Electronically Controlled Ultrasonic Particle Manipulation

Sonotweezers Programme

The **Sonotweezers** research programme aims to develop new tools using ultrasound to **manipulate micro-particles**. Harnessing the **acoustic radiation force**, we plan to extend the applications of ultrasonic particle manipulation beyond what is currently possible using DEP or optical tweezing. Sonotweezers devices will **trap and move particles**, or clusters of particles, by altering the nature of the ultrasonic excitation. We will focus particularly on **applications in life sciences** where issues such as **cell sorting and analysis** are of major importance, aiming for **flexible**, **reconfigurable devices** that could, for example, be used to assemble groups of cells for tissue engineering.

Our work is arranged around **three research objectives:**

(1). To **develop** basic understanding of the operation of electronically programmable and configurable ultrasonic manipulation devices through mathematical modelling.

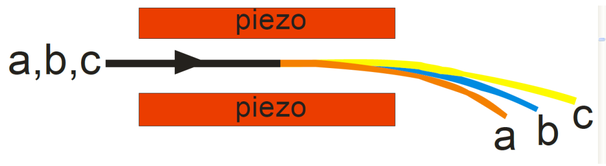
(2). To **design**, **manufacture** and **demonstrate** a range of Sonotweezers with integrated electronics, with different levels of sophistication and physical dimensions.

(3). To **explore** the use of sonotweezers for biological applications, focusing initially on cell analysis and sorting, cell force measurement and tissue engineering.

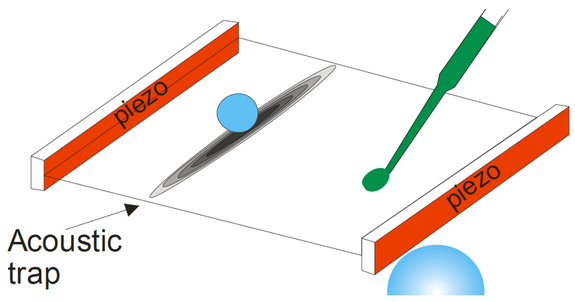
Applications

An important feature of the Sonotweezers research programme is that life scientists within the team can explore applications in parallel with the exploration and engineering of prototype devices. This is already producing a virtuous circle in which early prototypes are being used by life scientists, providing immediate feedback to the physicists and engineers, leading to rapid design improvements.

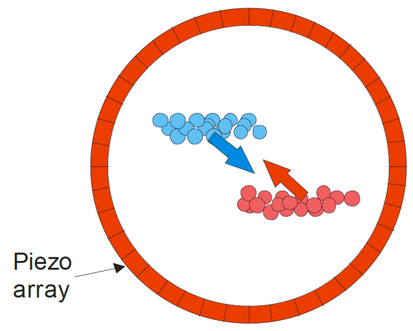
The work of fully assessing the optimum device performance and producing application specific devices is on-going, with a focus on **three pathfinder applications:**



1. Cell sorting and characterisation



2. Cell force measurement



3. Tissue engineering

Demonstrator Devices

Within our Sonotweezers research we are developing a range of technology demonstrators with the aim to provide new measurement and control capabilities in life sciences and medicine.

