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E-ELT Instrument concept study for first light. OPTIMOS-DIORAMAS: Slit Mask Manufacturing and Exchange Units design overview

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Abstract. The Seeing-limited, large multiplex, optical/near-IR spectrograph, Optimos-Dioramas, studied by a Consortium of Institutes from France, Italy, and Switzerland, is one of the possible candidates for first light on the E-ELT Telescope. The spectograph is designed to maximize the field of view and cover in two-shot the spectral range (0.37micron - 1.6micron).
This paper describes the studies performed to establish a base-line conceptual design of the Slit Masks System for the Optimos-Dioramas spectrograph. This unit has been designed in order to better satisfy the limits of the allowed volume on the Nasmyth E-ELT platform, and it is also able to guarantee all the optical specifications needed to cover the overall field of view (measures 1468x1468mm - divided in 4 quadrants). In order to take and position the masks in the focal plane, the system is fully robotic and able to load/unload the masks in the proper quadrant.

1. Introduction

The OPTIMOS-DIORAMAS study, proposed in response to ESO "Call for Proposals for a Phase A study for E-ELT PROGRAMME Study", is aimed at analyzing the feasibility of a wide field imaging multi object spectrograph for the E-ELT, covering an extended spectral domain from visible to NIR. In the multi-slits approach, the OPTIMOS-DIORAMAS concept is based on slit masks at the focal plane. This study, based on a slit masks approach, takes advantage of the experience of the VLT VIMOS and other multi slit spectrographs. DIORAMAS would be installed at the Nasmyth focus of the E-ELT. It rest on the platform, with a support structure enabling co-rotation with the telescope field. The beam from the telescope first encounters focal plane multi slit masks, collimating optics, filters or gratings, then visible or near IR cameras focusing onto detector arrays.

This paper describes the global preliminary mechanical design and the technical solutions of the MEUS and MMUS that are systems of the Optimos-Dioramas instrument. The function of this system is to perform the off-line, re-

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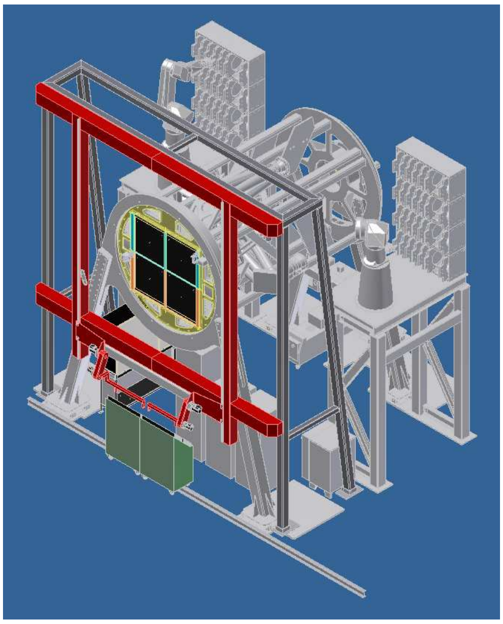

Fig. 1. Optimos-Dioramas: overall view.

Fig. 2. Field of view of Optimos-Dioramas.

motely controlled, mask manufacturing, identification and preparation of the mask reservoirs for the observing run.

1.1. FoV

The OPTIMOS-DIORAMAS instrument (see Fig. 1) field of view measures 1468x1468mm - will be divided in 4 quadrants. In order to hold and position the masks in the field of view, a central dead cross of 30mm is needed. The numbering and position of the 4 quadrants in the instrument field of view assumed it is shown in Fig. 2, which assumes a view of the "backbone cross mask" looking towards the sky from the spectrograph side.

1.2. Mask physical constraints and requirements

Each mask size will necessarily be larger than the useful quadrant FOV of 719x719mm, i.e. 780x780mm, as schematized in Fig. 2. Part of the free 49mm border of each mask will contain the mask identifiers.The selected material for the masks is AISI steel 1015 thickness 0.6mm. The overall requirement on the slit absolute positioning accuracy is 180micron: the design meets this requirements and can be improved at the expense of a higher cost for the laser cutting machine.

2. Mask Exchange Unit System

Once slits and reference apertures have been cut and masks are identified, they will be placed in two reservoirs/transporters, each serving two quadrants. Once the reservoirs/transporters are carried to the Nasmyth platform and placed below the instrument focal plane via a conveyor belt-rail, robotic arms will load/unload the masks in the proper quadrant. The mask exchange unit system will be composed of three main mechanical subsystems:

- FOCAL PLANE MASKS SUPPORT SUBSYSTEM;

- MASKS EXCHANGE ROBOTS;

- MASKS RESERVOIRS.

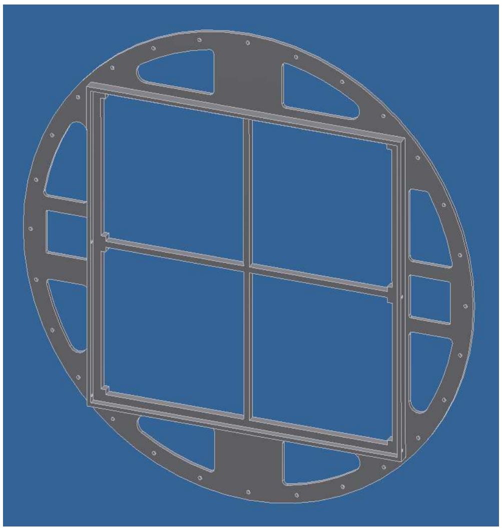

Fig. 3. Backbone cross mask.

