

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

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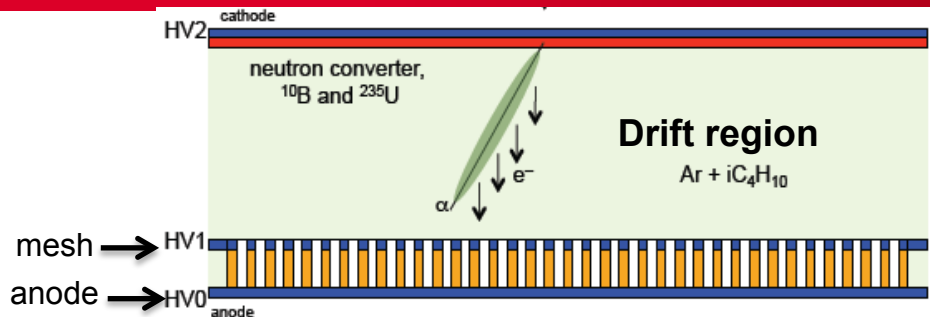
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⁴ University of Zaragoza, Spain.

⁵ IPN, Université d'Orsay, France.

⁶ IRMM, Geel, Belgium.

- 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

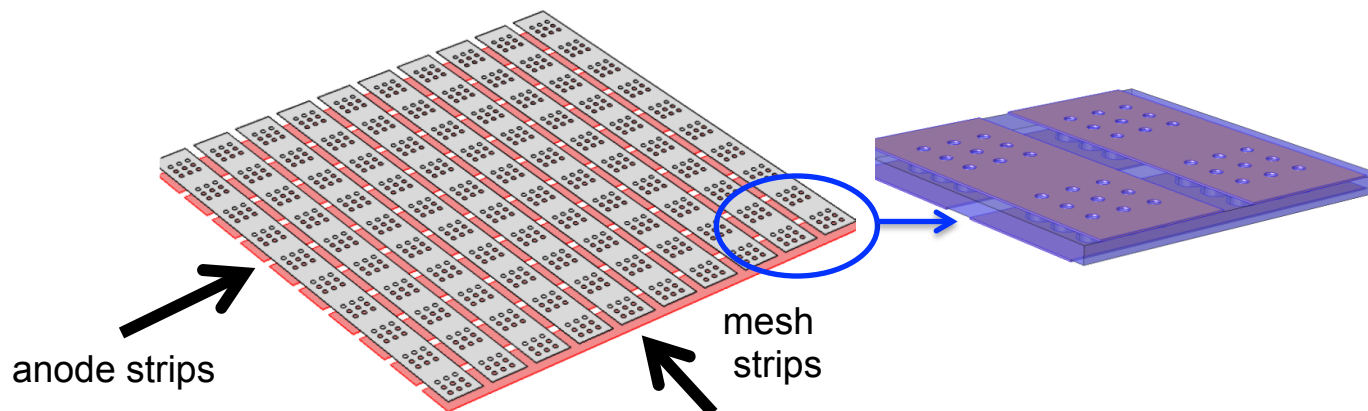


1. Mass minimisation (5um Cu - 50um kapton - 5um Cu).
2. Large surface detectors.
3. High radiopurity.

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

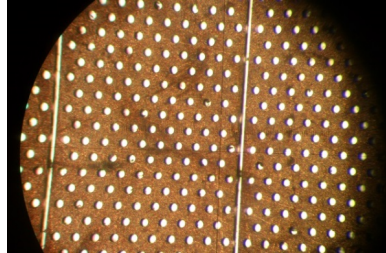
Segmented mesh microbulk:

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



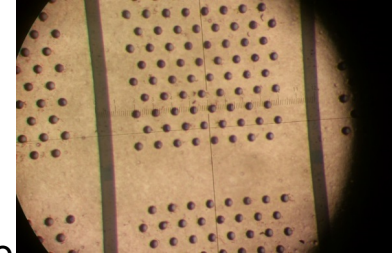
First batch:

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



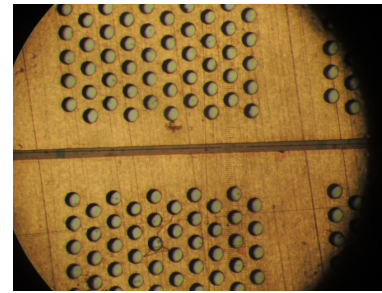
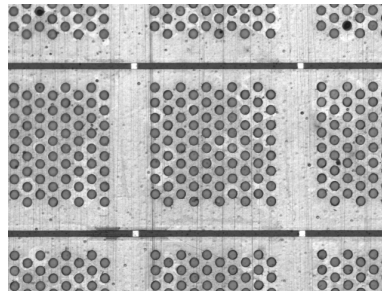
Second batch

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



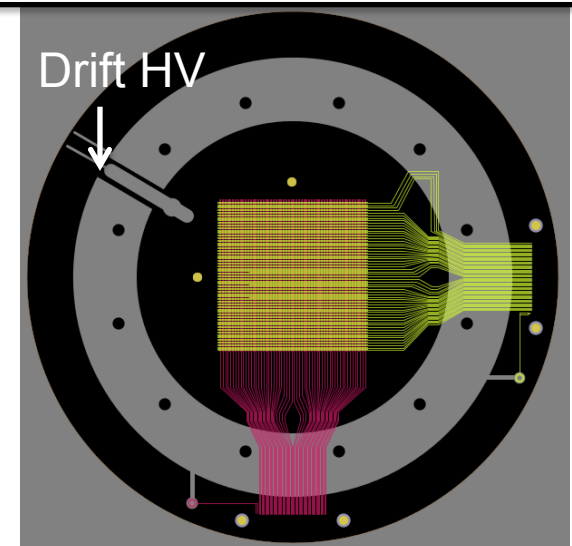
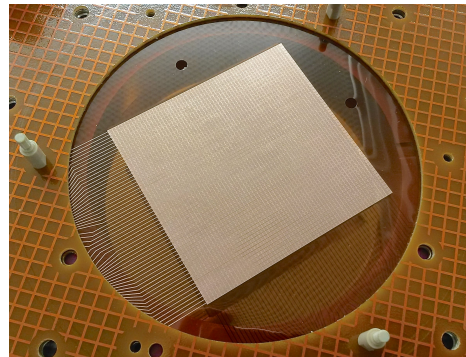
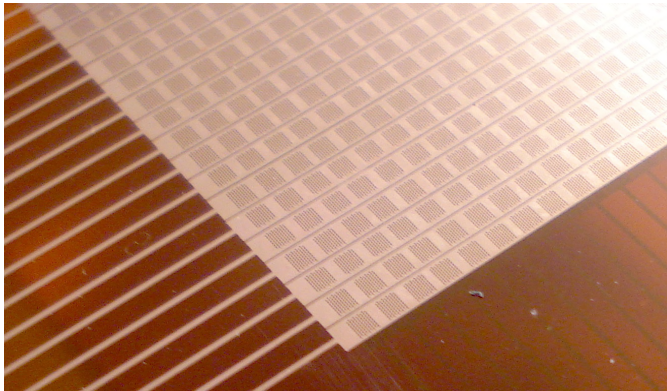
Third batch

- Holes \varnothing 60/100 μm
- Gaps reduced to 35 μm
- Energy resolution OK!



The first detectors produced:

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



Accurate neutron cross section measurements require:

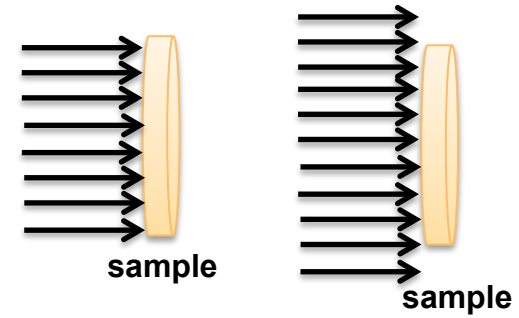
- **Neutron fluence/Beam interception factor**

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

- **Shape of the beam profile**

Beam optics misalignment => Beam fluence variations.

