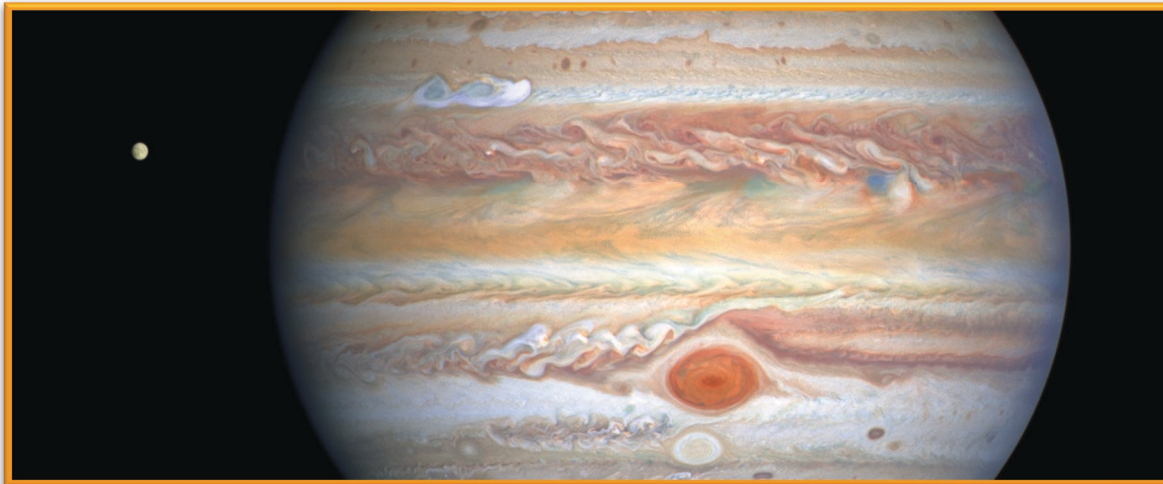




# HST/GSFC Project Report



*September 17, 2020*

## Hubble Captures Crisp New Portrait of Jupiter's Storms

### *Turbulent Storms Rage Across The Giant Planet*

More massive than all the other planets combined, Jupiter truly is the king of our solar system. The swirling clouds, arranged in colorful, banded structures, change from year to year. The rich colors are produced by trace compounds in Jupiter's predominantly hydrogen/helium atmosphere. Hurricane-force winds propel these clouds, and upwelling currents are ablaze with lightning bolts far more powerful than those seen on Earth. The Hubble Space Telescope serves as a "weather satellite" for monitoring Jupiter's stormy weather. The iconic Great Red Spot, a storm big enough to swallow Earth, shows that it's shrinking a little in the Hubble images, but it still dominates the entire southern atmosphere, plowing through the clouds like a cargo ship. Hubble astronomers patiently wait to get close-up snapshots as Earth make its nearest annual approach to Jupiter – an astronomical alignment called an opposition, when Jupiter is on the opposite side of the Earth from the Sun. "Closest approach" between the worlds is still on the order of nearly a half billion miles! **STSci-2020-42**

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Deputy Project Manager/Resources

### **Kevin Hartnett**

Science Operations Manager

**Space Telescope  
Users Committee  
Meeting  
October 15, 2020**

# Agenda

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- **Science highlights**
- **Project News/COVID-19 Impacts**
- **Observatory Status**
- **Budget Status**

