Towards an online MIP calibration

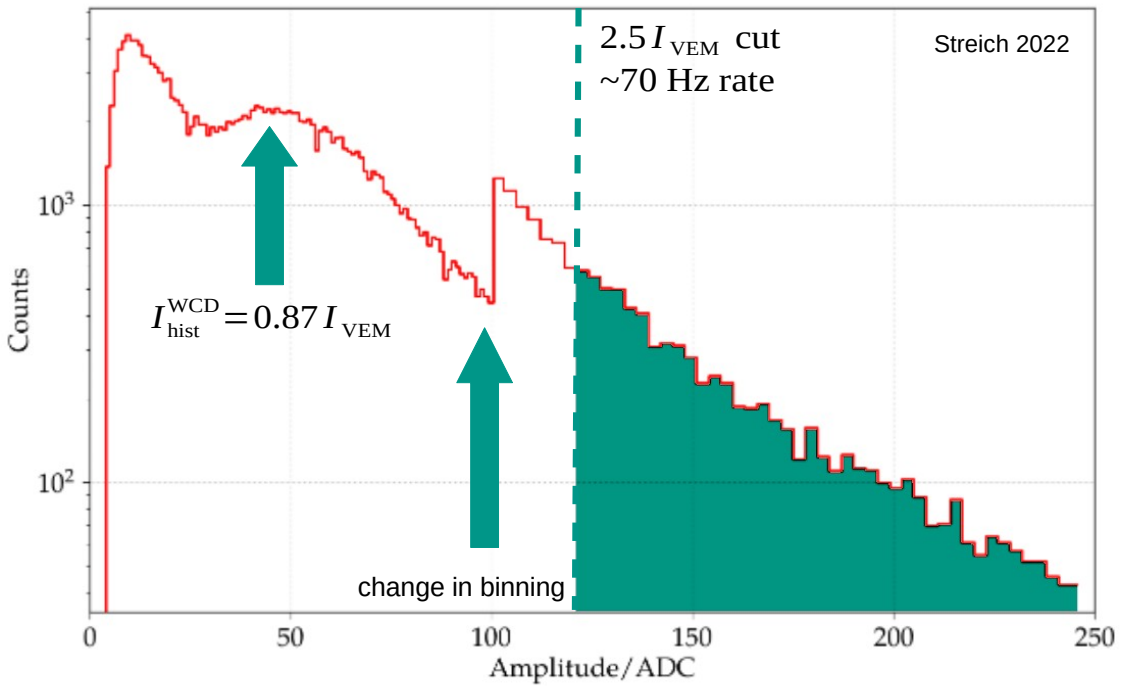
Paul Filip, David Nitz, Ricardo Sato, David Schmidt

Outline

- Overview of online (WCD) calibration
- `muonBuffer` vs. `showerBuffer`
- Integration test results
- Summary and outlook

Current (WCD) calibration

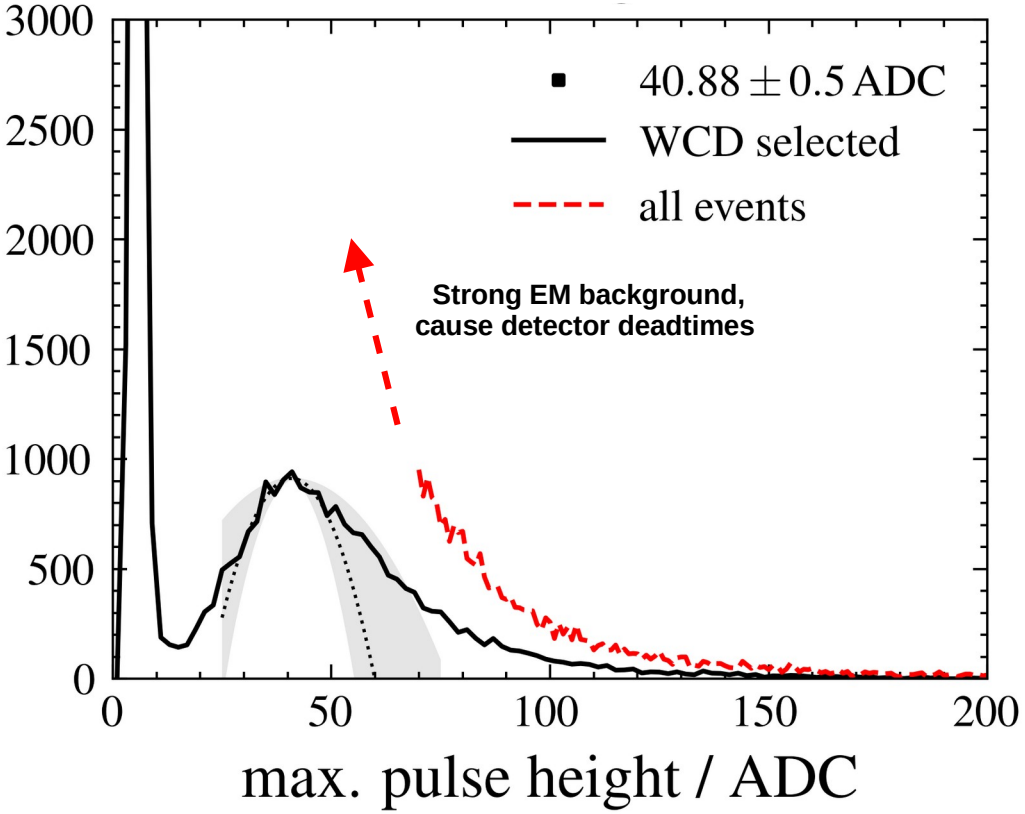
- WCD offline calibration
  - Fit muon hump in histogram

