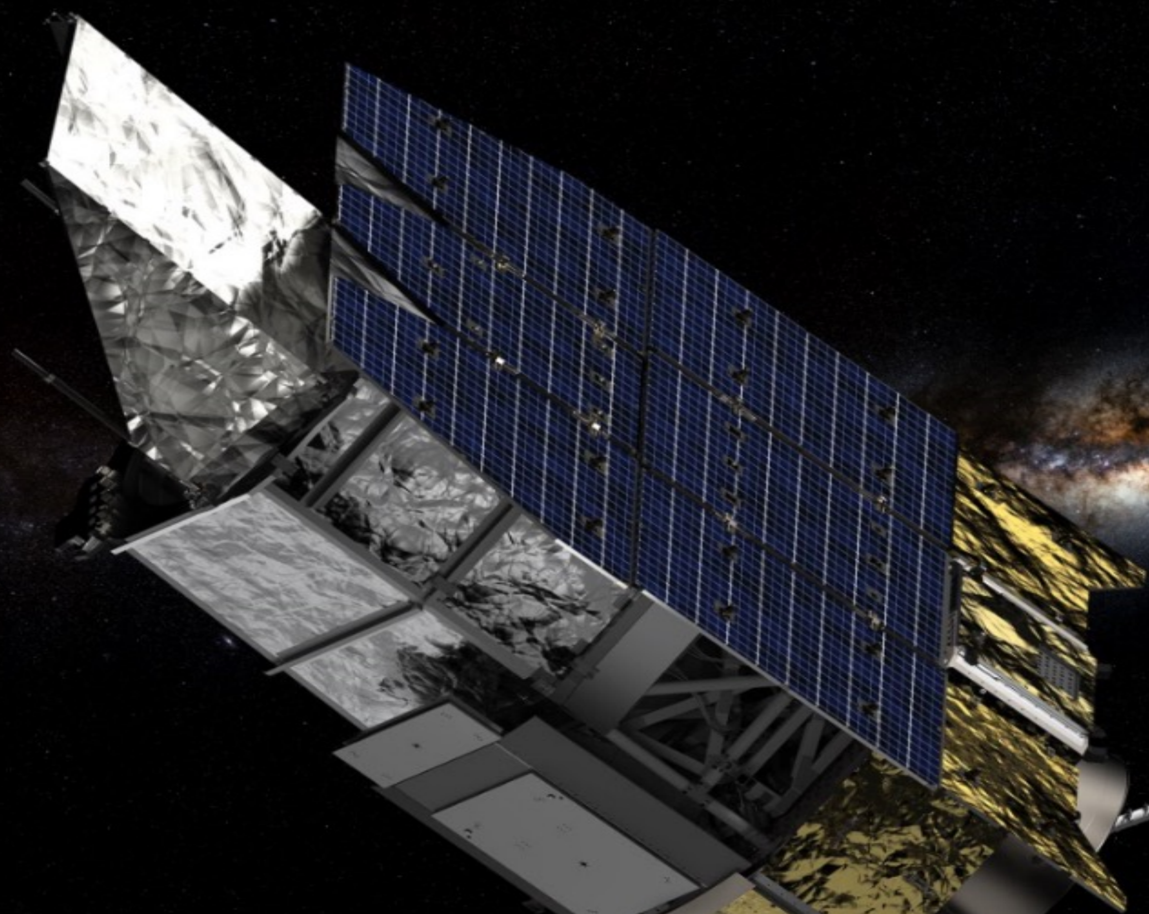

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LOS Control TVAC Results

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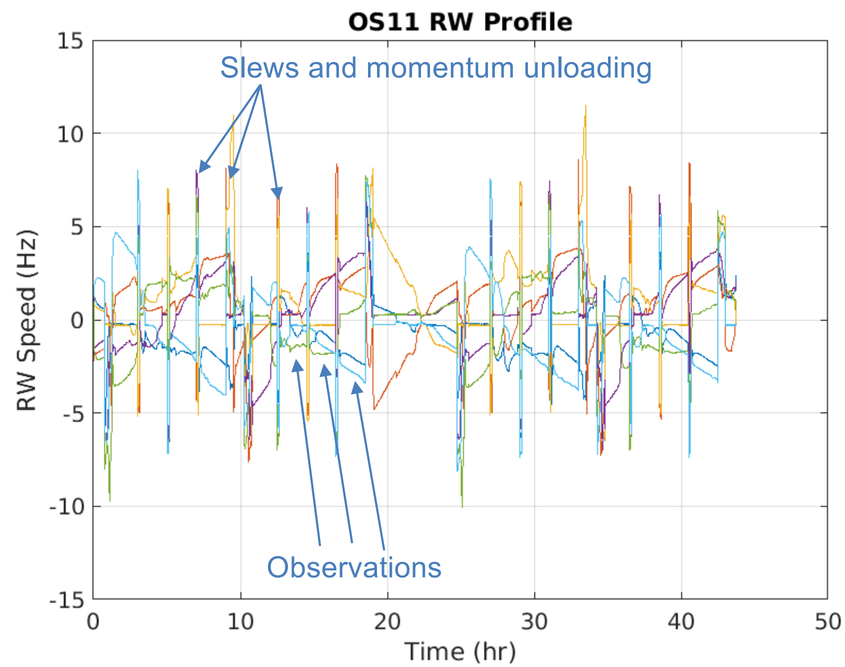
LOS Control Objectives

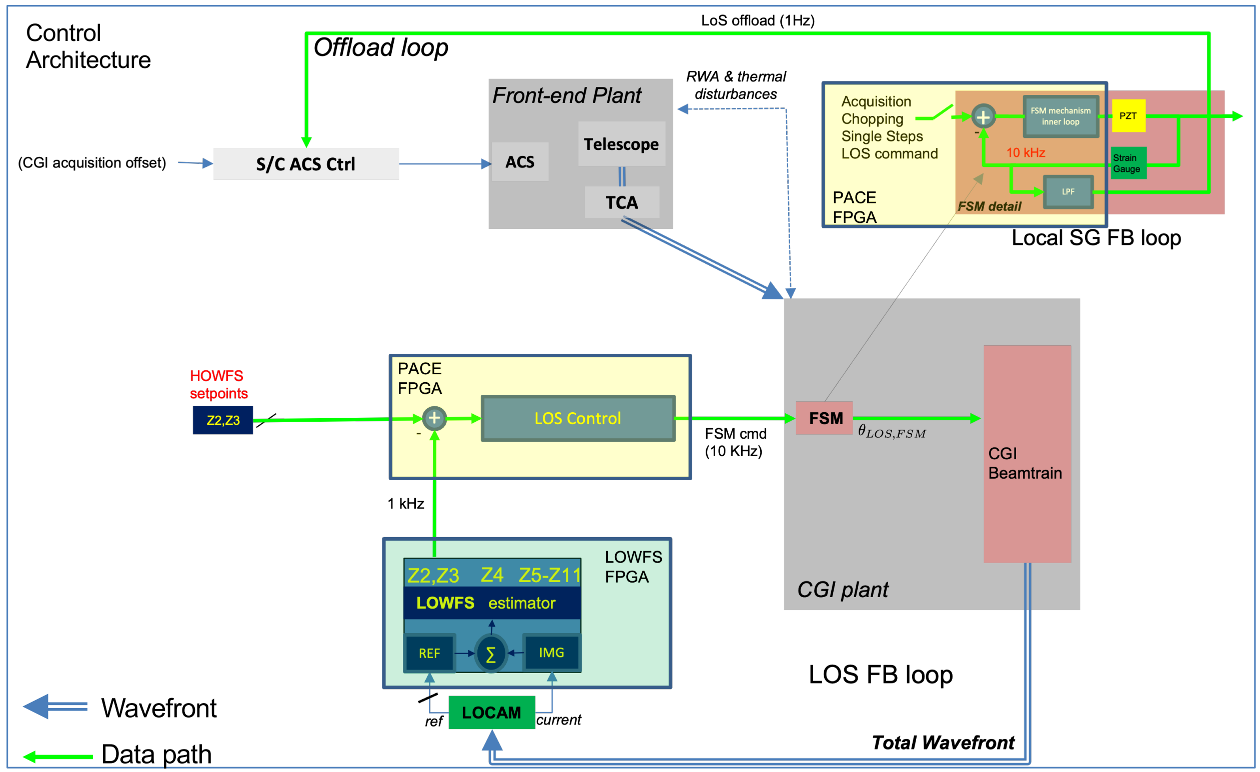
- One of the main objectives of LOS control subsystem is to achieve < 1 mas rms on-the-sky pointing in each axis
  - Main sources of pointing error are due to static and dynamic imbalances of the reaction wheel (frequencies driven by the RW speeds) and ACS (low, < 1 Hz)
  - Modeling has shown that main contribution to RW disturbances show up at fundamental frequencies (i.e., speed of the RW)
  - In order for keep frequency content of disturbances low and within the bandwidth of the FSM LOS control (~20Hz):
    - RW speeds are operationally limited to an ~ 0-5 RPS range,
    - RW offloads occurring during the slews.
  - Monte Carlo results have show that we can meet the “1 mas 70% of time” requirement with significant margin assuming the interface requirement with observatory (“external disturbance”) is satisfied
- Another objective was to demonstrate successful capture range on LOWFS (80 mas)
  - Since CGI does not have a dedicated acquisition sensor, star capture has to occur on the guidance sensor, LOWFS which has a nonlinear response away from the center of the mask



