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Low Frequency Performance of Piezoelectric Accelerometer Nodes versus Geophone Arrays

Pavel Golikov[1], George Barnes[2], Eamonn Murray[2], Amine Ourabah[2], Van Do[3]

1 - Upstream Advanced Research Center, Saudi Aramco

2 - STRYDE

3 - Geophysical Imaging Department Saudi Aramco

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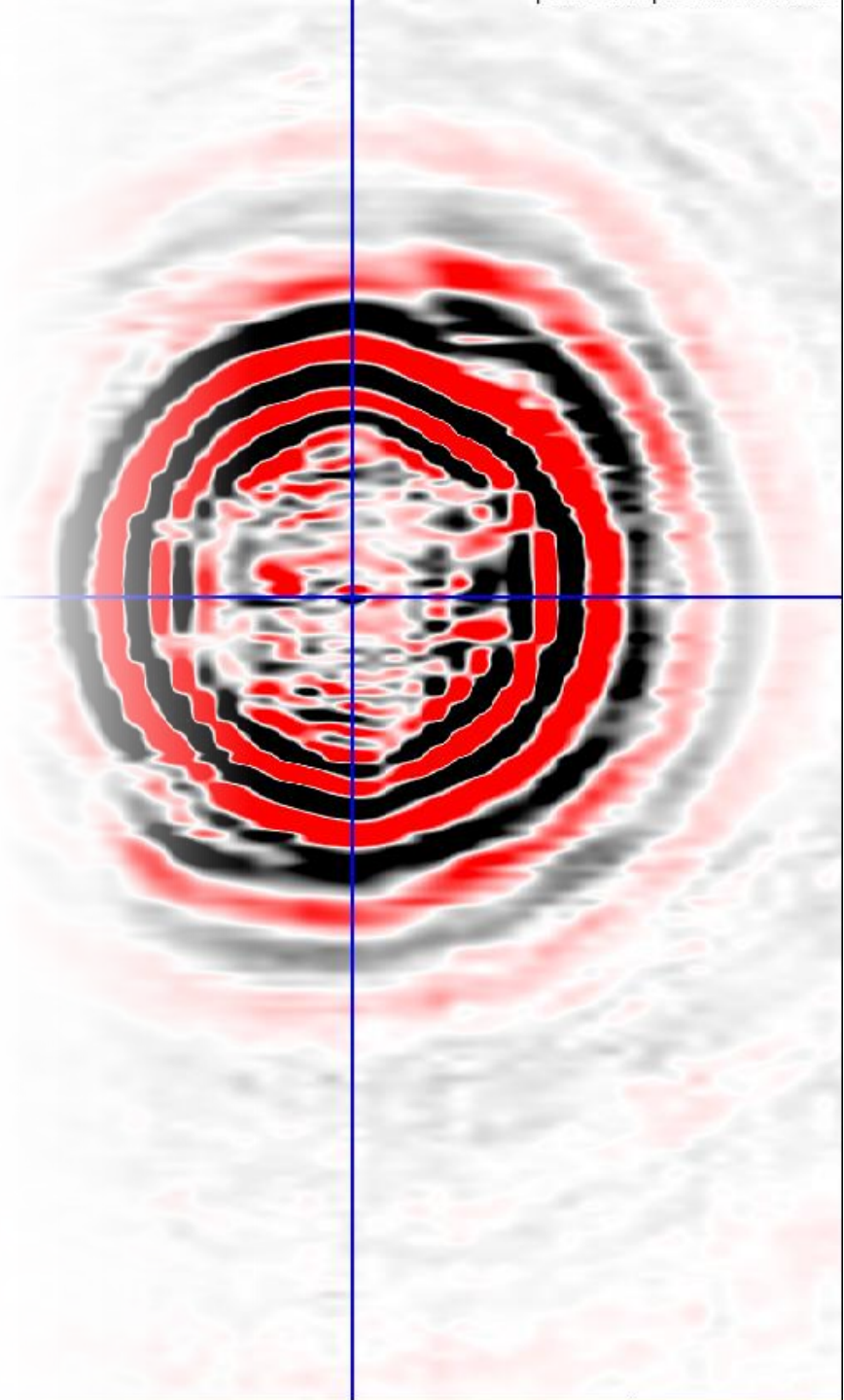
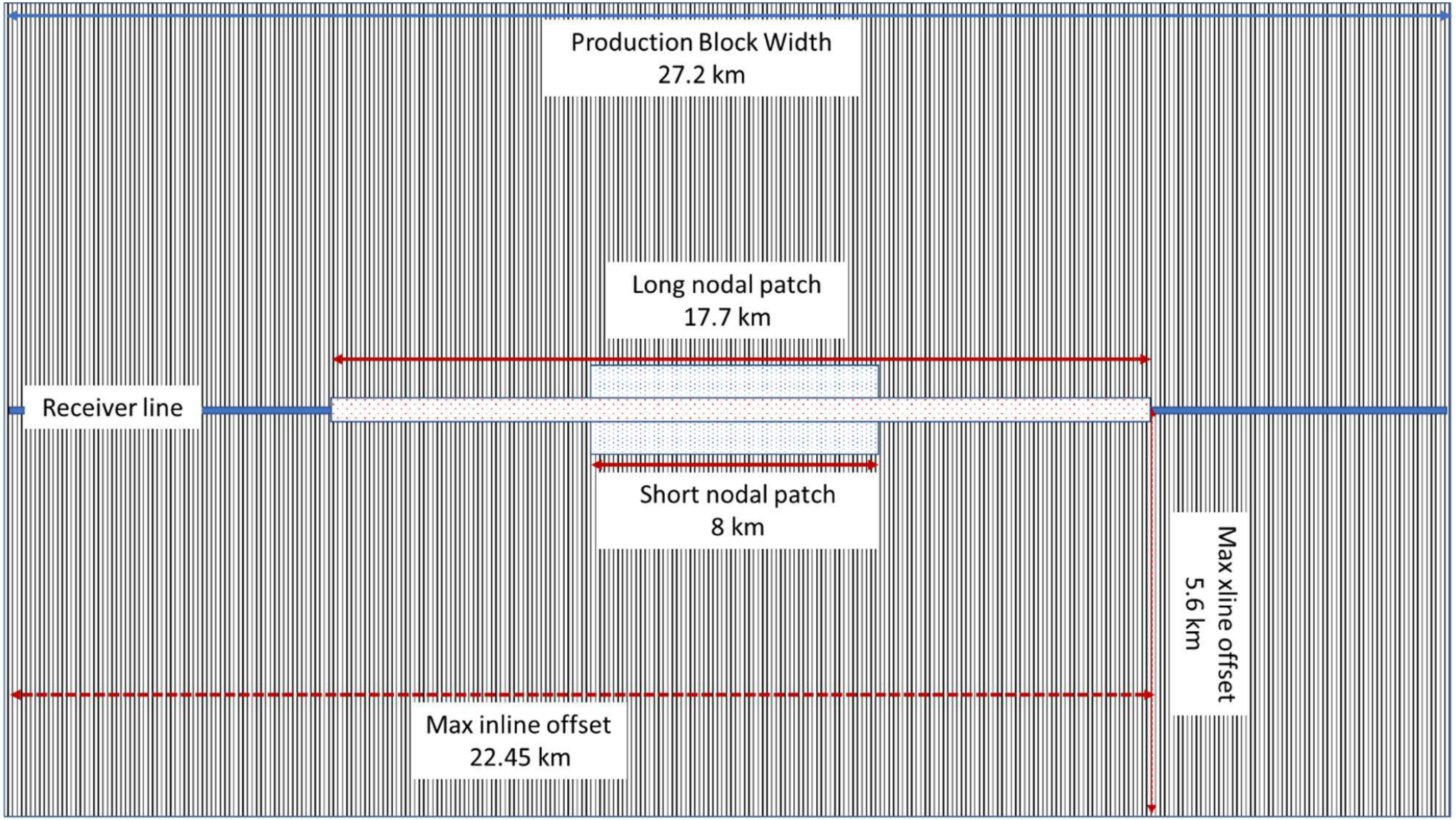
Outline

- Survey design and DGF geometries
- DGF9 vs geophone array
  - Inverse filter application
  - Full frequency range comparison
  - Frequency panels comparison
- Geophone vs DGF9 vs SS
- Time slices analysis
- Conclusions