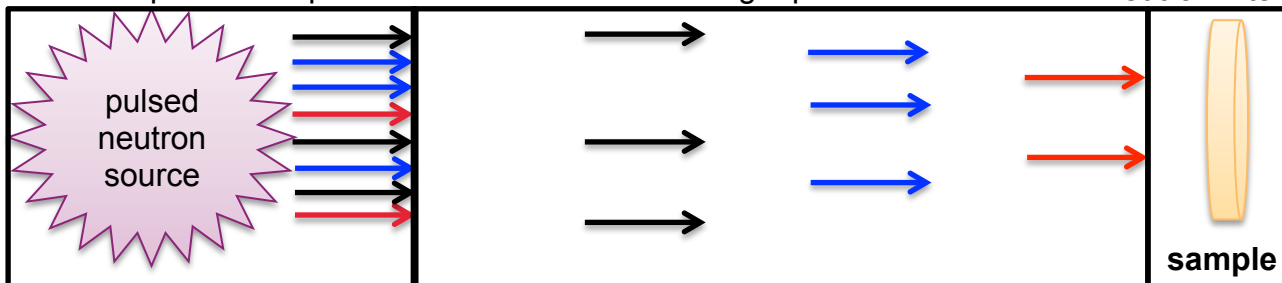
For **non-monoenergetic** neutron sources:



Neutron production point

Neutron flight path

Neutron interaction point



← TOF ⇒ neutron energy →

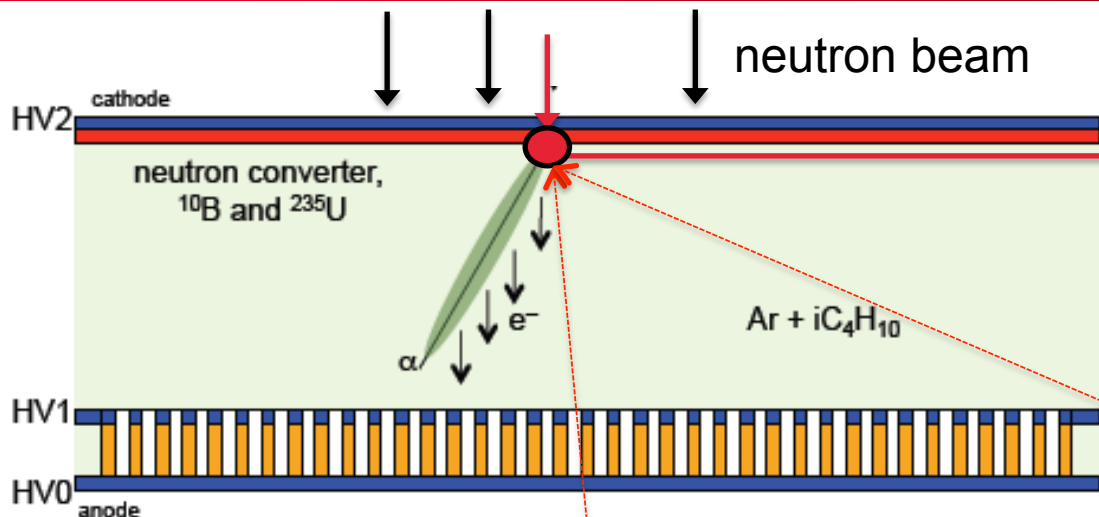
- n_TOF facility (CERN)
(thermal-GeV)
- GELINA (IRMM)
(1meV-20MeV)
- NFS (GANIL)

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

Requirements:

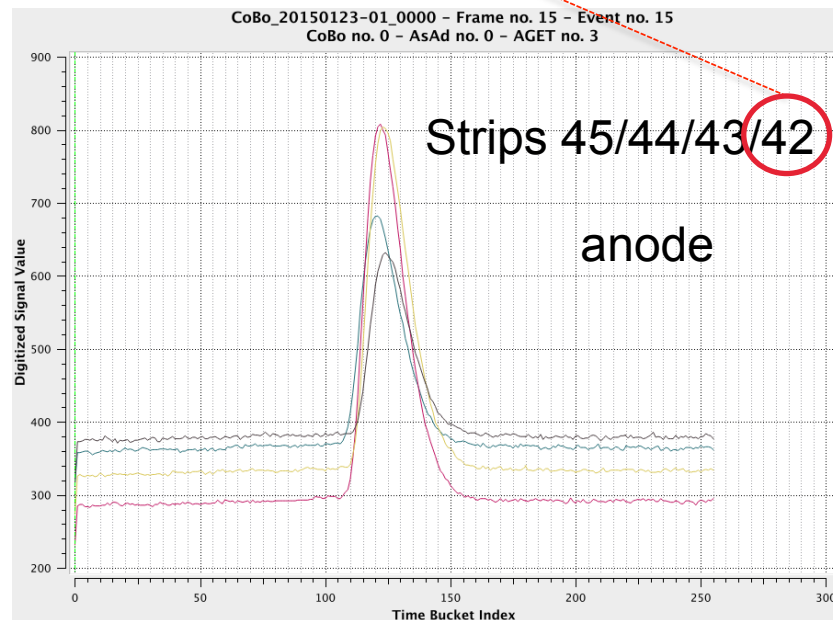
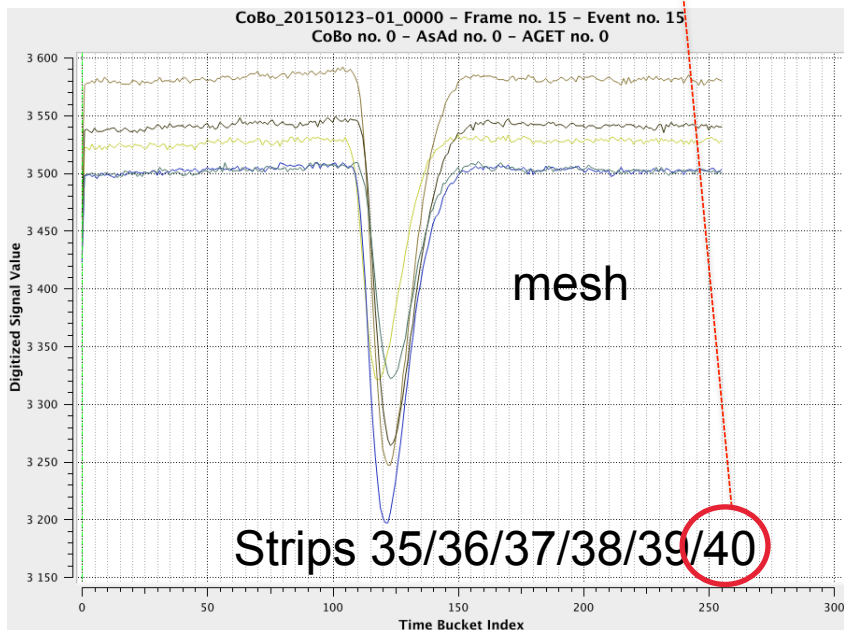
- Quasi-online neutron flux + beam profiler as well
- Minimal perturbation of the neutron beam / Minimal induced background
- Stay permanently in the beam

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



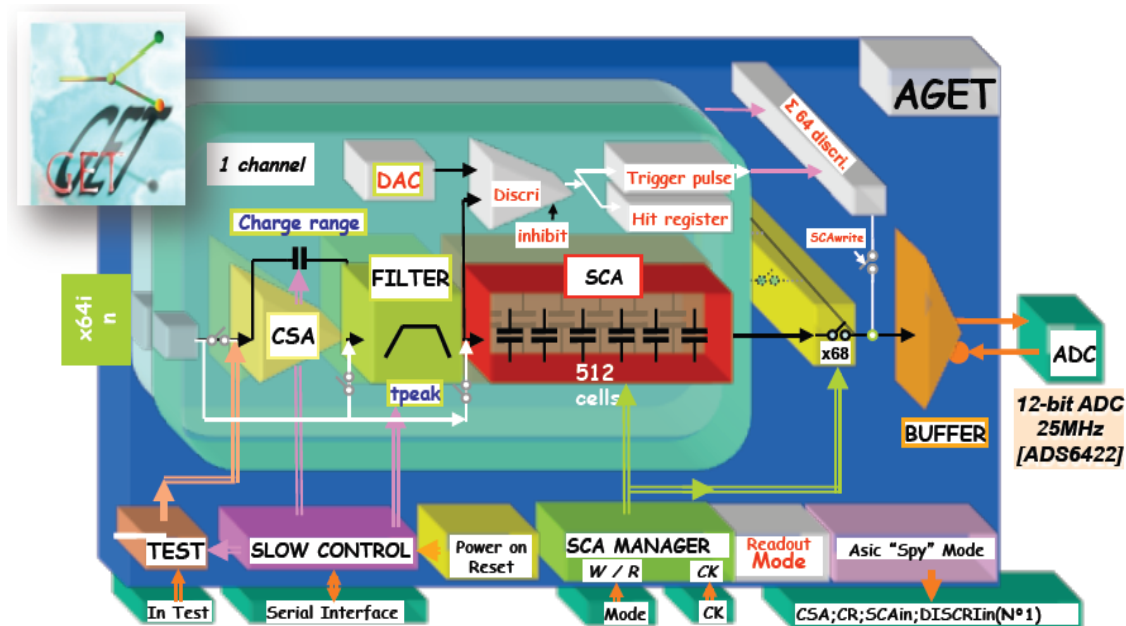
The neutron flux will be simultaneously extracted from the SUM SIGNAL.

Challenge:

No global trigger signal => **AGET electronics* + Reduced CoBo configuration**
Self triggering mode / timing difference between strips.

