

First Results of October CERN Testbeam with Postprocessed Timepix Chips in a TPC

RD51 Collaboration Meeting

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Martin Schultens ¹

Christoph Brezina ¹, Klaus Desch ¹, Jochen Kaminski ¹,
Martin Killenberg ³, Frederik Klöckner ¹, Markus Köhli ²,
Thorsten Krautscheid ¹, Uwe Renz ²

¹ Universität Bonn

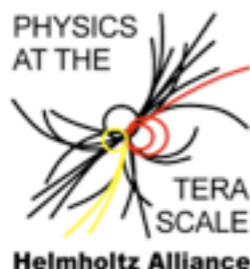
² Universität Freiburg

³ CERN



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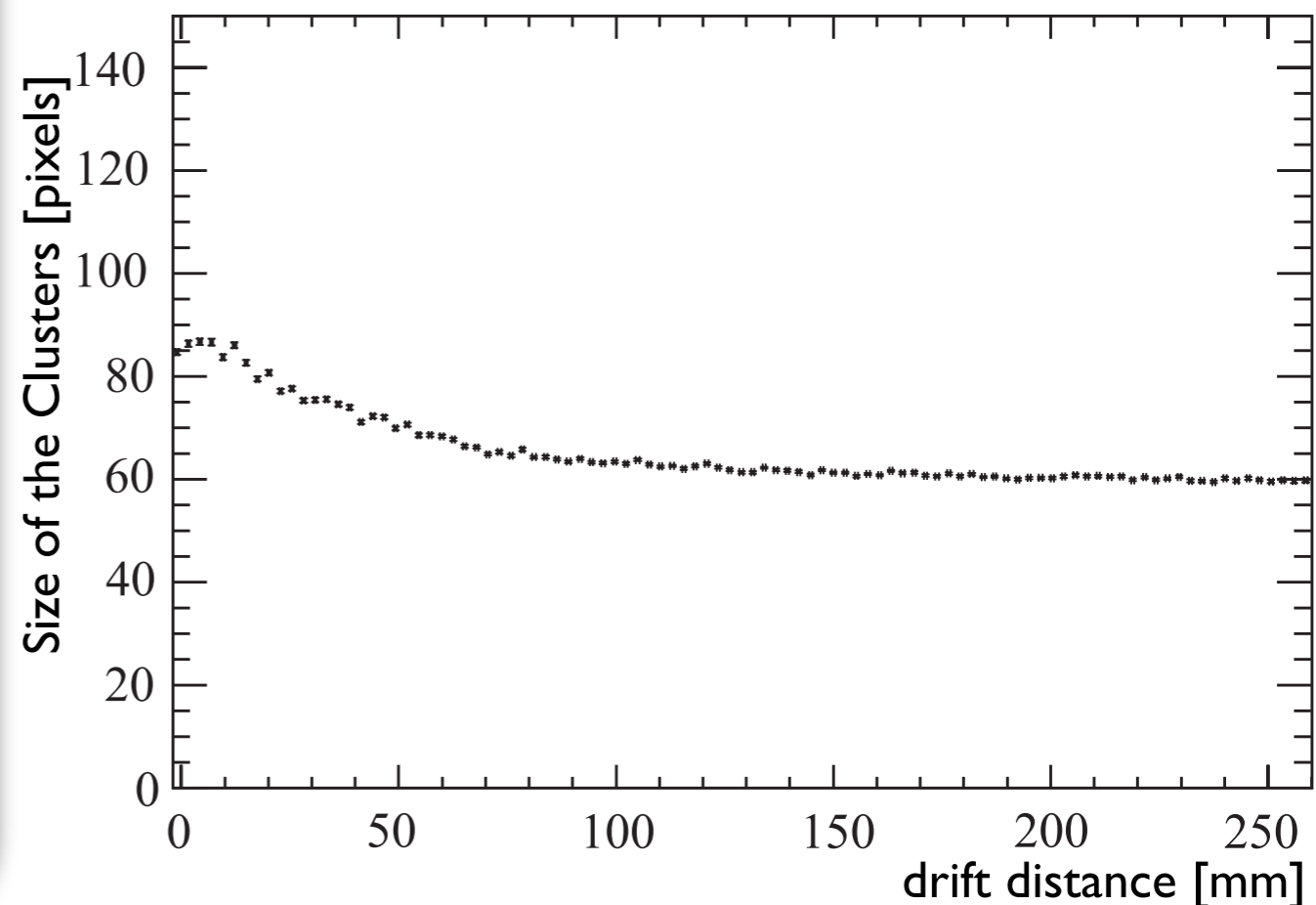
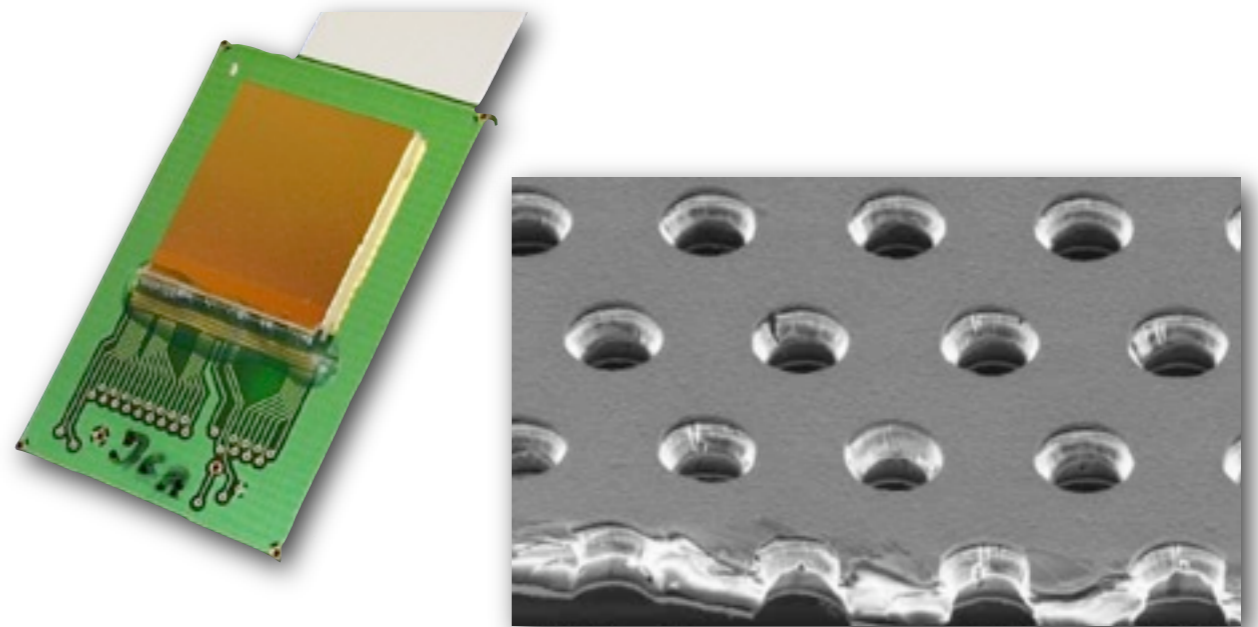


- I) Time Projection Chamber Prototype in Bonn
- II) Timepix with Gas Electron Multipliers
- III) Pad Enlargement Chips
- IV) Reconstruction with Marlin-TPC
- V) First Analysis Results

