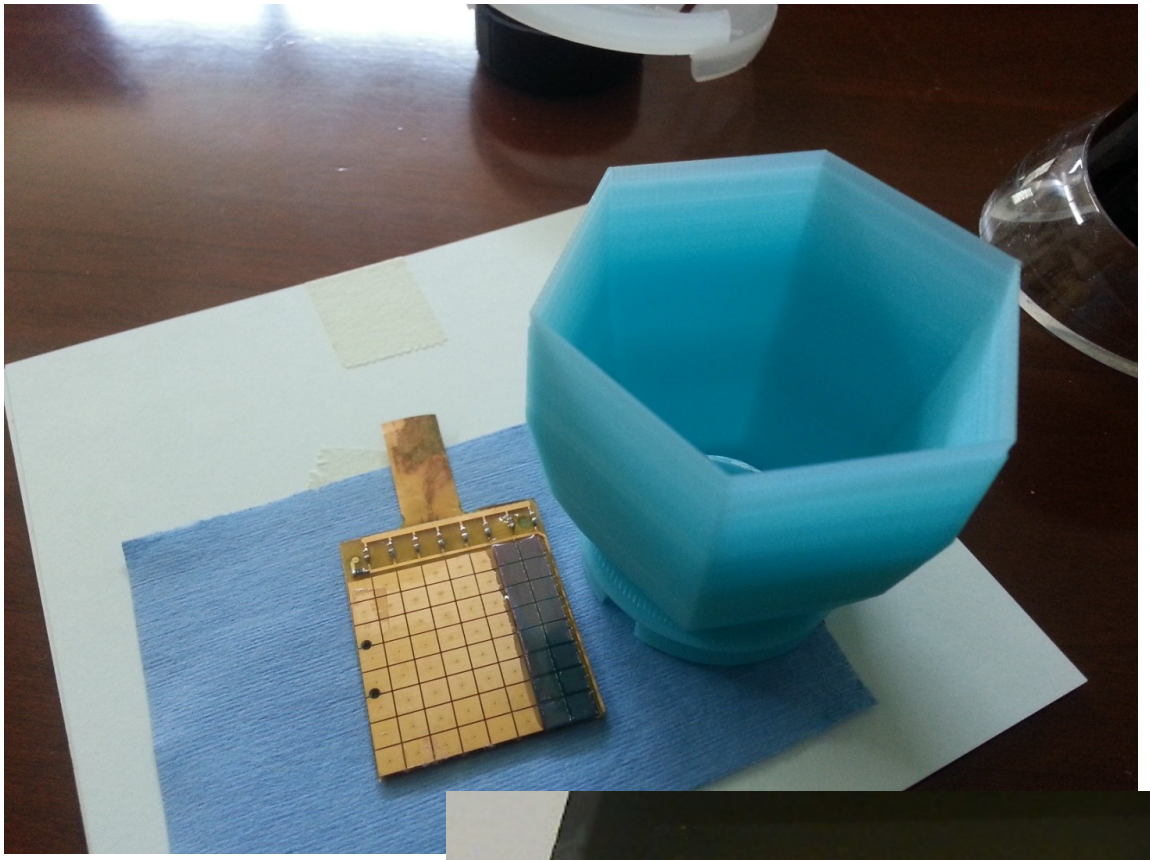
R. Rando

INFN SiPM status report

Outline

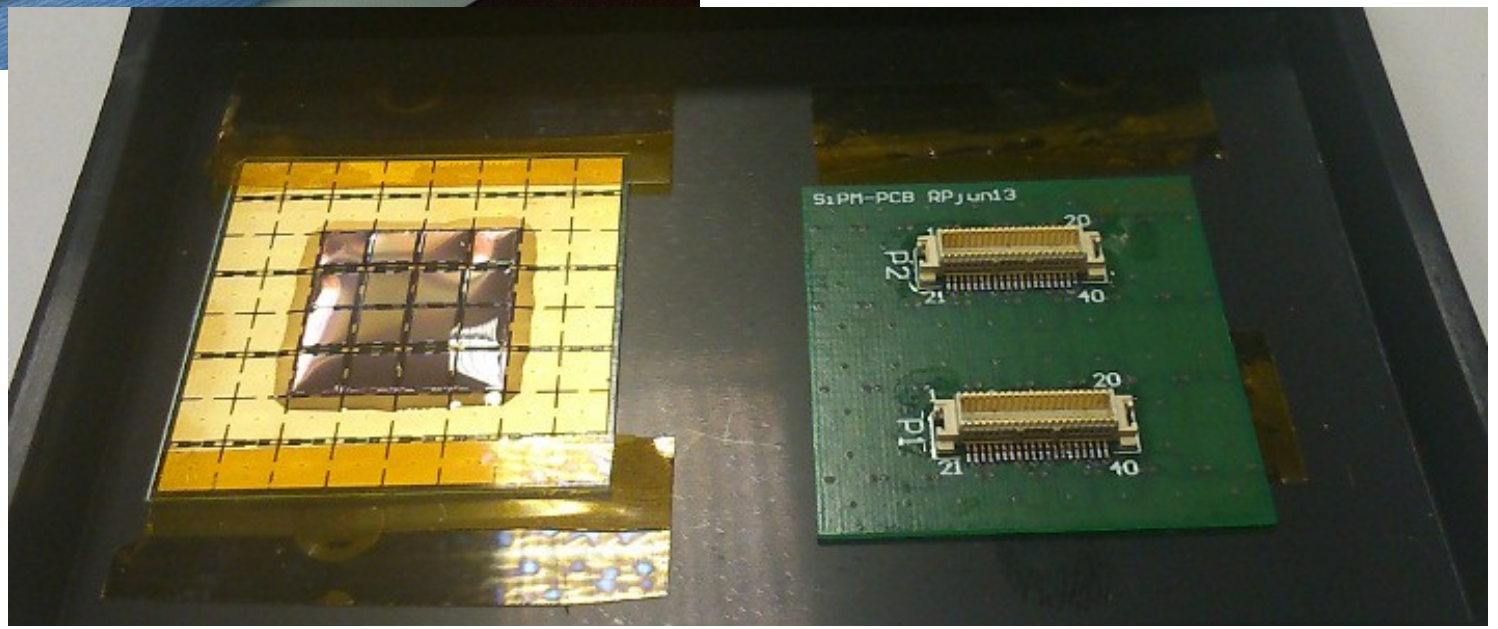
- SiPM matrix
- SiPM signal conditioning and characterization
- Summing at the SiPM level
- Prototype analog sum board
- Sensor procurement
- Optics
- Conclusion

