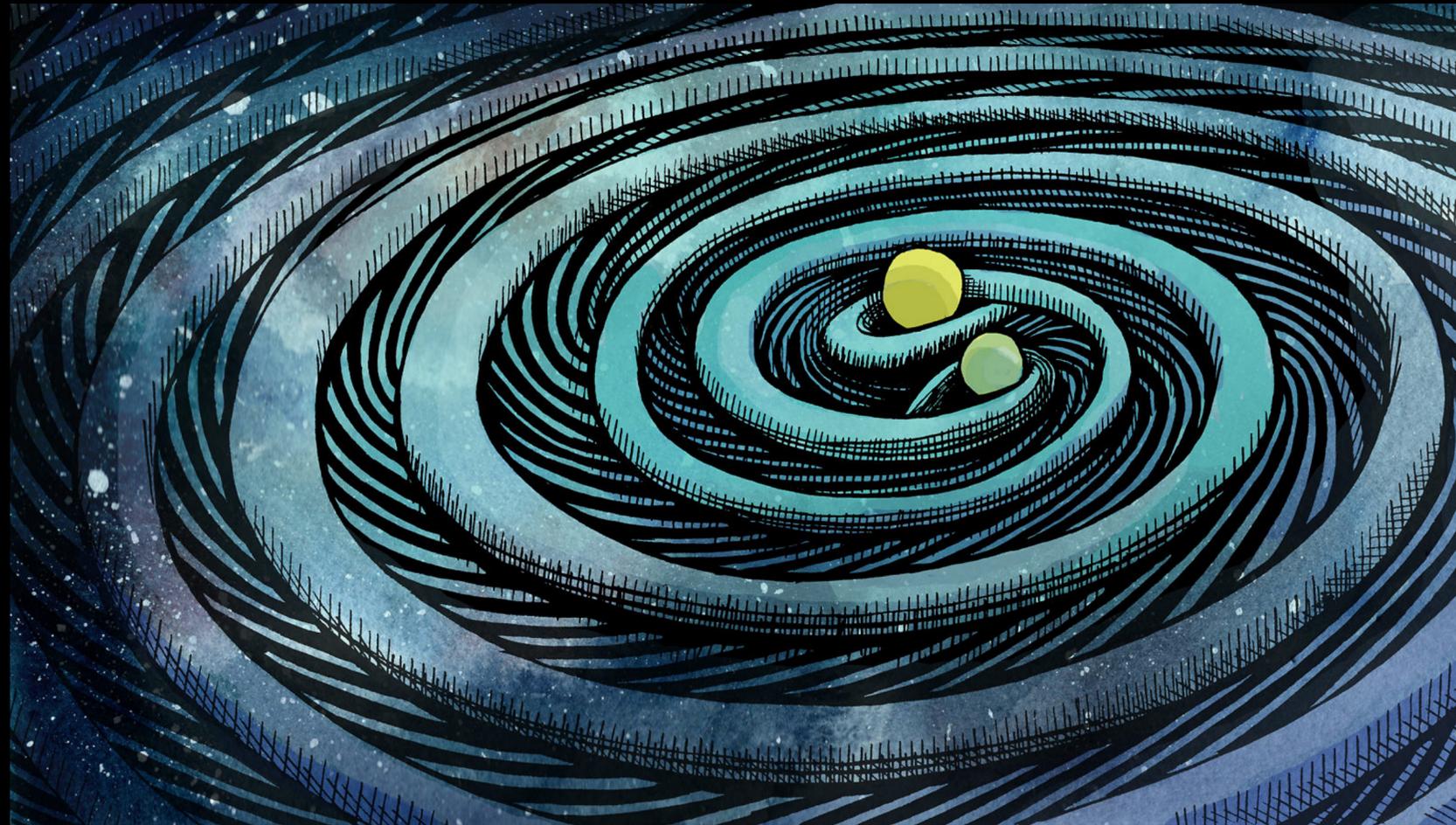


Detector Characterization

Data Quality Studies in LIGO's 3rd Observing Run



Katie Rink

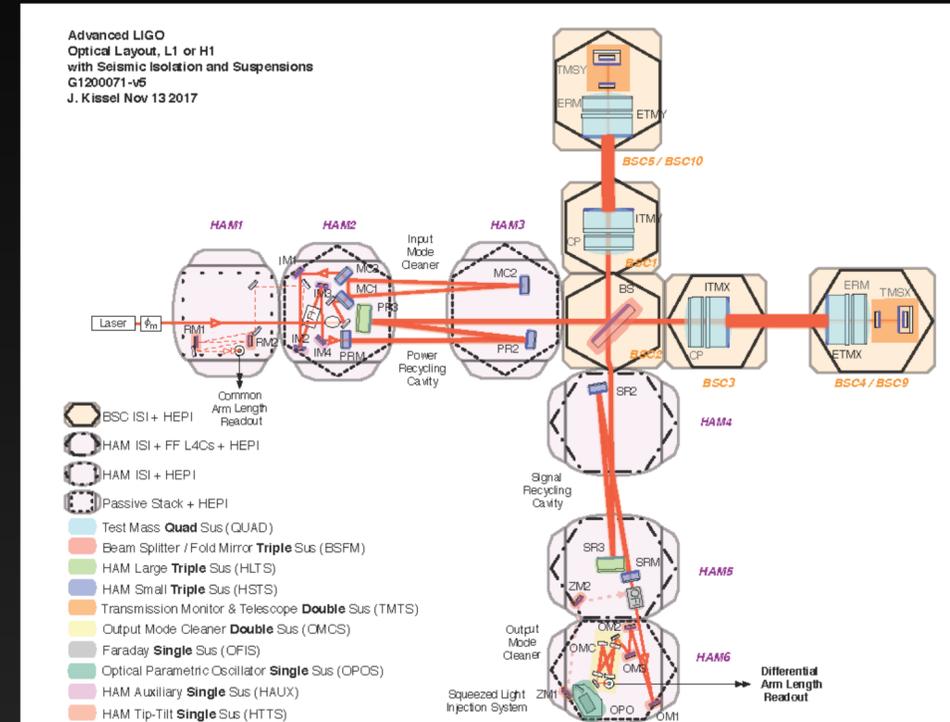
LIGO-G2001016-v1

Gravitational Wave Astronomy North West, June 29th 2020



What is Detector Characterization?

