Optomechanical design concept for the Giant Magellan Telescope Multi-object Astronomical and Cosmological Spectrograph (GMACS)

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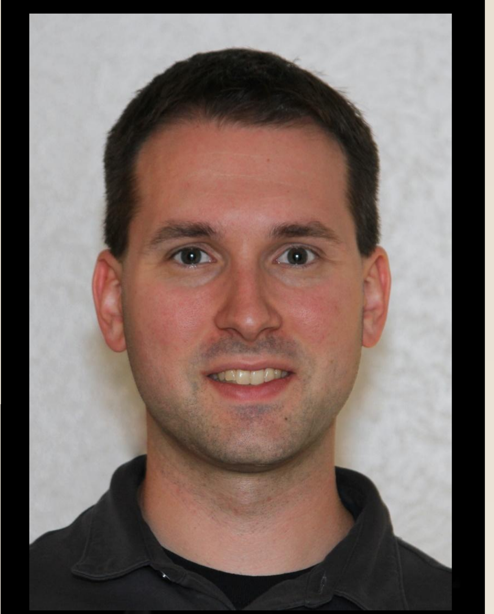

ASTRONOMY

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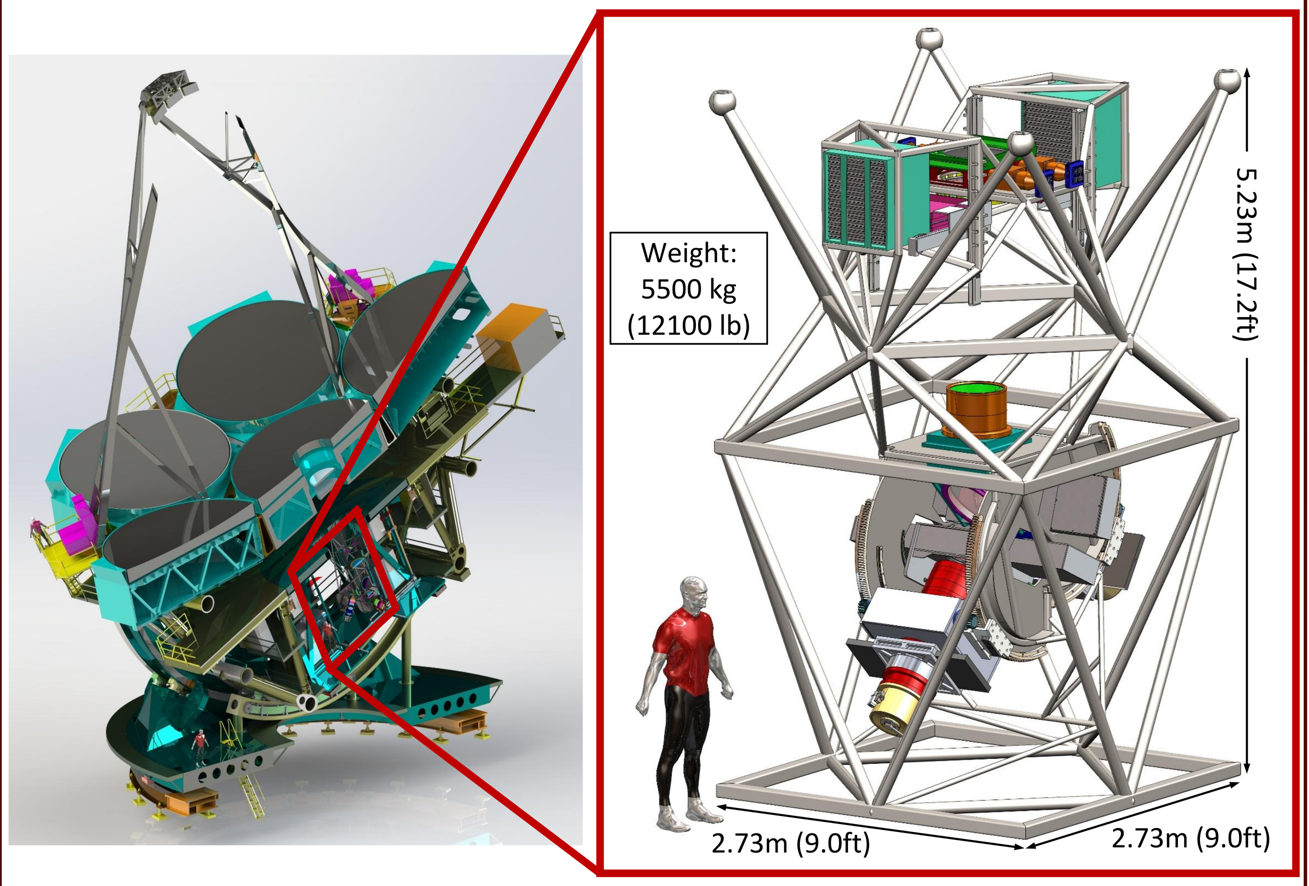
ABSTRACT

