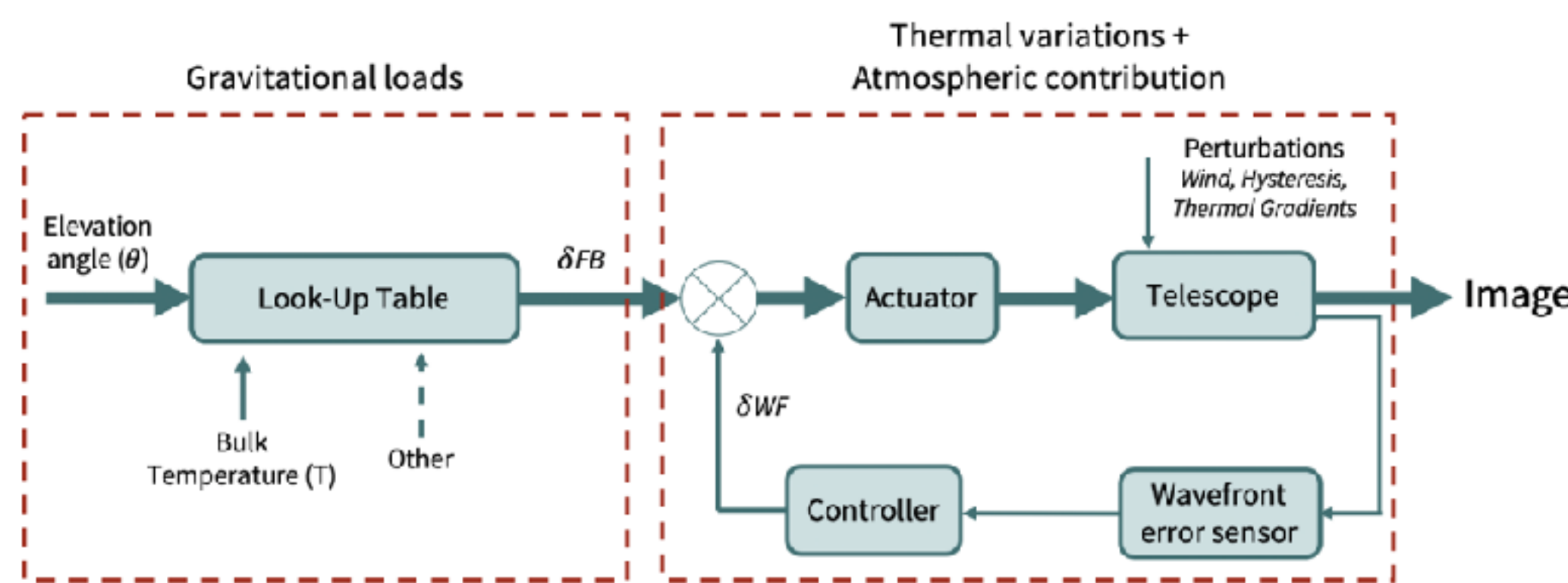# Rubin Observatory Active Optics System On-Sky Performance

J. Bryce Kalmbach[1,2,3], Andrew J. Connolly[3,4,5], John Franklin Crenshaw[3,6], Merlin Fisher-Levine[7], Guillem Megias Homar[1,2,8], Joshua E. Meyers[1,2], Rebekah Polen[9], Luca Rosignoli[10,11], Krzysztof Suberlak[3,4], Will Sutherland[12], Sandrine Thomas[7]

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Introduction

The Rubin Observatory Active Optics System (AOS) is integral to delivering the best possible image quality during the Legacy Survey of Space and Time (LSST). The AOS consists of two control components: i) An open-loop component that uses Look-Up Tables (LUTs) to apply constant offsets based upon filter, elevation, rotation and azimuth. ii) A closed-loop that corrects the optical system based for distortions from thermal gradients, wind and hysteresis of the system. The closed loop system gets information from the wavefront sensors on the edge of the camera focal plane.


