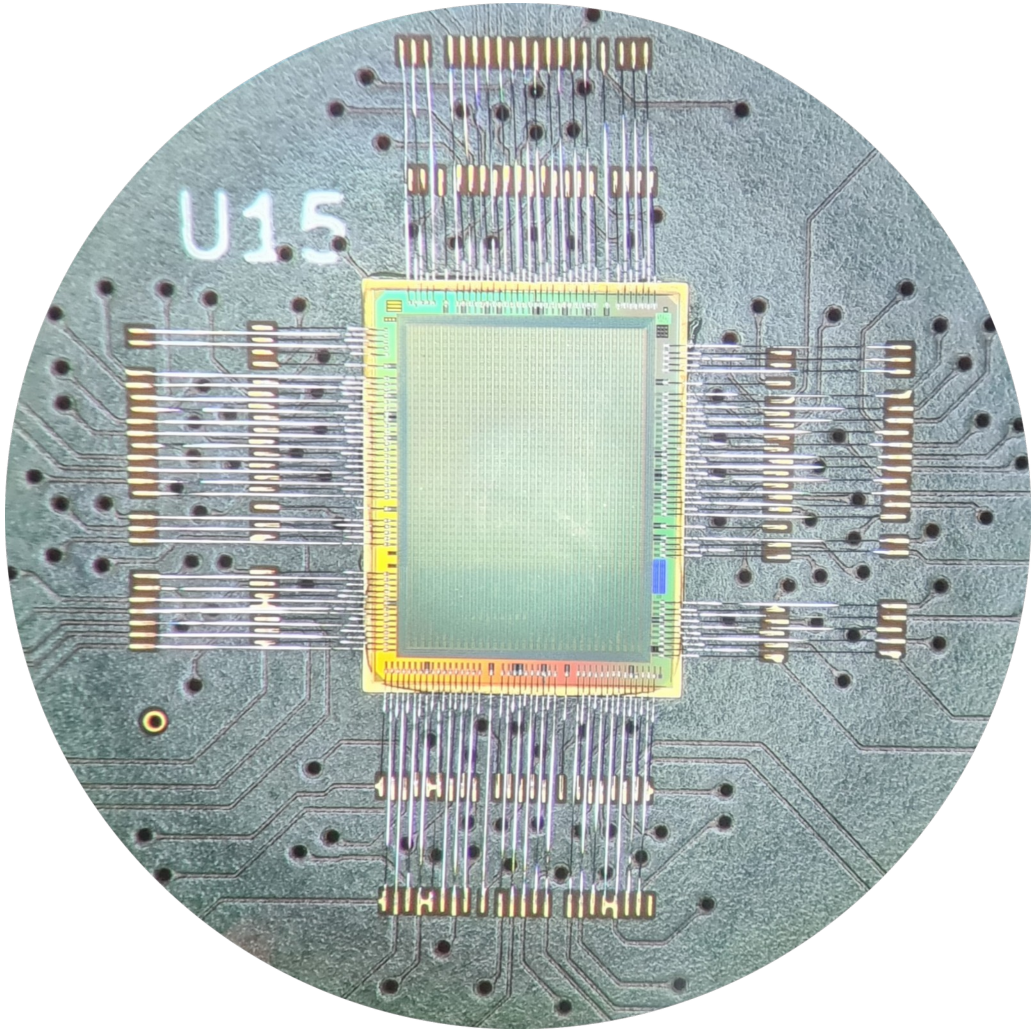
Further Testbeam Analysis

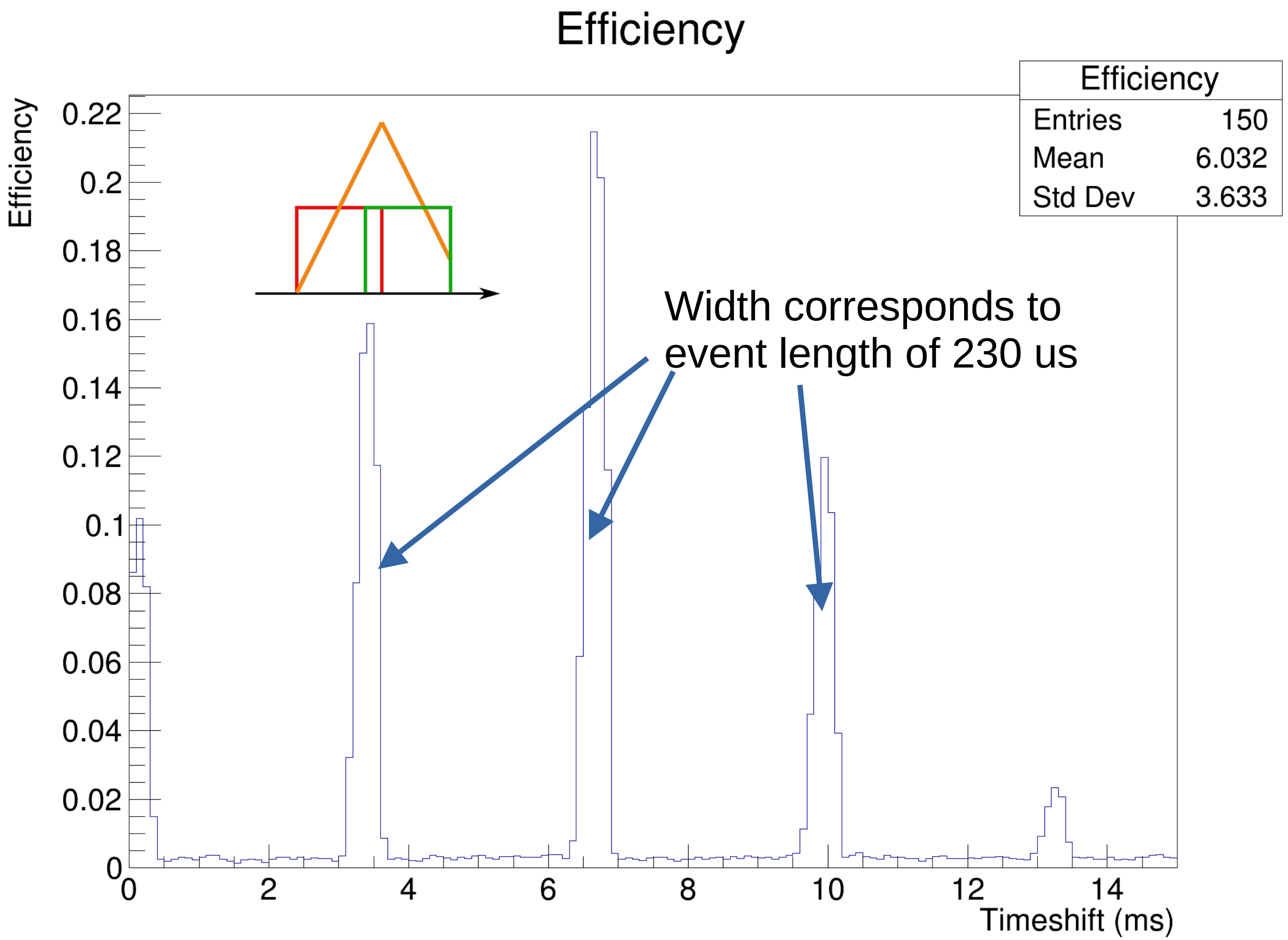
Short followup on previous work



Last time: Improved efficiency

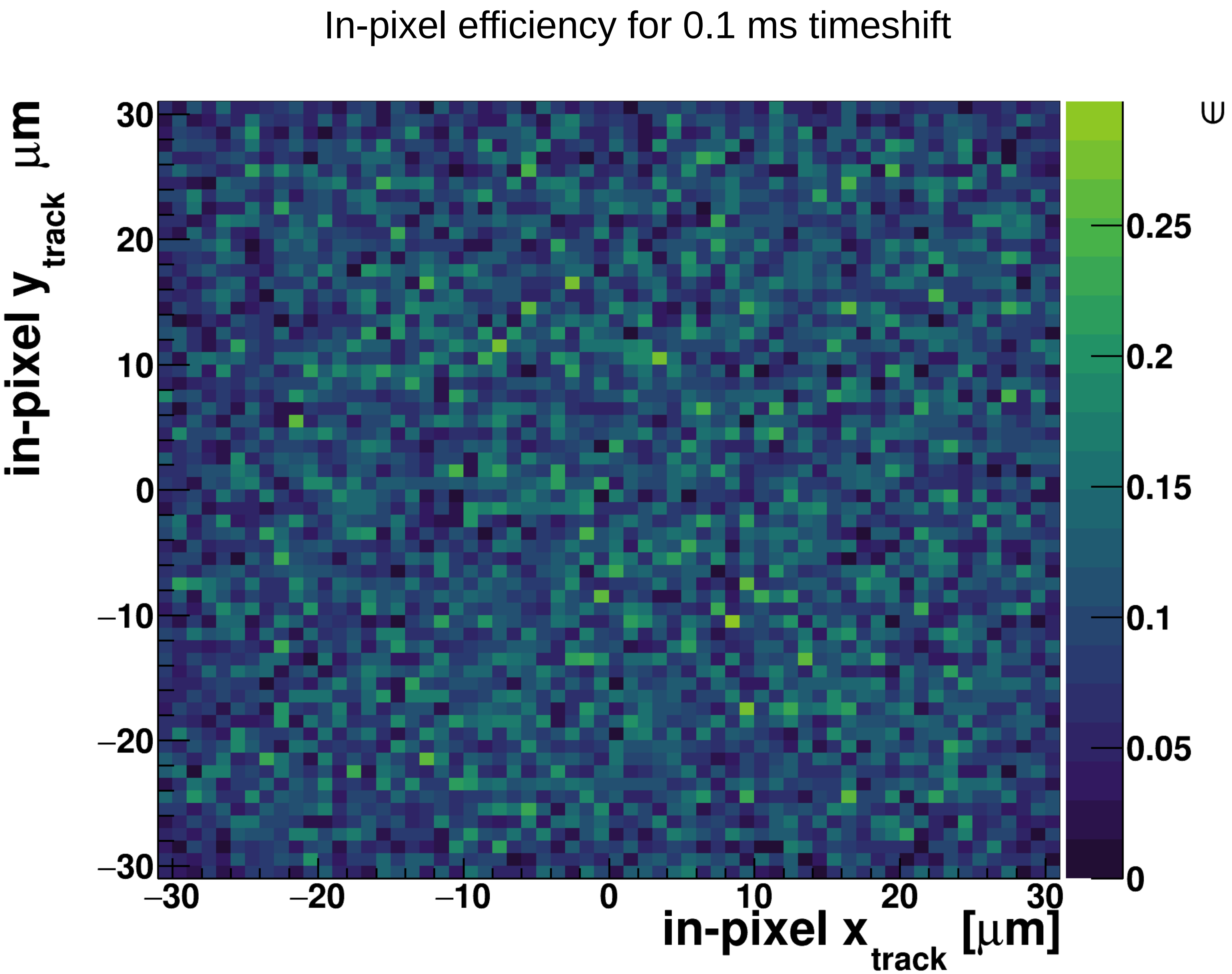
- Found clear correlation with the 16 bit TS overflow (3.27 ms)
- Slight offset O(100us) for first peak indicates some inherent offset that needs to be taking into account for the data
  - Most likely the 80 us that Patrick and Bernhard told us in his first talk
- Otherwise just random correlations with very minor contributions
- Total efficiency of the sensor = Sum of the peaks

