Geodetic VLBI Observations Using Giga-Bit VLBI System

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Giga Bit VLBI System

1 Gbps (1024 Mbps) VLBI System Developed by CRL

– Single channel with 1 bit/sample system (0-512MHz)

- ## Sampler

  – Modified Digital Oscilloscope (Tektronix TDS784/TDS580)

  – Use 1 bit output from 4 bit/sample

- ## Data Recorder

  – Modified HDTV Digital Recorder (Toshiba GBR1000)

  - Recording Speed : 984 Mbps $\rightarrow$ 1024 Mbps

  – D6 standard (cf. D1 standard is used by K-4 systems)

  - 61 minutes recording with a L-size cassette tape (364x205x32mm)

Giga Bit VLBI System

- ## Correlator (GICO/UWBC)

  - Originally developed by NAOJ for connected mm-array at Nobeyama (NMA)

  - 1 baseline / 2 Gbps correlation capability

  - Lag window : 256 bits

- ## Interface Units

  - DD-1 : extract 1 bit signal from 4 bits output of TDS784/TDS580

  - DRA1000 : Time-base control / Data formatting for recording

    Data synchronization for play-back

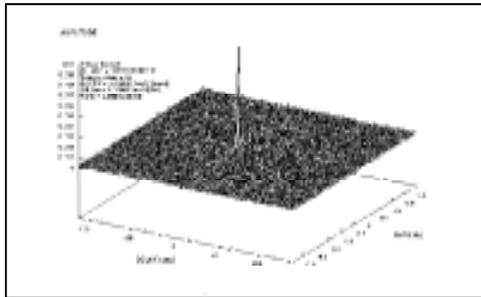 - DRA2000 : Delay tracking / 1 Gbit Buffer for e-VLBI

Giga-bit VLBI System
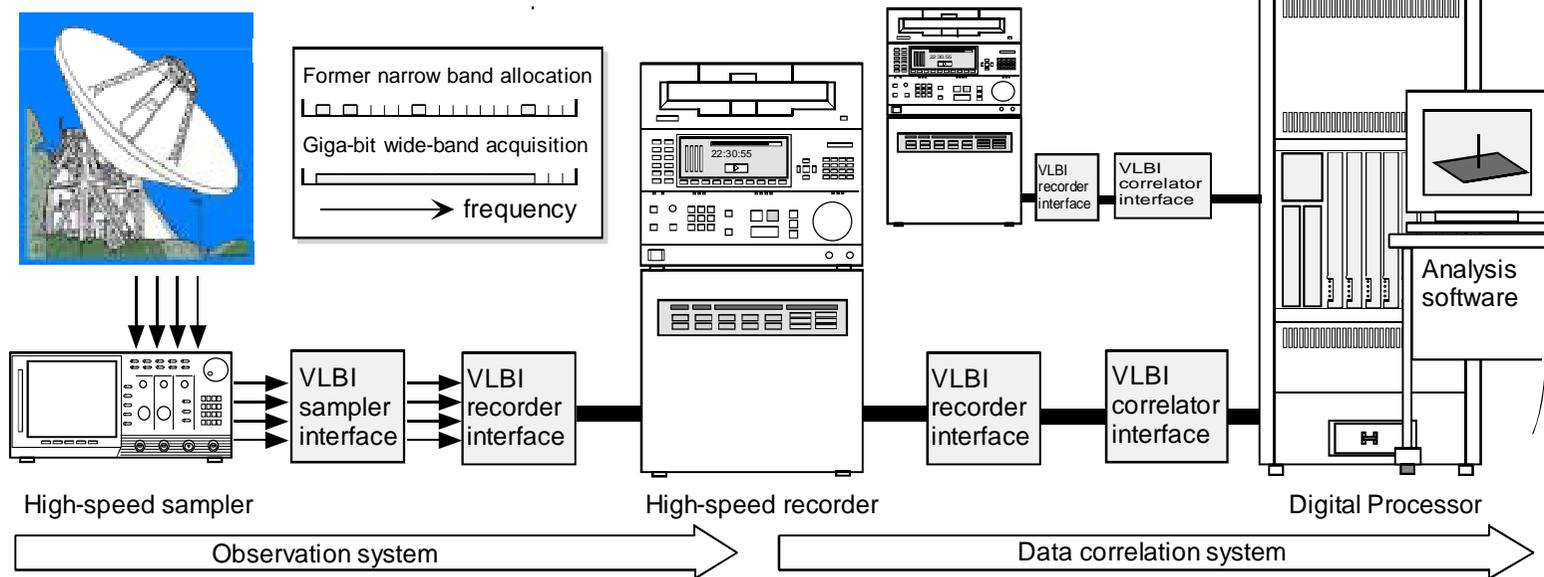

Sampler

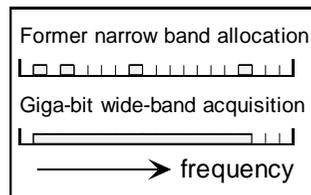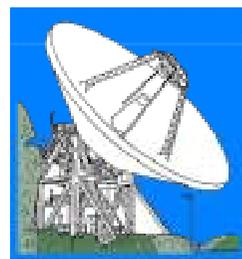Correlator (GICO/UWBC)