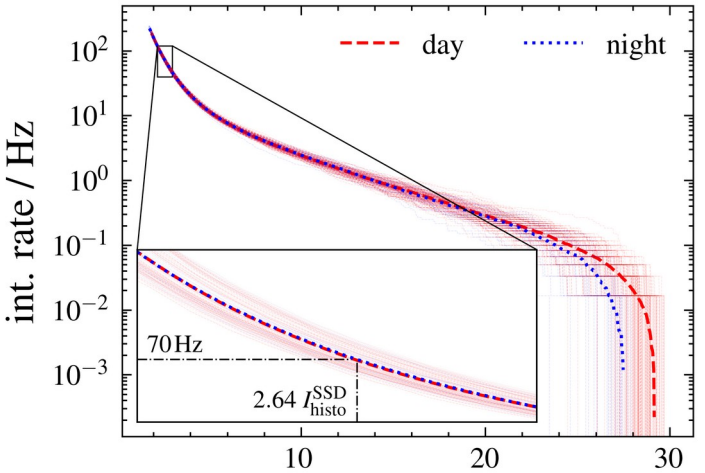


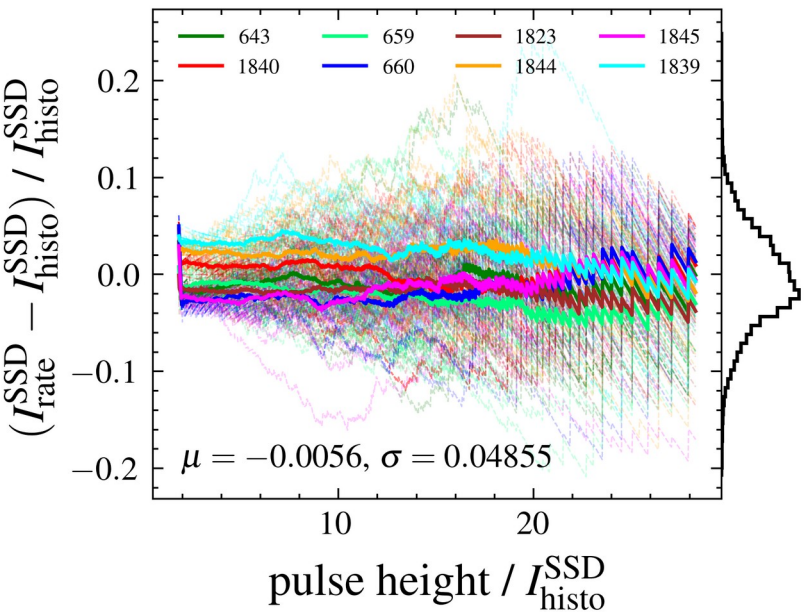
- WCD online calibration
  - Calibration trigger with threshold k, that satisfies:
    - Threefold coinc. of $0.7\,k$
    - >1 PMT above $1.0\,k$
  - Iteratively adjust threshold until 70 Hz rate is reached
  - Threshold equals $k \approx 2.5\,I_{\mathrm{VEM}}$
  - Accurate to ~2%
  - See also GAP2023-049

