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Simulation of seismic wave propagation for reconnaissance in machined tunnelling

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During machined tunnelling, there is a complex interaction chain of the involved components. For example, on one hand the machine influences the surrounding ground during excavation, on the other hand supporting measures are needed acting on the ground. Furthermore, the different soil conditions are influencing the wearing of tools, the speed of the excavation and the safety of the construction site. In order to get information about the ground along the tunnel track, one can use seismic imaging.
To get a better understanding of seismic wave propagation for a tunnel environment, we want to perform numerical simulations. For that, we use the spectral element method (SEM) and the nodal discontinuous galerkin method (NDG). In both methods, elements are the basis to discretize the domain of interest for performing high order elastodynamic simulations. The SEM is a fast and widely used method but the biggest drawback is it's limitation to hexahedral elements. For complex heterogeneous models with a tunnel included, it is a better choice to use the NDG, which needs more computation time but can be adapted to tetrahedral elements.
Using this technique, we can perform high resolution simulations of waves initialized by a single force acting either on the front face or the side face of the tunnel. The aim is to produce waves that travel mainly in the direction of the tunnel track and to get as much information as possible from the backscattered part of the wave field.