

Space probe image  
processing by amateur  
astronomers

# SUMMARY

1. WHY?
2. WHERE FROM?
3. APPROACH
4. NEW HORIZONS EXAMPLE
5. CASSINI EXAMPLE
6. CREDIT/COPYRIGHT




# 1. WHY?





# 2. WHERE FROM?

## 2. WHERE FROM?



PDS: The Planetary Data System

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April 1, 2015  
[Odyssey Data Release 51](#)

March 16, 2015  
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[Rings](#)  
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
## Welcome to the PDS

### Important Community Announcement

The National Aeronautics and Space Administration (NASA) Science Mission Directorate is releasing a Cooperative Agreement Notice (CAN) soliciting team-based proposals for participation in the NASA Planetary Data System (PDS) as Discipline Nodes.

For details of the CAN at NSPIRES, please visit: [PDS Discipline Nodes CAN at NSPIRES](#).

Additional info of the CAN can be found at: [PDS Management CAN 2015 Site](#).



The PDS archives and distributes scientific data from NASA planetary missions, astronomical observations, and laboratory measurements. The PDS is sponsored by NASA's Science Mission Directorate. Its purpose is to ensure the long-term usability of NASA data and to stimulate advanced research. All PDS data are publicly available and may be exported outside of United States under "Technology and software Publicly Available" (TSPA) classification. [Learn more about PDS](#).


If you're beginning a new archiving project, you must use PDS4 and you can start from [here](#).

If you're developing a dataset in response to Planetary Data Archiving, Restoration and Tools (PDART), you can start from [here](#).

If you're developing a dataset in response to SMALL INNOVATIVE MISSIONS FOR PLANETARY EXPLORATION (SIMPLEx), you can start from [here](#).

| Researchers                               | Data Providers                           | Data Reviewers                          | Proposers                            |
|---|--|---|--------------------------------------|
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PDS: The Planetary Data System

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## Raw data taken by New Horizons Long Range Reconnaissance Imager instrument during the JUPITER mission phase.


Citation: Cheng, A., NEW HORIZONS LORRI JUPITER ENCOUNTER V1.1, NH-L-LORRI-2-JUPITER-V1.1, NASA Planetary Data System, 2007.

Data Set Abstract: This data set contains Raw data taken by the New Horizons Long Range Reconnaissance Imager instrument during the Jupiter encounter mission phase.

Search/Access Data: [SBN Comet Website](#)

### Additional Information

|                        |  |
|------------------------|--|
| Mission Information    | NEW HORIZONS   |
| Data Set Information   | NH-L-LORRI-2-JUPITER-V1.1  |
| Instrument Host        | NH   |
| Information            | LORRI  |
| Instrument Information | CALIBRATION<br>EARTH<br>JUPITER<br>J RINGS<br>CALLISTO<br>GANYMEDE |
| Target Information     | J1 IO<br>J2 EUROPA<br>J6 HIMALIA<br>J7 ELARA                       |

 Privacy / Copyright  
Freedom of Information Act



# 3. APPROACH

## WORK STEPS

1. Choosing a subject: planet, moon etc.
2. Identification of the space probes which visited the object
3. Choosing a mission which gathered the needed type of data
4. Identification of the instrument which gathered the needed type of data
5. Knowing the instrument
6. Looking for the data in PDS
7. Data processing



# Knowing the instrument

## CASSINI IMAGING SCIENCE: INSTRUMENT CHARACTERISTICS AND ANTICIPATED SCIENTIFIC INVESTIGATIONS AT SATURN

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<sup>11</sup>DLR, Berlin, Germany

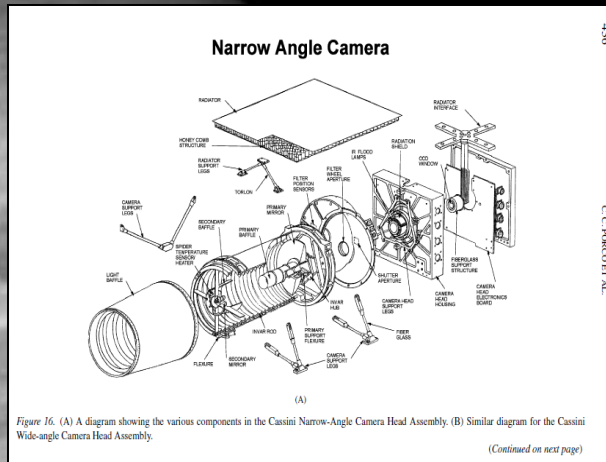
(\*Author for correspondence: E-mail: carolyn@ciclops.org)