Recap of past work

- GAP2024_065

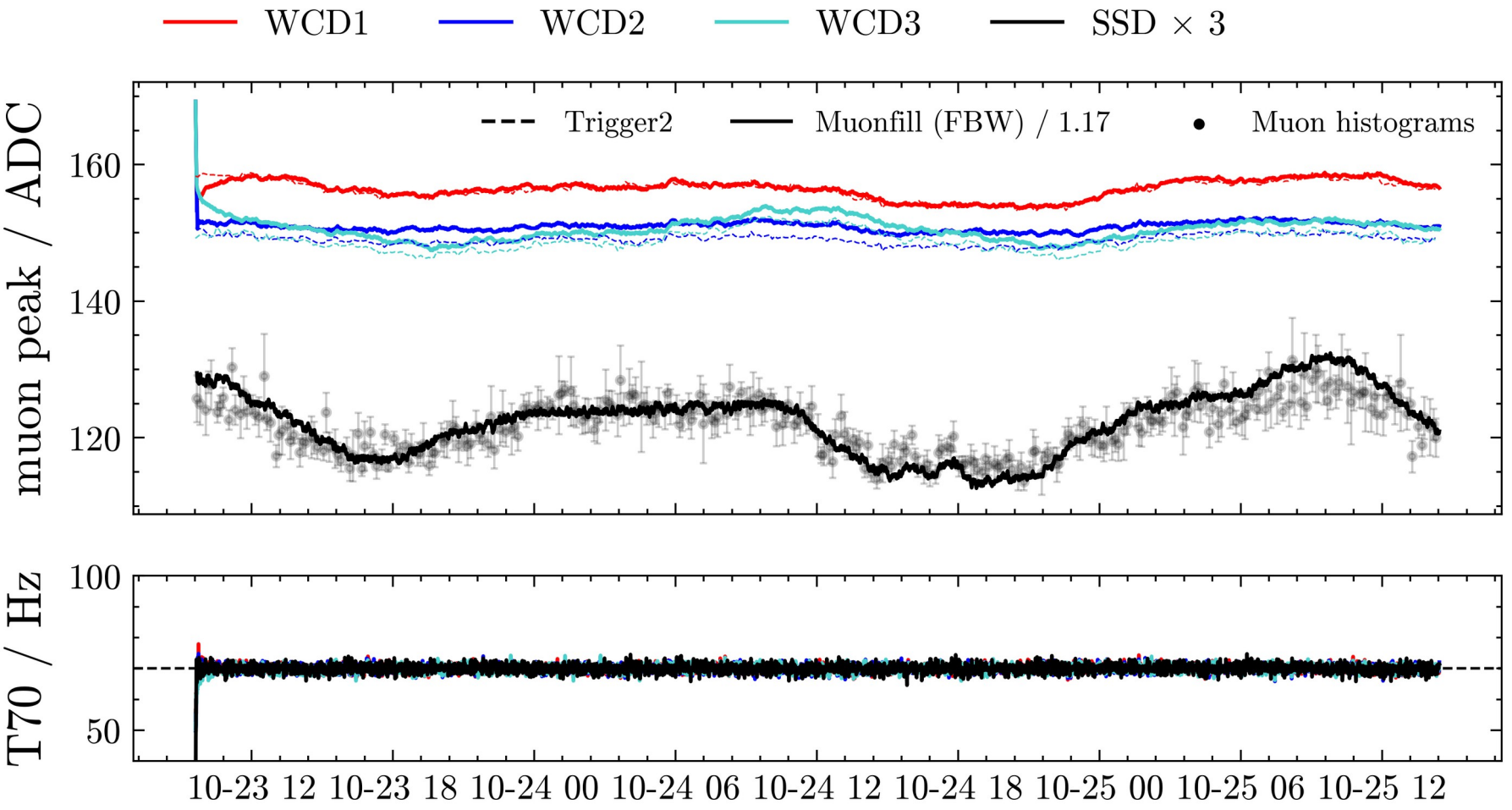




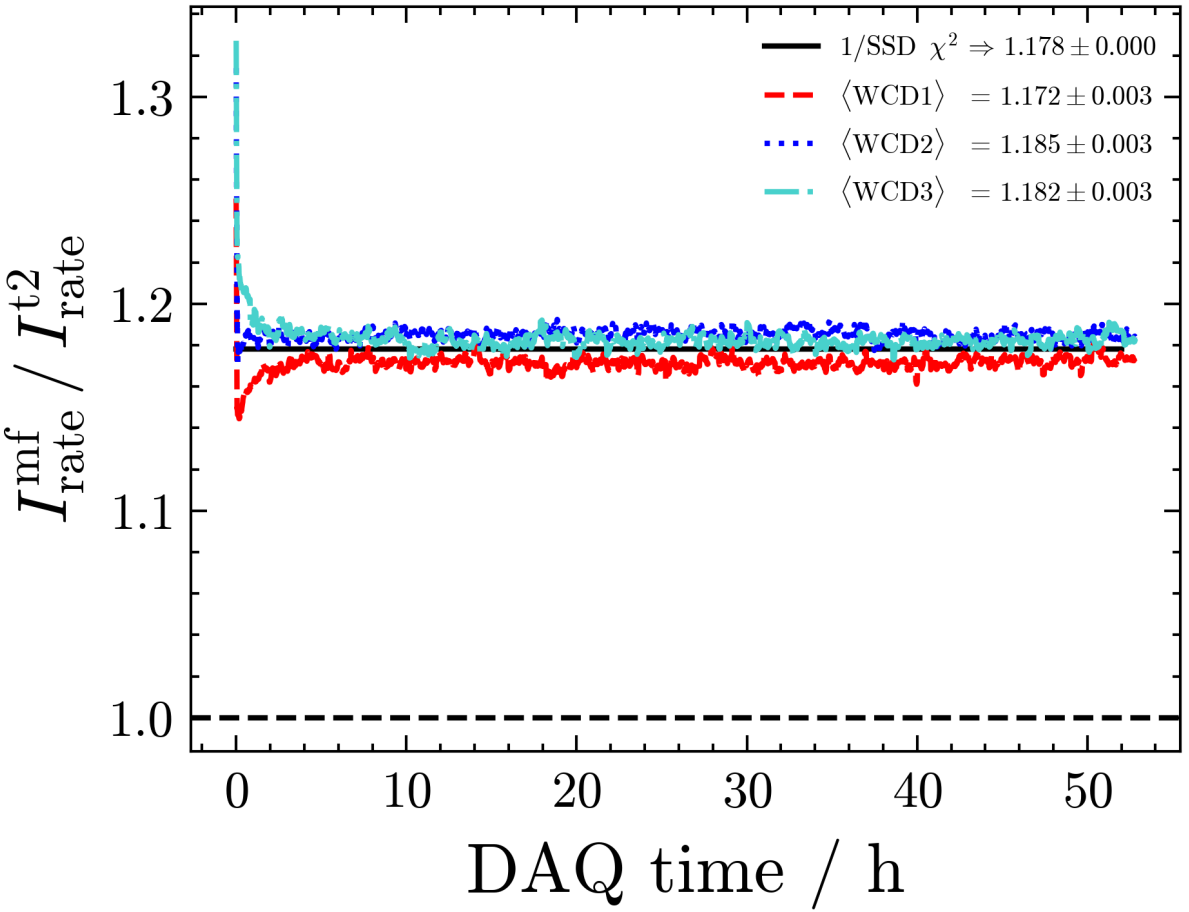


paul.filip@kit.edu

Integration test results



Integration test results



- WCD offset sensible
  - Issue w/ F&D vs. FBW
- SSD offset unexpected
  - Station fluctuations?
  - P$_{\text{roblem}}$ E$_{\text{xists}}$ B$_{\text{etween}}$ C$_{\text{hair}}$ A$_{\text{nd}}$ K$_{\text{eyboard}}$?
  - Why 1/WCD offset?
- Further tests needed

Summary and outlook

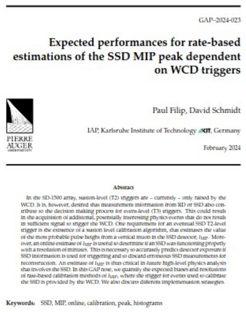
- New UUB DAQ version under development
  - running stable on test stations (Didi (136), Horacio (609))
  - get functioning online VEM peak calibration for free
  - Online MIP peak needs constant(?) correction factor, why?

- More tests/work for final implementation needed
  - Larger scope for integration tests (more stations, more time)
  - Propagate online MIP (+ VEM?) peak to monitoring
  - Reflect changes in CDAS & lay ground work for SSD triggers

Backup

Recap of past work

- GAP2024_023
  - Analyze muon histograms to derive rate-threshold for SSD shower buffer events, predict MIP with it
  - Caveats due to implicit dependence on WCD calib.



GAP–2024-023

Expected performances for rate-based estimations of the SSD MIP peak dependent on WCD triggers

Paul Filip, David Schmidt

IAP, Karlsruhe Institute of Technology KIT, Germany

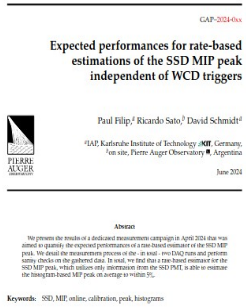
February 2024

Abstract

