Digital Pixel Calorimeter
Status and Next Steps

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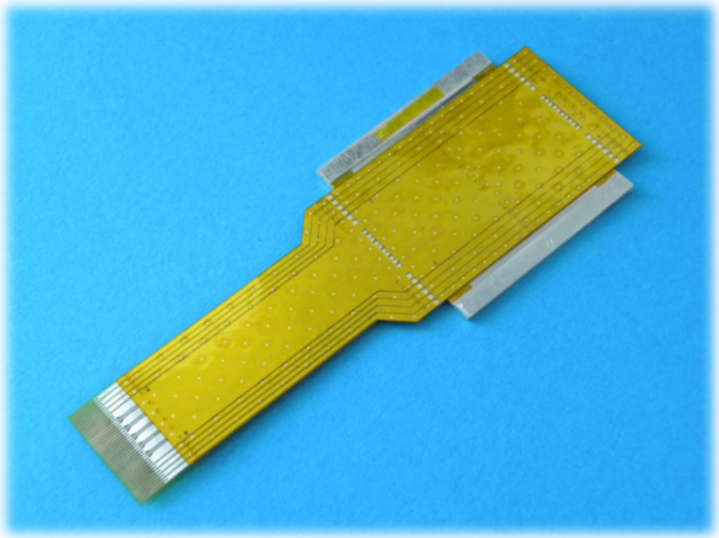
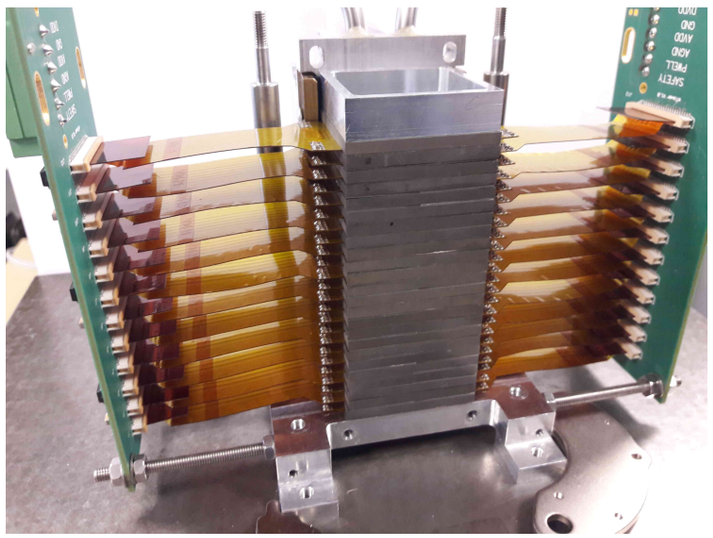
Status of Pixel R&D with Prototypes

- MIMOSA-based prototype:
  - successful proof of principle of digital calorimeter
    - single layer has information on shower energy (to be quantified)
  - precision measurements of lateral shower profiles in single layers
    - very narrow shower core, basis of two-shower separation power
- ALPIDE-based prototype:
  - ALPIDE works in calorimetric environment
    - can read out high density hit patterns, no artefacts seen in EM shower shapes up to 5.8 GeV (to be confirmed with higher energy at SPS)
  - performance similar or better than MIMOSA
    - better energy resolution, lower noise: should allow to use extrapolations from MIMOSA performance
  - higher readout rate than MIMOSA
    - current prototype limited by readout via USB link, full readout rate to be confirmed with realistic DAQ system

