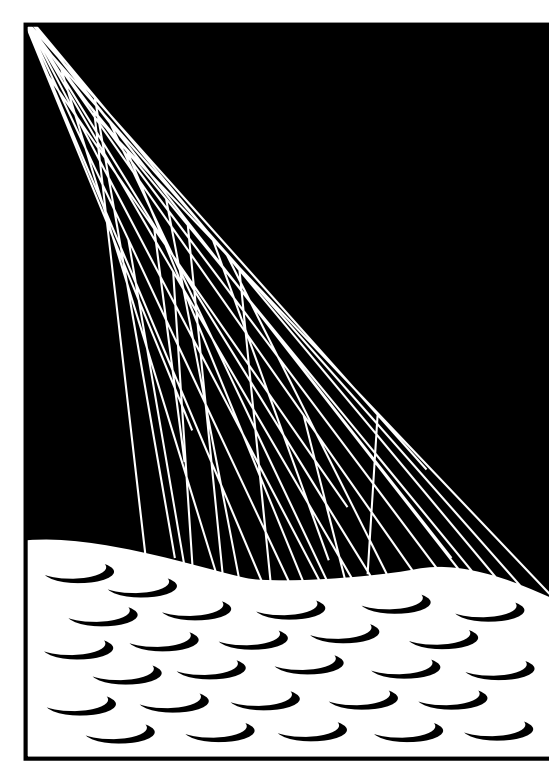


Calibration methods for the Surface Scintillator Detector of AugerPrime

Paul Filip^a for the Pierre Auger Collaboration^b

