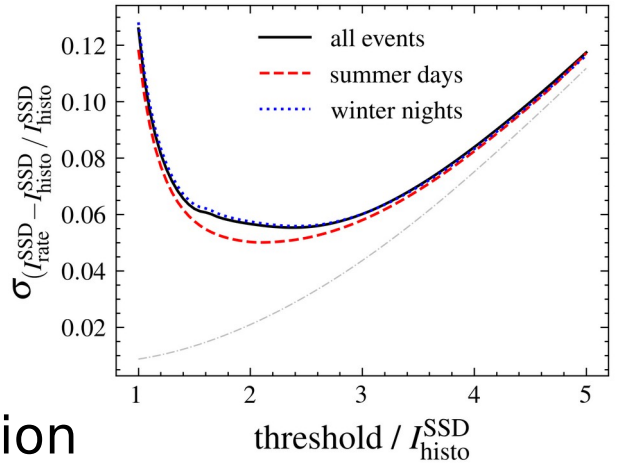
Status update on SSD online calibration

Paul Filip*, David Schmidt, Ricardo Sato

Motivation + Review

- Require SSD online calibration for Phase II
- Enable monitoring + triggering on scintillators



- Propose rate-based algorithm for SSD online calibration
- First results on expected performances in GAP2024-023
  - Build algorithm from rate/threshold-relationship in muon histos
  - Bias resolution on online MIP peak of ~6% for **all** SD-1500 stations

- **But!** Muon histos acquired from triggers in WCD
  - Only have fraction of data measured by SSD (coincidences with WCD)
  - Hidden problems from adopting WCD systematics/calibration?

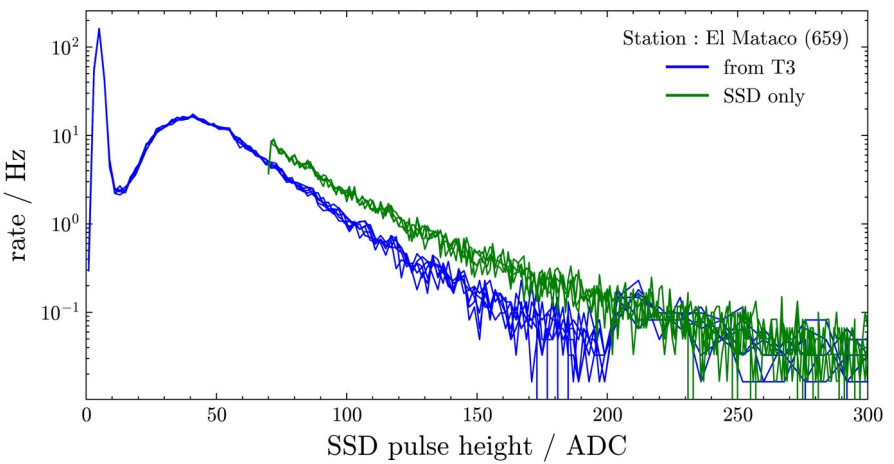
WCD independent online calibration of the SSD

- Different detectors! MIP peak shouldn’t rely on WCD
  - Calibration events currently selected from triggers in WCD
  - Headaches from dealing with masked WCD PMTs?

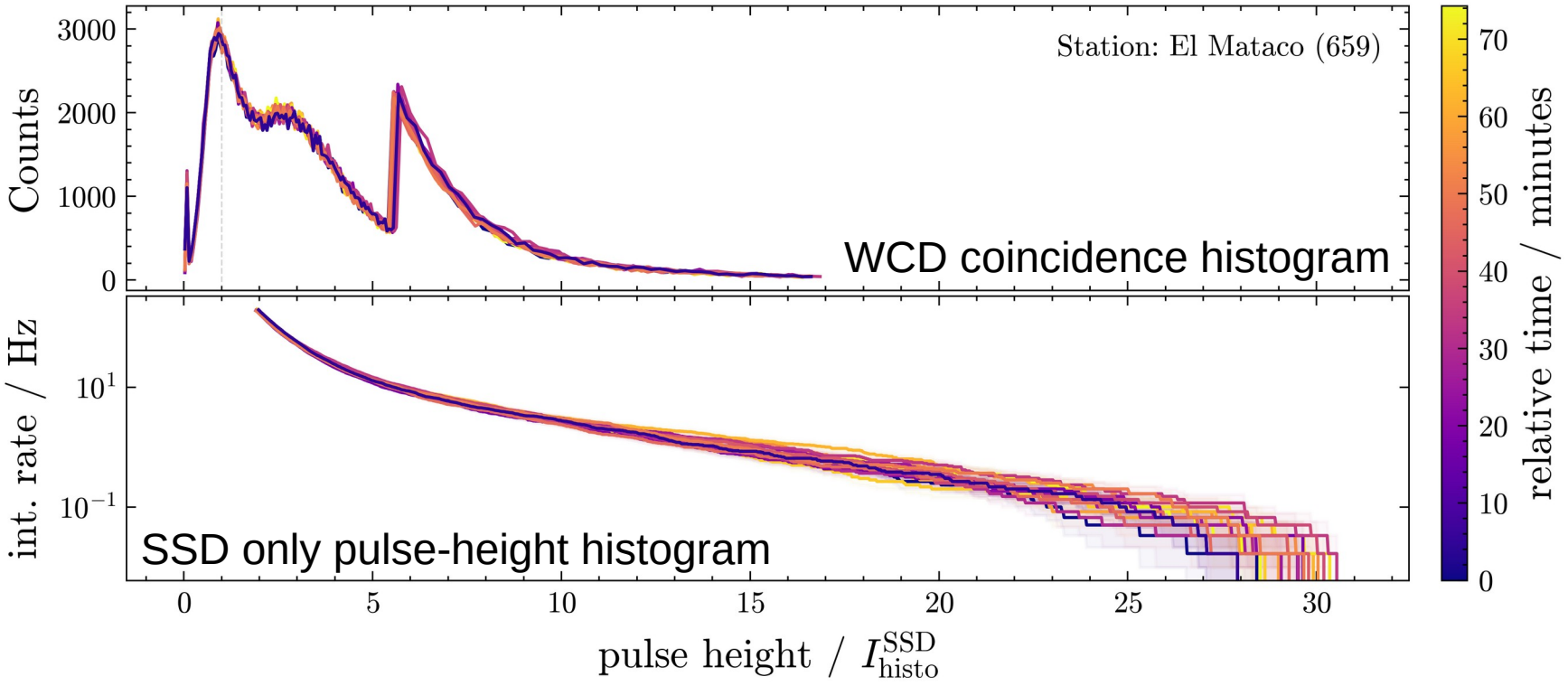
- MIP peak more variable than VEM peak
  - SSD more sensitive to EM component
  - Fluctuations too large to allow reliable calibration?
  - Only option to rely on WCD calibration?

