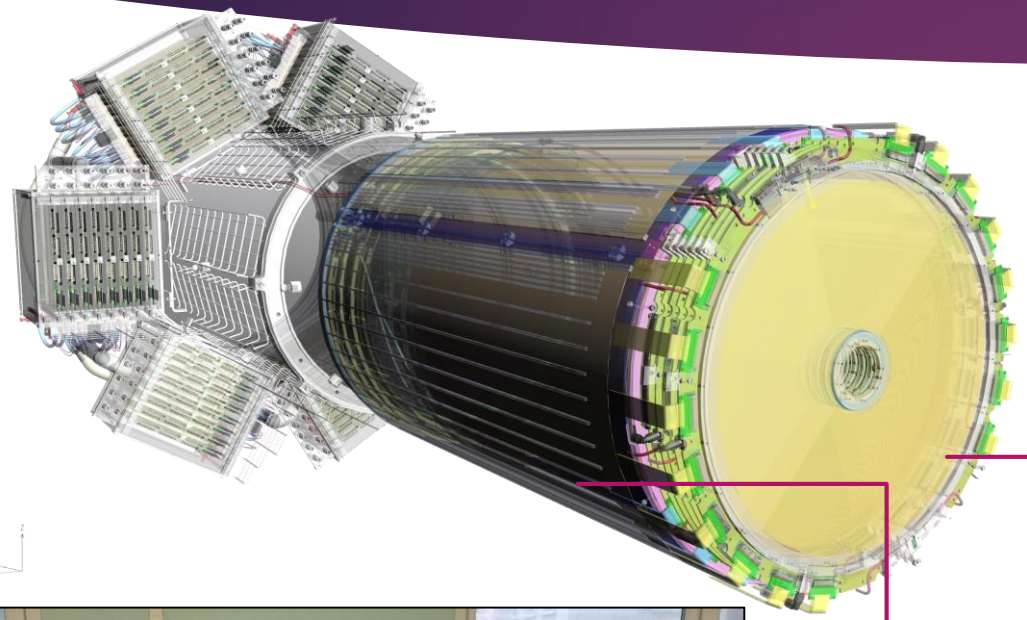
Irfu - CEA Saclay
Institut de recherche sur les lois fondamentales de l'Univers

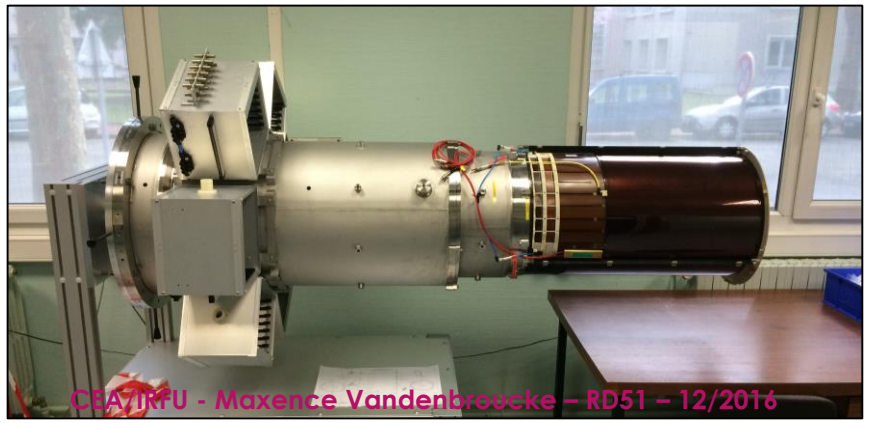
CLAS12 Micromegas Production

AND ISSUES WITH CONNECTIONS TO RESISTIVE LAYERS

MAXENCE VANDENBROUCKE – RD51 MINI-WEEK – DECEMBER 2016

The Micromegas Central Tracker for the CLAS12 Experiment at Jefferson Lab

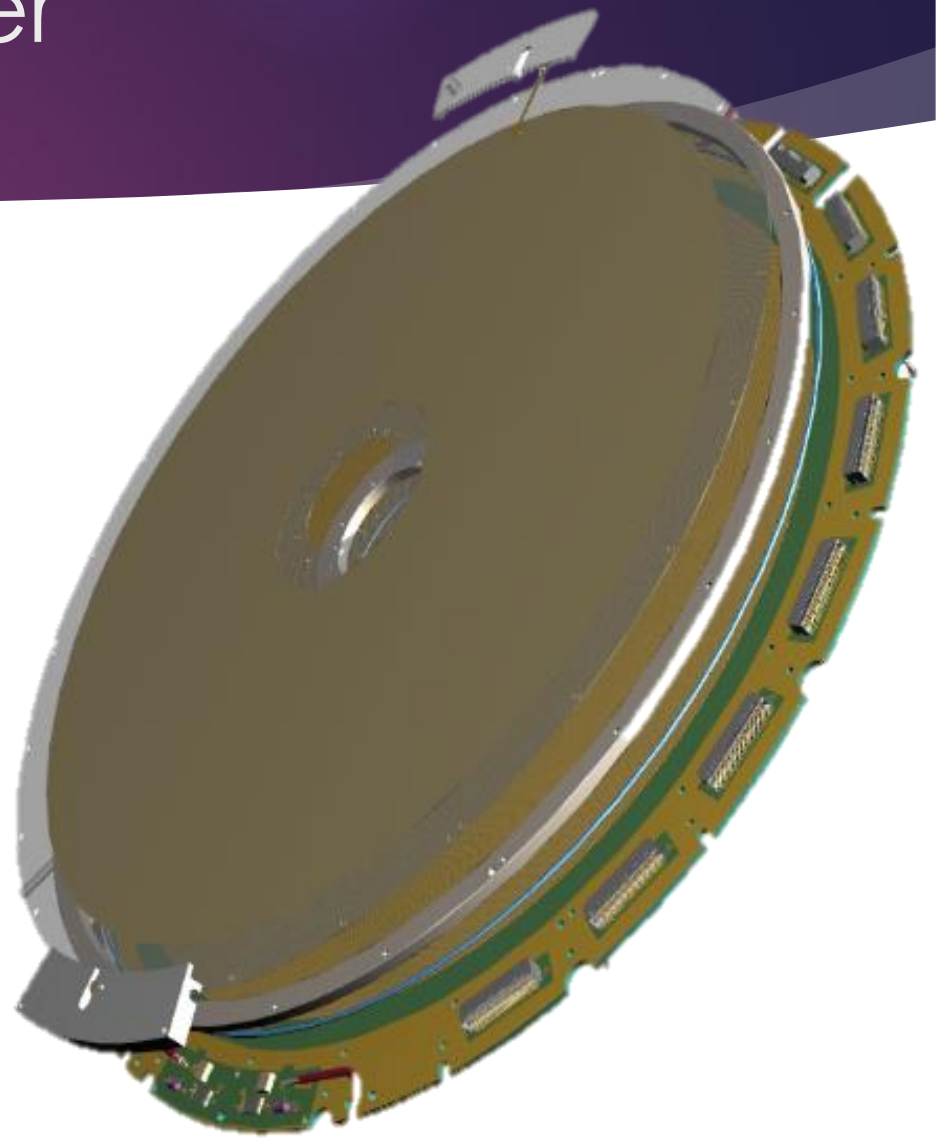




- High Rate 10 MHz
- High magnetic field (5 T)
- Deported electronics + 2.2m coax. cables
- **6 Disks after the target (Forward Det.)**
  - Resistive strips divided in 2 zone inner/outer
  - 1024 strips, pitch 525 µm
  - Dimensions: 430 mm diameter disk with a 50 mm diameter hole at the center
- **Cylindrical Barrel**
  - Resistive Detectors
  - Phase 1 : 2 Layers (6 Det.)
  - Phase 2 : 6 Layers (18 Det.)

