Plans for

MPGD Radiation hardness tests for full detectors and components

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CERN GDD Group

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Working Group 2

Outline

- Full Detector Tests
  - Standard Triple GEM
  - Bulk MicroMegas
  - THGEM
- Components Tests
  - Standard Triple GEM components
    - Electrical Tests
    - Mechanical Tests

Detector Technologies to be tested

- Triple GEM Detector [This detector is using the same material (GEM, glue, honeycomb and fiberglass) as TOTEM chambers]
- Bulk Micromegas
- THGEM

Method followed for Full Detectors

- Make a series of measurement before putting this detector in beam of ^{60}Co photons
- We would like to know if the performance of the detector is changed after strong irradiation (Total integrated dose of 10^6-10^7 Gy)

Laboratory Setup

- High Voltage Power Supply
  - Caen NA470 Power Supply
- Electronics
  - NIM Electronics
- DAQ
  - CAMAC System
- Radioactive Sources
  - ^{55}Fe 5.6 MBq Source (5.9 keV)
  - Cu X-Rays Generator (8.9 keV)

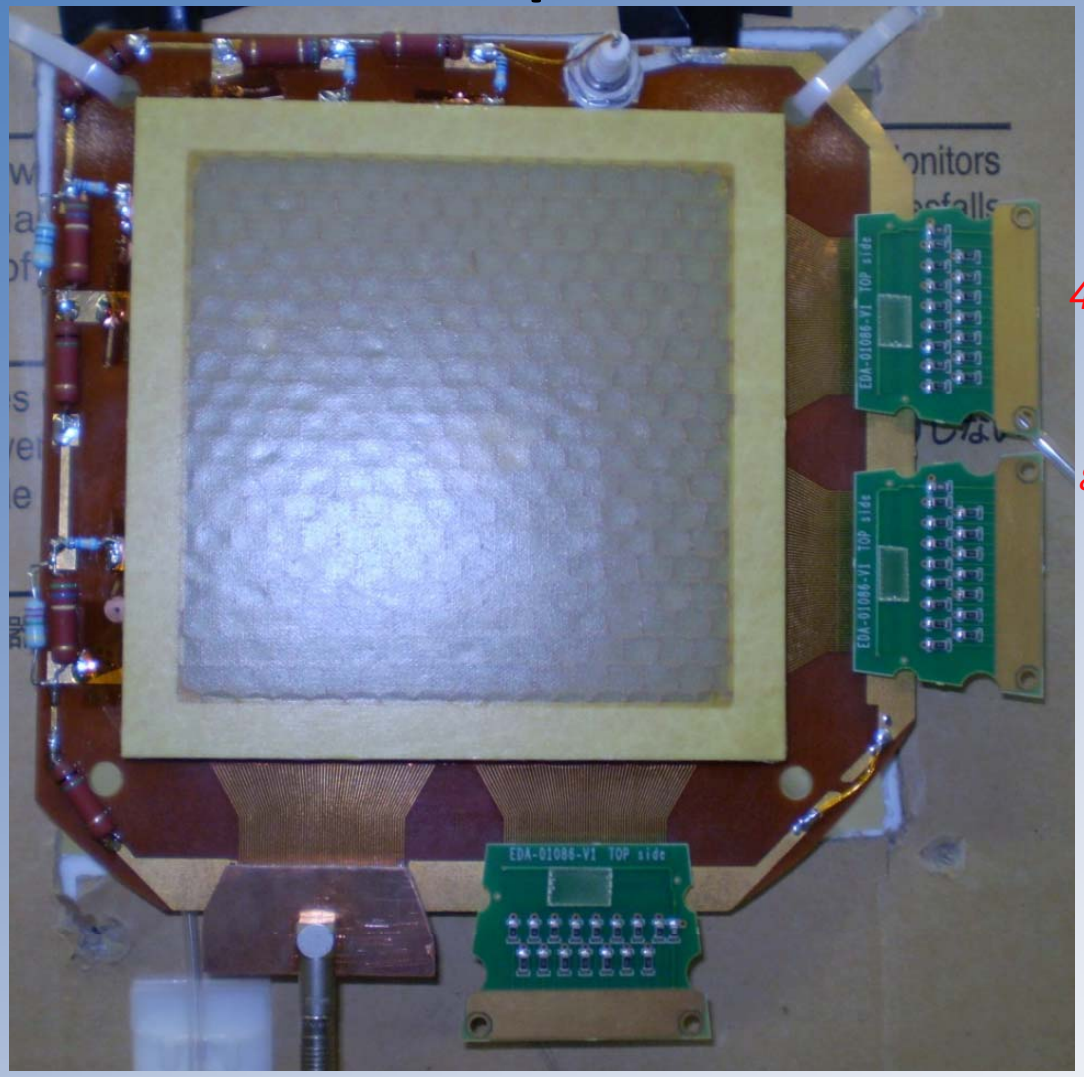
List of measurements

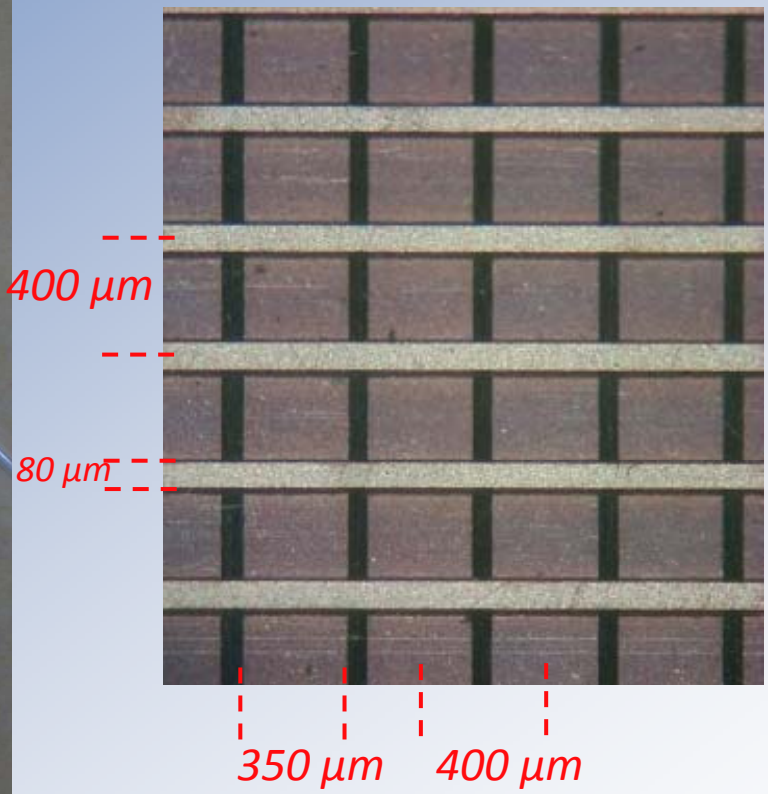
- Gain
- Rate Capability
- Discharge Probability
- Time Charging up Scan Type 1: Power on the detector and start to irradiate at the same time
- Time Charging up Scan Type 2: Power on the detector before starting the irradiation
- 2D Test (for Triple GEM)
- Test of uniformity over active area
- Counting plateau

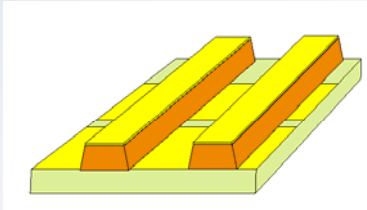
What might happen after strong irradiation..