MuonAcquisition in Malargue

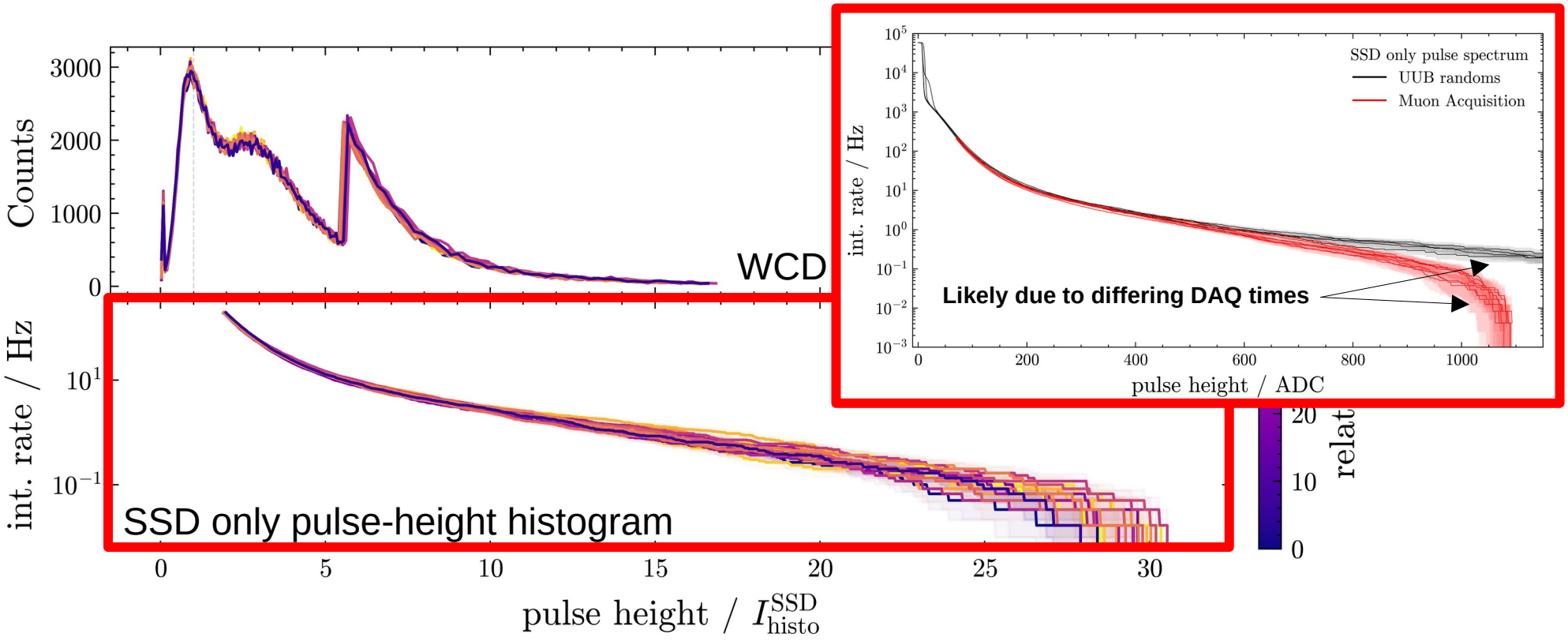
- Connect 8 Infill stations to separate CDAS instance
- Raise some standard muon histograms via forced T3
- Run special program on individual stations
  - Enable 2nd trigger mode (SSD only) on FPGA
  - Read out **muon histogram**
  - Save **SSD pulse-heights**
- Use **SSD only pulse-height histogram** for rate/threshold relationship and online MIP



