CTA observation scheduling using information on the atmospheric conditions

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Why should stargazers
also be cloudgazers?

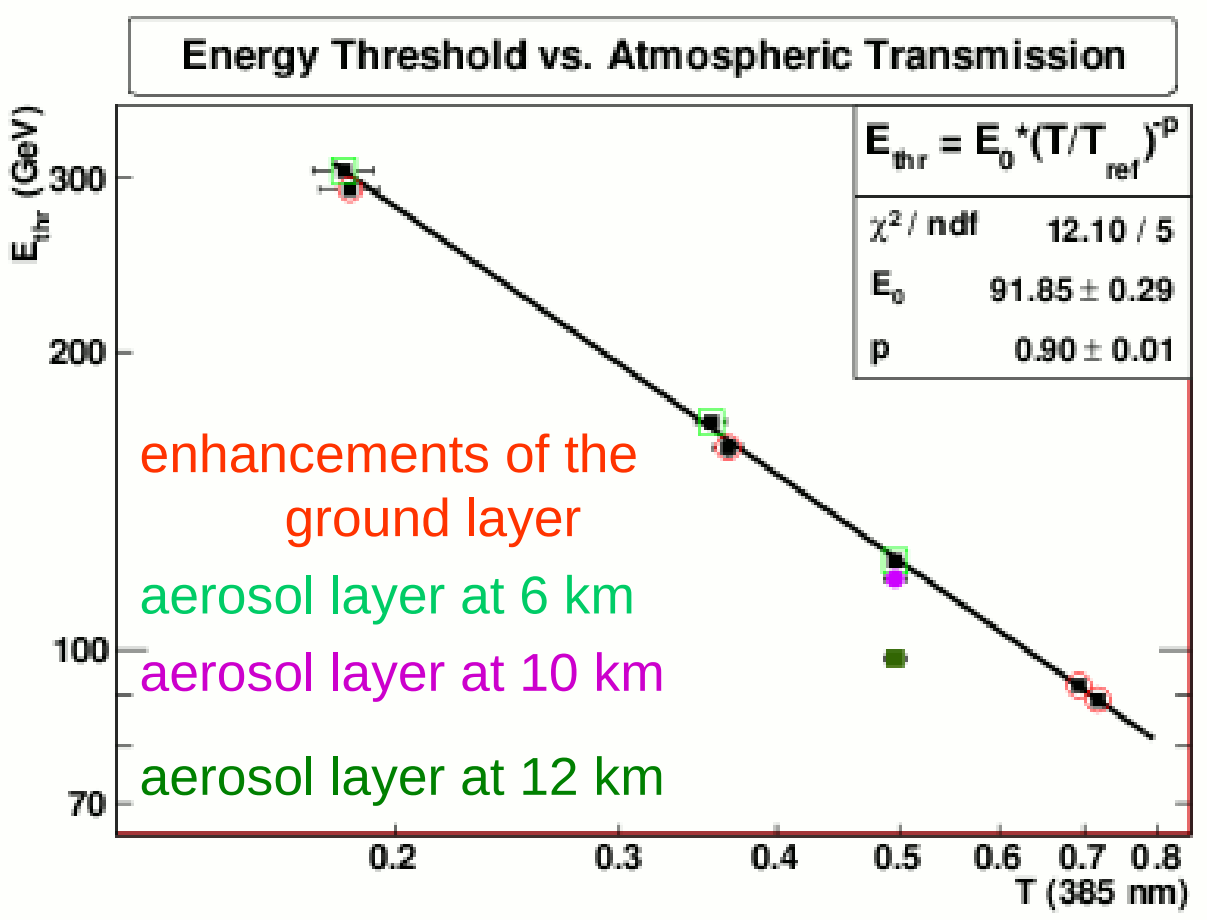
Outline

- Effects of the atmospheric transmission on the quality of data observed using Cherenkov telescopes
- MAGIC experience
- "Online Smart Observation Scheduling"
- CTA Use Case "Include atmospheric transmission measurements and predictions for short-term observation scheduling"