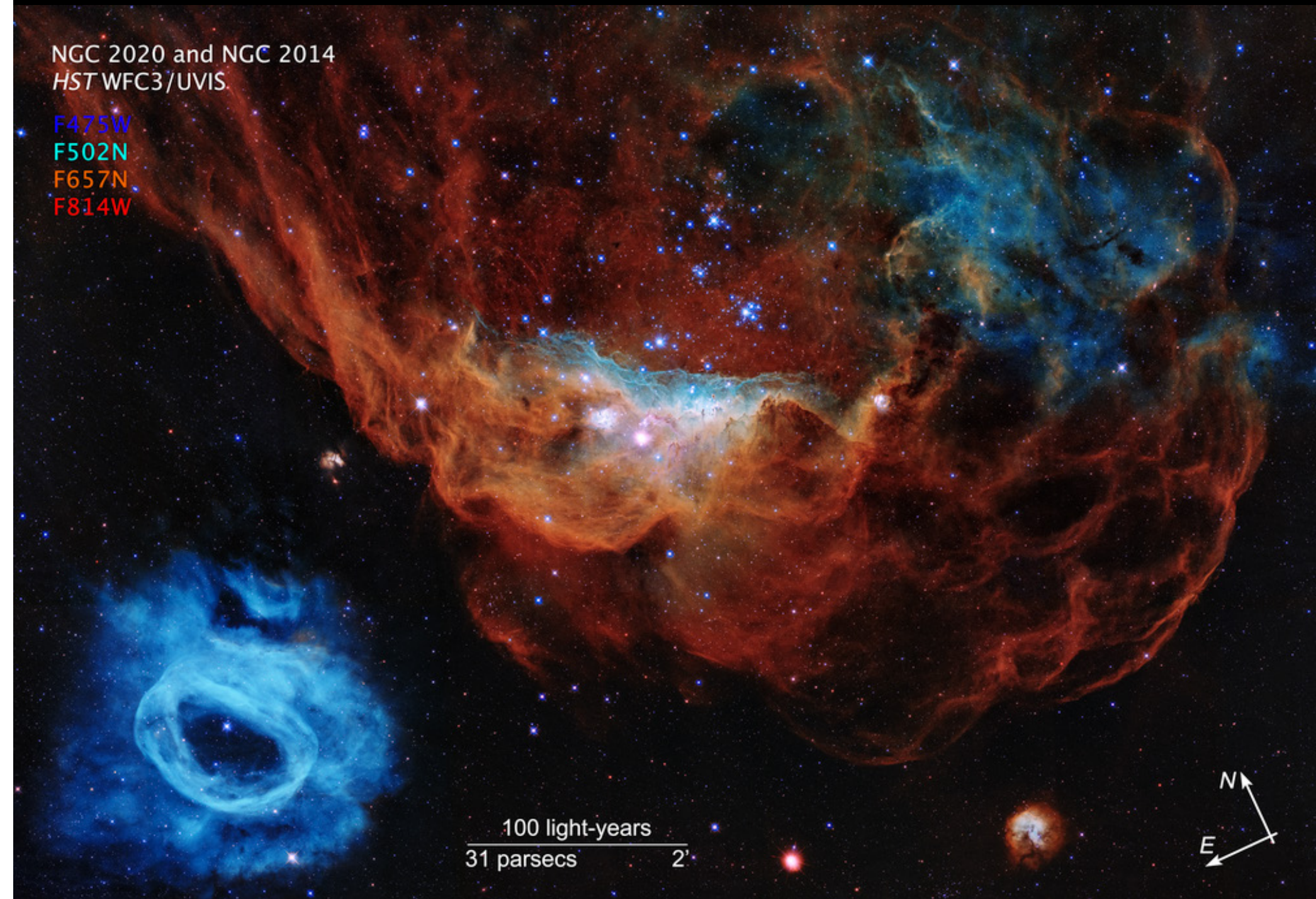


# HAPPY 30<sup>TH</sup> BIRTHDAY, HUBBLE!

NGC 2020 and NGC 2014  
*HST* WFC3/UVIS

F475W  
F502N  
F657N  
F814W

100 light-years  
31 parsecs 2'







