

Multiparameter FWI of ultrasound data

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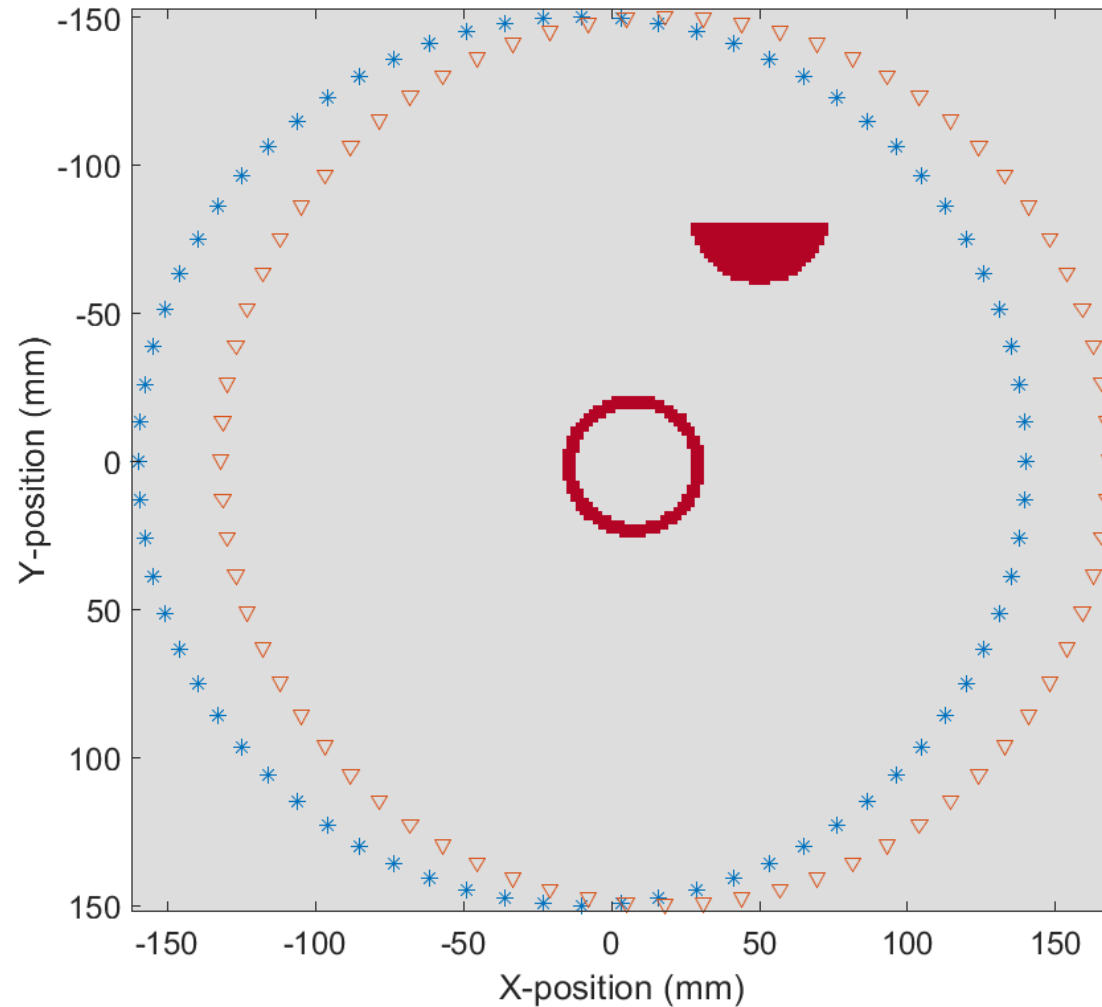
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UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
Department of Geoscience



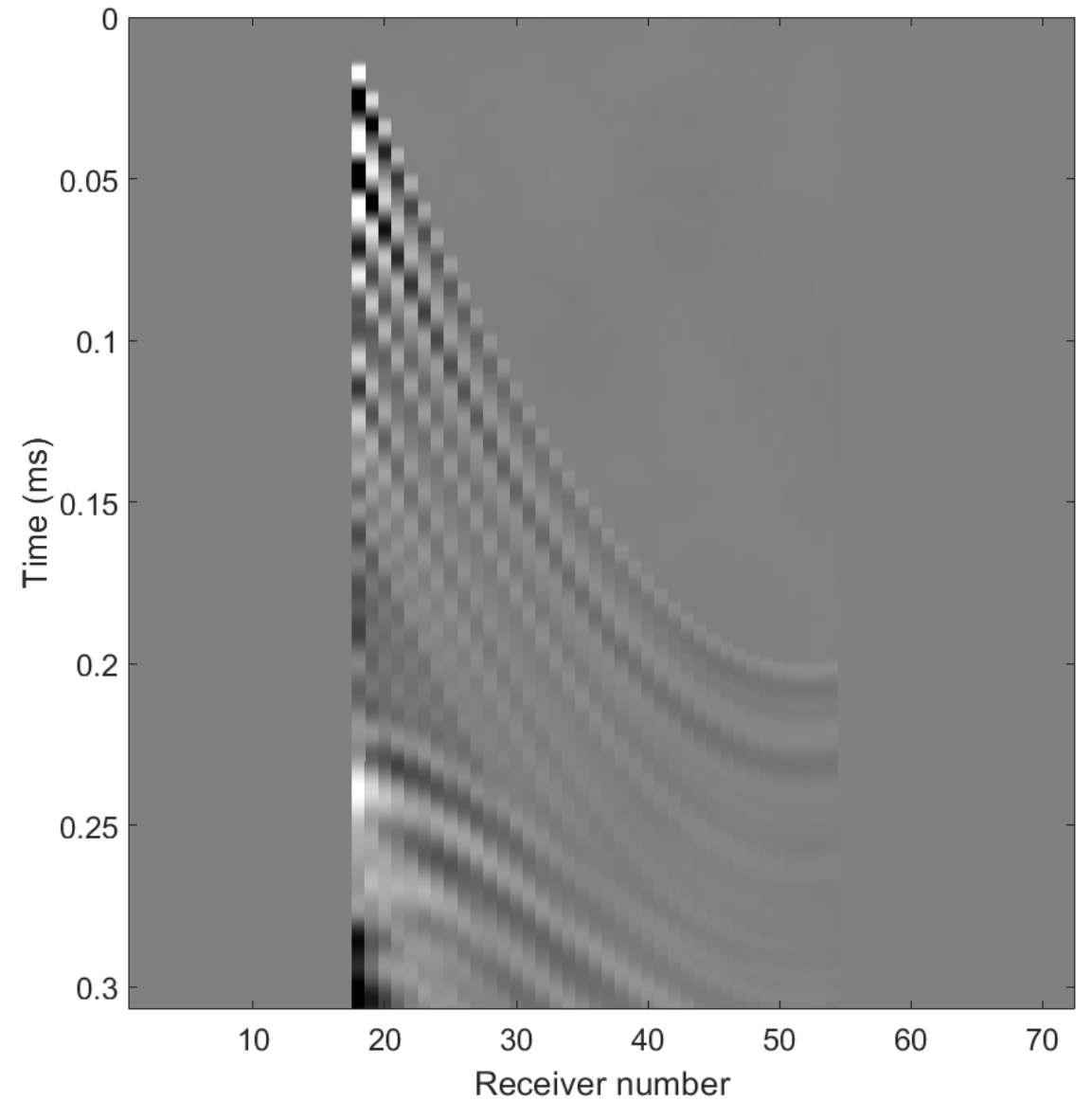
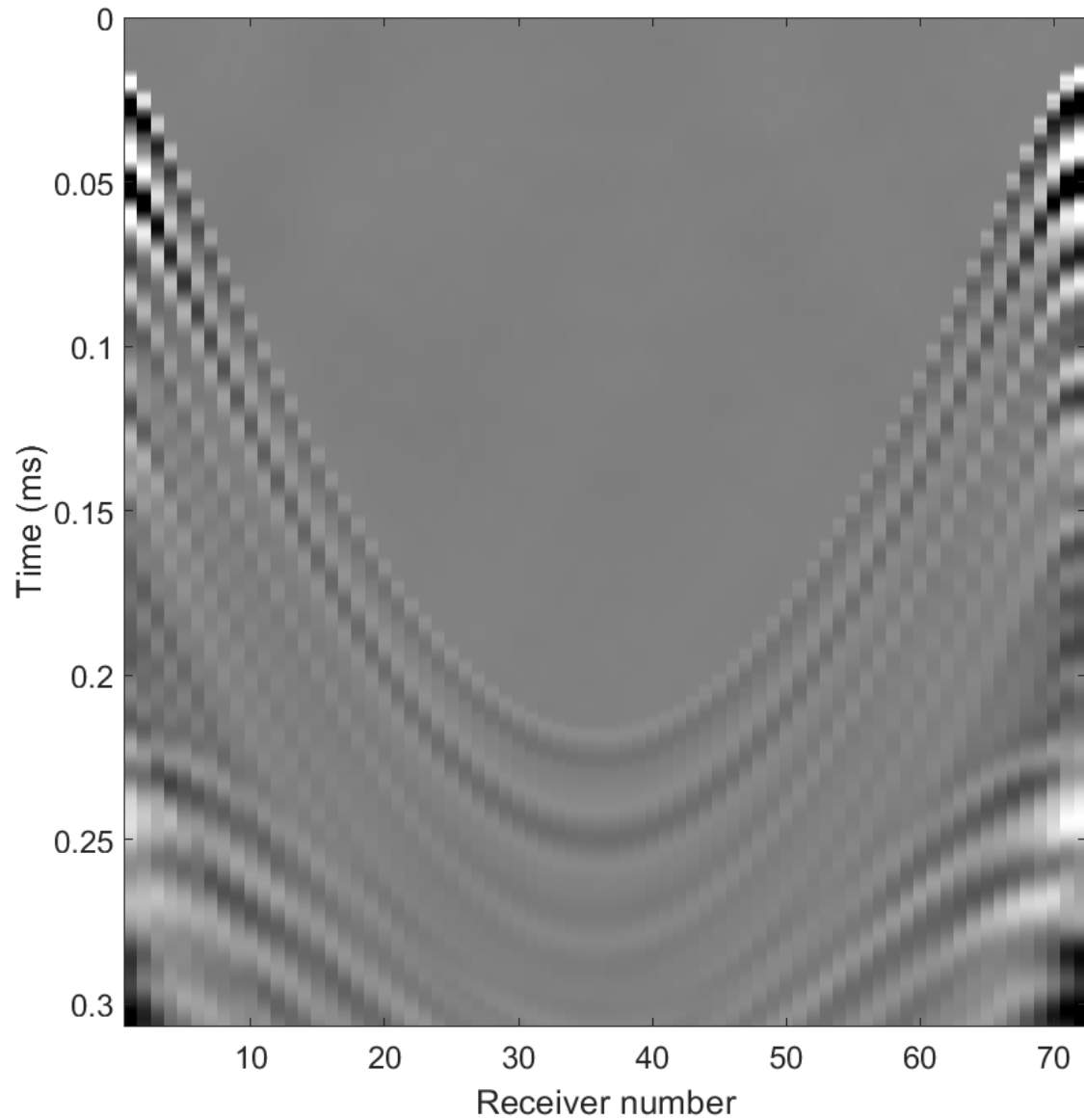
Surround acquisition



- Buzzer sources and receivers ($\sim 10 - 130$ kHz)
- Cylindrical targets
- In-plane surround acquisition

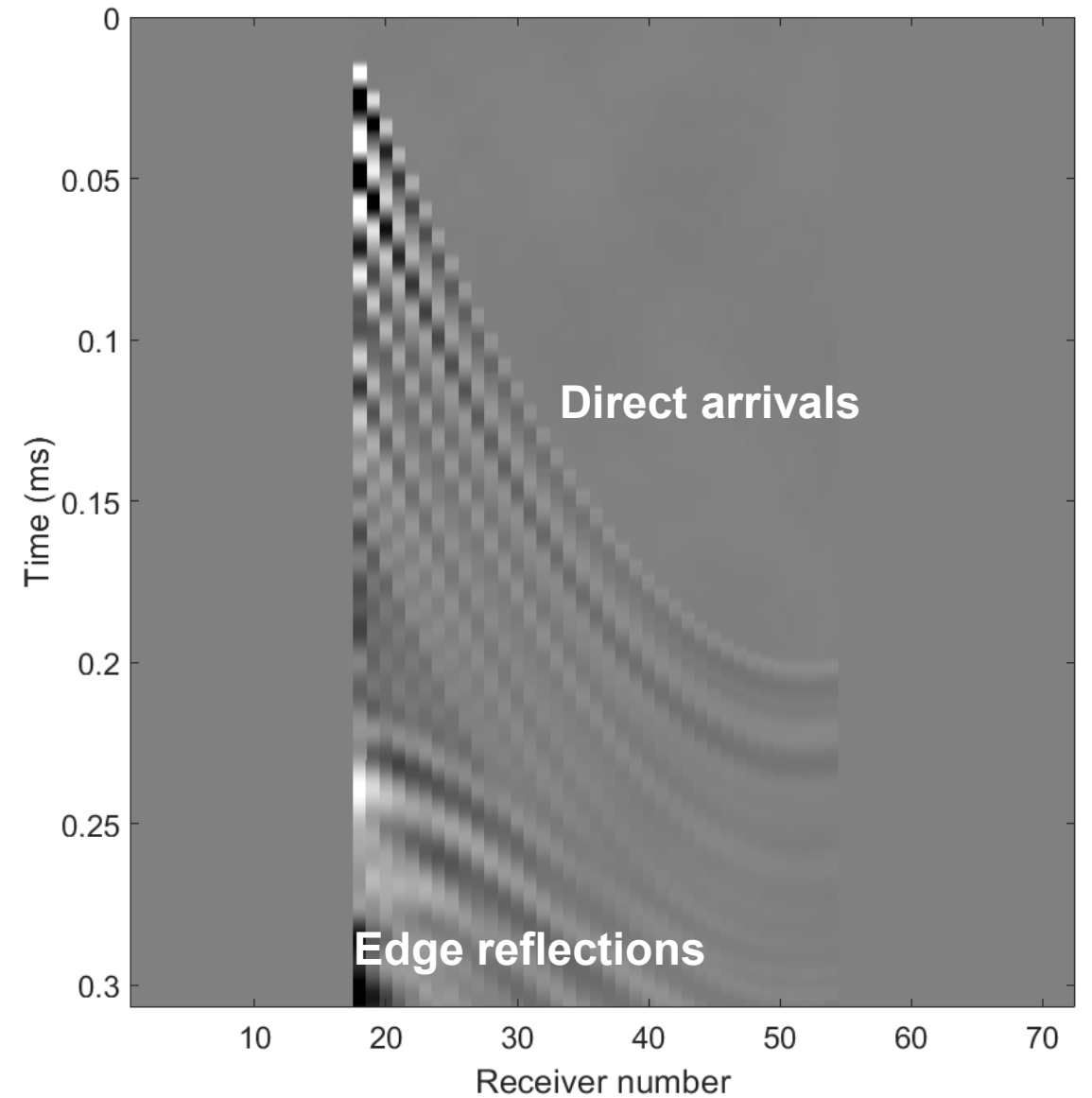
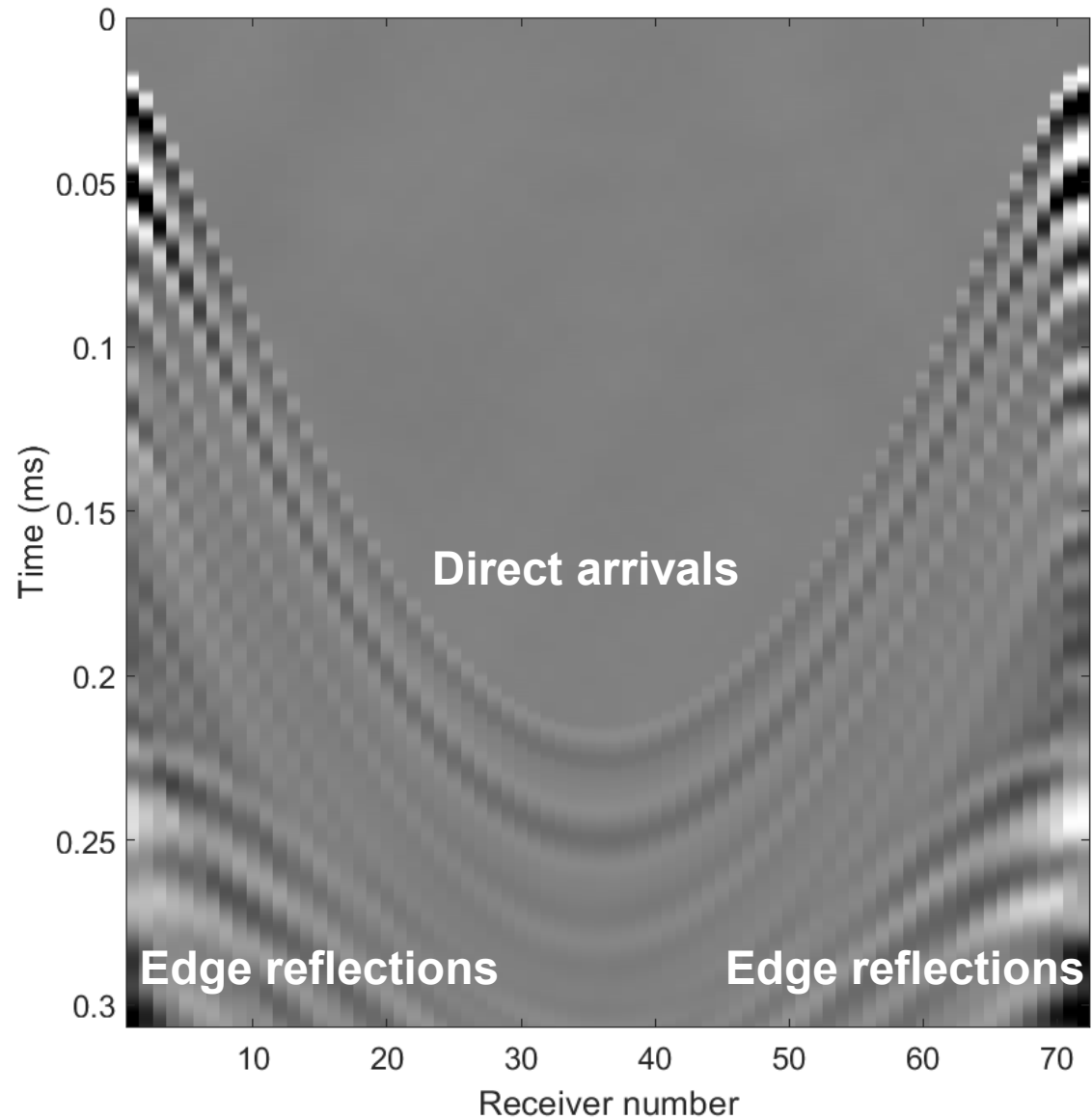