- Gain → For TGEM, if the kapton resistivity is changed we can have less gain than before at the same voltage; it may happen that this variation may only be on the irradiated spots.
- Gain variation with time → The detector can have different charging up proprerties
- .....

The Triple GEM Detector used







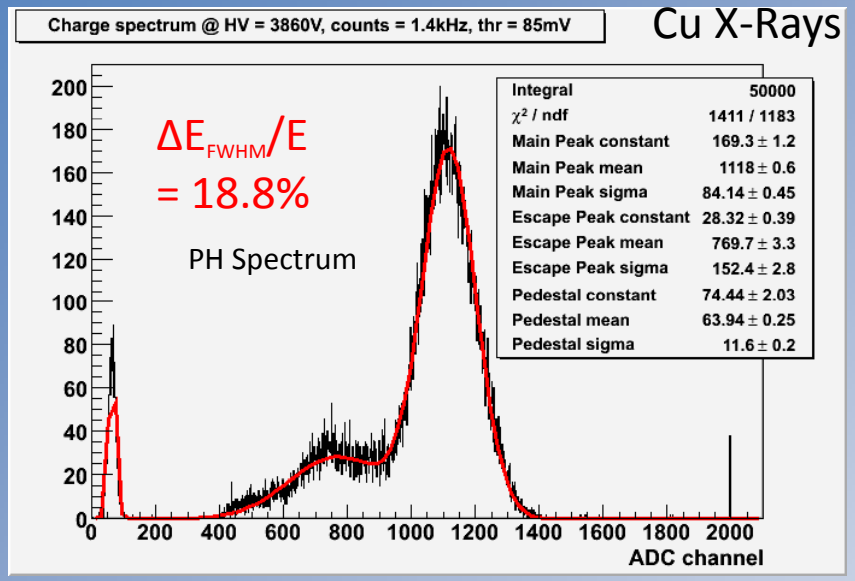
Cartesian 2D X-Y Readout

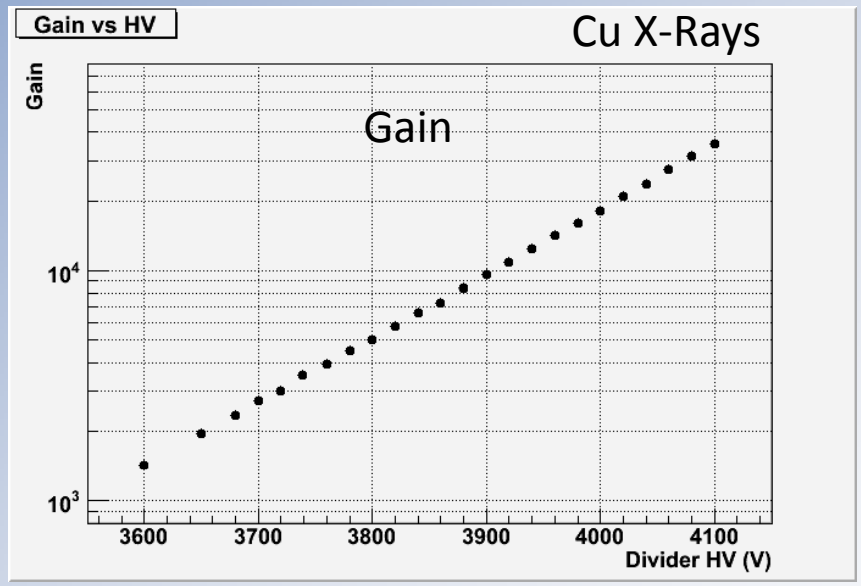
C. Altumbas et al, NIM A490(2002)177

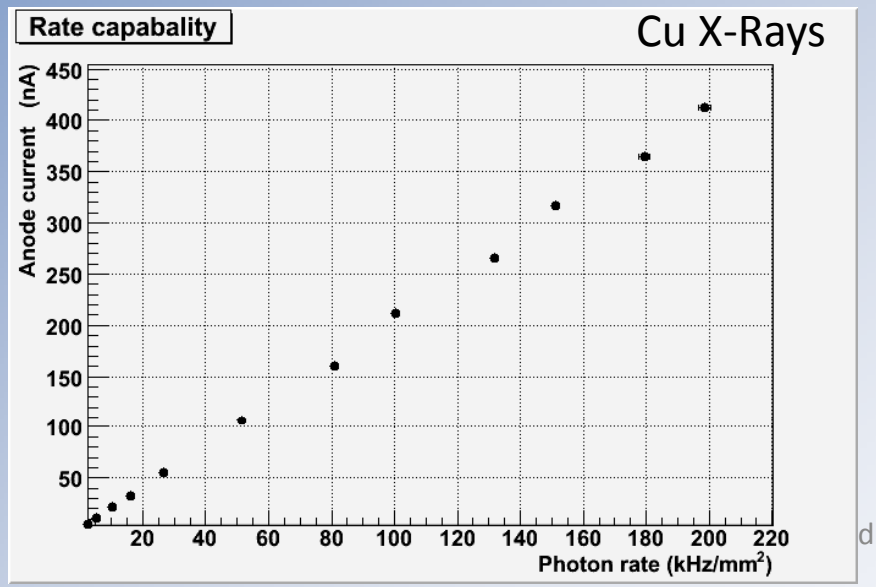
10 x 10 cm^2 Active Area

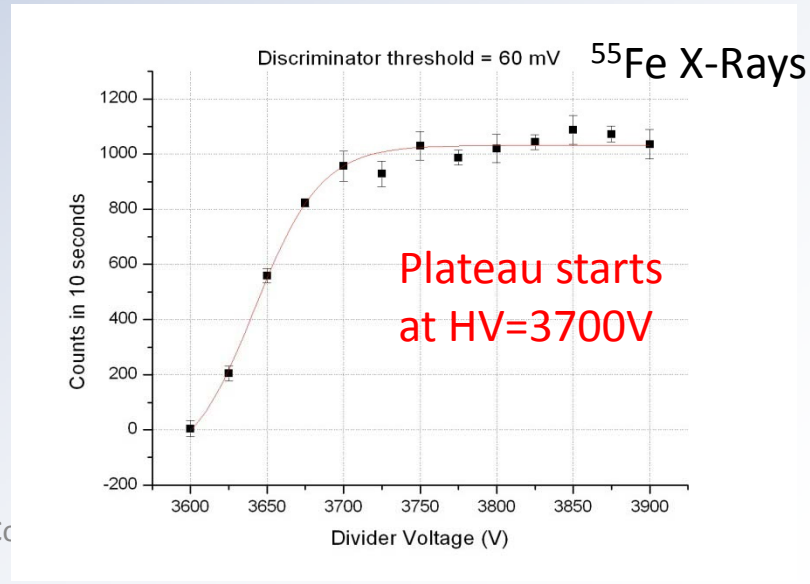
Gas Mixture used $Ar/C0_2$ 70%/30%

Measurements performed so far (before irradiation)