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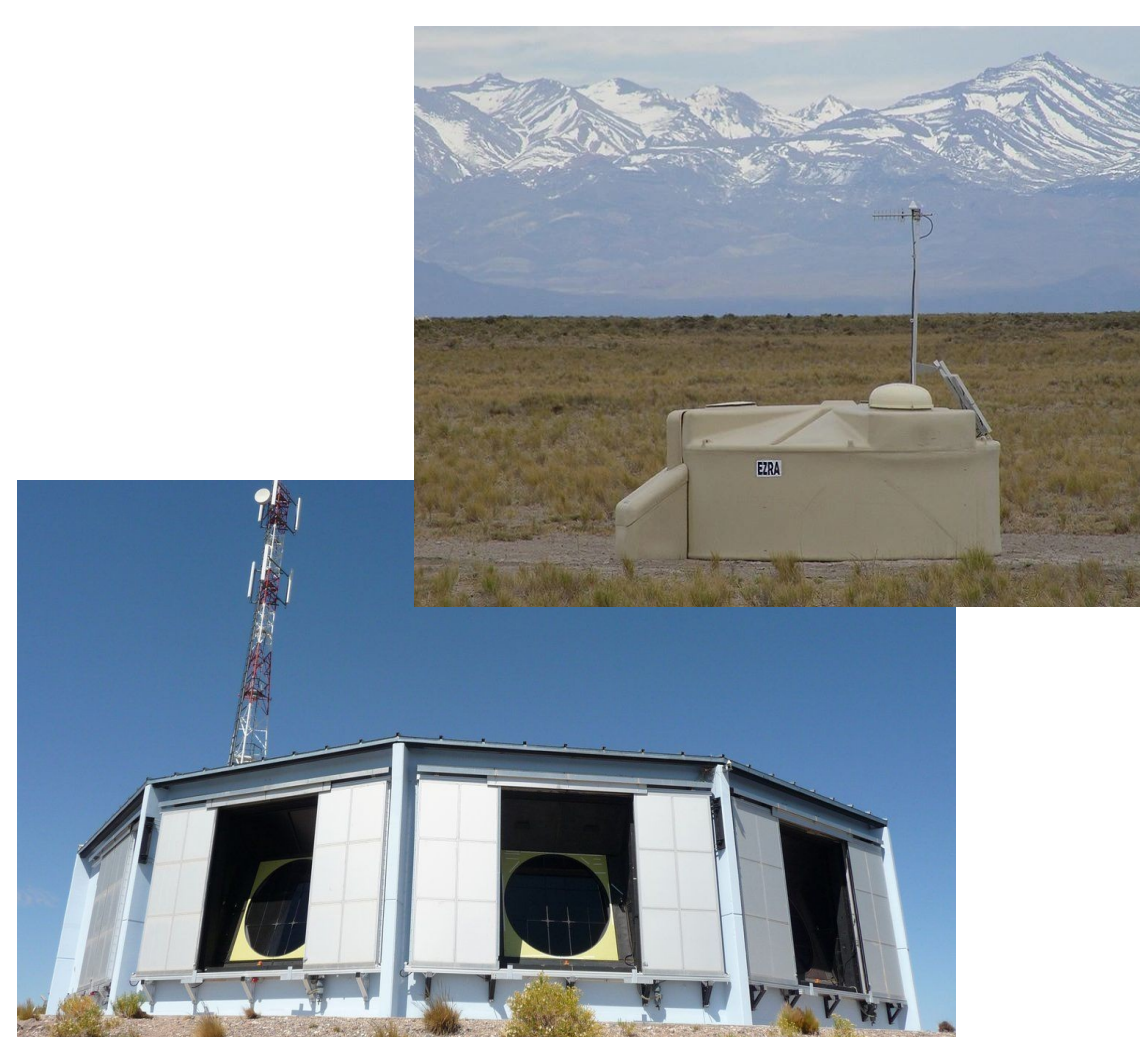
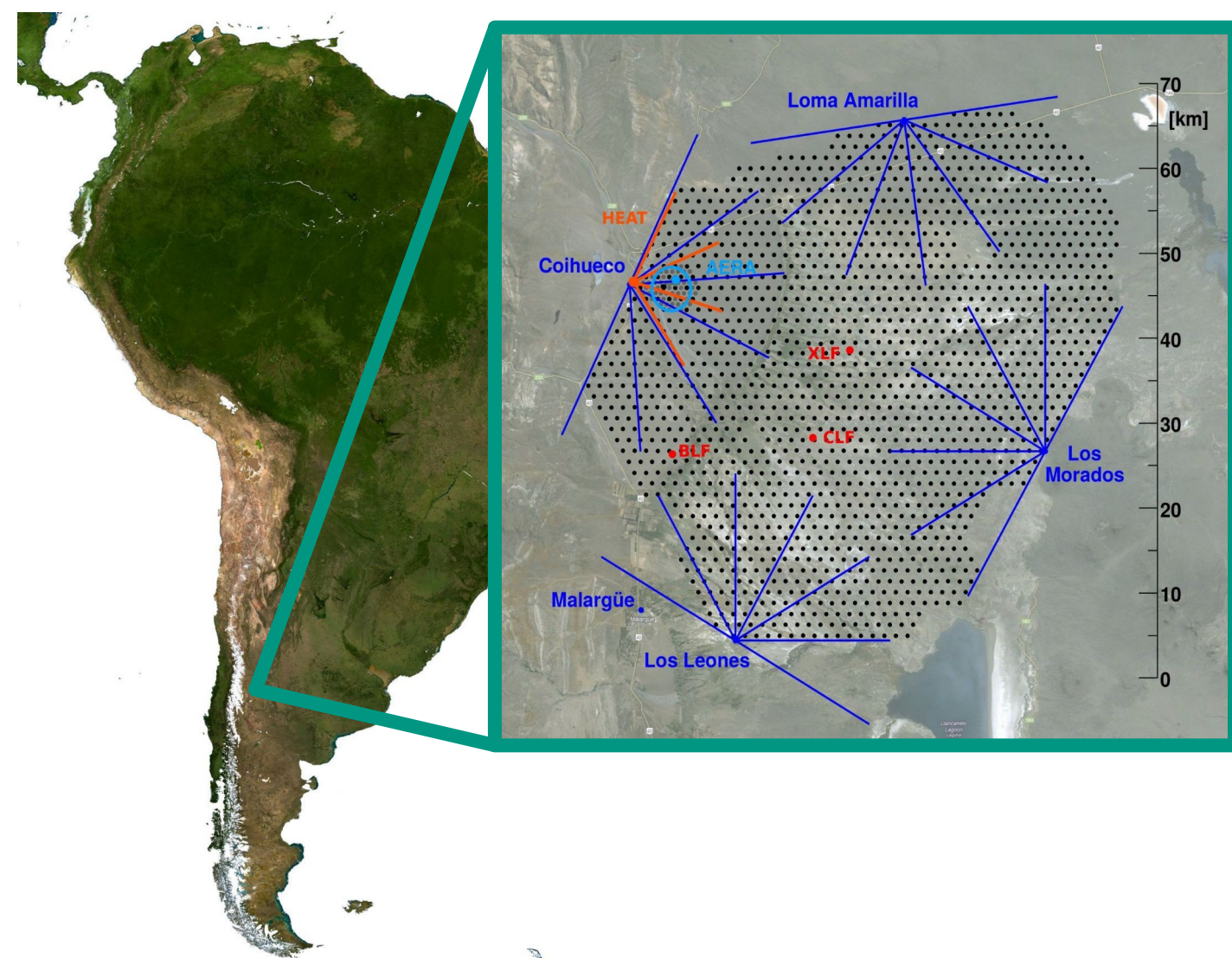
^b Observatorio Pierre Auger, Av. San Martin Norte 304, 5613 Malargue, Argentina



