There will be two presentations from our group:

I. Progress in development detectors based on resistive meshes

and

II. First beam tests of resistive THGEMs

I. Progress in development detectors based on resistive meshes

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Why not combining RPC and Micromegas

For large Micromegas (not segmented) discharge can be a problem for electronics. This can be avoided by adopting the RPC principle

1- Resistive anode
2- Resistive mesh : few M Ω.cm Kapton
holes made with LASER
(collaboration with Rui)

cathode

Resistive mesh

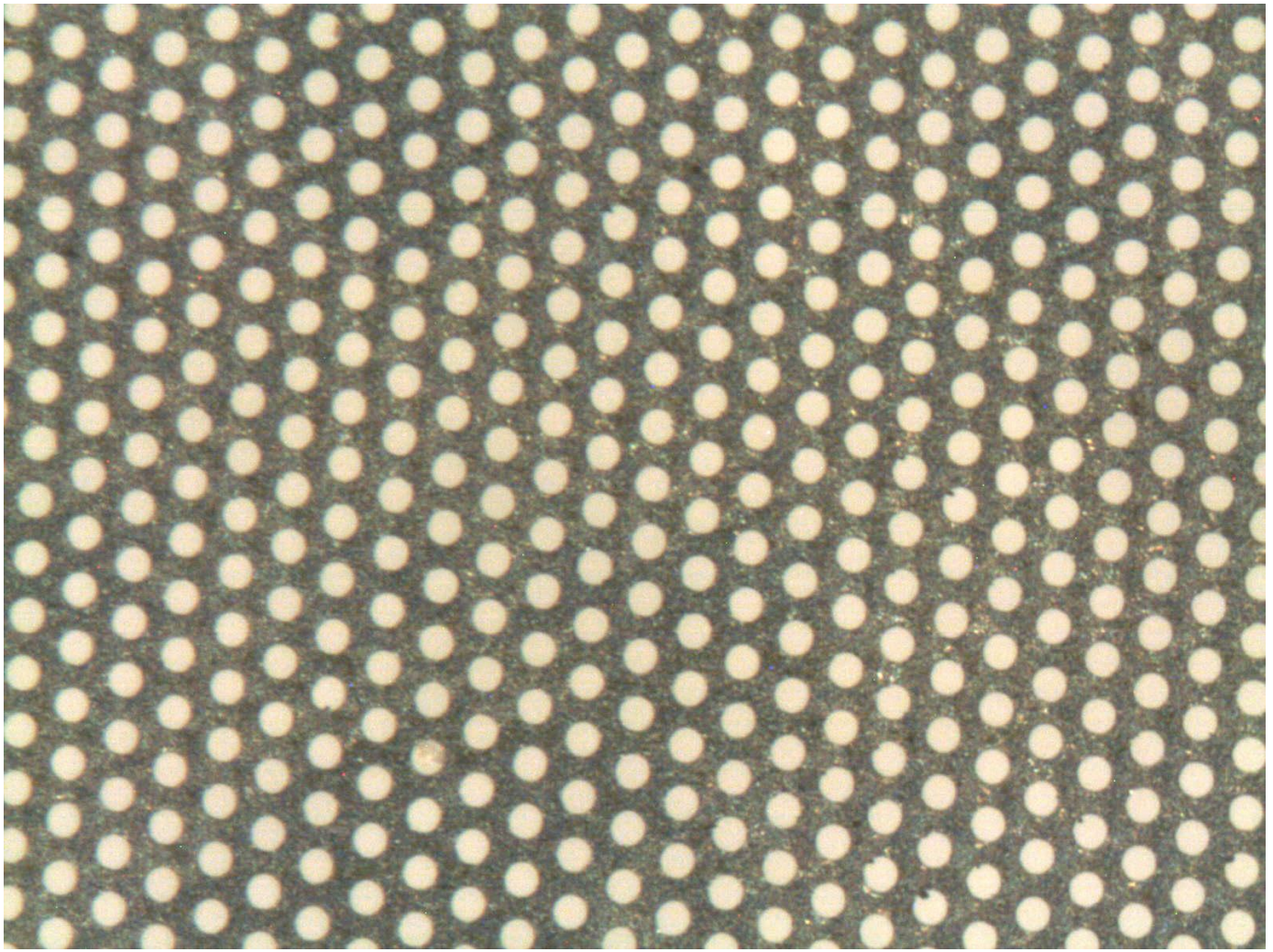
Anode

We have ordered from Rui resistive meshes much before the Laktineh talk,

however received it after the Laktineh talk

.. so certainly we give him and his group all credits

V. Peskv et al Presenetd at the RD51 Mini-week in February 2010



Resistive Kapton 100XC10E5, resistivity 2.8-3 MΩ/□a thickness of 20μm, a hole diameter d=50 μm and hole spacing a=100 μm

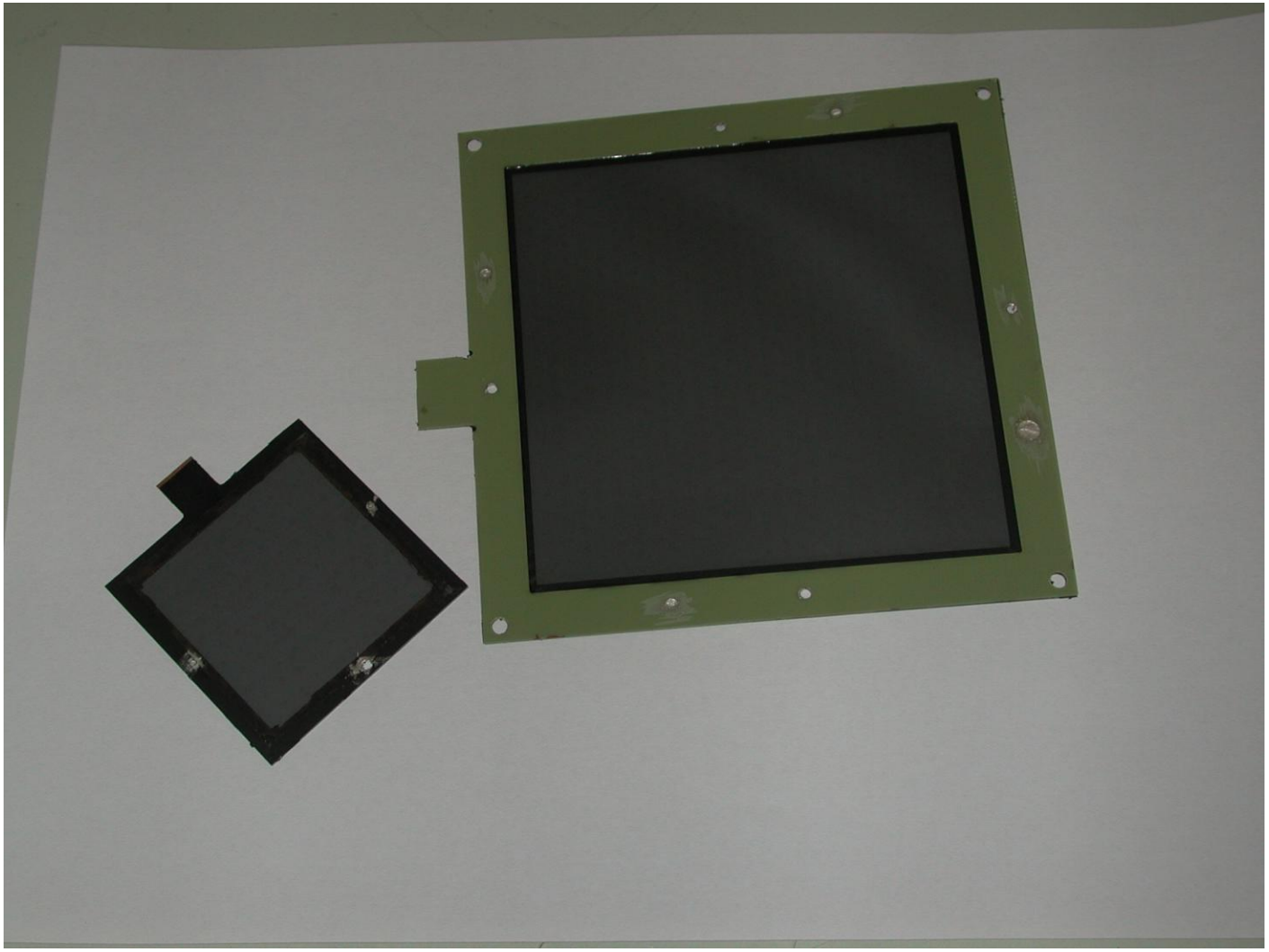
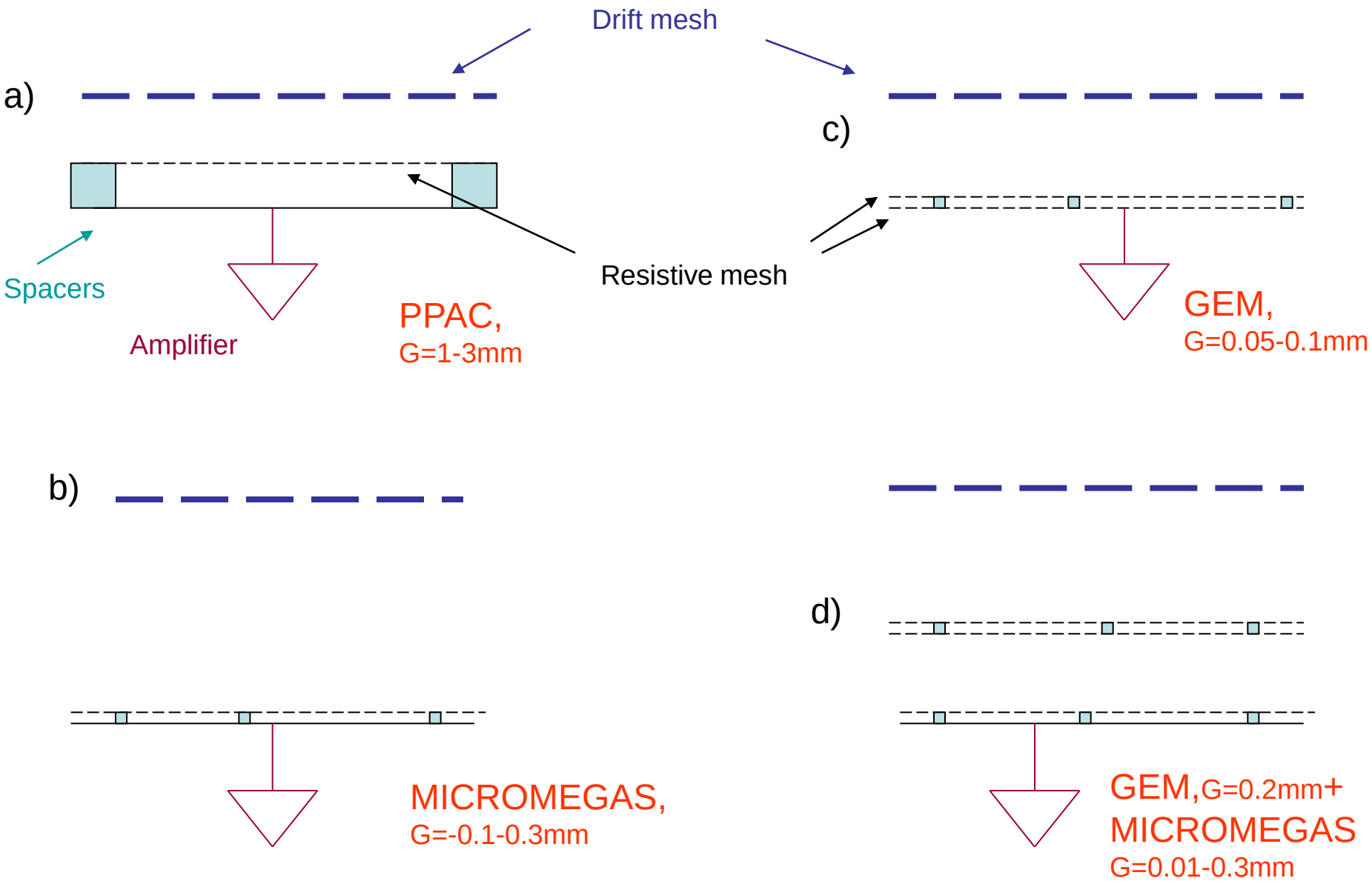


Photo of resistive meshes stretched on G-10 frames of size 5x5 cm^2 and 10x10cm^2

From these stretched meshes different detectors could be assembled:

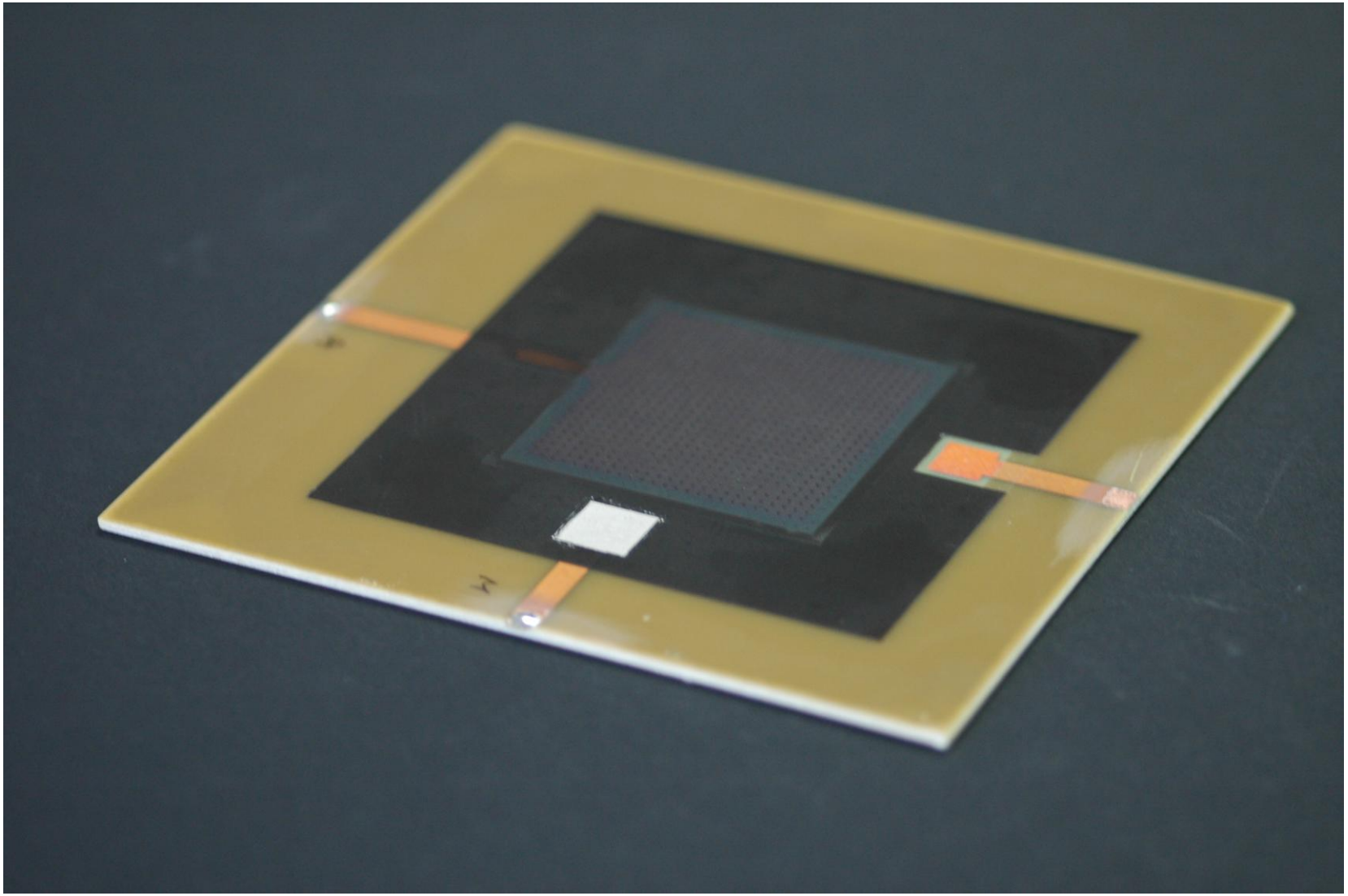


From February 2010 we have the following progress:

