SINE2020_1 task 9.3

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Goal

To develop a 2D ^{3}He MSGC with a sensitive area of 20 cm x 20 cm and a position resolution of 1 mm x 2 mm at a local counting rate of 10 kHz

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Motivation

3He proportional detectors are very efficient and provide high gamma rejection

Performance of MWPCs is good but limited in …

counting rate due to space charge effect

position resolution due to wires stability

MSGCs provide the following advantages (compared to MWPC):

1/ fast collection of ions on the cathode strips

→ counting rate ++

2/ Small readout pitch thanks to the photolithography technique

3/ High stopping gas pressure (7 bar of CF4 has been tested during FP7_1)

(2/ + 3/ → position resolution ++

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Charge division of parallel detection cells allows to reach high counting rate

A recent evolution of SANS detector has been the replacement of MWPCs by linear PSDs to make faster detectors

The idea here is to do the same for smaller detectors, and to use thin strips instead of wires (because the electrical resistance of short wires is too small)

Unfortunately, the resistance of anode strips in Chromium (standard material) is too high

Electrical resistance :

R_square=2.6 Ohm/square ⇔ 30 kOhm for 15 μm strips, 17 cm long

The high RC value of the anodes require long integration time for the shaping amplifiers
→ not compatible with high counting rate

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Cathod versus Anode charge division

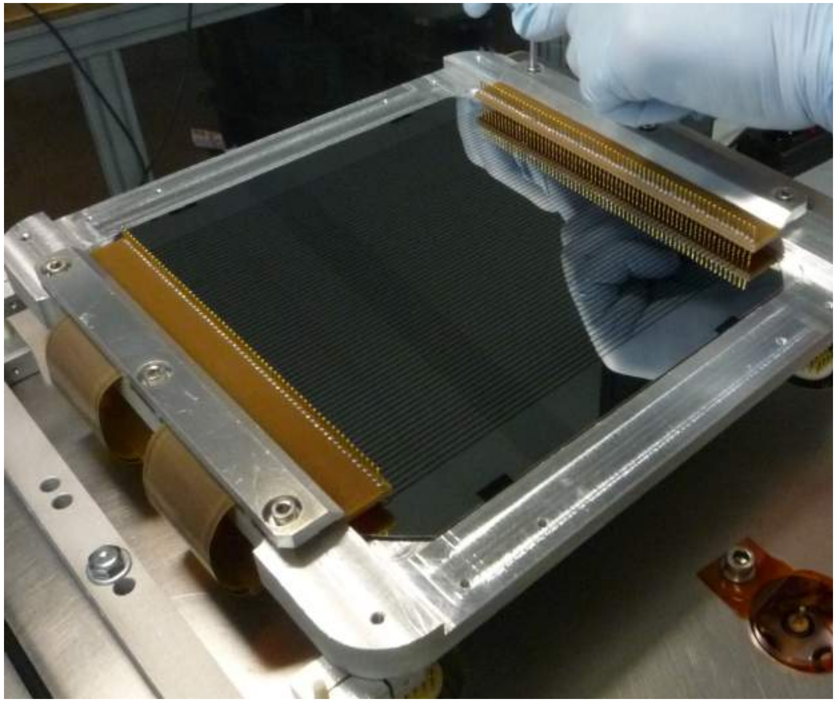
The Electrical resistance of the detection strip must be reduced by a factor of 5

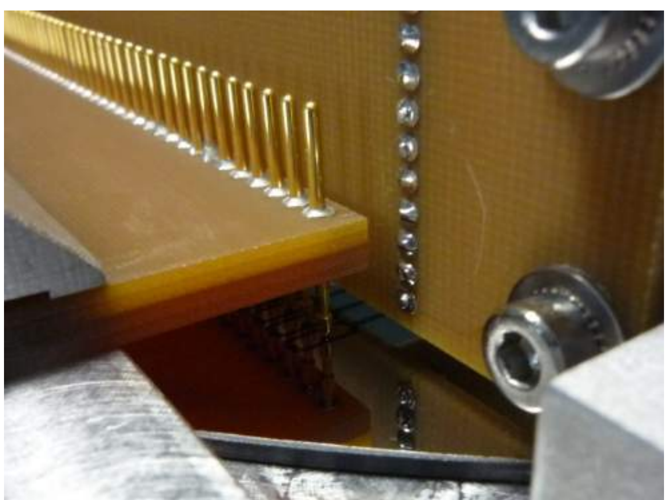
Increasing the anode width is not possible
→ We tried to reduce R_Square by adding an Aluminium layer on top of Chromium (IMT)

