Joachim Hahn, Raquel de los Reyes



- The H.E.S.S. instrument
- Monitoring Devices on site
- Data Quality Selection
- Smart Scheduling
- Data Correction





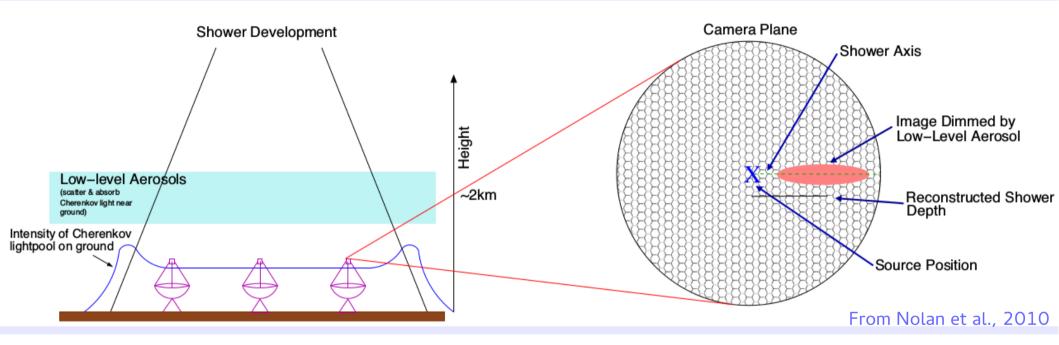
- H.E.S.S. phase I telescopes
 - 12m diameter
 - 5° field of view
 - Energy threshold ~100 GeV
 - 0.1° angular resolution
 - ~20% energy resolution



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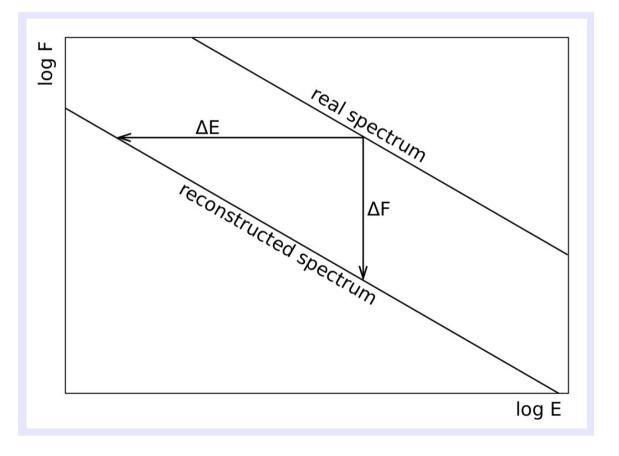
- H.E.S.S. phase II telescope
 - 28m telescope
 - 3.2° field of view
 - Energy threshold ~ 30GeV
 - Fast slewing speed (important for transients)
 - Mono or stereo mode

Atmospheric Monitoring With H.E.S.S. Impact of atmospheric absorbers



 Gamma-rays: Cherenkov light intensity proportional to primary energy

- -> Reconstruction: $E_{reco} \sim N_{ph}$
- -> Light-attenuation by atmospheric absorbers leads to downwards bias in E_{reco}



- Downwards bias

 in reconstructed
 energy
 > Downwards bias in
 reconstructed flux
 > Excess of particles
 - at the low energ end
 - -> slight spectral softening

Monitoring devices on site

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- Normal weather station
 - Precipation
 - Wind speed
 - Humidity
 - Air Pressure





- 5 Radiometers
 - 4 instruments mounted on the telescope structure, pointing in observational direction
 - λ = 8-14 μ m, 2° field-of-view
 - Allows detection of clouds
 - aerosol load measurement

→ See Michael's talk!

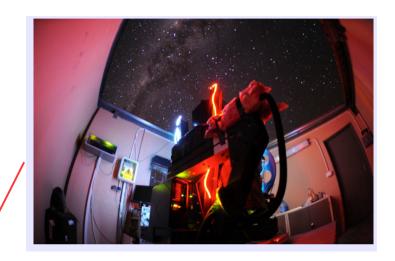
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- Scanning Radiometer
 - Same Type as the telescopemounted ones
 - Round-turn every ~30min
 - Cloud monitoring, also smart scheduling

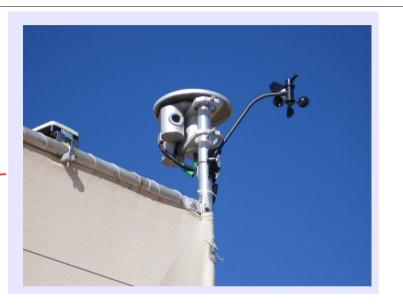




- LIDAR
 - 60cm diameter primary parabolic mirror
 - 532nm,355nm @ 10Hz
 - Records atmospheric profiles in between runs

→ See George's talk!





