TECHINOLOGY DEVELOPMENT CENTER NEWS

COMMUNICATIONS RESEARCH LABORATORY

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CONTENTS

Remarks: Logo used in the news title is not an official IVS logo. Official IVS logo will appear in the next issue.

Overview of the 14th CRL-TDC Meeting

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The 14th meeting of the Technology Development Center of the Communications Research Laboratory (CRL)was held on March 1, 1999 at the Kashima Space Research Center of CRL.

Attendance

CRL members

Kenichi Okamoto, Taizoh Yoshino, Michito Imae, Yukio Takahashi, Hitoshi Kiuchi, Akihiro Kaneko, Jun Amagai, Futaba Katsuo, Kouichi Sebata, Masato Furuya, Noriyuki Kurihara (KSRC: Kashima Space Research Center), Yasuhiro Koyama (KSRC), Junichi Nakajima (KSRC), Ryuichi Ichikawa (KSRC), Eiji Kawai (KSRC), Mamoru Sekido (KSRC), and Tetsuro Kondo (KSRC)

Special members

Tetsuo Sasao (National Astronomical Observatory), Noriyuki Kawaguchi (National Astronomical Observatory), Hideo Hanada (National Astronomical Observatory), Shoichi Ogi (Geographical Survey Institute), Seiichi Shimada (National Research Institute for Science and Disaster Prevention), Kachishige Sato (Tokyo Gakugei University), and Masayuki Takemura (Kobori Research Complex, Kajima Corporation)

The following special members could not attend: Masayuki Fujita (Hydrographic Department, Maritime Safety Agency) and Shuhei Okubo (Earthquake Research Institute, University of Tokyo),

Observer

Shigeru Matsuzaka (Geographical Survey Institute)

Minutes

1. Opening Greeting

Kenichi Okamoto, director of TDC at the Communications Research Laboratory (CRL), opened the meeting.

2. International VLBI Service for Geodesy and Astrometry (IVS) Reports

Report on Steering Committee of IVS (*Yasuhiro Koyama*)

Yasuhiro Koyama, who contributed to the establishment of IVS as a member of the steering committee, introduced the details of the IVS establishment. He reported that discussion of the IVS establishment started in May, 1997 at the CSTG (Commission on International Coordination of Space Techniques for Geodesy and Geodynamics) under IAG. The steering committee, which held its first meeting in May 1998, was organized to discuss the IVS establishment more in details. At the meeting preliminary terms of reference were fixed. Then call for proposal was announced in June 1998 to raise participation to IVS. Candidates for Directing Board members were nominated in December 1998, and were elected at the 3rd steering committee meeting held in January, 1999.

2.2 First Directing Board Meeting of IVS and the Policy of the Technology Development Center at CRL (*Tetsuro Kondo*)

Tetsuro Kondo, a directing board member of the IVS, reported that the first directing board meeting of the IVS was held at Wettzell in February, 1999 and the IVS was officially established on March 1, 1999.

In accordance with the establishment of IVS, IERS VLBI technical development center was taken over by the IVS technology development center. CRL joins the IVS not only as a technology development center but also as network stations, a correlator, a data center, and an analysis center.

He also represented the policy of Technology Development Center (TDC) at the Communications Research Laboratory (CRL) as follows. CRL-TDC was first established to develop new observation techniques and new systems for advanced earth's rotation observations using VLBI and other space techniques, to promote research in Earth rotation using VLBI, and to distribute new VLBI technology. Furthermore, CRL-TDC will promote publicity of new VLBI technology, contribute the standardization of VLBI interface, and deploy the real-time VLBI technique.

3. Activity Reports by Special Members

Each special member reported on the current status of each organization's activities.

National Research Institute for Science and Disaster Prevention (*Seiichi Shimada*)

Seiichi Shimada reported his recent research work entitled "Systematic error on the estimation of station positions and the asymmetrical distribution of water vapor obtained by GPS observations made at the time of cold-front passage in the Izu peninsula circumference" from a standpoint of GPS meteorological study. According to the data obtained by GSI's GPS measurements, the deviation between positions from March 6 to March 7, 1997 (the midst of offshore-Ito swarm earthquakes) and positions from March 7 to March 8 showed opposite direction but the same amount over the wider area not limited in the region close to the swarm epicentral area. A cold front passed through the Izu peninsula on March 7, 1997. The atmospheric gradient was estimated using GPS data obtained before the cold front passage, and it showed that, as for the points along the east coast of the Izu peninsula, air was more dry at west. However as for the Hatsushima island which is located about 7-km east offshore, air was more dry at east. The reason of this phenomenon is thought as follows. Wet air was left on the sea just off the east coast because dry and cold air accompanied by the cold front is pushed up on a mountain range of the east coast by the strong west wind, and it gets down the 5-10km off the east coast.

Mizusawa Astrogeodynamics Observatory, National Astronomical Observatory (*Hideo Hanada*)

Hideo Hanada reported on the current status of RISE (Research In SElenology) plan in the SELENE (SELenological and ENgineering Explorer) project and the future plan for SELENE-2. Regarding RISE, the current status of the development of the satellite, a radio source on the moon, and a laser altimeter (LALT) was introduced. The LALT is aimed at measuring the absolute altitude from the center of gravity of the moon with a resolution of 5 m, a measurement interval of about 800 m, and an orbital interval of 1-10 km. Furthermore the optical telescope for astrometry on the moon (ILOM) planned for SELENE-2 was also introduced. It is aimed at measuring the changes of the moon's rotation acculately by observing stars from the moon using a telescope of 20-30 cm diameter installed at the polar region of the moon.

National Astronomical Observatory (*Noriyuki Kawaguchi*)

Noriyuki Kawaguchi reported on the VLBI activities at the National Astronomical Observatory as follows.

As for the VSOP, although the satellite "HALCA" sometimes experienced troubles, it had successfully recovered from the troubles. Successful measurement of the beam pattern of HALCA's antenna by receiving radio signals from the geostationary weather satellite was also introduced. Furthermore by adopting a correlation technique, a very weak side lobe could be detected. The new discovery about the fluctuation of the atmosphere has been obtained by analyzing the phase-link data measured at USUDA.

Regarding the VERA project, it was introduced that the development of observation equipment has started because of the budget being revised. Furthermore, Kawaguchi expressed his hope that he would coperate with the Technology Development Center (TDC) at CRL in dveloping a VLBI standard interface and in realizing it. In addition, he reported that a large virtual telescope formed by combining KSP observation network and OLIVE observation network using the high speed communication link in real-time is yielding interesting results. He also introduced the current status of JNET (Japan VLBI-Network) observations.

Tokyo Gakugei University (*Kachishige Sato*)

Kachishige Sato introduced his recent paper entitled "Tectonic plate motion and station motion derived from rates of change of Global Positioning System baseline lengths", J.Geod.Soc.Japan, Vol.44, pp.143-167, 1998. He estimated plate motion parameters using the baseline-length-changing rate data, which were obtained by GPS measurements at 34 sites spanning for about 2 years. In the analysis, two kinds of models are considered. One is a model that takes the plate-inside deformation into consideration and the other does not consider the inside deformation. In both models, the Pacific Ocean plate is fixed. These analysis results are compared with the NUVEL-1A plate motion model to find significant discrepancies in motions of North American, Eurasian, and African plates. The results suggests large plate deformation occurs even at the place away enough from the plate boundary. The motion of Australian plate shows no significant discrepancy between the result and the NUVEL-1A.

