Practical operation of Micromegas detectors

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- Different kinds of Micromegas
  - Various meshes
  - On-frame
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  - Bulk
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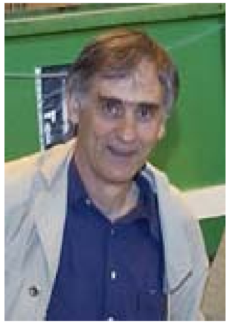
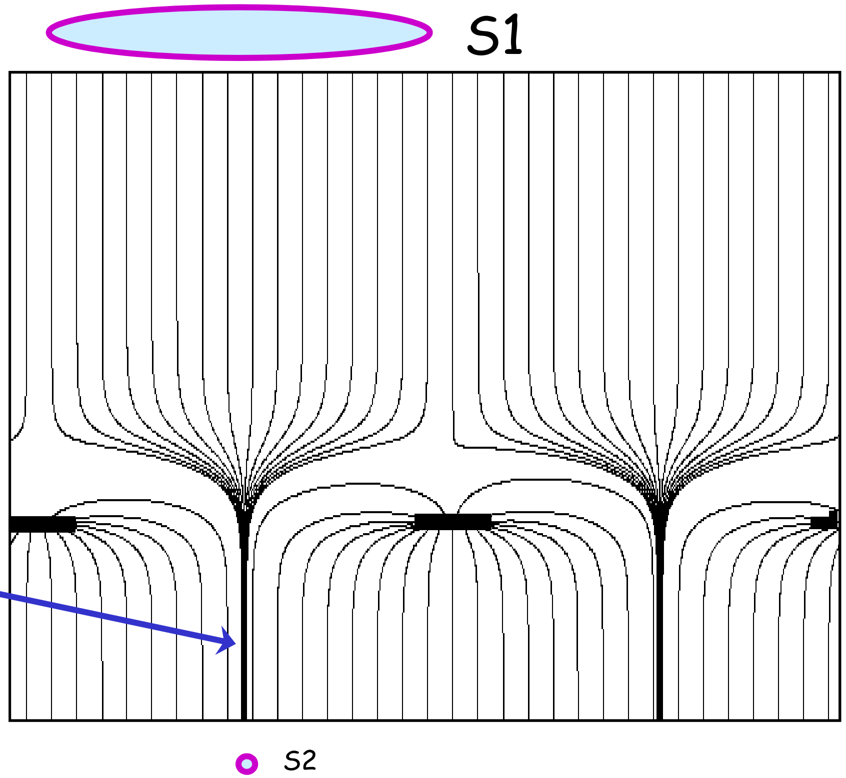
  - Microbulk
- « Cooking » process
- Examples

Micromegas: How does it work?



Y. Giomataris, Ph. Rebourgeard, JP Robert and G. Charpak,

NIM A 376 (1996) 29



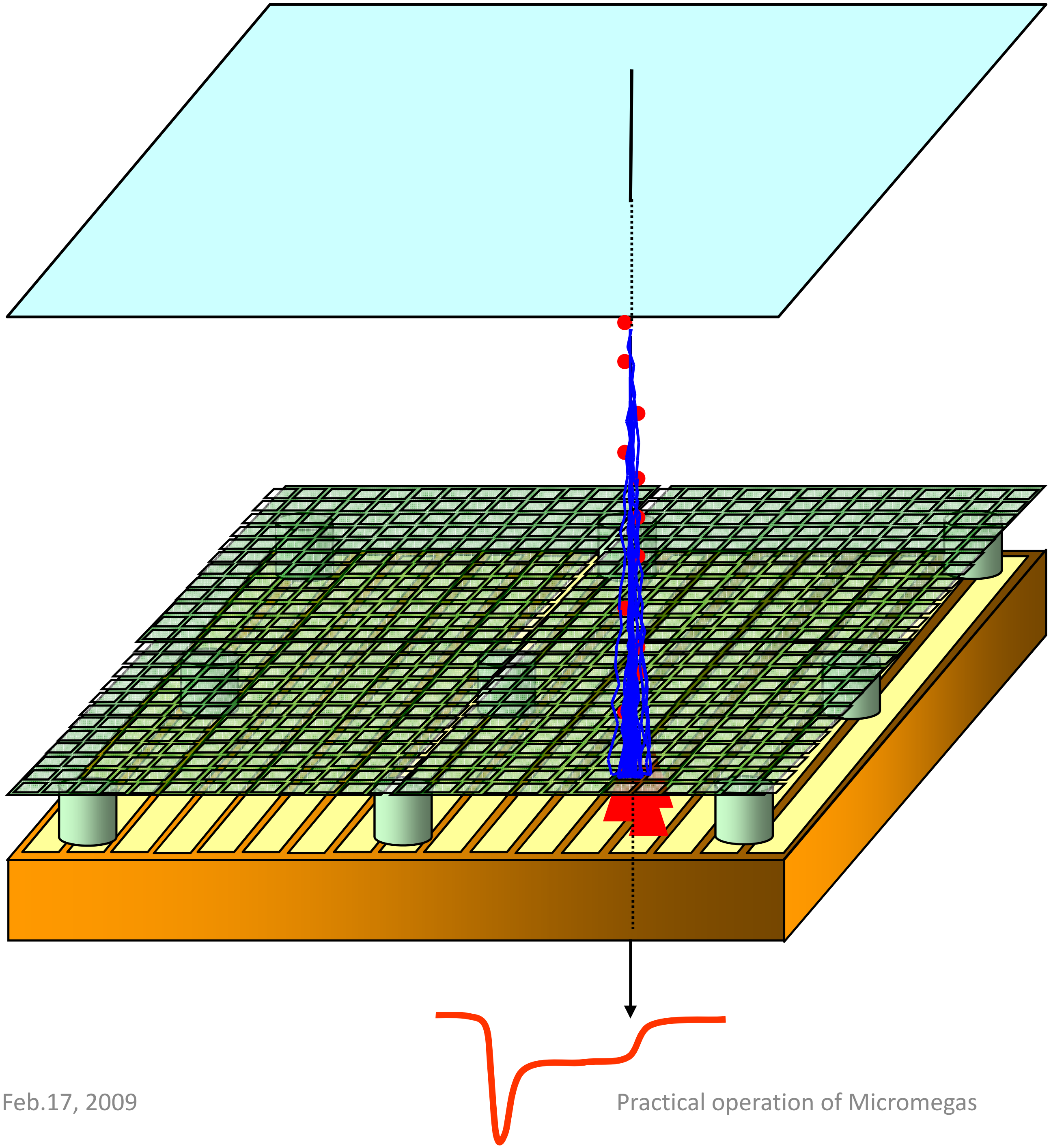
Micromesh Gaseous Chamber: a micromesh supported by 50-100 μm insulating pillars, and held at V_{anode} – 400 V

Multiplication (up to 10^5 or more) takes place between the anode and the mesh and the charge is collected on the anode (**one stage**)

