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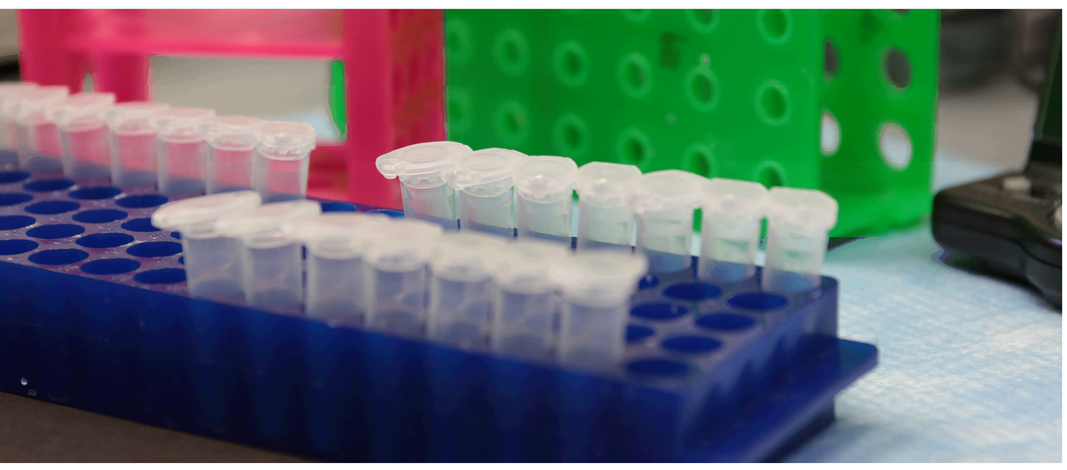
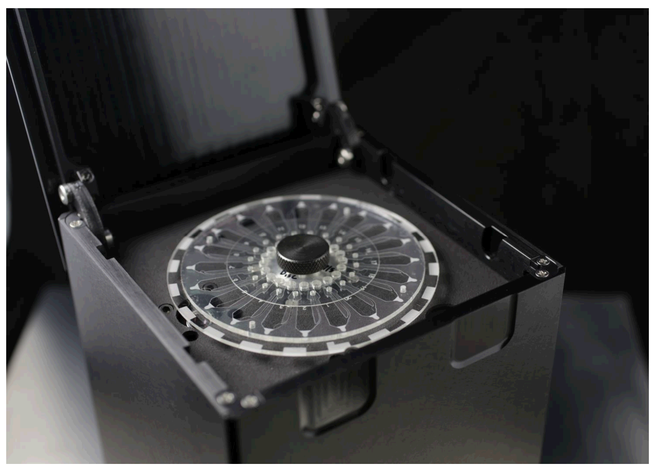
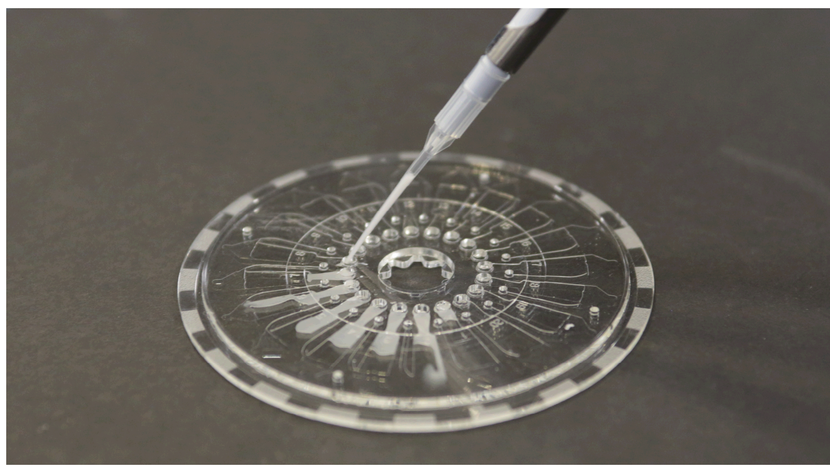






Improved Detection of Emerging Diseases on a Centrifugal Microfluidic Diagnostic Platform

