Geodetic VLBI Experiments with the K5 System

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VLBI Systems for e-VLBI


K3 Correlator (Center)
K3 Recorder (Right)

K3 System

1983~
Longitudinal Recorder
Open Reel Tapes
Hardware Correlator


K4 Terminal


K4 Correlator

K4 (KSP) System

1990~
Rotary Head Recorder
Cassette Tapes
Hardware Correlator
e-VLBI with ATM


K5 Data Acquisition Terminal

K5 System

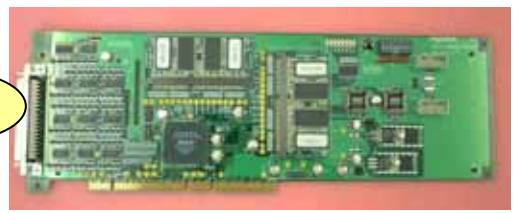
2000~
PC based system
Hard Disks
Software Correlator
e-VLBI with IP

K5 Family : Concept

ADS1000
(1024Msample/sec 1ch 1bit or 2bits)

ADS2000
(64Msample/ch·sec, 16ch, 1bit or 2bits)

PC-VSI Board
(Supports VSI-H specifications)

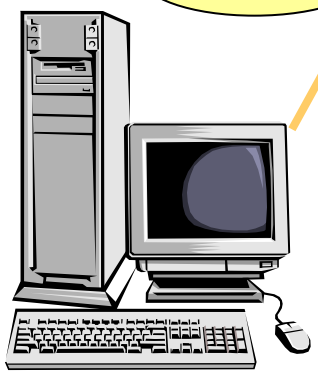


VSI

VSI

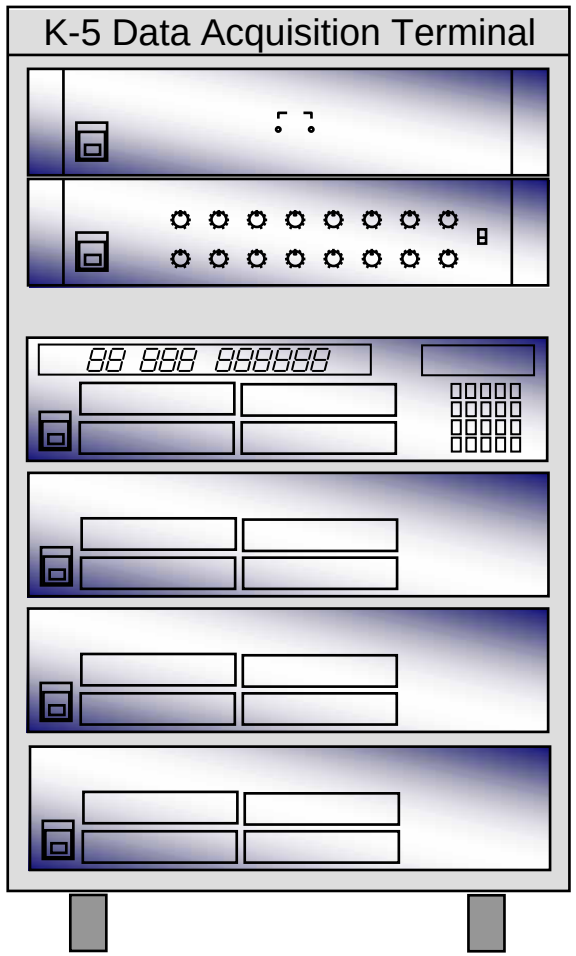
Correlator
other DAS

Internet



IP-VLBI Board
(~16Msample/ch·sec, ~4ch, ~8bits)

PC : Data Acquisition
Correlation



7625A (Reference signal distributor)

7626 (16ch video amps)