Kobori Research Complex, Kajima Corporation (*Masayuki Takemura*)

The research result about the relation of an earthquake fault and earthquake damage was introduced. Takemura investigated the relation between the magnitude of earthquakes that have occurred in the earth's crust in Japan and their damage in detail. He found that in case of taking magnitude greater than 6.8 the relations clearly differed from those in case of magnitude less than 6.5. When the magnitude became 6.8 or more, it was found that damage increases abruptly. Moreover, there were very few earthquakes having a magnitude of 6.6 and 6.7. He thought that an inland earthquake occurres only in the limited portion of the crust in the vertical direction and this may explain the above phenomena.

Mizusawa Astrogeodynamics Observatory, National Astronomical Observatory (*Tetsuo Sasao*)

Tetsuo Sasao introduced the background from the science side about the VERA project. VERA aims at directly measuring the distance to celestial bodies. And if this is achieved, it will be a great breakthrough for astronomy. He told that since the budget for VERA was revised we have started the development of VERA equipments. Environmental investigation of the site candidates, the optimum design of the antenna for phase compensation, etc. will be performed from now on. Lastly he asked CRL TDC to cooperate with NAO in the technologcical development of VERA.

Geographical Survey Institute (*Shoichi Ogi*)

Shoichi Ogi introduced VLBI activities of the Geographical Survey Institute as follows. Domestic VLBI experiments have been scheduled from March 2, 1999. Collocation with GPS in each domestic VLBI station is under examination. As for collocation, ground survey network and the details of pillar at Wettzell were introduced. Furthermore, the plan which performs VLBI observation and which is aimed at UT1 measurement between Tsukuba-Wettzell was shown. K4 terminal is Wettzell and correlation processing will be performed at Tsukuba. Moreover other activities were introduced as follows. Tsukuba has participated in APSG observation and is contributing to the construction of a high-precision geodetic network in the Asian Pacific region. Antarctic VLBI with Syowa station was carried out in February, 1999 and the data will be analyzed in April. GSI is preparing registration of each domestic VLBI stations to IERS as a reference point in order to construct a highly precise geodetic standard system both on the earth and on a regional area through integration of space geodetic technology and collocation to an IERS point.

4. Report on GEMSTONE Workshop (*Taizoh Yoshino*)

Taizoh Yoshino reported on the international workshop "GEMSTONE" (GEodetic Measurements by the collocation of Space Techniques ON Earth) which was held at the Communications Research Laboratory in January, 1999. Although collocation between different space geodetic techniques was the main theme in the GEMSTONE workshop, a session for APT/APSG was also prepared. There were 103 participants from 12 countries. Importance of collocation was recognized in this workshop and it is reflected in the resolution of workshop. Moreover, the usefulness of real-time VLBI technique was also recognized. The resolution recommends the preparation of an international pilot experiment or real-time VLBI. (See page 6 for details.)

5. Technical Development Reports

5.1 Key Stone Project (Crustal Deformation Observation System in the Tokyo Metropolitan Area)

Water Vapor Radiometer Observations in KSP Network (*Ryuichi Ichikawa*)

Ryuichi Ichikawa reported on results of Water vapor radiometer (WVR) observations aimed at evaluating the error of geodetic measurements due to atmospheric mesoscale turbulence. In the report, he introduced the current estimation of the atmospheric gradient vector in KSP-VLBI observation, the comparison result of WVR observation and radiosonde observation, and the atmospheric gradient vector obtained from WVR observation. From these results he concluded that WVR observation data serves as an effective method to evaluate the error of geodetic measurements.

5.2 R&D Experiment Reports

Survey Observation of Radio Sources using KSP (*Akihiro Kaneko*)

Akihiro Kaneko reported on a preliminary result of survey observations of radio sources currently performed using the KSP system. Observations are being made for radio sources in the 3C catalog, 1 Jy catalog, and Greenbank catalog. Currently 1300 sources were observed. However, about 500 sources have failed in the observation due to the defects of a computer software performing automatic observation. Re-observation is planned for these sources. B1920+1524, which is the source of HII region, was detected on all KSP baselines in S band. B2336+5953 was detected on KSP baselines excepting Koganei-Miura baseline, and Kaneko thought that this is very interesting.

Report on a Test VLBI Experiment using Giga-bit VLBI System (*Junichi Nakajima*)

Junichi Nakajima reported that a fringe was successfully detected for a giga-bit VLBI system experiment carried out in July, 1998. He also briefly introduced a 2nd giga-bit VLBI observation planned in March, 1999.

Large Virtual Radio Telescope (*Yukio Takahashi*)

Yukio Takahashi reported an xperiment which connects Usuda 64 m antenna, KSP antennas, and Kashima 34 m antenna in real-time through the high speed communications link of OLIVE and KSP was successful. The first observation which was a combination of Usuda 64 m antenna and KSP antennas was carried out on November 12, 1998. Then a joint observation with Kashima 34 m antenna took place in December, 1998. Observations were then made on a weekly basis after February, 1999. Finally, he introduced a 3-dimensional display system on the Internet developed at his section which is applicable for monitoring an antenna.

KSP Tie Experiment Report (*Yasuhiro Koyama*)

The outline of the experiment planned in order to connect a KSP-VLBI network to an ITRF directly was explained as follows. The experiment was performed using a K4 system. The first experiment was carried out between Kashima, KSP stations, and Fairbanks in January, 1999. The K4 system used in Fairbanks was carried out in advance for this experiment. The second experiment was performed in March. Kashima, KSP stations, Fairbanks, Wettzell, and Urumqi participated in the experiment. In addition, the K4 system was controlled by FS9 at Fairbanks and Wettzell. Correlation processing will be carried out in or after April.

5.3 Others

VLBI standard interface (VSI) (*Junichi Nakajima*)

Junichi Nakajima introduced the concept of a VLBI standard interface (VSI) proposed by Alan Whitney who is the IVS technology coordinator. Contribution from Japan to VSI is greatly expected. He also reported on the signal connector.

After the last technical report, Kenichi Okamoto expressed that he believes the technology-development center of the Communications Research Laboratory can contribute to the investigation of atmospheric fluctuations, the establishment of the VLBI standard interface, and the distribution of real-time VLBI technique.

6. Closing Address

The closing address was delivered by Taizoh Yoshino, leader of the Key Stone Project at the Communications Research Laboratory.

The 14th TDC meeting held at the Kashima Space Research Center of Communications Research Laboratory on March 1, 1999

Report of the International workshop on GEodetic Measurements by the collocation of Space Techniques ON Earth (GEMSTONE)

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The International workshop on GEodetic Measurements by the collocation of Space Techniques ON Earth (GEMSTONE) was held at the Communications Research Laboratory (CRL) in Tokyo, Japan on January 25-28, 1999. The workshop was supported by the Science and Technology Agency in Japan (STA) and the Japan International Science and Technology Exchange Center (JISTEC). In total, 103 people from twelve countries participated in the workshop.

The original meaning of "gemstone" is, of course, a precious stone for cutting and polishing. In the GEMSTONE workshop, modern space techniques were discussed for studying the invaluable Earth. In particular, the importance of collocation and integration of independent techniques were discussed relating to reference frame and local ties. In Japan, the collocation of space techniques is realized at the four stations of the Key Stone Project (KSP), which was initiated five years ago when we had the "iRiS93" workshop at CRL. During the conference, participants visited the KSP facilities and actively shared their expertise. At the workshop, the current topics of APT (Asia-Pacific Telescope) and APSG (Asia-Pacific Space Geodynamics) were also presented, including the recently approved VERA project as well as other ongoing projects and upcoming projects. Finally, the resolutions of the workshop were adopted at the plenary meeting, which tell us important directions for space geodesy. The proceedings of the workshop is published including the scientific contributions and the above resolutions. The last day of the conference was set aside for a scientific excursion to visit the Geographical Survey Institute and National Space Development Agency of Japan in Tsukuba Science City.