Arkansas Discovery Museum STEM Girls Summer Program 2020



# Arkansas Discovery Museum STEM Girls Summer Program 2020



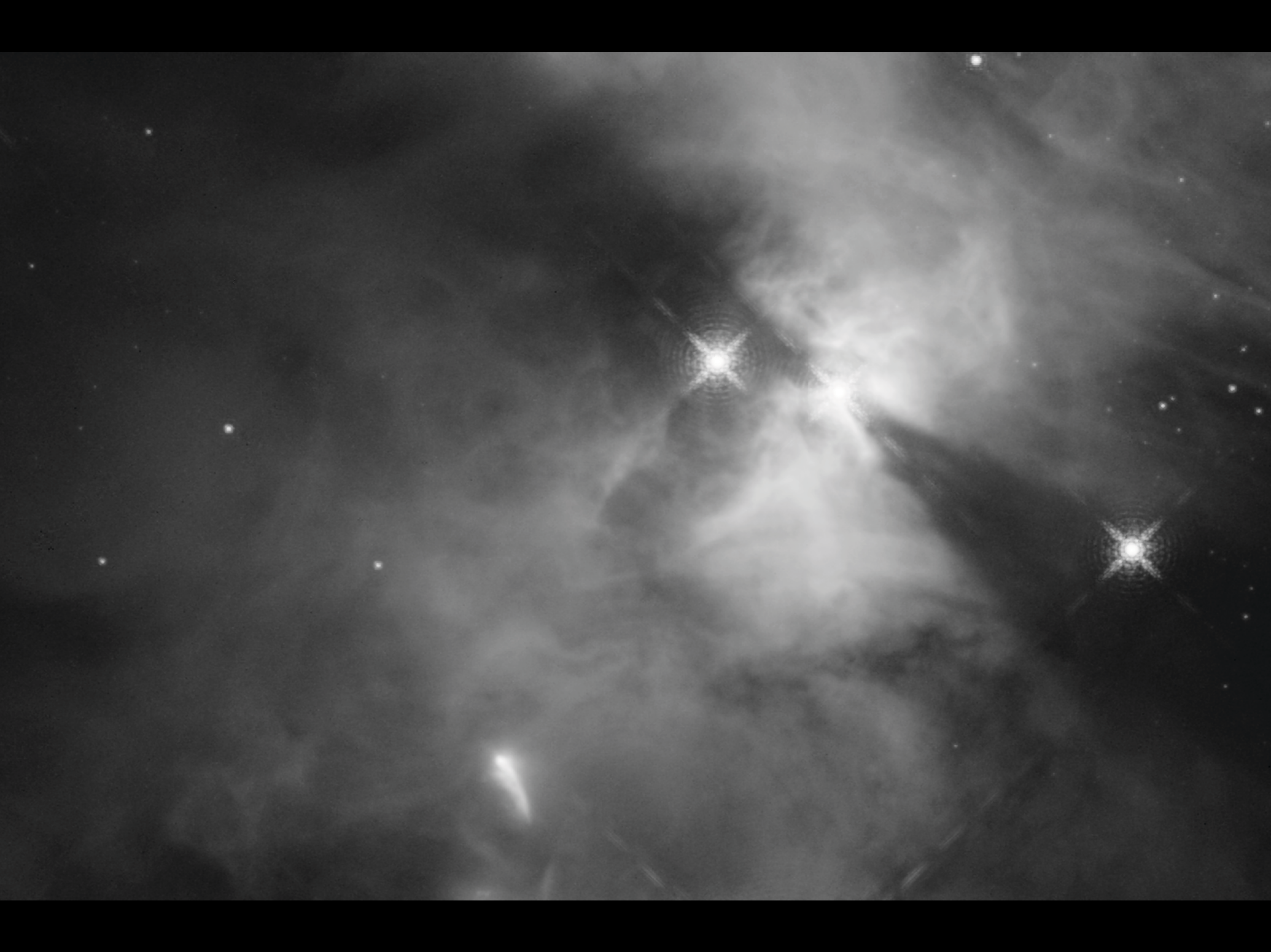


# The BAT SHADOW !!



HBC 672 in Serpens Nebula

NASA, ESA, and K. Pontoppidan (STScI)