Rack mount PC
with an IP-VLBI
board (9260)
and 4 removable
HDD x 4

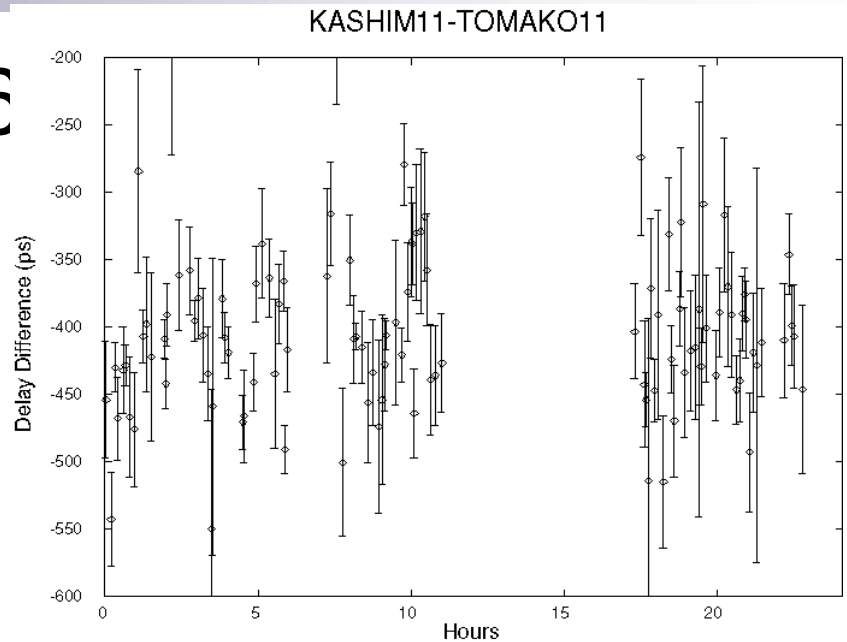
Domestic VLBI Experiments with K5 System

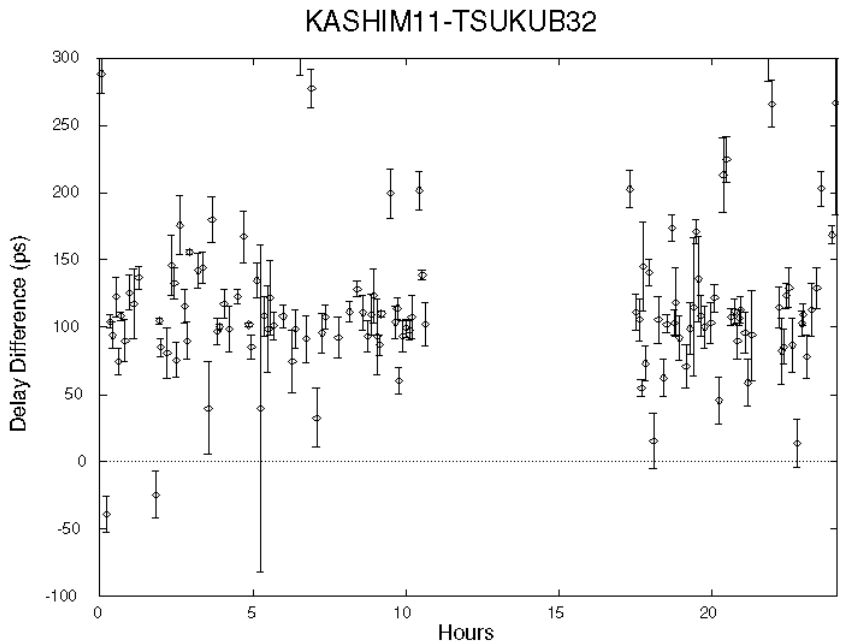
- Jan. 30-31, 2003 (U03031)
  - Single baseline experiment : Kashima (11m) and Koganei (11m)
  - 56Mbps (2MHz, 14ch.), 24 hours
  - Compared results with K4 and GBR systems

