Characterization of Potential U.S. Sites for the Cherenkov Telescope Array

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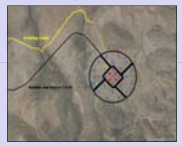
ABSTRACT

The Cherenkov Telescope Array (CTA) is a major ground-based observatory proposed for very high-energy (VHE) gamma-ray astronomy. CTA is envisioned to consist of two large arrays of atmospheric Cherenkov telescopes; one array would be located in the southern hemisphere and one in the northern hemisphere.

We have identified two potential sites in the USA for the northern array of CTA; both are located in northern Arizona. We describe the sites in terms of their atmospheric and climatic characteristics. We show recent data from automated monitoring equipment and compare these data to a commercial simulation. Details regarding the infrastructure relevant for the sites are also presented. Both sites are excellent candidates and meet all CTA requirements.

U.S. Site Locations

Yavapai Ranch



Proposed CTA layout for West Site

Meteor Crater

Proposed CTA layout for East Site

Yavapai Ranch

- 25km S of I-40 (Seligman)
- 1.75 hrs from Flagstaff
- Elevation 1670m
- Private land
- Flat, dry, and very dark

Flagstaff

- Population ~60,000
- Modern airport, excellent housing and hospital
- University (NAU) and major research facilities (USNO, Lowell Observatory, etc.).

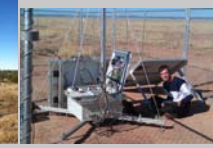
Meteor Crater

- 7 km S of I-40
- 0.75 hrs from Flagstaff
- Elevation 1680m
- Private land
- Very flat, dry, and dark

Measurements with CTA ATMOSCOPES

ATMOSCOPE installation at Meteor Crater site and the 30m anemometer tower

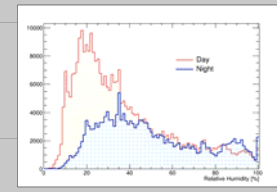
Yavapai Ranch site



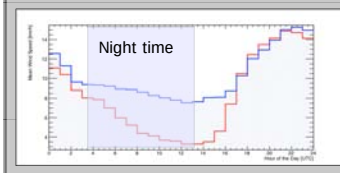
Jeff Hall at Meteor Crater site

CTA ATMOSCOPES consist of:

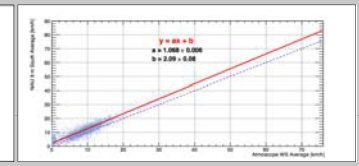
1. Weather station
2. LONS and SQM devices
3. All-sky camera (ASC)
4. On-board computing & networking



Relative humidity at West site measured by ATMOSCOPE for day and night



Average wind speeds measured at East (blue) and West (red) sites by ATMOSCOPE



Wind speed at East site as measured by NAU anemometers vs ATMOSCOPE

Meteorological & Atmospheric Conditions

General Characteristics

- Decades to >100 yrs of atmospheric monitoring at nearby locations.
- Historical records shows all conditions within CTA survivability requirements.

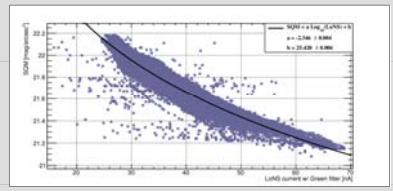
Quantity	Arizona E	Arizona W
Ave max temp	34.2°C (Jul)	33.3 °C (Jul)
Ave min temp	-6.8°C (Jan)	-7.5°C (Dec)
Ave precipitation	19.3 cm/yr	33.2 cm/yr
Ave snowfall	28.2 cm/yr	13.0 cm/yr

Table 1: Long-term average climate values for the proposed Arizona sites. The duration of climatic records for the Arizona E(W) site is 118(20) years

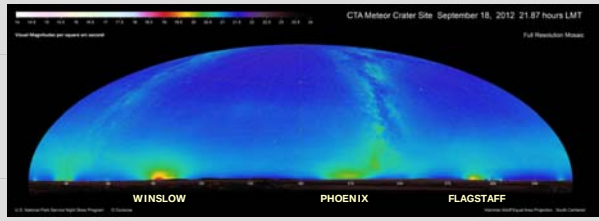
Night Sky Background (NSB) Measurements

NSB measurements done using:

1. Light Of Night Sky (LONS) device on CTA ATMOSCOPE: PIN-photodiode, V,B-band filters
2. Sky Quality Monitor (SQM) Commercial device (Unihedron)
3. Precision all-sky Photometry (D. Duriscoe, US NPS)



Comparison of NSB measured by SQM and LONS devices of CTA ATMOSCOPE

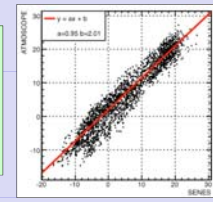


All-sky V-band panorama of NSB at Meteor Crater site. Zenith brightness = 21.7 mags/arcsec², essentially free of anthropogenic glow.

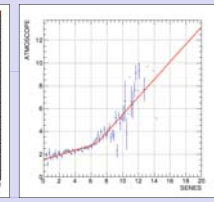
ATMOSCOPE Comparison with SENES

SENES Simulation

- Used to retrodict long-term weather behavior
- Validated and corrected by comparison with ATMOSCOPE ⟶

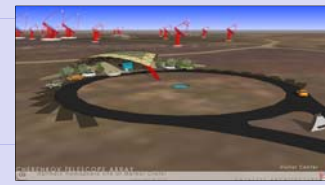


Temperature for AZ-East site ATMOSCOPE vs SENES



Wind for AZ-East site ATMOSCOPE vs SENES

Conceptual Plans for Meteor Crater Site



View of entrance and Visitor's Center

View of array and Control Building

CONCLUSIONS

- Two sites in northern Arizona, USA, are being proposed for CTA-North.
- CTA ATMOSCOPEs at sites measure weather, NSB and cloud cover conditions.
- The various NSB measurements agree; ATMOSCOPEs are used to calibrate a commercial simulation that estimates long-term weather conditions.
- Both sites are very dark and meet all CTA specifications.

Acknowledgment:
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