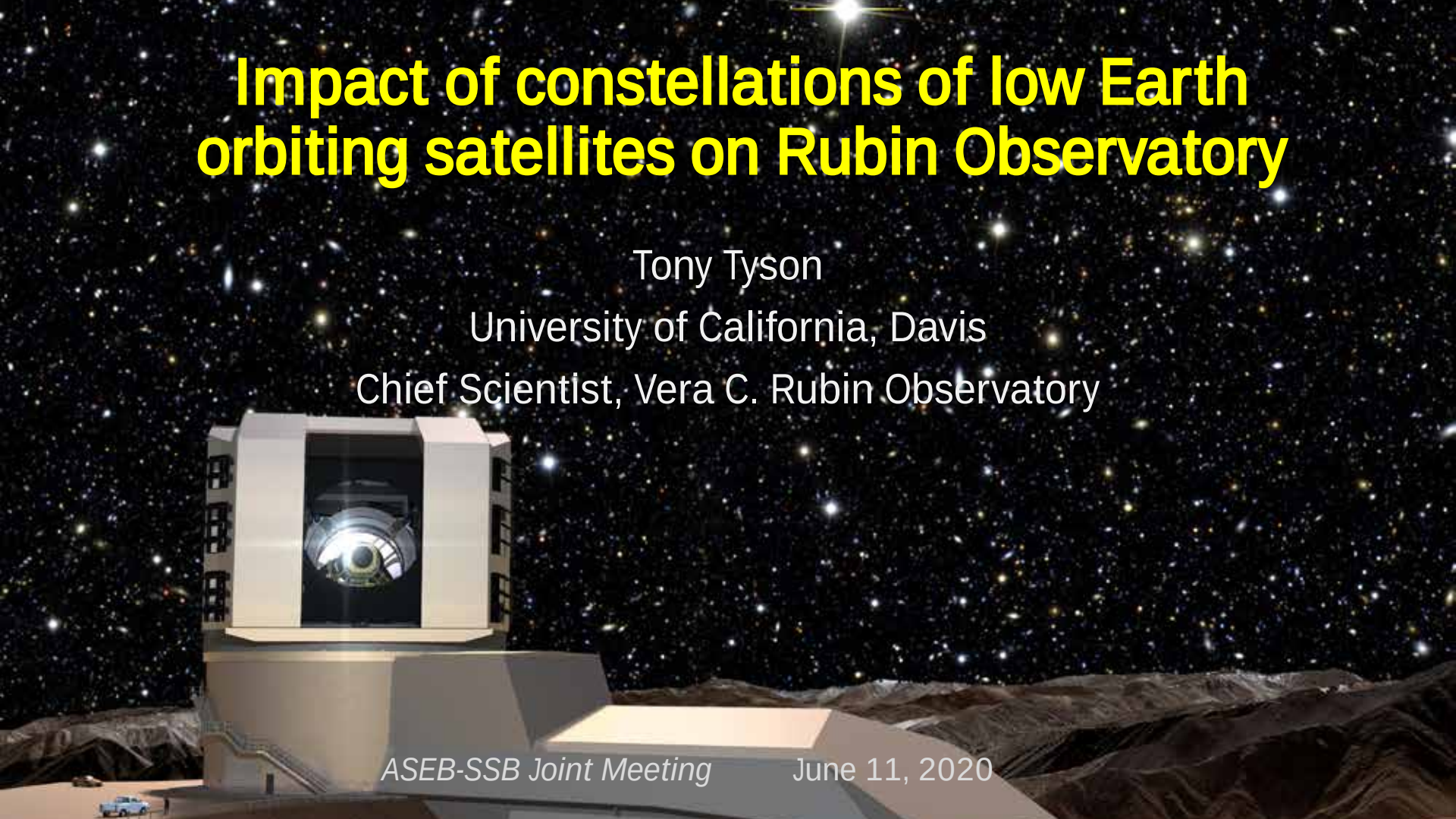
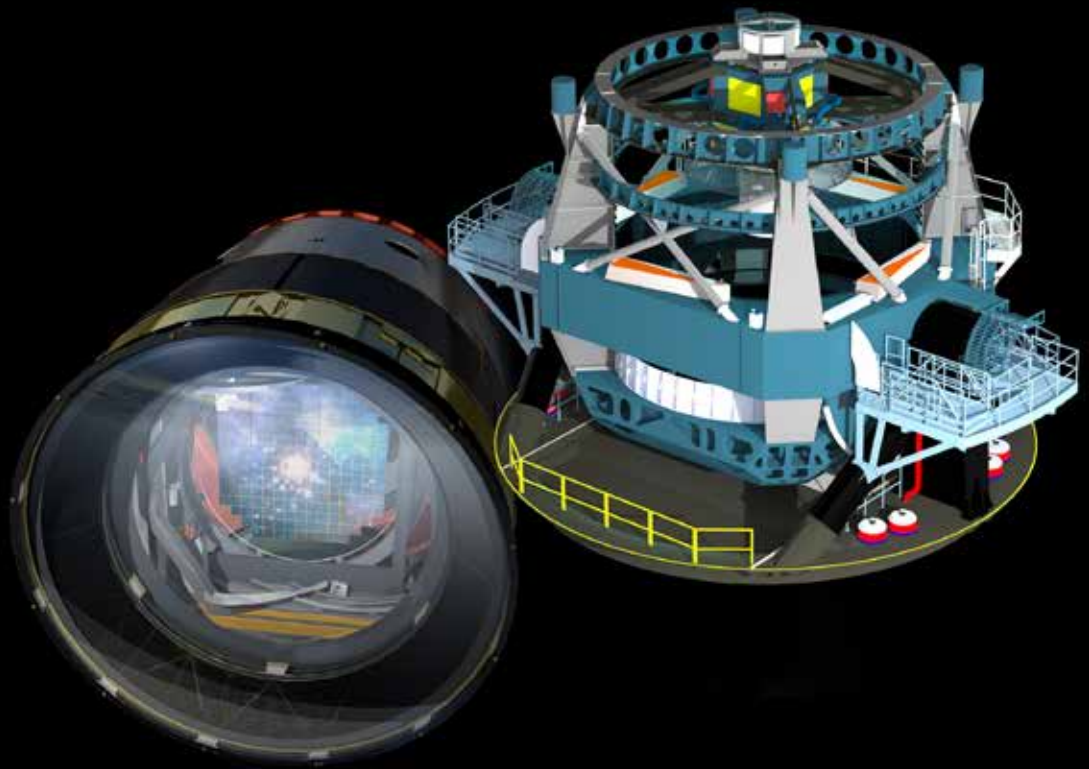
Impact of constellations of low Earth orbiting satellites on Rubin Observatory

