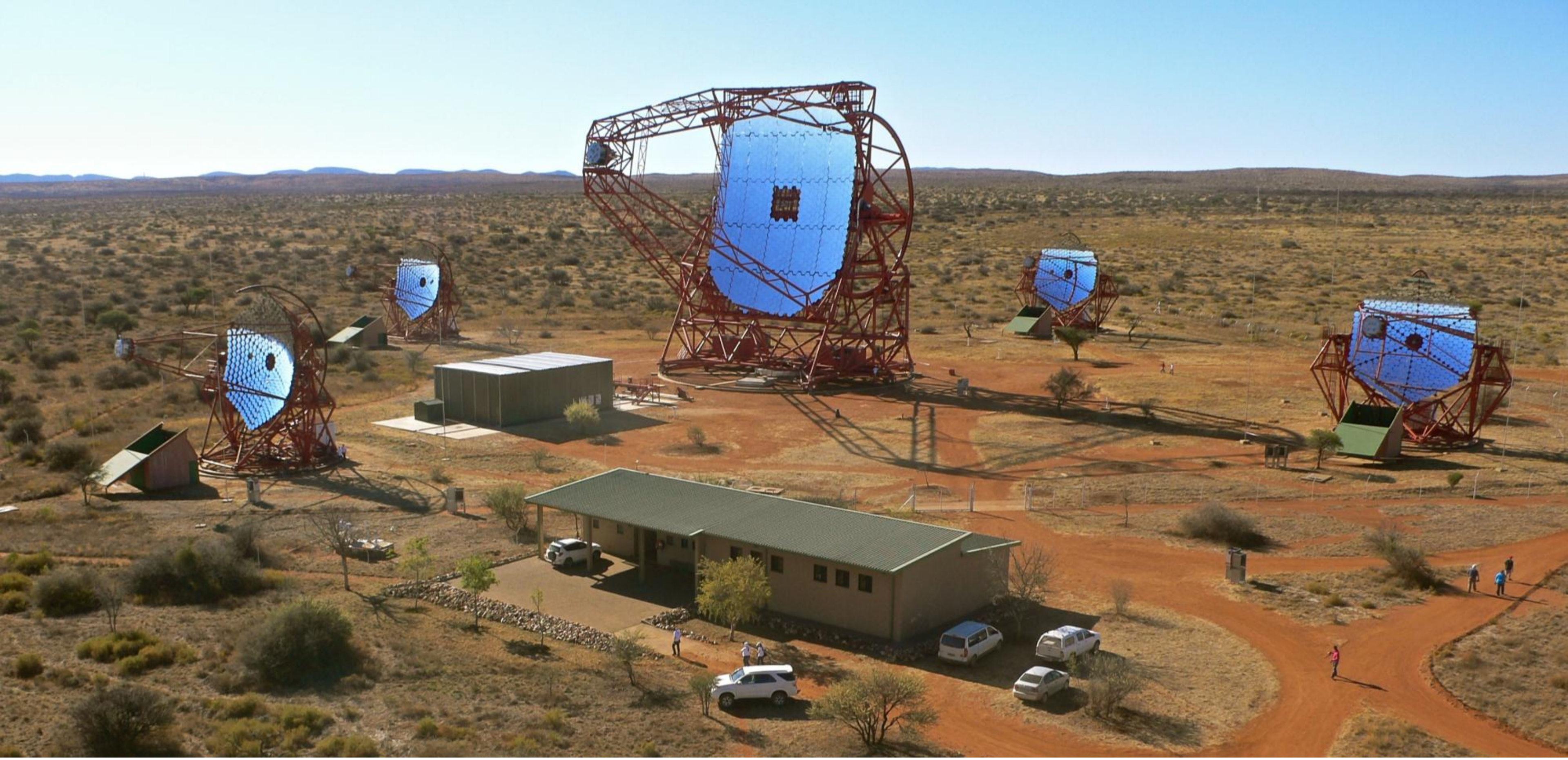
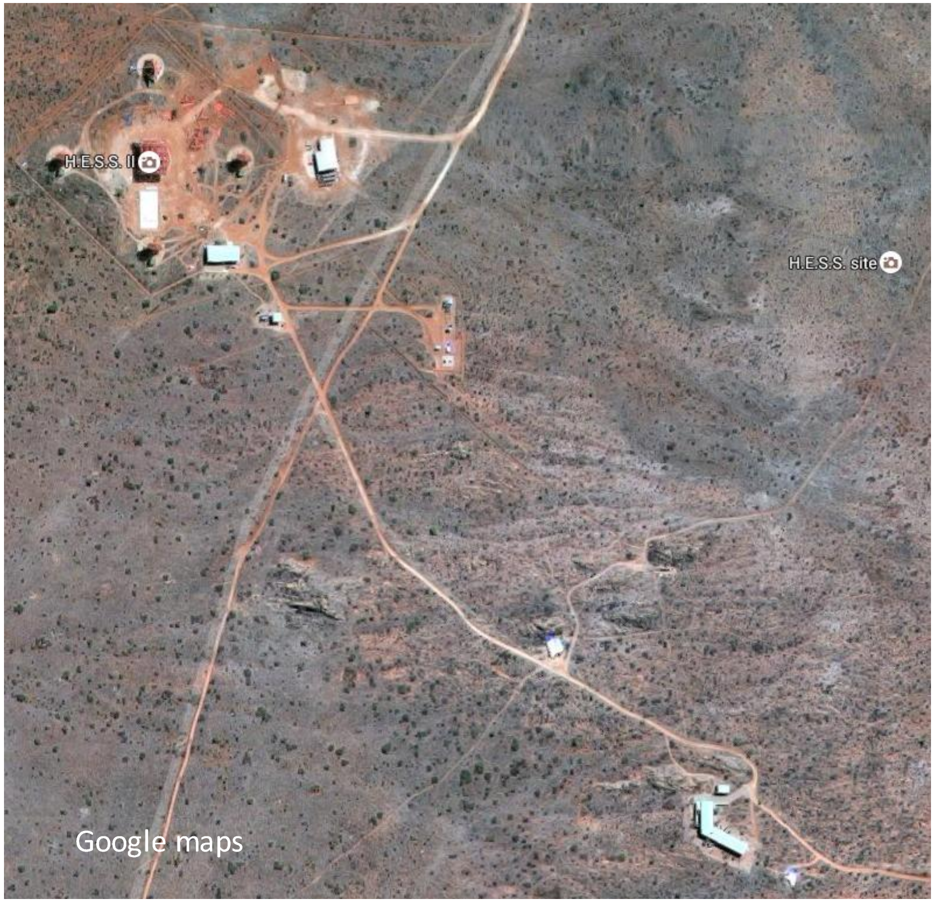


