

E-VLBI Development in NICT



National Institute of Information and
Communications Technology (NICT)
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E-VLBI Activity in NICT



- E-VLBI Project
 - JGN2 Sympo07 Demo: real-time e-VLBI with Haystack
 - Realtime e-VLBI (Kashima, Tsukuba, Gifu, Yamaguchi, Usuda)
 - Ultra-rapid UT1 measurement (Onsala, Tsukuba, Metsahovi)
 - 6Gbps S/X observation on Kashima-Koganei (100km) baseline.
 - E-VLBI demonstration (ATNF-Kashima-Seeshan) for today
- Hardware development
 - Two types of K5 system (K5/VSSP, K5/VSI)
 - ADS-3000plus (DBBC) development
- Benefit of Standard

JGN2Sympo2007 with Haystack

Experimental Network (JGN2Symposium07)



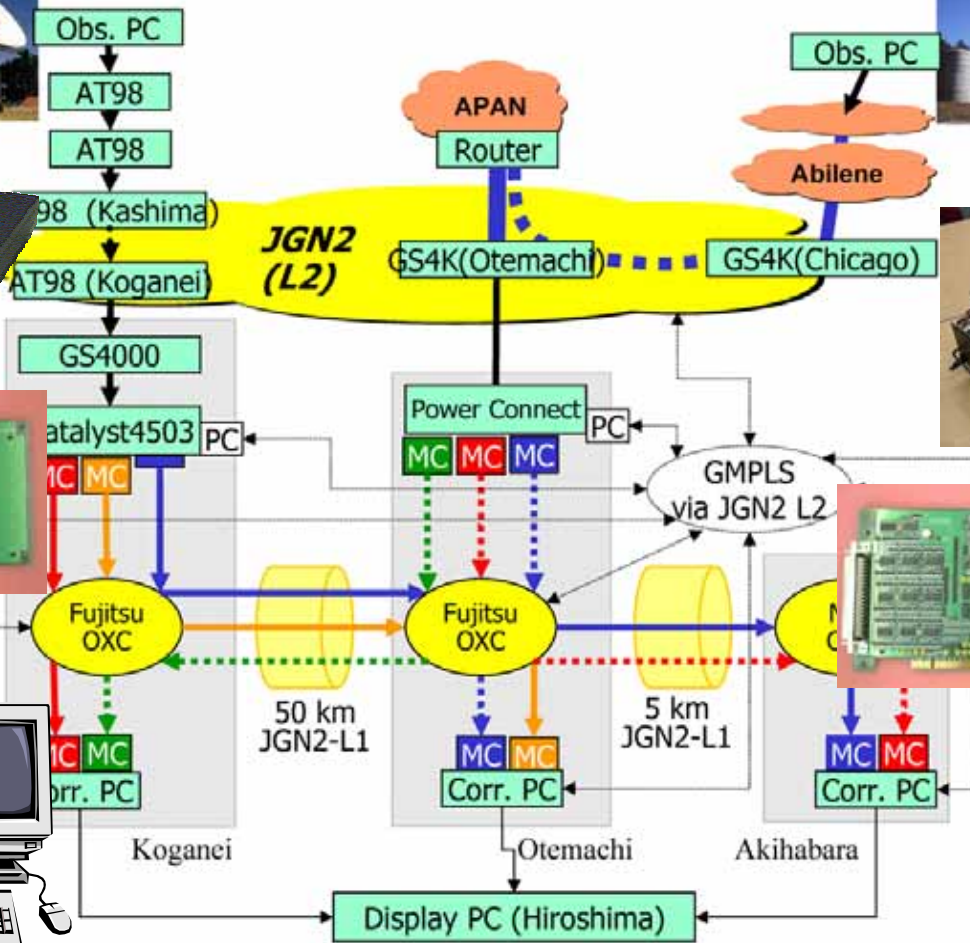
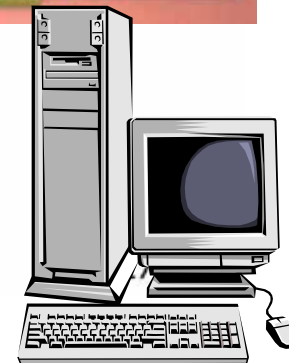
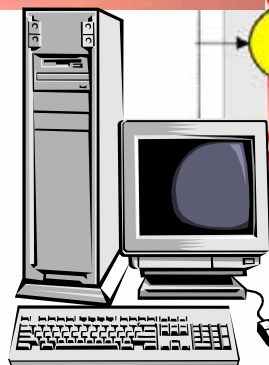
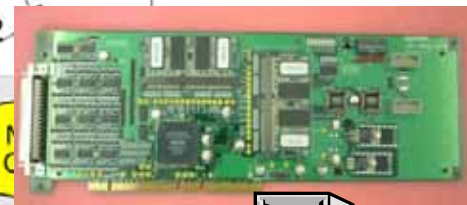
Kashima (34m)



Haystack (18m)



Mark5B



Ultra-rapid UT1 Experiment

Within 5 min after the session,
UT1 has derived!