Silicon matrix

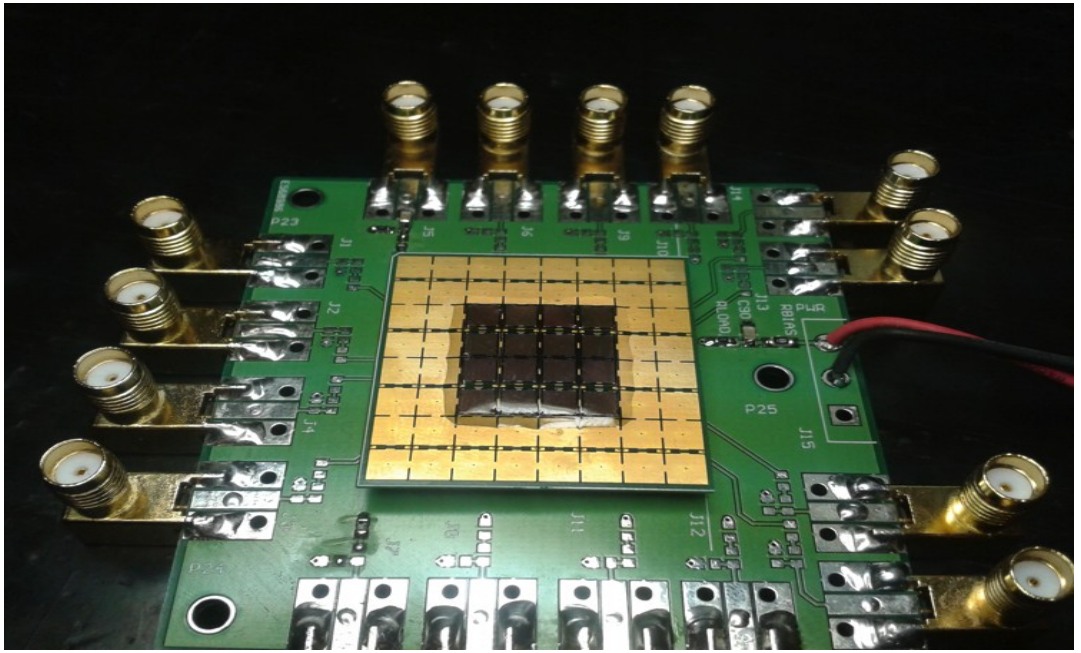


8x8 PCB holder
3x3 mm^2 pads
2 connectors on back

Side ~1 inch, LST WC fits



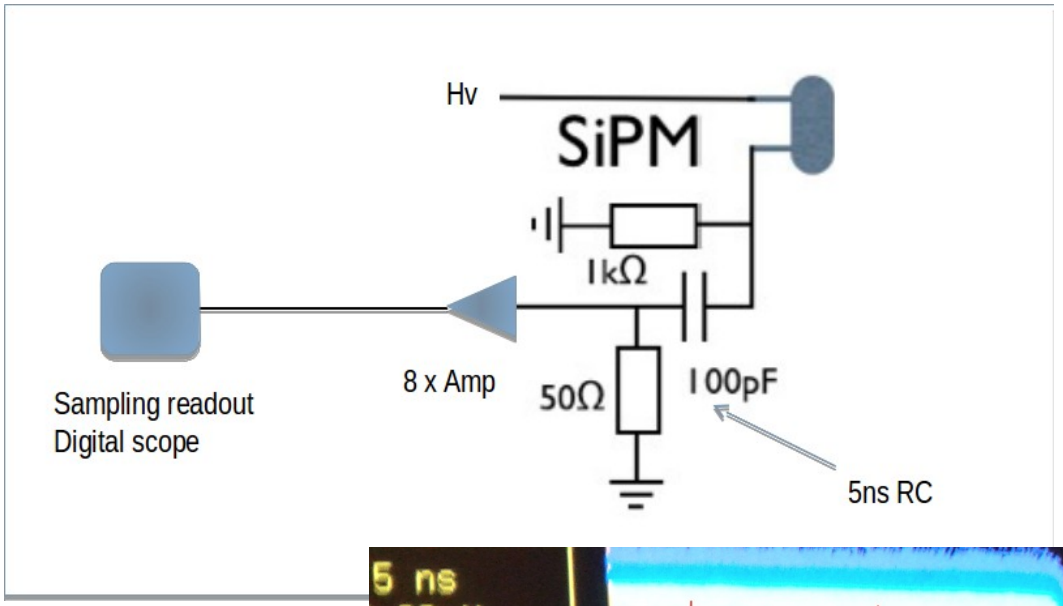
Sensor testing

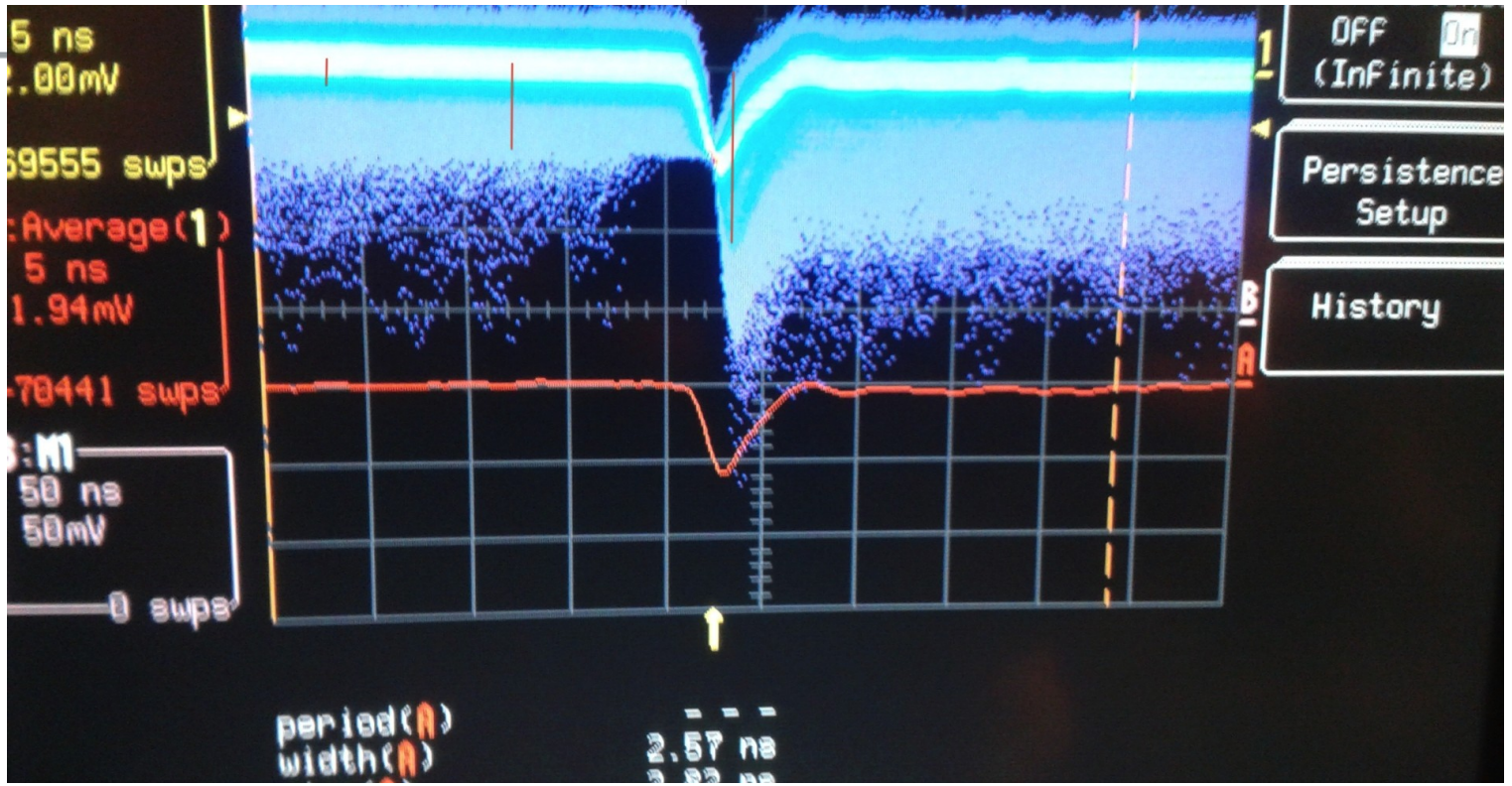