Tony Tyson
University of California, Davis
Chief Scientist, Vera C. Rubin Observatory



ASEB-SSB Joint Meeting June 11, 2020

Rubin Observatory



Legacy Survey of Space and Time

Rubin Observatory will execute the *Legacy Survey of Space and Time*, producing the deepest, widest, view of our dynamic Universe:

- 8.4-m mirror
- 3200 megapixel camera
- Each image the size of 40 full moons
- Scans the sky with 2000 images per night
- 10 year survey of the sky 2022-2032
- 37 billion stars and galaxies
- 10 million alerts, 20 Terabytes of data .. every night!
- **Significantly impacted by bright satellite trails**


2018

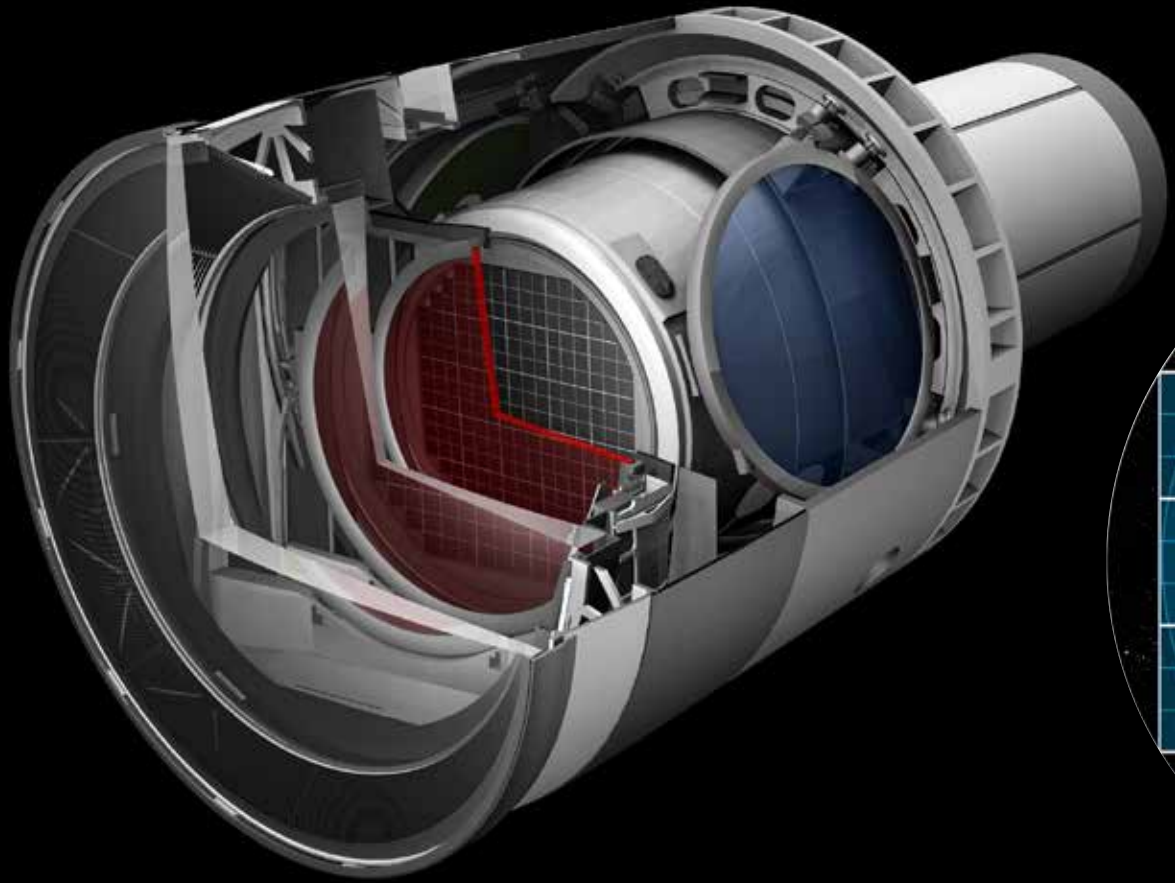

Rubin Observatory LSST survey 2022-2032
February 11, 2020

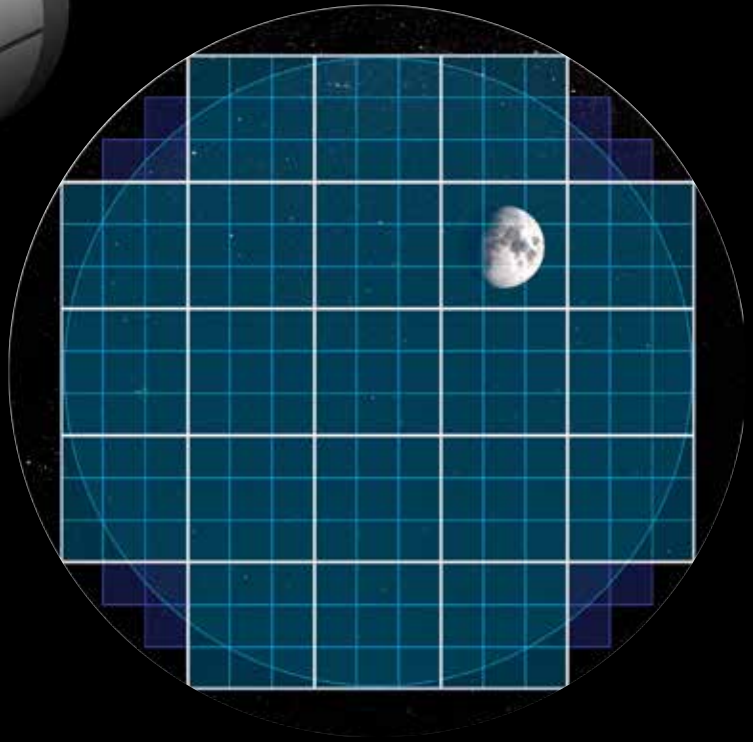
Starlink v0.9

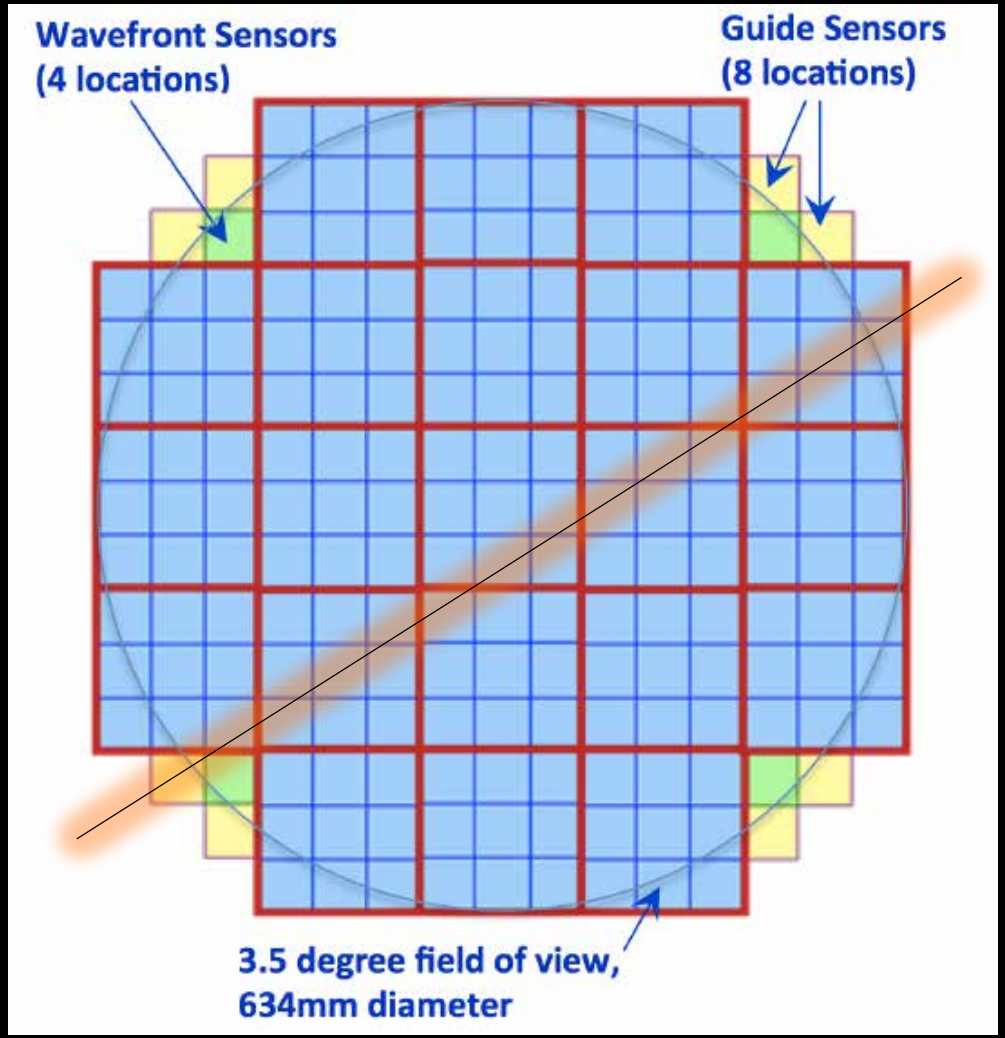