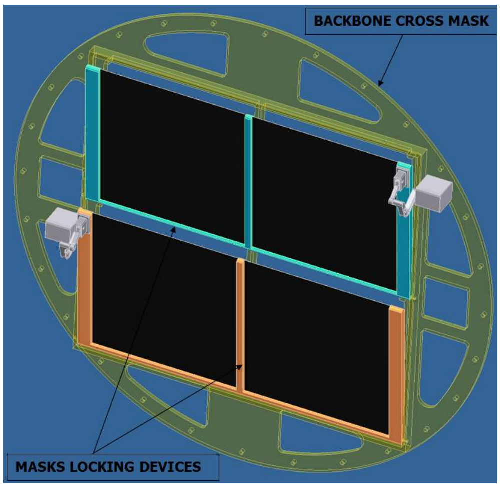

Fig. 4. Mask locking devices.

2.1. Focal Plane Masks Support Subsystem (Backbone Cross Mask - Masks Locking Devices)

The Backbone Cross Mask, shown in Fig. 3, will be directly screwed into the crown of the Dioramas Instrument Rotator. The Masks Locking Devices shown in Fig. 4, will be mounted on the previous sub-system. The locking devices will have 2 positions:

- open which allows insertion of a mask;
- closed/locked when the mask is inserted.

Two motors will operate the opening/closing of the devices. When all the masks have been carried in their proper position (see next paragraph) by the robots, electromagnets, mounted on the Mask Locking Devices, will block the masks in position and the Locking devices will be closed. The time needed to exchange a full mask set is estimated in 2 minutes, once the instrument has reached the "home" (reference) position.

2.2. Masks Exchange Robots

When the instrument is at a fixed reference rotation angle, masks can be exchanged using two industrial robots, mounted on a separate support structure, able to insert the masks in the focal plane (Fig. 5).

2.3. Masks Reservoir

We estimate that a minimum of 10 mask sets, i.e. 40 masks, should be made available for each observing night. Masks will be arranged in 1 set of reservoirs (a reservoir set is composed of 2 reservoirs). Each reservoir will contain masks for 2 predetermined quadrants (VIS and NIR) and thus hold 20 masks (in the next phase will be studied the possibility to increase such number to 24). The weight of each reservoir, once filled with masks, will be approximately 113kg, and its dimensions approximately 830x460x1200mm. Each reservoir will be marked with a proper identifier code (see the position of work of the two reservoirs on the E-ELT Nasmith Platform in Fig. 6). There will be a minimum of 2 reservoir sets (typically one at the MMUS and the other one at the Telescope), and a maximum of 4 (the other two could be kept as spare or could supplement the used sets).

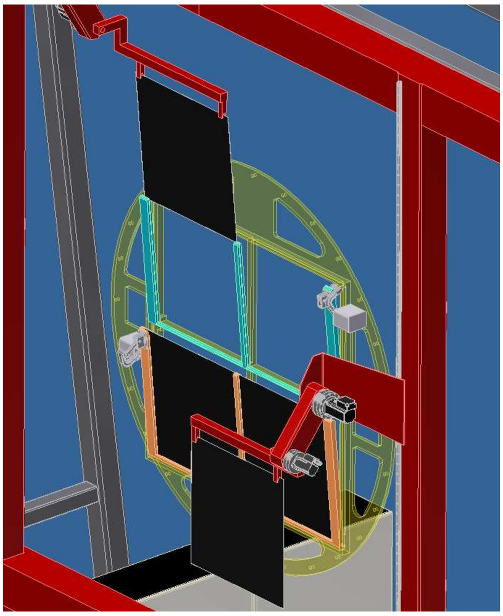

Fig. 5. Schematic of exchange robot.

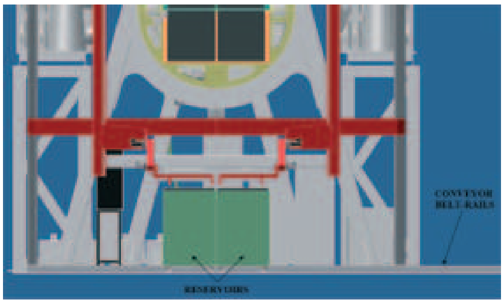

Fig. 6. Schematic of reservoirs position on the E-ELT Nasmith platform.

3. Mask Manufacturing Unit System

The proposed Laser machine for Optimos is a CO2 sealed laser available on the market, made by SEILASER. The MMU must be capable of:

- Interpret the files containing the list of slit positions and sizes and transform them into cutting instructions;
- Cut Slits into 0.6mm thick painted steel sheet with the required accuracy and speed;
- Cut or engrave the mask identifier code, cut the mask edge and the interfaces with the mask locking device with the required speed.

Acknowledgements

In this paper we have presented the OPTIMOS-DIORAMAS Slit Mask Manufacturing and Exchange Units design overview. The complete instrument is a result of a collaborative effort of a Consortium formed between Laboratoire d'Astrophisique de Marseille, INAF-IASF-MI, and Observatoire de Geneve. The Oxford University has contributed the detector system and control hardware design. The INAF Observatory of Trieste has contributed the control software design. The Instituto de Astrofisica de Canarias has participated to the early phase of this study.

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