

# K5システムによる測地VLBI実験

## 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 (KSP) System

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



K4 Correlator



K5 Data Acquisition  
Terminal

## K5 System

2002~  
PC based system  
Hard Disks  
Software Correlator  
e-VLBI with IP

# K5 Family : Concept

ADS1000

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



PC-VSI Board

(Supports VSI-H specifications)

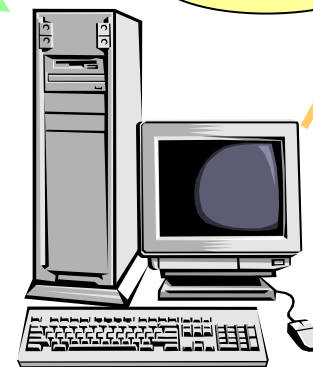


VSI

VSI

Correlator  
other DAS

Internet



IP-VLBI Board

(~16Msample/ch·sec, ~4ch, ~8bits)

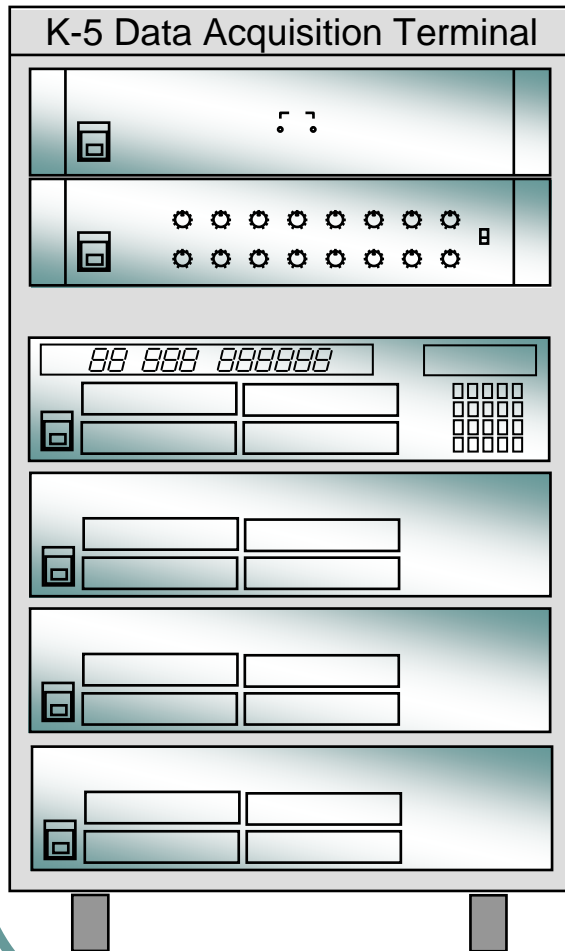


ADS2000

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

PC : Data Acquisition  
Correlation

# K5 Data Acquisition Terminal



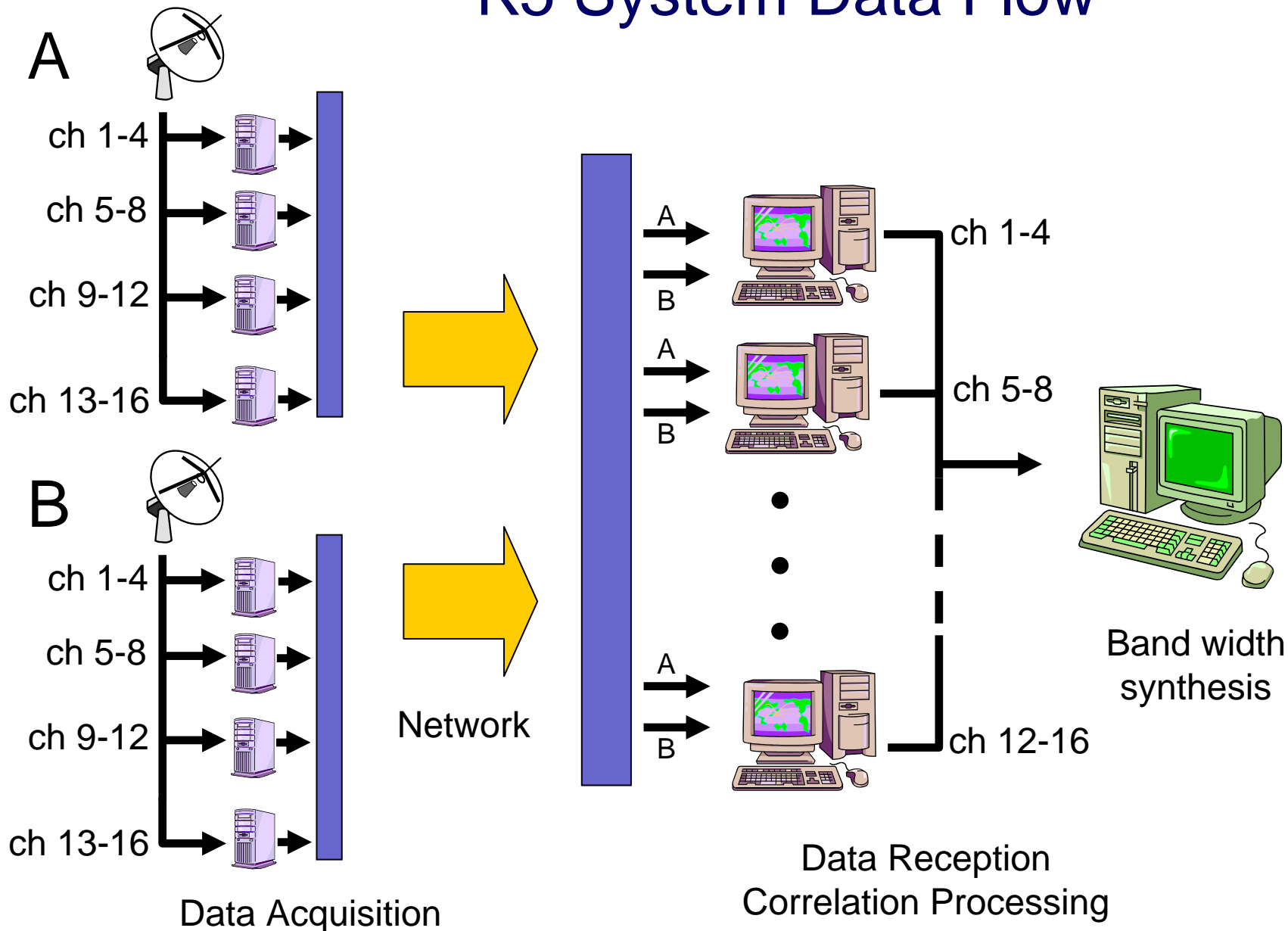
7625A (Reference signal distributor)

