E-VLBI Activities in Japan

M. Sekido (NICT), N.Kawaguchi(NAOJ)

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NAOJ: T.Oyama, T. Hara, Y.Kouno

GSI : S. Kurihara, K.Kokado, D.Tanimoto, K. Nozawa

JAXA: H.Takeuchi

NTT : Uose. H.

Universities: K.Fujisawa(Yamaguchi Univ.), H.Takaba(Gifu Univ)

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- International eVLBI activities
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- Domestic eVLBI activities
  - 8Gbps S/X observation on Kashima-Koganei(100km) baseline.
  - Connecting Japanese VLBI stations by Netowrk
- Technology development
  - K5 system and ADS-3000plus(DBBC) development
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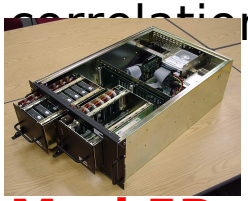
  - East Asia VLBI Network (EAVN)

International eVLBI Activities(1)

- Ultra-rapid UT1 measurement by eVLBI
  - Status:
    - **Stations:** Kashima,Onasala,Tsukuba,Metsähovi
    - **Format/Protocol:** Mk5A with Tsunami/UDP data transfer with Metsähovi card ⇔K5/VSSP32 data format
    - **Correlation:** K5 Software Correlator
    - **Results:** UT1-UTC result within 30min
      (4min. as the fastest record in Feb. 2008).
  - Plan for the next step:
    1. 24h eVLBI for geodetic VLBI (Ts,On,Ks) -> VLBI2010
    2. Regular UT1 measurement by eVLBI (Wz,Ts)
       - Wettzell – Tsukuba INT2 session
       - Mark5B + K5/VSI => (UDP transfer)=>Software correlation


Mark5B

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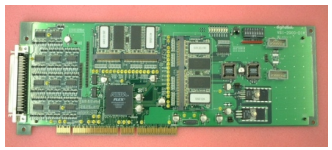
K5/VSI

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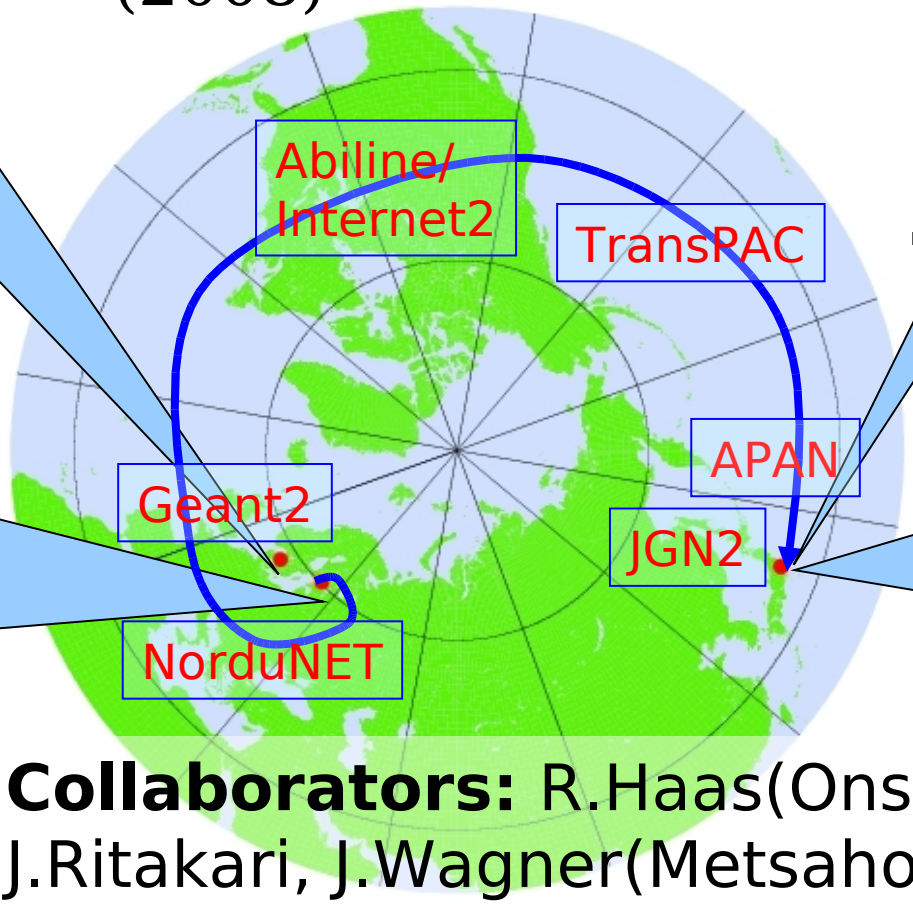
K5/VSSP

Stations and Network

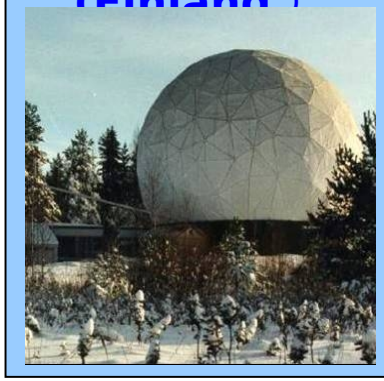
UT1 has been derived 5 min after the session! (2008)

Onsala20m (Sweden)

Tsukuba32 m (GSI)



Metsahovi14 m (Finland)



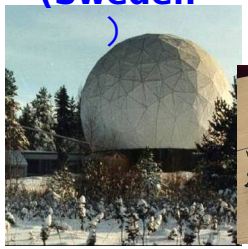
Kashima34 m (NICT)

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

DAS, Transport, Processing

Onsala20 m (Sweden)

Mark5A



Metsahovi14m (Finland)

Mark5A

VSIB (Metsähovi)

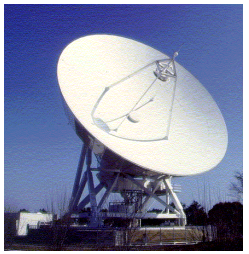
128/ 256/ 512Mbps

Tsunami/UDP

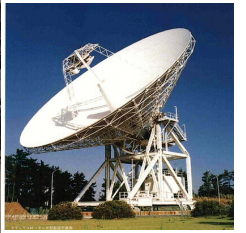
Mk5

Software Converter (K5 package)

