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EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

The JWST Science Operations

Bill Workman
(Science Planning and Scheduling Team Lead)

The Science Operations Teams

- Program Coordinators
  - Tony Roman (Team lead)
  - Beth Perriello (Deputy lead)
  - 14 team members

- Planning and Scheduling
  - Bill Workman (P&S Team Lead)
  - Dave Adler (Long Range Planning Group Lead)
  - Kristen Wymer (Short Term Scheduling Group Lead)
  - 16 team members

- Data Processing
  - Faith Abney (Team Lead)

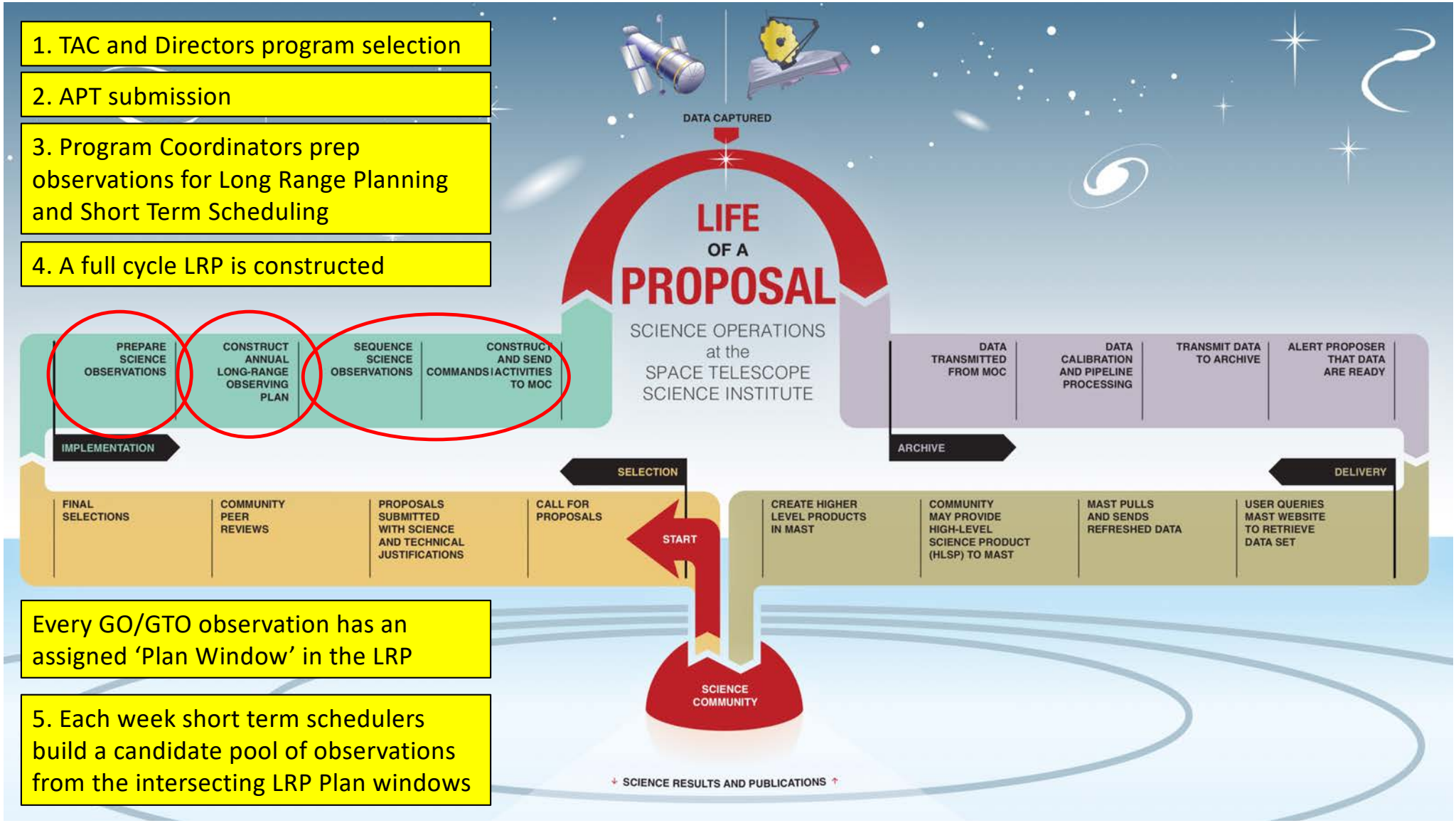
- Archive (MAST)
  - Dick Shaw (Team Lead)