(Received 8 January 2004; Accepted in final form 18 May 2004)

**Abstract.** The Cassini Imaging Science Subsystem (ISS) is the highest-resolution two-dimensional imaging device on the Cassini Orbiter and has been designed for investigations of the bodies and phenomena found within the Saturnian planetary system. It consists of two framing cameras: a narrow angle, reflecting telescope with a 2-m focal length and a square field of view (FOV) 0.35° across, and a wide-angle refractor with a 0.2-m focal length and a FOV 3.5° across. At the heart of each camera is a charged coupled device (CCD) detector consisting of a 1024 square array of pixels, each 12 μm on a side. The data system allows many options for data collection, including choices for on-chip summing, filter imaging and data compression. Each camera is outfitted with a large number of spectral filters which, taken together, span the electromagnetic spectrum from 200 to 1100 nm. These were chosen to address a multitude of Saturn-system scientific objectives: sounding the three-dimensional cloud structure and meteorology of the Saturn and Titan atmospheres, capturing lightning on both bodies, imaging the surfaces of Saturn's many icy satellites, determining the structure of its enormous ring system, searching for previously undiscovered Saturnian moons (within and exterior to the rings), peering through the hazy Titan atmosphere to its yet-unexplored surface, and in general searching for temporal variability throughout the system on a variety of time scales. The ISS is also the optical navigation instrument for the Cassini mission. We describe here the capabilities and characteristics of the Cassini ISS, determined from both ground calibration data and in-flight data taken during cruise, and the Saturn-system investigations that will be conducted with it. At the time of writing, Cassini is approaching Saturn and the images returned to Earth thus far are both breathtaking and promising.

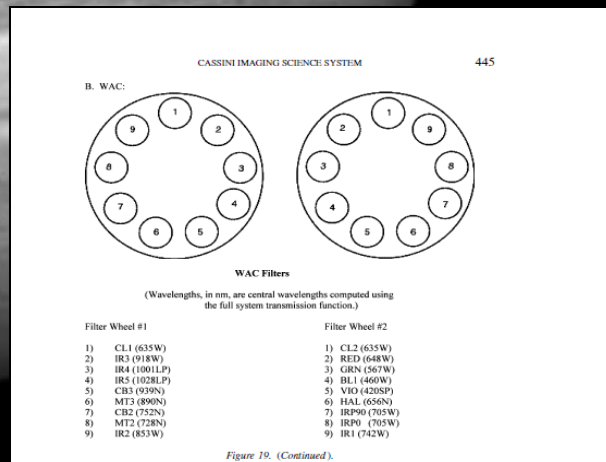
**Keywords:** Cassini, Saturn, Imaging, Rings, Moons

 Space Science Reviews 115: 363–497, 2004.  
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(Continued on next page)



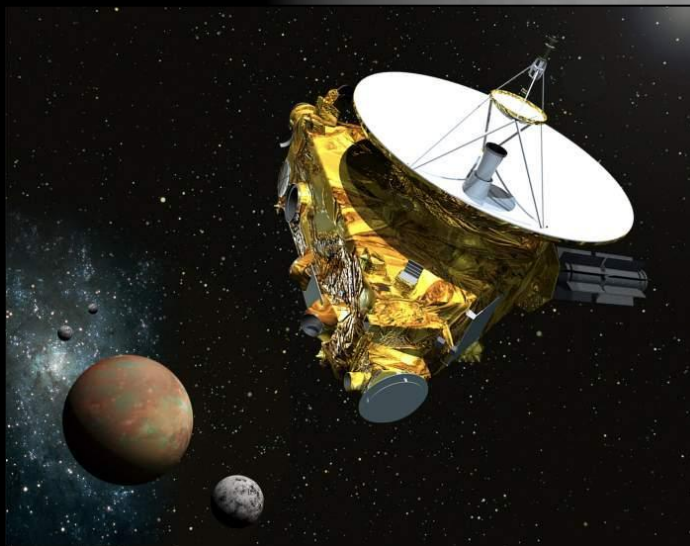


# 4. NH EXAMPLE

## 4. NH EXAMPLE

New Horizons is a mission whose purpose is to gather precise data of the Pluto-Charon system where it arrived in July 2015. It was launched in January 2006.

