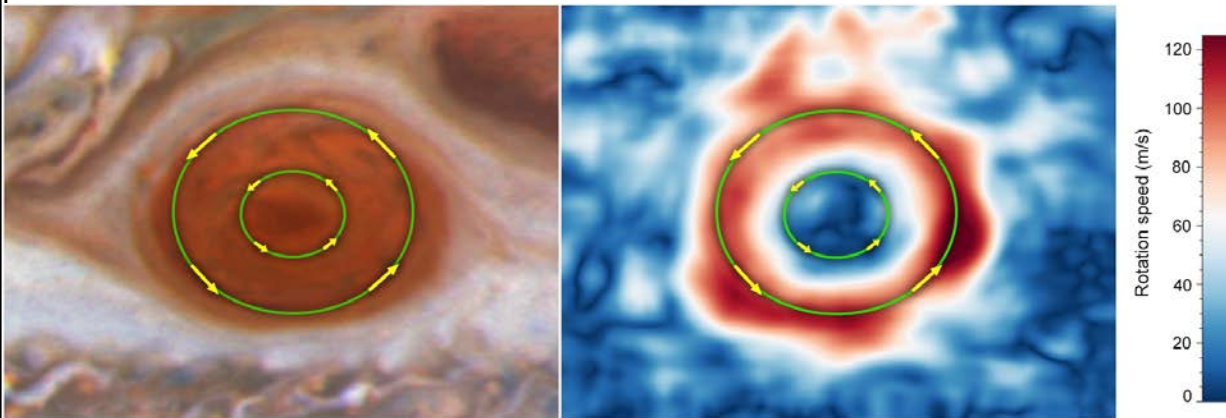




HST/GSFC Project Report



Hubble released a [new finding](#) based on the long time baseline of Hubble observations of Jupiter that indicate the outer winds in the Great Red Spot are speeding up! The analysis, enabled by Hubble's OPAL (Outer Planet Atmospheres Legacy), is led by Michael Wong of U.C. Berkeley, with co-investigator Amy Simon of GSFC. By analyzing images taken by NASA's Hubble Space Telescope from 2009 to 2020, the researchers found that the average wind speed just within the boundaries of the Great Red Spot, set off by the outer green circle, have increased by up to 8 percent from 2009 to 2020 and exceed 400 miles per hour. In contrast, the winds near the storm's innermost region, set off by a smaller green ring, are moving significantly more slowly.

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**Space Telescope
Users Committee
Meeting
October 7, 2021**

Agenda

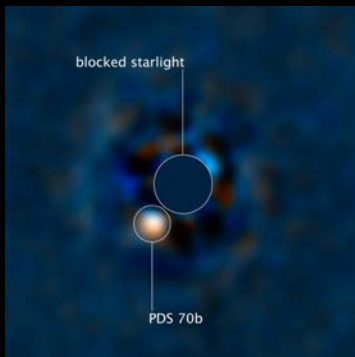
- **Science Highlights**
- **2022 Senior Review**
- **Recent Events**
- **Observatory Status**
- **Contract Status/Budget**

Hubble's Stunning Science Discoveries Continue...



