RD_FA : WP - 4

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1 – formally he cannot be listed in *2018 (AIDA2020 postdoc)*

OUTLINE

- ***Reminding the context***
- ***Activity: period 1/1/2017-30/6/2018***
- ***Activity planning: period 1/7/2018-31/12/2018***
- ***Complementary information***

GLOBAL CONTEXT

- **WP 4 : R&D for experiments at EIC**
  - **EIC-activities had not (yet) a dedicated house within INFN**
- **Building-up the INFN participation to EIC**
  - **Networking activity with alternated actions bottom-up and top-down**

→ ***INFN management indicates that an EIC-dedicated activity can be started in 2019 within CSN3***

→ **The activities of RD_FA WP4 ends at the end of 2018**

Building-up the INFN participation to EIC

- 3/12/2015 - EIC presentato in CSN1, Relazione R. De Vita
- 22/6/2016 - EIC presentato in CSN3, Relazione A. Bressan
- Ottobre 2016, ottobre 2017 – la partecipazione INFN al programma EIC è discussa nell'ambito del periodico bilaterale INFN-DOE
- 17/1/2017 – Giornata informativa a Genova, organizzata da M. Battaglieri, M. Contalbrigo, G. Urciuoli
  - Iniziativa bottom up con partecipazione del management (E. Nappi, N. Pastrone, M. Taiuti)
  - Ampia partecipazione di colleghi impegnati nella fisica a ALICE, COMPASS, JLAB12 e altri (ex HERA, per esempio), teorici
- 11/5/2017 – visita delegazione BNL in presidenza INFN: EIC piatto forte dell'agenda
- 19-22/7/2018 – EICUG a Trieste
  - anche un'opportunita' di incontro degli INFN
  - E. Nappi: INFN consider EIC an important opportunity for the hadronic physics community and encourage partnerships and collaborations with the other Institutions involved in the project
- 22/2/2018 – meeting della comunità per preparare la riunione del 1/3/2018
  - 25 partecipanti da 10 sedi
- 1/3/2018 – incontro management-comunità in vista della istituzionalizzazione dell'interesse espresso dalla comunità (per il management : E. Nappi, N. Pastrone, M. Taiuti)
- 18/4/2018 – rispondendo alla richiesta della comunità di formalizzare l'interesse, il management indica di considerare come afferenza la CSN 3
- 10/5/2018 – formazione di una collaborazione INFN per EIC

RICHes (and TPC) for EIC

The setup designs are still subject to important evolution, nevertheless

- About 2 crucial elements related to our direct interests
  - RICHes (high & low momenta) are necessary:
    - Our main focus
  - TPC is the central tracking element
    - Synergies with studies for RICH applications (IBF, miniaturized pads)
- All this matches our fields of expertise:
  - RICH detectors
  - MPGDs (the up-to-date approach to high-rate TPC read-out)

REMINDER

HIGH p RICHes

REMINDER

HIGH-p: PID in the range 6 < p < 60 GeV/c

- **Radiator: gas is mandatory**
- **Collider implementation: short (~ 1 m) radiator length**
  - → **Increased space resolution** ← **Activity performed within RD_FA WP4**
  - → **operate windowless (in CF_4 atmosphere)**
  - **Two possible ways, both requiring deeper exploration**
    - **High pressure, studied for ALICE upgrade VHMPID**
    - **Towards the very far UV with window-less approach (prototype tested at Fermilab)**
    - **In both approaches gaseous photon detectors have been used**

At the basis of our R&D activity for EIC

SYNERGIES

CSN 1

- The starting point is the development for COMPASS RICH upgrade
  - Construction completed, preliminary characterization
- Cultural synergies with the RD51 networking activities

CSN 5

- MPGD_NEXT, in particular task 4 – High-gain hybrid MPGD
  - jobs: development of THGEM technologies towards large gains

Non-INFN founds

- AIDA2020, WP13 – Innovative gas detectors, task 13.2.5
  - Overlap with MPGD_NEXT, task 4
- EIC R&D (within the ED6 Consortium)
  - Overlap with RD_FA, WP4

REMINDER

OUTLINE

- ***Reminding the context***
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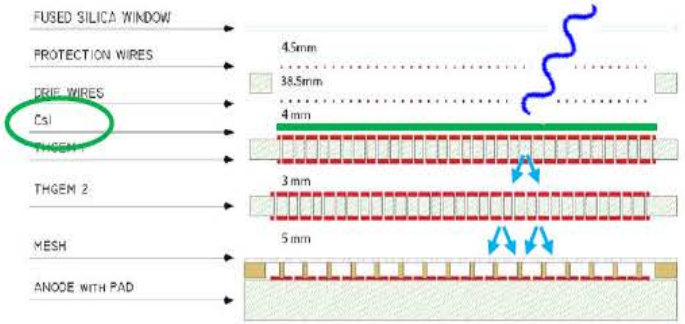
THE STARTING POINT: COMPASS RICH-1 UPGRADE

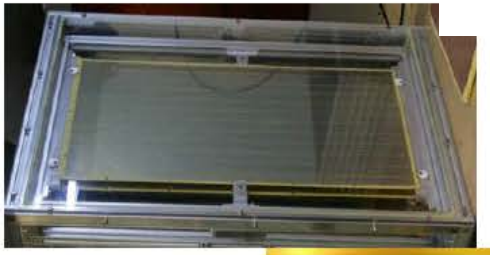


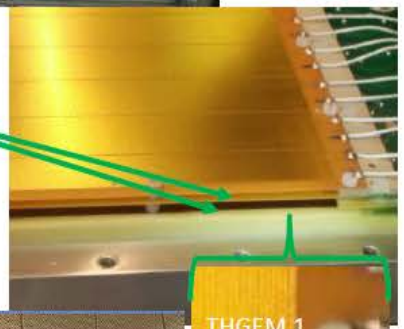
IBF reduction: approx. 3%
Charge splitting processes → Larger Gas Gain

Hybrid detector concept

To simplify the construction requirements a modular architecture has been adopted where one "*module*" consists of:

- One 300 mm x 600 mm Bulk Micromegas detector
- Two layers of THGEMs (300 mm x 600 mm) in *staggered* configuration

