Technical Development Center News No.2

(International Earth Rotation Service VLBI Technical Development Center News)

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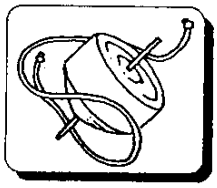


Introduction

In October 1990, the International Earth Rotation Service (IERS) designated the Communications Research Laboratory (CRL) and Haystack Observatory (in the United States) as Technical Development Centers (TDC).

The Technical Development Centers are concerned with

I. the development of new observation techniques and new systems for advanced Earth's rotation observations by VLBI and other space techniques,

II. the promotion of research in Earth rotation by advanced methods in VLBI,

and

III. the distribution of new VLBI technology.

The TDC meeting is held twice a year, including the special members from outside the CRL. The committee is advised by the special members concerning the plan of Technical Development. The Technical Development Center News is published biannually by the Communications Research Laboratory to inform on current activities to the IERS community. From this issue on, we publish the TDC News only in English taking the international distribution into account.

The Second TDC Meeting was held

on February 28, 1992 at the Conference Room of Kashima Space Research Center (CRL).

Agenda

1. Opening, by Mr.A.Sugiura, Director of Standards and Measurements Division, CRL
2. Report on the Technical Developments in 1991
   (1) Outline
   (2) K-4 System Development
   (3) Earth Rotation Observation
   (4) Geodesy
   (5) Millimeter Wave VLBI and Radio Astronomical Aspects
   (6) Utilization of Satellite Technipues
3. Discussion on the report
4. Discussion on the proposal about the Antarctica VLBI

MINUTES OF THE MEETING

Kawaguchi:	Is it really possible to have 32 MHz bandwidth in the sideband of Video Converter ?
Hama:	It is planned, and is under development.
Okihara:	Regarding the K-4 data recorder, GP-IB is available as well as RS422 interface. Moreover VME bus and SCSI interface are also available in near future. So controlling the K-4 data recorder will be easier by making use of a variety of functions.
Kawaguchi :	I hope 22GHz band receiver will be also included at the Antarctic station in Syowa for the future VLBI.
Nakayama:	Loss in the radome and surface accuracy of the 11m dish have to be taken into account. I think it is technically possible.
Uchida:	What is the difference between K-4 and new K-4?
Kawaguchi:	It has been a rule that new number (one digit) is given for a system when we introduce a new type data recorder in it. But to distinguish a system by version number (more detail) must be necessary after significant modification to avoid confusion.
Nakahori:	We are analyzing the long and short tidal terms to distinguish the mean sea level change from the tidal effects. These results will be taken into account when we evaluate our VLBI data.

Following the above discussion, a topic concerning the promotion of a VLBI project in the Syowa station was discussed. Discussions about this topic are also shown below.

Finally, it was suggested that the policy of VLBI development should be discussed between both Technical Development Centers in the United States and Japan. We will try to find an effective way for this purpose.

Discussion on the Resolution proposed by Prof. Ejiri about Promoting the VLBI project in Syowa station

Ejiri:	(He explained the meaning of his proposal. See the attached proposal (not included in this issue reproduced in 1998!).)
Kawaguchi:	I agree with the meaning of the proposal. But why does the TDC make such a resolution?
Uchida:	We can endorse the plan from the technical point of view. I suggest to stress the technical points in the proposal.
Sugiura:	I think the endorsement should be made also from the Japanese committee on geodesy.
Ejiri:	It takes time. But I should try.
Sasao:	I will also try to get an endorsement at the Japanese committee on astronomy.