In the SD-1500 array, station-level (T2) triggers are – currently – only raised by the WCD. It is, however, desired that measurement information from RD or SSD also contribute to the decision making process for event-level (T3) triggers. This could result in the acquisition of additional, potentially interesting physics events that do not result in sufficient signal to trigger the WCD. One requirement for an eventual SSD T2-level trigger is the existence of a station level calibration algorithm, that estimates the value of the most probable pulse height from a vertical muon in the SSD detector, I_{MIP}. Moreover, an online estimate of I_{MIP} is useful to determine if an SSD was functioning properly with a resolution of minutes. This is necessary to accurately predict detector exposure if SSD information is used for triggering and to discard erroneous SSD measurements for reconstruction. An estimate of I_{MIP} is thus critical in future high-level physics analysis that involves the SSD. In this GAP note, we quantify the expected biases and resolutions of rate-based calibration methods of I_{MIP}, where the trigger for events used to calibrate the SSD is provided by the WCD. We also discuss different implementation strategies.

Keywords: SSD, MIP, online, calibration, peak, histograms

- GAP2024_065
  - Run dedicated tests on Infill stations
  - WCD-independent SSD online calibration feasible
  - Error on rate-based MIP peak < 5% on average
  - < 2% for rate-threshold relationship <5 MIP



GAP–2024-0xx

Expected performances for rate-based estimations of the SSD MIP peak independent of WCD triggers

Paul Filip,[a] Ricardo Sato,[b] David Schmidt[a]

[a]IAP, Karlsruhe Institute of Technology KIT, Germany,
[b]on site, Pierre Auger Observatory, Argentina

