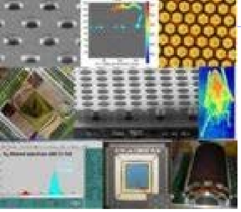


MPGD_NEXT, task 4

TASK 4

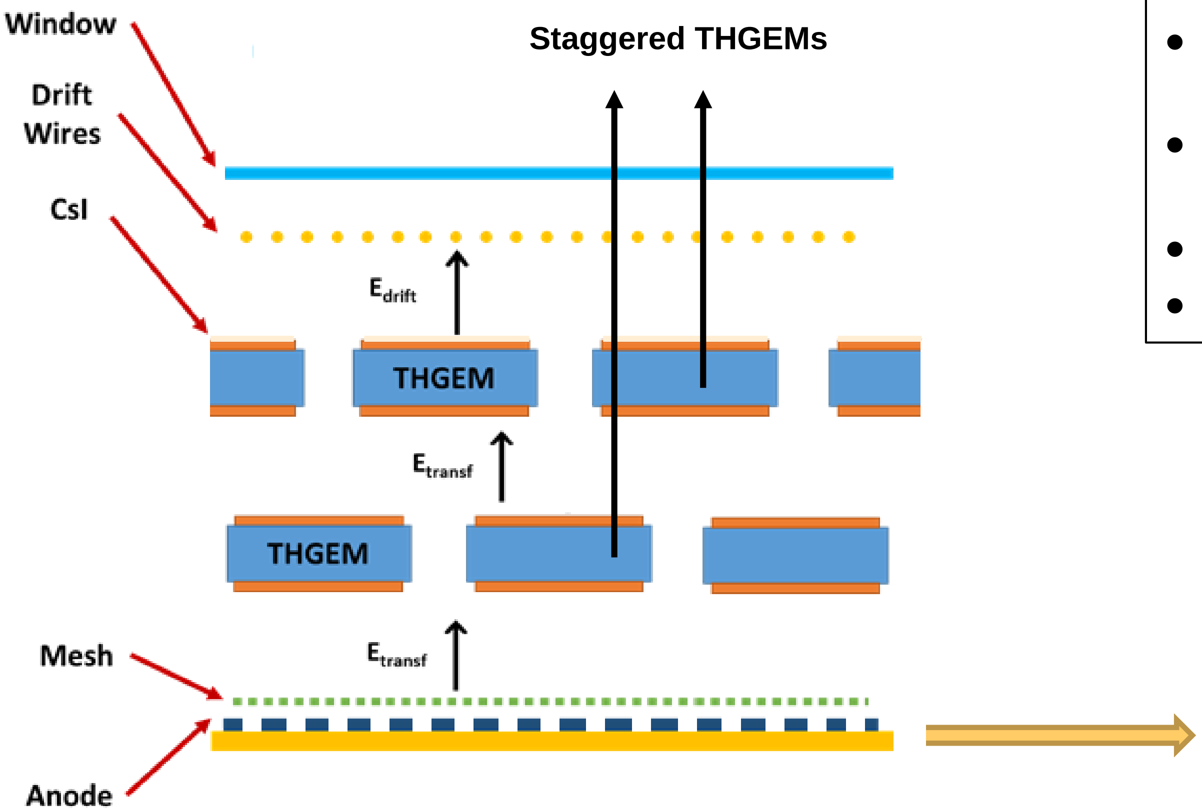
High-gain hybrid MPGD

TASK COORDINATOR: F.Tessarotto

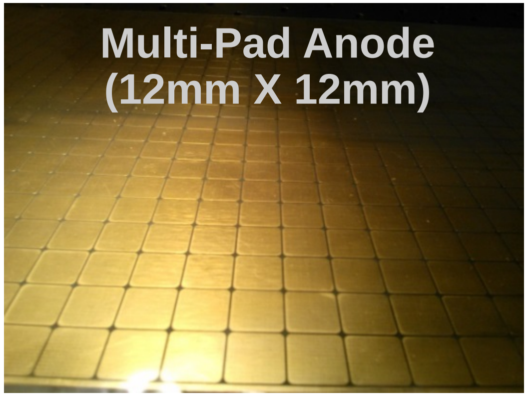
PARTICIPANTS: INFN - Trieste

OUR APPROACH TO HIGH GAIN

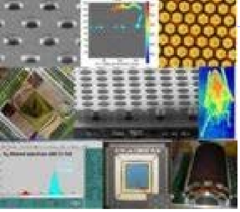
Hybrid Detector (2 x THGEMs + Micromesh)



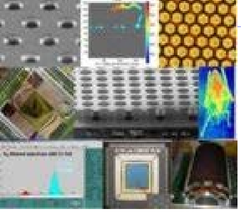
- Simple; robust; cheap;
- Signals → Electrons drift → $\sigma \approx 10\ ns$;
- Cascade → high gain, **present figure: $G \approx 10^5$ in beam**
- IBF $< 5\%$;
- Stability: time & high rates



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

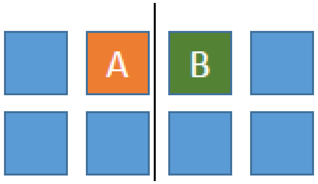


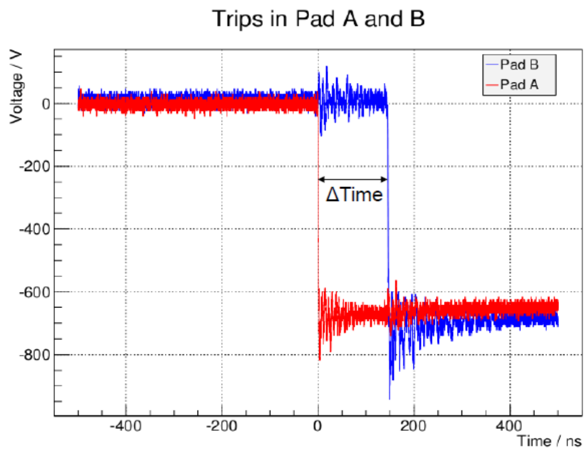
ABOUT DISCHARGES IN MICROMEGAS

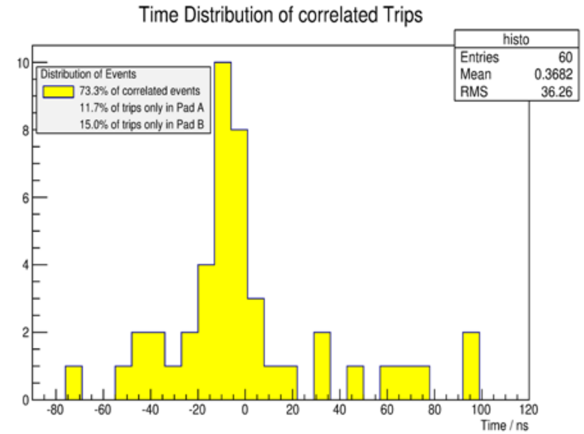


MM DISCHAGE STUDIES 1/3

- Two adjacent pads kept at anomalous high voltage (720 V) to enhance trip frequency (~ 0.1-0.2 Hz)

