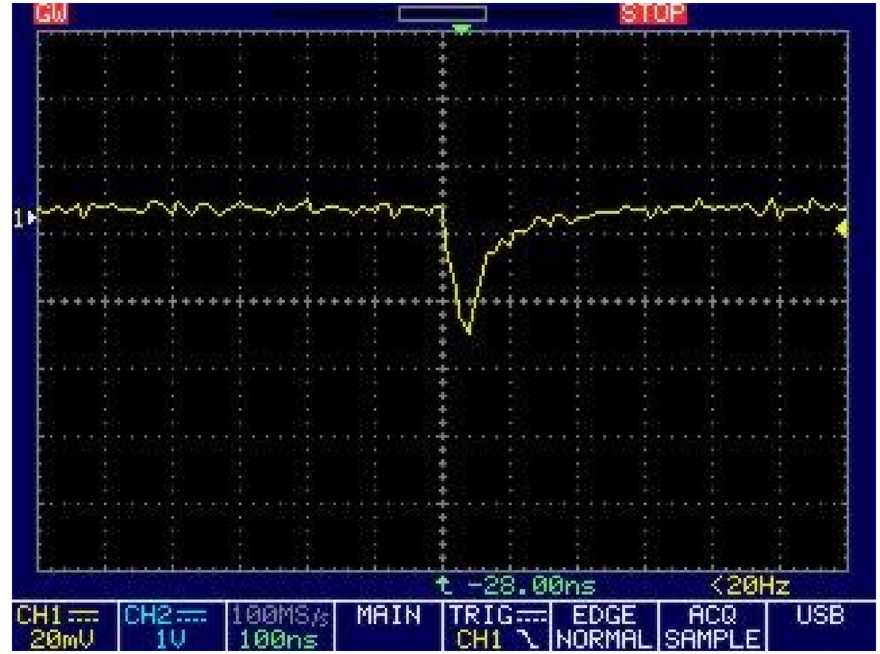
Wide (10 mm) strip zone, 200 microns gap.

VERY preliminary!!!

Anode charge distribution in case of Micromegas ($HeCO_2$, 80:20)



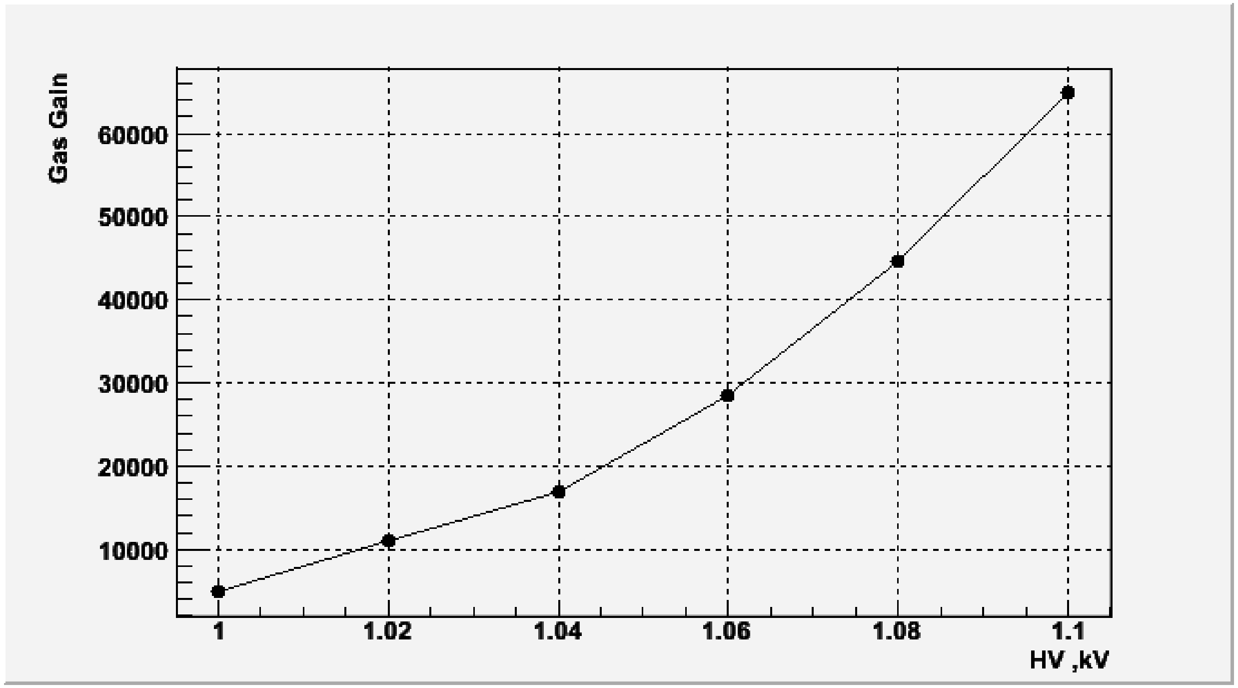
Wide (10 mm) strip zone, 200 microns.