- ATOM All Sky Camera
 - 180° field of view
 - Images every 3 min
 - Cloud monitoring

→ See Felix' talk!

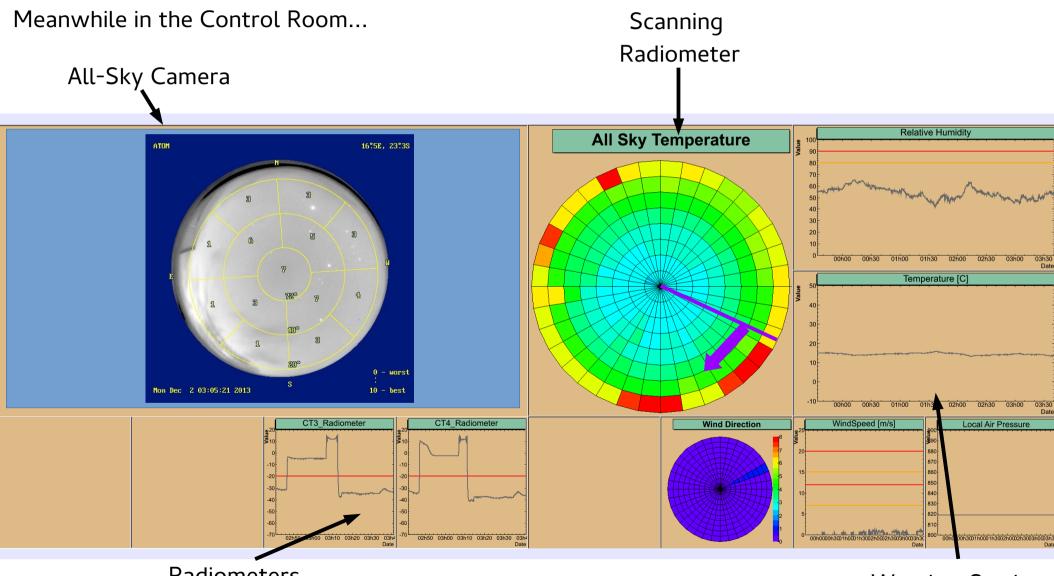




- H.E.S.S. phase I telescopes
 - Use the trigger rates
 to estimate air transparency
 -> Able to detect

