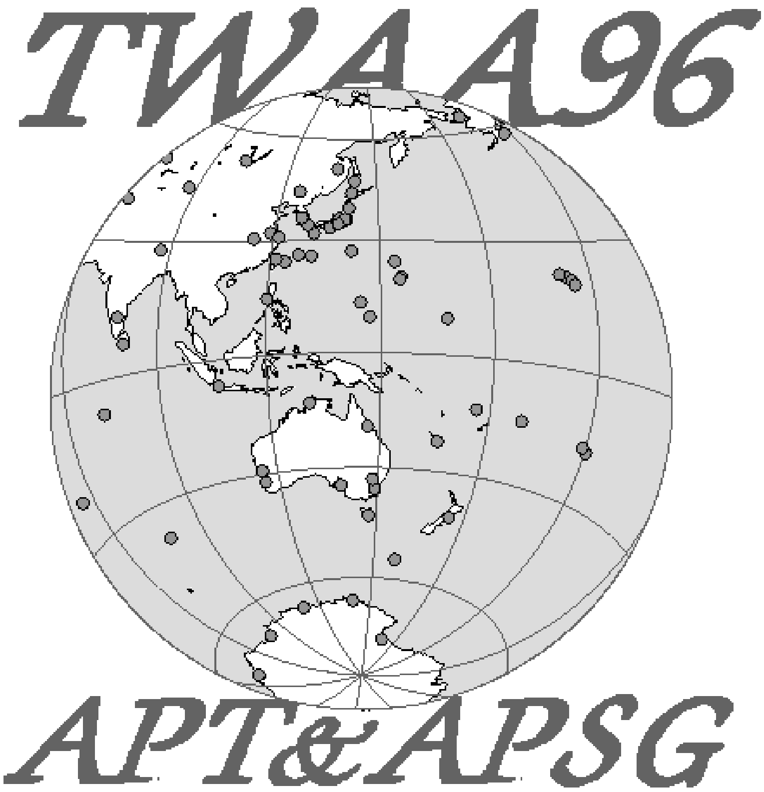
Technical Workshop for APT and APSG 1996



December 10 - 13, 1996

Kashima Space Research Center

Communications Research Laboratory

Japan

Local Organizing Committee / Workshop Secretariat

Workshop Secretary : Yukio Takahashi
e-mail : takahashi@crl.go.jp
TEL : +81-299-847136

Assistant Secretary : Yasuhiro Koyama
e-mail : koyama@crl.go.jp
TEL : +81-299-847143

Kashima Space Research Center
893-1 Hirai, Kashima, Ibaraki, 314 Japan
FAX : +81-299-847159

LOC Staff

Tetsuro Kondo, Noriyuki Kurihara, Eiji Kawai,
Ryuichi Ichikawa, Mamoru Sekido, Junichi Nakajima,
Akimasa Motohashi, Katsuya Kawamata, Akihiko Sugaya,
Syouji Odakura, Mamoru Iijima Naomi Shinotsuka, and Fumiko Iijima

Sponsors

Science and Technology Agency (STA)
Japan International Science and Technology Exchange Center (JISTEC)

Supporting Companies

Various expenses related with the workshop including travel supports for several participants will be supported by the following companies.

Nihon Tsushinki Co. Ltd.,
TOSHIBA Corporation
SONY Corporation
HITACHI Corporation
NEC Corporation
Anritsu Corporation
Meisei Erectric Co. Ltd.
Yamashita Engineering Manufacture Inc.

Technical Workshop for APT and APSG 1996

Program (as of November 18, 1996)

Session 1 : Opening

11:00-11:10	Welcome to the Workshop	Yoji Furuhama (CRL)
11:10-11:20	Opening Remarks	Fujinobu Takahashi (CRL)
11:20-11:50	The APT: Current Status	David L. Jauncey (CSIRO)
11:50-12:20	Recent Status of the APSG Project	Ye Shuhua (Shanghai O.)

Lunch Break

Session 2 : Status Report of Individual Observatories and Projects (Part 1)

[Wide Area Networks / Projects]

13:30-13:45	Recent Developments in the NASA Space Geodesy Program (SLR and VLBI)	John M. Bosworth (NASA / GSFC)
13:45-14:00	The CORE program: Geodetic VLBI for the new Millennium	Thomas A. Clark (NASA / GSFC)
14:00-14:20	Status and Near Future Prospects of the European VLBI Network	Leonid I. Gurvits (JIVE), and Richard T. Schilizzi (JIVE)
14:20-14:40	Global Astronomical VLBI Network	Makoto Inoue (NAO)
14:40-15:00	Western Pacific GPS Network	Teruyuki Kato (ERI/Tokyo U.)
15:00-15:20	Western Pacific and APSG SLR Network	John Manning (AUSLIG)

Coffee Break

15:40-16:00	Progress of the VLBI Program in the Japanese Antarctic Research Expedition after the APT'95 Workshop	Kazuo Shibuya, Koichiro Doi*, and Shigeru Aoki (NIPR)
16:00-16:20	VSOP	Hisashi Hirabayashi (ISAS)

[Regional Networks / Projects]

16:20-16:40	The Japanese VLBI Network	Osamu Kameya (NAO)
16:40-17:00	Interferometric SAR and Geodetic VLBI in	Mikio Tobita (GSI) Japan
17:00-17:20	Recent Progress on the VLBI Facilities in China	Qian Zhihan (Shanghai O.)
17:20-17:40	Activities in Australia	John Reynolds (ATNF)
17:40-18:00	Activities in India	Ashok K. Singal (PRL)
18:00-18:20	Report of National Cartographic Center Geodetic Activities in Iran	Farokh Tavakoli Tokhtameshlou (National Cartographic Center)

All-Together picture of the participants will be taken during this time.

18:30-20:30	Banquet

Day 2 (Wednesday, December 11, 1996)

Session 2 : Status Report of Individual Observatories and Projects (Part 2)

[Individual Institutes]

08:30-08:45	TBD	Masaki Morimoto (Kagoshima U.)
08:45-09:00	Key Stone Project	Noriyuki Kurihara (CRL)
09:00-09:15	VERA	Tetsuo Sasao (NAO)
09:15-09:30	Status Report of the Taedak Radio Astronomy Observatory and the Korea Astronomy Observatory	Young Chol Minh (Taedak Radio A. O., Korea A. O.)
09:30-09:45	VLBI in India and International Collaboration	Hari O. Vats (PRL)
09:45-10:00	Resent Status of Urumqi VLBI System	Aili Yusup (Urumqi O.)
10:00-10:15	The Status of the Hobart 26-metre and the Ceduna 30-metre Antennas	Marco E. Costa (Hobart O.)

Coffee Break

10:35-10:55	Giant Metre-wave Radio Telescope	Subramaniam Ananthakrishnan (Tata I.)
10:55-11:10	The DSN Radio Observatory and Asian Pacific VLBI Network	Valery I. Altunin, Thomas Kuiper, and Pamera Wolken (JPL)

Session 3: Developments of Technologies (Part 1)

[Receivers / Antenna / Front-end System]

11:10-11:25	A Tunerless 33-50 GHz band SIS Receiver	Masato Tsuboi (Ibaraki U.)
11:25-11:40	The Construction Methods of VLBI Receivers	Irina A. Ipatova (IAA/RAS)
11:40-11:55	The Mark-4 VLBI Timing Initiative (NASA/GSFC)	Thomas A. Clark
11:55-12:10	TIGO - a New Geodetic Tool	Hayo Hase (IfAG)
12:10-12:25	The Video Converters for Registering Terminal S2-RT	Nikolai E. Koltsov (IAA/RAS)

Lunch Break

[Real Time VLBI with High Speed Digital Communication]

13:30-13:45	Real Time VLBI of the KSP	Hitoshi Kiuchi (CRL)
13:45-14:00	Toward the International VLBI Linked by the Broadband Network	Taizoh Yoshino (CRL)
14:00-14:15	Real Time VLBI	Michail N. Kaidanovski (IAA / RAS)

[Field System / Scheduling]

14:15-14:30	Automated Remote Operation System and Data Analysis System for the Key Stone Project VLBI Network	Yasuhiro Koyama (CRL)
14:30-14:45	SLR Observation System for the Key Stone Project	Hiroo Kunimori (CRL)
14:45-15:05	Recent Improvements in the NASA Field System	Ed Himwich (NASA/GSFC)
15:05-15:20	Report on Radio Astronomy within the Tidbinbilla Tracking Station (Canberra DSCC)	Paul Harbison
15:20-15:35	Scheduling for VSOP and Implications for the APT	Philip Edwards (ISAS)
15:35-15:45	Summary and Preparation for the next day's Open Discussion	T.B.D.

Coffee Break

[Recorder / Data Acquisition Terminal]

16:05-16:25	The Mark IV VLBI System	Alan R. Whitney (Haystack O. / MIT)
16:25-16:40	K-4 and KSP VLBI Terminal	Hitoshi Kiuchi (CRL)
16:40-16:50	D-1 Cassette Data Recorders	Eiichi Tanaka (SONY)
16:50-17:05	S2 Recording System in VLBI	Wayne H. Cannon (ISTS)
17:05-17:20	S2 Recording System	Georg H. Feil (ISTS)
17:20-17:35	1024Mbps VLBI Data Recorder and Weak Radio Source Observation	Junichi Nakajima (CRL)
17:35-17:45	Applications of High-Vision Recorders	Shigeo Kizu (TOSHIBA)
17:45-18:05	Specification and Current Status of the VSOP Terminal.	Seiji Kameno (NAO)
18:05-18:25	VSOP/S2, VSOP/VLBA Translator Designed to Tie all APT Stations	Noriyuki Kawaguchi (NAO)
18:25-18:35	Summary and Preparation for the next day's Open Discussion	T.B.D.

