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A New Paradigm for Testing Granular Materials: Discrete Element Computation with Real Particles

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ABSTRACT
We describe progress in building a transformative framework for testing granular materials subject to shear and vibration in which the full dynamic trajectory of individual particles is measured in real time. 3D printed particles with implanted three-axis accelerometer and three-axis gyroscope are being used as the building blocks of the granular bulk. Each particle may thus measure its own translational acceleration and angular velocity. Both shearing and shaking experiments are conducted at the MUST-SIM facility at UIUC. The approach will give unprecedented insight into the details of the collective motion of the granular particles, nonlinear elasticity and how global instabilities such as stick slip and shear banding are connected to grain contact processes. The approach goes beyond the current state of the art (e.g. dynamic photoelasticity and acoustic emissions experiments) and is expected to lead to new insights into the constitutive response of granular materials that is crucial in multiscale modeling.

KEYWORDS: *granular materials, particle trajectory, global instabilities*