Large-size micromegas for ATLAS (MAMMA)

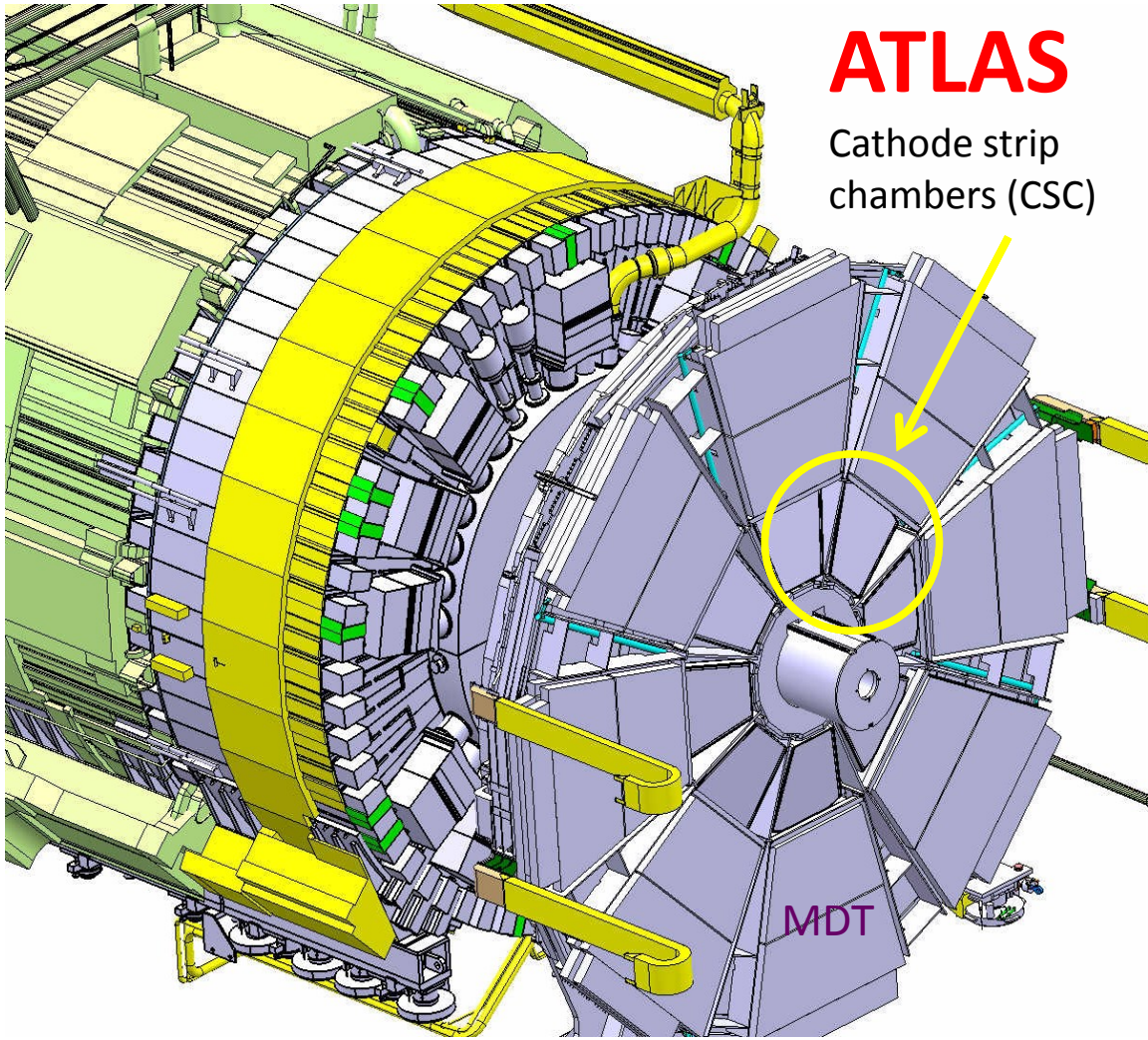
Status and prospects

The first large prototype (Nov 2009)

- Dimensions: 1.5 x 0.5 m^2
- Six separate (standard) mesh sections
- Strip lengths: 0.4 and 1 m
- Strip pitches: 250 and 500 µm
- Test beam: July 2010
- Long strips: noise x 2, but nice signals

Next step: CSC-size chamber

- MM chamber with the same dimensions as the large Cathode Strip Chambers (CSC) in the ATLAS forward muon system
- Dimensions: approx. 1.2 x 1.2 m^2, wedge-shaped
- Largest chambers of Small Wheel are now MDTs (drift tubes) with 2.4 x 1.2m^2