LUT Verification and Performance

Commissioning with ComCam gave us a preliminary LUT and experience with the analysis needed to verify and update the LUT. With LSSTCam we have taken dedicated LUT data and continually refined the offsets and are now continuing the process with the Science Verification (SV) data. Currently, LUT corrections are limited to elevation and rotator angle, while thermal effects are handled via closed-loop offsets as we continue to improve thermal control.
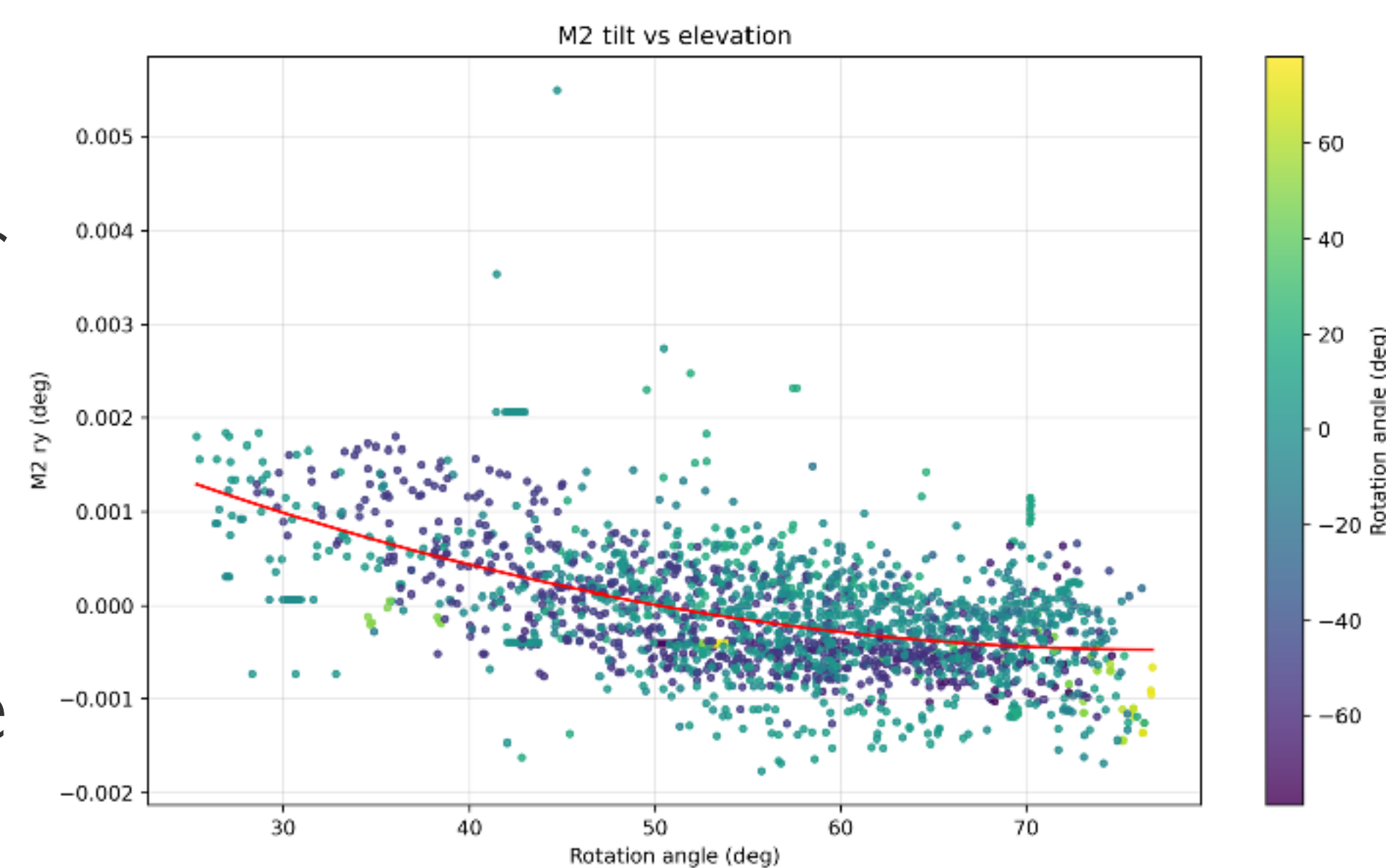