We describe a preliminary conceptual optomechanical design for GMACS, a wide-field, multi-object, moderate-resolution optical spectrograph for the Giant Magellan Telescope (GMT). This poster details the GMACS optomechanical conceptual design, including the requirements and considerations leading to the design, mechanisms, optical mounts, and predicted flexure performance.

INTRODUCTION

This poster presents the preliminary conceptual optomechanical design of the wide field, multi-object, moderate-resolution, optical spectrograph, called GMACS. GMACS (Giant Magellan Telescope Multi-object Astronomical and Cosmological Spectrograph) is a first light instrument for the Giant Magellan Telescope (GMT). High throughput, simultaneous wide wavelength coverage, moderate resolution, and wide field are the crucial design drivers for the instrument.

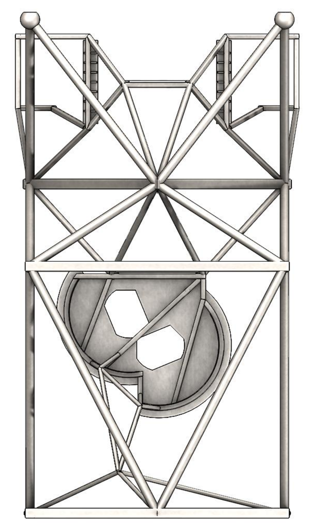


Location of the GMACS instrument within GMT

The current GMACS design is a preliminary concept, evolving from the 2012 conceptual design, while scaling its size down to meet budgetary constraints. The scope of the current optomechanical design is to illustrate how the optics and subsystems will be packaged, simulate articulation ranges of the moving components & identify potential collisions, estimate initial instrument envelope and weight, investigate GMT interfacing, and determine expected deformations.

