



# Interference with optical astronomy by new bright satellites

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SSB June 4, 2026



U.S. DEPARTMENT OF  
**ENERGY**



## OFFICE OF CHAIRMAN BRENDAN CARR

### **FCC Approves Next-Gen Satellite Constellation**

*Enabling Better, Faster Broadband throughout America*

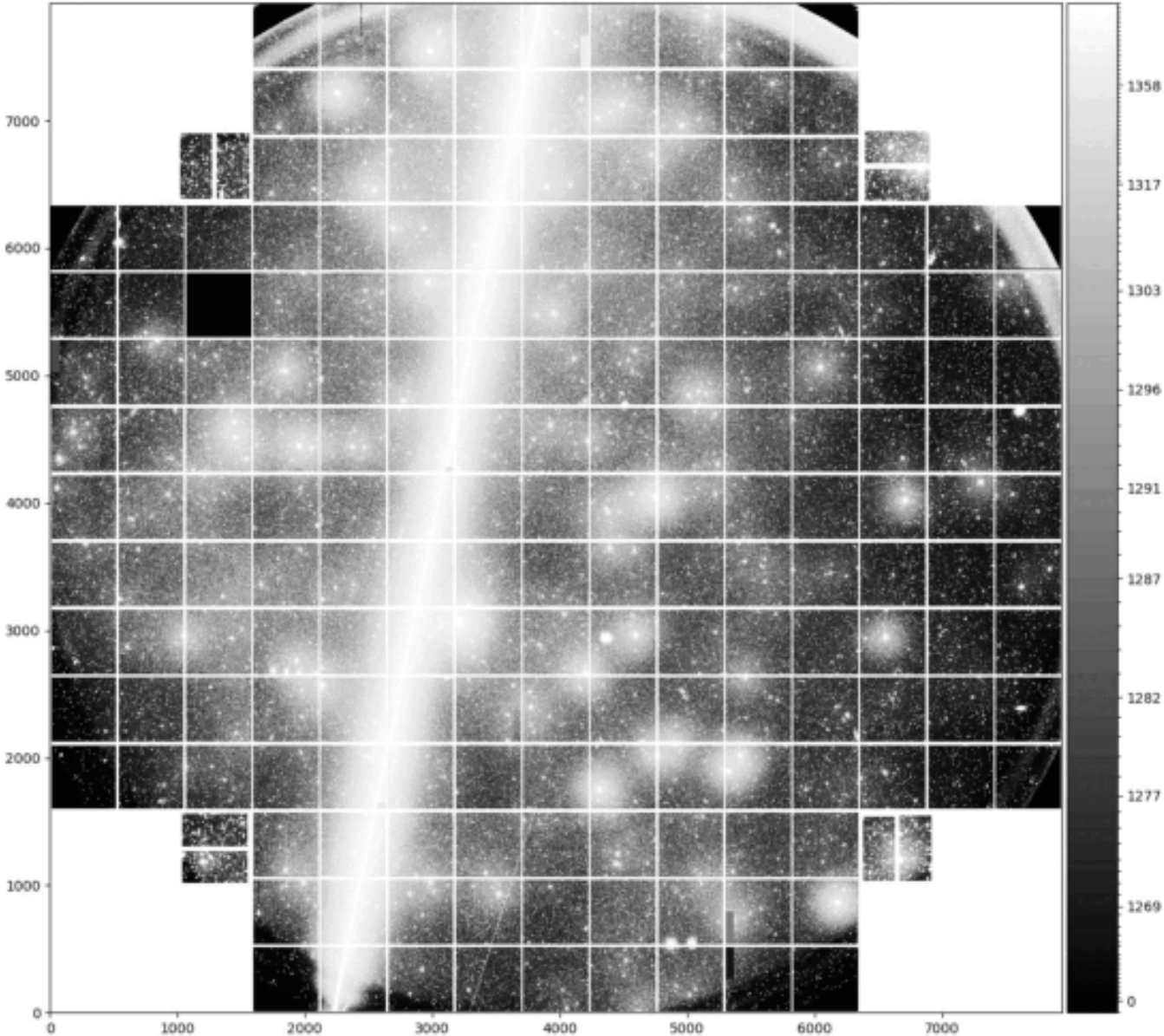
WASHINGTON, January 9, 2026 — Today, the FCC granted Space Exploration Holdings, LLC (SpaceX) a major authorization to advance its second-generation Starlink satellite system, marking a significant milestone in global broadband connectivity.

Under this grant, SpaceX is authorized to construct, deploy, and operate an additional 7,500 Gen2 Starlink satellites, bringing the total to 15,000 satellites worldwide. This expansion will enable SpaceX to deliver high-speed, low-latency internet service globally, including enhanced mobile and supplemental coverage from space. The FCC's decision today benefited in particular from the work and collaboration provided by the Commerce Department and NTIA.

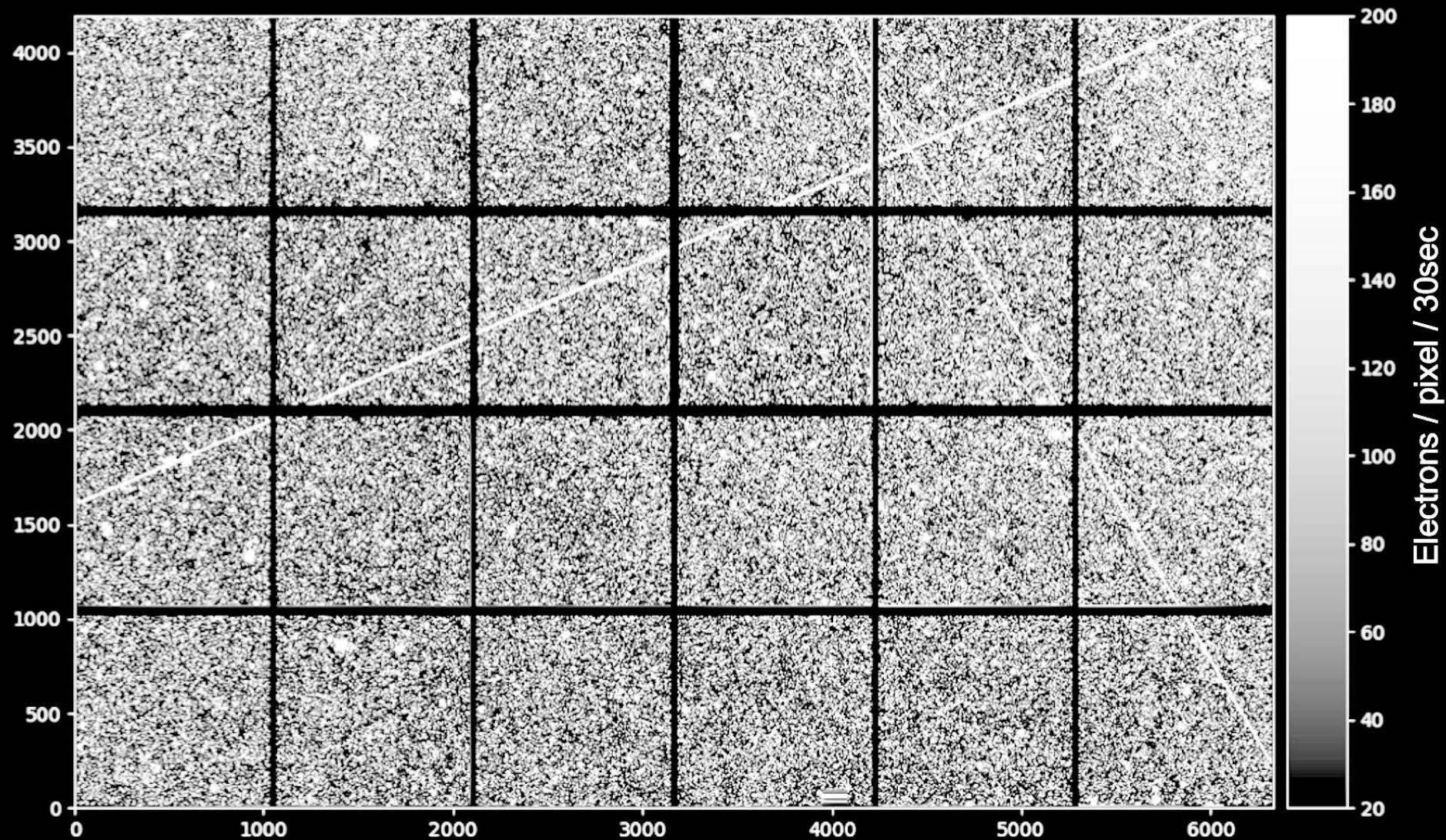
**Chairman Carr issued the following statement:**