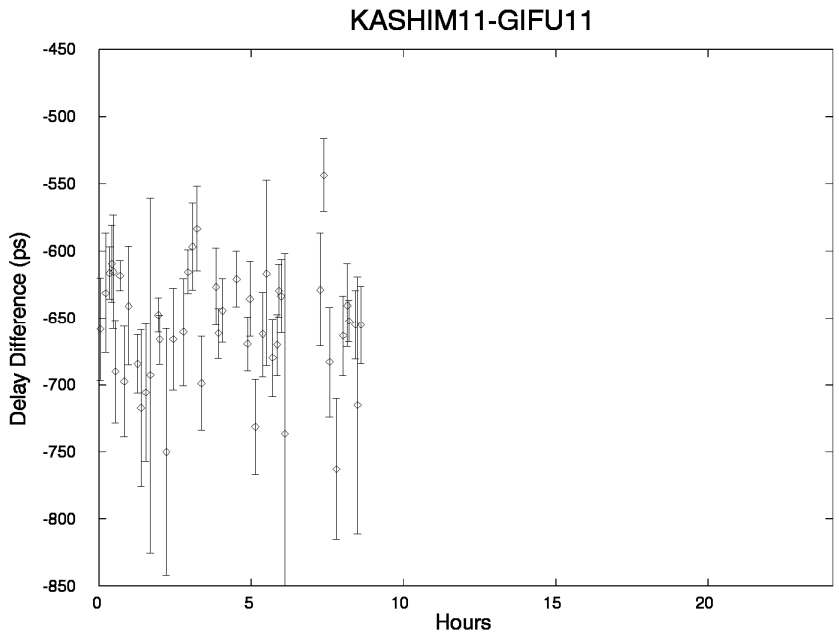
- July 16-17, 2003 (JADE0306)
  - 5 stations, 10 baselines : Kashima (11m), Tsukuba (32m), Tomakomai (11m), Gifu (11m), Yamaguchi (32m)
  - The first geodetiv VLBI for Yamaguchi (32m) station : X-band only
  - 128Mbps (4MHz, 16ch.), 24 hours
  - up to ~1.4TBytes

Time Delay (JADE0306

	Average	RMS
KASHIMA-TSUKUBA	113.3 ps	50.9 ps
KASHIMA-TSUKUBA	-658.0 ps	44.3 ps
KASHIMA-TOMAKOMAI	-404.1 ps	61.0 ps