**PIERRE
AUGER**
OBSERVATORY

The Pierre Auger Observatory Surface Detector [1]

- ~1660 surface detector stations
- daily autonomous operation
- Detect shower footprint on earth
- Multiple detection channels
- Cross-calibration via the FD



Fluorescence Detector [2]

- 27 Fluorescence telescopes
- Dedicated measurement shifts
- Observe longitudinal shower profile
- Sensitive to UV light from showers

AugerPrime detector upgrade [3]

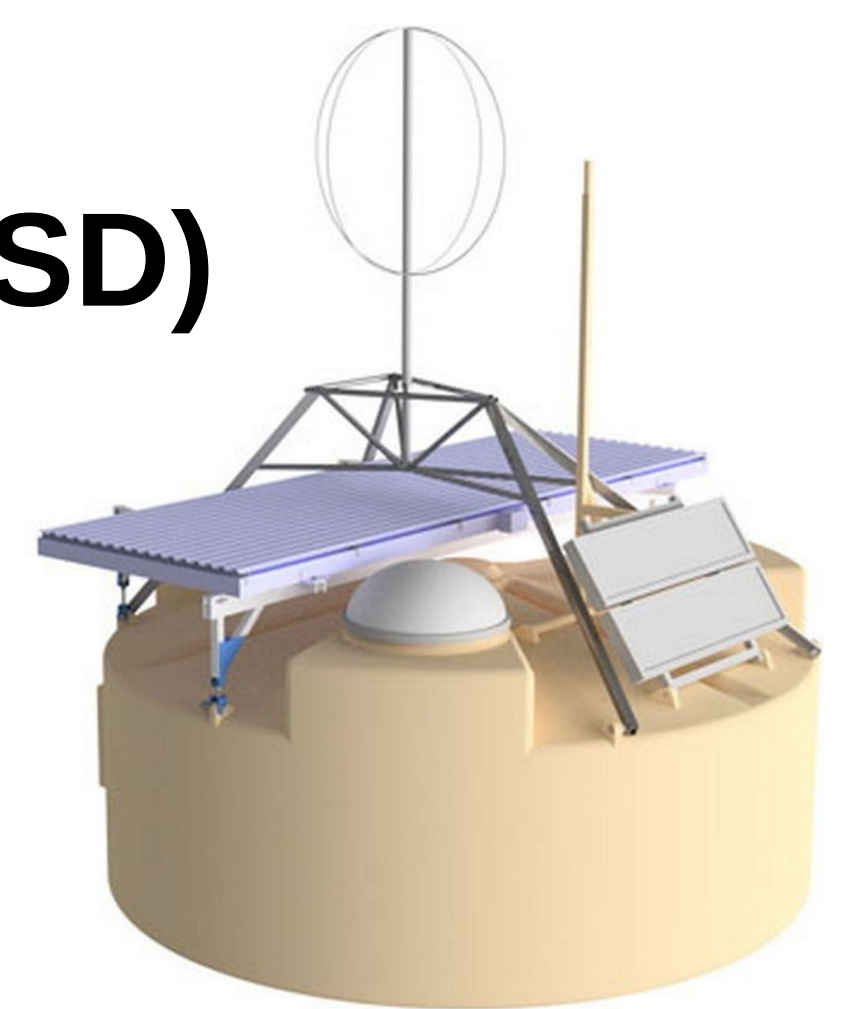


Facts & Goals

- Changes in SD hardware
- New SD Electronics
- New detection channels
- Better sensitivity to primary mass
- **See talk by D. Schmidt!**

Surface Scintillator Detector (SSD)

- Mounted on top of the water tank
- Extruded polystyrene scintillator bars
- Sensitive to EM component of shower
- Operated in slave mode to water tank