7626 (16ch video amps)

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



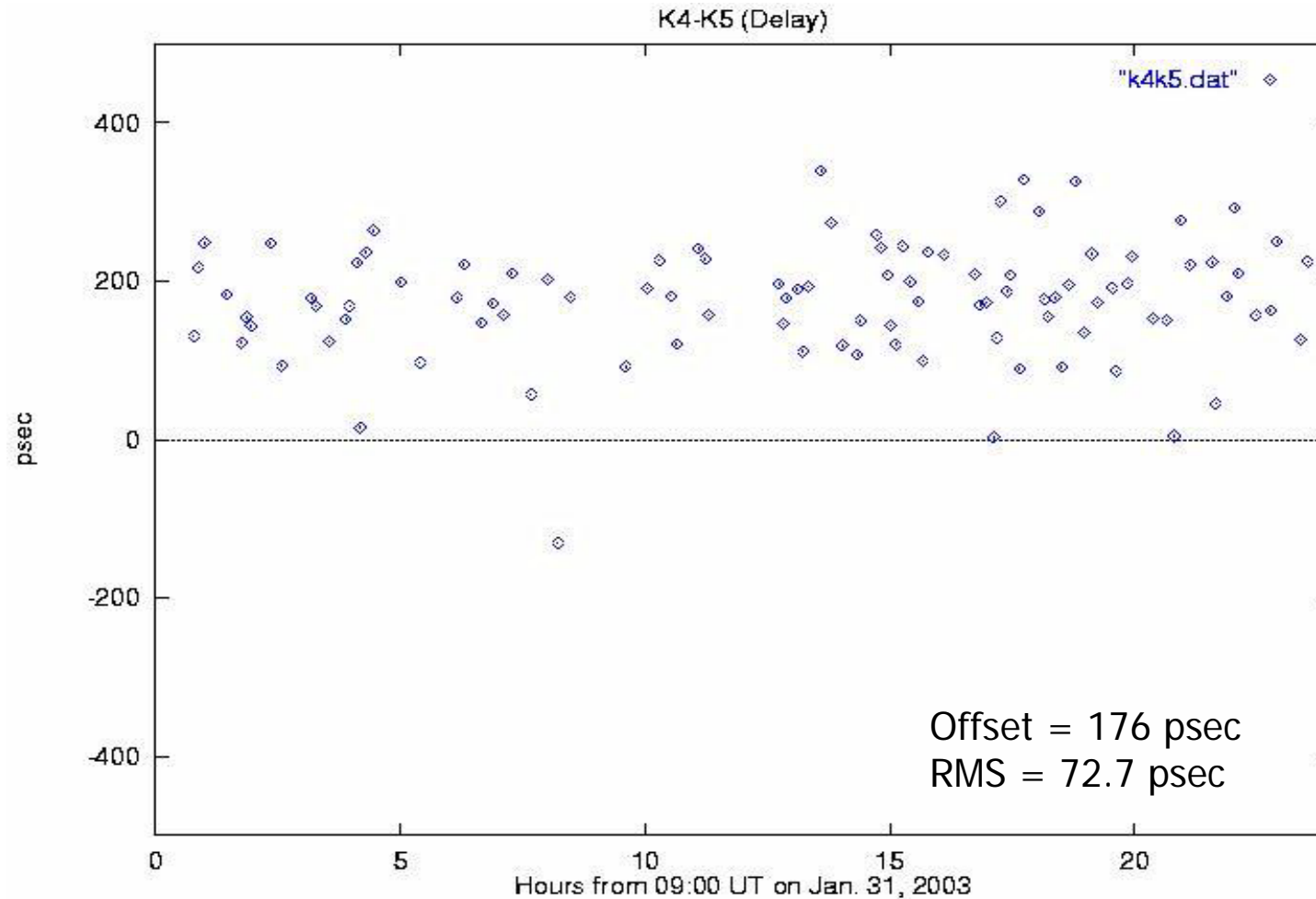
# K5 System Data Flow



# Domestic VLBI Experiments with K5 System

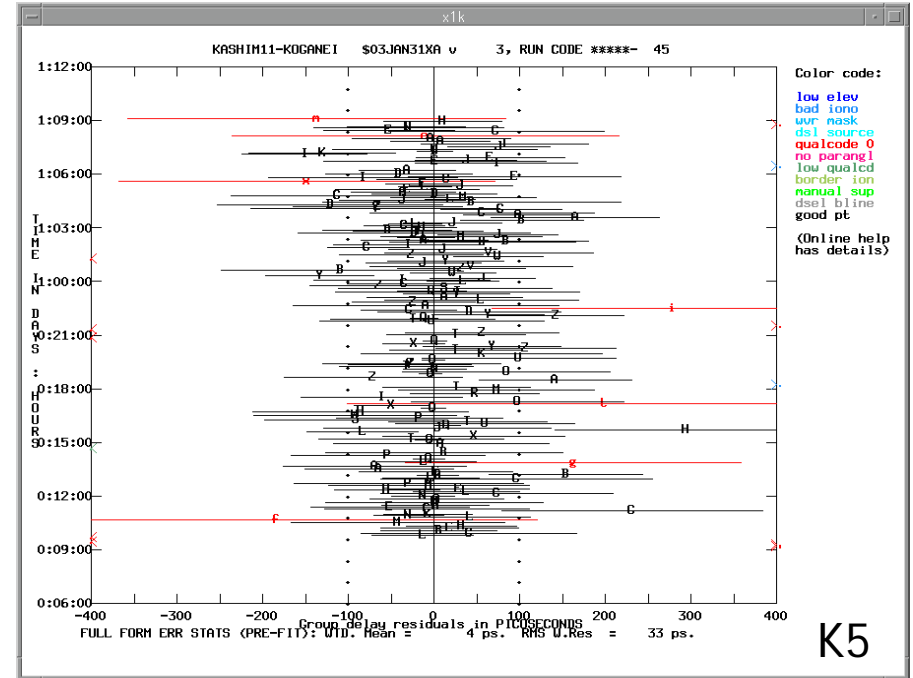
