

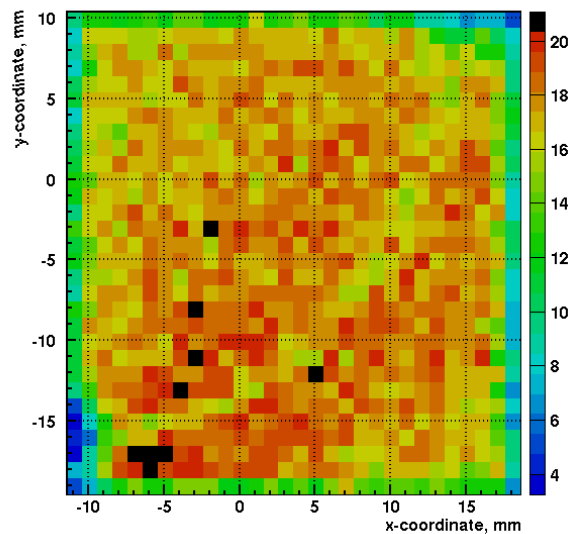
The study of uniformity in direct readout SiPM tiles

Institute for Theoretical and
Experimental Physics

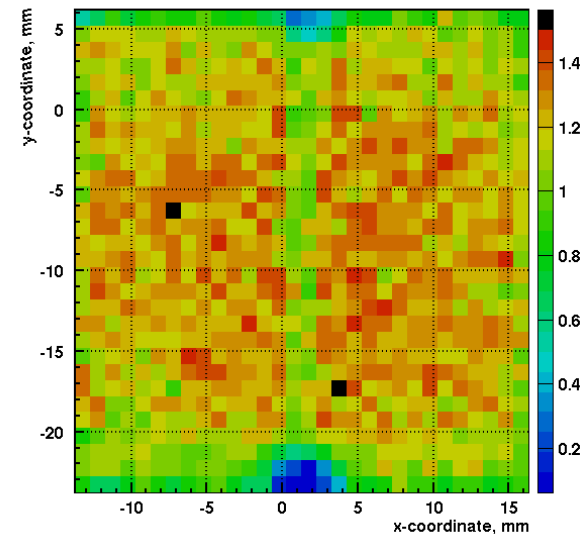
Dima Mironov, 2013

Fiber readout

30x30x5 mm³ tile



30x30x3 mm³ tile



10% RMS/Mean with 1mm precision

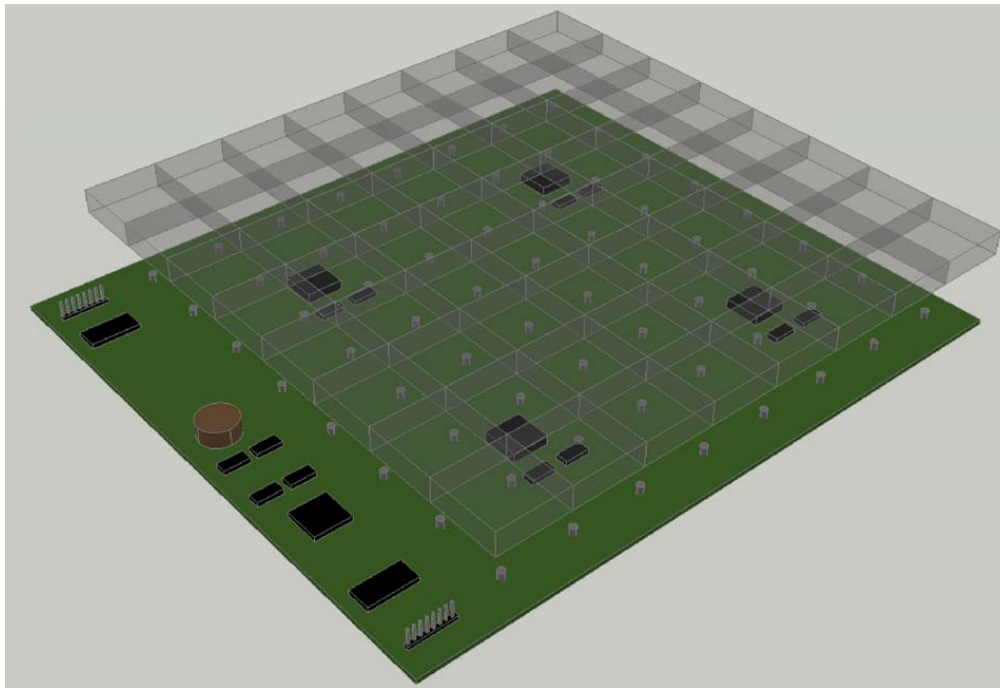
7% RMS/Mean with 2mm precision

Direct readout

- ~3 000 000 tiles are needed
- Wavelength shifting fiber is prepared and installed manually. This is expensive and time consuming
- An attempt of direct readout is made

