

# On the use of a pulsed-laser source in laboratory seismic experiments

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Reproduction of large-scale seismic exploration at laboratory-scale with controllable sources is a promising approach that could not only be applied to study small-scale physical properties of the medium, but also contribute to significant progress in wave-propagation understanding and complex media imaging at exploration scale via upscaling methods.

We seek to characterize the properties of a new laser-generated seismic source for laboratory-scale geophysical experiments. This consists in generating seismic waves in aluminum blocks by pulsed-laser impacts and measuring the wavefield displacement by laser vibrometry. Parallel 2D/3D simulations using Discontinuous Galerkin discretization method and analytic predictions have been done to match the experimental data.

Statistic analyses on the incident power density ( $P_d$ ) of the pulsed-laser impacts are done to highlight the repeatability and stability of the seismic source whose continuously-evolving regimes are thereby identified and characterized: from the thermoelastic regime to the ablation regime including the transitory regime, depending on  $P_d$  and the impact size. We have also experimentally measured the radiation patterns of the laser-pulsed seismic source in both regimes and compared them with that of a typical ultrasonic transducer, always in accordance with modelings. Application of this new source on limestone cores will be shown, especially the 2D  $V_p/V_s$  tomography slices as well as the possibility of performing FWI on these high resolution data.

The pulsed-laser source has two particularly interesting features for geophysical experiments: the quasi-isotropic radiation pattern due to the punctual source and the broadband wavelet which are for example potentially useful for seismic dispersion studies in porous or anisotropic media.

We conclude that this punctual, contact-free, reproducible, easily handling laser-generated seismic source is a promising alternative to piezoelectric sources for laboratory experiments such as NDT and digital rocks imaging of elastic or poroelastic properties, especially when small scale sub-metric experiments are concerned.