BASELINE ANALYSIS OF 24-HOUR GPS-VLBI HYBRID OBSERVATION

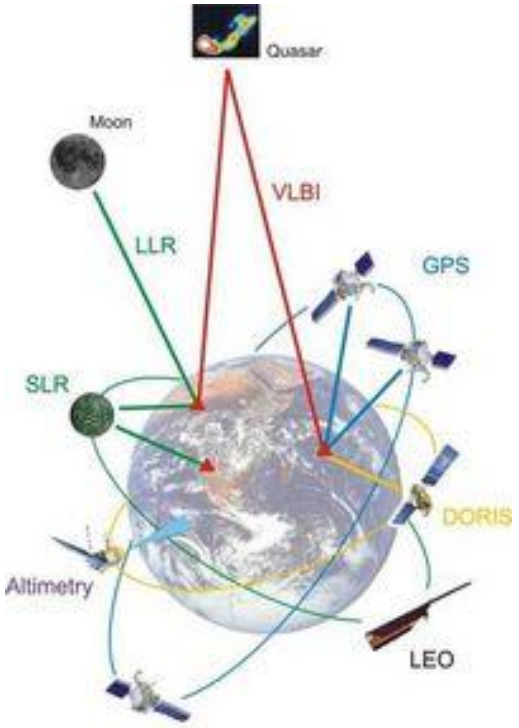
Kwak, Younghee[1]

Tetsuro Kondo[2], Tadahiro Gotoh[2], Jun Amagai[2], Hiroshi Takiguchi[3], Mamoru Sekido[2], Lucia Plank[4], Ryuichi Ichikawa[2], Junghe Cho[1], Tuhwan Kim[5] ,Tetsuo Sasao[6]

[1]*Korea Astronomy and Space Science Institute*
[2]*National Institute of Information and Communications Technology*
[3]*Auckland University of Technology*
[4]*Vienna University of Technology*
[5]*Ajou University*
[6]*Yaeyama Star Club*

Motivation

- Enhancement of VLBI technique
- Integrating Earth Observing Systems



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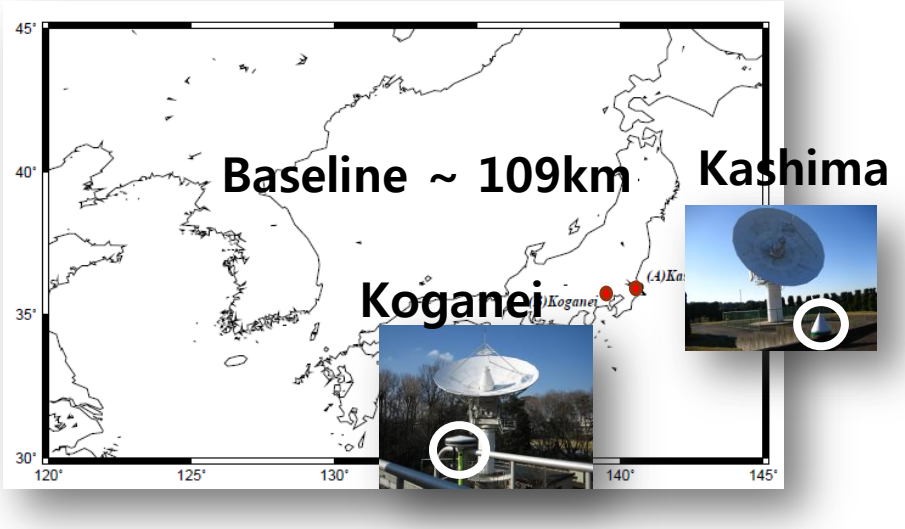
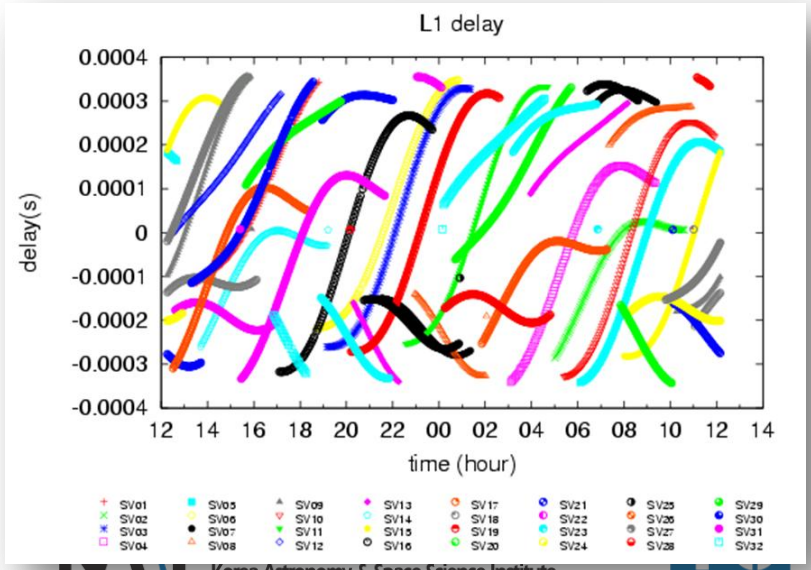
24-hour GV Hybrid Observation