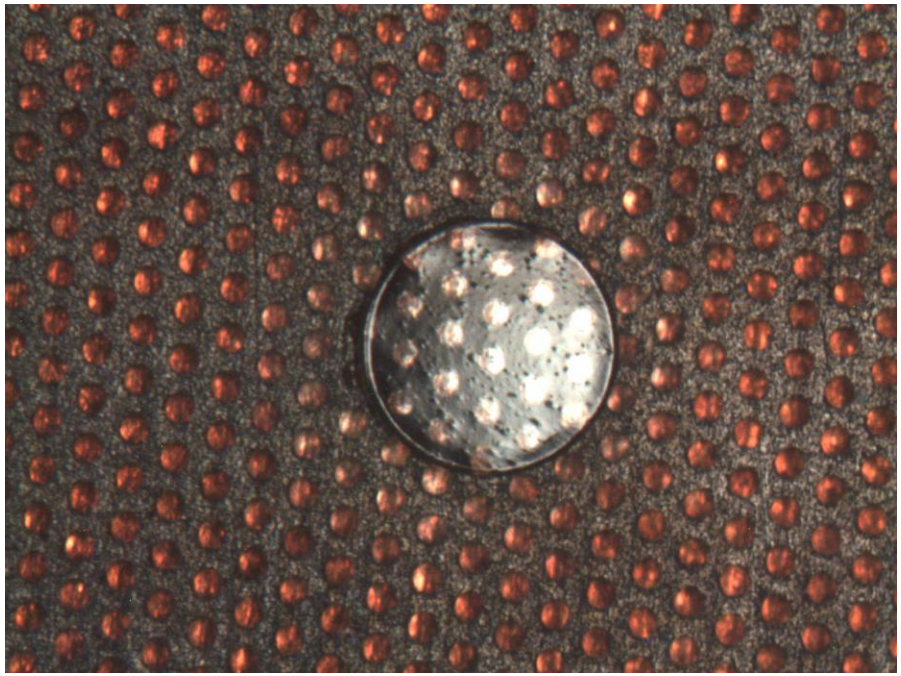
1)We have developed a bulk MICROMEGAS with resistive cathode mesh

2) We start developing high gain photosensitive detectors based on resistive meshes

1) Bulk MICROMEGAS

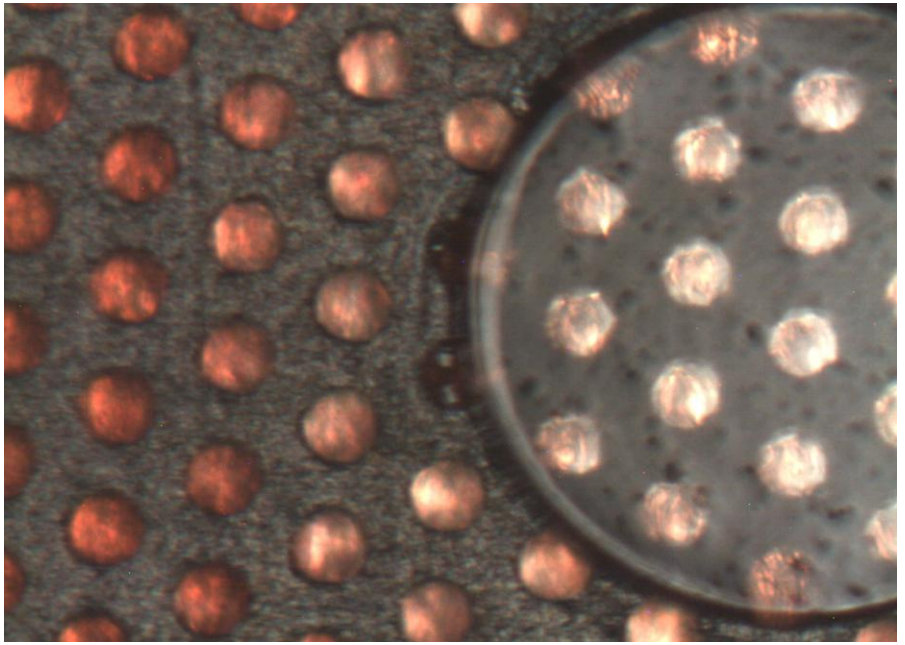


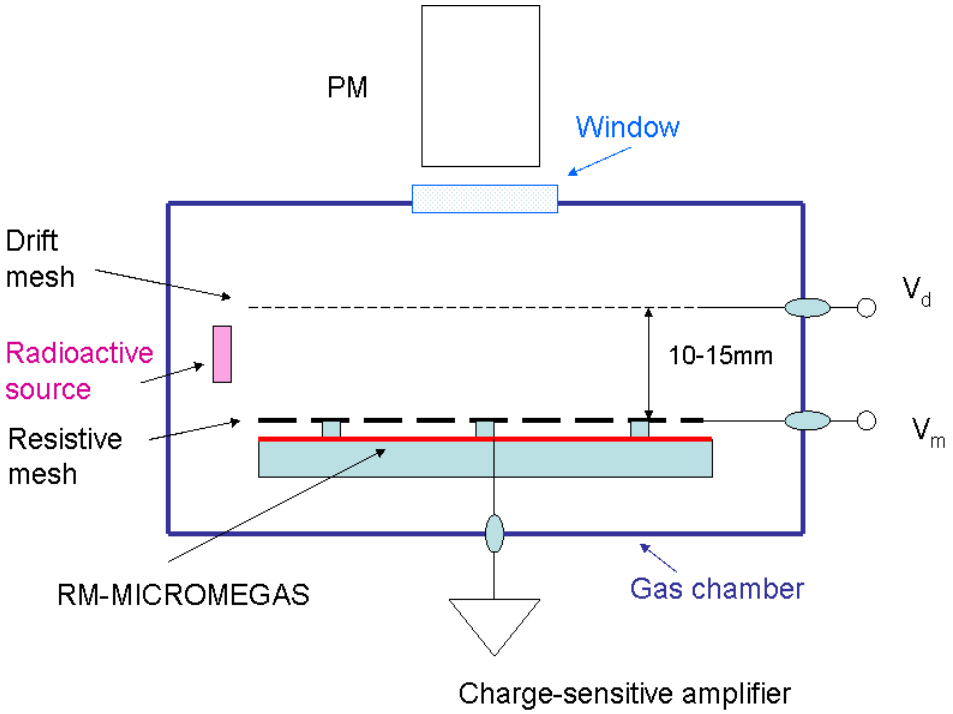
The bulk RM-MICROMEGAS was manufactured in a few steps. First the anode plate (fiber glass with a 20μm thick Cu layer) and a photosensitive film (DUPONT photoimageable coverlay PC1025) having the right thickness and the resistive mesh were laminated together at an elevated temperature forming a monolithic object. The photosensitive film was then photolitographically etched so that supporting pillars were formed



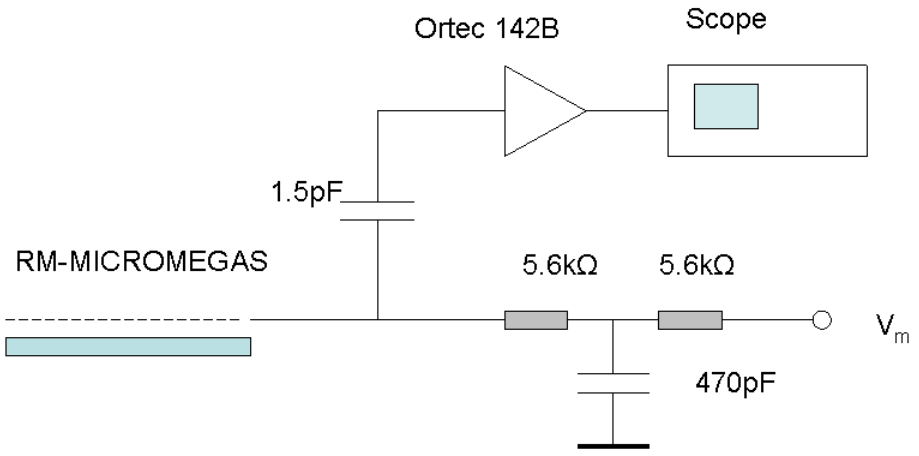
A magnified photograph of the bulk MICROMEGAS cathode resistive mesh with incorporated supporting pillars under it.

These pillars had a cylindrical shape with a 300μm diameter, their height was 128μm and the pitch was 2mm



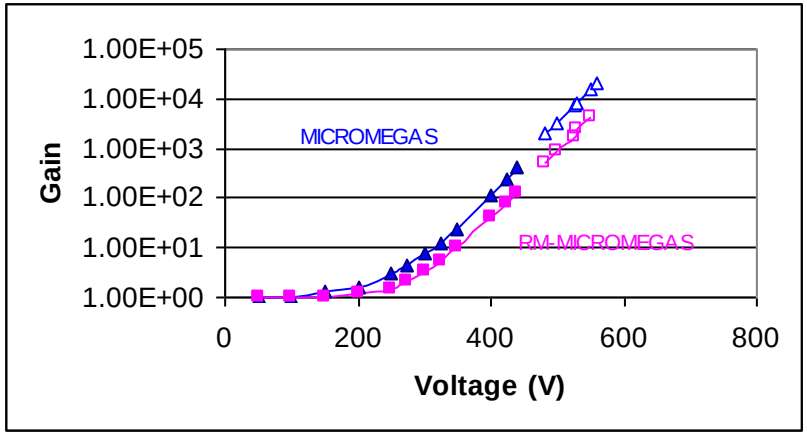


A schematic drawing of the experimental setup used for the RM-MICROMEGAS studies



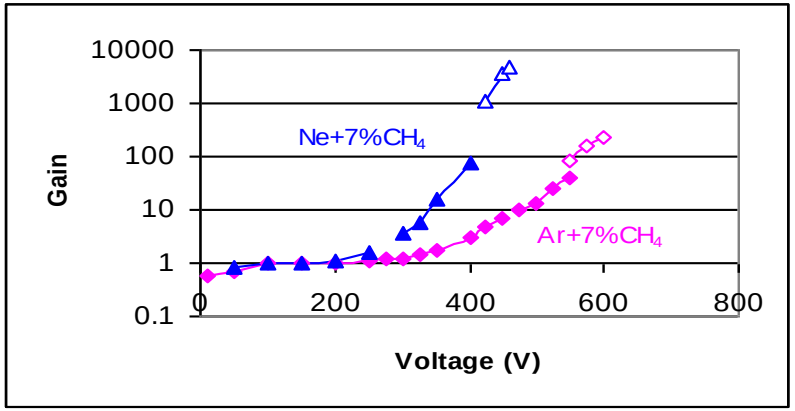
A schematic of the circuit used for measurements of the charge released by sparks

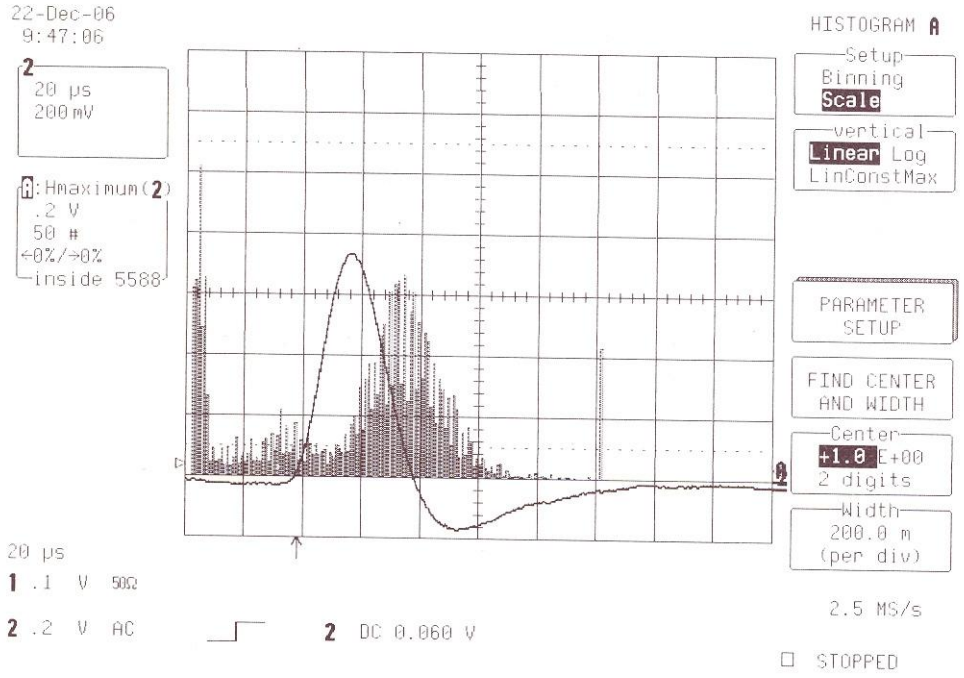
(*see E. Ferrer Ribas et al.*
, "Topology of sparks: tests in the laboratory",
Report at the RD51 Meeting, Saclay, January 24-25, 2010).



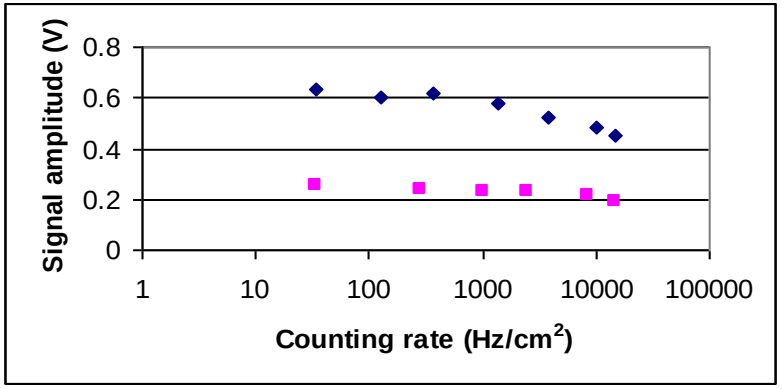
Gain vs. voltage curves measured in Ar+5% isobutene with bulk RM-MICROMEGAS (squares) and with the conventional bulk MICROMEGAS (triangles).
Filled symbols correspond to measurements Performed with alpha particles (^{241}Am), open symbols- 6keV photons from ^{55}Fe.