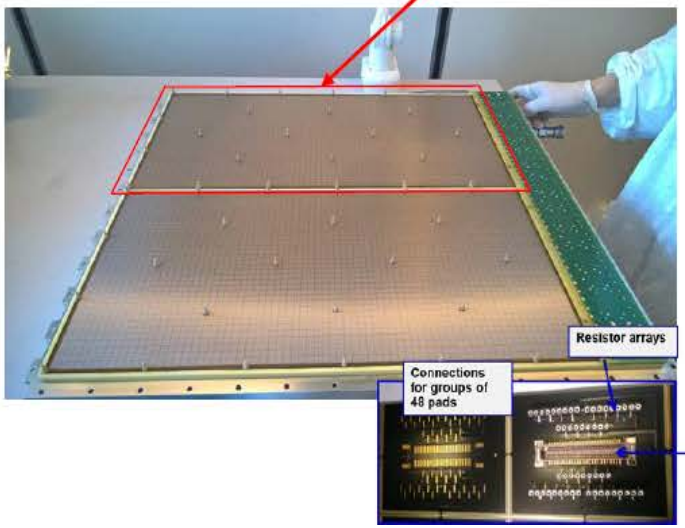


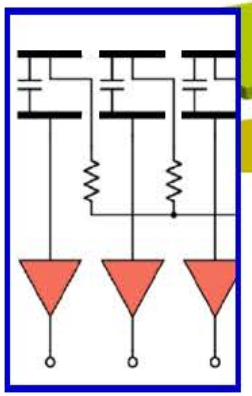


Operational gas mixture : Ar/CH_4 50/50

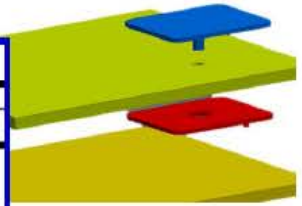
Two modules are put side by side to build a 600 mm x 600 mm detector

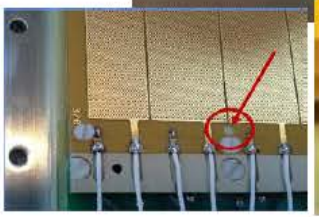
Signal read out via capacitive coupling pad readout and APV25 F/E boards





