A ^{3}He based microstrip gas chamber with a novel 2D readout

WP9.3

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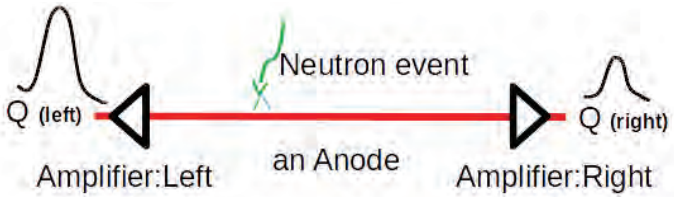
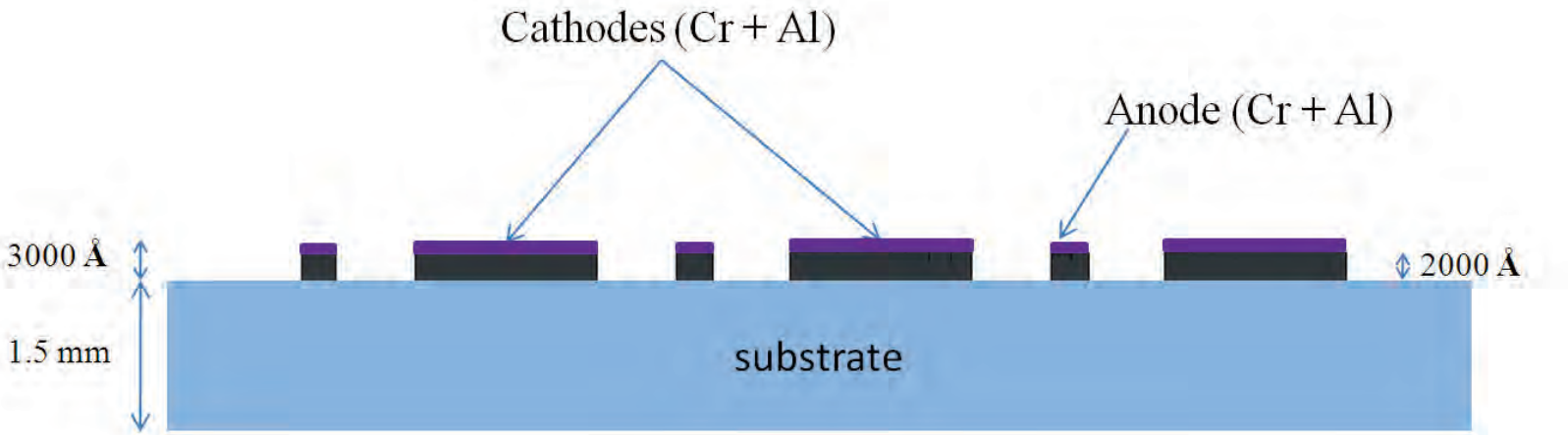
Previous microstrip

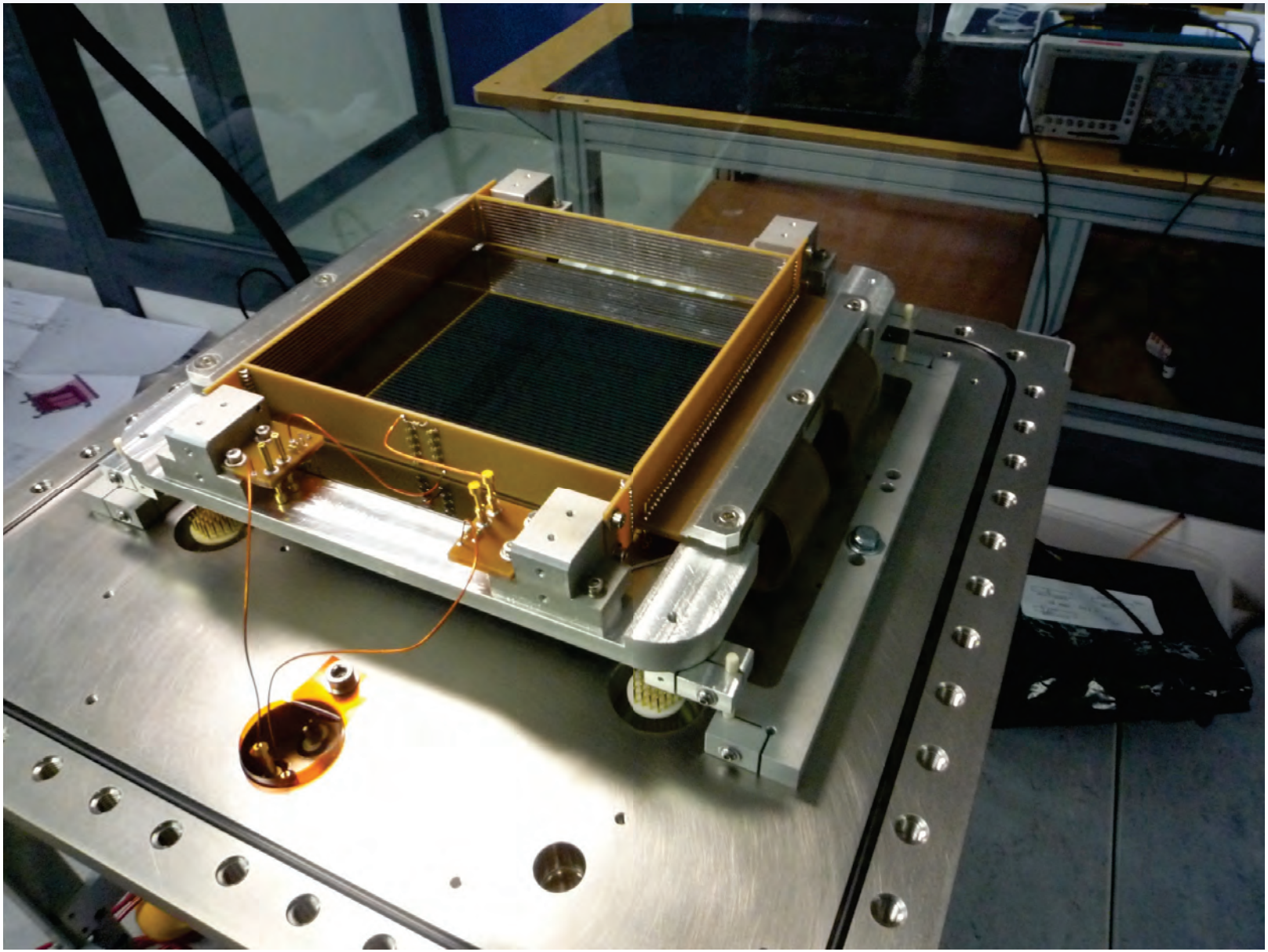
Design:

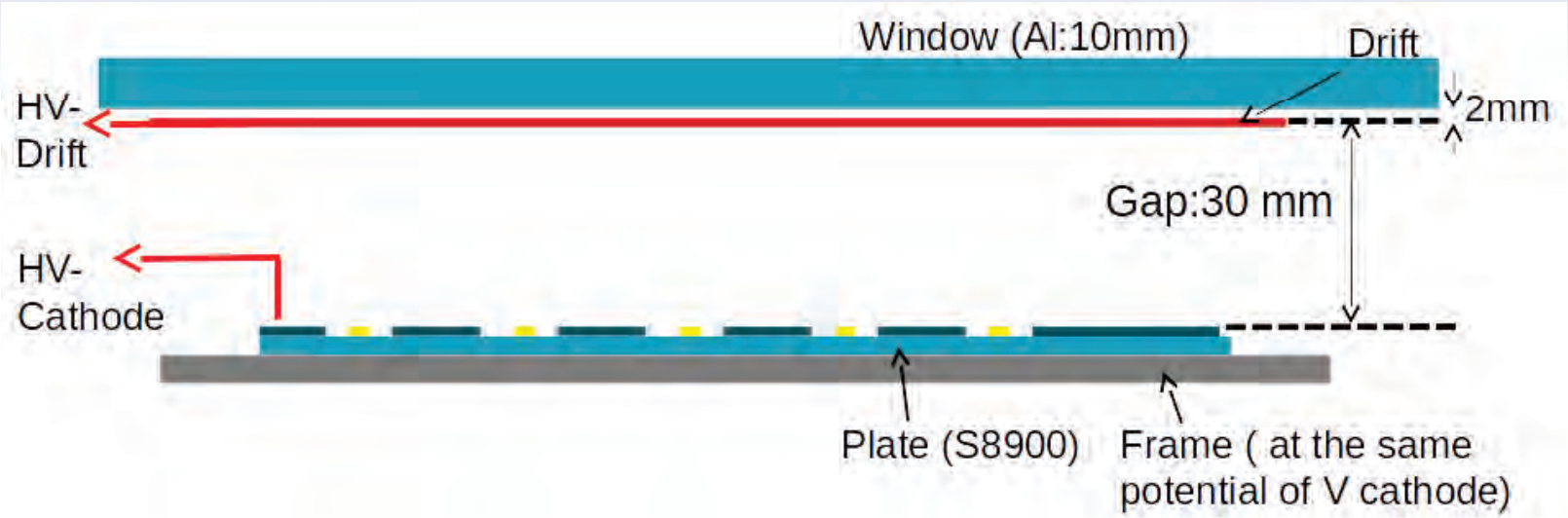
- 64 individual anode strips,
- 2500 μm pitch,
- Anode width = 15 μm,
- Anode-Cathode gap = 300 μm,
- Anode length = 173.7 mm
- Schott S8900 plate
- 100 nm Al on 200 nm Cr to reduce anode resistance (7.8 kΩ)

