The black hole and host galaxy relationship over the cosmic time.

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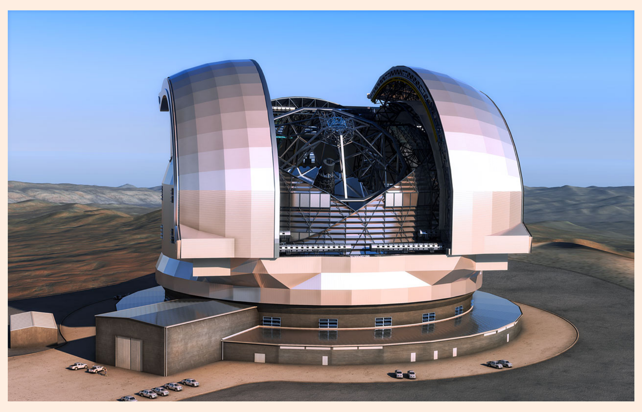
INTRODUCTION

The discovery of a relationship between the central black hole and the properties of their host galaxies is a fundamental ingredient for a comprehensive interpretation of the structure and evolution of the galaxies. Of particular relevance is the understanding how this relationship evolves over the cosmic time and can offer important clues for the study of the formation processes of galaxies and their central massive BHs.
To investigate this issue we need to measure the black hole mass and the properties (luminosity, size, morphology, stellar population, …) of a suitable sample of active galaxies at different redshift. This requires exceptional observing capabilities in terms of sensitivity and spatial resolution.
In order to explore this link it is needed to measure both the mass of the central BH and the properties of its host galaxy over a significant cosmic time. This can be done using spatially resolved spectroscopy of quasars and their host galaxies. The BH mass can be derived from the width of the broad emission lines and the continuum luminosity of the nucleus (using virial method from single epoch spectra or more accurately getting the size of BLR from reverberation mapping technique). At z > 2 quasar host galaxies are angularly very small (0.2”-0.3” half light radius) therefore it is extremely important to image the sources with a very narrow PSF (to reduce the emission from the nucleus) and high sensitivity to properly detect the faint extended emission from the galaxies. These conditions are well matched by the future EELT camera (MICADO) that thanks to the combination of high sensitivity and superb spatial resolution, when combined with MCAO corrections, is able to derive quasar host properties with high accuracy.
We present here a set of simulations of high z QSO aimed at evaluating the specific imaging capabilities of MICADO for the above scientific case.



