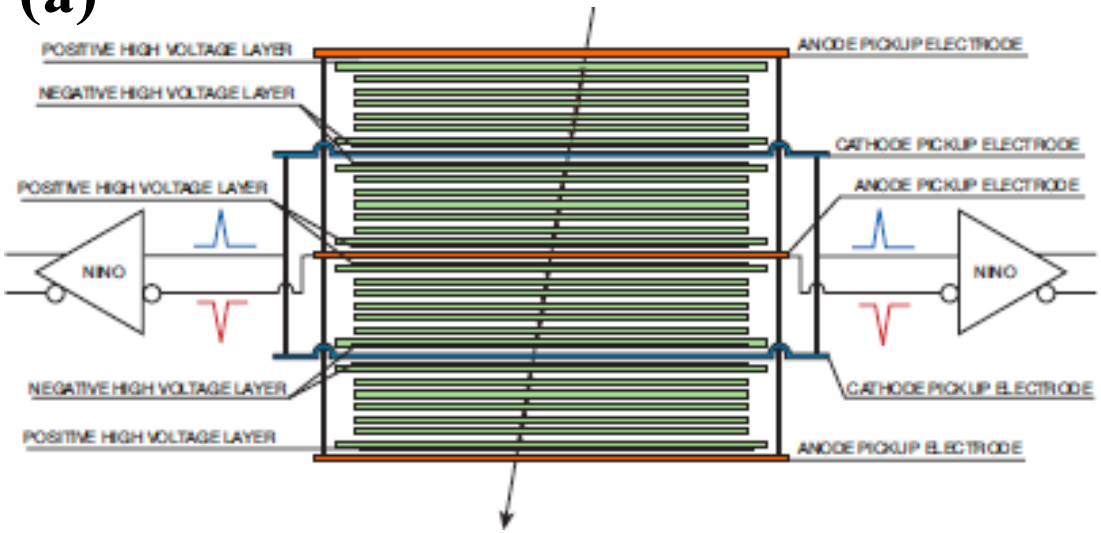
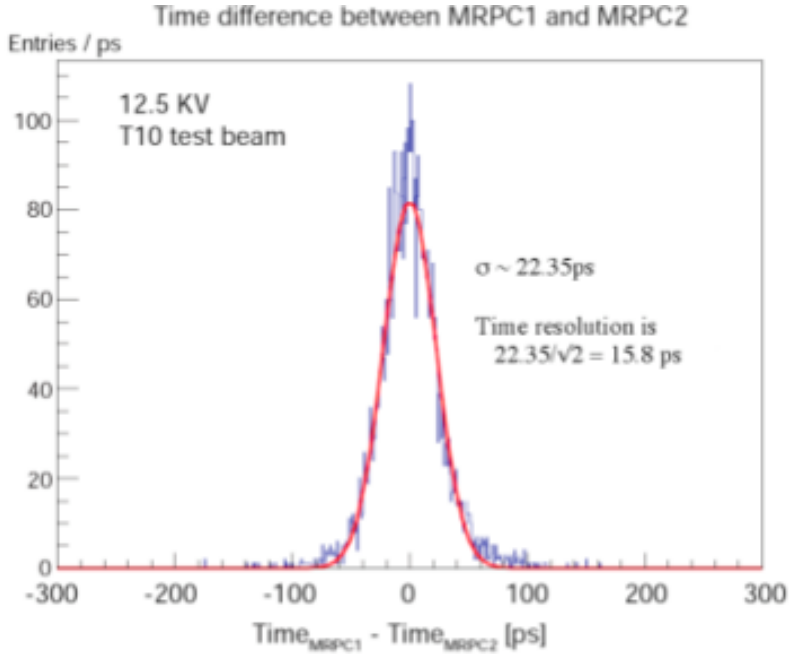
MRPC sub-detector

R. Messi, D. Moricciani, A. Saputi

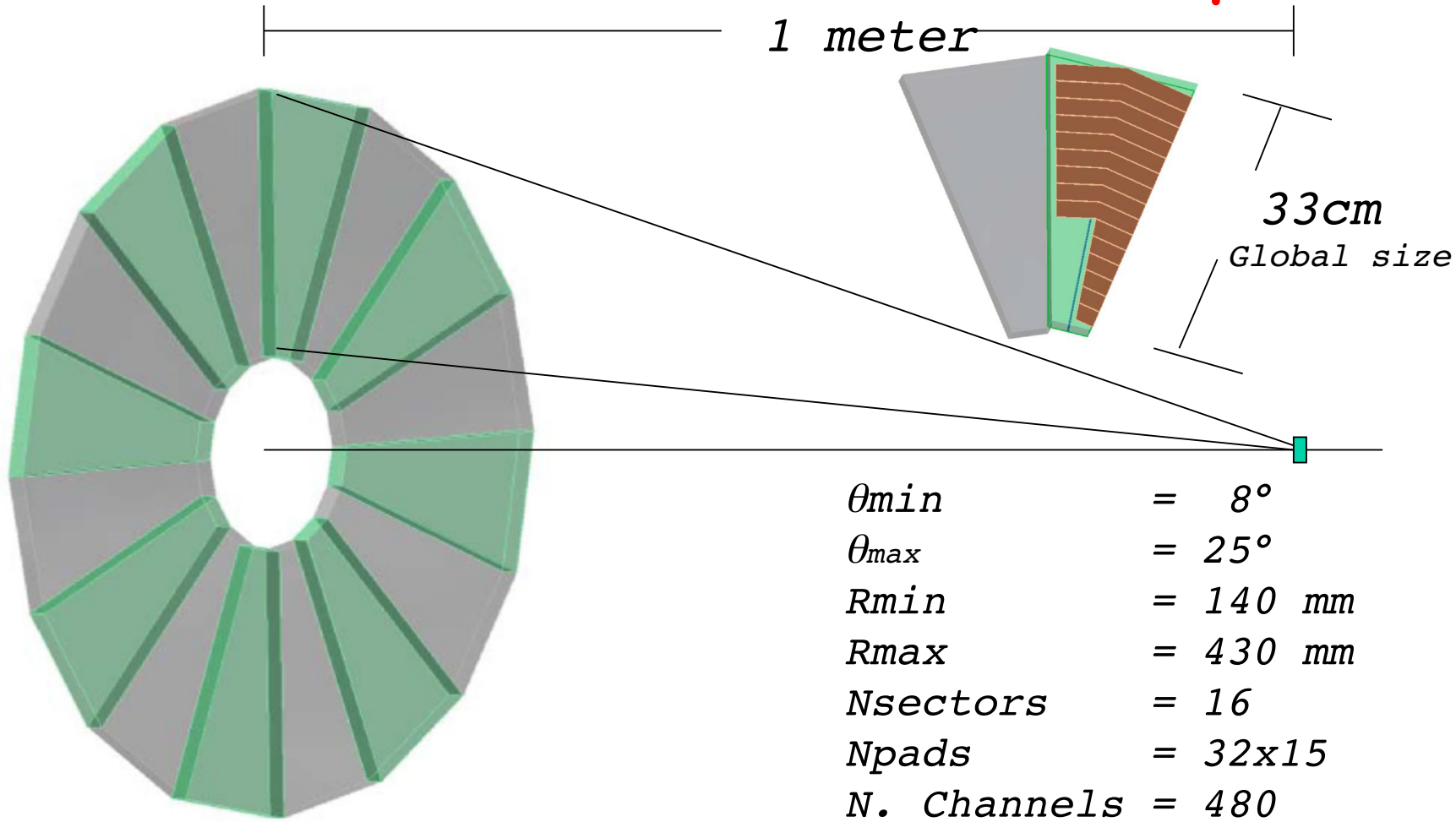
(a)


