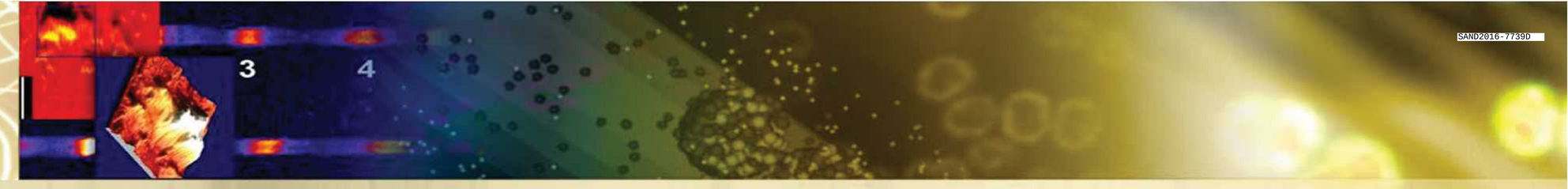
SANDIA BIOSCIENCE



SAND2016-7739D

Smart Trap

Real-time autonomous biosurveillance for mosquito-borne pathogens

Cameron Ball[1]*, Robert Meagher[1]**, Aashish Priye[1], Ron Renzi[1], Stephen Mueller[1], Jonathan Helm[1], Jaideep Ray[1], Chris Barker[2], Sarah Wheeler[2], William Reisen[2], Lark Coffey[2]; [1] Sandia National Laboratories, Livermore, CA [2] UC Davis Center for Vecterborne Diseases, Davis, CA -- *csball@sandia.gov **rmeaghe@sandia.gov

Motivation—Current biosurveillance tools are insufficient

Mosquito-borne pathogens are a menace worldwide. Malaria and dengue significantly burden both civilian and military populations in the tropics, and emerging arboviruses pose health and security risks across the continental U.S., e.g., West Nile virus, chikungunya virus, and now Zika virus. While the risks posed by arboviruses are well known, surveillance for vector-borne diseases is constrained by limited budgets, and a reliance on labor-intensive techniques for sample collection and analysis.

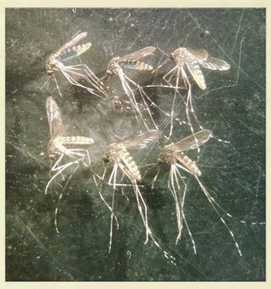
Trapping and manual sorting

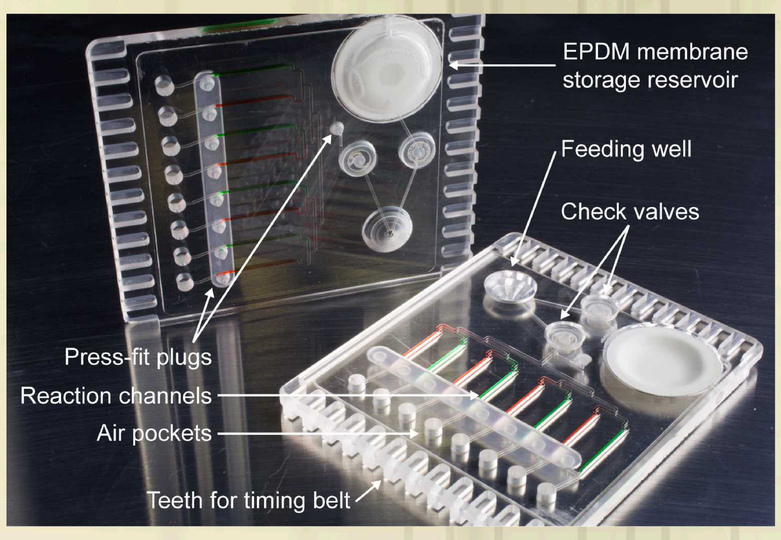
Molecular assays
$20 ea. target

Time to action:
1-2 weeks

The SMART trap

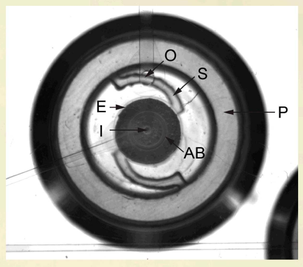
In collaboration with UC Davis, we have developed a device that automates a novel approach to detecting arboviruses in a field setting, based upon the sugar feeding behavior of mosquitoes. Mosquitoes (host-seeking or not) feed upon plant-based sugar on a daily basis for energy. Infected mosquitoes can deposit anywhere from 1-10,000 plaque-forming units of virus on a sugar bait, which we detect by RT-LAMP in 30 min with an autonomous shoe-box sized microfluidic instrument.

