Smart Phone Diagnostic Platform For Detection of Emerging Viral Pathogens

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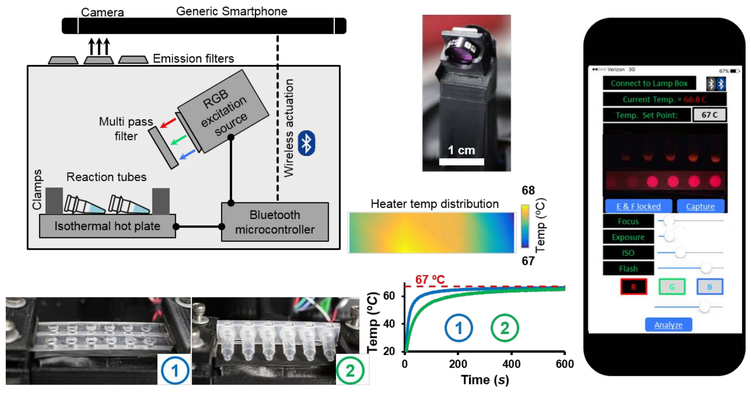
Background and Significance

- Current multiplexed molecular diagnostics for febrile illnesses such as malaria, Ebola, Zika, dengue, and chikungunya viruses are situated outside the intersection of affordability, high performance, and suitability for use at the point-of-care in resource limited settings.
- Insufficient diagnostic capabilities are a key limitation facing current infectious disease management strategies in the developing world.
- Transport of diagnostic specimens to centralized diagnostic laboratories introduces delays as well as logistical and biosecurity concerns when infection with highly pathogenic organisms are suspected.
- We demonstrate highly sensitive and specific detection of febrile pathogens by coupling reverse-transcription loop-mediated isothermal amplification (RT-LAMP) with an easy to use inexpensive and ultra-portable smartphone operated device: SmartLAMP.

Smartphone Enabled Pathogen Detection



- We conduct reactions in a simple, inexpensive and portable "LAMP box" supplemented with a consumer class smartphone. The entire assembly can be powered by a 5V USB source such as a USB power bank or solar panel.

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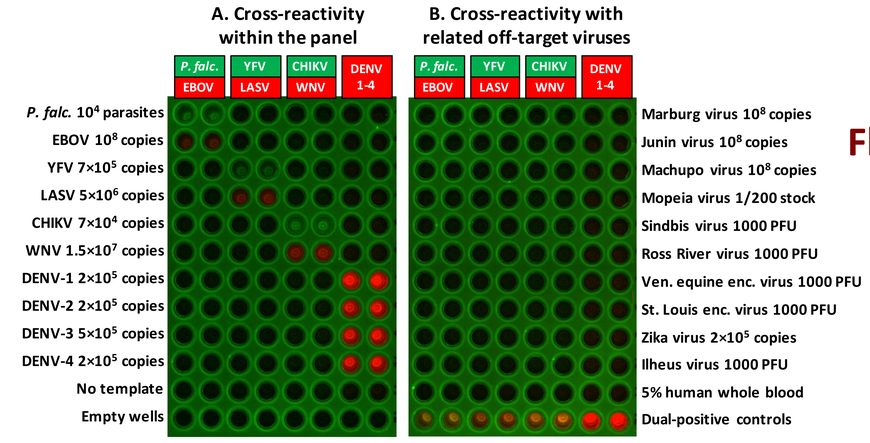
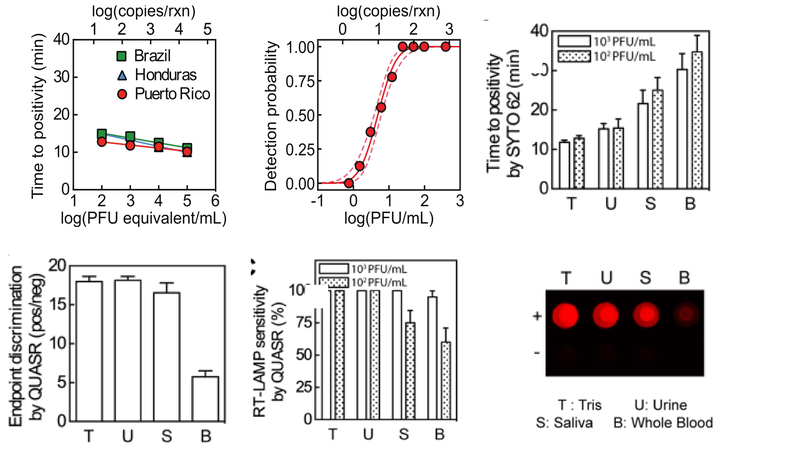
QUASR RT-LAMP Robustly detects Febrile Pathogens