K5/VSSP

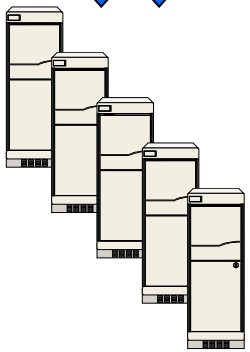


K5/VSSP



K5

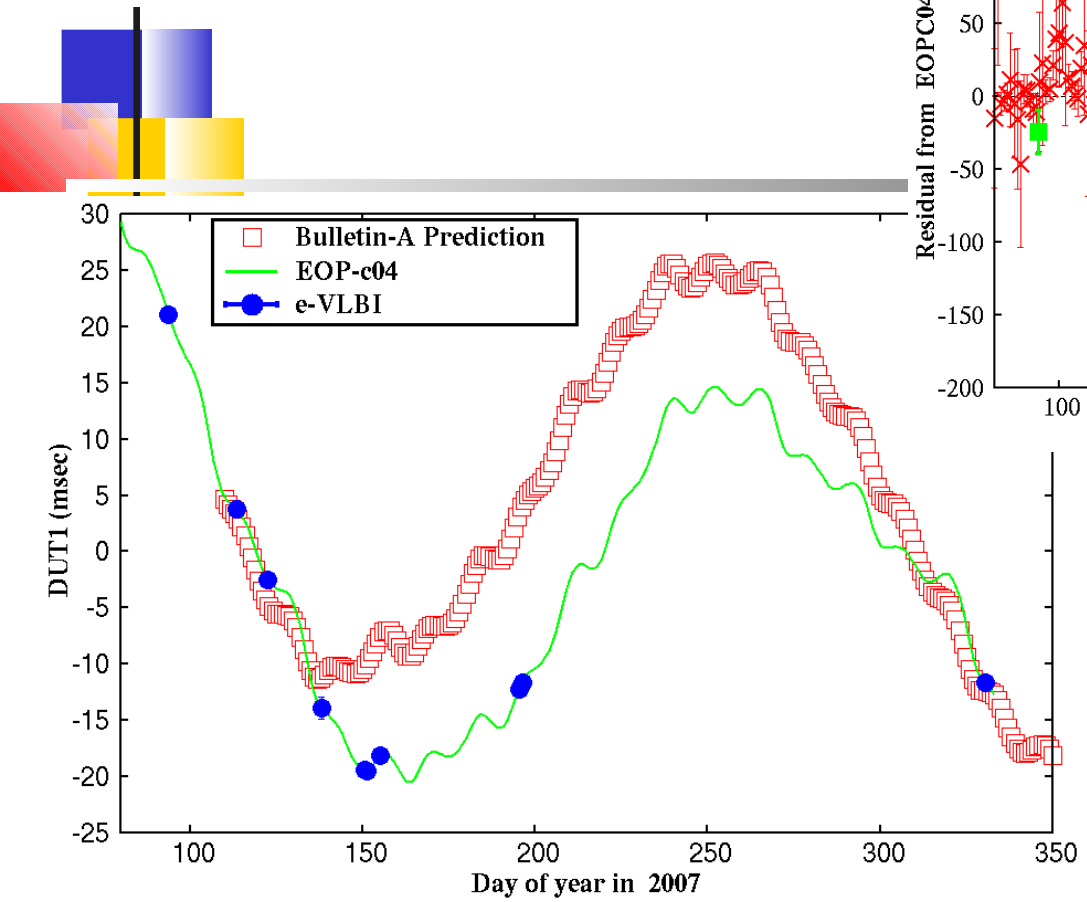
K5

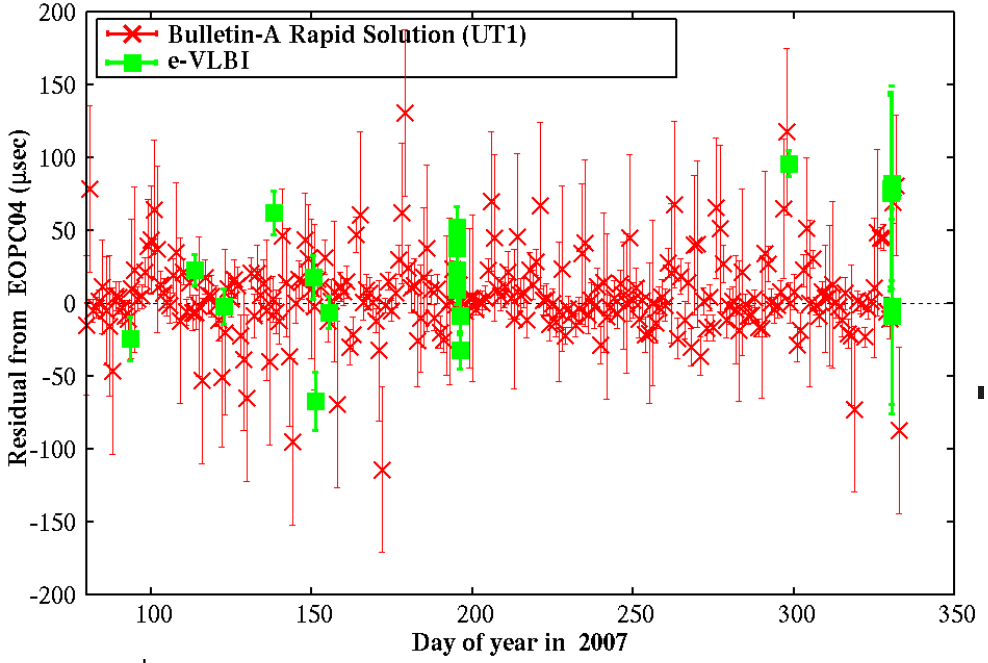


Correlation processing by K5 software correlator on cluster of PCs

- Data rate: 128,256,512 Mbps
- Network: Shared net
  - (GEANT2, Internet2, JGN2plus /SINET3)
- Automation of processing by Perl script
- Automatic MK3DB and analysis by NetCDF+Occam

Comparison between Prediction(BulletinA),EOPc04, and e-VLBI





International eVLBI Activities(2)

- Participations to Global eVLBI observations
  - First Realtime APT(ATNF,SHAO,NICT) (Jun. 2008)
  - IYA2009 demonstration event (Jan. 2009)
  - RG001 eVLBI session (May,June,July,2009)