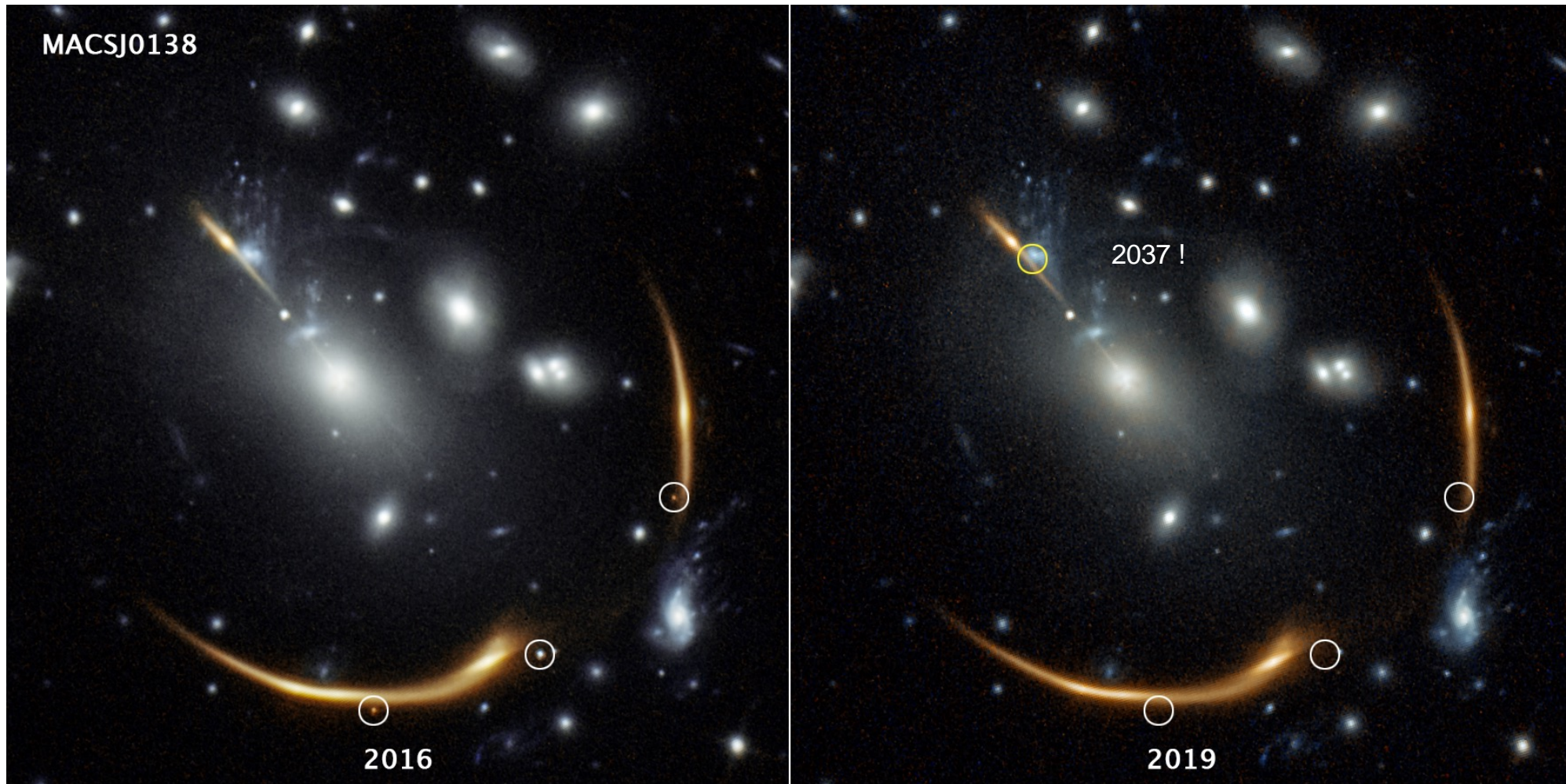
Mystery of missing dark matter deepens: The diffuse galaxy NGC 1052-DF2 has been claimed to have much less dark matter than other galaxies, but this claim depends on the distance to the galaxy being known. HST observations of red giant stars in the galaxy resulted in a larger determined distance than previously thought, which makes the claim of little dark matter in this ghostly galaxy even stronger. The science team is led by Pieter van Dokkum (Yale).

“Hubble Finds First Evidence of Water Vapor at Jupiter’s Moon Ganymede” is one of the biggest science news story of the year for Hubble, garnering a staggering 815 million impressions in 146 articles. The release describes comparisons of new and archival ultraviolet imaging and spectroscopic datasets. The water vapor forms when ice from the moon’s surface sublimates. The lead researcher is Lorenz Roth (KTH Institute of Technology, Sweden).



On April 29, a press release, “Hubble Watches How a Giant Planet Grows,” described Hubble ultraviolet observations of a Jupiter-sized, still-forming planet that is feeding off material surrounding a young star. This is the first time an exoplanet has been directly imaged in the UV. The science team is led by Yifan Zhou (U. Arizona).

Supernova predicted to re-appear in 2037!



Steve A. Rodney (University of South Carolina), Gabriel Brammer (Cosmic Dawn Center/Niels Bohr Institute/University of Copenhagen)
IMAGE PROCESSING: Joseph DePasquale (STScI)

Senior Review 2021

Call for Proposals released October 1st, 2021

“These reviews of operating missions are NASA’s highest form of peer review, as the subject is not a single science investigation, or even a single space mission, but rather a portfolio of operating missions. The reviews of operating missions are referred to as Senior Reviews, in recognition of the high level of the peer review.”

