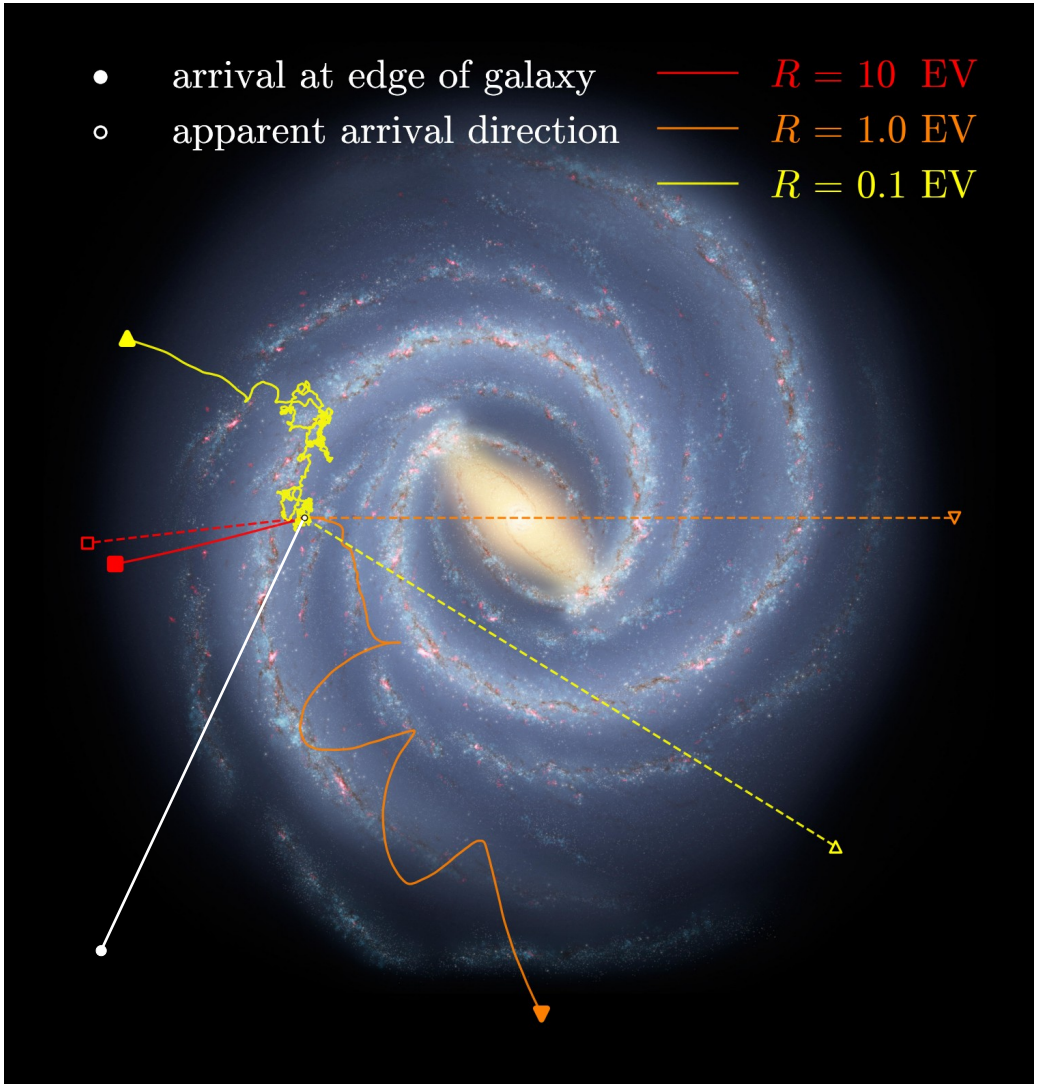
HE Photon search at the Pierre Auger Observatory

Paul Filip

(Part III)

