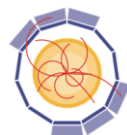


Megatile Studies

11.04.2019 – CALICE Collaboration Meeting, Utrecht
JGU Mainz – Sebastian Ritter

Peter Bernhard, Andrea Brogna, Volker Büscher, Phi Chau, Reinhold Degele, Karl-Heinz Geib, Sascha Krause, Lucia Masetti, Marisol Robles Manzano, Oliver Pilarczyk, Anna Rosmanitz, Ulrich Schäfer, Christian Schmitt, Stefan Tapprogge, Quirin Weitzel



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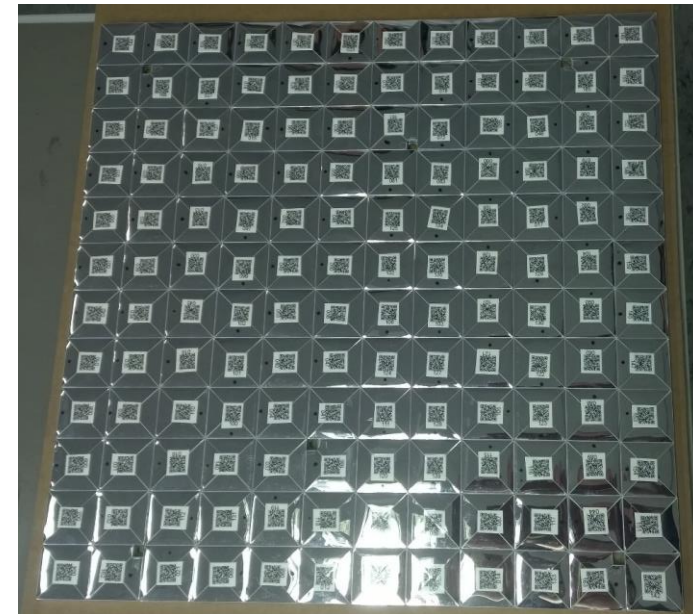
PRISMA+
DETECTOR LAB



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UNIVERSITÄT MAINZ

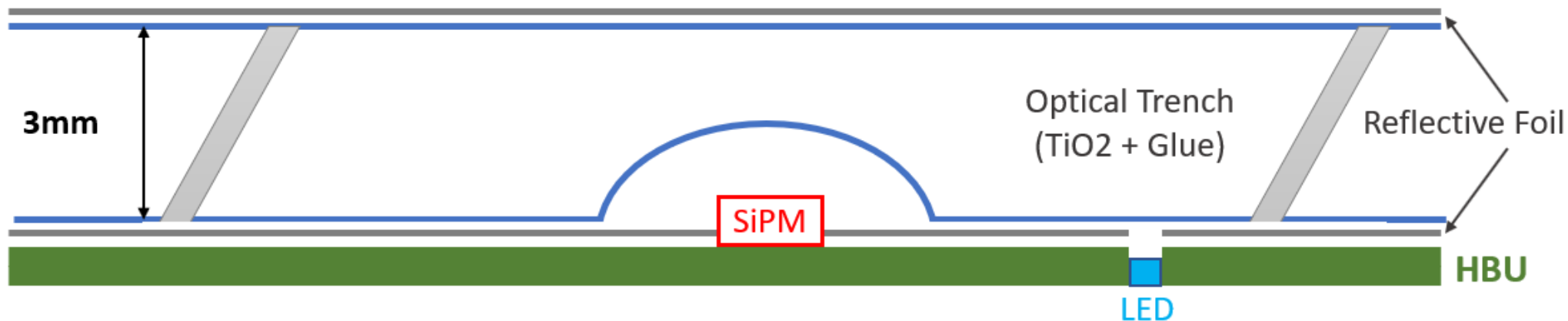
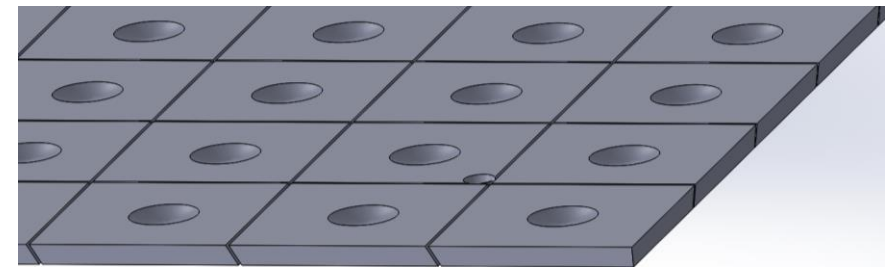
High Granularity Scintillators

- Base line: Scintillator tiles wrapped in reflective foil
- Advantages:
 - Maximum reflectivity
 - No crosstalk
- Challenges:
 - Handling of large numbers of single tiles in mass production
 - Process of bending foil mechanically delicate