Atmospheric Monitoring in H.E.S.S.

R. de los Reyes and J. Hahn

Contents

- The H.E.S.S. instrument
- Atmospheric monitoring devices on site
- Data quality selection
- Scheduling
- Data correction



The H.E.S.S. instrument

- H.E.S.S. (phase I)
  - 4 telescopes (12m diameter)
  - 5 ° FoV
  - E_{th} ~ 100 GeV
  - 0.06 ° angular resolution
  - ~ 15% energy resolution
- H.E.S.S. (phase II)
  - 1 telescope (28m diameter)
  - 3.2° FoV
  - E_{th} ~ 30 GeV
  - Fast slewing speed
  - Mono or stereo mode (with the other 4)

Observing operations:

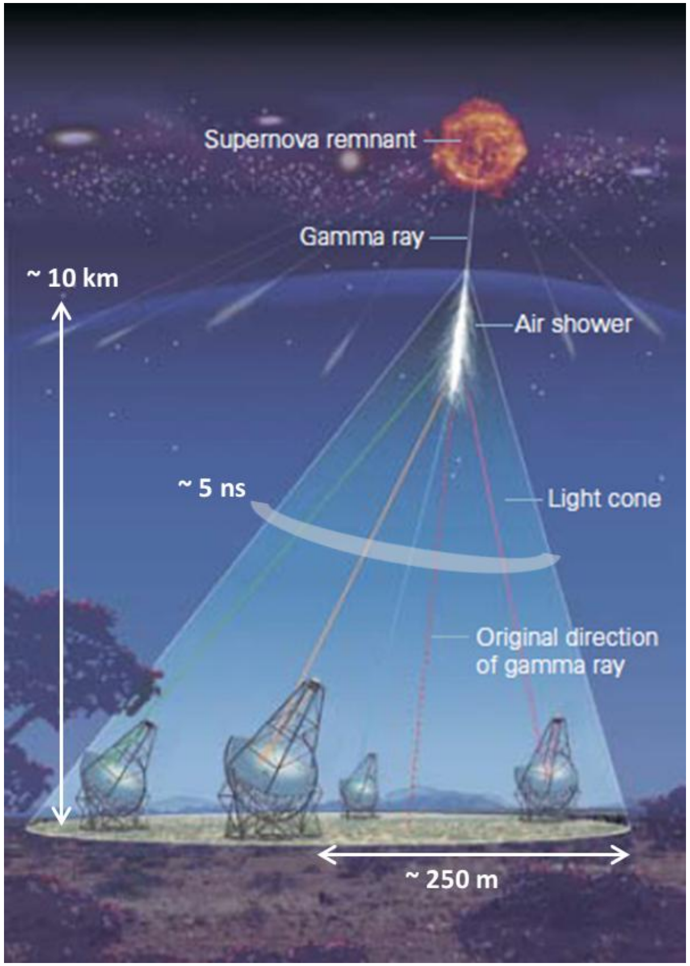
- Mono (phase II telescope)
- Stereo (> 2 telescopes).

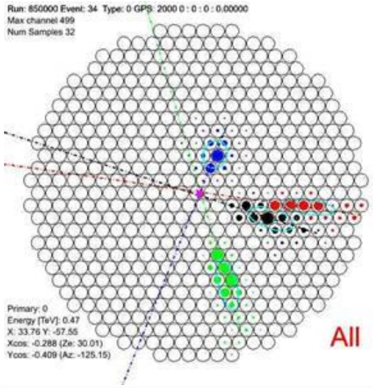
(can be simultaneous).

H.E.S.S.