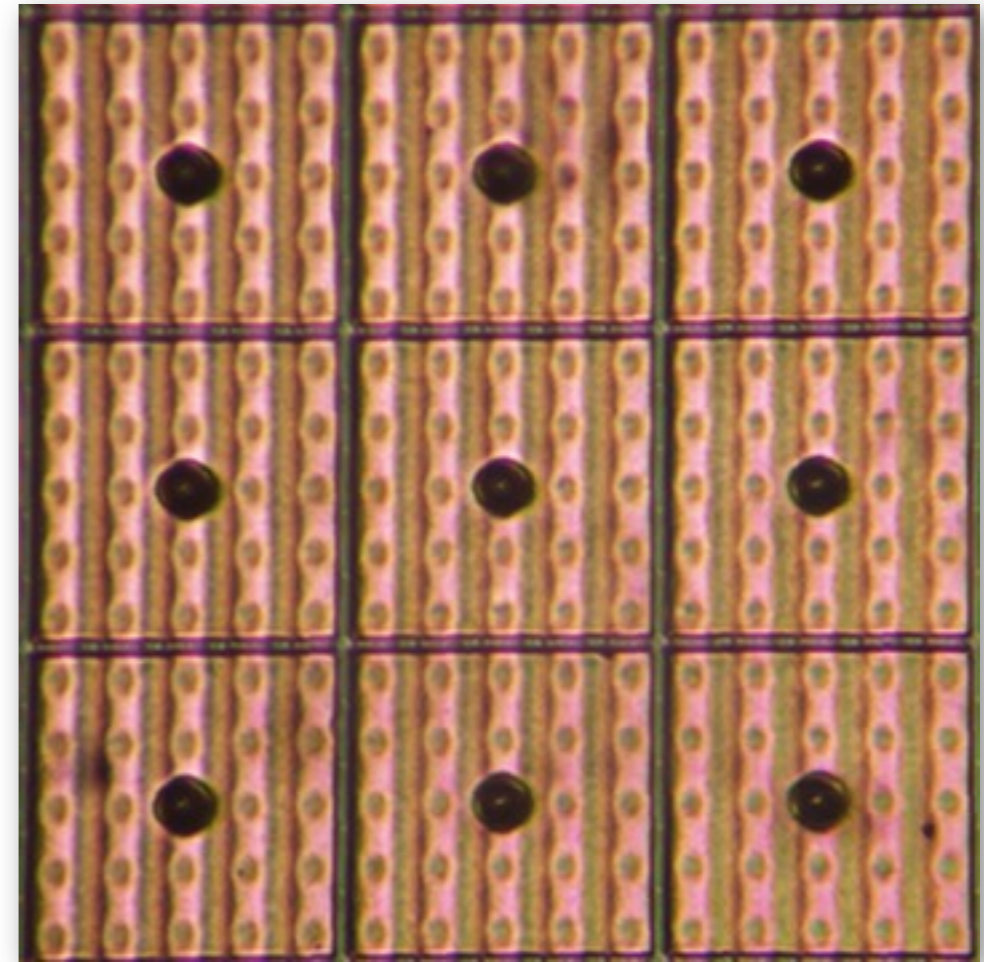
- Field cage developed at RWTH Aachen
- Drift distance: 26 cm
- Inner diameter: 23 cm
- Material budget: 1% X_0
- Cathode voltage up to 30 kV
- 187 copper rings generating a very homogeneous drift field
- Scintillators used as external trigger
- Readout with Timepix chip



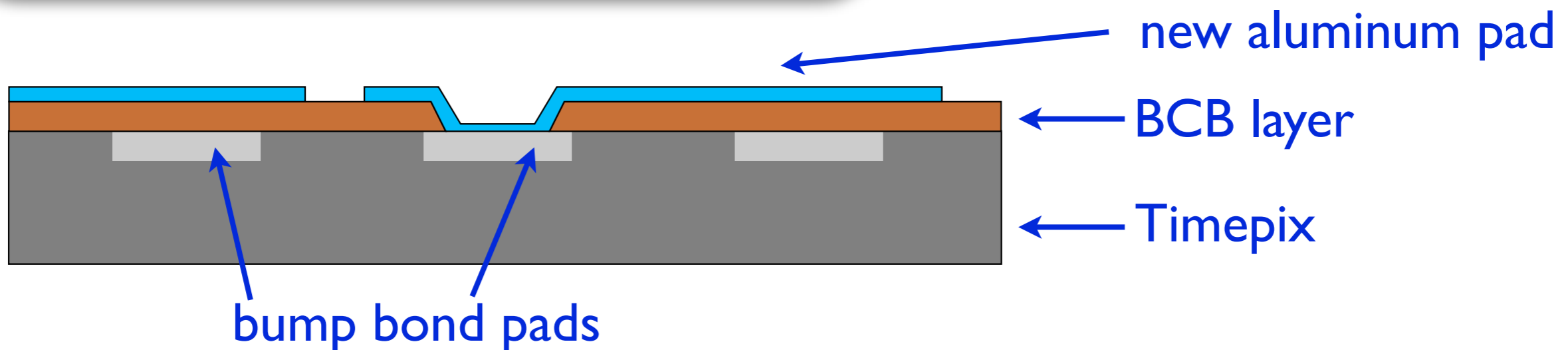
- Readout with Timepix chip
 - 256×256 pixels
 - pixel size: $(55 \times 55) \mu\text{m}^2$
 - active area: $(1.4 \times 1.4) \text{cm}^2$
- checkerboard pattern of time over threshold (charge) & time measurement
- Gas amplification with standard CERN GEM foils
- Charge depositions spread over 60 pixels
- High gas gains (60000 - 100000) needed



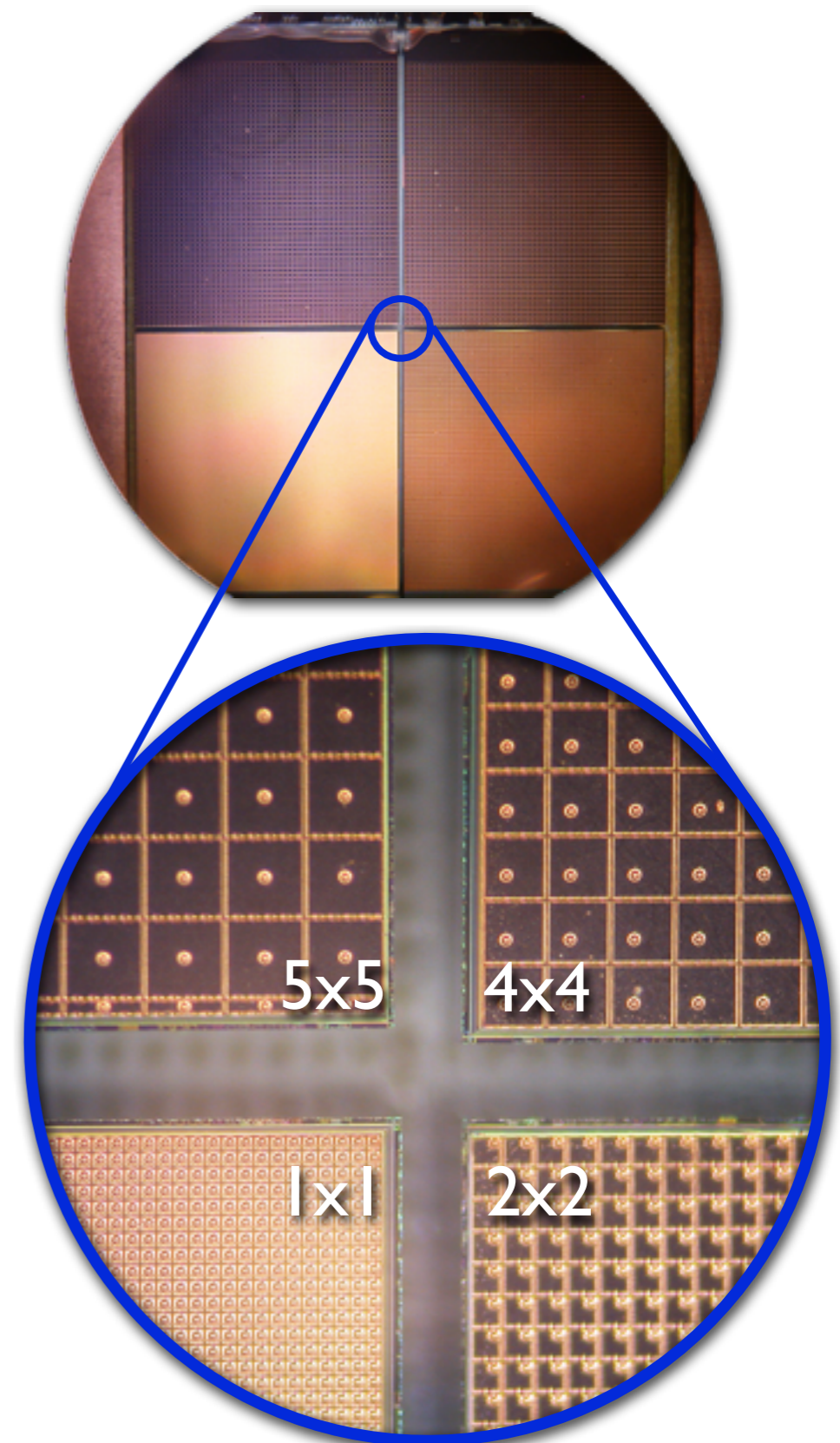
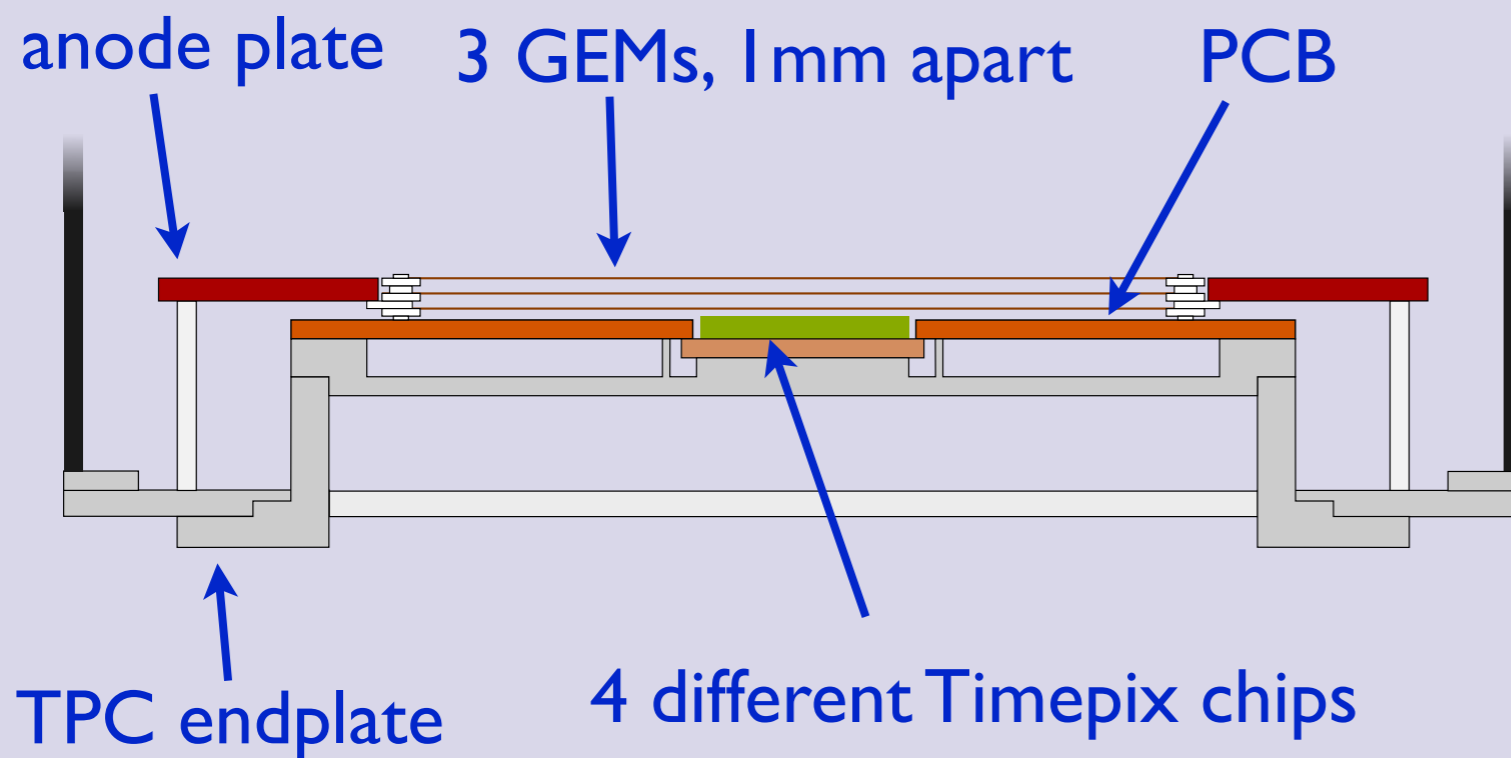
- Larger pads might be better
 - Design of new chips is expensive
-
- Postprocessed Timepix-Chips with larger aluminum pads on insulating BCB layer
 - Through connection to bump bond pad of Timepix chip in the middle of aluminum pad
 - Chips with 9 different geometries were build at IZM (Berlin)