Raw data – no target



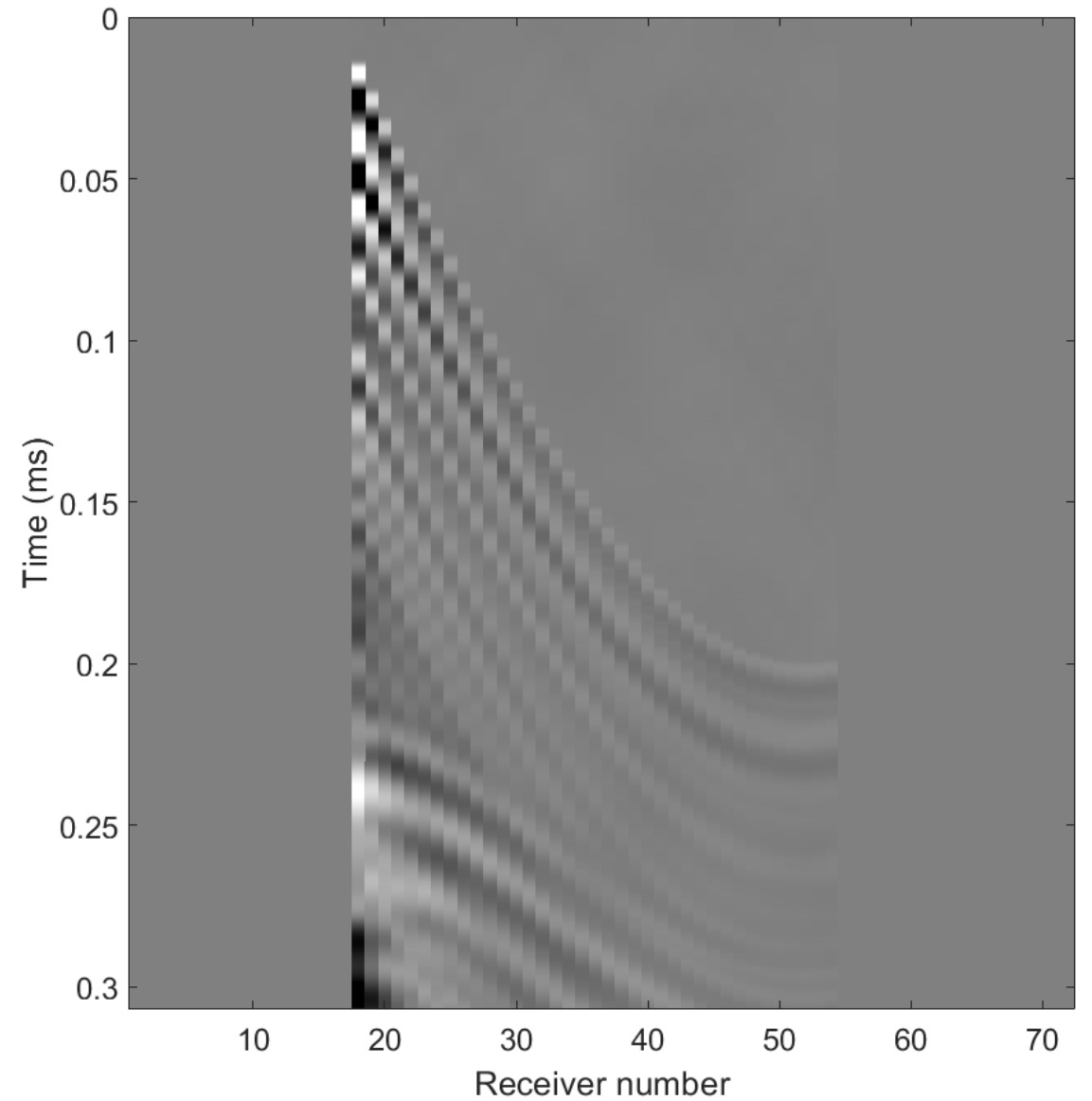
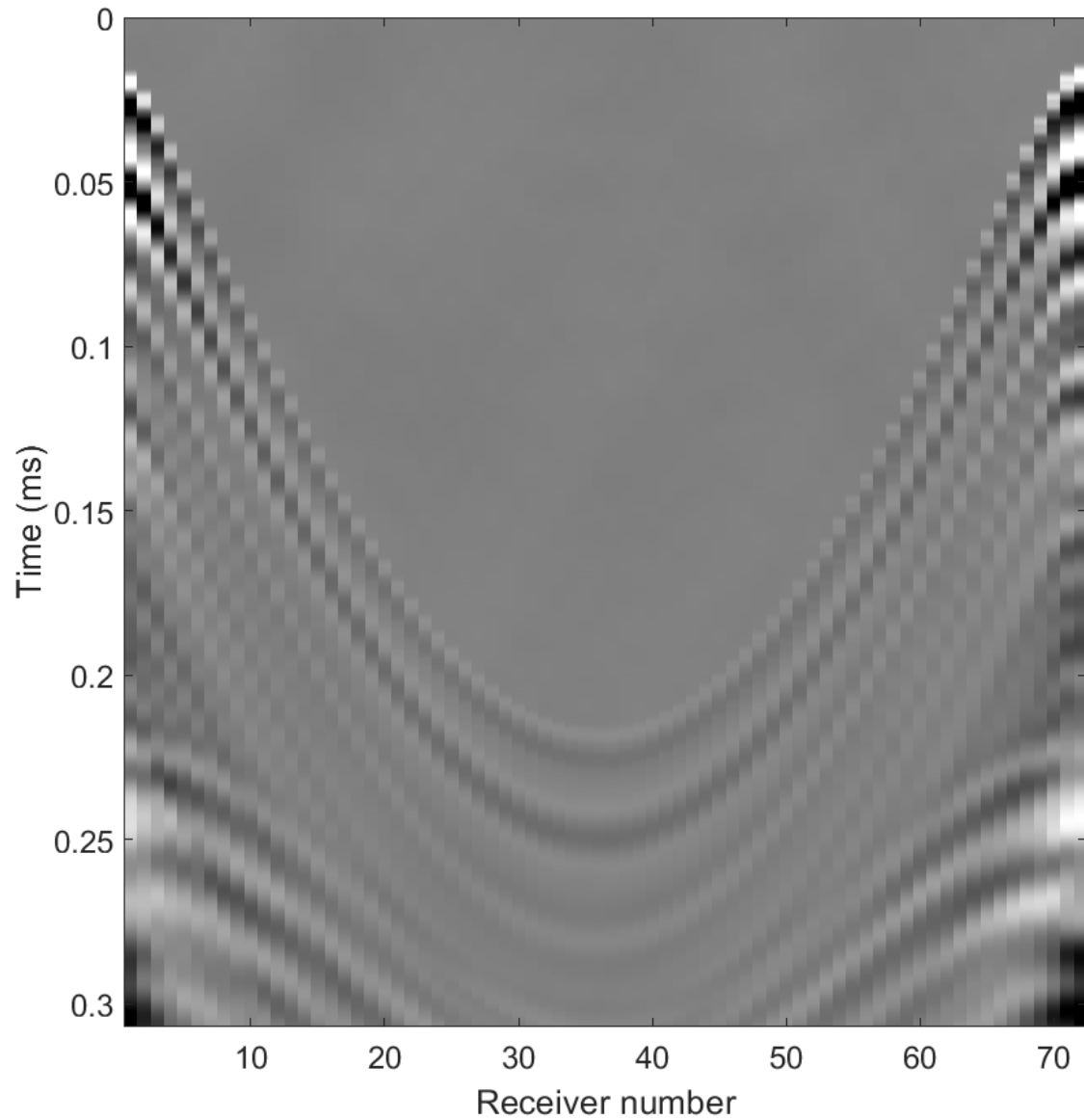


Raw data – no target



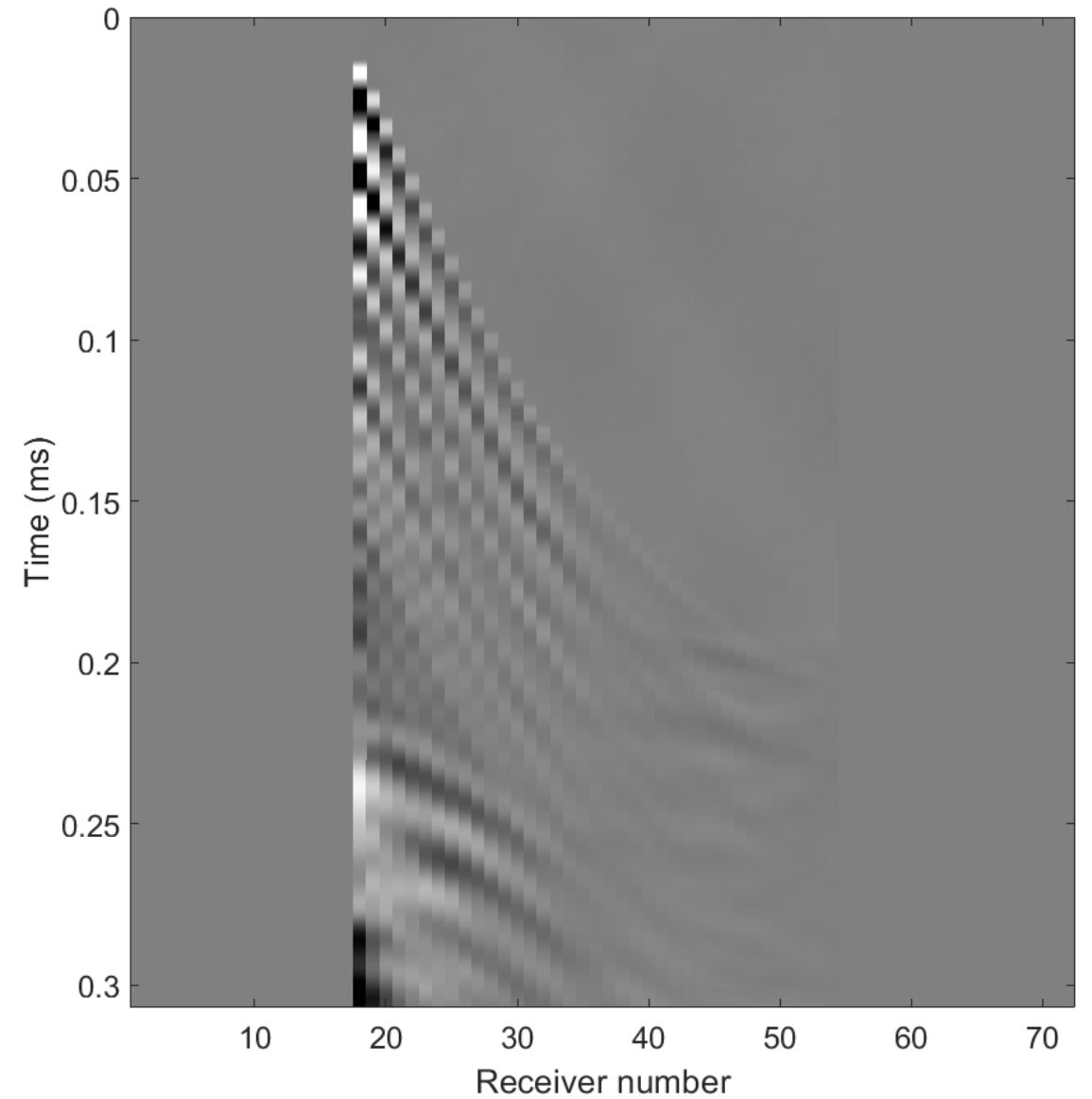
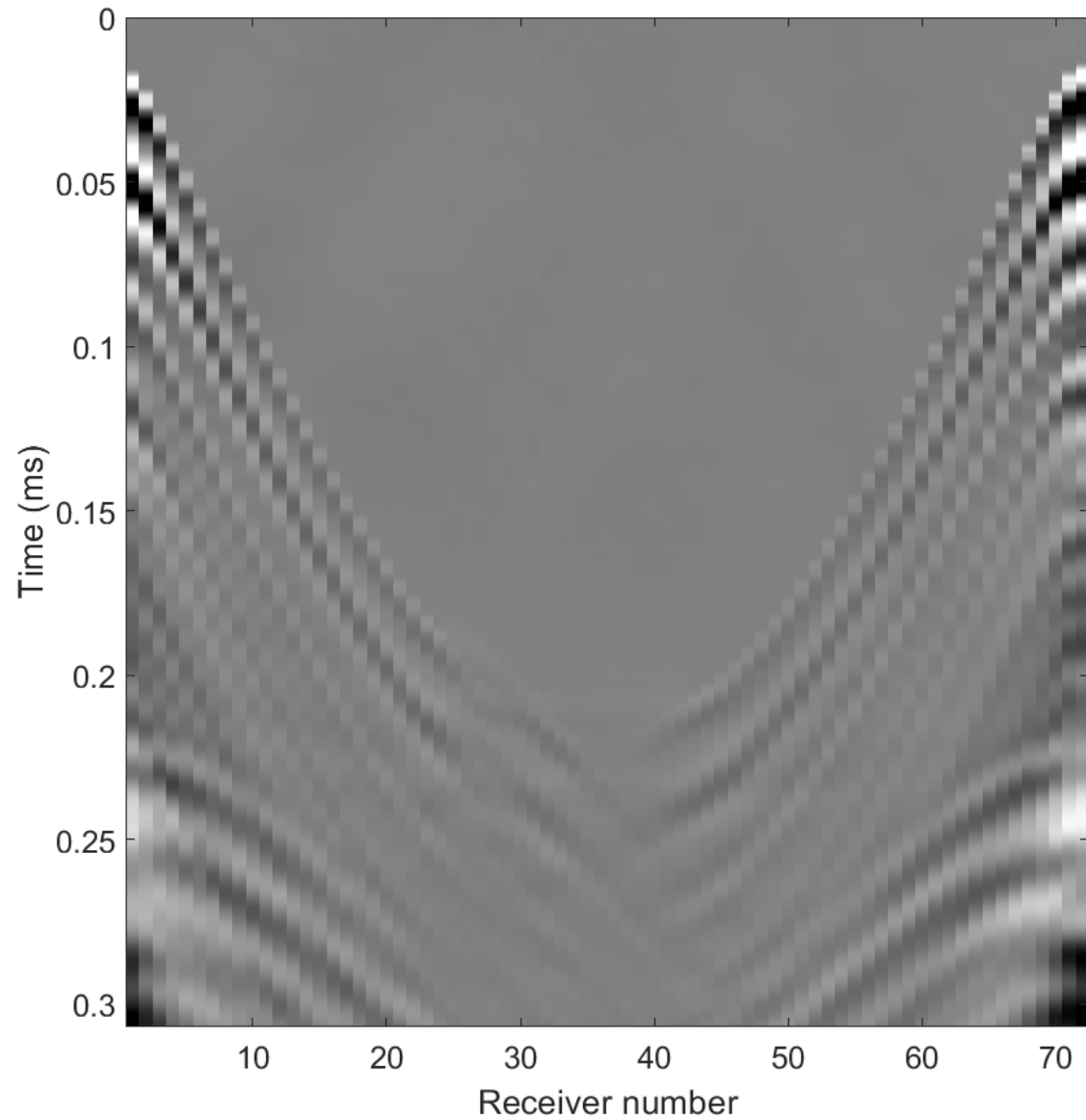