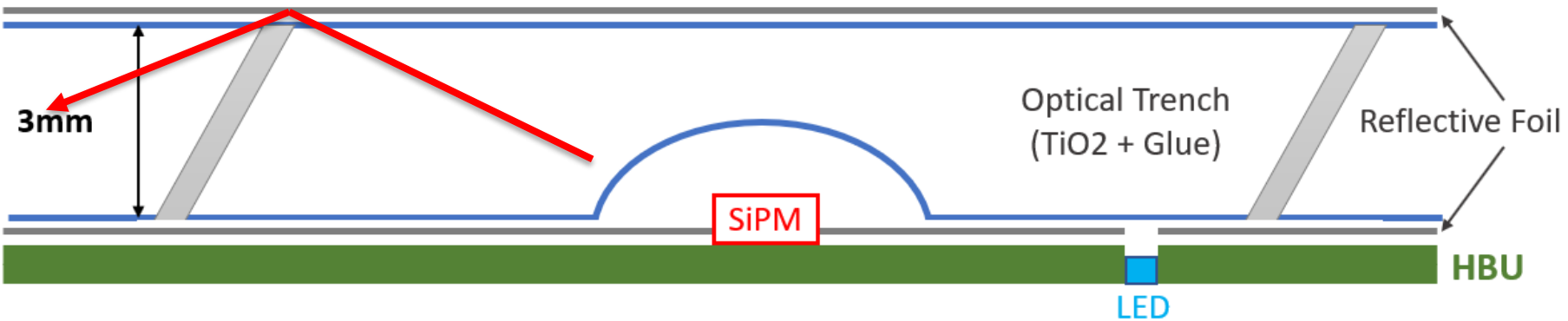
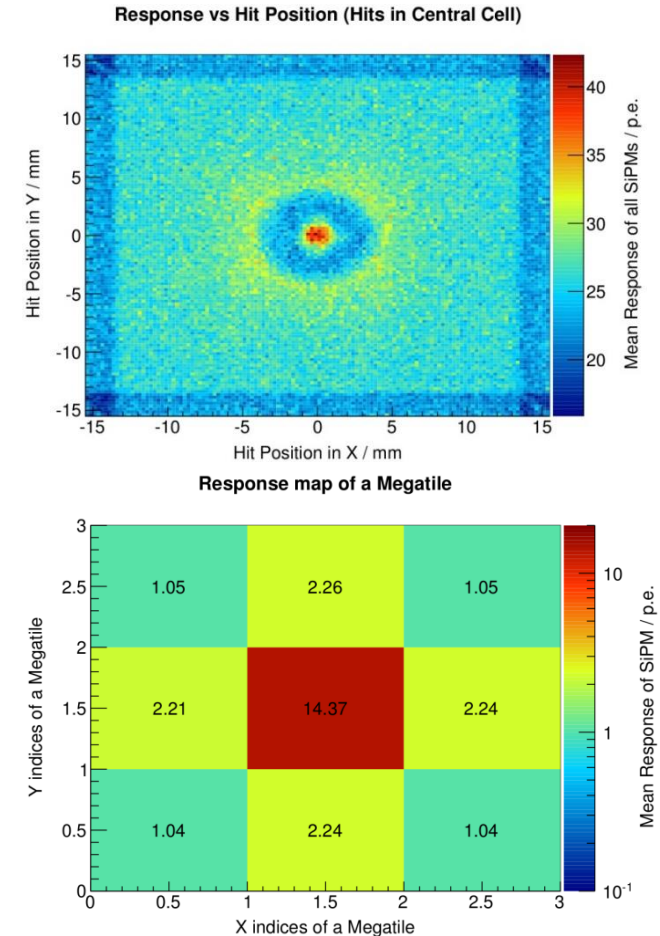
Megatile Concept

- Optically isolated channels in large scintillator plate
- Setup:
 - Scintillator covered by reflective foil at top and bottom, additional to total reflection
 - Channels are separated by trenches filled with reflective glue
 - Dimple maximizes light reaching SiPM
- Structure optimized by Geant4 simulation
 - MIP response, cell-to-cell crosstalk



