Tests of scintillator tiles for the technological prototype of highly granular hadron calorimeter

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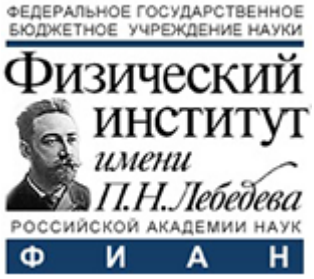

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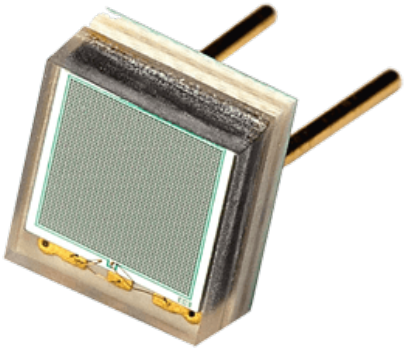
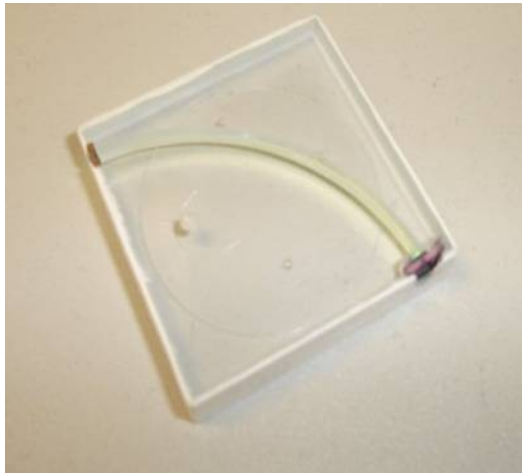
Application of SiPM in HEP experiments



SiPM



Cell of CALICE hadron calorimeter

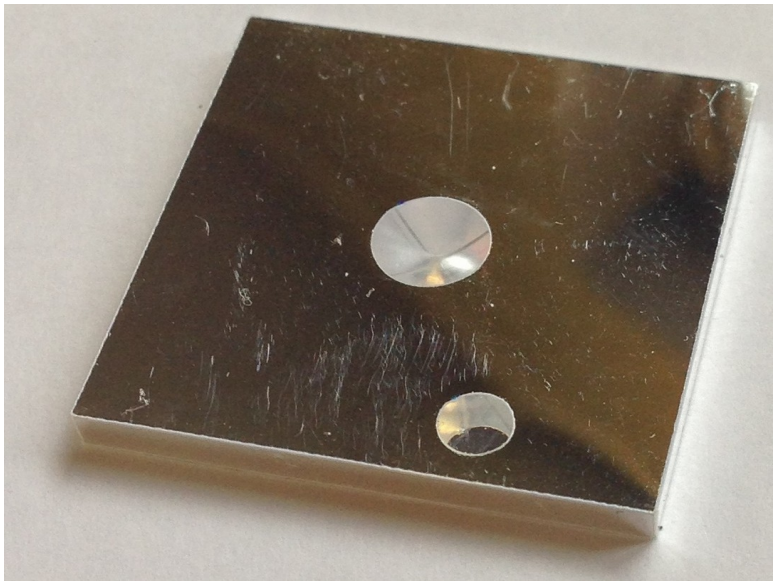
Current experiments (scintillator with WLS fiber):

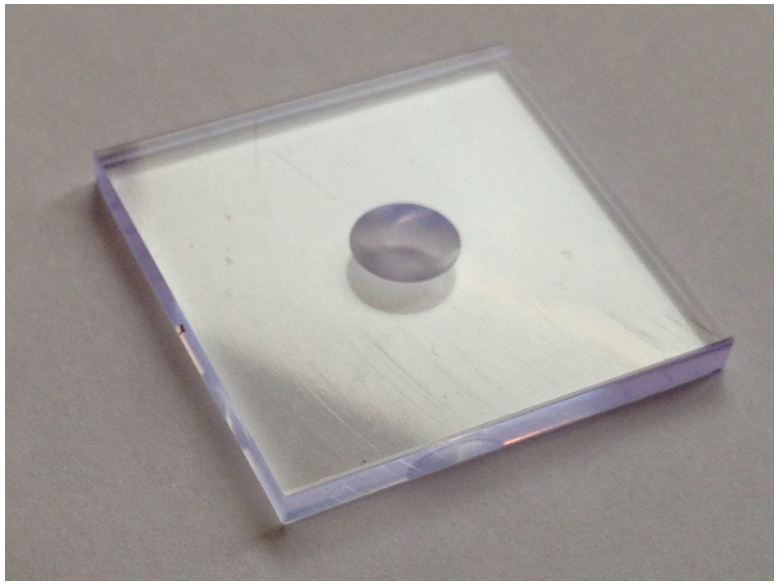
- CALICE: hadron calorimeter prototype (8000 channels, 3x3 cm^2 tiles)
- Belle II: muon system (scintillator strips)
- CMS: outer hadron calorimeter (HO)
- T2K: muon system (scintillator plates)

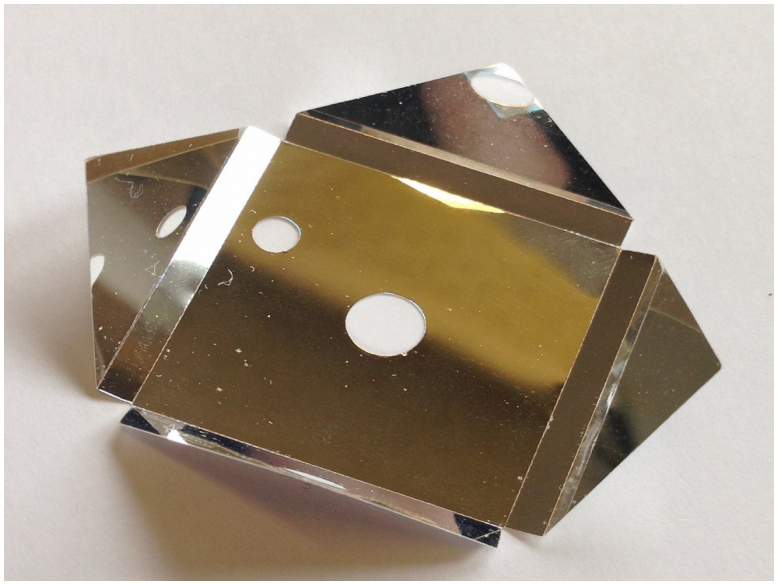
Planned experiments (scintillator with direct readout):

- CMS: upgrade of the endcap hadron calorimeter
- ILD: highly granular hadron calorimeter, tiles 3x3 cm^2 with direct readout

CALICE technological prototype

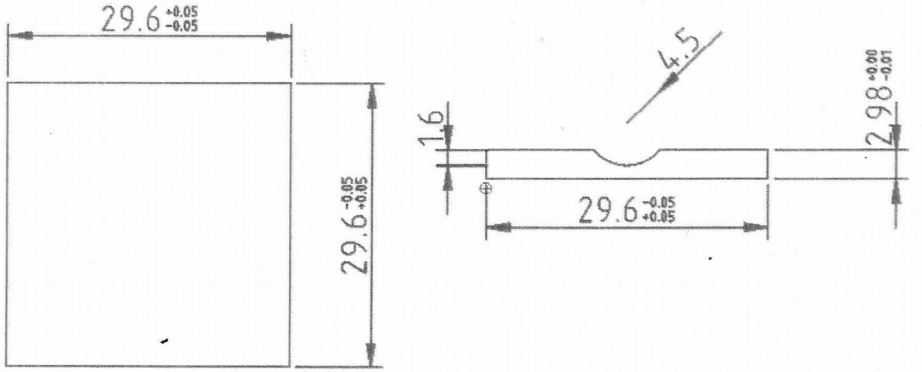






Parameters of new tiles

Requirements for tile production

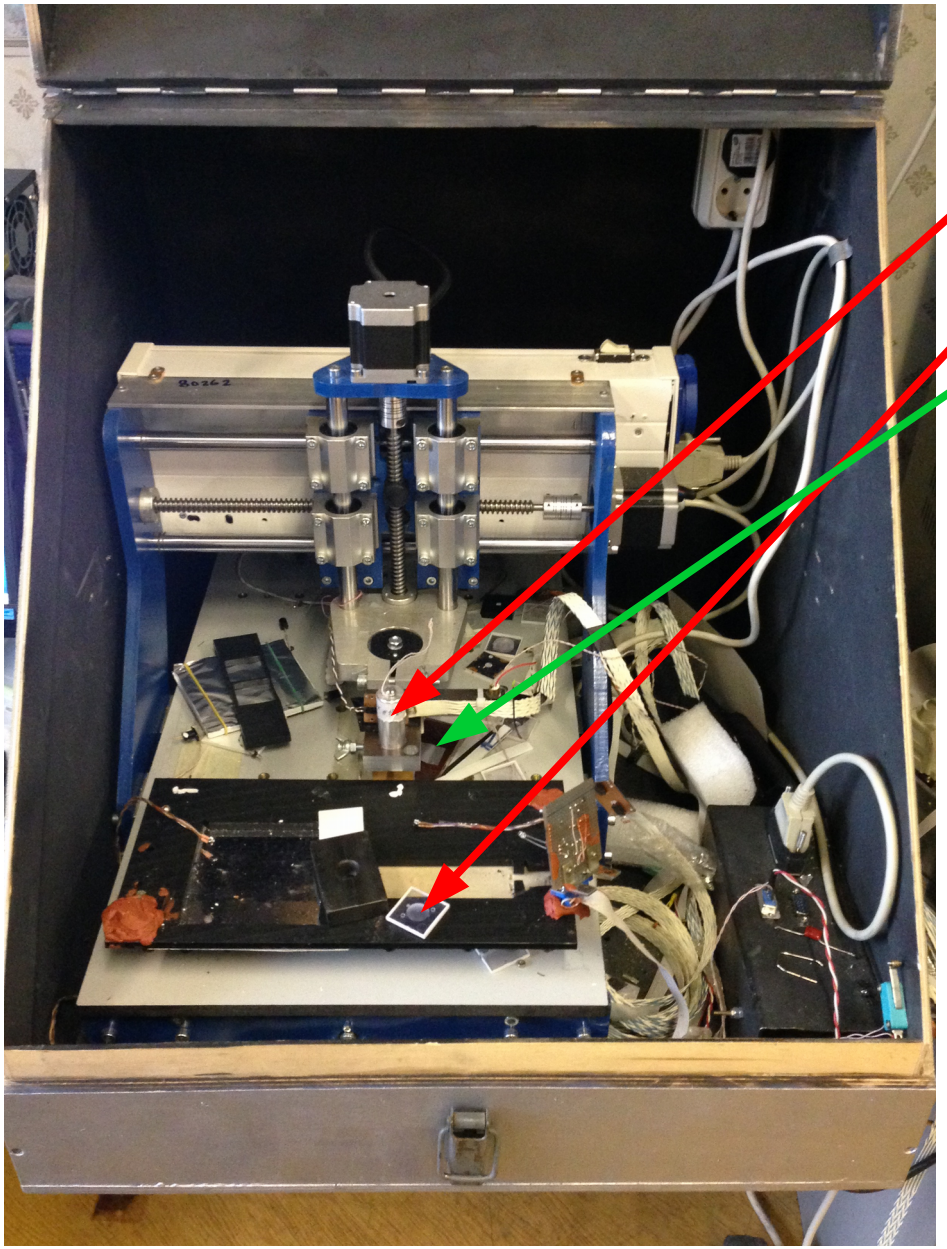


Geometry parameters for both tiles

- Refractive index of BICRON408 = 1.58
- Max. absorption length = 210 cm
- Reflectance of foil > 98 %