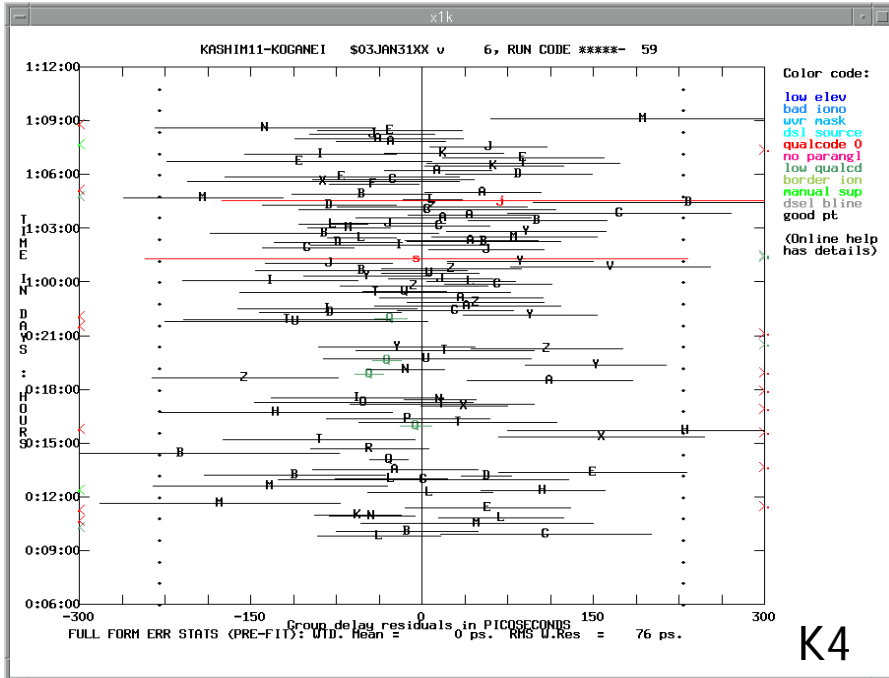
- Jan. 30-31, 2003 (U03031)
  - Single baseline experiment : Kashima (11m) and Koganei (11m)
  - 56Mbps (2MHz, 14ch.), 24 hours
  - Compared results with K4 and GBR systems
  
