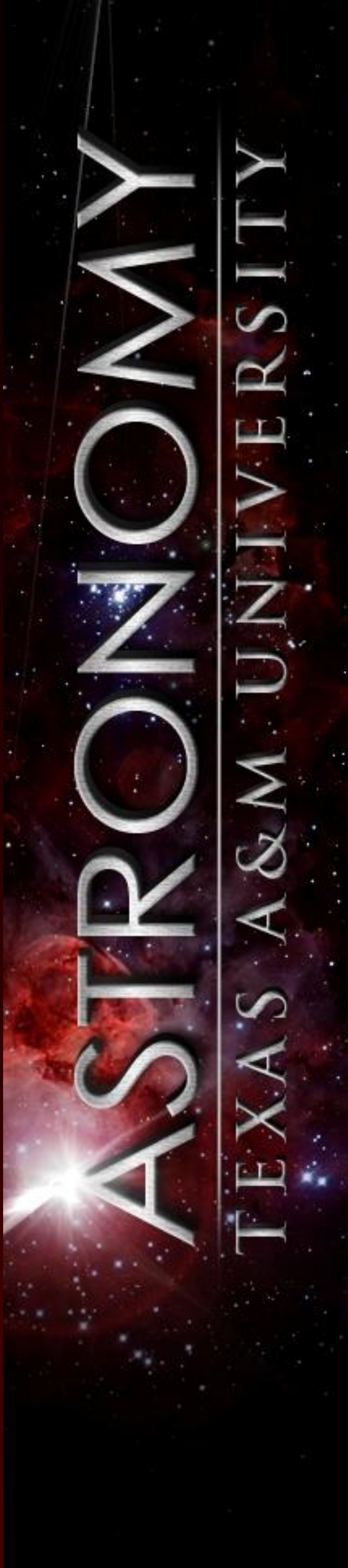

VIRUS Instrument Collimator Assembly

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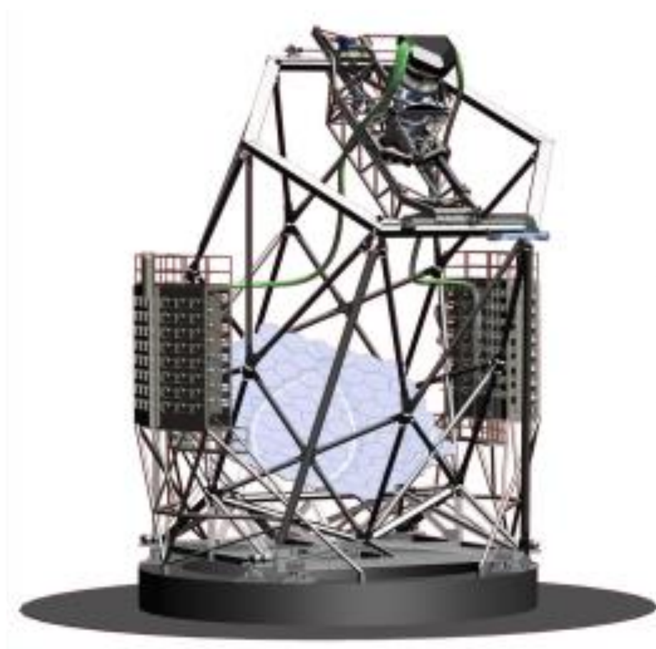
Abstract

The Visual Integral-Field Replicable Unit Spectrograph (VIRUS) instrument is a baseline array of 150 identical fiber fed optical spectrographs designed to support observations for the Hobby-Eberly Telescope Dark Energy Experiment (HETDEX). 130 VIRUS collimator subassemblies have been assembled in a production line and are now complete. Here we review the design choices and assembly practices used to produce a suite of identical low-cost spectrographs in a timely fashion using primarily unskilled labor.