Sanity checks on measured data

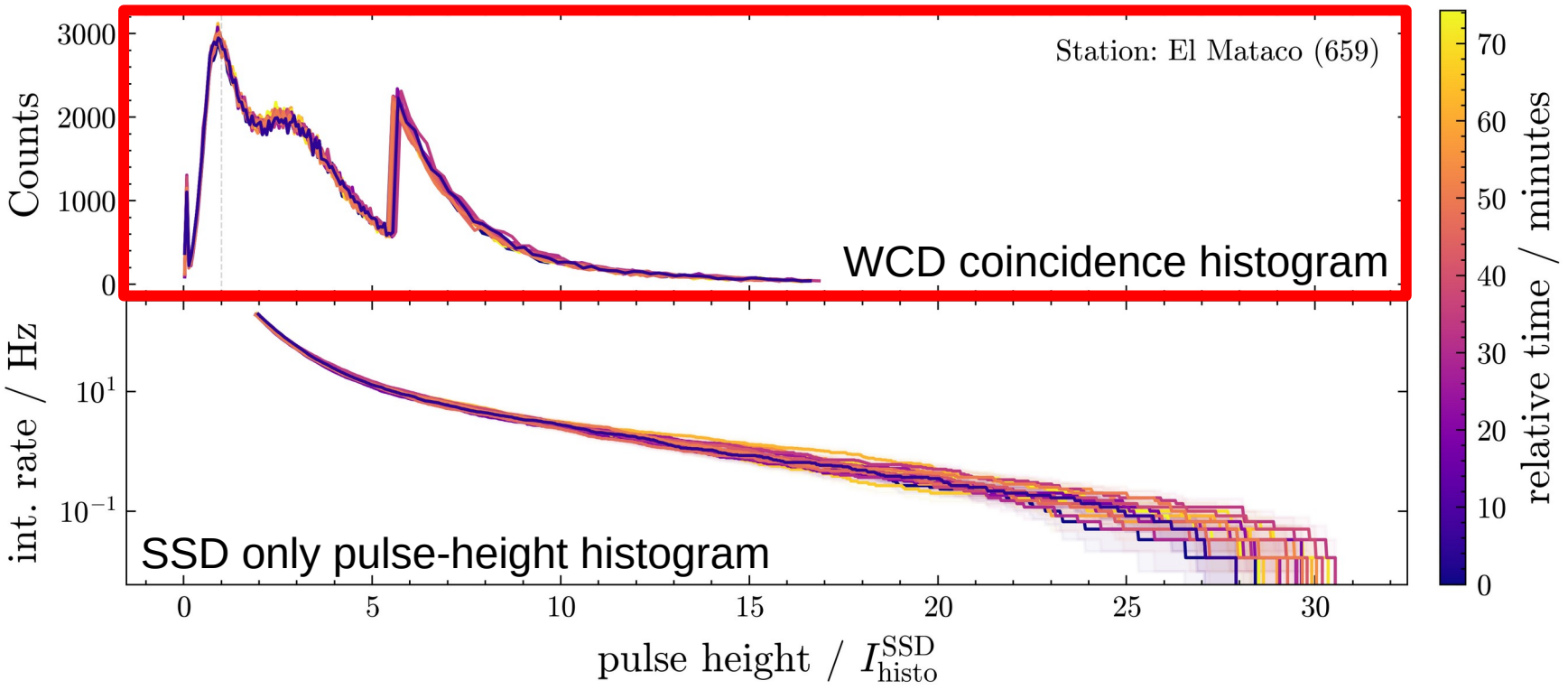


Sanity checks on measured data



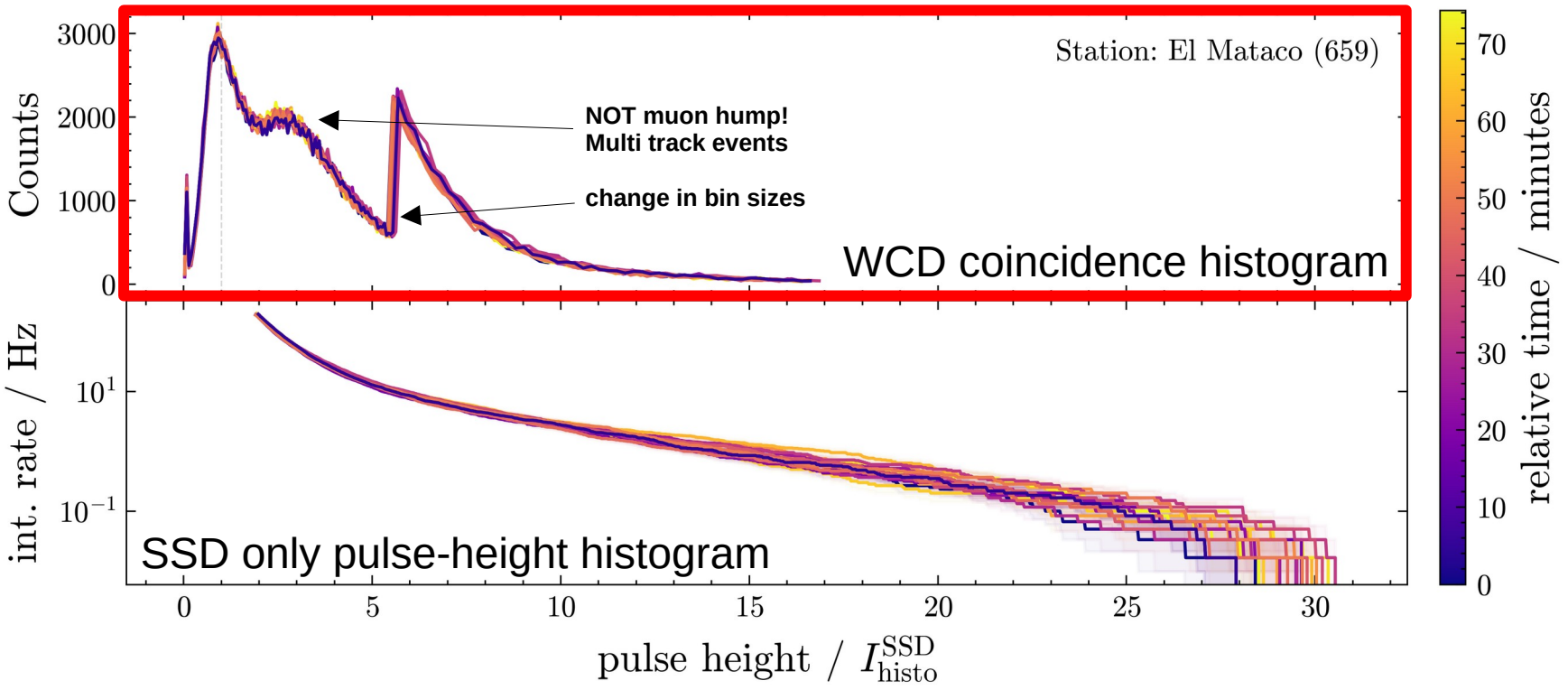
- SSD only histograms look as expected from UUB randoms

Sanity checks on measured data



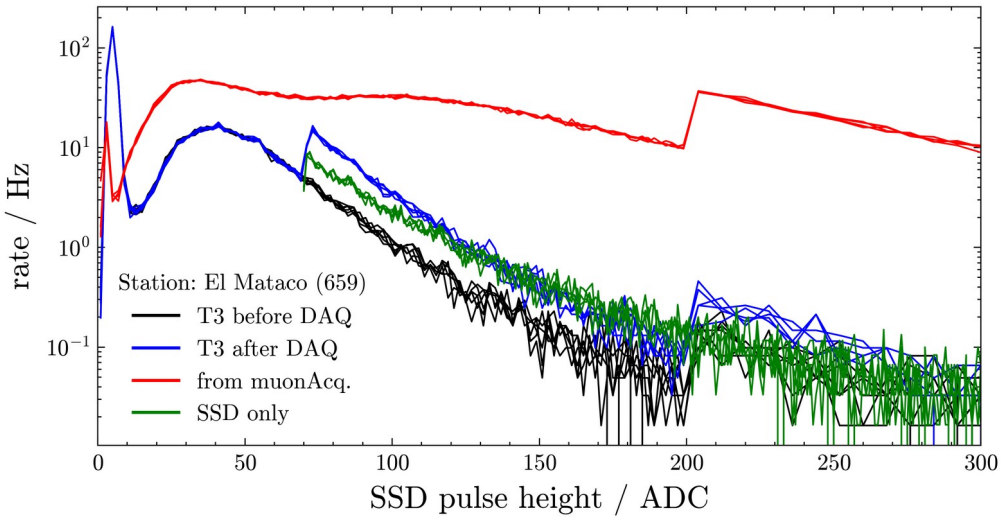
- WCD coincidence histogram differ from T3 histograms