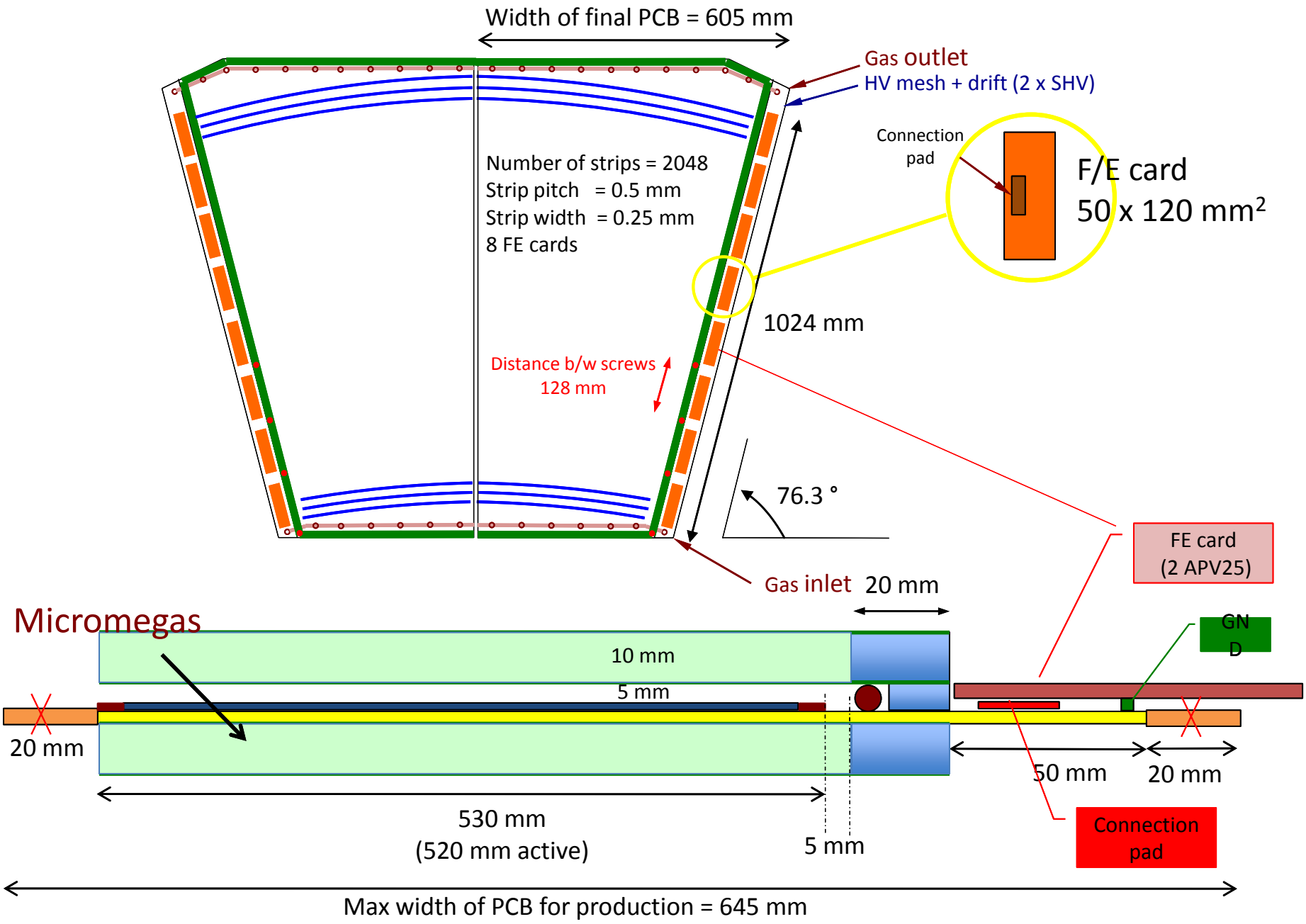


The ATLAS Small Wheel

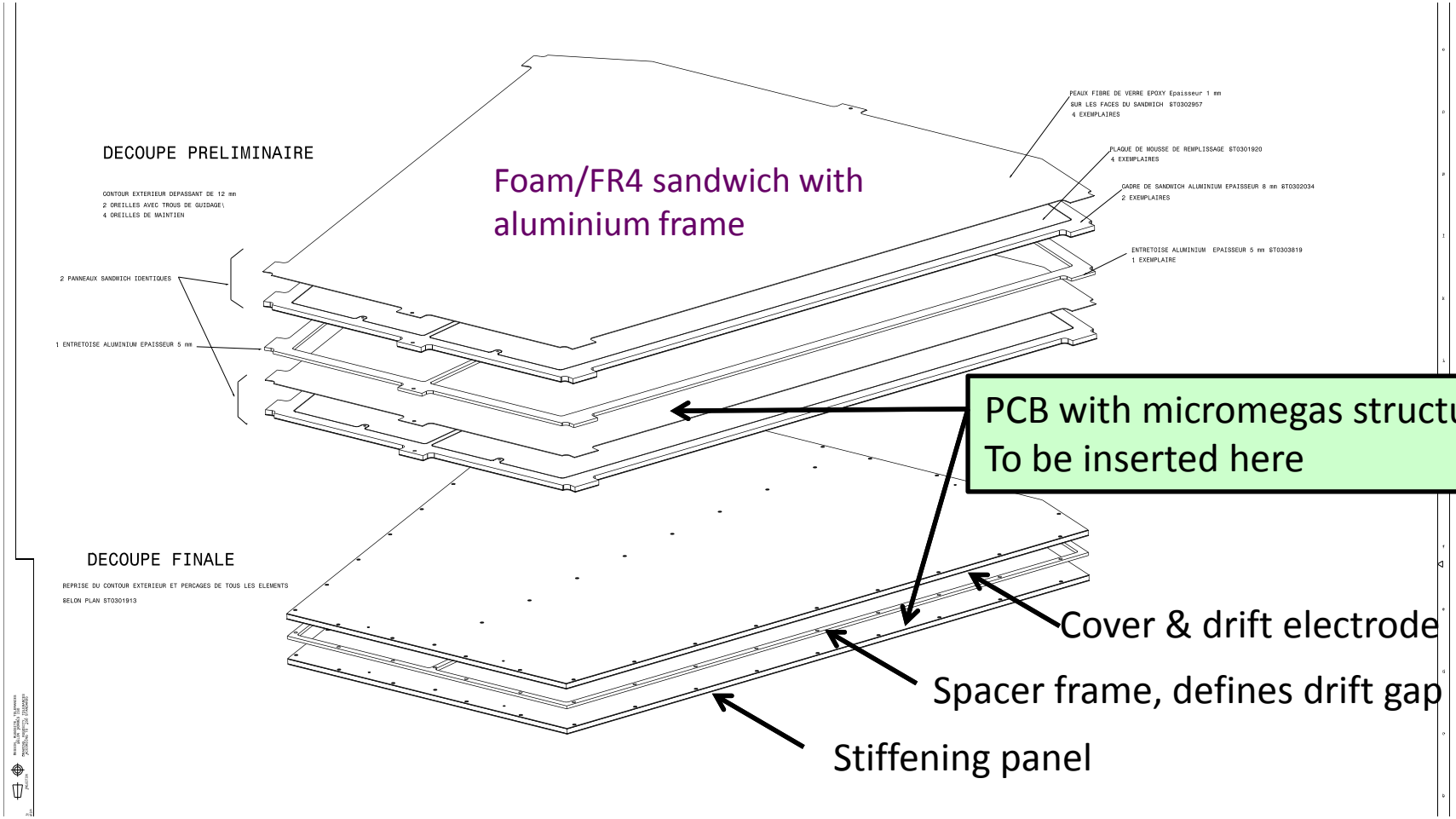
CSC-size chamber: constraints & plans

- Constraint: the size of the machines in the CERN PCB workshop

  Therefore we opted to start with half-size MMs in a common detector housing
- The plan:
  - Start with a standard, half-size MM (non-resistive) to test the procedure (fall 2010)
  - Construct a half-size MM chamber with resistive strips (end 2010)
  - Add 2nd half-size layer (spring)
  - Full-size layer, when new machines available (summer)
  - Construction of a 4-layer chamber (fall 2010)
  - Installation in ATLAS during LHC shutdown 2012 (or 2013)
- … and reality:
  - Non-resistive MM completed begin of November
  - Resistive MM completed begin of January (exactly 1 week ago)