Project2:Global eVLBI

The first real-time e-APT

Shanghai 25m Telescope

Kashima 34m Telescope

Seattle

Los Angeles

JGN2Plus

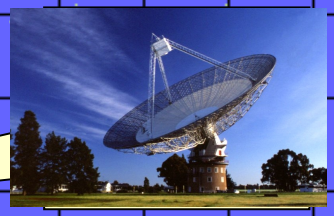
CSTNET

AARNet

ATCA 22m Telescope

Mopra 22m Telescope

Sydney



Parks 64m Telescope

Participation to the Global eVLBI

- Mark5B Emulator server by K5/VSI

ADS2000

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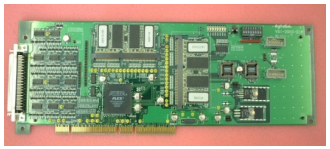

K5/VSI (PC-VSI)

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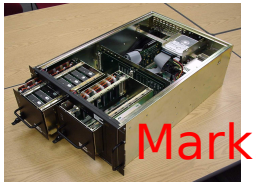
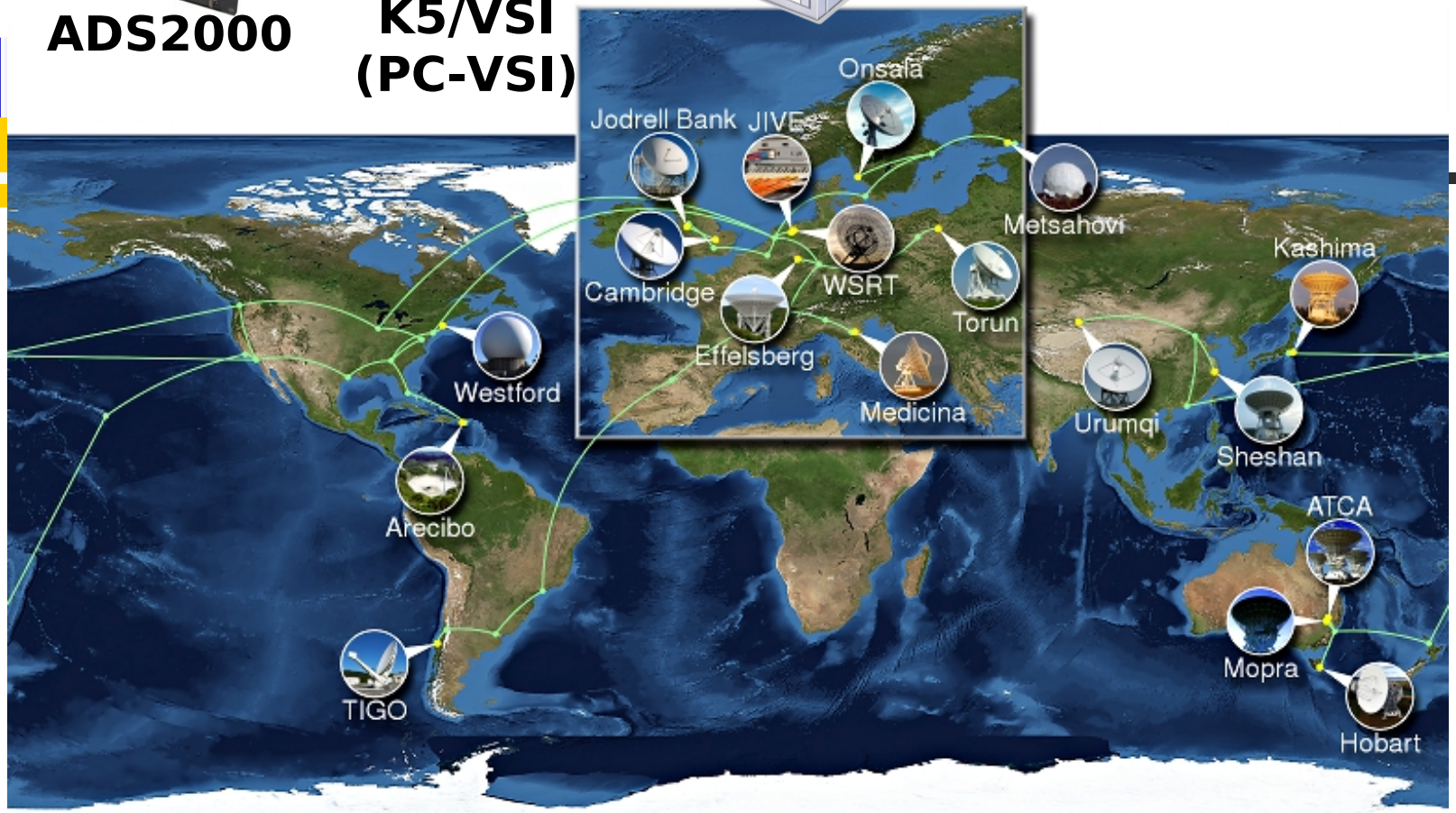


Mark5B

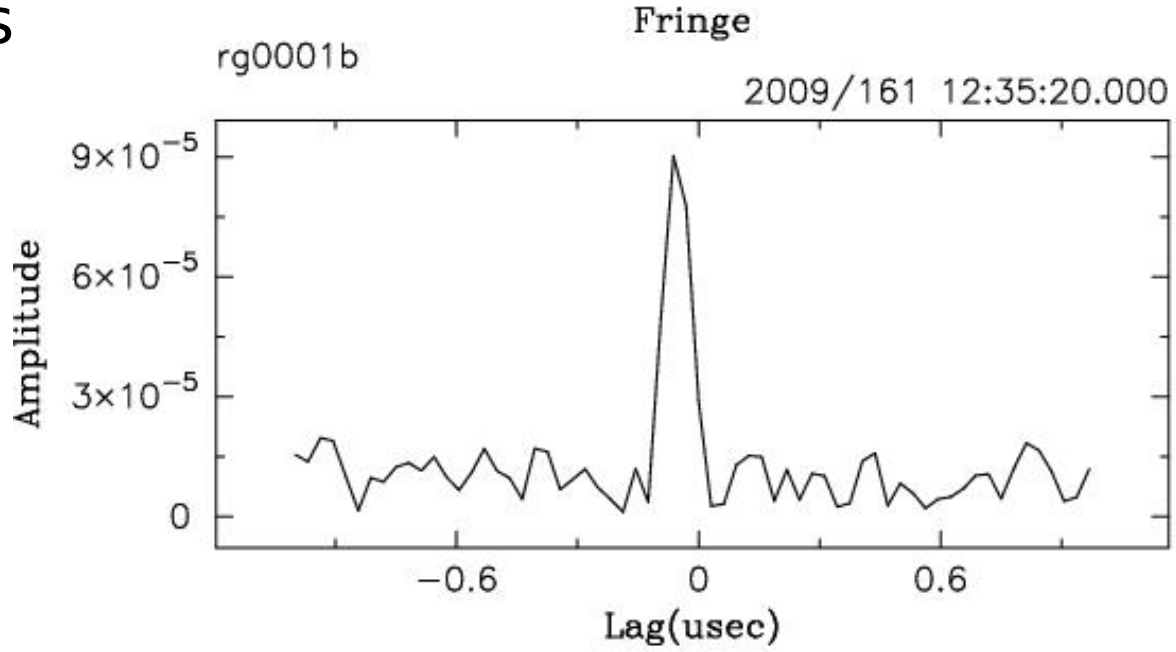


Networks and telescopes used for IYA2009 24hr e-VLBI. Image by Paul Boven <boven@jive.nl>. Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

