



A smartphone actuated isothermal amplification platform for rapid detection of nucleic acid assays

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Background and significance

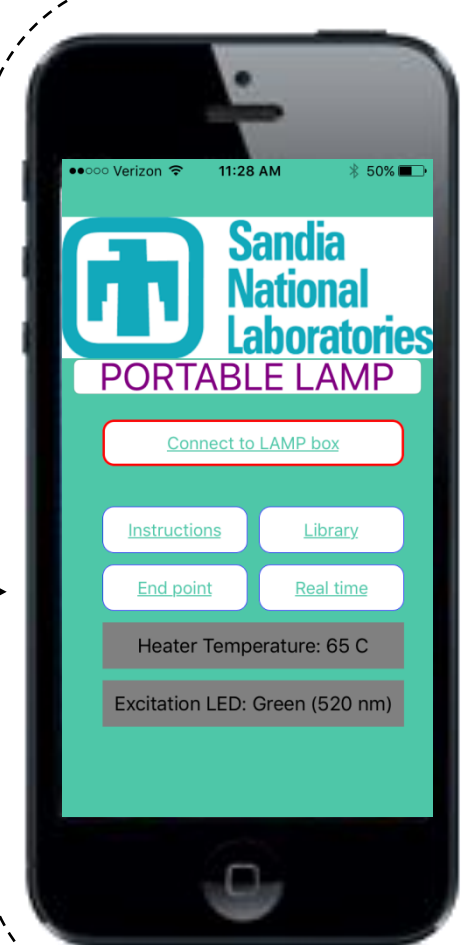
- The growing demand to deliver high-quality medical diagnostics in resource limited settings has created a drive to rapidly advance bio-analytical detection techniques.
- Isothermal nucleic acid amplification tests such as LAMP (Loop mediated isothermal amplification) offer good sensitivity and specificity and eliminates the need for a thermal cycler, making it more suitable for point of care applications than the polymerase chain reaction (PCR).
- However, detection of amplified products via LAMP generally requires extra peripheral devices for post analytical fluorescence based optical detection (fluorometer) which makes the device bulky and increases the cost and complexity of the system.
- Here we demonstrate a completely automated and easy to use smart-phone based amplification and real time detection system for LAMP assay in a microfluidic chip.