It was initially sent to Jupiter to take advantage of a gravity assist taking in the process measurements and images between September 2006 – June 2007.



The main imaging instrument is LORRI ( LONG-RANGE RECONNAISSANCE IMAGER), an 208mm f/12,6 RC coupled to a 1024X1024 pixel CCD camera which takes visible spectrum monochrome images (panchromatic). It is rigidly fixed to the probe, to bring the object in its field of view, the whole probe moves.

Table 2. Summary of LORRI Characteristics

|  |
|--|
| Visible Panchromatic Imager                      |
| Telescope Aperture 208 mm                        |
| Focal Length 2630 mm                             |
| Passband 0.35 – 0.85 $\mu\text{m}$               |
| Field-of-view $0.29^\circ \times 0.29^\circ$     |
| Instantaneous field-of-view 4.95 $\mu\text{rad}$ |
| Back-thinned, frame transfer CCD                 |
| Nominal exposure times 50-200 ms                 |
| On-chip 4x4 pixel binning available              |
| Autoexposure                                     |

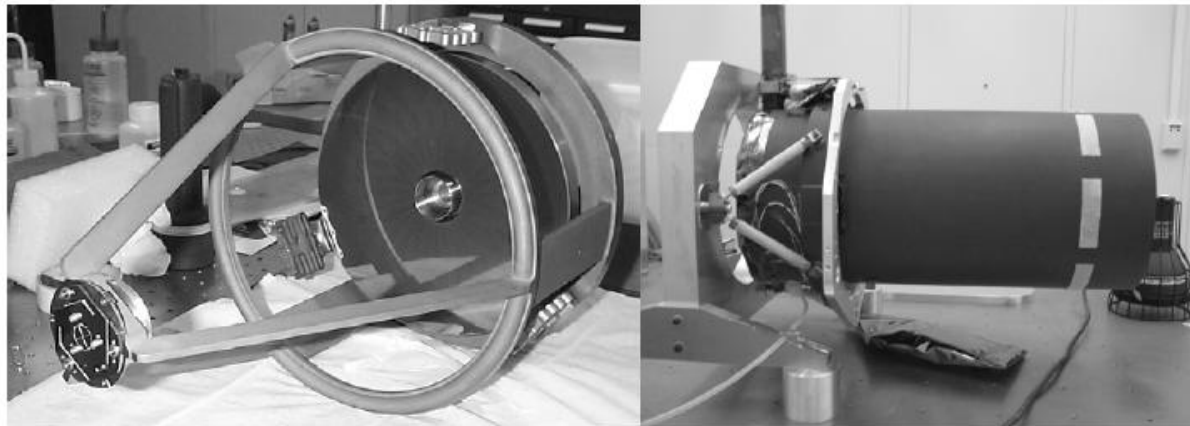


Figure 1 (left) LORRI telescope assembly, showing SiC mirrors and metering structure; (right) LORRI composite baffle and flexure mount on test stand

## 4. NH EXAMPLE

I've used 10 Jupiter images taken between 8 and 9 of January 2007 taken at one hour interval to have a full rotation.