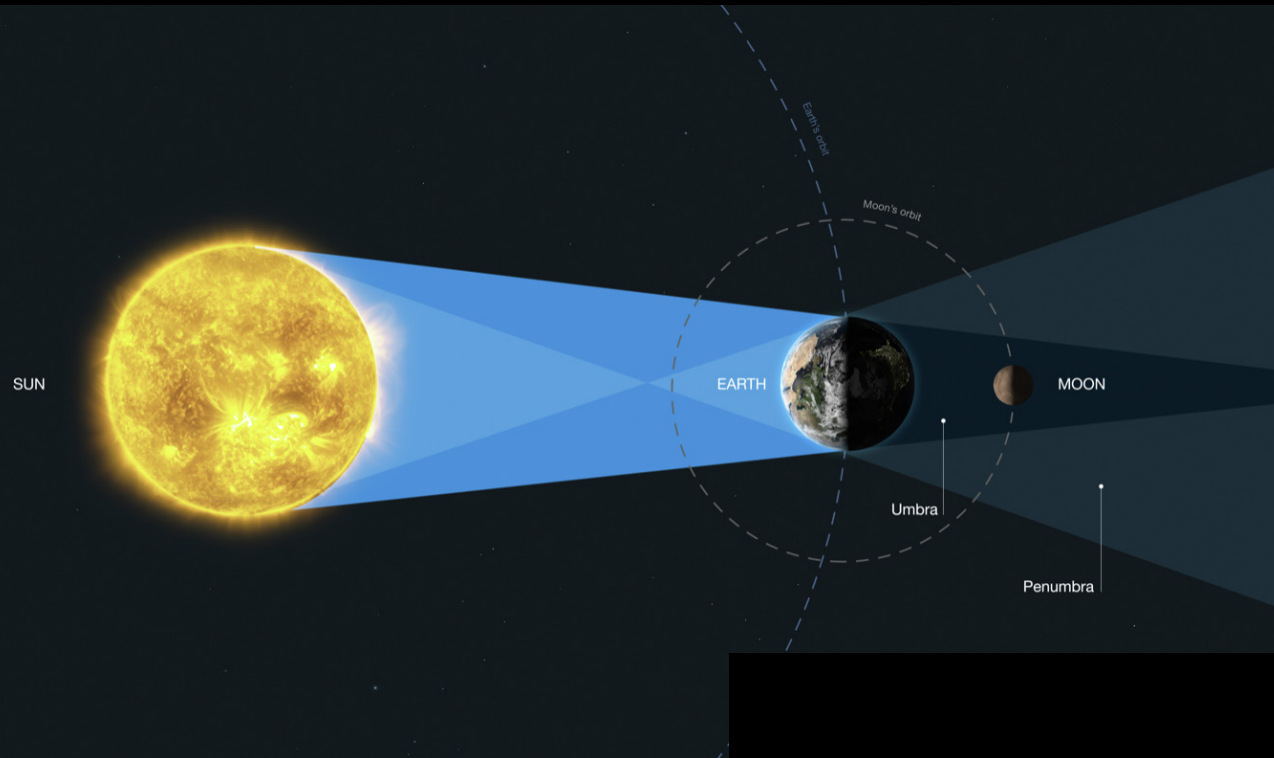


# Hubble Observes the Moon During Lunar Eclipse!

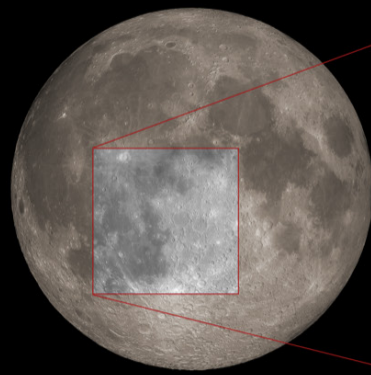




# HUBBLE USES EARTH AS A PROXY FOR IDENTIFYING OXYGEN (OZONE) ON POTENTIALLY HABITABLE PLANETS AROUND OTHER STARS



Credits: A. Youngblood, NASA, ESA  
M. Kornmesser (graphics)





# Agenda

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- **Science highlights**
  - **Cycle 28 HST Proposal Review:** First HST full proposal review to be conducted entirely virtually, requiring complex orchestration by STScI of dozens of panelists reviewing over 1000 submitted proposals. Of note -- 33% of accepted proposal PIs are 1st time PIs, a significant positive boost (likely due to the recently incorporated dual-anonymous proposal review process).
- **Project News/COVID-19 Impacts**
- **Observatory Status**
- **Budget Status**