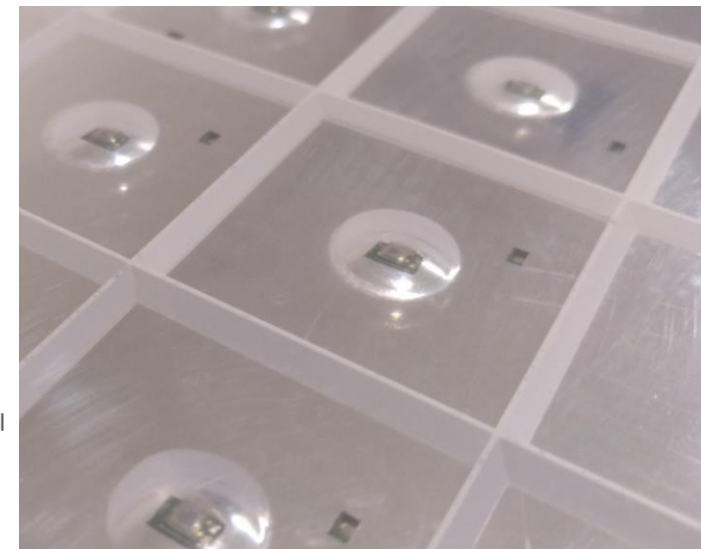
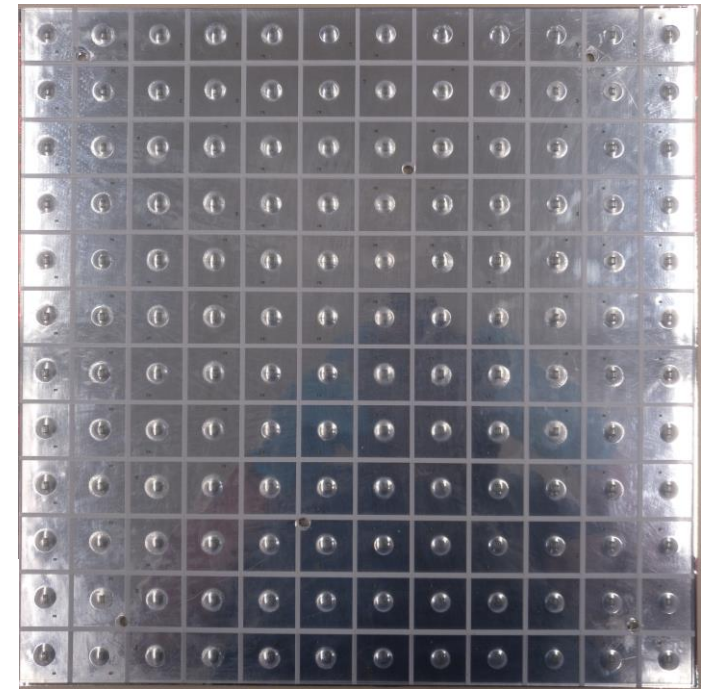
Simulation of Megatile Performance

- Simulation in Geant4, performed by Y. Liu:
 - High response uniformity in tile and at edges
- Crosstalk good, e.g. 3.5% for 0,1mm air gap



Production Process of Megatile

- Scintillator material: NE110
- Main issues:
 - Avoiding air bubbles in trenches
 - Get surface polished
 - High structural stability is necessary
 - High flatness to control air gap



