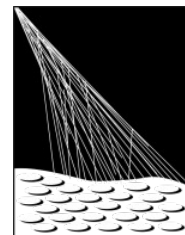


# Update on an algorithm for the online determination of the MIP peak in the UUB DAQ

Paul Filip, David Schmidt



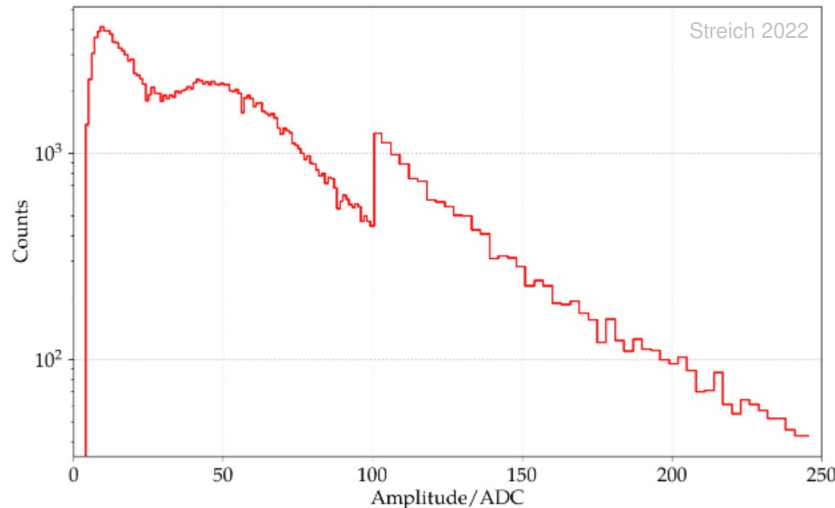
PIERRE  
AUGER  
OBSERVATORY



# Idea & terminology

## WCD offline calibration algorithm

- Fit peak of muon histogram



## WCD online calibration algorithm

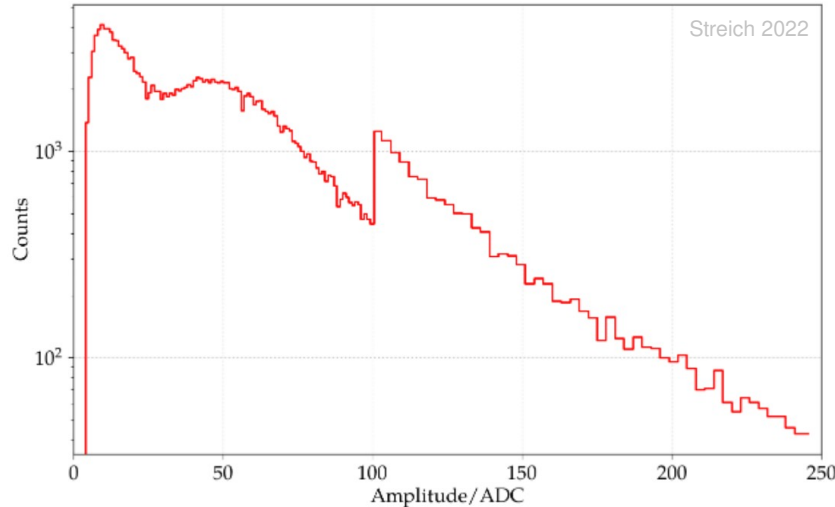
- (1) Start with a value of  $I_{\text{VEM}}^{\text{est.}} = 50$  ch.
- (2) Measure, for each PMT, the rate of events satisfying the calibration trigger by counting these events for a time  $t_{\text{cal}}$ , initially set to 5 s.
- (3) If, for a given PMT, the rate is above  $70 + \sigma$  Hz, increase  $I_{\text{VEM}}^{\text{est.}}$  by  $\delta$ . Likewise, if the rate is below  $70 - \sigma$  Hz, decrease  $I_{\text{VEM}}^{\text{est.}}$  by  $\delta$ , with  $\sigma = 2$  Hz and  $\delta = 1$  ch initially.
- (4) If the rate of any single PMT is more than  $10\sigma$  away from 70 Hz, adjust  $I_{\text{VEM}}^{\text{est.}}$  by 5 ch in the appropriate direction, set  $t_{\text{cal}}$  to 10 s,  $\delta = 1$  ch, and repeat from step (2).
- (5) Otherwise, if  $t_{\text{cal}} < 60$  s, increase  $t_{\text{cal}}$  by 5 s. If  $\delta > 0.1$  ch, decrease  $\delta$  by 0.1 ch, and repeat from step (2).