Scientific Committee
J. Bosworth (GSFC), Z. Altamimi (IGN), G. Beutler (Bern Univ), T. Herring (MIT), J. Manning (AUSLIG), M. Pearlman(HSCA), W. Schlueter (BKG), T. Yoshino (CRL)

APT/APSG
S. Ye (Shanghai Obs.), D. Jauncey(CSIRO), R. Govind(AUSLIG), M. Inoue(NAO)

LOC
T. Yoshino (CRL), T. Kondo (CRL), H. Kunimori (CRL)

Resolutions of the GEMSTONE Workshop

Communications Research Laboratory

Tokyo, Japan,
January 27, 1999

The international workshop on Geodetic Measurements by the collocation of Space Techniques ON Earth (GEMSTONE) sponsored by the Science and Technology Agency of Japan was held at the Communications Research Laboratory in Tokyo from January 25 to 27, 1999.

RESOLUTION 1

The participants of the GEMSTONE Workshop express their sincere appreciation to the Communications Research Laboratory of Japan and the Local Organizing Committee for their hospitality and excellent arrangements for this very important and beneficial meeting. The participants also thank the Science Committee for its guidance and organization for this meeting.

RESOLUTION 2

The GEMSTONE Workshop,

considering that;

a) the collocation of space geodetic measurements (GPS, DORIS, PRARE, SLR, VLBI) is required for the improvement of the terrestrial reference frame;
b) the collocation of space geodetic measurements is of great benefit to improving the performance of the individual space geodetic measurement techniques;

c) high accuracy local ground survey ties between collocated systems are as important as the space geodetic measurements for collocation data analysis;
d) monitoring of the long term stability of site monumentation and calibration targets is indispensable for the interpretation of geodetic results, including collocation analysis; and
e) collocation of geodetic systems on spacecraft is beneficial for accurate positioning in space and on the Earth;

urges the international space geodetic community to:

1) coordinate efforts to improve the reference frame by connecting the different space geodetic techniques through collocation;
2) recognize the importance of local geology in the selection of sites and the need for regularly repeating local surveys to monitor stability;
3) clarify and openly publish the methods and data bases of the ground surveys at each station as well as the results;
4) provide all results in full SINEX format for ease in collocation analysis;
5) consider the implementation of collocated geodetic systems on spacecraft, the Moon and planetary bodies;
6) continue discussions and actions related to the above items through the Geodetic and Geophysical Sites Subcommission (GGSS) of the CSTG in collaboration with the IERS Terrestrial Reference Frame Section;
7) support the establishment of the International Space Geodetic Network (ISGN) site and analysis criteria and their implementation at all major collocation sites;
8) establish regular collaborations among the space geodetic services (IGS, ILRS, and IVS) to enhance collocation activities and to plan joint strategies for exploiting the strengths of the individual techniques; and
9) support the establishment of new collocation sites for improved geographic coverage;

RECOMMENDATIONS

The Workshop also discussed the efficiency and stability that real-time VLBI could provide for geodetic observations, and VLBI's capabilities in Earth rotation monitoring and crustal deformation. The Workshop supports actions to start a real-time VLBI capability through a series of international data communication pilot experiments under the auspices of the International VLBI Service (IVS) Technical Development Centers.

The Workshop also supports active efforts by the IVS Technology Coordinator to develop an international standard for VLBI interfaces that will provide compatibility among heterogeneous VLBI data transport systems, thereby facilitating collocation measurements.

Resolution of the APT/APSG

1) The APT/APSG resolves to undertake a precision VLBI S/X astrometry program in support of the ICRF for Equatorial sources. The APT telescopes have particularly good N-S and E-W coverage with Urumqi and Kokee. Such a program supports both the astrophysical and geodetic goals of the APT/APSG.
2) In the spirit of international friendship and collaboration, the APT/APSG strongly encourages and supports new projects related to the activities of this Workshop. Such projects include:
   - The Korean VLBI Network,
   - The Japanese precision VLBI astrometry Project VERA,
   - The precision astrometry Project SELENE, and
   - The regional 1 square kilometre telescope developments in China and Australia.

   The APT/APSG believes that these new projects can stimulate the related research activities and also improve the quality of regional scientific research and collaboration.
3) The APT/APSG supports the initiative to develop a standard VLBI Interface Specification, being considered by the IVS. We also encourage the IVS to include the radio astronomy community in this initiative at the earliest possible time.
4) The APT/APSG wishes to encourage closer collaboration between the Astronomy and Geodesy communities, to the advantage of both communities.

K-4 Tie VLBI Experiments

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1. Introduction

Two international geodetic VLBI experiments using K-4 VLBI system were organized by the Communications Research Laboratory (CRL) under a close cooperation with the Goddard Space Flight Center (GSFC) of the National Aeronautics and Space Administration (NASA). In these experiments, Gilmore Creek Geophysical Observatory at Fairbanks (USA), Fundamental Station at Wettzell (Germany), Urumqi Astronomical Observatory at Urumqi (China), 34m antenna VLBI station in Kashima Space Research Center of CRL, and four 11-m antenna VLBI stations in the Key Stone Project (KSP) VLBI Network were involved. For these experiments, a K-4 data recorder (DIR1000M) and an input interface (DFC1100) were temporarily transported to Fairbanks and another K-4 data recorder (DIR1000) and an input interface (DFC2100) have been loaned to Wettzell VLBI station since January 1999. At Urumqi VLBI station, a K-4 data recorder (DIR1000M) and an input interface (DFC1100) have been loaned by the National Astronomical Observatory of Japan for long time.

The main purpose of these experiments was to tie four stations in the KSP VLBI network to the global terrestrial reference frame such as ITRF97. Such a tie had been attempted by a series of VLBI experiments with 34m antenna at Kashima and KSP VLBI stations, but the improvements of the reliability and the accuracy of the tie are expected by performing these tie experiments with globally distributed VLBI stations whose coordinates are precisely determined in the terrestrial reference frame. Both Fairbanks and Wettzell stations are considered to be ideal for the reference points for the tie. The accurate information for the tie is quite important for collocation studies and the estimations of the earth rotation parameters. Experiments were coded as K4TIE1 and K4TIE2 to reflect the purpose of the experiments and the fact that the experiments are performed with the K-4 VLBI system.

2. Experiments

Figure 1. 26m antenna at Fairbanks VLBI station in Gilmore Creek Geophysical Observatory.

The first experiment (K4TIE1) was performed for 24 hours from 19:00 UT on January 14, and the second experiment (K4TIE2) was performed for 27 hours from 09:00 UT on March 11, 1999. The duration of the K4TIE2 experiment was 3 hours longer than the K4TIE1 experiment. The extra 3 hours was added to test the GPS time and frequency reference receiver for a VLBI frequency reference [Kondo and Amagai, 1997]. The frequency reference for the KSP station at Kashima was switched from a Hydrogen maser system to the GPS-based frequency reference when 24 hours have passed from the beginning of the experiment. Fairbanks (Figure 1), Kashima-34m, and KSP stations participated in the K4TIE1 experiment while Urumqi and Wettzell were added to the K4TIE2 experiment.

