SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

The Role of Small Seismometers and Infrasound Sensors in On-Site Inspection (OSI) Verification for the CTBT

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INTRODUCTION AND MAIN RESULTS

Small seismometers and infrasound sensors are transformative for CTBT verification.

- Seismometers: used in OSI for passive seismic monitoring (aftershocks, location refinement).
- Infrasound: part of IMS, detects atmospheric signatures of nuclear tests.

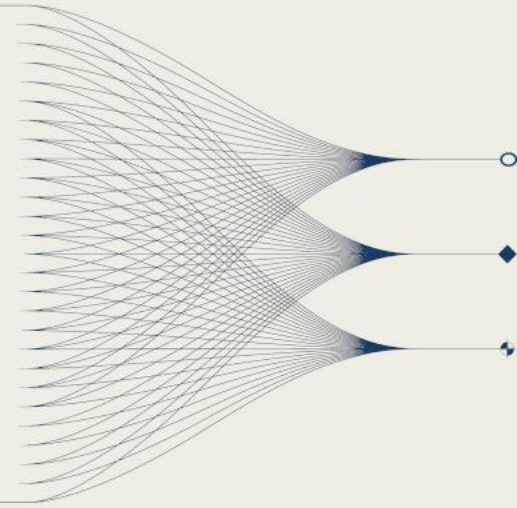
They are affordable, portable, scalable → enhances inclusivity and youth engagement.

Benefits: Affordable, portable, scalable, inclusive.

- Enable rapid deployment for OSI and expand IMS outreach potential.

Limitations: Higher noise levels, less sensitivity than traditional IMS instruments.

- Message: Small sensors complement, not replace, IMS-certified equipment.



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Instrument Capabilities (Seismic Sensors)

Feature	Raspberry Shake (RS1D/RS3D/RS4D)	Broadband Seismometers
Frequency Response	0.7–44 Hz (geophones), DC–44 Hz (RS4D MEMS)	120s (~0.008 Hz) – 50 Hz
Self-Noise	Higher; limits very small event detection	Very low; below Peterson NLNM
Minimum Detection	M2.0–2.5 within 50 km	<M1.0 routinely
Dynamic Range	24-bit ADC, ~126 dB effective	24-bit ADC, 140–150 dB
Clip Level	±21 mm/s (geo), ±2g (accel)	±20g accel; no saturation
Timing	NTP ±10 ms, optional GPS	GPS µs accuracy
Installation	Plug-and-play; homes/schools	Vault/borehole; quiet sites
Cost	$550–$1,100	$10,000–$30,000+

Field Performance (from Studies)

Study	Raspberry Shake Performance	Broadband Performance
Hughes (NZ, 2025)	Improved event location, noisier	Precise, low-noise catalogs
Paul (Haiti, 2023)	Detected M2.2 near-field	Detected smaller events
Subedi (Nepal, 2024)	Catalog comparable to observatory	Broader, quieter coverage
Zaharia (Romania, 2023)	Recorded Vrancea quakes (M>4.5)	Recorded all + small quakes
Anthony (ASL, 2018)	Required ~M0.3 larger	Detected smaller, teleseisms

Comparison of Infrasound Sensors (IMS Monitoring)

Sensor	Bandwidth	Sensitivity/Noise	Deployment	Role
Raspberry Boom	0.08–44 Hz	~0.3 mPa RMS	Portable, low-cost	Education, outreach, supplement
RedVox	0.1–50 Hz (phone mic)	Higher noise	Crowdsourced, smartphone-based	Citizen data, rapid response
Chaparral 60S	0.01–245 Hz	1.1 mPa RMS	IMS arrays	IMS standard, low noise
MB3a/MB3d	0.01–28 Hz	0.13 mPa/√Hz @ 1 Hz	IMS-certified	IMS backbone
SIS-1	0.063–50 Hz	Below LNM <1 Hz	Rugged, portable	IMS field deployment

Application in On-Site Inspection (OSI)

- Seismometers (e.g., Raspberry Shake) used during passive seismic monitoring.
- Detect aftershocks to refine event location within the inspection area.
- Portable and adaptable to challenging terrains for OSI deployment.
- Enhance OSI mission efficiency by reducing uncertainties in event characterization.

Application in IMS (Infrasound)

- Infrasound arrays (Chaparral, MB-series, SIS-1) detect atmospheric signatures of nuclear tests.
- Part of the IMS global backbone (60+ certified stations).
- Provide continuous, low-noise, high-fidelity monitoring of ultra-low frequency acoustic signals.
- Small infrasound sensors (RBOOM, RedVox) are not IMS-certified but support education and outreach.

Scalability & Inclusivity

- Small sensors enable dense, flexible networks → improved detection thresholds.
- Provide hands-on training opportunities for young scientists.
- Bridge scientific capacity with global non-proliferation goals.

Conclusion

- Small seismometers = OSI tools for passive seismic monitoring.
- Certified Infrasound sensors = IMS backbone for atmospheric monitoring.
- Together: strengthen CTBT verification regime, training, and inclusivity.
- Small sensors complement, not replace, IMS-certified equipment