RG001 session (May,June,July)

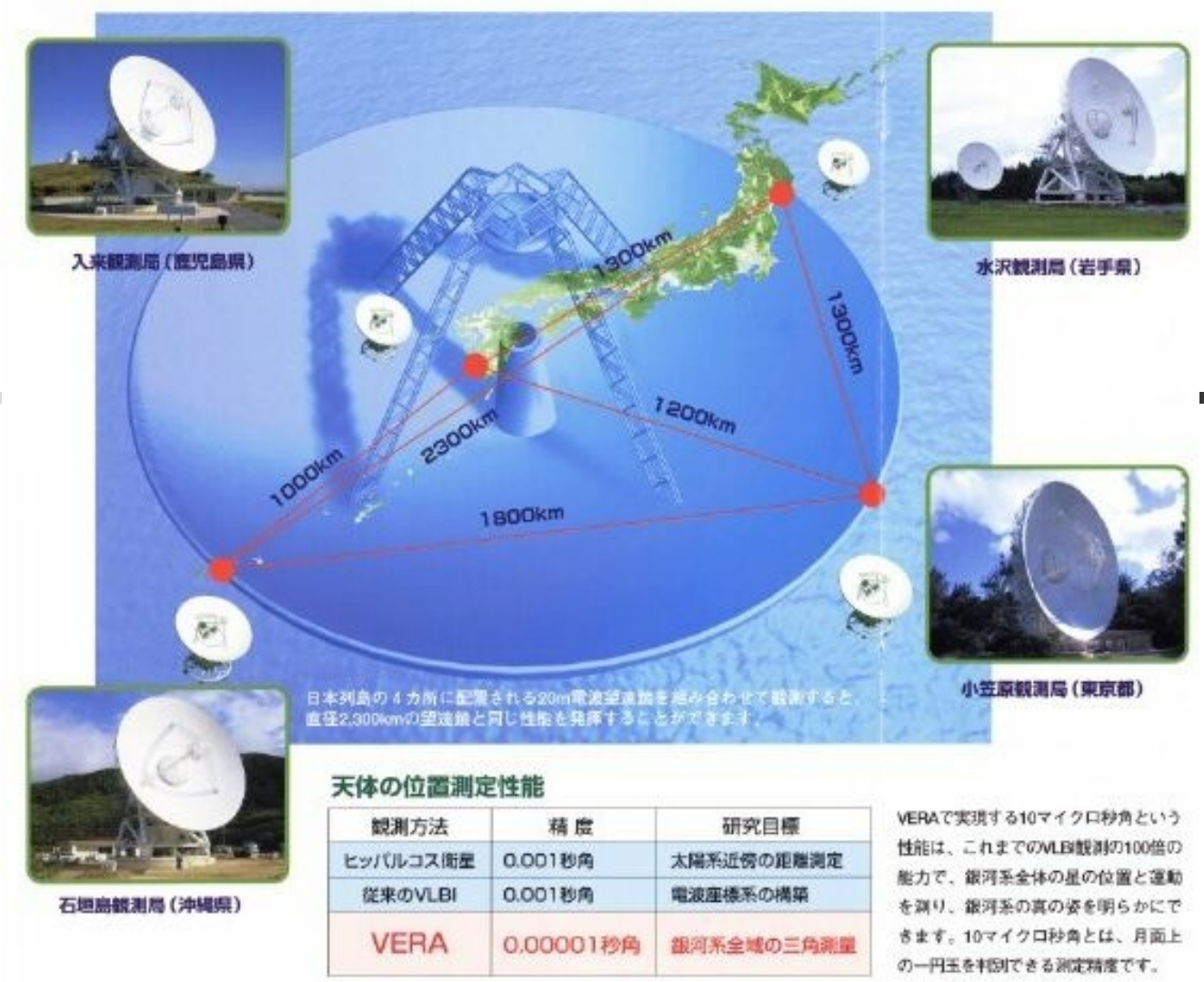
- Kashima34m has participated the first productive VLBI session, but fringe was not found for May, and June sessions. Scan No.49 was recorded at Ks-Ef in the session 10 Jun. and correlation processed by K5 Software correlator.

