Contingency Planning for Cassini's Final Mission Phase

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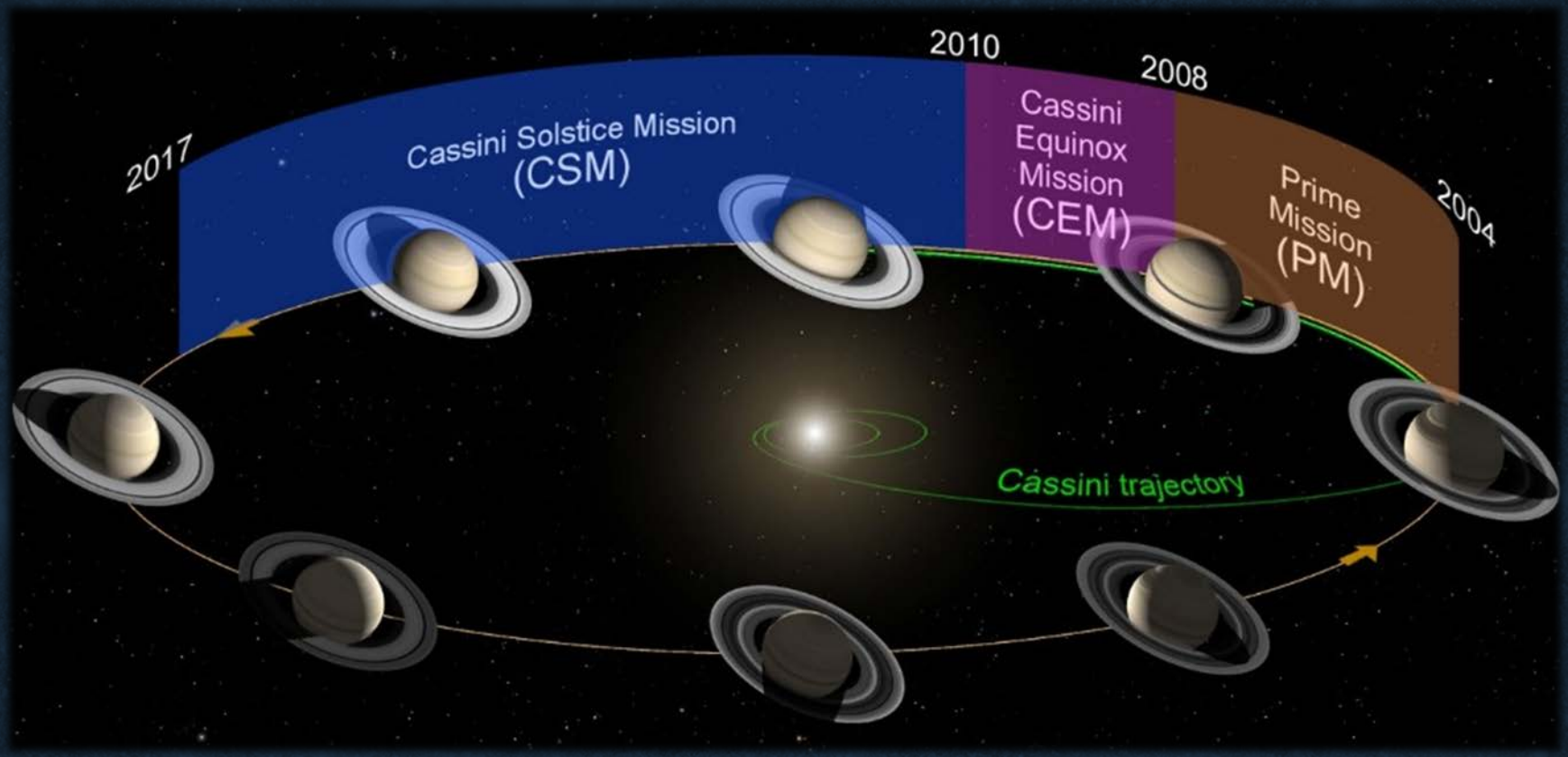
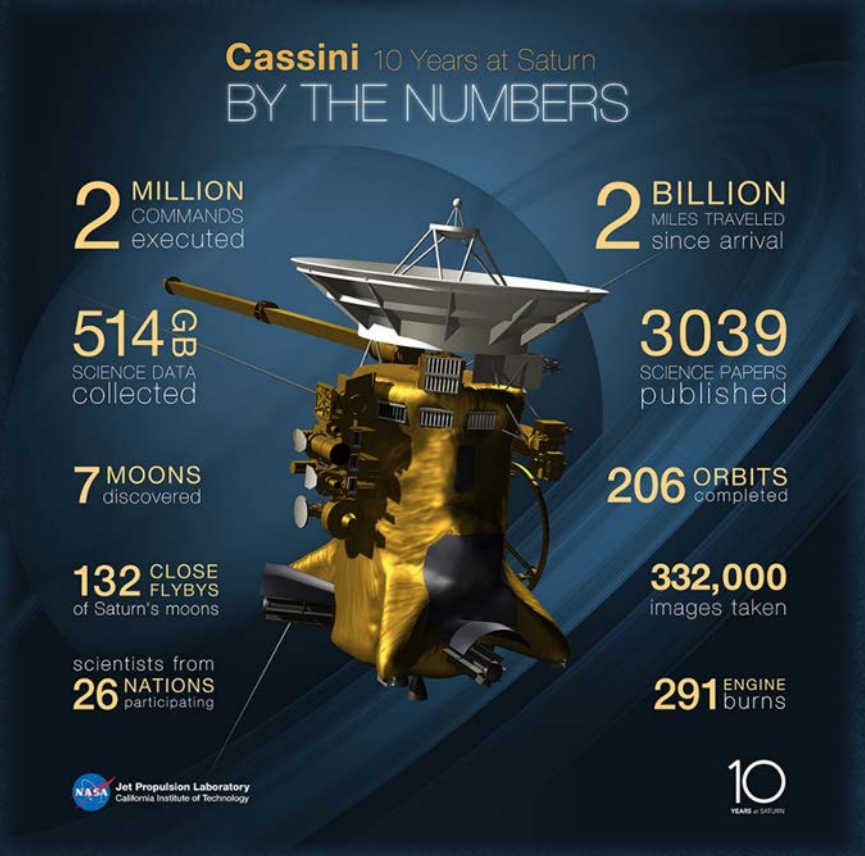
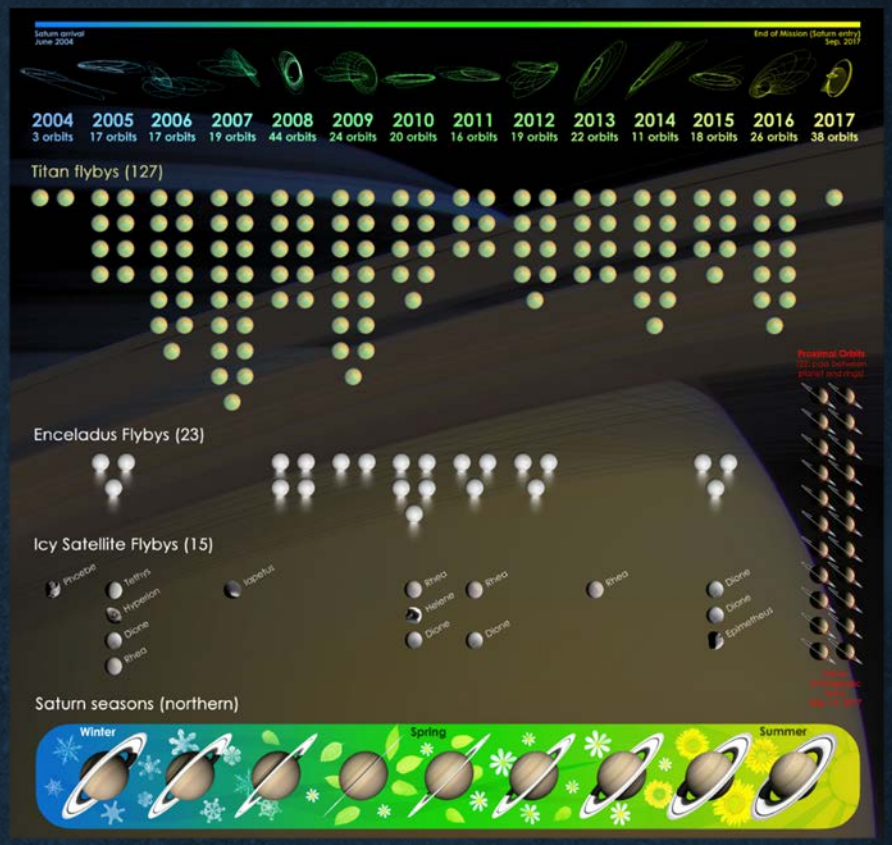
A Brief History of Cassini