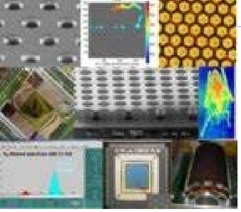






- One of the 2 pads at standard voltage : no trip observed

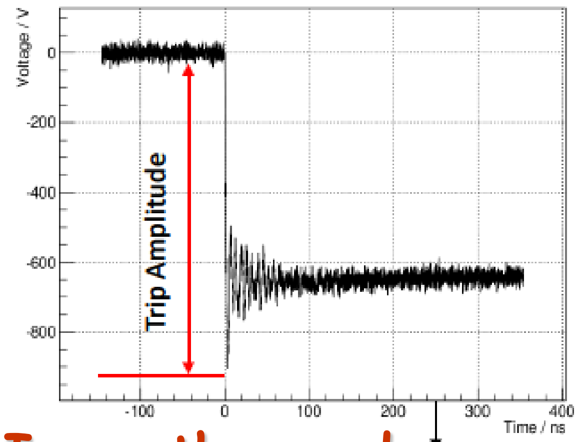
Coupled position	V(A)	V(B)	% correlated events	% only in A	% only in B
AB	720	720	73.3	11.7	15
AB	735	720	90	8.3	1.7
AB	720	735	70.5	1.6	27.9
AB	730	600	0	100	0
AB	600	730	0	0.0	100

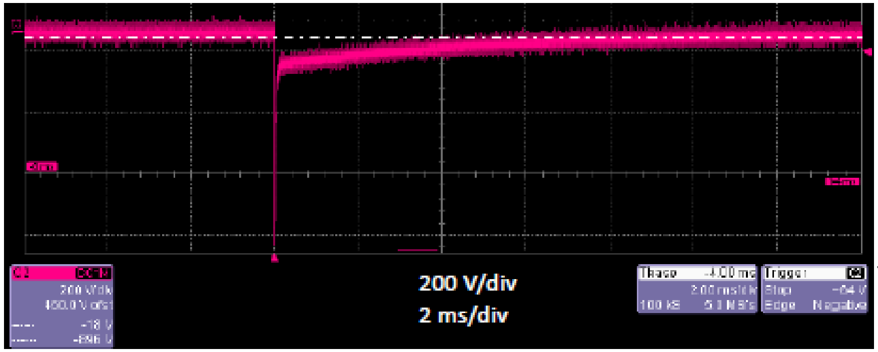


MM DISCHAGE STUDIES 2/3

Discharge in Pad A (720 V)

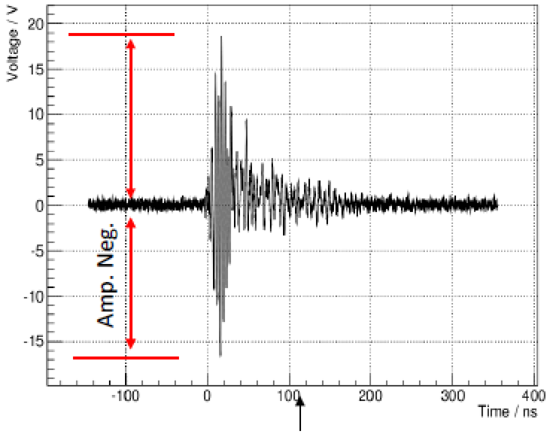
Voltage Drop in the tripping pad with R = 1M Ohm

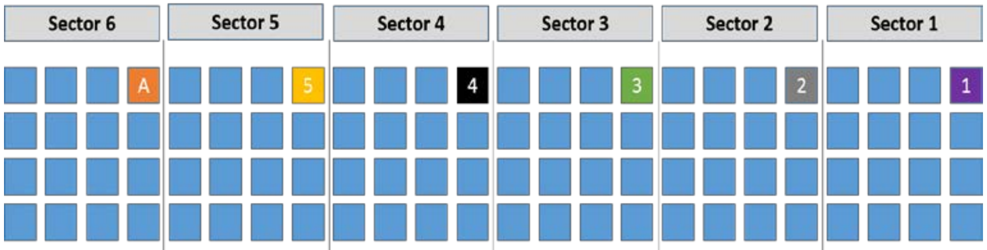




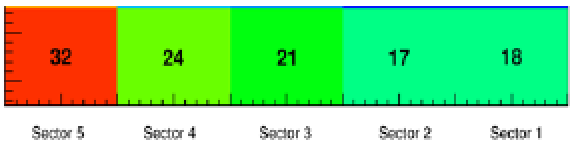
In another pad:

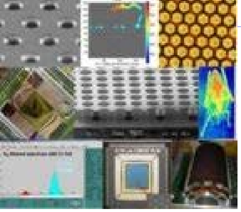
Induced Voltage drop in sector B1 with R = 1M Ohm





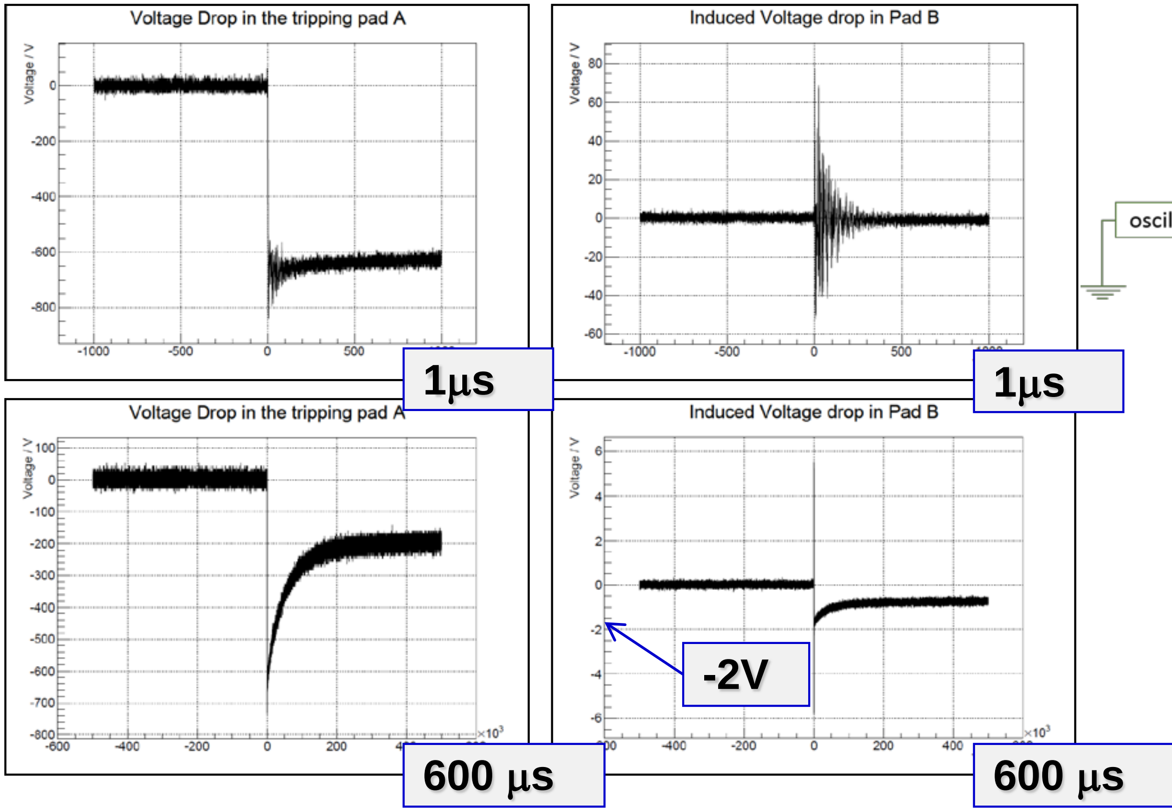
the amplitude decreases with the distance

