JPL VLBI Analysis Center IVS Annual Report for 2001

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Abstract

This report describes the activities of the JPL VLBI analysis center for the year 2001. This year's highlights include WVR support of the Cassini gravity wave experiment and our first operational use of e-VLBI in support of the Mars Odyssey probe.

1. General Information

The JPL analysis center is located in Pasadena, California. Like the rest of JPL, it is operated by the California Institute of Technology under contract to NASA. JPL has had a VLBI analysis group since about 1970. Our work is focussed on supporting spacecraft navigation. This includes several components:

1 Delta differenced One-Way Range (ΔDOR) is a differential VLBI technique which measures the angle between a spacecraft and a nearby extragalactic radio source.

2 Time and Earth Motion Precision Observations (TEMPO) measures Earth orientation parameters based on single baseline bi-monthly measurements which are combined with daily GPS measurements of Earth orientation. The combined product is used to predict Earth orientation for spacecraft navigation use.

3 Radio Reference Frame (RRF) is an effort which provides the infrastructure to support ΔDOR and TEMPO with particular emphasis on celestial reference frame work.

2. Technical Capabilities

The JPL analysis center acquires its own data and supplements it with data from other centers. The data we acquire is taken using the NASA's Deep Space Network (DSN).

1 Antennas: Most of our work uses 34m antennas located near Goldstone California, Madrid Spain, and Tidbinbilla Australia. These include the following Deep Space Stations (DSS): DSS 15, DSS 45, DSS 65, DSS 13, and DSS 25. Less frequent use is made of the DSN's 70m network (DSS 14, DSS 43, DSS 63). Typical system temperatures are 35K. Antenna efficiencies are typically well above 50% at X-band.

2 Data acquisition: The DSN sites have standard MkIV acquisition systems. In addition we have a JPL unique system called the VSRs which have digital "video converters" and record directly to hard disk.

3 Correlators: The JPL BlockII correlator handles the TEMPO and RRF correlations of MkIIIa format tapes. The ΔDOR data is correlated using SOFTC which is a software correlator that runs under UNIX and VMS.

4 Solution types: We run several different types of solutions. For ΔDOR spacecraft tracking we make narrow field ($\approx 10^\circ$) differential solutions. The TEMPO solutions typically have a highly constrained terrestrial (TRF) and celestial frame (CRF) as a foundation for estimating

Earth orientation parameters. The RRF solves for a full TRF and CRF which is later used by TEMPO and ΔDOR. Experimental CRF work this year has focussed on modelling source structure.

3. Staff

Our staff are listed below with a brief indication of areas of concentration.

- Jim Border: ΔDOR
- Chris Jacobs: RRF and ΔDOR
- Gabor Lanyi: ΔDOR, WVR, and RRF
- Sumita Nandi: ΔDOR
- Chuck Naudet: WVR, MkIV support
- Jean Patterson: ΔDOR
- Ojars Sovers: RRF. Maintains MODEST analysis code.
- Alan Steppe: TEMPO
- L.D. Zhang: RRF

4. Current Status and Activities

This year's highlight was our first operational use of e-VLBI. Our differential VLBI spacecraft tracking system has a digital front end with data recorded to disk then networked back to JPL for correlation by our software correlator, SOFTC. The software correlator was used operationally with 100% success in support of the Mars '01 Odyssey probe.

A-WVR: Another highlight was the deployment of the advanced Water Vapor Radiometer (A-WVR) in support of the Cassini gravitational wave experiment. This device calibrates the water vapor induced delay. Using this device stabilities of roughly a part in 10^{15} have been achieved over time scales of 2,000 to 10,000 seconds.

5. Future Plans

Our plans for the coming year are focussed on extending our work to higher frequencies. The VLBA just accepted a JPL led proposal to extend the ICRF to K-band (22 GHz) and Q-band (43 GHz). This proposal includes over 20 collaborators from several IVS centers. We are also in the planning stage for developing a Ka-band (32 GHz) realization of the ICRF. All this work is motivated by the anticipation that spacecraft navigation will require a 32 GHz reference frame within a few years.

6. Dedication

This report is dedicated to the memory of George M. Resch (26 March 1940 – 22 November 2001). George joined the JPL VLBI effort in the 1970s. For two decades he pioneered WVR technology culminating in the A-WVR systems now being used to search for gravity waves. George served in many roles including the supervisor of the VLBI group for nearly a decade. He was a technical and political leader in most of the activities discussed in this report. He was a tireless advocate for VLBI and a valued colleague. The current strength of the JPL VLBI program is due in no small part to his efforts. His passing is a huge loss to all of us in the VLBI group at JPL. He lives on in our memories.