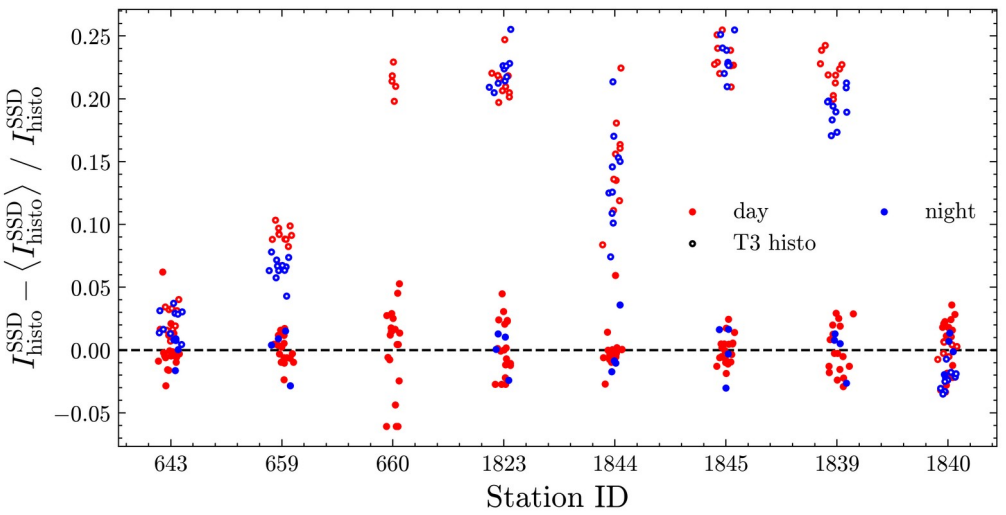
Sanity checks on measured data



- WCD coincidence histogram differ from T3 histograms

Sanity checks on measured data

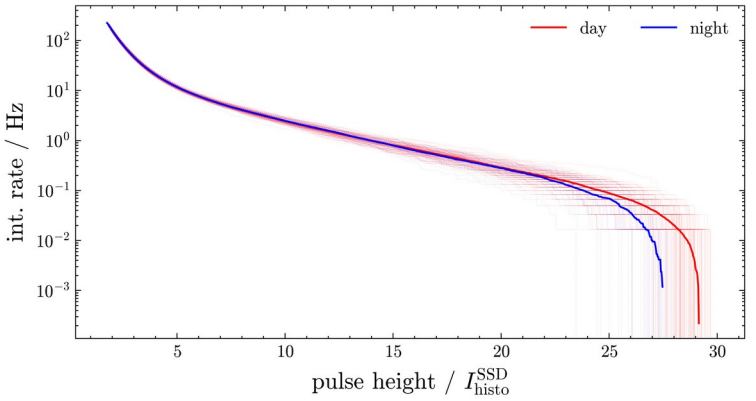




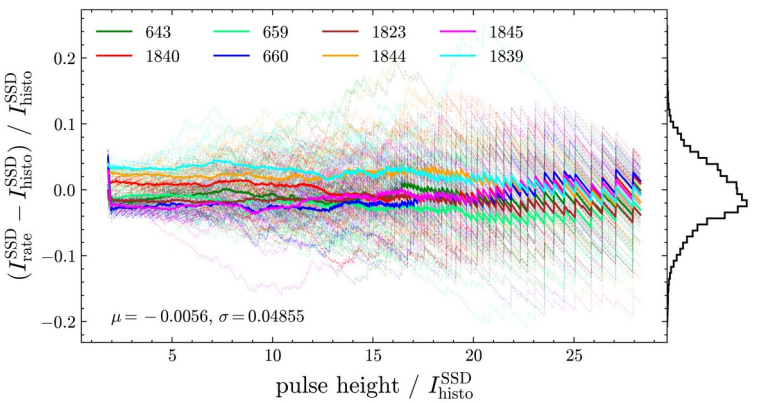
- Significant difference between histograms from **muonAcquisition** and T3s **before**/**after** DAQ
  - Station dependent bias of location of MIP peak?
  - Ongoing investigation of what went wrong

WCD independent online MIP

- Little variation between day/night
  - Lower counts at high pulse-heights expected for lower temperatures

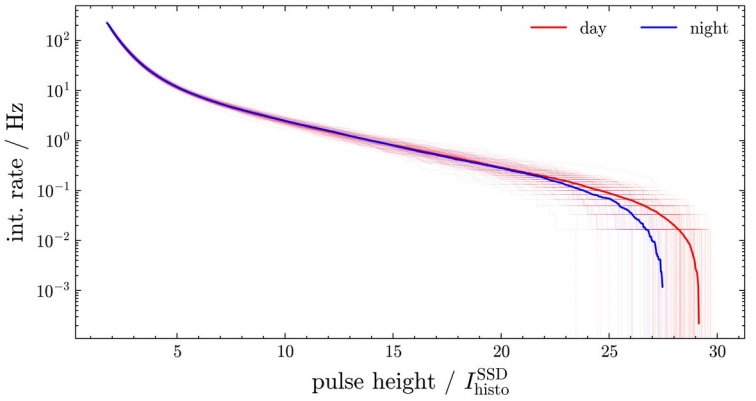


- Use relationship to estimate MIP
  - Unbiased estimator by definition
  - Very good resolution (~5%)
  - Aliasing effects at very high pulse-heights, no trustworthy resolution
  - Resolution below 5 MIP @ ~2%

