MuPix8 Status

– PANDA Collaboration Meeting 2021/2 –
Luminosity Detector Session

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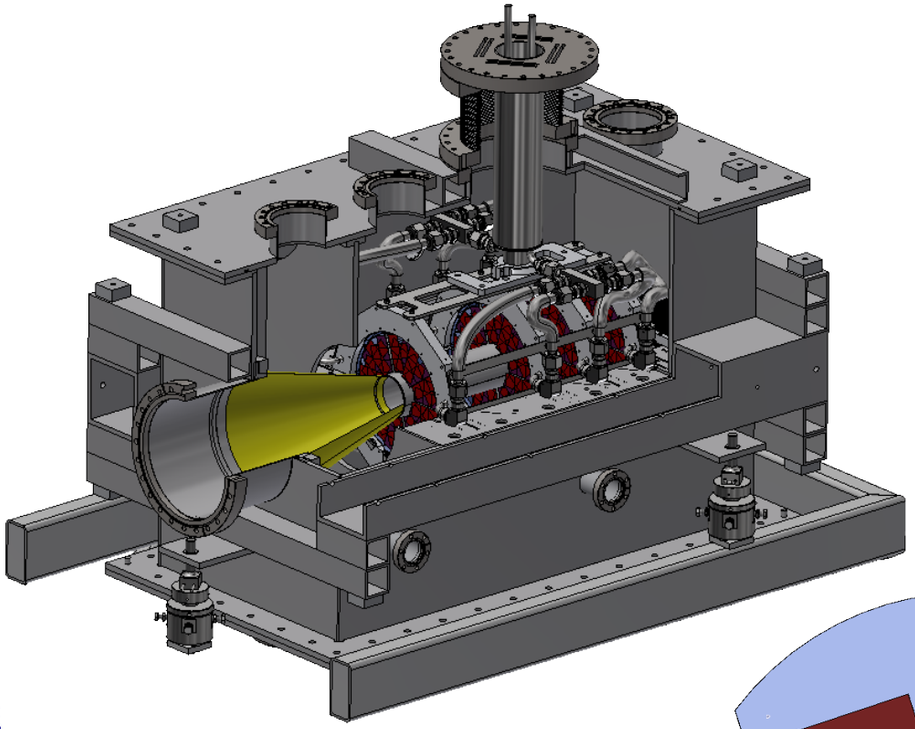
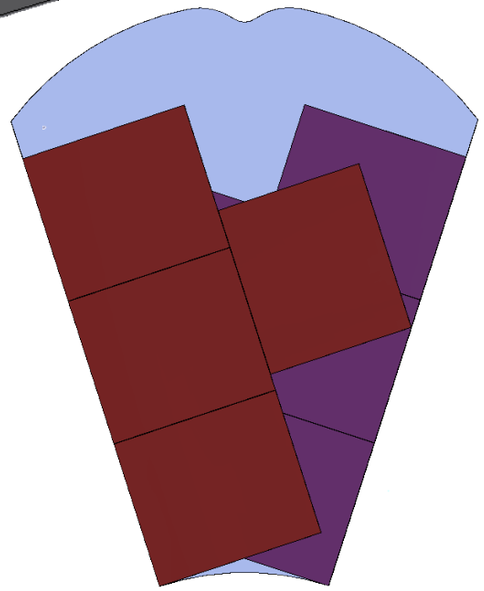
Luminosity Detector (LMD)

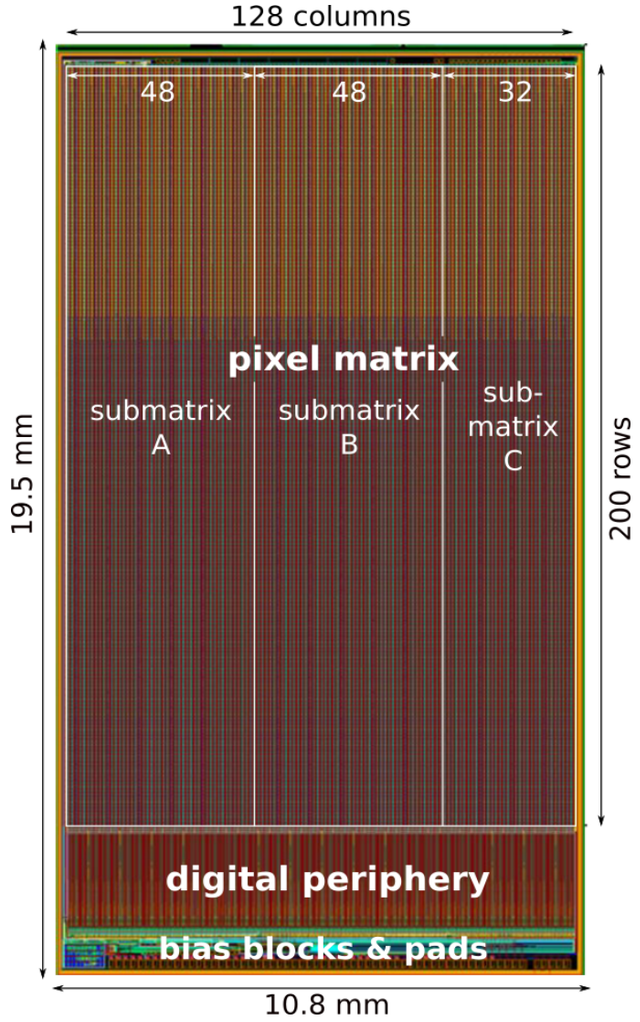
- 11 m behind IP
- Measure tracks of elastically scattered anti-protons
- Anti-protons enter detector vacuum through transition cone
- 4 detector layers with HV-MAPS on both sides
- 10 sensor modules per layer
- Aluminum holding structure with embedded steel pipe for cooling (coolant: -20°C ethanol)
- Total number of sensors: 320
- Active area of one sensor: 2 × 2 cm²
- Pixel size: 80 × 80 µm²





