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From medical Imaging to Seismology

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We apply ultrasonic shear wave elastography, an imaging technique developed for medical applications and used in hospitals today, to a geophysical research question. In order to better understand friction and rupture processes which are responsible for earthquake nucleation, we build a laboratory experiment that reproduces the stick-slip behaviour of a seismic fault for soft elastic materials. The rupture process is generated by controlling a driving slab through a motor in synchronization with the acquisition system (Verasonics Vantage ultrasound scanner). As an analog to the fault damage zone, a granular layer of sand or gravel constitutes the stick-slip behaviour. Elastography allows us to get unique insights into shear-wave generation of rupture processes. In contrast to classical seismological methods, we are able to follow the wave propagation inside the sample and are not limited to surface information. First results confirm the previously proven existence of supershear fronts for the in-plane shearing mode. These Mach fronts that have been observed for several earthquakes are of special interest since they increase the seismic hazard compared to subshear earthquakes. In the future, combining displacement and strain measurements for different experimental setups will give insight into the nature of rupture nucleation and propagation.