Photo-detector and scintillator studies at ITEP

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Outline

1. Check of casting form
2. Study of MRS APD's from CPTA
3. MC simulation of light collection in tiles and strips

Check of casting form

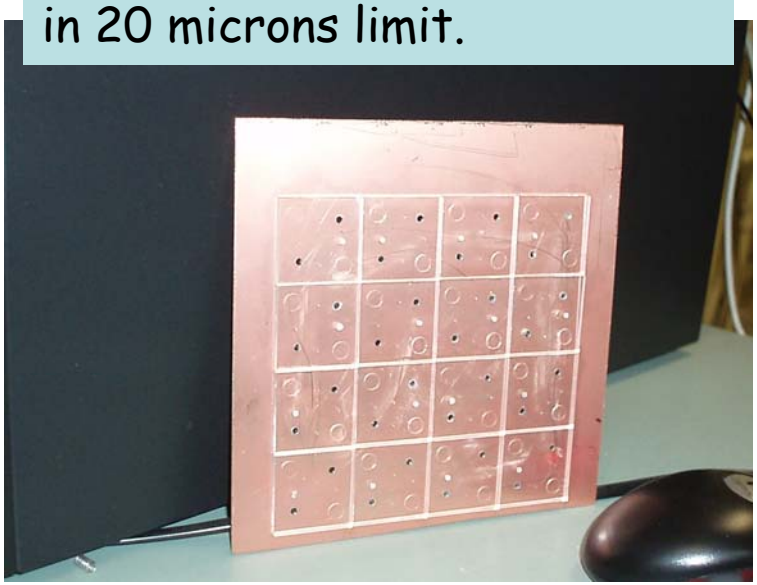
A casting form to produce tiles was manufactured.

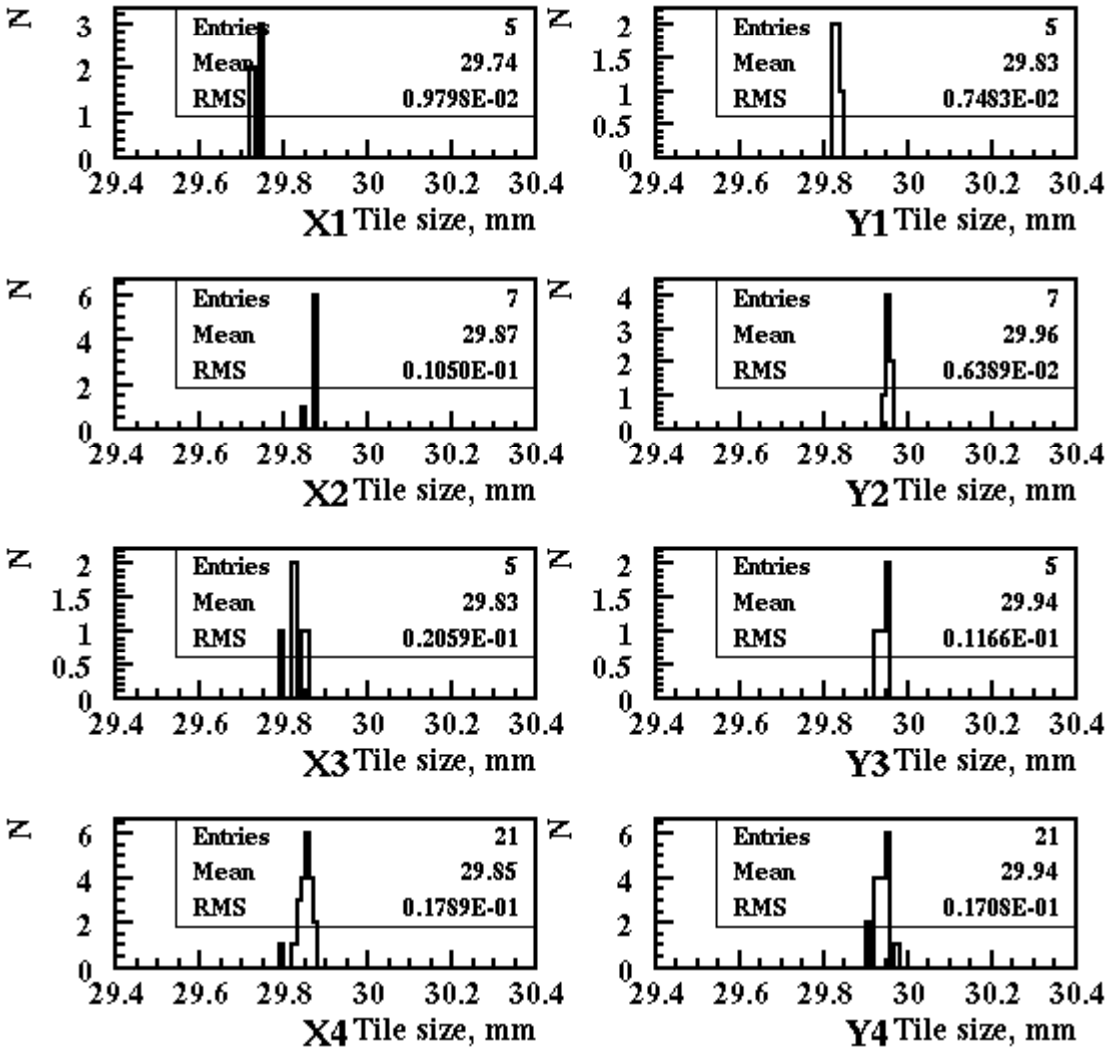
Tested tiles have been moulded by four technologies.

