

# SPS beamtest analysis:

## LSC-3 noise, analogue signal & digital signal preliminary analysis

F9 SiC lab weekly

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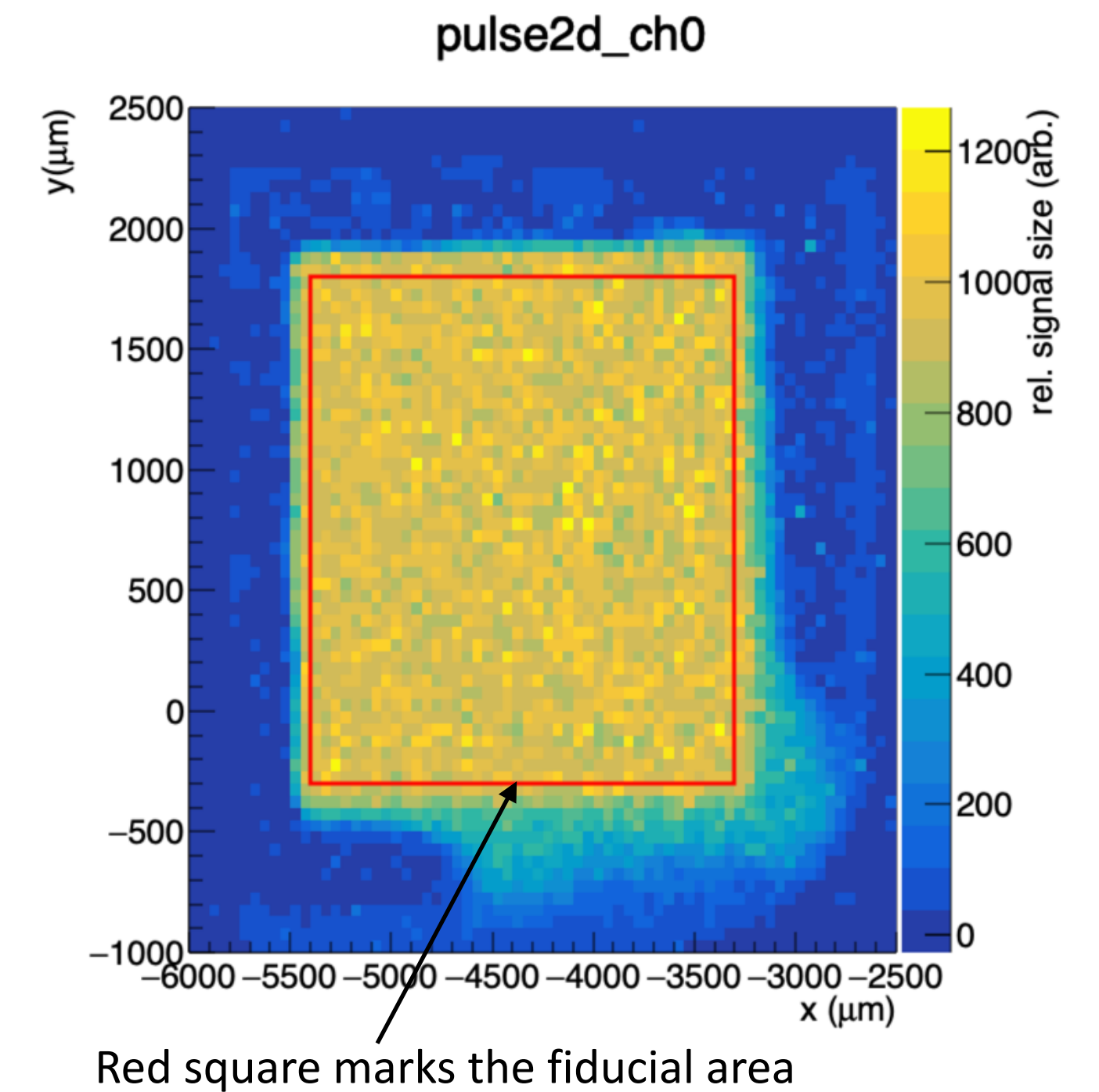
# Analysis overview

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- SPS testbeam in October 2021
- Single-Crystal diamond LSC-3 mounted on board #4
- +500 V and -500 V applied to SC diamond
- Calypso CH2 (analogue, D+, D-) and trigger connected to DRS
- Low and Med threshold configurations used on Calypso
- Around 1.5M recorded events used
- Analysis:
  - Tracking cuts
  - Noise analysis (detector surface divided into 2D bins)
  - Analogue signal analysis (detector surface divided into 2D bins)
  - Digital signals analysis

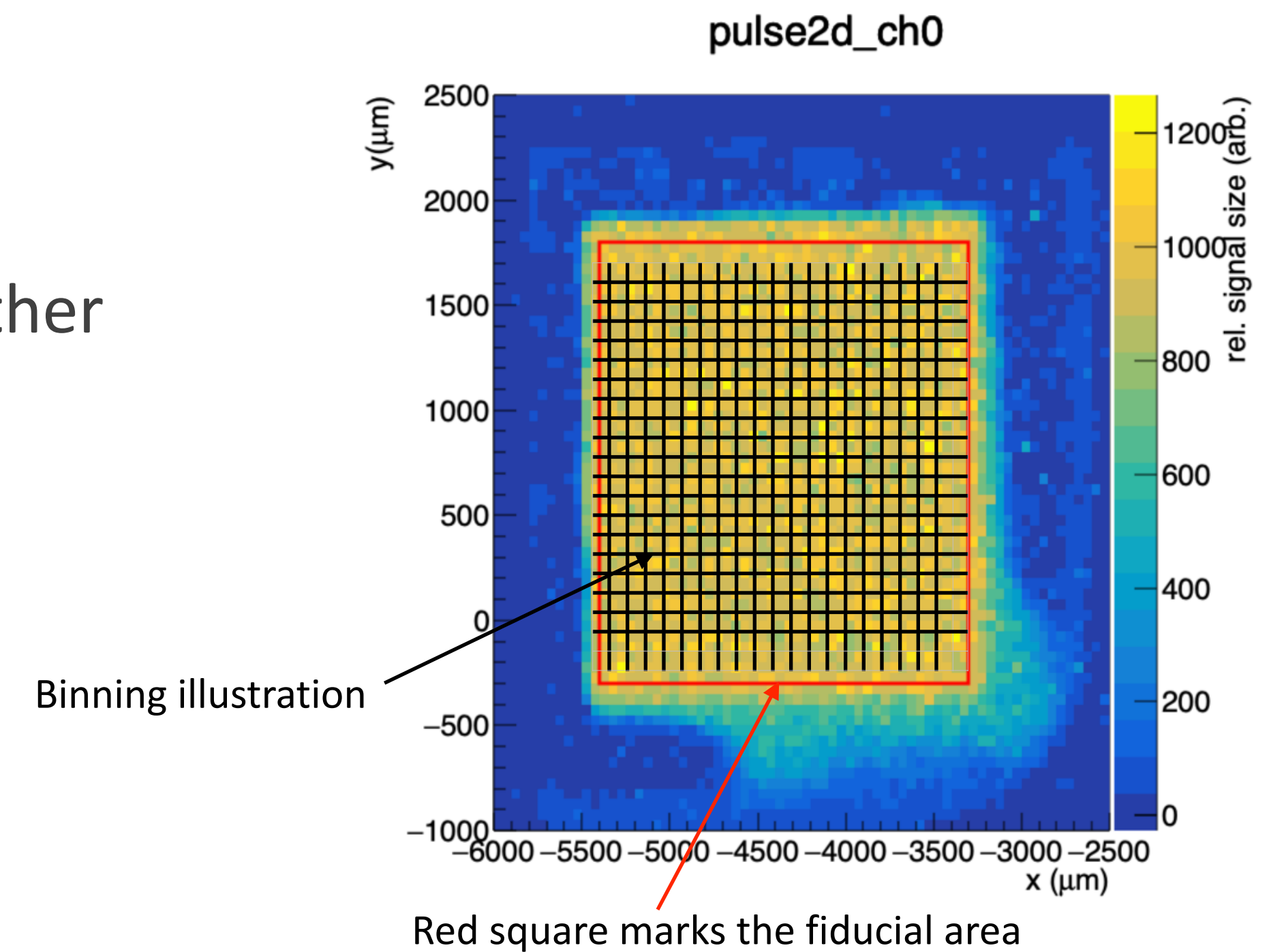
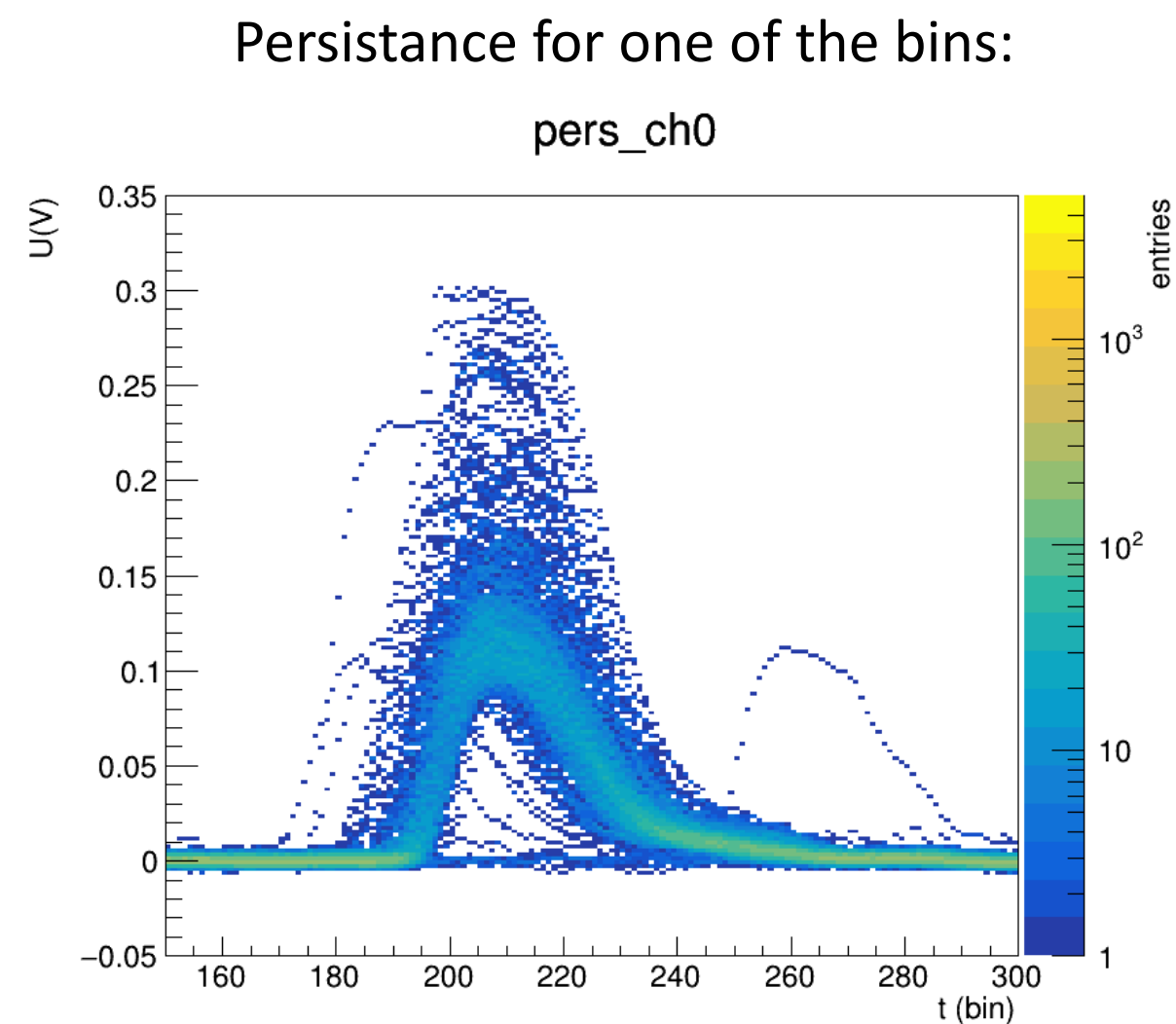
# Binning of the detector fiducial area

- Selected only events with U,V in the fiducial area of detector.
  - Fiducial area divided into 441 bins (21 x 21),  $100\ \mu\text{m} \times 100\ \mu\text{m}$  each.
  - Waveforms of events hitting the selected bin were added together
- ➡ The result is persistence waveform for each bin



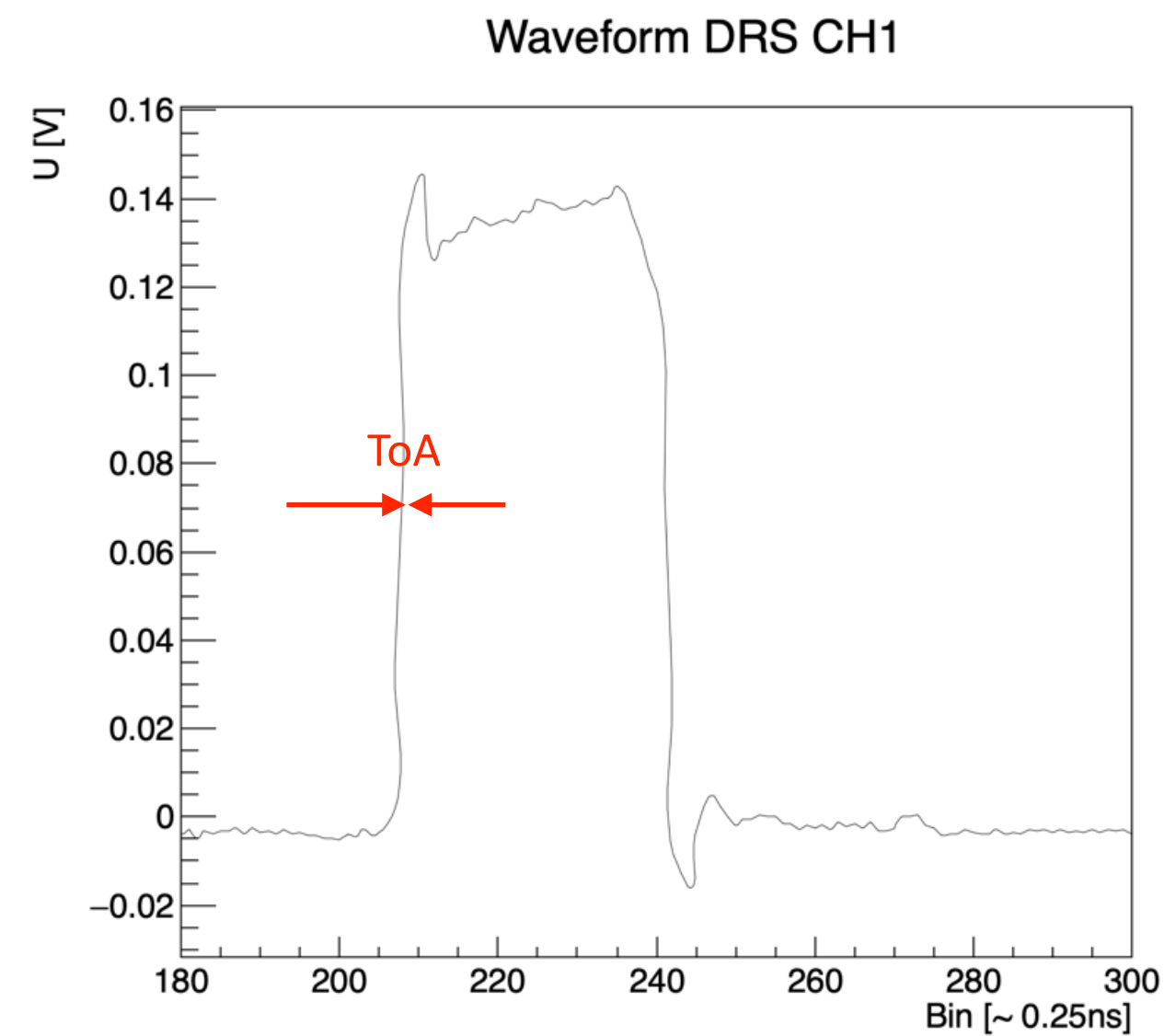
# Binning of the detector fiducial area

- Selected only events with U,V in the fiducial area of detector.
  - Fiducial area divided into 400 bins,  $100\ \mu\text{m} \times 100\ \mu\text{m}$  each.
  - Waveforms of events hitting the selected bin were added together
- ➡ The result is persistence waveform for each bin



# Tracking cuts

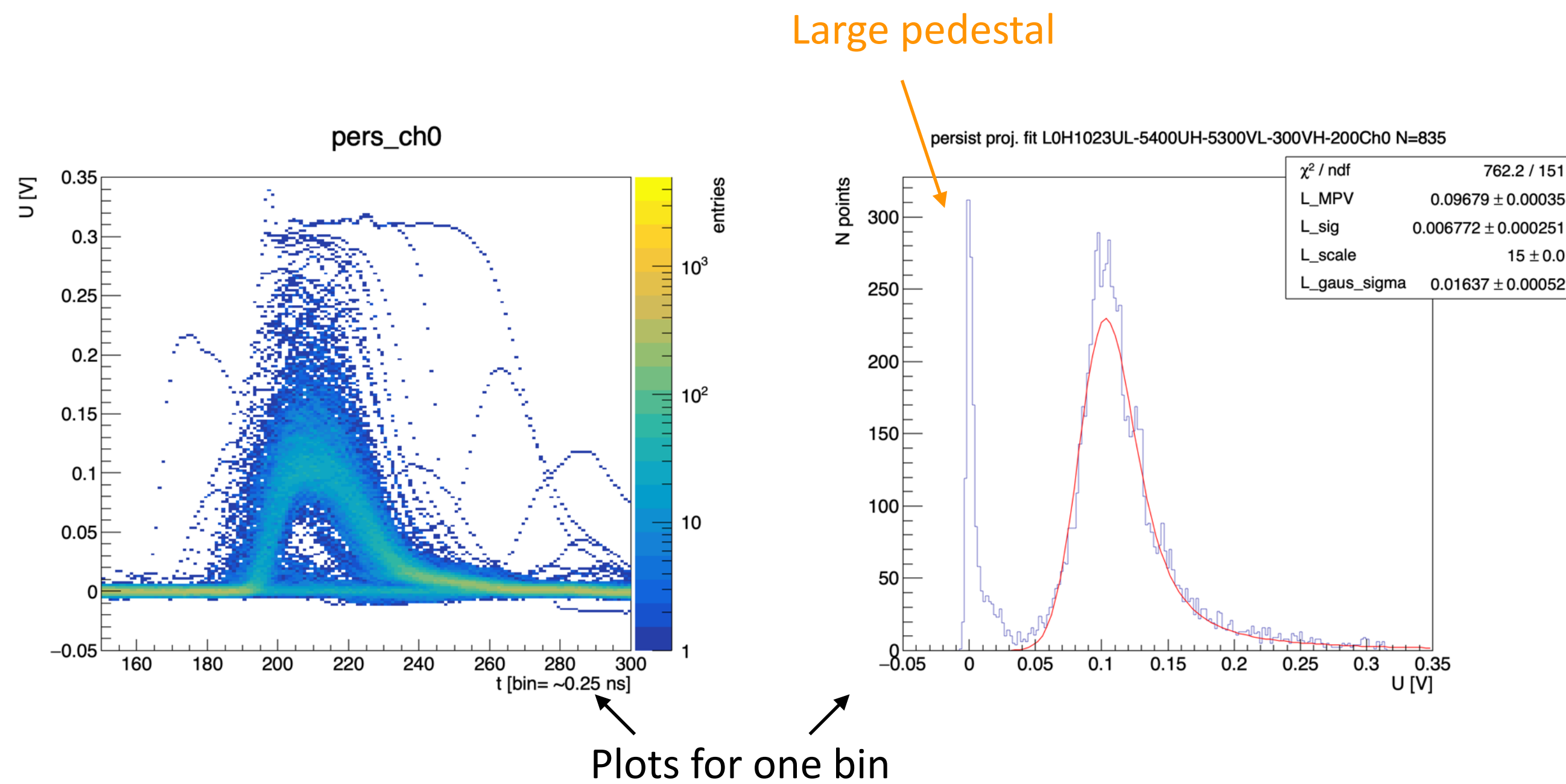
- Additional cuts on fitted track parameters from Malta telescope: number of tracks, Chi2, slope
- Cut on the digital signal ToA
- Goal is to keep only well reconstructed events with amplitude above threshold, which arrive within a selected time window



