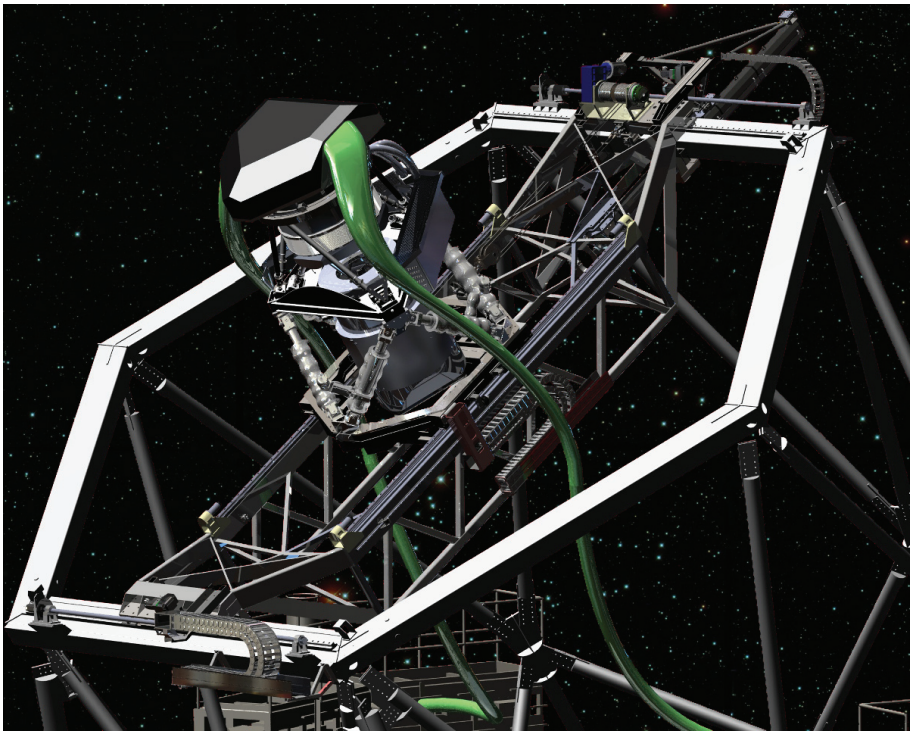
HETDEX Progress Report February 2010

Building Excitement

David L. Lambert

This is a very exciting time for the HETDEX team. Great progress is being made on the HET upgrade and the VIRUS spectrographs. Karl Gebhardt, Gary Hill, and Marc Rafal describe our progress in this document, and, as they make clear, HETDEX will not only make a unique contribution to understanding dark energy, it will be a revolutionary instrument in a host of other areas. We are grateful to the Board of Visitors for its leadership in securing much of the $26.2 million in funding we have received, and we ask for your continued help in closing the $7.8-million gap to complete HETDEX. *



Dark-Energy Science and the Competition: HETDEX's Unique Advantages

Karl Gebhardt

Five years ago, there were a dozen dark-energy projects planned from the ground and several more from space. Now, because of budget issues, the space-based dark-energy projects have been pushed back by several years, and there are only three ground-based projects left standing for the near term: the Baryon Oscillation Spectroscopic Survey (BOSS), the Dark Energy Survey (DES), and HETDEX. Of these, HETDEX has a unique position, looking back further in time to provide key information that our competitors can't.

BOSS is a collaboration of many institutions to extend the existing Sloan Digital Sky Survey, based at the Apache Point Observatory. It will also explore dark energy at late cosmic times (7 to 10 billion years after the Big Bang) using spectra of massive galaxies. This technique has been used by the same group with a smaller survey and they now plan to provide better uncertainties on the expansion of the universe with the upgraded survey. The project is expected to operate from 2009-2014.

DES, a very large collaboration run out of the Department of Energy at Fermilab, is upgrading a public telescope in Chile. After building a new camera for the telescope, the project will study dark energy at late cosmic times (i.e., 7 to 10 billion years after the Big Bang, like BOSS) using a combination of Counts of Galaxy Clusters, Weak-Lensing Shear Tomography, Supernovae, and Baryon Acoustic Oscillations. The unique aspect of this survey is that it should limit uncertainties from any given