Summary of the Experiment	
Baseline	Koganei-Kashima (~109km)
Period	12:12:00 25/12/09 – 13:00:00 26/12/09
Targets	VLBI : 23 sources GPS : 32 satellites
Scans	VLBI : 452 GPS : 496 (2531 obs.)
Observing Freq.	VLBI : S(4chx8MHz)/ X(8chx8MHz) GPS : L1(1chx32MHz)/ L2(1chx32MHz)
Sampler& Recorder	K5/VSSP32 (Kondo et. al., 2008)
Correlator	K5 software correlator





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Analysis

- Data set : Ion-calibrated VLBI data
  + GPS L1 data
- Lots of parameters(i.e. hydro. ,ion., rel., CRF, EOP, and sat. coord.) are fixed or already corrected
- Unknown parameters :

  ZWD, Clock and Station coordinates

Design Matrix – VLBI only

τ_{Gi} : VLBI Group delay

$$
\begin{matrix} i\text{ - th Epoch} \\ \\ \text{VLBI} \end{matrix}
\begin{pmatrix}
\vdots & \vdots & \vdots \\
\dfrac{\partial \tau_{Gi}}{\partial(\text{Station Position})} & \dfrac{\partial \tau_{Gi}}{\partial(\text{ZWD})} & \dfrac{\partial \tau_{Gi}}{\partial(\text{Clock param.})} \\
\vdots & \vdots & \vdots
\end{pmatrix}
$$

Design Matrix – VLBI&GPS

τ_{Gi} : VLBI Group delay

$\tau_{Pj1 \sim Pjg}$: GPS Group delay

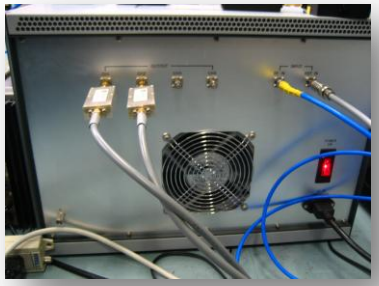
$$
\begin{array}{l|ccc}
 & \dfrac{\partial \tau_{Gi}}{\partial(\text{Station Position})} & \dfrac{\partial \tau_{Gi}}{\partial(\text{ZWD})} & \dfrac{\partial \tau_{Gi}}{\partial(\text{Clock param.})} \\
\hline
i\text{ - th Epoch (VLBI)} & & & \\
j\text{ - th Epoch (GPS)} & \dfrac{\partial \tau_{Pj1}}{\partial(\text{Station Position})} & \dfrac{\partial \tau_{Pj1}}{\partial(\text{ZWD})} & \dfrac{\partial \tau_{Pj1}}{\partial(\text{Clock param.})} \\
 & \vdots & \vdots & \vdots \\
 & \dfrac{\partial \tau_{Pjg}}{\partial(\text{Station Position})} & \dfrac{\partial \tau_{Pjg}}{\partial(\text{ZWD})} & \dfrac{\partial \tau_{Pjg}}{\partial(\text{Clock param.})}
\end{array}
$$