Impact of atmosphere on gamma-ray observations

- Indirect detection of γ-rays: detection of EAS Cherenkov light -> MC simulations for particle reconstruction.
- Cherenkov light produced at different heights (< 8-12 km), depending on E_γ .
- N_{ph} ~ E_γ (reco) (~ calorimeter)
- Absorption of the EAS Cherenkov light. For the same E_γ , N_{ph} decreases:
  - Downwards bias of E_γ (reco).
  - N_{ph}~0 (low E_γ) -> high E_{th}.

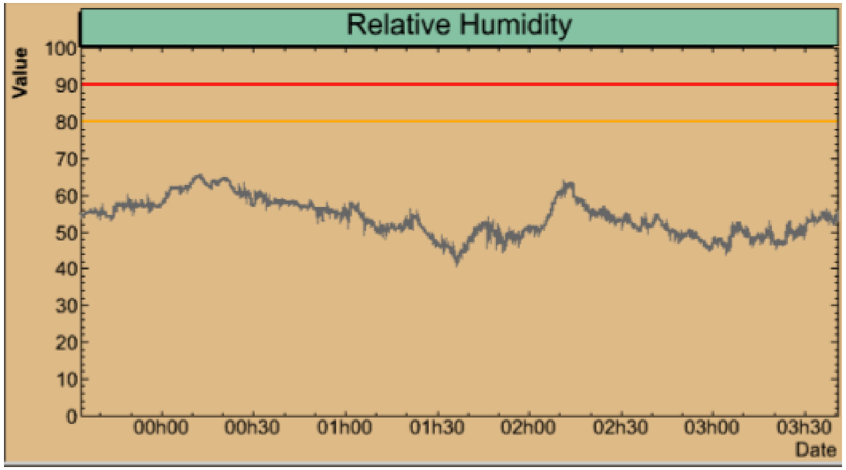




H.E.S.S.

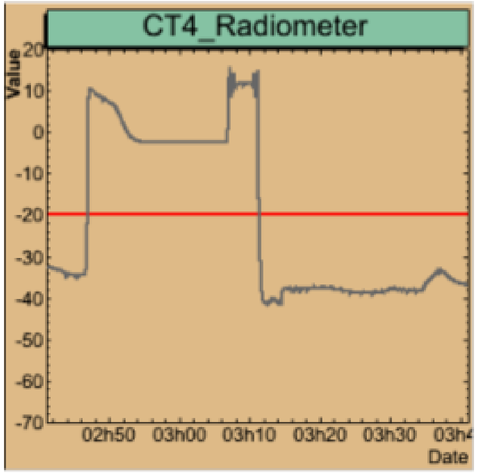
Atmosphere monitoring devices on site

- **Classical weather station**
  - Precipitation
  - Wind speed/direction
  - Humidity
  - Air pressure
  - Temperature
- Used for:
  - Experiment safety
  - Data quality: run selection
  - Scheduling (operator on site)



Atmosphere monitoring devices on site

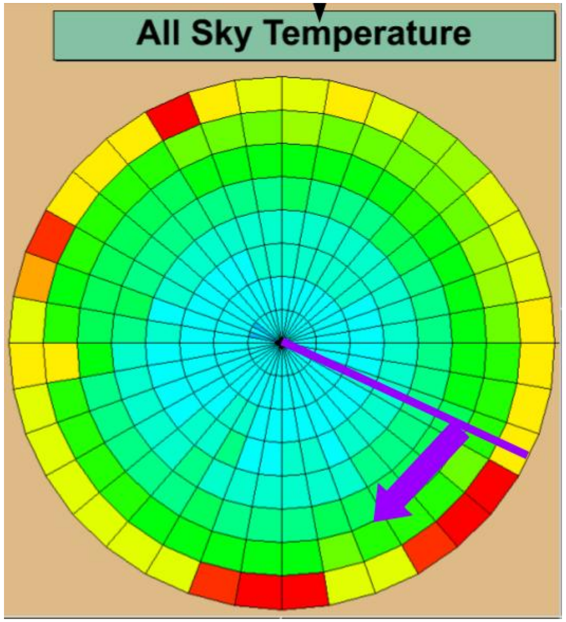
- **Radiometers** (@ phase I telescopes)
  - λ = 8-14μm, FoV = 2
  - °
  - 4 units, each mounted in the telescope structure (looks to the observation FoV)
- Used for:
  - Scheduling: detection of clouds and aerosols load measurements in the observations direction.