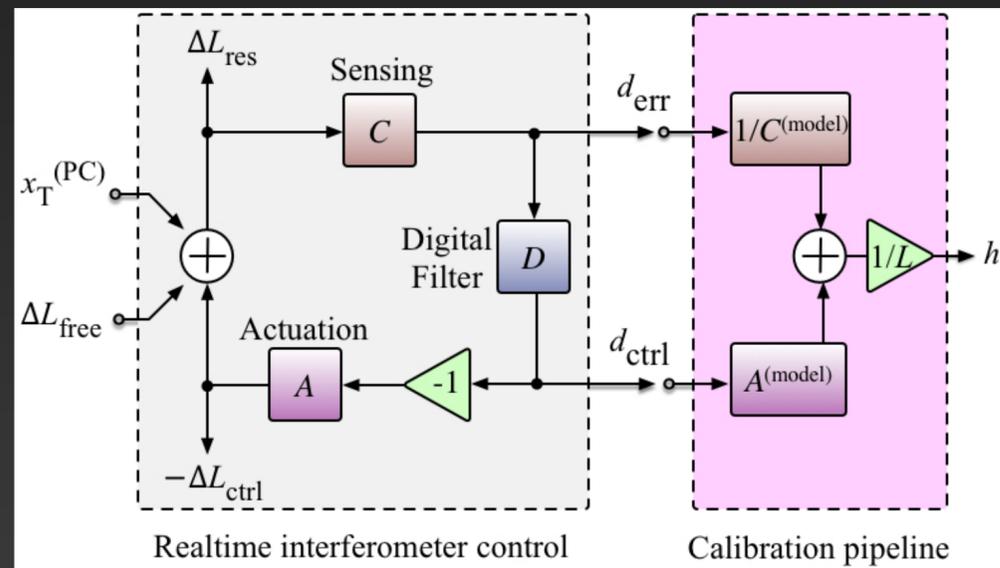
- GW detectors are complicated.
- Understanding noise sources is critical for detecting signals, estimating source parameters, and increasing the detectors sensitivity.
- DetChar connects the hardware & software to the data analysis.



