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INFN-Padova Report

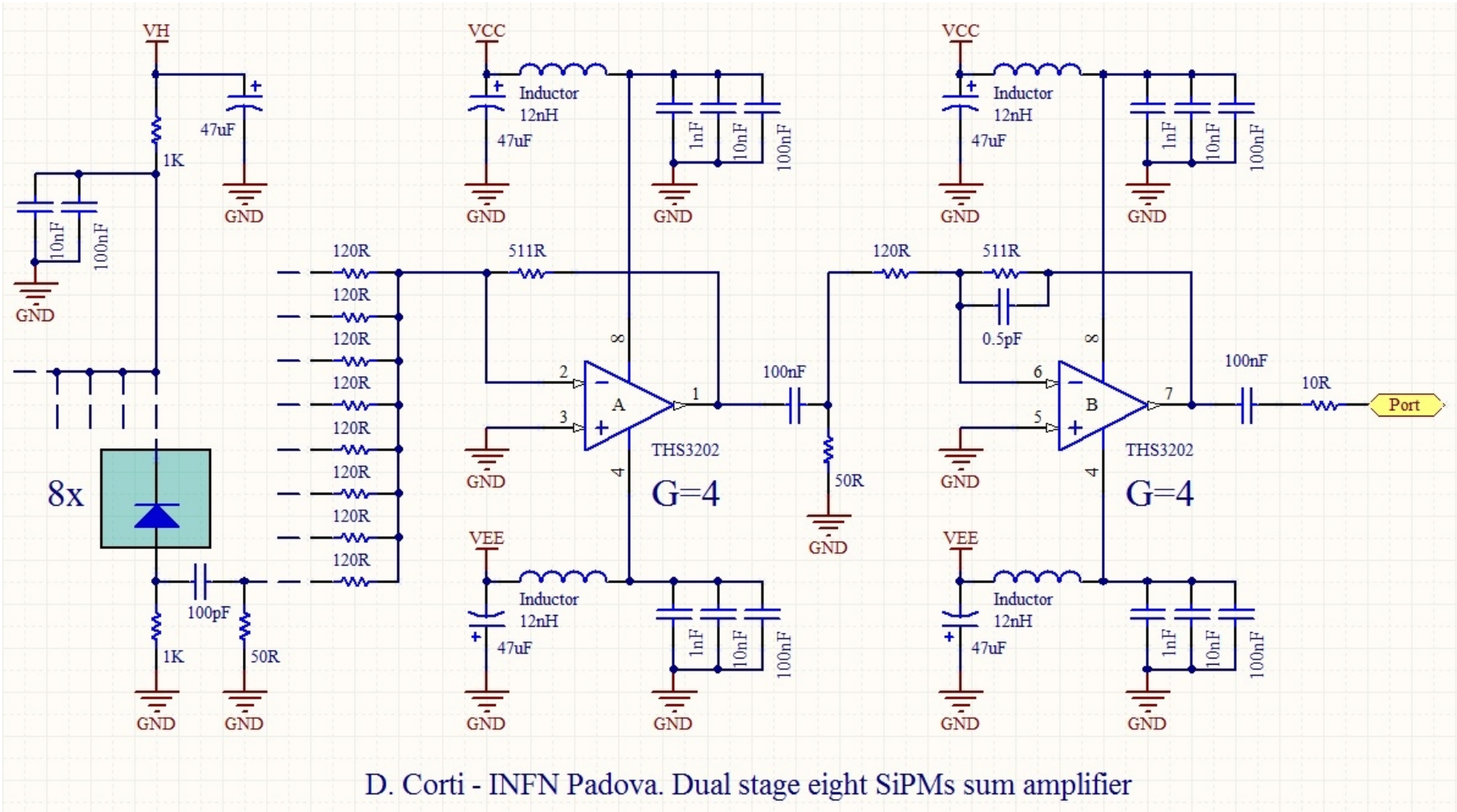
Outline:

Electronics (SiPM sum, no preamp)
Optics (lenses etc)