M. Daniel, AtmoHEAD2014

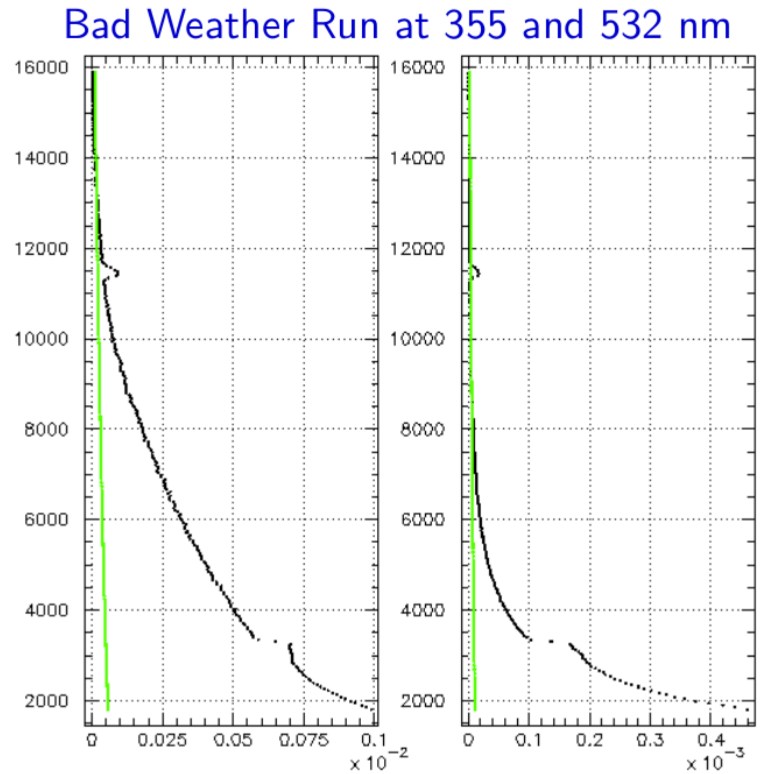
Atmosphere monitoring devices on site

- **Scanning Radiometers**
  - λ = 8-14μm, FoV = 2°
  - Round-turn every ~30 min.
- Used for:
  - Experiment safety: cloud monitoring
  - Scheduling (smart scheduling)



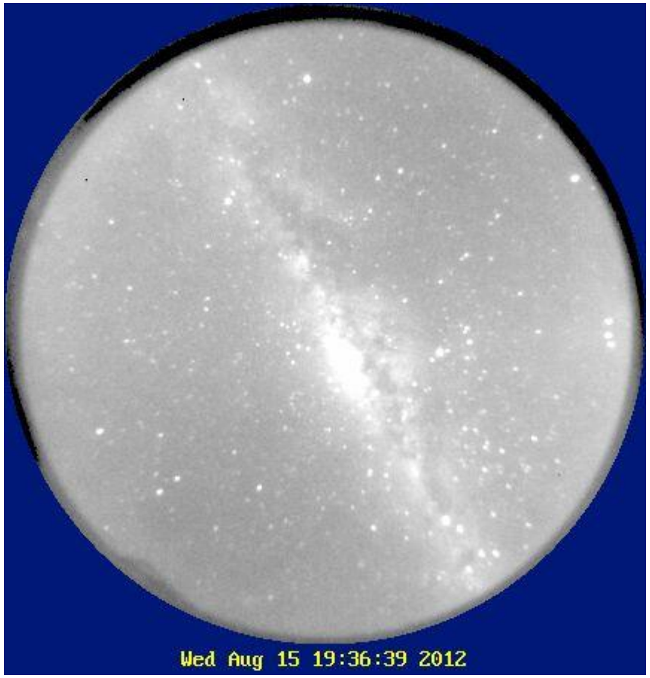
Atmosphere monitoring devices on site

- **Elastic LIDAR**
  - 60 cm diameter primary parabolic mirror
  - 355/532 nm @ 10 Hz.
  - Bi-axial / coaxial configuration.
- Used for:
  - Data quality: record atmospheric profiles @ 10° zenith angle between observation runs.



Atmosphere monitoring devices on site

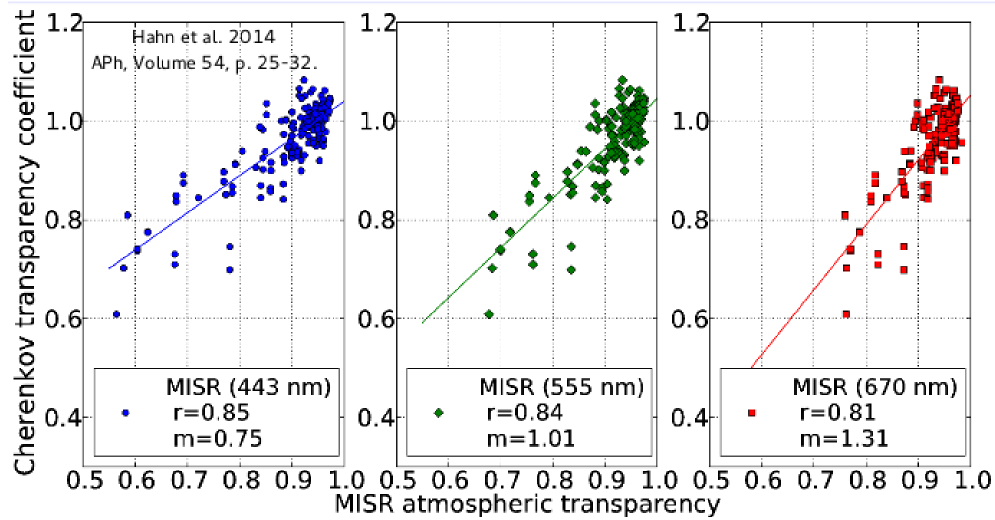
- **ATOM All Sky Camera**
  - 180 ° FoV
  - All-sky images each 3 min.
  - 640x480px behind fisheye lens, protected by lid.
  - Environment protected.
- Used for:
  - Experiment safety: cloud monitoring
  - Scheduling (operator on site)

