



STScI | SPACE TELESCOPE
SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

HST Mission Office Report

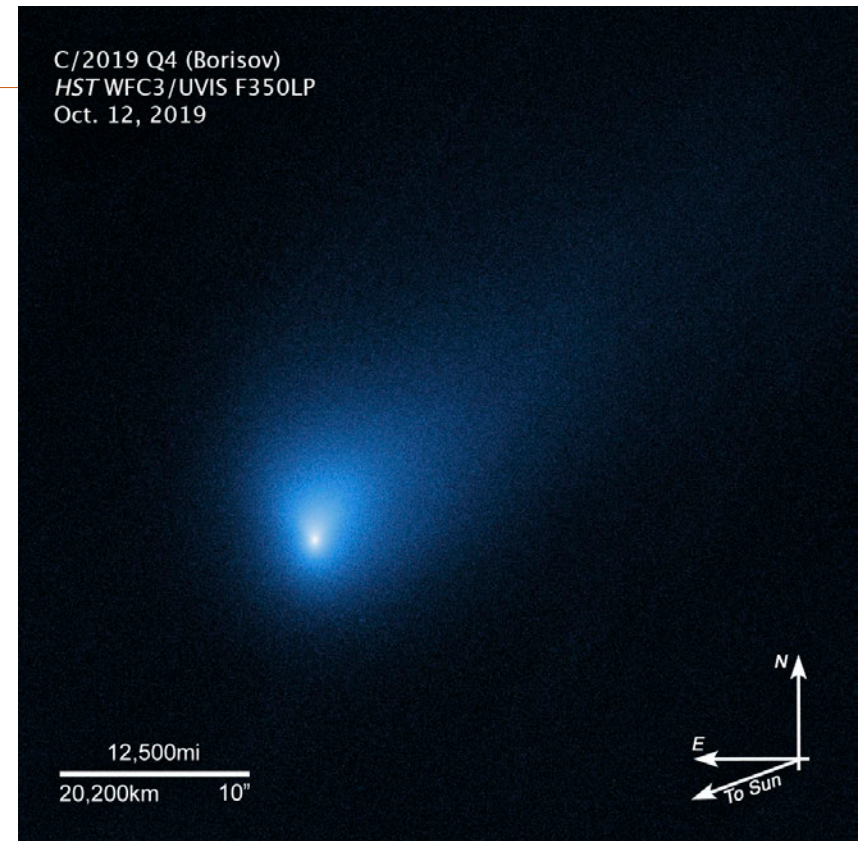
Tom Brown

STUC – 12 Nov 2019



Summary

- Hubble demand & productivity remain near all-time highs
- Positive HST Senior Review report in July
- Cycle 27 underway
- Time-constrained programs continue to be an exciting challenge
- ULLYSES program in implementation (see Julia Roman-Duval's presentation)
- Instruments performing nominally (see INS presentations)
- Working to mitigate acquisition problems (see HSTP/GSFC presentation)