Commercial detector



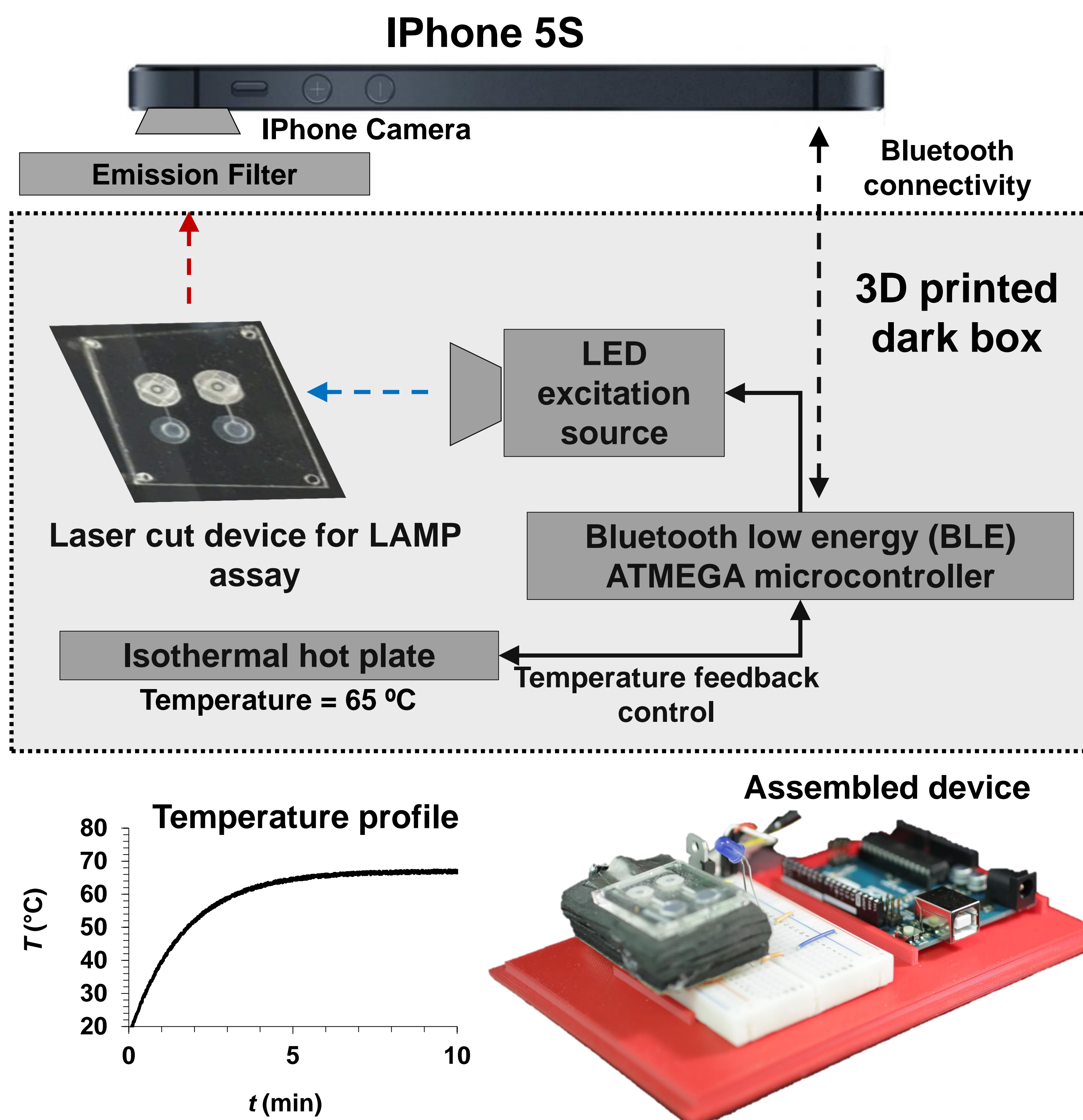
- Complex
- Bulky and heavy
- Expensive (> \$1,000)