[doi.org/10.1016/j.nima.2006.07.066](https://doi.org/10.1016/j.nima.2006.07.066)

# Idea & terminology

## WCD offline calibration algorithm

- Fit peak of muon histogram



## WCD online calibration algorithm

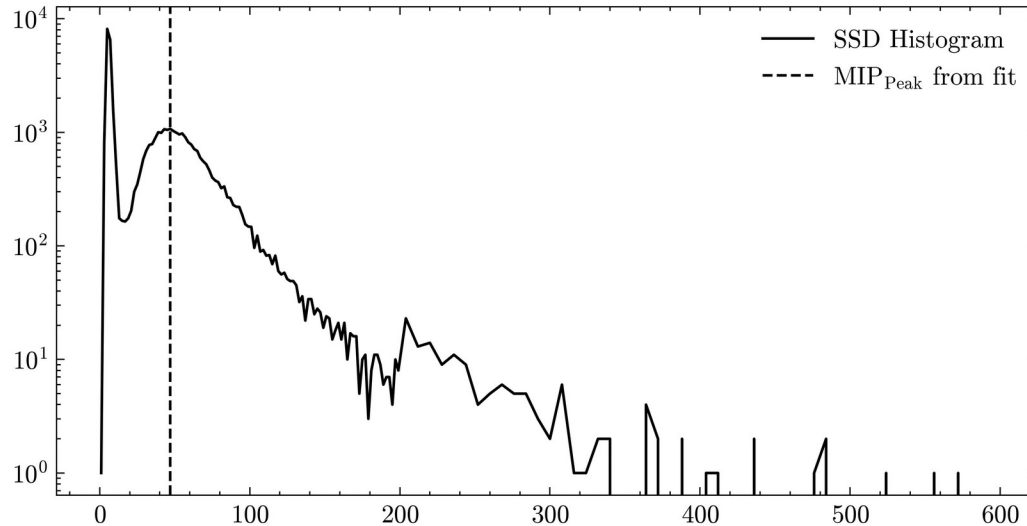
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[doi.org/10.1016/j.nima.2006.07.066](https://doi.org/10.1016/j.nima.2006.07.066)

**LACK THIS ALGO-RITHM FOR SSD!**

# Data

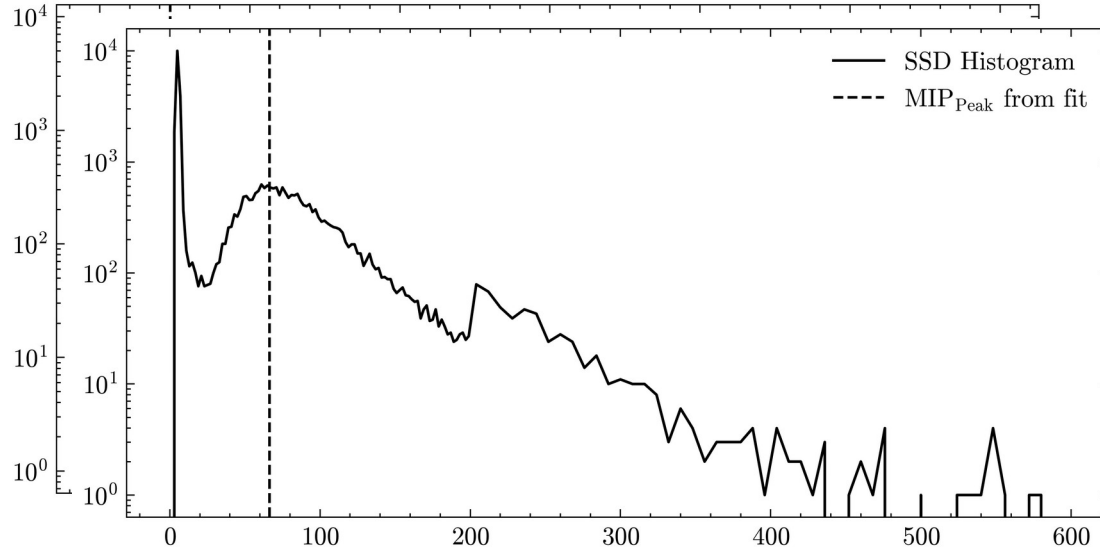
- T3 from {Mar, Jun, Sep, Dec} 2022/23 for 11 (10) stations ~ 150k (50k) SSD histograms
- Bootstrap muon events according to event histogram and fit MIP