Funnel field lines: electron **transparency** very close to 1 for thin meshes

Small gap: **fast** collection of ions

$S2/S1 = E_{drift}/E_{amplif} \sim 200/60000 = 1/300$



Small size =>

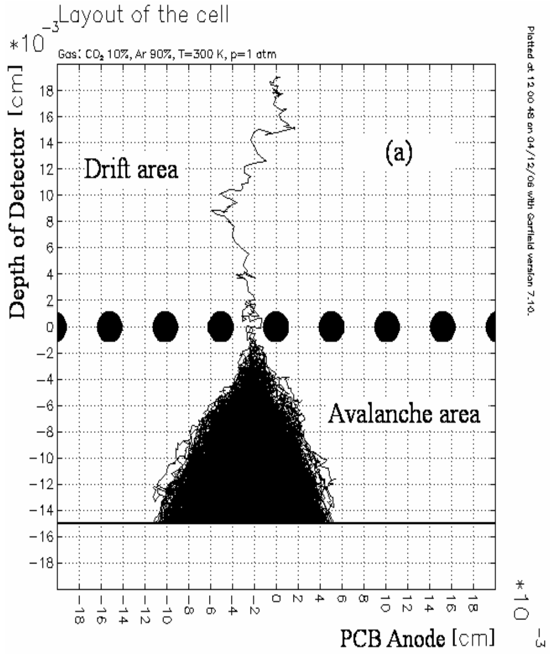
Fast signals =>

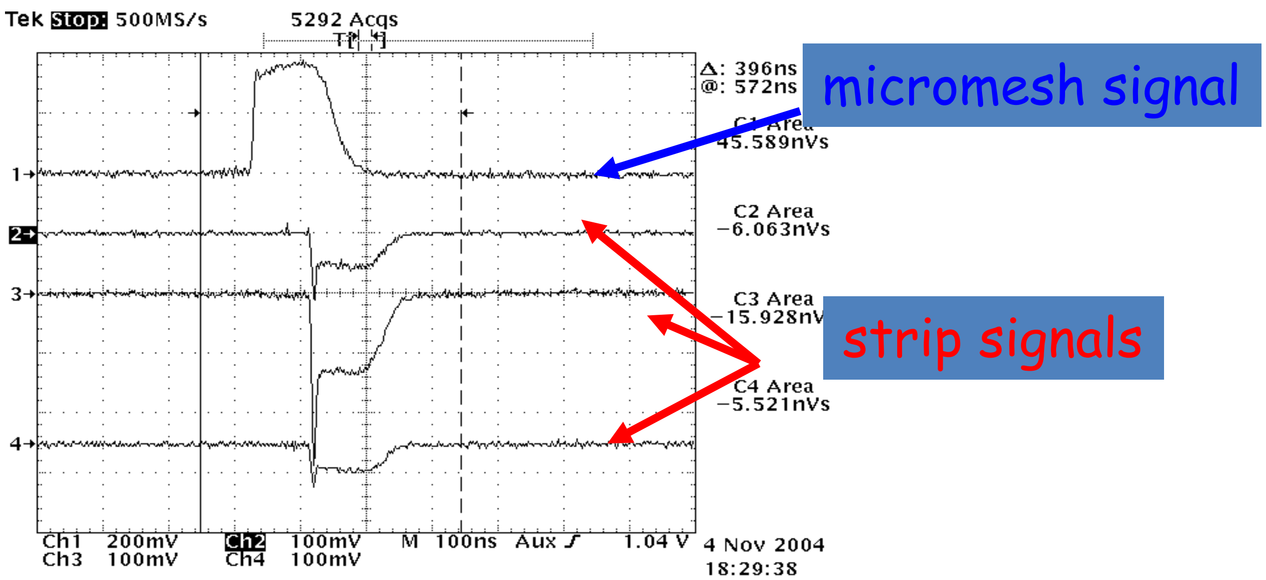
Short recovery time =>

High rate capabilities

A GARFIELD simulation of a Micromegas avalanche

(Lanzhou university)



