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FINAL TECHNICAL REPORT

Project Title: **Operation of the Planetary Plasma Interactions Node of the Planetary Data System**

Principal Investigator: **Raymond J. Walker**

Period of Award: **4/01/95 - 3/31/97**

Grant Number: **NAGW-4615**

Summary:

Five years ago NASA selected the Planetary Plasma Interactions (PPI) Node at UCLA to help the scientific community locate, access and preserve particles and fields data from planetary missions. We propose to continue to serve for 5 more years. During the first five years we have served the scientific community by providing them with high quality data products. We worked with missions and individual scientists to secure the highest quality data possible and to thoroughly document it. We validated the data, placed it on long lasting media and made sure it was properly archived for future use. So far we have prepared and archived over 10^{11} bytes of data from 26 instruments on 4 spacecraft. We have produced 106 CD-ROMs with peer reviewed data. In so doing we have developed of an efficient system to prepare and archive the data and thereby have been able to steadily increase the rate at which the data are produced.

Although we produced a substantial archive during the initial five years, we have an even larger amount of work in progress. This includes preparing CD-ROM data sets with all of the Voyager, Pioneer and Ulysses data at Jupiter and Saturn. We will have the Jupiter data ready for the Galileo encounter in December, 1995 We are also completing the Pioneer Venus data restoration. The Galileo Venus archive and radio science data from Magellan will be prepared early in the next period. We are assisting the Small Bodies Node of PDS in the preparation of comet data and will be archiving the asteroid data from Galileo. We will be moving in several new directions as well. We will archive the PPI Node's first Earth based data with data from the International Jupiter Watch and Hubble data taken I support of Ulysses particles and field observations. We will work with the Cassini mission in archive planning efforts. For the inner planets we will begin an archive of Mars data starting with Phobos data and will support the US and Russian Mars missions in the late 1990's. We will restore the Mercury data from Mariner 10 and prepare the lunar data from Clementine in time for the lunar data analysis program in 1995. We will work with the Discovery mission teams to plan their archive and have already started with one, NEAR. Finally we will begin archiving our first heliospheric data from Voyager, Galileo, and Mars observer.

We will continue to serve the science community by providing access to the data products. During the past 19 months we have filled nearly 6000 requests for on-line and CD-ROM data. The data delivered directly by the PPI Node has been - 5 x 10^{11} bytes. In addition to providing the data, we have provided users with software tools to manage and read the data which are computer, operating system and format independent. We have developed scalable systems so that the same software we use

to manage and access the data for the entire PPI Node can be used by individual investigators to manage the data on a single CD-ROM thereby greatly reducing the software development effort for both the PPI Node and users. We deliver this software with the disks. Recent technical advances have made it possible for us to serve a broader community than before. In the next five year period we plan to extend our outreach to the general public and in particular to increase our support for education.

Since planetary plasma data are varied and require expertise in many areas the PPI Node will continue to be distributed. In addition to the primary node at UCLA, the PPI Node has three subnodes with an Outer Planets Subnode at the University of Iowa, an Inner Planets Subnode at UCLA and a Radio Science Subnode at Stanford University. During the first two years of the renewal period there will be a Radio Astronomy Data Node at GSFC. These organizations will provide scientific expertise on the data, participate in node data selection activities and help with data restoration and mission activities.

Administrative Matters:

This is an on-going project. The project was originally funded through Jet Propulsion Laboratory, contract #959026 from 6/17/91 - 1/31/96. The decision was made at the NASA Headquarters to fund this project directly under the current grant NAGW-4615 from 4/1/95 - 3/31/97. However, due to recent NASA reorganization, it was decided that NAGW-4615 be terminated and funded under new Jet Propulsion Laboratory Contract #960512. The following report outlines the status of this work as of the end of this grant.