DD-1

DRA1000

DRA2000

Recorder

# Giga-bit VLBI System

The 1st-ever 1-Gbit finge of quasar 3C345

Research and development plan

1999 Performance and reliability evaluation test

2000 Initial geodetic VLBI observation

2001 Multiple baseline enhancement

2002 Scientific data reduction

VLBI-GICO

1G-bit corr.

Former narrow band allocation

Giga-bit wide-band acquisition

→ frequency

VLBI sampler interface

VLBI recorder interface

VLBI recorder interface

VLBI correlator interface

VLBI recorder interface

VLBI correlator interface

Analysis software

High-speed sampler

High-speed recorder

Digital Processor

Observation system

Data correlation system

The First Fringe

- Observation : July 10, 1998
- Antenna : Koganei(11m) - Kashima(11m)
- Frequency : 2 GHz and 8 GHz (alternative)
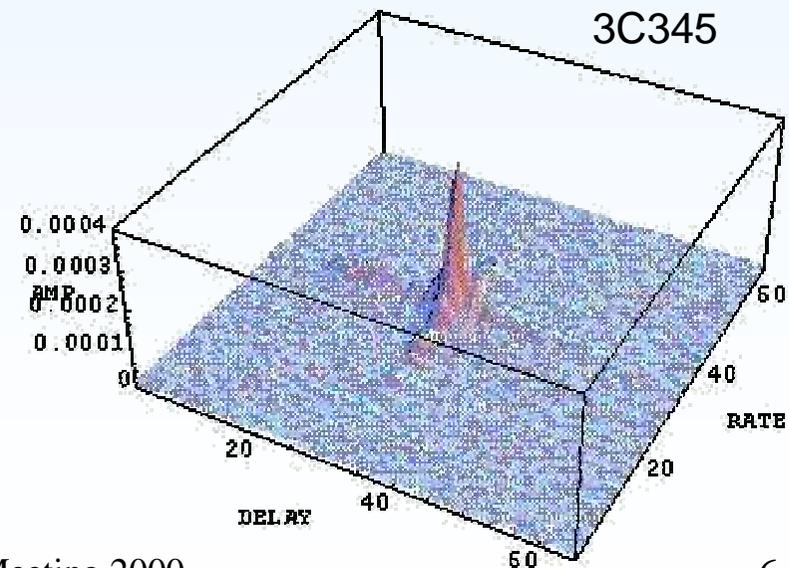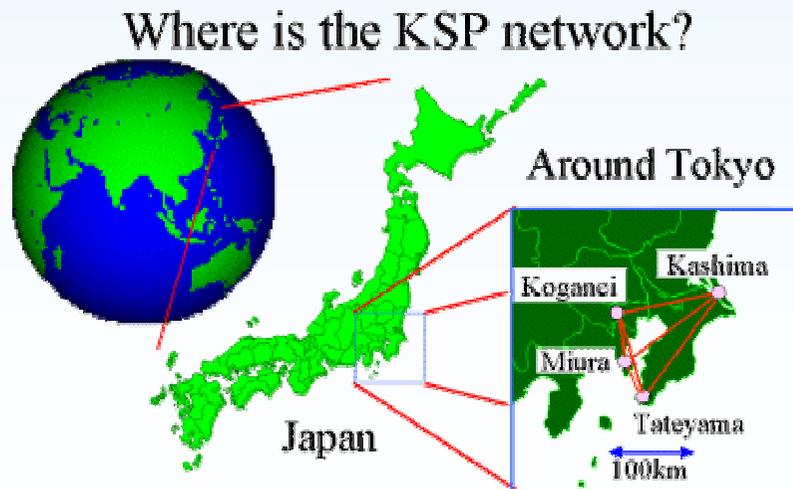
High-Sensitivity Observation

Nobeyama 45m

- Purposes
  - Compare total flux and correlated flux
  - Measure brightness temperature

- Source Selection
  - High Red Shift QSO z>3.5 60 sources
  - Total flux >10mJy@22GHz