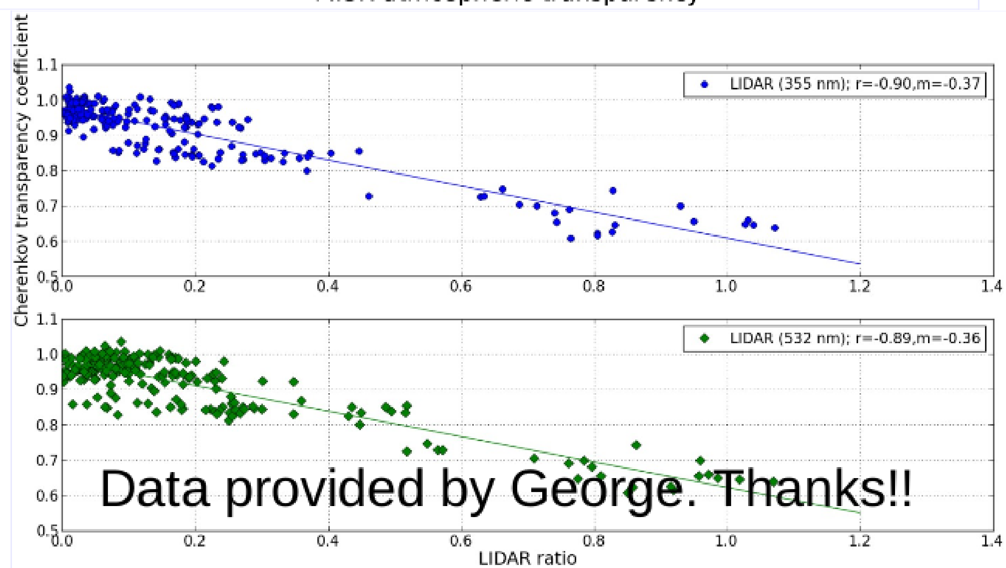


Atmosphere monitoring using H.E.S.S. data

- **Cherenkov Transparency Coefficient (CTC)**
  - H.E.S.S. phase I.
  - Observation direction and FoV of Cherenkov cameras.
  - Values each ~28 min (per observation run).
  - Detect atmospheric absorbers: clouds and aerosols.
- Used for:
  - Data quality
  - Scheduling (smart scheduling)

Method explained in Stanislav's talk

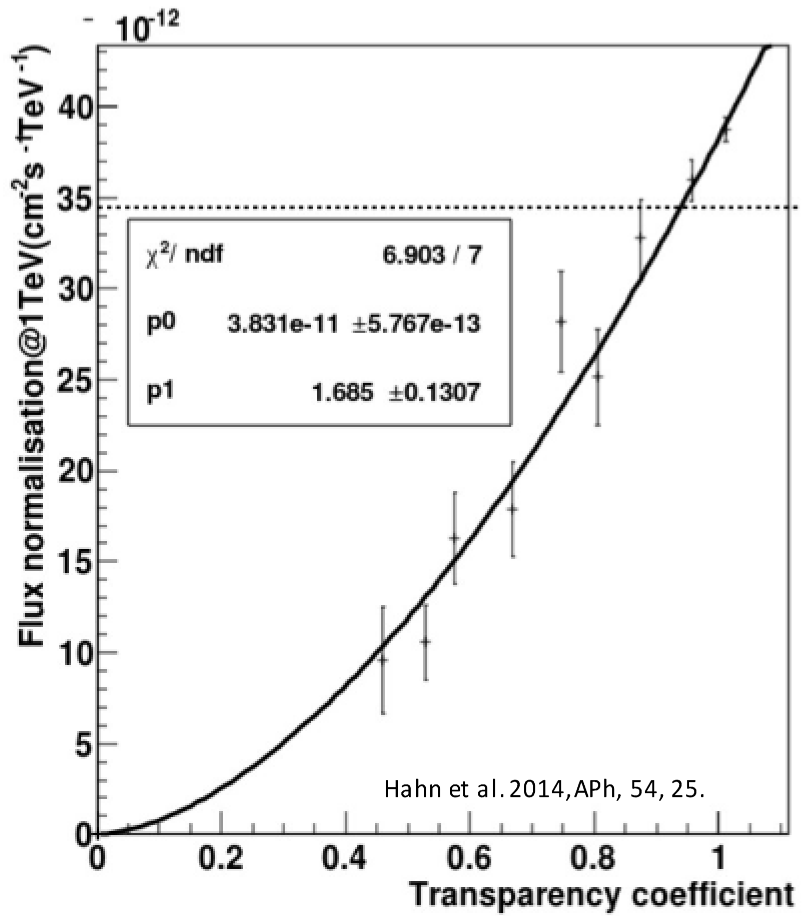




Data provided by George. Thanks!!