**Onsala20m
(Sweden)**



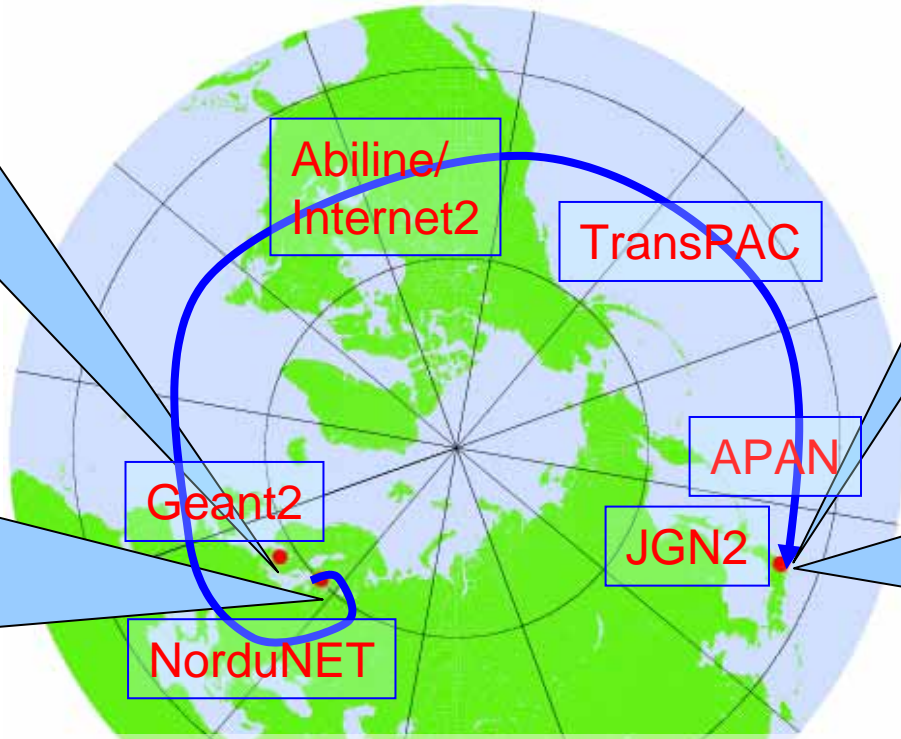
**Tsukuba32m
(GSI)**



**Metsahovi14m
(Finland)**

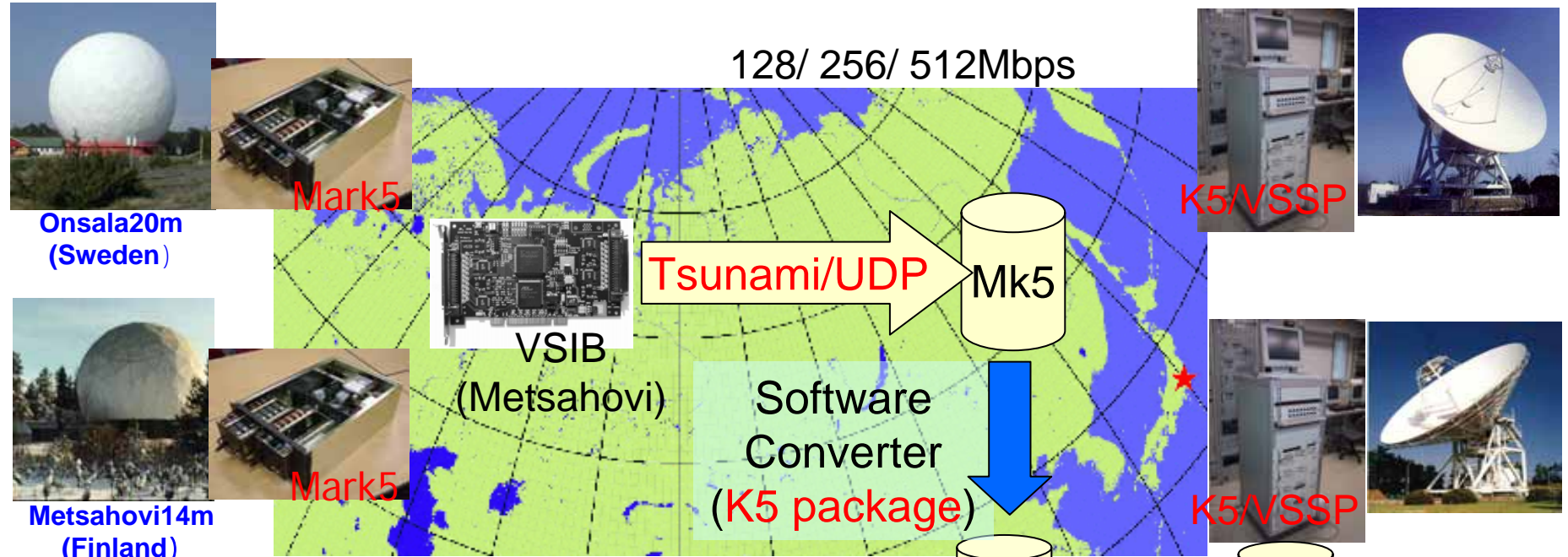


**Kashima34m
(NICT)**

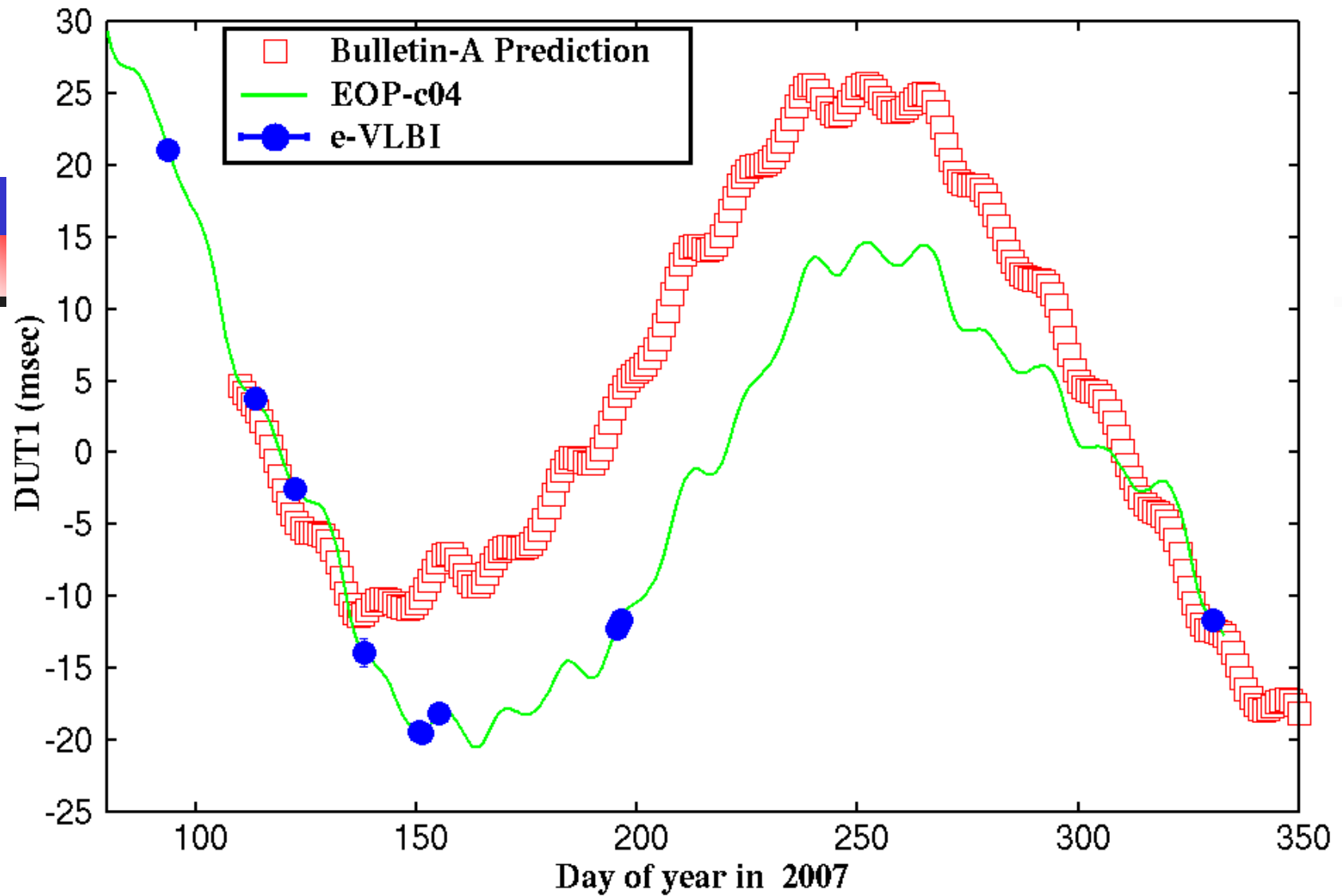


Collaborators: R.Haas(Onsala),
J.Ritakari, J.Wagner(Metsahovi),