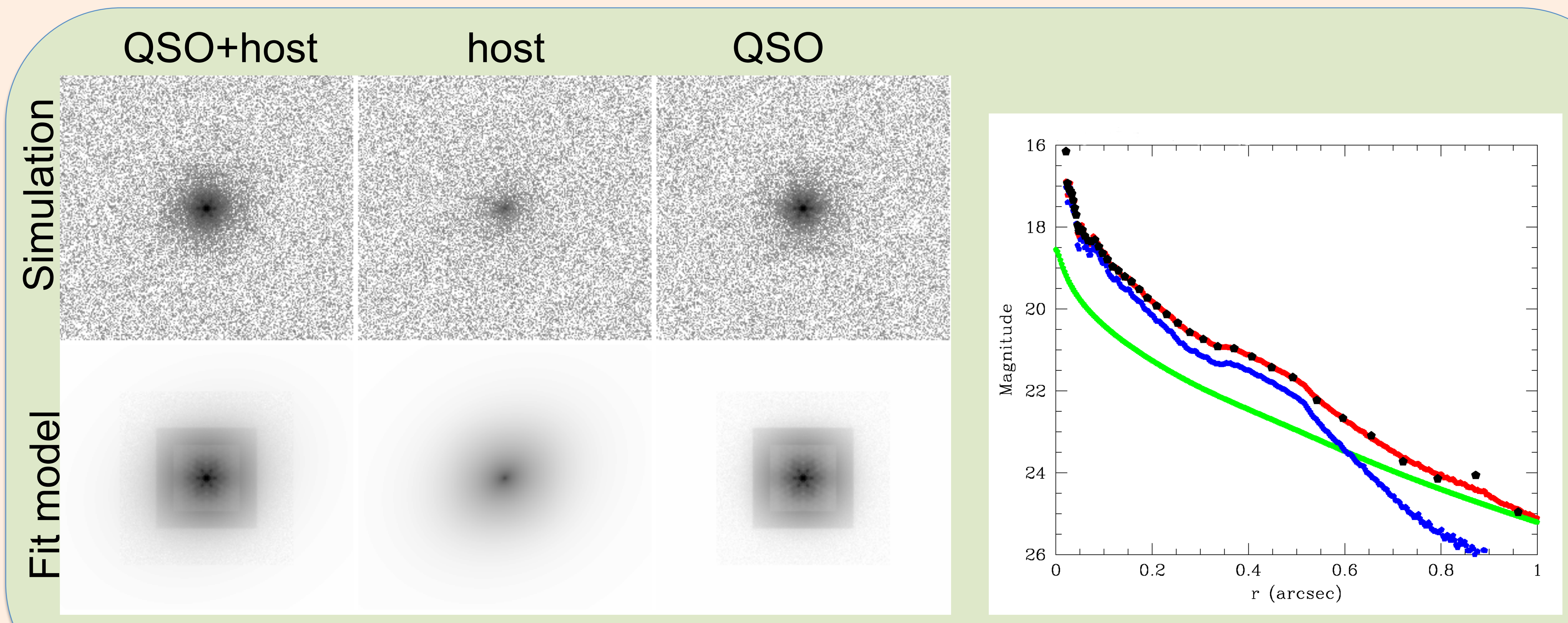
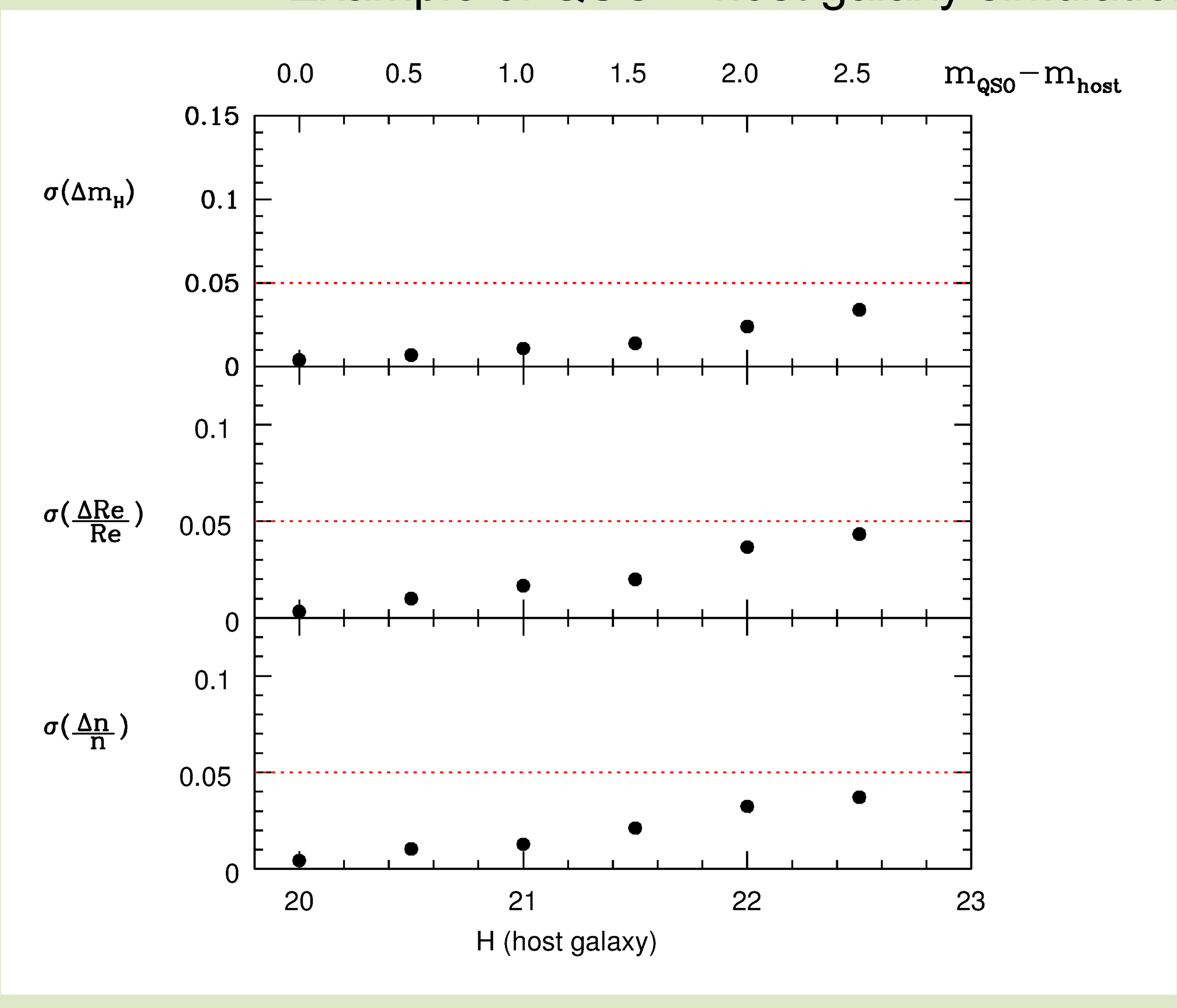