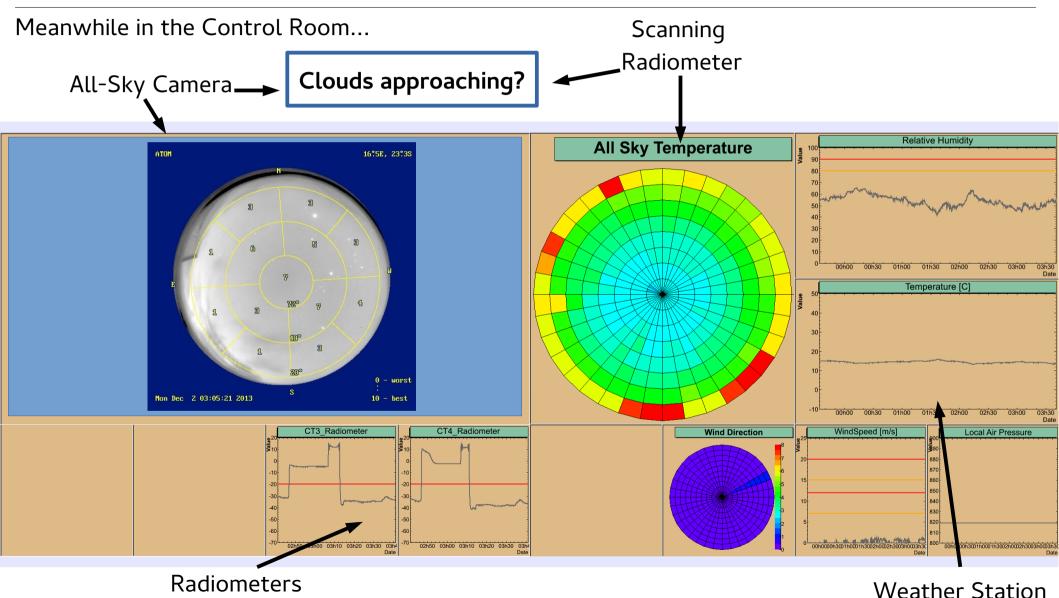
clouds & aerosols

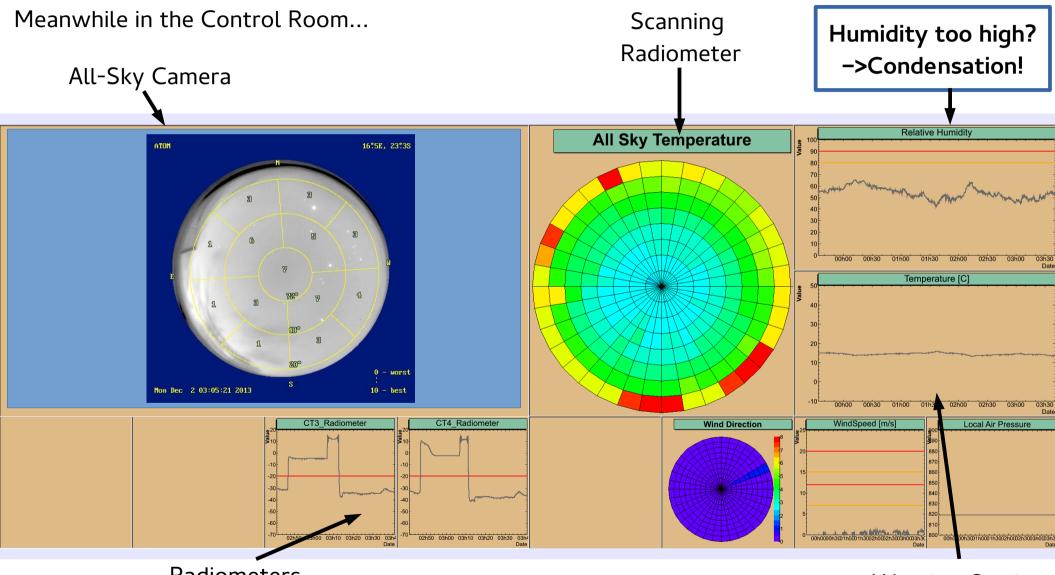
- Used in DQ monitoring



Radiometers

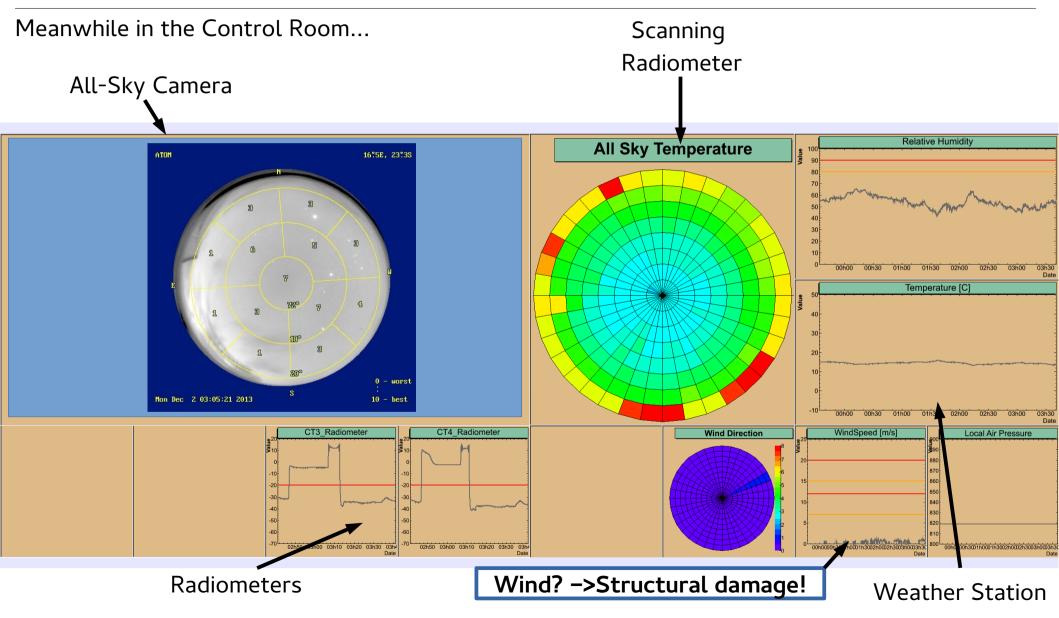
Weather Station





Radiometers

Weather Station



Atmospheric Monitoring With H.E.S.S. **Application**

Data Quality Selection

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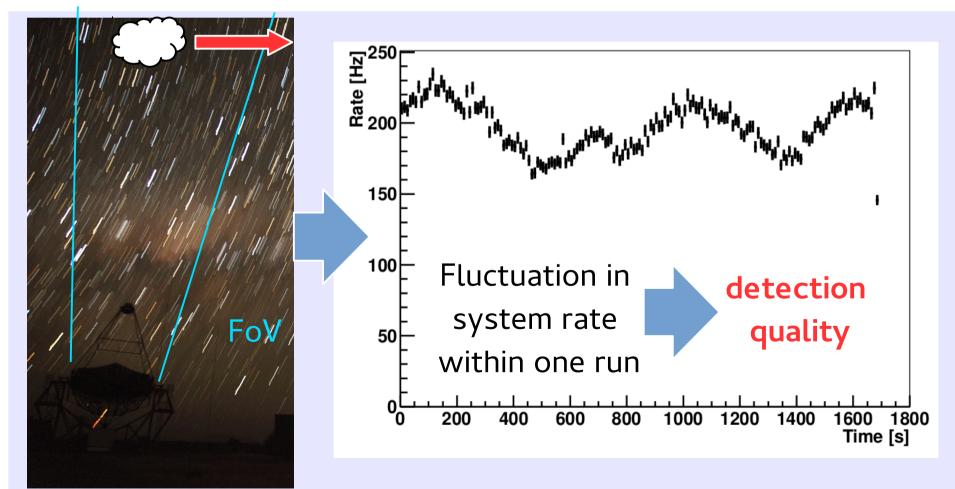
Atmospheric Monitoring With H.E.S.S. **Application – Data Quality Selection**

- In H.E.S.S., we classify our data in 2 quality categories:
 - Detection quality, hardware works fine, but atmosphere-induced energy biases are possible
