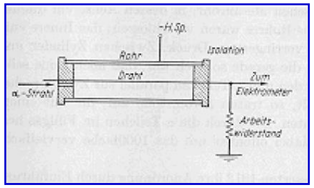
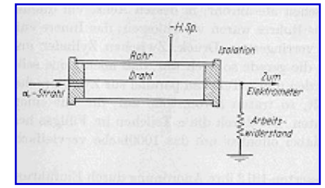


TASK 13.2.5

Development of <u>high-gain MPGDs</u> based on <u>advanced THGEMs</u> and <u>hybrid MPGDs</u>

TASK COORDINATOR: Silvia Dalla Torre

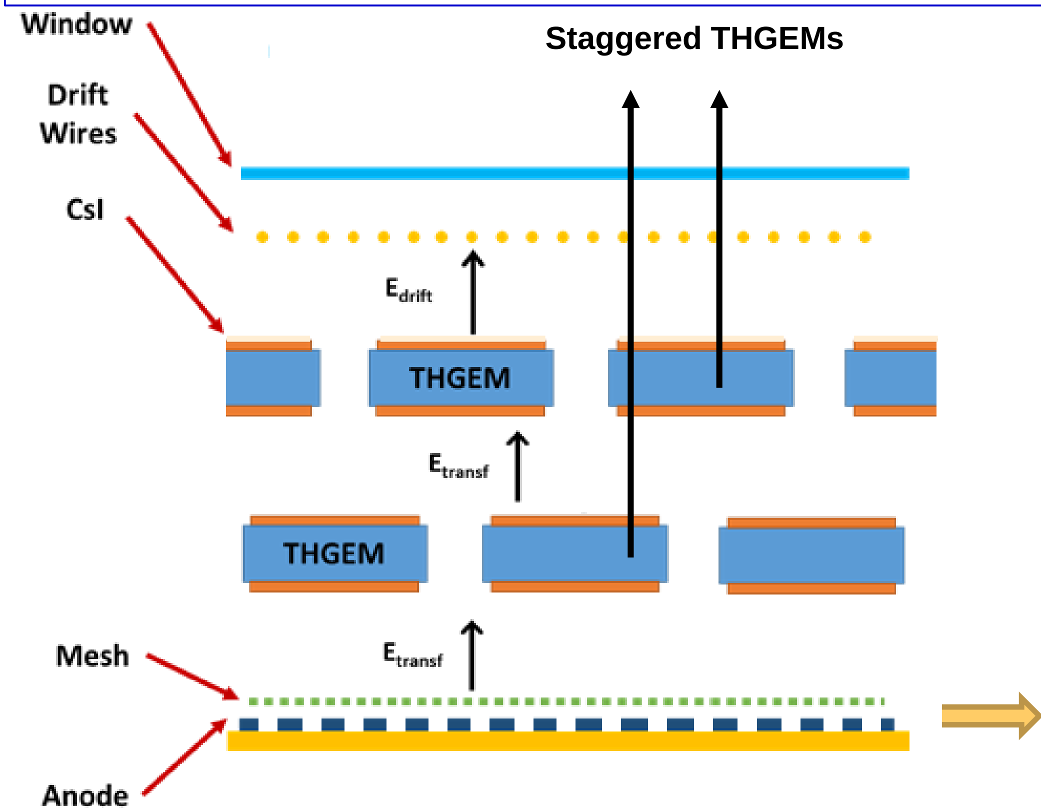
PARTICIPANTS: INFN - Trieste



OUR APPROACH TO HIGH GAIN

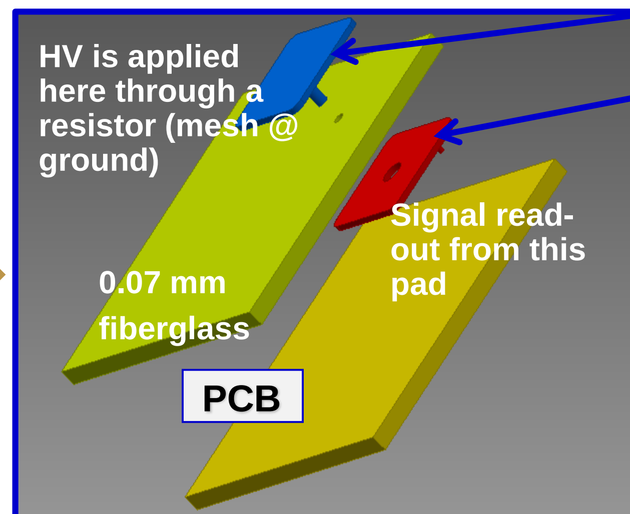
- **Simple; robust; cheap**
- **Signals → Electrons drift →** $\sigma \approx 10\ ns$**;**
- **Cascade → high gain, present figure: $G \approx 3x10^4$ in beam**
- **IBF:** 3%**;**
- **Stability: time & high rates**