S.Kurihara, K.Kokado(GSI)

DAS, Transport, Processing



- Work shared collaboration
 - Observation and data transport at European side.
 - Observation and Correlation processing at Japense side.

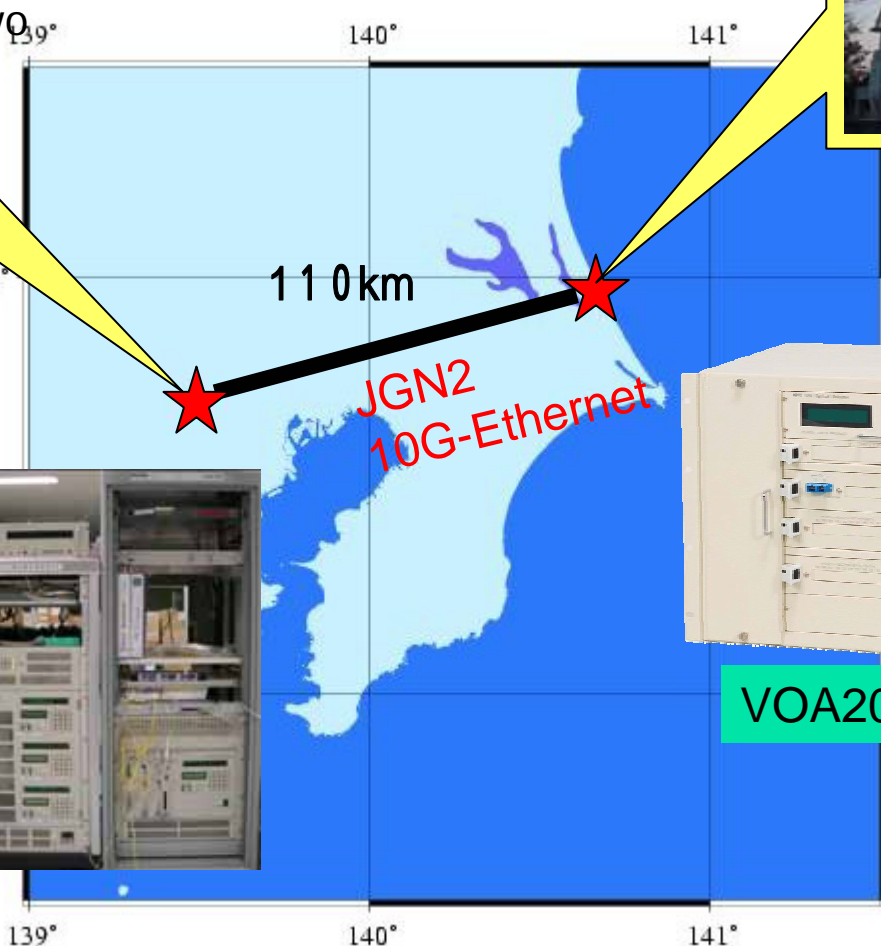
Prediction_(BulletinA), EOPc04,
and e-VLBI