Raw data – no target



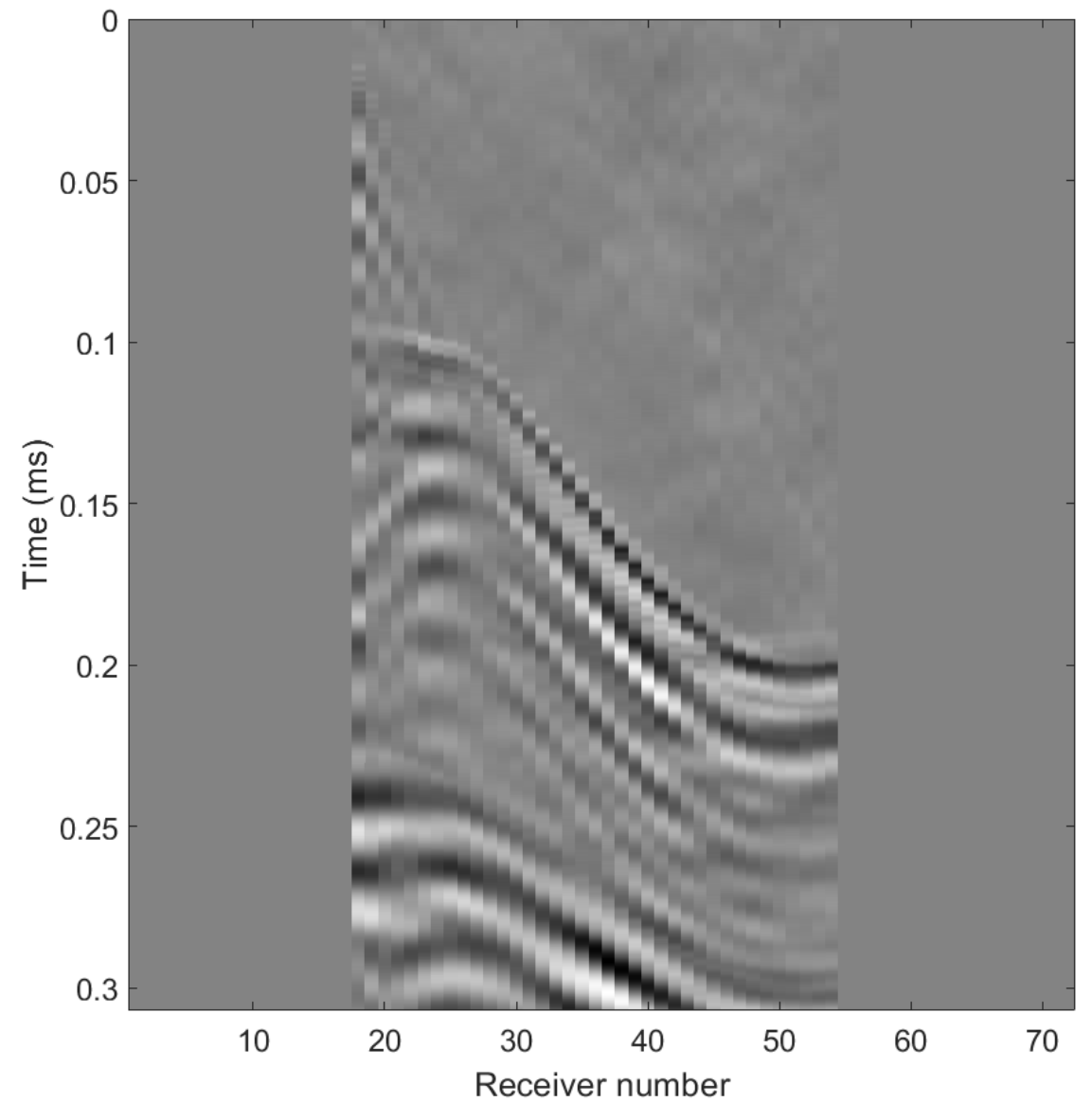
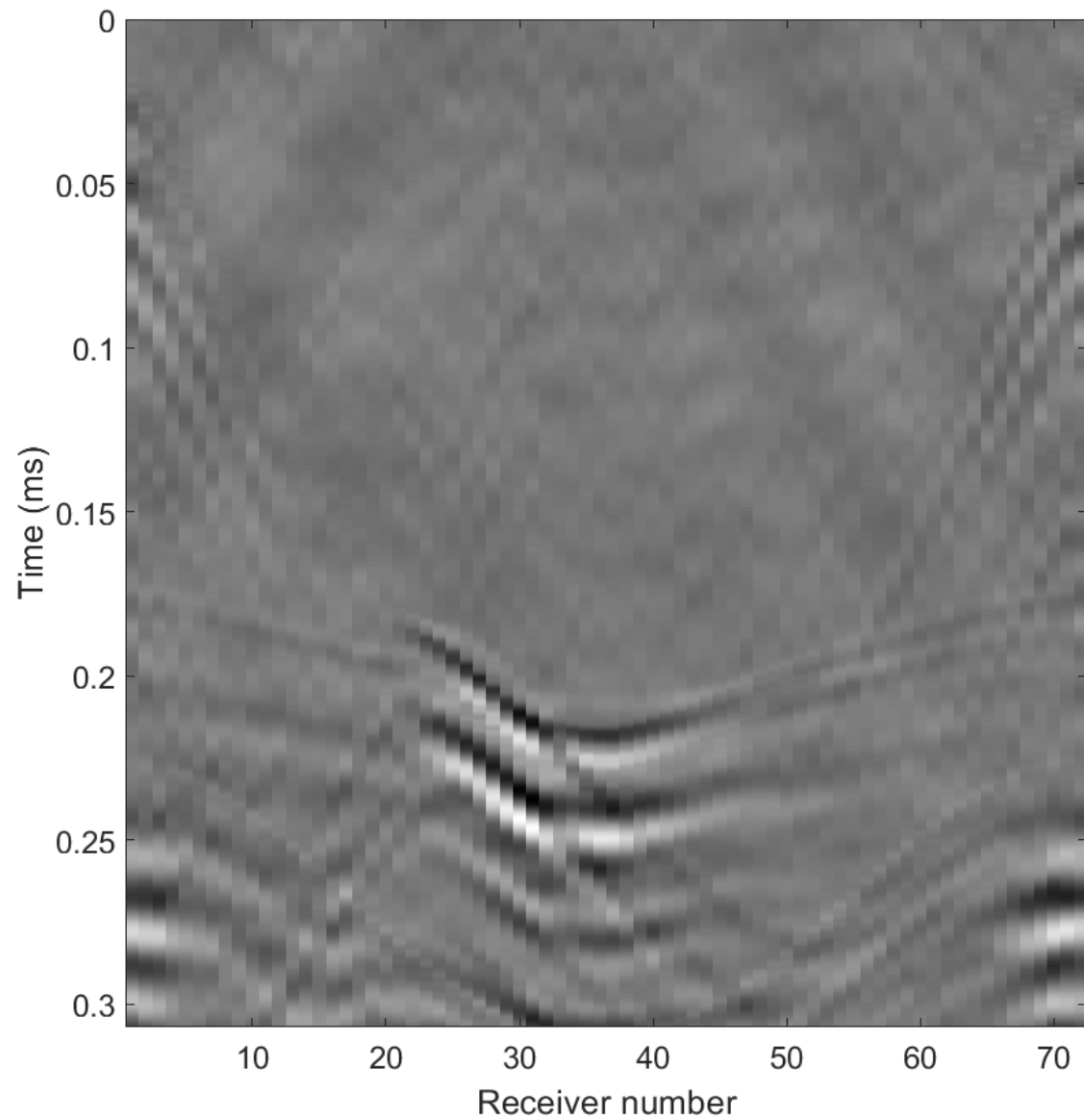


Raw data – target



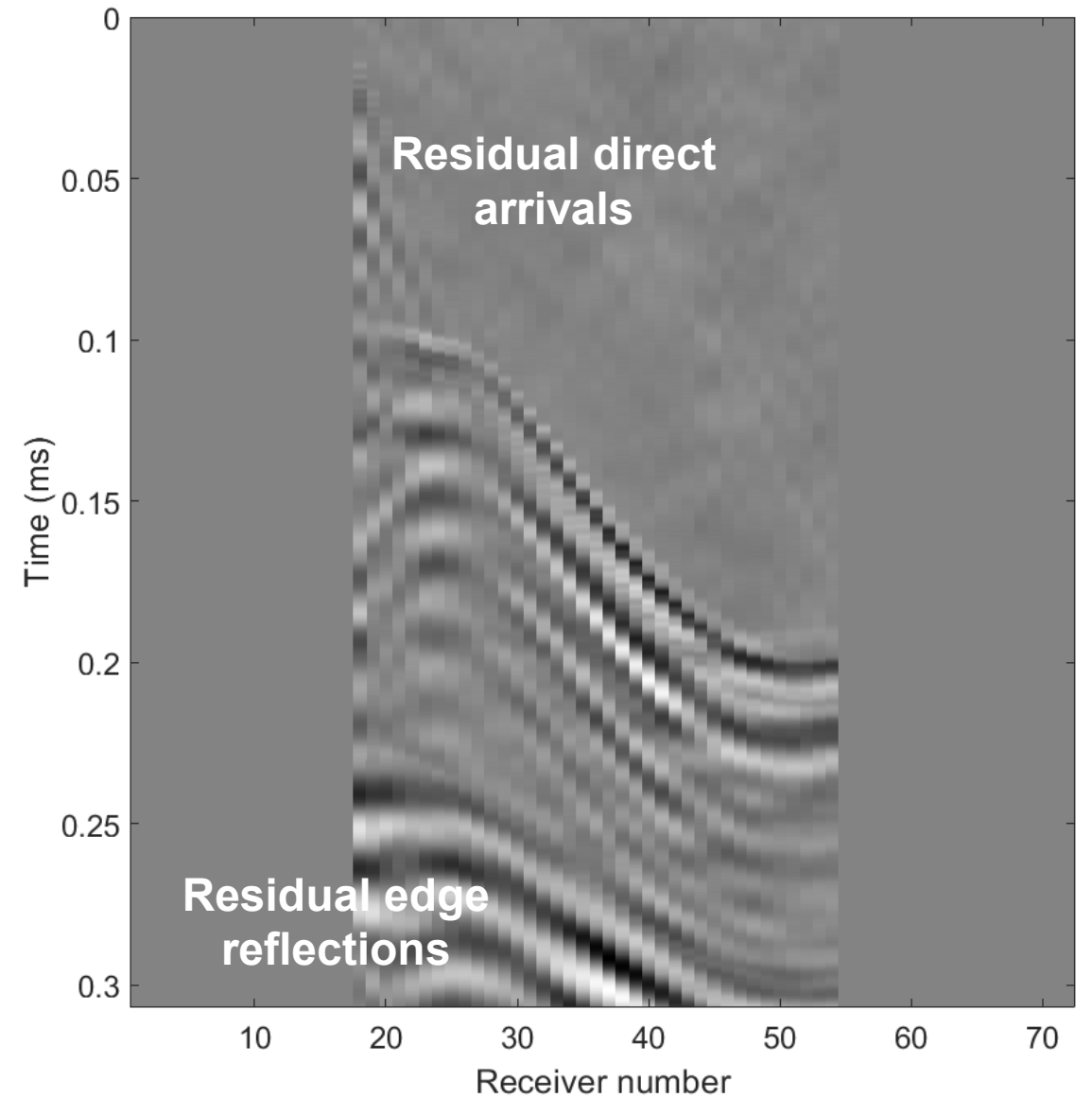
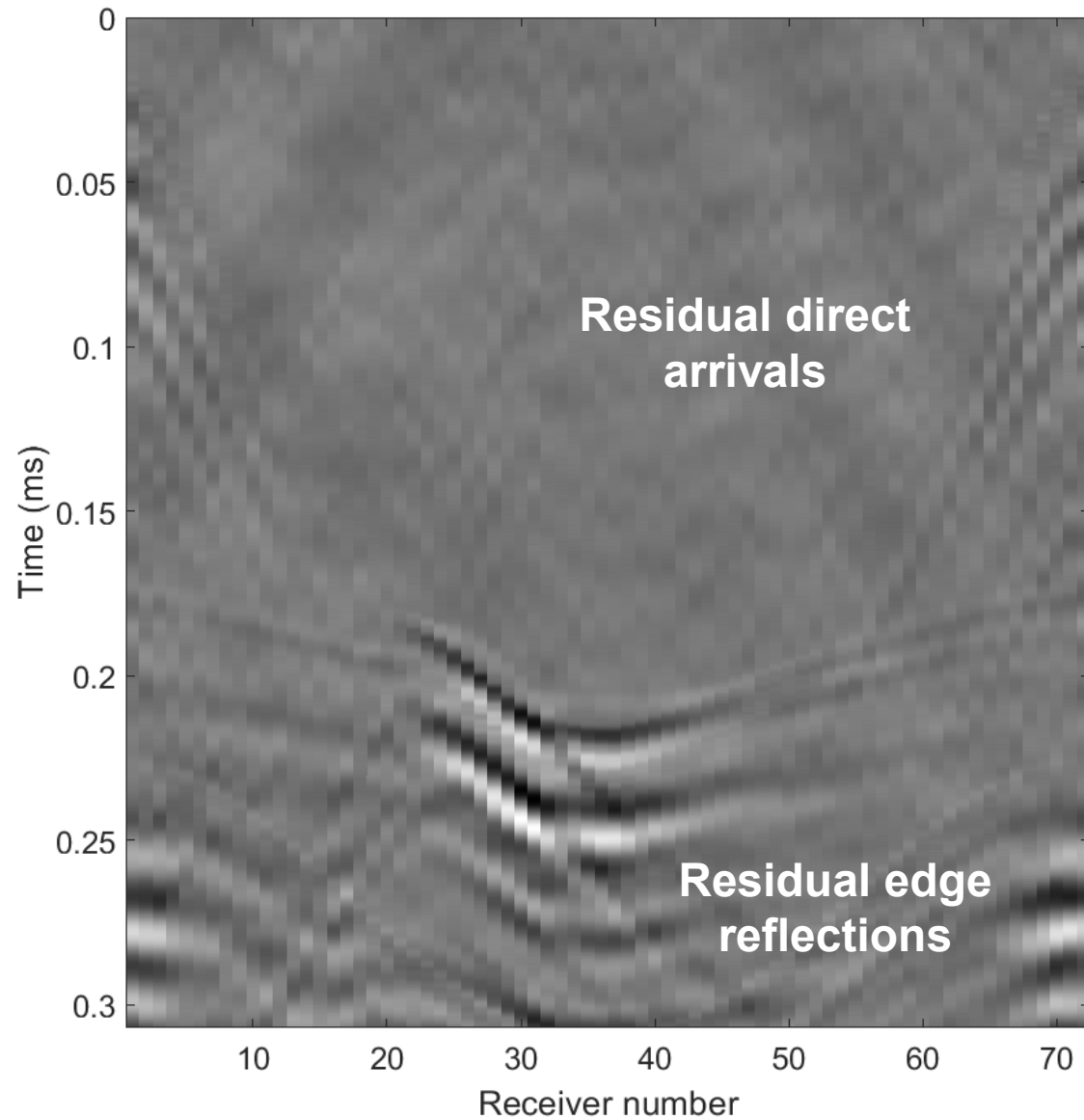