Wide strip zone, 100 microns gap,

VERY preliminary!!!

Gas Gain: HV dependence



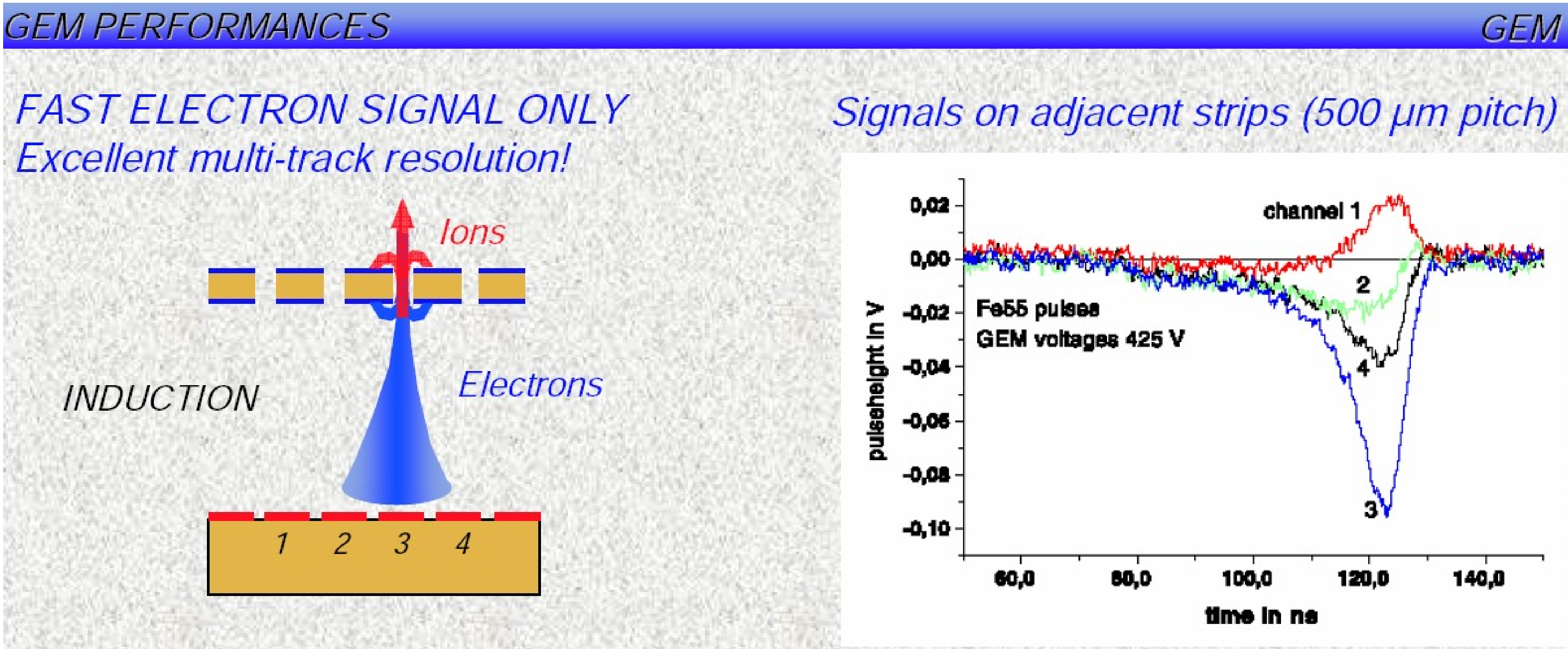
Micromegas, amplification gap of 200 microns

VERY preliminary!!!

GEM vs Micromegas: Summary

- High rate capabilities are similar, but the electronics for micromegas needs specific filters to eliminate the ion tail.
- Both detectors could suffer from discharges, but there are methods to reduce the risk to the affordable level
- HV granularity inherent to micromegas, but it is difficult to achieve in case of GEM
- GEM is much more expensive, but micromegas requires more careful assembling
- Charge radius is smaller (3-5 times compared to classic GEM).