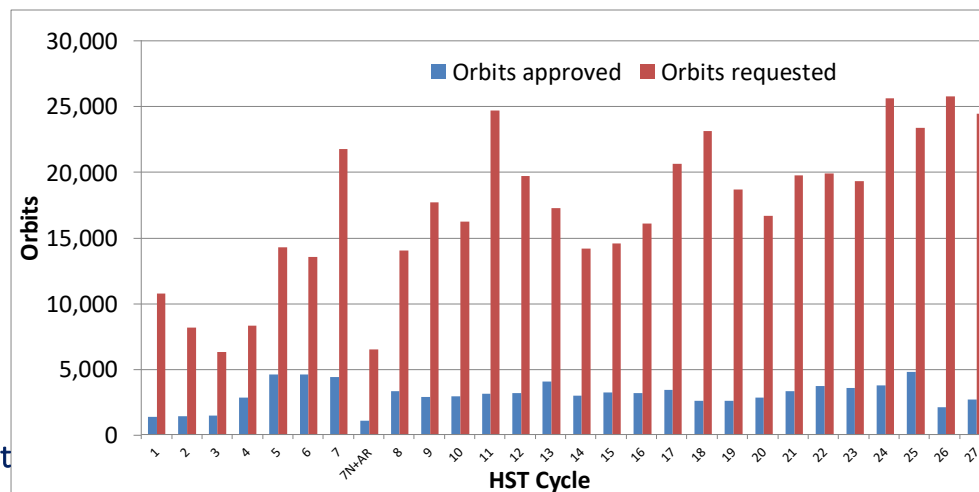
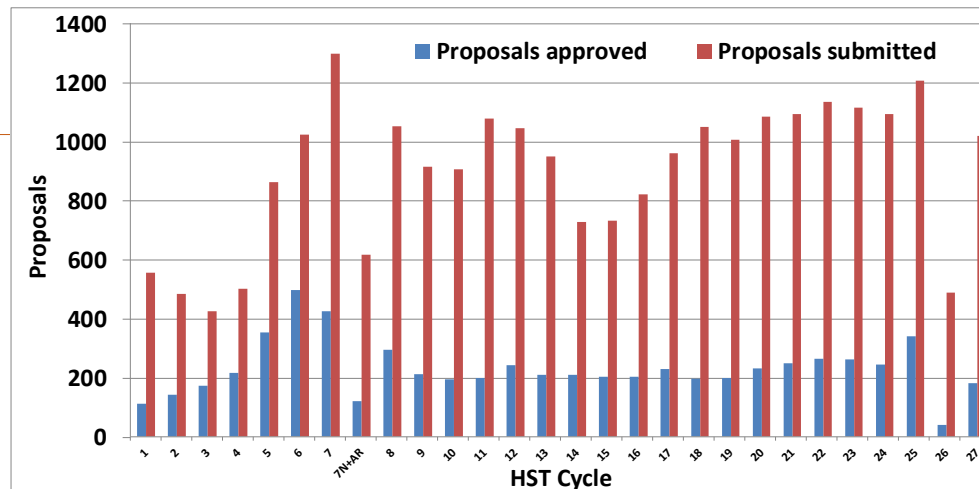
Hubble Observes First Confirmed Interstellar Comet



Hubble Cycle 27 Underway

Cycle 27 formally started on October 1

- First “normal” cycle after Cycles 25 & 26
 - Cycle 25 pre-allocated small programs
 - Cycle 26 medium and large programs only
- First dual-anonymous process in normal cycle
 - Went smoothly & was appreciated by the TAC
- Notifications went to observers June 27
- Planning windows went to observers on Aug 30
- Grant awards went out on Nov 6
- Cycle 27 allocated fewer orbits (2700) than usual
 - Higher failure rate due to gyro problems
 - Overallocation for special programs (e.g., Europa)
 - ULLYSES DD program on star formation
 - Cycle 28 will also allocate a reduced number of orbits
- Three cloud computing proposals accepted
- Time-constrained (e.g., exoplanets) & time-critical (e.g., gravitational wave) programs continue to present a scheduling challenge





2019 Astrophysics Senior Review

- Report received on July 16
 - Hubble & Chandra in “Tier 1”
 - Scores:
 - ▶ Science Merit
Excellent
 - ▶ Relevance & Responsiveness
Excellent / Very Good
 - ▶ Technical Capability & Cost Reasonableness
Excellent / Very Good
 - ▶ Overall
Excellent / Very Good
- Senior Review Subcommittee Report – Executive Summary:
“Hubble remains the most famous telescope in the world, an icon of American scientific achievement. Its exquisite image quality & its UV imaging and spectroscopic sensitivity are unique; the UV sensitivity will not be equaled for at least the next 15 years. The 900+ peer-reviewed papers a year arising from Hubble data span the full range of astronomy & astrophysics, from Europa’s water plumes to the primeval galaxies of cosmic dawn.”