INSTRUMENT FRAME

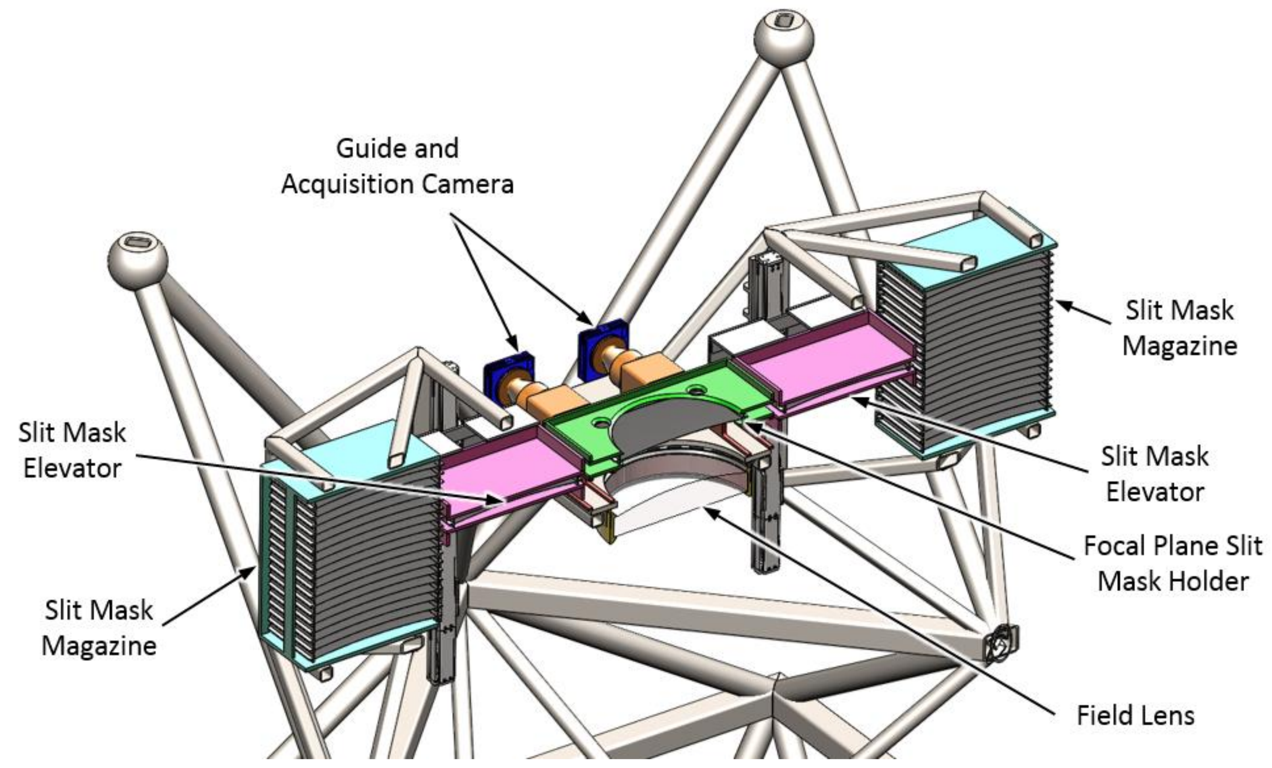
GMACS's steel tubular spaceframe structure will hold the instrument subassemblies together and attach the instrument to the back of the GMT. The spaceframe style will be very stiff and will help evenly distribute the instrument load to the GMT mechanical interface. This design demonstrates a sphere and cone system as an alternative attachment method to the back of the GMT.



GMACS spaceframe structure

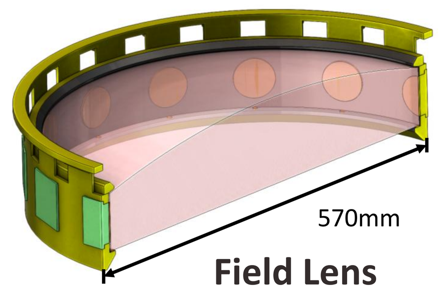
FOCAL PLANE ASSEMBLY

The focal plane assembly contains the field lens, guide & acquisition camera and the slit mask exchange mechanism.



Focal Plane Assembly

The field lens is a 520mm diameter silica lens that weighs 46kg. The cell design utilizes invar cells RTV pads to hold the lens and flexures to attach the cell to the frame.