- Fringe was found for all channels at Clock=-32.6us



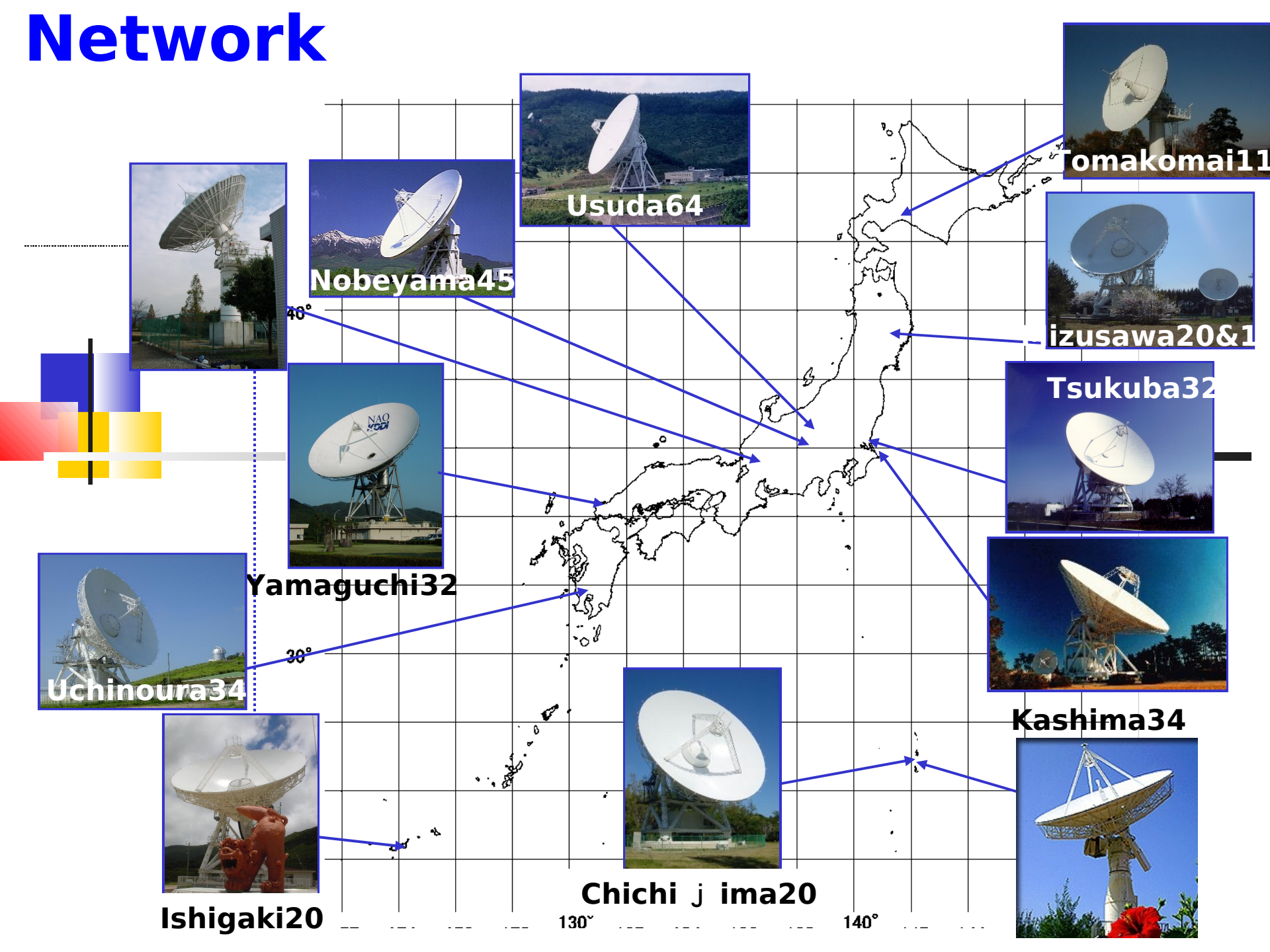
Domestic eVLBI in Japan

VERA(VLBI Exploration of Rado Astronomy) by NAOJ
Array configuration



Observation time ; 3000 hrs/yr -> 5000 hrs/yr

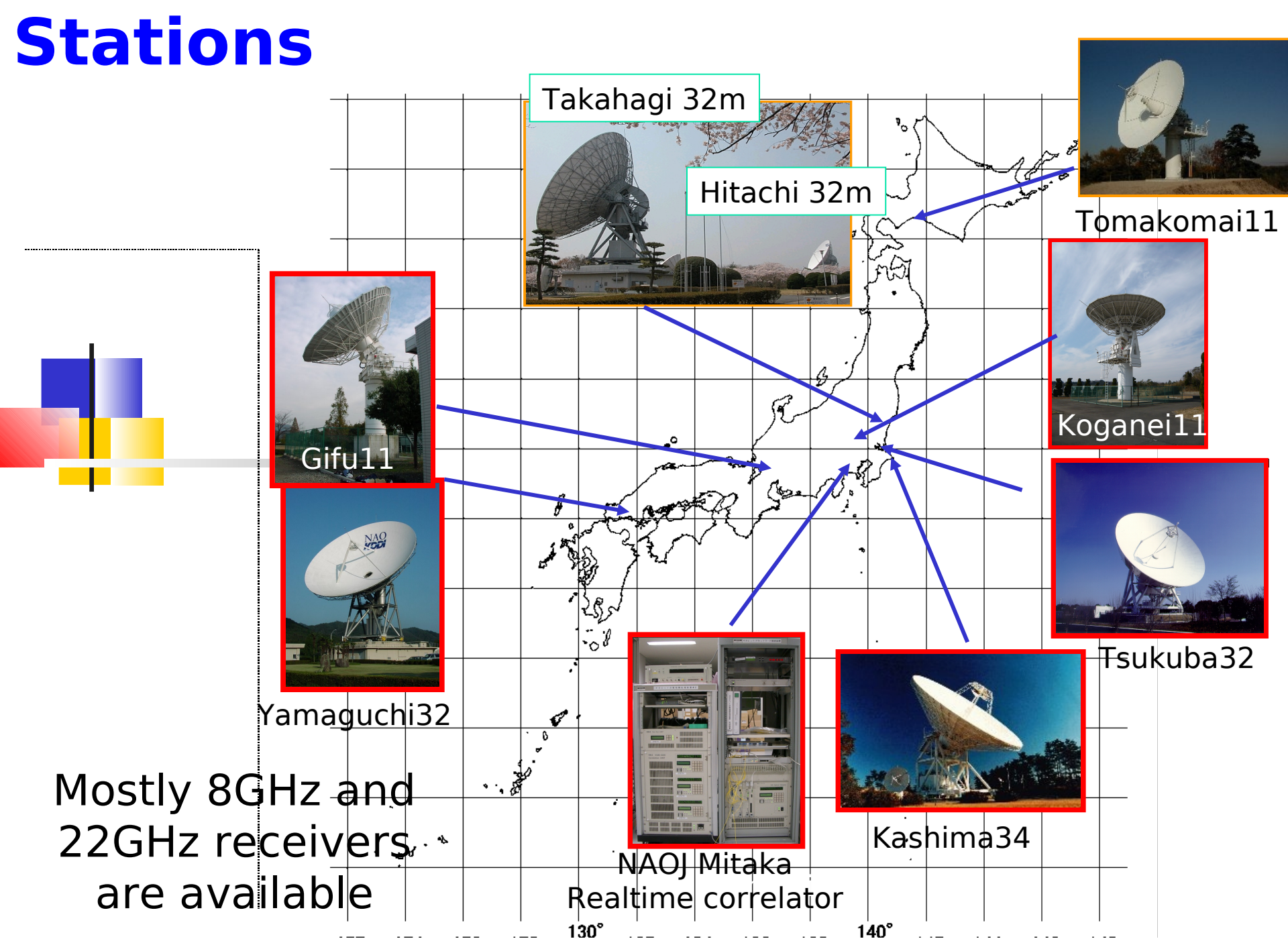
Network


Usuda64
Tomakomai11
Nobeyama45
izusawa20&1
Tsukuba32
Yamaguchi32
Uchinoura34
Kashima34
Ishigaki20
Chichi j ima20
40°
30°
130°
140°