“President Trump is restoring America’s technology leadership. And this FCC authorization is a game-changer for enabling next-generation services. By authorizing 15,000 new and advanced satellites, the FCC has given SpaceX the green light to deliver unprecedented satellite broadband capabilities, strengthen competition, and help ensure that no community is left behind.”

dayObs=20260513 - seqNum=710  
science image @ 30.0s in filter r\_57

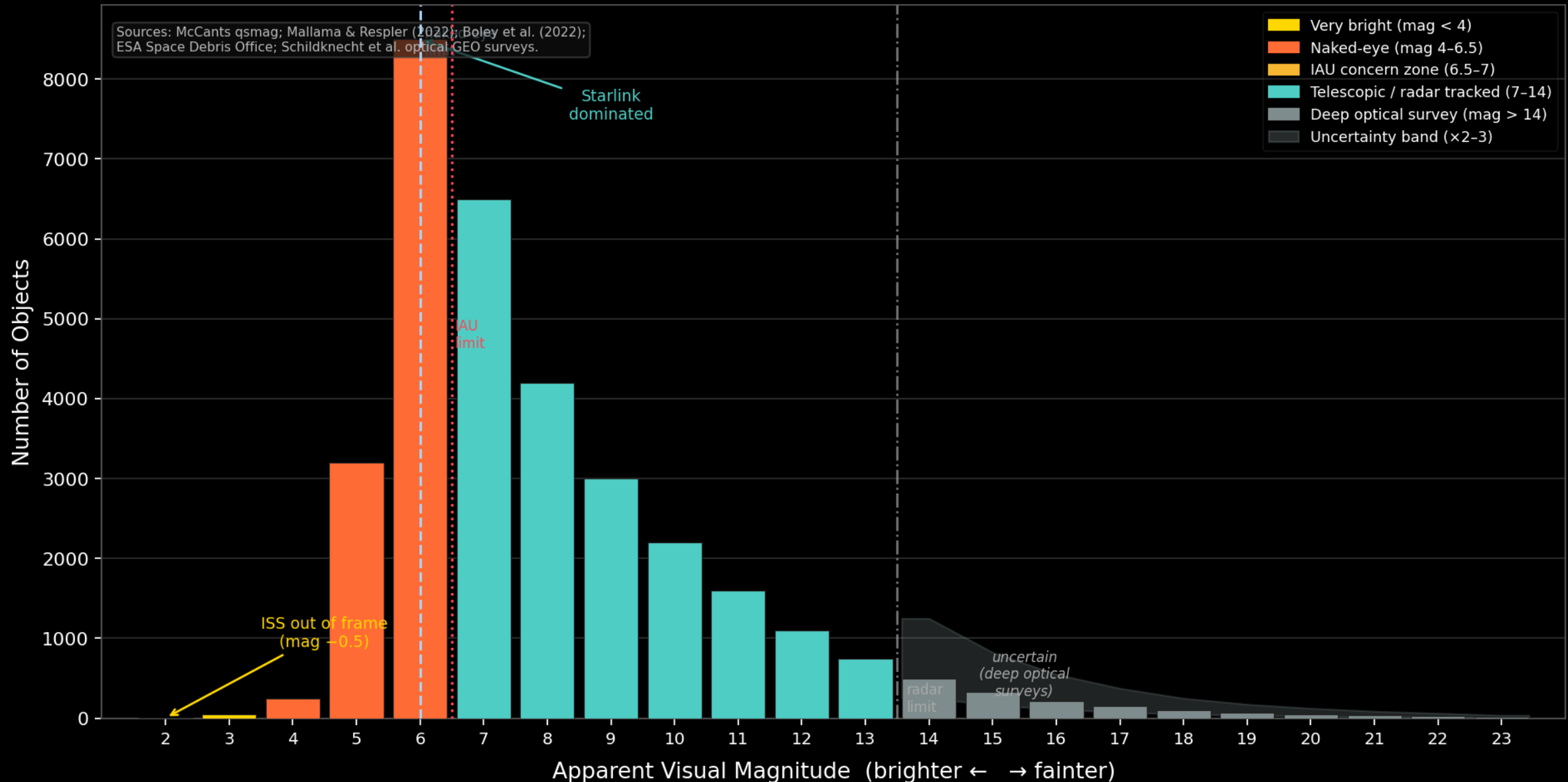


## Two LEO satellites in LSST-Cam data

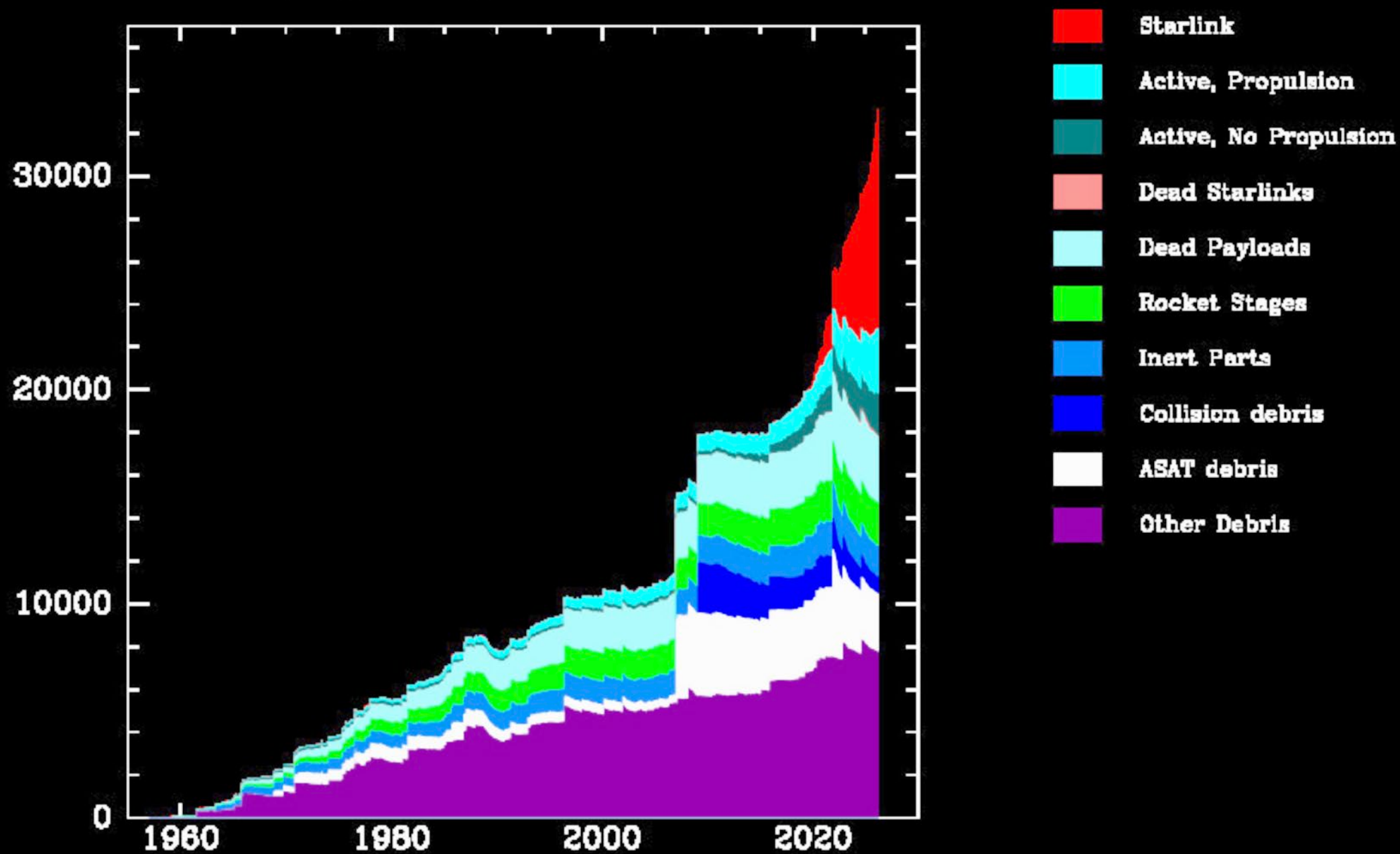


This small portion of a LSST 30-sec *i* band image taken on July 11, 2025 shows two faint unidentified satellites crossing several of the 189 LSST camera 4Kx4K pixel CCD detectors. The noise is not visible; most of the objects shown are stars in our galaxy.