Day 3 (Thursday, December 12, 1996)

Session 3: Developments of Technologies (Part 2)

[Correlators]

08:30-08:45	Development of K4 Correlator for Japan-Russia Pulsar VLBI	Mamoru Sekido (CRL)
08:45-09:00	KSP Correlator and Data Reduction System	Tetsuro Kondo, Hitoshi Kiuchi , and Mamoru Sekido (CRL)
09:00-09:20	The Status of Mitaka Correlator	Katsunori Shibata (NAO)
09:20-09:40	IAA S-2 Correlator for Geodetic VLBI	Andrej M. Finkelstein (IAA / RAS)
09:40-10:00	Mark-IV Correlator	Alan R. Whitney (Haystack O. / MIT)

[Tropospheric Delay Correction]

10:00-10:20	Tropospheric Delay Mapping Function	Arthur Niell (Haystack, MIT)
10:20-10:40	GPS Meteorology in Japan and its Implications to VLBI	Ryuichi Ichikawa (CRL)

Coffee Break

Session 4: Science

11:00-11:15	Measurement of Pulsar Proper Motion Using Asia Pacific Telescopes	Takayuki Sakurai (STE Lab., Nagoya U.)
11:15-11:30	VLBI-Holographic Surface Error Measurements of MUSES-B	Tomonari Suzuyama, (Kagoshima U.) Noriyuki Kawaguchi, (NAO) Yuuji Horie,(Kagoshima U.) and Tomoyuki Miyazaki (Kagoshima U.)
11:30-11:45	Measurement of Relative Motions Between SHAO, TAIW, USUD and TSKB IGS Stations	Zhu Wenyao (Shanghai O.)

Lunch Break

13:30-13:45	VLBI Errors and the Short Term Variation in VLBI Yukio Takahashi (CRL)	
13:45-14:00	Determination of Lunar Gravity Potential with Differential VLBI and Doppler Tracking in the SELENE Project	Kosuke Heki (NAO)
14:00-14:15	RISE (Research in Selenodesy) Project	Nobuyuki Kawano (NAO)
14:15-14:30	Idea of Geospots - a New Proposition for the Explanation of Continental Drift	Debasish Roy and Tushar K. Das (Geological Survey of India)
14:30-14:45	Fluctuation of Extragalactic Reference Frame due to Gravitational Lensing	Mizuhiko Hosokawa (CRL)
14:45-15:00	Southern Hemisphere Maser Surveys with the APT	Victor Migenes (NAO)

Coffee Break

Session 5 : Open Discussions

15:20-16:20	Compatibilities between Different Data Acquisition Terminal
16:20-17:20	Exchange File Format (SINEX, VEX, LOG, ...)
17:20-18:00	Collaborations between APT and APSG Future proposals, sharing the resources, ...
	Concluding Remarks / Decisions of the Workshop

Day 4 (Friday, December 13, 1996) 08:30-18:00

Excursion 1 **(KSRC/CRL and GSI Tsukuba)**

Excursion 2 **(KSRC/CRL, NAO Mitaka or ISAS Sagamihara or CRL Tokyo)**

Poster Presentations December 10 - December 11

1.	IAA Software Packages for Geodetic VLBI	Andrej M. Finkelstein (IAA/RAS)
2.	Time Synchronization via Communication Satellite	Michail N. Kaidanovski (IAA/RAS)
3.	Reference-Radio-Source Candidates for VERA Observations	Tetsuo Sasao (NAO), Yoshiharu Asaki (NAO), Atsuya Okudaira (Kyoto U.) and Toshihiro Omodaka (Kagoshima U.)
4.	A Reflector-type Polarimeter for Millimeter-wave Band	Hiroko Shinnaga (Ibaraki U.)
5.	Pulsar VLBI on Kalyazin (Russia) - Kashima(Japan) Baseline	Alexander E. Rodin (P.N.Lebedev Physical I.)
6.	Fundamental Experiments of Radio Interferometer Using Fiberoptic Links Modulated in Radio Frequency	Jun Amagai (CRL), Hiroo Kunimori (CRL), Hitoshi Kiuchi (CRL)
7.	Low Noise HEMT Receivers and K-4 VLBI Back-end System	Nihon Tsushinki Co. Ltd.
8.	Applications of High Speed Digital Data Recorders for VLBI Observations	TOSHIBA Corporation
9.	Automated VLBI Operations with the Digital Mass Storage System	SONY Corporation
10.	A New 32m Antenna System to be Constructed at Tsukuba	NEC Corporation
11.	Hydrogen Maser System and Future Frequency Standard Technologies	Anritsu Corporation
12.	1024 Mbps Digital VLBI Interface for GBR1000 Data Recorder	Yamashita Engineering Manufacture Inc.
13.	VLBI Correlator Control Software	Hiroto Sato (Kety Co. Ltd.)
14.	Design of Radix 4 FFT Based Butterfly LSI	Naoki Tanaka (Waseda U.) et al.
15.	2^{24} Point FFT Processor Design for Real Time Pulsar Survey	Hiroshi Takeuchi (Waseda U.) et al.
16.	Radioastron Mission	Sergey F. Likhachev (Astro Space Center)
17.	VLBI Activity of ASC on Russian Deep Space Tracking Network	Igor E. Molotov (Astro Space Center)
18.	Progress Report on Results of Bear Lakes-Tidbinbilla Experiment	Igor E. Molotov (Astro Space Center), et al.
19	Study of Caspean Sea Geodynamics	Farokh Tavakoli Tokhtameshlou (National Cartographic Center)

December 10, 1996 – Session – 1
Opening

The APT: Current Status

David L. Jauncey
Australia Telescope National Facility, CSIRO, Australia

Abstract The radio telescopes of the Asia-Pacific Region form a natural network for regional VLBI observations. The geographical distribution of the participating radio telescopes allows good north-south resolution and full access to radio sources in the equatorial and southern parts of the sky. The first steps in APT co-ordination were taken in 1991, and, since then the APT has expanded to encompass most radio telescopes in the region. The APT aims to provide a forum for discussion of common ideas, resource sharing and equipment needs, and to co-ordinate regional VLBI. Progress in fulfilling these goals is discussed, and some ideas presented as to future collaboration.

Recent Status of The APSG Project

Ye Shuhua
Shanghai Observatory, Chinese Academy of Sciences, China

Abstract No abstract

December 10, 1996 – Session – 2
Status Report of Individual Observatories and Projects (Part 1)

Recent Developments in the NASA Space Geodesy Program (SLR and VLBI)

John M. Bosworth
NASA Goddard Space Flight Center, U.S.A

Abstract No abstract

The CORE Program: Geodetic VLBI for The New Millennium

Thomas A. Clark

NASA Goddard Space Flight Center, U.S.A.

Abstract In the past 25 years geodetic VLBI has made remarkable progress at solving some fundamental questions in geophysics. Much of the research efforts have centered on Plate Tectonics, with questions like

- Is the contemporary motion of the major tectonic plates the same as the million year historical average rates?
- Are interiors of the major plates rigid?
- How does deformation occur along plate boundaries?

Geodetic VLBI has also made some fundamental contributions in areas like:

- The detailed nature of the earth's inner core.
- The interaction between the global circulation of the atmosphere and oceans with the rotation of the earth.
- Establishment of some key fundamental physical constants like General Relativistic parameterization, precession constants, etc.

The contributions of VLBI and more recently GPS have answered many of these questions. As we enter the new millennium we must ask what our next major challenge is. After much deliberation, we have come to the conclusion that VLBI will make its next major contribution to Geophysics by helping us develop an understanding of the short-term variations in the earth's rotation; we have named this program CORE: Continuous Observation of the Rotation of the Earth.

In order to embark on the "high data bandwidth" CORE program we have begun to coordinate our ideas with colleagues around the world. We are beginning to establish the criteria for the VLBI networks needed, to define the quality of performance needed from each station, and to identify the resources needed to develop such a program.

We will present to this workshop our current thoughts and anxiously solicit feedback and support.

Status and Near Future Prospects of the European VLBI Network

Leonid I. Gurvits and Richard T. Schilizzi
Joint Institute for VLBI in Europe, The Netherlands

Abstract At present the European VLBI Network (EVN) consists of 12 radio observatories distributed from Western Europe to the Far East (China). It carries out VLBI observations autonomously using the MkIII standard and as a part of the Global VLBI network (MkIII and VLBA standards). The Network is a facility available for use by the world wide scientific community. Several major technical developments in EVN instrumentation are currently under way. They will enhance observing capability and scientific return of the Network:

- The 16-station correlator is being constructed as part of a collaboration between the Joint Institute for VLBI in Europe (JIVE, Dwingeloo, NL), the Netherlands Foundation for Research in Astronomy (NFRA, Dwingeloo, NL) and the Haystack Observatory (MIT, MA, USA). Elements of the project are also being done by the Nuffield Radio Astronomy Laboratories (Jodrell Bank, UK) and the Institute for Radio Astronomy (Bologna/Noto, Italy). The correlator, located at JIVE, is expected to start operations in 1998. The correlator will be compatible with MkIII and VLBA recording modes and will feature such new characteristics as up to 1 Gb/s/station data rate, multiple pulsar gating, up to 4096 spectral channels/baseline, multiple phase center correlation.

- An upgrade program for VLBI recording terminals from MkIIIA to MkIV standard is nearly completed at 5 European observatories (Effelsberg, Jodrell Bank, Medicina, Onsala, Westerbork). The terminal at the Urumqi Observatory (China) will be upgraded to MkIV standard in 1997.

- VLBA recording terminals at EVN stations will be upgraded to MkIV standard also in 1997. This will allow use of the full MkIV capability at all EVN telescopes together with the EVN MkIV correlator at JIVE.

- Most EVN stations are upgrading their receivers, LO, IF and digital instrumentation. It is aimed at improving the sensitivity in all observing bands and providing operational flexibility (including a frequency agility and switching between VLBI and single dish observations in minimal time).