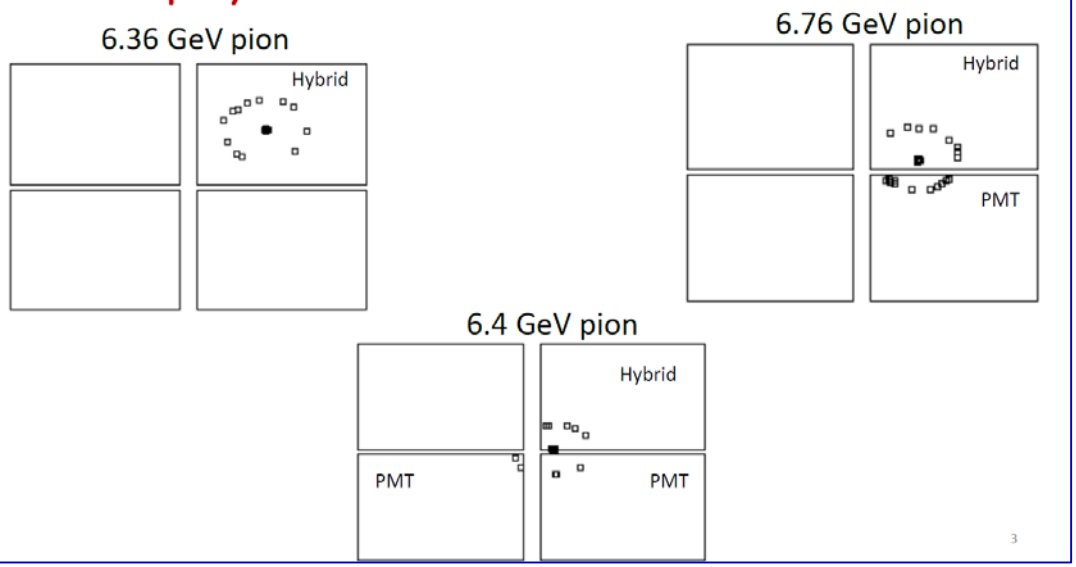
8mmx8mm pad size
0.5 mm pad spacing



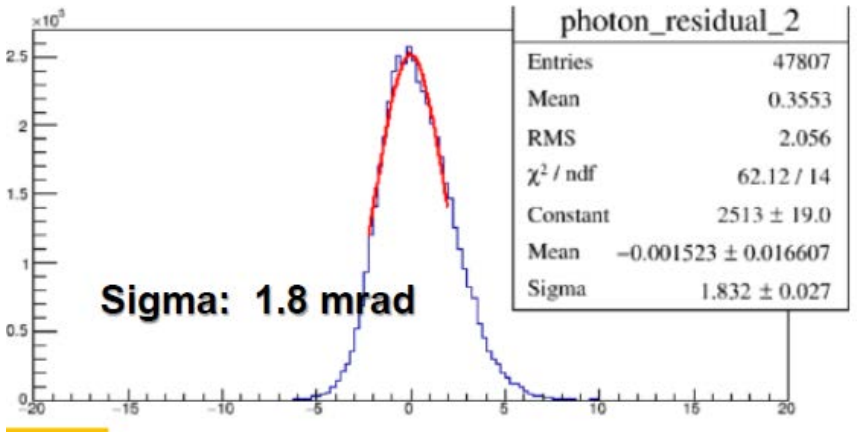


MPGD-based PSs: a performing approach

Event displays

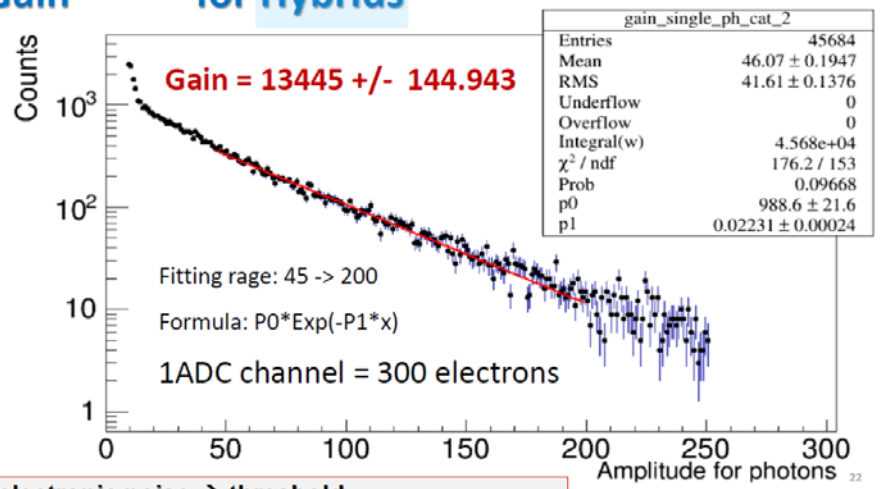


Photon residual distribution for Hybrids



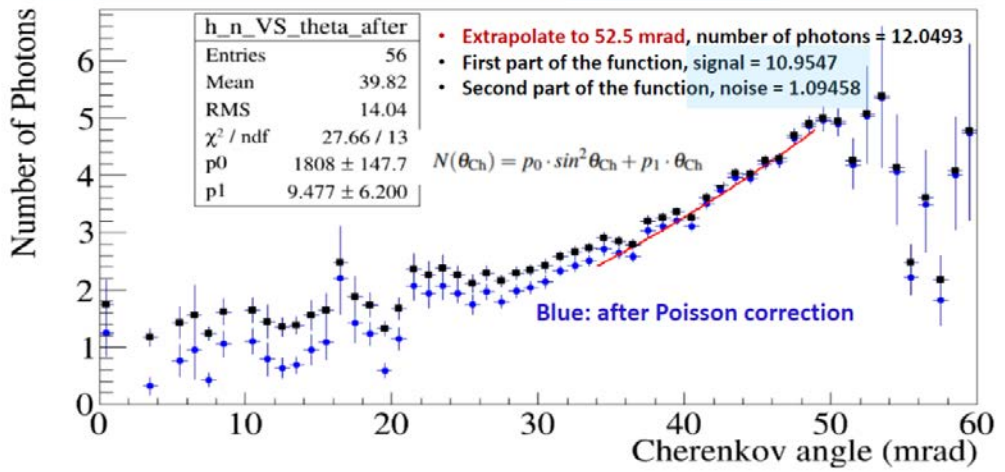
Gain for Hybrids

Run ID=281012, det.ID=2



From electronic noise → threshold
From threshold & gain → photoelectron detection (effective) efficiency > 80%

Number of photons study by using top half ring in Hybrid 2



PROTOTYPE with MINIATURIZED PAD_SIZE

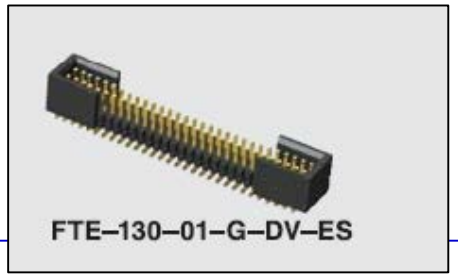
development of resistive MM by discrete elements with miniaturized pad-size

- 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:

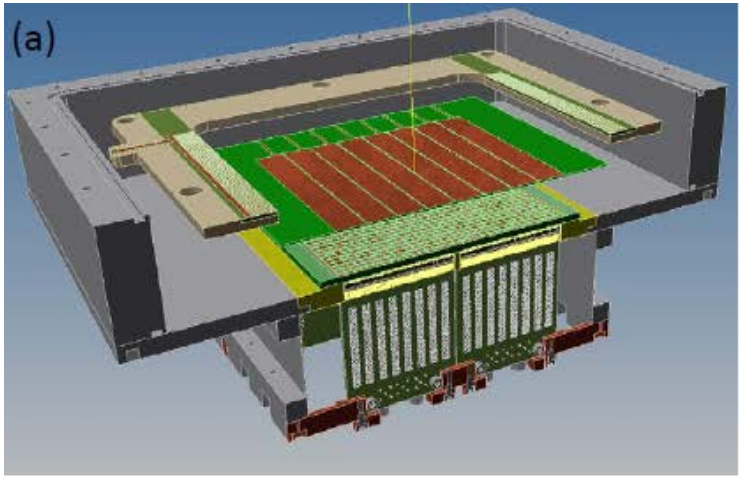
Major challenge

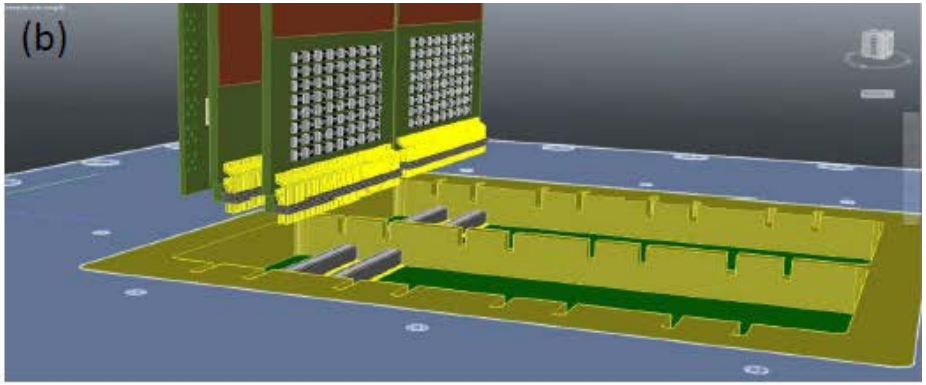
  - all the detector services (read-out FE cards, resistor boards) included in the active surface
  - Modular design based on groups of 128 pads (16 x 8), according to FE modularity

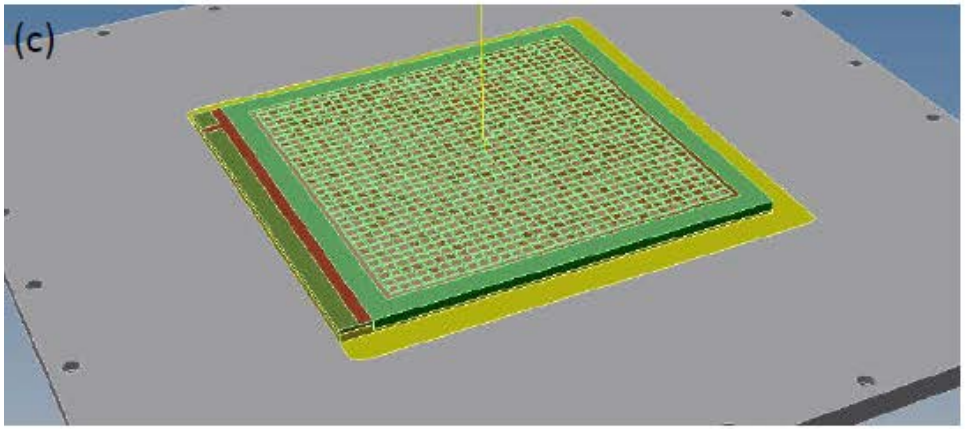
  - Connector selected: SAMTEC, FTE series