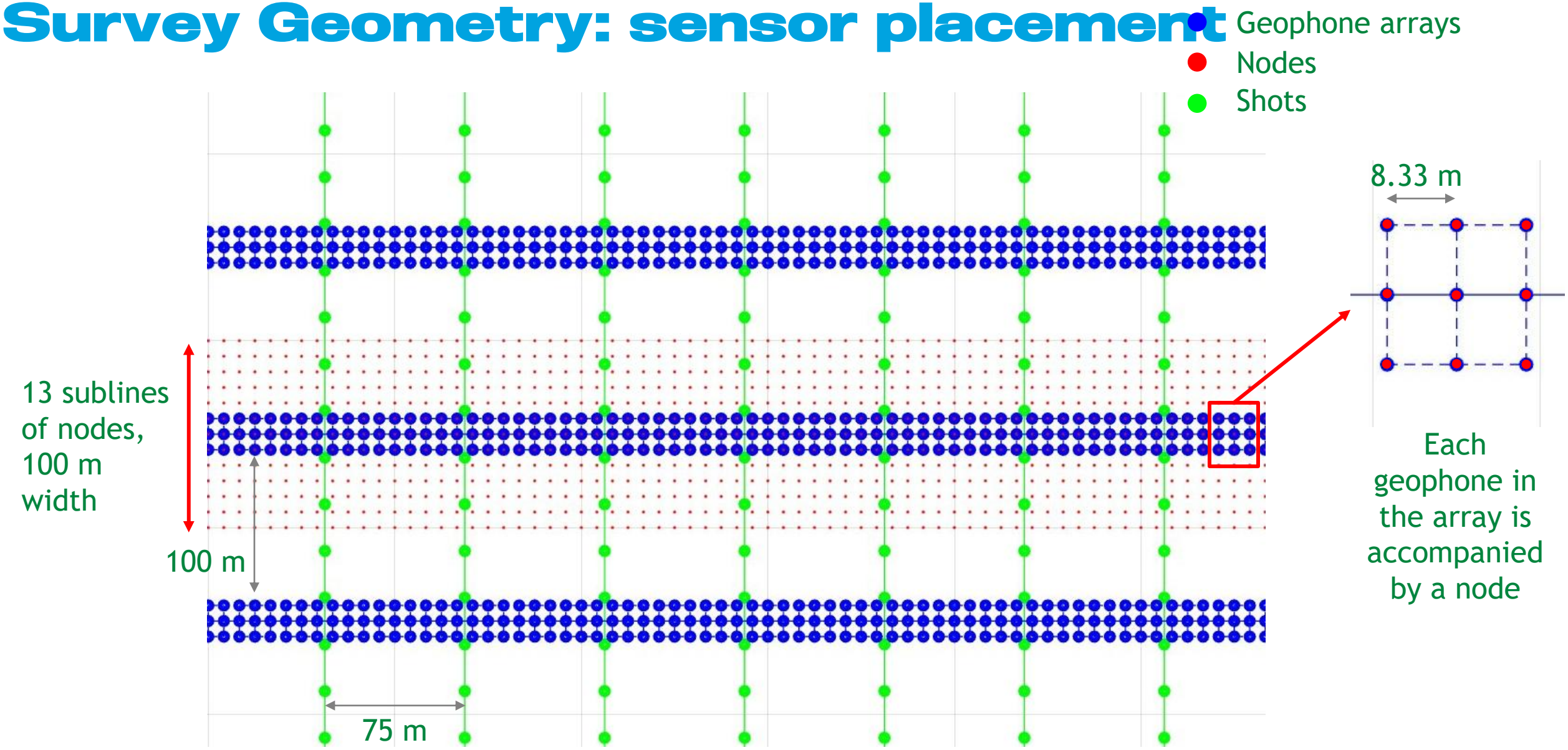


Survey design and DGF geometries

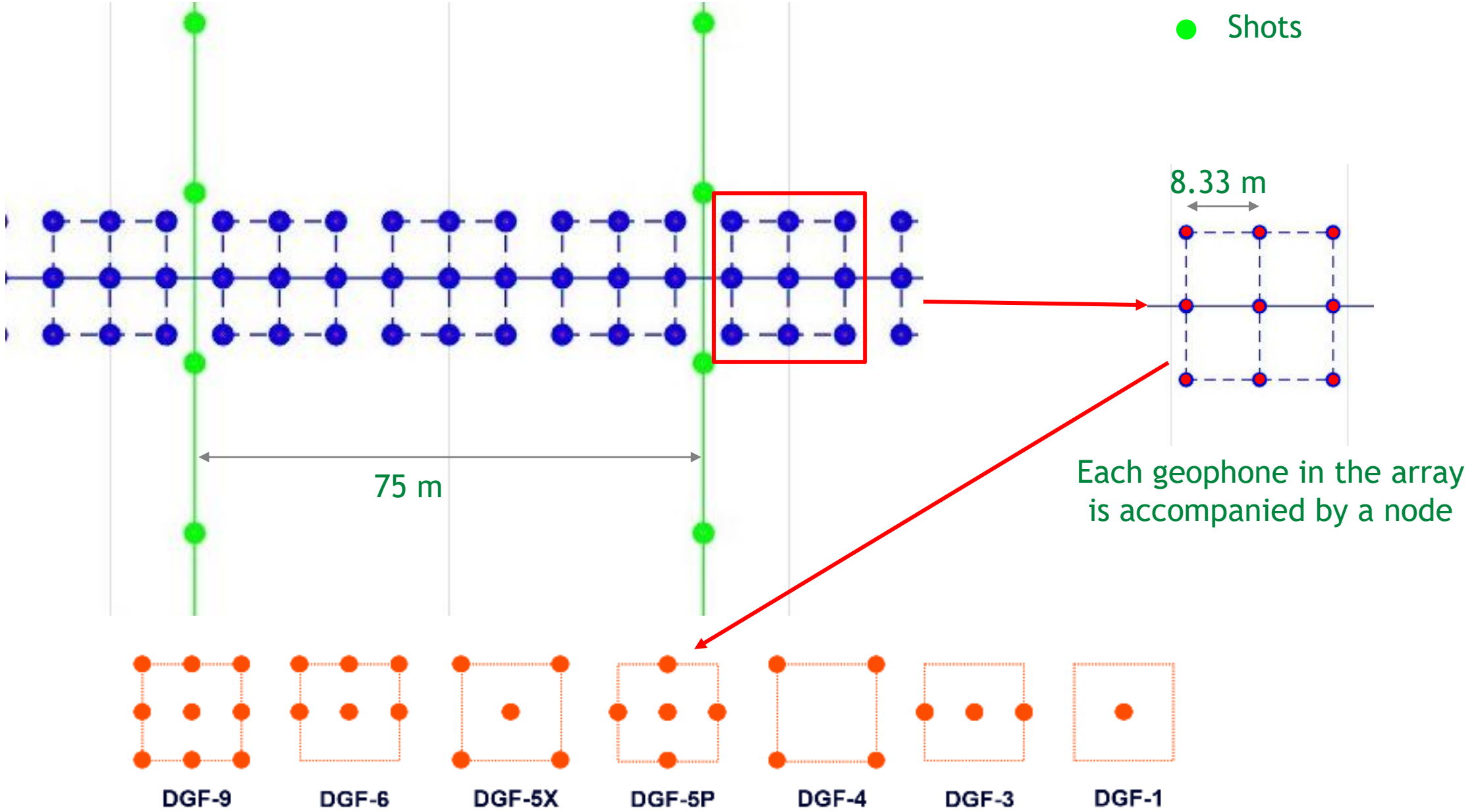
Survey Geometry: general overview



Survey Geometry: sensor placement



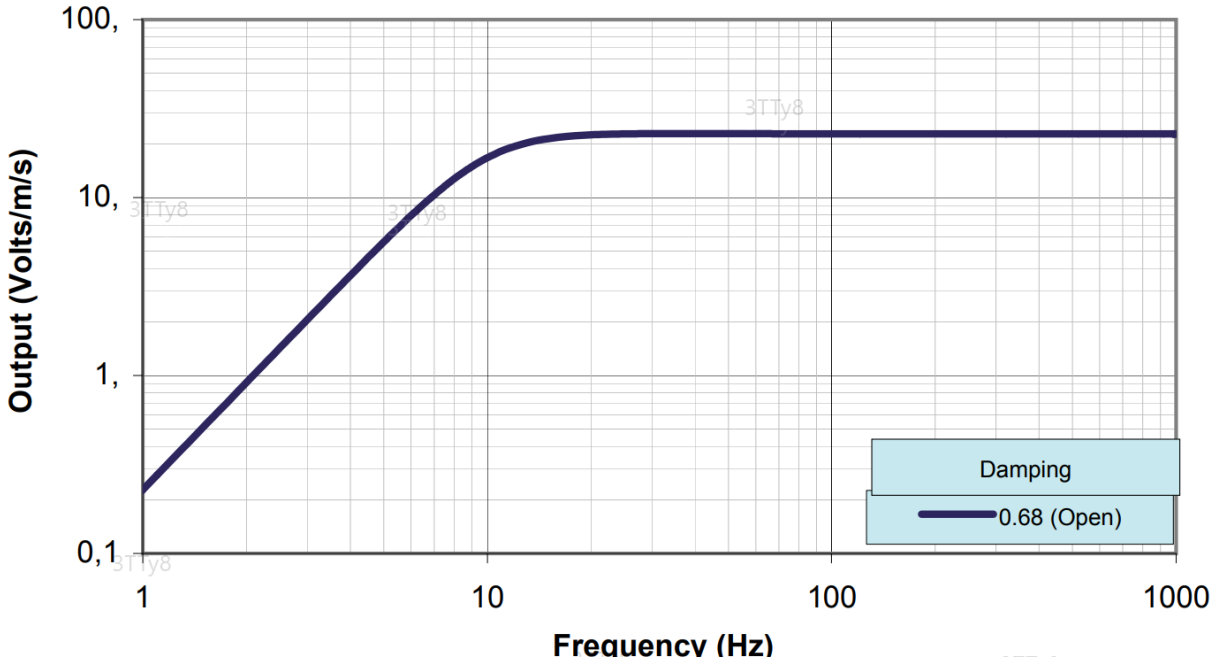
Survey Geometry: DGF definition



