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

WP9.3

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ILL

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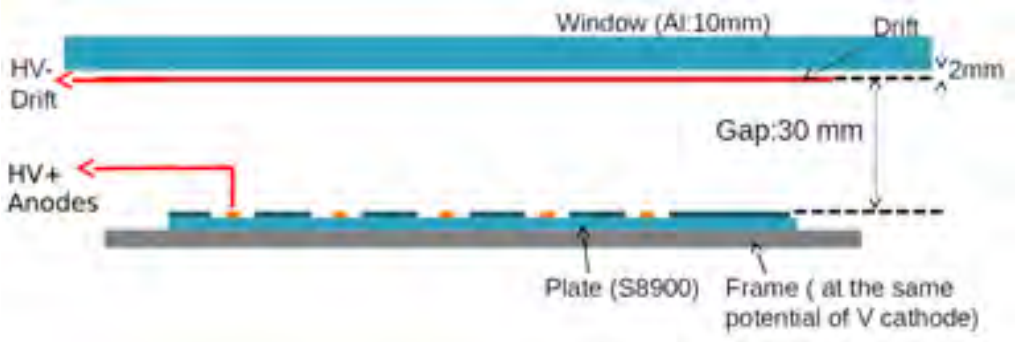
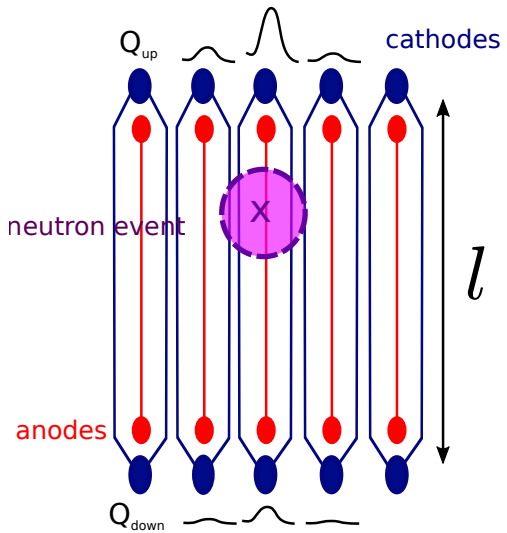
WP 9.3



2D microstrip detector

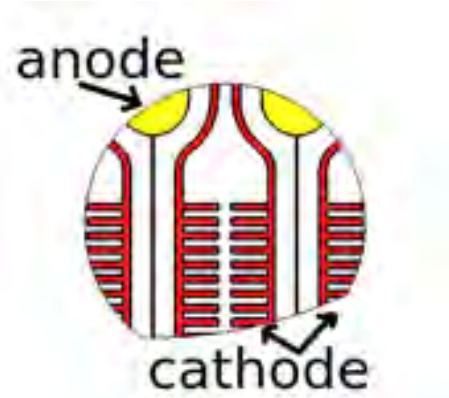
- charge division along the strips (Y), 1 mm resolution expected
- center of mass (X), 1 mm resolution
- High counting rate 10 kHz/"pixel" reading of cathodes (tunable resistance)



$$y = l \frac{Q_{up}}{Q_{up} + Q_{down}}$$

SINE2020 prototype

- 64 anodes and cathodes, 1 mm periodicity in X
- anodes 10 μm, cathodes 50 μm, length 76.5 mm
- Charge division on cathodes
- Chromium strips 200 nm thick
- Schott S8900 substrate (Borofloat 33 for initial tests)
- plates made by IMT (Greifensee, CH)



Expected anodes and cathodes resistances

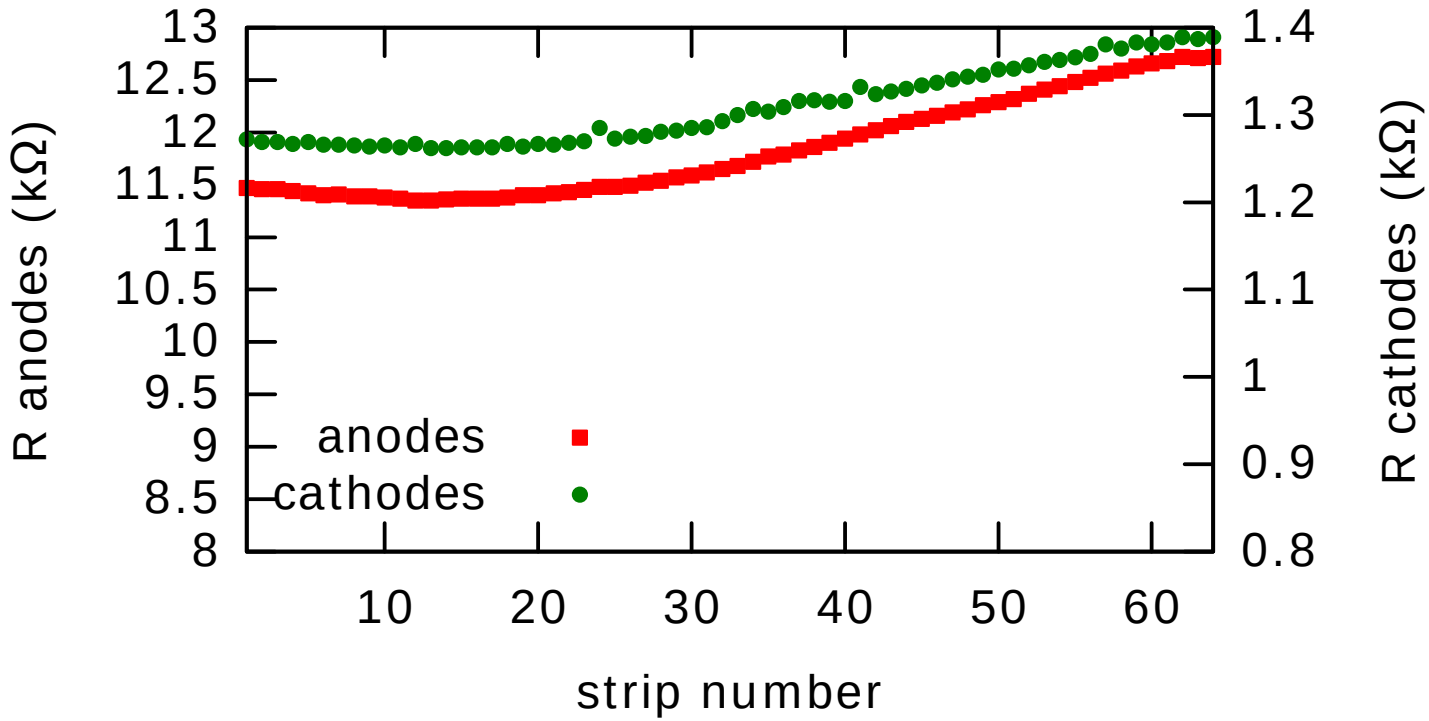
- length $l = 7.65$ cm
- thickness $t = 200$ nm
- anodes width $w_a = 10\ \mu$m
- cathodes width $w_c = 50\ \mu$m
- $R_s = 2.6\ \Omega/\square$