Fanout board (and SiPM matrix) by R. Paoletti
A simple filter can be added to the output (so before any amplification).

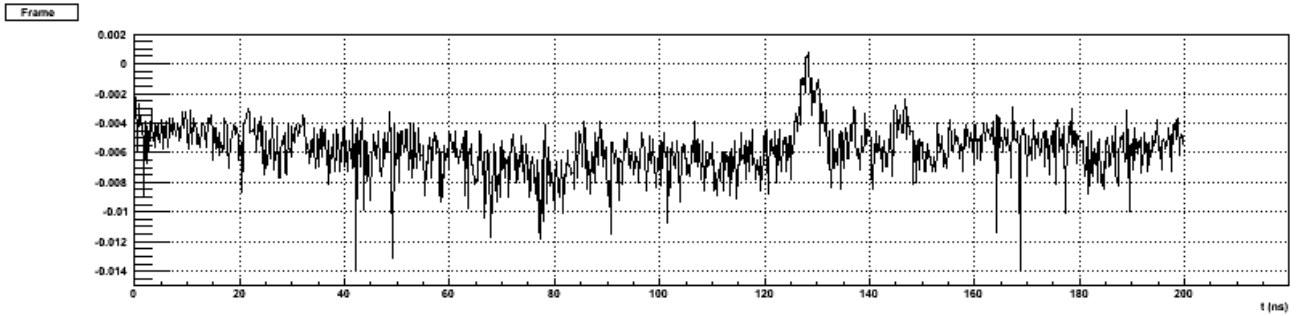
After a few tests we decided for a passive high-pass stage, to remove the tail after pulse.