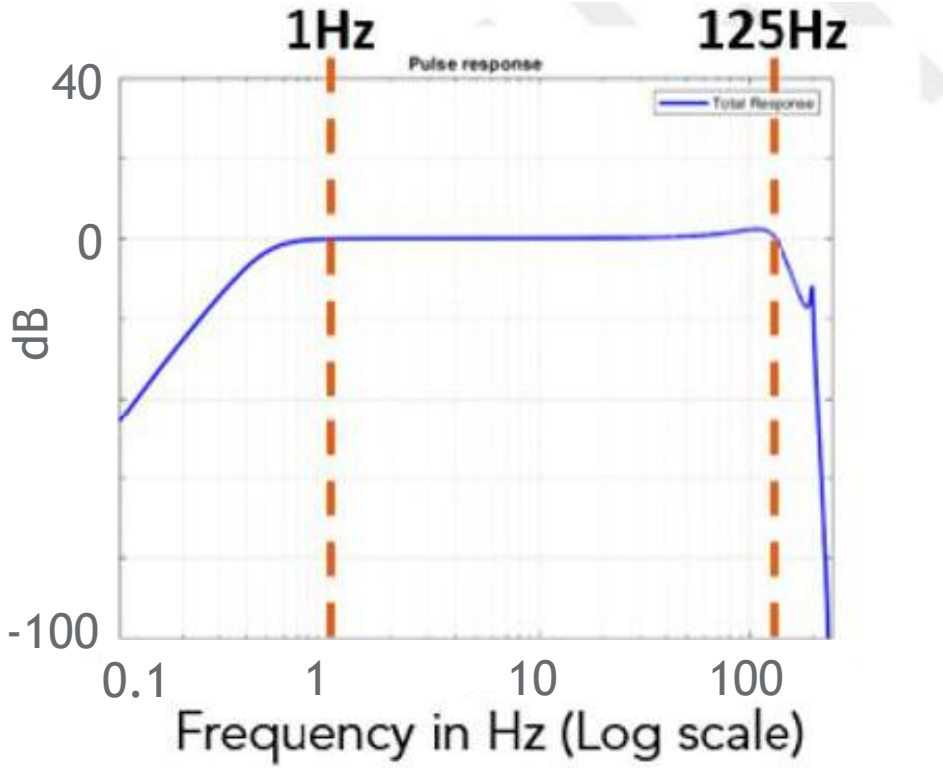
DGF9 vs geophone array

Instrument response

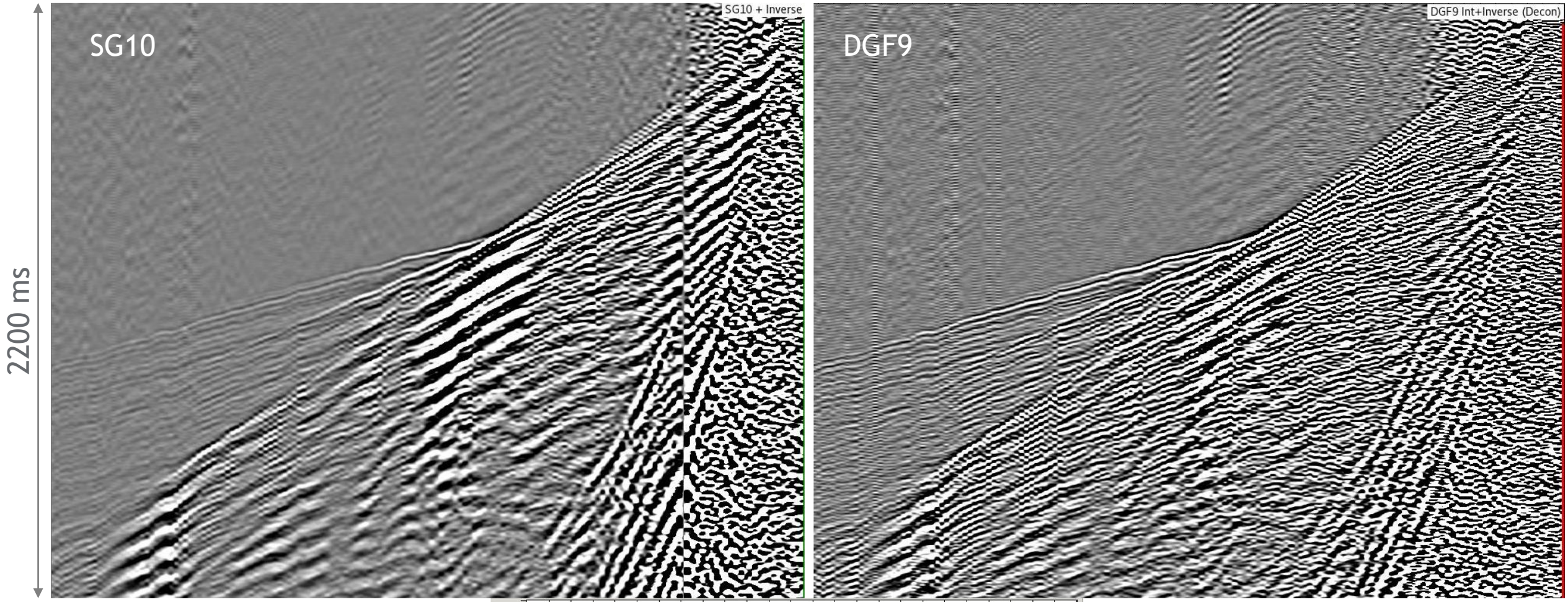
Geophone



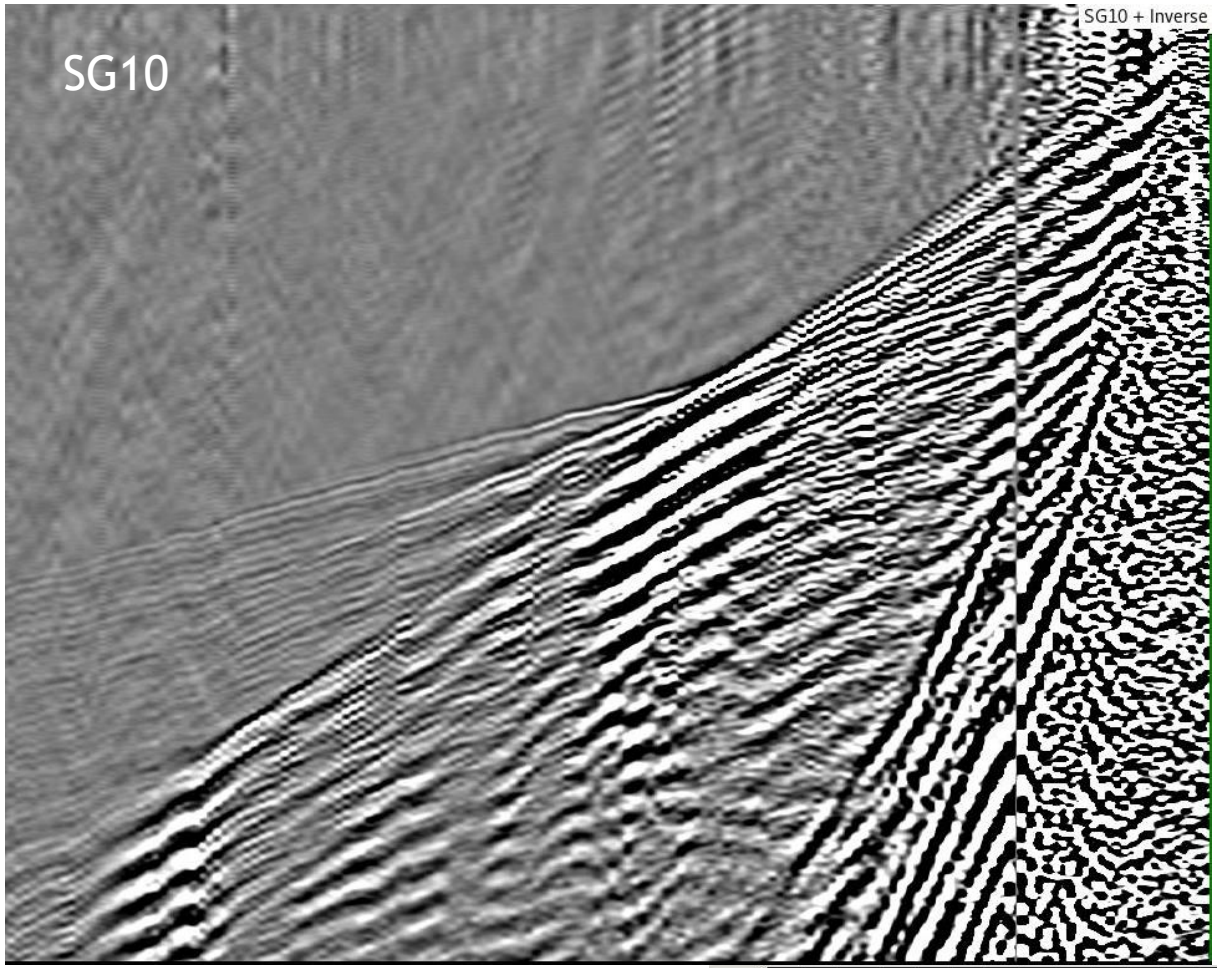
Piezoelectric accelerometer

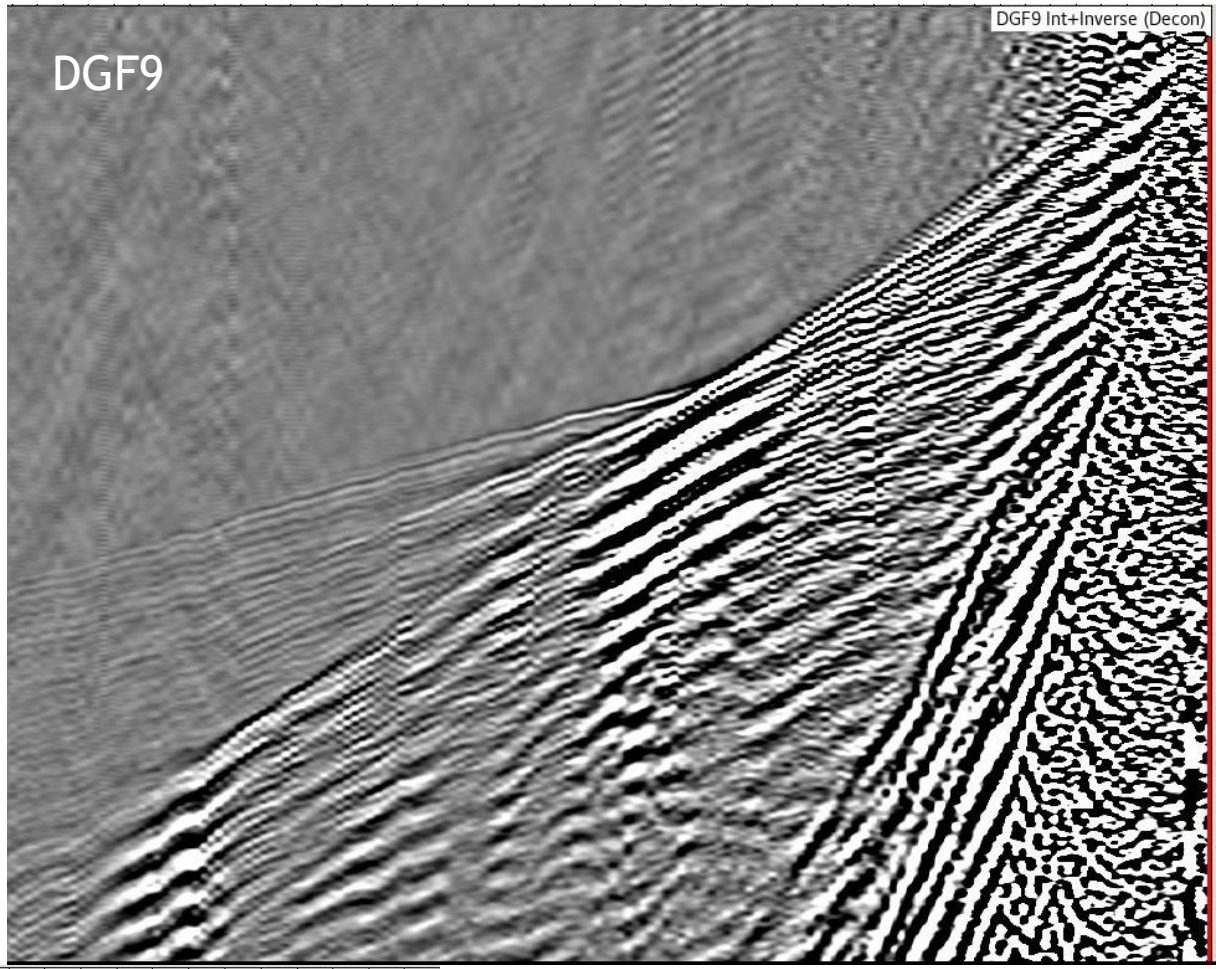


DGF9 vs Geophone array: raw data