  ≈ 60%



RD50MPW3 in detail

- Testbeam threshold of 1.2V equates to ~5200 electrons
- Achieved average efficiency of ~60% spread over different time shifts
- Single files still have too low statistics for some analysis



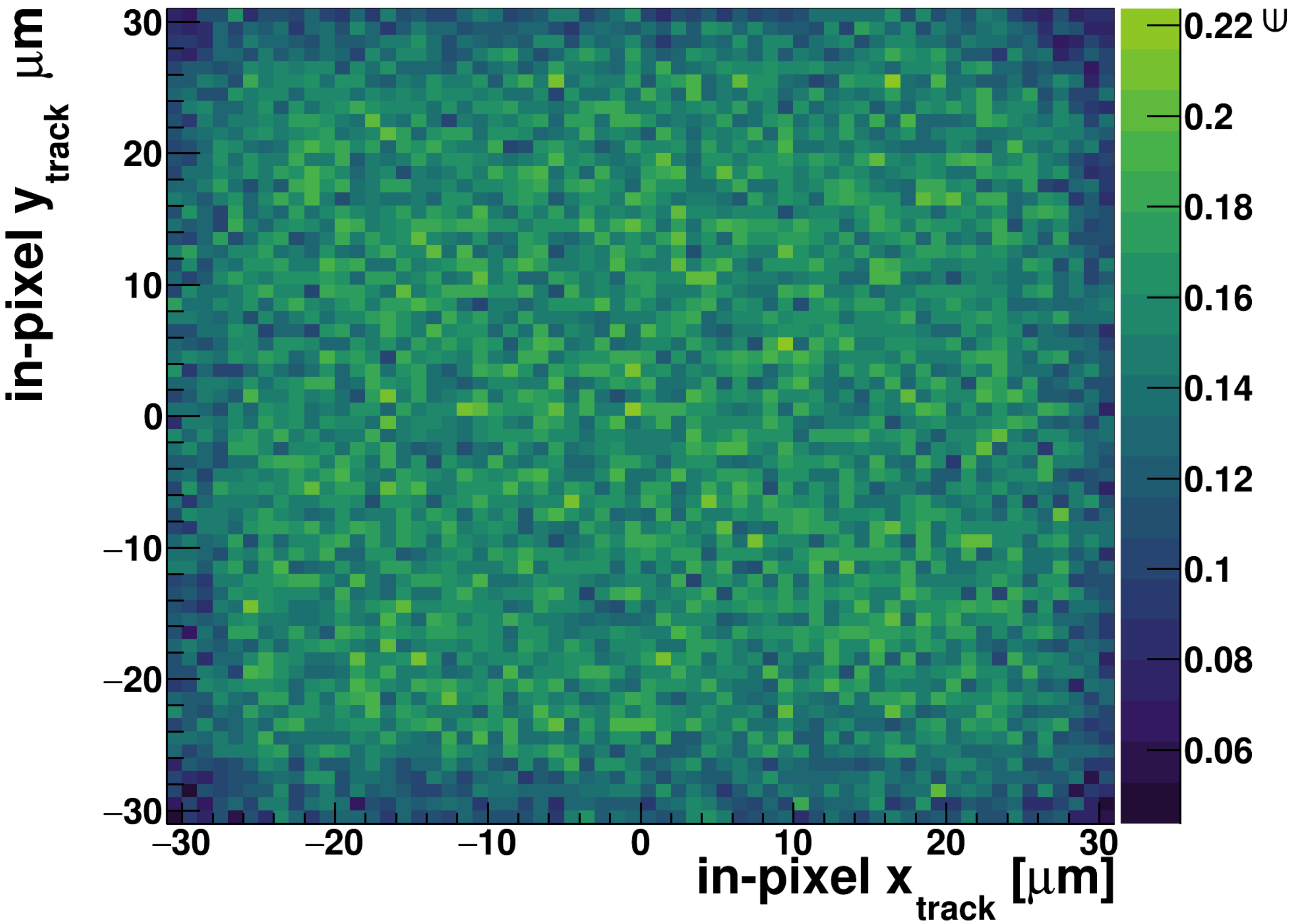
In-pixel efficiency

- Combined multiple timeshift files using hadd
- Efficiency does not get combined correctly

