A NEW TRANSPARENT XY-MICROMEGAS NEUTRON BEAM PROFILER: FIRST BEAM PROFILES AT n_TOF

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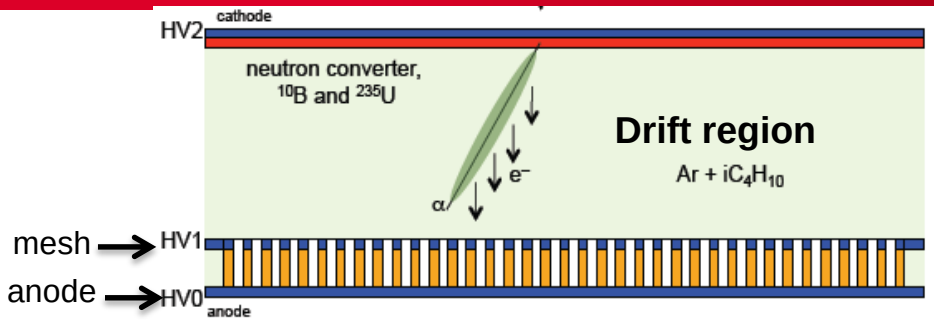
OUTLINE

- XYMGAS with segmented **mesh** + **anode** development.
- Application: quasi-online neutron beam profiler + flux monitor.
- First profiles at the n_TOF facility at CERN : Analysis and Results

SEGMENTED MESH MICROBULK DEVELOPMENT

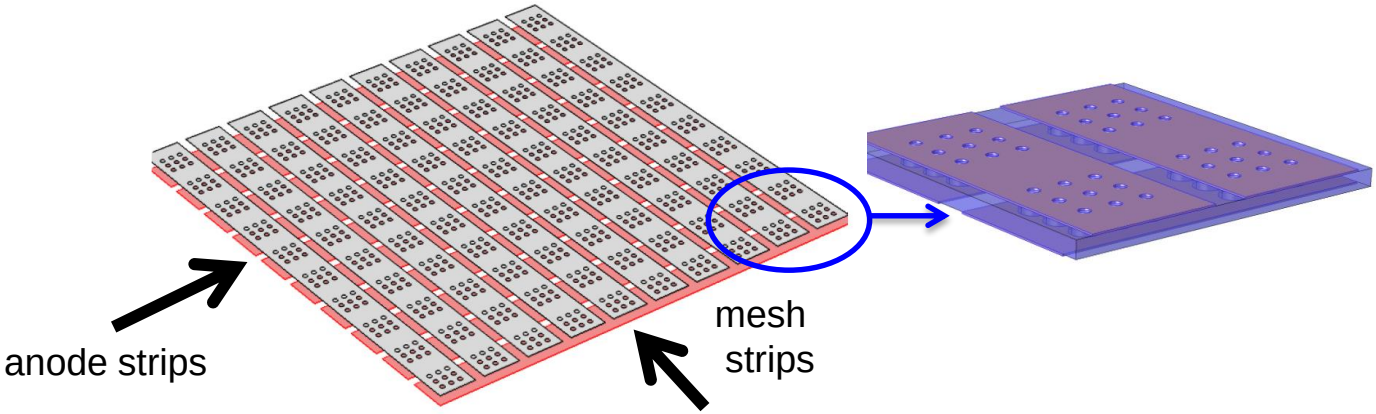


1. Mass minimisation
(5um Cu - 50um kapton - 5um Cu).
2. Large surface detectors.
3. High radiopurity.

« A low mass microbulk with real XY structure »,Th. Geralis, RD51 Common Fund Project

Segmented mesh microbulk:

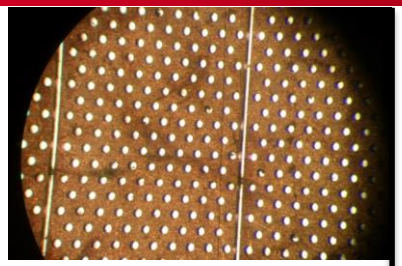
1) No extra layers
2) Production simplification
3) Real XY structure



PROTOTYPE EVOLUTION

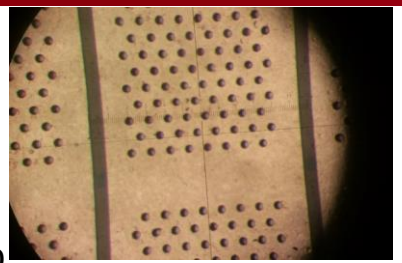
First batch:

- × Problems during etching due to holes topology.
- × Many strips in short circuit.



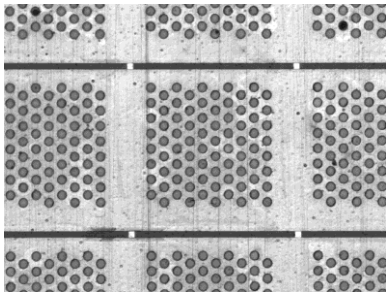
Second batch

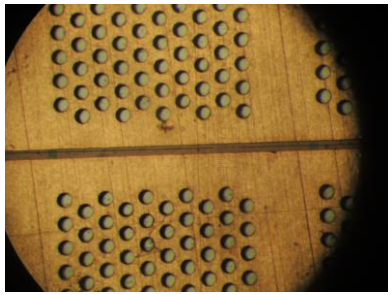
- Etching OK with the new topology
- All detectors working
- × Bad energy resolution due to large gaps (~150 µm)



Third batch

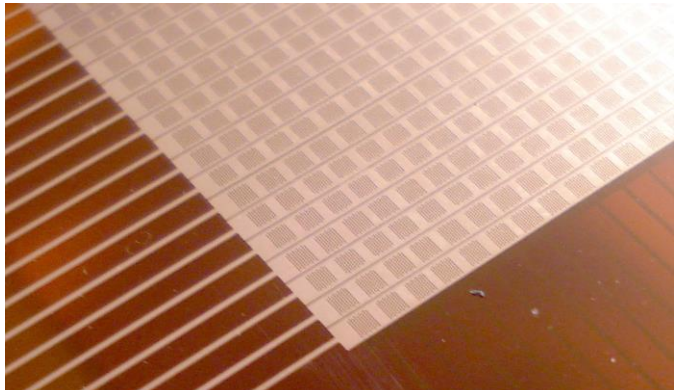
- Holes ∅ 60/50 µm
- Gaps reduced to 35 µm
- Energy resolution OK!

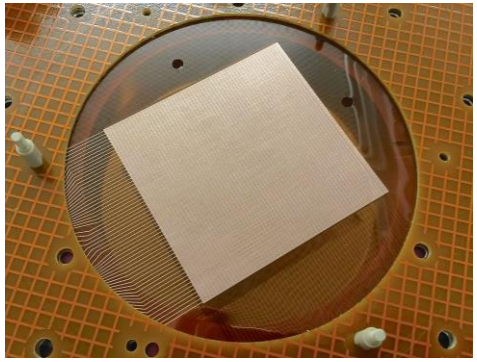


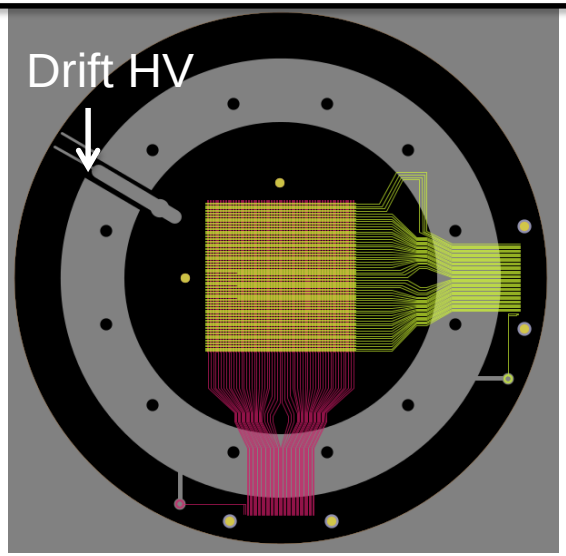


The first detectors produced:

- 58 x 59 strips on a 6 x 6cm^2 area (**1mm** thickness)
- Mesh hole:~ 60µm / Pitch: 100 µm.





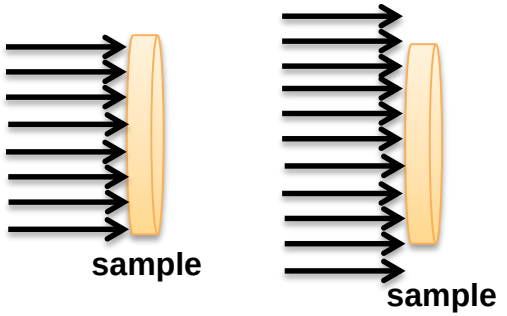


NEUTRON BEAM MONITOR + PROFILER

Accurate neutron cross section measurements require:

- **Neutron fluence/Beam interception factor**

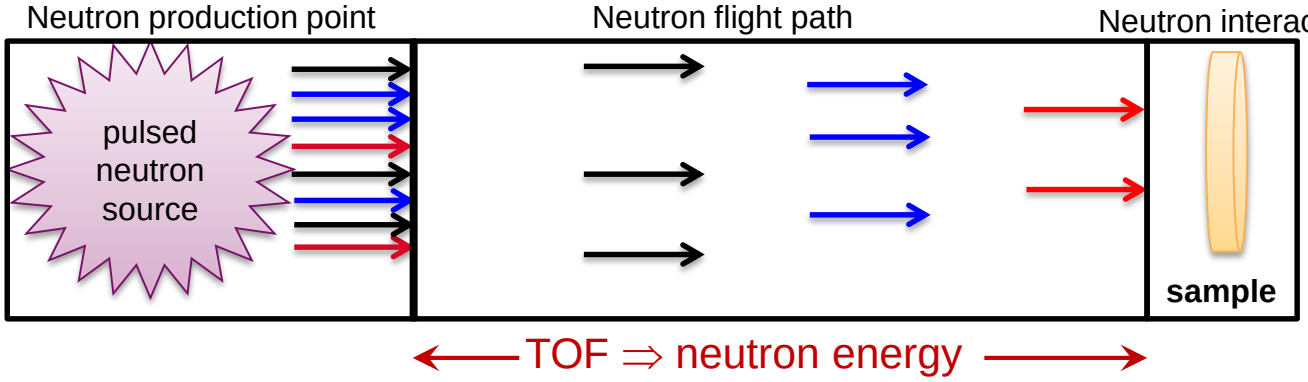
Number/fraction of neutrons hitting the area covered by the sample.