Success of 8Gbps real-time VLBI

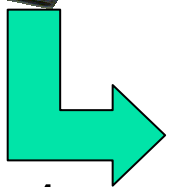


Koganei 11m
Headquater NICT,
Tokyo

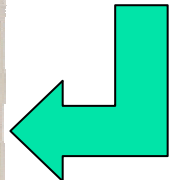
Kashima 34m
NICT, Kashima



VSI-H x4



VSI-H x4

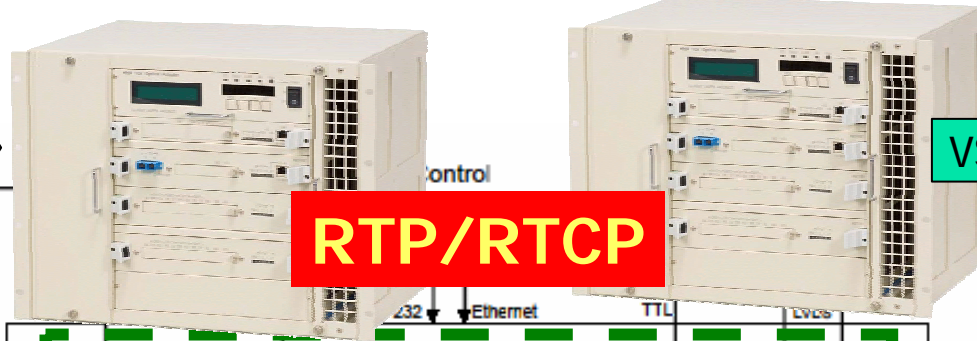


VOA200

VSI-H, VSI-S, VSI-E



VSI-H

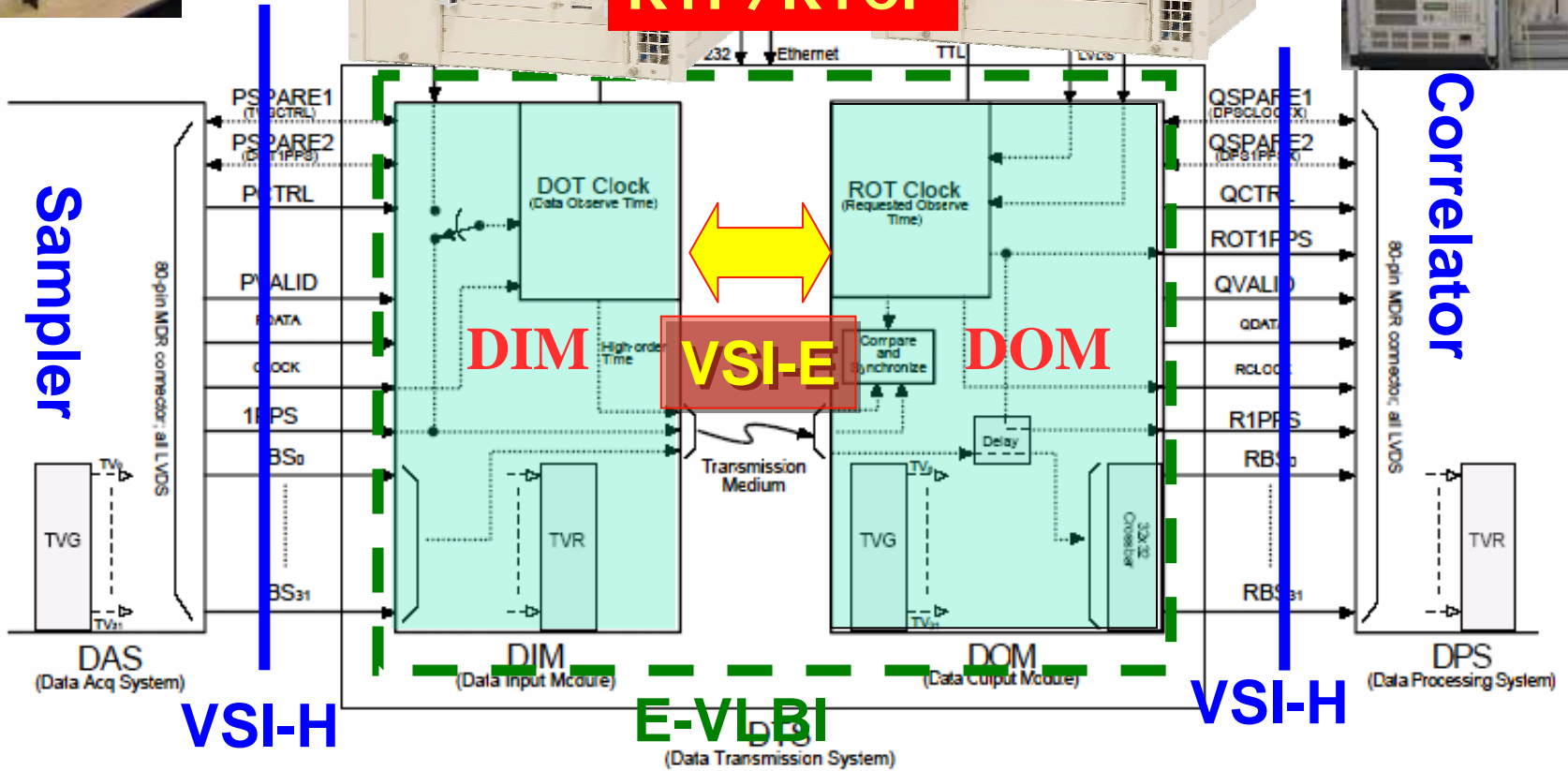


VSI-H

1PPS




Correlator



6Gbps routine VLBI for V773tau

- Monitoring of Flux
- S/X dual Freq.
- It is expected flare up with binary orbiting period.
- Variation of Spectrum index associated with orbiting period.