Part of them have been measured to see what is the size spread.

Results are shown at hists for all 4 batches.

One sees that all RMS's are in 20 microns limit.

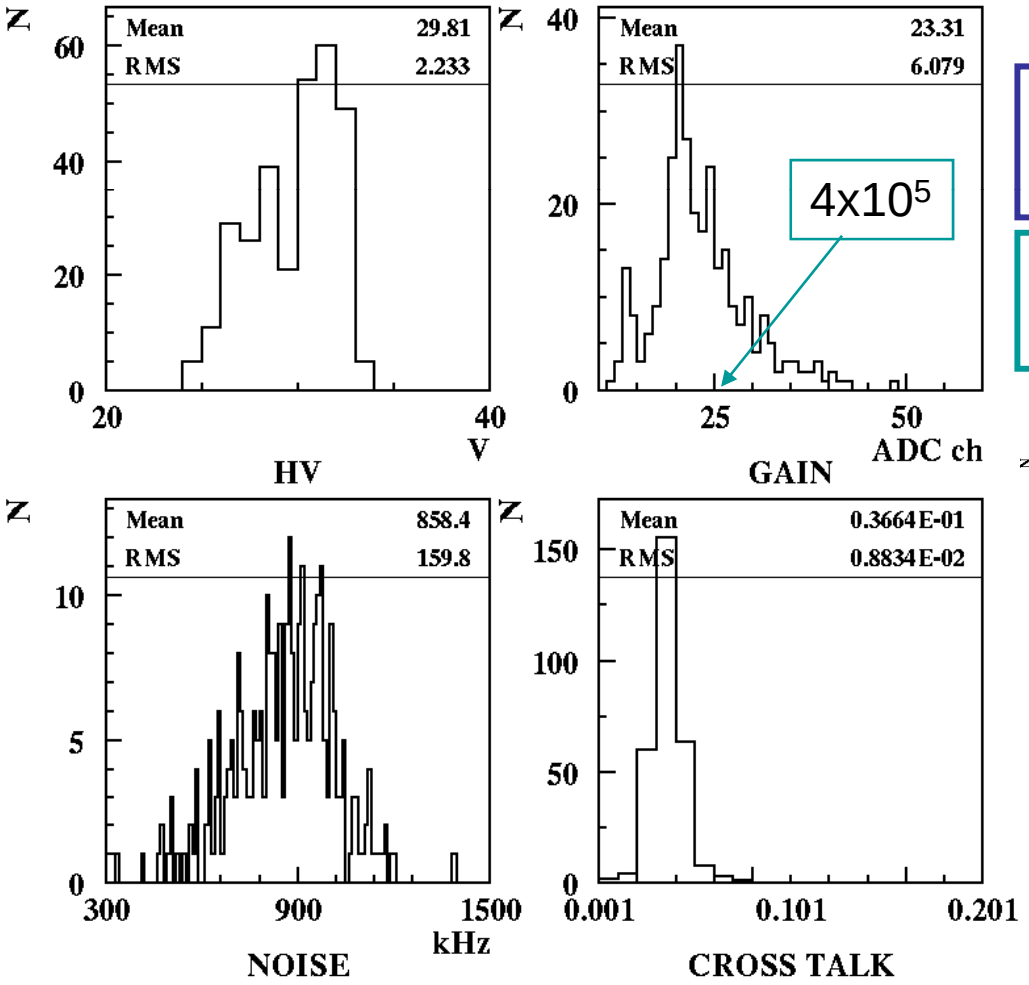




Next step: check tile sizes after tile edges are chemically etched ("painted").

Test of MRS APD from CPTA

APD parameters at Np.e.=10
for 30x30x3mm^2 tile