Wavefront Estimation Pipeline

The wavefront estimation pipeline takes the images from the wavefront sensors in every exposure, identifies donuts, cuts out postage stamps and estimates the wavefront using the *danish* code.
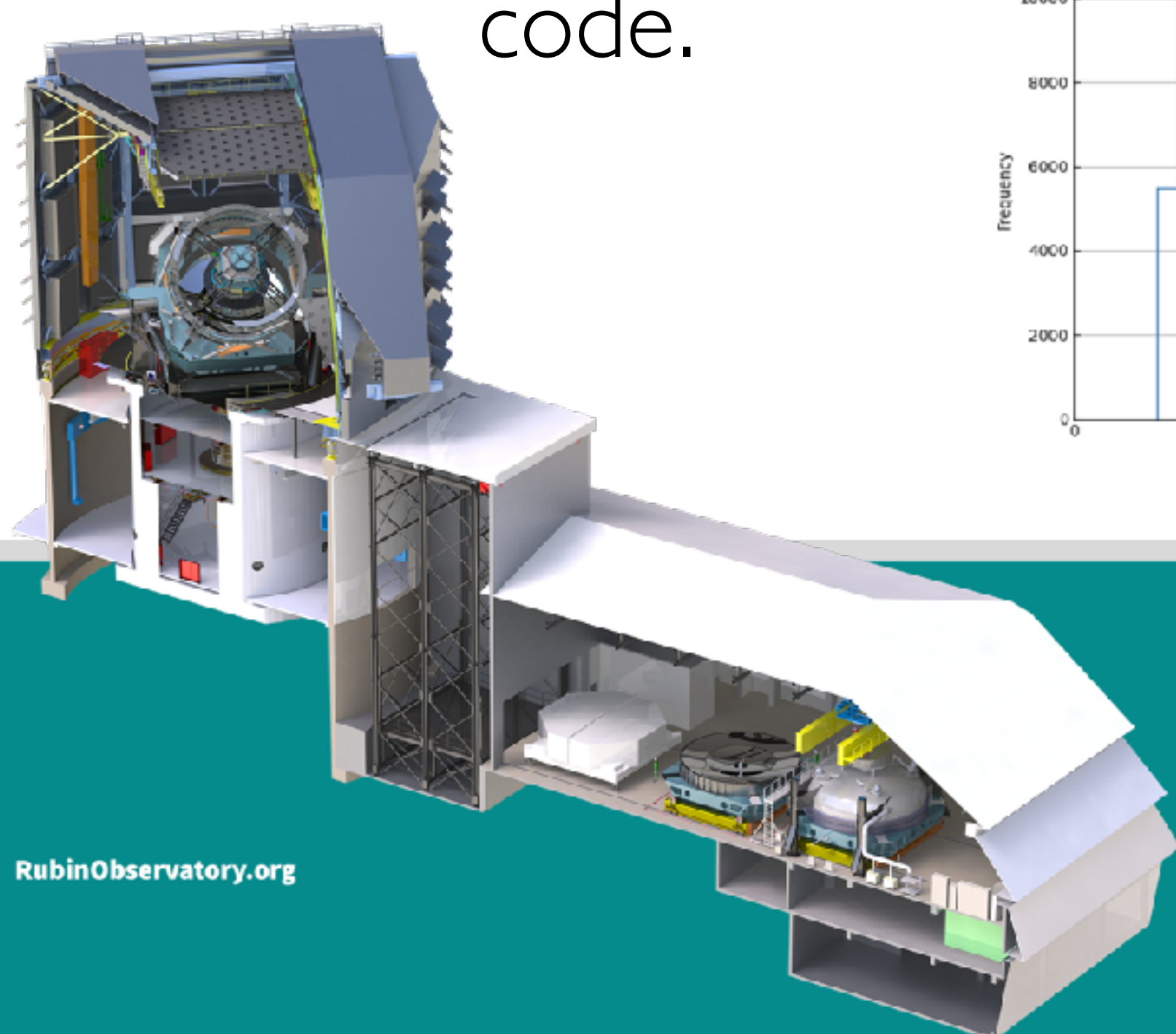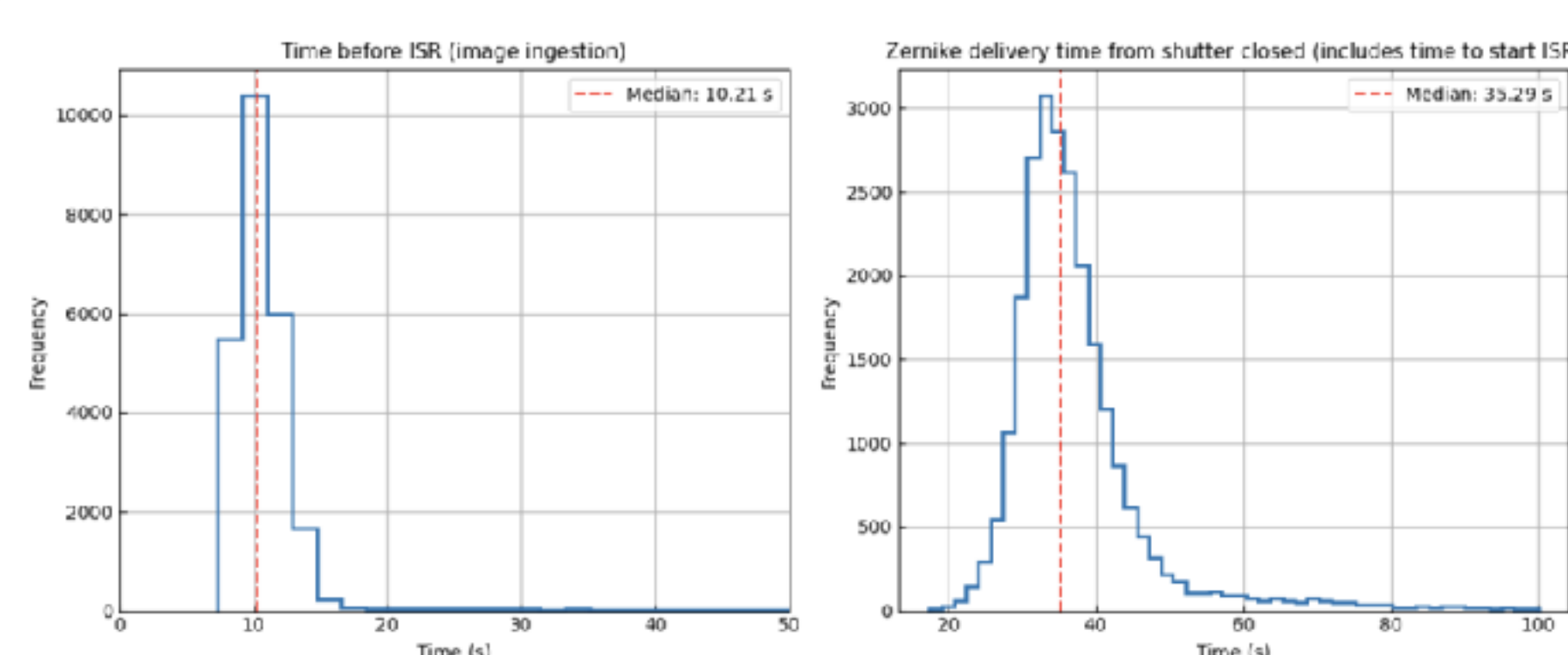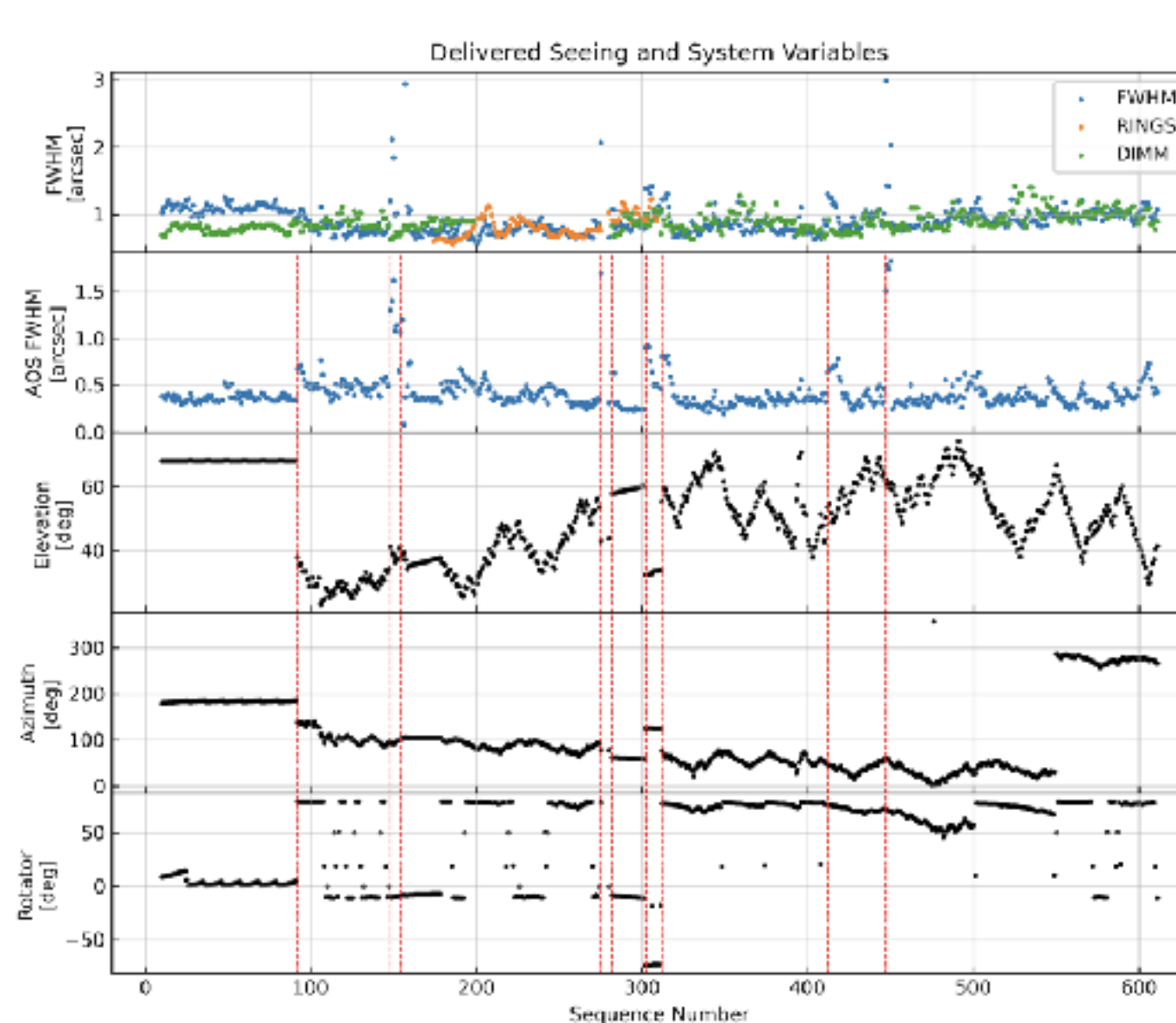