DGF9 vs Geophone array: preprocessed



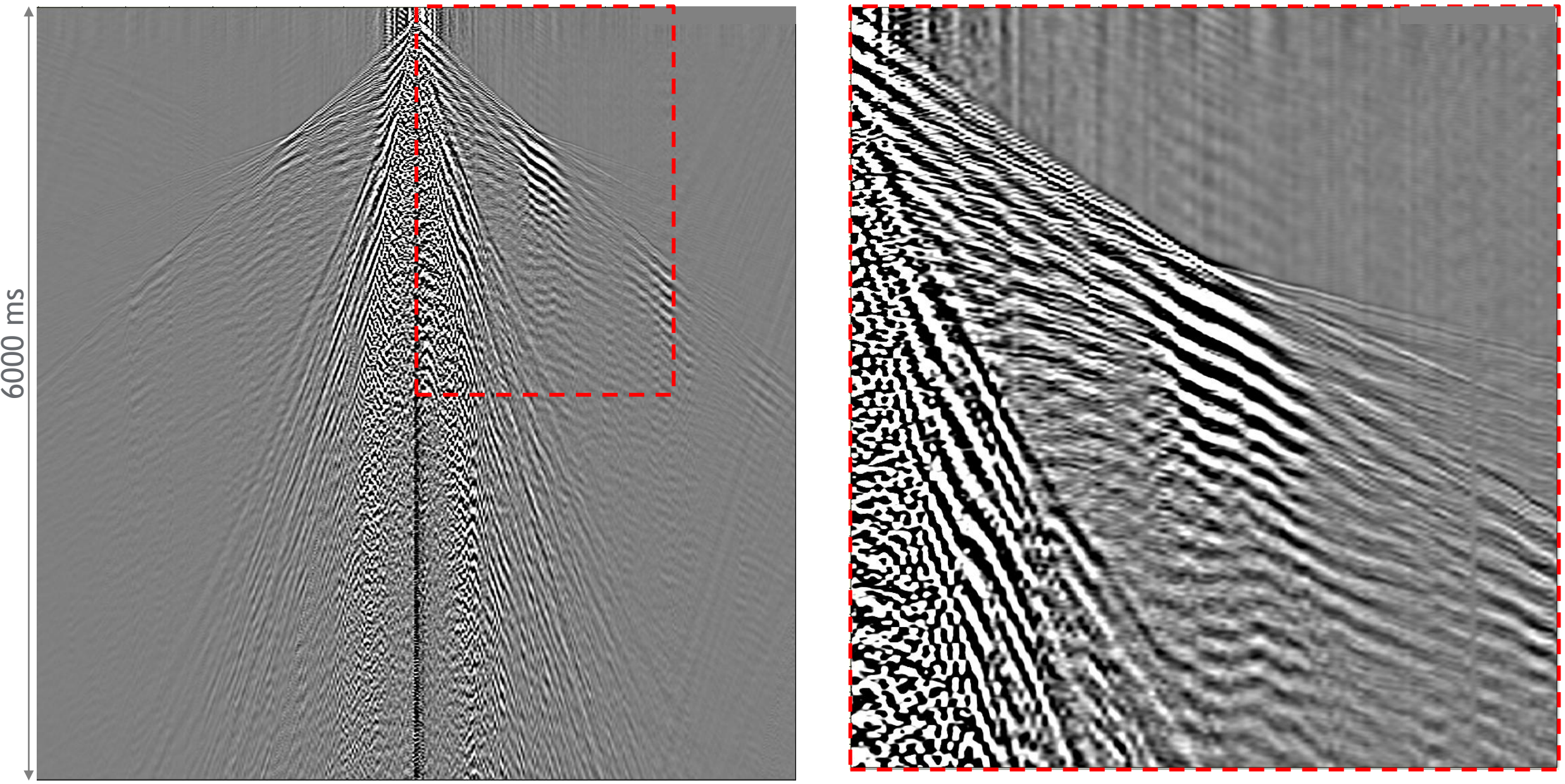


2200 ms

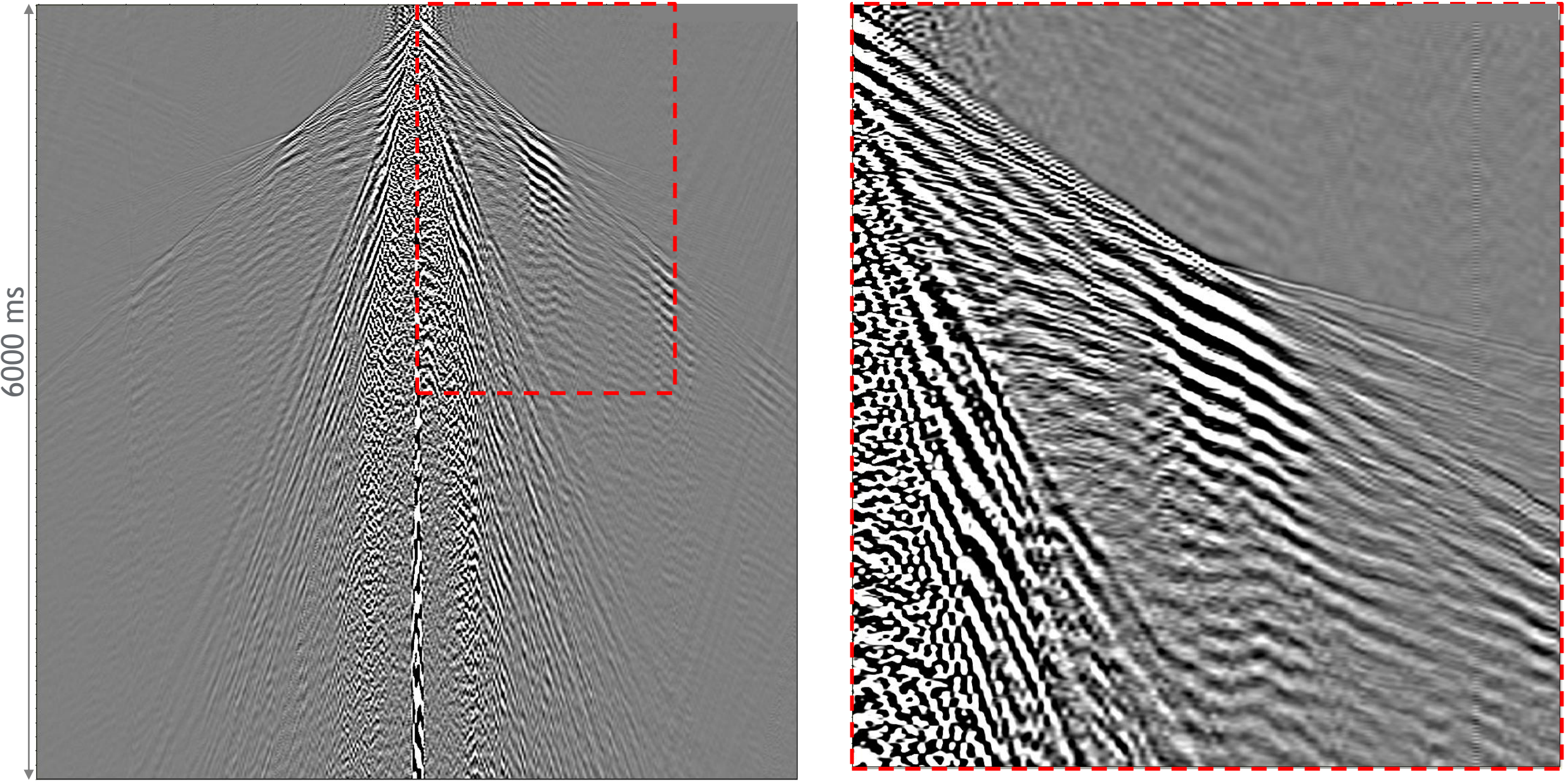
Inverse filter
Low cut up to 1.5Hz

Inverse filter
Low cut up to 1.5Hz

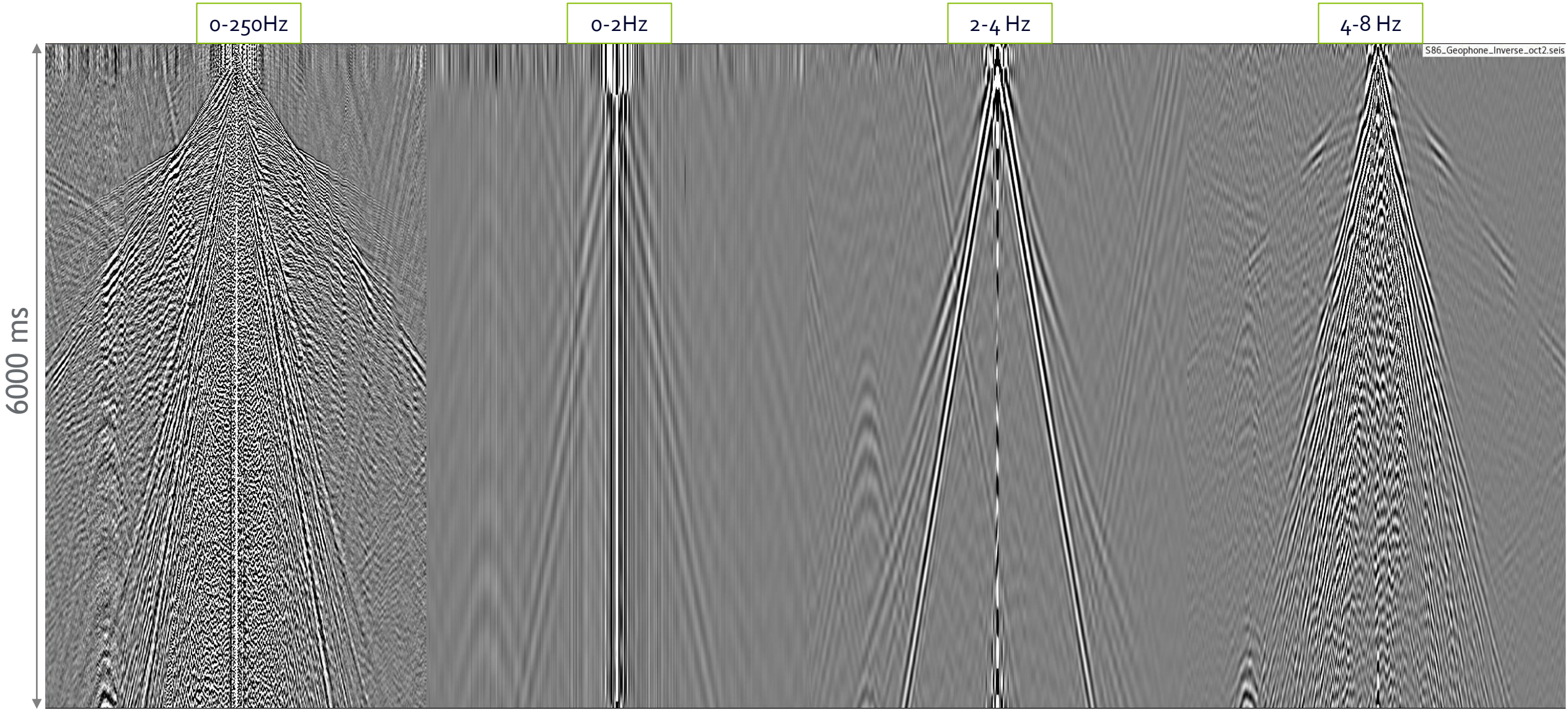
9-Geophone array: Shot after G-resp inv. Filter