Passive signal conditioning

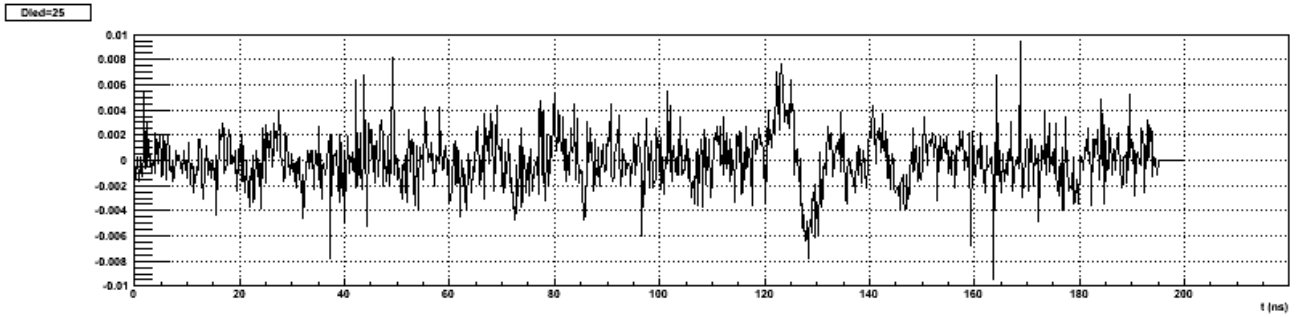




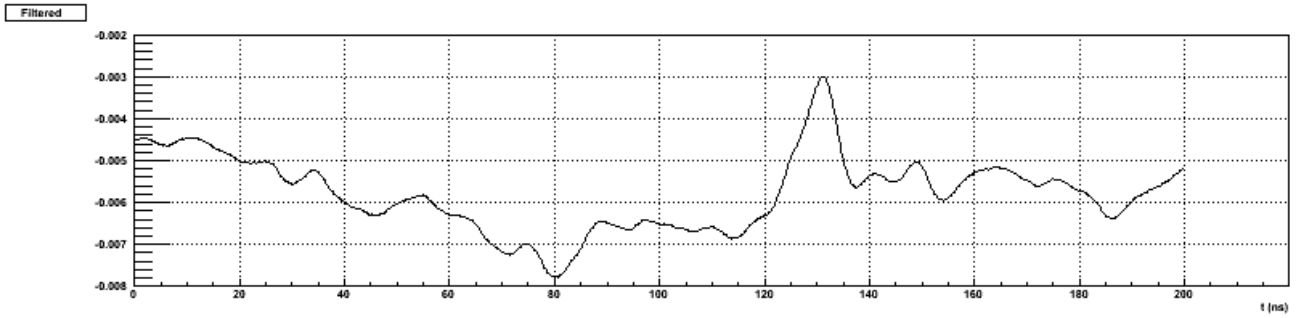
Tests: waveforms



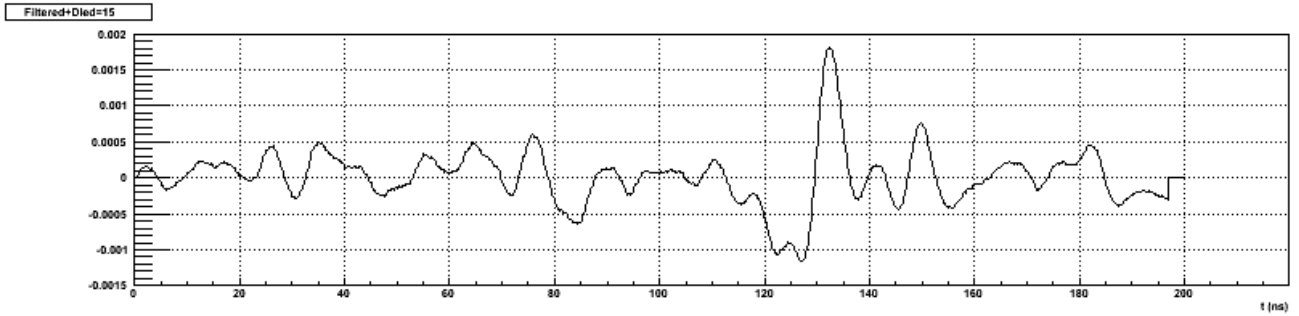
As acquired with DRS4
+ high G preamp



Differentiated only

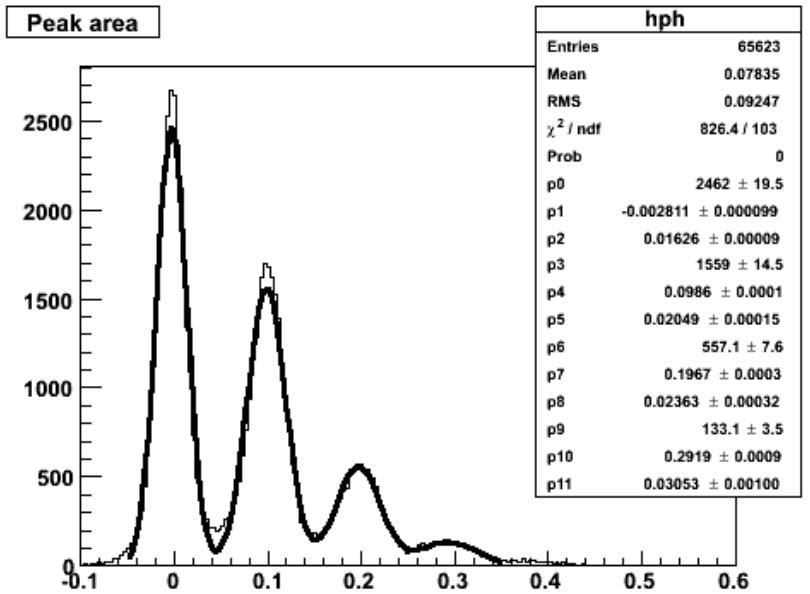


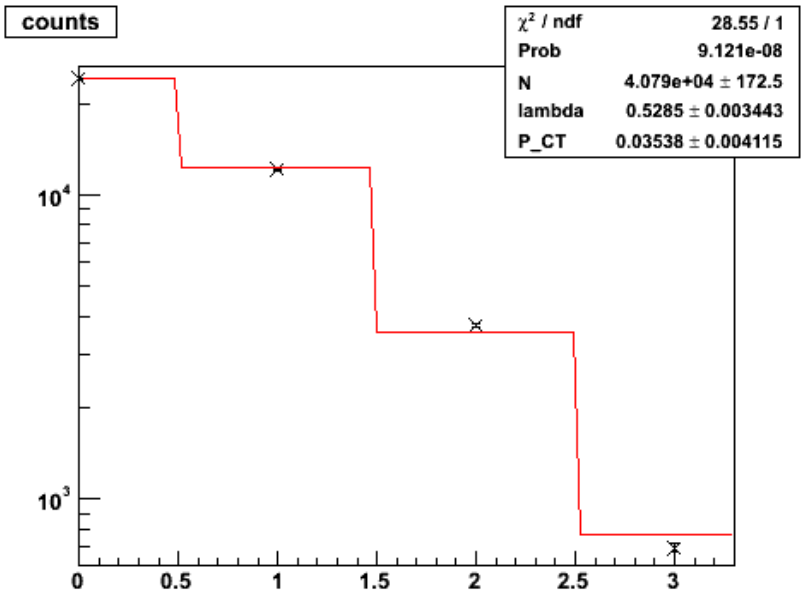
Filtered only
(with mean peak shape)

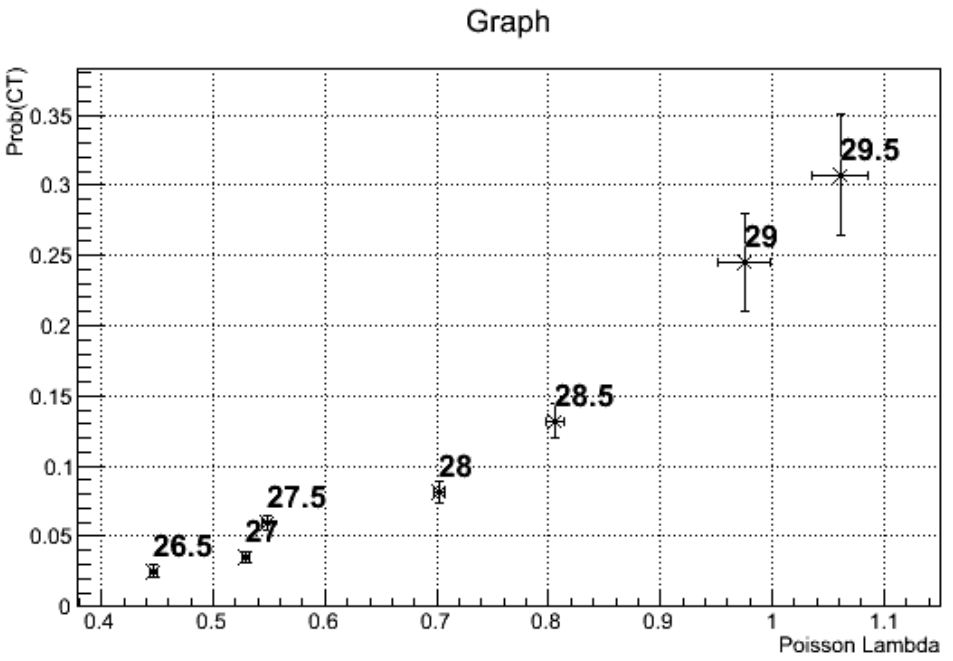


Filtered and differentiated

Test SiPM


Peak area
hph
Entries 65623
Mean 0.07835
RMS 0.09247
χ² / ndf 826.4 / 103
Prob 0
p0 2462 ± 19.5
p1 -0.002811 ± 0.000099
p2 0.01626 ± 0.00009
p3 1559 ± 14.5
p4 0.0986 ± 0.0001
p5 0.02049 ± 0.00015
p6 557.1 ± 7.6
p7 0.1967 ± 0.0003
p8 0.02363 ± 0.00032
p9 133.1 ± 3.5
p10 0.2919 ± 0.0009
p11 0.03053 ± 0.00100


counts
χ² / ndf 28.55 / 1
Prob 9.121e-08
N 4.079e+04 ± 172.5
lambda 0.5285 ± 0.003443
P_CT 0.03538 ± 0.004115