Width of final PCB = 605 mm
Gas outlet
HV mesh + drift (2 x SHV)
Connection pad
F/E card
50 x 120 mm²
Number of strips = 2048
Strip pitch = 0.5 mm
Strip width = 0.25 mm
8 FE cards
1024 mm
Distance b/w screws
128 mm
76.3 °
Gas inlet
20 mm
FE card
(2 APV25)
Micromegas
10 mm
5 mm
GND
20 mm
50 mm
20 mm
530 mm
(520 mm active)
5 mm
Connection pad
Max width of PCB for production = 645 mm

Mechanics – detector housing



Foam/FR4 sandwich with aluminium frame

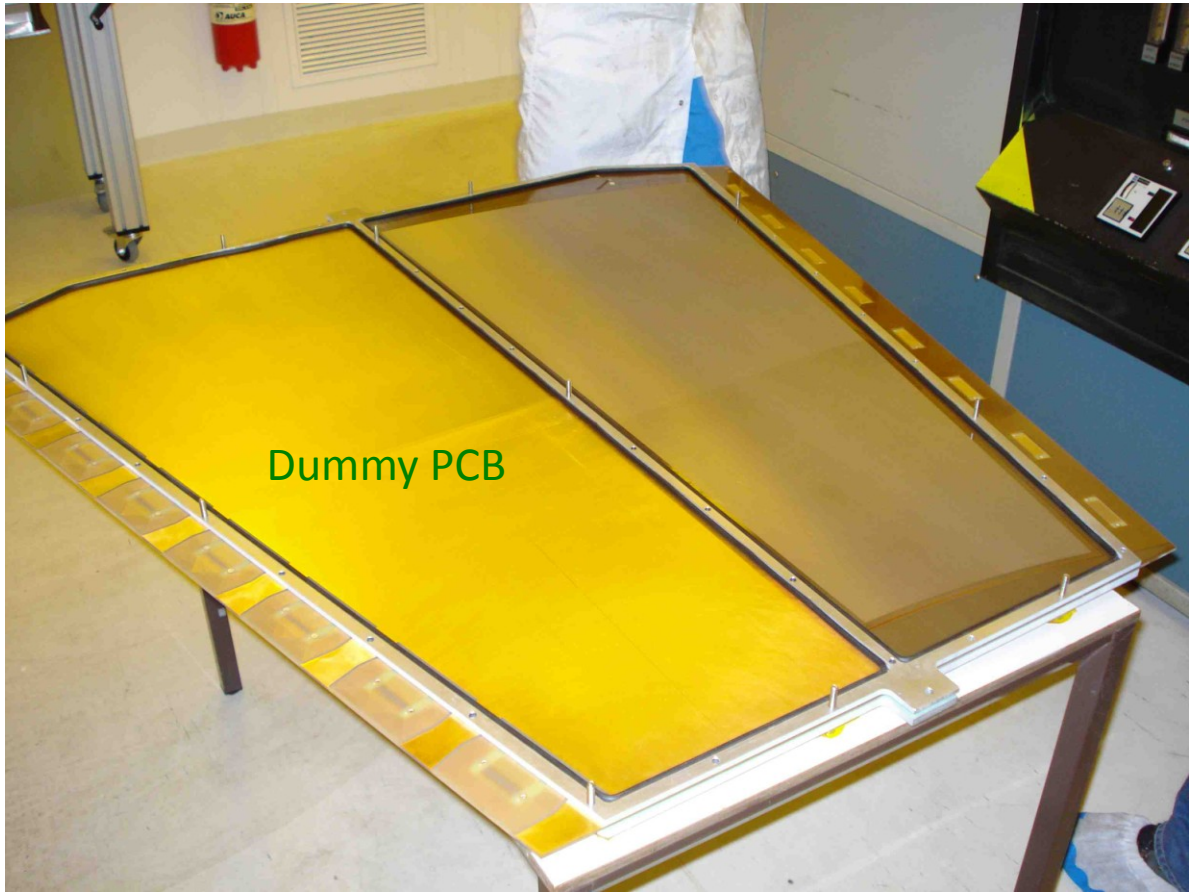
PCB with micromegas structure
To be inserted here

