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Enhancement of bead-based immunoassays by the use of acoustic radiation force

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Radiation forces generated by ultrasonic standing waves have long been used for increasing the speed and sensitivity of bead-based immuno-agglutination tests. More recently, detection methods based on confocal laser-scanning fluorometry and single-step homogeneous bead-based immunoassays show promise for fast, easy and sensitive bioanalytics. If such methods are combined with ultrasonic enhancement, very high sensitivity can be obtained.
Here, we analyze and compare the characteristics, performance and limitations of ultrasonic enhancement used in agglutination-based and fluorescence-based immunoassays. Both radiation force aspects, as well as reaction kinetics aspects, are discussed. Finally, we report on novel results where ultrasonic enhancement is performed in microtiter plates, using a fluorescence-based assay. Here, the ultrasound enriches the sample a factor 10^6-10^7, and a detection limit of 60 femtomolar is obtained for a thyroid stimulating hormone (TSH) assay. Our results are compared with the results from a high-performance commercial instrument (Luminex xMAP technology).