Predicted sky coverage for NFIRAOS

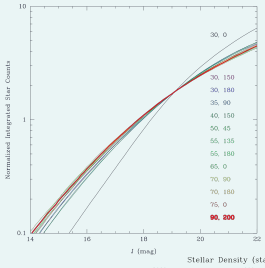
David Andersen

Lianqi Wang, Brent Ellerbroek, Glen Herriot

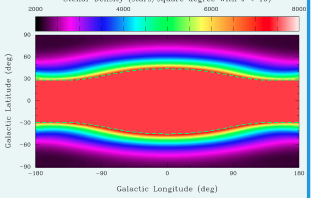
Method of building sky coverage maps

The Guide Star Density Map

The Besançon model was used to create a NFIRAOS NIR guide star density map.



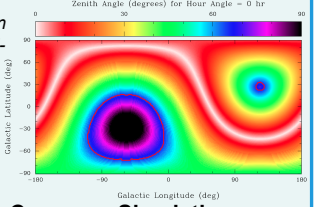
At high galactic latitudes, normalized star counts can be approximated by a single function (this breaks down closer to the plane, as shown), which simplifies sky coverage simulations.



We generated a map of stellar density which is accurate up to 7500 stars/ square deg with J<19.

Airmass Maps

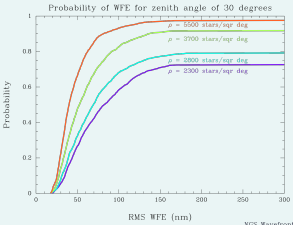
Galactic coordinates can be mapped onto declination. For a given DEC and HA, a zenith angle (or airmass; AM) map can be created.



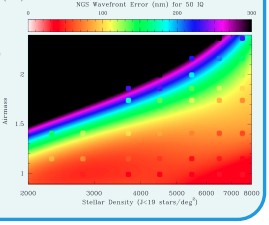
Zenith angle in galactic coordinates for HA=0 hr and Mauna Kea. The red lines show a zenith angle = 65°

MAOS Sky Coverage Simulations

MAOS was used to calculate the low order, NGS wavefront errors. See Wang, Ellerbroek & Véran (2009, Applied Optics) for details.



NGS WFEs were simulated for 500 random asterisms over 112 cases: 7 stellar densities, 8 zenith angles, and 2 atmospheric profiles.



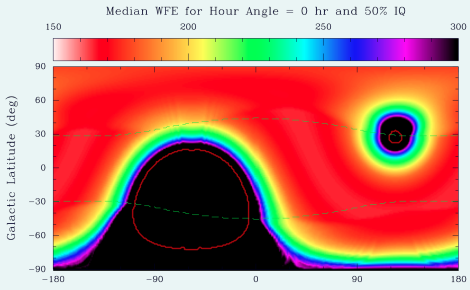
We interpolate MAOS results in the guide star density/ AM plane for e.g. the median NGS WFE (over 500 asterisms) for the median profile.

Summary

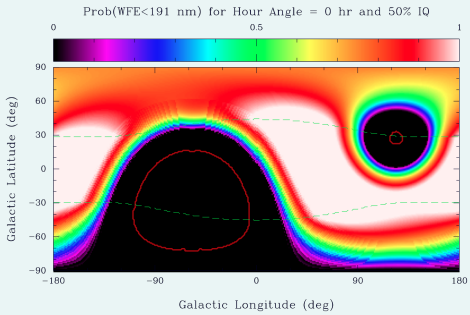
- NFIRAOS is required to deliver 50% sky coverage with wavefront errors (WFE) less than 191 nm RMS:
  - For median atmospheric conditions
  - For zenith observing
  - At the North Galactic Pole (NGP)
- To meet this requirement, NFIRAOS employs:
  - NIR NGSs
  - 2 arcmin MCAO corrected FOV
- Here, we show sky coverage maps built from MAOS simulations of L. Wang et al. for:
  - Different atmospheric conditions
  - Different Hour Angles (HA)
- NFIRAOS meets sky coverage requirement at NGP
- NFIRAOS sky coverage will be much higher than 50% at lower galactic latitudes

Key Results

By combining the guide star density map, the zenith angle map (for a given hour angle), the interpolated results from the MAOS simulations (left panel), and the high order WFE map (right panel), we can illustrate NFIRAOS performance over the entire sky. We highlight two key maps below.



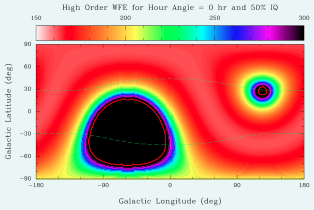
*For a model atmosphere that delivers median image quality (IQ), we show that for HA=0 hr, **the WFE delivered by NFIRAOS will be less than 180 nm RMS over much of sky** (for an average asterism).*



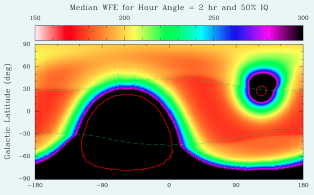
*For median IQ and HA=0 hr, **NFIRAOS will deliver a WFE less than 191 nm more than 70% of the time** over most of the sky observable from TMT.*

Exploring Parameter Space

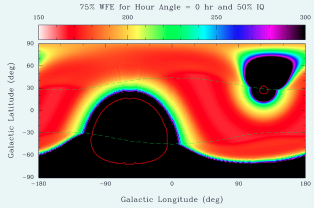
NFIRAOS sky coverage maps have been created to explore performance under different conditions.



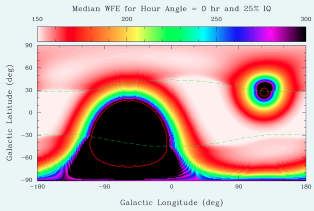
This map shows NFIRAOS WFEs for high order LGS modes. These WFEs are independent of the guide star density, and represents the best case performance (for a given atmosphere).



NFIRAOS performance for HA=2 hr (which allows 4 hours of observing with this performance – and better). The WFE < 210 nm RMS over most of the observable sky.



NFIRAOS performance for the "worst" quartile of random asterisms. 75% of the time the WFE<200 nm RMS at the NGP. The WFE closer to the Galactic Plane is relatively unaffected.



NFIRAOS performance for an atmosphere that delivers the 25% best IQ. The WFE<160 nm RMS over most of the sky in these favourable conditions.

National Research Council Canada / Conseil national de recherches Canada

Canada