**Multimode Resonant Sensing:**
**From Inertial Imaging to Microdroplet Characterization with Microwave Sensors**

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Simultaneous use of multiple modes of a resonant sensor can provide spatial information about analytes. In the context of micro and nano-mechanical sensors, multimode measurements provide size and shape information as well as the mass of the analyte. By combining the spatial information obtained in the measurements, an image can be reconstructed [1]. This technique, *Inertial Imaging*, transforms the capabilities of nanomechanical sensors to a new level: the combined knowledge of molecular mass, size and shape of the analyte can enable previously unattainable information for biomolecular analytics. The technique can be extended to two-dimensional resonators: for instance, the first six modes of a mechanical membrane enables for the determination of the location, size and orientation of an analyte. These principles, originally developed for mechanical sensors, can be extended to electromagnetic resonant sensing as well. By embedding microfluidic channels between the signal line and ground plane of a microstripline resonator, the excess electrical volume and position of microdoplets have been measured. Sensing with higher order modes in this platform can yield further spatial properties of analytes.

[1] Hanay, M. S., Kelber, S. I., O'Connell, C. D., Mulvaney, P., Sader, J. E. & Roukes, M. L., *Inertial Imaging with Nanomechanical Systems.* Nature Nanotechnology **10**, 339-344 (2015).