POSITIVE HIGH VOLTAGE LAYER
NEGATIVE HIGH VOLTAGE LAYER
POSITIVE HIGH VOLTAGE LAYER
NINO
NEGATIVE HIGH VOLTAGE LAYER
POSITIVE HIGH VOLTAGE LAYER
ANODE PICKUP ELECTRODE
CATHODE PICKUP ELECTRODE
ANODE PICKUP ELECTRODE
NINO
CATHODE PICKUP ELECTRODE
ANODE PICKUP ELECTRODE

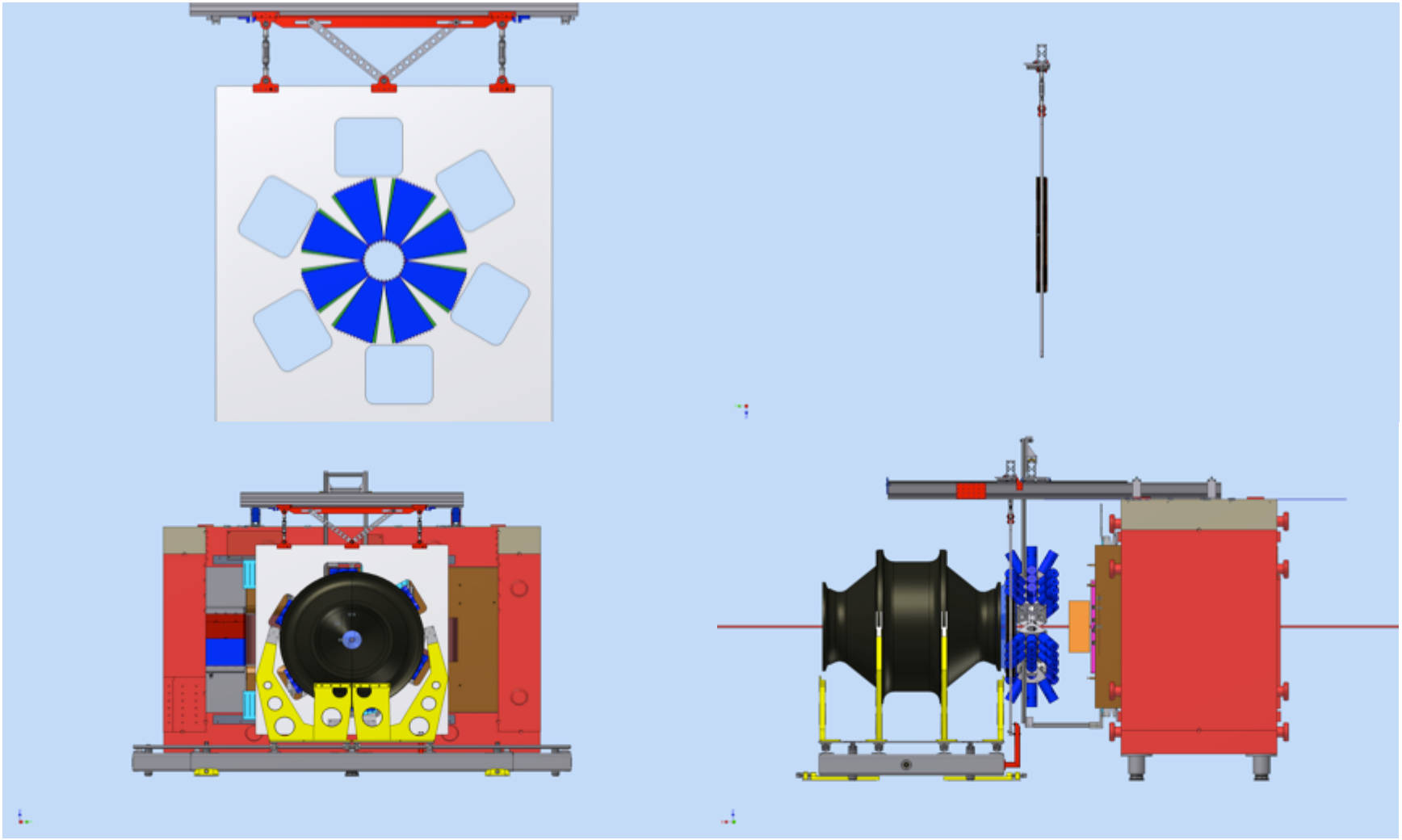
(b)