Electronics

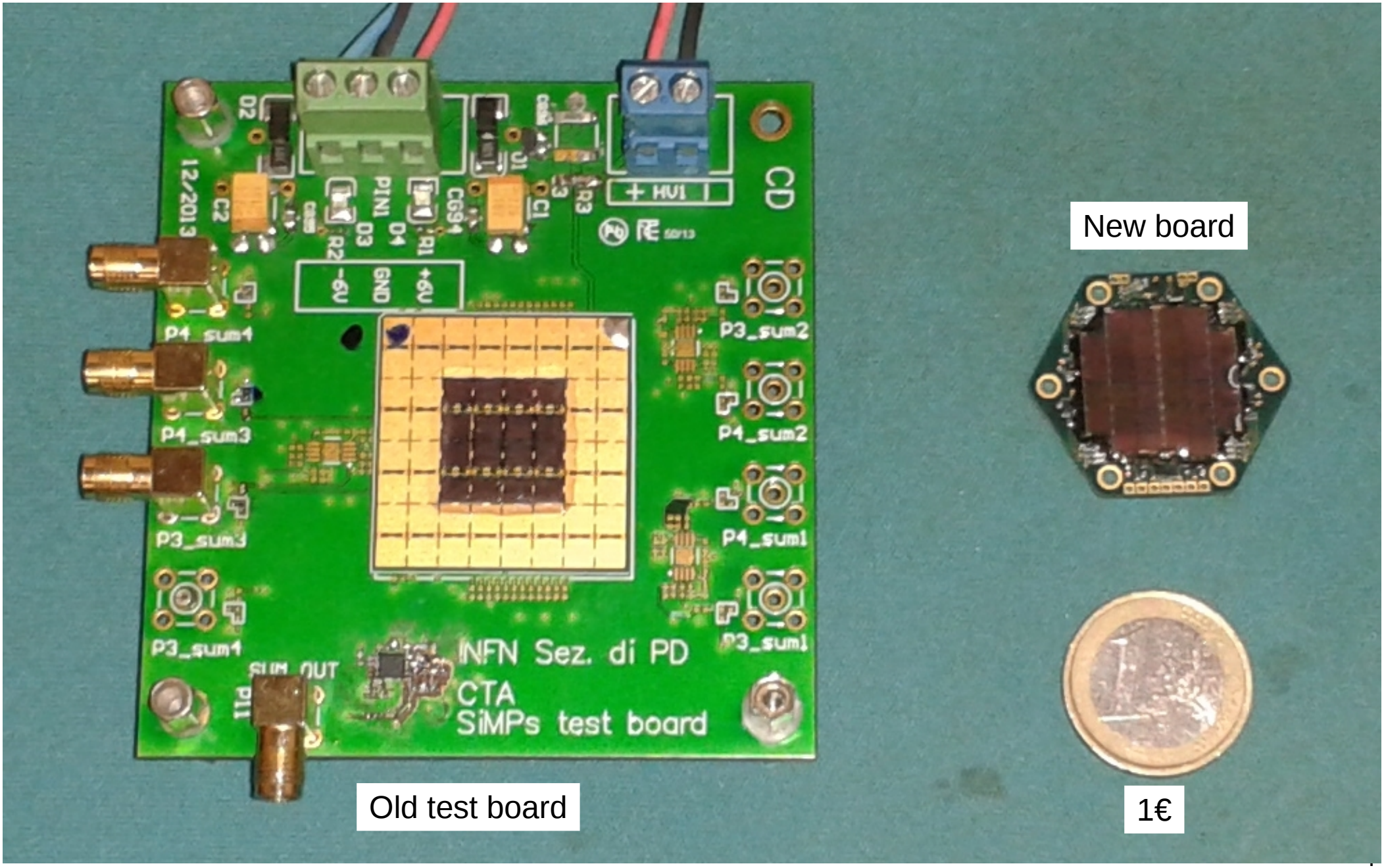
Old electronics (last meeting)

Sum in 2 stages, amplify a bit during sum (no preamplifier stage)
Old sum board: we could see “finger plots” up to 6 phe, then noise dominated
One main problem: long lines (several cm) between sensors and first amplification



