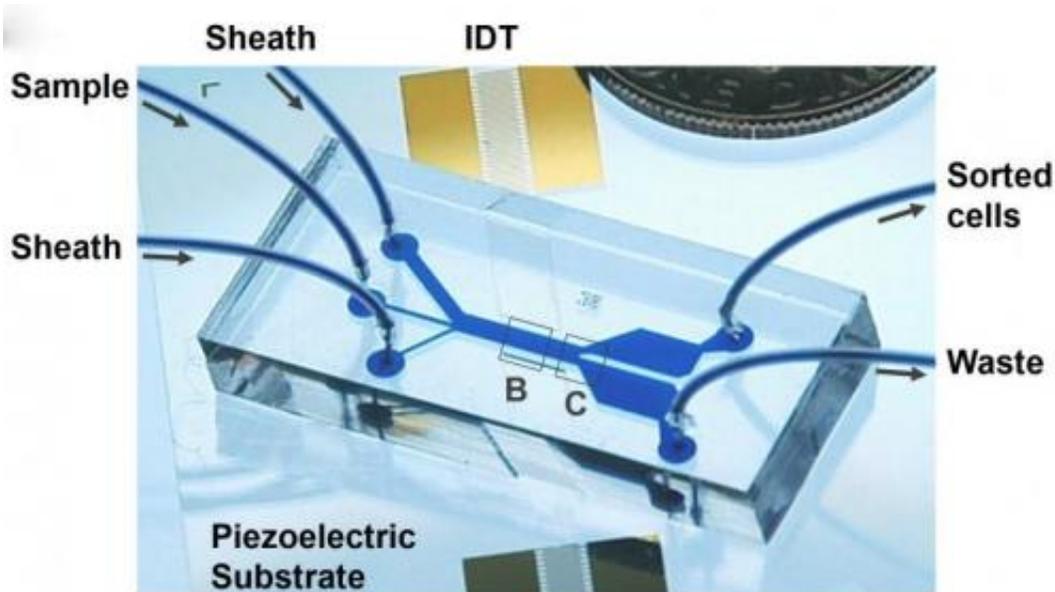


# Tilted acoustic tweezers separate cells gently

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A schematic illustration of working principle and device structure for a tilted-angle standing surface acoustic wave-based cell-separation device. Credit: Tony Huang, Penn State

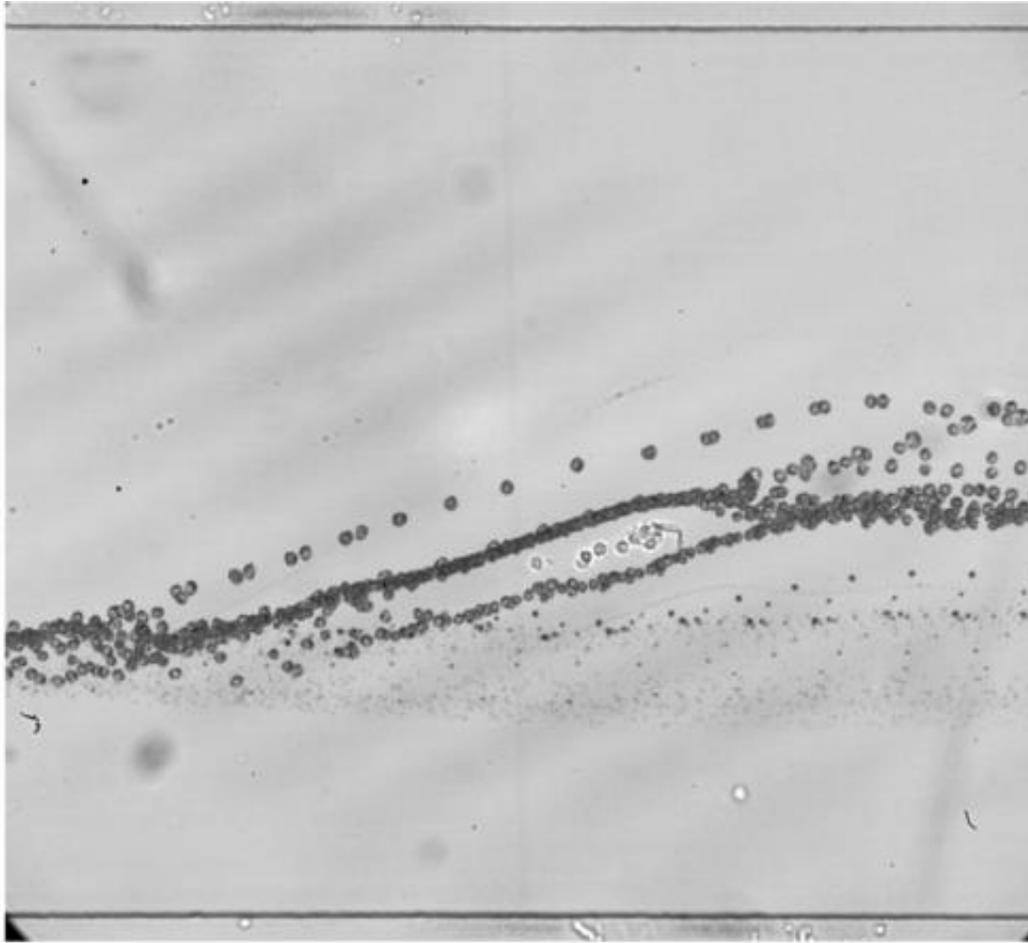
Precise, gentle and efficient cell separation from a device the size of a cell phone may be possible thanks to tilt-angle standing surface acoustic waves, according to a team of engineers.