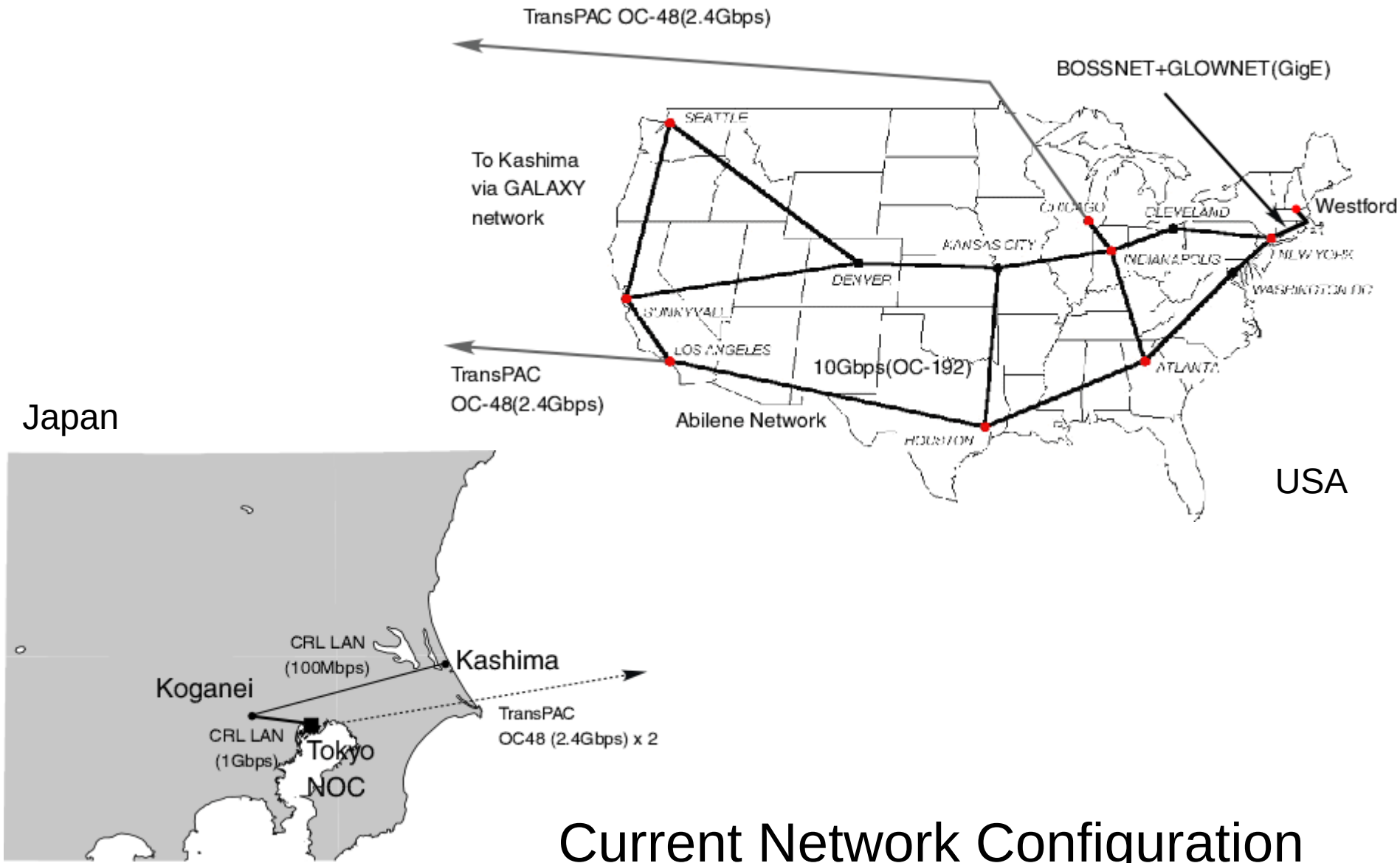


Comparisons of Results (JADE0306)

Baseline	System	No. of valid data	Baseline Length (mm)	RMS Residual Delay (psec)	RMS Residual Rate (fsec/sec)
Tsukuba-Kashima	K4	176	53811894.9 ± 2.1	53	158
	K5	130	53811891.6 ± 3.1	81	121
Tsukuba-Gifu	K4	184	311067474.0 ± 2.9	98	189
	K5	55	311067483.3 ± 4.0	58	136
Tsukuba-Tomakomai	K4	124	740526116.3 ± 4.4	103	165
	K5	169	740526119.4 ± 5.1	103	146
Kashima-Gifu	K4	174	358799168.6 ± 2.8	72	191
	K5	48	358799174.7 ± 4.5	92	144
Kashima-Tomakomai	K4	171	749810979.9 ± 4.4	115	125
	K5	108	749810985.5 ± 5.5	106	143
Gifu -Tomakomai	K4	154	902668931.2 ± 4.8	135	125
	K5	49	902668930.6 ± 6.1	116	138