Credit: J. Kissel, DCC LIGO-G1200071-v5

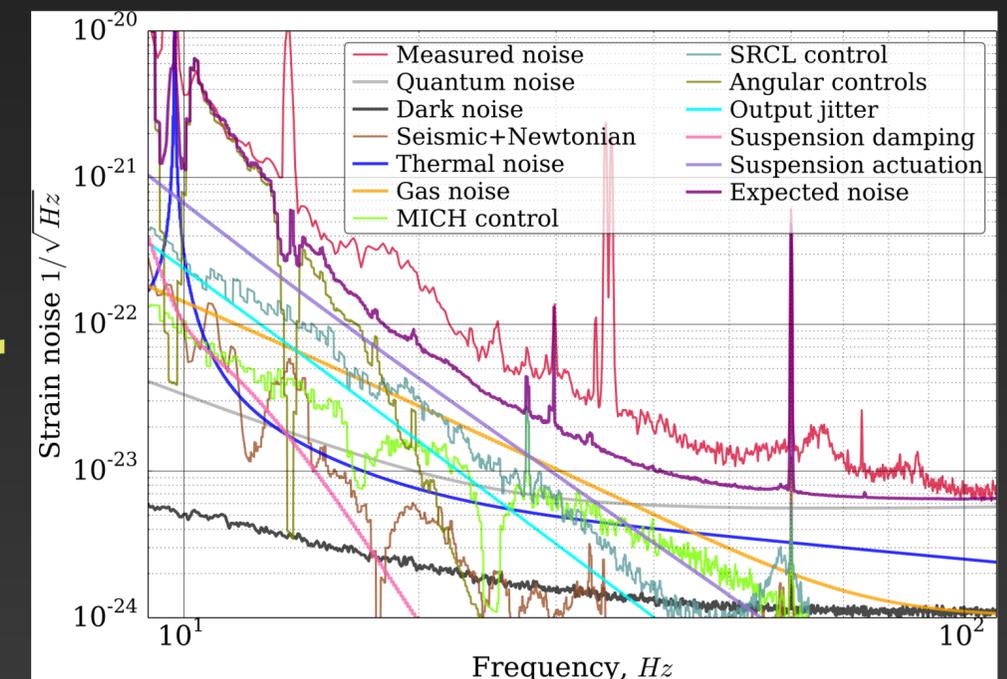
Optics Layout

Calibration Pipeline



Credit: The LSC, arXiv 1602.03845

Noise Floor



Credit: Martynov et al., arXiv 1604.00439

Observing Run Commissioning Breaks

- LIGO splits its operational time into “observing runs”
- Commissioning breaks occur periodically so that new upgrades or repairs can be implemented midway through an observing run.
- The most recent observing run (O3) had a commissioning break in October of 2019.
- During this commissioning break, two wind fences were installed at LIGO Hanford (LHO).