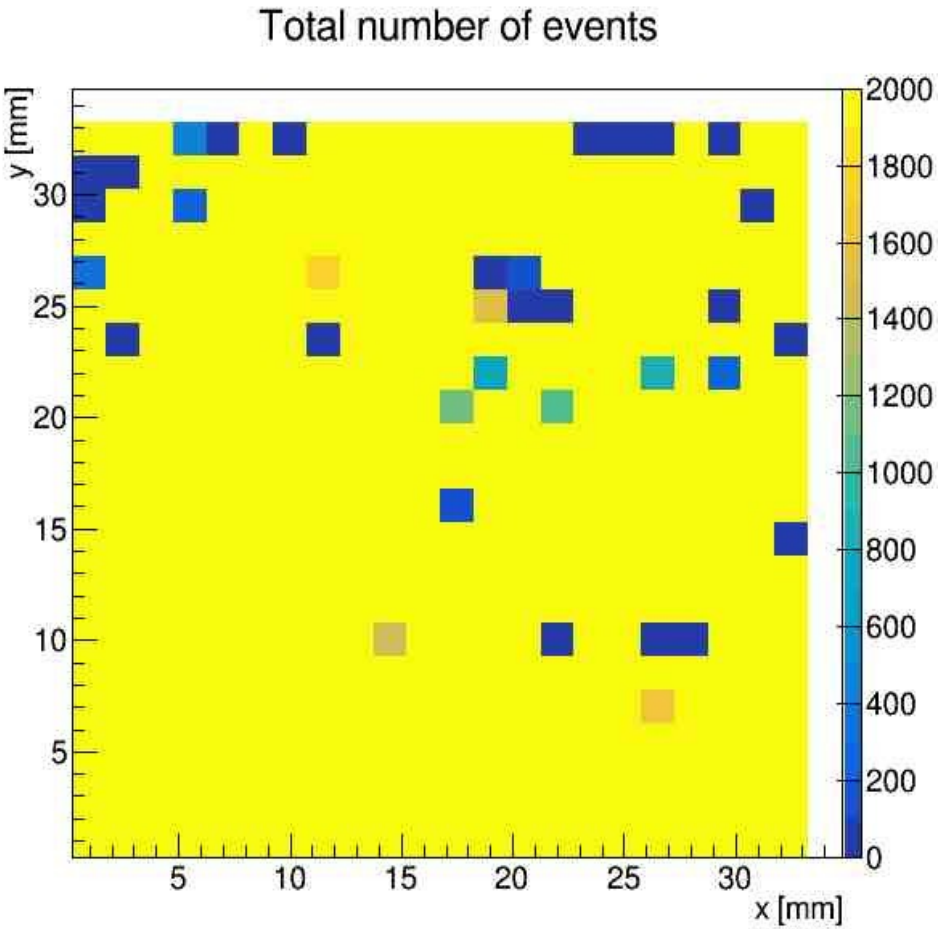
- The material of DESY tile is BICRON408 (Polyvinyltoluene); G4_PLASTIC_SC_VINYLTOLUENE
- The material of Vladimir tile is Polystyrene with p-Terphenyl (2%) and POPOP (0.01%)
- The base material of wrapped foil is aluminium
- Thickness of foil is 65 microns
- Light yield of BICRON408 is 10.0 photons/keV
- Production mode: injection moulding