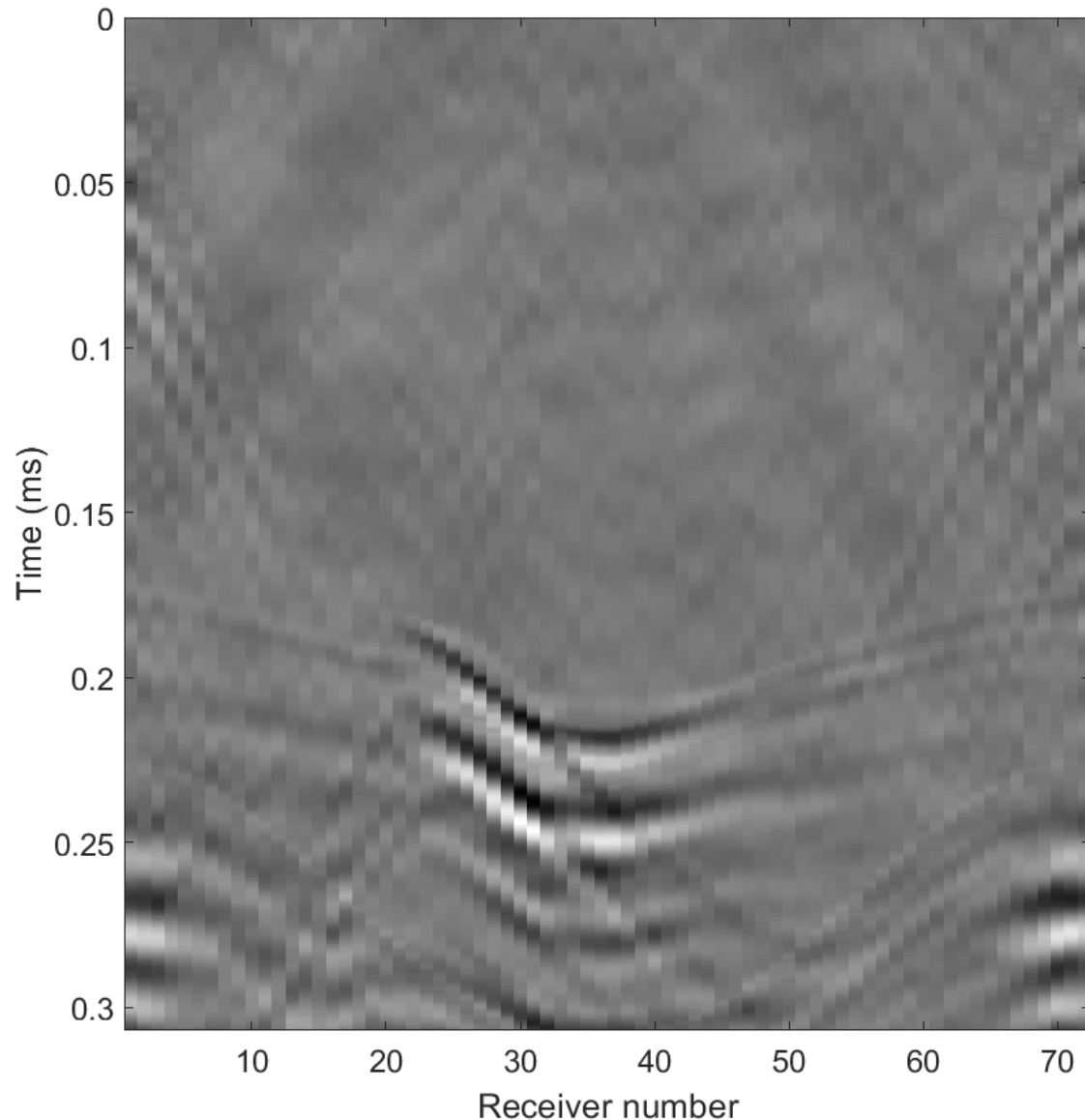
Raw data – difference



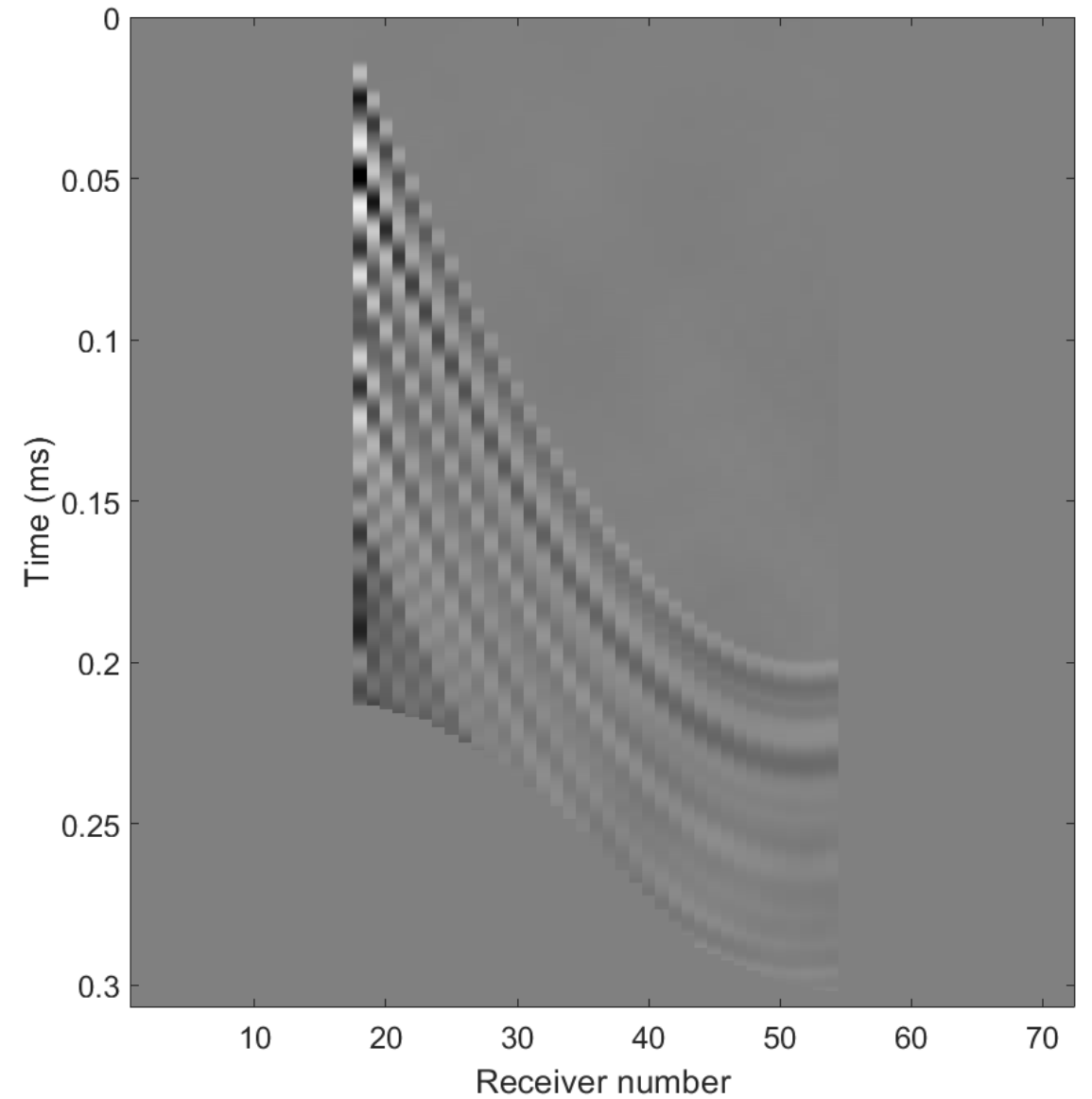
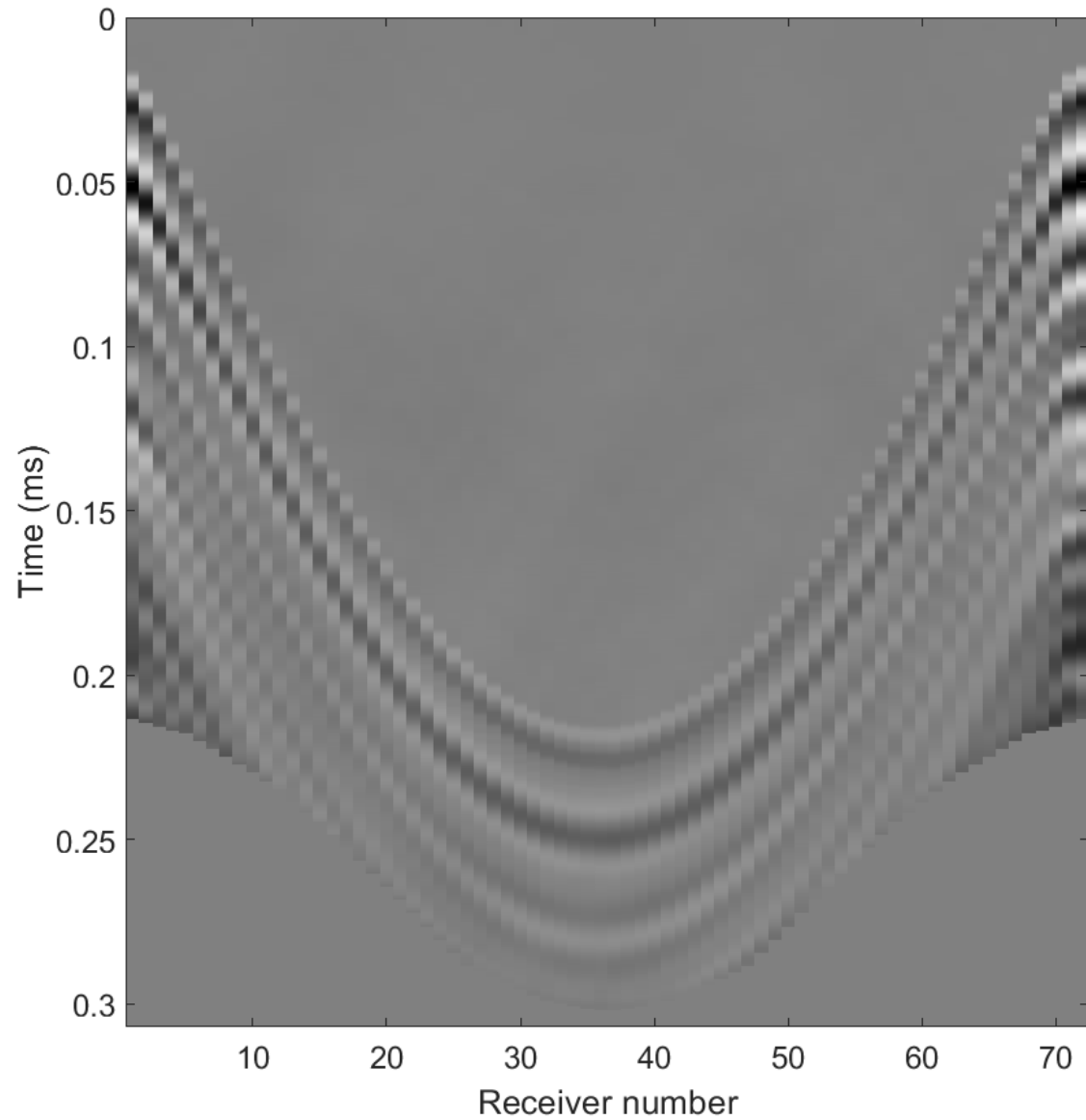


Raw data – difference



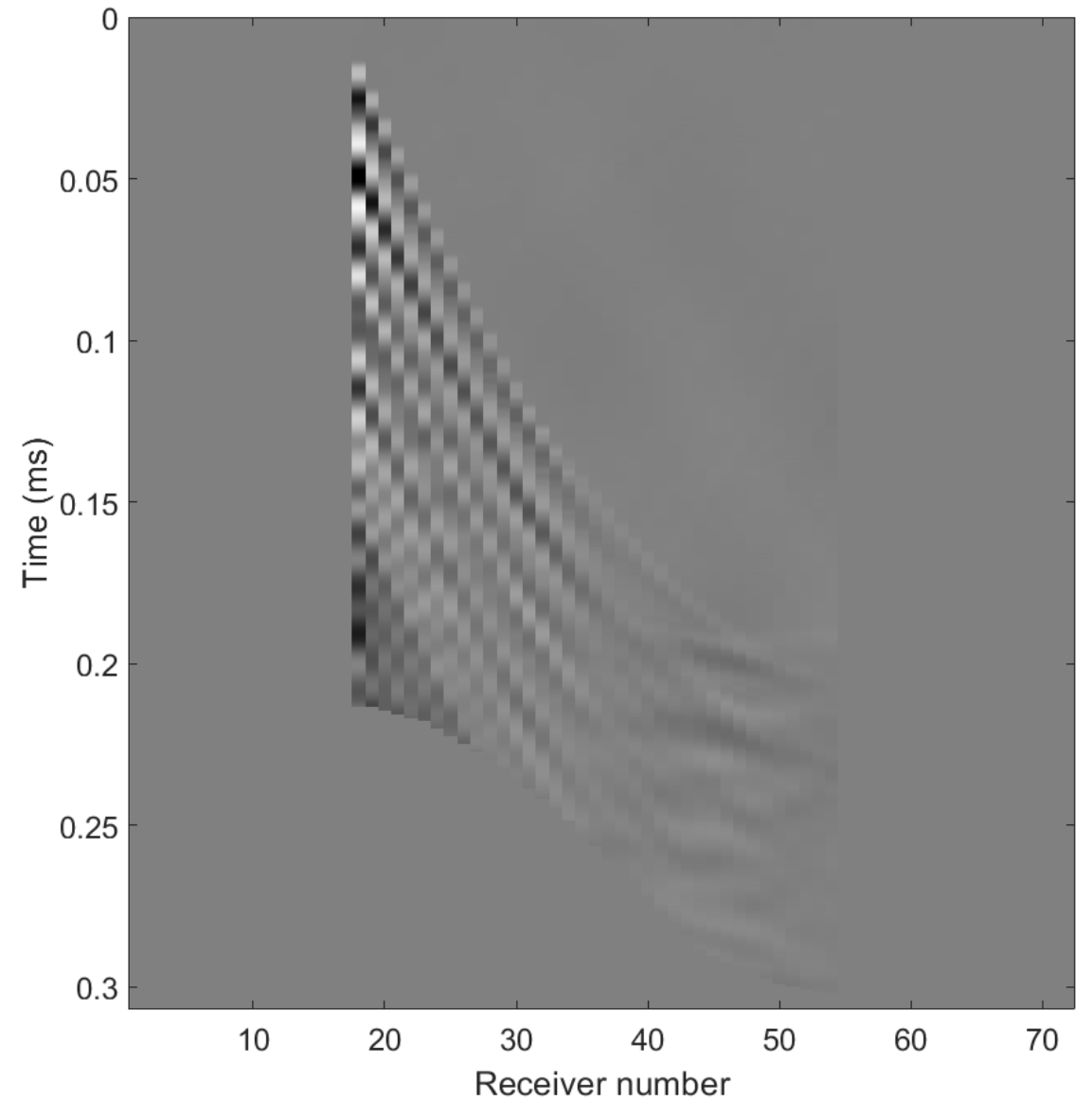
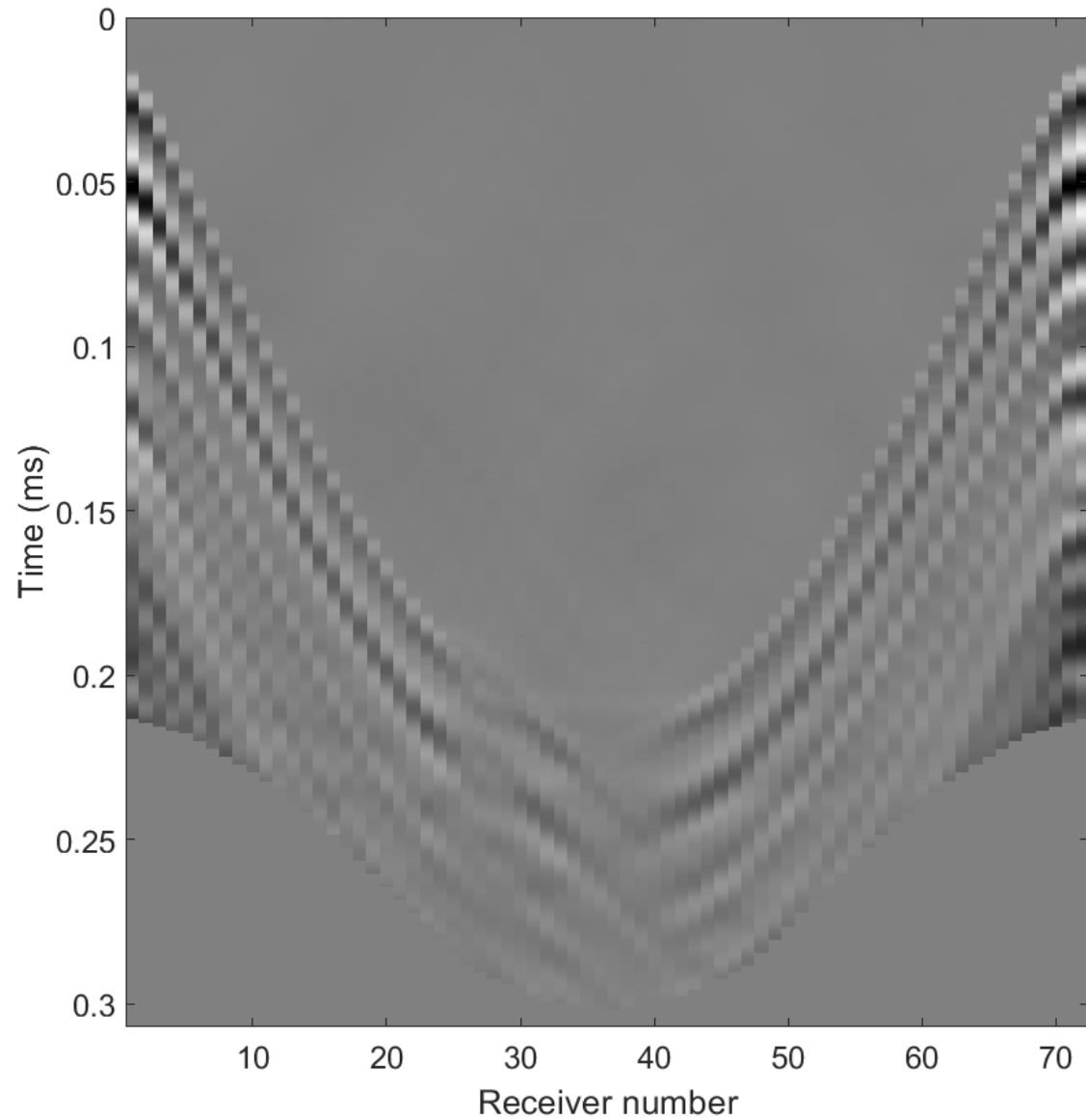