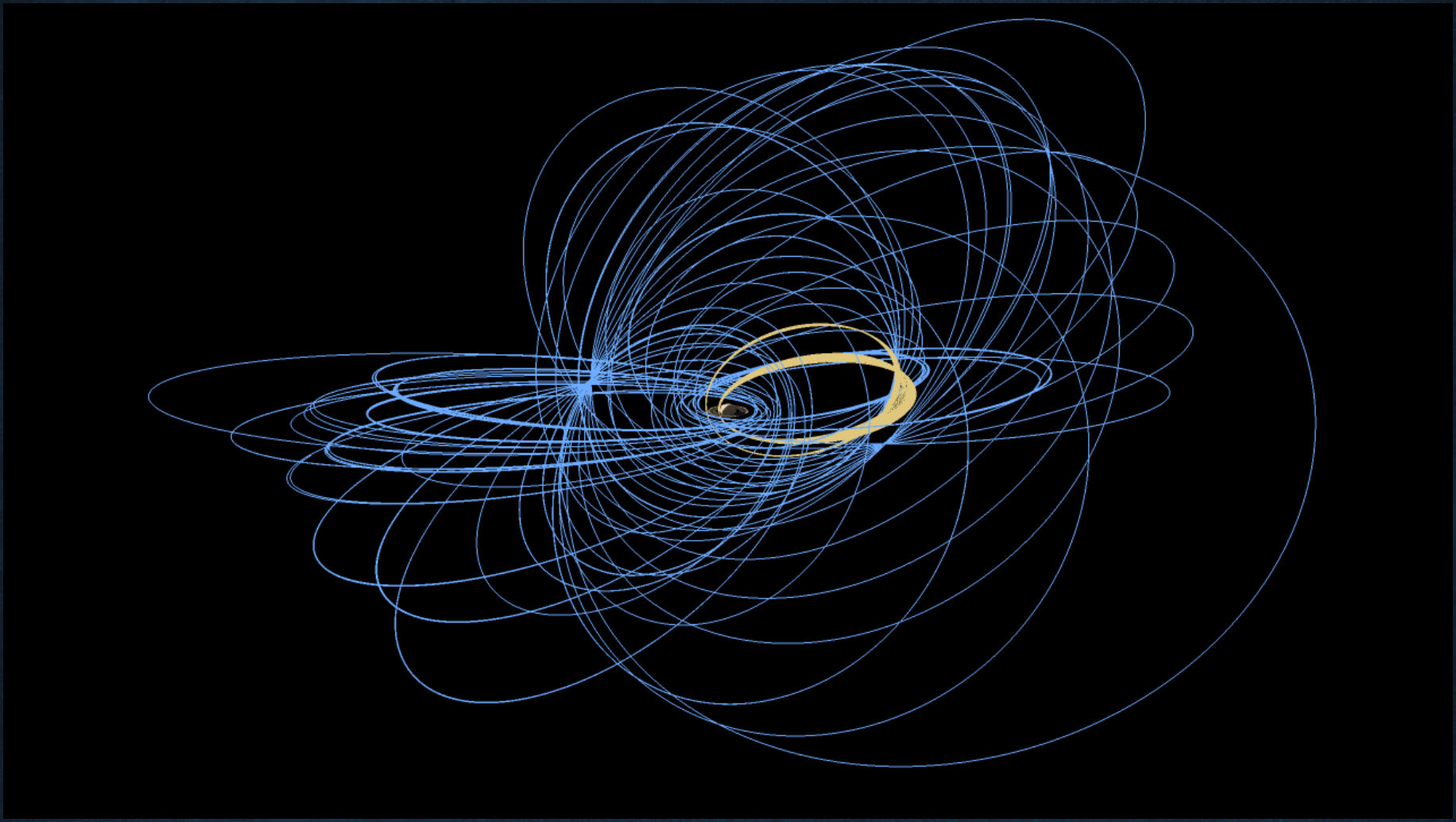


Cassini At A Glance

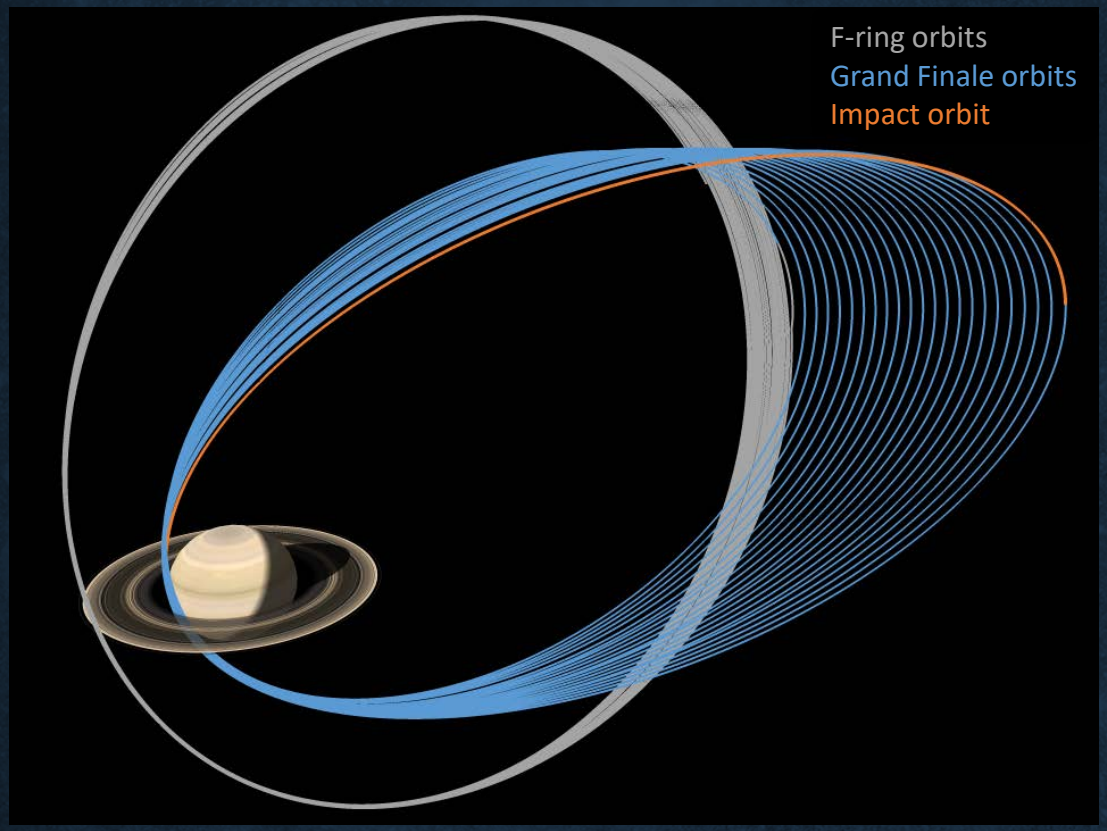


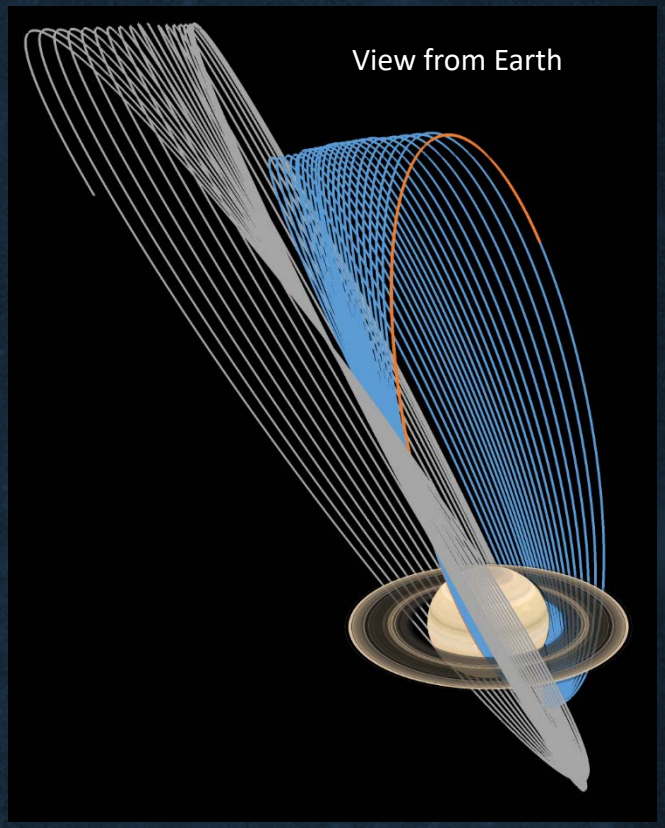


Solstice Mission Trajectory



Final 42½ Orbits





Grand Finale Objectives

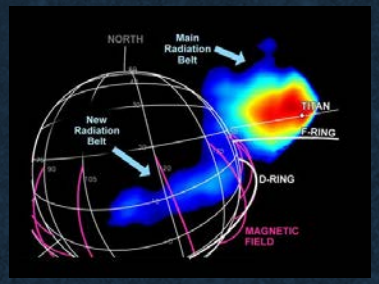
Bringing Cassini closer to Saturn than ever before

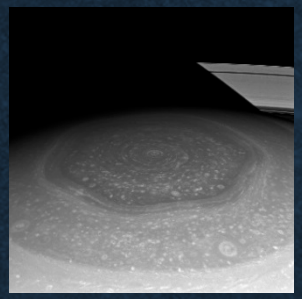
Planetary Protection

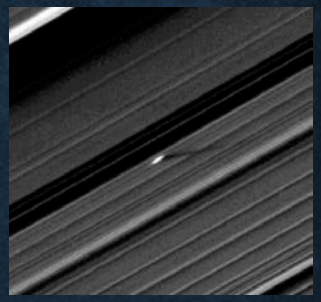
- Spacecraft disposal

Unique Science

- Saturn internal structure
  - Magnetic & gravity high-order moment measurements
- Ring mass
  - Address age of main rings
- In-situ measurements
  - Ionosphere, inner radiation belts, auroral region, and D ring particles
- High resolution observations
  - Rings, poles/aurora, atmosphere







Grand Finale Timeline

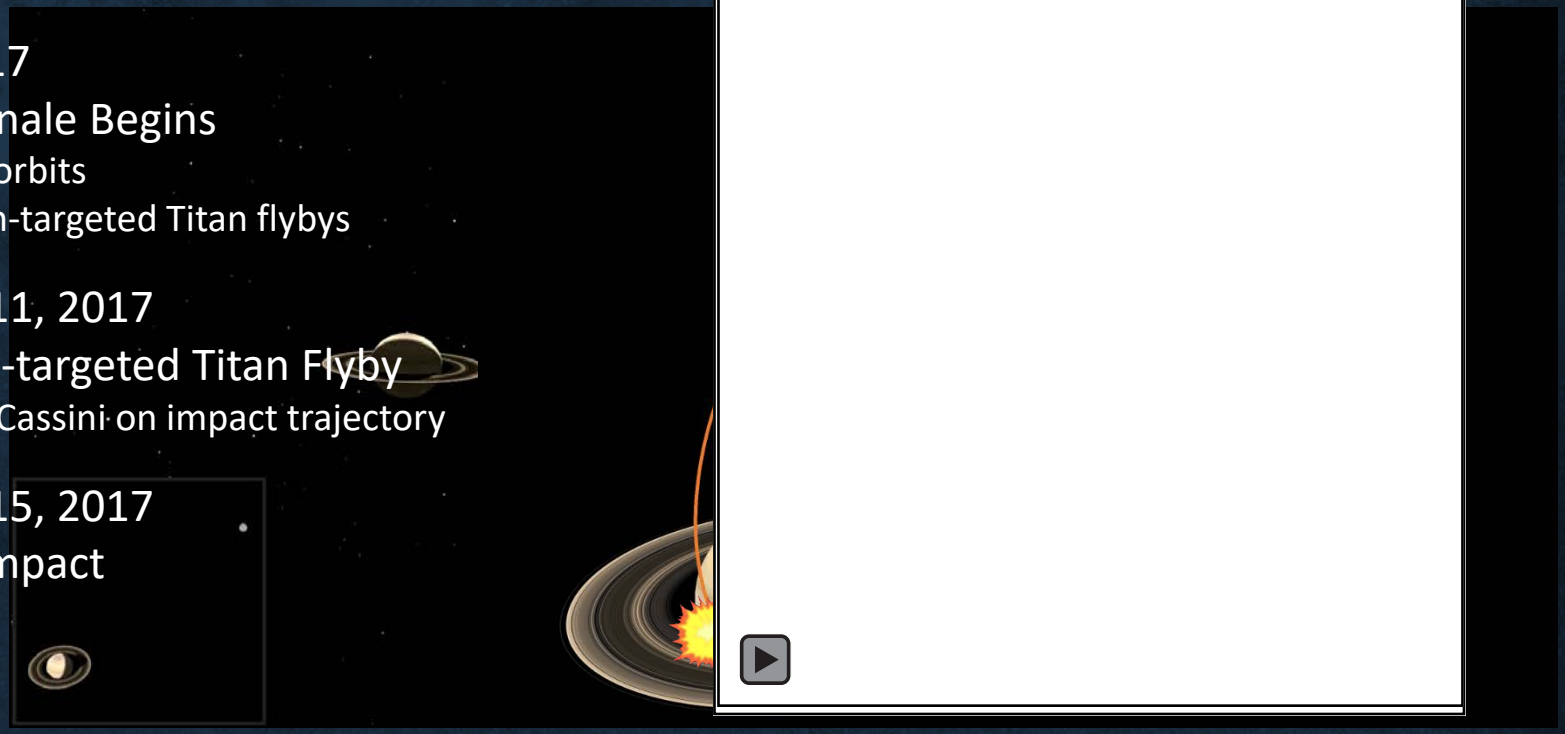
November 30, 2016
- F-ring Orbits Begin
  - 20 orbits
  - 3 maneuvers

April 22, 2017
- Last Targeted Titan Flyby
  - Produces Grand Finale trajectory

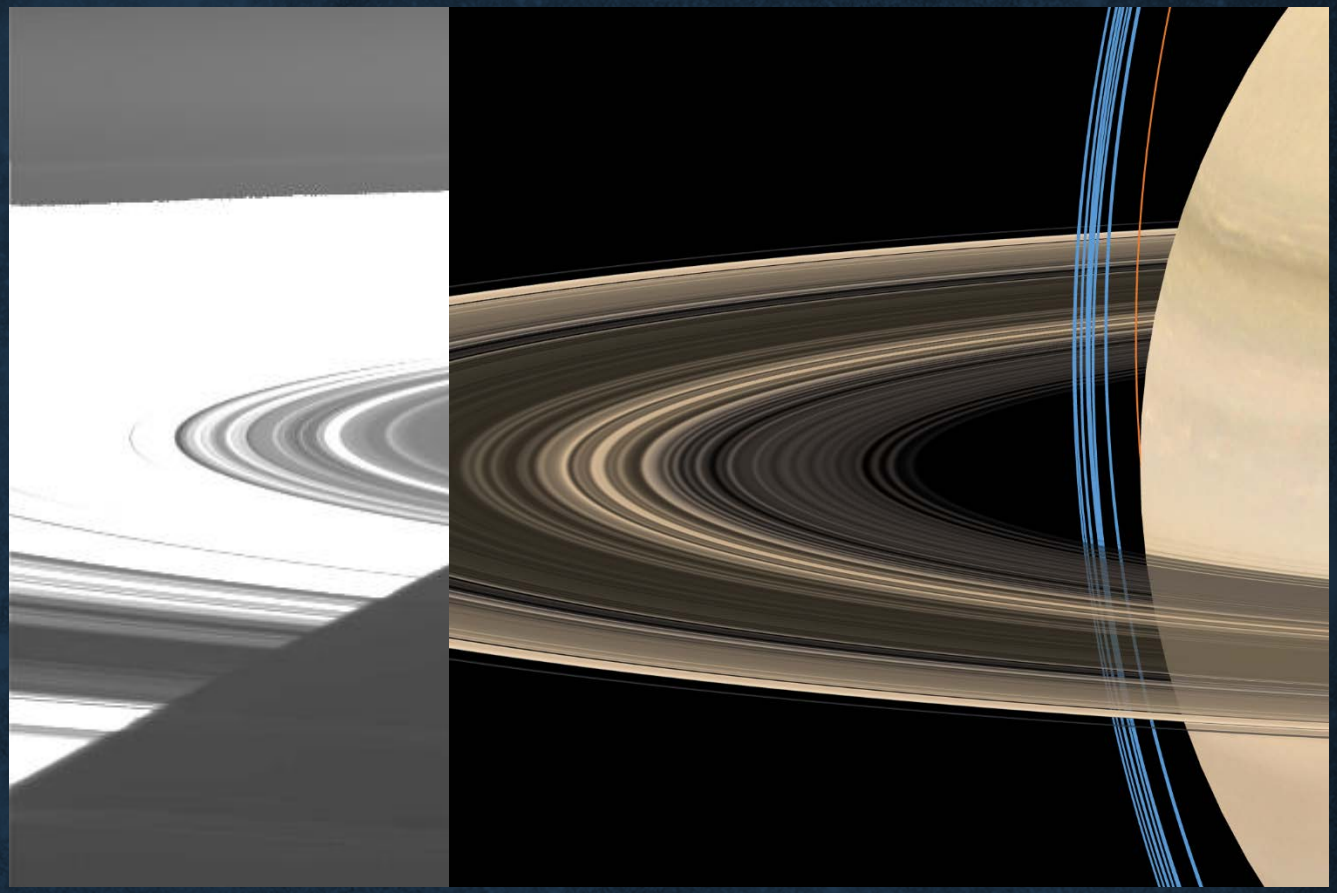
April 23, 2017
- Grand Finale Begins
  - 22½ orbits
  - 9 non-targeted Titan flybys

September 11, 2017
- Last Non-targeted Titan Flyby
  - Puts Cassini on impact trajectory

September 15, 2017
- Saturn Impact



Proximal Environment



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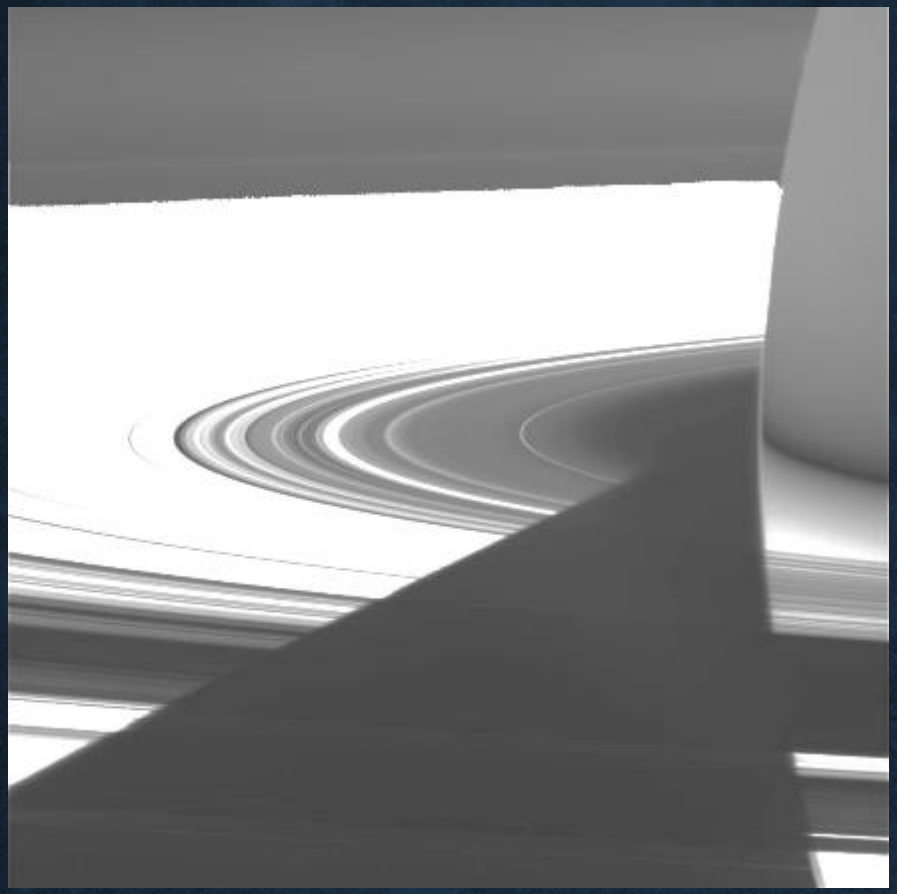