Name: V773 Tau A
 d=148pc
 Binary stars 
 M: 1.5M_☉ 1.3M_☉
 a=0.4AU
 P=51 days



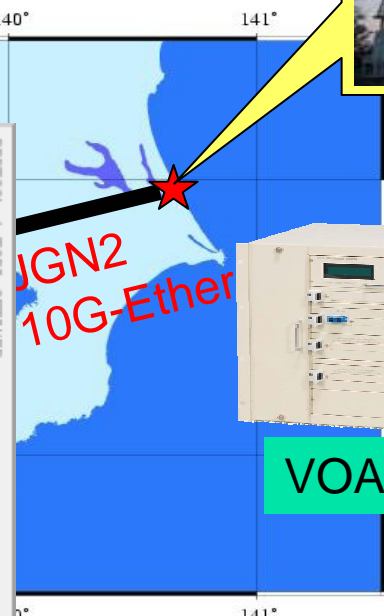
Koganei 11m



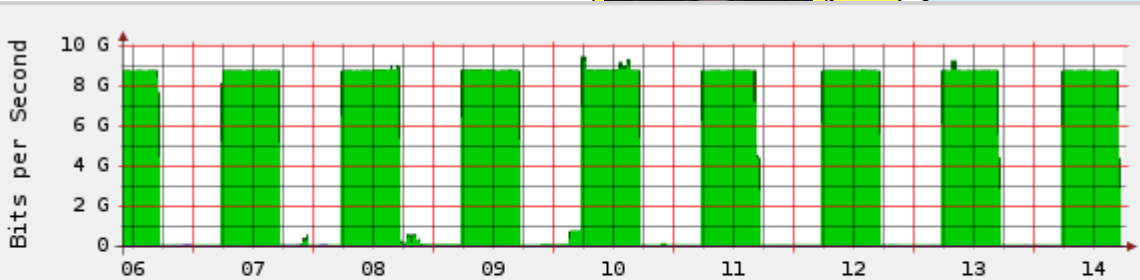
Kashima 34m

139° 140° 141°

36°

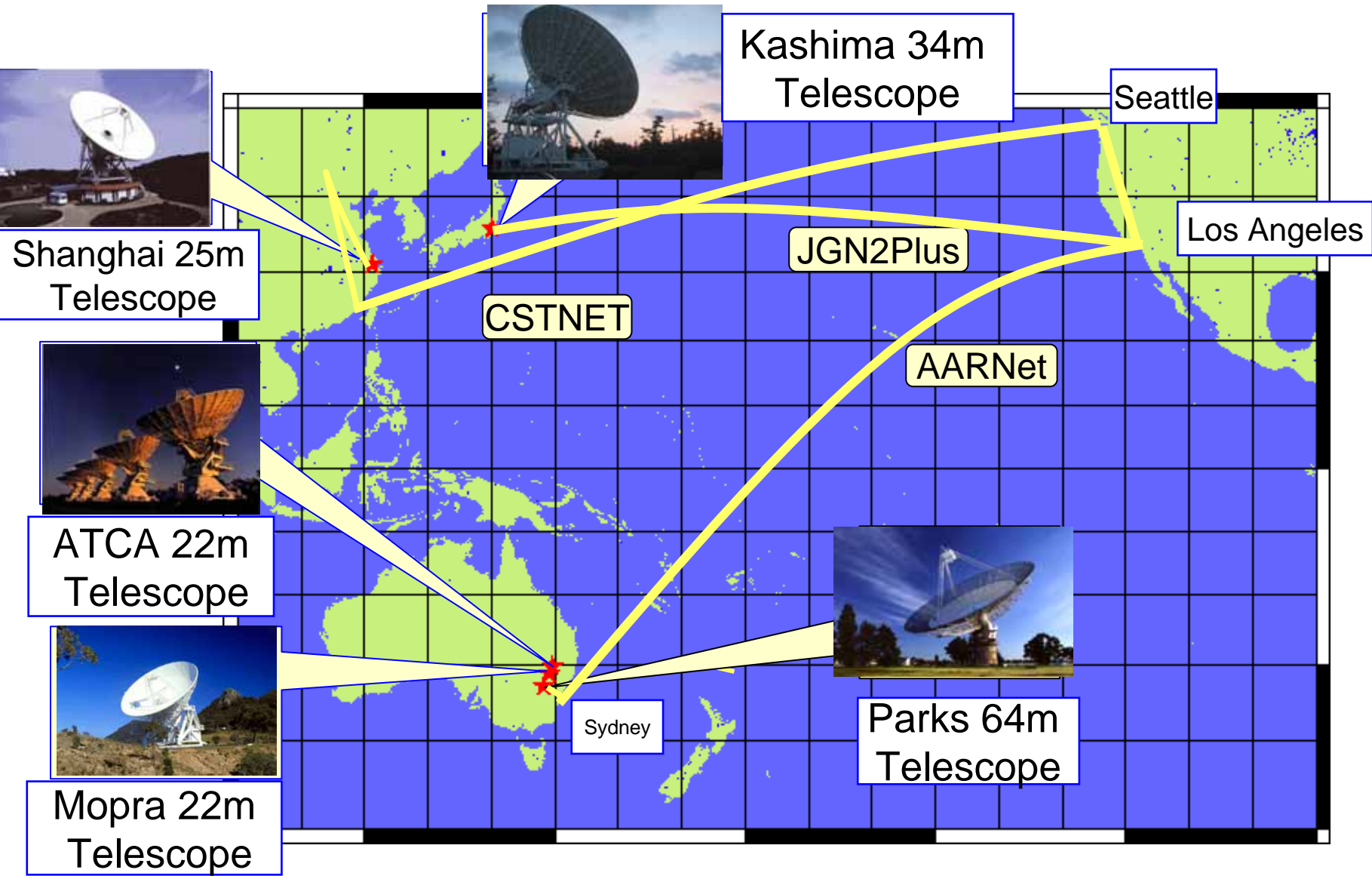


VOA200



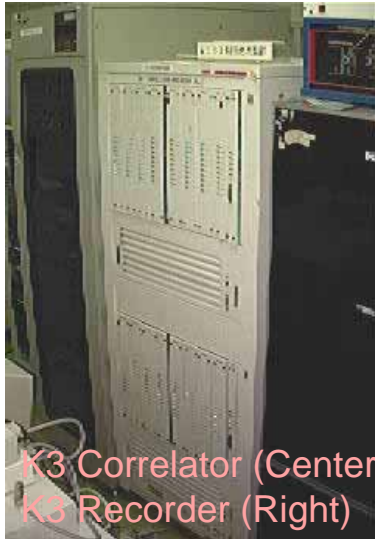
■ Maximal 5 Minute Incoming Traffic		■ Maximal 5 Minute Outgoing Traffic	
■ Incoming Traffic in Bits per Second		■ Outgoing Traffic in Bits per Second	
Maximal In: 9.416 G (94.16%)	Maximal Out: 39.148 M (0.39%)		
Average In: 4.372 G (43.72%)	Average Out: 1.649 M (0.02%)		
Current In: 2.836 G (28.36%)	Current Out: 500.517 k (0.01%)		