Easy tile vs SiPM + electronics pairing

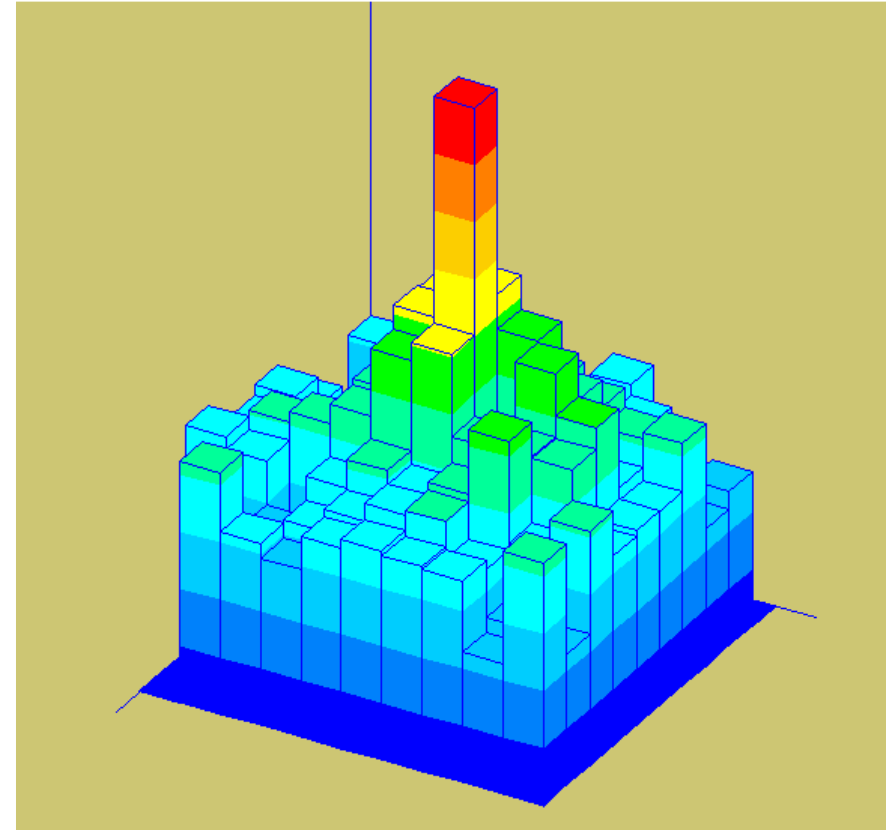
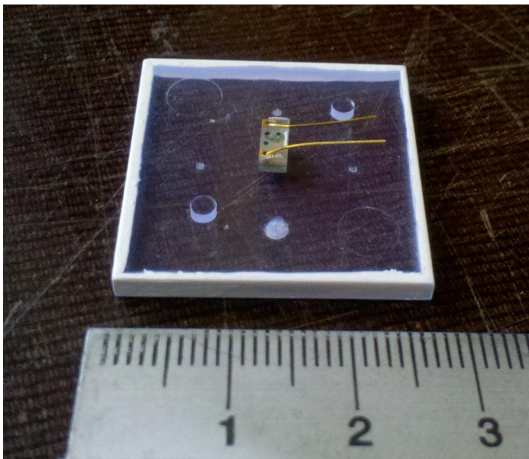
- Introduced by Northern Illinois University
- With the direct readout we can combine electronic planes and scintillator planes in the latest stage



Picture from NIU work

Uniformity

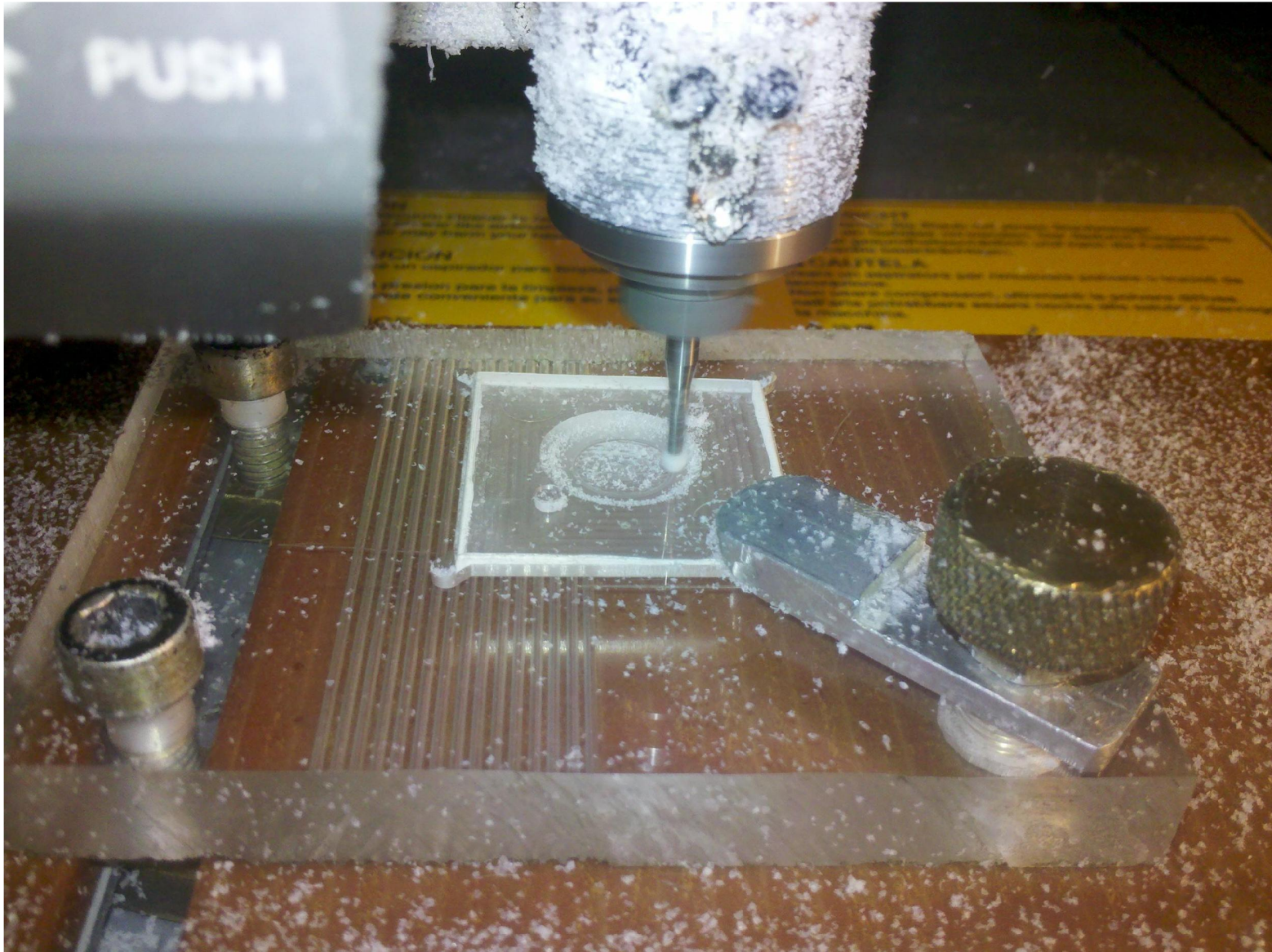
- The key concern when using direct readout is light collection uniformity
- The central value is 6 times bigger, than others.
RMS/Mean is $\sim 100\%$