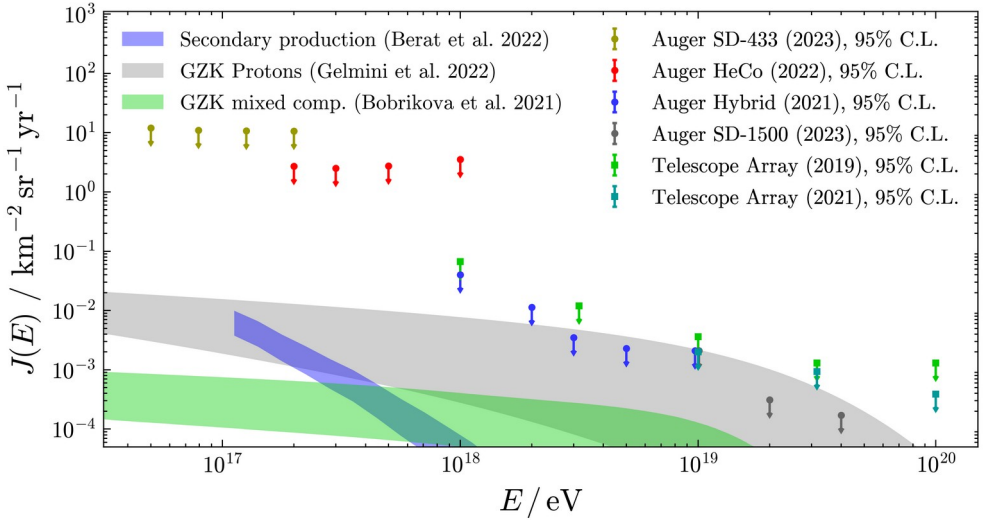
Why care about photons?

- Cosmic rays are charged
  - Deflected by Lorentz force
  - Diffusive + ballistic trajectory
  - Direction essentially random
- Photons are uncharged
  - Not affected by magn. fields
  - Travel in straight lines
  - Point directly to their source



What do we know so far?

- Potential for the direct observation of the universes most energetic processes
- Photons above $10^{17}\,\mathrm{eV}$ very rare



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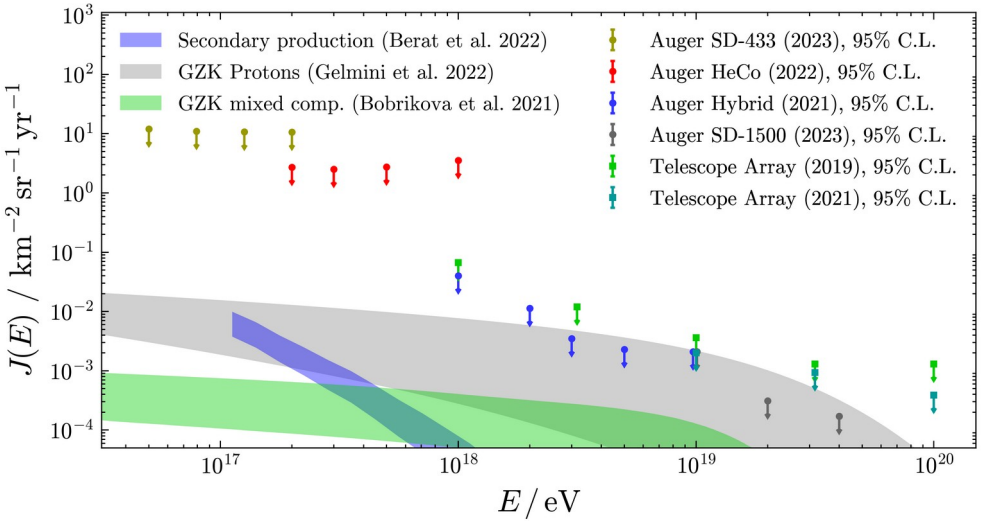
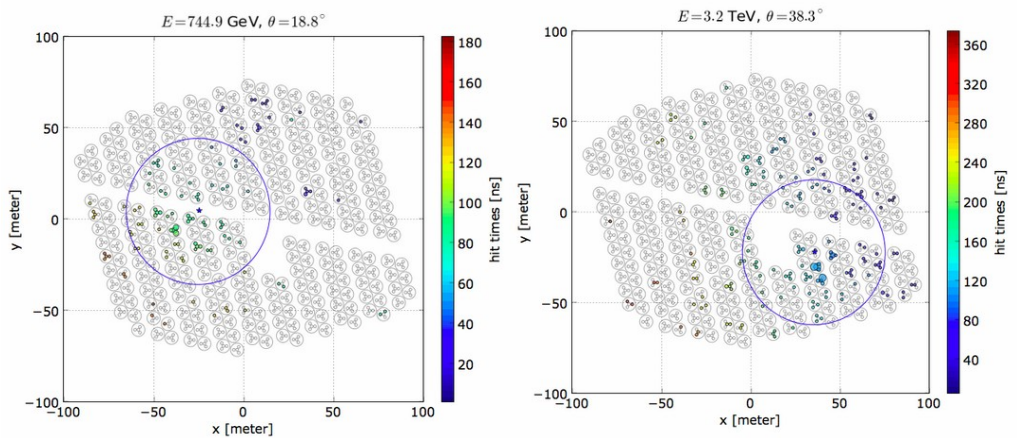