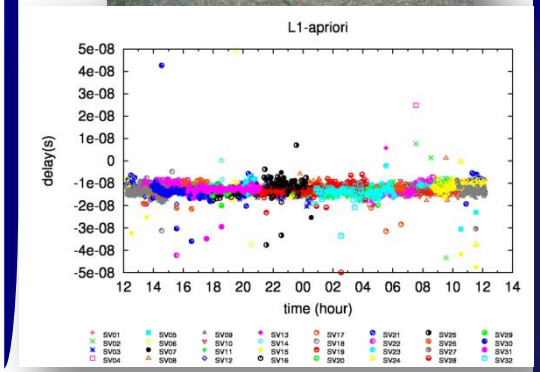
Design Matrix – VLBI&GPS

τ_{Gi} : VLBI Group delay

$\tau_{Pj1\sim Pjg}$: GPS Group delay

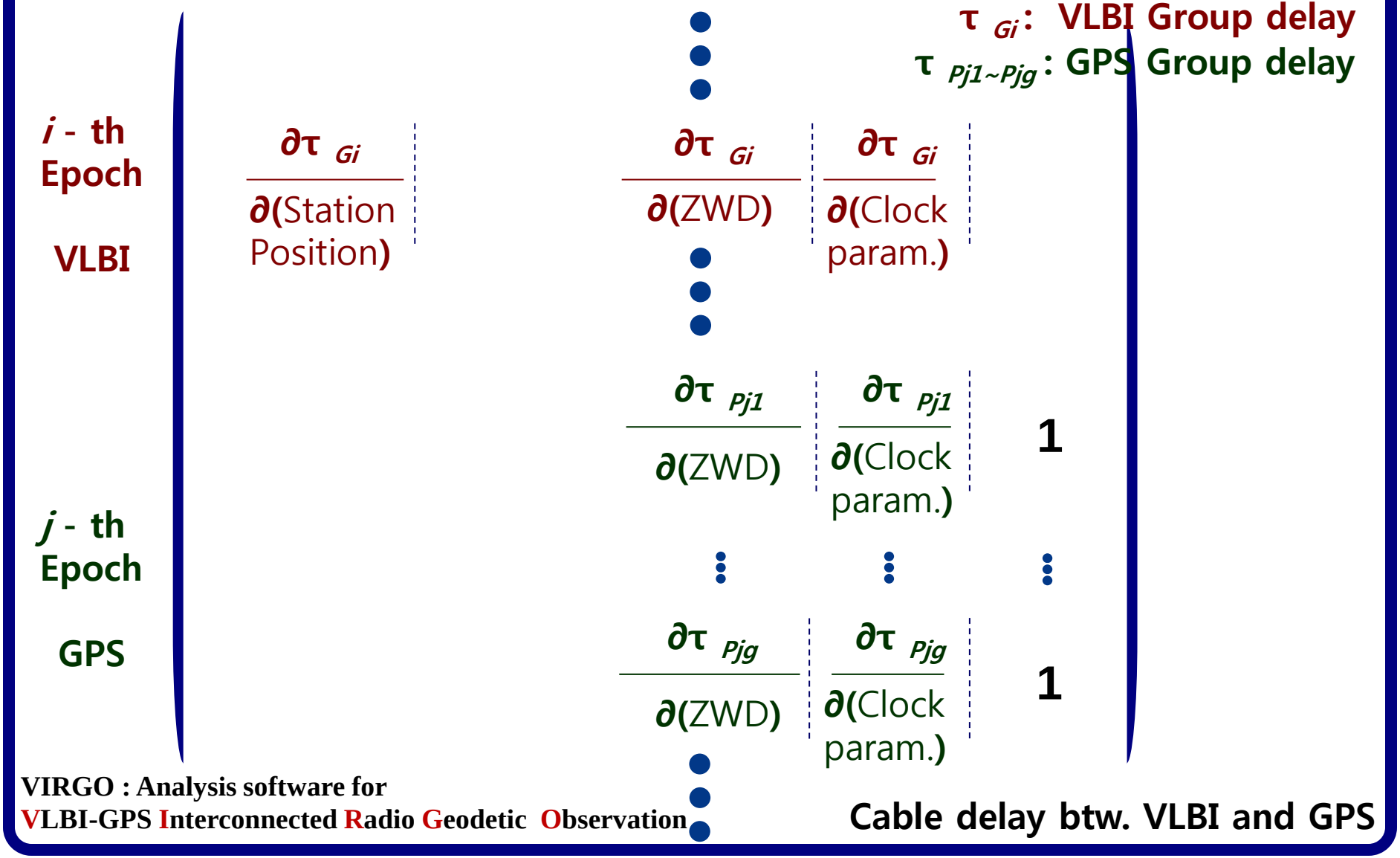
$$
\begin{array}{l|ccc}
 & \dfrac{\partial \tau_{Gi}}{\partial(\text{Station Position})} & \cdots & \dfrac{\partial \tau_{Gi}}{\partial(\text{ZWD})} & \dfrac{\partial \tau_{Gi}}{\partial(\text{Clock param.})} \\
\textbf{\textit{i} - th Epoch} & & & & \\
\textbf{VLBI} & & & & \\
 & \dfrac{\partial \tau_{Pj1}}{\partial(\text{Station Position})} & \cdots & \dfrac{\partial \tau_{Pj1}}{\partial(\text{ZWD})} & \dfrac{\partial \tau_{Pj1}}{\partial(\text{Clock param.})} \\
\textbf{\textit{j} - th Epoch} & \vdots & & \vdots & \vdots \\
\textbf{GPS} & \dfrac{\partial \tau_{Pjg}}{\partial(\text{Station Position})} & \cdots & \dfrac{\partial \tau_{Pjg}}{\partial(\text{ZWD})} & \dfrac{\partial \tau_{Pjg}}{\partial(\text{Clock param.})}
\end{array}
$$