- Antenna
  - NOBEYAMA (45m) – Kashima (34m)

- Frequency
  - 22GHz

Kashima 34m

First observations on December 25, 1999

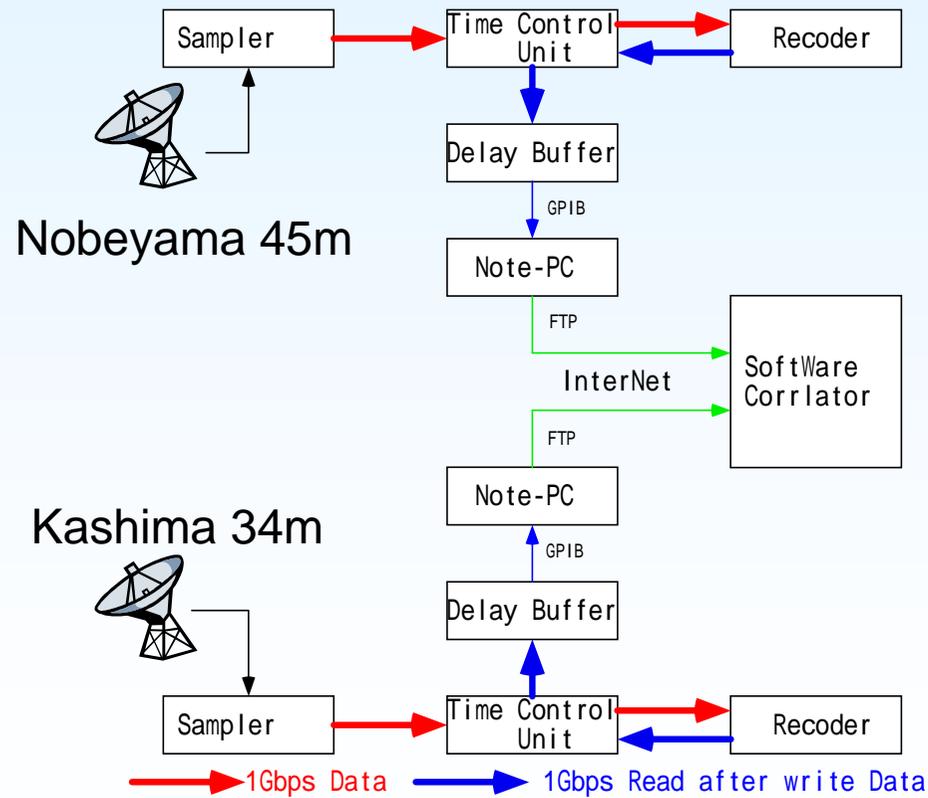Fringes from more than 50 QSOs identified!

ftp-VLBI for near-realtime fringe detection

Nobeyama 45m

Kashima 34m

Sampler → Time Control Unit → Recoder

Delay Buffer

GPIB

Note-PC

FTP

InterNet → SoftWare Corrlator

FTP

Note-PC

GPIB

Delay Buffer

Time Control Unit → Recoder

Sampler

→ 1Gbps Data   → 1Gbps Read after write Data

Source   : 3C279
Integration Time : 0.1 sec
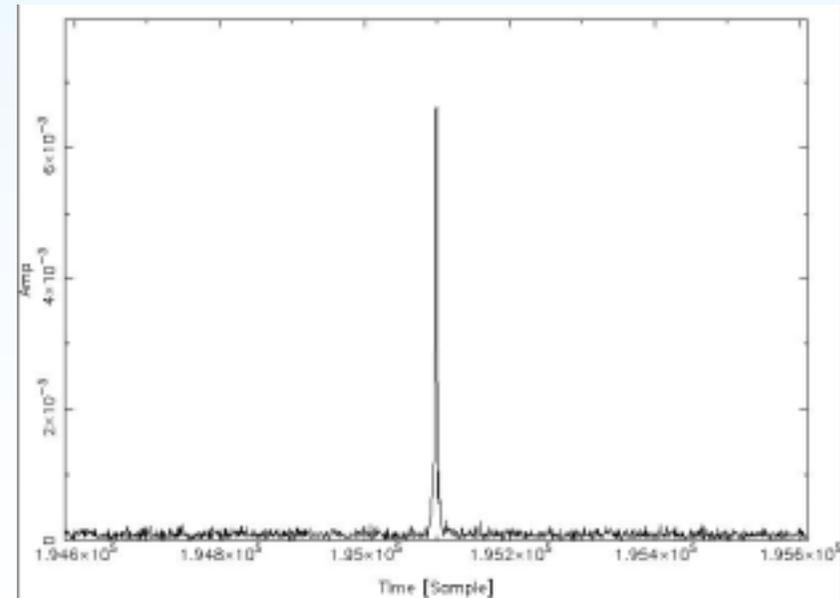
Geodetic VLBI with GBR System