 sufficient for source *detection*
 - Spectral quality, where data selection additionally guarantees limited systematics due to atmospheric effects
 - -> required for *spectral reconstruction*

Application – Data Quality Selection

Detect sources in the presence

• Small – medium sized clouds



Application – Data Quality Selection

Detect sources in the presence of

• Aerosol layers, large scale and dilute clouds

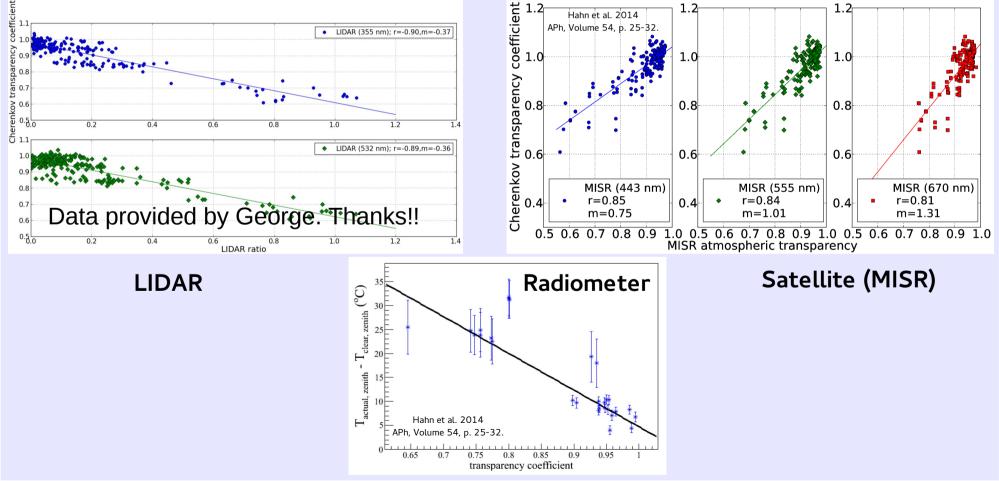
Cherenkov Transparency Coefficient (CTC)

$$T \equiv \frac{1}{N \cdot k_N} \sum_{i} \frac{R_i^{\frac{1}{1.7 - \Delta}}}{\mu_i \cdot g_i}$$

