Status report of Koganei 11-m antenna and local tie survey

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1. Koganei 11m VLBI Station

1.1 Antenna parameters and resources

Names of people related to the Koganei VLBI station and geodetic activities in NICT are listed in Table 1. The antenna parameters of Koganei 11m VLBI station is displayed in Table 2. Koganei 11m station has been participating to 10 – 20 sessions in a year. Performance degradation is reported from IVS correlation center. We suppose main reason of this is Radio frequency interference (RFI).

Table 1. Human resources related with Koganei Station

Name	In charge of
Mamoru Sekido (Space-Time Standards Lab.)	IVS Observation Maintenance of Koganei 11m station
Ryuichi Ichikawa (Space-Time Standards Lab.)	GNSS observation and maintenance Gravimeter measurement
Ishibashi Hiromitsu (Space Environment Lab)	Stereo satellite downlink data acquisition

Table 2. Paramars of Kogane 11m VLBI station

Antenna type Diameter Slew speed	Cassegrain focus AZ/EL mount 11m 1deg./s for AZ/EL
Receiving band	S-band : 2.212-2.36GHz, ⇒2.20-2.40 GHz X-band1: 7.70-8.20GHz (not for IVS) X-band2: 8.10-8.60GHz
Receiver LNA type	S-band: Room Temp. Waveguide ⇒ Room Temp.coax. X-band: Room Temp. Waveguide
Local Freq.	S-band : 3000 MHz X-band1:7200 MHz (not for IVS) X-band2:7600 MHz
Backend Recording mode	K5-VSSP32 16 ch x 1/2 bit x 1/2/4/8/16/32 Msps, Total bitrate < 1024 Mbps
Pcal Freq.	5MHz Interval
Network connection	10Gbps JGN

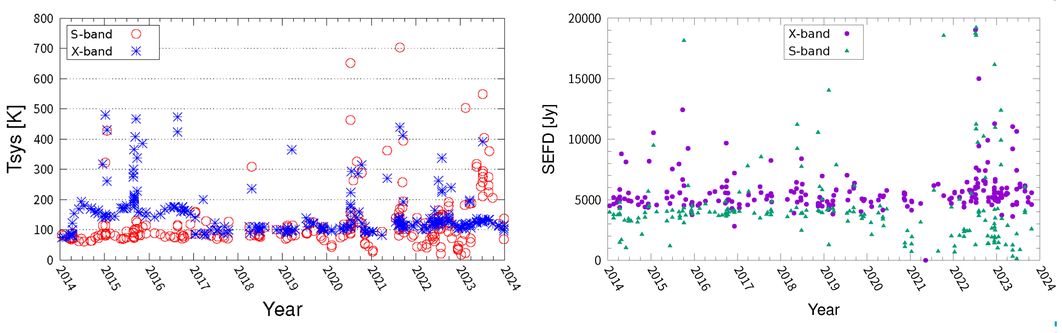

Fig1. Receiving performance (Tsys:Left, SEFD:Right) of Koganei 11m. Increased scatter of SEFD data in S-band from late 2020 would be indication of degradation of receiving performance due to RFI.

1.2 Radio Frequency Interference

Since Koganei site is surrounded by residential area with several hundred thousands of population, mobile phone's base stations are infrastructure of citizen's life. Radio environment is getting worse especially in S-band. RFI at 2.1GHz and 2.55-2.65GHz are strong enough to saturate LNA and causing mutual moderation at LNA. As workaround for this issue, we are going to insert band-pass filter (2.2-2.4GHz) in front of LNA. Even that will increase Tsys, we expect receiver performance will be recovered.

