Investigating the Central Stellar Content of M32 with Adaptive Optics on Gemini North

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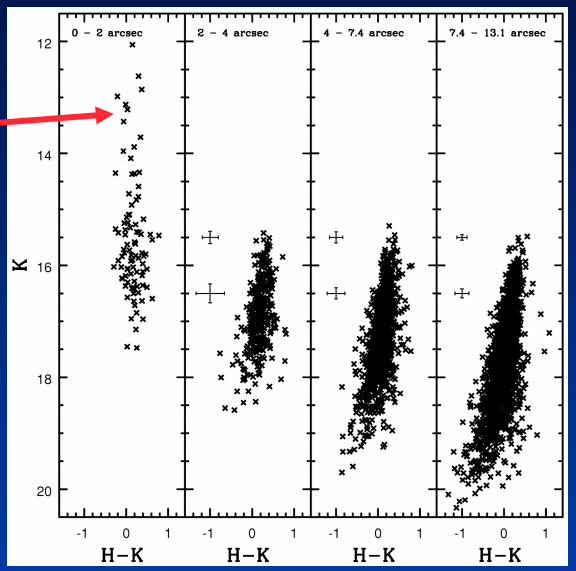
Why Should We Care About M32?

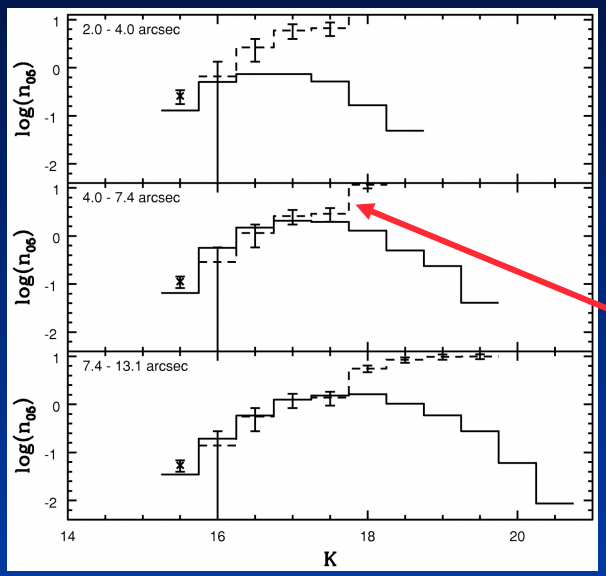
- M32 is a benchmark for testing our understanding of integrated galaxy spectra.
  - While the stellar content of M32 has almost certainly been affected by its close proximity with M31, it is close enough to be resolved into stars and yet distant enough for a representative integrated spectrum to be obtained through an arcsec wide slit.
- M32 might provide clues into the evolution of M31.
  - M31 has interacted with some of its companions, and there are indications that M32 may have passed through the M31 disk. The stellar content of M32 provides a means of determining when this happened.
- Studies of M32 may also provide insight into the formation of other cEs.

AO is required to resolve stars near the center of M32 from the ground. Three datasets obtained with AO systems on the Gemini 8 metre telescope will be discussed here.

The AGB-tip Brightness and Stellar Density

Blends



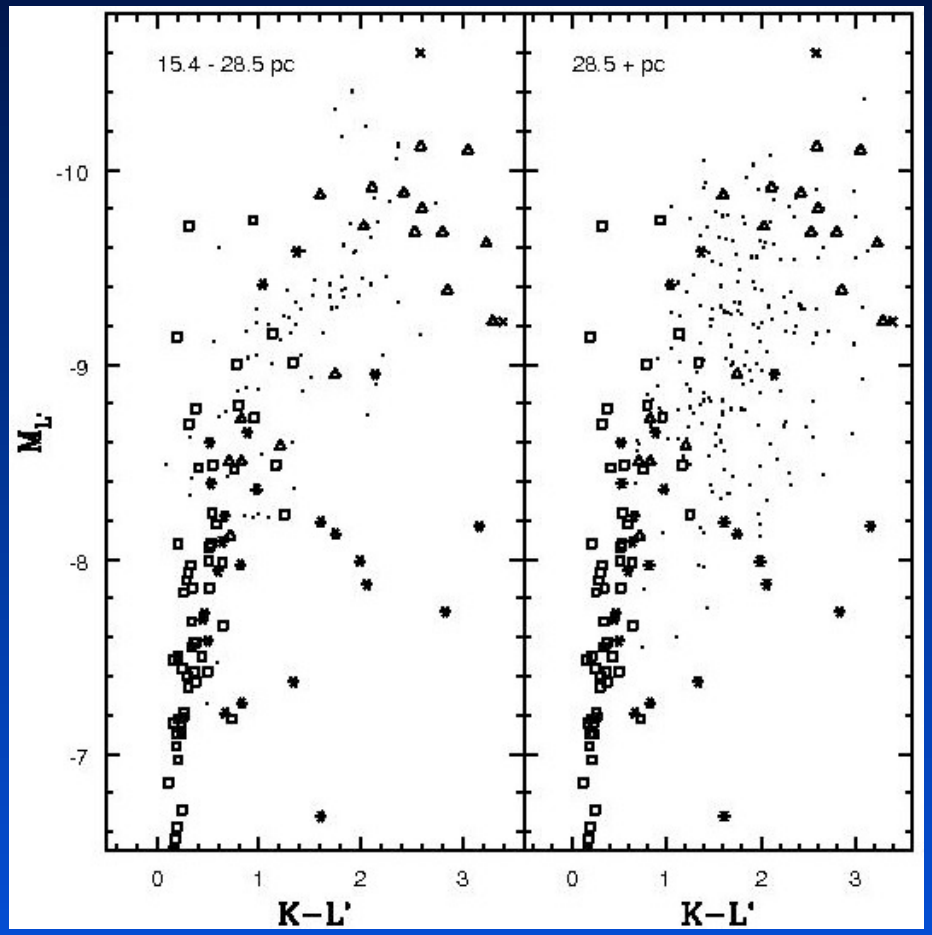


LF measured at 2 arcmin radius.

- Data taken with Hokupa'a (36 element curvature system) + QIRC, guiding on the nucleus of M32. FWHM ~ 0.12 arcsec in H and K_s.
- Individual bright stars are resolved to within 2 arcsec of the nucleus.
- Main results:
  - The peak brightness stays constant with radius if r > 2 arcsec.
  - The number densities of bright stars scale with r-band surface brightness throughout the main body of M32.

Comparisons with AGB Stars in Other Stellar Systems

- AO-corrected near-infrared data can be combined with L-band data (in this case also recorded with NIRI on GN) to further characterize the brightest red stars in M32.
- The brightest AGB stars in M32 have K brightnesses and K-L colours that are similar to those of the most luminous AGB stars in the Galactic disk.



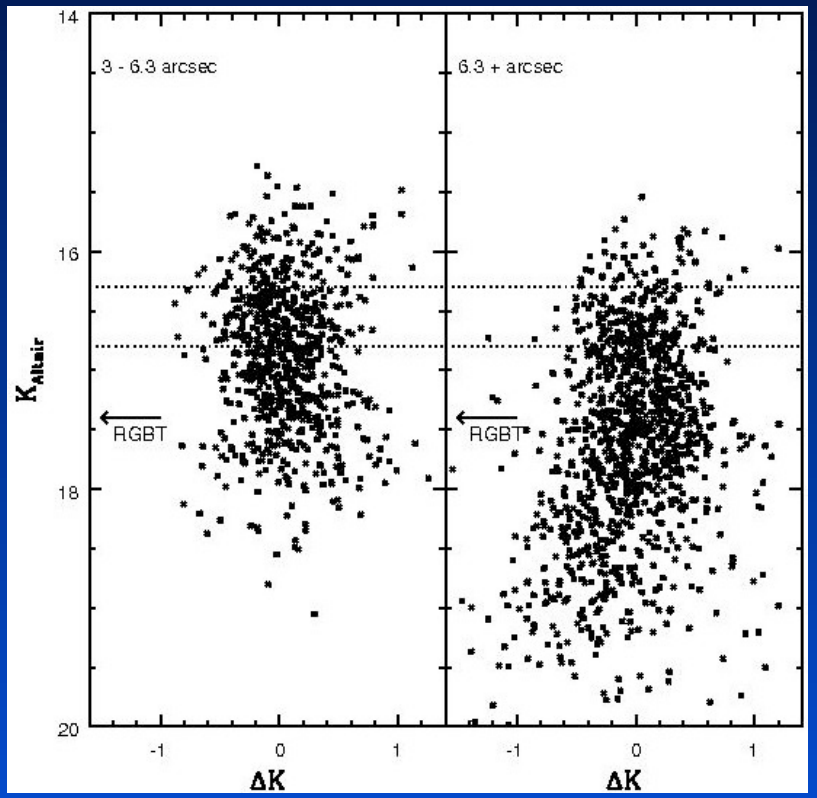
Δ : Solar neighborhood LPVs

*** : Bulge LPVs**

□ : Bulge giants

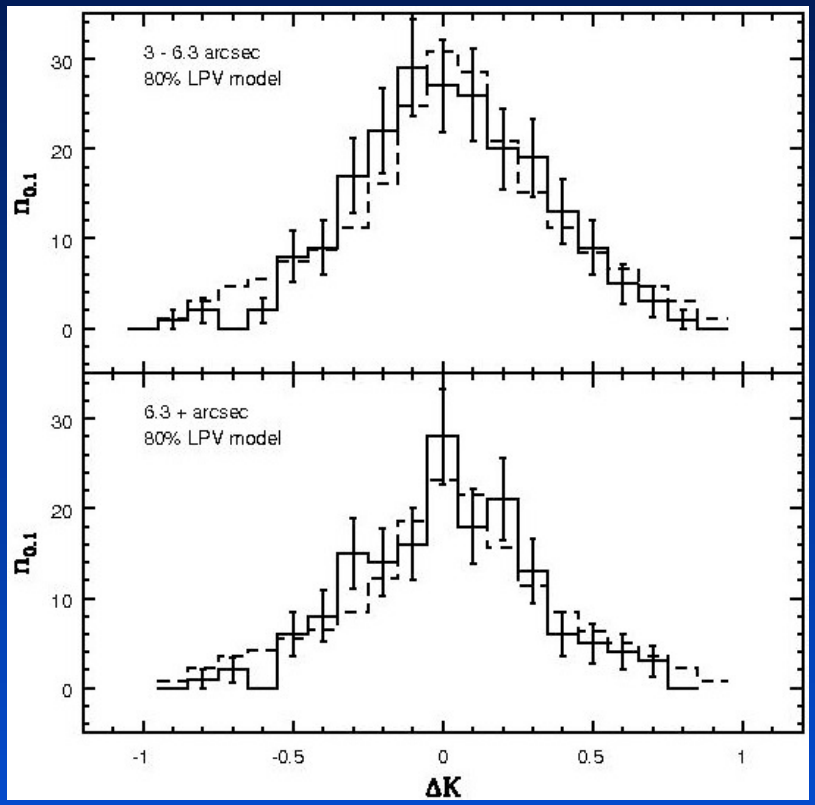
Characterizing the LPV Population Near the Center of M32

- Would expect many of the AGB stars in M32 to be LPvs. Is this the case?
- Data taken with Hokupa'a + QUIRC and ALTAIR + NIRI were combined to identify stars with K brightnesses that varied over a 3 year baseline.
  - ALTAIR uses a 12 x 12 Shack-Hartmann WFS that feeds a 177 acuator DM.
  - Used ALTAIR in NGS mode, guiding on the nucleus of M32.
- The basic idea: Compare observations taken over two epochs. If LPVs are present then the dispersion in ΔK will exceed that expected from photometric errors alone.
- Can model the ΔK distribution to constrain the fraction of bright stars that are LPVs.



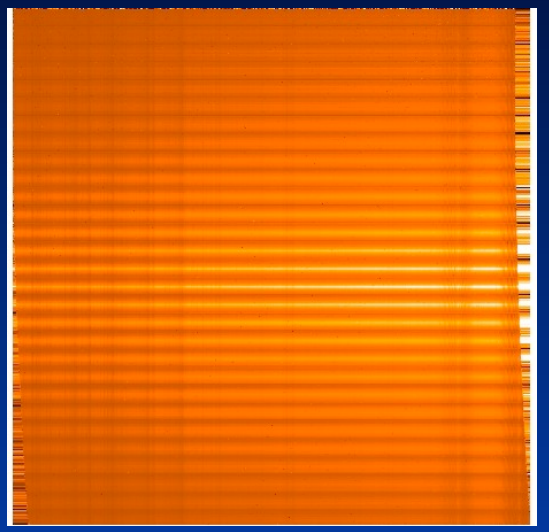
Measuring the Fraction of LPVs

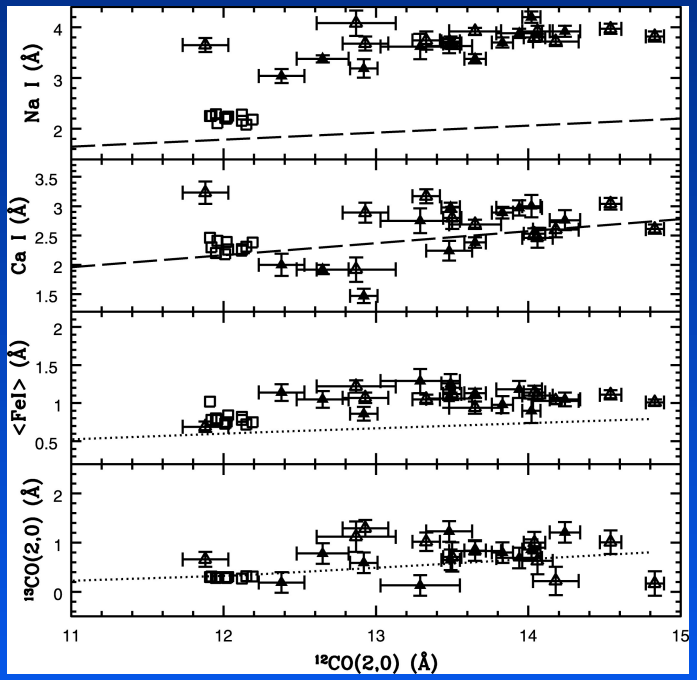
- Is the fraction of LPVs in M32 similar to other spheroidal systems?
- Adopt LPVs in the Galactic Bulge as a comparison data set.
  - Get similar results if use LMV LPVs
- A simulated ΔK distribution for a pure LPV population can be constructed using published data of Bulge LPVs. This can then be added in varying fractions to the ΔK distribution expected solely from photometric errors (determined from artificial star experiments).
- The observed ΔK dispersion in M32 can be reproduced if Galactic Bulge-like LPVs make up at least 60%, and nominally 80%, of the AGB stars in M32. This result is independent of radial interval near the center of M32.
- A similar LPV fraction has been measured in Cen A by Rejkuba et al. (2003, A&A, 411, 351).



The Near-IR Spectroscopic Properties of the Center of M32.

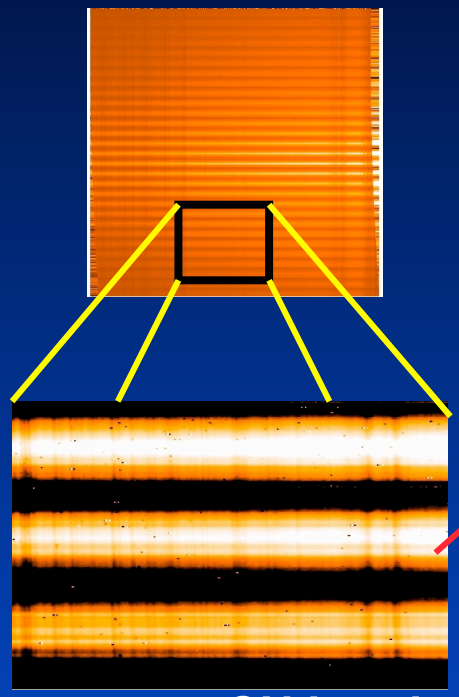
- NIFS is an integral field spectrograph on GN that is fed by ALTAIR
- Covers a 3 x 3 arcsec^2 area, with 29 0.1 x 3 arcsec^2 slitlets
- Spectral dispersion is 5300
- Data obtained by Peter McGregor and Tracy Beck with ALTAIR in NGS mode.