The setup

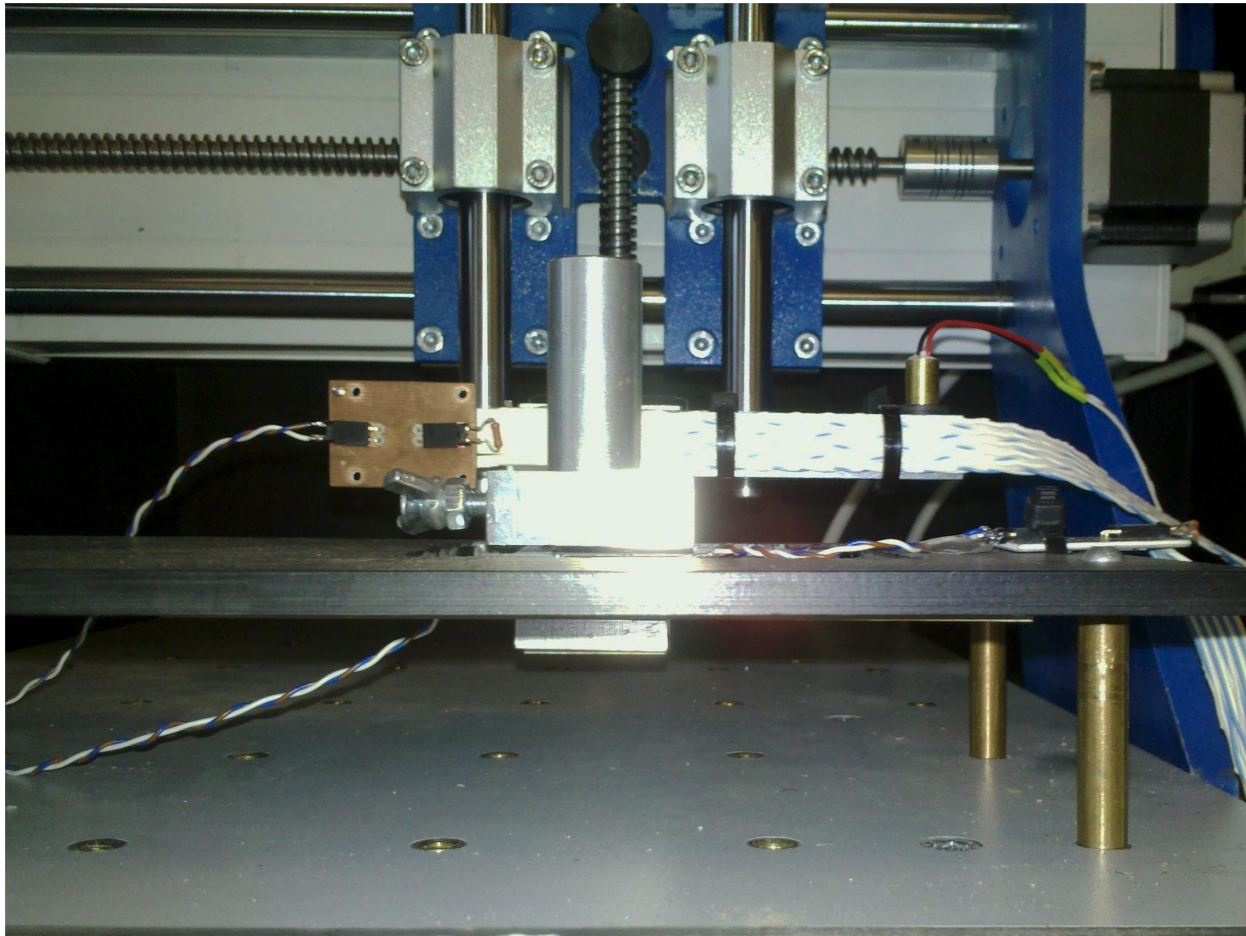
- 2 parts
 - Programmable milling machine with the software modified to be able to mill a generic shape hole in a tile
 - The automated uniformity measurement setup, consisting from 3 axis cartesian manipulator with a radioactive source and software for control and results processing.