# Tracking cuts: no cuts applied

- HV: +500 V

Persistence & projection of peak area (bins 202:212):

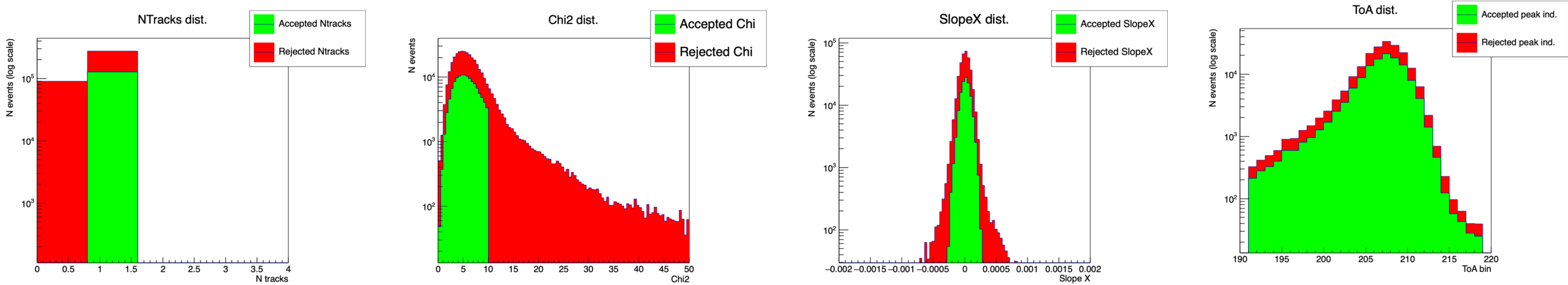


# Tracking cuts: nTracks, Chi2, Slope, ToA

Cuts:

nTracks	Chi2	SlopeX,Y	ToA [bin]
1	<10	<0.00025	190-220

- Diamond at +500 V, Low threshold settings

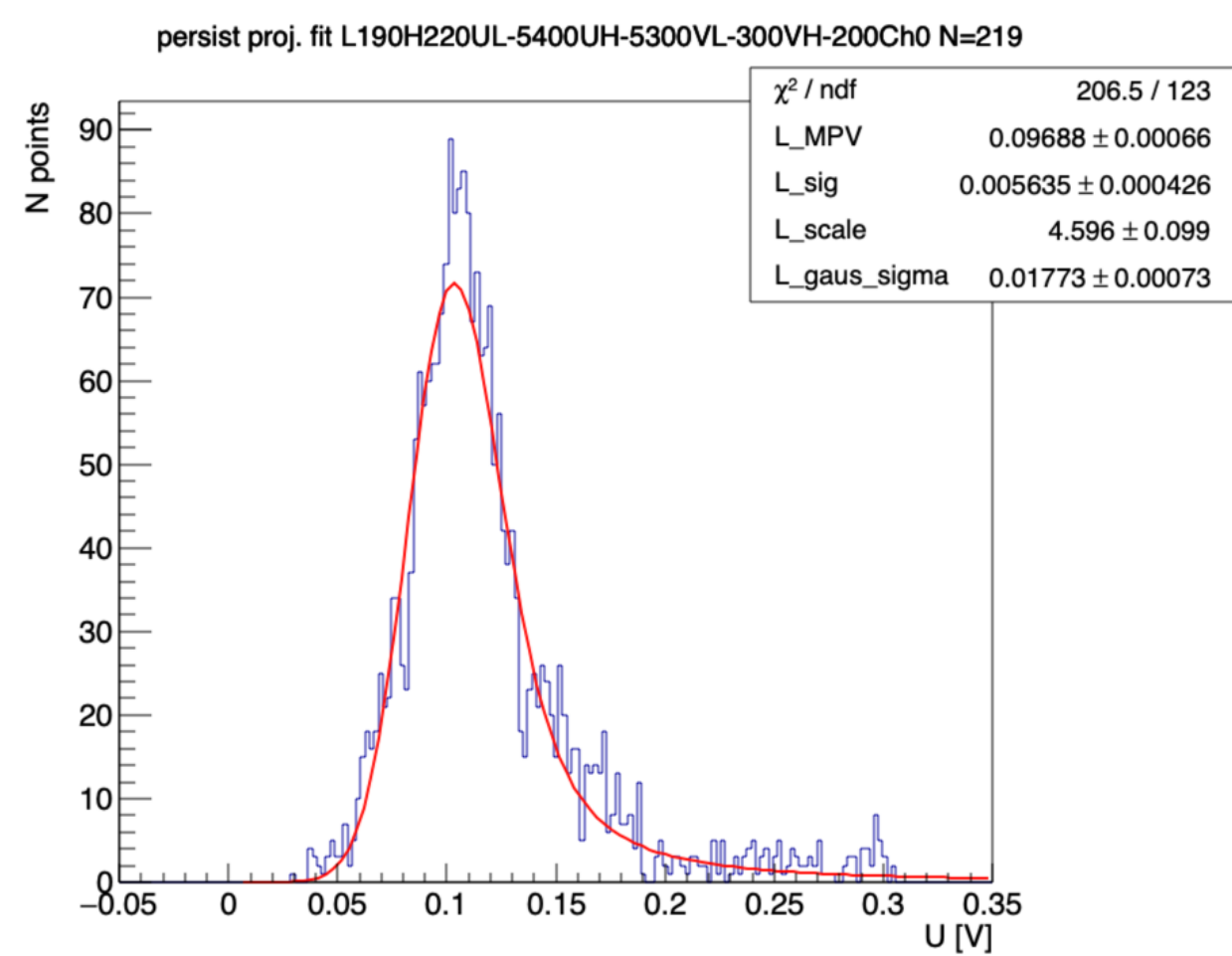
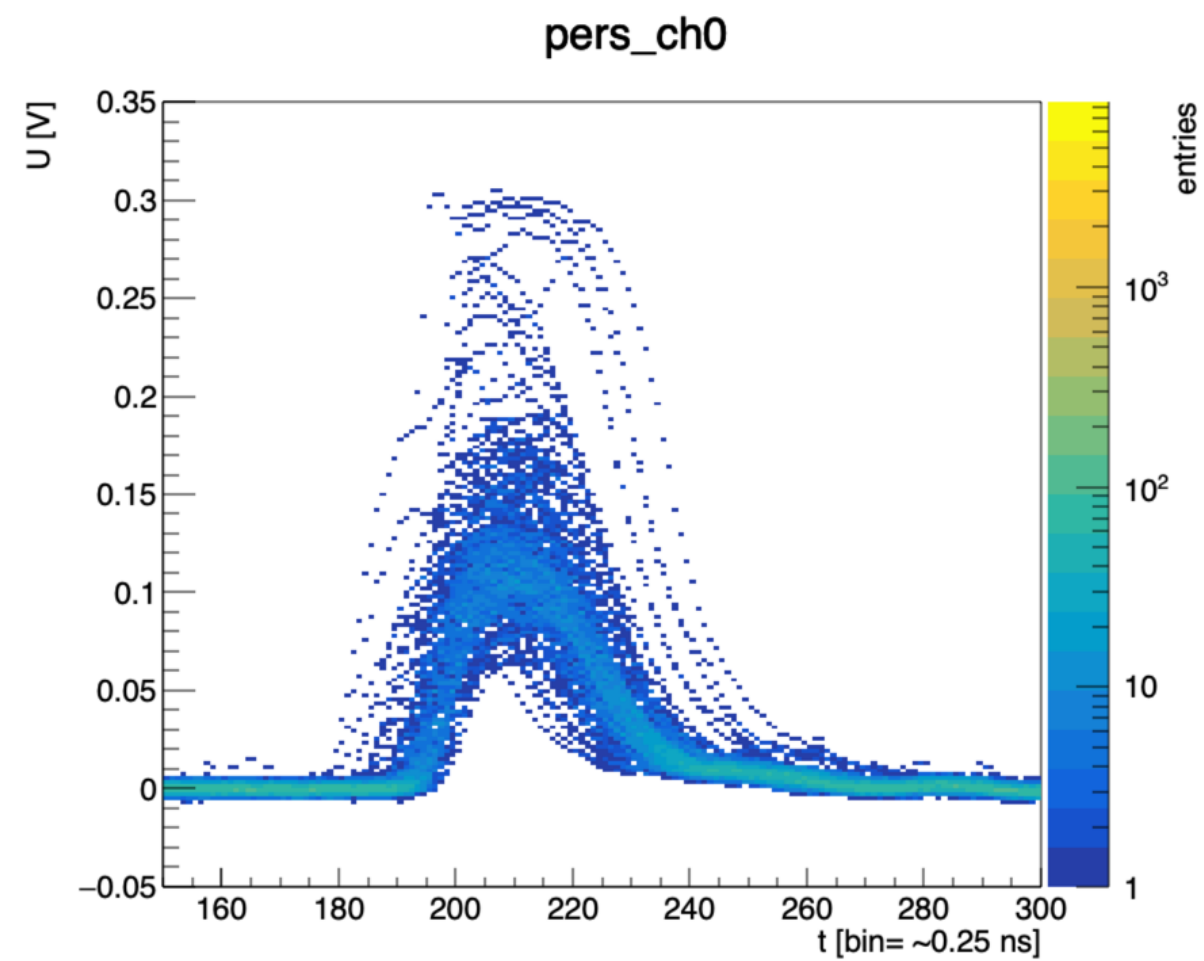
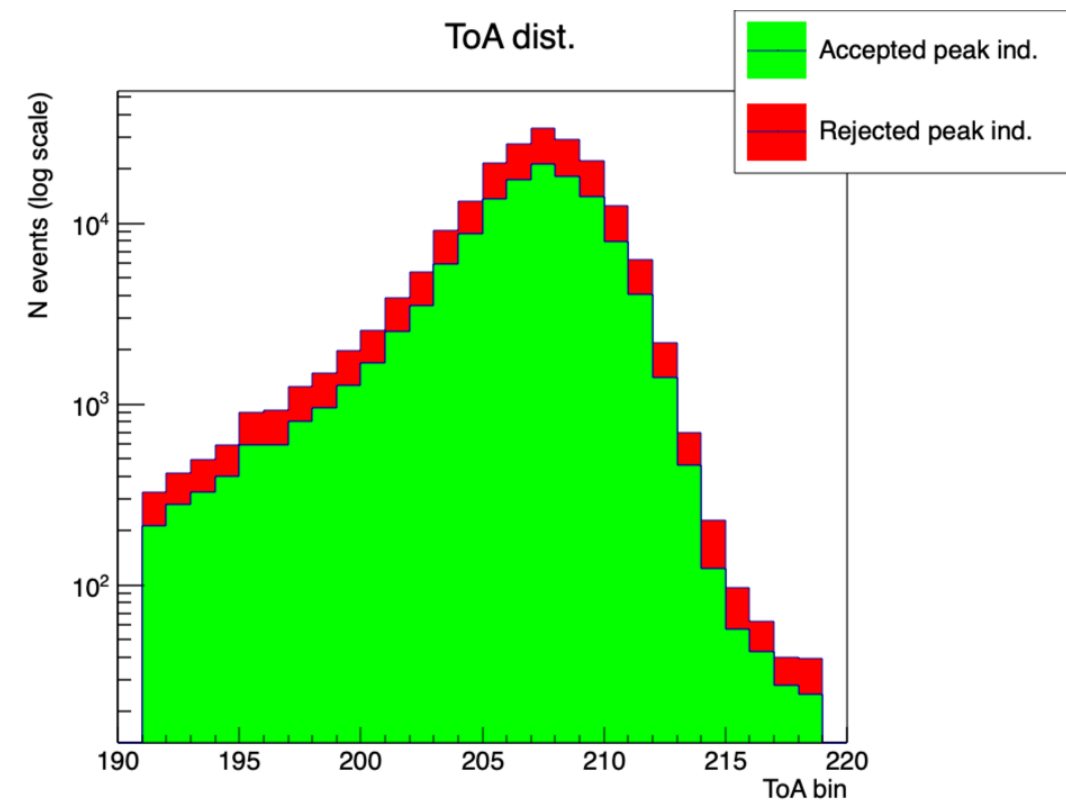
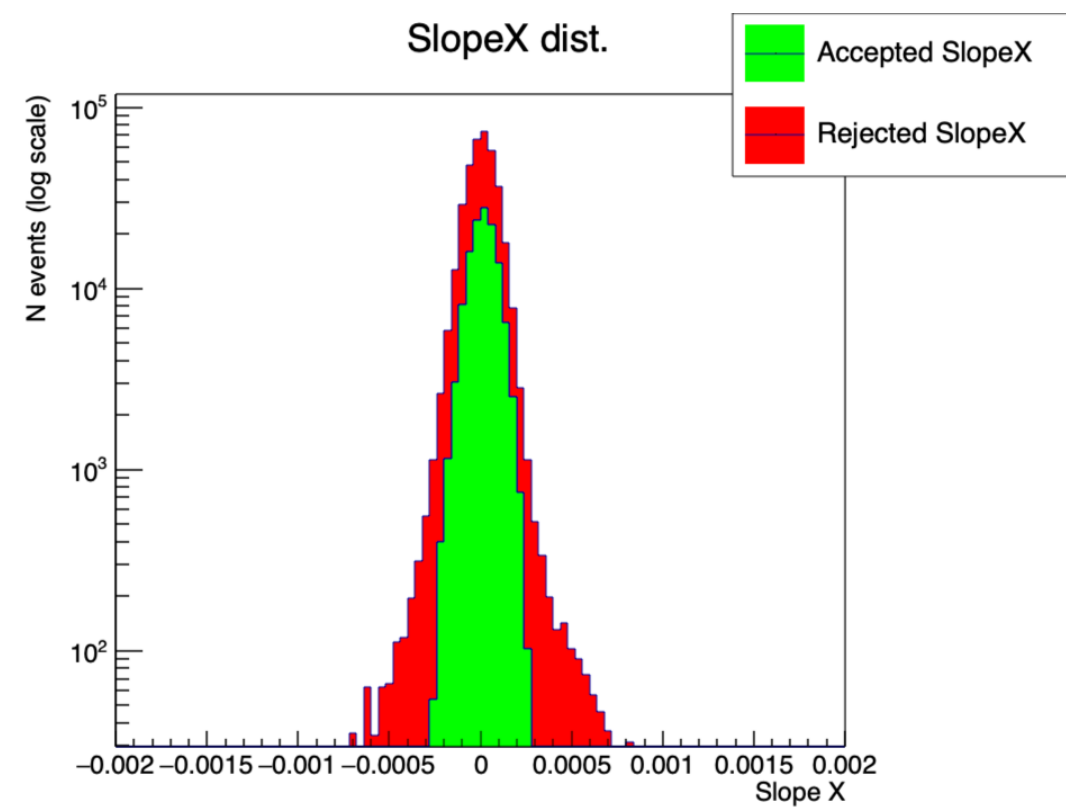
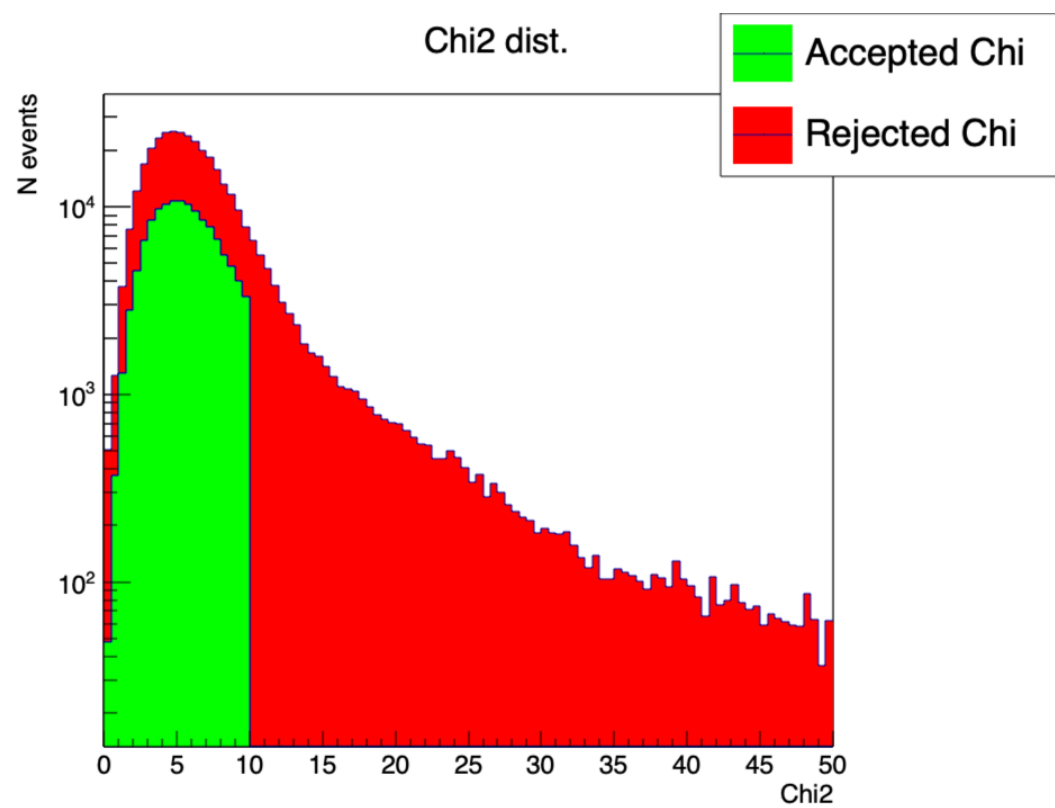
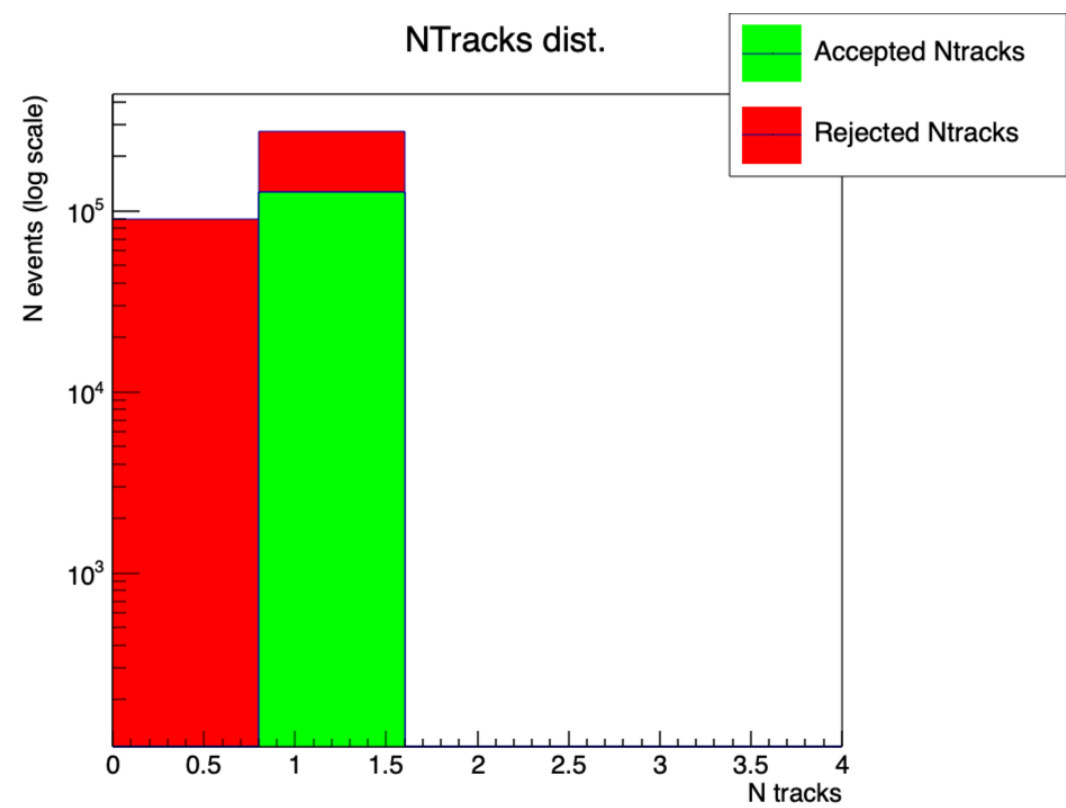


