A novel state-of-the-art device that generates an ultrasound Bessel beam are presented. Bessel beams are commonly used in optics where they manifest a theoretically infinite depth of focus due to their peculiar feature of being ‘non-diffractive’. In other words, Bessel beams are invariant against propagation and keep the same intensity profile (defined by a Bessel function of the zeroth-order) along the optical axis. The non-diffractive property is especially important, for example, in microscopy, where an extended depth of focus is key to maintain a high resolution at long working distances.
Moreover, optical Bessel beams have been demonstrated to be self-healing, a feature that enables a self-reconstruction of these beams after an obstacle encountered along the optical path. This property comes from the selective constructive interference of multiple waves propagating along a cone, which makes Bessel beams more resistant against scattering than the other conventional Gaussian beams.
The prototype comprises several ultrasound emitters mounted on a spherical structure to enable a conical orientation. An angle θ was set for all the emitters to achieve a spot size defined by $\sim\lambda/2\theta$, where λ is the acoustic wavelength arbitrarily chosen to be 40kHz.
As a result, the interference conditions for generating a Bessel beam were fully met.
Measurements were carried out using an ultrasound receiver optimized at the same wavelength. This was translated in the x and y plane to reconstruct the mean intensity profile. To demonstrate the non-diffractive property of this ultrasound Bessel beams, the width and amplitude of the central lobe along the longitudinal axis has been measured. The Bessel beam maintains a constant and tight focus, with its intensity slowly decreasing along the propagation. This demonstrates the invariance of the beam against propagation.