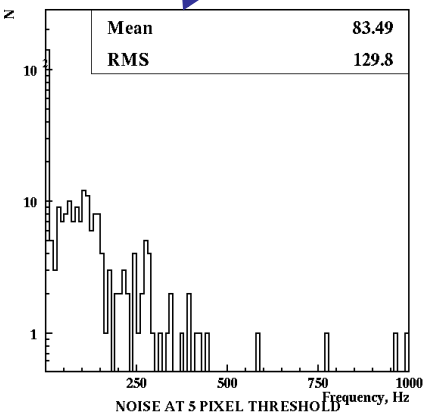


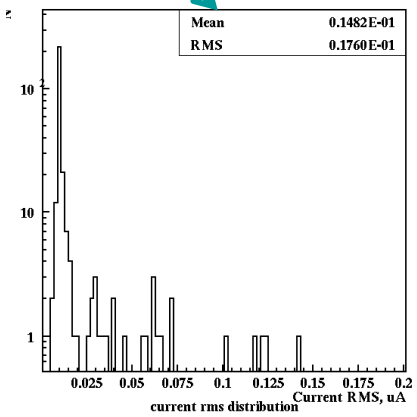
300 photo-detectors were tested

20 – not operated

Noise frequency at 5 pixel threshold is below 100 Hz

8% of tested devices showed bad current stability during 8-12 hours

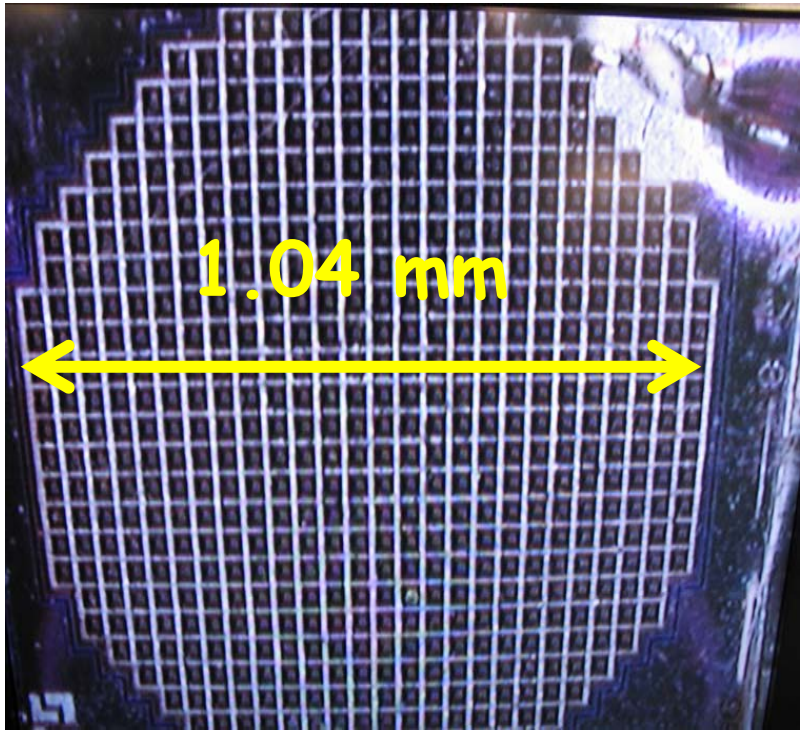




MRS APD from CPTA

556 cells, Ø1mm

We discuss with CPTA possibility to increase number of pixels.