Cable delay btw. VLBI and GPS

Design Matrix – This study



Clock Offsets and Rates

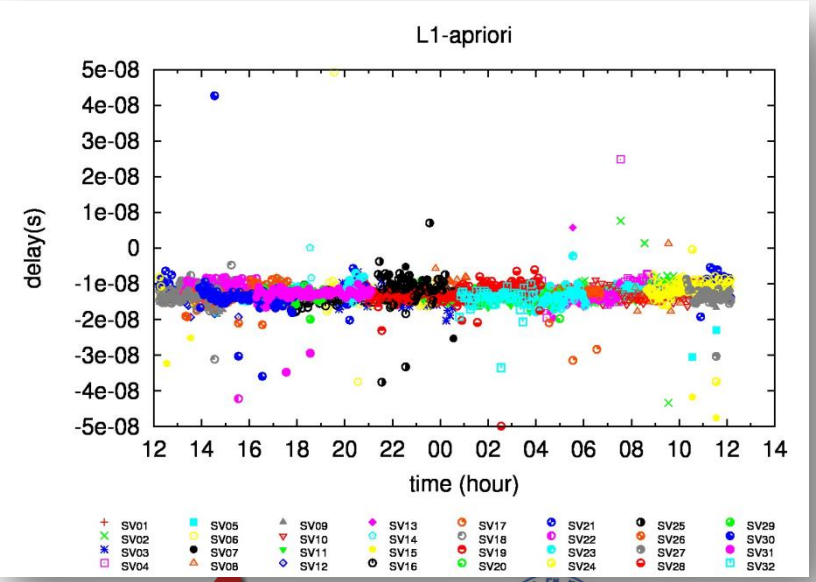
Estimates :
- ✓ ZWD
- ✓ Clocks
- ✓ additional GPS cable delay
- ✓ Station coordinates

Reference clock : Kashima

Piecewise linear offset
Interval : start time ~ end time

VLBI ONLY

	adjustments
Clock offsets (ps)	-612.6 ±167.4
Clock rate (ps/s)	-31.0 ±298.1



GPS + VLBI

	adjustments
Clock offsets (ps)	-612.6 ±65.8
Clock rate (ps/s)	-30.8 ±117.1
Cable delay(ns)	-10.9 ±6.0