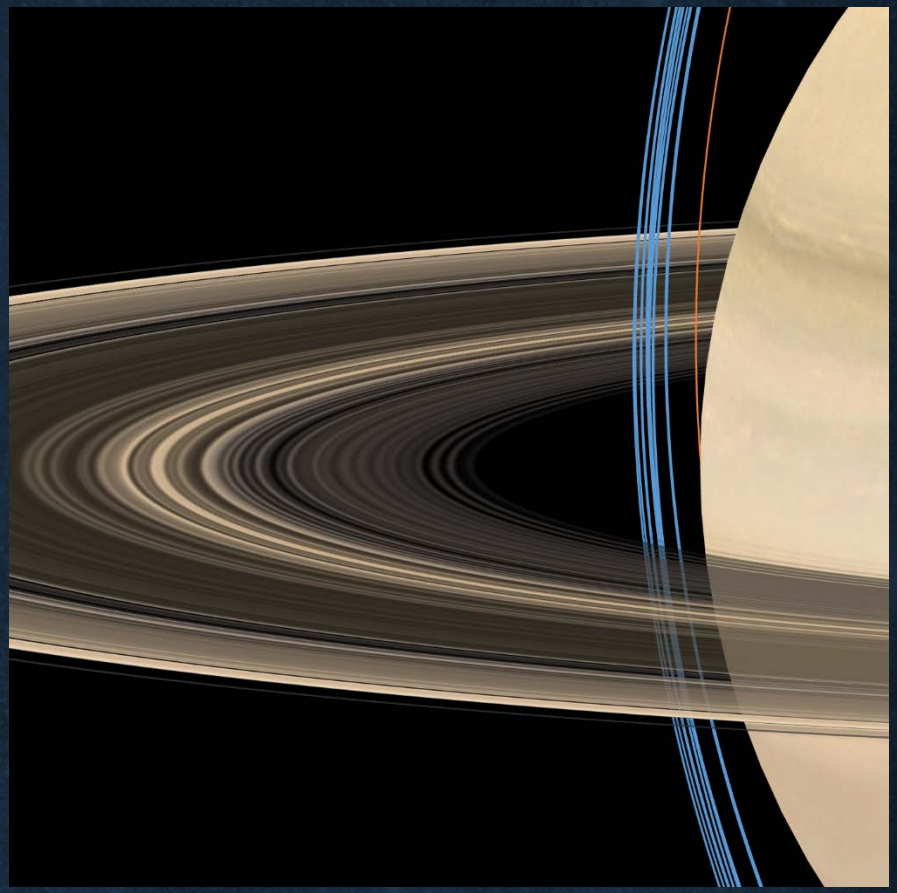

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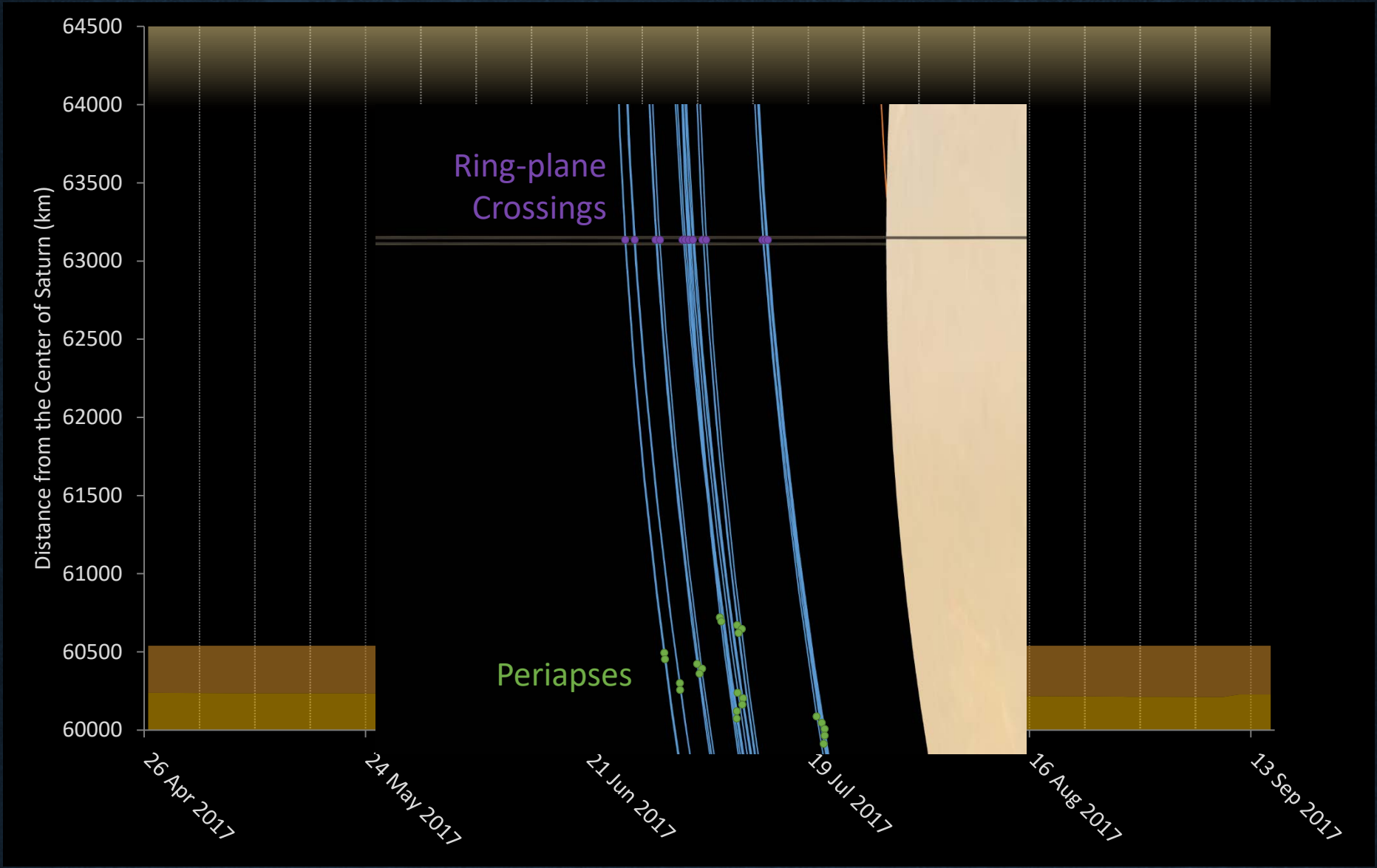
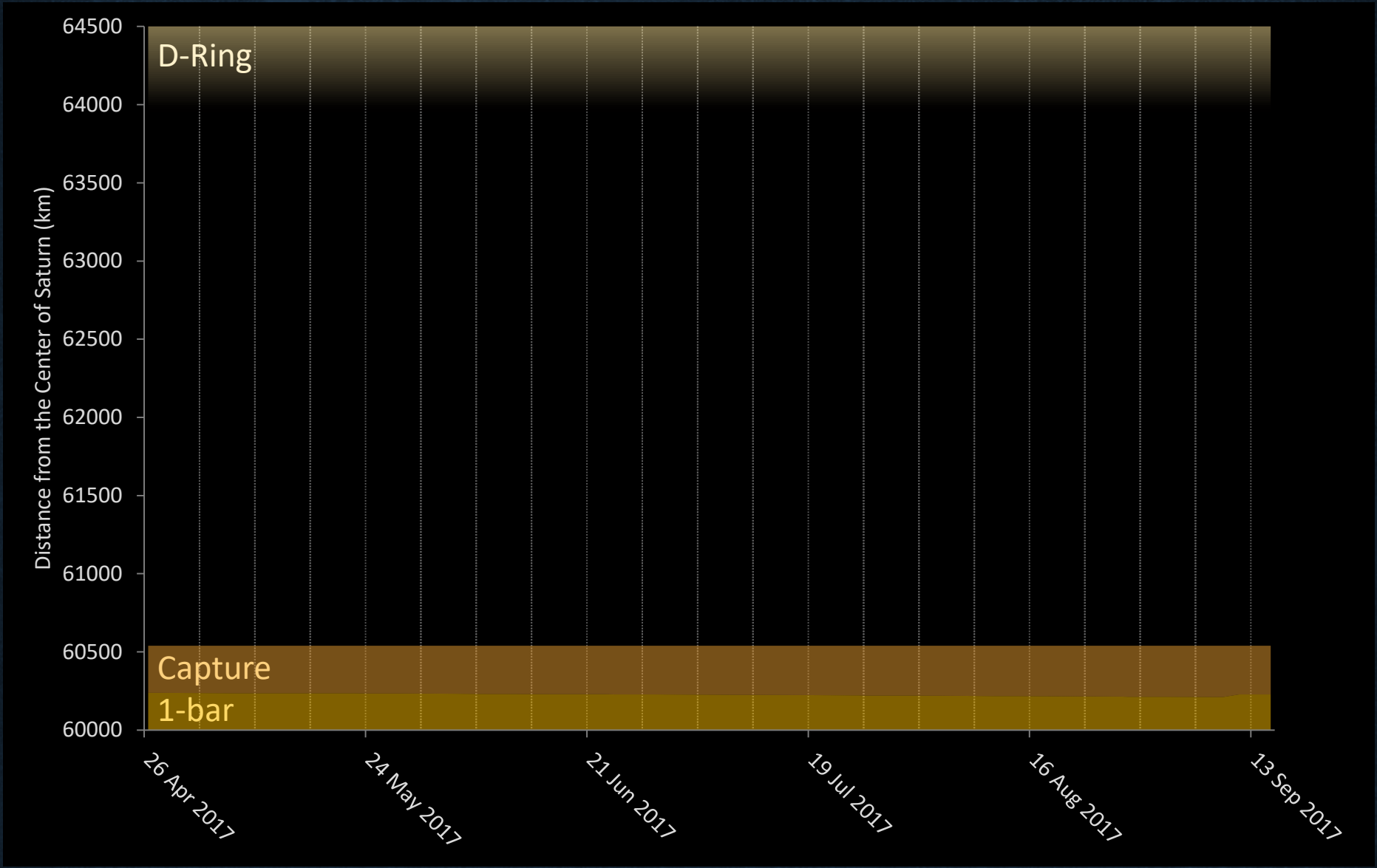


Proximal Corridor



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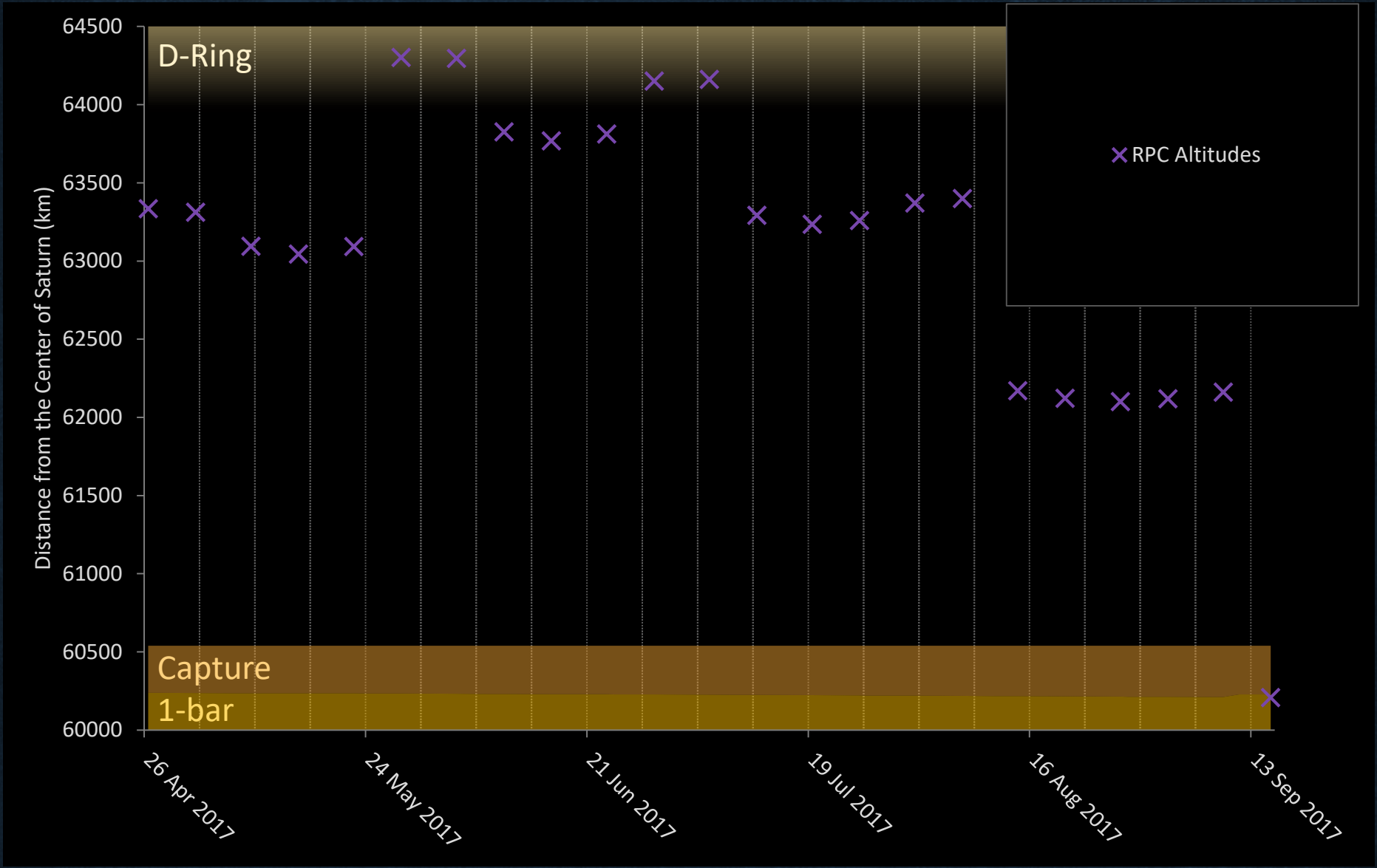