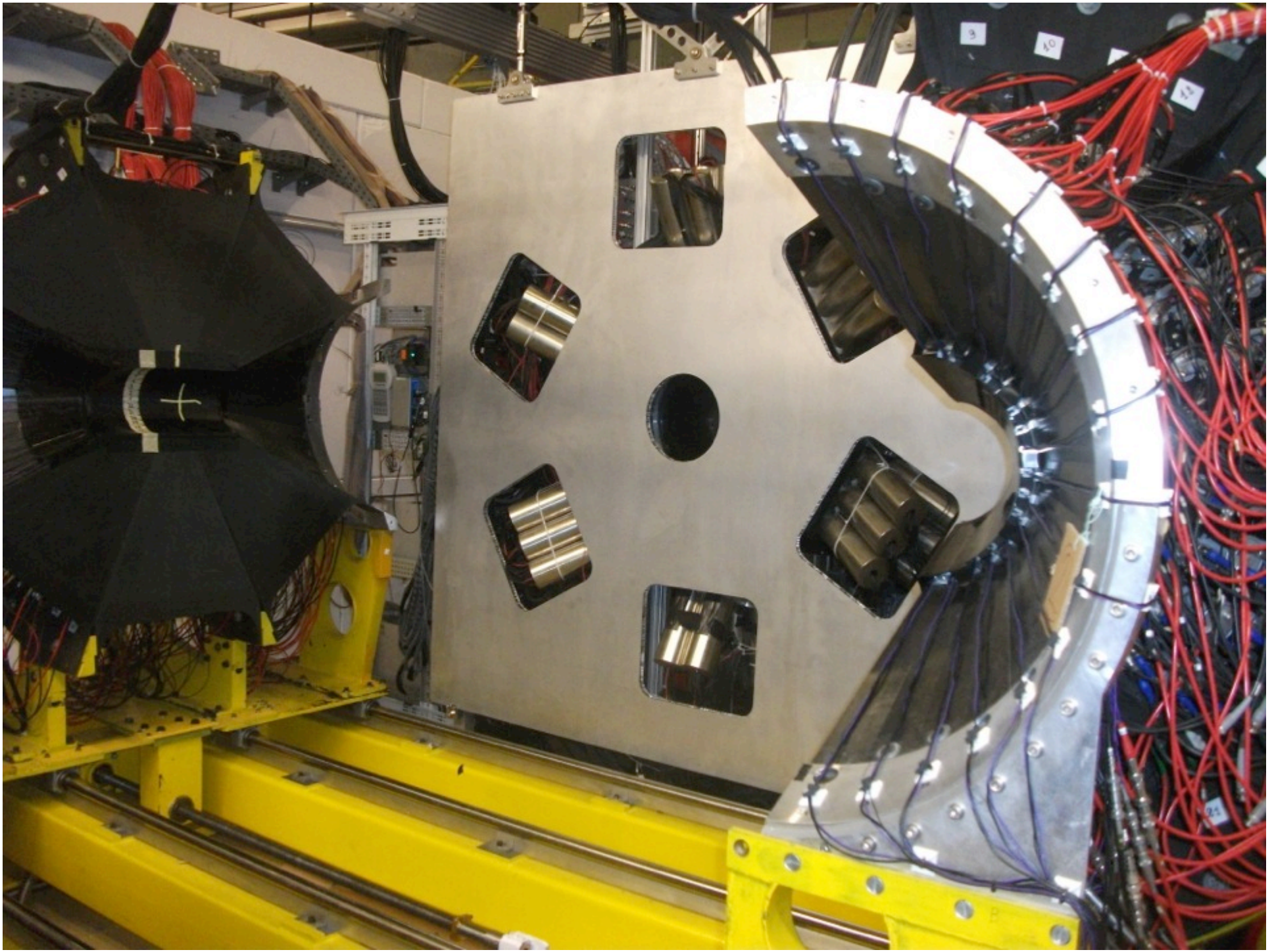

Time difference between MRPC1 and MRPC2
Entries / ps
12.5 KV
T10 test beam
σ ~ 22.35ps
Time resolution is
22.35/√2 = 15.8 ps
100
80
60
40
20
0
-300
-200
-100
0
100
200
300
Time_MRPC1 - Time_MRPC2 [ps]