Anodes

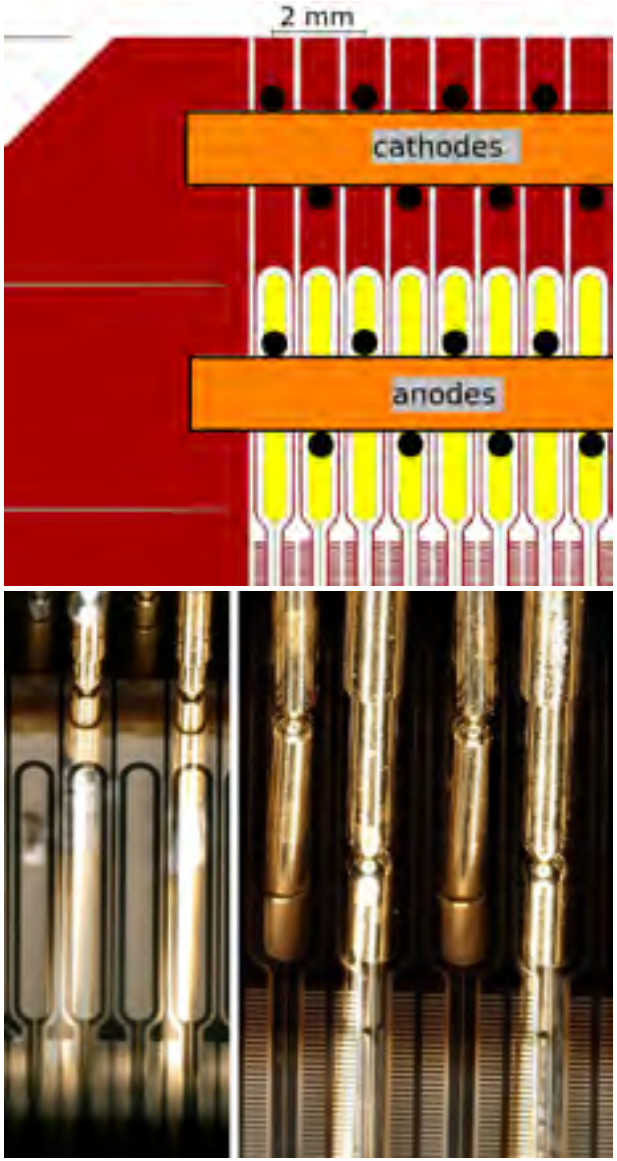
$R_a = R_s \frac{l}{w_a} = 20\ \text{k}\Omega$

Cathodes (approx. no comb pattern)

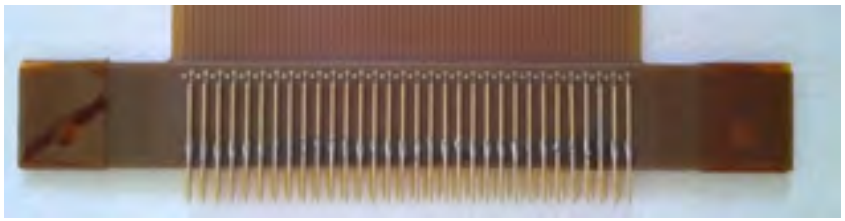
$R_c // R_c = \frac{1}{2} R_s \frac{l}{w_c} = 2\ \text{k}\Omega$