# Project News/COVID-19 Impacts

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- **Hubble team was recognized by the National Air and Space Museum to receive the 2020 Collins Trophy for Current Achievement**
  - Originally planned for March 2020, now planned for March 2021
- **Science operations at STScI have been performed remotely since mid-March**
- **Mission operations at GSFC have been performed remotely to the maximum extent possible since mid-March**
  - Routine operations onsite support is limited to 2-3 people on a single Friday shift
  - Special commanding that can wait, is planned for the Friday shift
  - Anomaly response scenarios have been reviewed to minimize onsite presence
  - Science Instrument Control Unit/Science Data Formatter lockup on August 12, routine recovery completed in ~21 hours
  - Flight Operations Team members have responded numerous times to address changes in the gyro bias that have impacted science operations



# Observatory Status

9/30/2020

Subsystem		Summary
Science Instruments (SI)	G	<ul style="list-style-type: none"> <li>ACS monthly anneal process updated October 2019 to no longer cycle the Main Electronics Box</li> <li>WFC3 performance is excellent; Channel Select Mechanism movements minimized without science impact; 7 dust particles on the optic in 2018, one in 2019; new particulate observed July 17, 2020; no impact to science</li> <li>COS               <ul style="list-style-type: none"> <li>4<sup>th</sup> lifetime position began 10/2017 using COS 2025 initiatives; FUV High Voltage increased on October 5, 2020 for 3 segments and LPs; Plan to begin use of 5<sup>th</sup> position beginning October 2021</li> <li>FUV detector sensitivity loss continues as expected; Sensitivity ARB closure 4/2011</li> </ul> </li> <li>ACS and STIS repaired instruments (SM4) performing nominally</li> <li>NICMOS in standby following decision to not restart following Cycle 19 proposal evaluations</li> </ul>
Electrical Power System	G	<ul style="list-style-type: none"> <li>Excellent battery performance; 510 Amp hour benchmark; Solar Array 3 performance remains excellent</li> <li>Solar Array Drive Electronics (SADE) investigation following 2/15/13 SWSP completed; no further actions</li> </ul>
Pointing Control System	G	<ul style="list-style-type: none"> <li>3-gyro mode using 3-4-6 gyro complement; <u>gyro 4 exceeded 110,000 hours on September 19, 2020</u></li> <li>Gyro 6 motor current: ~120 mA to ~180mA on 3/21/2019; <u>~183 mA to ~203 mA on 6/19/2020</u></li> <li>Gyro 3 powered on 10/6/2018 – anomalous rates reduced to normal 10/19/2018; noisy bias trends</li> <li>Gyro 2 failed on 10/5/2018</li> <li>Gyro 1 failed on 4/21/2018; Gyro 6 powered on 4/21/2018</li> <li>Gyro 5 failed on 3/7/2014; Gyros 1&amp;2 powered on; Gyro 6 powered off 3/13/2014</li> <li>Attitude Observer Anomaly (AOA) (ARB report 10/2011) mitigation completed 11/2012</li> <li>Due to AOA, Gyro 3 removed from control loop/powered off and Gyro 6 powered on (2011)</li> <li>FGS-3 bearings degraded (~10% duty cycle to preserve life); FGS-2R2 Clear Filter operations began 1/2015</li> </ul>
Data Management System	G	<ul style="list-style-type: none"> <li>SI Control and Data Handling (C&amp;DH) has had <u>16</u> lockup recoveries since 6/15/09; <u>most recent was 8/12/20</u></li> <li>Solid State Recorders (SSRs) 1&amp;3 each experienced lock up in 2011 in the South Atlantic Anomaly (SAA); SSR3 experienced another lockup in SAA on 1/9/18; Alert monitors detect condition to minimize data loss</li> </ul>
Communications	G	<ul style="list-style-type: none"> <li>Multiple Access Transponder 2 (MAT2) coherent mode failed (12/24/2011); Two-way tracking unavailable</li> <li>Combined Space Operations Center (CSpOC) now the source for the operational ephemeris via Conjunction Avoidance Risk Assessment (CARA) team and the Flight Dynamics Facility</li> </ul>
Thermal Protection System	G	<ul style="list-style-type: none"> <li>New Outer Blanket Layers (NOBLs) installed on Bays 5,7, and 8 during SM4</li> <li>Thermal performance is nominal</li> </ul>



