High-Precision Opto-Mechatronics for Astrophysics Instruments

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Since 1997, CSEM has been developing and producing high-precision mechanisms for the latest generation of astronomical telescopes. These are high-precision opto-mechatronic systems combining fine sensing, control electronics and software to operate along multiple axes of motion. The typical accuracy of these systems is of the order of 0.1 µm and 1 µrad, respectively for linear and angular positions.

In the course of 2006, several projects were pursued in the domain of fine positioning systems for astronomical application. Three projects are highlighted hereafter.

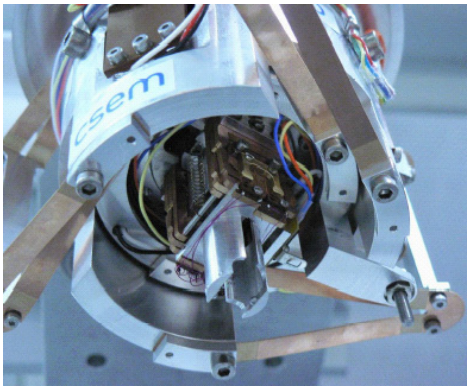

Figure 1: High-precision gripper for a vacuum-cryogenic pick and place positioning system

OPTICON is a European project that brings together major European actors, active in the development of astronomical instruments. In the framework of OPTICON, CSEM has developed a special gripper (Figure 1) for a pick-and-place system (Figure 2), expected to operate in vacuum and cryogenic conditions. This system has been realised to transport and configure small optical elements in the focal plane in order to relay collimated optical beams from the objects to steerable mirrors located around the periphery of the focal plane. The gripper mechanism is internally frictionless thanks to the use of flexures for all kinematic joints. Two voice-coil actuators are used, one to grip an object and a second one for the linear displacement of the jaws (Figure 1).

Figure 2: The complete pick and place robot including the CSEM gripper was demonstrated at a major instrumentation conference (Orlando – USA, May 2006)

The Detector Translation Unit (DTU, Figure 3) is a 3-axis parallel manipulator that translates the motion of 3 linear actuators into orthogonal motion of a target plate. The device is being built for the Institute of Astrophysics in the Canary Islands and is designed to function in vacuum-cryogenic conditions (80 Kelvin). In 2006, cryogenic tests were successfully performed and advanced metrology tests are ongoing.

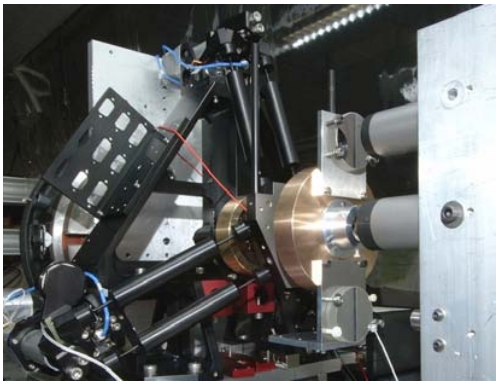

Figure 3: Detector Translation Unit (DTU) for the EMIR infrared spectrometer. Two autocollimators, a corner cube/rectitude sensor and an interferometer are used for concurrent monitoring of all 6 degrees of freedom of the mobile target.

The Differential Delay Line (DDL, Figure 4) is a complex opto-mechanical device and a key component of the PRIMA instrument that has been built to search extra-solar planets with the Very Large Telescope Interferometer of ESO at Paranal Observatory. CSEM provides the system engineering and integration support to a consortium including, among others, the Observatory of Geneva, EPFL and the Max Plank Institute for Astronomy. In 2006 the final design review was achieved and the DDL is now being fabricated for integration on site in late 2007.

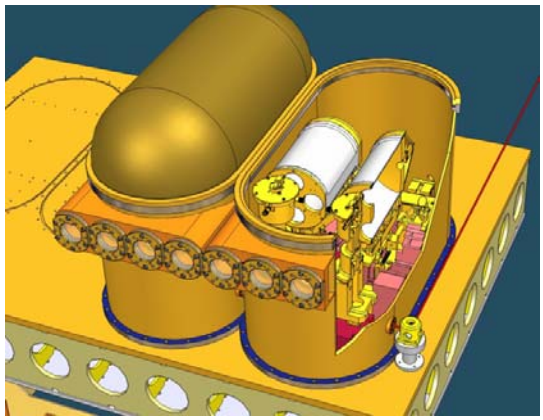

Figure 4: CAD view of the PRIMA Differential Delay Line (DDL)