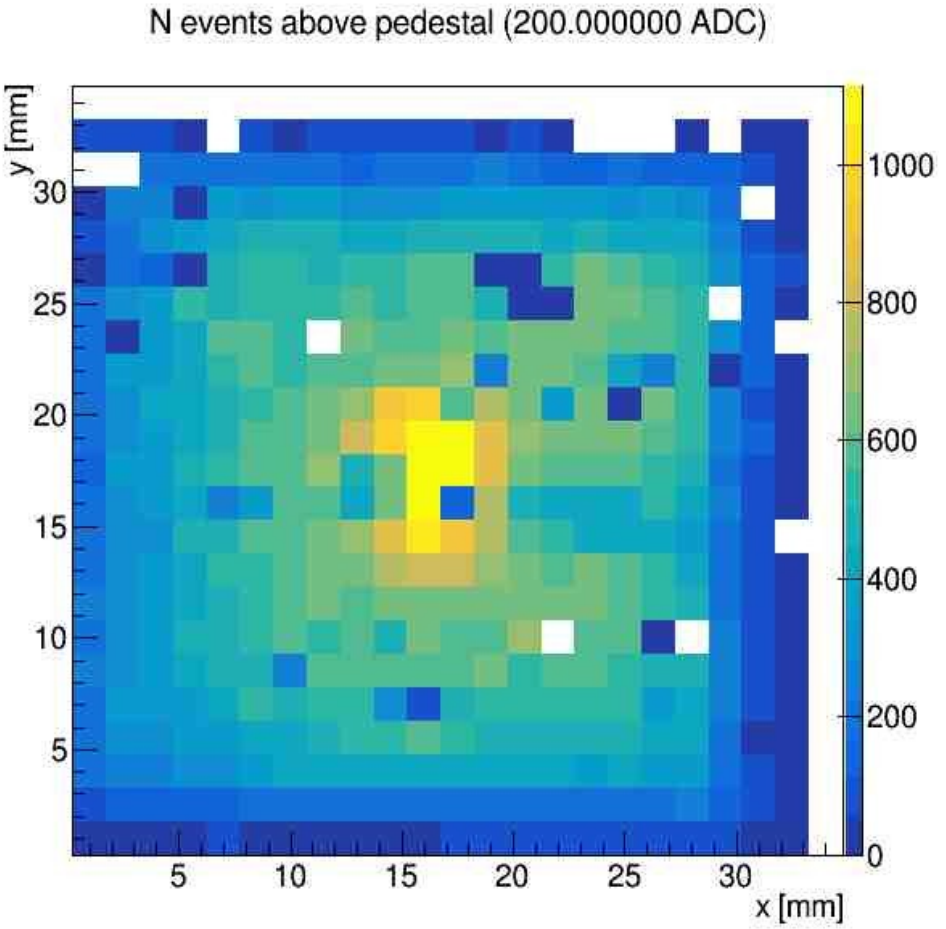
Experimental setup



- Beta - source
- Tile
- Placement of the wrapped tile

Uniformity measurements: tile from DESY

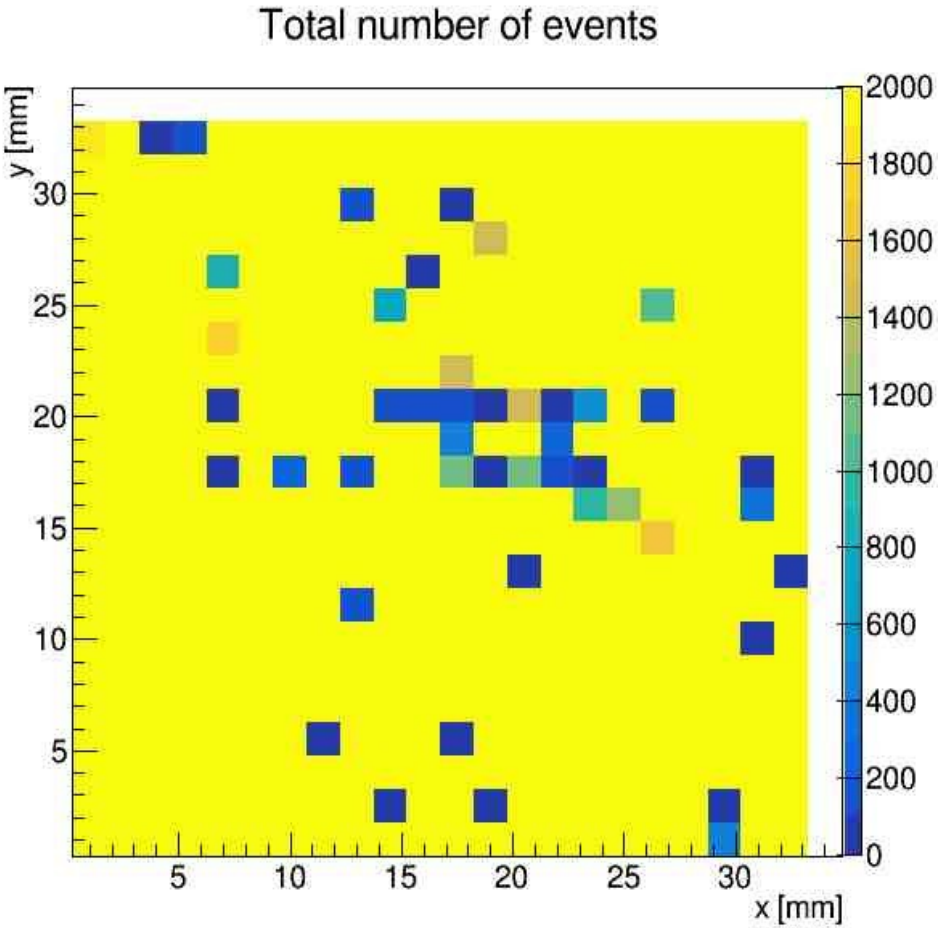


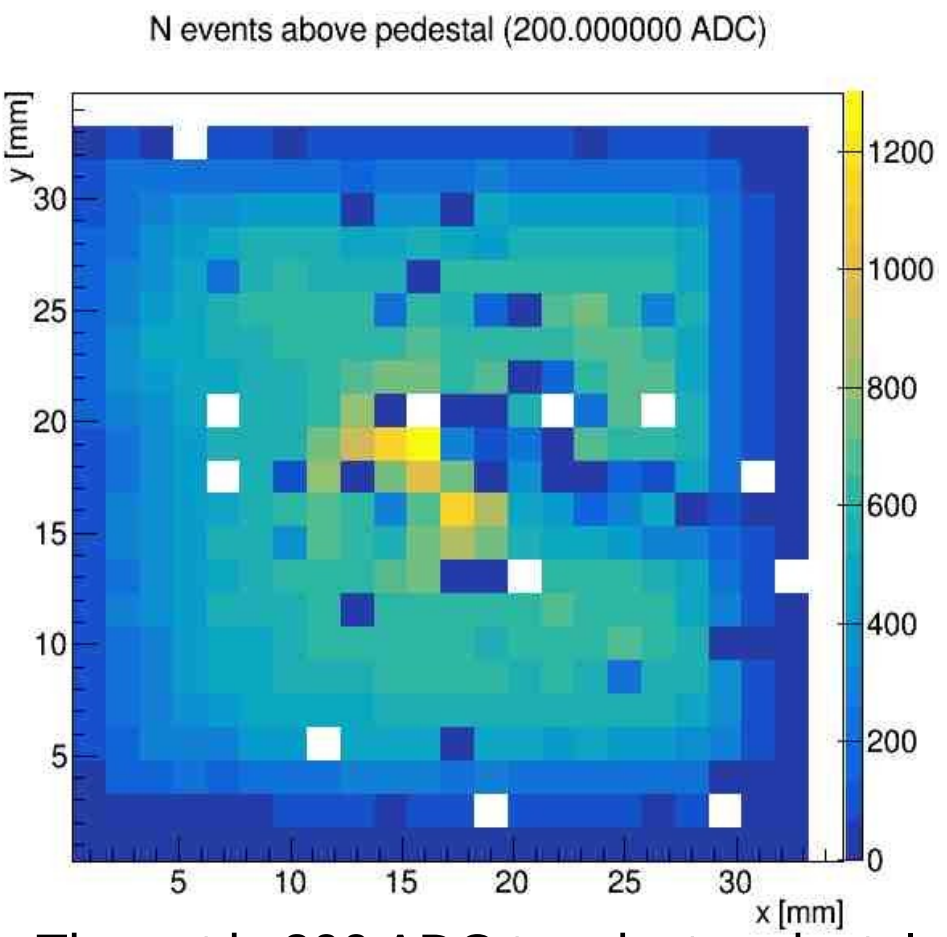


The cut is 200 ADC to reject pedestal

DESY flat tile for scan step = 1.5 mm

Uniformity measurements: tile from Vladimir

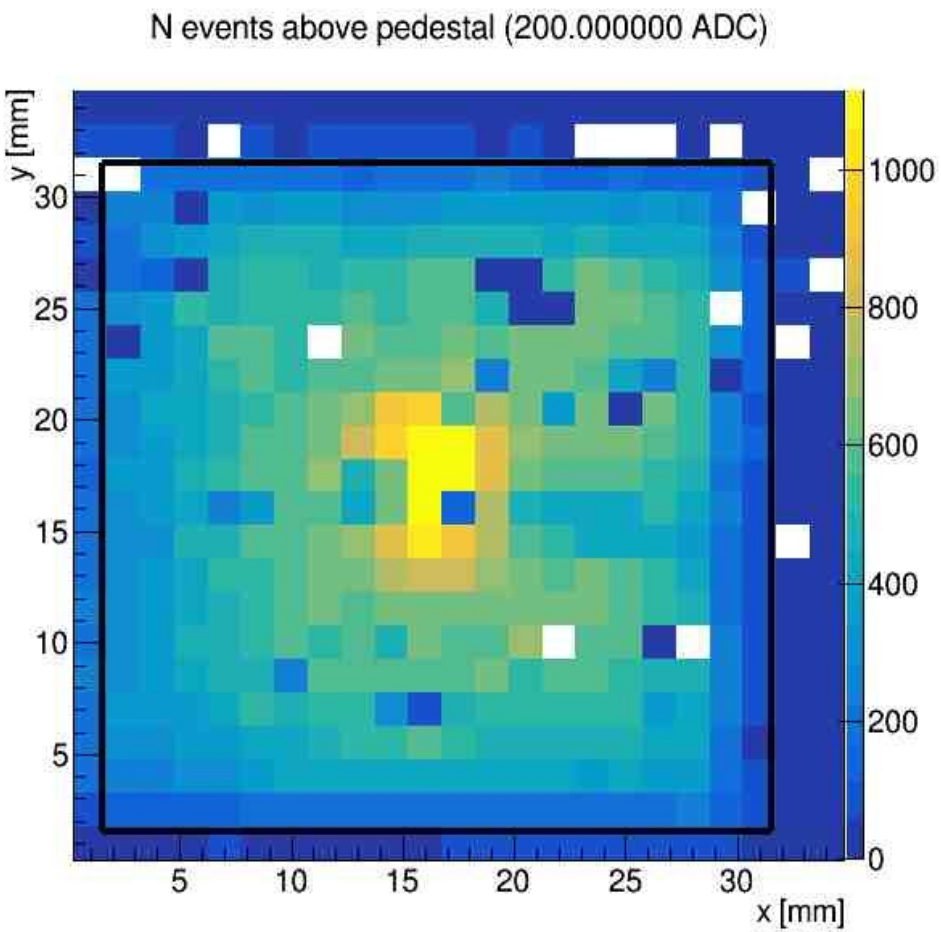




The cut is 200 ADC to reject pedestal

Vladimir flat tile for scan step = 1.5 mm

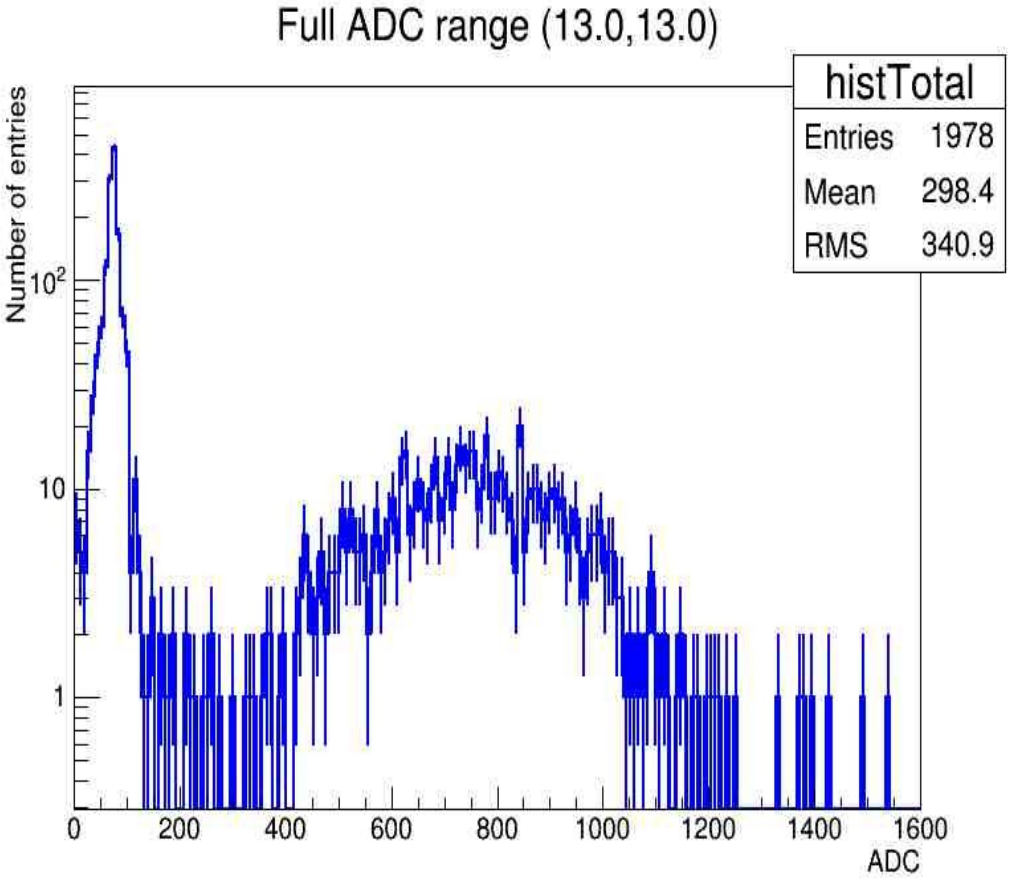
Identification of tile position

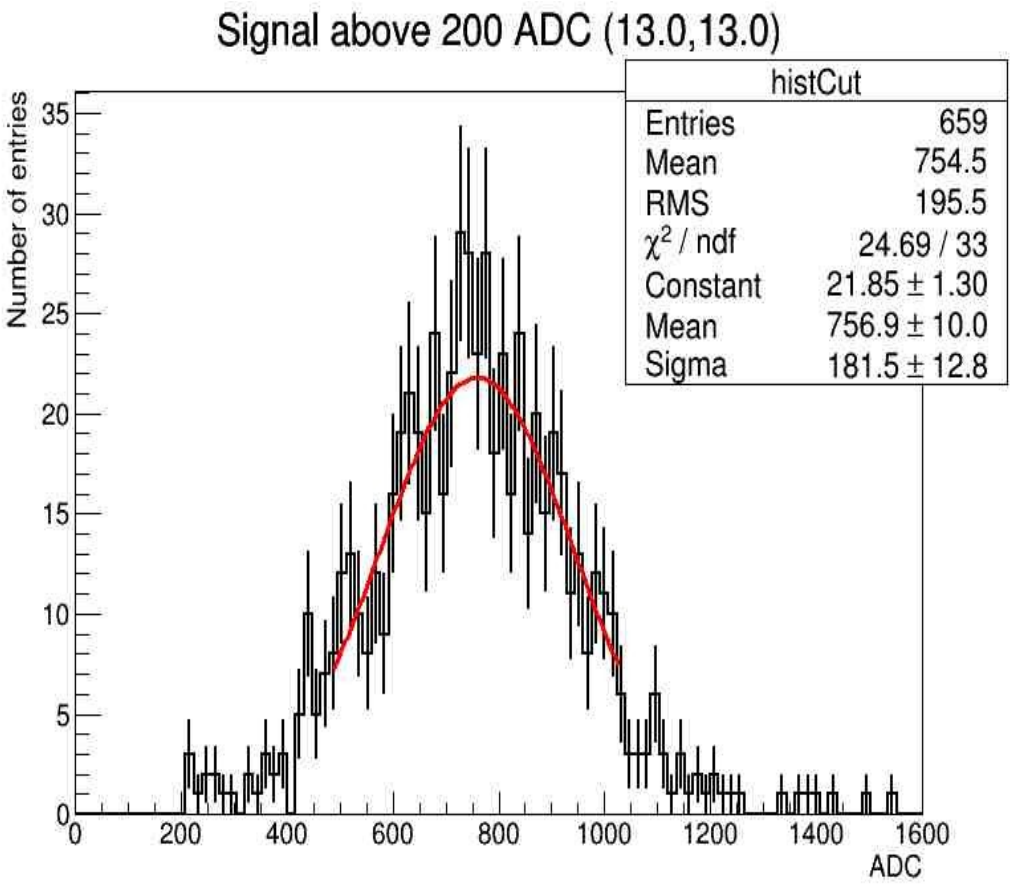


Data for flat DESY tile
for scan step = 1.5mm

- Tile size: 30x30 mm^2
- 20x20 points for 1.5 mm scan
- The measurements over the area greater than tile
- We use the maximum number of events to get border of the tile and calculate uniformity of the tile