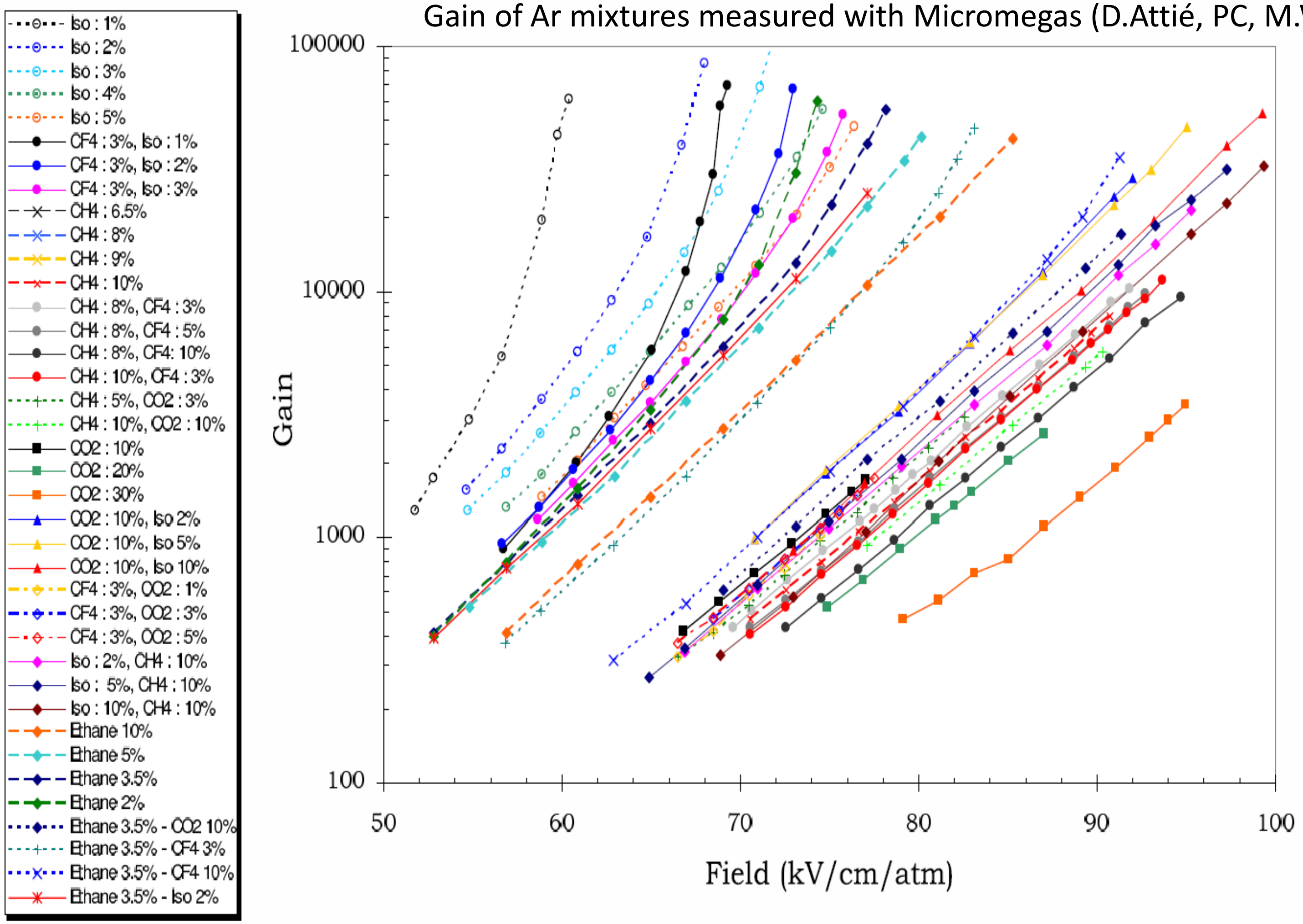


Electron and ion signals seen by a fast (current) amplifier

In a TPC, the signals are usually integrated and shaped

Gain

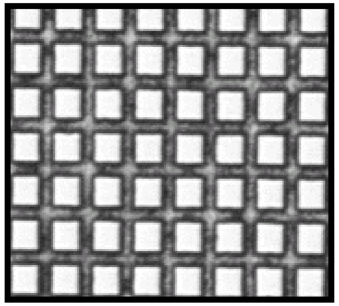
Gain of Ar mixtures measured with Micromegas (D.Attié, PC, M.Was)

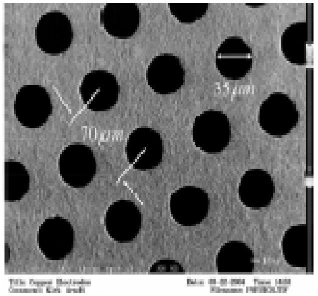


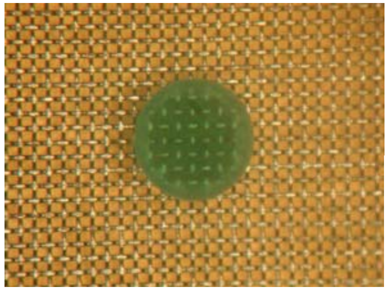
MESHES

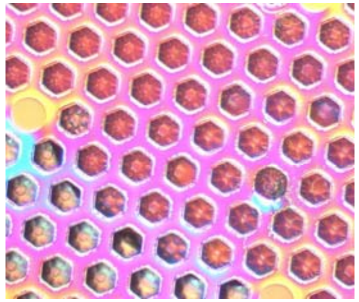
Many different technologies have been developped for making meshes (Back-buymers, CERN, 3M-Purdue, Gantois, Twente…)

Exist in many metals: nickel, copper, stainless steel, Al,… also gold, titanium, nanocristalline copper are possible.


Electroformed


Chemically etched


Wowen

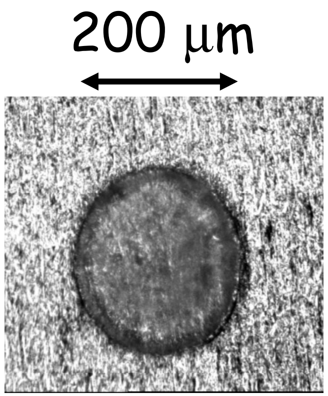

Deposited by vaporization

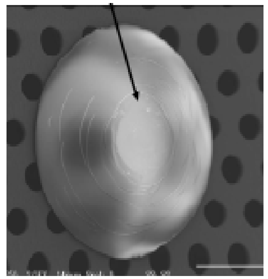
Laser etching, Plasma etching…

PILLARS

Can be on the mesh (chemical etching) or on the anode (PCB technique with a photoimageable coverlay). Diameter 40 to 400 microns.

Also fishing lines were used (Saclay, Lanzhou)





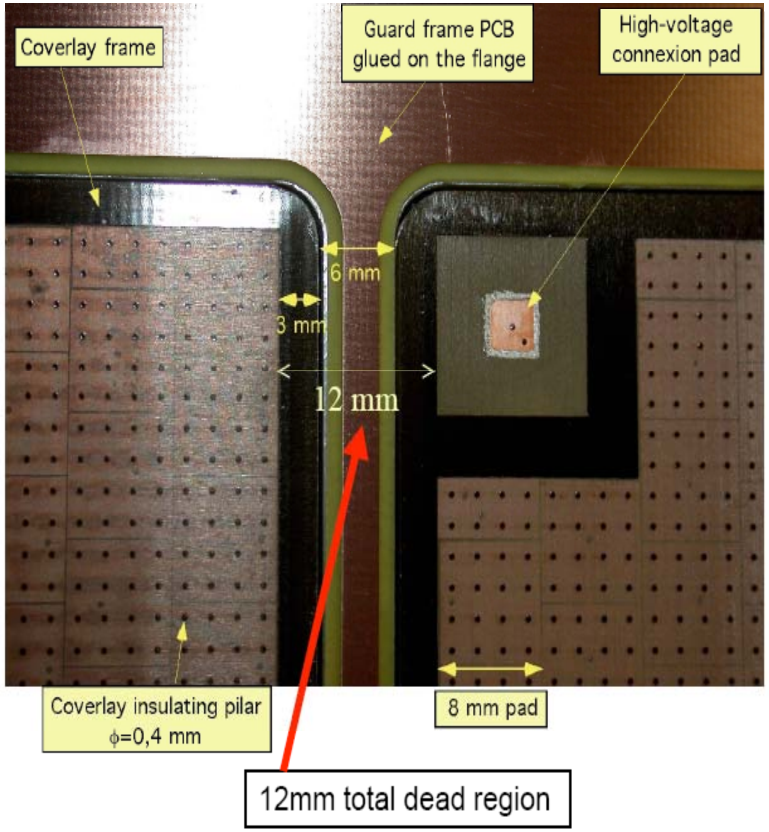
The Bulk technology

Fruit of a CERN-Saclay collaboration (2004)

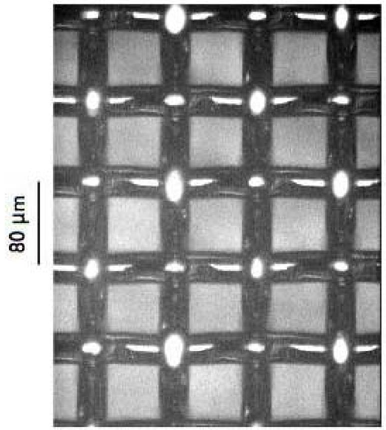
Mesh fixed by the pillars themselves :

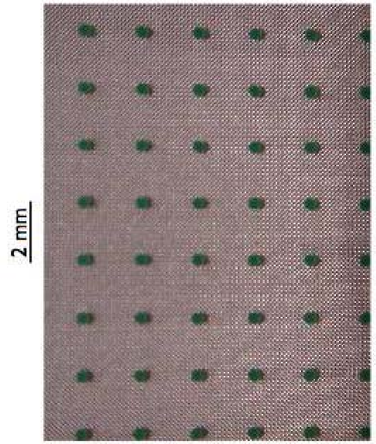
- No frame needed : fully efficient surface
- Very robust : closed for > 20 µ dust
- Possibility to fragment the mesh (e.g. in bands)
- … and to repair it

