P104

VLBI-GNSS collocation survey at the Ishioka VLBI station

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Abstract We conducted a two-week collocation survey campaign in November 2018 to determine a local tie vector between the Ishioka VLBI station and the IGS station ISHI. We determined the position of the VLBI antenna invariant point w. r. t. reference pillars by two different methods: ``outside method'' and ``inside method'' .
A preliminary analysis shows the local tie vectors determined by both methods agree within a few mm.

1. Collocation survey in 2018

The Ishioka VLBI station is equipped with four reference pillars (PIL1~PIL4) for determining a local tie vector between the VLBI antenna invariant point (IVP) and the phase center of the GNSS antenna of the IGS station ISHI (Fig. 1).
In 2018, we conducted the collocation surveys to determine the local tie vector. The survey includes 1) angle/distance measurements between the pillars, 2) leveling survey between the pillars, 3) GNSS survey at PIL2, PIL3 (and ISHI) and 4) GNSS survey at a nearby mountain (Mt. Tsukuba) to determine the orientation angle.

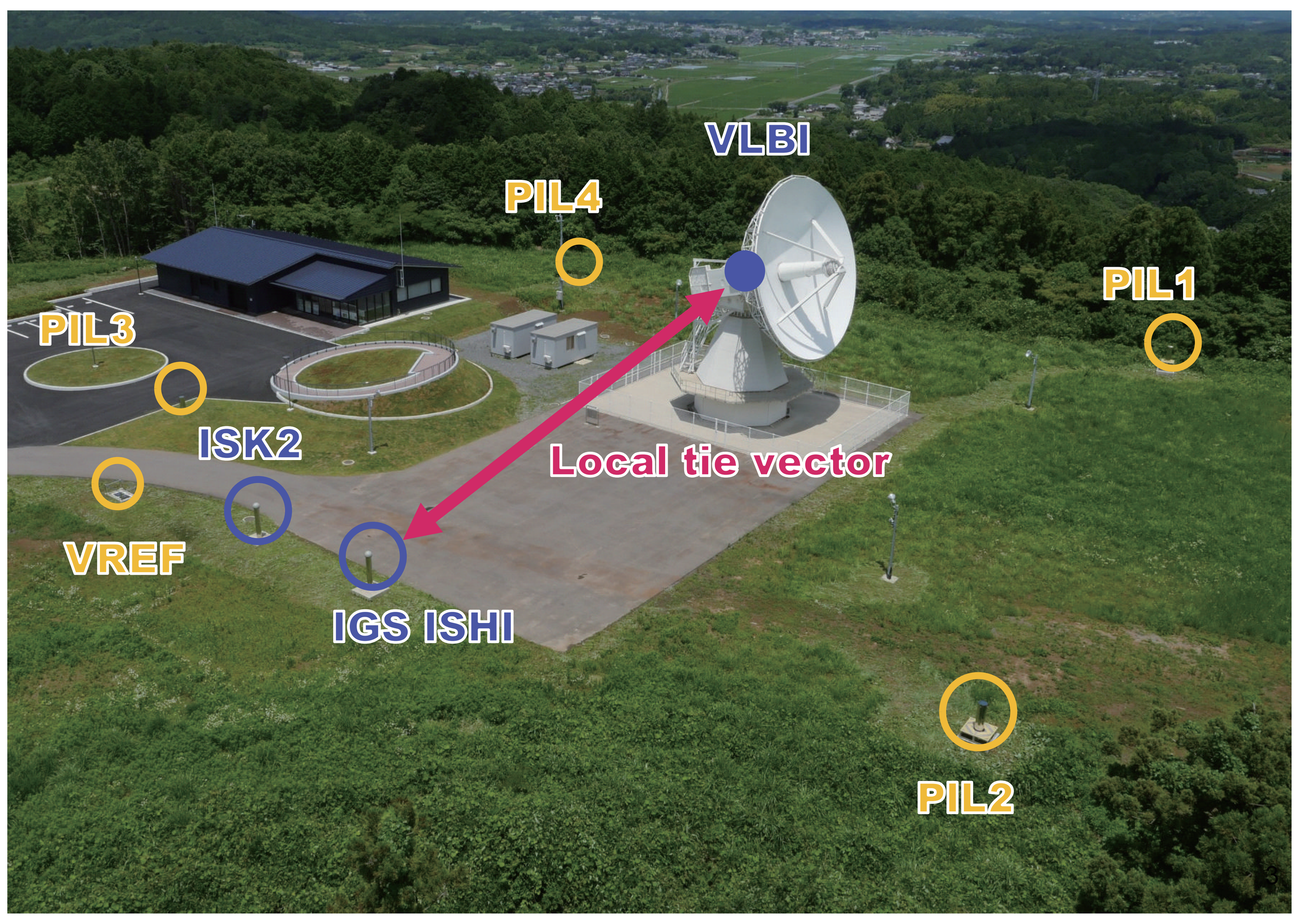

Fig. 1 Outlook of Ishioka VLBI station

2. Determination of the IVP of the VLBI antenna

The IVP of the VLBI antenna is defined as the intersection of azumuth and elevation axis. Its position should be determined indirectly since it is not directry observable.

