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Ryan Dungee
Project Summary

Telescope surveys have given us a great deal of information about our universe, but the images they capture carry with them an inherent limitation. The question then is how do we take this information to the next level? The answer: the Dark Energy Spectroscopic Instrument (DESI). DESI is an instrument that will measure the distance to tens of millions of galaxies in our night sky. This information can be combined with already existing images to construct a three dimensional map of our universe providing a great deal of new opportunities for cosmological research.

The DESI guidance system consists of 10 detectors called charge-coupled devices (CCDs). Each CCD is made of silicon atoms that emit electrons when struck with light, the electrons are counted and then used to reconstruct an image. But, CCDs suffer from an issue known as ‘dark current’ which are false counts that come from thermal motions of the silicon atoms. This is particularly problematic since they contribute to the uncertainty of a measurement without contributing to our signal. This causes a drop in the signal to noise ratio, a value that needs to be maximized in order to meet DESI’s high precision requirements.

This summer was spent ensuring the DESI guidance system would meet its specifications. Data was collected using a CCD of the same type that would be used on DESI and the effectiveness of dark current removal was tested. Exposures were taken for a wide range of temperatures and exposure lengths and a number of dark current removal methods were implemented. While further testing is required, the initial results are quite promising and the DESI guidance system is on track to meet its specifications.

SLAC National Accelerator Laboratory, 2575 Sand Hill Road, Menlo Park, CA 94025
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The design of the Dark Energy Spectroscopic Instrument (DESI) presents an interesting and unique challenge. Its design calls for a set of 10 CCDs which serve the purpose of Guidance Focus and Alignment (GFA) allowing it to determine, with high precision, where it is pointing in the sky. The challenge arises from the fact that these CCDs can not be cooled without interfering with data collection. All CCDs generate noise known as 'dark current' which is the signal the CCD reads even in perfectly dark conditions, it originates from the thermal motions of the electrons in the detector. As such, this dark current has a strong temperature dependence and because of this most projects will cool their CCDs to a point where the dark current is negligible. Since this is not an option on DESI we must instead find an effective way of correcting for this dark current over a wide range of different temperatures. To accomplish this we will be doing a great deal of testing with a CCD of the same model as those chosen for the project, taking a large number of dark exposures at varying temperatures and exposure lengths. We will then take this data and manipulate it in various ways until we can effectively and efficiently output zero signal. We seek a signal of zero since we are subtracting various dark currents from one another. It should also be noted that we would like to maximize the time for scientific exposures compared to the time for calibration exposures, hence the need for efficiency as well as effectiveness.