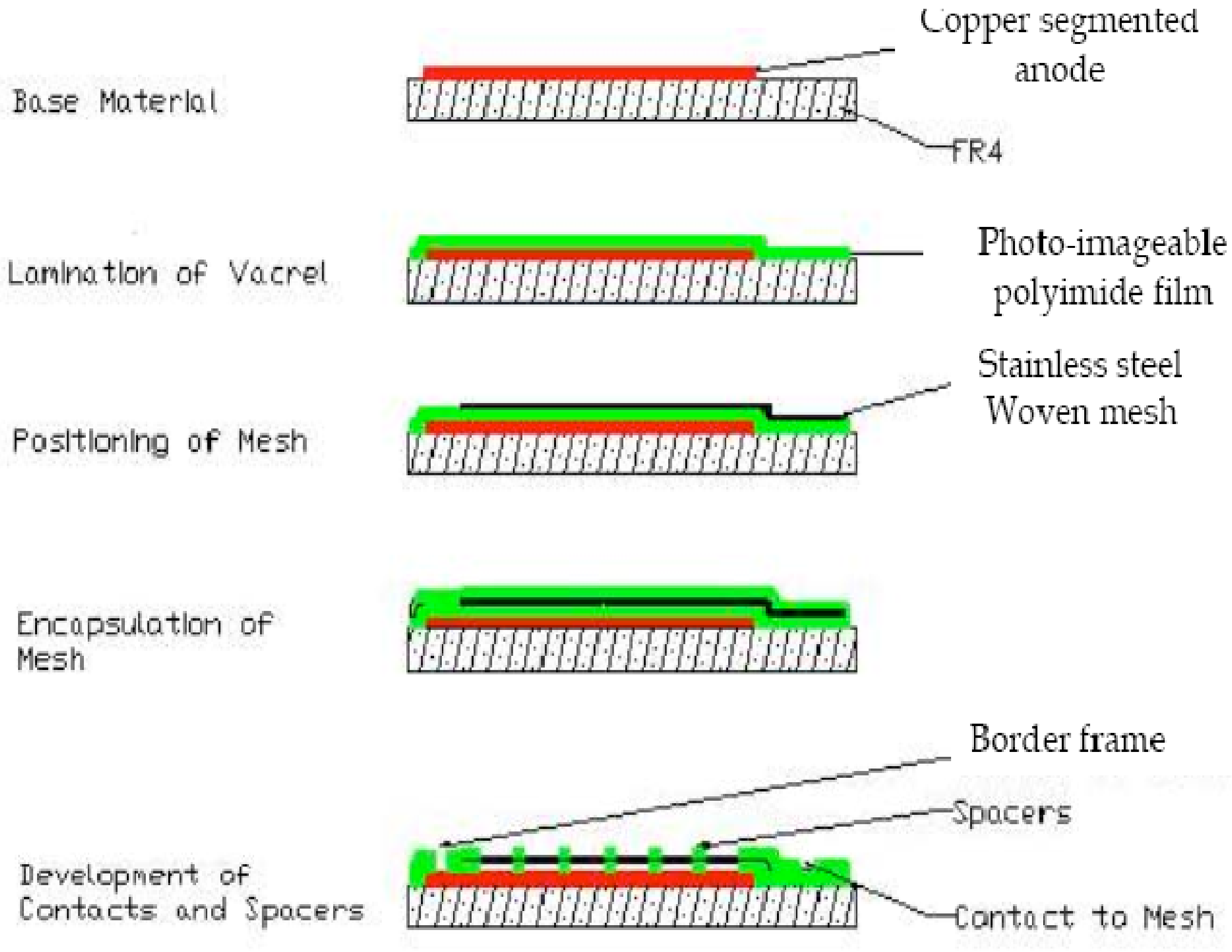
Used by the T2K TPC under construction



The Bulk technology







‘Choose your material

For first tests of a detector, a power supply with current limitation is preferred. Set the current limitation at 500 nA for instance.

The CAEN N471A is ideal for testing, though not very precise.
They have 2 chanels, you can use one for the mesh and one for the drift cathode.

Check your gasbox for gas-tightness : must bubble down to 1 l/h.

Before connecting the electronics, ‘cook’ your detector (see next slide).

Preamp: use a protected fast preamp (for instance ORTEC 142 series) and an amplifier-shaper (0.5 or 1 microsecond peaking time), for instance ORTEC 472 or 672.
Hunt noise (microphonic noise, radiated noise, noise from the grounds)

‘Burning’ or ‘cooking’ your detector

To make the detector stable for further operation, it must be ‘cooked’ : raise the voltage slowly to 550-600 V (50 micron gap) or 800-900 V (128 micron gap), step by step, to the level where it starts sparking.

This has to be done in air

It consists of burning small dusts (mostly fibres).

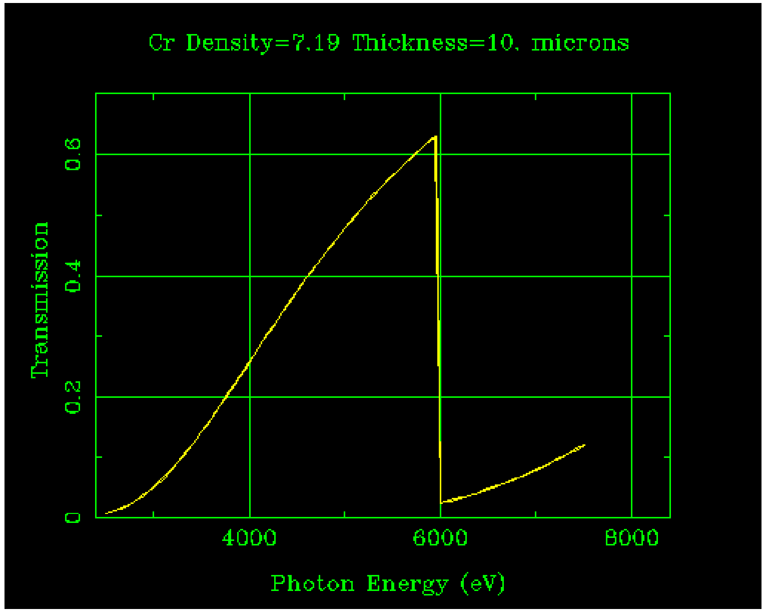
A relatively high (ionic) current (200-250 nA) can remain. It will decrease after circulation of the gas and go down to 0(1nA).