At Fairbanks and Wettzell VLBI stations, new version of the FS9 software was used to control K-4 equipments [Koyama and Himwich, 1998]. At Fairbanks, Wettzell, and Urumqi stations, upper-sideband signal outputs from the Mark-3 video converters were connected to the K-4 input interface (DFC1100 and DFC2100) (Figure 2). At Kashima-34m and KSP stations, K-4 video converters were used. Table 1 gives the frequency assignments of 16 observation channels used in the experiments. While all the 16 channels of the table were recorded at four KSP stations, Ch.1 and Ch.10 were omitted at other stations. It was necessary because there are only 14 video converters in the Mark-3 video

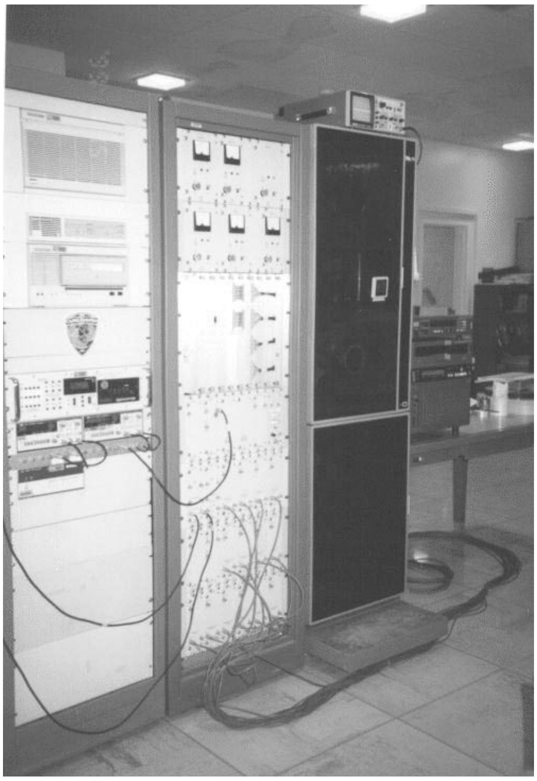

Figure 2. The K-4 recorder (DIR1000M) and its VLBI interface (DFC1100) set up next to the Mark-3 VLBI terminal at Fairbanks station.

converter set.

The observation schedule files were generated by using the SKED program. The catalog files in the SKED/DRUDG package were updated to specify necessary parameters for the K-4 recording system so that the tape changes can be correctly handled by SKED and DRUDG. Only strong sources were picked up from the flux catalog file for the observation schedule. Criterion of the selection was 1.7 Jy for X-band and 0.9 Jy for S-band. By rejecting southern sources below -25 degree in Declination, 23 sources passed these criterion. Scan lengths were calculated based on the flux densities of observed sources and correlated amplitudes of sources used in the regular KSP sessions to obtain minimum SNR of 20 for X-band and 15 for S-band for KSP baselines. The scan lengths were then fixed in the schedule. This was necessary because the capability of the Koganei correlator to process different scan lengths has not been tested yet.

In the K4TIE2 experiment, the 10MHz frequency reference signal at the Kashima-34m station was shifted by 1×10^{-9} to introduce artificial fringe rate for the short baseline between Kashima-34m and the KSP station at Kashima stations.

Table 1. Assignments of local frequencies.

VC	Band	Local Freq.
1 ch.	X-band	8124.99 MHz
2 ch.	X-band	8214.99 MHz
3 ch.	X-band	8224.99 MHz
4 ch.	X-band	8254.99 MHz
5 ch.	X-band	8314.99 MHz
6 ch.	X-band	8424.99 MHz
7 ch.	X-band	8504.99 MHz
8 ch.	X-band	8554.99 MHz
9 ch.	X-band	8574.99 MHz
10 ch.	X-band	8584.99 MHz
11 ch.	S-band	2219.99 MHz
12 ch.	S-band	2224.99 MHz
13 ch.	S-band	2239.99 MHz
14 ch.	S-band	2269.99 MHz
15 ch.	S-band	2294.99 MHz
16 ch.	S-band	2304.99 MHz

3. Data processing and remarks for future prospects

Observation tapes from the two experiments have been correlated at Koganei using the KSP correlator facility. Unfortunately, the observations at Urumqi and Wettzell were not successfully made because of the mechanical problem of the K-4 recorder at Urumqi station and a setting error to the DFC2100 at Wettzell caused by an erroneous descriptions in the protocol manual. The databases of the two experiments have been placed in the anonymous FTP area on the `ksp.crl.go.jp` server.

Although the K-4 VLBI system equipments used at Fairbanks have been shipped back to Kashima after two experiments, K-4 system will be available at Urumqi and at Wettzell for longer time scales. CRL is planning to organize similar K-4 VLBI experiments with these stations to improve reliability of the tie of the KSP VLBI network to the terrestrial reference frame.

References

Kondo, T. and J. Amagai, Evaluation of a GPS Time and Frequency Reference Receiver as a VLBI Frequency Standard, *IERS TDC news, Communications Research Laboratory, Vol. 11,* pp. 19-22, 1997.

Koyama, Y. and W. E. Himwich, Instructions to use K-4 VLBI system with FS9 software, *IERS TDC news, Communications Research Laboratory, Vol. 12,* pp. 6-7, 1998.

Giga-bit VLBI Experiment in Progress

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1. VLBI Status

After our successful first-ever 1-Gigabit fringe detection in GEX-1 (Gigabit experiment), we have carried out GEX-2 VLBI observation between Usuda 64m antenna and Kashima 34m antenna. The purpose of this experimental VLBI is a demonstration of high sensitivity VLBI using the two large telescopes.

A giga-bit VLBI system was installed to Usuda temporally. Observations were made on March 15, 1999. Eleven faint QSOs with 8 strong calibrators were selected and observed in 4 hours. The giga-bit system is controlled first time via a PCMCIA GPIB of Linux portable PC. In this observation, since there was no real-time connection between Usuda and Kashima, parallel K-4 64-Mbps recordings were made to obtain clock offset with nano second accuracy between the two stations. We found fringes in 10 observations. With these observations giga-bit fringe search is in progress. Rest of the observations were failed due to the telescope operation and the field system trouble. Successive observation GEX-3 for correlator check out using a short baseline observation is planned. In the GEX-3, our Kashima 34-m and the Kashima 26-m which belongs to GSI (Geological Survey Institute) will be used.

2. Development Policy

Developments of the basic component parts of the giga-bit VLBI system have been almost finished. We have completed the developents of the samplers, the recorders, the experimental correlators (Figure 1), and interfaces for those. Several field test and correlation experiments are currently underway. Removal of software bugs and hardware modifications are taking place in this stage. GEX-series experiment will be continued until they satisfy initial target.

Now our technical development activity is under IVS Technology Development Center (TDC) at CRL, and it is together with the technology coordinator and other TDCs. This means the development is not only for Japanese VLBI society but also for the VLBI community in worldwide. We have an open policy to these developed instrument. Please feel free to write us to know your interests or question to the IVS-TDC at CRL. We are preparing to put these instruments details on our web page for your reference. These document may be prepared based on your requests.

Figure 1. Newly installed front panel of the UWBC-GICO correlator.

Evaluation of KSP/VLBI Analysis Using an Anisotropic Mapping Function

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Abstract: We applied the anisotropic mapping function for the purpose of examining an impact on the analyses of KSP/VLBI. The repeatability of horizontal coordinate within two-months routine measurements is improved using the anisotropic mapping function. Further quantitative evaluation is required to understand the space-time variability of water vapor and to improve repeatability of site coordinates.