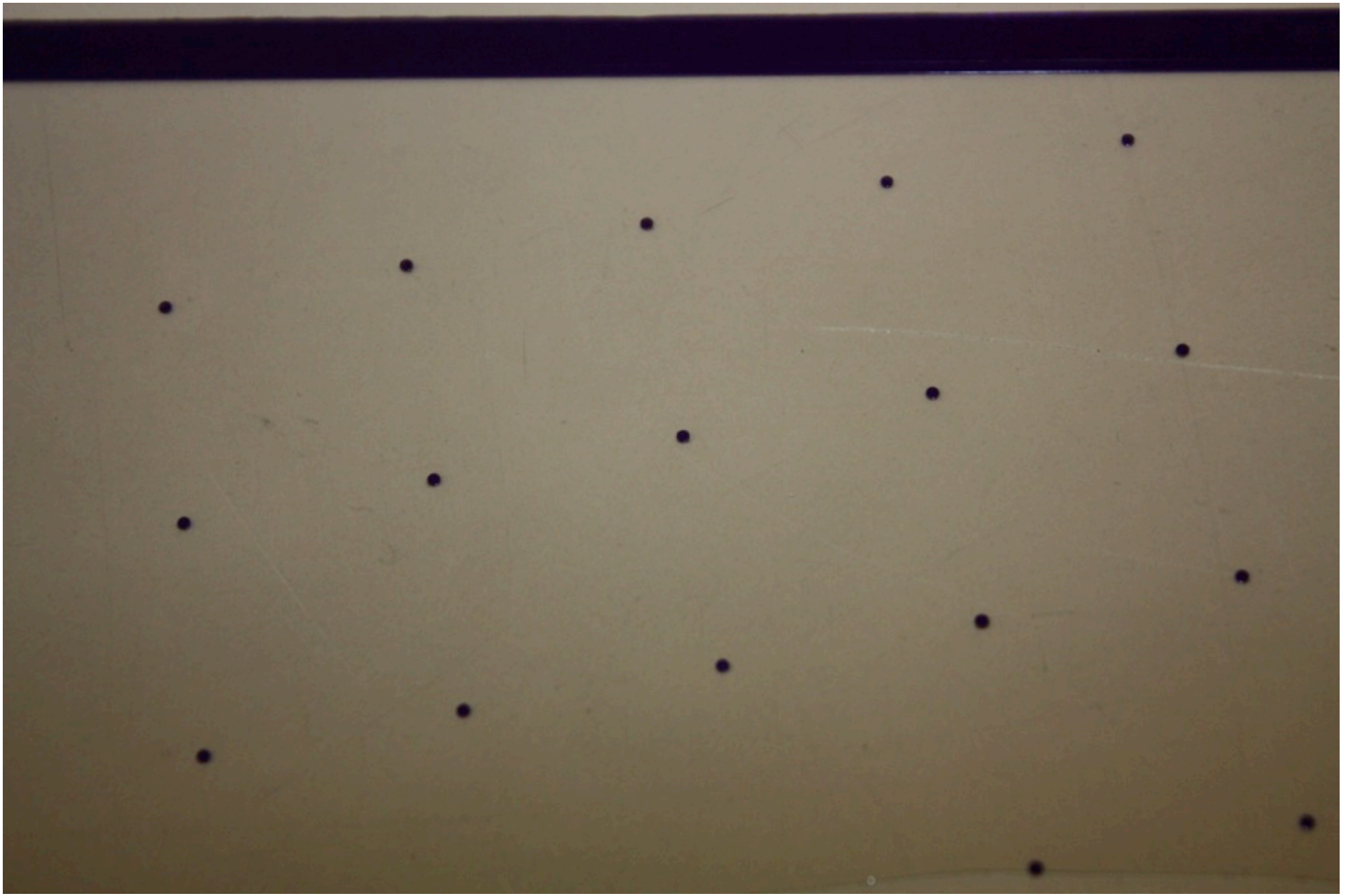
MPRPC for BGO-OD Set-Up

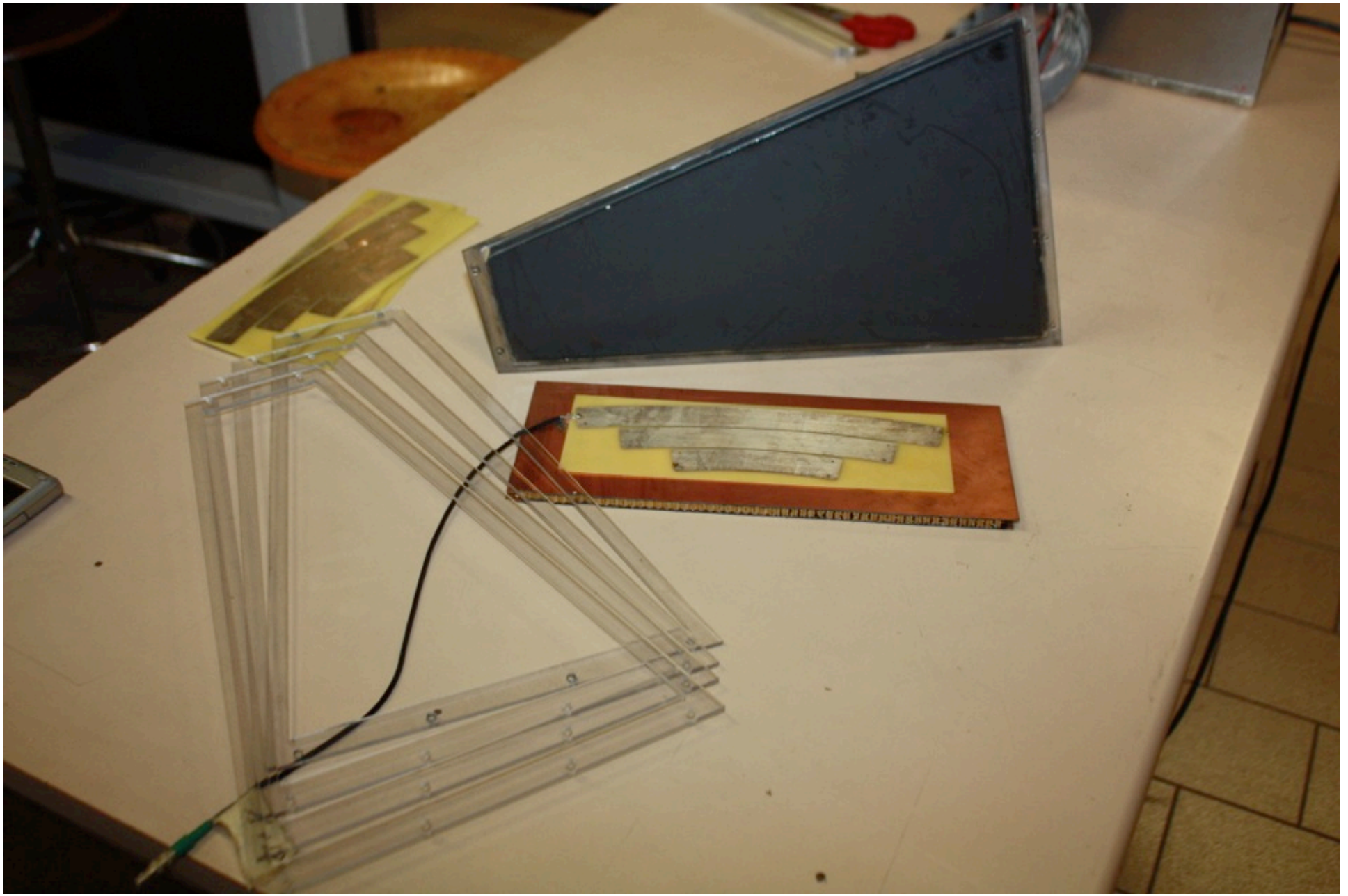


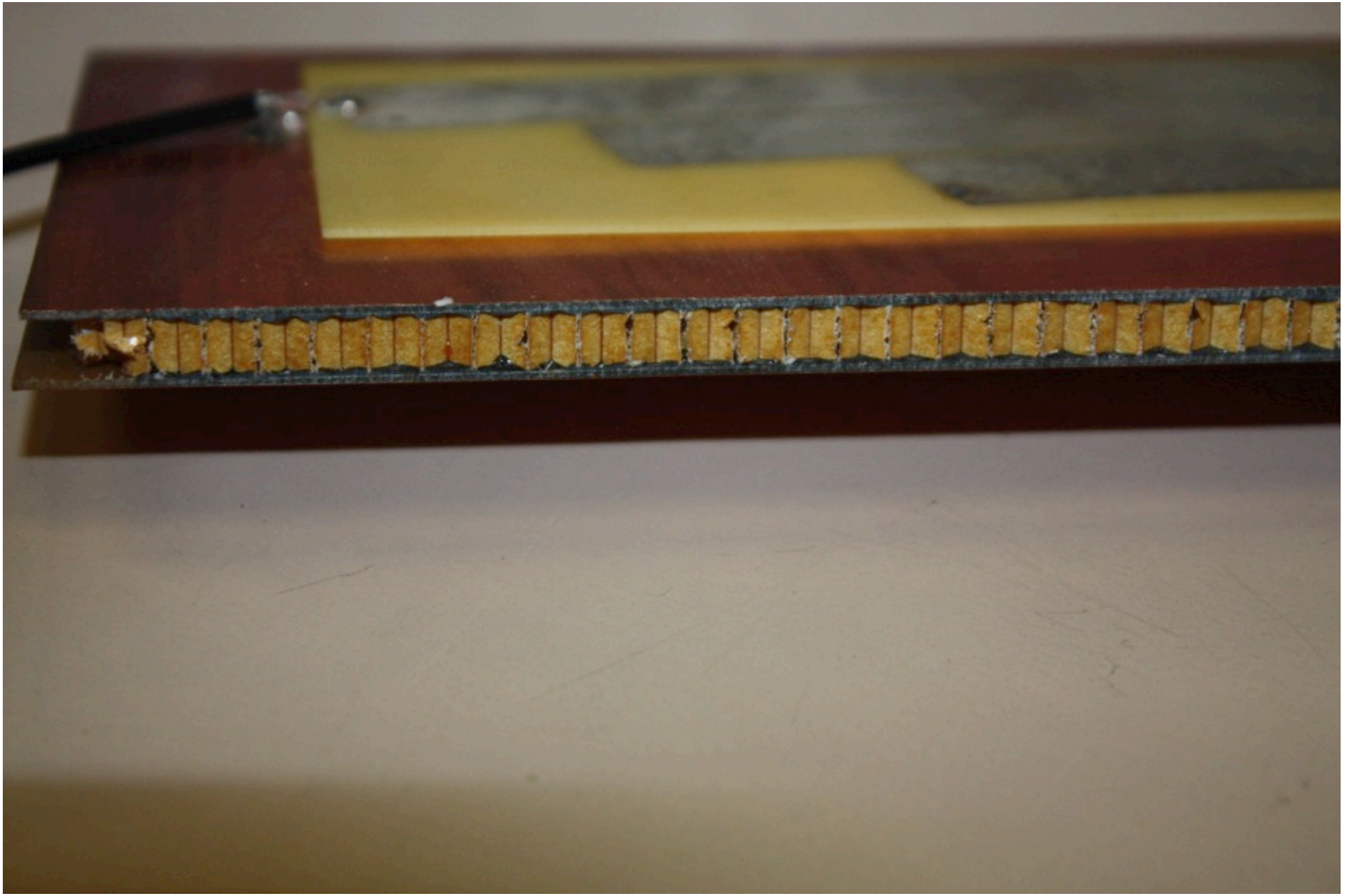
θmin	=	8°
θ_{max}	=	25°
Rmin	=	140 mm
Rmax	=	430 mm
Nsectors	=	16
Npads	=	32x15
N. Channels	=	480
PadsMax_dim	=	80x20mm