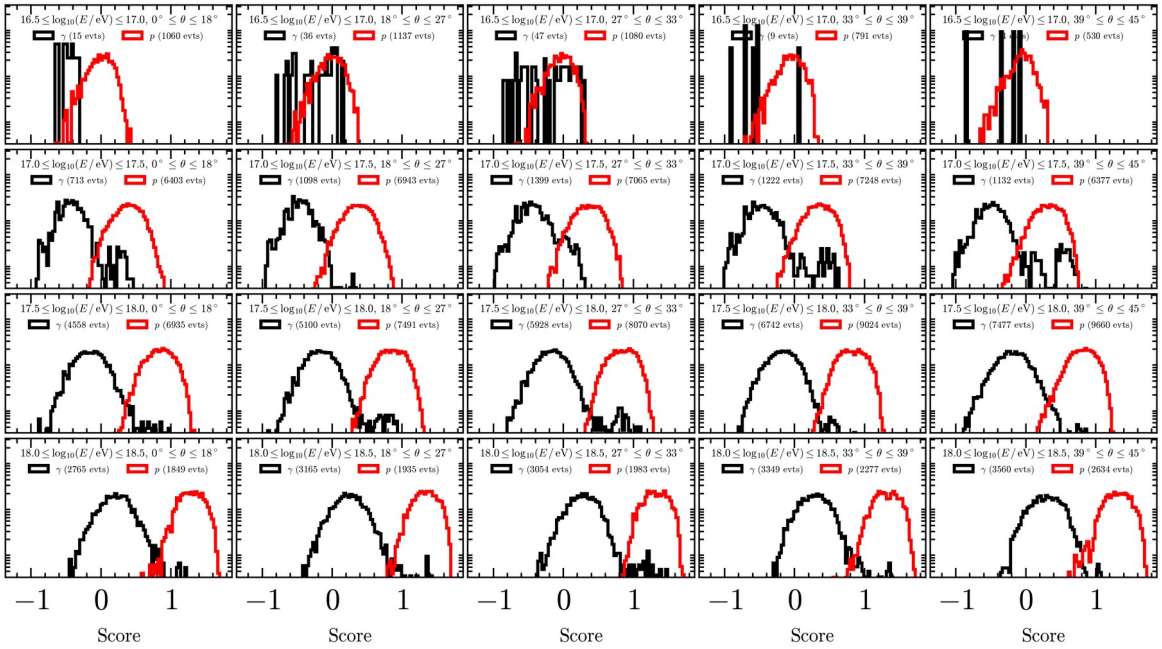


https://hawc-observatory.org/observatory/ghsep.php

- Need to discriminate between photon/hadron showers
- Difficult on an event-by-event basis → probabilistic analysis over many showers

Discrimination between photons and hadrons

- Use a score to judge the “photonness” of a shower
  - $M_b = \log\left(\sum_i \frac{\rho_i}{\rho_{\mathrm{Pr}}(E,\theta)} \times \left(\frac{r_i}{r_{\mathrm{Pr}}}\right)^b\right)$
  - M_b not only existing score
  - Calculate from simulations