2019 Astrophysics Senior Review

Hubble Report Executive Summary:

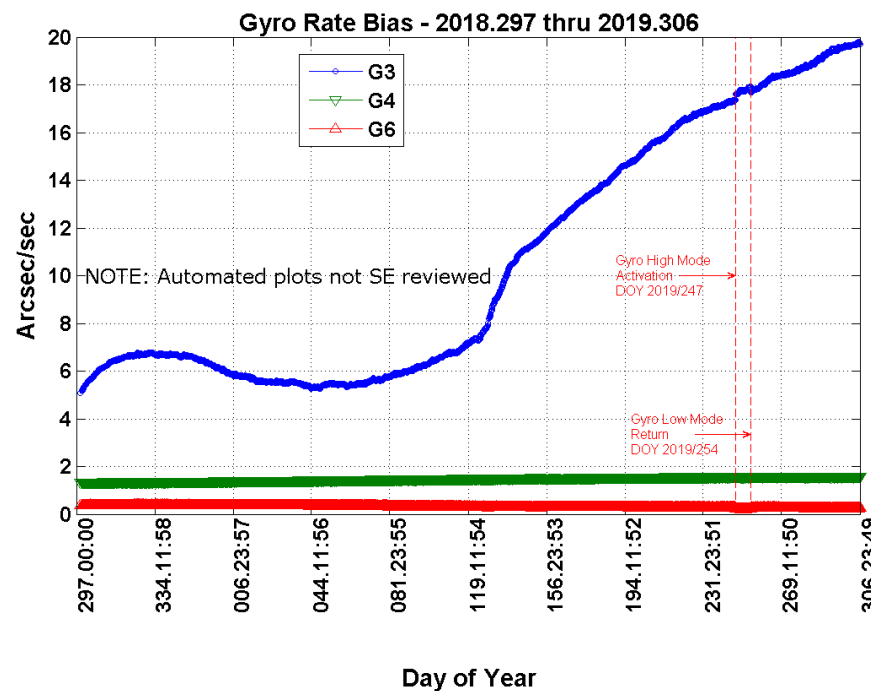
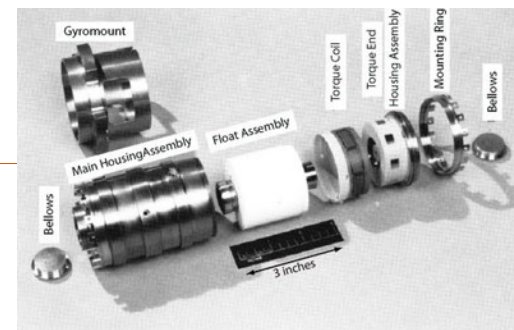
- “High publication & citation rates attest to the fact that Hubble data, thanks in large part to the level of observatory & instrument support provided by the Space Telescope Science Institute, is extremely valuable for answering the key science questions driving astrophysics today. Hubble enables a truly astonishing range of science & the Project continues to be responsive to the changing scientific landscape. The dual-anonymous reviews is a prime example of the Project’s forward-thinking leadership status in the astronomy & broader scientific community.”
- “The Project has made very good progress against the 2016 scientific & technical primary mission objectives.”
- “The Project has taken a proactive stance on mitigating the likely failure modes and degradation.”
- Concerns:
 - Insufficient information to fully assess resource allocation
 - Migration and distribution of data analysis software
 - GO funding levels
 - Long-term support for archive access