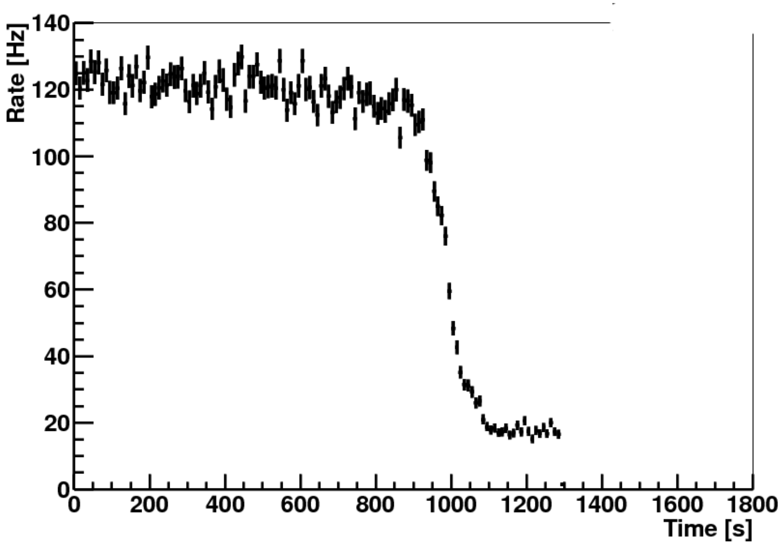
Data quality selection

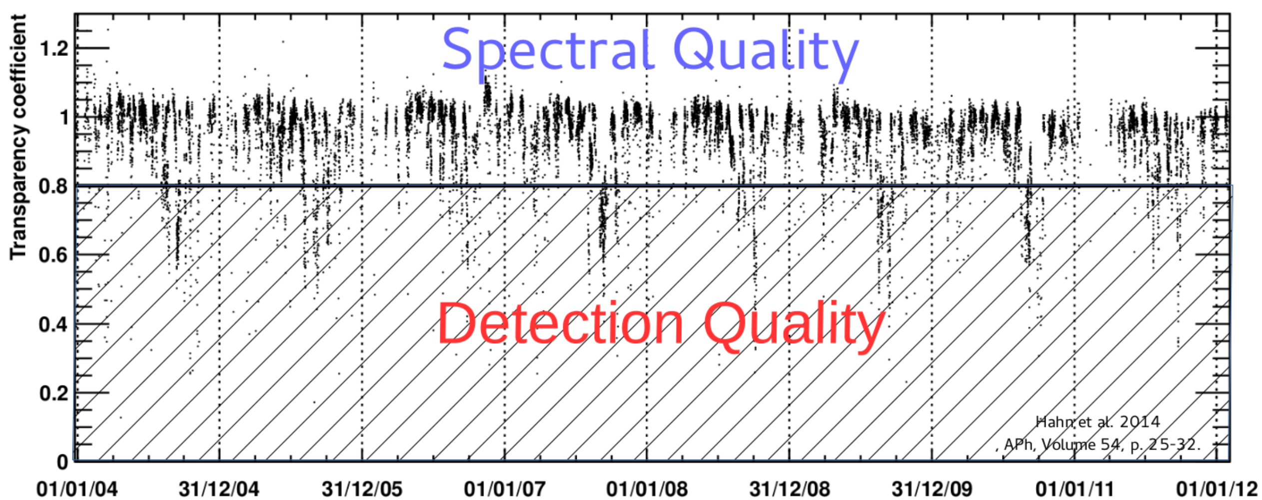
- Data quality criteria based on systematics required by analysis results:
  - **Detection** (~ source detection):
    - Telescope efficiency is ok: homogeneous array acceptance.
  - **Spectral** (~ spectral results):
    - Detection DQ
    - Flux systematics <20% due atmospheric effects.



Data quality selection

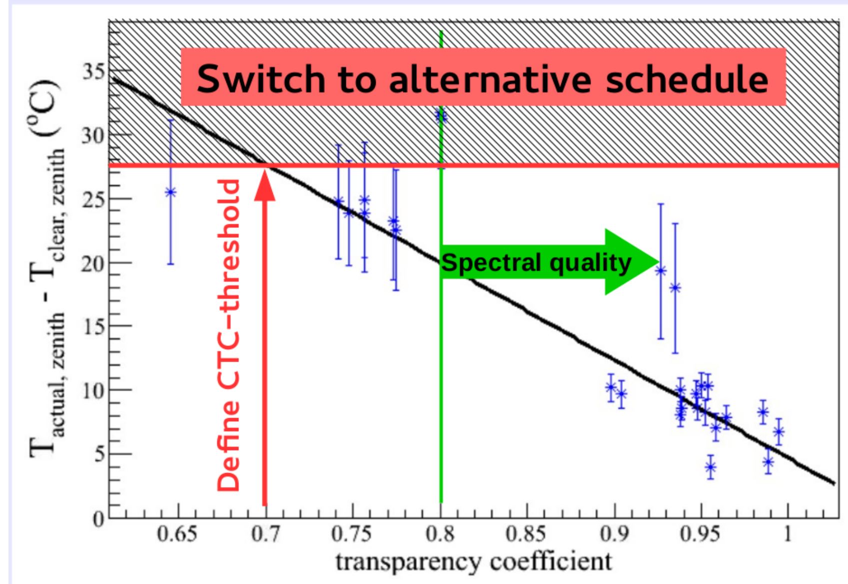
- **Atmospheric effects (spectral DQ)**
  - Trigger rate: small/medium sized clouds.
  - CTC: aerosols, large scale and dilute clouds.

