Purdue REU Summer 2010
Final Talks: LSST Group

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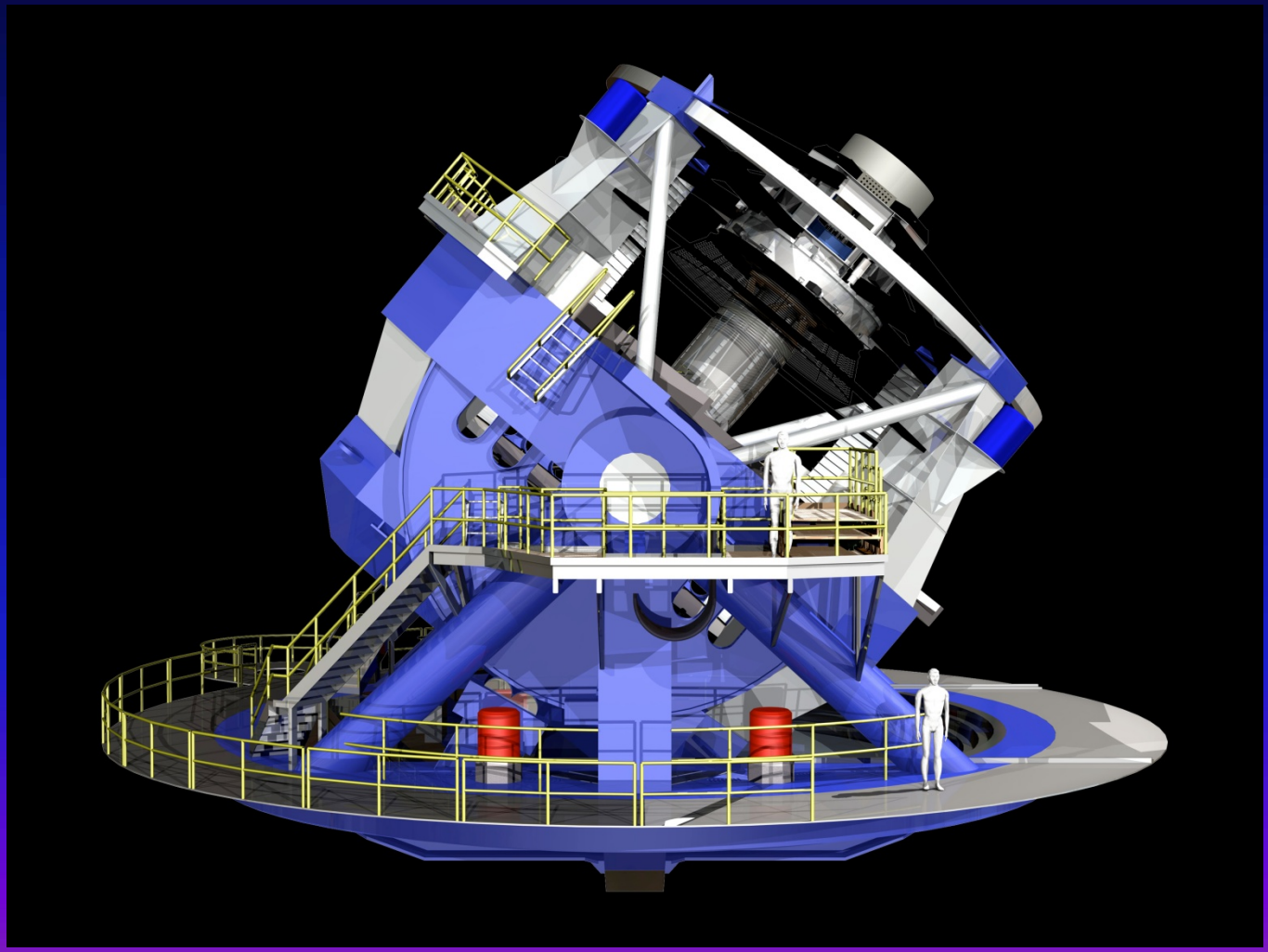
Outline

- What is the LSST?
- Simulator
- Calypso
  - Hot Pixels
  - Offset effect
  - Future work
    - Cosmic Rays
    - Quantum Efficiency
- Summary

What is the LSST?



LSST Filters

Table 2.1: Design of Filters: Transmission Points in nanometers

Filter	Blue Side	Red Side	Comments
u	320	400	Blue side cut-off depends on AR coating
g	400	552	Balmer break at 400 nm
r	552	691	Matches SDSS
i	691	818	Red side short of sky emission at 826 nm
z	818	922	Red side stop before H_2O bands
y	950	1080	Red cut-off before detector cut-off

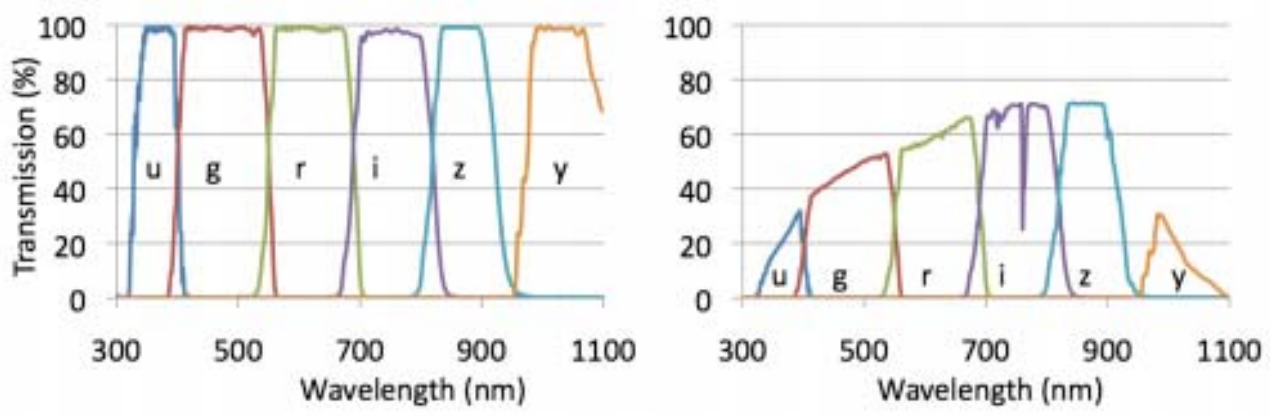


Figure 2.11: The left panel shows the transmission efficiency of the *ugrizy* filters by themselves as calculated from models of the filter performance. The total throughput, accounting for the transmission through the atmosphere at the zenith, the reflectivity of the reflective optics, the transmissivity of the refractive optics, and the quantum efficiency of the sensors is displayed in the panel on the right.

LSST the CCDs

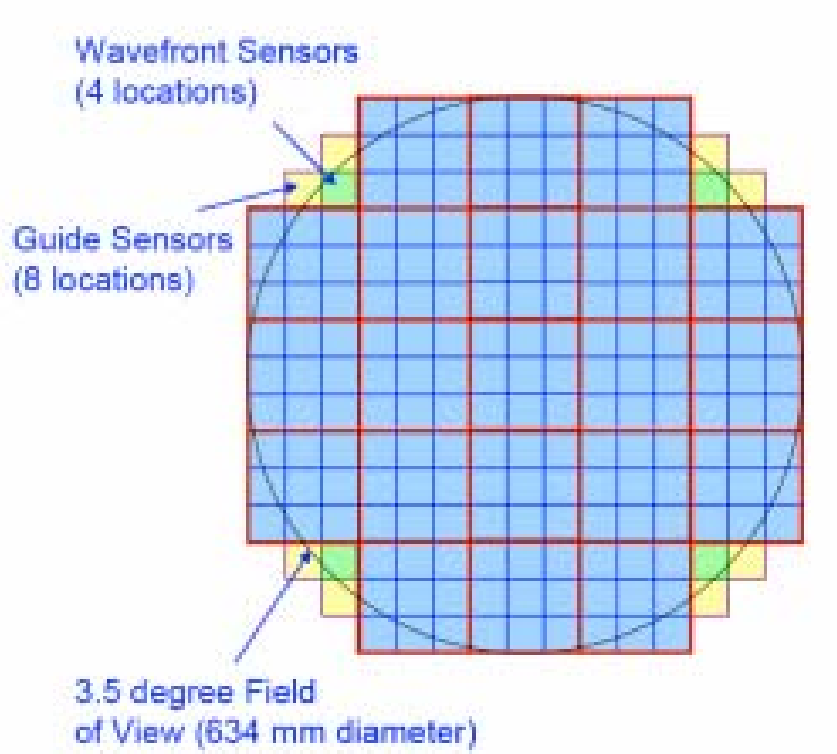


Figure 2.9: With its 189 sensors, each a 4 K × 4K charge-coupled device (CCD), the focal plane of the camera images 9.6 deg^2 of the sky per exposure. Note the presence of wavefront sensors, which are fed back to the mirror support/focus system, and the guide sensors, to keep the telescope accurately tracking on a given field.