Connectics



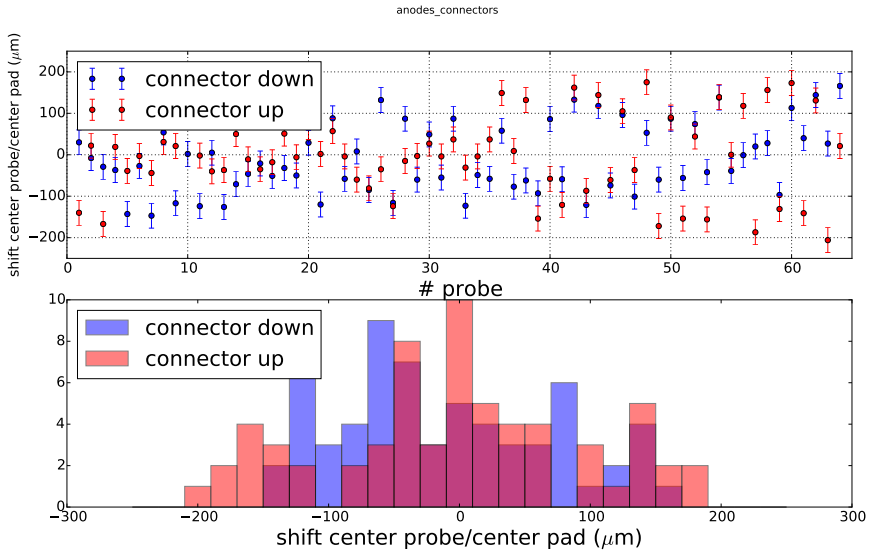
- flexible kapton
- pins every 2 mm on each side of the connector $\rightarrow$ every 1 mm on the MSGC.
- 2 connectors for the 64 anodes (0.5 mm pads) and 2 connectors for the 64 cathodes (0.8 mm pads).
- Spring probes (spherical head $\emptyset$0.53 mm) are used to make contact with the pads

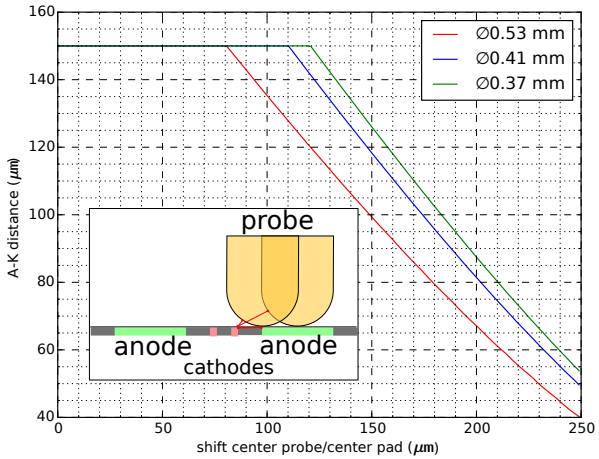


Connectics

Problem at high gain on anode pads :

