The World's Forum for Aerospace Leadership

Using AUTORAD for Cassini File Uplinks: Incorporating Automated Commanding into Mission Operations

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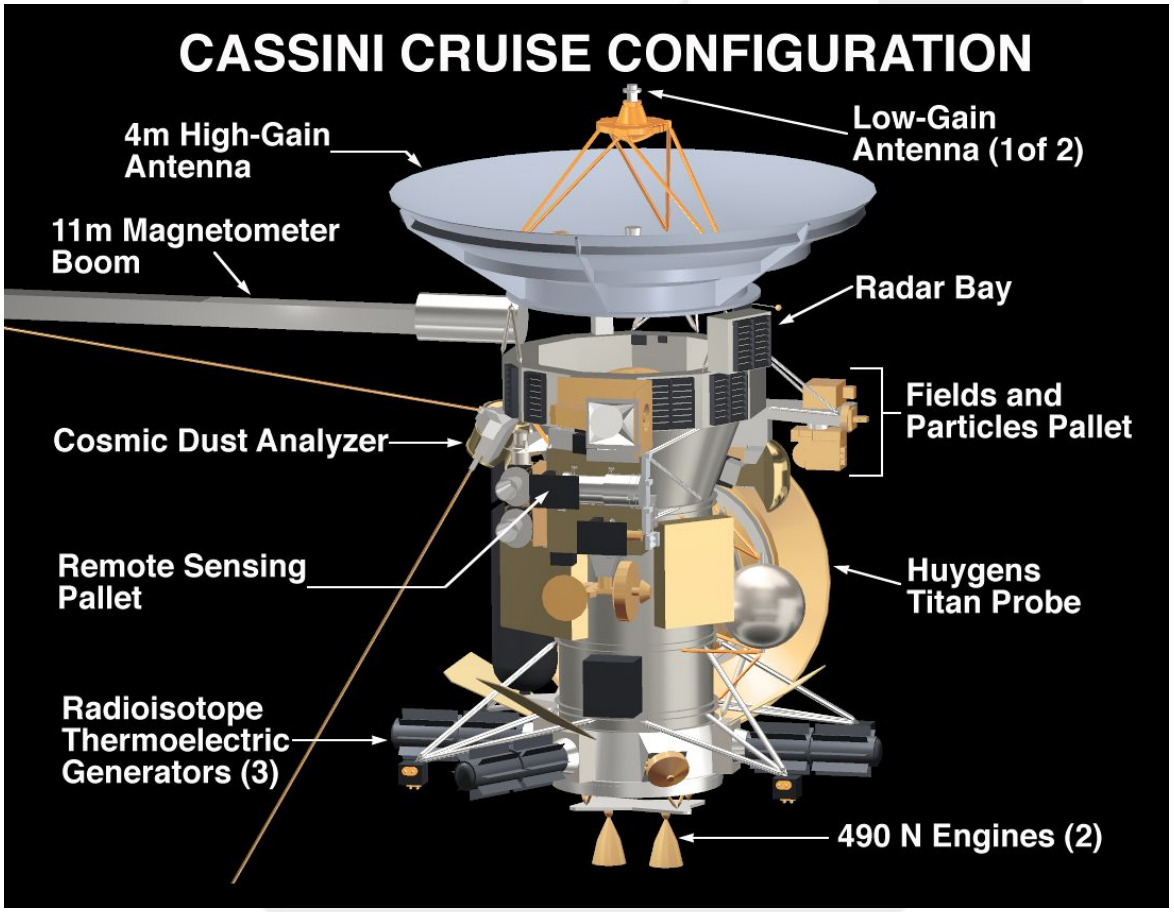
- Cassini is the largest and most complex interplanetary spacecraft ever launched
- Twelve instruments are mounted on the orbiter
- The Huygens Titan Probe was built and operated by ESA