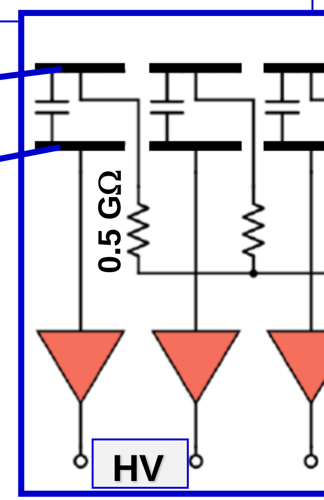
Hybrid Detector (2 x THGEMs + Micromesh)



Double THGEM: t = 0.4 mm; p = 0.8 mm; h = 0.4 mm

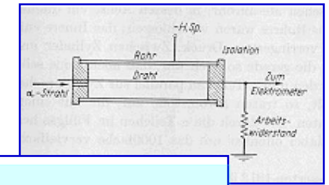
Resistive MM by discrete elements





Resistor arrays

PLANNING



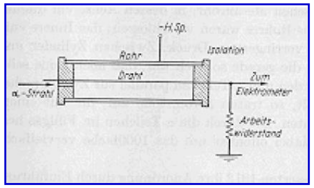
- **1st YEAR**
  - ACTIVITY: Detailed characterization of the discharge sources in the hybrid MPGD architecture and discharge propagation in the hybrid MPGD architecture
- **2nd YEAR**
  - ACTIVITY: New candidate materials for THGEM substrate and improved production techniques are qualified by THGEM prototyping.
  - MILESTONE: **MS13.4**, Qualification of the new candidate materials for THGEM substrate, M26, Report to StCom

OFFICIAL MILESTONE

- **3rd YEAR**
  - ACTIVITY: The qualification of the new candidate materials for the high-gain performance of hybrid MPGDs is demonstrated by small size prototyping. Resistive MICROMEGAS will be employed
- **4th YEAR**
  - ACTIVITY: An engineered large-size high-gain hybrid MPGD prototype is realized and validated by laboratory and test-beam measurements
  - DELIVERABLE: **D13.5**, Prototype of a large-size high-gain MPGD (a large-size fully engineered and validated prototype of the a high-gain MPGD), M44, DEM

OFFICIAL DELIVERABLE

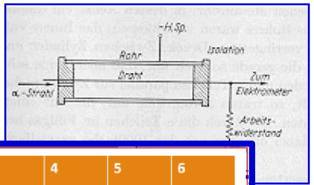
3rd year activity



- **More exotic materials as THGEM substrate**

  (also following the recommendation by the ***AIDA2020 Scientific Advisory Board***)

- **Realization of an optimized small-size prototype**

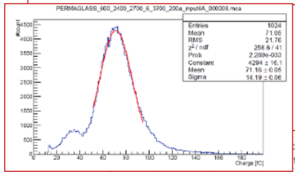


REMINDER

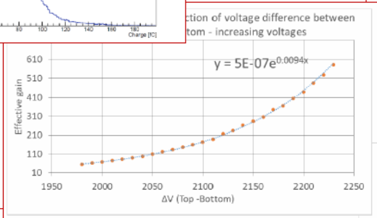
- UNIFORMITY SCAN:
  - σ: 13%

Effective gain	1	2	3	4	5	6
A	150	139	139	134	120	121
B	121	108	101	103	116	116
C	142	105	121	121	116	90

- ENERGY RESOLUTION:
  - 20 %



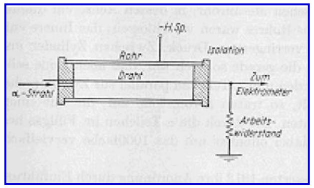
- GAIN PERFORMANCE:
  - A robust device



PERMAGLASS as THGEM substrate

→ MS61 REPORT

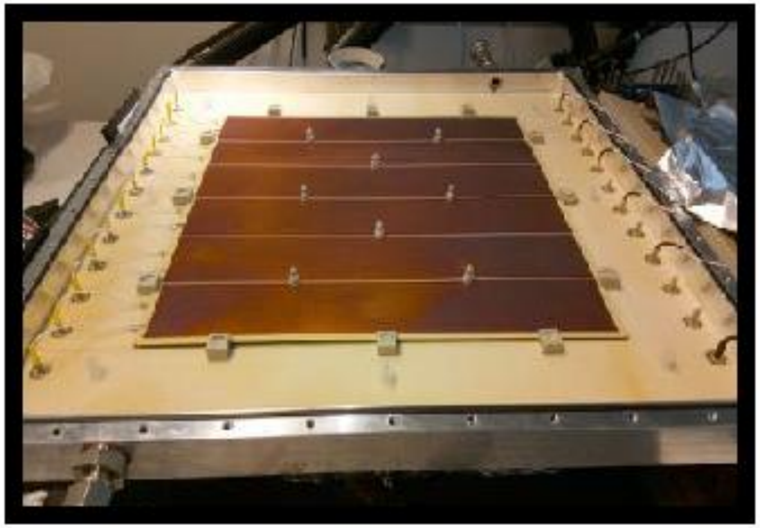
- Robust material offering remarkable uniformity performance
- Difficult to get good quality thin foils
- Easy to operate and limited gain dependence on rate (charging up) and time (ion displacement in the bulk dielectric)
- Good potentialities for high gain multilayer devices