Requirement	CBE		Margin (%)
	Z2	Z3	
1.0 mas	0.31 mas	0.45 mas	55

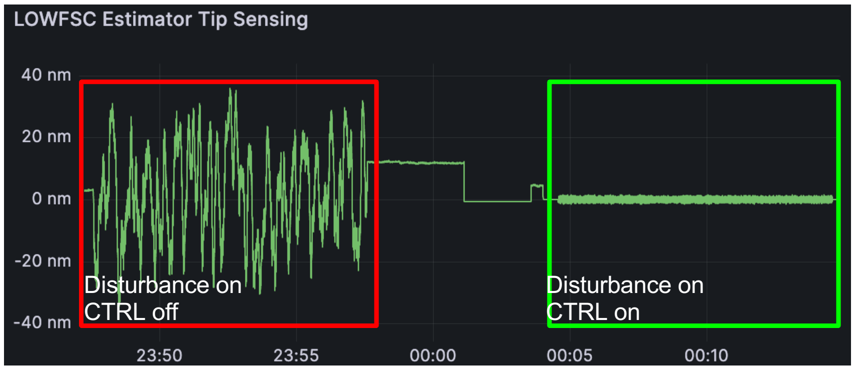
Objectives of LOS TVAC Testing

- Main objectives of TVAC testing were to:
  - Demonstrate rejection capability of the control design
  - Demonstrate capture range
- Functionality of the system successfully demonstrated **in air** during risk-reduction FFT testing,
- TVAC provided flight-like environment with no atmospheric seeing.
  - This allowed for cleaner signals and better signal to noise ratio
- Both objectives have been demonstrated successfully



LOS Sample Disturbance Rejection - Movie

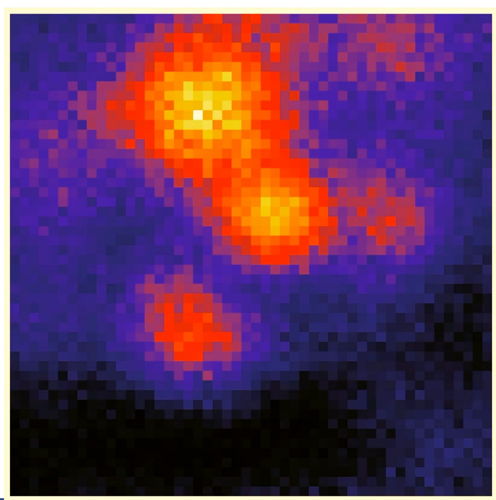
Z2 (100ms avg)



Z3 (100ms avg)

Sample movie:

- LOCAM images
- External disturbance signal turned on during whole recording
- LOS control turned on after several seconds



Sample performance: **0-175Hz**

Without control	Z2 no CTRL RMS = 4.73 mas Z3 no CTRL RMS = 6.21 mas
With control	Z2 with CTRL RMS = 0.33 mas Z3 with CTRL RMS = 0.64 mas