The probes are not soldered precisely enough on the connector

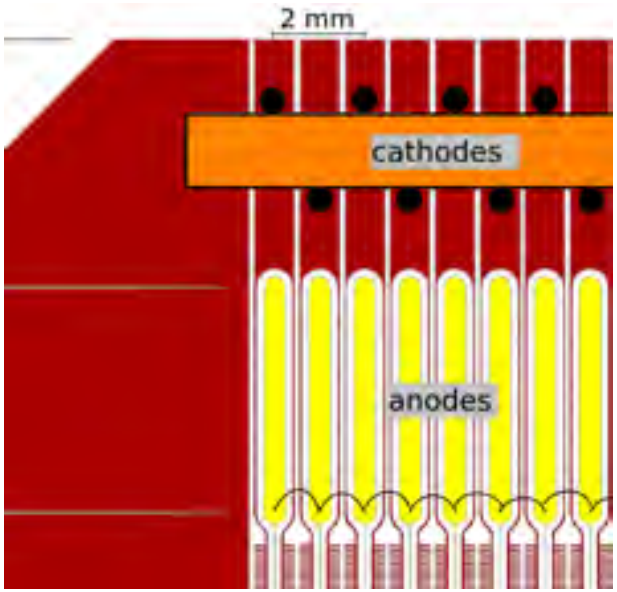


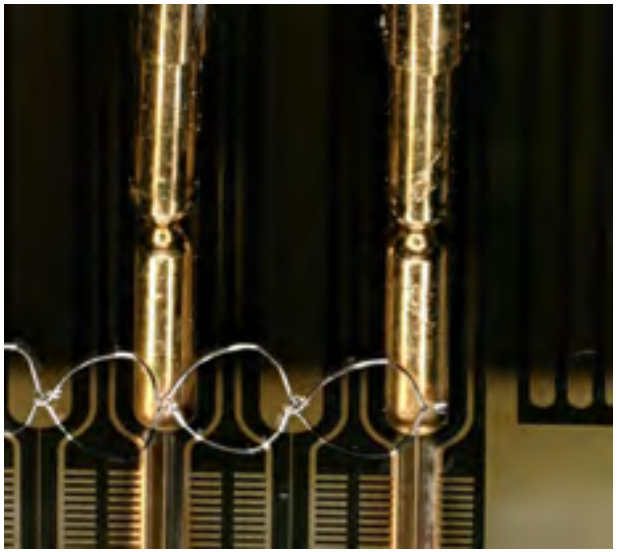


$\Rightarrow$ the anode-cathode distance is reduced

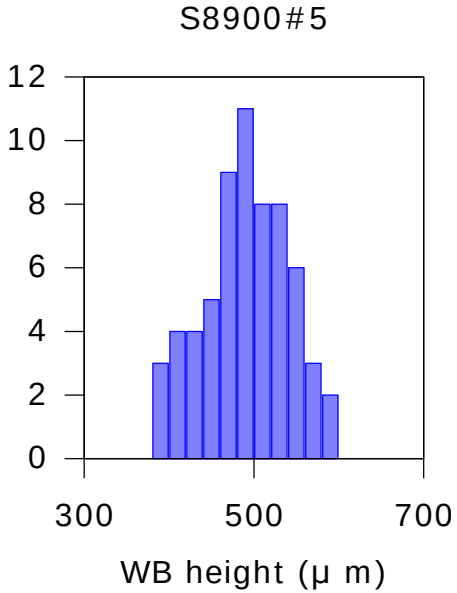
$\Rightarrow$ cathode strips can be damaged with breakdowns

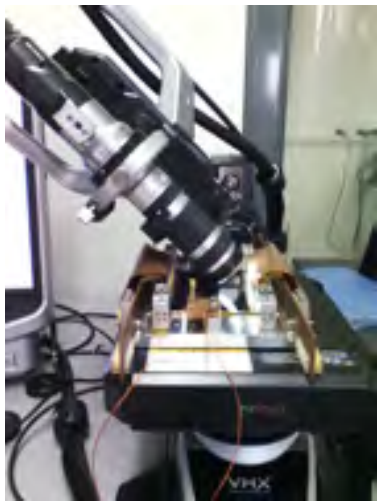
Connectics alternative : wire-bonding on anodes



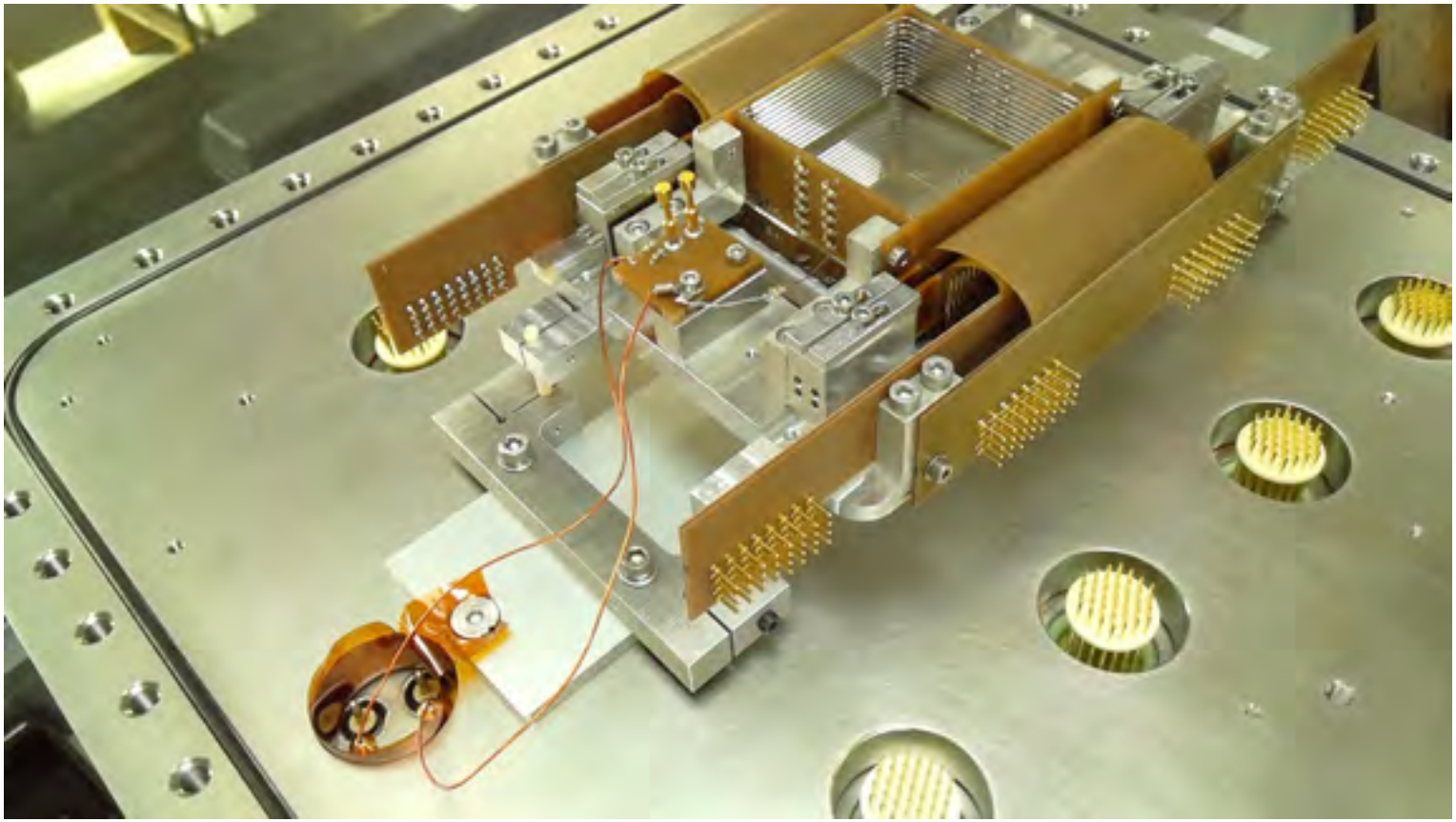


- realized at CIME nanotech / CNFM (special thanks to Irene Peck)
- wedge bonding (cold soldering with ultrasonic waves)
- Ø33 μm diameter Al wire