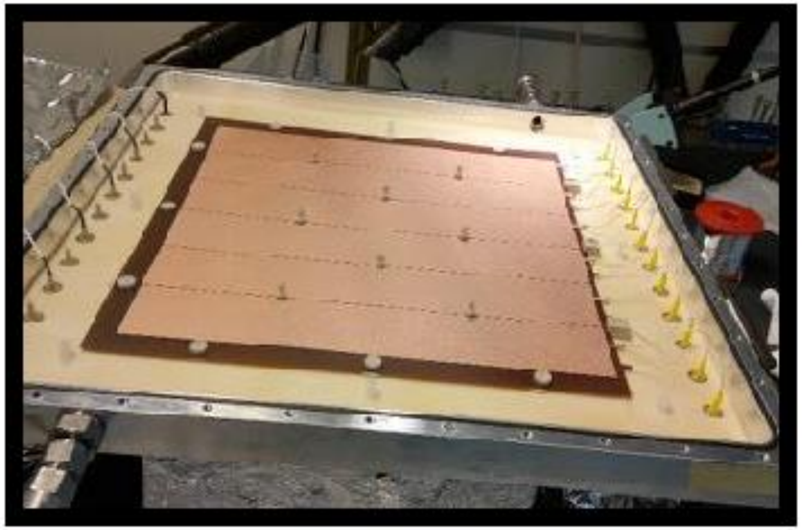


THGEM by ARLON

ARLON and FR4 THGEMs

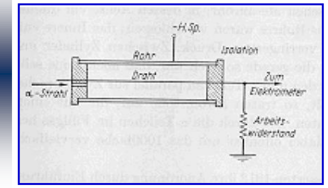
ARLON 25 FR	Fiberglass FR4
Dielectric constant: 3.58	Dielectric constant: 4.7
Ceramic-filled fiberglass material	Woven fiberglass and epoxy resin



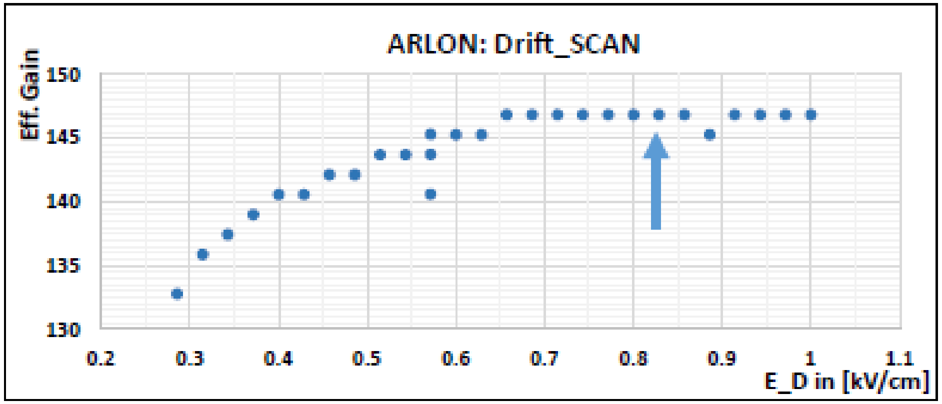


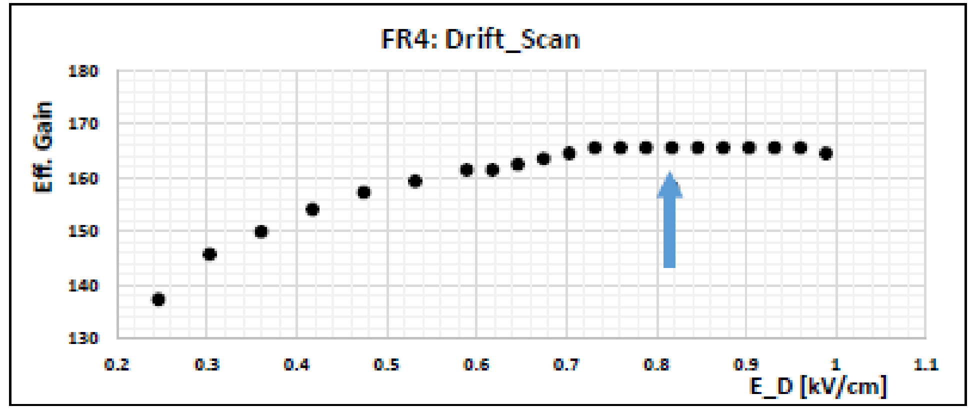
Area: (300 x 300) sq. mm   Thickness of the piece: 0.4 mm
Pitch: 0.8 mm   Hole diameter: 0.4 mm   No Rim