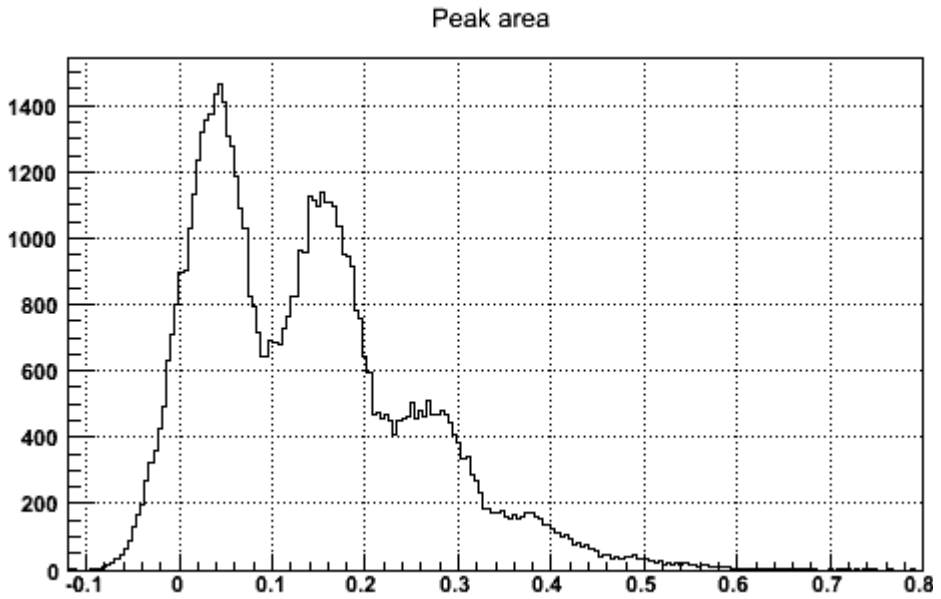

Graph
Prob(CT)
Poisson Lambda
26.5
27
27.5
28
28.5
29
29.5

Sum stage: test

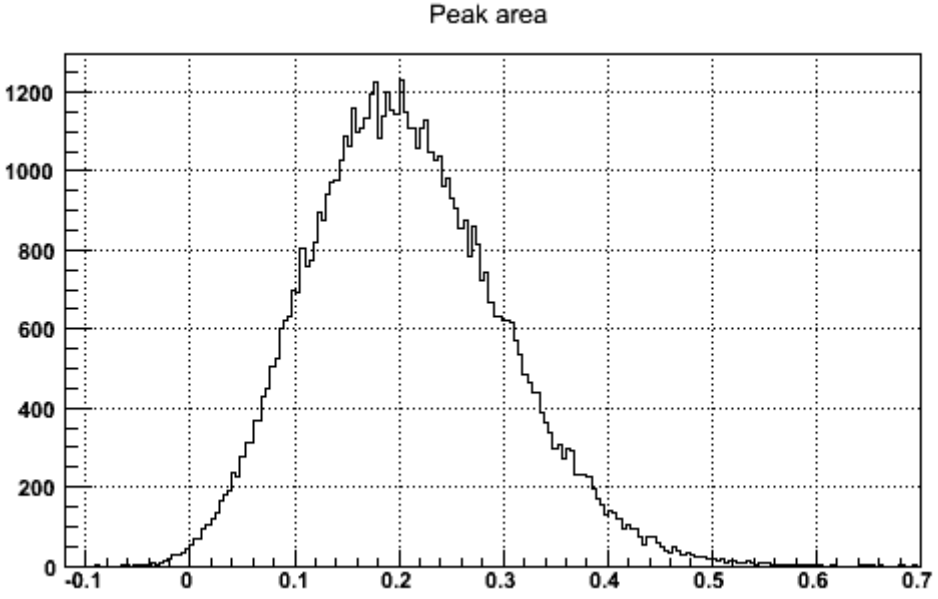
We are currently test possible sum scenarios at the SiPM level

- 4 pads soldered together into one channel (done)
- 2 pads soldered together into one channel (tomorrow)

Soldering pads is a simple sum by itself, but the increased capacitance makes the amplified signal noisier and “finger” plots become blurred. Working on this.



One 3x3 mm^2 SiPM with LED illumination
Vb=27V (2.4V overvoltage)