The details of each image can be found in the \*.lbl file archived with each image.



```
lor_0030602039_0x630_sci_1.lbl - Notepad
File Edit Format View Help

MISSION_NAME           = "NEW HORIZONS"
DATA_SET_ID           = "NH-J-LORRI-3-JUPITER-V1.1"
PRODUCT_ID            = "LOR_0030602039_0X630_SCI_1"
PRODUCER_INSTITUTION_NAME = "SOUTHWEST RESEARCH INSTITUTE"
PRODUCT_TYPE          = "EDR"
SOFTWARE_NAME         = "TOPDS 1.0"
MISSION_PHASE_NAME    = "JUPITER ENCOUNTER"
SEQUENCE_ID           = "JELR_JOBSATM01"
TARGET_NAME           = "JUPITER"

PRODUCT_CREATION_TIME = 2009-03-02T06:24:41
START_TIME             = 2007-01-08T22:42:01.359
STOP_TIME              = 2007-01-08T22:42:01.362
SPACECRAFT_CLOCK_CNT_PARTITION = 1
SPACECRAFT_CLOCK_START_COUNT = "0030602038:48850"
SPACECRAFT_CLOCK_STOP_COUNT = "0030602038:49000"

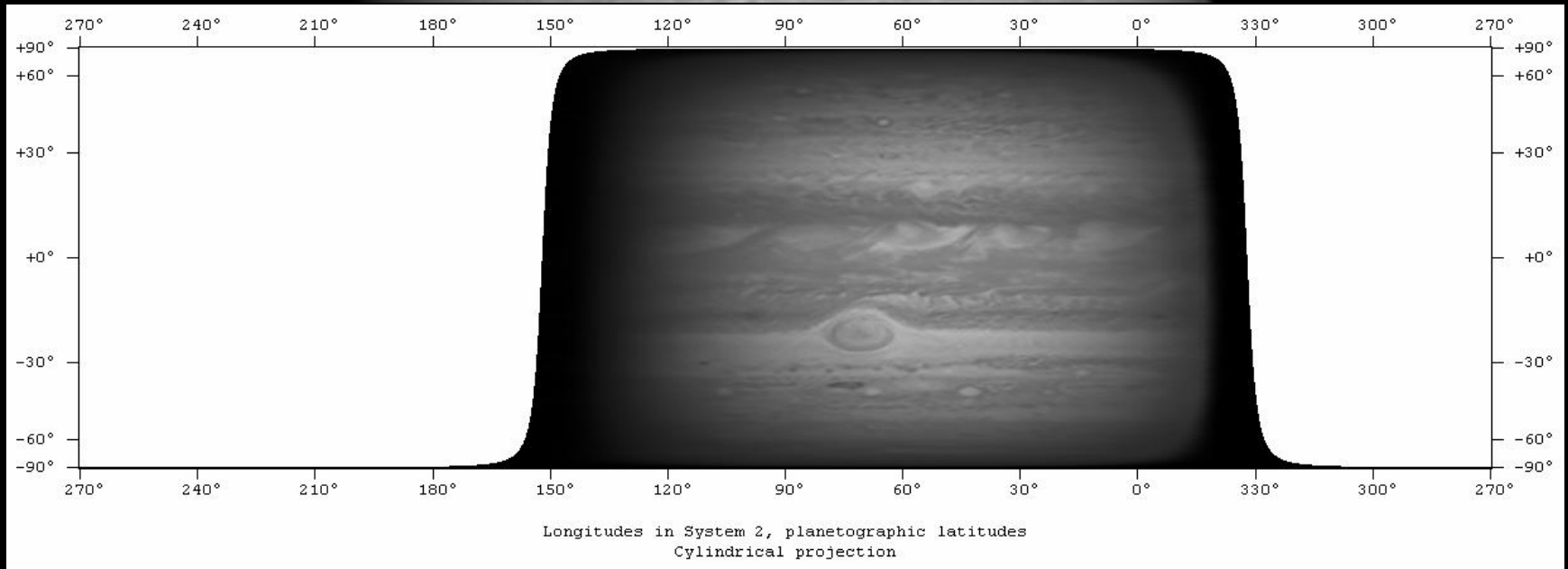
INSTRUMENT_NAME="LONG RANGE RECONNAISSANCE IMAGER"
INSTRUMENT_HOST_NAME = "NEW HORIZONS"
INSTRUMENT_ID     = "LORRI"
TELEMETRY_APPLICATION_ID = "0x630"
EXPOSURE_DURATION = 0.003 <S>
FILTER_NAME       = "N/A"
DETECTOR_ID      = "LORRI"
DETECTOR_TYPE    = "CCD"
INST_CMPRS_TYPE  = "LOSSLESS"

SC_TARGET_POSITION_VECTOR = (
  -48164656. <KM>
  , -61102428. <KM>
  , -24301376. <KM>
)
TARGET_CENTER_DISTANCE = 81510108. <KM>
TARGET_SUN_POSITION_VECTOR = (
  3.6236300E+08 <KM>
```