- Characteristic shape

# Data

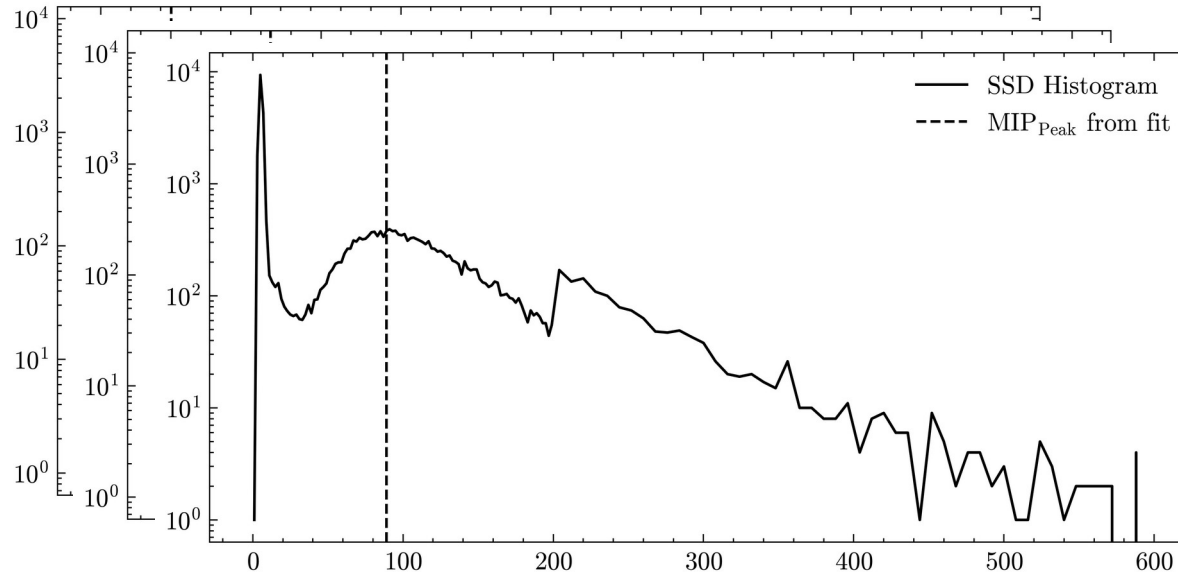
- T3 from {Mar, Jun, Sep, Dec} 2022/23 for 11 (10) stations ~ 150k (50k) SSD histograms
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- Characteristic shape
- Differences across stations