Gain curves for RM-MICROMEGAS operating in Ne +7%CH_4 (triangles) and in Ar+7%CH_4.
Filled symbols - ^{241}Am, open symbols - ^{55}Fe.





Pulse-height spectrum of ^{55}Fe measured with RM-MICROMEGAS operating in Ar+5%isobutane at a gas gain of 810^3in Ar+5%isobutane



Signal amplitude vs. the counting rate measured for the RM-MICROMEGAS at a gas gain of ≈810^3 (rhombus) and ≈2.510^3 (squares).

Conclusions

Successful implementation of the bulk technology for RM-MICROMEGAS manufacturing demonstrates the possibility of building high quality, large- area, spark-protected detectors of photons and charged particles by an industrial process.

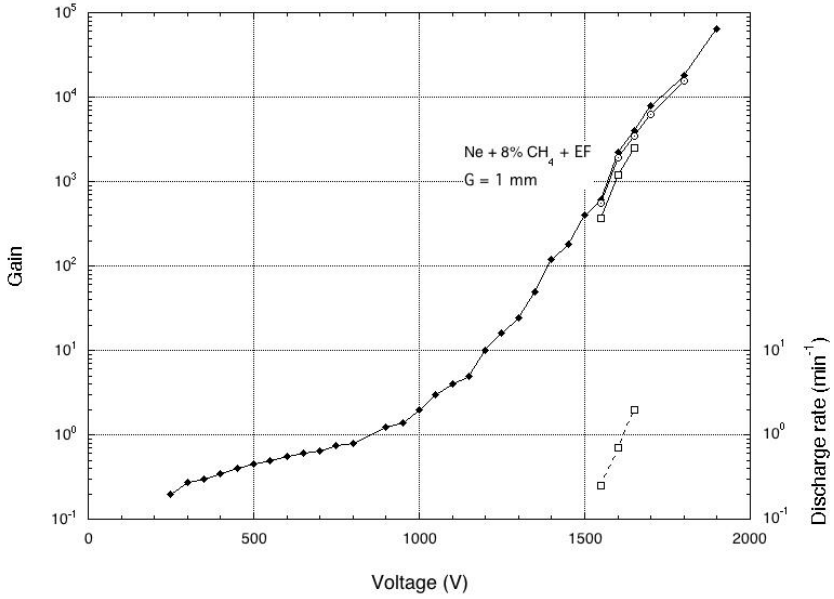
This approach could be complementary to ongoing efforts performed by various groups within the framework of the RD51 collaboration to develop MICROMEGAS and other types of gaseous detectors with the resistive electrodes.

2) High gain photosensitive detectors based on resistive meshes

Detector type	Gas mixture	Avalanche gap (mm)	Maximum achievable gain
RM- μM	Ar-based	0.1	(2-3)x10^2
Bulk RM-μM	Ar-and Ne-based	0.12	2x10^2 and 5x10^3
RM- μM	Ar -and Ne-based	0.2	4x10^3 and 7x10^3
RM-μM	Ar -and Ne-based, no spacers	0.5	5x$10^3$and 3x10^4

Summary of results obtained with various designs of RM-μM in Ar- and Ne-based mixtures

The gain vs. the voltage curves for the very large gap RM-μM (G=1mm, Nylon spacers, active area 10x10cm2) cathode of which was coated with a CsI layer.
Filled rhombus-gains measured in current mode with UV light. Open squares -the gain measured in pulsed mode when the detector was simultaneously irradiated with UV light and 22keV photons from ^{109}Cd over the entire sensitive area (the counting rate was 310^{5}Hz).
The drift field was 200V/cm. Dash line with open squares –breakdown rate measured at these conditions.
Open circles represent gain vs. the voltage measured in current mode when the detector was simultaneously irradiated with UV and 22keV photons, however the drift field had reversed polarity and its value was 50V/cm.
With this reversed drift field no discharges were observed at a gain 2x10^4 or below during 7 hours of continuous operation.



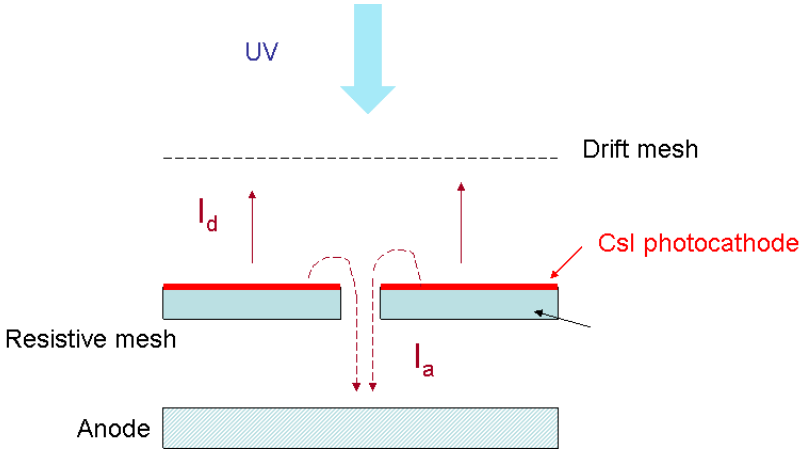
Raether limit:

the maximum achievable gains of hole –type structures A_{max} are governed by the so-called Raether limit:

$A_{max} n_0 = Q_{max} = 10^6\text{-}10^7$ electrons,

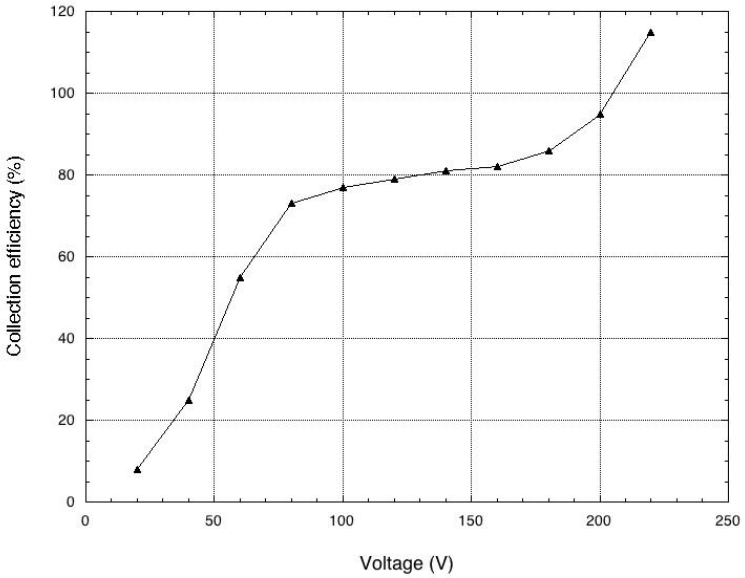
where n_0 is the number of primary electrons created in the drift region of the detector

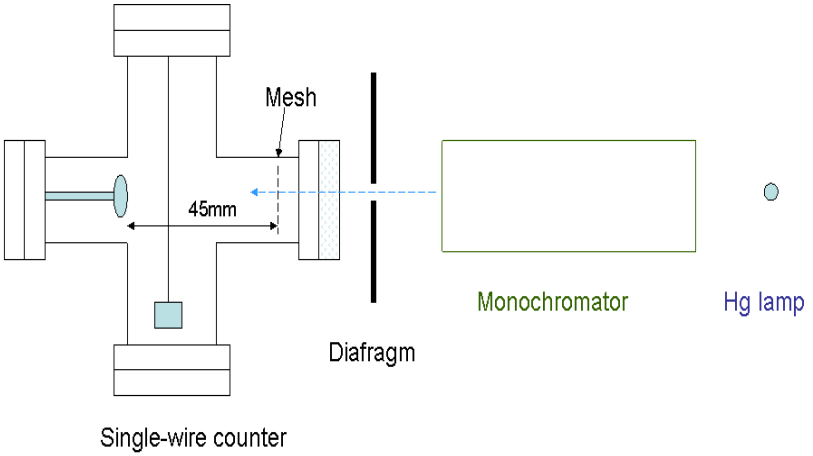
(Q_{max} depends on the detector geometry and the gas composition)



The current flow diagram in the case of the measurements of the photoelectrons collection efficiency K. $=I_a/I_d$

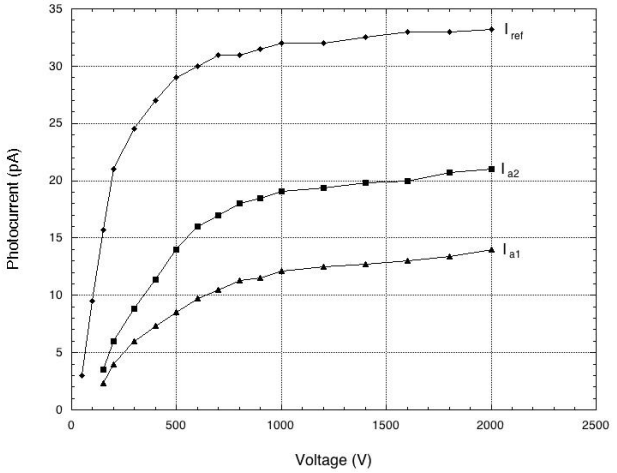
Photoelectrons collection efficiency K vs. the voltage between the resistive cathode mesh and the anode for RM-GEM, G=0.05mm in CH_4. Note that at V>200V the amplification starts, however it is clear that in the voltage interval 100-200V the collection efficiency is about 80%.





A schematic drawing of a single- wire counter used for the calibration of the absolute intensity of the UV beam from the monohromator

Photocurrents I_{ref} and I_{a1} vs. the applied voltages measured in the single-wire counter (CH4+TMAE) and in between the drift mesh and the resistive cathode meshes (CH4) respectively.
The current I_{a2} represents the measurements performed in Ne+8%CH4 saturated with ethylferrocene vapors



In the gas mixture Ne+8%CH_4 saturated with ethylferrocene (EF) vapors the quantum efficiency measured at 185nm was Q_{185}=21% ,K≈80% (before the multiplication started) and thus the estimated detection efficiency at 185nm in the reversed drift filed mode is D= 18%. At high gain operation the collection efficiency most probably is around 100% so in reality the quantum efficiency of this detector may be as high as 26%.

Conclusions:

A large-gap detector bases on resistive meshes allows to achieve gas gains >10^4 (in the case UV+^{55}Fe) and QE at least 18%.

Our future work will be focused on the mesh geometry optimization and on tests of various mesh-based designs in order to achieve even higher gas gains and better position resolutions.

II) First beam tests of resistive THGEMs

V. Peskov

Behalf of ALICE VHMPID team

RETGEM

Thickness: 0.45 mm
Hole d: 0.4 mm
Pitch: 0.8 mm

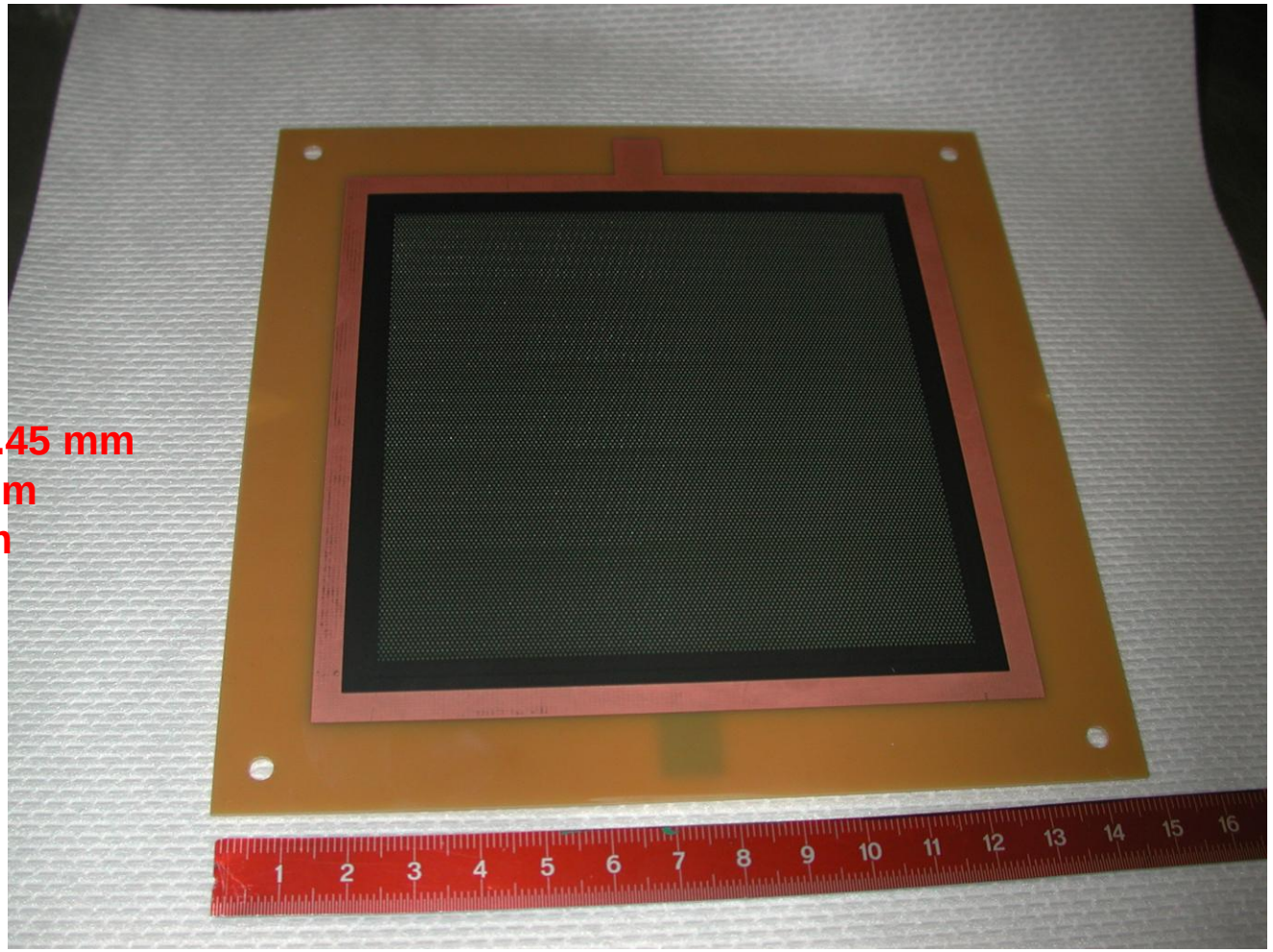
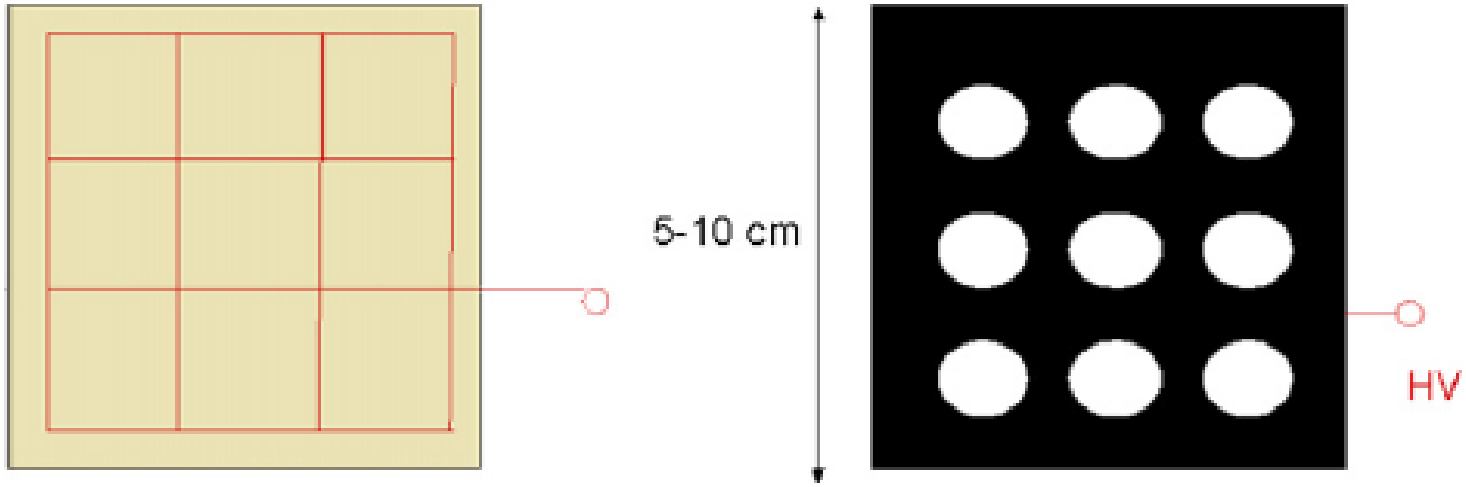