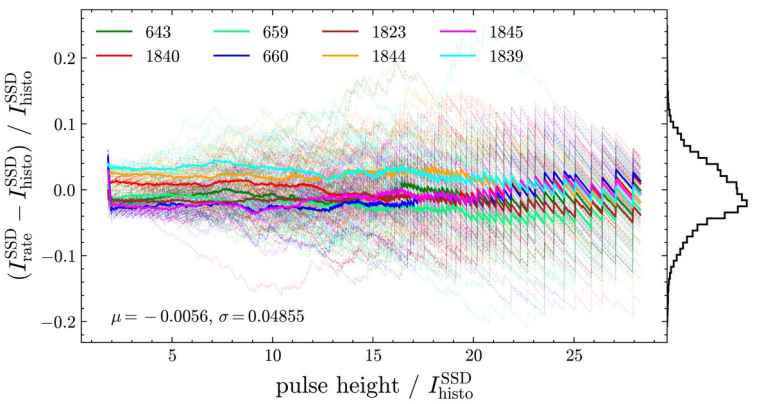


WCD independent online MIP

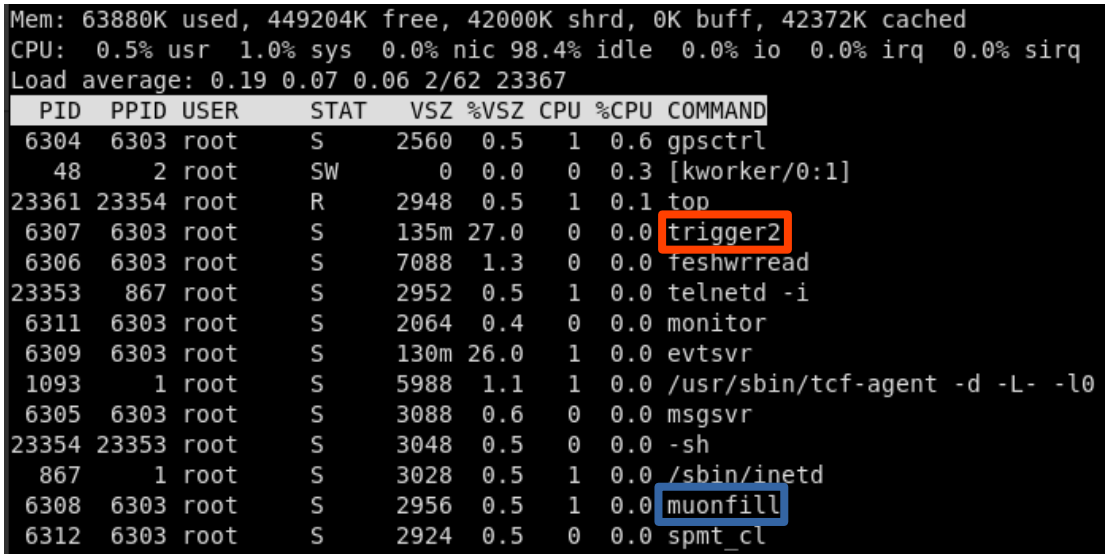
- Little variation between day/night
  - Lower counts at high pulse-heights expected for lower temperatures



- Use relationship to estimate MIP
  - Unbiased estimator by definition
  - Very good resolution (~5%)
  - Aliasing effects at very high pulse-heights, no trustworthy resolution
  - Resolution below 5 MIP @ ~2%



Implementation in UUB DAQ



- **trigger2** process
  - reads **`ShowerBuffer`**
    (= WCD-T1 traces)
  - Handles T2s, etc …
  - **online calibration**

- **mounfill** process
  - reads **`MuonBuffer`** (now: 1 LMPT > 30 ADC)
  - Builds all histograms used for offline calibration

Implementation in UUB DAQ

```
Mem: 63880K used, 449204K free, 42000K shrd, 0K buff, 42372K cached
CPU:  0.5% usr  1.0% sys  0.0% nic 98.4% idle  0.0% io  0.0% irq  0.0% sirq
Load average: 0.19 0.07 0.06 2/62 23367
  PID  PPID USER     STAT   VSZ %VSZ CPU %CPU COMMAND
 6304  6303 root     S     2560  0.5   1  0.6 gpsctrl
   48     2 root     SW       0  0.0   0  0.3 [kworker/0:1]
23361 23354 root     R     2948  0.5   1  0.1 top
 6307  6303 root     S     135m 27.0   0  0.0 trigger2
 6306  6303 root     S     7088  1.3   0  0.0 feshwrread
23353   867 root     S     2952  0.5   1  0.0 telnetd -i
 6311  6303 root     S     2064  0.4   0  0.0 monitor
 6309  6303 root     S     130m 26.0   1  0.0 evtsvr
 1093     1 root     S     5988  1.1   1  0.0 /usr/sbin/tcf-agent -d -L- -l0
 6305  6303 root     S     3088  0.6   0  0.0 msgsvr
23354 23353 root     S     3048  0.5   0  0.0 -sh
  867     1 root     S     3028  0.5   1  0.0 /sbin/inetd
 6308  6303 root     S     2956  0.5   1  0.0 muonfill
 6312  6303 root     S     2924  0.5   0  0.0 spmt_cl
```

- **trigger2** process
  - reads **`ShowerBuffer`**
    (= WCD-T1 traces)
  - Handles T2s, etc …
  - **online calibration**

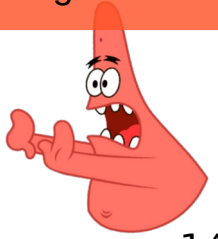
- **mounfill** process
  - reads **`MuonBuffer`** (now: 1 LMPT > 30 ADC)
  - Builds all histograms used for offline calibration
  - . . .

Implementation in UUB DAQ

```
Mem: 63880K used, 449204K free, 42000K shrd, 0K buff, 42372K cached
CPU:  0.5% usr  1.0% sys  0.0% nic 98.4% idle  0.0% io  0.0% irq  0.0% sirq
Load average: 0.19 0.07 0.06 2/62 23367
  PID  PPID USER     STAT   VSZ %VSZ CPU %CPU COMMAND
 6304  6303 root     S     2560  0.5   1  0.6 gpsctrl
   48     2 root     SW       0  0.0   0  0.3 [kworker/0:1]
23361 23354 root     R     2948  0.5   1  0.1 top
 6307  6303 root     S     135m 27.0   0  0.0 trigger2
 6306  6303 root     S     7088  1.3   0  0.0 feshwrread
23353   867 root     S     2952  0.5   1  0.0 telnetd -i
 6311  6303 root     S     2064  0.4   0  0.0 monitor
 6309  6303 root     S     130m 26.0   1  0.0 evtsvr
 1093     1 root     S     5988  1.1   1  0.0 /usr/sbin/tcf-agent -d -L- -l0
 6305  6303 root     S     3088  0.6   0  0.0 msgsvr
23354 23353 root     S     3048  0.5   0  0.0 -sh
  867     1 root     S     3028  0.5   1  0.0 /sbin/inetd
 6308  6303 root     S     2956  0.5   1  0.0 muonfill
 6312  6303 root     S     2924  0.5   0  0.0 spmt_cl
```

- **trigger2** process
  - reads **`ShowerBuffer`** (= WCD-T1 traces)
  - Handles T2s, etc ...
  - **online calibration**