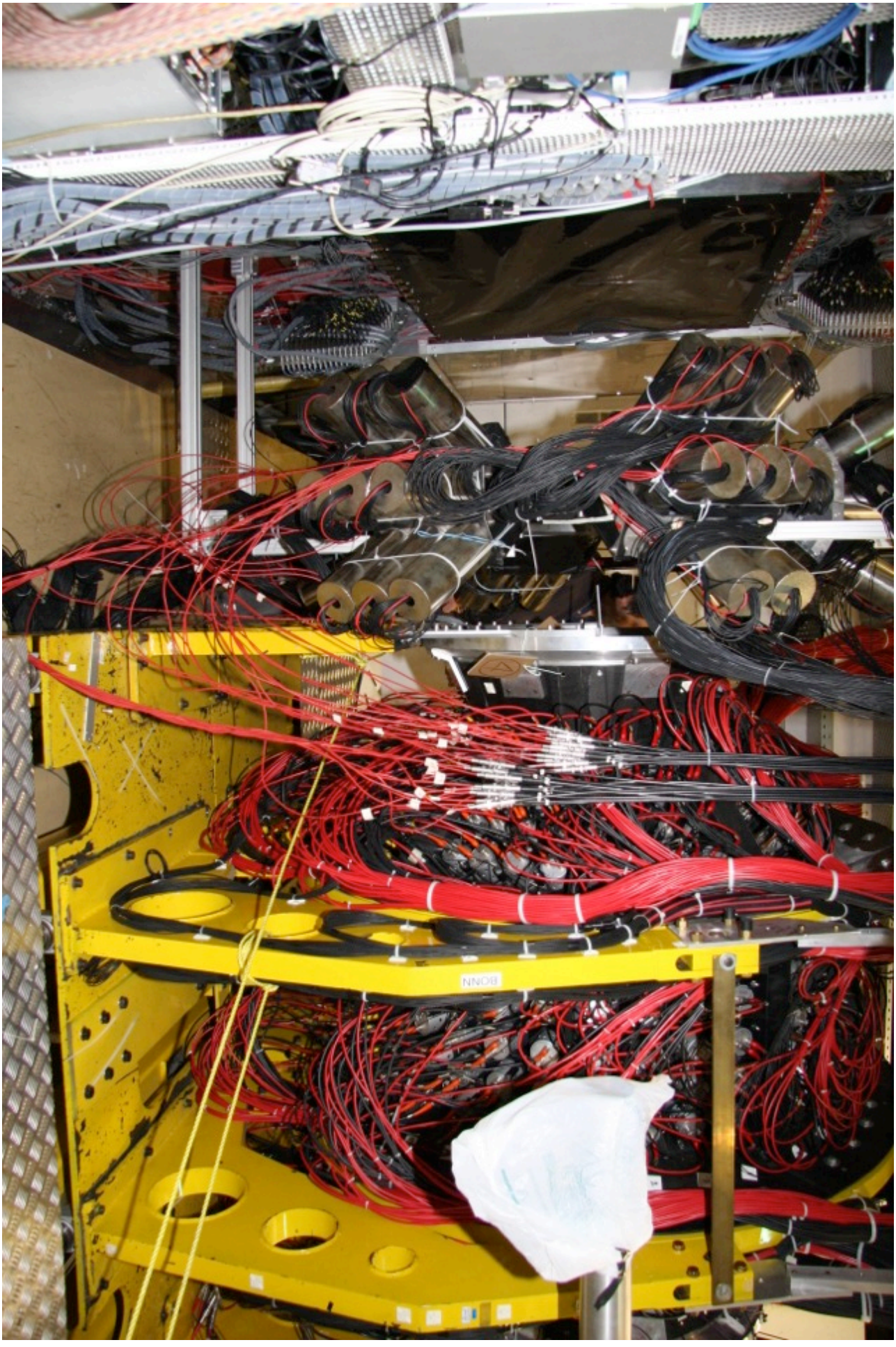


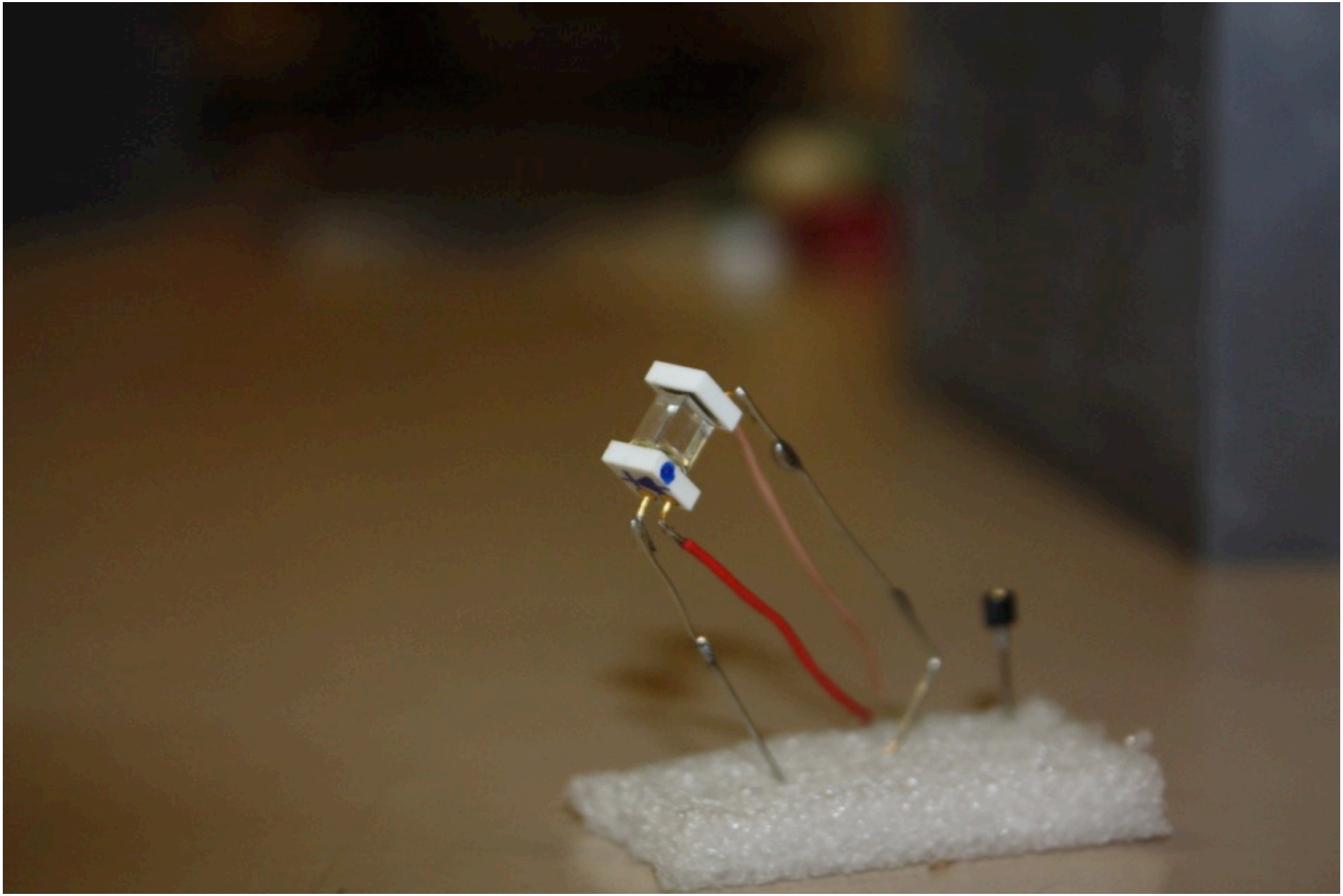


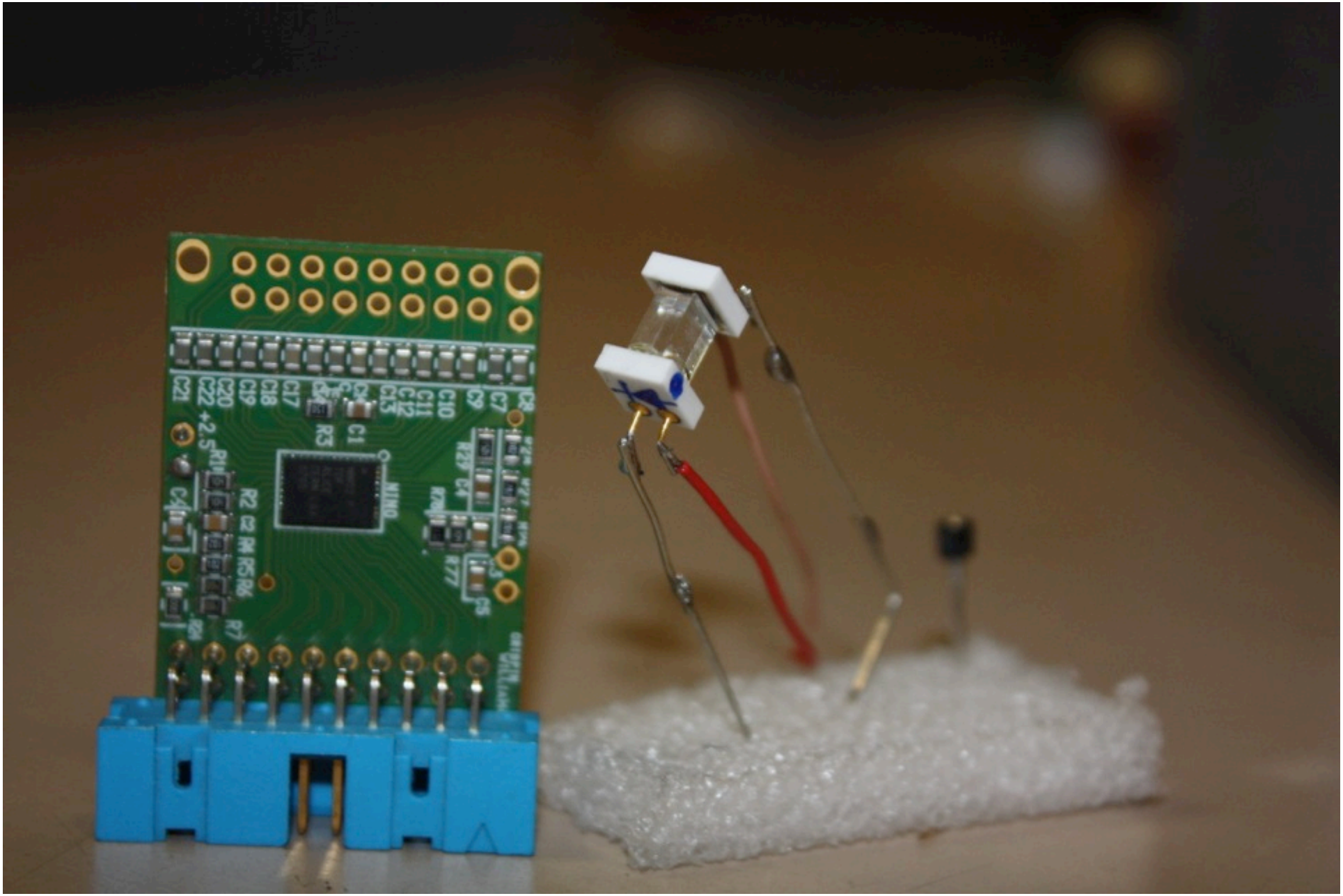











C21
C20
C19
C18
C17
C16
C15
C14
C13
C12
C11
C10
C9
C8
C7
+2.5
R1
R2
R3
C1
C4
R4
R5
R6
R7
R27
C5

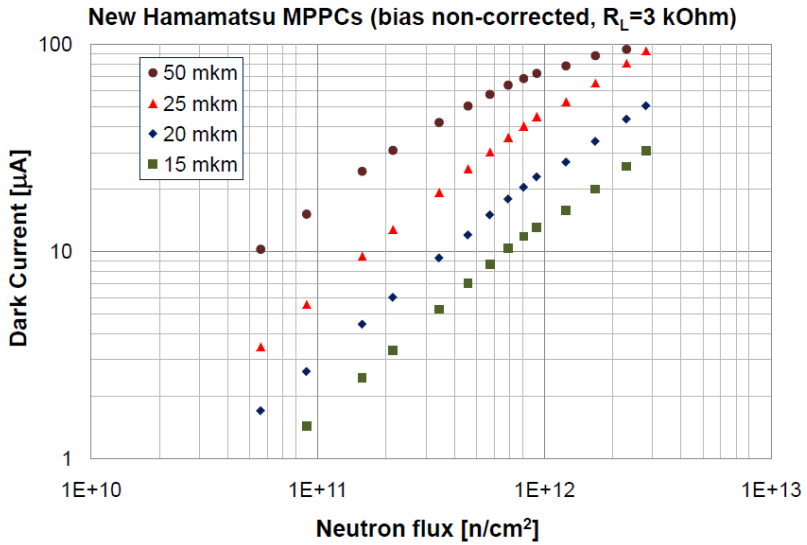
Radiation hardness studies

Motivation: G-APDs will be used in HEP experiments

Radiation may cause:

- Fatal G-APDs damage (G-APDs can't be used after certain absorbed dose)
- Dark current and dark count increase (silicon)
- Change of the gain and PDE vs. voltage dependence (G-APDs blocking effects due to high induced dark carriers generation-recombination rate)
- Breakdown voltage change