# Data

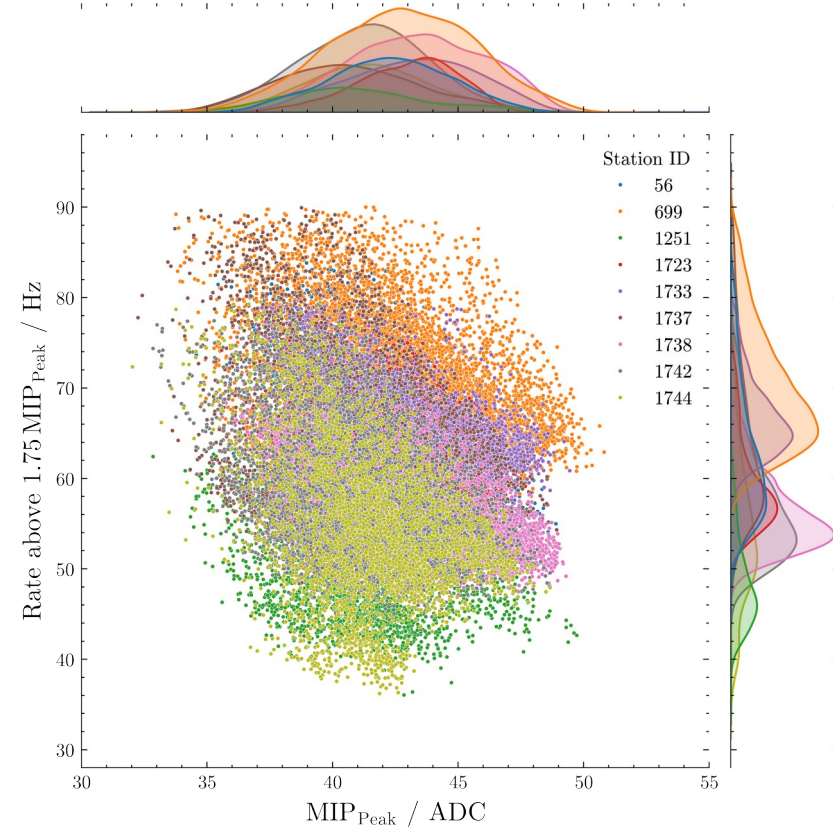
- T3 from {Mar, Jun, Sep, Dec} 2022/23 for 11 (10) stations ~ 150k (50k) SSD histograms
- Bootstrap muon events according to event histogram and fit MIP



- Characteristic shape
- Differences across stations
- MIP value determined by:
  - Weather
  - Electronics
  - ???
- Does there exist a stable threshold/rate relationship?

