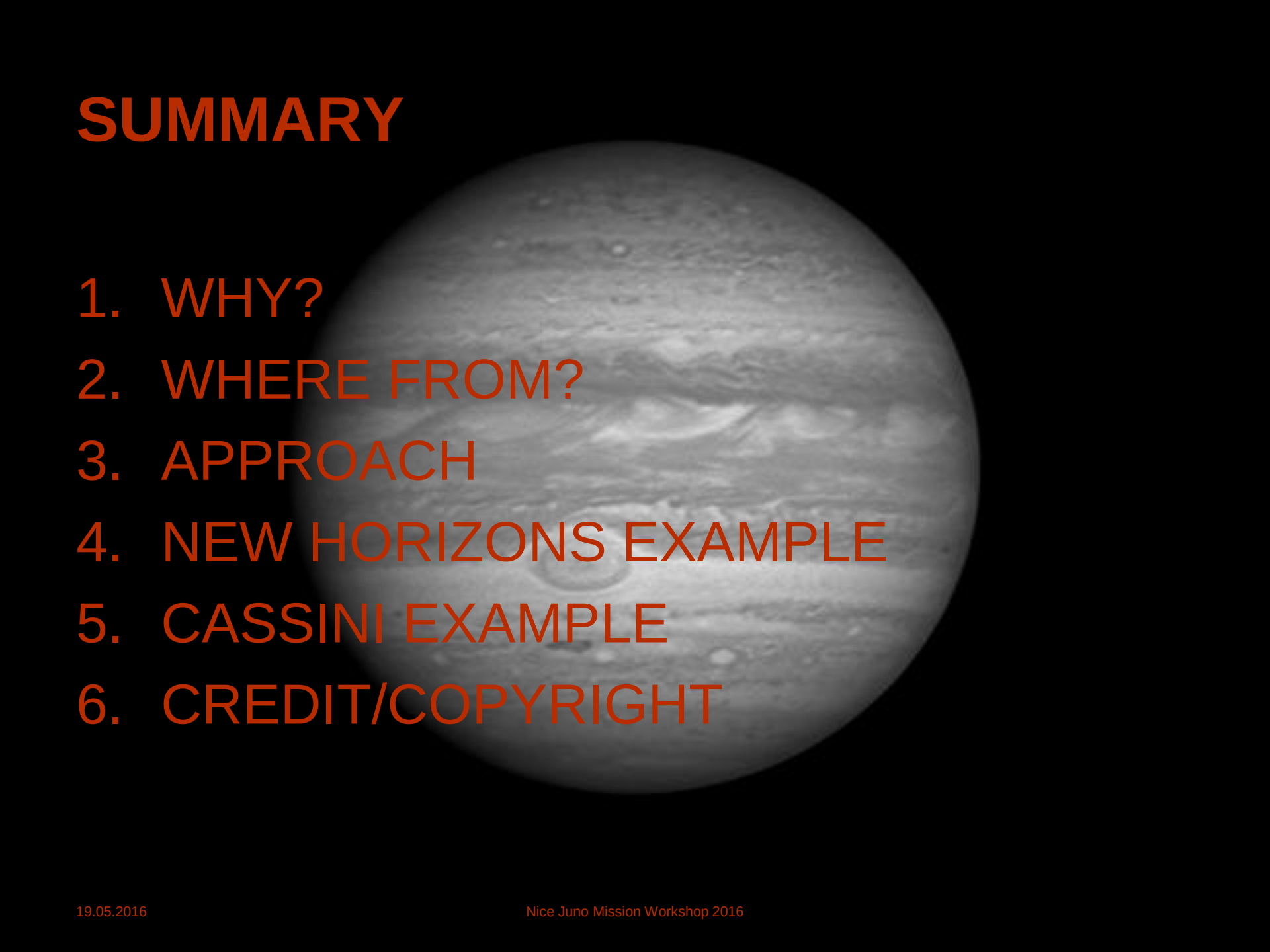
Space probe image processing by amateur astronomers