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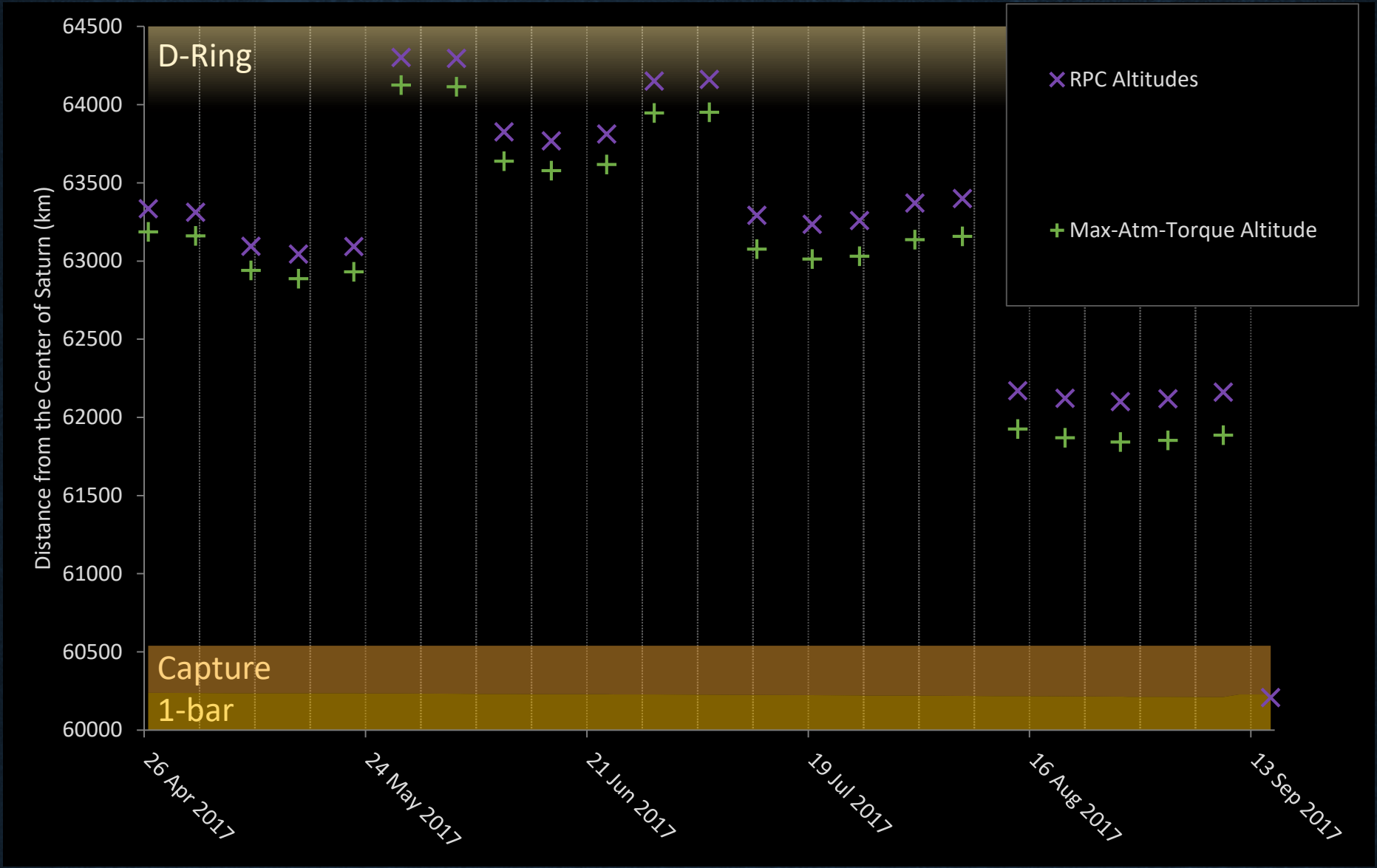