Milling



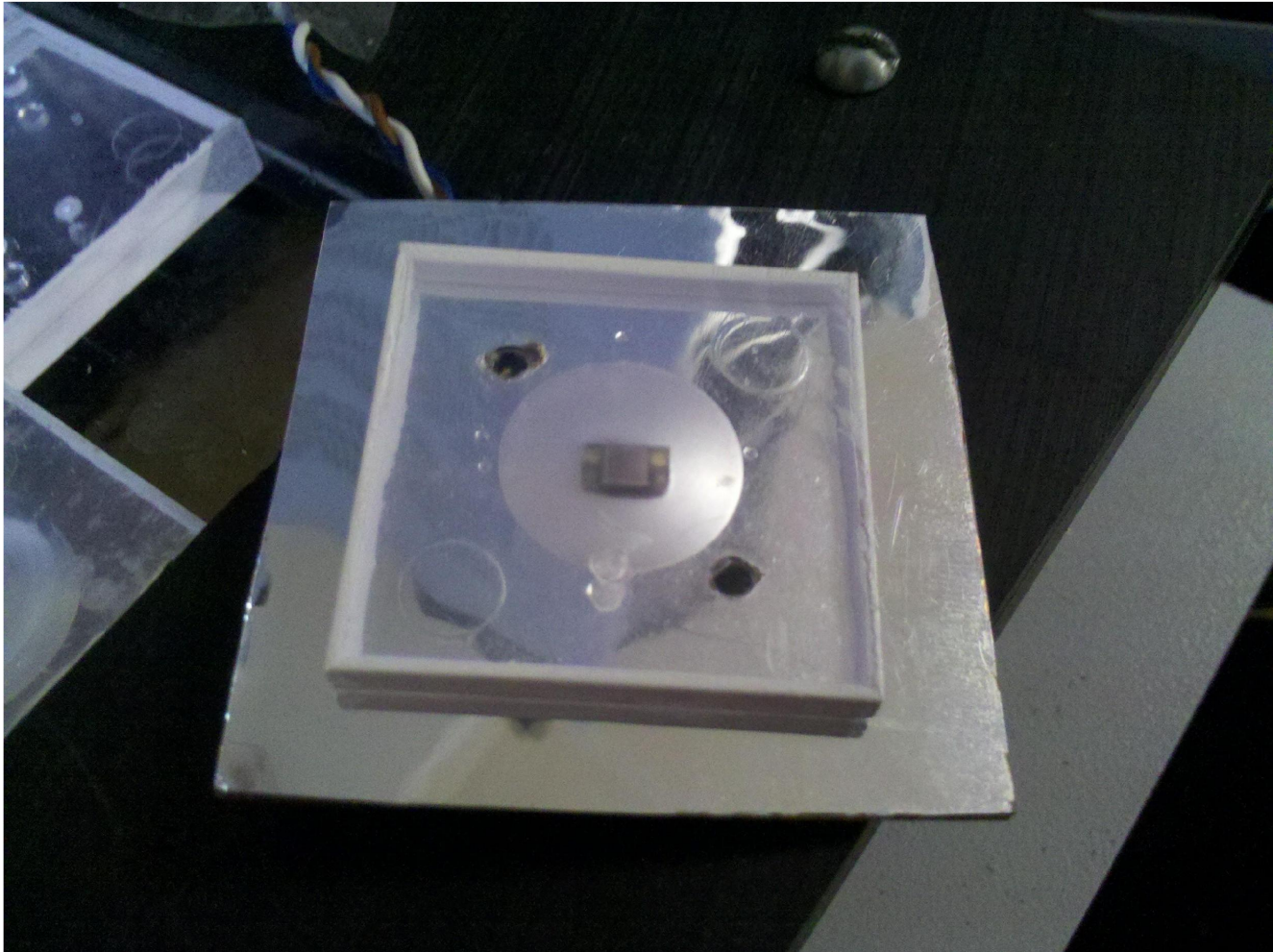
The setup

- Manipulator with mounted ^{90}Sr beta-source and trigger tile. Collimator size is 1mm.