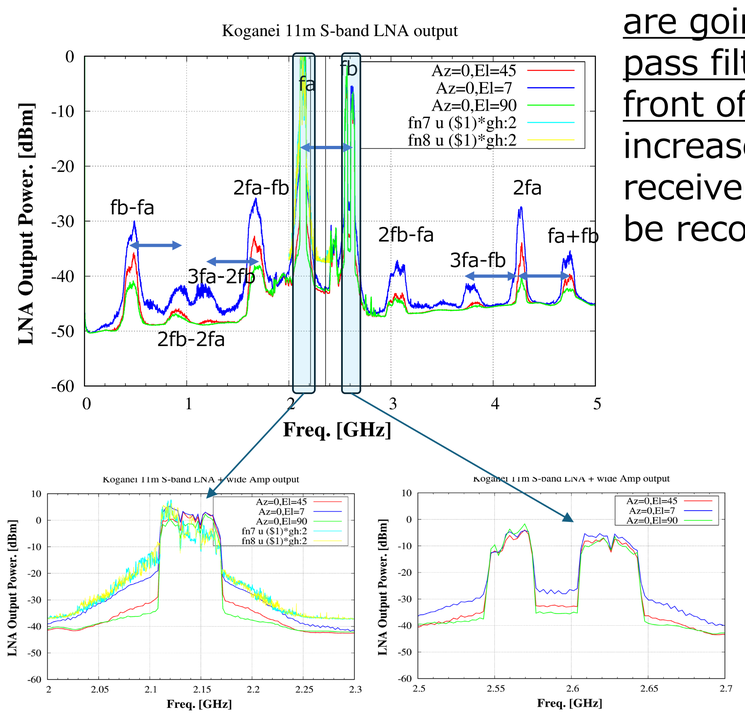

Fig.2 Frequency spectrum of LNA output measured in 2022.

1.3 Trouble shooting and recovery

Antenna has stopped operation due to several troubles: damage of thunderstorm (2021.7), increase of drive resistance (2023.5), and breaking of drive control unit(2023.11). They are recovered by grease up and replacement of broken unit. Although, one of two drive systems are malfunctioning at each of Az/El drive at present.

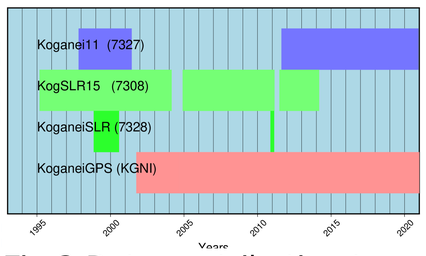

Fig.3 Data contribution to ITRF2020

2. Local Tie Geodetic Survey

2.1Local tie survey in 2022

Local tie measurement is increasingly important for further improvement of ITRF. Koganei site has long observation history contributing ITRF (Fig.3) with multiple space geodetic techniques. And local geodetic surveys have been conducted in the period 1996-1999[1] and 2013 in the past. The latest local tie survey was made in Oct.-Nov. of 2022. Fig4 shows the map of local survey network in 2022. Stable geodetic monuments and ground markers (Fig. 5) have been repeatedly used in those surveys. Equipment used in this survey are listed in Table 3.

Fig.4 Local tie geodetic survey network in 2022

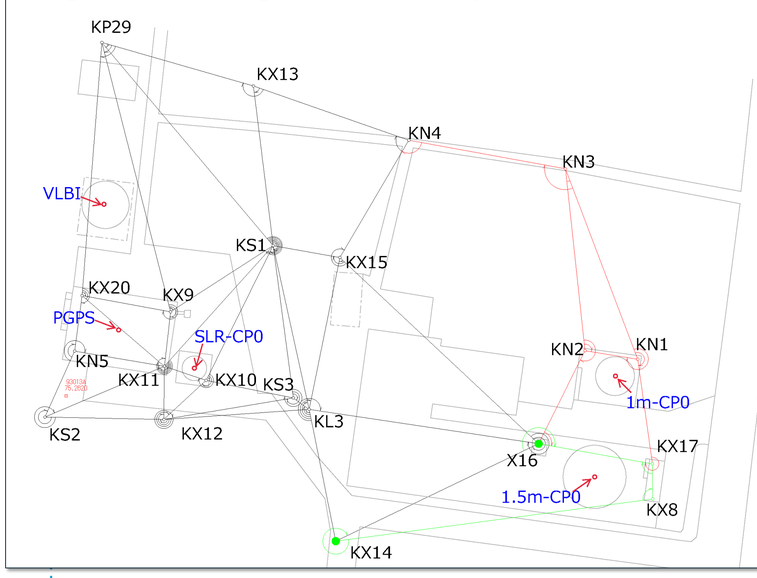

Fig.5 Site view of Koganei site and ground marker/monuments used for local tie survey.