Westford-Kashima Experiments for Rapid UT1-UTC

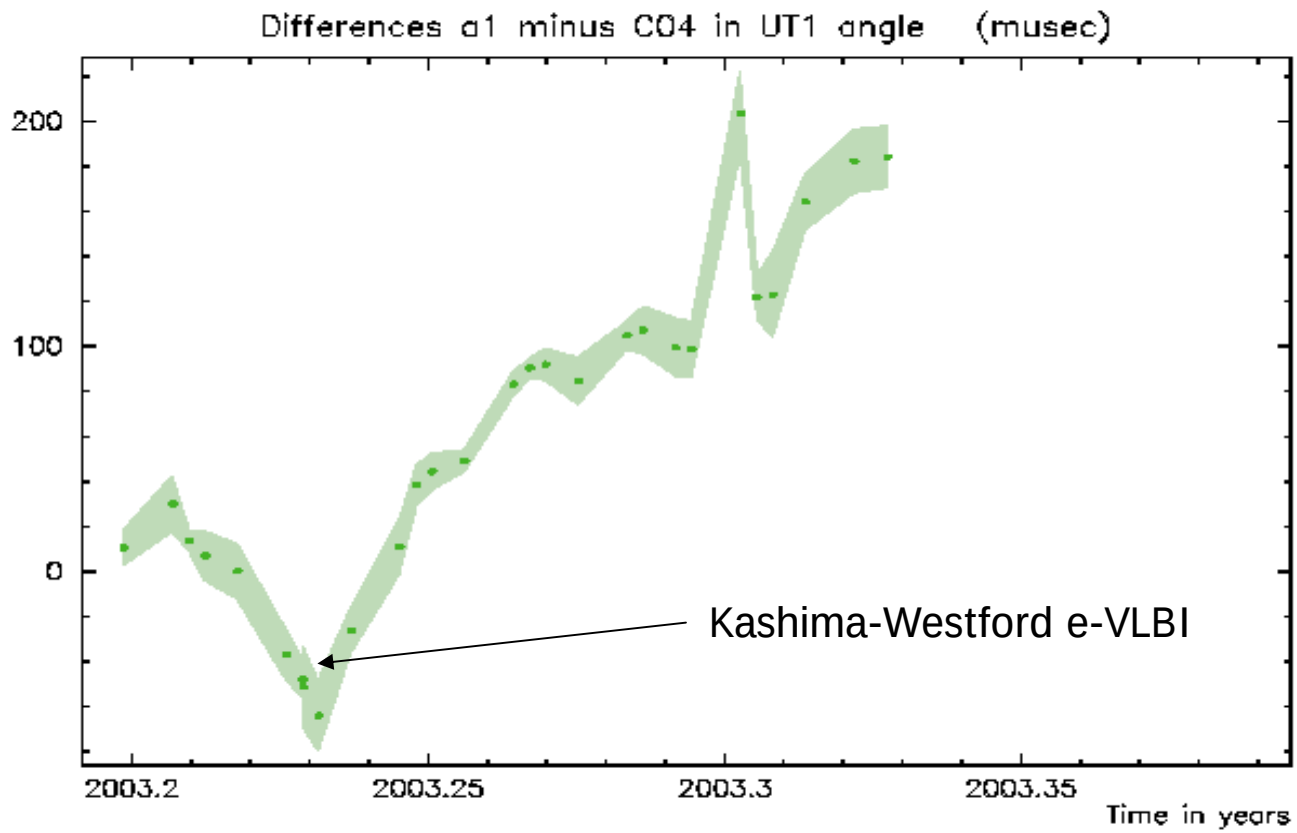
- Mar. 25, 2003 (evlbi4)
  - Westford (Mk5)-Kashima34m(K5), 2 hours, 56Mbps
  - Fringes were found on Mar. 27!
- Jun. 27, 2003 (evlbi6)
  - Westford (Mk5)-Kashima34m(K5), 2 hours, 56Mbps
  - UT1-UTC estimation 21 hours after the observations!



Current Network Configuration

Consistency of UT1-UTC Results

UT1-UTC estimation compared with NEOS Intensive VLBI sessions



* Data analysis done by Dr. Leonid Petrov at Goddard Space Flight Center, NASA

Time Sequence of Data Transfer and Processing

e-VLBI6

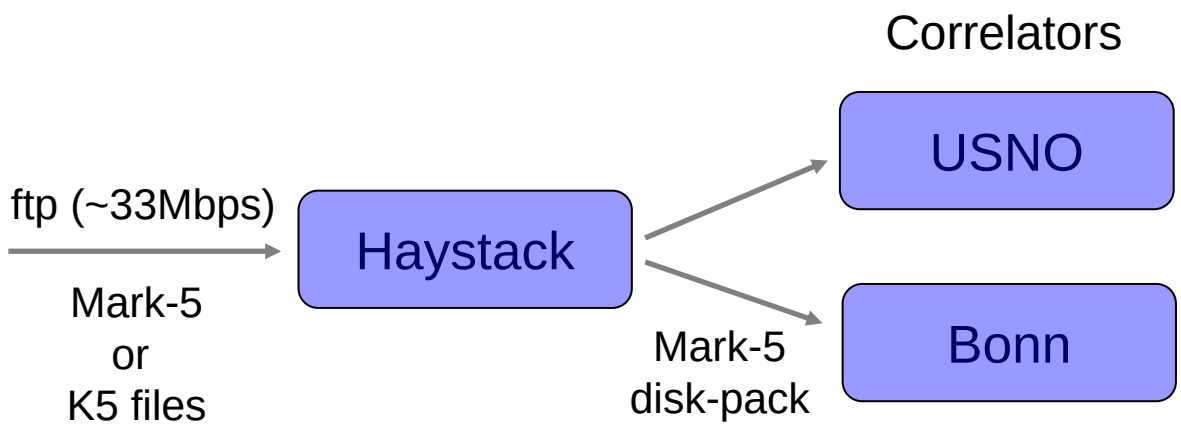
- 22:00 (JST) Observations Start
- 00:00 Observations End
- ~04:20 File extraction and transmission
  - From Kashima to Westford : 107Mbps 41.54GByte in 51m 35s
  - From Westford to Kashima : 44.6Mbps 41.54GByte in 2hr 04m 02s
- ~08:10 File Conversion (Mark5 to K5)
- ~20:30 Software Correlation
- ~21:20 Bandwidth Synthesis Processing, Database Generation, Data Analysis