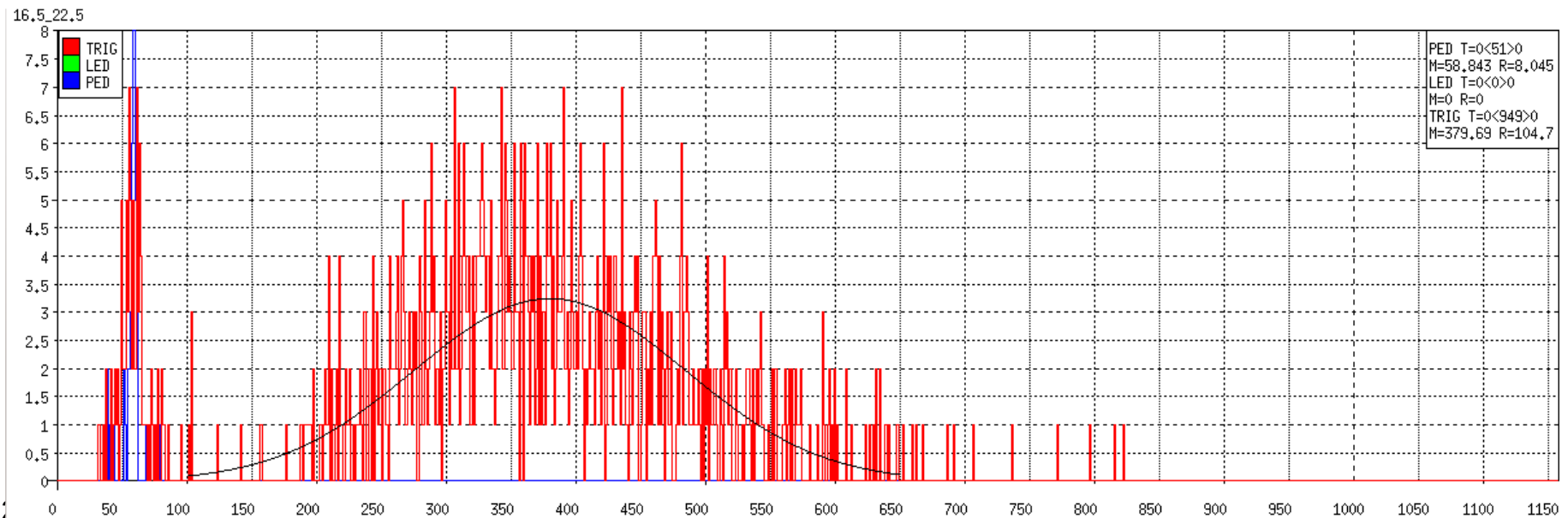
The setup

- SiPM in the upper mirror



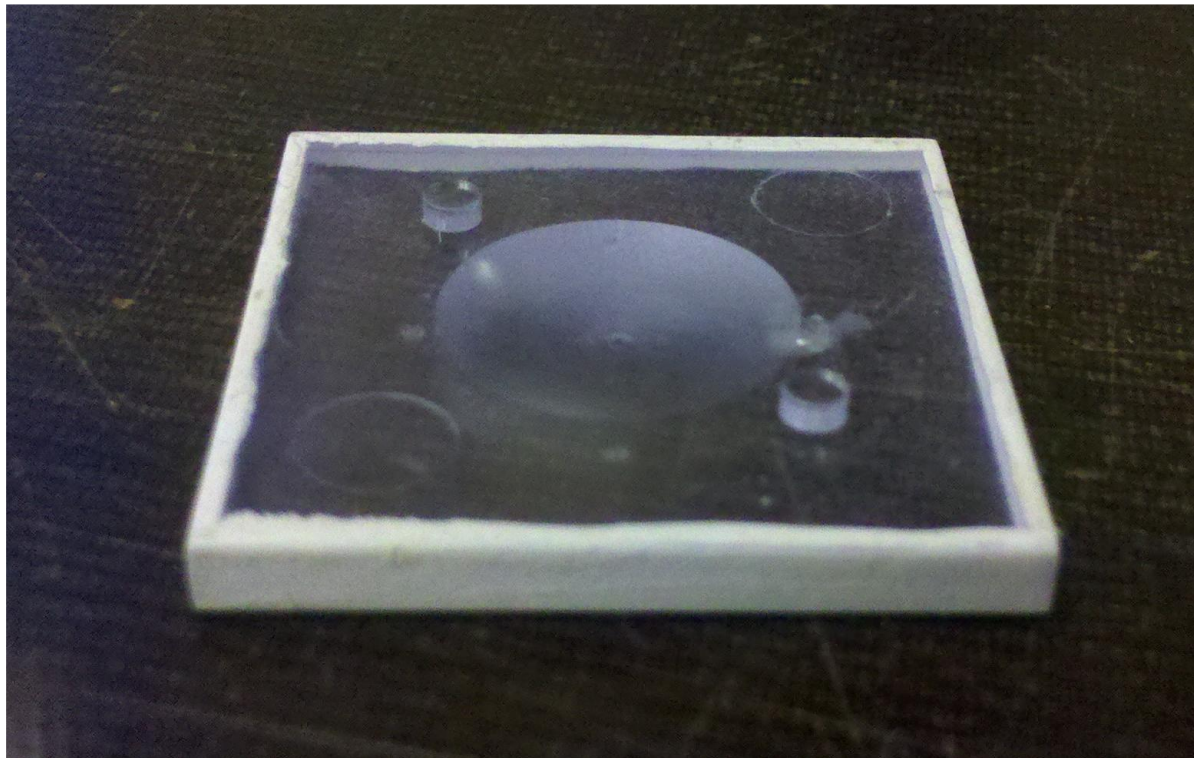
Measurements

- Only particles passed through the studied tile are used (with the signal in trigger tile)
- The spectrum of signals from their passes is considered (number of particles with vs ADC from SiPM)
- Fit it with gaussian



