Modularized Software Control of the RIMAS Instrument for Rapid-Response Gamma Ray Burst Observations

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GOAL: The development of a hierarchy of control software, ranging from primitive serial communication to advanced user-controlled interfaces, for operation of the RIMAS instrument.

What is RIMAS?

The **Rapid near-infrared IMAger Spectrometer** (RIMAS) is a collaboration between NASA Goddard, the University of Maryland, and Lowell Observatory. As one of four instruments to be installed in the new **Discovery Channel Telescope** at Lowell Observatory in Happy Jack, Arizona, RIMAS will be used for **rapid-response observations of GRBs** detected by the Swift space gamma ray observatory. RIMAS is particularly valuable for its versatility: it **operates simultaneously in two near-infrared wavelength bands** (0.97-1.33 µm and 1.11-1.78 µm, or YJ and HK bands) and **can be used as either an imager or a spectrometer**. By capturing spectra in the near-infrared, RIMAS can provide redshift measurements for the most distant ($z > 7$) gamma ray bursts.

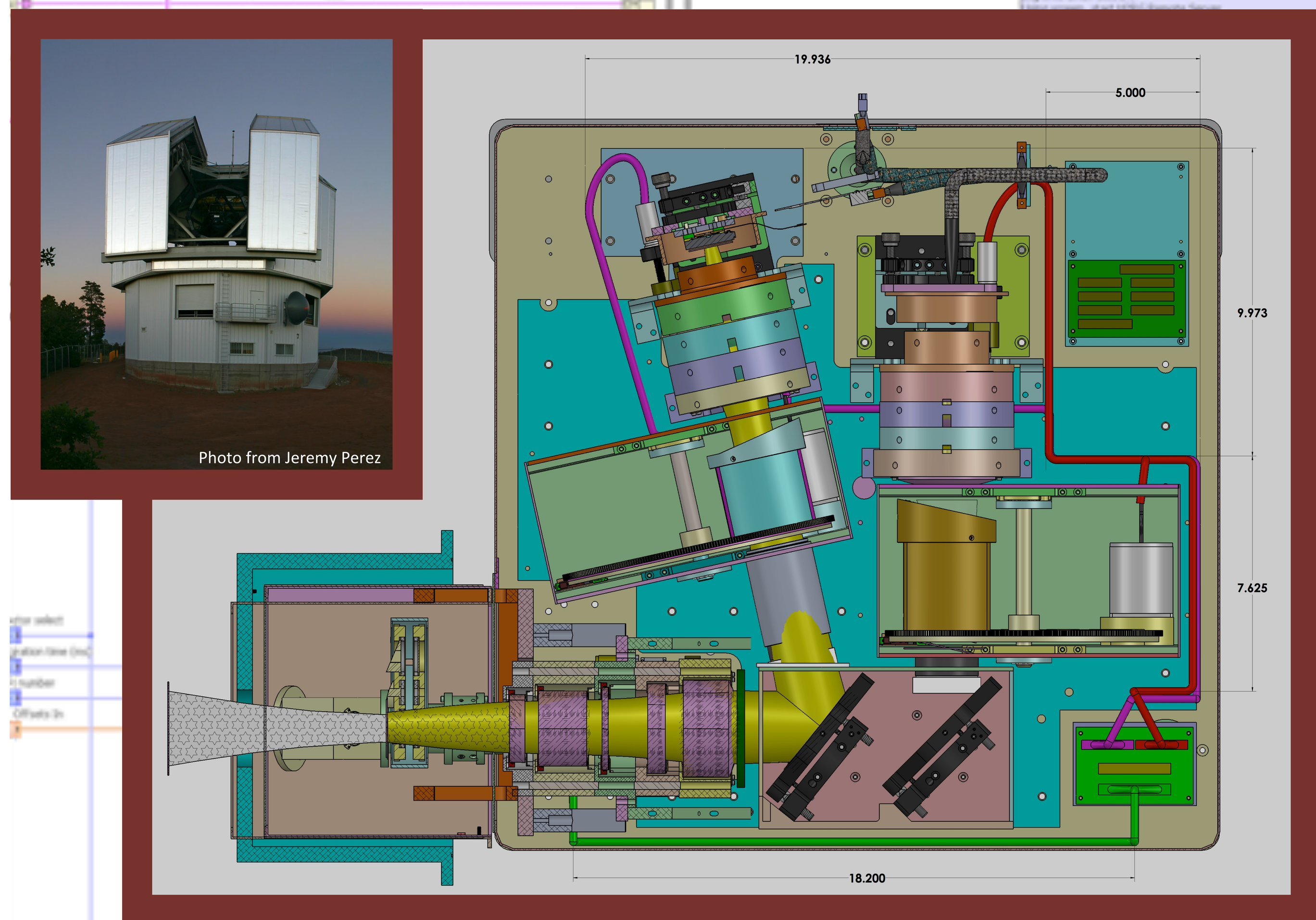


Photo from Jeremy Perez

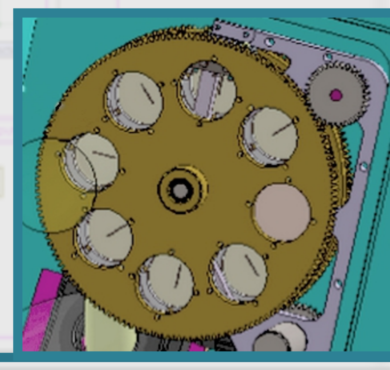
Science: Gamma Ray Bursts

Gamma ray bursts (GRBs) are the highest-energy events in the universe, produced only in the most violent conditions such as supernovae or compact object mergers. Such explosions emit an initial burst of gamma radiation that is followed by an afterglow of lower-energy radiation (x-ray, then ultraviolet, then optical, and so on) caused by the burst's interaction with surrounding gas, dust, or stellar remnants. The extreme energy present in GRBs makes them powerful tools for probing the earliest universe, with observations dating back to 13 billion years.

Hardware

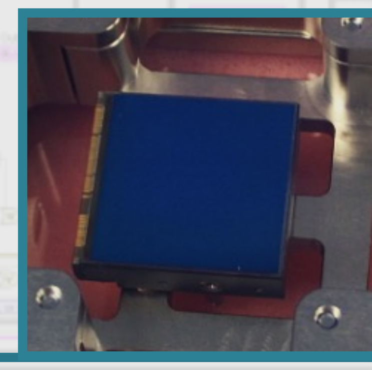
Filter Wheel

The custom-machined **filter wheel** includes circumferential notches corresponding with the positions of each filter. A single **motor** rotates the wheel, and a **limit switch** triggers when in a notch, i.e. when a filter is aligned.



Detector

The 2k x 2k HgCdTe Astronomy Wide-Area Infrared Imager with Reference pixels and Guide mode (HAWAII-2RG) **CMOS detector** is powered and controlled by two **"Leach" controllers** produced by Astronomical Research Cameras, Inc.



