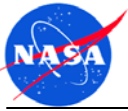




# Cassini Engineering Operations at Saturn

Shaun Standley

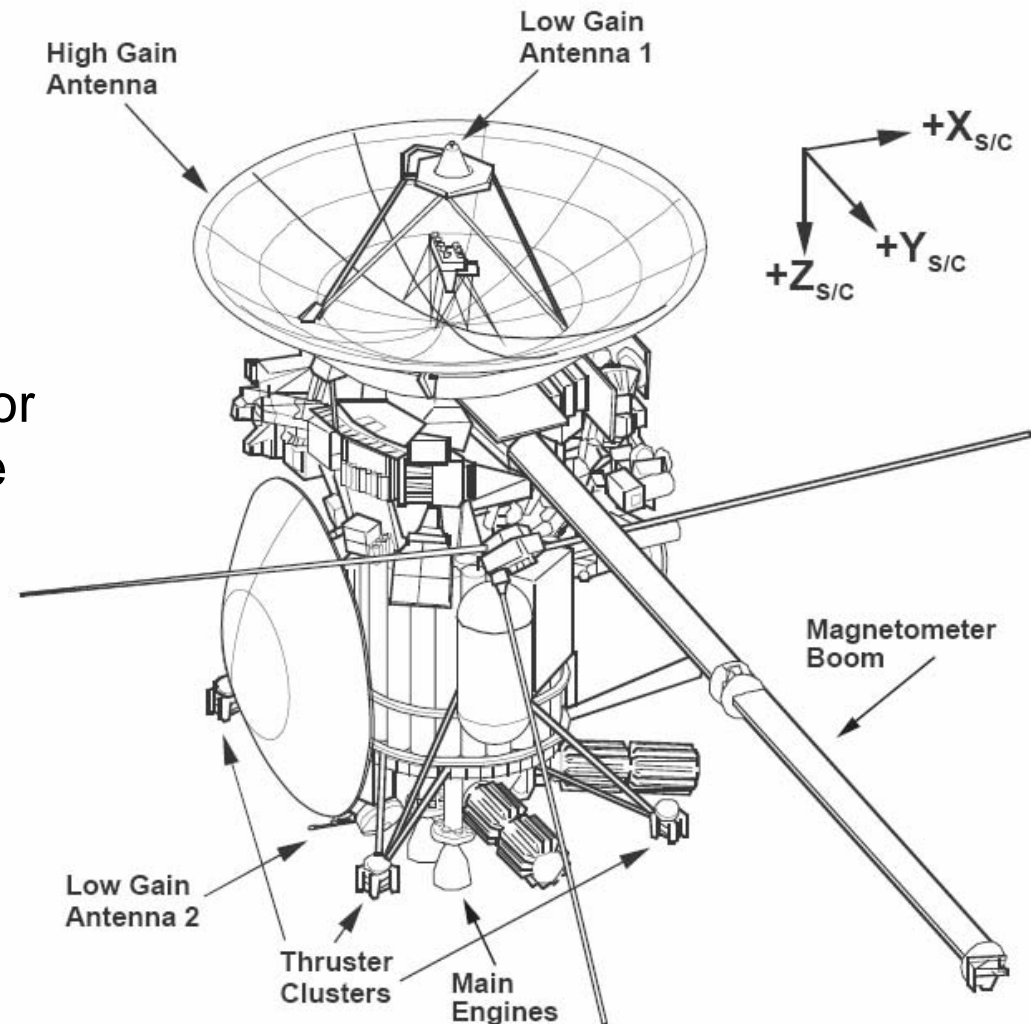


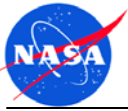
# Cassini Engineering Operations at Saturn

- Types of engineering operations needed for Cassini
- Process for integrating engineering with science operations
- Orbit Trim Maneuver (OTM) operations process
- Reaction Wheel Biasing & RWA Operations process

## The Cassini Spacecraft

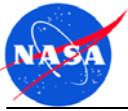
- 1N thrusters provide three axis attitude control
- Reaction wheels provide good pointing stability but have less control authority
- Attitude is derived from Sun sensors, gyros, and a star sensor
- Two Main Engines each provide 100lbs thrust, for orbit trim maneuvers not attitude control
- Main engine cover to protect against dust impacts