Photo of advanced RETGEM with an inner metallic mesh

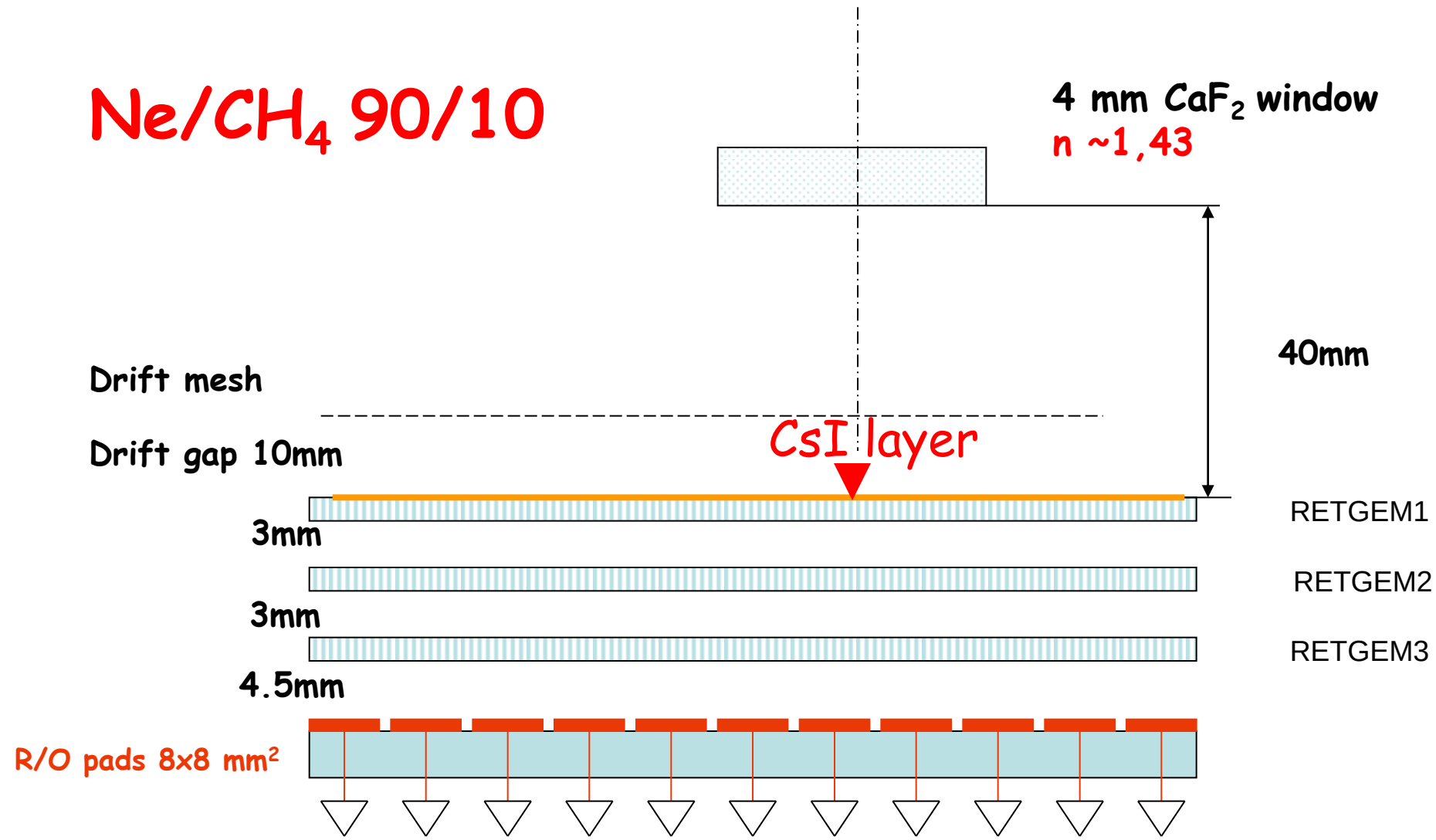


Charge collecting
metallic mesh

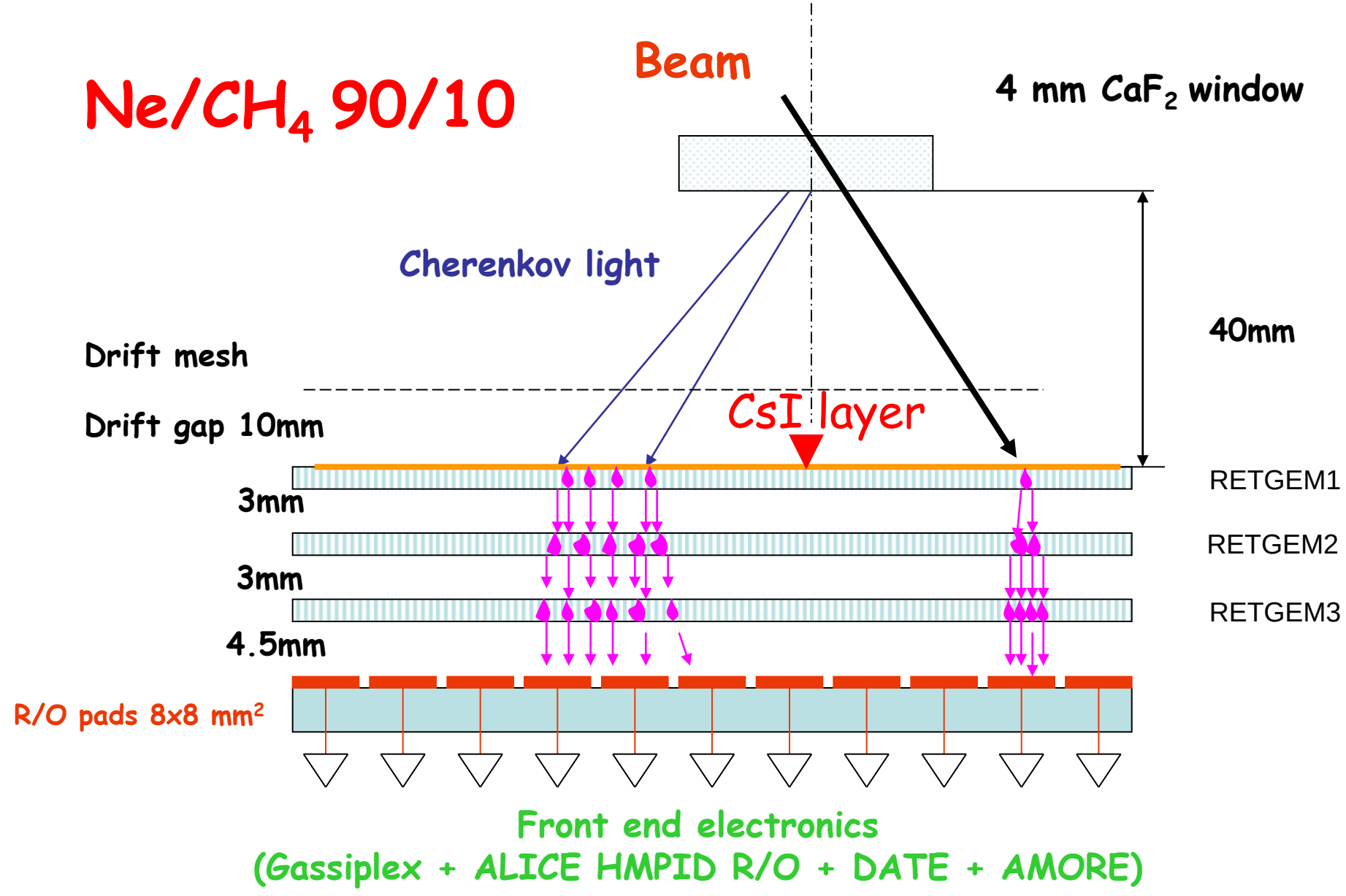
Resistive coating and drilling

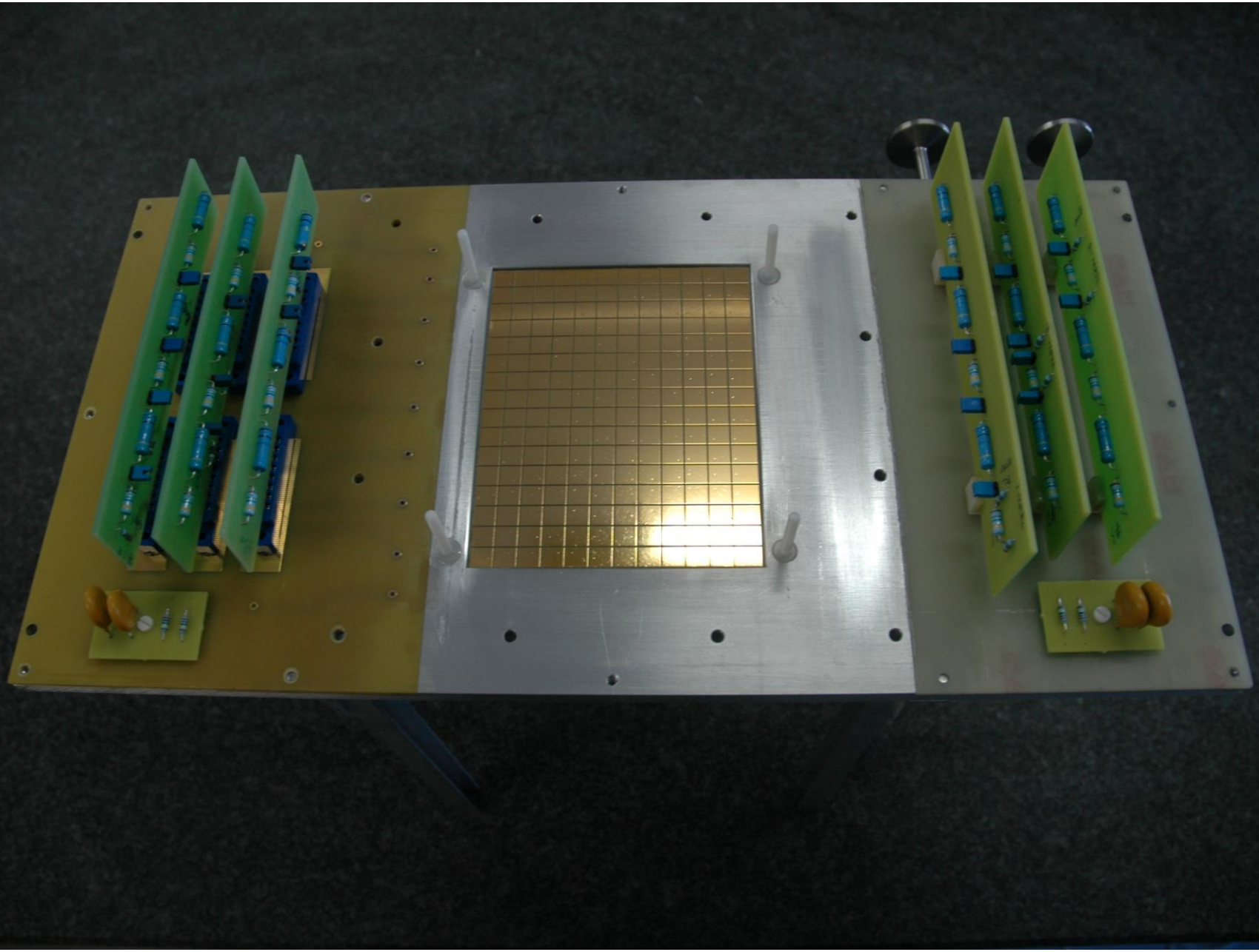
Triple RETGEM RICH prototype

Prototype layout