Domestic eVLBI Network (NAOJ)

- Connecting Japanese VLBI stations
  - Currently connected
    - Kashima34, Tsukuba32, Yamaguchi32,Gifu11, Koganei11
  - Soon being connected
    - Tomakomai11 operated by Hokkaido Univ.
      - Using Link aggregation in SINET3 by using three 1Gbit Ethernet lines to transfer 2048Mbps data to Mitaka.
    - Takahagi32,Hitachi32 operated by Ibaraki Univ.
      - NAOJ (Ibaraki Univ) received two 32m diameter antennas from KDDI, which is Japanese communication carrier company. Now under refurbishing for Radio telescope.

Stations



Mostly 8GHz and 22GHz receivers are available

Japanese eVLBI Array

(2008.4 ～)

10Gb E

Tomakomai 11m

Ibaraki 32m

Hokkaido University

JGN-2+

10GbE

Koganei

Yamaguchi 32m

GbE x 3 Link Aggregate

Kashima 34m

GEMNET By NTT

High Energy Accelerator Research Organization

Yamaguchi University

NAOJ (Correlation Site)

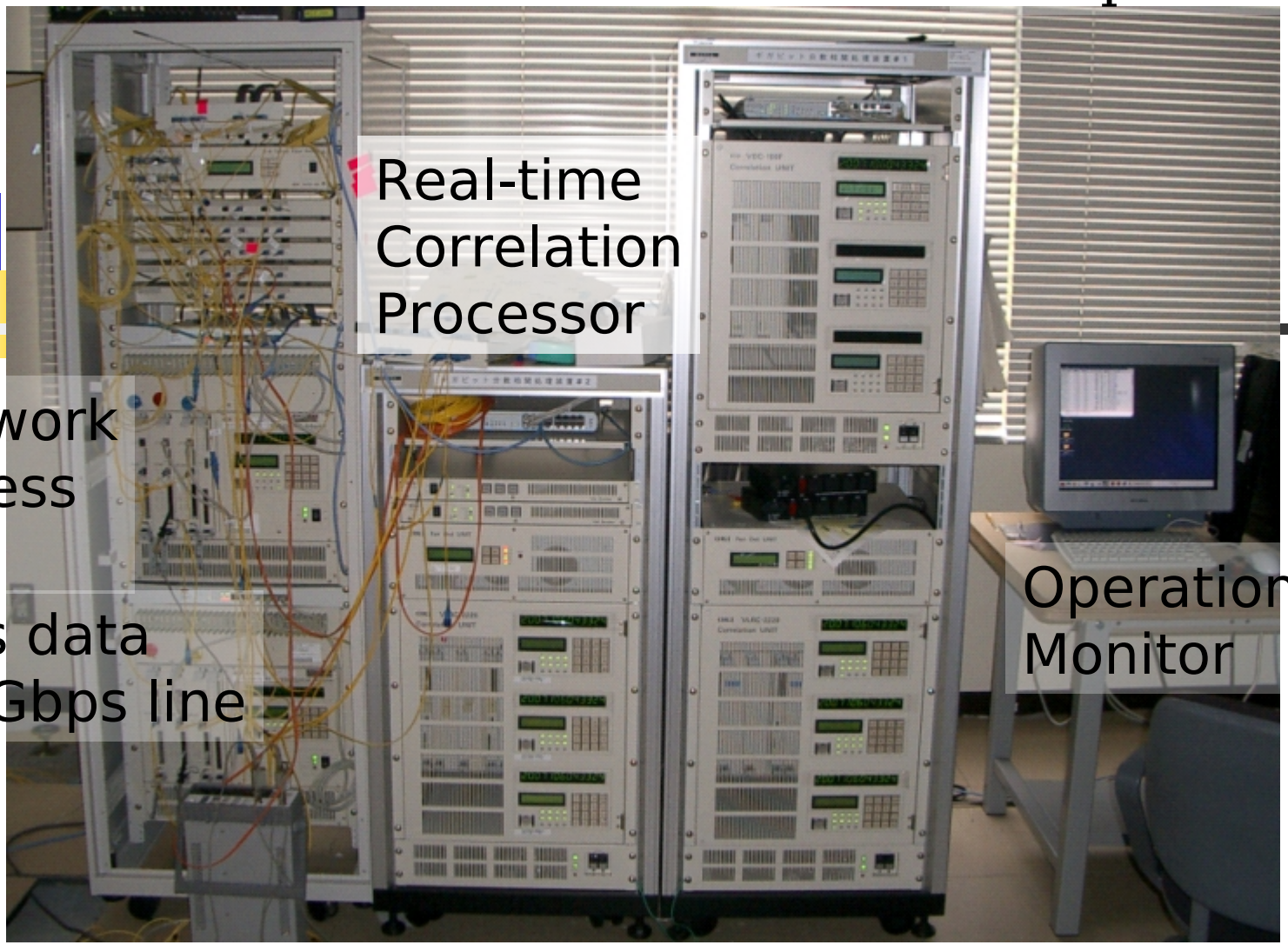
National Institute for Fusion Science

Gifu 11m

Tsukuba 32m

Mitaka Center, NAOJ

4-station
6-baseline
2-Gbps real-time



E-VLBI Projct(2)

Success of 8Gbps real-time VLBI

Koganei 11m
Headquater NICT,
Tokyo

Kashima 34m
NICT,Kashima

VSI-H
x4

VSI-H
x4

VOA200

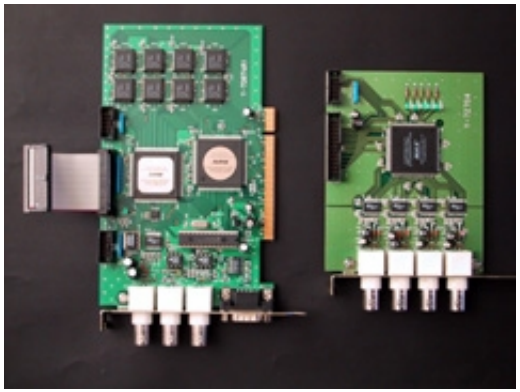
Technology Development

- Japanese K5 VLBI system
  - Two types of K5: K5/VSSP, K5/VSI
  - Digital BBC sampler ADS3000+
- Software Correlator
  - K5 Software Correlator(T.Kondo)
    - Geodesy, etc..
  - Fast correlator GICO3 (M.Kimura)
    - Implementation to VERA project.