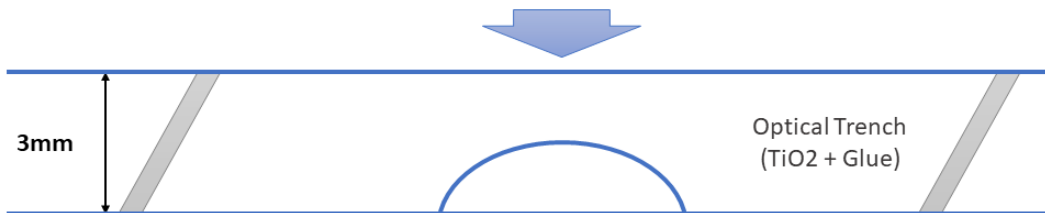
Step 1

Trenches only
from the top



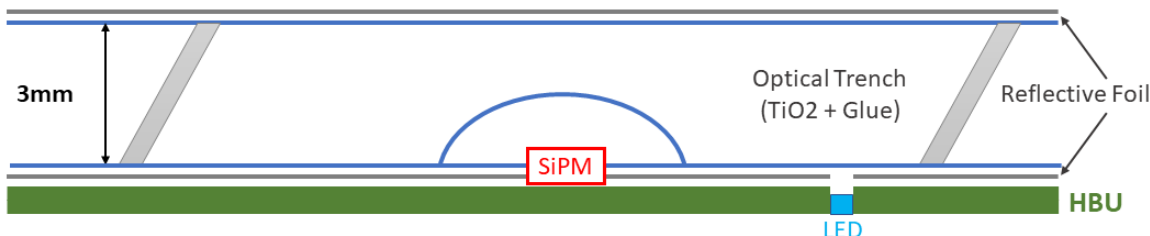
Step 2

Fill trenches
with TiO₂ and
glue, mill
down to 3mm



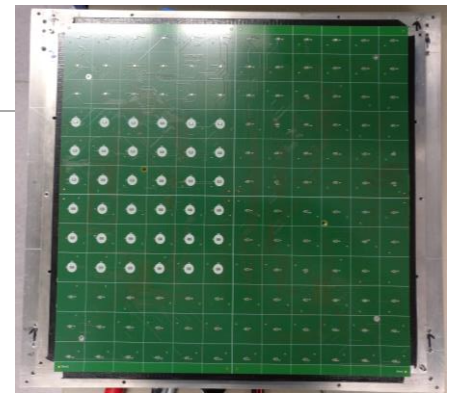
Step 3

Assembly:
reflective foil,
SiPM, LED



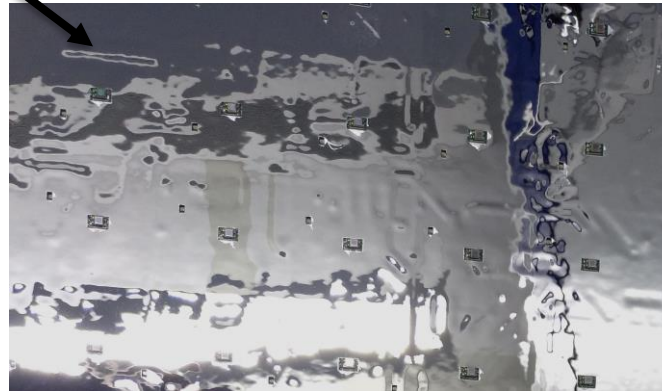
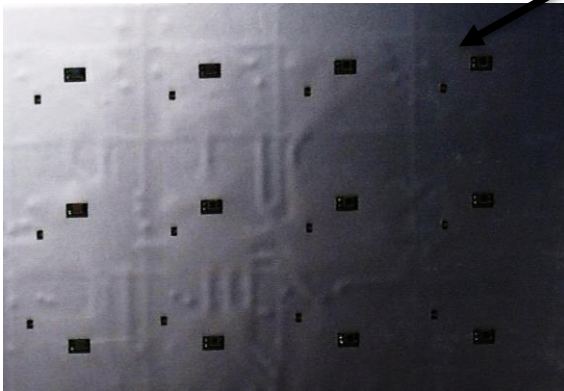
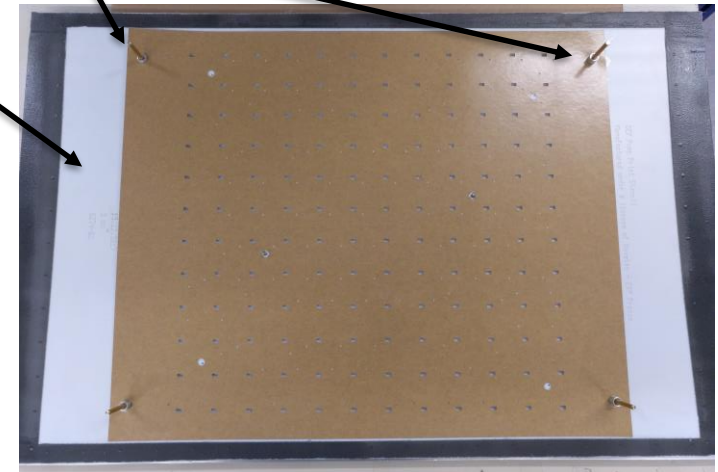
Foil Placing Procedure

- Reflective foil is placed on HBU and cassette
 - Holes are cut out for LED, SiPMs and screws
- Main issues:
 - Avoiding air bubbles
 - Precise positioning
- Solution: placing with stencil and guiding system
 - Required accuracy is reached and reproducible
- Edges of Megatile are covered with reflective tape
- Uneven foil surface due to conductor tracks on HBU