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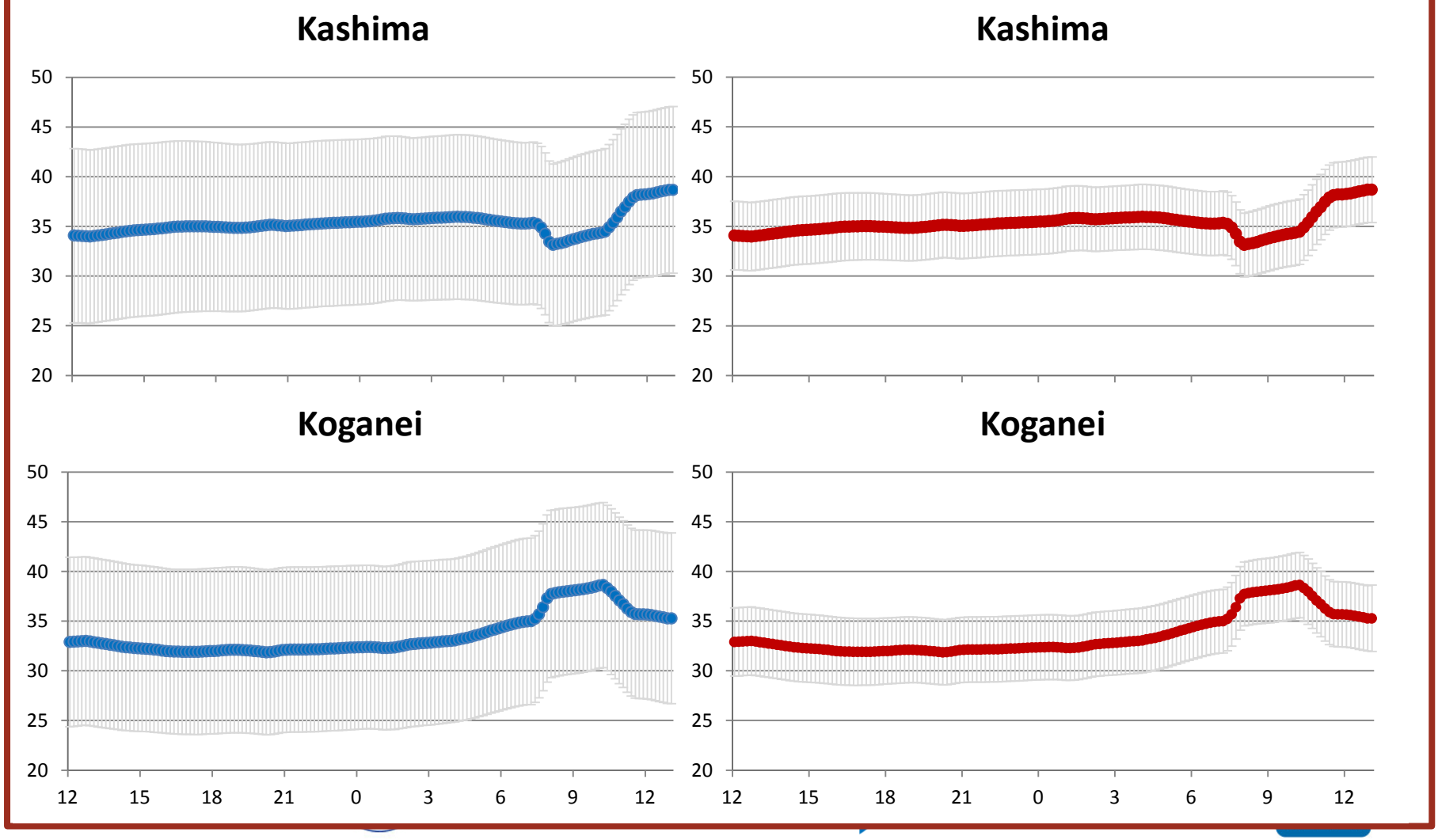
ZWD every 10 min.

VLBI ONLY vs. GPS+VLBI



Station Coordinates

VLBI ONLY

	VLBI antenna(mm)
sites	Koganei
ΔX	-11.3±15.1
ΔY	-15.5±14.8
ΔZ	6.1±14.7

GPS + VLBI

	VLBI antenna(mm)
sites	Koganei
ΔX	-11.3±5.9
ΔY	-15.5±5.8
ΔZ	6.1±5.8

- Un-optimized frequency channel allocation
- Big side lobe
- Delay ambiguity

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Potential for improvement

Since it was a pilot experiment, there are lots of missing points

- Un-optimized frequency channel allocation for VLBI
- Un-optimized correlation model for GPS
- No phase/cable calibrator for GPS
  (Parameter correlation btw. Cable & GPS coordinates)
- Non Ion-calibrated GPS data
- No atmospheric gradient
- No tidal corrections
- …

Global Geodetic Observing System

Global GV hybrid network

- Estimating EOP, satellite coordinates and CRF together.
- Tying satellite positions to CRF
- Determining UT1 with contribution of GPS

Thank you for your attention!!!

FYI

Please take bus No. **14** in front of Agumar hotel.

It brings you to the stadium, Santiago Bernabeu.

No more matches in this week.

Tour is **16 €**.