Acoustic characterization of a highly sensitive broadband all-optical ultrasound sensor without any deformable parts

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Akinetic Sensor
- Fabry-Pérot cavity + tunable narrow-linewidth laser
- Signal: transmitted light intensity
- Detection: with photodiode
- No moveable membrane

Characterization Setups
- Substitution method
- Signal: transmitted
- Frequency response is uniform over the range of
- Diameter of detection laser inside the sensor is affecting

SNR Comparison
- Photoacoustic waves generated by laser irradiation of PTFE-Tubings filled with India-ink water mixture ($\mu_\text{a}=0.2\text{mm}^{-1}$)
- Comparison of XARION sensor and three different Panametrics ultrasound transducers
- The noise equivalent pressure (NEP) was measured using a calibrated hydrophone

Signal-Noise Comparison
- Frequency range of the source = 0.5 MHz – 3.5 MHz (-6 dB)
- The SNR of the XARION sensor near the piezo-based transducers
- Light absorption inside the XARION sensor << compared to piezo-ceramic sensors

NEP Comparison
- Measured NEP of XARION sensor vs. theoretical limits for ideal PZT-based piezo transducers
- NEP of the XARION sensor was determined by the use of a calibrated hydrophone

Conclusions
- A rigid akinetic wideband optical hydrophone has been developed and characterized
- Directivity measurements were performed and show anisotropy as expected from the cylindrical detection volume
- Signal-to-noise and NEP-comparison shows an unprecedented size-to-NEP ratio (NEP: 2 Pa at 20 MHz bandwidth)
- Frequency response is uniform over the range of 0.5 – 22.5 MHz and the signal output shows a excellent linearity (Dynamic range: 137 dB)