Full waveform inversion and imaging in model reduction framework in seismic exploration

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This talk will be preceded by a quick overview of the seismic imaging concept from industrial point of view. Without pretending to be complete, we consider different types of acquisition techniques and pay attention to numerical techniques for seismic data inversion, such as ray tracing, migration and full waveform inversion. We outline their advantages and current drawbacks as well as general challenges in the seismic imaging

Then I will present a new inversion approach based on the theory of projection-type reduced-order models, that resolves essential drawbacks of existing approaches. We sample the data at a rate close to the Nyquist one and construct a low-dimensional stable dynamical system matching the picked data. This system is obtained from the measured data only, however, it is equivalent to the full-scale system projected onto the subspace of orthogonalized time-domain solution snapshots. We demonstrate how the snapshots orthogonalization essentially removes the dominant part of all the multiples, and, consequently, avoids one of the key challenges in seismic inversion. Using a map from the data to low-dimensional system, we constructed three different approaches: 1)direct layer-stripping imaging method, similar to Gelfand-Levitan-Marchenko method; 2)iterative full-waveform approach with preconditioner removing most of the local minima; 3)direct nonlinear migration-type approach for imaging with known smooth kinematic model. The talk will be finished with few numerical examples.