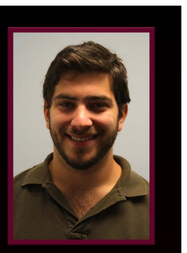
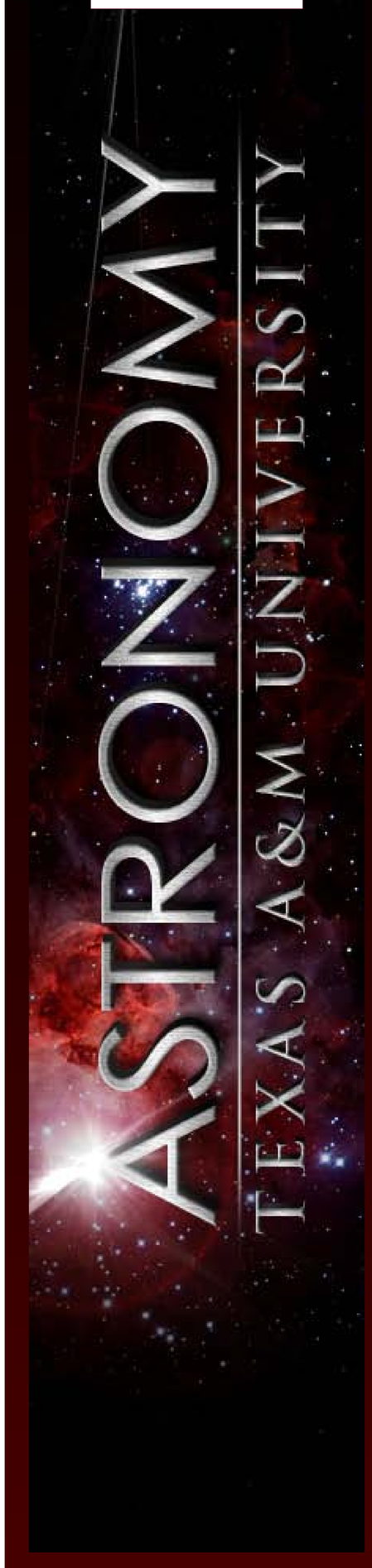
Automation of Calibration System for Dark Energy Survey

Jason Wise[1], J. P. Rheault[1], D. L. DePoy[1]

[1]*Texas A&M University Department of Physics and Astronomy.*





Introduction:

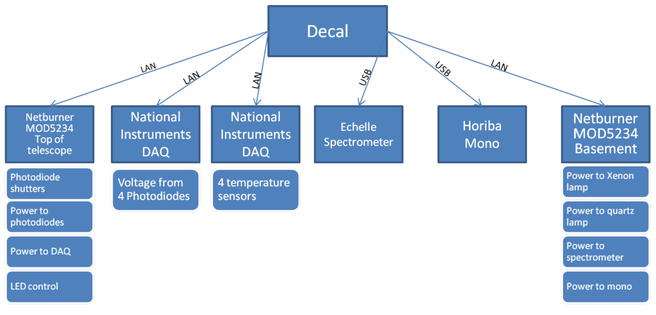
This year's Nobel prize in Physics was awarded for the discovery that the universe is accelerating as opposed to slowing from gravitational interactions. The Dark Energy Survey (DES) is a sky survey designed to find the reason for this acceleration. It will use the Dark Energy Camera (DECam), which is a 570 Megapixel camera that will be installed on the Blanco 4-meter telescope at CTIO. The camera has a 2.2 degree field of view and a system that is able to take an image in about 17 seconds.

To ensure the telescope gives as accurate information as possible, we have created a spectrophotometric calibration system that will measure the total instrument throughput versus wavelength, from about 300nm to 1100nm. The system will be permanently installed on the telescope and will monitor the throughput throughout the 5-year survey.

Having already tested a prototype of the system at the Swope and DuPont telescopes at Las Campanas Observatory in Chile, we are able to make necessary improvements to DECal to get better accuracy and more precise throughput measurements. One of the major changes we have made is that the entire system is now completely automated.

Components:

DECal has many different components chosen to ease integration and automation run smoothly. It uses a Horiba monochromator along with both quartz and xenon lamps to project light at a single wavelength, an Echelle spectrometer to measure the actual wavelength in real time, two National Instruments DAQ devices, two NetBurner MOD5234 microprocessors. All of these are able to be controlled by the DECal software. Below is a diagram that shows how each are connected and what they control.