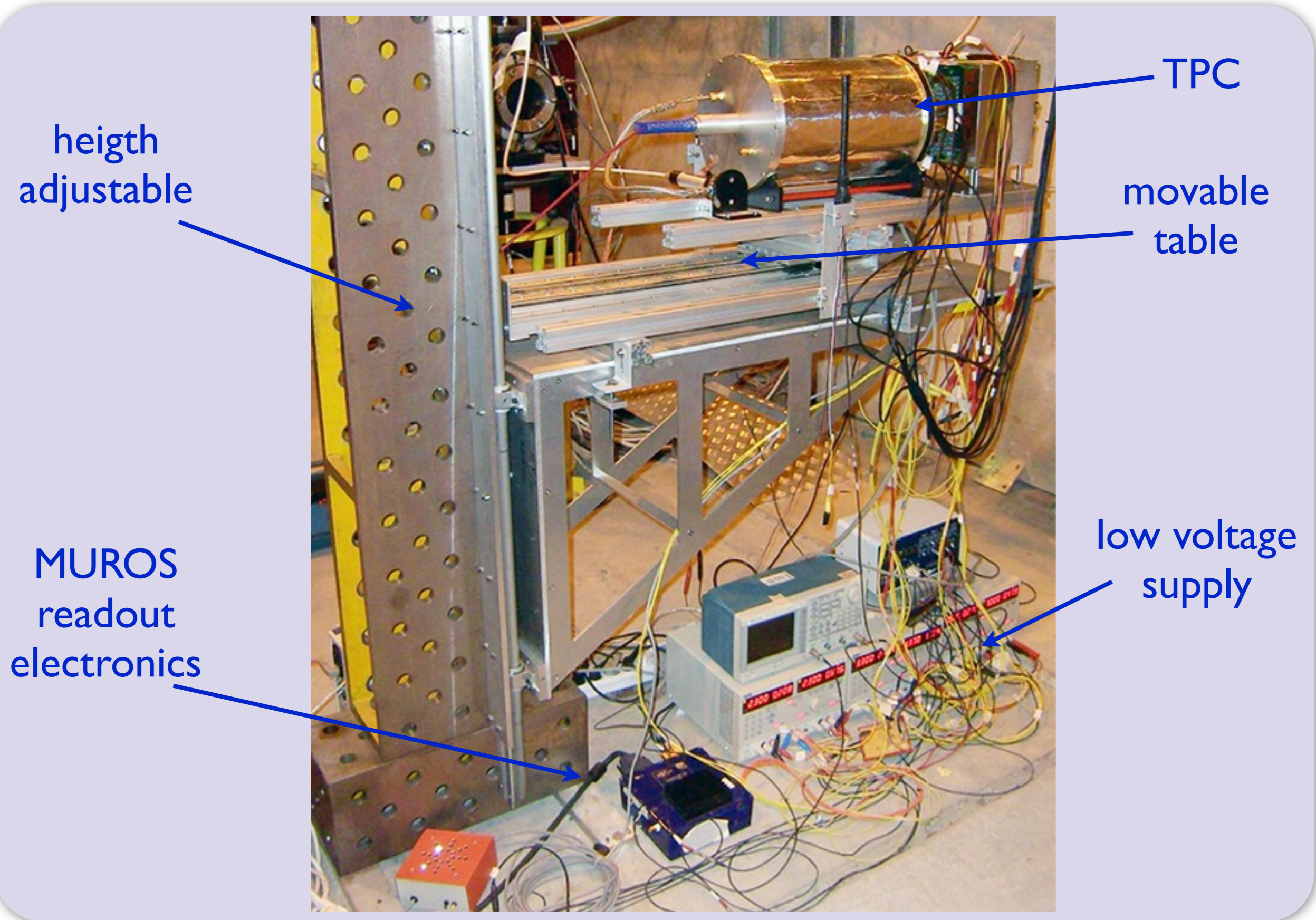


surface of new pads seen through microscope

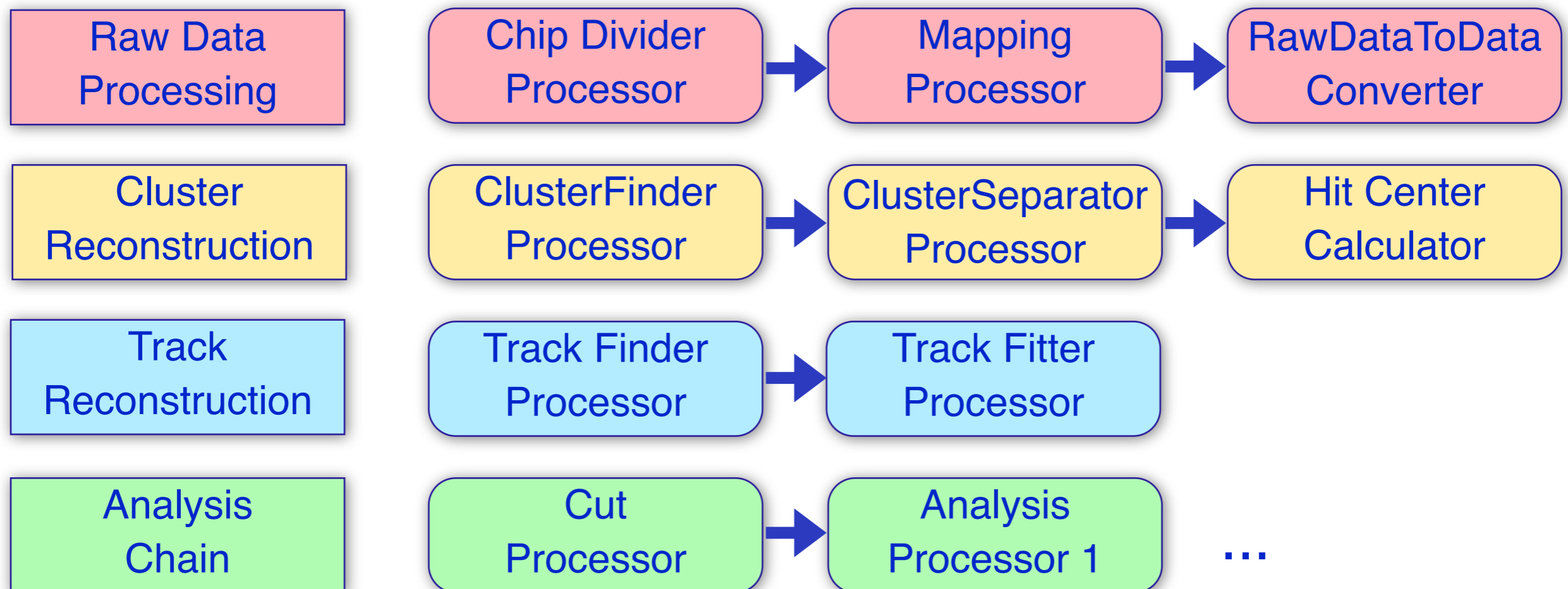


- 4 chips with different pad sizes were tested:
1x1 pixels for comparison, 2x2 pixels, 4x4 pixels and 5x5 pixels
- all chips connected to one readout board