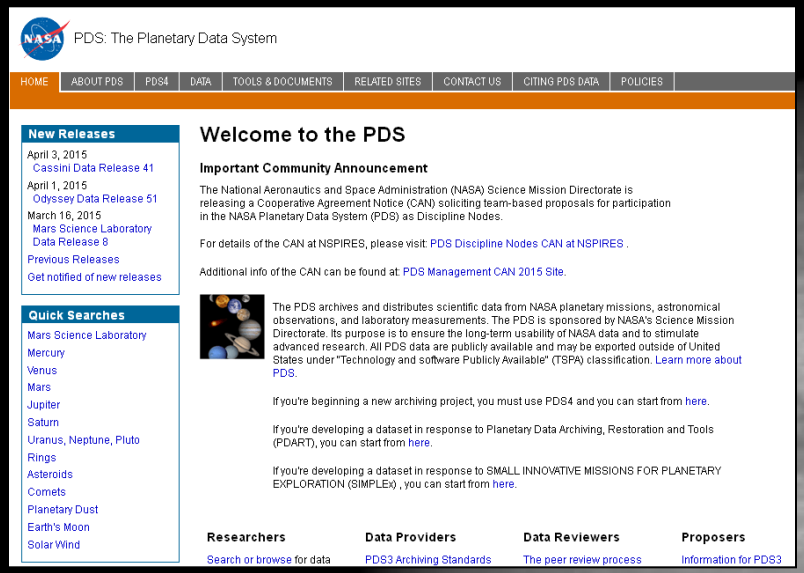
SUMMARY



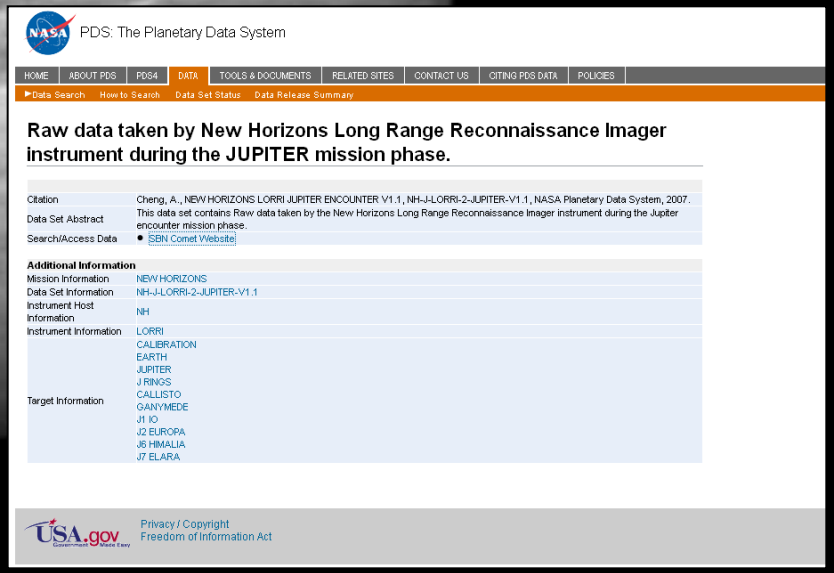
1. WHY?
2. WHERE FROM?
3. APPROACH
4. NEW HORIZONS EXAMPLE
5. CASSINI EXAMPLE
6. CREDIT/COPYRIGHT

1. WHY?


2. WHERE
FROM?



https://pds.nasa.gov/




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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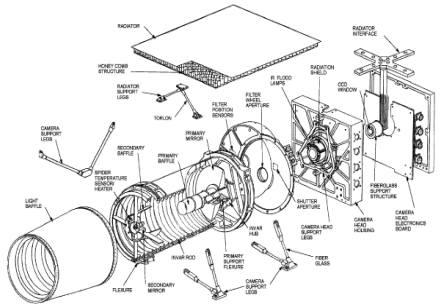
Abstract. The Cassini Imaging Science Subsystem (ISS) is the highest-resolution two-dimensional imaging device on the Cassini Orbiter and has been designed for investigations of the bodies and phenomena found within the Saturnian planetary system. It consists of two framing cameras: a narrow angle, reflecting 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 μ on a side. The data system allows many options for data collection, including choices for on-chip summing, rapid 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.

Narrow Angle Camera

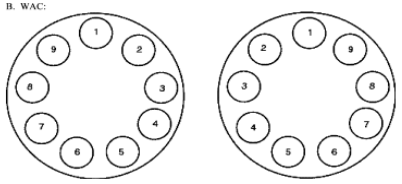


(A)

Figure 16. (A) A diagram showing the various components in the Cassini Narrow-Angle Camera Head Assembly. (B) Similar diagram for the Cassini Wide-angle Camera Head Assembly.