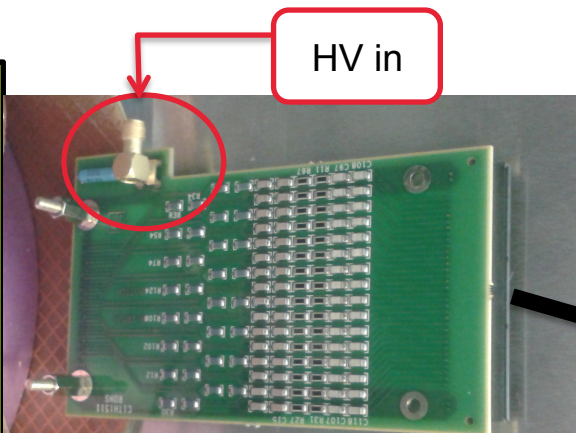
- 64 analog channels /chip.
- Auto trigger: discriminator and threshold
- Multiplicity signal: analog OR of 6 discriminators
- Address of the hitted channels
- SCA readout mode (all/hitted/selected channels)

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



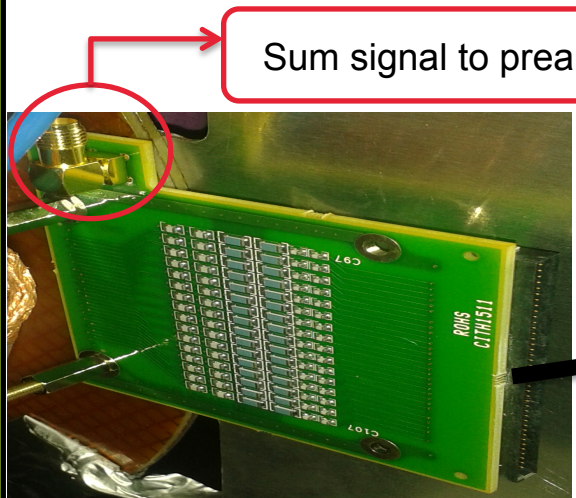
*GET, General electronics for TPC, ANR proposal / GET-QA-000-0005, AGET Data Sheet.

DETECTOR MESH STRIPS
ANODE STRIPS



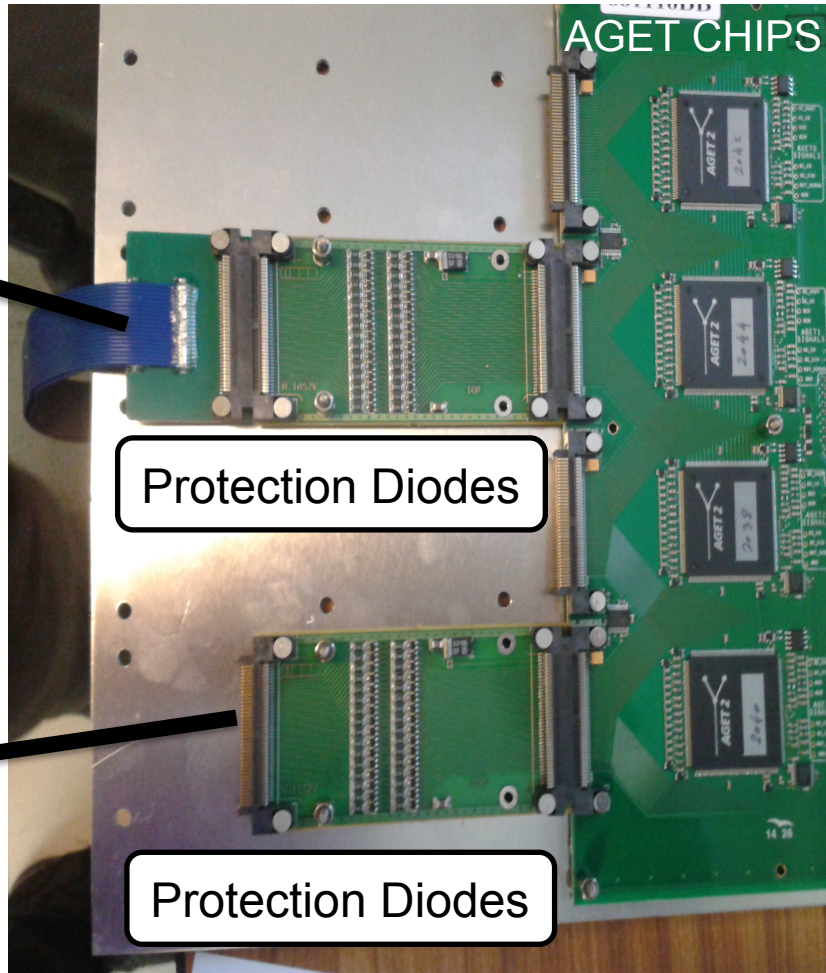
HV in

HV splitting + strip signals



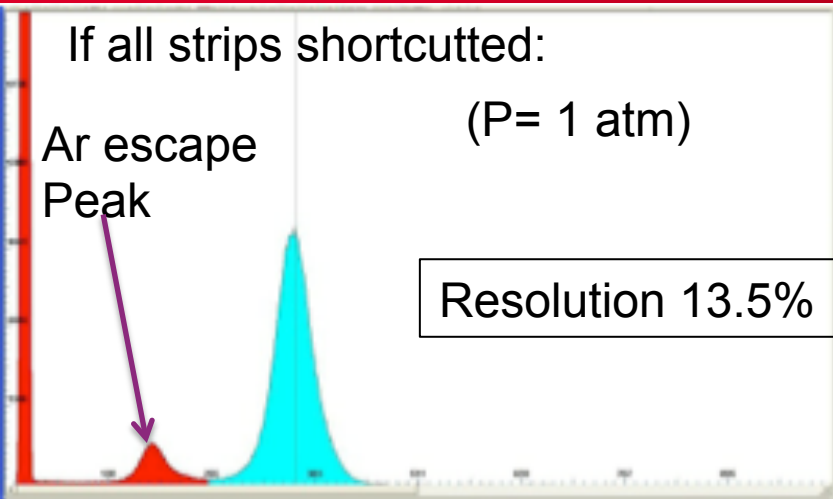
Sum signal to preamp+n_TOF DAQ

Strip signals+Sum signal

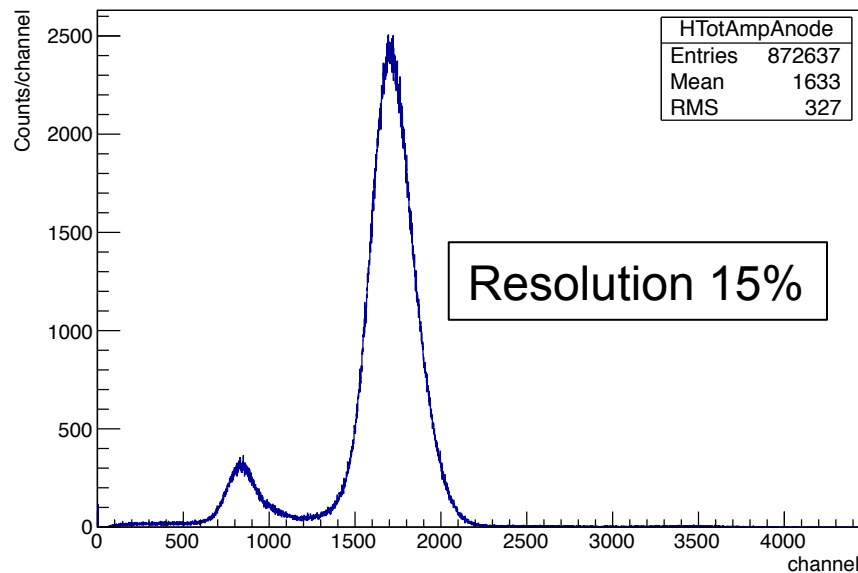


Protection Diodes

Protection Diodes



Anode total amplitude spectra

**Energy resolution:**

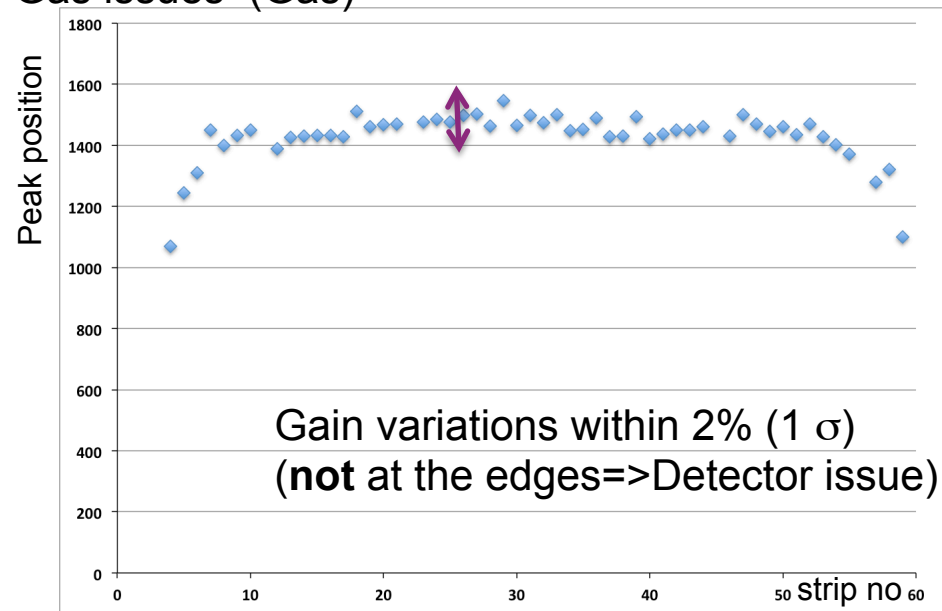
- strip shortcut: 13.5% (vs 11% for std microbulk)
- adding strips: 15%

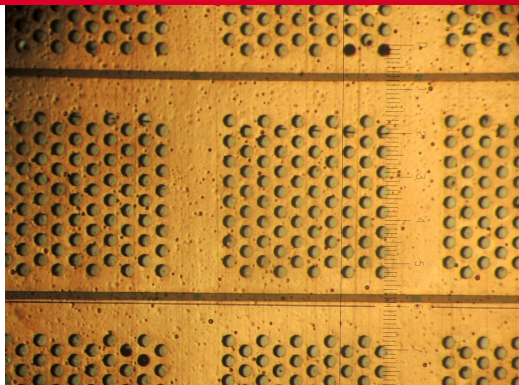
The degradation might be due to:

- additional electronic noise
- strip not crossing the threshold
- gain variation from strip to strip

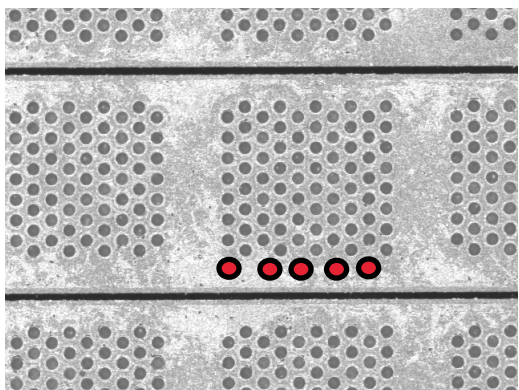
Gain strip variation may have 4 components:

- Strip to strip HV variation (HV cards)
- Channel gain variation (DAQ)
- Field degradation at border (Detector)
- Gas issues (Gas)

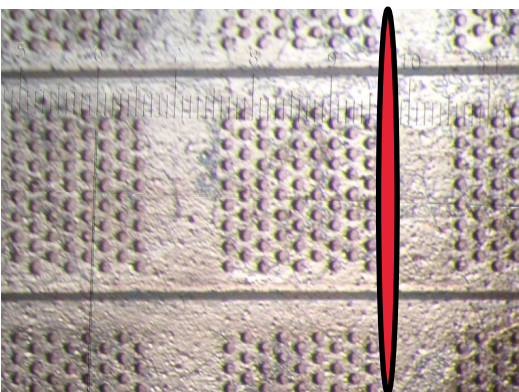


**3rd prototype:**60 μm hole \varnothing , 100 μm pitch

10 columns of 8 holes

Interstrip spacing: 35 μm Energy resolution (strips shortcut) @5.9 keV: **12%****1st final detector:**60 μm hole \varnothing , 100 μm pitch

5 columns of 8 holes + 5 columns of 7 holes

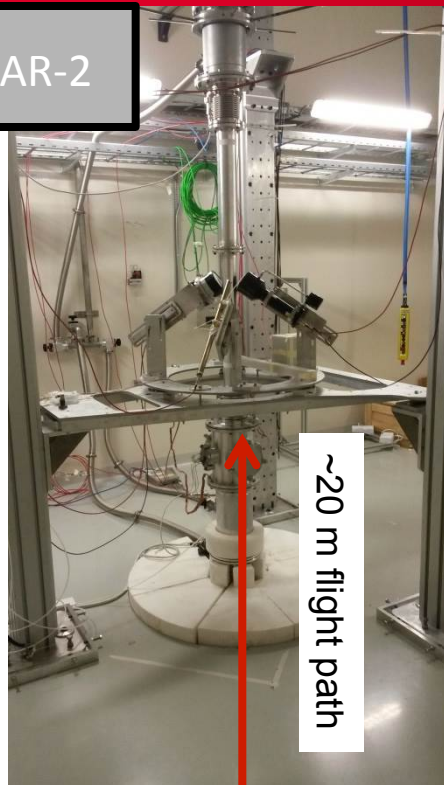
Interstrip spacing: 60 μm Energy resolution (strips shortcut) @5.9 keV: **13.5%****2nd final detector:**60 μm hole \varnothing , 100 μm pitch

9 columns of 8 holes

Interstrip spacing: 60 μm Energy resolution (strips shortcut) @5.9 keV: **19%**Peak is not symmetric (tail position depends on V_{drift})

THE n_{TOF} FACILITY (CERN)

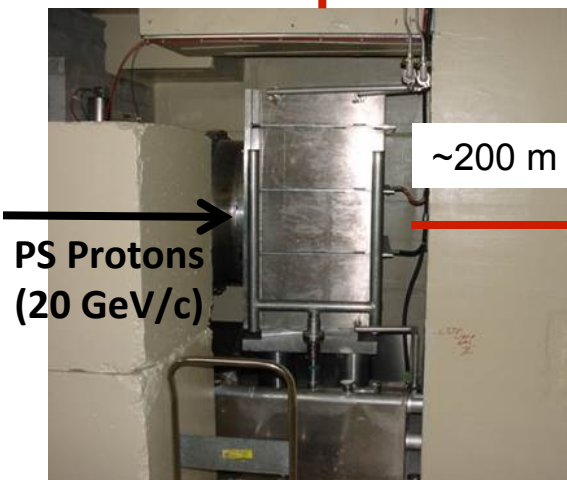
EAR-2



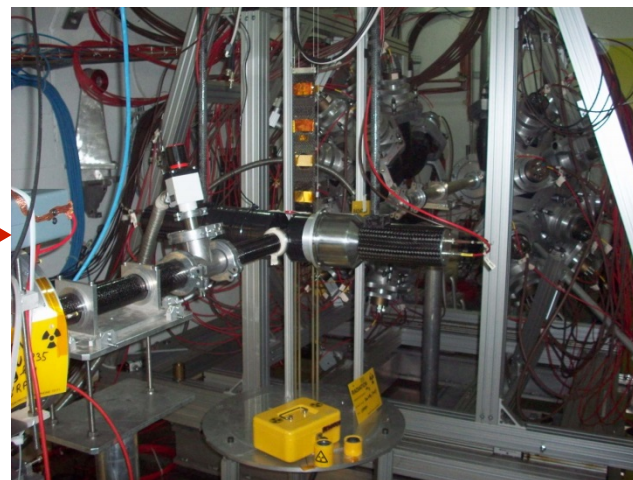
~20 m flight path

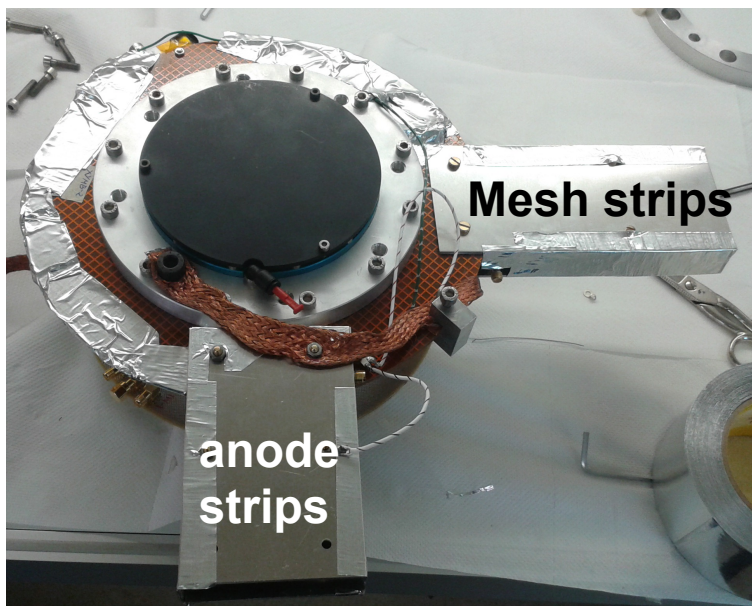
Neutron beam characteristics:

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 > 1 s
5. Excellent energy resolution

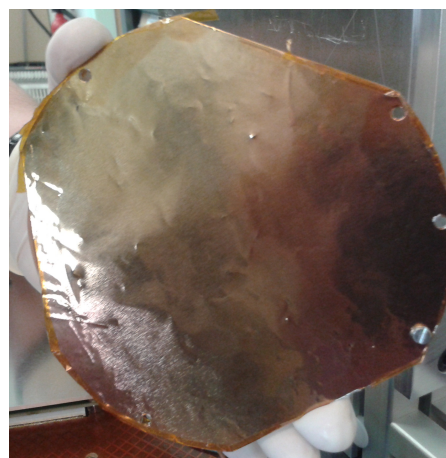
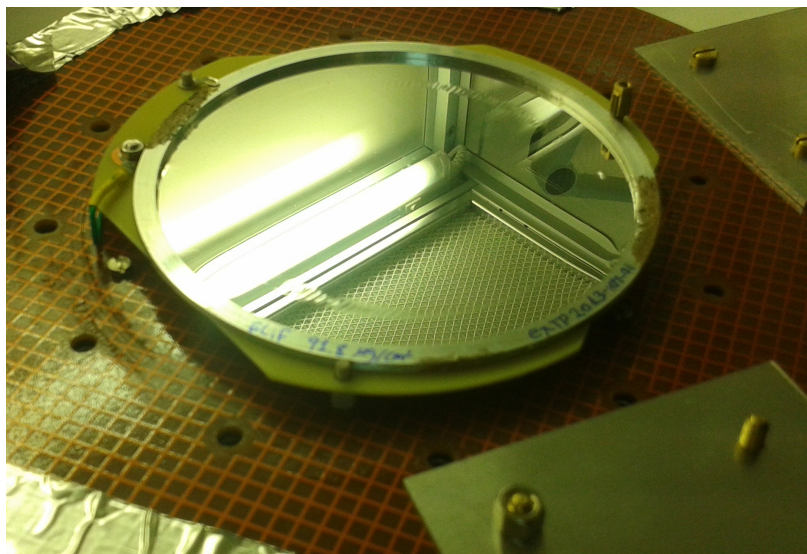
PS Protons
(20 GeV/c)