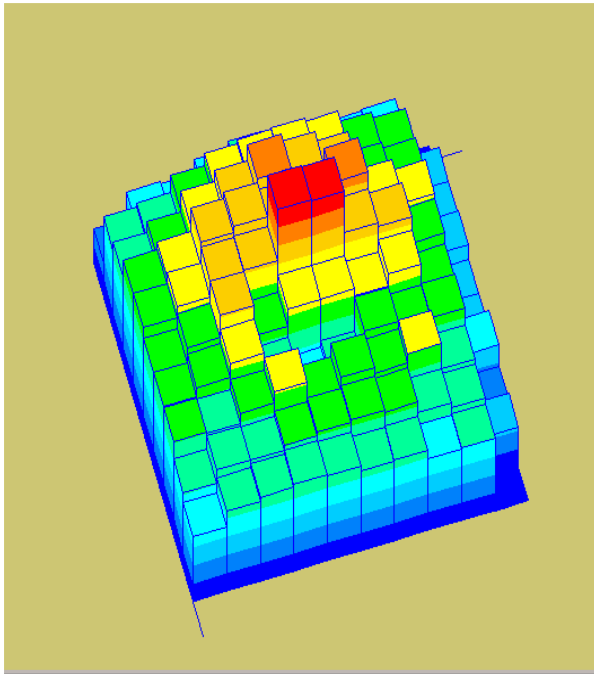
Tile shape

- Parallelepiped with the hole in the center of the flat face in the form of paraboloid. It has two parameters - the depth and radius of the hole on the surface.

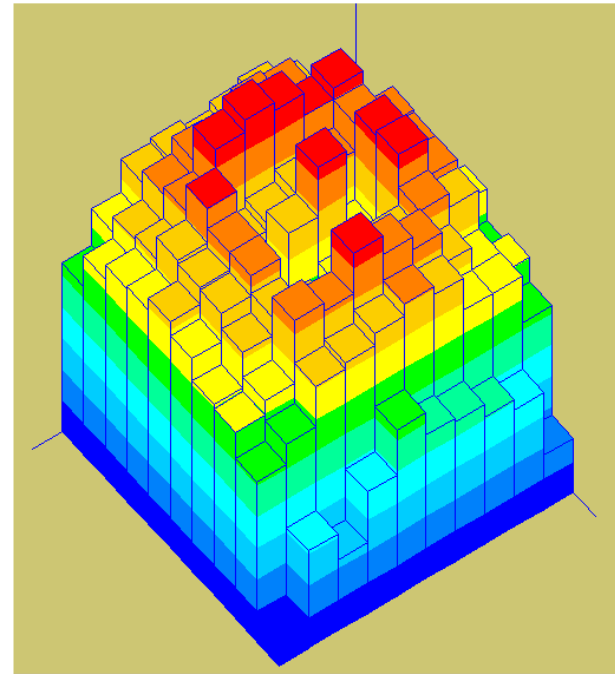


2d scans

0 on z-axis on the plots is placed in the minimum of the distribution.
The scan precision is 3mm.