# Mission Operations – Gyro Run Time Performance

9/30/2020

**Current Gyro Runtimes**

Post SM4 RGA	Status	Flex Lead	Total Hours 2020/274 (9/30/2020)
G1	Failed April 2018	Standard	43,359
G2	Failed October 2018	Standard	47,550
G3	On	Enhanced	39,775
G4	On	Enhanced	110,273
G5	Failed March 2014	Standard	51,497
G6	On	Enhanced	57,387

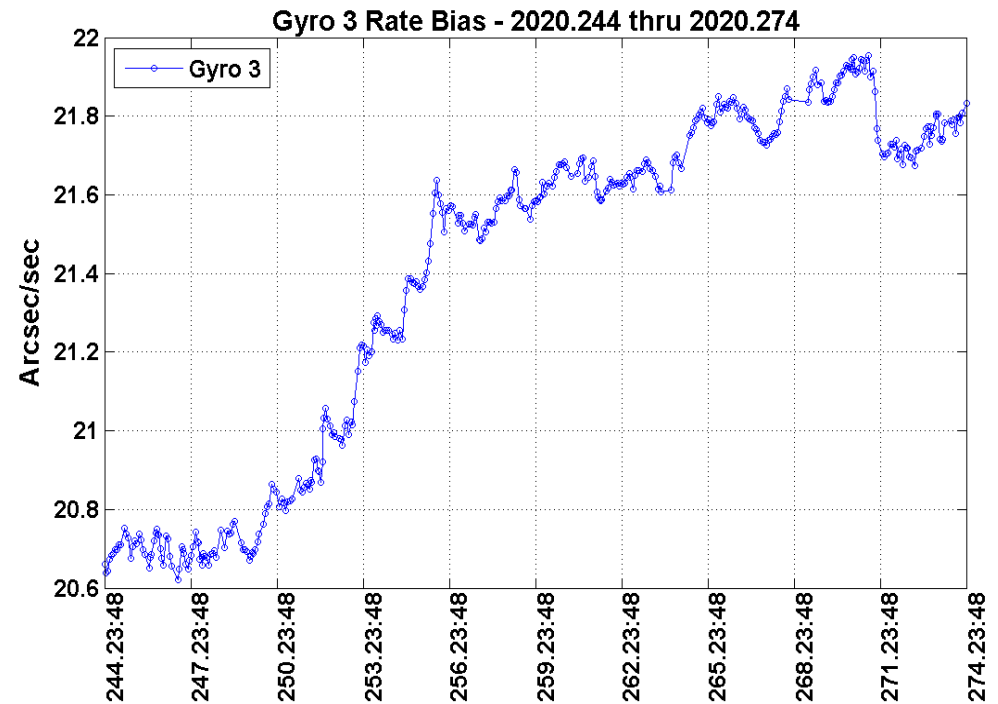
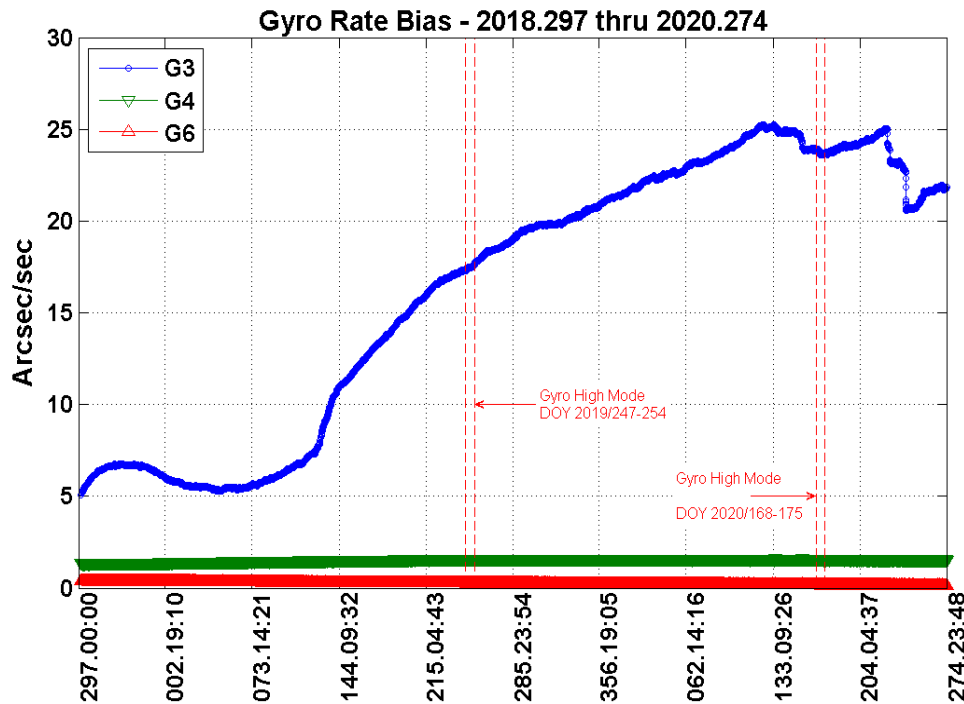
**Previous Flex Lead Failure Runtimes**