Patent and Inventions:

None

Explanatory Remarks

Following please find mission interface charts that outline the current status and progress of each project of the Planetary Plasma Interactions Node (PPI) of the Planetary Data System (PDS). The data curation process for each mission has been divided into 6 stages and results in the preparation of archival quality data. During *initial contact* members of PPI Node meet with instrument teams from each instrument on the spacecraft, explain the data archiving procedure and plan the data archiving. Next the *metadata* for each experiment is *prepared.* This includes the preparation of instrument, catalog and data set templates. The third stage in the data curation process involves *preparing* the actual *science data* for archiving. In the fourth stage the *data volumes* which will contain the data and metadata from the instrument are *designed.* After the design process is complete preliminary volumes are prepared usually on write once CD-ROMs and the preliminary volumes are sent to members of the scientific community for *peer review.* The peer review process involves checking the data and metadata for accuracy and correcting any errors detected. After a final check of the data at the Central Node, (CN) the final *data volumes* are prepared and *released* to the scientific community.

In the mission interface charts the current state of each task for each instrument is denoted with circles. Filled black circles represent tasks that are complete, filled gray circles represent partially complete tasks and open circles represent tasks which have been begun but are still in the beginning stages. Items in red indicate tasks that have changed during the past 4 months. The instruments are identified by their official NASA acronym (please see *Walker et al., Planet. Space Sci. 44,* 1, 55, 1996 for a complete list of acronyms).

Following the mission interface charts we have provided a chart showing the PPI Node's planned activities for the next year. Milestones are listed by quarter. The PPI Node schedule lists the mission and the phases of each mission. The mission phases are usually given by the body encountered (e.g. Voyager 1 Jupiter etc.). Galileo orbits are designated by the moon encountered during the orbit and the orbit number (e.g. Ganymede 1). For Pioneer Venus Orbiter the plan is given by instrument.

Following the schedule we have presented a chart that lists our accomplishments in maintaining the software and hardware system and in improving the PPI Node services to the scientific community. Finally we discuss the progress during the last 4 months on the PDS Explorer software that is being designed and implemented to help scientists easily extract and browse the CD-ROMs containing PPI Node prepared data.

Earth/Moon Volume Archive Status

	Initial Contact	Metadata Preparation	Data Preparation	Volume Design	Peer Review	Release & Distribution
GLL - E1	**MWG**					**Q3/97**
MAG	●	●	●	●	○	
PWS	●	●	●	●	○	
EPD	●	●	●	●	○	
EPHEM	●	●	●	●	○	
SPICE	●	●	●	●	○	
PLS	●	●	●	●	○	
GLL - E2	**MWG**					**Q3/97**
MAG	●	●	●	●	○	
PWS	●	●	●	●	○	
EPD	●	●	●	●	○	
EPHEM	●	●	●	●	○	
SPICE	●	●	●	●	○	
PLS	●	●	●	●	○	
GLL- IDA	**MWG**					**Q3/97**
MAG	●	●	●	●	○	
PWS	●	●	●	●	○	
EPHEM	●	●	●	●	○	
SPICE	●	●	●	●	○	
PLS	●	●	●	●	○	
GLL- GASPRA	**MWG**					**Q3/97**
MAG	●	●	●	●	○	
PWS	●	●	●	●	○	
EPHEM	●	●	●	●	○	
SPICE	●	●	●	●	○	
PLS	●	●	●	●	○	
GLL- CRUISE	**MWG**					**Q3/97**
MAG	●	●	●	●	○	
EPHEM	●	●	●	●	○	
SPICE	●	●	●	●	○	
HIC	●	○	○	○	○	
UVS	●	○	○	○	○	
EUV	●	○	○	○	○	
DDS	●	●	●	●	○	

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Earth/Moon Volume Archive Status