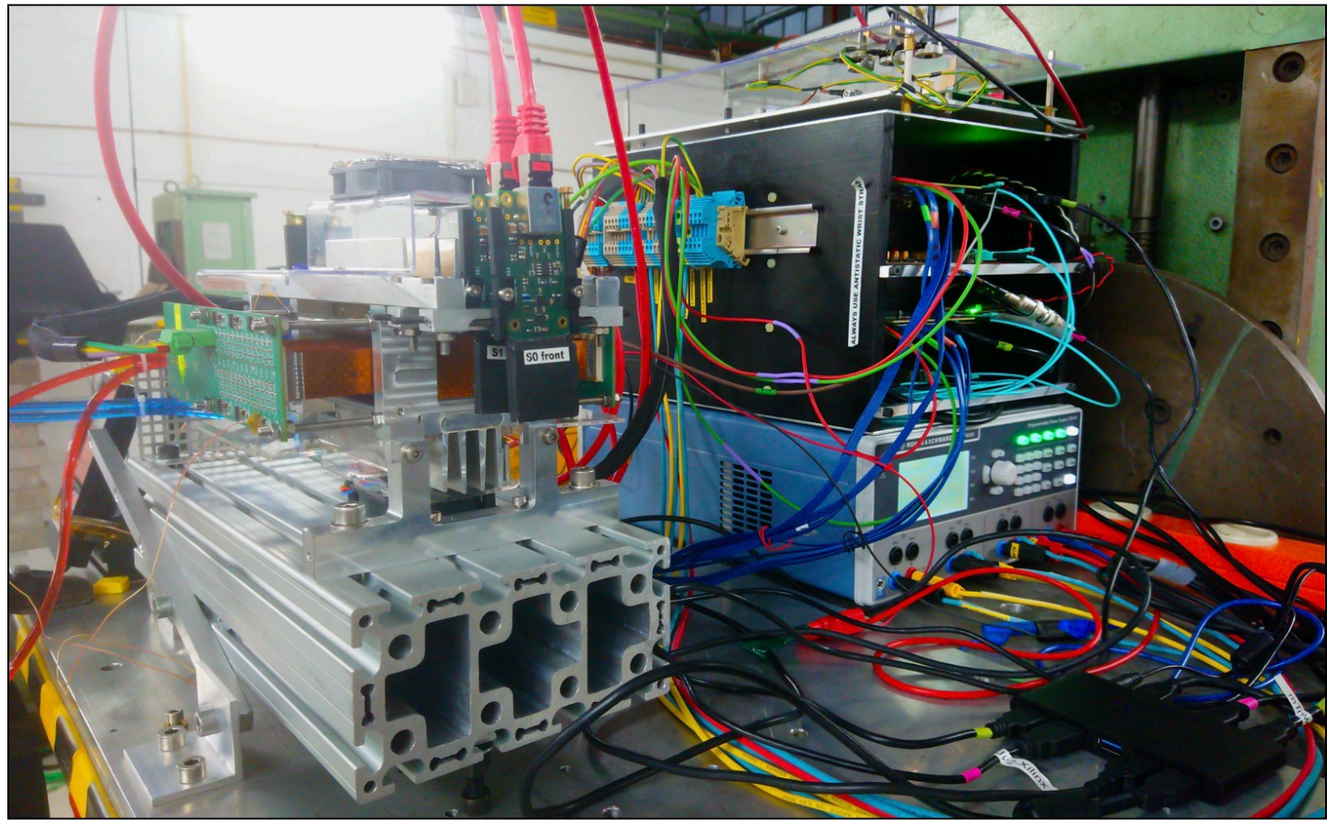
ALPIDE: Prototype in Test Beam



mTower prototype layer
(LTU, Kharkov)