1. TAC and Directors program selection

2. APT submission

3. Program Coordinators prep observations for Long Range Planning and Short Term Scheduling

4. A full cycle LRP is constructed



Every GO/GTO observation has an assigned ‘Plan Window’ in the LRP

5. Each week short term schedulers build a candidate pool of observations from the intersecting LRP Plan windows

JWST Cycle 1 Observing plan – Long Range Planning – Cycle build

1. Take a broad look at overall mix of proposals.
   - Target distribution
   - Timing/orient constraints (Tight links, Micro-Shutter array visits, etc.)
   - Large programs

2. Set up Spike model scripts to determine most efficient model.

3. Iterate LRP process, analyze results

4. Adjust plan windows by hand as needed to achieve goal of conflict free time and data volume resource subscribed LRP:
   - Address regions of over/under-subscription.
   - Adjust windows to keep programs from extending longer than needed.
   - Resolve remaining timing conflicts.

5. Baseline new Cycle LRP.

6. Announce windows to the observers.

JWST Cycle 1 – Short Term Scheduling – Weekly scheduling process

1. Create a pool of scheduling observations from LRP Plan Windows that intersect a 7 day period

2. Schedule earliest to latest; Select/adjust order of candidates
   - timing constraints/time critical visits, etc. to
   - minimize time gaps / maximize efficiency
   - manage/optimize momentum and science recorder volume
   - build in tolerances for execution uncertainties due to Event Driven on-board operations
     - actual vs modeled timing differences
     - GS or Target Acq failures

3. Baseline weekly timeline/generate the Observation Plan Package
   - The OP Package contains the visit files which specify how to execute the observation onboard
   - Also specifies the visit execution earliest start and latest start times

4. OP Package is uplinked 3-4 days ahead of scheduled start time of 1st visit in this timeline.
   - Ensures onboard OP segment does run empty
     (e.g. – if visits are being skipped due to a problem on board)

5. LRP is updated to reflect schedule results

JWST Cycle 1 – Long Range Planning – Weekly Maintenance process

1. Ingest weekly schedule results and observation changes from PI

2. Run LRP update process

3. Review results and iterate
   - Identify, troubleshoot and resolve lost PWs
   - Evenly distributed time and data volume resources / conflicts
     - Target distribution
     - Timing/orient constraints (Tight links, Micro-Shutter array visits, etc.)
     - Large program conflicts

4. Adjust plan windows by hand as needed to:
   - Address regions of over/under-subscription.
   - Adjust windows to keep programs from extending longer than needed.
   - Resolve timing conflicts.

5. Update the baseline Cycle LRP and notify schedulers for next week's STS/OP build.

Cycle 1 JWST Long Range Plan – it's quite full!

- LRP Cycle 1 dates: **Monday, June 27, 2022 – Sunday, July 2, 2023**:
  - Beyond July 2, 2023: Cycle 1 plan windows taper down in an "observing-tail."
- When building the LRP, we also need to account for "unplannable" science:
  - **206 hours** of Targets of Opportunity
  - **350 hours** of Director's Discretionary Time, yet to be awarded.
  - **~500 hours** of "WOPRs" (Webb Operational Problem Reports)
    - – estimated to be 5% of 10,000 hours
- **11,009 hours** of **Cycle 1** observations planned; **850 hours** unplanned
  - **But…there are only 8760 hours** available in a calendar year!
  - **Commitments for Cycle 1 observations account for 30-40% of Cycle 2.**
  - **~85% of GO programs are expected to receive their first observations during Cycle 1**
  - ***Many PI's will receive some plan windows in Cycle 2 (July 3, 2023 – early 2024).***

JWST Cycle 1 Long Range Plan; the LRP constantly evolves

LRP Summary

- The LRP is built for overall telescope efficiency.
- The Long Range Plan is not static, but changes to meet the needs of the Observatory and users.
- In general, ~70-80% of HST plan windows remain unchanged before execution.
- Changes and requests for repeats of failed observations are adjudicated by the JWST Telescope Time Review Board.