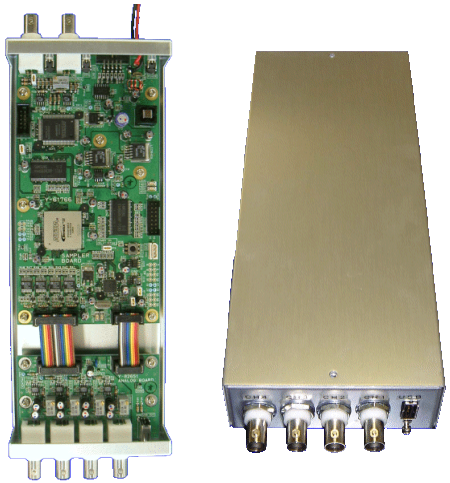
K5-System （1）：K5/VSSP

	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	256 Mbps (1024Mbps with
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	4
No. Channels	1	16	Programmabl	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

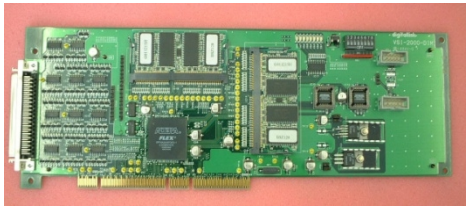
ADS3000
(2048Msample/sec 1ch 8bits + FPGA)

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

VSI-H

VSI-H

PC-VSI Board
(~2048Mbps)

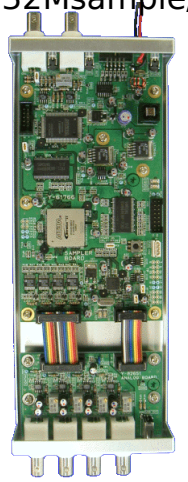


VSI-H

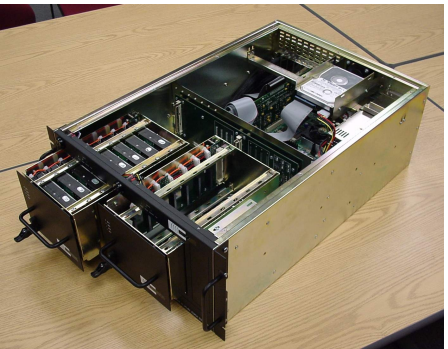
ADS2000
(64Msample/ch·sec, 16ch, 1 or 2bits)

VSI-H

K5/VSSP32 Unit
(~32Msample/ch·sec, ~4ch, ~8bits)

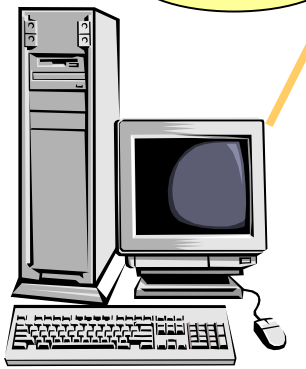


Mark5B sampler
(64Msample/ch·sec, 16ch, 1 or 2bits)



Correlator
other DAS

Internet



PC : Data Acquisition
Correlation

eVLBI is a chance to make all DAS compatible.

Sampler with VSI-H output

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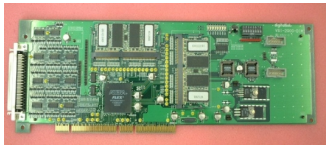

K5/VSI card

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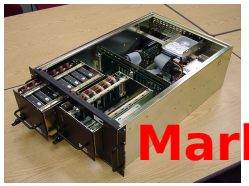
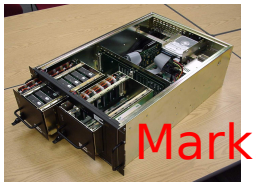


Mark5B



Mark5B

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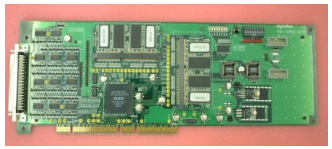

K5/VSI card

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K5/VSSP

K5/VSSP

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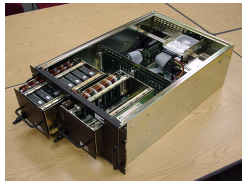


Mark5B

- I am going to make our K5 system compatible with Mk5 and VDIF. That will enhance mutual collaboration and boost the activities both in geodesy and Astronomy.