Attendees:

Akira Sugiura	CRL/Tokyo
Fujinobu Takahashi	CRL/Tokyo
Taizoh Yoshino	CRL/Tokyo
Hiroo Kunimori	CRL/Tokyo
Kuniaki Uchida	CRL/Kashima
Michito Imae	CRL/Kashima
Shin'ichi Hama	CRL/Kashima
Yukio Takahashi	CRL/Kashima
Jun Amagai	CRL/Kashima
Hiroshi Takaba	CRL/Kashima
Tetsuo Sasao	NAO/Mizusawa
Noriyuki Kawaguchi	NAO/Nobeyama
Yoshiro Nakabori	GSI
Masaki Ejiri	NIPR
Daishiro Okihara	SONY
Makoto Nakayama	NEC

Abbreviation:

CRL:	Communications Research Laboratory
NAO:	National Astronomical Observatory
GSI:	Geographical Survey Institute
NIPR:	National Institute of Polar Research

IERS VLBI TDC Resolution

28 February 1992

RESOLUTION FOR PROMOTING VLBI AT SYOWA STATION IN ANTARCTICA

The Committee on VLBI Technical Development Center (TDC) in Communications Research Laboratory (CRL) under International Earth Rotation Service (IERS),

CONSIDERING,

(a) that Japan conducted successfully the test VLBI experiment in Antarctica in January, 1990, whose results are of great contribution to the international VLBI community,

(b) that it is, however, still under planning phase to prepare the necessary equipments for the regular VLBI experiment at Syowa Station,

(c) that Germany has recently constructed the VLBI systems at O'Higgins in Antarctica, and the USA is planning to develop the VLBI station in Antarctica,

(d) that Syowa Station is expected to play an essential role in Antarctica VLBI,

(e) that IERS understands the importance of

- precise earth's rotation observation by global VLBI network including Antarctic region,
- establishment of the terrestrial reference frame especially in the southern hemisphere including the Antarctica,
- establishment of the celestial reference frame including the radio sources in the southern hemisphere,

and

- monitoring the global environments including the atmosphere and oceans in Antarctica,

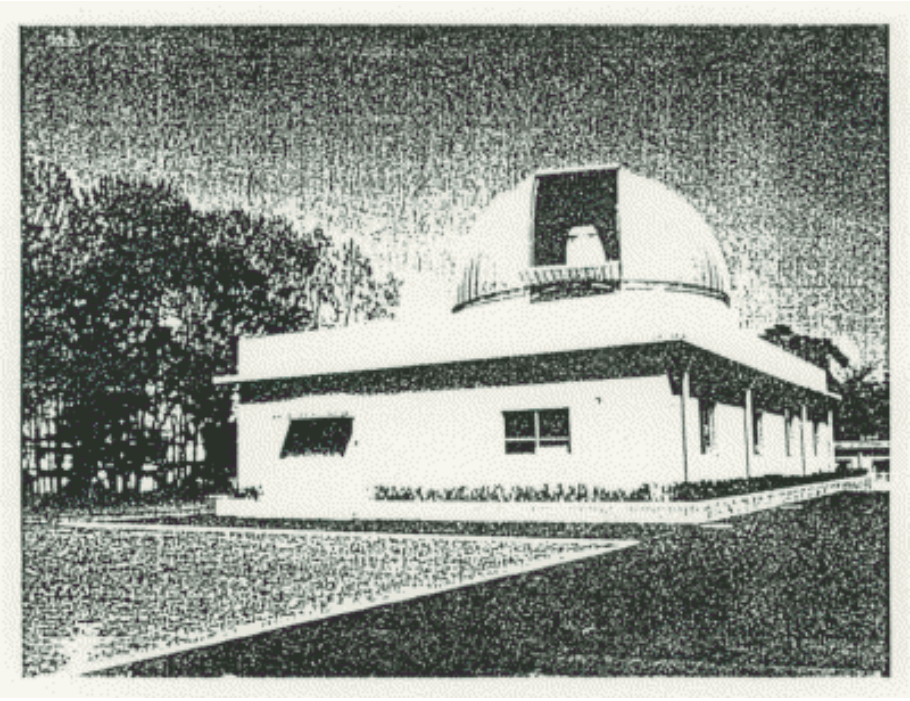
UNANIMOUSLY RESOLVES that the following actions should be urged,

(1) that the institutions and organizations conducting IERS VLBI program make every efforts to promote the construction of a VLBI facilities in Antarctica,

(2) that the regular VLBI experiment will be started urgently at Syowa Station in Antarctica among the international VLBI network.