# Tracking cuts: nTracks, Chi2, Slope, ToA

Cuts:

nTracks	Chi2	SlopeX,Y	ToA [bin]
1	<10	<0.00025	190-220

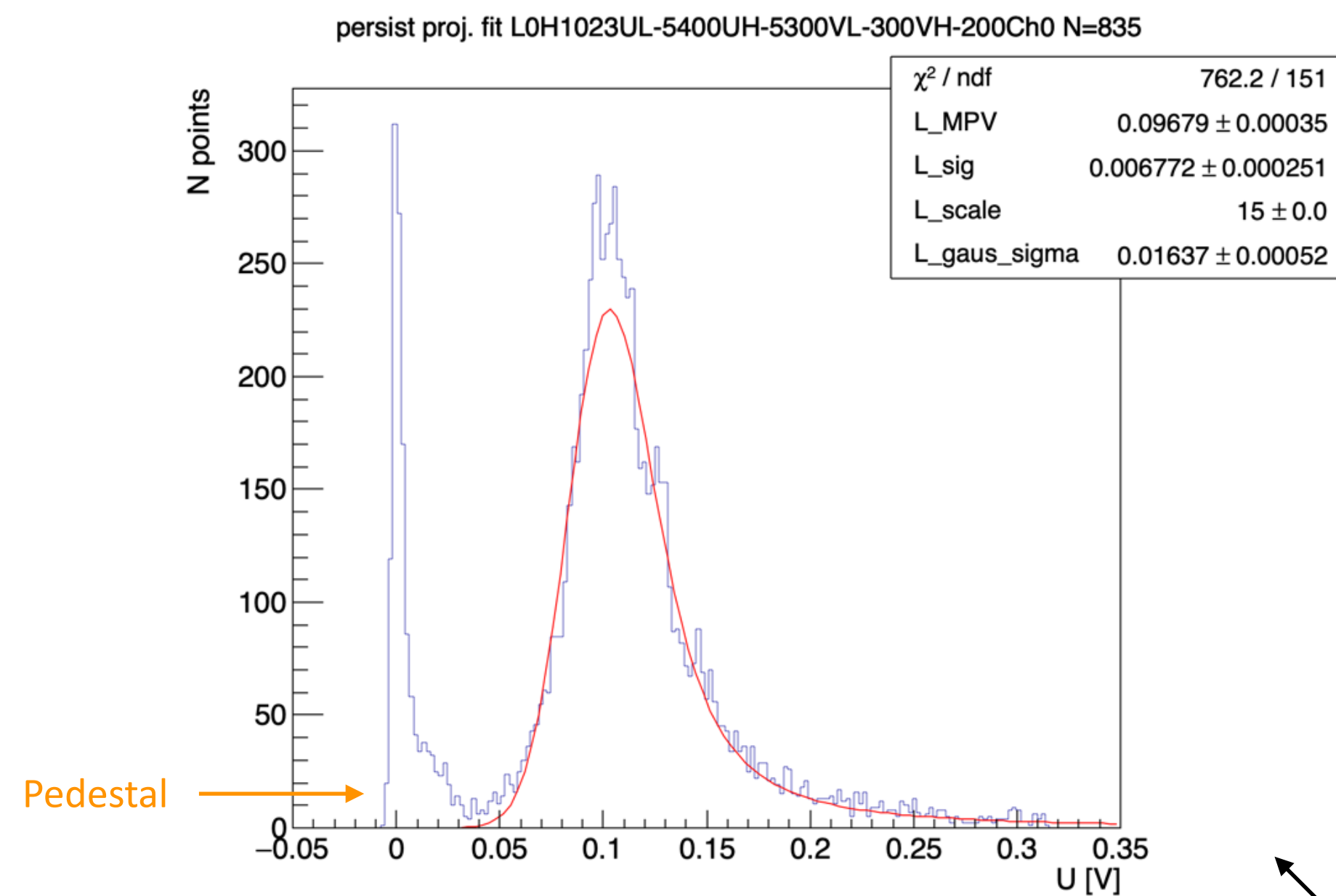
- Diamond at +500 V, Low threshold settings



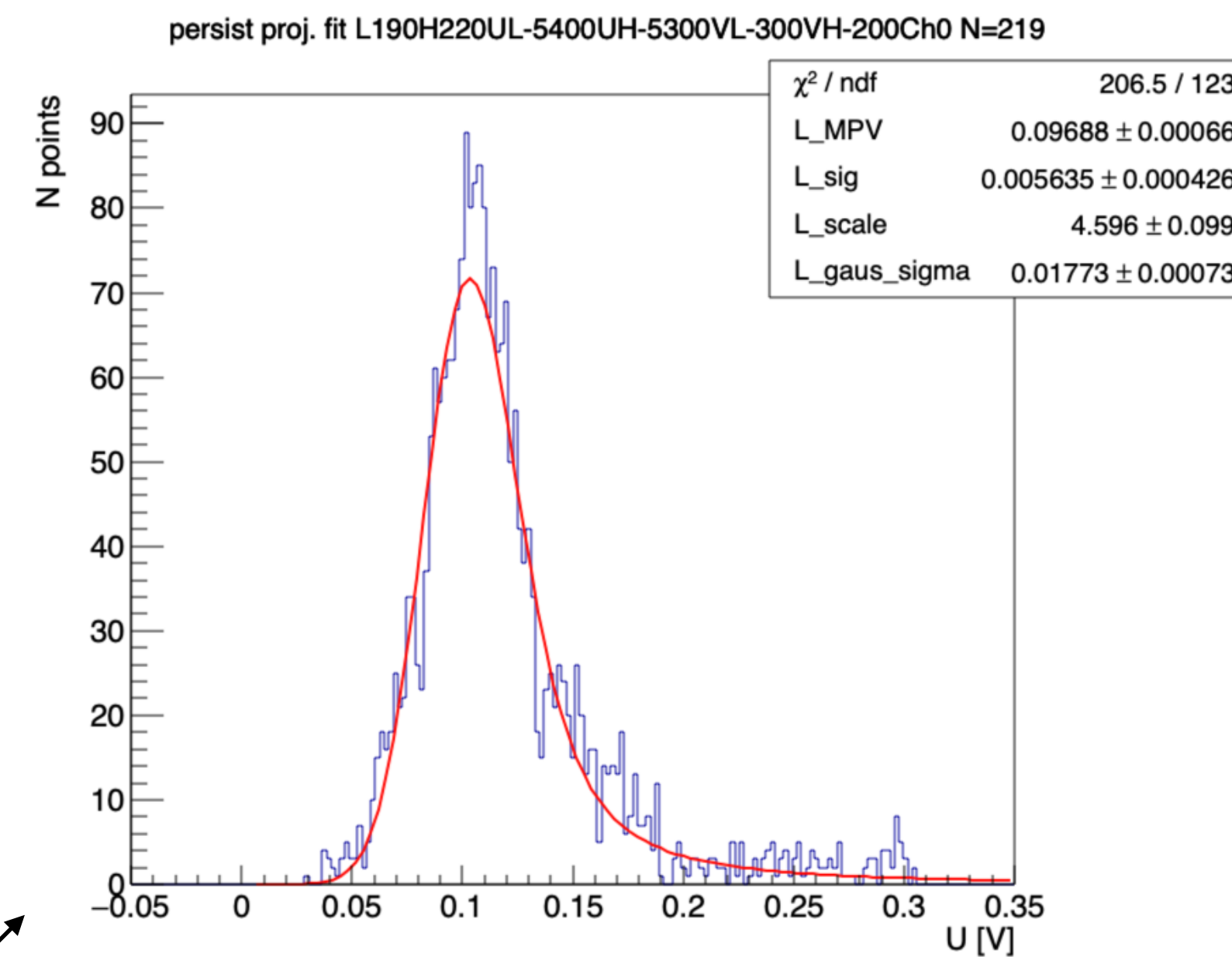
# Tracking cuts:

- Final cut gives a “clean” persistence plot with pedestal removed

No cut on parameters



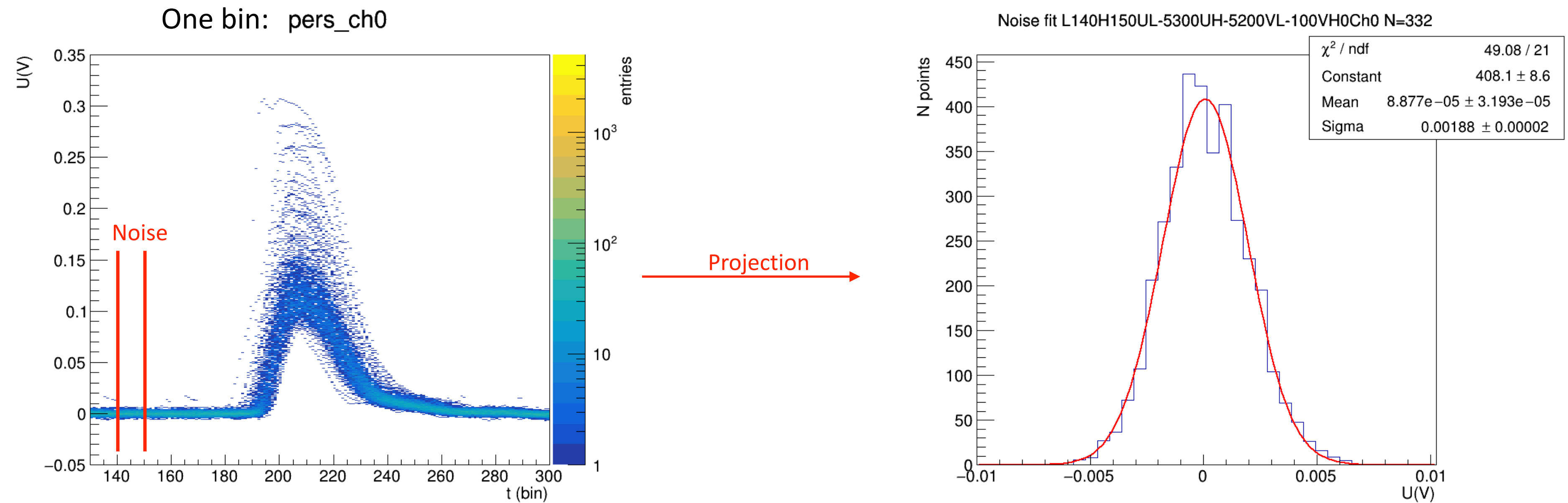
Final cut



Plots for one bin

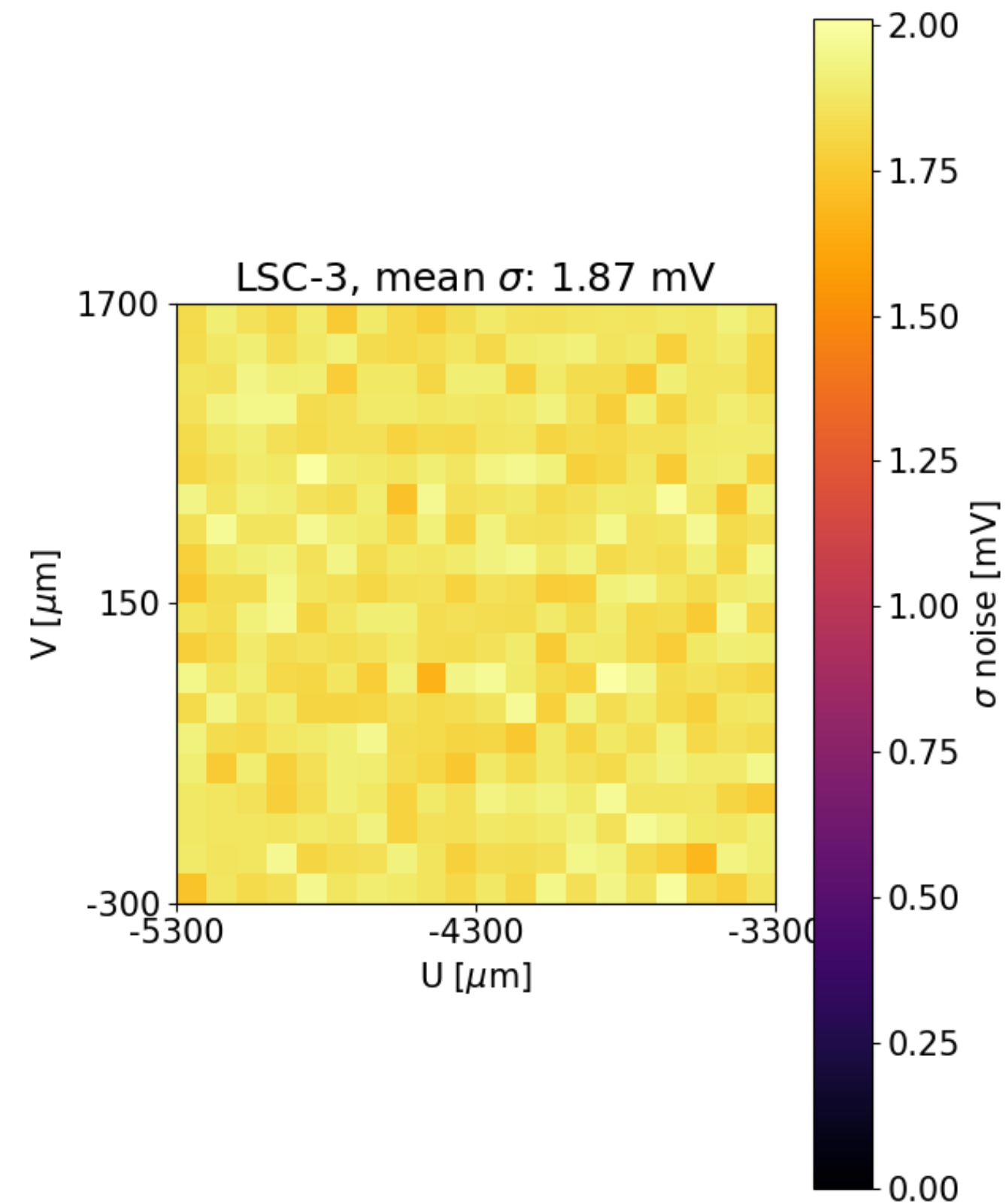
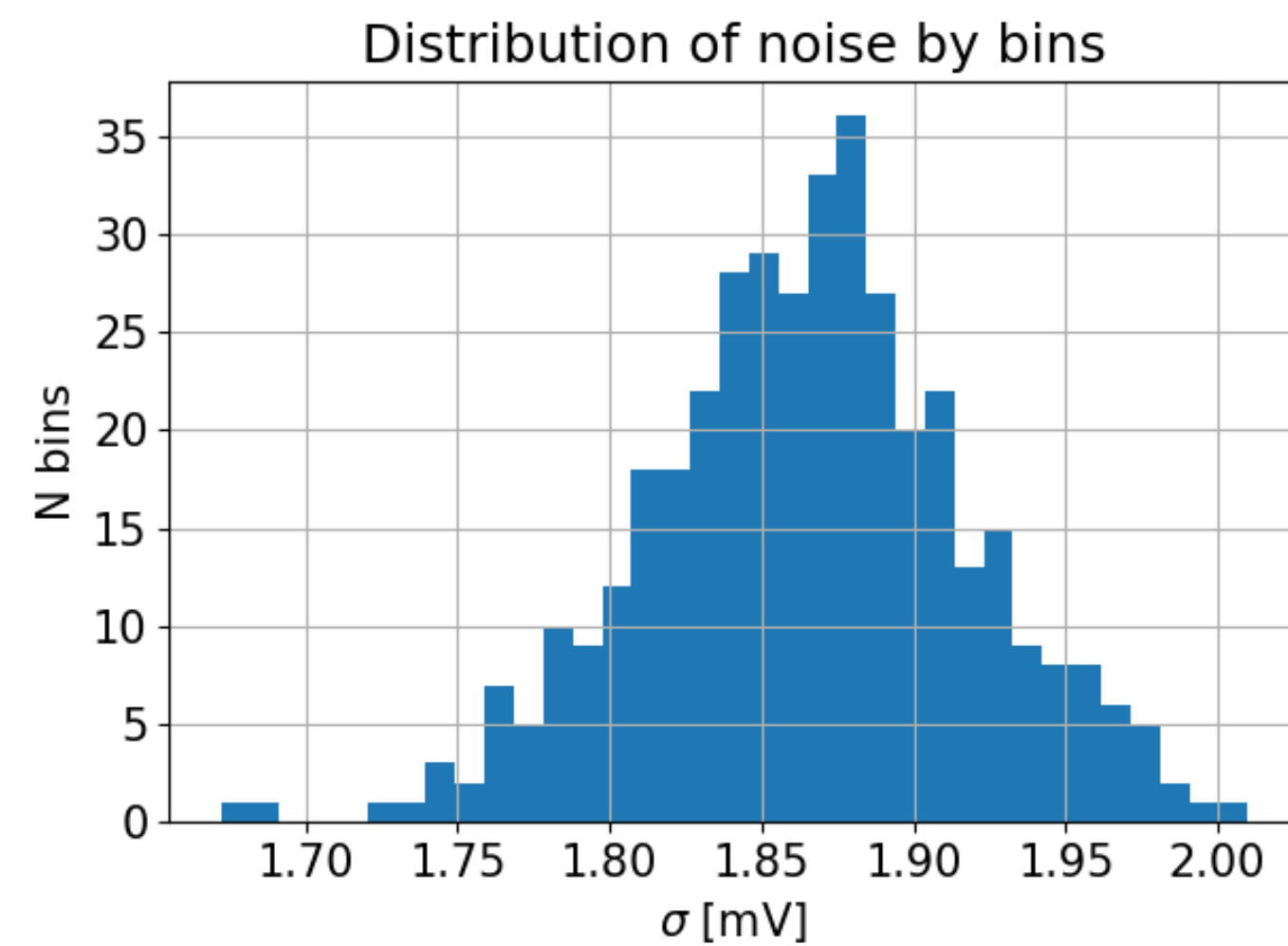
# Noise analysis

- Estimated noise before the signal for each bin
- Projected bins 140-150 from persistence graph
- Gaussian fit to distribution