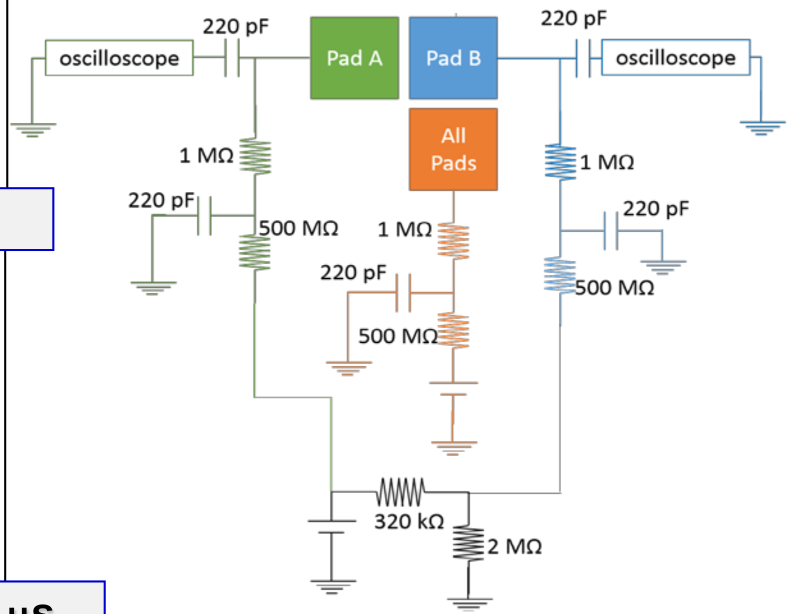




MM DISCHAGE STUDIES 3/3

Pads A & B (the two adjacent pads being studied) are powered <u>by the same PS</u>

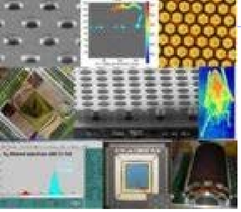




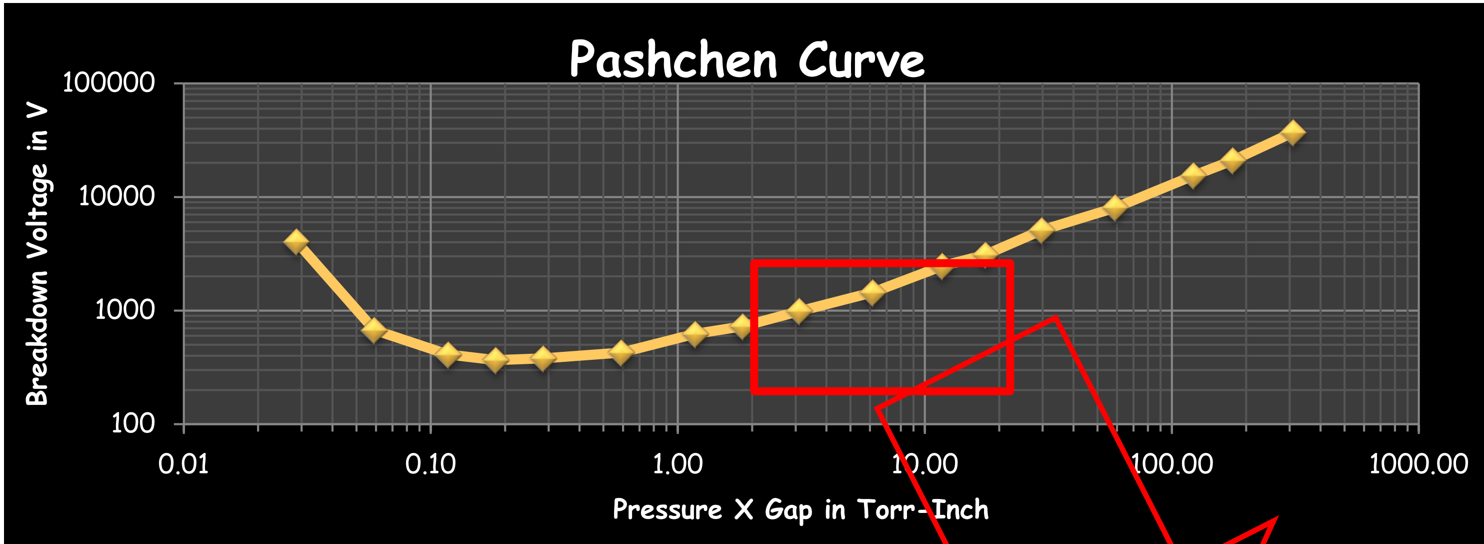
The HV of the non tripping pad is very limited affected:

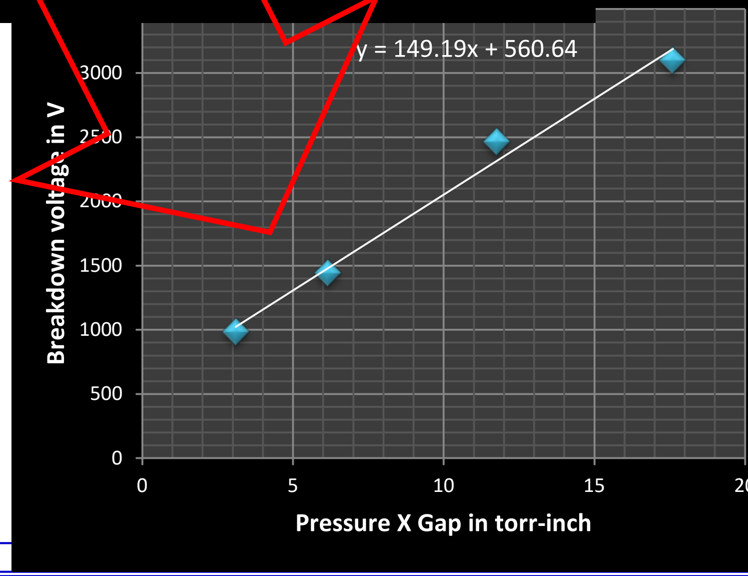
2V drop → ~4% drop in G

<u>R ~ 0.5 GΩ is preserving the non-tripping pads efficient all the time !</u>



ABOUT DISCHARGES IN THGEMs





For our case pressure ~ 970mbar = 727.56torr, gap ~ 0.4mm = 0.01575m. So Pressure X Gap = 11.45 torr-inch