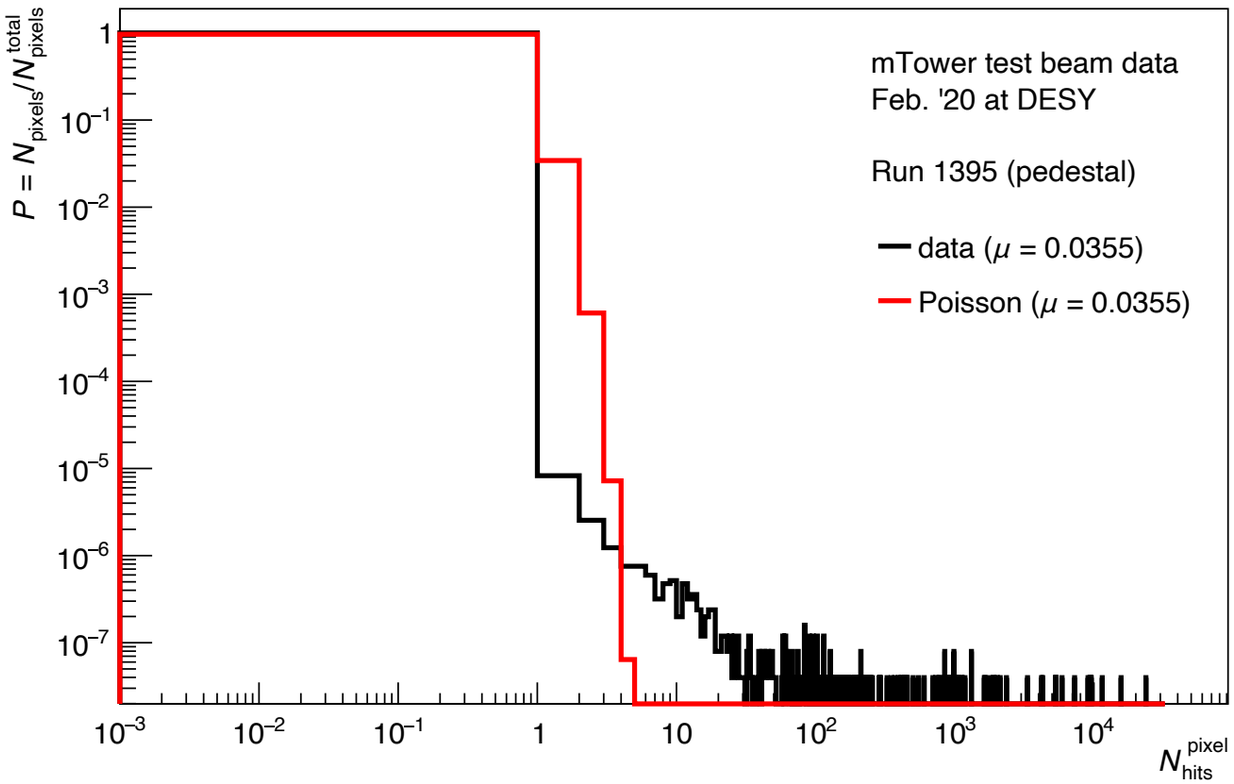
mTower prototype assembly (Utrecht)
24 layers, 2 sensors each, 3x3 cm² cross section



Test beams at DESY:
Nov 2019 (12 layers), Feb 2020 (24 layers)

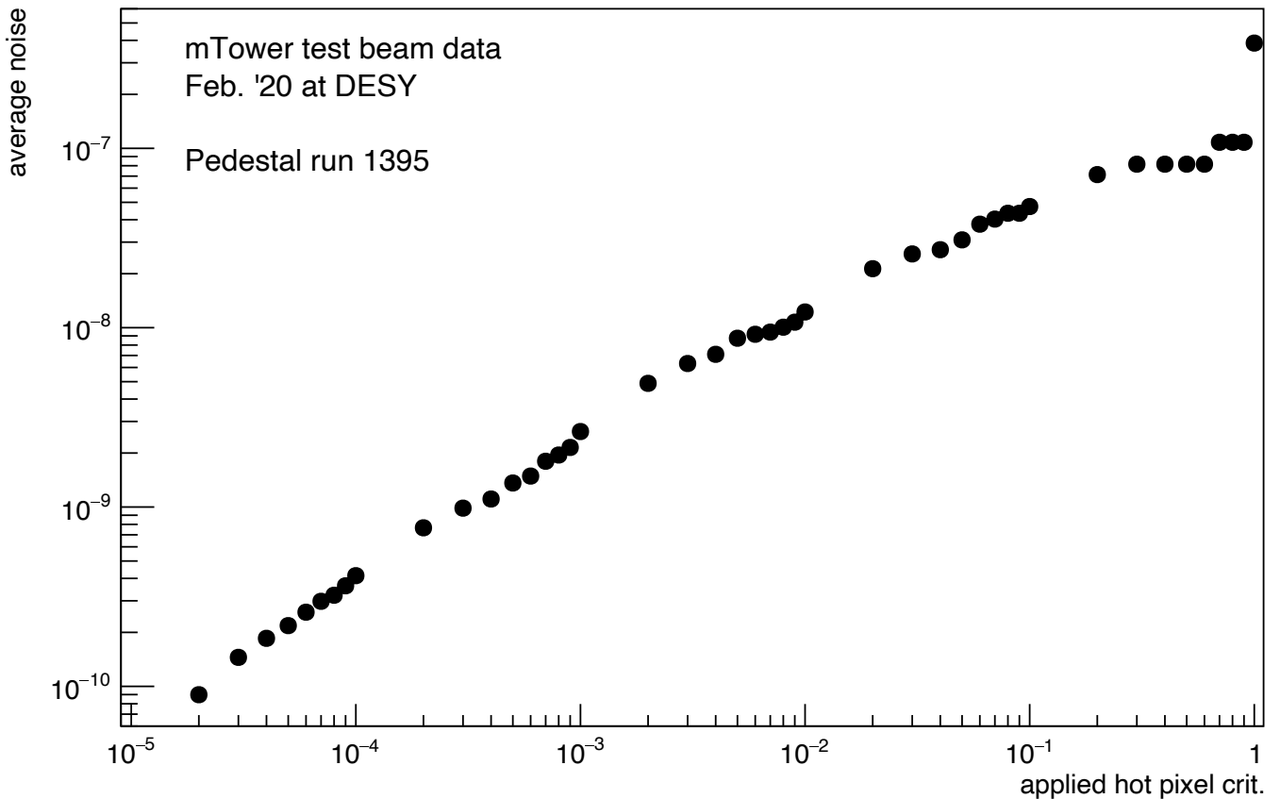
R. Barthel, A. van Bochove, E. Broeils, N. van der Kolk, T. Peitzmann, S. van Rijk, M. Rossewij, H. Yokoyama *(Utrecht, Nikhef)* – R. Bosley, N. Watson *(Birmingham)* – V. N. Eikeland, E. H. Solheim *(Bergen)* – Q. W. Malik *(Oslo)* – F. Pliquet *(Frankfurt)*