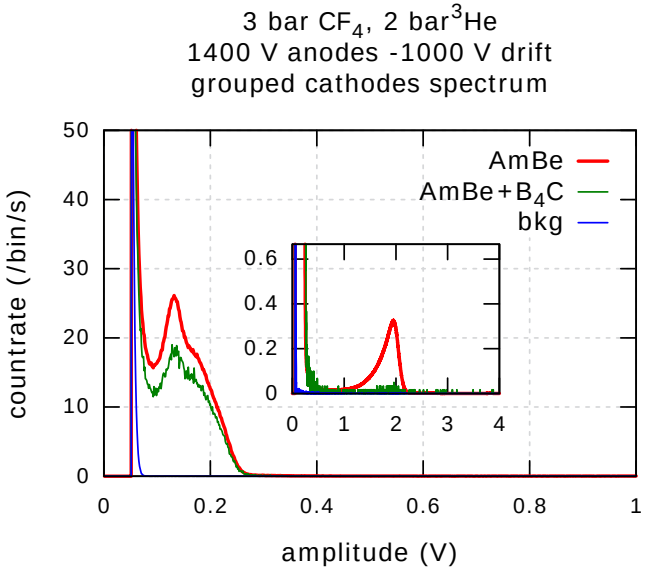
Setup



Setup

- B33 plate, tested with neutron beam
- S8900 plate, tested with AmBe source

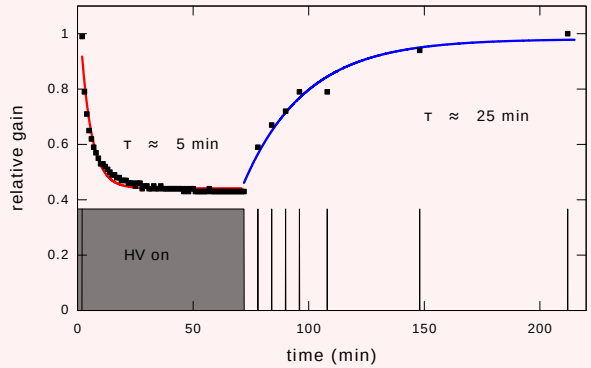
- 3 bar CF_4 (up to 1 mm resolution), 2 bar ^3He
- Drift -1000 V / -1600 V
- cathodes to ground
- HV $+1400$ V on anodes
- charge division amplifiers ~ 2.5 V/pC, 700 ns



Stability

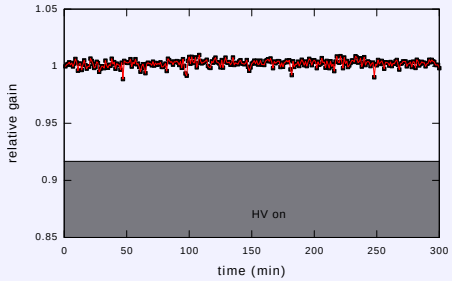
B33 substrate

Charge accumulation on surface
$\Rightarrow$ dramatic gain loss

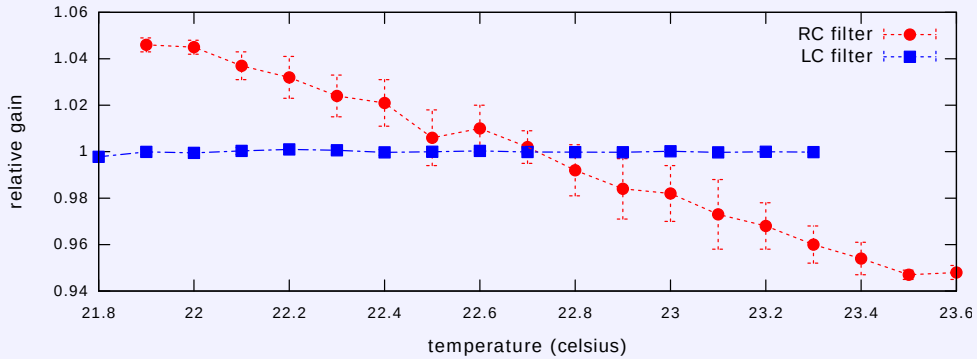


S8900 substrate

- no charge accumulation



- substrate resistivity varies with T^o
  $\Rightarrow$ gain variations when RC filter, LC filter OK