Simulator: Ray Tracing

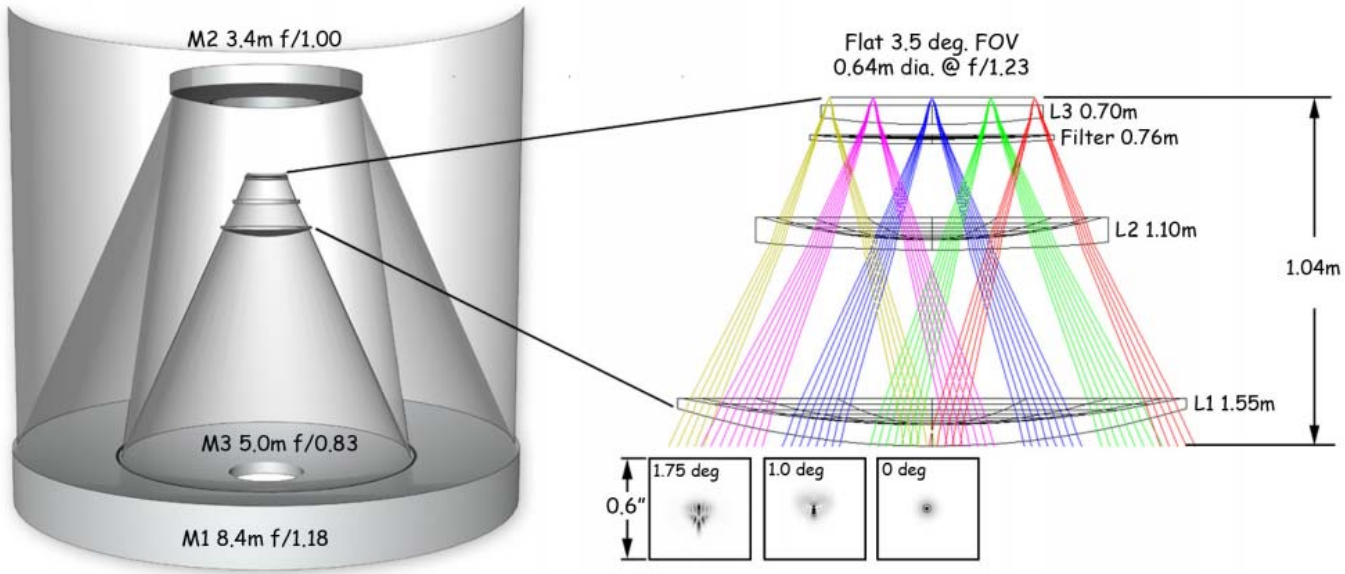
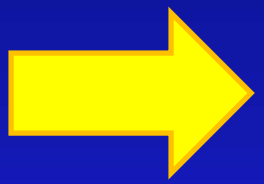
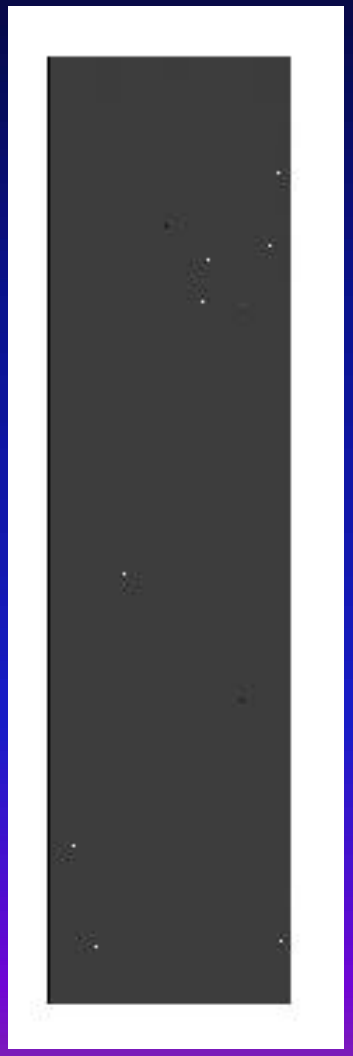


Figure 2.4: The optical design configuration showing the telescope (left) and camera (right) layouts. Diffraction images in r for three field radii, 0, 1.0, and 1.75 degrees, are shown in boxes 0.6 arcseconds square (3×3 pixels).

Simulator: Example Image



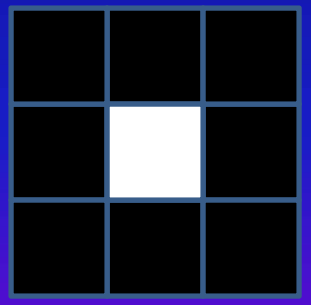


Calypso

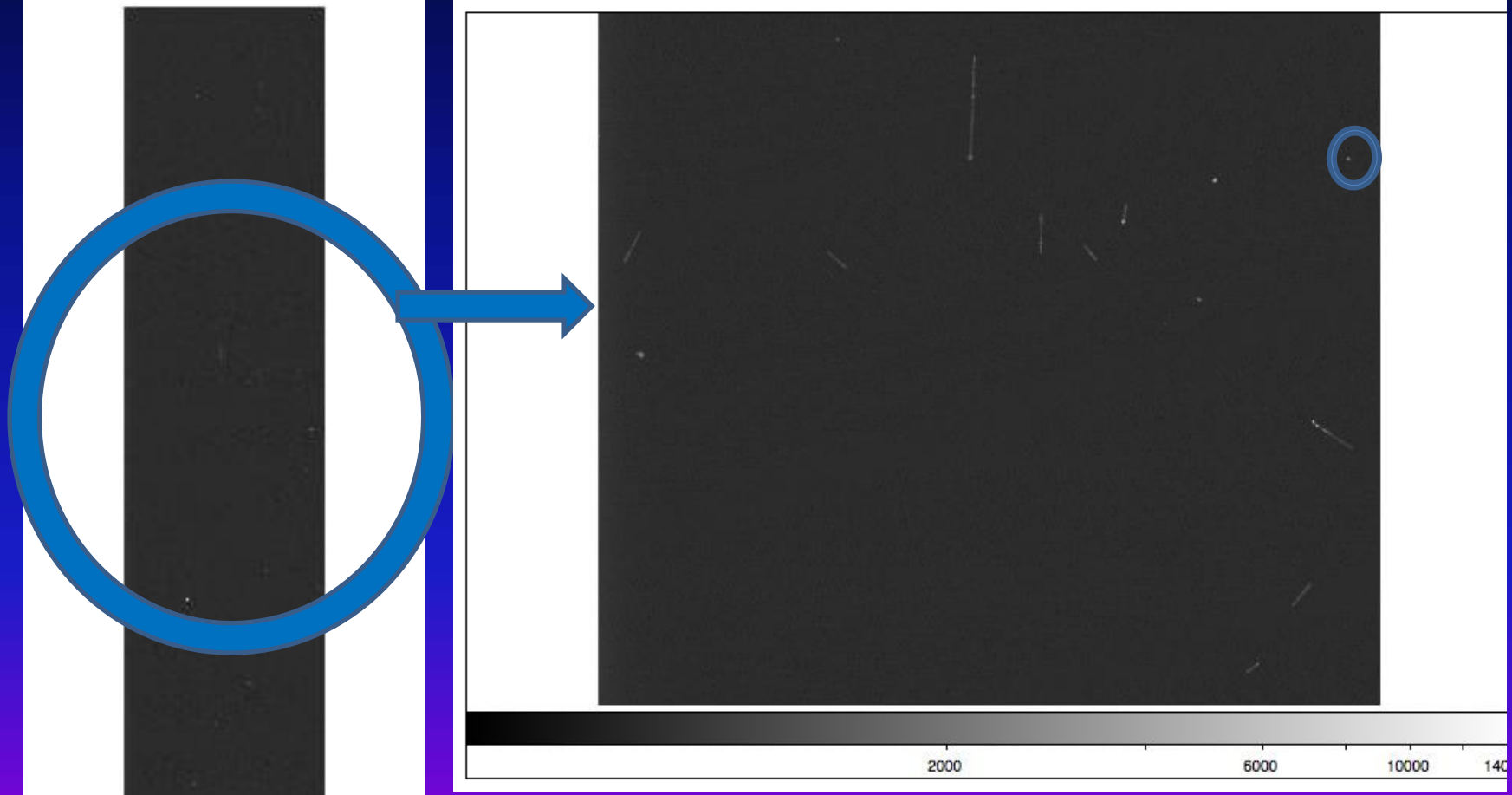
- Private observatory founded in 1992
- Located on Kitt Peak (elevation 637.6m), Tucson, Arizona
- Types of Data
  - Approximately 5,800 images taken
    - Approximately 2,600 are darks
    - bias
    - Flats
      - Dome Flats
      - Sky Flats
      - Twilight Flats
    - Objects

