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Considerations in Event Detection and Location using Small-Aperture Seismic Arrays

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The current trend in Nuclear Explosion Monitoring is the detection, location and identification of seismic events of ever decreasing magnitude. This leads to a large increase in the number of earthquakes needing to be processed and also in the volume of industrial seismicity which should ideally be associated with the correct source. Access to extensive Ground Truth information on industrial mining events in NW Russia and Fennoscandia has provided an excellent basis for evaluation of event location estimates, both fully-automatic and analyst-reviewed. The spread in automatic locations is due to three principal factors: (1) complicated firing sequences which preclude the correct interpretation of the observed arrival sequences, (2) spurious phase identification and association, and (3) the estimation of slowness and azimuth in varying frequency bands. Processing in fixed frequency bands can result in a dramatic improvement in the stability of slowness estimates for a given phase from a given site. However, different frequency bands may be associated with significant biases which vary greatly from band to band - and the frequency band providing the most stable estimates for a given phase can vary greatly from one site to another.

As an example, we examine a series of over 100 military explosions in northern Finland. Waveform correlation analysis indicates that all these events occurred within very close proximity of each other, and automatic location estimates based upon a calibrated template scheme are demonstrated to be far more stable than the corresponding reviewed network solutions. This is because the template specifies the same frequency bands for all events whereas the analyst picks a different band for each event examined. In this case, the band resulting in the most stable direction estimates has neither the best SNR nor the highest beam gain. It is unclear as to how the spectacular improvements possible in site-specific studies can be applied to general detection algorithms.