- Signals are read via 64 individual Anodes (0 V)
- Negative voltage applied on Cathode (-1.5 kV to -1.8 kV)
- Charge Division Method







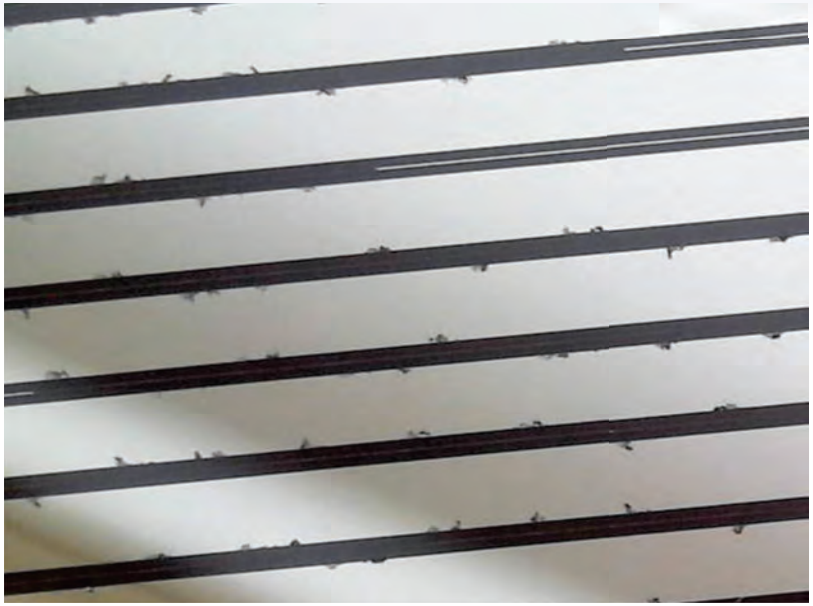


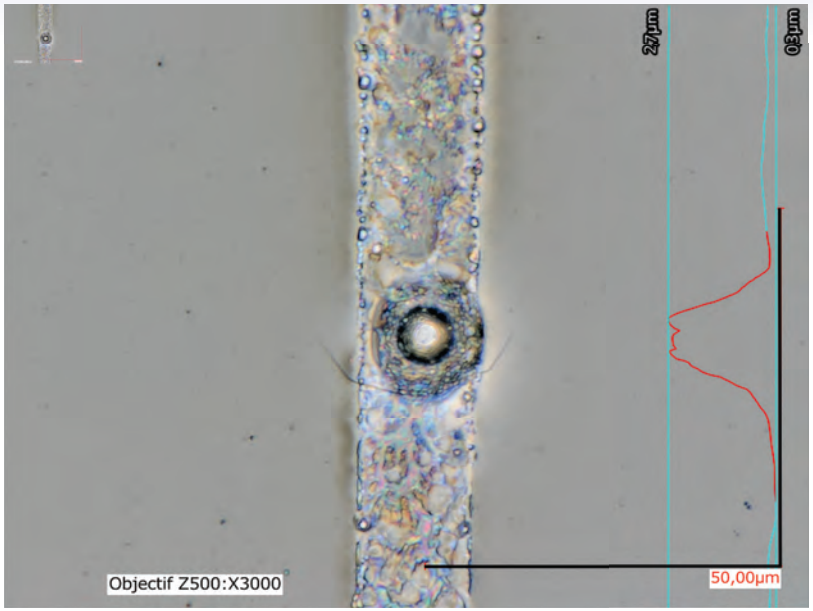
- Drift : -2.5 kV
- Guard ring (to avoid edge electrical field distortion)
- Conversion Gap : 30 mm
- Gas ^{3}He (2 bar) + CF_4 (3 bar) $\sim$ 67.05% of efficiency (λ=2.5Å, 10 mm Al window + 30 cm Gap of ^{3}He)

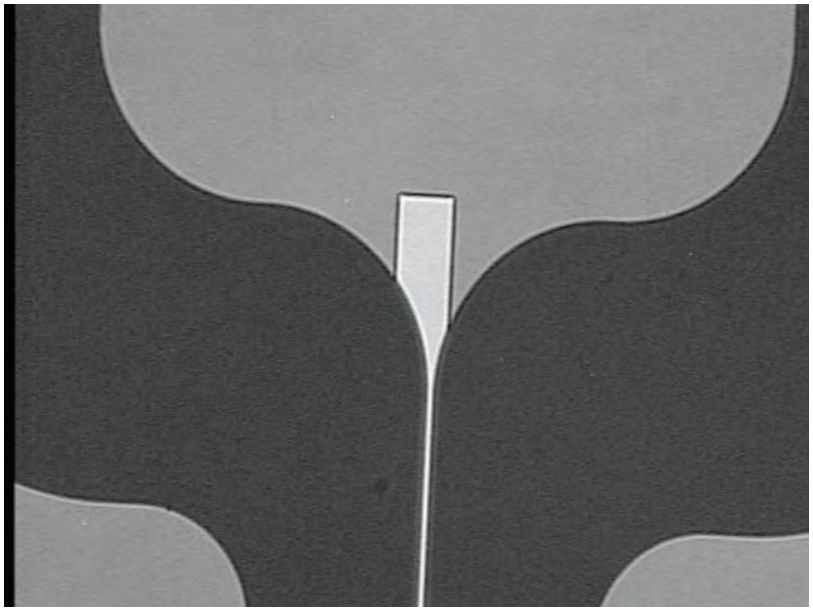
Results (2011)

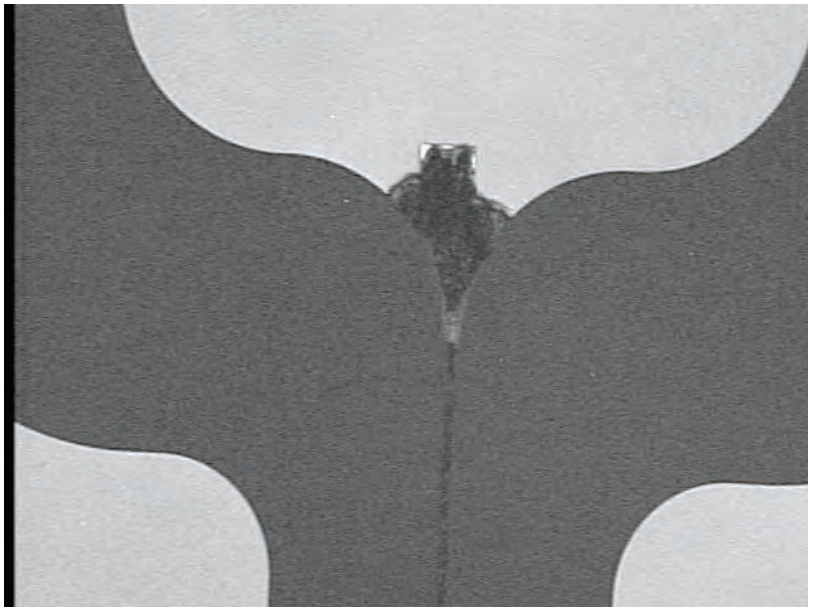
Resolution 1.56 mm

Problem : very quick ageing (44% gain drop in 3 hours, unrecoverable)