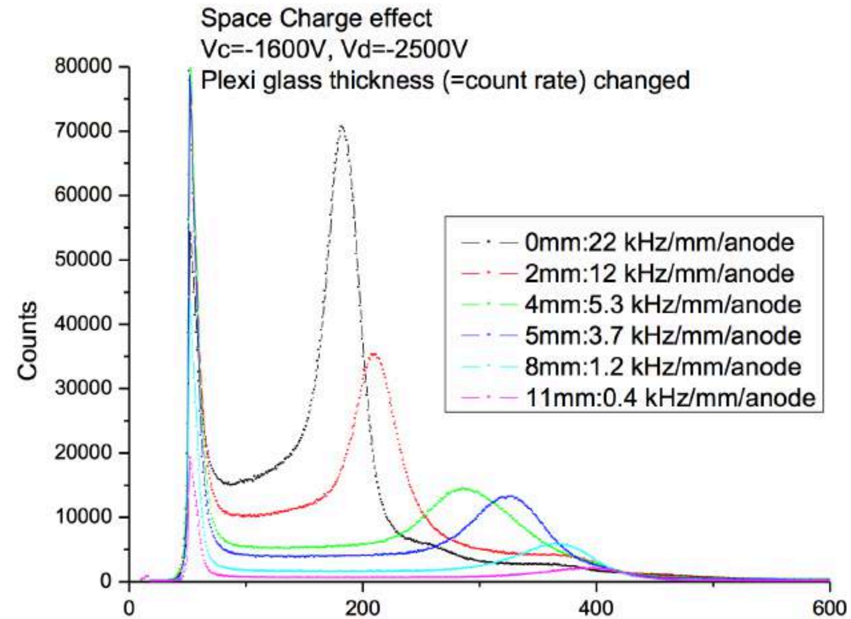
It worked, but only for a few hours on CT1 beam line (see Hisako's work during FP7_1), before the electrical resistance of the anode increased due to the chemical attack of Aluminium by CF4 ions

Ar-CO2 could have been tried, but we prefered to keep the standard Cr process (cheaper) and to readout the cathods instead of the anodes

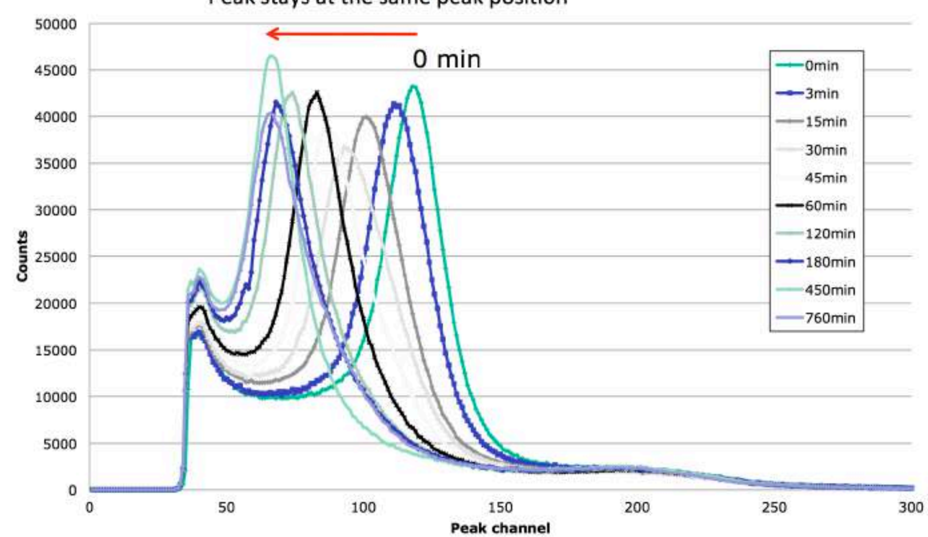
Results from FP6/2011 (Hisako Niko)