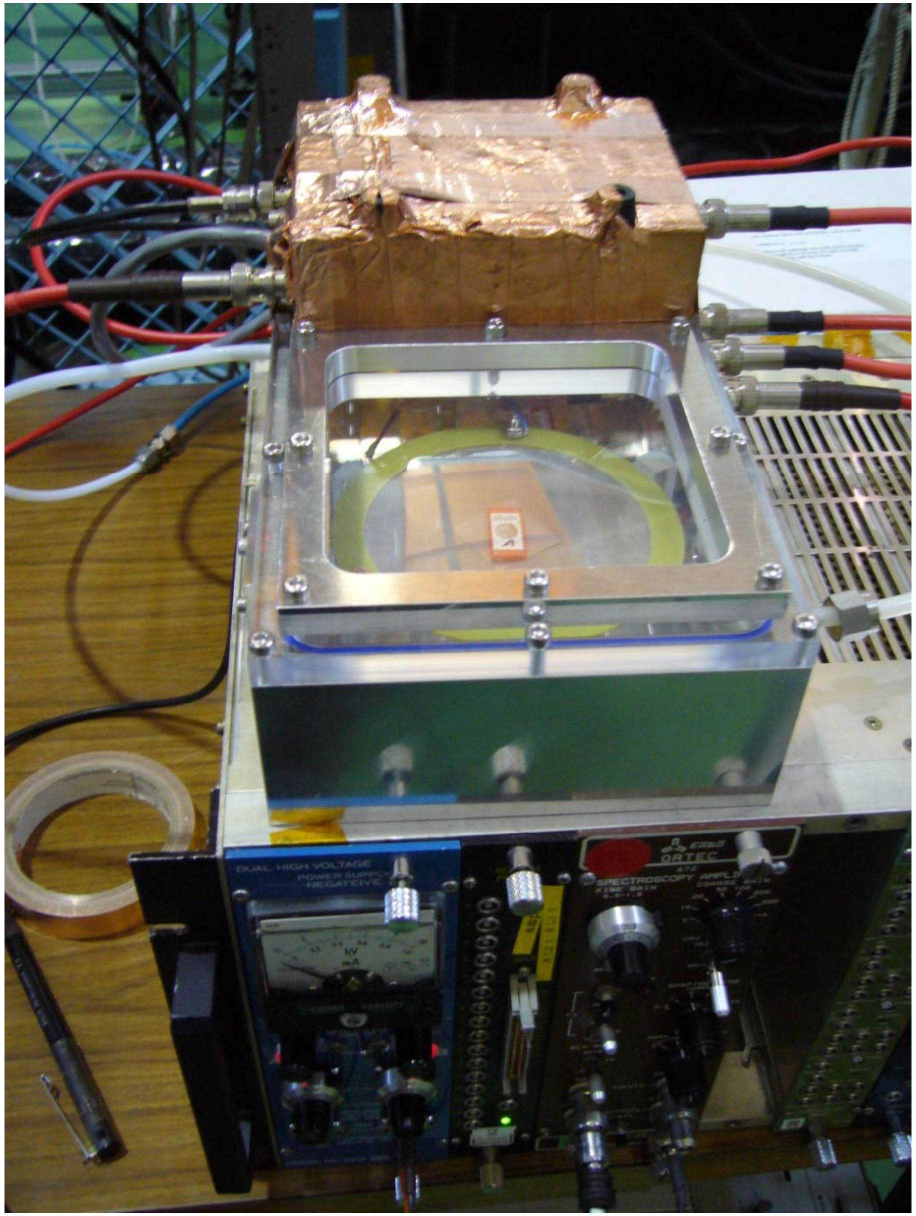
A detector which stands its voltage in air will always work in gas.

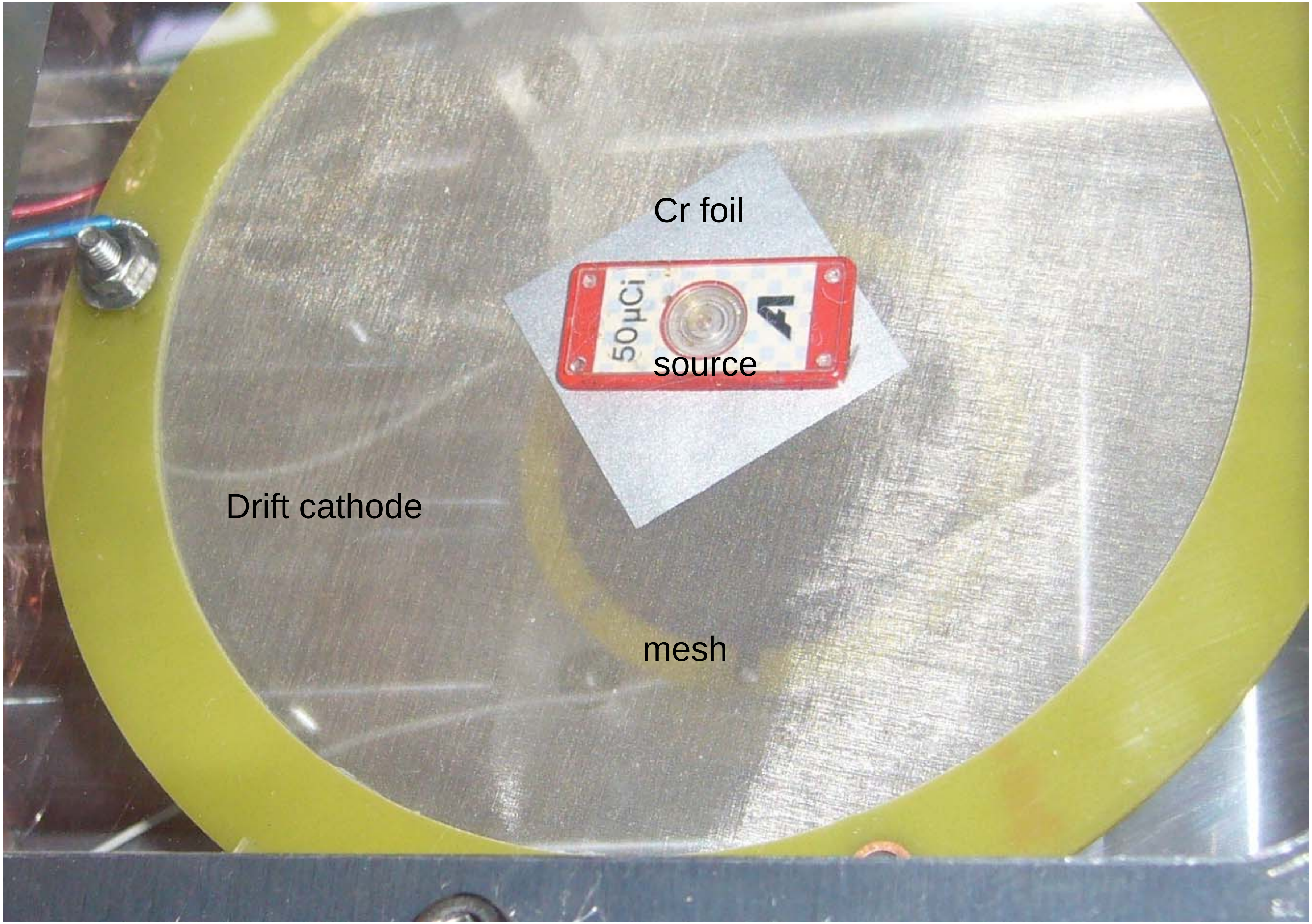
KEK Japan 2007 - Detector used

- Multi-purpose gas box (D. Attié, P.C., A. Giganon, M. Riallot) designed in Saclay.
- 2 copies in Saclay for Medipix/Timepix and Ingrid measurement, 1 built in Japan for energy resolution measurements (plus in the future)
- Gas : Ar+ few % isobutane