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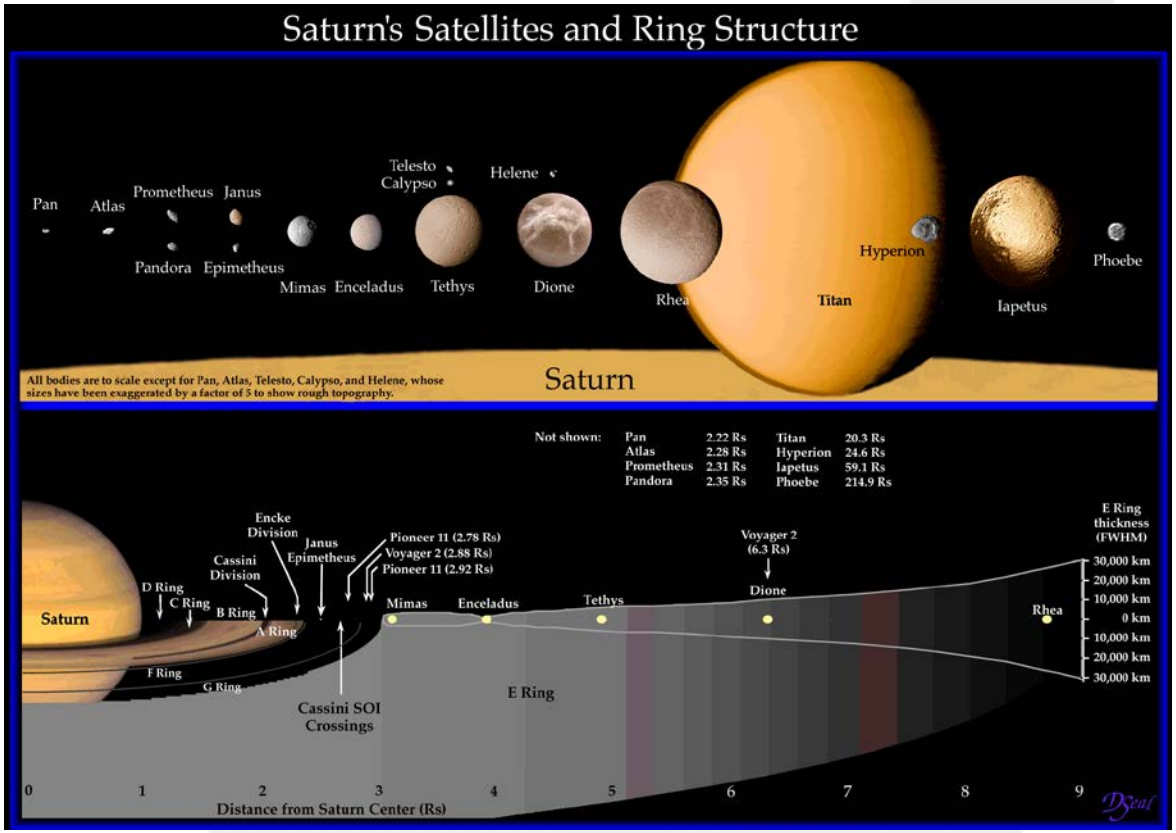
5 Science Objectives

- Titan, Saturn, Rings, Icy Satellites, Magnetosphere

7 year Solstice Mission

- 56 targeted Titan flybys
- 12 targeted Enceladus flybys
- 5 targeted icy satellite flybys
- Solstice Mission funding and workforce decreased significantly



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Cassini Real-Time Command Process

Cassini Command Request Form

GO TO CRF 'BACK SIDE'
Status: Uplinked
Last modified by geller
at 12 / 16 / 2013 15 : 11
Cancel Refresh Read Only

☐ Contingency
Type
Expires: 2013 361 T 22 : 56
☐ EOM
LOG No. 13-7475

Descriptive title of this command file: *(Plain language rather than mnemonics)*
Please do not use any apostrophes (') in the title.
VIMS S82 IEB SSR LOAD001

Purpose of Command
☒ Planned Sequence
(list memory address under characteristics)
☒ SCO Procedure
(Specify Procedure ID) SCO-1970
(Specify)
☐ Anomaly Resolution
(Specify ISA #)
☐ Preparation in Case of Anomaly
☐ Planned Mini-Sequence
☐ Other

Downlink Effects:
☐ Red Alarms persisting past EOT:
☐ Transient Red Alarms clearing before EOT:
☒ Real Time MRO Downlink
☐ Telecom Link Effects (LOS, etc. Specify)

If an alarm text does not fit in the text box, put 'See Instructions,Additional Information' in that field and put the alarm text in the instruction space below.