GEBHARDT continued, page 3

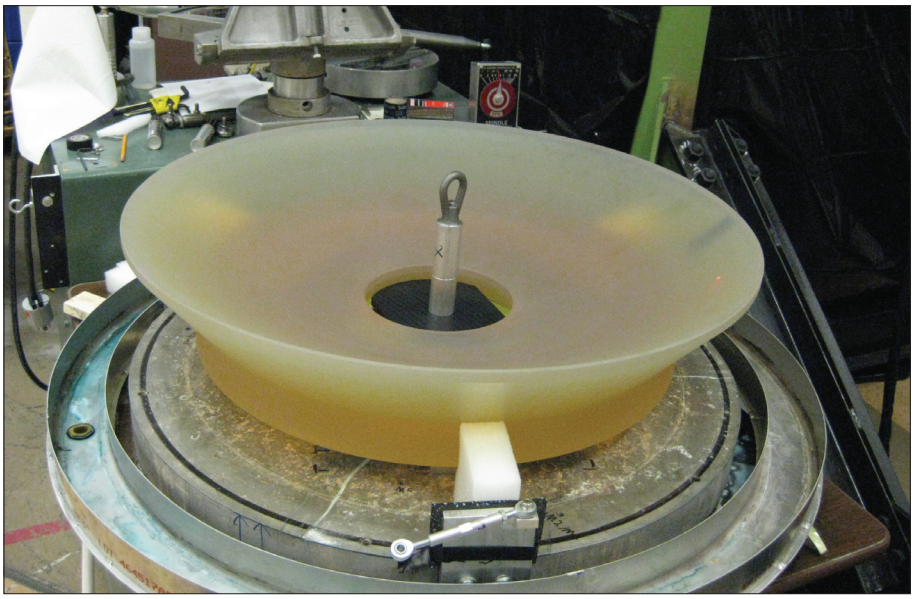
VIRUS: Moving Toward Replication

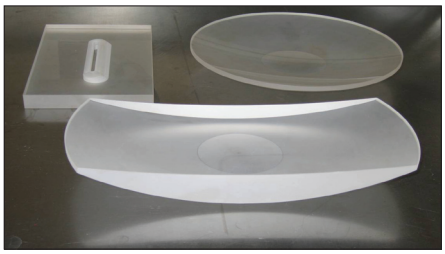
Gary Hill

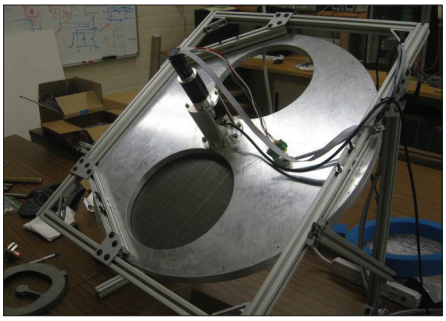
Progress on VIRUS in collaboration with Texas A&M is on schedule for deployment with the HET Wide Field Upgrade (to be named in honor of donor Harold C. Simmons) in Fall 2011. The key milestones have been the start of the CCD detector-system contract and completion of the production design. The detector system is the pacing item, with optics and gratings following. We have had a large number of responses and quotes from interested optics manufacturers,

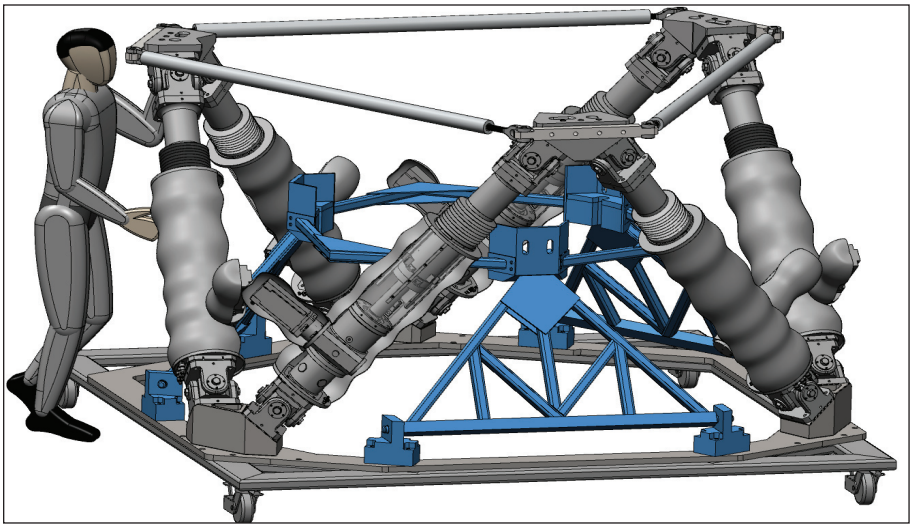
HILL continued, page 3

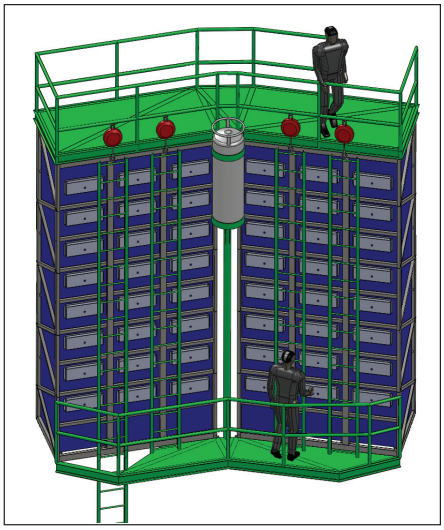
Above: Rendering by the University of Texas at Austin Center for Electromechanics, showing the new tracker and the Harold C. Simmons Dark Energy Optical System for the Hobby-Eberly Telescope. See page 2 for more.











