CYTO VIRTUAL INTERACTIVE JUNE 7–10 2021

www.KineticRiver.com
info@KineticRiver.com
+1 (650) 439-7413

A Highly Customizable Fluidics Control Module for Flow Cytometry

Giacomo Vacca[1], Elijah Kashi[1]

[1]R&D, Kinetic River Corp., Mountain View, CA, United States

BACKGROUND

Highly specialized, cutting-edge flow cytometry applications often require unique fluidics specifications. For example, ultra-low flow rates may be needed to increase sensitivity for nanoparticle detection or to prevent damage to delicate samples. Such flexibility is often not achievable with the fixed layout fluidics packages included with most turnkey flow cytometry systems. We have designed the *Shasta*, a flexible and highly customizable fluidics module that can be adapted for any flow cytometer and enable an unprecedented level of customizability to allow them to meet their unique requirements.

Figure 1. *The* Shasta *Fluidics Control Module front panel with all-analog dials and gauges.*

METHODS

The *Shasta* Fluidics Control Module is compact (8.5" x 10" x 10", <5 pounds) and is designed to easily integrate into virtually any commercial flow cytometry system. The front panel enclosure (**Figure 1**) allows easy access for the user to monitor and fine-tune system pressures, optimizing fluid flow rates to meet specific application needs.

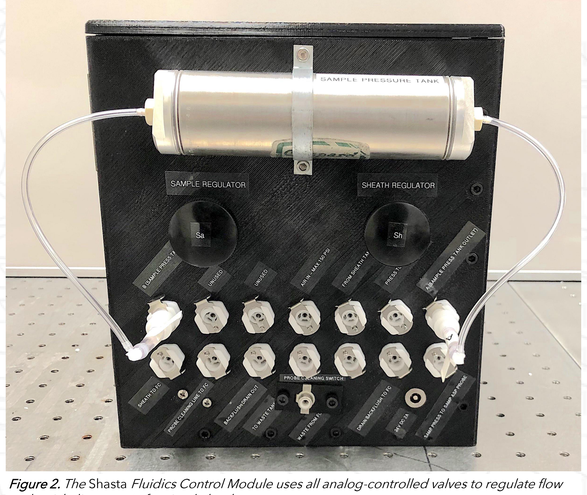

Figure 2. *The* Shasta *Fluidics Control Module uses all analog-controlled valves to regulate flow and quick disconnects for simple hookup.*

The proprietary, patent-pending design* is driven by dual hydrostatic pressure (sheath pressures up to 30 psig) and can accommodate sheath tanks from 1L to 8L. Users can directly control and monitor sample and sheath pressures independently, providing extremely stable fluidics and enabling *Shasta* to support essentially unlimited flow rates or particle transit times.

Using reliable, analog-controlled valves (**Figure 2**), the system operates in five different modes—drain, fill, run, standby, and backflush—which control movement of the fluids through the system via different paths depending on user needs. Based on end-user feedback, we have included key built-in functions, such as probe clean, sample boost, and automatic venting for increased functionality.

For ease of use, we have incorporated quick disconnects for easy attachment or removal of tubing. Importantly, the system is fully customizable and is designed to be retrofitted to virtually any cytometer on the market today, allowing users greater fluidics precision and flexibility on their existing instruments.

RESULTS

Figure 3 shows a core stream generated by the *Shasta*. Our studies have demonstrated extremely stable flow rates as low as 0.3 µL/min and as high as 130 µL/min. The low end of this range provides the extremely long transit times required to produce detectable signal and provide the sensitivity required for nanoparticle detection studies. The *Shasta* has been used to easily detect particles as small as 160 µm (see Poster #266 – "Triple-UV/Violet Excitation Analyzer for Label-Free Flow Cytometry").

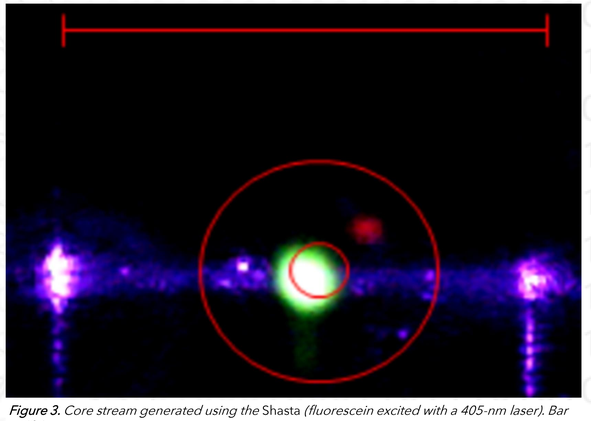

Figure 3. *Core stream generated using the* Shasta *(fluorescein excited with a 405-nm laser). Bar = 404 µm.*

Stem cell-derived cardiomyocytes (SC-CMs) are a type of heart cell used, among other things, to screen drug candidates for toxicity. Due to the elongated shape and fragile nature of these cells (**Figure 4**, courtesy of James Chan, UC Davis), sorting them requires exquisitely controlled fluidics to drive the cells through the laser interrogation region on a flow cytometer or a microfluidic chip. The *Shasta* was used to establish a highly stable core stream in a 300 µm channel of a microfluidic chip (**Figure 5**). We achieved flow rates as low as 0.25 µL/min – about 100 times lower than in typical flow cytometers. This setup will make possible the interrogation, and ultimately sorting, of SC-CMs.

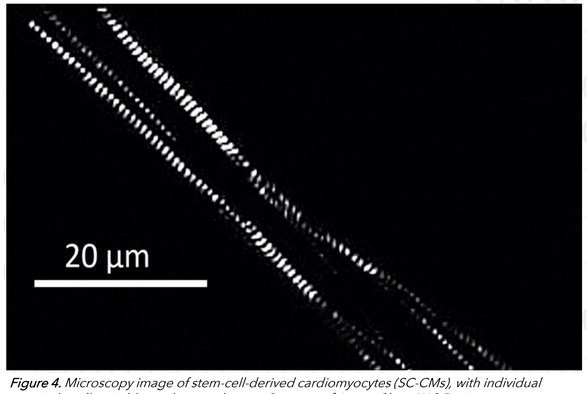

Figure 4. *Microscopy image of stem-cell-derived cardiomyocytes (SC-CMs), with individual myosin bundles visible as elongated spots. Courtesy of James Chan / UC Davis.*

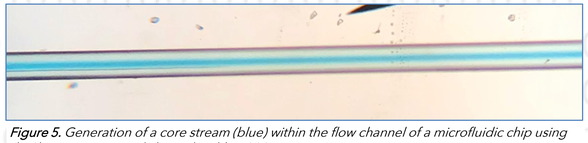

Figure 5. *Generation of a core stream (blue) within the flow channel of a microfluidic chip using the* Shasta. *Transversal channel width is 300 µm.*

CONCLUSION

For certain research applications, a wide degree of fluidics customization is required that cannot be achieved using standard off-the-shelf solutions. The *Shasta* Fluidics Control Module was designed with that unmet need in mind. The *Shasta* is expected to enable improved performance in difficult assays such as nanoparticle detection when adapted to an existing flow cytometer.

This work was made possible in part by government support under one or more grants awarded by the NIH, and NSF funding (through UC Davis), Federal Award No. 1827611, Subaward No. A19-0870-S001.