Ace: retrieve CMD files(s) listed above...
From SEQOPS DOM Collection S82
ACE Radiate at 500.0000 BPS
☐ CPF Delays are suitable for U/L at any rate

Sequence No. S82
CPF Name: e6459a.cpf
SASF Name: i6459a_VIMS_S82_IEB_SSR_LOAD001.sasf
Command File:
Name: e6459a.scmf
FCT:
2013 336 T 23 : 50 : 25
Checksum: bb5b

No. Msgs: 453
No. of CMDs in file (if known): 1885
Built by: Jo ELIZA Pitesky
Total Radiation Time:
00 : 39 : 47
Calculated Rate: 500.0000

☒ Ace Checked Bit Rate
☒ Ace Check FCT at U/L Time
MSSO put to DSOT DOM, viewed, checked:
Mandel Eller
12 / 11 / 2013 10 : 06

Reference Log No.

Cmd File Characteristics
Nominal
☐ This is a new CRF for existing CMD File
☒ Restricted CMDs

☐ Absolute ☒ Relative/Immediate
SCET Execution Start (for absolute time):

Execution Duration:
00 T 00 : 38 : 51

Memory Addresses (if applicable)
0x 1232c to 0x 1efff

- The electronic Command Request Form (eCRF) is the reference for the Cassini Sequence Implementation Lead (SIPL) and the ACE to uplink approved real-time commands
  - Command files are verified by visual inspection of the file name and file creation time

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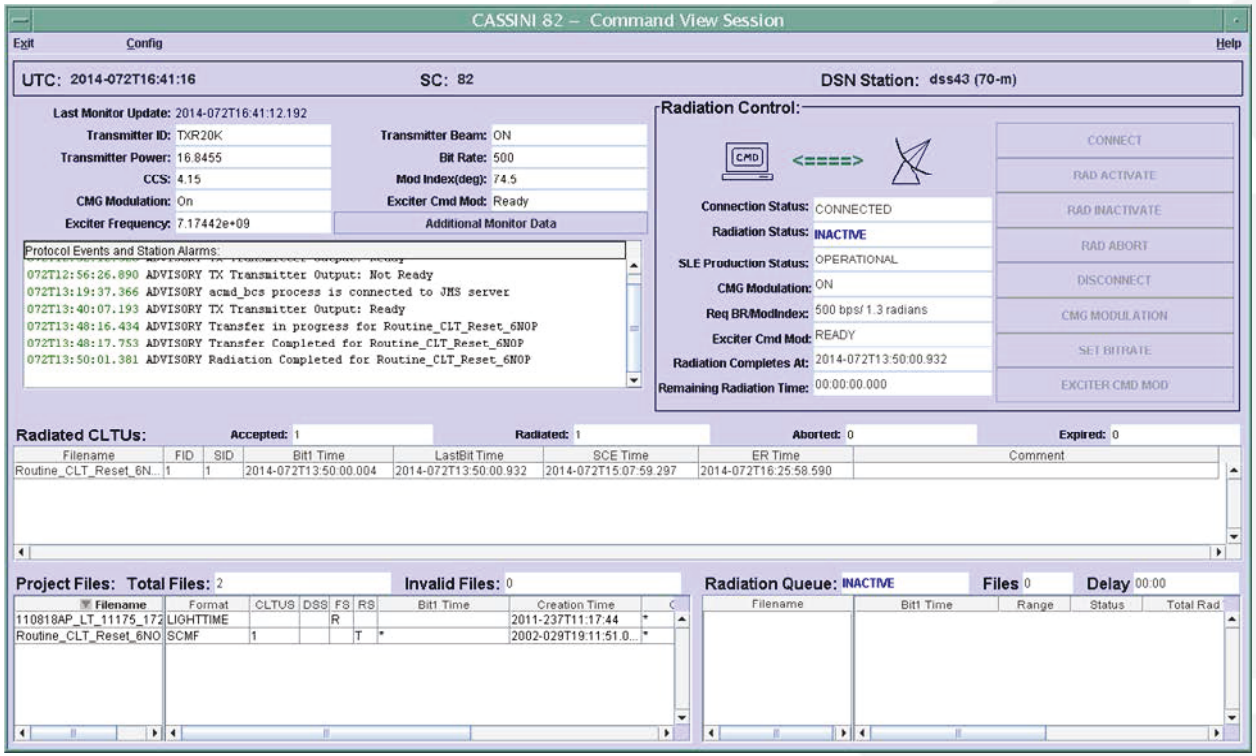
Cassini Real-Time Command Process