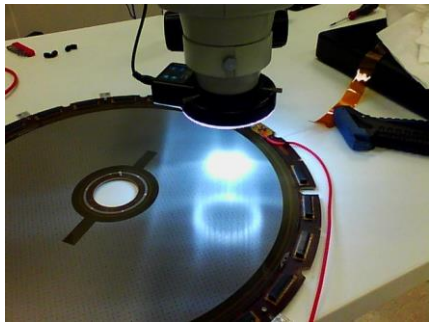
CLAS12 MM Forward Tracker

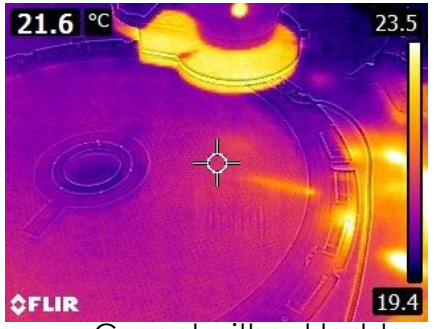
- 6 layers of Micromegas with strips alternatively at 0°, 60°, 120°
- Same detector design for the 6 detectors
- Specifications:
  - Dimensions: 430 mm diameter disk with a 50 mm diameter hole at the center; 5mm drift gap
  - 100 µm PCB glued on ROHACELL
  - 525 µm pitch, with 120 µm between two strips
  - 2 separated resistive strips zones



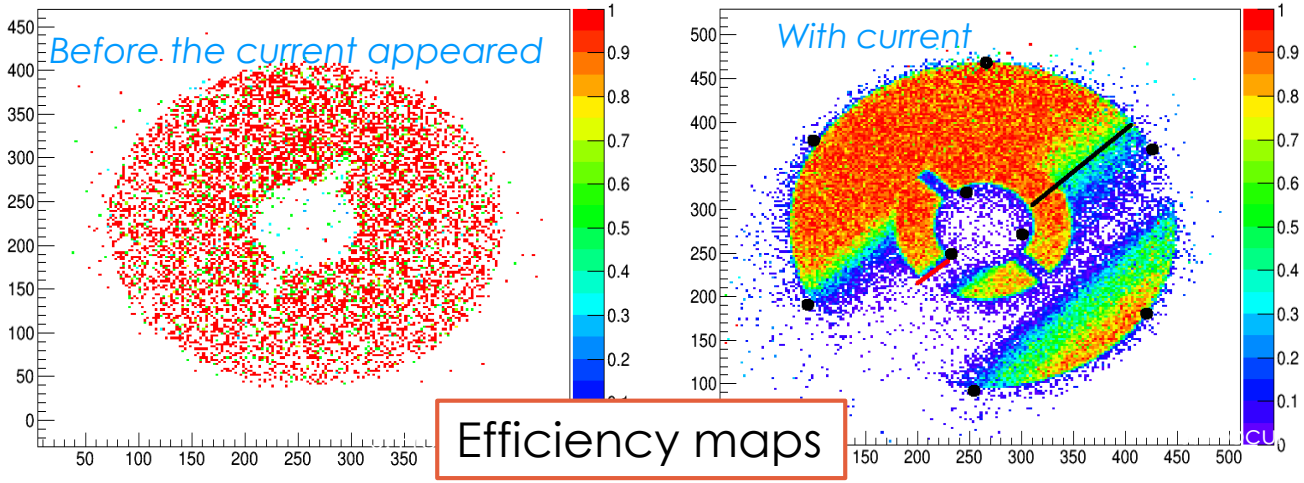
Pre-Production Forward Disk for CLAS12: issue with resistive ladders

- 2 pre-production (2015) detector tested, One was not ok :
  - High current due to a contact in the active area (can't burn it with sparks)
  - Current flows from the contact to ground (black dots)
  - Large impacted zone due to ladders
  - Drift electrode glued (intervention impossible)
  - Carbon frame for gas distribution

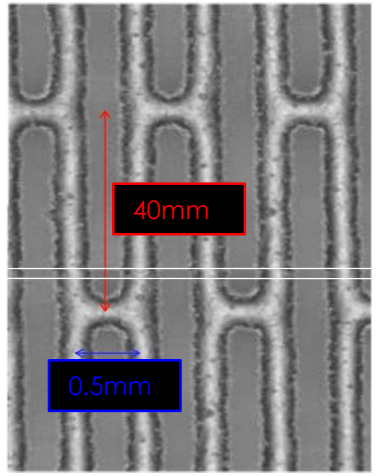




Current without ladders



Efficiency maps

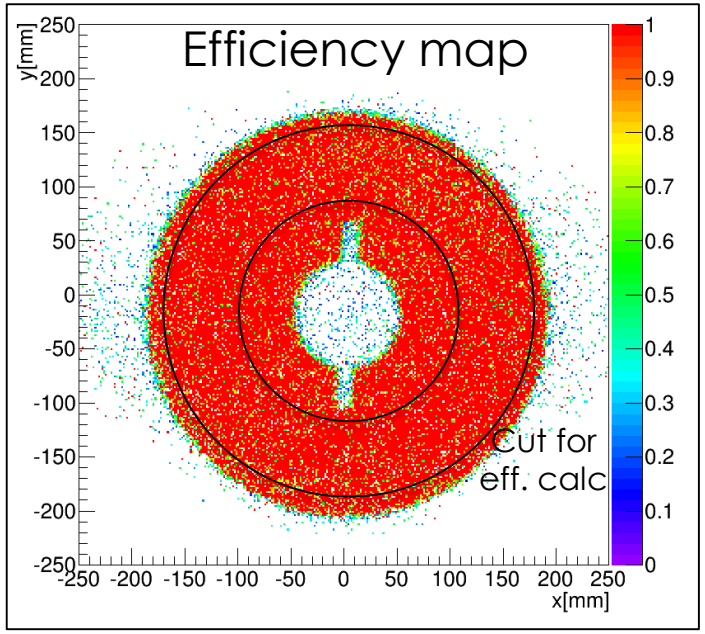


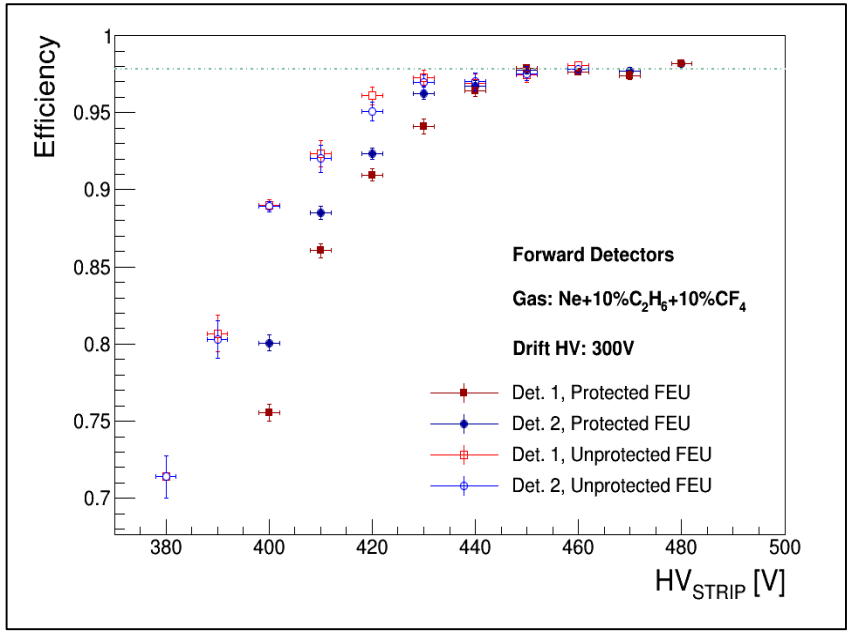
Resistive Strips

Forward Detector – Final Design

- Non-glued design
- Aluminum frame for gas distribution
- No ladder between resistive strips
- Validation using X-Ray generator
- **More ground connections**