Cycle 1 JWST Long Range Plan – current state

- **The Cycle 1 Long Range Plan was released to the public on Friday, April 22.**

Breakdown of plannable science in Cycle 1

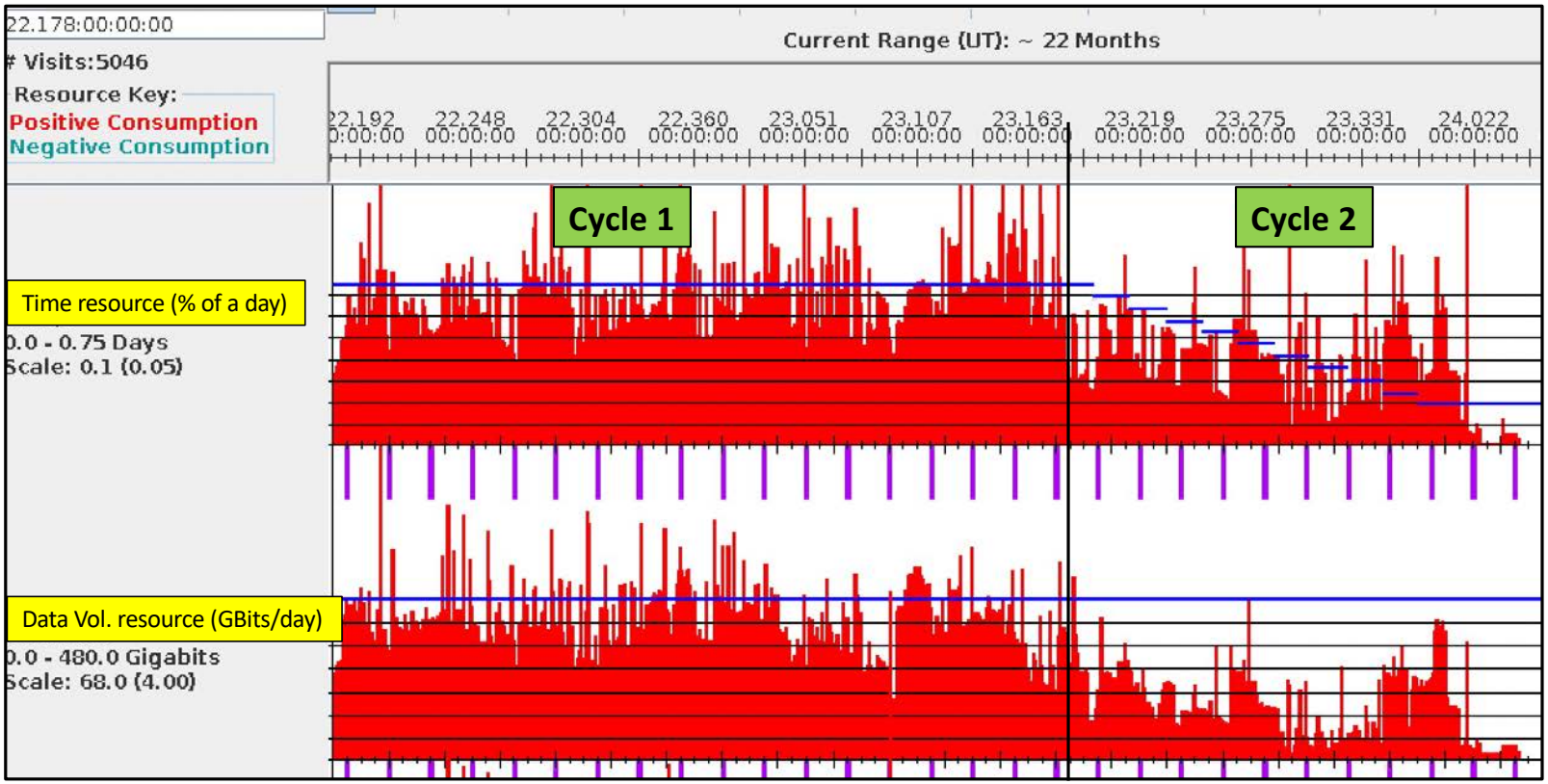
Category	Total Time [hrs]	Total Planned Time [hrs] (%)
GO	6071[1]	5750 (95%)
GTO	3746[2]	**3713 (99%)**
ERS	532	532 (100%)
CAL	660	660 (100%)
Total	11,009	10,665 (97%)