Dark current vs. exposure to neutrons (E_{eq}~1 MeV) for different SiPMs



High energy neutrons/protons produce silicon defects which cause an increase in dark count and leakage current in SiPMs:

$$I_d \sim \alpha * \Phi * V * M * k,$$

α – dark current damage constant [A/cm];
Φ – particle flux [1/cm^2];
V – silicon active volume [cm^3]
M – SiPM gain
k – NIEL coefficient

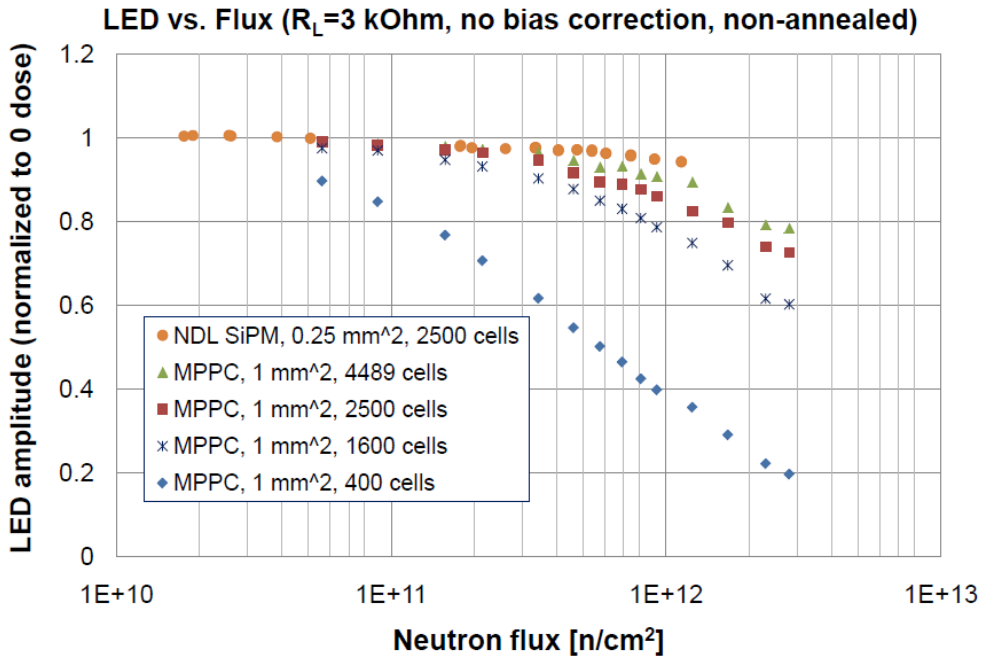
α_{Si} ~4*10^{-17} A*cm after 80 min annealing at T=60 C (measured at T=20 C)

- No change of VB (within 50 mV accuracy)
- No change of R_{cell} (within 5% accuracy)
- Dark current and dark count significantly increased for all the devices