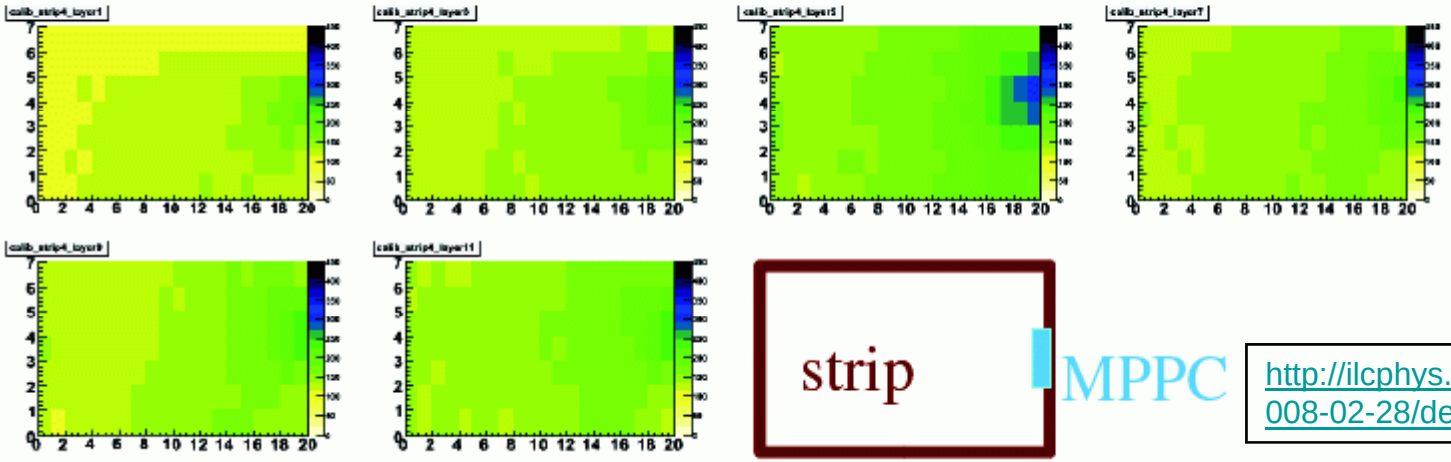
Simulation of light collection was done with use of package for light transport propagation in optical media

Main parameters:

- ✓ Scintillator attenuation length – 25 cm
- ✓ Reflection of mat coating at tile (strip) edges - 0.94
- ✓ Reflection at mirror surface (3M foil) – 0.98
- ✓ Scintillator as a whole was wrapped with mirror reflector
- ✓ There was by default an optical contact between scintillator and photo-detector entrance window
- ✓ Spectral distribution of materials were taken into account