- **Shape of the beam profile**

Beam optics misalignment => Beam fluence variations.

For **non-monoenergetic** neutron sources:



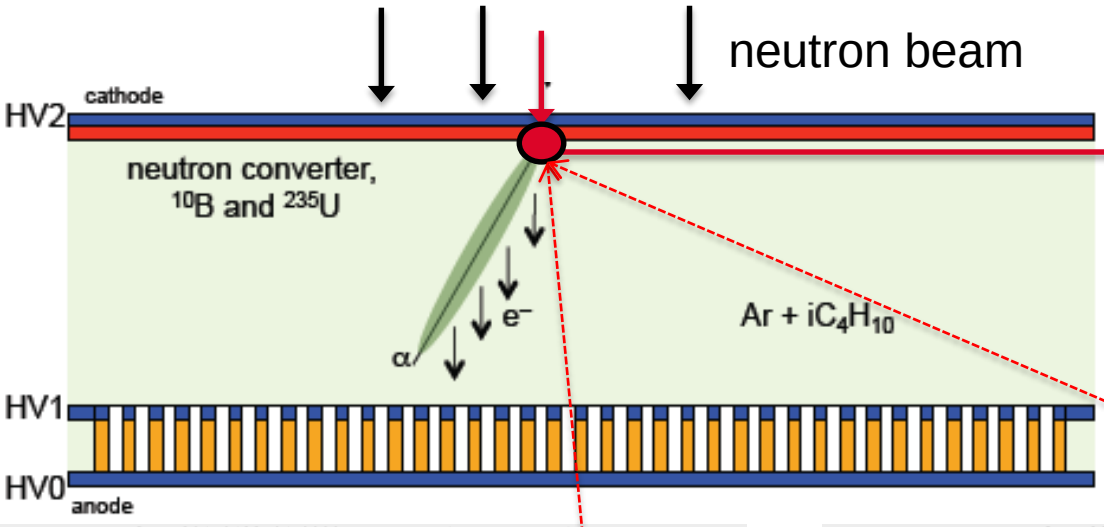
- n_TOF facility (CERN) (thermal-GeV)
- GELINA (IRMM) (1meV-20MeV)
- NFS (GANIL)

=>***Dependence of profile on the neutron energy***

Requirements:

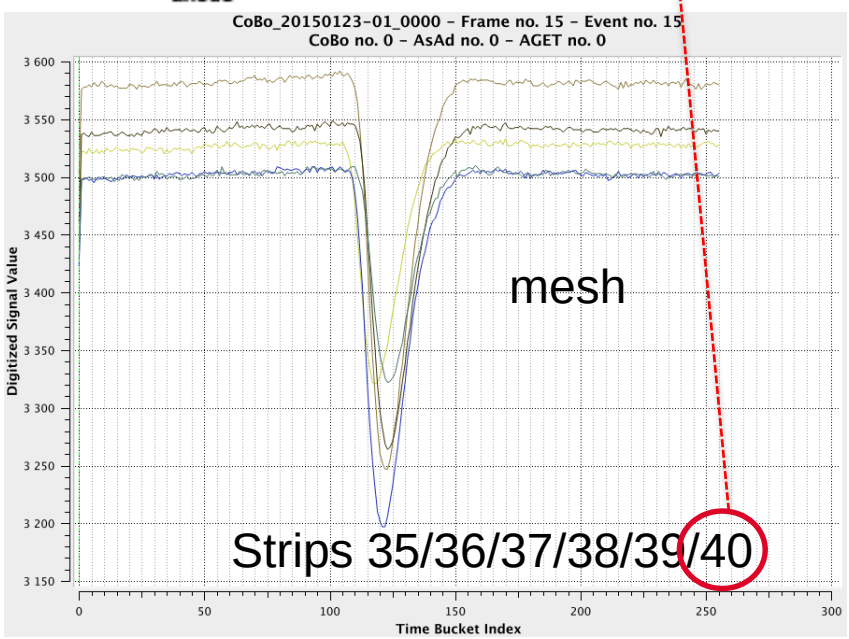
- Quasi-online neutron flux + beam profiler as well
- Minimal perturbation of the neutron beam / Minimal induced background
- Stay permanently in the beam

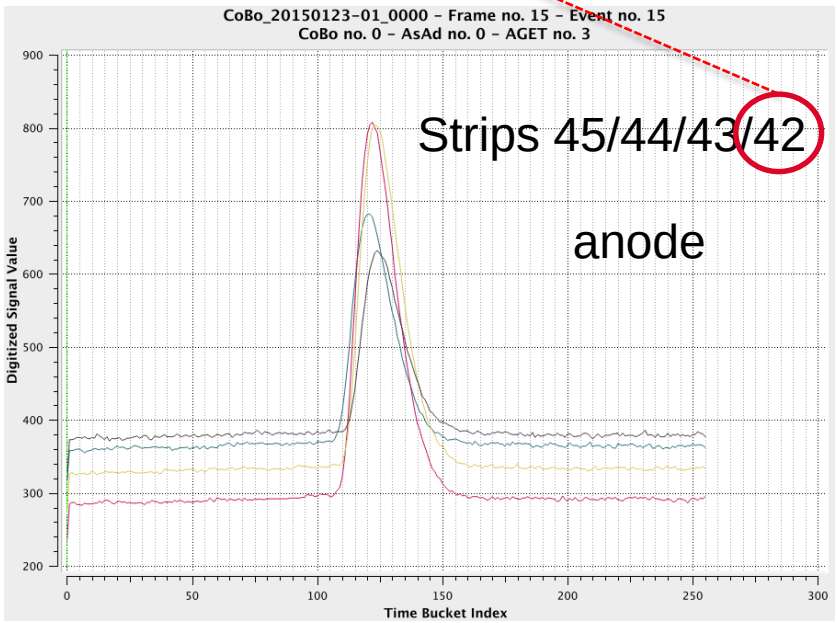
PRINCIPLE OF NEUTRON BEAM PROFILER + MONITOR OPERATION



The longest electron drift time corresponds to the point of the interaction of the neutron with the target.

consecutive strips





The neutron flux will be simultaneously extracted from the SUM SIGNAL.

ELECTRONICS

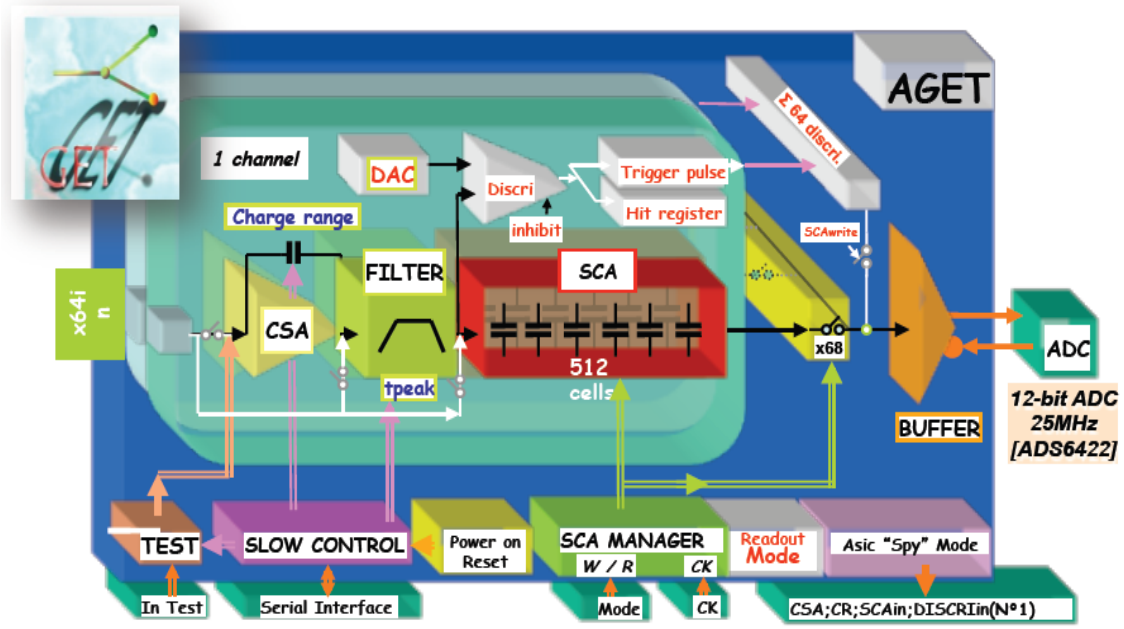
Challenge:

No global trigger signal => **AGET electronics* + Reduced CoBo configuration**

Self triggering mode / timing difference between strips.