Objectif Z500:X3000
50,00µm

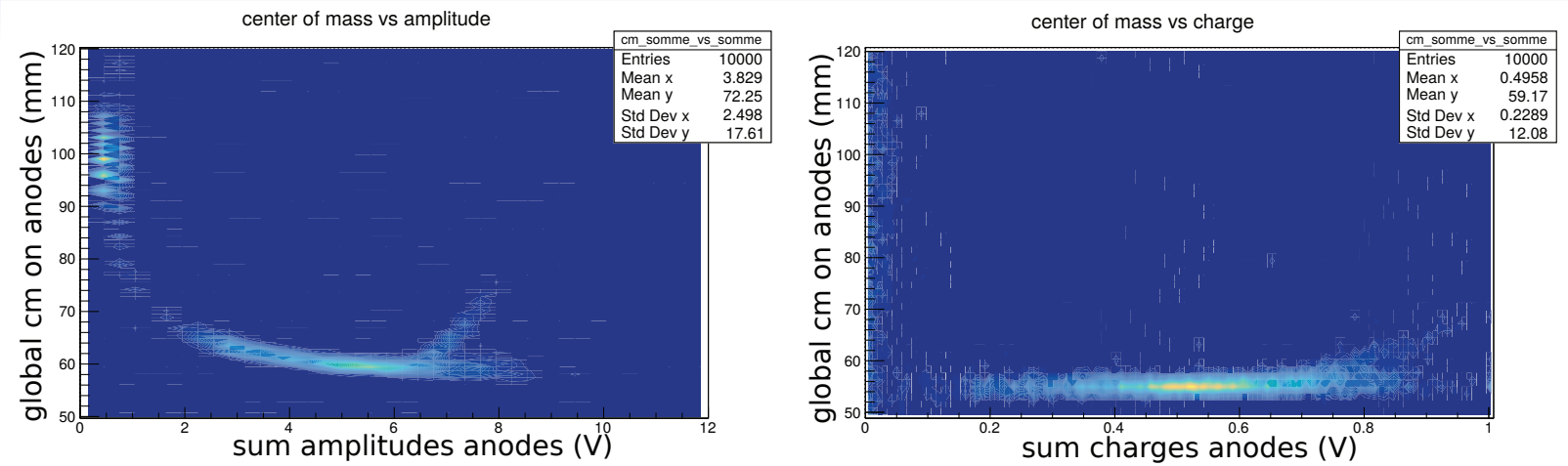




New tests

With $ArCO_2$ instead of CF_4
Expected spatial resolution not as good (lower stopping power)

- Gas ^{3}He (2 bar) + $ArCO_2$ (3 bar) $\sim$ 67.05% of efficiency (λ=2.5Å, 10 mm Al window + 30 cm Gap of ^{3}He)
- Drift : -1.4 kV
- Cathodes to -700 V
- Anodes to $300 - 500$ V

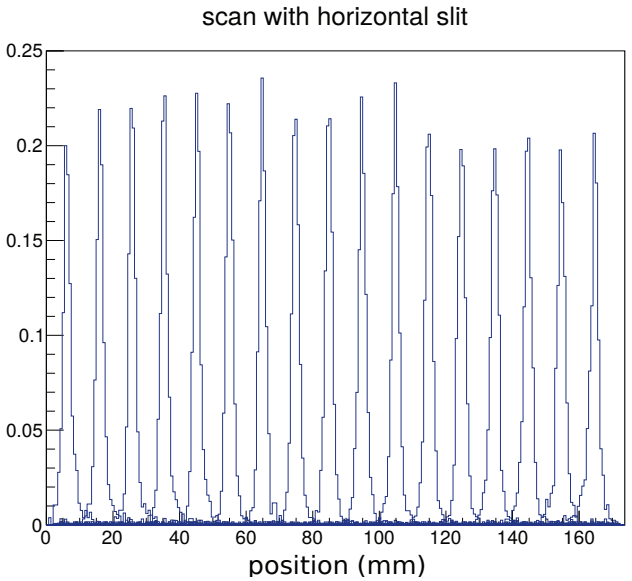


- typical cross-shape can be corrected with offset
- use of integral of signal instead of max. amplitude

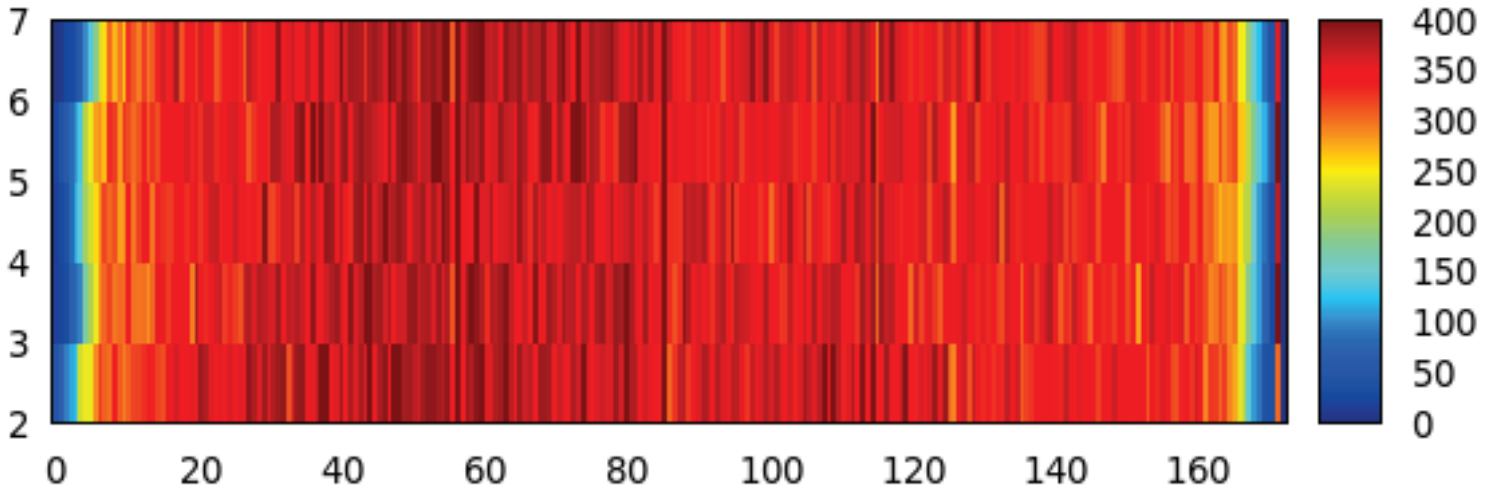
$\Rightarrow$ improved resolution, image "un-shrunk"

Scan with a perpendicular slit every 10 mm

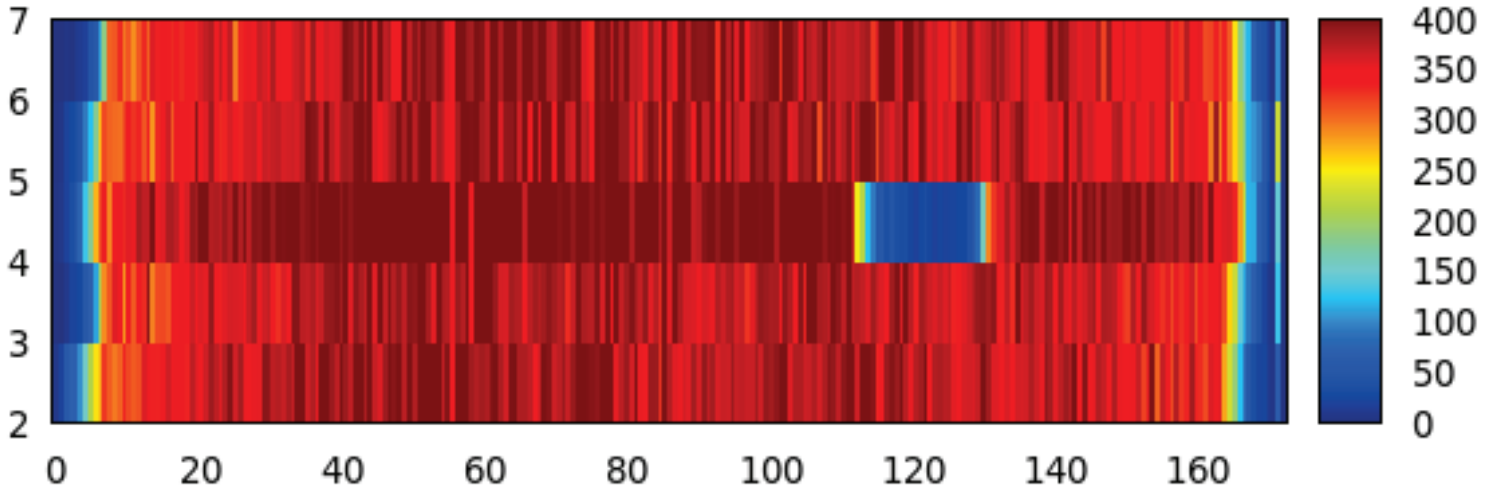
$\Rightarrow$ resolution between 2.5 mm and 3 mm