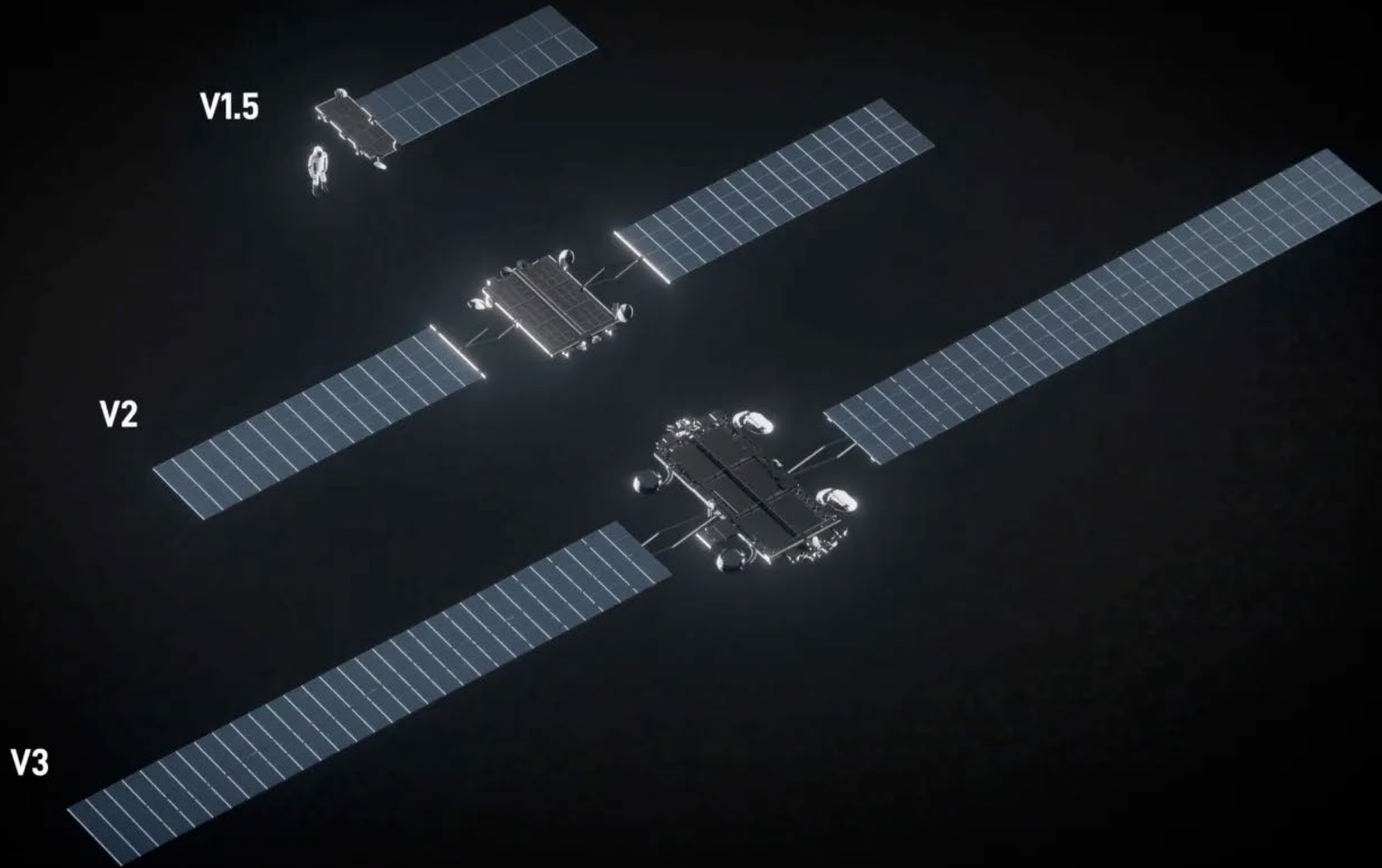
# Earth-Orbiting Satellites & Debris by Apparent Brightness