Date of Failure	Gyro	Flex Lead	Total hours at failure
1992.281	G6	Standard	34825
1997.099	G4	Standard	31525
1998.295	G6	Standard	46276
1999.110	G3	Standard	51252
1999.317	G1	Standard	38470
2007.243	G2	Standard	58039
2014.066	G5	Standard	51497
2018.111	G1	Standard	43359

G4 (Enhanced Flex Lead) – Highest runtime hours on program	110,273
Mean runtime hours for the 3 operating Enhanced Flex Lead gyros	69,145
Second highest hours (Standard Flex Lead G1 from SM3A)	60,444
G6 (Enhanced Flex Lead) – currently 4 <sup>th</sup> highest hours	57,387
Mean runtime hours for all 22 HST gyros	45,989
Mean runtime hours for the 8 HST Standard Flex Lead failure gyros	44,405
Mean runtime hours for 19 Standard Flex Lead gyros	42,332
G3 (Enhanced Flex Lead) – currently 15 <sup>th</sup> highest hours	39,775

# Gyro-3 Bias Trend

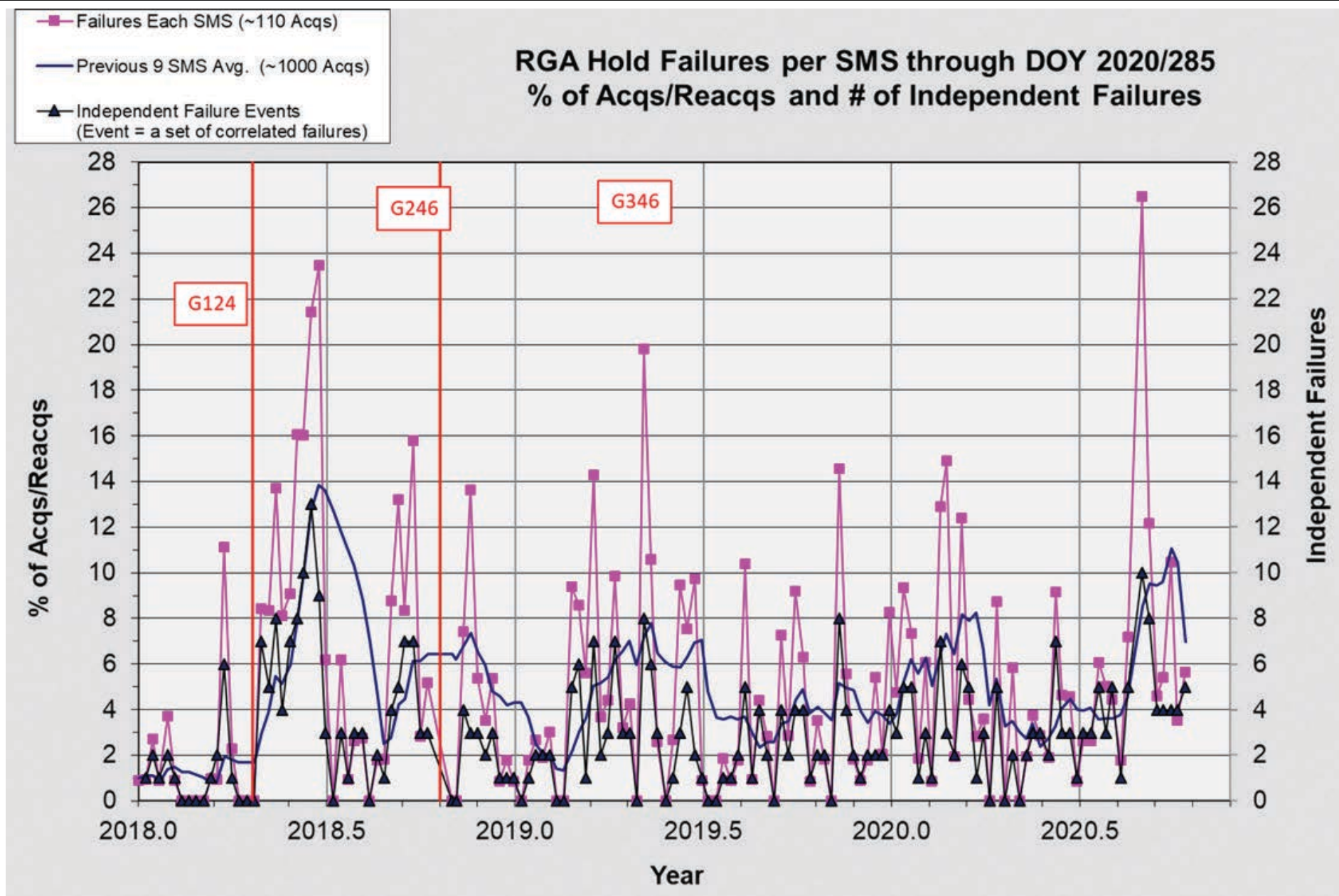
9/30/20



- Gyro 3 bias (drift-rate) was ~5 arcsec/sec after recovery in October 2018; peaked at ~25.2 arcsec/sec in May and August, followed by “large” downward steps
- Operations teams working to mitigate effects of bias noise