1. Introduction

Tropospheric delay significantly degrades the precision of the Global Positioning System (GPS) and Very Long Baseline Interferometry (VLBI). Recently, several anisotropic mapping functions in which atmospheric gradients are assumed to have a simple linear form have been proposed [MacMillan, 1995; Chen and Herring, 1996]. The MacMillan gradient model is available in the VLBI analysis software. It is very important to evaluate the efficiency of the atmospheric gradient model in the VLBI analysis of the Key Stone Project (KSP) geodetic network. We report the preliminary results of KSP/VLBI analysis using the anisotropic mapping function.

2. Data analysis

In the KSP network real-time VLBI measurements are carried out at one-day intervals. VLBI data were analyzed with SOLVE (Ver. 5.0094) and CALC (Ver. 8.2) software [Ma et al., 1994]. In the analyses of VLBI, geodetic station coordinates were estimated for Koganei, Miura, and Tateyama sites relative to Kashima site. Tropospheric delays in the zenith direction were simultaneously estimated every three hours. Since the VLBI analysis software includes an atmospheric gradient option, we have applied the gradient model in the analysis of VLBI data at the minimum elevation angle of 10 degrees. We tried to estimate the gradient vector parameters for each KSP site. However, it was difficult to estimate the parameters accurately because of the instability of the least squares estimation due to the relatively short baseline length of less than 150 km. Thus, we estimated the gradient vector parameters for only the Tateyama site, though the estimated parameters include the effects of the atmospheric gradient at the other three sites.

3. Results

Figure 1 shows the time series of the daily three-dimensional position of the Tateyama site with respect to the Kashima site from June 1 through August 4, 1998. In Figure 1 we show the VLBI estimates of the position with and without atmospheric gradient parameters at the minimum elevation of 10 degrees. When gradients are estimated, the RMS of the north component is reduced from 3.0 mm to 2.8 mm and the RMS of the east component is reduced from 3.2 mm to 2.6 mm. Moreover, the RMS of the vertical component is also reduced from 18.2 mm to 16.4 mm.

For a more detailed interpretation further investigations are required - comparisons with water vapor radiometer (WVR) data for example. WVR observations were started on June 24, 1998 and are still in progress. WVR observations are being collected at four stations. Two WVRs, one at the Meteorological Research Institute (MRI) of Tsukuba and one at the Communications Research Laboratory (CRL) of Kashima, are sequentially pointed towards each of the GPS satellites in view. Another two WVRs, one at the GSI of Tsukuba and one at Chiba University, are sequentially pointed from north to south at elevations of 10, 15, 30, 45, 75 and 90 degrees. The results of the WVR observations will be reported in another paper.

4. Summary

The anisotropic mapping functions are preliminarily applied examining their impact on the analyses of the KSP/VLBI. The two-months repeatability of the horizontal coordinate is improved using the anisotropic mapping function. We have to quantitatively evaluate the space-time variability of water vapor under the various meteorological conditions based on these results. For this purpose, we have been carrying out an experimental measurement for detecting and characterizing variations in water vapor by using water vapor radiometers (WVRs) in the Kanto district of central Japan.

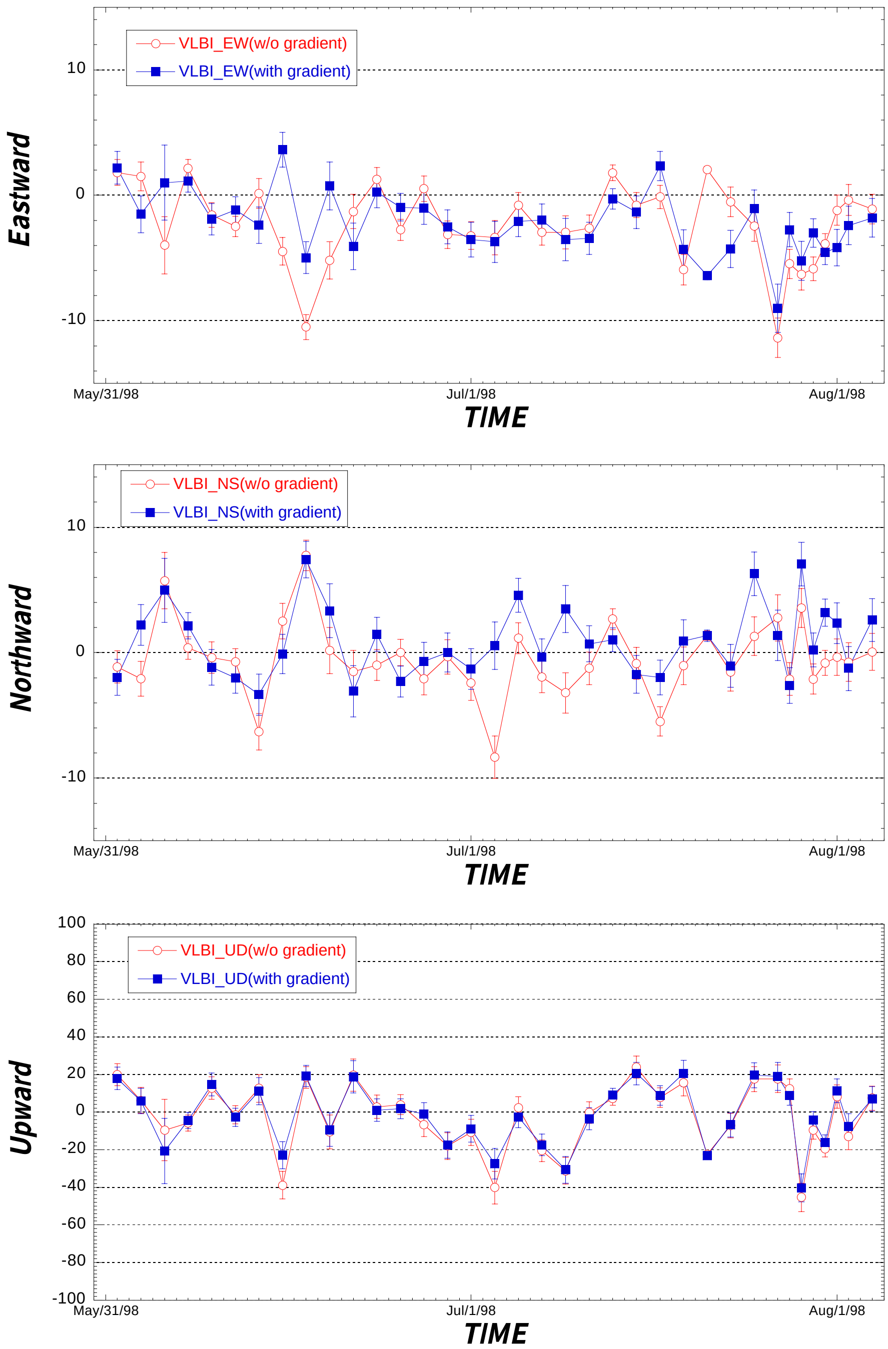

Figure 1. Estimates of the east, north, and vertical components of the Tateyama site relative to the Kashima site from June 1 to August 4 1998.