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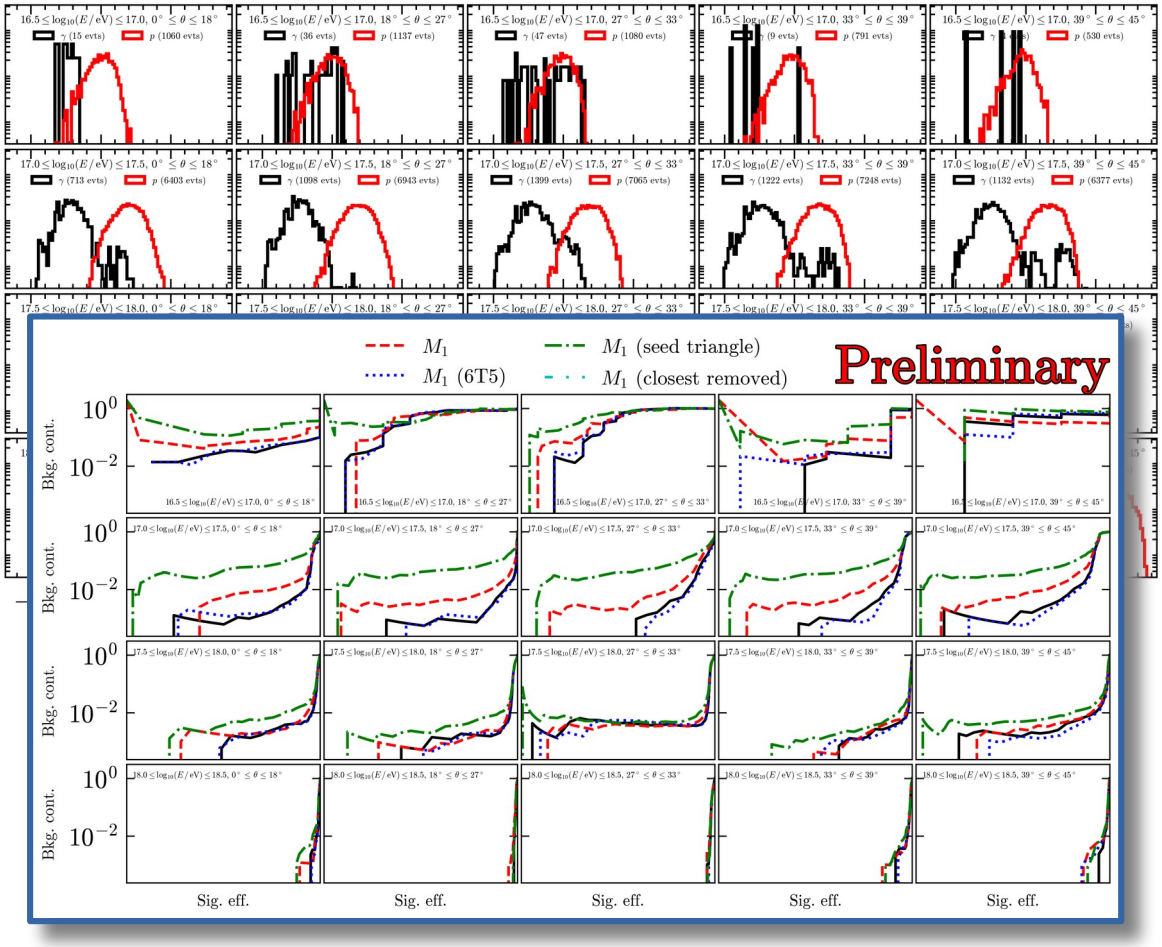
- Decide if shower is p/γ based on cut in score
  - Calculate signal efficiency and bkg. contamination