~200 m flight path

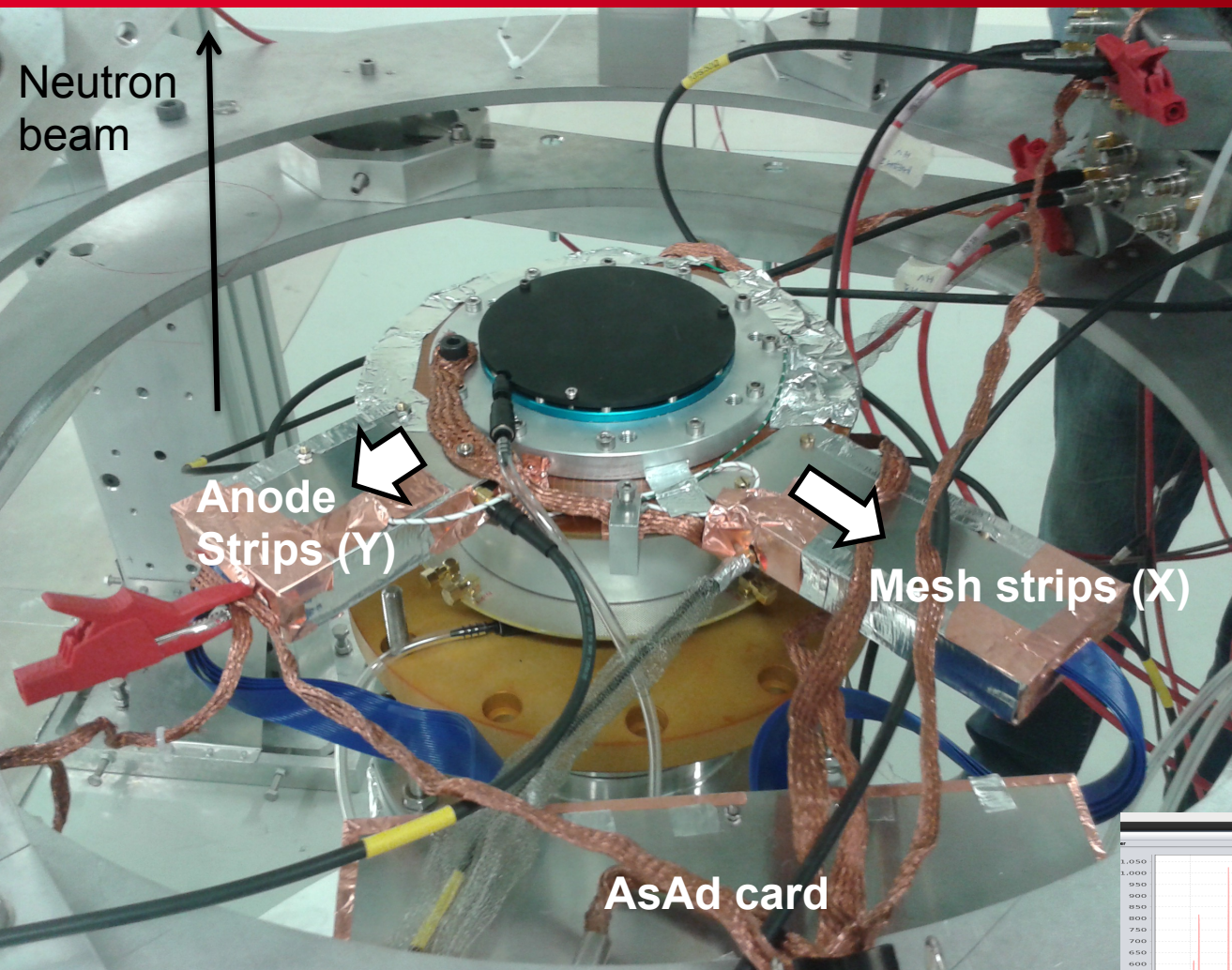




- Proper grounding + shielding essential.



- ${}^6\text{LiF}$ target,
91.8 $\mu\text{g}/\text{cm}^2$
(EXTP 2013-104-01)

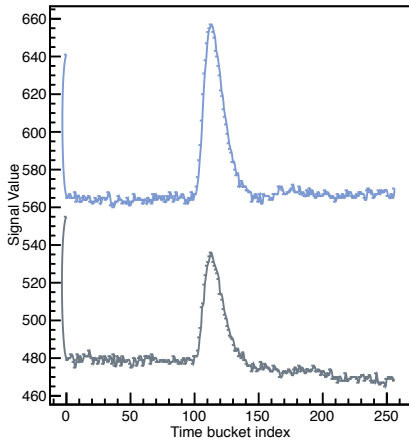


- AsAd card very close to beam.
- $V_m = 310 \text{ V} / V_d = 750 \text{ V}$.
- Through n_TOF DAQ:
 - 1) Sum signal (neutron flux)
 - 1) Trigger signal
 (with conventional preamps)



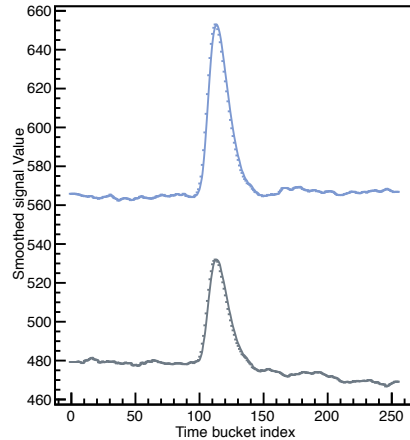
Initial pulses

AGET 1_Frame 0



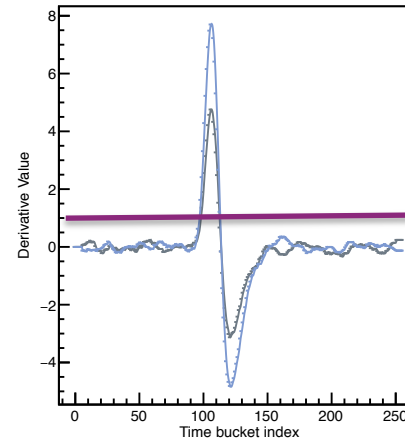
Smoothed pulses

AGET 1_Frame 0

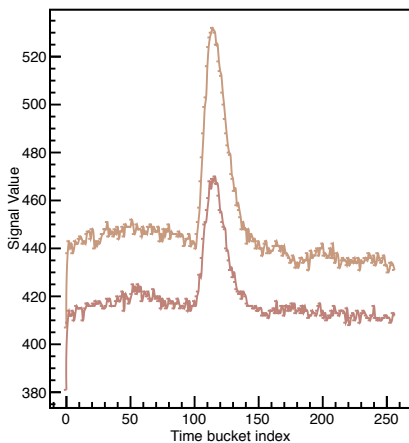


Derivative pulses

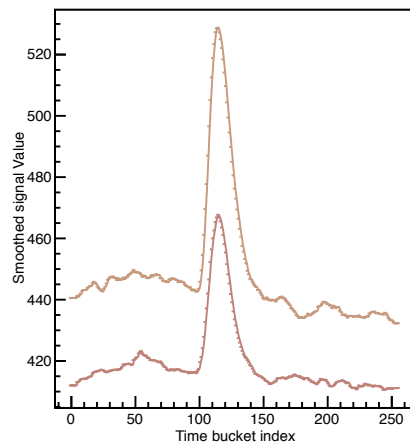
AGET 1_Frame 0



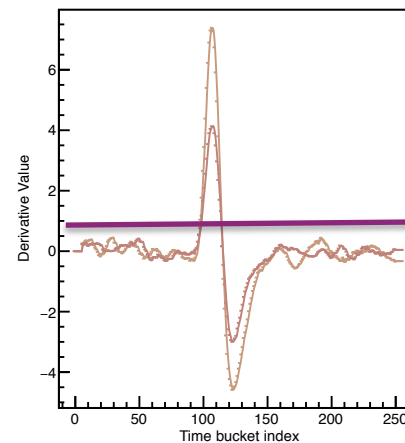
AGET 3_Frame 0



AGET 3_Frame 0



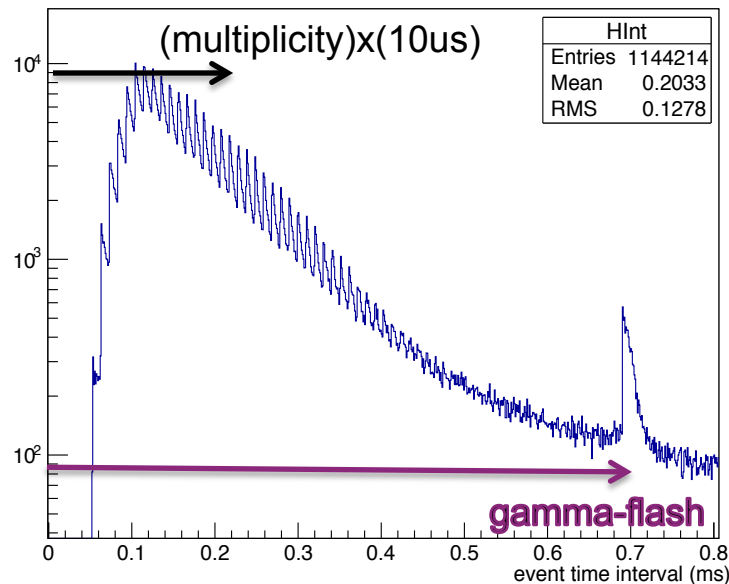
AGET 3_Frame 0



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

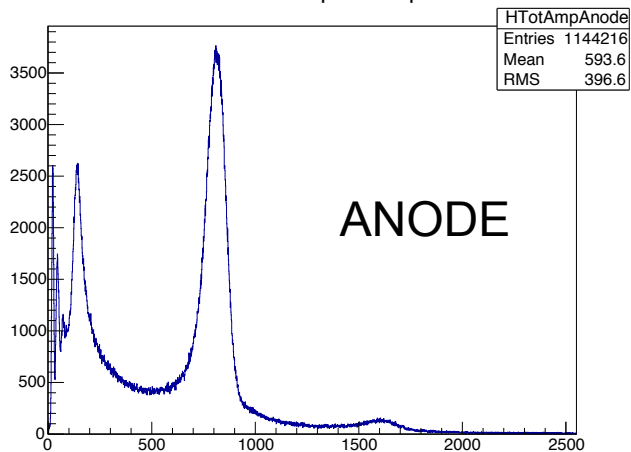
Peak useful parameters are stored (**A**mplitude, **P**eak position, TOT etc)
Event useful information is stored (Time of event, multiplicities etc)