- The ACE transfers files to the radiation queue with data entries by hand
- Two person rule requires the SIPL and the ACE to verify the command to be radiated in real-time

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Cassini Real-Time Command Process

- Assigned Deep Space Network (DSN) tracks for telemetry and commanding can occur at any day or time
  - The SIPLs assigned to the executing background sequence usually have responsibilities and assignments which take place during prime shift
  - Activities requiring significant amounts of real-time commanding can interfere with SIPL duties during normal working hours
- Automation of this process would help minimize errors

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Integrating AUTORAD into the Real-Time Command Process

- The AUTORAD utility presented an opportunity for Cassini to minimize both needed off shift workforce for real time command support and the risk of introducing command errors
- These opportunities were realized through AUTORAD itself and the processes & scripts implemented to integrate AUTORAD into the Cassini real-time command process

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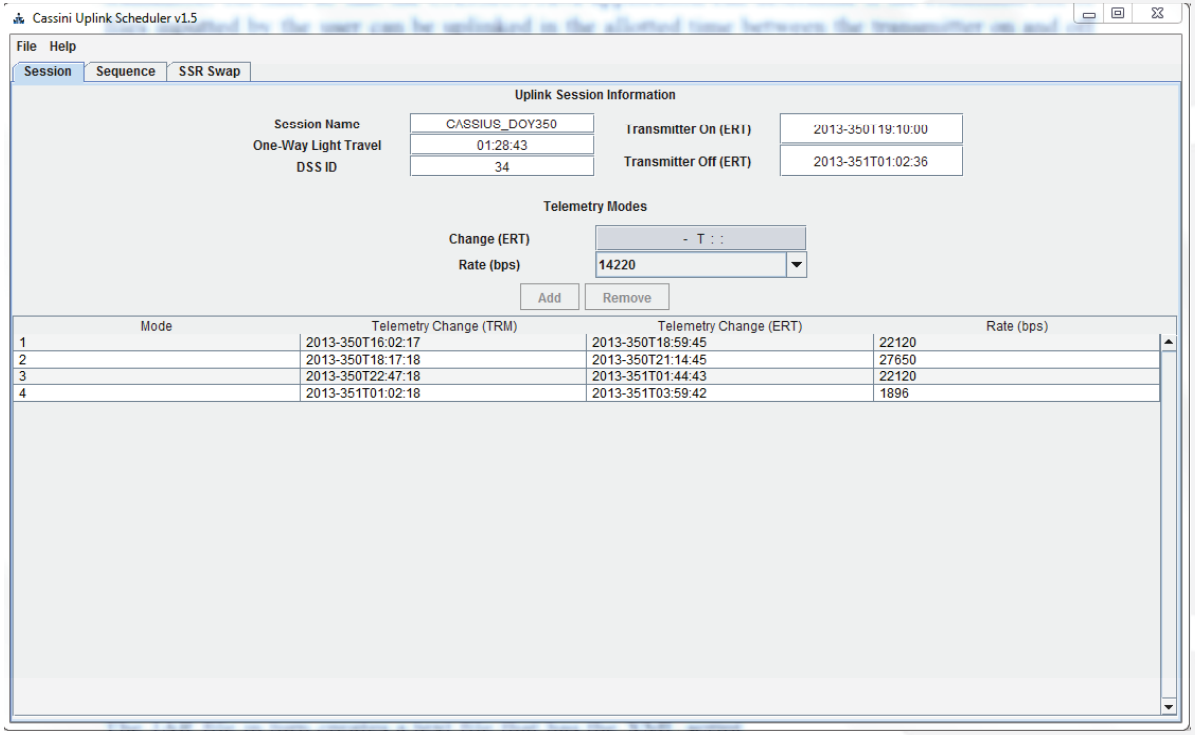
Integrating AUTORAD into the Real-Time Command Process