Introduction

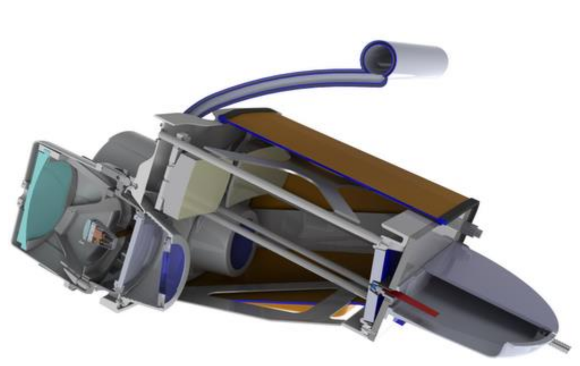
The Hobby-Eberly Telescope Dark Energy Experiment (HETDEX) is a project designed to probe the nature of Dark Energy using the HET telescope. HETDEX consists of three main parts: a major telescope upgrade including replacing the top end of the telescope to allow for a larger focal plane, the construction of the Visual Integral-Field Replicable Unit Spectrograph (VIRUS) instrument, and the execution of a large area blind survey for Lyman alpha emitting galaxies at redshifts z<3.5. The VIRUS instrument is composed of three subassemblies: the integral field unit (IFU) fiber bundle that carries the light from the focal plane of the telescope to the instrument; the collimator assemblies, described here,, that form the body of the spectrograph; and the camera that focuses the dispersed light onto the detector. The VIRUS instrument is currently nearing the end of the construction phase, with production of IFU units and cameras well underway. The 130 collimator assemblies described here are now completely assembled and aligned.



The VIRUS spectrograph pairs will be mounted inside two climate-controlled enclosures located on either side of the telescope.

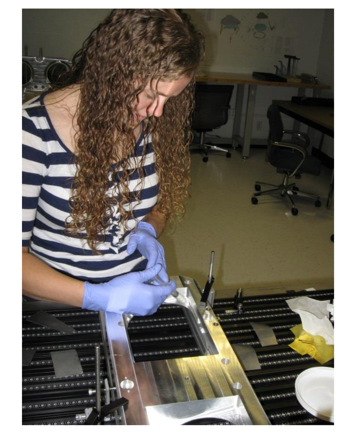
The VIRUS Collimators

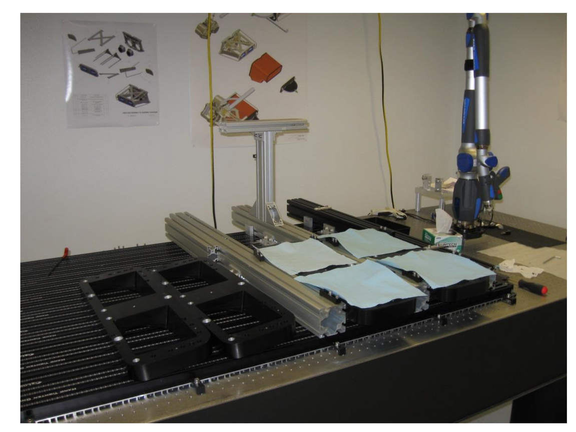
To facilitate the assembly line-style production of this unique instrument, the optical and mechanical designs of VIRUS have been carefully studied to make the instrument both affordable and able to be constructed in a reasonable amount of time. These studies represented a significant amount of time invested early in the project. For the collimator assembly construction described here, this early effort has now paid off and resulted in a unique set of instruments that were completed efficiently using primarily unskilled (undergraduate student worker) labor.