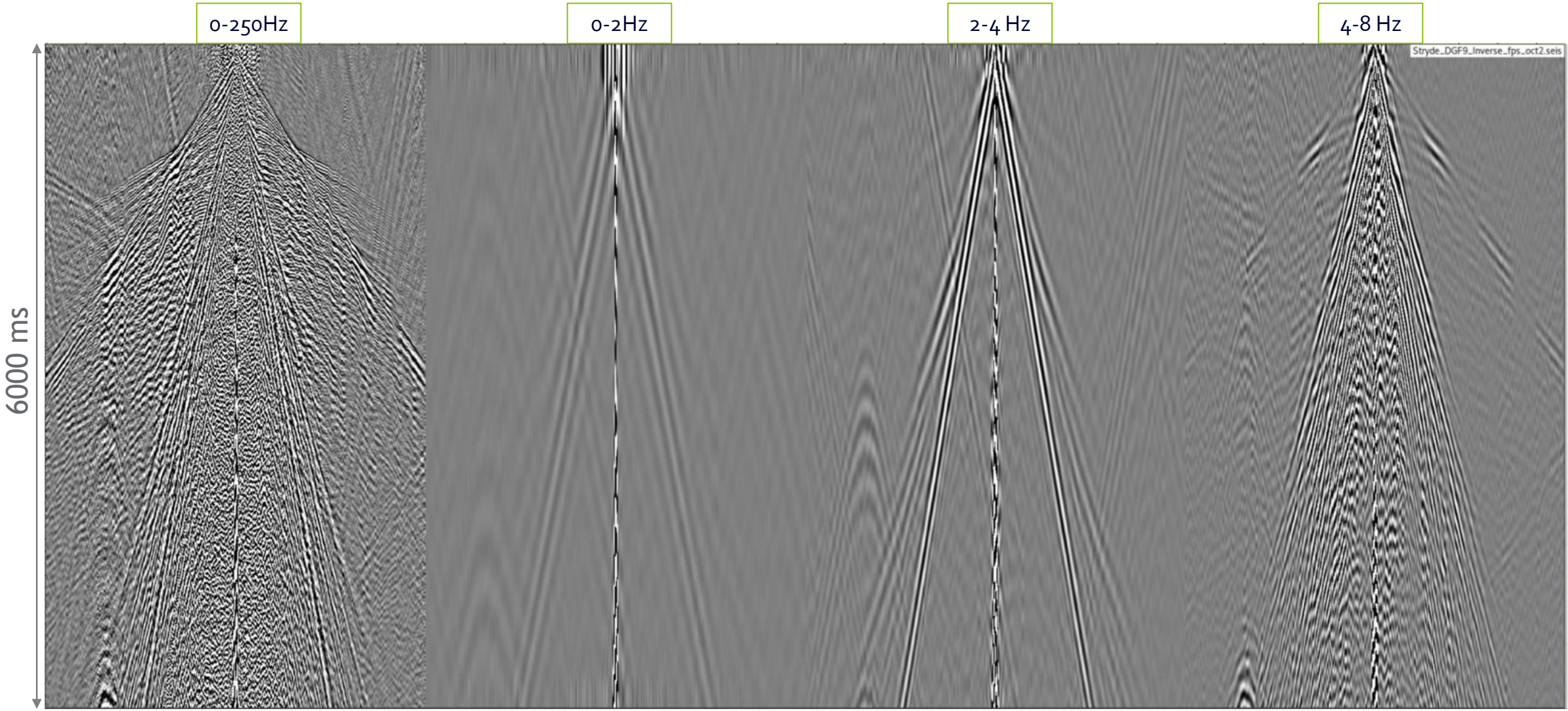
DGF9: Shot after Node Inverse Filter



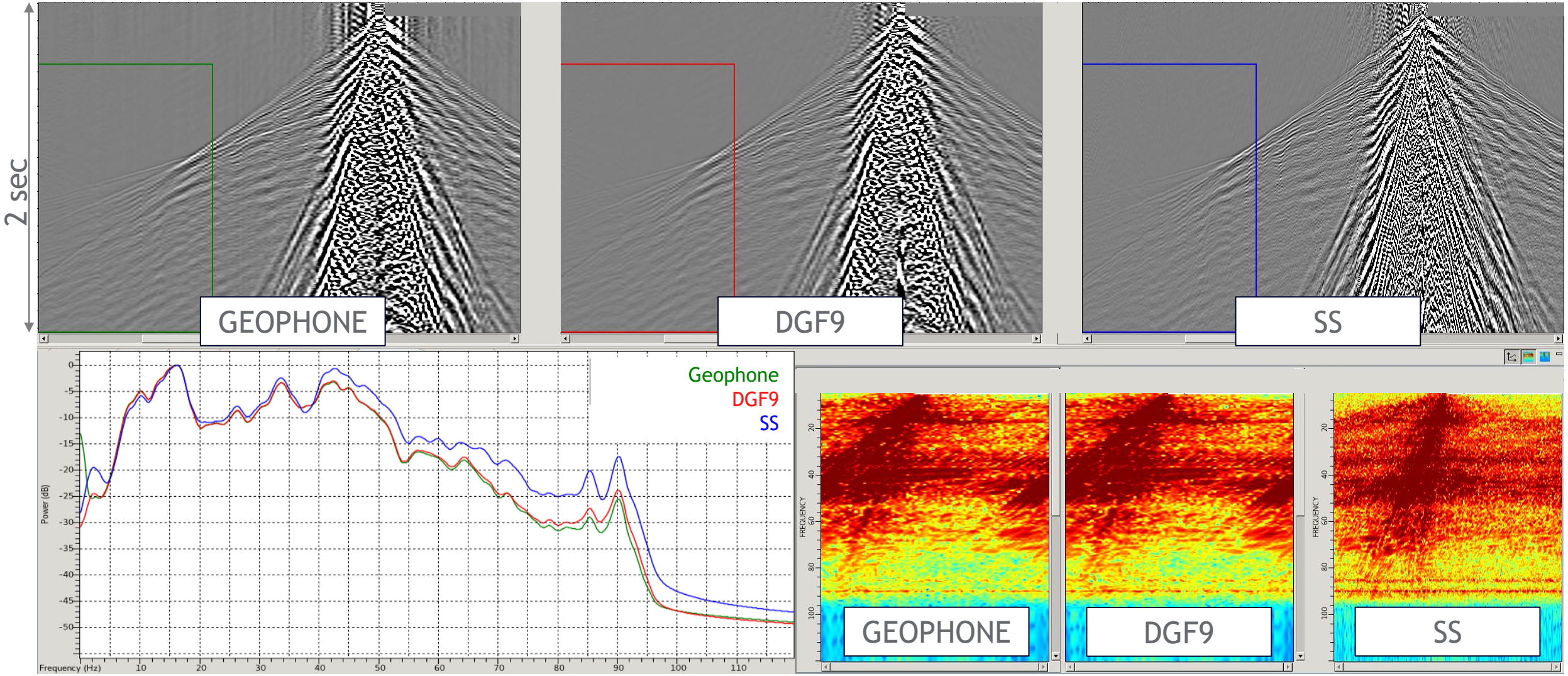
Geophone array: Frequency Panel



DGF9: Frequency Panel

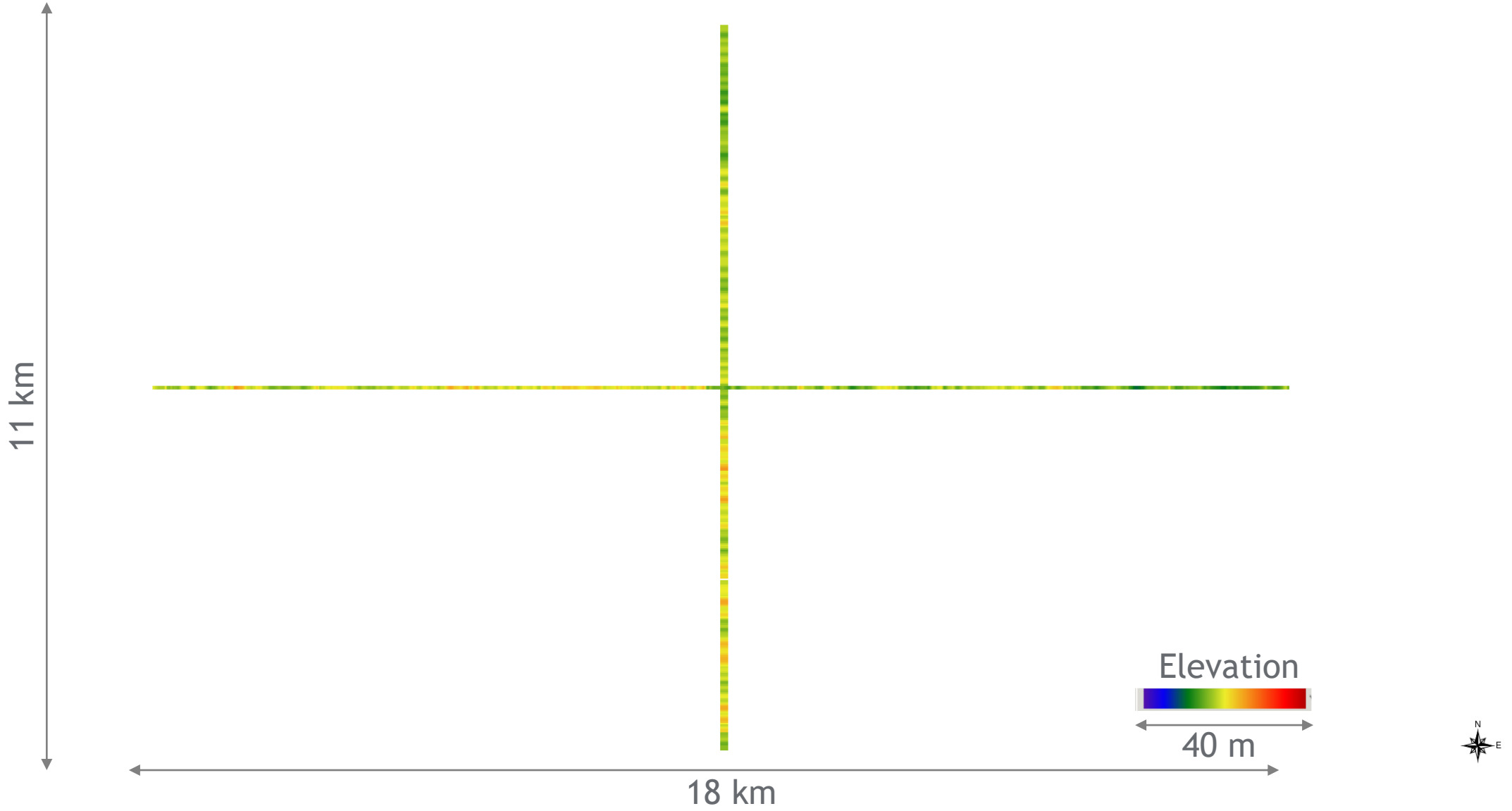


Geo / DGF9 / SS: Shot gather

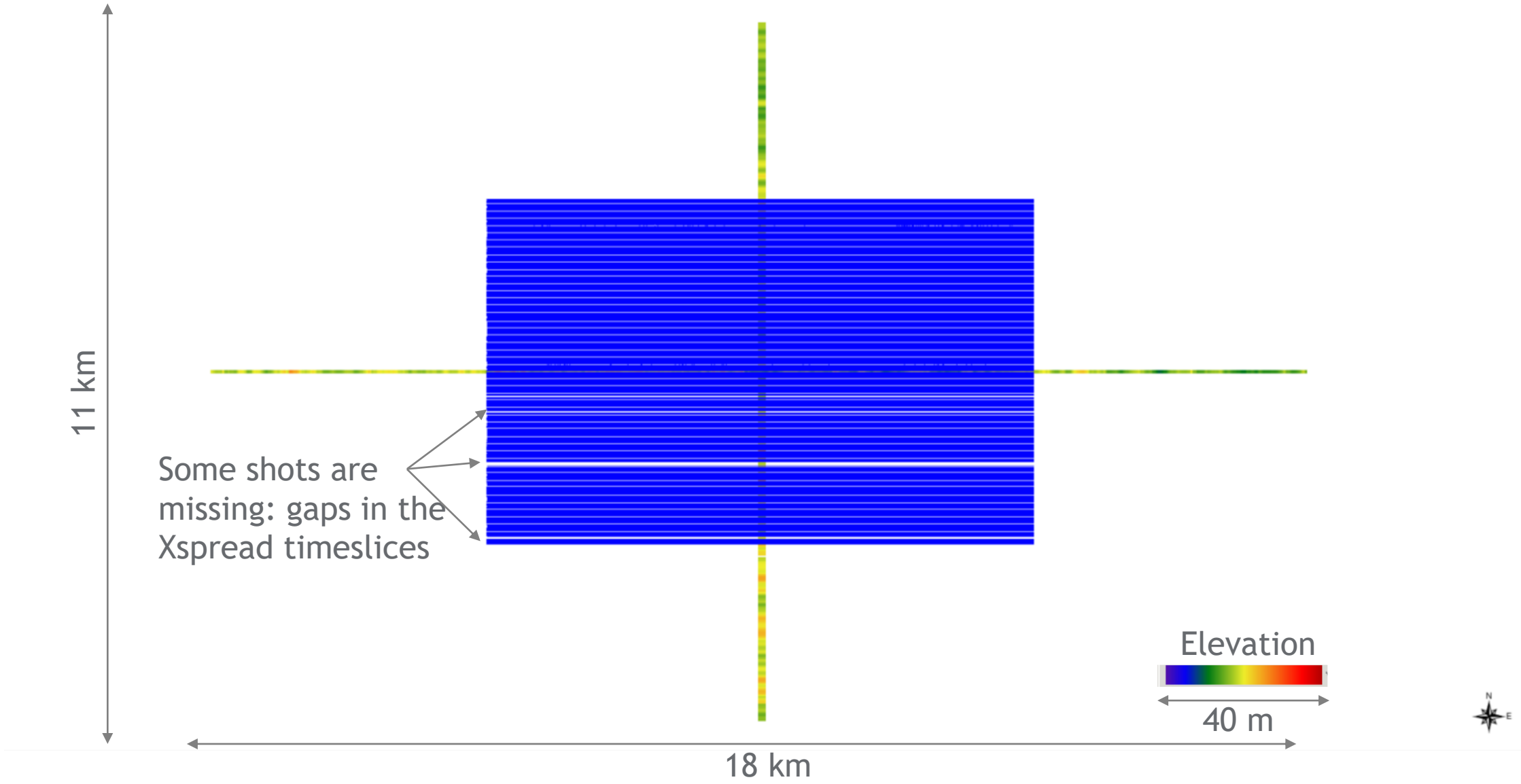