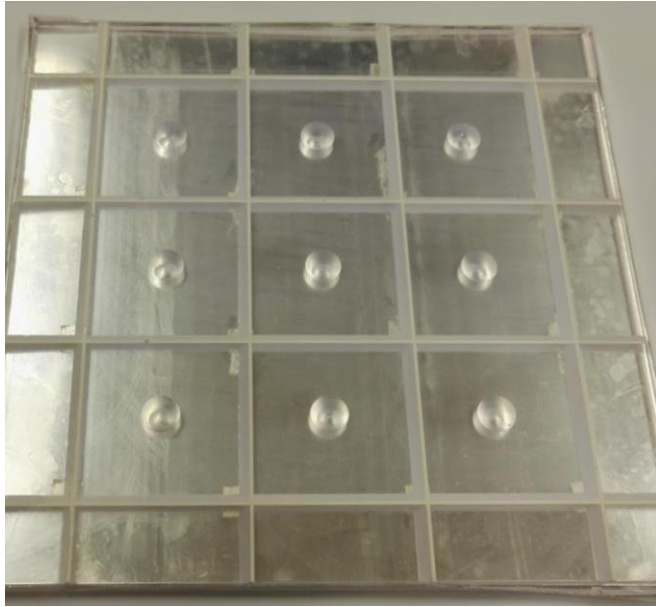


Guiding System

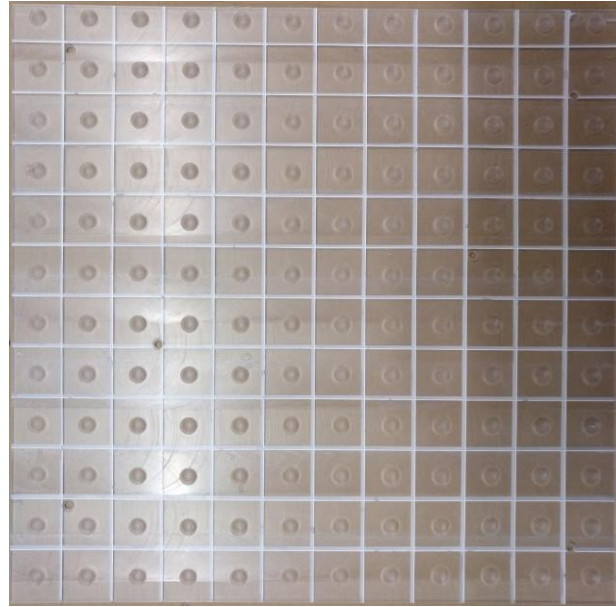
Stencil



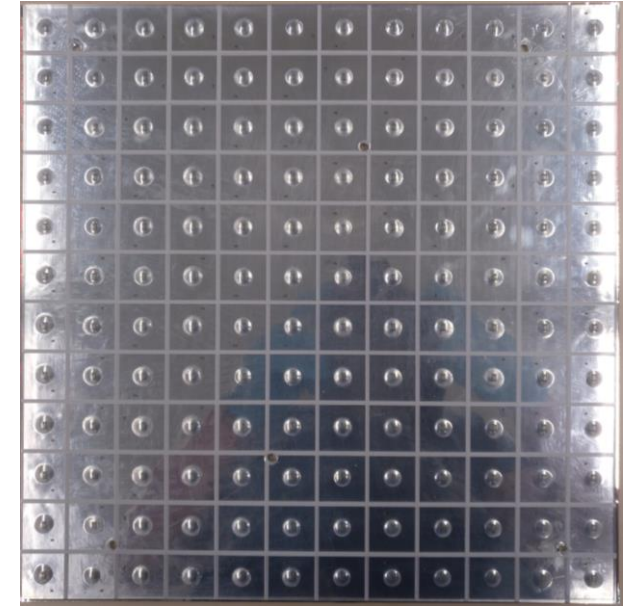
History of Prototypes



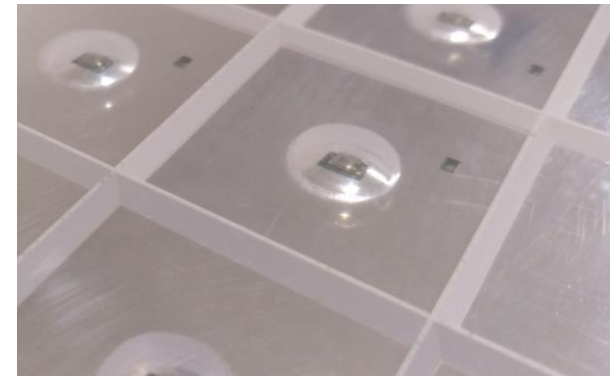
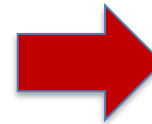
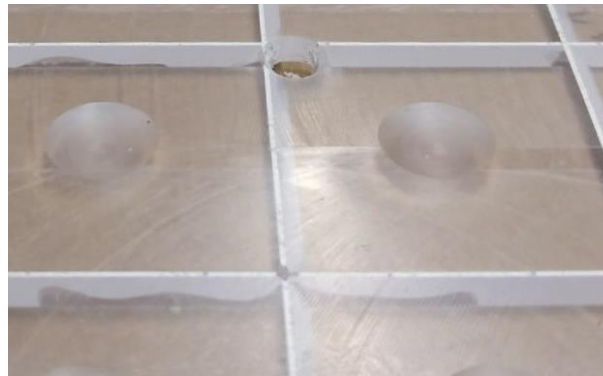
3x3 Prototype