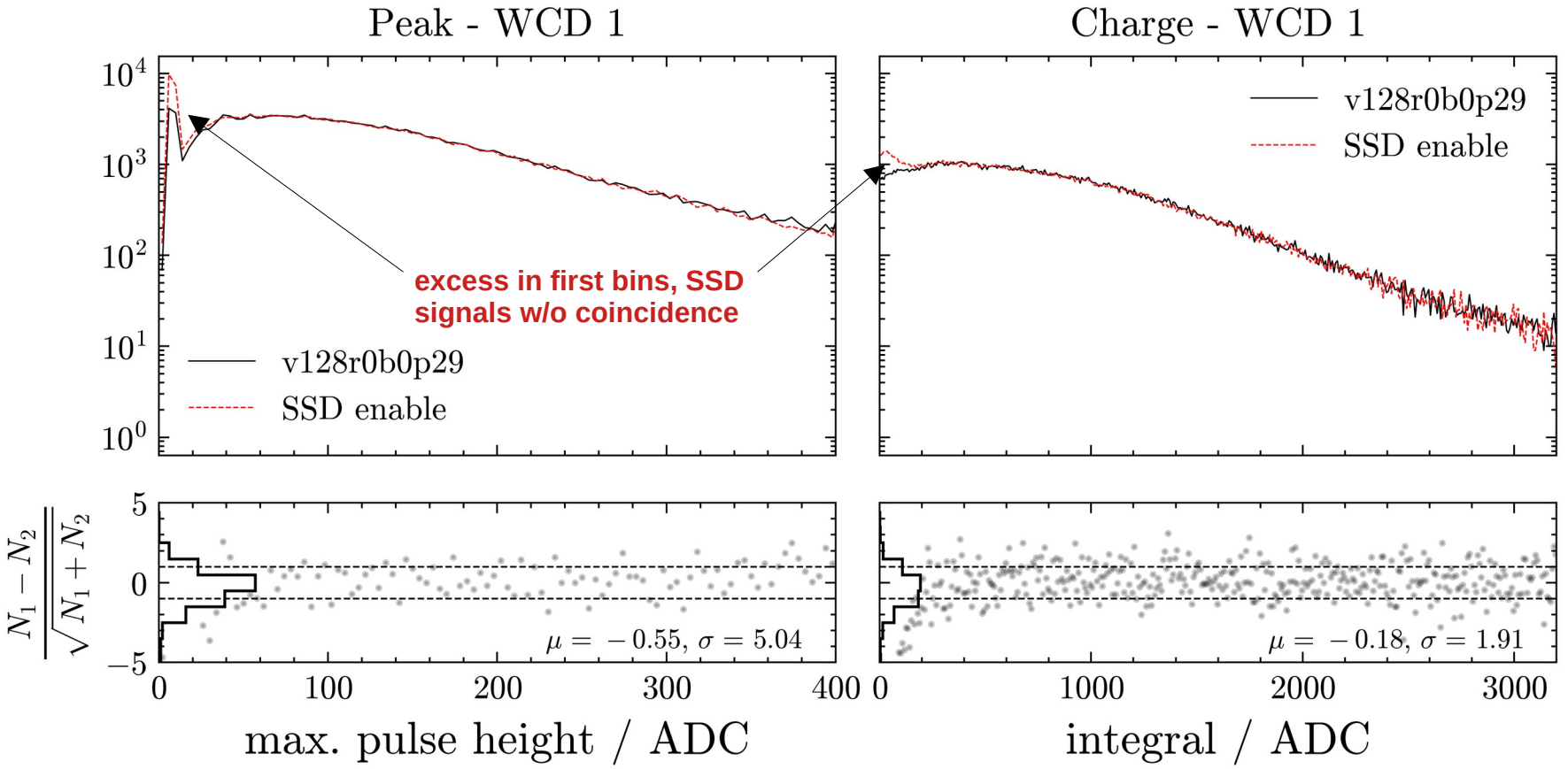
June 2024

Abstract

We present the results of a dedicated measurement campaign in April 2024 that was aimed to quantify the expected performances of a rate-based estimator of the SSD MIP peak. We detail the measurement process of the - in total - two DAQ runs and perform sanity checks on the gathered data. In total, we find that a rate-based estimator for the SSD MIP peak, which utilizes only information from the SSD PMT, is able to estimate the histogram-based MIP peak on average to within 5%.

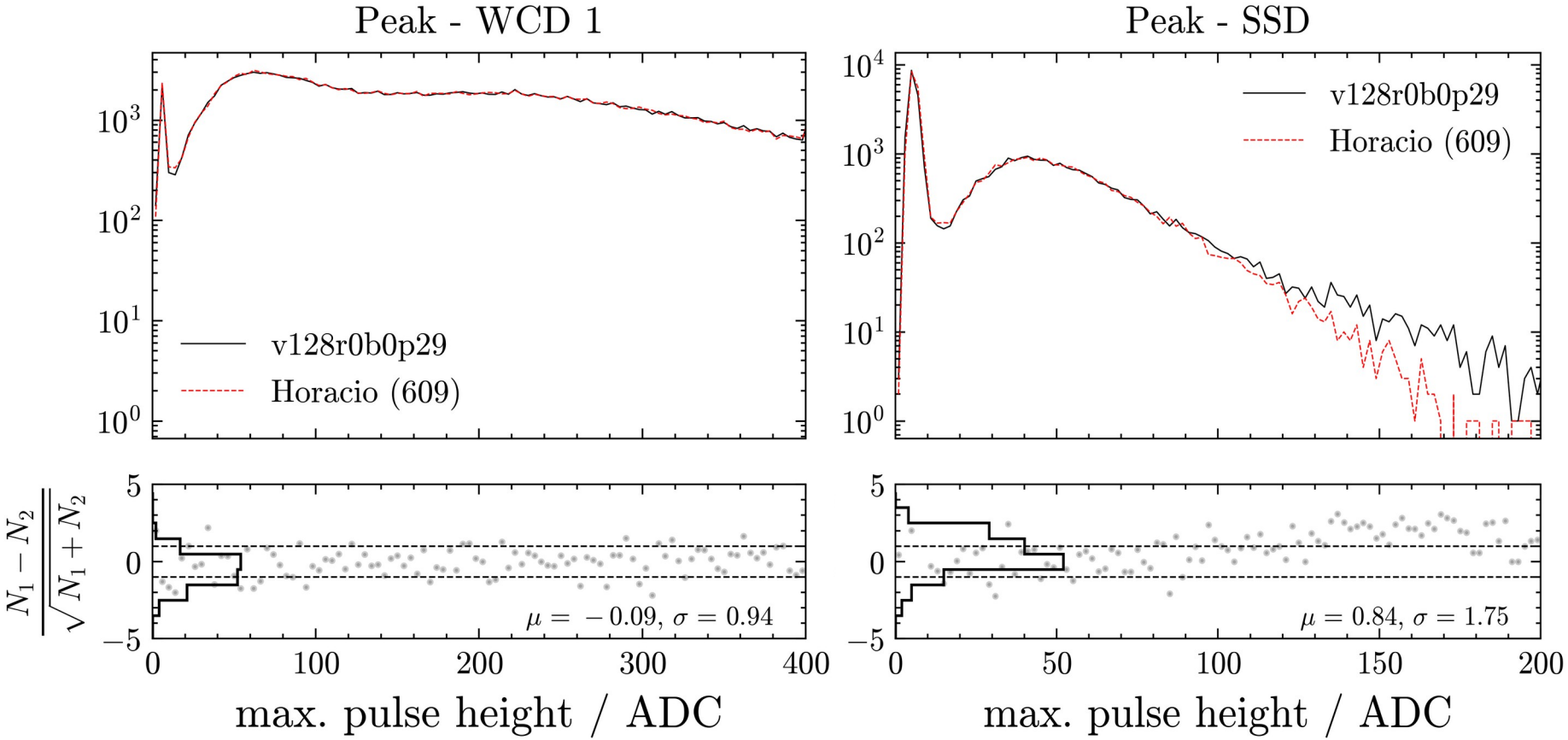
Keywords: SSD, MIP, online, calibration, peak, histograms