Technical Topics

In each issue of the TDC News, topics of technical development are introduced by researchers of TDC.



Tokyo SLR Station

Status Report of the System Development Group

by Shin'ichi HAMA

1. New K-4 Input Interface

New K-4 VLBI input interface which has multi-bit sampling capability, is under development. Input interface corresponds to the formatter in Mark-III system. Fig.1 shows its block diagram. Sampling in 1, 2, 4 and 8 bits is possible. The number of channel can be 1, 2, 4, 8 or 16. As the total bit rate is 256Mbps, the bandwidth of each video channel depends on their combination, though video bandwidth wider 20MHz is not easy to achieve. It is planned to have a complete version in 1993. The system is to be used for VSOP (Space VLBI in Japan) and IRIS-P experiments.

2. K-4 Correlator

The K-4 data processor is not for routine process but for R&D experiments such as multi-bit sampling, detection of milli-second pulsar timing. And it will be a test version of the correlator for regular VLBI including IRIS-P. Test model of K-4 correlator is being developed by making use of LCA (FPGA produced by Xilinx Co.). It is a simple one unit correlator but can process 2 bit sampling data.

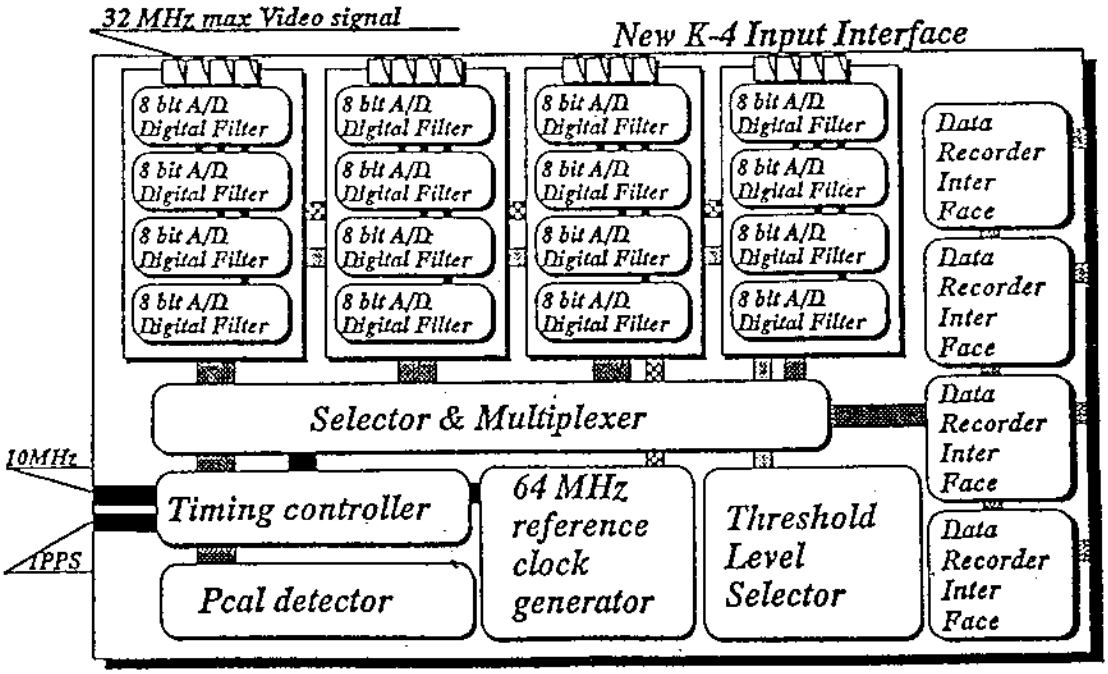


Figure 1. New K-4 Input Interface with Multi-Bit Sampling.

Earth Rotation Observation and other Current Topics

by Yukio TAKAHASHI

1. Status of Earth Rotation Observations

The regular VLBI experiments (IRIS-P) have been conducted every month for the earth rotation observation. However, the high density head of the MarkIII type data recorder in Kashima got a serious problem last year. It was repaired by Haystack Radio Observatory, and Kashima started IRIS-P observation again since January 1992. We will stock the high density head in the National Astronomical Observatory.