# MIP $\rightarrow$ Rate

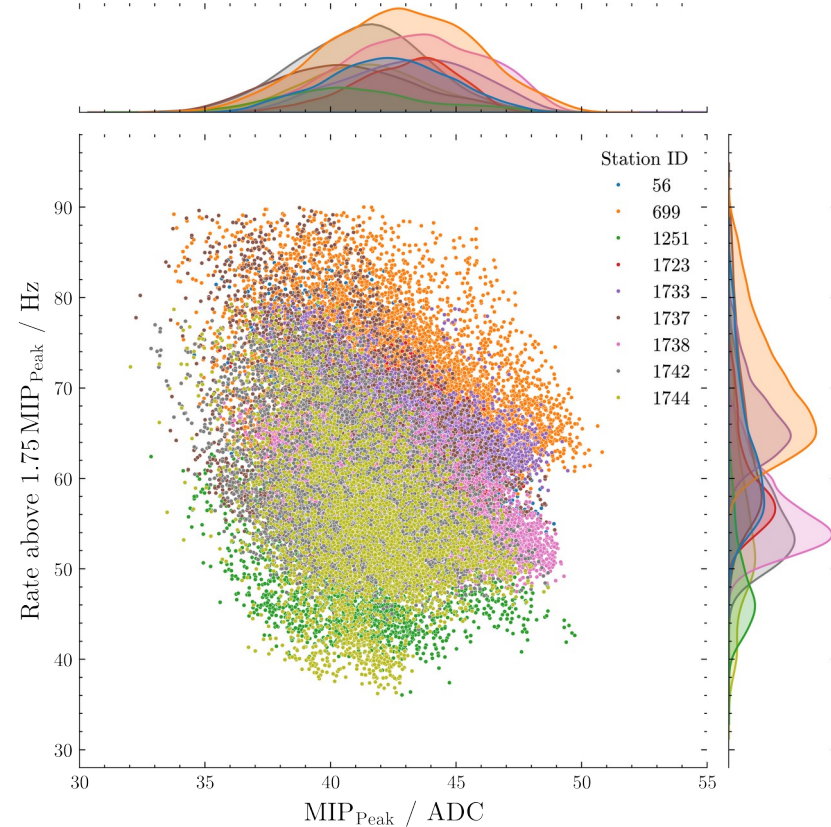
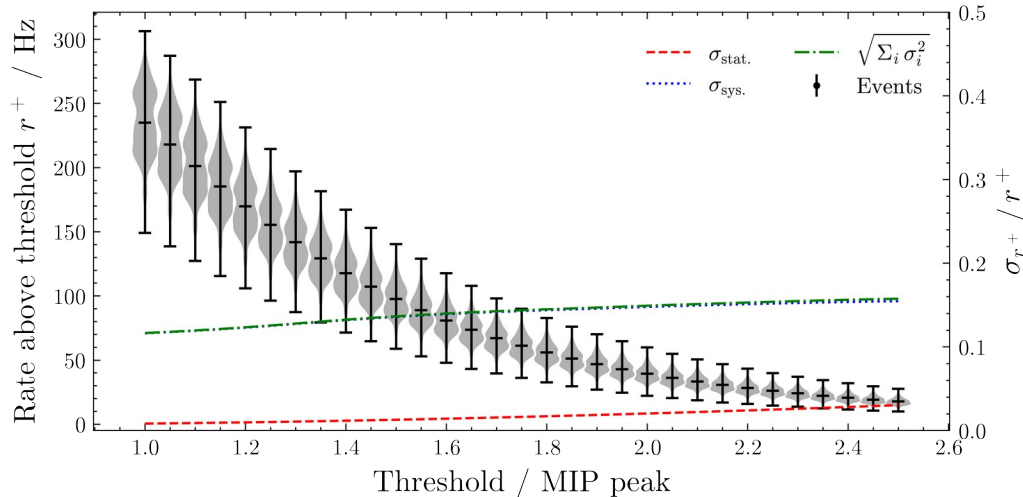
- Fit MIP from histogram
- Count all entries above threshold to calculate rate





# MIP → Rate

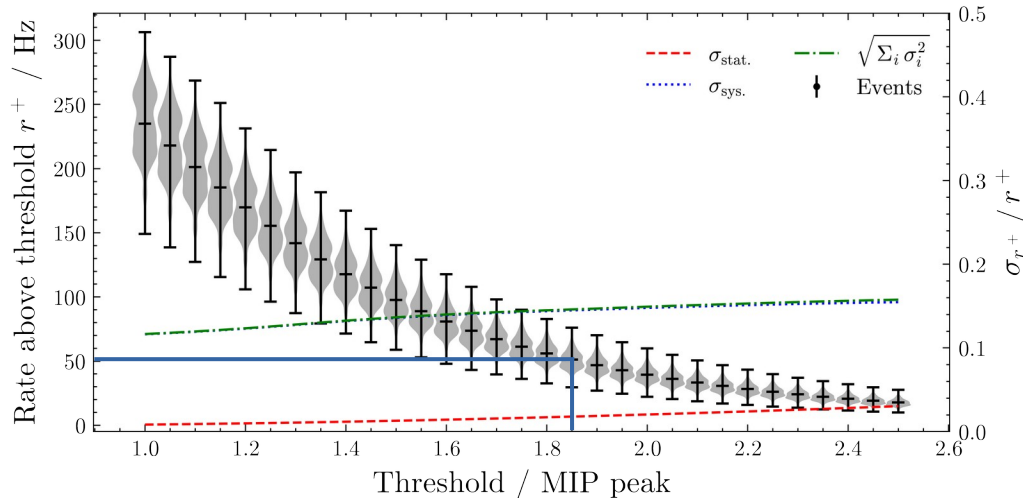
- Fit MIP from histogram
- Count all entries above threshold to calculate rate
- Average per-station rate over multiple stations
- Rate spread rather big (+10%), but not greatly dependant on set threshold