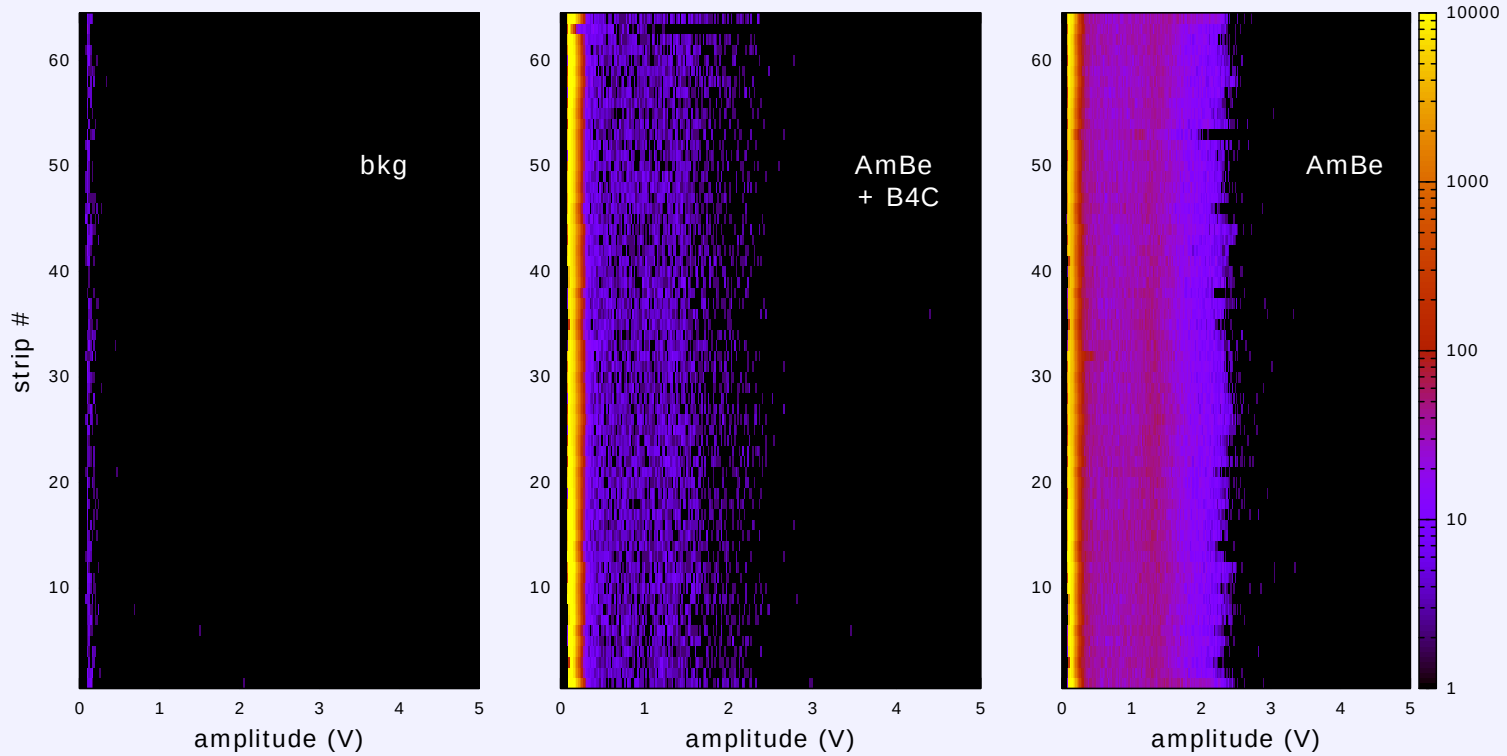


Uniformity

Measurements with multitubes electronics :

(each strip considered individually, possibility of counting several times the same event)