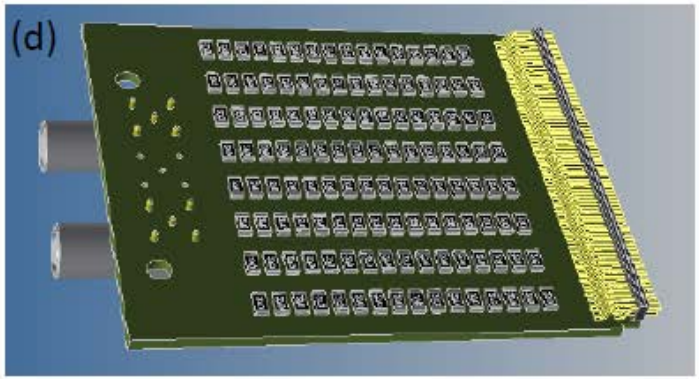


DETECTOR DESIGN

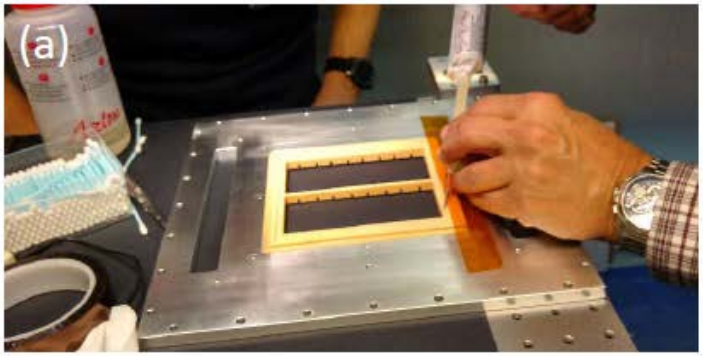


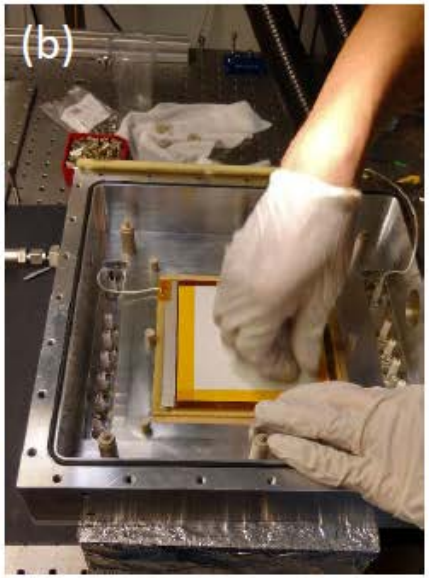


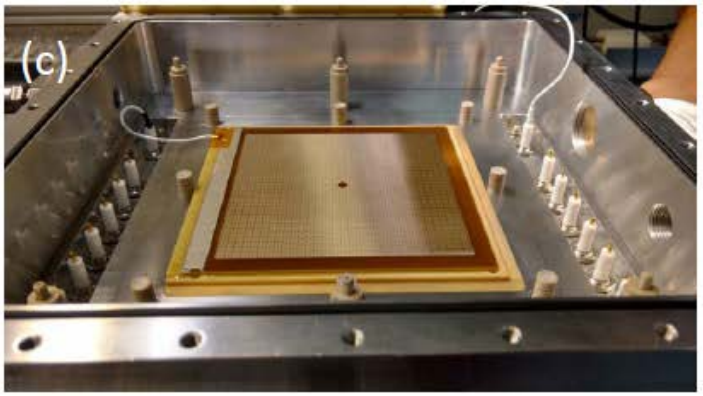


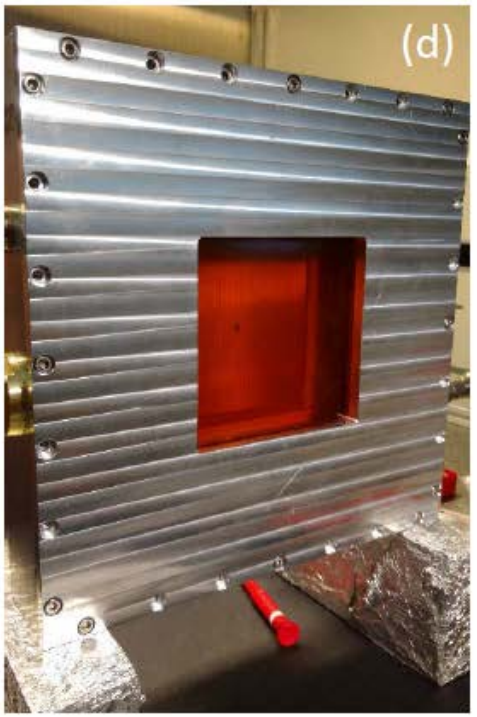


DETECTOR CONSTRUCTION

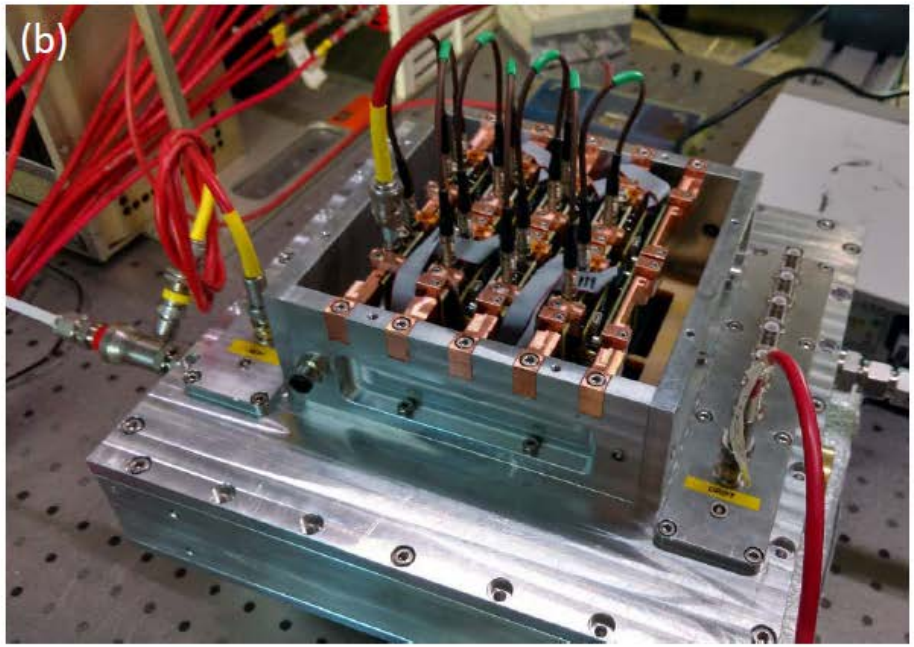






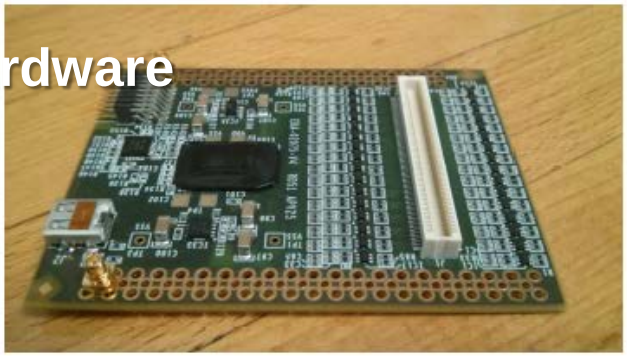


DETECTOR EQUIPPED

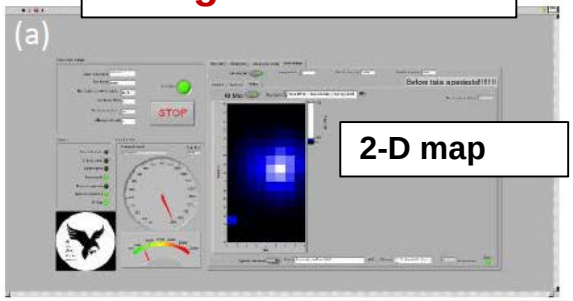


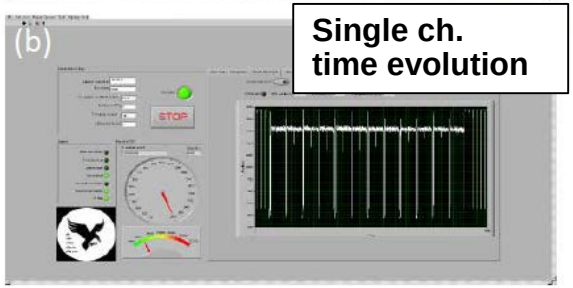
DETECTOR READ-OUT

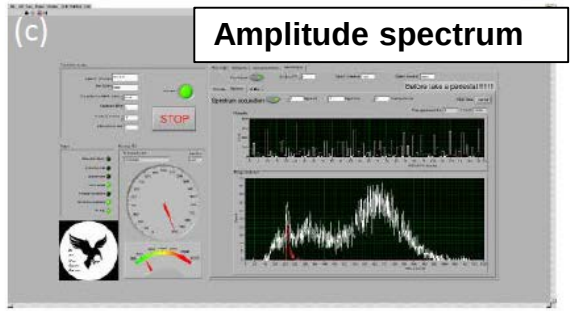
- *By the SRS (Scalable Read-out System), FE: APV25*
- *Development of an original DAQ system: RAVEN*