Field Lens

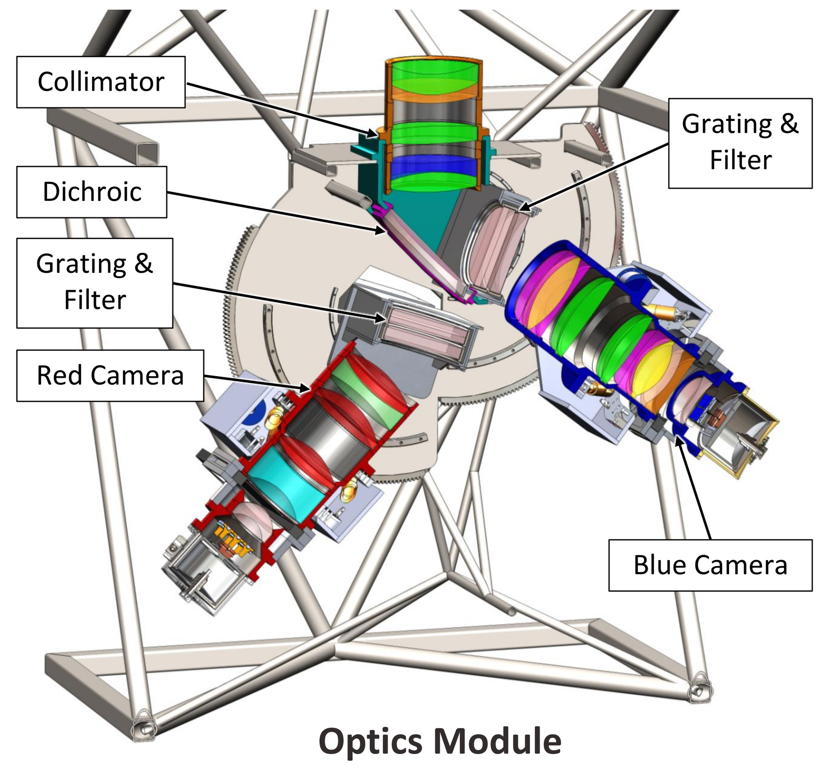
Four alignment and acquisition cameras are behind the focal plane and will allow precision alignment of the slit masks relative to reference stars.

In order to observe objects in different fields throughout the night, a jukebox style exchange mechanism will be used to move various slit masks into the focal plane and back into a storage magazine. There is enough space for 2 slit mask exchange mechanisms that share the same focal plane holder. Each slit mask magazine can hold 18 slit masks for a total of 36 slit masks.