Smartphone detector

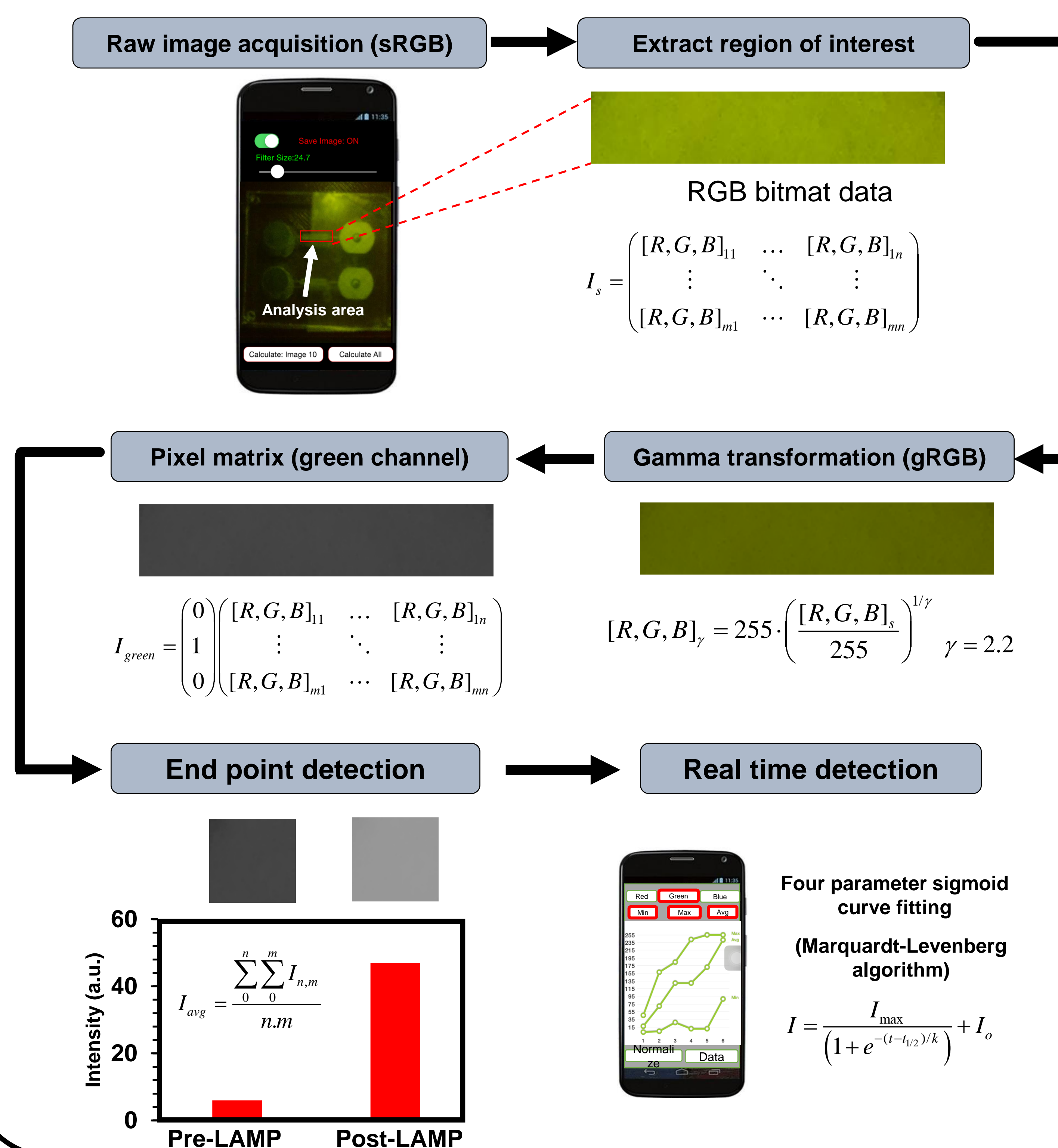


- Ubiquitous
- User friendly
- Small footprint and ultra portable.
- Low cost (< \$100)
- Low power operation