4 SiPM with same LED illumination
Equivalent to a 6x6 mm^2 SiPM

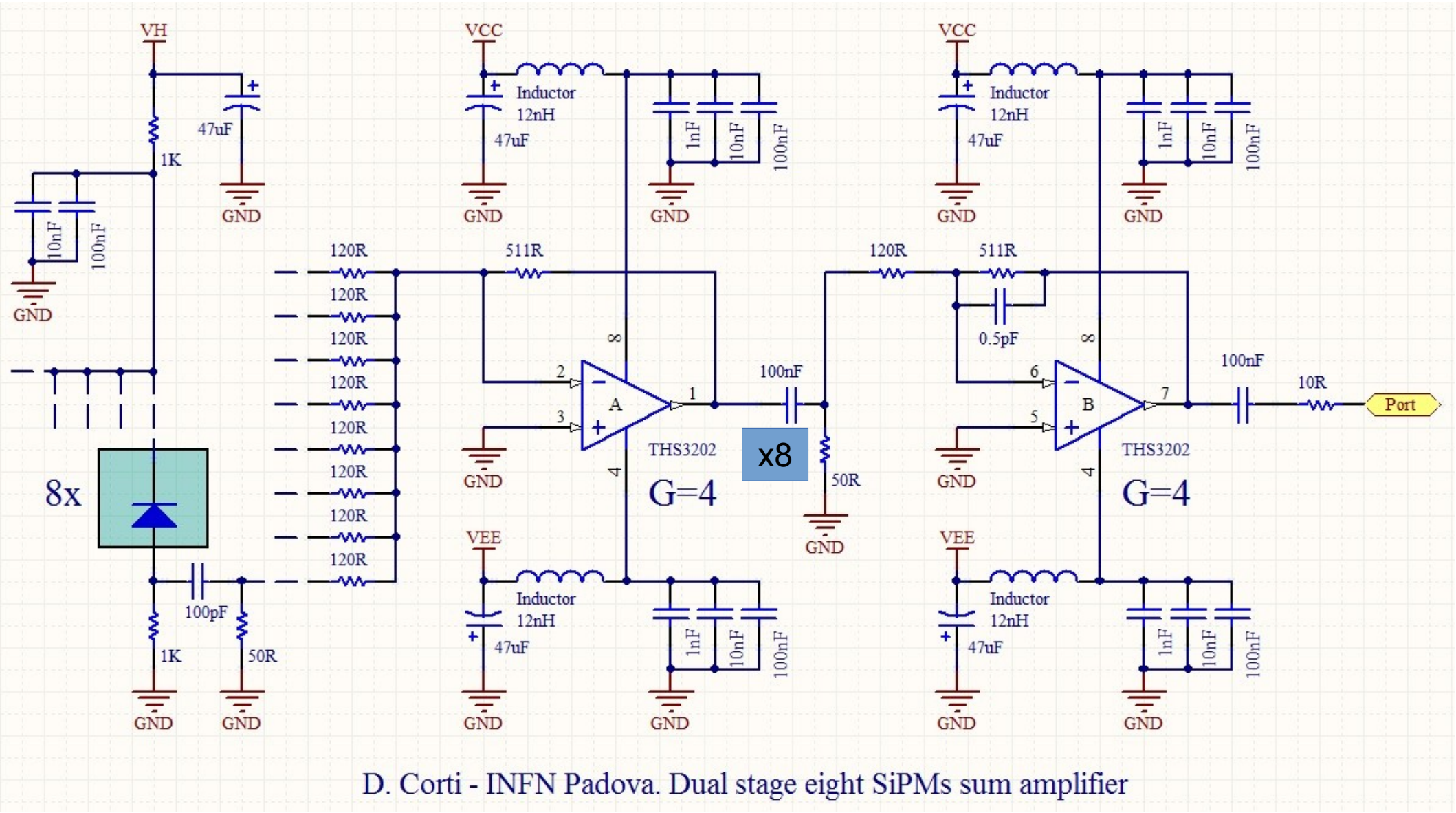
Sum stage

Analog sum stage (D. Corti)

- 8 sums, 8 SiPM each
- 1 final sum, all 64
- Some gain possible (x4x4 now)
- Good BW (dep. on gain)

A lot of work last weeks to minimize the intrinsic noise and some ringing.
Some additional work to optimize the sum configuration.

Sum schematics

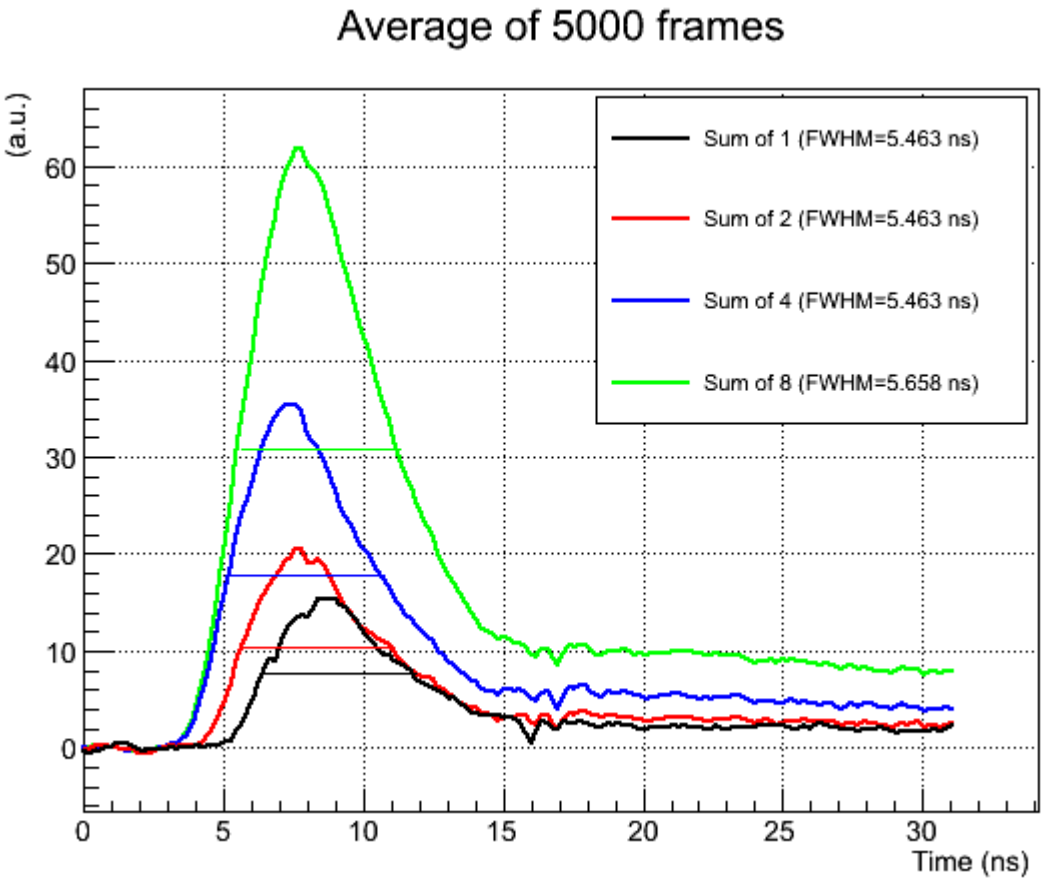


D. Corti - INFN Padova. Dual stage eight SiPMs sum amplifier

Sum stage: currently noise is still too large to see the usual “finger plots”, i.e. to distinguish the peaks of 1.2,... phe.

We still can see the peaks and test the signal width by using the LED illumination, so triggered. Noise increases with √n while peak increases ~ linearly with n. Peak width does not increase summing 8 signals.

Some tail appears on the right. Additional passive conditioning (high pass) at this end of the chain will be tested to squeeze the peak and remove the tail (done, I have to measure).