$$\epsilon_{\mathrm{true}} = \epsilon_{\mathrm{hadd}} \cdot 4$$

- Can see clear reduction in efficiency along pixel edges

In-pixel efficiency for combined 0.1+3.3+6.6+9.9ms

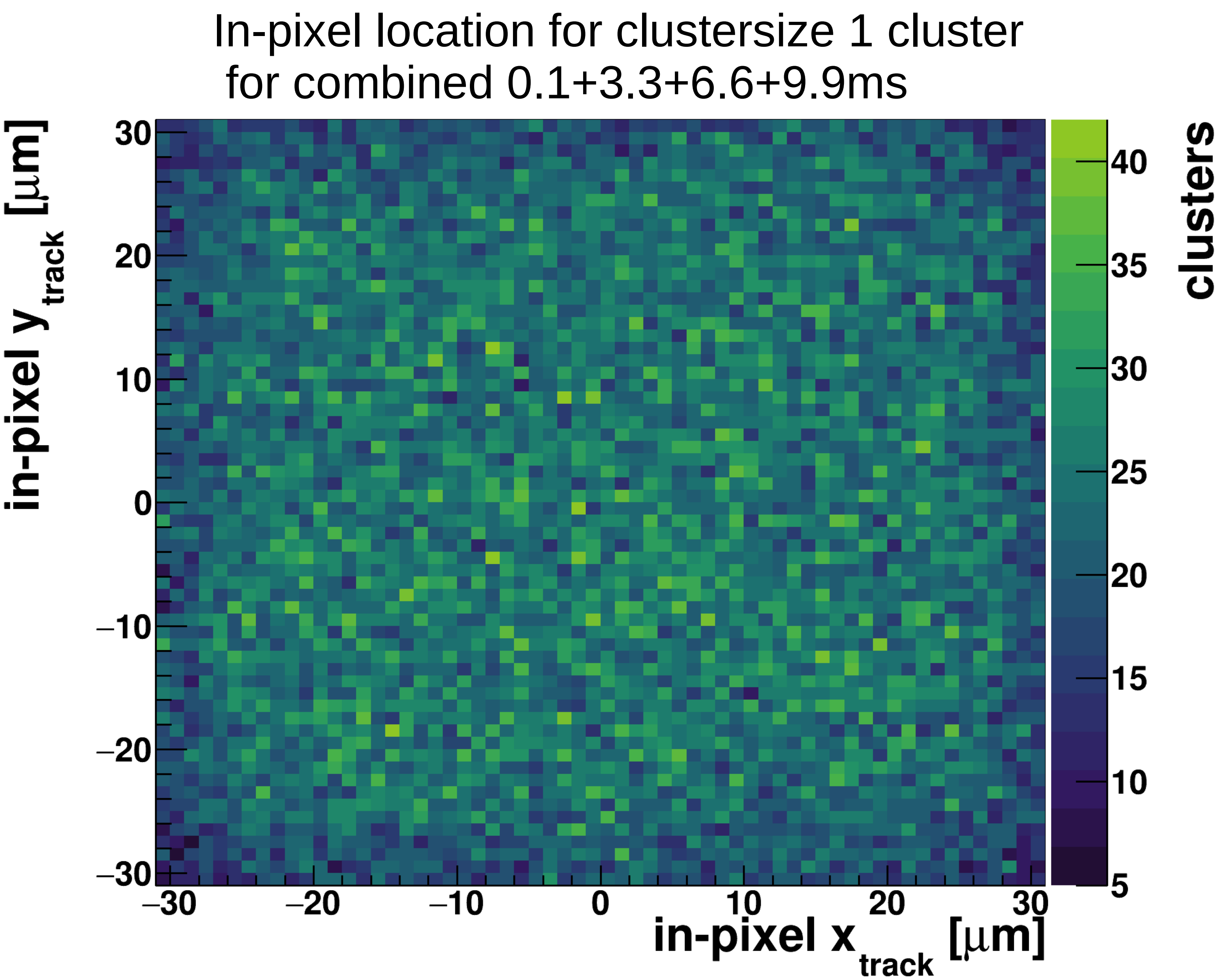


