

VLBI-GNSS co-location survey at the Ishioka Geodetic Observing Station in 2018 and 2020

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Abstract

At Ishioka Geodetic Observing Station, we conducted **co-location** in November 2018 and September 2020 to determine a **local-tie vector between the Ishioka VLBI antenna and the IGS station ISHI**. To determine the position of the VLBI antenna invariant point (IVP), which is defined as the intersection of azimuth (AZ) and elevation (EL) axes, we adopted the “**inside method**.” In this method, we observe targets attached inside the cabin from the fixed point inside the cabin and estimate the IVP from their trajectory. The results for 2018 and 2020 were consistent with each other within a few mm. We **submitted these results to IERS for ITRF2020** in February 2021.

1. Introduction

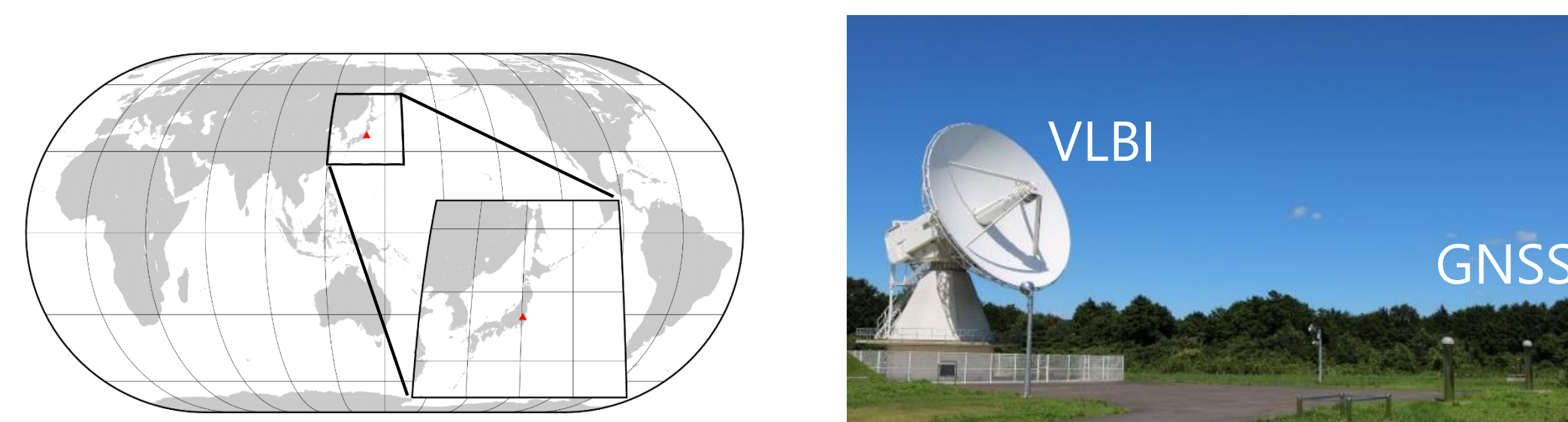


Figure 1 Location (left) and view (right) of Ishioka Geodetic Observing Station

- Ishioka Geodetic Observing Station (hereinafter simply referred to as Ishioka), located in Ishioka-city, Japan, operates an VLBI antenna, which regularly participates in IVS sessions, and a GNSS station registered as an IGS station “ISHI” (Fig. 1).
- To determine the local-tie vector between the VLBI antenna invariant point and the phase centre of the GNSS antenna, we regularly conduct co-location.
- Since the survey in 2018, we have adopted “inside method” (Munekane et al., 2019) to estimate the IVP. It makes the observation more efficient.
- In this poster, we describe how to measure with the inside method and show the results for the surveys in 2018 and 2020, which were submitted to IERS for ITRF2020.

Acknowledgements

We would like to thank Land Information New Zealand (LINZ) for making the pyaxis software publicly available (<https://github.com/linz/python-linz-pyaxis>).

References

Munekane et al. (2019) VLBI-GNSS collocation survey at the Ishioka VLBI station, Proceedings of the 24th European VLBI Group for Geodesy and Astronomy Working Meeting, pp. 80-83.

2. Method

● Overview of co-location survey

At Ishioka, we estimate the local-tie vector using four pillars installed around the VLBI antenna (Fig. 2). Observation in co-location can be divided into the following four steps (Fig. 3).