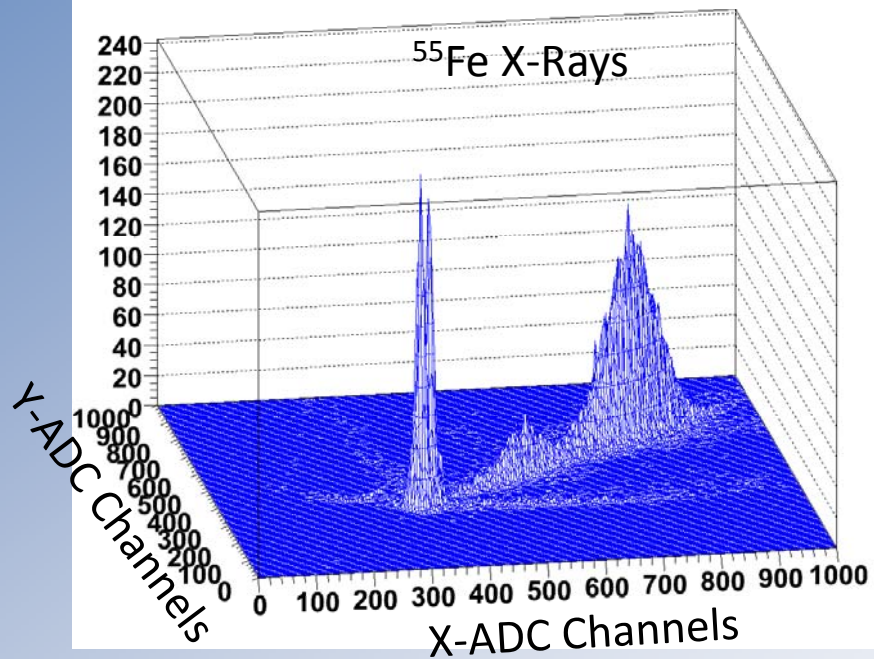
2 Dimensional Test

READOUT:

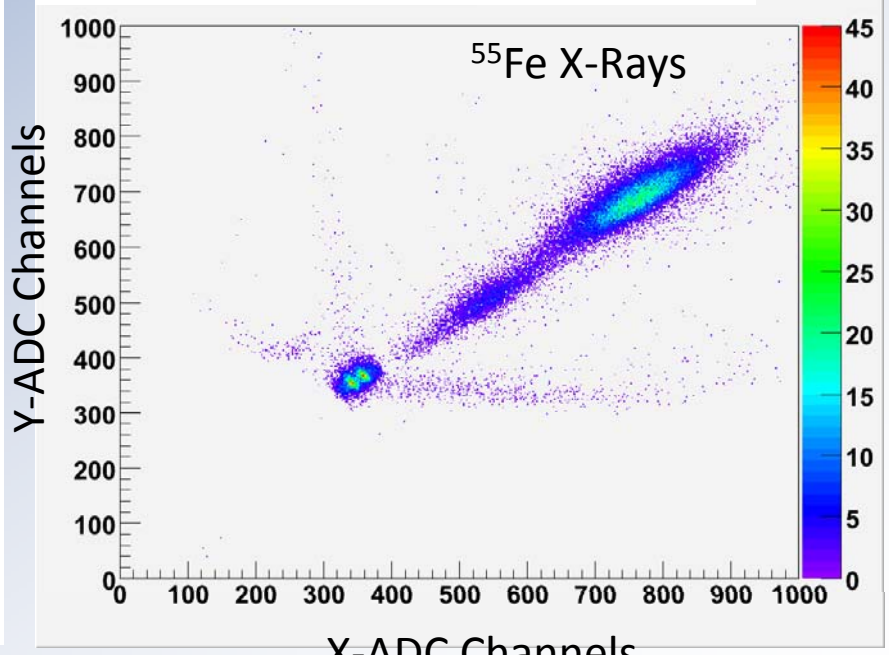
- 128 X-strips connected together
- 128 Y-strips connected together.

Acquisition of PH spectrum from the two clusters of strips triggering on Y cluster

Charge: X-cluster Vs Y-cluster



Charge: X-cluster Vs Y-cluster

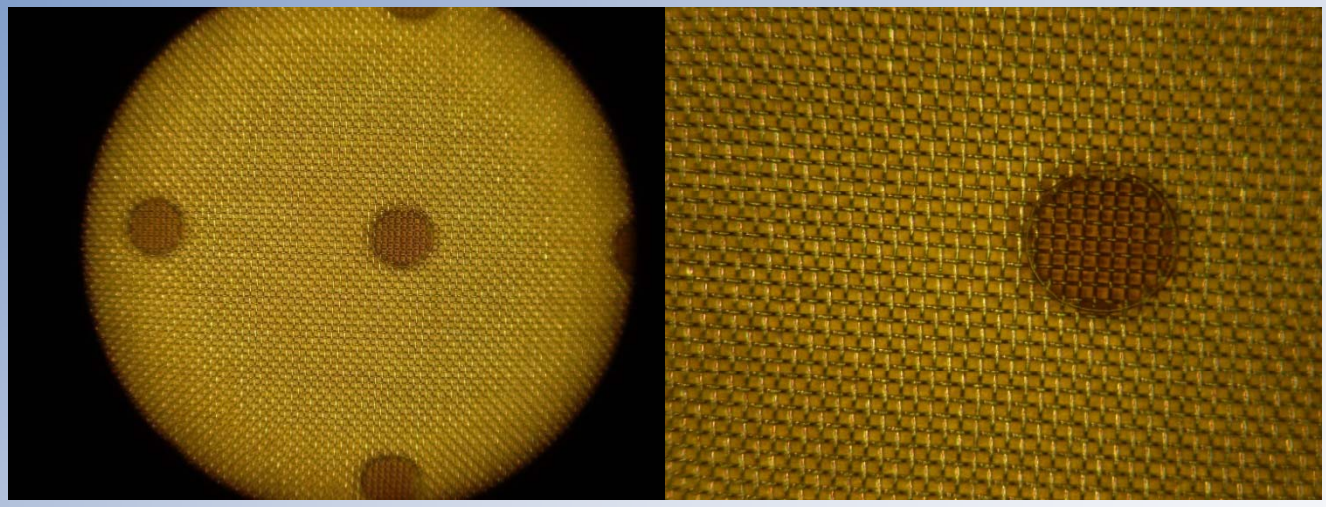


Testing Standard Bulk Micromegas in air (with Paul Colas)