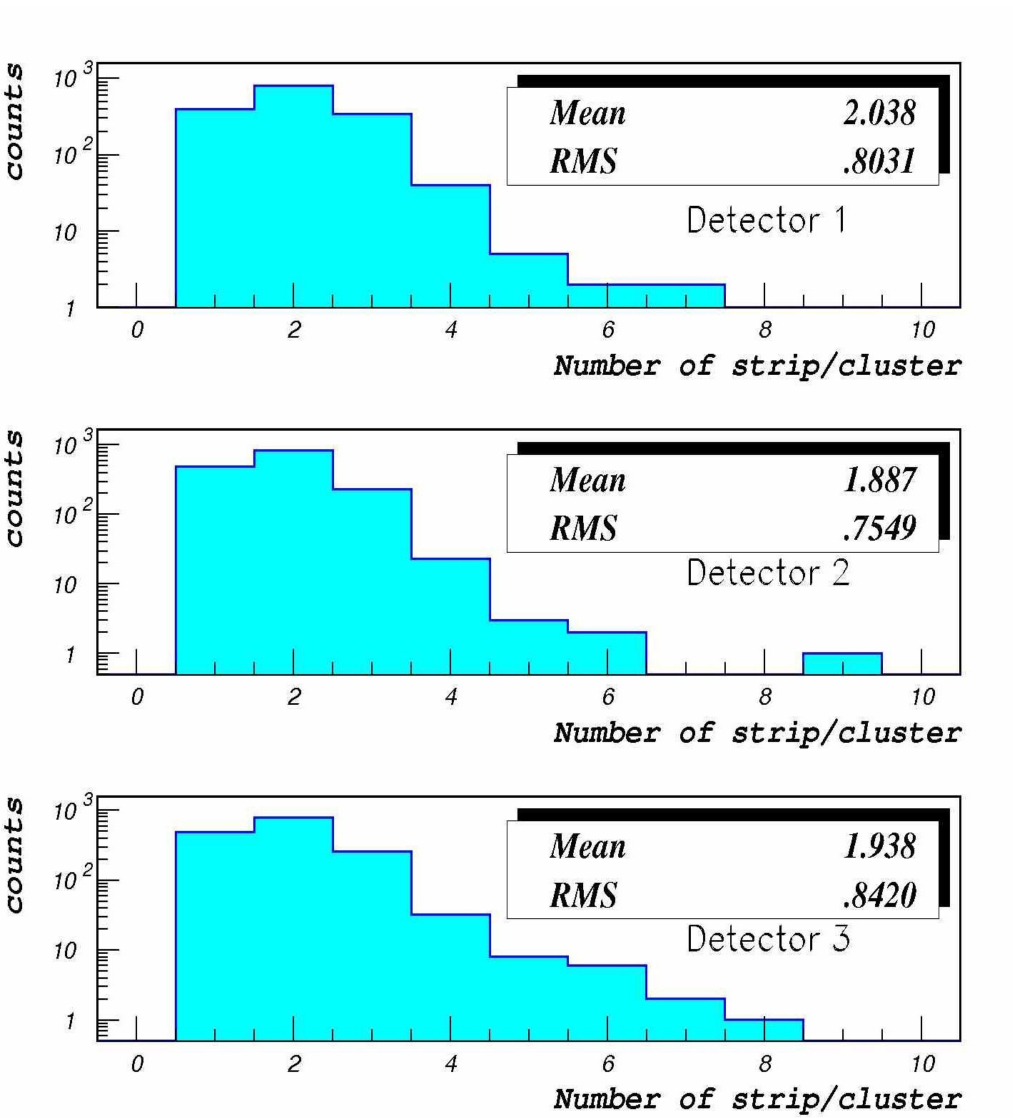
GEM vs Micromegas
Anode charge distribution for GEM



The figure is taken from the report by F. Sauli (borrowed from the PhD thesis by M. Zeigler)

Spot size: FWHM ~ 0.8 mm (σ~0.4 mm)
Typically 3 strips fired

GEM vs Micromegas
Anode charge distribution in case of Micromegas



SUBATECH prototype

2 strips fired (mean), strip pitch 0.2 mm

To be compared with GEM where 3 strips with pitch of .5 mm fired

Size of a charge in MM is factor of 3-5 smaller than in GEM.

Approximately proportional to the ratio of the mean electron drift path
(1.5+3x2) / 1.6

R&D to reduce the spot:
to decrease the distances between GEM foils and the foil and the anode

Simulations are required to study the level of importance of the effect

NB!!!