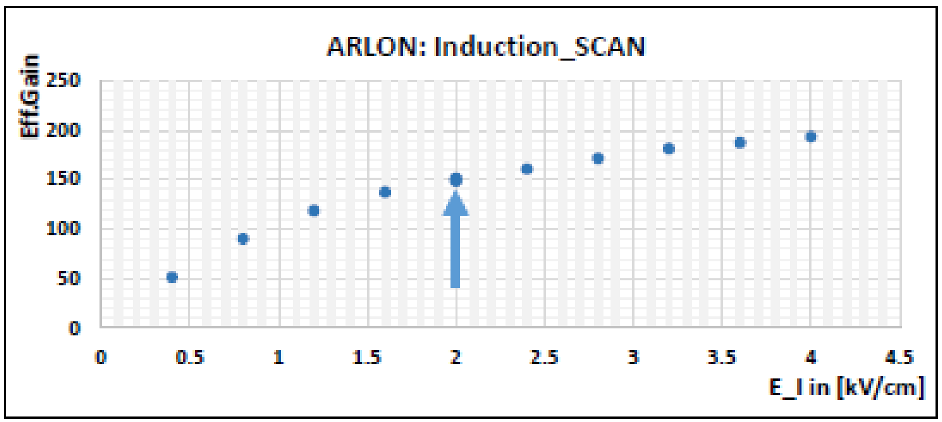
Both produced by ELTOS

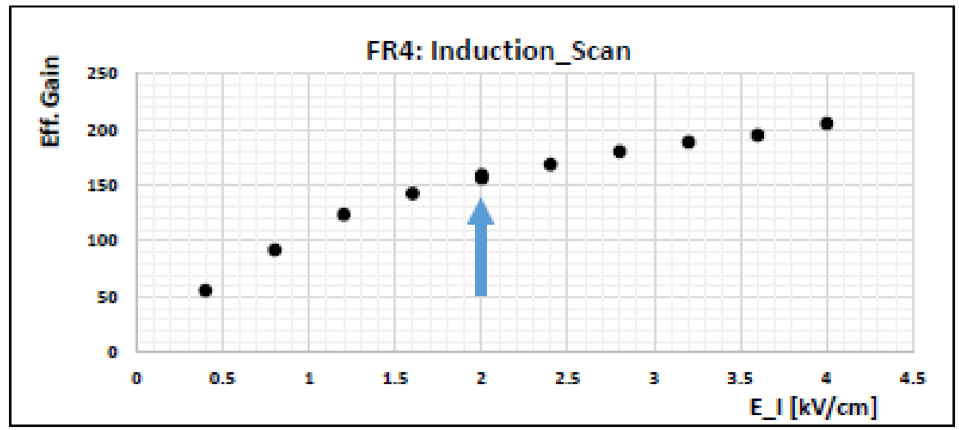


DRIFTY SCAN & INDUCTION





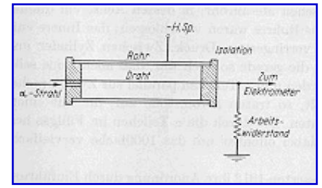




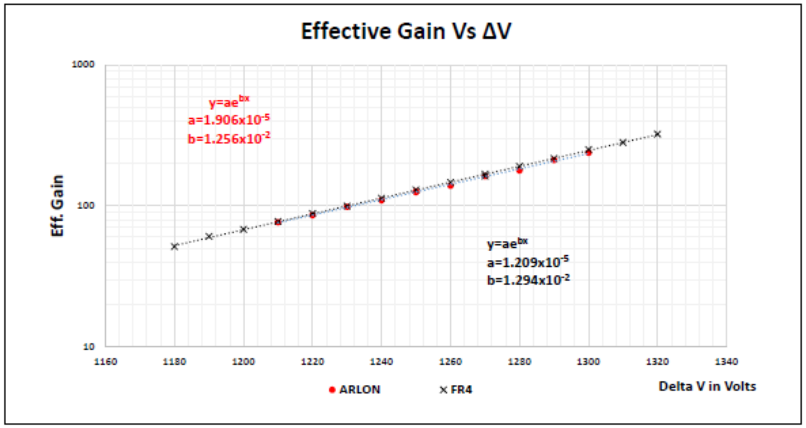
Similar responses

GAIN & RESOLUTION

GAS DETECTORS



E_Ind= 2kV/cm, E_D= 0.8 kV/cm



Very similar effective gains

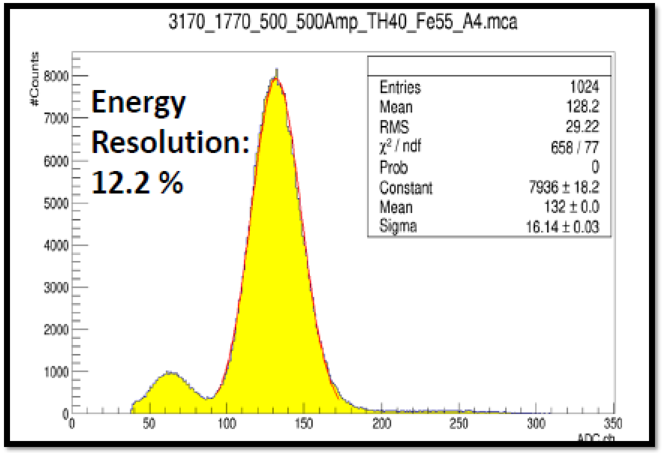