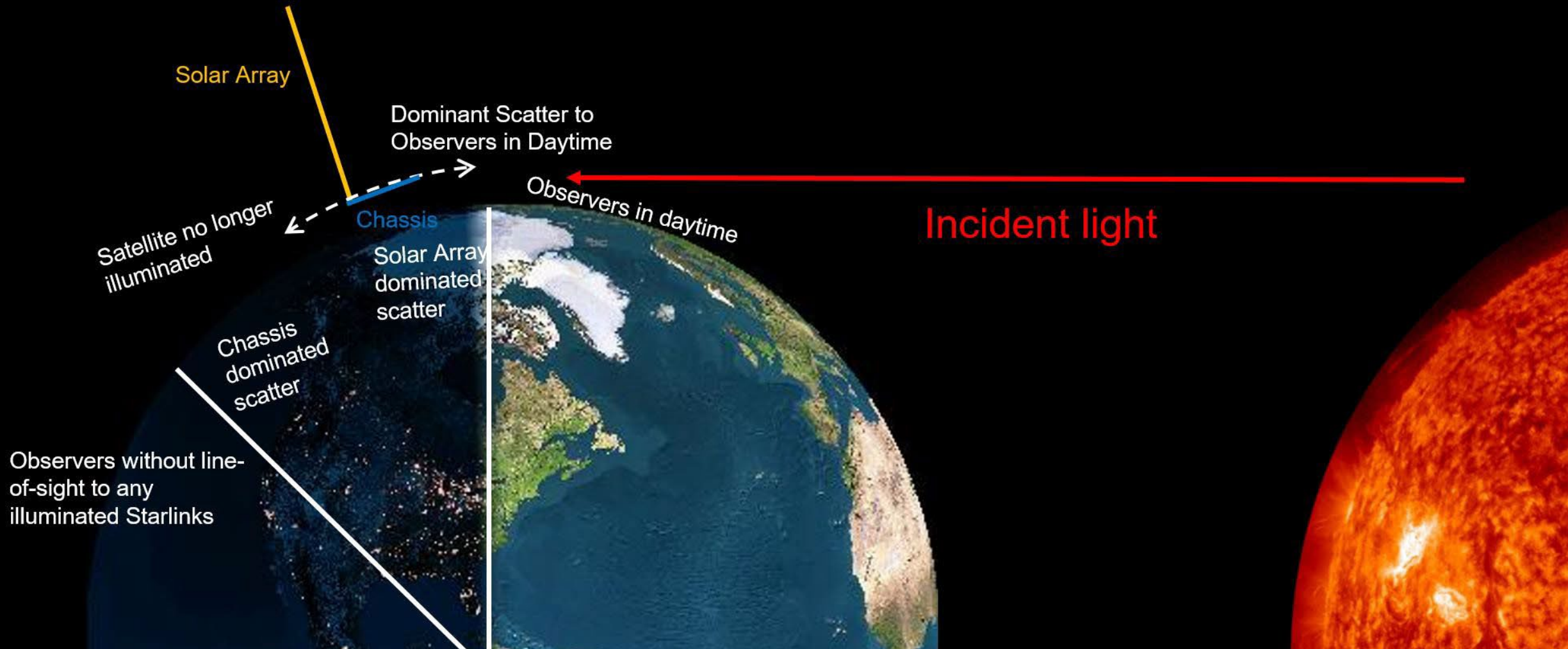
## Orbital Population



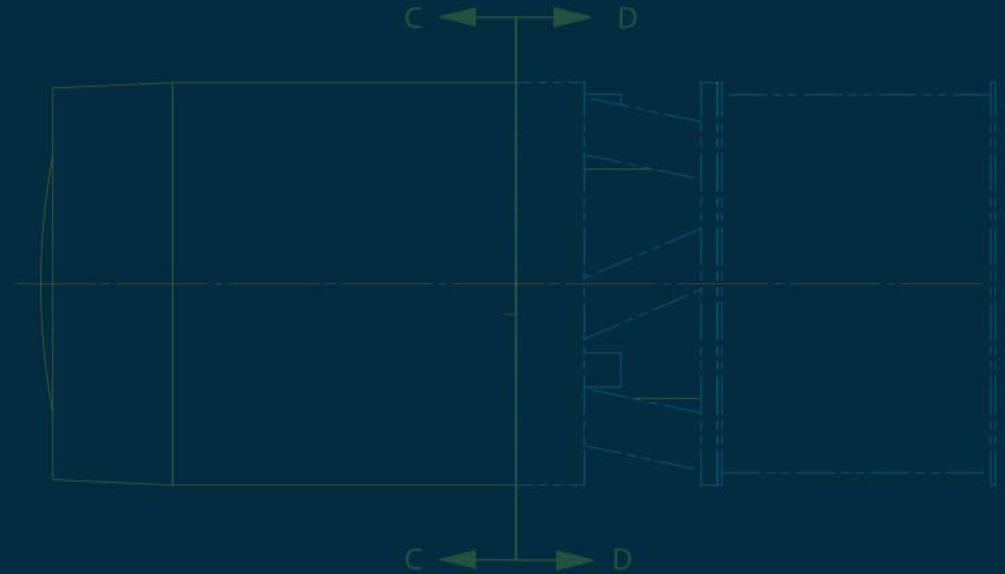
# SpaceX Starlink satellites



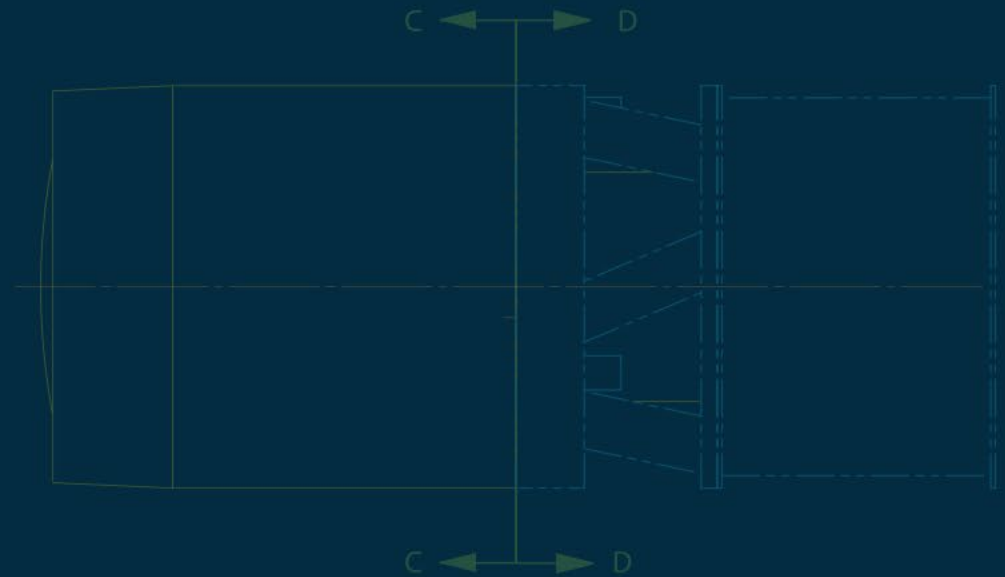
# Mechanism for Satellite Brightness



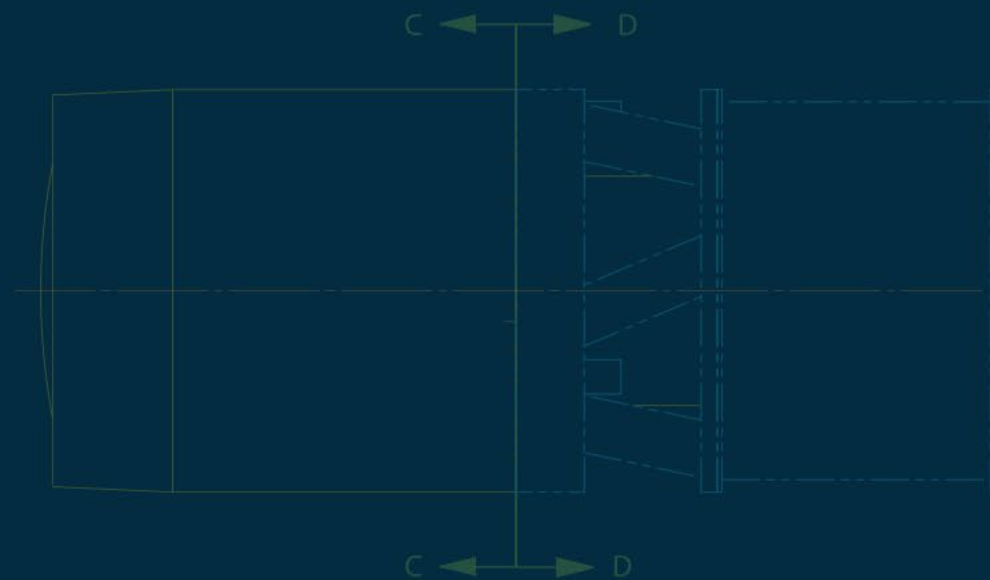
Due to the volume of data, sky survey science will be limited by systematics rather than sample statistics.



Both *static sky* and *time domain* systematics occur.



Many LEOsats are *100 million times* brighter than the faint objects LSST seeks to image!

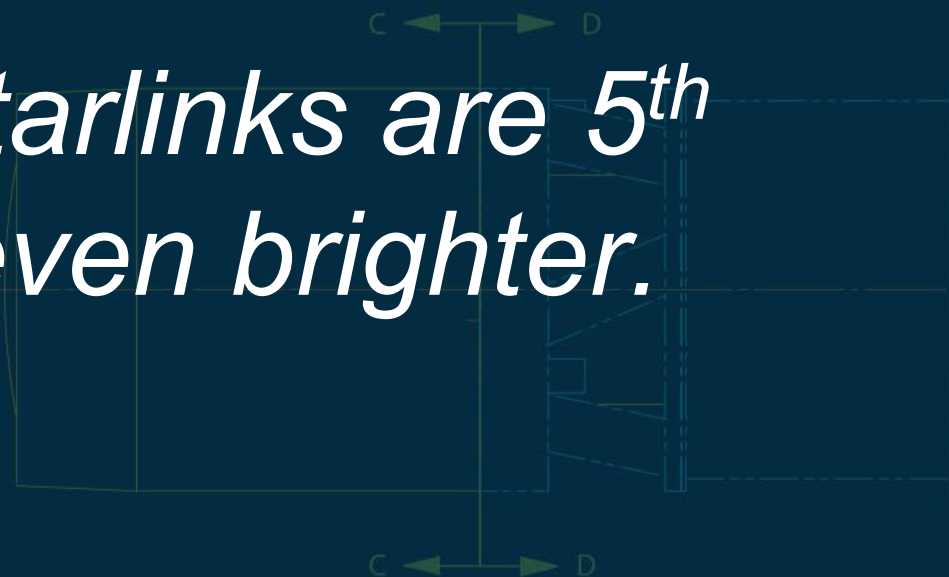


Many LEOsats are *100 million times* brighter than the faint objects LSST seeks to image!