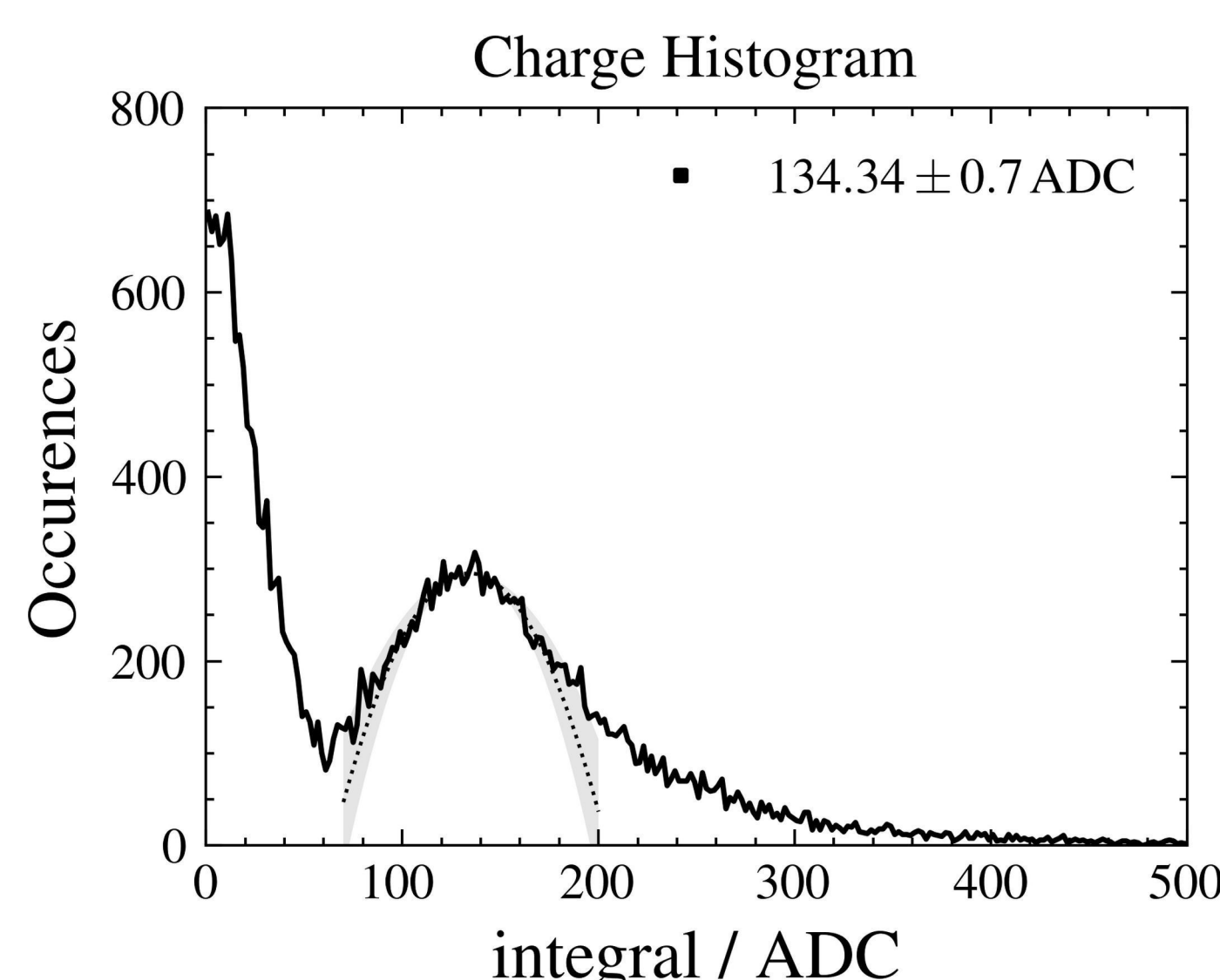