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

The evolution



Characteristics

New board, size fits into MAGIC cluster

- Mounts 32 SiPMs, FBK NUV 3mm*3mm
- Analog sum electronics on the back

Same scheme as in the previous sum board: 2 stages

- Amplify-and-sum 8 SiPMs
- Sum the 4 partial sums into the final output

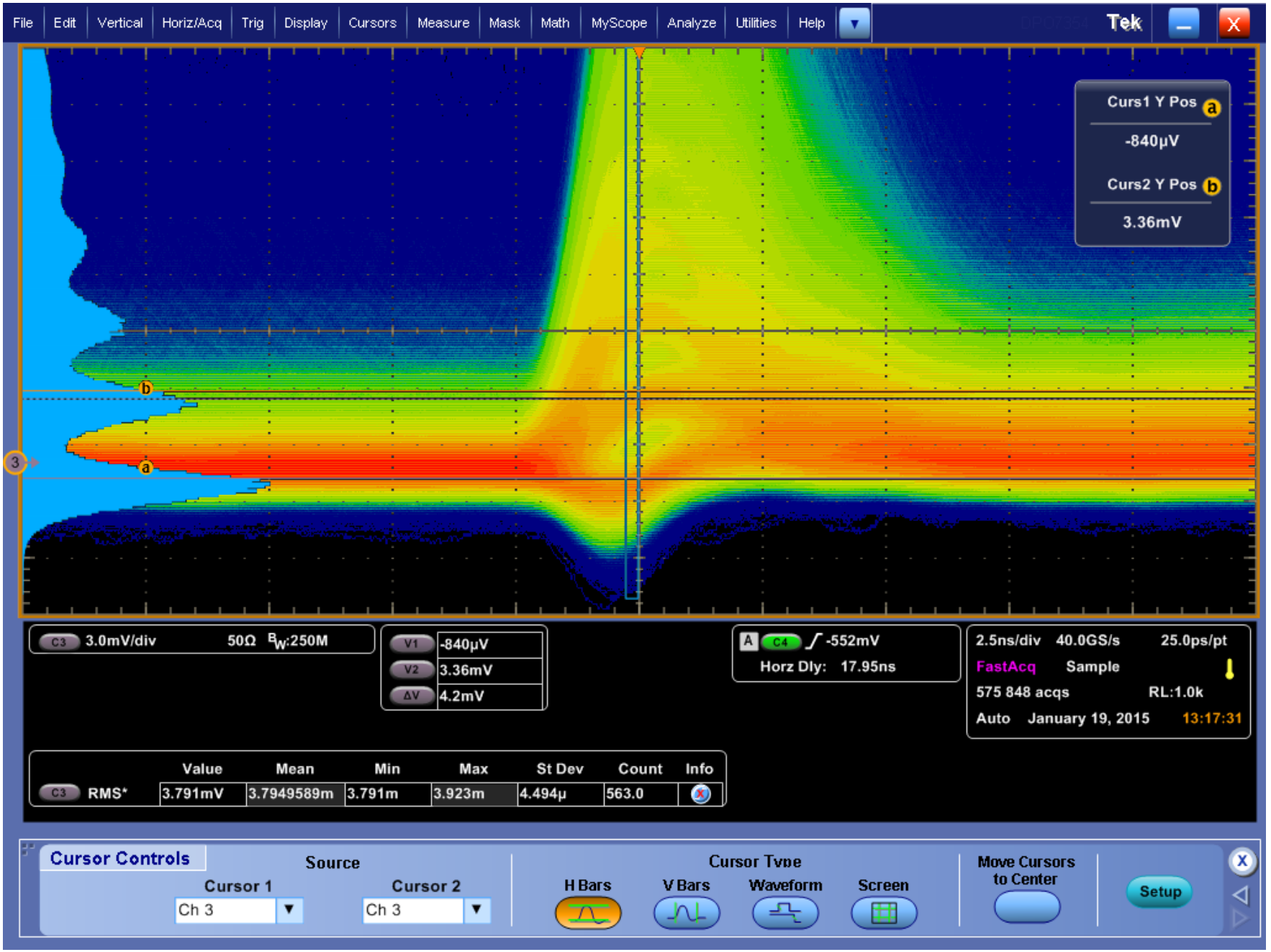
Low consumption, low noise opAmp (THS3201)
Power: ±2.5V, 65 mA for a consumption of 360 mW

Currently working on the prototype board (some dead SiPMs/channels)
A LOT of optimization, changed several components over and over
Pretty beaten up by now...

