MEGARA

Multi Espectrógrafo en GTC de Alta Resolución para Astronomía

MEGARA Observing Preparation Software Suite (MOPSS)

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Abstract

We describe the software components of the **MEGARA Observing Preparation Software Suite (MOPSS)**. MEGARA is an optical Integral-Field Unit (IFU) and Multi-Object Spectrograph (MOS) designed for the GTC 10.4m telescope in La Palma. The MEGARA IFU mode will offer both IFU and MOS capabilities.

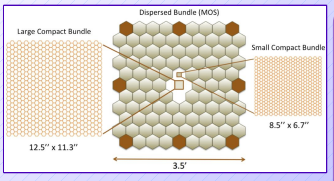
The MOPSS will provide observers the necessary tools to plan their observations with GTC/MEGARA in an optimum way. It includes the **MEGARA Exposure Time Calculator**, the **MEGARA Image Simulator**, and the **Fiber MOS Positioning Tool**. The three tools shall be stand-alone, multi-platform, and easy-to-install software packages. Web-based GUI versions that will not require any previous installation to be run by the user are under consideration too.

The MEGARA ETC allows obtaining in a straight-forward way an estimate of the required observing time with MEGARA to achieve a specific scientific objective. This tool is best suited for the Phase I preparation of observing proposals. The MEGARA Simulator is intended for astronomers planning on doing an intensive use of the instrument or working very close to the sensitivity limits of the instrument. It will fully simulate the 2D frames to be generated by the instrument. Finally, the FMPT allows estimating the optimal configuration and use of the MEGARA MOS starting from a list of sources with different priorities.

An updated view of the current status of each tool (at a level of Critical Design Review) is provided. MEGARA first light is scheduled in 2016.

A brief MEGARA description

The MEGARA IFU mode will offer two different fiber bundles, one covering 12.5x11.3 arcsec^2 (**Large Compact Bundle; LCB**) and another covering 8.5x6.7 arcsec^2 (**Small Compact Bundle; SCB**), with different spaxel sizes (0.62 and 0.42 arcsec, respectively). The **MOS mode** consists of a total of 92 additional mini-bundles with 7 fibers each that will be positioned by Robotic Positioners (RPs) in a region 3.5x3.5 arcmin^2 in size around the central IFUs. Eight additional RPs in the outer edge of the field-of-view will be used for sky background measurements.



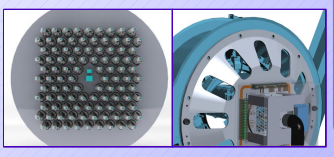


Figure 1: ***Top:*** Diagram of the MEGARA geometrical layout for the three observing capabilities of the instrument (LCB, SCB, and MOS). The hexagons in the LCB and SCB represent the section of the micro-lens appended to each fiber. The hexagons in the MOS correspond to the spatial region that is patrolled by each RP. ***Bottom:*** Design of the MEGARA Positioner system at the GTC Folded-Cassegrain (FC) focal plane. A RP locates a 7-fibers mini-bundle on the target position combining the interpolation of two rotations.

MEGARA will use Volume Phase Holographic (VPH) grisms as dispersive elements. The wavelength coverage will be 3,650-10,000 Å with a spectral resolving power from 6,000 to 18,700 in the LCB and MOS modes and from 7,000 to 21,500 in the SCB mode, depending on the selected VPH. The whole optical spectrum will be covered both at low (R~6,000) and medium (R~11,000) resolutions. At R~19,000, both the Hα and CaT would be also accessible

Exposure Time Calculator

The MEGARA Exposure Time Calculator (ETC) is a tool intended to simulate the signal-to-noise (S/N) ratios that will be obtained for the continuum and a spectral line of a target for a given light distribution in the source, exposure time, MEGARA setup, and night atmospheric conditions at La Palma Observatory.