FR4

Vc	889 V
|Ec|	22.2 kV/cm
ΔV_{10}	178 V
$\|\Delta E_{10}\|$	4.45 kV/cm

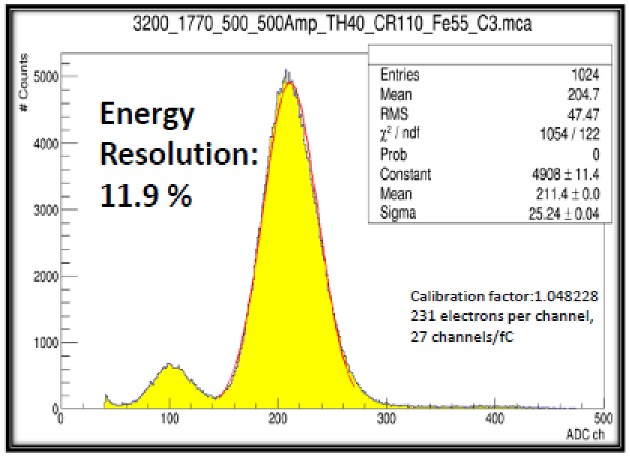
ARLON

Vc	902 V
|Ec|	22.6 kV/cm
ΔV_{10}	192 V
$\|\Delta E_{10}\|$	4.8 kV/cm

ARLON

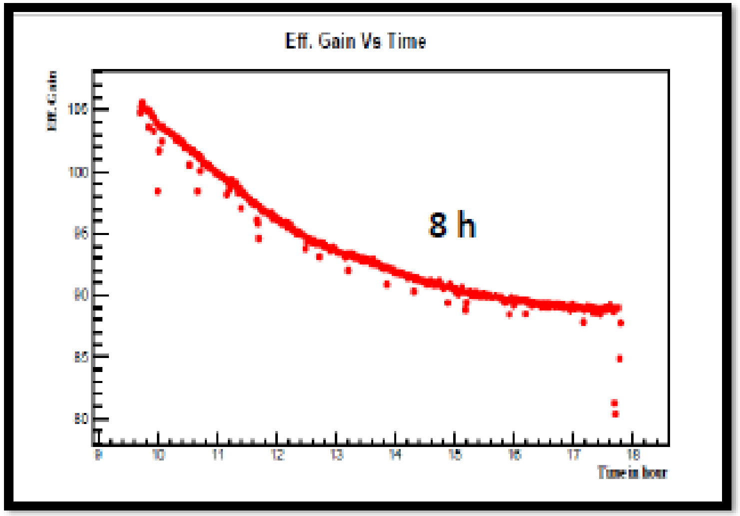


FR4

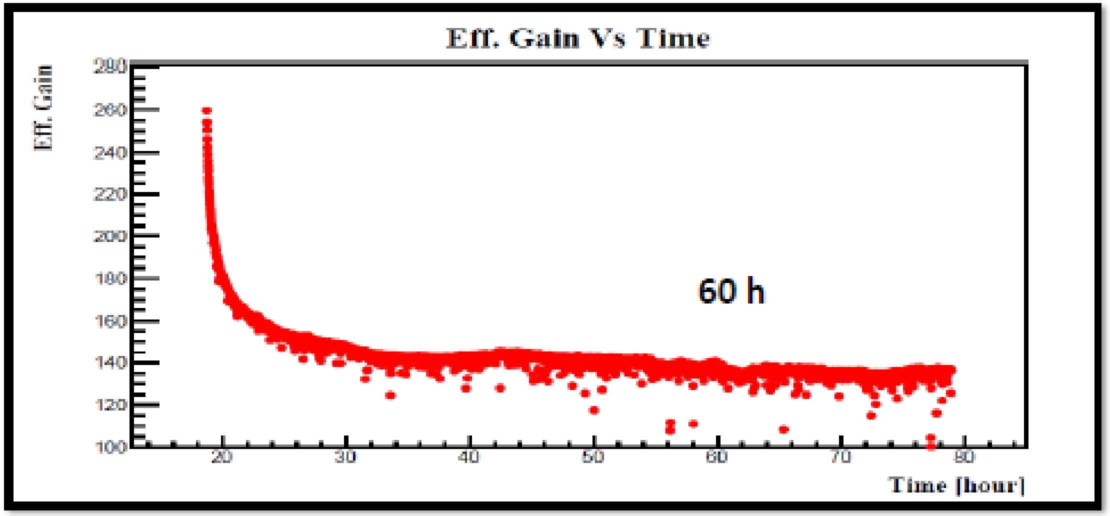


They have the same Energy Resolution