- July 16-17, 2003 (JADE0306)
  - 5 stations, 10 baselines : Kashima (11m), Tsukuba (32m), Tomakomai (11m), Gifu (11m), Yamaguchi (32m)
  - The first geodetic VLBI for Yamaguchi (32m) station : X-band only
  - 128Mbps (4MHz, 16ch.), 24 hours
  - up to ~1.4TBytes

# Comparison in Time Delay (U03031)



# Comparison of Results (U03031)

## Delay Residual



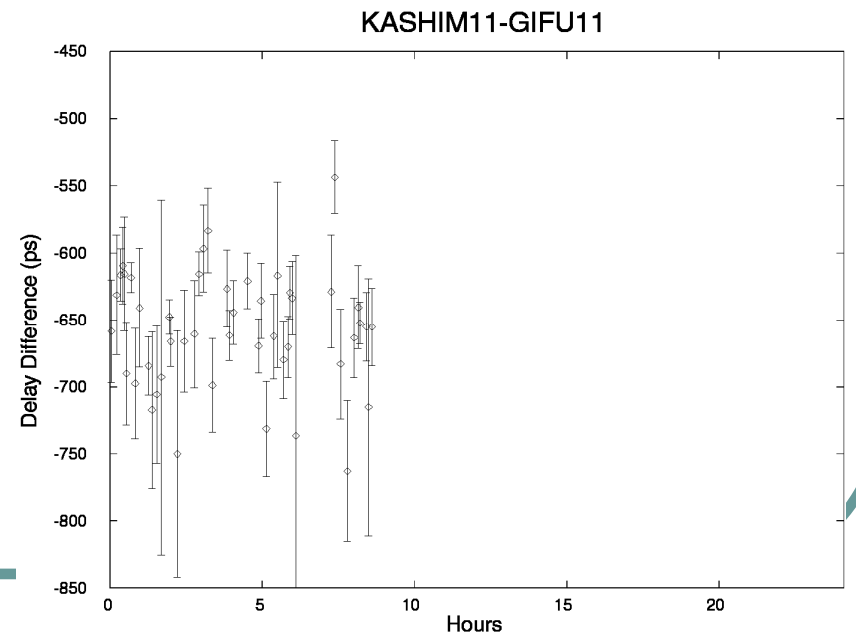
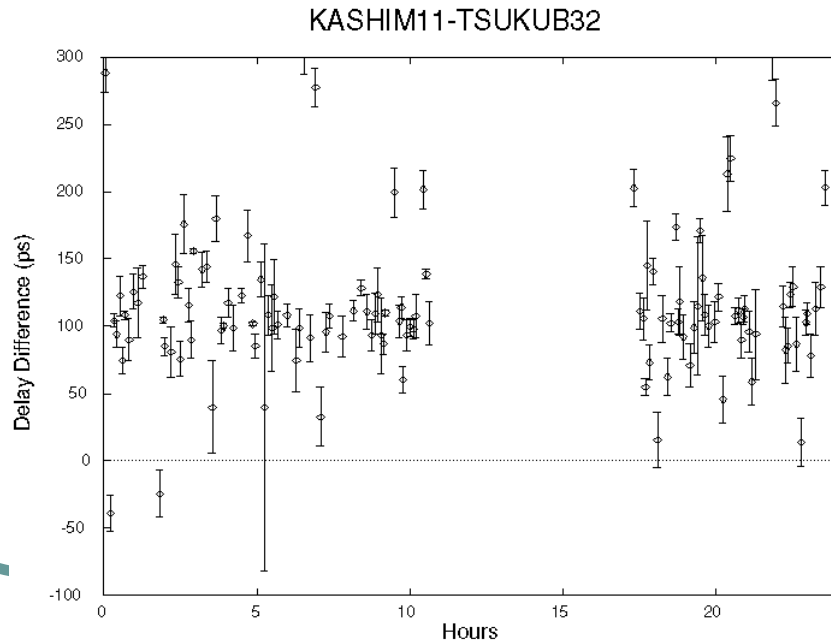
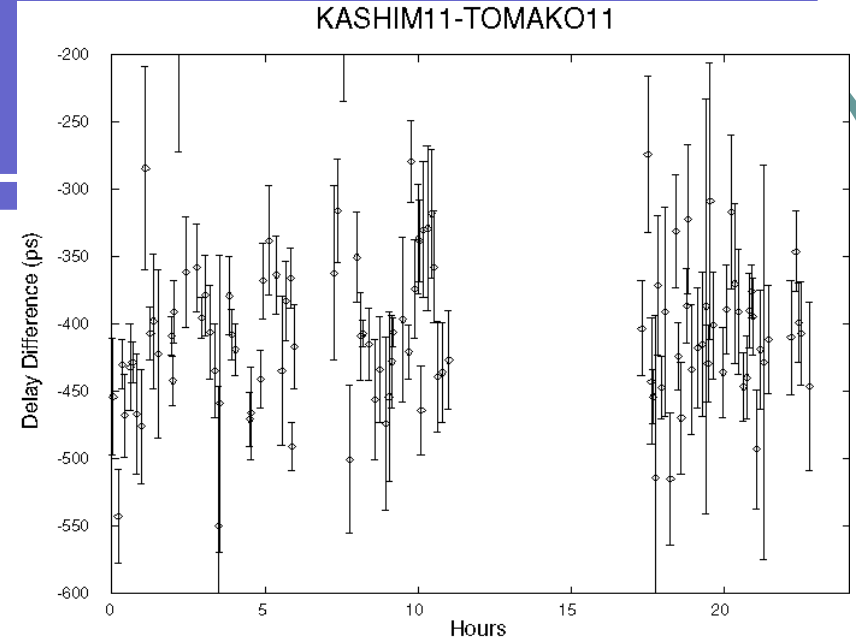
## Data Analysis Results