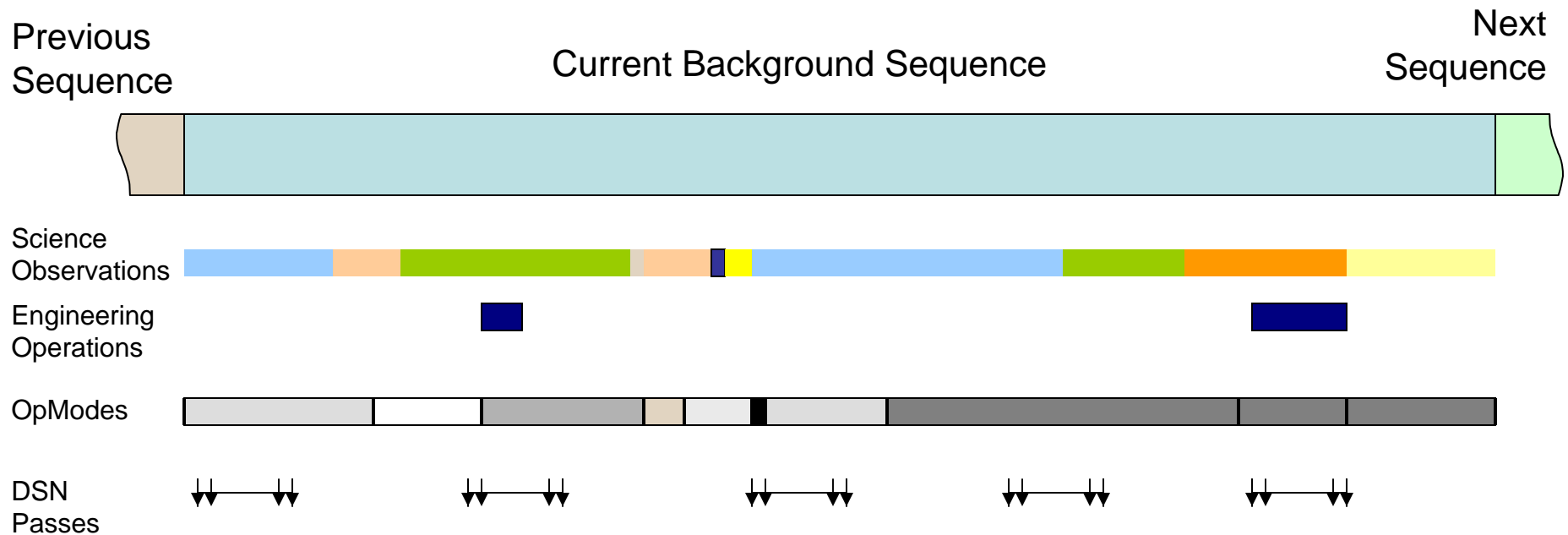


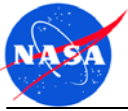
## Cassini Engineering Operations

- Orbit trim maneuvers (OTMs)
- Inertial Reference Unit (IRU) calibrations
- Main engine cover is deployed and stowed in response to dust hazards
- Stellar Reference Units (SRU) – calibration and response to dust hazards
- Suspend Star Identification – in response to bright bodies
- Reaction Wheel Assembly (RWA) biasing
- RWA friction tests
- Backup RWA exercises
- Pyrotechnic firing operations
- Engine Gimbal Actuators (EGAs) exercise
- On-board parameter update
- Command Loss Timer (CLT) adjustment
- Optical navigation images
- Operational Mode (OpMode) transitions between power states