Cover & drift electrode

Spacer frame, defines drift gap

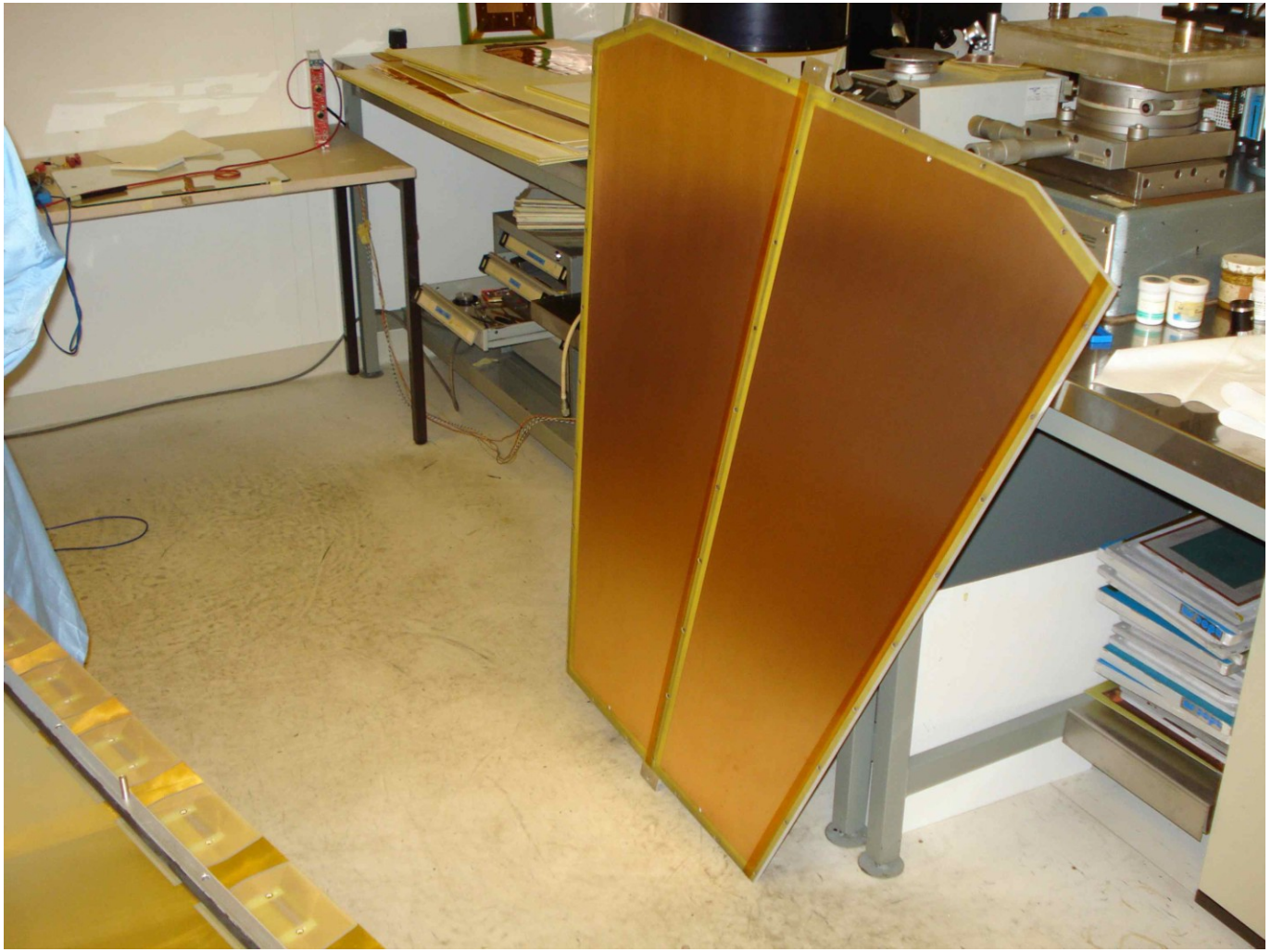
Stiffening panel

A) Standard MM (C1)