Credit: Caltech/MIT/LIGO Lab

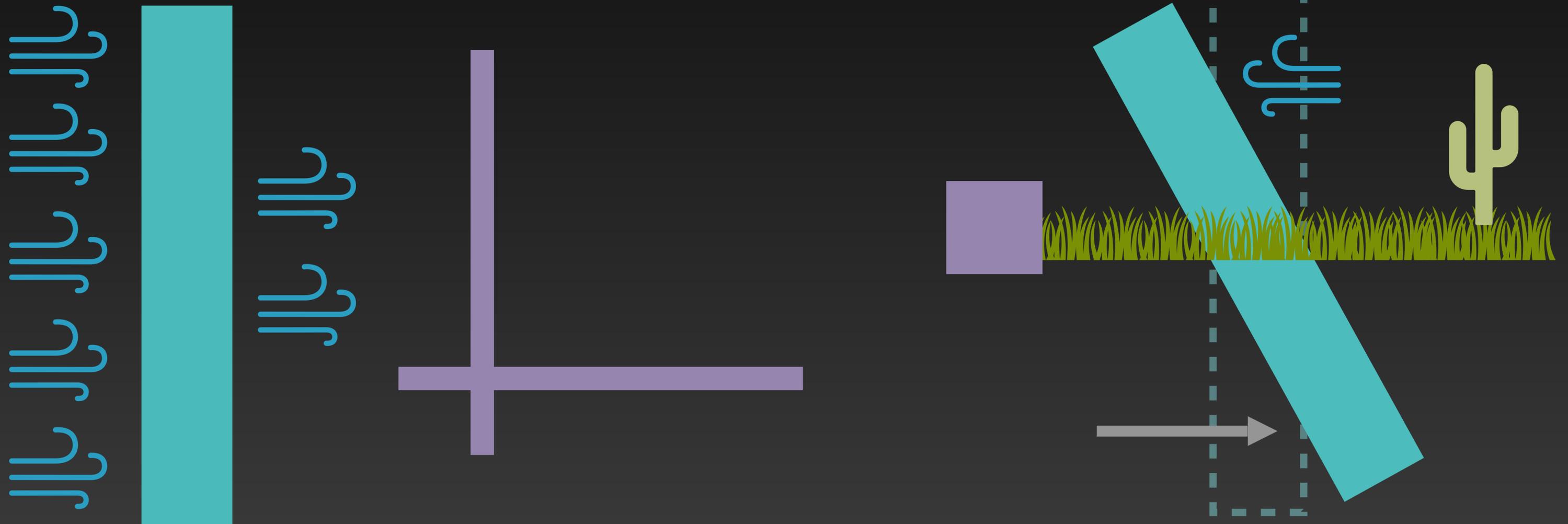


Credit: Caltech/MIT/LIGO Lab

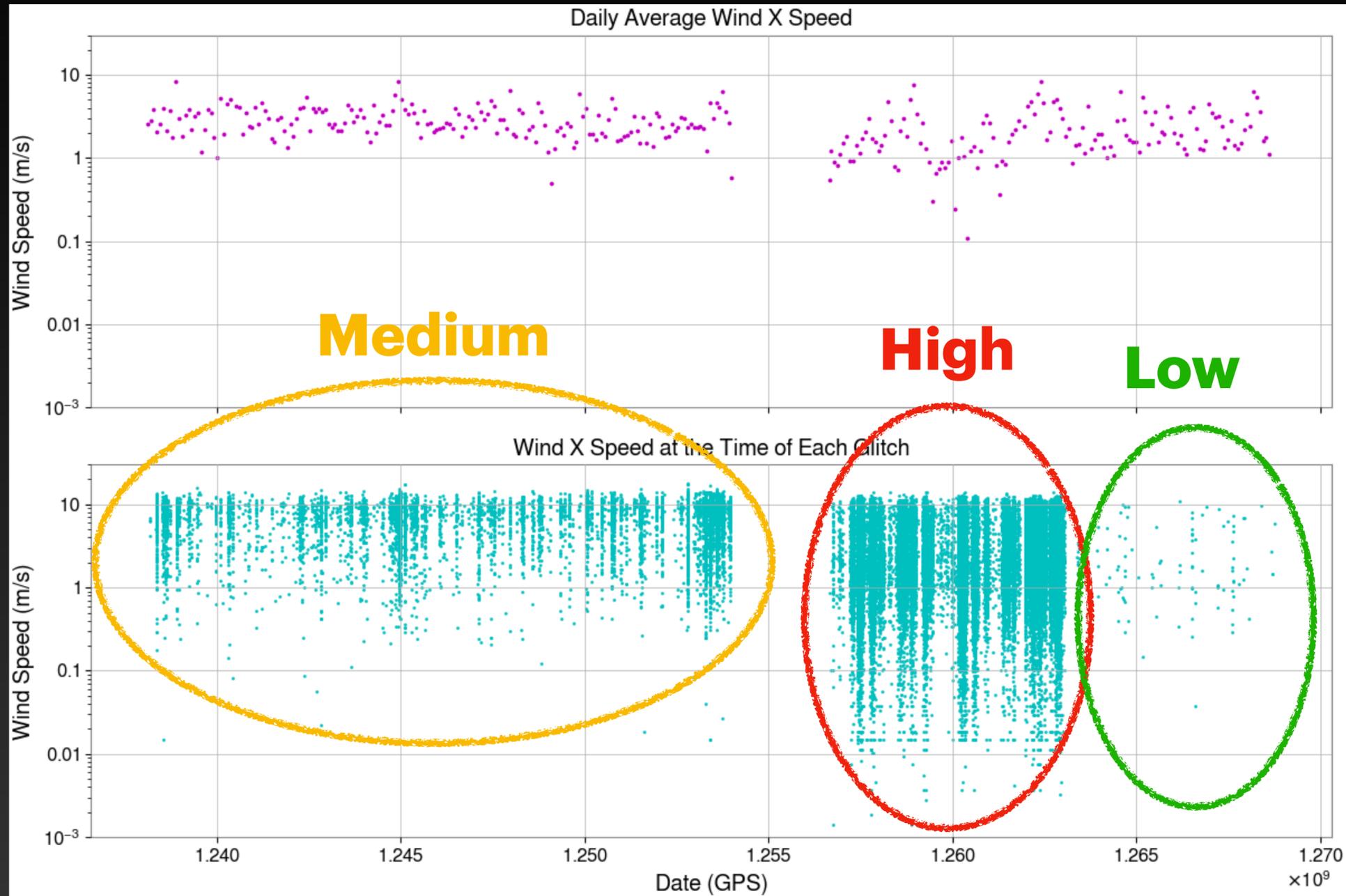
The Wind Fence

➤ Does the wind fence mitigate the amount of scattering glitches caused by wind?

➤ Does the wind fence couple wind to ground motion?