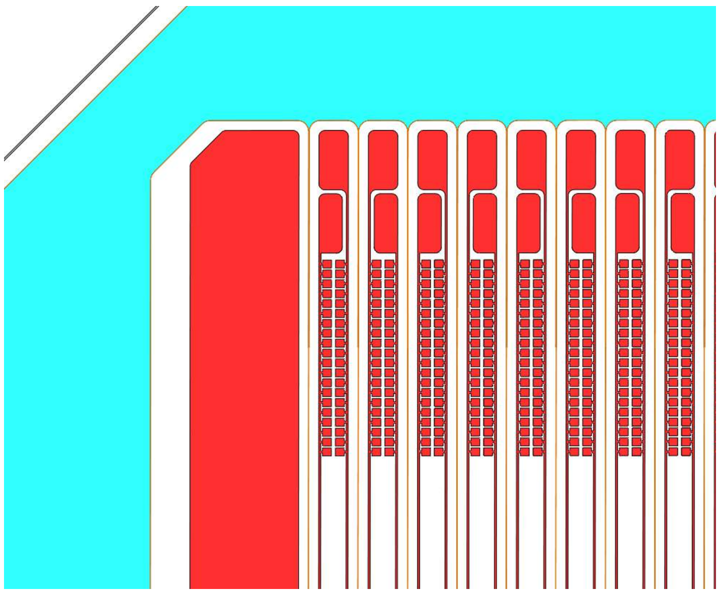




After 180min:
Peak stays at the same peak position



MSGC layout presented during the former meeting



Common anode (blue) +
individual cathods (red)

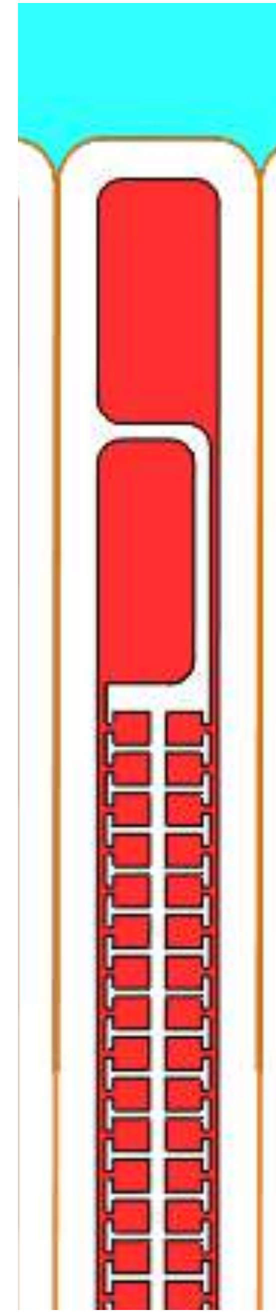
pitch : 2.5 mm.

The 2 cathods surrounding one anode must be connected with a ceramic connector plugged to the MSGC to make 1 detection cell