muonfill backwards compatibility



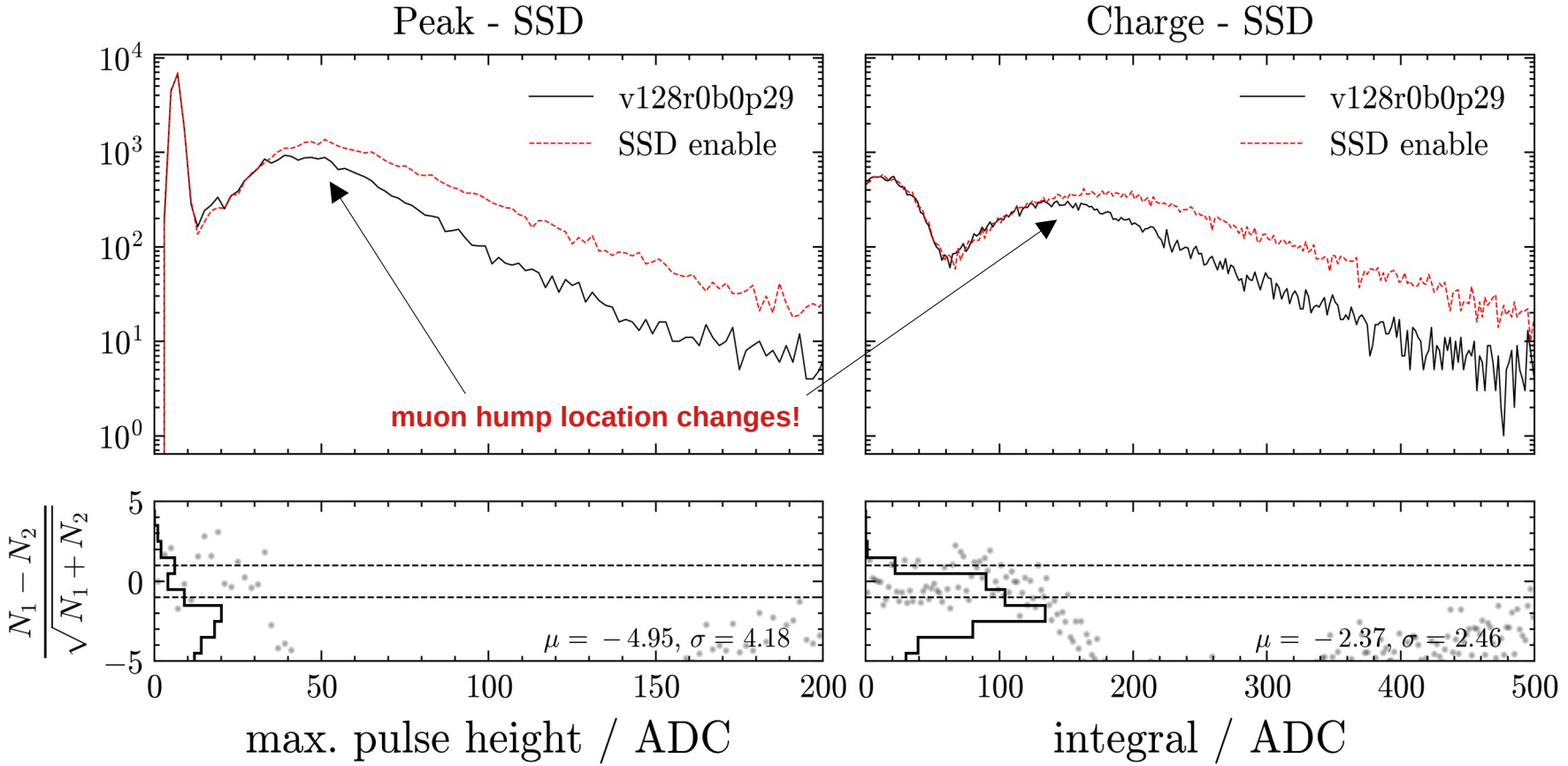
- Muon hump not present due to hardware(?) problems in Didi (136)

muonfill backwards compatibility



- Softer spectrum for SSD. Why? Significant? Detector deadtimes?

