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Wave-selective beamforming with Distributed Acoustic Sensing

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As fibre-optic DAS deployments become more common, researchers are turning to tried-and-true methods of locating or characterizing seismic sources such as beamforming. However, the strain measurement from DAS intrinsically carries its own sensitivities to both wave type and polarization (Martin et al. 2018, Paitz 2020 doctoral thesis). Additionally, a measurement along a conventional fibre-optic cable only provides one component of motion, and so certain azimuths may be blind to certain types of seismic sources, unless the cable layout can be designed to be oriented in multiple directions.

In this work, we explore the development and application of a beamforming algorithm that explicitly searches for multiple wavetypes. This builds on 3-component beamforming or Matched Field Processing (MFP) algorithms by Riahi et al. (2013), and Gal et al. (2018), where in addition to gridsearching over possible source azimuths, a distinct gridsearch is performed for each possible wavetype of interest. This does not solve the problem that a given cable orientation might be less sensitive to certain directions, but at least an array-response function can be robustly defined for each type of seismic excitation. This might help further distinguish whether beamforming observations are dominated by primary sources or by secondary scattering (van der Ende and Ampuero, 2020 preprint).

Much of this work uses analytic theory and synthetic examples. Time permitting, the enhanced algorithm will also be applied to data from the Mt. Meager experiment to explore its feasibility and efficacy with real data (EGU contribution from Klaasen et. al, 2021).