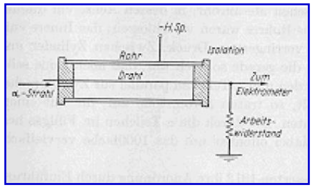
ARLON



FR4

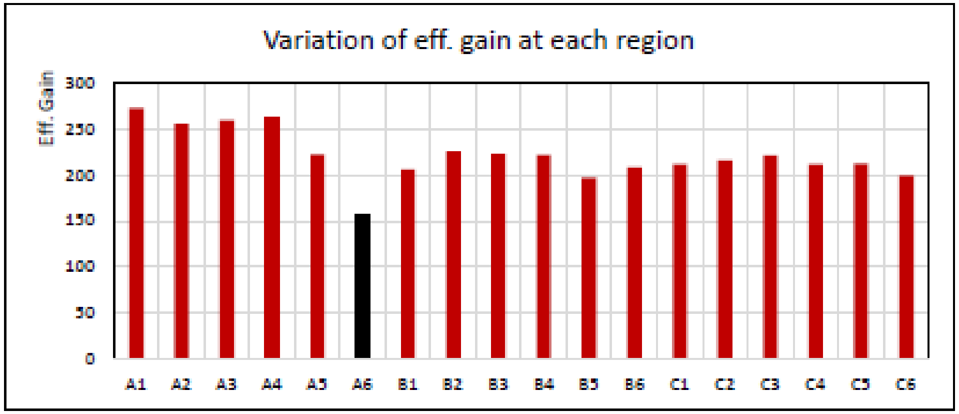


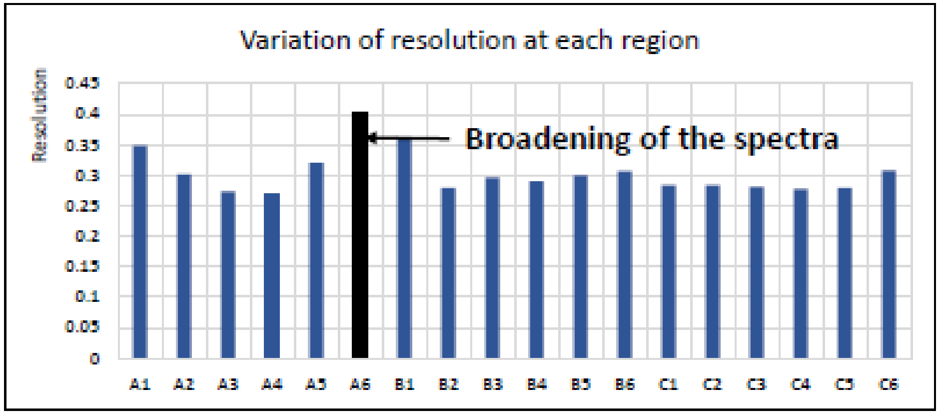
Gain variations with time for the two pieces are not the same



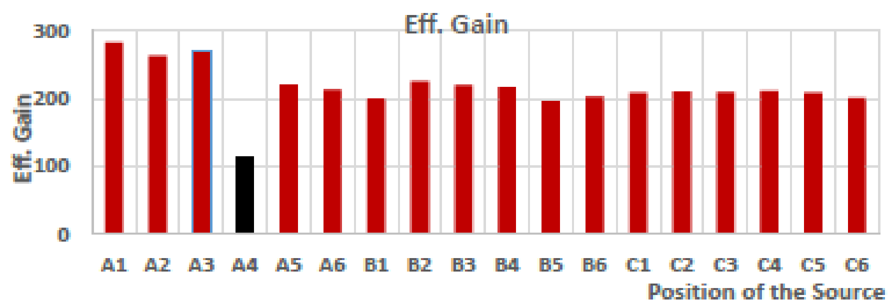
ILLUMINATING WITH ^{55}Fe

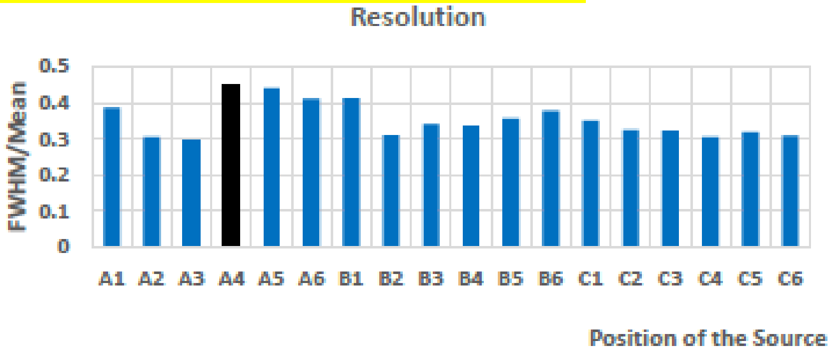
Uniformity scan performed after A6 was illuminated for 5 hours