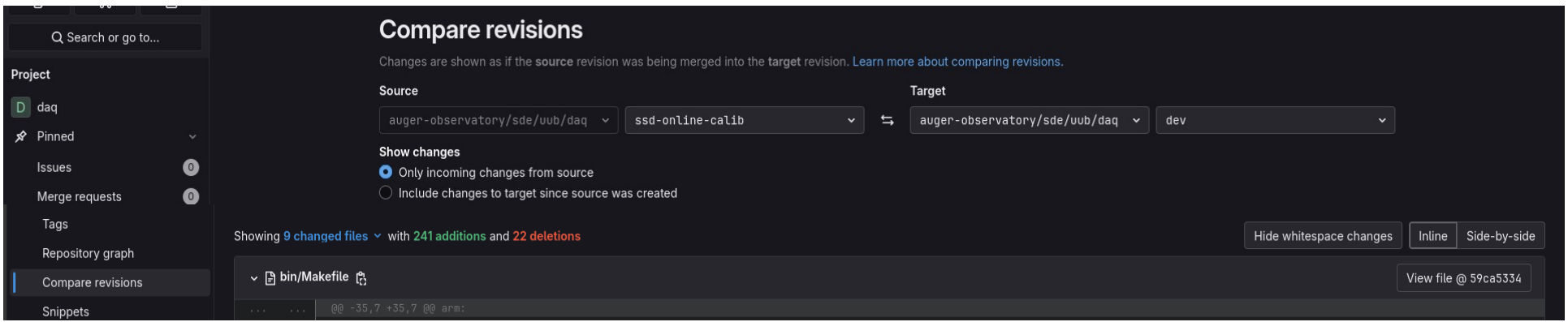
muonfill backwards compatibility



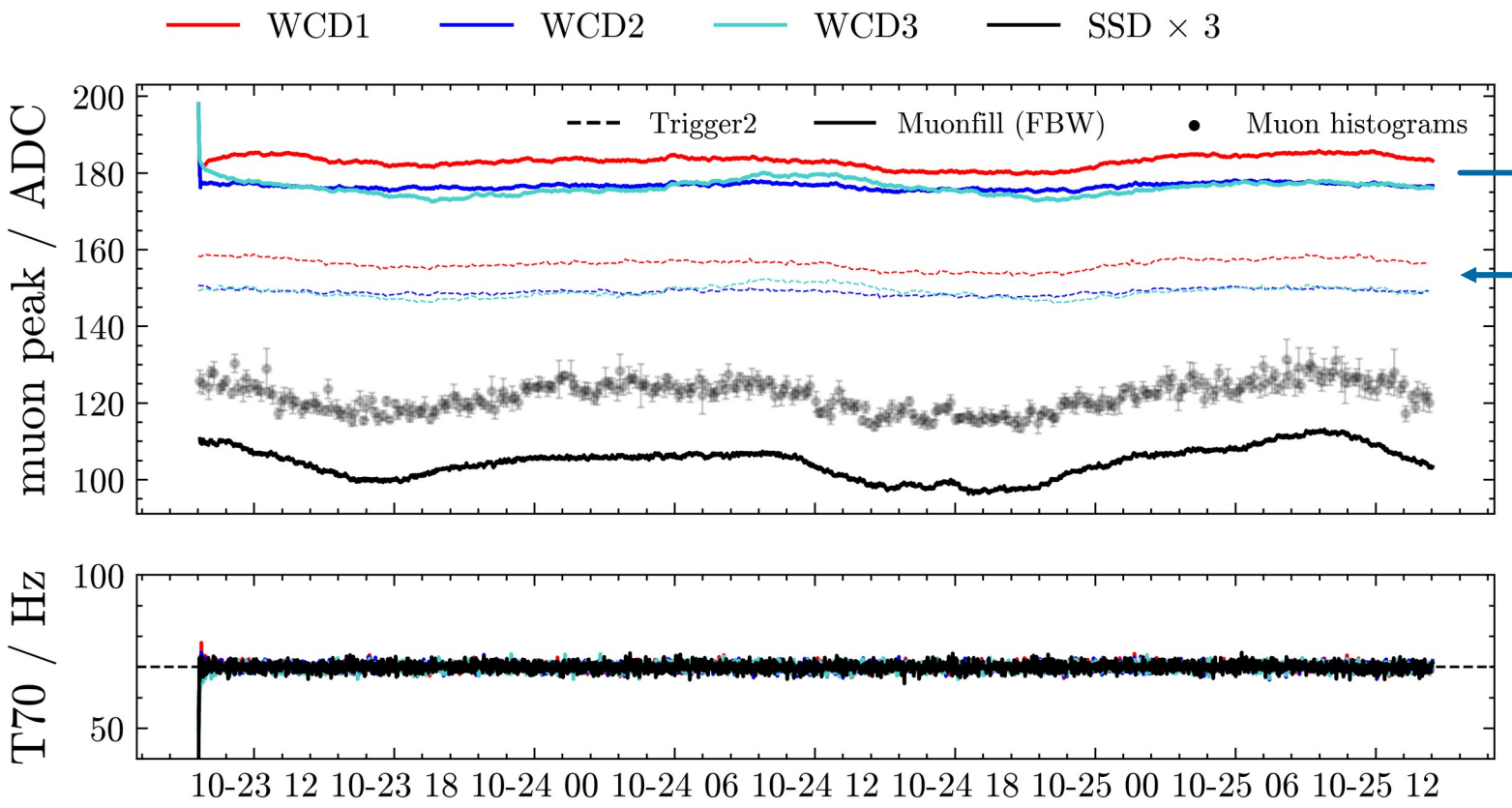
- Which peak to calibrate on? Muon? Or Muon + EM?