Time slice analysis

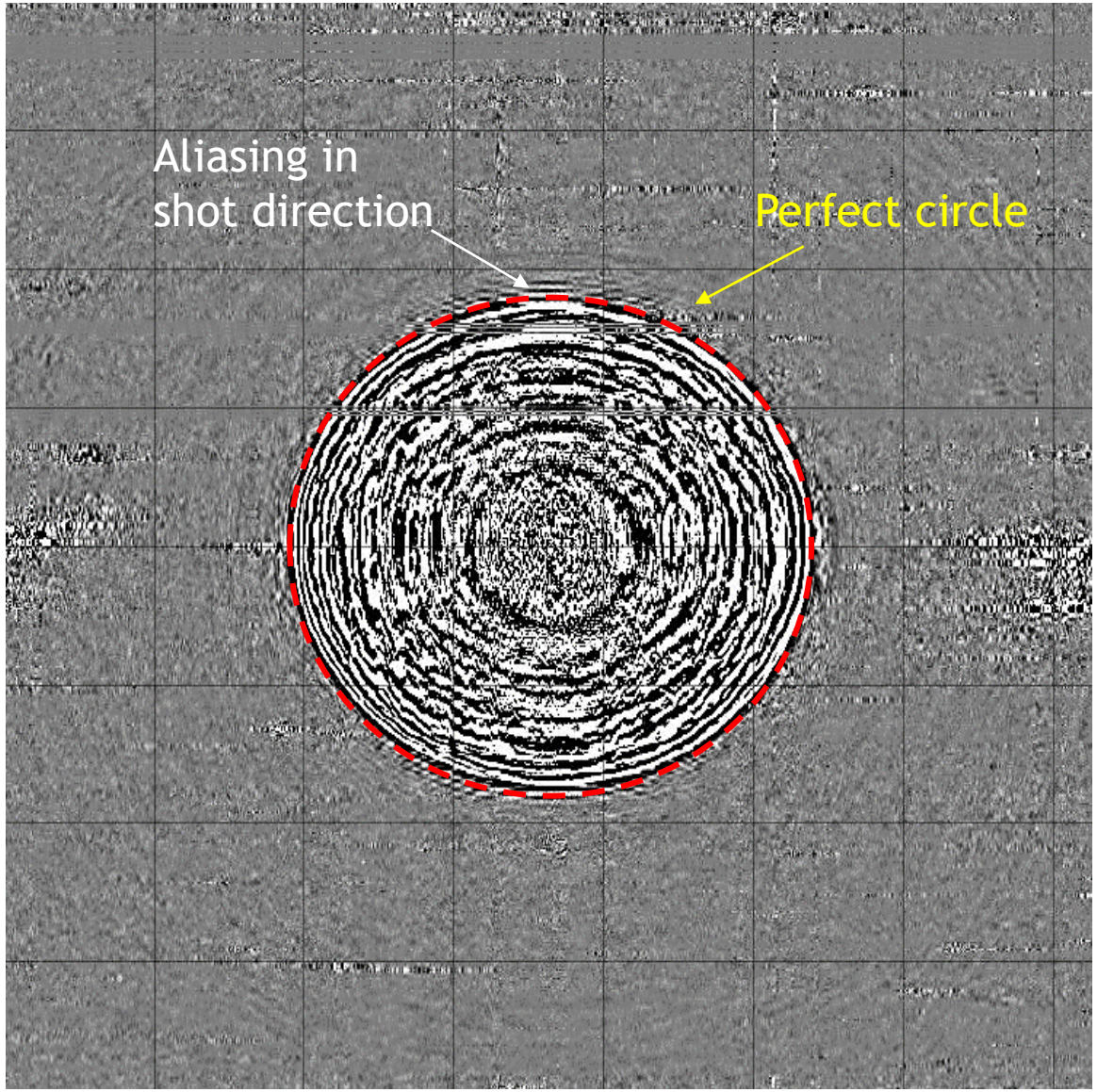
Xspread through center lines



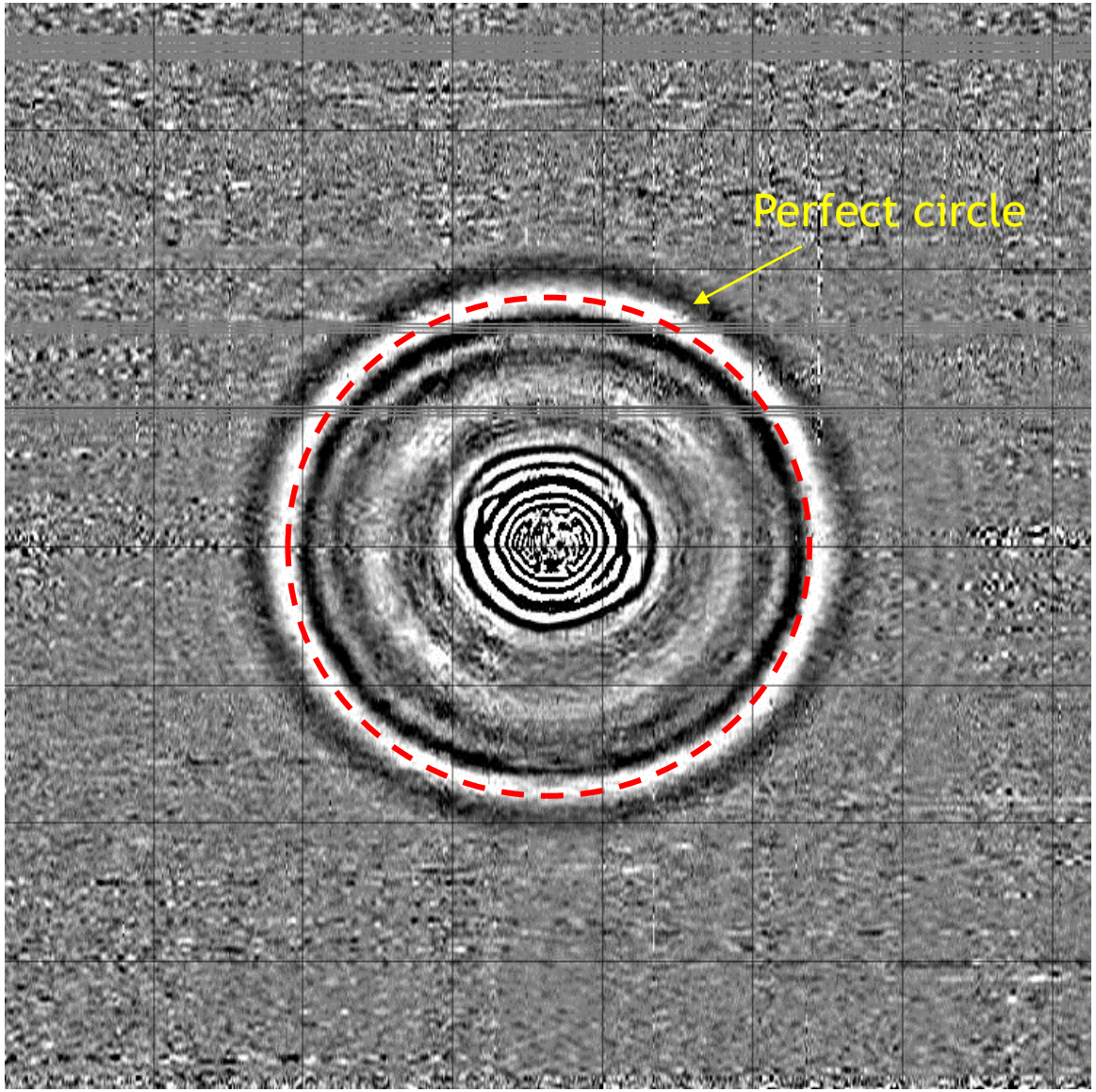
Xspread through center lines



Time slice: full spectrum

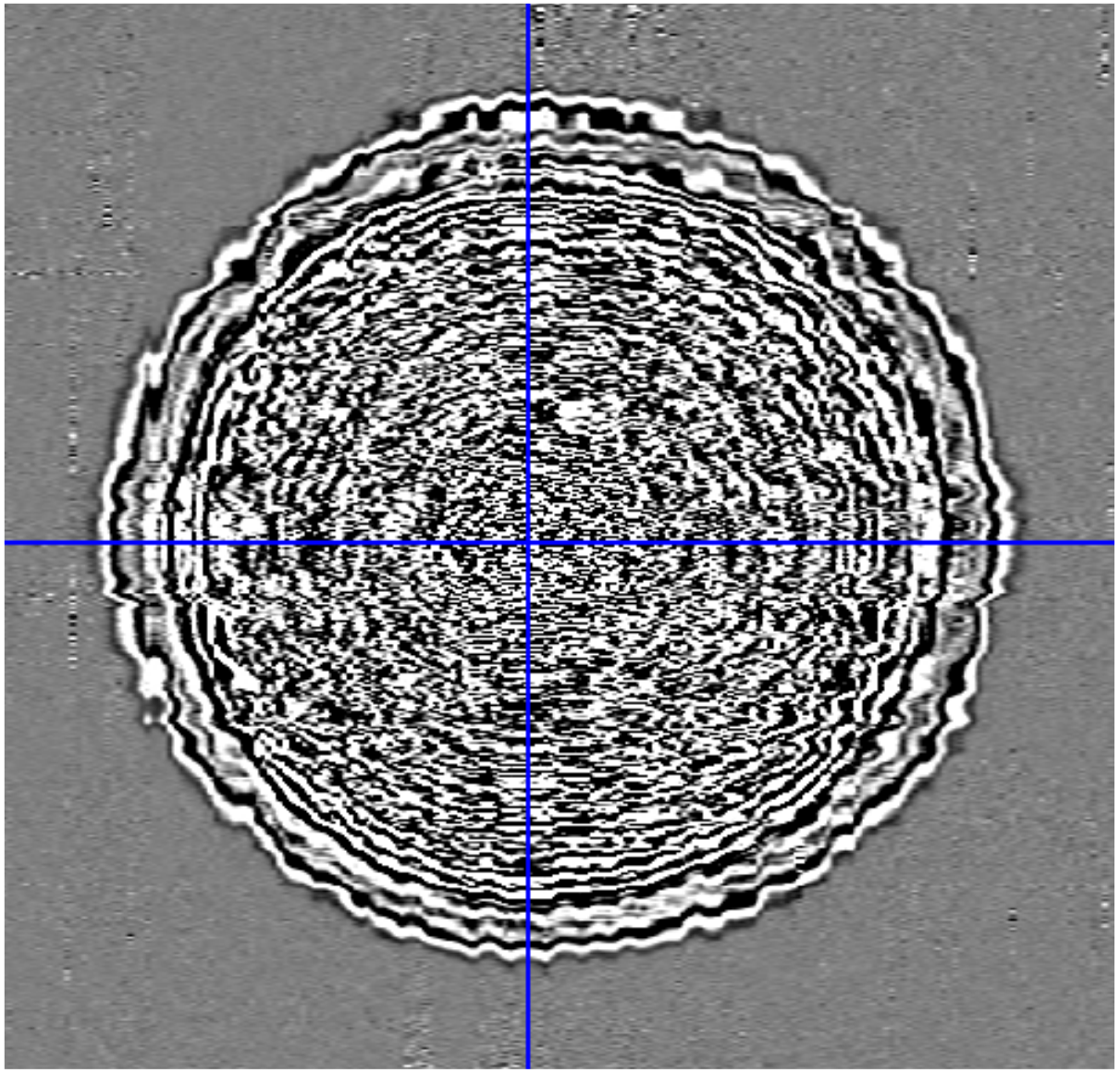


Time slice: Low frequencies (<8Hz)