1 detection cell = 2 readout channels

4N **cathod** connections → 2N readout channels

1 **Anode** Connection → 1 readout channel

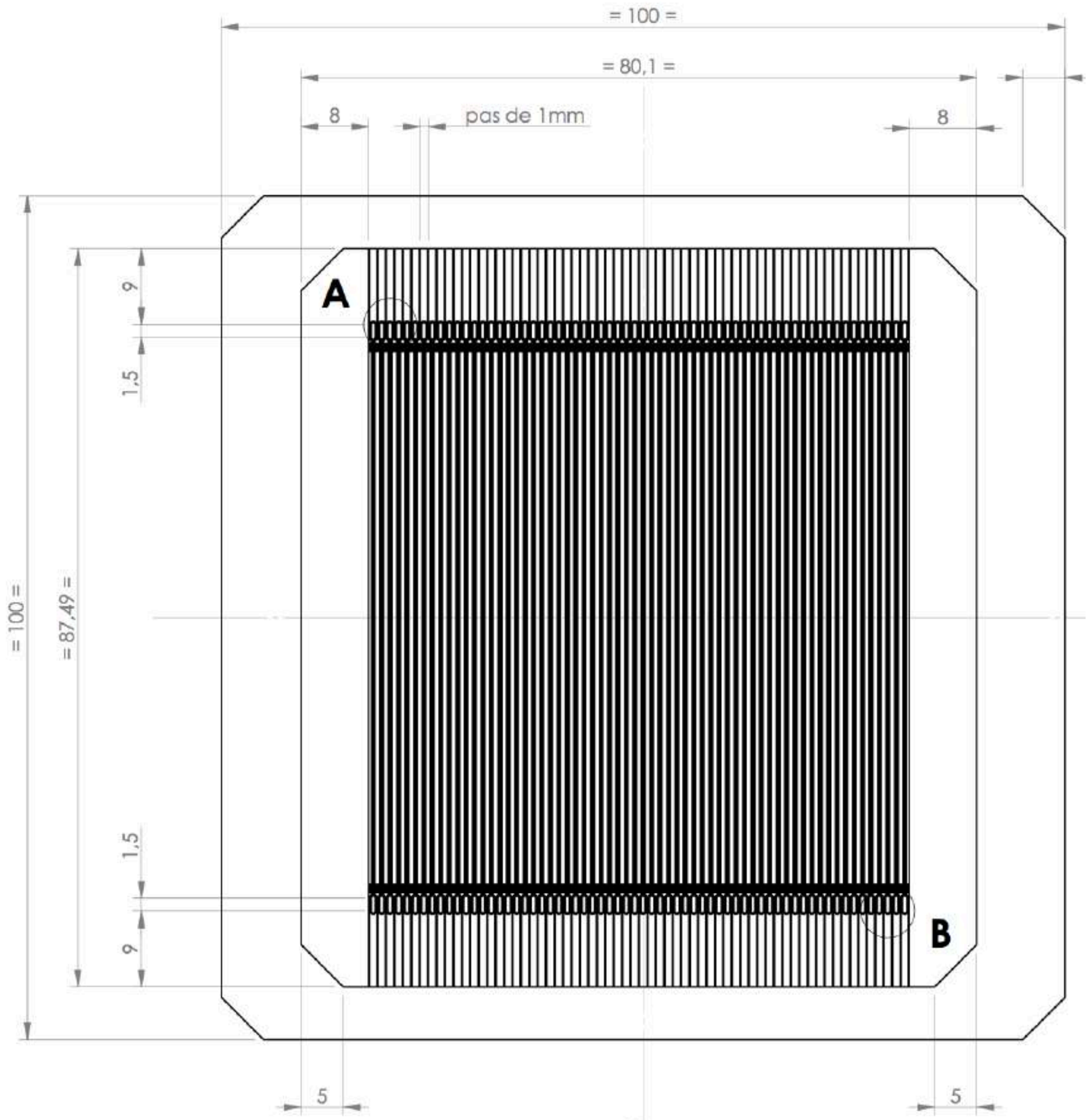


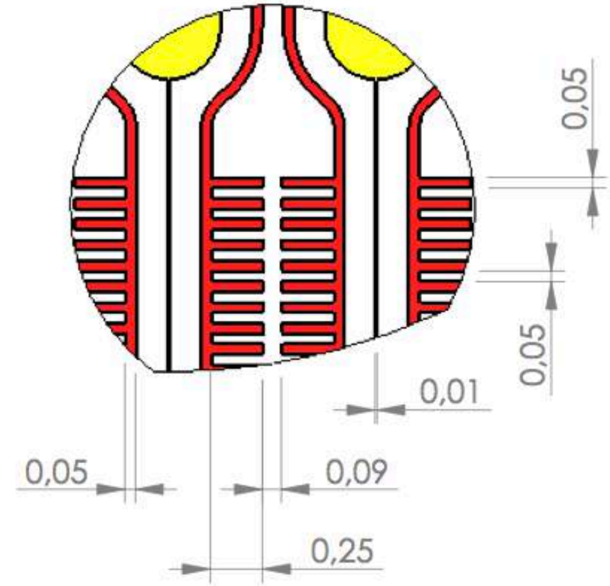
Electrical resistance : 4.3 kOhm for 2 resistive lines in // with 60 μm width, 20 cm length

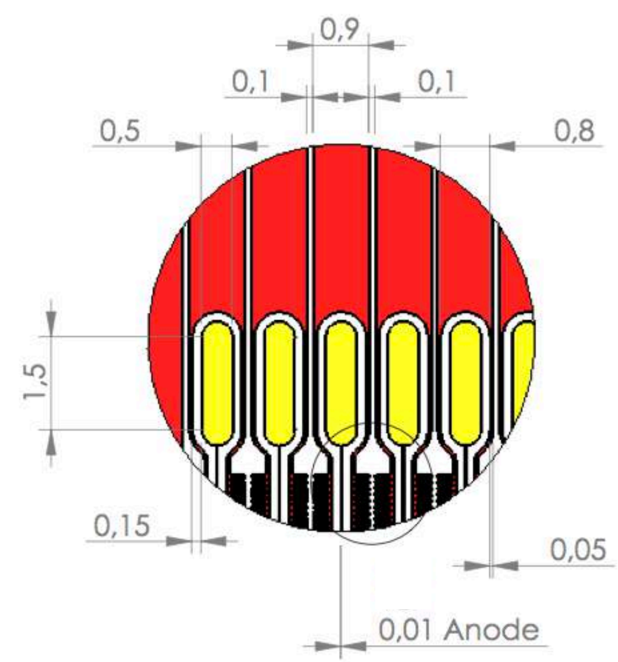
Several MSGCs can be mounted side by side to make a large detector without dead zone

