MIRROR SOILING STUDY (CTA)
-
ATMOSPHERIC ANALYSIS (H.E.S.S.)

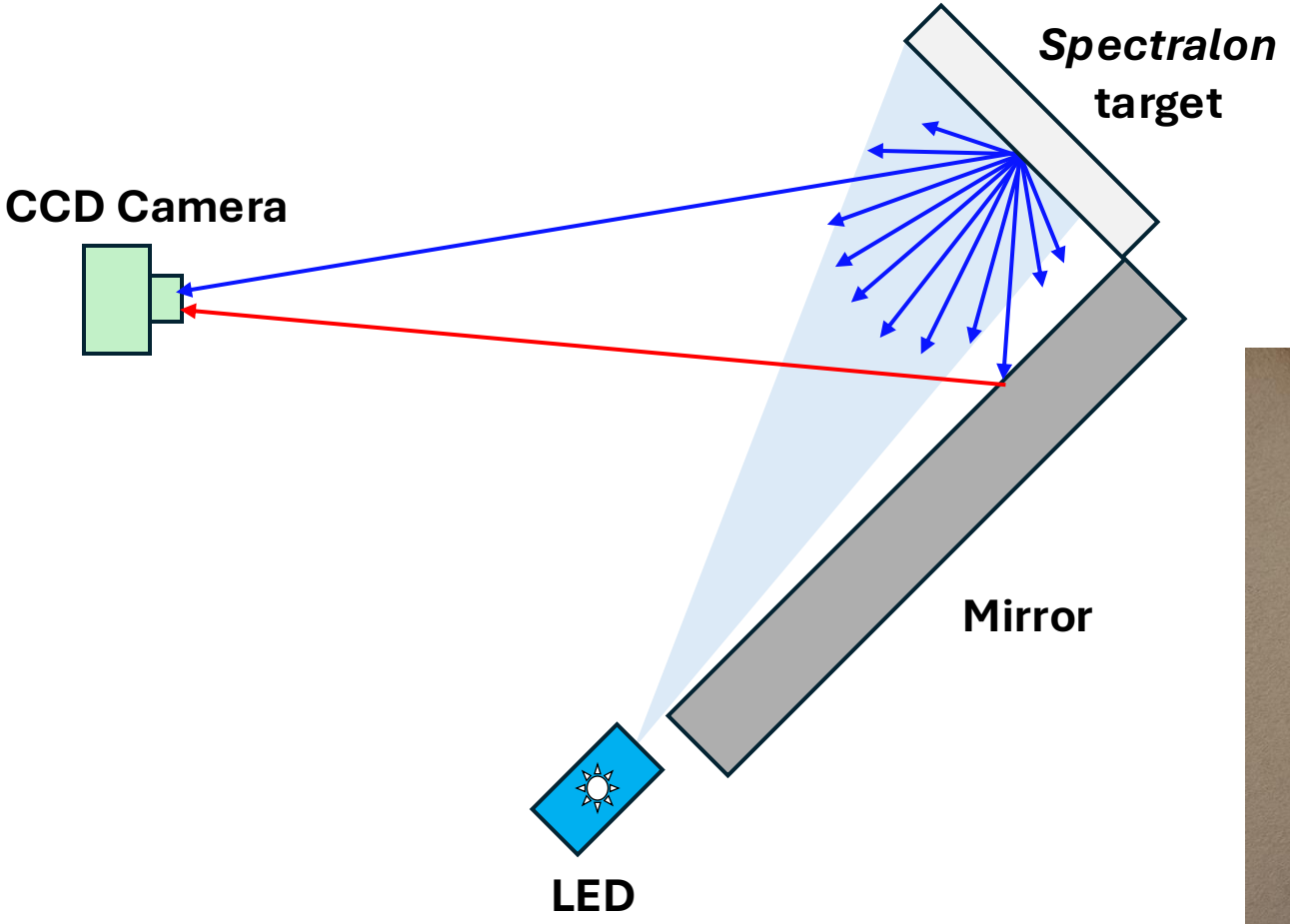
Doramas Jimeno Sánchez

03.06.2025

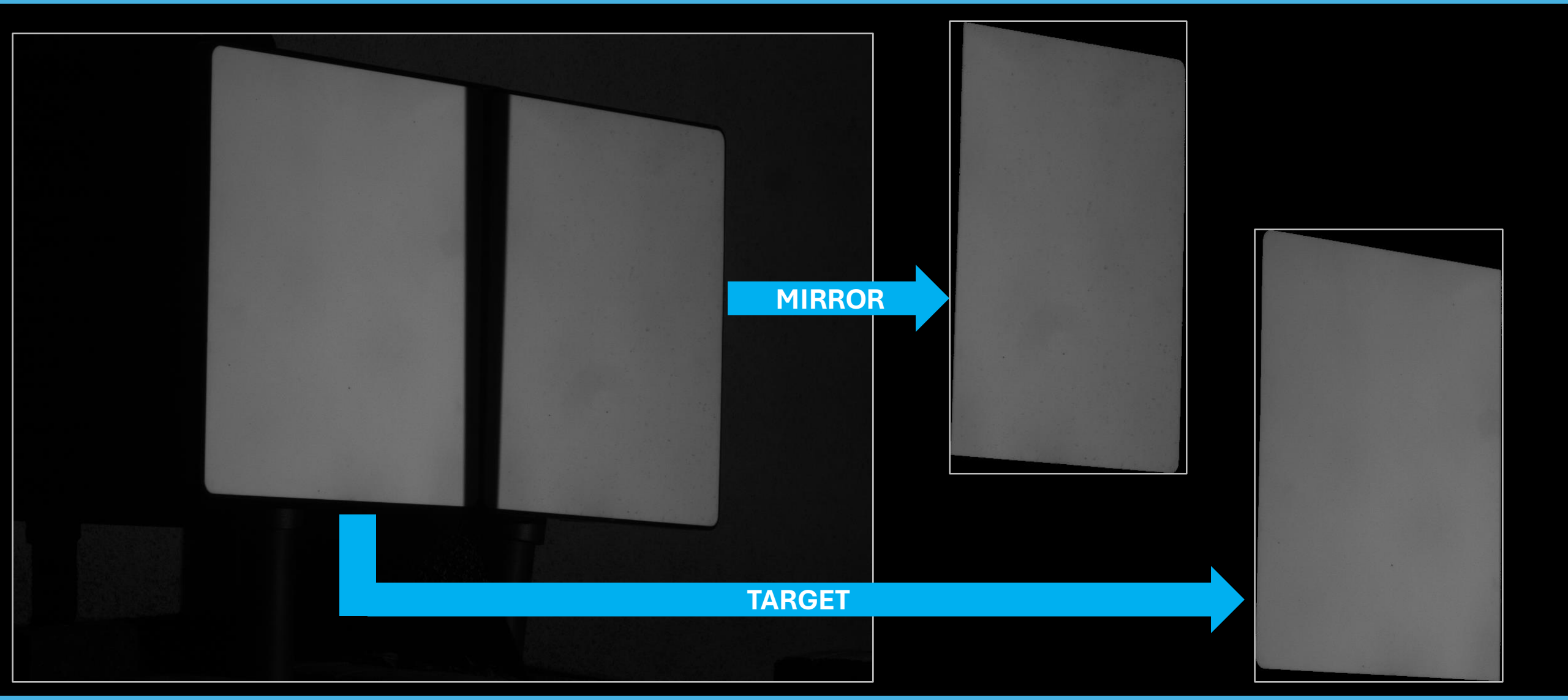
HELMHOLTZ WEIZMANN
RESEARCH SCHOOL
MULTIMESSENGER ASTRONOMY

MIRROR SOILING STUDY

Mirror soiling study - Setup

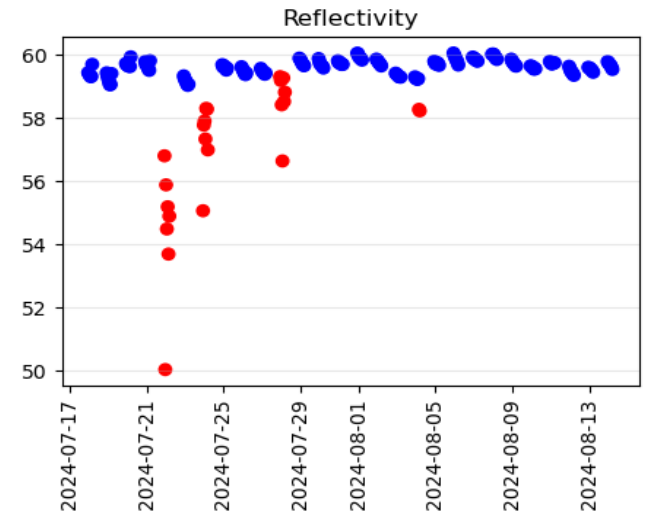


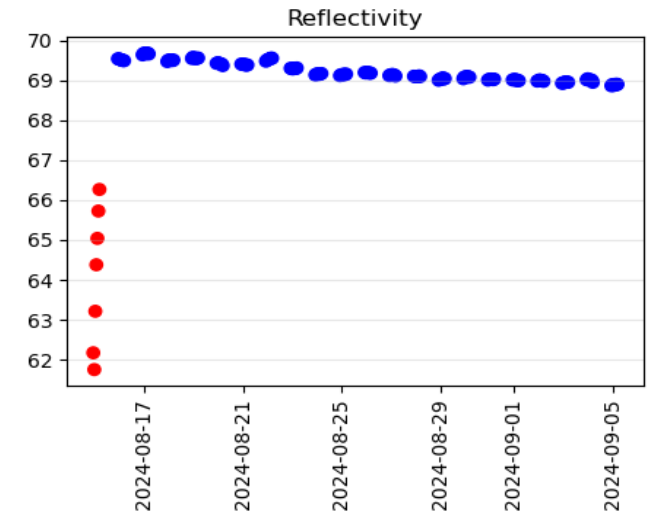
Mirror soiling study - Method