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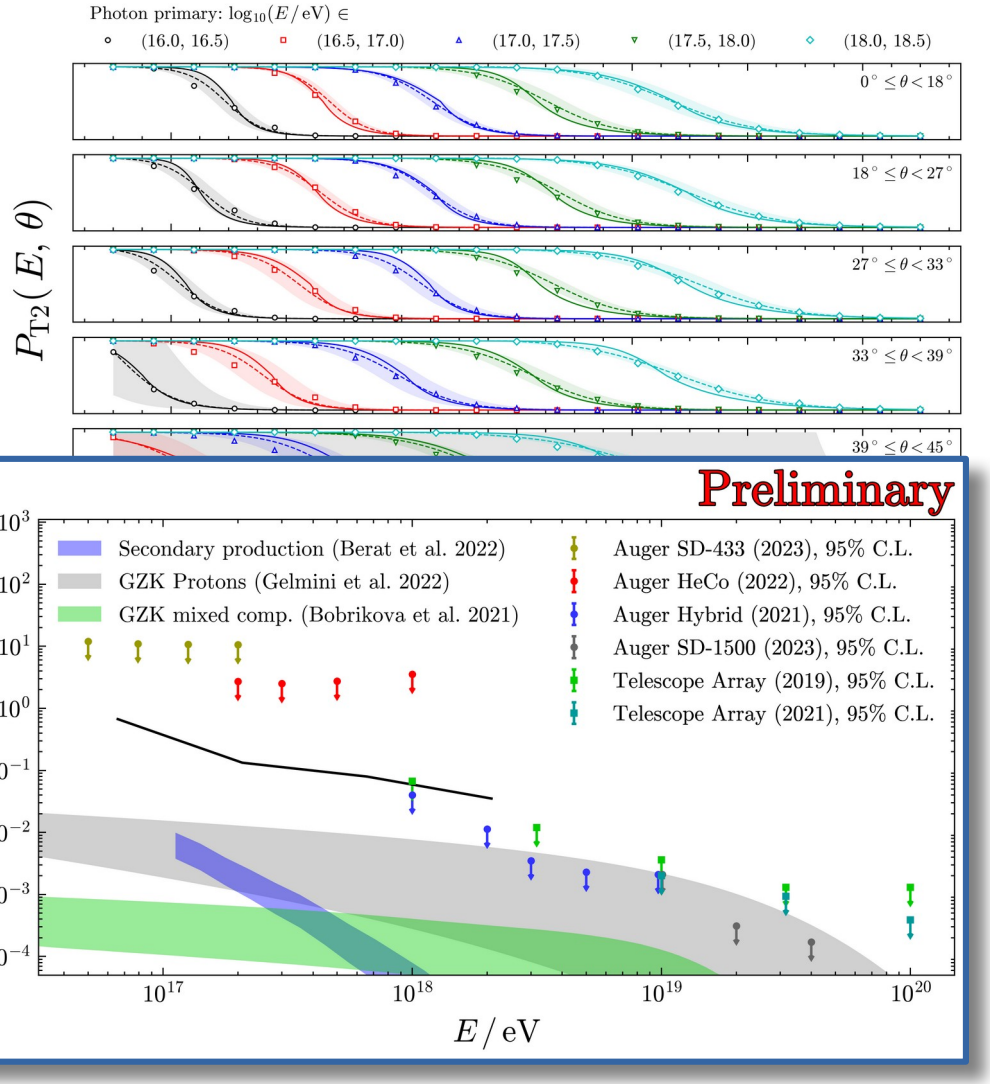
Calculation of upper flux limit

- Calculate upper flux limit as:

$$J_{\max} = \frac{n(\rho_\gamma)}{e\,\epsilon_{\mathrm{T3}}(E,\,\theta)\,\rho_\gamma(E,\,\theta)}$$

- Where ϵ_{T3} = detection chance
- ρ_γ = detected photon fraction
- $n(\rho_\gamma)$ = confidence limits