Last news: CERN, Sept'07

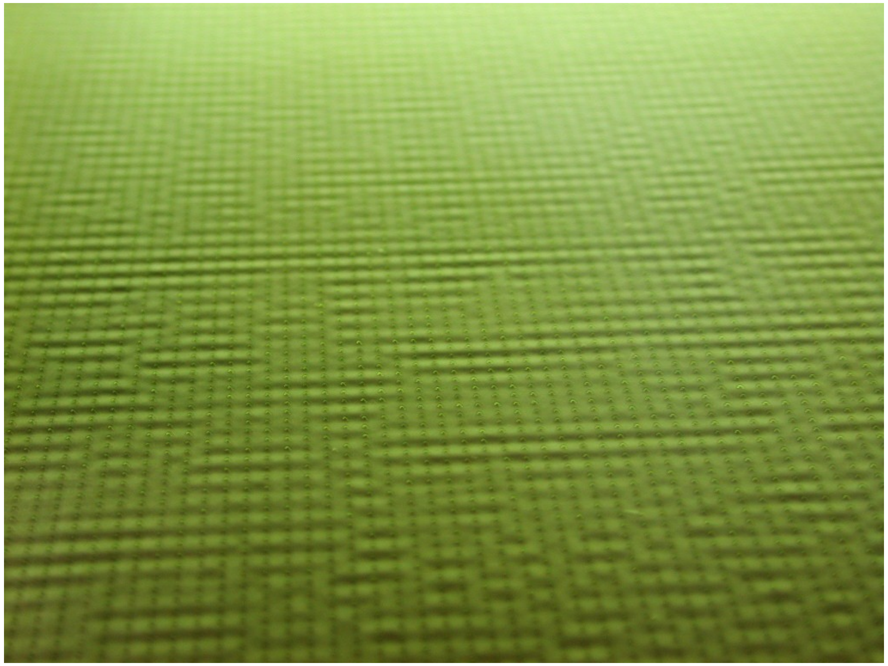
http://indico.cern.ch/conferenceOtherViews.py?view=standard&confId=16213

Available (in nearest future, not now!) MAX sizes:

GEM size (500x800 mm) is limited by Laser direct imaging machine, bad alignment
Micromegas woven mesh – quality of mesh (up to 1000x1000 mm)

Future improvements are possible...

GEM cost reduces **VERY** slowly :(



Waves on the surface of the Micromegas mesh (from 3 {good} to 30 microns {bad}) in amplitude)...
To be studied.
Tooling to detect(?) / eliminate (??)

THGEM size

Rui di Oliveira

Raw material: 1200mm x 1000mm in any thickness

CNC drilling:

- **-size : 600mm x 500mm**
- **-time : 3000 to 6000 holes/hour**
- **-tooling : 1 tool= 1000 to 3000 holes**
- **-possibility to drill up to 5 circuits at a time (0.2 to 0.3mm boards)**

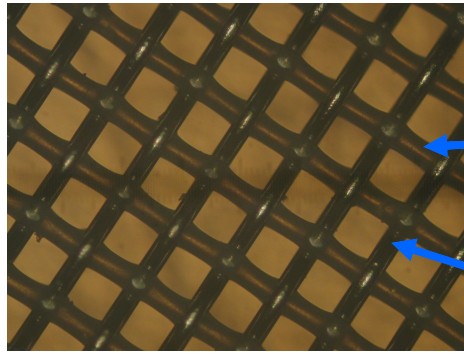
Screen printing:

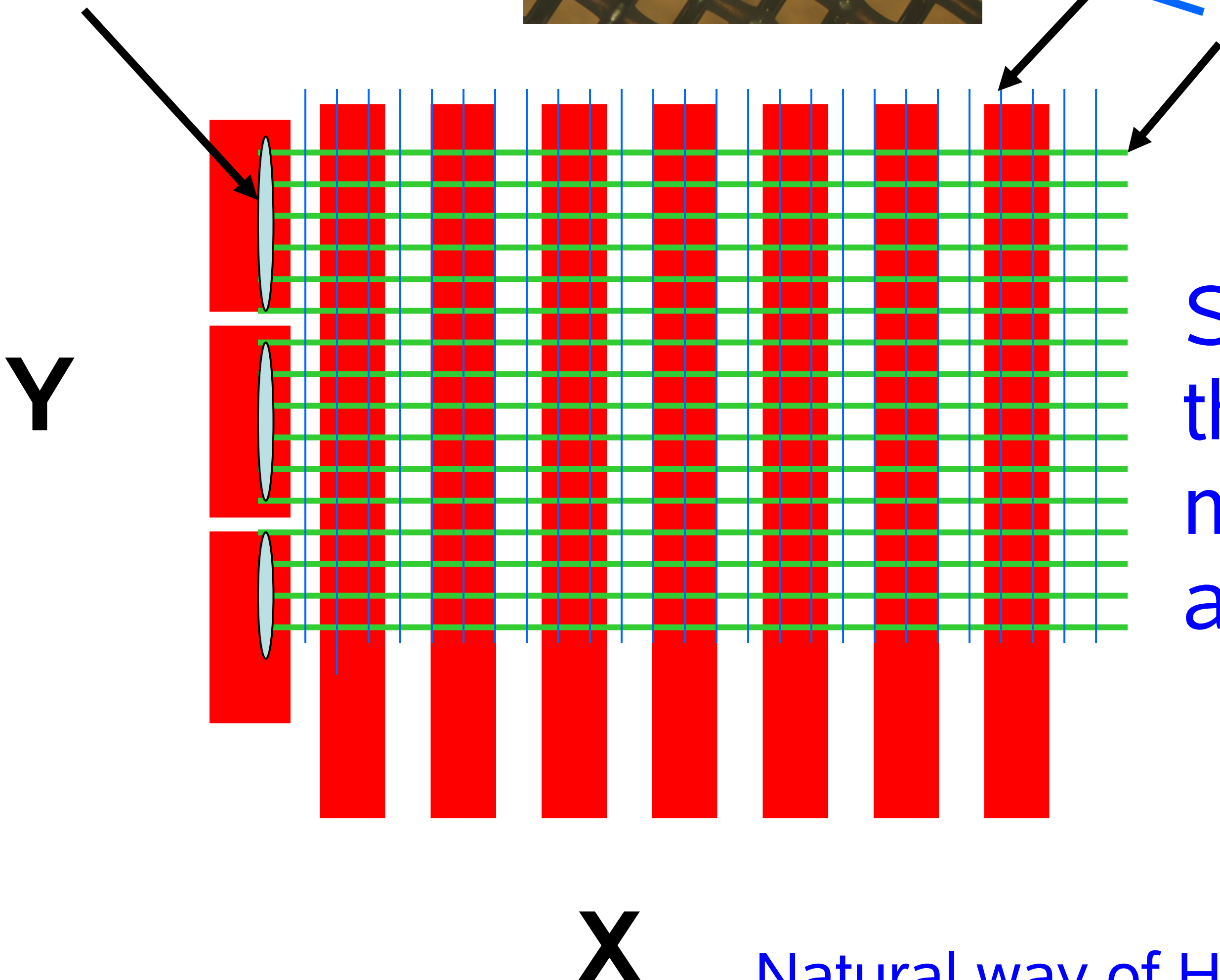
- **-size: 600mm x 500mm**
- **-absolute resistor value accuracy +/- 50% on large sizes (estimated)**