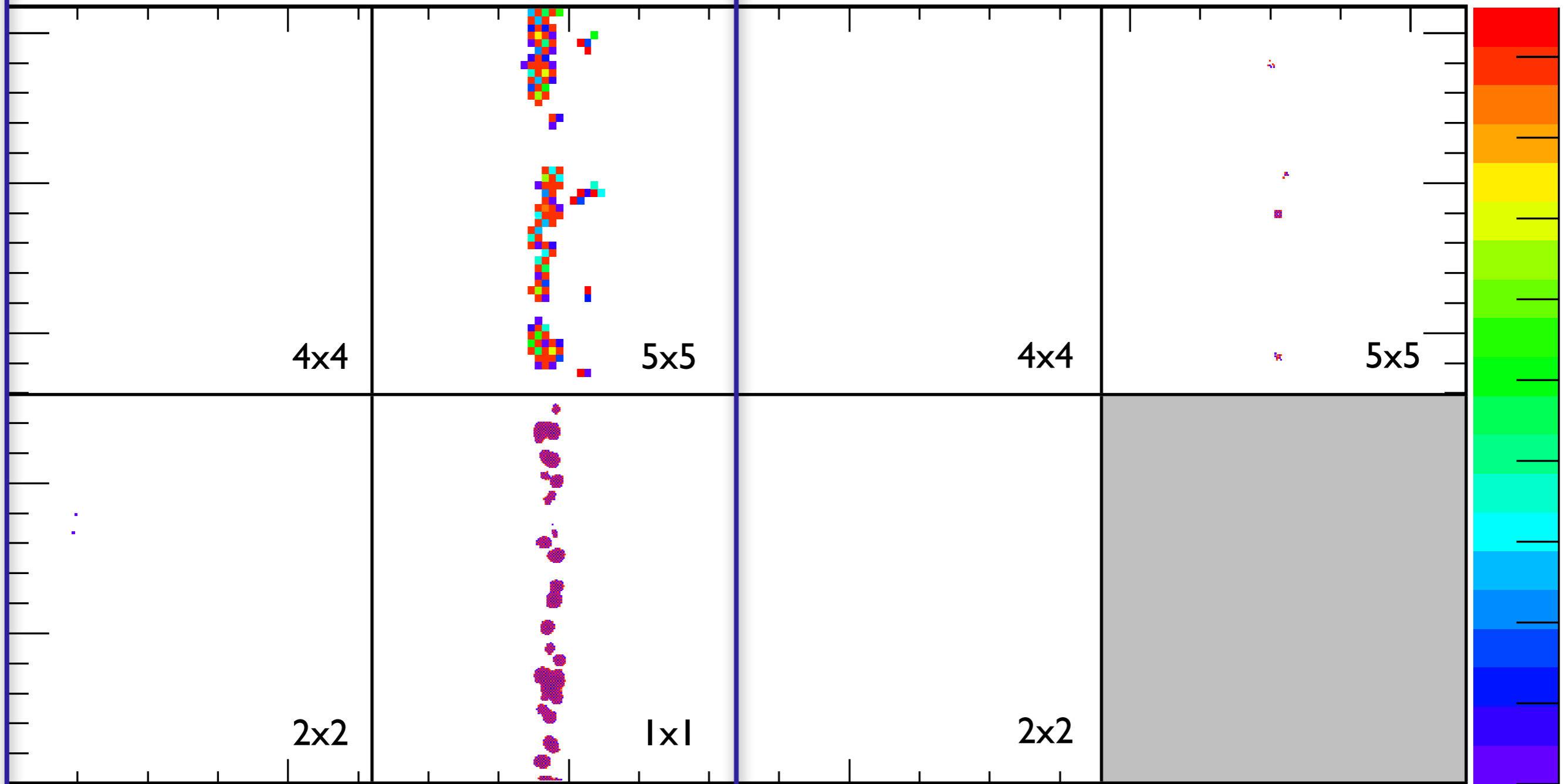


- Reconstruction and analysis with MARLIN TPC (Modular Analysis and Reconstruction for the Linear Collider)
- All detector systems use common data format (LCIO)
- Every task in the reconstruction chain is done by a Processor