Chromium K-edge (Center for X-Ray Optics)

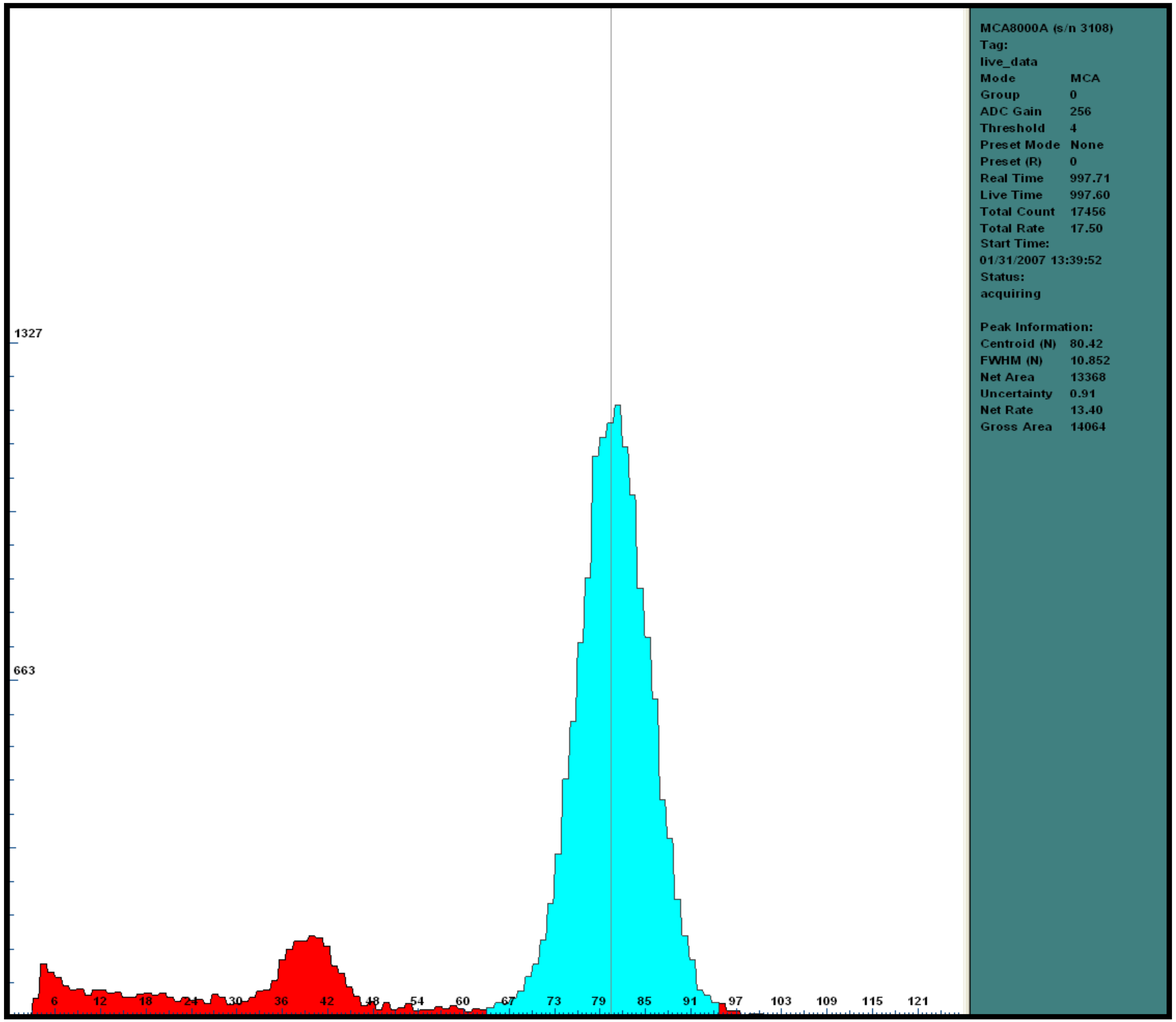





Cr foil
50µCi
source
Drift cathode
mesh

Result : 5.6%
r.m.s. resolution

(Broken record)



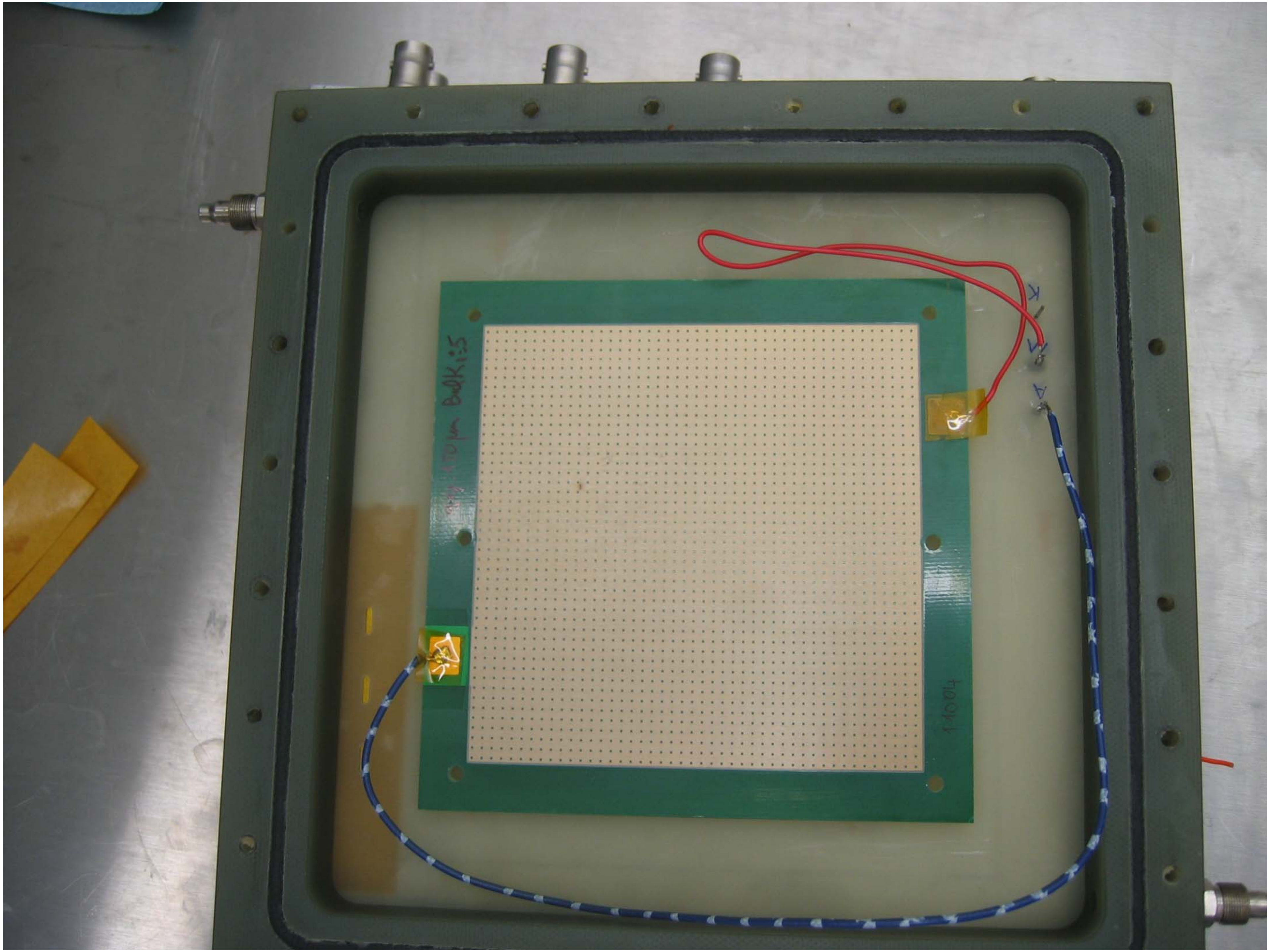
Noise very small
thanks to adequate
filter on the mesh