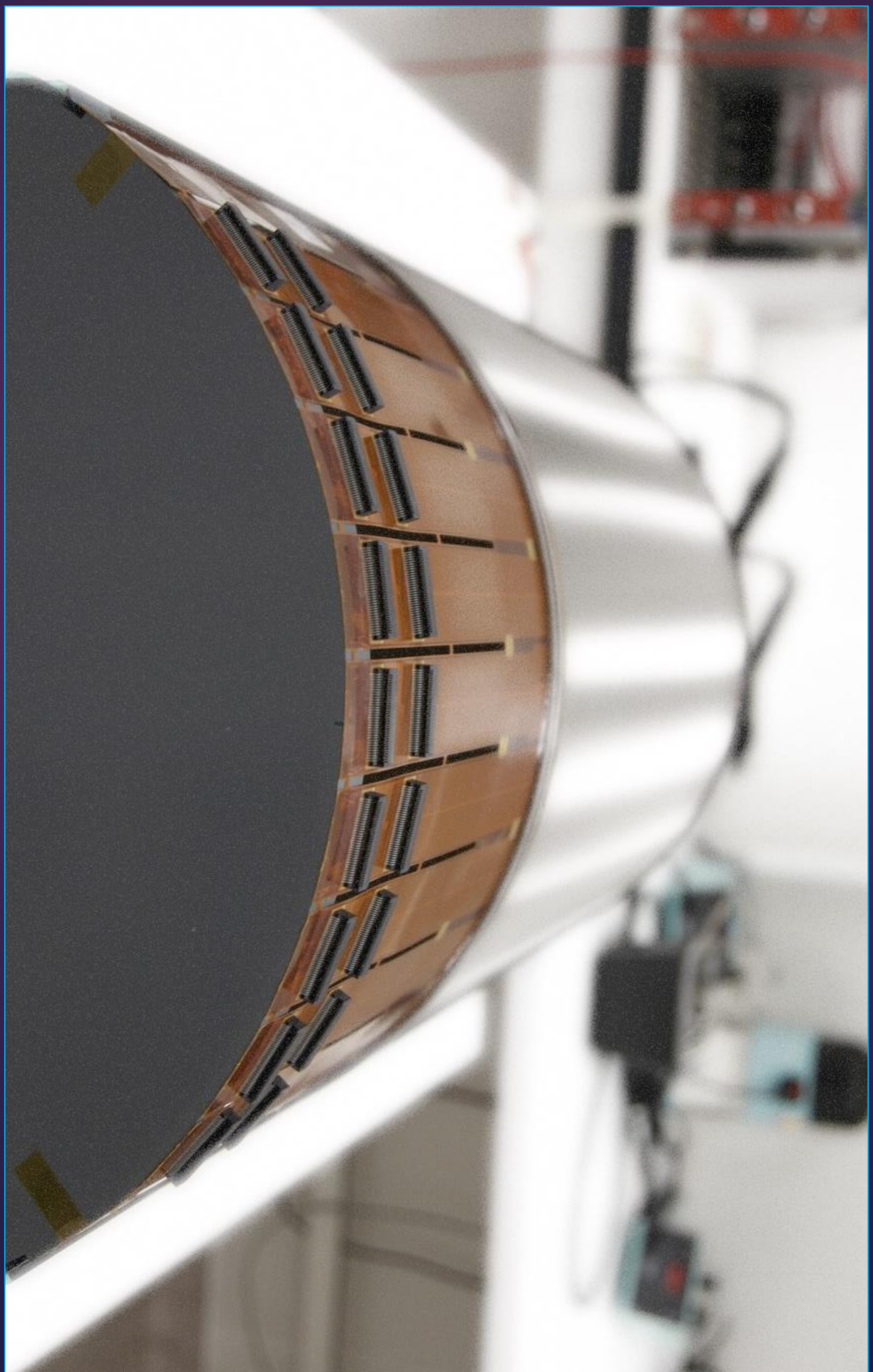
- **Production of 6 Disks finished and sent to Jlab in September 2016**