Real-Time Evaluation Tools

During each night we upload plots to RubinTV to monitor image quality and AOS performance in real-time. These help observing specialists and AOS team members understand potential issues that might arise.
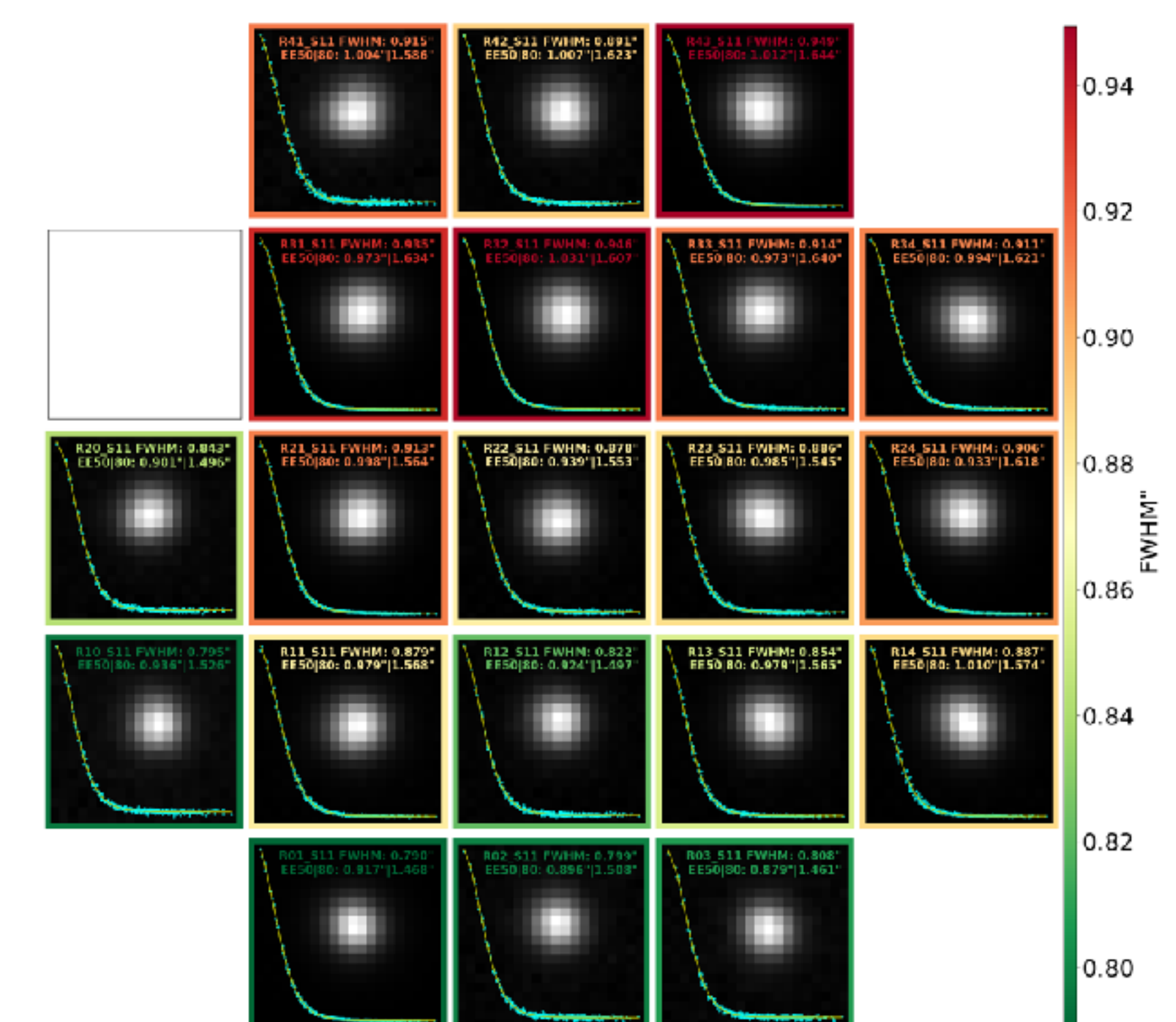