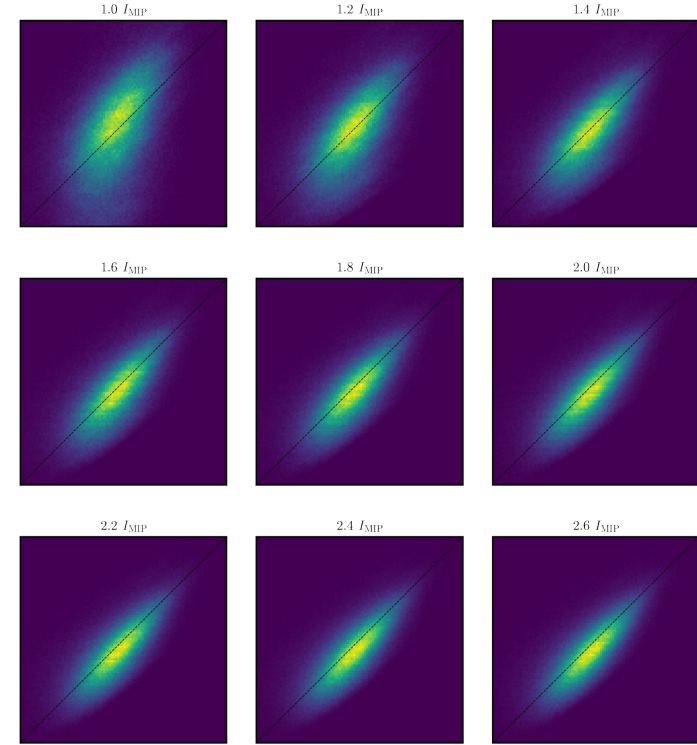
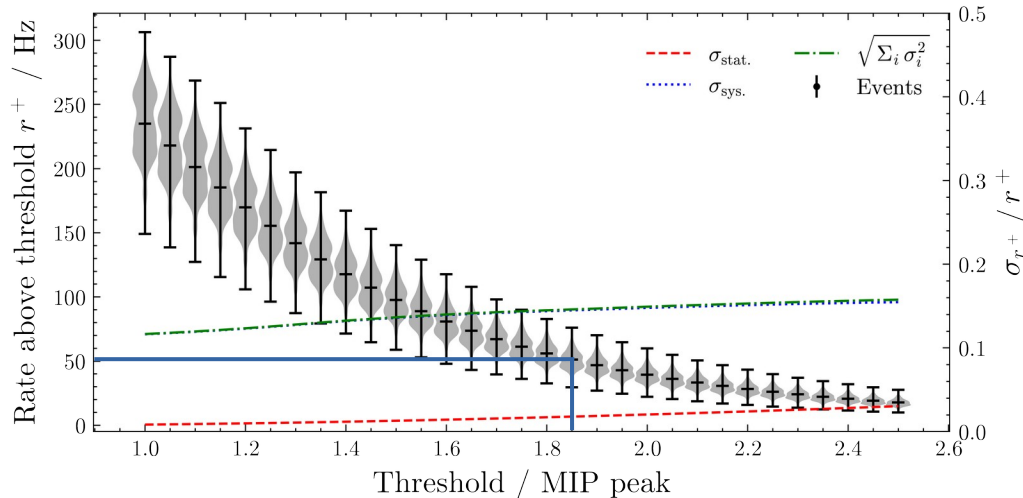
# Rate $\rightarrow$ MIP

- Setup threshold/rate relationship from plot below
- Determine **threshold** for 50 Hz rate is observed
- (online) MIP is then (e.g.) **threshold** / 1.85