Rubin Observatory: a limiting case

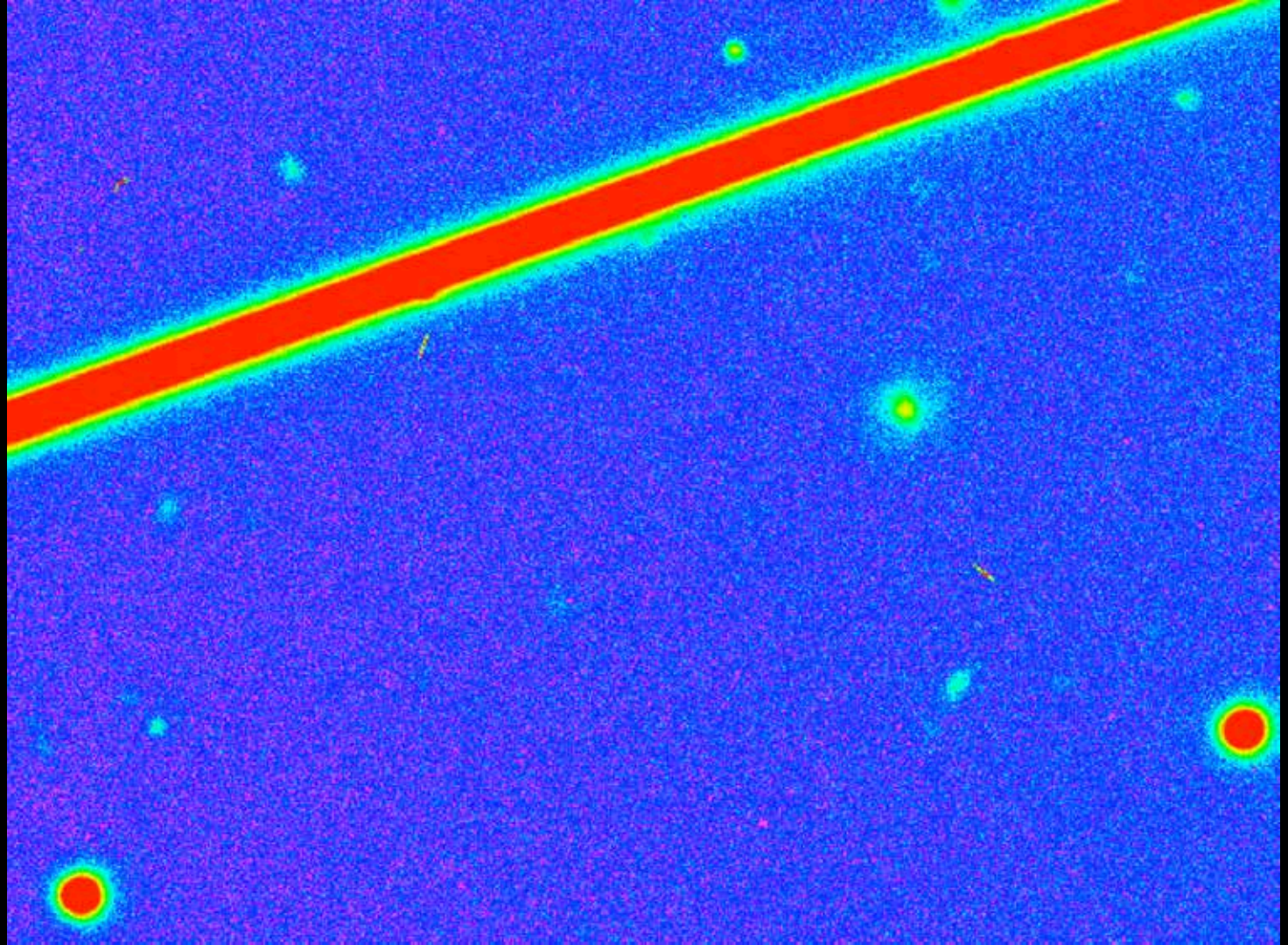
- All optical astronomy observatories will be affected to some degree by the light pollution generated by LEO Sats. The issue is frequency of LEOsat trails in their data and their brightness.

- Rubin Observatory is the limiting case because of its unprecedented throughput: the product of its light collection and the wide field of view per exposure.