Different sources produce different spectra

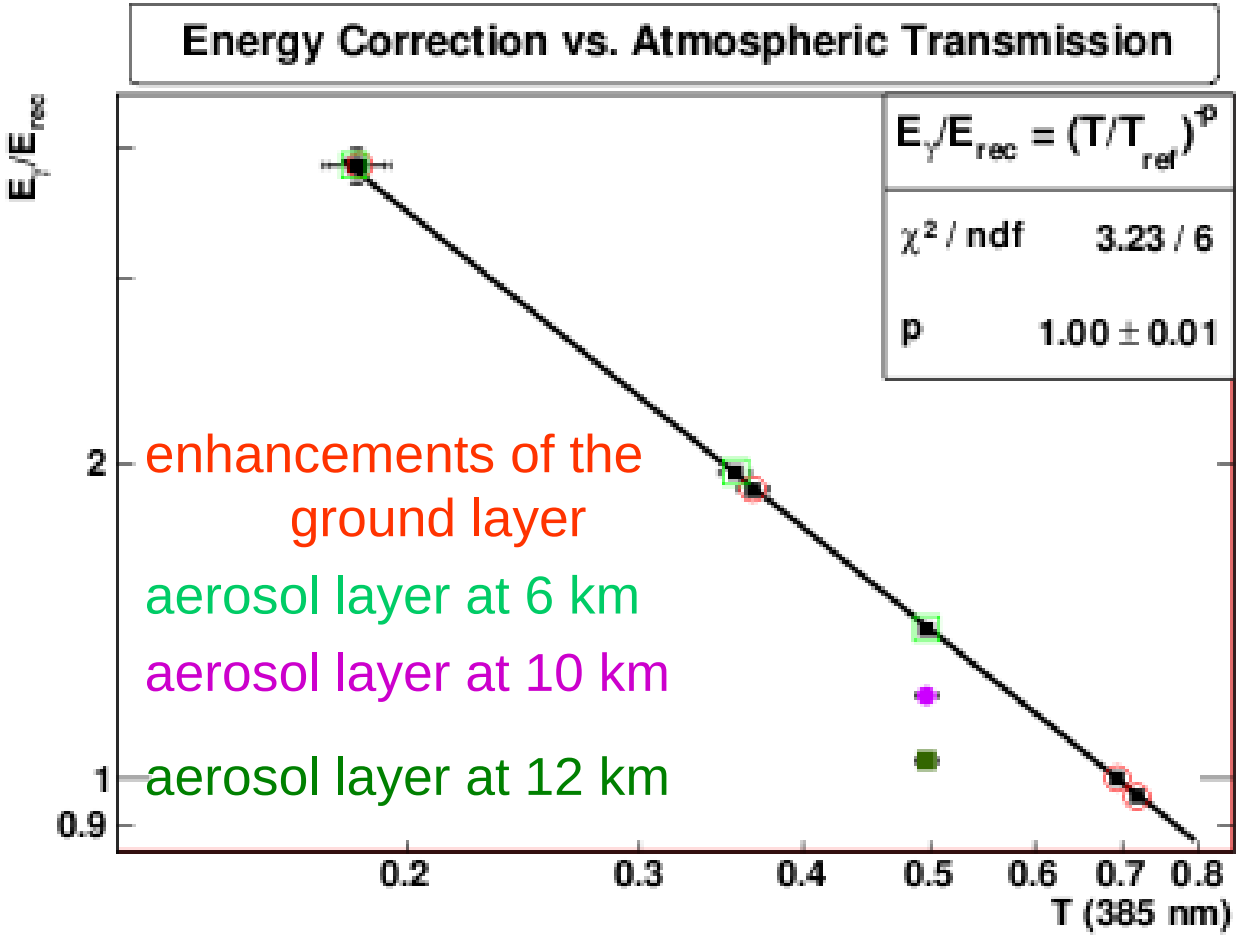
- “Hard” and “Soft” VHE gamma spectra
- EBL absorption (depending on *z*)
- High-state (Flare) -> harder spectra
- Different energy thresholds needed for observations of different targets
- How does the atmospheric transmission change the observed spectra?