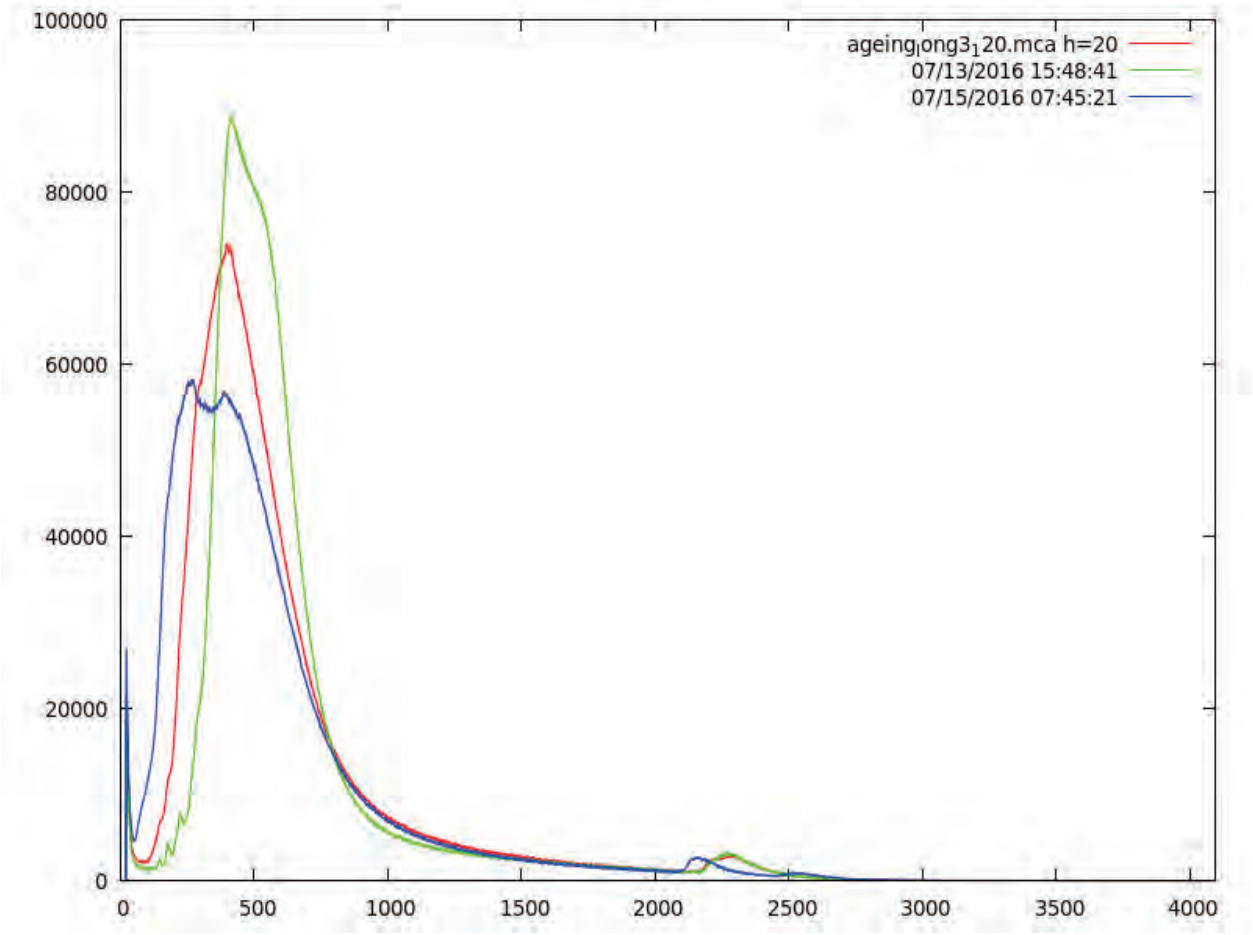


Ageing



irradiation on a 5 mm$\times$5 mm square ($\sim$ 10 kHz/mm anode) during 40 hours





Ageing is not as severe as with CF_4, but strong enough to prevent use on any ILL instrument

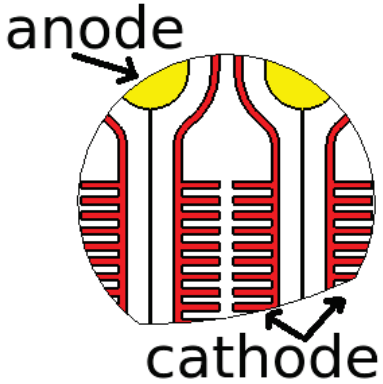
Conclusion

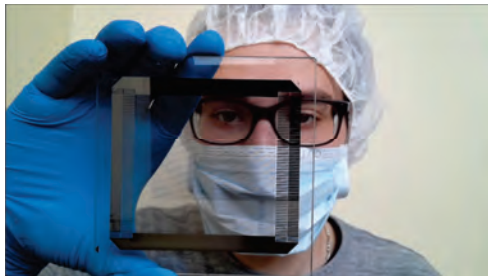
- Successful center of mass reconstruction with $ArCO_2$
- Several leads to determine how to analyse data with new prototype
- Confirmation that Al layer is not a sustainable solution

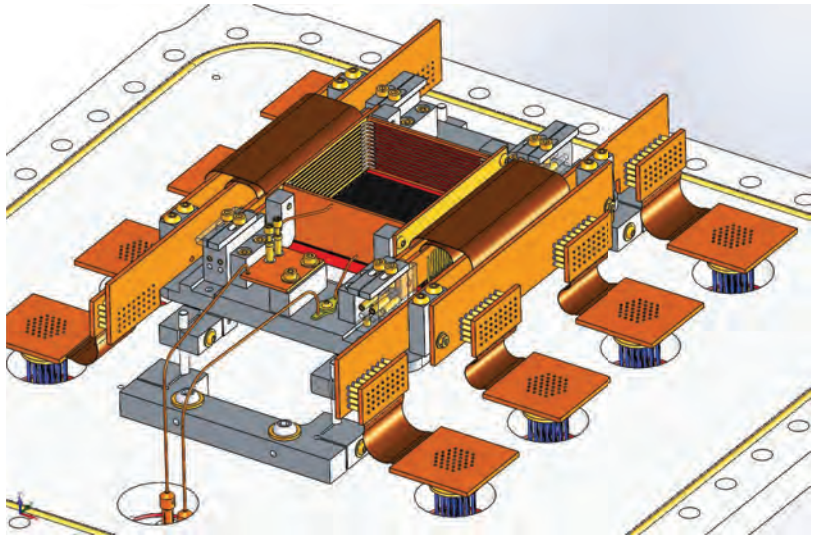
New microstrip

- 64 anodes and cathodes, individual readout
- anodes 10 μm, cathodes 50 μm, length 76.5 mm
- Charge division on cathodes (lower resistance than anodes)
- Chromium strips, no additional layer
- Borofloat 33, not S8900 (cheaper, for prototyping).

5 plates made by IMT (same manufacturer)

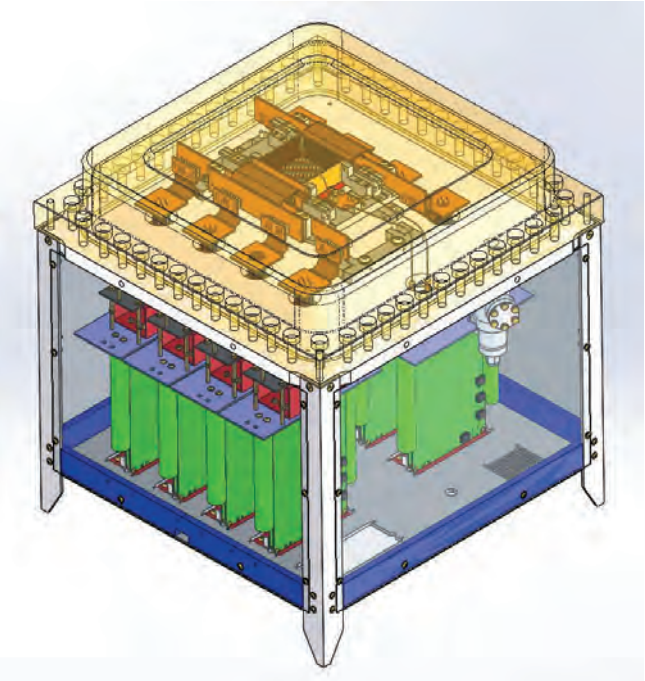






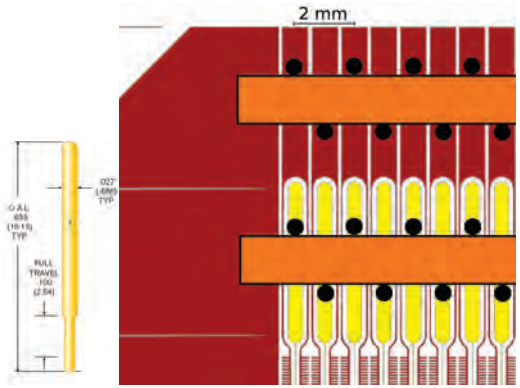
- coupling boards re-used
- charge division boards re-used

- 64 anodes, 64 cathodes
  $\rightarrow 128 + 128 = 256$
  connections
- bidim100 enclosure re-used