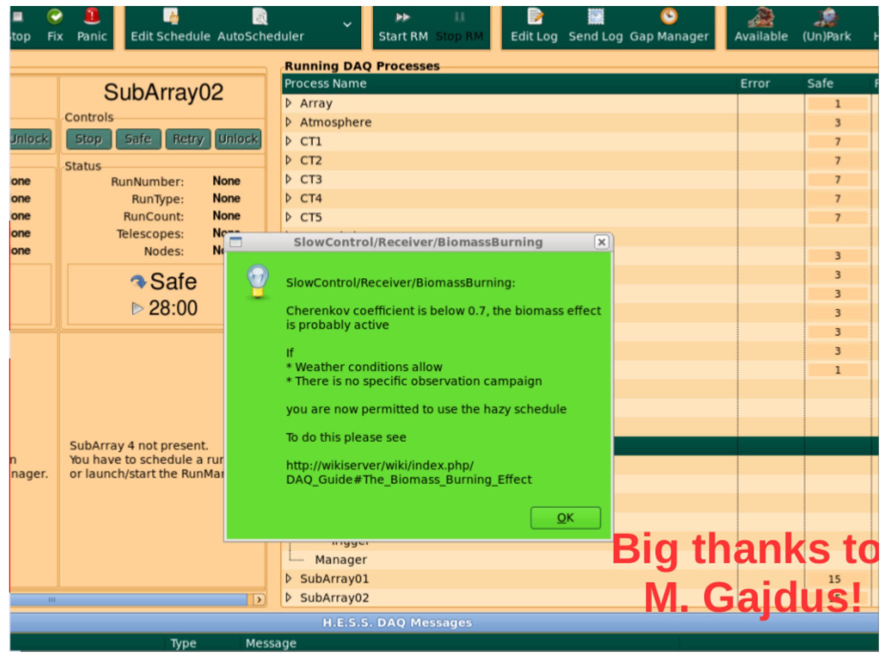




Scheduling

- Managed by operator on site based on reports from:
  - Classic weather station
  - Scanning radiometer
  - ATOM All-Sky-Camera
- **Smart scheduling (under development).**
  - Not all observations require the best atmospheric conditions.
  - Schedule "detection" DQ sources during bad atmospheric conditions.
  - Based on Radiometer Scanning to switch between two schedules.