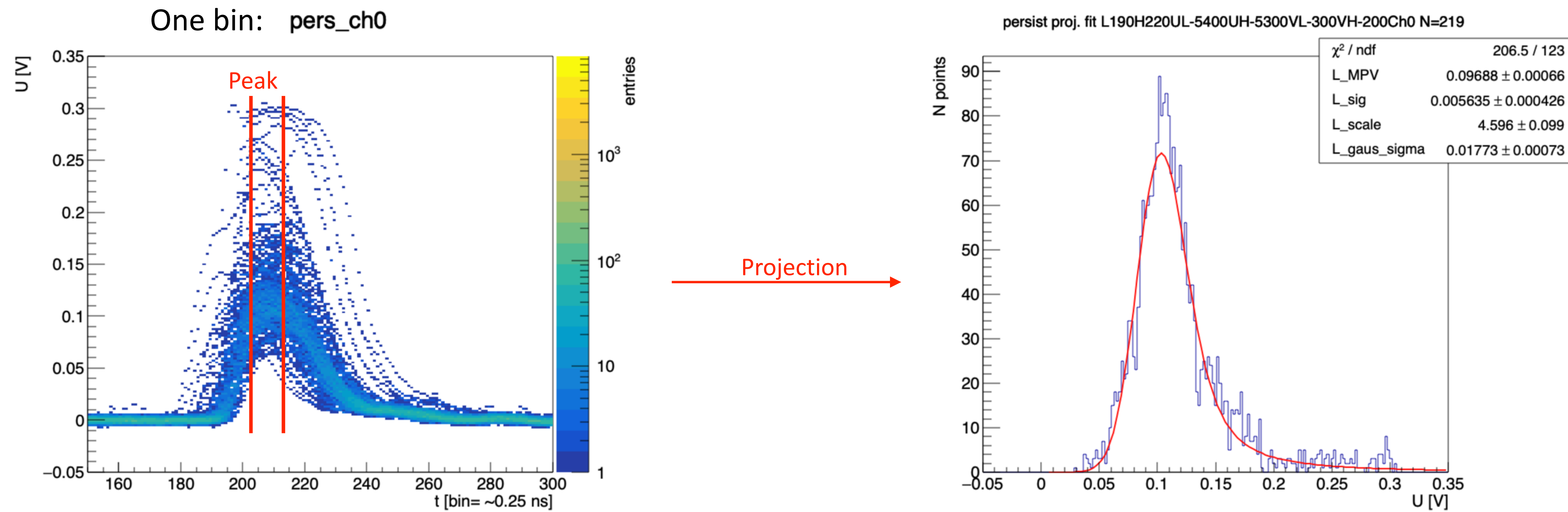
# Noise analysis

- Results for entire fiducial area of the detector, HV: +500 V
- Even distribution for different bins.
- Mean noise: 1.87 mV



# Signal (MPV) analysis

- Estimated MPV of signal for each bin
- Projected persistence between bins 202 and 212 (peak area)
- Fit LanGau function to distribution & estimate MPV



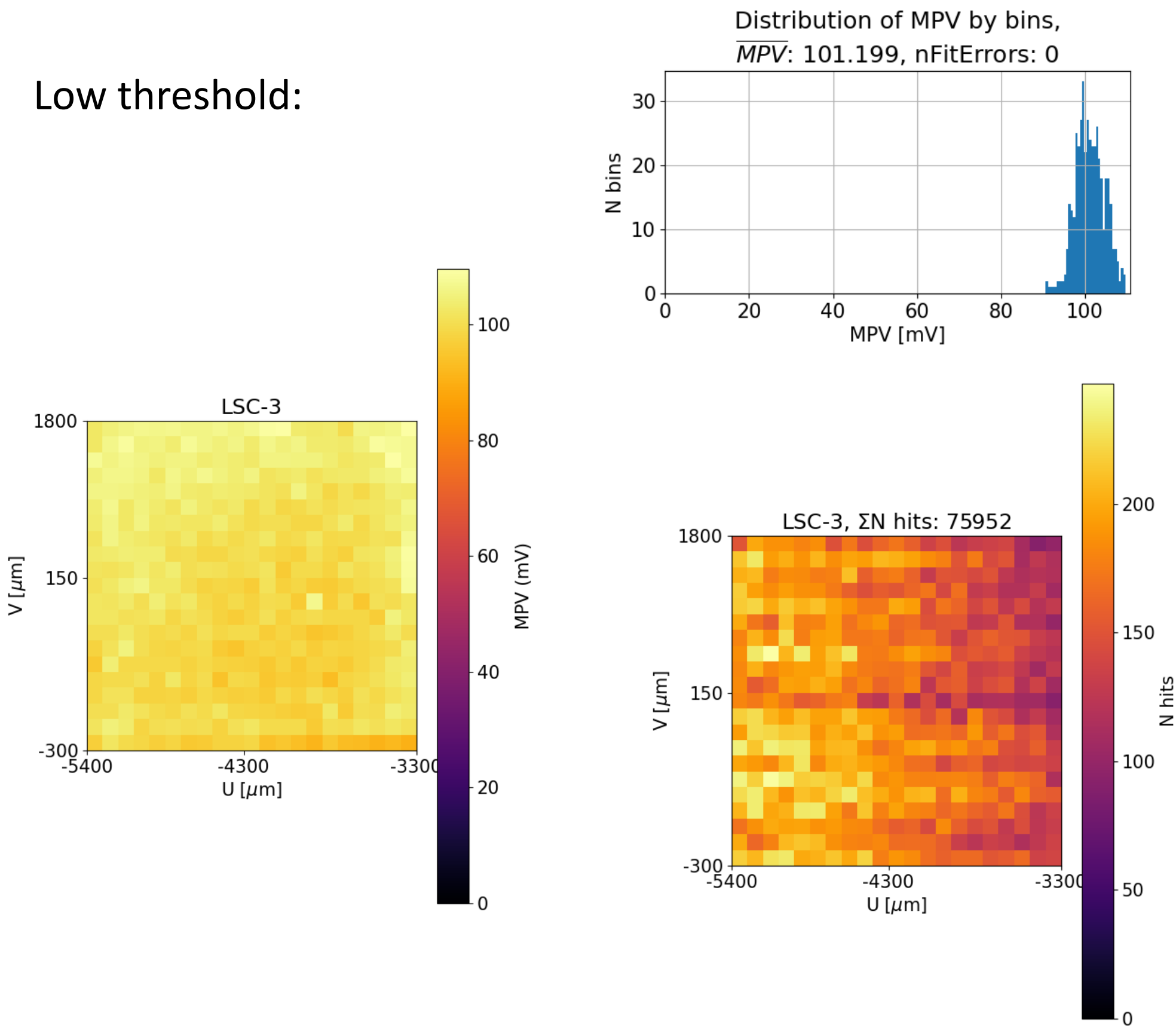
# Signal (MPV) analysis +500 V

- Diamond at +500 V, Low & Med threshold

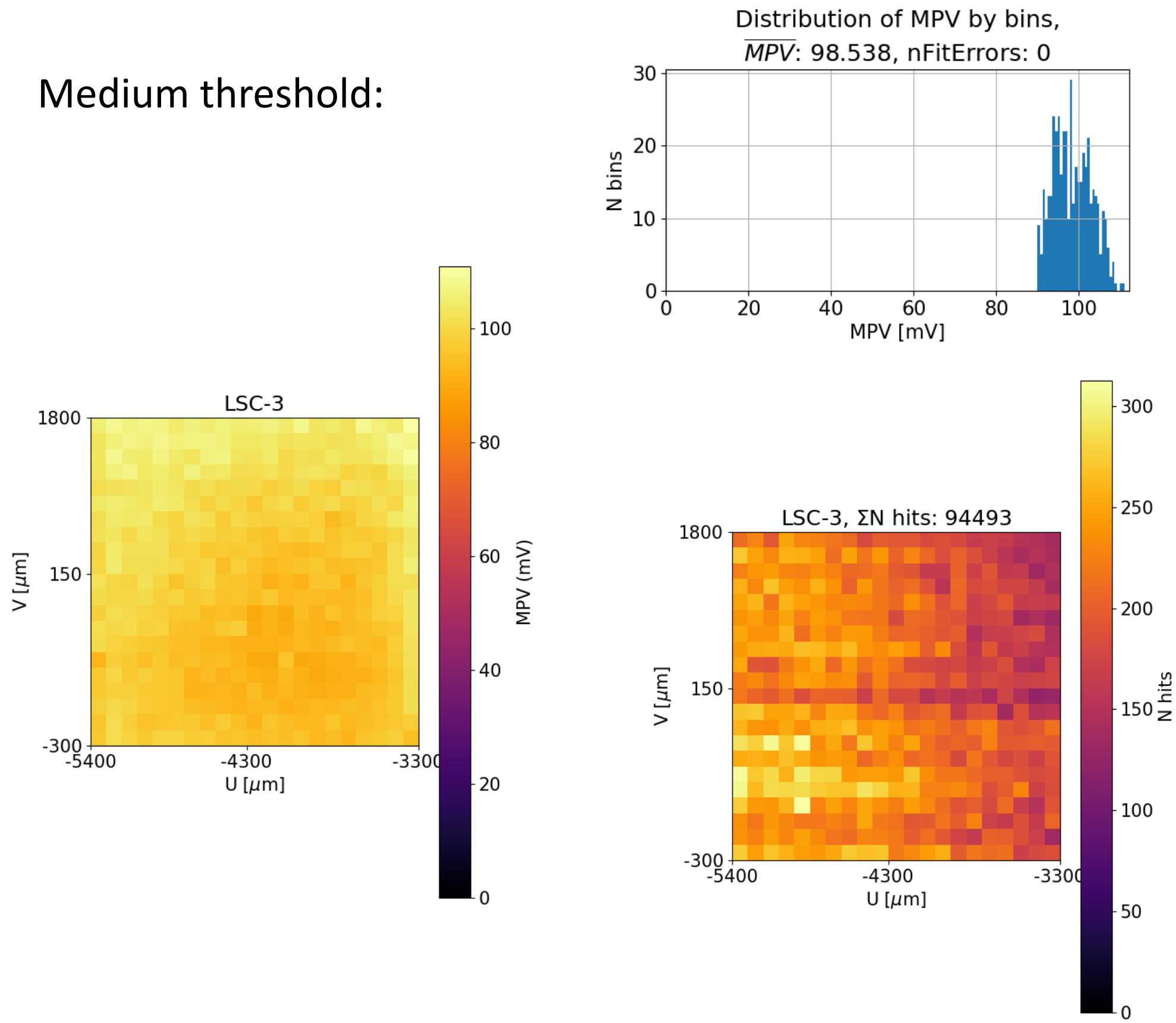
Cuts:

nTracks	Chi2	SlopeX,Y	ToA [bin]
1	<10	<0.00025	190-220

Low threshold:



Medium threshold:



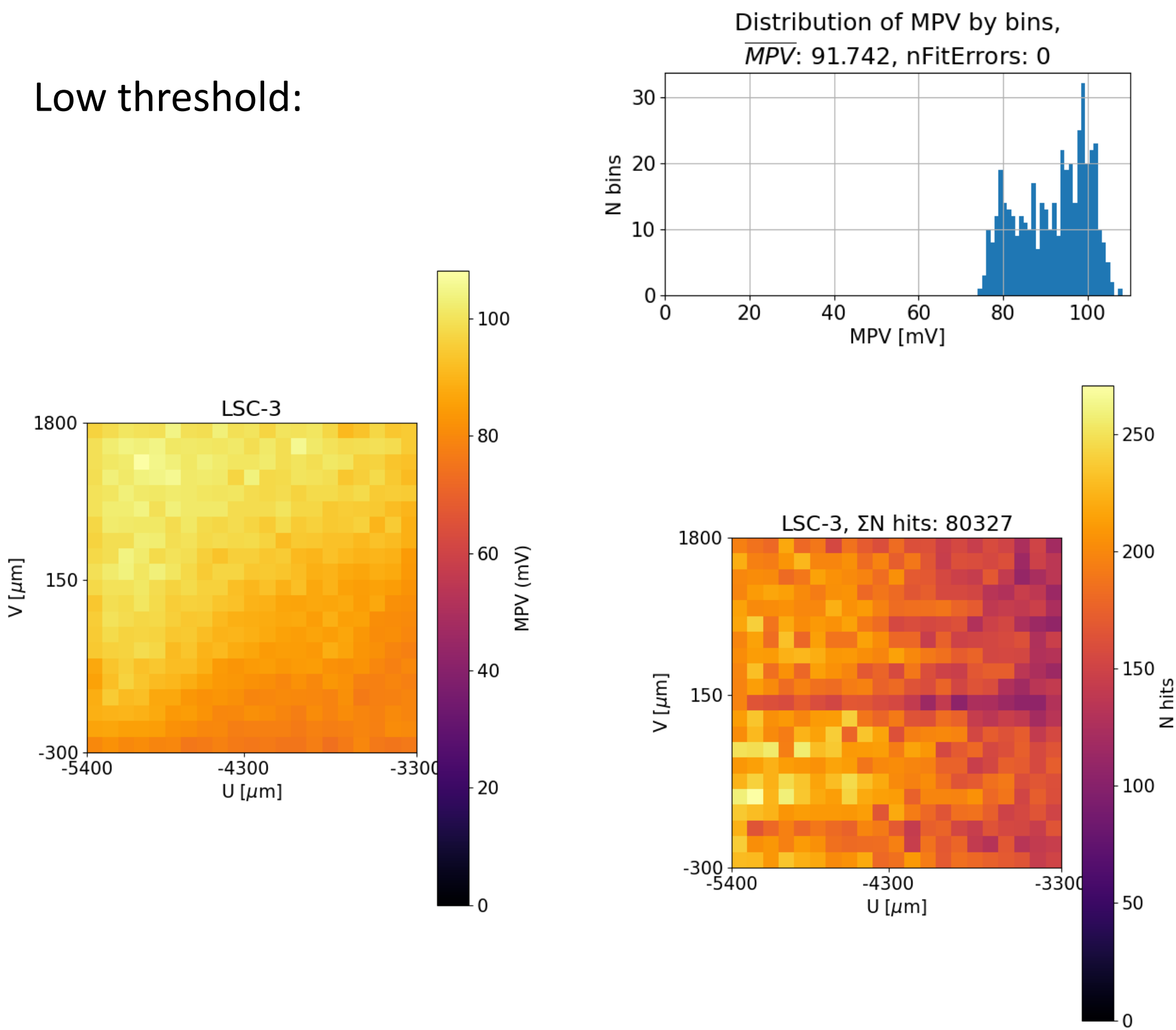
# Signal (MPV) analysis -500 V

Cuts:

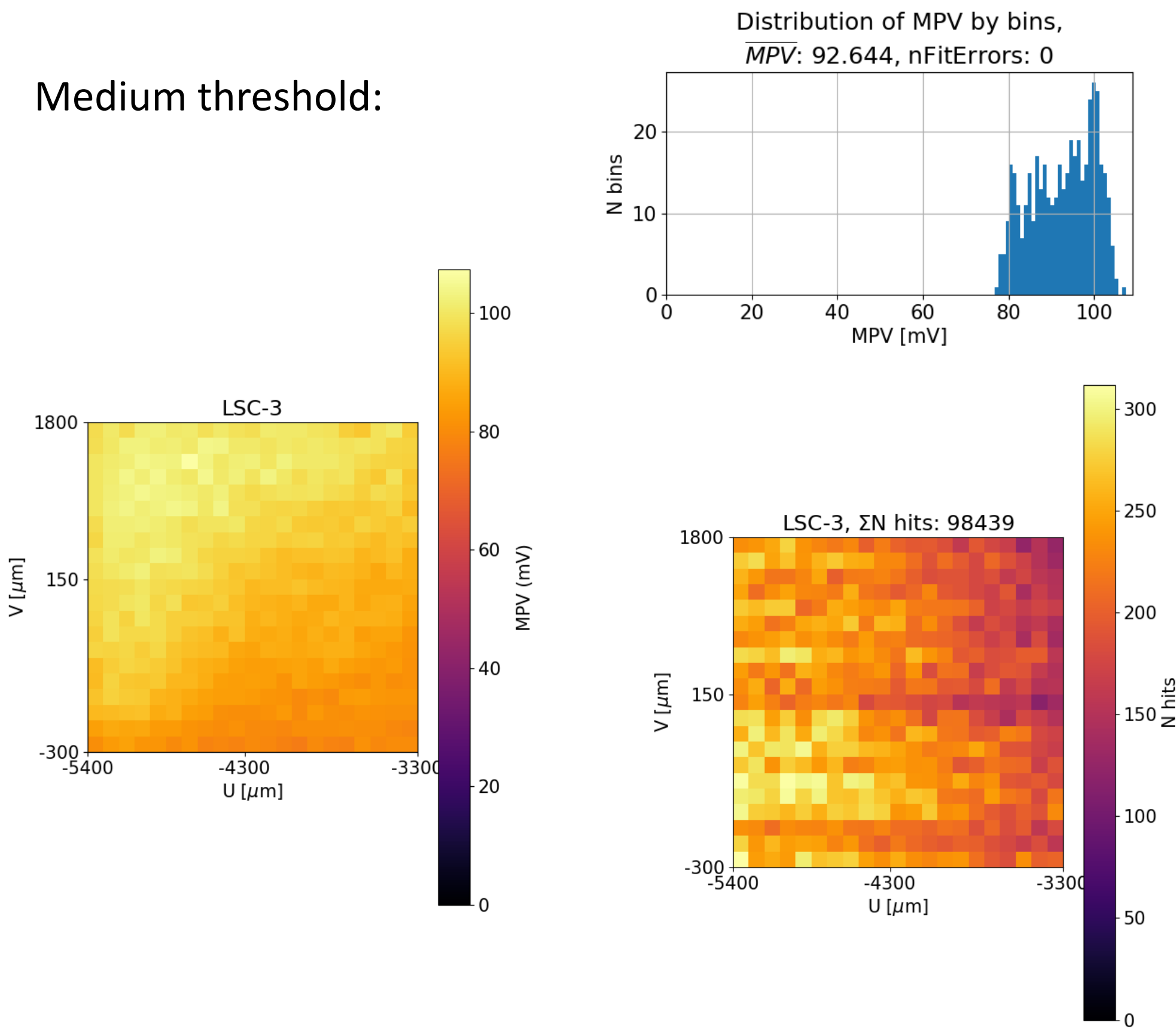
nTracks	Chi2	SlopeX,Y	ToA [bin]
1	<10	<0.00025	190-220

- Diamond at -500 V, Low & Med threshold
- Non-homogenous signal distribution across the diamond!