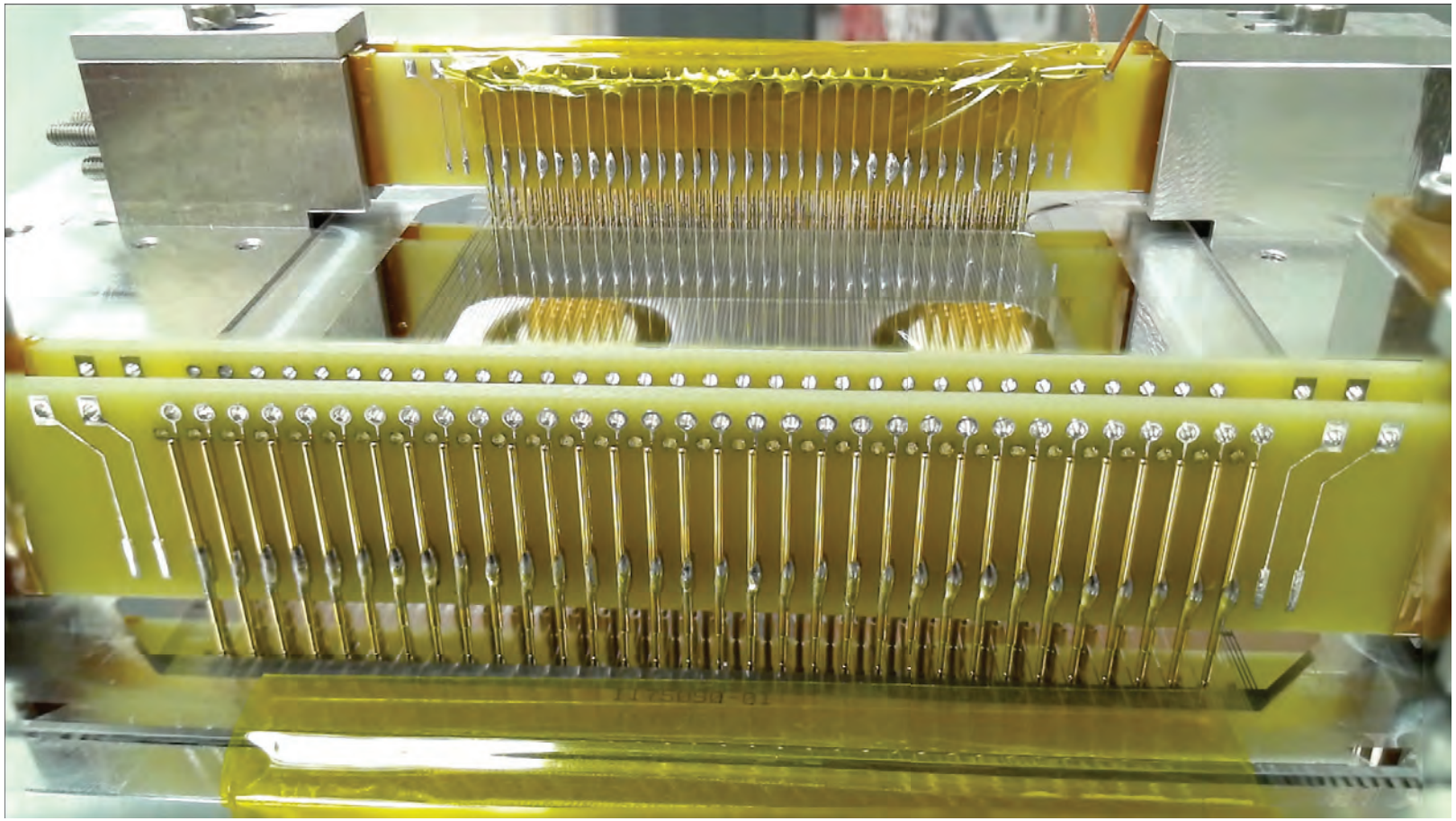


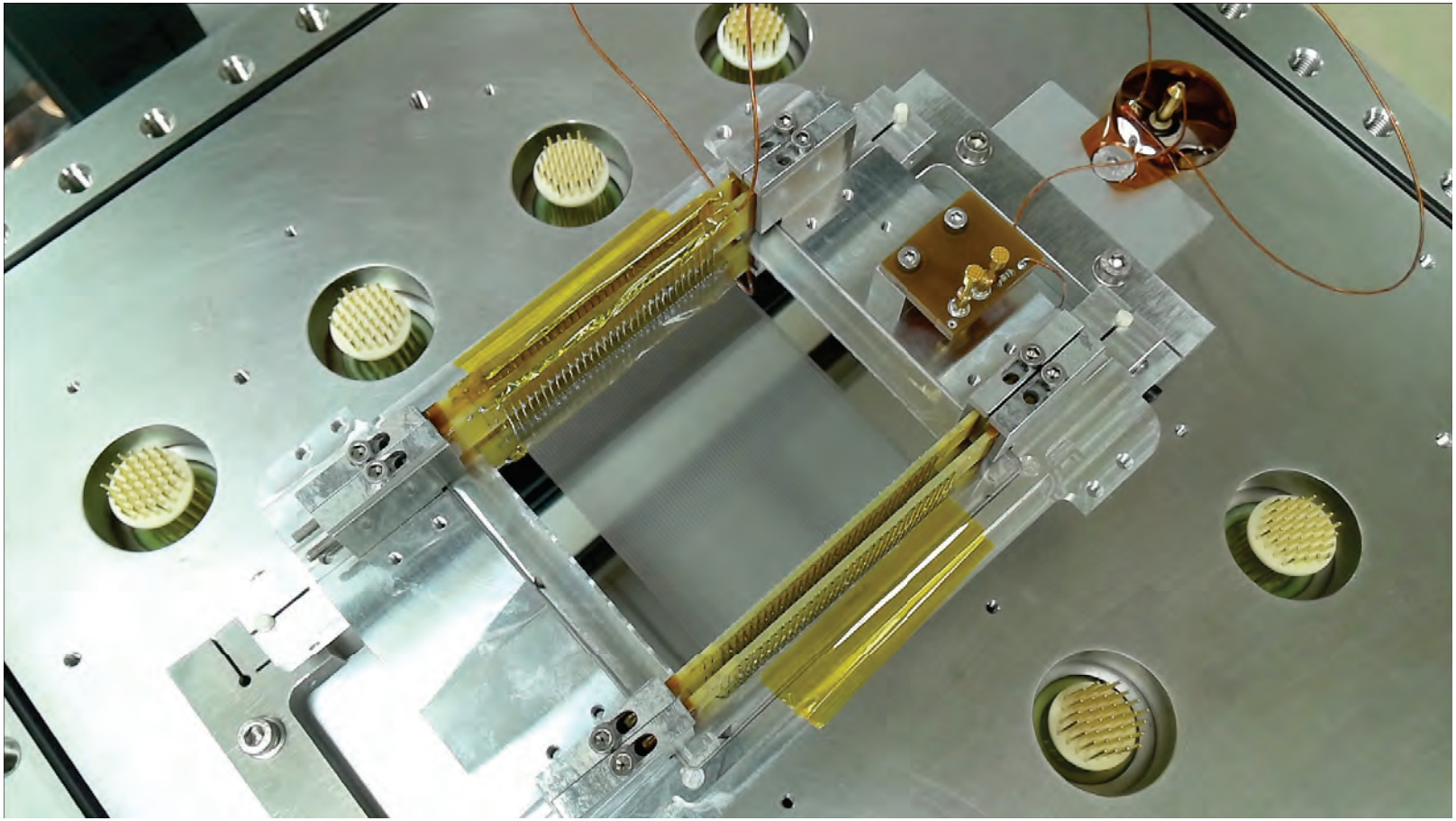
Building the connectors

- Pins are every 2 mm on each side of the connector $\rightarrow$ every 1 mm on the MSGC.
- 2 connectors for the 64 anodes (0.5 mm pads) and 2 connectors for the 64 cathodes (0.8 mm pads).
- Future connectors will be with flexible kapton. To test the design, FR4 and wires.
- Spring probes (spherical head Ø0.5 mm) are used to make contact with the pads



Spring probes can be aligned with the pads optically (with magnification)