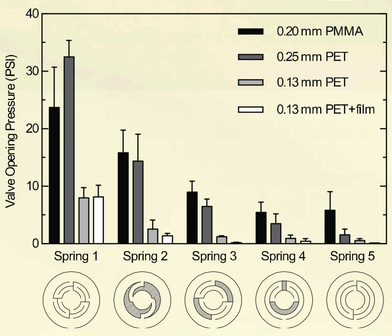


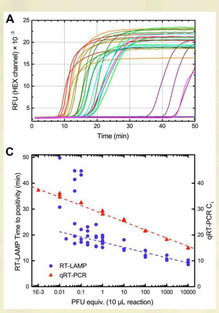


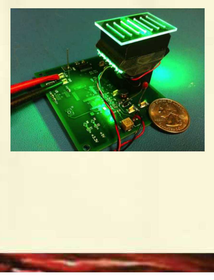
Left: Spun sugar bait and fed mosquitos (blue). **Right:** Plastic (PMMA) analysis chip with dried reagents for up to six virus-specific RT-LAMP assays, plus controls.

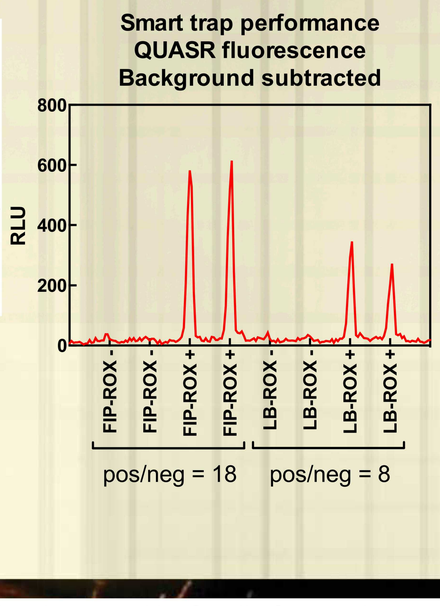
Below Left: Novel microfluidic check valves enable controlled fluid handling without pricey hardware. **Below Right:** Our novel RT-LAMP detection chemistry called "QUASR", improves signal discrimination and reduces false positive detection.



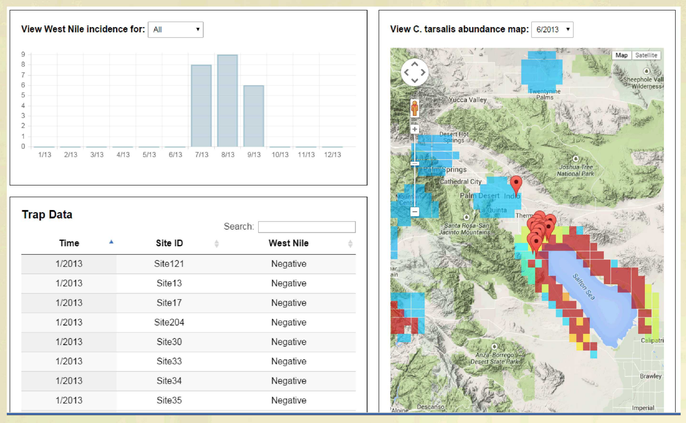








Networked biosurveillance and BSVE integration

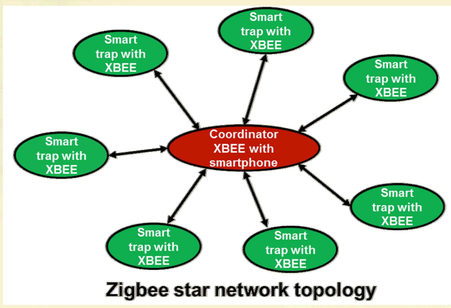


SMART Traps App
Running with BSVE as 3rd Party App
HTML5, Javascript, Google Maps API

Download data via REST

SMART traps web server and datastore running on Amazon AMI
Spring Framework, Java, R

Upload data via REST



Zigbee star network topology

SMART traps are intended to be inexpensive enough ($500 each, upon scale up) to deploy in a mesh network, allowing daily reports at multiple locations within a region of interest. We built an app to provide access to trap data sorted by date or location, as well as map visualizations. Mapping incorporates a statistical model that predicts vector abundance based upon environmental factors.

Conclusions and future work

- Trap detects <1 PFU of a 6 virus panel from sugar feeding mosquitos with low false-positive rate in 30 min.
- Trap is designed for mass manufacture at low cost ($500 per trap, $10 per chip).
- Trap can be reconfigured to target other pathogens.
- Development of novel IP including QUASR and microfluidic technologies.
- Established strong collaborations with UC Davis team.

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. **SAND Number:**

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories