NACO Science Verification Program
Spatially resolved observations of Seyfert Galaxies

1 Introduction

Understanding the complex structure of the close environment of an AGN and the way the *monster* can be fueled with matter, are two major issues in the field of Active Galactic Nuclei. However, given the predicted size of a structure as the dusty/molecular torus –from 1 to 100 pc–, sub-arcsecond imaging or spectroscopy is mandatory. The near-infrared range is especially well suited to this type of study, since it offers three advantages: the best angular resolution achievable with adaptive optics, a deep probing capability through the opaque dust associated to those very dense regions, a number of spectroscopic signatures of the various components (young and evolved stars, ionized and molecular gas, dust, coronal lines, etc). Many active nuclei actually show signatures of both a starbust and an accreting massive object, so that the spectroscopic diagnostic, coupled to the high angular resolution provided by adaptive optics, is required to separate the different components that are mixed at a typical scale of 1-100 pc. Detailed HAR observations of the closest AGNs should allow us to put in evidence the morphological and/or spectroscopic signatures of several pieces of the puzzle: accretion disk, ionization cone, NLR and BLR, compact starburst, dusty/molecular torus, micro spirals and bars.

2 Scientific and technical goals

The main scientific objectives of this science verification program will be:

- the search for morphological structures invoked in the *unified model* of AGNs: molecular disk, dust/gas torus, cusp, micro-bars and micro-spirals, micro-disk distribution of stars, dynamically decloupled (even counter-rotating) nuclei. BB imaging (J,H,K,L), especially in the thermal IR is the first basic approach, but spectro-imaging (long-slit) in the H_2 rovibrational lines, in the recombination lines (Br_γ and Pa_β) and in the 3.3 μm PAH lines will also be of particular importance in this quest.

- the spectroscopic study of the stellar population in the very central region (100 pc): for instance, a very sensitive starburst tracer is M/L ratio at 1.62 μm derived from observed stellar fluxes (mainly CO 6-3 line); Fe lines can be used to trace supernovae and measure the star-formation rate; stellar absorption lines are a good estimator of the age and metallicity of the stellar population.

- the search for spectroscopic signatures of the AGN : coronal lines (Si IX, Si VI, Ca VIII), which are very specific AGN tracers, broad lines (BLR) seen through the dust, lack of PAH (3.3 μm) line.

- the kinematic analysis of the various lines profiles in order to constrain the mass of the central massive object and the density distribution of its environment.

In addition to these scientific goals, this program will constitute a test of the ability of NACO to servo on slighly extended sources. Indeed, no natural guide star are available in the near environment of the nuclei chosen for this program: the nucleus itself will be used for guiding. The experience of this program will be helpful for future similar use (extragalactic or solar system observations).

As we intend to test as many observing modes as possible, we plan to observe each target with all the offered modes before going to another one.

3 Observations

We plan to observe three nearby Seyfert galaxies. Table 1 summarized their main parameters.

Table 1: Main parameters of the galaxies proposed for the AGN program

Galaxy	NGC 1097	NGC 1386	NGC 7582
Alpha (J2000)	02 46 19.2	03 36 45.42	23 18 23.3
Delta (J2000)	-30 16 29	-35 59 56.7	-42 22 16
Seyfert class	1	2	2
redshift (km.s^{-1})	1285	742	1545
m$_K$ in 2$''$	10.6	10.7	9.4
Observability	5.8h@sec(z)<3	5.1h@sec(z)<3	9.5h@sec(z)<3
in	4.9h@sec(z)<2	4.2h@sec(z)<2	8.6h@sec(z)<2
August	4.0h@sec(z)<1.5	3.2h@sec(z)<1.5	7.3h@sec(z)<1.5

For all galaxies, we intend to guide on the nucleus itself and to use the infrared wavefront sensor of NAOS.

For NGC 1097 and NGC 1386, broad-band imaging in J, H, K, and L band will be performed with the following set-up:

- J band: camera C50S, DIT=xxx, NDIT=xxx
- H band: camera C25S, DIT=xxx, NDIT=xxx
- K band: camera C25S, DIT=xxx, NDIT=xxx
- L band: camera C12S, DIT=xxx, NDIT=xxx

The long-slit spectrosocopy of the three galaxies will be done with the following set-up:

- 1.00 μm-1.40 μm: slit width=86 mas, filter S1, grism 4 in order 1, camera 12S, R=1800, DIT=xxx, NDIT=xxx
- 1.50 μm-1.82 μm: slit width=86 mas, filter H, grism 3 in order 3, camera C12S, R=900, DIT=xxx, NDIT=xxx

- 1.85 μm-2.50 μm: slit width=86 mas, filter S3, grism 2 in order 2, camera C12S, R=1500, DIT=xxx, NDIT=xxx
- 3.20 μm-3.76 μm: slit width=86 mas, filter L, grism 1 in order 2, camera C12L, R=900, DIT=xxx, NDIT=xxx

For NGC 1097, we will use x slit positions for each wavelength domain, for NGC 1386 x slit positions, and for NGC 7582 x slit positions.