	Initial Contact	Metadata Preparation	Data Preparation	Volume Design	Peer Review	Release & Distribution
GLL - MAG	**GOMA**					
EDR/RDR	●	●	●	●	●	**CD-WO**
LRS	●	●	●	●	●	**Q2/97**
GLL - PWS	**GOPW**					
EDR	●	●	●	●	○	**CD-WO**
LRS	●	○	○			**??**
WB	●	○	○			**??**
GLL- PLS	**GOPL**					
EDR	●	○	●			**??**
LRS	●	○	●			**??**
GLL - GOHI	●	●	●	●	○	**CD-WO**
GLL - GOEP	●	●	●	●	○	**CD-WO**
GLL - GOPR						
EDR	●	●	●	●		**CD-WO**
RRD	●	●	●			**Q1/97**
Clementine						
CPT	●	○				**Q3/98**

● Complete ◯ - Partially Complete ◯ - Begun ▬ - New Update

Venus Volume Series Archive Status

	Initial Contact	Metadata Preparation	Data Preparation	Volume Design	Peer Review	Release & Distribution
PVO						
ORSE - ODR	●	●	●	●	●	65/66
OMAG/OEFD processed	●	●	●	●	●	67/68/68
ORPA - RDR	●	●	●	●	●	15/16
SEDR	●	●	●	●	●	4/8/12
OIMS processed	●	●	●	●	●	0/1/3
ONMS processed	●	●	●	●	●	1/1
OETP processed	●	●	●	●	●	2/2
OPA/OGBD	●	○	○			Q2/97
ORPA processed	●	○	○			Q2/97
GLL	**MWG**					Q2/97
MAG	●	●	●	●	●	
PWS	●	●	●	●	●	
EPD	●	●	●	●	●	
EPHEM	●	●	●	●	●	
SPICE	●	●	●	●	●	
PLS	●	●	●	●	●	
MGN						CD-WO
RS-ODR	●	●	●	●	○	36/37

● - Complete ◔ - Partially Complete ○ - Begun ▬ - New Update

Jupiter Volume Series Archive Status

	Initial Contact	Metadata Preparation	Data Preparation	Volume Design	Peer Review	Release & Distribution
Voyager					Q2/97	Q3/97
PWS	●	●	●	●		
PLS	●	●	●	●		
MAG	●	●	●	●		
LECP	●					
EPHEM	●	●	●	●		
PRA	●	●	●	●		
CRS	●	●	●	●		
SPICE	●	●	●	●		
Pioneer 10/11					Q2/97	Q4/97
UVP	●	◐	●	◐		
VHM	●	●	●	●		
FGM	●	●	●	●		
TRD	●	◐	○	◐		
PA	●	◐				
CPC	●	◐	○	◐		
CRT	●	◐	○	◐		
GTT	●	●	●	◐		
SPICE	●	●	●	◐		
Ulysses						(1/1)
SWOOPS	●	●	●	●	●	
SWICS	●	N/A	N/A	N/A		
URAP	●	●	●	●	●	
EPAC	●	●	●	●	●	
VHM/FGM	●	●	●	●	●	
HISCALE	●	●	●	●	●	
COSPIN	●	●	●	●	●	
GRB	●	●	●	●	●	
DUST	●	●	●	●	●	
SCE	●	●	●	●	●	

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PWS - Plasma Wave Subsystem
PLS - Plasmas Science Experiment
MAG - Magnetometer
LECP - Low Energy Charged Particles Experiment
PRA - Planetary Radio Astronomy
CRS - Cosmic Ray Science
SPICE - S/C and Solar System Orbital Element Kernels

UVP - Ultra Violet Photopolarimeter
VHM - Vector Helium Magnetometer
FGM - Fluxgate Magnetometer
TRD - Trapped Radiation Detector
CPC - Charged Particle Composition

SWOOPS - Solar Wind Observations Over the Poles of the Sun
SWIC - Solar Wind Ion Composition
URAP - Unified Radio and Plasma Wave Ingestion
EPAC - Energetic Particle Composition
HISCALE - Heliospheric Instrument for Spectra, Composition, and Anisotropy at Low Energies
COSPIN - Cosmic Ray and Solar Particle Investigation
GRB - Gamma Ray Burst
DUST - Dust Detector System
SCE - Solar Coronal Experiment