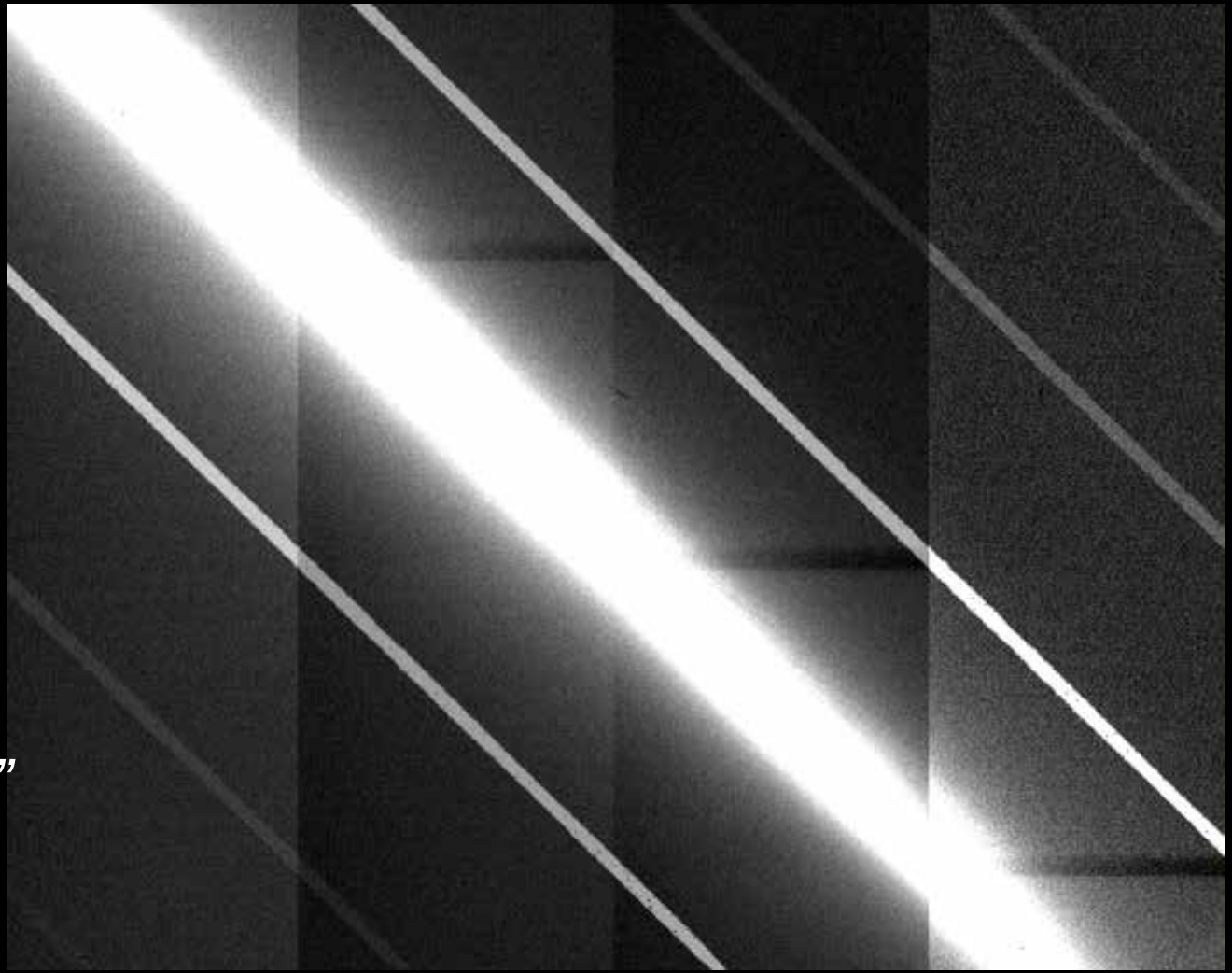



Wavefront Sensors
(4 locations)
Guide Sensors
(8 locations)
3.5 degree field of view,
634mm diameter



Bright satellite trail in the Rubin Observatory camera induces image artifacts.

If LEOsat darkened to 7th magnitude, special pixel processing can remove the “ghost” trails.



- SpaceX is working with the astronomy community to reduce the light pollution effects on optical astronomy

- Making the Starlink 7th magnitude can remove some satellite trail electronic ghosts in the Rubin Observatory camera

- We are working with SpaceX to measure the effect of darkening test satellites in future launches

- However, *even if that works*, the satellite trails will clearly be in the data – complicating data analysis and limiting discoveries

Analysis of Blanco telescope imaging of 5 recent Starlinks demonstrates progress to darkening goal

- *Darksat:* 6.1 magnitude
- *Visorsat* may reach the goal of 7th magnitude for LEOsats at 550 km.
- SpaceX brightness mitigation efforts set an example for others to follow

Looking to the next decade, industry together with the astronomy community must address these issues

- Work jointly to develop spacecraft design and operations solutions to minimize science impact. *Tools for efficient scheduling.*

- LEOsats at 550 km impact several Rubin Observatory programs, including searches for potentially hazardous asteroids.

- LEOsats at 1200 km may be seen all night long in summer, and are incompatible with many Rubin Observatory LSST science programs.