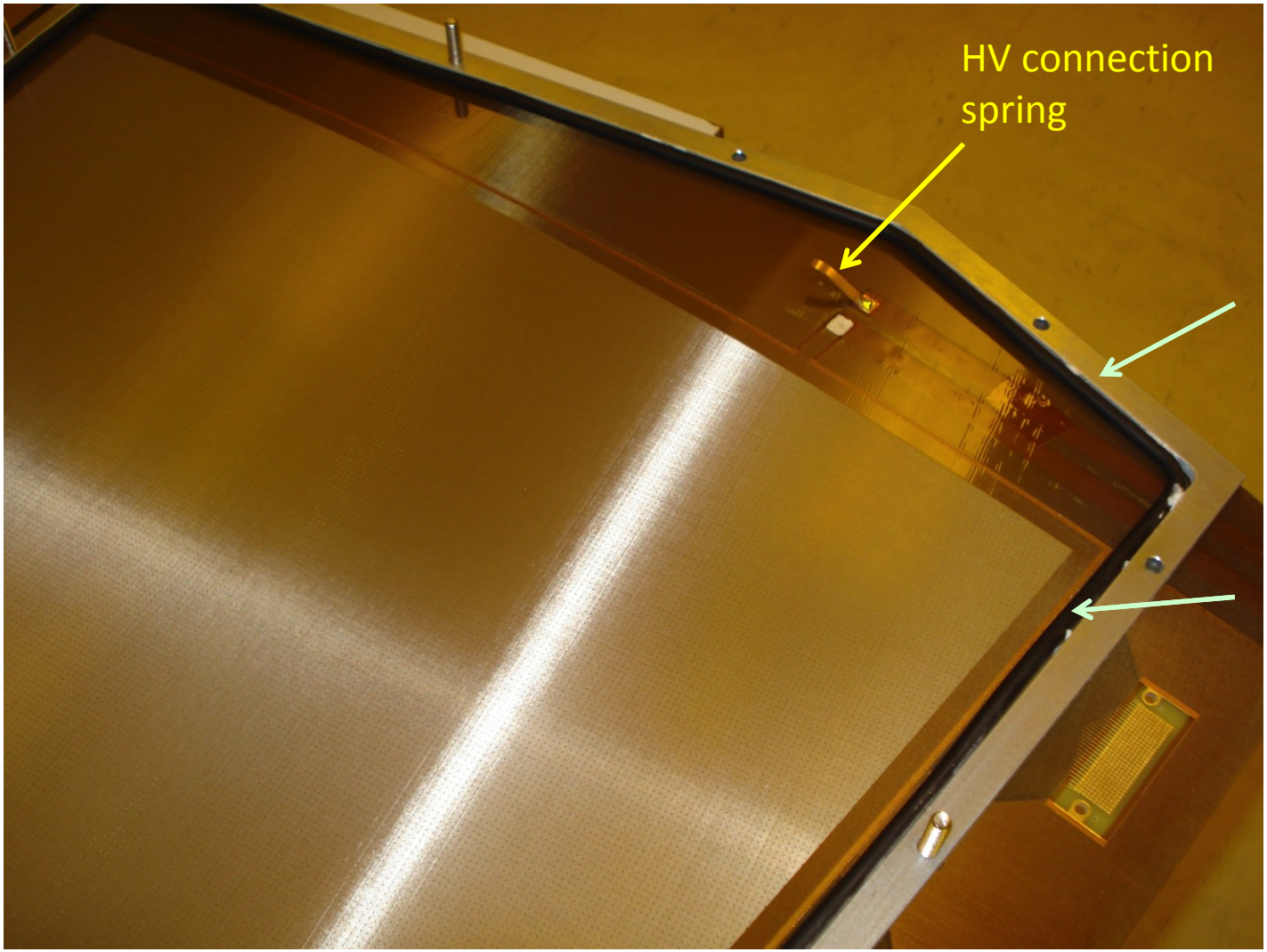


- 2048 circular strips
- Strip pitch: 0.5 mm
- 8 connectors with 256 contacts each
- Mesh: 400 lines/inch
- 5 mm high frame defines drift space
- O-ring for gas seal
- Closed by a 10 mm foam sandwich panel serving at the same time as drift electrode

Cover and drift electrode

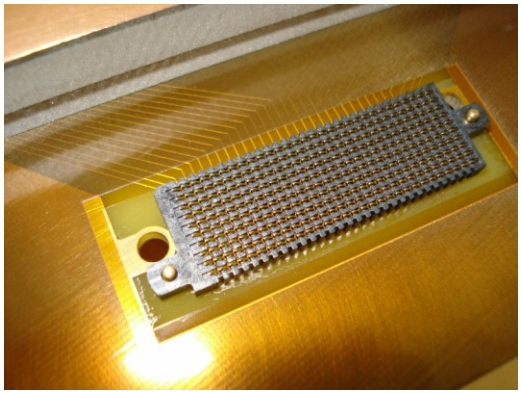


Drift electrode HV connection



Chamber closed

- Assembly extremely simple, takes a few minutes
- Signals routed out without soldered connectors

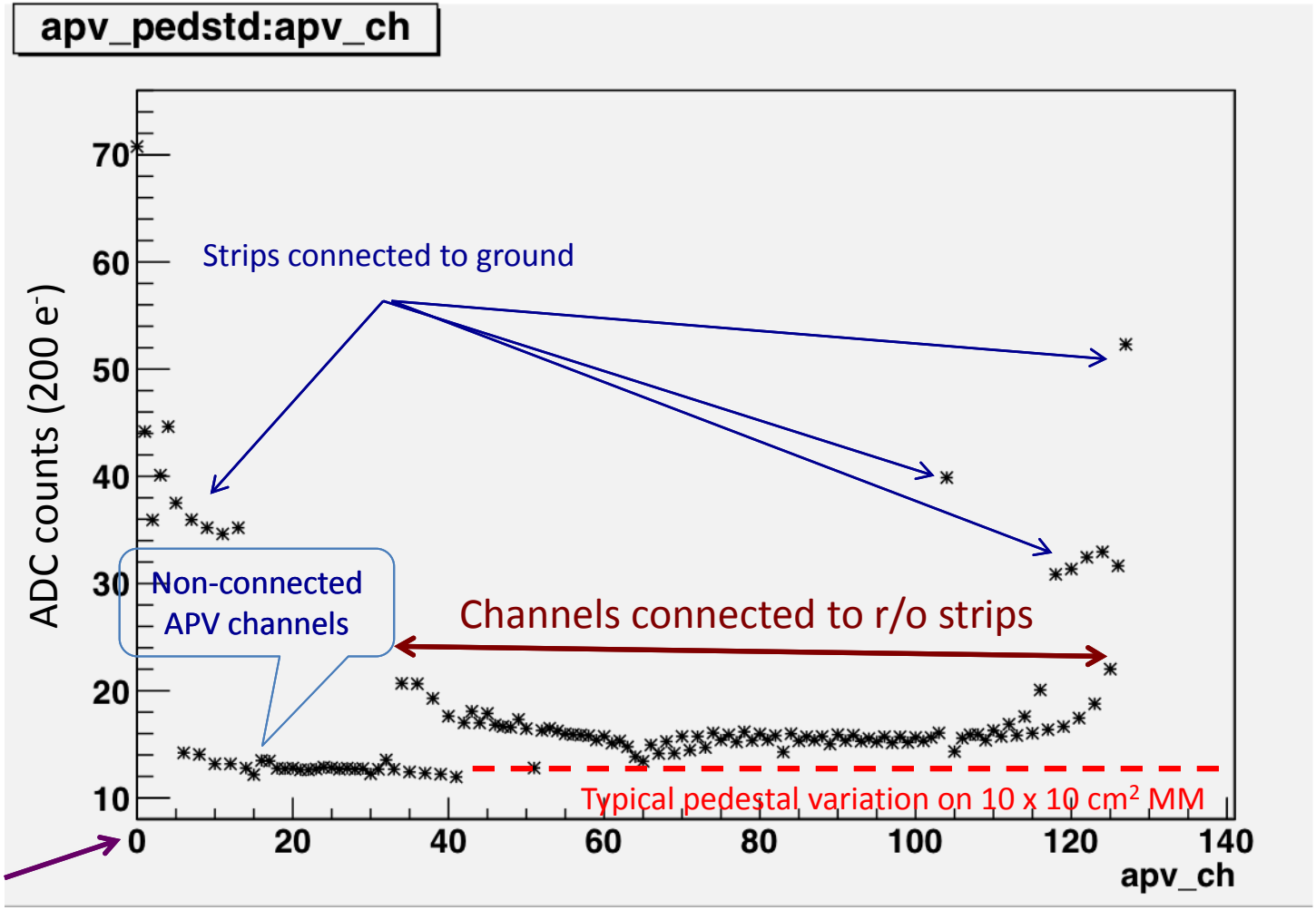


First experience with C1 (ongoing)