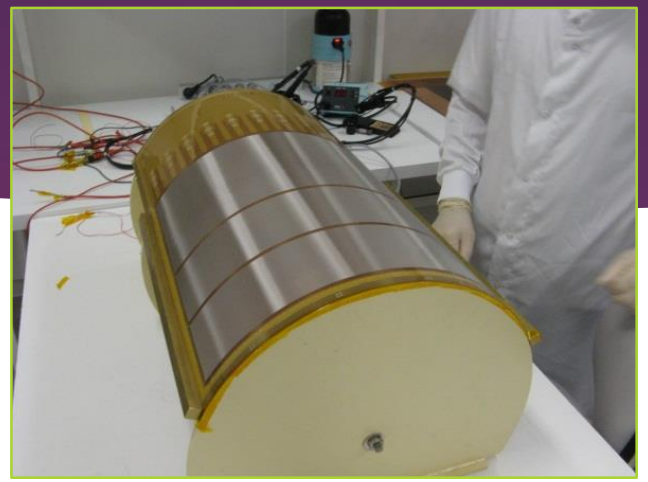
Production: David Attié

CLAS12 Barrel Detectors



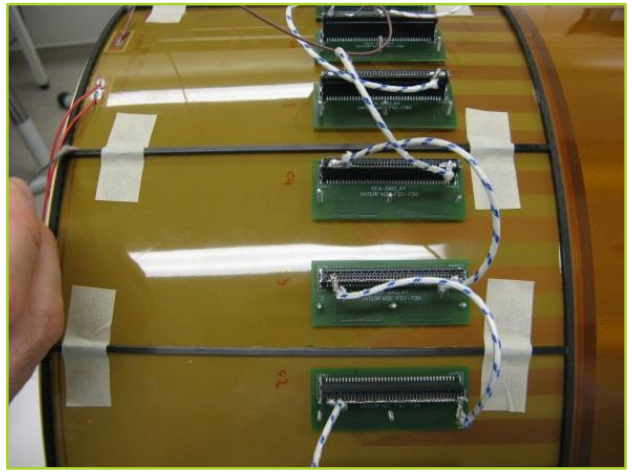
Cylindrical Micromegas

Segmentation and preparation

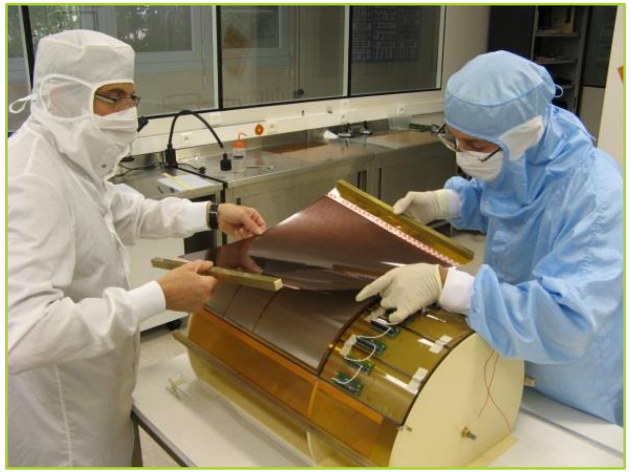


Gluing of the side carbon ribs on circular shape

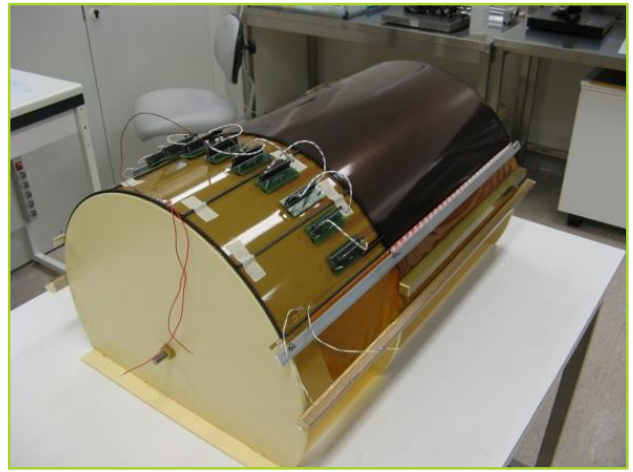
Electric leak test



Gluing of additional ribs



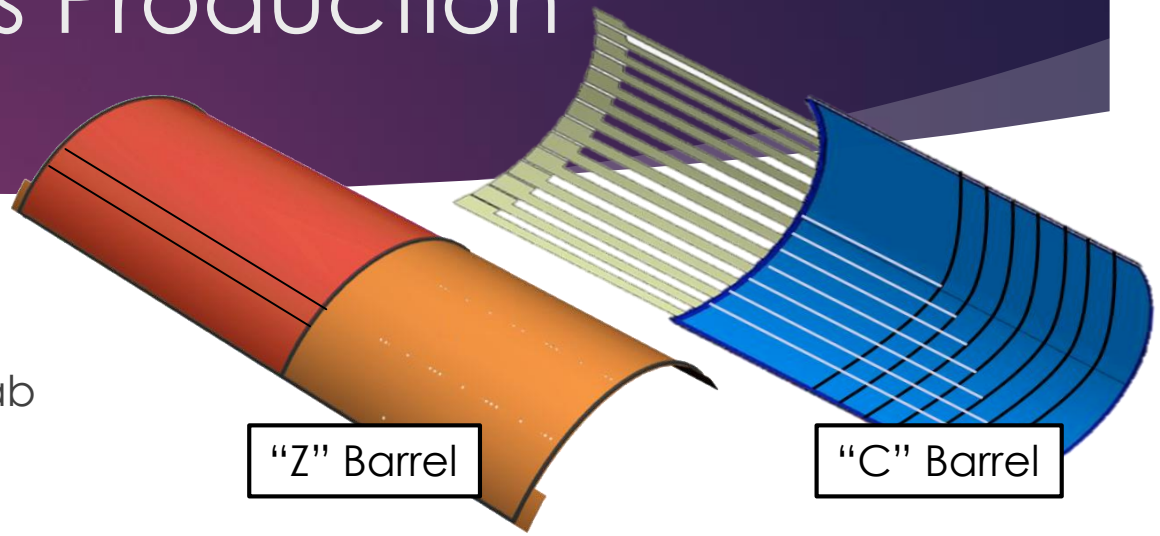
Setting drift plane



Gluing of the drift plane

CLAS12 Barrel Detectors Production

- Material (PCB/Bulk + Drift) from CERN
- Assembly to cylindrical shape at Saclay
- Test and Characterization at Saclay before shipping to J-Lab
- 8-9 days to assemble one detector + 1 week of test

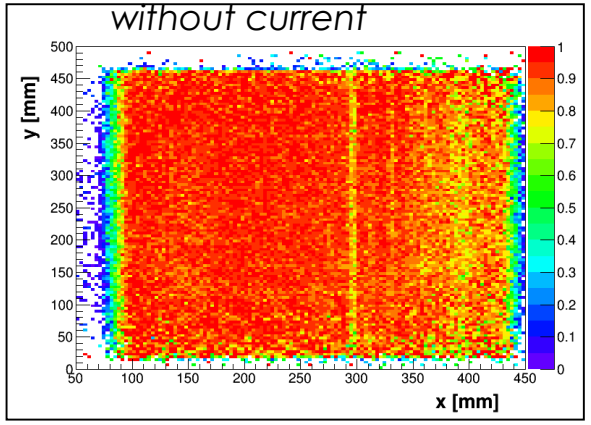


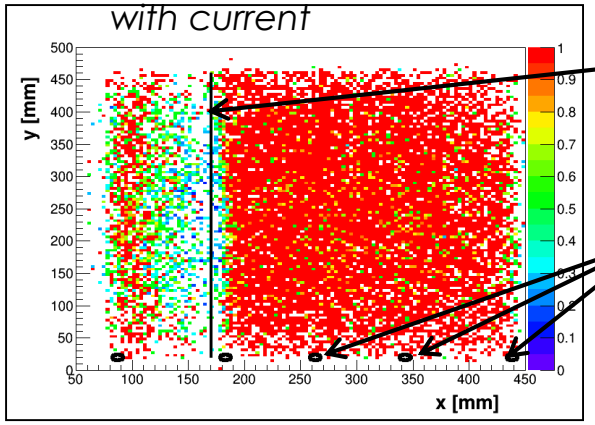
Layer	Production	ch.	Radius	Length	Width	Prod. PCB @ CERN	Finished @ Saclay	Working @ 12/2016
CR4-C	3 + 1spare	896	146mm	712mm	302mm	4/4	0/4	0/0
CR4-Z	3 + 1spare	640	161mm	712mm	333mm	4/4	**4/4->1/4**	**0/4->1/1**
CR5-Z	3 + 1spare	640	176mm	712mm	364mm	4/4	1/4	-
CR5-C	3 + 1spare	1024	191mm	712mm	396mm	0/4	0/0	0/0
CR6-Z	3 + 1spare	768	206mm	712mm	427mm	4/4	4/4	3/4
CR6-C	3 + 1spare	1152	221mm	712mm	459mm	5/5 + 0/4	4/5	2/4

Production : Remi Granelli

High current on Pre-Production Barrel detectors for CLAS12

- Same issues than with Forward Detectors

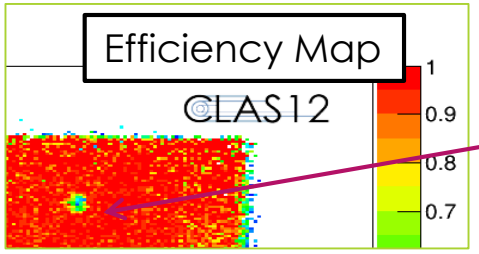


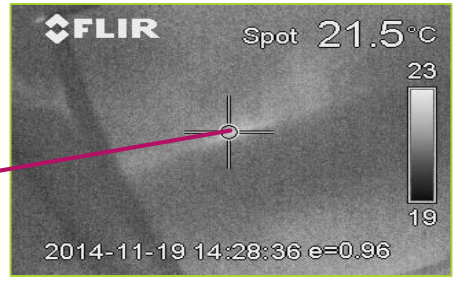


position of the strip with current

position of resistive contacts

- Solutions :
  - No resistive interconnection (ladders)
  - Aluminum frame at the gas inlet
  - More ground connections
    - **"C" Barrel detectors had no problem => Problem solved?**