(*Continued on next page*)

B. WAC:



WAC Filters

(Wavelengths, in nm, are central wavelengths computed using the full system transmission function.)

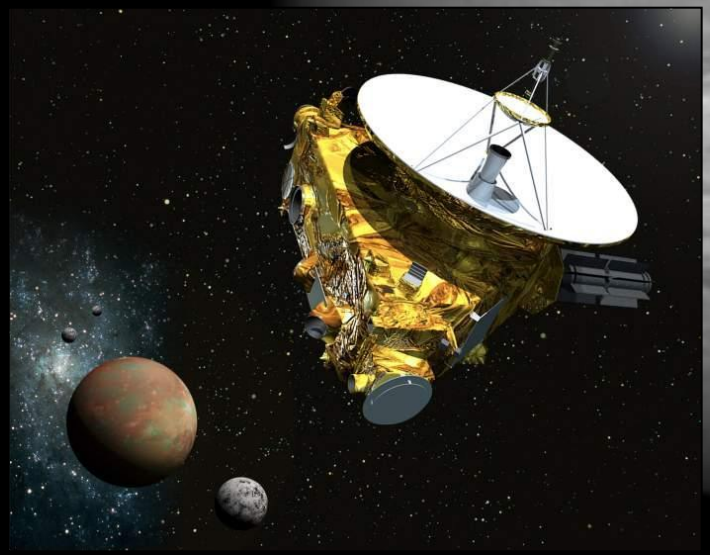
Filter Wheel #1	Filter Wheel #2
1) CL1 (635W)	1) CL2 (635W)
2) IR3 (918W)	2) RED (648W)
3) IR4 (1001LP)	3) GRN (567W)
4) IR5 (1028LP)	4) BL1 (460W)
5) CB3 (939N)	5) VIO (420SP)
6) MT3 (890N)	6) HAL (656N)
7) CB2 (752N)	7) IRP90 (705W)
8) MT2 (728N)	8) IRP0 (705W)
9) IR2 (853W)	9) IR1 (742W)

Figure 19. (*Continued*).

4. NH EXAMPLE

New Horizons is a mission who's 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 μm
Field-of-view 0.29° × 0.29°
Instantaneous field-of-view 4.95 μrad
Back-thinned, frame transfer CCD
Nominal exposure times 50-200 ms
On-chip 4×4 pixel binning available
Autoexposure