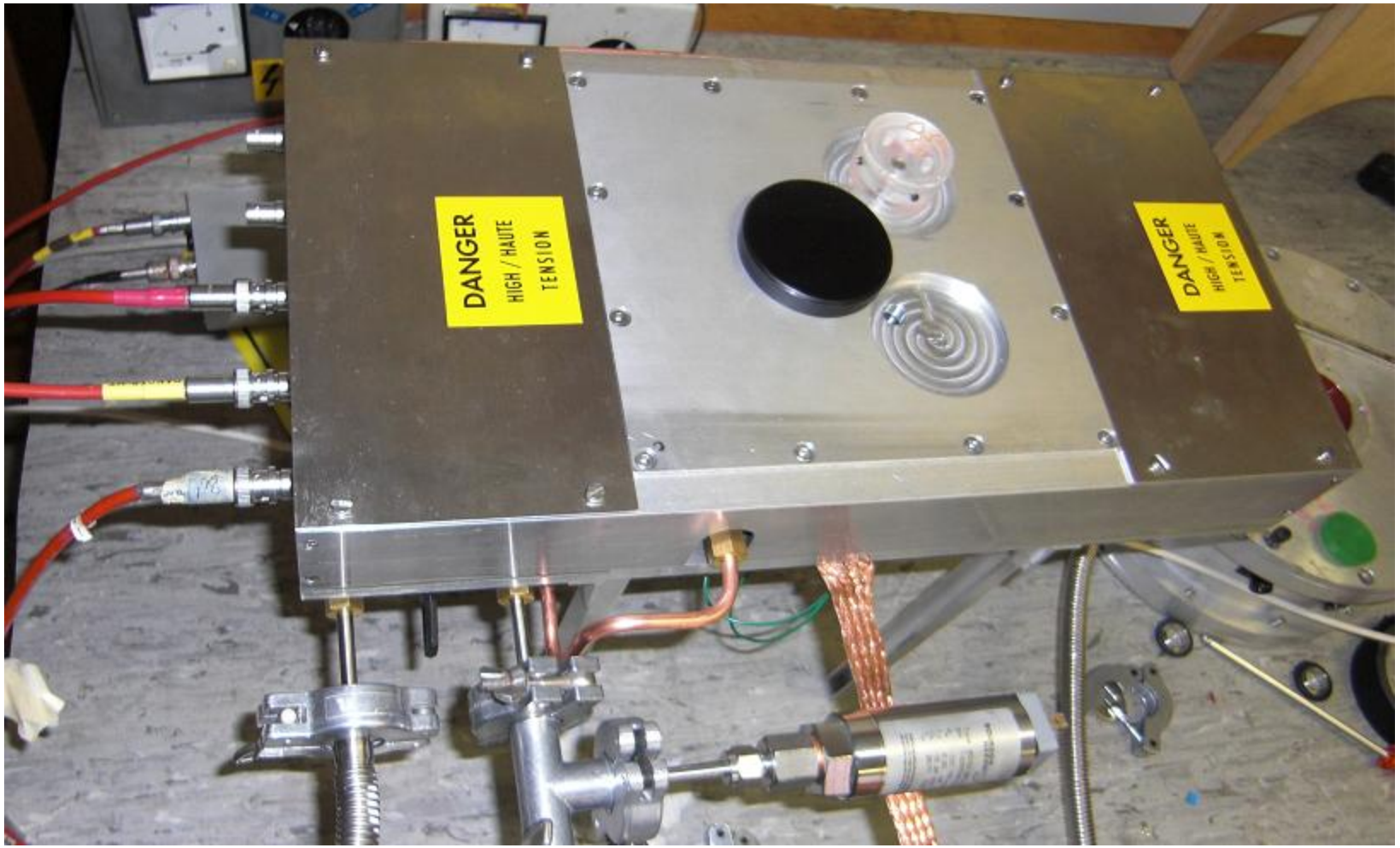


Prototype layout

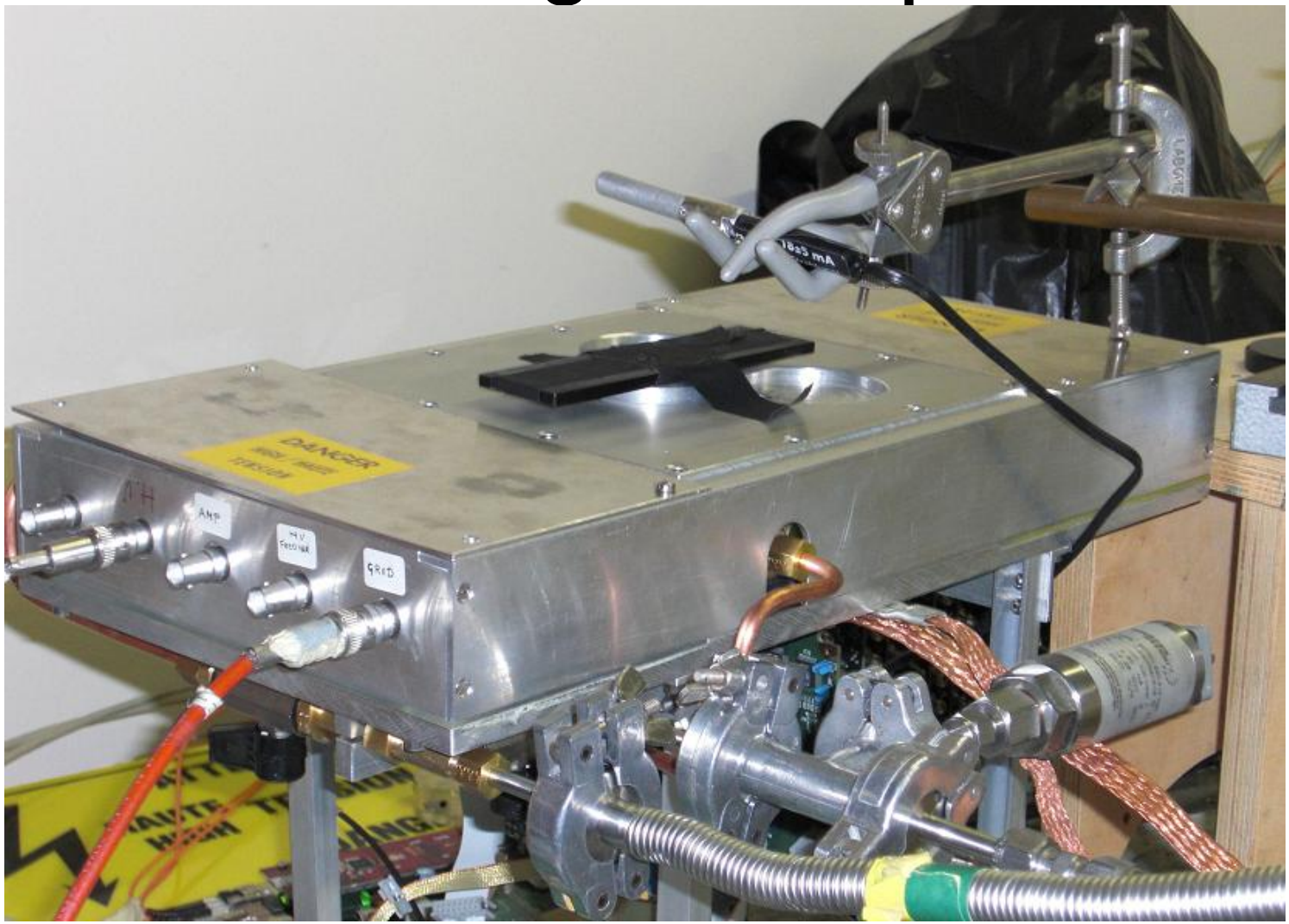


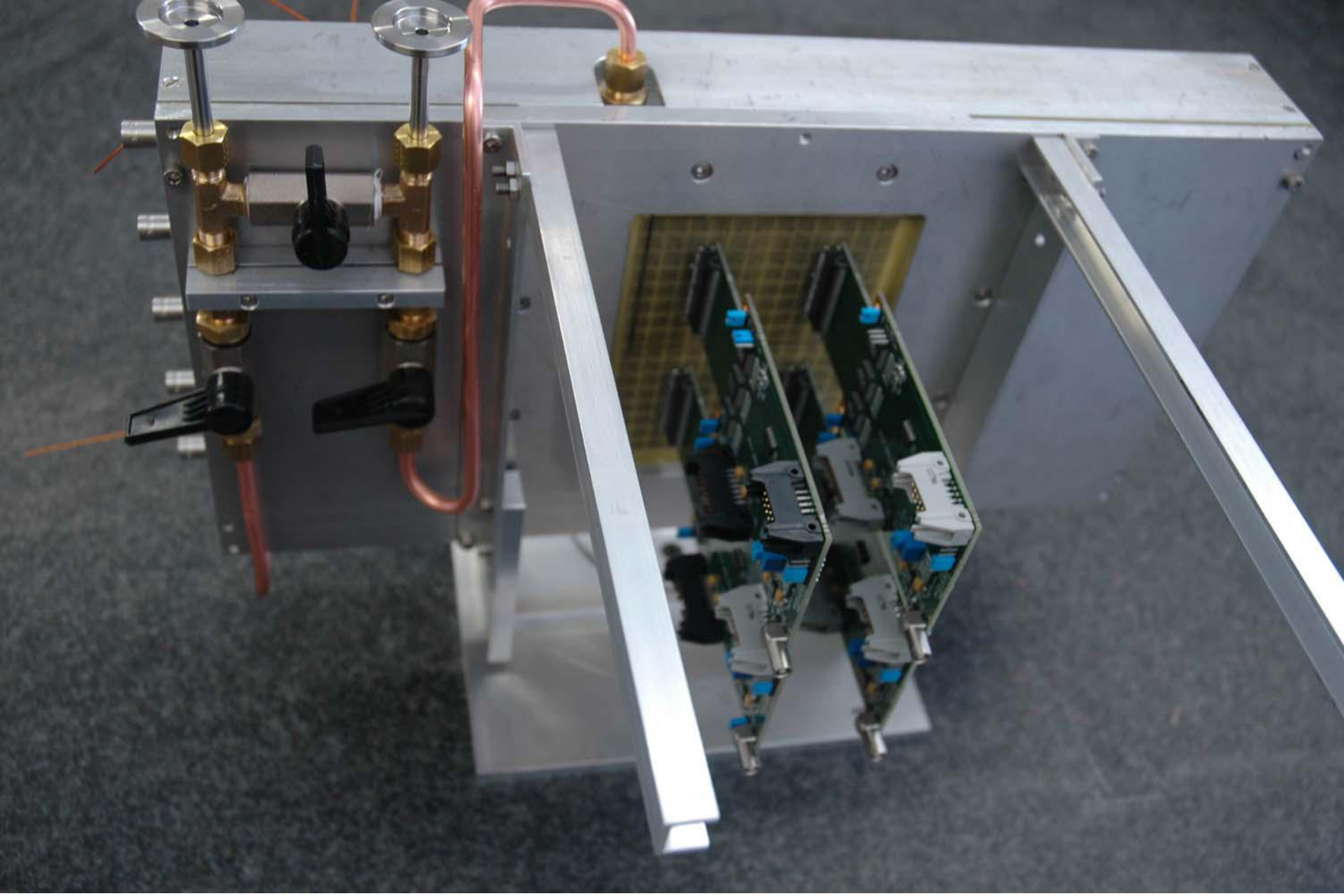


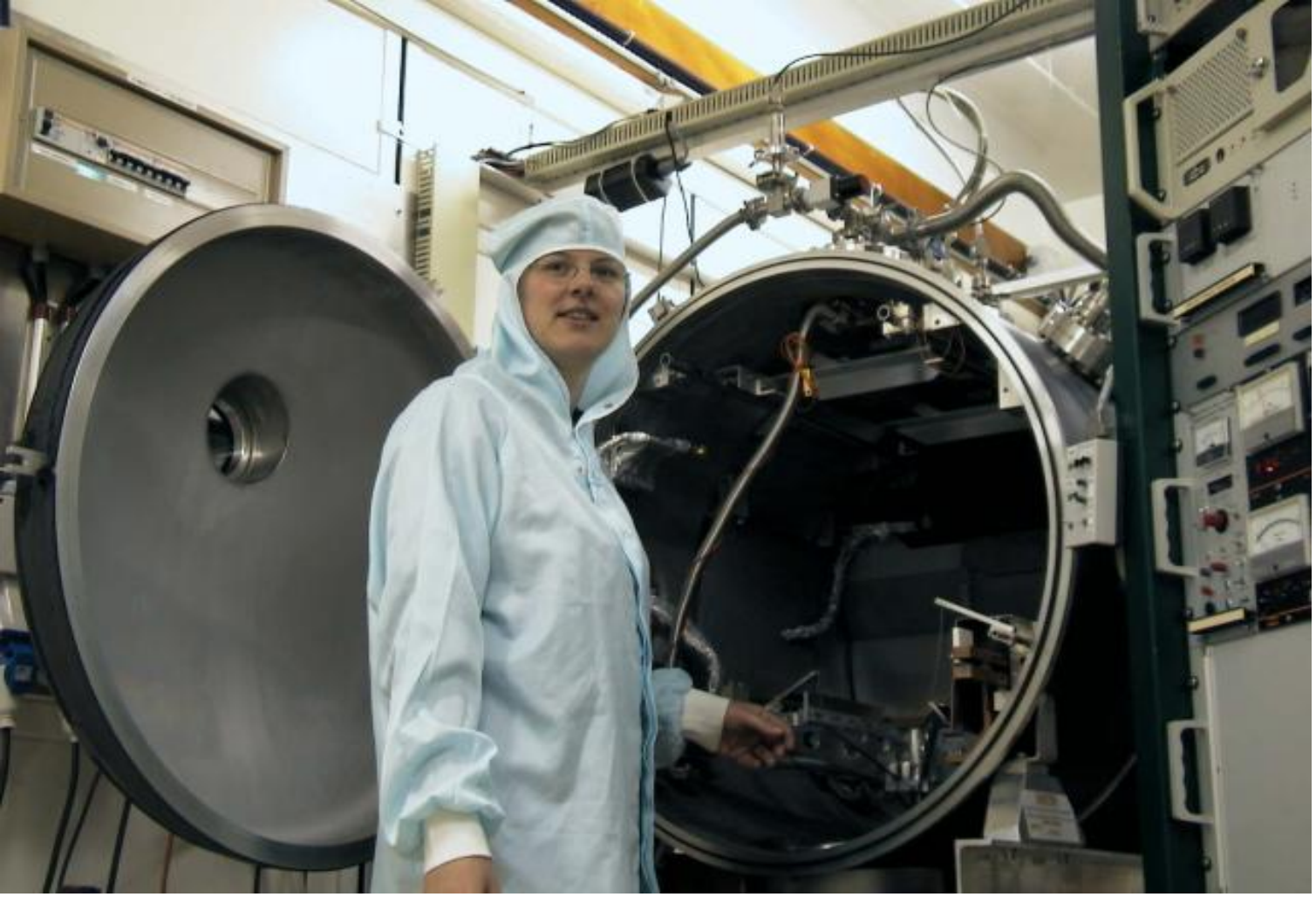
Complete Setup



UV light setup



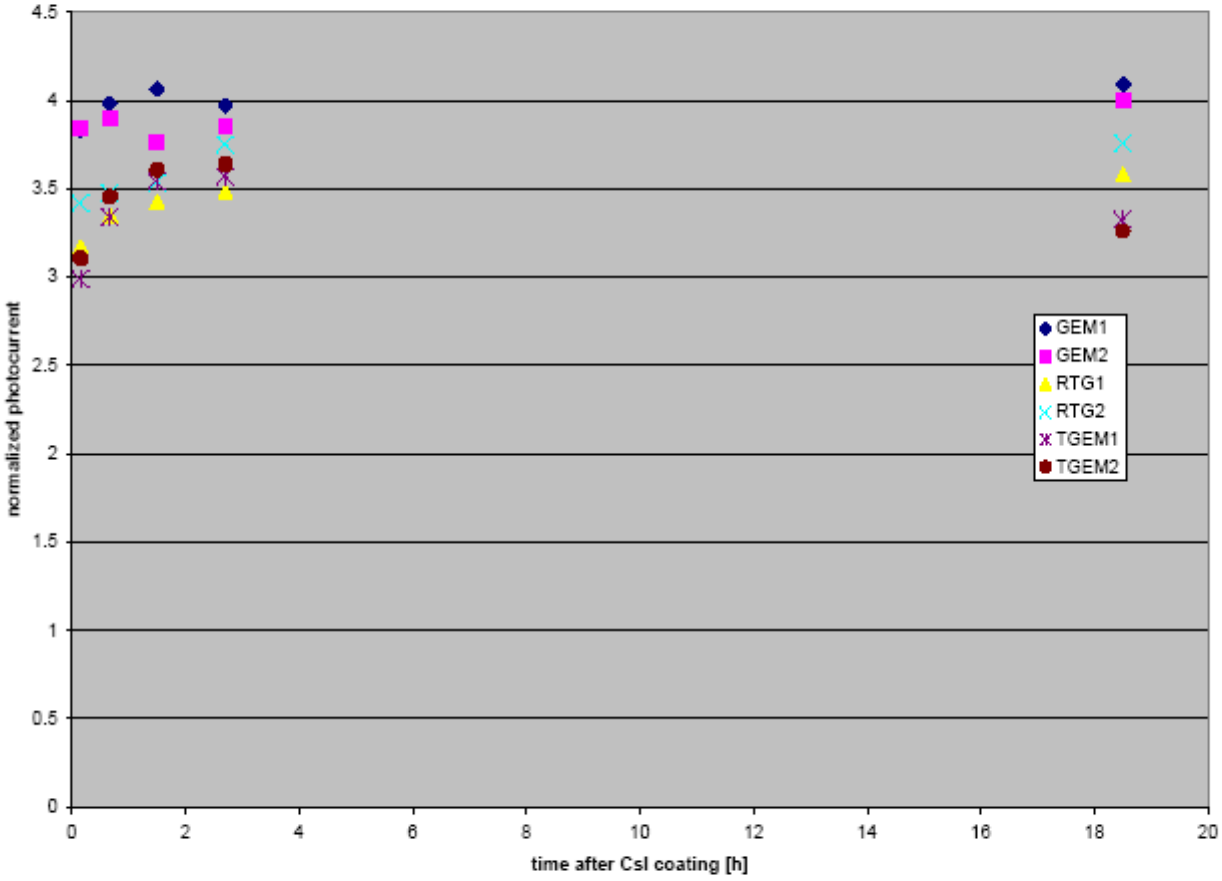




Many thanks to Miranda!