Vmesh (V)	I (nA)
200	2
300	2
400	2.1
450	2.2
500	2.3
600	2.7
650	2.75
700	2.95
800	3.1
830	First Spark, than stable
870	Last Stable Value before having many sparks

V_{anode} = 0

Mesh Photos



The gas that will be used to test this detector (under Paul Colas' suggestion) is

Ar/CF4/Iso 95%/3%/2%

and the maximum voltage that will be applied to the mesh (being V_{anode} =0) is 360V

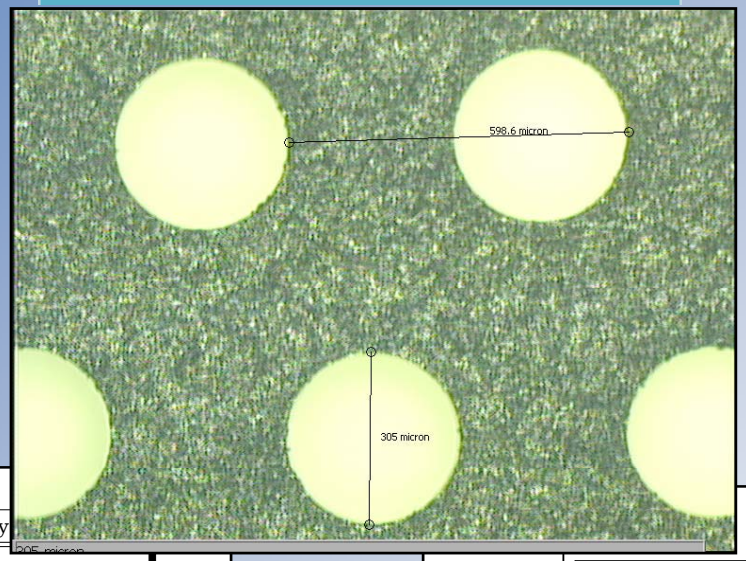
The radiation hardness of the pillars material (coverlay, pyralux pc 1025 Dupont) is the key point

THGEM Measurements (see E. Rocco's talk)

THGEM #	Diam	Pitch	Thick	Rim
1	0.3 mm	0.7 mm	0.6	0

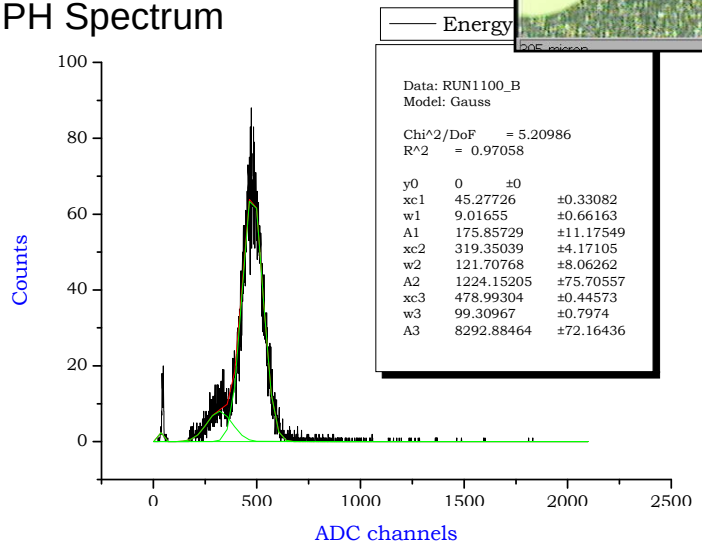
DE156 Fiberglass

THGEM

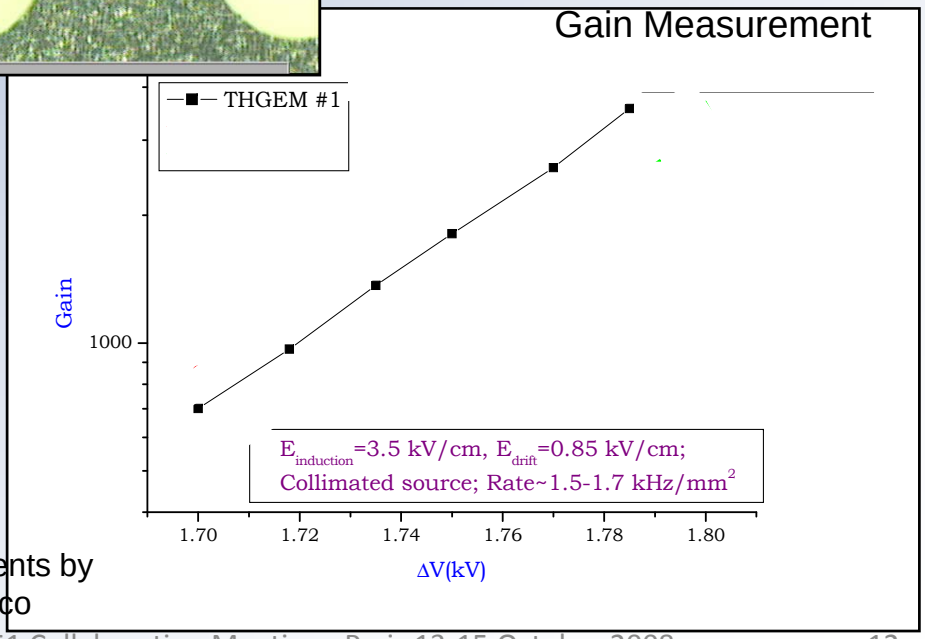


Gas Mixture used Ar/CO_2 70%/30%

PH Spectrum



Gain Measurement



Measurements by E. Rocco

Radiation Hardness tests of Triple GEM detector components

- Materials to be tested:
  - GEM Polyimide (Apical AV Kaneka)
  - Glue (Araldite AY103) + Hardener (HY951)
  - Frames Material (Permaglas)
- Tests to be performed
  - Electric Test
    - Measure kapton resistivity before and after gammas irradiation
  - Mechanical Tests: make mechanical tests on components that represent crucial part of detector assembly
    - Shear Test
    - Peeling Test

We found a very old paper on kapton irradiation…

R.G. Filho et al, "Induced conductivity of Mylar and Kapton Irradiated by X-Rays", IEEE Transactions on Electrical Insulation Volume EI-21 No. 3, June 1986

Kapton Samples of 80 mm diameter with thickness varying from 6 to 75 µm were irradiated with W X-Rays for several hours; They saw a variation of the Kapton conductivity