Hubble gyros are in good shape

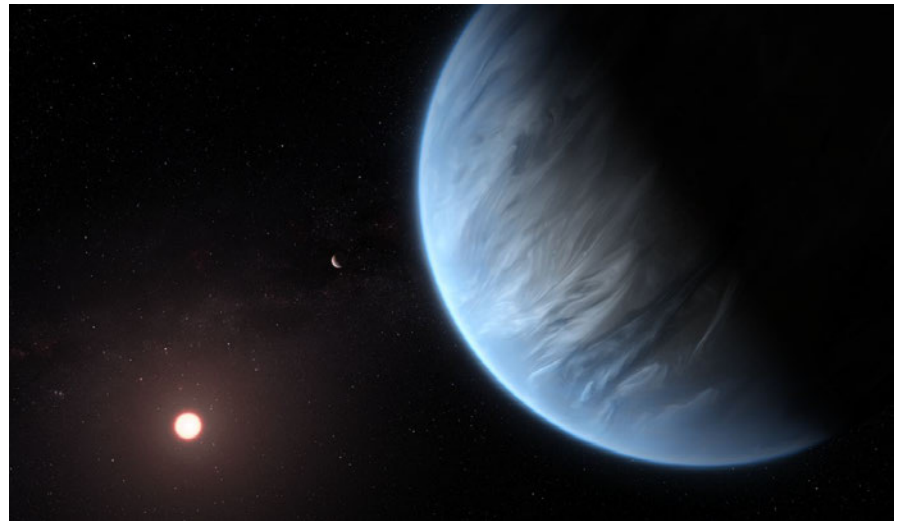
- Configuration since Oct 2018:
Gyro-3 / Gyro-4 / Gyro-6
All have enhanced flex leads
- When Gyro-3 was powered on, it exhibited high rate bias making it unusable for science
- Gyro-3 was eventually brought within science operational range, but the rate bias has been drifting higher, and is expected to fall outside of normal operational range soon
- Staff at GSFC & STScI have developed a new capability to stay in 3-gyro mode with good performance even after the Gyro-3 bias drifts out of normal operating range. Utilizes “high mode” dynamic range used for slewing. Deployed for one week in early September, now in low mode during development to improve high mode performance.
- We expect to remain in 3-gyro mode for at least several more years, and reduced gyro mode for many years beyond that
- More broadly, the instruments and observatory are performing well, with >80% reliability through 2026





Upcoming Events

- ULLYSES implementation team is active, expecting to start observations in the latter half of Cycle 27
- HST Cycle 28 deadlines shifting 1.5 months earlier to accommodate JWST Cycle 1
 - Call for Proposals 2 Dec 2019
 - Phase I deadline 6 Mar 2020
- Hawaii AAS special session on HST-JWST synergy
8 January 2020 10:00am-11:30am
“Maximizing the Science from Two Great Observatories”
- Work on the next Hubble contract will be starting in 2020, following the outcome and recommendations of the Senior Review
- Hubble 30th Anniversary 24 April 2020
 - Hubble images to be displayed at Dulles International Airport
 - Conference on HST and JWST science to be held in Stockholm at the end of March 2020
 - BBC hour-long special on HST



Hubble Finds Water Vapour on Habitable-Zone Exoplanet
for the First Time

Credits: Tsiaras et al. (UCL)
ESA



Long Range Plan: Current Status

Cycle 27 plan released on August 21

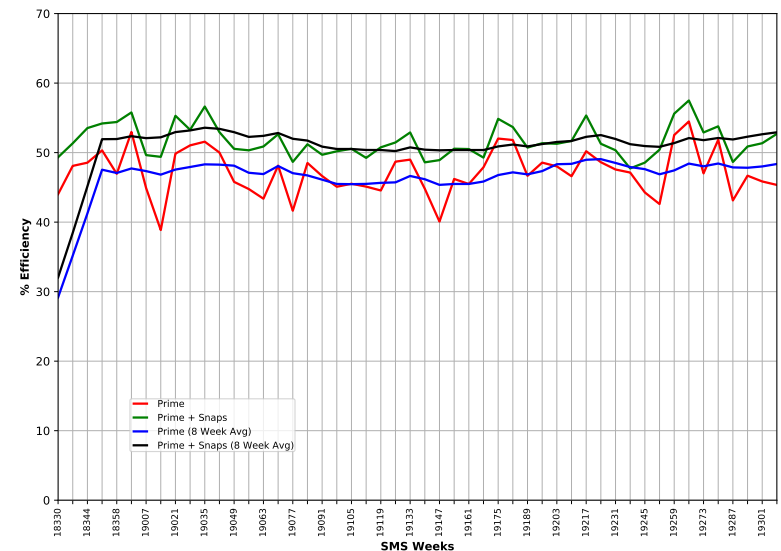
- 2686 orbits of GO science
- Does not include coordinated observations, up to 300 orbits of mid-cycle science, and ULLYSES
- At cycle start, 1300+ orbits of Cycle 25/26 remained in the “tail”