ADS3000 plus under development

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

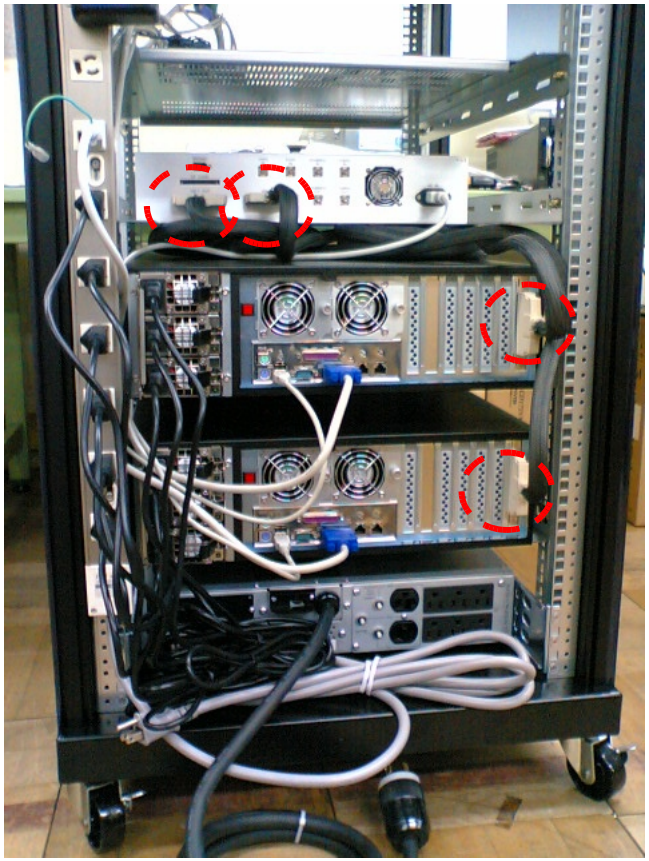
4 X VSI-H data outputs

Upgrade to support 10GEther or USB3

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

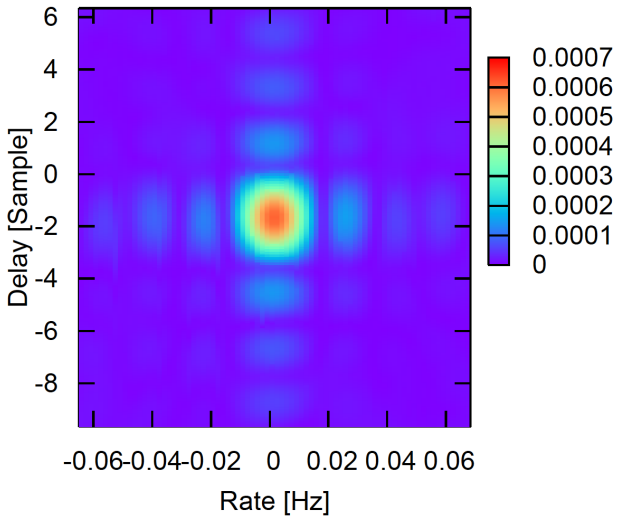
ADS3000 + PC-VSI Recorder

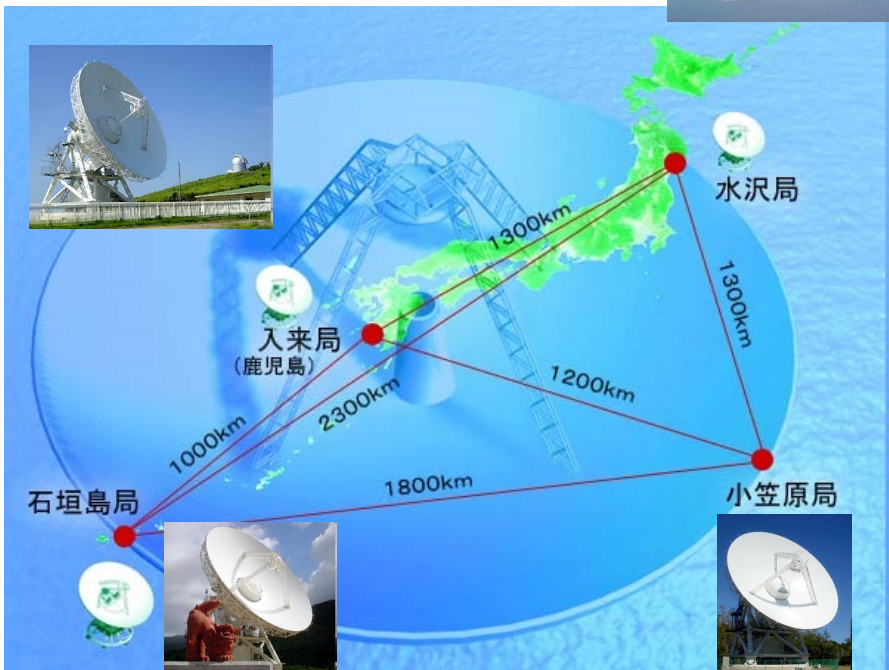


4096Mbps recording for 1 7 hours

Software Correlator(GICO3) for VERA(NAOJ)

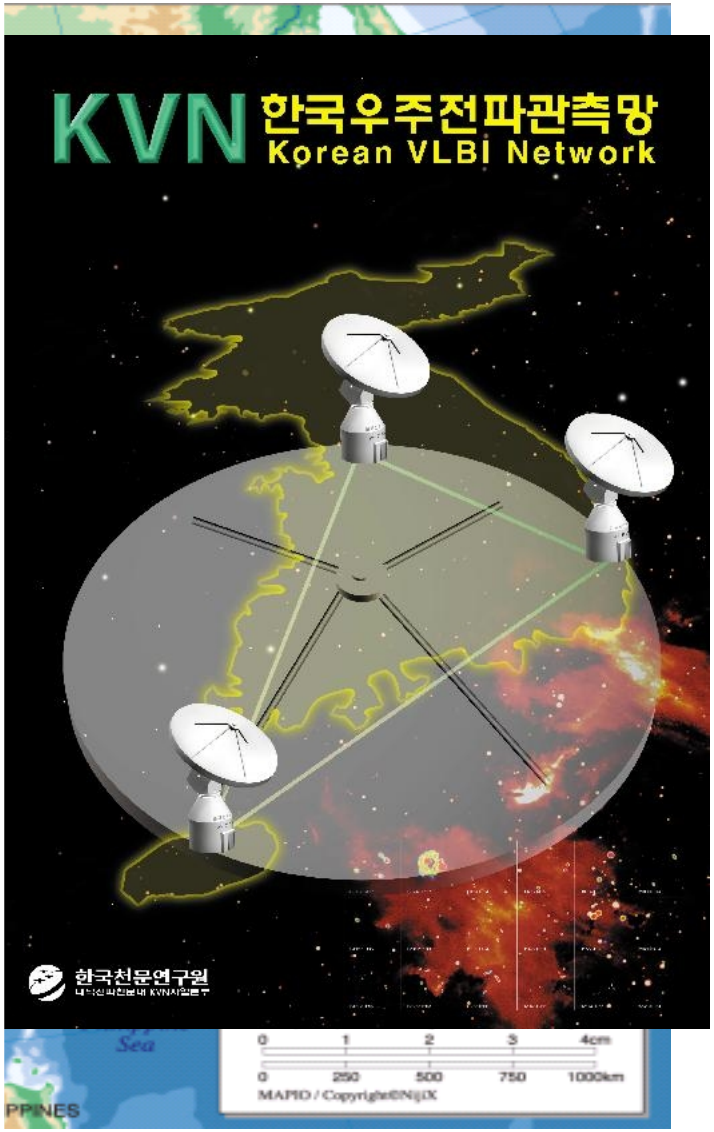
- NICT has developed a software correlator system for VERA project under a contract with NAOJ.
- The system is capable to process 512Msps/station X 5 = 2.5Gsps in real time.
- Multi-beam (VERA specific) and cross polarization correlations are supported.





Prospect: KVN-JPN⇒EAVN

- Korean VLBI Network(KVN) is starting up.
- Korea-Japan Joint VLBI Correlator (KJJVC) project is running (KASI-NAOJ). 16stations data processing capability is supposed. 1



East VLBI Network array


Thank you for attention!