Special attention is being given to enhancing the operational efficiency and reliability of all components of the EVN, in particular at the new EVN telescopes in China (Shanghai and Urumqi) and in Poland (Torun). The latter three telescopes participate in a Quality Assurance Programme whose goal is to speed up the involvement of the new telescopes in productive scientific operations.
We expect that these developments will open the way for new scientific applications. Some of them, like recent observations of the 6 GHz OH line emission from star forming regions (Desmurs et al. 1996) and a demonstration Cluster-Cluster VLBI experiment (Gurvits et al. 1996) have been successfully tested on the EVN.
Finally, all the current developments in the EVN are crucially important for active participation of the Network in the VSOP mission and future Space VLBI projects.

Global Astronomical VLBI Network

Makoto Inoue
National Astronomical Observatory, Japan

Abstract No abstract

Western Pacific GPS Network

Teruyuki Kato
Earthquake Research Institute/ University of Tokyo, Japan

Abstract No abstract

Western Pacific and APSG SLR Networks

John Manning
Australian Surveying and Land Information Group, Australia

Abstract The Western Pacific Laser Tracking Network (WPLTN) was formed in 1995 to promote quality laser ranging in the Asia Pacific region. This group is involved in technology developments leading to a new generation of precise laser, such as is being applied in the Keystone SLR project. A joint data analysis project is in progress to compare results from each WPLTN analysis centre. the most recent meeting was held in conjunction with the 10th Laser Ranging Instrumentation Workshop in Shanghai in November 1996.
At the formative meeting of the Asia Pacific Space Geodynamics group in May 1996, a series of technique working groups was established to provide technical assistance to scientists involved in cooperative research in crustal plate motions in the Asia and the Pacific Region. The SLR working group provides a means of communication and coordination for the APSG and is not intended to supplant the functions of other international groups such as WPLTN and CSTG.

Progress of the VLBI Program in the Japanese Antarctic Research Expedition after the APT'95 Workshop

Kazuo Shibuya, Koichiro Doi* and Shigeru Aoki

Center for Antarctic Environment Monitoring, National Institute of Polar Research, Japan

Abstract We presented a project proposal "VLBI programs in the Japanese Antarctic Research Expedition and role of Syowa Station as an observatory for global geodesy in Antarctica" at the APT95 Workshop held at the Australian Telescope National Facility (ATNF) Sydney, 4-7 December 1995. Almost one year passed from the workshop and steady progress was made as summarized below.
There still remain action items before departure (14 Nov. 1997) of JARE-39, which brings the VLBI back end system to Syowa Station and efforts continue.

1. Preparation for Syowa Station

   (a) Device test for the K4 back end system began from the fringe detection test with the DIR1000M recorder which was integrated to the 5 m VLBI antenna at GSI, Tsukuba.

   (b) Design of transport platform for the hydrogen-maser (2 sets) is finished and all the related instruments will be ready in March 1997.

   (c) Candidate of JARE-39 wintering VLBI scientist was nominated by the Japanese ad-hoc Working Group for the Antarctic VLBI.

   (d) Device test and overall test must be finished before pre-determined cargo making schedule (mid October 1997).

   (e) Ice-breaker Shirase will stay at Syowa Station from end December 1997 to February 12, 1998 and one 48 hour observation is planned in February.

2. International collaboration

   (a) Three sets of geodetic (16 ch) samplers for the S2 recording system (S2-RT/MK3 data acquisition interface) will arrive at NIPR on end of February 1997, and will be made available to the S2 station in Australia and South Africa.

   (b) Administrative efforts are going on to make an MOU with the Australian VLBI group and the South Africa station to realize 4 campaigns of 48- hour observations. This will (must) be finalized before June 1997 and we think difficulties were basically overcome.

   (c) Because of the reduction of antenna time allocated to remote sensing satellites, even one-week continuous observation can be programmed at Syowa Station. Discussion to realize the campaign with the O'Higgins Station (or to include the O'Higgins Station) will be continued.

   (d) There is a good news that VSOP group successfully correlated the FS9.1 formatted S2 data record with the K4 data record, although detailed way of correlator processing for the Antarctic VLBI is still open.

VSOP

Hisashi Hirabayashi
The Institute of Space and Astronautical Science, Japan

Abstract In February 1997, the VLBI Space Observatory Programme (VSOP) satellite will be launched by ISAS. An 8-meter telescope will be deployed in orbit, and observations made at 1.6GHz, 5GHz and 22GHz in concert with the world's radio telescopes. The apogee height of 22,000 km and perigee height of 1,000 km will enable resolutions three times better than that achievable on earth-based baselines to be realized. In this Very Short Oral Presentation, the project will be reviewed and the kinds of observations that will be undertaken will be described.

The Japanese VLBI Network

Osamu Kameya
National Astronomical Observatory, Mizusawa Astrogeodynamics Observatory, Japan

Abstract A 22GHz VLBI network is under operation for three years in Japan. The network is operated by using mainly four antennas. Three of them belong to National Astronomical Observatory; Nobeyama 45m millimeter wave antenna, Mizusawa 10m VLBI antenna, and Kagoshima 6m antenna. These three are also used for common use VLBI observations in Japan. The other is Kashima 34m antenna which belongs to Communication Research Laboratory. This antenna often participate in many kinds of VLBI observations. The USDA 64m antenna of ISAS also sometimes participate in the network. The network uses K4 backends and K4 magnetic cassette tapes for data recording. The data recording rate is regularly 64Mbps. The recorded data is correlated by using two kinds of correlators: the one is NAOCO (New Advanced One-unit Correlator) which was developed by National Astronomical Observatory, Japan. We have finished the almost correlation process for two years data by using it. The other is Mitaka FX correlator which is under test operation. This correlator will be used for correlation of VSOP and Eurasian VLBI network data. The main targets of the network are study of distribution of water maser spots in star forming regions and late type stars and that of shape or size of continuum radio sources. 43GHz VLBI observations of the network will be available in near future.

Interferometric SAR and Geodetic VLBI in Japan

Mikio Tobita
Geographical Survey Institute, Japan

Abstract GSI's 26 m antenna at Kashima has been participating in the DOSE global VLBI network. Recently the GSI built two 3.8 m dish antennas at Shintoshukawa and Tsukuba; and started to construct two 10 m dish antennas at Chichijima and Aira and 32 m antenna at GSI/HQ in Tsukuba. These antennas will contribute to geodetic VLBI and CORE. GSI has applied SAR interferometry to measure surface changes. Mid November, CRL and GSI used their VLBI antennas for precise calibration of InSAR.

Recent Progress on the VLBI Facilities in China

Qian Zhihan

Shanghai Observatory, Chinese Academy of Sciences, China

Abstract This presentation briefly describes the progress on the VLBI facilities in China since last APT workshop in Sydney, December,1995.

1. A new 1.3 cm cryogenic cooled receiver ordered from the ATNF, CSIRO, Australia and 3.6 cm and 6 cm receivers ordered from the IAA, Russian were sucessfully installed on the 25m antenna at Shanghai VLBI station in this year. The values of the system noise temperature are 100k and 52 K and 55 K, respectively. To widen the bandwidth of the 3.6 cm receiver to 800 MHz for increasing the delay resolution is planned.

2. Also, a new 1.3 cm receiver provided by the NAO, Japan has reached Urumqi VLBI station. It will be installed on the antenna in December this year. The 3.6 cm and 6 cm receivers also ordered from the IAA are being installed in Urumqi. The performance of the IAA's receivers is same with those in Shanghai.

3. A second Phase-lock Loop was added to the Hydrogen maser at Shanghai for the clean of the phase noise and the 50 Hz interference from the power supply of the 5 MHz output.

4. All electronic boards of the SH-3 Correlator compatible with MK III and VLBA have been finished. The modifications of the playback units for the improvement of the parity errors have been completed by the P & G Company, UK. The assembly and the test of the correlator will be performed in the near future.

5. The manufacture of a mobile VLBI system for the monitoring of the crustal motions in China has been completed. At present, it is at the test stage and will be in operational in the first half of 1997.

Activities in Australia

John Reynolds

Australia Telescope National Facility, Australia

Abstract No abstract

Activities in India

Ashok K. Singal

Physical Research Laboratory, India

Abstract No abstract

TBD

Masaki Morimoto
Kagoshima University, Japan

Abstract No abstract

Key Stone Project

Noriyuki Kurihara
Communications Research Laboratory, Japan

Abstract The Tokyo Metropolitan Area is situated above the triple-layered structure of the major tectonic plates; the North American, the Philippine Sea and the Pacific plates. The Communications Research Laboratory (CRL) had developed the Crustal Deformation Monitoring system for the Tokyo Metropolitan Area using both VLBI and SLR. This program is called the "Key Stone Project (KSP)". The four observation stations (Kashima, Koganei, Miura, and Tateyama) in this program are located around the Tokyo Metropolitan Area. This system is characterized by no operator at each station, and by the remote operation system from the Koganei Central station, and by real time VLBI system. The real time VLBI (detection of fringes) was realized this summer. The daily 5 hours VLBI experiments have conducted on six baselines among Kashima, Koganei, Miura and Tateyama since September in 1996. SLR observations will be conducted always in the clear sky. The precision in SLR are expected to be a few mm. The SLR observation will be started at early next year.

VERA (VLBI Exploration of Radio Astrometry)

Tetsuo Sasao
Mizusawa Astrogeodynamics Observatory / National Astronomical Observatory, Japan

Abstract VERA (VLBI Exploration of Radio Astrometry) is a project for constructing a dedicated VLBI Array in Japan. The array is mainly oriented towards high precision astrometry and geodesy with extensive use of the differential VLBI technique. In particular, VERA is expected to become the first instrument which enables us to draw a three-dimensional map of our Milky Way Galaxy in terms of measuring annual trigonometric parallaxes and proper motions of thousands of astronomical masers. A unique design of array composed of four stations with two medium-sized antennas each is adopted for VERA. Using pairs of baselines connecting the stations, we will be able to conduct simultaneous phase-referenced VLBI observations of target masers and adjacent reference quasars. Studies based on the statistical model of the turbulent troposphere and experiments using Nobeyama Millimeter Array show that this 'multi-view differential VLBI' will mostly eliminate the degrading phase fluctuations due to the water vapor component in the troposphere and allow us to achieve the unprecedentedly high astrometric accuracy of 10 micro-arcsecond level required for the above purposes. VERA anticipates wide-field cooperation with VLBI stations of APT and APSG. Scientific objectives, performance requirements and design concepts of VERA are briefly discussed.