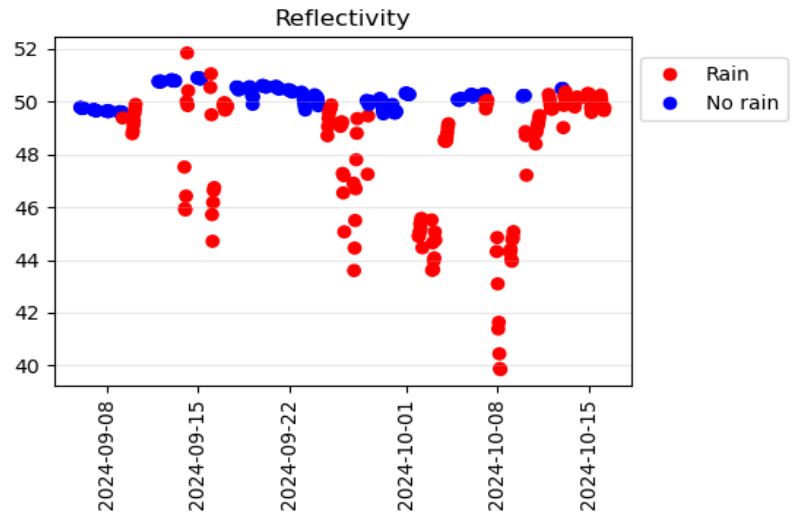
Mirror soiling study - Results

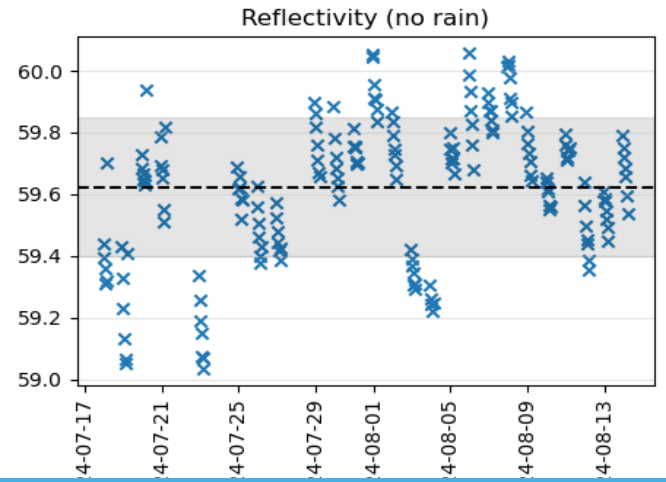
MAGIC

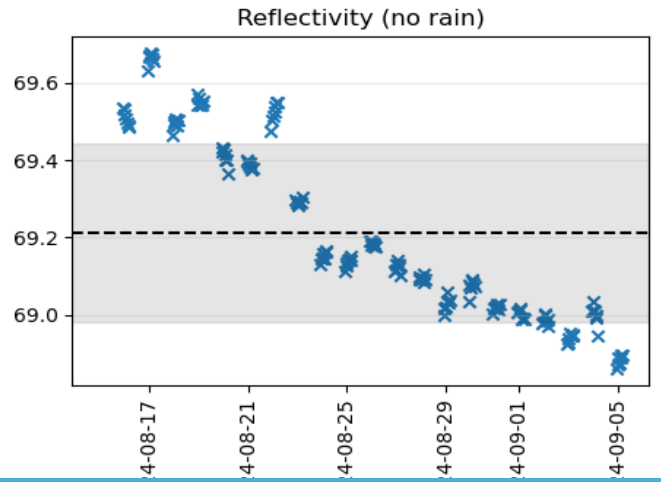


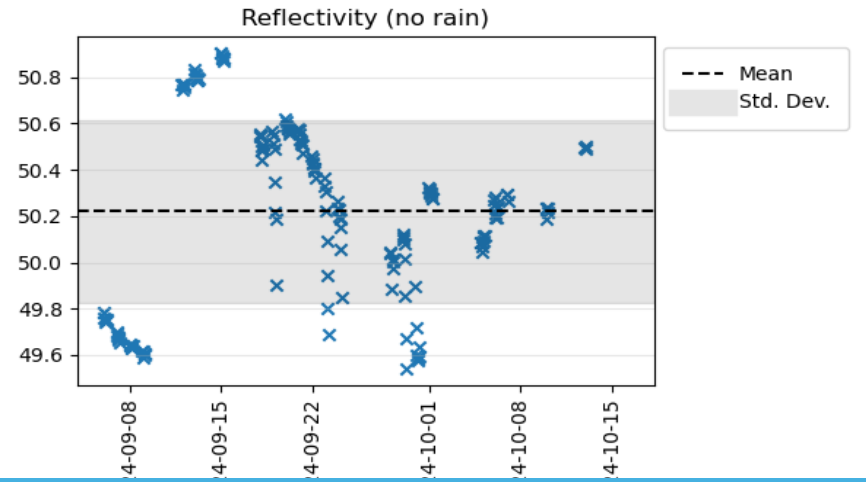


CTA

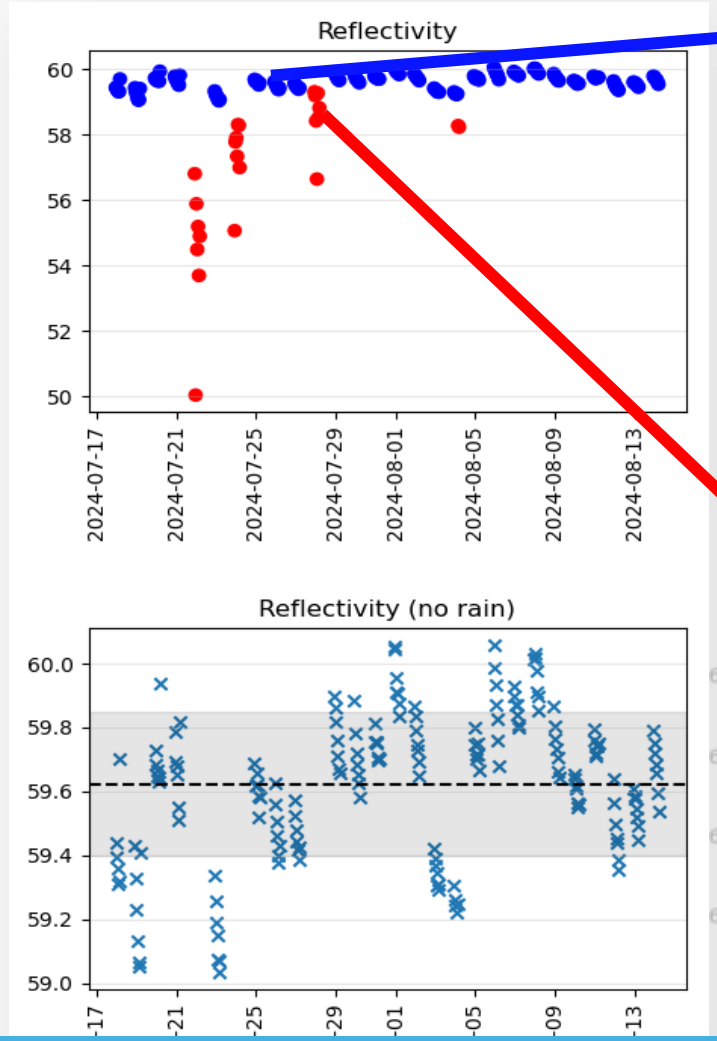


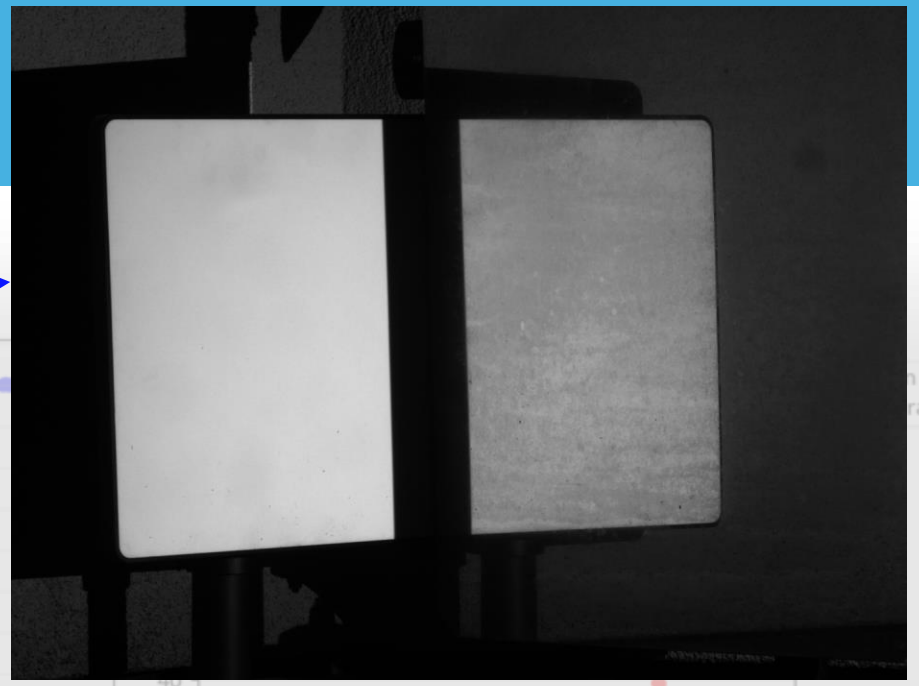


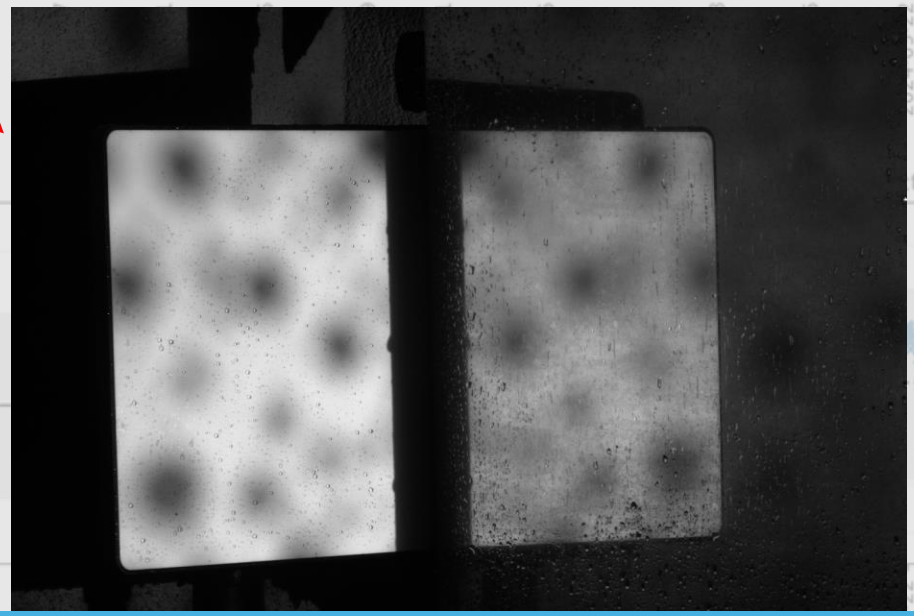




Mirror soiling study - Results

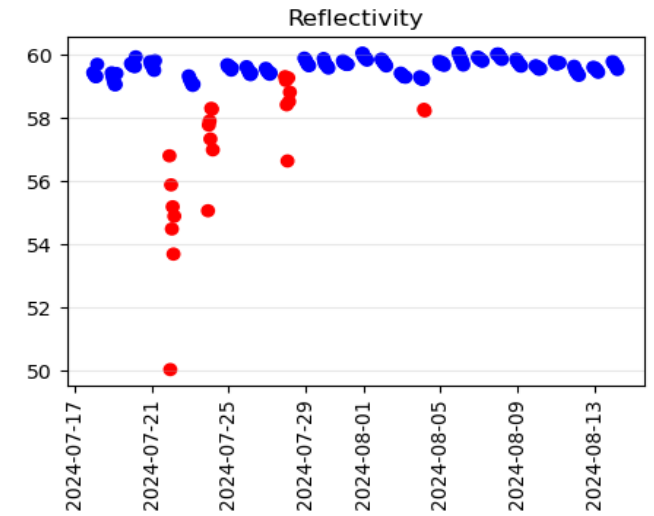


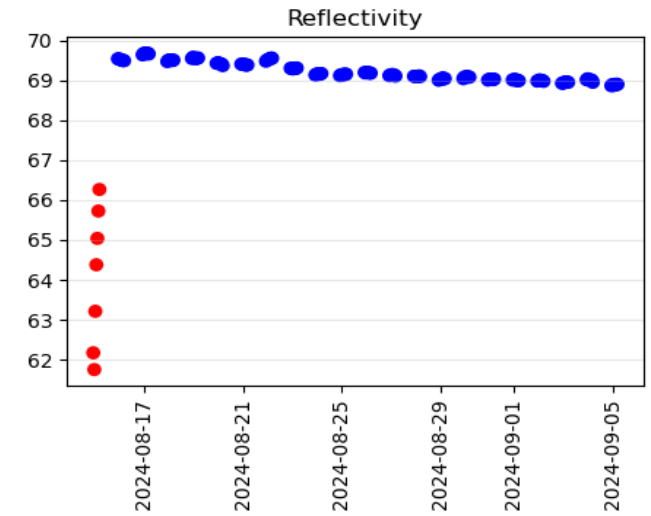




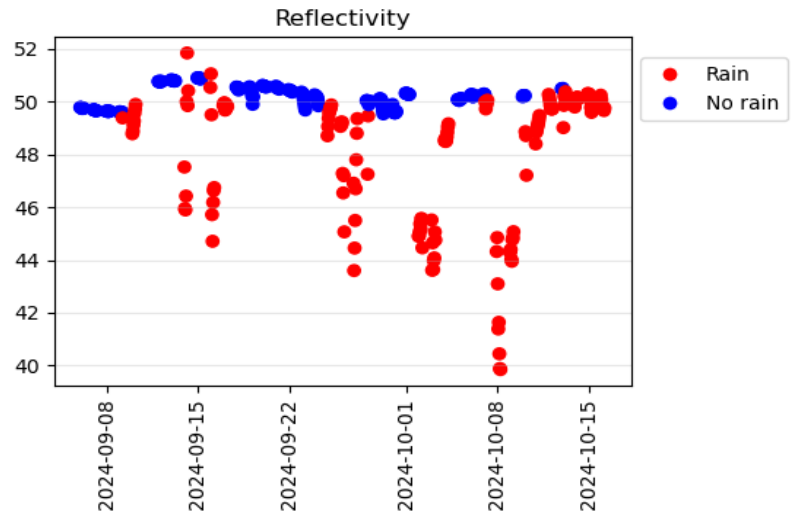
Mirror soiling study - Results

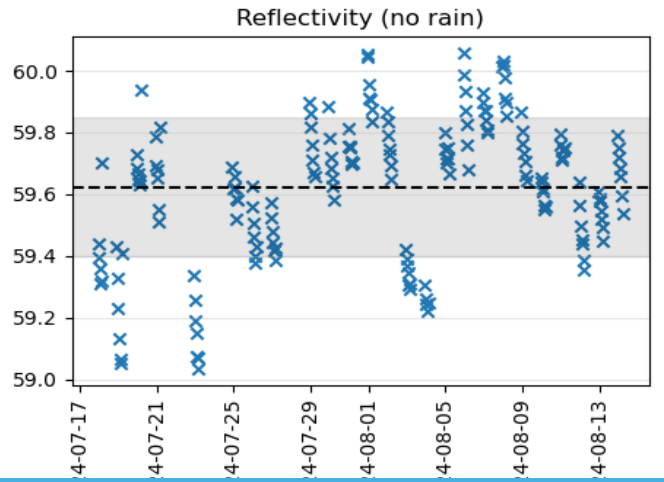
MAGIC

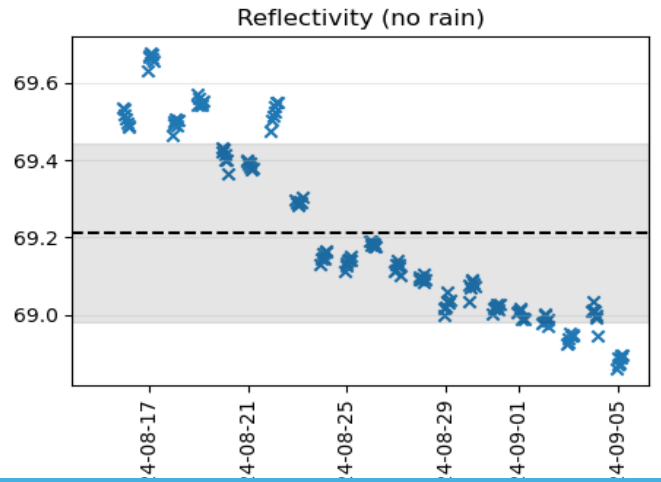


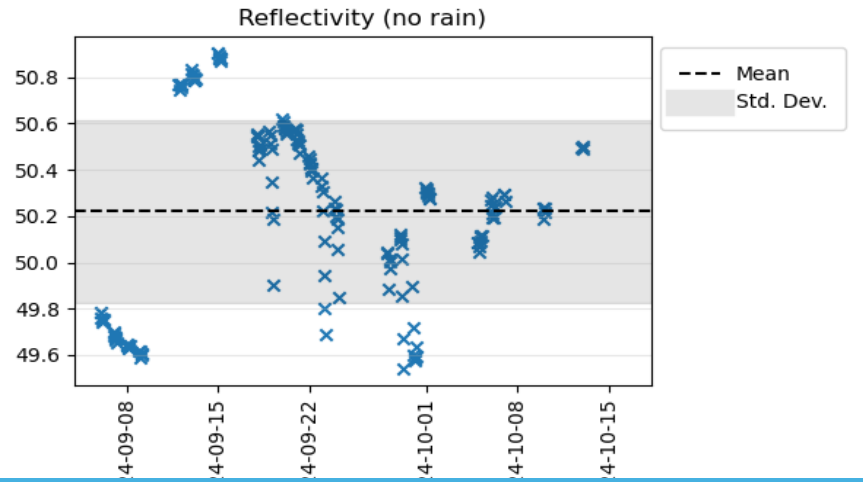


CTA



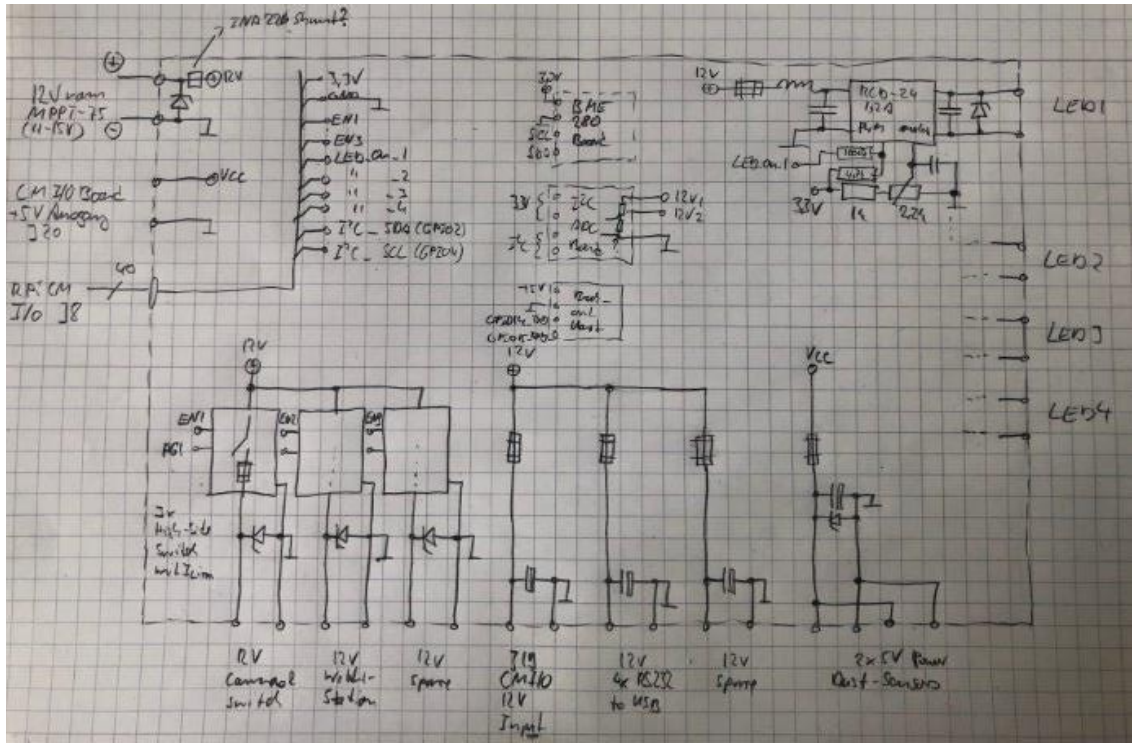


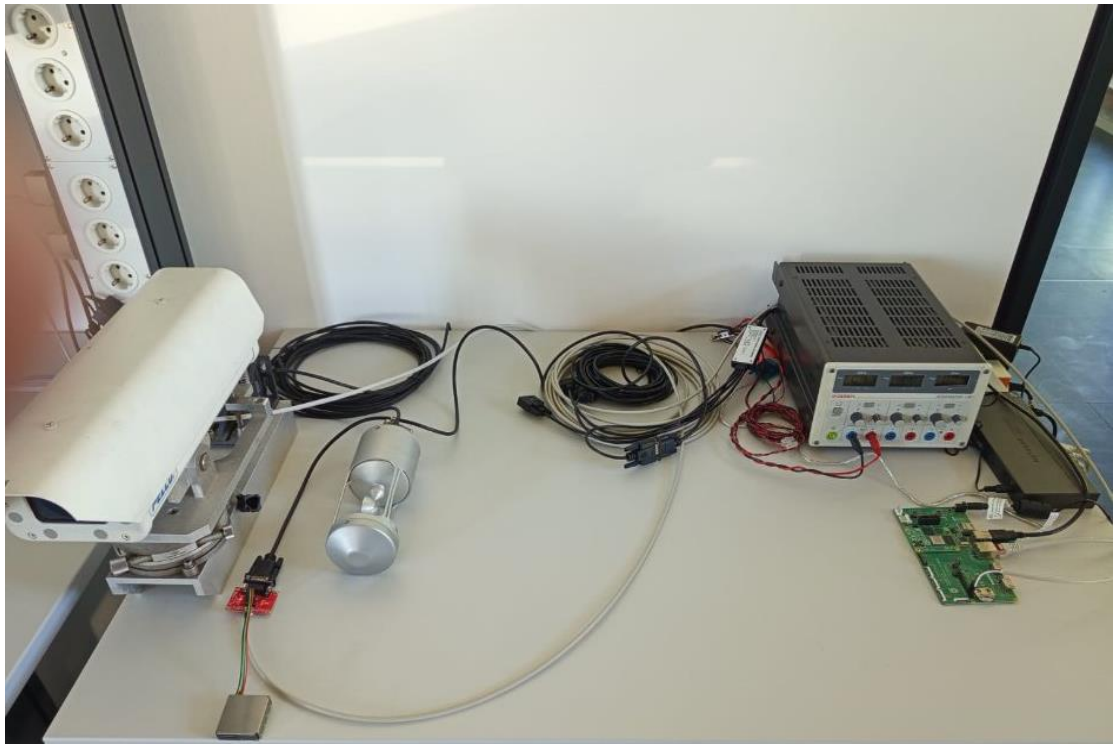




Mirror soiling study – Multiple mirror setup

- Weather station (p, T, wind, humidity)
- 3 dust counters
- Solar panel + Battery
- 2 cameras
- 4 mirrors + LEDs
- 4 diffuse reflector targets





Mirror soiling study – Summary

- Reflectivity monitoring method:
  - Absolute ❌
  - Relative ☑

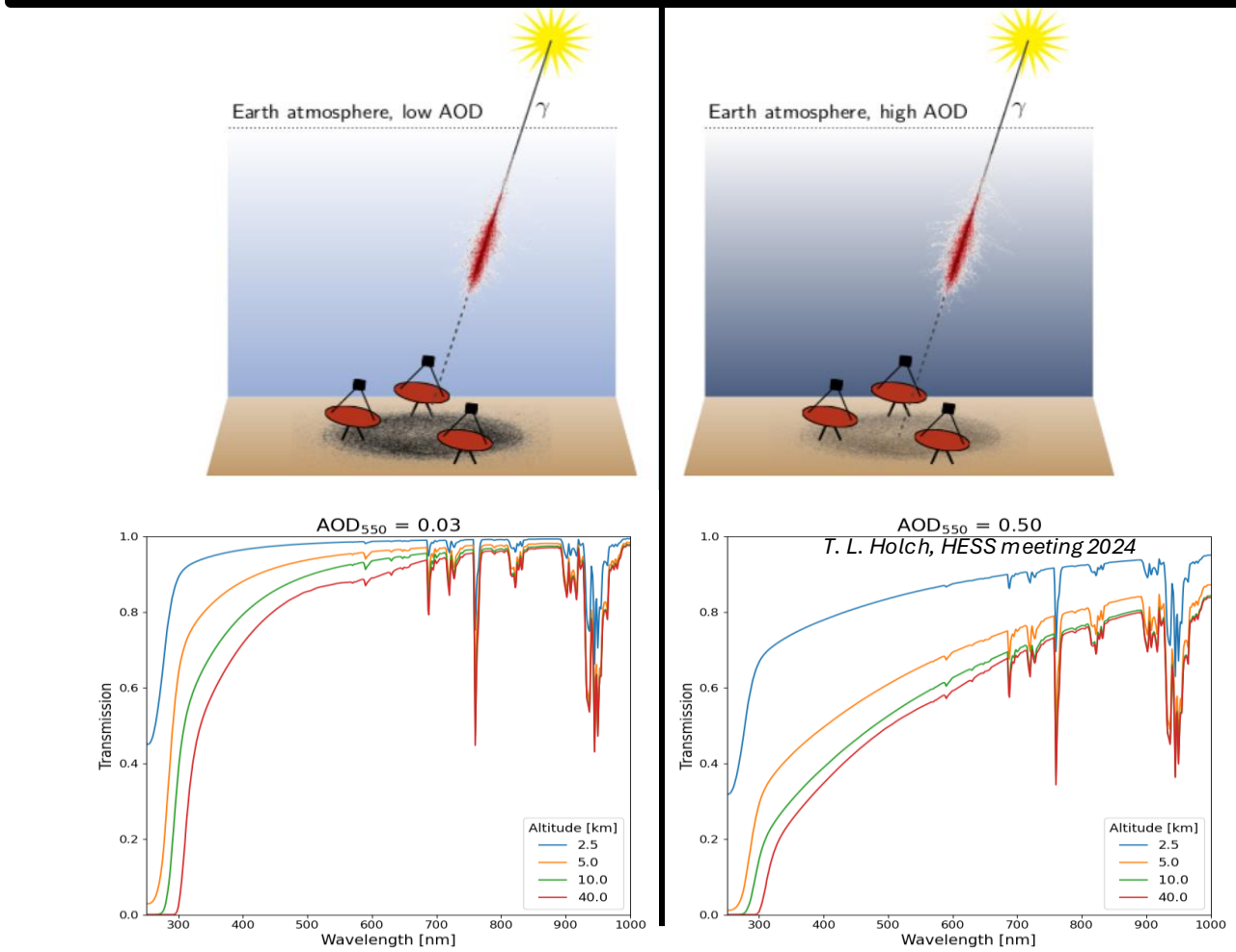
Next steps…

- Awaiting approval from CTAO
- Deployment of the setup on-site in Chile
- Data collection (~1 year)
- Data analysis