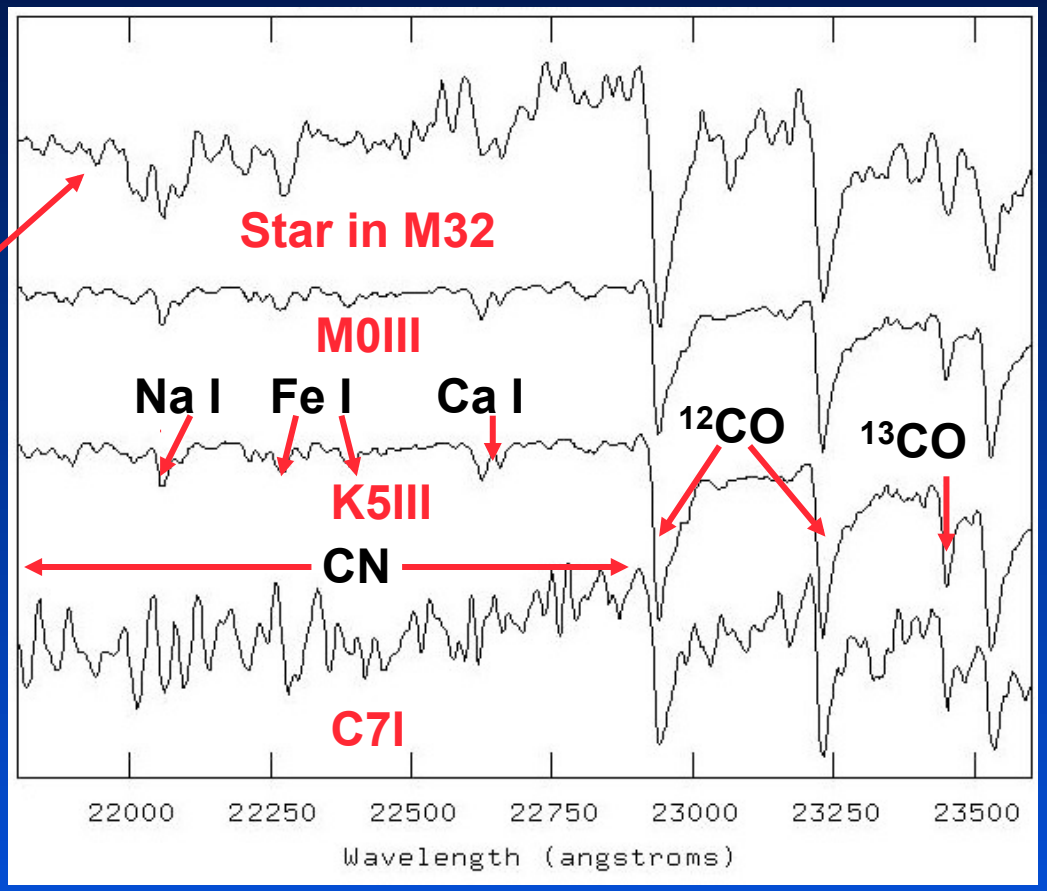




- Spectral indices measured from M32 spectra are shown as open squares, while the dashed line is the trend defined by solar neighborhood giants.
- The line indices suggest that the integrated light within 1.5 arcsec of the nucleus has solar-neighborhood like abundances.
- There is no radial gradient in line strengths in M32.

Pushing the Envelope: Near-IR Spectra of Star/Star Complexes Near the Center of M32 (Davidge et al. 2009, in preparation)

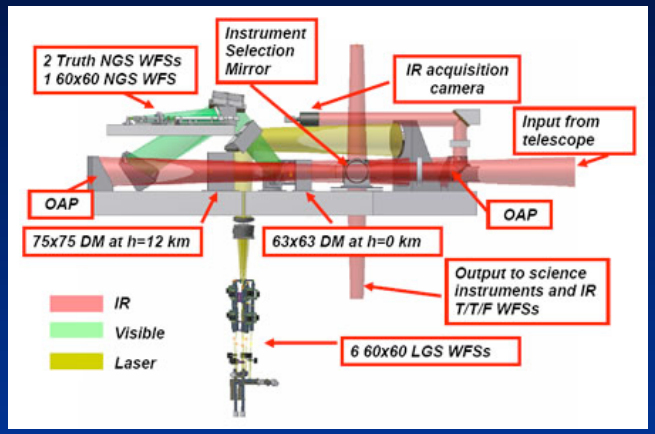


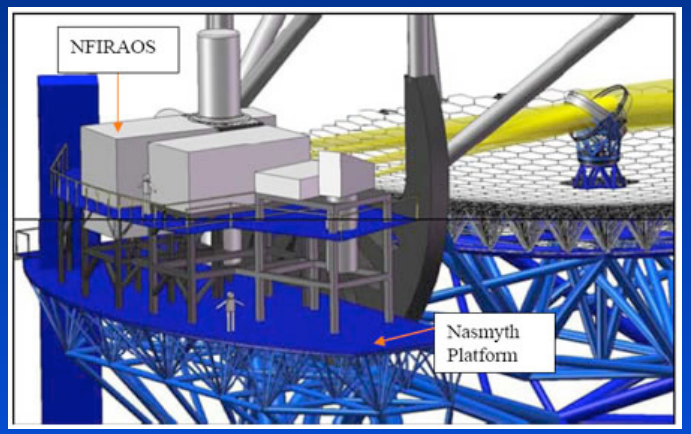


- Note strong CN bands in the M32 star.
- Other stars in M32 show similar characteristics.
- Evidence for C stars in M32?
- H-band spectra are currently being reduced to search for C_2 bands.