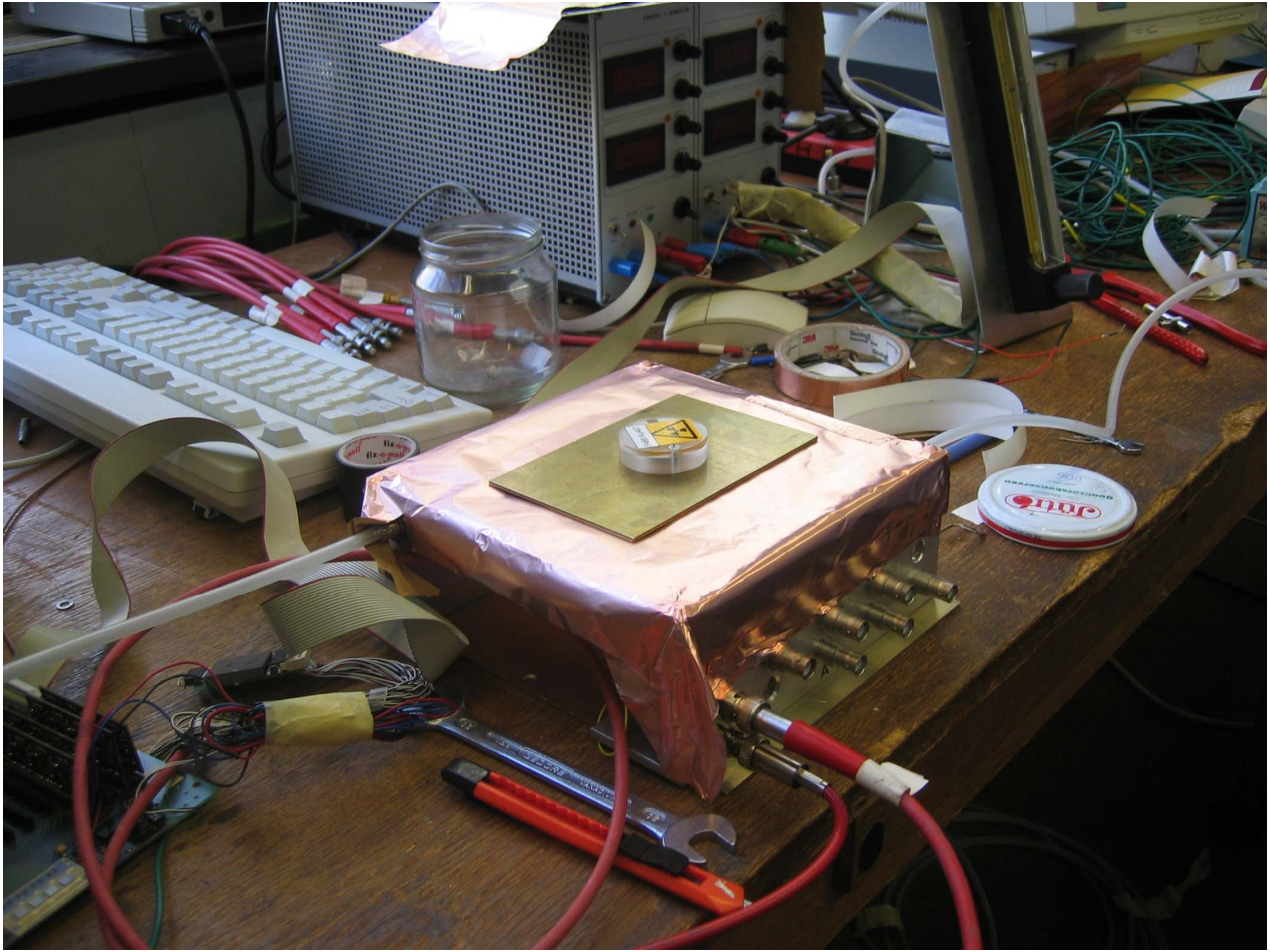
•Aachen

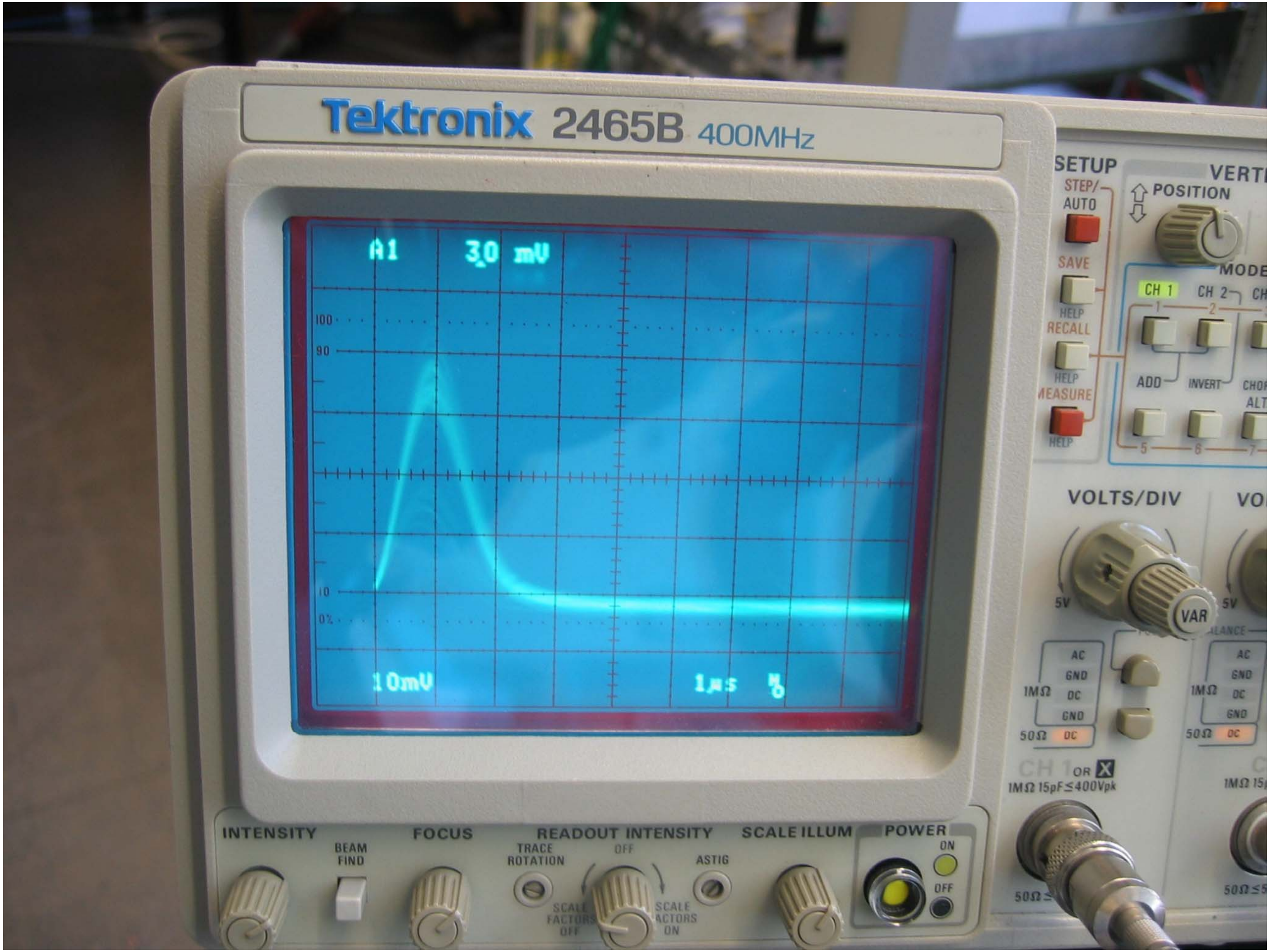
•9-11 octobre 2006. Démonstration d’un Micromégas.