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New Type Cryogenic Cooled HEMT Receiver

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1. Purpose

Receivers currently used at VLBI station are categorized into two groups. One is the receivers with the GM like cryogenic using Helium (He) gas compressor and the other is those in ambient temperature. The latter one is mainly used at remote automatic VLBI station or less important band receiver. Because the cryogenic with the He-gas compressor need expensive regular maintenance and it also needs skilled vacuum start up procedure. To fill the gap between these two kind receivers, we had been investigated several cooled system. But most of them are not adequate because of their short life time and higher maintenance cost compared to their performance. Recently, a technique developed to enhance mobile cellular base ability realized cooled low noise receiver with less maintenance. We will design a new type receiver for radio telescope using this technique to fill the gap between the He-cooled and ambient receiver.

2. Status

We are preparing installation of a new type cryogenic cooled HEMT receiver in Kashima 34-m antenna. Table 1 summarizes its specifications. The new receiver is equipped with a compact closed cycle cryogenic which can provide intermediate receiver noise (Trx) between the ambient temperature and He cryogenic. Since there is no external gas compressor or Helium flexible line, it is easy to replace a receiver to the cooled one for grade up. There is no additional maintenance and no vacuum dewar care in this system. A C-band (5 GHz) LNA mainly used for VSOP observation will be replaced to the new type.

Due to its inside liquid pumping, the unit must be operated within ±30 degrees tilt. On the other hand at the telescope secondary focus, instruments are applied tilt almost 90 degrees according to observing angle. To operate under this tilt, we designed a swivel mount (Figure 1). In the table size and specification of the receiver is shown. Using the mount, the unit is maintained horizontally in its operation. Major problems happened in this mount are the variation in LNA gain and a phase instability. They are thought to be caused by an RF flexible cable which is usually neglected in the case of the LNA being attached rigidly. The first experiment using this new cryogenic HEMT receiver is scheduled in June 1999.

Table 1. New cryogenic receiver specification

Nominal gain	35dB
LNA noise temperature	25K
Cooled physical temperature	120K
Power supply	+24V(110V) 5A
MTBF	65000 (Hr)
Cryogenic system dimension	350x220x310 mm
Dimensions with swivel mount	355x300x310 mm
Installation required space	360x400x325 mm

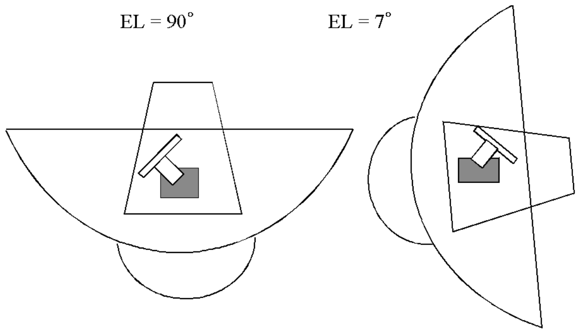

Figure 1. Receiver swivel mount idea for the new 5 GHz receiver.

Acknowledgement: The replacement budget is partially supported by ISAS.

LF Time and Frequency Service

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LF Time and Frequency Service has been performed by an experimental station using 40 kHz. To improve the time and frequency service CRL has constructed a new LF station (Figure 1 and 2). It will be started its operation from June 10, 1999. Table 1 shows the main specifications of new LF station.

Table 1. Specifications of the new LF station.

Station name	Otakadoyayama station
Location	Otakadoyayama, Fukushima prefecture 37°22' N, 140°51' E
Center frequency	40 kHz
Call sign	JJY
Transmitter power	50 kW
e.i.r.p.	> 10 kW
Operation	Continuous (24 hours/day)
Time information	1 cycle/minute Minute, Hour, Day of year, day of week, Year, and information of leap second

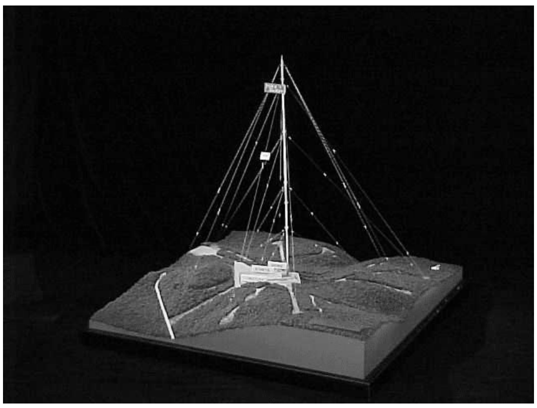

Figure 1. A scale model of the new LF station.

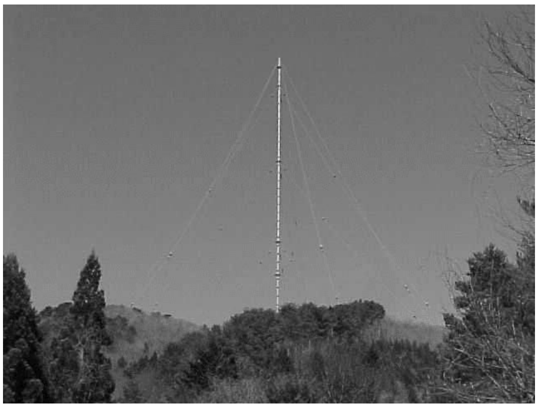

Figure 2. Outward appearance of transmission antenna.

CRL also has a plan to construct second LF time and frequency service station at southwest part of Japan. The purposes of the second station are

- improve the reliability of the time and frequency service.
- expand the service area of the time and frequency.

The construction of the second LF station will be started in 1999 and it will be in operation around middle of 2002.

Figure 3 shows the expected field strength using these two LF standard signal stations.

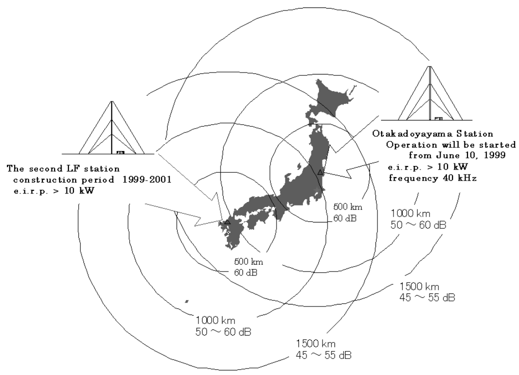

Figure 3. Expected field strength from two LF time service stations.

The Development of 3-Dimensional PostgreSQL GIS RDBMS for Space Geodetic Data Analysis

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The open source database PostgreSQL , which implements major parts of the ANSI SQL/92 RDBMS, is next generation Object RDBMS and it will increasingly deal with Object databases and Object data types. Major PC-UNIX distributions already include the PostgreSQL package. PostgreSQL is famous for the unique two-dimensional GIS objects, as follows:

ObjectName	Storage	Representation	Description
point	16 bytes	(x,y)	Point in 2-dimensional space
lseg	32 bytes	((x1,y1),(x2,y2))	Finite line segment
box	32 bytes	((x1,y1),(x2,y2))	Rectangular box
path	4+32n bytes	[(x1,y1),...]	Open path
polygon	4+32n bytes	((x1,y1),...)	Polygon

Present PostgreSQL also has a powerful R-tree(2D) index tool.