“The NASA Astrophysics Division (APD) will host its next Senior Review (SR) of operating missions in 2022. The Senior Review assesses proposals for funding, usually involving additional resources in upcoming years, to continue operations of missions in the extended operations phase. The purpose of the review is to assist NASA in maximizing the scientific productivity and operating efficiency of the Astrophysics Division mission portfolio within the available funding. NASA will use the findings from the Senior Review to:

- Prioritize the operating missions and projects;
- Define an implementation approach to achieve astrophysics strategic objectives;
- Provide programmatic direction to the missions and projects concerned for FY23, FY24 and FY25; and
- Issue initial funding guidelines for FY26 and FY27 (to be revisited in the 2025 Senior Review).

NASA actions resulting from the Senior Review could include authorizing a mission to pass from its prime phase to extended phase; maintaining the status quo; significantly restructuring the project; or terminating an ongoing science mission.”

Recent Events

- **Science Instrument Control and Data Handler (SI C&DH2) Anomaly**
 - June 13 anomaly caused NASA Standard Spacecraft Computer I to transition to fixed format; recovery to normal mode on June 14 lasted ~35 minutes
 - Recovery attempts through June 24 exhausted Side B redundant paths
 - Following extensive planning, testing, and management briefings, the Side A switch was executed on July 15
 - Similar Side B switch was performed in 2008 following the Side A Science Data Formatter on the original SI C&DH unit that was replaced in SM-4
 - Science instruments were recovered on July 16 and normal science operations was restored
 - Investigating feasibility/operational approach and concessions for enabling science capability if a return to Side B becomes necessary
 - Initial feasibility assessments/tests performed
 - Operations concept and test plan development in early stages