Hot Pixels

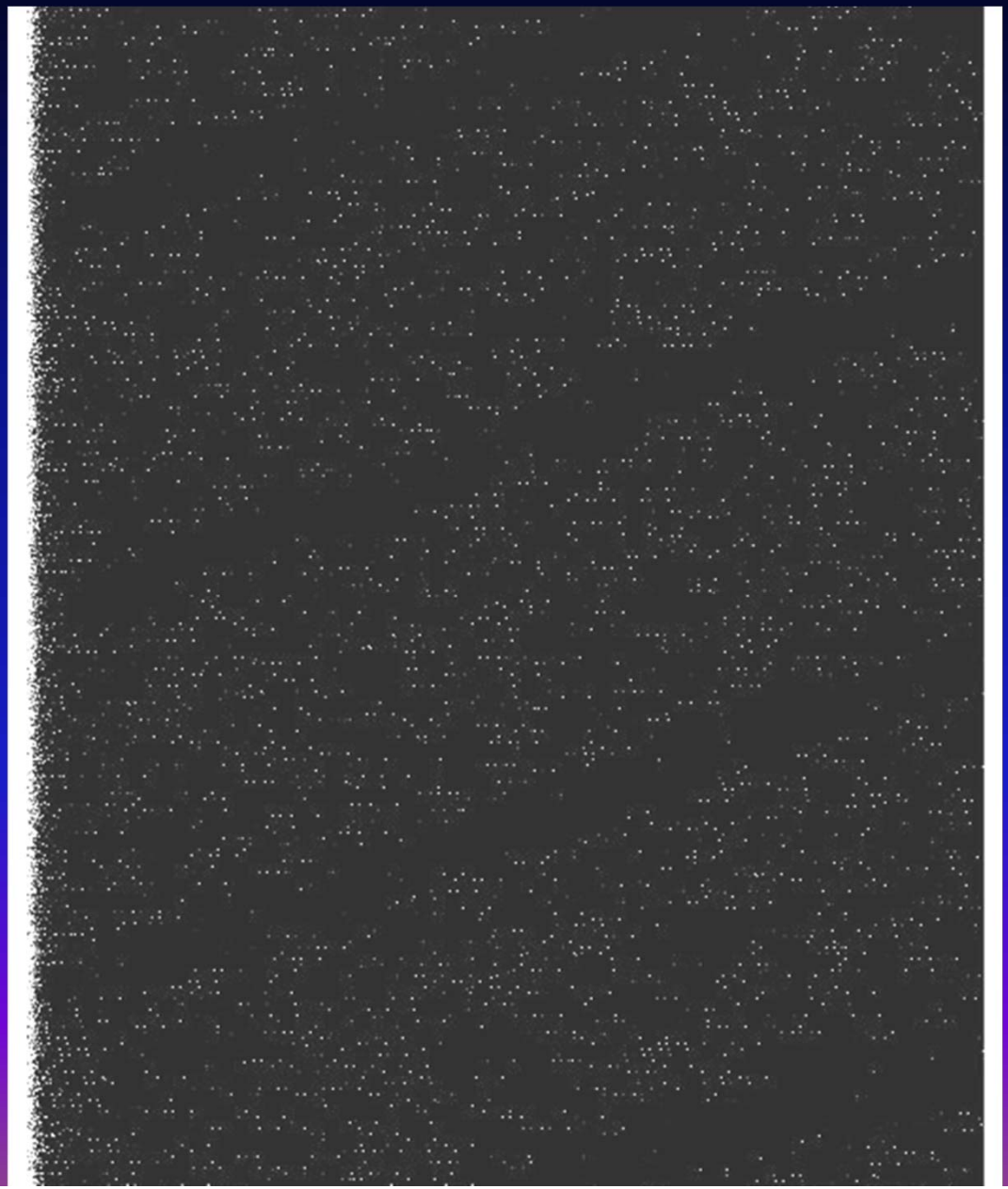
- CCD read in electrons however sometimes a pixel will read in a unusually high count of electrons
- To simulate this we must first have an idea of how many hot pixels are in the CCD camera
  - Create an IDL program that looks for hot pixels
  - If $N > A + X\sigma$
    - A is the average of the neighbors
    - N is the number of counts in a pixel
    - X is the number of standard deviations away (5-20)
    - σ is the standard deviation among the neighbors