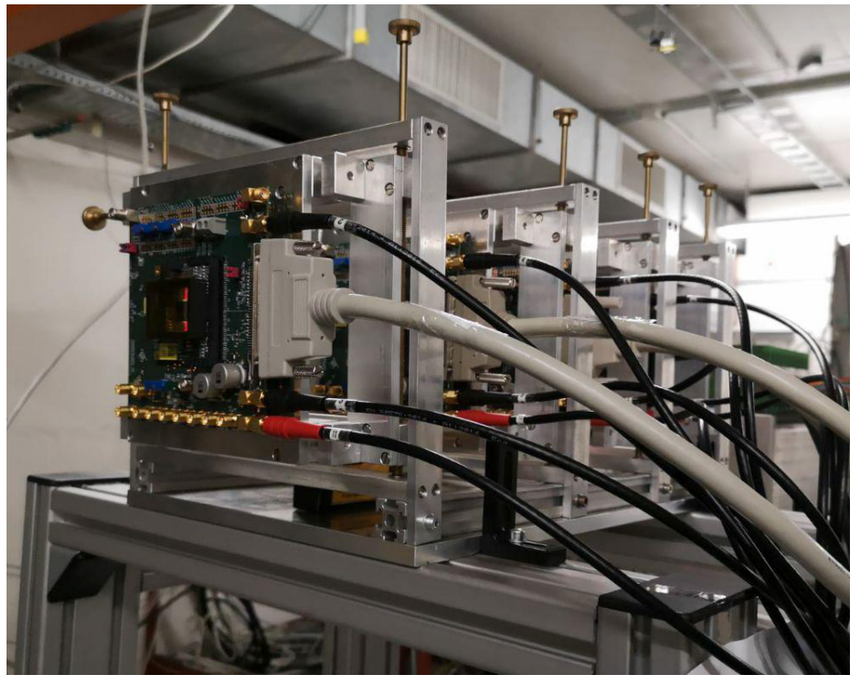
The MuPix8 Chip

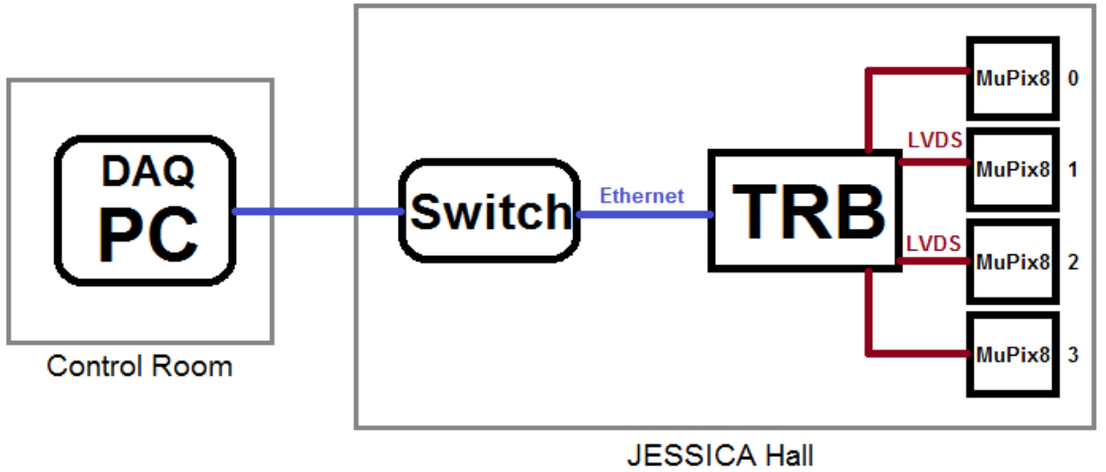
- Originally developped for Mu3e
- Physical size: 10.8 × 19.5 mm²
- Active area: ~ 10.2 × 16.2 mm²
- Matrix: 128 × 200 Pixels, three Submatrices
  MatA: source follower
  MatB/C: current mode
- Pixel: 80 × 81 µm²
- Charge sensitive amplifier in each pixel
- Two comparators in each periferal cell
  (timewalk compensation)
- 4 LVDS links (each submatrix + select/mux)
- Analog readout of Hitbus (ToT information)
  and amplifier output (for leftmost column only)