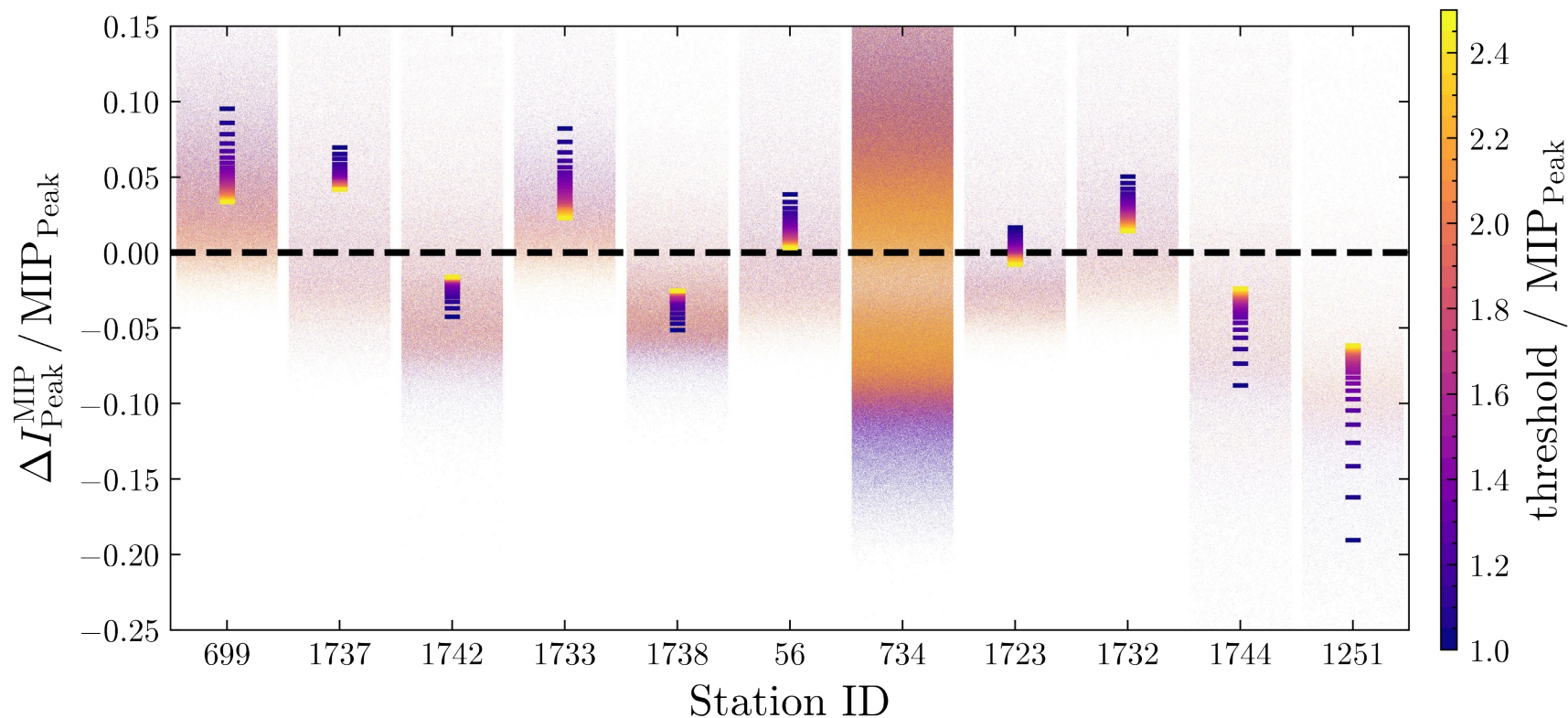


# Rate $\rightarrow$ MIP

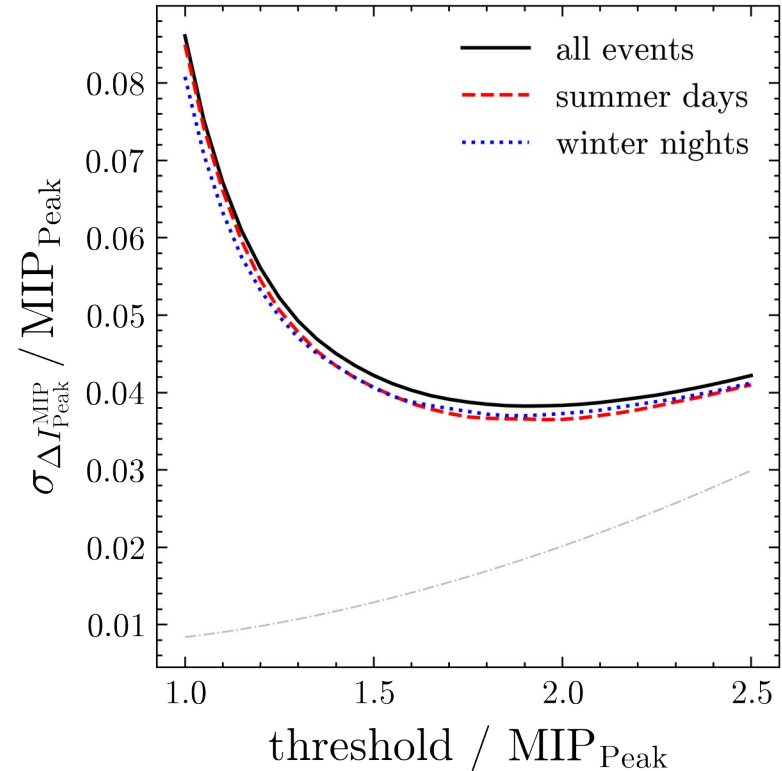
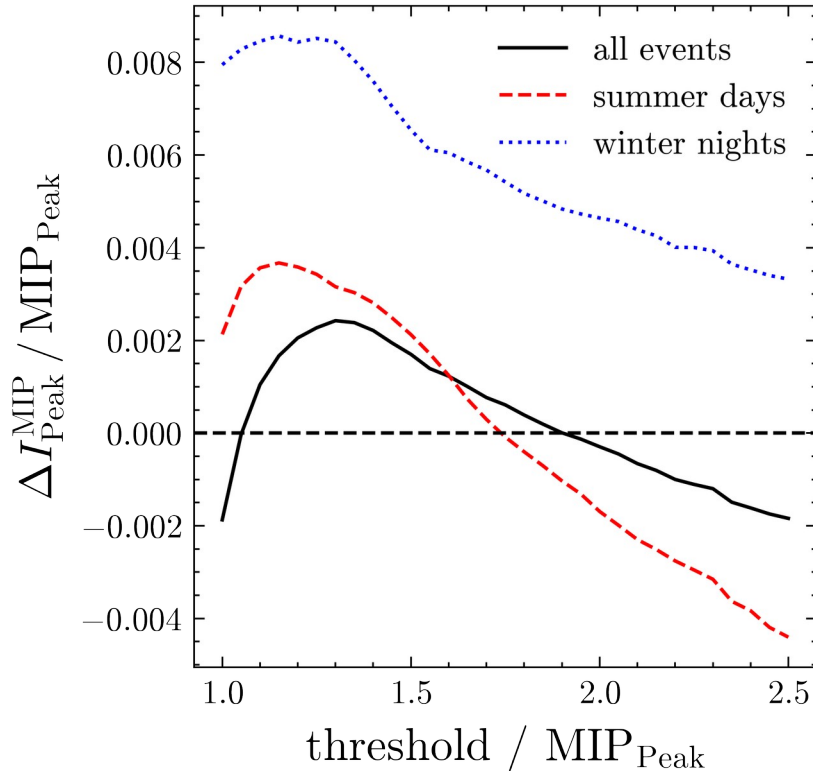
- Setup threshold/rate relationship from plot below
- Determine **threshold** for 50 Hz rate is observed
- (online) MIP is then (e.g.) **threshold** / 1.85



Rate → MIP



# Rate $\rightarrow$ MIP



# Next steps

- Repeat analysis with more stations (finished)
- Publish GAP note
- Decide about implementation strategy (T1 preselection possible?)
- Gather further UUB randoms
- Test on station hardware