- Decrease current world best limits by a factor of 10-100



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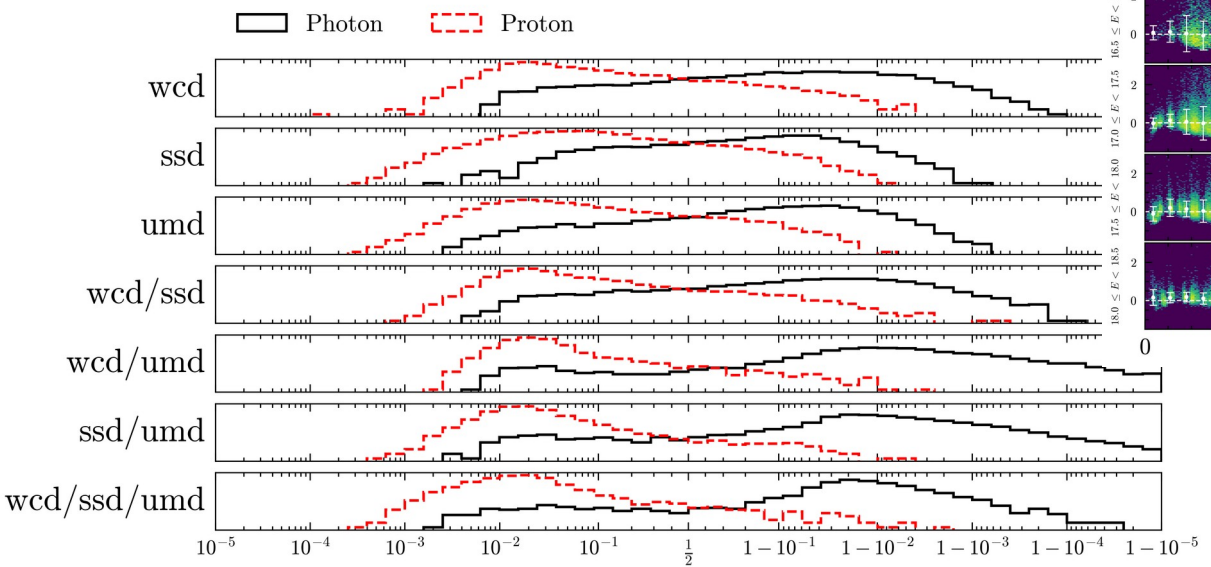
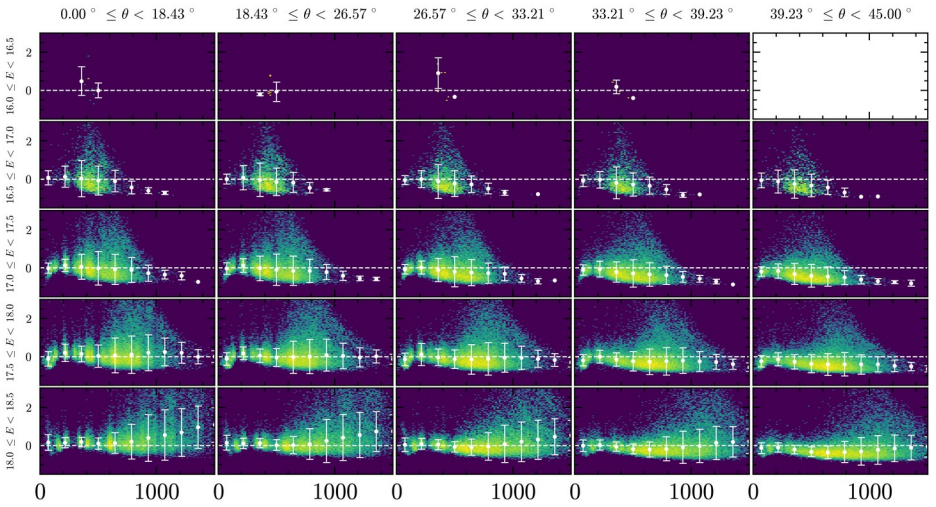


- Increase discrimination power



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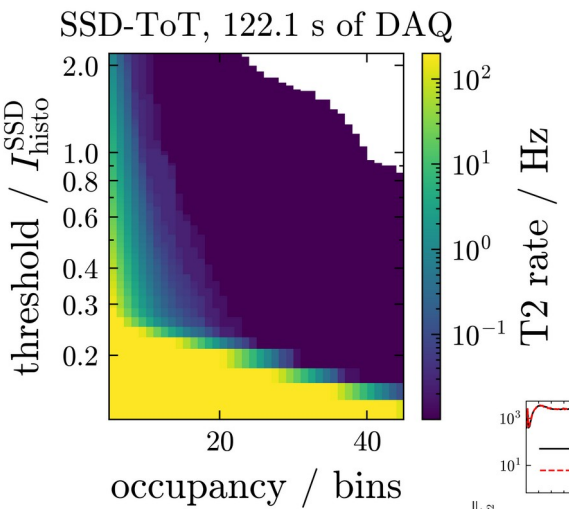
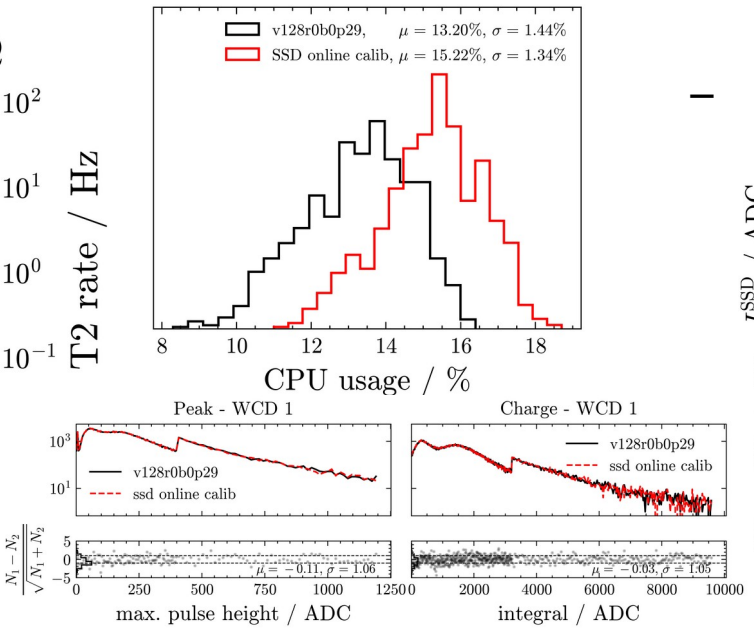
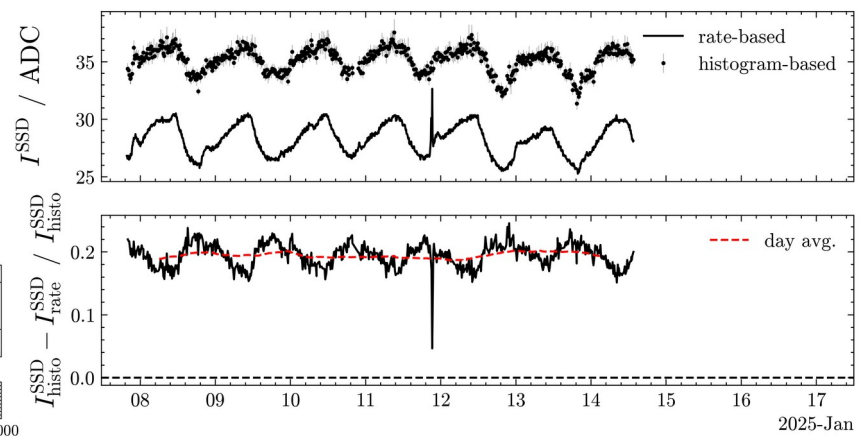