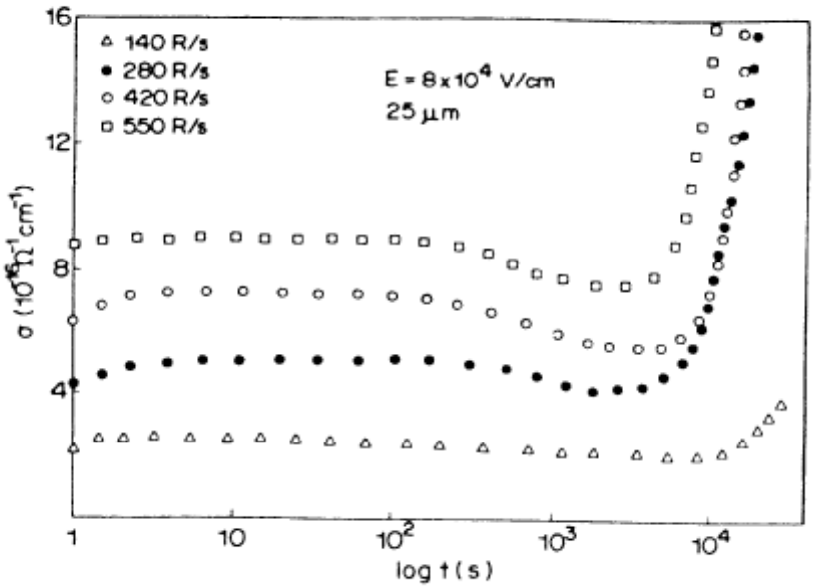
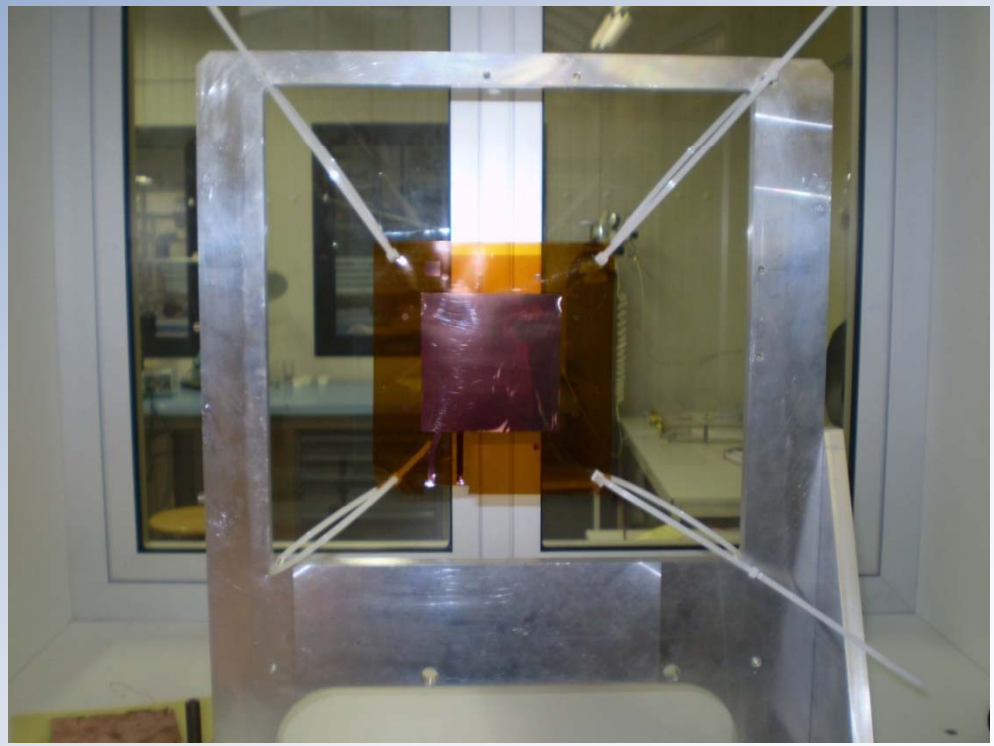


Fig. 14: Kapton: RIC as a function of time for different exposure rates.

First Lab Irradiation Test (prelim. results)

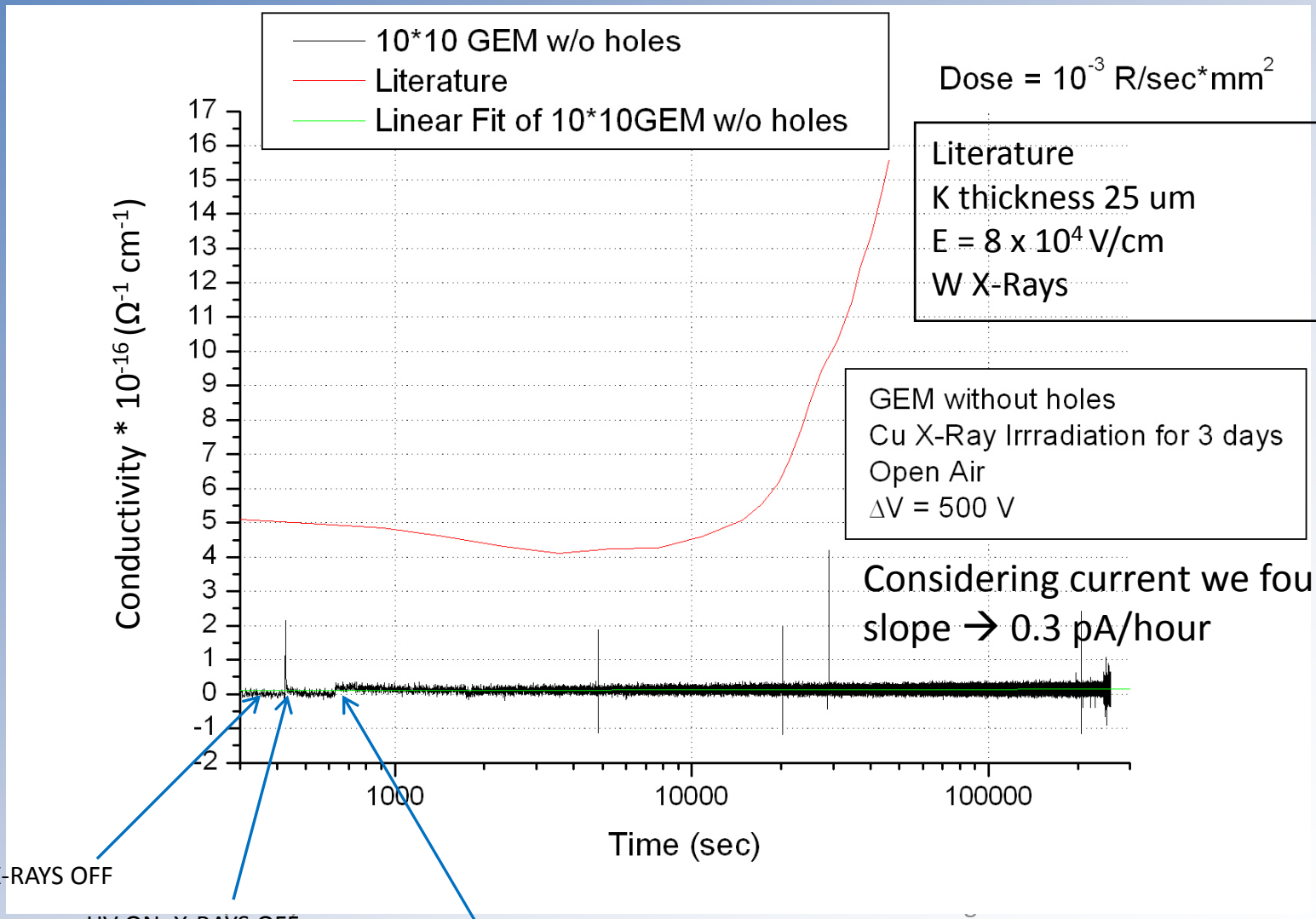
Measurement of Induced Conductivity inside a copper-clad 50 µm thick kapton foil **(GEM w/o holes)**

This copper-clad kapton foil was powered with 500 V and irradiated at very high rate in open air with Cu X-Rays to understand if irradiation will vary its conducibility.
Since measurement was performed in open air, air ionisation could be a problem.