Price:

400 Euros for Compass like size (300mm x 300mm) for 1 piece
266 Euros “ “ “ “ “ “ (qty 100 pieces)
These prices are without any post treatment
Company ELTOS (Italy)
Holes of 0.2mm pitch 0.5mm (250 000 holes)

Maximum size 600mm x 500mm





Segmentation of the micromegas mesh (eventually add resistance)

Natural way of HV segmentation!!!

MUCH Design Specifications
(to be discussed)

- Chambers up to 3.5 m in diameter of the sensitive zone
- Thickness envelope – below 40 mm (preferably 30 mm)
- Possibilities for the displacements:
  - Side (working/servicing positions)
  - Storage position
- Spatial resolution – to be discussed (0.3 - 0.5 mm??)
- Reproducibility of the detector geometry
  - In XY ~0.3 of the chamber spatial resolution ~ 0.1 mm
  - In Z ~ doubled of the chamber spatial resolution (at base ratio ~4) ~0.5 mm

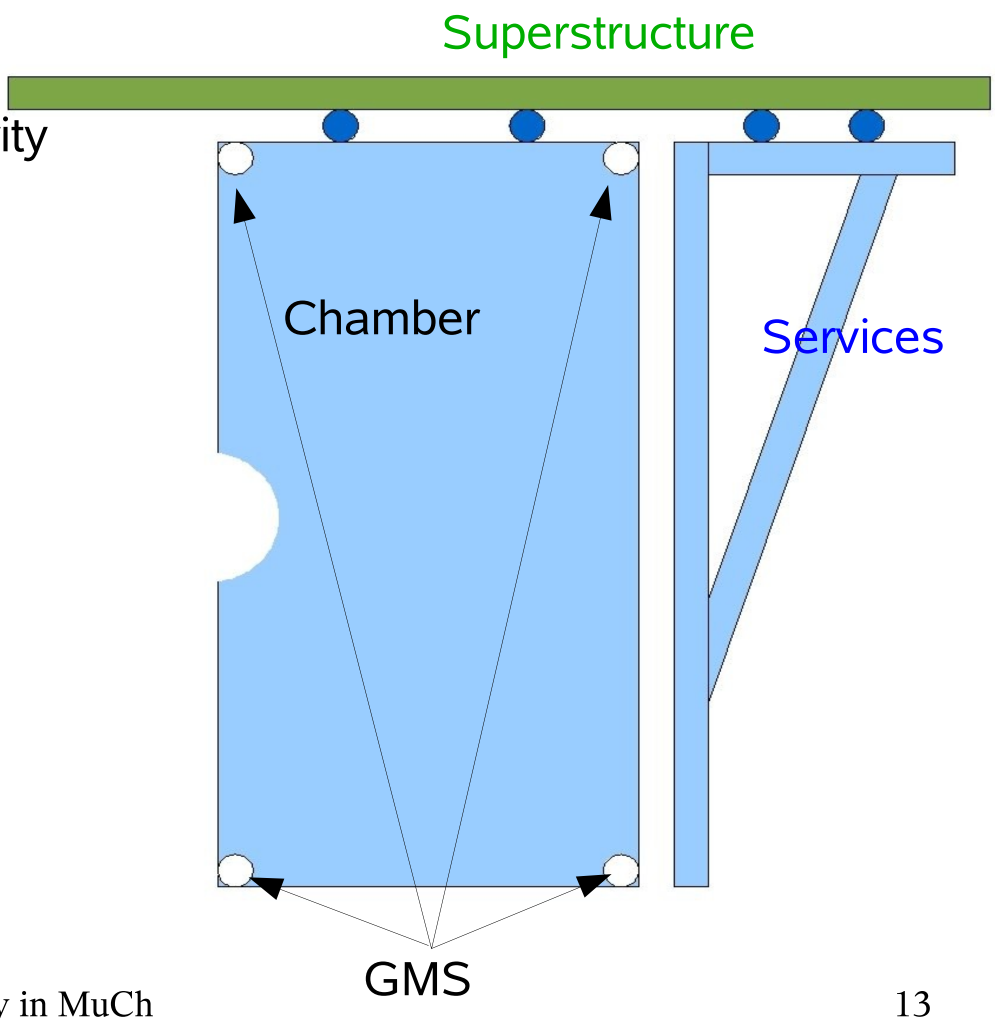
  These tolerances should be checked within CBMroot analysis
-