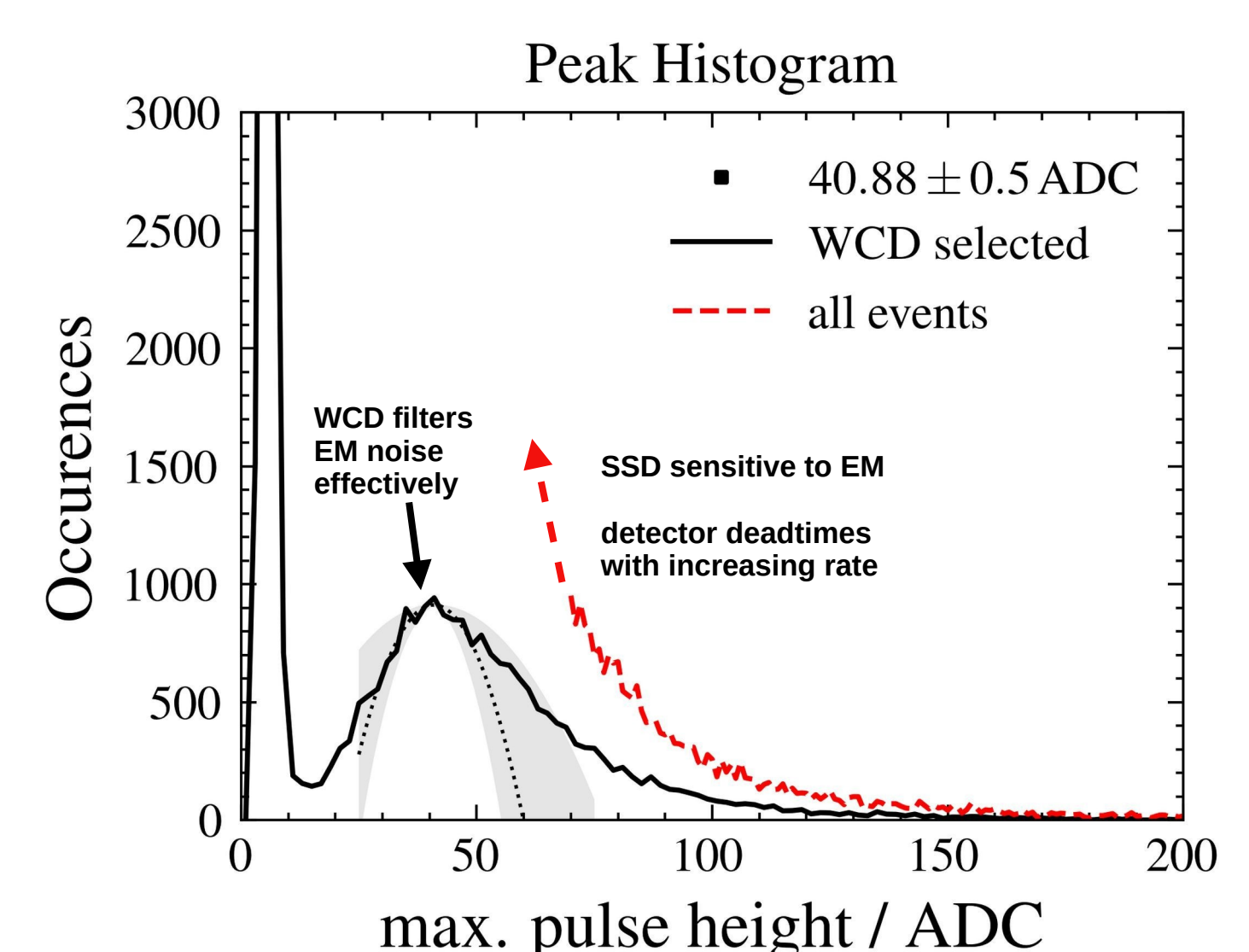
Motivation & Idea