24-25 octobre 2006. remove 10 MOhm resistors on HV, then shield

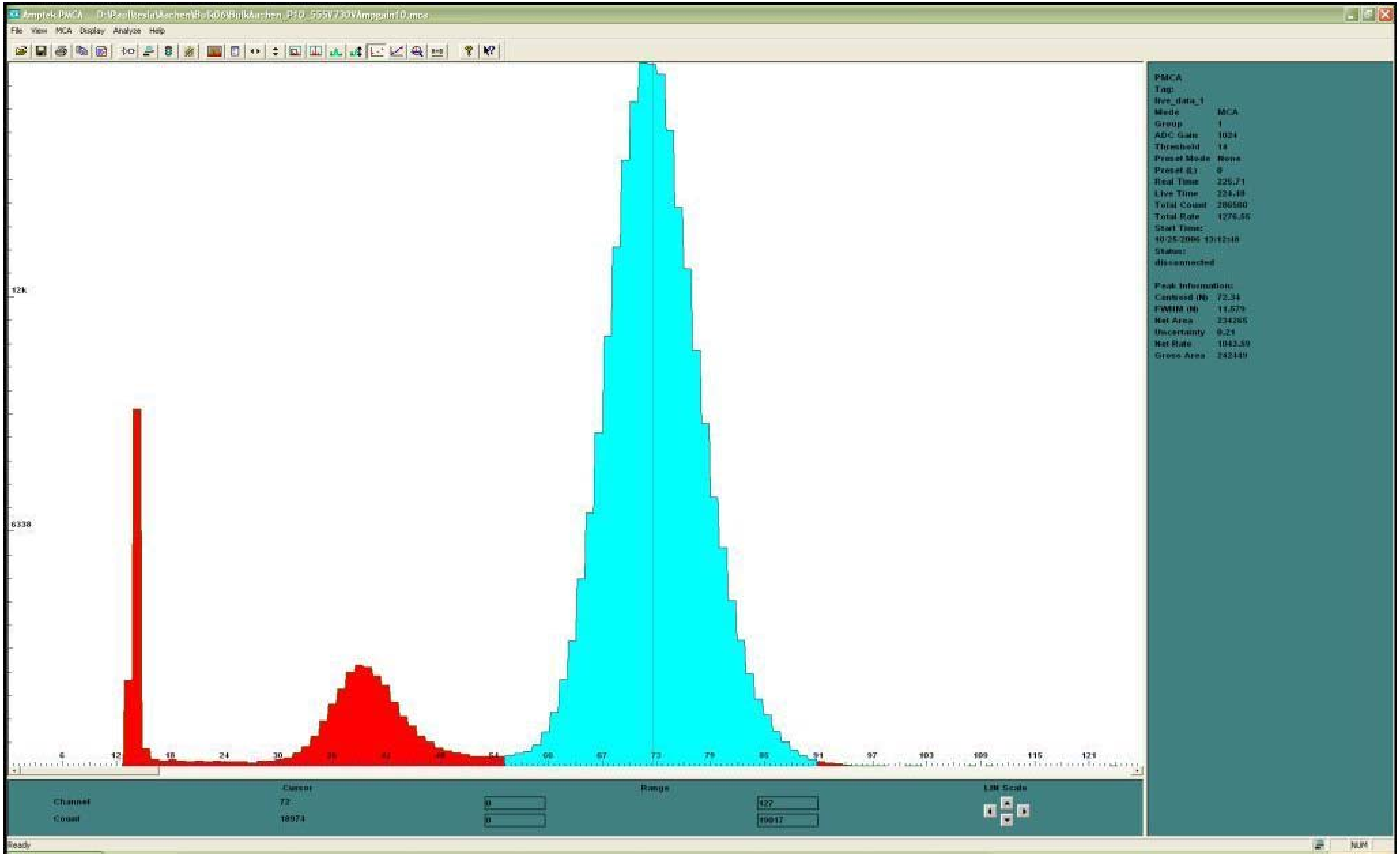
Resolution 6.7%rms.




3M



Tektronix 2465B 400MHz
A1 3.0 mV
10mV
1µs
SETUP
STEP/ AUTO
SAVE
HELP
RECALL
MEASURE
POSITION
MODE
CH 1
CH 2
ADD
INVERT
VOLTS/DIV
VAR
AC
GND
DC
1MΩ
50Ω
CH 1 OR X
1MΩ 15pF ≤400Vpk
INTENSITY
BEAM FIND
FOCUS
READOUT INTENSITY
TRACE ROTATION
OFF
ASTIG
SCALE FACTORS OFF
SCALE FACTORS ON
SCALE ILLUM
POWER
ON
OFF


Amptek PMCA
File View MCA Display Analyze Help
12k
6338
6
12
18
24
30
54
67
73
79
85
97
103
109
115
121
Cursor
Channel
72
Count
Range
LIN Scale
Ready
NUM
PMCA
Tag:
live_data_1
Mode MCA
Group 1
ADC Gain 1024
Threshold 14
Preset Mode None
Preset (L) 0
Real Time 225.71
Start Time:
Status:
disconnected
Peak Information:
Centroid (N) 72.34
FWHM (N) 11.679
Net Area 234265
Uncertainty 0.21
Gross Area 242449