1) Interval time between consecutive events:

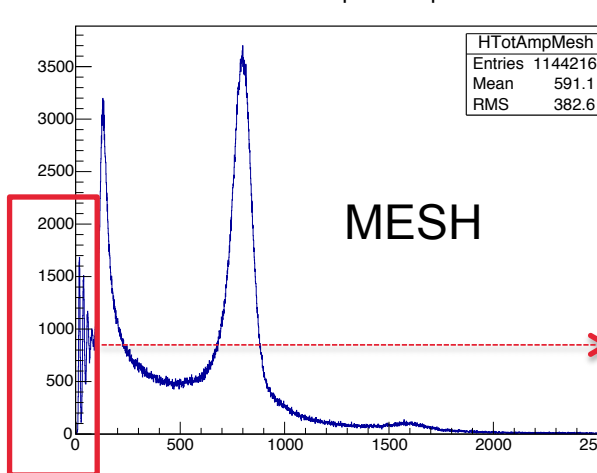


2) Total Amplitude histogram (sum of strip amplitudes for each event):

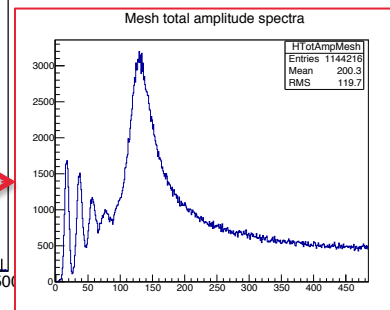
Anode total amplitude spectra



Mesh total amplitude spectra



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

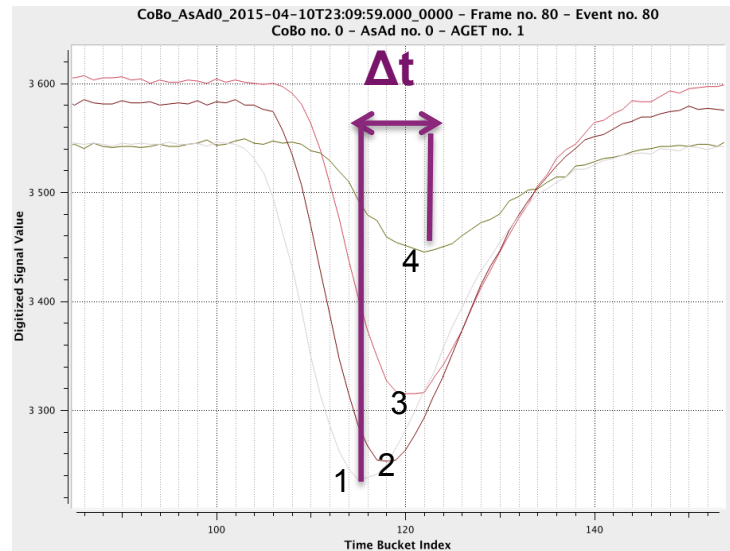
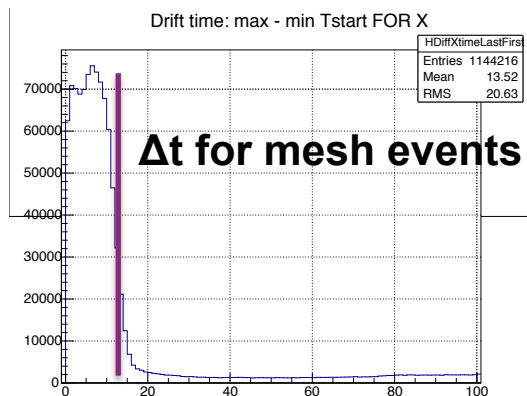


Low energy deposition events => to be cleaned.

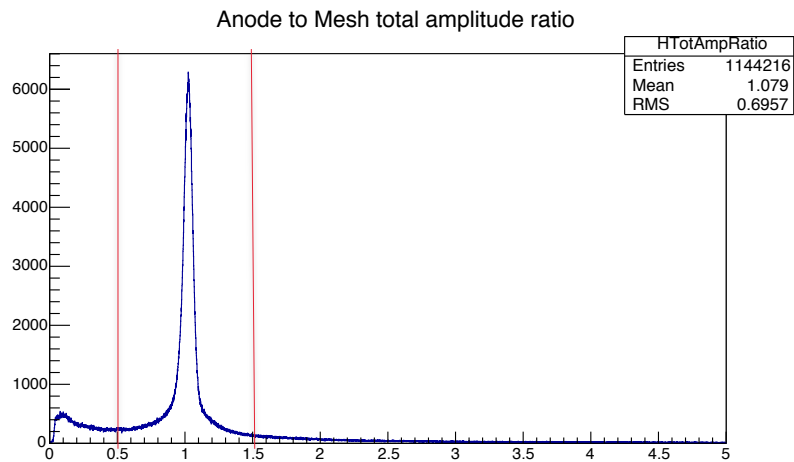
From each event + for each dimension we calculate the time difference between first and last strip hit (Δt)

Criterion 1:

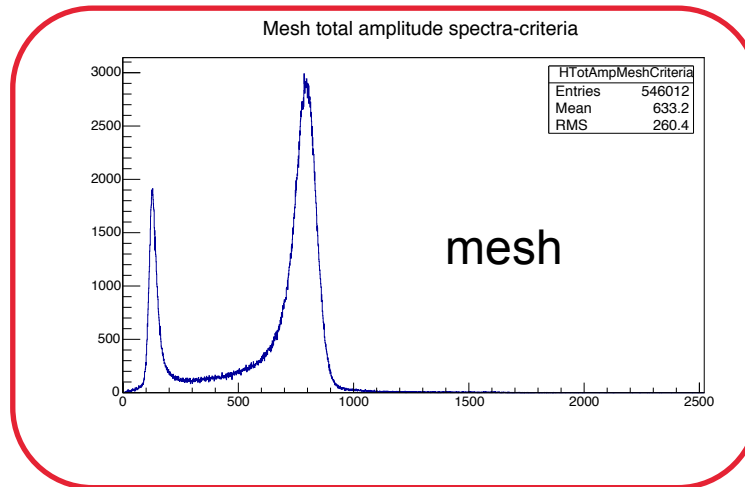
$$\Delta t \leq (\text{drift space}) / (\text{drift velocity})$$



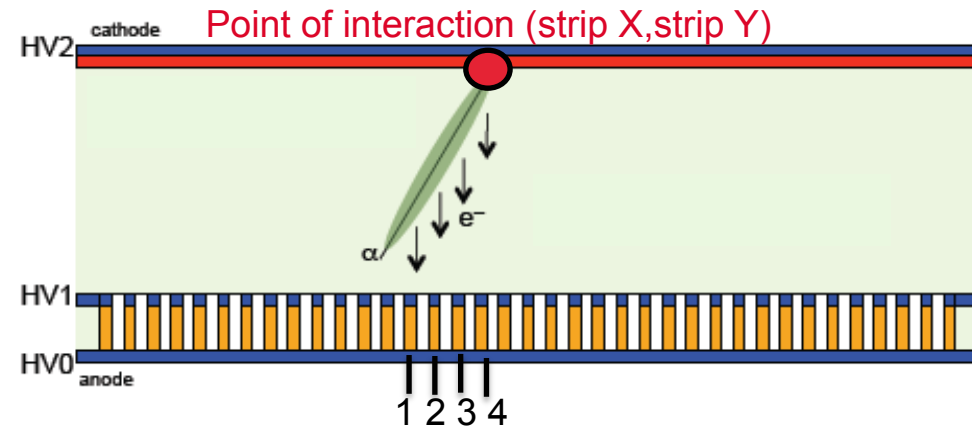
Criterion 2: $0.5 < \text{tot amp ratio} < 1.5$



Final total amplitude hist much cleaner:

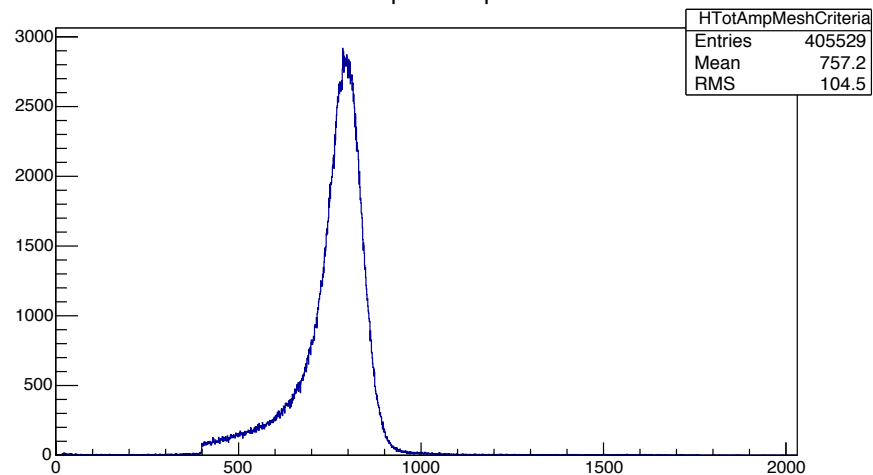


Criterion 3: strips hit have to be consecutive=> pile-up events rejected



Criterion 3: Only alphas

Mesh total amplitude spectra-criteria



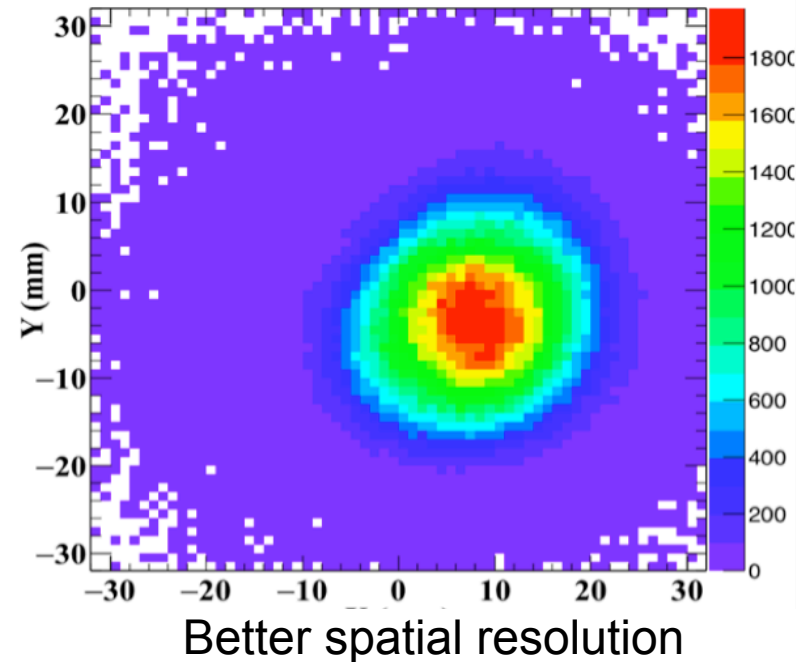
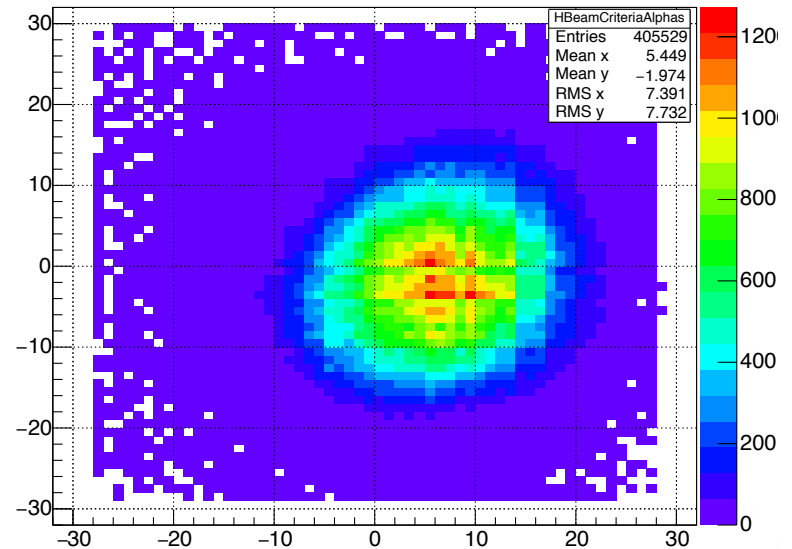
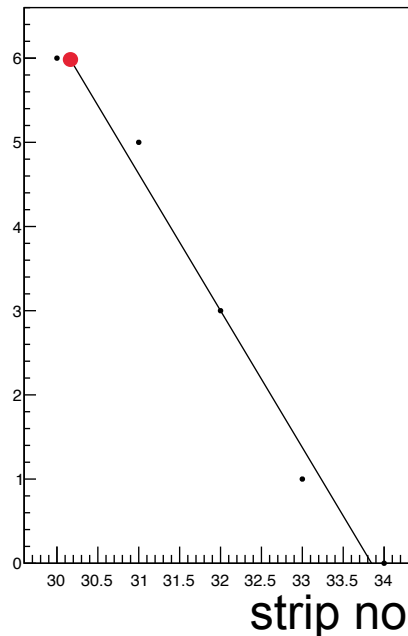
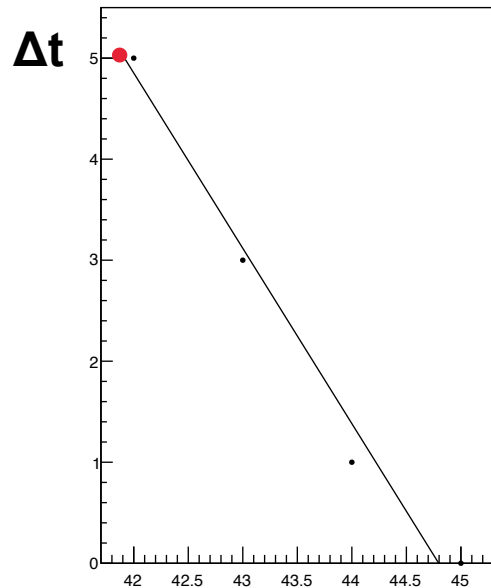
1) Taking the last strip that gave signal:

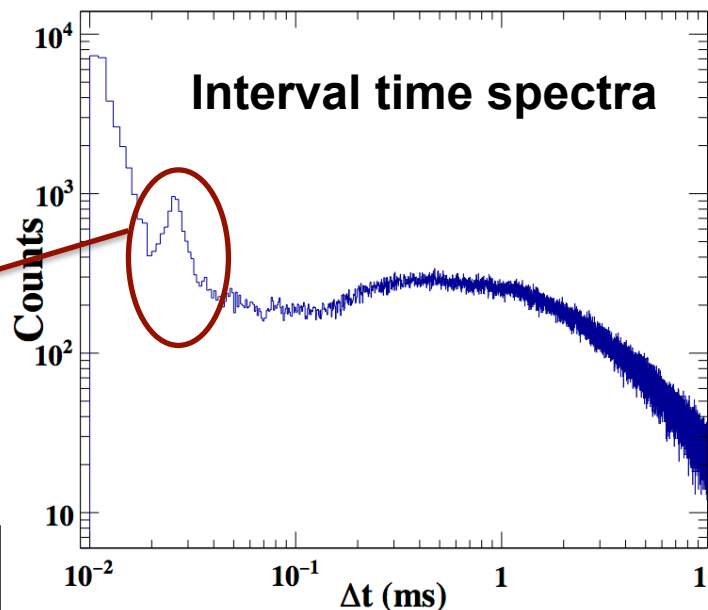
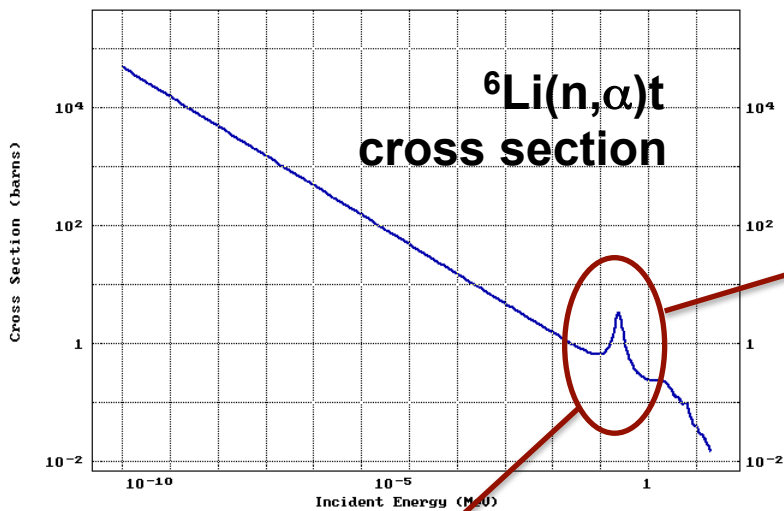
- Distorsion due to threshold variation between strip

2) Particle track fitting:

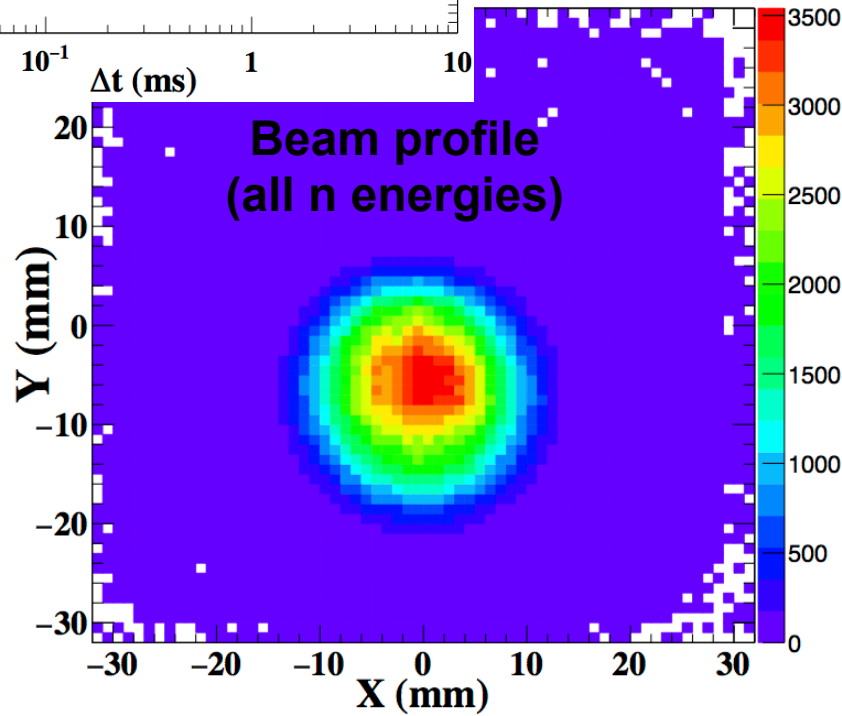
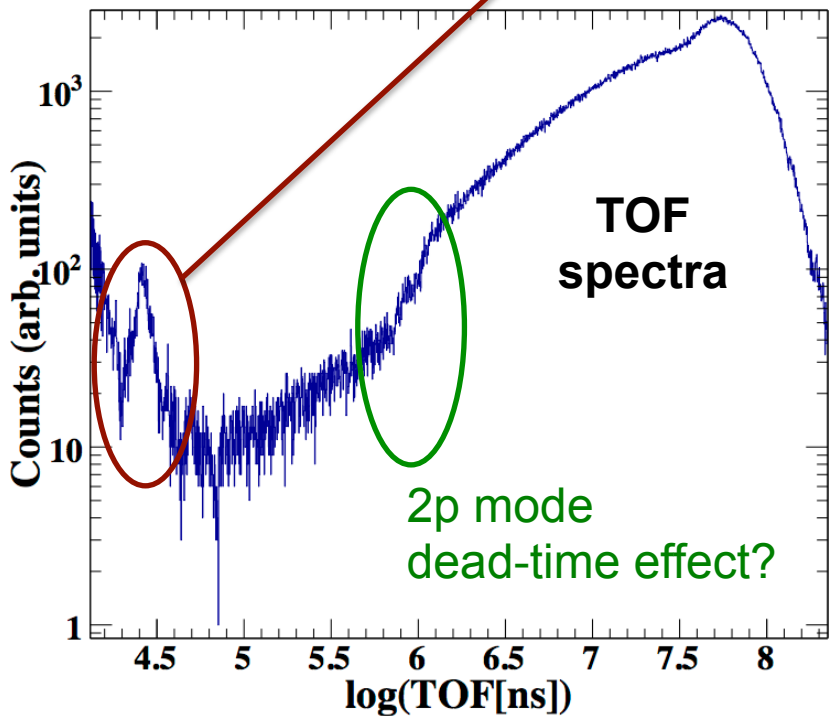
Track_X_FRAME 12

Track_Y_FRAME 12





GET system in 2p mode configuration to go higher in neutron energy

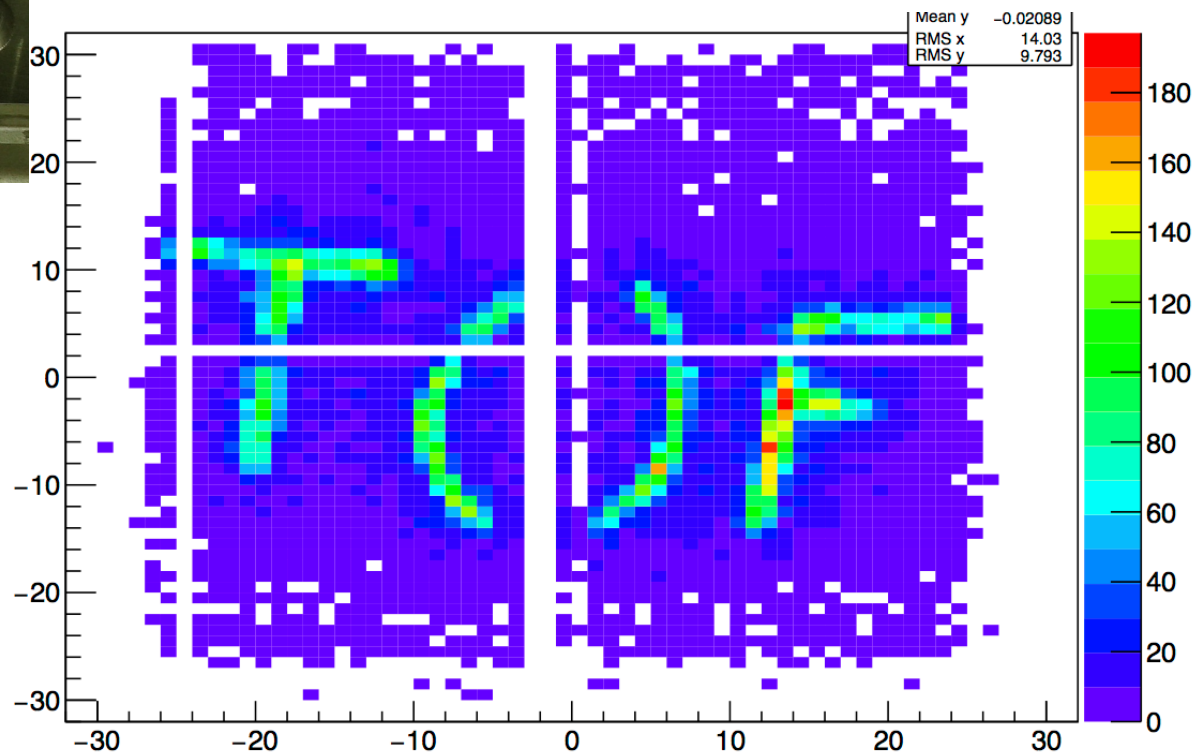
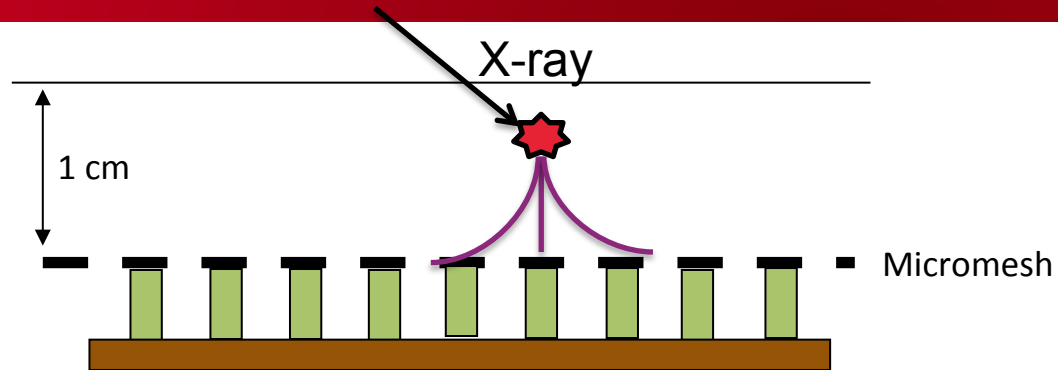


- XYMGAS neutron beam profiler in operational mode.
The electronics were improved
Will stay permanently in-beam at n_TOF.
- Further improvements in the design of the detector for the next production, based on the tests performed is foreseen.
- Neutron fluence determination through the sum signal has to be improved.
- 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.

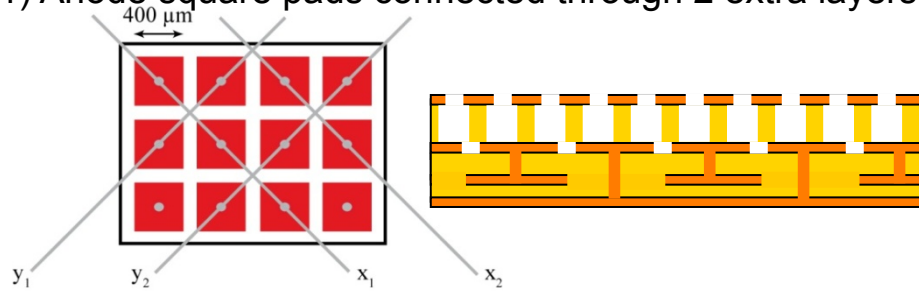
.....Thank you.....

EXTRA SLIDES

RECONSTRUCTED MASK IMAGE X-RAYS



1) Anode square pads connected through 2 extra layers.



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