[1] Total time includes 200.5hrs of ToO's which do not get planned until activation

[2] Total time includes 5.2hrs of ToO's which do not get planned until activation

Cycle 1 JWST Long Range Plan – Resource Plot

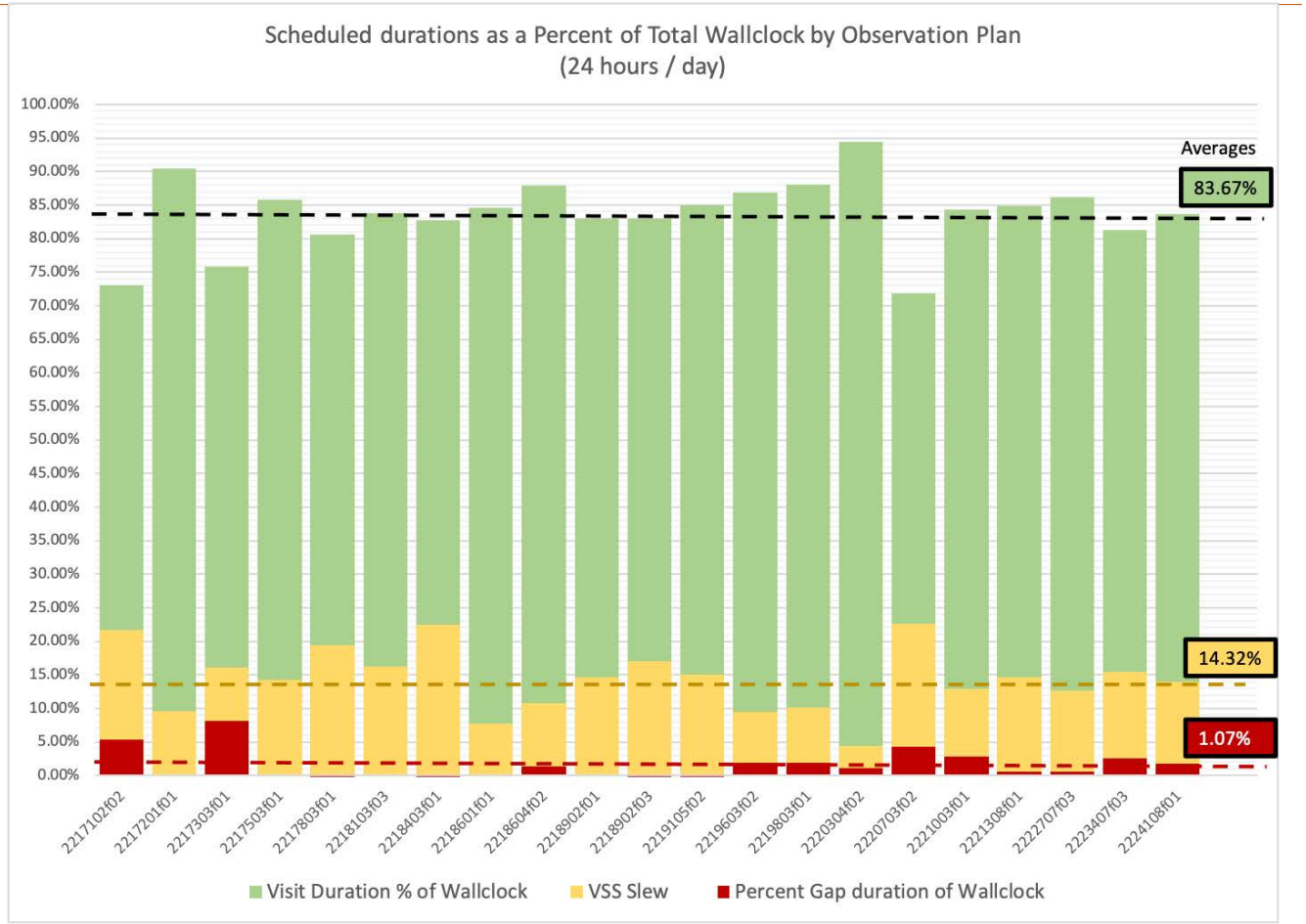
- **The Cycle 1 LRP is fully subscribed, with some high/full subscription time-frames in Cycle 2.**