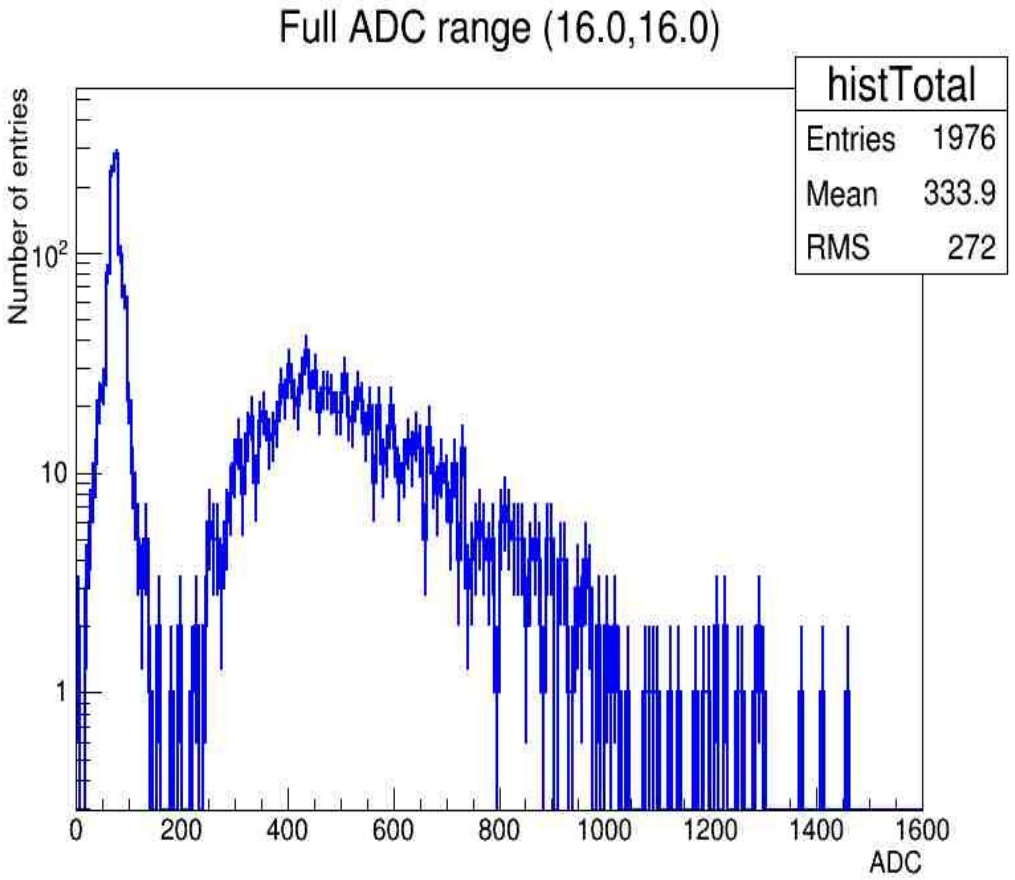
Examples of signal distributions

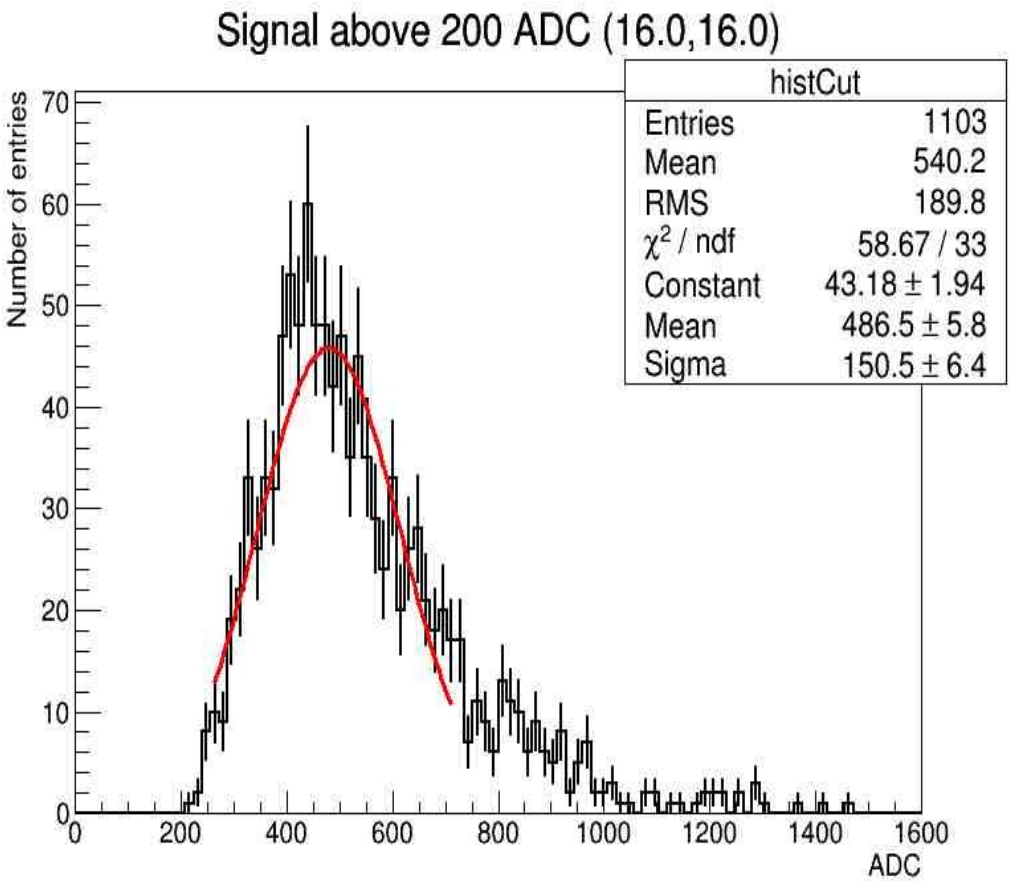




Good Gaussian fit

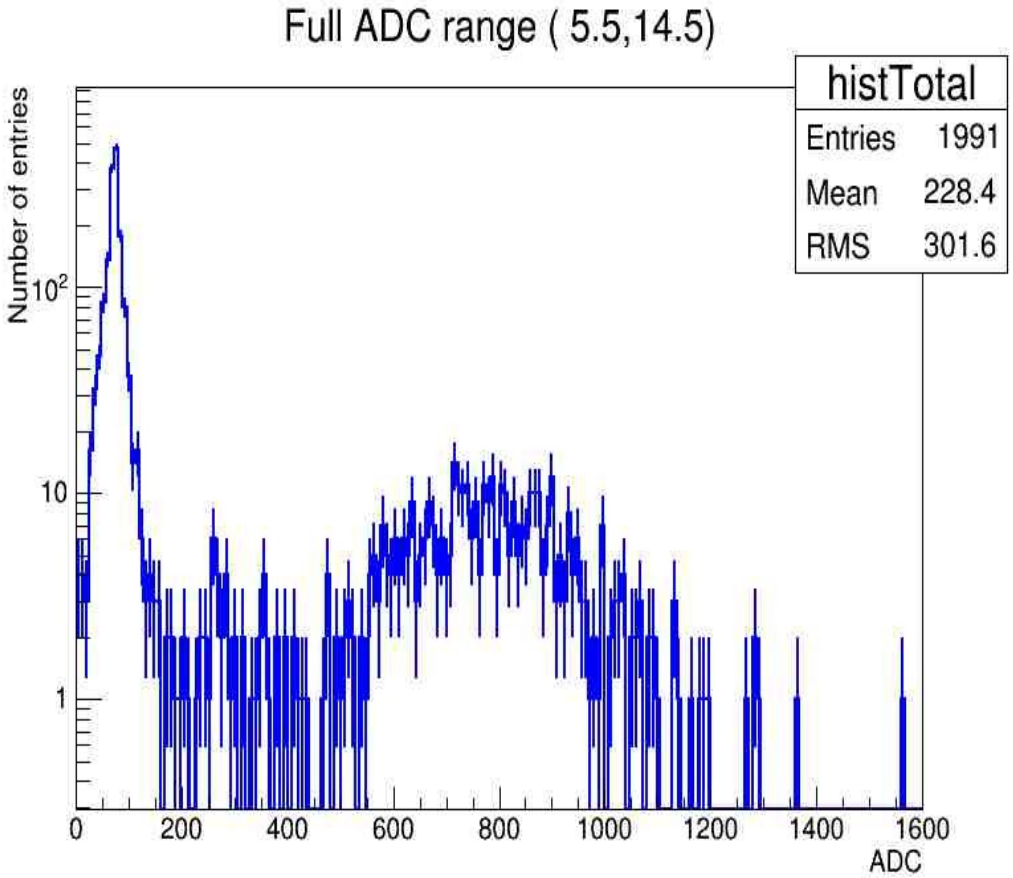
Examples of signal distributions

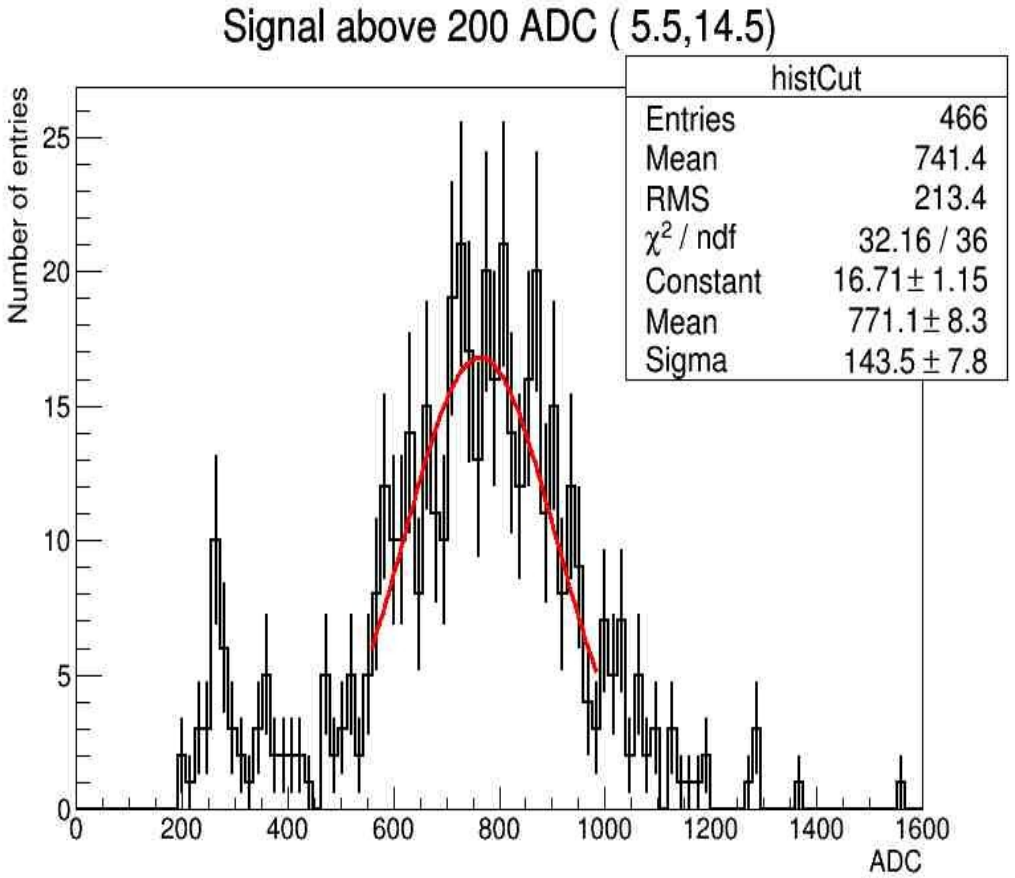