Quantity designed to isolate atmospheric contributions to decreased trigger rate

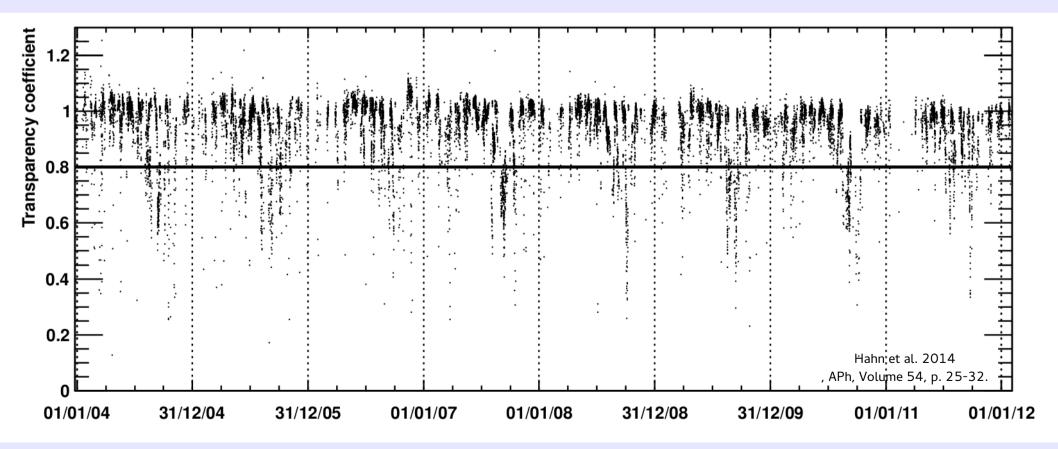
Application – Data Quality Selection

Detect sources in the presence of



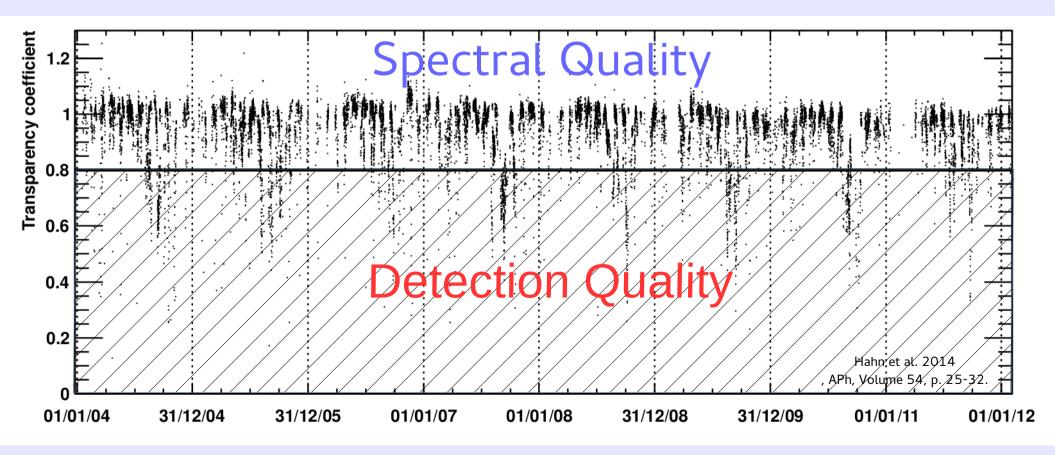
Application – Data Quality Selection

Detect sources in the presence of



Application – Data Quality Selection

Detect sources in the presence of



Atmospheric Monitoring With H.E.S.S. **Application**

Smart Scheduling

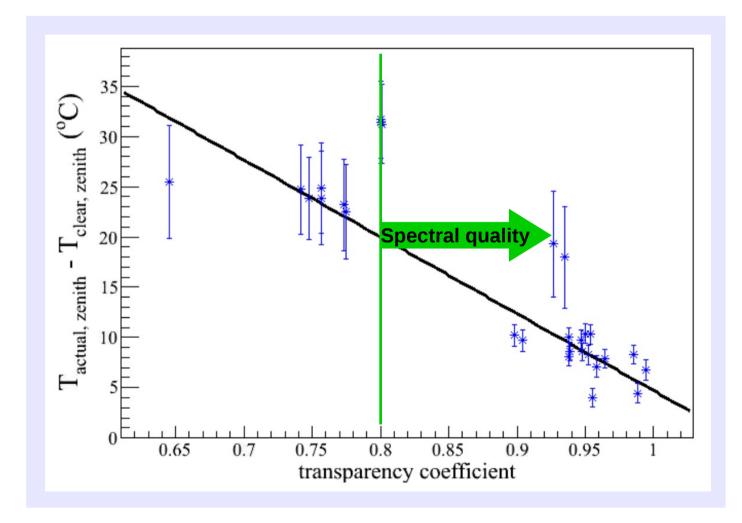
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Atmospheric Monitoring With H.E.S.S. **Application – Smart Scheduling**

- Not all observations require the best atmospheric conditions, e.g. source detections
 - Take this into account in observation planning
 - Different observation schedules
- Radiometer is continuously taking data during observations
 - Use this data to switch between schedules
- Corresponding mechanism is implemented
 - currently being investigated and tested with H.E.S.S.

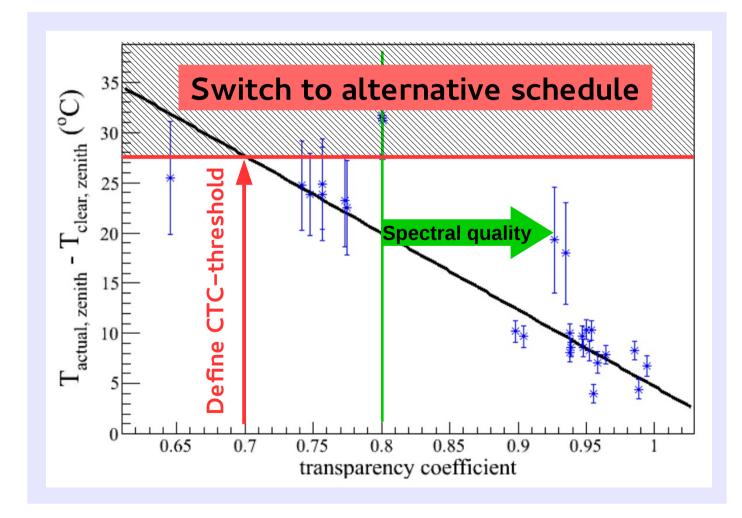
Atmospheric Monitoring With H.E.S.S. **Application – Smart Scheduling**