2-1 Outside method

In the outside method, the target on the antenna is observed from the refernce pillars while moving the antenna direction. The target should be on the sphere whose center is the IVP.

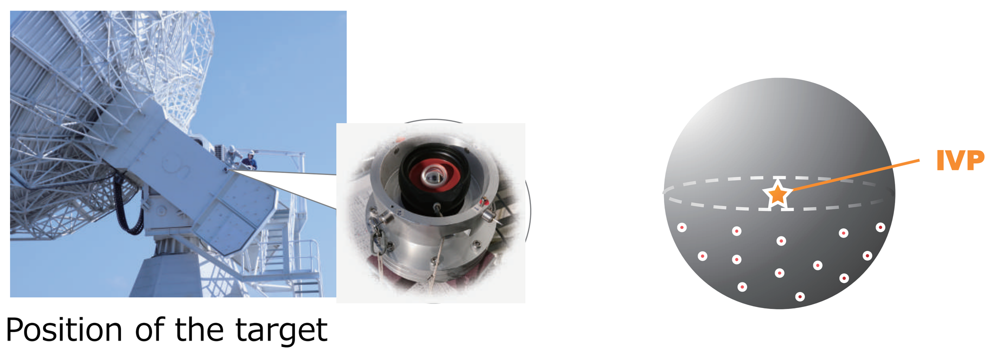

Fig. 2 The outline of the outside method

2-2 Inside method

In the inside method, the targets on the cabin wall are observed from the cabin base, which does not follow the antenna movement. Targets should be on the circles whose centers are on the azimuth/elevatoin axis.
The IVP is given as their intersection.

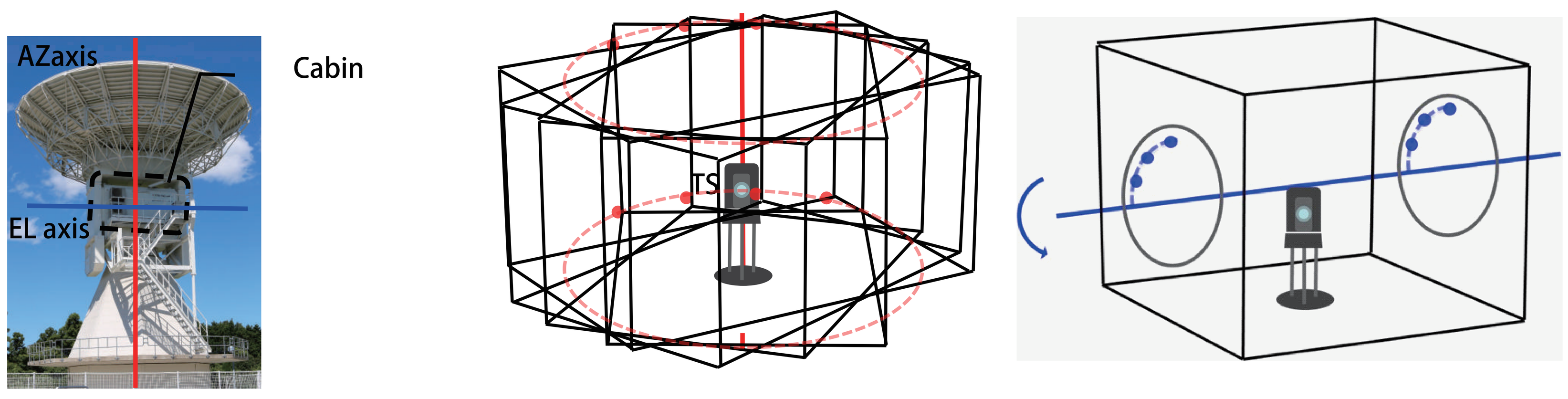

Fig. 3 The outline of the inside method

3. Results

3-1 Outside method

Fig. 4 (left) shows the traces of the target projected on the horizontal plane. Fig. 4 (right) shows the scatter of the target from the assumed sphere. Both figures show that the assumption that the target traces are on the sphere whose center is the IVP is appropriate. In fact, the deviations from the sphere are generally below 1 mm.

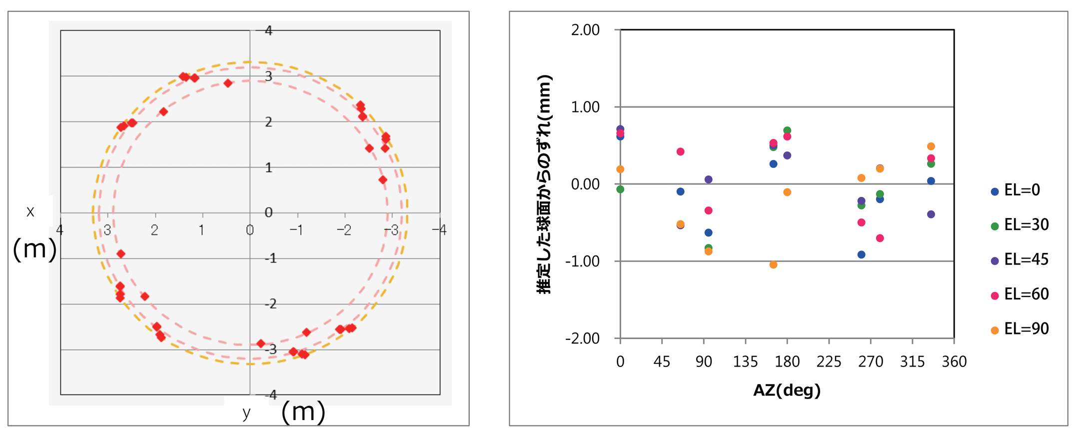

Fig. 4 (left) Traces of the target projected on the horizontal plane
(right) Deviation of the target from the sphere

