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ELMER ELECTRO-MECHANICS

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ELMER is a multi-purpose Camera&Spectrograph in the optical range for the GTC. ELMERs electro-mechanical design was based in well known, straightforward and reliable solutions, hence each mechanism is based in a wheel driven by a pre-loaded worm gear transmission, except focusing of the focal plane on the CCD which is based in a translation stage. All mechanisms are driven by the same stepper motor type with an incremental encoder, being commanded each one by a local control unit. After integration, an intensive campaign was carried out at factory for testing the functionality and performances of each mechanism. We present the electro-mechanical design of ELMER and the resulting performance after factory tests.

Introduction

ELMER is a multi-purpose Camera & Spectrograph in the optical range for the GTC. It will provide several scientific observing modes: imaging, long slit spectroscopy, fast photometry, fast short-slit spectroscopy, slit-less multiobject spectroscopy and mask multiobject spectroscopy. ELMER′s imaging mode will provide both broad band (Sloan) and narrow band filters, over the whole FOV (3 x 3 arcmin, ϕ 4.2 arcmin). Besides, spectroscopic modes will provide several resolution ranges by using prisms (R=50-500), grisms (R= 1000) and VPHs (R=2500). The ELMER CCD camera consists of a CCD44-82 from E2V Technologies in a standard LN2 bath cryostat and a SDSU-II controller. The detector′s frame-transfer structure allows high duty cycles for the fast photometry and spectroscopy modes.

Electro-mechanics

Since the beginning ELMER′s electro-mechanical design was required to be versatile enough to provide a wide range of instrument features, which means placing in the optical path 16 filters, 10 dispersing elements and 4 masks, plus a focussing stage. It also had to be robust, highly reliable, easily maintainable and cheap, as the instrument is intended to be used as a work-horse instrument for the GTC. The design was based on well-known solutions, minimizing the risk of mechanisms failures, ending up with 4 wheels, two composing the Slit unit and the other two forming the Wavelength selection unit, plus a linear translation stage for the Collimator unit.

Each wheel is independently rotated by a pre-loaded worm gear drive. The worm consists of two parts referred to as master and slave. The slave will pre-load the wheel against the master, avoiding backlash in the transmission (Fig 1). The master part is directly coupled to a stepper motor that fixes the angular position of the wheel.

To measure the achieved position each motor is equipped with an on-axis incremental encoder, hence absolute positioning is achieved by a reference switch of 1μm repeatability.

Slit unit

This sub-system is composed by two identical wheels: the Slits wheel and the Covers wheel. The Slits wheel allows to place into the focal plane the set of slits for spectroscopy and the Covers wheel allows to choose the right slit masking out the rest with a cover.

Each wheel is mounted on a pair of thin section angular contact bearings, assembled back to back to ensure high stiffness without clearance. These wheels are made of carbon steel.

Wavelength Selection unit

This sub-system is composed by two wheels: the Filter wheel and the Prisms/Grisms wheel. The function of this unit is to place the filters and the dispersion elements into the instrument pupil at the collimated beam. The Filter wheel holds 14 filters and

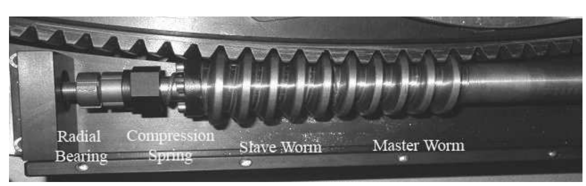

Fig. 1. Wheels transmission.

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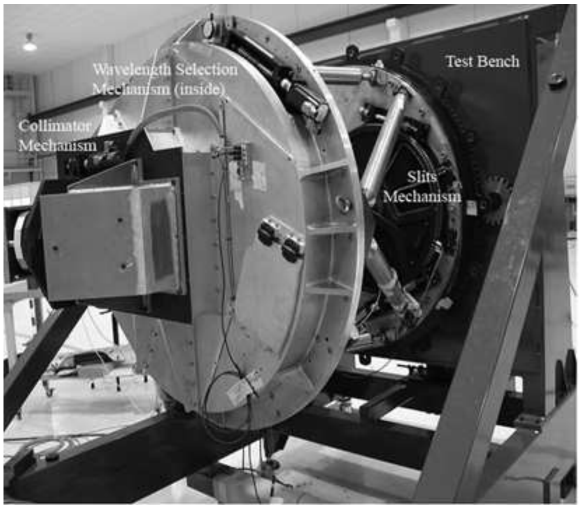

Fig. 2. ELMER mounted on its test bench, used at factory to measure the performance of all the mechanisms in several orientations around the opto-mechanical axis.

the Prisms/Grisms wheel holds: 2 prisms, 2 grisms, 6 VPHs and 2 neutral density filters. Both wheels are made in aluminium and mount angular contact ball bearings.

Collimator unit

The function of this mechanism is to move the collimator doublet acting as the focusing element of the instrument. The collimator mechanism is a linear translation stage composed by two preloaded linear guides and a ball-screw with preloaded nut driven by a stepper motor with an incremental encoder, with brake and two limit switches, using one of them also as the reference switch for positioning.

Tests and Performance

The functionality and performance of each mechanism were tested individually, both in horizontal and in vertical orientations. For these tests we used a Mitutoyo micrometer (accuracy ± 3 mm) to measure linear displacements, a Heidenhain angular encoder (accuracy $\pm 6.7\,\mu rad$) to measure angular movements of wheels and laser tracker from FARO (accuracy ± 10 mm) to test the exact positioning and flatness.

TABLE 1

MECHANISMS PERFORMANCE

Cover & Slits Wheels	Required	Measured
Time 360^0 (sec)	< 40	35
Repeatability		
Angular (μrad)	< 60	< 37
Focal Consecutive (mm)	< 0.1	< 0.1
Focal Non-Consec (mm)	< 0.5	< 0.15
Radial displacement (mm)	< 0.1	< 0.09
Filters & Prisms/Grisms		
Time 360^0 (sec)	< 60	54
Repeatability		
Angular (μrad)	< 60	< 51
Focal Consecutive (mm)	< 0.1	< 0.1
Focal Non-Consec (mm)	< 0.5	< 0.2
Radial displacement (mm)	< 0.1	< 0.1
Collimator		
Motion range (mm)	-13 to $+15$	-12.79 to $+15$
Time full range (sec)	< 12	20
Repeatability (μrad)	< 20	< 10
Motion run-out (μrad)	< 20	< 20
Motion parallelism (mm)	< 0.2	< 0.2

Finally, we used a custom-made test bench to hold and rotate the whole instrument allowing us to place it in different orientations (Fig 2). The results are the following:

Conclusions

After factory tests the functionality of all mechanisms was demonstrated and the performance of each mechanism was tested. Results show that each mechanism fulfils the requirements. Even though some requirements are just fulfilled, it should be noted that our initial requirements were quite tight. Further tests and characterization are carried out at the IAC workshop by the ELMER team, in order to confirm these results and to fully characterize each mechanism. It will also allow us to develop and test the final control software for these mechanisms.