Environmental Hazard Protection

Dust

Atmosphere

Environmental Hazard Protection

Dust

- Close MEA cover

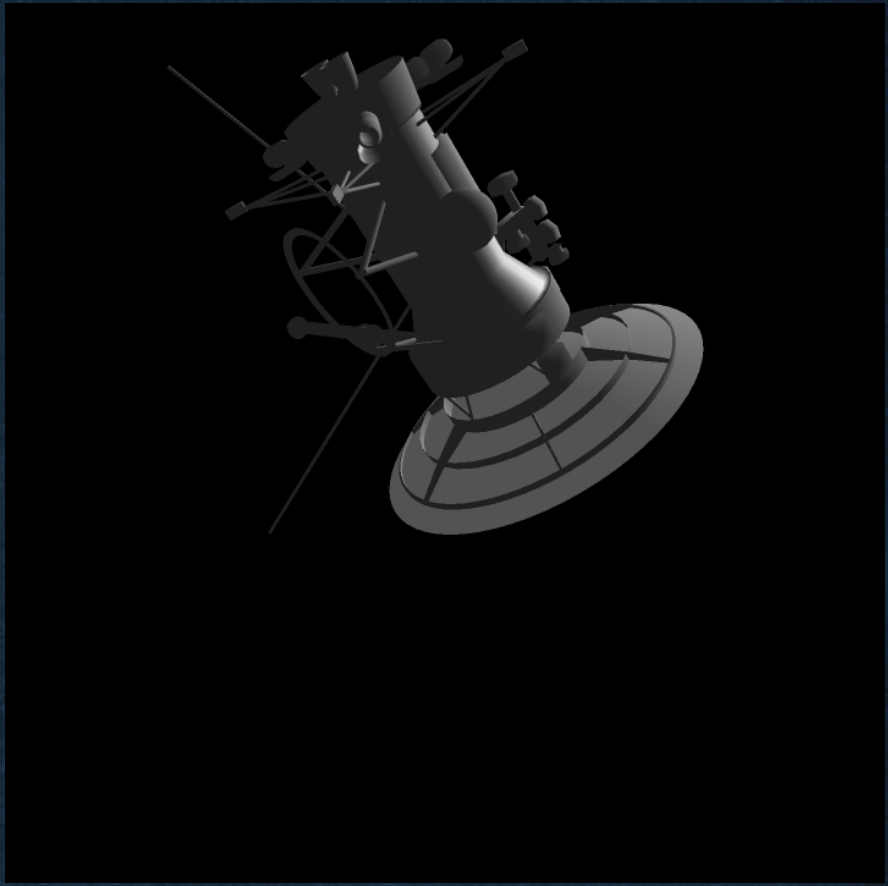
Atmosphere

Environmental Hazard Protection

Dust

- Close MEA cover
- HGA-to-Dust-Ram

Atmosphere



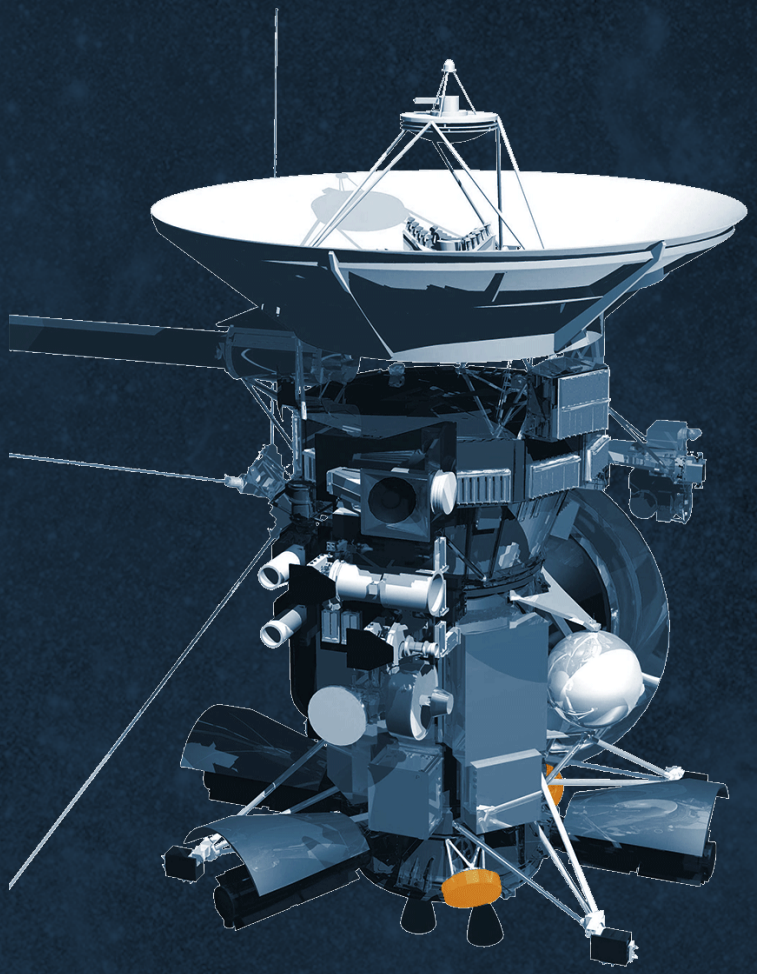
Environmental Hazard Protection

Dust

- Close MEA cover
- HGA-to-Dust-Ram

Atmosphere

- Switch to thrusters



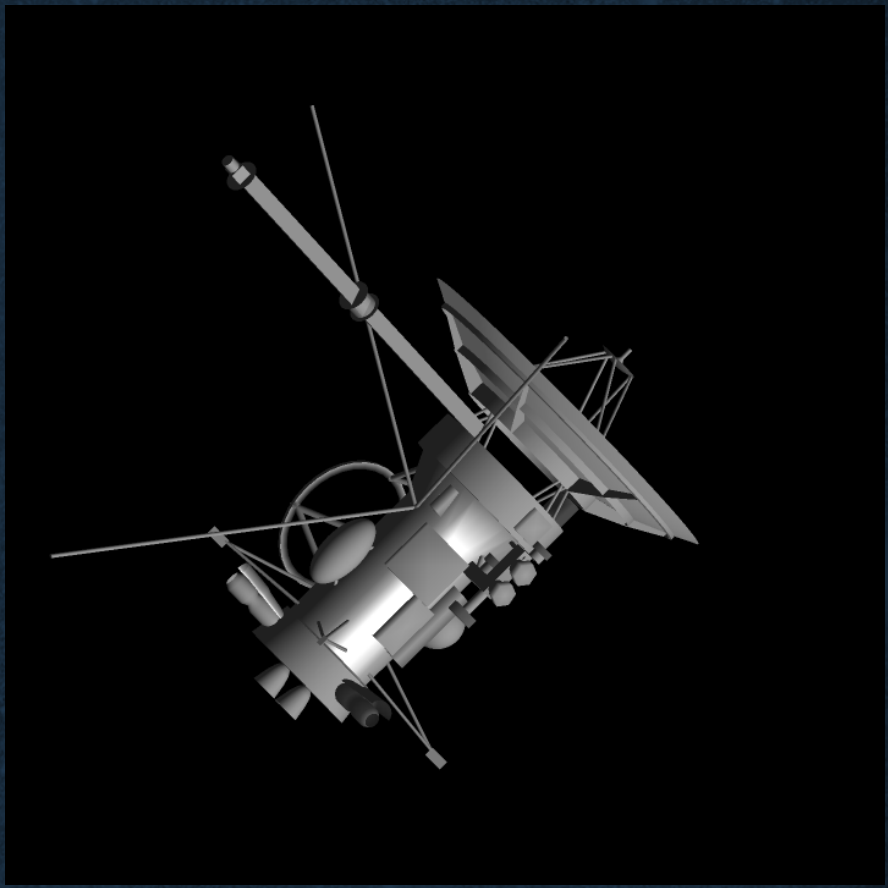
Environmental Hazard Protection

Dust

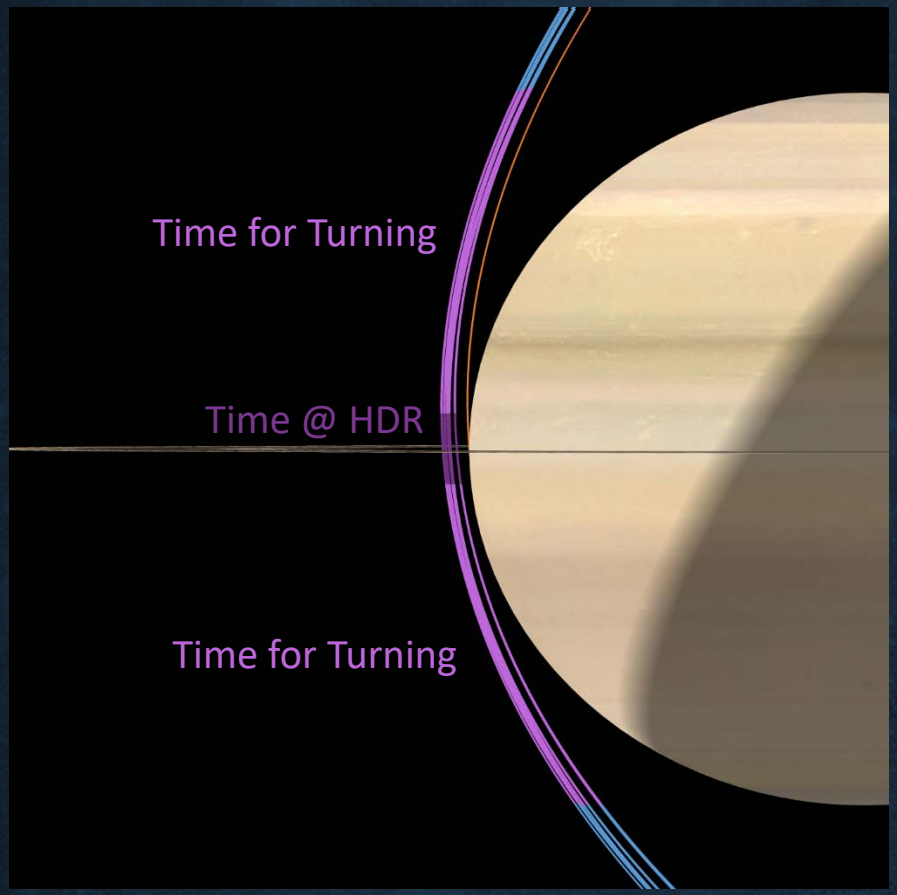
- Close MEA cover
- HGA-to-Dust-Ram

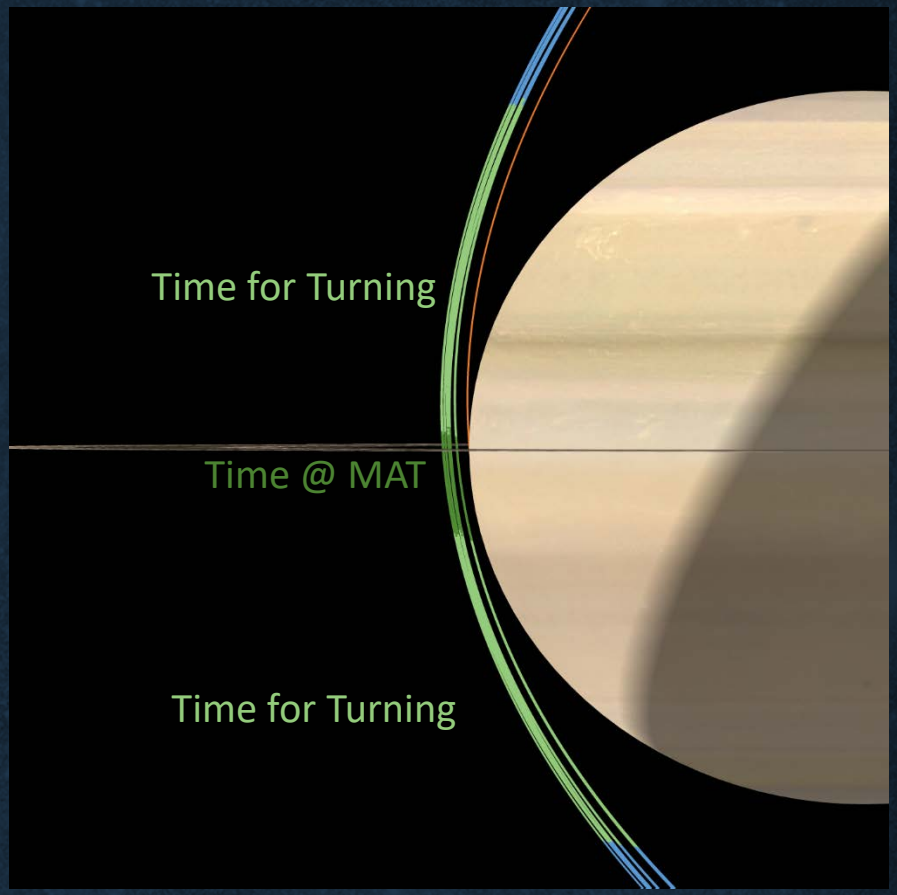
Atmosphere

- Switch to thrusters
- Min-aero-torque attitude

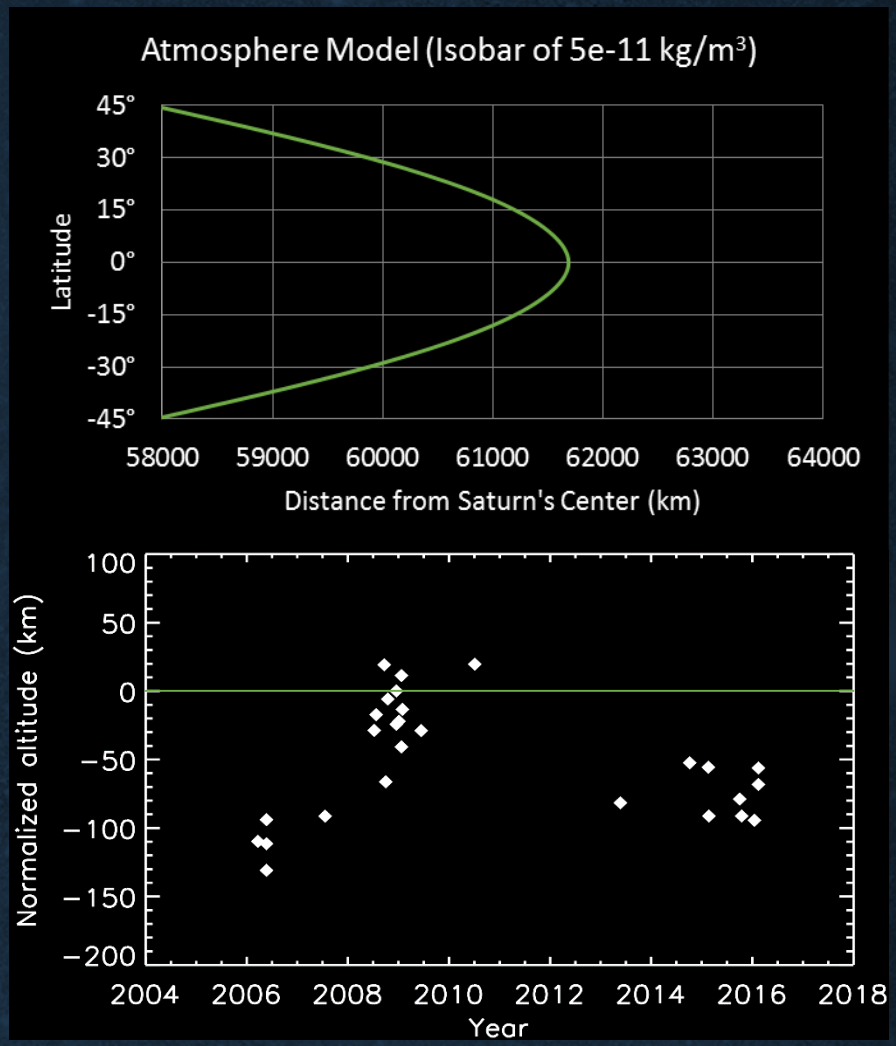


Environmental Hazard Protection





Remote Atmosphere Detection



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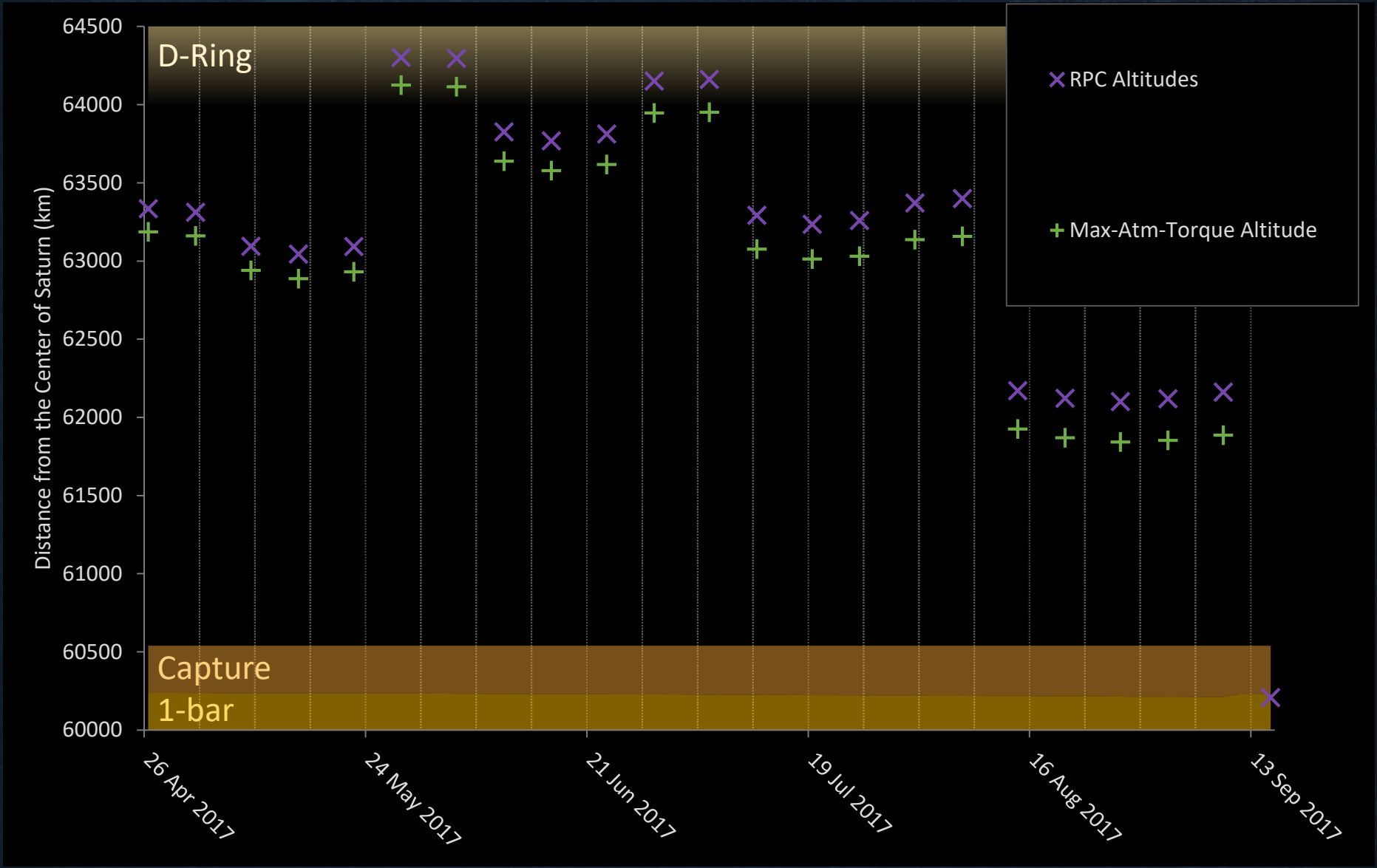

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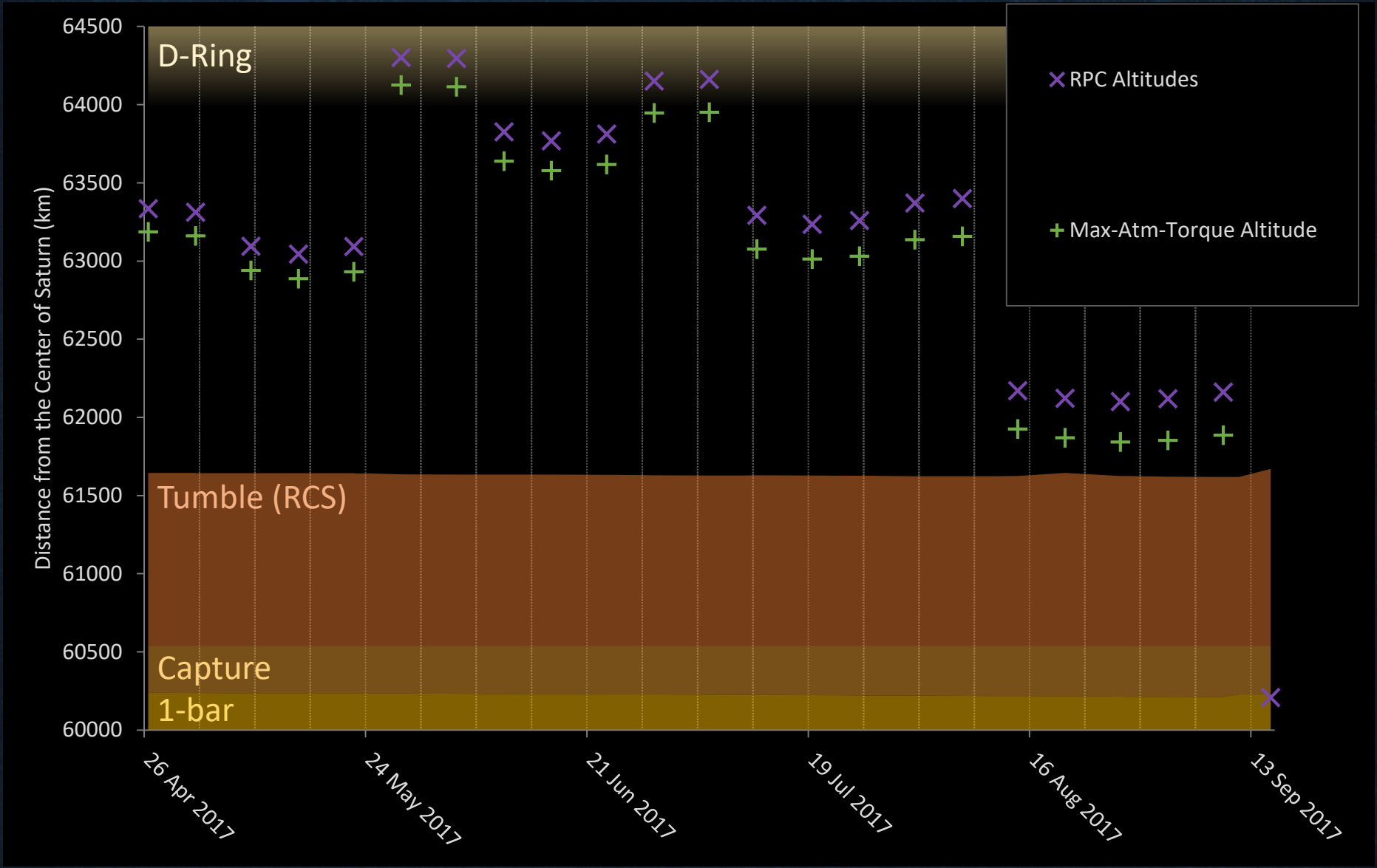

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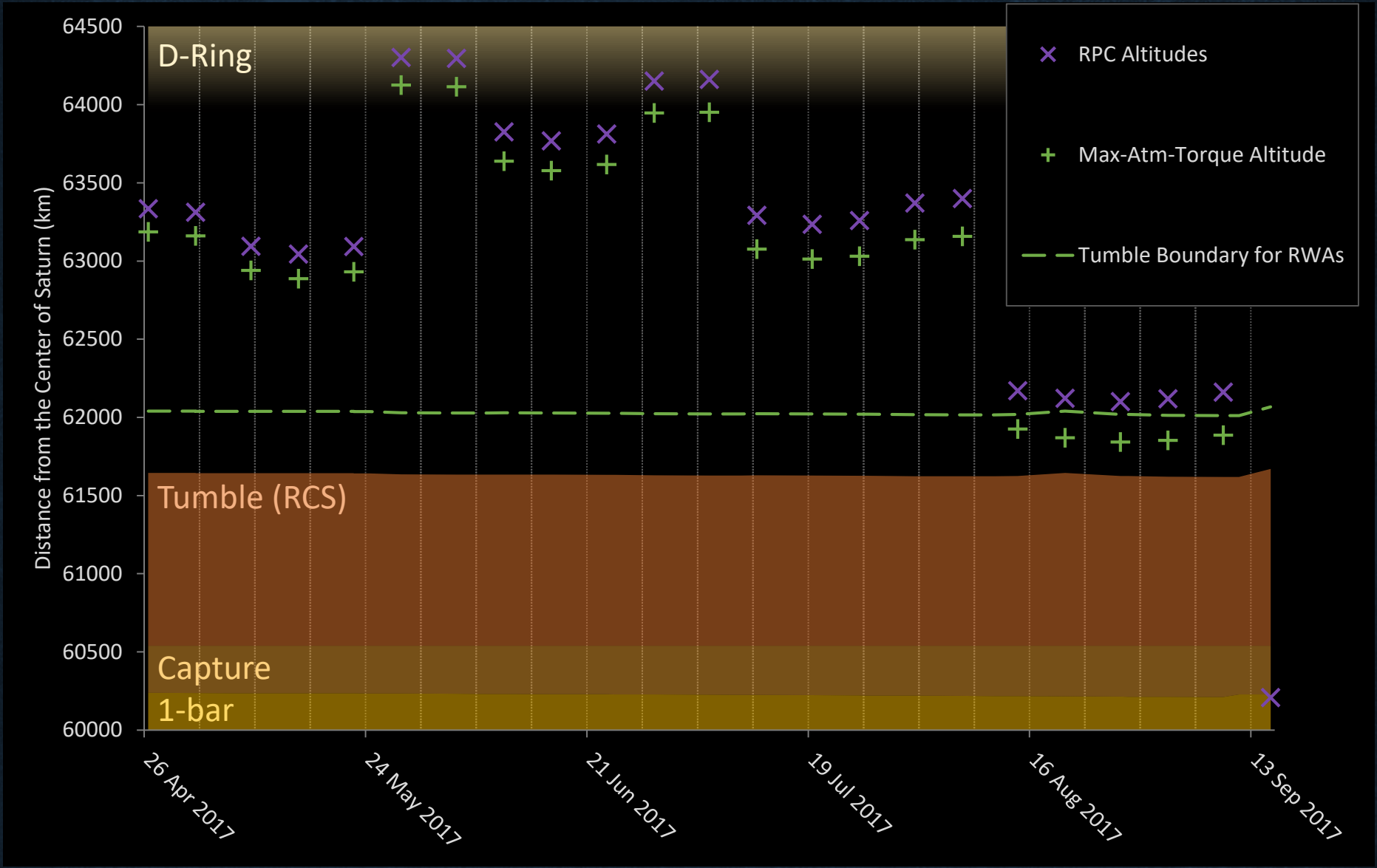

