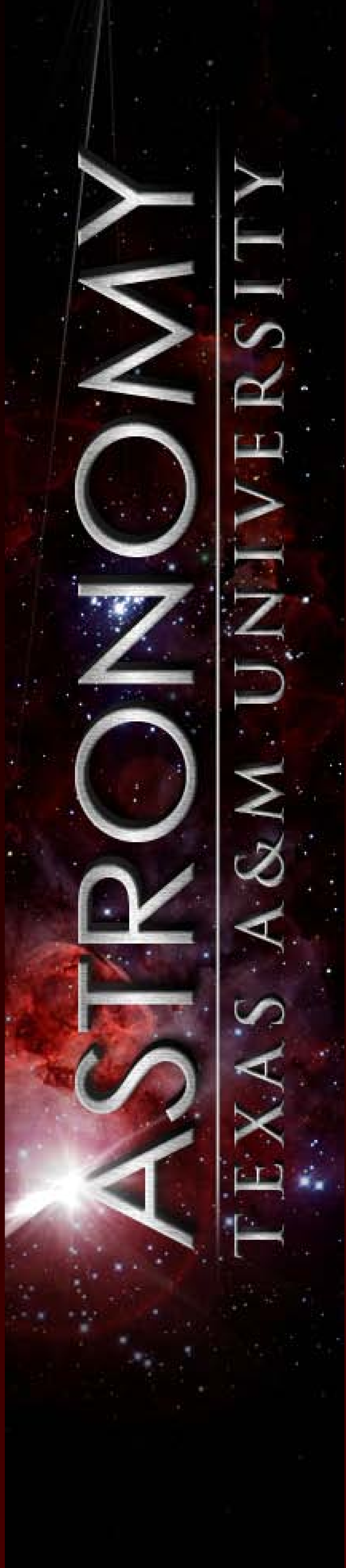
VIRUS instrument enclosures

T. Prochaska[a], R. Allen[a], N. Mondrik[a], J.P. Rheault[a], M. Sauseda[a], E. Boster[a], M. James[a], M. Rodriguez-Patino[a], G. Torres[a], J. Ham[a], E. Cook[a], D. Baker[a], D. L. DePoy[a], J. L. Marshall[a], G. J. Hill[b,c], D. Perry[b], R.D. Savage[b], J.M. Good[b], B.L. Vattiat[b]

[a]Department of Physics & Astronomy, Texas A&M University, 4242 TAMU, College Station, TX 77843-4242
[b]McDonald Observatory, University of Texas at Austin, 2515 Speedway, C1402, Austin, TX, USA 78712
[c]Department of Astronomy, University of Texas at Austin, 2515 Speedway, C1400, Austin, TX, USA 78712