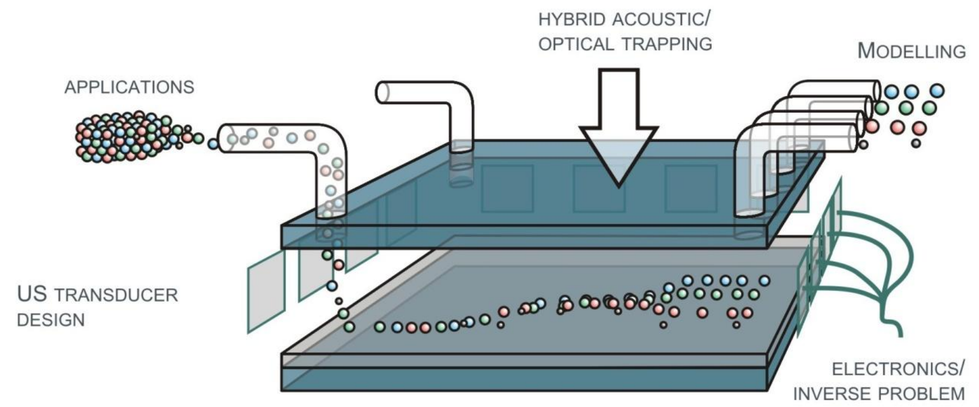


Fig.1. Reconfigurable Sonotweezers

Figure 1 depicts reconfigurable Sonotweezers that can be thought of as a channel-less micro fluidic chamber. The ultrasonic layer around the walls creates a force field to achieve dexterous manipulation. In the example, particles are separated into three groups; this could be cells of three different sizes, densities or physical stiffnesses. One of our key research objectives is to understand the degree to which this reconfigurability can be achieved in practical devices.

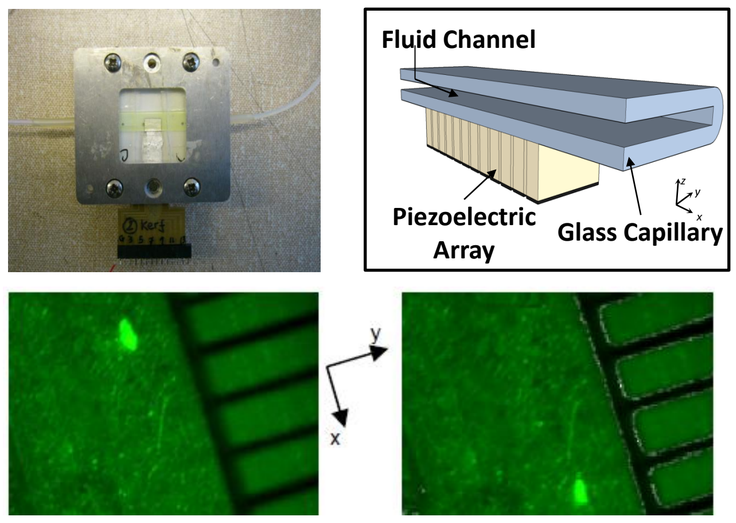


Fig. 2. Fluorescent bead agglomerate moved laterally along the microfluidic channel with 1D Array Device. Ruler markings are with 1 mm.

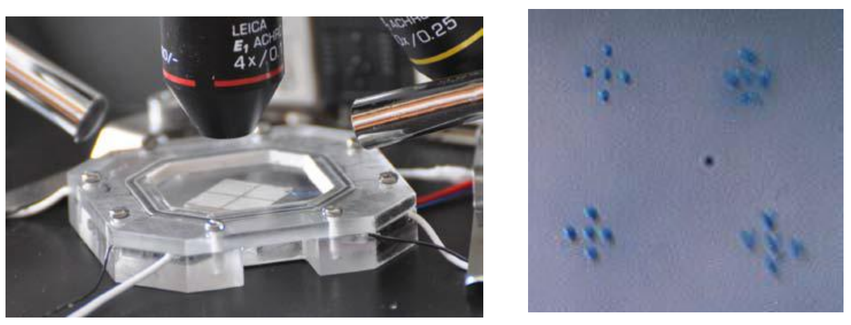


Fig. 3. Movement of 10 µm polystyrene beads into a 100 µm cross

Aims of Sonotweezers:

- Scalable technology
- Move large particles with large forces
- Integrated systems more easily fabricated
- Compatible with and complementary to other manipulation techniques

Funding and Structure

Sonotweezers is a four-year, £4.2 million research programme funded by the UK's Engineering and Physical Sciences Research Council (EPSRC). It is a collaboration between four universities:

- **University of Bristol**
- **University of Dundee**
- **University of Glasgow**
- **University of Southampton**

The project brings together established expertise in ultrasonic modelling, device fabrication, microscale systems integration and biological applications and includes **engineers, applied physicists** and **life scientists.**

Industrial Partners:

- **Agilent Technologies**
- **DSTL**
- **Genetix-Leica**
- **Fraunhofer IKTS**
- **Loadpoint**
- **Logitech**
- **PCT Ltd**
- **Weidlinger Associates Inc.**

This group is working to develop commercial exploitation routes for the Sonotweezers technology at an early stage as well as helping to inform aspects of the device development and applications research.

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