# ‘Weather’ in LSST Camera
# Characterizing Turbulence as seen in Flat Illuminated Images

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## Introduction

The Legacy Survey of Space and Time (LSST) Camera underwent a recent electro-optical (EO) testing run last year at SLAC. One of the tests for this run were the creation of Photon Transfer Curves (PTCs) via flat field images. Analysis of the pixel value correlations in these images found a unique feature to this EO run, a long range correlation that extends 20-40 pixels. This feature is especially prominent in higher pixel value flats. An example of this can be seen in Figure 1. The long range correlation can be seen as a plateau extending past 20 pixels but can extended further.

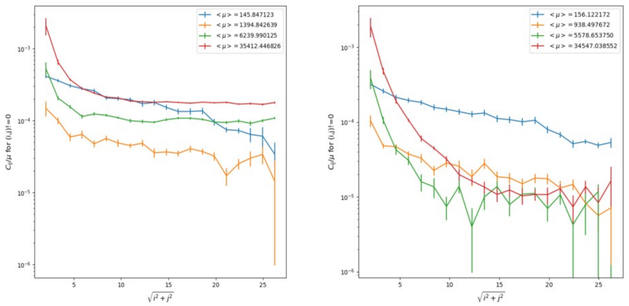
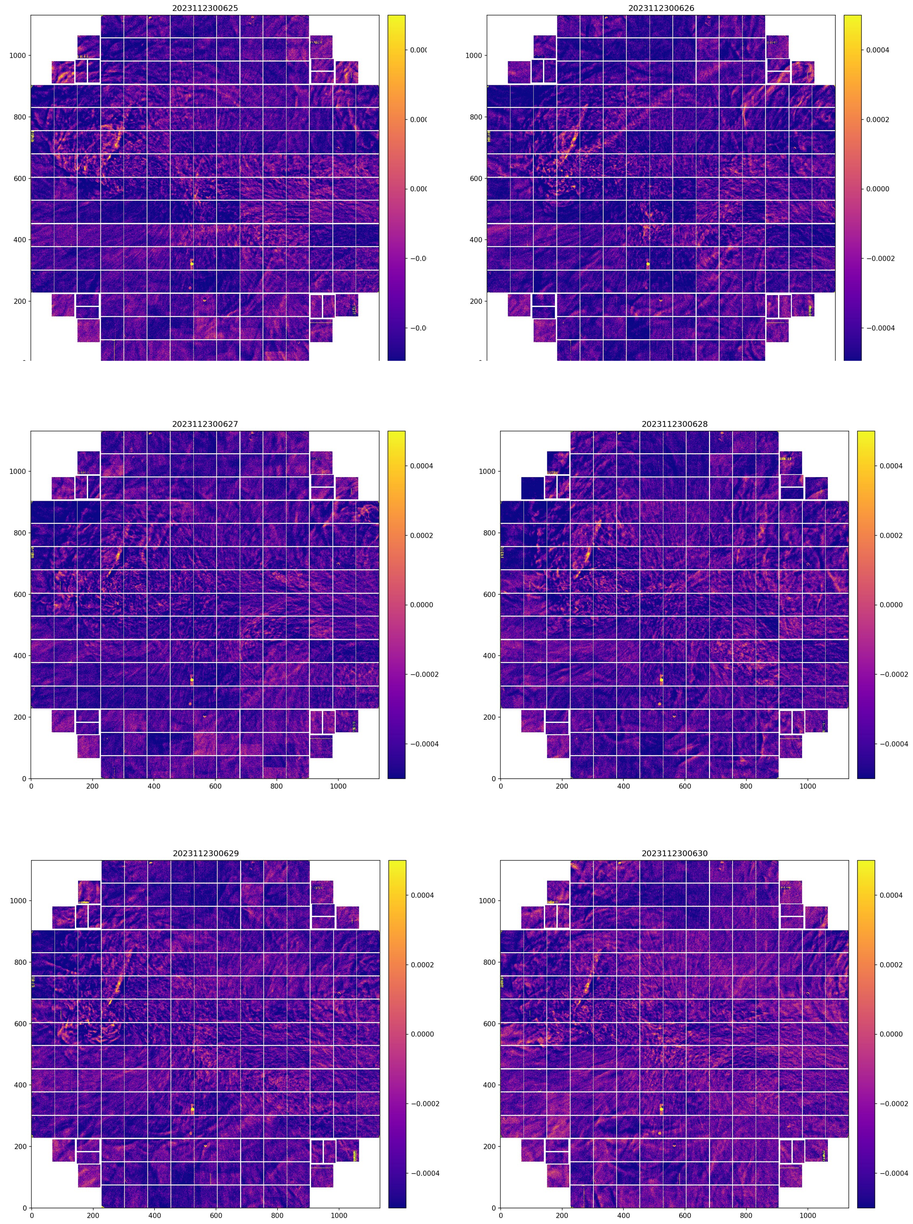



Figure 1: Correlation functions for pixels of one detector at four different PTC pair flux levels comparing the latest EO run (left) with a previous run (right). While the low flux PTC pair remains similar, the high flux PTC pairs display this long range correlation.

## ‘Weather’-Like Patterns

Investigating the cause of this long-range correlation, we begun by looking at the individual flats themselves. While the individual flat images visually looked as one would expect, the differences in the PTC flat pairs showed a non-random pattern. Digging further, we found that this pattern is not unique just to PTC flat images but all types of flat images. Figure 2 shows sequential flat images taken at the same exposure level. Further investigation found that these patterns were present in a previous EO run but at a lower amplitude.

Figure 2: These six images are binned flat images of the LSST focal plane subtracted from a combined flat. These are subsequent images and highlights the turbulent and temporal nature of the flat field variations.




## Possible Cause

A possible cause of this effect is the projector that we use to create this images. Figure 3 shows the projector that we use for flat field illumination.

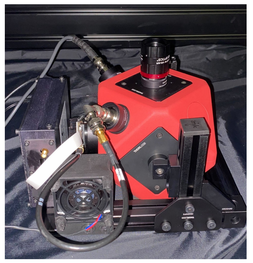


Figure 3: The wide beam projector used to create flat illumination across the entire focal plane.

Using this projector, we effectively increase the F number to around 100, much larger than the 1.4 that the optical system will have once in use. This means we are possibly probing slight temperature variations as the light travels to the focal plane. Evidence to support this can be seen in Figure 4. This is a flat image taken when the camera purge system was turned off. This shows a new structure to the weather patterns.

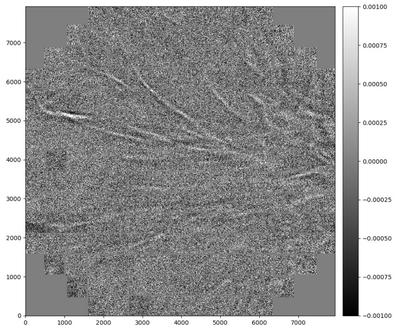


Figure 4: Subtracted and binned flat field image taken when the camera’s purge system was turned off.

## Future Work

The next stage of this study is to determine how this effect will possibly impact camera performance. Work is currently being done to utilize actual images, similar to those in Figure 2, and use *galsim* and simulate the size and shape of the PSF with and without this effect. This will help determine the magnitude of the effect and if a mitigation strategy would be needed.

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