Main Findings

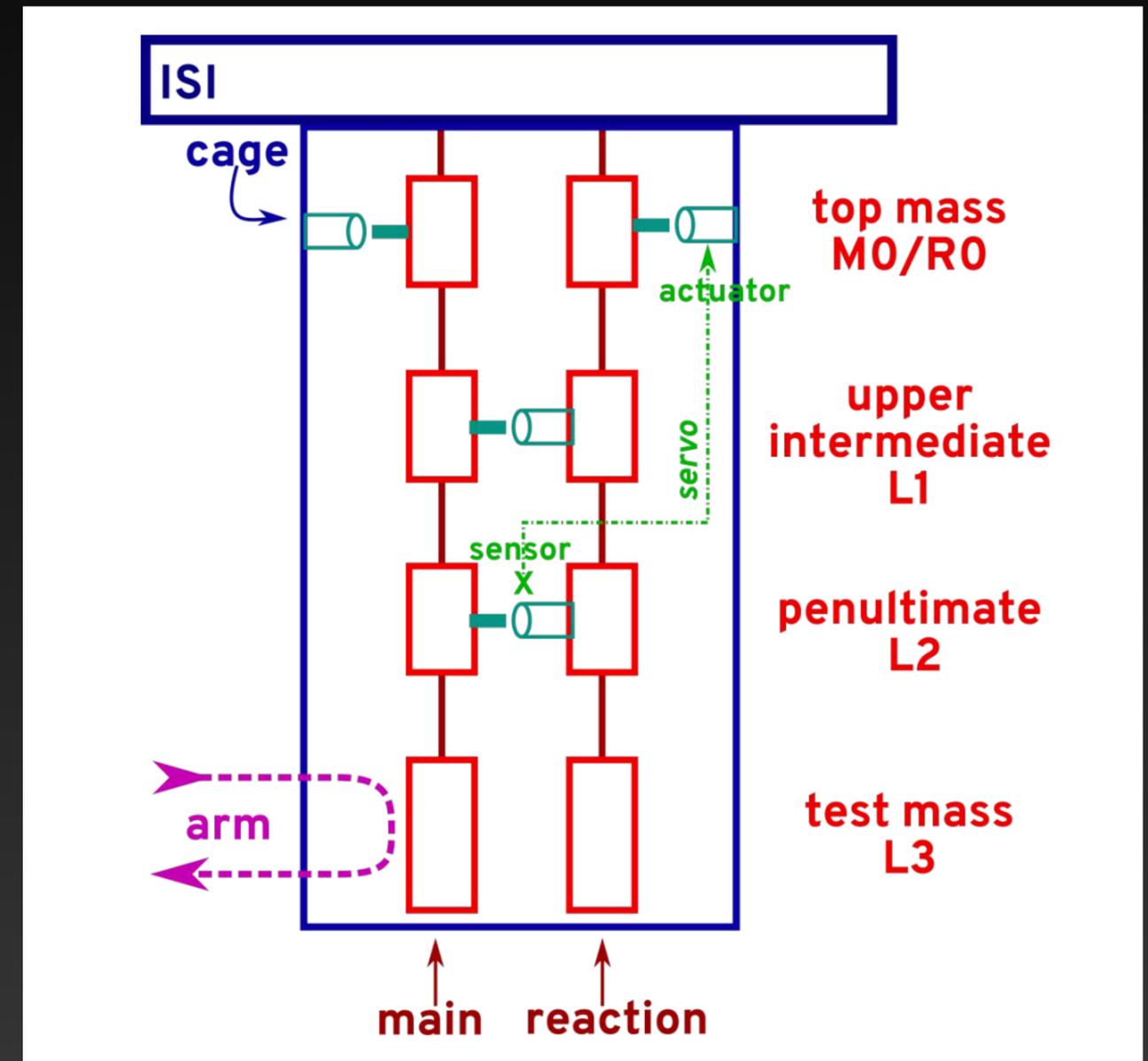


1. Increase in glitch rate during first half of O3b.
2. Sudden drop in glitch rate mid-O3b.



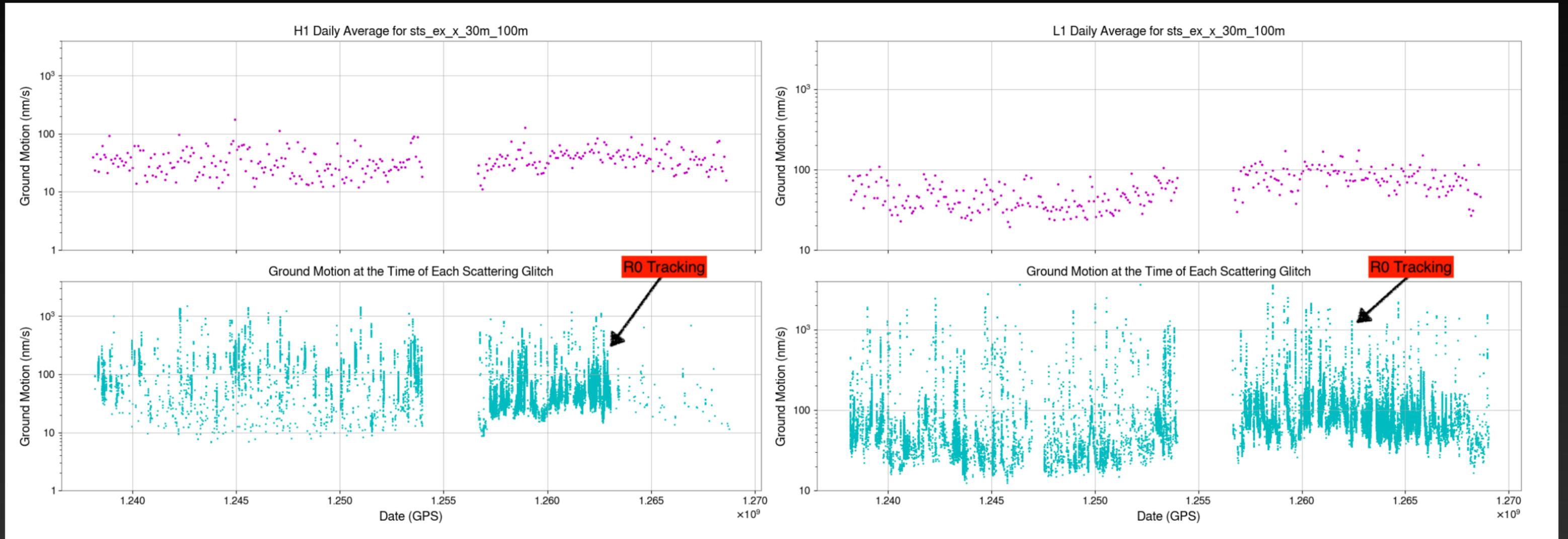
R0 Tracking

- The main beam in the detector bounces off of a mirror at both end stations.
- This mirror is seismically isolated using a quadruple suspension system and kept still by the reaction mass chain.
- R0 tracking reduces the relative motion between the top test mass and reaction mass.