2018 Prototype

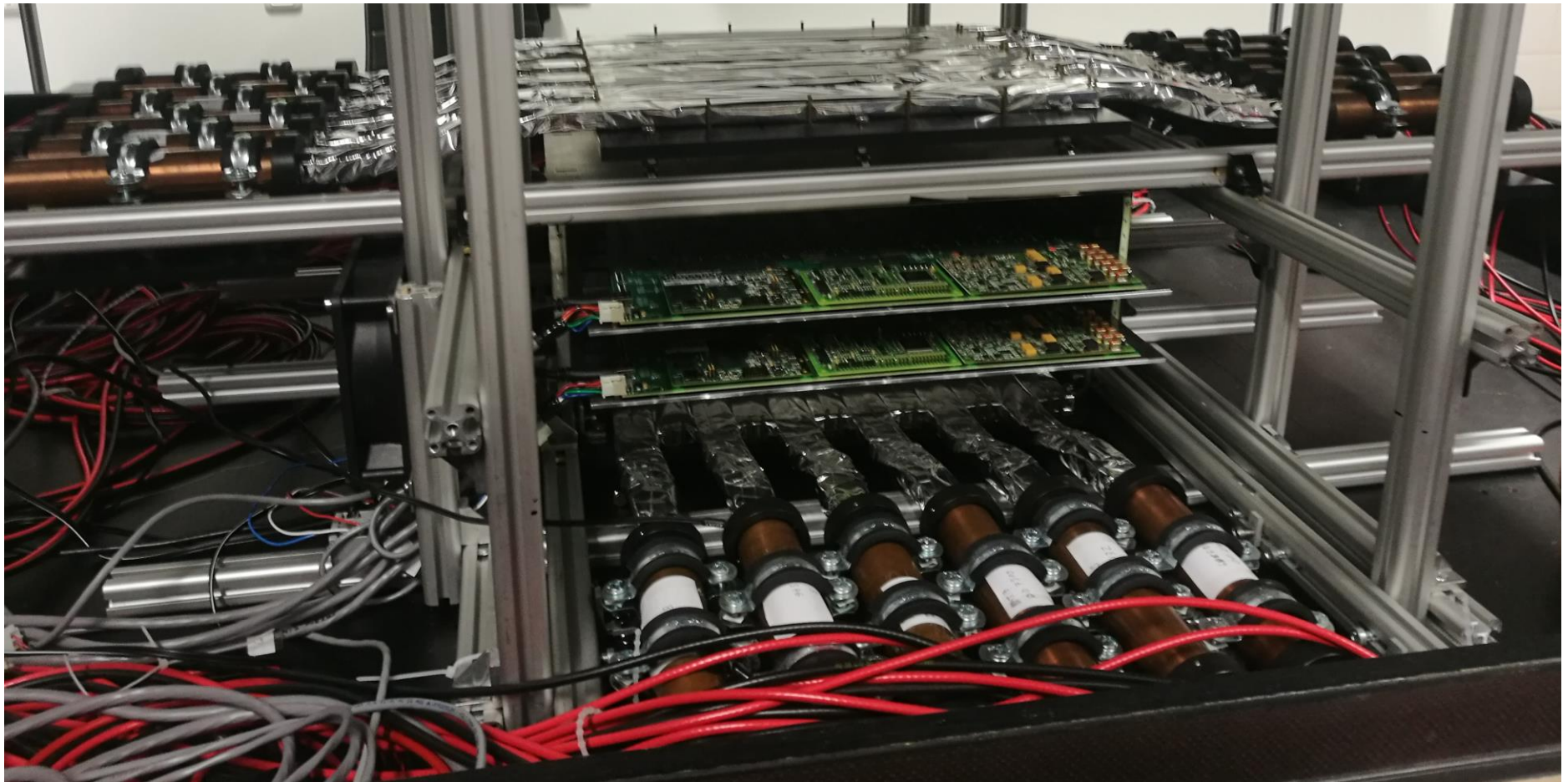


2019.1 Prototype



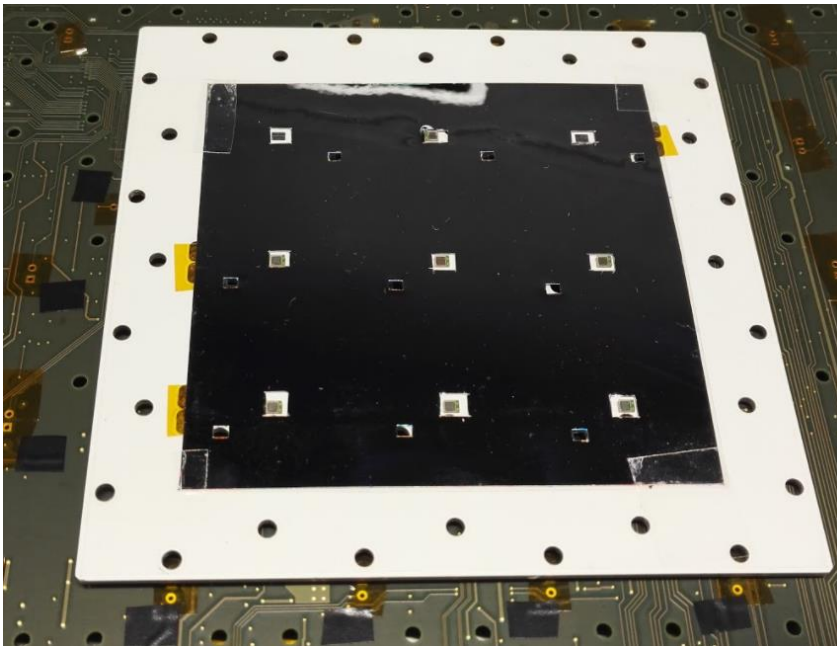
Characterization in Cosmic Ray Test Stand

- 12 scintillators with PMT readout for each top and bottom layer
- Up to 10 boards could be aligned in stack structure
- An air circulation system within the box is installed

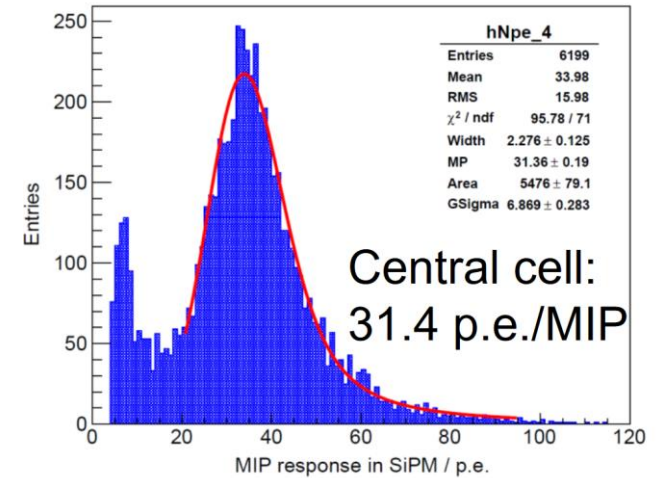


3x3 Prototype

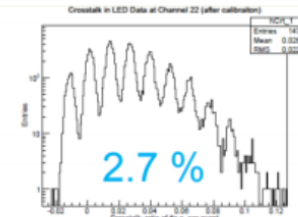
- 3x3 prototype was tested on adapter board for HBU3
 - Scintillator material: NE110
 - Reflective foil: 3M DF2000MA
- LY of 31.4 p.e. / MIP in central cell is a good result
- Crosstalk between 3 and 6 % is acceptable