Testbeam Analysis – Efficiency Estimation

- Analysis of testbeam data taken at COSY in March 2020
  - 4 Layer Telescope read out via TRBv3





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- Based on analysis method for MuPix6 Telescope
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Testbeam Analysis – Efficiency Estimation

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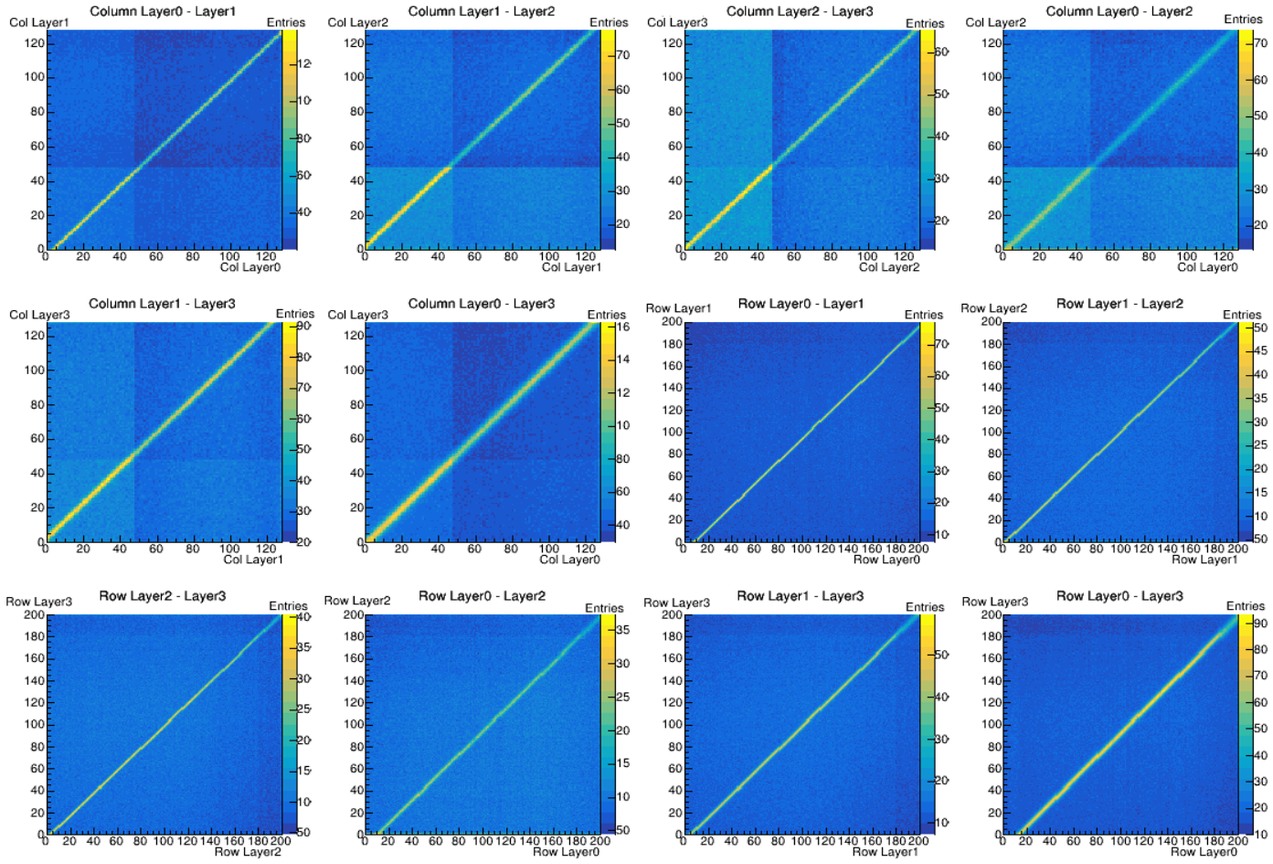
- Based on analysis method for MuPix6 Telescope adapted for MuPix8:
  - Software alignment of layers