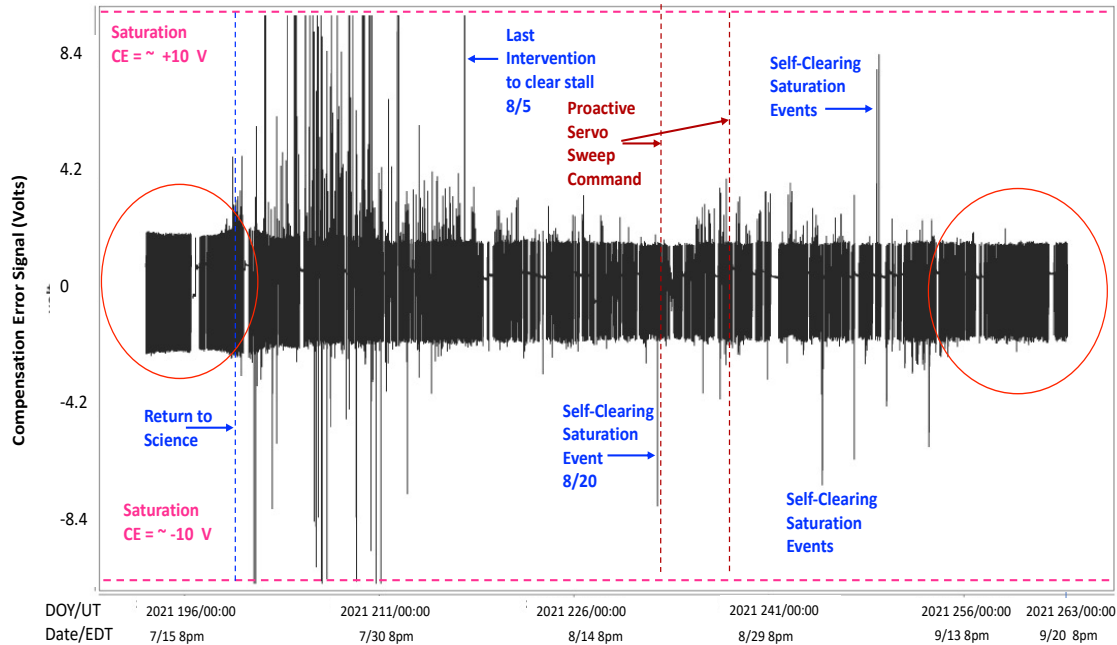
Recent Events

8/31/2021

- **Fine Guidance Sensor-2R2 (FGS2R2) Star Selector Servo B Stalls**
 - Following recovery from the SI C&DH anomaly, FGS acquisition failures began 7/20/21
 - During the science “down time” 6/13-7/17, FGS acquisitions were performed to manage the Gyro-3 bias
 - A single guide star pair was used June 21-July 4
 - A second guide star pair was used July 5-July 15
 - Both pairs were positioned at nearly the same location in the FGS2R2 Field of View
 - Tiger Team concluded that the stalls are likely due to lubrication/debris on ball bearing or toroid preventing small motion slews as indicated by the Compensation Error saturating
 - Ground procedure to command clearing slew has been successfully used and other mitigation steps were implemented, including making FGS 2 the primary sensor to avoid the small motions associated with the secondary sensor
 - Last ground intervention on August 5 and last self-clearing stall occurred September 6
 - The FGS2R2 Compensation Error signal has returned to pre-anomaly performance
 - FGS 1 Compensation Error, while within nominal range, has trended up while designated as the secondary sensor
 - Primary and secondary designations to return to normal scheduling approach to balance the duty cycle again between FGS 1 and FGS 2

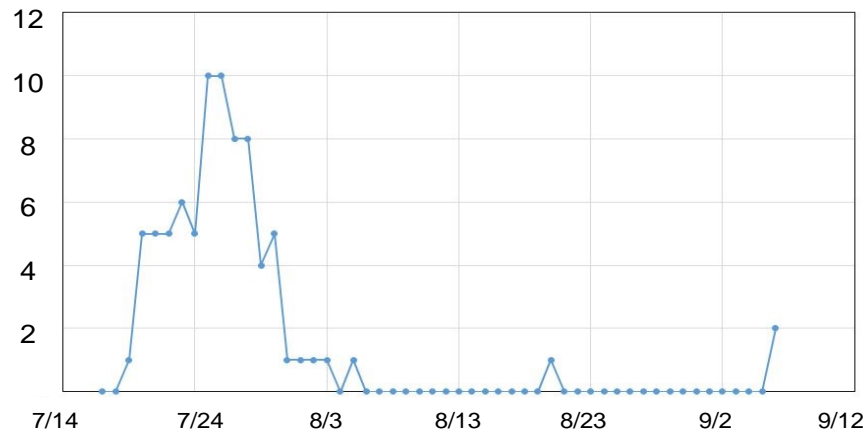
Recent Events

FGS2R2 Servo-B CE (Volts) vs time through 9/6/21 - Each point is 10-second average