ATMOSPHERIC ANALYSIS

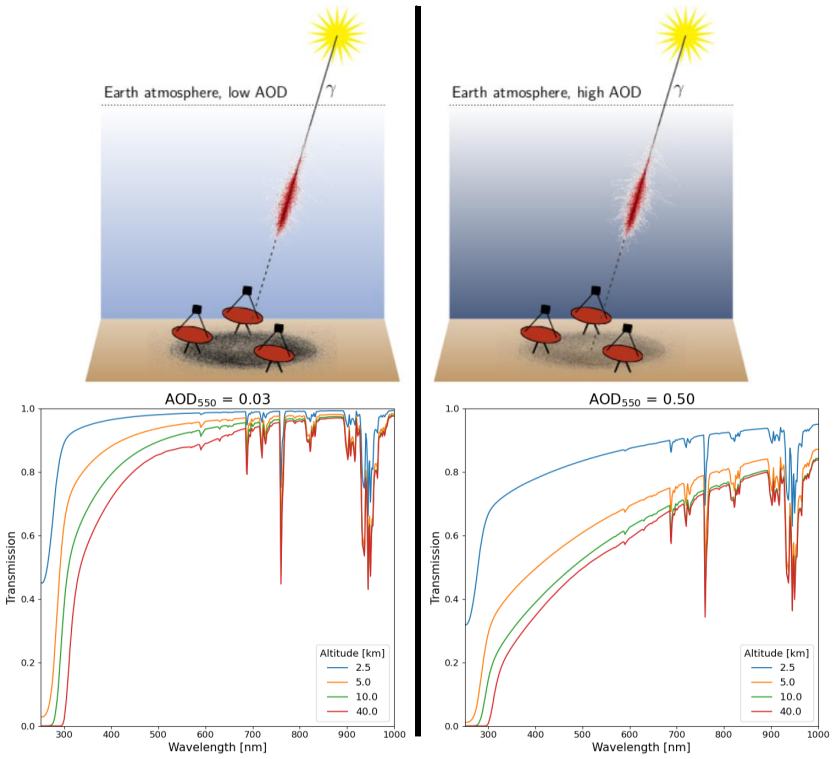
Atmospheric analysis - Concept

ATMOSPHERE = CALORIMETER of our detector



Atmospheric analysis - Concept

ATMOSPHERE = CALORIMETER of our detector



- Higher transparency

  shift towards lower energies

- Lower transparency

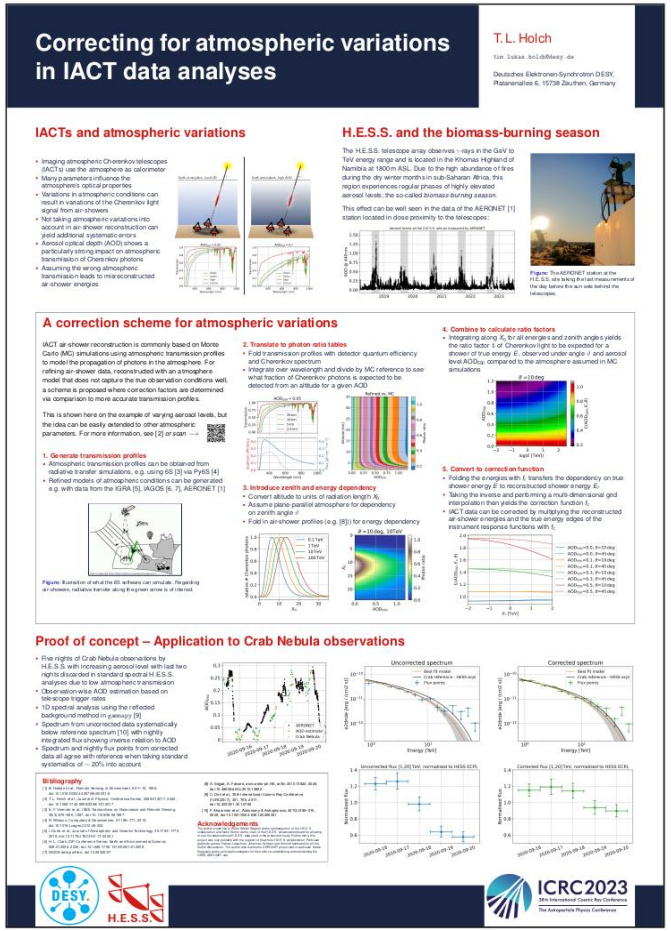
  shift towards higher energies

→ Not distinguishable in reconstructed energy

Atmospheric analysis - Method

CORRECTION SCHEME FOR ATMOSPHERIC VARIATIONS

1. Generate atmosphere transmission profiles
2. Get photon ratio table
3. Introduce zenith and energy dependency
4. Calculate ratio factor
5. Translate to correction function



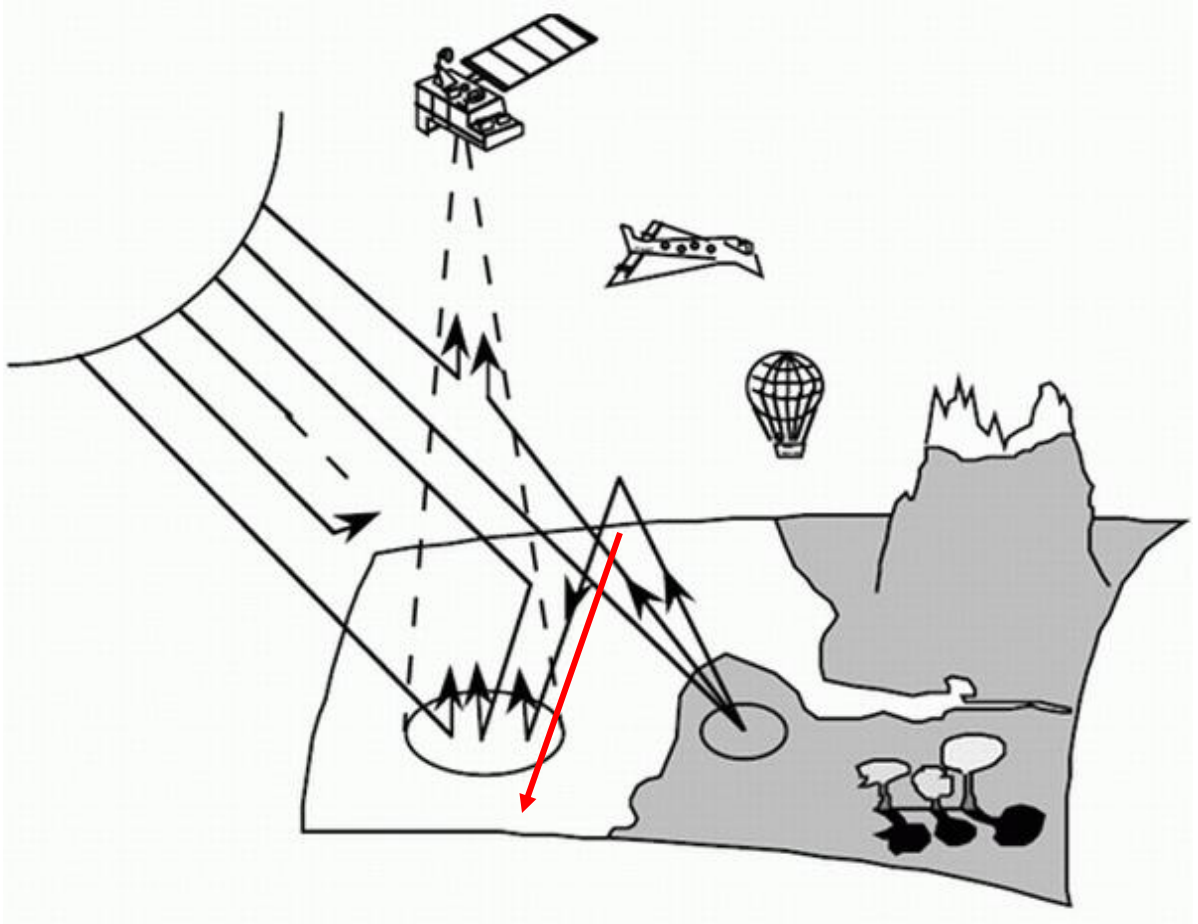
T. L. Holch, ICRC 2023

Atmospheric analysis – Method & Results

1. Generate atmosphere transmission profiles → Py6S

- Radiative transfer simulations
- Atmospheric data:
  - Aerosol → AERONET
  - Altitude
  - Pressure
  - Temperature
  - Water content
  - Ozone