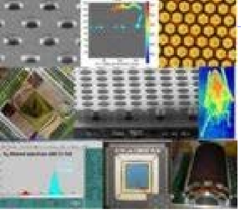
The breakdown V_{bd} depends on

- **P**
- **d (electrode distance)**
- **the specific gas**

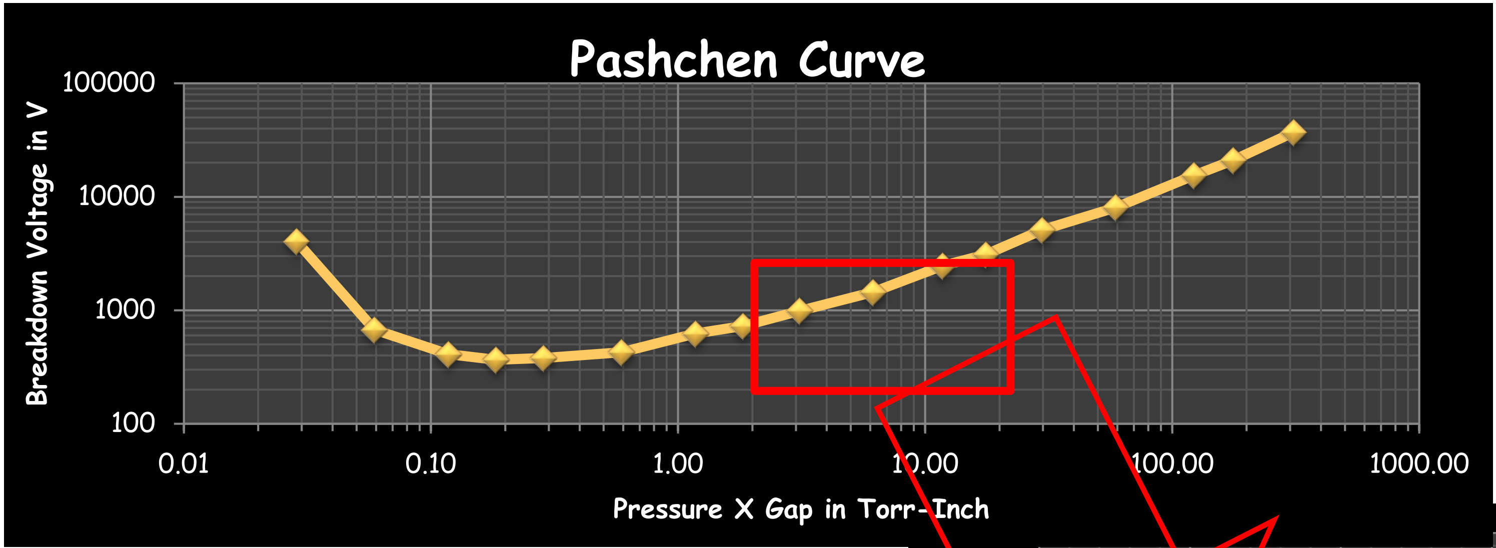
d = 0.4 mm → V_{bd} = 2270 V

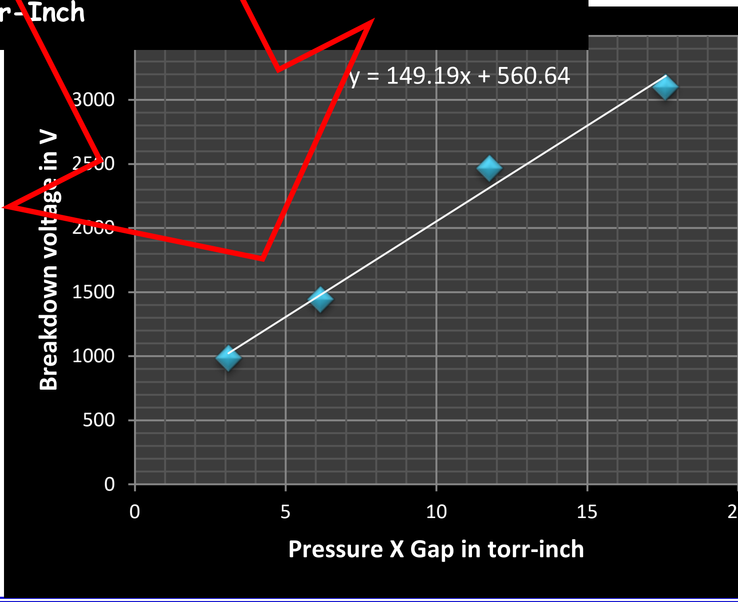
Δd = 20 μm → ΔV_{bd} = 100 V

ΔP = 20 mbar → ΔV_{bd} = 35 V



A conceptual tool:
THE PASCHEN CURVE (EMPIRICAL)





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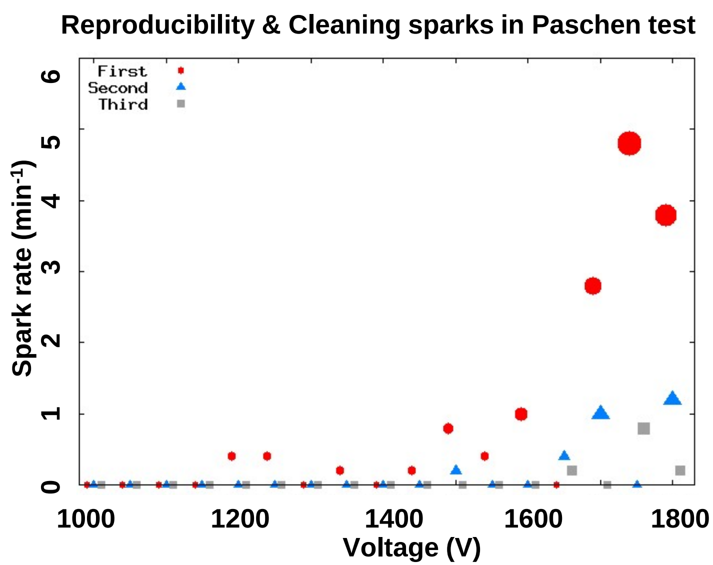
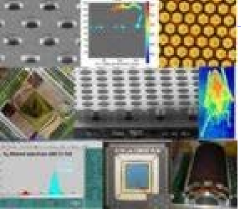
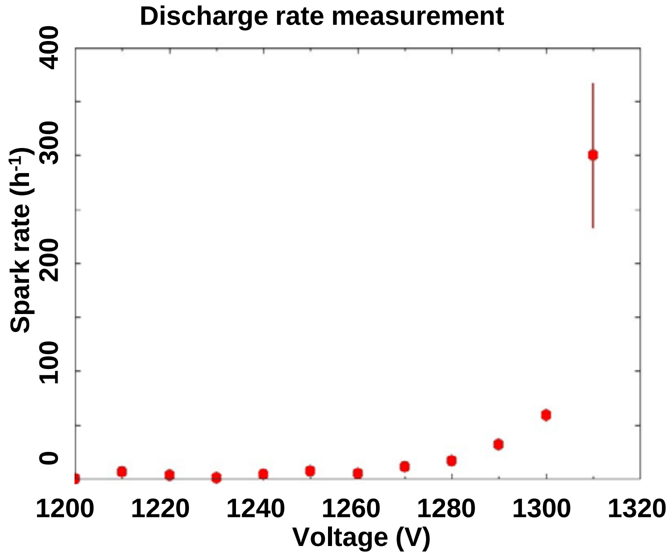
- **PASCHEN LIMIT**
- **Paschen measurements in N_2 (expected Paschen limit at ~2250V)**
  - The measured limit is set at the HV where discharge rates ≈ 1/min
  - 30 x 60 cm² THGEMs:
  - thickness 04. mm, pitch: 0.8 mm, hole diameter 0.4 mm
  - → 325 k holes !!!
  - Note the "cleaning" discharges (at first test)
  - Second and third test: reproducibility

