Guidelines on Preparing an ALFA Proposal

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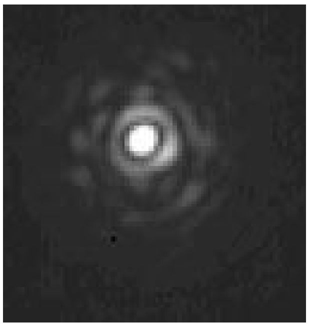
Important Remarks

Performance Limitations

The performance of ALFA strongly depends on atmospheric conditions, i.e. seeing, wind speed, and temperature difference between the main telescope mirror M1 and the environment. The characteristics below assume **good** atmospheric conditions (< 1.5 arcsecs seeing in the V-band, wind speed < 10 m/s, and temperature difference between M1 and air < 3 K).



Using the Laser Guide Star (LGS) as reference for wavefront sensing requires **very good** transparency conditions.

The best results achieved with ALFA so far were Strehl Ratios of ~70% in K-band (with near-diffraction limited images and FWHM ~0.15 arcsecs, see figure on the left side) and 12% in J-band. These results were taken using the observed object as a natural guide star (NGS) for wavefront sensing as well as for tip-tilt correction.

Selecting a reference star

Whenever the science object itself is bright enough ($m_V \leq 11$, see also QE of wavefront sensor CCD below) and point-like (FWHM < 1 arcsec) it should be used as the NGS.

If the science object is not bright enough, or it is too extended, then there must be a reference star in the field (max. 30 arcsecs distance from the science object) to be used as the NGS with the same restrictions as above.

In all other cases the LGS is the only choice for using the high order adaptive optics compensation system.

Selecting a tip-tilt reference star while using the LGS

When the LGS is used for wavefront sensing, a natural guide star for tip-tilt correction has to be available within 30 arcsecs radius (within the isoplanatic patch) around the science object (1 arcmin radius with non-ideal correction). The limiting magnitude for this tip-tilt reference star is m_V=15 (see also QE of tip-tilt sensor below). The science object itself can also be used for this purpose if it is bright enough.

Sky frames and making mosaics with Omega-Cass

When the AO system is locked on a given reference star the science object cannot be moved around on the OMEGA-Cass detector by more than ±20 arcsecs.

For extended objects, it may be necessary to move > 20” to obtain a sky frame for background subtraction. This is possible if the LGS is being used. With a NGS the AO has to be switched off and the telescope slewed by the observer.

Observing Efficiency

A typical Alfa calibration procedure takes 5-10 minutes. Calibration profiles for different seeing conditions, telescope positions, reference star brightness, etc. can be stored but have to be repeated as necessary. The first half of the first night is spent on instrument setup.

Observing Support

MPIA will provide the technical support to operate ALFA. No special knowledge of adaptive optics is required.

General Technique for the Laser Guide Star (LGS)

The LGS operator will advise you on this.

General Technique for Natural Guide Stars (NGS)

Most observing techniques can also be used with adaptive optics, but there are some restrictions, most importantly:

1. Before moving the telescope make sure the AO operator has *opened* the loop(i.e. turned off ALFA). And before taking data, particularly after moving, make sure the AO operator has *closed* the loop(i.e. turned ALFA on).
2. If dithering, then you must move in small steps (10" max) so that the AO operator can follow the guide star with the wavefront sensor. The maximum dither may be limited by how far off-axis the wavefront sensor can move, which is about 20".

3. If separate PSF calibration exposures are needed, they should be made every 10-15 minutes.

Science Object Exposures

The guide star should always be acquired first in the centre of the field so that it can be found on the wavefront sensor. If necessary, it is then possible to move it off-axis in small steps to bring the science object nearer the centre of the camera, allowing the AO operator to re-centre the wavefront sensor each time.

Observing can then proceed - it is strongly recommended that macros are used.

A typical sequence for object-sky

Pause while AO loop is being closed
Integrate on target
Pause while AO loop is opened
Move to sky, integrate, move back exactly to NGS & target
repeat

A typical sequence for dithering may be

Pause while AO loop is being closed
Integrate on target
Pause while AO loop is opened
Move 10"
Pause while wavefront sensor is centred on the NGS
Move another 10" and pause again
repeat

PSF Exposures

It is often important to be able to quantify the PSF, and there are a number of ways to do this. The simplest requires a pair of stars which can replicate as closely as possible the observing conditions for the science object:

1. their separation should be similar to that of the science object and NGS
2. they should be in roughly the same direction on the sky
3. the one used for correction should be a similar magnitude to the NGS, and the other as bright as possible for high signal-to-noise
4. the number of modes corrected and frame rate should be the same as for the science object

Because the atmospheric conditions can change on short timescales it is important to take PSF measurements frequently, i.e. every 10-15 minutes.

Quantum efficiency curves of the Shack-Hartmann wavefront sensor CCD (LLCCD) and of the Tip-tilt sensor CCD (EEV39-02).