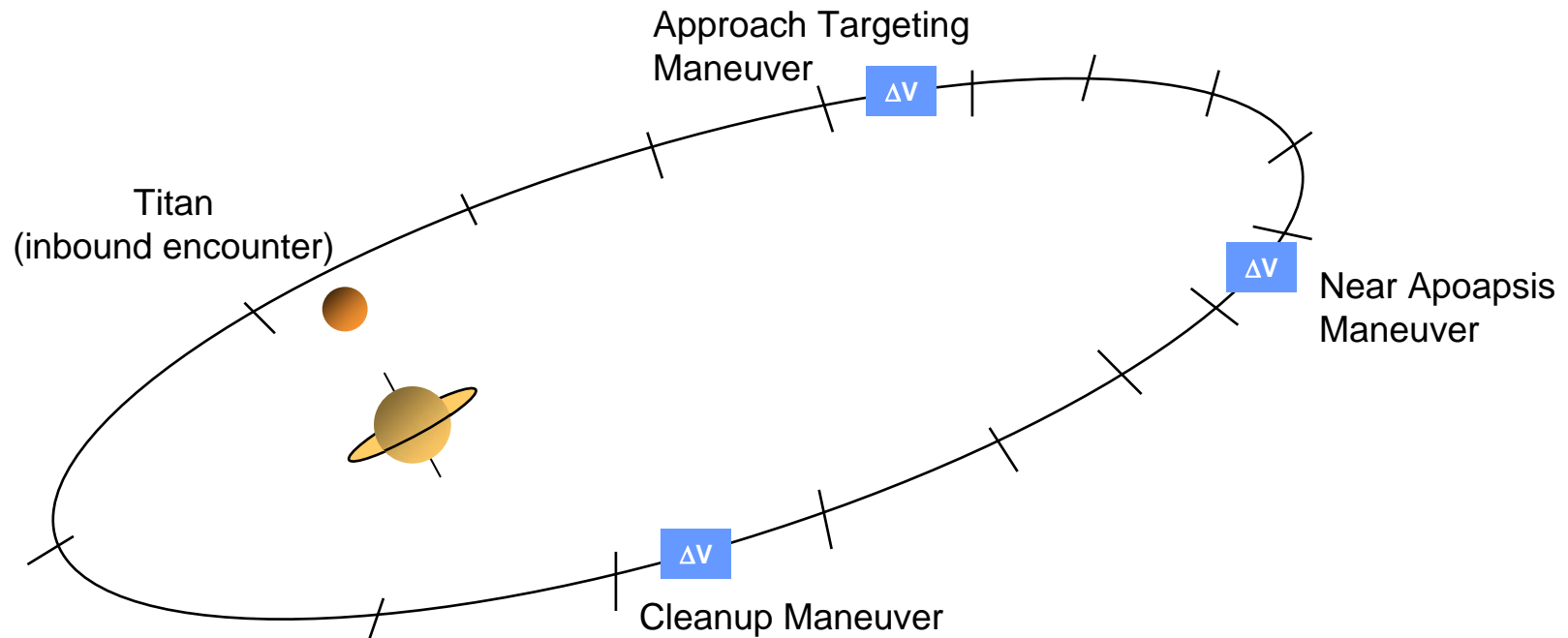
# Integration of Engineering and Science operations