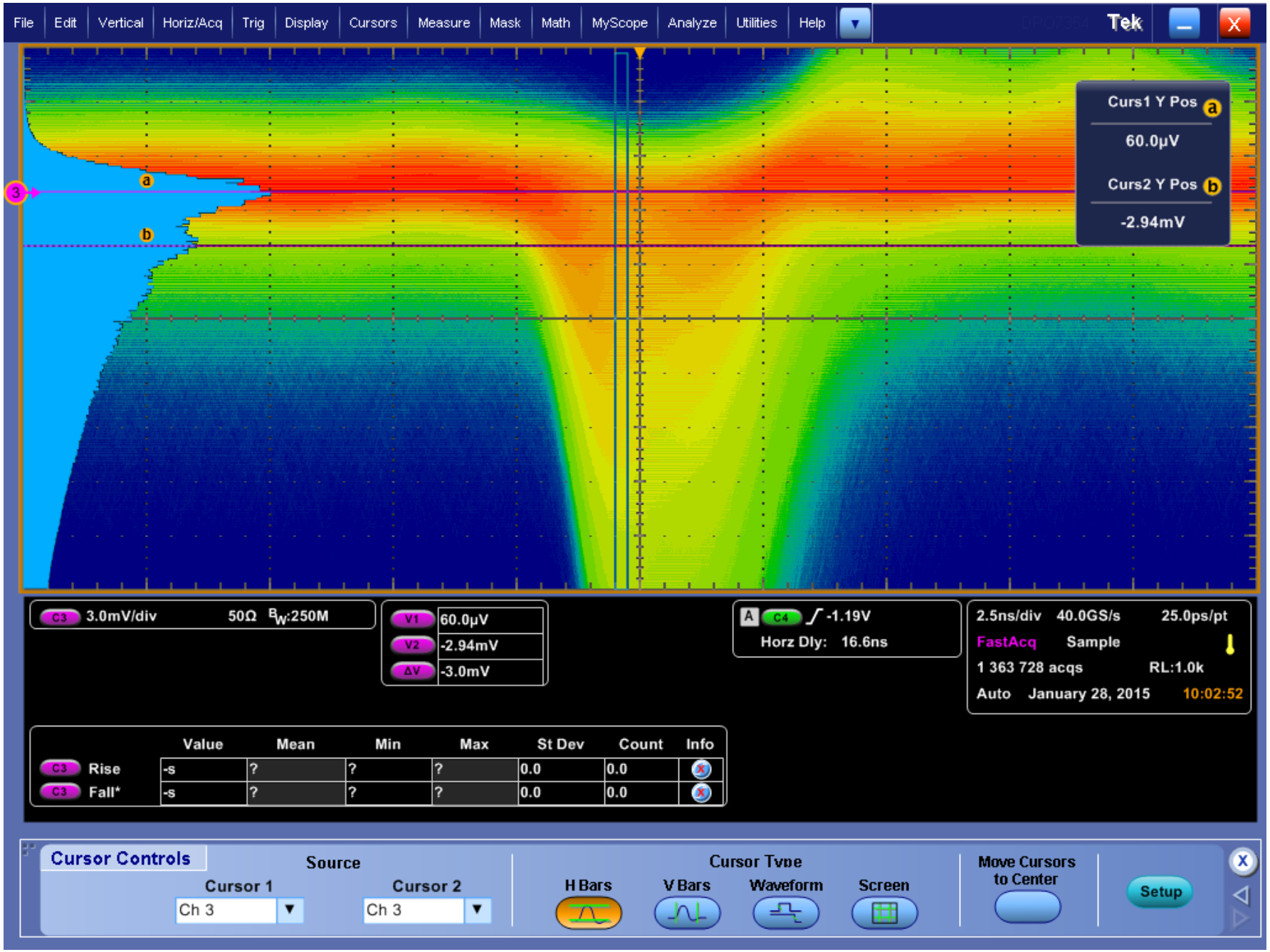
Intrinsic noise: 400 uVrms after the first stage, 1 mVrms at the output
Gain: currently 3 mV per 1ph
Pulse width 2-3 ns

NB: no gain adjustment on SiPMs (15% spread?)