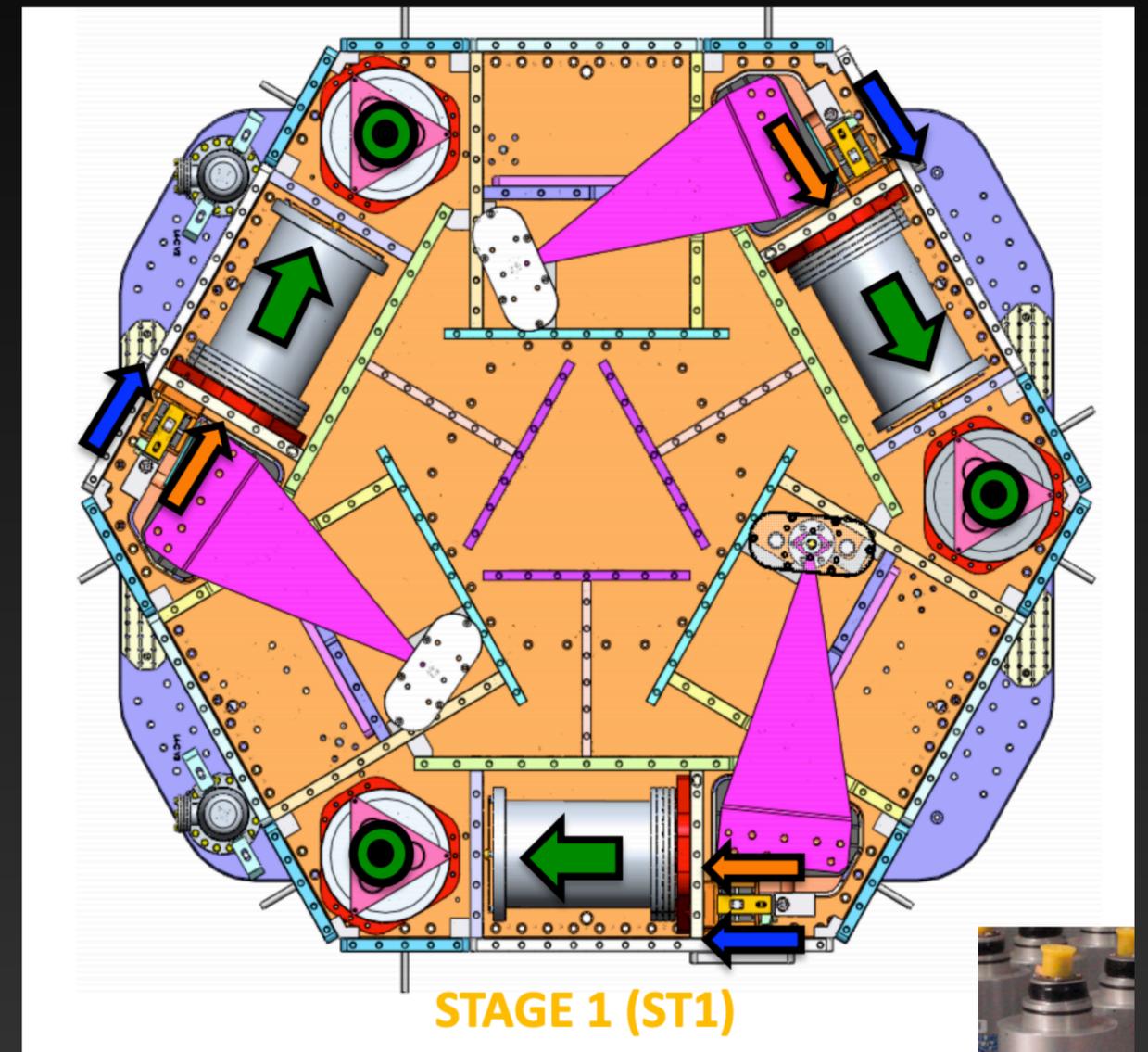
LHO

LLO



Increased Glitch Rate in O3b

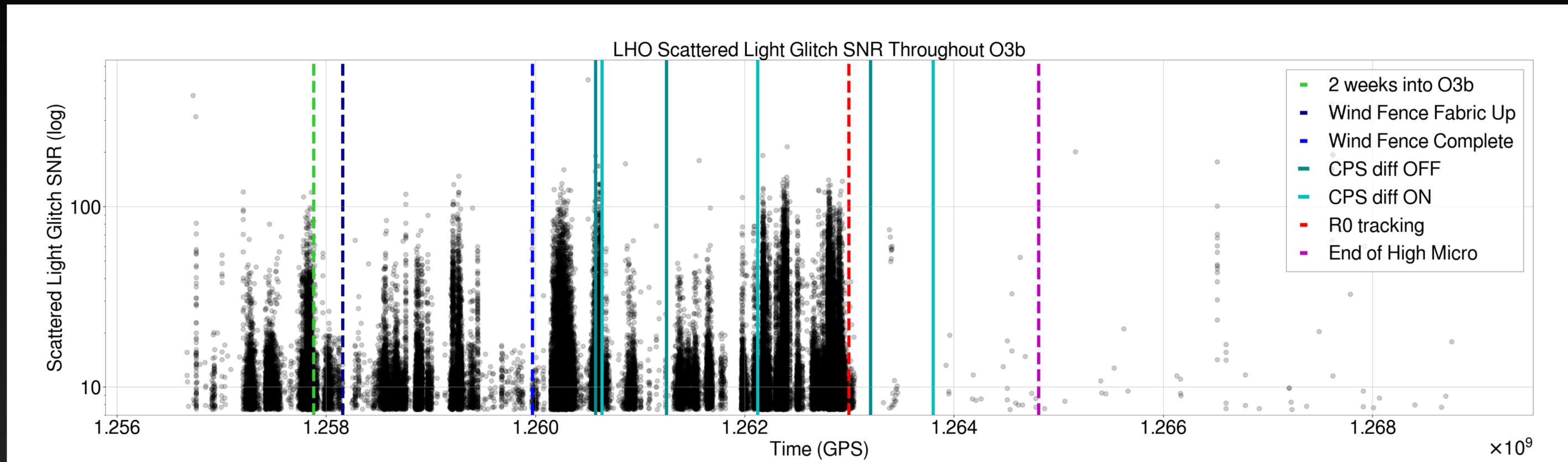
- Why was there an increase in glitch rate after O3b?
- One hypothesis: the capacitive position sensor (CPS) differential
 - [alog 53926](#)
- The CPS diff uses capacitors to account for differential motion between different chambers of the interferometer.



Credit: Jeffrey Kissel, DCC LIGO G0901062

 = CPS differential

CPS Diff Impact on Glitch SNR



- Ongoing investigation, inconclusive thus far.
- We are currently working on threshold techniques to isolate glitches with no known causes (i.e. removing times associated with earthquakes or high anthropogenic noise, for example).
- I will also use these thresholds to isolate the impacts of the wind fence.

Summary

- Wind fence investigation revealed interesting effects from other commissioning break upgrades.
- RO tracking proved to be extremely effective at mitigating glitch rate for LHO.
- Future work:
 - Applying thresholds to isolate effects due to the wind fence.
 - Investigate why RO tracking was so much more effective at LHO than compared to LLO.
 - Is the CPS differential the main culprit behind the increased glitch rate in O3b?
- More information: [alog 55971](#) & [alog 56080](#)

Thank you!

Questions?