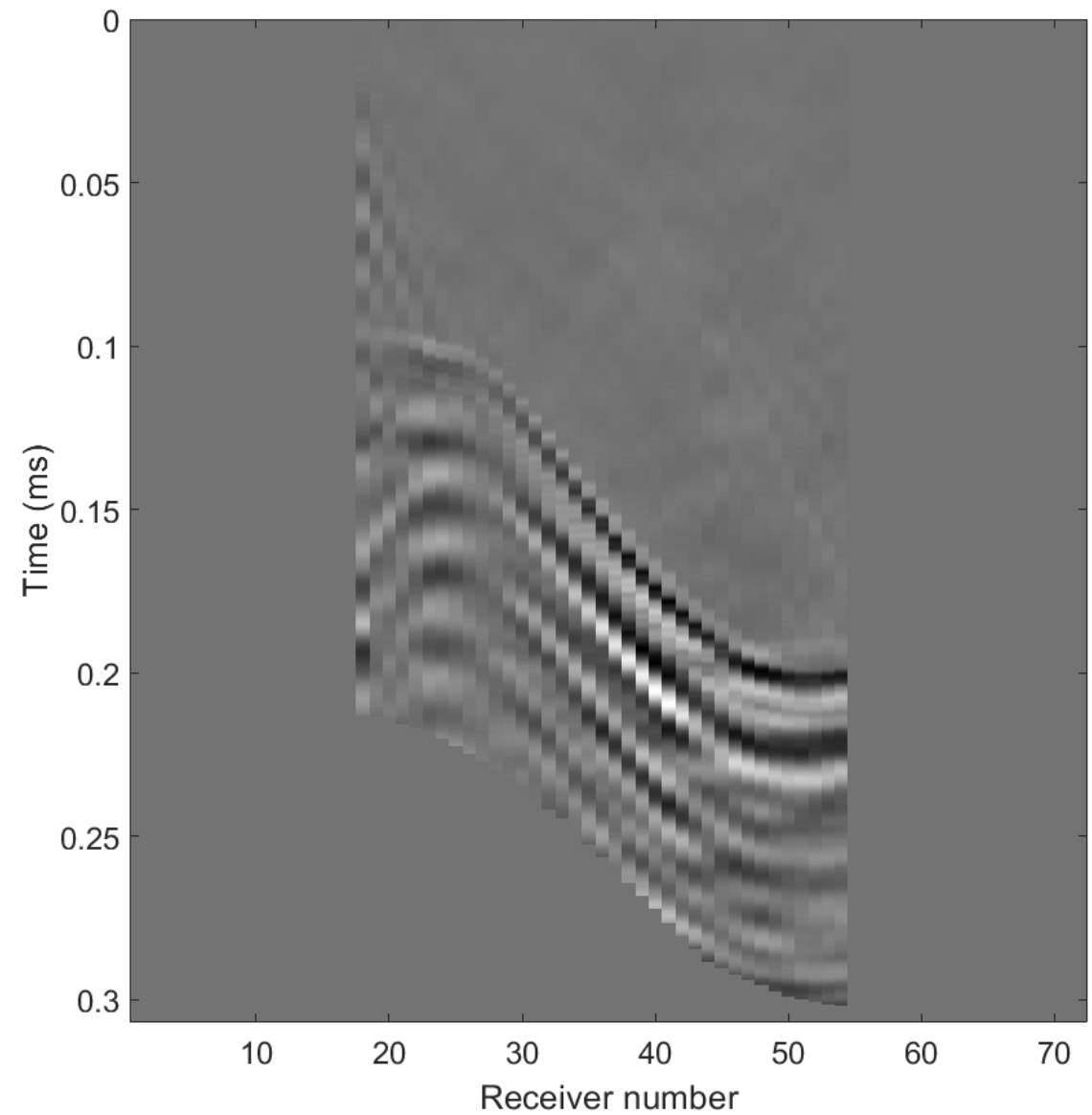
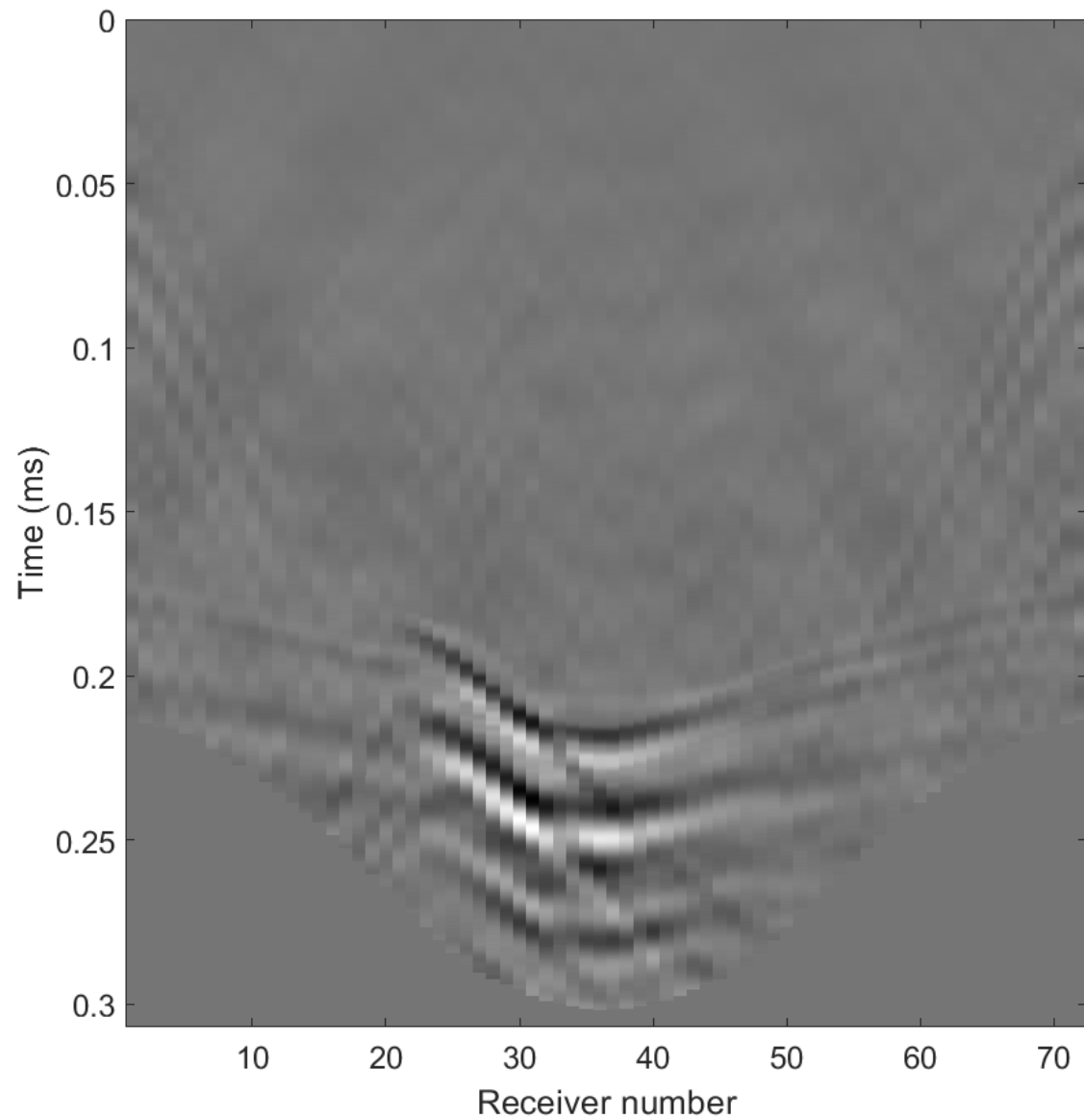
- Amplitude correction (3D to 2D)
- Muting of edge reflections
- Heavier processing flows didn't improve results

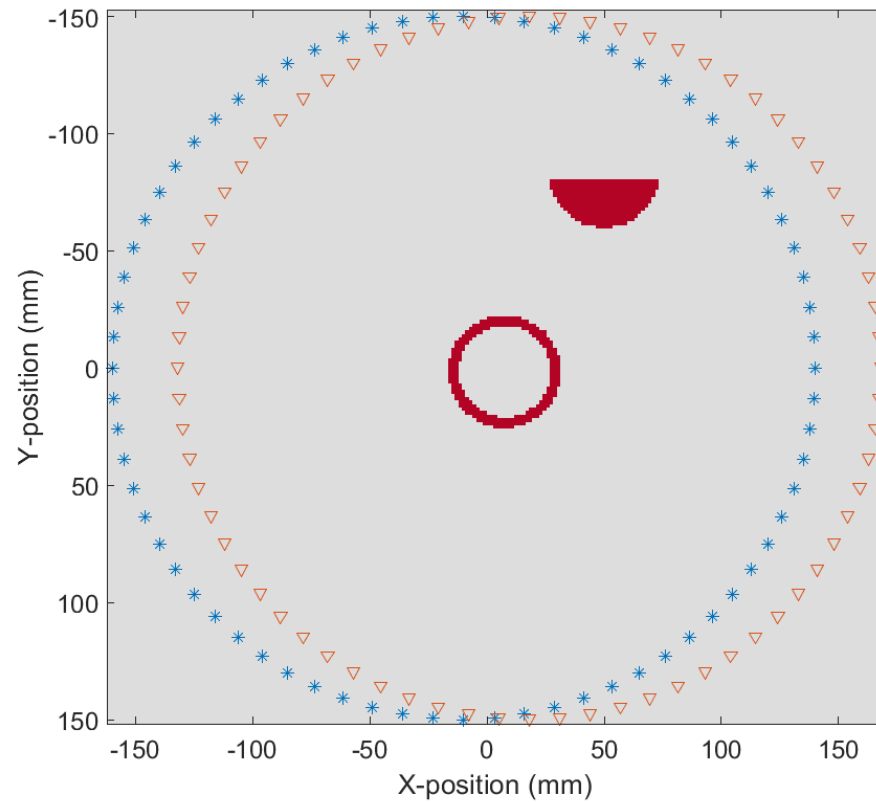




Processed data – target



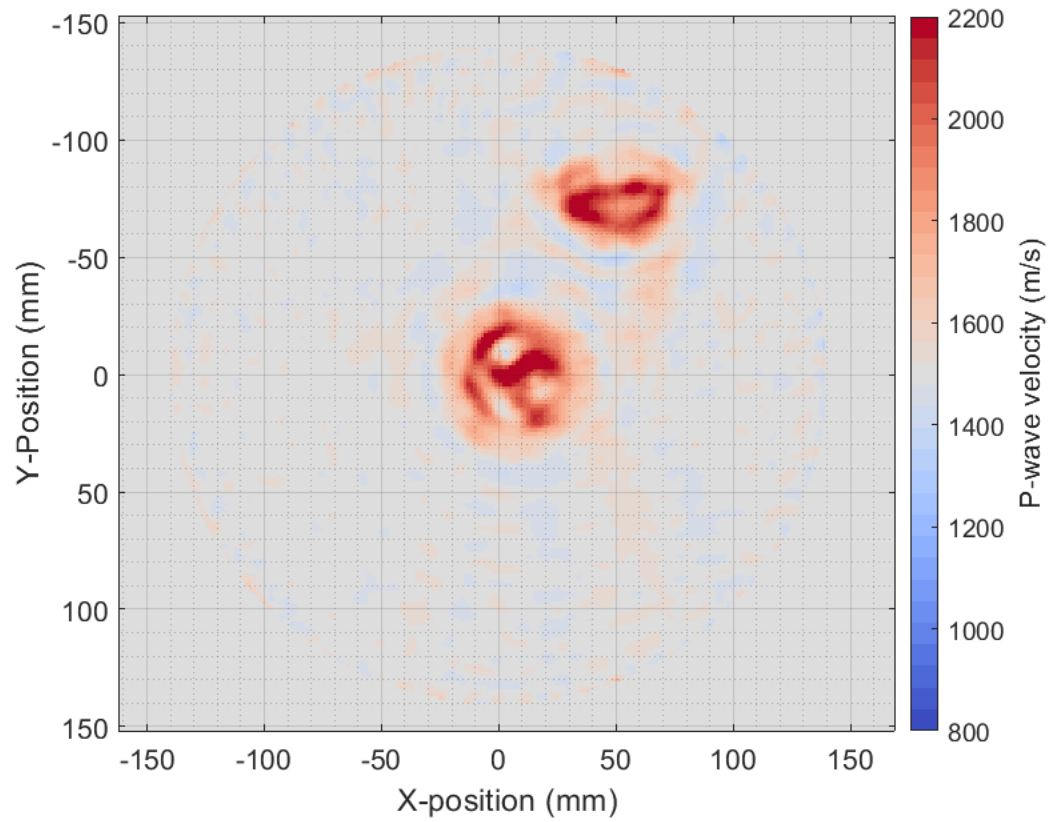




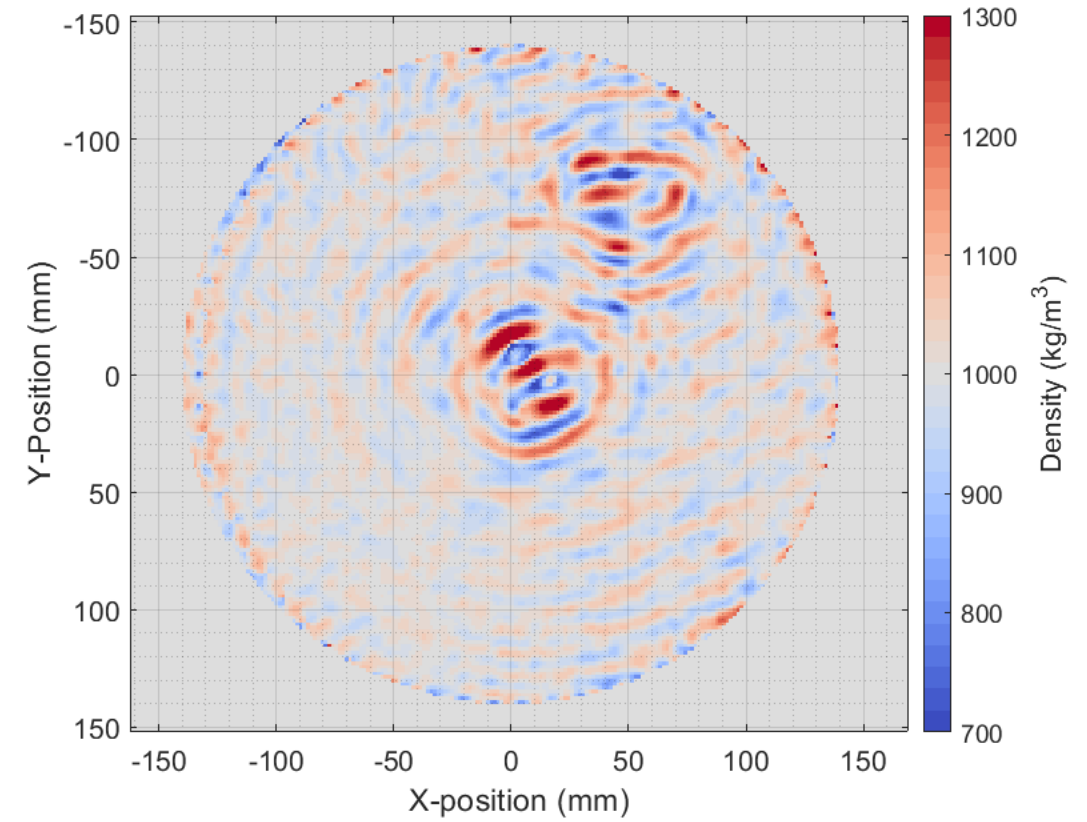
- FWI on 8 frequency bands, 10 iterations per band
- Inversion for v_P and density
- Water velocity starting model