The first real-time e-APT



A brief History of VLBI development in NICT

From K3-system to K5-system



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(256M)



K5 Data Acquisition Terminal

K5 System

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

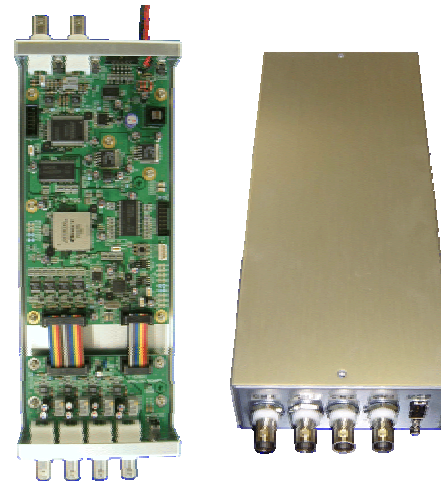
K5-System (1) : K5/VSSP

	K5/VSSP	K5/VSSP32
Sampling Speed	40, 100, 200, 500kHz, 1, 2, 4, 8, 16 MHz	40, 100, 200, 500kHz, 1, 2, 4, 8, 16, 32, 64MHz,
Sampling Bits	1, 2, 4, 8	1, 2, 4, 8
No. Channels	1 or 4 (16 with 4 PCs)	1 or 4 (16 with 4 PCs)
Max. Data Rate	128 Mbps (512 Mbps with 4 PCs)	256 Mbps (1024Mbps with 4PCs)
Interface	PCI (Full Height)	USB2.0