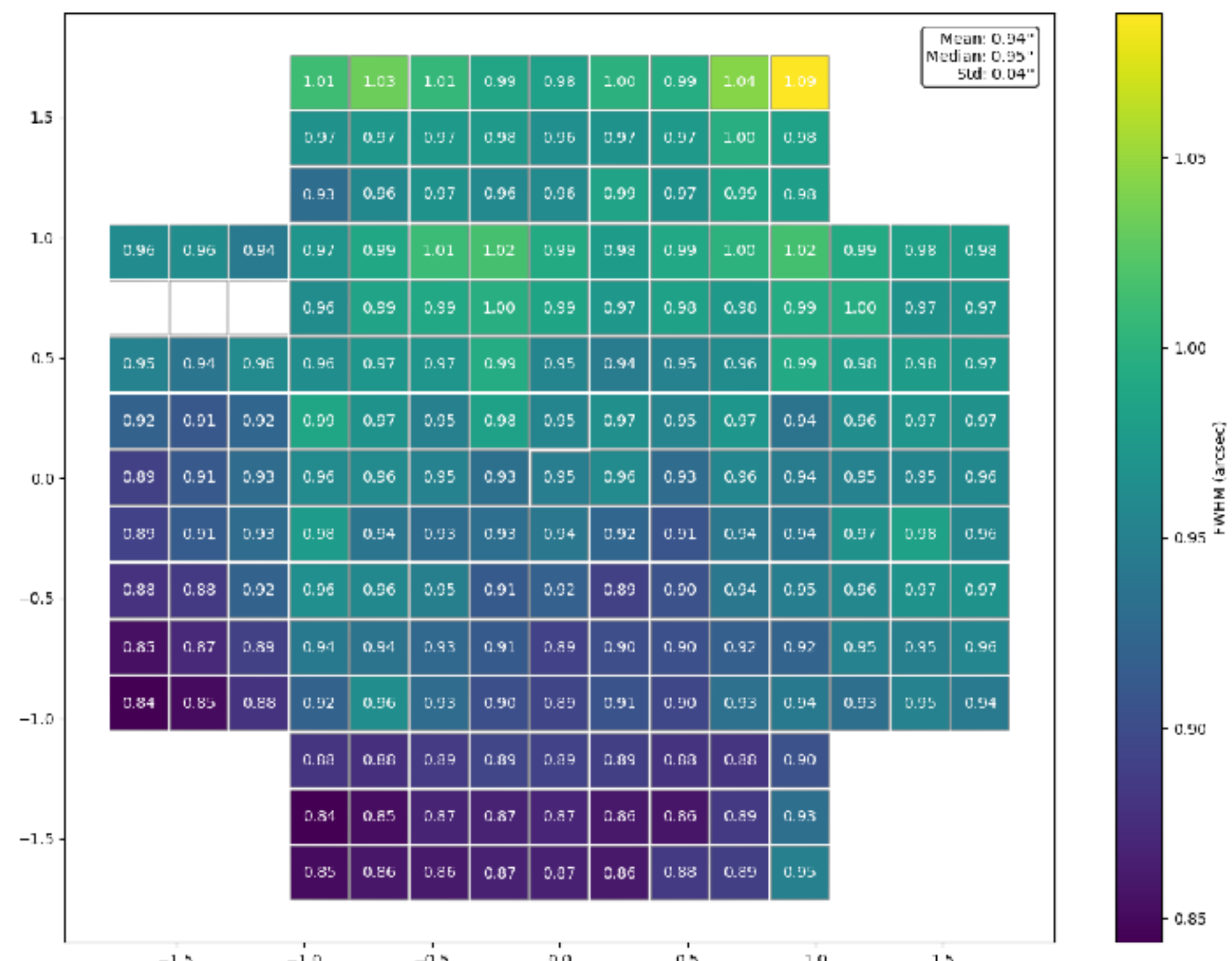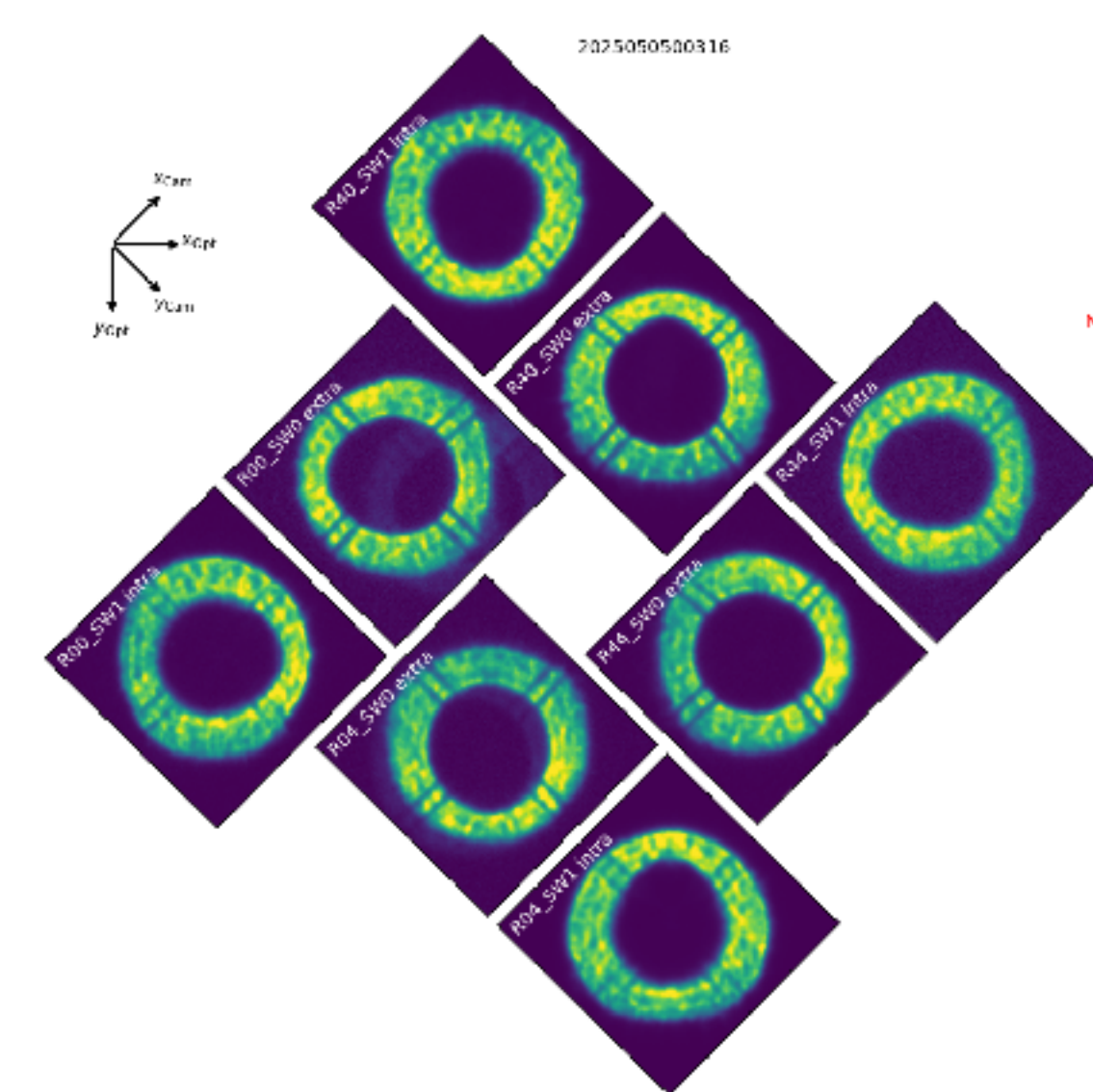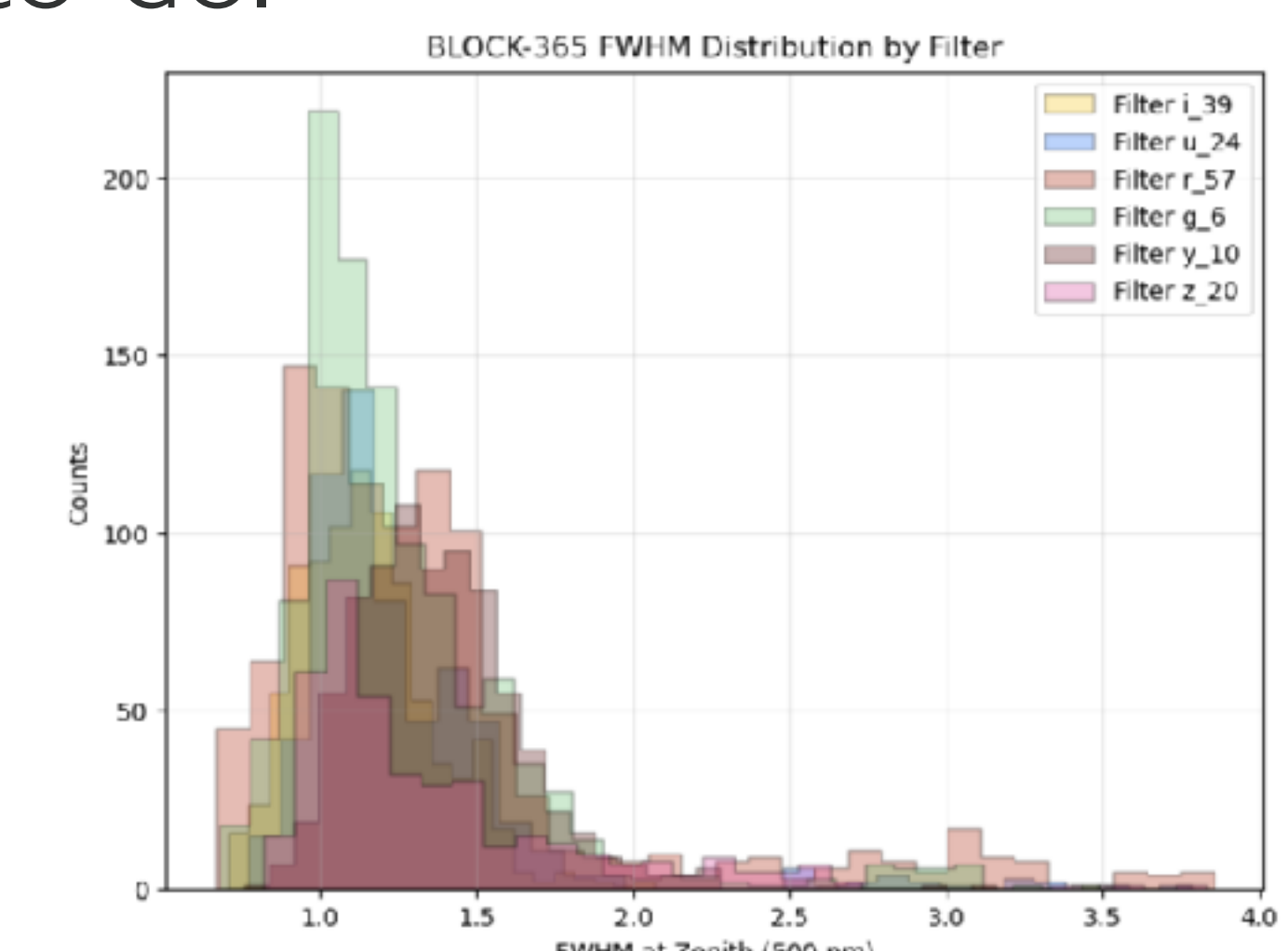

Image Quality Performance (so far)

During the night our delivered image quality often meets our DIMM measurement. AOS residuals are low, with small jumps due to elevation changes (LUT update needed), but still work to do.

System achieves expected contributions on good nights but further work is needed for control under poor seeing conditions.

What we're working on now

We are continuing to work on understanding the thermal environment and its effects on AOS performance. We are also focused on improving system robustness, uniformity across the FOV and understanding our ability to estimate how the system responds to each degree of freedom.

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