P-wave velocity

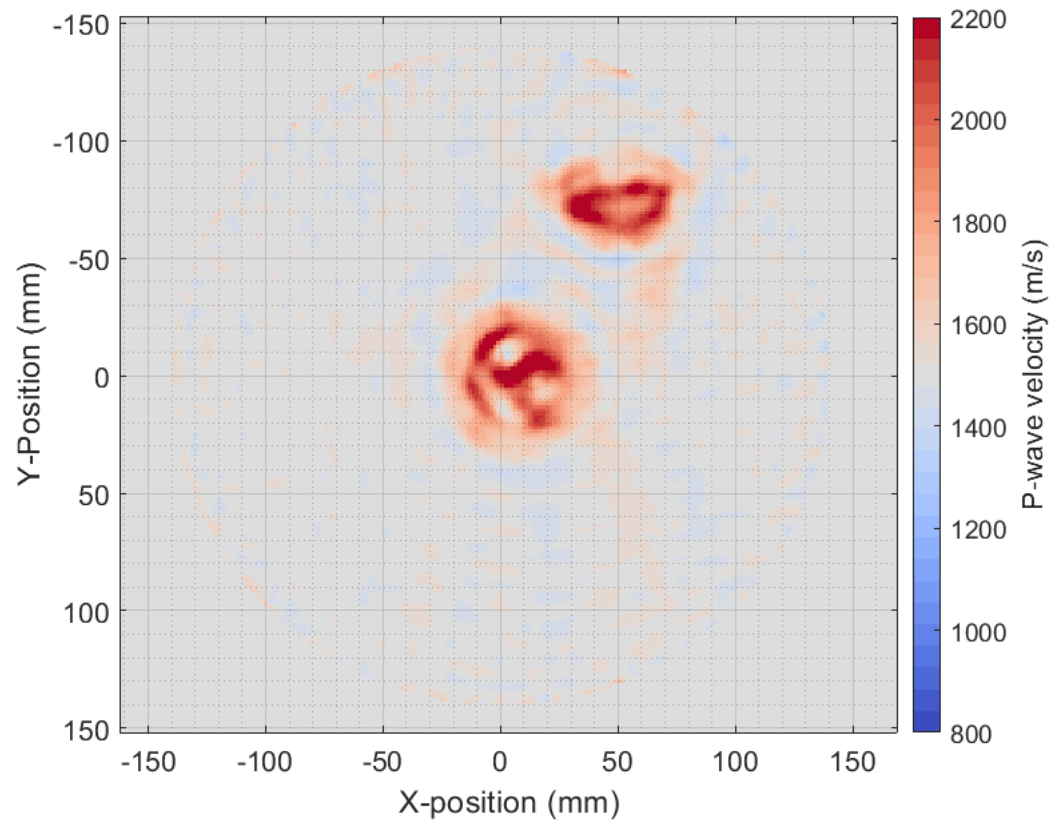


Density





P-wave velocity



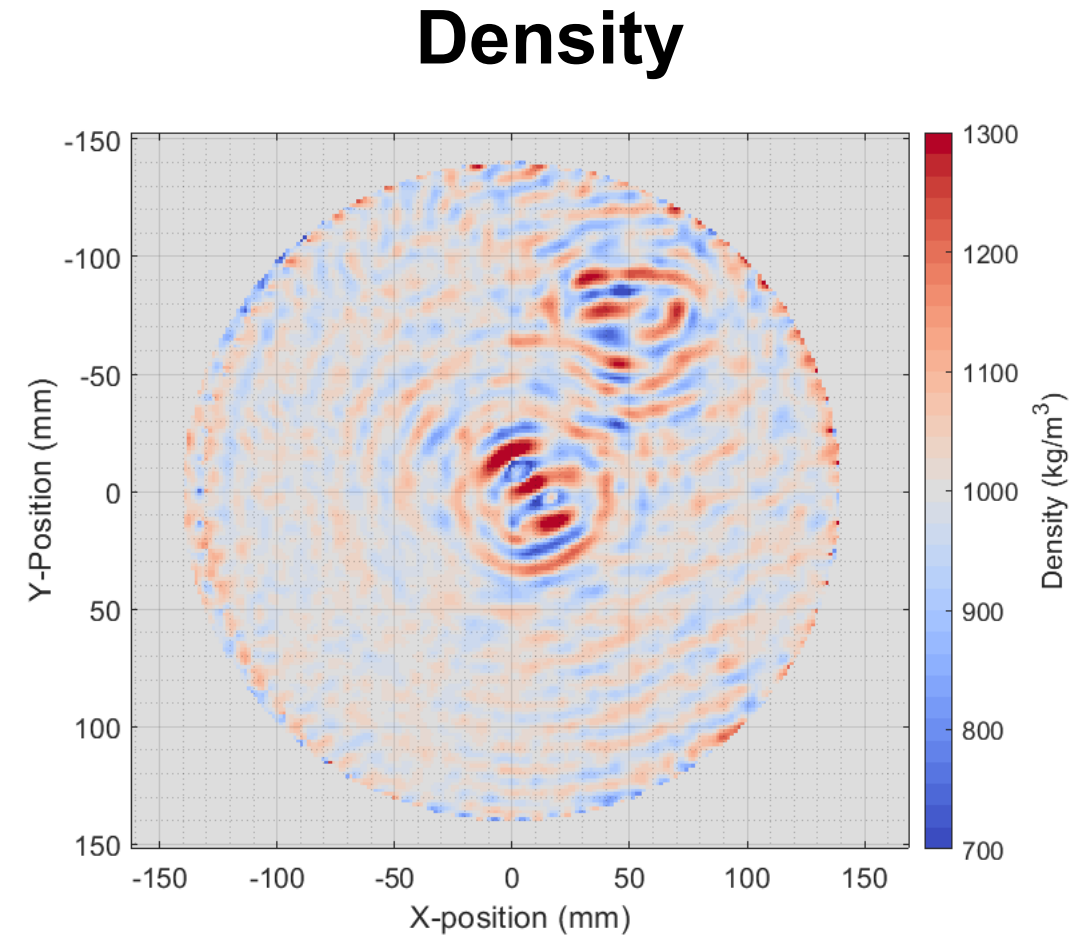
Long wavelength match ✓

Short wavelength match ✗



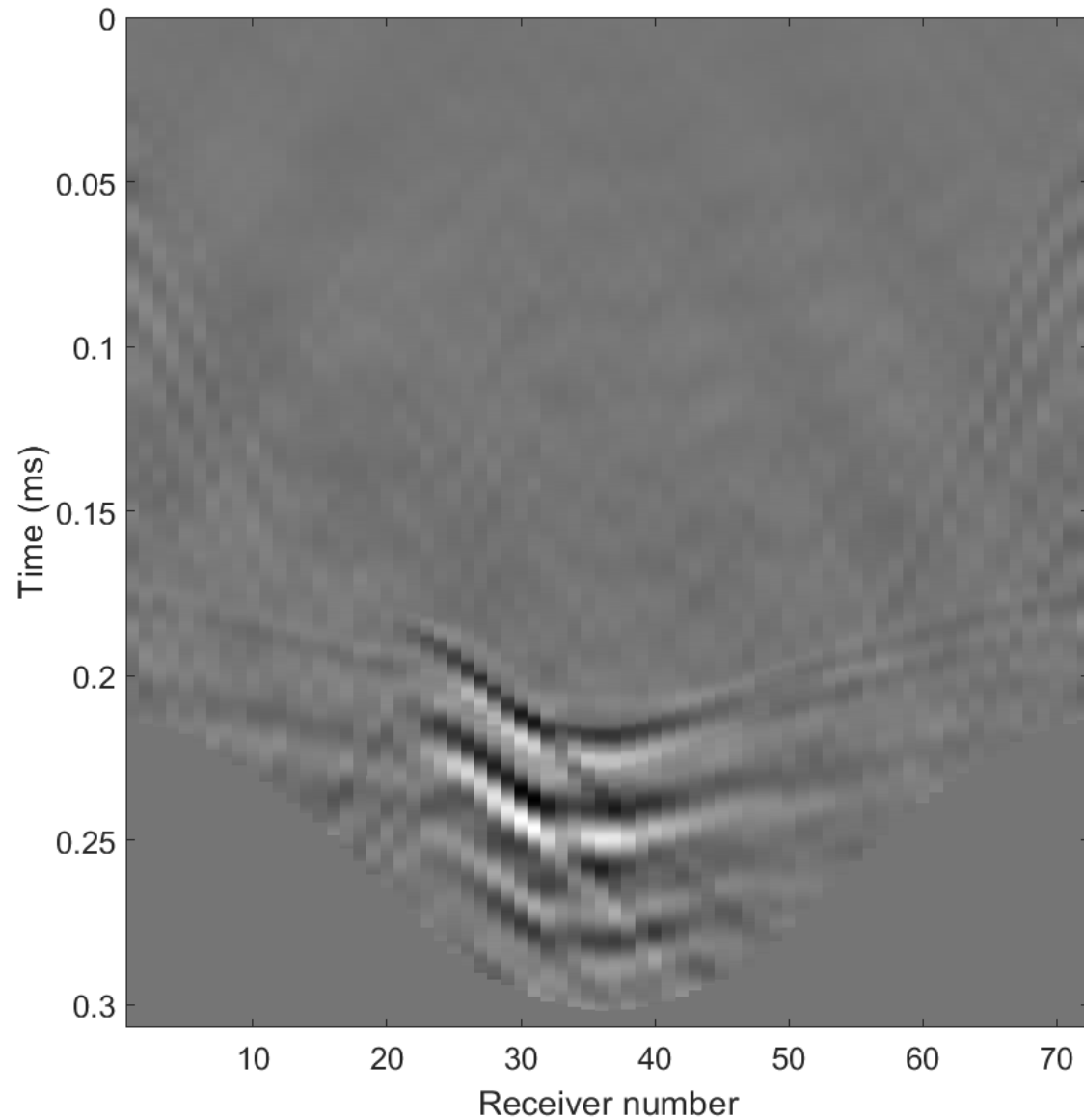
Long wavelength match ✖

Short wavelength match ✖

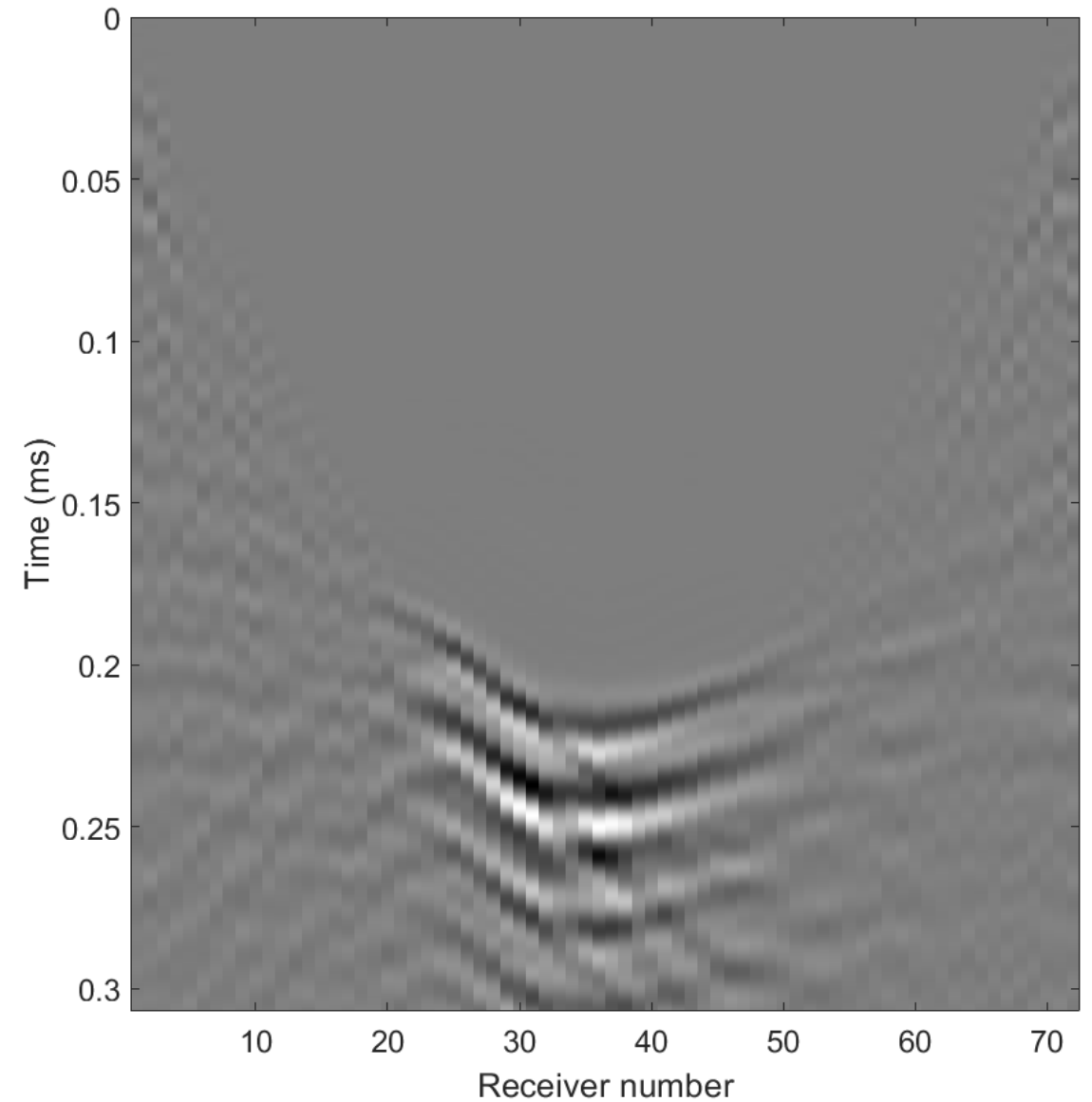




Measured difference

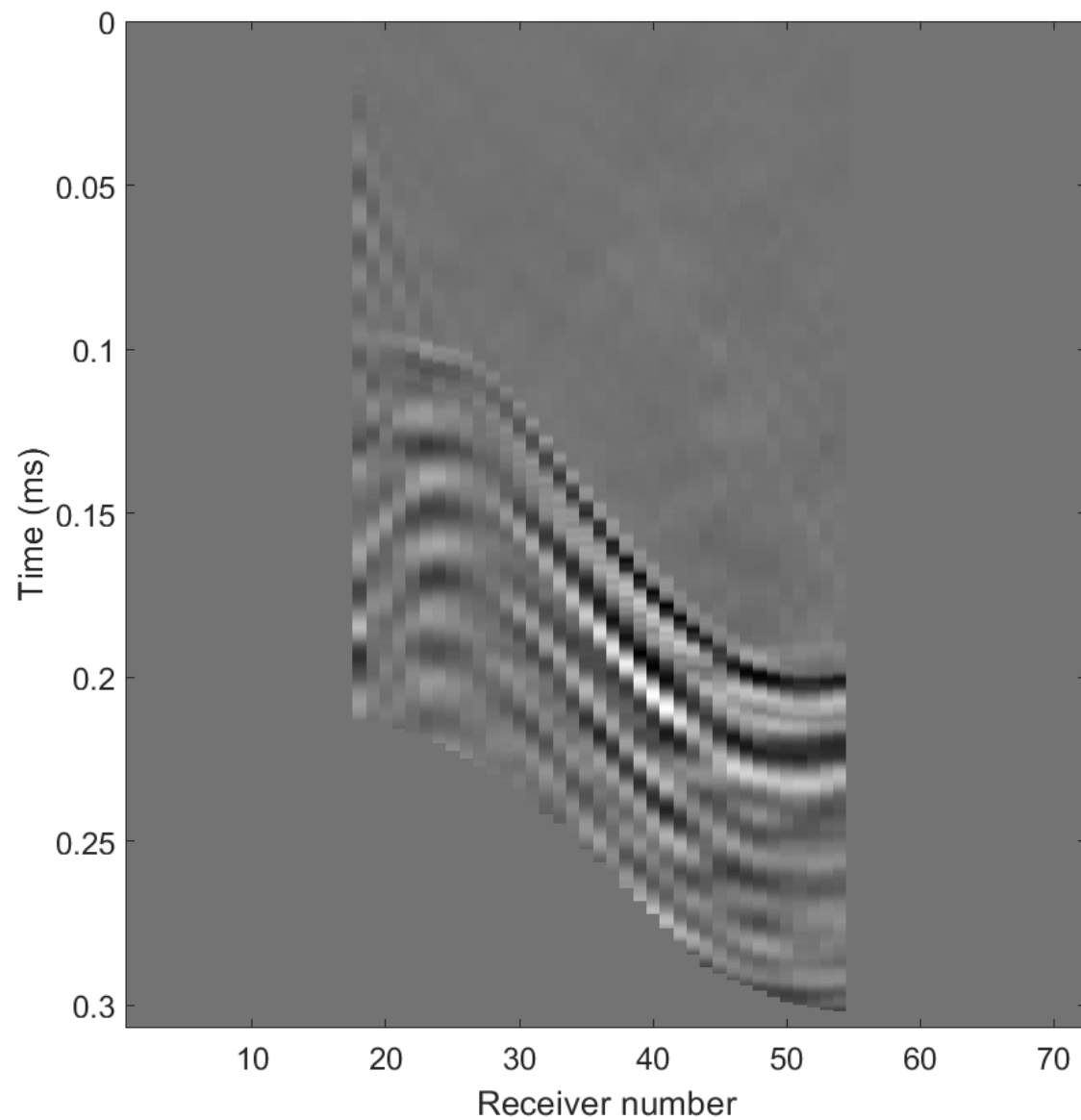


Modeled difference

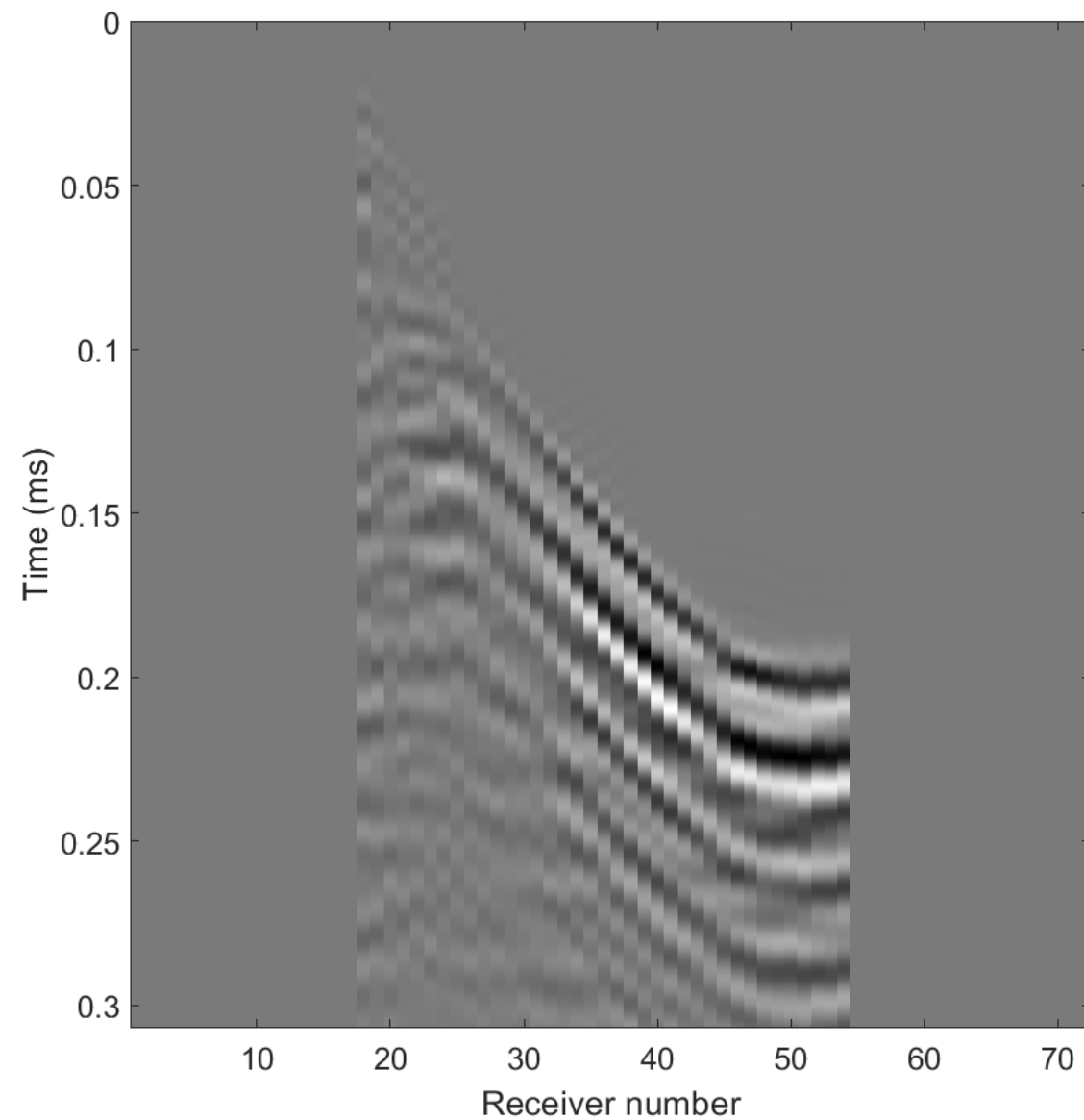




Measured difference



Modeled difference

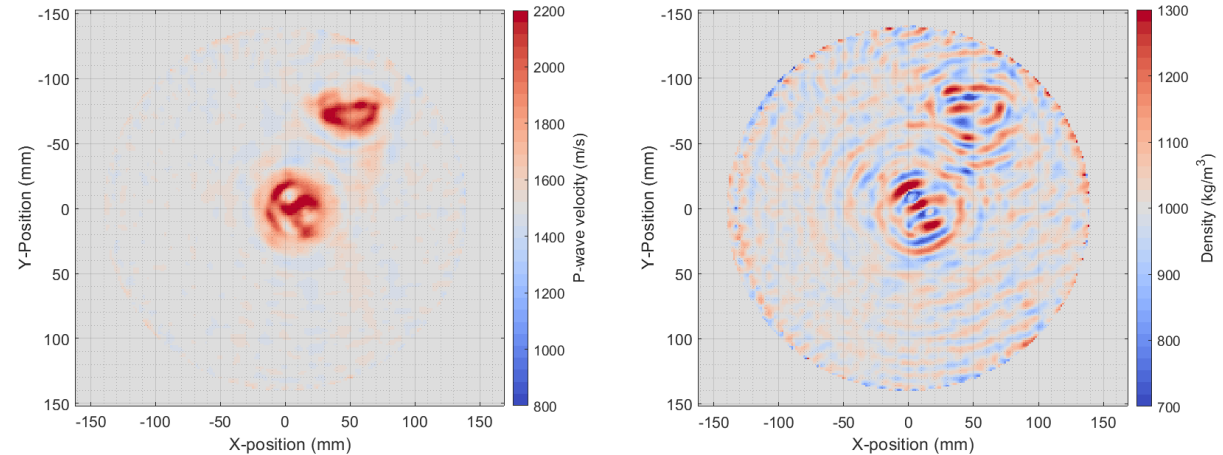




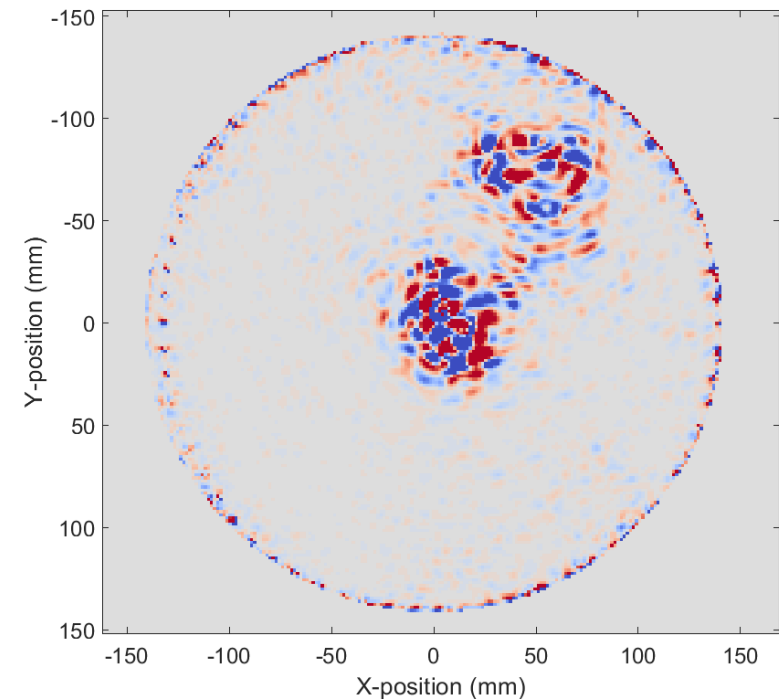
Density estimates can be improved with information from velocity

We generally have high confidence of **geometric similarity** between parameters

Penalizing the **cross-product** of the **spatial gradient** of parameters promotes parallel or zero-amplitude contrasts