Energy Threshold



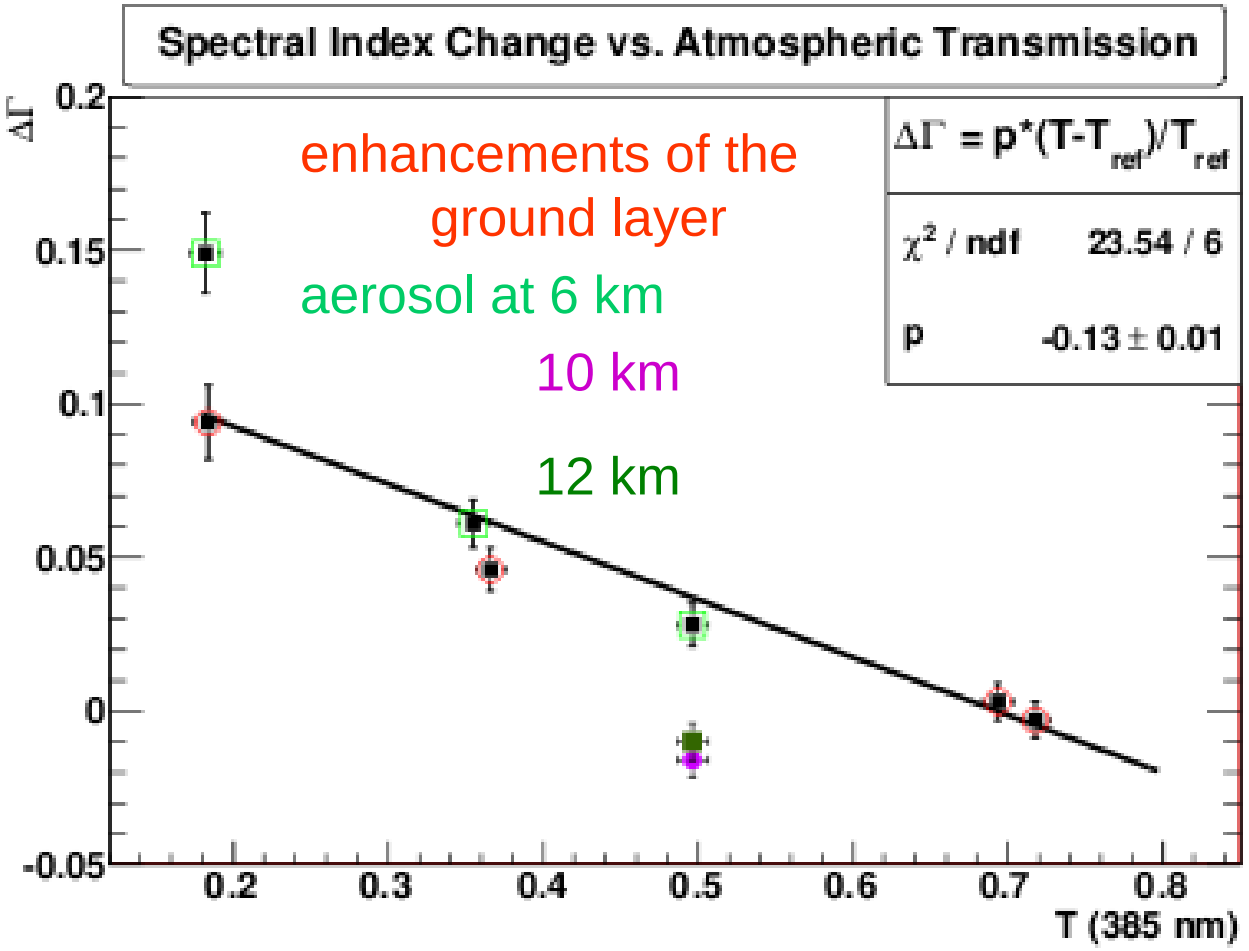
Garrido, Gaug, Font, Moralejo (MAGIC Coll.), 2014