Column and Row Correlations for all matrices:
HV = 50 V and ThHigh = 600 mV



Testbeam Analysis – Efficiency Estimation

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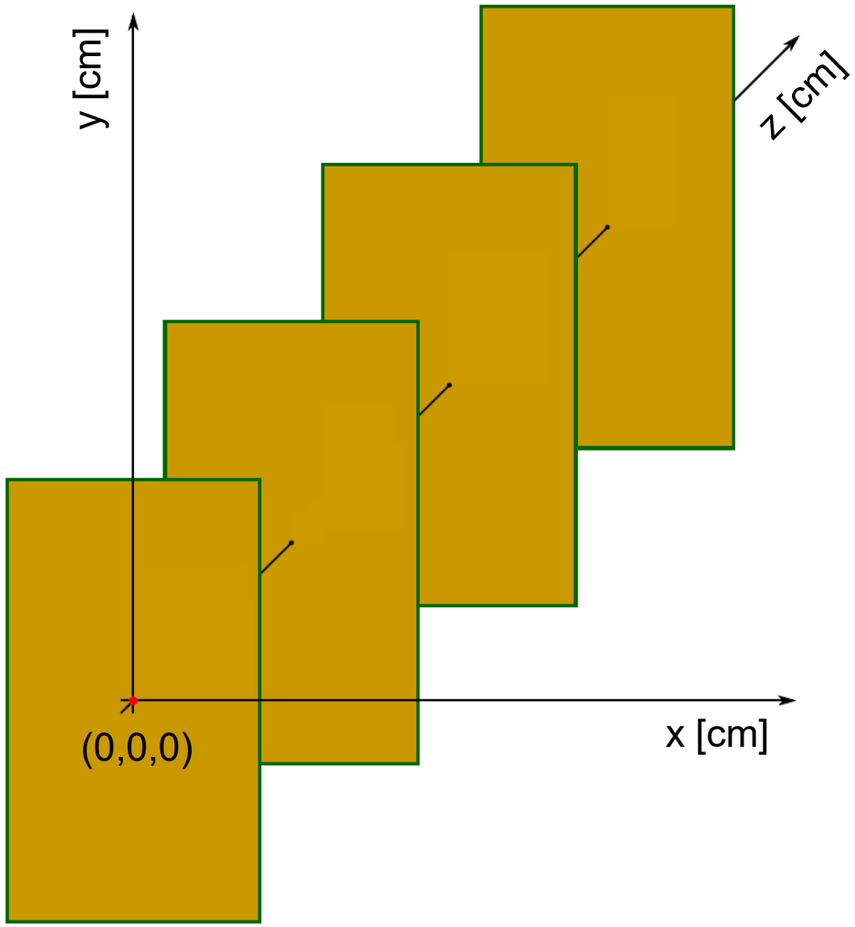
- Based on analysis method for MuPix6 Telescope adapted for MuPix8:
  - Software alignment of layers
  - Coordinate transformation to global x-, y-, z-coordinates



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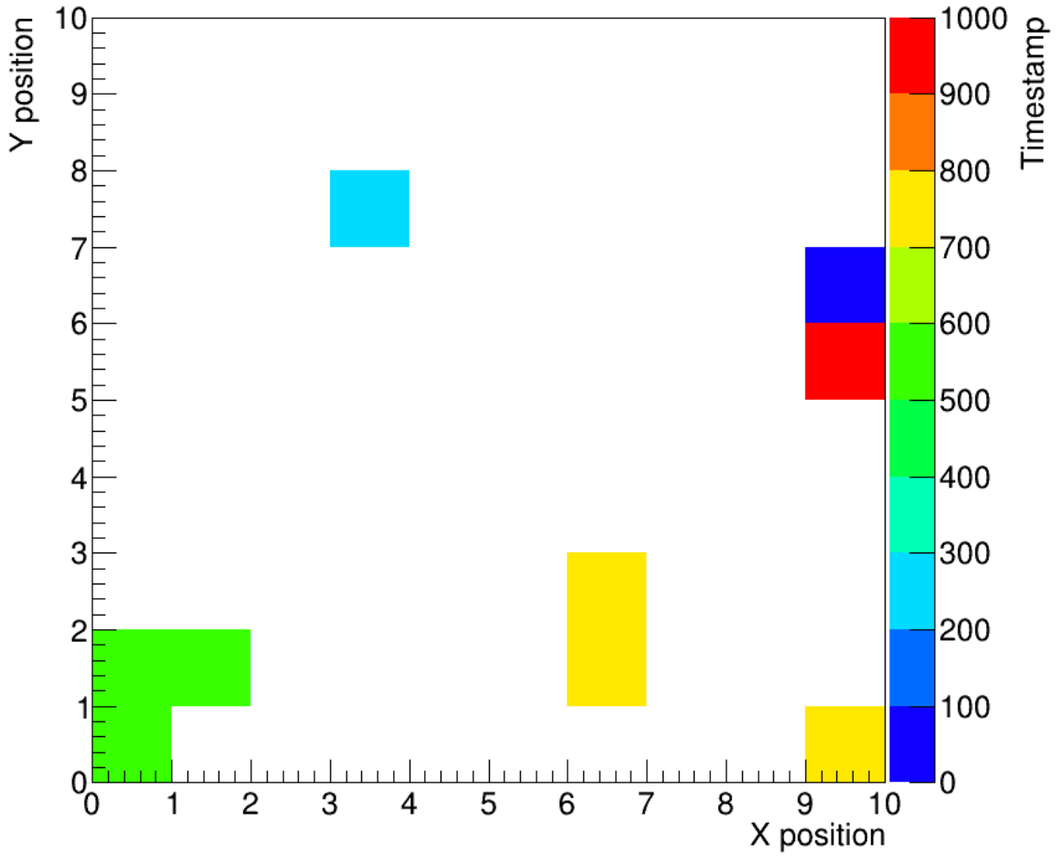
- Analysis of testbeam data taken at COSY in March 2020

- Based on analysis method for MuPix6 Telescope adapted for MuPix8:
  - Software alignment of layers
  - Coordinate transformation to global x-, y-, z-coordinates
  - Hit sorting & cluster finder

