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# Processing Strong and Weak Motion Data from a Combined Instrument to Verify Calibration and Maximize Dynamic Range

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Co-locating weak-motion seismometers with strong-motion accelerometers enables monitoring of seismicity at all scales, from the largest earthquakes to background-level microtremors. However, a combined analysis depends on having comparable data from both instruments, installed at the same depth, accurately aligned in the same package, and precisely calibrated so they can produce equivalent data, i.e. the same ground motion velocity or acceleration signals after response correction.

We present data from recent earthquake sequences in the Hualien region of Taiwan, captured by dual downhole sensors (Cascadia Slim Posthole) in the Downhole Seismic Observation Network of Taiwan CWA. In this example the seismometer and accelerometer signals match within 0.5% on average after response correction, allowing for the synthesis of a combined data stream with an unprecedented dynamic range of 220 dB. Algorithms for optimal combination of the data are discussed and demonstrated.

This processing also enables a new quality assurance metric for calibration accuracy. Previously, it has only been possible to verify this by running a calibration test procedure, typically no more often than once a year, since the test process is laborious and interrupts normal data collection. However, in analyzing data from a dual instrument, the response-corrected amplitude ratio of the strong and weak-motion data streams can be continuously measured and reported as a state-of-health metric, to verify that the two instruments are operating correctly and measuring ground motion with the same accuracy in terms of sensitivity and frequency response.