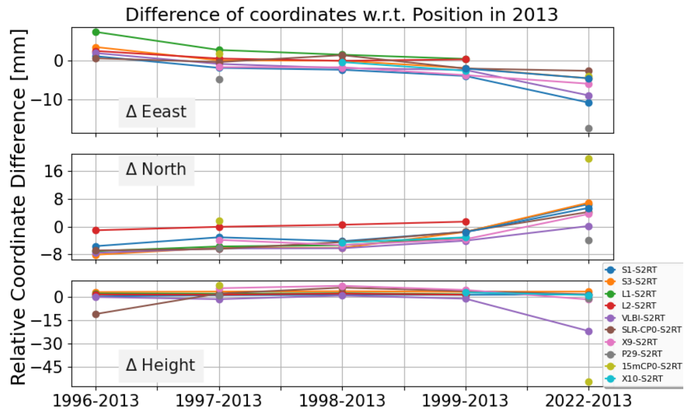

Fig.6 Repeatability of the relative position between local survey in 1996-1999, and 2022 w.r.t. that of 2013.

2.2 Local tie Analysis with pyaxis

Least square 3D geometrical analysis was made by using '**pyaxis**'[2]. Input dataset (Table4) and preliminary results(Fig.6, Fig.7) are displayed below. Final result will be submitted to ITRF center for next update.

Table 3. Equipment used for the survey

Equipment	Model	Performance
GNSS Receiver	Trimble R12	Horizon: 3mm+0.1ppm Vertical: 3.5 mm +0.4 ppm
Leveling equipment	Trimble Navigation DiNi 0.3	0.3 mm (1km round)
Leveling bar	Tamaya LD-13S	Thermal exp. 0.2 ± 0.03 ppm/deg.
Total Station	Leica Nova MS60	Distance:1 mm Angle: 1 arc sec.

Table 4. Dataset used in the analysis

Observation	Dataset
Total Station	154 observations (horizontal angle, zenith angle, slant distance)
Leveling	22 relative height measurements
GNSS	1 day observation at X16, KX11, KX20, and KN2

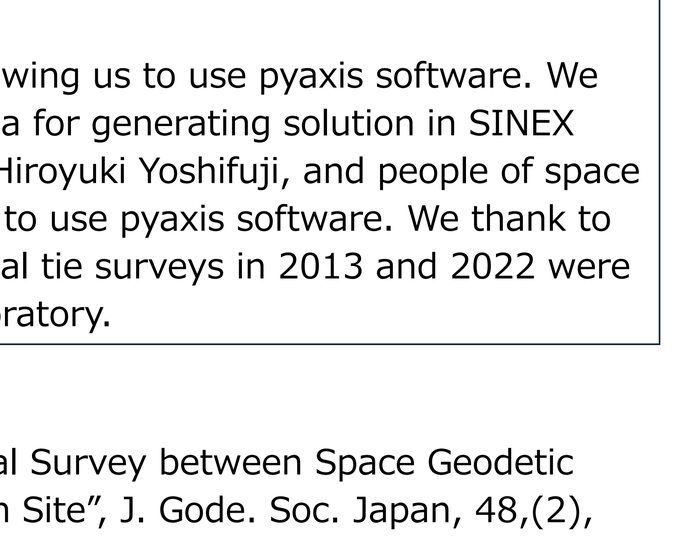

Fig.7 Least square 3D analysis/adjustment of local tie network was made by using 'pyaxis'. Obtained relative coordinates of reference points for each space geodetic w.r.t. S2 monument are displayed in East-Height (upper panel) and East-North(lower panel) plane. While the horizontal plane is constrained by the network and has a small error, the height direction has few constraint conditions and has a large uncertainty.

Acknowledgements

We thank to Land Information New Zealand (LINZ) for allowing us to use pyaxis software. We used "Online GPS Processing Service" of Geoscience Australia for generating solution in SINEX format from GNSS RINEX file. We greatly appreciate to Mr. Hiroyuki Yoshifuji, and people of space geodesy group of GSI for kindly supporting us learning how to use pyaxis software. We thank to Mr. Shinichi Ueda of Nippo Co Ltd. for support. Geodetic local tie surveys in 2013 and 2022 were conducted by support of Space Communication System laboratory.

References

[1] H.Hasegawa, et al., "Method of Local Survey between Space Geodetic Observation Systems at a Collocation Site", J. Gode. Soc. Japan, 48,(2), 85-100, 2002. Doi: 10.11366/sokuchi1954.48.85

[2] linz-pyaxis, adjustment, and geodetic packages, https://github.com/linz/python-linz-pyaxis

[3] "Online GPS Processing Service" of Geoscience Australia https://gnss.ga.gov.au/auspos