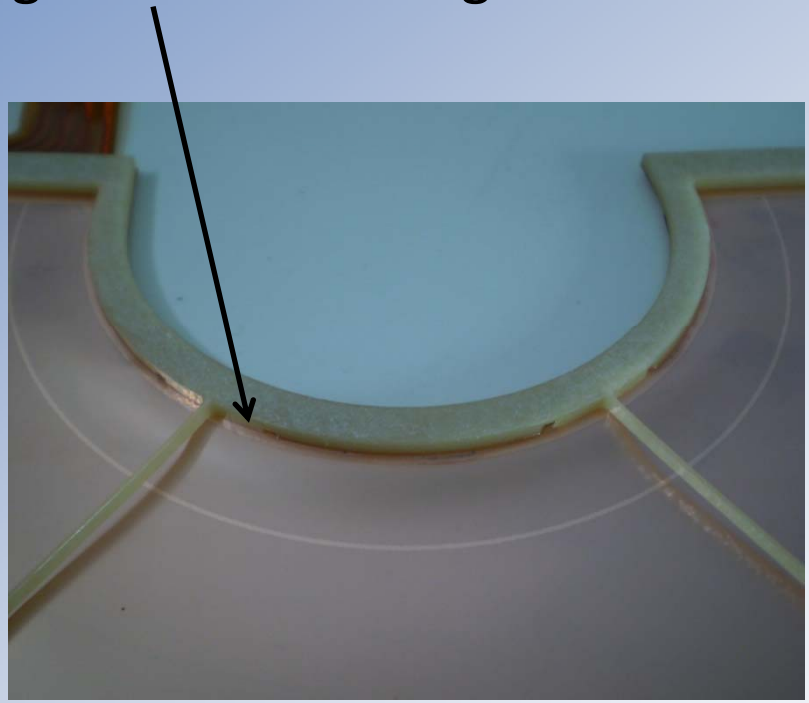
The current flowing from the top to the bottom electrode was monitored during irradiation

Measurement of Induced Conductivity inside a copper-clad kapton foil (GEM w/o holes)



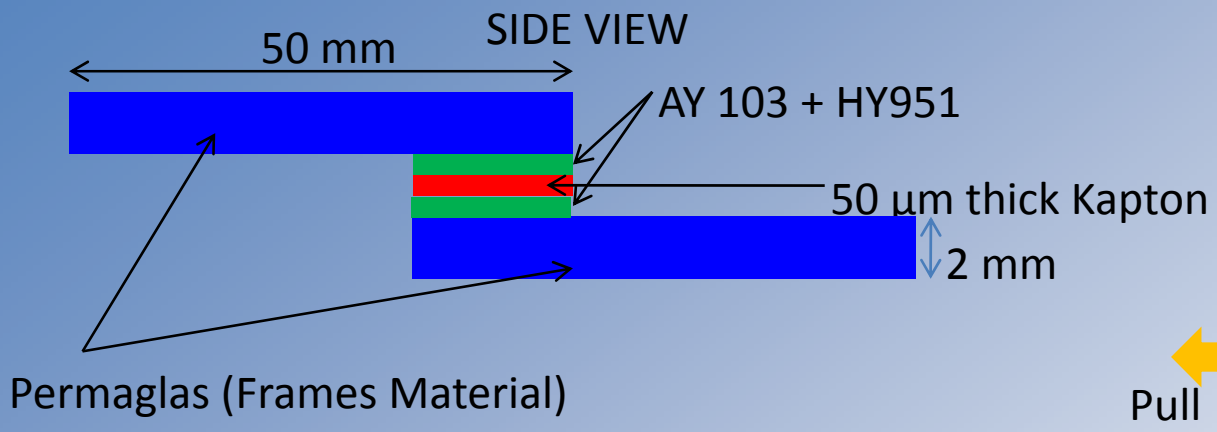
Mechanical Tests

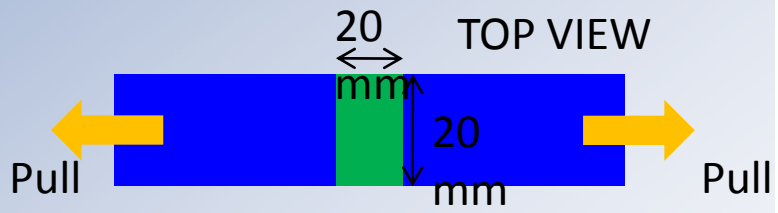
- The tested samples represent the part of the detector where the GEM foil is glued to the fiberglass frame