Worse fit than on previous slide

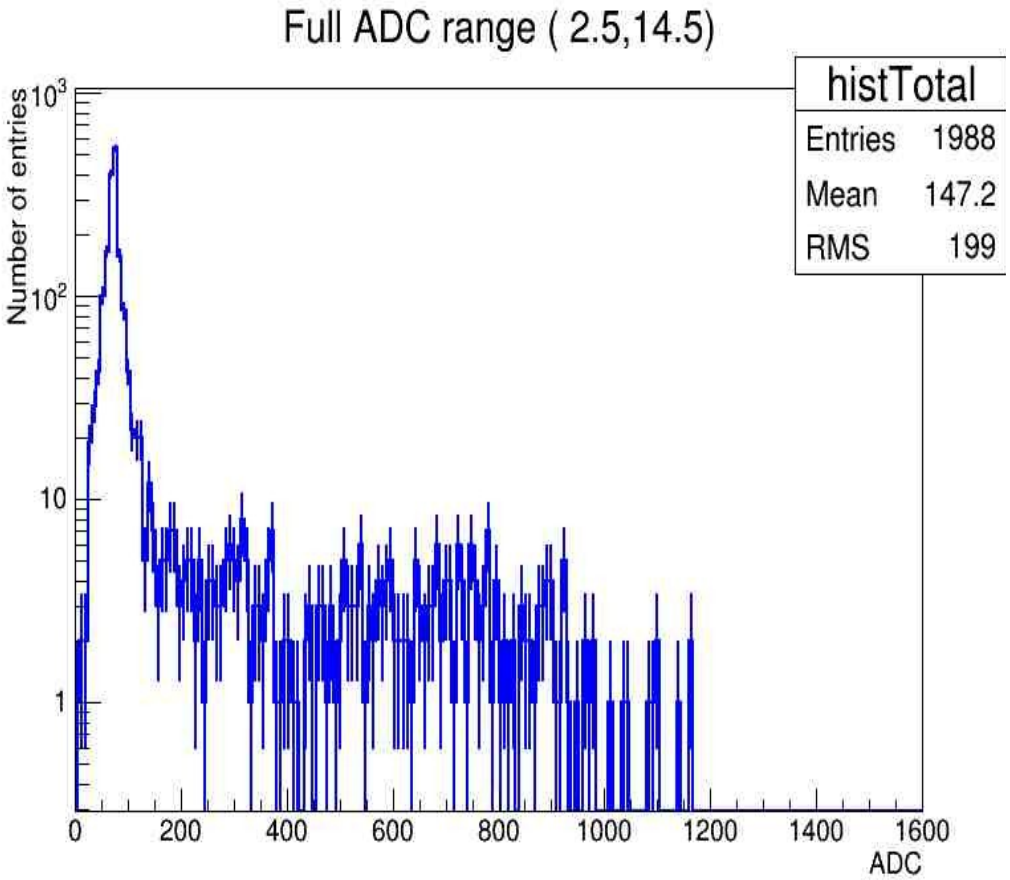
Examples of signal distributions

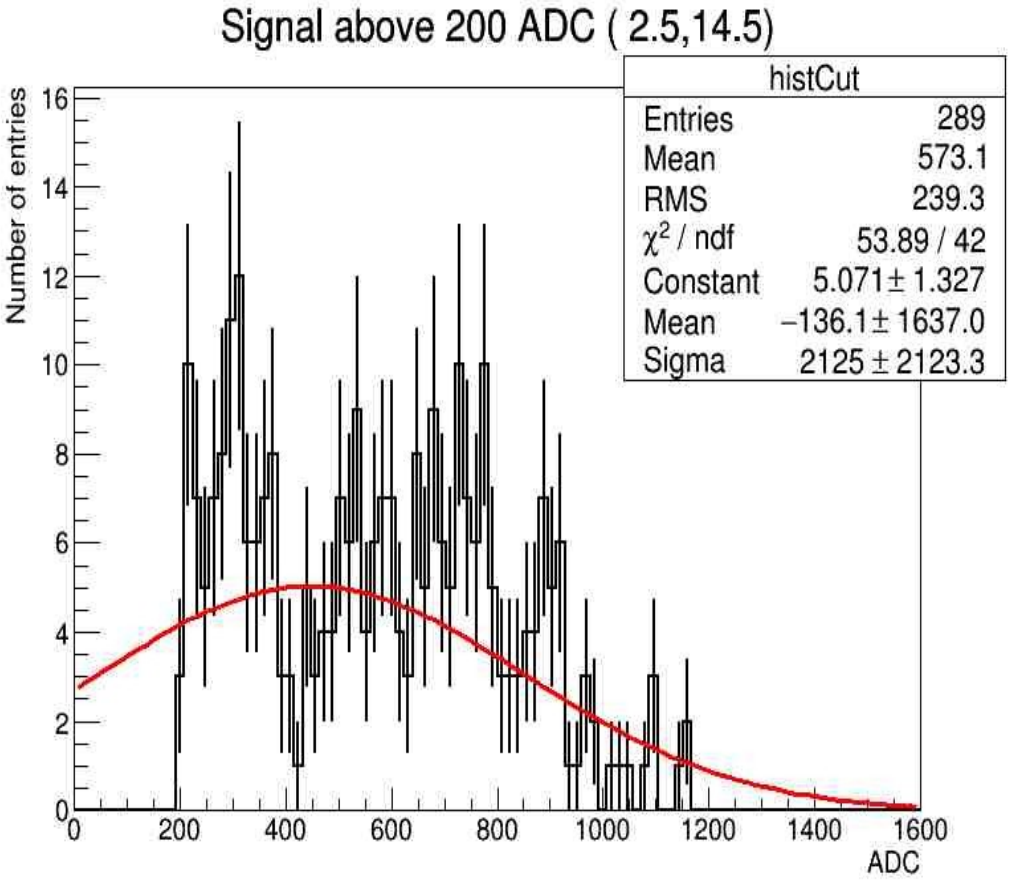




Good Gaussian fit

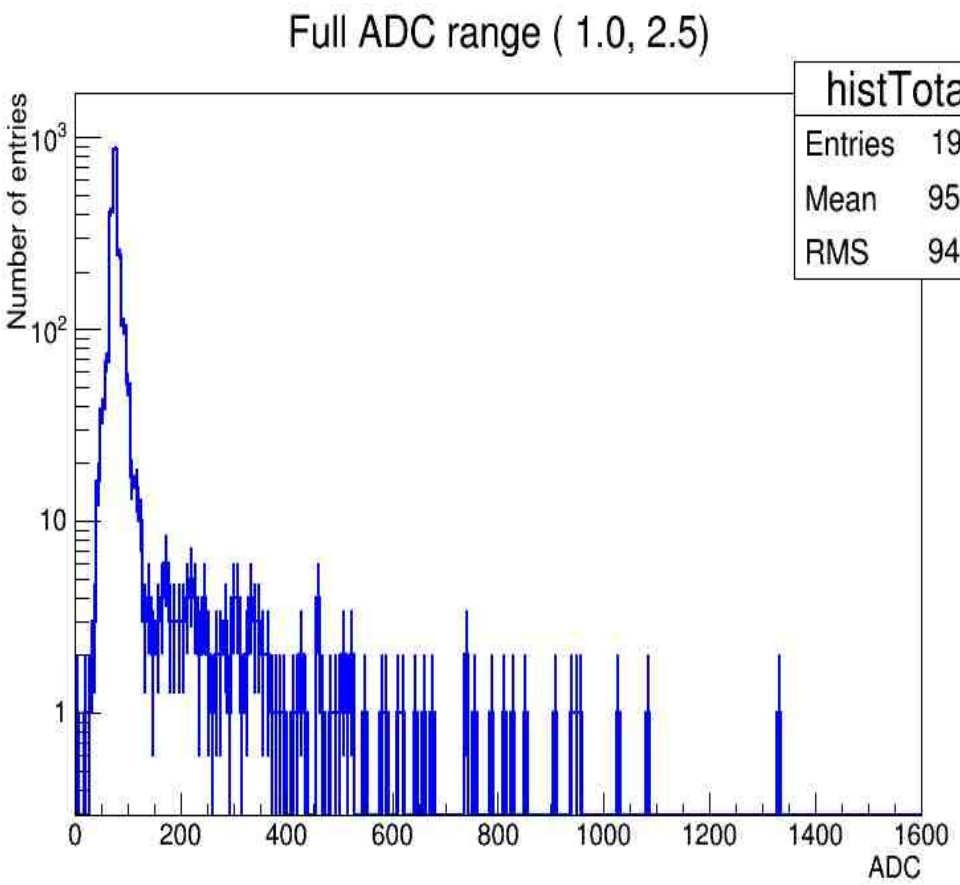
Examples of signal distributions

