Electronics prototypes for the Giant Magellan Telescope Multi-object Astronomical and Cosmological Spectrograph (GMACS)

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Abstract
We describe the current electronics prototypes for the Flexure Compensation System (FCS) and the Slit Mask Exchange Mechanism (SMEM) for GMACS, a wide-field, multi-object, moderate-resolution optical spectrograph for the Giant Magellan Telescope (GMT). We discuss the details of the FCS and SMEM prototypes, how the prototypes relate to the preliminary conceptual designs of these systems, and what information the prototypes give that can be applied to the final design, as well as the possible next steps for each prototype.

Current GMACS Concept
Important factors for GMACS are its high throughput, simultaneous wide wavelength coverage, accurate and precise sky subtraction, moderate resolution, wide field, and minimized downtime not collecting data. The Flexure Compensation System (FCS) and Slit Mask Exchange Mechanism (SMEM) enhance and support these factors. The FCS maintains the optical alignment of the gratings and camera arms that achieve the simultaneous wide wavelength coverage and adjustable resolution. The SMEM changes the slit masks in the focal plane between exposures for minimal downtime. Prototyping these subsystems help develop and improve the subsystems’ designs.

Flexure Compensation System (FCS) Prototype
Under normal conditions, large structures experience some flexure under the structure’s own weight. This flexure can usually be predicted and accounted for. However, as the GMT rotates and changes position, the gravity vector on GMACS will change. This changing gravity vector will cause the instrument’s flexure to change. If the instrument’s flexure changes, the optics become misaligned.¹

Physik Instrumente (PI) lent an H-840.D2 hexapod with an EtherCAT slave controller. The EtherCAT controller takes motion commands from the EtherCAT master PC and translates them into motion of the individual hexapod actuators. The Beckhoff EtherCAT master PC runs Beckhoff TwinCAT 3.0. The program written for this prototype is controlled by the user through a TwinCAT GUI.

We currently expect that positional feedback to the control system for the hexapods will come from lasers mounted on the VPH gratings and camera arms and pointed at lateral sensors. The sensor measures the displacement of the laser beam relative to the center of the sensor. The sensor returns the X and Y position of the laser beam, and the hexapod moves to recenter the beam. To reflect this in the FCS prototype, a Thorlabs PDP90A lateral sensor is mounted to the hexapod, and a 5 mW 632.8 nm laser points at the center of the lateral sensor.

Slit Mask Exchange Mechanism (SMEM) Prototype
The SMEM is a jukebox style mechanism that retrieves slit masks from the focal plane, places the slit masks in an empty slot in the magazine, retrieves the next slit mask, and places it in the focal plane. Two vertical linear actuators (VLAs) raise and lower the elevator that houses the slit mask in transit. A horizontal linear actuator (HLA) moves the slit mask from the elevator to the magazine. The HLA is a grasper that retrieves the slit mask from the slit mask magazine.

The SMEM prototype is a 90% scale of the horizontal portion of the slit mask elevator. The slit mask holder is mounted on a THK linear actuator, which is powered by a Beckhoff motor controlled by a Beckhoff EtherCAT terminal and Beckhoff EtherCAT master PC.

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References

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