- *Stage and master thesis: M. Baruzzo*



Using RAVEN GUI





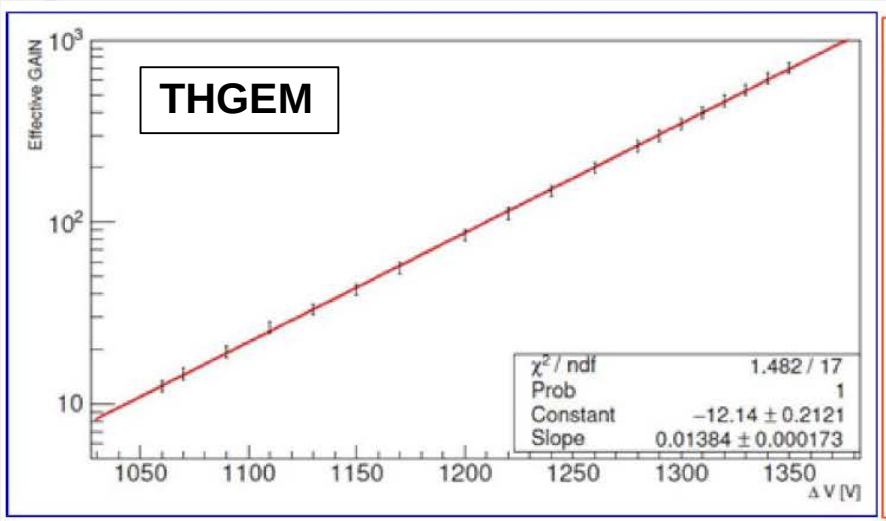


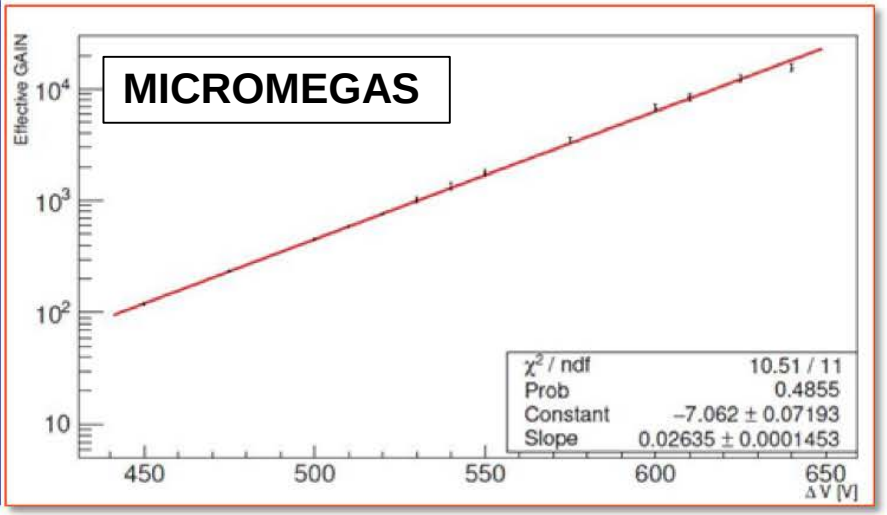
About RAVEN

- Dedicated to SRS
- Entirely LabView based
- APV25 chip setting and configuration performed via Raven
- Mapping
- Pedestal subtraction
- Zero suppression
- data collection and visualization
- extremely user friendly graphical interface
- bandwidth obtained is the maximum compatible with the SRS architecture:
  - Raven can transfer data up to the saturation rate of the Gigabit Ethernet when the UPD protocol with Jumbo Frame format is used, as in SRS