- **High Sensitivity**
  - Smaller Antenna
  - More observations in a given time period

- **Single Channel VLBI**
  - Frequency bandwidth = consecutive 512 MHz
  - No base-band converters
 - No phase calibration tones

3m antenna system

- **Developed in 1987**
  - Transportable
    - Transported to Koganei, Daito, Wakkanai, and Okinawa
  - Diameter : 3m
  - Frequency
    - X-Low : 7860-8200MHz
    - X-High : 8180-8600MHz
  - Efficiency : 37%
  - System Noise Temperature : 120K
  - Slewing Speed : 3 deg./sec.

Experiments

- ## October 19, 1999
  - 6 hours
  - KASHIM11-KOGANEI (11m)
  - Baseline Length = 109.1 km
  - to develop softwares after correlation processing

- ## January 18, 2000 (GIFT-1)
  - 25.5 hours
  - KASHIM34 (34m) - GIFUUNIV (3m)
  - Baseline Length = 358.9 km
  - the first full-day geodetic VLBI experiment

- ## February 29, 2000 (GIFT-2)

October 19, 1999

KASHIM11 (11m)
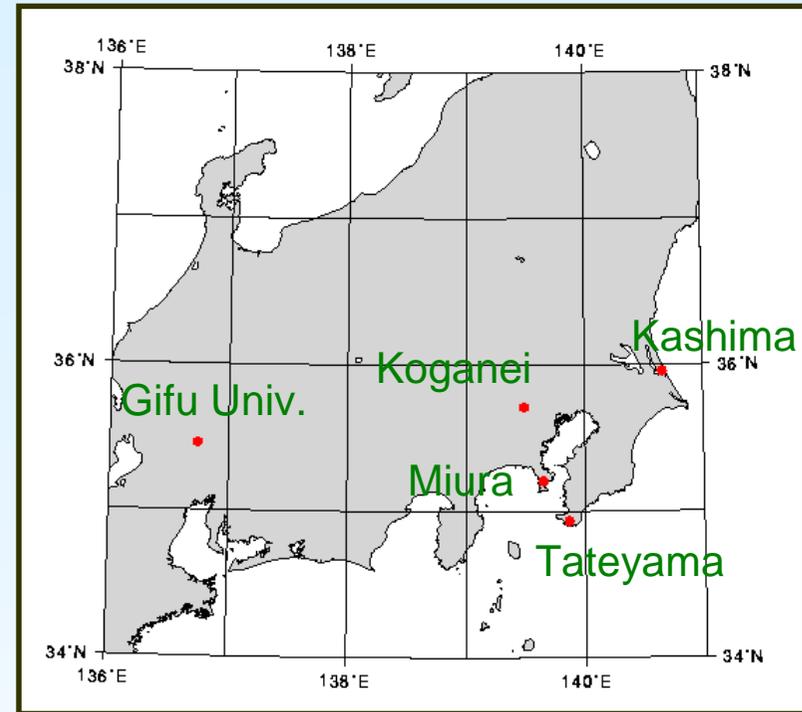
- 6 hours test observations with KSP facilities : comparisons with KSP results
  - RF : 8100-8600 MHz
  - IF (500-1000MHz) was converted to baseband (0-500MHz) by a hybrid mixer and 500MHz CW signal from a synthesizer

Preliminary Comparison

	K-4 (KSP)	GBR
RMS Delay	48 ps	183 ps
Baseline Length	109099666.04 ± 3.69 mm	109099667.87 ± 13.14 mm

KOGANEI (11m)

January 18, 2000 (GIFT-1)

KASHIM34 (34m)

- The first full day geodetic VLBI
  - RF : 8180-8600 MHz
  - Higher frequency of the IF (100-520MHz) was cut by a low-pass filter (Lc=500MHz)
- 64 Mbps (K-4) observations for comparison
- GPS observations
  in parallel

GIFUUNIV (3m)

Future Plan

- Data processing of the GIFT-1 in progress
- Further improvements required to improve the delay determination from the Giga-Bit VLBI system
- GIFT-2 is currently scheduled on February 29, 2000

- Multi-channel VLBI observations
  - ex. Filter bank and over-sampling method
- Another Giga-Bit VLBI System (D1 based) will be developed under the VERA Project (NAOJ)
  - Compatibility test will be performed using the VLBI Standard Interface (VSI)