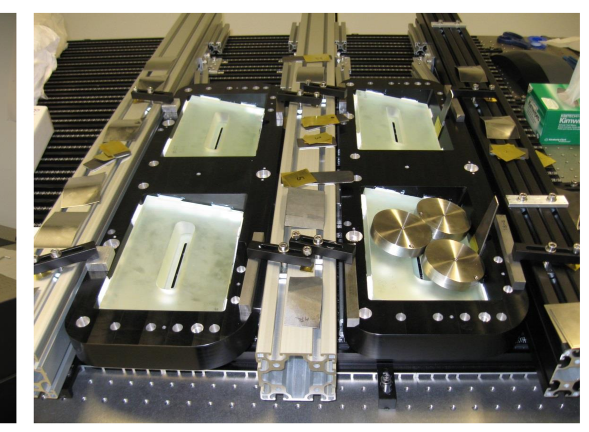


Left: Section-view drawing of a pair of VIRUS spectrographs. Right: One complete collimator with all optics installed. Additional completed collimators (with their protective covers installed) may be seen in the background

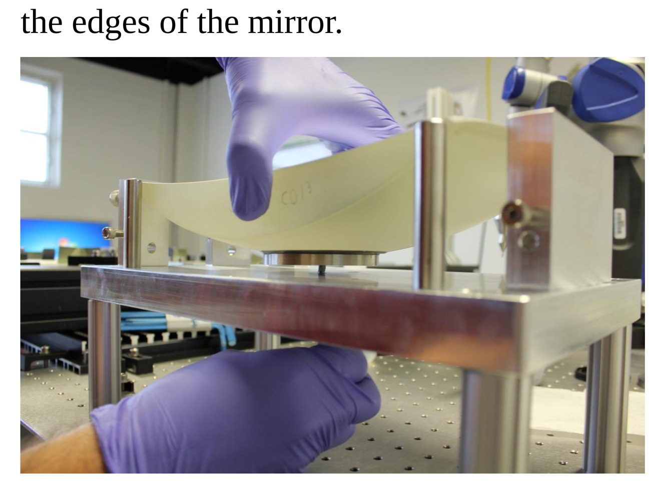
Optical and Mechanical Subassemblies



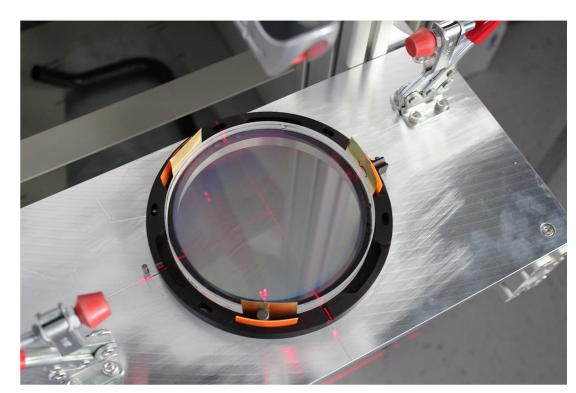


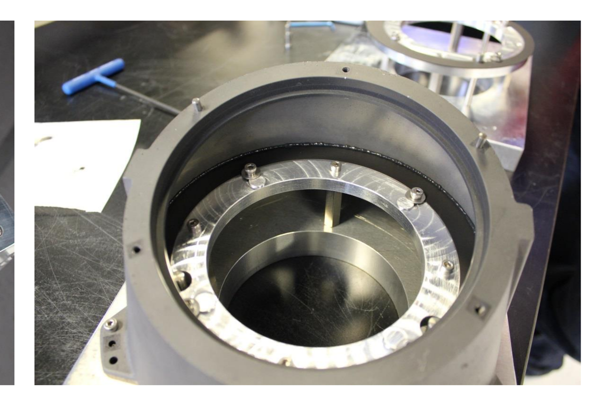


Installation fixture used to install the folding flat into the head plate. Two pairs of mirrors are installed into two head plates in one setup. The fold mirrors are precisely positioned with respect to the head plates using a Faro coordinate measuring machine (CMM) arm having a measurement accuracy of ~25 microns and are held in place with metal shims while RTV is applied around the edges of the mirror.



Collimator mirrors are installed in the instrument using an Invar mounting puck that is bonded to the back of the mirror. The puck is precisely located with respect to the edges of the mirror using an alignment fixture.