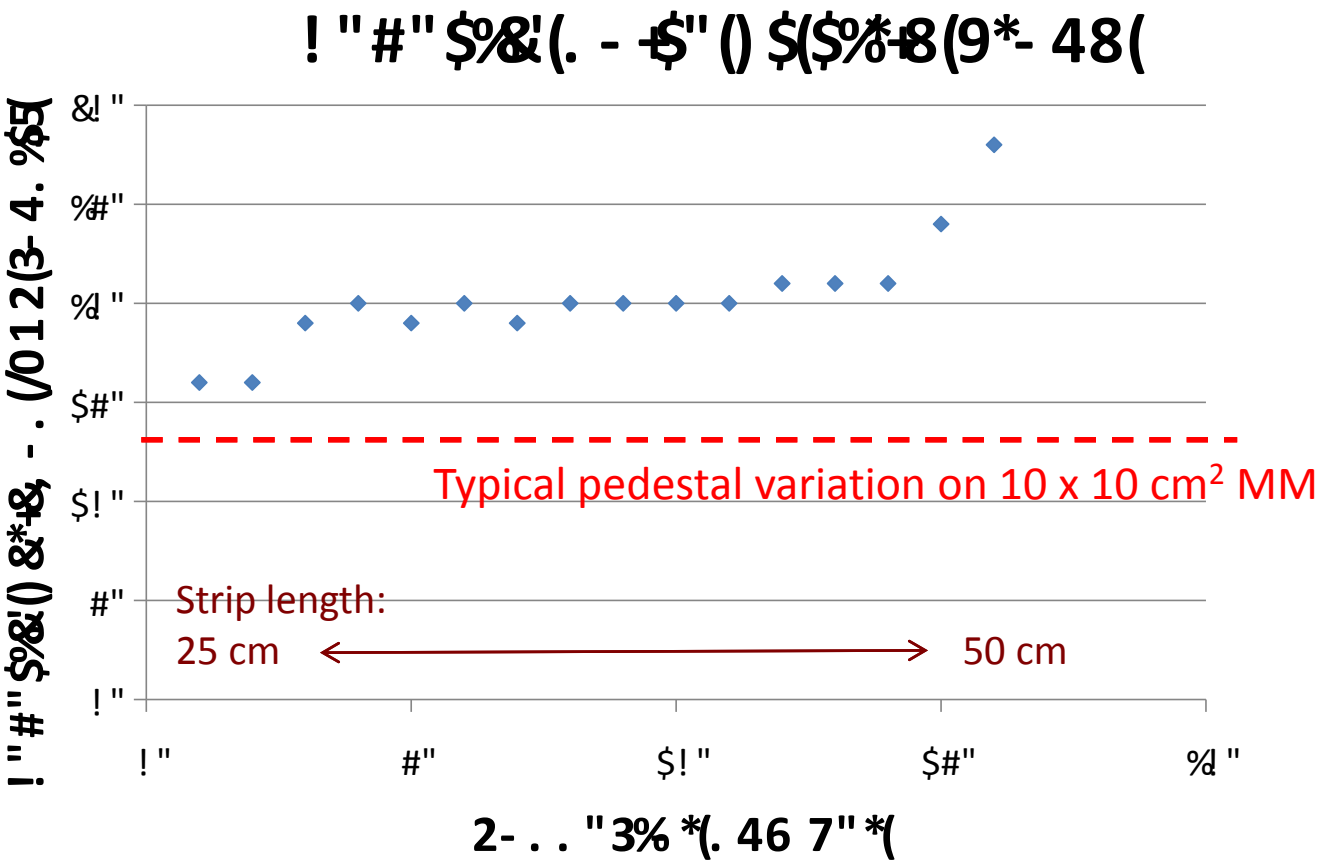
- C1 is a standard MM with a mesh area ≈0.4 m^2 (50 times the area of 10 x 10 cm^2 MMs) => high rate of sparks

  (Mesh-GND capacity ≈35 nF, still small compared to buffer capacity of 100 nF used in HV input line of small MMs)
- Tests performed, so far:
  - Connectivity – OK
  - Noise vs strip length – OK
  - Spark signals – large currents
  - APV25 hybrid spark protection
- … and took a some cosmic events (signals look normal)

Pedestal noise (APV25)