- The CASSIUS executable was developed to generate the AUTORAD session XML file
  - Data extracted from the Sequence of Events file (SOE) gives CASSIUS the DSN track and telemetry mode time change information needed to schedule Instrument Expanded Block (IEB) command uplink times

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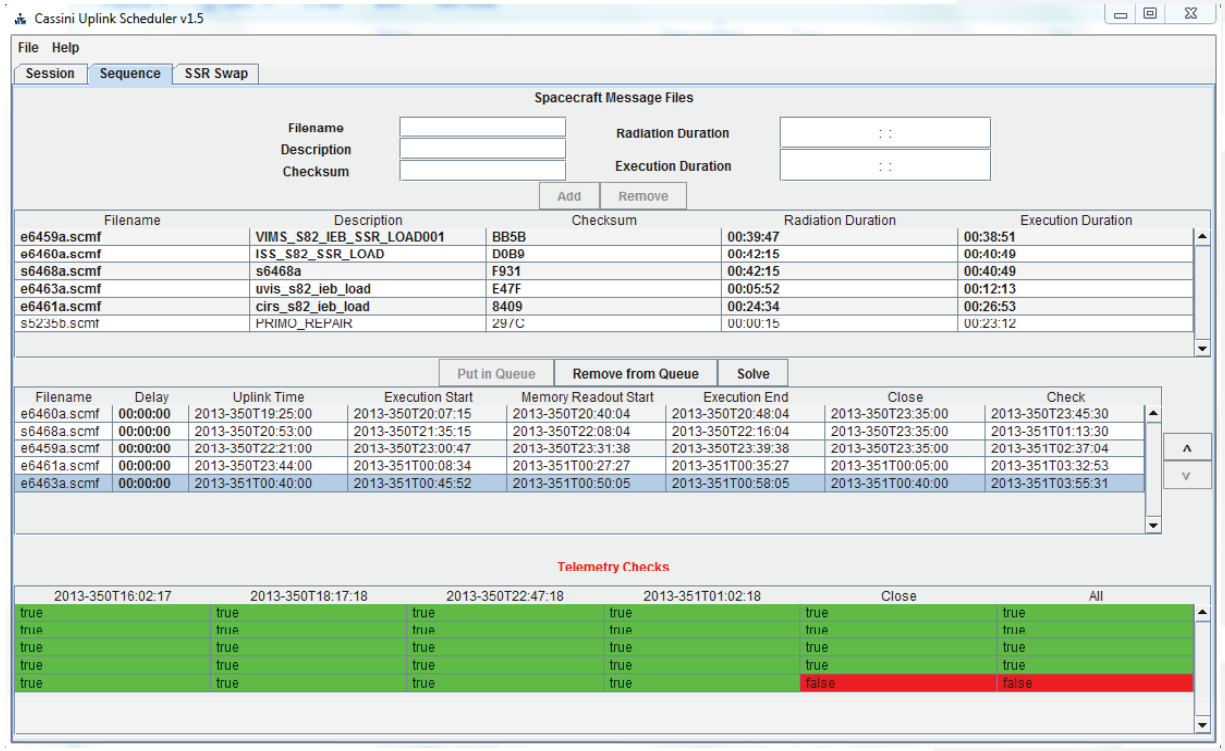

