MEGARA spectrograph for the GTC: mechanical and opto-mechanical design

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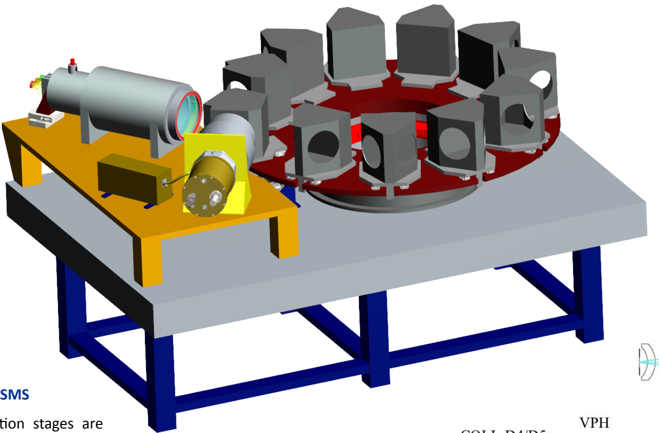
Abstract

MEGARA (**M**ulti-**E**spectrógrafo en **G**TC de **A**lta **R**esolución para **A**stronomía) is the future optical Integral-Field Unit (IFU) and Multi-Object Spectrograph (MOS) for the GTC 10.4m telescope (Gran Telescopio CANARIAS, La Palma). This contribution summarizes the current mechanical design of the spectrograph and the adopted solutions for the mechanisms and the opto-mechanical components. MEGARA Preliminary Design Review took place on 21-22 March 2012.

MEGARA INTRODUCTION

MEGARA is a fiber-fed spectrograph with two optical Integral-Field Units (IFU) and a set of robotic positioners for Multi-Object Spectroscopy (MOS) that will be installed at Folded-Cassegrain focus of the GTC. The fibers will feed one or two spectrographs (it depends on budget) to be placed on a Nasmyth-type platform. Both spectrographs will be identical.

The whole spectrograph is located on a 2m x 3m commercial optical table. All optical elements but the gratings wheel are located in another table that is 290 mm above the main table. The size of this table is 950 x 1890 mm.

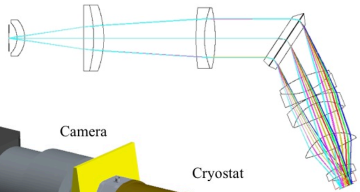


SPECTROGRAPH MAIN OPTICAL PATH

The Baseline Spectrograph Optics Design is based in a fully refractive system. At the spectrograph entrance there is a pseudo-slit, where the fibers are placed like in a long slit.

Then a collimator barrel, composed by 5 lenses (1 singlet and two doublets). A slit shutter is placed just beyond the 1st lens. The pupil has 162mm diameter and it is the location for the VPH-gratings.

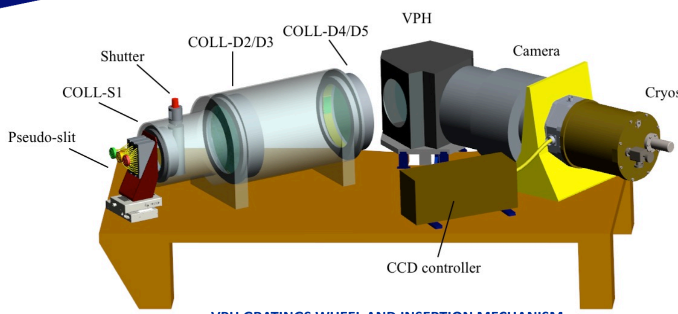
Once the beam passes through the VPH grating it goes to the camera and then to the detector, cooled by a LN2 bath cryostat.

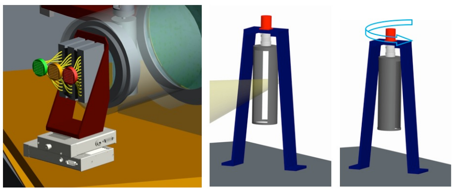


PSEUDO SLIT AND SHUTTER MECHANISMS

At pseudo-slit position, two orthogonal translation stages are included; one for fiber bundle selection and the second one to allow fine focusing for improving image quality in the different grating configurations. The translation stage proposed is a commercial component, which features all in one base, table, motor, precision recirculating ballscrew, preloaded nuts, reference and limit switches.

