

**1191194 A System for Ghost-Free Marine Seismic Acquisition**

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The ghost in marine seismic recording is the result of an almost perfect reflection of the acoustic wavefield from the sea surface. Up-going waves are reflected back as down-going waves with a reversed polarity, and interfere constructively for certain frequencies and destructively for other frequencies. This phenomenon occurs both on the source side and on the receiver side. The affected frequencies depend solely on source and receiver depths. Conventional marine seismic acquisition therefore involves a trade-off between the various frequency ranges. To record high frequencies, sources and receivers have to be towed shallow, which strongly attenuates low frequencies. Conversely, a deep tow favors low frequencies at the expense of high frequencies.

Recently a dual-sensor streamer, with collocated pressure and motion sensors, has been developed. Such a streamer effectively removes the receiver ghost while maintaining the efficiency of towed streamer acquisition. Unlike the pressure sensors, the motion sensors are sensitive to the direction of propagation and this directional sensitivity coupled with measurement of pressure and velocity enables removal of the receiver ghost.

A ghost-free source can be achieved with a time and depth distributed source using sub-sources deployed at specific depths and fired with specific firing time delays. The depths of the sub-sources are chosen such that the ghost functions are complementary, avoiding deep notches in the spectrum. The firing time delays of the sub-sources would generally be less than around one second. This means that the geology illuminated by each sub-source is essentially identical, and the receivers are essentially in the same locations when the sub-sources fire. The source can be fired with the same shot efficiency and density as a conventional source. Techniques for separating the wavefields from sub-sources have been developed that utilize the known firing time delays. The subsequent source ghost removal step involves re-combining those wavefields using well established techniques that have been developed for processing data acquired with over/under streamers.

De-ghosting or wavefield separation for source and receiver is based on first principle science and makes no restricting assumptions. The result is a seismic data with a broader bandwidth both at the high end and the low end of the frequency spectrum.