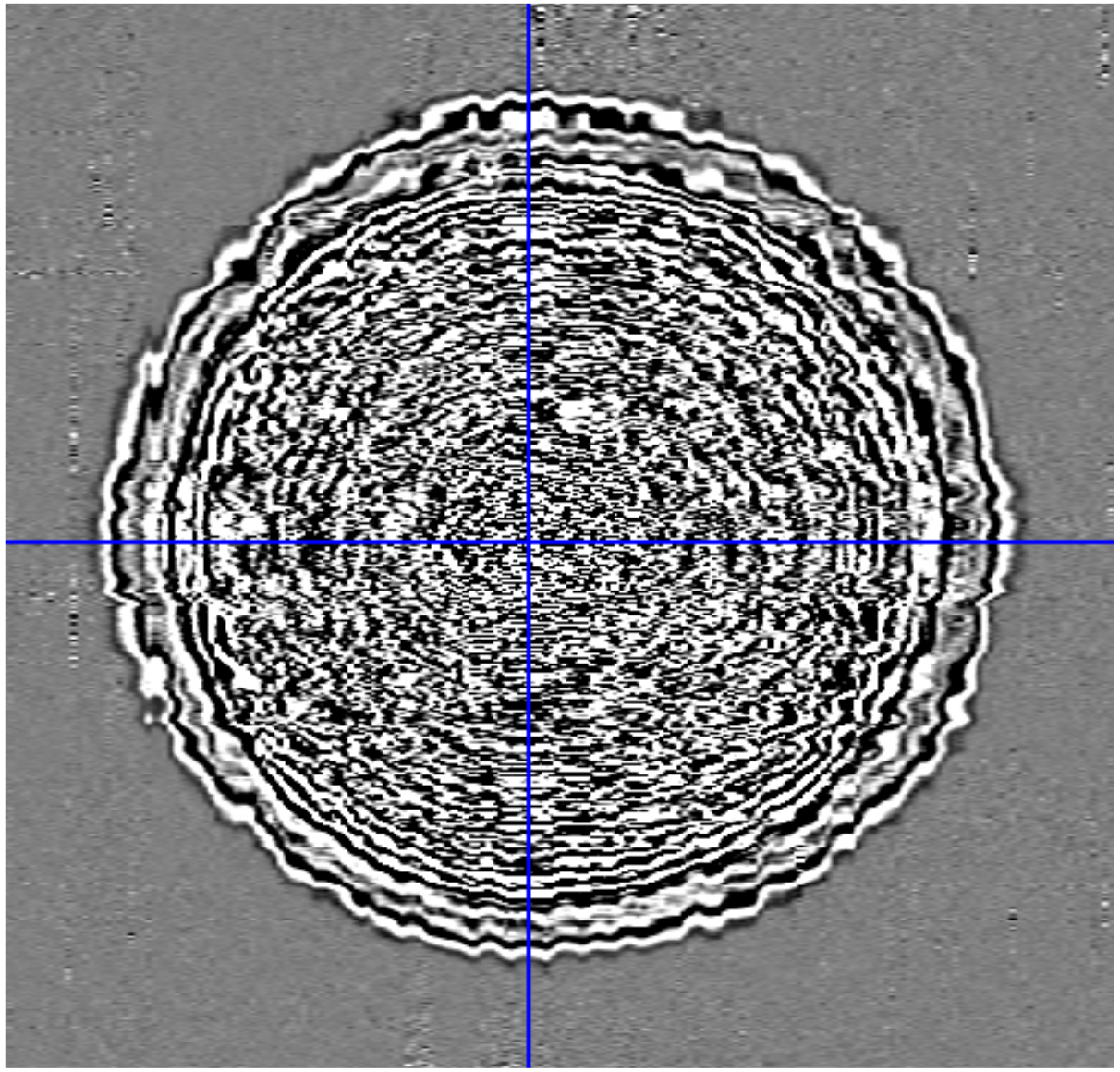


Sand dunes static effect: full spectrum

No statics applied

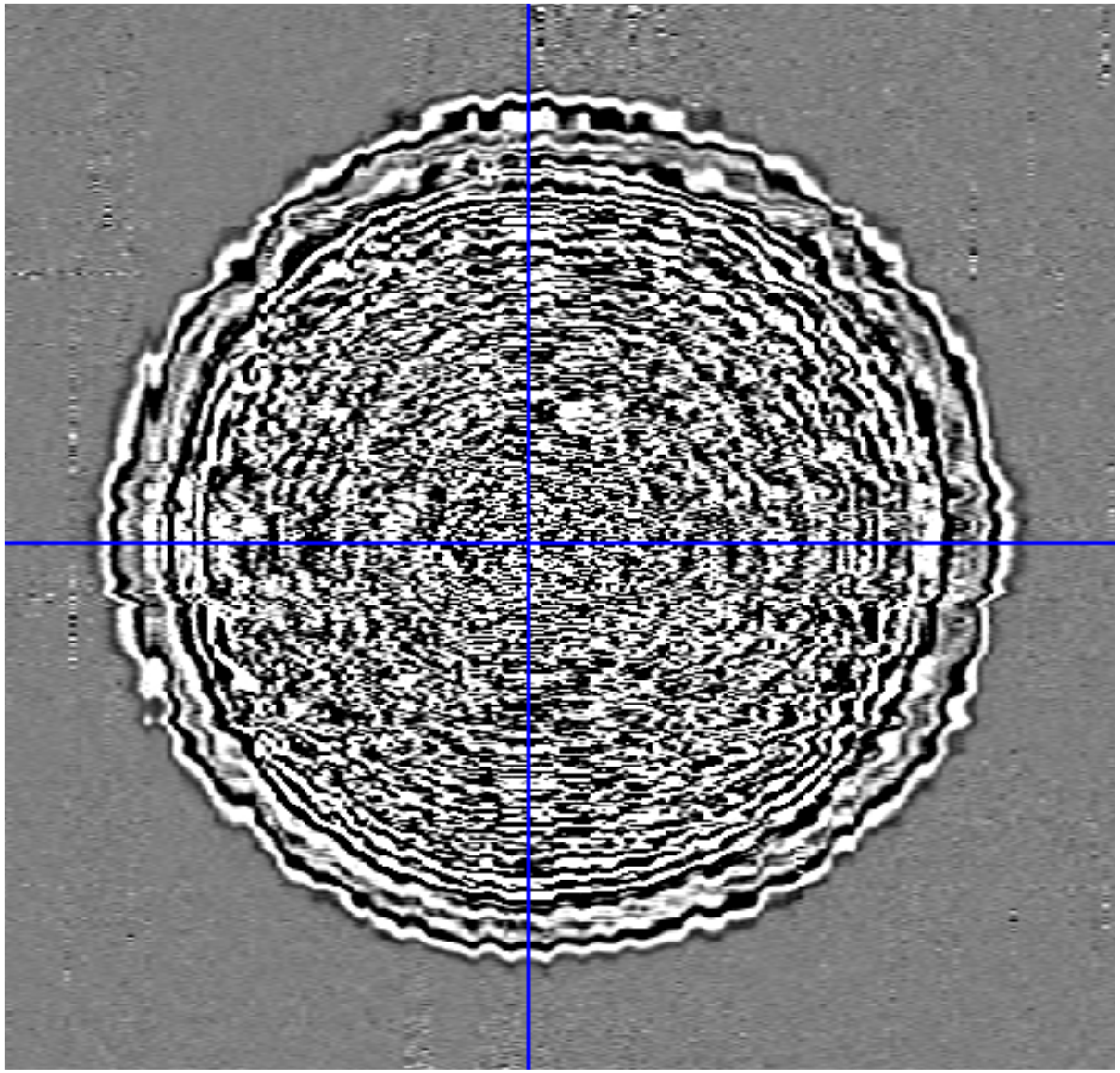


No statics applied

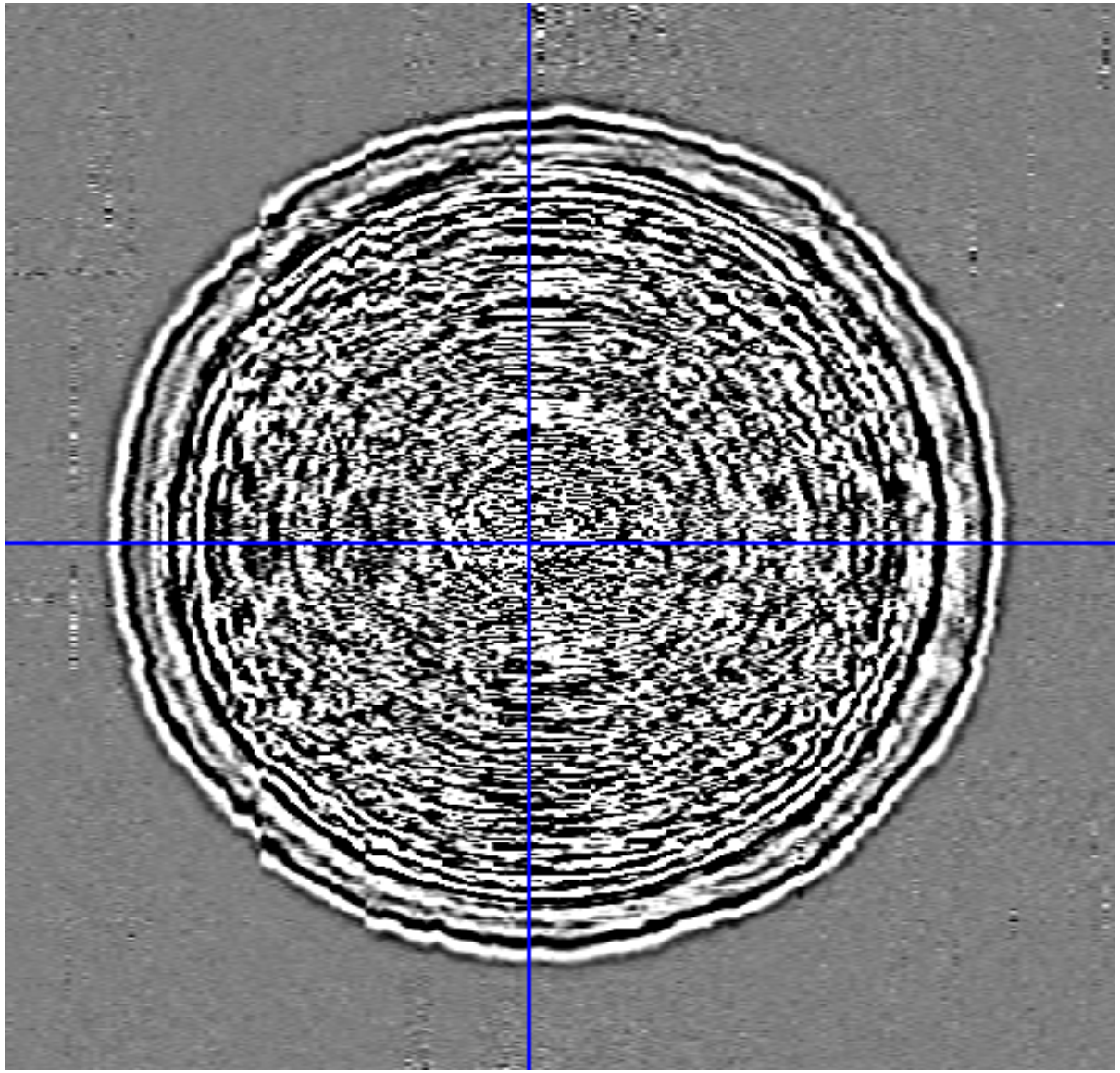


Sand dunes static effect: full spectrum

No statics applied

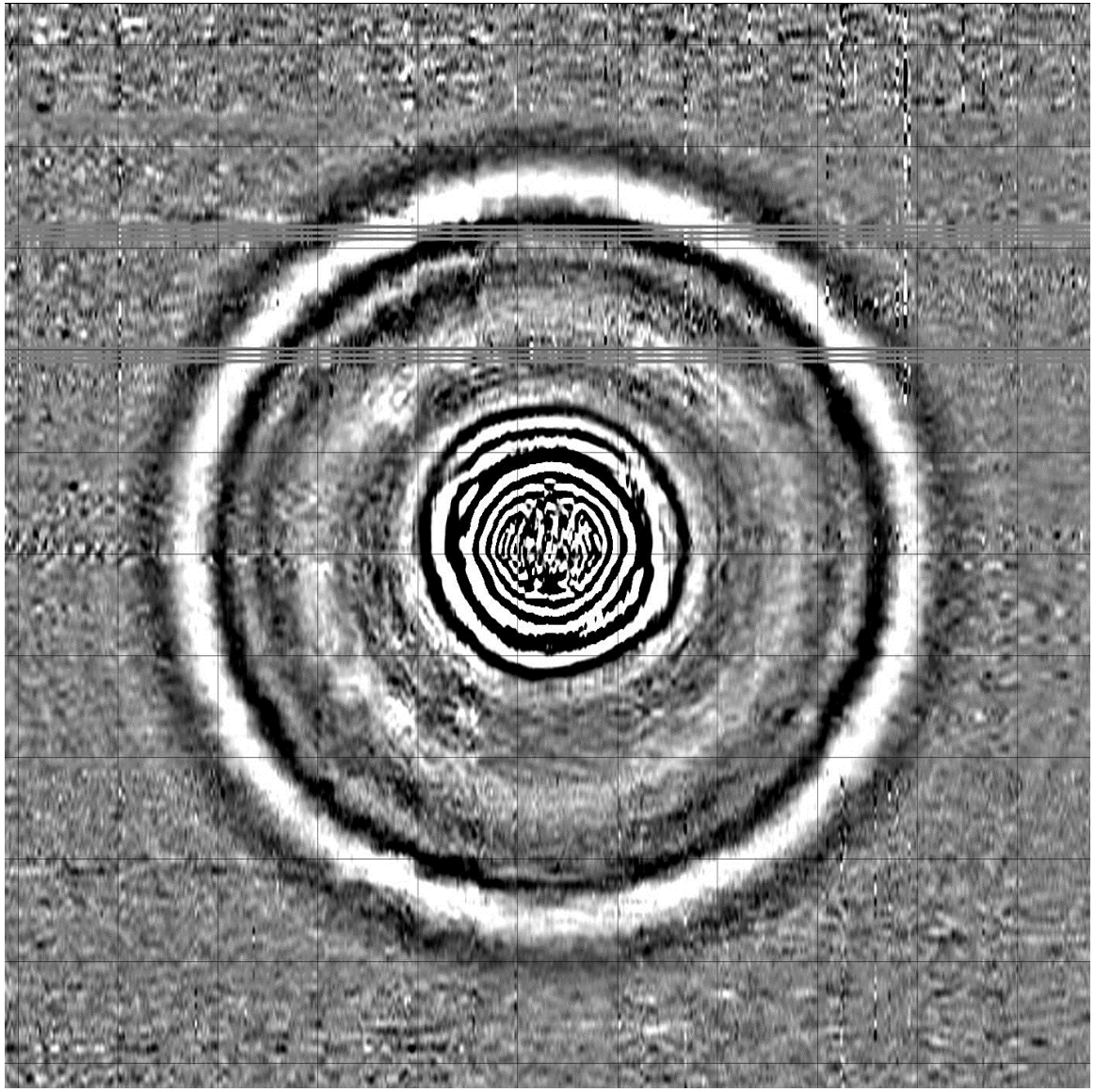


Dune statics applied



Sand dunes static effect: Low frequencies (<8Hz)