- Amplitude spectra

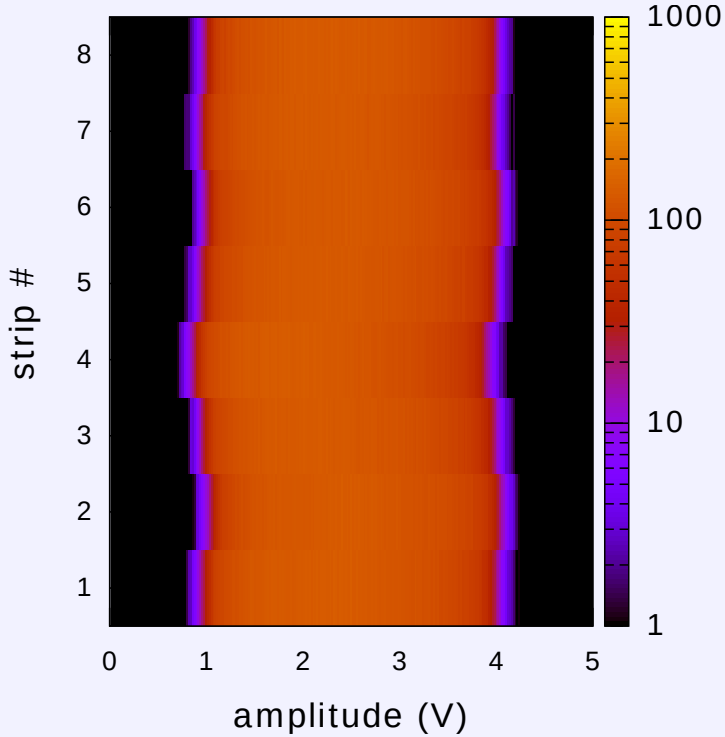


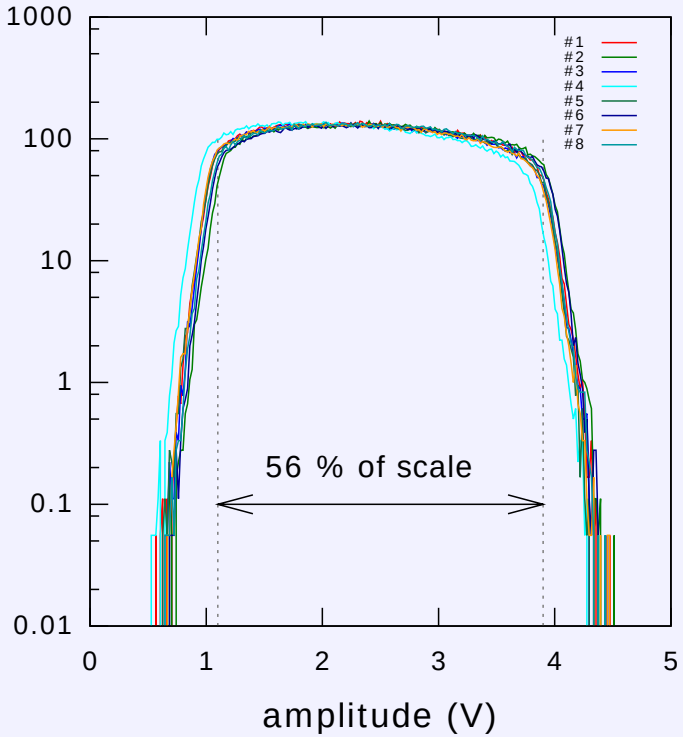
Uniformity

Measurements with multitubes electronics :

(each strip considered individually, possibility of counting several times the same event)

- Charge division on 8 strips

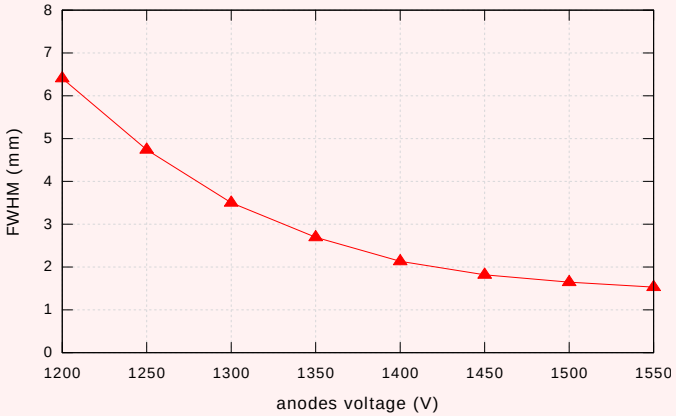


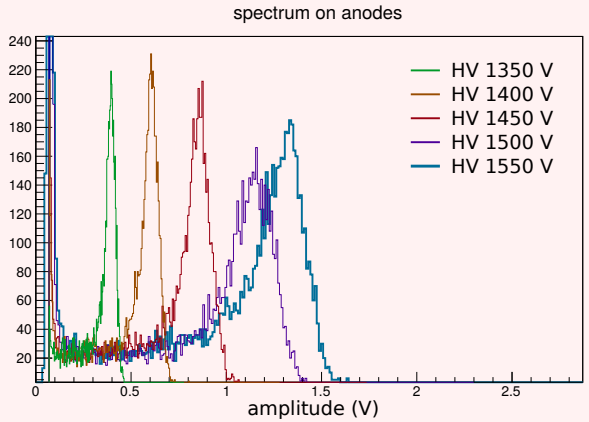


Resolution with charge division

Measurements with multitubes electronics :

- Resolution measurement on anodes, B33 substrate



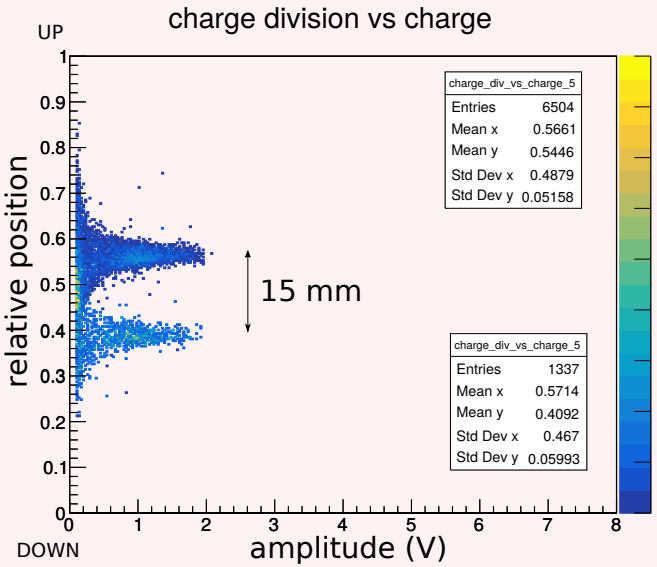


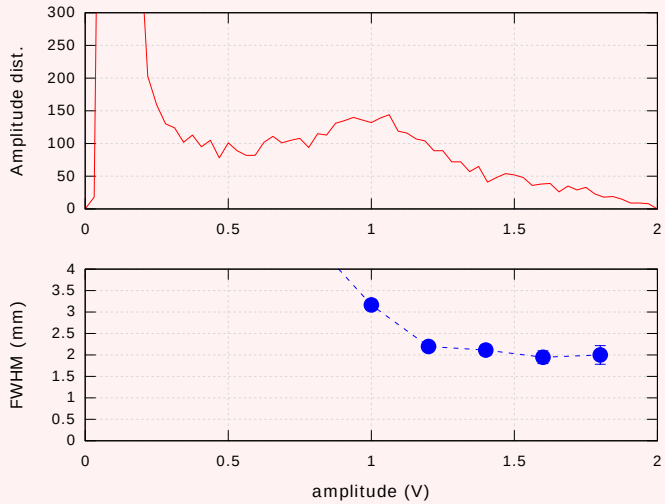
$\Rightarrow$ FWHM almost stabilized at 1550V