"For biological testing we often need to do cell separation before analysis," said Tony Jun Huang, professor of engineering science and mechanics. "But if the separation process affects the integrity of the cells, damages them in any way, the diagnosis often won't work well."

Tilted-angle standing surface acoustic waves can separate cells using very small amounts of energy. Unlike conventional separation methods that centrifuge for 10 minutes at 3000 revolutions per minute, the surface acoustic waves can separate cells in a much gentler way. The power intensity and frequency used in this study are similar to that used in ultrasonic imaging, which has proven to be extremely safe, even for fetuses. Also, each cell experiences the acoustic wave for only a fraction of a second, rather than 10 minutes.

"The tilted-angle standing surface acoustic waves method has the least disturbance or disruption to the [living cells](#) being separated compared to other available methods so far," said Ming Dao, principal research scientist, materials science and engineering, Massachusetts Institute of Technology. "It adds to the portfolio of latest technology developments for separating such things as rare circulating tumor cells in the blood."

Previous work by Huang showed that acoustic tweezers work by setting up a standing surface [acoustic wave](#). If two sound sources are placed opposite each other and each emits the same wavelength of sound, there will be a location where the opposing sounds cancel each other. Because sound waves have pressure, they can push very small objects, so a cell or nanoparticle will move with the sound wave until it reaches the location where there is no longer movement.