## 4. NH EXAMPLE

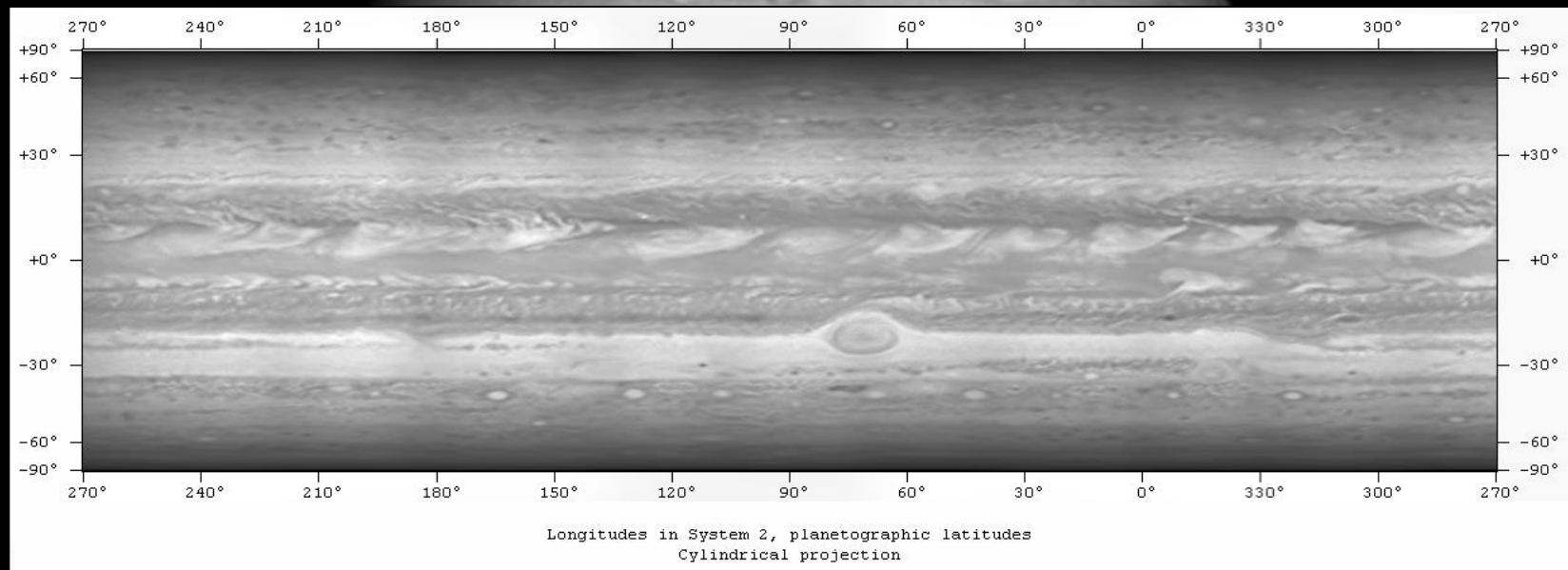
Using PS an WinJupos, each image was used to make a map.



NASA / New Horizons / map by Constantin SPRANU

## 4. NH EXAMPLE

The 10 partial maps were used to make the complete map.  
This map was then used to make the animation using WinJupos.  
The GRS animation was made using two of the partial maps.