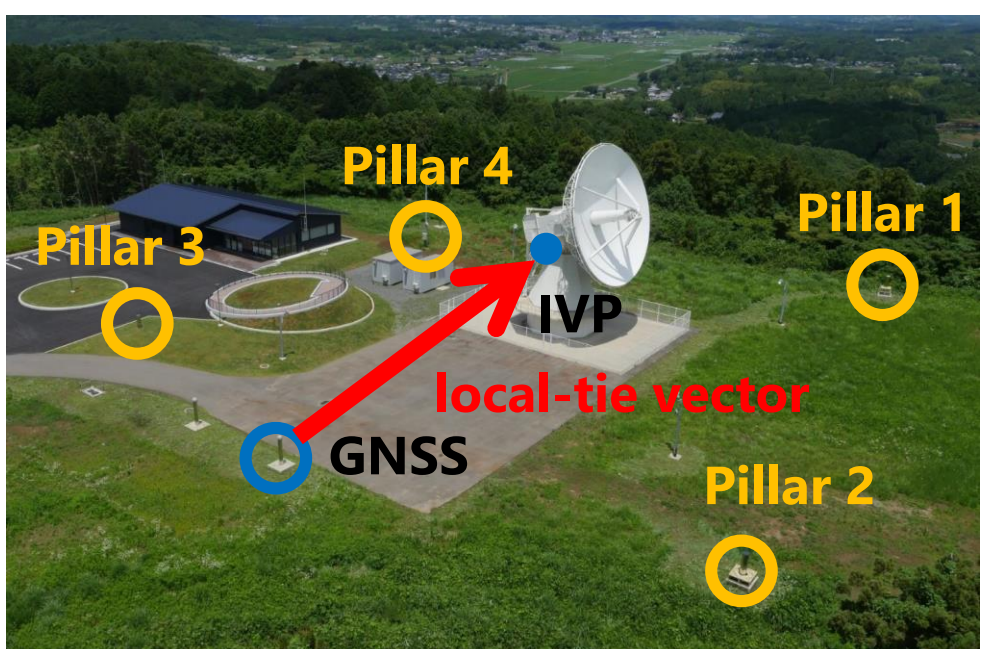


Figure 2 Panoramic view of Ishioka. Four pillars are installed to conduct colocation.

- Step 1** Measure the relative position of the pillars (A, D, L)
 - Step 2** Measure the position of phase centre of the GNSS antenna (A, D, L)
 - Step 3** Measure the position of the IVP (A, D)
 - Step 4** Determine the orientation angle (G, A)
- A: angle measurement, D: distance measurement, L: leveling, G: GNSS survey

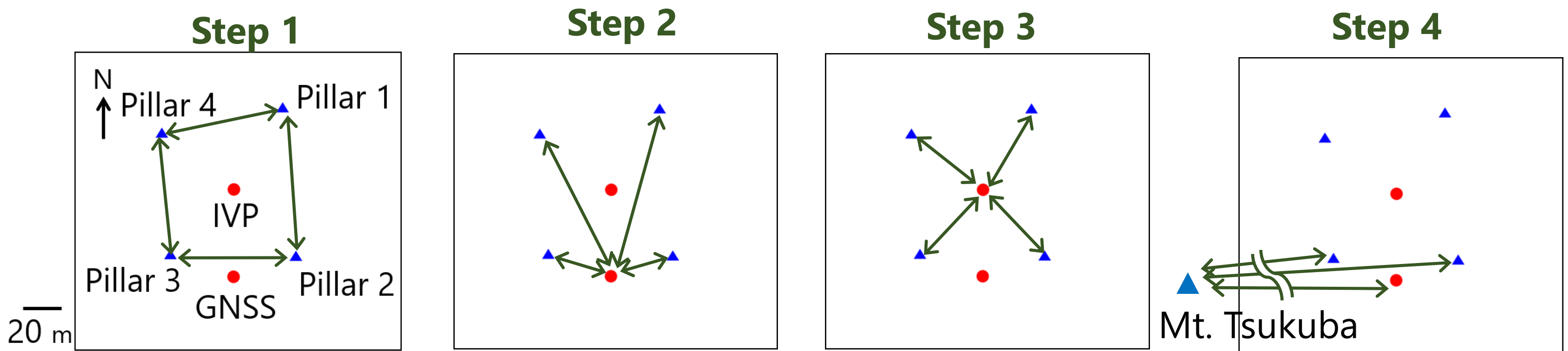


Figure 3 Observation of co-location can be divided into four steps.

● Inside method

- In case that the IVP cannot be observed directly, it has to be estimated from the trajectory that targets attached to the antenna draw when the azimuth/elevation angle is changed slightly.
- In the widely used method, which we call “outside method,” targets attached to the moving part of the antenna, e.g. the dish, are observed from around the antenna.
- In the survey at Ishioka, we adopted “inside method” to estimate the IVP. In this method, different from the outside method, targets are attached inside the AZ cabin and they are observed from the total station (TS) mounted on the pillar inside the cabin (Fig. 4).