Status Report of the Taedak Radio Astronomy Observatory and the Korea Astronomy Observatory

Young Chul Minh
Taedak Radio Astronomy Observatory , Korea

Abstract Taedak Radio Astronomy Observatory belongs to the national astronomical institute, Korea Astronomy Observatory, which also includes optical observatories and a positional research division. We introduce recent activities of our Observatory and the present status of our 14 m radio telescope, our VLBI project, and our future plan to build the VLBI network in Korea. We are very eager to achieve our goals but need many suggestions and inputs from outside. We hope that our observatory will be an active member of the Asia-Pacific VLBI networks in near future.

VLBI in India and International Collaboration

Hari O. Vats
Physical Research Laboratory, India

Abstract This article will outline the plan of making a moderate size VLBI system in India. This will operate in three modes : (1) VLBI with APT for astronomy and geodesy ; (2) VLBI with other telescopes in India, this will be at meter-wave mostly ; and (3) Stand alone usage for the observations of active galactic nuclei and galaxies, this operation will complement our IR and Optical observations from Guru Shikhar Observatory at Mt Abu. There is a proposal of cooperation between Japan and India on VLBI, this paper will also outline that in brief.

Recent Status of Urumqi VLBI System

Yusup Aili
Urumqi Astronomical Observatory, China

Abstract Introduction of the basic status of Urumqi VLBI station,receivers and future.

The Status of the Hobart 26-metre and the Ceduna 30-metre Antennas

Marco E. Costa
University of Tasmania, Australia

Abstract This paper will present a general description of the antennas located at Hobart in Tasmania and Ceduna in South Australia which are operated by the University of Tasmania and lie along the southern edge of the Australian continent. The Hobart antenna has recently been re-fitted with a new control system and new L/C band and 22 GHz receivers are being constructed for it in preparation for the space VLBI missions. The newly acquired Ceduna antenna, which was until recently owned by a telecommunications company, is being equipped for operation as a radio astronomy instrument. A brief description will also be made of the European Space Agency 15-metre antenna which is located at Perth in Western Australia and has been used in recent years to add a long, east-west baseline to Australia's VLBI capability.

Giant Metre-wave Radio Telescope

Subramaniam Ananthakrishnan
Tata Institute of Fundamental Research, India

Abstract The Giant Meter-wave Radio Telescope(GMRT) is nearing completion in western India. Consisting of 30 antennas of 45 m. diameter each, it will be the most sensitive aperture synthesis instrument in the world in its operating frequency range of 50-1500 MHz. The telescope will also be used as a ground VLBI station for the Radioastron satellite antenna being launched from Russia in 1997-1998 period for the frequency 325 MHz. This paper will describe the operational status of GMRT.

The DSN Radio Observatory and Asian Pacific VLBI Network

Valery I. Altunin, Thomas Kuiper and Pamera Wolken
Jet Propulsion Laboratory /Deep Space Network, U.S.A.

Abstract The current status of VLBI radio astronomy at the DSN is described. Recent upgrades of the radio astronomy and VLBI recording instrumentation will provide new capabilities (MKIV and S-2 (provided by the CSIRO, only at Tidbinbilla) for recording, two polarization receivers (at L- and K-bands, etc.) and will enhance VLBI radio astronomy at the DSN. Time allocation, compatibility issues, and operational interfaces between the DSN radio telescopes and the Asian Pacific VLBI network (APT) are discussed.

A Tunerless 33-50 GHz Band SIS Receiver

Masato Tsuboi
Institute of Astrophysics and Planetary Science, Ibaraki University, Japan

Abstract We have developed a new 33-50 GHz band SIS mixer for a multi-beam receiver of the Nobeyama 45-m telescope. The mixer is operated on the cold stage in the receiver vessel, which is cooled by a mechanical refrigerator. The PCTJ-type Nb junctions are installed in the reduced height waveguide of the mixer. This mixer has full-band tunerability (33-50GHz) without any mechanical tuner. The mixer can use IF frequency up to 7 GHz. The typical receiver noise temperature is below 30 K(DSB) at the IF frequency of 1.5 GHz.

The Construction Methods of VLBI Receivers

Irina A. Ipatova
Institute of Applied Astronomy Russian Academy of Sciences, Russia

Abstract In the radio astronomy it is important to use the cooled low-noise amplifiers and cooled short input lines to achieve very low noise temperature of the radio telescope. This work presents the engineer's method of design for cooled low-noise amplifier systems operating at L-X frequency ranges. The algorithm for noise temperature minimization is shown. One must take into account all factors influencing decrease of the receiver noise temperature. The row of cooled radiometers at L-X bands with very low noise temperatures is created based on this algorithm for minimization. The best results from laboratory testing of these receivers are presented.

The Mark-4 VLBI Timing Initiative

Thomas A. Clark
NASA Goddard Space Flight Center, U.S.A.

Abstract As we began to plan for the CORE program we identified the need for significant improvement in the timing used at all the VLBI stations:

- The geodetic delay and delay-rate observables are time-tagged by the observing network. If the network has a systematic bias from "true" UTC (i.e. UTC(BIPM) or UTC(USNO)), then the UT1 observed by VLBI will biased.
- The correlator facilities can be made much more efficient if they can correlate "blind" without the need for fringe searches to define station clock models.
- Careful monitoring of H-Maser performance at each station is needed to insure reliable station operation.
- The H-Masers at the VLBI stations constitute an international "clock resource" which could be of use to others users of precise time/ frequency. Several groups have attempted to do absolute "clock sync" measurements, but no systematic program exists.

We plan to begin an initiative to tackle these issues as a part of our Mark-4 development program. The first phase was begun a couple of years ago. I developed my "Totally Accurate Clock" (TAC) as a way to establish an accurate and precise timing reference to UTC(USNO) at isolated stations at low cost. As a part of this workshop I will demonstrate my TAC in operation.

The TAC consists of a low-cost commercial GPS receiver (basic cost < $500 US) plus a standardized interface between the GPS receiver and other station hardware (designed by me). We have spent much time studying the optimum way to use this low-cost hardware to achieve the needs of VLBI. By applying the techniques we have developed, it is possible to achieve timing accurate at levels ¡ 30 nsec at any station in the world. We have now supplied about 50 TACs to the community and we have identified a way for others to copy it.

The TAC is augmented by a high quality time-interval counter. We have identified an excellent low cost (< $1800 US) counter that seems perfect for VLBI use. One difficulty in the past has been that most VLBI stations do not have a counter dedicated to station epoch timing, so routine logging is chaotic and not uniform between the stations. Since many different types of counters are used at various VLBI stations, it is very difficult to establish a uniform software interface.

Since there are several timing signals to be compared (for example, the H-Maser 1PPS signal, the Formatter clock signal, GPS timing signal, etc), we have identified the need to develop a new multiplexer that would become a standard part of the Mark-4 system. The design also includes a generator for "IF" Phase Calibrator signals that can be injected (at VHF/UHF) into the VLBI signal path.

We see the need that the Field System software needs to be augmented. At present the FS operates the equipment only during an experiment. But this timing data (along with other key parameters from the station) needs to be logged full-time.

In order to perform an accurate clock synchronization we plan to begin to perform a complete end-to-end calibration of all time delays (both electrical and geometrical) at a few key stations. By VLBI observation, these stations would "transfer" the instrumental calibrations to other stations.

TIGO - A New Geodetic Tool

Hayo Hase
Institute for Applied Geodesy, Germany

Abstract The Transportable Integrated Geodetic Observatory (TIGO) consists of all the relevant space geodetic techniques as such as VLBI, SLR, GPS and also gravity meter at one location. It is envisaged to place TIGO for the densification of reference frames at remote locations and contribute to the ongoing long-term research activities.

The Video Converters for Registering Terminal S2-RT

Nikolai E. Koltsov
Institute of Applied Astronomy Russian Academy of Sciences, Russia

Abstract The usage of the Canadian recording terminals S2-RT for VLBI observations at the radio telescopes was limited, because of the lack of high quality video converters providing the connection between the terminals and the low noise receivers of the radio telescope. The video converters that was worked out in IAA RAS solves this problem. The main parameters of the converters are presented.

Real-time VLBI of the KSP

Hitoshi Kiuchi
Communications Research Laboratory, Japan

Abstract Communications Research Laboratory and NTT Telecommunication Network Laboratory Group have developed a new VLBI system, called the KSP (Key Stone Project) real-time VLBI system, using a high-speed ATM (Asynchronous Transfer Mode) network. The KSP has four VLBI stations connected by an ATM network and the data transmitted from these remote observing stations to the correlation site in Tokyo. In real-time VLBI, the cross-correlation processing and data observation are carried out simultaneously, and it will take about three hours to analysis the crustal deformation data after the VLBI observation is completed. In ATM, the transmission rate (capacity) can be chosen freely. The data rate to the ATM transmitter can be selected from five rates between 16 and 256 Mbps. Real-time VLBI is expected to be one of the breakthrough technologies for improving VLBI performance, and will give us data on crustal deformation in the Tokyo metropolitan area quickly. Good fringes (correlated patterns) are obtained in real-time 4-station 6-baseline KSP system, and we are making an automatic correlation control software.

Toward The International VLBI Linked by The Broadband Network

Taizoh Yoshino
Communications Research Laboratory, Japan

Abstract In the Keystone Project (KSP), real time VLBI experiment with 256 Mbps was demonstrated successfully in a domestic network. For a future use of VLBI, quick service is needed such as in the UT1 determination. Real time VLBI is the best tool for this purpose. Moreover, broadband network provides us higher sensitivity of VLBI. International compatibility of the system should be also considered.