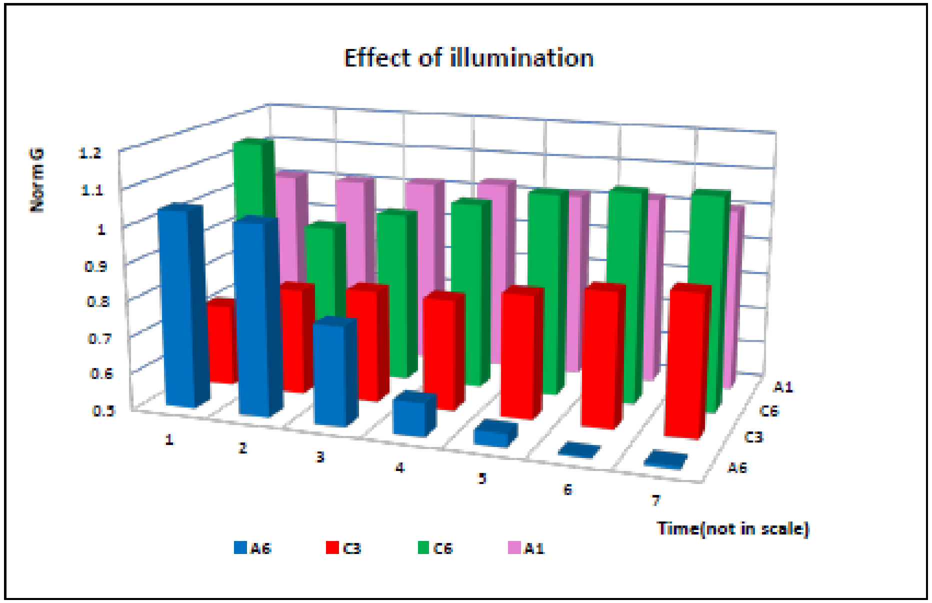
Uniformity scan performed after A4 was illuminated for 67 hours





RECOVERY TIME

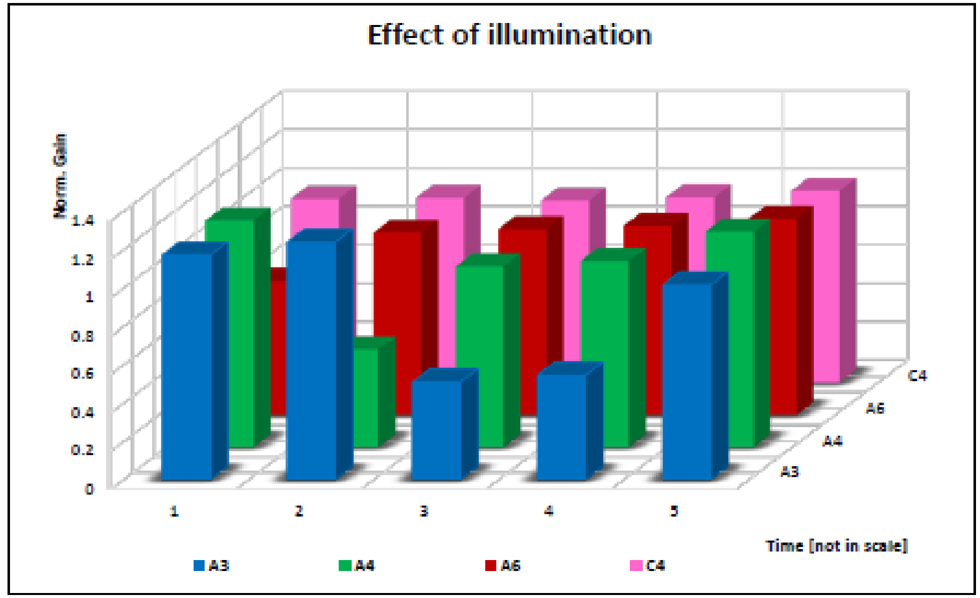
ARLON



26-Jun 21-July 24-July 01-Aug 09-Aug 06-Sept 08-Sept

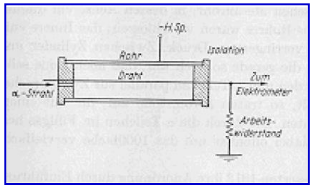
70 DAYS

FR4



08-Sept 11-Sept 13-Sept 15-Sept 18-Sept

10 DAYS

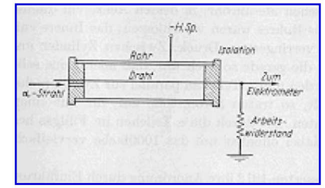


CONCLUDING ABOT ARLON

- The gain and the energy resolution are the same
- The charging up is faster in FR4
- The recovery from the illumination effect is much slower in ARLON

→

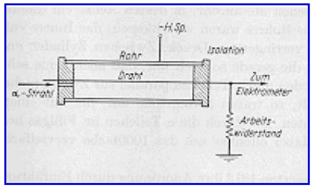
The ARLON material is <u>not</u> suitable for THGEM application



3rd year activity

- More exotic material as THGEM substrate

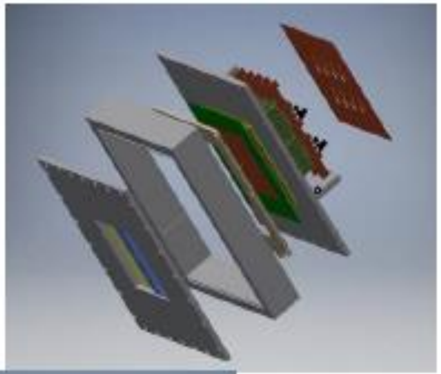
- Realization of an optimized small-size prototype