One single SiPM



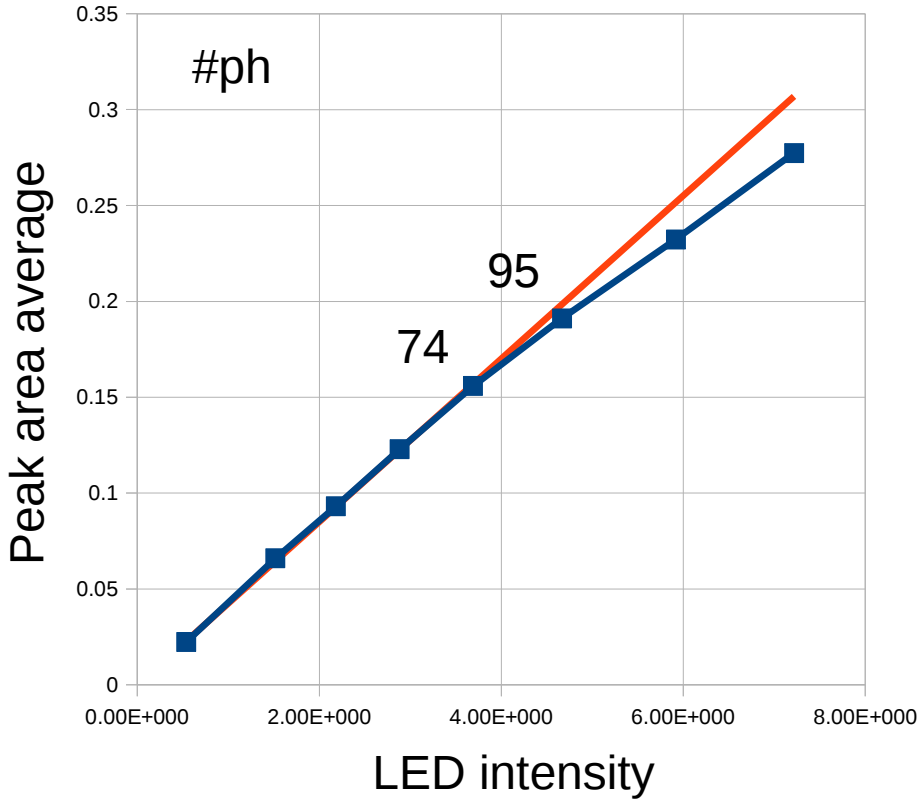
14 SiPM (in 3 blocks)



Linearity

Test circuit linearity: pulsed 380nm LED, intensity measured with a reference SiPM
No particular analysis on Sum output: plot peak area, take average
Loss of linearity starts between 75-90 photons (on 14 SiPM)

Gain can be lowered a bit (at the 1st or 2nd stage, depending on who is the culprit).



Done yesterday, to be verified

What next

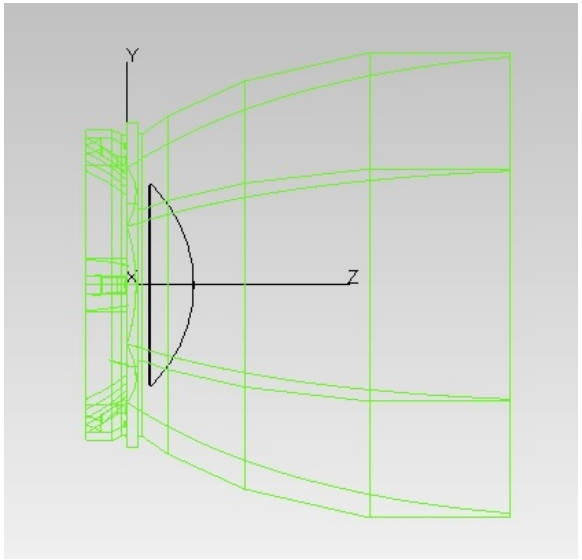
Current test board has done its job, retired
Switch to new “production” board, install components, test
Should have very few dead channels (if any)

Fine-tune gain-noise-bandwidth-linearity etc

Fully characterize performance
Add low noise power supply (~40V?)
New sensors, controlled gain distribution
Assembly a complete demonstrator

Optics

Status of work on lenses/solid WCs



Optics is needed to efficiently replace PMT with SiPM
- Adapt incidence angles for best QE
- Reduce Si surface as possible