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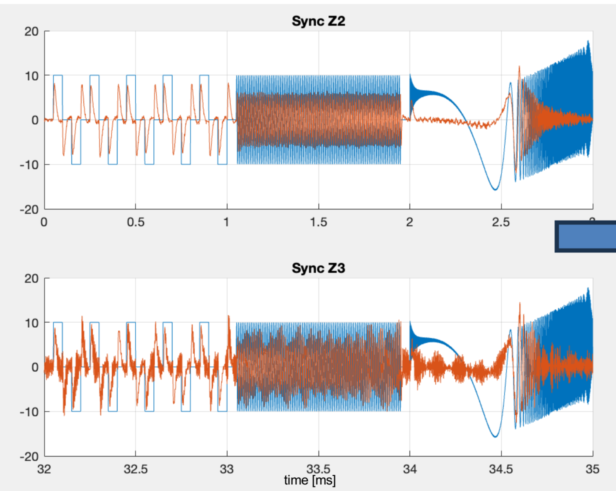
Approach: Schroeder and Disturbance Rejection

ROMAN CORONAGRAPH

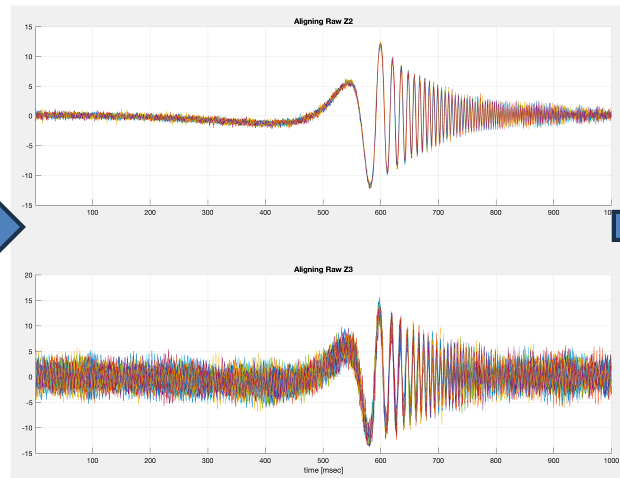
In order to properly assess the disturbance rejection capability, we used Schroeder disturbance signal applied via external jitter mirror

- Schroeder signal is similar to “sine sweep”, with power applied to specific frequencies

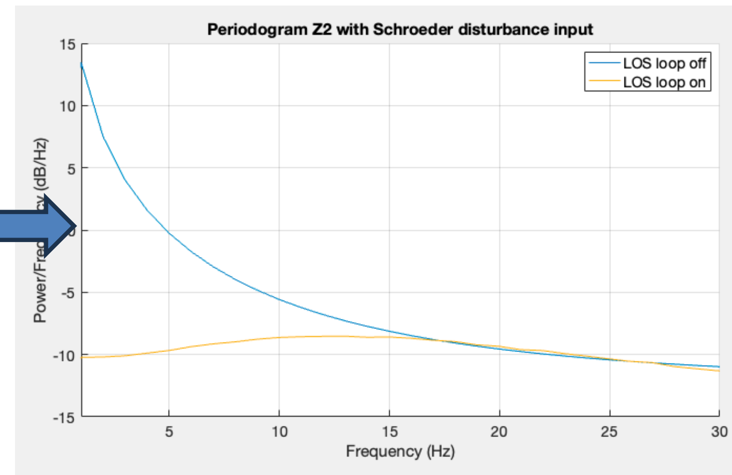
Syncing the signal:



Aligning the Schroeders for averaging



Disturbance rejection:

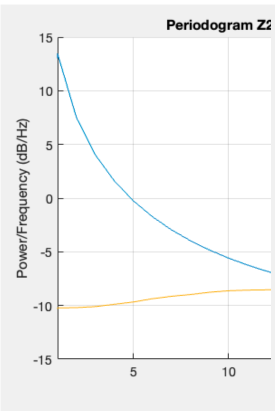


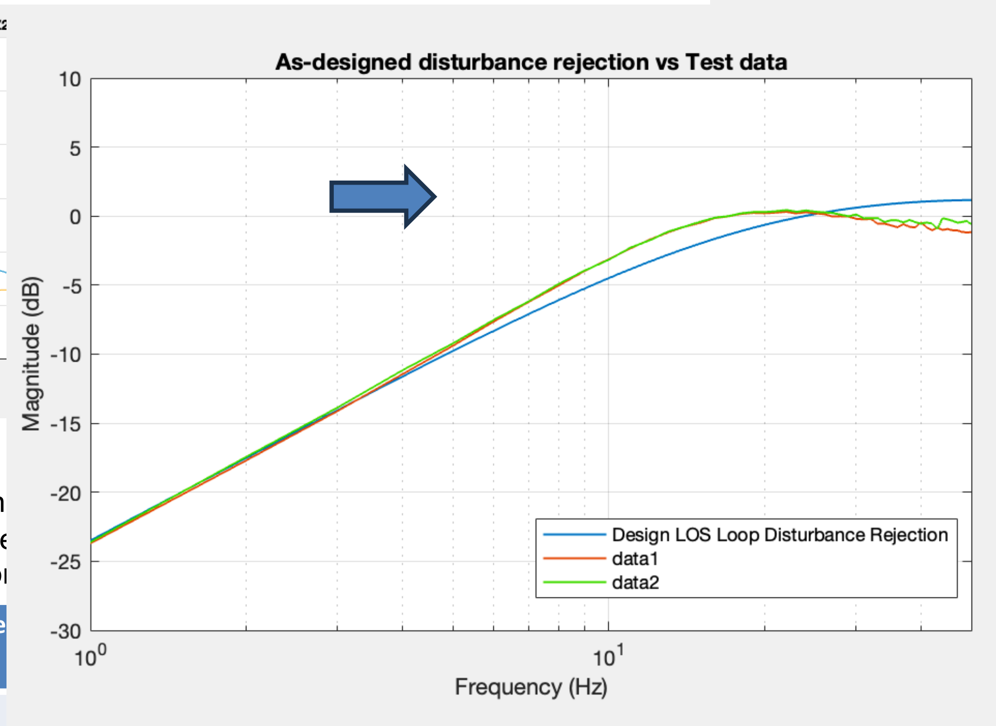
Frequency Domain: TVAC Disturbance Rejection Plots

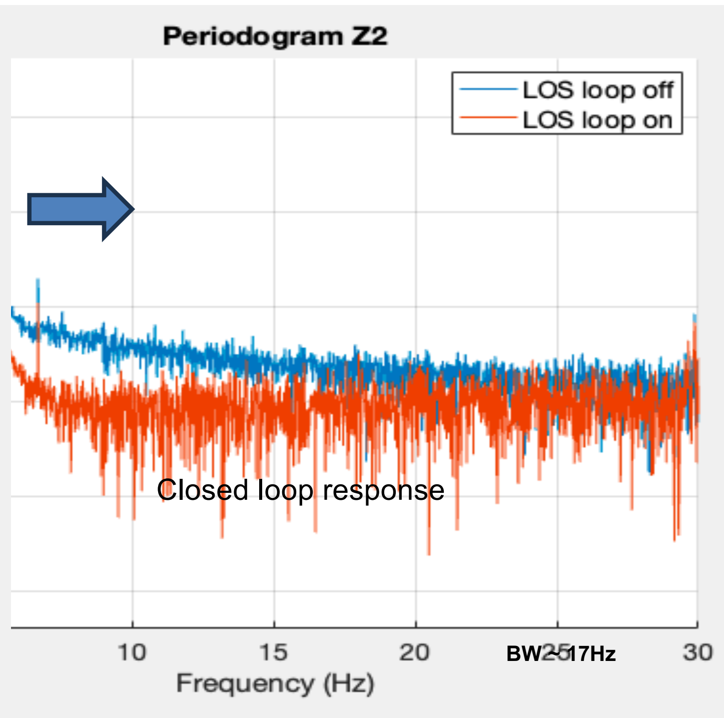
Open/Closed LOS loop PSDs with Schroeder disturbance signal

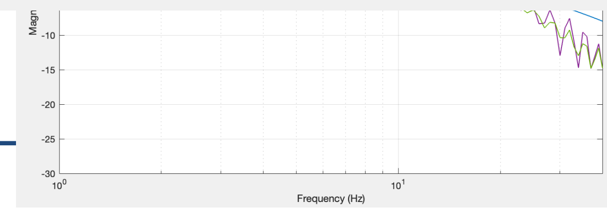
Disturbance Rejection:

Representative disturbance signal suppression









TVAC results sh

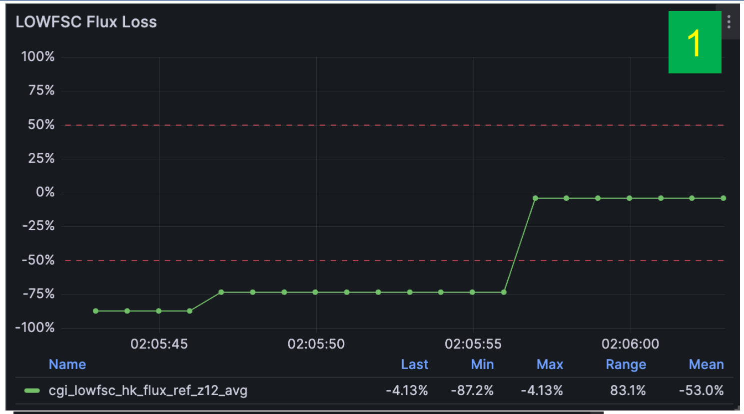
- Based on the compensator

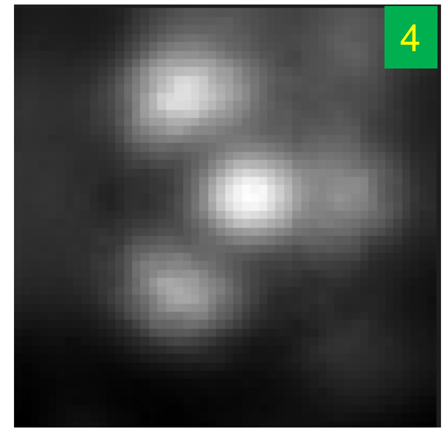
Requireme			
1.0 mas	0.31 mas	0.45 mas	55

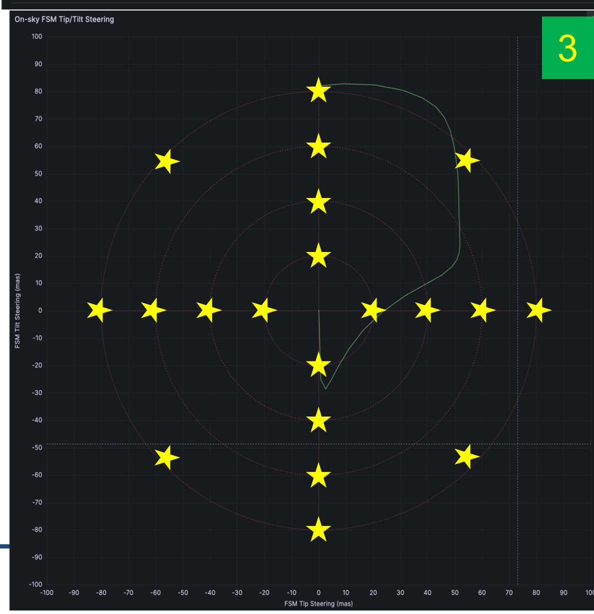
Capture: Typical example of successful capture

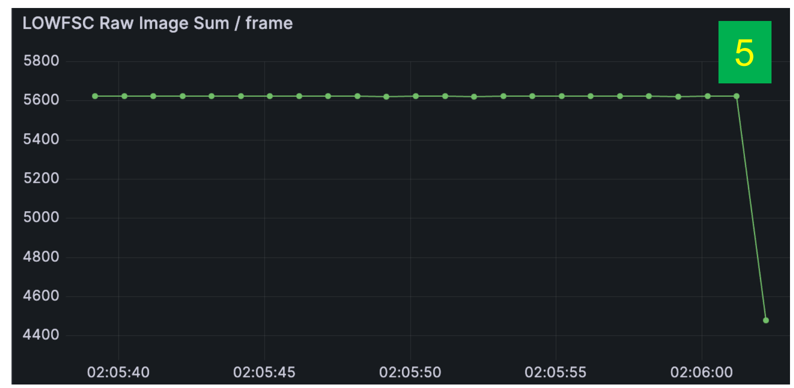
Tested with brighter (Vmag = 2.55) and dimmer stars (Vmag = 5) with camera gain adjusted

