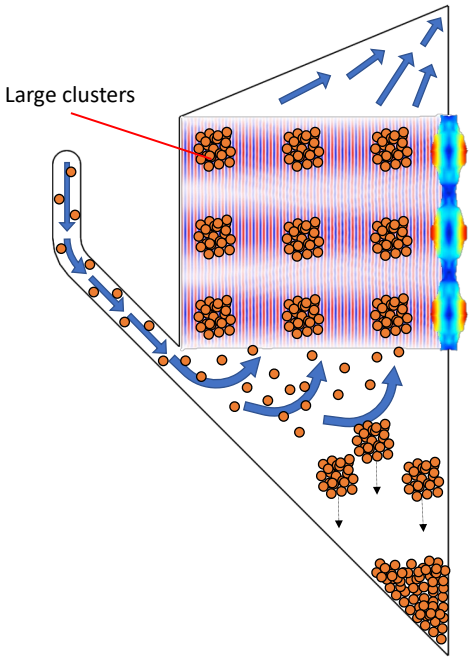
# How can invisible ultrasonic waves be used for processing cells?

Dr. Bart Lipkens, Co-founder and CTO of FloDesign Sonics, explains the science behind ***acoustophoresis*** and how it can be used to solve big challenges in cell and gene therapy bioprocessing.

**What is acoustophoresis and how can it be used to manipulate cells suspended in a fluid?**

Acoustophoresis is a low-power, no-pressure-drop, no-clog, no-shear, solid-state approach to particle removal from fluid dispersions. It can be used to achieve separations that are more typically performed with porous filters or centrifuges, but it has none of the disadvantages of filters and centrifuges. FloDesign Sonics' platforms are extremely powerful in that they can be used to sort and separate particles of different sizes, density, or compressibility in a single pass through an acoustophoretic cavity.

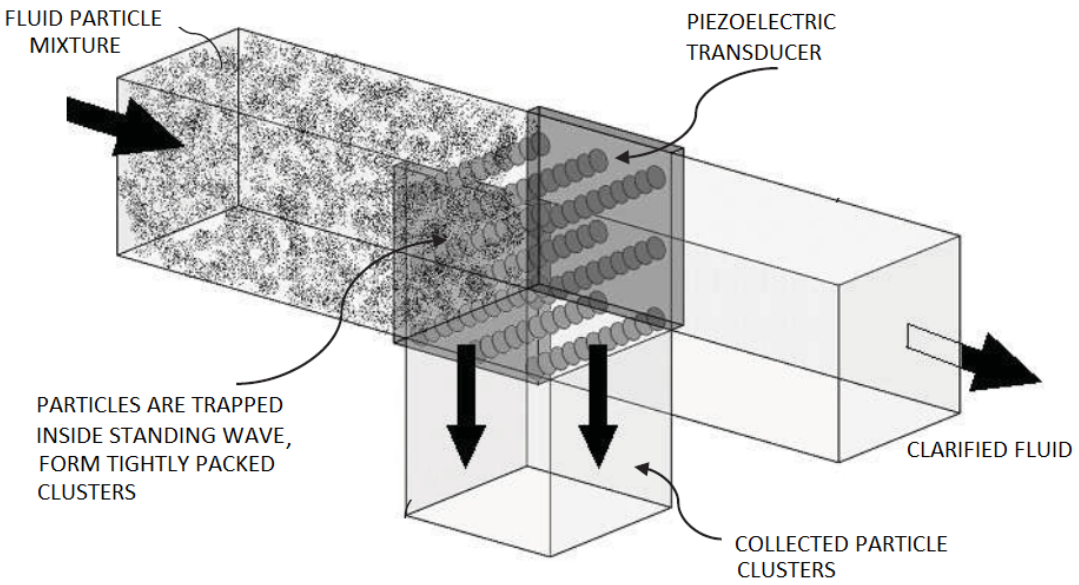



**How is FD Sonics technology different? How can it be used in cell and gene therapy bioprocessing?**

FloDesign Sonics' patented acoustic wave separation platforms utilize macroscale acoustofluidics principles to accomplish a variety of cell processing applications such as clarification, perfusion, concentration, washing, acoustic affinity cell selection, and label-free cell selection.

**What do you mean by macroscale acoustofluidics and how are they generated and used?**

Macroscale ultrasonic standing waves span multiple wavelengths with total distances on the order of inches; they are typically generated by a piezo-electric transducer which excites a multidimensional standing wave. The standing wave is oriented at a particular angle with respect to the fluid flow which carries the particles of interest through the standing wave. The acoustic standing wave generates an acoustic potential field, which exerts an acoustic radiation force on any particles in the fluid. Particles, like cells, are forced to the standing wave nodes or antinodes depending on their acoustic contrast factor (which is defined by the density and compressibility of the particle relative to that of the fluid). If the acoustic forces are strong enough, the standing wave will capture the cells and hold them against the fluid drag. In some cases, when many cells are clustered at a node



an enhanced settling occurs creating a separation step. There are many ways the acoustics can be utilized to accomplish a variety of cell manipulations.

**What fluid flow rates can a chamber of several inches support? How scalable is this technology?**

The ultrasonic separator spans hundreds of wavelengths, i.e., operates at the macro-scale, and provides a system configuration that is scalable up or down to accommodate large (>50 L/hr) or small flow (< 5 ml/min) rates. Generally, throughput depends on the configuration of the fluid path and acoustic transducer as well as the specific kind of cell manipulation to be performed.

**What effect do acoustics have on the cells?**

The effect of the standing wave on the cells is benign since it is a pressure based phenomenon that is in essence shear-free. Cell viability testing on a variety of cell lines such as CHO, HEK, T-cells, SF6, and others have revealed no impact on cell viability after exposure to the standing wave.

**What physical properties of the cell affect the acoustic's ability to capture and manipulate?**

There are a number of characteristics in a given acoustic system that will influence our ability to capture, settle, differentiate, or otherwise manipulate the cells. The magnitude of the acoustic forces are directly linked to several physical properties of the cells we are trying to capture. Size, density, and compressibility of the cells or particles influence the magnitude of acoustic forces and differences in these properties is the basis for our fractionation and selection platforms. There are also additional factors outside of the cells themselves; e.g., acoustic power and frequency are significant knobs we can turn to adjust and control acoustics forces. In many systems flow geometries and flow rates influence performance of a separation as well. Depending on what task is performed, we can use many design parameters to optimize performance and control.

- Particle Density & Compressibility
- Fluid Density & Compressibility
- Size and Shape of Particle
- Flow Velocity
- Acoustic Power
- Acoustic Frequency
- Fluid Viscosity

**Tune Geometry and Conditions To Accomplish Cell Manipulations**