connected pixels

unconnected pixels



connected pixels

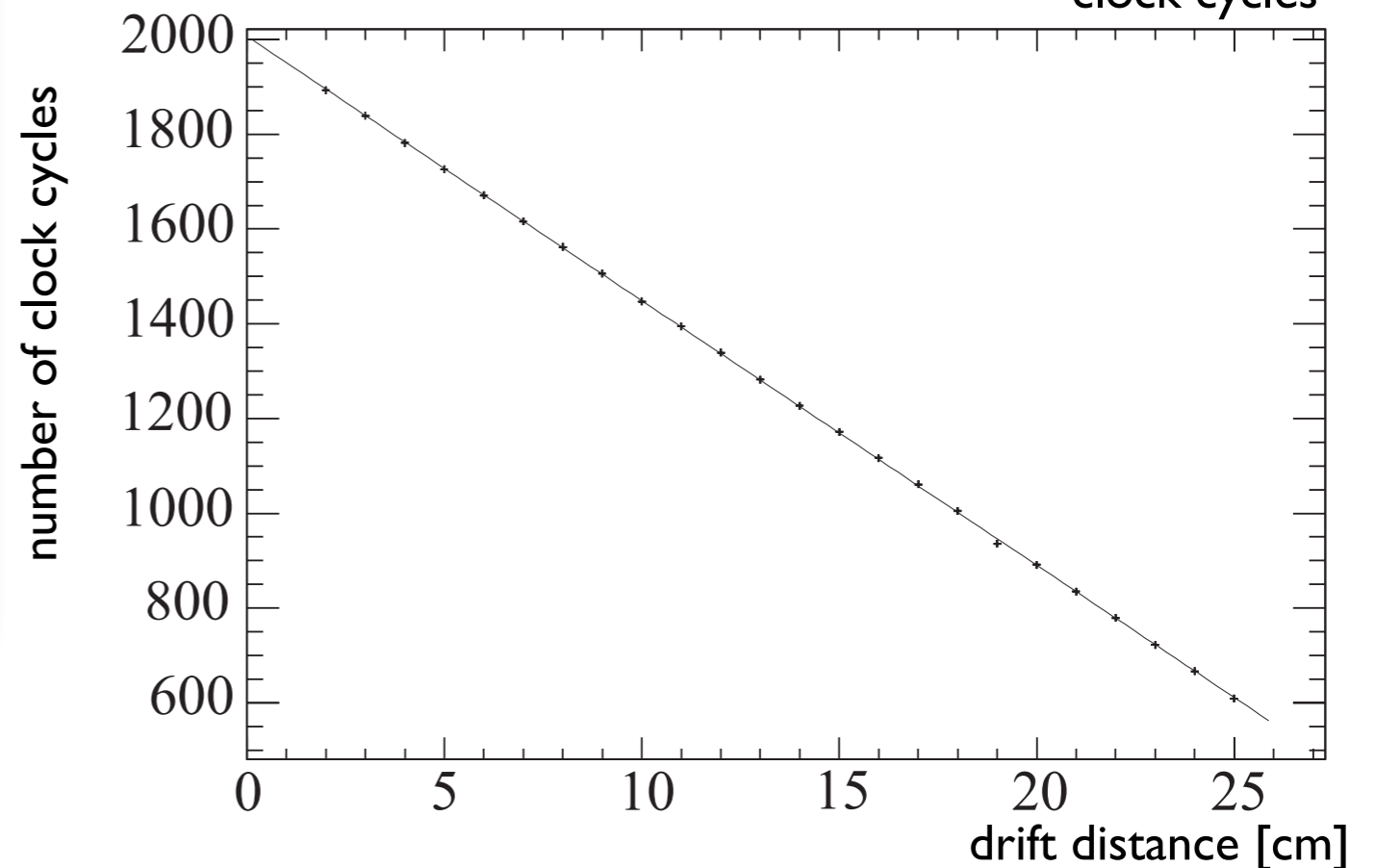
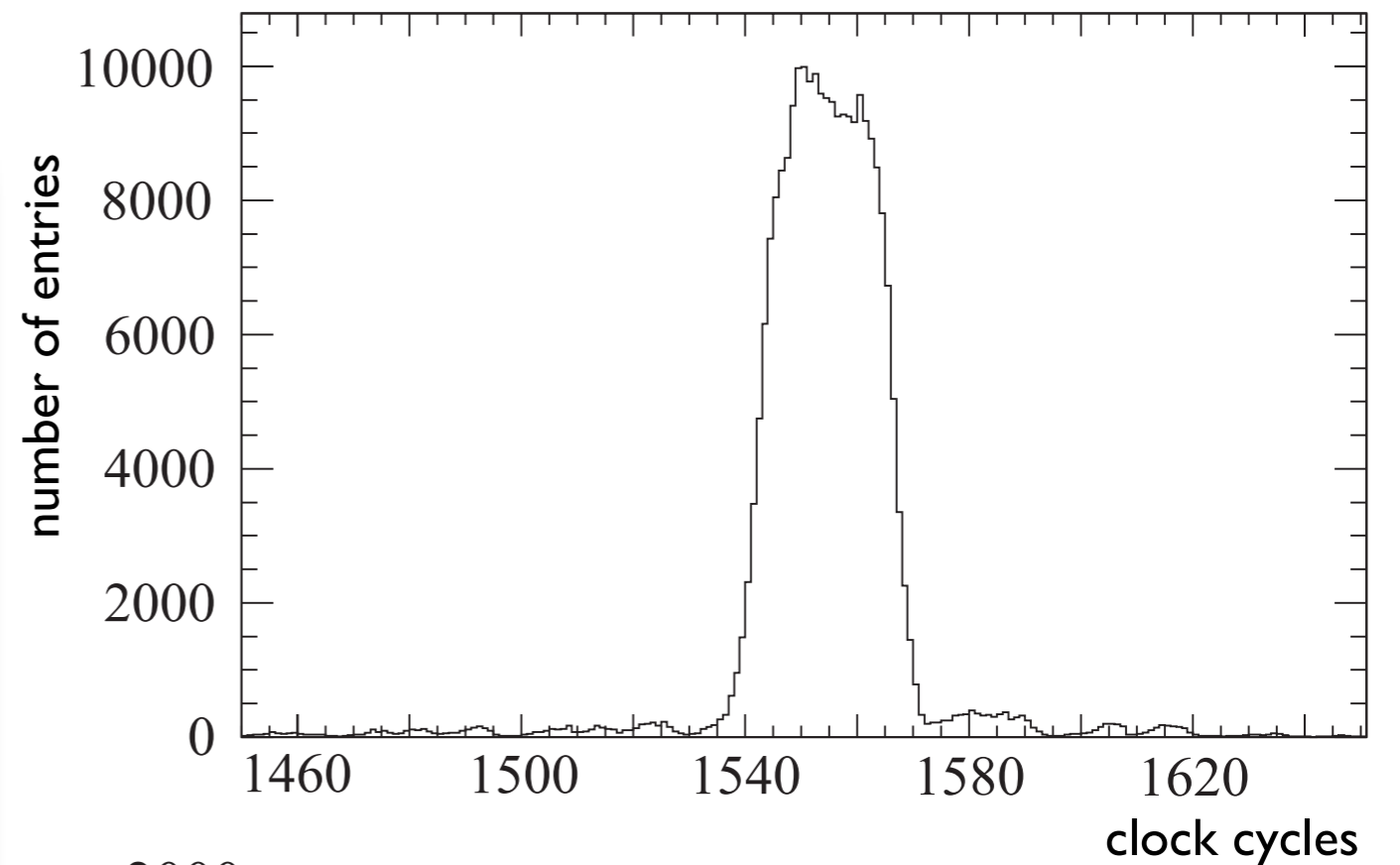
unconnected pixels

Spectrum of all pixels in time mode:

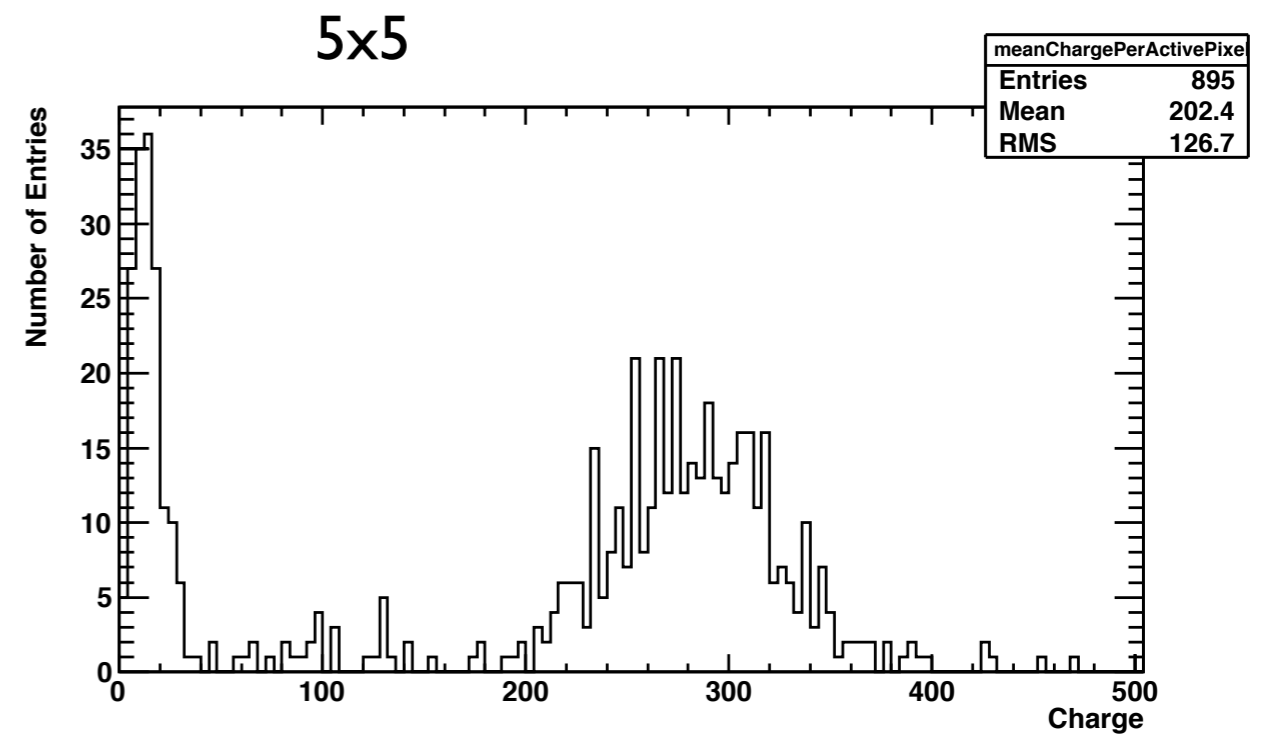
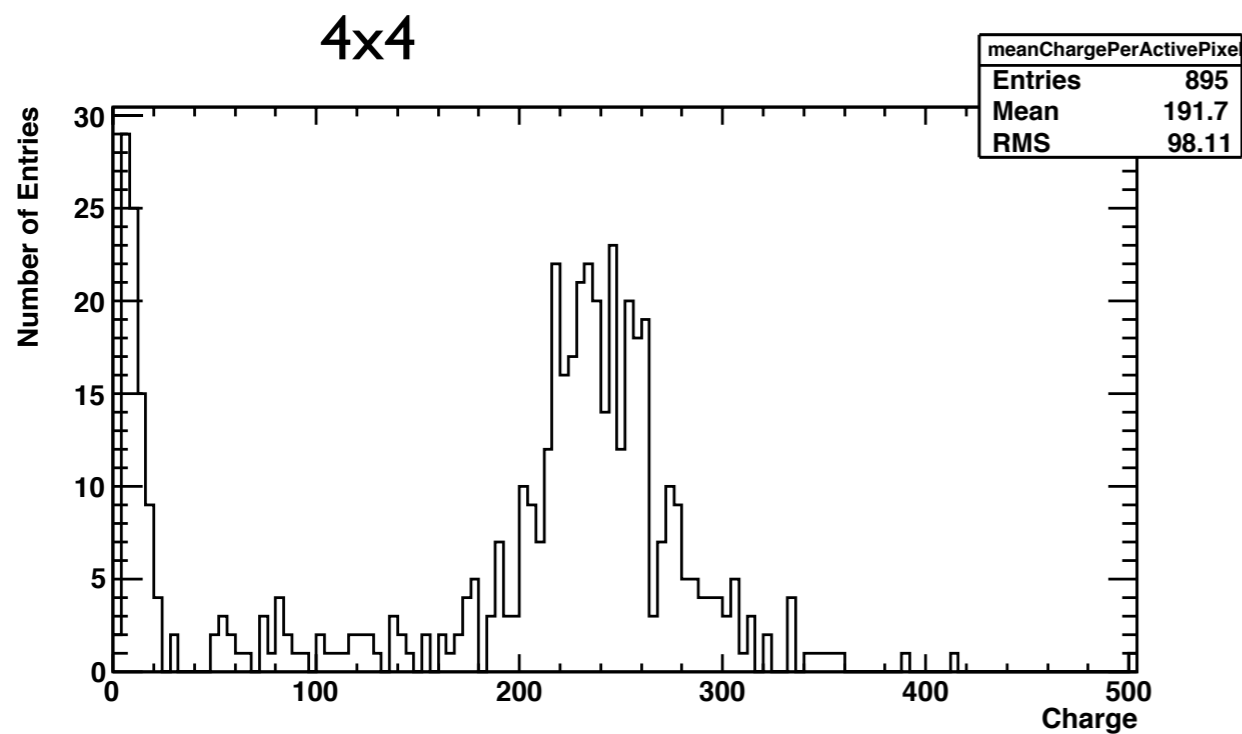
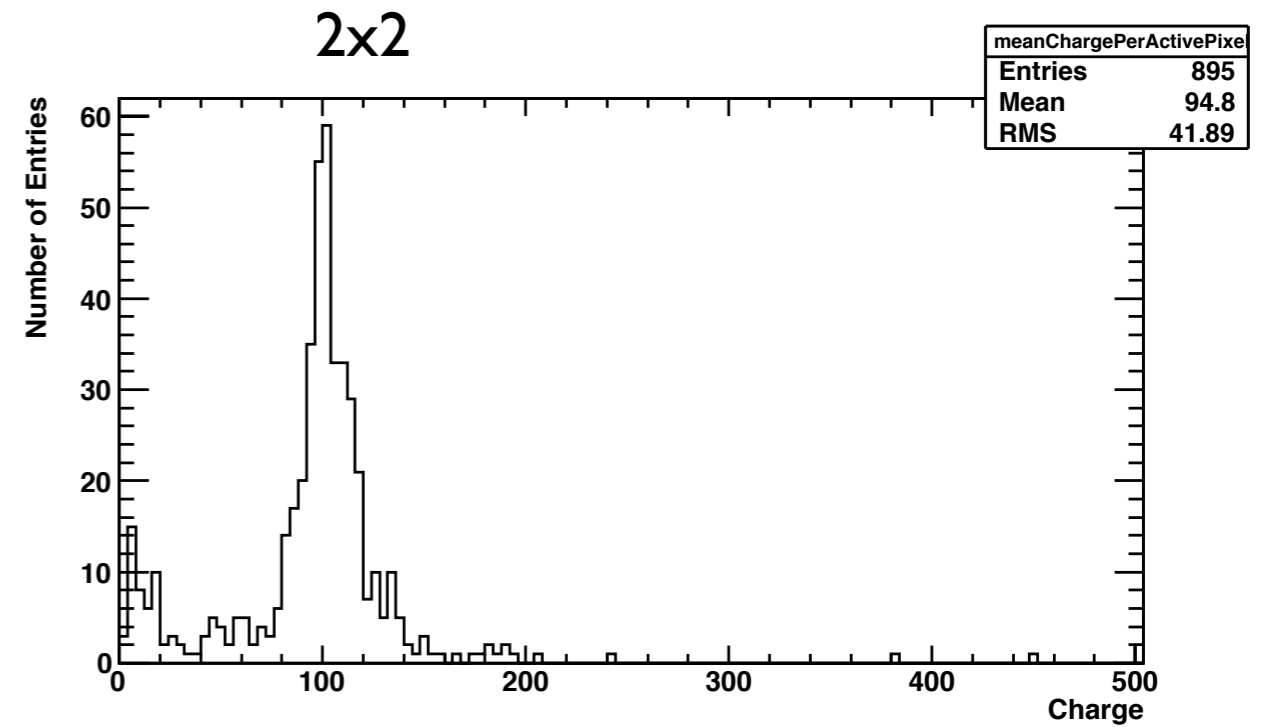
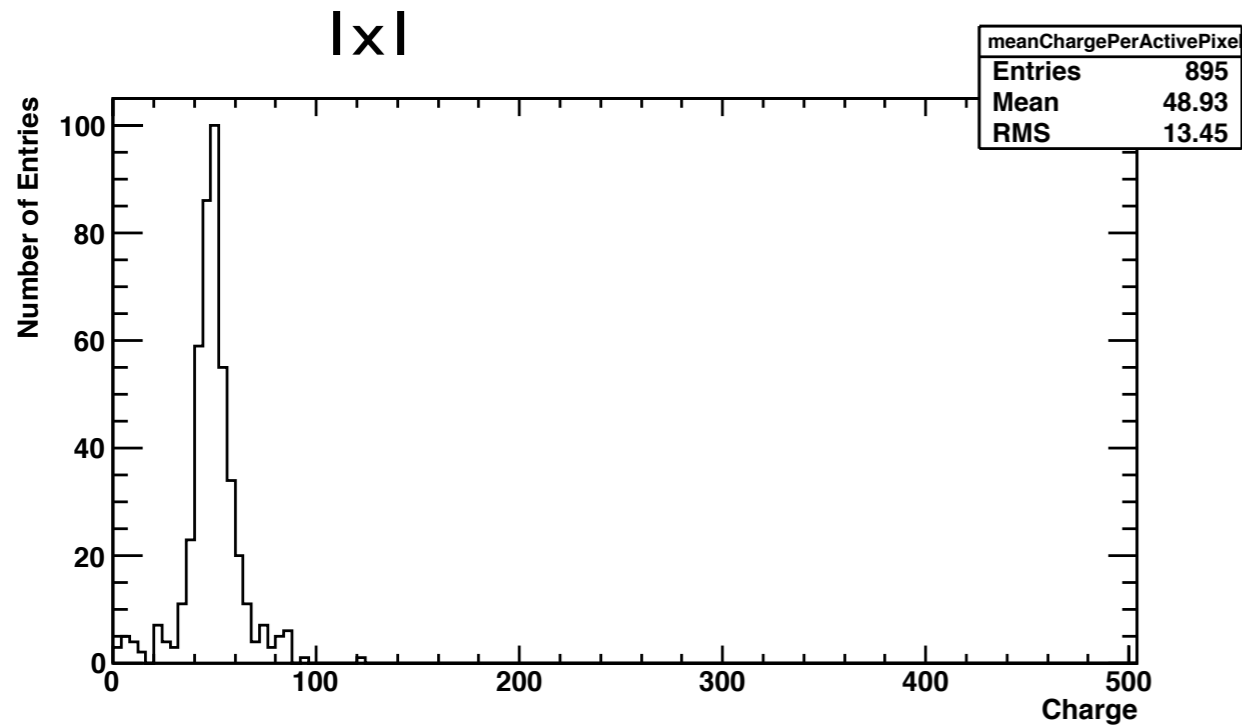
- beam profile in drift direction
- position of the peak was determined by iterative method

fit results:

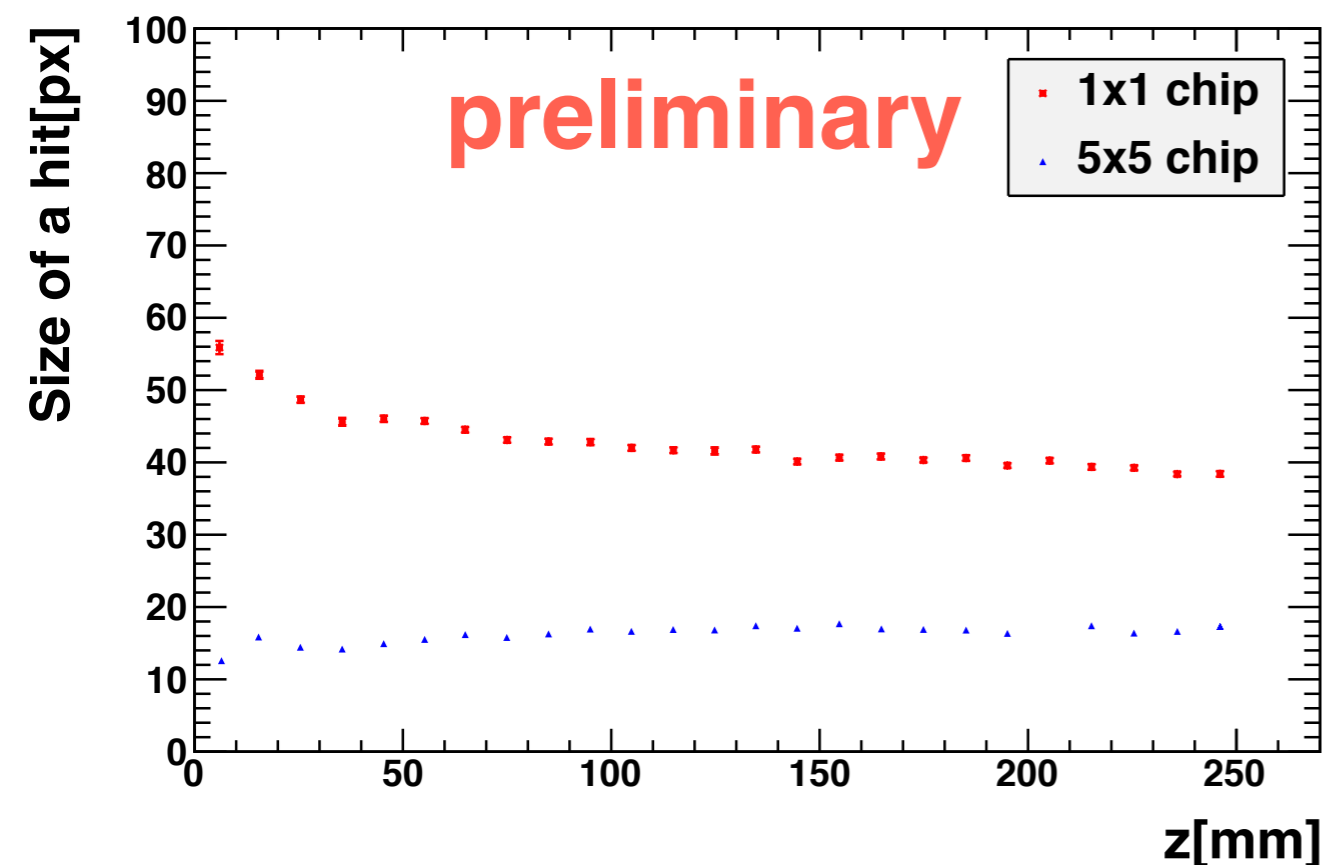
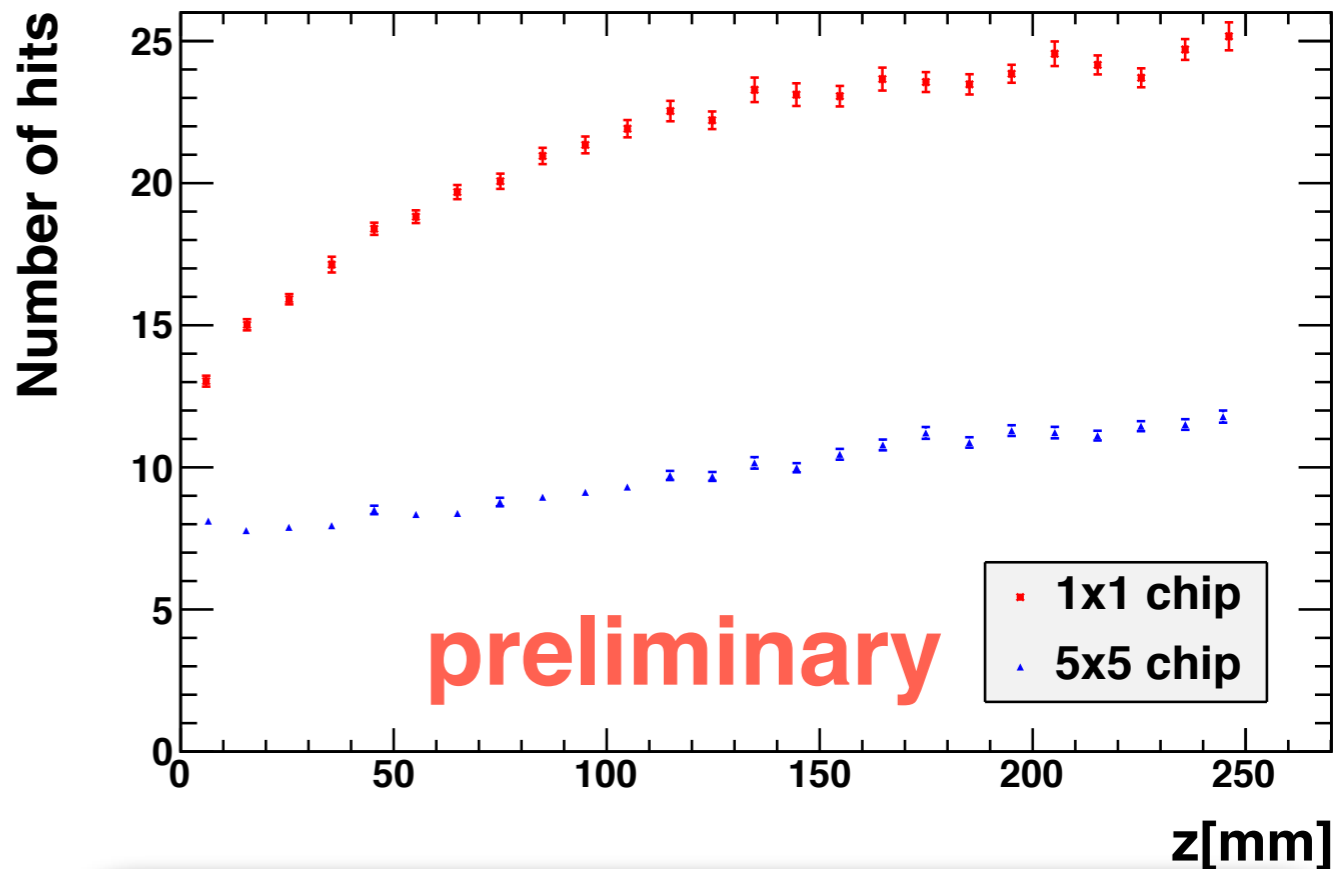
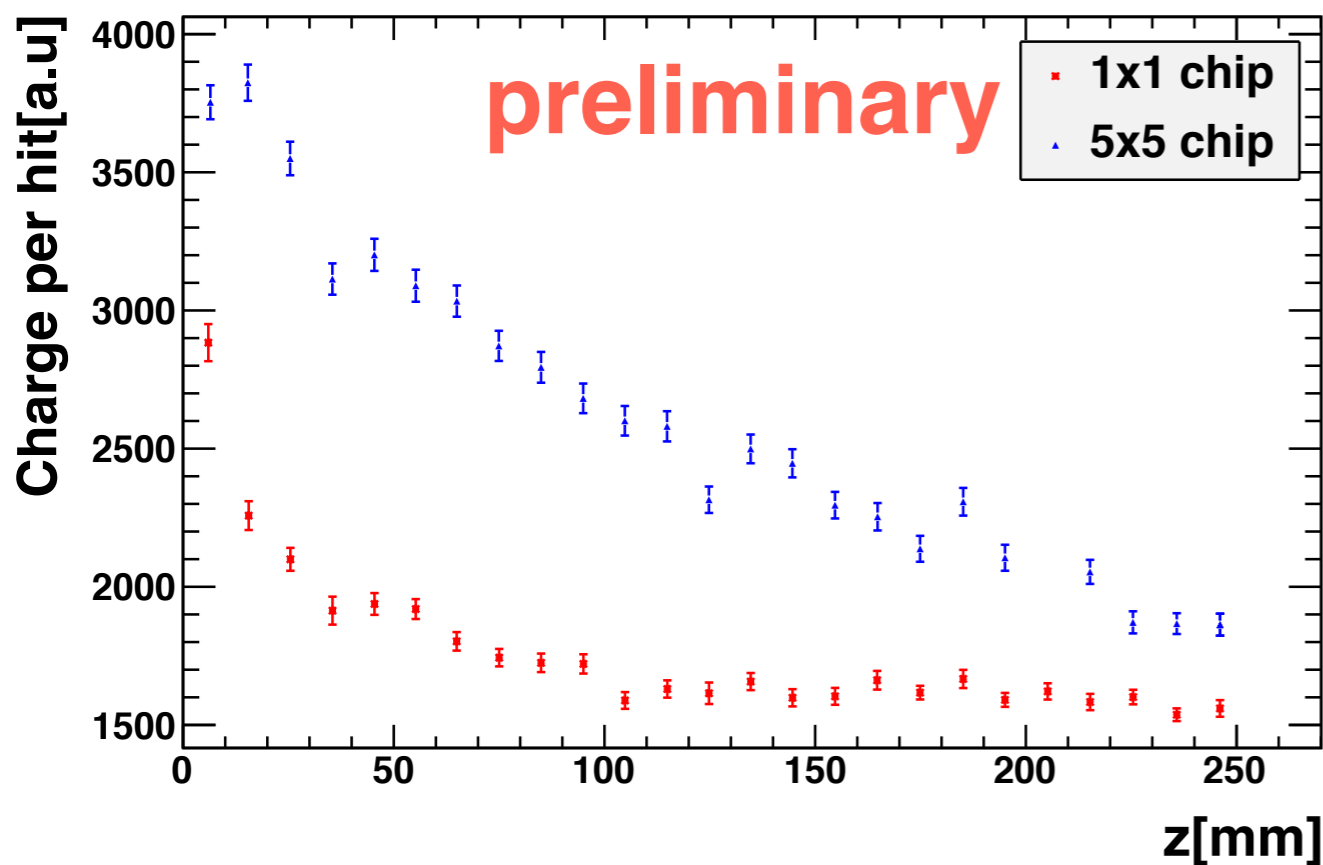
- shutter length: $35.1 \mu\text{s}$
- clock frequency: 55.6 MHz
- drift velocity: $0.99 \text{ cm}/\mu\text{s}$