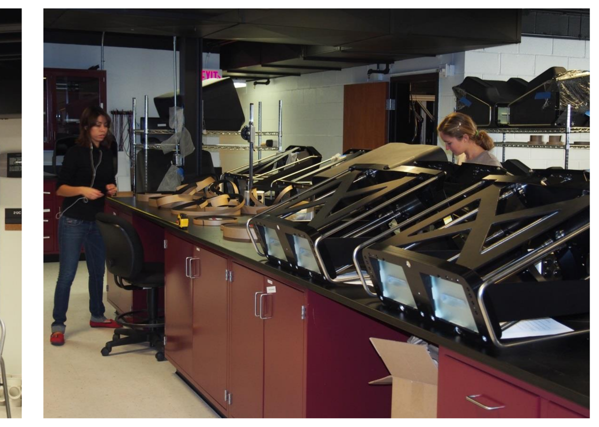


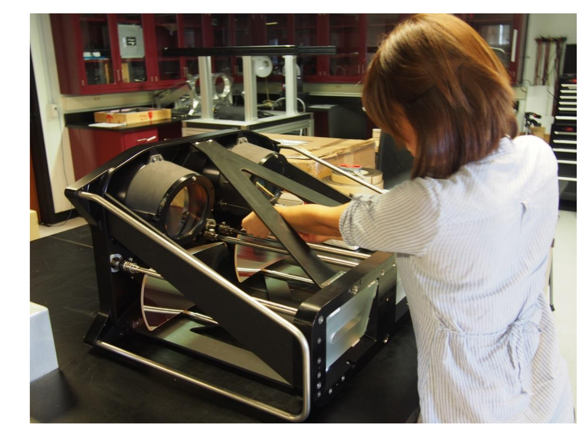
VPH gratings are optically aligned in their cell during installation using a laser (left). Internal baffles of the grating housings are installed using a fixture (right). The grating cell is later installed on top of the housing.

Collimator subassemblies were pre-assembled and stored before the final collimator assembly. Shown here are the base plates (left) and side, top, and bottom plates (right). Each of these components has multiple alignment and attachment features to facilitate the final assembly. Collimator mounting plates with attached Invar metering rods can be seen on the top rack of the carts.

Final Collimator Assembly

Collimators were completed in batches of 10-15 at a time. This number was primarily set by the size of the assembly bench. Each set of 10-15 collimators were assembled over a 2-3 week period.





In the end, the final mating of collimator subassemblies into a complete collimator unit was accomplished relatively quickly, with the final thirty pairs of collimators being assembled in just over two weeks in December 2013. The record assembly time of fifteen minutes to complete one pair of collimators is shared by the team of Nagasawa and Li.

Once the final collimator assembly is complete no further optical alignment is required at this stage. The completed collimators are fitted with a plastic cover that remains with the collimators once installed on the telescope, protected from dust with plastic wrap, and finally packaged and shipped to UT-Austin for integration with the VIRUS cameras and final optical alignment.

Conclusions

The VIRUS collimator assembly process is complete for 130 collimators (65 pairs). Important considerations throughout the design and construction process included an optical design with relatively loose alignment tolerances, thoughtful vendor selection and management, careful prototyping of components followed by redesign when necessary, precision alignment of optical components within cells that can be rigidly mounted at precise locations within the instrument, preliminary subassembly construction that enabled rapid collimator unit completion, and careful attention to quality control throughout the entire process. Although the VIRUS spectrographs comprise a challengingly large instrument unlike any previously produced in astronomy, these considerations resulted in a suite of VIRUS collimators that have been completed in a cost-effective and timely manner.

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

Munnerlyn Astronomical Instrumentation Lab
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GMT

HETDEX Illuminating the Darkness
Hobby-Eberly Telescope Dark Energy Experiment

LSST Large Synoptic Survey Telescope

DARK ENERGY SURVEY

Acknowledgments

Texas A&M University thanks Charles R. '62 and Judith G. Munnerlyn, George P. '40 and Cynthia Woods Mitchell, and their families for support of astronomical instrumentation activities in the Department of Physics and Astronomy.