Response uniformity in various geometries measurement vs simulation

MIP response uniformity: detailed scan across single strip

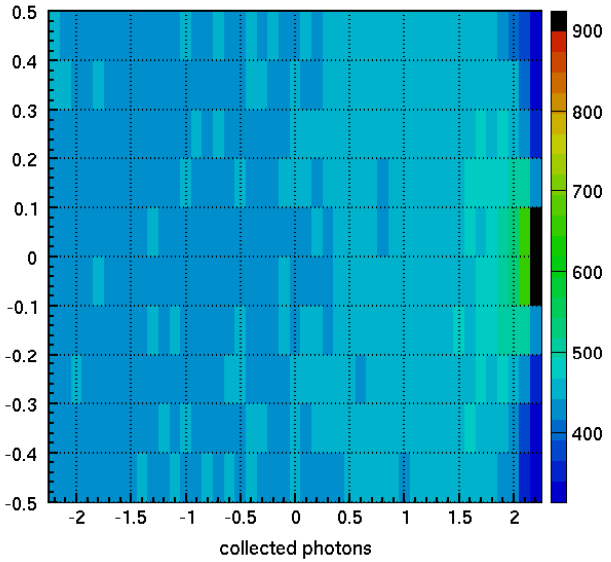


Kuraray

direct readout

strip | MPPC

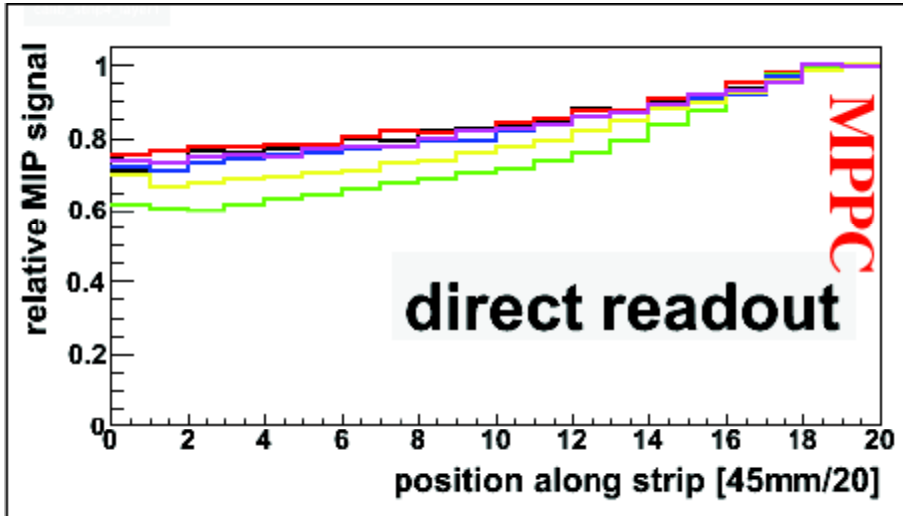
http://ilcphys.kek.jp/meeting/cal/archives/2008-02-28/desytb.pdf