SSD online calibration

- Branch in SDE/uub/daq in development since Aug. 12th
- `muonfill` process iterates over each bin/PMT/trace in `muonbuffer`
  - For histograms: record max. pulse height and charge
  - **For online calib: check calibration trigger conditions**
- Evaluate trigger rate and reset trigger thresholds periodically



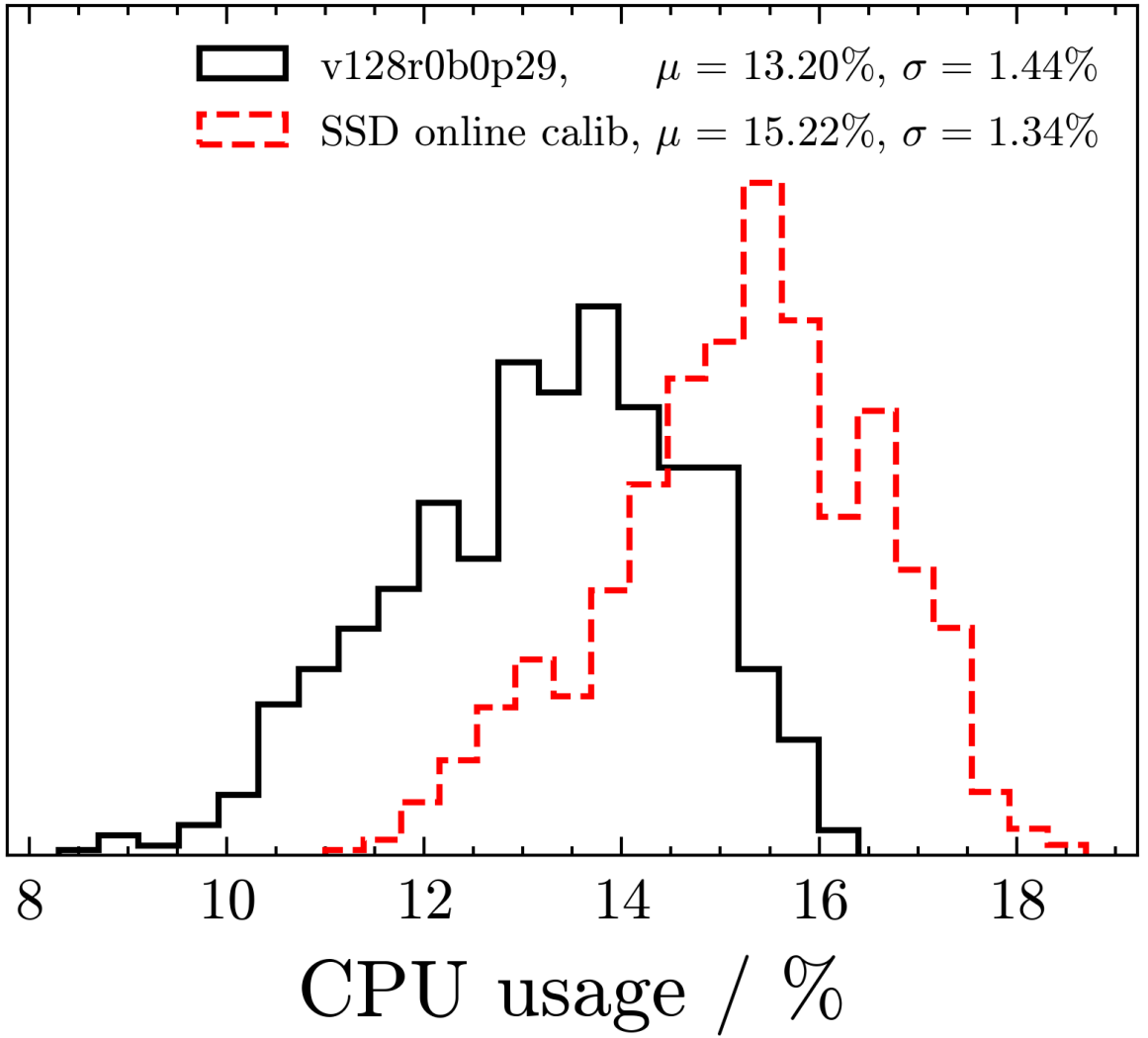
Integration test results



Use F&D rate-threshold relationship on FBW data
Need correction factor!

- Tested on Horacio (609)
- Running for <52h
- Stable VEM/MIP peak

- VEM ⟷ Trigger2 VEM
- MIP ⟷ T3 Histograms


v128r0b0p29, $\mu = 13.20\%$, $\sigma = 1.44\%$
SSD online calib, $\mu = 15.22\%$, $\sigma = 1.34\%$
8
10
12
14
16
18
CPU usage / %