Wavefront Sensing Guider

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Scope

- Guiding is ubiquitous with optical telescopes
- CCAT large aperture and short wavelength may require active guiding
- CCAT mirrors may be reflective in the O/IR
- What are the options for "optical" guiding with CCAT if required/desired?

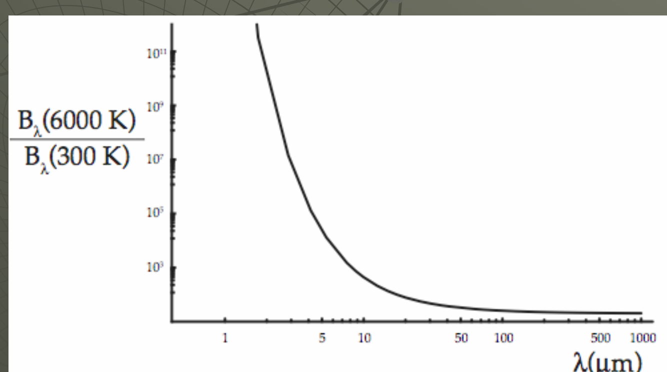
Edwin Hubble guiding the Mt Wilson 100" telescope

Requirements

- Guidestars within field of view
- Sensitivity to guide at 0.1-20 Hz
- Goal to guide in common mode with science starlight, avoiding additional non-common path concerns of a side-mounted guide telescope

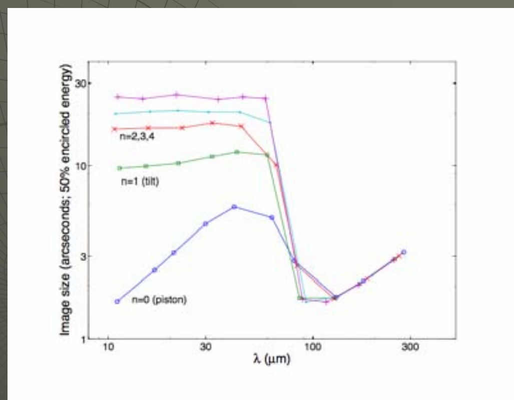
Key Design Issues

- Sensitivity requires λ<2.5 μm, for bright stars and dark sky



Key Design Issues II

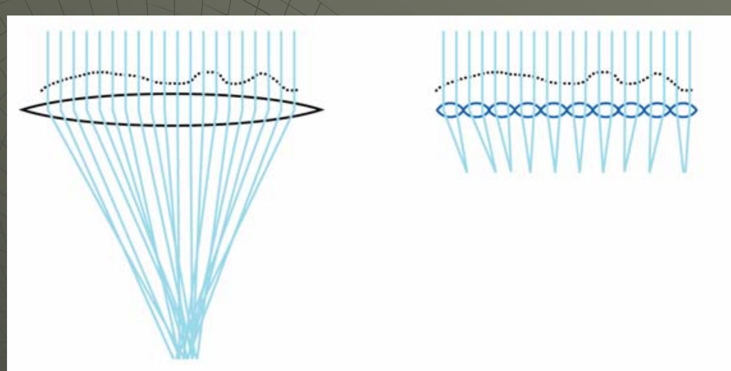
- PSF quality at short wavelengths



5 μm RMS segment aberration calculation by J. Zmuidzinas

System Design

- Consider subapertures on the primary



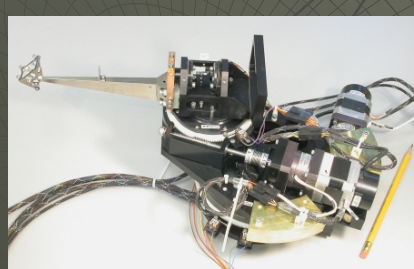
Sufficiently small subapertures will have low enough WFE for a compact PSF

System Design

- For subapertures small enough for a good PSF and large enough to avoid excessive diffraction, guiding signal (global tilt) is recovered without significant SNR penalty by averaging
- Can be considered as a parallel set of small guide telescopes, each using only a small piece of the optics
- Additional benefit is wavefront sensing
- Coarse alignment will require additional modes (e.g. Curvature/Phase Diversity) to sense segment edge discontinuities, as used for Keck mirror alignment, which can be implemented in same guider

System Design

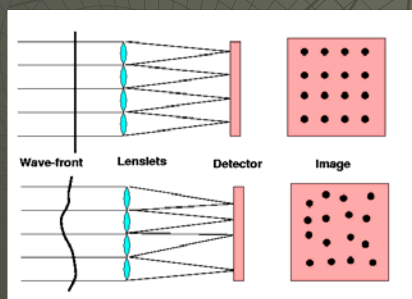
- Similar conclusions reached with optical telescopes, e.g. Gemini, TMT employ full time wavefront sensing guiders



Gemini Flamingos-2 OIWFS (NRC/HIA)

Shack-Hartmann Wavefront Sensing

- Most common form of wavefront sensing in Adaptive Optics; also used in optical metrology



Risk Assessment

- Requires specular reflectivity at short wavelengths
- FPA and optics technology is mature and available
- May require additional spec on small scale wavefront error (e.g. <1 μm RMS on scales < 30cm)
- May require additional maintenance of mirror surfaces
- Mitigates risks of mirror alignment and maintenance

Conclusion

- Wavefront sensing/guiding can be implemented at λ~2 μm
- There is a very large advantage in SNR available from astronomical objects by going to these wavelengths
- If the choice of panel technology supports these wavelengths, then an IR wavefront sensor can be a solution to initial calibration and maintenance of segment and telescope alignment