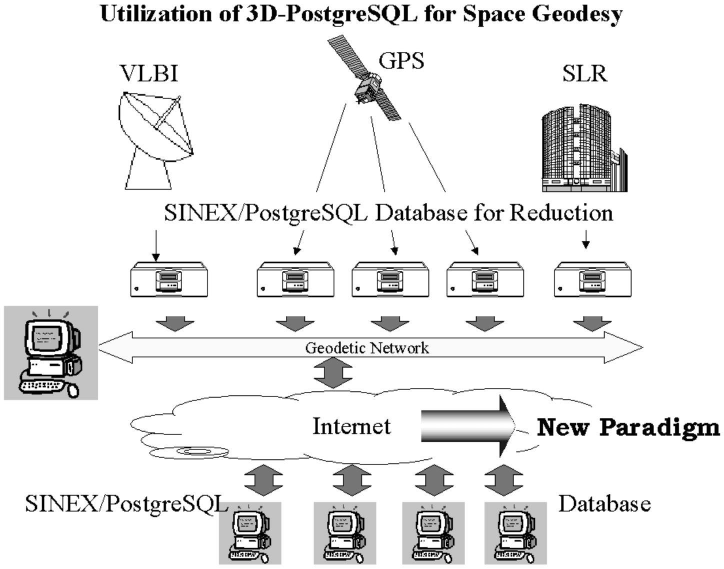
This paper describes the our development of three-dimensional GIS objects, such as:

point3D	24 bytes	(x,y,z)	Point in 3-dimensional space
lseg3D	32 bytes	((x1,y1,z1),(x2,y2,z2))	Finite 3D line segment
		....	

and the development of three-dimensional R-tree index tool. A rich set of 3D functions and 3D operators will be available to perform various geometric 3D-operations such as scaling, translation, rotation, and determining intersections. This paper also describes the new application of PostgreSQL to GPS SINEX format. SINEX format is an ASCII file with lines of 80chars or less and covers VLBI and SLR as well as GPS. We will show the demonstration of the relational SINEX database using 3D-GIS objects using developing 3D-PostgreSQL

Near future our 3D-PostgreSQL will be open for the PostgreSQL community. We expect that the combination of the 3D measurements by space techniques such as GPS and the open- source software movement such as PostgreSQL may create new frontier of science and technology development.

Utilization of 3D-PostgreSQL for Space Geodesy



Science Camp Report, Home Brew Radio-astronomy Receiver

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1. TDC Educational Activity

Since 1997, CRL has joined a "Science camp" program for high school student education promoted by the Science and Technology Agency, Japan. High-school students from nation wide choose and join the camp held in several research institutes in the summer holidays. One of the popular courses in this camp is our "Made it easy, Radio-astronomical receiver" program at the Kashima Space Research Center of CRL. In this course of the last summer, every students made their own detectors and amplifiers by themselves. Finally they assembled a little dish type radio telescope using broadcasting satellite antennas. They were also asked to calculate direction of the sun using their trigonometry knowledge to precisely direct their radio telescopes to the sun. Several group competed with each other for the accuracy of transit pointing. CRL-TDC Kashima group provided for the whole instruction and materials. We felt it is very important to stimulate interests of high school students for science through our educational activity.

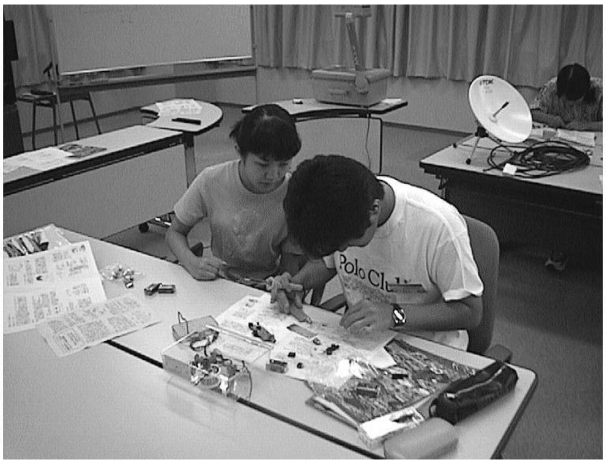


Figure 1. Students solder parts on CRL-TDC receiver kits.

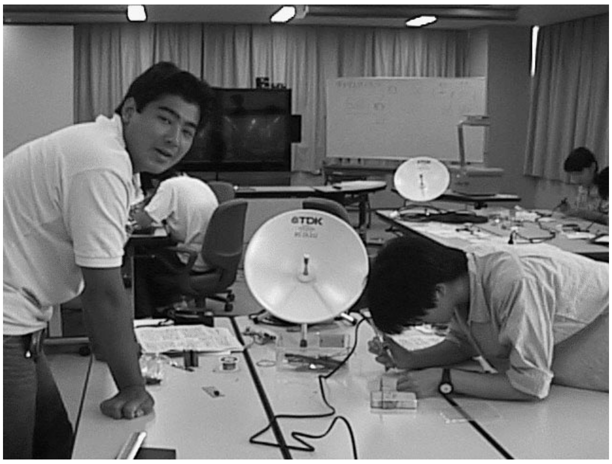


Figure 2. They completed their radio telescope systems with small dishes.

2. Antenna and Receiver System

Recently, we can find 10-12 GHz LNA blocks for about $10 to $30 in electrical shops in Akihabara, Japan. They are sold in junk shops as excess production units. Broadcasting satellite reception set are also sold around $150-$200. These products can be used to assemble radio astronomical receivers with Trx=100 K to 200 K, typically. Detector and amplifier parts are provided as a kit in the Science Camp. We prepared an original surface mount printed board. Shott-key diode 1SS16, 1S99 or similar one were used for IF detectors. Successive OP-amps well known as 741 compatible were also used. Introductory knowledges in electronic circuits were obtained by students directly from devices, schematic, and parts soldering. The kit costed only around $10 each. Students were allowed to bring their receiver to home for further studies. Pen recorders were used to record the output from the small radio telescopes while they receive radio power from the sun. In future, we are planning to modify this section to a popular PIC based data acquisition boards for personal PCs.

3. Using Own Radio-astronomical Receiver

At first, they checked their detector-amplifier circuits by using weak signals from their walkman or portable CD players and observed these signals were amplified to certain level to drive a speaker. Secondly, they observed their bodies, which are emitting 300 K emission, by directing their telescopes to their bodies. Sensitive receivers could apparently distinguish the difference between sky and 300 K. Thirdly, they received the signals from

Figure 3. Small telescopes were pointed to the transit direction of the sun and all student are watching the movements of the recorder pen.

a GSO (Geo Stationary Orbit) satellite. Since its signal is very strong, half power point of the antenna beam width (HPBW) can be defined clearly. Then the direction of the GSO becomes a reference of the direction for the following challenge.

Finally, students were asked to point their telescopes toward the transit direction of the sun. Using simple trigonometry, true south direction is determined from the GSO's direction. If the presetted AZ and EL angles are correct, signal level recorded by a pen recorder will show maximum at the time of transit. Each group can compare their results and know which group was the most accurate.

The reception of the solar radio emittion by their radio telescopes complete the three-days Science Camp. But advanced students can calculate surface temperature of the sun by obtaining antenna's HPBW and 300 K emission level as a calibrator. Students who want to continue their studies were advised to use equational mount for popular optical telescope to continuously track the sun.

Many student were seemed to be impressed by the successful radio astronomical observations of the sun. Some of them managed to understand the black body radiations and the others noticed that how the artificial RFIs are strong. With their strong demand, interferometric-expansion of these simple telescope kits within their pocket money budget is the current challenges by them.

Letter to the Editor

Australia Telescope National Facility Stay Report

Mizuhiko Hosokawa, Measurements and Standards Section, CRL

Thanks to Australian S&T Award, I have got a chance to stay in Australia Telescope National Facility (ATNF), CSIRO for twelve months since last September. It is my first experience to live in a foreign country. So before I came here, I had a little anxiety for the new life in Australia. So far, however, with the great help of many persons both in Japan and Australia, I have had a good and fruitful stay in Australia. Now more than half of the staying period has passed. I would like to make a brief report of my stay in ATNF.