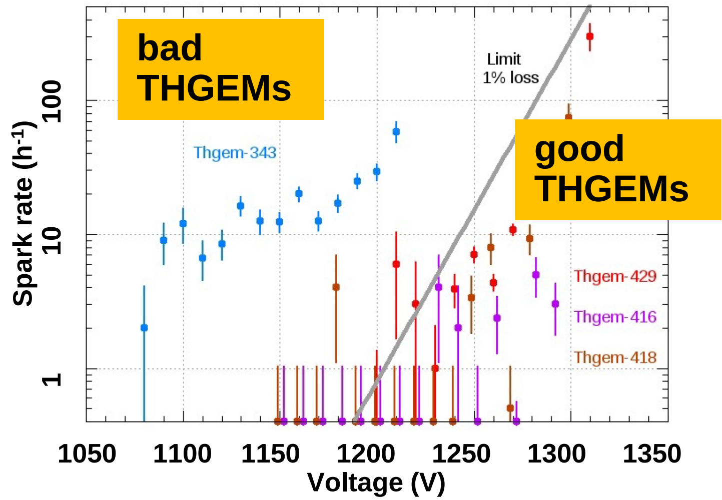




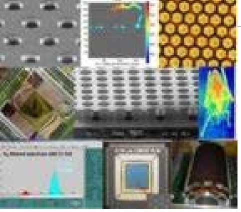
THGEM DISCHAGE STUDIES 2/3

- **DISCHARGE RATES in single layer THGEM**
  - Discharge rates measured in
    Ar : CO_2 = 70 : 30
- **Which operation voltage (i.e. which gain)?**
  - Gain (single layer) 20 → voltage 1125 V
- **Tolerable discharge voltage ?**
  - ARBITRARY fixed at 1% DEAD TIME for a total surface of 3 m²
  - Recovery time after a trip : 1 min
  - → 1 trip/d for a 30x 60 cm² THGEM
  - → Non directly measurable:
    EXTRAPOLATION down to 1125 V

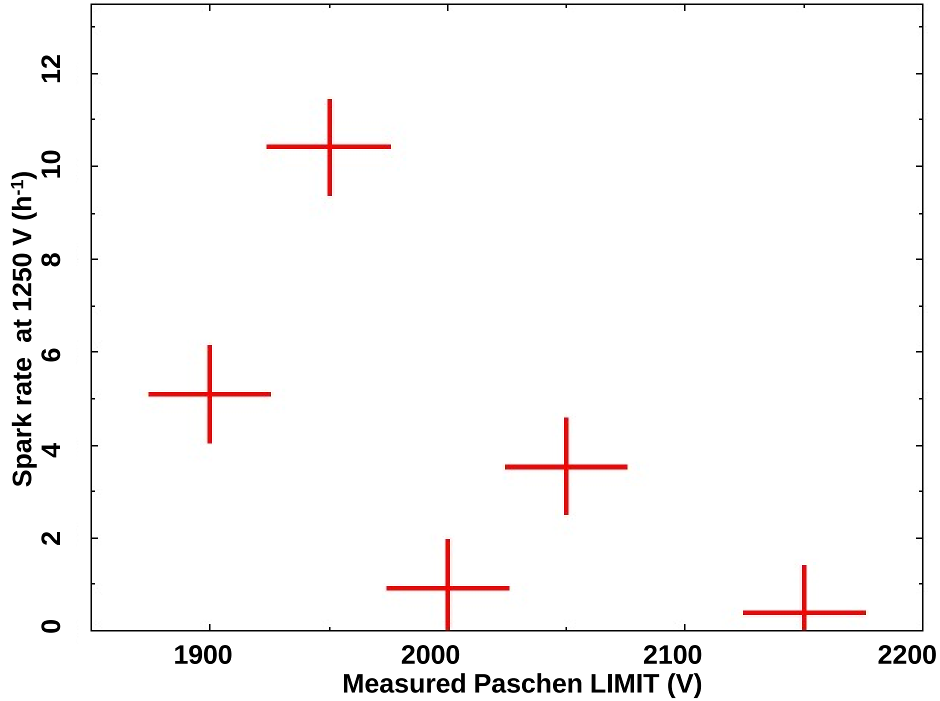




THGEM DISCHAGE STUDIES 3/3

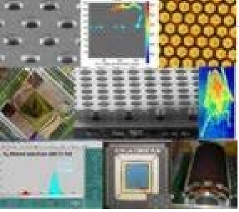


- Correlation of PASCHEN LIMIT vs SPARK RATES
  - Each point in the plot is a 30 x 60 cm^2 THGEM