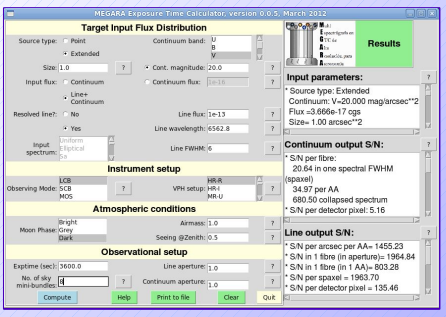


Figure 2:

Graphical user interface of the ETC prototype. Future versions will also provide estimates of the exposure time required to achieve a given S/N on a target, and limiting fluxes for a given S/N and exposure time under certain conditions.

The limiting magnitudes of MEGARA for continuum in point sources at high, medium, and low resolutions are V=24.0, 24.3, and 24.6 mag respectively in the whole wavelength ranges covered by B, V, and R bands, for S/N=5 per spaxel in 1 h of exposure time.

Limiting line fluxes of 2.8x10^{-19}, 3.0x10^{-19}, and 2.7x10^{-19} c.g.s. units can be achieved at S/N=5 per spaxel at the center of the R band at high, medium, and low resolutions respectively, for 1h of exposure time.

Image Simulator

The Simulator tool creates a set of data frames simulating the output of the MEGARA instrument depending on the observational strategy adopted for observing a given source. The Simulator creates a sky+object model, including the different noise sources in the CCD frame. It also includes the effects associated to the observation that are removed through a typical reduction process: bias, flat, geometrical distortion, non-linear dispersion, cross-talk, cosmetic defects, and cosmic rays. To date, only 2D-gaussians with different FHWM can be used as light distributions for the sources. Sersic profiles will be soon implemented.

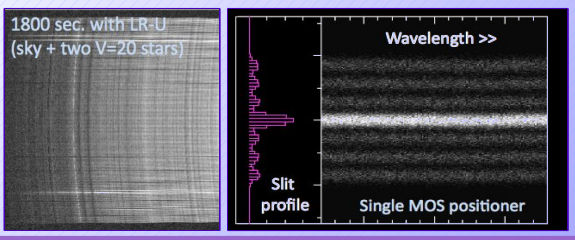


Figure 3: **Left:** Simulated MEGARA CCD frame of two stars with V=20 mag, with the Low Resolution U-band VPH and a exposure of 0.5h. **Right:** Simulated MEGARA light distribution of a point source in the 7 fibers of a MOS mini-bundle.

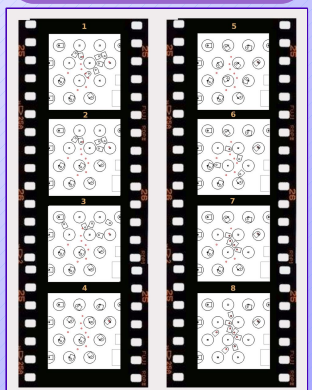
This tool accounts for the flux distribution of the input source, the instrument configuration, the atmospheric conditions of the run, and the observational strategy used to simulate the CCD frame.

Fiber MOS Positioning tool

The Fiber MOS Positioning tool (FMPT) shall define the optimal assignment of the 92 Robotic Positioners (RPs) for a set of targets in the MOS field-of-view. It shall generate a series of Configuration Blocks (CBs), designed to cover as many sources as possible.

Each CB contains information to:
- point the telescope and set the Fiber-MOS position angle with the FC rotator;
- assign a RP to each target;
- move the RPs from safety positions to observing positions avoiding dynamic collisions, and viceversa;
- optimize the sequence of RP movements to minimize the configuration time.

Figure 5: Example of sequence of coordinated simultaneous movements (in 8 phases) required by a set of RPs in the MEGARA MOS to place the fiber mini-bundles onto 9 objects on the sky, starting from another pointing configuration. The target positions are marked with red circles in all panels.



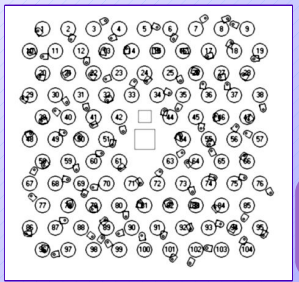


Figure 4: An example of CB placing the RPs onto 100 targets on sky. The CBs will be used to configure the MOS in observing runs and to allow the Data Reduction Pipeline to identify the RP used to observe each specific target.

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