Twelve Instruments, One Goal
Archive Usable Science Data

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Cassini Mission to Saturn
Tour Highlights

Cassini will spend 4 years orbiting the Saturn system. During that time, the spacecraft will make 75 orbits about the planet and 45 flybys of Titan.

Some of the exciting events early in the Saturn tour include:

- Phoebe encounter - 11 June 2004 (closest approach is 2,000 km, 1243 miles)
- **Saturn Orbit Insertion - 1 July 2004**
- Huygens Probe Release - 25 December 2004
- Huygens Probe Mission - 14 January 2005
CASSINI MISSION CRUISE TRAJECTORY
Earth (E), Saturn (S), and Cassini (C) locations on 27 January 2004

VENUS FLYBY
26 APR 1998

VENUS FLYBY
24 JUN 1999

EARTH FLYBY
18 AUG 1999

DEEP SPACE MANEUVER
3 DEC 1999

JUPITER FLYBY
30 DEC 2000

LAUNCH
15 OCT 1997

Orbit of Jupiter

SATURN ARRIVAL
1 JUL 2004

EARTH FLYBY
18 AUG 1999

VENUS FLYBY
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Saturn Arrival
1 Jul 2004

May 2004
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Touring Saturn

During the 4-year tour, Cassini will make 75 orbits of Saturn, using Titan to turn the spacecraft’s orbit.

Orbits will range in length from 7 to 118 days.

Cassini’s orbital distance from Saturn will range from 156,858 km to 953,214 km (98,036-592,422 miles). The spacecraft’s orbit will change orientation from equatorial to an inclination of approximately 75°. This allows scientists to study Saturn’s polar regions.

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Introduction

The Cassini mission is a complex undertaking.
- Twelve instruments operated by teams around the world.

http://saturn.jpl.nasa.gov

May 2004

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Cassini’s 5 groups of science objectives at Saturn are:

- Saturn - the planet and its atmosphere
- Saturn’s extensive Rings
- Titan
- Magnetosphere
- Icy Satellites

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Saturn System of Satellites

The order of the rings and moons, starting with the closest to Saturn, is:

Saturn  Epimetheus  Titan
D-Ring  Janus  Hyperion
C-Ring  G-Ring  Iapetus
B-Ring  Mimas  Phoebe
Cassini Division  E-Ring  New Discoveries
A-Ring  Enceladus
Encke Division  Tethys
Pan  Telesto
Atlas  Calypso
Prometheus  Dione
Pandora  Helene
F-Ring  Rhea

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Lessons learned from the Galileo Mission to Jupiter are a large driver behind the Cassini archive design

- Diverse data sets make it a challenge to support collaborative science analysis
- Large data sets make it a challenge to
  - validate data for science content and format
  - Distribute data
  - Track data production at a program level
- It is always a challenge to compile the right level of documentation.
The Cassini Legacy

- Cassini is archiving science data with the Planetary Data System (PDS) http://pds.jpl.nasa.gov

- A reliable Cassini archive will

  - Support a Saturn data analysis program
  - Allow comparisons of the Saturnian system with the Jovian system (the Galileo and Jupiter Icy Moons Orbiter (JIMO) missions)
  - Provide a basis for future mission planning.
Timeline

- Oct 1997
  Launch

1998
  Downlink Working Group formed

- Dec 2000
  Jupiter Flyby

2000
  Archive Plan for Science Data,
  Ops Concept published

- Jan 2004
  Saturn Approach

2001
  Science Archived Working Group formed

- Jul 2004
  SOI

2003
  Archive Design Reviews of team archive plans

- Jul 2008
  End of prime mission

2004
  Data Products Defined, Peer Reviews held, Cassini Archive tracking system
  (CATS) developed.

2005
  July is the first delivery of data to the PDS. Includes all data collected up to Saturn
  Orbit Insertion (SOI).

May 2004
  End of prime mission

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Ingredients of a Useable Archive

- **DOCUMENTATION** of the mission, spacecraft, instruments and datasets - a detailed history of the mission and full description of the capabilities is required,

- **STANDARDIZATION** of data formats - to assure long-term access, data formats should be as simple as possible,

- **PRESERVATION** of navigation and calibration - retrieval of pointing information and calibration should be planned early and accomplished in a monitored incremental process,

- **VALIDATION** of data products – data validation is best accomplished by distributing products to the science team in their archive form.

- **OPTIMIZATION** for correlative studies - coordination among experiments to ensure correlative studies are supported by defining standards for data products and documentation.
- DRAFT -

Documentation

- Mission Events and science objectives
- Spacecraft and instrument design and operations
- Interface Agreements
  - Describe who is delivering what to whom and how
  - Template developed for new missions
- Data
  - Formats and parameter descriptions
  - Calibration algorithms
  - Usage restrictions
  - Coordinate system
Standardization

- Data formats
  - Simple ASCII preferred for non-imaging instrument data.

- Consistent time representation
  - file and directory names
  - keywords
  - Internal to data

- Coordinate systems
  - Planetocentric or planetographic - use international standard IAU
  - East or west longitude - consistent on given planet
PDS Navigation Ancillary Information Facility
SPICE formatted data files
- Spacecraft pointing geometry
- Trajectories of spacecraft and satellites
- Instrument boresights and FOV descriptions
- Mission events
  - Boresights used for pointing s/c as a function of time
  - Primary target for observation
  - Various spacecraft and instrument configurations

Calibration algorithm as a function of time
Validation

- Design review of planned data formats and volume contents
  - Identify areas that need to most work
- Peer review of sample volume
  - Put data formats, documentation, and software to the test
- Through Scientific use
  - Members of the science teams use same products as go into the archive.
Correlative studies within scientific disciplines
- Atmospheres
- Surfaces
- Physics

Search parameters

Temporal & spatial resolution

Similar formats (cohesive)
Cassini is a mission that presents many challenges for archiving data

- Distributed ops
- Large diverse data sets
- Complex mission plan with a variety of scientific objectives and science targets

The Cassini legacy will be the archived data. When the mission has collected the last data, the only challenge remaining will be to analyze and interpret that data.