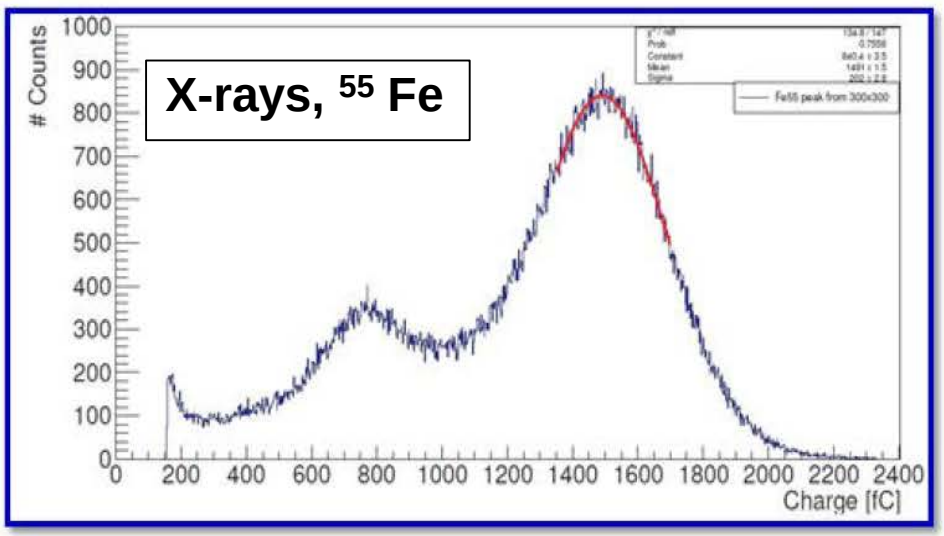
PROTOTYPE PERFORMANCE

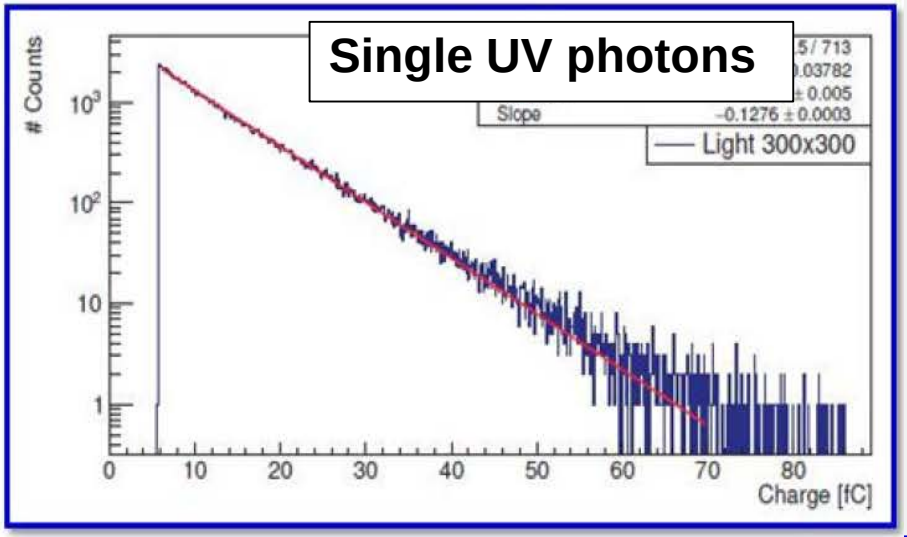
- **gain in the individual elements**





- **amplitude spectra, complete detector**

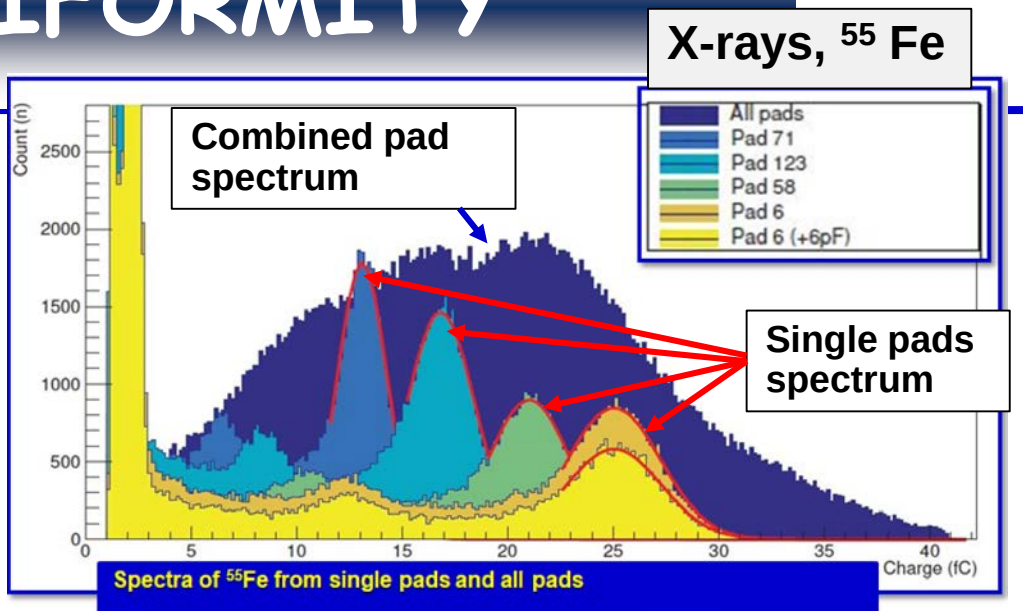


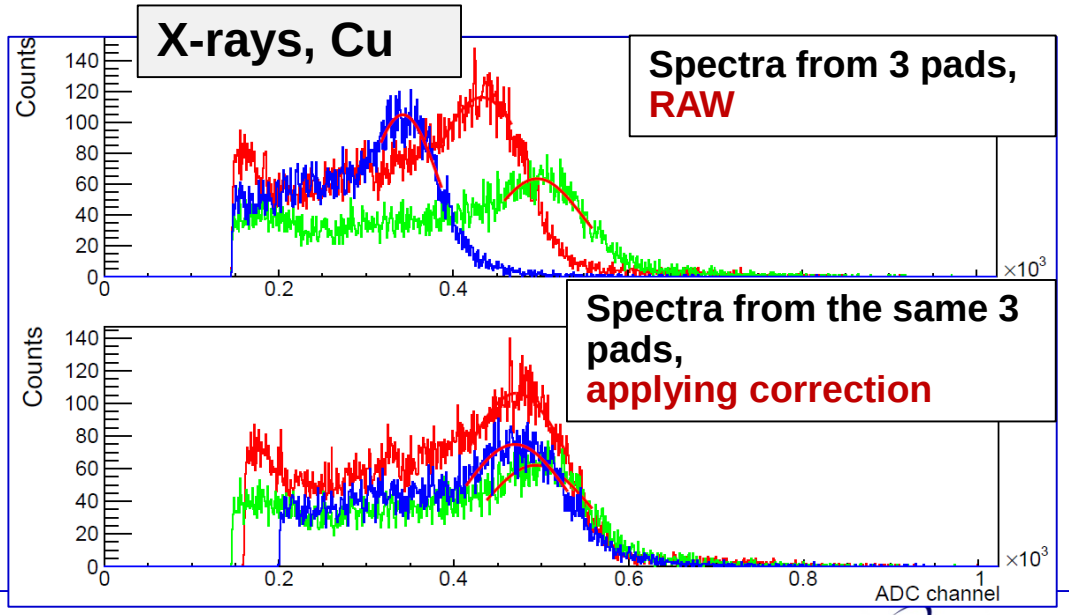


GAIN UNIFORMITY

- **Non satisfactory uniformity:**
  - **Up to a factor ~2 even between adjacent pads**
- **Different parasitic capacitance for the various ch.s in the anode PCB**
  - **Effect directly measured**
  - **It accounts for the non-uniformity**

→ Go for a new PCB design





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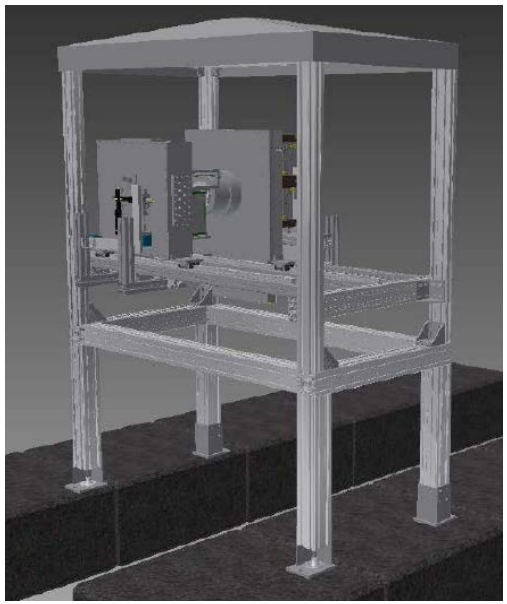
DETECTOR @ TEST BEAM in OCT2018

- Detector, ready
- Photocathode THGEMs coating with Ni+Au, then CsI in Summer
- HV, LV ready (already used in lab tests)
- R-O & DAQ ready (already reported)