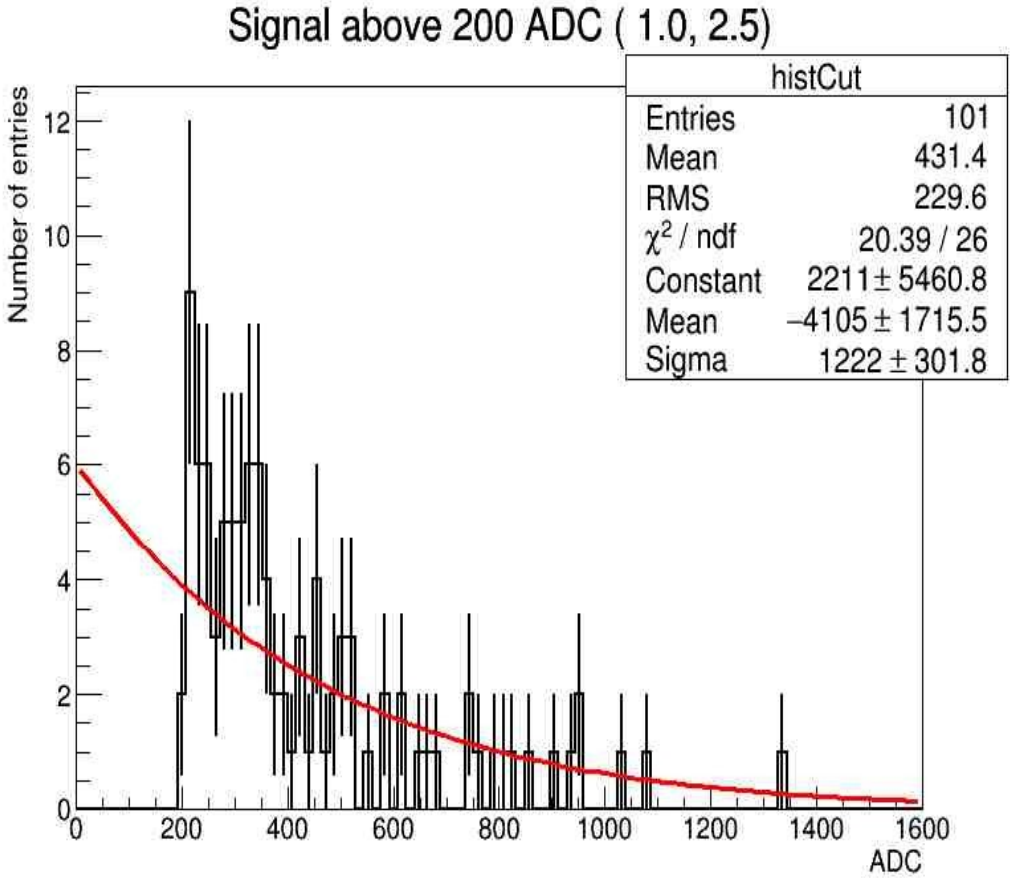




Bad fit

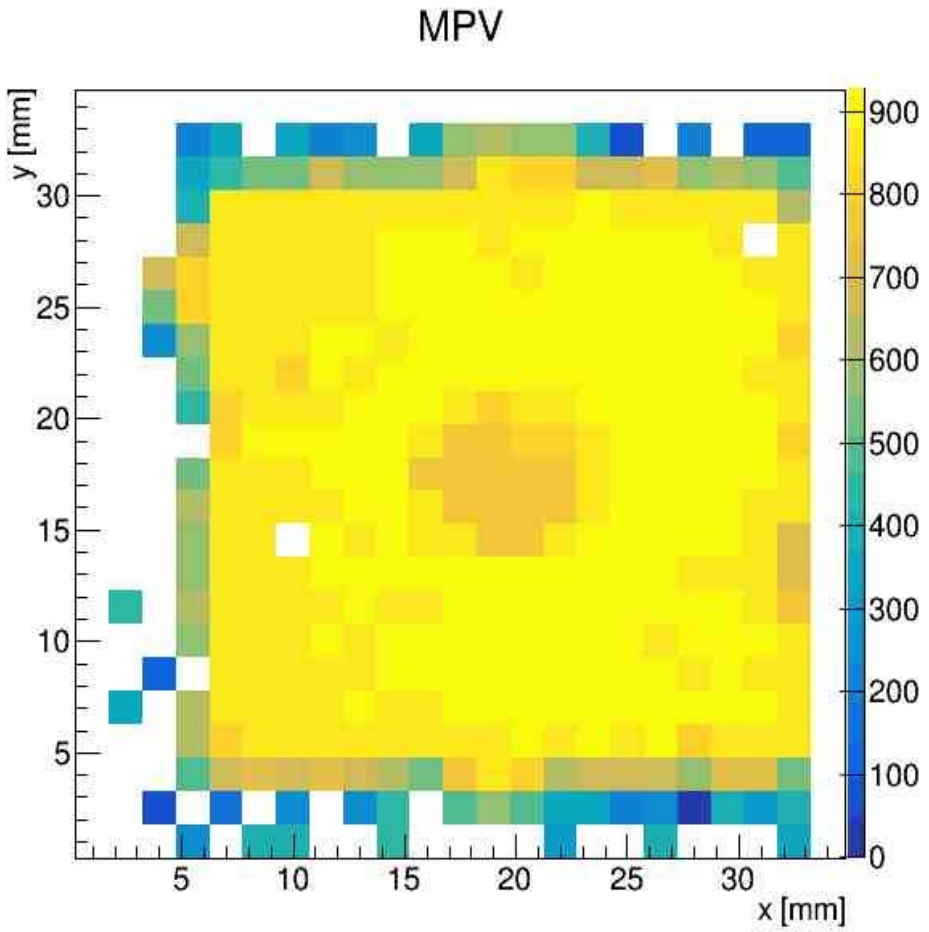
Examples of signal distributions

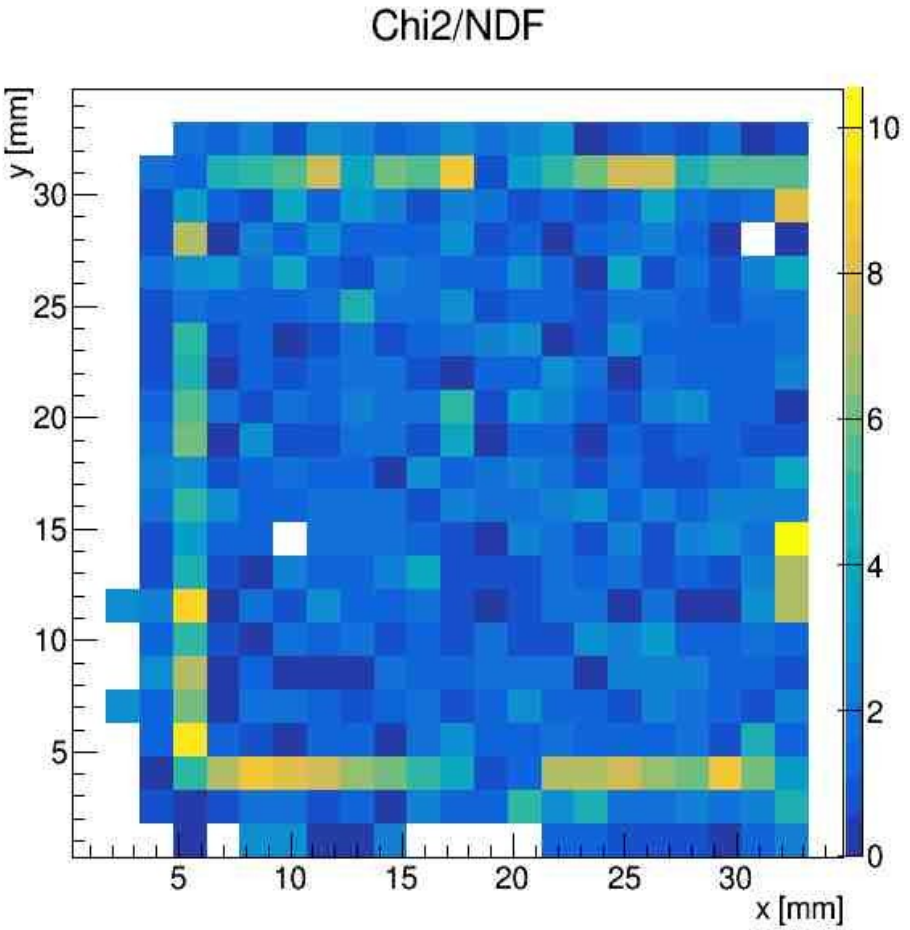




Bad fit

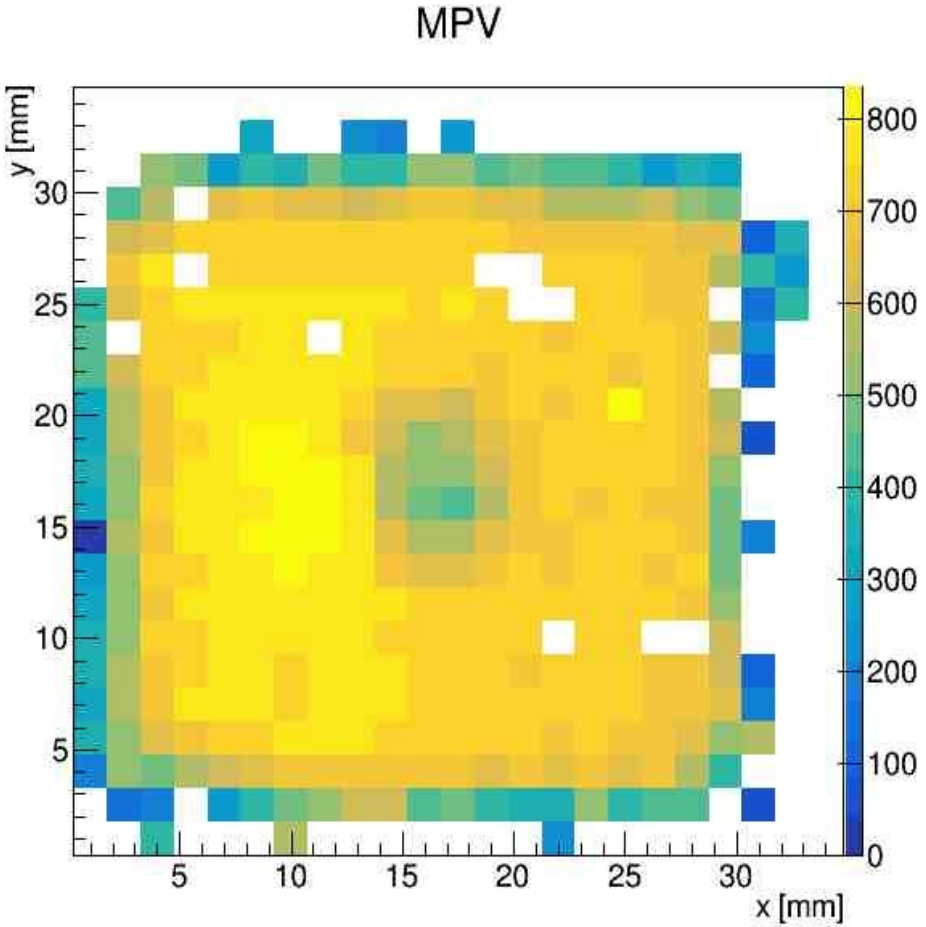
Map of most probable values: DESY tile

