Microfluidic AcoustoMagnetic Sample Preparatory Platform for Astrobiology

K. A. Ohiri (Korine.Ohiri@jhuapl.edu), T. B. Van Volkenburg, J. K. Skerritt, M. A. Hagedon, C. E. Bradburne, and K. L. Craft,

Johns Hopkins University Applied Physics Laboratory, Laurel, MD

The detection of life outside Earth would be an incredible discovery, revolutionizing our perception of life and providing insight into how life develops and persists in various environments. Microfluidic sample preparatory platforms have grown increasingly prolific throughout research and development efforts into a wide variety of terrestrial biochemical studies, but as of yet there is a dearth of investigation into its applications for astrobiology. In this work, we present early results on the development of a microfluidic platform, the AcoustoMagnetic Preparatory Chip (AMP-Chip) for carrier lysing and long-chained polymer (e.g. DNA) purification towards downstream applications for life detection in planetary environments. This AMP-Chip will be roughly 25 x 55 mm in size and contain three main modules: (i) the acoustofluidic mixing module (Figure 1.d), (ii) the acoustophoretic focusing module (Figure 1.e), and the (iii) magnetophoretic separation module (Figure 1.f). The chip will be acoustically excited on demand with an attached piezoelectric transducer such that steady acoustic streaming and acoustic radiation forces will be generated in the channels of the microfluidic chip. The mixing module will be dominated by steady acoustic streaming, whereby high velocity fluid vortices will be concentrated along the sharp edges patterned along the channel walls (Figure 1). Contrastingly, the focusing module will be designed in such a way as to generate a pressure standing wave in this region to focus the magnetic beads to the center of the channel. Additionally, the width of the magnetophoretic separation module is designed such that it is 3.5 times the excitation wavelength in order to suppress acoustic forces in the region that may compete with magnetophoretic separation. Finally, permanent magnets will be adhered to the underside of the chip near port g to transport beads into the ethanol wash stream. In this work, we overview the design, challenges, and preliminary optimization results for our system.

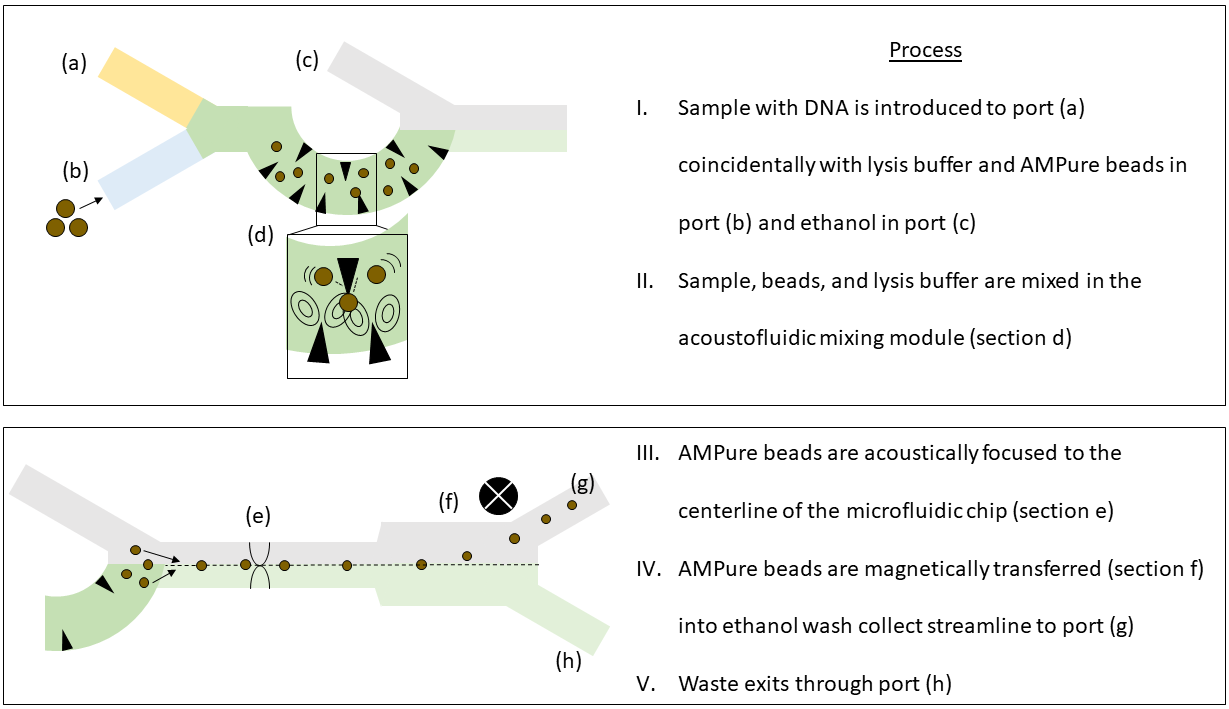

Figure 1: Preliminary design of AMP-Chip for long-chained polymer purification. Figure not to scale.