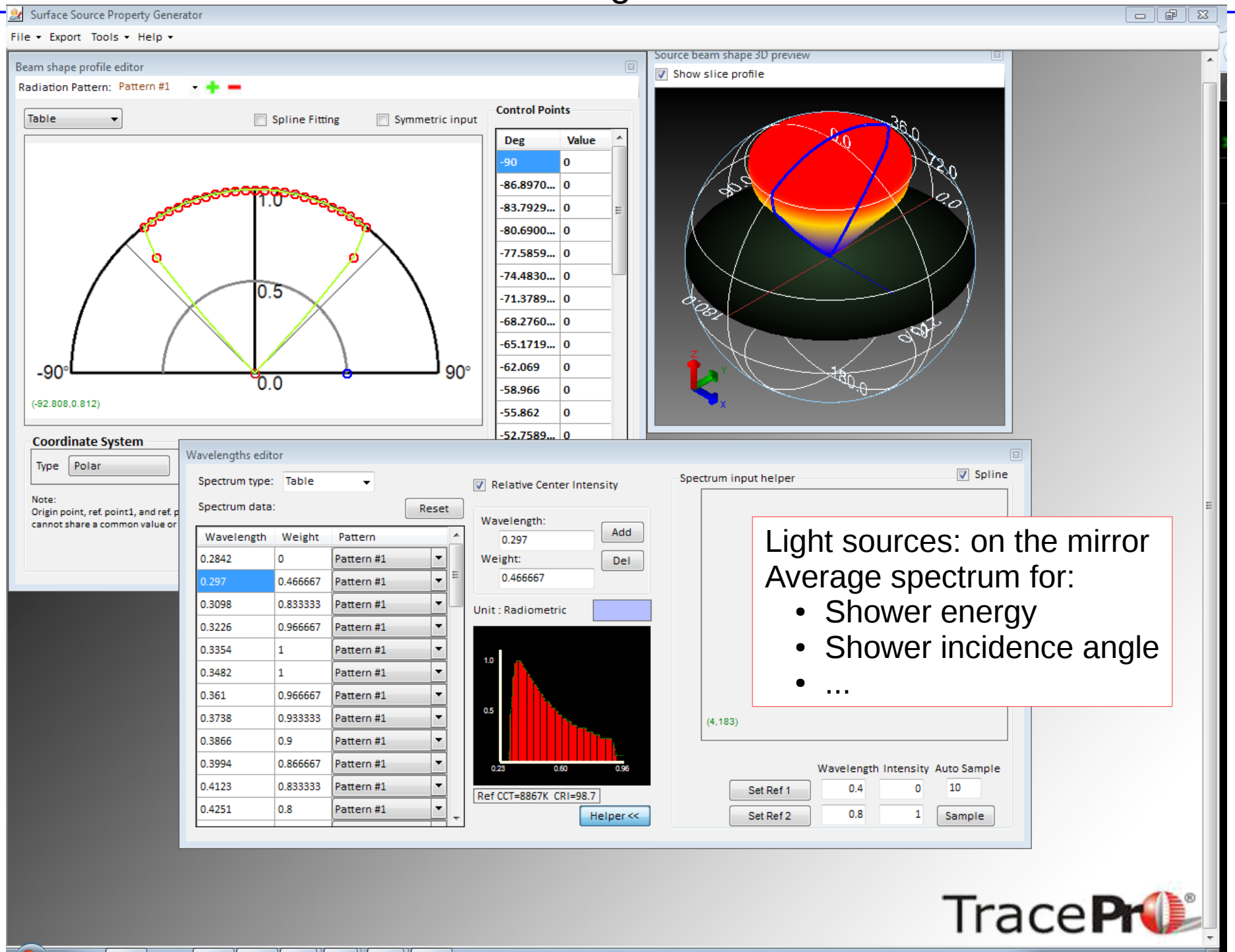
Two ways
- Lens on top of Si, standard/optimized WC
- Replace WC with solid concentrator

Simulations to evaluate
Started with MAGIC geometry
Next: extend study to LST

Lenses:
- Take as reference Edmund Optics industrial products

Solid concentrator:
- Evaluate material performance
- Tune shape (make it shorter than an empty WC)
- Check with companies (issues if shape is too complex and/or small q.ties)
- 3D printed molds under investigation

Simulation: light source



Light sources: on the mirror
Average spectrum for:

- Shower energy
- Shower incidence angle
- …

TracePro®

Results for lenses

MAGIC (Mylar)	MAGIC (Samivex)	MAGIC with lens (NFK5)	MAGIC with lens (IODA)	MAGIC with lens (NFK5)	MAGIC with lens (IODA)	Solid WC (NFK5)	Solid WC (IODA)
0.35	0.34	0.33	0.28	0.32	0.26	0.37	0.22

- Light on Si active area, arbitrary units
- Lens (NFK5) similar results than with current layout
- Solid WC (hexagonal entrance circular exit) can do slightly better than current layout
- IODA material (resin) is not appropriate (for near-UV)

- Lenses ordered 10 + 10 + 20 pcs (IODA company; Thorlabs; Japanese company Solid)
  - Glass (material proposed by companies)
  - Some of the lenses arrived at beginning of January 2015
- Companies contacted for solid WC prototype