CsI quality control

Normalized photocurrent

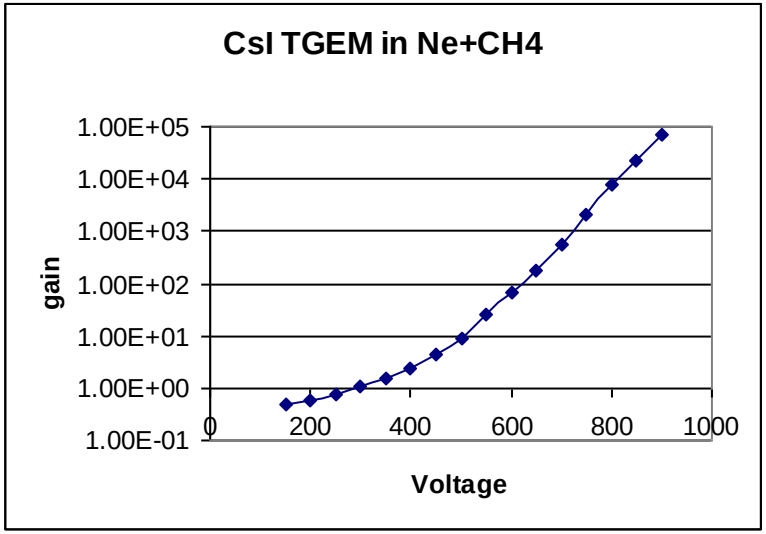


Time after coating [h]

Laboratory tests

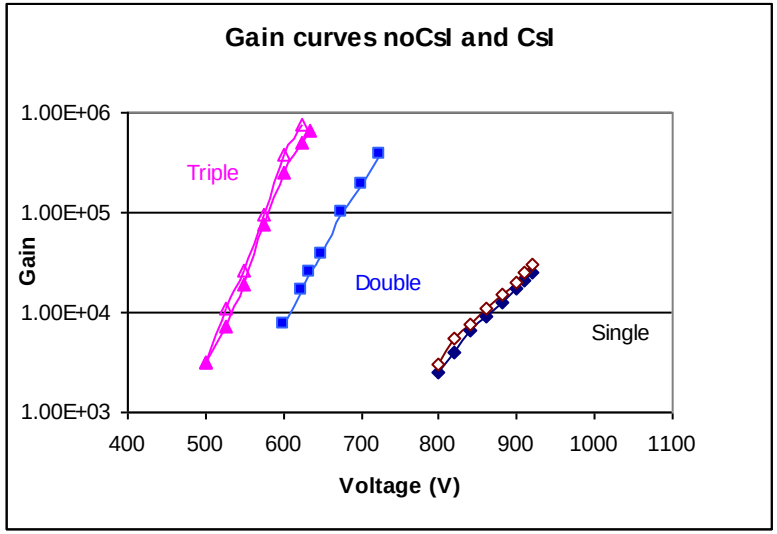
(For details see Himank presentation tomorrow)