In-pixel cluster sizes

- Combined multiple timeshift files using hadd
- Efficiency does not get combined correctly

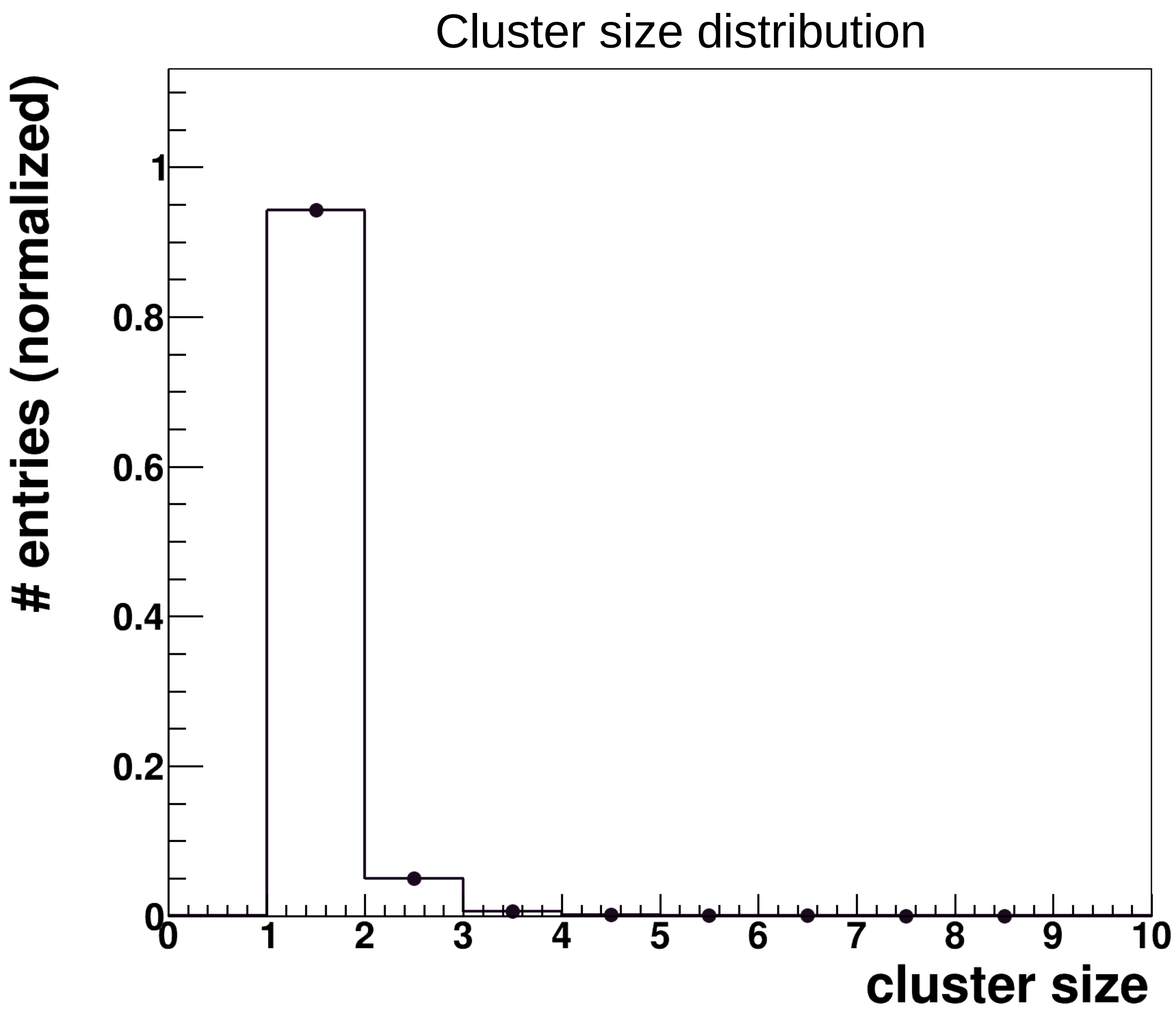
$$\epsilon_{\text{true}} = \epsilon_{\text{hadd}} \cdot 4$$