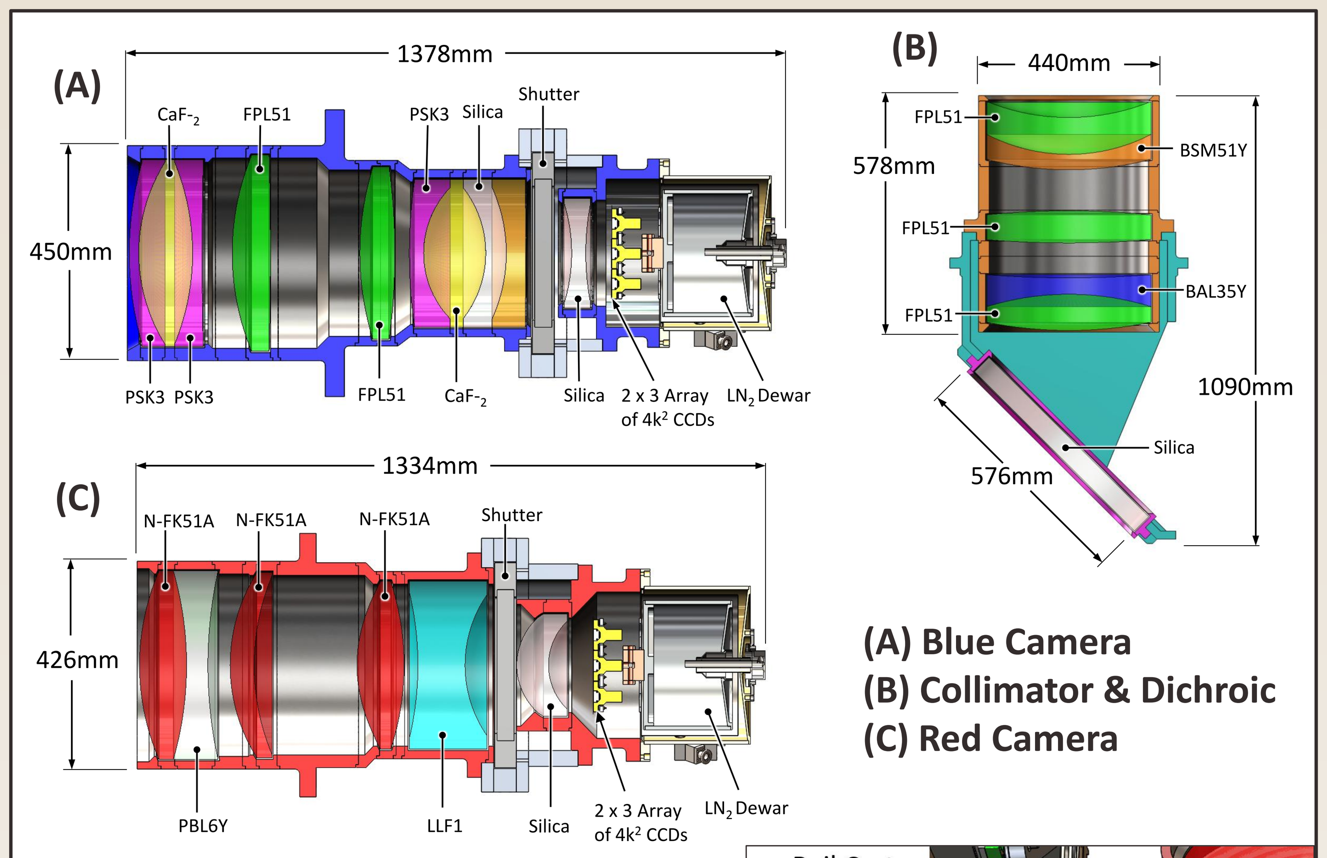
OPTICS MODULE

The optics module contains the collimator, dichroic, gratings and cameras. It also contains the systems to independently articulate & hold the cameras and gratings at various angles to accommodate multiple grating resolutions. In low resolution mode (R~1000) and high resolution mode (R~6000) the collimator-camera angle must be ~18.2° and ~88.9°, respectively.

The lens cell concepts for the collimator, dichroic and cameras optomechanical systems will use roller pin flexures and glass filled Teflon plugs to hold the lenses in alignment over varying temperatures.

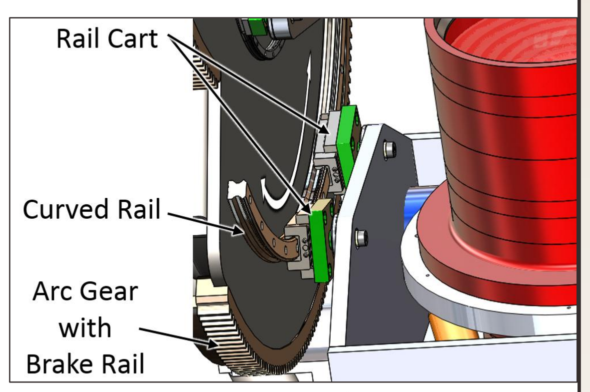


Optics Module



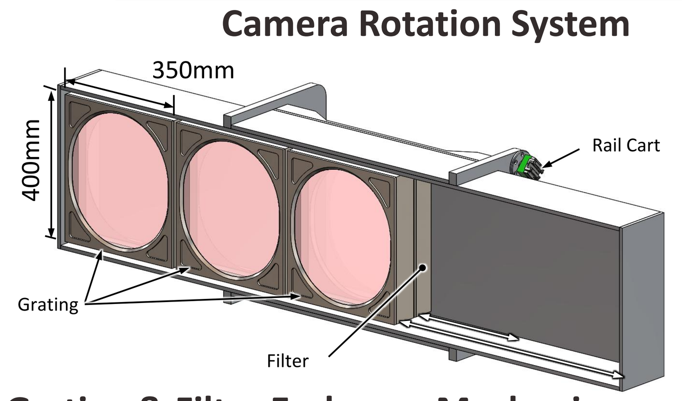
(A) Blue Camera
(B) Collimator & Dichroic
(C) Red Camera

Each red and blue camera rotates ~90° on two sets of THK curved rails attached to the internal faces of the mount plates. The grating and filter exchange mechanisms will rotate the same way (~45°), but on smaller rails.



Camera Rotation System

The grating exchange mechanism will hold up to 3 gratings and 1 filter. Each can translate in & out of the light path, but only 1 grating can be engaged at a time.

