Muscles are the most evident example of the plasticity of tissues in response to mechanical cues: training makes them grow whereas lack of stimulation leads to atrophy. This phenomenon has been studied both on animal models and on culture cells, and unraveled its biochemical and genetic actors. Though the molecular pathway of their interaction is now relatively well known, its response to mechanical cues and especially the dynamics of this system is poorly characterized, with contradictory time scales given by different studies.

Here we designed two experimental devices, magnetic tweezers and a cell stretcher, to assess the response to respectively local force and global strain, and observed actin and Myocardin-Related Transcription Factor with fluorescence live imaging. We observed that the system indeed reacts to local and global mechanical cues in the absence of any external biochemical signal. We discovered a two timescales dynamics consistent with both previous observations. Further investigations showed that the two timescales are linked to the mechanically-induced reorganization of different parts of the actin cytoskeleton.