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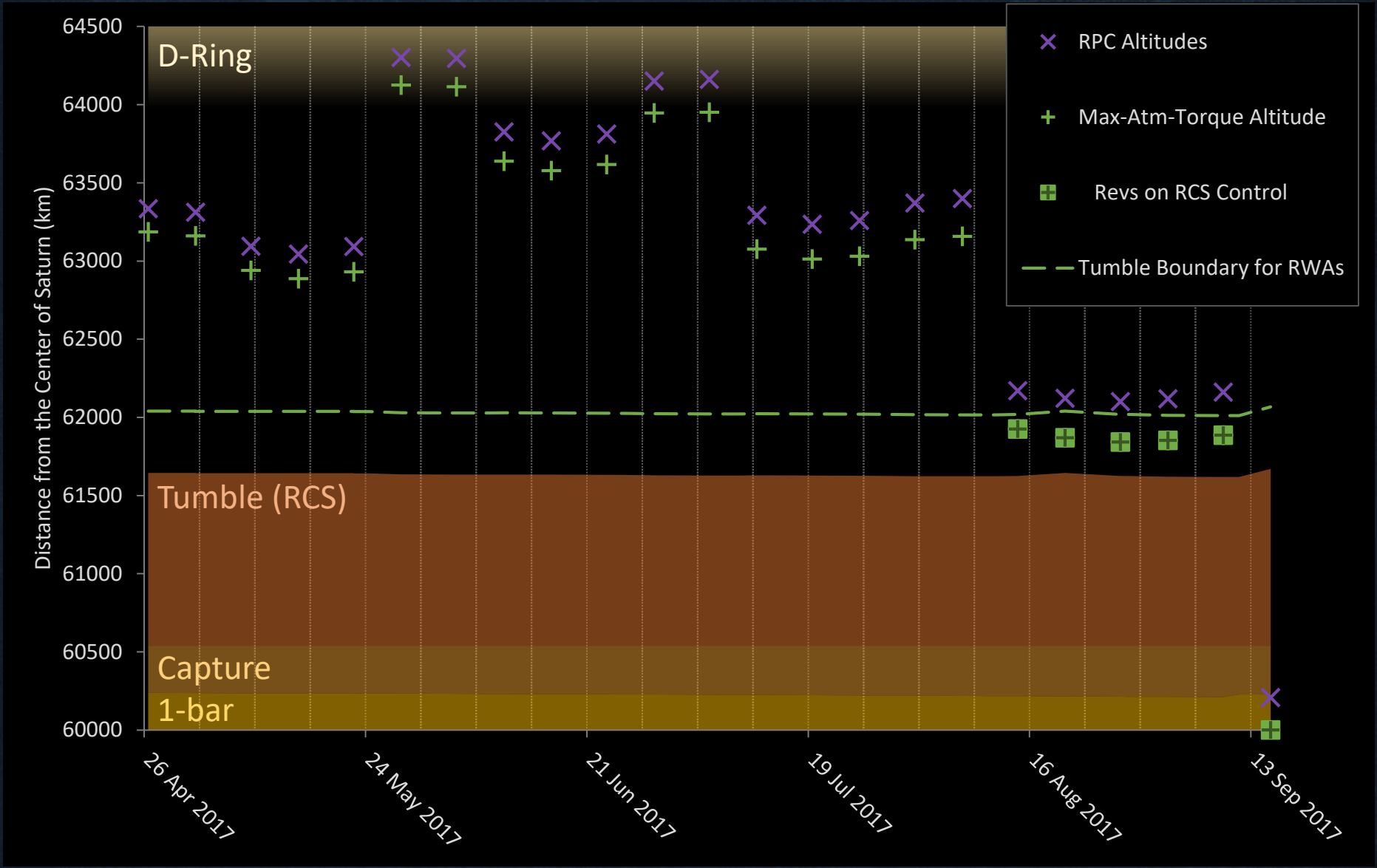
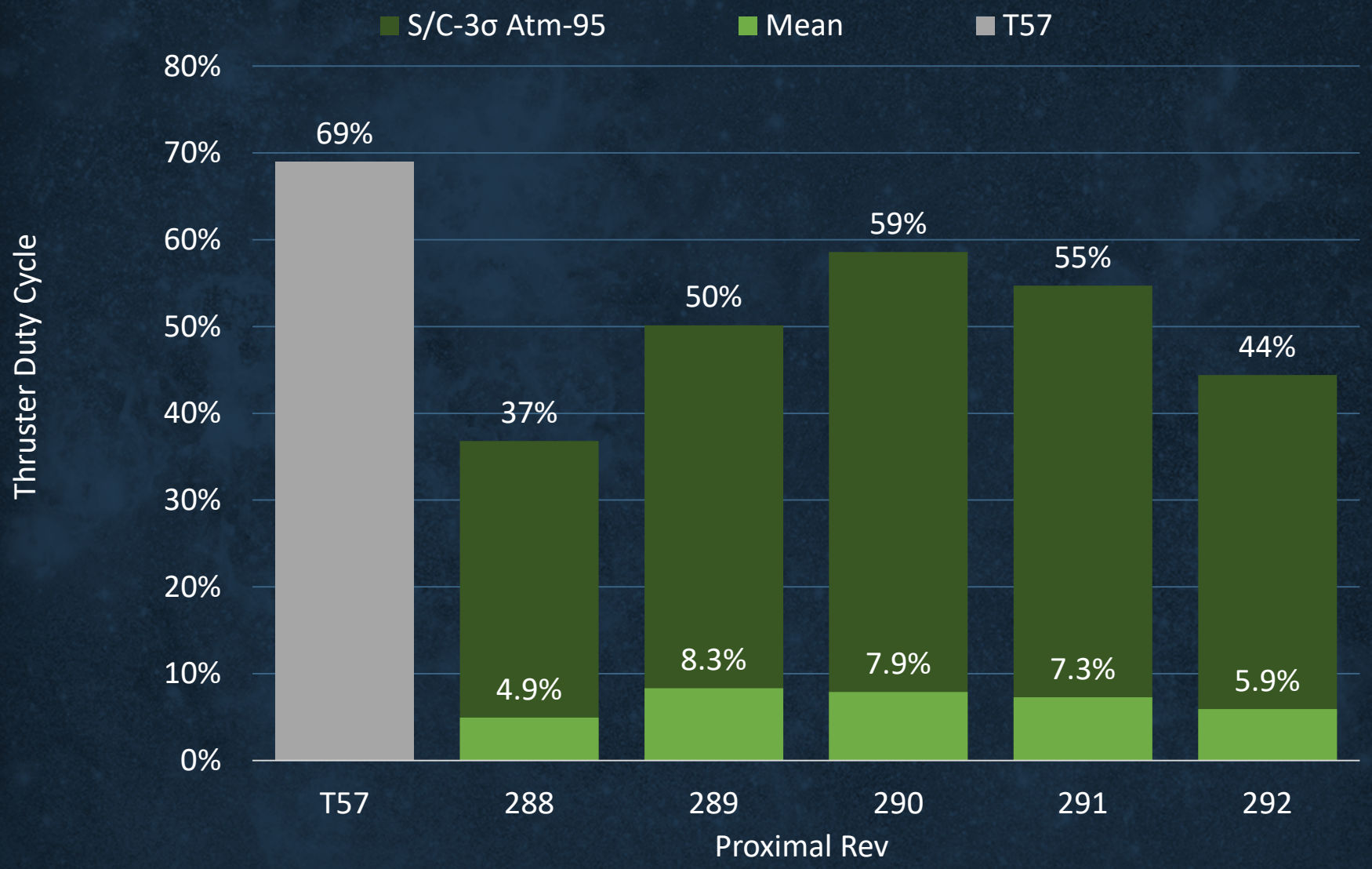
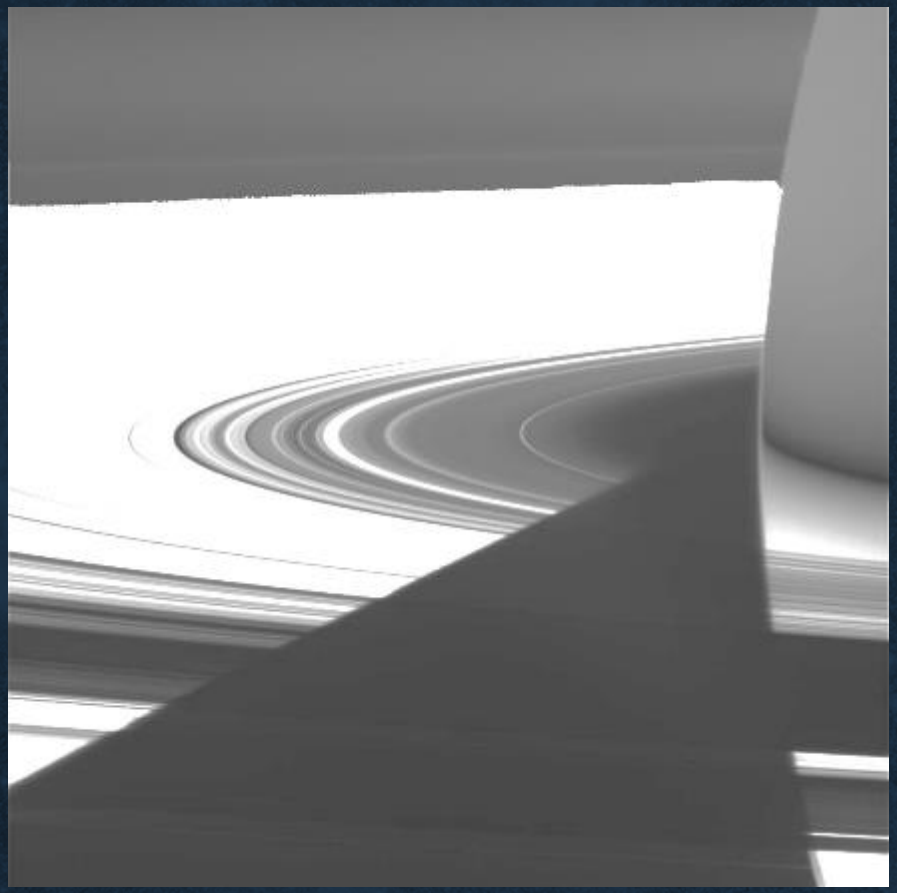
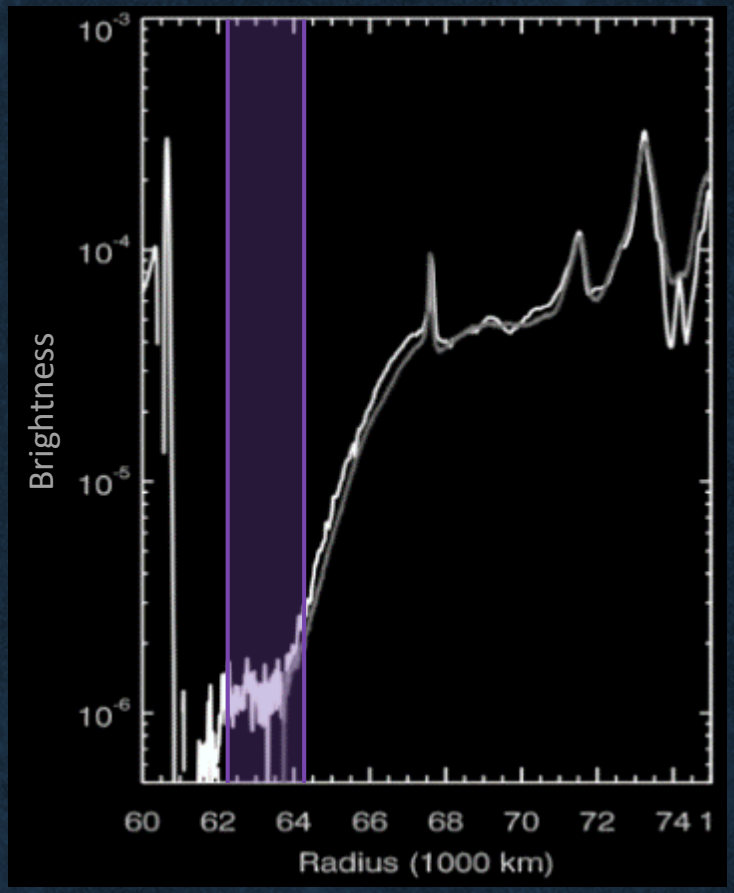


Atmosphere Density



Remote Dust Detection





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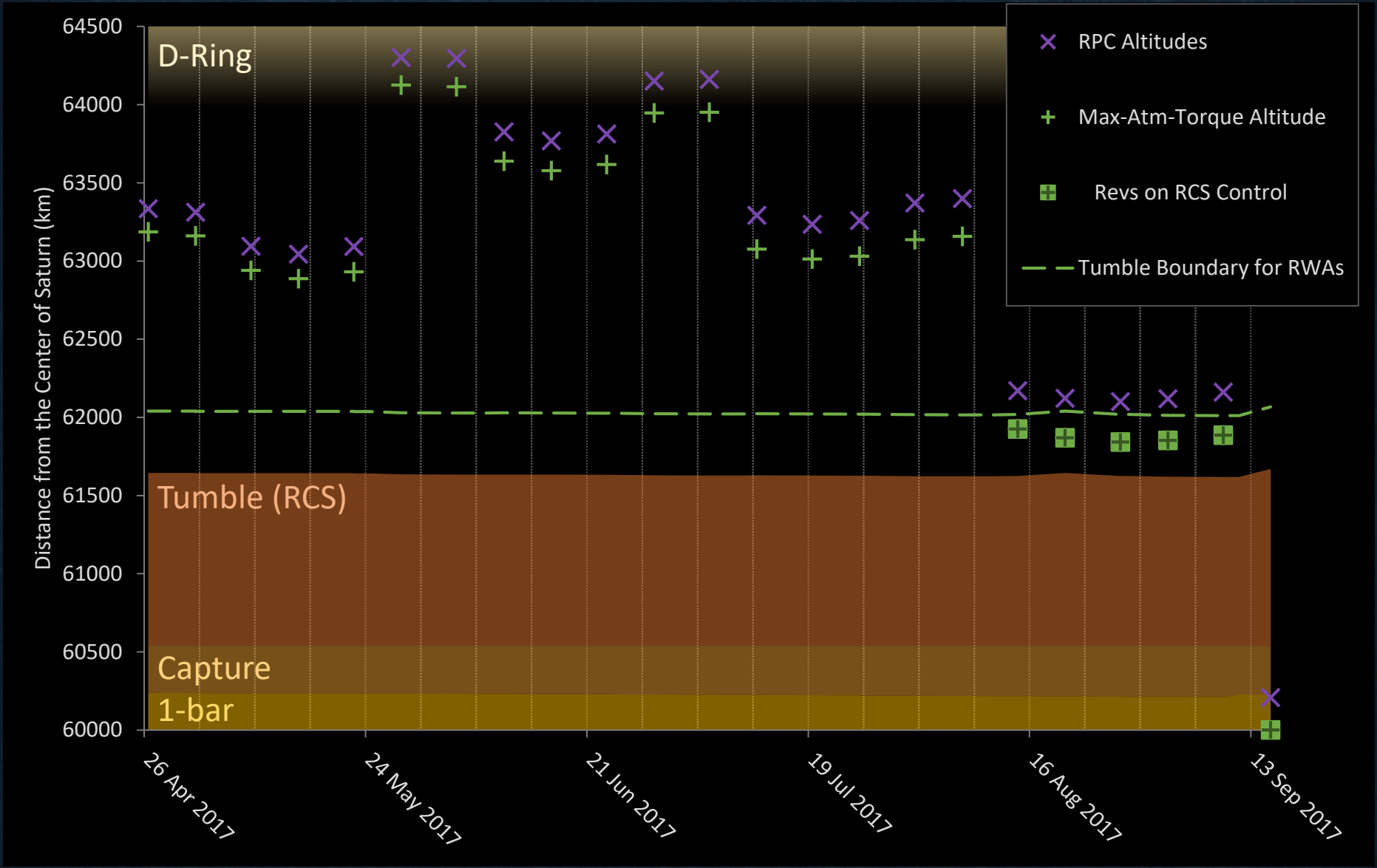