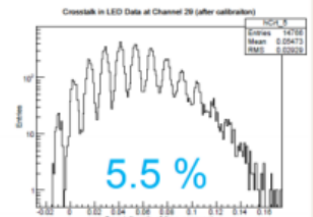
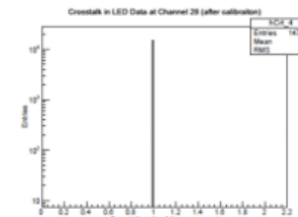
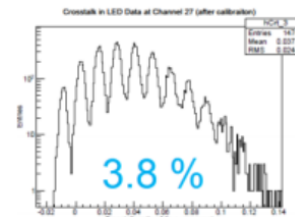
MIP Response in Cosmics Data at Channel 28



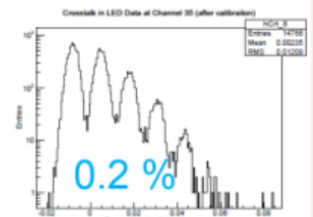
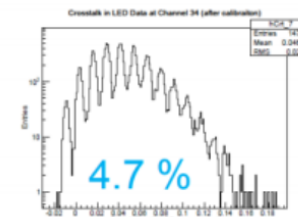
No SiPM



No SiPM



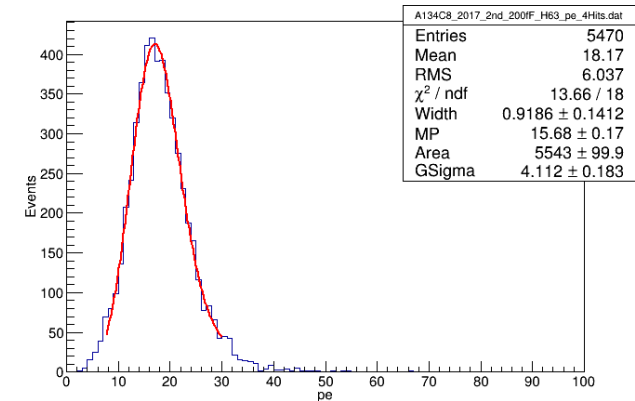
No Signal



Light Yield Results of 2019.1 Prototype

- Very homogenous LY distribution
- Recognizable difference between edge and center
 - Optical isolation of edge channels has to be improved
- Mean LY: 16 p.e.
- Reduced LY is understood as issue with dimple treatment (will be fixed for next prototype)