ATNF is famous for Australian icon Parkes 64 m antenna and powerful Narrabri Compact Array. These prominent facilities in Southern Hemisphere and the lively research activity of the staff makes ATNF one of the world Centers of Radio Astronomy. Many researchers visit ATNF from over the world continuously. I have already been once in Parkes and three times in Narrabri. One of the visit to Narrabri, on November last year, was to join the celebration of 10th anniversary and upgrade completion of AT Compact Array. It was a great ceremony. Two Directors of Foreign Radio Astronomical Observatory were invited to the ceremony. One is Prof. Lyne from Jodrell Bank Observatory, and the other is Prof. Nakai from Nobeyama Observatory.

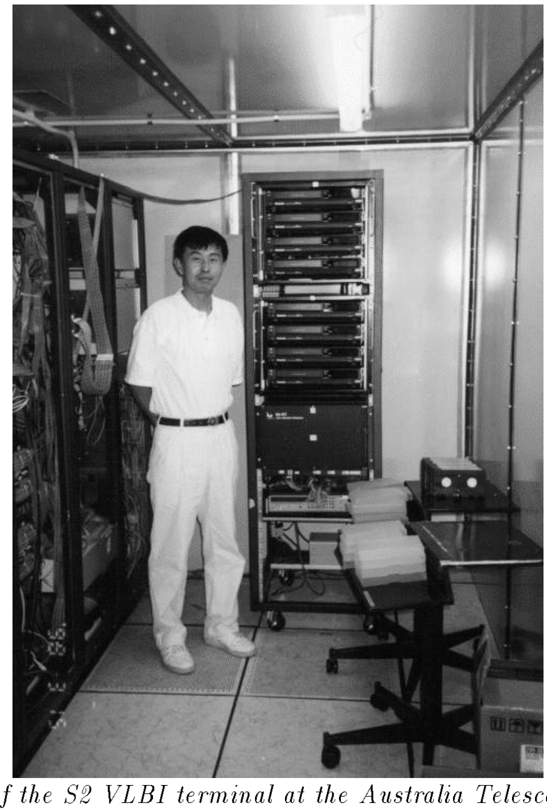
It should be mentioned that these Observatories equip not only good observing facility, but also very conformable lodge for visitor observers. Staying such conformable lodge makes the communication between researchers easy and active. When I have visited Parkes in January, I met Ken Freeman in MSSO. In that time, there are also Ron Ekers, ATNF Director and John Reynolds, Officer In Charge of Parkes. In some dinner times, I asked them many questions and I have learned many from them. In March, I have been to Narrabri for the help(?) of a VLBI observation. In that time, I have met Bodie Seneta and heard many on Sydney University Stellar Interferometer (SUSI) from him. Also there I have met Kondo-san from CRL Japan, who have visited IPS Culgoora observatory. After that visit, Kondo-san have been Sydney and one day he have visited ATNF headquarter. In that occasion, Kondo-san and I saw the VLBI development activity in ATNF. He have talked with some persons on the future VLBI standards. In March, besides the visit to Narrabri, I had many guest at ATNF from Japan. Especially, the arrival of Antarctica ice breaker "Shirase" was very impressive for me. Shirase visit Sydney every year on the way back to Japan. This year, the visit of Shirase is somewhat different from other year's ones. One is that a few months ago, she helped an Australian Antarctica expedition ship that was confirmed by the ice in the Antarctica Ocean in that time. So this year "Shirase" was a heroin for Australian people. The other, special for me and ATNF, is that the expedition leader of this year is Prof. Shibuya who have conducted the Antarctica VLBI geodetic observation and also was the ex-external member of VLBI Technical development Center in CRL. While his short stay in Sydney, Shibuya-san visited ATNF. In that time he saw the VLBI activity of ATNF and discussed with ATNF VLBI group on how to analyze Antarctica VLBI data easily and quickly. The other day he invited some of ATNF persons, including me, to the icebreaker "Shirase". To see the control room, helicopter hanger, engine room and many place inside Shirase was an exiting experience to me.

Besides ATNF Observatories, I have visited many Universities in Australia and have met the persons of Astrophysics group or Radio Astronomy group. At the end of January, the Melbourne University, at the beginning of April, the University of Tasmania and at the end of April, Australia National University and Mt. Stromlo Observatory. At every University or Observatory, I talked on my research at the colloquium or an informal seminar and heard many of the research activity on each group. In spite of my poor English, many person said that my talk was interesting. And also, they told me their research activities very kindly. The visit to Mt. Stromlo observatory was especially impressive for me. Because there I saw the MACHO group microlensing observation facility. The microlensing events found by MACHO group and other groups have given the great impact on my research. So seeing that system was impressive for me. Also, in the University of Tasmania I saw the 26 m antenna, one of the very important Southern hemisphere VLBI antenna, and 14 m antenna that is famous for continuous, every day 18 hours timing observation of VELA pulsar since early 80's.

Visiting many observatories, I was impressed that they have very good facilities and attractions for non specialists. ATNF Observatories have good Visitor Centers. In the Mt. Stromlo Observatory, I found the Stromlo Explorer, very good Exhibition pavilion of Astronomy for common people. I guess these facilities would be a great help for arousing interest and understanding of astronomy for wide range people.

Living in foreign country might be not so easy sometimes. But every time I felt difficulty, many persons in both Australia and Japan have helped me very warmly. I would like to appreciate these many persons, and hope that the rest of my stay be fruitful as ever, or even better.

The Australia Telescope Compact Array located at the Paul Wild Observatory in Narrabri.



Standing in front of the S2 VLBI terminal at the Australia Telescope Compact Array.

"IVS CRL Technology Development Center News" (IVS CRL-TDC News) published by the Communications Research Laboratory (CRL) is the continuation of "International Earth Rotation Service - VLBI Technical Development Center News" (IERS TDC News) published by CRL. In accordance with the establishment of the International VLBI Service (IVS) for Geodesy and Astrometry on March 1, 1999, the function of the IERS VLBI technical development center was taken over by that of the IVS technology development center, and the name of center was changed from "Technical Development Center" to "Technology Development Center".

VLBI Technology Development Center (TDC) at CRL is supposed

1) to develop new observation techniques and new systems for advanced Earth's rotation observations by VLBI and other space techniques,
2) to promote research in Earth rotation using VLBI,
3) to distribute new VLBI technology,
4) to contribute the standardization of VLBI interface, and
5) to deploy the real-time VLBI technique.

The CRL TDC meeting, attended by the ordinary members from inside the CRL and the special members from the outside, is held twice a year. The special members advise the committee, concerning the plan of technical developments. The CRL TDC newsletter (IVS CRL-TDC News) is published biannually by CRL.

This news was edited by Tetsuro Kondo and Yasuhiro Koyama, Kashima Space Research Center, who are editorial staff members of TDC at the Communications Research Laboratory, Japan. Inquires on this issue should be addressed to T. Kondo, Kashima Space Research Center, Communications Research Laboratory, 893-1 Hirai, Kashima, Ibaraki 314-0012, Japan, TEL : +81-299-84-7137, FAX : +81-299-84-7194, e-mail : kondo@crl.go.jp.

Summaries of VLBI and related activities at the Communications Research Laboratory are on the World Wide Web (WWW). The URL to view the home page of the Radio Astronomy Applications Section of the Kashima Space Research Center is : **"http://www.crl.go.jp/ka/radioastro/"**. The URL to view the Keystone project's activity is **"http://ksp.crl.go.jp/"**.

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