No statics applied



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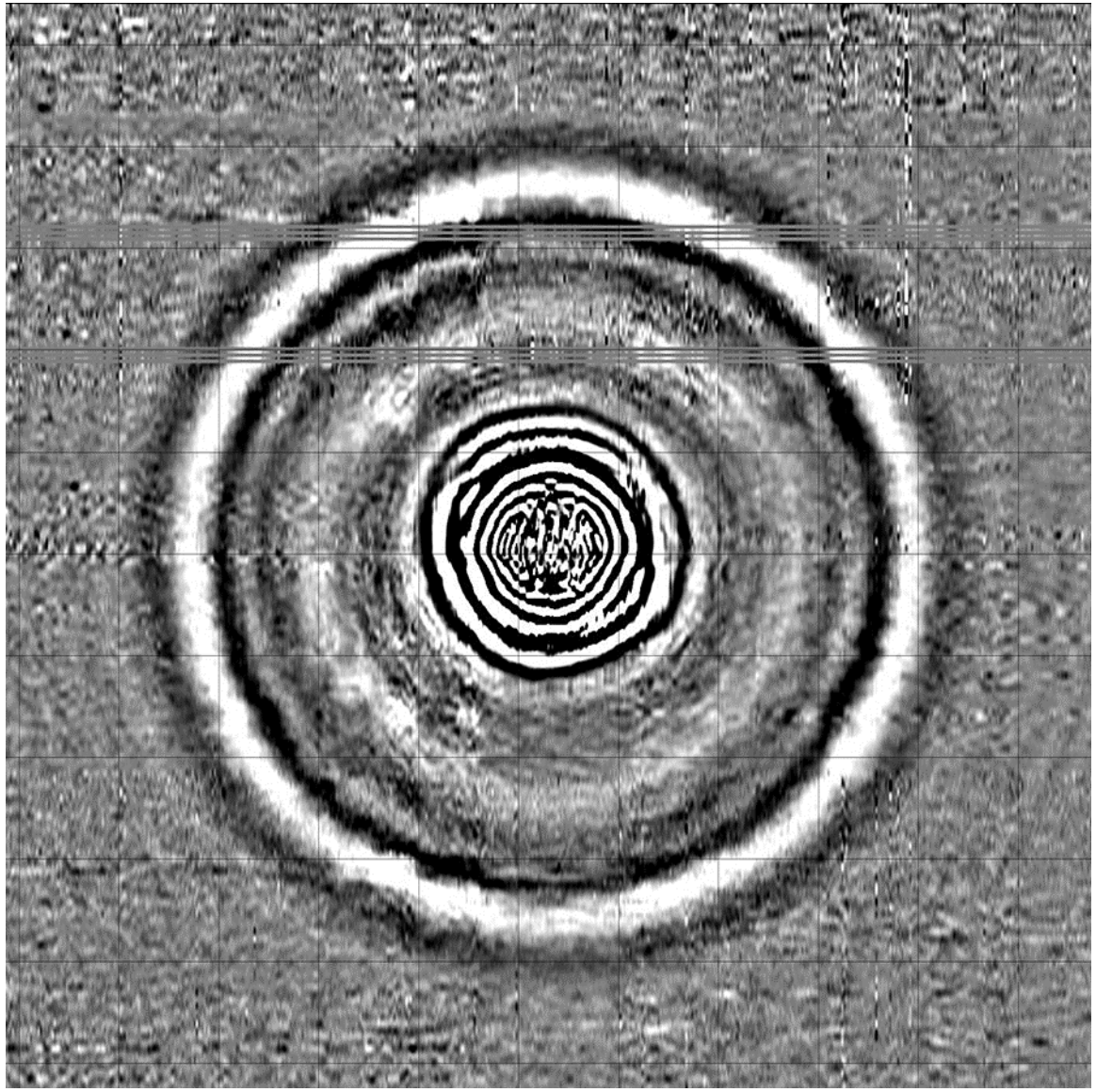

Sand dunes static effect: Low frequencies (<8Hz)

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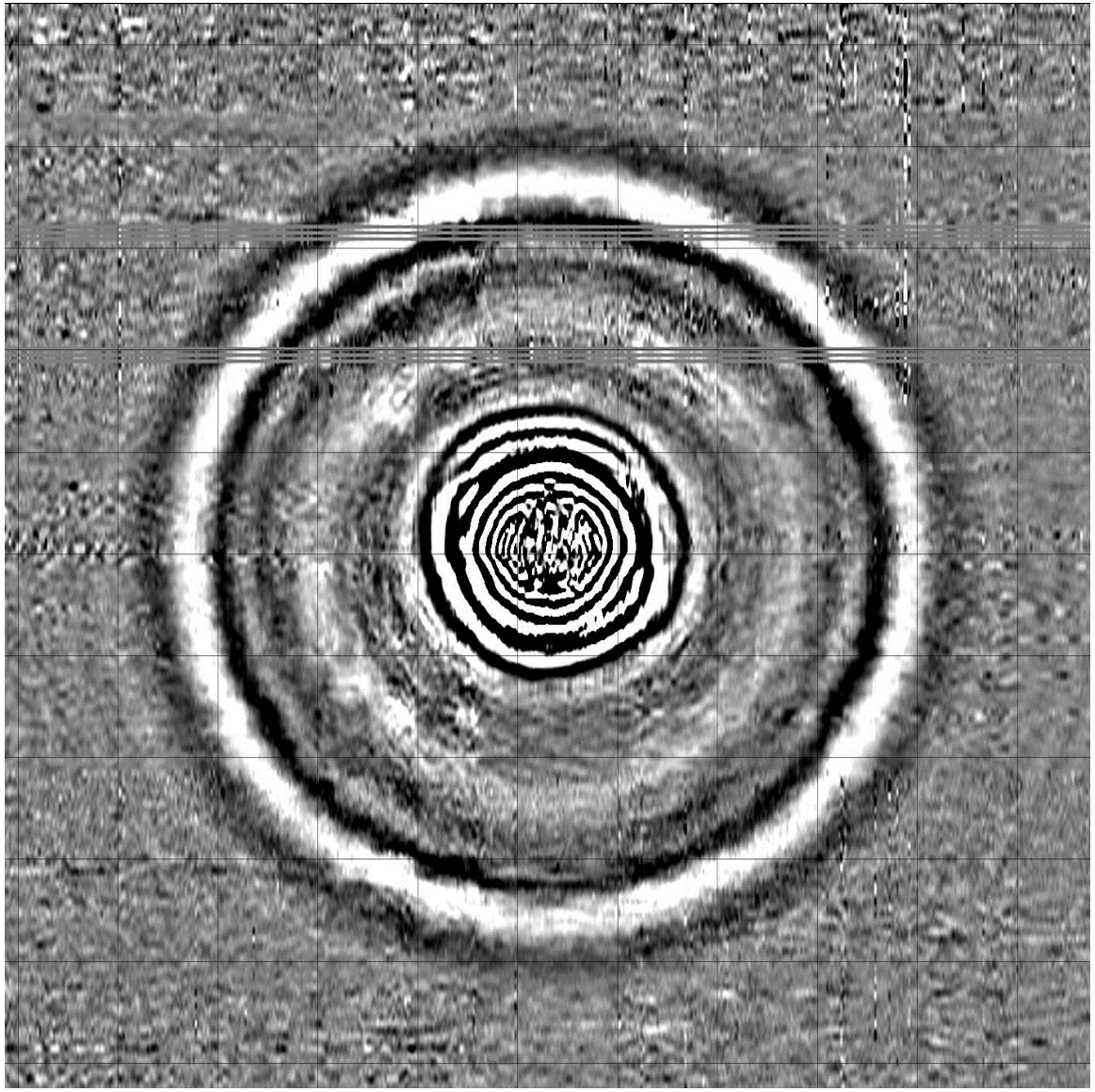
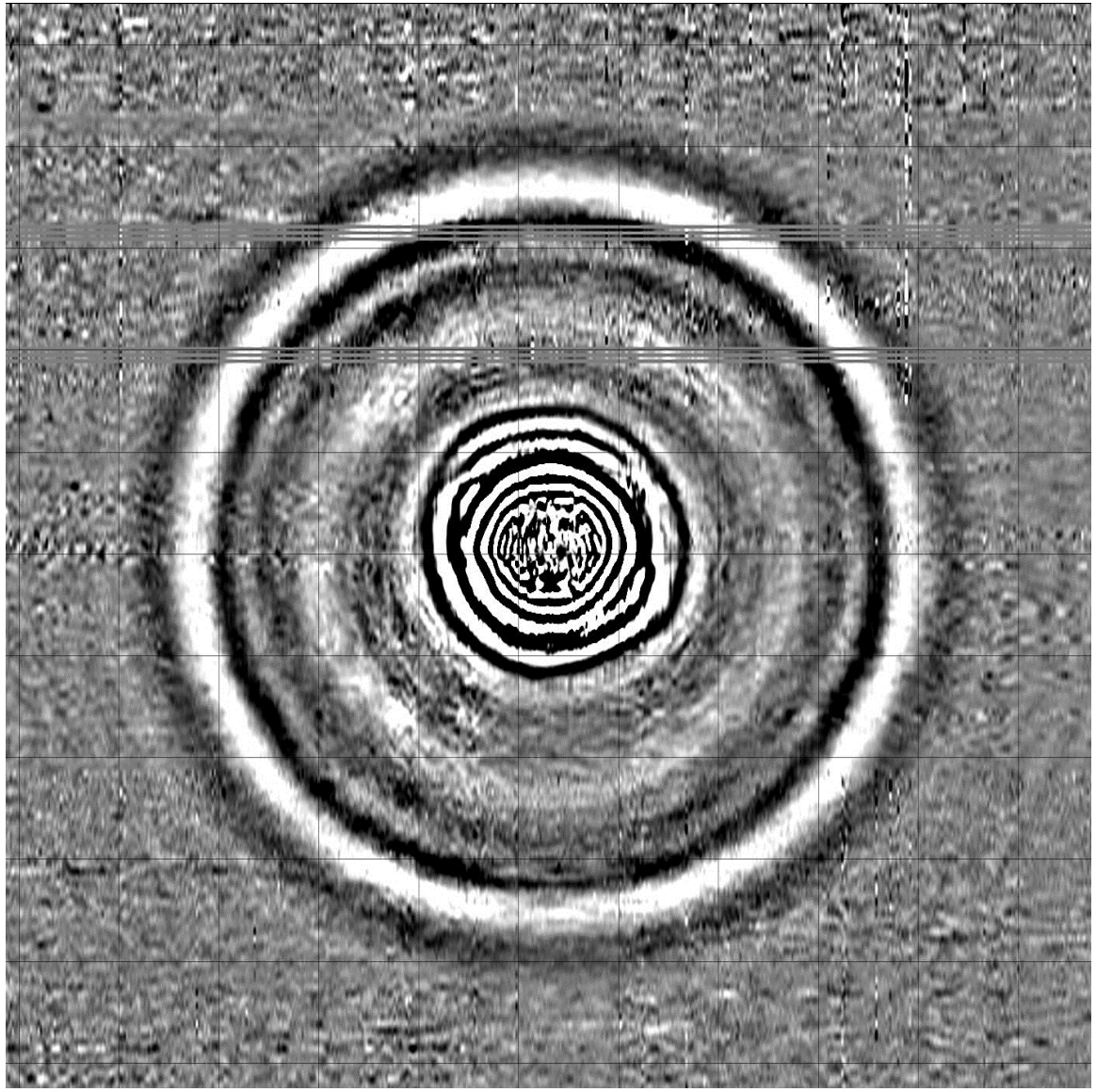


Dune statics applied



Conclusions

- **Comparable overall performance:** The conventional geophone array and the digital array (DGF9) built from nine collocated piezoelectric accelerometers produced nearly identical raw data across the full recorded bandwidth after sensor-response correction.
- **Low-frequency advantage:** In the 1–2 Hz range the DGF9 showed noticeably cleaner signals, giving it a performance edge at low frequencies.
- **High-quality single-sensor traces:** Individual accelerometer nodes delivered strong, broadband recordings with dense spatial sampling, which can improve processing when treated as separate traces.
- **Processing flexibility:** The digital-group-forming approach allows pre-processing of each trace before summation, extending usable bandwidth and enhancing adaptability for advanced workflows such as full-waveform inversion.
- **Practical implication:** Deploying a mixed geophone/accelerometer system provides the same baseline results as a traditional array while offering extra low-frequency fidelity and greater data-handling versatility in challenging sand-dune environments.

Thank you for your attention!

For questions and enquires please contact Pavel Golikov:
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