Use the correlation CTC-Sky Temperature



Atmospheric Monitoring With H.E.S.S. **Application – Smart Scheduling**

Use the correlation CTC-Sky Temperature



Application – Smart Scheduling

Use the correlation CTC-Sky Temperature

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Atmospheric Monitoring With H.E.S.S. **Application**

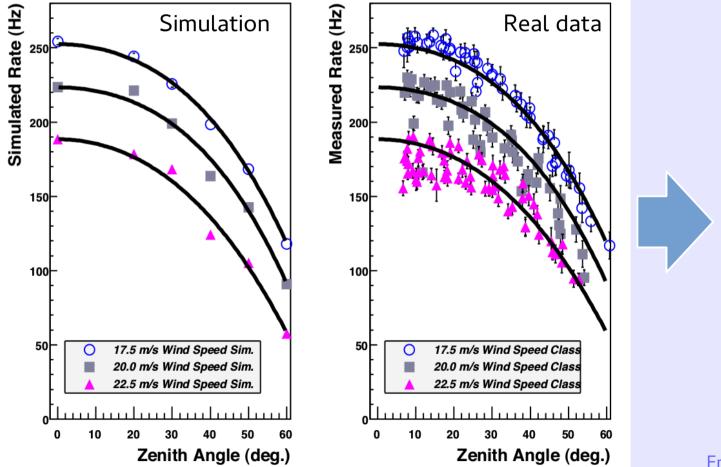
Data Correction

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Detailed study by Nolan, Pühlhofer and Rulten (2010, APh, Volume 34, Issue 5, p. 304-313.)

- Aim: Recovery of important data on PKS2155-304 recorded during bad weather and a MWL campaign
- Method: Atmospheric simulations for adverse conditions(haze) using MODTRAN, use results in standard H.E.S.S. analysis

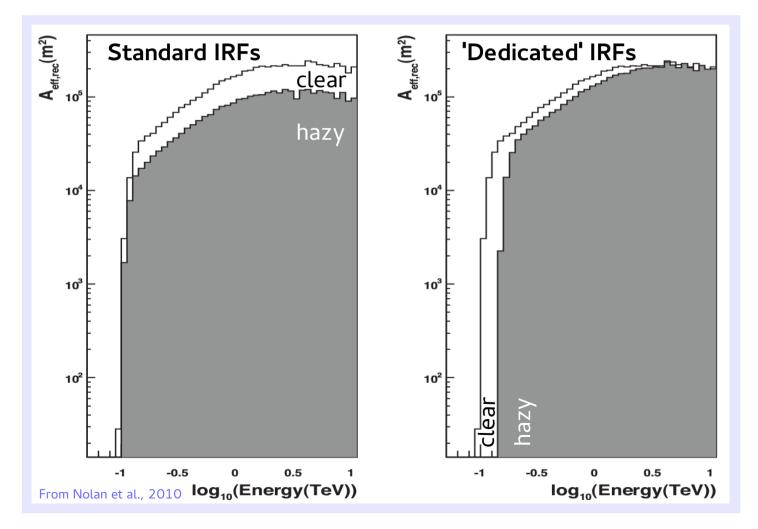
Compare simulated BG rate data under different assumed atmospheric conditions to observation until there is a match