*This greatly exceeds the dynamic range of our detectors and software.*

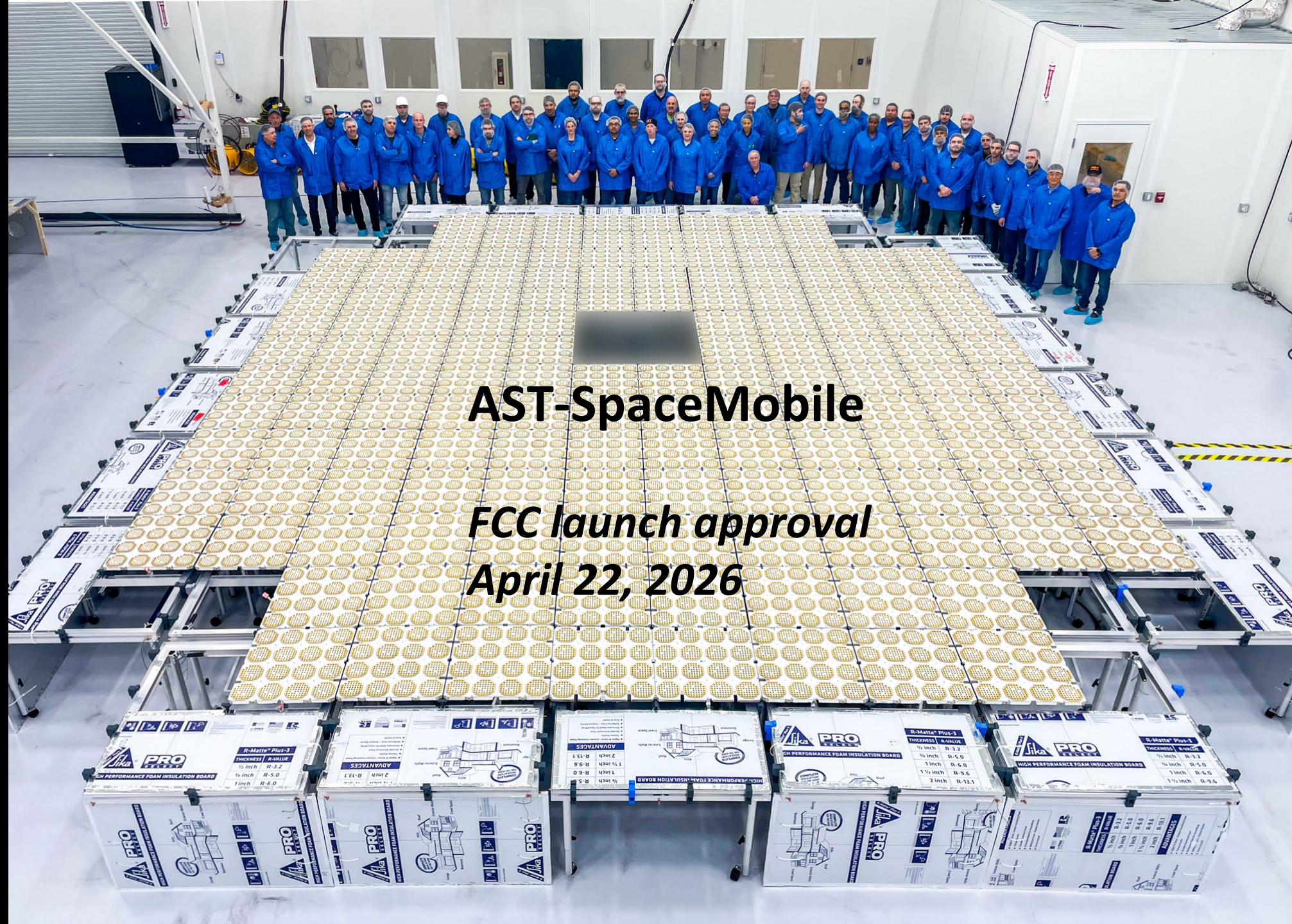
SpaceX has set the standard for mitigation of satellite optical brightness.

*But many of their v2 Starlinks are 5<sup>th</sup> magnitude; v3 will be even brighter.*



# Amazon Leo





**AST-SpaceMobile**

**FCC launch approval**

**April 22, 2026**

# Scaling for massive capacity    AI farms in space

1 Billion

Optimus robots  
to do the work

10 Million

Tons of mass/year  
launched into orbit

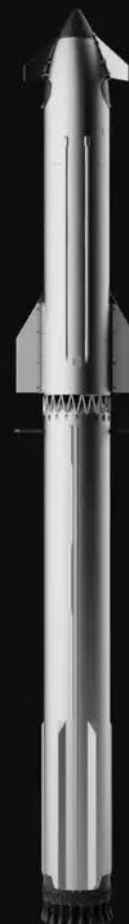
1 TW+

Solar power  
needed

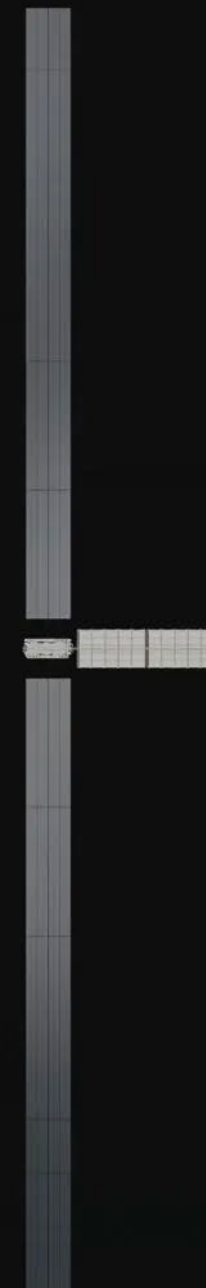
Optimus



Starship V3



AI Sat Mini



SpaceX

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**DA 26-113**

**Released: February 4, 2026**

**SPACE BUREAU ACCEPTS FOR FILING  
SPACEX'S APPLICATION FOR ORBITAL DATA CENTERS**

**ICFS File No. SAT-LOA-20260108-00016**

**Comments/Petitions Due: March 6, 2026**

**Response to Comments/Oppositions to Petition Due: March 16, 2026**

**Replies to Responses/Oppositions Due: March 23, 2026**

By this Public Notice, the Space Bureau (Bureau) accepts for filing and seeks comment on an application by Space Exploration Holdings, LLC (SpaceX) for a new non-geostationary orbit (NGSO) system of up to one million satellites.<sup>1</sup> This satellite system will represent the “first step towards becoming a Kardashev II-level civilization – one that can harness the Sun’s full power,” according to SpaceX.<sup>2</sup>

On January 30, 2026, SpaceX filed an application seeking authority to launch and operate a new NGSO satellite system of up to one million satellites to operate as the “SpaceX Orbital Data Center system” (System). The System will operate at altitudes ranging from 500 km to 2,000 km and in 30 degree and sun-synchronous orbit inclinations within orbital shells spanning up to 50 km each.<sup>3</sup> The proposed satellites will use high-bandwidth optical inter-satellite links and conduct telemetry, tracking, and command (TT&C) operations.<sup>4</sup> The Bureau seeks comment on the application and the associated requests for waiver.

## ORBITAL DATA CENTERS



## ORBITAL DATA CENTERS



While the need to launch these satellites will act as a similar forcing function to drive Starship improvements and launch rates, the sheer number of satellites that will be needed for space-based data centers will push Starship to even greater heights. With launches every hour carrying 200 tons per flight, Starship will deliver millions of tons to orbit and beyond per year, enabling an exciting future where humanity is out exploring amongst the stars.