Cycle 26 averaged 79.7 orbits/week

- Without 3-week downtime in fall 2018 due to gyro failure, Cycle 26 was 84.6 orbits/week
- Cycle 17-23: 84 orbits/week
- Cycle 24: 82 orbits/week
- Cycle 25: 85 orbits/week
- **Cycle 27 to date: 84.7 over seven weeks**

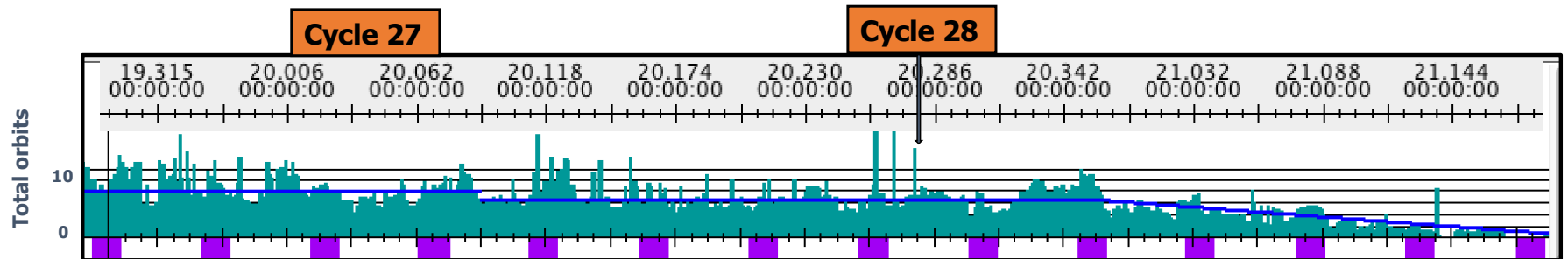
Previous Cycle Completeness

- Cycle 24: finished in early September 2019
- Cycle 25: ~150 orbits remain, with windows to May 2020
- Cycle 26: ~875 orbits remain, with windows to Sep 2020





Long Range Plan: Current Status



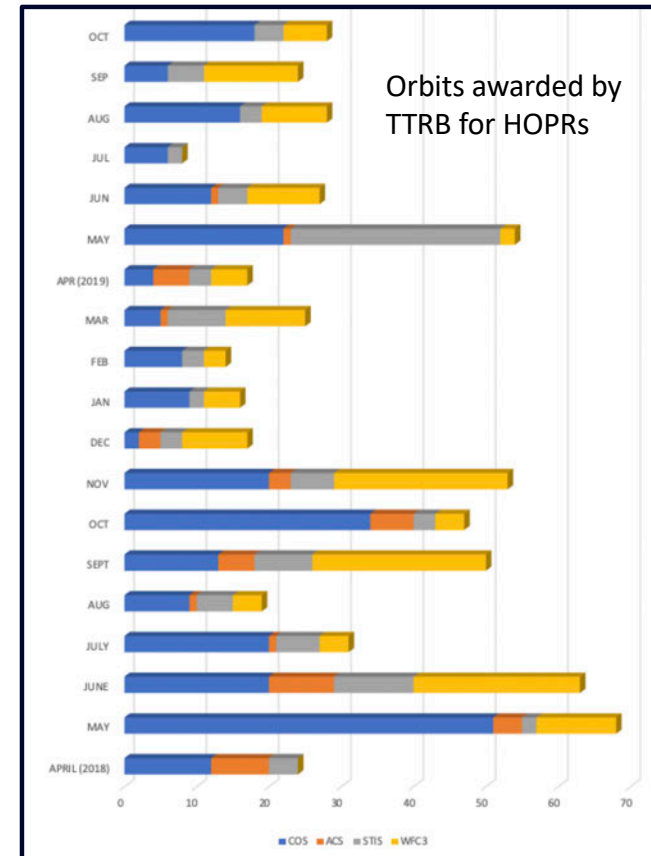
- **Tail of Cycle 25/26 material dominates the start of the Cycle 27 long range plan**
 - 1300+ orbits remained from those previous cycles as of October 1
 - Cycle 27 tail (post October-2020) will be similarly-sized (currently 1250 orbits)
 - Some Cycle 27 windows extend to October 2021
- **When Cycle 27 LRP was built, room was left for:**
 - Up to 300 orbits of mid-Cycles
 - 300+ orbits of ULLYSES (UV Legacy Library as Essential Standards)
 - Higher rate of HOPRs than in cycles past