- 64 analog channels /chip.
- Auto trigger: discriminator and threshold
- Multiplicity signal: analog OR of 6discriminators
- Address of the hitted channels
- SCA readout mode (all/hitted/selected channels)

- Max sampling rate: 100 MHz.
- 16 peaking time values: 50 ns-1us.
- 4 charge ranges/channel: 120fC/ 240fC/ 1pC/ 10 pC.

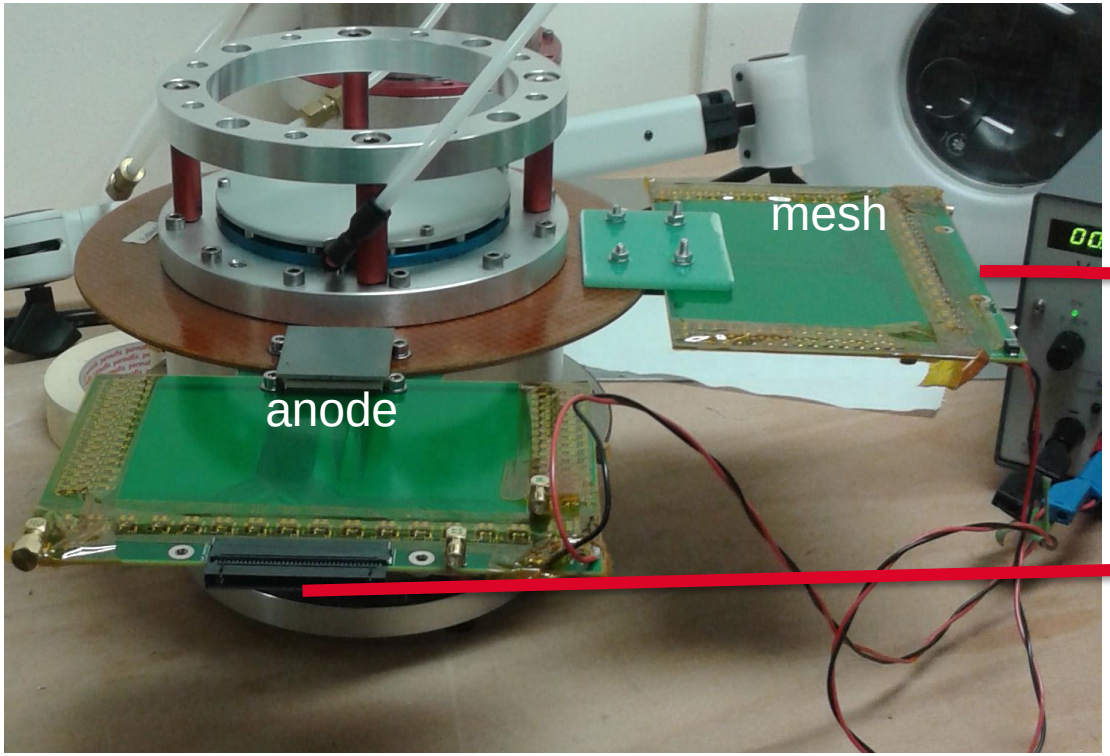


*GET, General electronics for TPC, ANR proposal / GET-QA-000-0005, AGET Data Sheet.

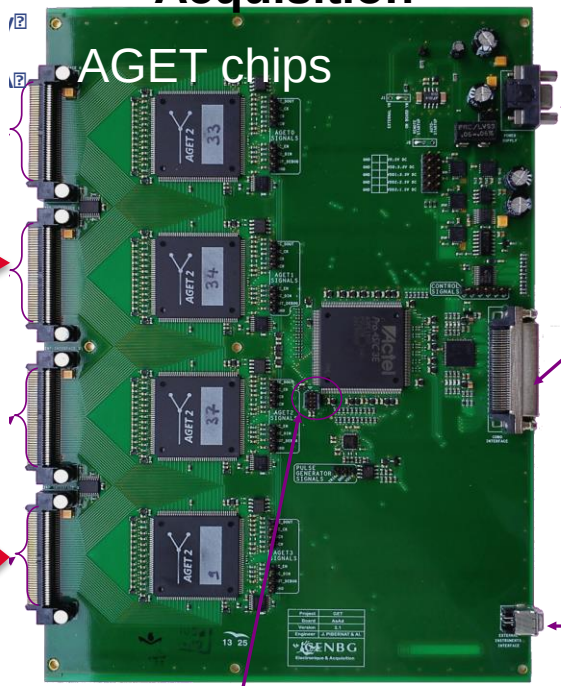
PREVIOUS FRONT-END CARDS SETUP

Front end electronics: protection card, able to

1) take the signal from the strips (mesh+anode)
2) distribute the HV (mesh)
3) take the sum signal (recorded with conventional electronics).