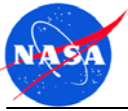




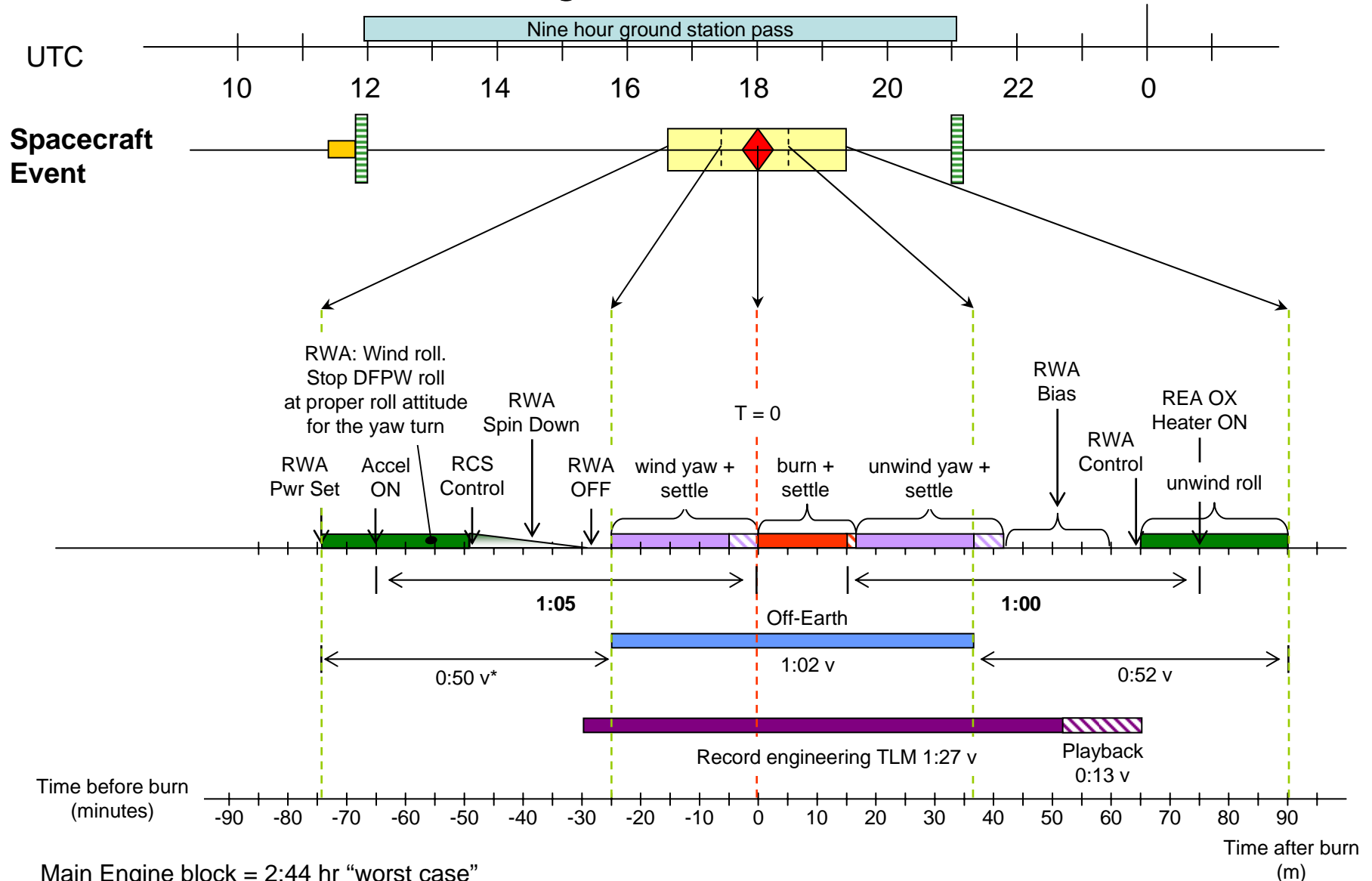
# Maneuver Strategy

- Three maneuvers per targeted encounter, periods as low as 7 days, often 16 days, maneuver magnitudes from  $\sim 393\text{m/s}$  to  $0.02\text{m/s}$
- Nine hour long primary and backup DSN passes reserved for each maneuver
- op mode transitions which support OTMs are placed in background sequence during sequence development, all other commands have to be developed within hours of the maneuver
- Maneuvers executed during a single station pass: state of health determined, uplink, maneuver performed, engineering data recorded and played back, science playback before and after maneuver