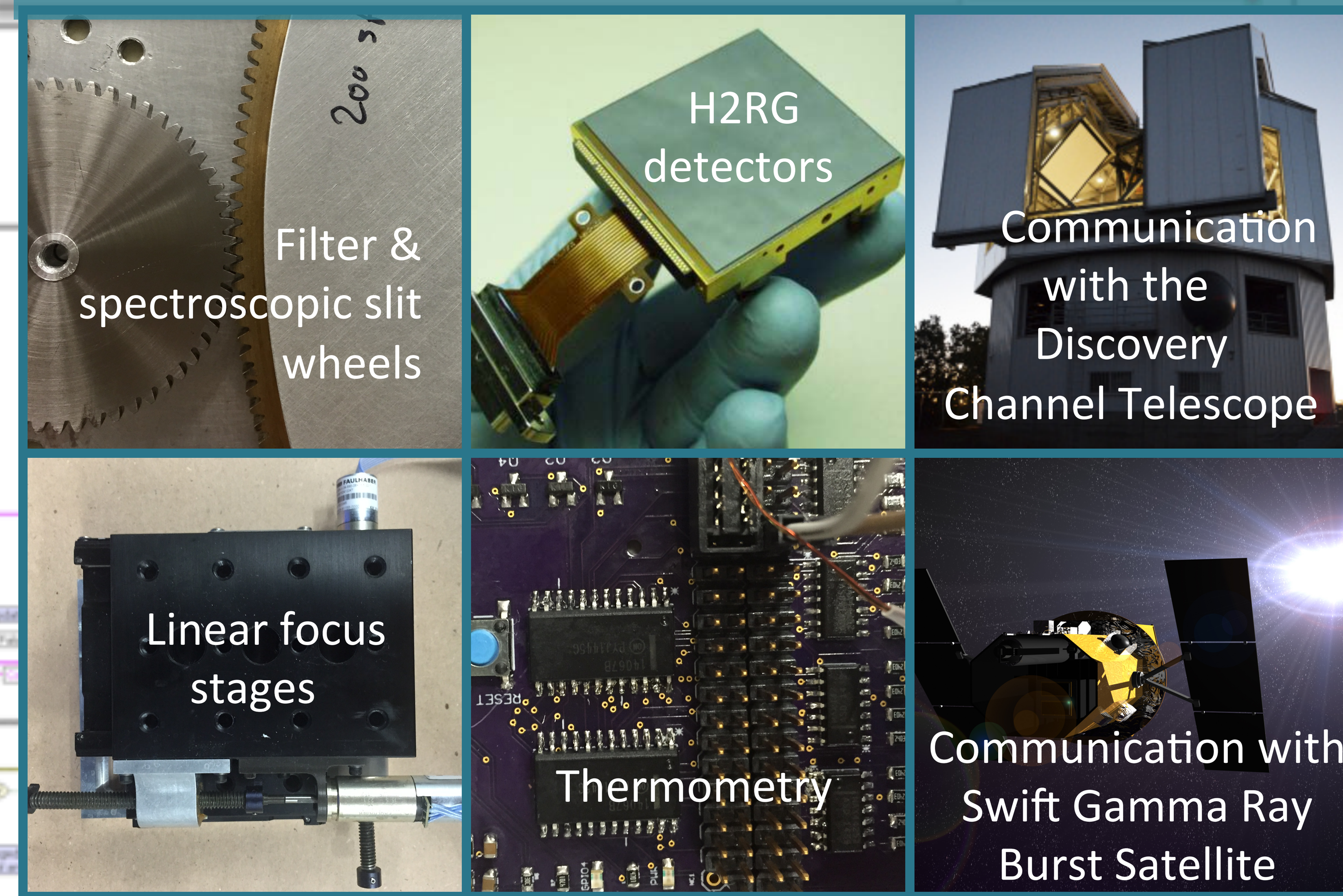
LabVIEW Software

Progress Made This Summer:

While allowing for direct control of motor speed and acceleration, a **positioning algorithm** determines the optimal direction (clockwise or counter-clockwise) to a user-specified target filter, immediately sending a chain of pre-determined commands. This comprehensive program **generates errors** if the wheel is unexpectedly moved or if the filter wheel is in an unexpected position. In such an event, a **homing process** determines the current filter position. The current position is logged externally and loaded upon startup.

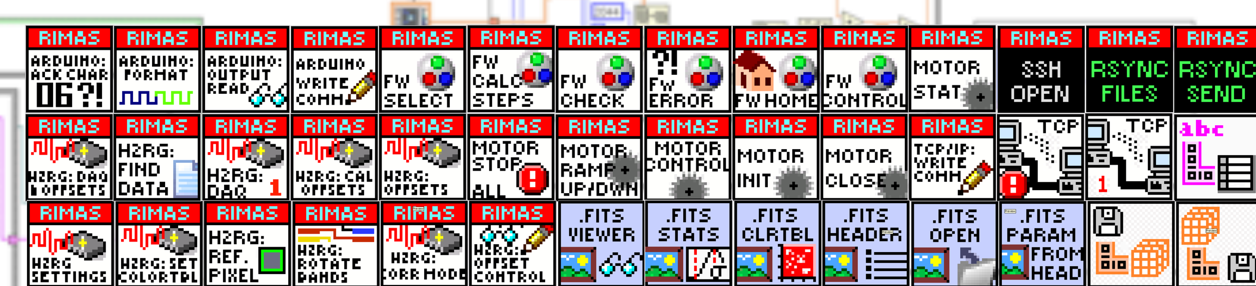
Using SSH with rsync and TCP/IP within LabVIEW, users can **remotely read and write commands and files** to the Linux computer that currently controls the detector. Commands to set exposure time, set the up-the-ramp number, start or stop DAQ, and so on can be relayed individually or in predetermined packages. Viewers can easily **view FITS files** captured by the detector and flip through multiple frames from a single exposure. Additionally, **ADC offsets** for the Leach controllers can be easily adjusted with a simple algorithm, and each offset setting is externally logged.

Software Modules



Results