Mean Charge per Active Pad



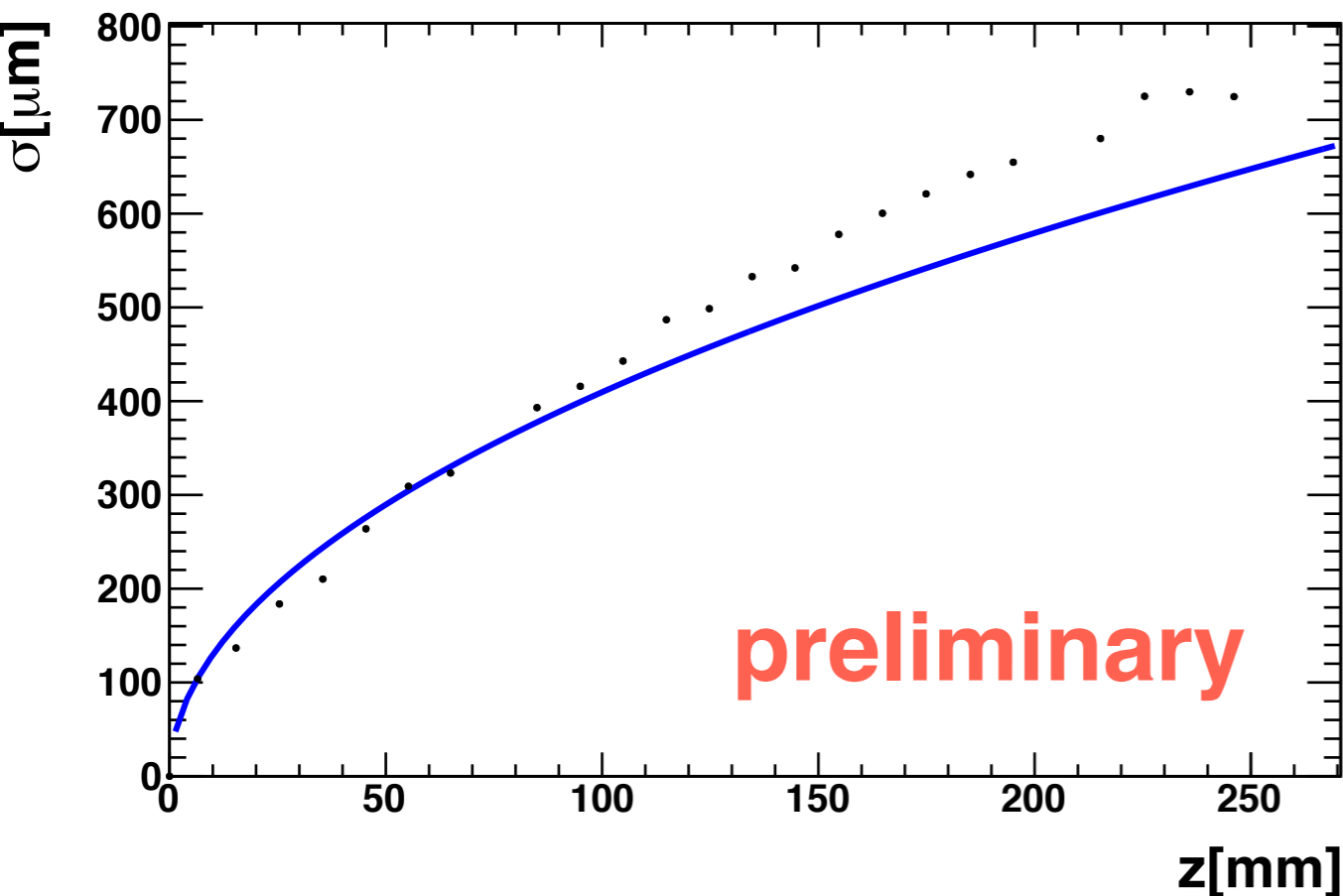
Plots are from raw data!



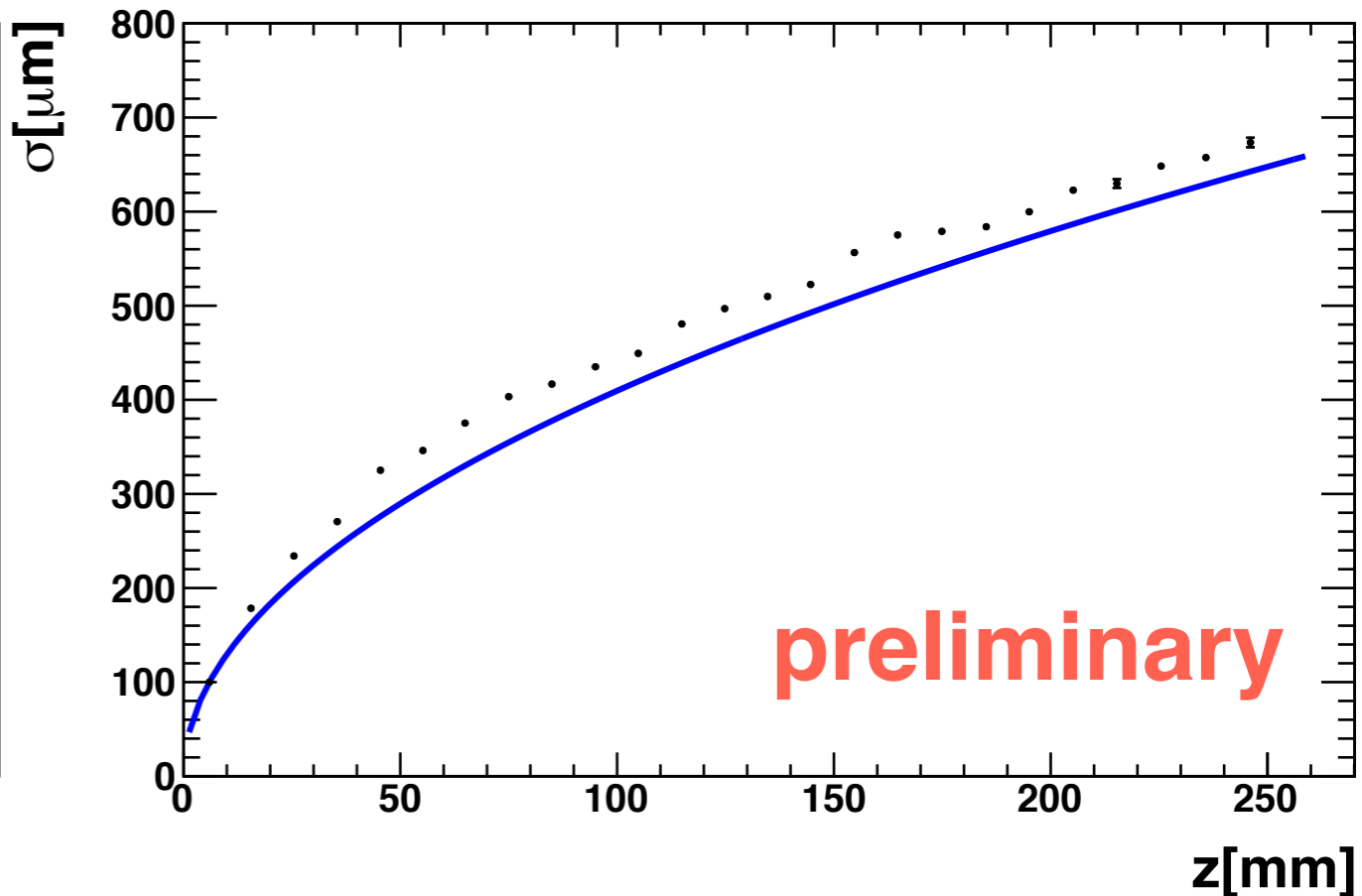
Comparison of 5x5 and 1x1:

- More charge per hit
 - Fewer hits per track reconstructed
 - Clustersize constant over drift distance
- ➔ Clusters are more difficult to separate

5x5 chip: transversal spatial resolution



1x1 chip: transversal spatial resolution



- Blue line: for single electron diffusion $\sigma = D_T \sqrt{z}$
$$D_T = 129.541 \frac{\mu\text{m}}{\sqrt{\text{cm}}}$$
- Transversal spatial resolution is of the same magnitude

- A readout module for the Bonn TPC Prototype was tested successfully at the SPS accelerator
- Higher charge deposition at same gas gain was observed on the postprocessed chips
- Separation of the clusters on 5x5 chip needs to be improved
- Transversal spatial resolution is in the same order of magnitude
- Next step: Analysis in dependence of the gas gain
- Analysing the Data of the 2 other chips is work in progress