- Hybrid control mode that uses the 3-gyro controller for maneuvers between observations, and the Fine Guidance Sensors and 1 gyro controller to perform observations was installed and successfully demonstrated on orbit June 16-23
  - Some gyro bias calculation enhancements will be available in February



# Target Acquisition Performance Trending



# Budget Status

- **Budget Outlook - New Obligation Authority (NOA)**

\$M	FY20	FY21	FY22	FY23	FY24	FY25	FY26
Current Guidance	\$90.8	\$88.3	\$98.3	\$98.3	\$98.3	\$98.3	\$98.3

- Using uncosted carryover to augment FY20-21 NOA to maintain “flat” spending
  - Issued a Request for Proposal to AURA/STScI for science operations contract for the period of July 1, 2021 – June 30, 2026; expect proposal in January
  - Working with HQ to obtain inflation adjustments to augment flat budget projection
- **General Observer / Archival Research Outlook**
    - Cycle 24 was ~\$31.6M and Cycle 25-26 averaged was \$33.9M
    - Cycle 27 Cycle Value was ~\$30M despite ~20% fewer orbits awarded
    - Cycle 28 Cycle Value expected to be ~\$31M; similar number of orbits as Cycle 27
    - Current budget, without inflation adjustments, will be challenged to maintain \$30M cycle values as we progress through the horizon