Recent FGS2R2 Servo Events

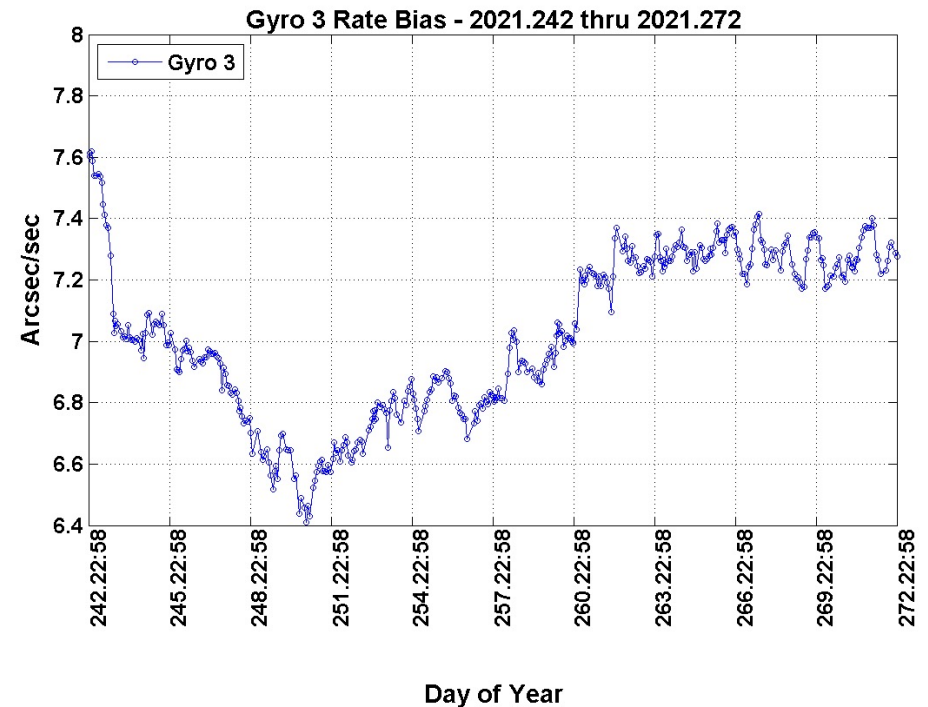
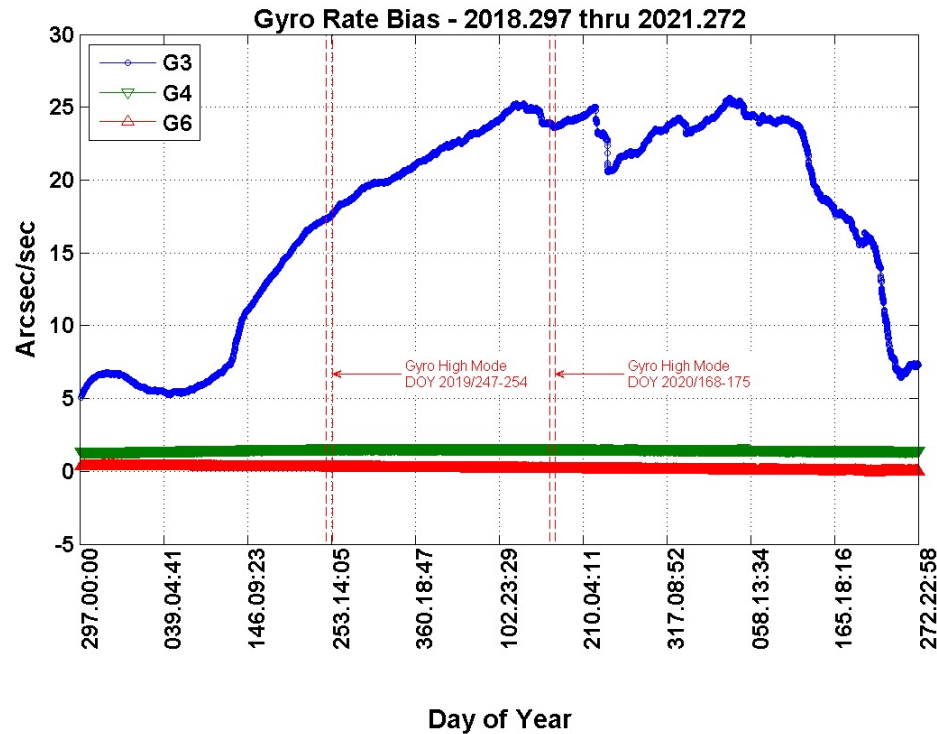
Date	DOY, UT	Event
8/5	217/14:36	Last intervention to clear stall
8/20	232/09:51	Self-clearing stall
8/20	232/13:45	Proactive Servo Exercise
8/26	238/17:35	Proactive Servo Exercise
8/26	238/19:25	Proactive Servo Exercise
9/6	249/07:09	Self-clearing stall
9/6	249/11:56	Self-clearing stall



Total Number of FGS2R2 Servo-B Stalls that last for 2 or more 40 Hz samples

Recent Events

9/30/2021



- **Gyro-3 Performance**

- Following period of rapid decline in August, the Gyro-3 rate bias has been relatively flat recently
- Real-time commanding is required to uplink ground-determined gyro rate biases when the bias changes too rapidly for successful guide star acquisition and autonomous updates to occur
- Manual updates were required many times in the month of August, but were not required the last two weeks of September
- Assessing the effort/schedule to implement the ground-based solution onboard

Mission Operations – Gyro Run Time Performance

9/30/2021

Current Gyro Runtimes

Post SM4 RGA	Status	Flex Lead	Total Hours 2021/273 (9/30/2021)
G1	Failed April 2018	Standard	43,359
G2	Failed October 2018	Standard	47,550
G3	On	Enhanced	48,535
G4	On	Enhanced	119,033
G5	Failed March 2014	Standard	51,497
G6	On	Enhanced	66,147

