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# Evaluation of installation methods for STS-2 seismometers

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In the course of the upgrade of the Gräfenberg Array (GRF) from Streckeisen STS-1 seismometers with 20 sec free period to STS-2 seismometers with 120 sec free period the question of how best to install the sensors was reconsidered. It was understood early on that the Streckeisen STS-1 seismometers need elaborate shielding in order to reach their full potential. Because some of the experience gained with the shielding of the STS-1 entered the design of the casing of the STS-2, it was not clear what kind of additional shielding was needed for getting best results with the STS-2. Since the first deployments of STS-2s starting with the German Regional Seismic Network (GRSN) in 1991, different types of insulations have been tried and it became apparent that the data quality at low frequencies can be markedly improved by extensive shielding of the sensors. In contrast to the STS-1 the STS-2 has a sealed casing such that variable air pressure should not lead to any buoyancy forces on the sensor masses. However, since the warp free design of the sensor does not completely remove pressure induced tilt, Wielandt proposed to install the STS-2 in a sealed container consisting of a thick gabbro base plate and an upside down stainless steel pot as cover (Stuttgart shielding). The German Regional Seismic Network (GRSN) and the Gräfenberg Array (GRF) are so far the only networks which have adopted this shielding. Its principal benefits are three fold: it reduces pressure fluctuations by approximately a factor of 30, reduces temperature fluctuations and keeps the sensor dry.

We inspect two types of signals to make inferences about the STS-2 shielding used by different networks: Horizontal component free mode spectra from the 2004 Sumatra earthquake and vertical component noise spectra tuned for the detection of the per-

manently excited background free oscillations (hum). The networks considered here are the GRSN, the GEOFON network of the GFZ Potsdam, the Swiss SDSnet and the Japanese F-net. Only few of the STS-2s operated by the GEOFON network, the F-net and the SDSnet stations can detect the hum (28, 26 and 19%, respectively), whereas 78% of the GRSN and GRF stations equipped with the Stuttgart shielding give positive results. We primarily attribute this difference to the different kinds of sensor shieldings in these networks. In our comparison of horizontal component spectra of the 2004 Sumatra event we find that the F-net ranks in quality second behind the GRSN but before SDS-net and GEOFON. The elevated noise level in the GEOFON spectra is probably due to the fact that the GEOFON shield is not stiff enough so that variations in ambient air pressure induce large tilt noise. In spite of the lack of side-by-side comparisons of differently shielded seismometers we have found clear indications that the shielding proposed by Wielandt yields by far the least noisy low frequency vertical and horizontal component data. While our study concentrated on the free mode band our findings are certainly also relevant at the frequencies of surface waves and long-period body waves since noise levels in these frequency bands are highly correlated. Based on our study we recommend the use of the Stuttgart shielding for STS-2 based networks.