Abstract

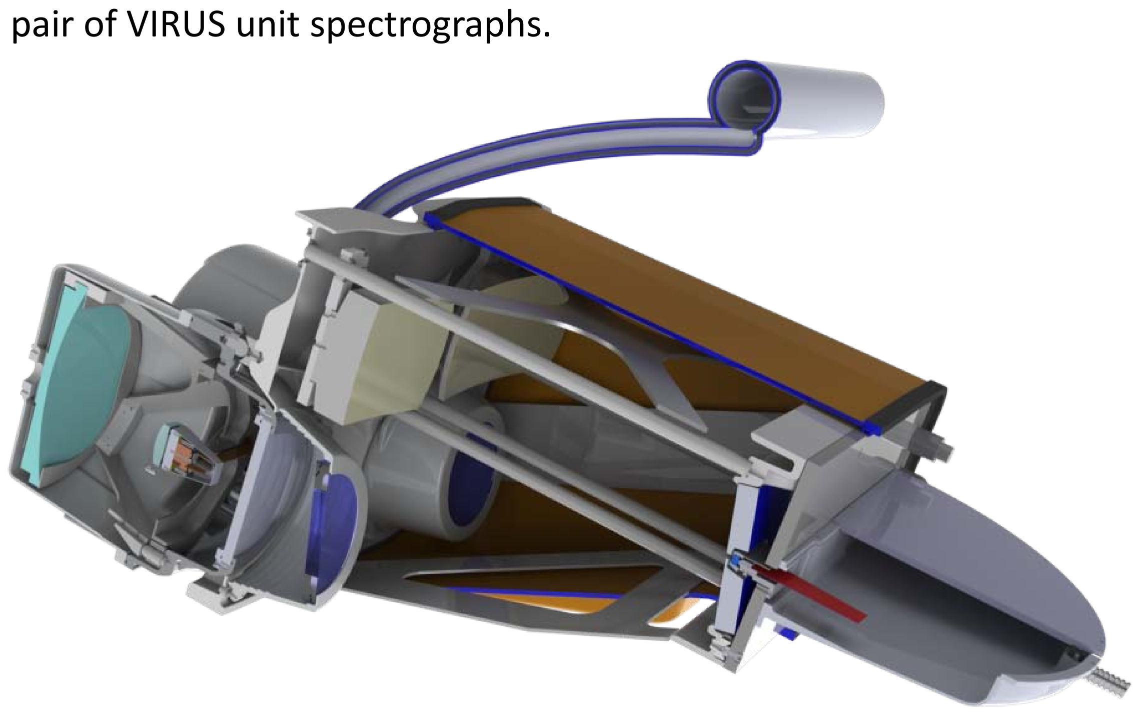
The Visible Integral-Field Replicable Unit Spectrograph (VIRUS) instrument will be installed at the Hobby-Eberly Telescope in the near future. The instrument will be housed in two enclosures that are mounted adjacent to the telescope, via the VIRUS Support Structure (VSS). We have designed the enclosures to support and protect the instrument, to enable servicing of the instrument, and to cool the instrument appropriately while not adversely affecting the dome environment. The system uses simple HVAC air handling techniques in conjunction with thermoelectric and standard glycol heat exchangers to provide efficient heat removal. The enclosures also provide power and data transfer to and from each VIRUS unit, liquid nitrogen cooling to the detectors, and environmental monitoring of the instrument and dome environments. In this poster, we describe the design and fabrication of the VIRUS enclosures and their sub-systems. The Hobby – Eberly Telescope is operated by McDonald Observatory on behalf of the University of Texas at Austin, Pennsylvania State University, Ludwig-Maximillians-Universität München, and Georg-August-Universität, Göttingen.

Introduction

Visual Integral-Field Replicable Unit Spectrograph (VIRUS) is an instrument that will support observations for the Hobby-Eberly Telescope Dark Energy Experiment (HETDEX) Project. HETDEX will use VIRUS with the upgraded Hobby-Eberly telescope (HET) to probe the nature of Dark Energy at high redshifts. VIRUS is comprised of 130 to 156 fiber fed optical spectrographs, which are collaboratively built by the University of Texas, Texas A&M University and University of Potsdam. The VIRUS units are projected to be completed by late 2014.