Comprehensive software has been created for both the filter wheel and detector systems, including the creation of libraries with **30 and 16 distinct LabVIEW programs for detector and motor control, respectively.** The master filter wheel and detector control programs have been tested on their appropriate hardware. Development of software to communicate with the Discovery Channel Telescope is in preliminary stages, waiting on external interface documentation from Lowell.



The Future

LabVIEW code for communication with DCT must be completed. The completed filter wheel motor control can be easily adapted into motor control software for the linear focusing stages. New software for thermometry must be created, as well as software incorporating Swift GRB triggers. Once all of these modules are individually completed, they will be incorporated into a **master program** that simultaneously controls all elements. Finally, this master program will be fine-tuned, formatted like the other user interfaces currently in use at Lowell, and incorporated into the overall telescope control system to allow observers to easily operate and observe with RIMAS.

Acknowledgements: Firstly, I am extremely grateful for my mentors, **Alexander Kutyrev** and **Neil Gehrels**, for bringing me to Goddard with an awesome project for the summer. Thanks to the Goddard RIMAS team: **Thomas Hams, Vicki Toy, Marc Finzi, John Capone, Dave Robinson**, and **Gennadiy Lopkin** – especially Thomas and Vicki for patiently answering all my questions. Extra thanks to USRA and the Mellon-Bouchet Fellowship for making my summer in DC financially possible.

References:
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