Optimizing Operation of Sample Preparation Device for Blood-Borne Pathogen Diagnostics

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Introduction

- **Point-of-care nucleic acid testing** for blood-borne pathogens such as HCV is difficult as sample preparation requires **plasma separation** and **nucleic acid extraction**. Current clinical methods are **too complex** and require **expensive** equipment.
- **Simple**, **inexpensive**, **manually-operated device** prepares fingerstick blood samples for molecular diagnostic testing
  - Utilizes **microfiltration** to effectuate plasma separation
  - **RNA-binding microparticles** enable viral RNA extraction

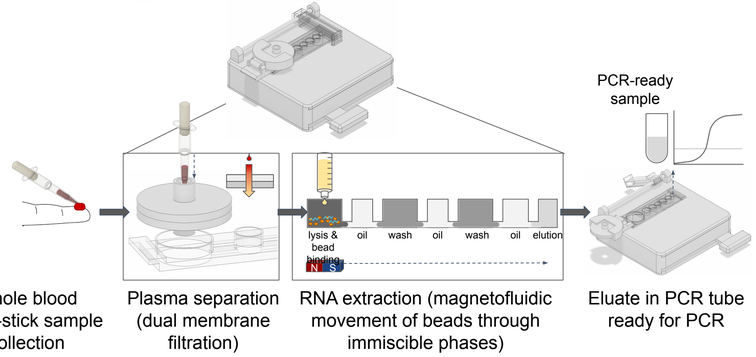
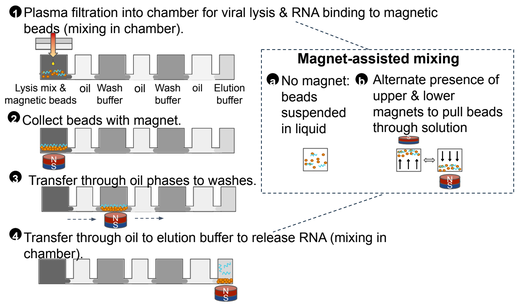


Figure 1 (top). Blood sample preparation device. Blood is inserted in the top of the filtration module, plasma is extracted from the bottom. RNA binding magnetic microparticles are guided by external magnets.

Figure 2 (right). Method using external magnets to mix and guide magnetic microparticles.



- Aims: **improve throughput** (beyond one sample per run) and make device **more efficient** toward **point-of-care operation**

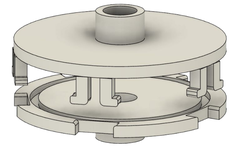
Methods

- **Design:** Design for the new, optimized modules was done in Fusion 360.
- **Fabrication:** Printing was done on a Stratasys 3D printer. Parts were post-processed in a chemical bath and oven before testing.

Results

Easy-assembly filter for plasma separation from blood

- The filter module was redesigned with **quick side- release buckles** for **simpler, quicker** assembly, and **less assembly variability.**



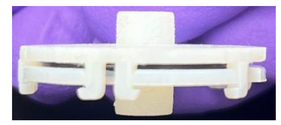
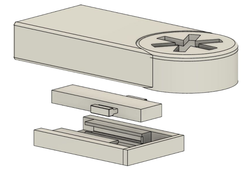


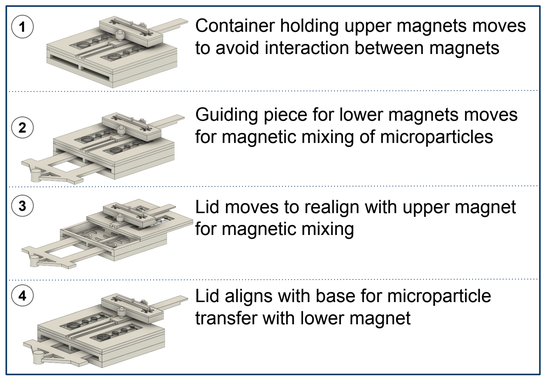
Image of printed filter

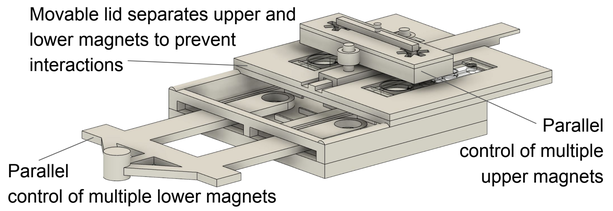
Parallelized, higher throughput RNA extraction cartridge

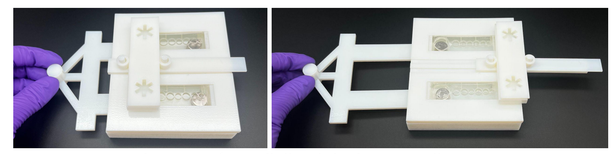
- Improved design for efficient microparticle mixing: A **sliding mechanism** was designed for the **upper magnet** to enable a **quicker transition** between upper and lower external magnets, **increasing efficiency** of magnetic mixing during RNA binding and release steps on extraction cartridge.



- A device was designed with **parallelized cartridges**, a movable lid, and external pieces that can guide multiple magnets simultaneously without interacting or affecting one another. This enables multiple sample testing at once for **higher throughput**.







Images of parallelized device operation

Future Work

- Expansion of number of cartridges in parallel (three or more)
- Incorporation of PCR instrumentation for all-in-one sample preparation and detection device

Acknowledgements

This opportunity was made possible by the Columbia and Amazon/Thornton Tomasettii SURE Program. I would like to thank Abby Ayers and Christia Victoriano for mentoring me.

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