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# A versatile ultrasound system for *in vitro* experiments

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## Objective

One of the most difficult tasks to achieve with the available instrumentations used to study the interaction between ultrasound (US) and cellular model systems is to design an experiment, where only the effects of one physical parameter at a time is evaluated, while all the others are kept constant.

The set-ups are usually custom-made, often by means of clinical instrument intended for a different therapeutic purpose. Furthermore, the results are not strictly comparable with others obtained with techniques considered standard in molecular and cellular biology at this time, because there is the need to use non-standard devices to contain biological samples. Sterility, as well as temperature, is not well controlled and reproducibility is usually a major concern.

In our study we show the effects of ultrasound treatments on different cellular systems. The experiments are performed with a versatile bench-top US apparatus to be adapted for several *in vitro* experiments and that allows easy and robust reproducibility using standard set-ups for the cell samples.

## Methods

One main feature of our bench-top US system is that it has been designed in order to use standard plasticware commonly used in molecular biology labs, ensuring the temperature control and sterility conditions needed in the field. We present a set-up where the simultaneous use of a set of transducers operating at different frequencies on the same plate, allows the comparison of the deposition of the same acoustic pressure, whilst evaluating the effect of frequency alone on the readout of the cell experiments. The apparatus modular design also allows the use of a set of transducers operating at the same frequency, in experiments where the throughput is a relevant factor.

We demonstrate that it is possible to define the position of the target within all the achievable areas of the acoustic field with sub-millimetric accuracy.

Tests for several applications based on biologic effects by ultrasound have been carried out by varying the acoustic parameters such as power, frequency range, sonication time and duty cycle, all controlled within robust protocols executed in automation.

## Results

The resulting data proves that it is possible to perform *in vitro* experiments for different purposes (i.e. drug delivery, cellular sonoporation, nanoparticles or microbubbles swelling, tissue regeneration, neuronal cell

stimulation etc.) keeping the relevant physical parameters of sonication constant, for instance acoustic pressure, but varying the others parameters (i.e. frequency, pulse length or duty cycle etc) one at the time.

## Conclusions

We show that with our apparatus it is possible to obtain robust and reproducible results on cellular experiments, using all the standard devices that are commonly available in biological labs. The improvement on the side of reproducibility and portability of the experiments allows a straightforward comparison between our results and those obtained with other techniques.