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ELMER MECHANICS: MANUFACTURING, INTEGRATION AND TESTING

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ELMER is a visible imager-spectrograph currently scheduled to be in operation at the GTC on Day One. The design phase of the ELMER Structure and Mechanisms ended on November 2002. Since then, after manufacturing and mechanical integration, an exhaustive test campaign at factory was carried out. We present the fabrication and assembly highlights and the overall performance of the mechanics prior to the integration of the optics.

Introduction

ELMER is an optical instrument for the GTC designed to observe between 3650 and 10,000 Å. The general configuration of this instrument is based on a front section where the focal plane components are mounted (cover masks and slits) and a rear section where the rest of the components are mounted (field lens, folder mirrors, collimator, shutter, filters, prisms, grisms,VPHs, the camera and the cryostat with the image acquisition system). The rear section is connected to the front section with structural trusses defining a hexapod.

Manufacturing

Procurement and manufacturing covered from December 2002 to June 2003. In this process, large dimensions are combined with tight tolerances. Almost all the mechanical tolerances have been ensured by the manufacturing tolerances of the individual parts. An overview of the sizes, materials and manufacturing process of the main ELMER mechanical parts, as follows: Nasmyth interface structure (ϕ 2620 x 325 mm): carbon steel, welding and machining,weight: 853 kg. Front section (ϕ1150 x 45 mm): carbon steel, machining, weight: 115 kg. Hexapod trusses (ϕ67 x 872 mm): high strength steel, machining, weight: 20 kg each. Drum (ϕ1300 x 200 / ϕ1300 x 140 mm): aluminium, machining, weight: 83 / 71 kg.

Collimator support box (810 x 552 x 142 mm): aluminum, machining, weight: 25 kg. Slits unit wheels (ϕ652 x 30 mm): carbon steel, machining, weight: 30 kgs each Filter wheel (ϕ1086 x 36mm): aluminium, machining, weight: 30 kg. Prism wheel (ϕ1086 x 135 mm): aluminum, welding and machining, weight: 40kg. In addition, the manufacturing of the worm gears (bronze), shafts, the covers and slits (in 0.5 mm carbon steel) and their mounts, baffles, and test dummies was an important package for the manufacturing contractor. The rotating test bench (see figure 2), the lifting support for the instrument, and the instrument cart were also manufactured and checked during this period.

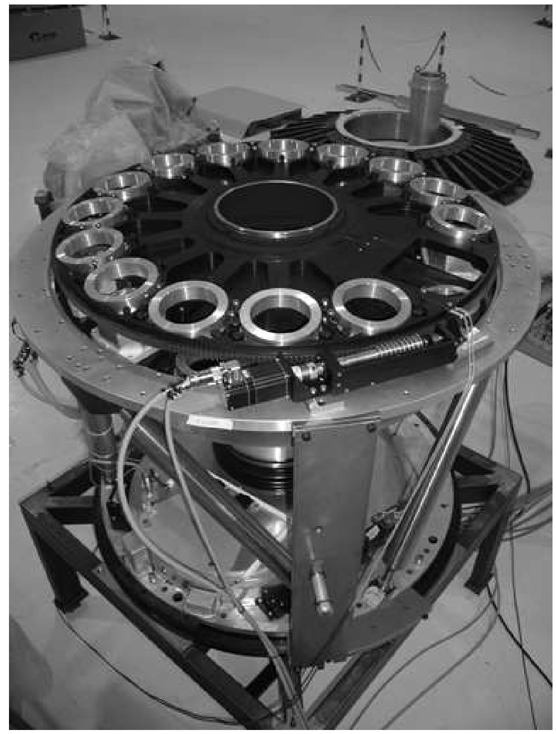

Fig. 1. The filter wheel with dummies during the test.

Integration

Mechanical and electrical integration was accomplished on September 2003. The following steps were carried out in this chronological order:

1. Assembly of the skeleton of the support structure. Integrating the front section, the hexapod

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Fig. 2. ELMER on its test bench, testing the deflection of the whole instrument under self weight.

trusses and the main body of the drum. For this a dedicated alignment tool was used.

2. Integration of the slit and cover wheels. The shaft of the wheels is attached to the front section. Then the covers wheel and the slits wheel are inserted with their pairs of preloaded angular contact bearings on the shaft. Then the drives (stepper motor and preloaded worm gear) are attached to the front section. Two reference switches per wheel are assembled in their respective supports and attached directly to the front section The system is finally closed with a cover.

3. Integration of the prism wheel and the filter wheel. The shafts are attached to the instrument, then the bearings and the wheels. Finally the drives (stepper motors and preloaded worm gears) and reference switches.

4. Integration of the collimator assembly. Consisting of the linear guides, collimator support, preloaded ball bearing, bearings, stepper motor and limit switches.

5. Integration of the field lens support (with the bellows) and the cryostat support with the cryostat handling mechanism.

6. Integration of covers (for the folder mirrors, collimator assembly and prism and filter wheels drives) and temperature sensors.

7. Integration of the electronic board and routing of cables through the instrument structure.

8. Installation of the instrument on its test bench (See figure2), ready for testing.

TABLE 1

ELMER MECHANICS PERFORMANCE

Dimension	Required	Measured
Slits wheel focal position	75 ± 0.5	$74.65\, mm$
Slits I/F parallelism	$< 2mrad$	$0.6\, mrad$
Covers wheel focal position	68.25 ± 0.5	$68.32\, mm$
Covers I/F parallelism	$< 2mrad$	$0.6\, mrad$
Cryostat attachment flange:		
Z position	522 ± 0.1	$521.926\, mm$
Parallelism with drum	± 1.75	$1.33\, mrad$
Field lens attachment flange:		
Z position	280 ± 0.1	$279.969\, mm$
Parallelism with drum	± 0.87	$0.24?\, mrad$
Collimator attachment flange:		
Z position	1350 ± 0.15	$1349\, mm$
Angle with front section	$90^\circ \pm 0.08^\circ$	89.996°
Folder mirror 1 interface:		
Z position	1151 ± 0.07	$1150.535\, mm$
Parallelism with drum	$\pm 0.1^\circ$	0.047°
Folder mirror 2 interface:		
Z position	1151 ± 0.07	$1150.611\, mm$
Parallelism with drum	$\pm 0.1^\circ$	0.024°
Gravitational deflection:		
Rear section	$x - axis$	$23\, \mu m$
Rear section	$y - axis$	$94\, \mu m$

Testing

The test campaign at factory covered from the end of September to mid November 2003. A complete verification of the instrument mechanics was carried out at factory to ensure the compliance with the specifications. The first step of the test campaign was the dimensional tolerances verification of the assembled instrument. This was carried out with a laser tracker measuring all the external interfaces relative to the instrument flange, located at the front section. These external interfaces are: field lens, folder mirrors, collimator, filters, prisms and cryostat. Furthermore, internal interfaces such as the position of the cover and slit masks were also verified. The second step of the test campaign was the verification of the critical performances of the mechanisms and the gravity deflections of the instrument.

Elmer arrived at the GTC office (in the IAC headquarters, La Laguna) on November 27, 2003.