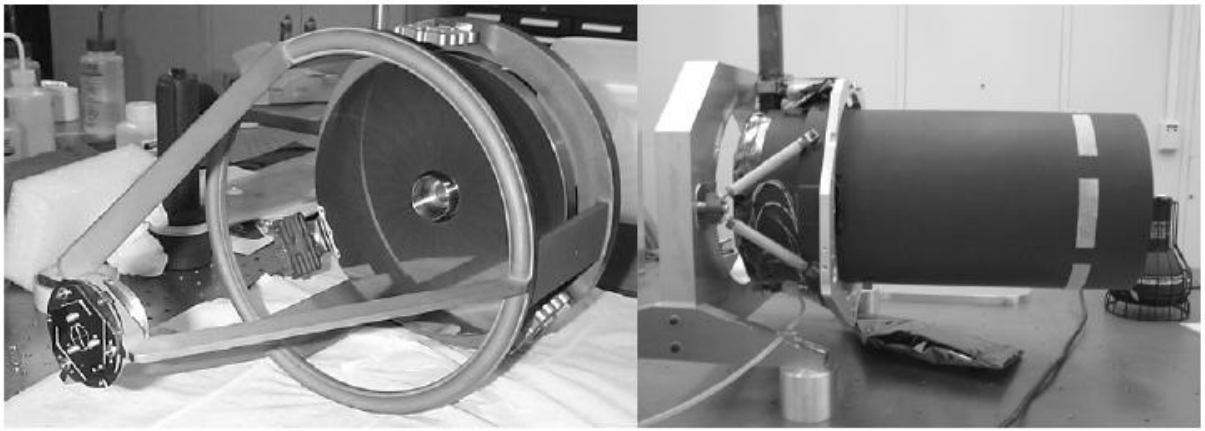
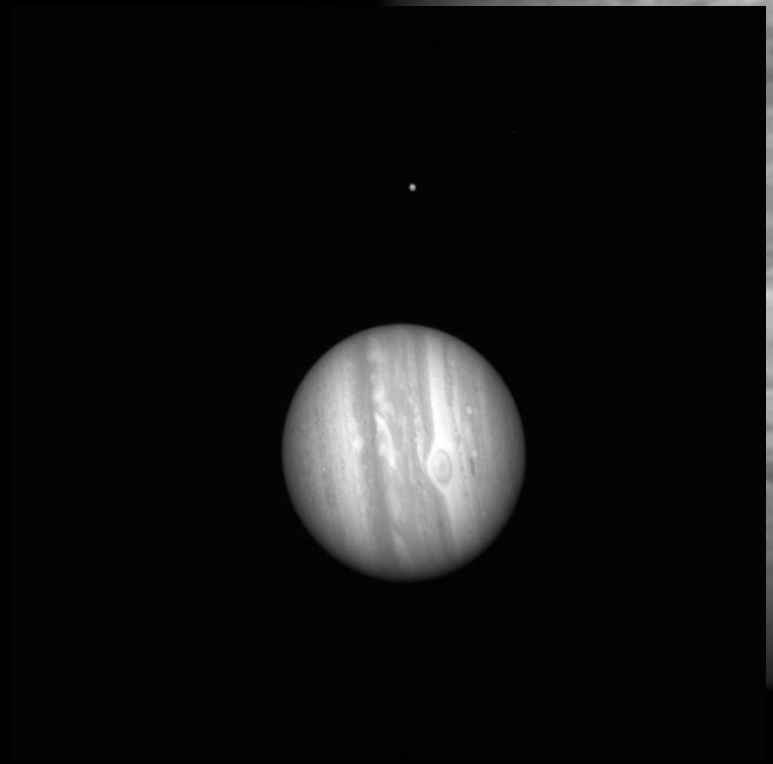


Figure 1 (left) LORRI telescope assembly, showing SiC mirrors and metering structure; (right) LORRI composite baffle and flexure mount on test stand

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.



NASA / New Horizons

lor_0030602039_0x630_sci_1.lbl - Notepad

File Edit Format View Help

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PRODUCT_TYPE          = "EDR"
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INST_CMPRS_TYPE       = "LOSSLESS"