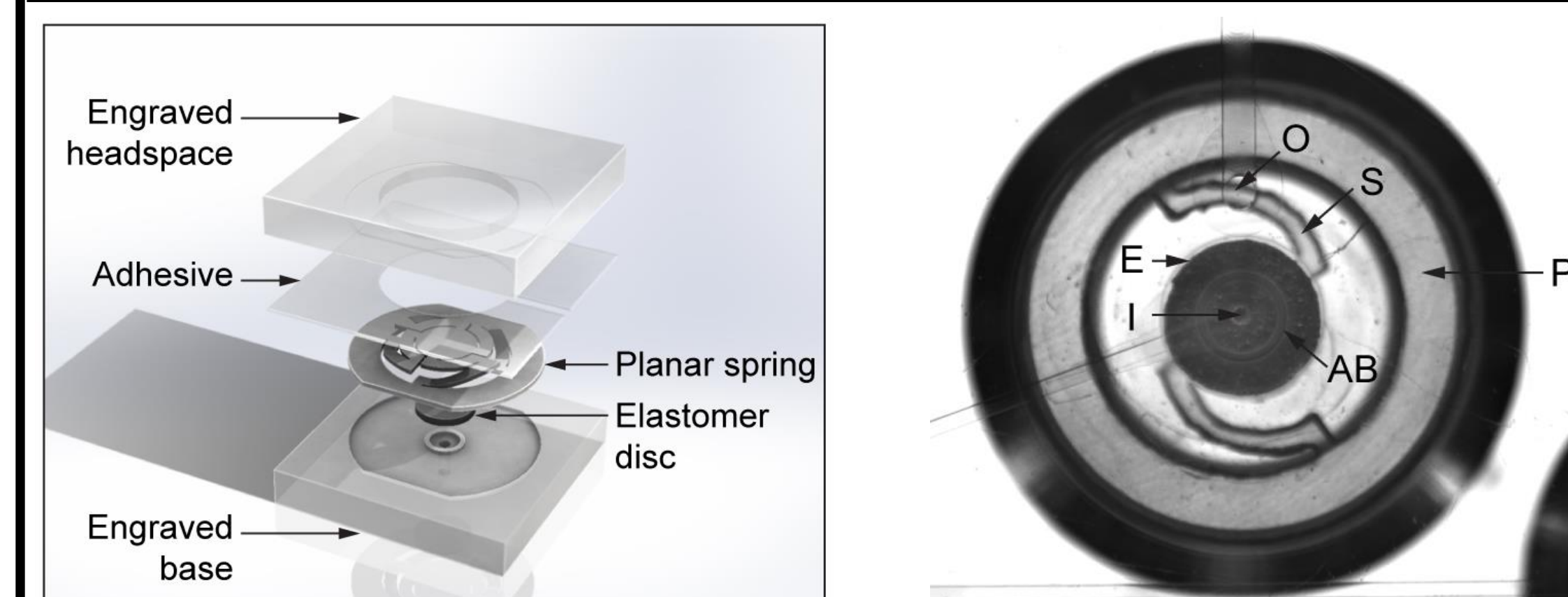
Integrated smartphone detection unit



Onboard image analysis