	Baseline Length	Delay RMS	Delay Rate RMS
K4	109099657.0 ± 6.7mm	76 psec	136 fsec/sec
K5	109099641.2 ± 3.2mm	33 psec	92 fsec/sec



# 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)	Rate (fsec/sec)
Tsukuba-Kashima	K4	176	$53811894.9 \pm 2.1$	53	158
	K5	130	$53811891.6 \pm 3.1$	81	121
Tsukuba-Gifu	K4	184	$311067474.0 \pm 2.9$	98	189
	K5	55	$311067483.3 \pm 4.0$	58	136
Tsukuba-Tomakomai	K4	124	$740526116.3 \pm 4.4$	103	165
	K5	169	$740526119.4 \pm 5.1$	103	146
Kashima-Gifu	K4	174	$358799168.6 \pm 2.8$	72	191
	K5	48	$358799174.7 \pm 4.5$	92	144
Kashima-Tomakomai	K4	171	$749810979.9 \pm 4.4$	115	125
	K5	108	$749810985.5 \pm 5.5$	106	143
Gifu -Tomakomai	K4	154	$902668931.2 \pm 4.8$	135	125
	K5	49	$902668930.6 \pm 6.1$	116	138

# Position of Yamaguchi (3 2 m) Station

X : -3502544258.3 ± 22.1 mm

Y : 3950966396.9 ± 25.8 mm

Z : 3566381164.9 ± 22.0 mm

(Results in ITRF97, X-band only)

# CPU array for Software Correlation

K5cor-status - Microsoft Internet Explorer

http://ryuu.crlgo.jp/k5cor/

## K 5 相関処理ステータス

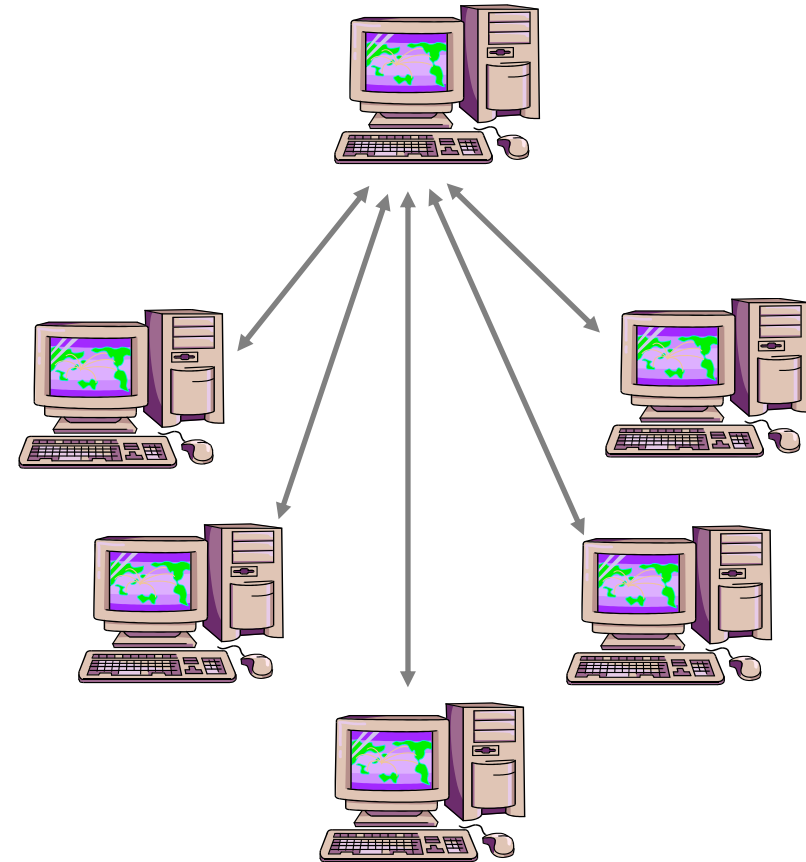
通信総合研究所 鹿島宇宙通信研究センター  
Communication Reserach Laboratory