MC

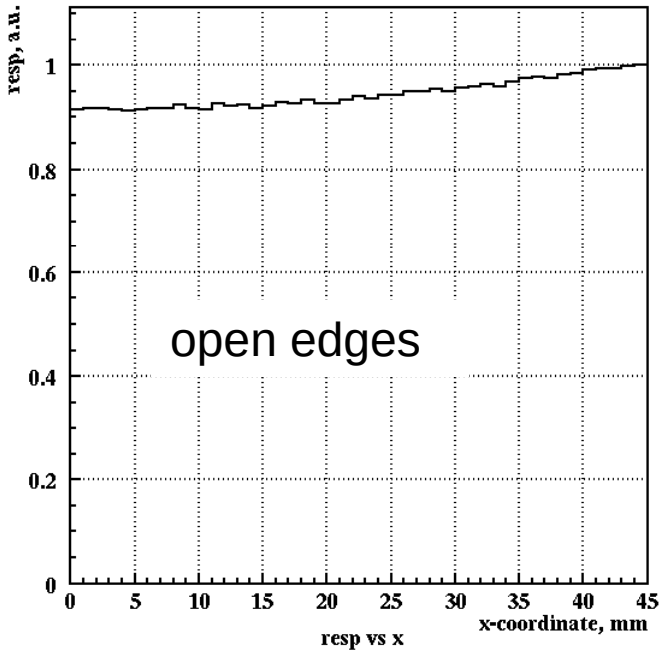
Strip 45x10x3 mm^3

Strip 45x10x3 mm3 – response longitudinal profile

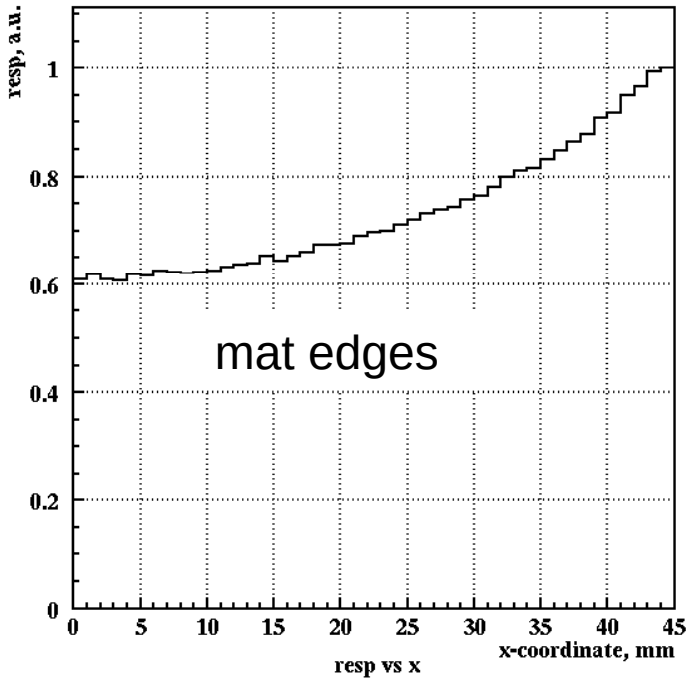


Projected along strip length

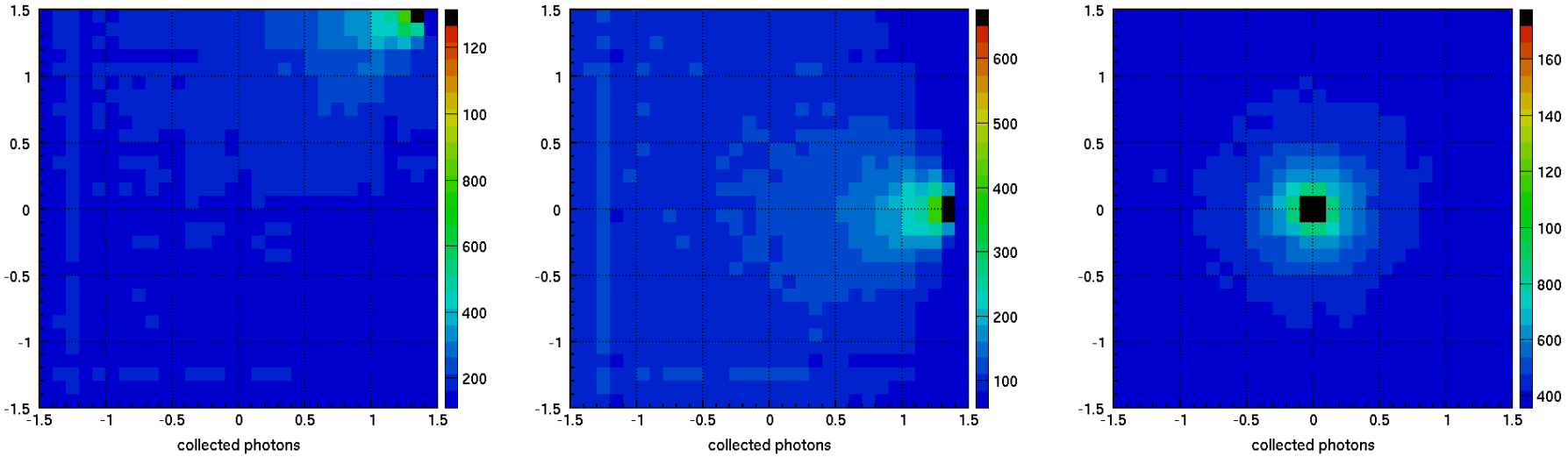
http://ilcphys.kek.jp/meeting/cal/archives/2008-02-28/desytb.pdf



MC



Response uniformity in 30x30x3 mm^3 tiles



Non-uniformity region is of several percents of the total tile area.

Which non-uniformity can we allow to have required performance of the calorimeter?

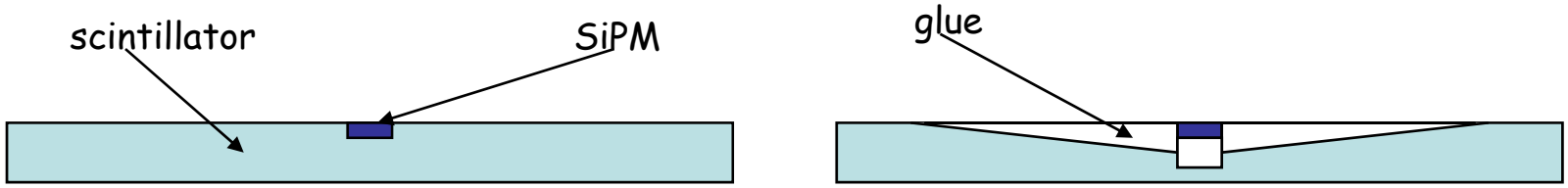
Results of MC simulation of light collection efficiency in tiles and strip of various geometry