Real-Time VLBI

Michail N. Kaidanovski
Institute of Applied Astronomy Russian Academy of Sciences, Russia

Abstract VLBI technics is extremely effective in the field of geodetic and Earth rotation. However in the mode of independent data recording the real-time operation is impossible. For the real-time operation it is necessary to accelerate all procedure and to create a data transmission lines. The special satellite communication system QUASAR-S was constructed. The basic technical features of the system are presented. The results of the experimental data transmission are given.

Automated Remote Operation System and Data Analysis System for the Key Stone Project VLBI Network

Yasuhiro Koyama
Kashima Space Research Center, Communications Research Laboratory, Japan

Abstract To achieve the daily observations and the fast delivery of the analysis results for the Key Stone Project (KSP) VLBI Network, highly automated systems were required in many respects. The remote operating system for the VLBI observations is capable to perform fully automatic daily observations over a security controlled dedicated computer network. The redundant design of the system increases the reliability of the operation over malfunctions of any segment of the computer network or a part of the VLBI stations. Data analysis of the acquired data is also performed without human operations. Complicated tasks, such as data editing and resolving ambiguities, are processed after the completion of band width syntheses. Human operation is required only when the data analysis system concluded it is necessary, otherwise the estimated results are made available to the researchers with multiple methods within a day from the last VLBI observation was made.

SLR Observation System for The Key Stone Project

Hiroo Kunimori
Communications Research Laboratory , Japan

Abstract No abstract

Recent Improvements in the NASA Field System

Ed Himwich
NASA Goddard Space Fright Center, U.S.A.

Abstract NASA and the EVN have entered into a joint venture to upgrade the FS for use with the Mark IV DAS. The first step in this cooperative program was to port the Field System to the Linux operating system. This switch has reduced the cost of being able to use the FS to that of acquiring a typical high-end PC. This and other recent improvements including support for VLBA recording modes, Mark IV DAS and S2 Recorders will be reviewed. The features of the FS that allow it to be customized for different stations and antennas will be presented. Prospects for support of other Data Acquisition Systems will be discussed. The FS is evolving toward accepting VEX format schedule file for routine operations. Some of the important features of the VEX format will be reviewed.

Report on Radio Astronomy within the Tidbinbilla Tracking Station (Canberra Deep Space Communications Complex)

Paul D. Harbison
Canberra Deep Space Communications Complex, Australia

Abstract A report on how the Radio Astronomy equipment is being integrated into the tracking station via UNIX TCP/IP networks and X-windows. Also status reports on VLBI hardware, spectroscopy hardware and other astronomy programs.

Scheduling for VSOP and Implications for the APT

Philip Edwards
The Institute of Space and Astronautical Science, Japan

Abstract VLBI Space Observatory Program (VSOP) observations will require recording in a variety of formats: VSOPT, S2, VLBA and MkIV. The scheduling for such experiments, and the handling of log files and other data required for correlation of the data will be described. As all four formats will – amongst others – be used within the APT, the implications for APT scheduling and observing will also be addressed.

The Mark IV VLBI System

Alan R. Whitney
MIT Haystack Observatory, U.S.A.

Abstract Several years ago the geodetic-VLBI community,spearheaded by NASA, committed its support to develop a VLBI system capable of making global millimeter-accuracy measurements by the end of this decade. The result of this commitment has grown into a broad international development effort that has reached deep into both the geodetic and astronomical VLBI communities. The results of this effort are now starting to bear fruit as Mark IV system become operational at a number of worldwide sites.
The Mark IV system consists of several components: 1. Major upgrade to the Mark IIIA/VLBI data-acquisition system to support Gbit/sec data rates. Also includes upgrades such as timing-system upgrade. 2. New advanced correlator system to support up to 32 stations at Gbit/sec/station data rates. 3. Major field-system upgrade to provide a broad base of acquisition-system support.
The Mark IV data-acquisition system is implemented as a major upgrade to existing Mark IIIA and VLBI DAS systems,Primarily supported by NASA and developed at Haystack Observatory, this effort has increased the recording bandwidth by more than a factor of 4 to over 1 Gbit/sec.This translates to more than a twofold sensitivity increase,which has major obvious implications for both the geodetic and astronomical VLBI communities. Central to this upgrade was the design of a new formatter to replace the Mark III formatter,expansion of BBC bandwidths(Mark IIIA only)from 4 MHz to 16 MHz, and major mechanical-tape-path upgrades to support the necessary tape-guiding and astronomical observations.
The correlator system to support Mark IV is being developed by an international consortium, dubbed IACC(for International Advanced Correlator Consortium) including Haystack Observatory, NFRA/JIVE(Netherlands) and Jodrell Bank (UK), with support in the U.S.from NASA, USNO and Smithsonian,and in Europe from JIVE. Target correlators for this development effort include four large VLBI correlators in the U.S. and Europe,as well as the Westerbork array in The Netherlands and the Smithsonian Sub-millimeter Array on Mauna Kea. The key technical developments and capabilities will be discussed.
The Mark IV field-system, primarily under the sponsorship of NASA, is undergoing major hardware and software upgrades to offer uniform support over a wide variety of VLBI system. Considerable international Cooperation, with both geodetic and astronomical interests,has greatly aided in standardizing a traditionally diverse community.

K-4 and KSP VLBI Terminal

Hitoshi Kiuchi
Communications Research Laboratory, Japan

Abstract We are developing a new VLBI system, which was specially designed for the Key-Stone Project (Metropolitan area crustal deformation measurement project), and which supports the VLBA and the VSOP data acquisition mode. The new system consists of a local oscillator, a video converter, an input interface unit, an output interface unit, a data recorder and a digital mass-storage system. The required specifications for the new data acquisition system are (1) One and two-bit quantization capability, (2) Sampling rate of up to 64 Mbps, (3) an Image rejection ratio of better than 20 dB for the entire video bandwidth. These requirements are realized by a 64 Msps A/D converter with a threshold level control circuit, a digital filter, and a wide bandwidth image rejection mixer. By using new K-4 system, it is possible to improve the precision of the geodetic VLBI and contribute to radio astronomy VLBI. The in put interface unit is adopted to a VSOP data acquisition system.

D-1 Cassette Data Recorders

Eiichi Tanaka
SONY, Japan

Abstract No abstract

S2 Recording System in VLBI

Wayne H. Cannon
Institute for Space and Terrestrial Science, Canada

Abstract No abstract

S2 Recording System

Georg H. Feil
Institute for Space and Terrestrial Science, Canada

Abstract No abstract

1024Mbps VLBI Data Recorder and Weak Radio Source Observation

Junichi Nakajima
Communications Research Laboratory, Japan

Abstract Joint Japanese group have developed brand new 1024Mbps VLBI cassette data recorders. Although the Radio telescope systems sensitivities (Tsys) are improved during this 10 years. But these are achieved mainly depending the HEMT/SIS receivers performance. VLBI sensitivity of each baseline is still around 1Jy even in the VLBA or such good facilities. VLBI researcher should recognize that it must make better use of the band width of the receiver especially in continuum observation. And it become possible with the recorder using digital technology HDTV. This recorder will increase the number of possible Geo.-VLBI sources. Even it will reach the VLA deep survey weak astronomical sources with certain VLBI baseline.

Applications of High-Vision Recorders

Shigeo Kizu
TOSHIBA, Japan

Abstract No abstract

Specification and Current Status of the VSOP Terminal

Seiji Kameno
VSOP Office, National Astronomical Observatory, Japan

Abstract The VSOP terminal is a VLBI data acquisition system designed for ground telescopes in the VSOP (VLBI Space Observatory Program) project. It is upper compatible with the MUSES-B satellite, New K-4, and K-4 system. All sampling modes in VSOP are supported.

The VSOP terminal consists of IF down converter, formatter, timing control unit, data recorder, cassette changer, and control PC. The formatter contains total 4 ADCs. Second order sampling at 64 Msps X 8 bits for 64 - 96 MHz input passband avoids difficulty with baseband conversion. Digital filter is applied to enhance bandpass characteristics for narrow passband observations. The recording speed into D1 cassette tapes is 256, 128, and 64 Mbps at maximum, VSOP, and K-4, respectively. Up to 24 cassettes are stored in cassette changer and changed be schedule. tapes is 256, 128, and 64 Mbps at maximum, VSOP, and K-4, respectively. Up to 24 cassettes are stored in cassette changer and changed be schedule. All operations are controlled by field system on a personal computer.

S2 and VLBA tapes can also be correlated with VSOP terminal after tape coping in Mitaka correlation center.

We report results from the test observations and the performance of whole system.

VSOP/S2, VSOP/VLBA Translator Designed to Tie all APT Stations

Noriyuki Kawaguchi
National Astronomical Observatory, Japan

Abstract The VSOP/S2 and VSOP/VLBA translators are under development. The translator makes possible to convert any data recorded on three major recording system of the VSOP, VLBA and S2 to others. Two VSOP/VLBA translators and one VSOP/S2 translator to be equipped in the Mitaka FX correlator will be used not only for VSOP project but also in the APT observations. In my talk, a brief summary of the translating system and correlating facilities in Japan. The future plan of Apt data acquisition will also be noted.

December 12, 1996 – Session – 3

Developments of Technologies (Part 2)

Development of K4 Correlator for Japan-Russia Pulsar VLBI

Mamoru Sekido

Kashima Space Research Center, Communications Research Laboratory, Japan

Abstract P.N. Lebedev Physical Institute in Russia and Communications Research Laboratory in Japan have started a joint research of Pulsar VLBI observation from 1995. The purpose of this experiment is precise measurement of positions and proper motions of pulsars by VLBI. For enhancement of SNR of pulsar data, K4 correlator is under the development, which has pulsar gate function. The status of K4 correlator will be reported here.