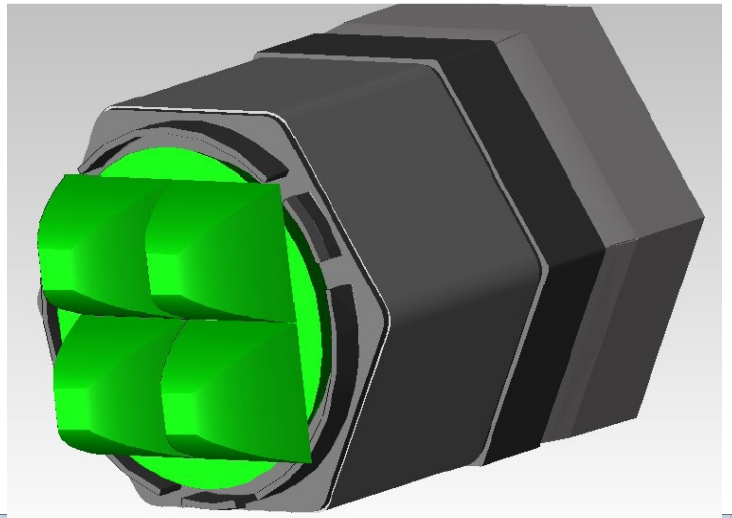
Solid concentrator

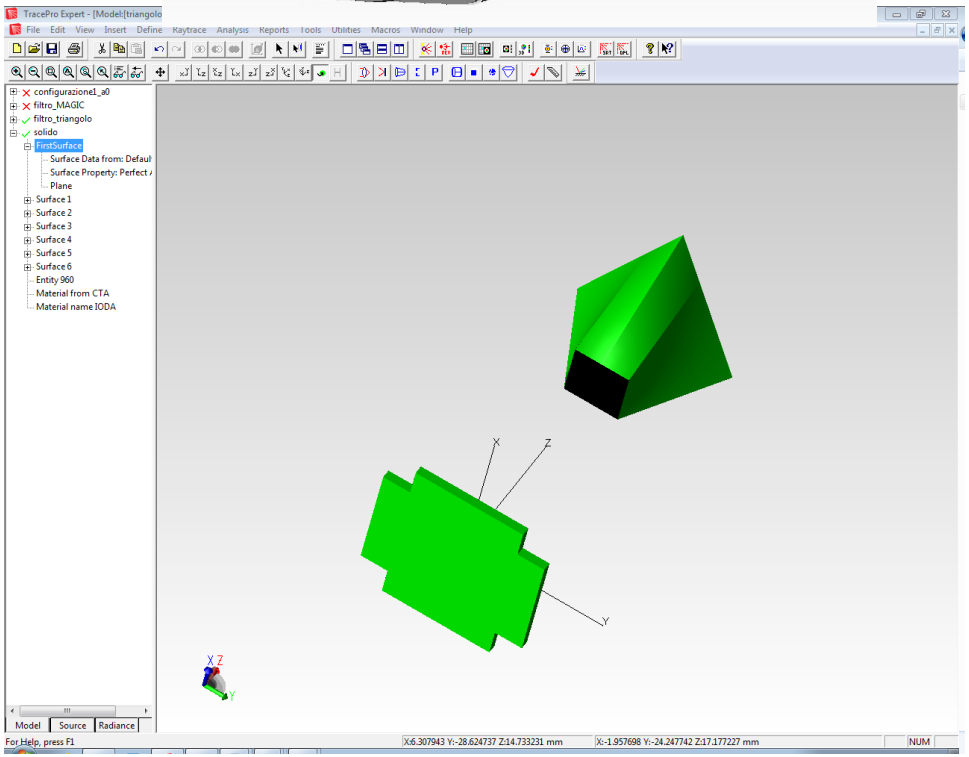
Alternative layouts are under consideration
Last time we mentioned the “tooth” lens

Another one is the “triangle-to-square”

- Pieces are easier to produce
- Assemble 6 elements into hexagon
- Shorter
- reduces amount of sensors to 24