Approaches for the chamber design: Monolithic option

Though less probable, should be studied (e.g. glued pieces of GEM)

Half-moon or quadrant

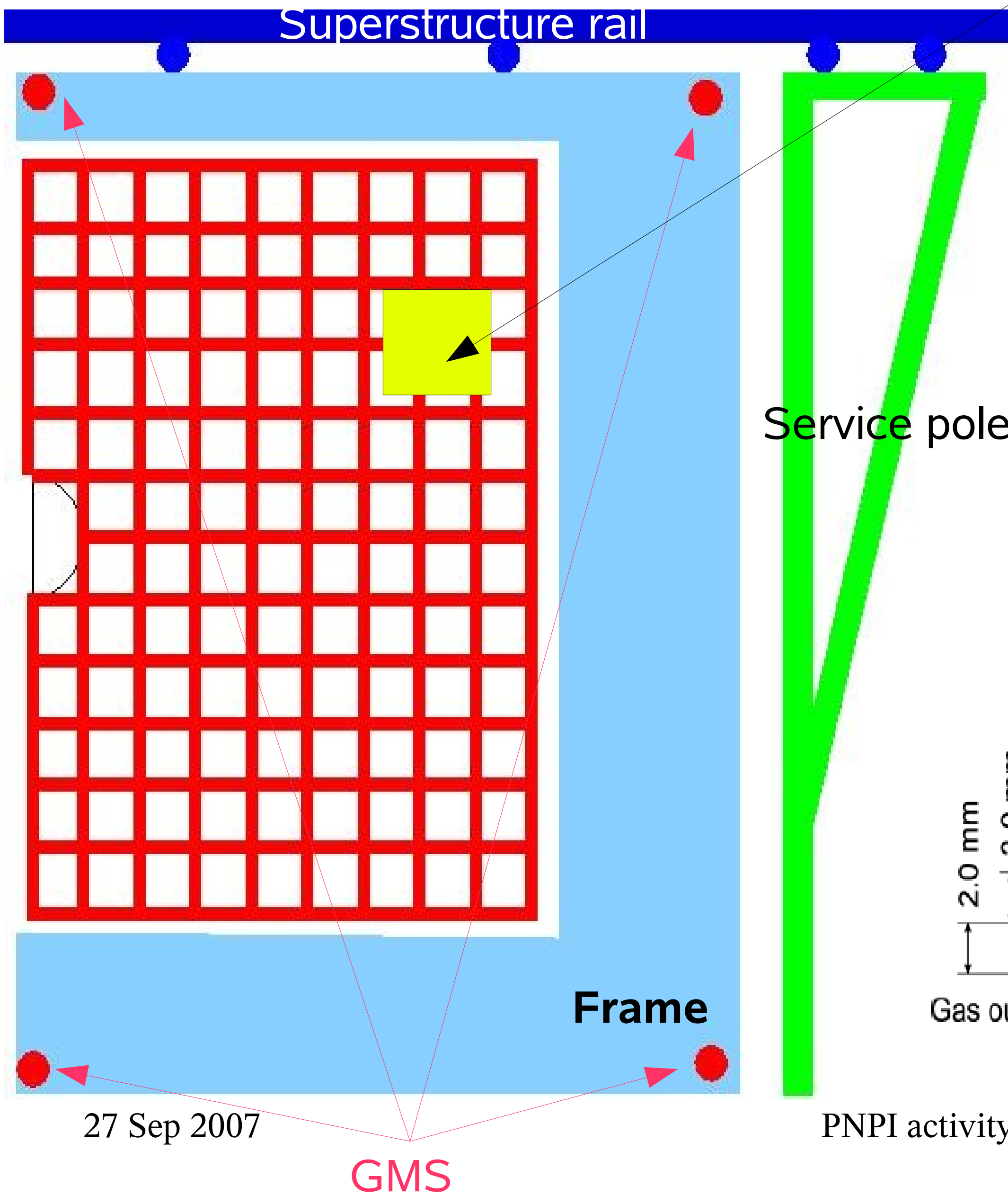
Thin and large – easy to loose the planarity