- (uncalibrated) SSD response fluctuates w/ environment
- Defines common ground during event reconstruction
- Enables monitoring + quantification of detector changes
- Allows conceptually simple, but meaningful triggers
- Use atmospheric muon signals to calibrate detector
- Have sharp muon energy distribution, and good statistics

Offline algorithm [4]

Building muon histograms

- Collect signals with >30 ADC in WCD
- Calculate max. pulse height (peak) and integral (charge) for each signal
- Log distribution of peaks and charges
- Restart process after 61s of acq. time

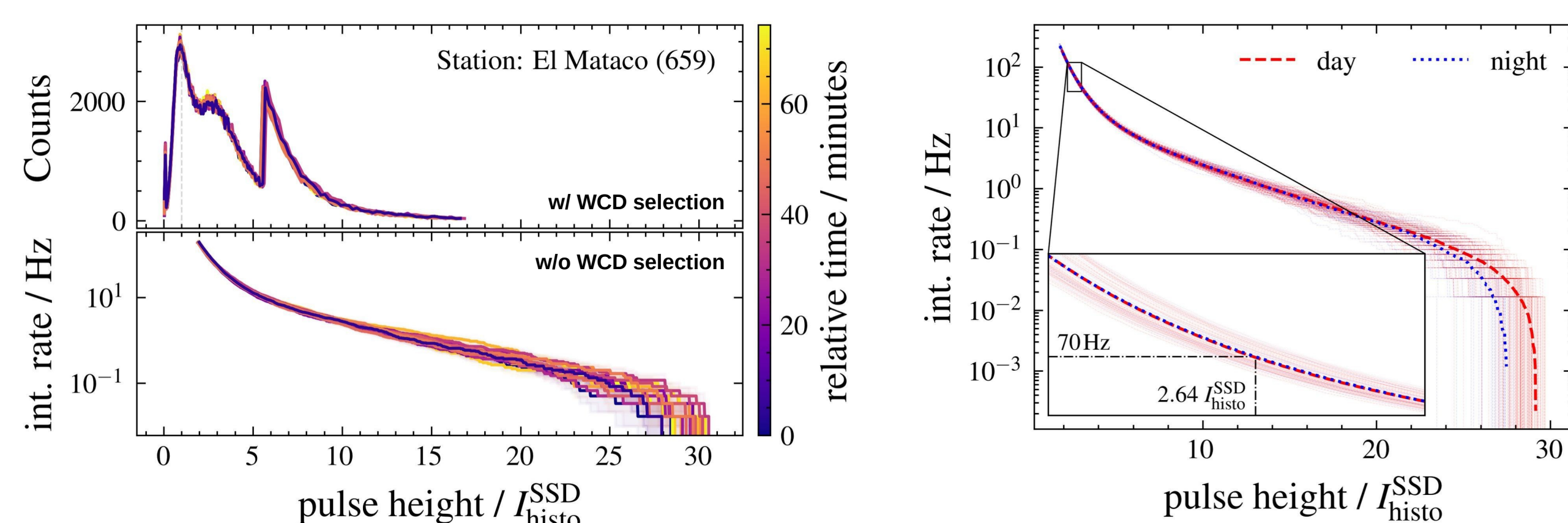


Fitting the muon hump

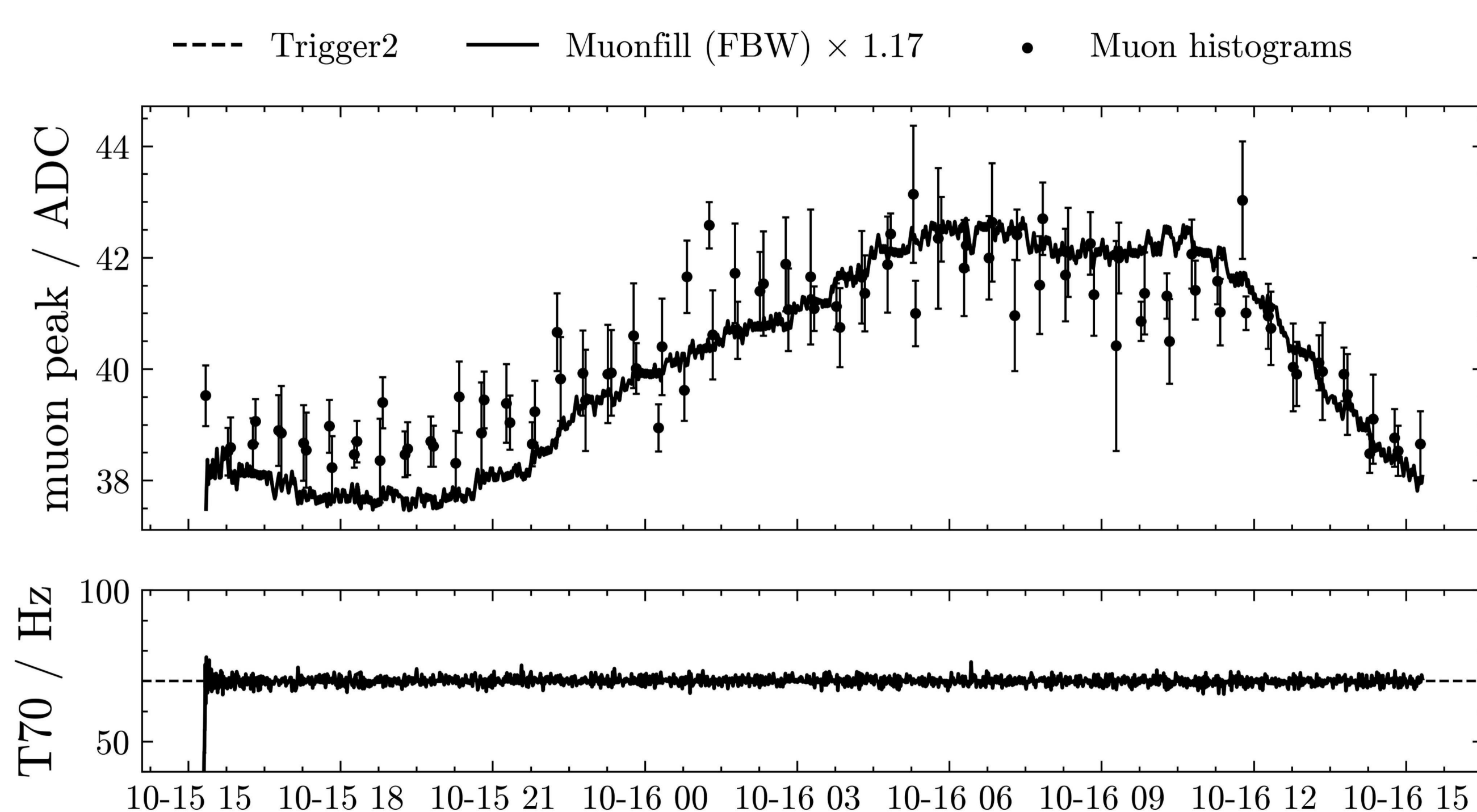
- Muons have characteristic energy deposit
- Visible in distribution of peak and charge
- Fit parabola to peak/charge distribution
- MIP given as vertex of parabola
- Statistical error of ~1% on fit result

Online algorithm

- Measure raw pulse spectrum of SSD events >70 ADC
- Find (calibrated) rate-threshold relationship is the same for different stations, times of day, temperature, etc.