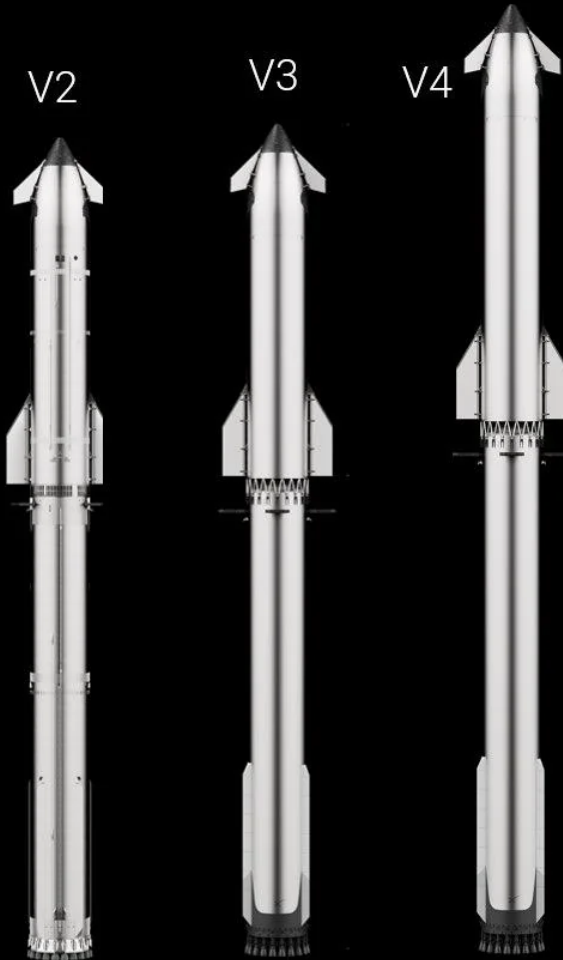
The basic math is that launching a million tons per year of satellites generating 100 kW of compute power per ton would add 100 gigawatts of AI compute capacity annually, with no ongoing operational or maintenance needs. Ultimately, there is a path to launching 1 TW/year from Earth.



# VEHICLE SUMMARY

FULLY REUSABLE

|                             | V1 (2023/24) | V2 (2025) | V3 (2025/26) | V4    |
|-----------------------------|--------------|-----------|--------------|-------|
| PAYLOAD TO ORBIT (t)        | ~15          | ~35       | 100+         | 200+  |
| BOOSTER PROP LOAD (t)       | 3250         | 3250      | 3650         | 4050  |
| SHIP PROP LOAD (t)          | 1200         | 1500      | 1600         | 2300  |
| BOOSTER LIFTOFF THRUST (tf) | 7100         | 7100      | 8240         | 10000 |
| SHIP INITIAL THRUST (tf)    | 1250         | 1400      | 1600         | 2700  |
| SHIP SL ENGINES             | 3            | 3         | 3            | 3     |
| SHIP VAC ENGINES            | 3            | 3         | 3            | 6     |
| BOOSTER HEIGHT (m)          | 71           | 71        | 72.3         | 81    |
| SHIP HEIGHT (m)             | 50.3         | 52.1      | 52.1         | 61    |
| TOTAL HEIGHT (m)            | 121.3        | 123.1     | 124.4        | 142   |



SpaceX



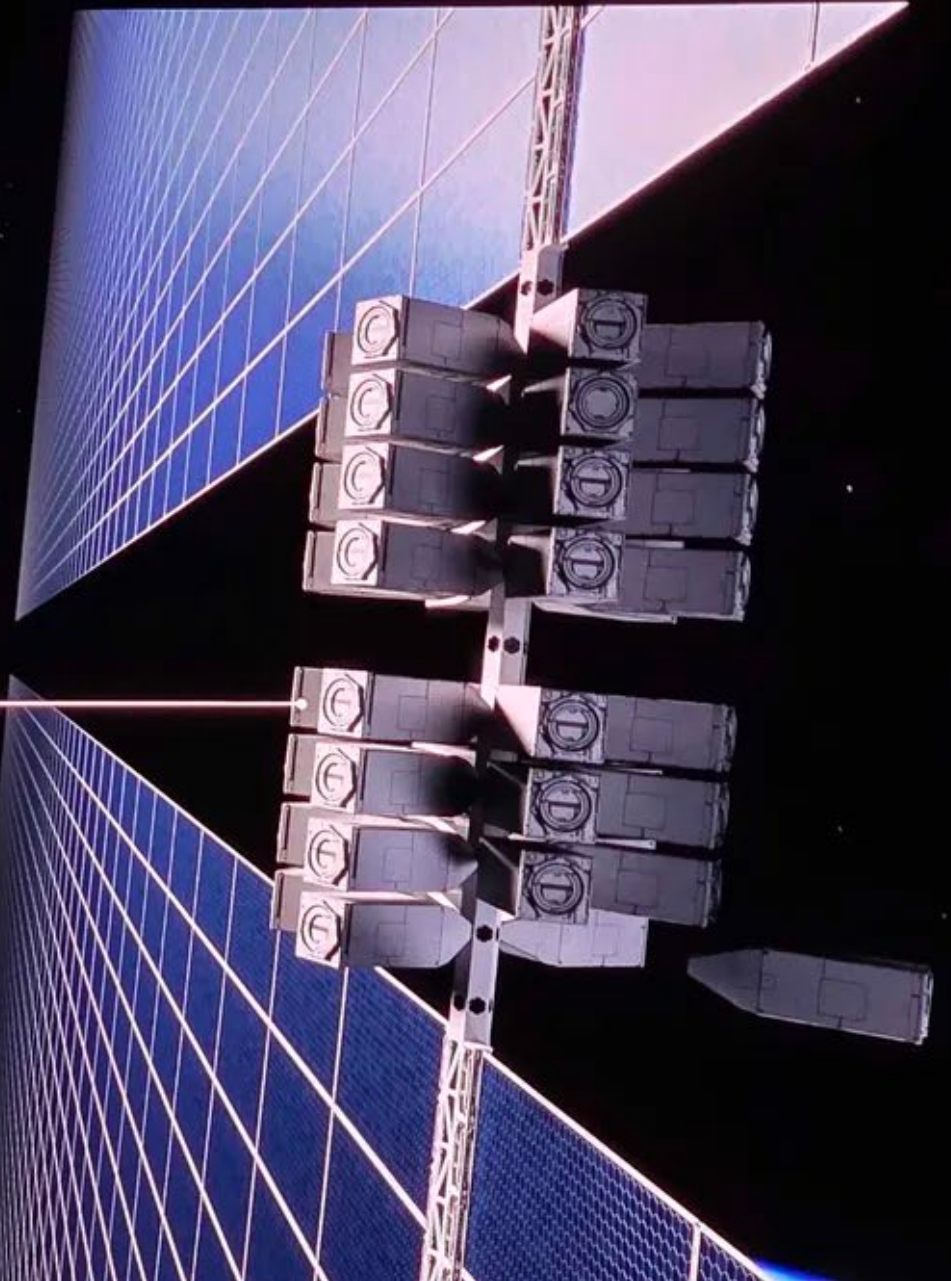
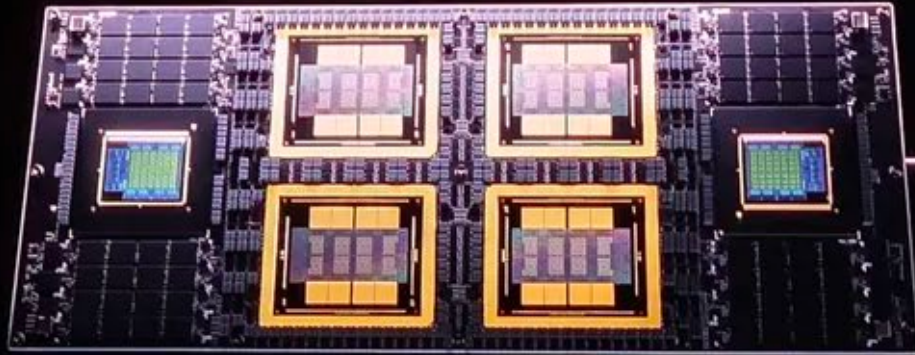
# Challenges during orbiting AI operations



Orbit raising requires that each satellite pause at an initial low LEO orbit for some time before raising. This will create an ultra-bright pileup of satellites visible to the un-aided eye, polluting the sky for all. *These bright lanes will be a permanent feature which LSST could not avoid.* At one million total satellites, the sky brightness would be similar to the glare of a half moon, which would preclude most of the LSST science programs.