→ The simple PASCHEN test is a valid tool for THGEM QC

→ Large surfaces with very low dead time rate can be instrumented

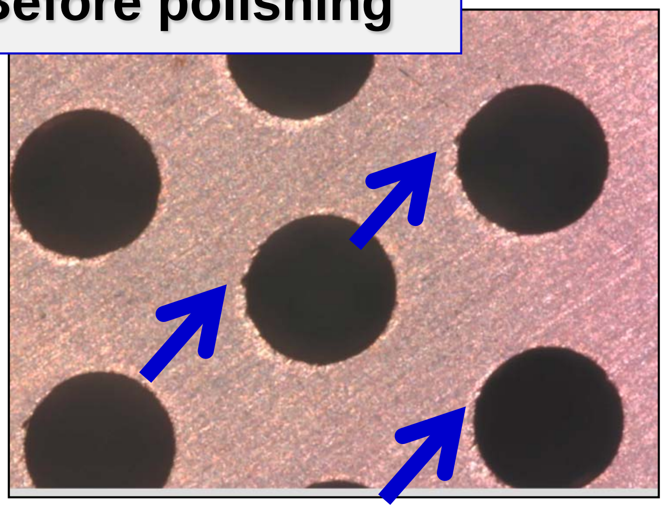


PASCHEN TEST and THGEM TECHNOLOGY

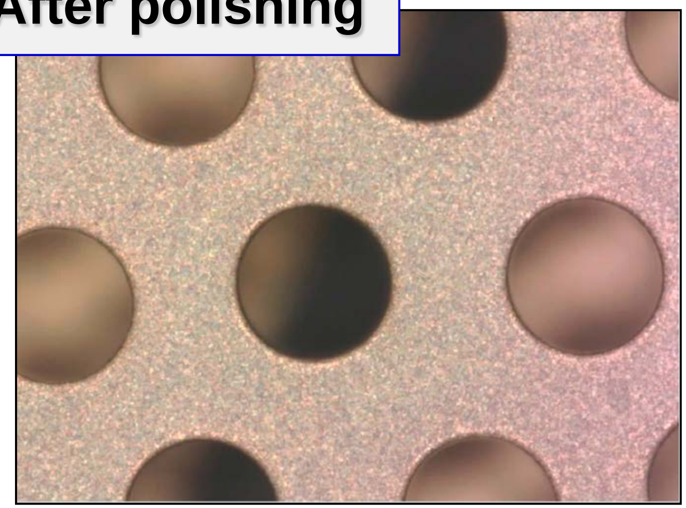
- The Paschen test is a fundamental tool also to progress in THGEM technology

- Polishing procedure introduced in Trieste to increase the quality of the industrially produced THGEMs

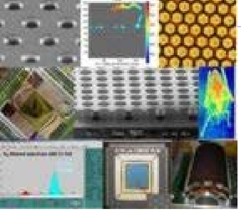
Before polishing



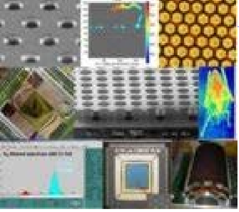
After polishing



PASCHEN LIMIT: 1390 V 2180 V



THGEMs by NOVEL MATERIALS

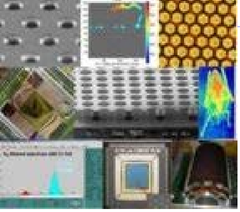


THGEM by NOVEL MATERIAL

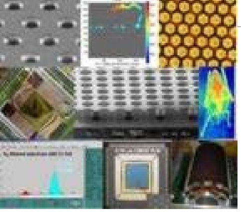
- **Material procurement so far:**
  - Permaglas (fiberglass w/o fibers)
  - Etchable glass → not converged, the Japanese producer is no longer interested to invest in this direction

Photo etchable glass process (PEG3 by HOYA Corp.)

- **Under evaluation:**
  - The procurement of THGEM by PTE



Qualification of THGEMs by PERMAGLAS



About PERMAGLAS

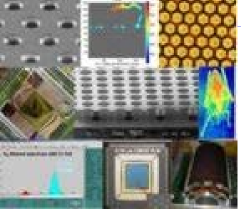
- Permaglas ME730 by RESARM Engineering Plastics SA
  - Epoxy glass fibre material, amorphous, machinable
  - The plate planarity is obtained by machining
    - Purchased by us:

Permaglas ME730 th=1.00 mm

Machined foils of Permaglas ME730. 500 mm x 500 mm, thickness = 1.00 mm tolerance on thickness: +- 0.04 mm

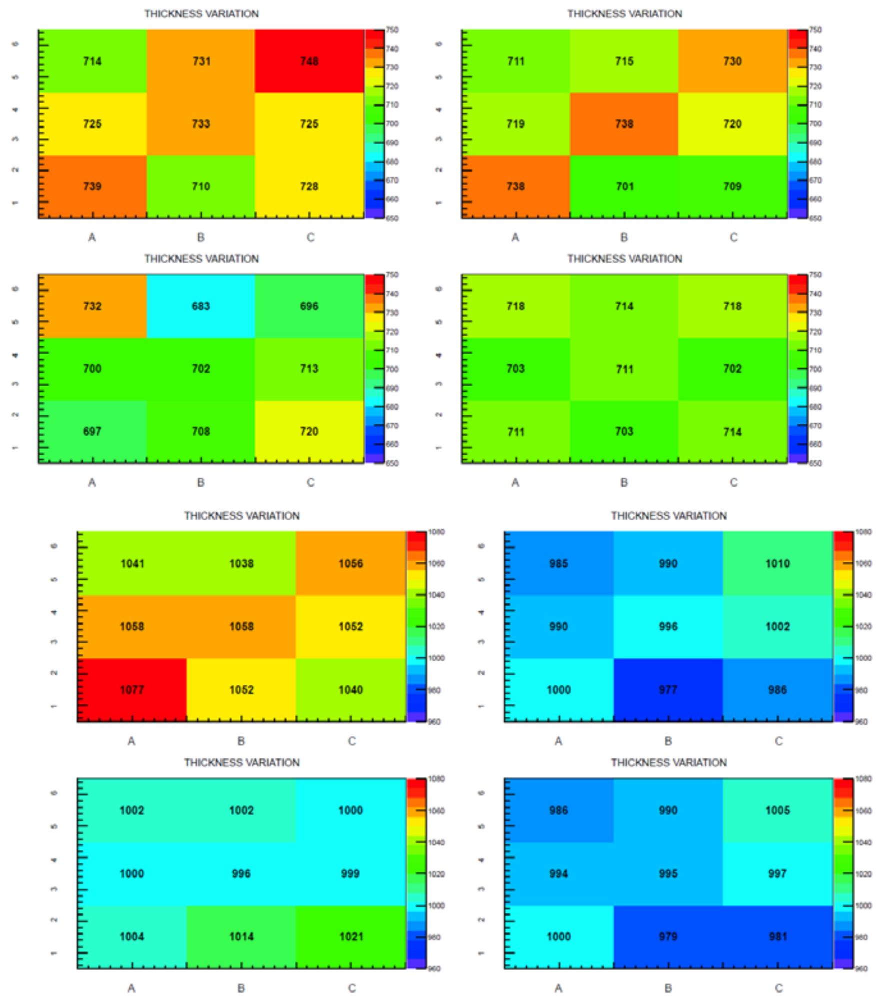
Permaglas ME730 th=.70 mm

Machined foils of Permaglas ME730. 500 mm x 500 mm, thickness = 0.70 mm tolerance on thickness: -0.00 +0.05 mm