- Setup almost complete (this slide)

- Supports
- Structure flammable gas compliant
- Scintillators for trigger
- Remote control for scintillator alignment (step motors)



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PROTOTYPE FUTURE

- **Version 2 to be realized in 2019:**

  novel design of the anode PCB in order to remove the channel-dependent parasitic capacitance already realized

  - **Specific support being requested in the context of EIC_NET**

- **Interfacing of the prototype with the novel VMM3 FE also in the pipe-line**

PROPOSAL REJECTED BY CSN 1

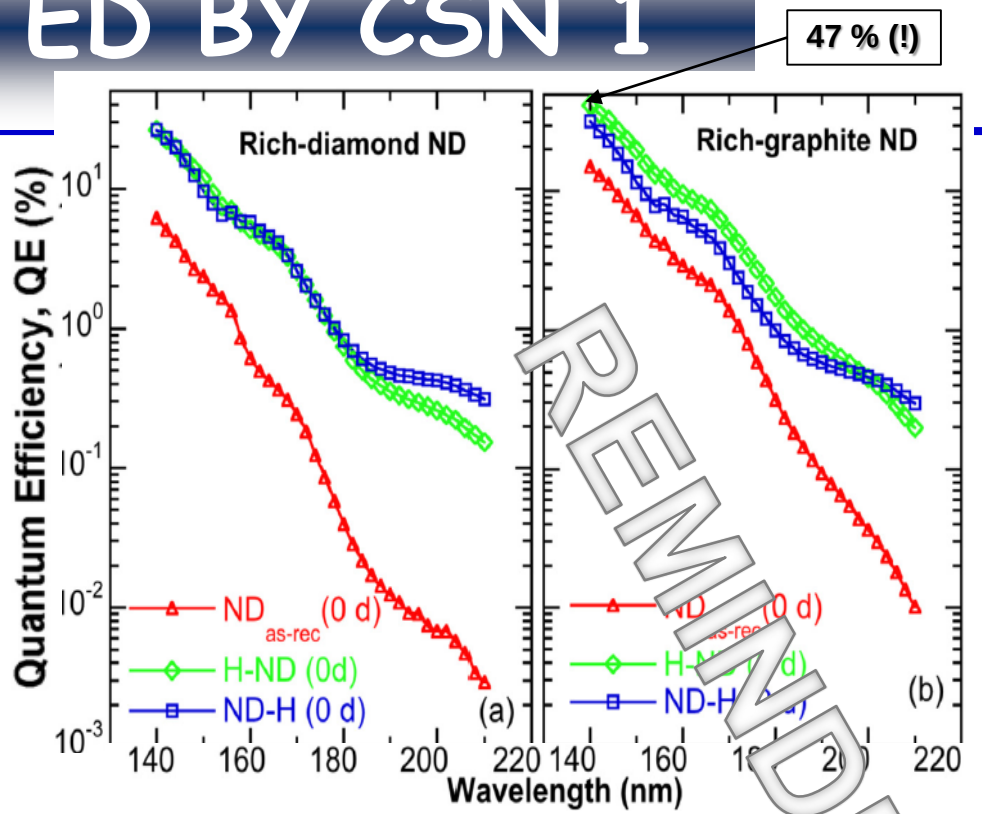
CsI, the only standard photoconverter compatible with gaseous atmospheres, has problematic issues, main ones:

- It does not tolerate exposure to air (water vapour, O_2)
- Ageing by ion bombardment

NEW !!!