HETDEX Status Pictures

TOP LEFT: *One of four mirrors being fabricated for the Wide Field Corrector. It has been rough-machined to the required shape and is being prepared for precise grinding and polishing to a smooth surface. The four mirrors, when assembled and mounted on the new Tracker, will collect the light from the HET primary mirror and bring the image to a sharp focus.*

ABOVE LEFT: *The Tracker Hexapod. Made up of six strut actuators, the Tracker Hexapod controls the orientation of the Wide Field Corrector as it tracks across the HET Primary Mirror. It can move a payload in excess of five thousand pounds within tolerances of less than 1/1000 of an inch. The factory acceptance test for the first strut is scheduled for March 2010.*

TOP RIGHT: *VIRUS Spectrograph Components. VIRUS spectrographs are being constructed as pairs using high-volume production techniques.*

MIDDLE RIGHT: *Prototype Shutter. The Shutter controls the integration (exposure) time for the VIRUS spectrographs. A half-circle blade rotates with precisely controlled accelerations to expose each detector for the same period of time.*

BOTTOM RIGHT: *VIRUS Support Structure. Two VIRUS Support Structures, attached to each side of the HET, will each house up to 48 pairs of VIRUS spectrographs. Light captured by the HET is transported to each spectrograph via a bundle of optical fibers called an Integral Field Unit.* *

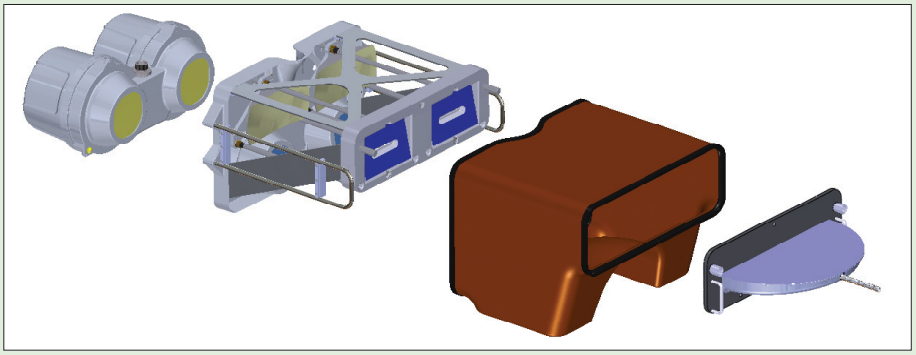
Marc Rafal

HILL continued from, page 1

which demonstrate that the VIRUS concept truly has hit the sweet spot for cost-savings through volume production. In quantity, the optics are costing a third of what they cost for VIRUS-P, in line with our predictions. As a result, the cost of VIRUS is well understood and within estimates. We are making visits to vendors and hope to start the optics procurement by June, if funding can be found.

The production design of VIRUS makes extensive use of carefully designed castings to reduce cost and speed production. We have assembled a pre-production prototype and are now ready to enter production.

VIRUS-P continues to be the most sought-after instrument on the 107-inch Harlan J. Smith Telescope. We have completed the pilot survey for HETDEX, demonstrating that we're finding the galaxies for HETDEX in the required numbers. VIRUS-P is now being used for a wide range of science, including VENGA (the subject of a presentation by Guillermo Blanc at the February, 2010, BoV meeting).



VIRUS-P is the premier instrument on our planet for studying star-formation, star populations, and the dynamics of nearby galaxies. *

Above: Use of cast (instead of machined) components for the VIRUS spectrographs is helping hold down costs and speed production.

GEBHARDT continued from page 1

technique by comparing results across the three methods. DES is based on taking images of galaxies and using their distribution to study the expansion of the universe. They expect to operate from 2011-2016.

With funding, we will report HETDEX's findings in 2014, ahead of either BOSS or DES. BOSS and DES are both fully funded. HETDEX is three-fourths funded.

HETDEX is unique because it takes the approach of opening up a new regime of expansion for study. It is focused on an epoch in the universe that is unexplored for dark energy and that DES and BOSS won't study -- between 2 and 5 billion years after the Big Bang. HETDEX will map the locations of more than a million star-forming galaxies in the early Universe, then use the same BAO technique as BOSS to calculate the Universe's expansion history. With its deep survey, HETDEX will be able to show whether dark energy has evolved and it will also provide an extremely accurate measurement of the curvature of the Universe. In the later-epoch surveys conducted by BOSS and DES, it won't be possible to separate the effects of this curvature from the effects of dark energy without the precision measurements that only HETDEX will provide.

Beyond studying dark energy, the remarkable improvements in the Hobby-Eberly Telescope and the powerful new VIRUS instrument have the HET community here and at our partner institutions excited. We held a very successful meeting in Austin in February 2009 to discuss uses of VIRUS and the HET beyond dark energy, and another is planned for April, 2010.

In broad outline, the topics under discussion include using HET/VIRUS for understanding how our galaxy assembled, quantifying the amount of dark matter in nearby galaxies, and understanding how stars formed in early galaxies. The HETDEX dataset will also unlock a number of additional issues that are currently unknown: for example it will provide a hard limit for the total mass of the neutrinos in the Universe. *