KSP Correlator and Data Reduction System

Tetsuro Kondo, Hitoshi Kiuchi and Mamoru Sekido

Communications Research Laboratory, Japan

Abstract We have developed correlator and data reduction system dedicated to the Key Stone Project. A KSP correlator is characterized as (1) use of Field Programable Gate Array (FPGA), (2) multi-baseline processing (6-baselines so far), (3) automatic bit synchronization during multi-baseline processing, (4) use of NFS (network filing system) for storing correlated data, (5) maximum data rate of 256 Mbps, (6) 16 ch / unit (7) 32-lag-complex correlation data/ch or 512-lag-complex in combined ch mode (8) 16 ch / unit (9) 2-bit sampled data processing capability, (10) 16 ch high speed (32 Mbps/channel) processing, (11) compact and light-weight, and (12) signal supply from VME back plane. Data reduction software such as bandwidth synthesizing originally developed for K-3 VLBI system was modified to process KSP correlator data. We compared the results processed by the KSP correlator and its data reduction system with those by the K-3 system, and found no fatal system error in KSP system.

The Status of Mitaka Correlator

Katsunori M. Shibata

VSOP project, National Astronomical Observatory, Japan

Abstract The construction of Mitaka correlator is almost finished and now is under test phase using the data of domestic VLBI observations. The Mitaka correlator is designed for the VSOP observations, but it also has very useful capabilities for APT observations. The correlator is an FX type and can process the data from up to 10 stations with a rate of 256 Msps. It can accept both VLBA and S2 tapes using the tape copying system. In this presentation, I will introduce the performance and the status of the Mitaka correlator.

IAA S-2 Correlator for Geodetic VLBI

Andrej M. Finkelstein

Institute of Applied Astronomy Russian Academy of Sciences, Russia

Abstract No abstract

Mark-IV Correlator

Alan R. Whitney
MIT Haystack Observatory, U.S.A.

Abstract No abstract

Improving the Short Term Accuracy of the Hydrostatic Mapping Function

Arthur E. Niell
MIT Haystack Observatory, U.S.A.

Abstract When low elevation data are included in geodetic VLBI analysis, a significant contribution to the error in measurement of the local vertical is due to the hydrostatic mapping function. A high correlation has been found between the mapping function obtained from ray-tracing radiosonde profiles and a parameter produced by global meteorological data analysis. Use of this parameter represents a new approach to the calculation of the hydrostatic mapping function, and should provide a significant improvement in vertical repeatability while maintaining the accuracy.

GPS Meteorology in Japan

Ryuichi Ichikawa
Kashima Space Research Center, Communications Research Laboratory, Japan

Abstract Water vapor plays an important role in temporal and spatial variabilities of atmosphere. Recent studies have revealed that Global Positioning System (GPS) is a powerful tool of monitoring water vapor. In addition, we expect that GPS meteorology will also contribute an improvement of the precision of space geodetic techniques such as GPS, VLBI, and In-SAR. Then, we propose a cooperative study which is titled "Establishment of Water Vapor Information Database by GPS Meteorology and Its Applications to Numerical Weather Prediction, Earthquake Prediction Research and Hydrology" to Science and Technology Agency of Japan (STA). Final goal of the study is to establish water vapor information database using dense operational GPS sites of Geographical Survey Institute (GSI) and the numerical prediction data with high resolution (20 km grid intervals and 36 vertical levels) of Japan Meteorological Agency (JMA). As of April 1996, there are 610 GPS sites of GSI. By the end of 1996 fiscal year, 250 GPS sites will be added to the present network. If a proposal of the cooperative study would be accepted, international cooperations are indispensable to evaluate variabilities of precipitable water vapor and to revise GPS analyzing software. We hope that GPS meteorology in Japan will contribute numerous fields of earth science.

Measurement of Pulsar Proper Motion Using Asia Pacific Telescopes

Takayuki Sakurai
Solar-Terrestrial Environment Laboratory, Nagoya University, Japan

Abstract An observational program to measure pulsar proper motion using the cross-correlation of temporal intensity data from antennas separated by thousands of kilometers is proposed. Antennas in Australia, Japan, and India provide baselines of up-to 8000 km in both north-south and east-west directions, thus enabling us to measure both the direction and the magnitude of the pulsar proper motion. In addition, the same data may be also used to study the interstellar medium via intensity scintillation. Plausibility of the experiment will be discussed with specific examples of antennas and pulsars.

VLBI-Holographic Surface Error Measurements of MUSES-B

Tomonari Suzuyama, Yuuji Horie, Tomoyuki Miyazaki,
Kagoshima University, Japan

and Noriyuki Kawaguchi
National Astronomical Observatory, Japan

Abstract The main reflector of MUSES-B is the largest deployable parabola composed of a thin flexible mesh, which is the first example in the world. Since a lot of new techniques are applied to the antenna, experimental results of surface profile will be useful in technology. MUSES-B has no instruments to measure its surface error by itself. To measure the surface error of the spacecraft, a method was proposed in which VLBI and a Radio holography are used. Results of preparatory experiments using Kagoshima 6-m and Nobeyama 45-m suggest the usefulness of the VLBI-holography method. In the conference we discuss how to maneuver MUSES-B to perform VLBI-holographic experiments. In VLBI-holography, radial scan with the interval of 20 deg is adopted; the spacing of 0.0483 deg between sampling points and the maximum scan of +/- 1.0385 deg yielding to the spatial resolution of 40 cm. When MUSES-B is moved, for example, at a constant speed of 0.001 deg/s, VLBI-holographic measurements take more than 6 h, which is too long compared with ~ 3 h] during which we can see MUSES-B at a station. However, by changing the scanning speed from 0.001 deg/s at outer edges to 0.01 deg/s at the beam center, the time necessary for measurements can be reduced to 2.5 h. In this case we have the integral time T ~ 30 s and SNR ~ 10 at outer edges and T ~ 5 s and SNR ~ 200 at the beam center. These values of T and SNR will allow us to get data sufficient to obtain the surface error. The accuracy to be expected in the surface error measurements is discussed under these conditions.

Measurement of Relative Motions between SHAO, TAIW, USUB and TSKB IGS Stations

Zhu Wenyao
Shanghai Observatory, Chinese Academy of Sciences, China

Abstract A GPS data set collected at SHAO,TAIW,USUB and TSKB IGS stations from Aug.1994 to Aug 1996 has been processed using Shanghai observatory GPS Analysis Program(SHAGAP) Based on the preliminary results of measurement of the relative motions between SHAO,TAIW, USUB and TSKB stations given in this paper,it has been shown that:

1. At present,the relative accuracy of measuring baseline is better than 10 pps,and 1pps using GPS technique,it is possible to obtain a reliable information about large scale crustal horizontal motion from the periodic repetitious measurement for no long time.
2. SHAO.TAIW stations located in the Chinese plate are approaching the TSKB station in E-W direction at a near same rate about 4cm/yr., while the relative motions in N-S direction are very small.
3. There is only a minor relative motions in E-W between USUB and TSKB stations,the approaching rate is about 5 mm/yr.

VLBI Errors and The Short Term Variation in VLBI

Yukio Takahashi
Communications Research Laboratory, Japan

Abstract VLBI errors are not only noise errors, but also other errors such as atmospheric delay error, clock error, system errors. We conducted the 22GHz VLBI experiment between Kashima, Japan and Onsala, Sweden in March 1996. At 22GHz band, the coherence loss is related with the short term phase variation cause by atmospheric scintillation and reference signal. I estimated the delay error using the coherence loss. Furthermore, the short term variation in station positions were found on the baseline length between Kashima and Kauai baseline, and on Kashima and Koganei baseline. I estimated the period of the short term variation and the similarity between the data. I present these results.

Determination of Lunar Gravity Potential with Differential VLBI and Doppler Tracking in the SELENE Project

Kosuke Heki
National Astronomical Observatory, Earth Rotation Division, Japan

Abstract In the SELENE (Selenological and Engineering Explorer) project, to be launched in 2003, we are planning three selenodetic submissions, that is, artificial radio sources for differential VLBI, laser altimetry and relay sub-satellite. VLBI data are combined with the Doppler observation data to enable three dimensional tracking of the lunar satellite. These data are further used to derive lunar gravity potential coefficients, which give important constraints on the origin of the Moon by clarifying its internal mass distribution.

RISE(Research in Selenodesy) Project

Nobuyuki Kawano
National Astronomical Observatory, Japan

Abstract No abstract

Idea of Geospots - A New Proposition for the Explanation of Continental Drift

Debasish Roy and Tushar K. Das
Geological Survey of India, India

Abstract As the existing theories about the heat generation of earth are untenable in the light of convective current necessary for plate movement, the formation of Geospot, similar to that of sunspot in the solar photosphere, has been propounded in order to explain the possible heat source for generating the convective current in the earth's interior, which has been proposed to be responsible for the plate motion. The heat has been presumed to be generated out of the annihilation of the magnetic field of the Geospot, the energy evolved being of the same order that is needed for the plate motion. The theory has been hypothesized on the basis of magneto-hyorodynamical equations required for the study of'ion= blob' motion with frozen in magnetic field (magnetic rope).

Fluctuation of Extragalactic Reference Frame due to Gravitational Lensing

Mizuhiko Hosokawa
Communications Research Laboratory, Japan

Abstract Expectation values of the position shift and its variation of the quasars due to the gravitational lensing by the stars and MACHOs in our galaxy are calculated. Typical values of these are the order of 10 microarcsecond and several microarcsec/year. When constructing highly accurate reference flame, these will cause the aging of the frame and we have to take these effects into account. At the same time, the detection of these effects might be useful for determine the contents of our galaxy.

Southern Hemisphere Maser Surveys with The APT

Victor Migenes

VSOP Project / National Astronomical Observatory, Japan

Abstract The Institute of Space and Astronautical Science (ISAS) of Japan will put an 8-meter radio telescope into earth orbit in February, 1997. This telescope will be used with ground telescopes over a three year period in order to produce images of active galaxies and maser sources with unprecedented resolution. The satellite will have receivers at 1.6 GHz, 5.0 GHz and 22 GHz, with LCP only. Approximately 50Observing Time (GOT) proposals. Of the remaining time, about 25be used for testing, calibration and re-pointing of the telescopes and 25of continuum sources and OH/H2O maser sources with limited ground support. This set of observations is called The VSOP Survey. The systematic and uniform survey of a large number of sources will be invaluable in determining the properties of the sub milliarcsecond emission from active galaxies and maser sources. This survey requires a list of very compact and strong sources that show the highest probability of detection on the long VSOP baselines. This issue has been approached, especially in the Northern hemisphere, with pre-launch Space-VLBI surveys.