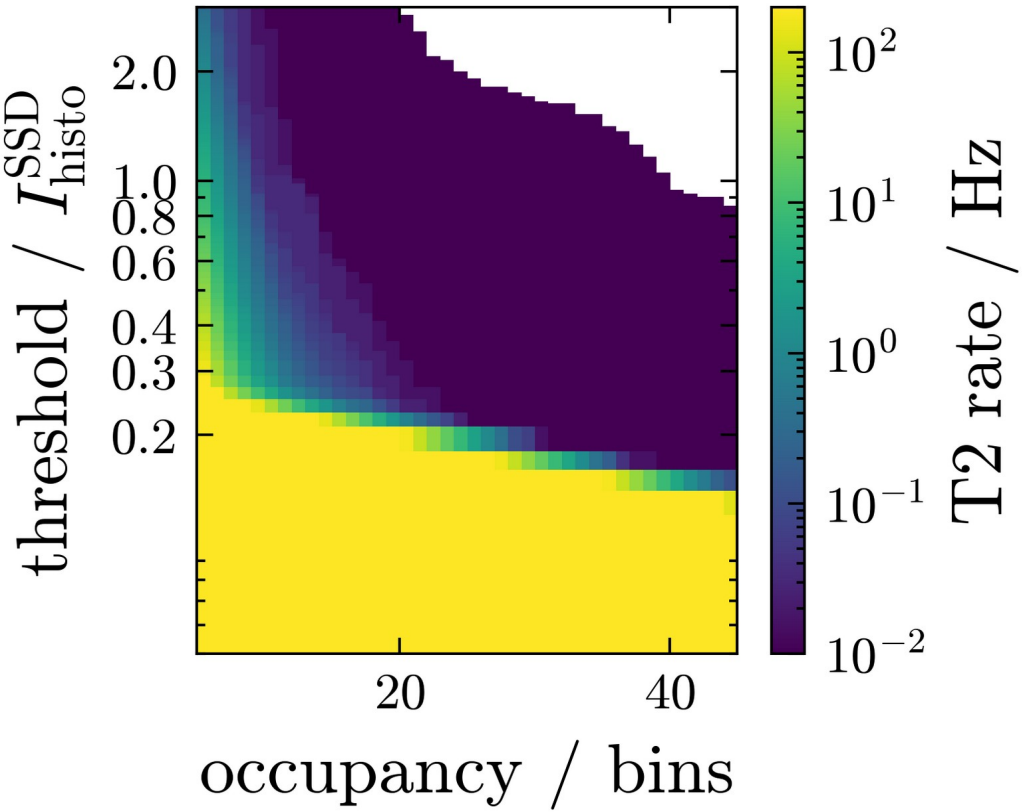
Implemented for some time now, **but lack testing!!!** Many complications when running CDAS from Karlsruhe and communicating with tanks in Malargüe



- **mounfill** process
  - reads **`MuonBuffer`** (now: 1 LMPT > 30 ADC)
  - Builds all histograms used for offline calibration
  - . . .