NB: tails add to “noise” do to the high hit rate (a few MHz per SiPM)

SiPM procurement

Right now:

- We have 2 pads with 4x4 FBK SiPM
- Not state of the art, ok for testing

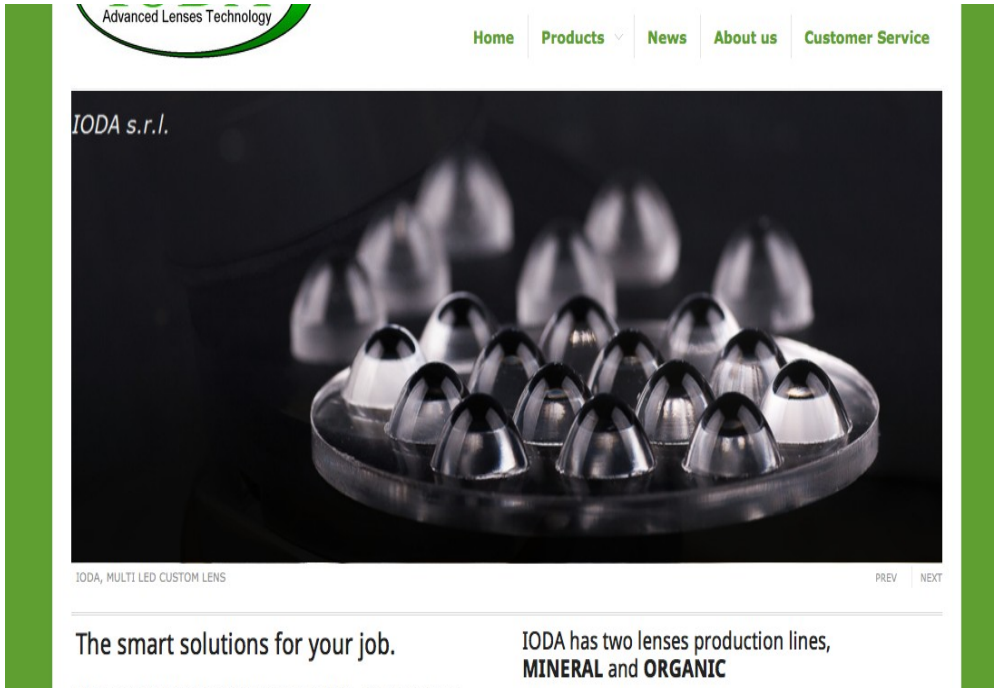
Soon:

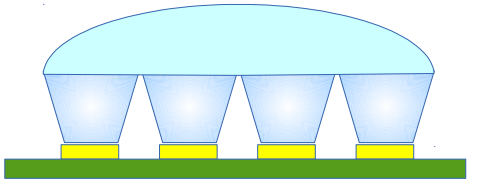
- 2 FBK runs already in agreement for Q2/2014
- NUV “standard” SiPM (40um cell)
- NUV HD (small cell), should have very low dark rate, good QE
- New Hamamatsu matrix for comparison

Later:

- Major FBK production expected for end of Q3/2014, state of the art NUV sensors
- Few things still TBD but we are converging fast (e.g. on size, probably 3x3 mm^2)

Optics





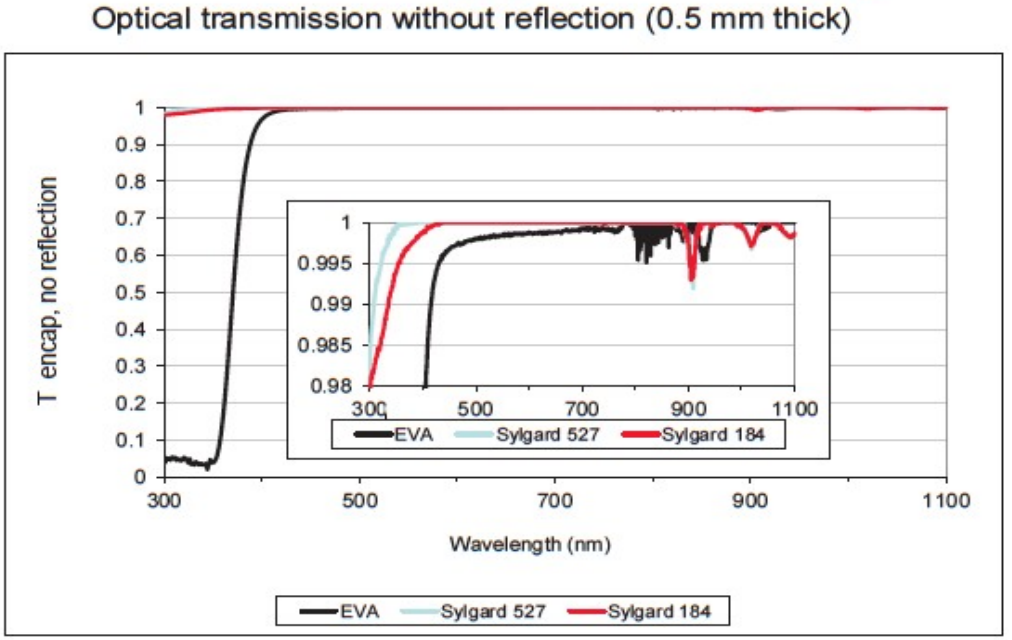
Options:

FK5 UV glass lenses + standard cone
PMMA lenses + standard cone
PMMA solid cone

- Lens layout optics simulation
- Solid cone optics simulation
- Industries agreement for R&D and mass production

- Silicon based UV transparent resin
- In our hands dow corning Sylgard 184 for optical coupling and/or lens moulding

Optical Transmission-Sylgard 527 & Sylgard 184



- Easy to test SiPM sensors, verify characteristics
- Prototype sum stage: open issues
  - ➔ Some noise to be removed: optimize configuration
  - ➔ Perhaps some sum can be done at the SiPM level, check “sum of 2”
  - ➔ Some trouble is caused to the readout (DRS4 evaluation board v4): need to amplify above board noise (~2mV). Alternative readout?
- New SiPM will be available: smaller cells, faster signal, low dark rate
- Design and test optics concentrator