- CASSIUS also uses command file data from the CASSINI Distributed Object Manager (DOM) to allow the SIPL to create the uplink order for a set of commands
  - Uplink/execution/Memory Readout (MRO) times are compared to the telemetry mode changes to ensure uninterrupted file execution

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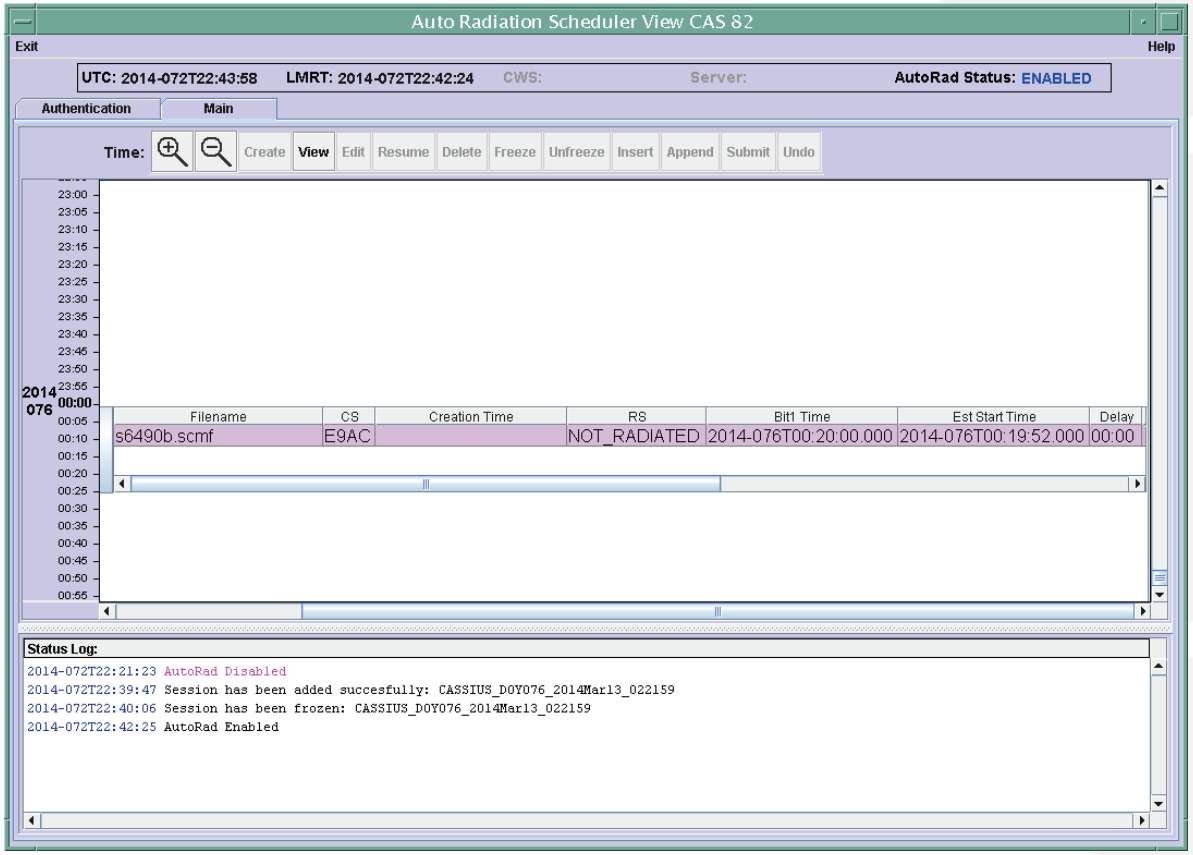

- The Cassini Real Time Operations (RTO) team lead loads the CASSIUS generated XML file is loaded into AUTORAD and freezes the session when AUTORAD is enabled
  - Both the SIPL and the RTO team lead verify the session contents before AUTORAD is enabled