実験コード名	データ総数	処理済	処理中	処理待ち
JD0306	28	3	3	22

Obs	Baseline	Apri file	Mark	host	Start	Stop
1	KASHIMA-GIFU11	ape197020000RYc.bt	●	byakko	031118180719	031118183127
2	KASHIMA-GIFU11	ape197020610RYc.bt	●	seiryuu	031118180733	031118211300
3	KASHIMA-GIFU11	ape197021950RYc.bt	●	byakko	031118183128	031118113510
4	KASHIMA-GIFU11	ape197022640RYc.bt	●	seiryuu	031118211309	*****
5	KASHIMA-GIFU11	ape19702305RYc.bt	●	byakko	031118213511	*****
6	KASHIMA-GIFU11	ape19702305RYc.bt	●	K5la	031118213623	*****
7	KASHIMA-GIFU11	ape19702305RYc.bt	●	*****	*****	*****
8	KASHIMA-GIFU11	ape19702305RYc.bt	●	*****	*****	*****

処理済 赤  
処理中 黄  
処理待ち 青

ページが表示されました インターネット

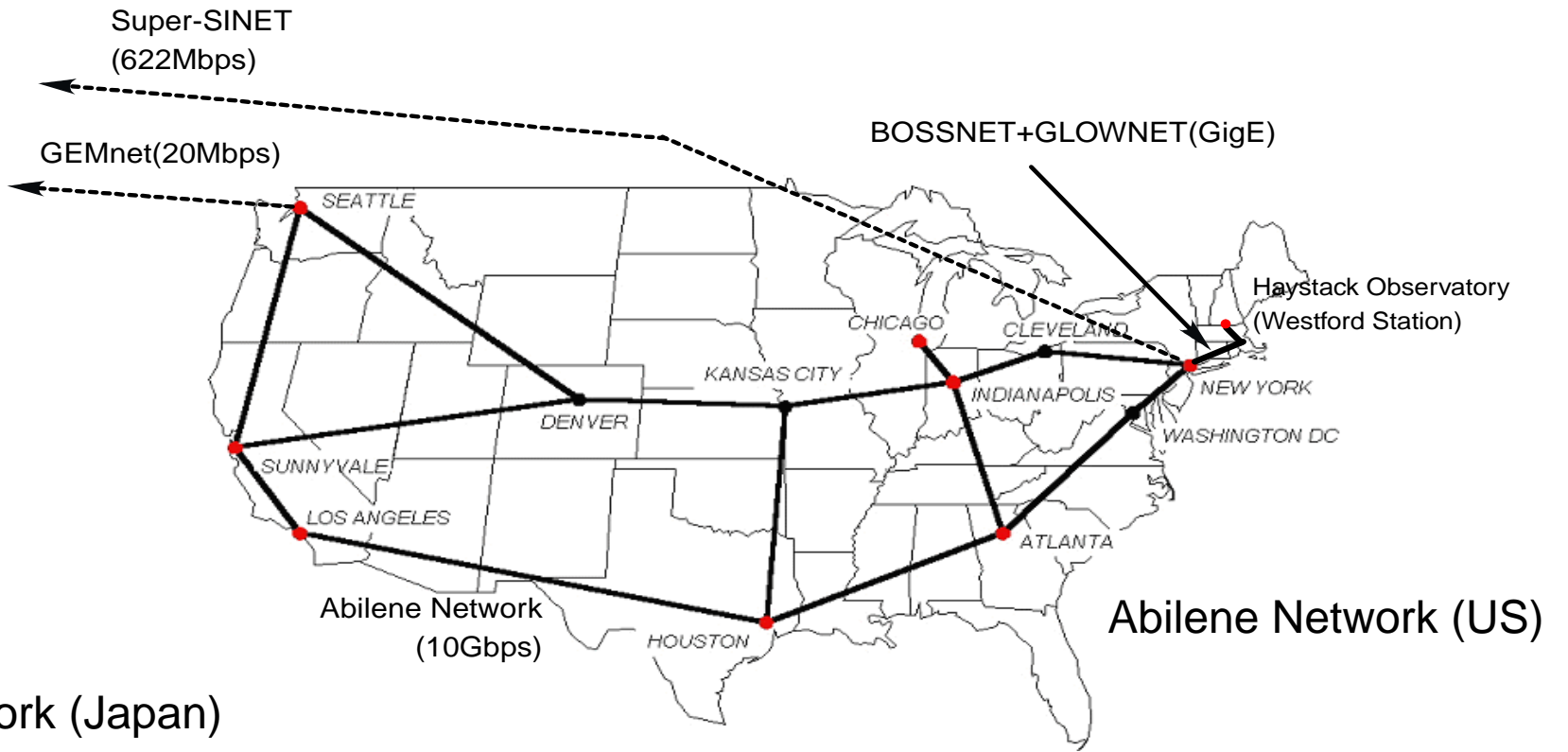


Correlation Master Table/Database

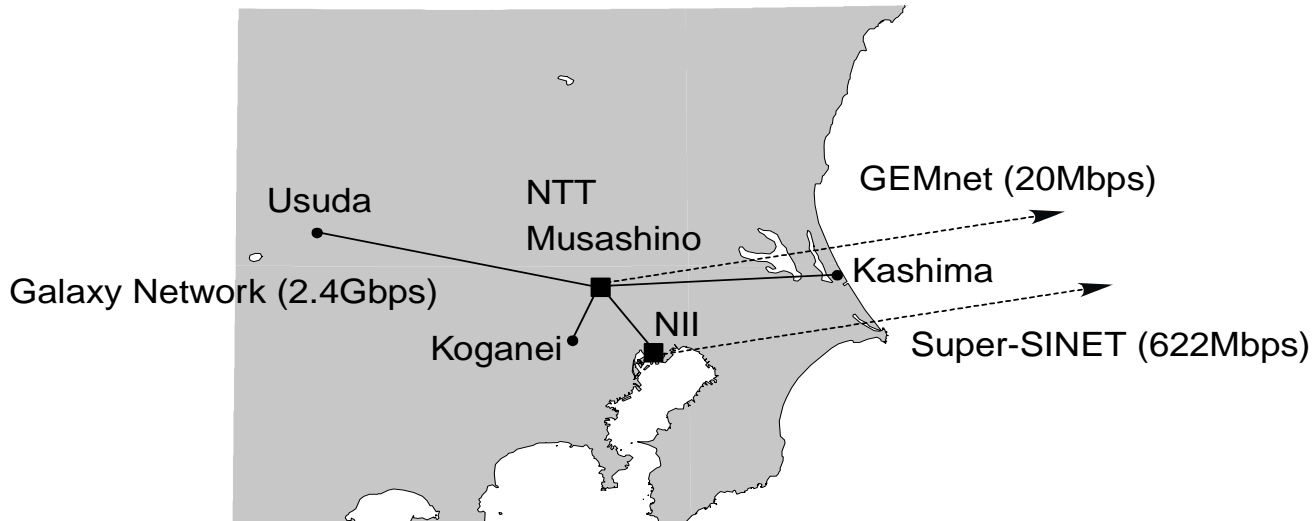
# Westford-Kashima Experiments for Rapid UT1-UTC

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





Galaxy Network (Japan)



Network

# e-VLBI4 data processing

File Transfer ~ 20 hours

Delay = 234 msec

Buffer Size = 64 kbytes

Speed

= 2.2 Mbps / Connection

= 11 Mbps (5 connections)

Correlation ~ 20 hours with 4 PCs

Bandwidth Synthesis ~ 10 min.