Acquisition



Problems: missing strips, wrong routing, noise from low voltage supply module

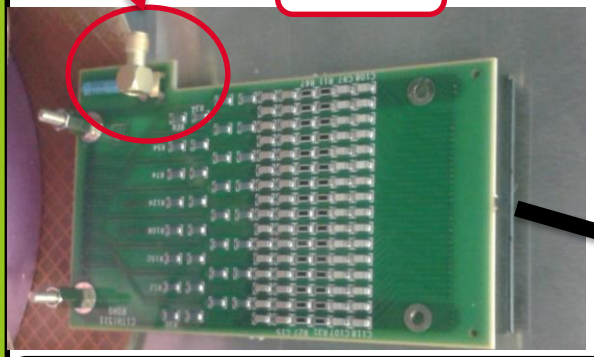
NEW FRONT END CARDS

DETECTOR

MESH STRIPS

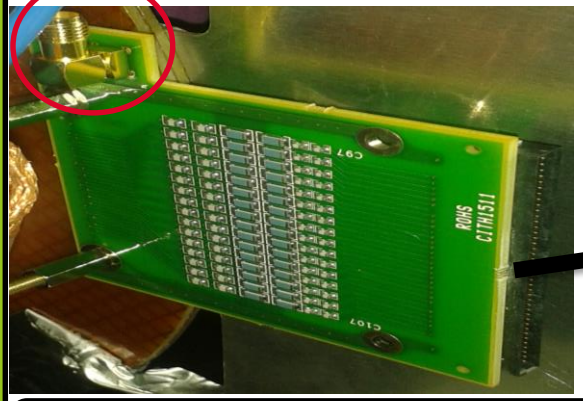
ANODE STRIPS

HV in

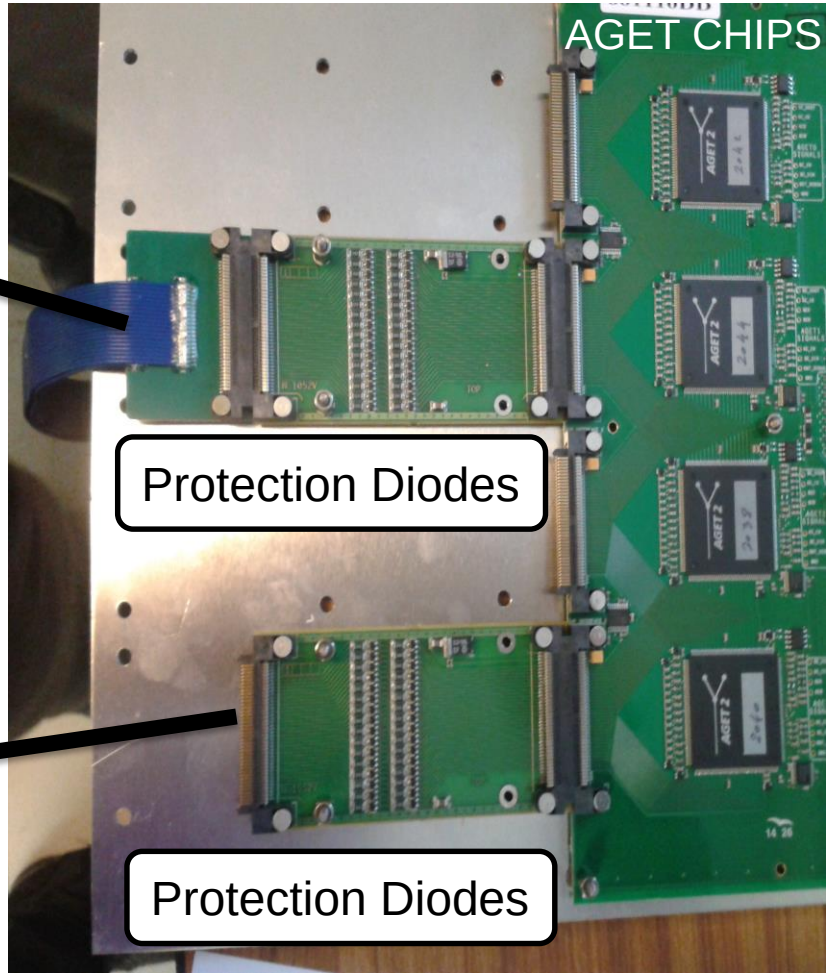


HV splitting + strip signals

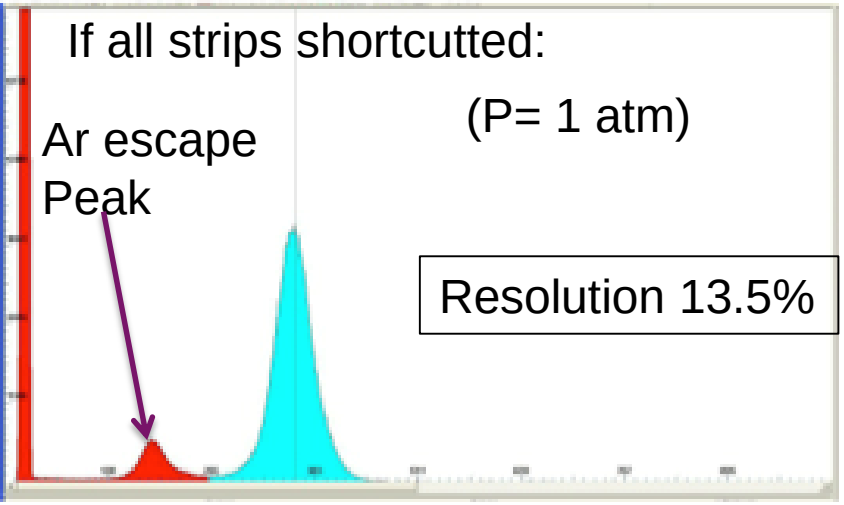
Sum signal to preamp+n_TOF DAQ



Strip signals+Sum signal

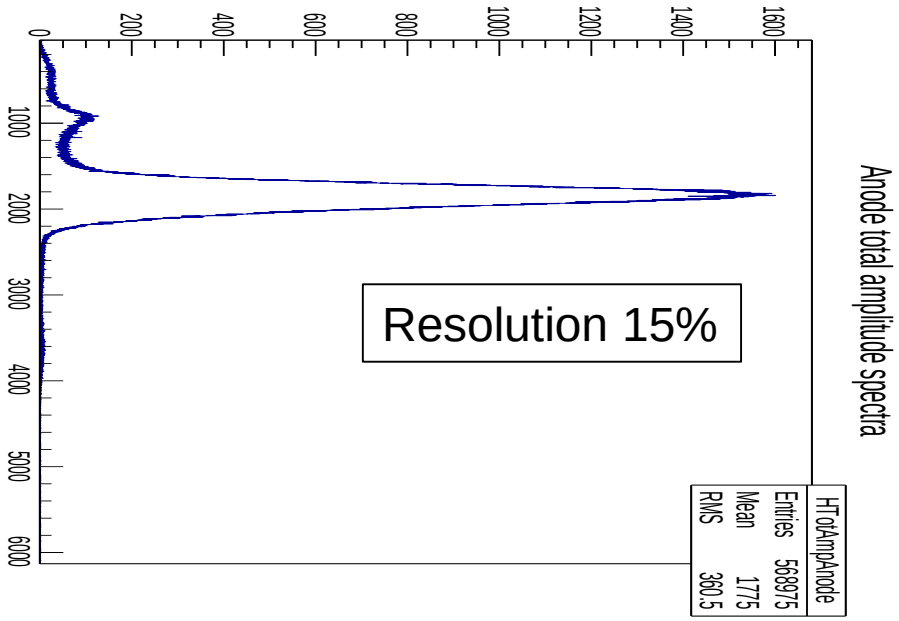


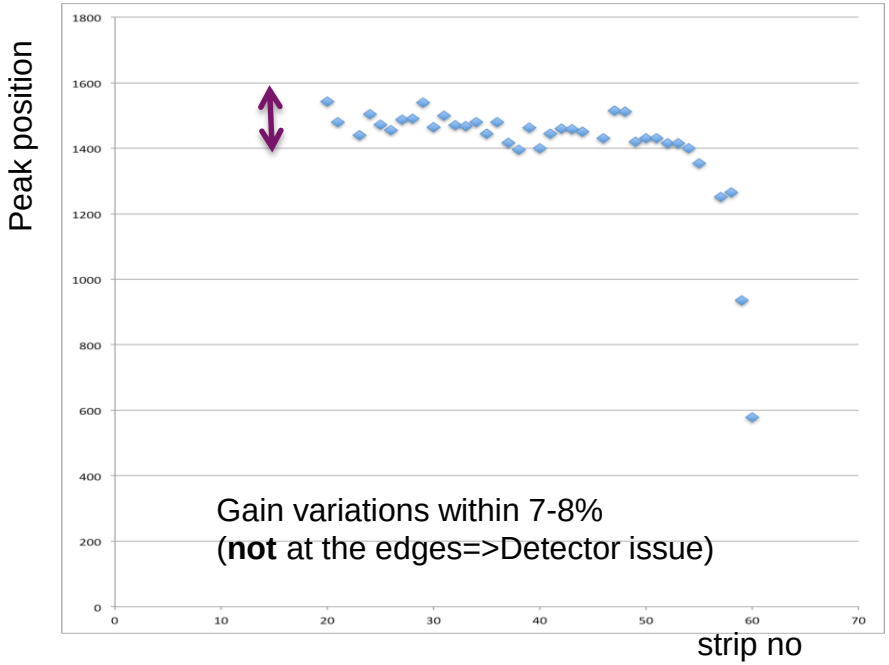
DETECTOR PERFORMANCE WITH Xrays



X-ray source : ^{57}Fe

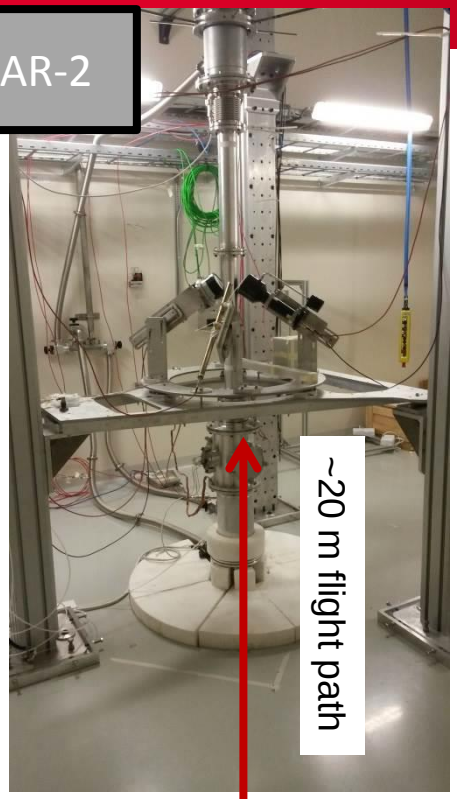
- No stripped microbulk at good transparency: ~11%.





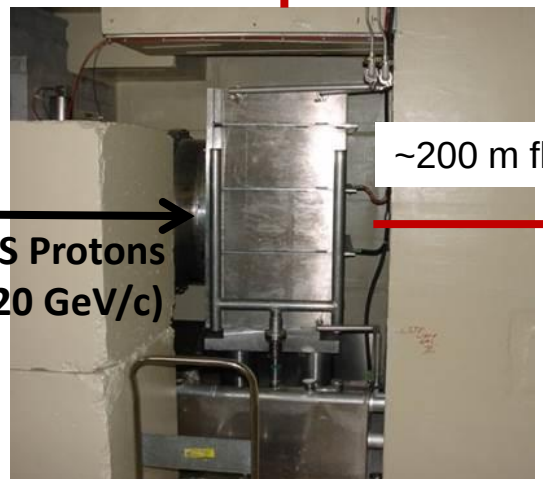
THE n_TOF FACILITY (CERN)

EAR-2

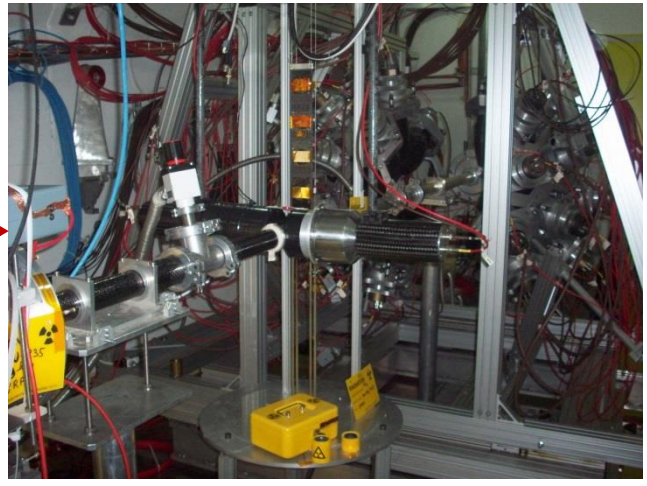


Neutron beam characteristics:

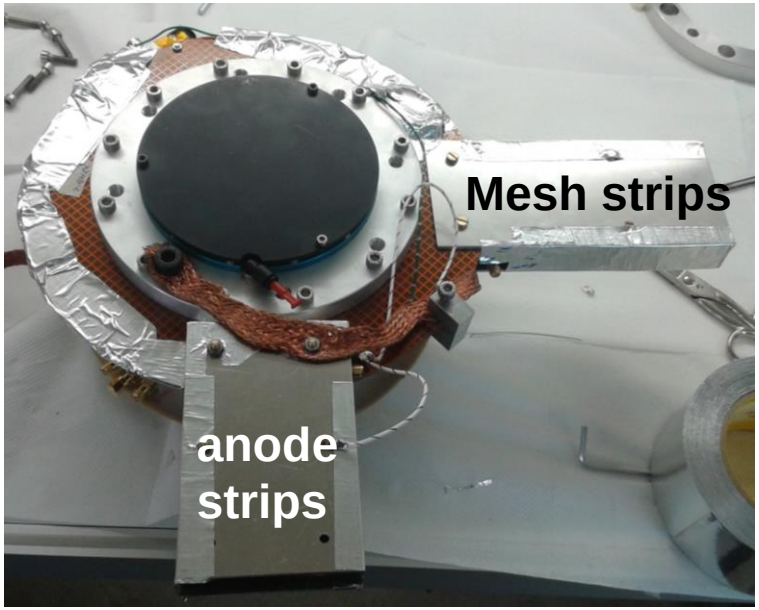
1. White neutron beam (0.025 eV-1 GeV).
2. Neutron energy defined by the Time-Of-Flight.
3. High instantaneous flux.
4. 7ns width proton pulse every > 1s
5. Excellent energy resolution



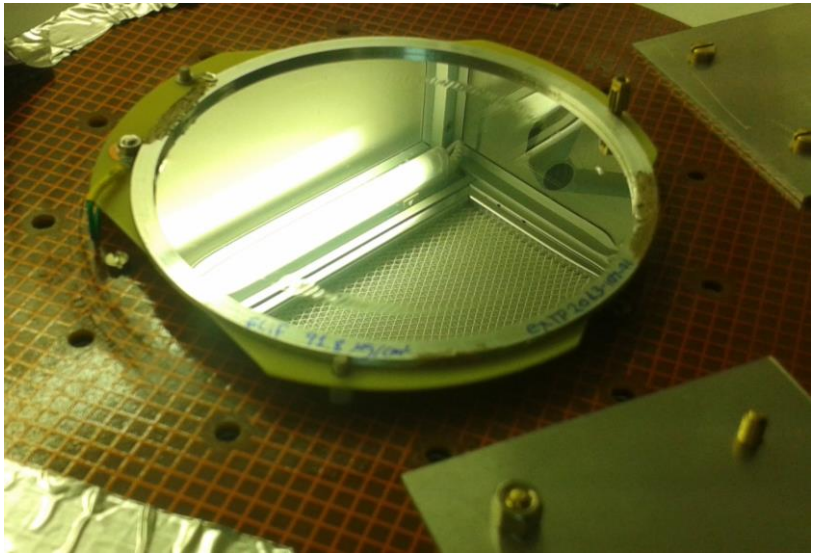
~200 m flight path

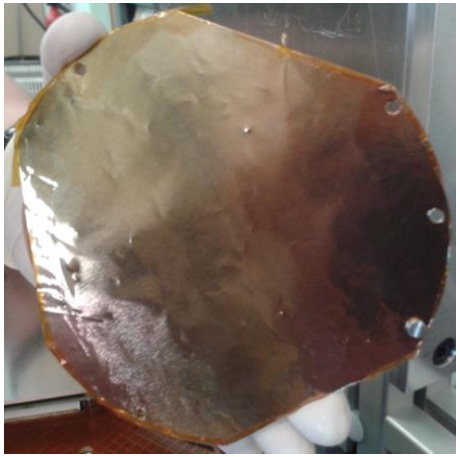


MOUNTING THE DETECTOR IN EAR-2 (1)



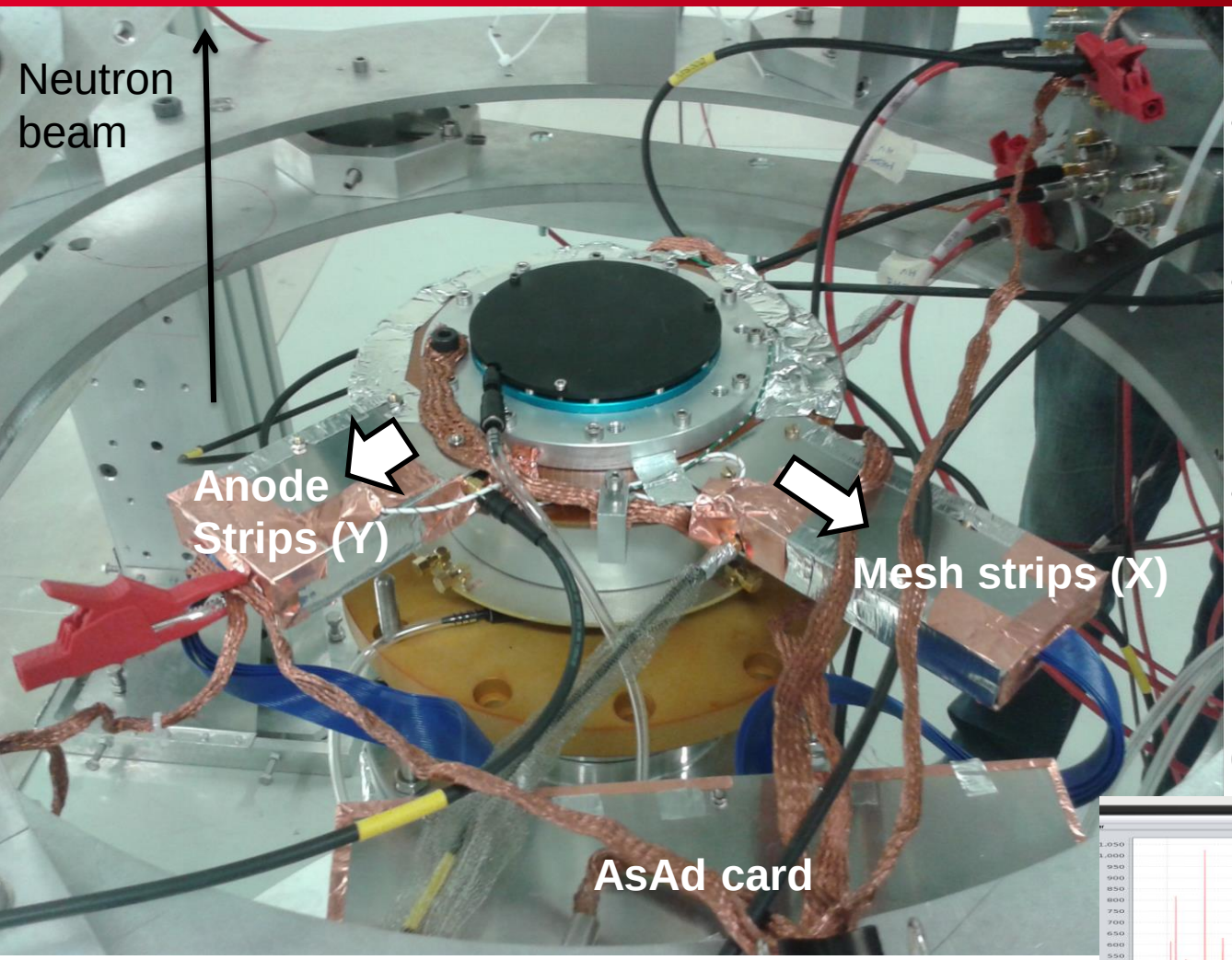
- Proper grounding + shielding essential.





- ^{6}LiF target, 91.8µg/cm^{2} (EXTP 2013-104-01)

MOUNTING THE DETECTOR IN EAR-2 (2)

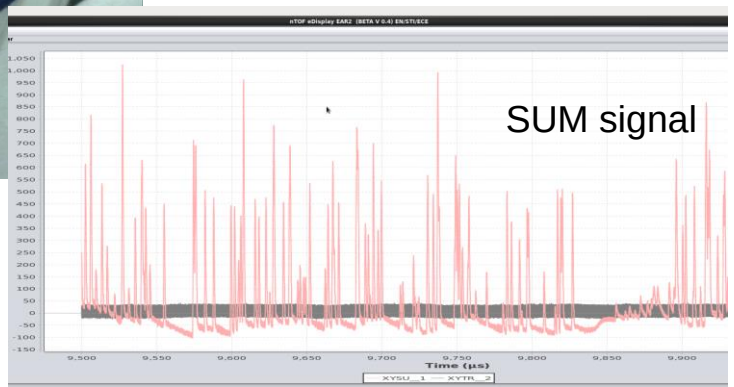


- AsAd card very close to beam.
- V_m=310 V / V_d =750 V.