LRP: Recent activity

Gyro issues continue to lead to higher rate of guide star acquisition failures

- **Switch to high mode in early September lasted a week**
 - Upon return to low mode, Gyro 3 has been noisier
 - REACQs have been running long, with many failures
 - COS particularly hard hit
 - In the past, failure rate was typically 1-2%
 - Recently, failure rate has been in the 6-8% range
- **Higher failure rate was taken into account when building the Cycle 27 LRP**
 - Leaves more room for repeats
 - “Urgent” repeats worked into flight schedules as possible
- **Re-Acquisition Pad recently increased by 90 seconds**
 - Went into effect on Nov 11 flight calendar

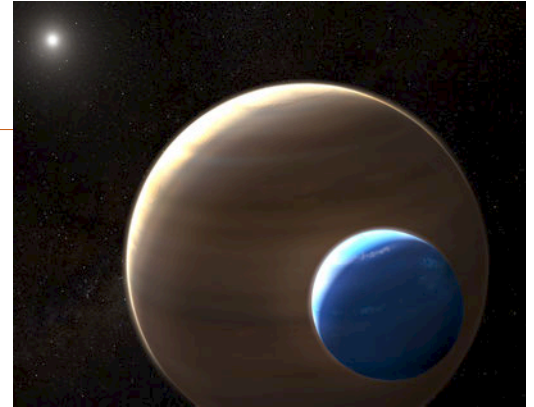




LRP: Statistics

Exoplanet Programs: Highlights

- **Sing** (Cycles 24/25 Large): 498 orbits; completed in August 2019.
 - **deWit** (Cycle 25 Large): 81 of 114 complete.
 - Remaining 33 orbits are awaiting “real” windows (<10 weeks in the future).
 - **Crossfield** (Cycle 25 Large): 81 of 127 complete.
 - 4 visits/19 orbits planned by end of the year; remaining 5/27 waiting for windows.
 - Other cycle 25 highlights:
 - 15-orbit 15246 **Parmentier** - failed in November 2018. Schedulable once a year; HOPR planned in Feb 2020.
 - Two other cycle 25 exoplanet programs still active.
 - **Mikal-Evans** (Cycle 27 medium): 60 orbits total. 30 consecutive 1-orbit visits in two sequences.
 - Others with 1-orbit visits that have to be sequenced in up to 10 straight orbits. Most planned in 2020/21.
-
- **337 orbits of C25/27 exoplanets with period/phase constraints remain in the plan.**
 - Due to ephemeris limits, only windows less than 70 days from current time are considered reliable.
 - Many currently have no windows.