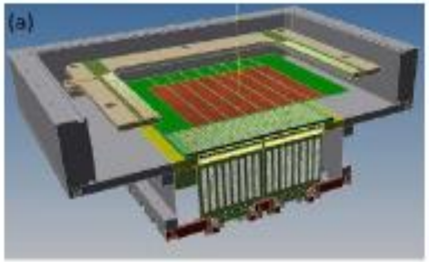


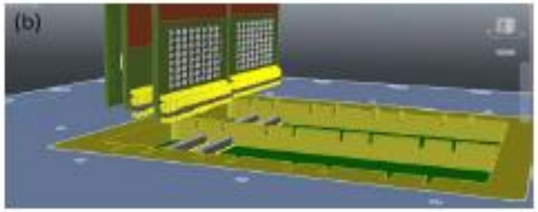
SMALL-SIZE PROTOTYPE, CONSTRUCTION

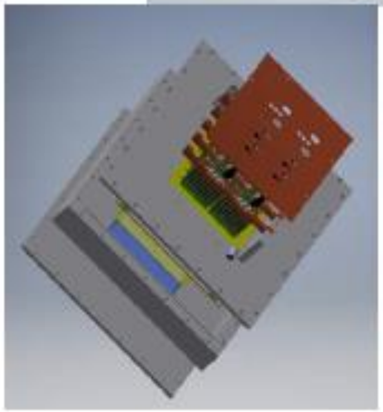
Project and construction of resistive MM by discrete elements with miniaturized pad-size

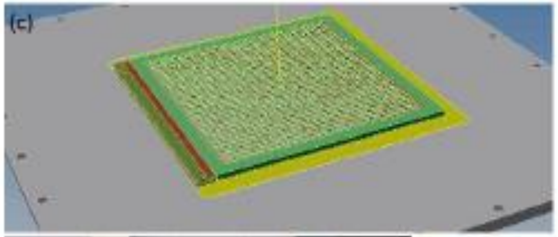
- pad-size: 8 x 8 mm^2 → 3 x 3 mm^2 (3.5 mm pitch)
- prototype active area: 10 x 10 cm^2
- easy expandability of the active surface: all the detector services (read-out FE cards, resistor boards) included in the active surface, modular design based on groups of 128 pads (16 x 8), dictated by APV-25 chip readout → new connector coiche and interface card via connectors CLE-165-01-G-DV-A FTE-165-01-G-DH

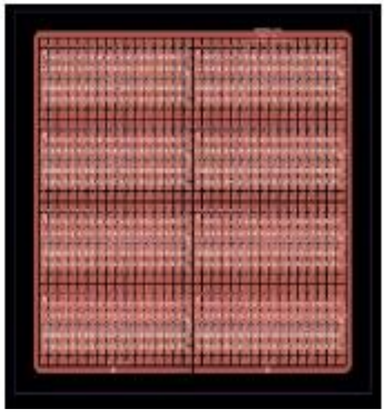


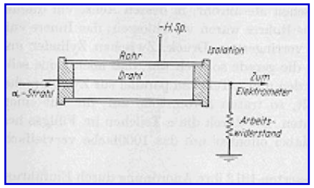








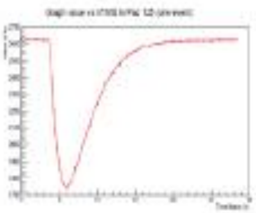


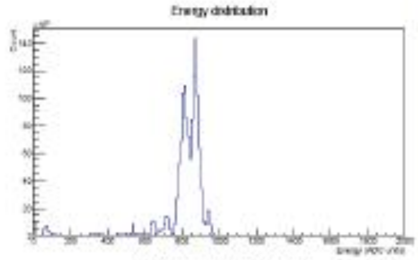


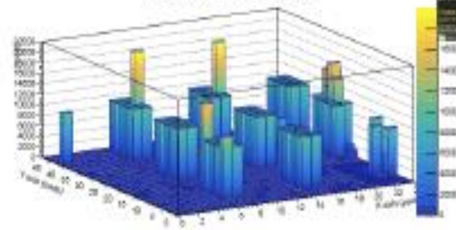
SMALL SIZE PROTOTYPE, READ-OUT

In parallel, prototype read-out:

- *Based the SRS (Scalable Read-out System) DATE+Amore, FE: APV25*
- *Development of the DAQ software and test with an existing prototype (2018 Test Beam)*







New Datadecoding library rewritten to overcome the limitation of the existing software, Date still used but raw data processing is new, speed up the analysis since zero suppression is not implemented (APV is fully analog, missing firmware at the FPGA level)

Future → Adopt the VMM chip developed for ATLAS MM, better coupling with C_{det} , larger dynamic range but mostly zero suppression implemented at the single channel level -> large reduction of data flow and data processing time, DAQ: Fully compatible with the SRS