We will participate in the intensive VLBI experiments this summer which are proposed by USNO, because we have been making efforts to undertake such intensive VLBI experiments since several years. The test experiment was already conducted on March 10.

CRL and NAO discussed the possibility of observation in IRIS-P network by K-4 system and also with Mark-IIIa system in order to conduct the more frequent observation (weekly) and intensive VLBI together with the other IRIS network and NAVNET.

2. Other Toprcs

2.1 VLBI Experiments with the Syowa Station in Antarctica

VLBI terminals of Syowa Station were set up not permanently but temporarily in the first experiment (1990). CRL provided technical suggestions to the National Institute of Polar Research for the permanent VLBI system at Syowa Station, such as H-Maser frequency standard, Receiver system, K-4 data acquisition terminal and the check system at Syowa station.

2.2 Absolute Sea Level Monitoring by Space Geodetic Techniques

We have developed a transportable VLBI station for the absolute sea level monitoring in cooperation with Geographical Survey Institute (GSI) under the auspices of Environment Agency. The 2.4m antenna system, which is the smallest for VLBI, was already developed with only X band receiver. If we observe the Total Electron Content by GPS receiver such as TECMETER developed at CRL during VLBI observation, we can reach almost the same precision as with the dual frequency observation by increasing the number of observations. We will start the mobile VLBI experiment this year.

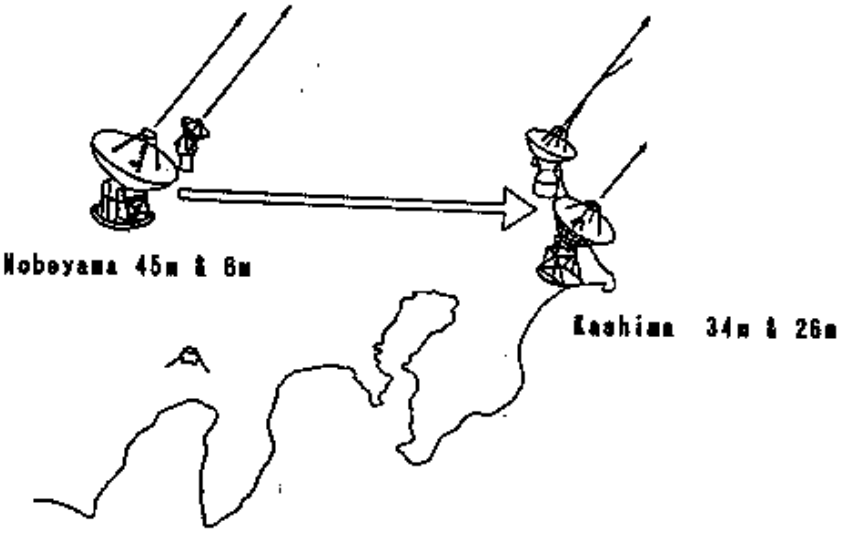
2.3 Geodetic VLBI Experiment at 22GHz

A new type Phase Calibration equipment for 22GHz band was developed at CRL. And it was applied for the geodetic VLBI experiment in the 22GHz band which was conducted at 16th February in 1991, in cooperation with Institute of Radio Astronomy in Bologna University (Italy). We obtained the fringes at 22GHz band for a 8000km baseline using 40 quasars. And we made a baseline analysis.

We also estimated the coherence loss caused by the atmospheric scintillation using a phase calibration signal. It is applicable for estimating the amplitude of the radio sources. It implies the importance of the Phase Calibration signal for the astronomy in 22GHz band.