ALPIDE Prototype: First Results



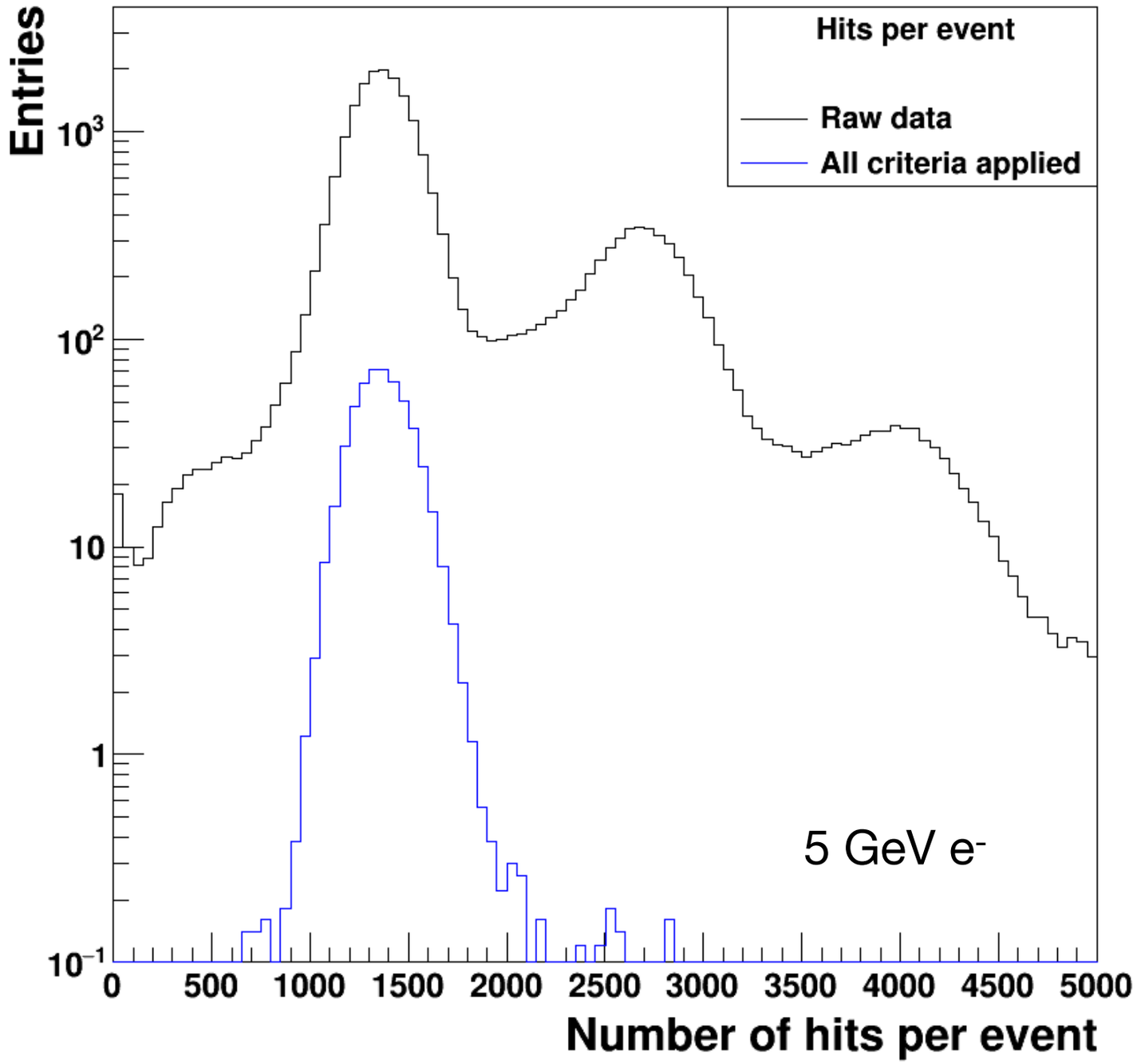
noise from pedestal runs

random noise very low



very few additional hot pixels

ALPIDE Prototype: First Results



significant pileup in test beam

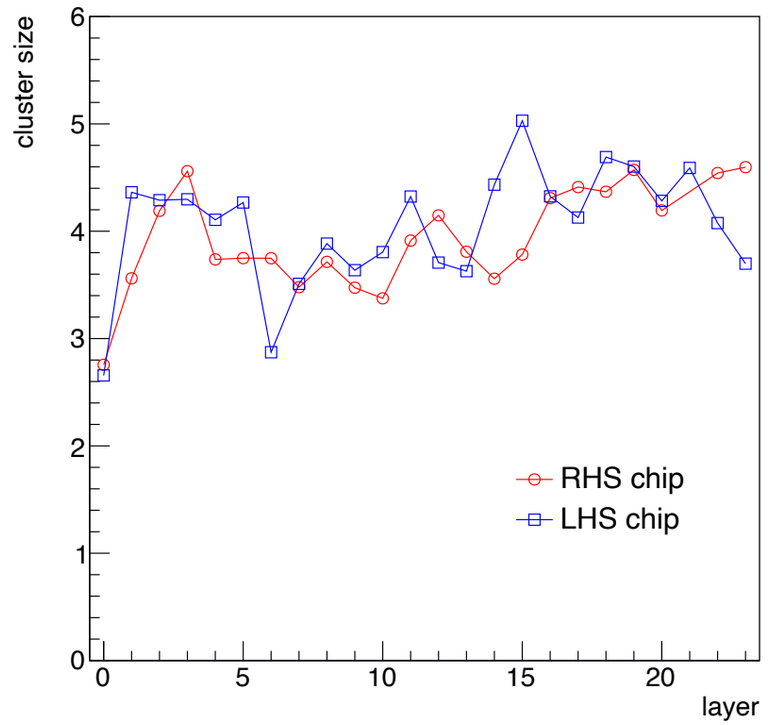