VSSP = Versatile Scientific Sampling Processor



K5/VSSP



K5/VSSP32

K5 System (2) : K5/VSI

	ADS1000	ADS2000	ADS3000	ADS3000Plus
Sampling Speed	1024Msps	64Msps	2048Msps	~ 4 Gbps
Sampling Bits	1 bit or 2 bits	1 bit or 2 bits	8 bits	2/4/8 bit
No. of Input	1	16	1	2
No. Channels	1	16	Programmable	Programmable
Max. Data Rate	2048Mbps	2048Mbps	4096Mbps	8192Mbps
Interface	VSI-H (2 ports)	VSI-H (2 ports)	VSI-H (2 ports)	VSI-H (4 ports)



ADS1000



ADS2000



ADS3000



ADS3000Plus

K5 System

ADS1000

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



ADS3000

(2048Msample/sec 1ch 8bits + FPGA)



VSI-H

VSI-H

PC-VSI Board
(~2048Mbps)



VSI-H

ADS2000

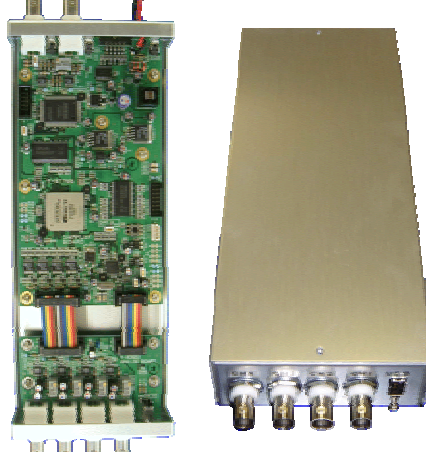
(64Msample/ch·sec, 16ch, 1 or 2bits)



VSI-H

K5/VSSP32 Unit

(~32Msample/ch·sec, ~4ch, ~8bits)



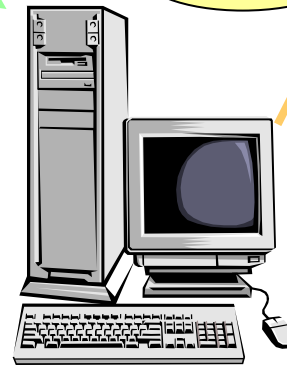
Mark5B sampler

(64Msample/ch·sec, 16ch, 1 or 2bits)



Correlator
other DAS

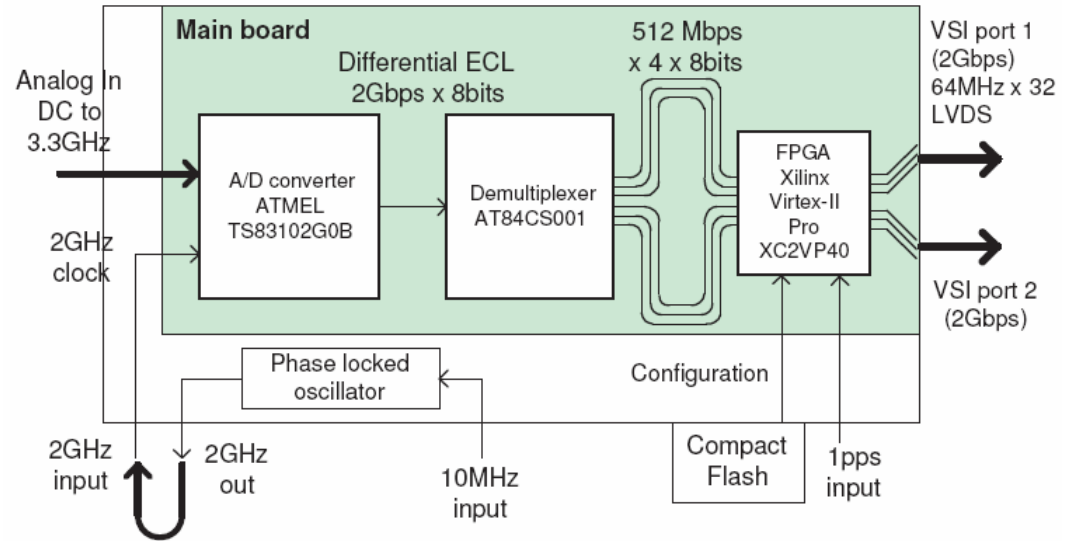
Internet



PC : Data Acquisition
Correlation

K5/VSI

DBBC ADサンプラー : ADS3000

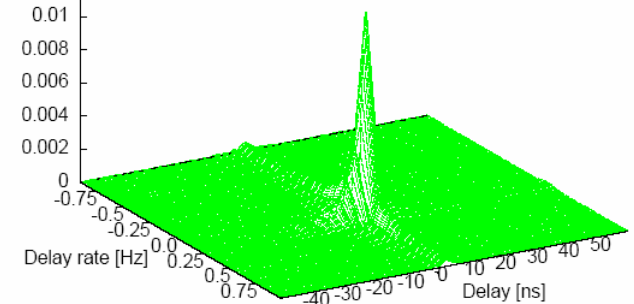


4Gbps (2GHz, 2sps) 初FRING
(2006年1月)