NASA / New Horizons / map by Constantin SPRANU

Jupiter animation



GRS animation



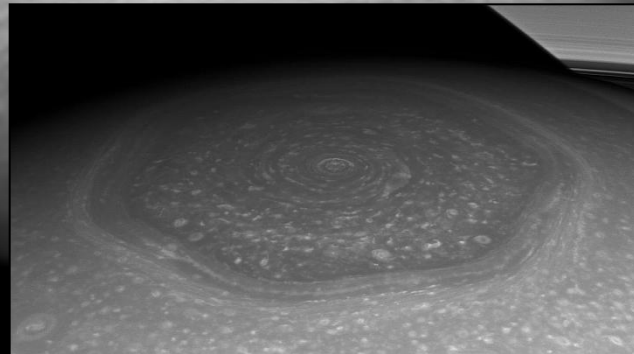
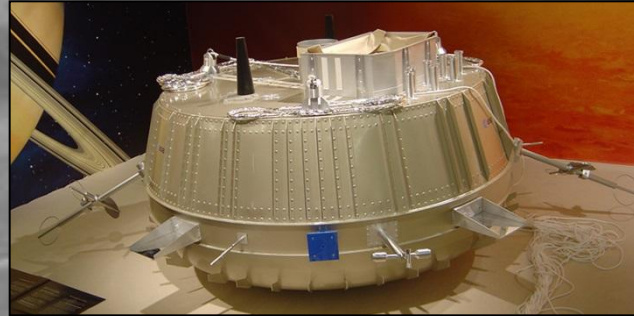
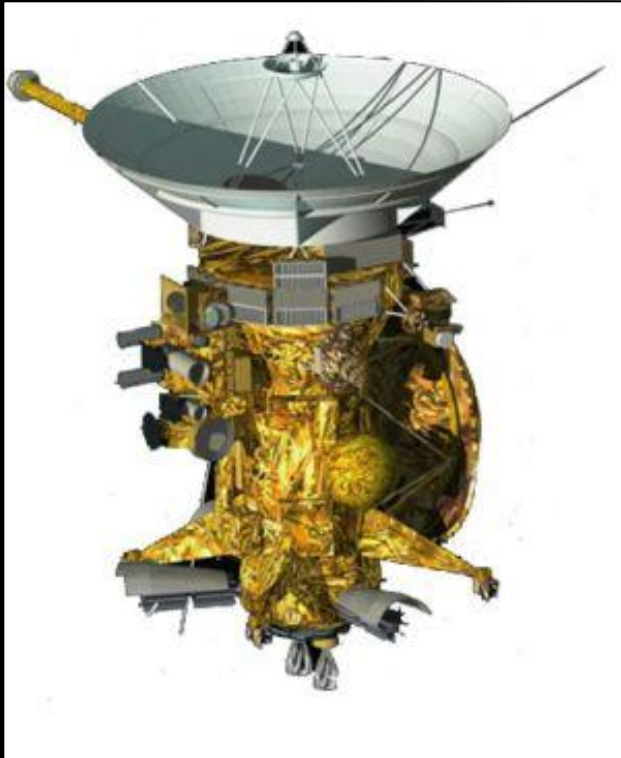


# 5. CASSINI EXAMPLE



## 5. CASSINI EXAMPLE

Cassini-Huygens is a mission to study Saturn and its moons. It is composed by the Cassini probe and the Huygens landing module (now inactive). It was launched on October 15<sup>th</sup> 1997 and, after being gravity assisted by Earth, Venus and Jupiter, it entered Saturn's orbit on the 1<sup>st</sup> of July 2004. The Huygens module landed on Titan on the 14<sup>th</sup> of January 2005.