Low threshold:

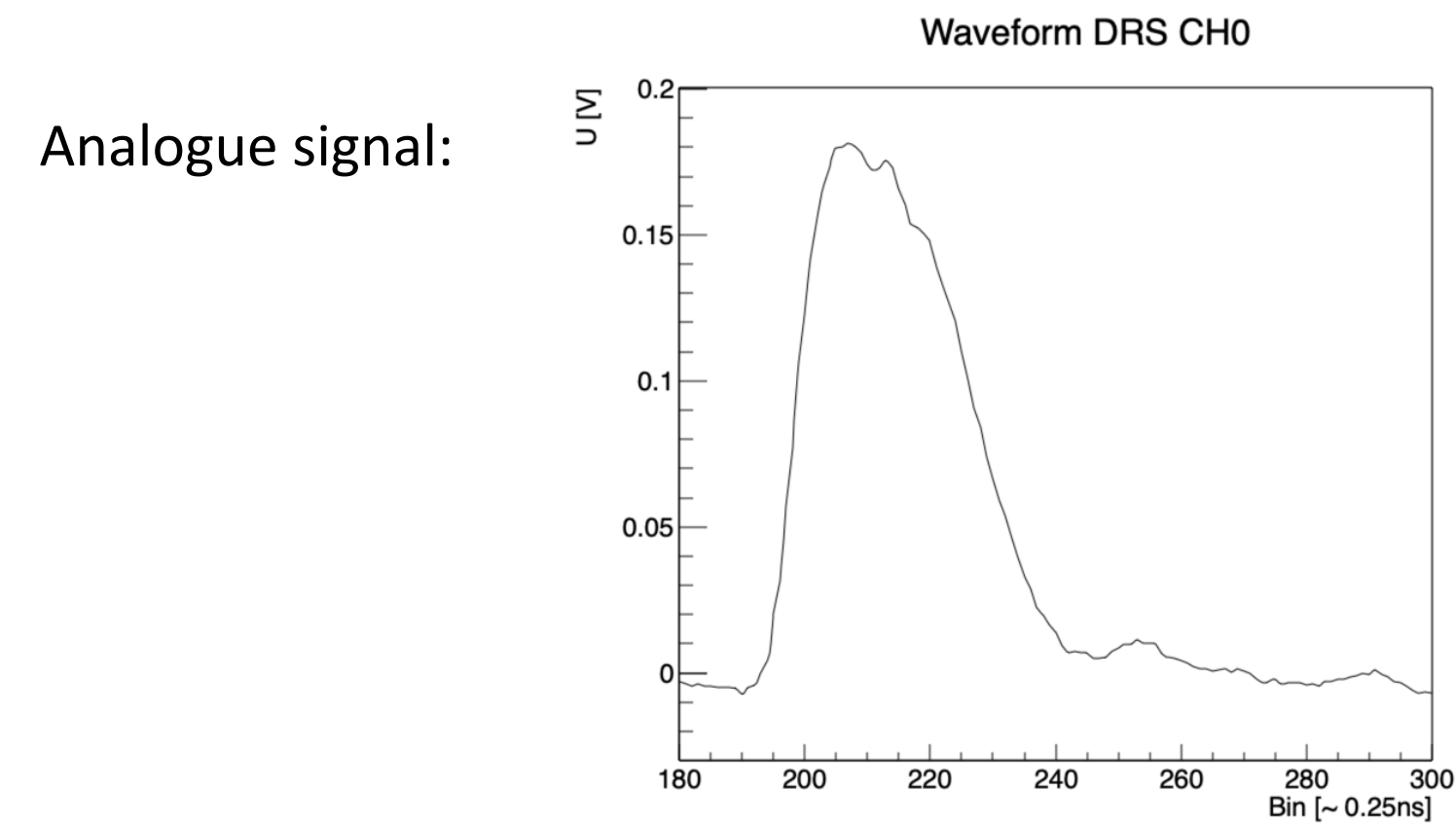
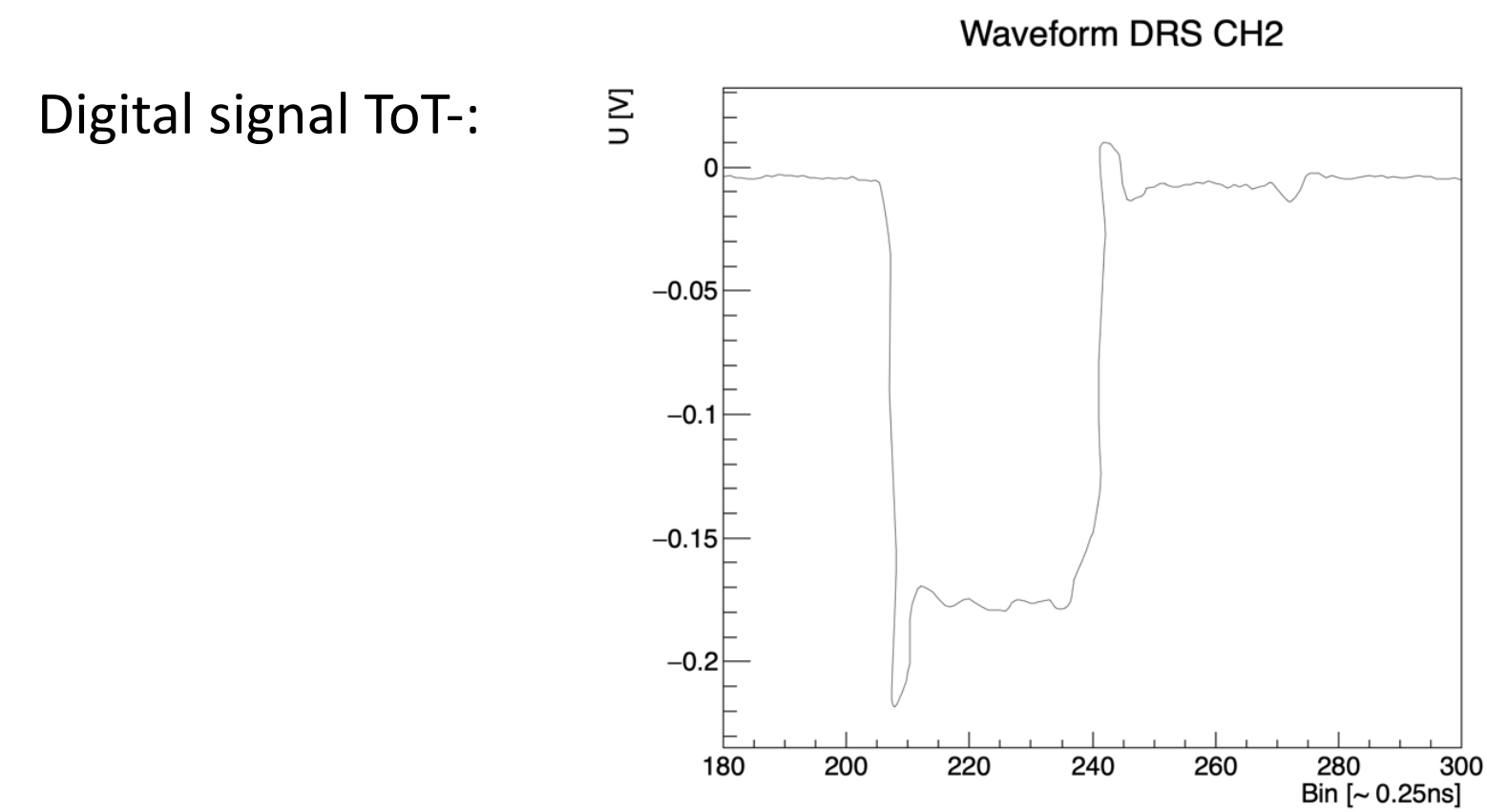
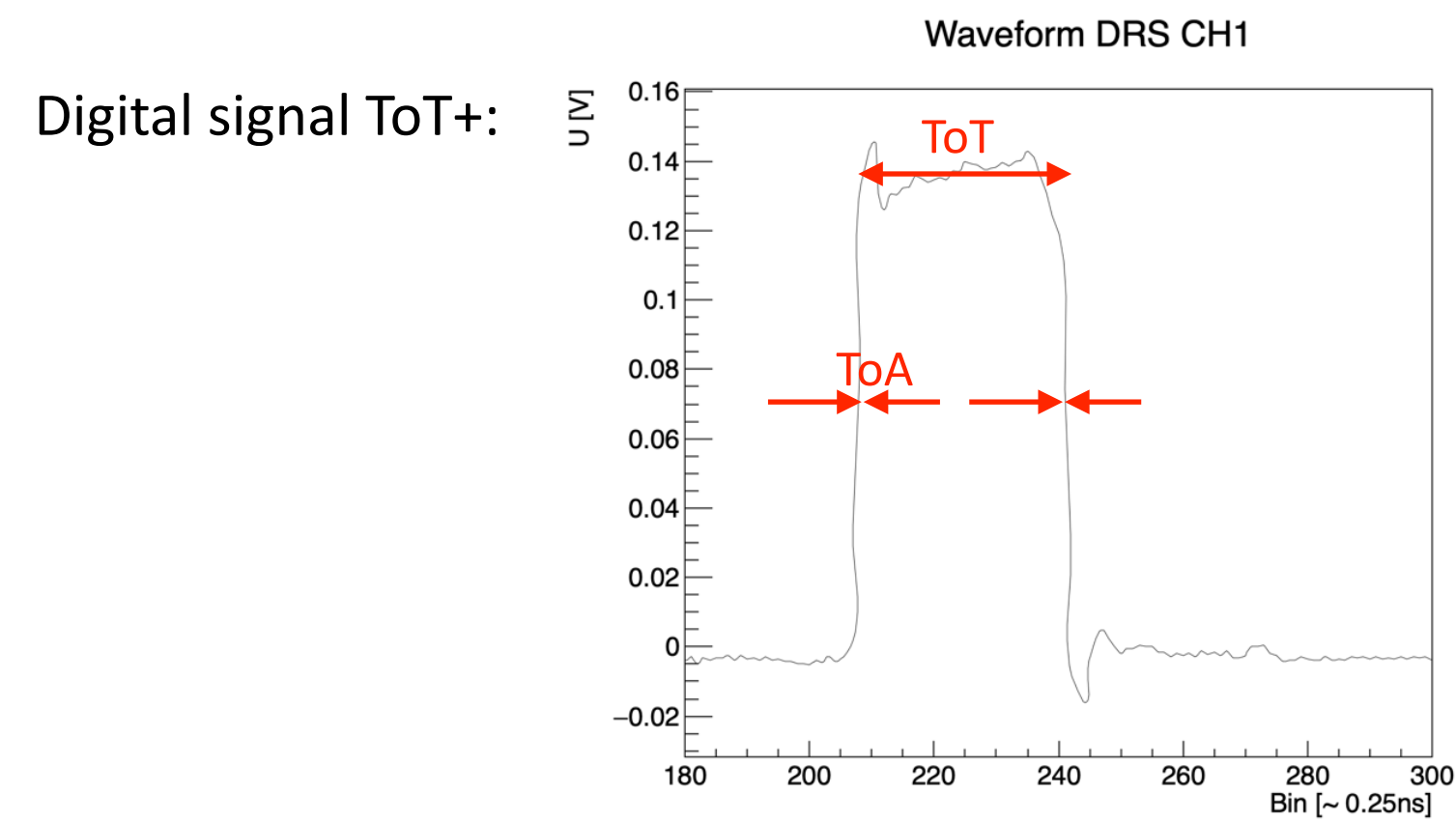


Medium threshold:



# Digital signals

- Differential ToT signals:

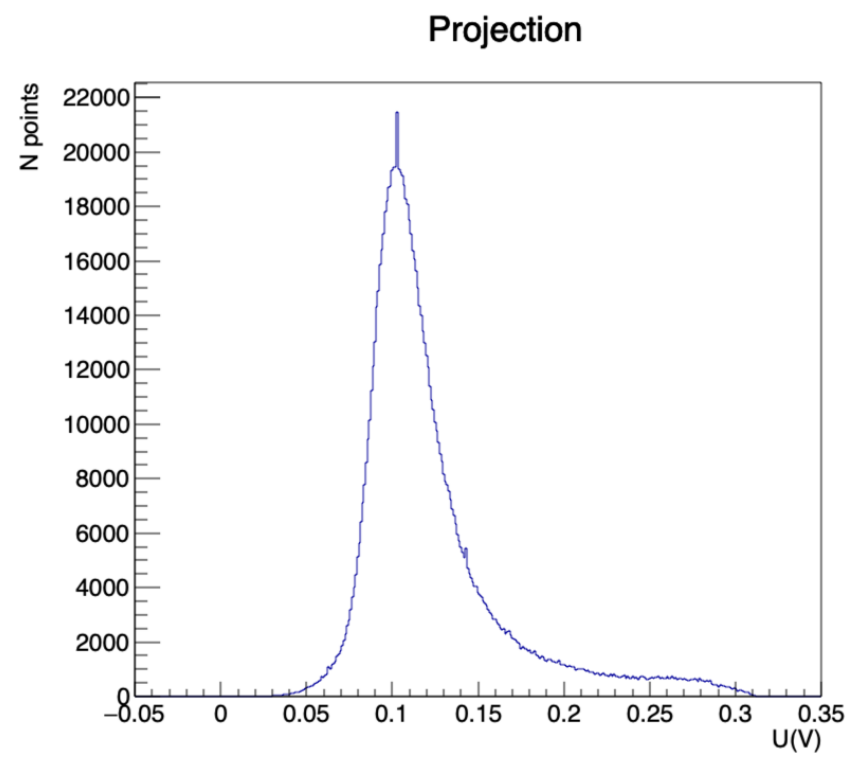


# ToT signals for +500V, MedT, entire fid. region

Cuts:

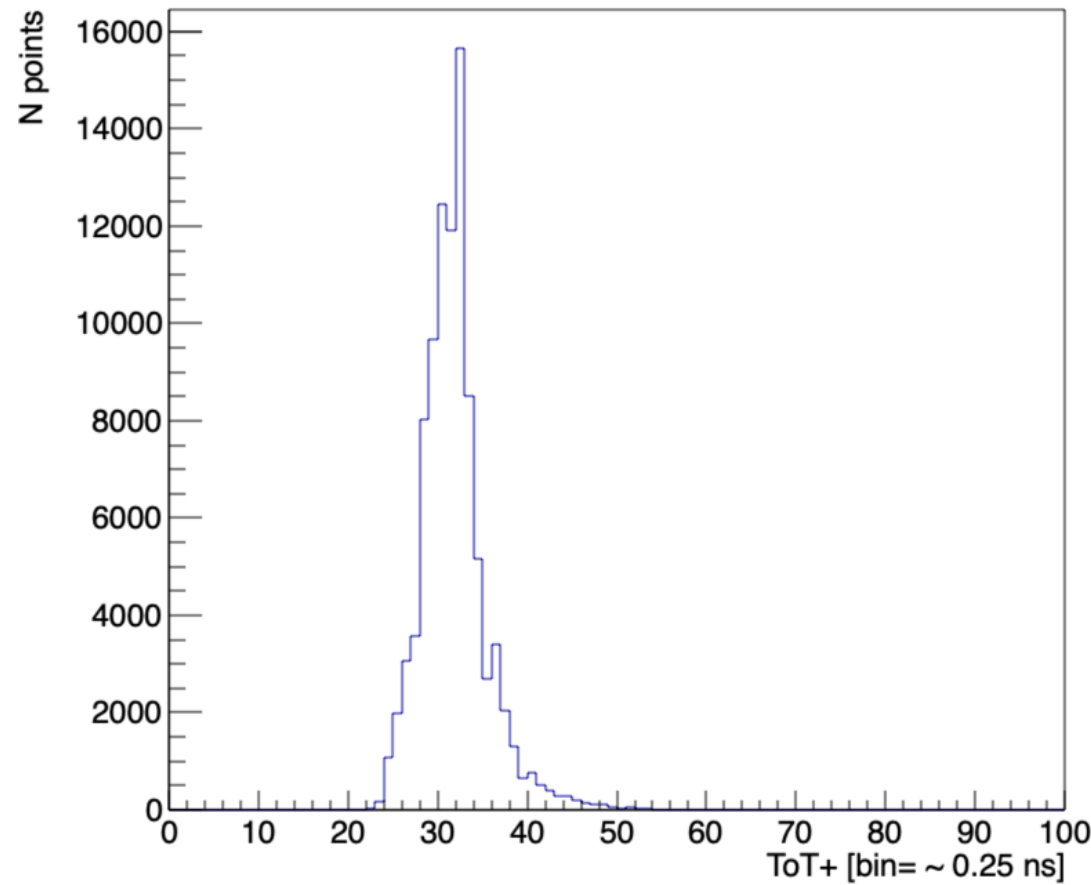
nTracks	Chi2	SlopeX,Y	ToA [bin]
1	<10	<0.00025	190-220

Analogue peak distribution:

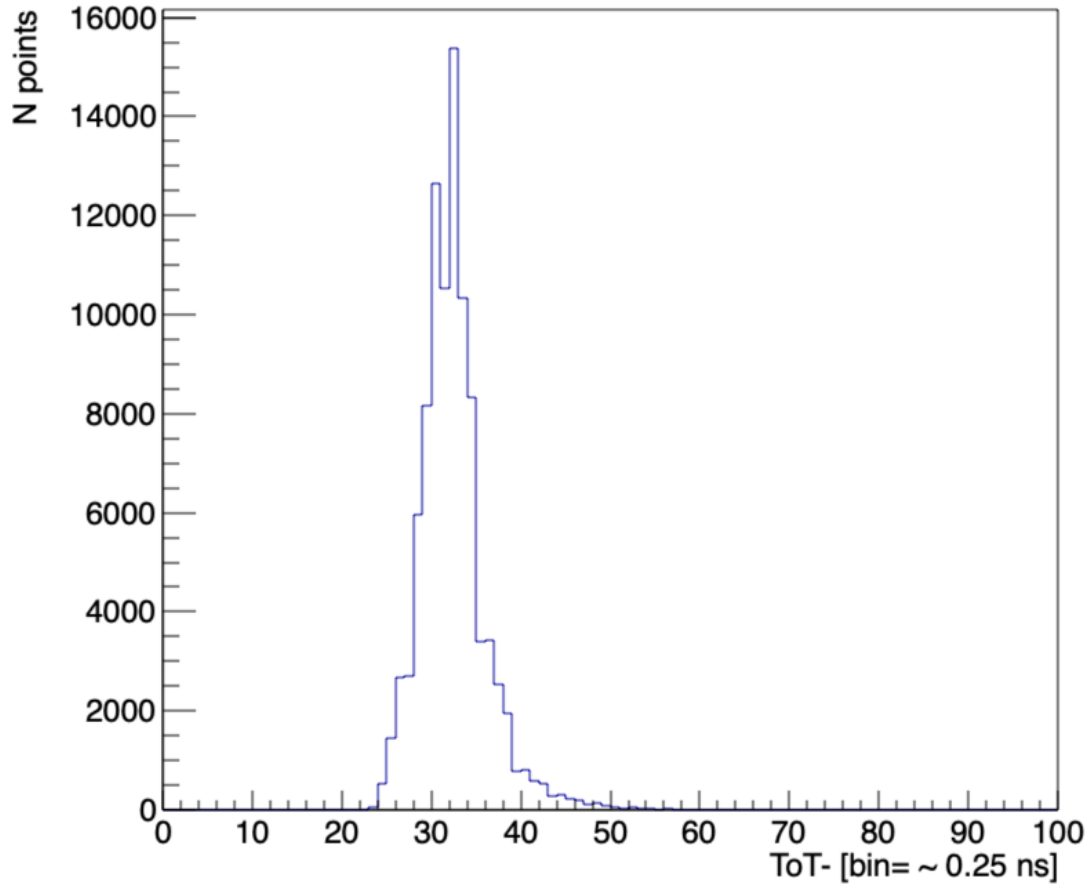


Mean: 0.123 V

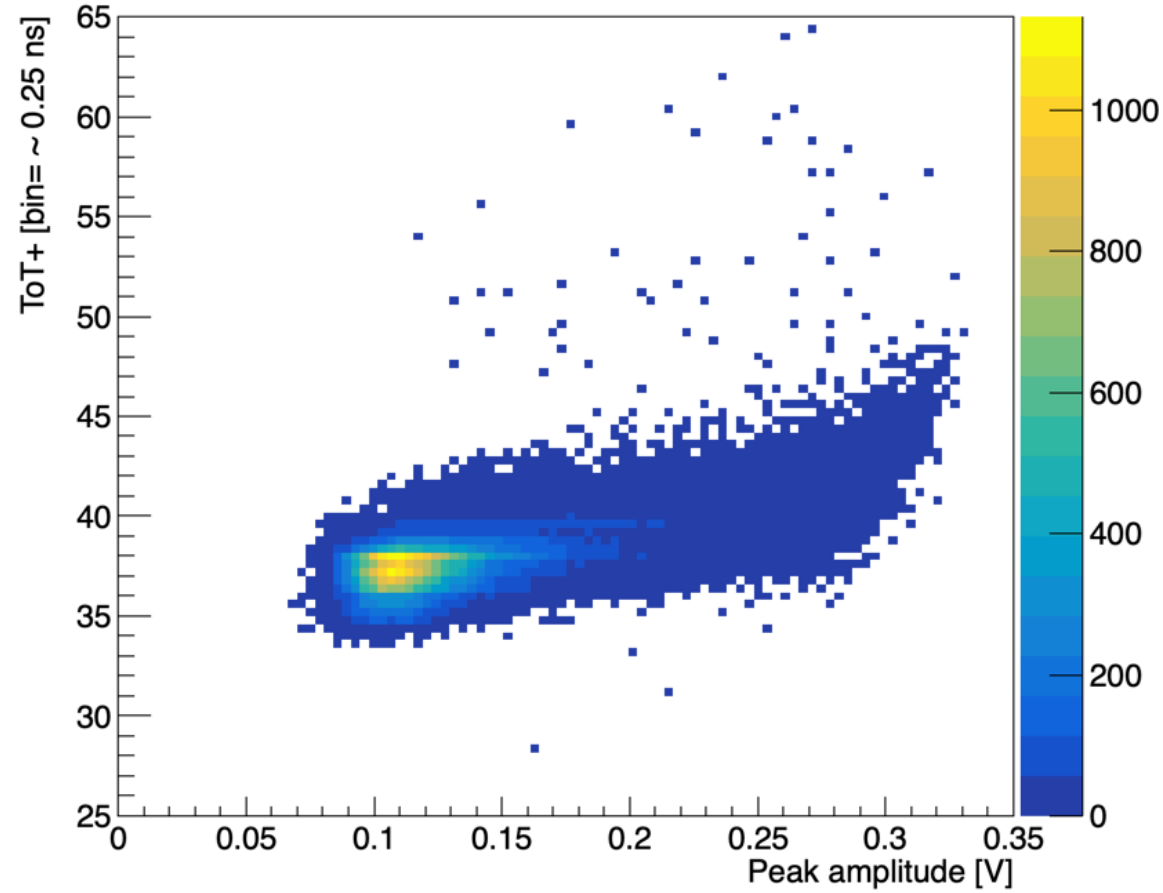
ToT+ distribution mean: 31.9 bins = 7.98 ns