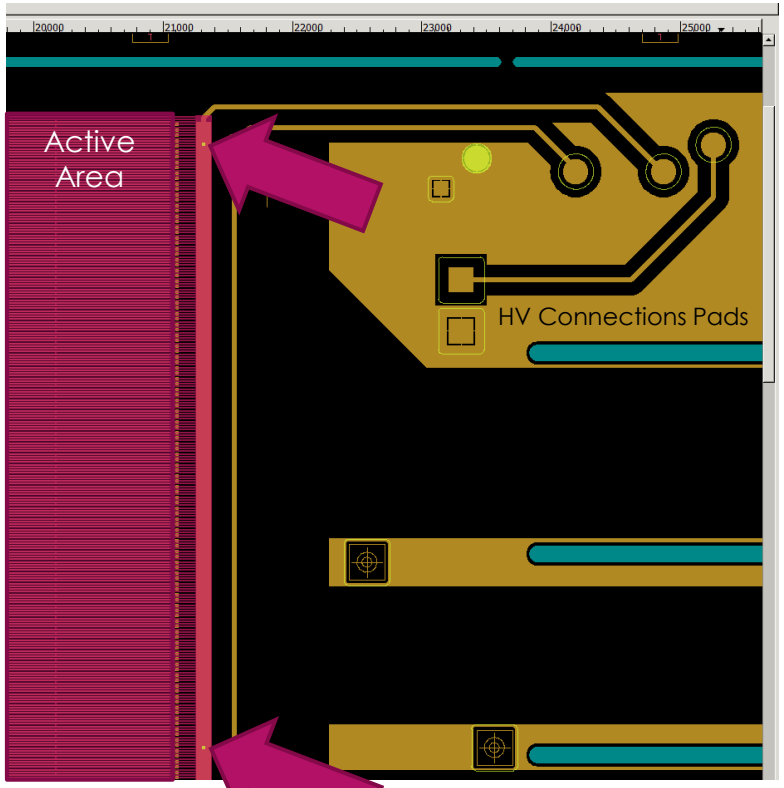




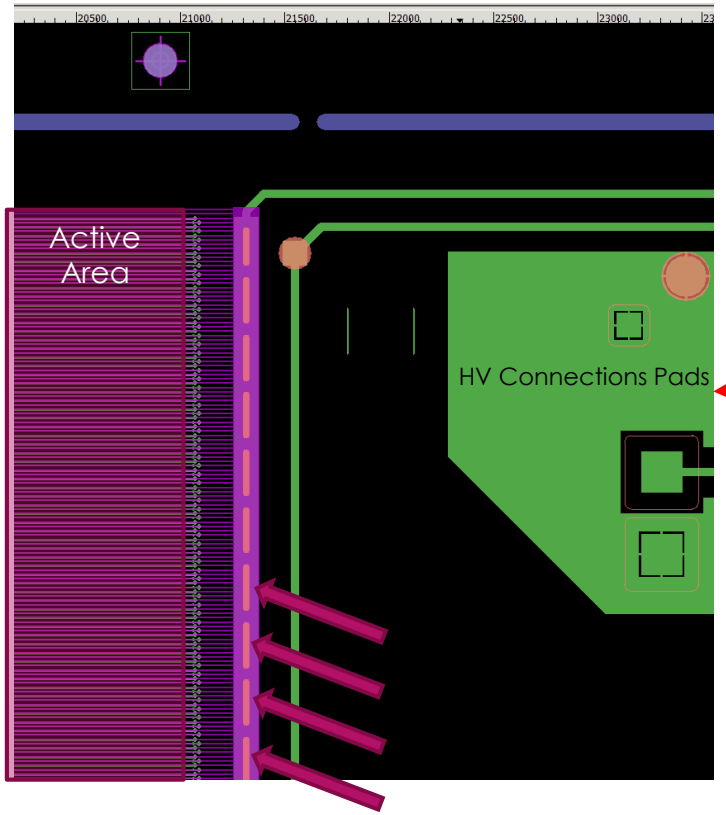
Zoom on a part of the CLAS12 Barrel with thermal cam, with HV on and current of about 300 µA

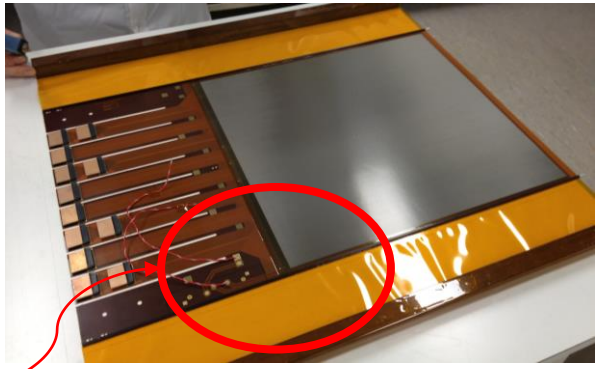
New Connection scheme between resistive kapton layer and PCB

- Before



- After



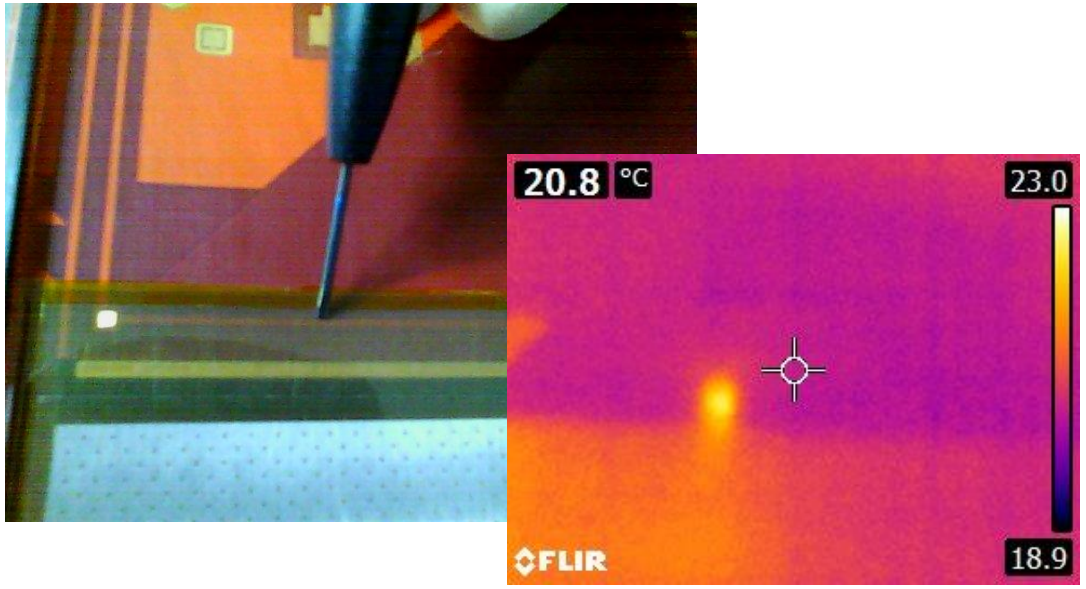


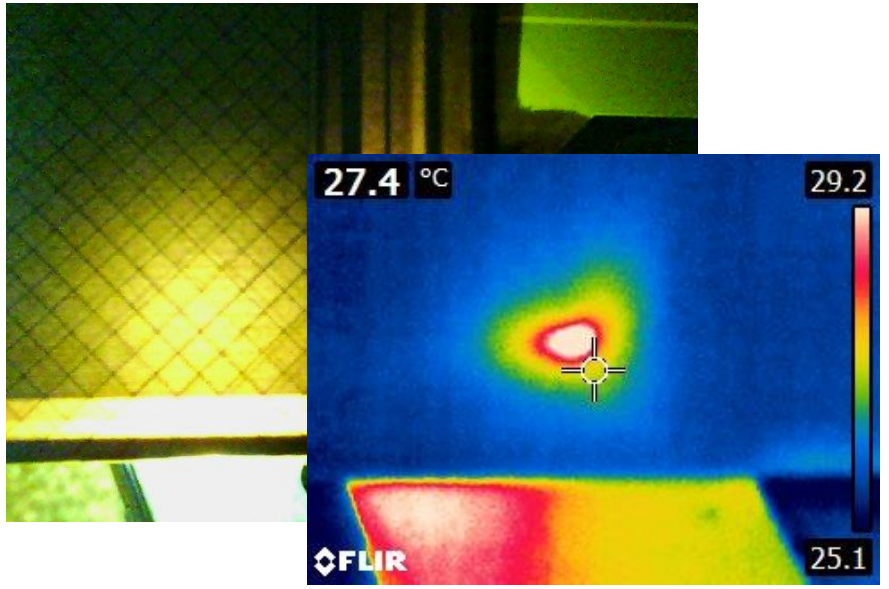
⇒ A lot more ground connection between Resistive kapton and pcb