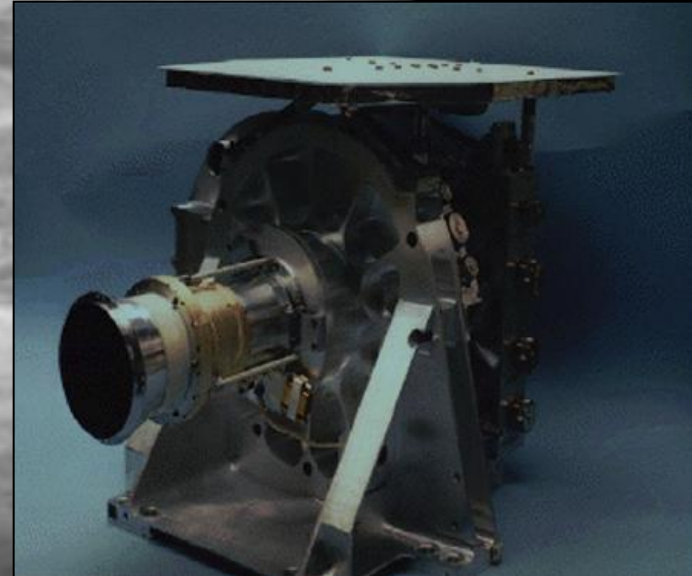


NASA / JPL / SSI



NASA / JPL / SSI

Cassini's imaging instrument is ISS (Imaging Science Subsystem) and it has two subsystems: the Narrow Angle Camera (NAC) – 190mm f/10,5 RC and the Wide Angle Camera (WAC) – 57mm f/3,5 refractor. They are fitted together on the probe and each has two filter wheels.



## 5. CASSINI EXAMPLE

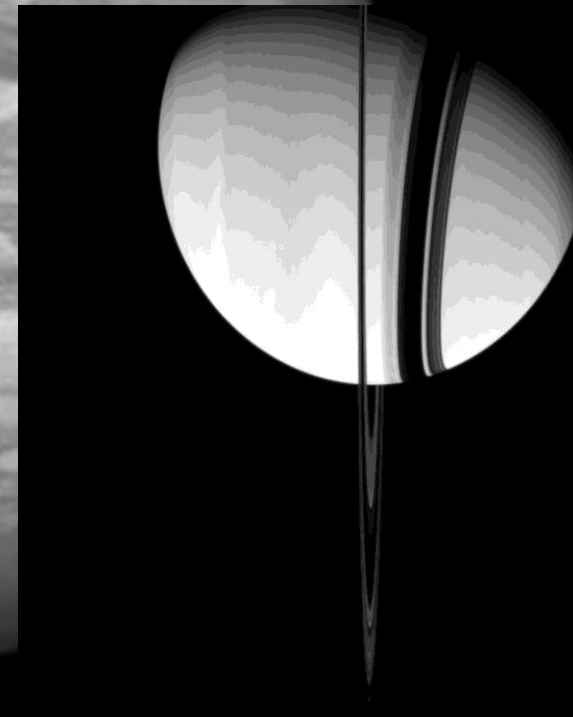
I've selected and used 3 visible spectrum images taken on the 7<sup>th</sup> of January 2012 to create a color image. From a Dione image series, I've made an animation with Dione and its Titan transit seen from the probe. As for NH, each image has its own \*.lbl file. To convert the images from \*.img format to \*.png, I have used the img2png software made by Bjorn Jonsson.

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W1705494688_1.LBL - Notepad
File Edit Format View Help
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RECORD_BYTES = 1048
FILE_RECORDS = 1028