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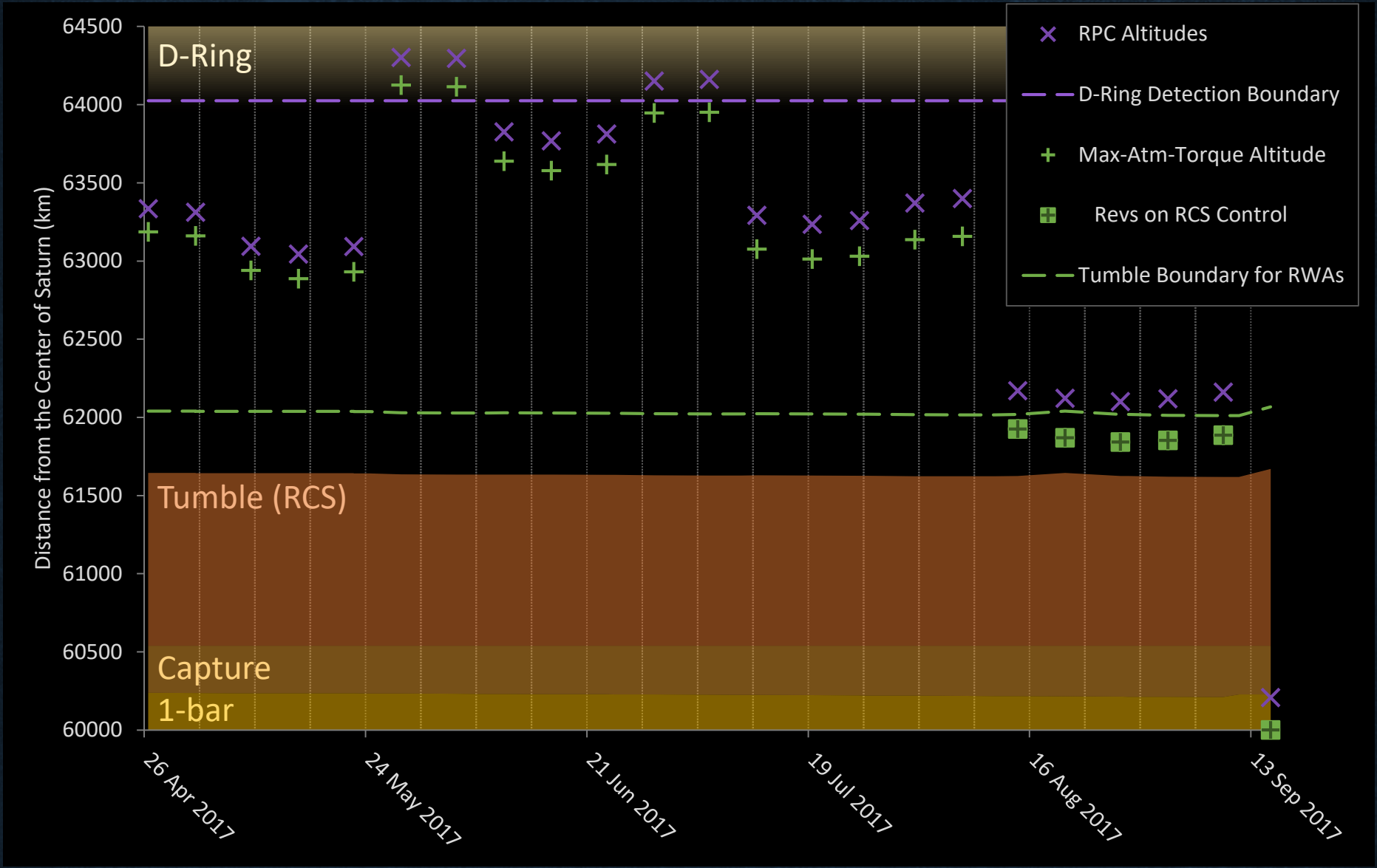

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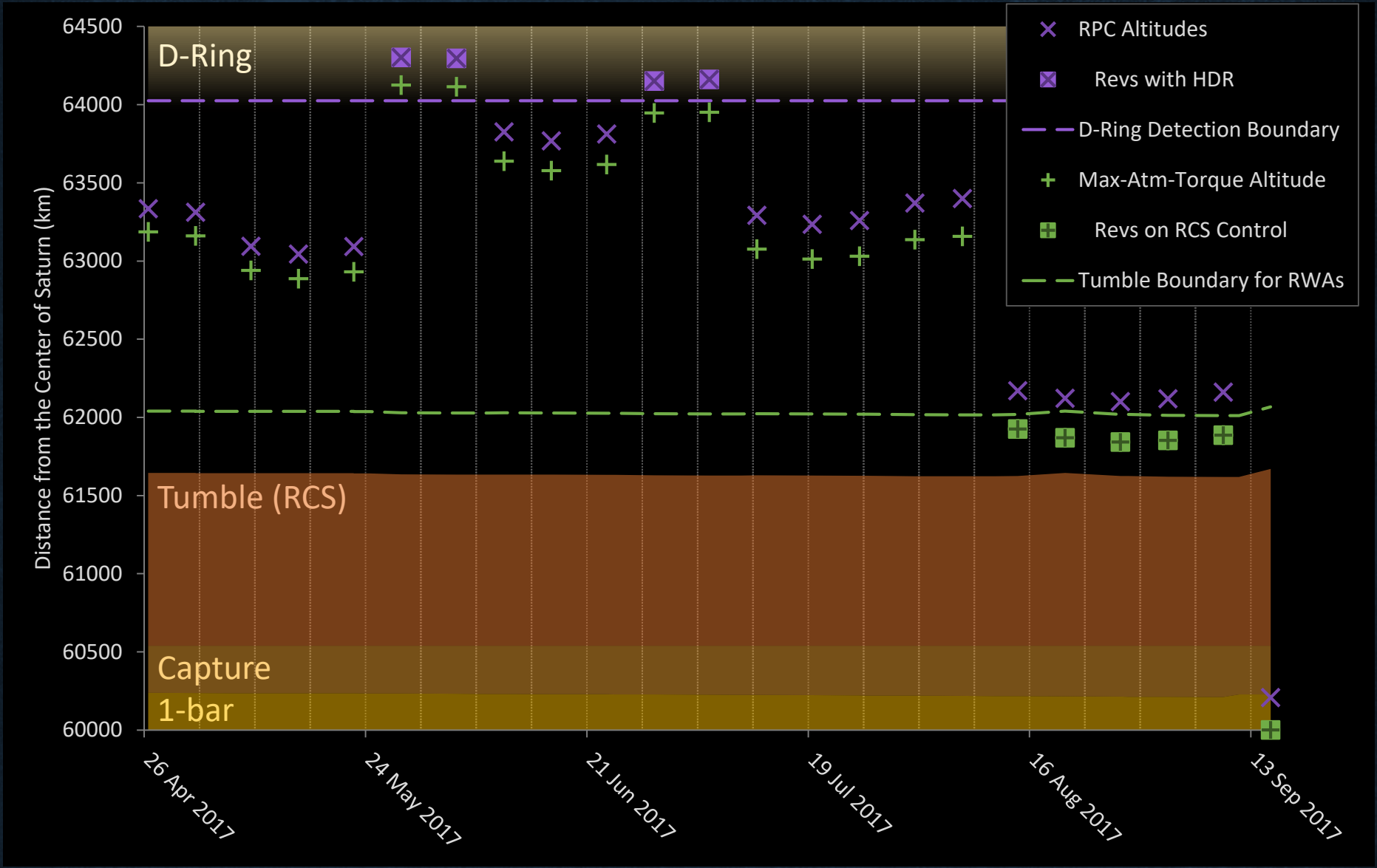
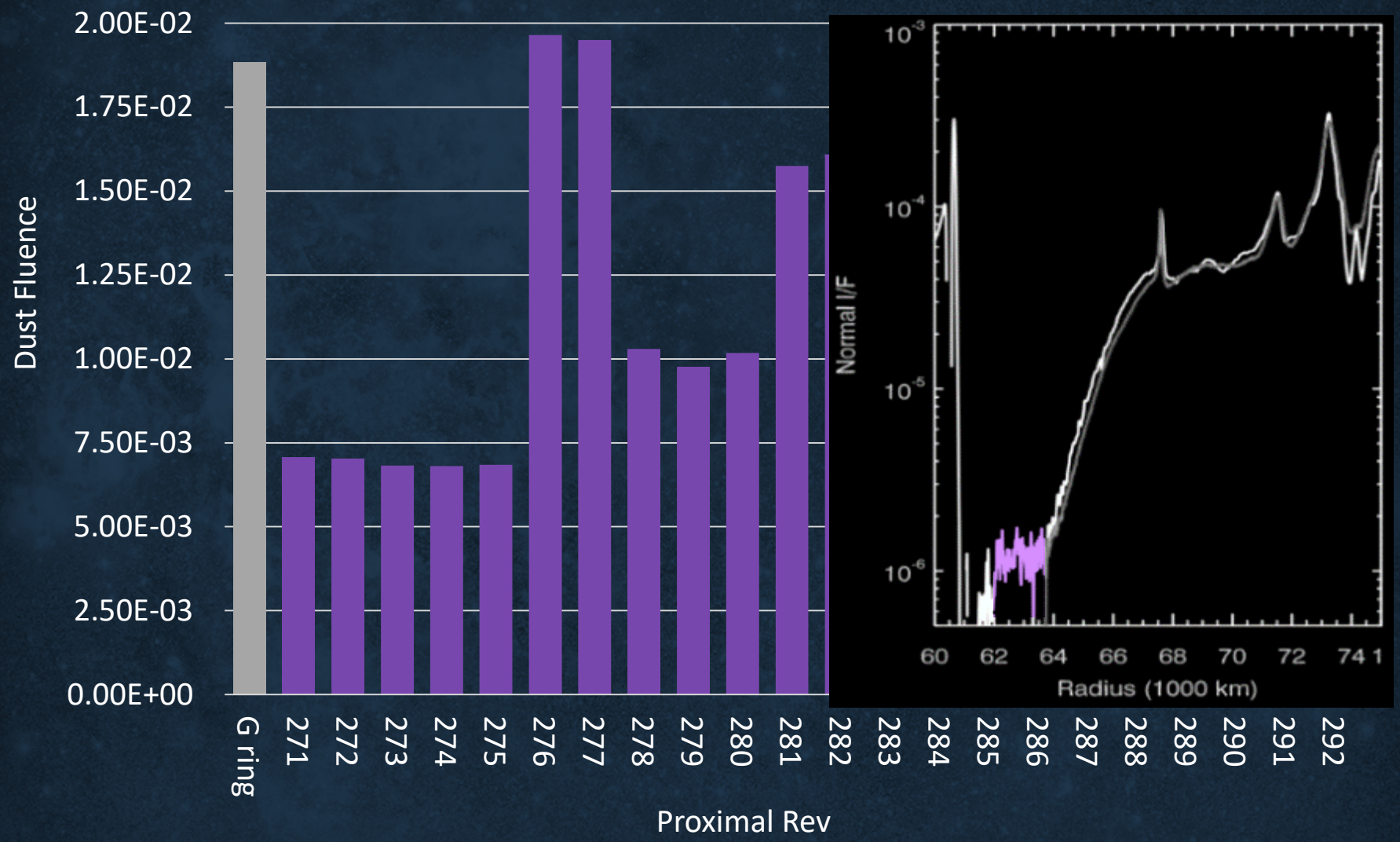
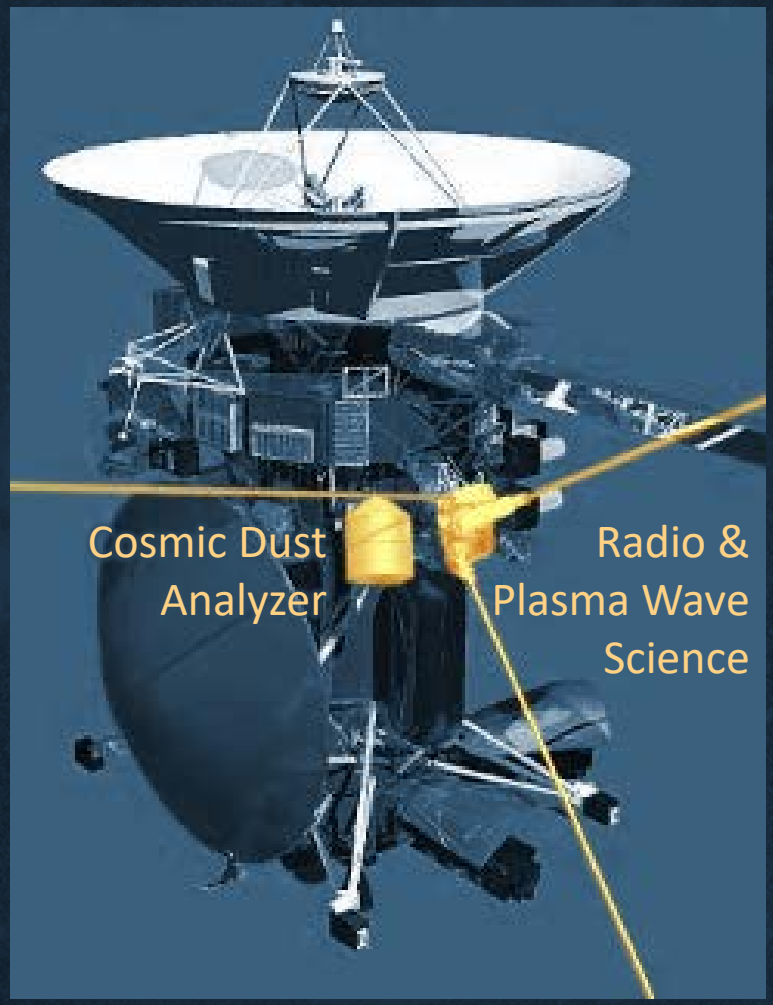