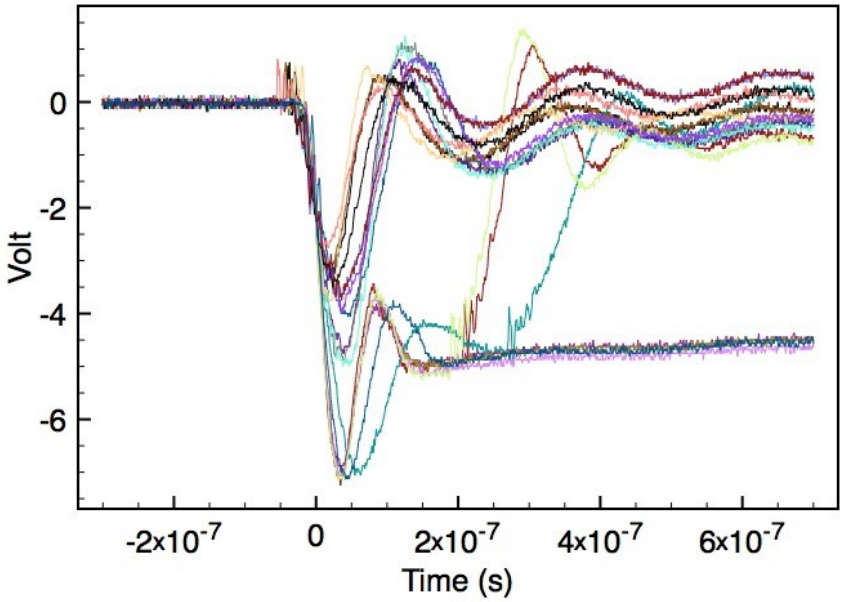


Pedestal fluctuation vs strip length

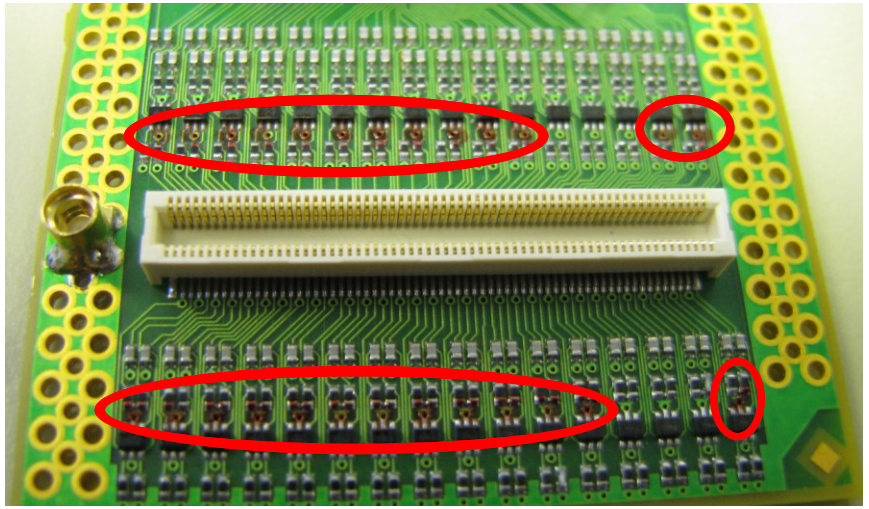


Sparks and … their effect

- Examples of spark signals as seen on the oscilloscope (on 50 Ω, attenuated 1:100)
- Spark pulses of few hundred volts (compared to 0.5 V for the MM with resistive strips)



- Connected C1 to APV25 to test spark protection of hybrid card
- Successfully destroyed 52 diodes (not connected channels survived)



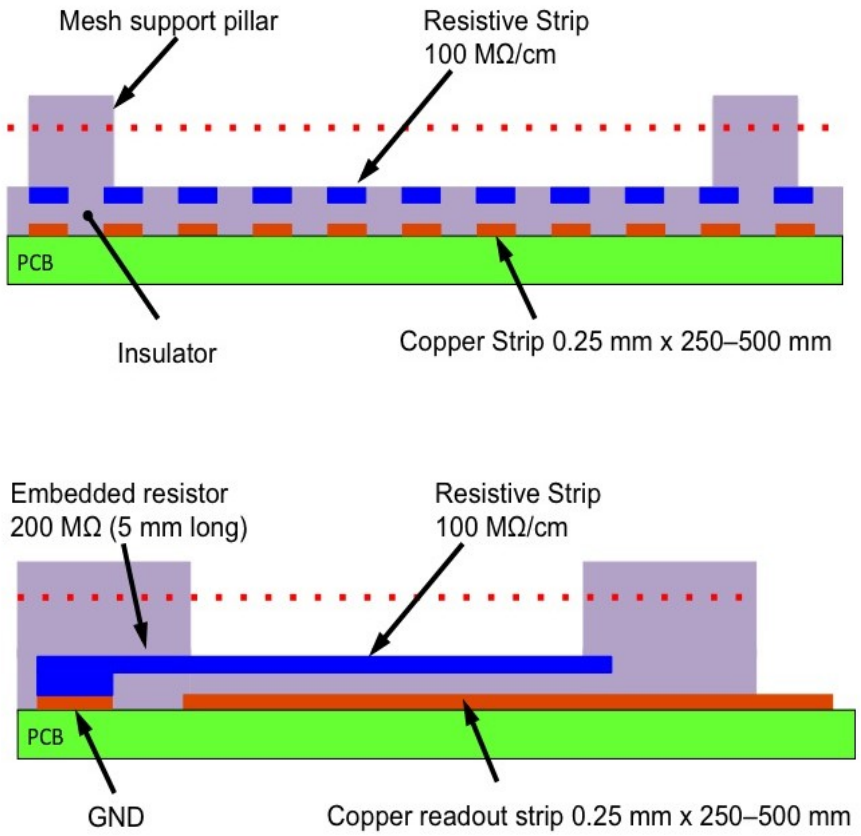
Conclusion from C1

- Chamber construction worked fine
- Easy assembly, gas-tight
- Behaves like other standard MM chambers
- No dark currents
- But many sparks (large area)
- Sparks lead to large HV drops and big currents

Confirms earlier conclusion: Need spark protection

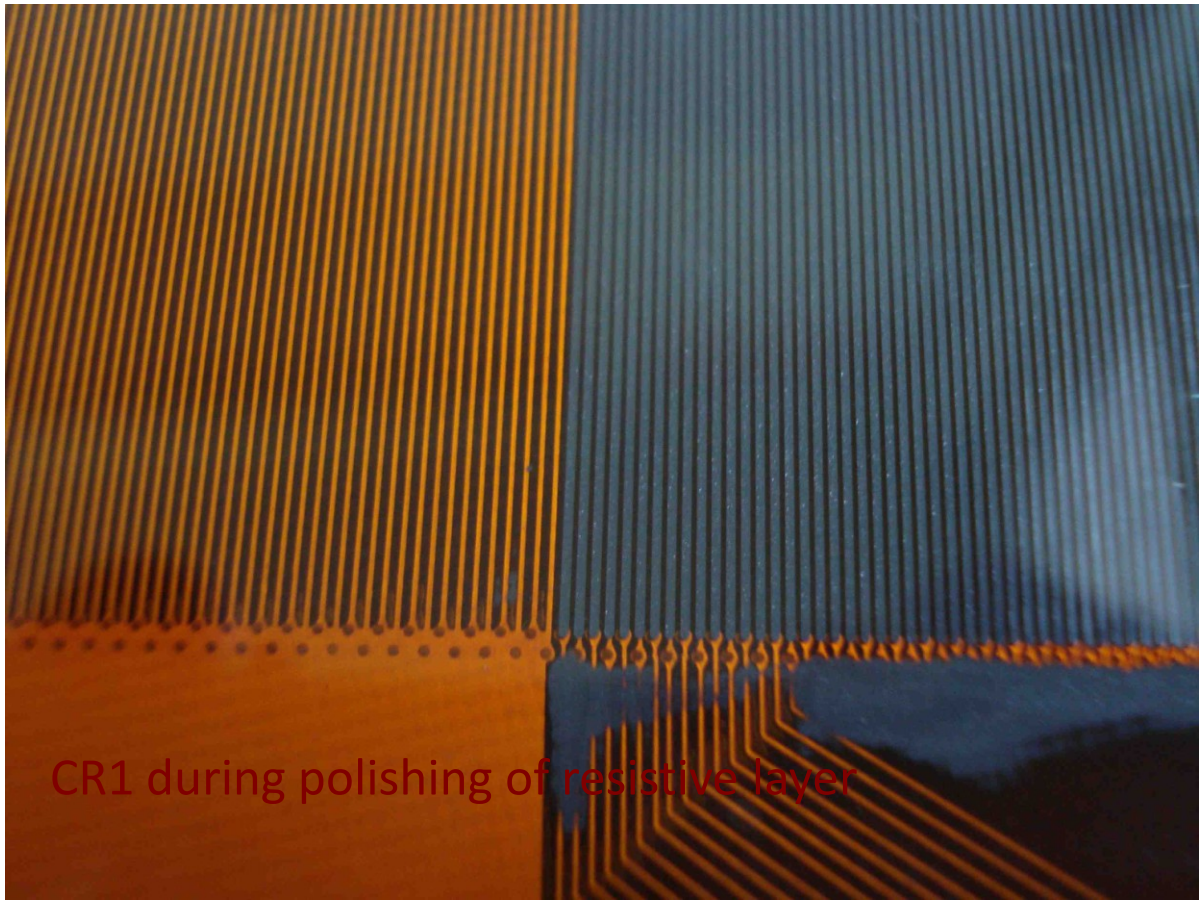
B) MM with resistive-strips (CR1)