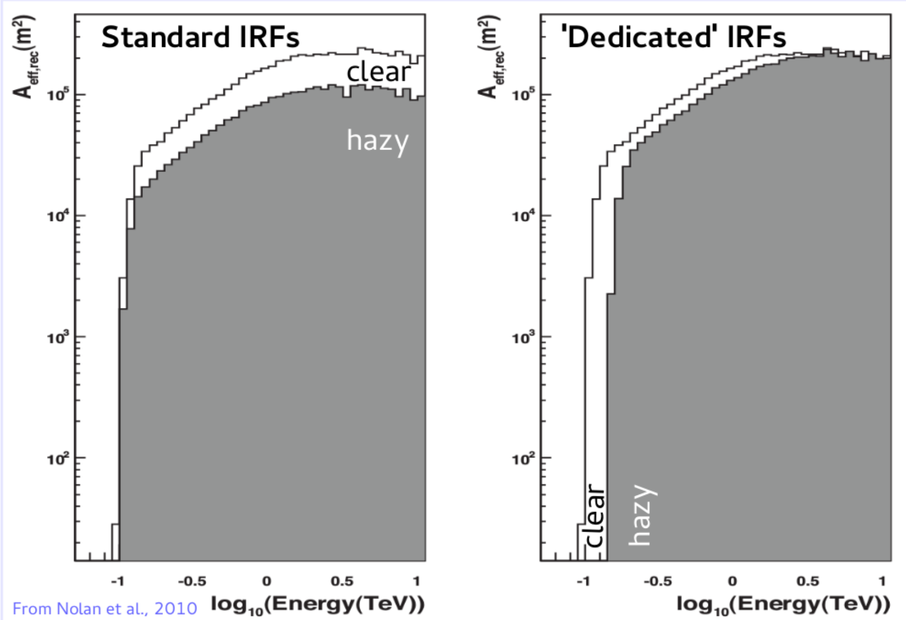


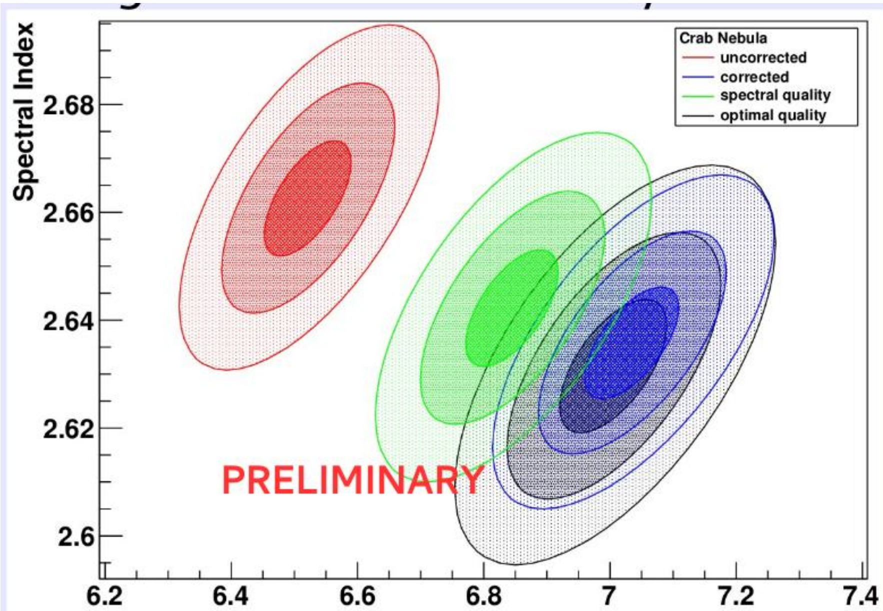


Data correction

Possible methods to correct detection DQ data from atmospheric effects.

- Detailed study by Nolan et al, 2010, APh, 34, 5, 304:
  - Atmospheric **MC simulations** for adverse conditions (MODTRAN) included in the analysis of PKS2155-304 MWL observations.
- **CTC**: Based on Nolan's results. Preliminary results (not yet implemented in the std analysis).

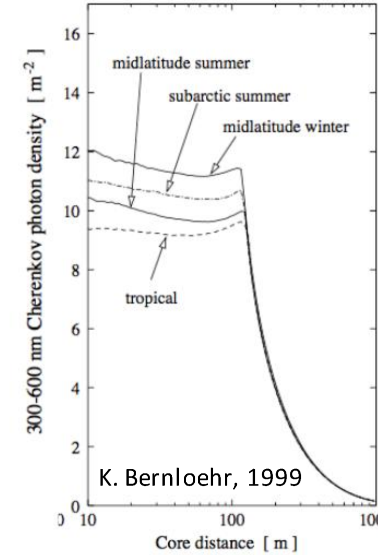


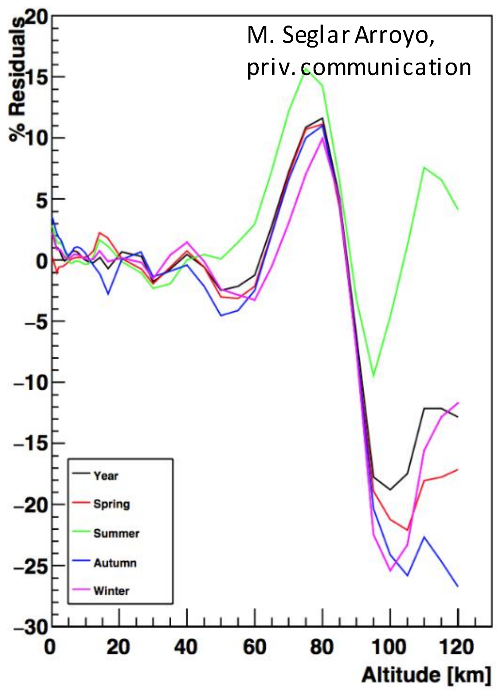


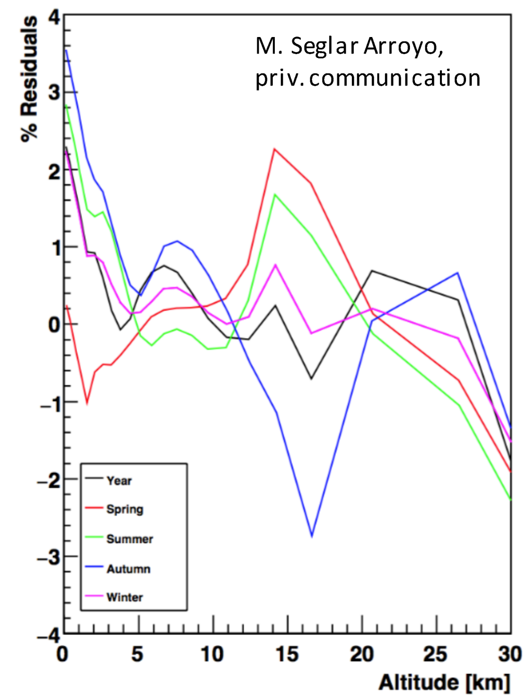
Data correction

Currently under study: implementation of new GDAS+NRL-MSISE profiles into H.E.S.S. MC simulations (M. Seglar Arroyo, Saclay)

- Discrepancies with old MC simulations at high altitudes.
- Derive influence on H.E.S.S. IRFs.
- Input GDAS profiles into run-wise simulations.







See M. Seglar Arroyo on Wednesday for further details and discussion.

H.E.S.S.

Summary

- Atmospheric absorbers are an important source of systematics in the source spectrum.
- Several monitoring devices are in place at the H.E.S.S. to control the atmosphere during observations (e.g. Radiometer, LIDAR) and to the experiment safety.
- Scheduling is currently managed by the operator. Smart scheduling will be based in radiometer data (studies with CTC are on going).
- Data quality selection based on the final analysis: detection or spectral.
- Spectral data quality selection uses the trigger rates + CTC.
- Data correction successfully performed in H.E.S.S. observations using Ceilometer data and atmosphere MC simulations.
- Data correction using the CTC, GDAS is still in progress.