Investigating other symmetries





What next

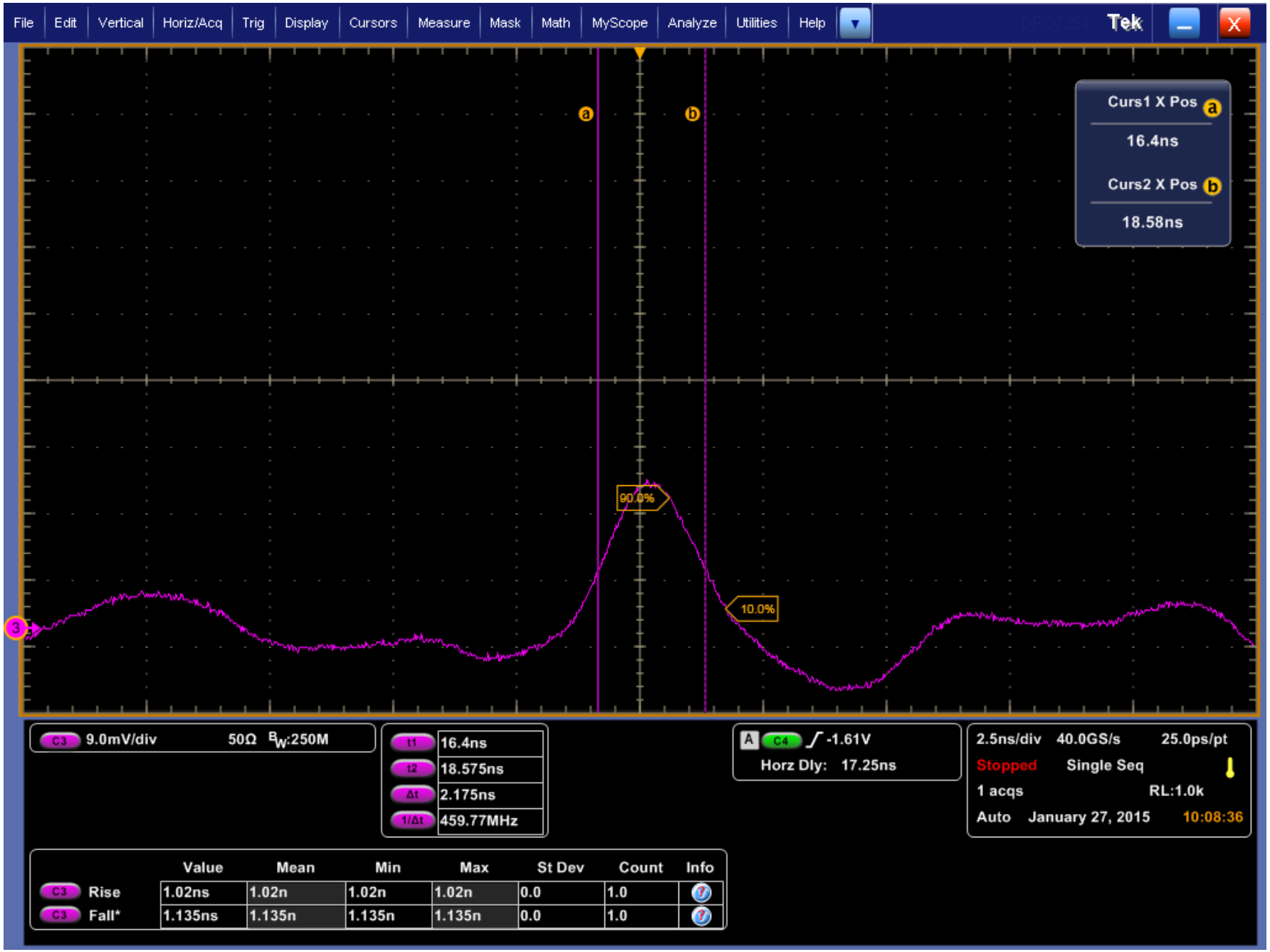
Conclude studies on MAGIC optics

- Compare simulations with measurements
- Test bench? One available in Munich, or assemble one in Padova
- Some components still missing (e.g. epoxy glue and liquid for optical coupling)
- Measure transmittance

Start working on LST geometry
Solid concentrator more difficult due to bigger dimension

Spare slides

Pulse width


File
Edit
Vertical
Horiz/Acq
Trig
Display
Cursors
Measure
Mask
Math
MyScope
Analyze
Utilities
Help
Tek
Curs1 X Pos a
16.4ns
Curs2 X Pos b
18.58ns
90.0%
10.0%
C3 9.0mV/div 50Ω BW:250M
t1 16.4ns
t2 18.575ns
Δt 2.175ns
1/Δt 459.77MHz
A C4 -1.61V
Horz Dly: 17.25ns
2.5ns/div 40.0GS/s 25.0ps/pt
Stopped Single Seq
1 acqs RL:1.0k
Auto January 27, 2015 10:08:36
Value Mean Min Max St Dev Count Info
C3 Rise 1.02ns 1.02n 1.02n 1.02n 0.0 1.0
C3 Fall* 1.135ns 1.135n 1.135n 1.135n 0.0 1.0