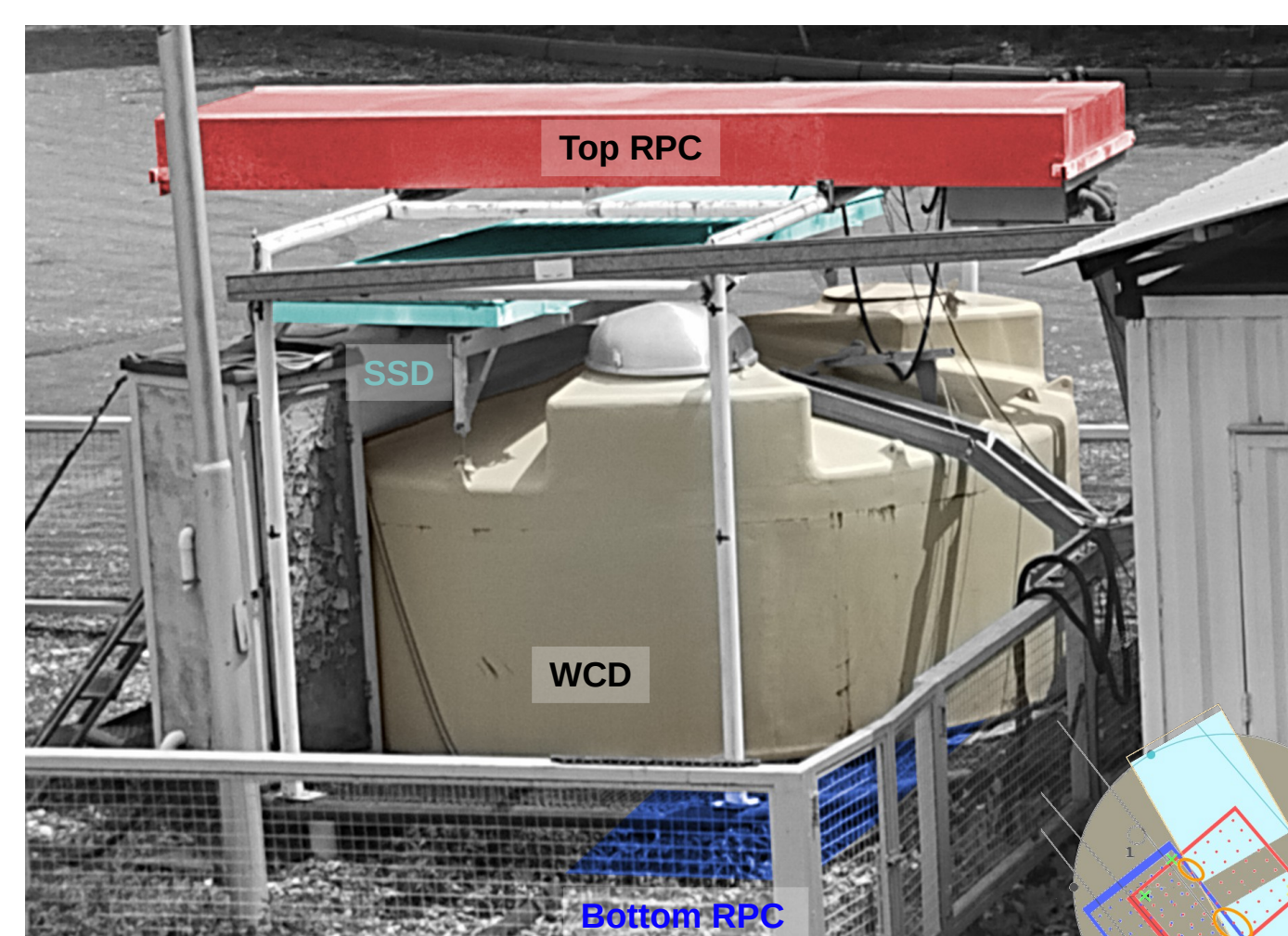


- Build calibration trigger with predefined target trigger rate
- Change calibration trigger thresholds until rate converges
- Read off MIP peak from rate-threshold relationship
- Need further testing/checks before final implementation