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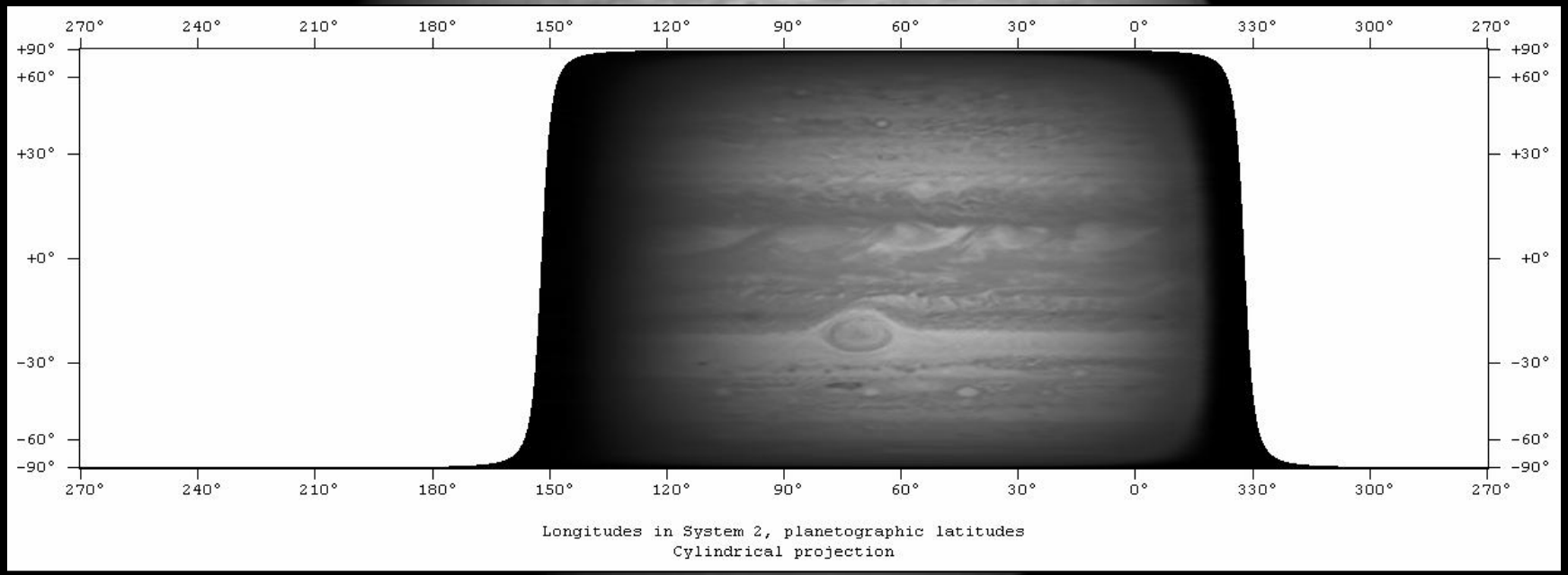
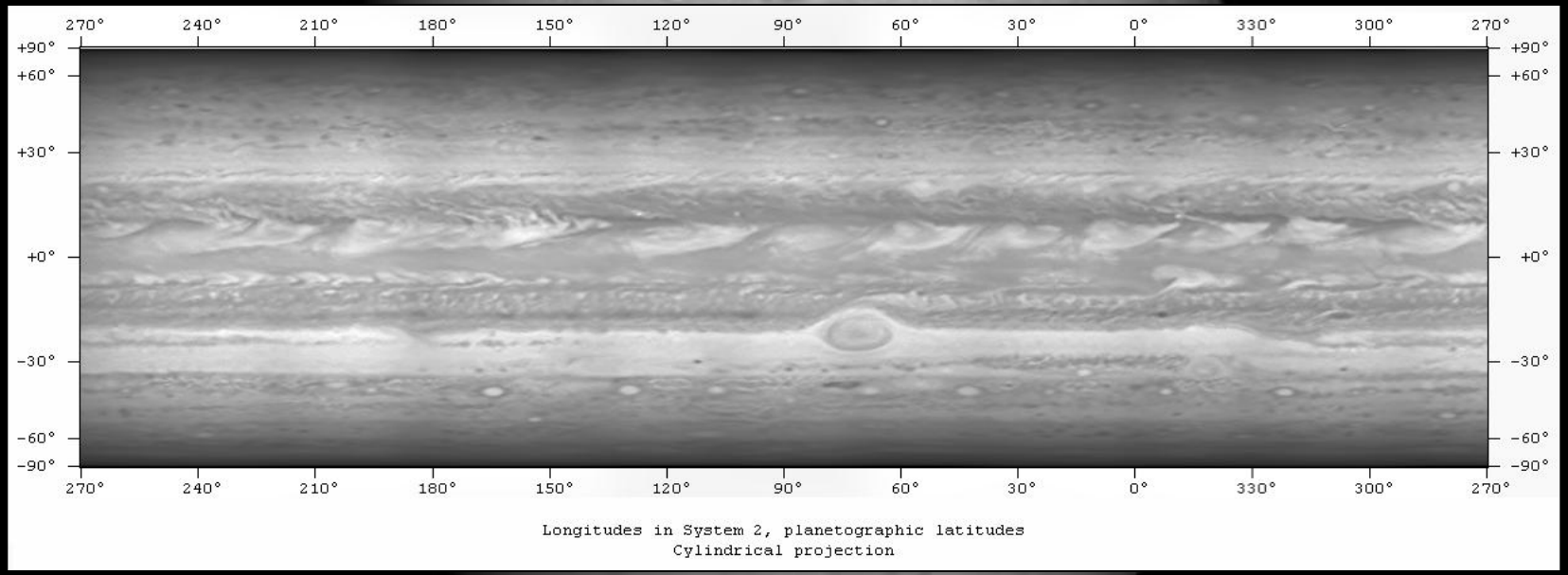
Using PS an WinJupos, each image was used to make a map.



NASA / New Horizons / map by Constantin SPRANU

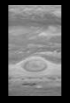
The 10 partial maps where the used to make the complete map.
This map was then used to make the animation using WinJupos.
The GRS animation was made using two of the partial maps.