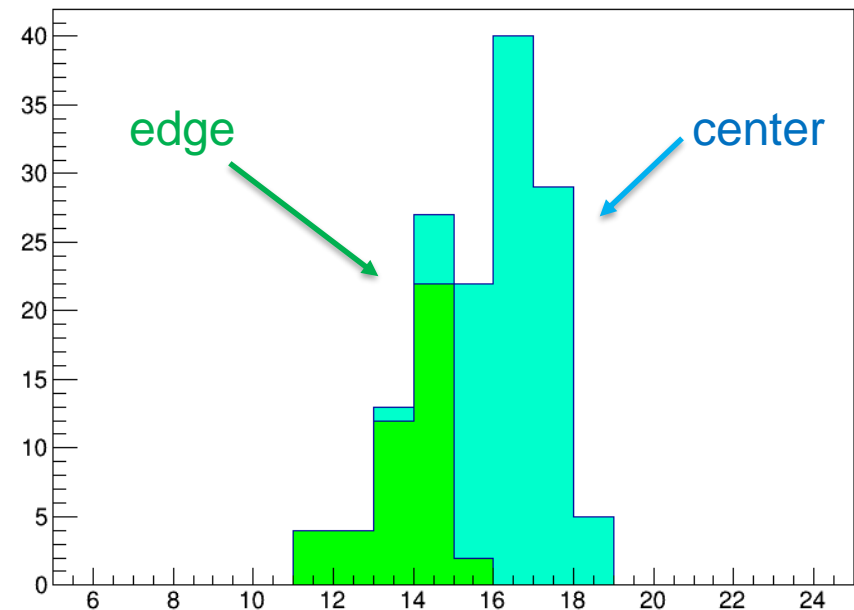
Landau Gauß Fit of A134C8



Light Yield Map of Megatile Board



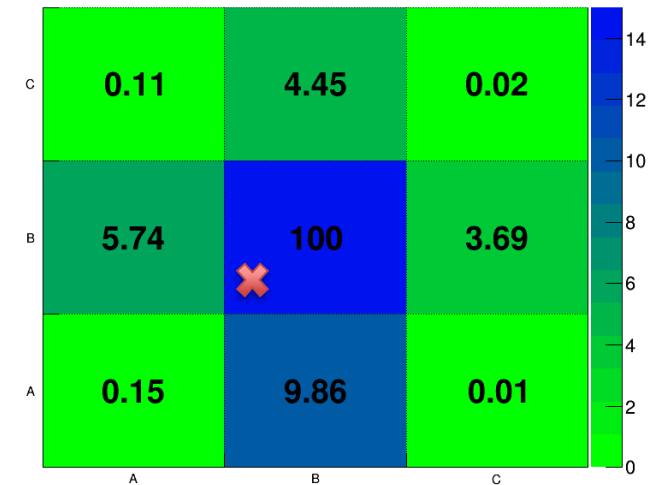
light yield of edge and center channels



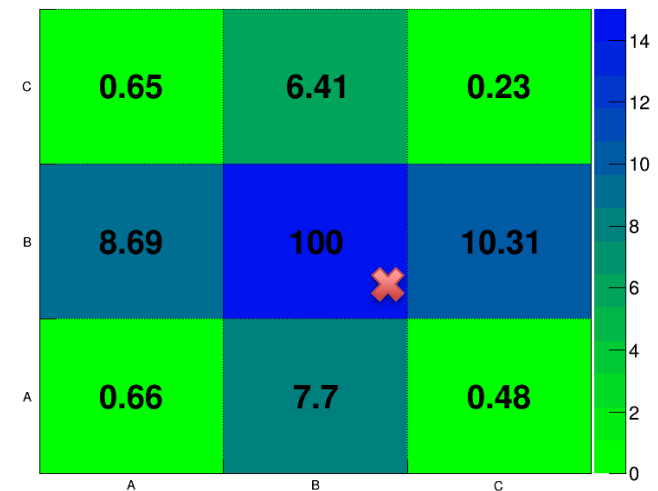
Measurement of Crosstalk

- Measurement performed in different positions
- Light injection via external LED
- Measurements ongoing
 - Preliminary results of 2018 Prototype
 - First results between 5 and 10% for neighbor cells
 - Presumably dependent on LED position
- Crosstalk dependent on air gap size between scintillator and reflective foil
- Controlling air gap needs mechanical solution

Crosstalk 5BGA2, Spot1, low space



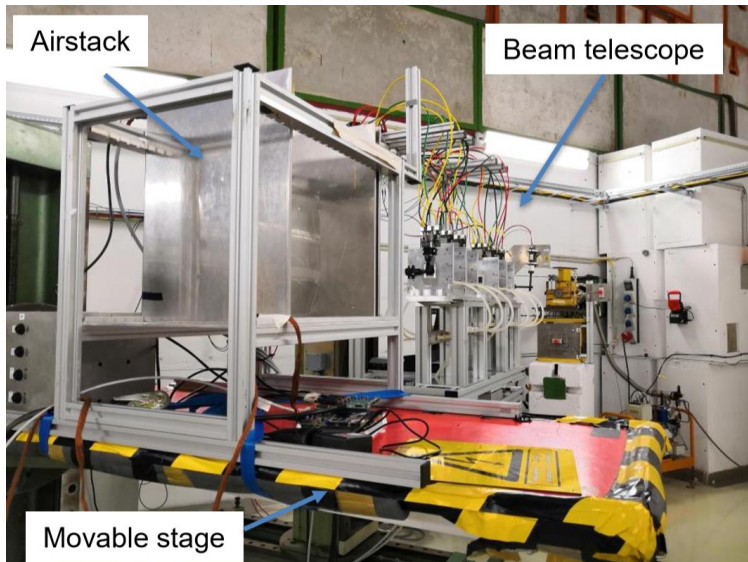
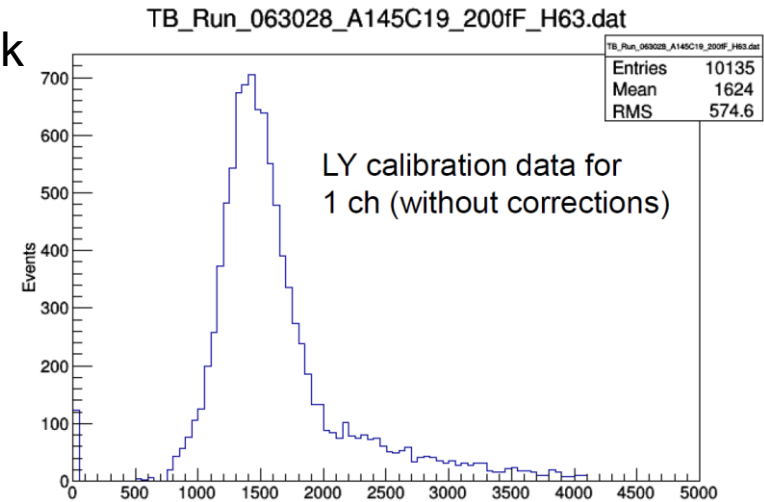
Crosstalk 5BGA2, Spot2, low space



Crosstalk values are shown in percent,
✗ LED position

DESY Testbeam Campaign

- First measurements taken in March AHCAL air stack
- Data taken:
 - Light yield scan for all channels with electrons
 - Single tile uniformity scan in different channels
 - Shower data at different energies
- Analysis is ongoing

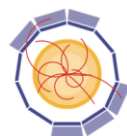


BIG thanks to Jiri from DESY for supporting us the whole week!

Summary and Outlook

- Megatile concept now demonstrated with full size prototypes
 - Good LY and Crosstalk results
- Extensive testbeam measurements, analysis ongoing
- Next testbeams at DESY in May and July 2019 (new megatile prototypes, in combination with new KLauS HBUs)

Thank you for your attention



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