Calypso Images: Darks

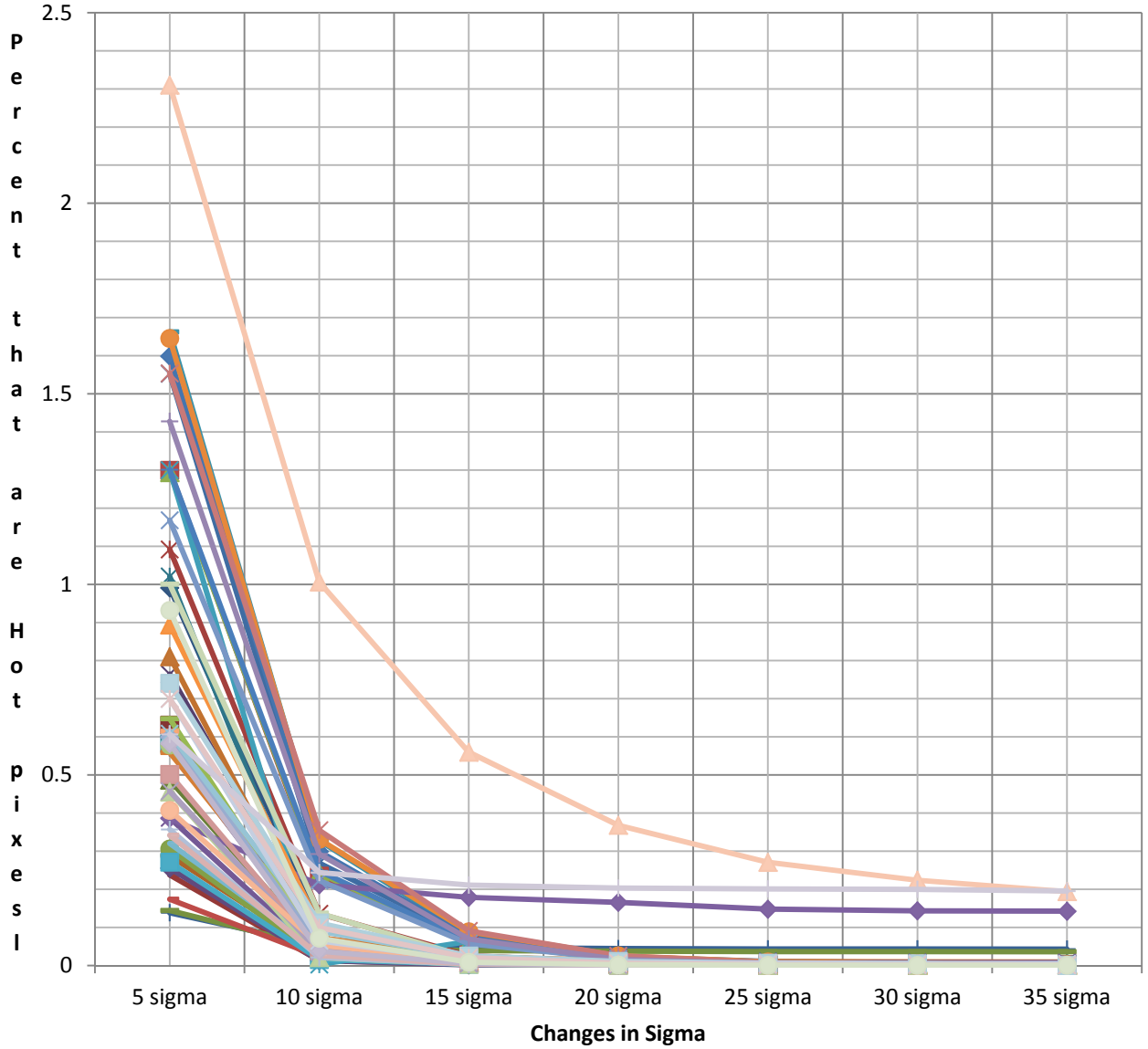


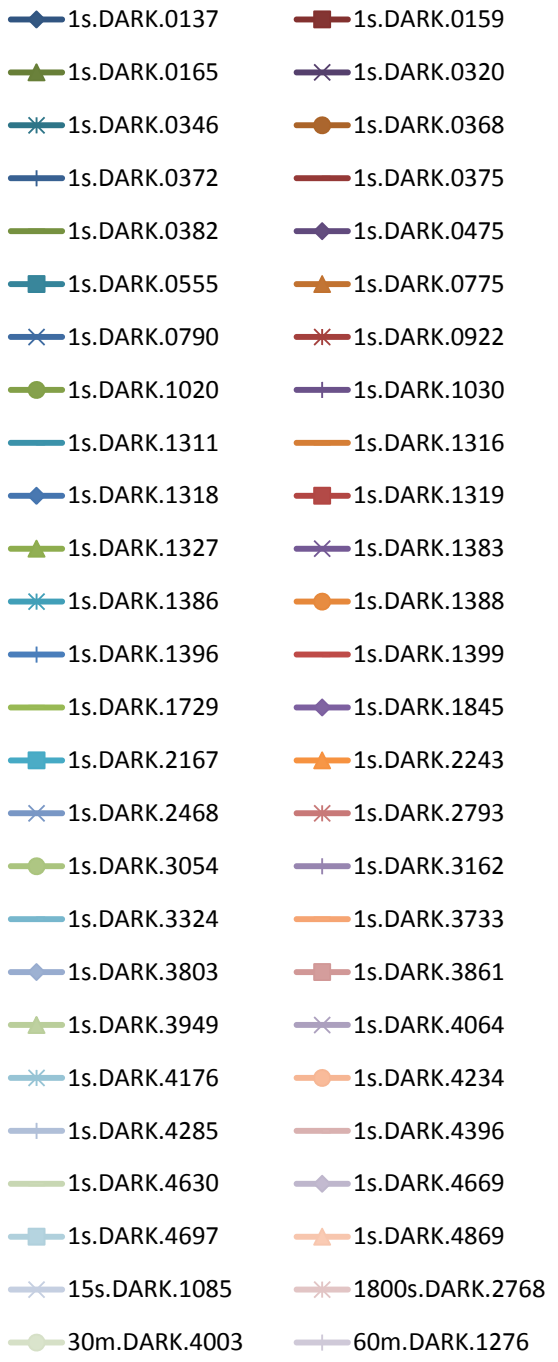
Fixed Pattern



Example of hot pixel

High Count : Changes in Sigma

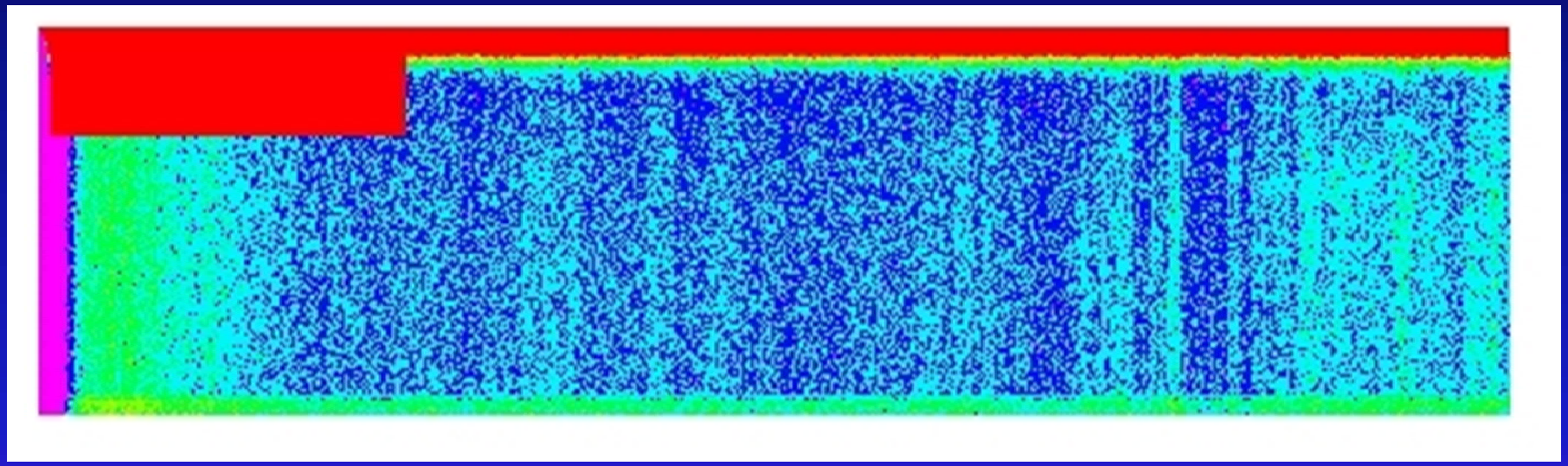


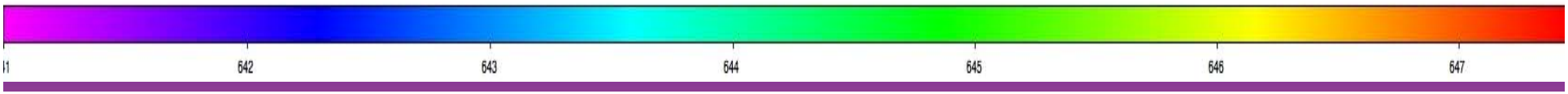


The Offset Effect

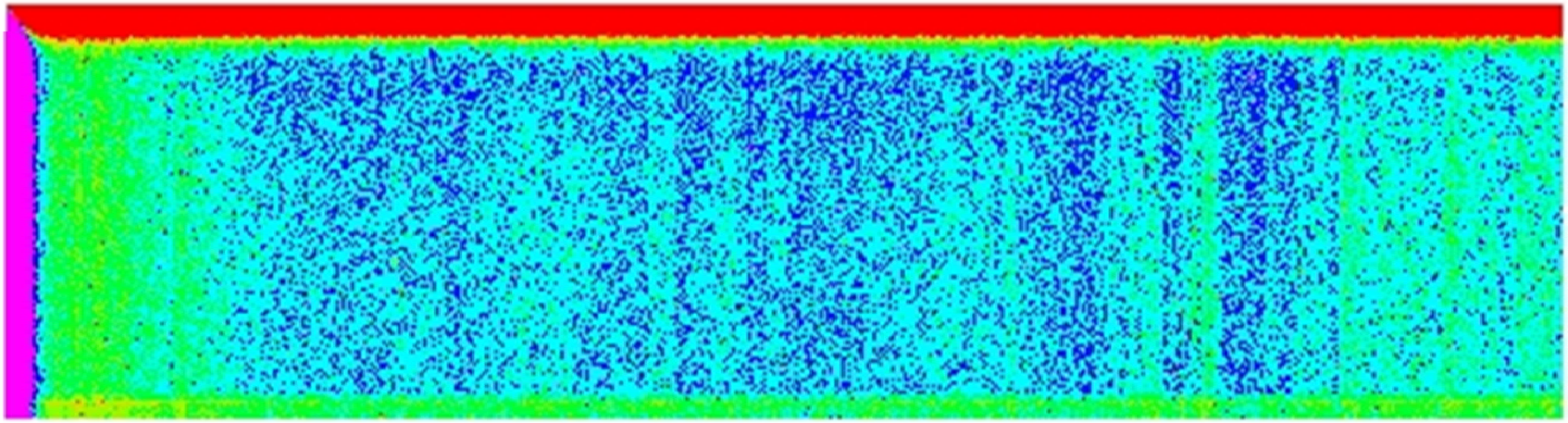
- The left edge tended to have a higher count than the rest of the dark image
- Created a idl program to take the average count of each pixel to see if we could add this edge effect into future simulations