Figure 1
LEFT: Example of the simulated image (H band; 2h exp) of a QSO at z =2. The QSO (M_R =-24 and its host galaxy : M_R =-22.5; Re = 0.3” (~ 2 kpc) and Sersic index n=2.5.
RIGHT: The average radial brightness profile of the QSO (filled squares) compared with the fit (red line) of the two components model: point source (blue) and host galaxy (green) as derived from GALFIT.

IMAGE SIMULATIONS & ANALYSIS

We are carrying out several simulations of high redshift QSO in order to evaluate the capabilities of MICADO@EELT to characterize the structural and photometric properties of their host galaxies. We assume the specifications adopted in the phase-A study of the instrument (see Davies et al 2010). In particular we assume as PSF that provided by MAORY under 0.6” seeing (see http://www.bo.astro.it/maory/Maory/DATA.html for details). The simulation of the images were performed using the Advanced Exposure Time Calculator (AETC; http://aetc.oapd.inaf.it/). These include sky and environment background, statistical and read out noise, and appropriate convolution of the galaxy models with the PSF.
We show here a representative example of a QSO at z = 2 with H = 20 and host galaxies (n = 2.5) of various magnitude fainter. For each case (QSO nucleus + host galaxy) we performed 30 simulations and then analyzed the images with GALFIT. For the PSF we adopted simulated images of a number of bright stars in order to properly map the PSF over a large dynamic range. For each case (same nucleus and host galaxy parameters) we derive the average values of the parameter fit (total magnitude, effective radius) and the 1-sigma dispersion value. These are shown in Figure 2 for a representative example of QSO simulations. Full details of these analysis including the effects of PSF variations will be reported in Paiano et al 2015 (in preparation).

Example of QSO + host galaxy simulation at MICADO@EELT



QSO z = 2
H = 20 (M_R ~ -24)

Host galaxies

H = 20-22.5
(M_R ~ -24,-21.5)
Re ~ 2.5 kpc

Figure 2
The 1-sigma uncertainty of the main parameters of the QSO host galaxies as derived from 30 simulations of each combination (nucleus, host galaxy) of QSO images.

Under the assumed (ideal) conditions it will be possible to determine the host galaxy luminosity, effective radius and Sersic index of distant QSO with an accuracy better then 5% (horizontal red dotted lines).

These observations will allow one to well characterize high z quasar host that are compact (2-3 kpc) and 2-3 mag fainter than their nuclei.

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