Photocatodes: diamon film obtained with Spray Technique making use of *NC powder*

- *Spray technique: T ~ 120° (instead of ~800° as in standard techniques)*



L.Velardi, A.Valentini, G.Cicala, Diamond & Related Materials [illegible] 7) 1

For next year, we are planning a very basic set of studies:

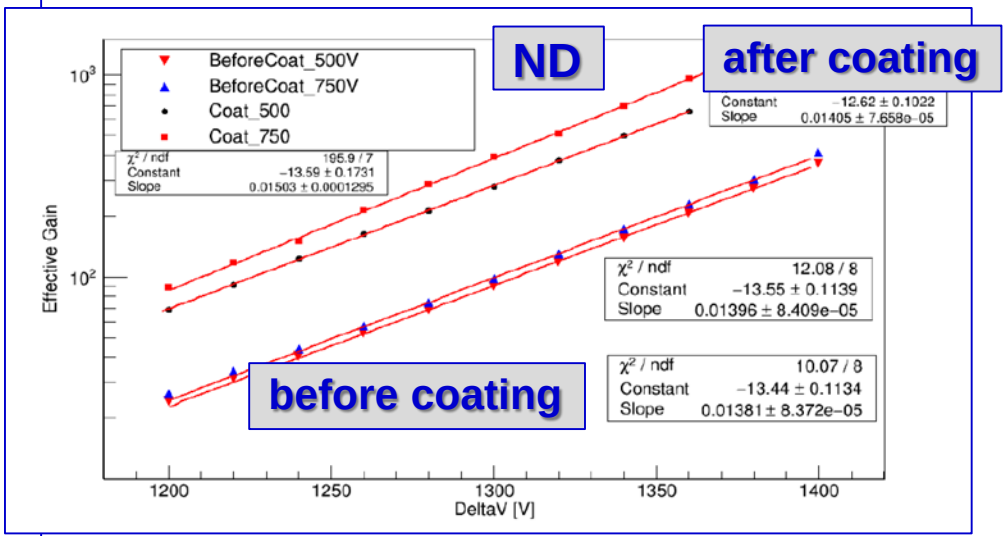
- to compare the QE of photocathode samples in vacuum and in different gaseous atmospheres;
- to realize a photon detector prototype with a photocathode using as substrate a THGEM and to characterize it;
- to perform a preliminary ageing study measuring the QE before and after collecting defined amount of charge at the photocathode itself.

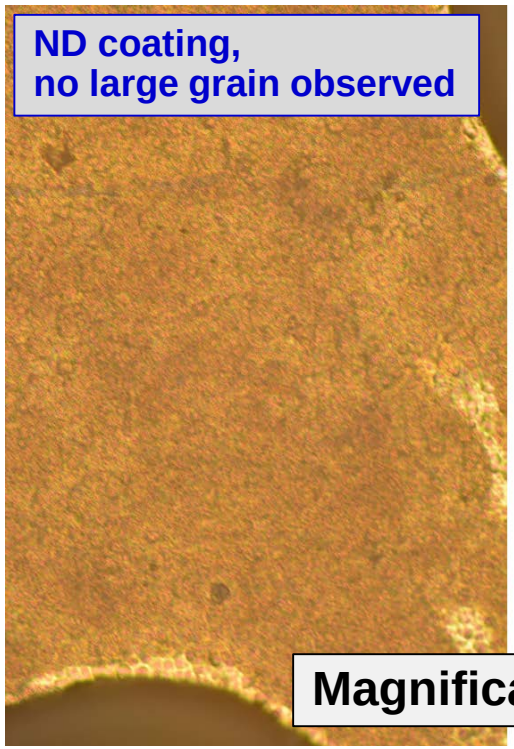
NEVERTHELESS …

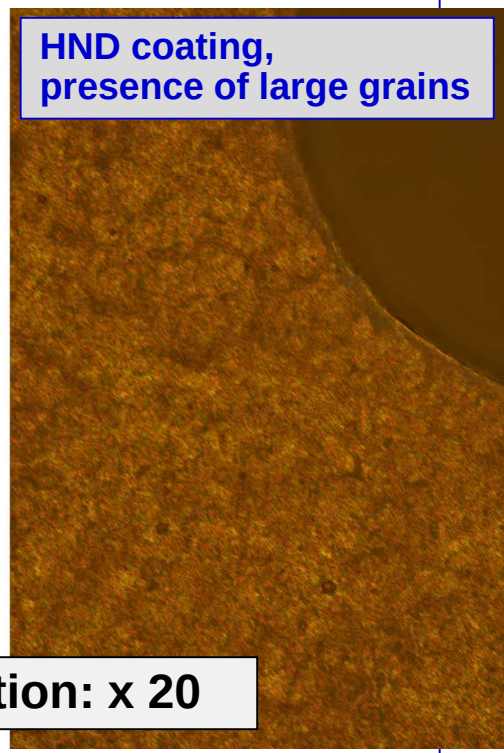
- 1 y of explorative studies within MPGD_NEXT (CSN5) proposed for 2019

- Some VERY PRELIMINARY exploratory activity performed

6 small-size THGEMs (30 x 30 mm^2) fully characterized before and after coating with ND powder & Hydrogenated ND (HND) powder:







Magnification: x 20

- ND : systematically higher gain
- HND : systematically do not stand the HV, morphology ?

→ Already indications for future explorative studies

IN CONCLUSION

The support received by WP4 within RD_FA

has been an important boost for our activities and

a precious bridge to move towards experiments at EIC