The Offset Effect for All 1 Second Exposures

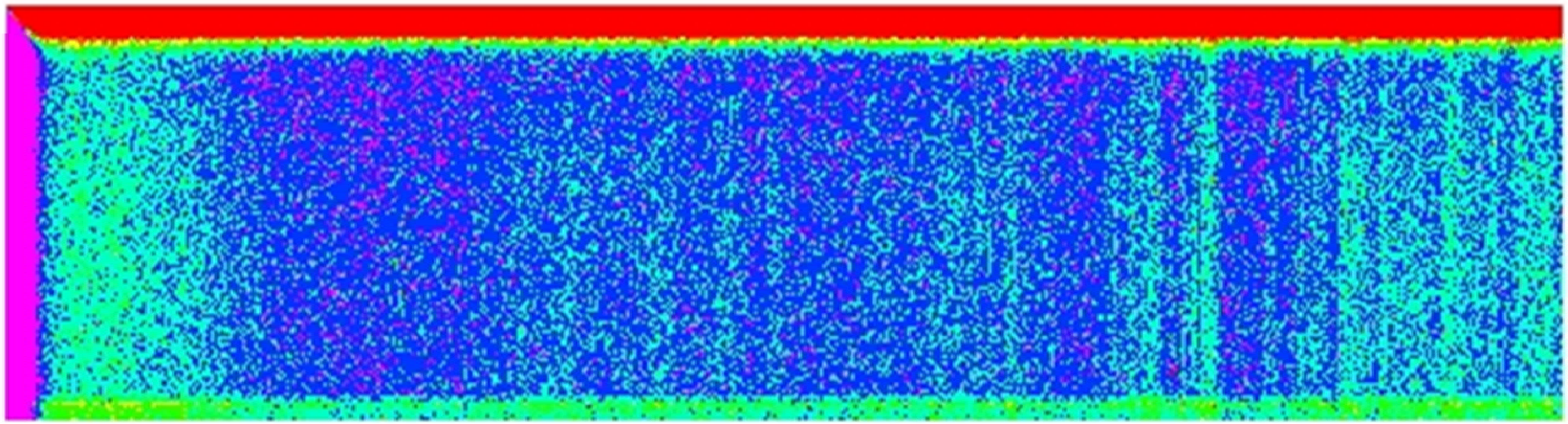




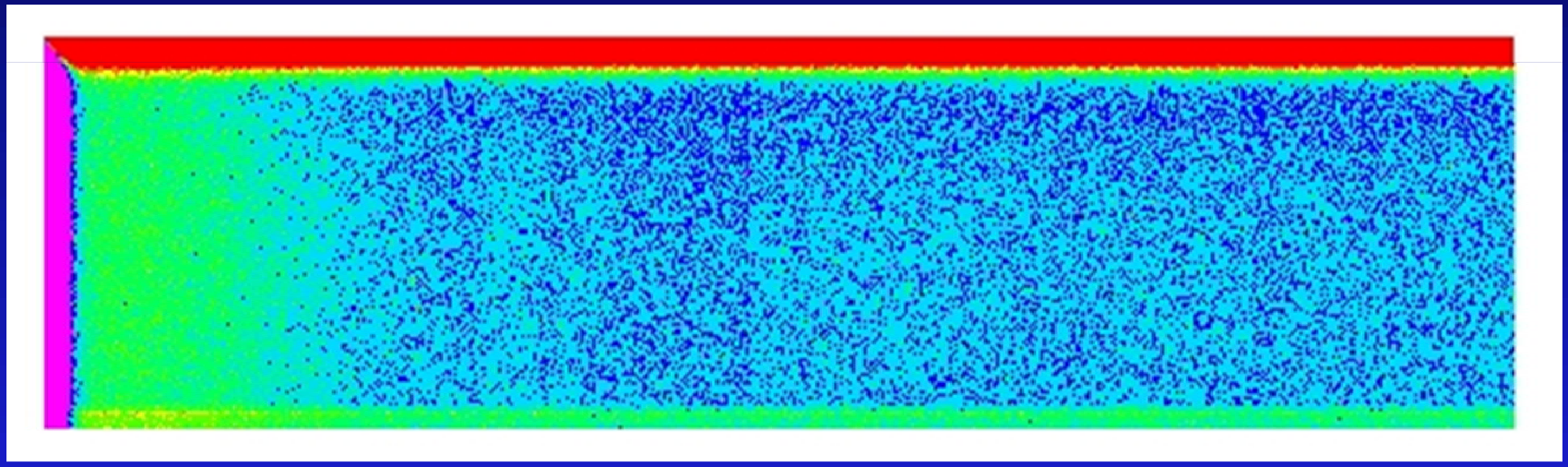
The Offset Effect for All 1 Second Exposures without May 21



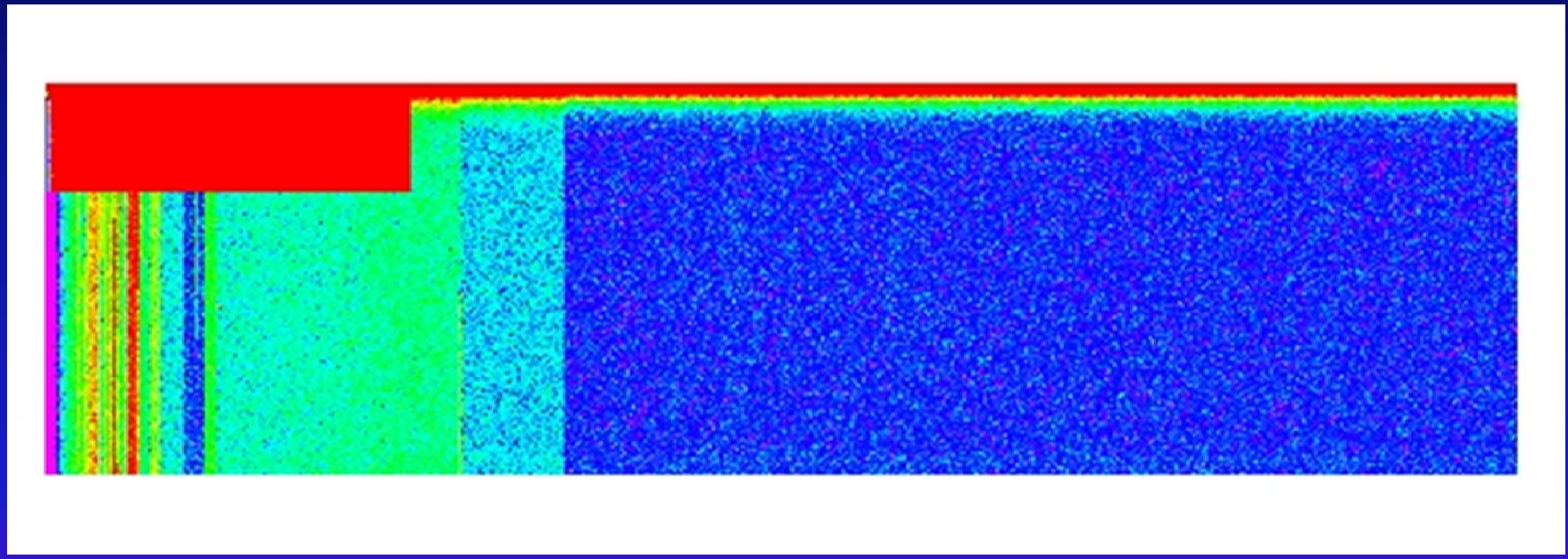
The Offset Effect for All except the Low Rates and May21 (1 second Exp)



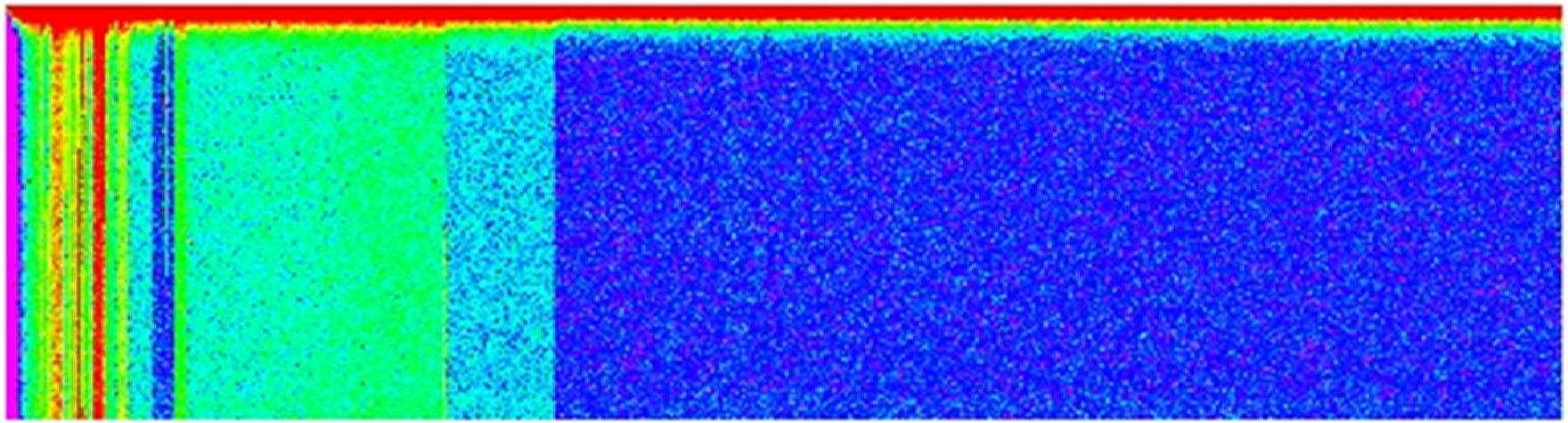
The Offset Effect for All except the High Counts and May21 (1 second Exp)