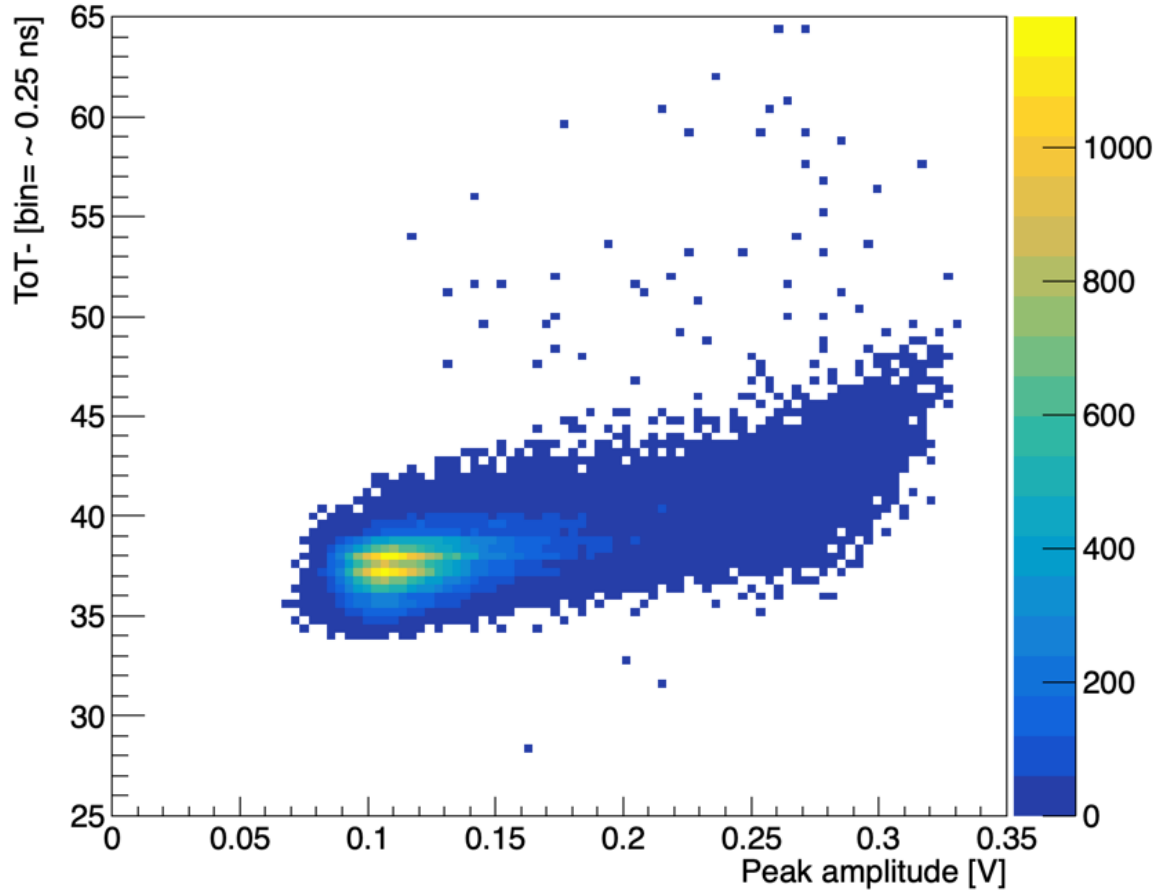
ToT- distribution mean: 32.4 bins = 8.1 ns



ToT+ vs Analog signal



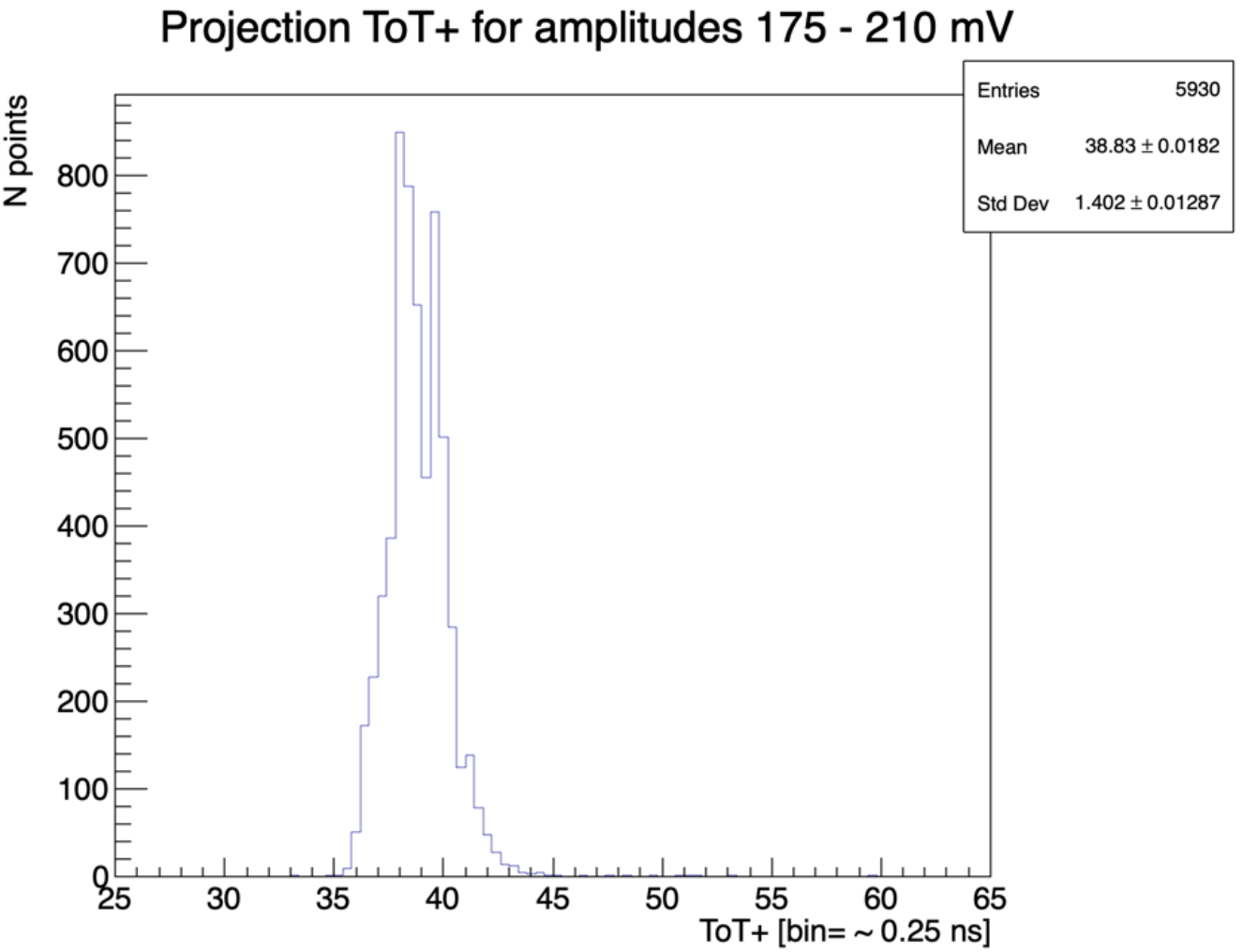
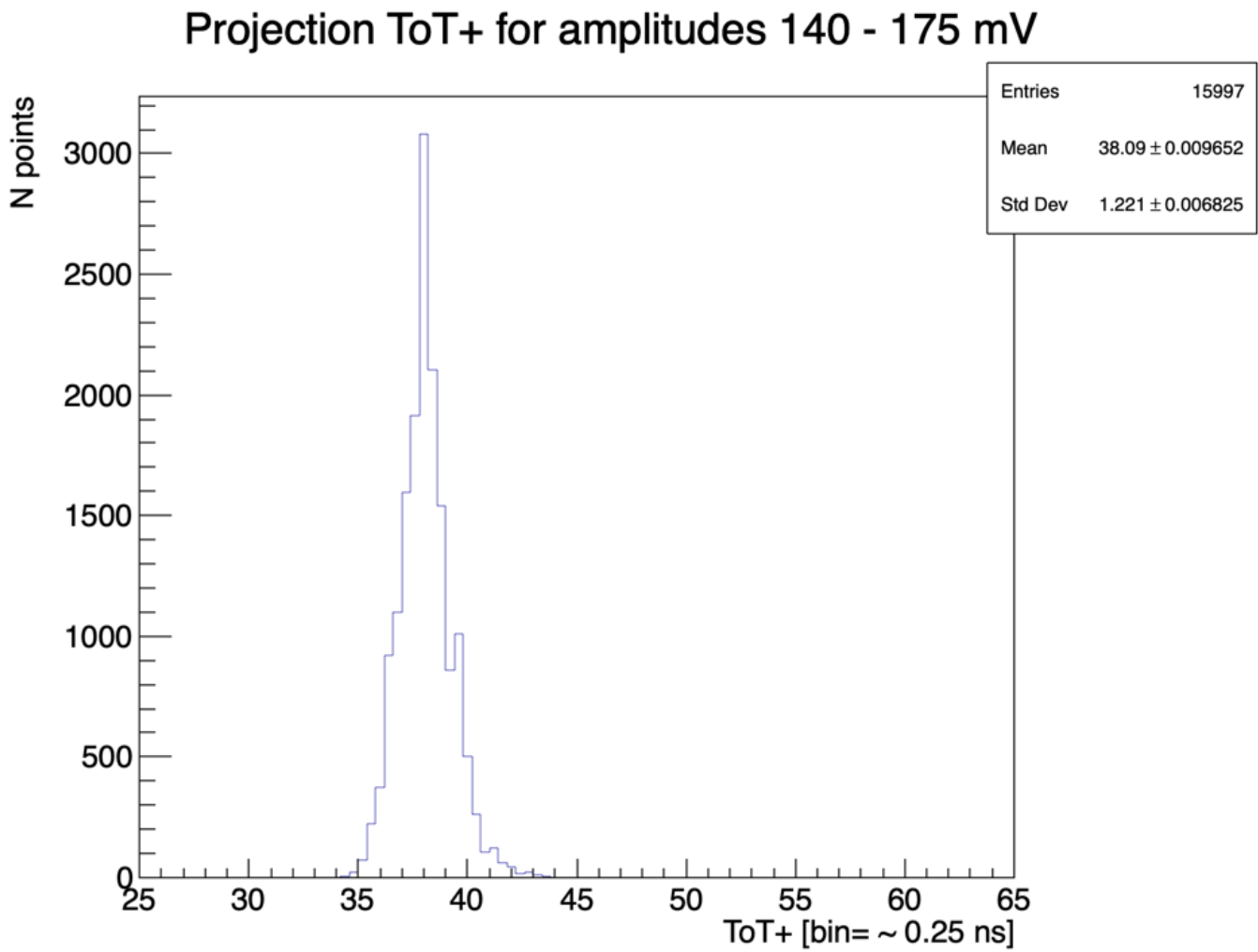
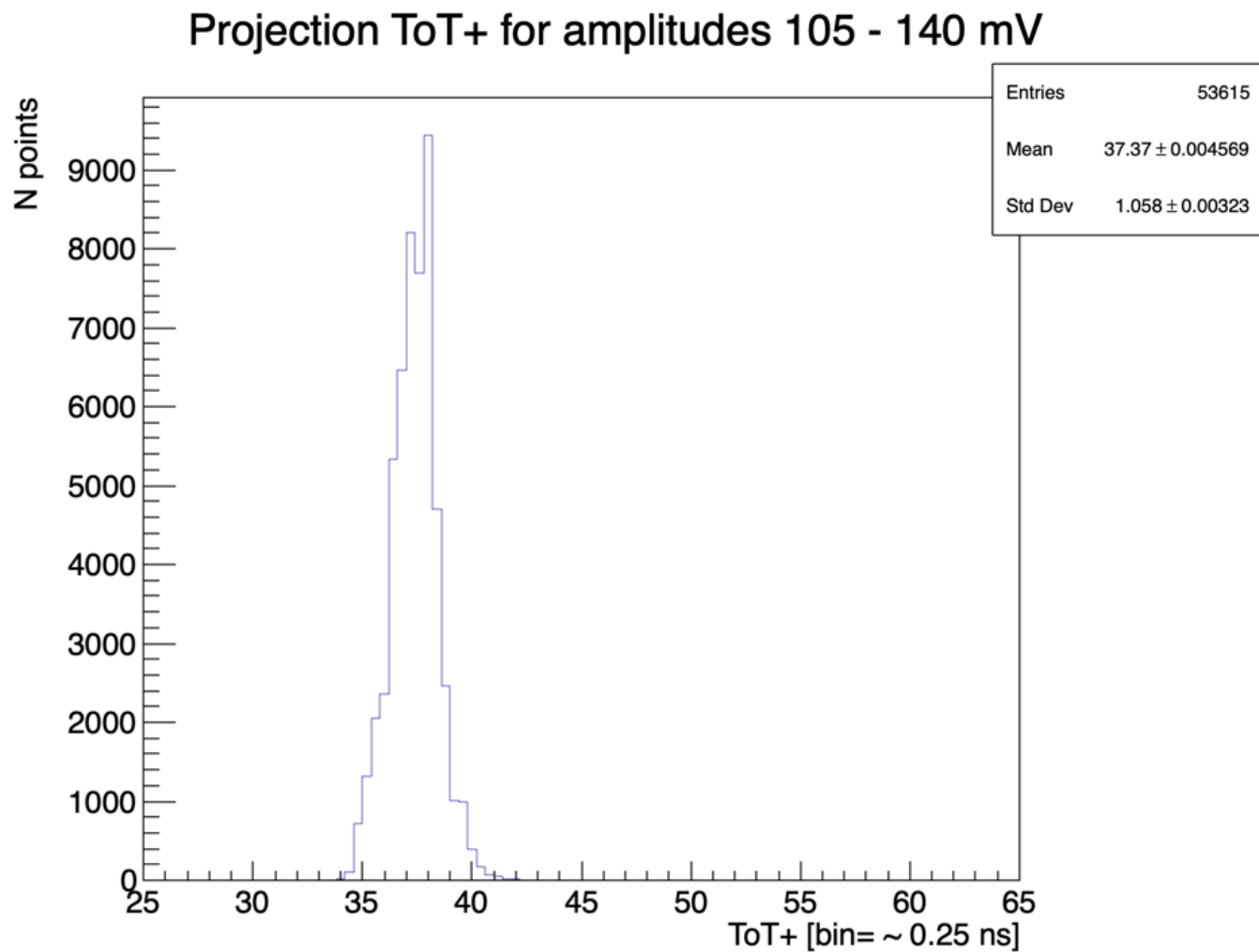
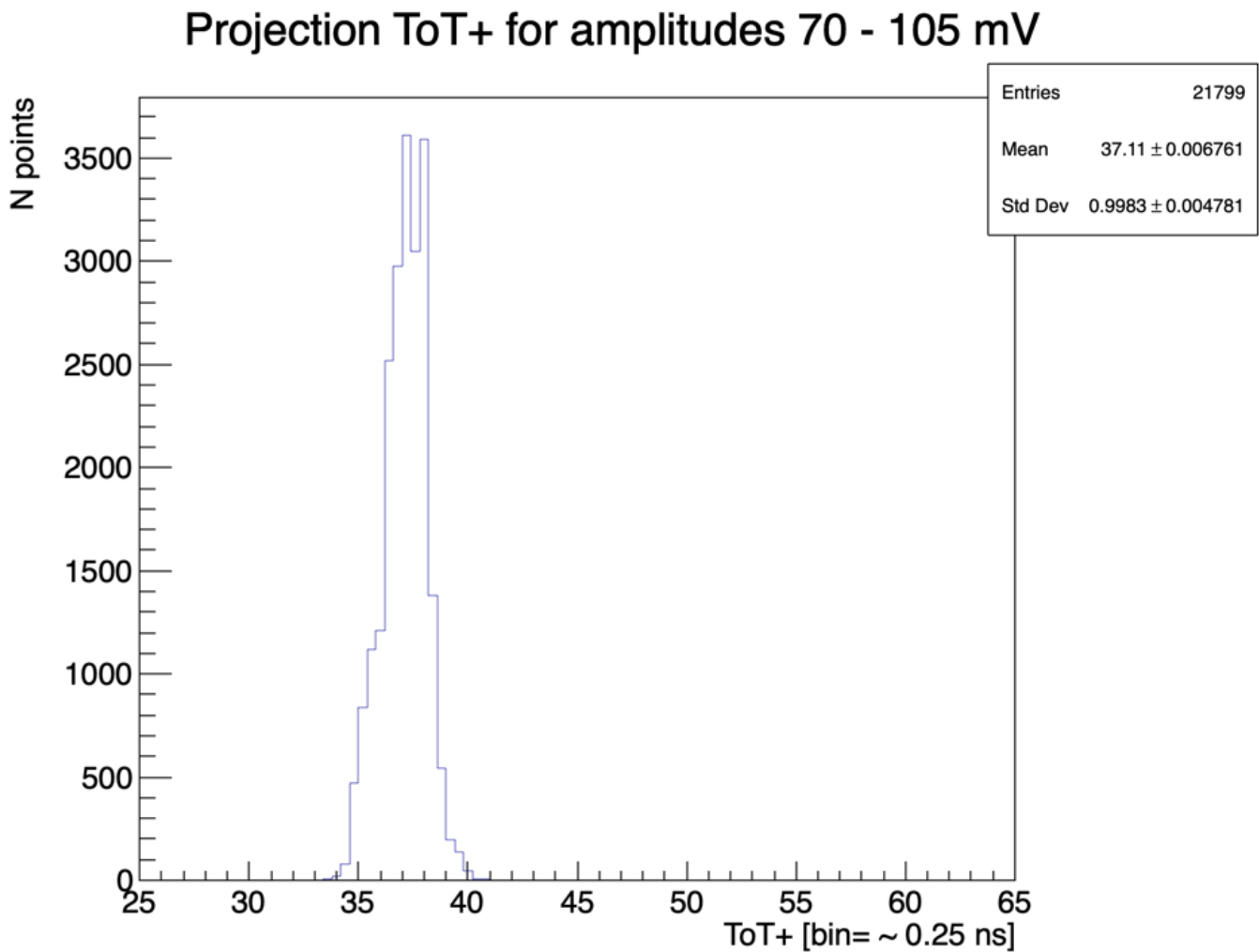
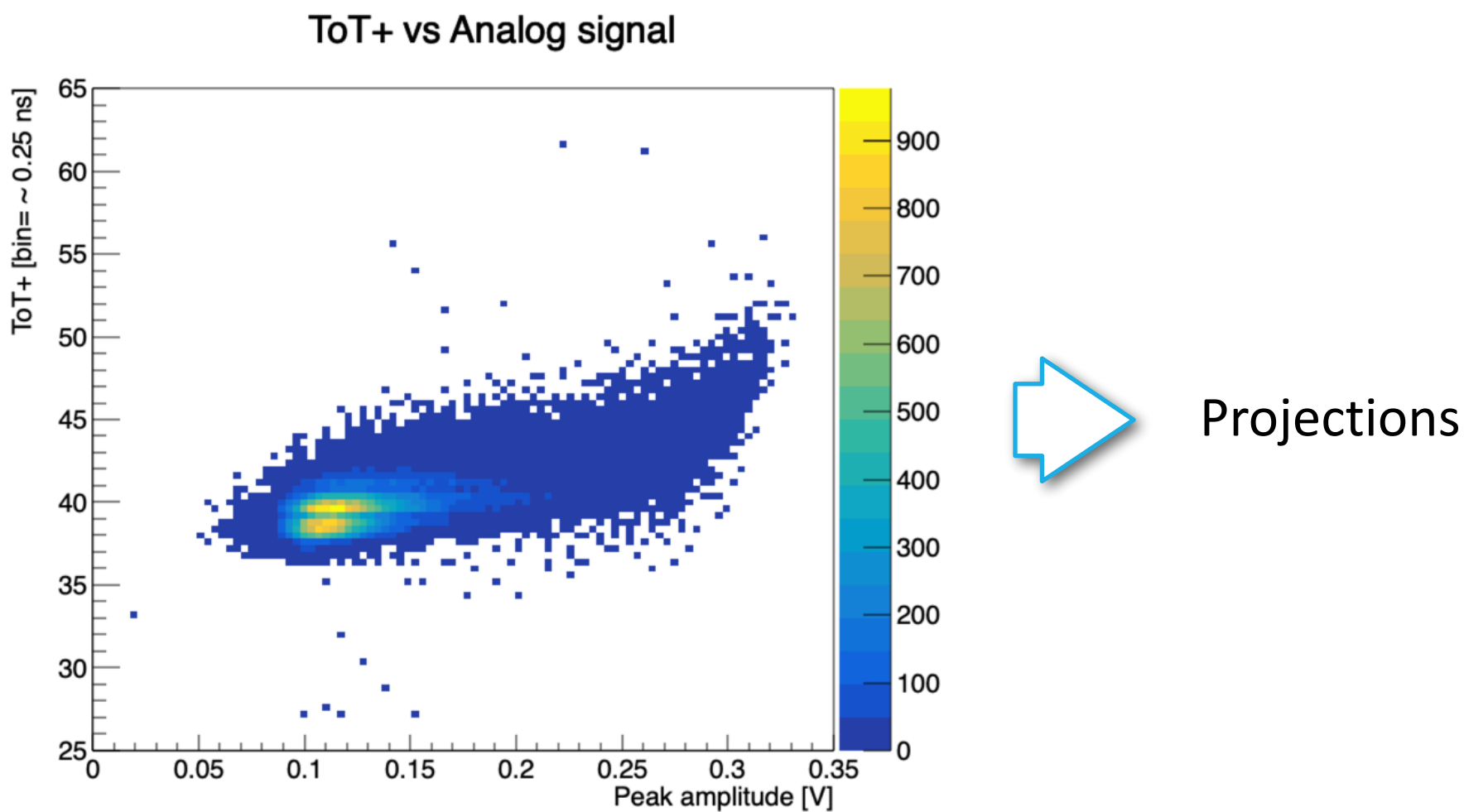
ToT- vs Analog signal