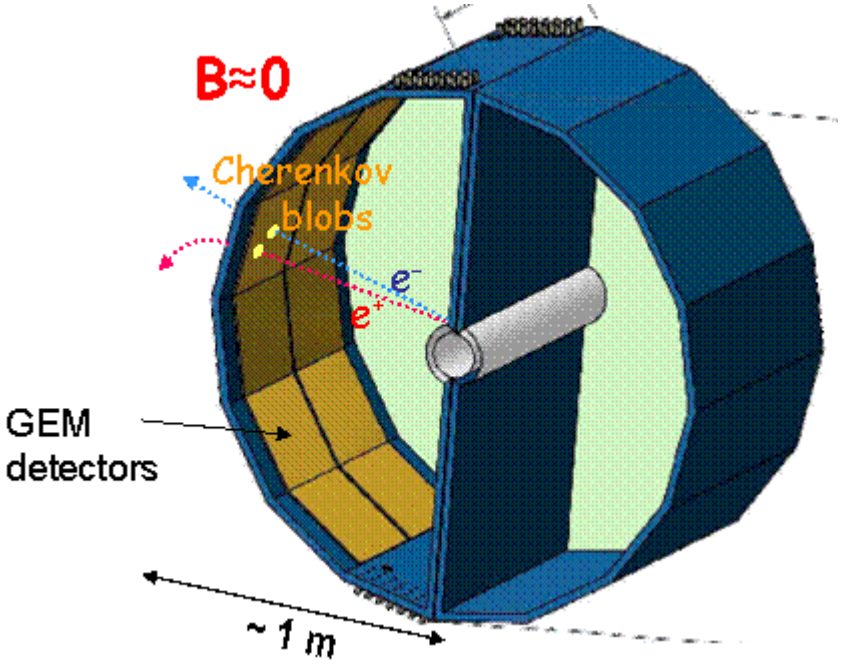
Gain of selected TGEMs

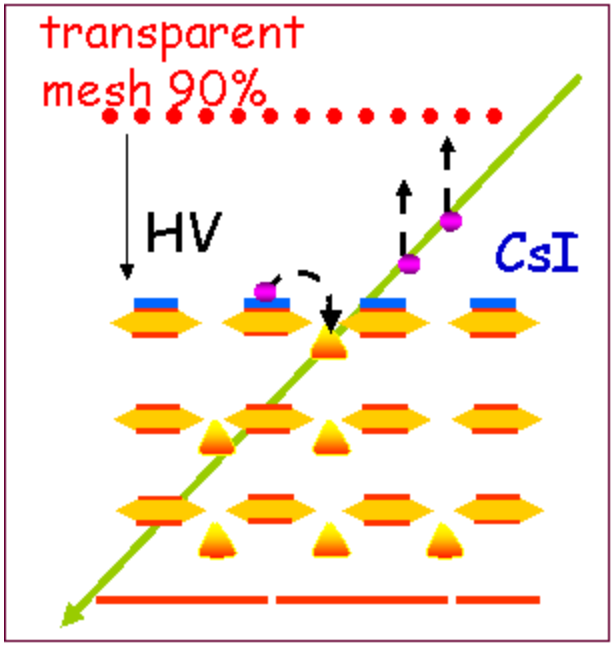


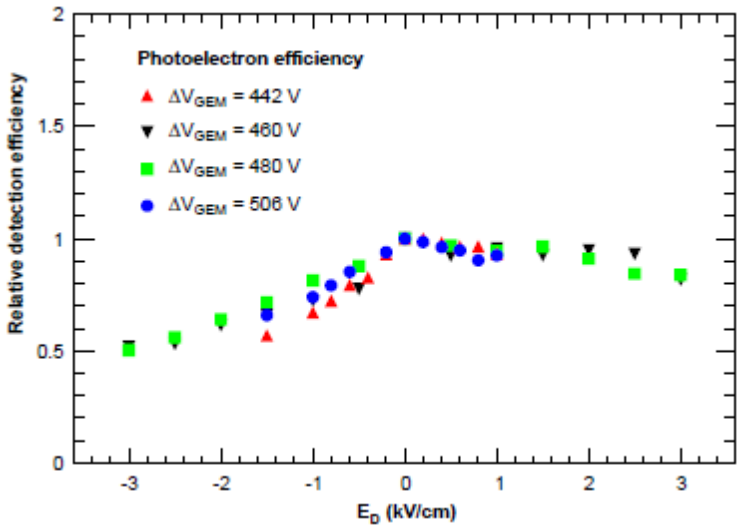
← UV photons

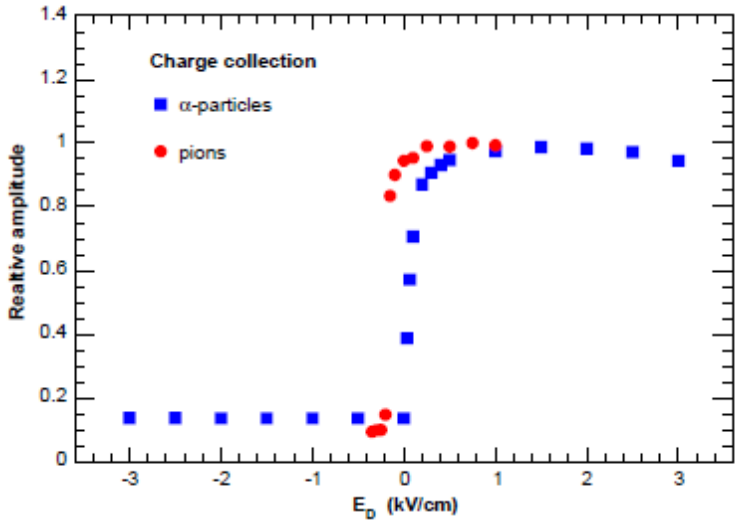
^{55}Fe →





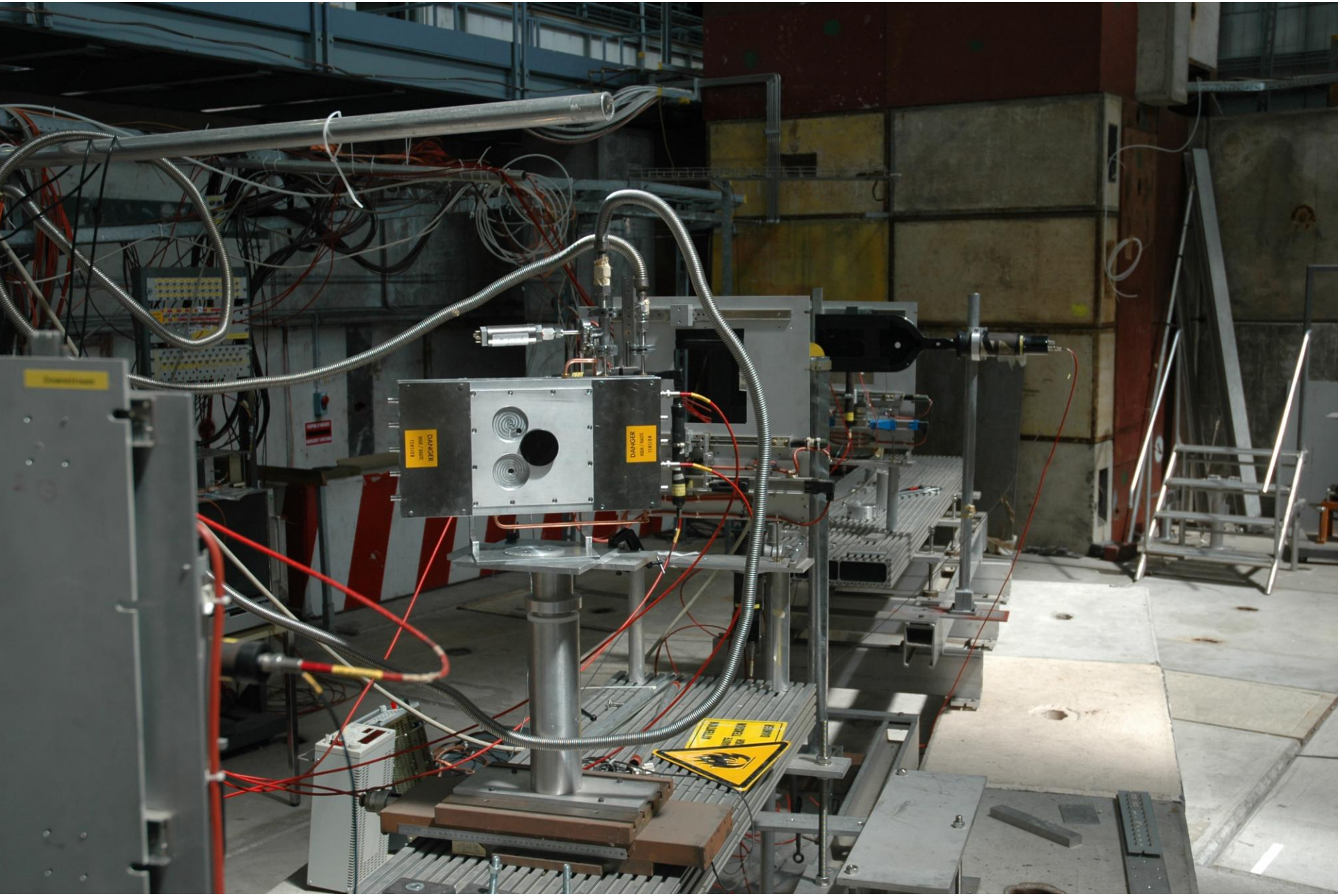






Z. Fraenkel et al., NIMA546 (2005) 466

Beam test at T10

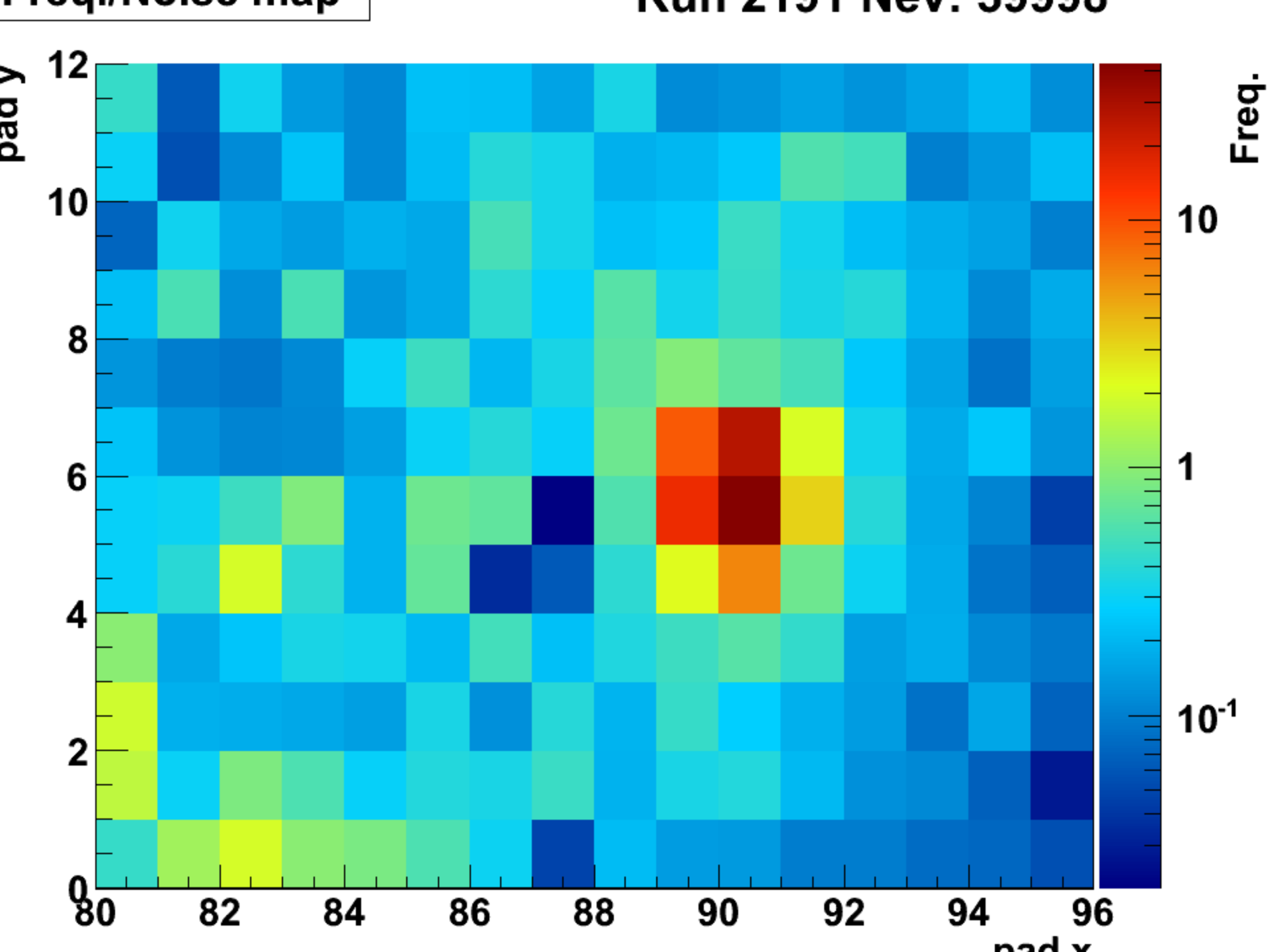

DANGER
DANGER

Gases:

$Ne+10\%CH_4$

and

$Ne+10\%CF_4$


Freq./Noise map
Run 2191 Nev: 35958
pad y
pad x
Freq.
0
2
4
6
8
10
12
80
82
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86
88
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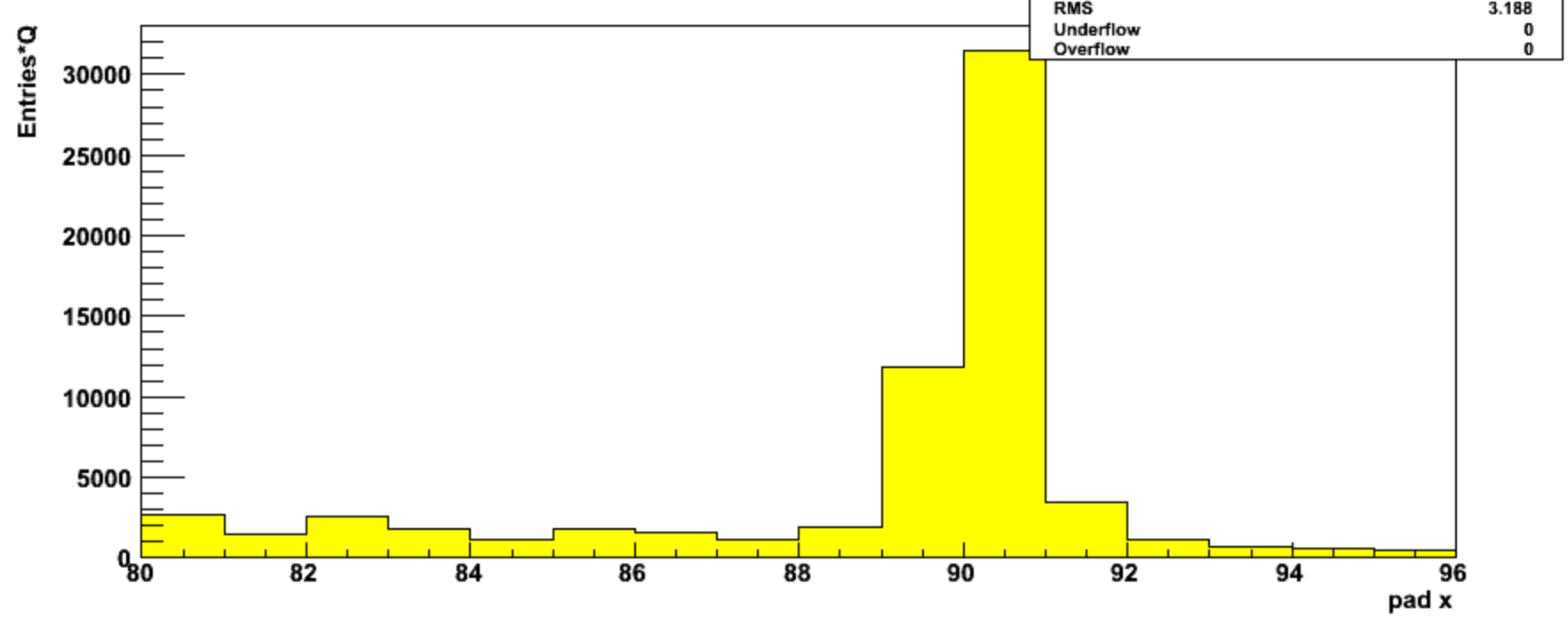
1
10^{-1}


RMS 3.188
Underflow 0
Overflow 0
Entries*Q
30000
25000
20000
15000
10000
5000
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86
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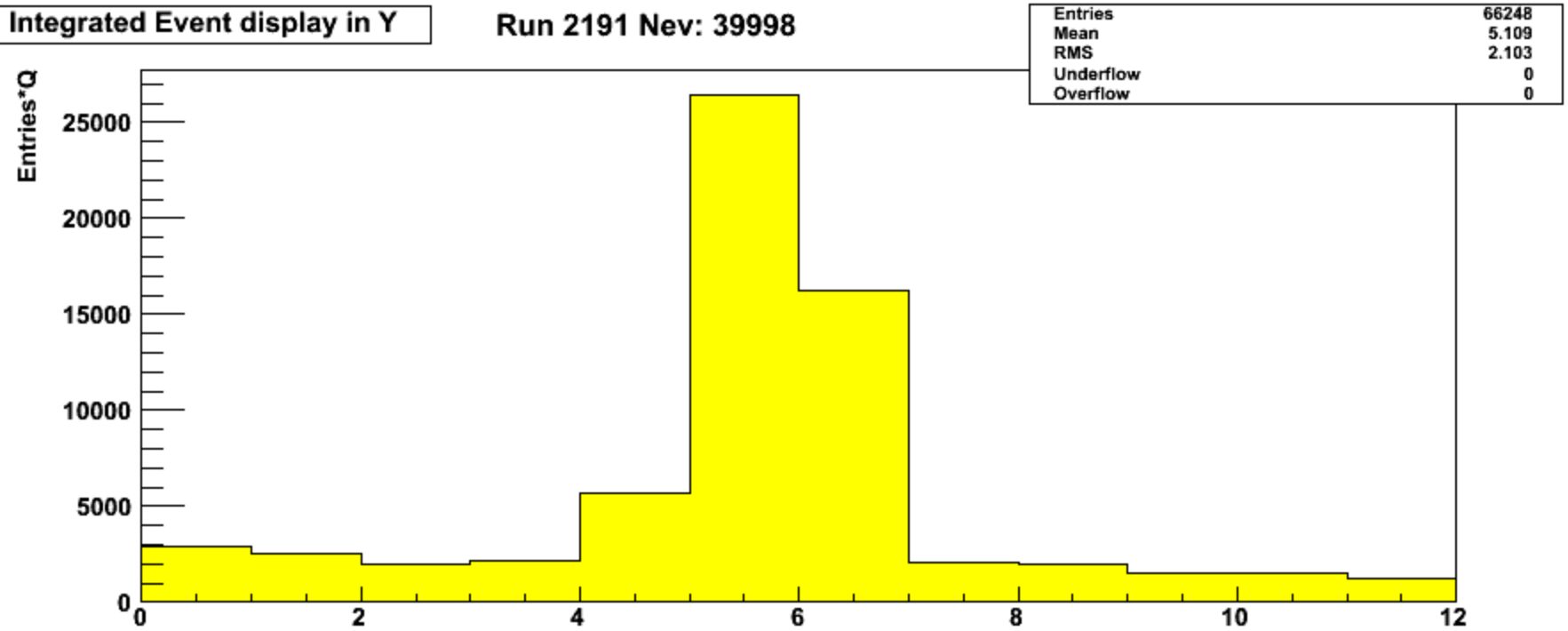
90
92
94
96
pad x


Integrated Event display in Y
Run 2191 Nev: 39998
Entries 66248
Mean 5.109
RMS 2.103
Underflow 0
Overflow 0
Entries*Q
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20000
15000
10000
5000
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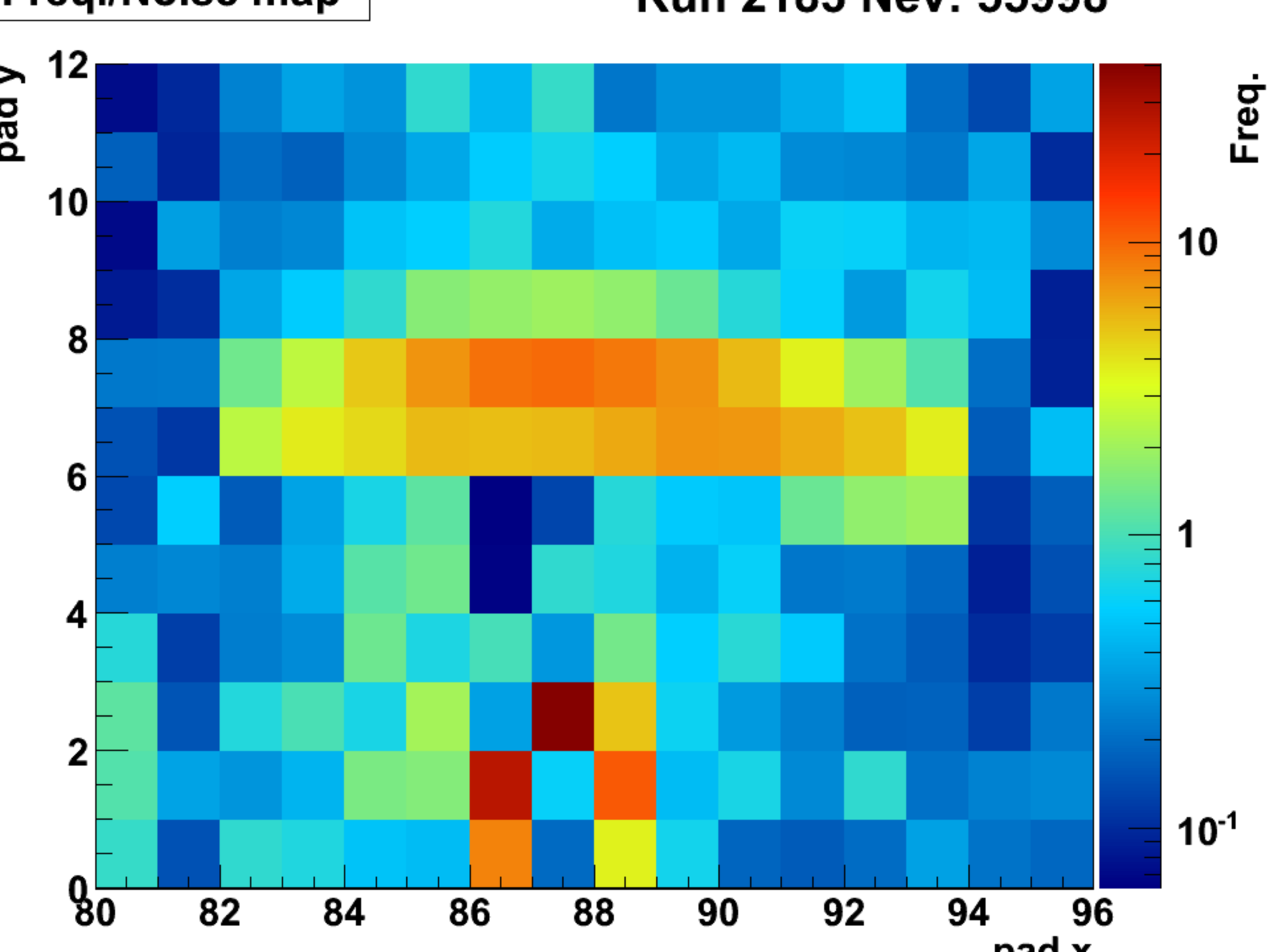
2
4
6
8
10
12