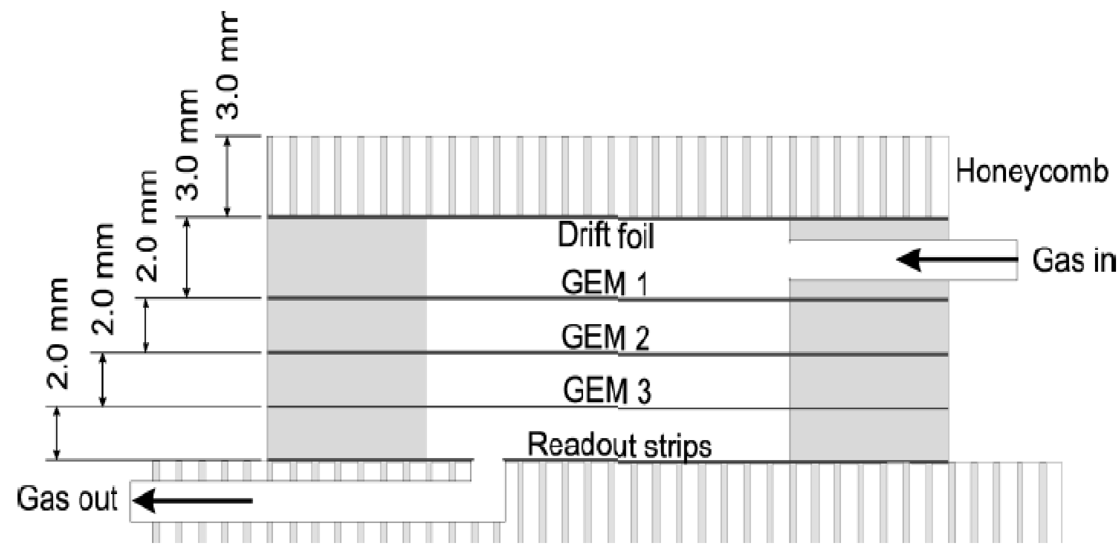
Electronics is located on the chamber surface

Approaches for the chamber design: Mosaic

Inspirited by STS



More realistic, keeping in mind size limitations of the foils.
A support structure (most likely a grid made of carbon skins and honeycomb) with fixation pins
The sensitive area will be covered with a set of relatively “small” detectors (size of from 300x300 mm to 600x600 mm)



COMPASS design

Chamber design considerations

Careful finite element analysis is required for both designs

FEE location:

- On the surface of a chamber (requires complicated machining of sandwich and increase of its thickness).
- Over the chamber perimeter (requires expensive multi-layer PCB)

