SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
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In-situ Calibration of CTBTO Seismic Monitoring Stations in Indonesia

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INTRODUCTION AND MAIN RESULTS

An in-situ calibration was carried out at the CTBTO seismic monitoring station AS-040 LEM in Lembang, West Java. A Trillium-120 reference seismometer calibrated at NMI was compared with a co-located STS-2 using the Gabrielson method implemented in Python GUI.

The results showed deviations below ±5% from the nominal 1500 V/(m/s) datasheet sensitivity value.

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Methodology

This study applied an in-situ calibration approach at the CTBTO seismic monitoring station AS-040 LEM in Lembang, West Java. A Trillium-120 broadband seismometer, previously calibrated at the National Metrological Institute (NMI), was deployed as the reference sensor (REF) alongside a co-located STS-2 broadband seismometer as the Seismometer Under Test (SUT). The field configuration ensured both instruments recorded the same ground motion simultaneously.

The raw data from REF and SUT were band-pass filtered, segmented, and processed using Welch's method to compute cross- and auto-spectral densities. Segments with coherence ≥0.8 were retained for transfer function estimation based on the Gabrielson method. The sensitivity of the SUT was then calculated from the ratio of output voltages relative to the reference, multiplied by the sensitivity value of the REF as certified by NMI:

$$S_{SUT} = \frac{Volt_{SUT}}{Volt_{REF}} \times S_{REF}$$

The procedure allows the SUT's sensitivity to be directly traceable to international standards (ISO/IEC 17025) through the NMI calibration of the reference sensor.

Results and Discussion

The in-situ calibration was conducted at the CTBTO seismic monitoring station AS-040 LEM in Lembang, West Java. Sensitivity estimates were obtained using the Gabrielson method across different passbands after Butterworth band-pass filtering, and the average values are summarized in Table below.

Uncertainty (Unc) was calculated following the Law of Propagation of Uncertainty (LPU), where Type A components represent statistical repeatability of the measurements, and Type B components come from the instrument datasheet, including device accuracy and resolution.

According to the datasheet, the nominal sensitivity of the STS-2 broadband seismometer is 1500 V/(m/s). The in-situ results show deviations of 5.3% for the Up–Down (UD) component, 2.1% for the North–South (NS) component, and 4.28% for the East–West (EW) component. These results confirm that the field calibration at the CTBTO station provides reliable estimates in good agreement with the manufacturer's nominal values.

FREQUENCY (Hz)	UD		NS		EW	
	SENSITIVITY (V/(m/s))	U_{NC}	SENSITIVITY (V/(m/s))	U_{NC}	SENSITIVITY (V/(m/s))	U_{NC}
0.10-0.28	1417.04	29.57	1499.96	44.34	1426.87	42.69
0.25-0.55	1401.99	15.19	1498.58	14.67	1435.67	19.84
0.50-1.10	1421.41	18.9	1499.52	7.92	1433.52	10.49
1.00-6.00	1393.14	14.06	1411.85	4.75	1413.19	6.82
5.00-11.00	1468.6	17.63	1432.71	10.57	1469.67	4.67

Conclusion

The in-situ calibration using the developed Python GUI-based software successfully implemented the Gabrielson method, providing automated and traceable sensitivity estimation. Compared to the manufacturer's datasheet value of 1500 V/(m/s), the deviations were below ±5% within the 0.1–11 Hz range. These results demonstrate that the in-situ calibration procedure can be effectively applied at CTBTO–BMKG seismic monitoring stations to ensure traceability and improve calibration efficiency.

BMKG