- Increase discrimination power
- Increase trigger efficiency
  - new detectors → new triggers?
  - new SSD calibration algorithm



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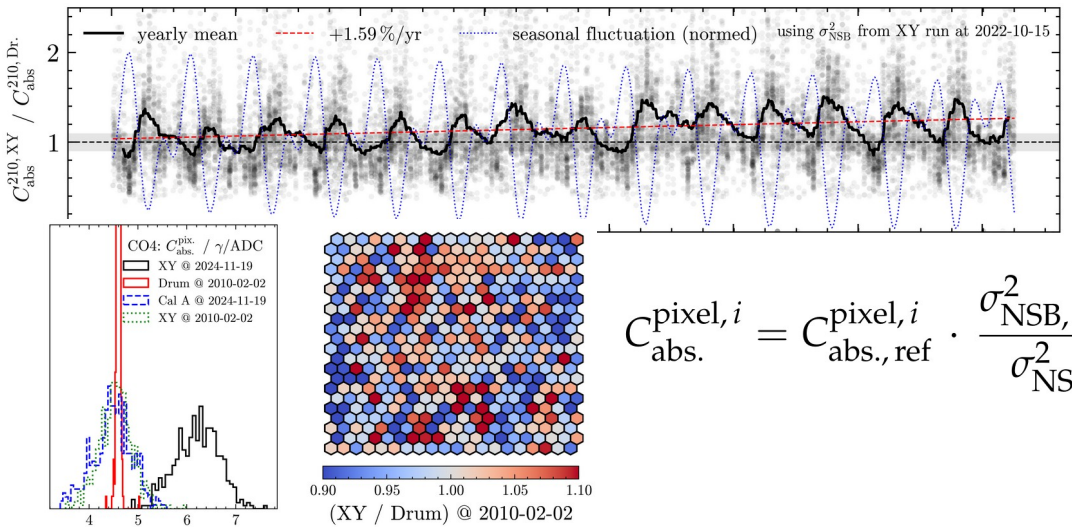

$$C^{\mathrm{pixel},\,i}_{\mathrm{abs.}} = C^{\mathrm{pixel},\,i}_{\mathrm{abs.,\,ref}} \cdot \frac{\sigma^2_{\mathrm{NSB,\,ref.}}}{\sigma^2_{\mathrm{NSB}}}$$

- Increase discrimination power
- Increase trigger efficiency
  - new detectors → new triggers?
  - new SSD calibration algorithm
- Revisit Augers energy scale
  - Evidences of telescope aging
  - FD energy changes w/ time
  - Attempt to correct this

Backup