LRP: Statistics



Planetary Programs: Highlights

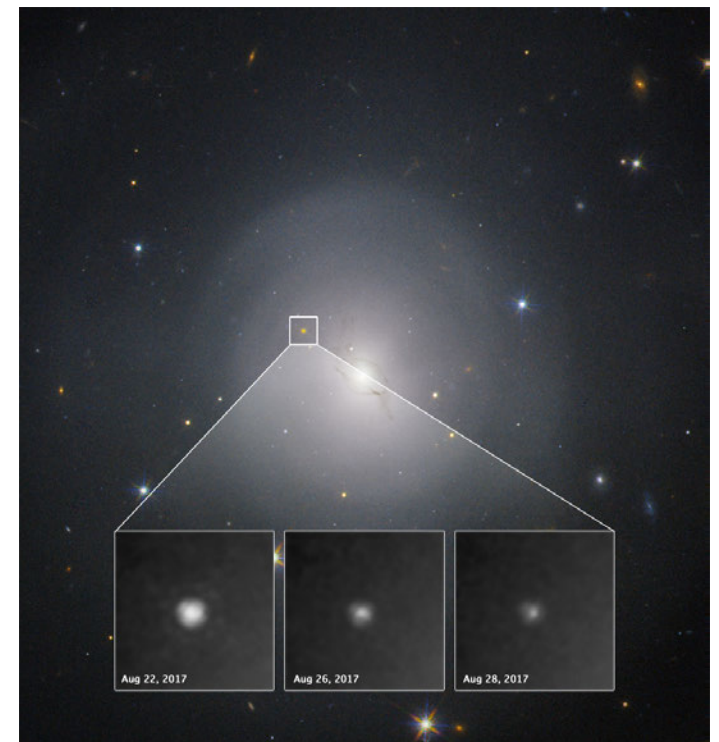
- **Medium/Large Jupiter/Juno programs**
 - **Grodent** (Cycle 24 Large): 151 orbits, complete
 - **Wong** (Cycle 24 Medium): 45 orbits, complete
 - **Grodent** (Cycle 26 Medium): 52 of 54 orbits done, with 2-orbit HOPR planned in April 2020.
- **Europa Cycle 25 mid-cycle campaign**
 - **Roth**: 50 of 55 orbits done with five orbits of HOPRs planned in March 2020
 - **Sparks**: complete (30 orbits)
 - **deKleer**: complete (10 orbits)
- **OPAL: Outer Planet Atmospheres Legacy**
 - Cycles 22-24: 29 total orbits per cycle on gas giants
 - Cycle 25-26: 41 total orbits per cycle (Saturn added after Cassini mission ended)
 - Cycle 27: 41 orbits planned
 - Uranus done in early November, Jupiter and Saturn planned in June 2020, Neptune planned in September 2020.



LRP: Statistics

Other Large/Medium highly constrained programs: Highlights

- **Kelly – Individual Stars as probes of Dark Matter**
 - Six sets of 16 consecutive orbits
- **Three active ultra-rapid ToOs**
 - **Best-case turn-around, on-source approximately 36+ hours after receipt of Phase-II instructions**
 - **Levan** – gravitational wave counterparts (one ultra-rapid among other ToOs)
 - **Cemco** – neutron star mergers
 - **Foley** – interactive supernova





Large/Treasury programs

C25/26 Program	alloc	Exec/sched by 11/10/19	Planned before 10/1/20	Planned after 10/1/20	comment
Crossfield - *	127	81	46*	0	
deWit - *	114	81	8*	12*	13 not in plan
Krauss	132	131	1	0	1 HOPR remains; Feb 2020
Steinhardt	101	80	16	0	BUFFALO. 5 unplanned (ToO)
Freedman	54	42	12	0	
Jaskot	134	84	50	0	
Lee	122	37	84	0	1 not in plan
Levan (ToO)	45	1	0	0	Includes Ultra-rapid ToO
Parker	206	128	74	0	4 not in plan
Peek	73	52	12	0	9 not in plan
Rafelski	90	86	4	0	4 HOPRs in September 2020
Riess	110	49	57	0	4 not in plan
Teplitz	164	62	102	0	

* - many exoplanet visits not planned, “in the bullpen” until the LRP group can pull them forward.



Large/Treasury programs

C26 Program	alloc	Exec/sched by 11/10/19	Planned before 10/1/20	Planned after 10/1/20	comment
Berg	133	0	76	57	
Jha (ToO)	51	2	11	6	32 not in plan. C27 and 28
Kelly	96	0	48	48	
Roman-Duvall	77	0	44	33	
Weisz	244	30	111	103	



Summary

- Hubble is performing at peak productivity
- Challenges continue from time-constrained and time-critical programs, but we are working to enable these exciting science explorations
- We're thinking broadly about the landscape in the next decade and Hubble's role in it