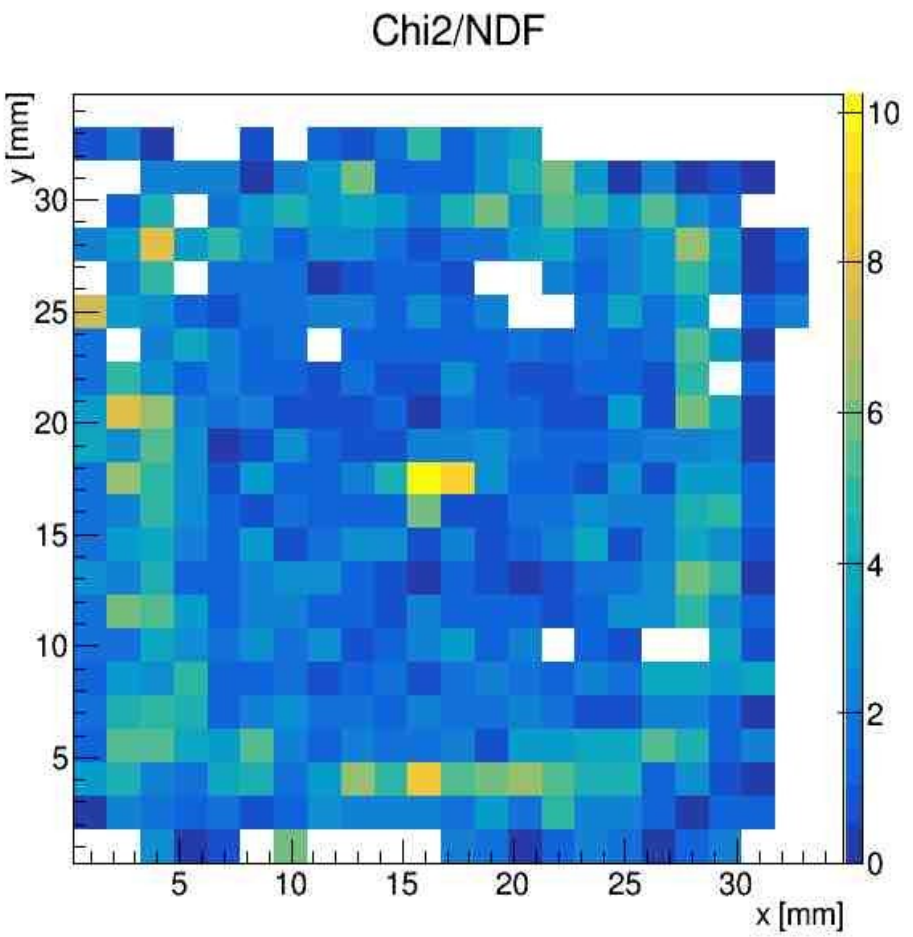




MPV and Chi2/NDF for tile with SiPM in dimple

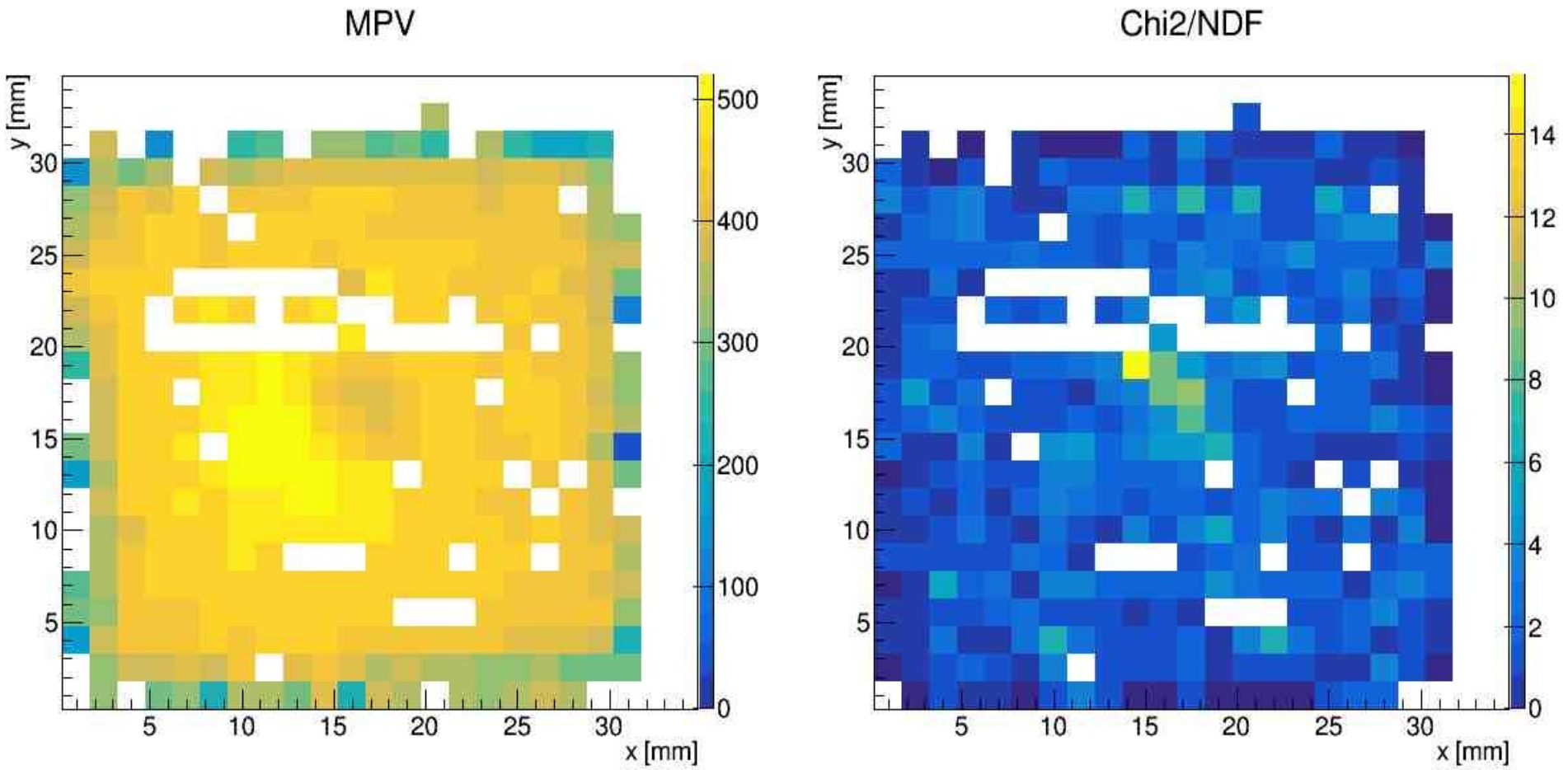
Map of most probable values: DESY tile





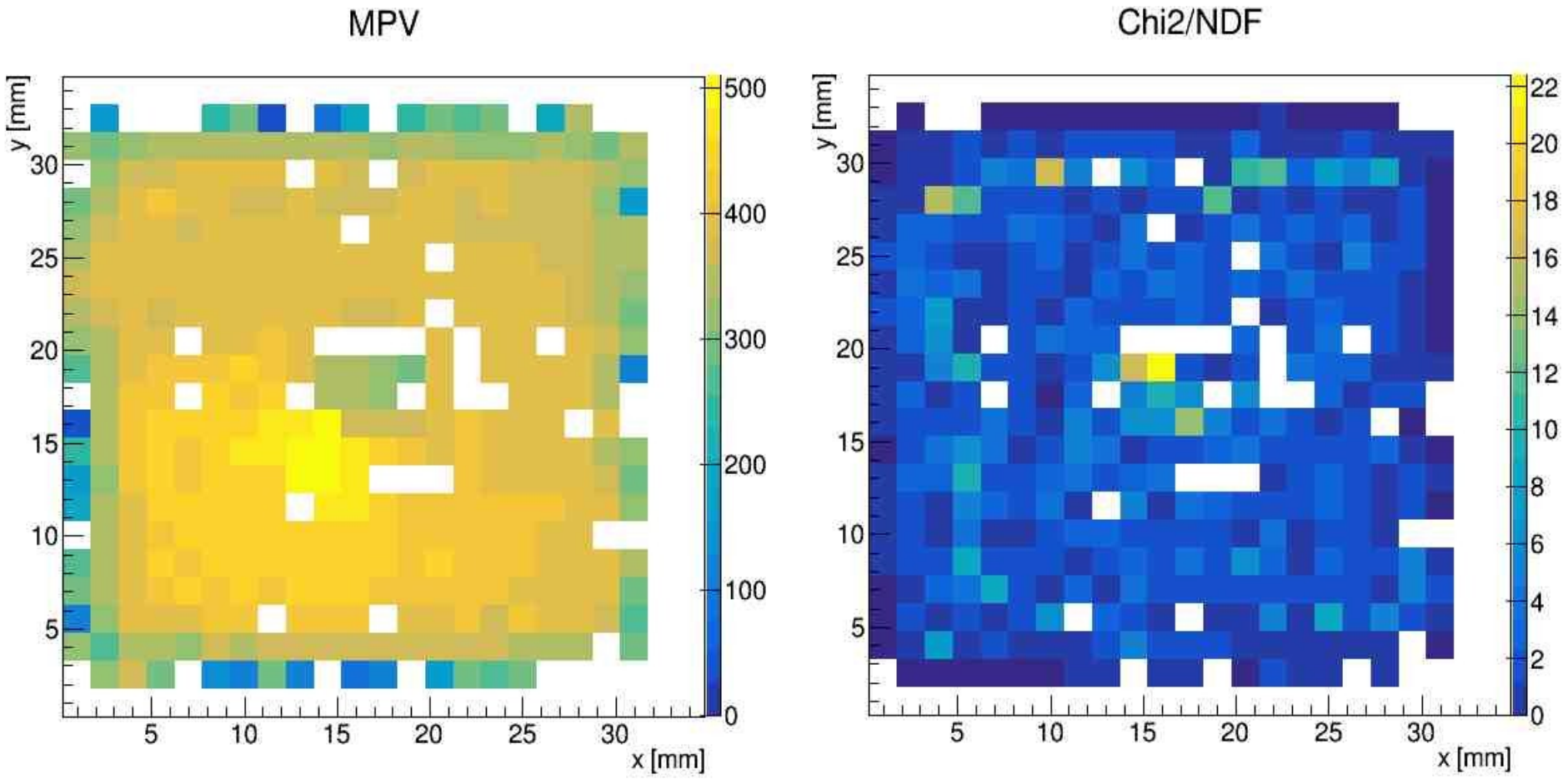
MPV and Chi2/NDF for SiPM over the flat surface of the tile