New layout (small proto) MSGC_SINE2020_1

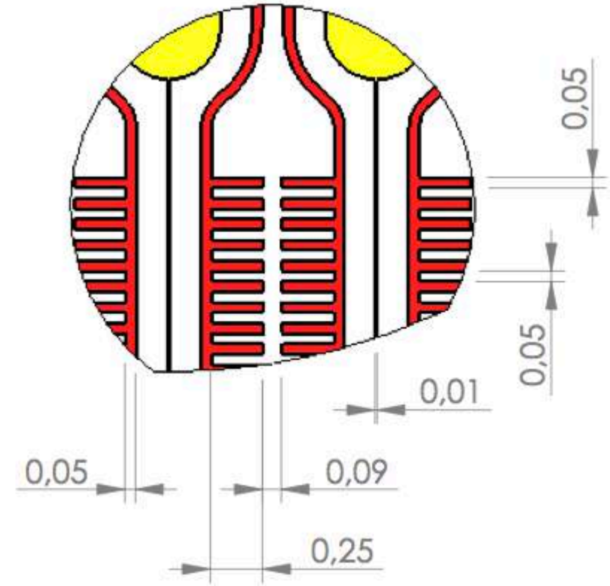
Pitch 1 mm / sensitive area 64 mm x 64 mm







New layout (small proto) MSGC_SINE2020_1



Individual anodes (yellow) +
individual cathods (red)

pitch : 1 mm (instead of 2.5 mm)

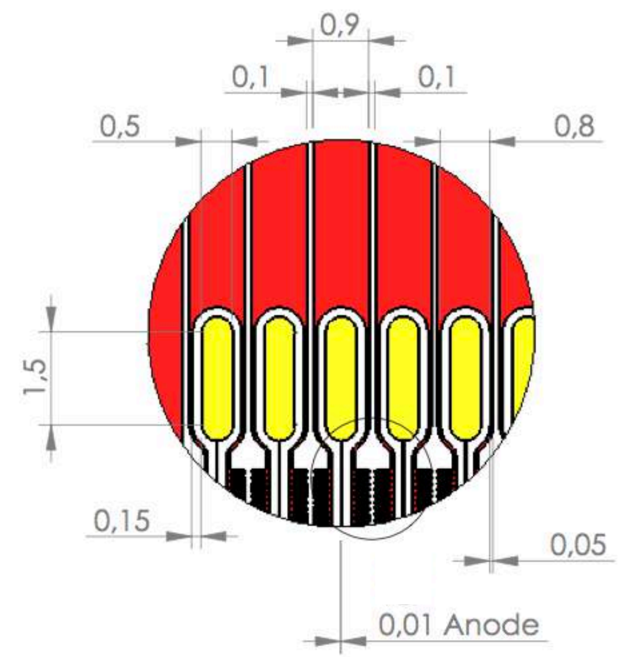
The 2 cathods surrounding one anode are connected directly on the MSGC to make 1 detection cell

1 detection cell = 2 readout channels

128 **cathod** connections → 128 readout channels

64 **Anode** connections → 1 readout channel

Cathode resistance: 3 kOhm
Anode resistance: 16 kOhms



Advantage compared to previous layout: 3N connections instead of 4N +1

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Sub-tasks

T1: Study of small MSGC prototypes with different geometries
standard glass (instead of Schott S8900) used at the beginning
Critical probles to solve: high density of connections

T2: Design study of a large MSGC detector

T3: Fabrication of a 20 cm x 20 cm MSGC at IMT

T4: Mounting and test of the large area 2D MSGC

Deliverables

9.5 Novel MSGC detector hardware (M24)

9.6 Interim report on MSGC detector development programme (M24)

9.11 Final report on MSGC detector development programme (M48)