Our major concern is that little high spatial-resolution information is available of the OH and H2O maser sources in the southern hemisphere. With the new recording capabilities of the APT (S2 and K4/VSOP formats), access to the LBA/ATNF and Mitaka/VSOP correlators (and Mitaka's tape "copiers" between recording formats), and new upgrades for 22 GHz capability this is the right time to address this short-coming. We are proposing the use of the APT for such maser survey.

Poster Session

1 – Poster Session
IAA Software Packages for Geodetic VLBI

Andrej M. Finkelstein
Institute of Applied Astronomy Russian Academy of Sciences, Russia

Abstract No abstract

2 – Poster Session
Time Synchronization via Communication Satellite

Michail N. Kaidanovski
Institute of Applied Astronomy Russian Academy of Sciences, Russia

Abstract The report is devoted to the remote time scale synchronization via communication satellite using two-way method. Basic principal of constructing the system of time exchange, ground stations delay calibration are clarified. The optimal signal far time transfer and new modification of time exchange are proposed. Some results of experimental test are described.

3 – Poster Session
Reference-Radio-Source Candidates for VERA Observations

Tetsuo Sasao, Yoshiharu Asaki, Atsuya Okudaira and Toshihiro Omodaka
National Astronomical Observatory, Japan

Abstract Project VERA mainly aims at high precision astrometry of Galactic maser sources in terms of multi-view differential VLBI observations. For successful realization of the differential observations, we need suitable reference sources within a few degrees around each target maser source. Survey of existing radio source catalogues including ICRF VLBI source catalogue gives us an encouraging perspective that at least one compact flat-spectrum source with flux density greater than 100 mJy is normally found within 2 degrees or so from arbitrary direction of the sky. We propose APT S/X VLBI observation of the candidate reference sources to confirm their VLBI detectability.

4 – Poster Session
A Reflector-type Polarimeter for Millimeter-Wave Band

Hiroko Shinnaga
Institute of Astrophysics and Planetary Science, Ibaraki University, Japan

Abstract We are developing a reflector-type millimeter-wave polarimeter for the Nobeyama 45-m telescope. The polarimeter comprises of a free-standing grid, a reflector, and a turn-table. This can be operated as a good quarter-wave or a good half-wave plate for 40-250 GHz by changing the spacer between the metal grid and the reflector. We introduce it in brief.

5 – Poster Session
Pulsar VLBI on Kalyazin (Russia) - Kashima (Japan) Baseline
Alexander E. Rodin
P. N. Lebedev Physical Institute, Russia

Abstract VLBI observations of pulsars have been started on Kalyazin (Russia) - Kashima (Japan) baseline at frequency 1.4 GHz in March 1995 . The aims of these experiments are

- to link celestial coordinate systems (CCS):radio CCS based upon positions of extragalactic sources and dynamical CCS based upon the motion of Solar system bodies;
- to determine parallax and proper motions of pulsars for their distances and spatial velocities.

Radio telescopes TNA-1500 (diameter 64m) of Special Research Bureau of Moscow Power Engineering Institute and RT-34 (diameter 34m) of Communications Research laboratory (CRL) were used for the observations. Data acquisition system K-4 of CRL was used for data registration in 16 MHz bandwidth.

6 – Poster Session
Fundamental Experiments of Radio Interferometer using Fiber-optic Links Modulated in Radio Frequency
Jun Amagai, Hiroo Kunimori and Hitoshi Kiuchi
Communications Research Laboratory, Japan

Fiber-optic links modulated in radio frequency make us possible to realize a radio interferometer which has neither data recorder nor frequency standard at each observation site. In this type of the radio interferometer it is not necessary for baseline analysis to estimate clock offset which causes relatively large error to upward component of estimated station position. Another advantage is utilization of phase delay which improves delay determination accuracy considerably. The results of fundamental experiments show that the phase delay was measured within the error less than 1psec. It is also confirmed that cable delay difference of fiber optic links was compensated by calibration signals which make a round trip between analysis station and observation site.

7 – Poster Session
Low Noise HEMT Receivers and K-4 VLBI Back-end System
Nihon Tsushinki Co. Ltd., Japan

Abstract No abstract

8 – Poster Session
Applications of High Speed Digital Data Recorders for VLBI Observations
TOSHIBA Corporation, Japan

Abstract No abstract

9 – Poster Session

Automated VLBI Operations with the Digital Mass Storage System

SONY Corporation, Japan

Abstract No abstract

10 – Poster Session

A New 32m Antenna System to be Constructed at Tsukuba

NEC Corporation, Japan

Abstract No abstract

11 – Poster Session

Hydrogen Maser System and Future Frequency Standard Technologies

Anritsu Corporation, Japan

Abstract No abstract

12 – Poster Session

1024 Mbps Digital VLBI Interface for GBR1000 Data Recorder

Yamashita Engineering Manufacture Inc., Japan

Abstract No abstract

13 – Poster Session

VLBI Correlator Control Software

Hiroto Sato
Kety Co. Ltd., Japan

Abstract No abstract

14 – Poster Session

Design of Radix FFT Based Butterfly LSI

Naoki Tanaka, Susumu Sudo, Yuichiro Saito, May Suzuki, Masahiko Adachi, Tsuneaki Daishido
Waseda University, Japan

and Seiichiro Iwase
SONY Corporation, Japan

Abstract 64 pixel radio images have been obtained at Nyquist rate(50ns) by the present 64 element Direct Imaging Interferometer of Waseda University. RF frequency is 10.6GHz, and bandwidth of each pixel is 20MHz, so the equivalent total bandwidth of the present spatial FFT processor as a Digital Lens is 1.28GHz, which corresponds to 150-200GOPS. 128 A/D converters of 8 bit are used at 20 MHz.
Nyquist rate imaging makes it possible for us to obtain both ergodic and non-ergodic radio images. So, 64 directional pulsar survey is possible, which is 64 times faster than a single dish survey.
Pulsar Survey Project at 1.4 GHz has started in 1996 with the present 64 element-interferometer. The required size of spatial and temporal (2+1)D FFT is $8 \times 8 \times 64 = 4096$ point, and we must process the 4096 point FFT within $64 \times 50ns$ (Nyquist rate). Number of Butterfly / 64 clk = $4096 \times \log(4096)/64 = [64 \times \log(64)] \times 2$, so the size of new (2+1)FFT processor is just twice of the present one.
Considering expand-ability to $16 \times 16 \times 256$ point (2+1)D FFT, we are designing the following Radix 4 FFT based LSI, which includes the capability of (1) Shift Resister, (2) Digital Filter, (3) Complex Equalizer, (4) Butterfly Operation, (5) Squaring, (6) Integration.

15 – Poster Session

2^{24} Point Floating FFT Processor Design for Real Time Pulsar Survey

Hiroshi Takeuchi, Naoki Tanaka, Susumu Sudo, Yuichiro Saito, May Suzuki, Masahiko Adachi, Tsuneaki Daishido
Waseda University, Japan

and Naoki Watanabe
Hitachi, Japan

Abstract 2 24 point huge FFT processor has been developed for the Pulsar Survey Project which has started 1996. In the pulsar survey we must determine P(period) and DM(dispersion measure), and they are obtained by 2D FFT of the multi-channel temporal 2D data.
Bandwidth of each pixel(see N. Tanaka et al) is 20MHz, and frequency resolution is 20MHz/64ch or 20MHz/256ch. After integrating each pixel power to 100 us, the resulting 2D data of

$$\begin{array}{rrcccc} & 64ch \times 512^2\text{point} & = & 2^6 \times 2^{18} & = & 2^{24} \\ \text{or} & 256ch \times 256^2\text{point} & = & 2^8 \times 2^{16} & = & 2^{24} \end{array}$$

point in Frequency-Time domain will be Fourier transformed. In huge FFT as $N = 2^{18}$ point, twiddle factor $W = \exp(i * 2 * \pi/N)$ requires floating point operation. Recent floating point DSPs make it possible to construct FFT processor for real time pulsar survey.

16 – Poster Session

Radioastron Mission

Sergey F. Likhachev
P. N. Lebedev Physical Institute/ Astro Space Center, Russia

Abstract The current status of the Radioastron mission is described. At present time the main activity of the Astro Space Center concentrated on the manufacturing and further deployable antenna testing. Some spectacular results of a possible new Radioastron orbit are shown. The current status of a digital equipment for ground support of the mission is in progress. The status of ASC testing correlator is described. The results of the processing of some ground-based pre-luanch observations are discussed.

17 – Poster Session

VLBI activity of ASC on Russian Deep Space Tracking Network

Igor E. Molotov
P. N. Lebedev Physiscal Institute/Astro Space Center, Russia

Abstract Since ASC was established in 1990, one of its main activities has been VLBI observations performing for Radioastron mission purposes that includes the both scientific program forming and ground shoulders preparing.

There were a few series of pre-launching survey on all frequencies of Radioastron project was organized in the ASC. The main goal of the servey is a sources selection that could be interesting for the SVLBI observation and study of propagation scattering effects in the interplanetary and interstellar medium.

Moreover these observations permit to examine the VLBI equipmemt of Russian telescopes that was mounted for Radioastron project, to master the VLBA recorder and S2 system that was planned for use in SVLBI, to train the personnel, to set right the interaction with both Russian and foreign VLBI institutes.

First of all, the ASC is interested to use Russian Deep Space Tracking Networkfor the Radiastron purposes. The Network has the largest Russian antennas with highest sensitivities (Ussuriysk RT-70 near Vladivostok, Bear Lakes RT-64 near Moscow and Evpatoria RT-70 in Crimea).