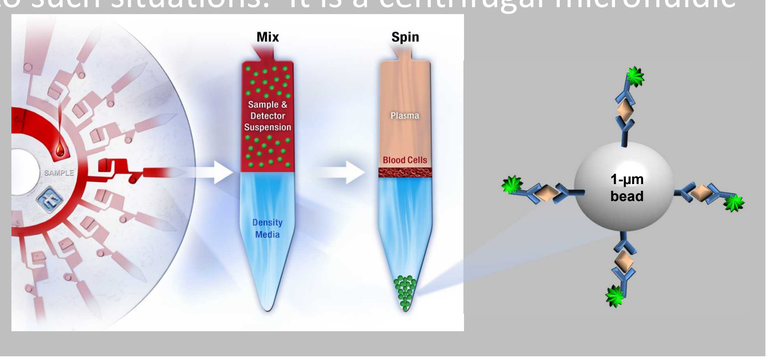
Gabriel Mickel

University of Pennsylvania, B.S. Materials Science and Engineering '18

Mentor: Chung-Yan Koh, *Biotechnology and Bioengineering Department, Org 08621*

Abstract. Infectious disease outbreaks pose a serious risk in developing countries where the expensive equipment necessary to perform diagnostic tasks is not widely available and the infrastructure to support large clinical laboratories does not exist. SpinDx is intended as an inexpensive, portable, quick, and reliable point of care (POC) diagnostic device. The simple immunoassays require little to no training and few pieces of auxiliary equipment. A serology assay panel of emerging viruses was developed, testing for Ebola, West Nile, and Zika viruses. Using new bioconjugate chemistries we improved the limits of detection and quantitation of SpinDx immunoassays by specifically orienting the capture antibodies on the assay surface.

Introduction. In the 2014-16 outbreak of Ebola, more than 1 in 3 cases of Ebola resulted in death. During the incubation, noncontagious, period high levels of an Ebola glycoprotein are present in the blood. An inexpensive point of care (POC) diagnostic platform could be of great use in such a circumstance, providing pre-emptive screenings. SpinDx is a field ready, battery powered, self contained platform applicable to such situations. It is a centrifugal microfluidic platform capable of performing highly sensitive detection of proteins from pathogens from untreated samples such as whole blood or saliva in under 30 minutes.



Conclusion. The disease panel developed and the improvements made to conjugation methods serve to broaden the scope of capabilities of SpinDx. More efficient conjugation strategies can additionally decrease the cost per assay, making the system a more affordable and deployable platform for medical diagnostics in the developing world. In the coming weeks the disease panel will be extended to testing for antigen in whole blood and serum.

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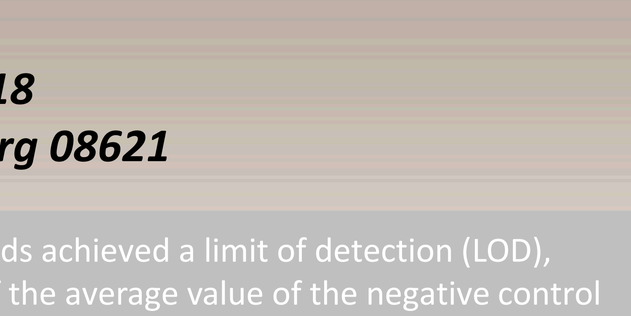
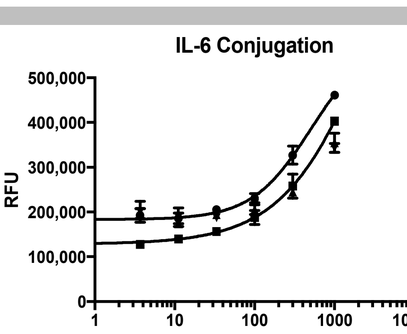
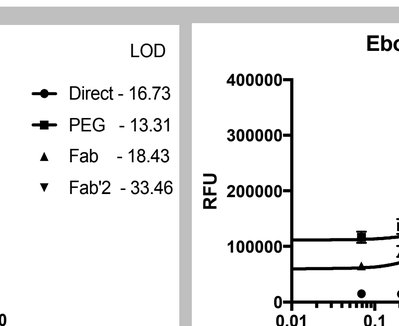
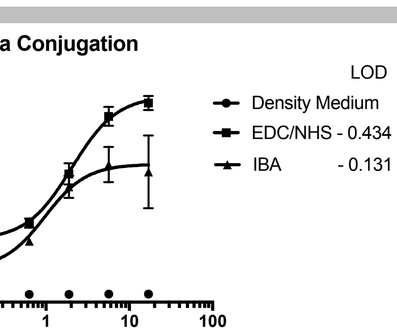
Conjugation Methods. IBA conjugated beads achieved a limit of detection (LOD), defined as a signal greater than the sum of the average value of the negative control and three times the standard deviation of the negative control, three- to four-fold improved over the original method while using less material. Other methods were attempted with IL-6 such as antibody cleaving–creating fab and $f(ab)_2$ fragments–and PEG linking, however, none of these methods proved as effective as IBA.



Disease Panel. A serology assay panel for a number of emerging diseases was developed. Unlike the typical sandwich assay commonly utilized by SpinDx and ELISA, the immune response of the host is being measured. The beads are conjugated with antigen, bacteria, virus particles, proteins etc., instead of capture antibodies. Secondary antibodies appropriate for the host organism are chosen for detection, e.g., fluorescently-labeled anti-Human Ab will be used as our indicator antibody. Using these methods, serology assays were developed for Ebola, West Nile, and Zika Viruses. We obtained LODs of 0.194, 1.39, and 2.35 ng/ml for Ebola, West, and Zika antibodies respectively. An additional Ebola immunoassay obtained a LOD of 13.3 pg/ml of Ebola glycoprotein.







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