The CTA-North Performance in Conditions of Reduced Atmospheric Transmission

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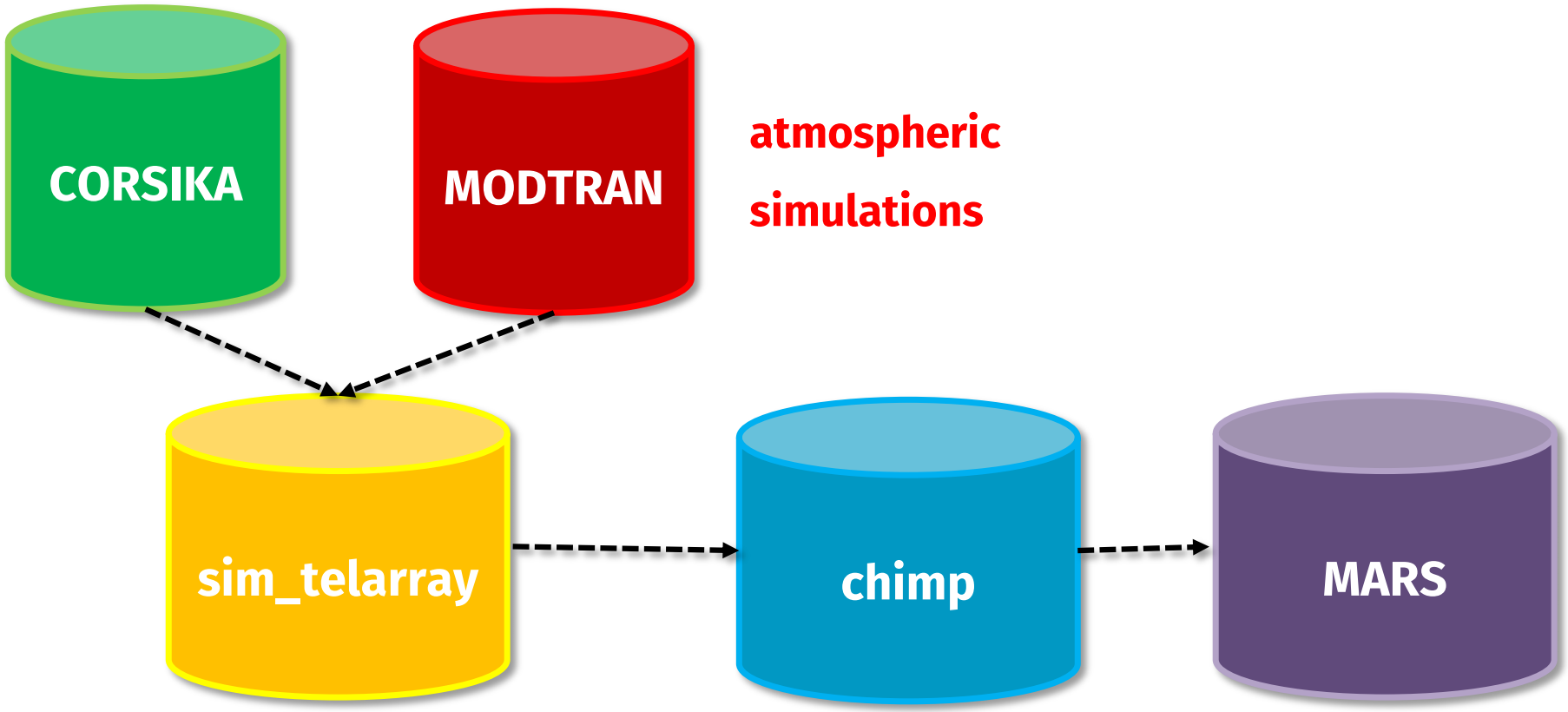
Motivation

- the Cherenkov yield in the air shower is dependent on the refractive index of the air
- the loss of Cherenkov may be introduced by absorption and scattering, both by molecules (Rayleigh scattering) and aerosols (Mie scattering)
- the presence of clouds reduces the number of Cherenkov photons recorded by the Cherenkov camera which may introduce a bias towards lower energies, reduced sensitivity, and misconstructed spectra

Simulation and analysis chain

air shower development and

Cherenkov light emission



simulations of detector response and

atmospheric impact on Cherenkov light

signal extraction

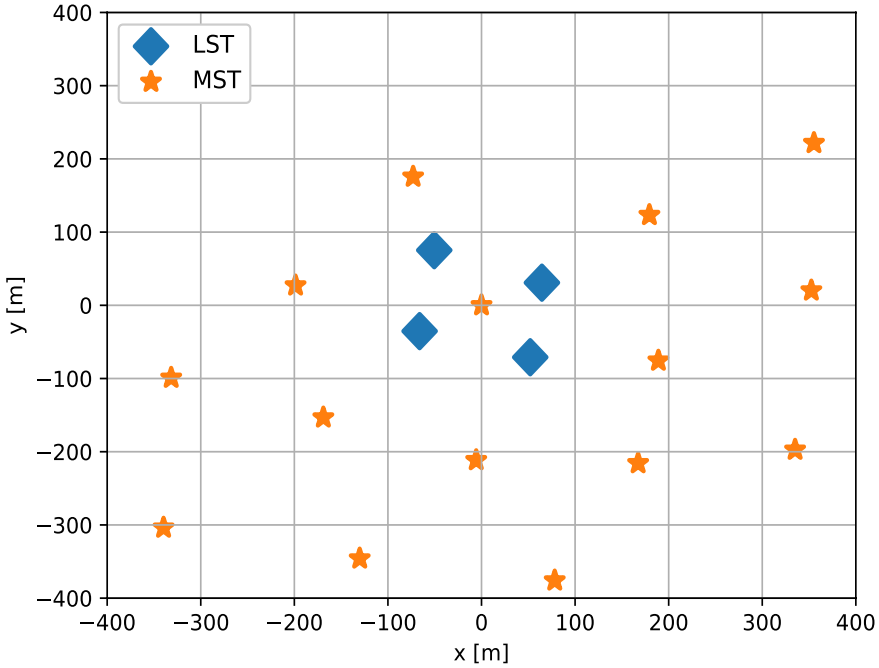
and calibration

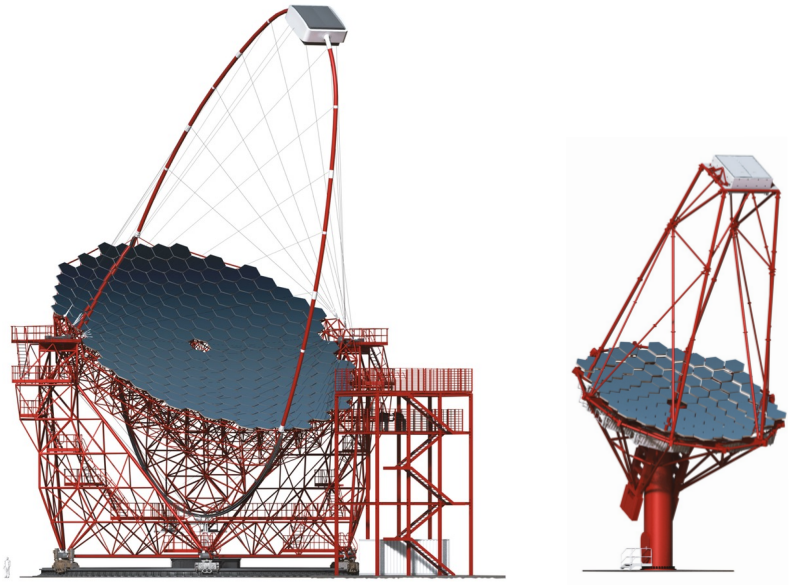
analysis of

simulated data

Simulation chain

- COsmic Ray SImulations for Kascade (CORSIKA) code version 7.6400
- study was performed for Northern CTA site (La Palma, Spain)





From: www.cta-observatory.org

- 20 degrees in Zenith, 180 degrees in Azimuth
- atmospheric transmission → within sim_telarray code

Simulation chain

- MODerate resolution atmospheric TRANsmission (MODTRAN) code version 5.2.2
- US Standard Atmosphere, desert extinction
- wavelength range: from 200 nm to 1000 nm
- ground altitude at the observatory level (2147 m a.s.l.)
- 1 km thick clouds at 3, 5, and 7 km a.g.l.
- simulated transmissions: 1.00, 0.75, and 0.50

Analysis chain

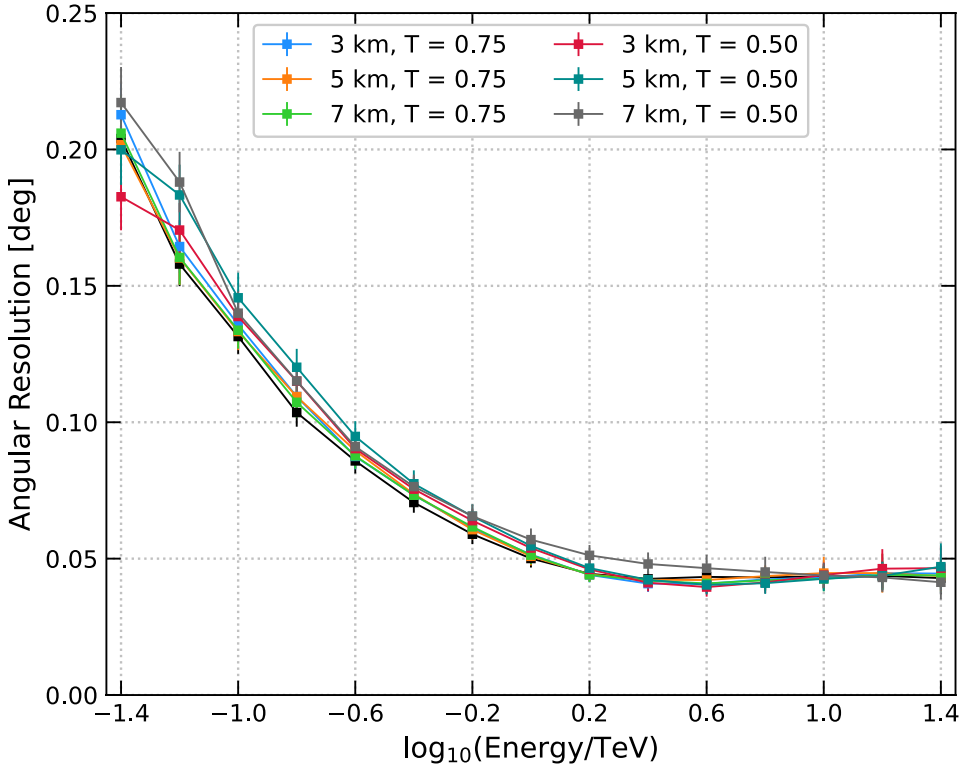
- Convert Hessio to MARS Input (chimp)
  - Signal extraction
  - Calibration
  - Image parametrization

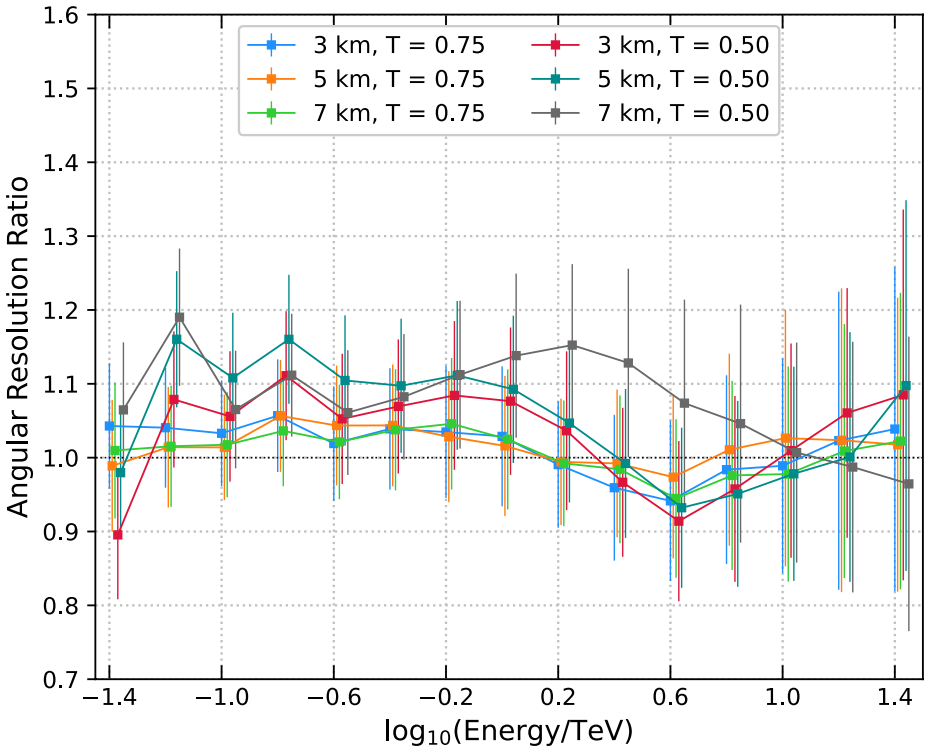
- MAGIC Analysis and Reconstruction Software (MARS)
  - Direction → direction look-up table
  - Energy and gamma-hadron separation → Random Forest

- Final output:
  - Angular resolution
  - Differential sensitivity
  - Effective Area
  - Energy resolution

Same kind of Monte Carlo simulations used for training and test sample!

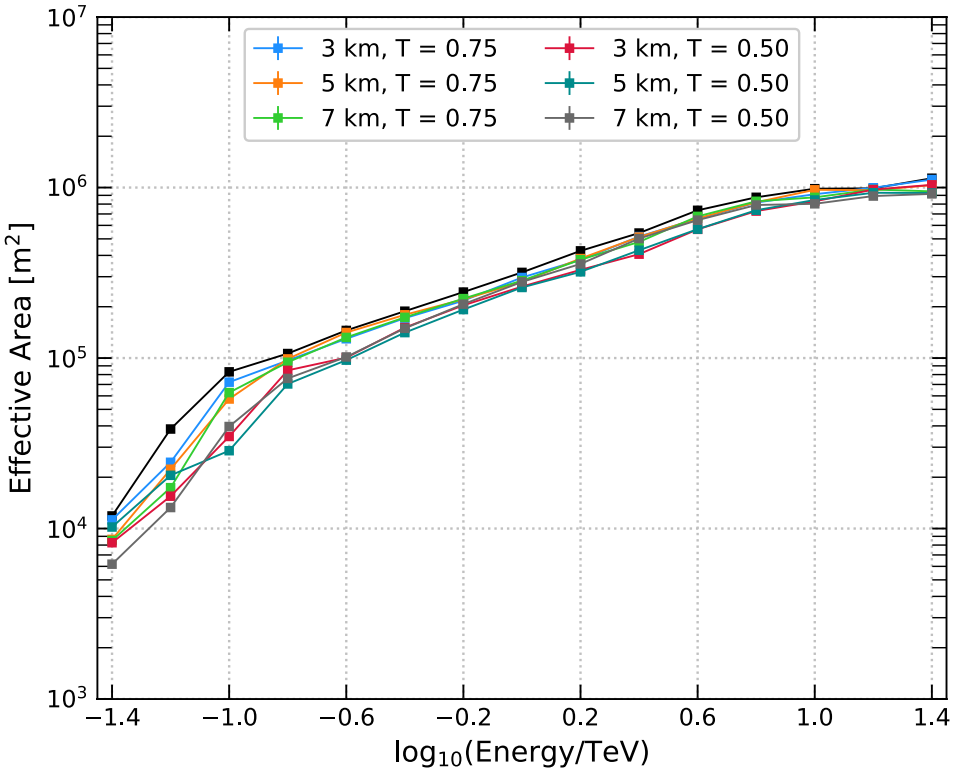
Angular Resolution

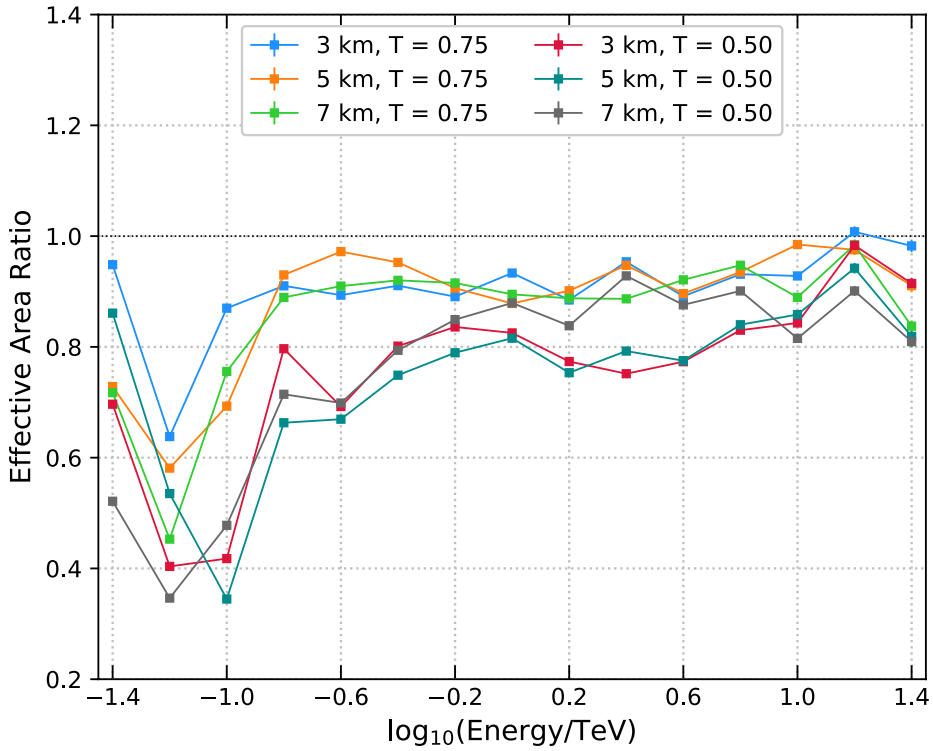




- varies from 0.18 deg to 0.22 deg at the energy of ≈ 40 GeV to 0.06 deg at the energy of 1 TeV, depending on the properties of clouds, reaching a plateau of ≈ 0.05 above 1 TeV

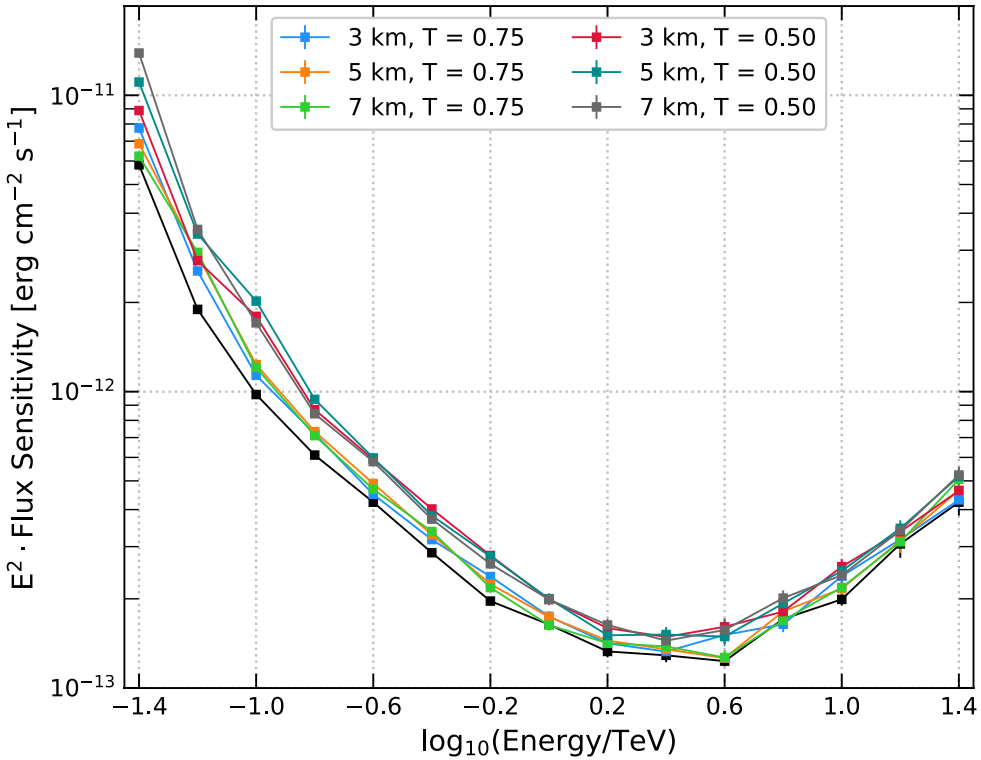
Effective Area

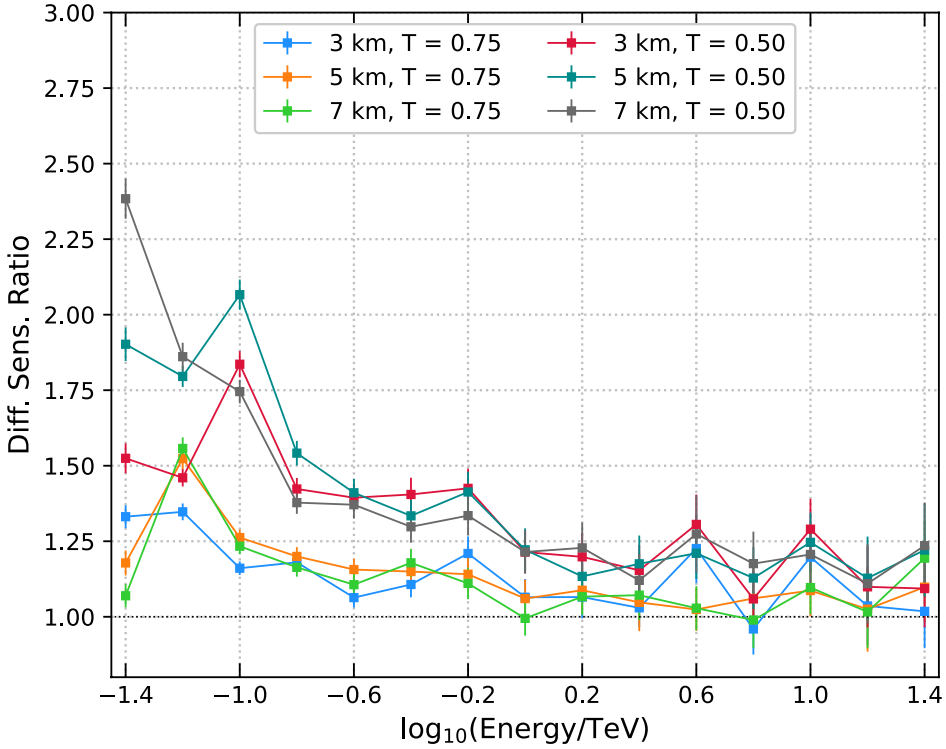




- severely reduced below ≈ 250 GeV, up to 60% depending on the properties of clouds; above a few hundreds of GeV reduction is 20% in the presence of clouds with $T = 0.50$

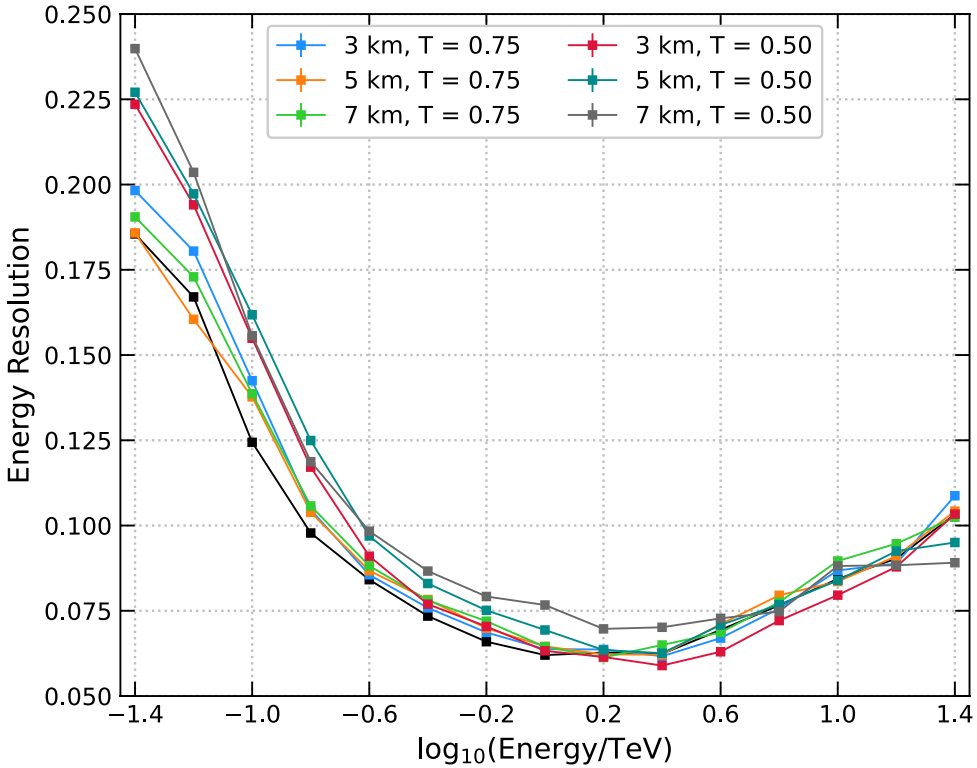
Differential Sensitivity

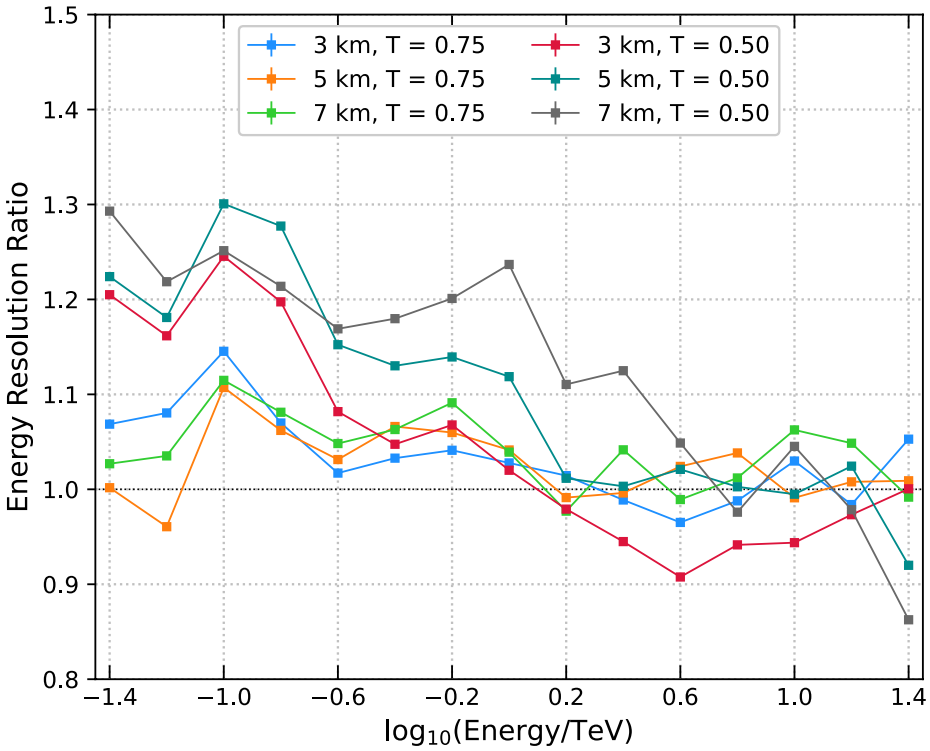




- the most visible effect of clouds is at energies $\leq$ 150 GeV
- at energies $\geq$ 1 TeV the stability in reduction is achieved: $\approx$ 25% for $T = 0.50$, and $\approx$ 10% in the case of $T = 0.75$

Energy Resolution





- varies between 0.18 and 0.24 in the lowest energy bin to ≈ 0.10 at the energy of 15; significantly degraded at energies below 250 GeV, by 30% for $T = 0.50$ and by less then 10% for $T = 0.75$

Conclusions

- the influence of different transmissions and altitudes of clouds on the performance of CTA-N
- less transparent clouds → more severe effect on the performance, while the differences between close altitudes are small
- the reduction in sensitivity does not cross 50% above a few hundreds of GeV, except at the energy threshold where the impact is much more severe
- at the same energies, the reduction of angular resolution, energy resolution, and effective area are below 20%

Acknowledgments

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