→ Copernicus - ERA5

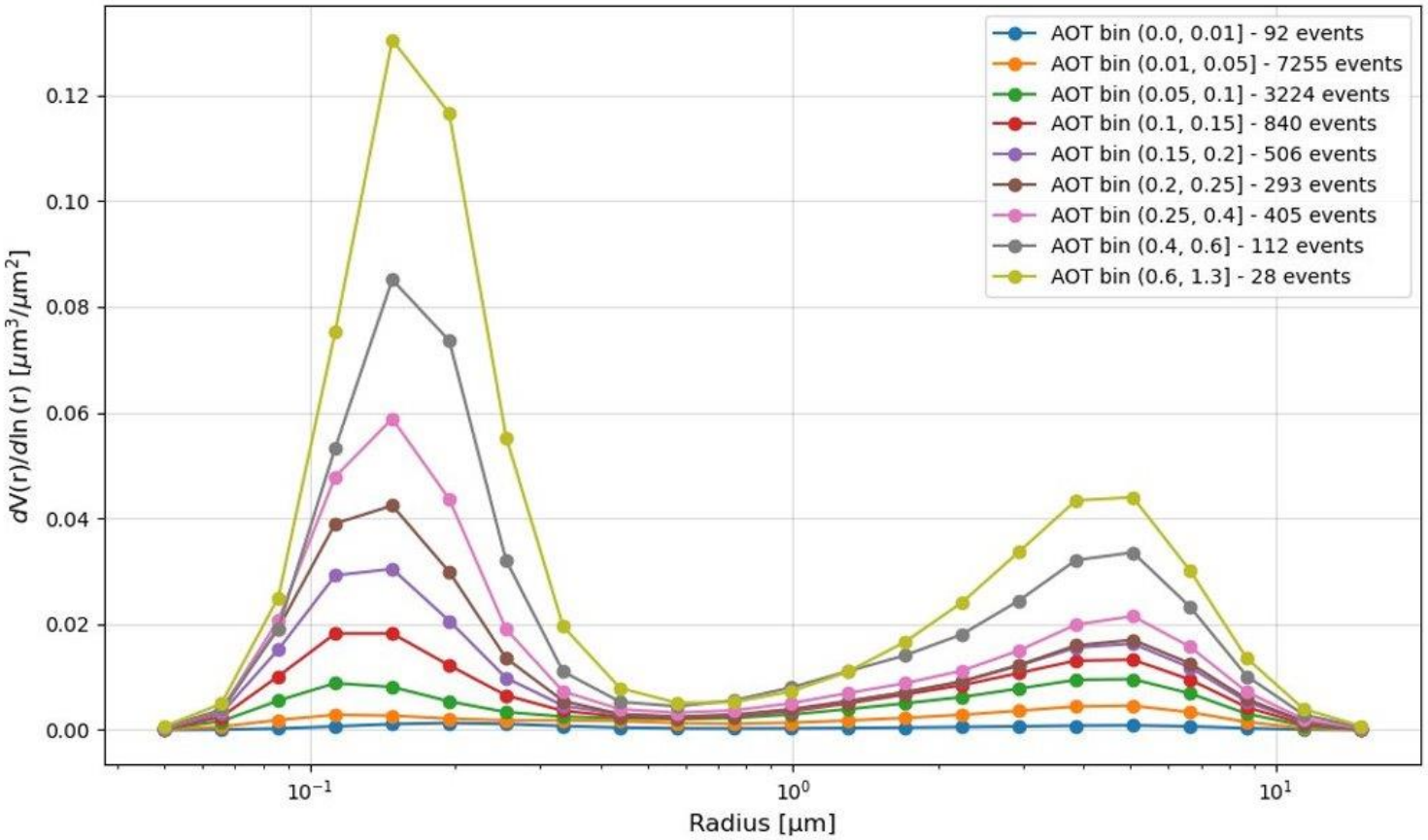


Atmospheric analysis – Method & Results

1. **Generate atmosphere transmission profiles: study of aerosol size distribution**

   - AERONET provides real aerosol size distribution data
   - Distribution by AOT

AEROSOL MODEL FOR PY6S



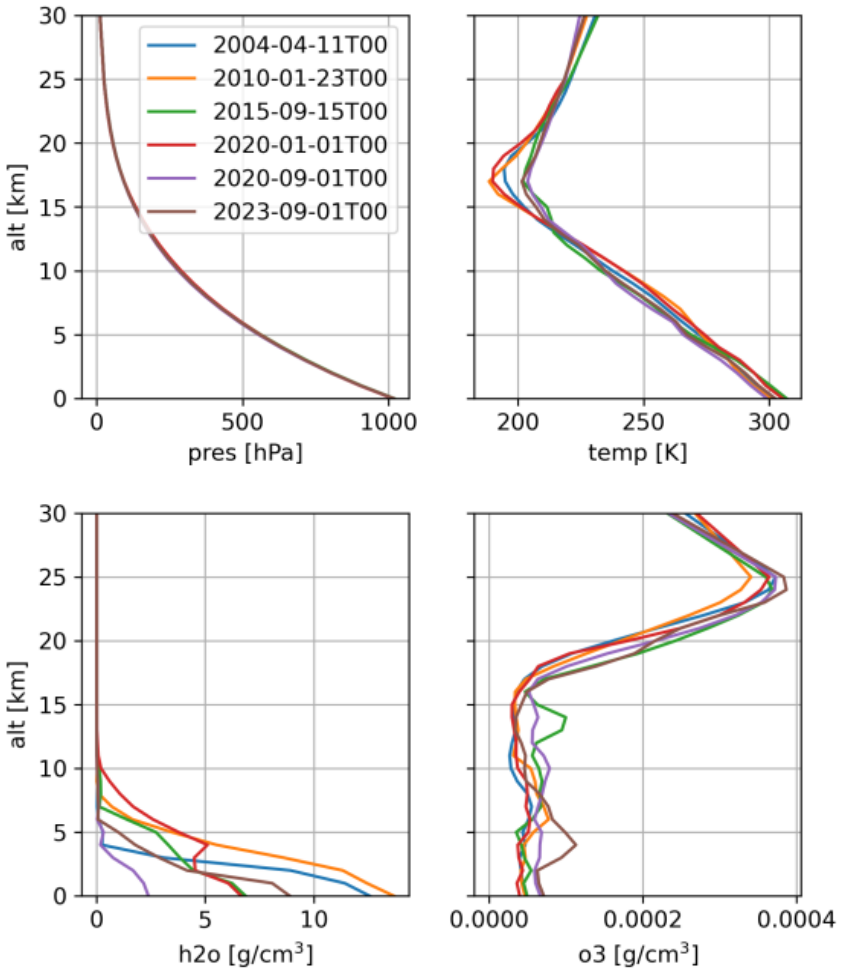
Atmospheric analysis – Method & Results

1. Generate atmosphere transmission profiles: study of climate data

Climate Change Service

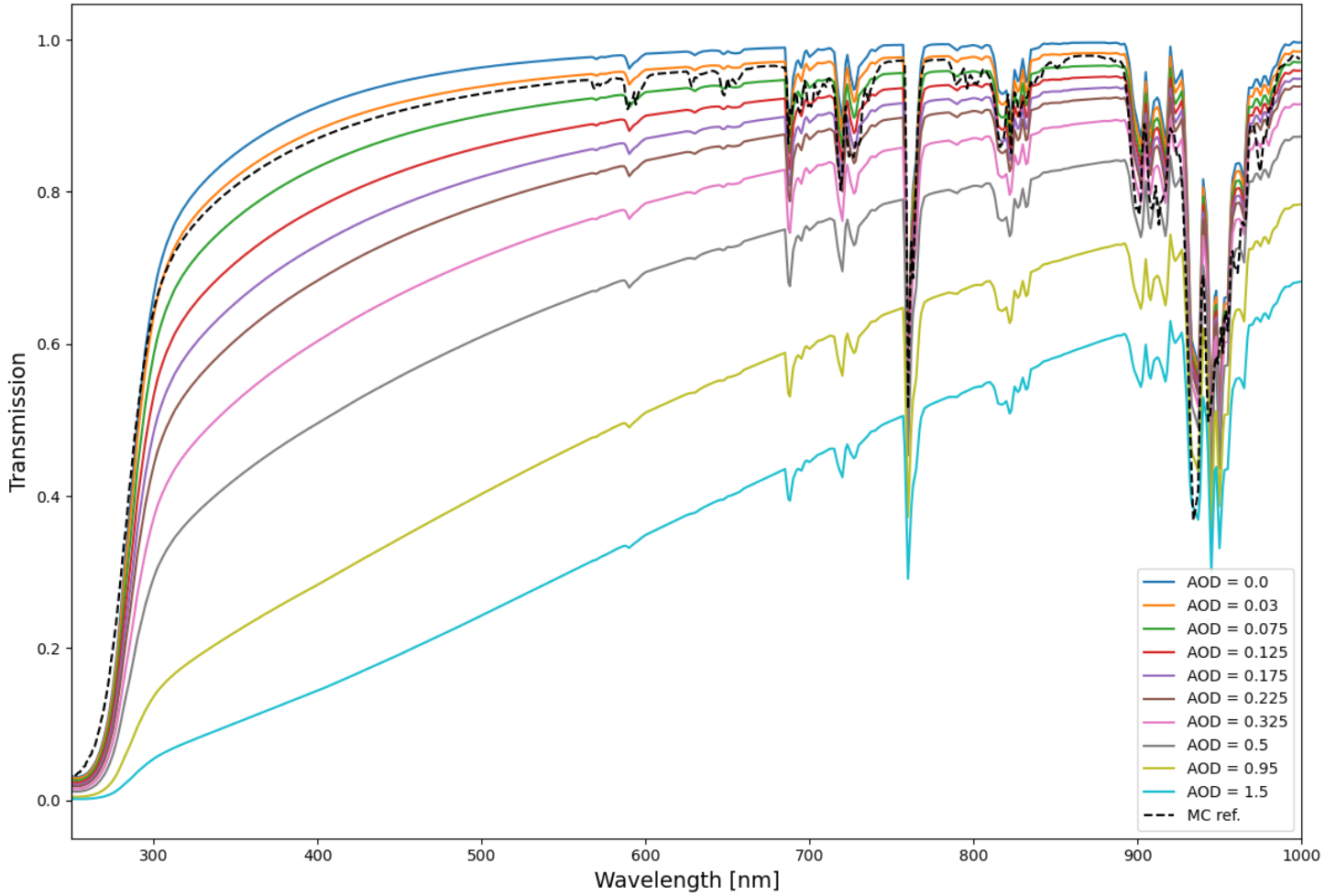
climate.copernicus.eu

- Altitude, pressure, temperature, water content, ozone, etc.
- Hourly time resolution
- Closest grid point ~ 10 km from H.E.S.S. site
- Ground level + altitude multi-level profiles



Atmospheric analysis – Method & Results

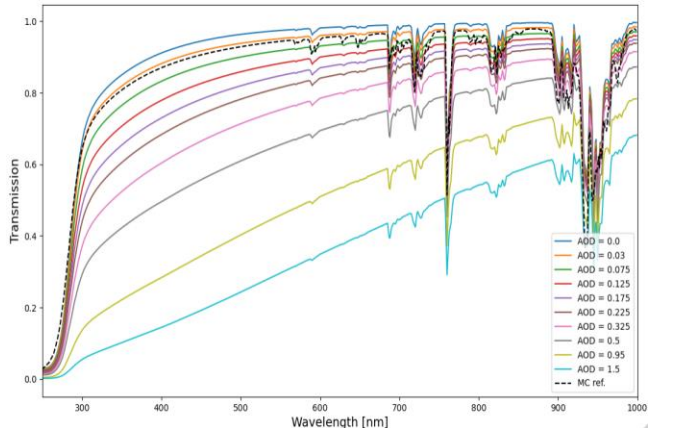
1. Generate atmosphere transmission profiles