$V \sim S * G_f * d_{eff}$,
S - area
G_f - geometric factor
d_{eff} - effective thickness

For Hamamatsu MPPCs : d_{eff} ~ 4 - 8 μm

Relative response to LED pulse vs. exposure to neutrons (E_{eq}~1 MeV) for different SiPMs

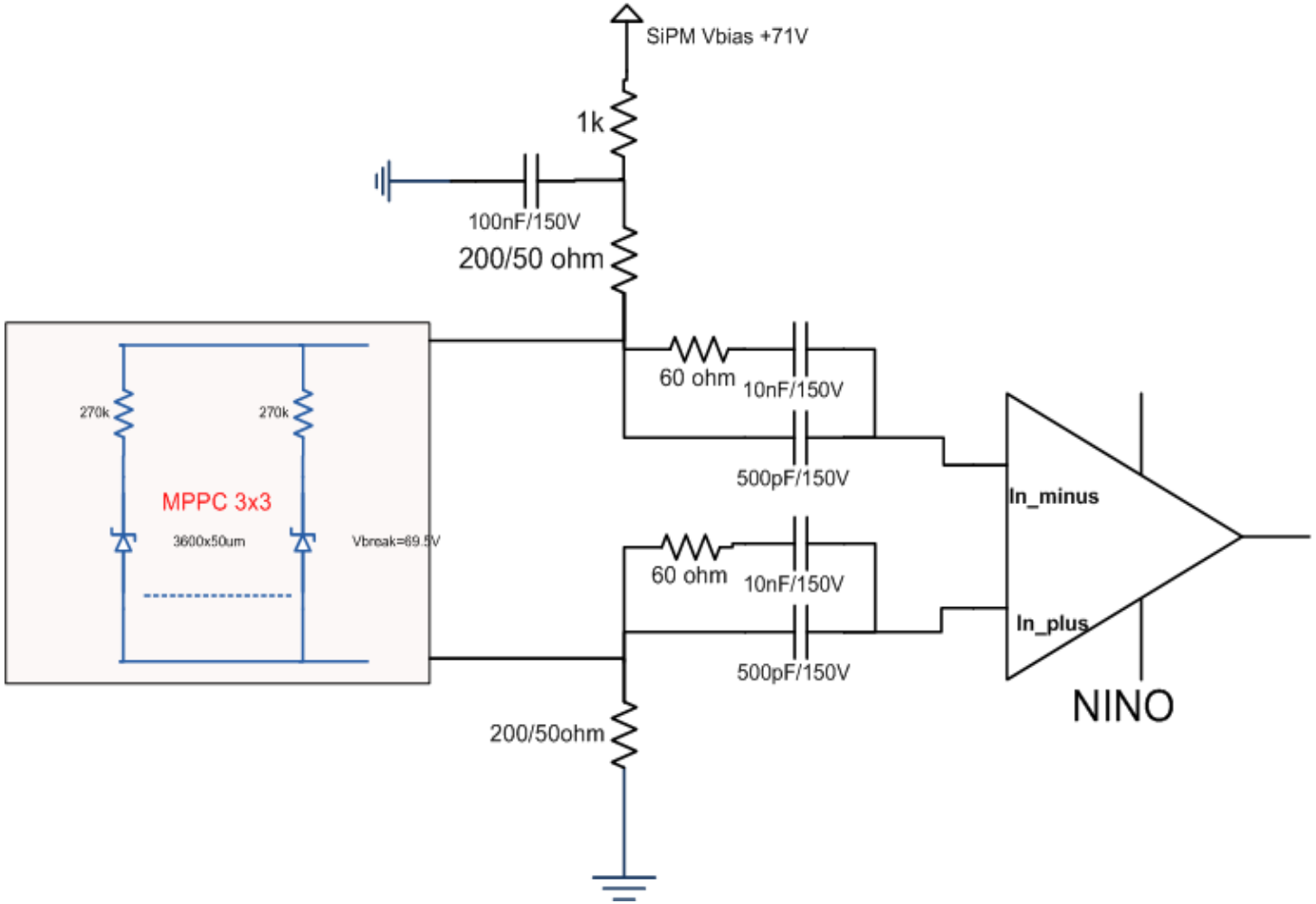


SiPMs with high cell density and fast recovery time can operate up to $3*10^{12}$ neutrons/cm^2 (gain change is< 25%).

Future of SSPMs (my dreams)

The development of G-APDs is accelerating. What can we expect in 2-4 years from now?

- PDE > 50-60% for 350-650 nm light
- dark count rate <50 kHz/mm^2 at room temperature
- single photon timing < 50 psec (FWHM)
- active area >100 mm^2
- high DUV light sensitivity (PDE(128 nm~20-40%)
- very fast CCDs operated in Geiger mode
- super radiation hard G-APDs - up to $10^{14} \div 10^{15}$ n/cm^2 (new materials: diamond?, GaAs?, SiC?, GaN?)
- production cost <1 \$/мм^2
- .


SiPM Vbias +71V
1k
100nF/150V
200/50 ohm
270k
270k
MPPC 3x3
3600x50um
Vbreak=69.5V
60 ohm
10nF/150V
500pF/150V
60 ohm
10nF/150V
500pF/150V
200/50ohm
In_minus
In_plus
NINO

Dear Dario

Looking back at my records - you paid 75 CHF per NINO mounted on a board.... and this was a real bargain. I am making some plugins for a North area experiment and they are paying 125 chf per NINO asic mounted on a pcb (and they have a real bargain). One problem is that Rui charges 50 chf per small pcb since the etching is very difficult: then each NINO costs 25 chf ... then the NINO has to be mounted on the PCB : then connectors, etc etc.... and then some do not work... so I cannot match even the 75 chf price I charged previously.

The only positive thing is that I have become more expert at designing these pcbs making them smaller etc etc

So given this how should we proceed?

I am away from CERN until July 4th.

best regards
Crispin

Collaterali … é tempo di…

- Simulazione!!!!! Tempi, flusso, ombre ….
- Aquisizione: librerie, monitor….
- Sistema di slow_control : interfaccia controlli… chi lo gestisce?
- Integrazione decisioni finali
- Linea gas (forse togliamo l'isobutan!!!!), problema tempi morti!

Che abbiamo che serve…

Detector: vetri, fattibilitá pillars, contatti con ditta per produzione, 80 frame,

Elettronica: 12 c# HV, Aliment. B.T., …

Gas: sistema di miscelazione, tubi, pressostati,…