- Can see clear reduction in efficiency along pixel edges
- Similar effect is visible in distribution of single pixel clusters
- Strong indication that low efficiency is due to high threshold operation



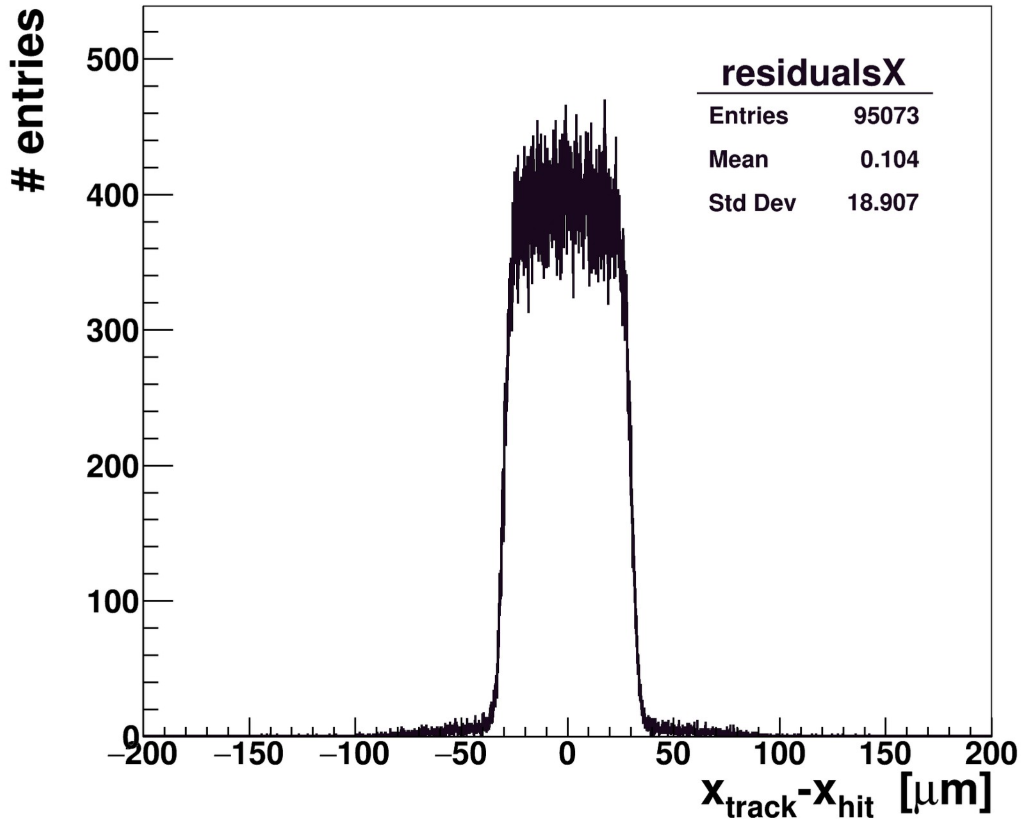
Cluster size distribution

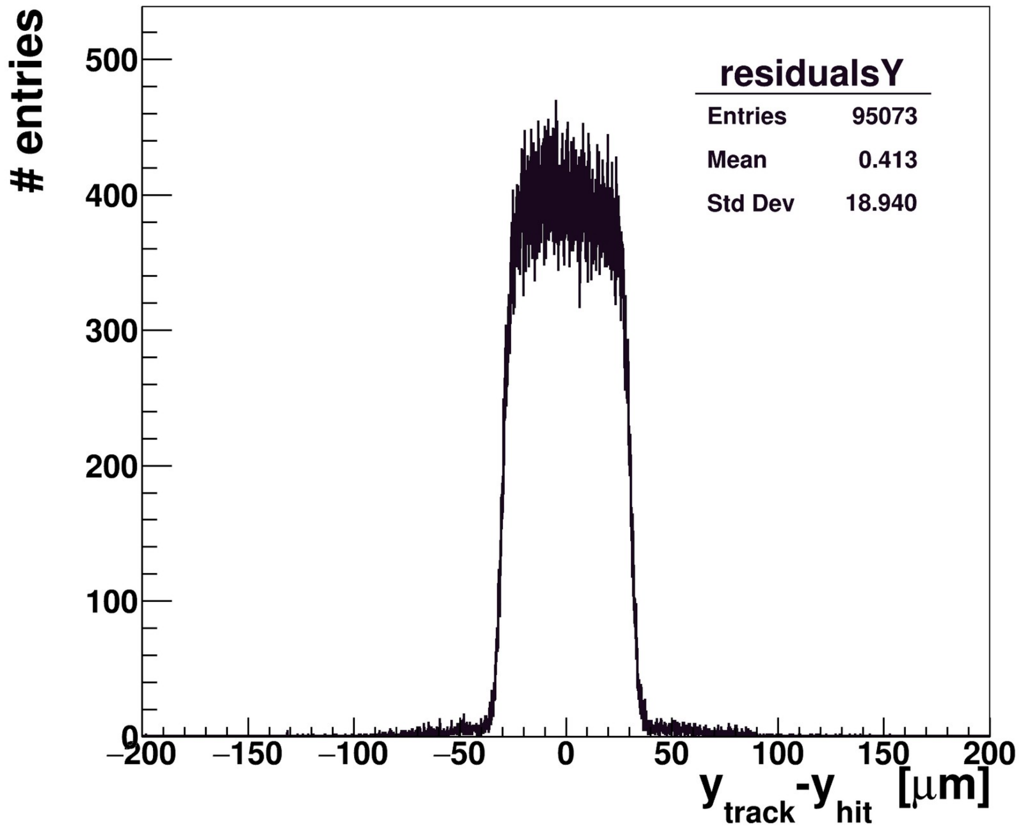
- Low amount of clusters with size > 1
- Combined effect of:
  - Large collection well
  - Large pixel size
  - Perpendicular incident beam angle
  - High threshold



RD50MPW3 spatial resolution

- Achieved spatial resolution of ~18 μm in X and Y
- Almost binary distribution due to low amount of multi hit clusters





Backup

Explaining the efficiency

- Hadd is typically used to combine independent measurements
  - N_i = Number of tracks with hits
  - T_i = Number of total tracks

$$\epsilon_{\text{hadd}} = \sum_{i=1}^{4} \frac{N_i}{T_i} = \frac{N_1 + N_2 + N_3 + N_4}{T_1 + T_2 + T_3 + T_4}$$

- Combination of 4 same data sets with different time shifts underestimates efficiency
  - $N_{true} = N_1 + N_2 + N_3 + N_4$
  - $T_{true} = T_1 = T_2 = T_3 = T_4$
- Combination of objects results in factor 4 reduced efficiency compared to true efficiency

$$\epsilon_{\text{hadd}} = \sum_{i=1}^{4} \frac{N_i}{T_{true}} = \frac{N_1 + N_2 + N_3 + N_4}{4 \cdot T_{true}}$$

$$= \frac{1}{4} \cdot \frac{N_{true}}{T_{true}} = \frac{1}{4} \cdot \epsilon_{\text{true}}$$