NASA / New Horizons / map by Constantin SPRANU

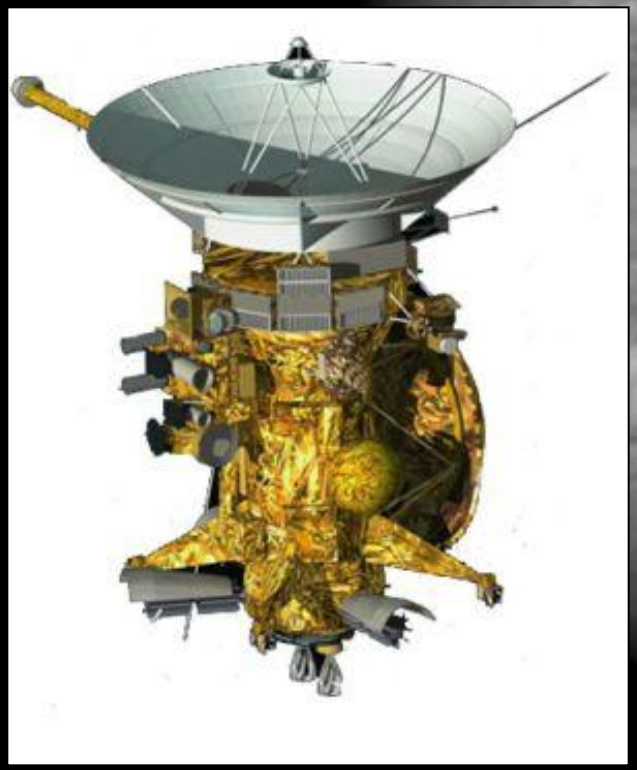
Jupiter animation

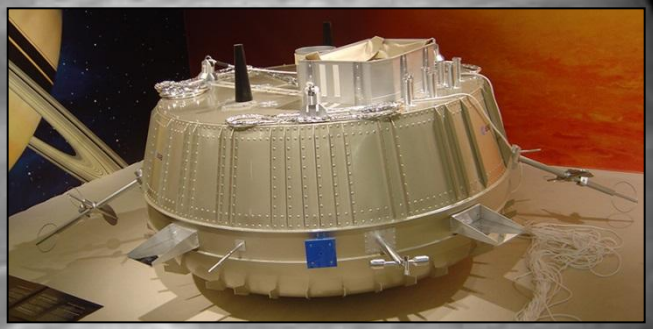
GRS animation

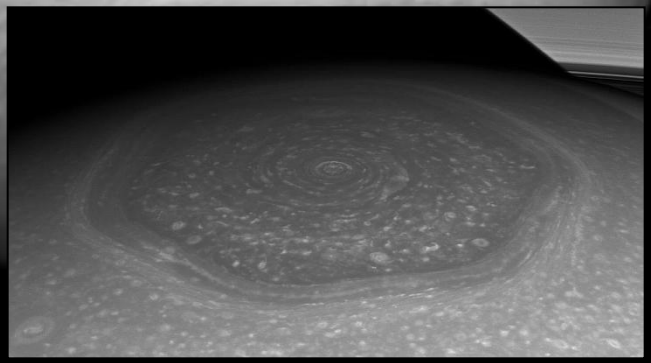


5. CASSINI EXAMPLE

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 15th 1997 and, after being gravity assisted by Earth, Venus and Jupiter, it entered Saturn's orbit on the 1st of July 2004. The Huygens module landed on Titan on the 14th of January 2005.