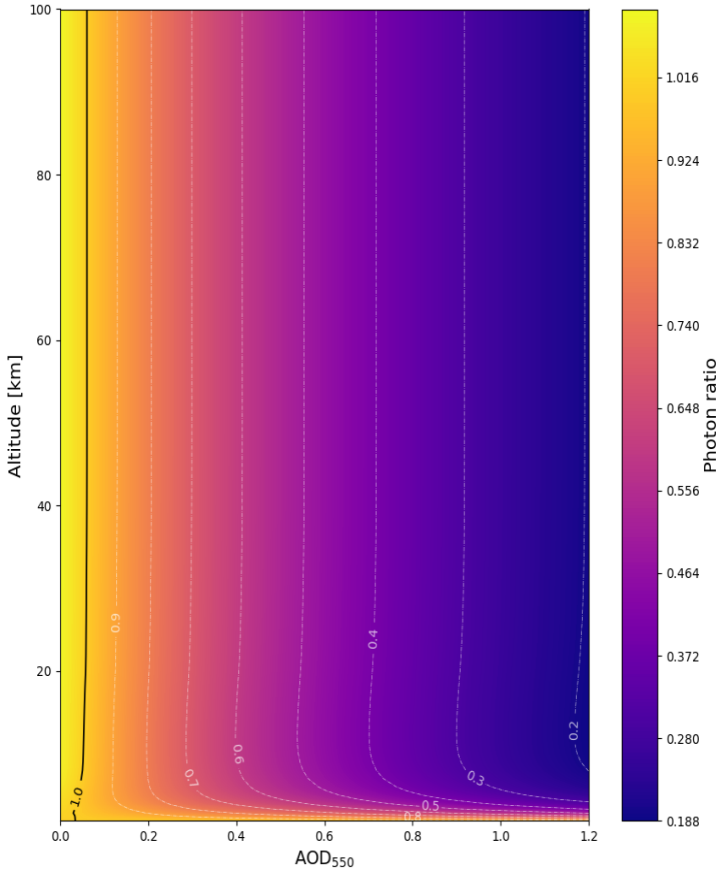


Atmospheric analysis – Method & Results

2. Get photon ratio table

- Transmission × PMT QE × Cherenkov spectrum
- Integrate over wavelength
- Divide by MC reference

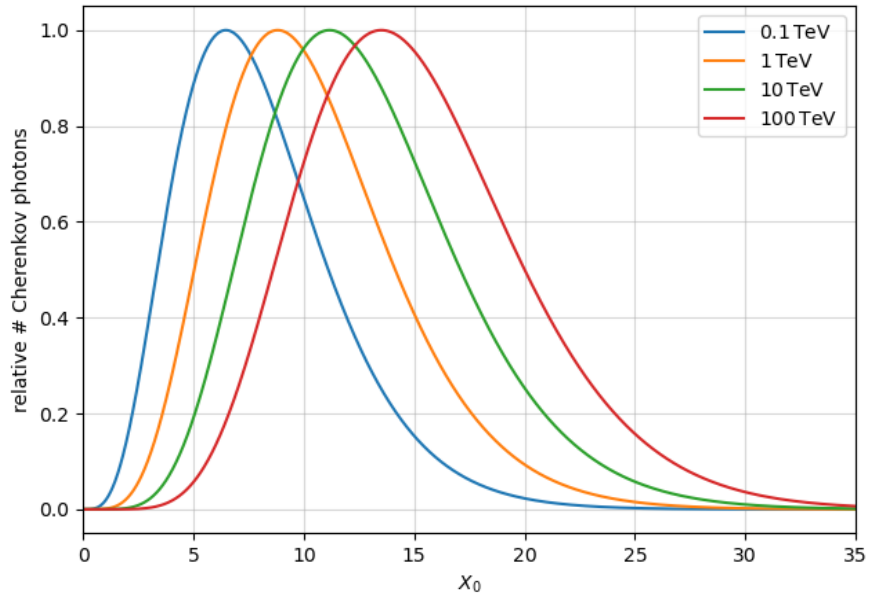


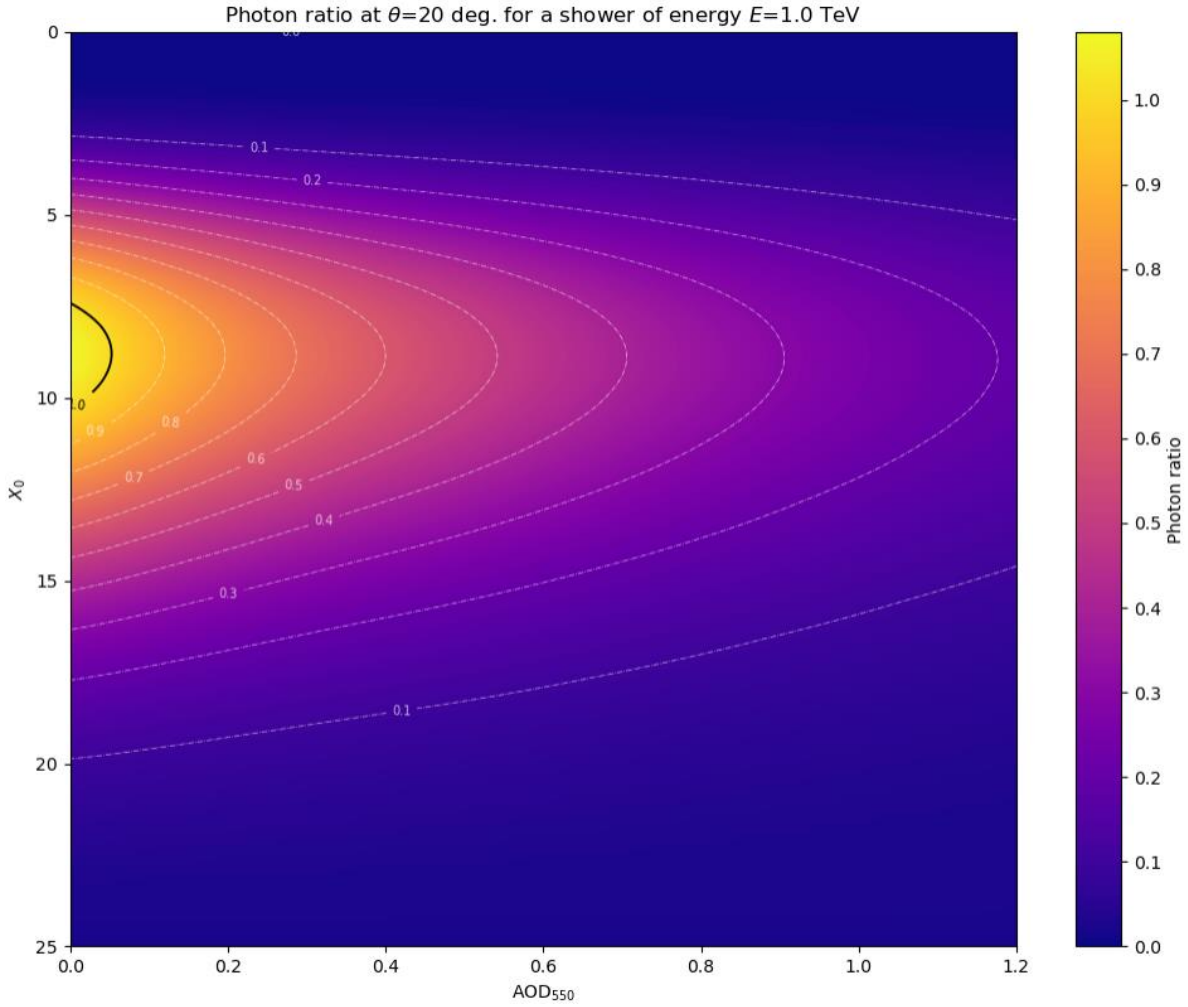


Atmospheric analysis – Method & Results

3. Introduce zenith and energy dependency

- Assume plane-parallel atmosphere
- Convert altitude to radiation length
- Fold in shower profile