Instrument Overview

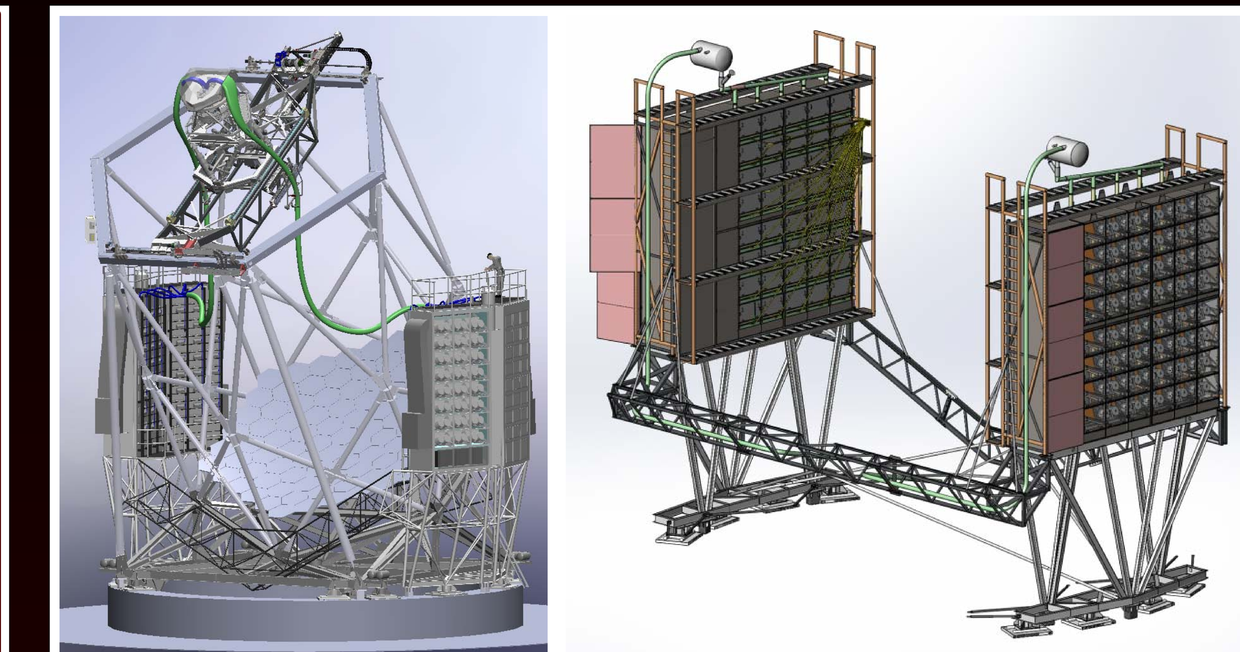
The VIRUS unit spectrographs are assembled in pairs, and consist of a simple Schmidt spectrograph (referred to as the "collimator") with an on-axis Schmidt vacuum camera. A volume phase holographic (VPH) grating provides a wavelength range of 350-550 nm. The detailed optical and mechanical designs of the instrument are described in more detail in other papers. The figure below shows a rendering of a pair of VIRUS unit spectrographs.



Section-view drawing of a pair of VIRUS spectrographs

Current Enclosure Positioning

The two enclosure structures will mount to the VIRUS Support Structure (VSS), which is made from free-standing frames, linked together by two trusses. The VSS holds the enclosures ~5m above the ground on either side of the telescope structure. The enclosures are positioned 180° from each other around the telescope to create a more optimal path to run the fiber bundles as well as keeps sections of the telescope more accessible for maintenance. The VSS has already been fabricated and is installed and fully functional at HET.



Rendering of the VSS, enclosures, and IFUs with and without the HET

Enclosure Structure

Each enclosure structure is primarily made of 4 weldments that are bolted together to form the area that houses up to 40 VIRUS units. Two additional weldments are bolted to the side of the housing area to form the enclosure annex. The annex will hold the power, control and data systems that connect to the VIRUS units. The HVAC system for the enclosure and its annex will also be contained in the annex space. The enclosure weldments have already been fabricated and are currently being assembled at Texas A&M University.