Orbiting AI hardware must be updated every few years

Announcing NVIDIA Space-1  
Vera Rubin Module

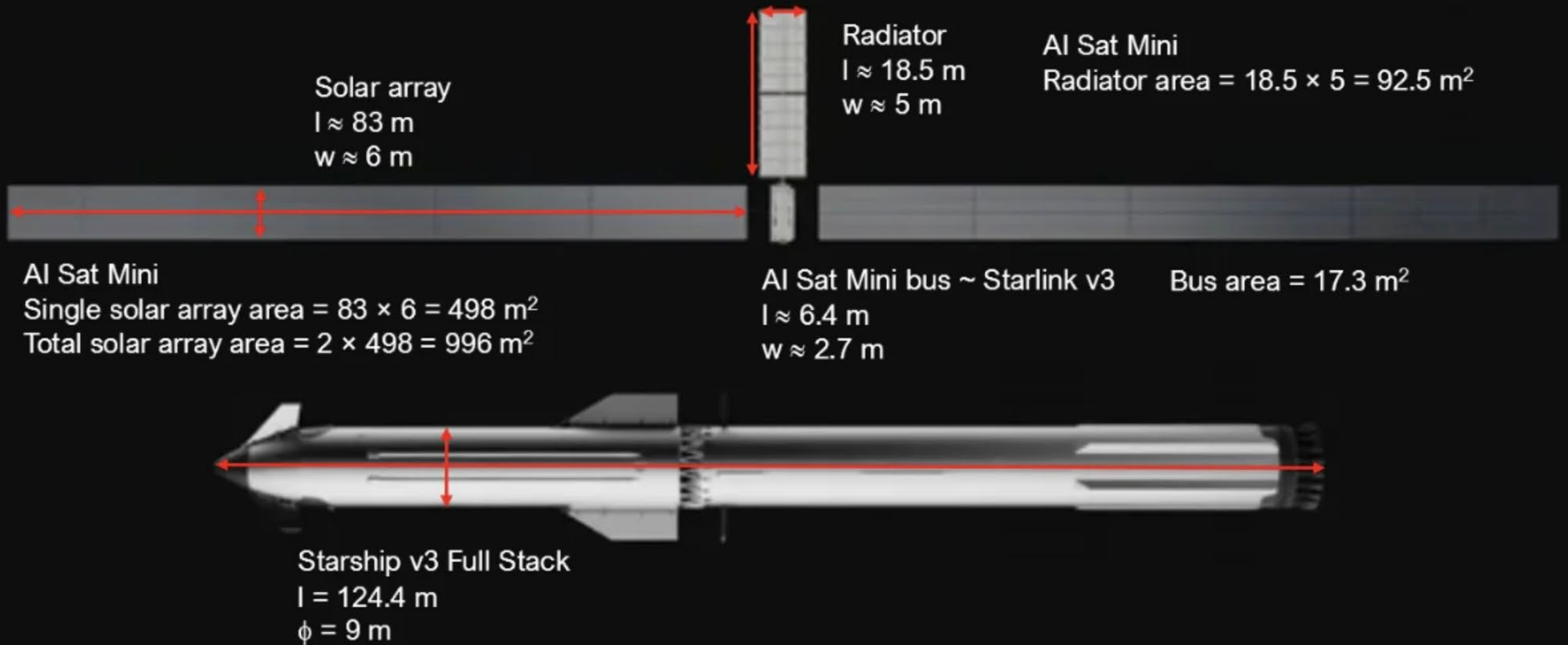


# SpaceX LEO mini AI satellite



SpaceX

# SpaceX LEO mini AI satellite 270 KW



# Brightness of SpaceX LEO mini AI satellite 270 KW @ 600km

- Each of these satellites will appear as bright as the full moon, with all-sky diffuse scattered light preventing LSST faint survey work.
- A GW data center could have 400 of these satellites;  
~50 visible at ground-based site

# Brightness of SpaceX single LEO v4 AI satellite @ 600km

- Starship v4 will launch 15 sats per hour. 130,000 per year!
- These satellites will pile up at the low altitude pause to deploy solar panels before raising. The 1000 sq.m panels combined will be brighter than the full moon.
- At station, each of these 1-2 ton satellites can produce glints as bright as Venus.
- Whole-sat will be 0<sup>th</sup> magnitude for 30 deg or more elevation.

**Ultimately there will be many such orbiting AI data centers**

# Challenge of future AI facilities in LEO

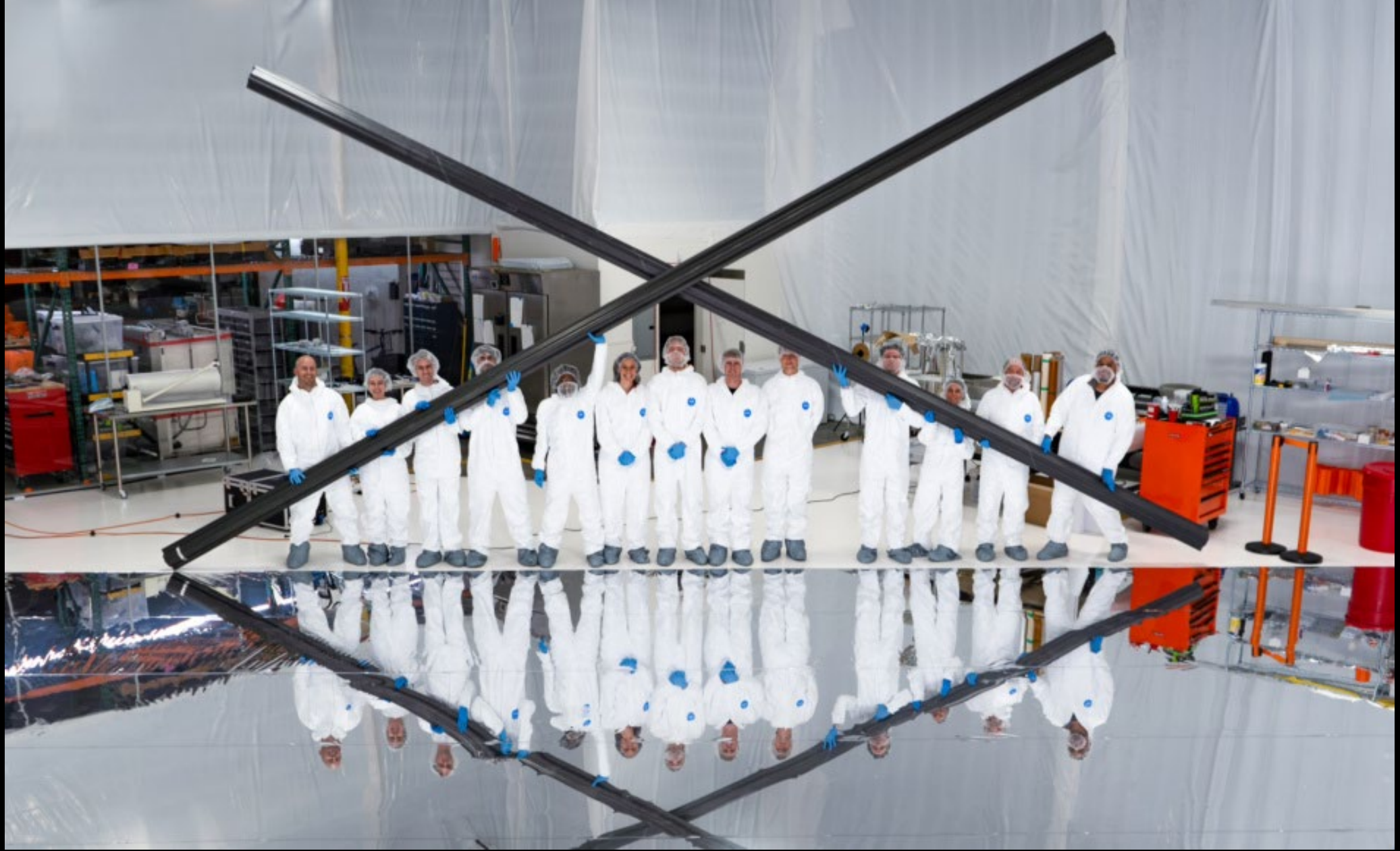
- Bright lanes in the sky due to pileup of sats prior to orbit raise.
- The light from these lanes can saturate CCD arrays.
- There will be glints from thousands of sats distributed over the sky at all times.