PA - Plasma Analyzer
CRT - Cosmic Ray Telescope

● - Complete ◐ - Partially Complete ○ - Begun ▬ - New Update

Jupiter Volume Series Archive Status

	Initial Contact	Metadata Preparation	Data Preparation	Volume Design	Peer Review	Release & Distribution
GLL – IO				**3/97**	**4/97**	**1/98**
MAG	●	○	○			
PWS	●					
EPD	●					
EPHEM	●					
SPICE	●					
PLS	●					
HIC	●					
DDS	●					
GLL – G1	●			**3/97**	**4/97**	**1/98**
- G2	●			**4/97**	**1/98**	**2/98**
- C3	●			**4/97**	**1/98**	**2/98**
- E4	●			**1/98**	**2/98**	**3/98**
- E6	●			**2/98**	**3/98**	**4/98**
- G7	●			**2/98**	**3/98**	**4/98**
- G8	●			**3/98**	**4/98**	**1/99**
- G9	●			**3/98**	**4/98**	**1/99**
- C10	●			**4/98**	**1/99**	**2/99**
- C11	●			**1/99**	**2/99**	**3/99**
- Europa Mission						

● - Complete ○ - Partially Complete ○ - Begun ▬ - New Update

Saturn Volume Series Archive Status

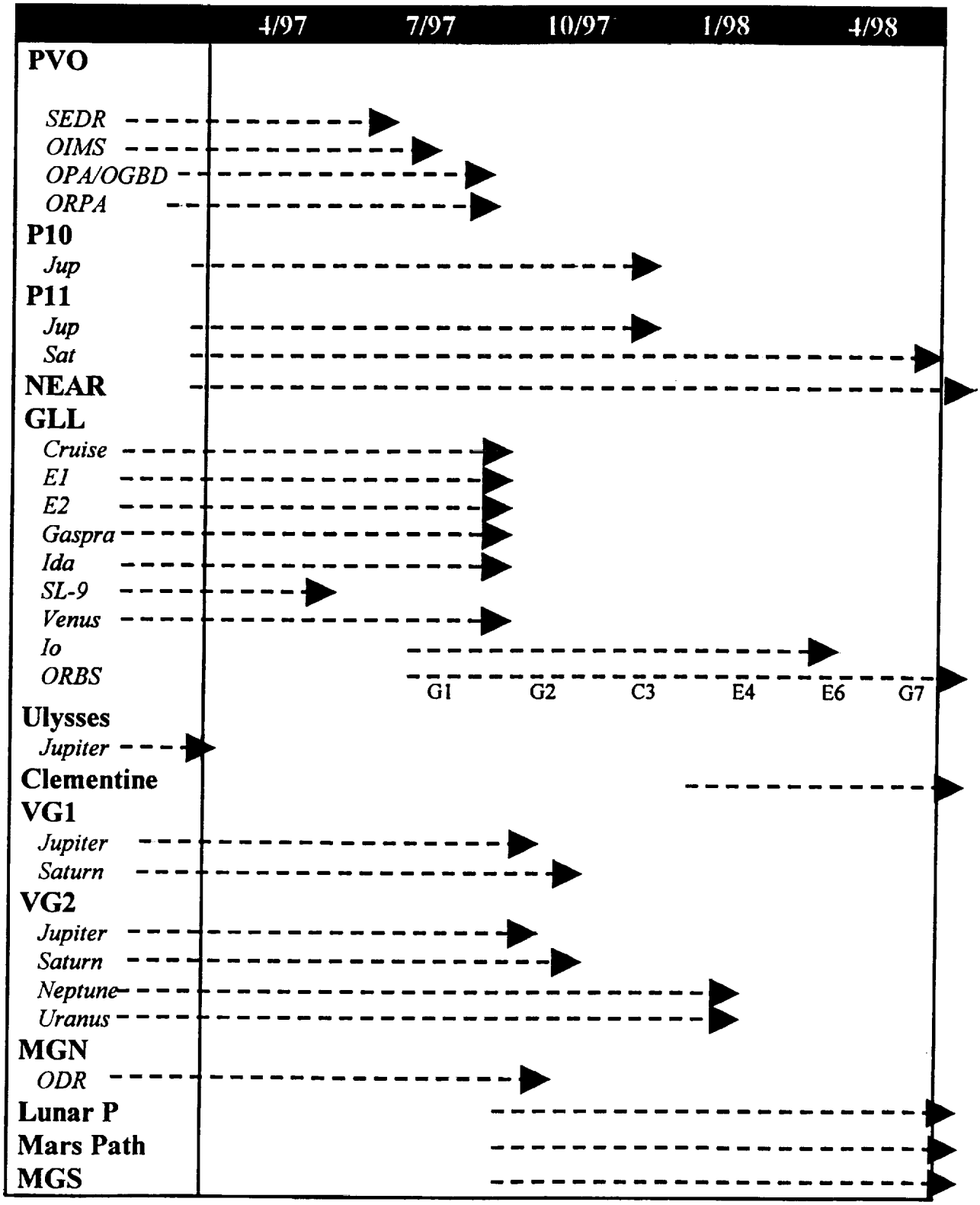
	Initial Contact	Metadata Preparation	Data Preparation	Volume Design	Peer Review	Release & Distribution
Voyager					Q2/97	Q3/97
PWS	●	●	●	●		
PLS	●	●	●	●		
MAG	●	●	●	●		
LECP	●					
EPHEM	●	●	●	●		
PRA	●	●	●	●		
CRS	●	●	●	●		
SPICE	●	●	●	●		
Pioneer 11					Q4/97	Q2/98
UVP	●	◉	●	◉		
VHM	●	●	●	◉		
FGM	●	◉	●	◉		
TRD	●	◉	◉	◉		
PA	●	◉	●	◉		
CPC	●	◉	○	◉		
CRT	●	◉	◉	◉		
GTT	●	●	●	◉		
SPICE	●	●	●	◉		