Pseudo data for cluster finding algorithm test



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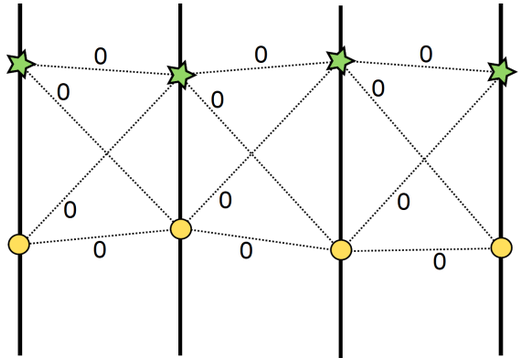
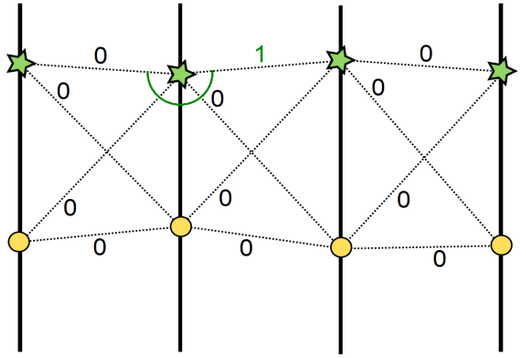
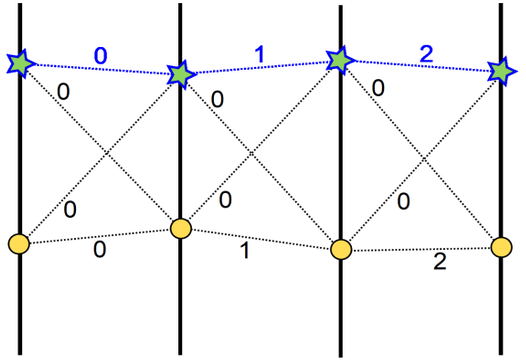
- Based on analysis method for MuPix6 Telescope adapted for MuPix8:
  - Software alignment of layers
  - Coordinate transformation to global x-, y-, z-coordinates
  - Hit sorting & cluster finder
  - Tracking algorithm based on cellular automaton & linear fit method