Cycle 1 JWST Schedule Efficiency

Efficiency:

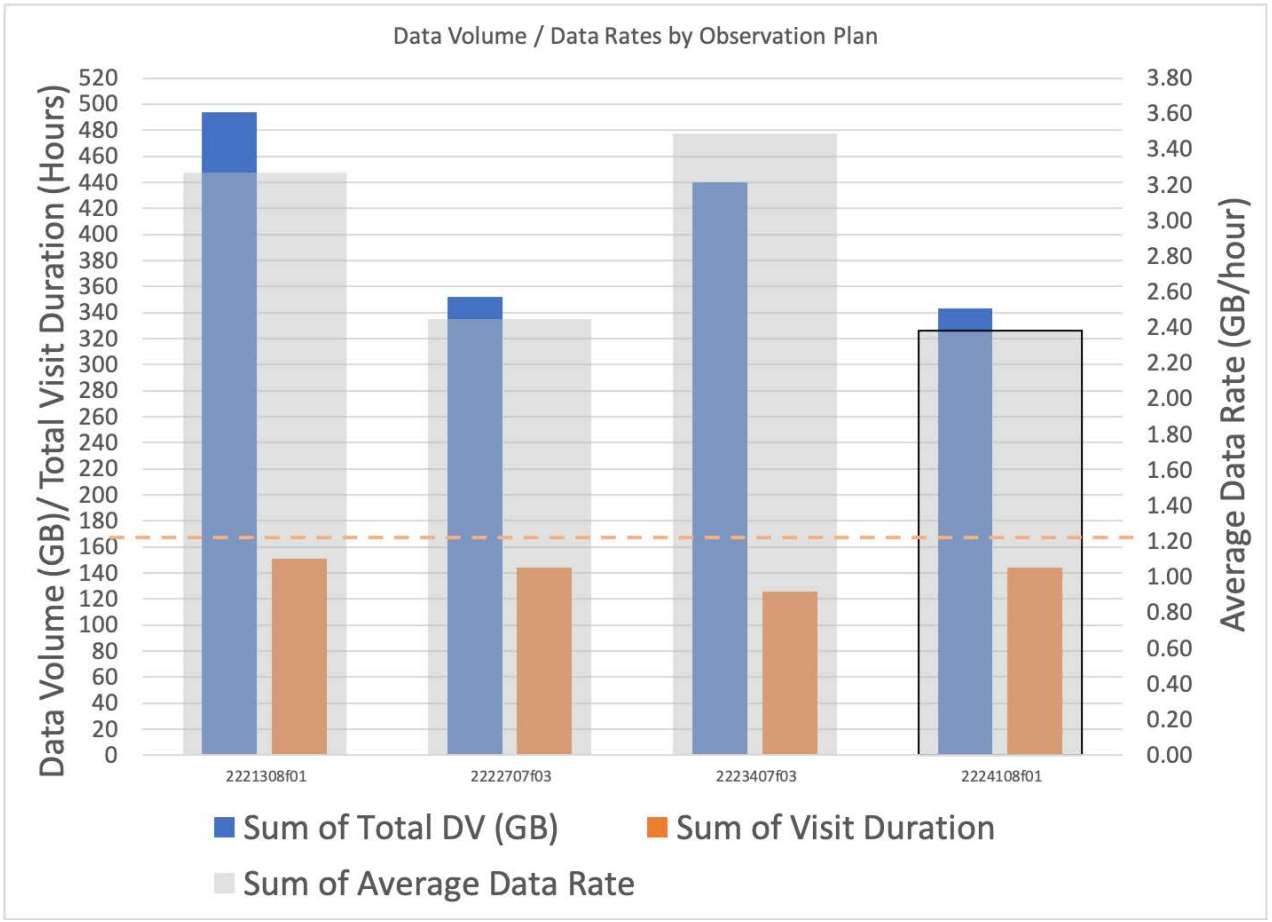
- Primary overhead:
  - slewing
  - gaps between visits
- Since start of Cycle 1 observing:
  - 83.67% - Visit related activities; includes:
    - Includes GS acq
    - SI overheads
  - 14.32% - slewing
  - ~1% gaps
    - Primarily due to time critical observations
    - Leaving buffer for execution uncertainy
    - Unable to find visits fill small gaps