Passive check valve assembly for LAMP assay

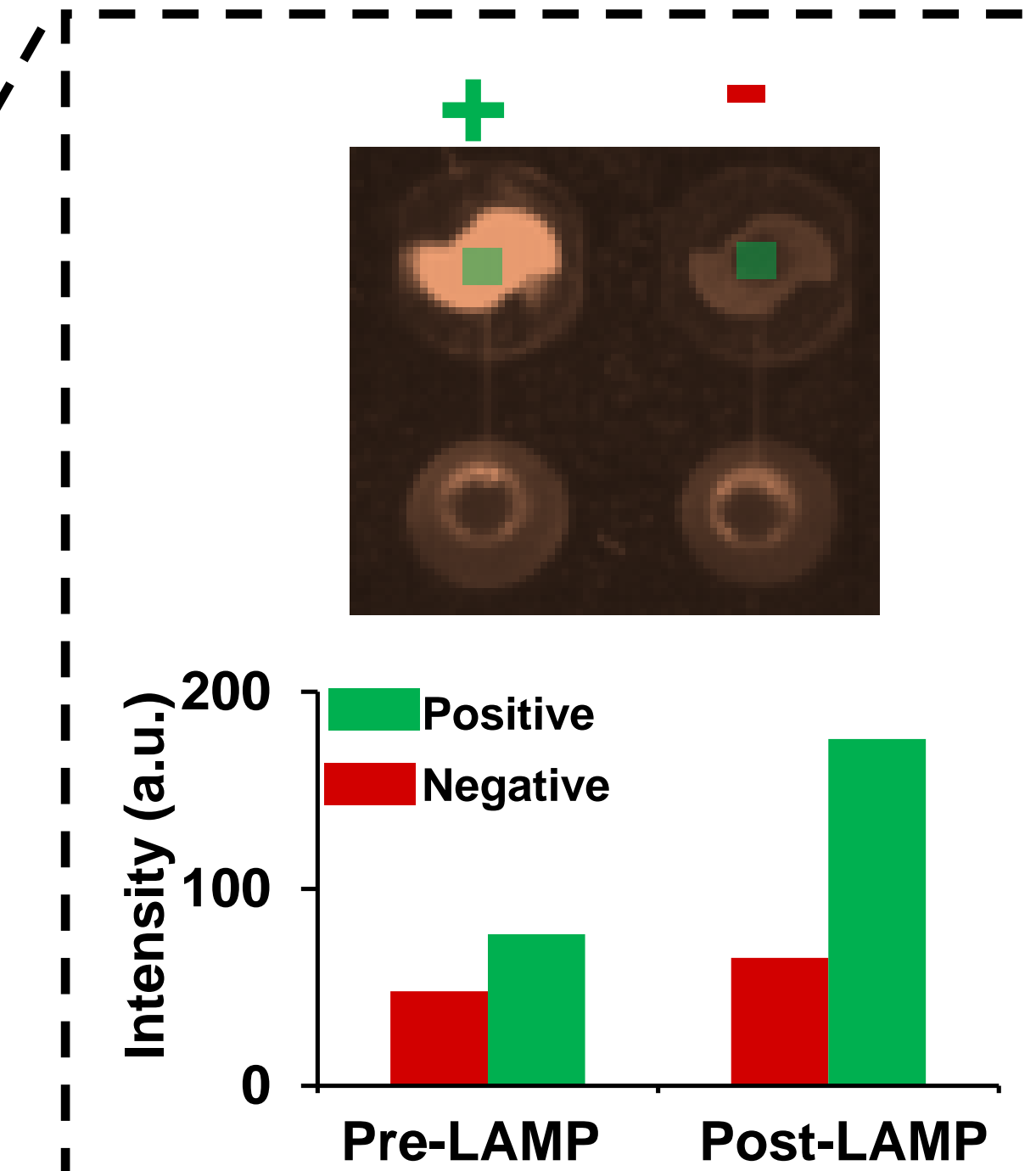
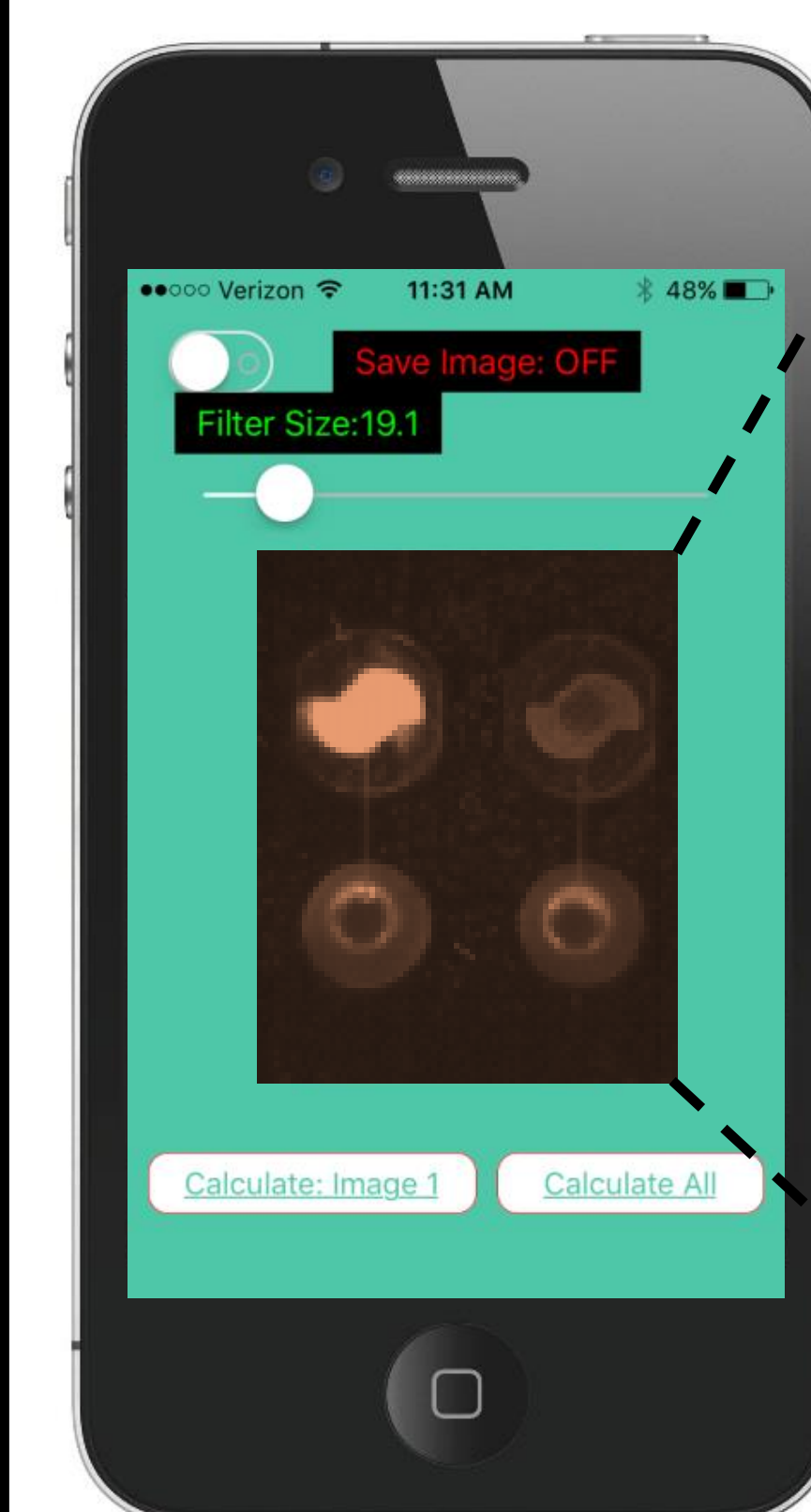