- Through n_TOF DAQ:

1) Sum signal (neutron flux)
1) Trigger signal

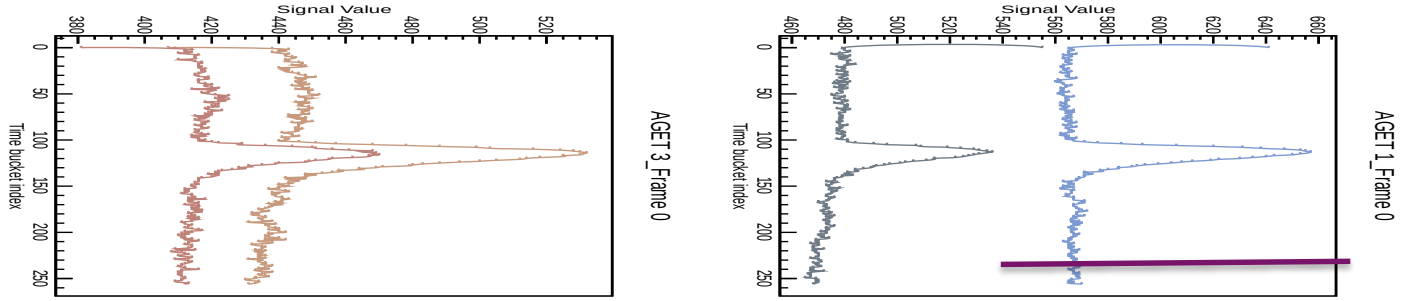
(with conventional preamps)

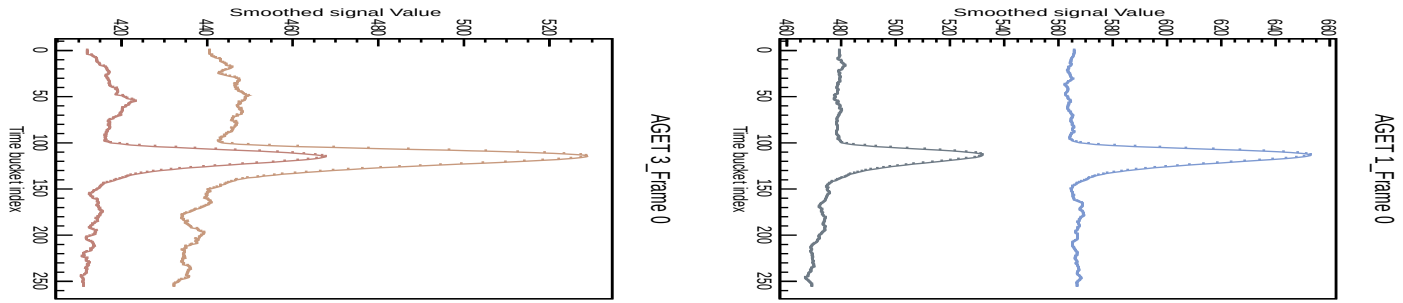


SIGNAL ANALYSIS

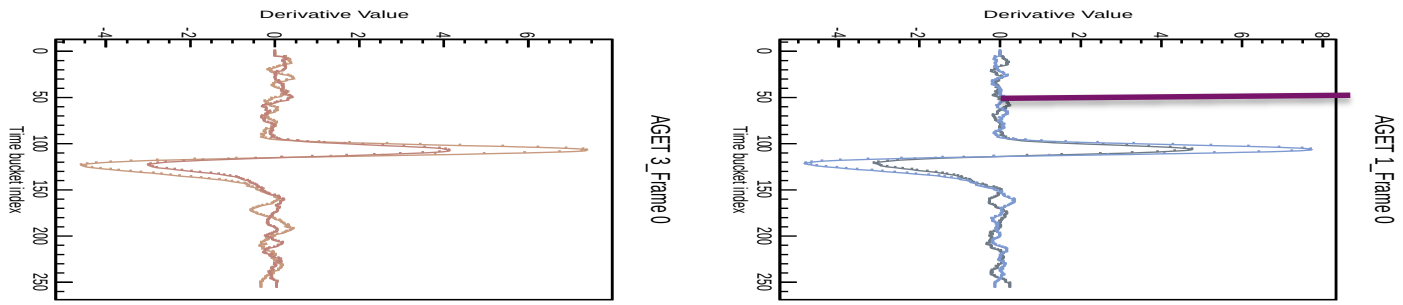
Initial pulses | Smoothed pulses | Derivative pulses

MESH





ANODE

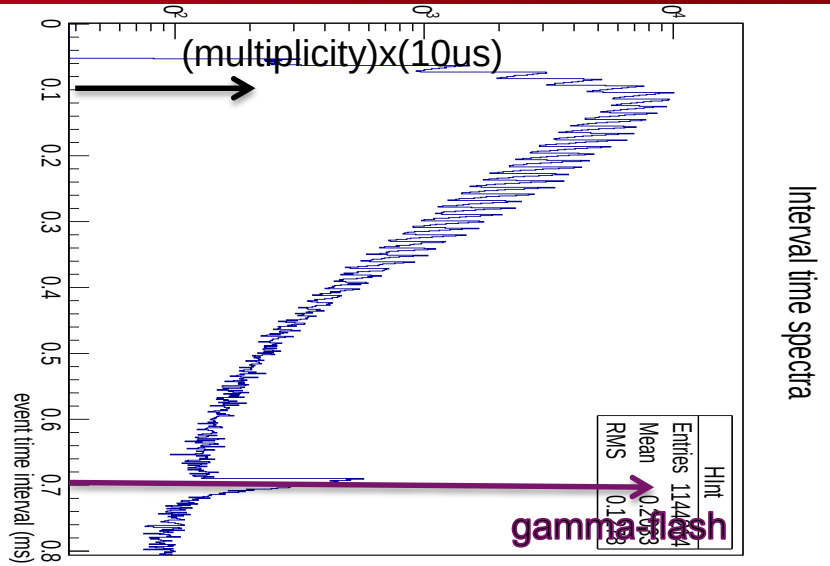


CONDITION:
If **both** mesh and anode had at least one strip with signal.

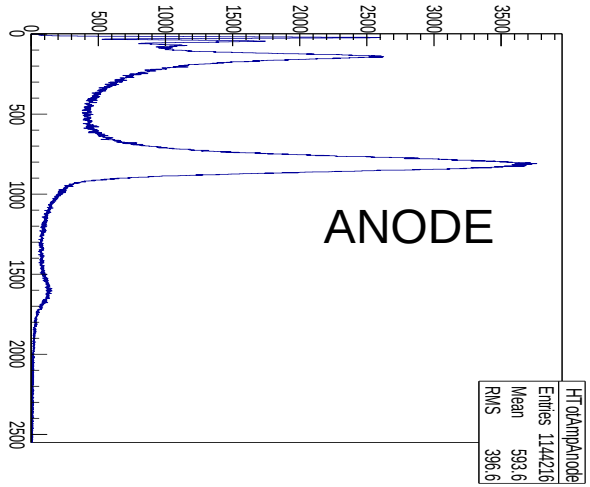
Peak useful parameters are stored (**Amplitude**, **Peak position**, TOT etc)
Event useful information is stored (Time of event, multiplicities etc)

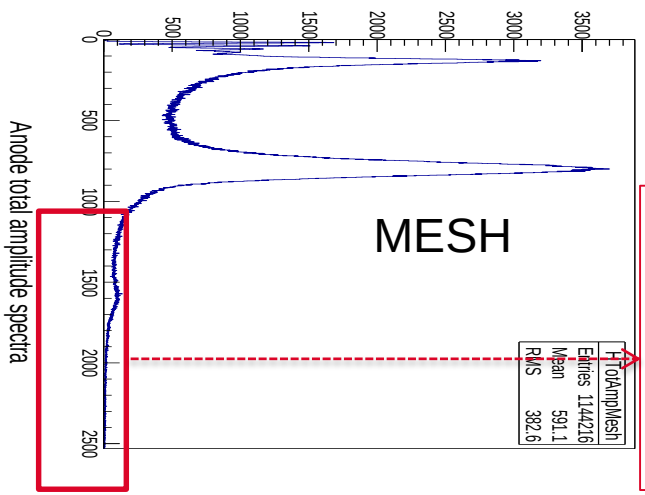
SOME RESULTS

1) Interval time between consecutive events:

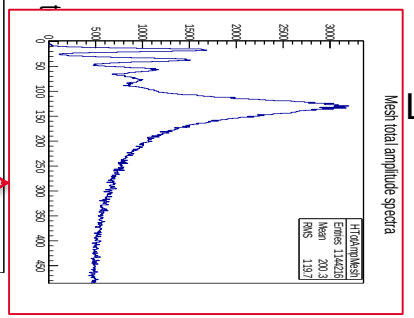


2) Total Amplitude histogram (sum of strip amplitudes for each event):





- Good energy resolution, (Similar for mesh+anode)
- Pile-up.

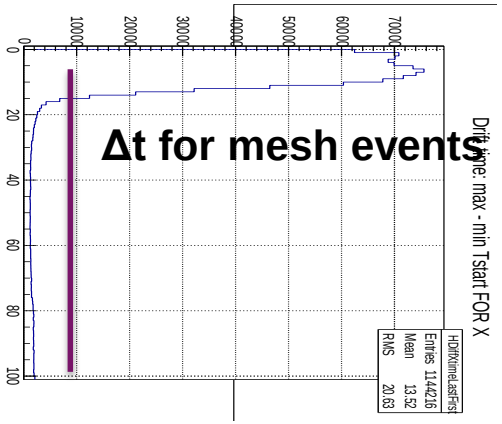


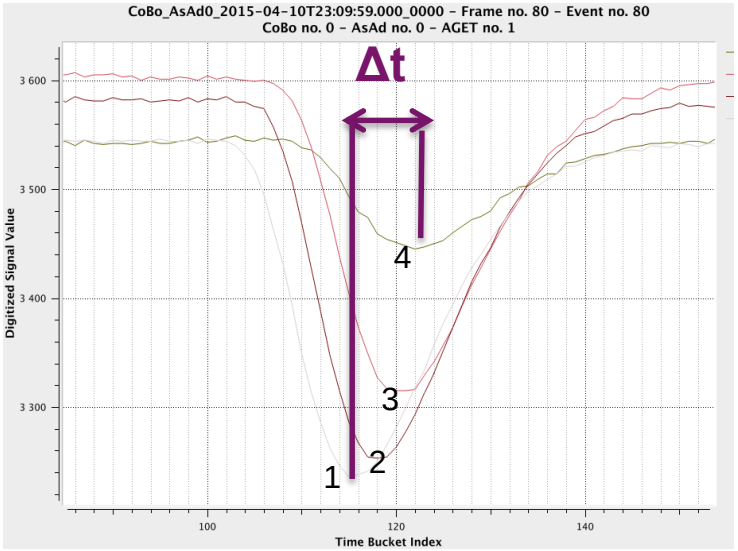
Low energy deposition events => to be cleaned.