2.4 Differential VLBI Technique

CRL and NAO are developing new differential VLBI technique using 34m and 26m antenna in Kashima, and 45m and 6m in Nobeyama. The influence of the instability of hardware and atmospheric scintillation can be canceled out more precisely than the usual differential VLBI to change the antenna pair. The precise source position will be also obtained, and the phase delay may be useful to improve the precision of the geodetic VLBI. (See the following Figure)


Nobeyama 45m & 6m
Kashima 34m & 26m

The Space VLBI Project using ETS-VI

by
Takahiro IWATA

Space VLBI experiment is scheduled using ETS-VI geostationary satellite. Japan's Engincering Test Satellite VI which will be launched in 1993. Fig.1 shows the schematic block diagram of the experiments. VLBI observations on the satellite will be made with the 19-element of 34 cm diameter phased array antenna at 2.3 GHz. Received data at the satellite and frequency standard signals at the ground station will be transmitted between the satellite and the 5 m diameter antenna of the Ka-band feeder link system at Kashima Space Research Center. Experiments for the real time fringe monitoring system will be made using the imitated radio star signals which will be emitted from the S-band imitated satellite station at Kashima Center. These experiments with technologies of data and frequency standard signal transmissions will take the initiative in future space VLBI observations.

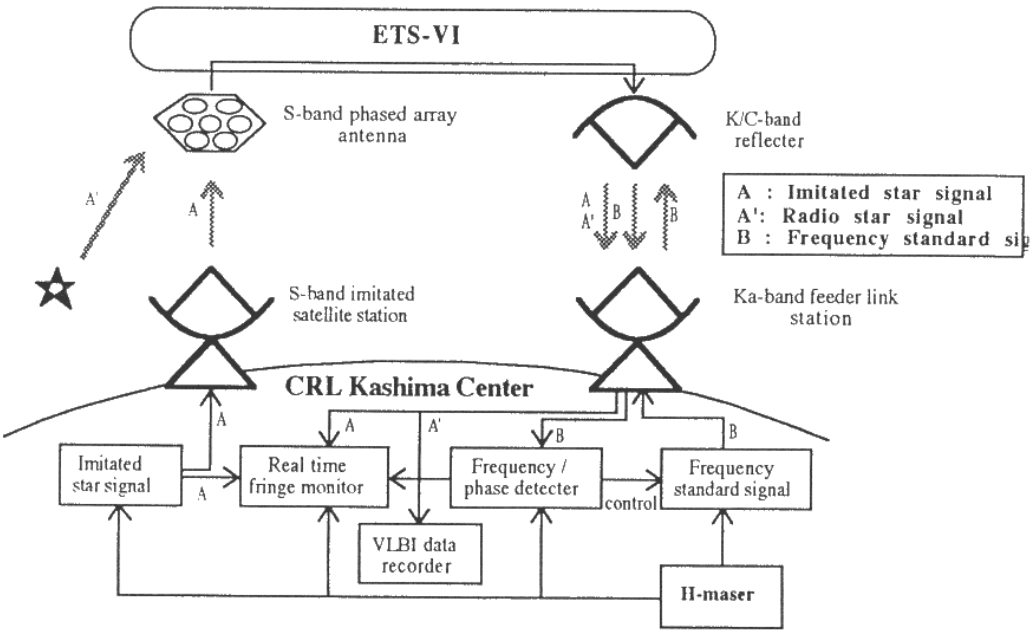


Figure 1. A schematic block diagram of the space VLBI experiments using ETS-VI.

IONOSPHERIC DELAY CORRECTION IN SINGLE BAND VLBI MODEL IMPROVEMENT

by T. KONDO

Total electron content (TEC) measured by dual band GPS receiver can be utilized for calibration of ionospheric excess delays of geodetic VLBI when observations are made at a single frequency band. A key point in realization of ionospheric delay correction is how well TEC measured for GPS direction is mapped to radio star direction observed by VLBI. We have developed a two step mapping method: at first distribution of vertical TEC (VTEC) on a time(UT)-latitude plane at a station is estimated from TEC measurements (Fig.1), then VTEC is mapped to a desired radio star direction. This process is carried out at each station. By differentiating TECs mapped to a star direction, we can obtain an ionospheric correction for VLBI data analysis. The results is evaluated by comparing actual ionospheric correction observed by dual frequency band VLBI and that calculated from TEC measured by GPS receiver. As demonstrated in Fig.2, a good coincidence (SD $<$ 0.1nsec) is obtained in an elevation angle range larger than 20 degree. By taking horizontal density gradient into a mapping model, fitting could be improved.