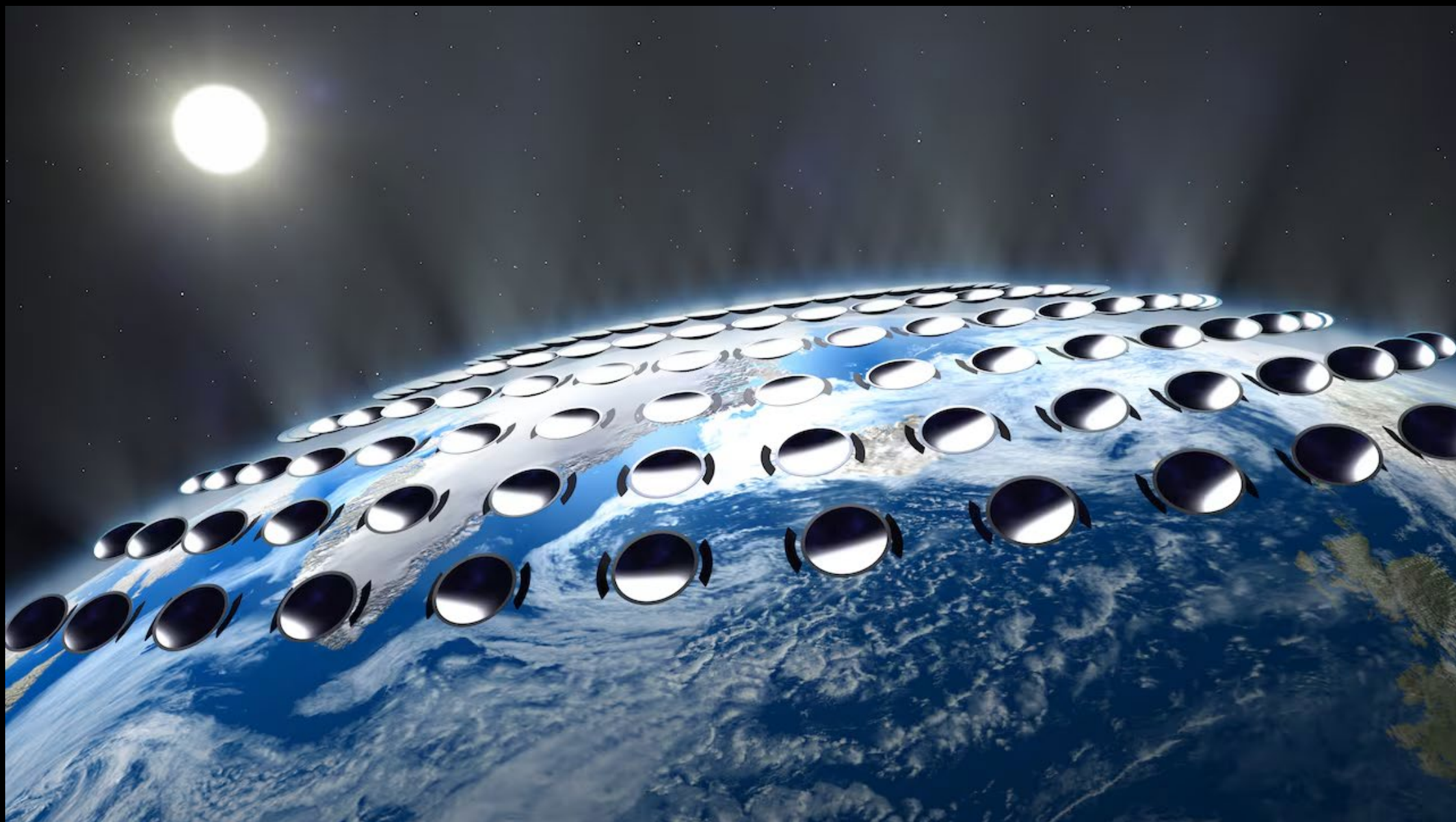
Finally, satellites must be de-orbited when AI hardware becomes obsolete.

Continuous re-entry of 200 tons per hour



# Reflect Orbital

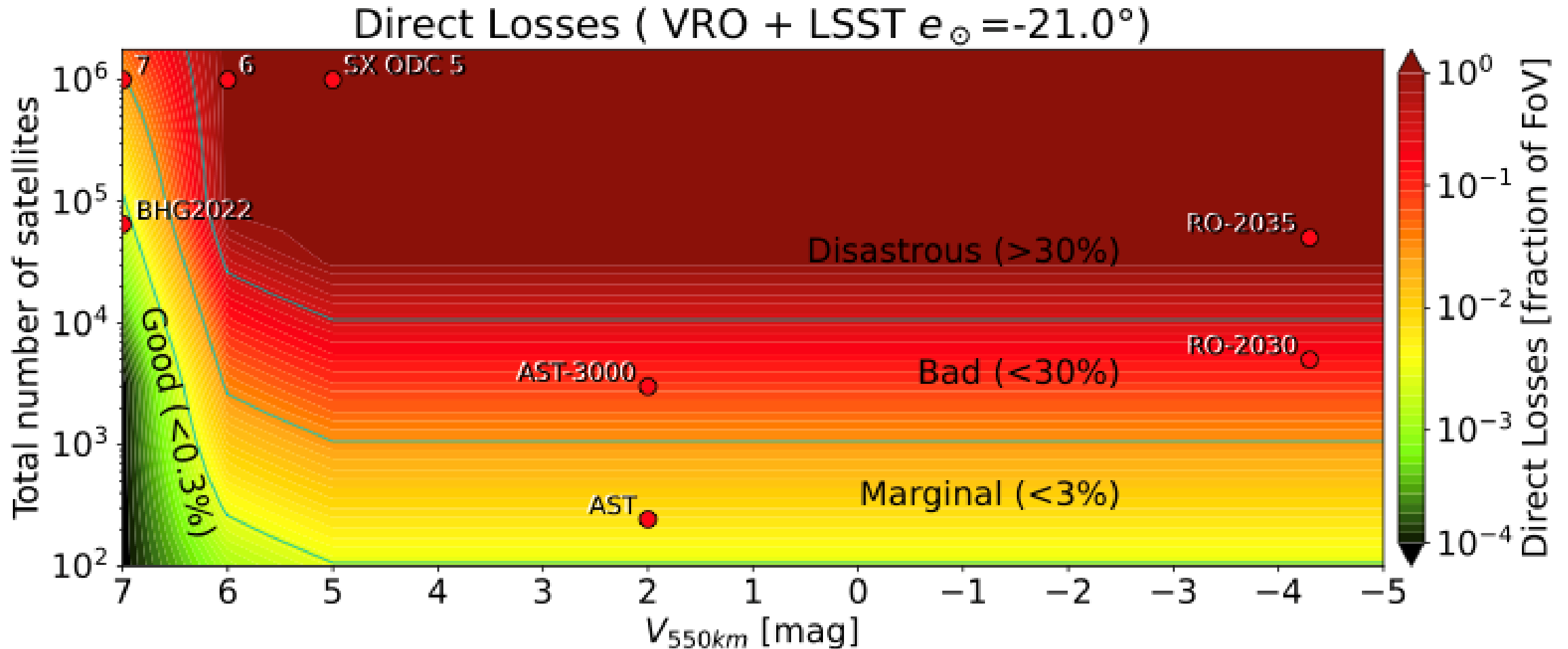




# Challenges discussed at NSF workshop

**Report on LEO satellite impacts on ground-based  
optical astronomy for the Rubin Observatory LSST**

arXiv:2509.19758



Constellations currently proposed for launch and operation, with over 1.7 million satellites, many of them much brighter than 7<sup>th</sup> mag, would have a devastating effect.

# FCC rules for constellation licensing

- **The 50% Milestone:** Operators must launch and operate half of their maximum authorized fleet no later than 6 years after the grant date.
- **The 100% Milestone:** Operators are required to launch and operate the remaining 50% to complete their full authorized constellation within nine years.
- **Penalties:** If an operator fails to meet these interim or final milestones, their FCC authorization is automatically reduced to the exact number of satellites they have successfully launched and are operating on that specific milestone date.

# Summary

- Major impact on optical astronomy 2027-on
- Kessler syndrome much more likely
- Orbiting data centers – failed business model\*
- Reflect Orbital – failed business model\*
- FCC will require launches of initial phases

*\*My opinion*