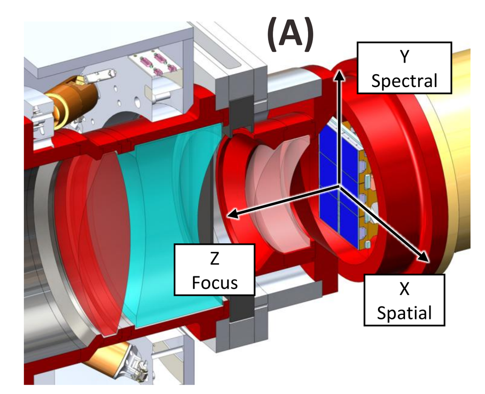


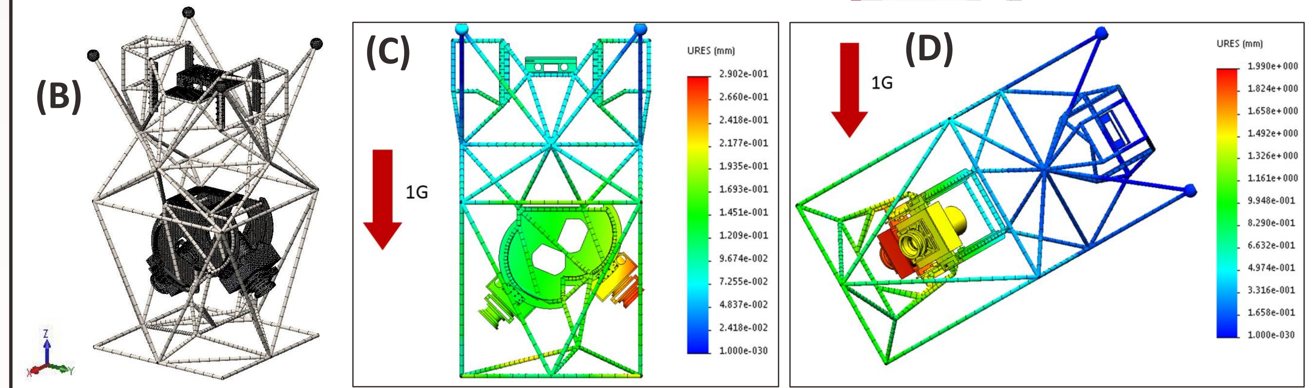
Grating & Filter Exchange Mechanism

FLEXURE

Gravity-induced image motion is a common issue for spectrographs mounted at the Gregorian focus of a large telescope. To help understand how these motions will affect our system, preliminary simulations were ran to estimate the expected deflections.

(A) Camera CCD Coordinate System
(B) Meshed Simplified Version of GMACS
(C) Resultant Displacement of GMACS at Zenith (0°)
(D) Resultant Displacement of GMACS at 60° about the Y Axis





Preliminary FEA Results

Instrument Orienation	Red Camera CCD X Shift Spatial (mm)	Y Shift Spectral (mm)	Z shift Focal (mm)	θ_X (°)	θ_Y (°)	θ_Z (°)	Blue Camera CCD X Shift Spatial (mm)	Y Shift Spectral (mm)	Z shift Focal (mm)	θ_X (°)	θ_Y (°)	θ_Z (°)
60° about X	-0.074	0.833	0.383	0.000	0.017	0.000	-0.031	0.680	-0.410	0.014	0.002	0.002
60° about Y	-1.759	0.008	-0.072	0.000	0.375	0.008	-1.457	-0.154	-0.084	0.005	0.006	0.006
Zenith (0°)	0.044	0.085	-0.149	0.000	0.041	0.001	-0.026	-0.248	-0.127	0.006	0.001	0.001

Munnerlyn Astronomical Instrumentation Lab
Texas A&M University

Texas A&M University Department of Physics and Astronomy is an institutional member of:

GMT

HETDEX Hobby-Eberly Telescope Dark Energy Experiment

LSST Large Synoptic Survey Telescope

DARK ENERGY SURVEY

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