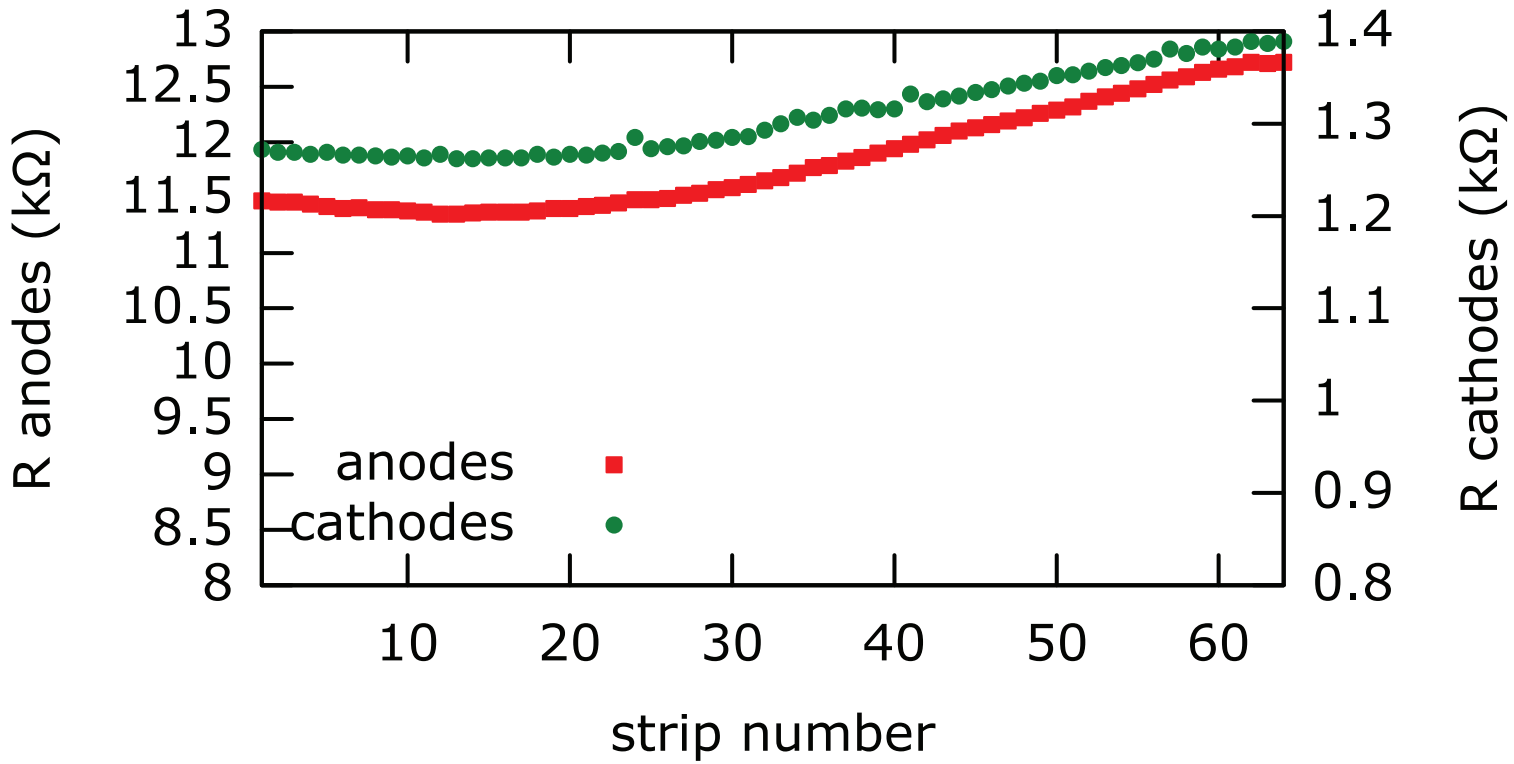




Expected anodes and cathodes resistances

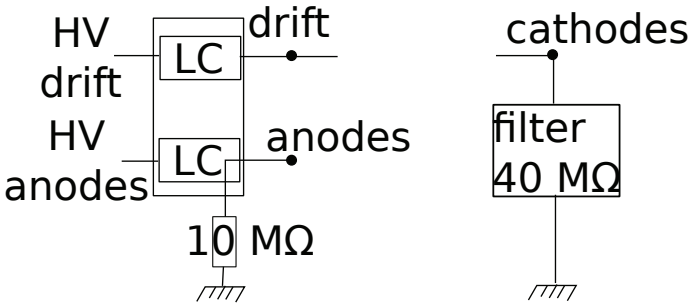
- length $l = 7.65$ cm
- thickness $t = 200$ nm
- anodes width $w_a = 10\ \mu$m
- cathodes width $w_c = 50\ \mu$m
- $R_s = 2.6\ \Omega/\square$

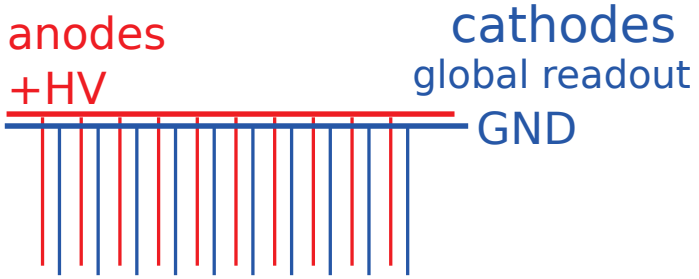
$$R_a = R_s \frac{l}{w_a} = 20\ \text{k}\Omega$$
$$R_c//R_c = \frac{1}{2} R_s \frac{l}{w_c} = 2\ \text{k}\Omega$$



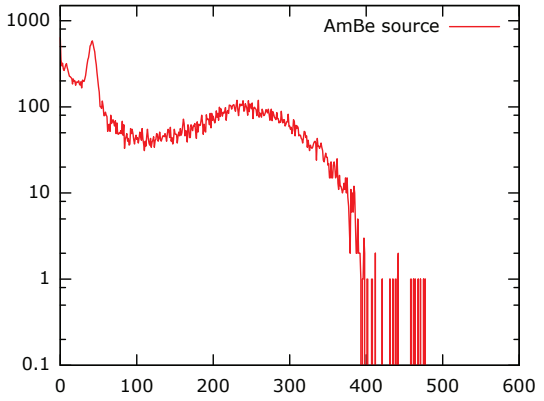
10 % variations

First tests with gammas



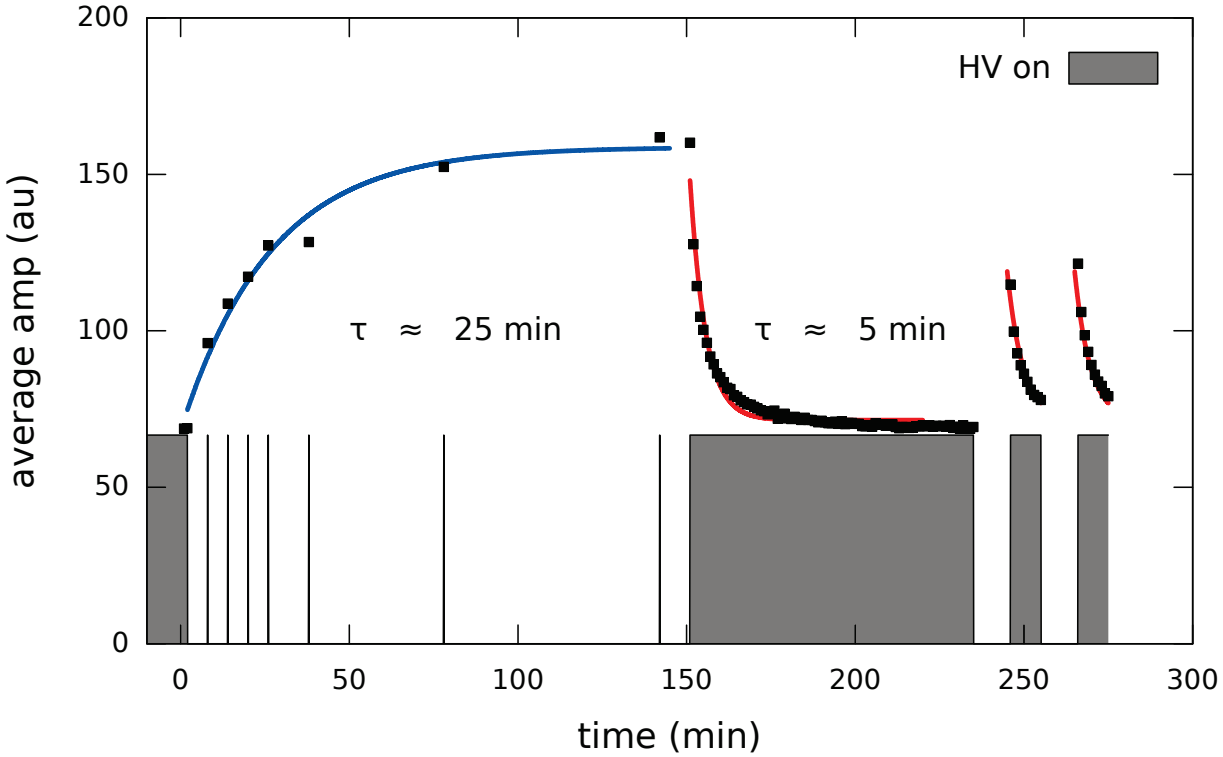


- Tests with 3.5 bar Ar, 0.2 bar CO_2, no helium, gamma detection
- Drift -1000 V
- HV $+850$ V on anodes
- AmBe source
- 60 keV and 14 keV gamma peaks



Glass conditioning

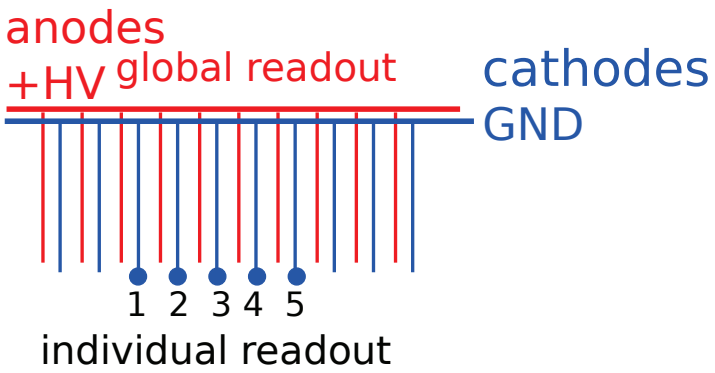
We observe variations of gain depending on how long the detector has been counting (HV-supply+source)