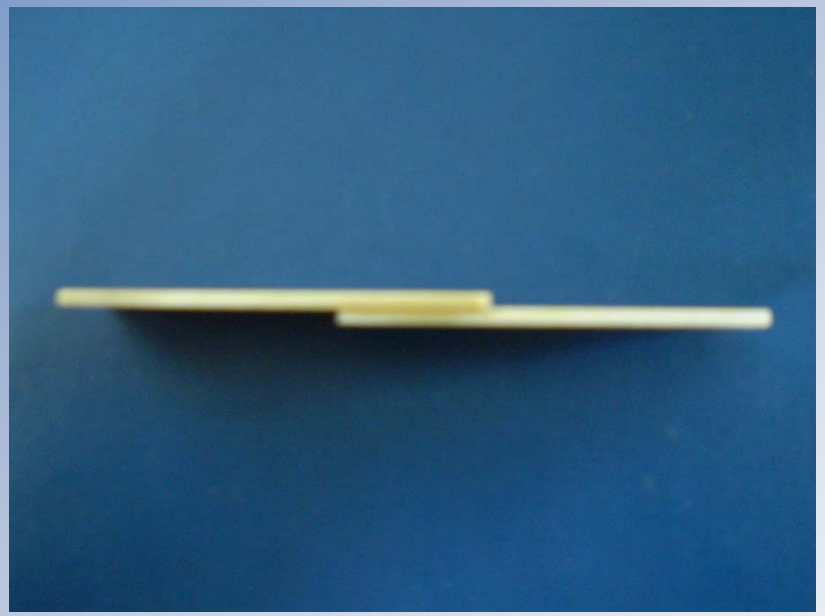


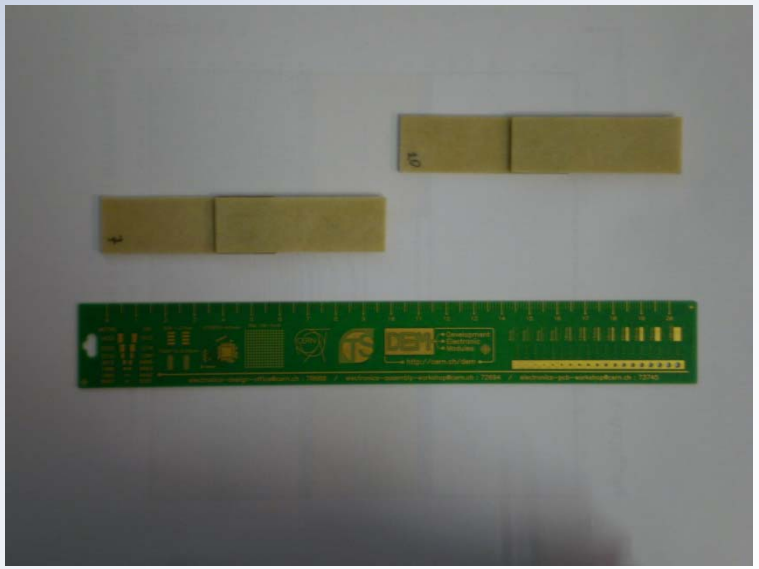
Shearing and peeling stresses of GEM foil/frame are the most dangerous risk for the detector