The Future: NFIRAOS and the TMT

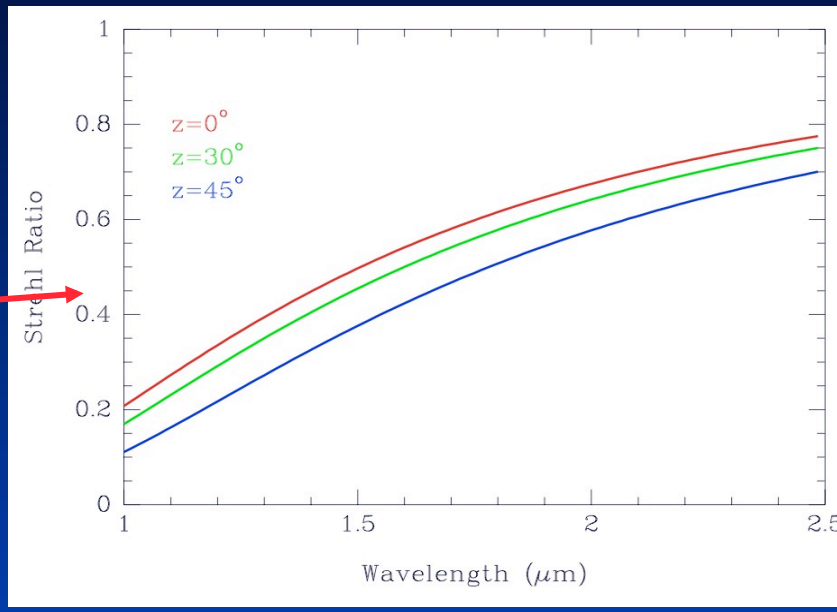
- Narrow-field adaptive optics system geared for use in the near-IR.
- Will be the facility Multi-Conjugate Adaptive Optics System for TMT
- Designed by HIA (Project Manager: Glen Herriot) and the TMT Project (AO Scientist: Brent Ellerbroek)
- Diffraction limited PSF on TMT has FWHM between 7 mas (1 μm) and 17 mas (2.5 μm)

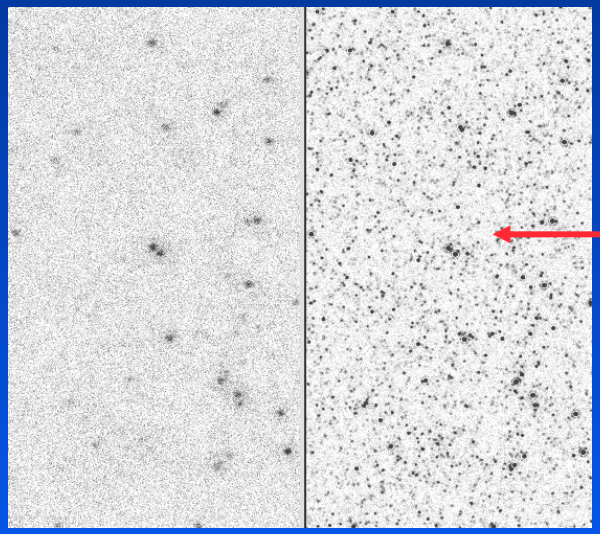




The Future: AGB Stars in Virgo Spheroids

Mean Strehl ratios (Mahajan's approximation using latest WFE budget) over 10 arcsec FOV in median conditions and 50% sky coverage at the Galactic pole for different zenith angles. Includes ~2.5 mas of blurring (tip/tilt and plate scale modes). Roughly 70% sky coverage is obtainable if 3.5 mas of PSF blurring is acceptable to the science. Credit: L. Gilles, L. Wang and J.-P. Veran)





3 Hour simulated exposure of a field in a Virgo cluster spheroid with ALTAIR+NIRI (left) and NFIRAOS+IRIS (right).