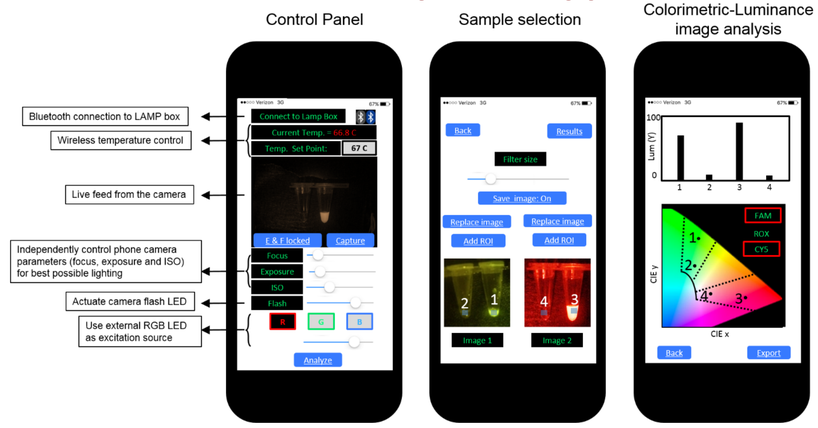
- QUASR is an endpoint fluorescence detection technique that improves upon common non-specific detection techniques for RT-LAMP by providing bright, target-specific, multiplexable signals with reduced false-positive results.
- We developed a panel of four multiplex assays for 7 targets: *P. falciparum*, Ebola virus, yellow fever virus, Lassa virus, chikungunya virus, West Nile virus, and dengue virus (serotypes 1-4), with limits of detection (LOD_{90}) in the range of 10 – 1000 copies for most targets.



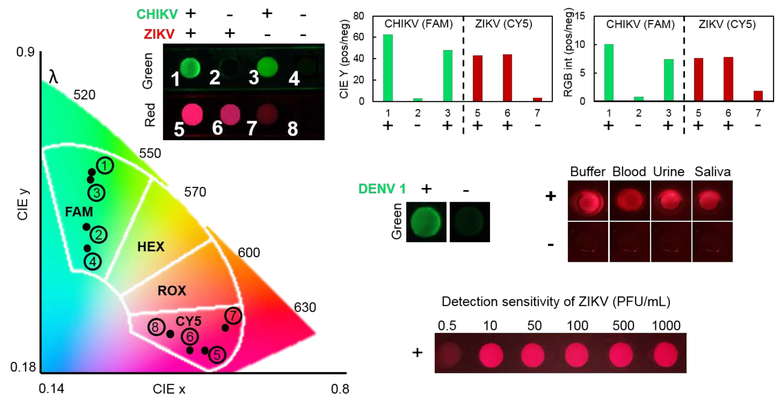
- We also developed a QUASR RT-LAMP assay for Zika virus that detects as few as 50 copies (LOD_{95}), within 10-30 minutes, in a variety of clinical sample matrices (urine, saliva, whole blood, or serum).
- We observed *no difference* in sensitivity when assays were performed with intact infectious virus, or extracted RNA.



Custom on board Smartphone App



Fluorescence Image Analysis on a Smartphone



- Our smartphone employs a novel algorithm utilizing chromaticity to analyze fluorescence signals, which improves the discrimination of positive/negative signals by 5-fold when compared to detection with traditional RGB intensity sensors or the naked eye.

Conclusion

- Our instrument is rugged and versatile, enabling pinpoint deployment of sophisticated diagnostics to distributed field sites.
- These advancements make it possible to build a complete DNA/RNA analysis system at a cost of ~$100 ($US).

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