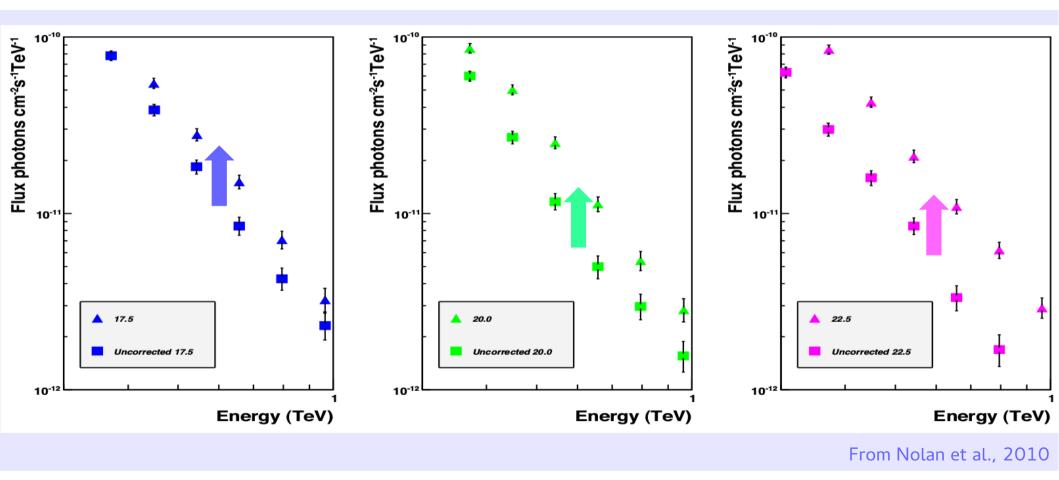
Models match real data! -> Create correct IRFs for analysis

From Nolan et al., 2010

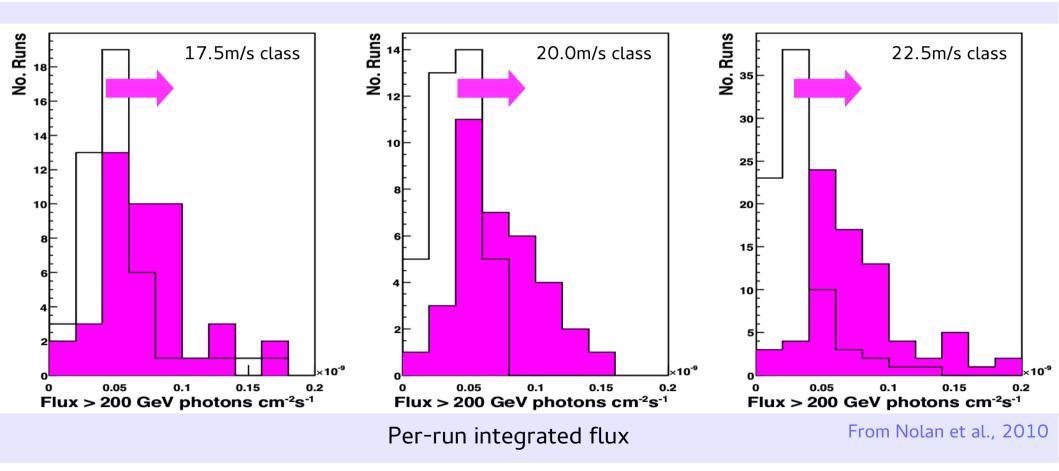
Allows to reconstruct proper energies -> proper effective areas



Reconstruct unbiased spectra!



Reconstruct unbiased spectra!

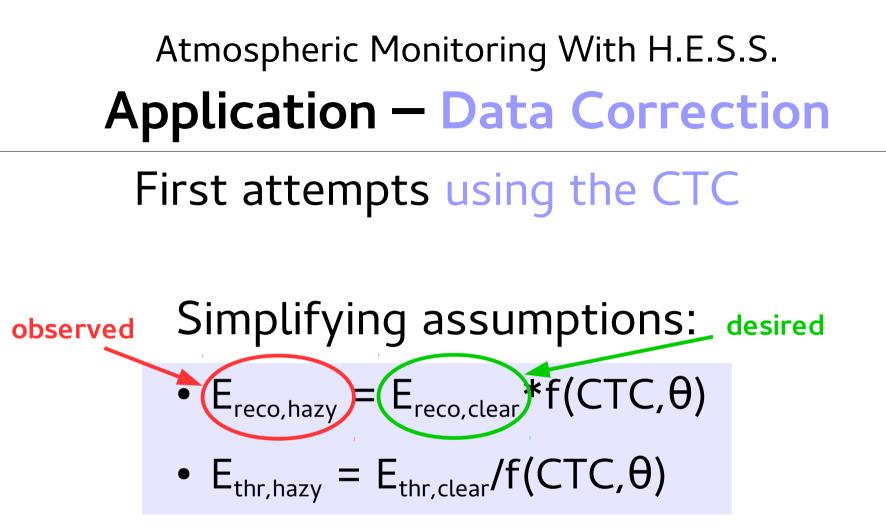


First attempts using the CTC

Simplifying assumptions:

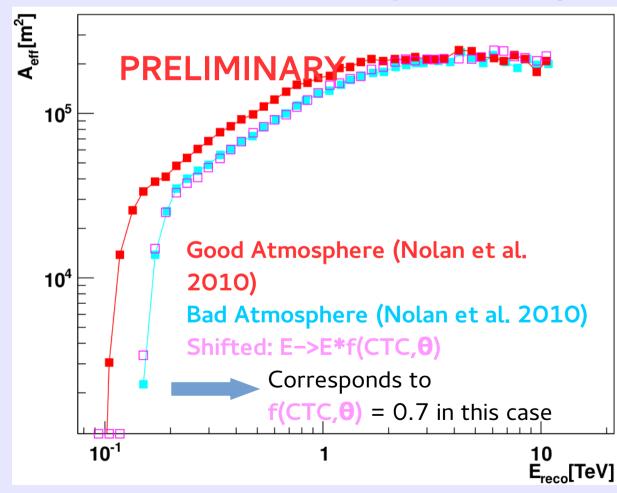
•
$$E_{reco,hazy} = E_{reco,clear} * f(CTC, \theta)$$

•
$$E_{thr,hazy} = E_{thr,clear}/f(CTC,\theta)$$



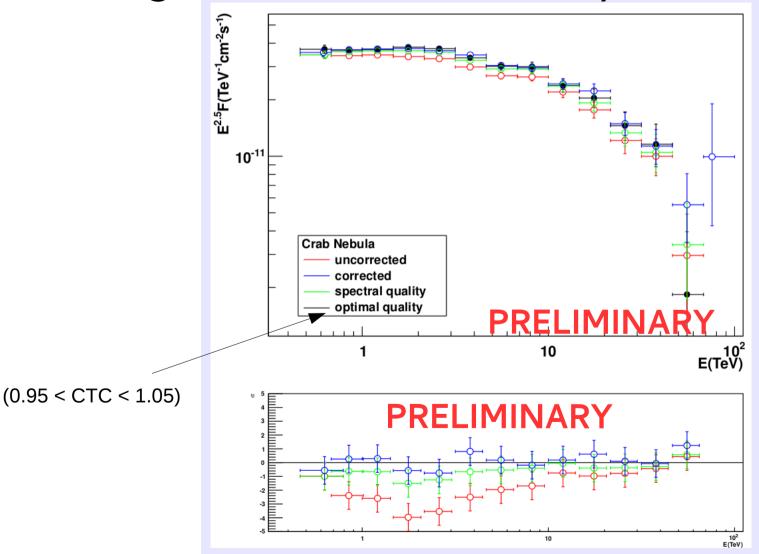
with $f(CTC) = pow(CTC, 1/cos \theta)$ and $\theta = zenith$ angle

Atmospheric Monitoring With H.E.S.S. **Application – Data Correction** First attempts using the CTC Effective areas for hazy atmosphere



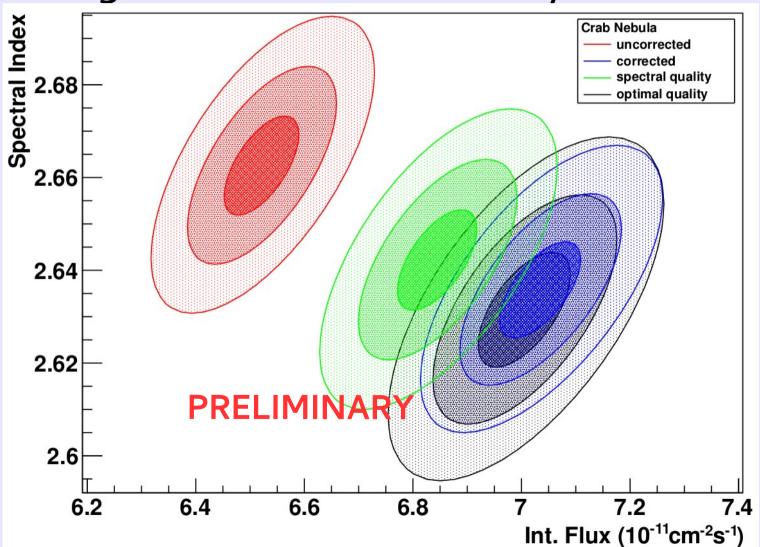
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Using the CTC: Preliminary results



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Using the CTC: Preliminary results



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Summary

- Atmospheric attenuation leads to biased shower reconstruction in the IACT method
 - -> Important source of systematic effects
- Several monitoring devices are in place at the H.E.S.S. site, from Radiometers to LIDAR
- Data quality selection uses
 Cherenkov telescope trigger rates
 + CTC
- Smart scheduling

(work in progress) applies Radiometer data + CTC

- Data correction:
 - Succesfully performed for
 PKS2155-304 observations using
 Ceilometer data and atmosphere
 simulations
 - First attempts to use the CTC (work in progress)
- Future CTA will have more stringent criteria on systematics
 - -> Good understanding of on-site atmosphere will be essential

Atmospheric Monitoring With H.E.S.S. Additional Slides

Application – Data Quality Selection

Detect sources in the presence of