Measurements on single cathode strip

with Acqiris, unknown countrate/efficiency

HV anodes : 1650 V





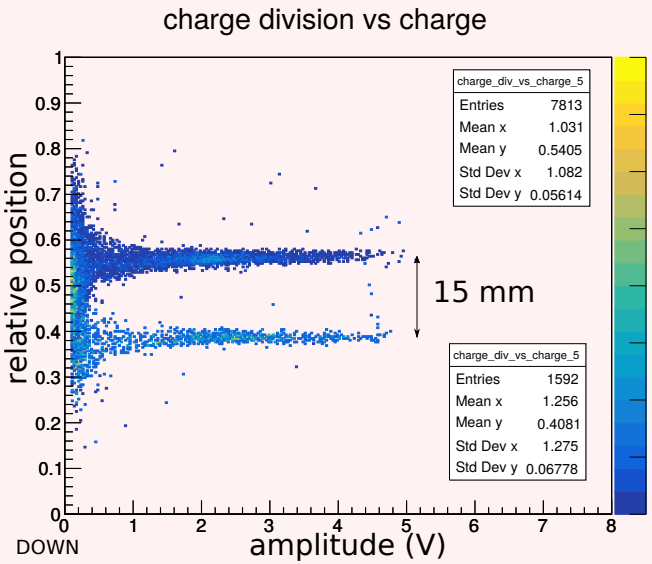
⇒ FWHM between 2 mm and 4 mm according to the collected charge

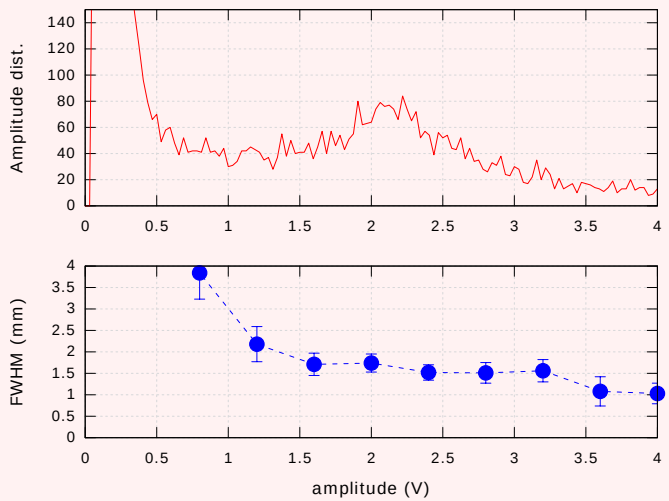
⇒ gain is not sufficient

Measurements on single cathode strip

with Acqiris, unknown countrate/efficiency

HV anodes : 1800 V

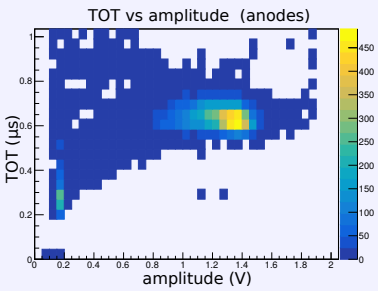


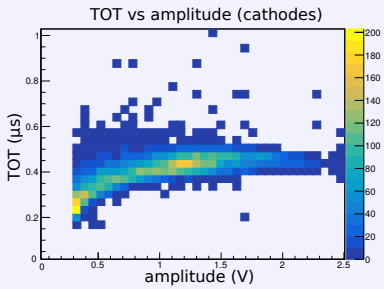


$\Rightarrow$ FWHM lower than 2 mm

Events characterization

- Signals duration (with faster amplifiers)





Average signal duration :

- 600 ns for anodes (all anodes)
- 400 ns for cathodes (one cathode)

- Multiplicity
  - Signal is not concentrated on 1 strip, on average on 2-2.5 strips (cluster size to be defined)
  - Studies with previous microstrip design showed that electronics must be well calibrated to improve resolution with a cluster

Conclusion and prospects

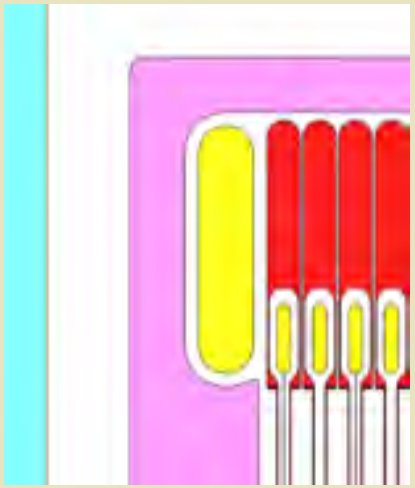
Progress since AG-SINE2020 (sept.16)

1. building and testing kapton connectors
2. testing B33 plate on beam, resolution OK
3. observing limitations with anode connectors
4. wire-bonding solution
5. getting S8900 plates and making them work
6. starting investigation on countrate capability
7. dedicated electronics in June (tunable amplifiers)

Conclusion and prospects

SINE2020-MSGC2

- larger plate (about 17 cm $\times$17 cm detection area)
- 128 strips (1.3 mm between anode strips)
- same comb pattern
- cathode reading only
- simplification with anode wire-bonding



Thank you