Energy correction



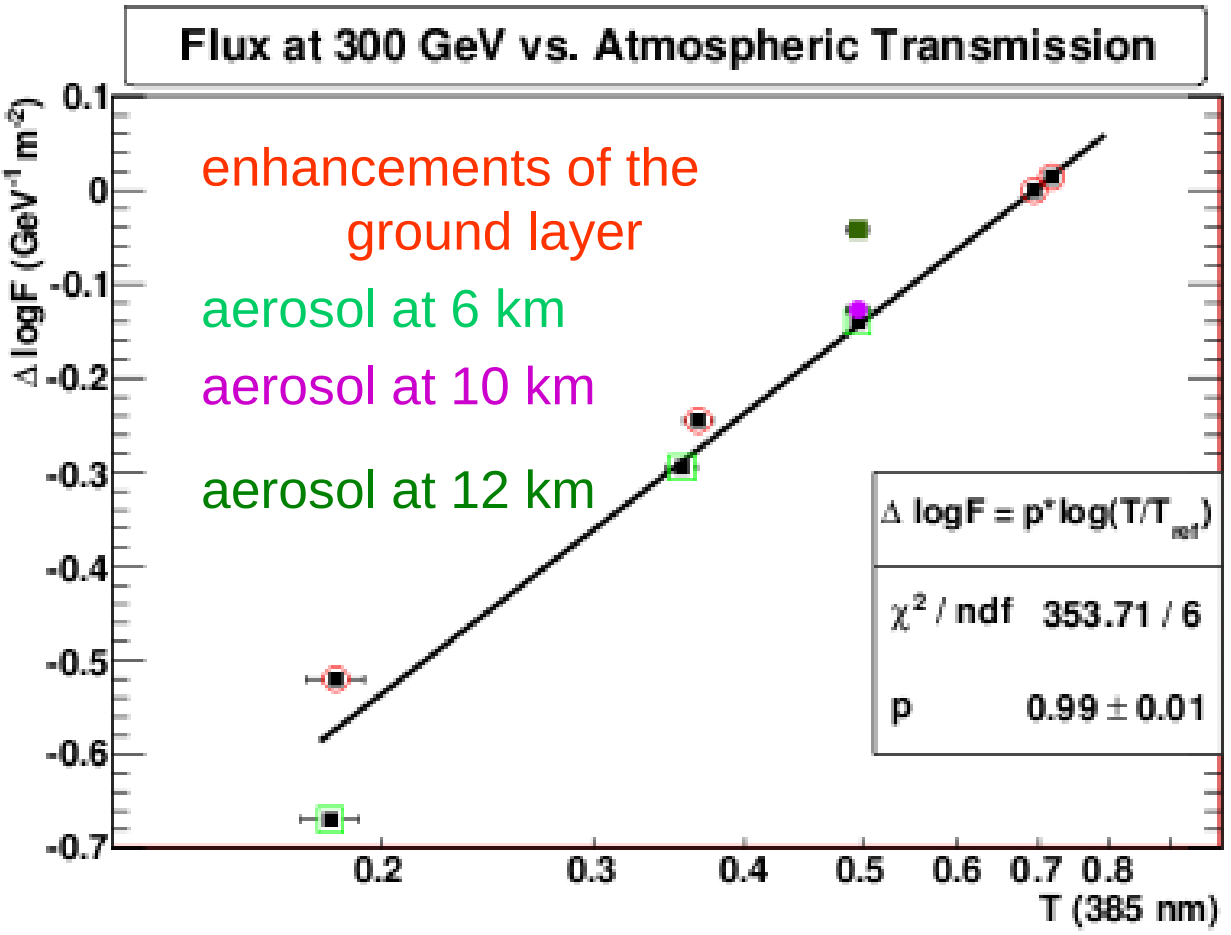
Garrido, Gaug, Font, Moralejo (MAGIC Coll.), 2014