A rotary shutter is inserted in the collimator barrel. It has a mini-motor that rotates a cylinder mechanized to allow the light to be blocked or to pass at 90º intervals. Its simple operation is shown at the image on the right.



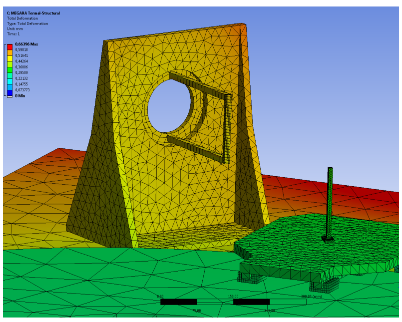


FINITE ELEMENT ANALYSIS

A global FE model is used to calculate the displacement of the optical elements of the instrument produced by gravitational strain and thermal strain . The results obtained are then introduced in the optical design in order to analyze their effect on the image motion and image quality of the spectrograph.

Control nodes are placed at the positions of the optical elements in order to obtain their displacements. Point mass are placed at the location of different elements to simulate its weight. These elements are connected to the structure using rigid (not flexible) ideal bars made of the material with the same CTE as the part of the structure where they are attached.

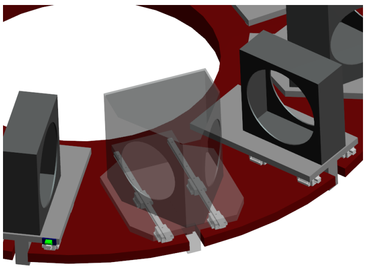
Preliminary results are satisfactory and compatible with the optical requirements.

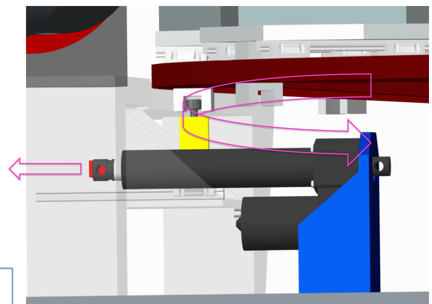


VPH GRATINGS WHEEL AND INSERTION MECHANISM

The spectrograph includes the capability of the **automatic interchange of 11 VPH gratings** that are placed on a Ø1880 mm aluminum alloy wheel. The mechanical mount of each VPH is screwed to a platform that has a pair of guideways screwed on its downside. These guideways are inserted on their corresponding carriages that are screwed to the wheel. VPH mounts are to be seated in a flat-cone-groove kinematic system with fine alignment capabilities on the platform.

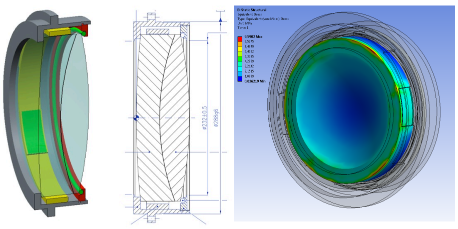
The insertion mechanism consists of an electro-mechanical actuator that translates a stud type track roller that moves on a railway. As the wheel rotates, platform protrusions are passing by the roller during grating selection. Once the desired VPH is located on position, this track roller engages the protrusion of the VPH mount platform and pushes it to the optical path or pulls it out of it. The **actuator** will be a precision electro-mechanical actuator comprised of a stepper motor, a high precision preloaded ballscrew with an absolute encoder on the motor. The actuators proposed for driving the wheel are a pair of servomotors with planetary reducers preloaded on a crossed rolled bearing gear by pinions in order to remove backlash.

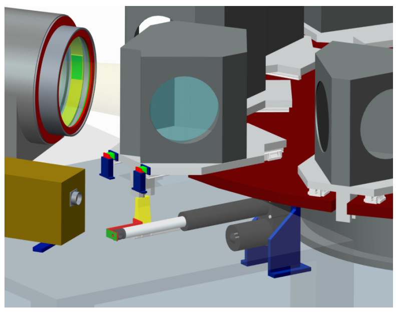




LENS OPTO-MECHANICS

Example of the 2nd collimator doublet sub-cell preliminary design. Each mount will be comprised of a barrel or cell, a flexible aluminum ring for radial support, an elastomer O-ring for axial support and a screwed blocking ring.





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