Geometry Monitoring System

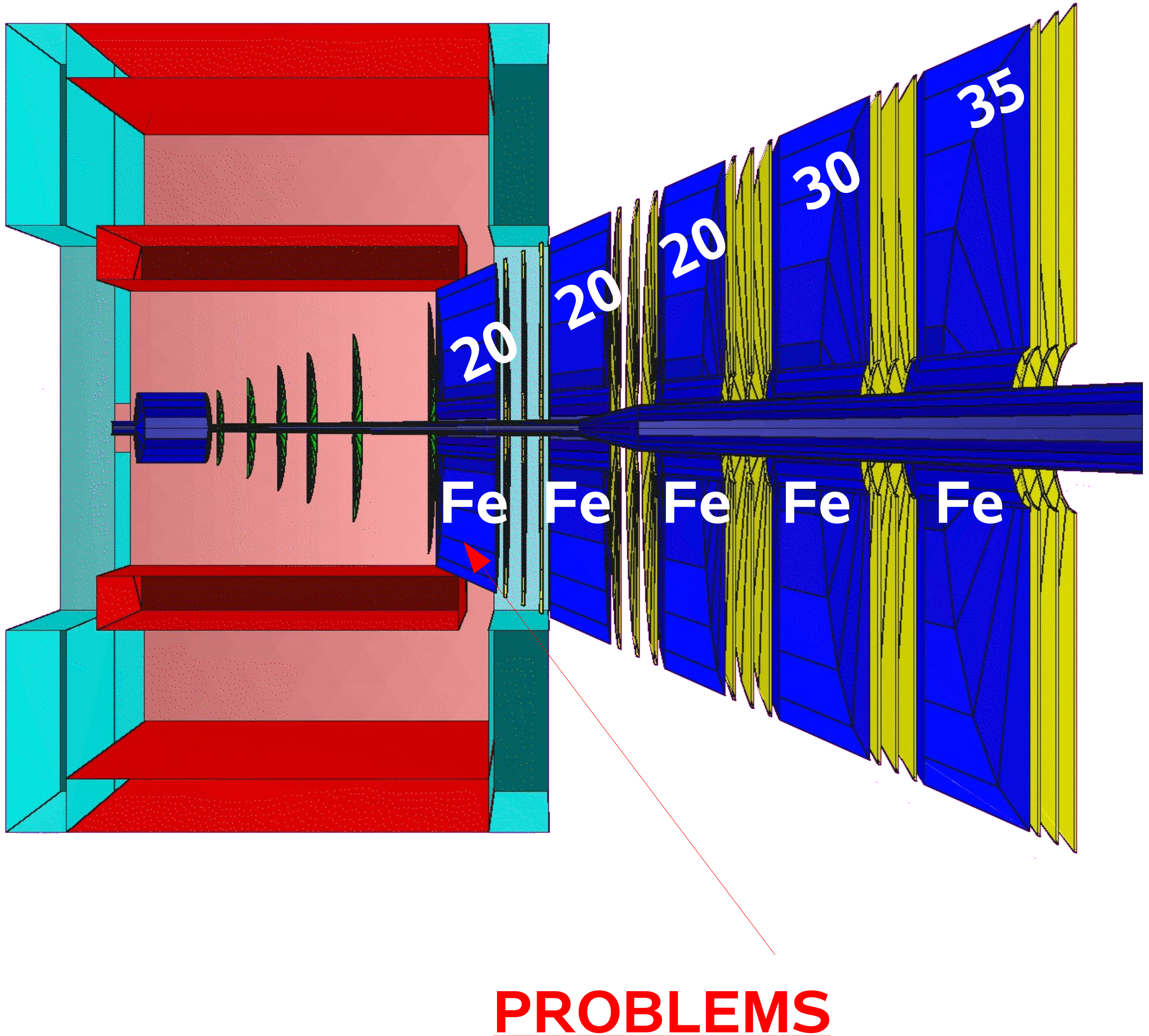
Goal: to measure the displacements due to temperature (change and gradients), magnetic fields, etc in order to have a possibility to introduce the software or hardware corrections.

- Absolute overall positioning of the detector **EMS** (external)
- Reproducibility of the detector elements position, time stability **LMS** (longitudinal, the chambers assumed to be rigid)
- Detector deformation monitoring **TMS** (transverse)
  - Bending
  - Twisting

A set of devices is developed (BCAM, RASNIK); they are widely used in LEP (L3) and LHC experiments (ATLAS, ALICE)

IR lasers + CCD

Integration MuCh detector



Problems:

- Independent installation/removal of the chambers and absorbers (for purpose of calibration with direct particles without magnetic field) (???)
- Servicing of the first chambers
- Chamber size >> size of active zone (stiffness requirements + GMS)

Integration – first considerations

- The common concrete basement for MUCH and RICH in the middle of the cave; floor outside
- Detector either:
  - Sits on the movable along Z platform capable to get out of the magnet (?? one of the approaches)
  - Or the first chambers will be accessed by removing of the absorber-2
- The half-chambers are grouped in blocks of 3. (?)
- The beam-pipe consists of several elements coupled with vacuum flanges
- Chamber suspension system enabling :
  - Chamber movements in work/service positions
  - Chamber shape correction
- Ground floor used for services and electronics
- Gangways along the walls

Integration – first considerations

Half-chambers are bound in blocks of 3
• The inserting/removing procedure is simpler
• Better stiffness
• Deformations (non-planarity) could be measured/corrected outside
individual access – in servicing position

A half-chamber (a set of “small” detectors) could be calibrated with thin X-ray beam mounted on high precision XY device: all offsets and mutual rotations with respect of the GMS sensors will be known

R&D plans for nearest future

- To try to develop bulk micromegas in Russia
- To test the detectors with alpha source (5.5 MeV)
- To optimize the gas (signal shape and discharges)
- To build a prototype with resistive electrodes
- To develop the anode PCB close to the required one
- To build a classical GEM prototype
- To develop the detector design and integration

Conclusions

• The tested micromegas has been tested with 2 gas mixtures and 2 gap sizes; it works as expected
• All detectors of interest can work in MUCH conditions, the choice is not evident
• Several options for the chamber design and integration should be studied; integration in case of MUCH has special importance.
• We prefer to have the first chambers **outside the magnet,** however existing design of MUCH is also feasible. The goal is to minimize number of movements.
• The design of MUCH should be done **in tight contact** with the design of the Dipole **magnet, beam pipe** and **RICH**

Rui di Oliveira (CERN):

Maximum size possible with existing equipments in low volume:

→ GEM : 1400mm x 500mm foil – 1350mm x 450mm active area

→ Micromegas : 550mm x 1000mm

→ THGEM : 600mm x 500mm

Thank you