EVENT SELECTION CRITERIA FOR BEAM PROFILE (1)

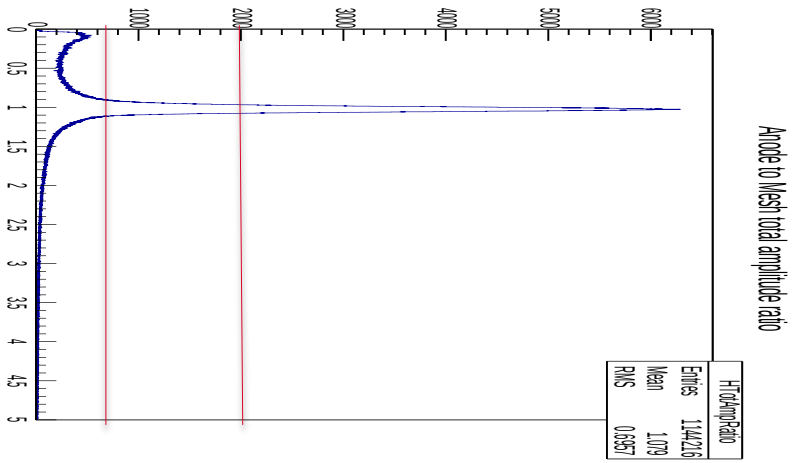
From each event + for each dimension we calculate the time difference between first and last strip hit (**Δt**)

Criterion 1:
Δt <= (drift space)/(drift velocity)

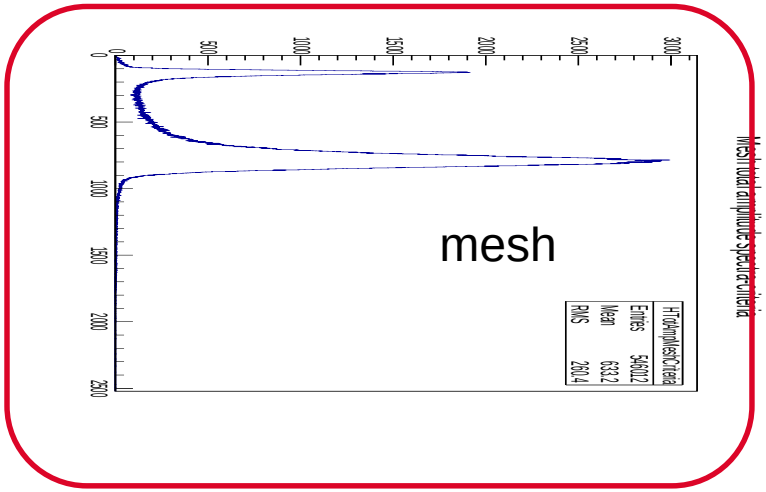




Criterion 2: 0.5 < tot amp ratio<1.5

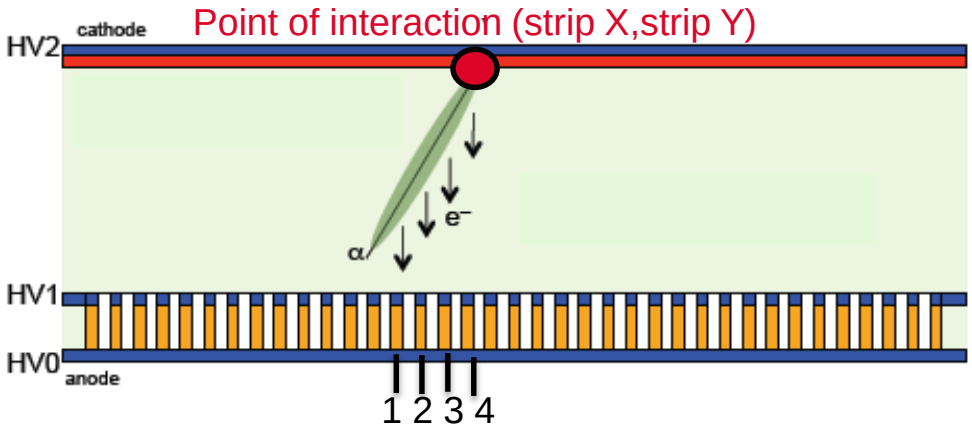


Final total amplitude hist much cleaner:

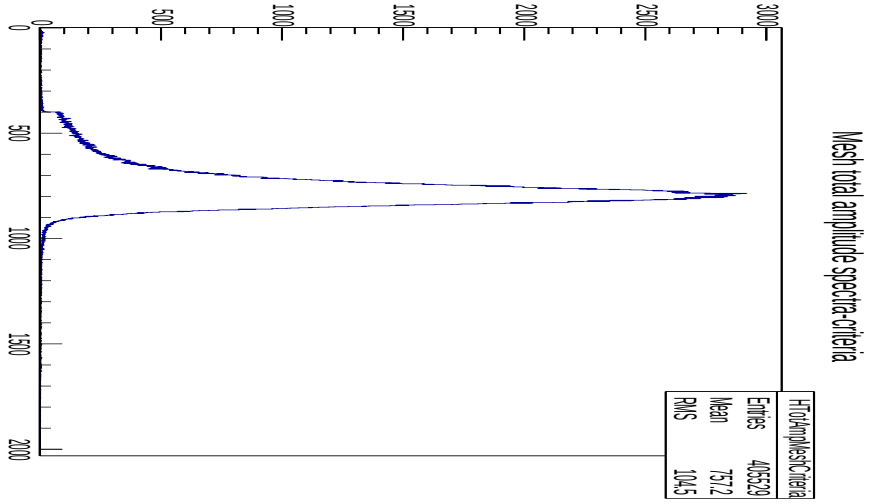


EVENT SELECTION CRITERIA FOR BEAM PROFILE (2)