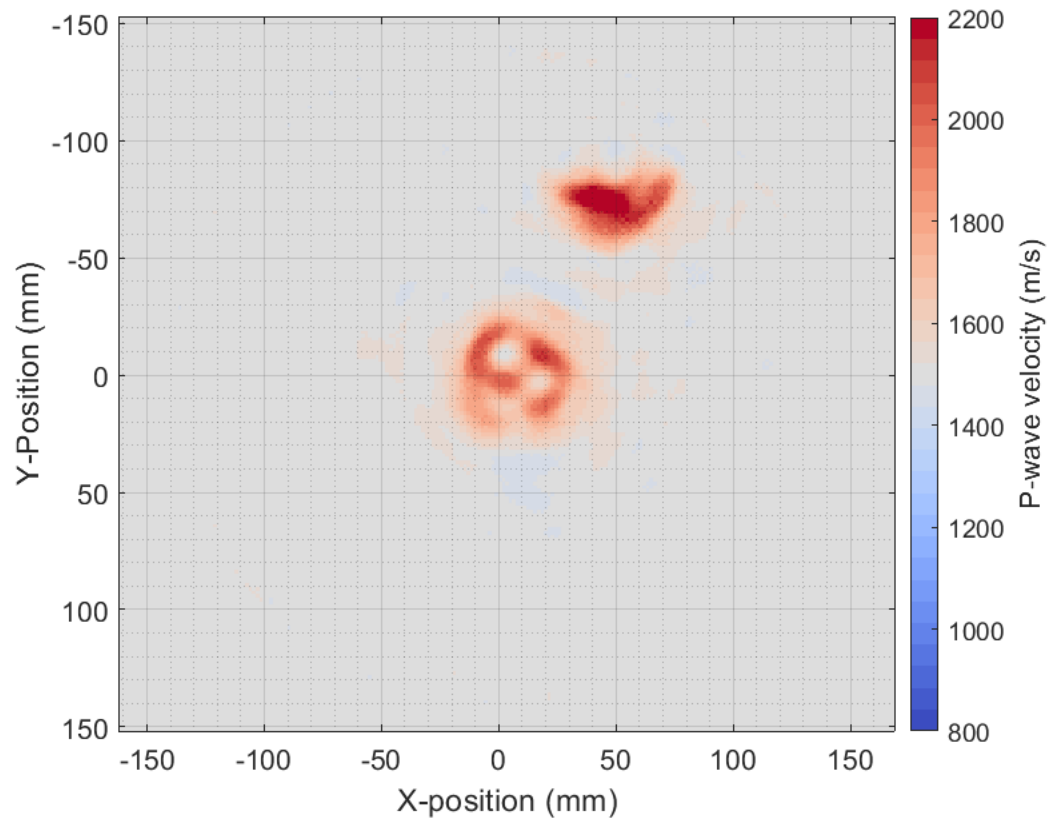


Cross-gradient

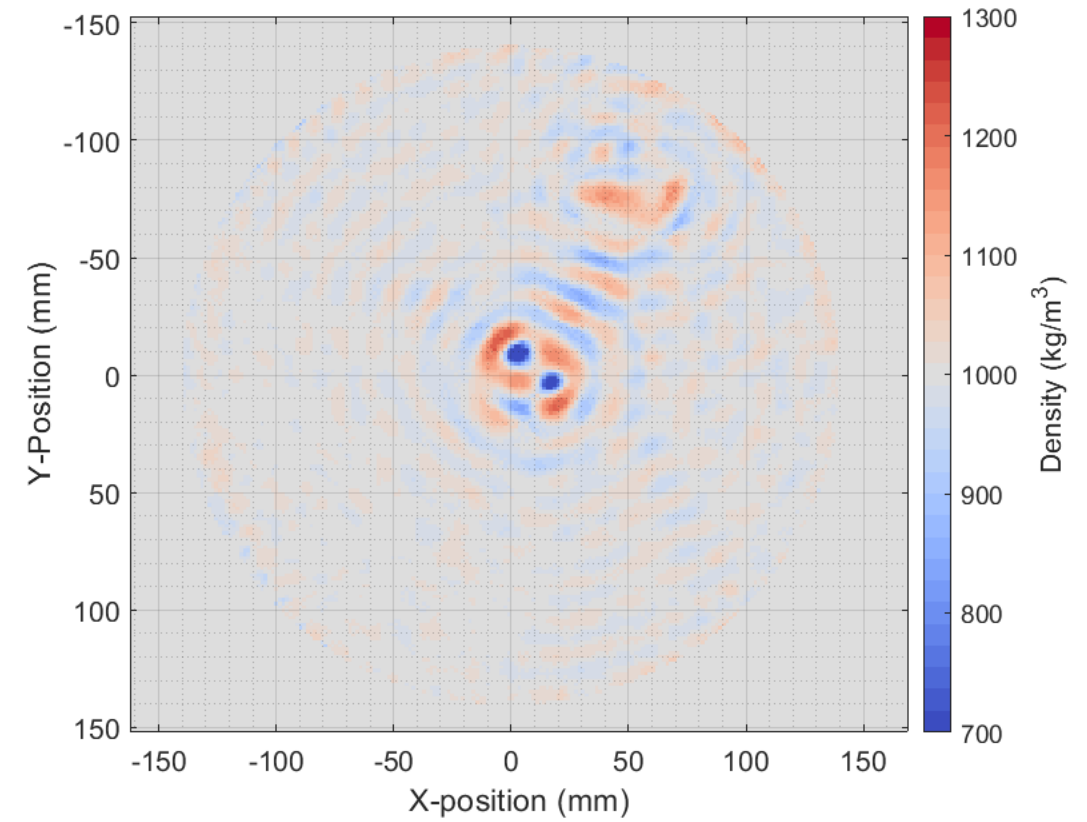




P-wave velocity

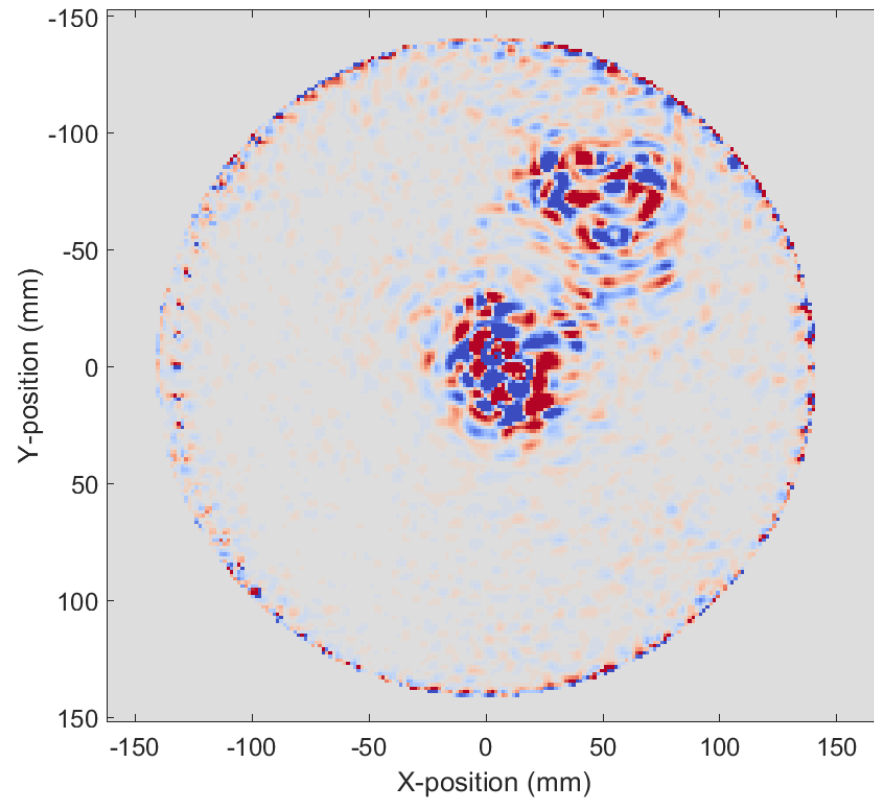


Density

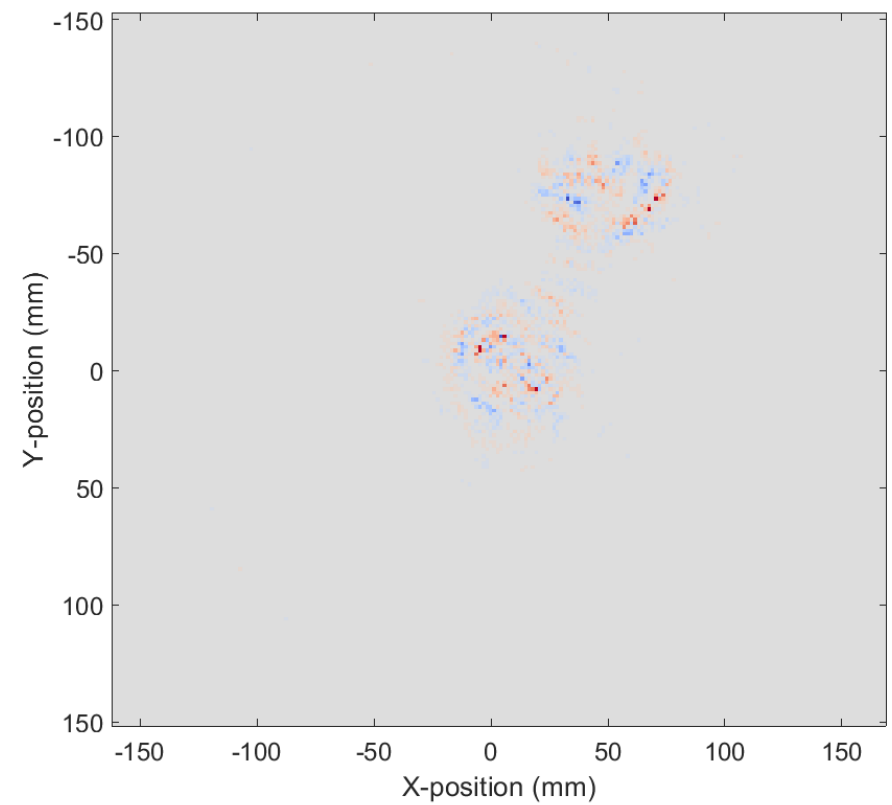




Unregularized

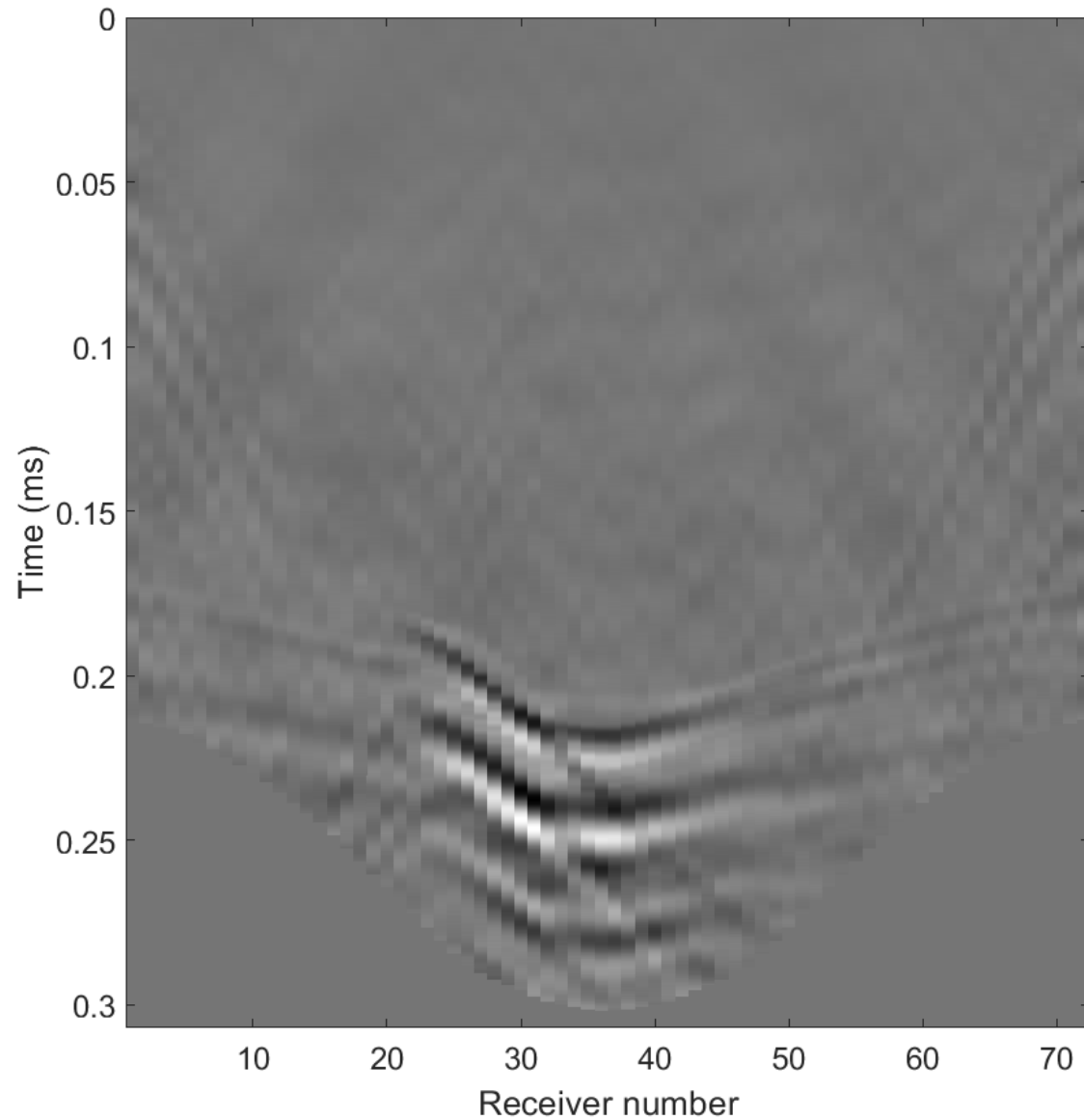


Regularized

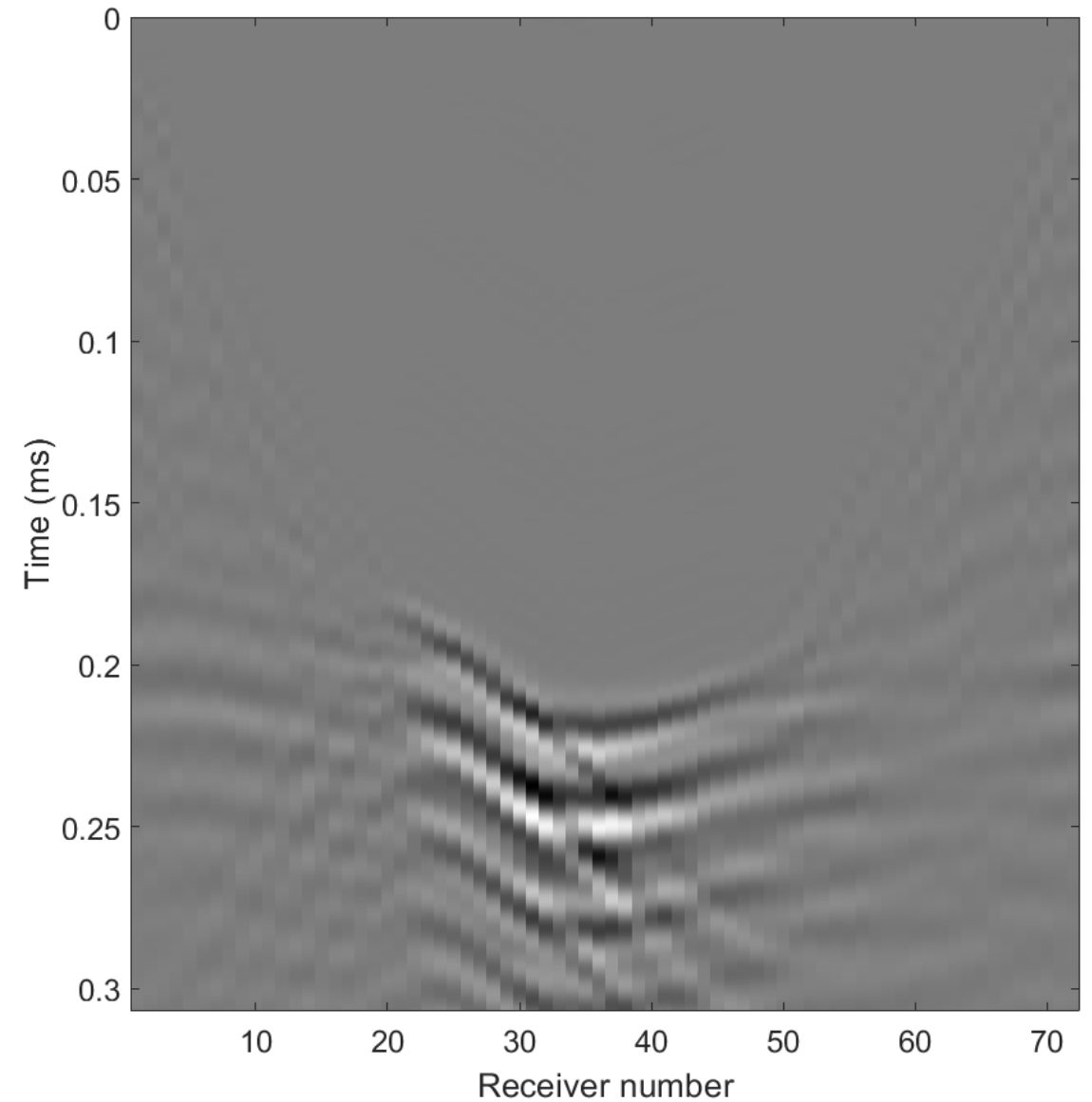




Measured difference

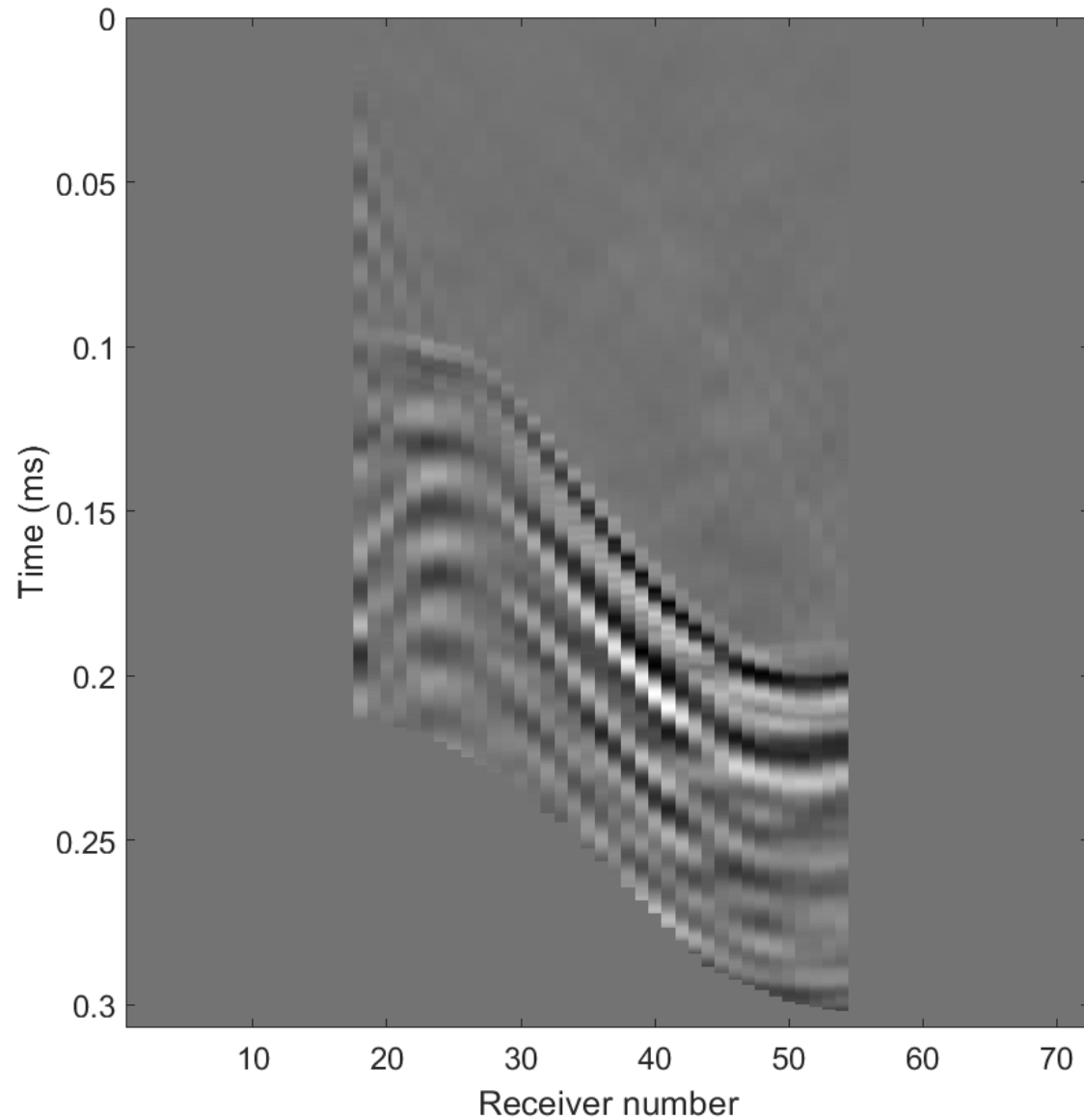


Modeled difference

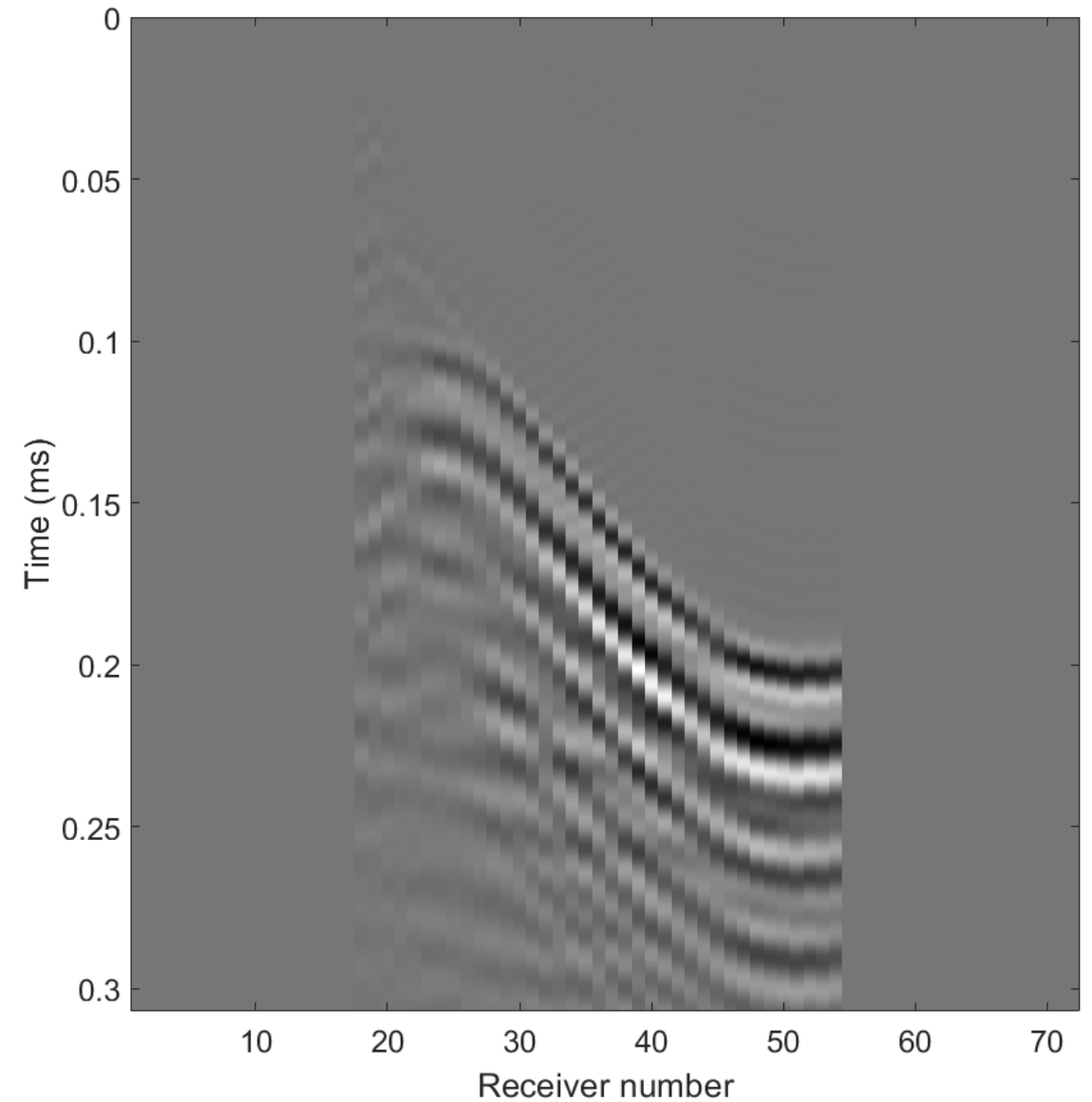




Measured difference



Modeled difference

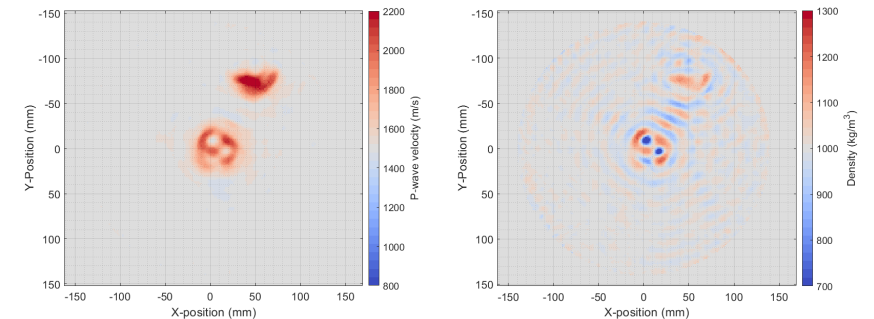
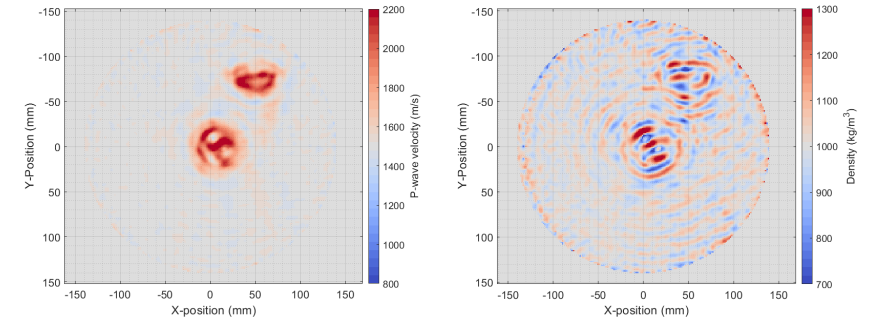