Stacked VIRUS enclosure structures

Instrument Housing

Mounting Rails

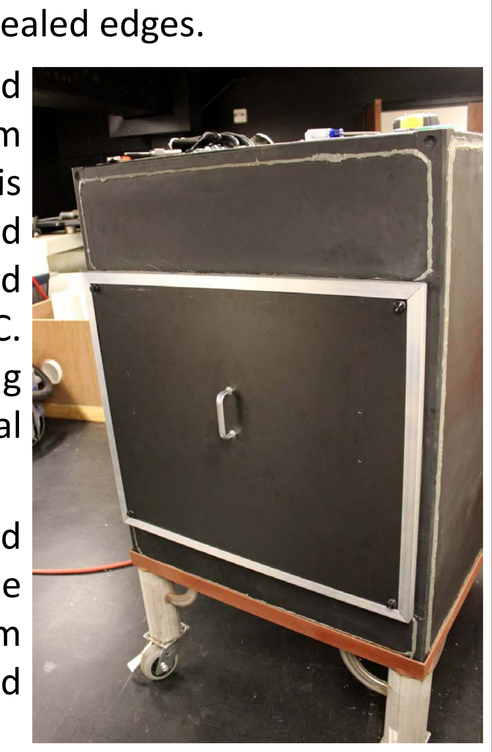
One of the most fundamental requirements of the enclosure is to securely hold the VIRUS units. The VIRUS units have two stainless steel rails on either side that are used to support their weight. These rails are held using a kinematic mounting system that will not induce any stress in the VIRUS instrument. The mounting system uses a v-groove for one rail and a piece of angle iron on a fulcrum for the other.

Enclosure Doors

Each instrument will have its own set of access doors, one that opens towards the dome and one that open towards the telescope. These doors are used to install, remove, and service the VIRUS instruments. These doors are required to be light weight, have captured thumb screws, be thermally insulative, and have sealed edges.

The doors will be light weight and thermally insulative by using a plastic-foam composite as the main door material. This material is made of 23.4mm extruded polystyrene (XPS) foam that is sandwiched between two 1mm thick sheets of PVC. This results in the complete doors being less than 2.55kg (5.6lb) with great thermal properties.

To protect the exposed foam faces and stiffen the edges, Al trim is glued to the outer edges. Similarly, to protect the foam around the holes, Al tubes will be glued into the holes.



Enclosure door design installed on the enclosure prototype

Thermal Management System

The enclosure thermal management system is designed to keep the VIRUS electronics boxes and equipment from overheating, and to prevent heat from escaping into the dome. To cool the VIRUS electronics boxes, air is sucked through the boxes via a vented duct system. This air passes through a series of fin-tube heat exchangers to cool the air to ambient temperatures and returns to the open area of the enclosure. The heat exchangers are cooled with 50/50 ethylene glycol and water (EGW), which carries the heat outside the dome. Matching the air temperature inside the enclosures to the ambient dome temperature will virtually eliminate heat transfer in or out of the enclosures.

There is an isolated cooling system for the enclosure annex. This cools the electronics used to run the VIRUS instruments as well as the enclosure air blower.