Freq./Noise map
Run 2185 Nev: 55958
pad y
pad x
Freq.
12
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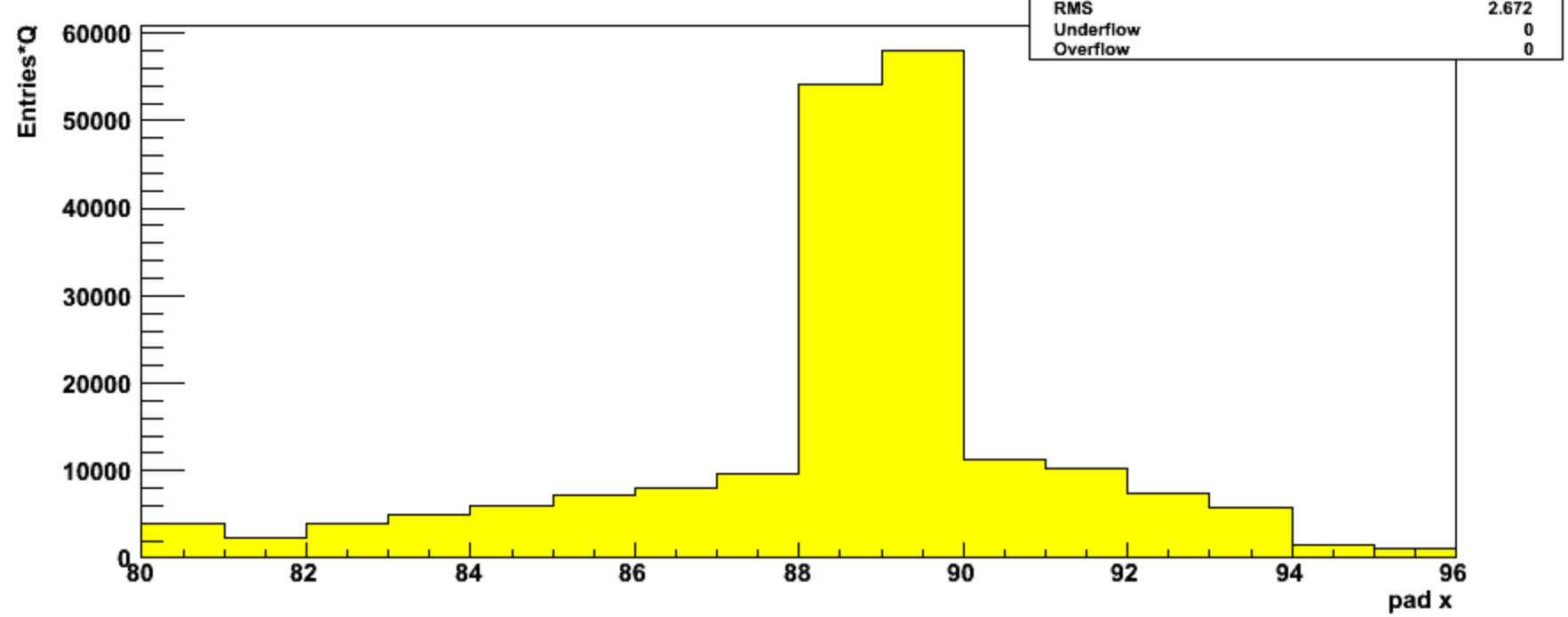
RMS 2.672
Underflow 0
Overflow 0
Entries*Q
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50000
40000
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20000
10000
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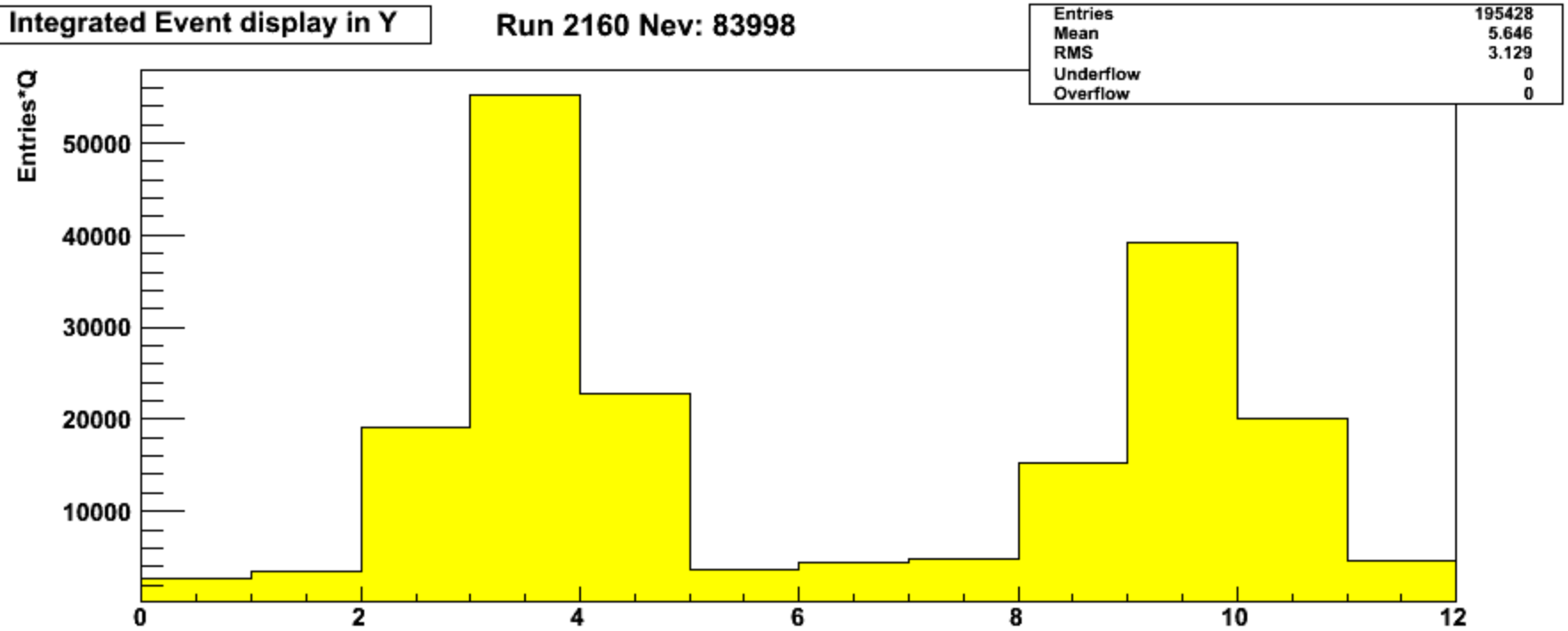
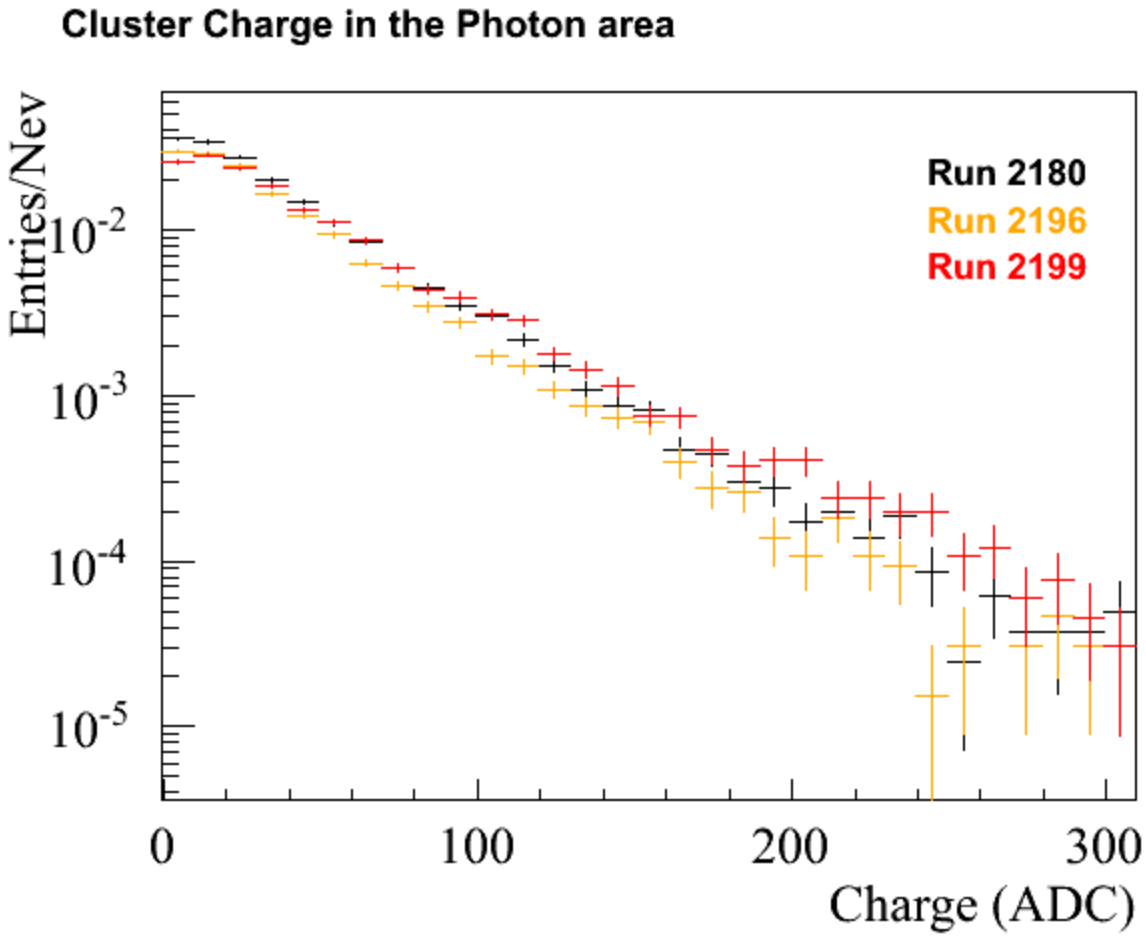
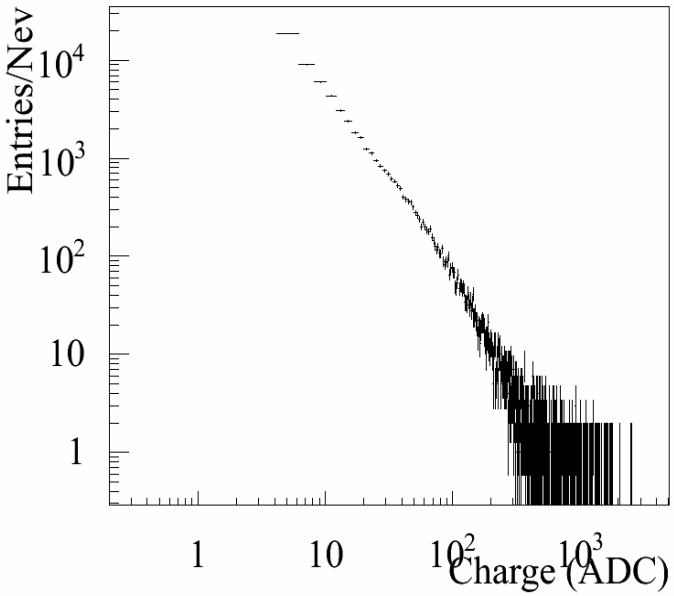
pad x


Integrated Event display in Y
Run 2160 Nev: 83998
Entries 195428
Mean 5.646
RMS 3.129
Underflow 0
Overflow 0
Entries*Q
50000
40000
30000
20000
10000
0
2
4
6
8
10
12

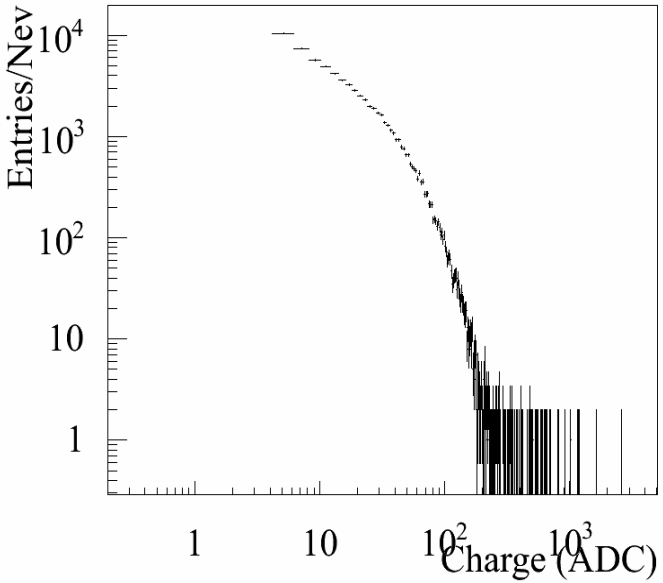

Cluster Charge in the Photon area
Entries/Nev
10^{-2}
10^{-3}
10^{-4}
10^{-5}
Run 2180
Run 2196
Run 2199
0
100
200
300
Charge (ADC)

MIP Pad Charge, Run: 2183 Event: 50616



Entries	62575
Mean	23.23
RMS	62.86

Photon Pad Charge, Run: 2183 Event: 50616



Entries	71445
Mean	23.91
RMS	30.97

Conclusions:

The beam test of triple RETGEM coated with a CsI layer was **very successful:**

We were able to operate the detector at gains more than 10^5 without a single spark during the entire beam period in Ne+10%CH_4 and Ne+10%CF_4 gas mixtures.

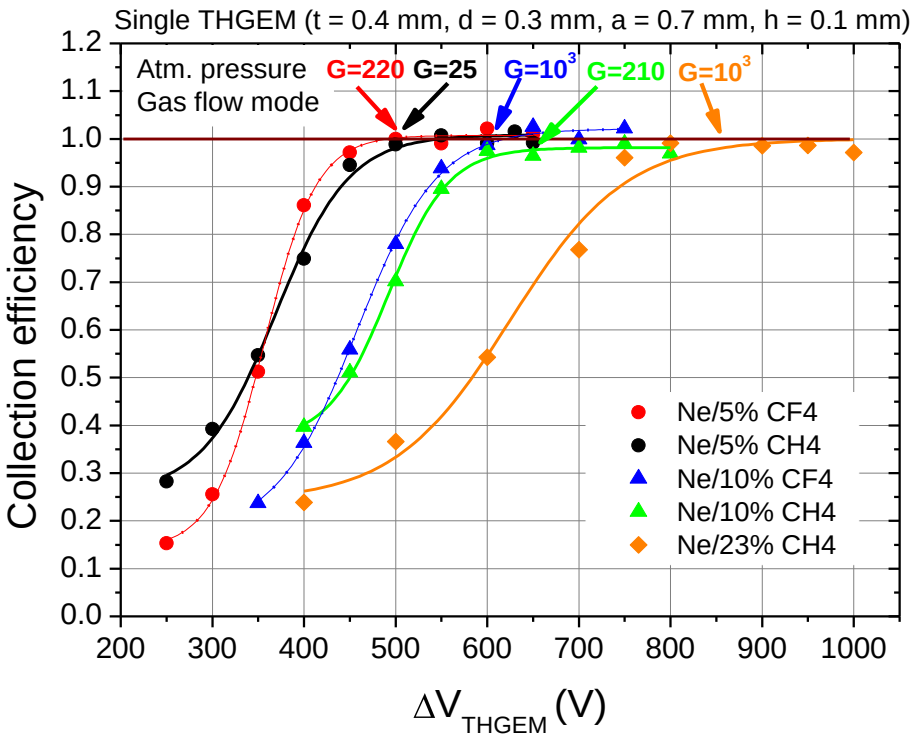
The Cherenkov light was detected indicating that the QE was high

The obtained data are currently under the analysis

More beam test under the preparation (see Himank talk tomorrow)

- It looks that RETGEM **is an attractive option for the ALICE VHMPID:**

Spare


Single THGEM (t = 0.4 mm, d = 0.3 mm, a = 0.7 mm, h = 0.1 mm)
Atm. pressure
Gas flow mode
G=220
G=25
G=10^3
G=210
G=10^3
Collection efficiency
ΔV_THGEM (V)
Ne/5% CF4
Ne/5% CH4
Ne/10% CF4
Ne/10% CH4
Ne/23% CH4
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
200
300
400
500
600
700
800
900
1000