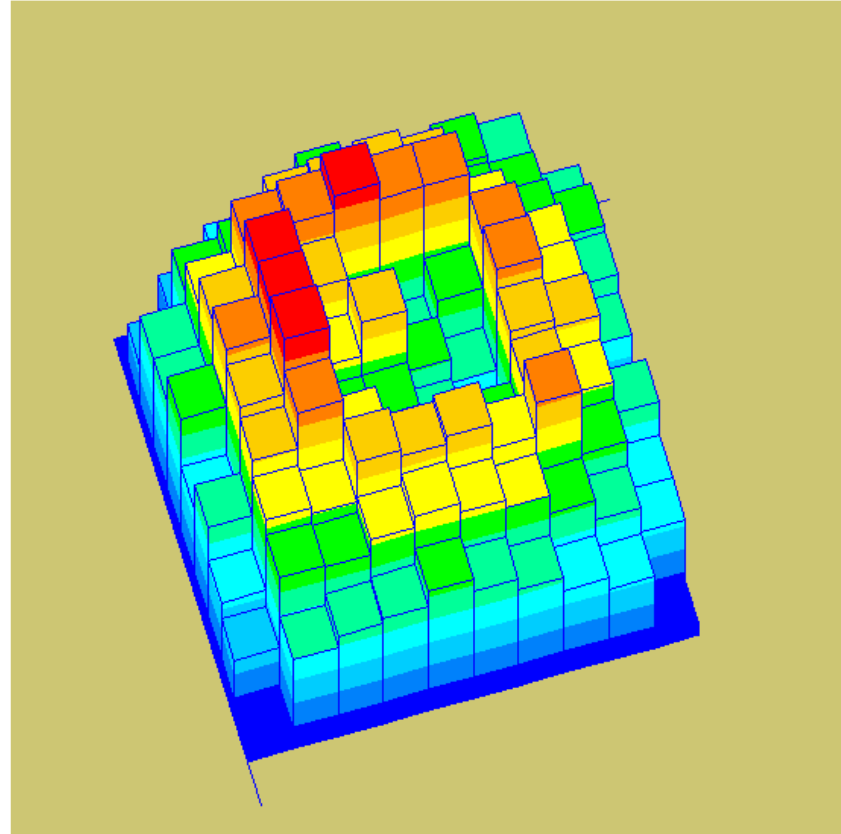


Depth 1.7mm
Radius 8mm
Mean 246
RMS/Mean 10%



Depth 1.9mm
Radius 8mm
Mean 262
RMS/Mean 10%

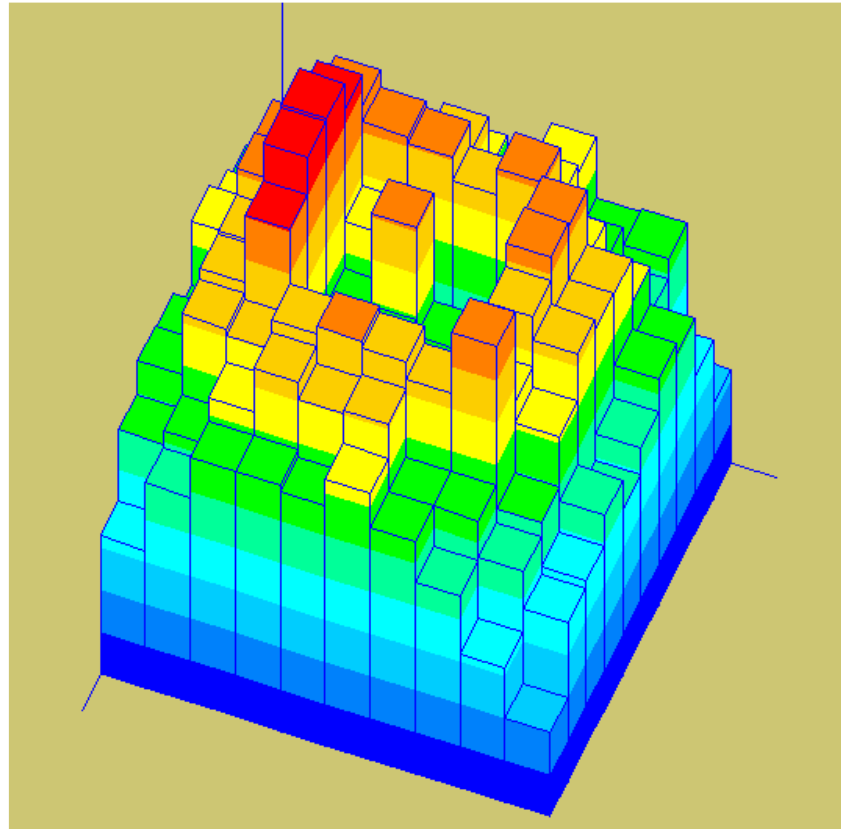
2d scans



Depth 1.8mm
Radius 8mm
Mean 272
RMS/Mean 8%

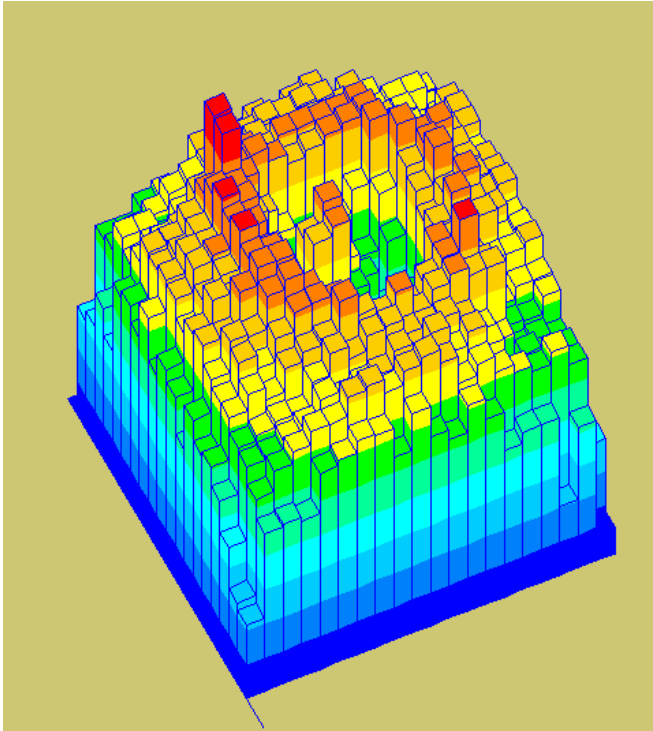
2d scans

Moved
SiPM
1.7mm
down

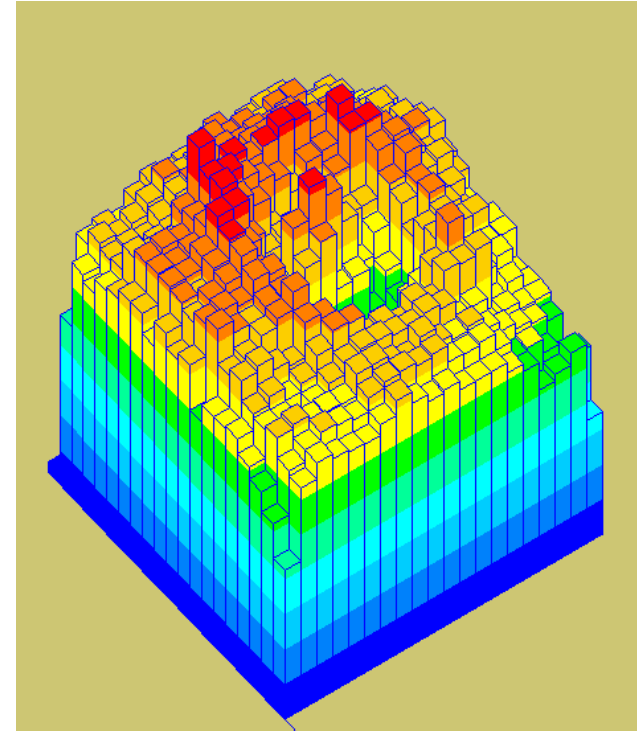


Depth 1.8mm
Radius 8mm
Mean 292
RMS/Mean 8%

2d scans

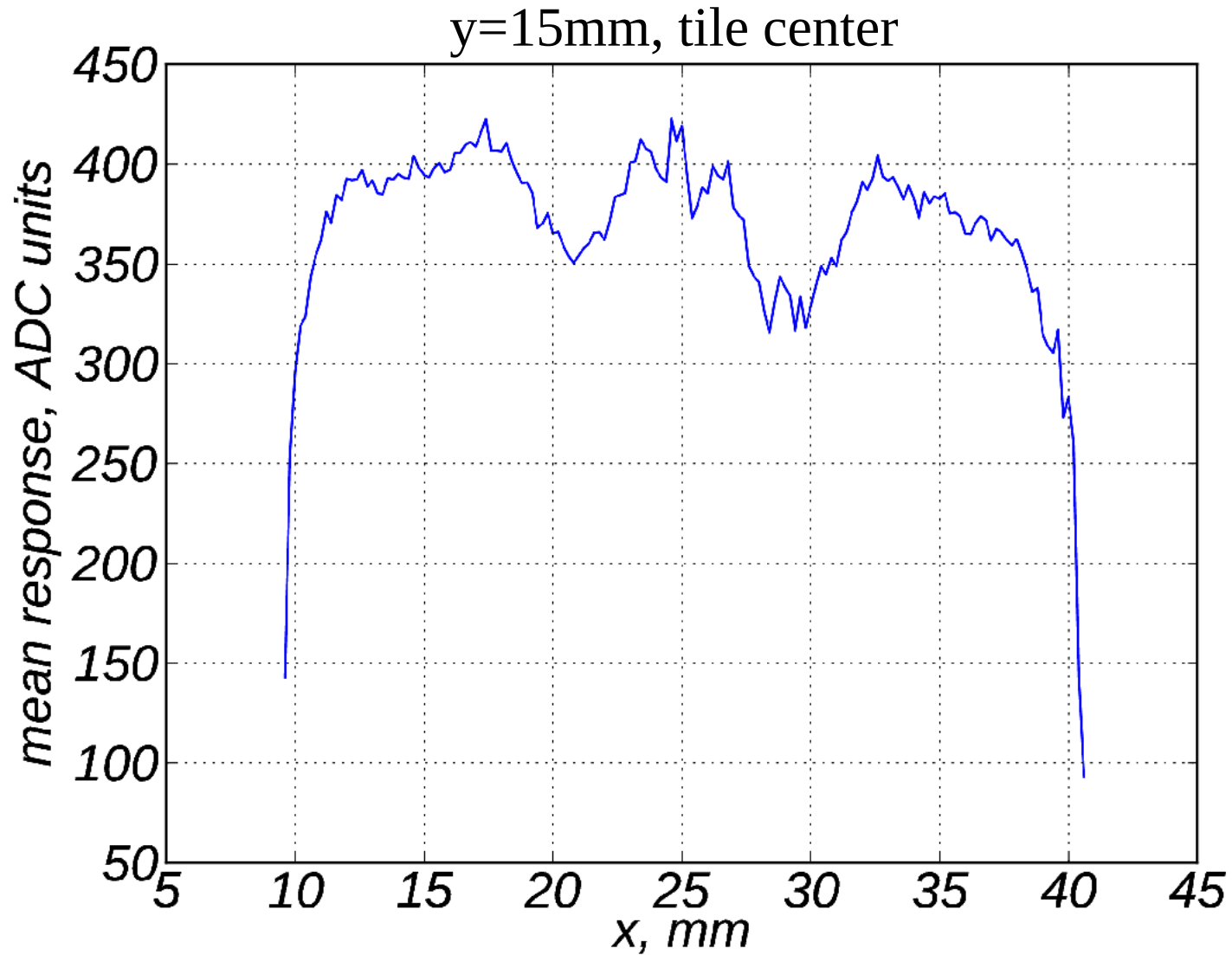


Depth 1.8mm
Radius 8mm
Mean 298
RMS/Mean 12%



Depth 1.8mm
Radius 8mm
Mean 288
RMS/Mean 9%

1d scan



Conclusions

- It is possible to achieve $\sim 10\%$ RMS/Mean in direct readout with 1.5 mm scan precision
- The configuration with the separate electronics assembly and SMD SiPM's is enabled
- The selected shape can be easily reproduced with injection molding

Further plans

- Study boundary effects
- Measure light crosstalk
- Check reproducibility with same parameters
- Study other possible hole geometries

Thank you for your attention!