Spectral index change



Garrido, Gaug, Font, Moralejo (MAGIC Coll.), 2014

Flux at 300 GeV



Garrido, Gaug, Font, Moralejo (MAGIC Coll.), 2014

Experience in MAGIC

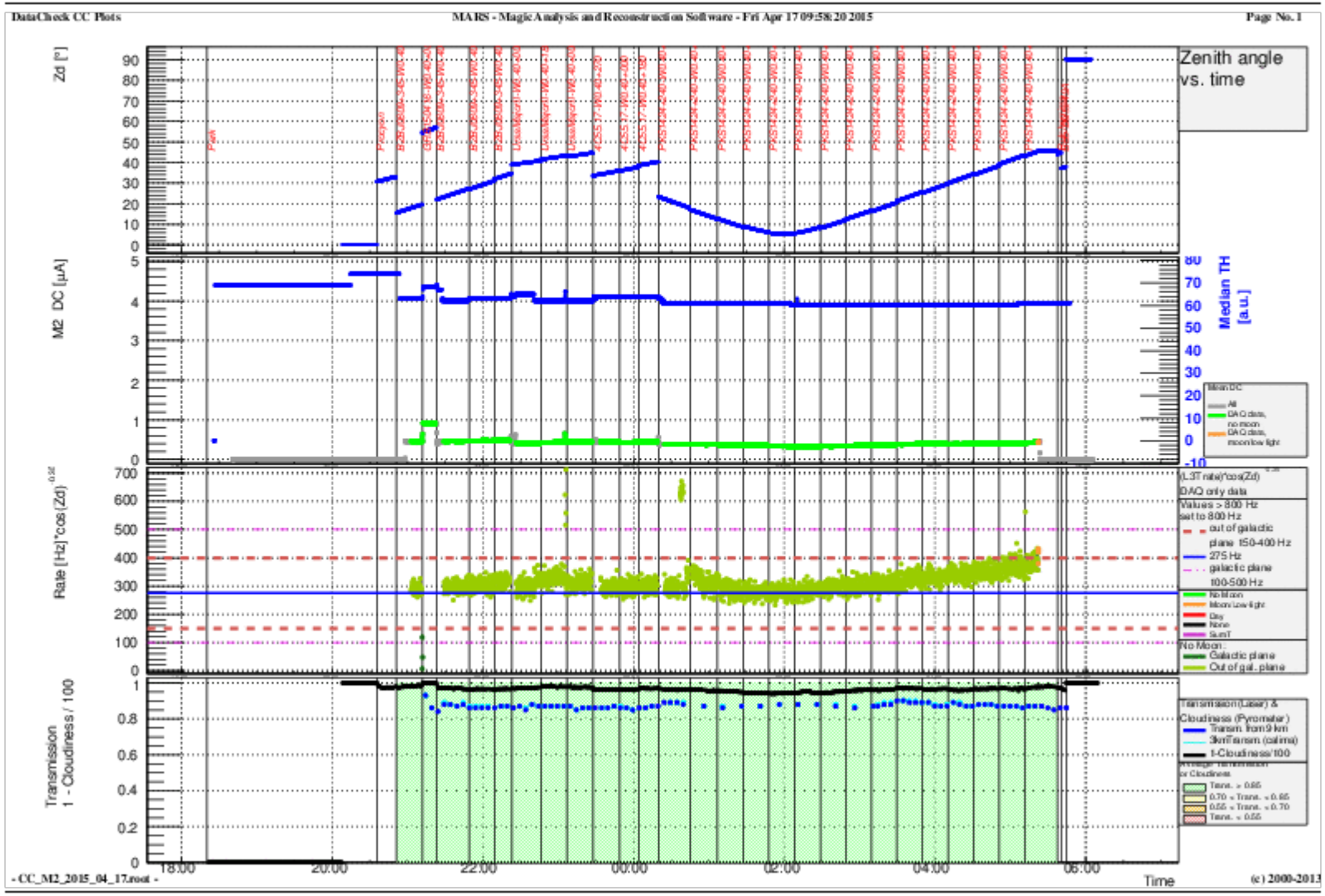
- atmospheric transmission measured at La Palma using LIDAR (532 nm)
- Testing of the effects: Crab Nebula
- Observations checked for different ranges of T at 9 km (cirrus clouds) and 3 km (calima):