⇒ It was first made by hand and then by machine

New connection scheme, New Problems…

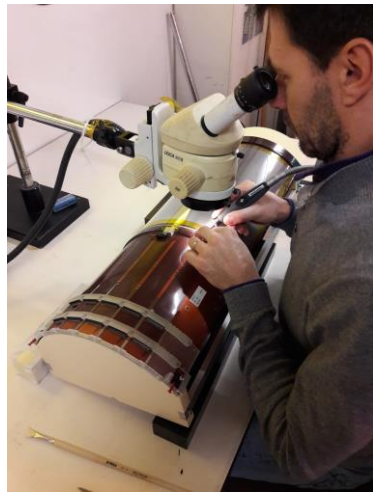
- The CR4Z layer has been the first produced using this method
  - **=> All 4 of them died after ~2 weeks of tests**

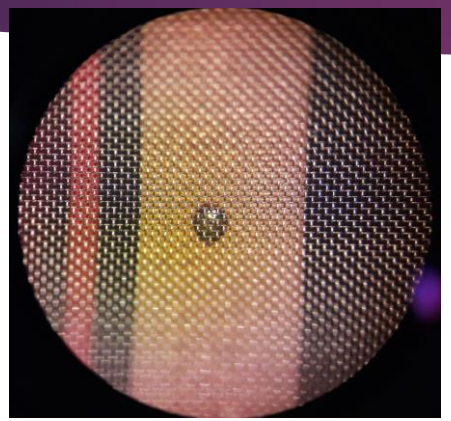


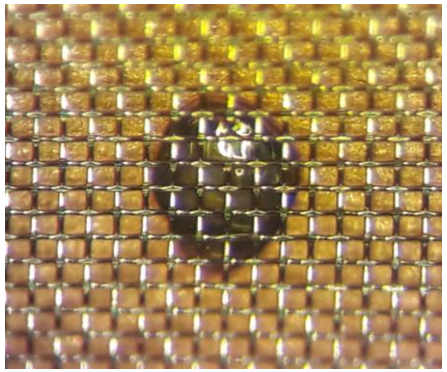


=> Thermal imaging shows that high current appeared on the silver paste connection between the resistive layer and the PCB

Investigating the issue





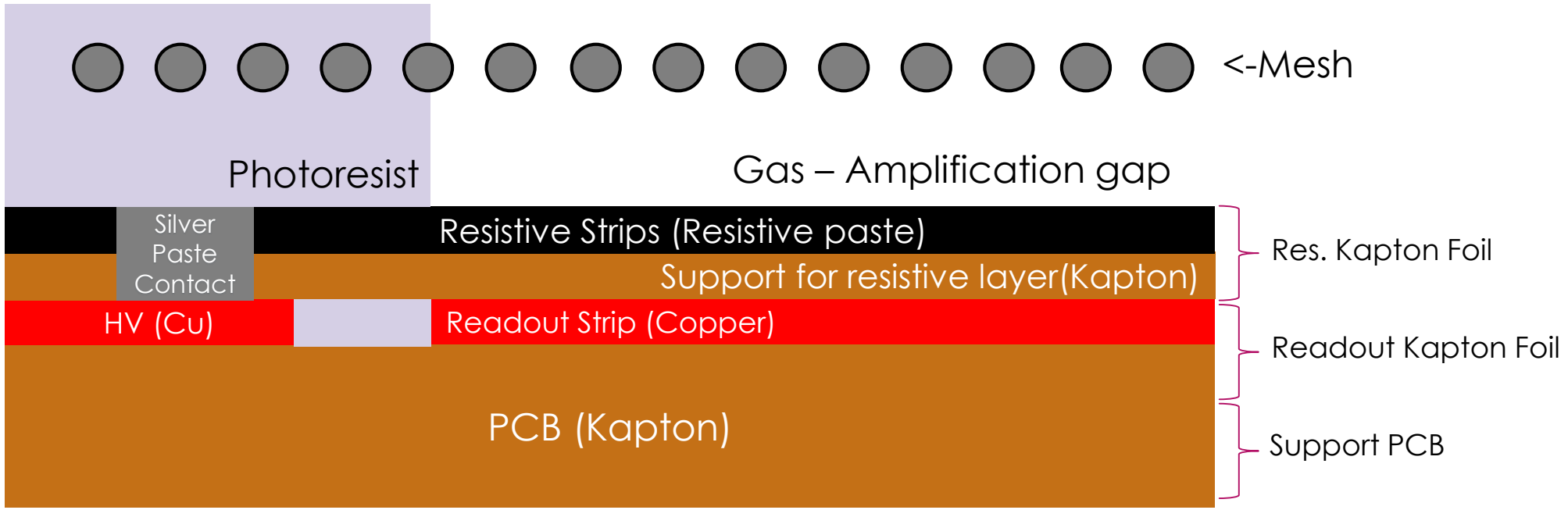


Bubbles has been observed between the mesh and the silver paste contact

Solution: Remove the mesh over the full silver paste zone, and modify future layout

Why the bubbles ?

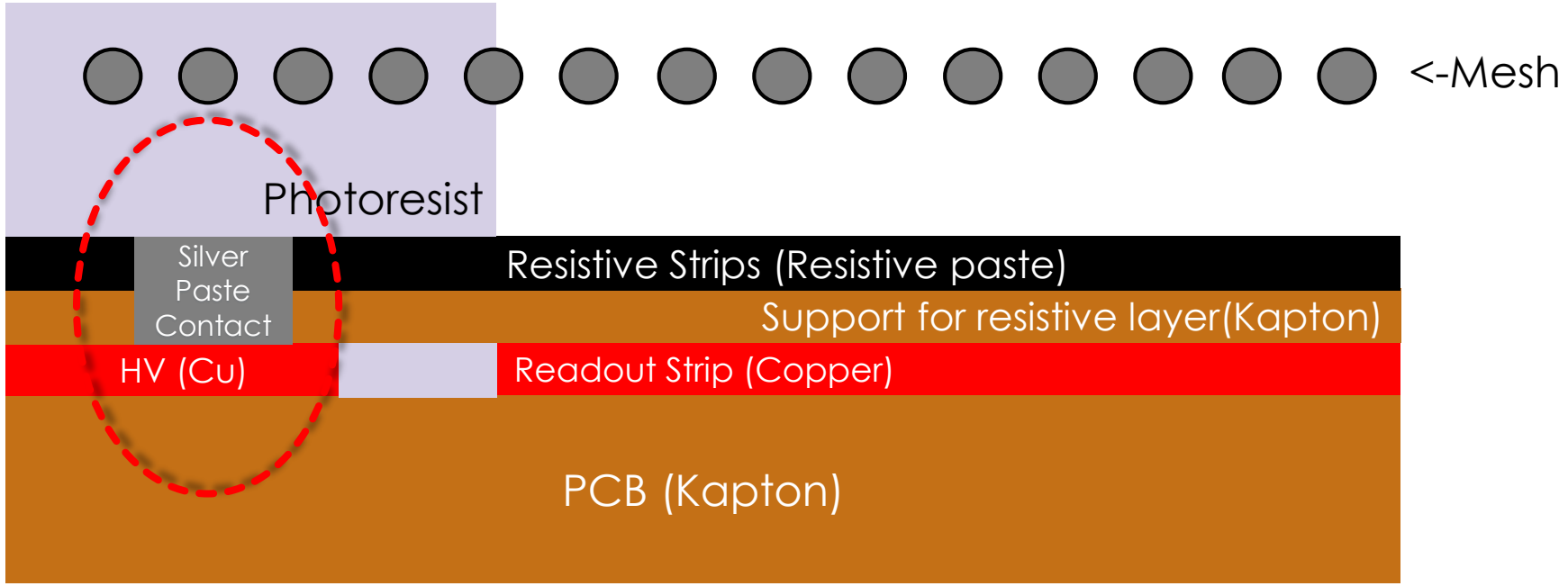
- Detector Transverse Cut :



Absolutely *not* at scale

Why the bubbles ?