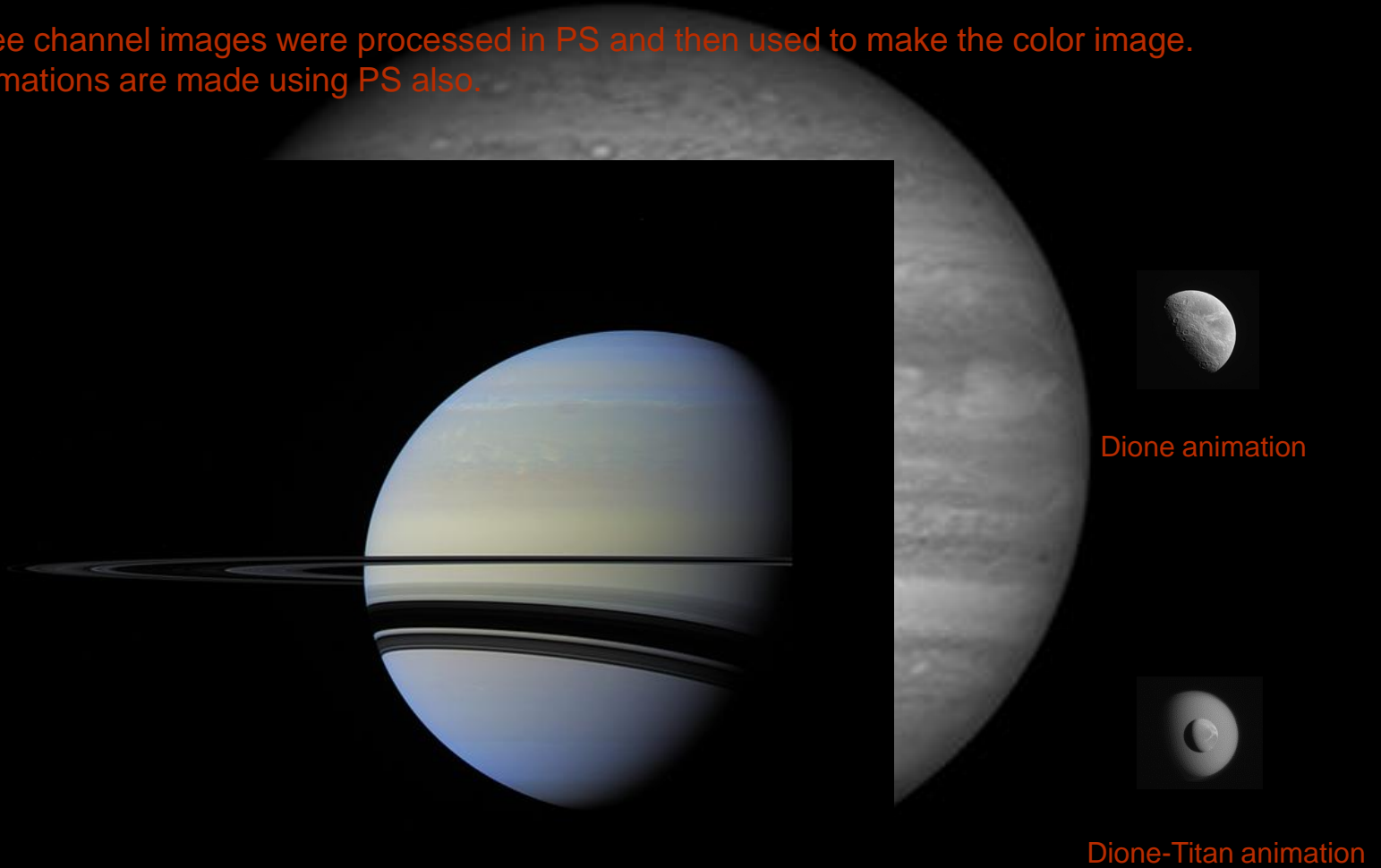
/* POINTERS TO DATA OBJECTS */
AIMAGE_HEADER = ("w1705494688_1.IMG",1)
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AIMAGE = ("w1705494688_1.IMG",5)

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COMMAND_SEQUENCE_NUMBER = 32151
DARK_STRIP_MEAN = 22.750490
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DATA_SET_ID = "CO-S-ISSNA/ISSWA-2-EDR-V1.0"
DELAYED_READOUT_FLAG = "NO"
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DETECTOR_TEMPERATURE = -87.895164 <DEGC>
EARTH_RECEIVED_START_TIME = 2012-018T17:56:30.267
EARTH_RECEIVED_STOP_TIME = 2012-018T17:58:01.349
ELECTRONICS_BIAS = 112
EXPECTED_MAXIMUM = (44.296398,48.837299)
EXPECTED_PACKETS = 324
EXPOSURE_DURATION = 150.000000
FILTER_NAME = ("CL1","BL1")
FILTER_TEMPERATURE = 1.764572
```



NASA / JPL / SSI

The three channel images were processed in PS and then used to make the color image.  
The animations are made using PS also.





# 6. CREDIT/ COPYRIGHT

The raw images gathered by most planetary missions are public domain. Even so, the current practice is to mention those who produced the images:

Ex: NASA / JPL / SSI (for Cassini)

For processed images using raw images from planetary space probes, we need to add the following:

Cassini example: NASA / JPL / SSI/ color image by Constantin SPRIANU

It is possible for these mentions to be different; depending on the instrument, there are situations where different organizations manage the instruments on the same space probe.