  T: 0-0.55 - reject data

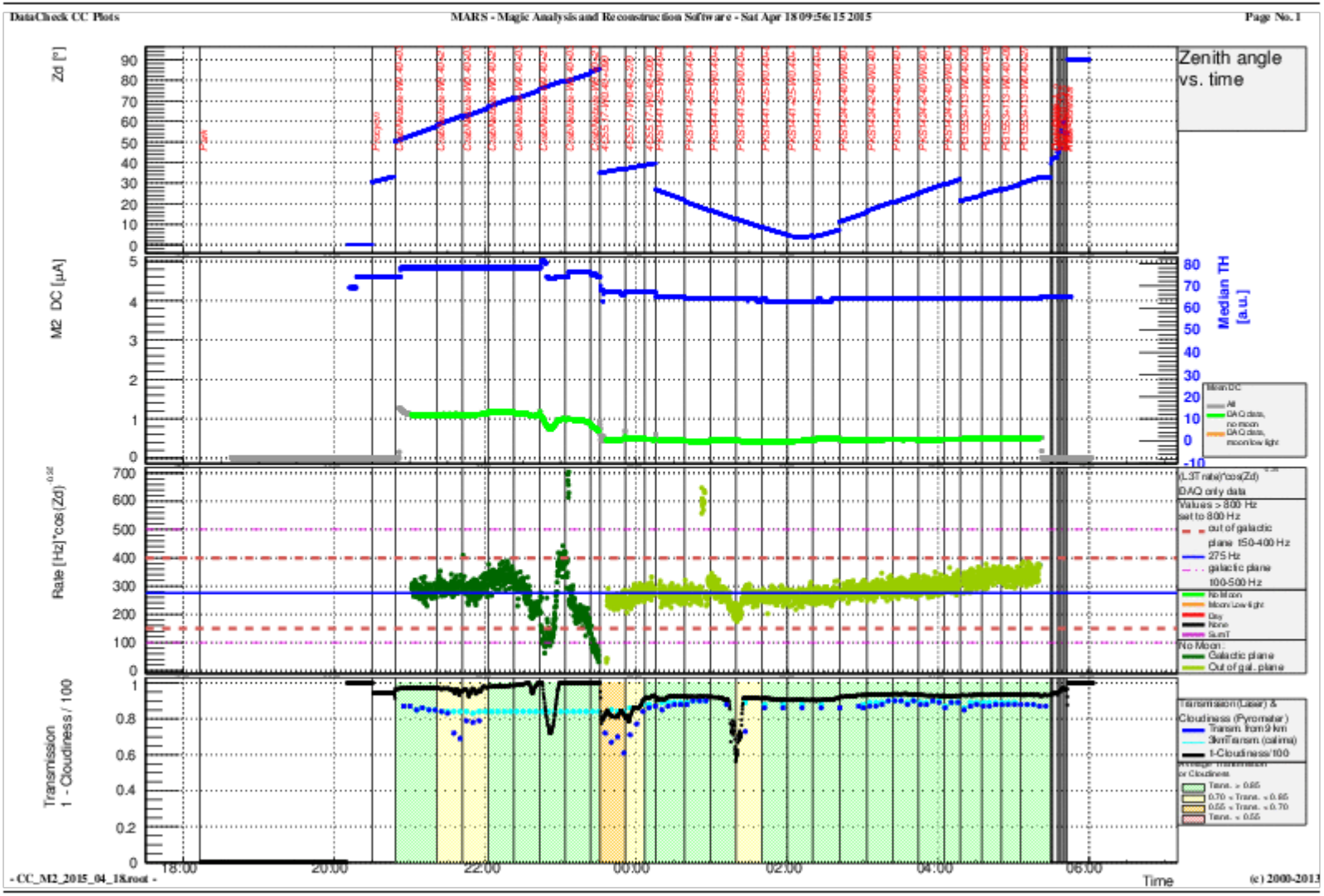
  T: 0.55-0.7, 0.7-0.85 – corrections can be applied

  T: 0.85-1.0 – no corrections
- Data quality check
- Future plan: applying “Smart Scheduling” for different types of targets