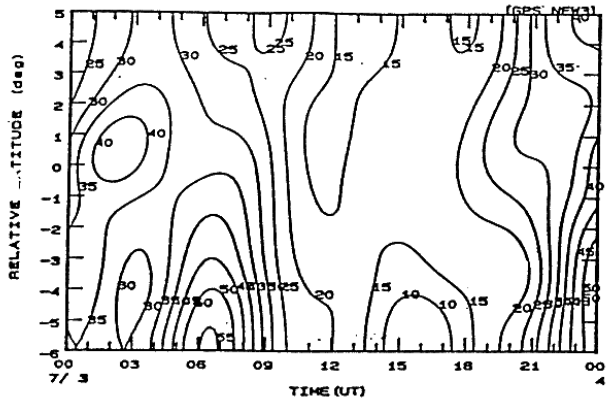


Figure 1. An example of VTEC distribution. Unit is $1O^{16}$ electron/m^2.

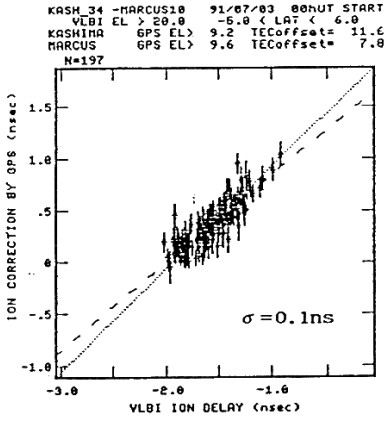


Figure 2. Comparison between ionospheric corrections (abscissa: observed by dual band VLBI, ordinate: calculated from GPS TEC).

Development of Space Geodetic Technology Analyzer, CONCERTO : The First Phase

by Hiroo KUNIMORI

Communications Research Laboratory (CRL) has made SLR obsefvation and has taken the data since 1990. We are now engaged in development of a unique analysis software for SLR, named "CONCERTO" (Computalized satellites' Orbits aNalyzer by CRL spacE and time Research Group in TOkyo) on Sun SPARC workstation.