The NetBurner modules are able to use both a TTL signal used for power switches, and analogue signal used to adjust the output of the LEDs.

Abstract

DECalS is a fully automated remote control program for the Dark Energy Survey spectrophotometric calibration system (DECal). Expected to be used roughly once a month to calibrate the Dark Energy Camera, DECalS provides a TCP/IP server with commands to give the user access to all aspects of the calibration. There is a separate "expert mode" used for installation and debugging purposes. Data gathered from the DECal system will track changes in the throughput of the compete optical path of the telescope system.

DECalS:

DECalS is the software for the DECal calibration system designed to make the process faster and easier for the user. Using National Instruments' LabVIEW programming language we have created two modes of operation for the software.

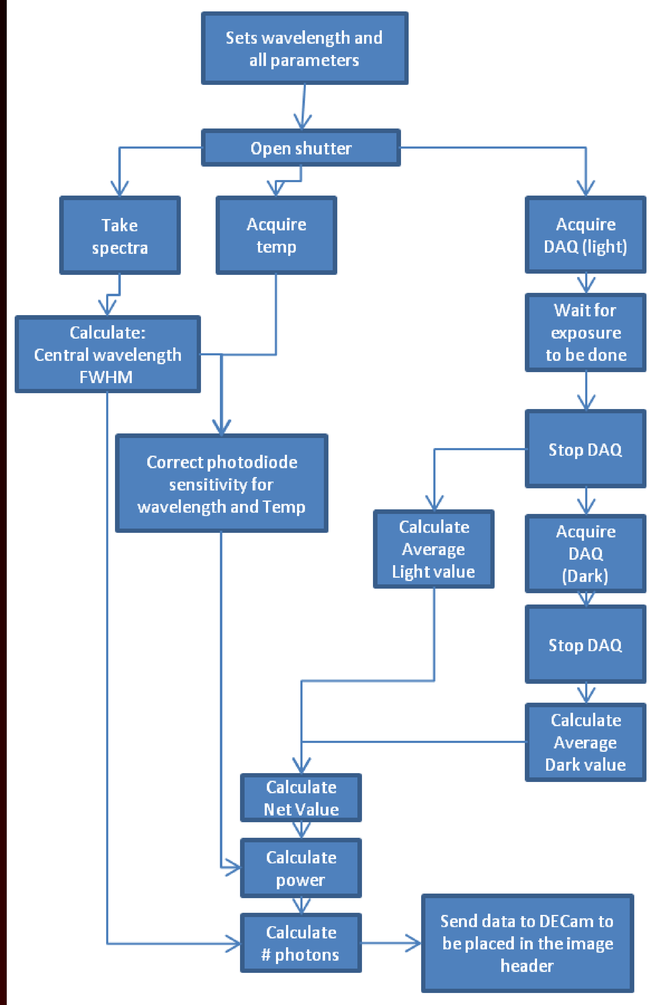
Manual Mode. The first, shown below, is the manual mode. Here the user is able to input the exact parameters they wish to run the scan over. Once the scan has started the user is given updates on the status of the calibration. This mode is used in the set up and debugging of the system. Though called manual once the scan is started it will automatically run what has been selected.

Server Mode. The second mode of operation is the server mode. This is the more commonly used mode. The server is a TCP/IP server that works over the LAN. With over one hundred commands, the server mode is able to execute all steps that the expert mode runs automatically. This mode will be used along with a SISPI interface.

Flat Field Calibration. DECalS will be used once a month to track changes in the throughput of the system. It also includes LED control for a flat field calibration for daily use before observing.

Process:

The process that the software goes through is quite extensive. Below is a flowchart that shows the steps the DECalS takes to get to the final throughput of the telescope-camera system. This process is the same in both modes of DECalS.



Output:

The results that are given by DECalS are neatly organized by date, time, and filter name. The files include all necessary information including all parameters of the run, on and off values, and reduced data. Once the run is finished we have a complete model of the throughput of the system. This is beneficial to calculate more precise measurements .

Future:

The system is already down at CTIO and will be up and running in the next few months. DECam is scheduled to begin its 5-year survey later this year.

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Munnerlyn Astronomical Instrumentation Lab, Texas A&M University

GMT

HETDEX Hobby-Eberly Telescope Dark Energy Experiment — Illuminating the Darkness

LSST Large Synoptic Survey Telescope

DARK ENERGY SURVEY

Acknowledgments

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