* Correlation at Haystack Observatory (Mark4 Correlator) finished at 14:19 JST

Use of K5 System in IVS Sessions

- Following 4 IVS sessions at Kashima were recorded with VLBA and K5 systems in parallel
  - IVS-CRF22 October 28-29, 2003
  - IVS-CRF23 November 4-5, 2003
  - IVS-T2023 November 18-19, 2003
  - IVS-T2024 December 2-3, 2003

K5 files → Mark-5 files
(except for T2024)



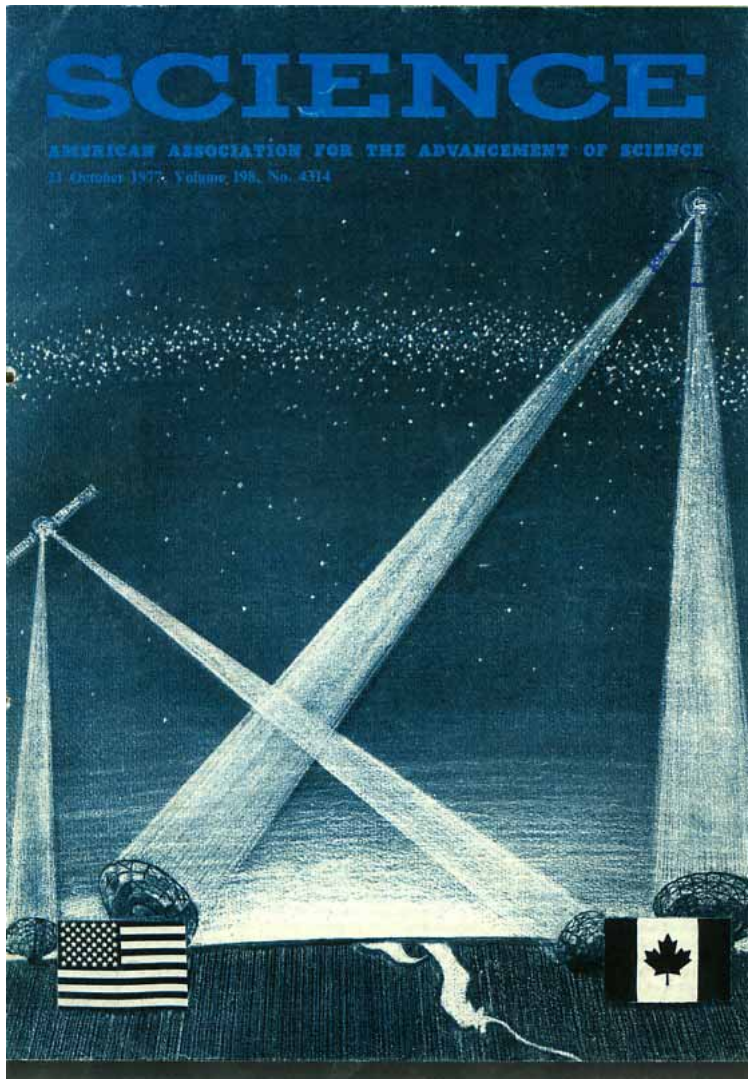
Future Plan

- Improve data transfer speed.
  - Network speed upgrade at Kashima : 100Mbps => 10Gbps
  - Further tuning.
  - Replace slow network instruments.
  - Examine high performance protocols (ex. HS-TCP).
- Develop Software Correlator with CPU Array System.
- Real-time data transfer and real-time correlation.
- Regular use of K5 system in IVS sessions.
  - Kashima, Syowa (Antarctica), and Tsukuba.
- Tsukuba-Westford e-VLBI Sunday intensive sessions.

Summary

- K5 VLBI system showed comparable or better results compared with tape based K4 system in geodetic VLBI.
- Rapid turn-around estimation of UT1-UTC less than one day was successfully demonstrated (further improvements will be achieved soon).
- Full compatibilities between K5 and Mark5 systems have been demonstrated.
- Routine K5 use in IVS sessions started.

Pioneering Work in e-VLBI



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