Since 1991 ASC did more then 25 VLBI experiments on antennas of RDSTN in cooperation with Russian institutes (RRI, RISDE, SDDMPEI, IAA) and with support of foreing institutes (JPL, ATNF, ISTS, JIVE and NRAO).

18 – Poster Session

Progress Report on Results of Bear Lakes-Tidbinbilla Experiment

Igor E. Molotov, Sergey F. Likhachev, A. Chuprikov,
P. N. Lebedev Physical Institute/ Astro Space Center, Russia

David L. Jauncey, John Reynolds,
Australia Telescope National Facility, Australia

V.Alekseev, B.Lipatov,
RRI, N.Novgorod, Russia

Valery I. Altunin,
Jet Propulsion Laboratory, U.S.A.

V.Grachev, A.Ratner, V.Frolov,
Institute of Applied Astronomy Russian Academy of Sciences, Russia

B.Poperechenko and Yu.Gorshenkov
SDDMPEI, Russia

Abstract The VLBI experiment between Bear Lakes RT-64 and Tidbinbilla RT-70 was organized with both S2 and Mk2 registration systems on 18 cm waveleght during June 29/30. The main purpose of this test was the examination of equipment for Russian S2 VLBI Network and SVLBI missions (modernizing telescope, new feed system, S2 DAS, S2 correlator). The scientific program includes the survey for SVLBI missions, study of Solar Wind and Corona, OH-maser, pulsars.
The processing of results was organized by three correlators: S2 processor in ATNF, Mk2 processor in JPL and S2 TISS-1 processor in IAA (the results was sent also at Canada).
This experiment permited to receive the first "Russian" S2 fringes.

WAA96 Participant List

Australia

John E. Lauf	British Aerospace Australia	john.e.lauf@jpl.nasa.gov
Paul D. Harbison	Canberra Deep Spcae Communication Complex	harbison@reber.cdscc.nasa.gov
Marco E. Costa	University of Tasmania	marco.costa@phys.utas.edu.au
David L. Jauncey	CSIRO/ATNF	djauncey@atnf.csiro.au
John Reynolds	CSIRO/ATNF	jreynold@atnf.csiro.au
John Manning	AUSLIG	jmanning@auslig.gov.au

China

Ye Shuhua	Shanghai Observatory	ysh@center.shao.ac.cn
Qian Zhihan	Shanghai Observatory	qzh@center.shao.ac.cn
Zhu Wenyao	Shanghai Observatory	Zhuw@center.shao.ac.cn
Juliang Zhao	Shanghai Observatory	jlzhao@center.shao.ac.cn
Yusup Aili	Urumgi Astronomical Observatory	uao@rose.cnc.ac.cn
Chen Junyong	National Bureau of Surveying and Mapping	jychen@sun.ihep.ac.cn

Korea

Jung Jae Hoon	Taeduk Radio Astronomy Observatory	jhjung@hanul.issa.re.kr
Minh Young Chol	Korea Astronomy Observatory	minh@hanul.issa.re.kr
Kim Jongsoo	Korea Astronomy Observatory	
Kim Kwang Dong	Korea Astronomy Observatory	

Russia

Irina A. Ipatova	Institute of Applied Astronomy	ipatov@isida.ipa.rssi.ru
Nikolai E. Koltsov	Institute of Applied Astronomy	nec@isida.ipa.rssi.ru
Alexander E. Rodin	P.N.Lebedev Physical Institute	rodin@rasfian.serpukhov.su
Michail N. Kaidanovski	Institute of Applied Astronomy	kmn@ipa.rssi.ru
Andrej M.	Institute of Applied Astronomy	gmk@isida.ipa.rssi.ru
Igor E. Molotov	Astro Space Center	molotov@dpc.asc.rssi.ru
Sergey F. Likhachev	Astro Space Center	slikhach@platon.asc.rssi.ru

India

Ashok K. Singal	Physical Research laboratory	asingal@prl.ernet.in
Hari O. Vats	Physical Research Laboratory	vats@prl.ernet.in
Subramaniam Ananthakrishnan	Tata Institute of Fundamental Res.	ananth@gmrt.ernet.in
Tushar K. Das	Eastern Centre for Research in Astrophysics	tkdas@ecracu.ernet.in
Debasish Roy	Geological Survey of India	tkdas@ecracu.ernet.in

Europe

Hayo Hase	IfAG - Germany	hase@wettzell.ifag.de
Leonid Gurvits	Joint Institute for VLBI in Europe	lgurvits@jive.nfra.nl

USA / Canada

John M. Bosworth	NASA Goddard Space Flight Center	jmb@ltpmail.gsfc.nasa.gov
Thomas A. Clark	NASA Goddard Space Flight Center	clark@tomcat.gsfc.nasa.gov
Ed Himwich	NASA/GSFC/NVI	weh@vega.gsfc.nasa.gov
Valery I. Altunin	Jet Propulsion Laboratory	Valery.I.Altunin@jpl.nasa.gov
Alan R. Whitney	MIT Haystack Observatory	arw@dopey.haystack.edu
Arthur E. Niell	MIT Haystack Observatory	en@bashful.haystack.edu
Paul Scott Newby	ISTS	paul@sgl.ists.ca
Wayne Harry Cannon	ISTS	wayne@sgl.ists.ca
Georg Helmut Feil	ISTS	georg@sgl.ists.ca

Japan

National Astronomical Observatory

Tetsuo Sasao	NAO, Mizusawa	sasao@miz.nao.ac.jp
Nobuyuki Kawano	NAO, Mizusawa	kawano@gprx.miz.nao.ac.jp
Kosuke Heki	NAO, Mizusawa	heki@miz.nao.ac.jp
Osamu Kameya	NAO, Mizusawa	kameya@miz.nao.ac.jp
Tadayoshi Hara	NAO, Mizusawa	hara@miz.nao.ac.jp
Takaaki Jike	NAO, Mizusawa	jike@miz.nao.ac.jp
Katsunori M. Shibata	VSOP project, NAO	shibata@hotaka.mtk.nao.ac.jp
Victor Migenes	VSOP project, NAO	migenes@hotaka.mtk.nao.ac.jp
Makoto Inoue	VSOP project, NAO	inoue@nao.ac.jp
Seiji Kameno	VSOP project, NAO	kameno@hotaka.mtk.nao.ac.jp
Noriyuki Kawaguchi	NAO, Nobeyama	kawagu@vsop.isas.ac.jp

Institute for Space and Astronautical Science

Philip G. Edwards	ISAS	pge@vsop.isas.ac.jp
Hisashi Hirabayashi	ISAS	hirax@vsop.isas.ac.jp
Hideyuki Kobayashi	ISAS	hkobaya@vsop.isas.ac.jp

National Institute for Polar Research

Koichiro Doi	NIPR	shibuya@nipr.ac.jp

Geographical Survey Institute

Shigeru Matsuzaka	GSI	shigeru@gaos.gsi-mc.go.jp
Takashi Saito	GSI	takasi-s@gsi-mc.go.jp
Mikio Tobita	GSI	micky@gaos.gsi-mc.go.jp

Universities in Japan

Takayuki Sakurai	STE-Lab., Nagoya Univ.	sakurai@stelab.nagoya-u.ac.jp
Munetoshi Tokumaru	STE Lab., Nagoya Univ.	tokumaru@stelab.nagoya-u.ac.jp
Masato Tsuboi	Ibaraki Univ.	tsuboi@masato.sci.ibaraki.ac.jp
Hiroko Shinnaga	Ibaraki Univ.	shinnaga@orion.sci.ibaraki.ac.jp
Tomonari Suzuyama	Kagoshima Univ.	suzuyama@libastro.cla.kagoshima-u.ac.jp
Masaki Morimoto	Kagoshima Univ.	morimoto@cla.kagoshima-u.ac.jp
Teruyuki Kato	Earthquake Research Institute, Tokyo Univ.	teru@eri.u-tokyo.ac.jp
Ley Furuya	Ibaraki Univ.	xley@crl.go.jp
Tsuneaki Daishido	Waseda Univ.	daishido@mn.waseda.ac.jp
Hiroshi Takeuchi	Waseda Univ.	696l0651@cfi.waseda.ac.jp
Naoki Tanaka	Waseda Univ.	694l5120@cfi.waseda.ac.jp

Communications Research Laboratory

Yoji Furuhama	CRL	furuhama@crl.go.jp
Kuniaki Uchida	CRL	uchida@crl.go.jp
Taizoh Yoshino	CRL	yosh@crl.go.jp
Michito Imae	CRL	imae@crl.go.jp
Hiroo Kunimori	CRL	kuni@crl.go.jp
Shin'ichi Hama	CRL	hama@crl.go.jp
Mizuhiko Hosokawa	CRL	hosokawa@crl.go.jp
Jun Amagai	CRL	amagai@crl.go.jp
Hitoshi Kiuchi	CRL	kiuchi@crl.go.jp
Akihiro Kaneko	CRL	kaneko@crl.go.jp
Yuko Hanado	CRL	yuko@crl.go.jp
Chihiro Miki	CRL	c-miki@crl.go.jp
Kouichi Sebata	CRL	seba@crl.go.jp
Hideyuki Nojiri	CRL	nojiri@crl.go.jp
Toshimichi Otsubo	CRL	otsubo@crl.go.jp
Fujinobu Takahashi	KSRC/CRL	fuji@crl.go.jp
Yukio Takahashi	KSRC/CRL	takahashi@crl.go.jp
Tetsuro Kondo	KSRC/CRL	kondo@crl.go.jp
Noriyuki Kurihara	KSRC/CRL	kurihara@crl.go.jp
Yasuhiro Koyama	KSRC/CRL	koyama@crl.go.jp
Junichi Nakajima	KSRC/CRL	nakaji@crl.go.jp
Mamoru Sekido	KSRC/CRL	sekido@crl.go.jp
Eiji Kawai	KSRC/CRL	kawa@crl.go.jp
Ryuichi Ichikawa	KSRC/CRL	richi@crl.go.jp
Tadahiro Gotoh	KSRC/CRL	tara@crl.go.jp