Criterion 3: strips hit have to be consecutive=> pile-up events rejected



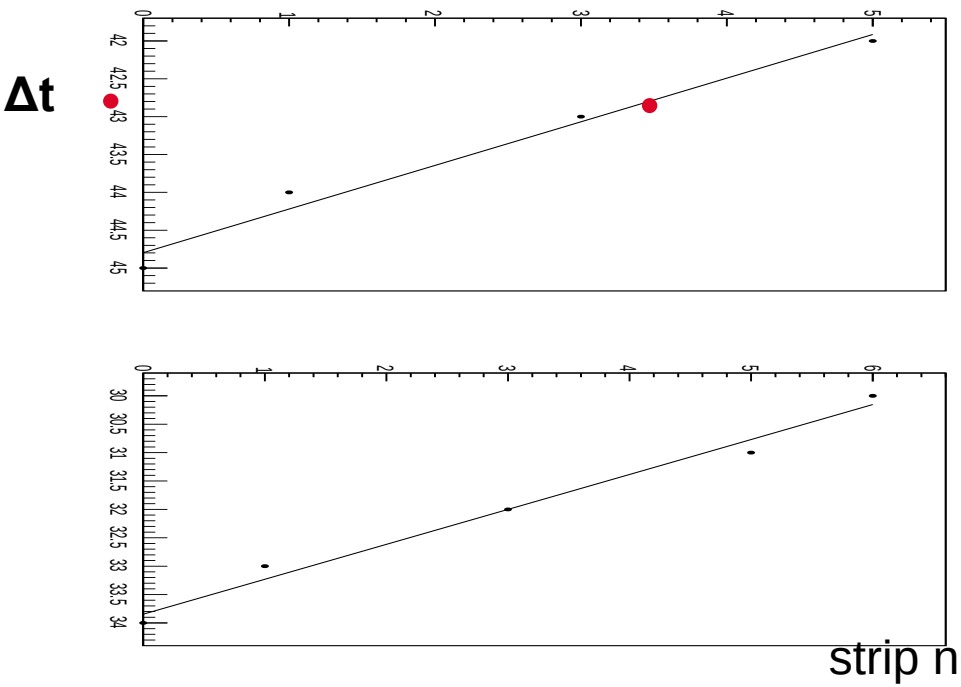
Criterion 3: Only alphas

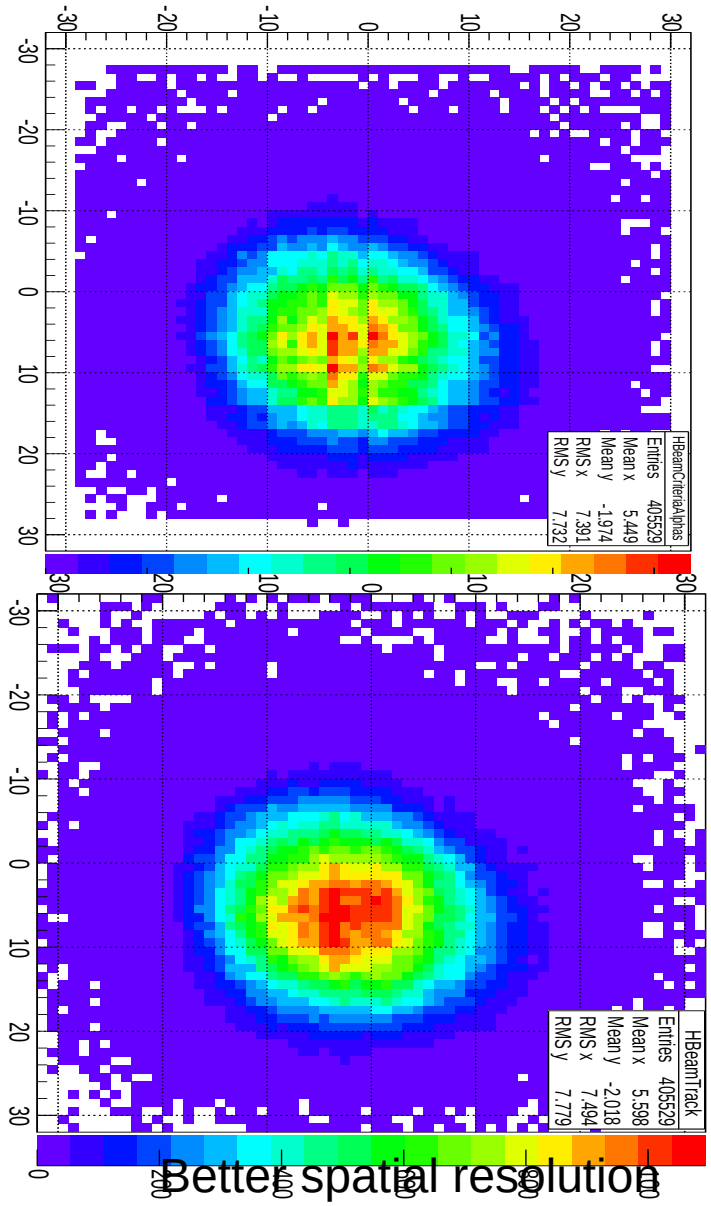


TOWARDS THE BEAM PROFILE

1) Taking the last strip that gave signal:

2) Particle track fitting:





OUTLOOK –FUTURE PERSPECTIVES

- XYMGAS neutron beam profiler in operational mode.

The electronics were improved / Dead time
Will stay permanently in-beam at n_TOF.

- Further improvements in the design of the detector for the next production, based on the tests performed is foreseen.

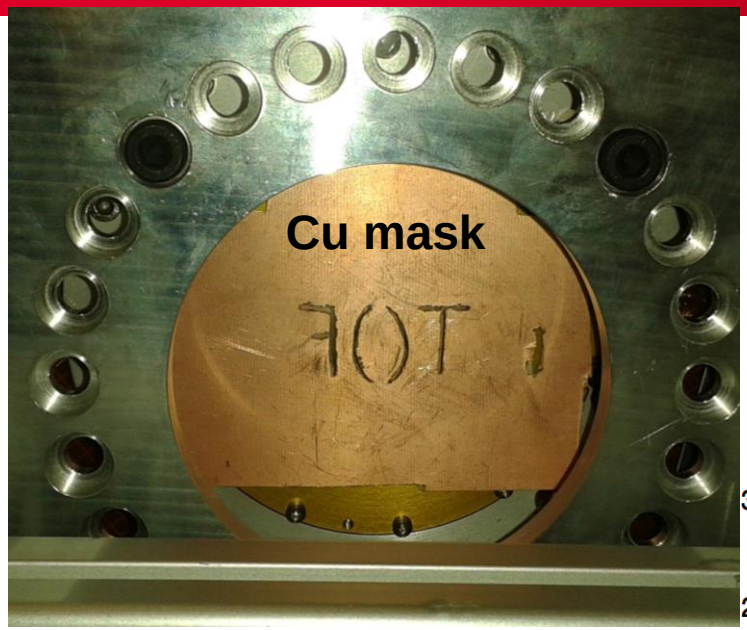
- Complete characterisation of the detector at the nuclear reactor Orphee, CEA-Saclay (spatial resolution etc).

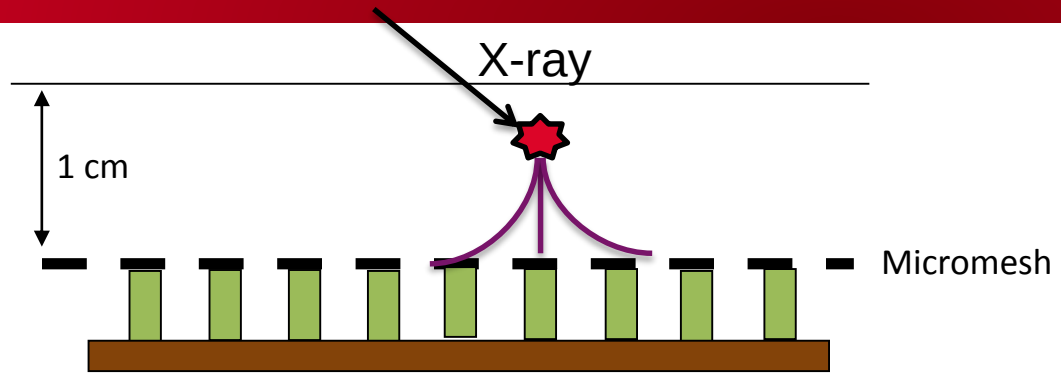
- Challenging physics measurements (neutron induced charged particle reactions, angular distributions etc) will be investigated with this detector.

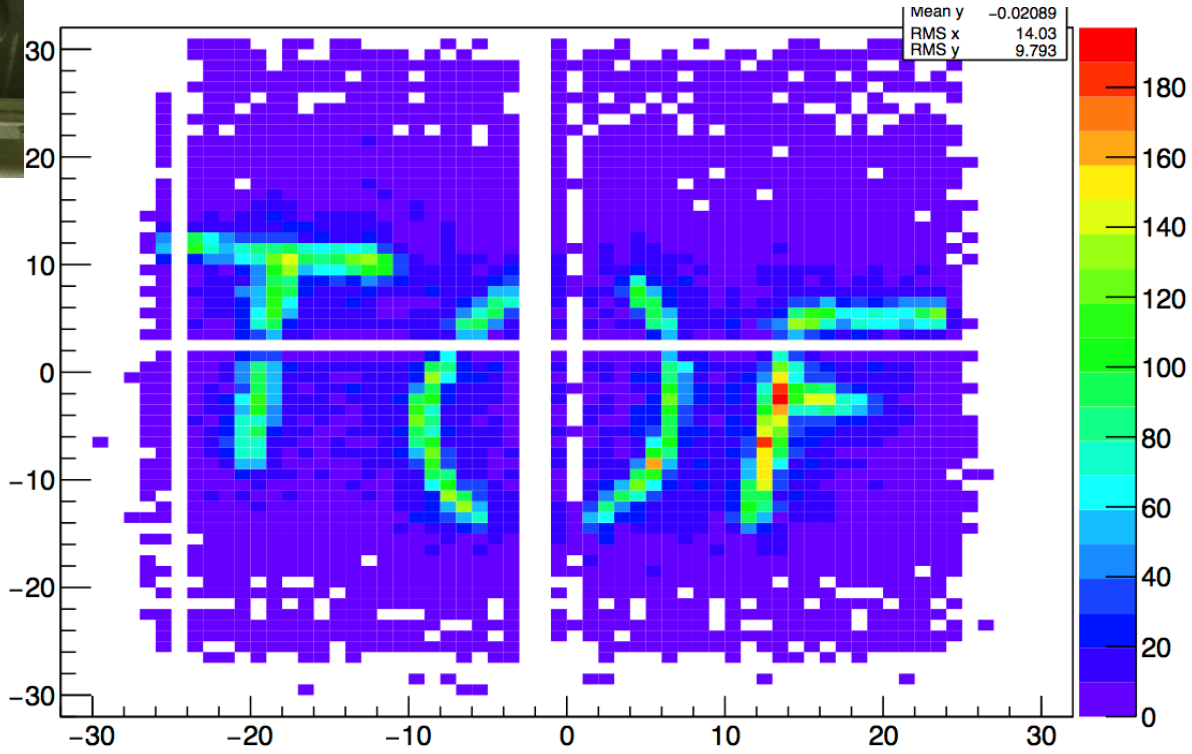
……...Thank you…….

EXTRA SLIDES

RECONSTRUCTED MASK IMAGE X-RAYS

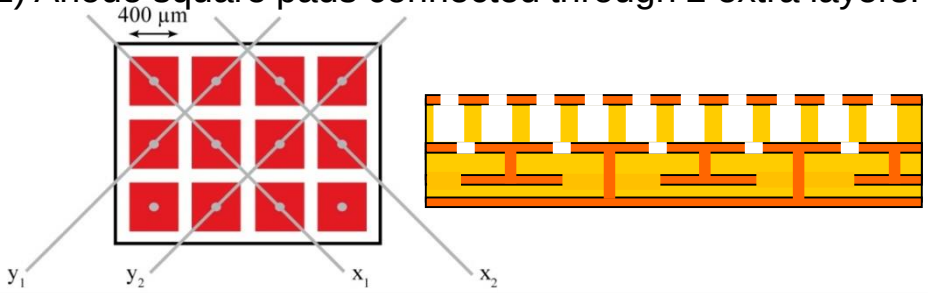






Previous 2D ubulks

1) Anode square pads connected through 2 extra layers.



2) Anode pads/strips connected through 1 extra layer.