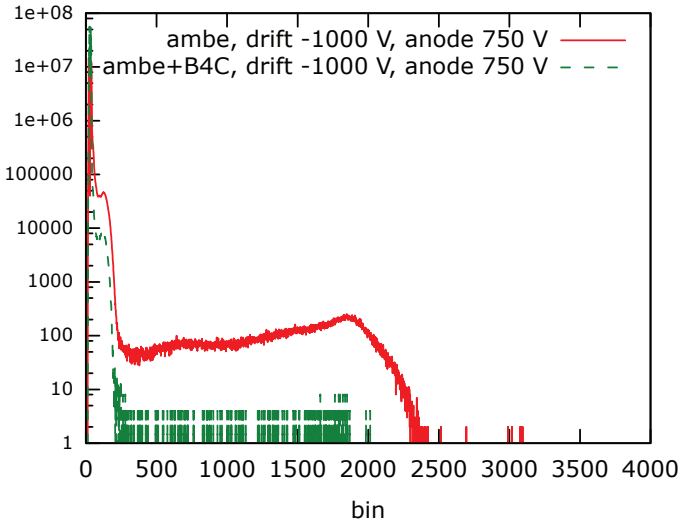
Questions to be answered to :

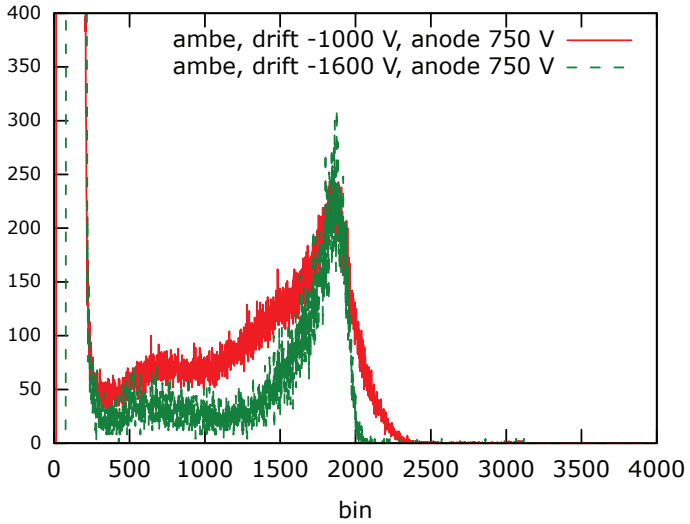
- is it HV dependant?
- is it beam/source dependant?
- is it gas dependant?

Tests with neutrons

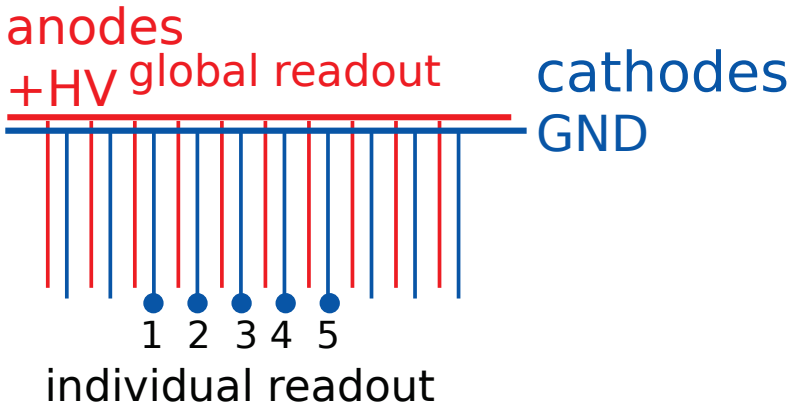


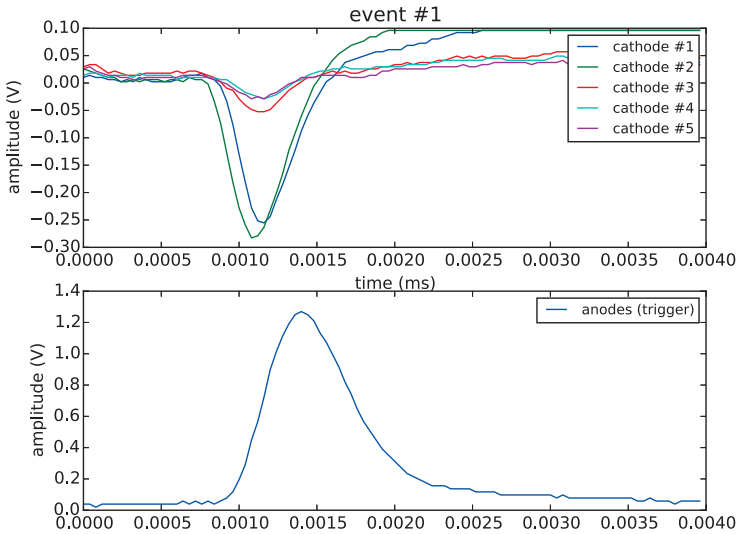
- Tests with 3.5 bar Ar, 0.2 bar CO_2, 1.3 bar ^{3}He
- Drift -1000 V / -1600 V
- HV $+750$ V on anodes
- AmBe source
- 60 keV gamma peak and neutron peak