offline pileup rejection possible

still studying (small) residual pileup effects

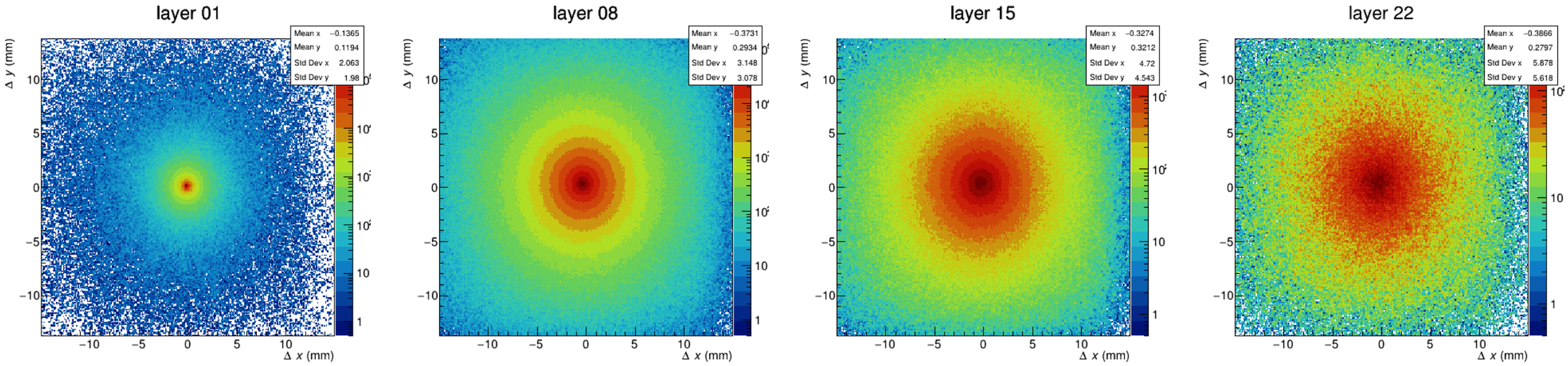
ALPIDE Prototype: First Results

Test beam Feb 2020: 24 layer prototype

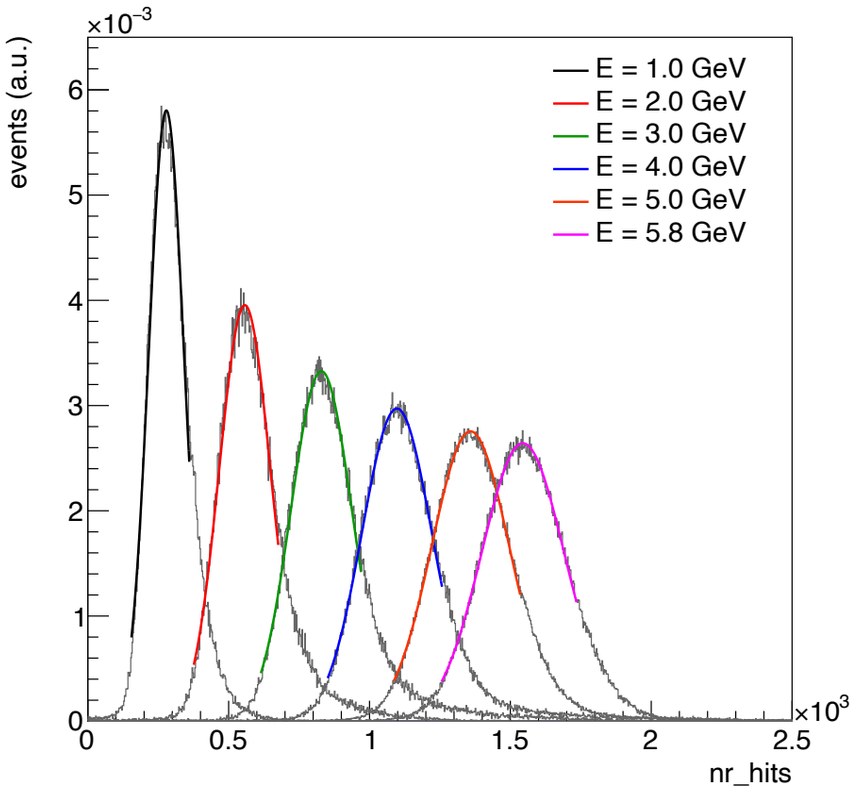
preliminary gain correction
from cluster size