Longer recording times for reflections could help improve short-scale features

Inconsistencies and asymmetries in the data confuse the inversion

Some of these issues may be helped by alternate processing

New tests in the bigger tank

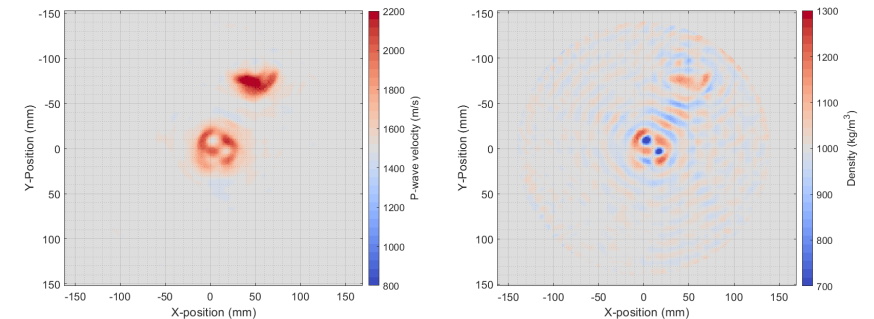
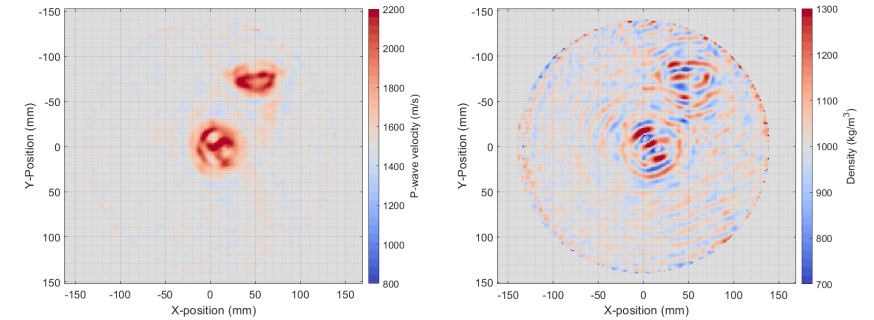




Full-waveform inversion seems to provide accurate results at long to medium wavelengths

Cross-gradient regularization can significantly stabilize density estimates

Longer recording times may be needed for improved results





- CREWES sponsors, staff and students
- CFREF



NSERC-CRD (CRDPJ 543578-19)