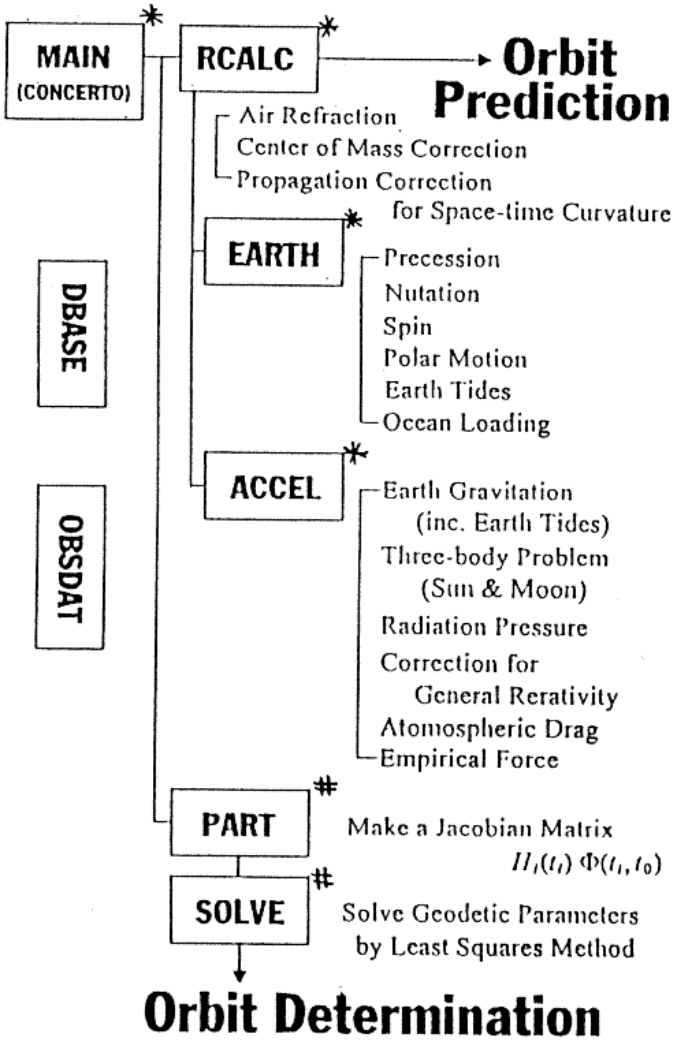


Figure 1. Structure of CONCERTO.

Numerical standards and algorithm used in CONCERTO are consistent with VLBI analyzer in CRL Kashima. CRL is one of institutions which have both SLR and VLBI observation systems. Though each of the two geodetic methods has attained very high precision, it is difficult to verity their own accuracy. The models and constants in the VLBI analyzer and CONCERTO mostly utilize IERS Standards to compare the results from each other working with a model switcher and databases. It is used for laser

ranging analysis such as collocation experiment with VLBI and at present it can be handling with small data volume and number of stations. The functions of CONCERTO are orbit prediction of geodetic satellites orbits, and solution of geodetic parameters.

The functions of modules in CONCERTO are as follows :

MAIN	:	Supervise whole programs.
ACCEL	:	Calculate the modeled accelerations that influence to satellite.
EARTH	:	Calculate the position of the observation site in J2000.0 reference frame.
RCALC	:	Output the range prediction, using results of two modules above.
PART	:	Prepare the partial derivatives by parameters.
SOLVE	:	Determine the set of parameters by means of least squares method.
OBSDAT	:	Access the SLR observation data files.
DBASE	:	Access the data files of physical constants, earth rotation parameters, and so on.

Figure 1 shows the structure of CONCERTO. The blocks marked with "#" are modules under development, ones with "*" have been completed. The other modules will be programmed soon. Figure 2 shows the "O - C" ([observation range value] - [calculated value by CONCERTO]) plot of LAGEOS I 09/24/91 pass. The initial position and velocity vector of the satellite are estimated by software 'UTOPIA' developed in Center for Space Research of University of Texas at Austin.

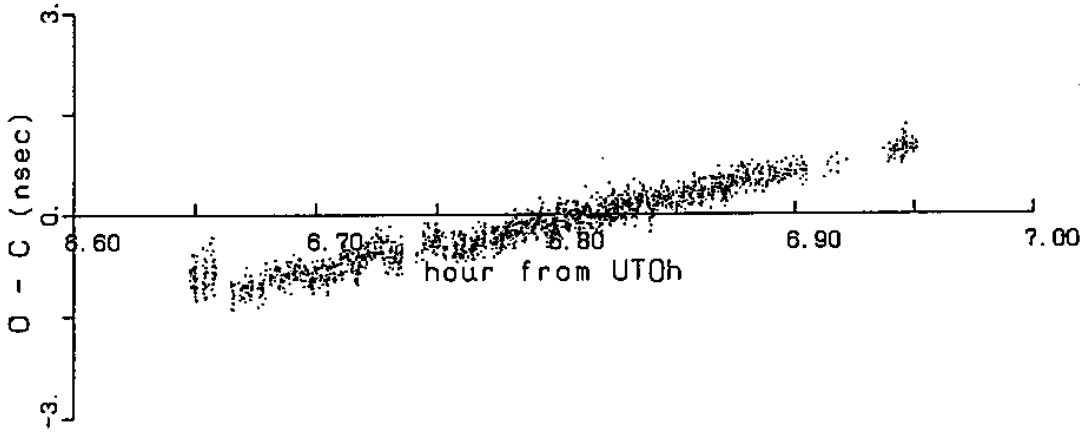


Figure 2. "O - C" plot of range for LGEOS I orbit on 09/24/90 (integration begins at UTOh).

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