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 119,033

Mean runtime hours for the 3 Enhanced Flex Lead gyros 77,905

G6 (Enhanced Flex Lead) – 2nd highest hours 66,147

Third highest hours (Standard Flex Lead G1 from SM3A) 60,444

G3 (Enhanced Flex Lead) – 9th highest hours 48,535

Mean runtime hours for all 22 HST gyros 47,183

Mean runtime hours for the 8 HST Standard Flex Lead failure gyros 44,405

HST Observatory Status

9/30/2021

Subsystem		Summary
Science Instruments (SI)	G	<ul style="list-style-type: none"> WFC3 performance is excellent; Channel Select Mechanism movements minimized without science impact; 7 dust particles on the optic in 2018, one in 2019; one in 2020; no impact to science COS <ul style="list-style-type: none"> 4th lifetime position began October 2017 using COS 2025 initiatives FUV High Voltage increased on October 5, 2020, for 3 segments and 3 lifetime positions; <u>5th lifetime position began on October 2021; 6th position to be available beginning October 2022.</u> FUV detector sensitivity loss continues as expected; Sensitivity ARB closure 4/2011 <u>COS suspended on 9/26/21 due to a Single Event Upset (SEU) while in the SAA, first time since 2014</u> ACS monthly anneal process updated October 2019 to no longer cycle the Main Electronics Box ACS and STIS repaired instruments (SM4) performing nominally NICMOS in standby following decision to not restart following Cycle 19 proposal evaluations
Electrical Power System	G	<ul style="list-style-type: none"> Excellent battery performance; 510 Amp hour benchmark; Solar Array 3 performance remains excellent Solar Array Drive Electronics (SADE) investigation following 2/15/13 SWSP completed; no further actions
Pointing Control System	G	<ul style="list-style-type: none"> 3-gyro mode using 3-4-6 gyro complement Gyro 4 exceeded 110,000 hours on 9/19/2020; Gyro 6 became 2nd longest running on 2/5/2021 Gyro 6 motor current: ~120 to ~180mA on 3/21/2019; ~183 to ~203mA on 6/19/2020; ~210mA on 12/13/2020 Gyro 3 powered on 10/6/2018 – anomalous rates reduced to normal 10/19/2018; noisy bias trends Gyro 2 failed on 10/5/2018; Gyro 1 failed on 4/21/2018; Gyro 6 powered on 4/21/2018 Gyro 5 failed on 3/7/2014; Gyros 1&2 powered on; Gyro 6 powered off 3/13/2014 Due to Attitude Observer Anomaly, Gyro 3 powered off and Gyro 6 powered on in 2011 FGS-3 bearings degraded (~10% duty cycle to preserve life); FGS-2R2 Clear Filter operations began 1/2015
Data Management System	G	<ul style="list-style-type: none"> SI Control and Data Handling (C&DH) has had 16 lockup recoveries since 6/15/09; most recent was 8/12/20 <u>SI C&DH switched to Side A on July 15, 2021 restoring nominal performance after June 13 anomaly</u> Solid State Recorders (SSRs) 1&3 each experienced lock up in 2011 in the South Atlantic Anomaly (SAA); SSR3 experienced <u>3rd lockup in SAA on 9/3/21</u>, first since 1/9/18; Alerts detect condition to minimize data loss
Communications	G	<ul style="list-style-type: none"> Multiple Access Transponder 2 (MAT2) coherent mode failed (12/24/2011); Two-way tracking unavailable Combined Space Operations Center (CSpOC) now the source for the operational ephemeris via Conjunction Avoidance Risk Assessment (CARA) team and the Flight Dynamics Facility
Thermal Protection System	G	<ul style="list-style-type: none"> New Outer Blanket Layers (NOBLs) installed on Bays 5,7, and 8 during SM4 Thermal performance is nominal

Contract/Budget Status

- **Contract award expected this month. Goddard procurement has issued contract extensions as necessary to ensure no loss of service.**
- **PPBE-23 budget process**
 - **Outyear budget guidance was flat FY22-26**
 - **Highlighted productivity impacts without an inflation adjustment**
 - **Guideline remains flat to be addressed by 2022 Senior Review**
- **2022 Senior Review**
 - **Final call for proposals released October 1, 2021**
 - **Proposal due Feb 1, 2022**
 - **Will result in firm budget guidance for FY23-25, notional for FY26-27**
- **Budget Outlook (New Obligation Authority (NOA) - \$M)**

FY21	FY22	FY23	FY24	FY25	FY26	FY27
\$93.3	\$98.3	\$98.3	\$98.3	\$98.3	\$98.3	\$98.3