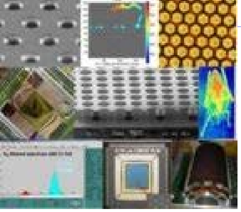
THICKNESS UNIFORMITY

- **Raw material characterization**



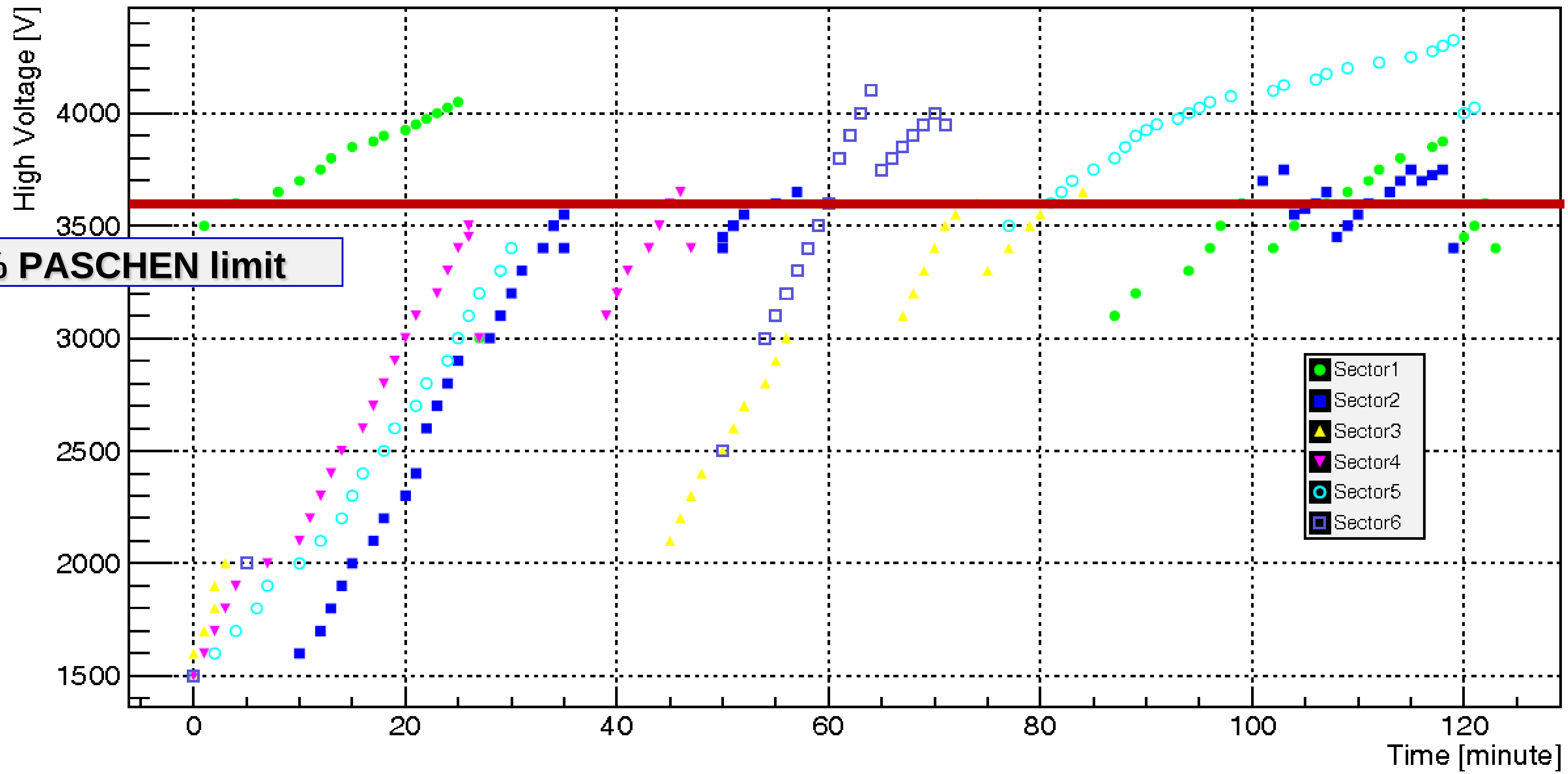
- **Nominal thickness 0.7 mm**
  - $|\Delta| < 4\%$; $\sigma < 2\%$
- **Nominal thickness 1 mm**
  - $|\Delta| < 2\%$; $\sigma < 1\%$