Dust Fluence

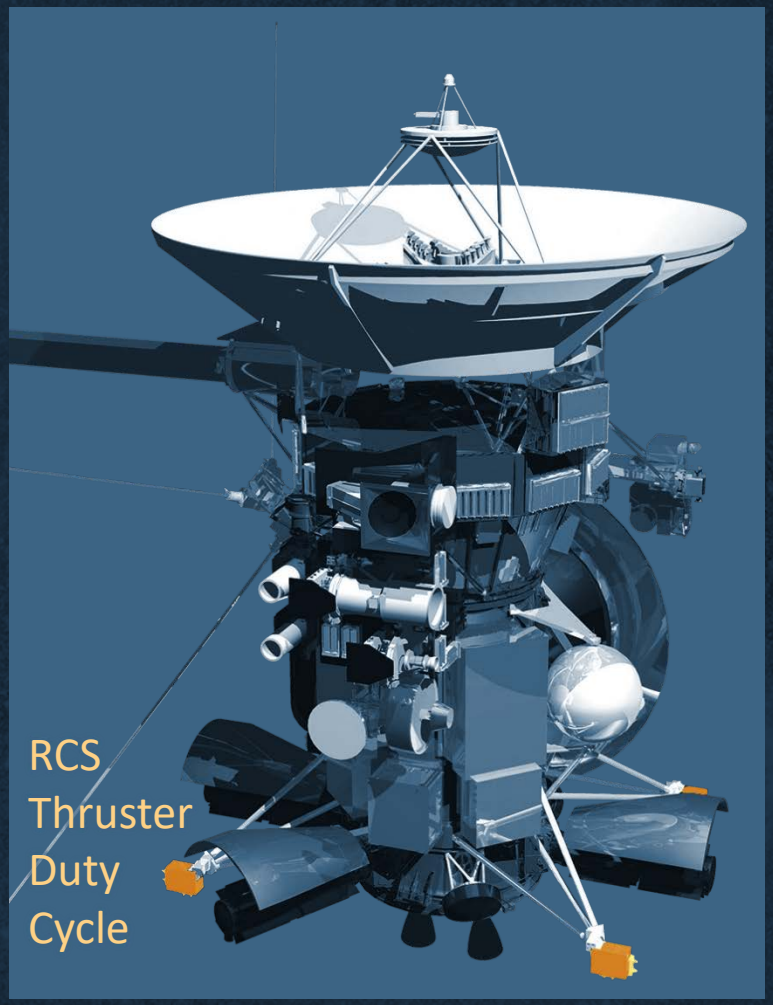


In-Situ Hazard Detection

Dust



Atmosphere



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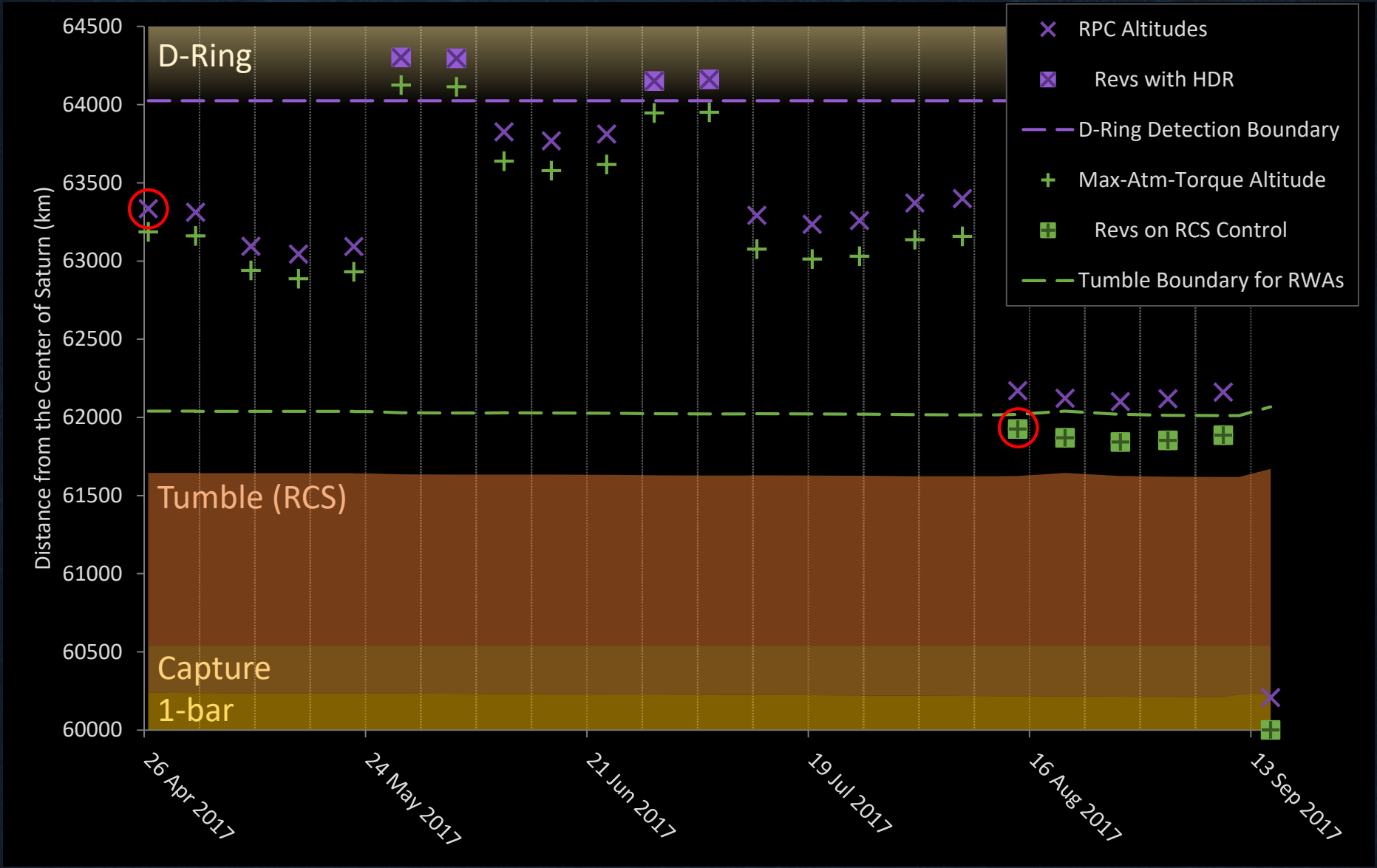

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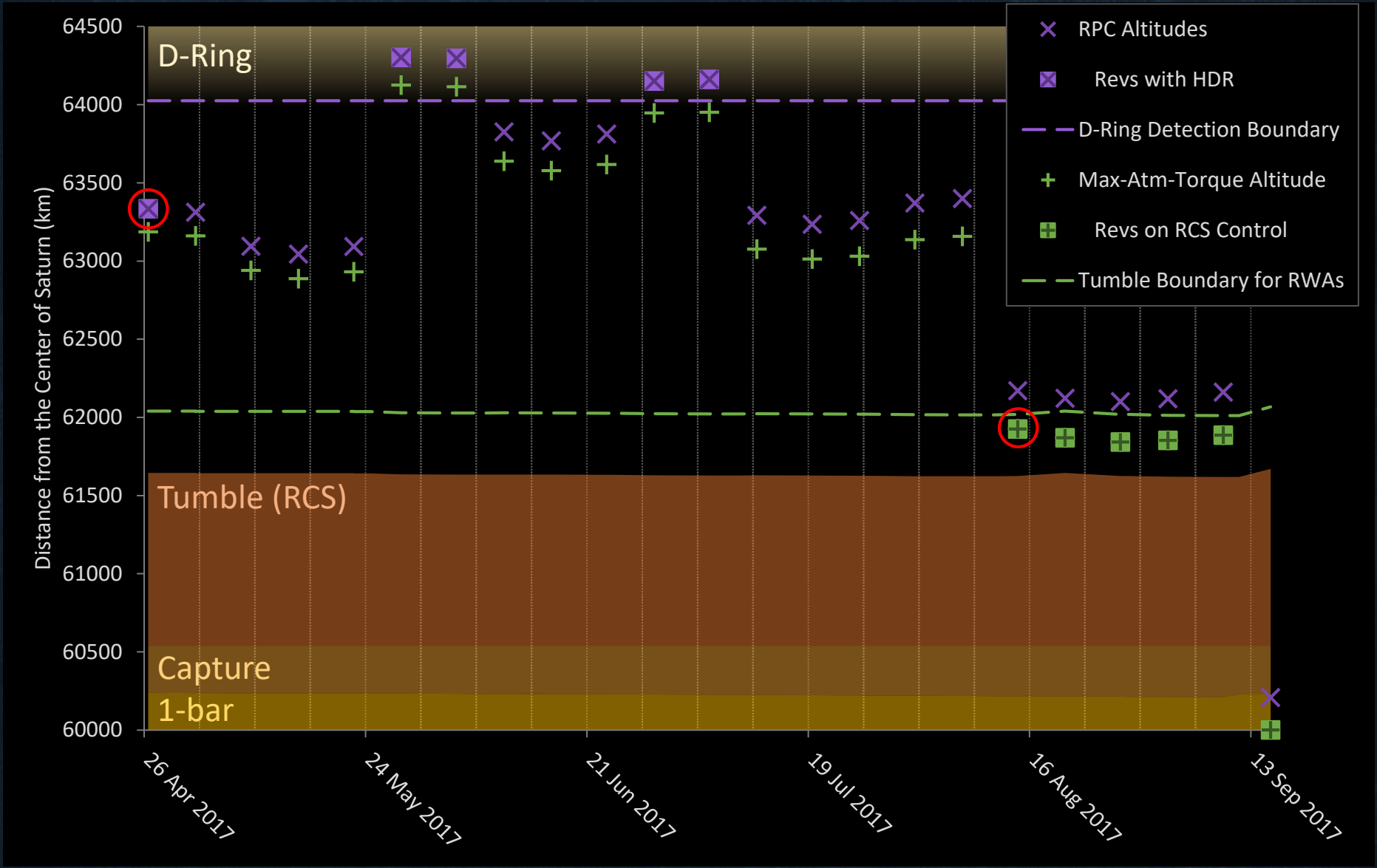
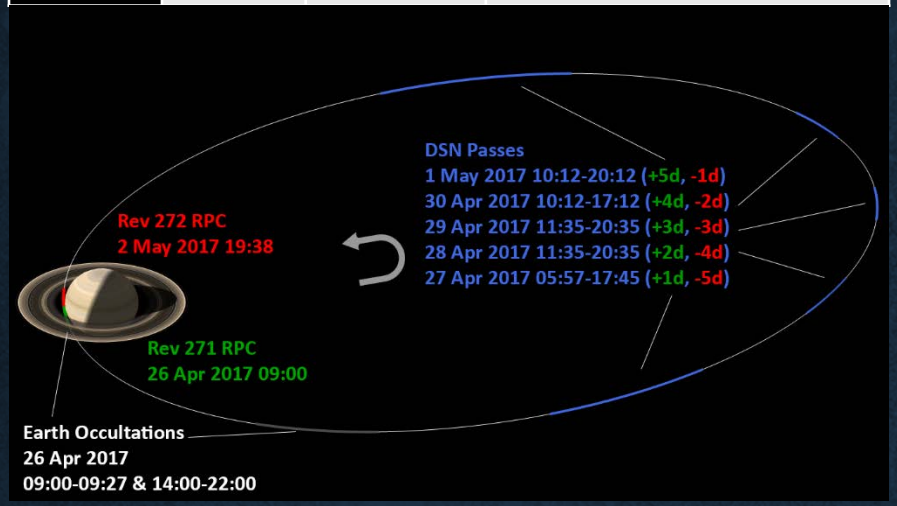
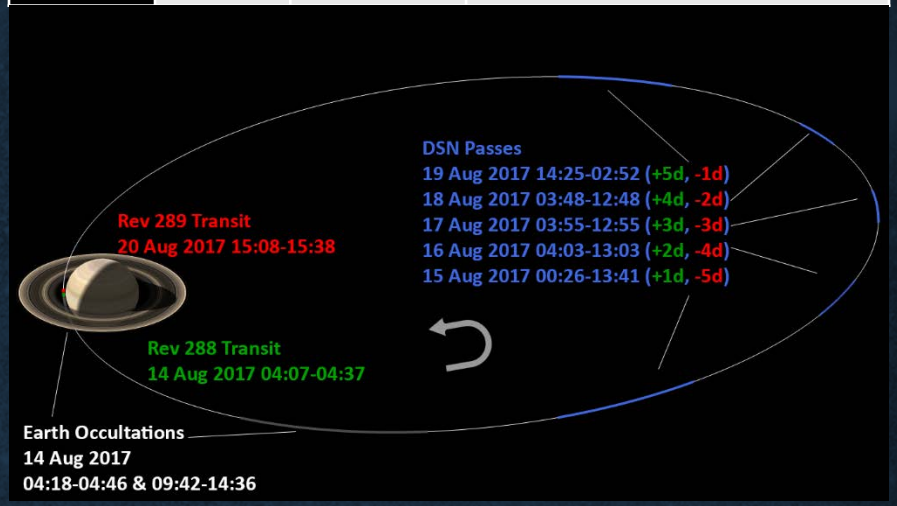


Contingency Timeline

Timeframe	Date	Team(s)	Action
RPC -6 days	26 Apr 2017		Rev 271 ring-plane crossing
RPC -5 days	27 Apr 2017		Downlink and dual playback of RPWS and CDA data from Rev 271 RPC
RPC -5 days to RPC -2 days	27 Apr 2017 to 30 Apr 2017	RPWS CDA MP	Quick assessment of proximal dust environment (RPWS/CDA) and risk to spacecraft (MP)
RPC -2 days	30 Apr 2017	PM	Final decision on implementing contingency response
RPC -2 days RPC -1 day	30 Apr 2017 01 May 2017	Science Planning Real-time Ops	Uplink opportunities for contingency real-time program
Rev 272 RPC	02 May 2017		Rev 272 ring-plane crossing

Timeframe	Date	Team(s)	Action
P289 -6 days	14 Aug 2017		Rev 288 atmospheric transit
P289 -5 days	15 Aug 2017		Downlink of thruster duty cycle data from P288
P289 -5 days to P289 -2 days	15 Aug 2017 to 18 Aug 2017	AACS	Assessment of atmospheric density from thruster duty cycle data
P289 -2 days	18 Aug 2017	PM	Final decision on implementing contingency response
P289 -2 days P289 -1 day	18 Aug 2017 19 Aug 2017	Science Planning Real-time Ops	Uplink opportunities for contingency real-time program
Rev 289 Periapsis	20 Aug 2017		Rev 289 atmospheric transit





Summary

- Grand Finale
  - 22½ orbits between Saturn's rings and atmosphere
  - Spacecraft disposal
  - Unique science opportunities
- Potential environmental hazards
  - Ring particle dust
  - Saturn atmosphere
- Environmental contingency plans
  - Enable responding to in-situ measurements of the environment
  - Allow nominal plan to focus on science without sacrifice spacecraft health & safety

Questions?