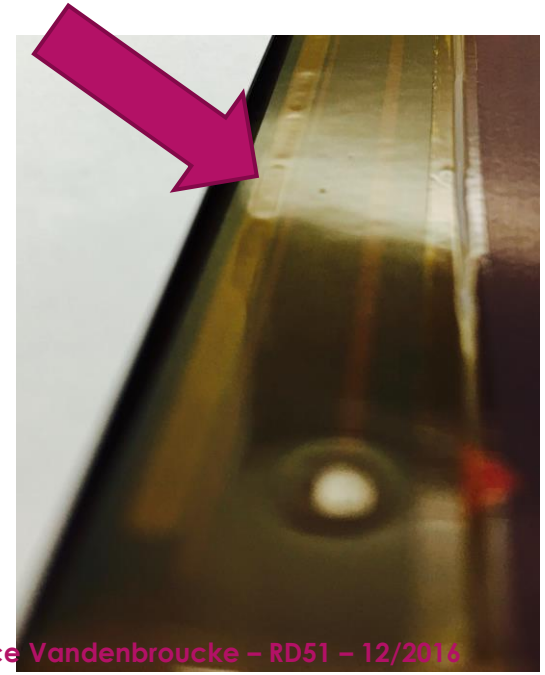
- The short are always located in the silver paste contact area

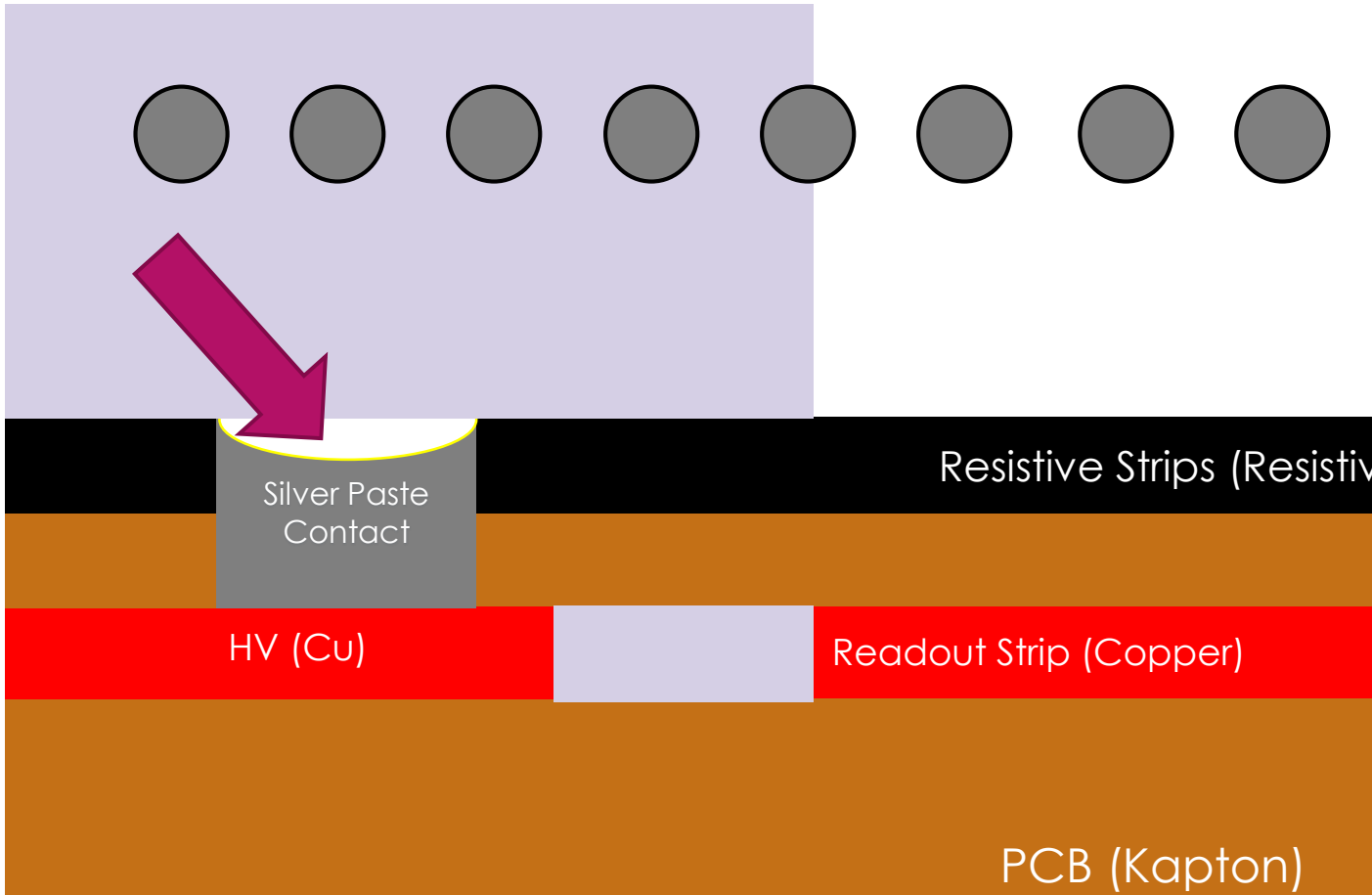


Absolutely *not* at scale

Why the bubbles ?

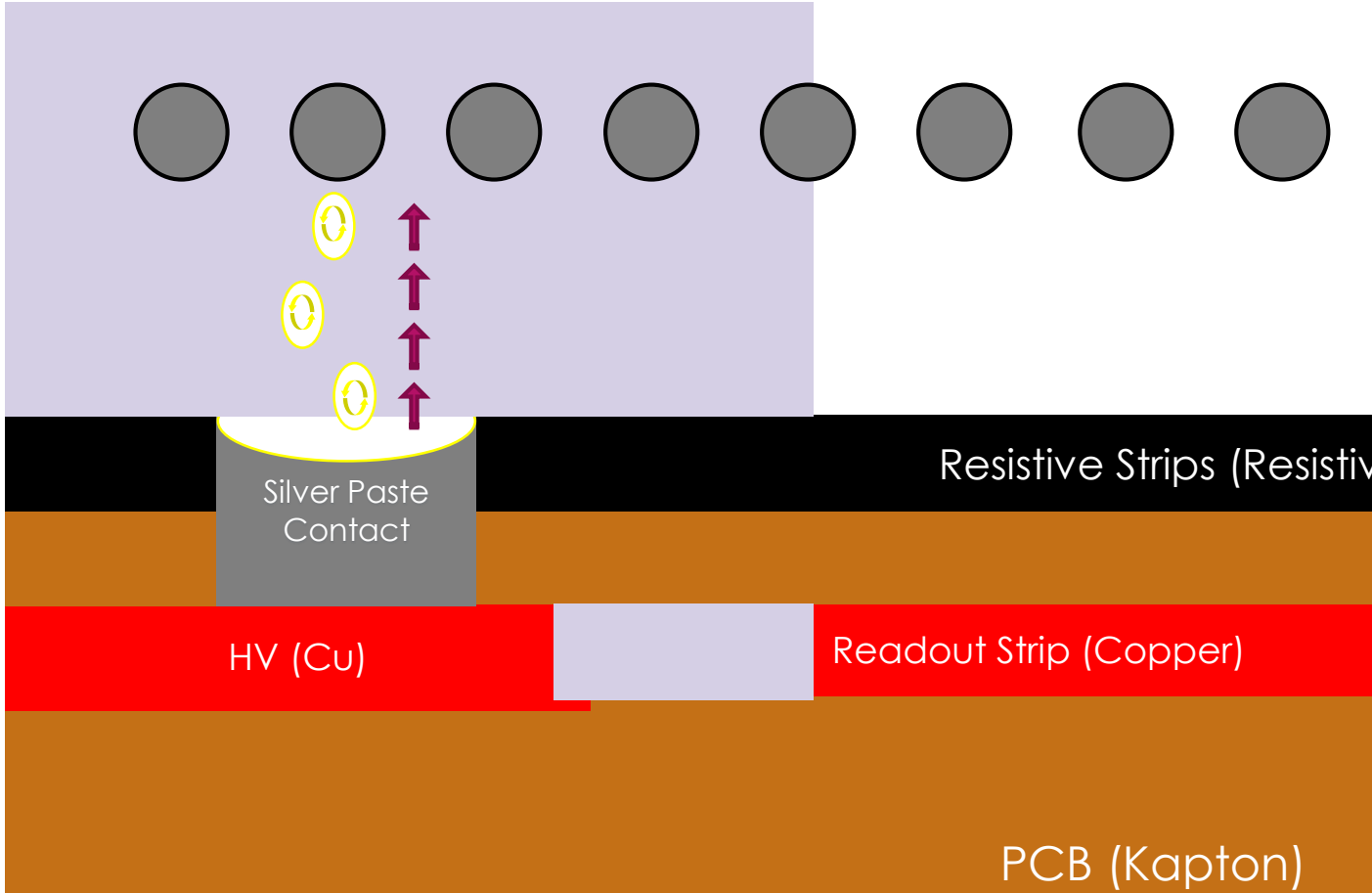
- Rui's explanation :
  - The Silver paste hole is not fully filled
  - Outgassing of the silver paste filled the hole