→ **Very good thickness uniformity!**



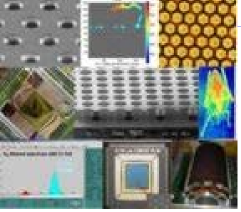
ELECTROSTATIC PROPERTIES

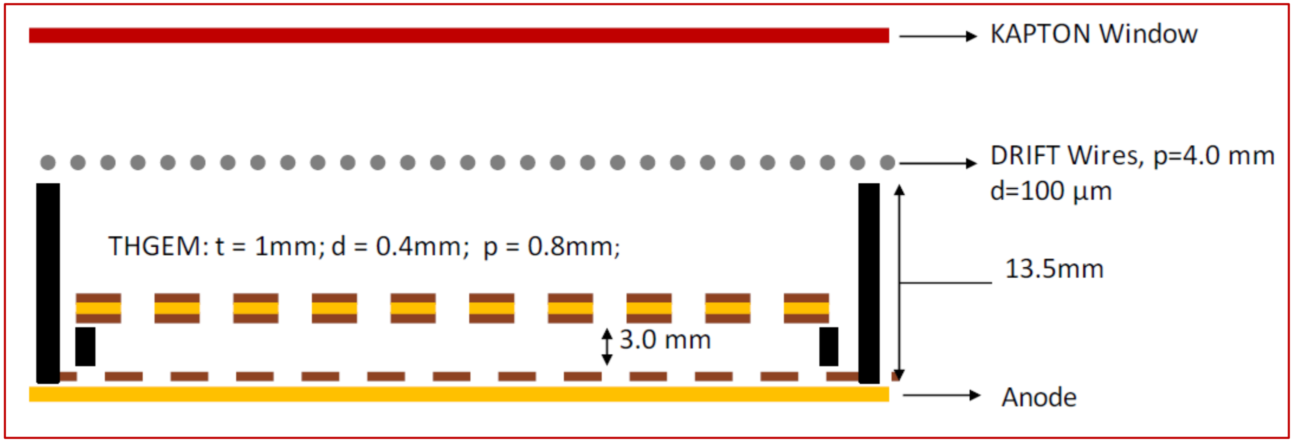
PASCHEN test



90% PASCHEN limit

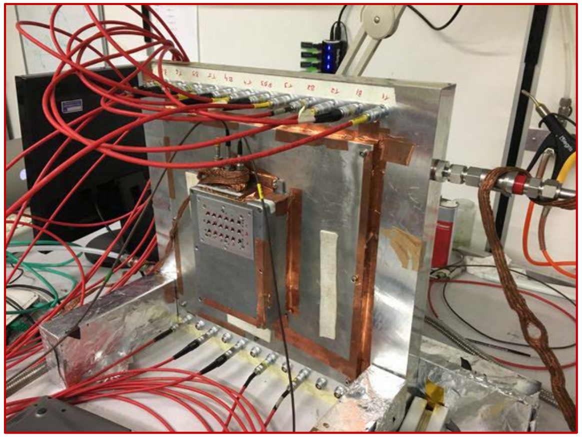
CHARACTERIZATION MEASUREMENTS

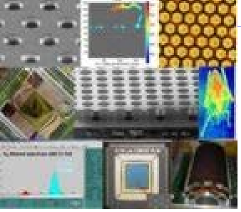




- Sources: ^{55}Fe

- Gas mixture: 70% Ar, 30% CO_2

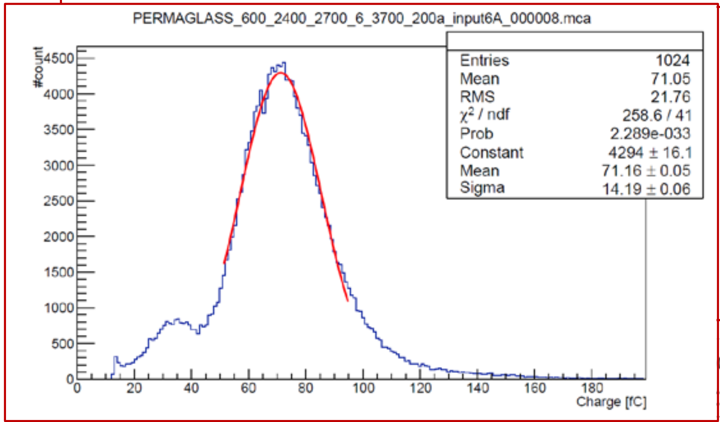




RESULTS

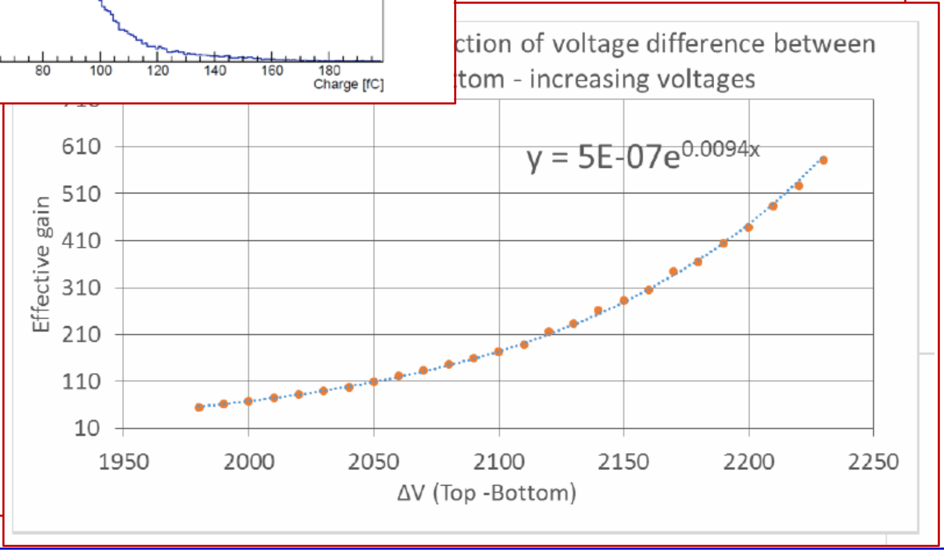
Effective gain	1	2	3	4	5	6
A	150	139	139	134	120	121
B	121	108	101	103	116	116
C	142	105	121	121	116	90

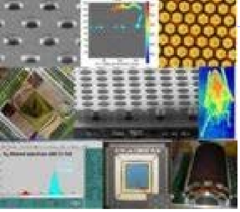
- **UNIFORMITY SCAN:**
  - **σ: 13%**



- **ENERGY RESOLUTION:**
  - **20 %**

- **GAIN PERFORMANCE:**
  - ***A robust device***





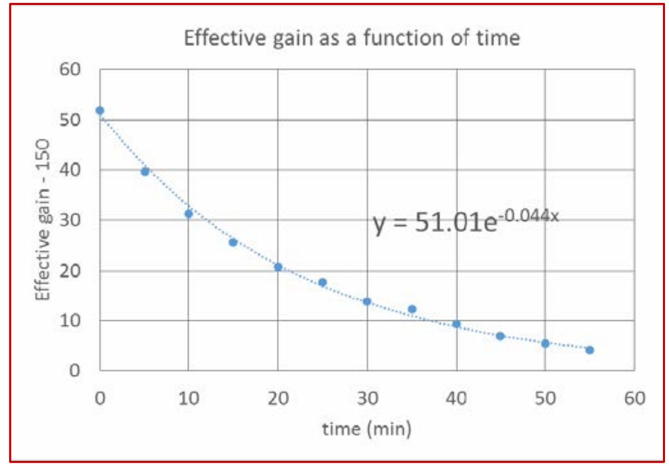
TIME DEPENDENT EFFECTS

CHARGING UP STUDIES

Time constant:

$$\tau = \frac{1}{0.044}\,\text{min} = 22.7\ \text{min}$$

Asymptotic effective gain = 150

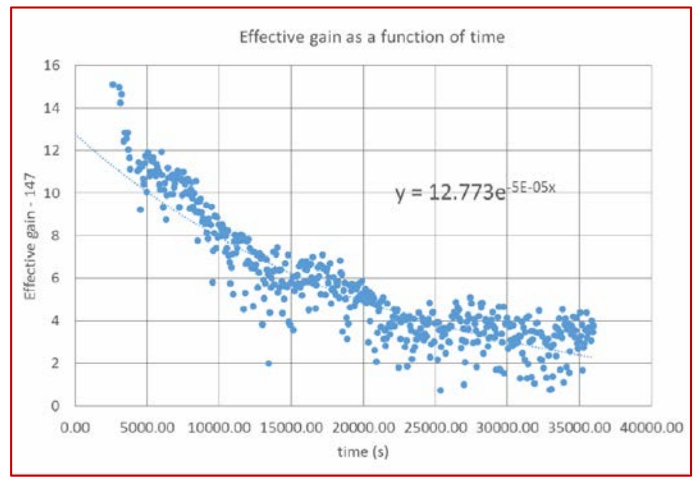


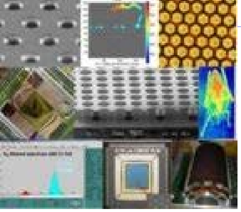
Effect of the ion motion in the material

Time constant:

$$\tau = \frac{1}{0.00005}\,\text{s} = 333\ \text{min}$$

Asymptotic effective gain = 147





CONCLUSIONS about PERMAGLAS THGEM

- 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
- Interesting as a replacement for THGEM by etchable glass approaches: much cheaper !