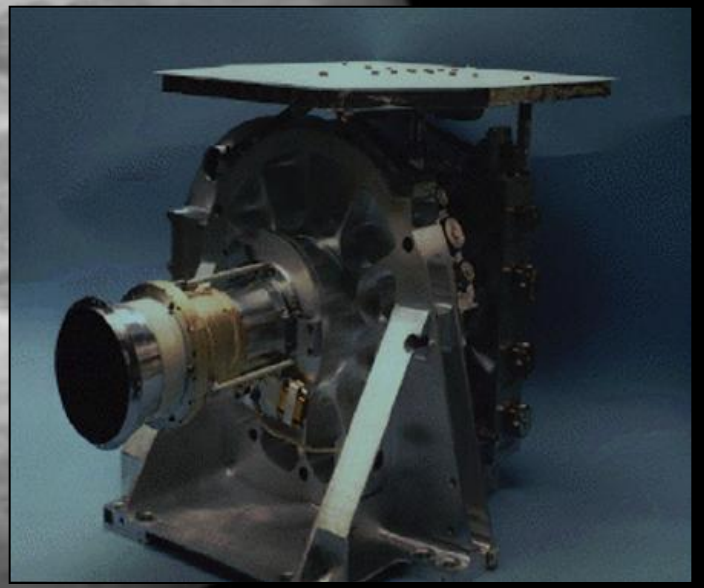




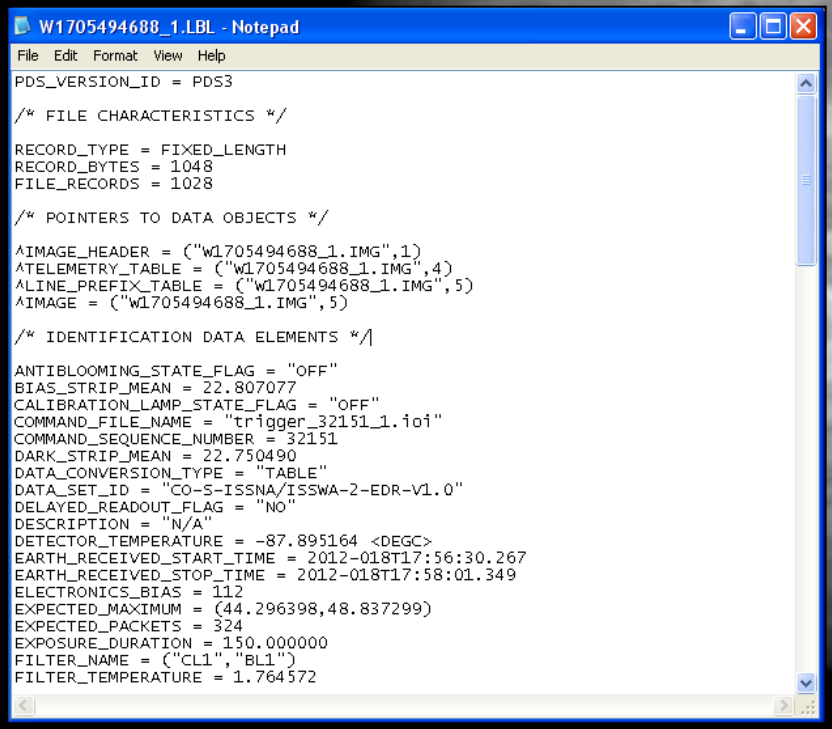
NASA / JPL / SSI

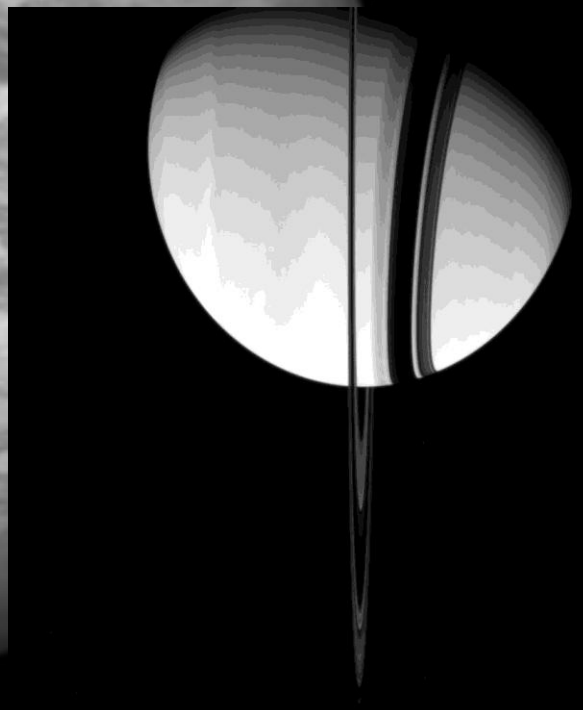
NASA / JPL / SSI

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.



I've selected and used 3 visible spectrum images taken on the 7th 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.

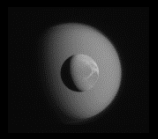




NASA / JPL / SSI

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

Dione animation



Dione-Titan animation

NASA / JPL / SSI/ colour image by Constantin Sprianu

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.


FINISH!