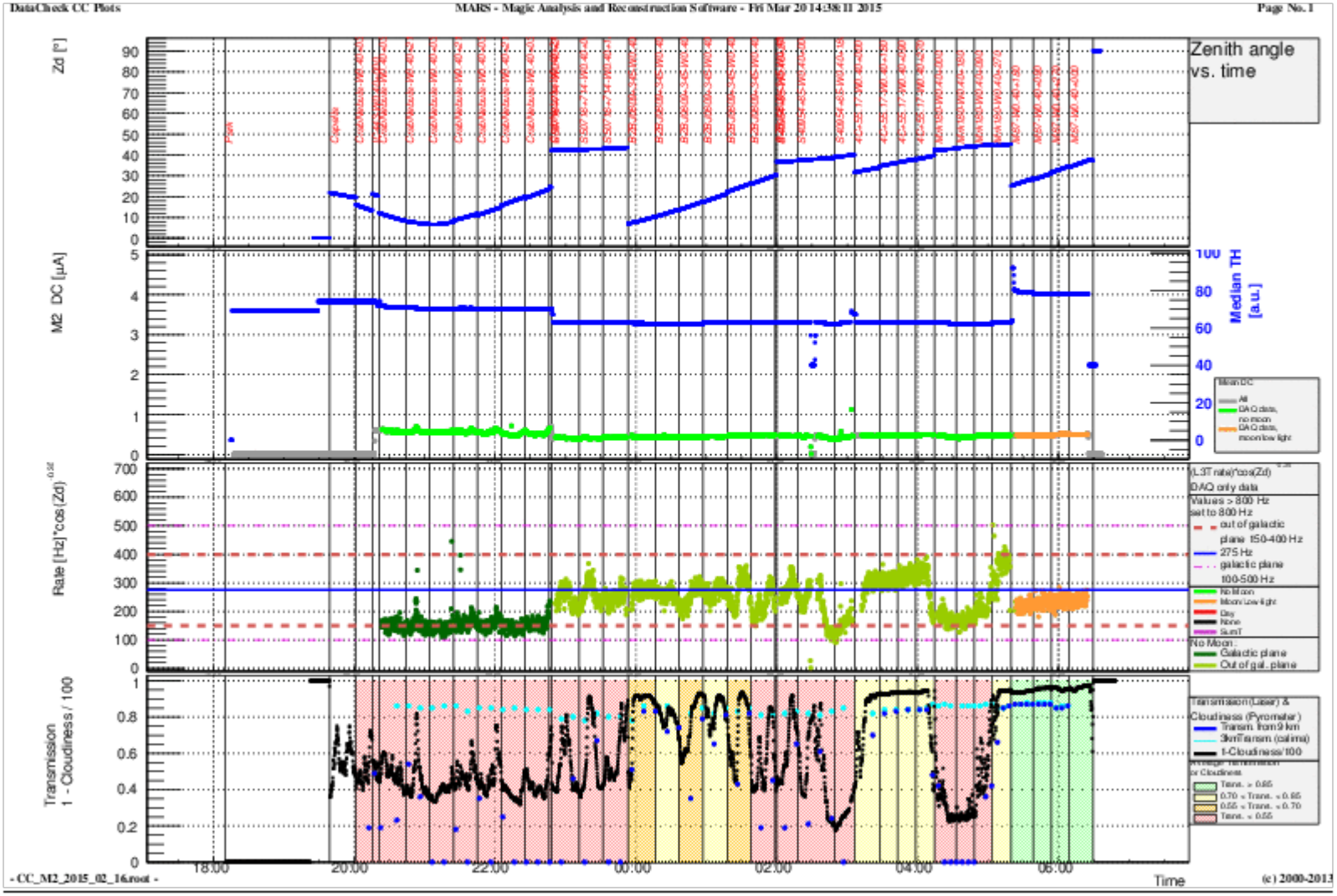
MAGIC - perfect weather



MAGIC – easy corrections possible



MAGIC - variable atmosphere



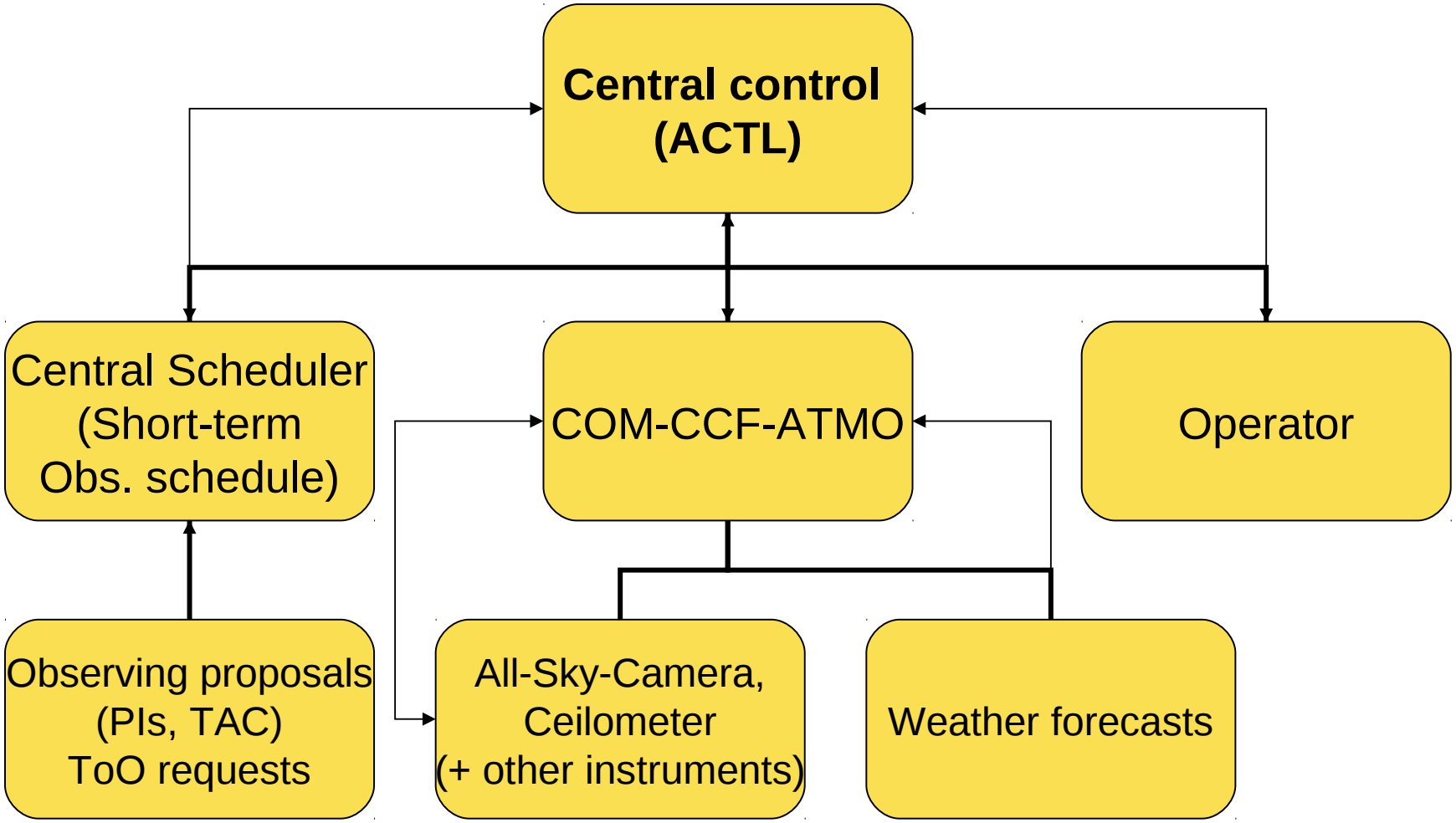
Measuring atmospheric transmission in CTA

- Instruments used for the smart scheduling:
  - All-Sky-Camera (ASC) – map of sky cloud coverage
  - Ceilometer (900 - 1100 nm) – cloud height
- Instruments used for data correction:
  - Raman lidars
  - FRAMs (large FOV optical telescopes)
- Auxiliary instruments and methods:
  - UVscope
  - CTA weather stations
  - Weather forecasts (external)
  - Calculate Cherenkov Transparency coefficient (CTC) – after the observations

Input from ACTL-COM-CCF for the Central scheduler

- Each observing target – specify min. energy threshold & observing mode in the proposal
- CCF: Produce transmission cubes (Zd, Az, Alt.) using data from the All-Sky-Camera and the Ceilometer
- For each position in the sky calculate forecast maps for: energy threshold, degradation of the energy resolution, degradation of the pointing resolution and sensitivity degradation as f(E)
- Central scheduler uses these forecasts to update the short-term observation schedule during the night

Information flow



Open questions

- Continuous variables, or transmission ranges (data quality classes)?
- Weather forecasts – produce the new obs. schedule before the beginning of the night (long observing slots, MWL...)
- Angular resolution of the sky forecast maps?

Conclusion

- The atmosphere is our detector -> important to monitor atmospheric transmission
- Optimize the usage of the available observing time (maximize effective duty cycle)
- If we know how to deal with the weather changes, they become less important factor