Correlation amplitude

3C273B Integration time 4s, 2Gsp/2bit
Kashima 34m - Kashima 11m
SNR:1083.7 Calibrated with pcal at Kashima 34m

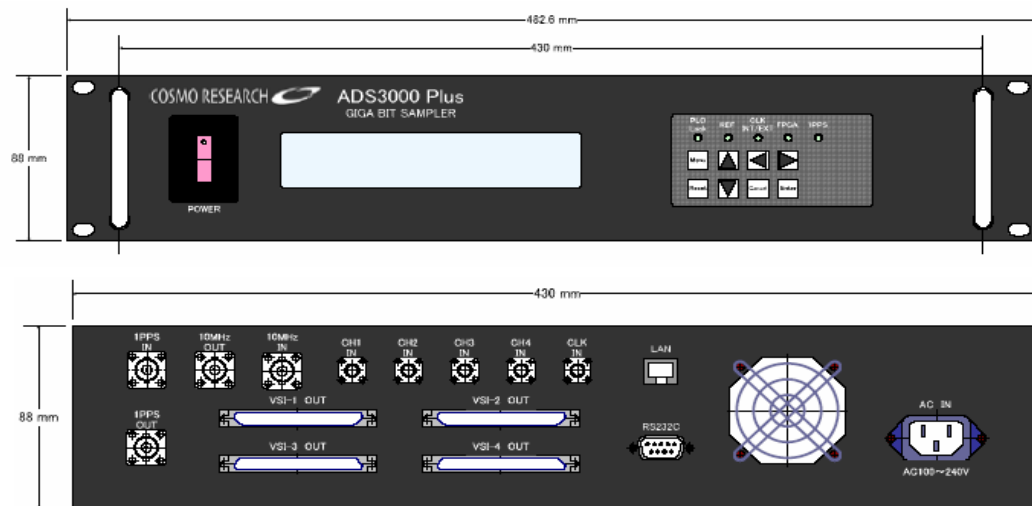


ADS3000 plus under development

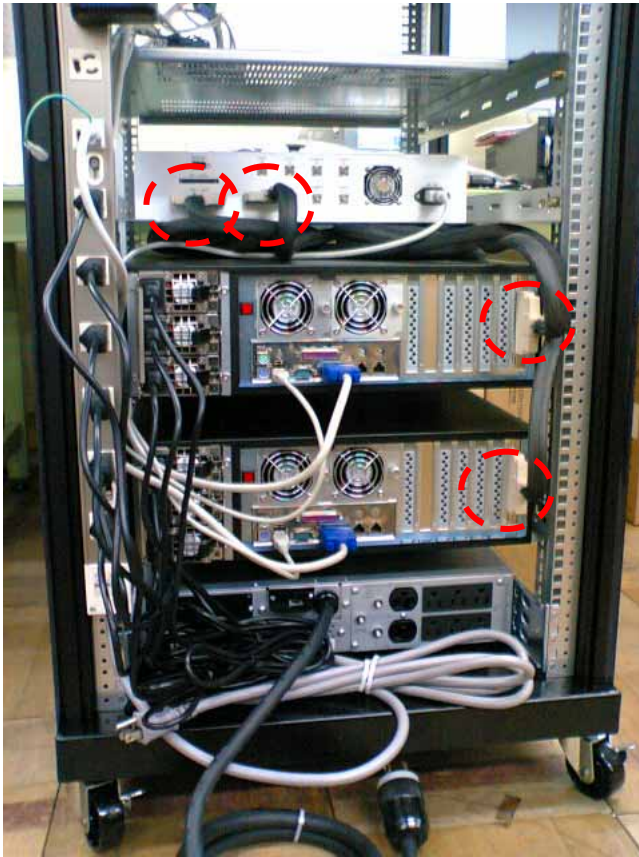
- Dual Channel sampler
 - For S/X observation
- DBBC Function
- VSI-H Compliant

Sampling Mode

Mode	Total Rate/ch	Sample (MSPS)	Quantization	Clock (MHz)
A	1Gbps	128	8bit	32
B	2Gbps	1024	2bit	32
C	2Gbps	512	4bit	32
D	4Gbps	2048	2bit	64
E	4Gbps	1024	4bit	64
F	4Gbps	512	8bit	64



ADS3000 + PC-VSI Recorder



4096Mbps recording for 17 hours

Summary

- VSI-H was quite successful, and useful.
 - Mark5B-K5@JGN2Symp2007
 - Mark5-VSIB@Ultra-rapid UT1
 - NICT-NAOJ Devices(ADS-X000,VOA100/200,Software Corr(VERA)
- Sharing **standard interface** reduces the cost and brings freedom and benefit for VLBIers.
- E-VLBI era is good chance to make all VLBI system fully compatible/connectable.
 - Handling data via software/network is great advantage.
- We may discuss about standard or framework for taking compatibility.
 - Defining Standard Data Transport protocol
 - Sharing interface software developed by each institutes.

A large satellite dish antenna is the central focus, mounted on a complex metal support structure. The dish is a grid of metal panels, and the structure has multiple levels with railings. The background is a sky with soft, colorful clouds in shades of blue, purple, and orange, suggesting a sunset or sunrise. Silhouettes of trees and utility poles are visible in the distance. The overall scene is dimly lit, with the primary light source being the low sun.

Thank you for attention!