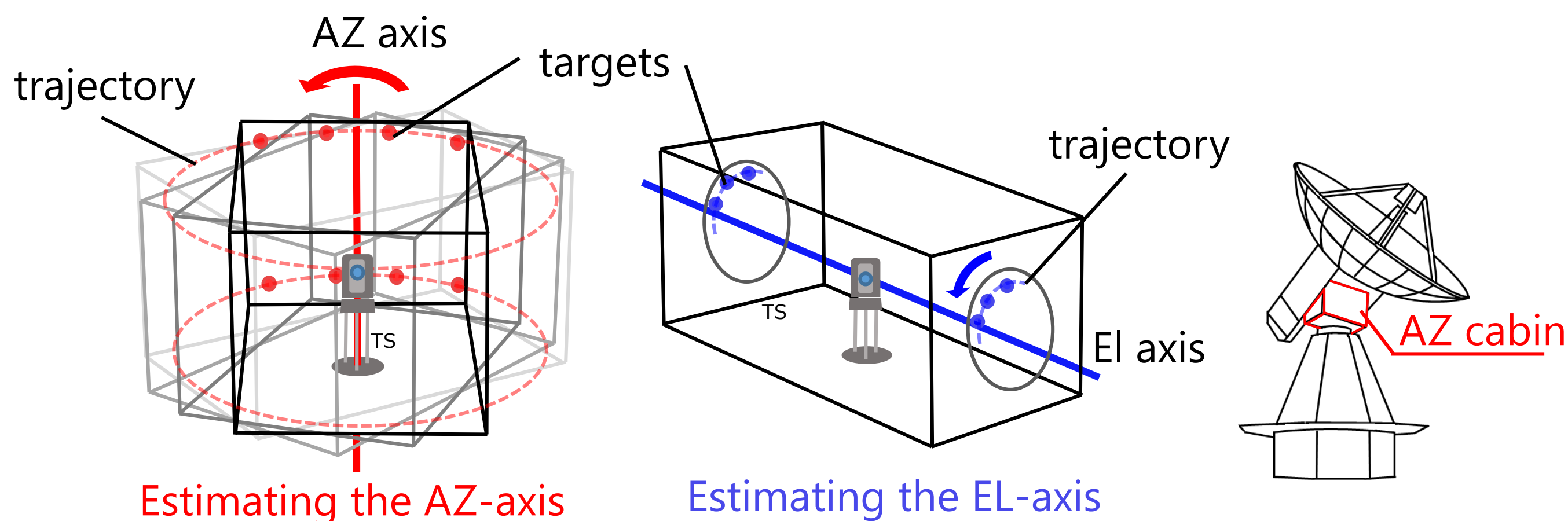


Figure 4 In the inside method, targets attached inside the AZ cabin are observed from TS mounted on the pillar inside the AZ cabin. The pillar does not follow the antenna movement

● Calculation

For calculation, we used pyaxis software developed by LINZ. It can deal with the observation data for all of the steps described above and estimate the IVP as the intersection of AZ/EL axes.

3. Results & discussion

● Results for the co-location in 2018 & 2020

Table 1 shows the local-tie vector from the 2018 and 2020 surveys. Both were determined by using the inside method. They agree within a few mm. We submitted the results in SINEX format to IERS for ITRF 2020.

Table 1 Local-tie vector determined by the 2018 and 2020 surveys				
	East (m)	North (m)	Up (m)	Baseline (m)
2018	0.1961 ± 0.0010	39.8206 ± 0.0007	8.4063 ± 0.0010	40.6987
2020	0.1966 ± 0.0006	39.8186 ± 0.0005	8.4059 ± 0.0011	40.6967
Difference	0.0005	-0.0020	-0.0004	-0.0020

● Discussion

Comparison of inside and outside method

Accuracy In 2018, we also carried out a co-location by outside method. The result, shown in Table 2, agrees with that for inside method within 1 mm. It indicates that both the method give the same results with accuracy of 1 mm.

Table 2 Local-tie vector determined by the 2018 survey (outside method)				
	East (m)	North (m)	Up (m)	Baseline (m)
2018 (outside)	0.1967 ± 0.0005	39.8202 ± 0.0004	8.4062 ± 0.0011	40.6983
Difference from 2018 inside	0.0006	-0.0004	-0.0001	-0.0004

Efficiency Table 3 shows the number of days and personnel required for the measurement of IVP. Although there is room for efficiency for both methods, it indicates that the inside method is more efficient. This is because all the observation for the measurement of IVP can be done from one pillar for the inside method while observation from the four pillars is necessary to obtain the sufficient number of data for the outside method.

	days	personnel (/day)	Table 3 Number of days and personnel required for inside and outside method in the 2018 survey
inside method	1	5	
outside method	7	6-9	

Difference between the results for 2018 and 2020

Although results for the surveys in 2018 and 2020 were consistent with each other in a few mm, there is still a difference. Even though Ishioka has undergone large post-seismic deformation caused by the 2011 off the Pacific coast of Tohoku earthquake, the difference of 2mm/40m=5x10⁻⁵ is too large to attribute to the deformation. In order to evaluate the accuracy of the local-tie vector, it is necessary to conduct the survey and monitor the local-tie vector regularly.

4. Summary

- We conducted co-location in 2018 and 2020 to obtain the local-tie vector between the phase centre of the GNSS antenna of the IGS station “ISHI” and the VLBI antenna invariant point.
- We adopted “inside method” for the measurement of the IVP and it was found to be more efficient than the “outside method”, which is usually used.
- The results for 2018 and 2020 were consistent with each other. We submitted them to IERS for ITRF2020.
- We continue to conduct co-location regularly to monitor the local-tie vector.