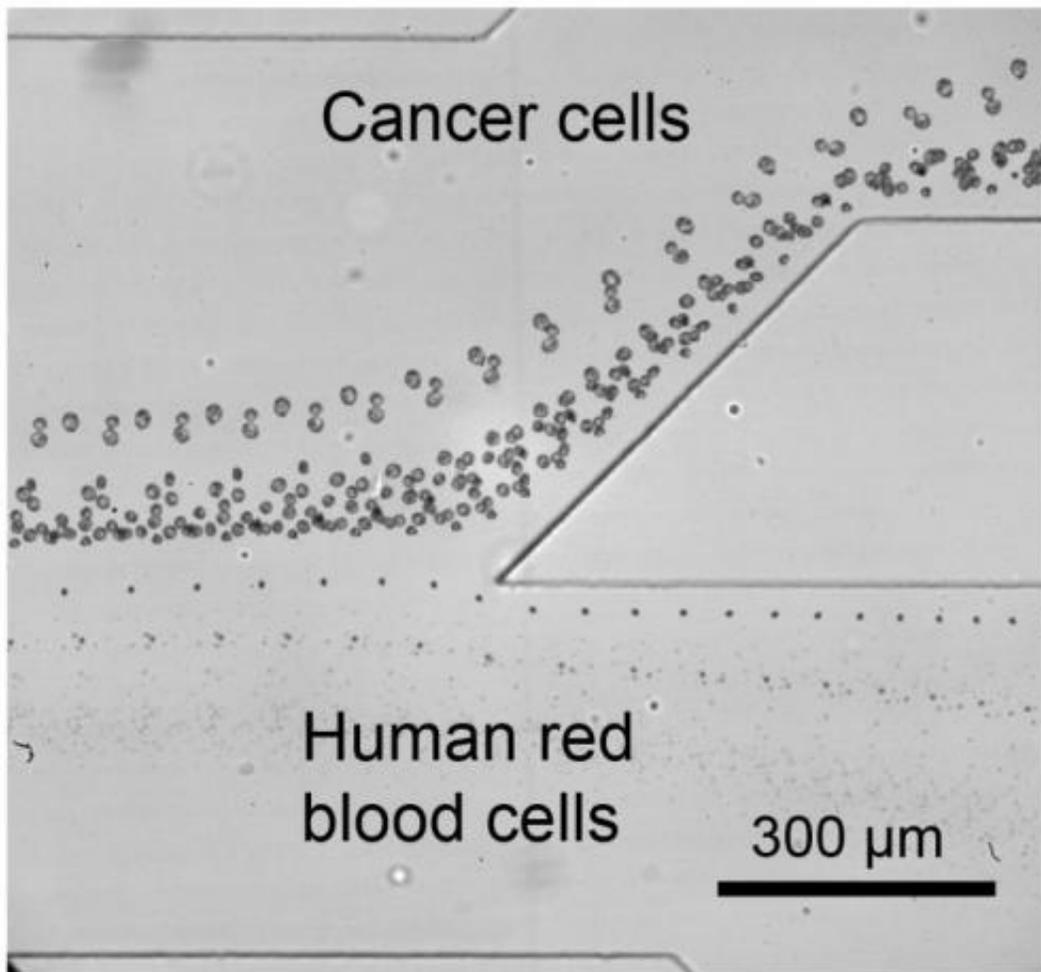
This image shows the beginning of separation stream separating cancer cells from red blood cells in the tilted-angle standing surface acoustic wave-based cell-separation device. Credit: Tony Huang, Penn State

If the sound sources are at right angles to each other, an evenly spaced set of rows and columns form in a checkerboard pattern. In this case, the team from Penn State, MIT and Carnegie Mellon University used simulation programs to determine the angle the sound sources should be tilted at to produce the best separation. They report their results today (Aug. 25) online in the *Proceedings of the National Academies of Science*.

By tilting the sound source so that it is not perpendicular, the researchers

created better separation distance and could more efficiently sort cells.

The acoustic tweezers are made by manufacturing an interdigital transducer, which creates the sound, onto the piezoelectric chip surface. Standard photolithography creates microchannels in which the liquid containing the cells flow.



This image shows the end portion of separation stream separating cancer cells from red blood cells in the tilted-angle standing surface acoustic wave-based cell-separation device. Credit: Tony Huang, Penn State

The researchers created the separator, which can run continuously. The device separated 9.9-micrometer particles from 7.3-micrometer particles so efficiently that 97 percent of the 7.3-micrometer particles went to the correct location. The device can also separate cancer cells from white [blood cells](#) with high efficiency and purity. It is simple and inexpensive to fabricate and does not need strict alignment to achieve this separation.

"The method we describe in this paper is a step forward in the detection and isolation of circulating [tumor cells](#) in the body," said Subra Suresh, one of the study's authors and president of Carnegie Mellon University. "It has the potential to offer a safe and effective new tool for cancer researchers, clinicians and patients."

The researchers see devices like this one separating [cancer cells](#) from other cells, bacteria from blood, [white blood cells](#) from red blood [cells](#) and malaria parasites from blood, to name a few uses.

**More information:** Cell separation using tilted-angle standing surface acoustic waves, *PNAS*, [www.pnas.org/cgi/doi/10.1073/pnas.1413325111](http://www.pnas.org/cgi/doi/10.1073/pnas.1413325111)

Provided by Pennsylvania State University

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