Initialization



Forward Evolution



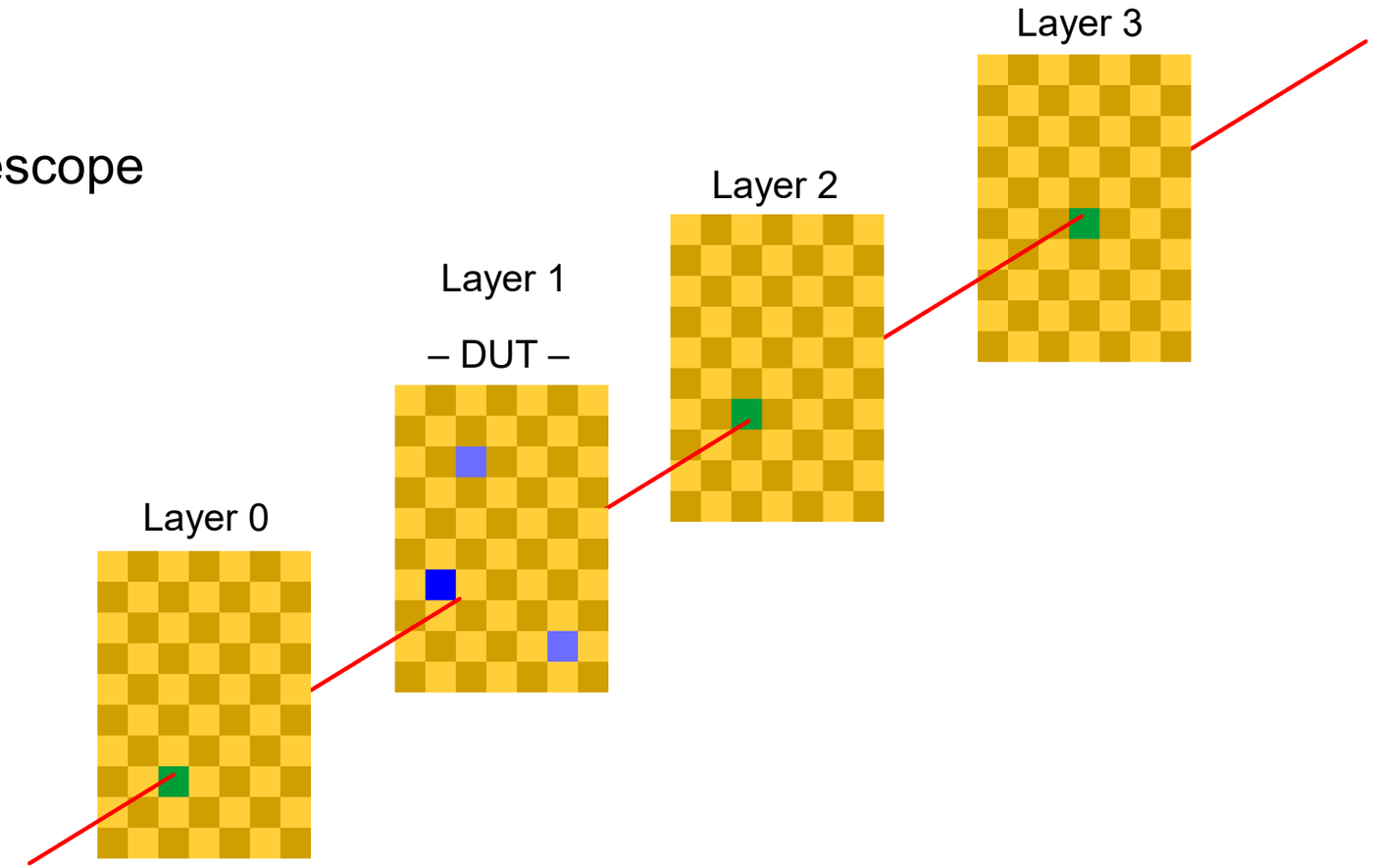
Backward Pass

Testbeam Analysis – Efficiency Estimation

- Analysis of testbeam data taken at COSY in March 2020

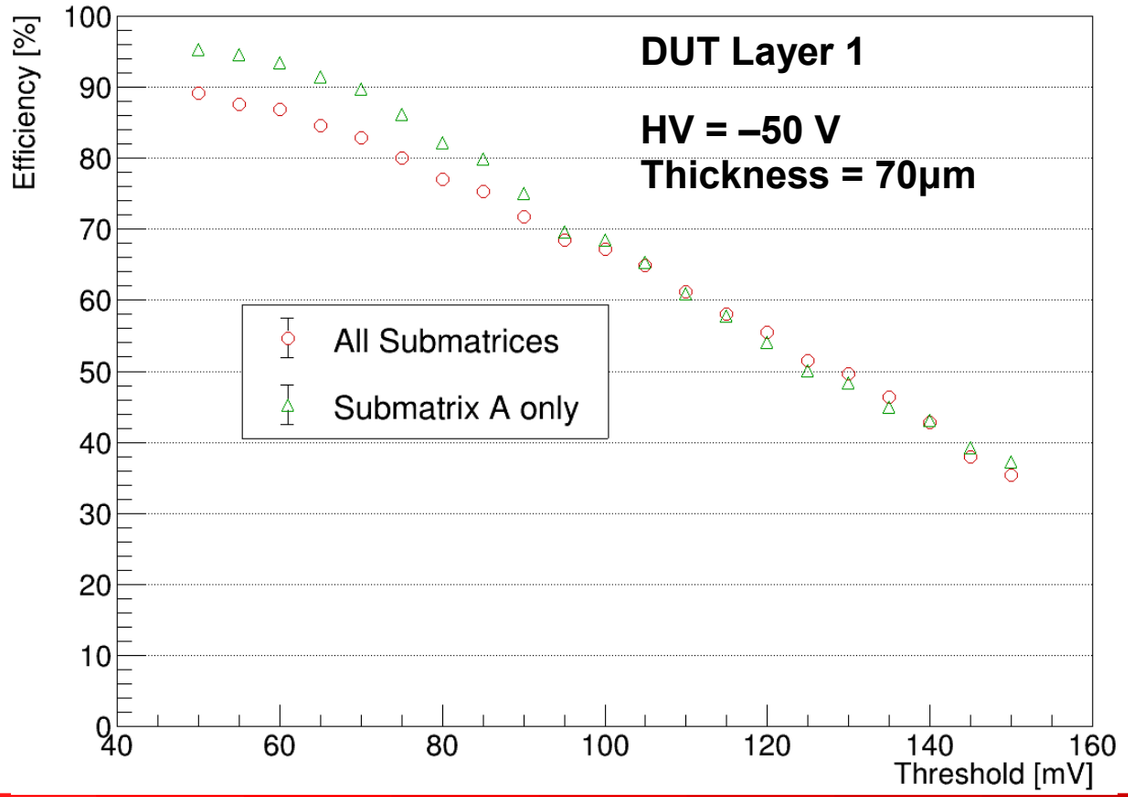
- Based on analysis method for MuPix6 Telescope adapted for MuPix8:
  - Software alignment of layers
  - Coordinate transformation to global x-, y-, z-coordinates
  - Hit sorting & cluster finder
  - Tracking algorithm based on cellular automaton & linear fit method
  - Efficiency calculation:

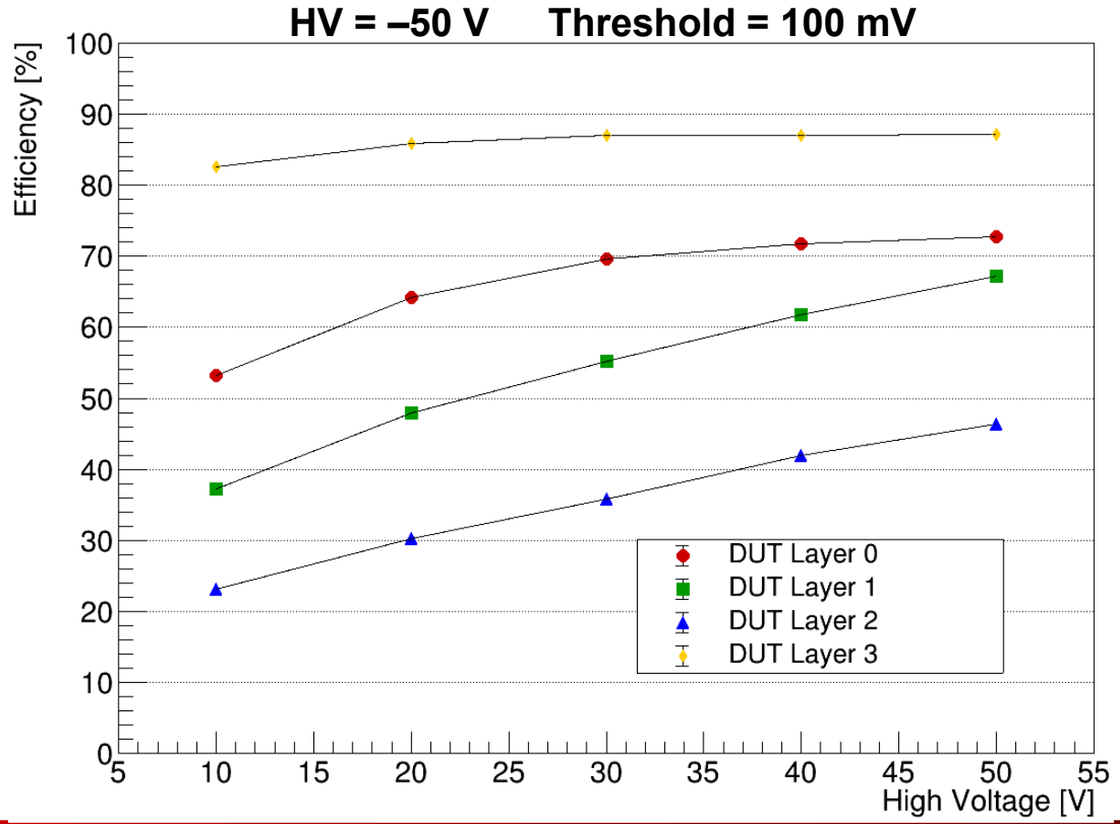
$$\text{efficiency} = \frac{\#\text{ of tracks w/ DUT hit}}{\#\text{ of all tracks}}$$



Efficiency Result

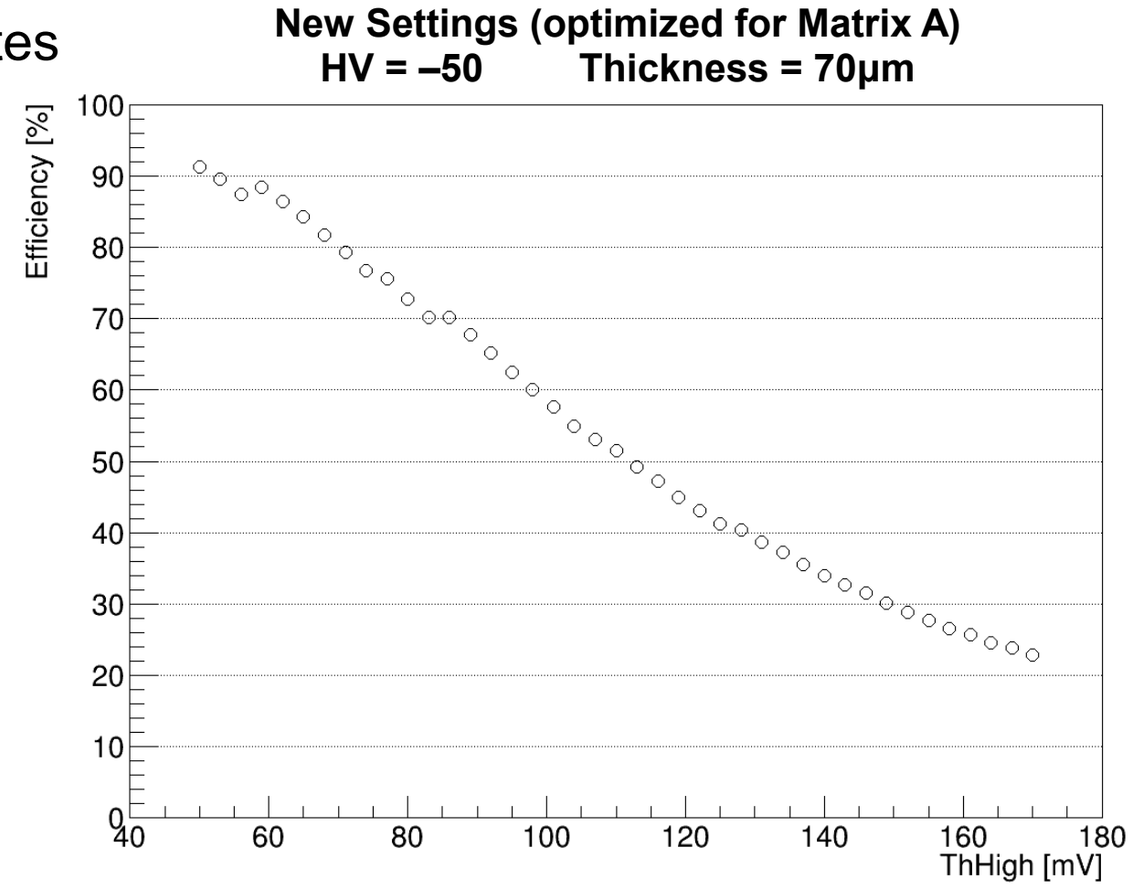
- Estimated mean efficiency for all submatrices and submatric A only
- Very fast drop-off in efficiency at higher thresholds observed
  - Possible issue with MuPix settings: Full Matrix readout not optimized for performance
- Different performances for different DUTs