Shear Test Samples

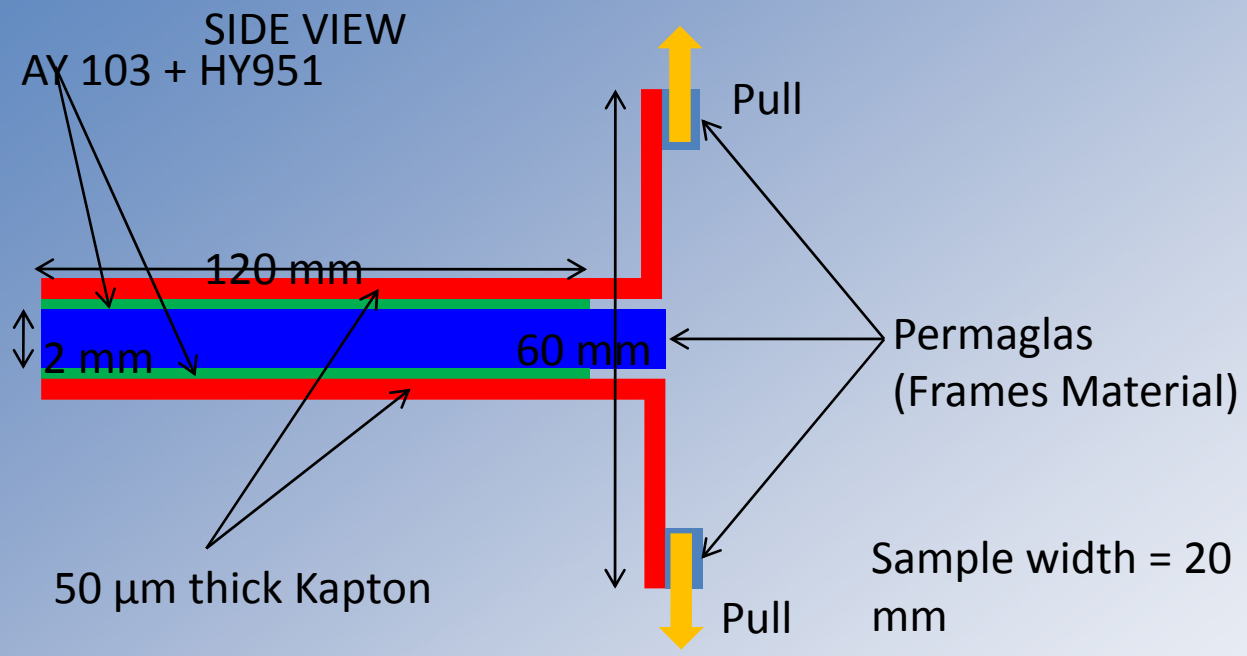


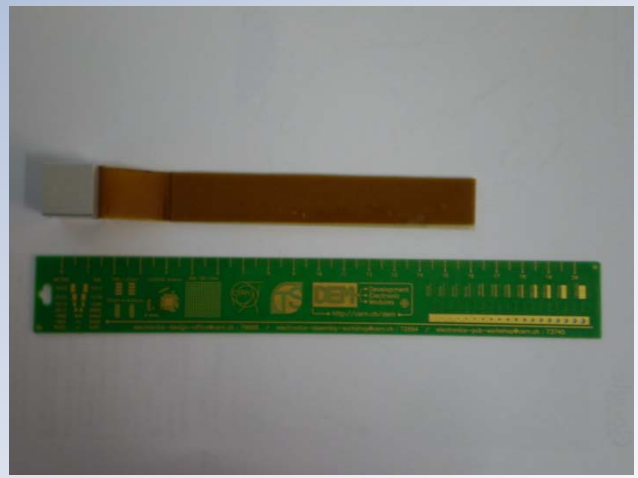




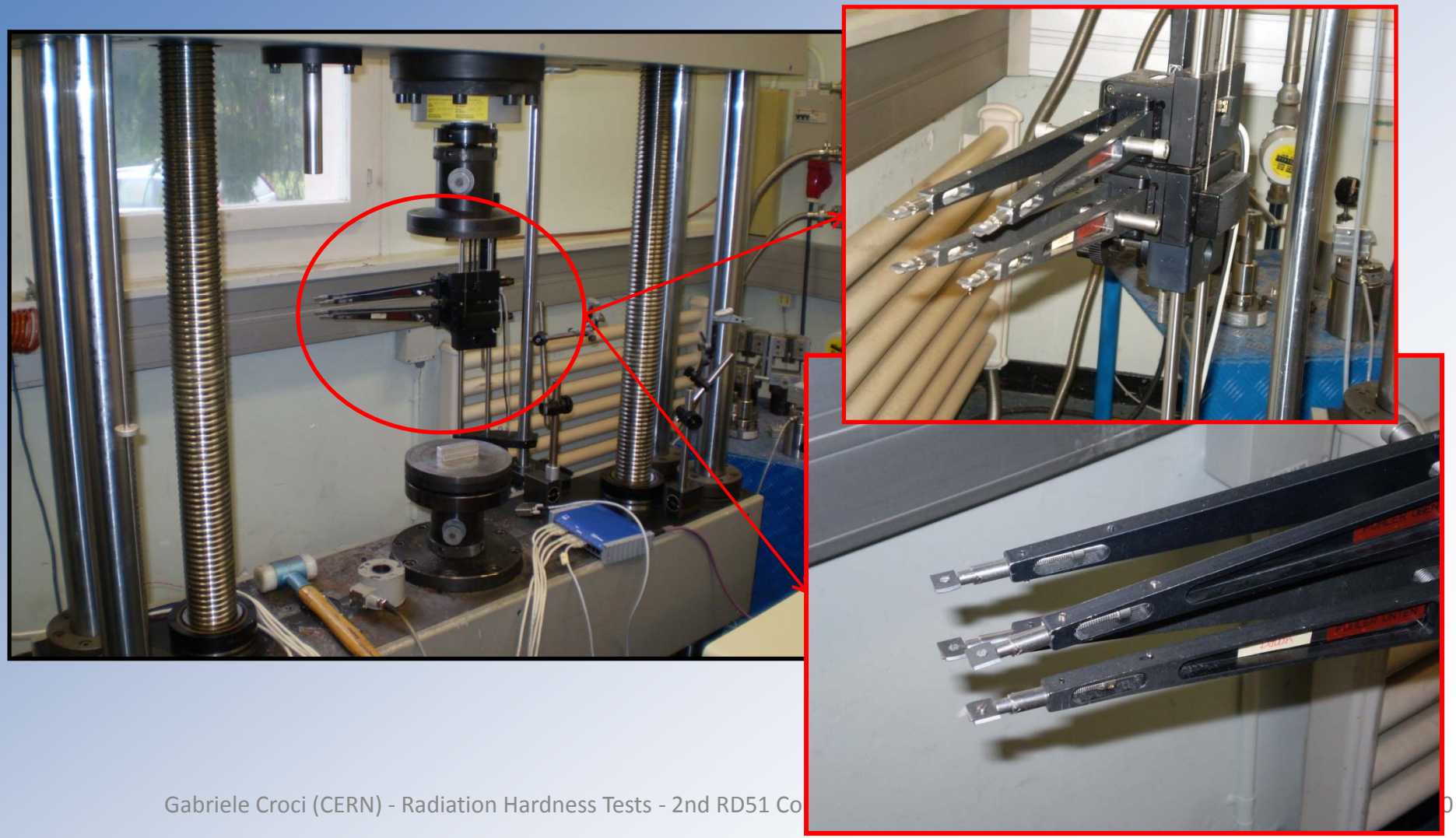


Peeling Test Samples





Pictures of the machine used to perform these tests



Previous studies on Araldite AY103 +HY951

Studies made at CERN some years ago on the same glue used in Triple GEM detectors assembly

***Compilation of radiation damage test data**, 4. / Guarino, Francesco et al. CERN-2001-006. - Geneva : CERN, 2001. - 131 p.*

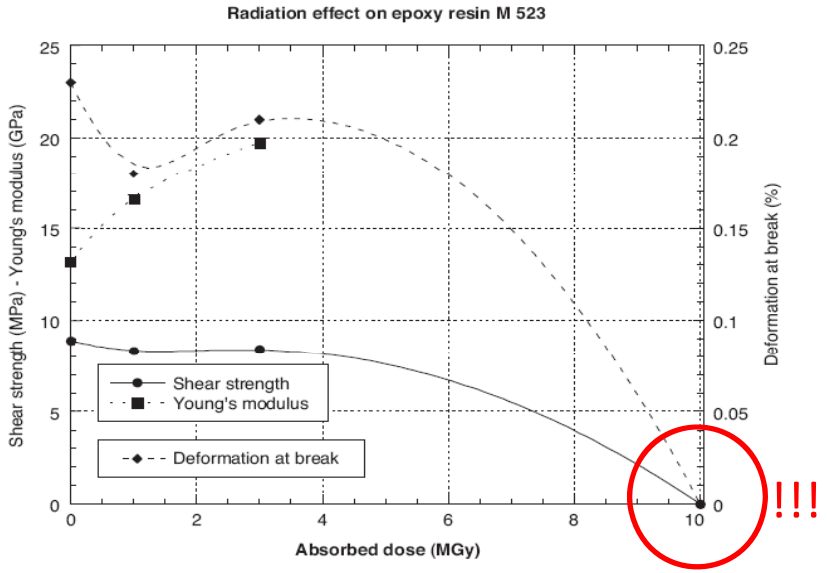
Material: Epoxy structural adhesive — **ID No. M 523**
Type: Araldite AY 103/HY 951 (100/8)

Supplier: Ciba-Geigy

Test method: Shear test with aluminium samples
Sample geometry: Equivalent to ASTM D 1876-93
Surface treatment: Sand blasting
Polymerization temperature: 25°C
Radiation source: Cobalt 60 and Switched-off reactor

Absorbed dose (MGy)	Dose rate (kGy/h)	Shear strength (MPa)	Deformation at break (%)	Young's modulus (GPa)
0	0	8.9 ± 0.6	0.23 ± 0.03	13.2 ± 6.6
1	4	8.3 ± 0.5	0.18 ± 0.04	16.6 ± 1.1
3	4	8.4 ± 0.3	0.21 ± 0.01	19.7 ± 1.8
10	20	0.0	0.0	–

Critical property = deformation at break
Radiation index (RI) ~ 6.7 at a mean dose rate of 4 kGy/h



Present Situation

- We are performing the tests before irradiation **but now we need to find a ^{60}Co irradiation facility!!!!!**

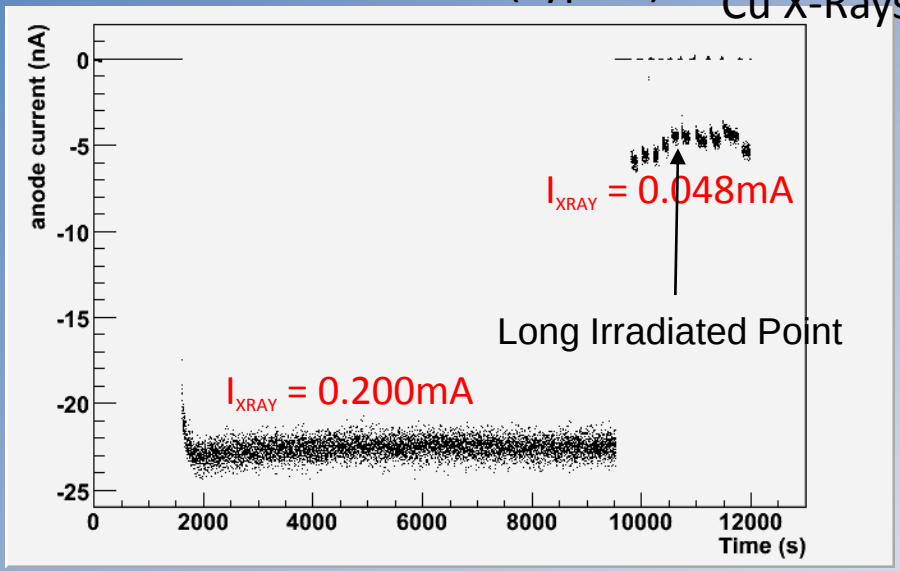
ANY SUGGESTIONS?????

Is anybody interested in irradiating other detectors or components ???

Spare Slides

TGEM: Time Charging up scans

Charging up, chamber already on before irradiation (Type 2)



Charging up, irradiation as soon as chamber is on (Type 1)