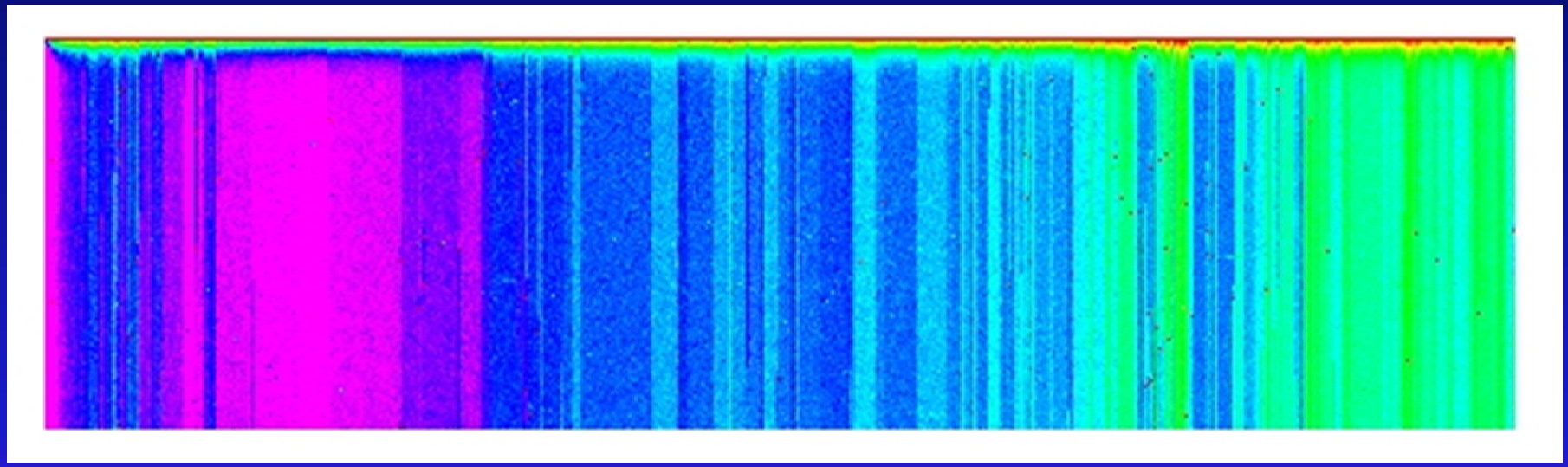
The Offset Effect for Low Rates (1 second Exp)



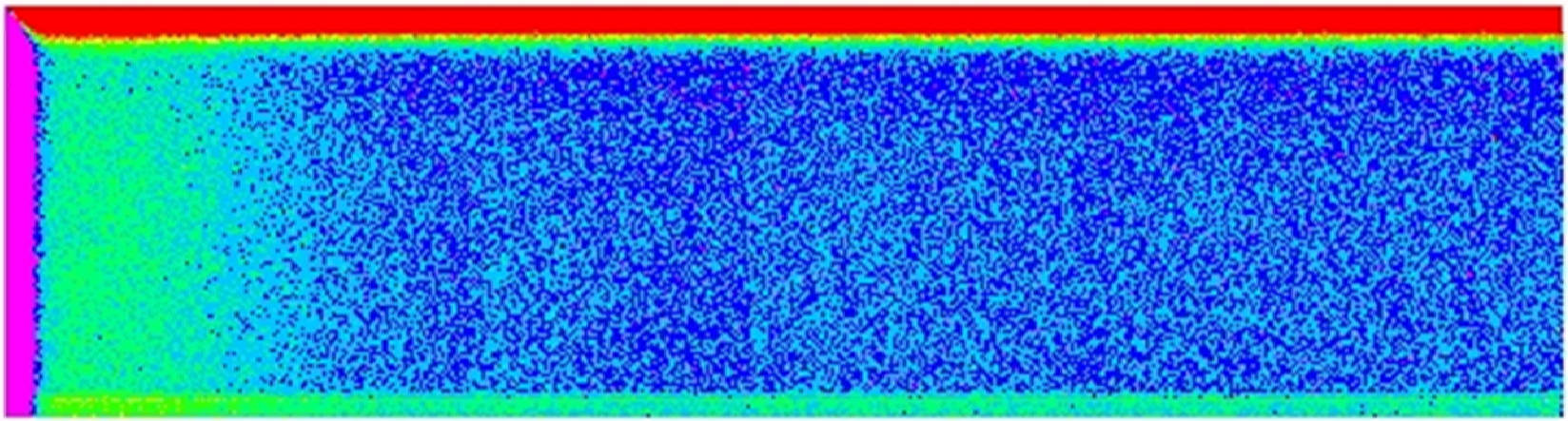
The Offset Effect for Low Rates without May 21 (1 second Exp)



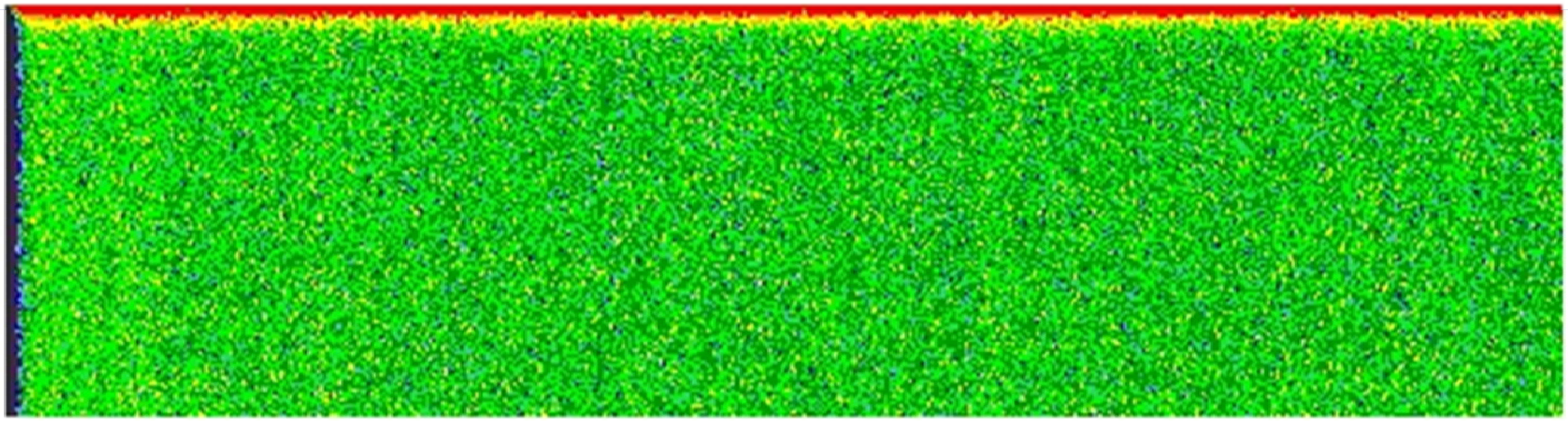
The Offset Effect for High Counts without May21 (1 second Exp)



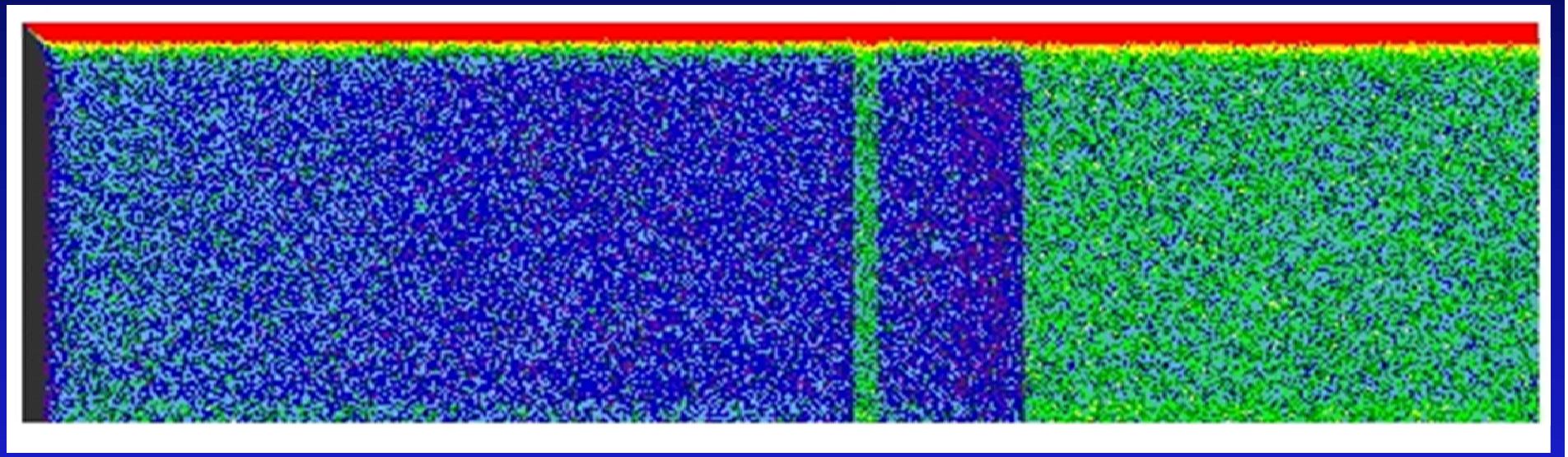
The Offset Effect for 1 sec Exp without High Counts or Low Rates