Data Analysis ~ 1 hour

UT1-TAI

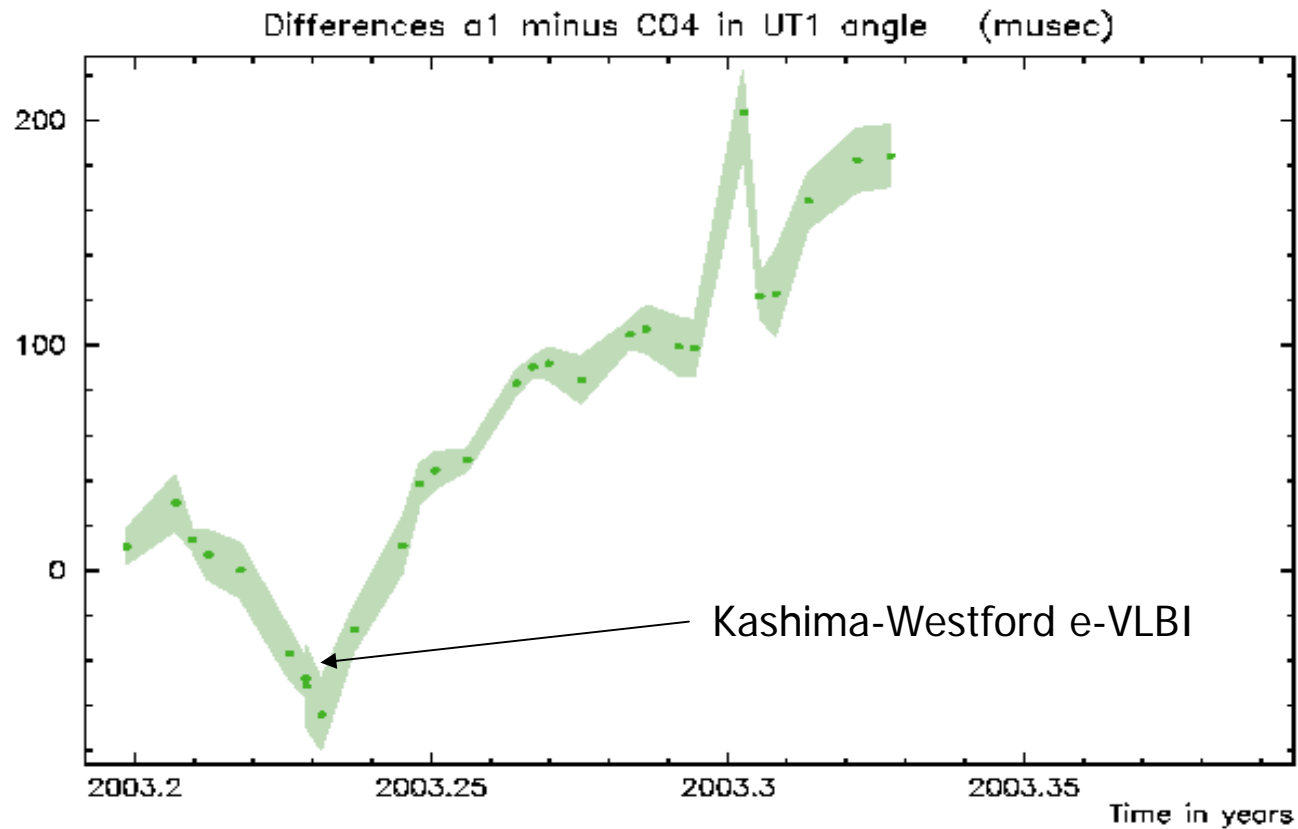
= -32338.7280 +/- 23.90

(micro sec)

	Source Name	Duration (sec)	File Size (Mark5)	File Size (K5)
1	4C39.25	90	1,620 Mbytes	180 Mbytes x 4
2	1736+455	200	3,600	400 x 4
3	1357+769	90	1,620	180 x 4
4	0059+581	250	4,500	500 x 4
5	2234+282	310	5,580	620 x 4
6	1300+580	140	2,520	280 x 4
7	0955+476	90	1,620	180 x 4
8	2113+293	300	5,400	600 x 4
9	1739+522	500	9,000	1,000 x 4
10	1357+769	90	1,620	180 x 4
11	0059+581	270	4,860	540 x 4
12	2234+282	510	9,180	1,020 x 4
13	1044+719	784	1,4112	1,568 x 4
14	1128+385	180	3,240	360 x 4
15	1300+580	130	2,340	260 x 4
16	0955+476	90	1,620	180 x 4
17	2113+293	390	7,020	780 x 4
18	1739+522	530	9,540	1,060 x 4
19	1357+769	90	1,620	180 x 4
Total		5,034	90,612 Mbytes	40,272 Mbytes

# Consistency of UT1-UTC Results

UT1-UTC estimation compared with NEOS Intensive VLBI sessions



\* Data analysis done by 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

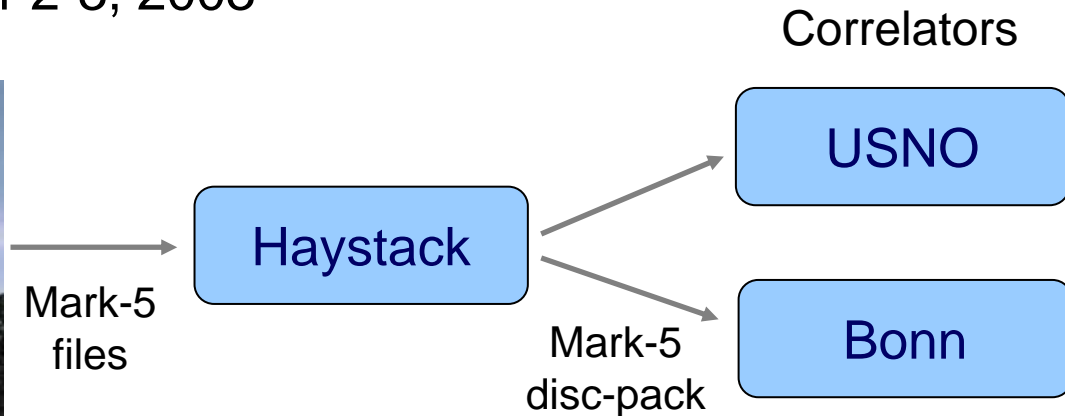
\* Correlation at Haystack Observatory (Mark4 Correlator) finished at 14:19 JST

# 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 4-3, 2003
  - IVS-T2023 November 18-19, 2003
  - IVS-T2024 December 2-3, 2003



K5 files    Mark-5 files



# Future Plan

- Improve data transfer speed.
  - Upgrade current bottle neck (Kashima-Koganei) from 100Mbps to 10Gbps.
  - Examine high performance protocols (ex. HS-TCP).
- Develop Software Correlator with CPU Array System.
- Software developments for real-time data transfer and real-time correlation.
- Regular use of K5 system in IVS sessions (Kashima and Tsukuba).

# Summary

- K5 VLBI system showed comparable or better results compared with tape based K4 system in geodetic VLBI.
- Position of the Yamaguchi 32m station was determined by geodetic VLBI for the first time.
- Rapid turn-around estimation of UT1-UTC less than one day was successfully demonstrated.
- Full compatibilities between K5 and Mark5 systems have been achieved.
- Routine K5 use in IVS sessions started.