Cycle 1 JWST Schedule Data Volume

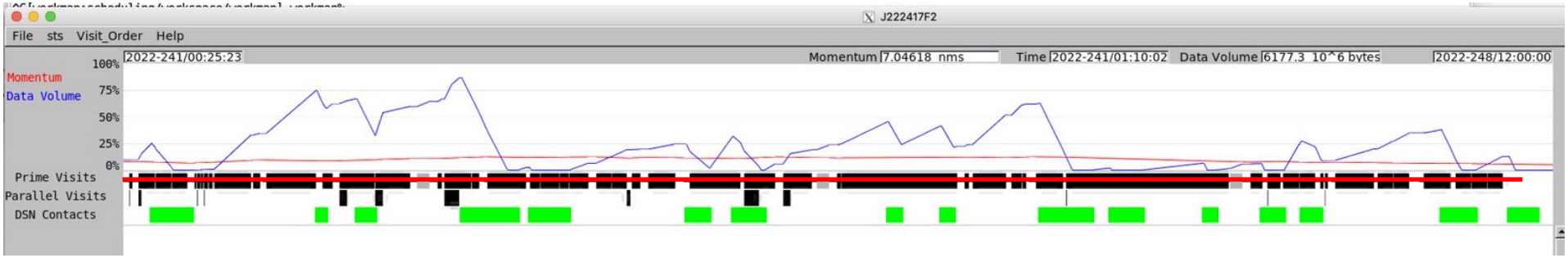
- 350-500 GB per 7 day schedule
  - For last four schedules
  - Includes some calibration parallels
  - No Science parallels yet

- Normal scheduling:
  - DSN contact schedules provide 8-12 hours of downlink
  - SSR is scheduled at 50% of science partition allocation
  - Plenty of margin for current demand
  - Expect plenty of DV capacity in general for science parallels.



Cycle 1 JWST Scheduling – Data Volume

Example from next weeks Short Term Schedule August 19 – Sep 4, 2022



- Normally schedule to 50% of SSR capacity (Red line)
- Increased to 96% this week due to reduced DSN support for NASA Artemis mission
- Scheduled a higher mix of low data rate observations (<~2.5 to 3 GB/hour)
  - May have to pull forward from later in the LRP
- As of right now, have not had to drop higher data rate time critical observations
  - Would delay execution and very likely require PI to rework/reimplement some observations
- Weeks like this impact the LRP and limit parallel scheduling

Cycle 1 JWST Science Parallels

- 779 Total hours of Cycle 1 Science Parallels approved
  - Program 1571 – 591 hours for high galactic latitudes (>= 20 degrees)
  - Program 2211 – 38 hours for ecliptic latitudes < 10 degrees
  - Program 2514 – 150 hours for high galactic latitudes (>= 35 degrees)

- Science Parallels have not been implemented yet.

- In process of identifying prime scheduling opportunities (slots)

- Still need to access availability of prime slots that
  - satisfy program constraints (duration and pointing)
  - Feasibility – combined SI data rates and total scheduling data volume limits

- Hope to begin providing slot list to PIs in September
  - Dependent on final assessment of calibration program needs (in progress)