Why the bubbles ?

- Rui's explanation :
  - The Silver paste hole is not fully filled
  - Outgassing of the silver paste filled the hole
  - With HV, a corona effect starts in the hole
  - Bubbles starts migrating through the photoresist
  - This creates the short between mesh (ground) and the resistive layer (HV)



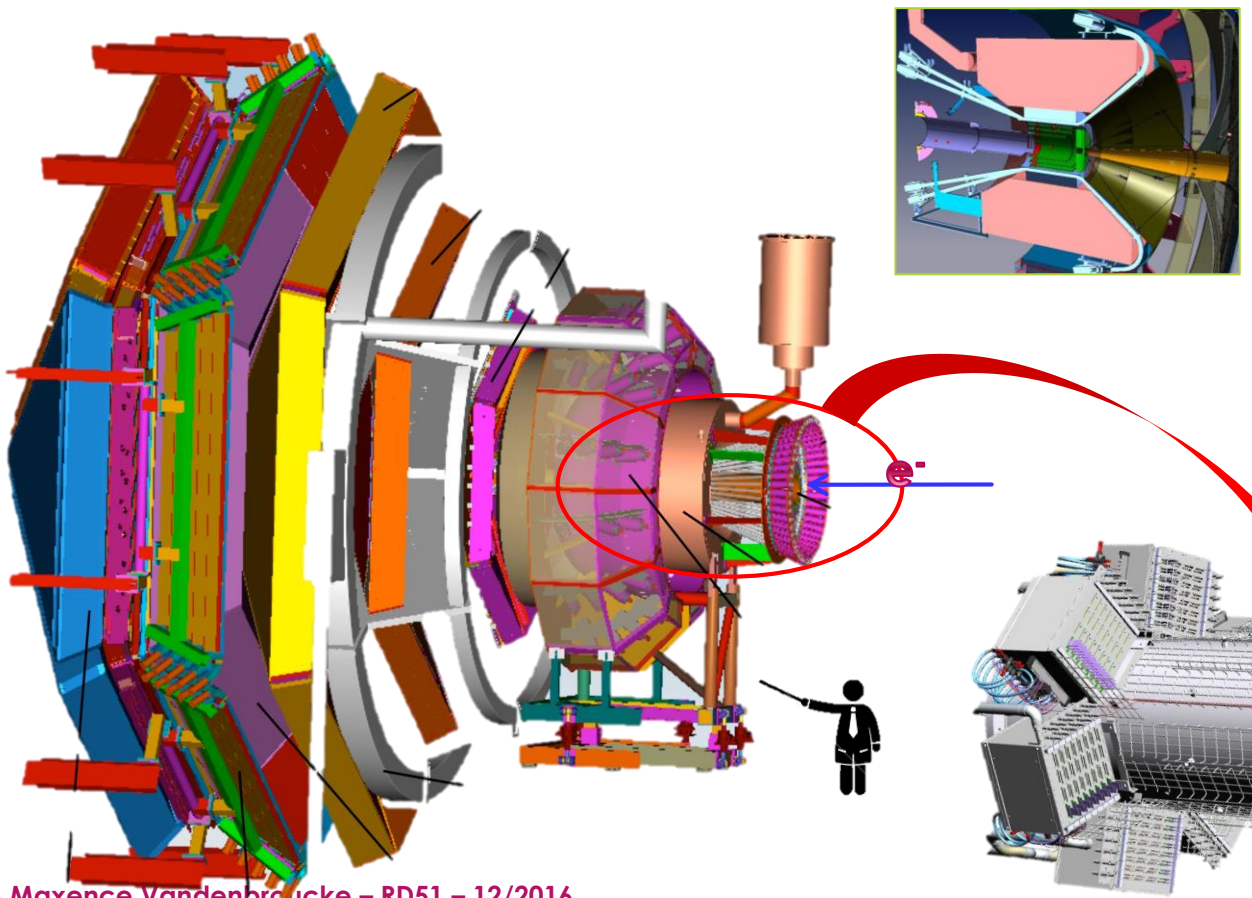
Conclusion

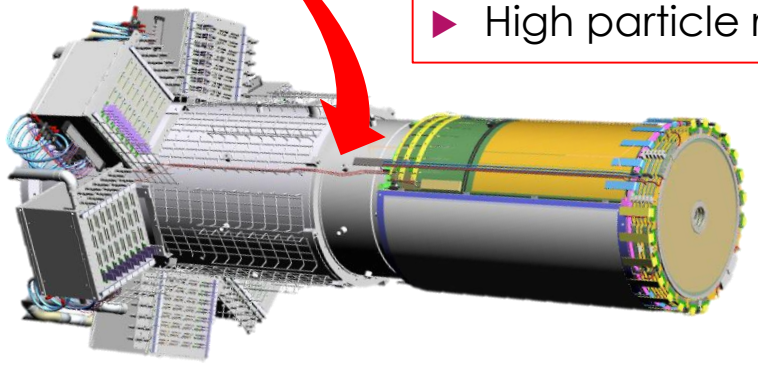
- CLAS12 Production is ongoing, we have to be ready for summer 2017
  - **6 Forward Disks finished** and sent to Jlab, one spare will be produced later
  - **Barrel :**
    - 2 outer layers almost complete, **B2 almost ok**
    - 1 layer of assembled detectors has been heavily repaired due a major issue in the PCB/Bulk
    - 1 Repaired detector is under HV since 3 weeks, no pb so far
    - 1 Layer has been repair before assembly (flat)
    - Next layers won't have the mesh above the silver paste contact
  - 4 layers to be produced and assembled in the next 6 months
- **Silver paste is also causing other issues**
  - HV contact on drift electrode has to be woven with conductive wire for improved reliability
  - Mesh contact made of silver paste aged badly with demanding conditions (current/sparks)

Spare matos

The CLAS12 Experiment

- Upgrade of the CLAS experimental detector hall B
- Study of the nucleon structure with high 11 GeV electron beam at high luminosity (10^{35} $cm^{-2}.sec^{-1}$)





Micromegas Vertex Tracker :

- Improve the track reconstruction in the vicinity of the target
- Reduced volume bet. the magnet and the Silicon Vertex Tracker (SVT)
- Large curved Micromegas
- 5T field
- Remote electronics
- Resistive technology
- Small dead space
- High particle rate (30 MHz)

Bulk Technology (2006)

- Embedded of the MicroMesh on the readout electrode

- Goal : Make the Production of Micromegas an Industrial process

- Robust, Cheap

- Simplified and light mechanical structure

- Ability to use thin PCBs and produce different shapes (cylindrical detectors !)