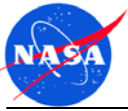




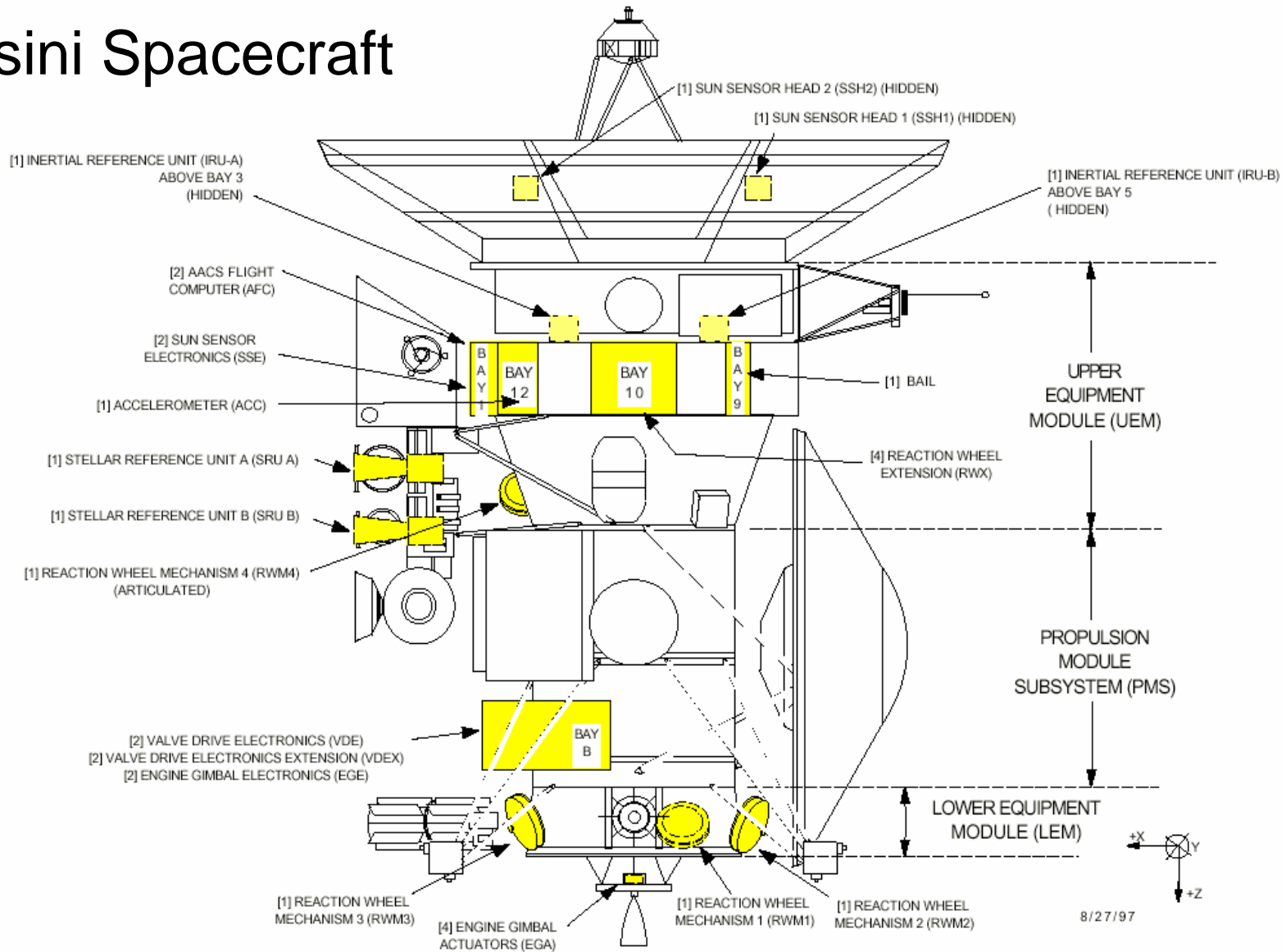
# Main Engine Maneuver Block



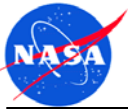
Main Engine block = 2:44 hr "worst case"



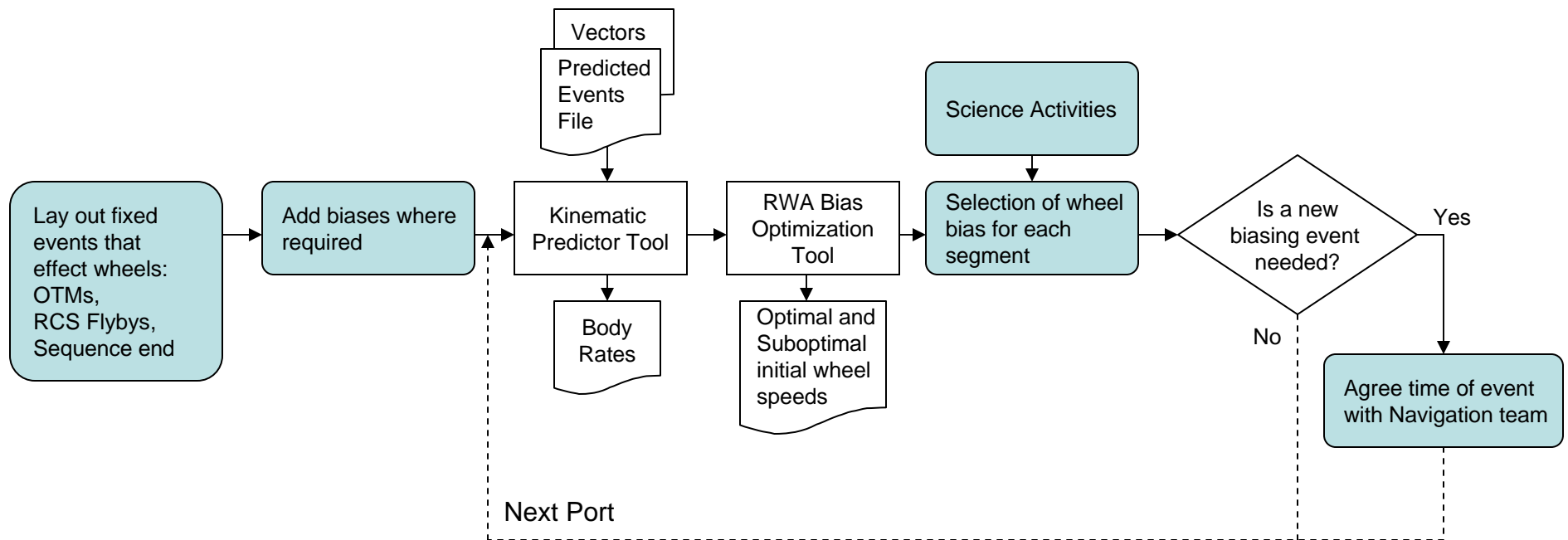
# Cassini Spacecraft

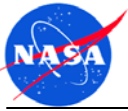






# Cassini RWA Biasing Process





## Conclusions

- Cassini is a complex mission, kept on track by meticulous attention to engineering detail.
- Our approach to operational complexity is progressive automation of ground processes to the extent possible.
- Automation of ground processes has improved the efficiency and accuracy of operations.
- Developing tools and processes for the optimal selection of momentum bias has ensured efficient use of reaction wheel consumables.
- The spacecraft is in excellent health and we look forward to implementing the remainder of the Saturn Tour and an extended mission.