1. Flux recovered
2. Controller finds the trained location (“calibrated center of the mask”)
3. Capture starts from the center of the FSM range, finds a path to the star, slightly beyond 80 mas in tilt axis
4. LOCAM image recovered to expected morphology
5. Image sum stays at the expected high level
6. Various offsets were tested for capture during FFT and TVAC with and without representative disturbance





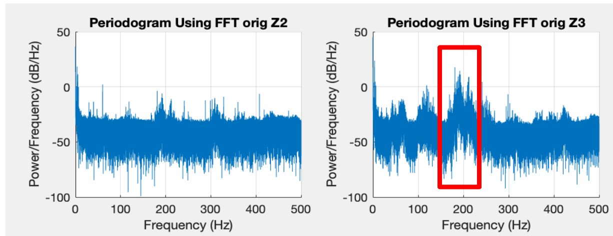




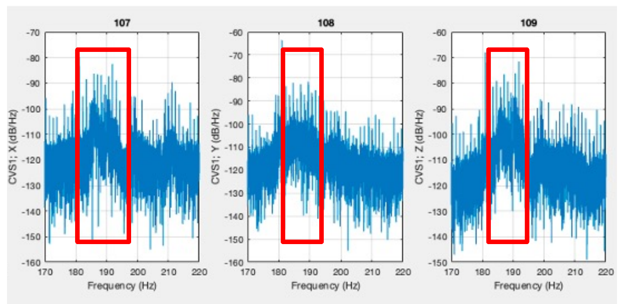
High-Frequency Jitter Contribution

- Data shows high frequency contribution in Z3 channel only
  - Frequency content mainly @ ~180 Hz and ~190 Hz
  - Suspected external line noise and potential structural mode (possibly external)
  - Line noise is typical in testing, not present in flight
  - Suspected structural mode contribution varies, 0.2 - 0.45 mas
- Additional accel data identifies
  - Line noise mode at ~180Hz across many sets of data (harmonic)
  - Structural mode at ~190Hz at CVS location
    - Sets 107,108,109
    - Exact source not identified

Z2 and Z3 data:



Accel data from CVS location

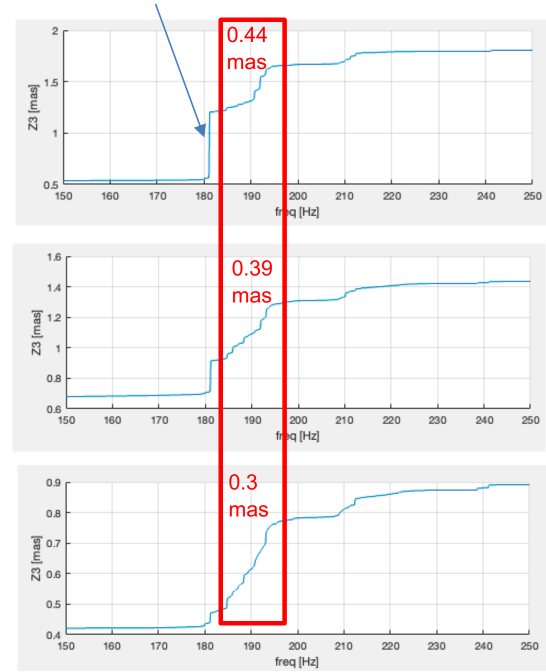


Line noise harmonic @ 180Hz (in run 1, about 0.7mas, but varies) (not present in flight)

Run 1, Z3

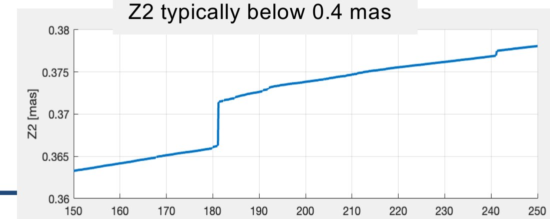
Run 2, Z3

Run 3, Z3



Run 1, Z2

Z2 typically below 0.4 mas



Summary

- During the functional testing, we demonstrated the functionality of the LOS control system in air
- Testing in vacuum allowed for a cleared signal and better evaluation of the disturbance rejection
  - Demonstrated appropriate disturbance rejection capability of the LOS control
  - Demonstrated appropriate capture range of the system
  - LOS loop remained closed during testing for an extended period of time (tens of hours), performing nominally