Laser cut process enables simple layer by layer assembly

- Easy integration with no external actuation.
- Tunable opening pressure

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App for post processing



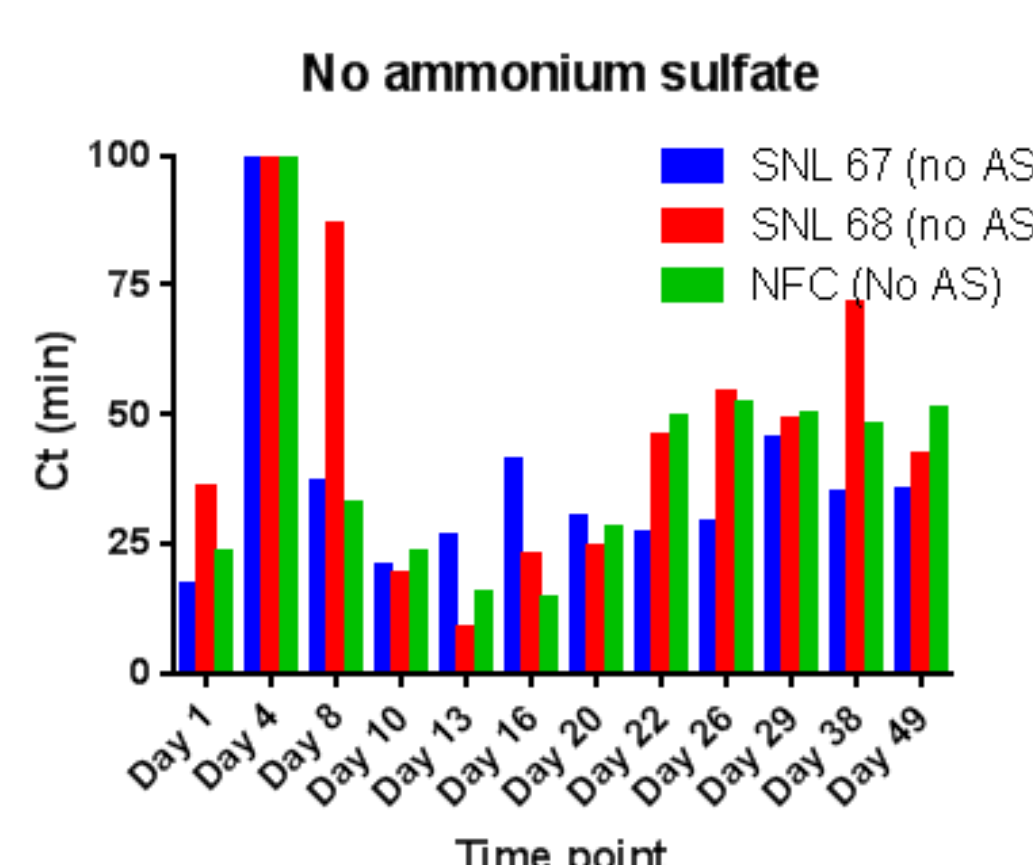
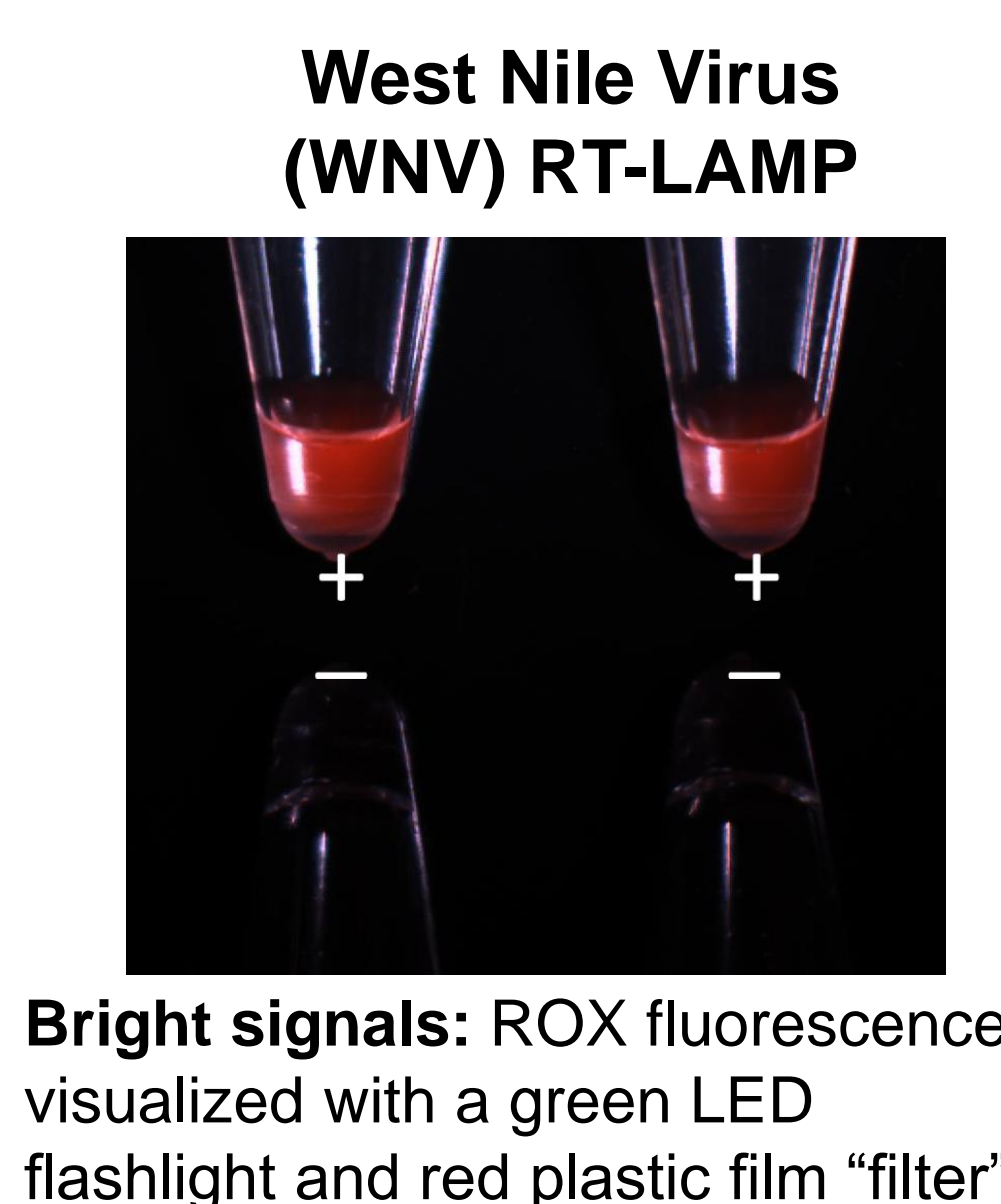
- The *Portable LAMP* application was written and developed in JAVA in Android studio. This enabled images to be accessed via either the user's photo library or directly from the camera
- The focus and exposure are locked before each image acquisition session ensuring constant lighting.
- The selected analysis area is converted into bitmap image format stored as a mutable data set containing 4 bits per pixel corresponding to RGBA color space.
- The average, maximum and minimum RGBA pixel values for each image are calculated and can either be tabulated on the screen or plotted.

Acknowledgement

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Loop mediated isothermal amplification (LAMP)

Easily visualized endpoint: The SYTO intercalating dyes are compatible with closed-tube detection in LAMP, but are non-specific, and offer ~3-fold difference in brightness between positive and negative reactions. Our novel technique allows >10X difference in brightness and can be visualized with an LED flashlight and colored plastic filter.



Stabilized reagents: LAMP assay reagents were vacuum-dried using stabilizing formulations developed in partnership with Biomatrix. In accelerated aging tests, reagents were stable when stored for >3 weeks at 40 °C. This is expected to reduce dependence on cold chain for forward deployed assays.