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Advantages of using AUTORAD

- AUTORAD sessions are nominally verified and loaded during prime shifts
  - This reduces the need for the SIPLs to support sequence development activities during the weekdays and off-prime shifts/weekend commanding
  - Less impact for the SIPL and SIP team workforce needed for real-time commanding
- The scripts and executables developed to support AUTORAD directly access online information for the real-time commands and DSN tracks
  - Minimizes risk of possible command errors due to manual hand entries
  - Scheduling uplinks of IEB command files can utilize automated checks of telemetry modes to ensure uncorrupted MROs

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Conclusion

- AUTORAD has helped minimize impacts on the Cassini operations team workforce caused by off-shift commanding and eliminate possible command errors caused by mistakes in manual data entries
  - AUTORAD automation in both the real-time command approval and uplink process has contributed significantly in these areas
- All commands radiated using AUTORAD has been successfully received on board the Cassini spacecraft

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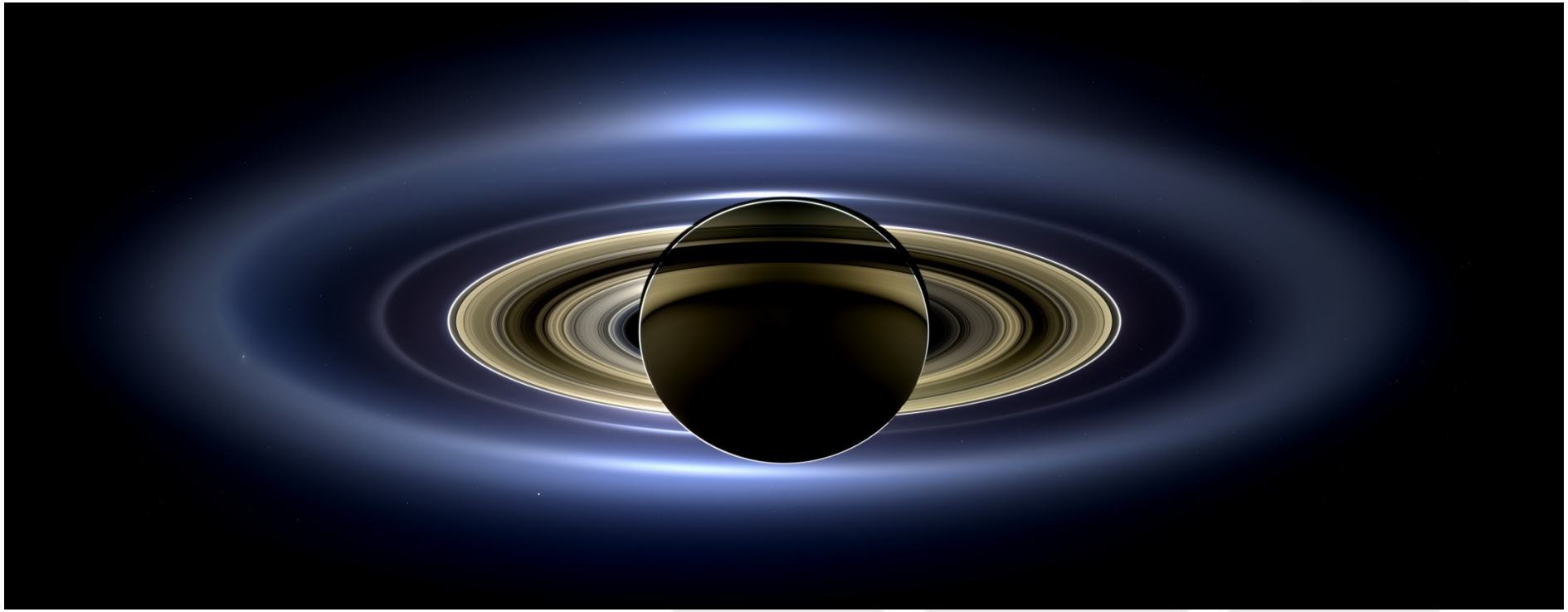

- This backlit mosaic image of Saturn was created by combining a total of 141 images taken by the Cassini wide angle camera at a distance of 1.2 million km on 19 July 2013
- The Cassini orbiter continues to operate nominally and is returning great science data and images!

AIAA

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