# ToT signals for +500V, MedT, entire fid. region

Cuts:

nTracks	Chi2	SlopeX,Y	ToA [bin]
1	<10	<0.00025	190-220

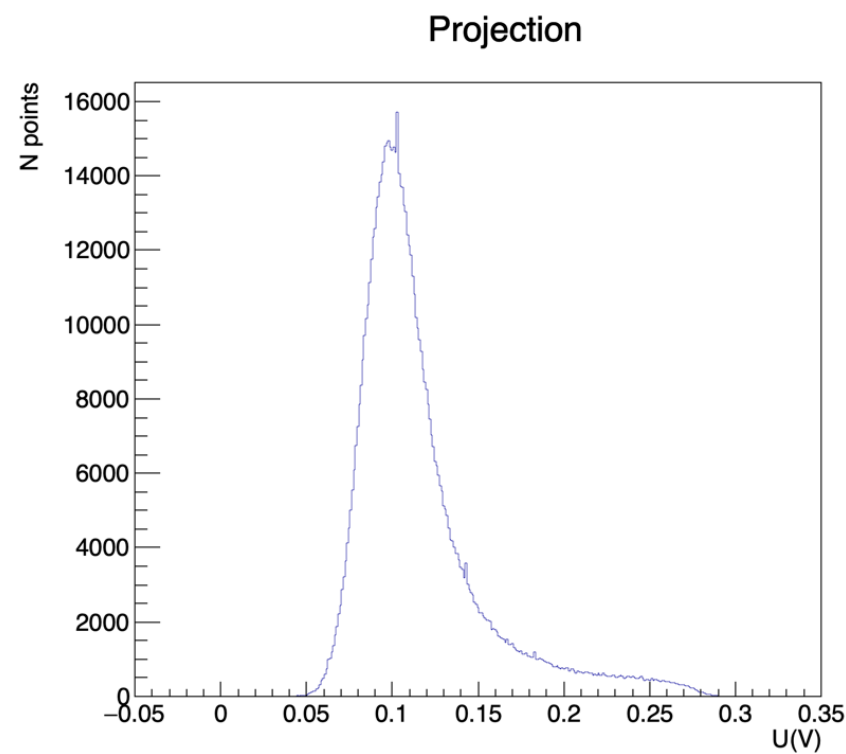


# ToT signals for -500V, MedT, entire fid. region

Cuts:

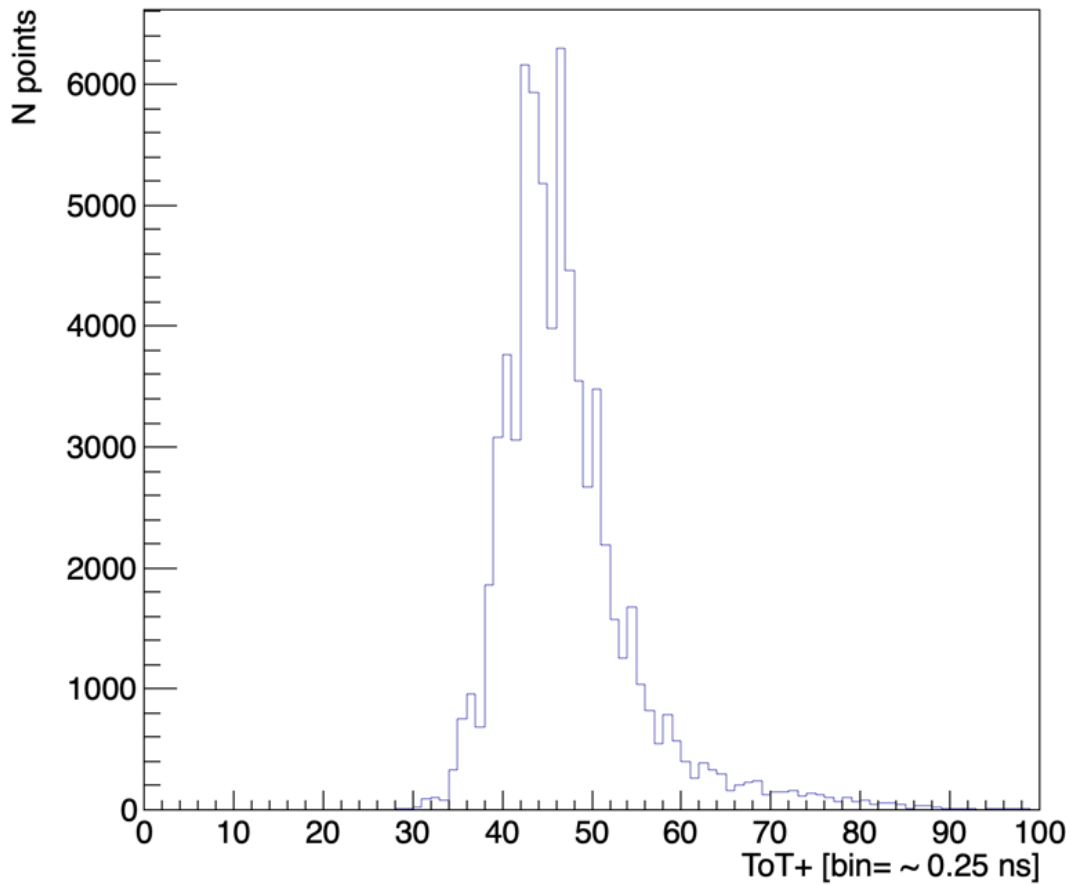
nTracks	Chi2	SlopeX,Y	ToA [bin]
1	<10	<0.00025	190-220

Analogue peak distribution:

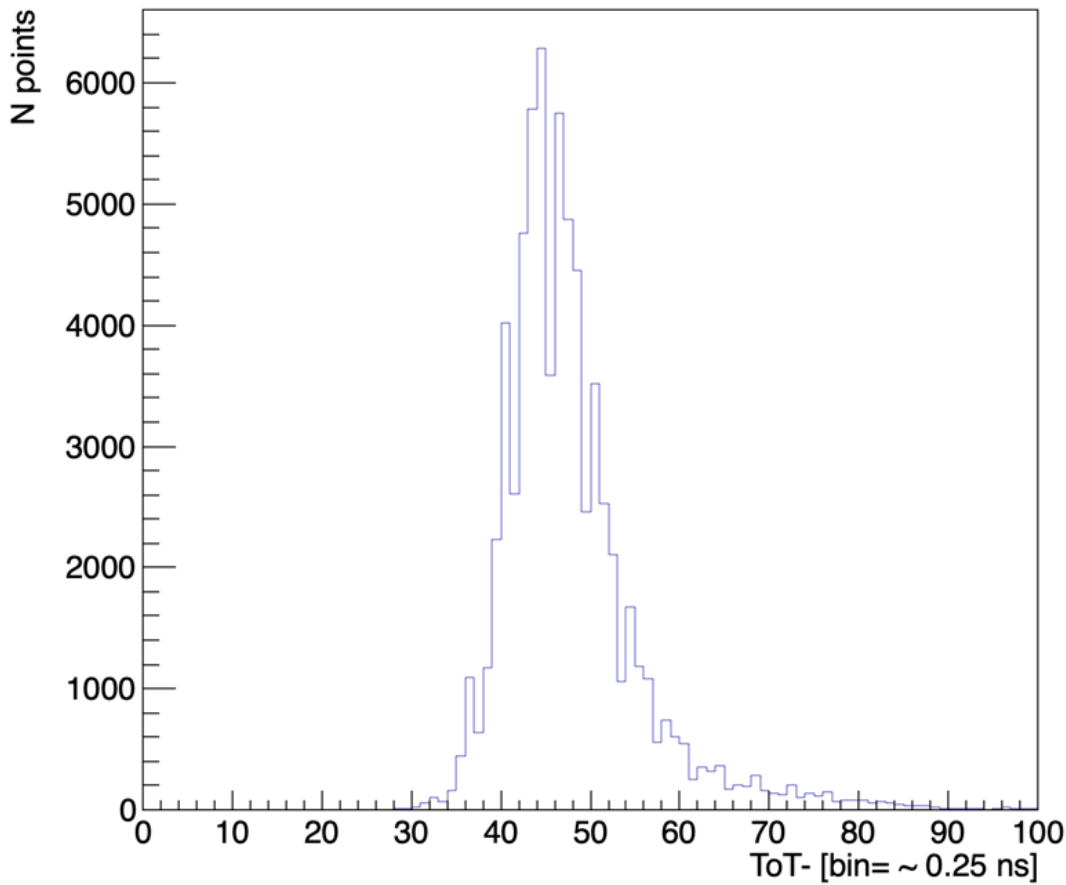


Mean: 0.116 V

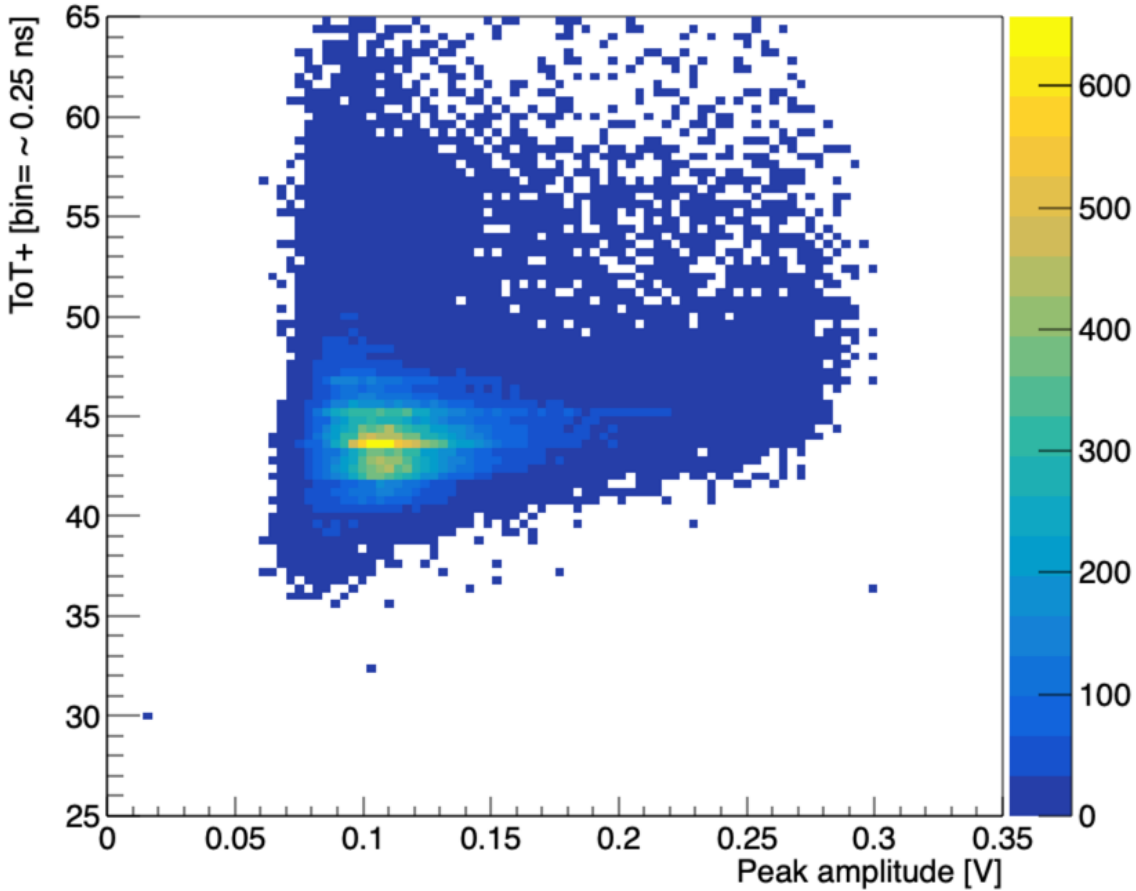
ToT+ distribution mean: 47.2 bins = 11.8 ns



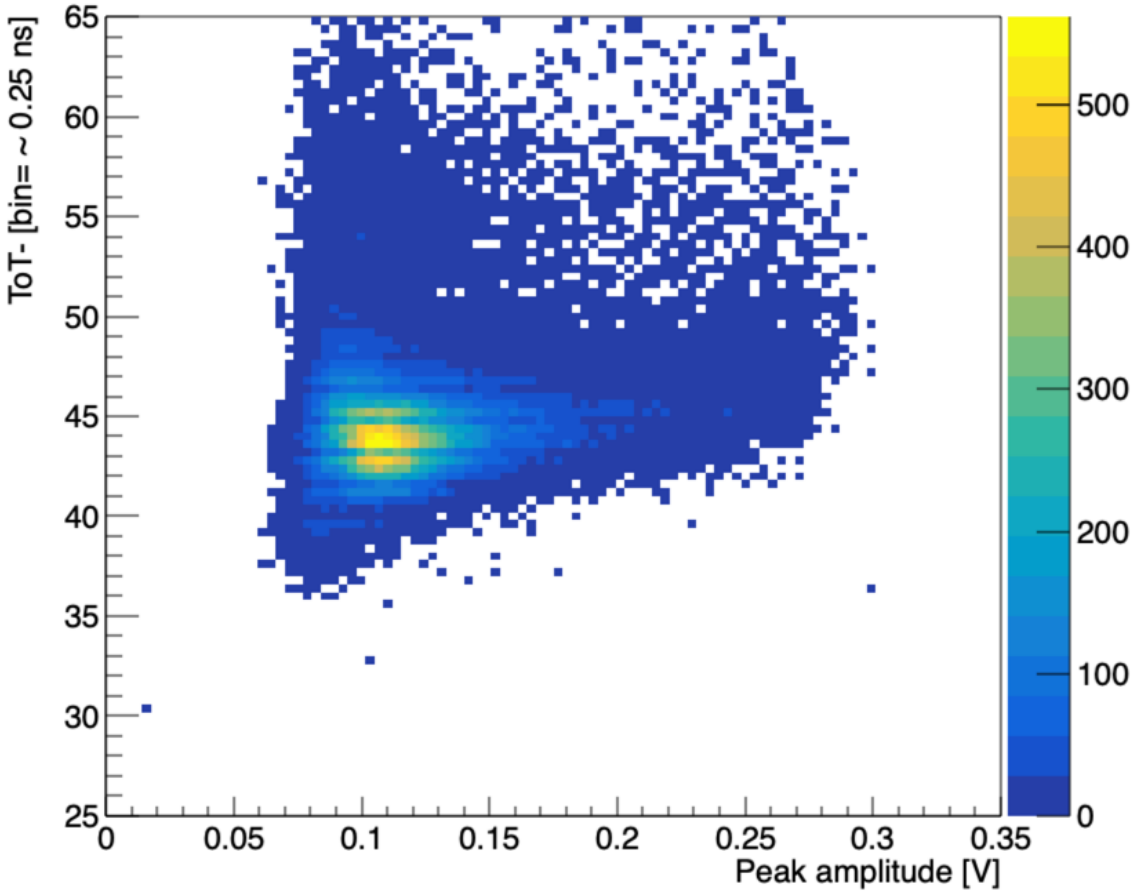
ToT- distribution mean: 47.8 bins = 11.95 ns