5 GeV electrons: average shower shape evolution

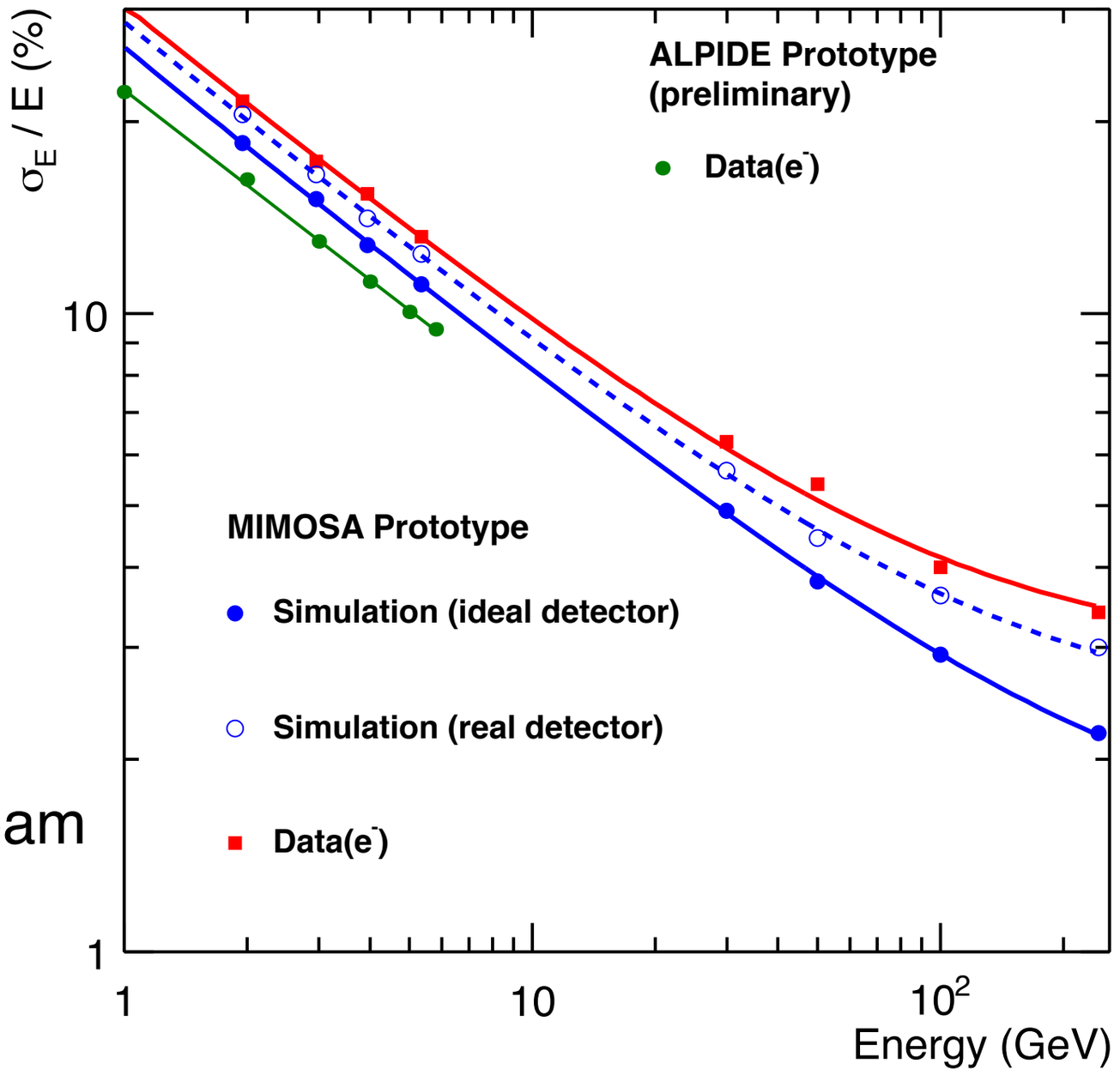


ALPIDE: Energy Resolution



preliminary results of DESY test beam

- using preliminary pileup rejection and calibration



MIMOSA prototype:

$$\frac{\sigma_E}{E} = \frac{28.5\,\%}{\sqrt{E/\mathrm{GeV}}} \oplus 3.0\,\%$$

ALPIDE prototype:

$$\frac{\sigma_E}{E} = \frac{22.3\,\%}{\sqrt{E/\mathrm{GeV}}} \oplus 0.2\,\%$$

first analysis shows very good performance: work in progress

Pixel R&D Next Steps

- Can still further exploit data of MIMOSA-based prototype:
  - detailed shower shapes up E = 244 GeV
- Ongoing analysis with ALPIDE based prototype
  - Solve a few issues: residual pileup, artefacts from trigger inefficiency
- Further beam tests
  - Another beam test at DESY (improved setup)?
  - Long-term: high energy data at SPS
- Gearing up for first papers
  - performance paper (e.g just linearity and resolution)
  - technical paper (sensors properties, noise, readout, …)

Status of FoCal Project in ALICE

- Internal ALICE approval of LoI: May 15, 2020
- LoI submitted to LHCC
- LHCC approval of LoI: June 2, 2020
  - LoI available at https://cds.cern.ch/record/2719928
- Now preparing for TDR

- Interested groups welcome!
  - SiW pad technology (similar to CALICE ECAL/CMS HGCAL)
  - SiW pixel technology (based on Alpide sensor, see this talk)
  - “generic” hadronic calorimeter
  - all other modern calorimeter challenges …