size(mm^3)	sipm pos.	edges	opt. contact	$<\varepsilon_{lc}>$(%)	RMS(%)
30x30x3	corner	mat	yes	1.43	38
30x30x3	side	mat	yes	0.94	36
30x30x3	side	mat – 96%	yes	1.05	36
30x30x3	side	mat – 98%	yes	1.15	36
30x30x3	side	open	yes	1.9	17
30x30x3	side	open	no	0.73	20
30x30x3	top	mat	yes	1.1	28
45x10x3	side	open	yes	2.5	9
45x10x3	side	mat	yes	1.6	23
45x10x3	side	open	no	1.4	10
90x10x3	side	open	yes	1.94	15
90x10x3	side	mat	yes	1.22	40
60x15x3	side	open	yes	1.93	16
60x15x3	side	mat	yes	1.16	32

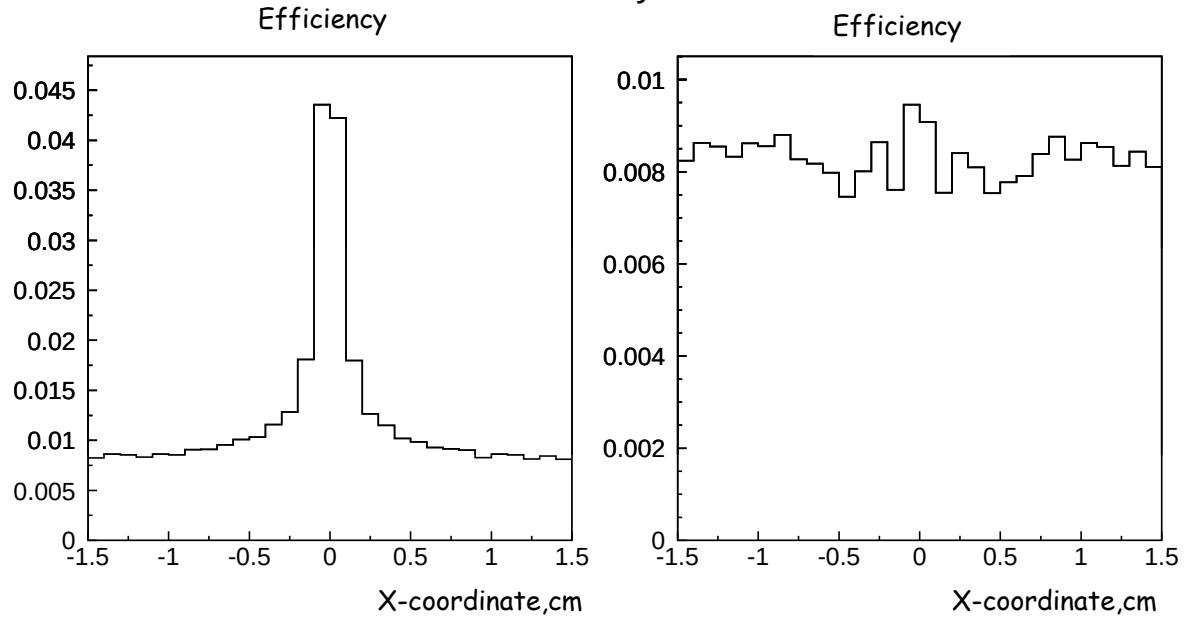
Calculated number of photoelectrons for 1 mm2 sensitive area photo-detector

$N_{p.e.}=dL/dx*\Delta x*\varepsilon_{lc}*\varepsilon_{pd} = 14x10^3*0.3*0.008*0.3 = 10$ p.e.