- Follow the same scheme as for R11–R16
- Thin insulation layer + resistive strips above readout strips
- Resistive strips are connected to ground through $R_{GND} \approx 200$ MΩ
- Resistivity along strips $R_{strip} \approx 100$ MΩ/cm



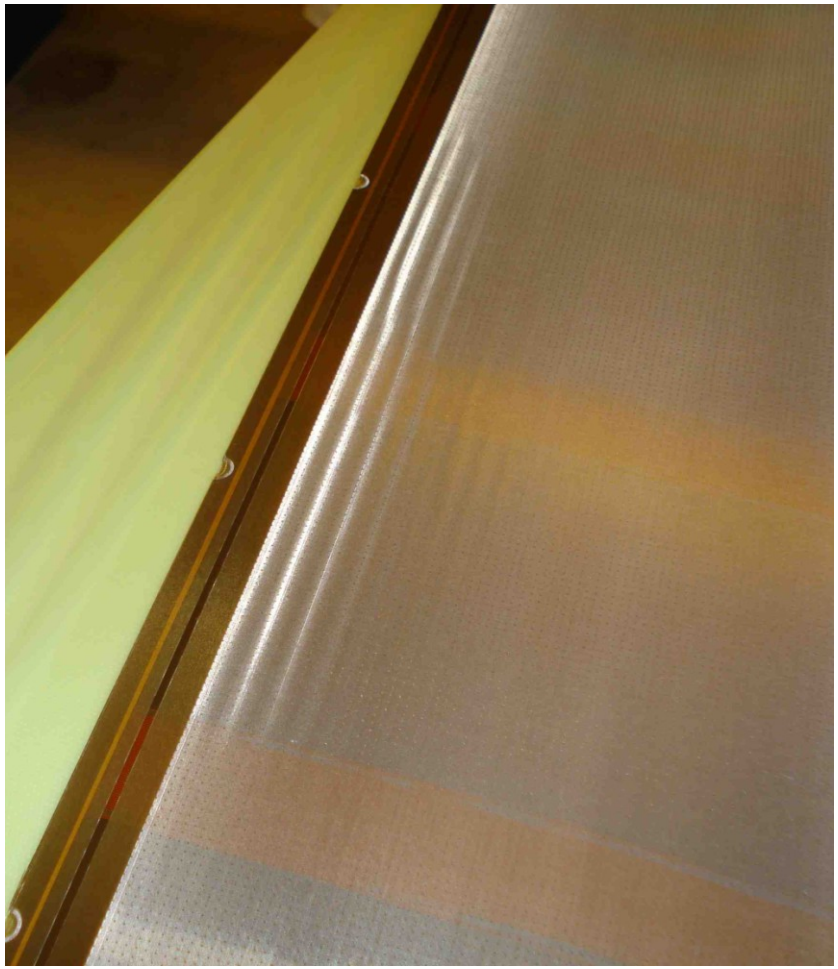
Construction of CR1

- Same PCB as for C1 500 µm strip pitch
- Same mesh as C1(400 lines/inch)
- Spark-protection scheme as for R11–R16
- Resistive strips only above connected strips
- Resistive paste with higher resistance values
- R_{GND}≈200 MΩ
- R_{strip}≈100 MΩ/cm



Production problems with CR1

- Mesh wavy (slipped during curing)
- Ohmig connection between mesh an ground (R ≈ few GΩ), compatible with resistance along the strips
- Likely: connection of one (or few strips) to mesh
- Visual inspection w/o success
- Resistive protection works
- Protection very effective, impurities cannot be burned with high currents
- Resistive strips cannot be easily isolated => Need to change concept



What next ?

- Another chamber with resistive strips, hopefully in a few weeks
  - Prevent slipping of mesh
    - Better mesh fixation during curing process
    - Stiffer mesh (400 -> 325 lines/inch ?)
    - Other solutions …
  - Change connection concept of resistive strips
    - Connect resistive strips to readout strips ?
    - Other solutions …
  - Test concepts with small MM(s)
- In parallel work on optimization of
  - Layout of readout board (strip width, signal routing, connectivity)
  - Resistivity values for R_{GND} and R_{strip}

Conlusions + prospects

- Good progress with full-size MM, very useful exercise, but we are not yet there
- Mechanics look very promising, simple and easily extendable to multi-layer chambers
- Connectivity to readout electronics is good
- MM production needs a second iteration with a more reliable mesh deposition and curing procedure
- Resistive-strip protection seems to work, but the strip connection scheme needs to be revisited for easier diagnostics/repairs
- Next resistive chamber to be expected by about Easter