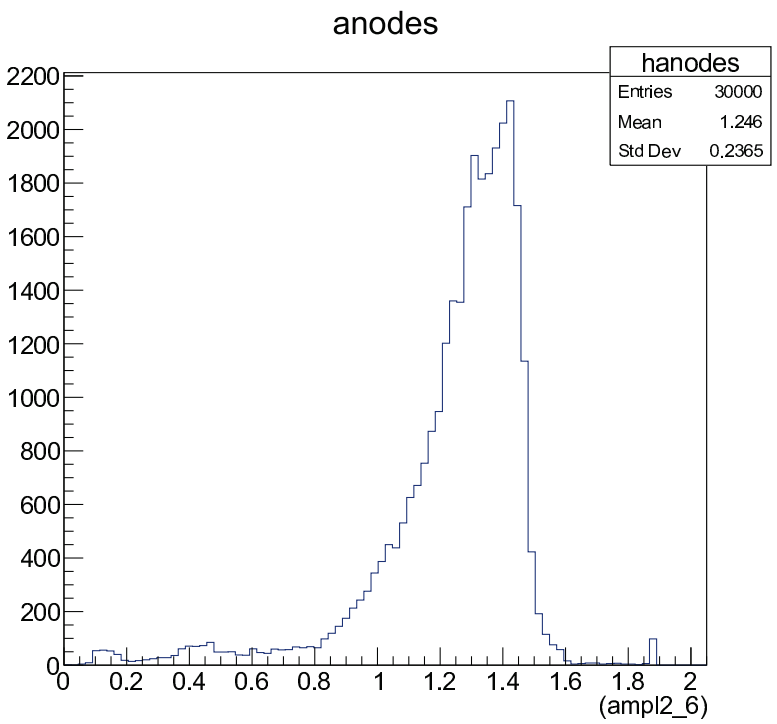


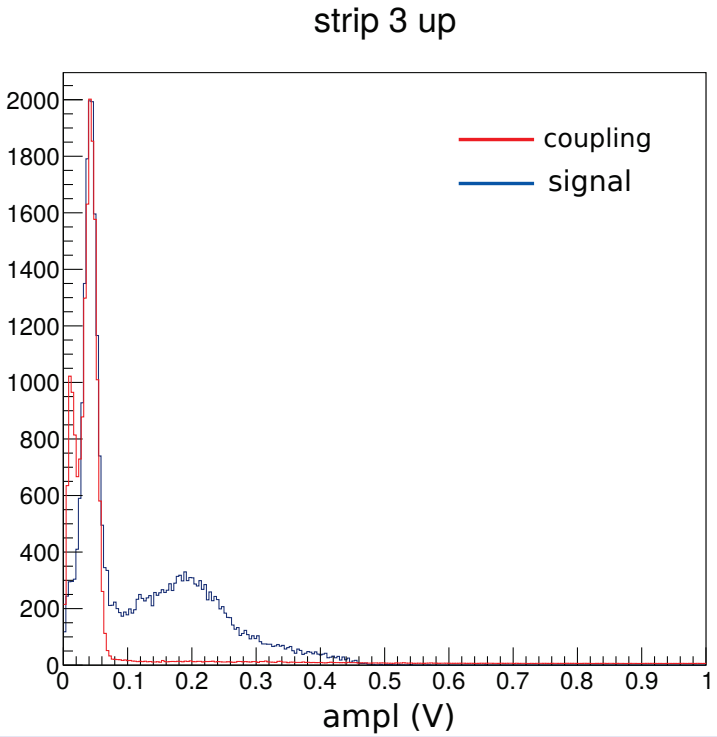


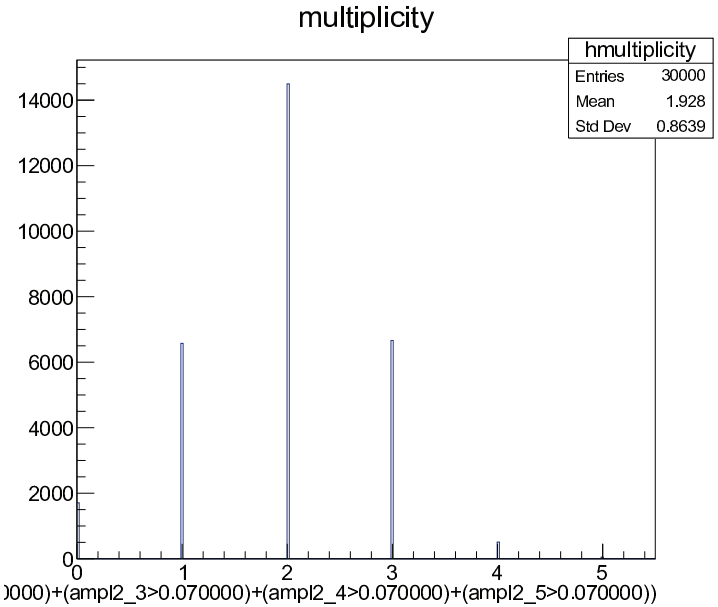
Preliminary tests with neutron beam

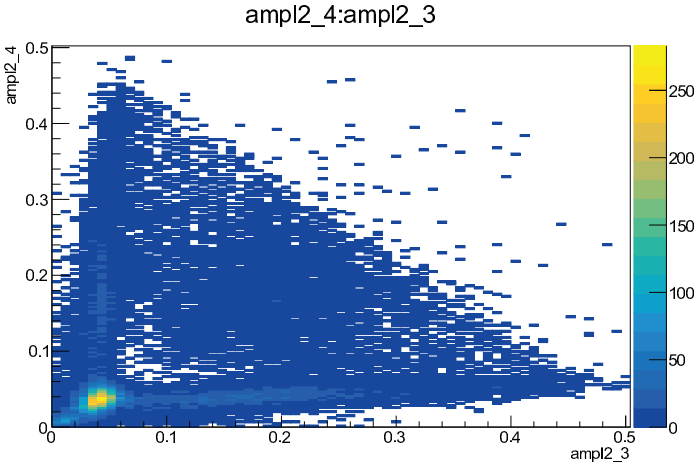









multiplicity
hmultiplicity
Entries 30000
Mean 1.928
Std Dev 0.8639
14000
12000
10000
8000
6000
4000
2000
0
0 1 2 3 4 5
)000)+(ampl2_3>0.070000)+(ampl2_4>0.070000)+(ampl2_5>0.070000))


ampl2_4:ampl2_3
ampl2_4
ampl2_3
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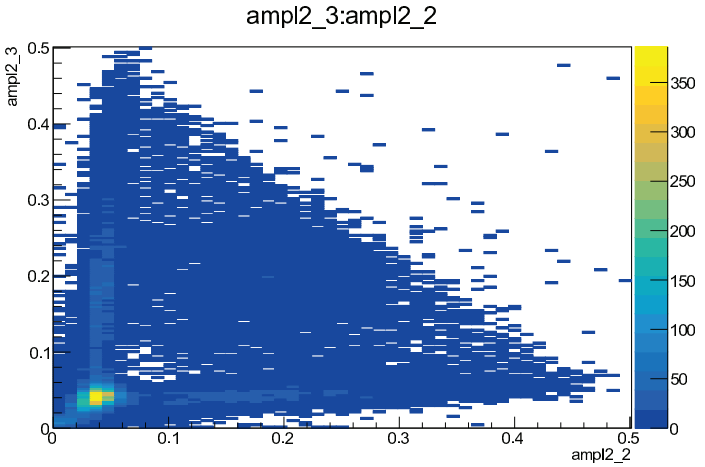
200
150
100
50
0


ampl2_3:ampl2_2
ampl2_3
ampl2_2
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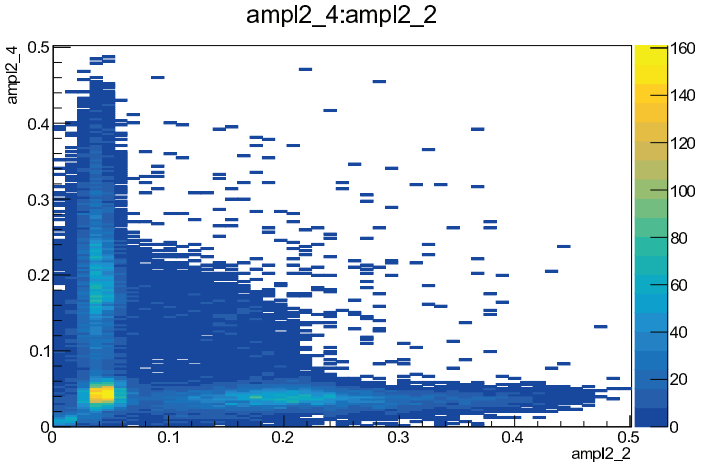
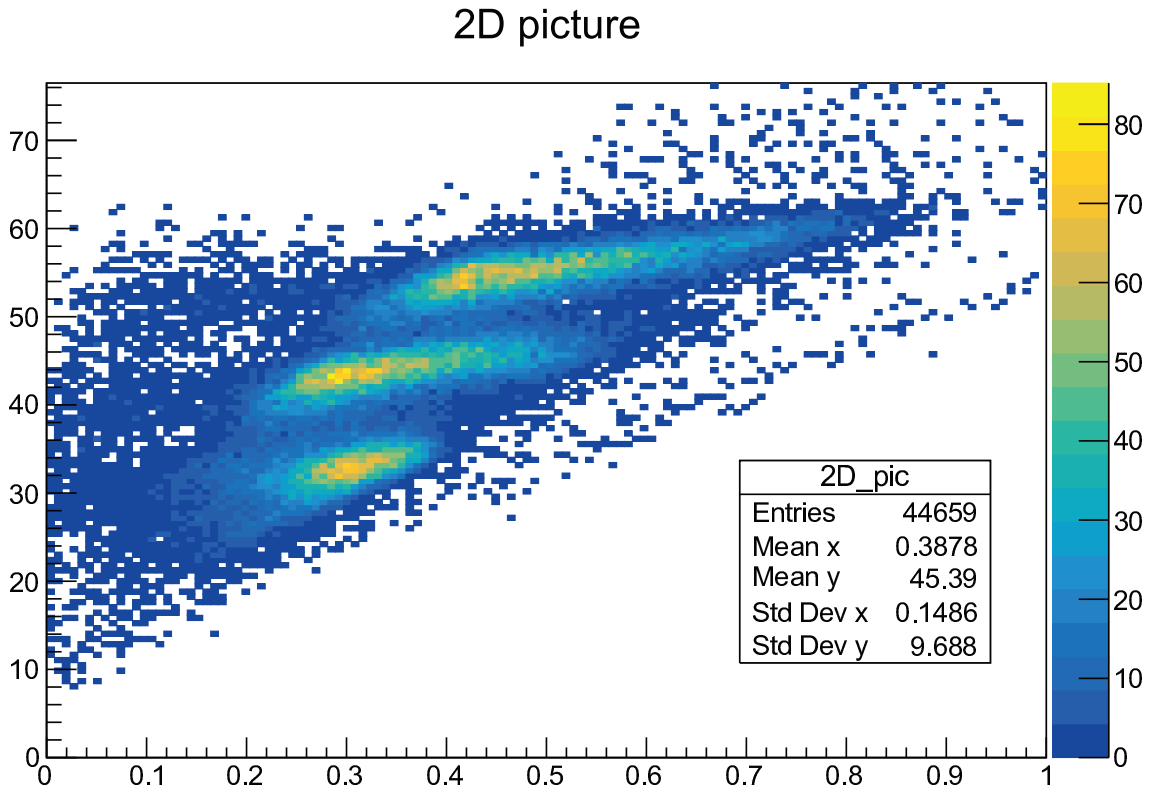
350
300
250
200
150
100
50
0


ampl2_4:ampl2_2
ampl2_4
ampl2_2
0 0.1 0.2 0.3 0.4 0.5
160
140
120
100
80
60
40
20
0

Position sensitivity

The position along the strips is given by the sum of the individual cathode signals divided by the anode signal with the condition that the the central strip should carry the maximum amplitude.
Horizontal slit at 3 positions (10 mm translations), perpendicular to the strips.



Conclusion

- progress made concerning how to analyse data
- mechanical difficulties for new prototype have been identified and overcome during the design, all parts have been ordered
- new plate tested with neutrons in temporary configuration

Prospects

SINE2020-MSGC1

- Final mounting (Kapton circuits)
- full characterization on beam line
- production on Schott S8900 glass (to replace Borofloat)

SINE2020-MSGC1 $\times 2$

- Mounting of 2 SINE2020-MSGC1 side by side (Borofloat or Schott S8900)
- Consult Schott about maximum size for Schott S8900 substrate

SINE2020-MSGC2 (around 20 cm $\times$20 cm)

- 1 mm cathode readout pitch (both sides) with new pressure vessel and connectics

Thank you