3-2 Inside method

We estimated one azimuth axis and two elevation axes (azimuth=125, 215 degrees, respectively).
In Fig. 5 we summarized the estimated axes and the offsets/angles between them. Note that the offsets between the axes are small (~0.2 mm) and orthogonality of the azimuth/elevation axes holds to a high precision.

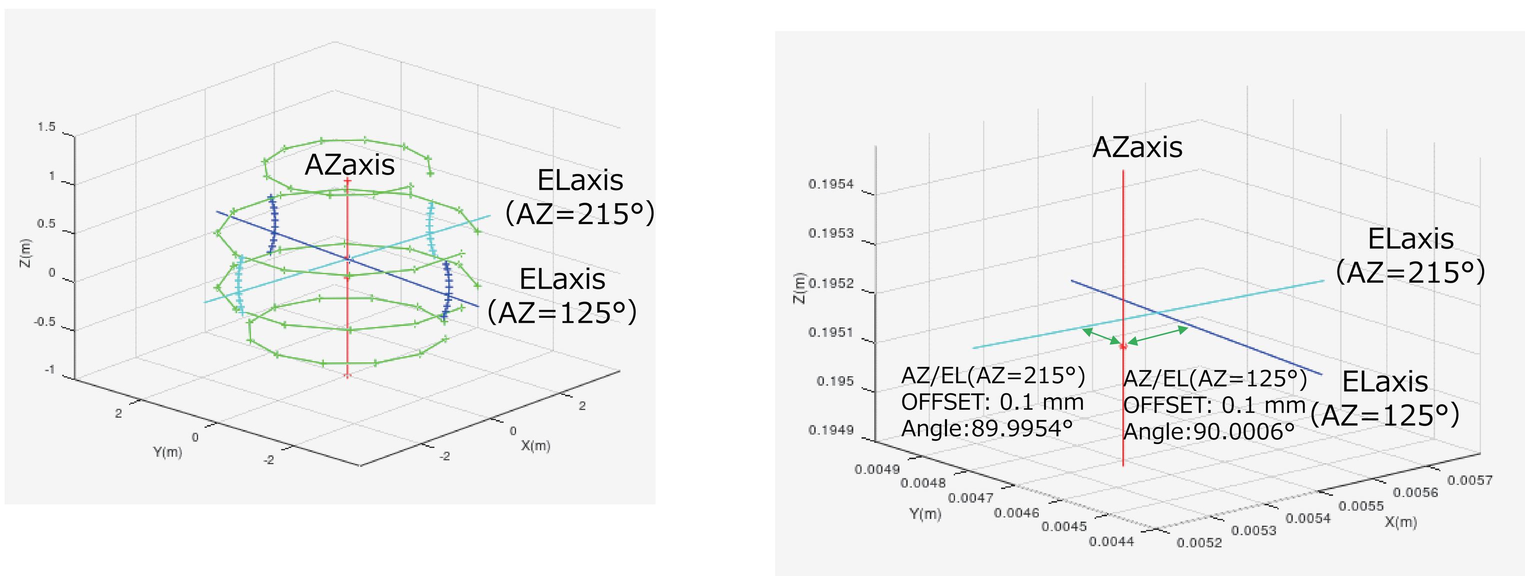

Fig. 5 (left) Estimated azimuth/elevation axes
(right) Offsets/angles between the axes

3-3 Comparizon of local tie vectors obtained by the two methods

The estimated positions of the VLBI IVP and ISHI in ITRF 2014 obtained by the inside method are shown in Table 1, and comparizon of the local tie vectors by the inside/outside methods are given in Table 2. Note that local tie vectors estimated by two different methods agree within a few mm.

Table. 1 The positions of the VLBI IVP and ISHI

	X (m)	Y (m)	Z (m)
VLBI IVP	3959648.8907 (0.0021)	3296836.3330 (0.0023)	3747005.4978 (0.0022)
ISHI	3959636.1498 (0.0022)	3296825.4718 (0.0023)	3747042.5934 (0.0022)

Table. 2 Comparison of the estimated local tie vectors

	X (m)	Y (m)	Z (m)	Baseline (m)
VLBI IVP →ISHI (Outside method)	-12.7412	10.8590	-37.0955	40.6981
VLB IVP →ISHI (Inside method)	-12.7408 (0.0006)	10.8612 (0.0006)	-37.0957 (0.0005)	40.6987

Acknowledgements

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