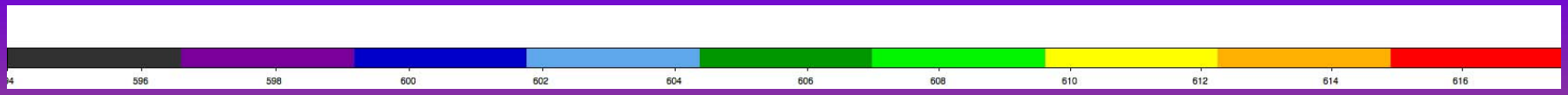


The Offset Effect for Biases

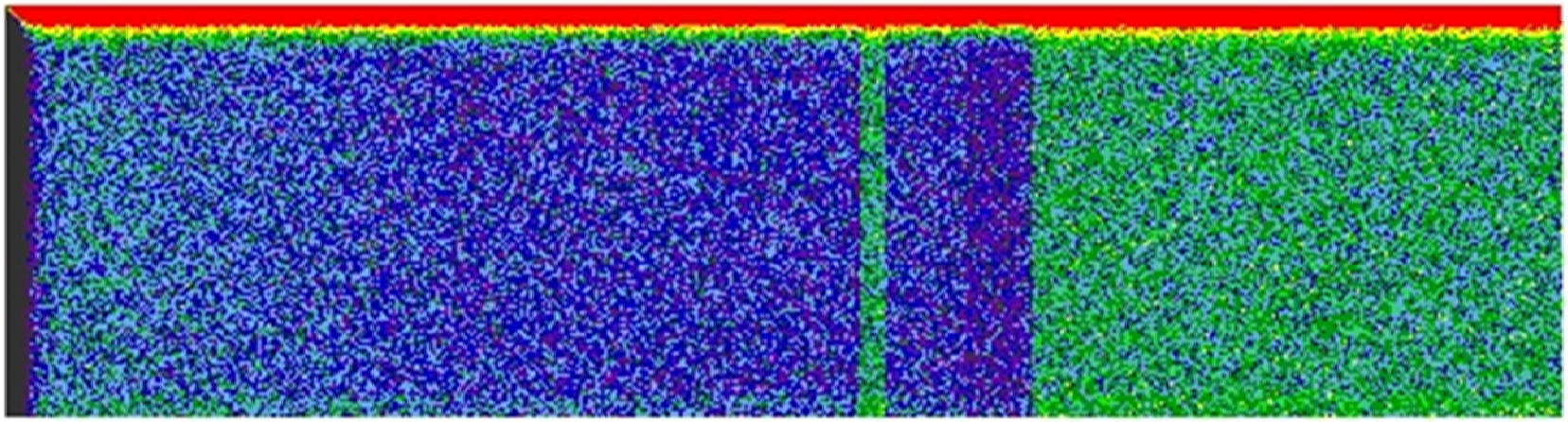


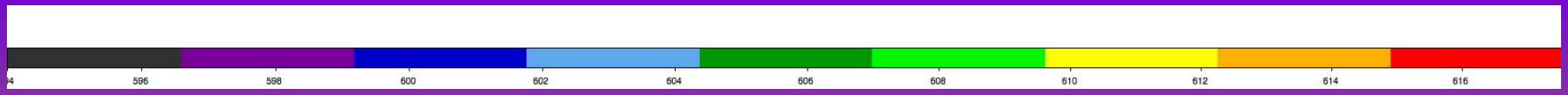
The Offset Effect for 15 seconds



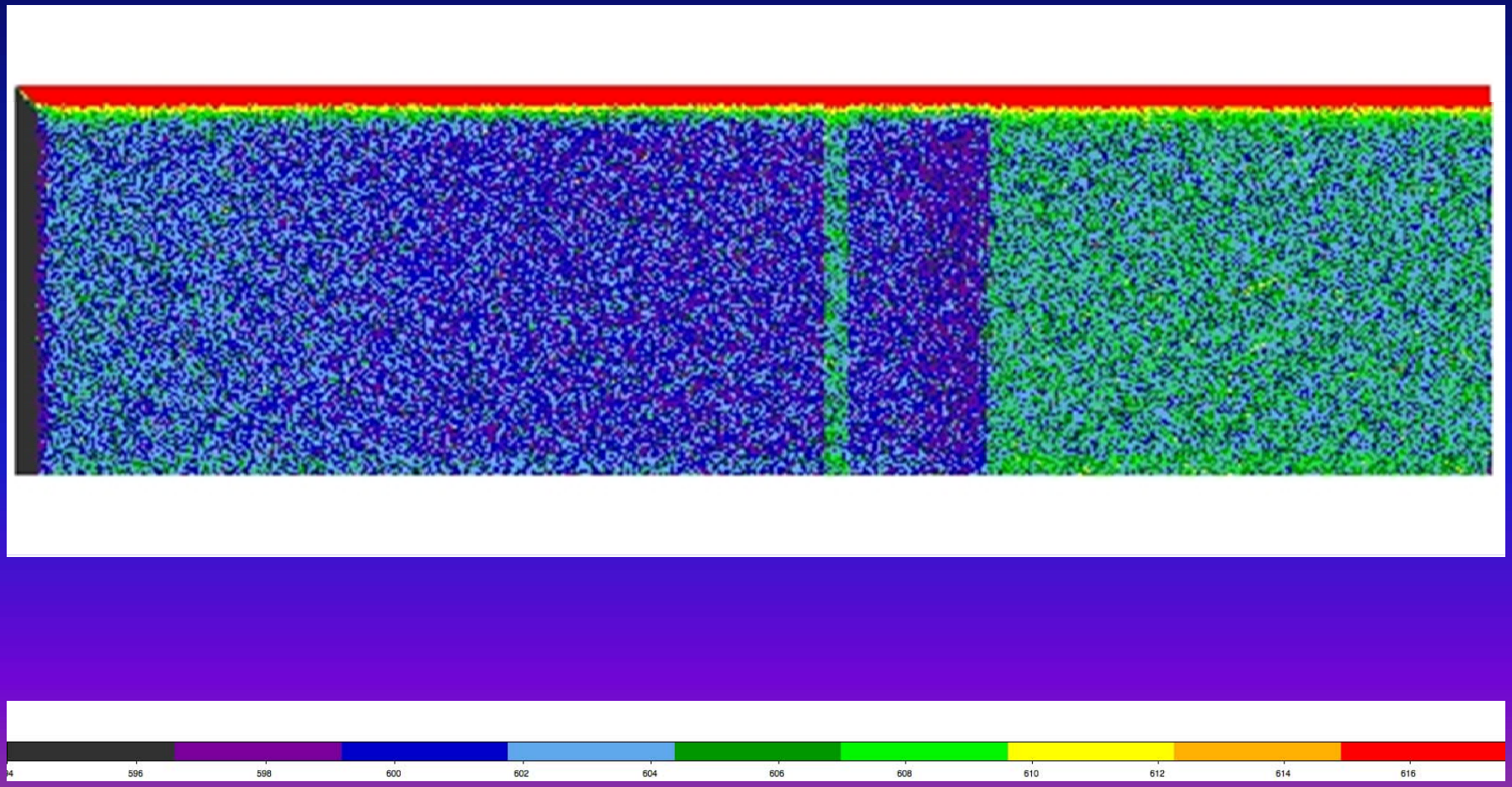


The Offset Effect for 30 seconds

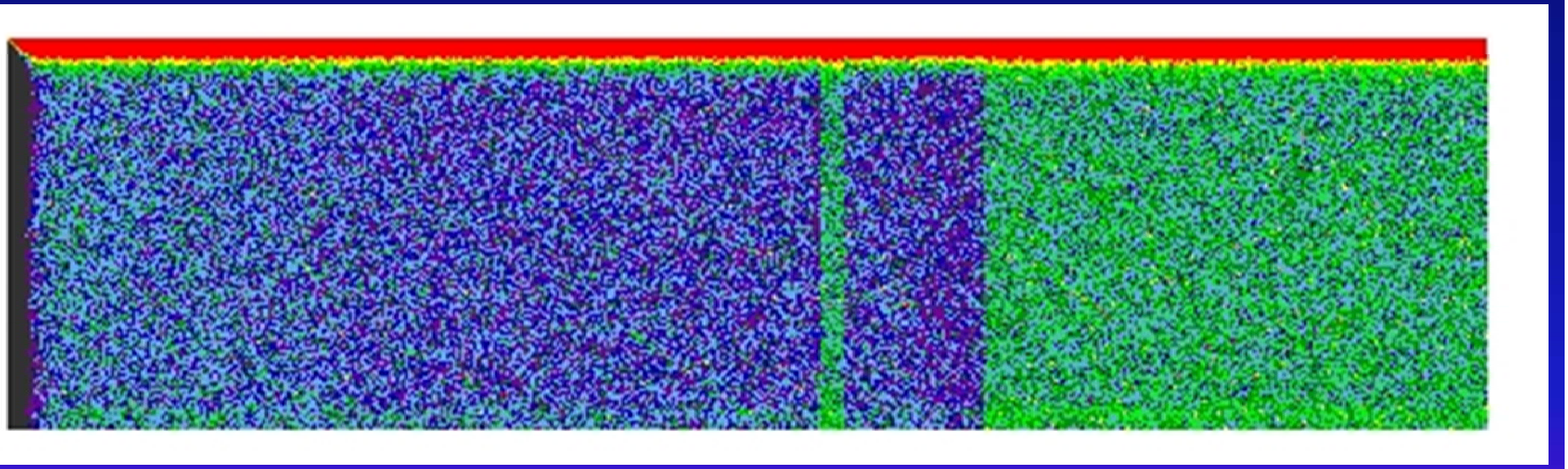


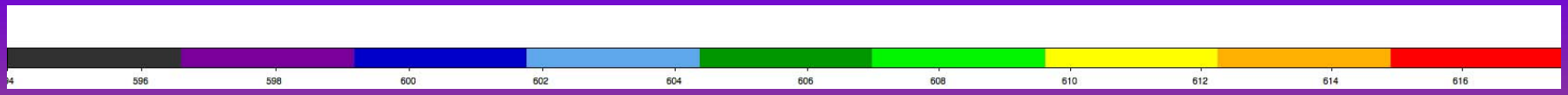


The Offset Effect for 300 seconds

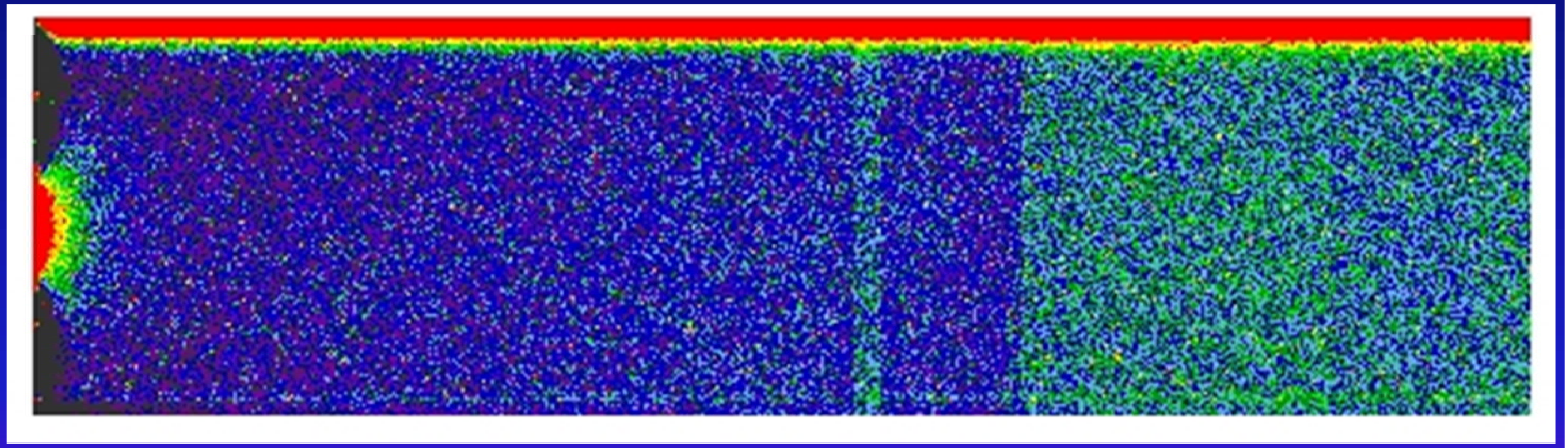


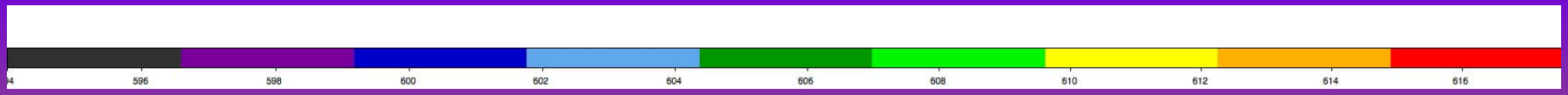
The Offset Effect for 900 seconds



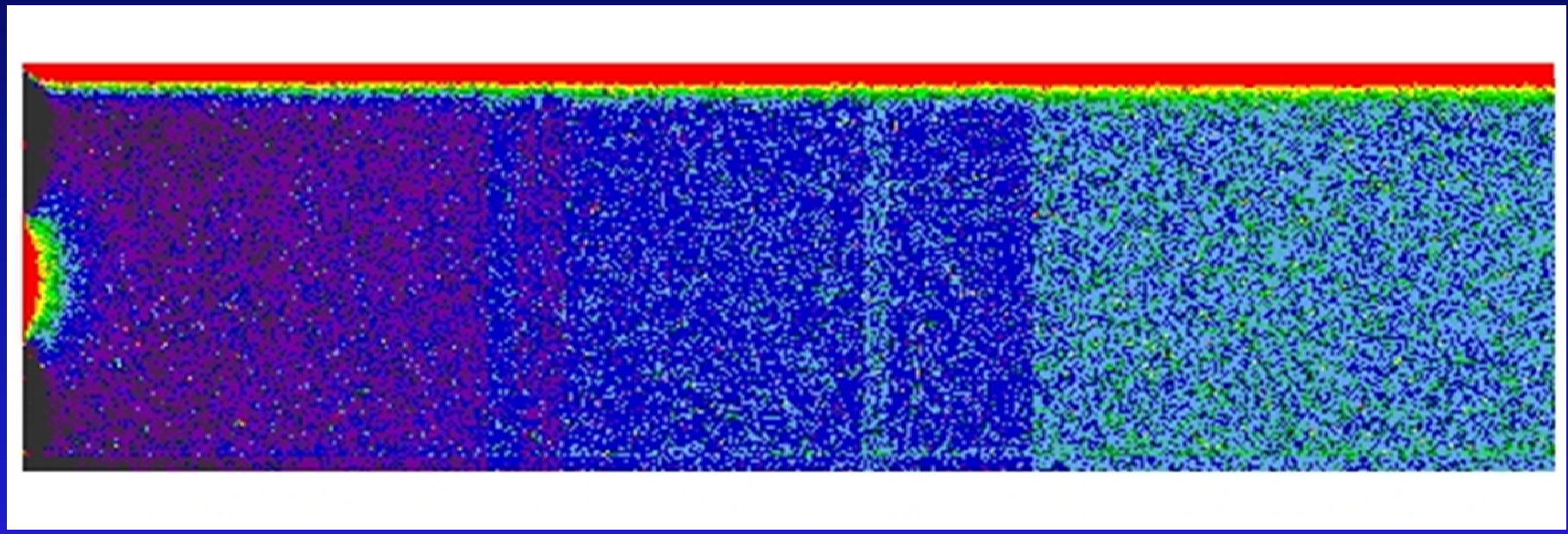


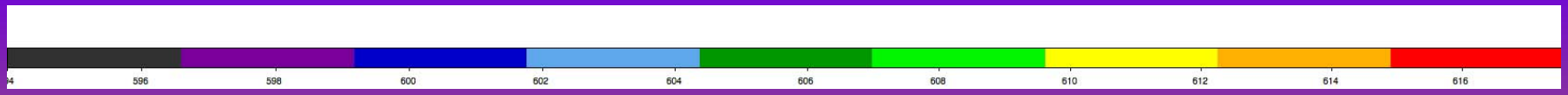
The Offset Effect for 1800 seconds





The Offset Effect for 3600 seconds





Cosmic Rays (future work)

- Cosmic Rays like stray gamma rays and muons are constantly streaming in from outer space these cosmic rays will effect the CCD read out
- To simulate the rays we have to know approximately how many there are
  - Write IDL program to find cosmic rays in darks and biases
- Problems
  - Kitt Peak (elevation 637.6 meters) is at a lot lower elevation than the LSST (elevation of 2662.75 meters)

QE Variations (future work)

- We will use the Flats to test for quantum efficiency variations
- Find how much the variations effect the output using IDL code

Summary

- LSST will help us better understand our universe by allowing us to see more of it than ever before.
- What has been done
  - Code written to find hot pixels
  - Cataloged all Darks into excel file
  - Found the Offset Effect for various conditions
- Future Work
  - Catalogue other images (flats and objects)
  - Look to see how many Cosmic Rays
  - Look to see what the Quantum Efficiency of the pixels are