PWS - Plasma Wave Subsystem
PLS - Plasmas Science Experiment
MAG - Magnetometer
LECP - Low Energy Charged Particles Experiment
PRA - Planetary Radio Astronomy
CRS - Cosmic Ray Science
SPICE - S/C and Solar System Orbital Element Kernels

UVP - Ultra Violet Photopolarimeter
VHM - Vector Helium magnetometer
FGM - Fluxgate magnetometer
TRD - Trapped Radiation Detector
PA - Plasma Analyzer
CPC - Charged Particle Composition
CRT - Cosmic Ray Telescope
GTT - Geiger Tube Telescope

● - Completed ○ - Partially Complete ◉ - Begun ▬ - New Update

1997 Node Schedule



Infrastructure

- Improved jukebox stability
  - Replaced faulty reader
  - Reparied SCSI interface.
- Developed the ability to produce custom full color labels for write-once CD-ROMS.
- Improved the DITDOS server.
- Developed a DITDOS inventory editor to aid in the administration of the inventory tables.
  - Provides a complete top-to-bottom view of the inventory.
  - Provides the ability to edit the inventory through a forms like interface.

PDS Explorer

- Distributed PDS Explorer version 0 to PPI advisory group and selected scientists in US and Europe.
- In general the comments were favorable.
  - Most impressed with the development speed.
  - Most felt it was a useful tool.
  - Advisory panel felt that tool development should be secondary to preparing the data.
- Completing work on prototype.
  - Streamlined version of SPLASH.
  - Correcting problems.
- Future development will require additional resources.