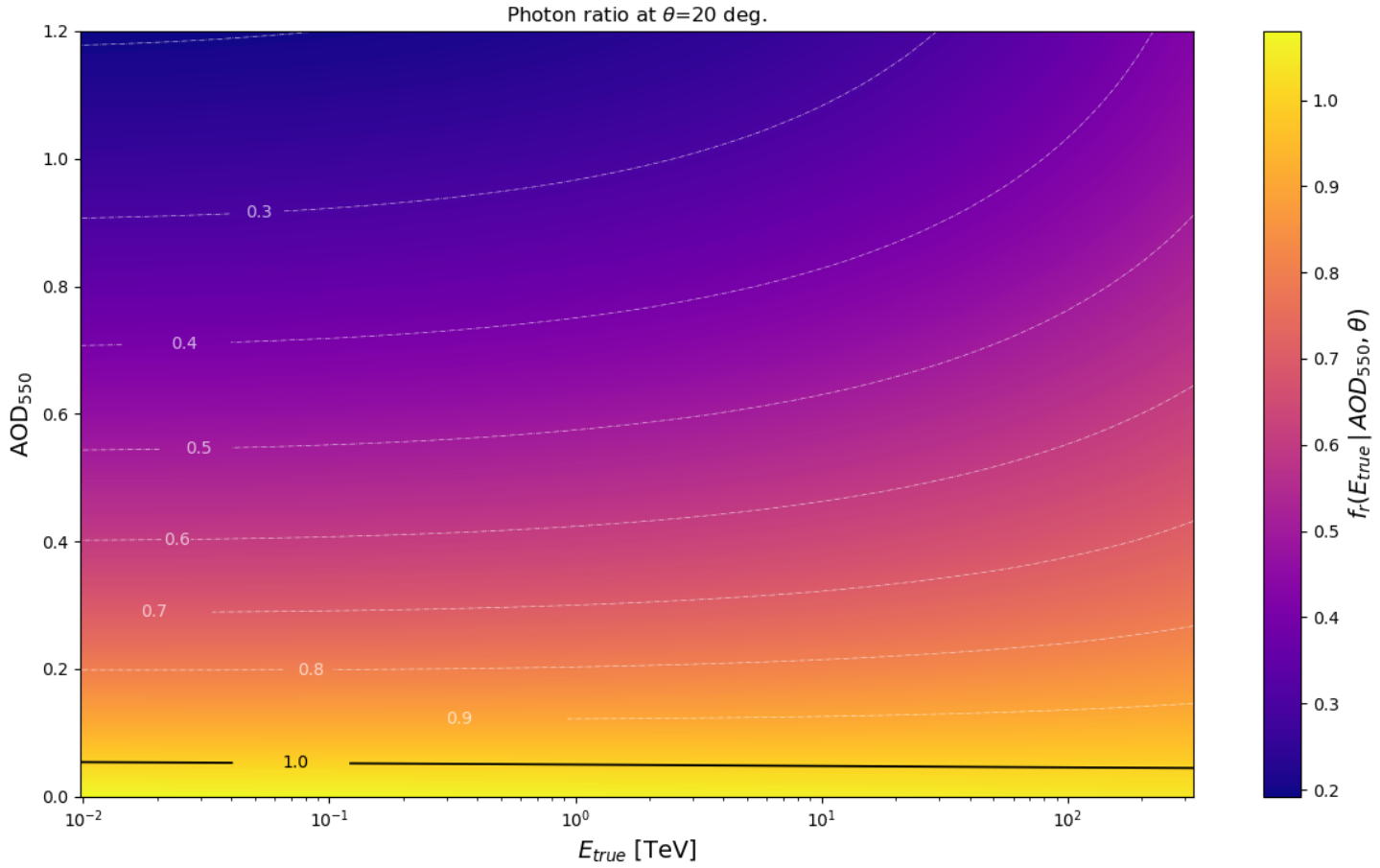




Atmospheric analysis – Method & Results

4. Calculate ratio factor

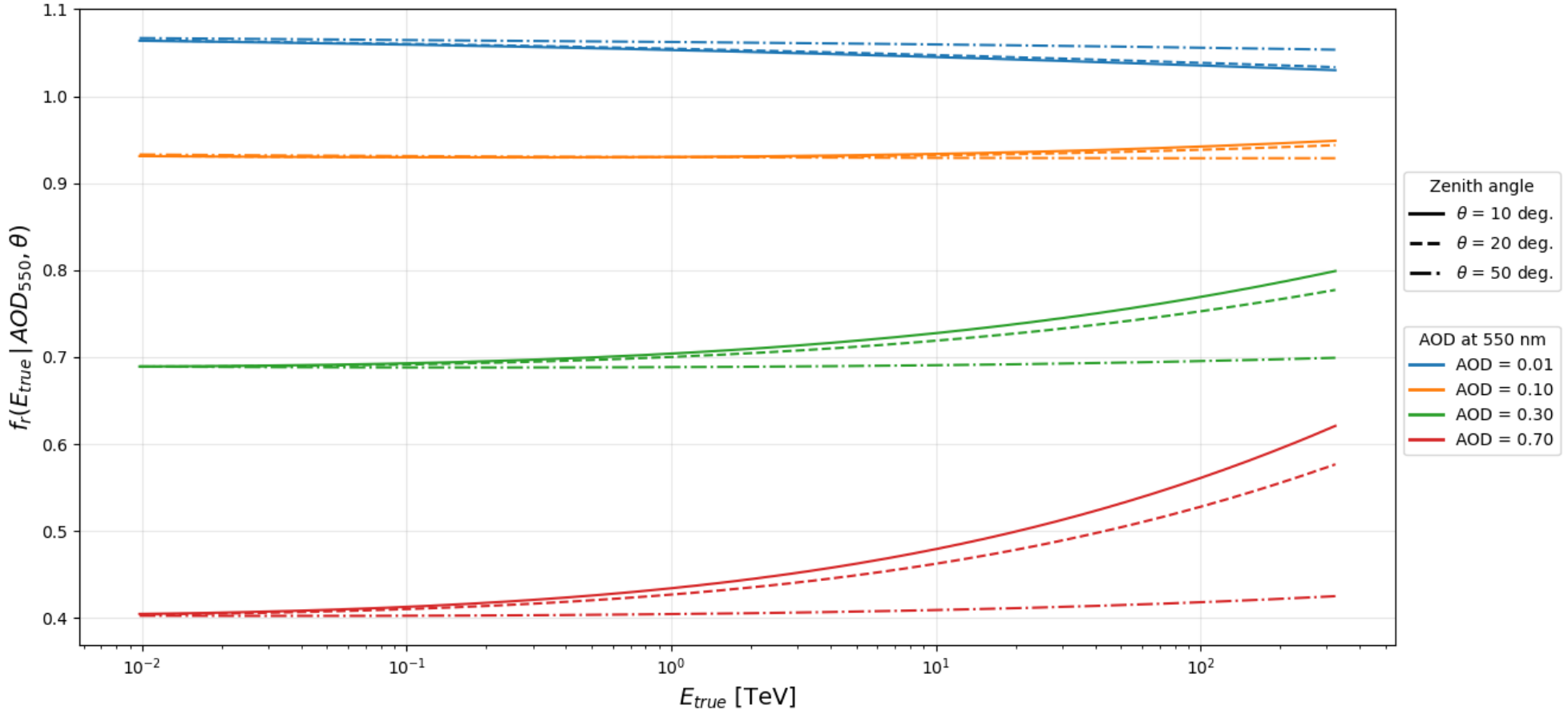
- Integrate over X_0 for all energies



Atmospheric analysis – Method & Results

4. Calculate ratio factor

- Integrate over X_0 for all energies

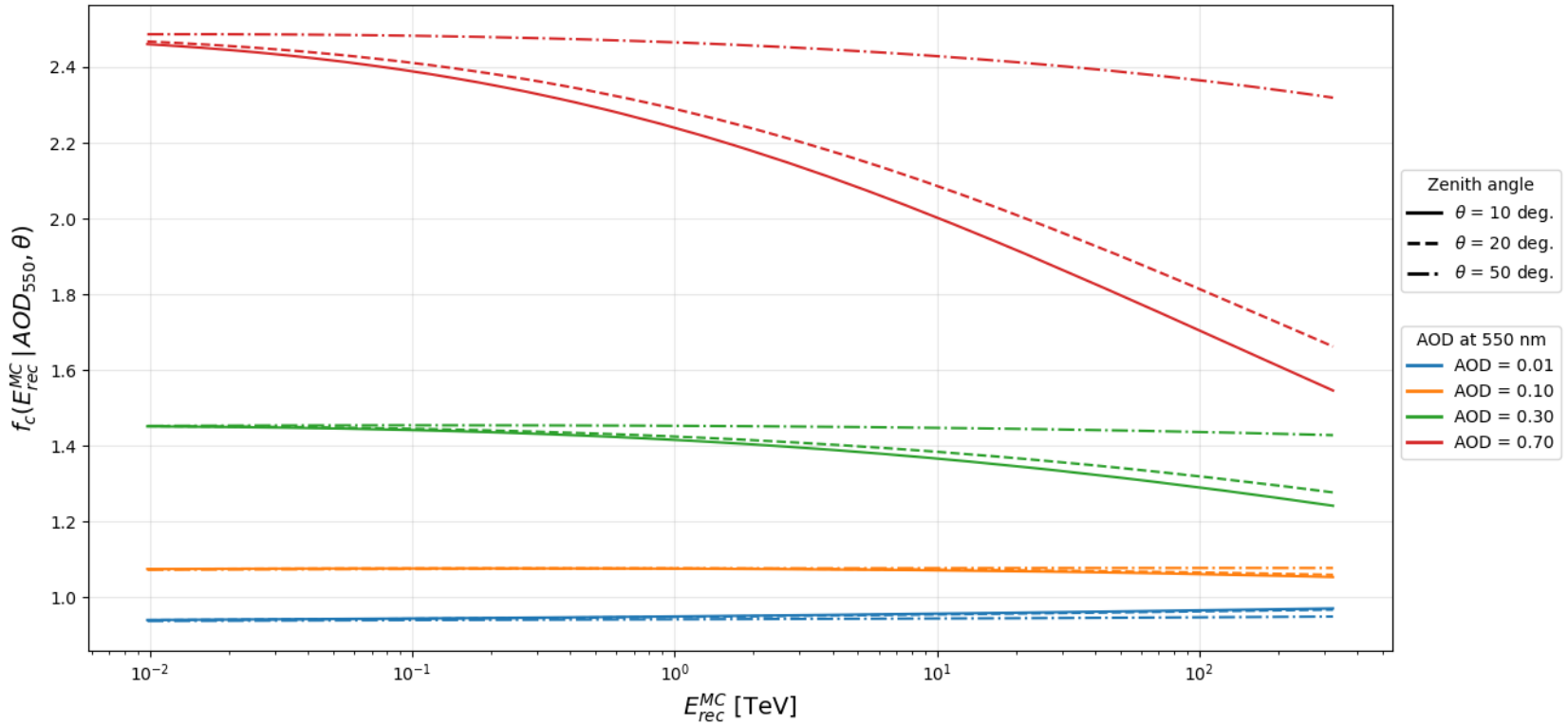


Atmospheric analysis – Method & Results

5. Translate to correction function

- Shifting energies multiplying by f_r
- Taking the inverse of f_r and interpolating

$$f_r(E_{true}) \rightarrow f_c(E_{rec})$$



Atmospheric analysis – Summary

- Python libraries to access AERONET and Copernicus data
- Study of aerosol profile
- Study of climate parameters
- Script to run Py6S simulation and generate correction function

Next steps…

- Test correction function with data of known sources
- Apply same method to study muon efficiency variations