ToT+ vs Analog signal



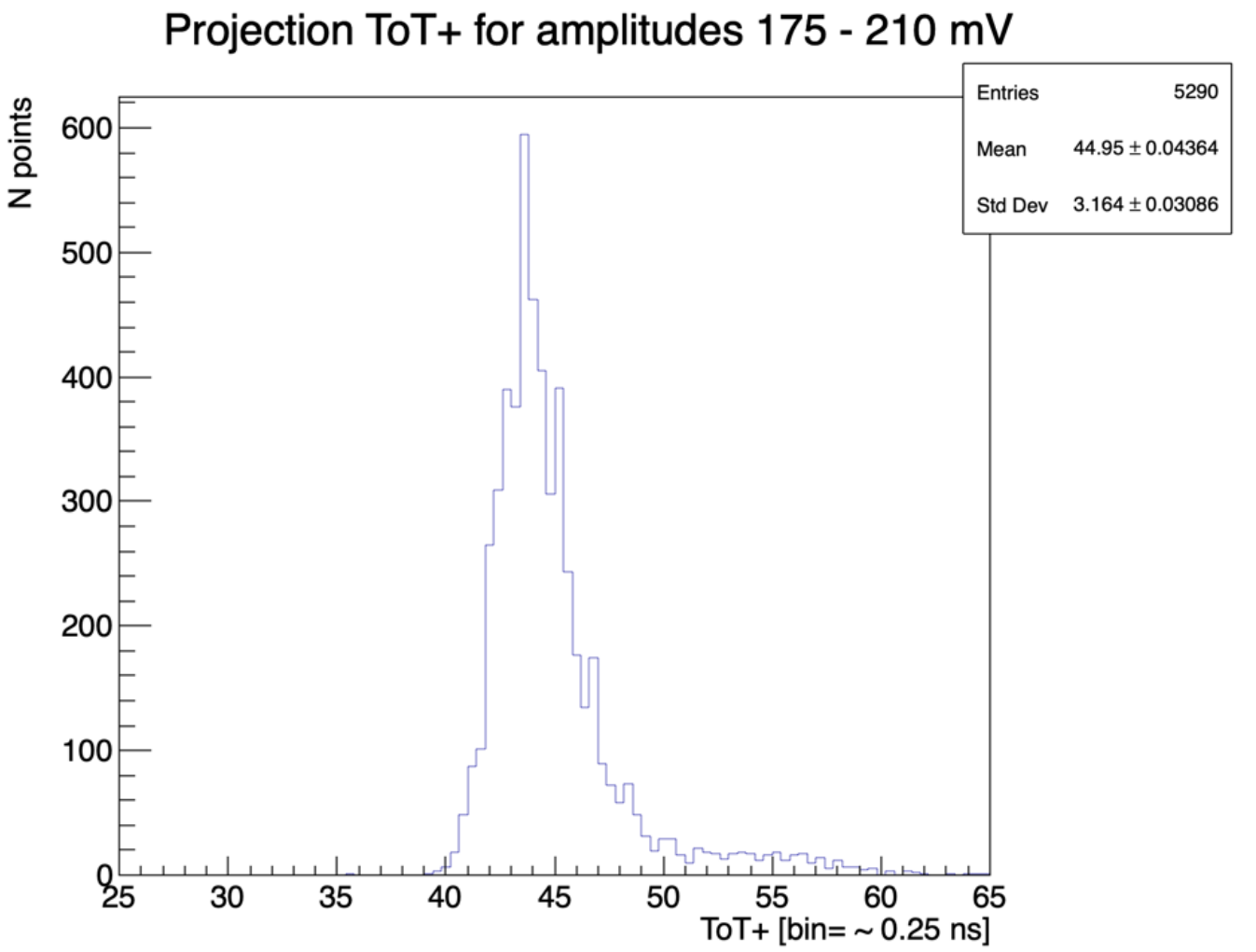
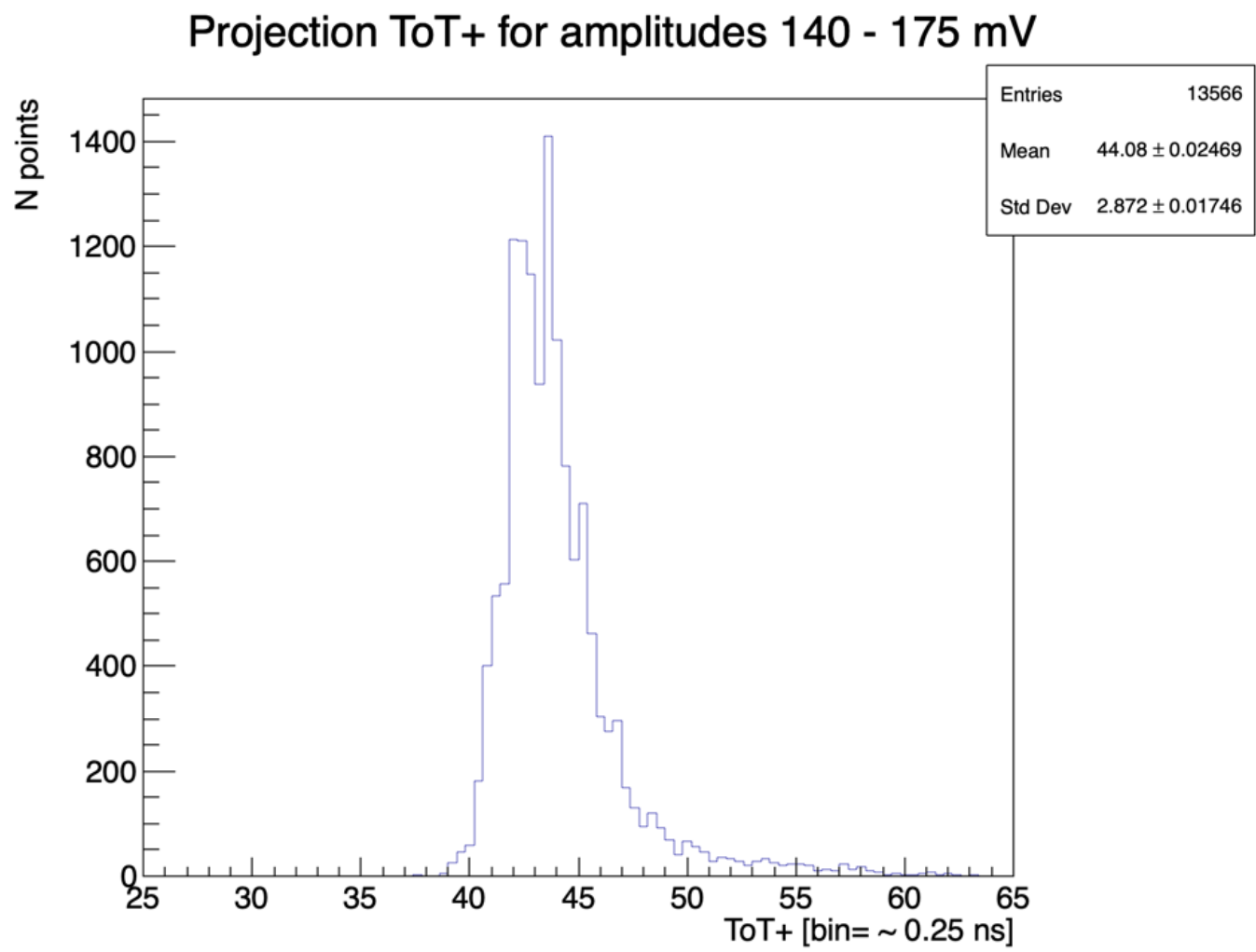
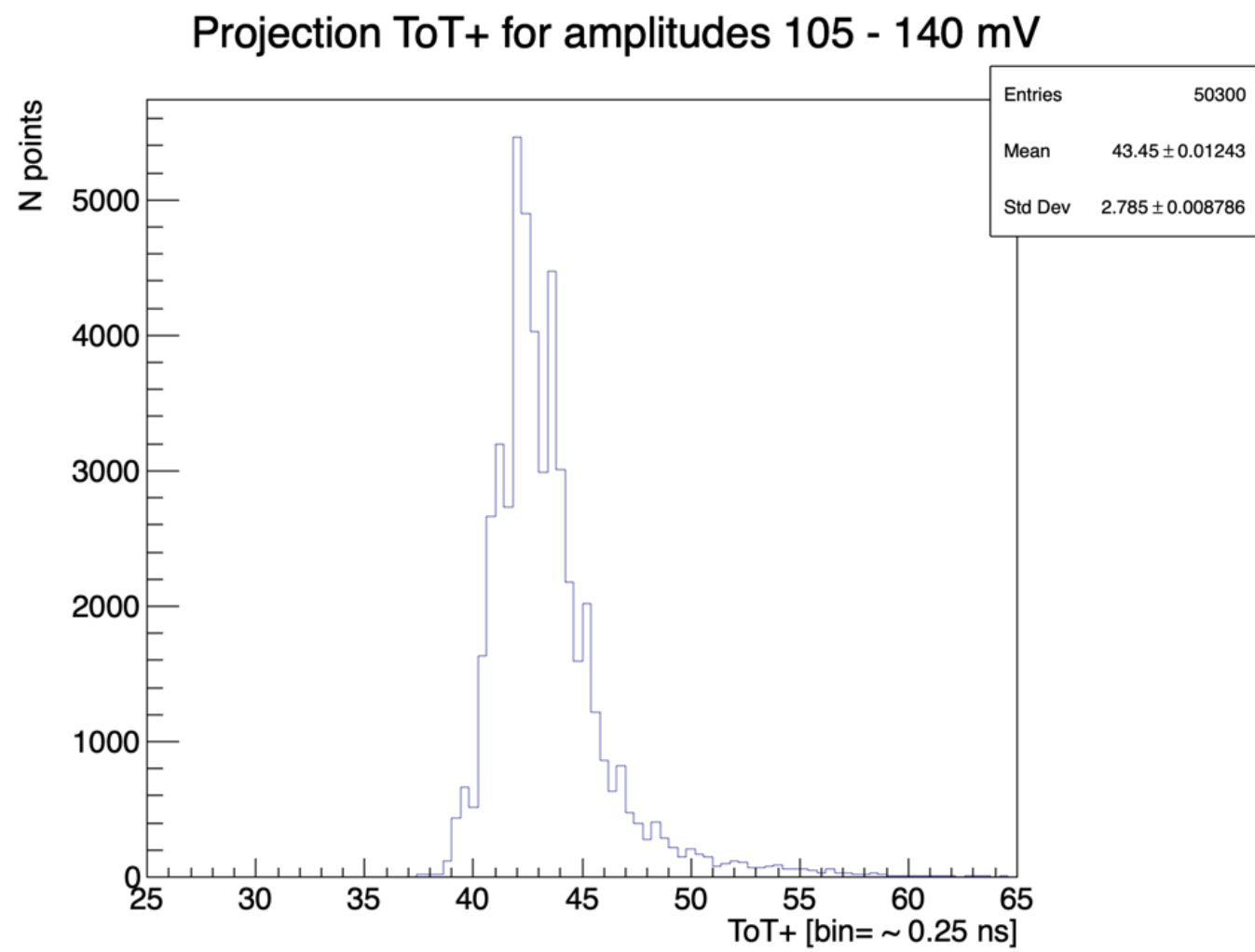
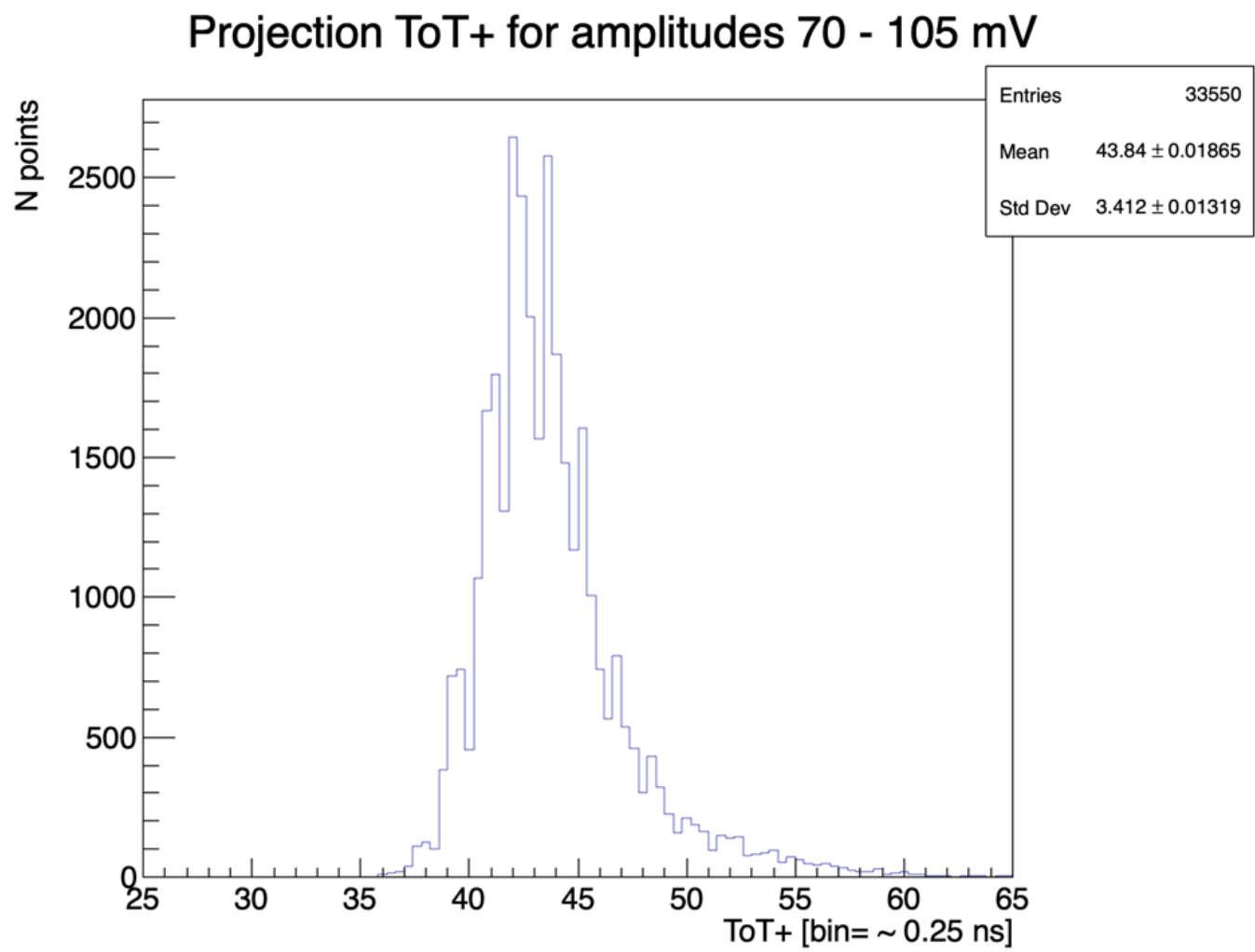
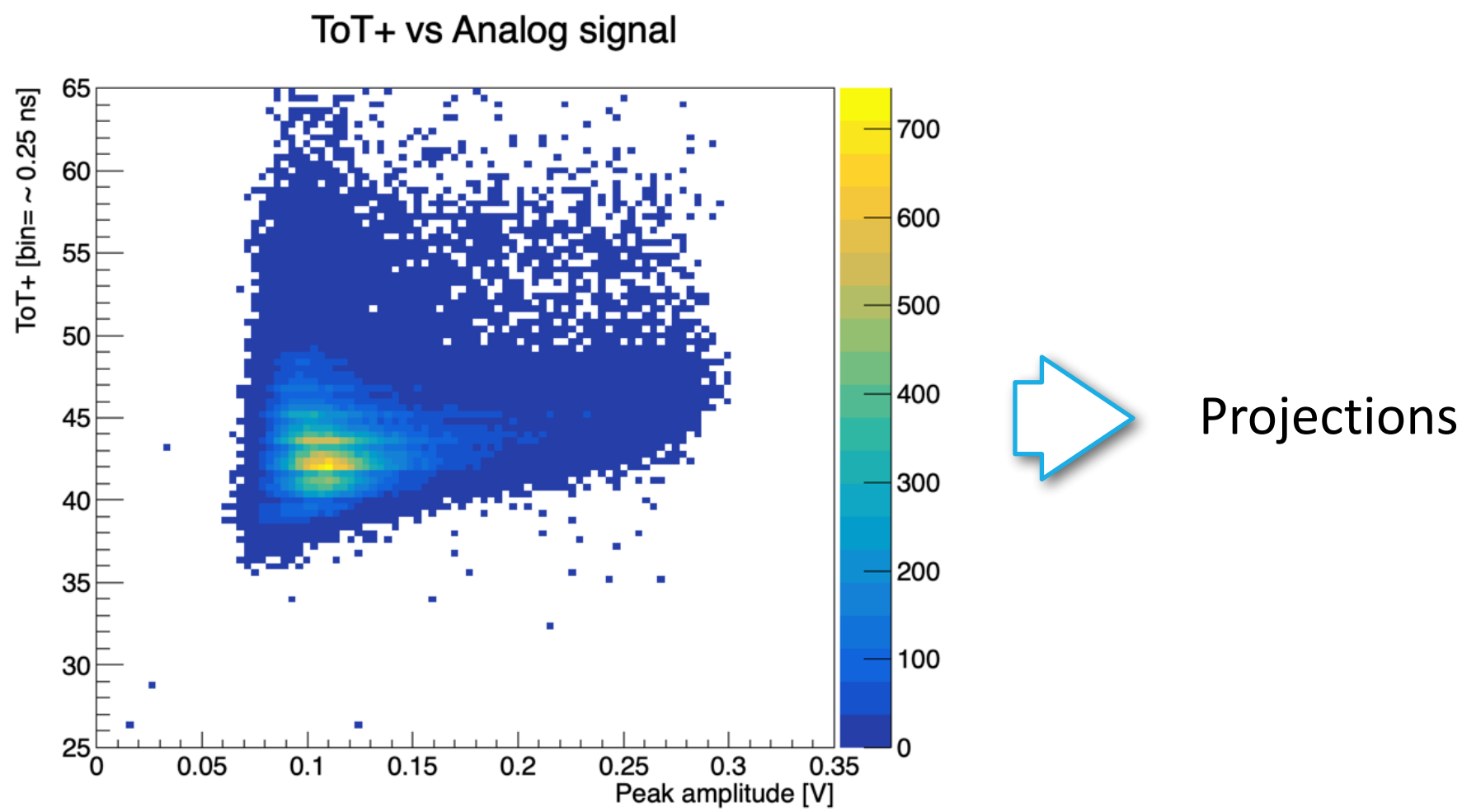
ToT- vs Analog signal



# ToT signals for -500V, MedT, entire fid. region

Cuts:

nTracks	Chi2	SlopeX,Y	ToA [bin]
1	<10	<0.00025	190-220

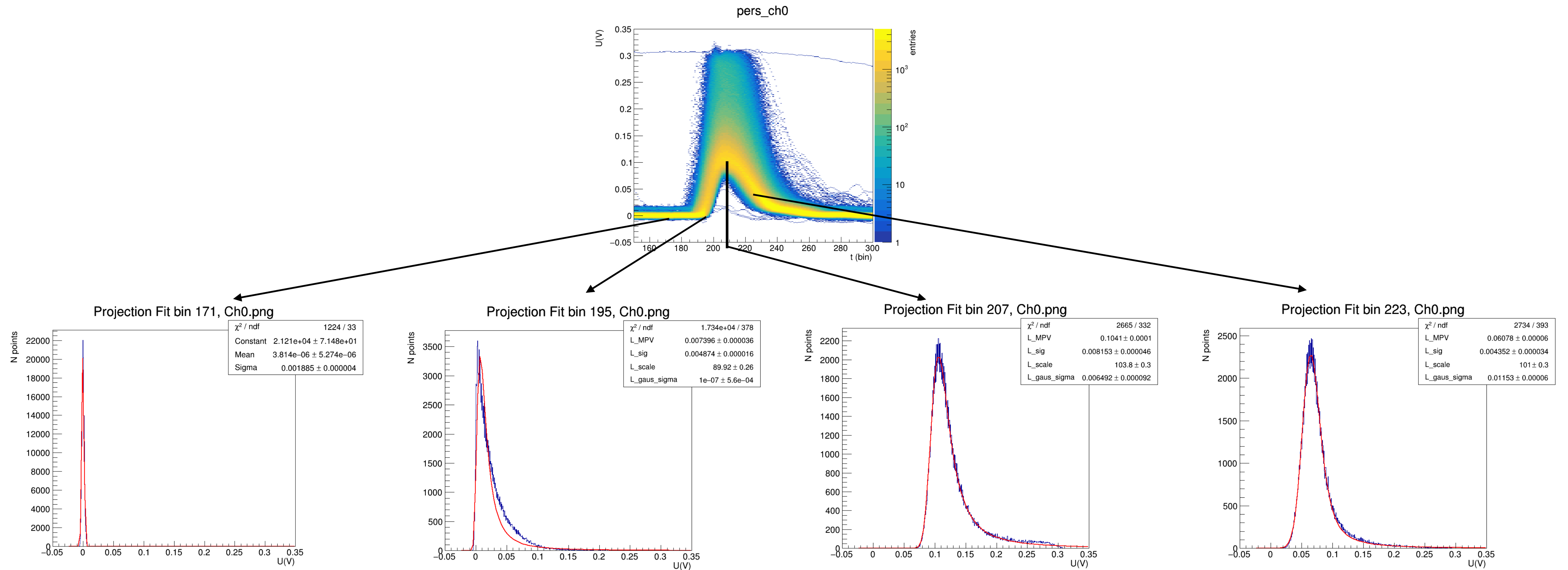


# Extra slides

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# Analogue signal rise-time

- Most probable or Mean signal calculated for each bin using the persistence graph
- Gauss or LandGau function fitted to distribution



# Analogue signal rise-time

- Rise-time estimated as time when signal rises 10%-90%
- Equidistant bins, bin width 0.25 ns (needs to be corrected for each bin!)
- Rise-time: 7.7 bins or 1.925 ns