Map of most probable values: Vladimir tile



MPV and Chi2/NDF for tile with SiPM in dimple

Map of most probable values: Vladimir tile



MPV and Chi2/NDF for SiPM over the flat surface of the tile

Conclusions

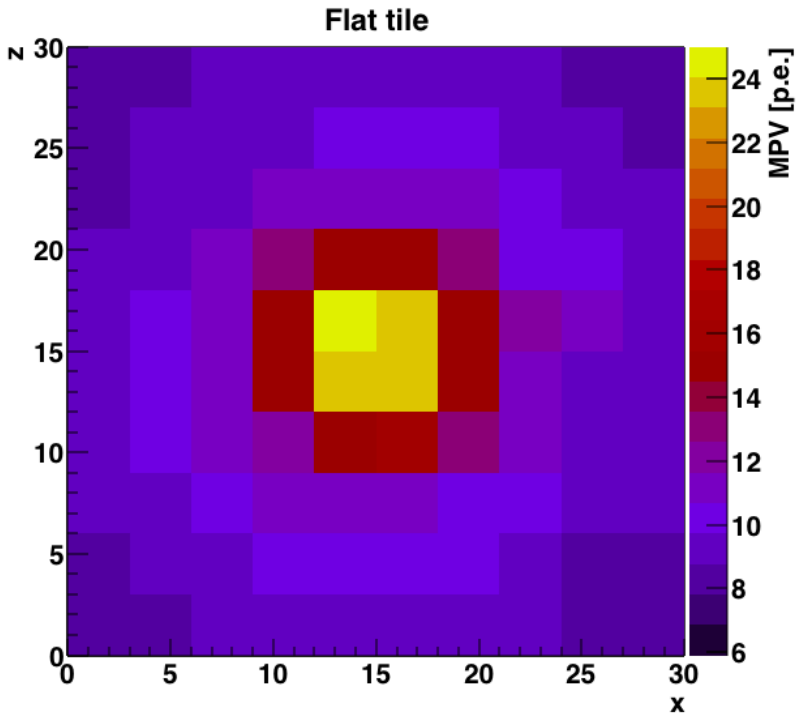
- We started the measurements of new scintillator tiles wrapped in foil (produced in DESY and in Vladimir).
- The algorithm for identification of tile position was developed.
- Preliminary results: light yield of new tiles is higher than that of previously measured tiles.
- Preliminary fit results reveal problems due to small statistics.
- The Geant4 model and simulation of wrapped tiles is under development.

Work in progress

Backup Slides

Flat tile: uniformity

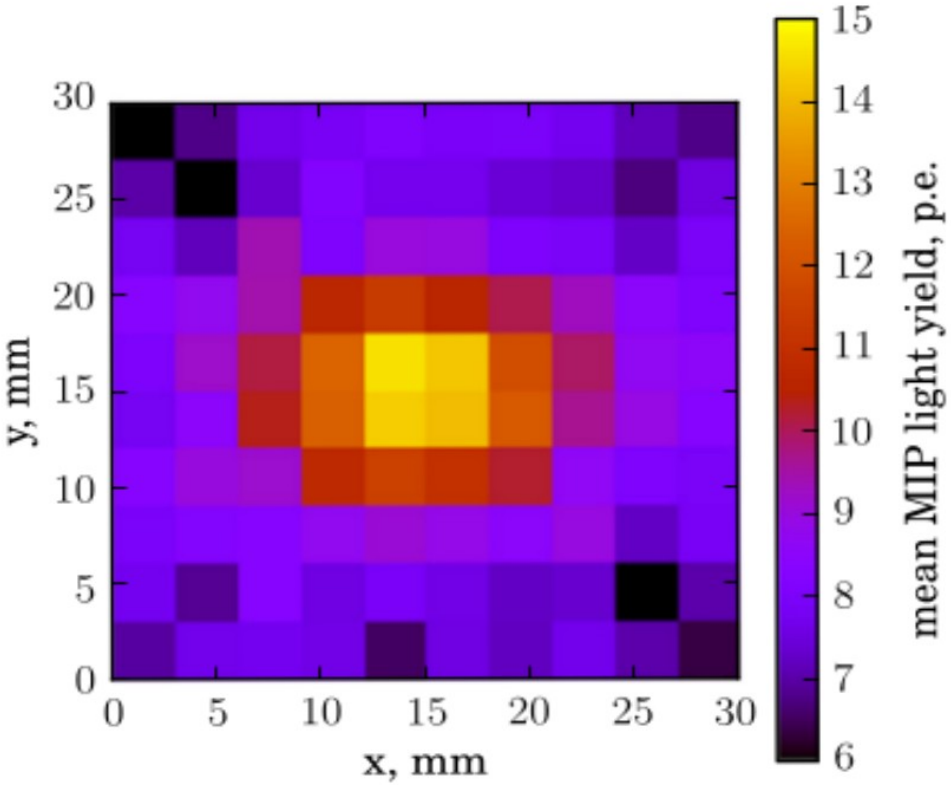
Simulation



Rm = 0.99 Rc = 0.95

Uniformity : 30.2%
Mean MPV: 10.7 p.e.

Experiment

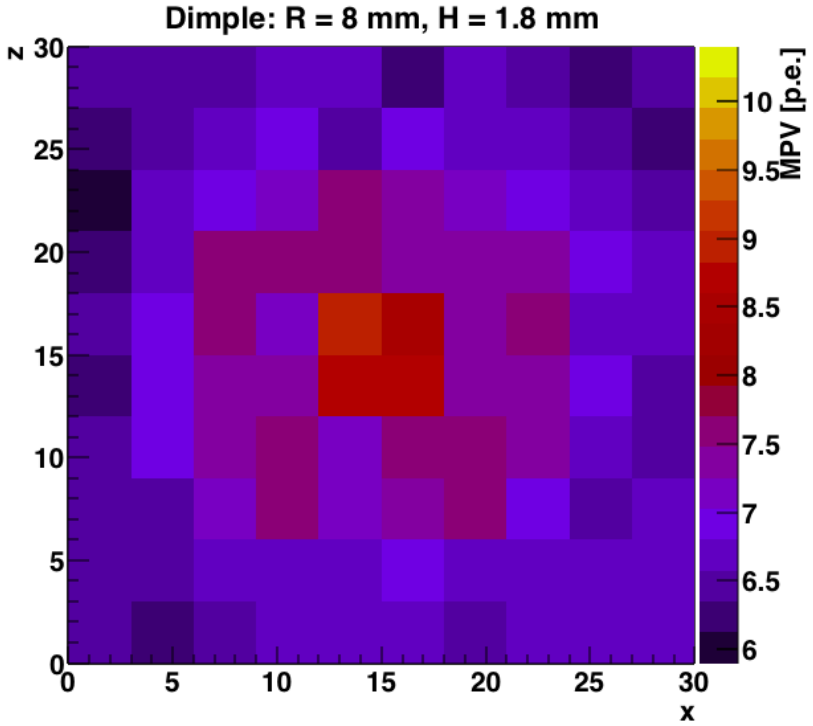


Experimental work: **NIM A572 (2015) 45**

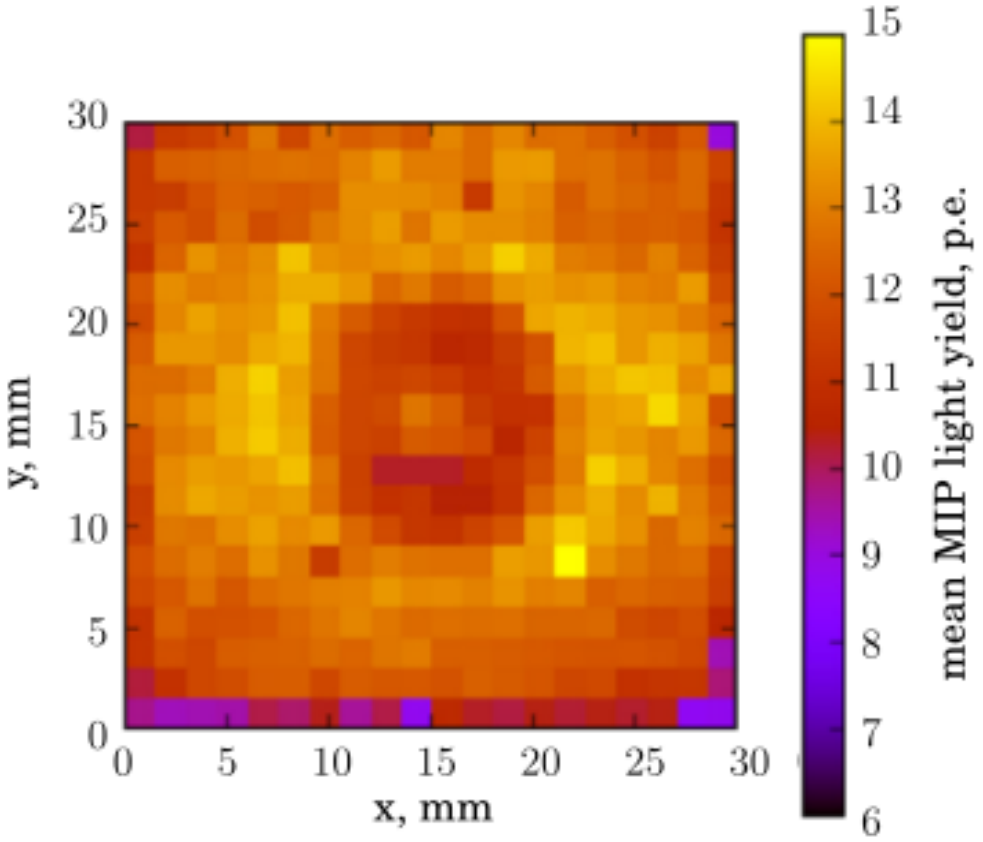
Uniformity : 21%
Mean MPV: 7.6 p.e.

Tile with dimple: uniformity

Simulation



Experiment



Rm = 0.99 Rc = 0.95

Uniformity : 7.9%
Mean MPV: 6.9 p.e.

Experimental work: **NIM A572 (2015) 45**

Scan step:	1.5 mm	3.0 mm
Uniformity :	8.8%	7.7%
Mean MPV:	12.5 p.e.	11.9 p.e.

Results of data to simulations comparison

The simulation provides a qualitative description of the response changes when we change the geometry of tile-SiPM system. It was found that the best agreement with the experimental data can be achieved for Rc = 0.8 and Rm = 0.95.

Experimental data: NIM A572 (2015) 45

(for scan step = 3.0 mm)	Flat design		Dimple design	
	Simulations	Experiment	Simulations	Experiment
Mean MPV (p.e.)	11.3	7.6	8.0	11.9
Uniformity (%)	24.5	21.0	6.5	7.7