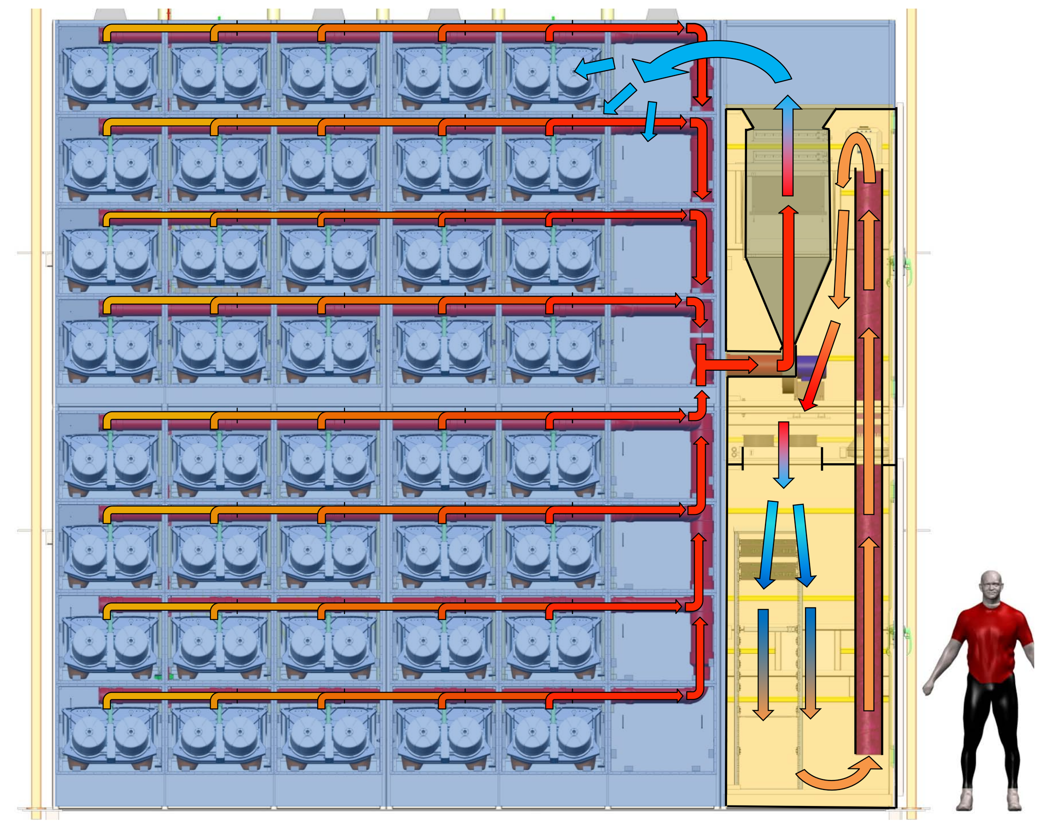
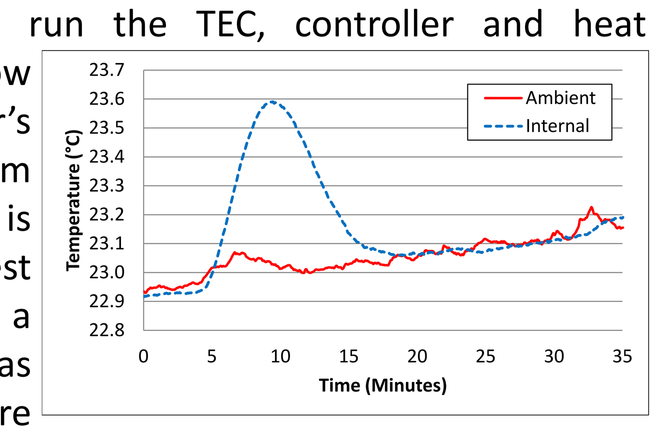


Illustration of the two HVAC zones. Up to 1200W and 2770W will need to removed from the main enclosure (blue) and annex (yellow), respectively.

Thermoelectric cooling

To cool the air back down to ambient temperatures, a thermoelectric cooler will chill a secondary heat exchanger. This system can remove up to 600W from its process fluid and move it directly to the facility EGW. To keep the enclosure air temperature matching dome ambient, we developed a custom controller that can track the ambient temperature by iteratively calculating the TEC set point temperature .

To check the validity of the controller and TEC, we set up a scaled, closed-loop HVAC system to run the TEC, controller and heat exchanger. The plot below shows the TEC & controller's ability to track the ambient room temperature when 370W is added to the closed loop test system. It shows that after a couple of minutes the TEC was able to bring the temperature back down to the ambient temperature where it continued to match within 0.1°C.



Temperatures of the air inside and out of the closed loop test system. The bump in internal temperature starts when extra heat is added.

Conclusion

With the VIRUS unit assembly finishing before the end of 2014, the instrument enclosures must be installed at the HET soon. Construction of the enclosures is well underway, with all of the major components designed and many of them fabricated. We plan to deliver the first enclosure to HET by early September 2014 and the second enclosure in October. The delivered enclosures will be able house up to 80 fiber-fed VIRUS units and cool them without leaking an adverse amount of heat into the dome environment.

Munnerlyn Astronomical Instrumentation Lab
Texas A&M University

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

GMT

HETDEX Illuminating the Darkness
Hobby-Eberly Telescope Dark Energy Experiment

LSST Large Synoptic Survey Telescope

DARK ENERGY SURVEY

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