Testbeam May 2021

- 4 Layer Telescope in beam at COSY (TOF Hall)
  - Readout (again) with TRBv3 at higher trigger rates with optical connection to the outside
  - Two different settings for MuPix8 (full sensor, improved Matrix A)
  - Several DUTs with different thicknesses (50 µm, 70 µm, 100 µm, 625 µm)
  - Thresholdscans at different HVs



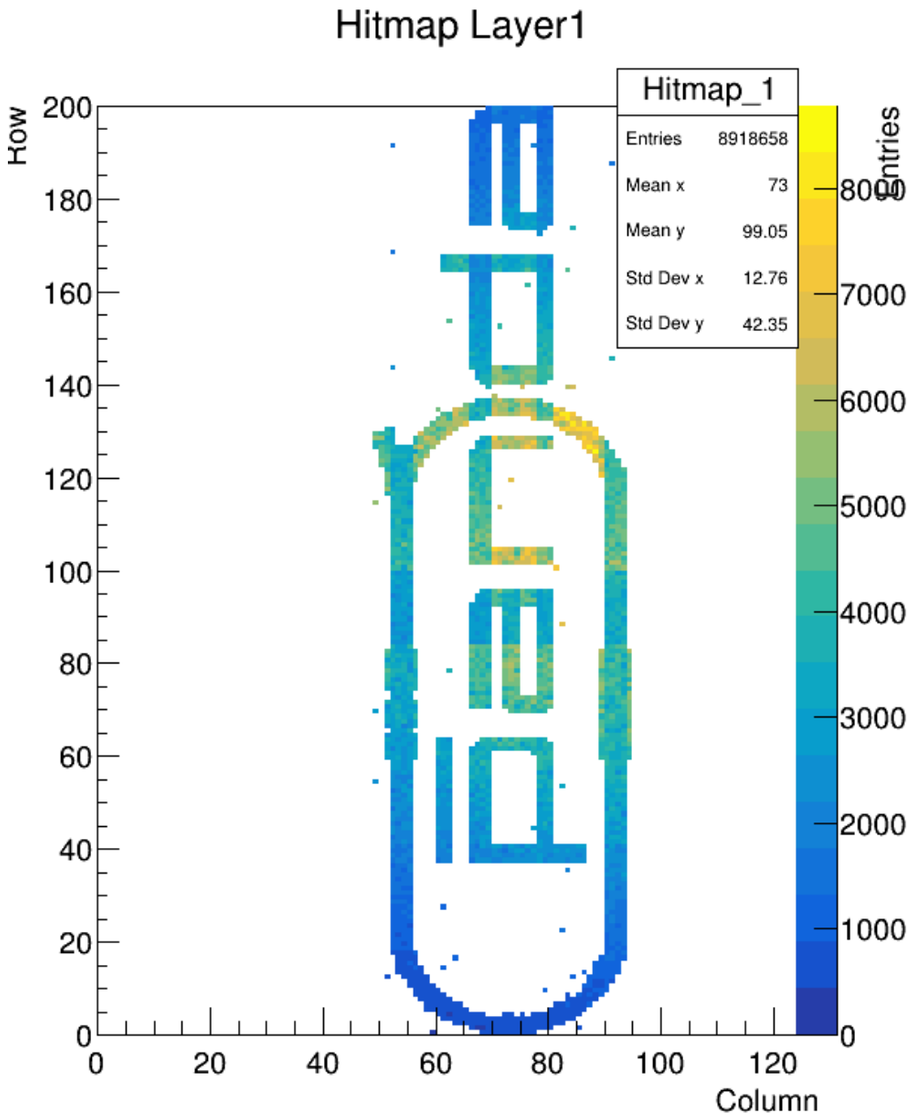
- Preliminary efficiency results of "new" settings show no improvement

- Debugging of Kintex7 DAQ (see Florian's talk)

Summary & Outlook

- Testbeam data analysis based on cellular automaton algorithm used for MuPix6
  - Fast drop-off in efficiencies
  - Overall worse performance of matrices B and C

- New testbeam data need further analysis but first results show no improvement
  - Maybe still some issue with one of the analysis steps (?)
  - Focus on MuPix10 for prototype



Matrix B of MuPix8 with PANDA Mask