**Diagnosing Disease on a Microchip: Finding Nanoscale Needles in a Nanoscale Haystack**

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**Abstract**

The transformative growth in microelectronics in the latter half of the 20th century was fueled fundamentally by the ability to miniaturize complex circuits onto chips. The impact of this has been profound– computing is pervasive and portable and communication is instant and global. My research aims to harness this same engineering approach to solve high impact problems in medical diagnostics. To accomplish this goal my lab develops hybrid microchips, where microfluidics are built directly on top of semiconductor chips. In this talk I will focus on recent work at Penn on 'digital asays.' Digital assays — in which ultra-sensitive molecular measurements are made by performing millions of parallel experiments in picoliter droplets — have generated enormous enthusiasm due to their single molecule resolution. These assays have incredible untapped potential for disease diagnostics but are currently confined to laboratory settings due to the instrumentation necessary to generate, control, and measure tens of millions of droplets. To overcome this challenge, we are developing a hybrid microelectronic / microfluidic chip to ‘unlock’ droplet-based assays for mobile use. Our microDroplet Megascale Detector (µMD) takes inspiration from cellular networks, in which phones are identified by their carrier frequency and not their particular location.  In collaboration with physicians at The Abramson Cancer Center, we are demonstrating the power of this approach by developing a multiplexed extracellular vesicle-based diagnostic for the early detection of pancreatic cancer. I will also discuss ongoing projects on the early diagnosis of lung cancer, treatment guidance for traumatic brain injury, and the differential diagnosis of Alzheimer's versus Lewy body dementia.