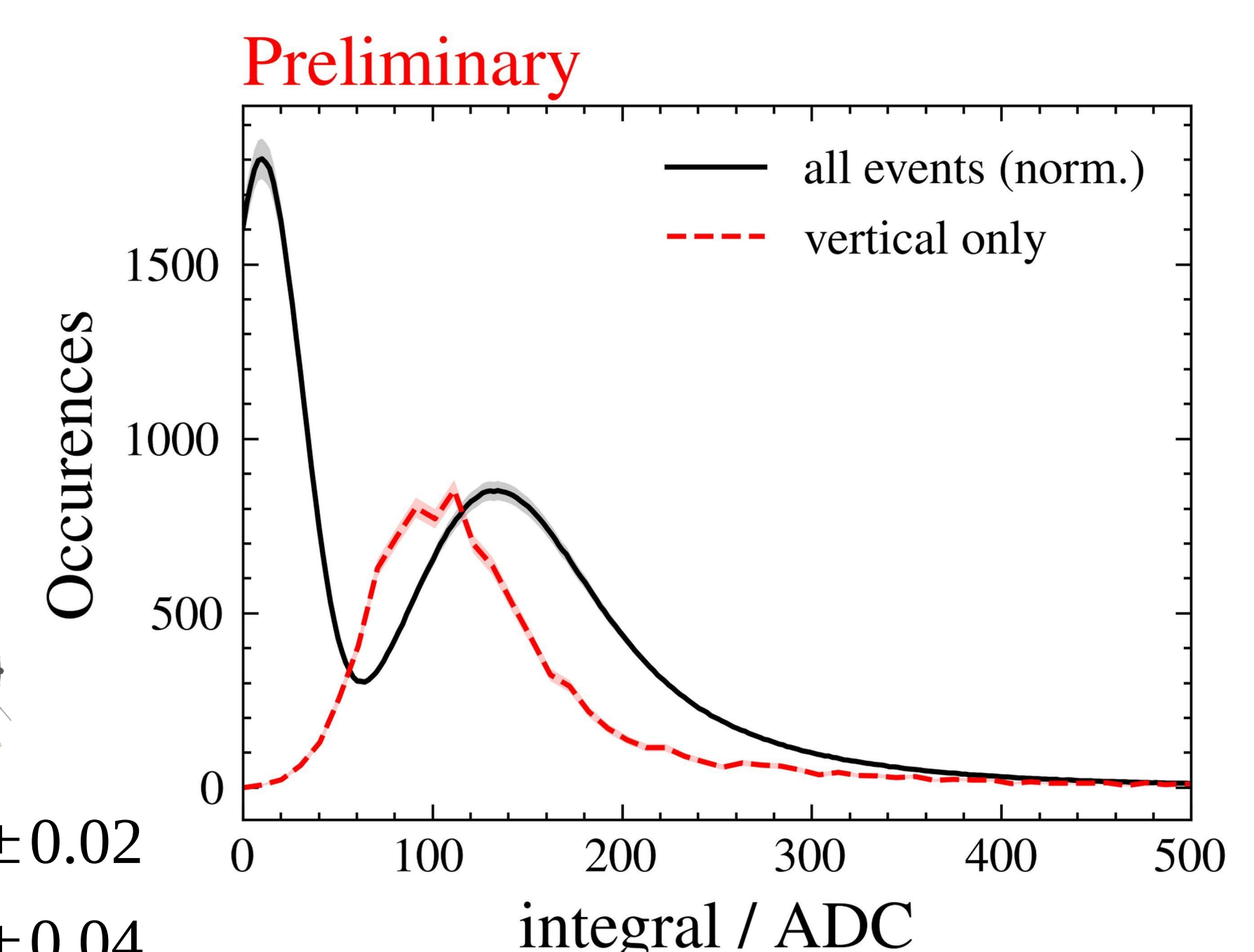


Vertical vs. Omnidirectional MIP

- Deposited signal (~ track length in SSD) dependent on arrival direction
- Have superposition of all arrival directions, omnidirectional MIP
- Determine conversion factor via coinc. measurements @ Gianni Navarra



- Correction factor peak: 1.16 ± 0.02
- Correction factor charge: 1.19 ± 0.04



References

- [1] I. Alekotte et al., *Nucl. Instrum. Methods Phys. Res. A*, **586** (2008) 409-420
- [2] J. Abraham et al., *Nucl. Instrum. Methods Phys. Res. A*, **620** (2010) 227-251
- [3] A. Castellina [Pierre Auger Collaboration], *EPJ Web Conf.*, **210** (2019) 06002
- [4] X. Bertou et al., *Nucl. Instrum. Methods Phys. Res. A*, **568** (2006) 839-846