Equalizing of non-uniformity in a tile read out from the top



30x30 mm^2 tile read out by 1x1 mm^2 detector



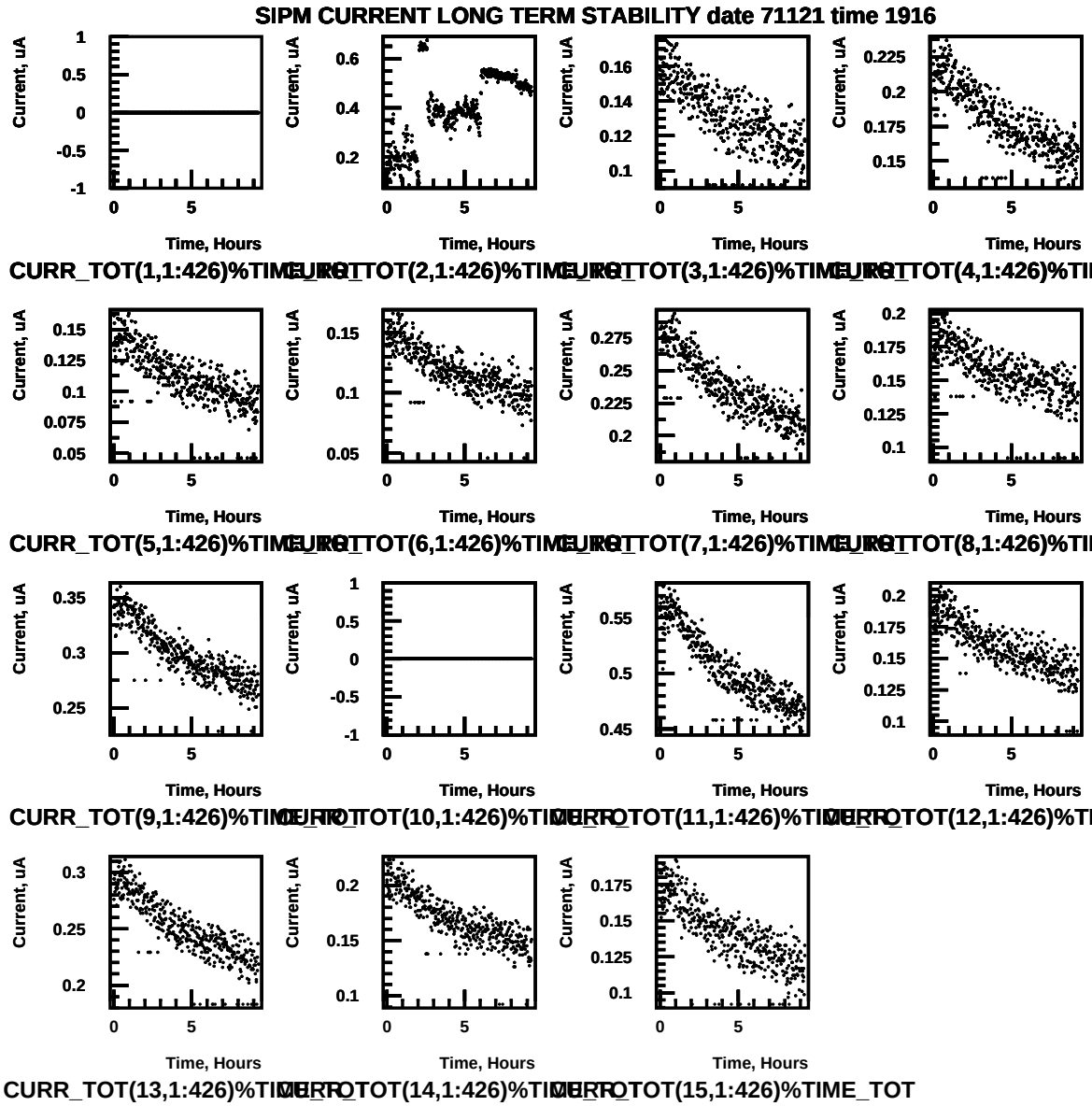
But design with photo-detector at top of a tile seems to be not suitable for mass production (possible problems during assembly – ensuring of optical contact at many tiles, as well as difficulties during test and replacement)

Plans

- Produce 100 tiles 30x30x3mm^3 equipped with WLS fiber and photo-detector in summer 2008.

Back up

Test of RMS APD long term stability



Typical variation of MRS APD current versus time is shown at plots

Distributions over MRS APD parameters @ various PDE