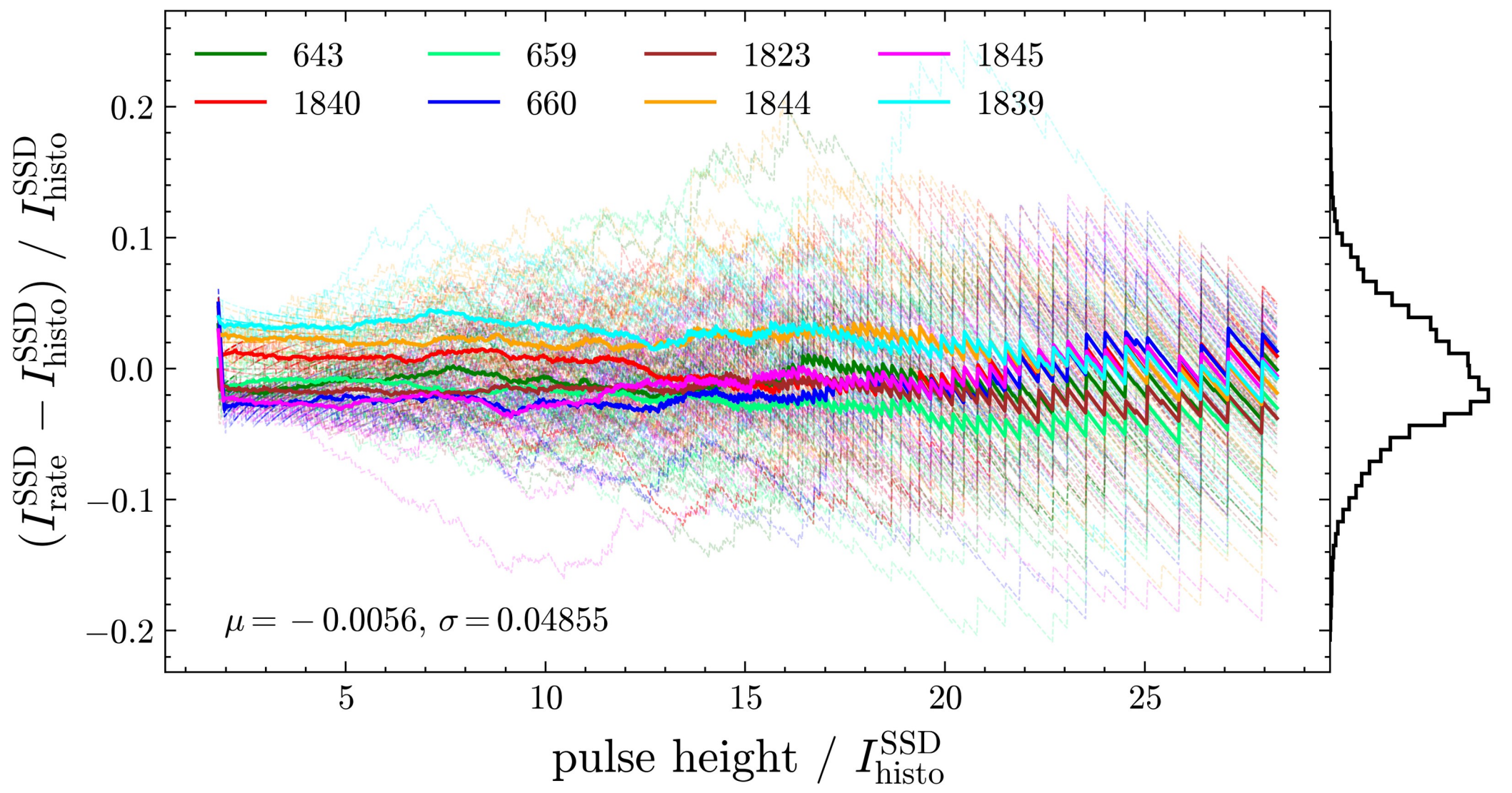
Outlook for standalone SSD-ToT triggers

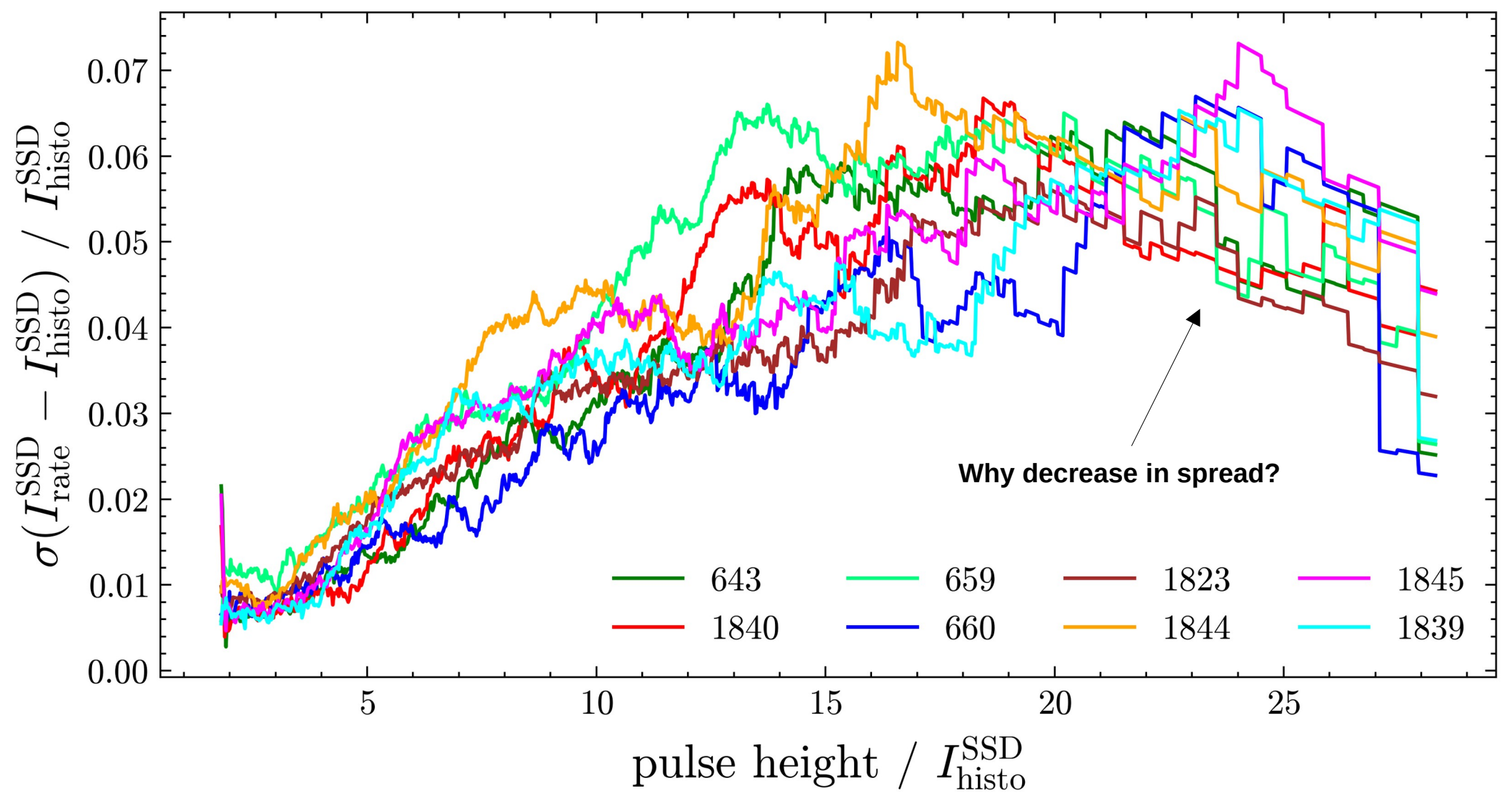
- (Background) trigger rate

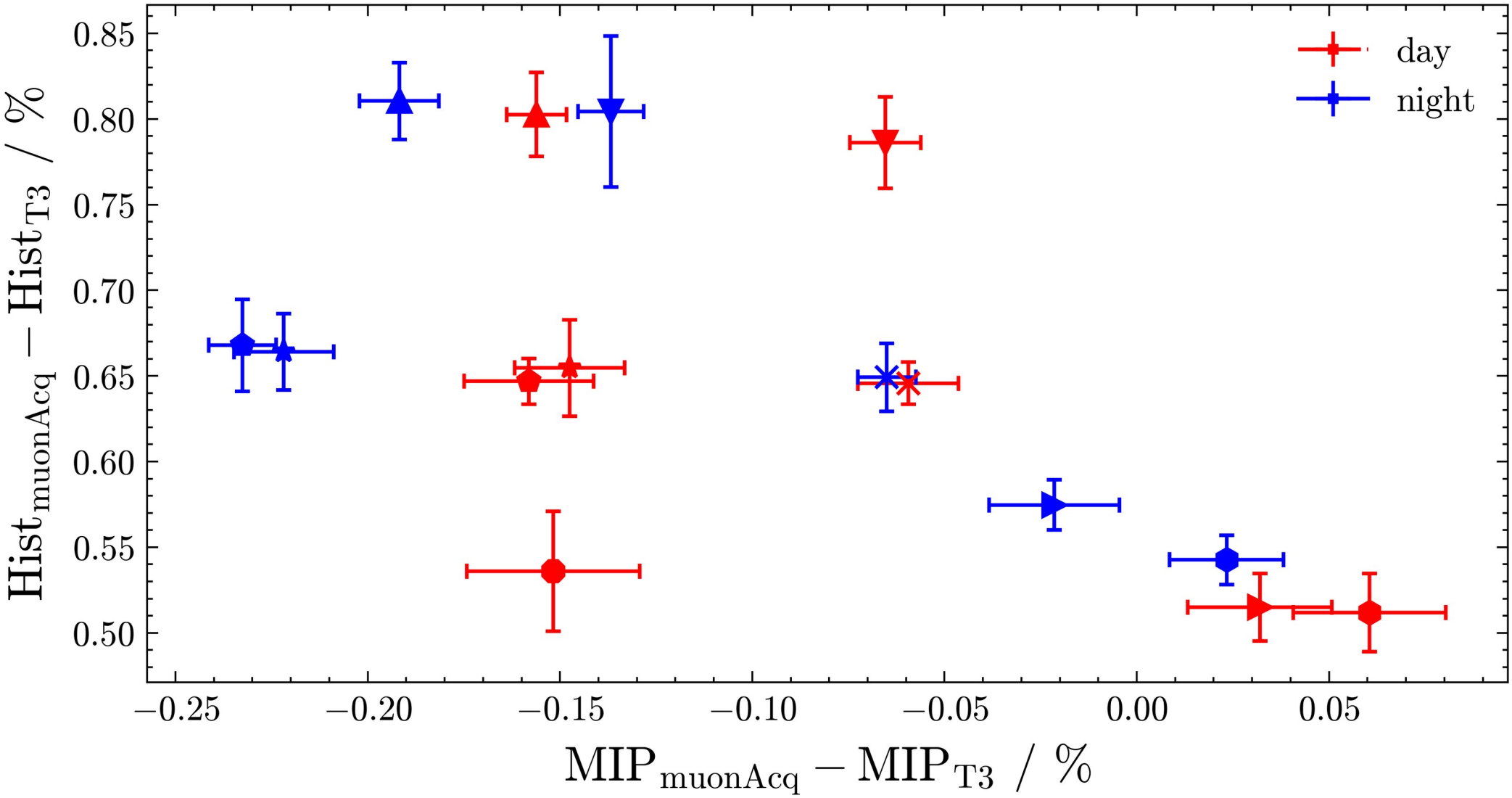


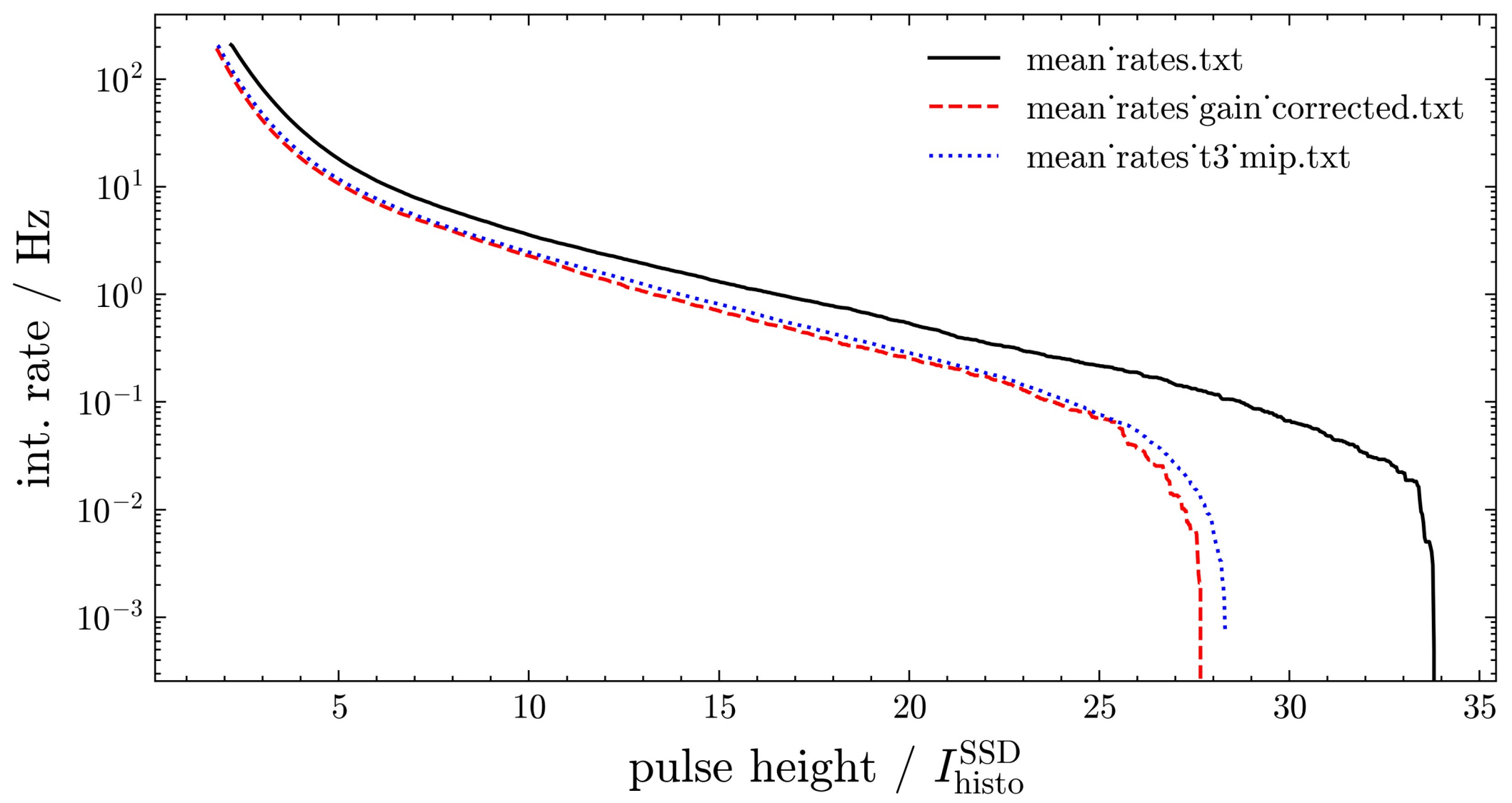
- T2/T3 trigger efficiency
  - Simulations upcoming
  - First step in implementing new SSD triggers in Offline
  - needed to narrow down trigger settings of SSD-ToT

Backup


643
659
1823
1845
1840
660
1844
1839
0.2
0.1
0.0
−0.1
−0.2
$\mu = -0.0056,\ \sigma = 0.04855$
5
10
15
20
25
$\left(I_{\mathrm{rate}}^{\mathrm{SSD}} - I_{\mathrm{histo}}^{\mathrm{SSD}}\right) \ / \ I_{\mathrm{histo}}^{\mathrm{SSD}}$
pulse height / $I_{\mathrm{histo}}^{\mathrm{SSD}}$


$\sigma(I^{\mathrm{SSD}}_{\mathrm{rate}} - I^{\mathrm{SSD}}_{\mathrm{histo}}) \ / \ I^{\mathrm{SSD}}_{\mathrm{histo}}$
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
5
10
15
20
25
pulse height / $I^{\mathrm{SSD}}_{\mathrm{histo}}$
Why decrease in spread?
643
1840
659
660
1823
1844
1845
1839


day
night
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
$\mathrm{Hist}_{\mathrm{muonAcq}} - \mathrm{Hist}_{\mathrm{T3}}$ / %
−0.25
−0.20
−0.15
−0.10
−0.05
0.00
0.05
$\mathrm{MIP}_{\mathrm{muonAcq}} - \mathrm{MIP}_{\mathrm{T3}}$ / %


mean˙rates.txt
mean˙rates˙gain˙corrected.txt
mean˙rates˙t3˙mip.txt
int. rate / Hz
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
5
10
15
20
25
30
35
pulse height / $I^{\mathrm{SSD}}_{\mathrm{histo}}$

WCD ToT+ToTd rates from UUB randoms