

Hybrid Sensor for Multiple Threats Detection

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Problem

RESEARCH CHALLENGE: “There is a need to improve analytical tools to better predict and prevent the enemy’s successful use of IED threats.”



DETECT AND DEFEAT

■ Requirements:


- **Good sensitivity and specificity for a broad range of threats**
- **Sensor system miniaturization enabling wide deployment, e.g., unmanned platforms, embedded in infrastructure**
- **Ruggedness to enable reliable outdoor performance**
 - **Temperature, Humidity, Dust**
 - **Clutter: interference due to other species/materials in the environment.**

Background



Evolving threats require multiple modalities of detection using an orthogonal sensor combination.

R&D trends are: Miniaturized sensors with high sensitivity and selectivity for rapid threat detection and wide deployment.

Present	Near-Term 2-3 Year	Future ~ 5yr.+
 <p>Trace Portal ~ \$120k</p>	 <p>Portable Raman uProbe ~ \$25k</p>	 <p>MEMS Array Sensor < \$1k</p>
	Susan Hallowell	April 5, 2004
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Rugged, miniaturized sensors operating in difficult environments are needed to mitigate evolving threats.

Objective



- **Develop a compact hybrid sensor – initial focus is on trace explosives detection, but the sensor components have merits for responding to other threats as well.**
 - **Combine the best features of complementary technologies to achieve high detection sensitivity and high selectivity.**
 - **Achieve performance that significantly exceeds that of current sensors, especially for trace detection using single modality sensors.**

Activities

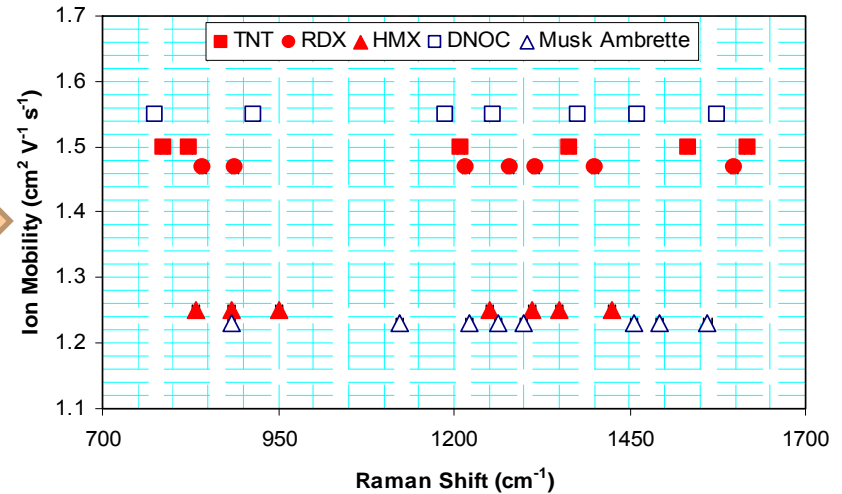


- **Develop an experimental facility for baseline measurements with the COTS technology.**
- **Design a compact hybrid sensor with Ion Mobility Spectrometry (IMS) and Surface-Enhanced Raman Spectroscopy (SERS)**
 - Design an optimal IMS system through modeling and experiments: examine electric field uniformity, space-charge effects, dielectric charging and their role on miniaturization
 - Employ an appropriate SERS substrate and build comprehensive spectral library.
- **Build, test and integrate subcomponents: Judge if 1+1 >> 2 or ~2.**
- **Develop algorithm and sensor training protocol for threat identification in a cluttered environment.**

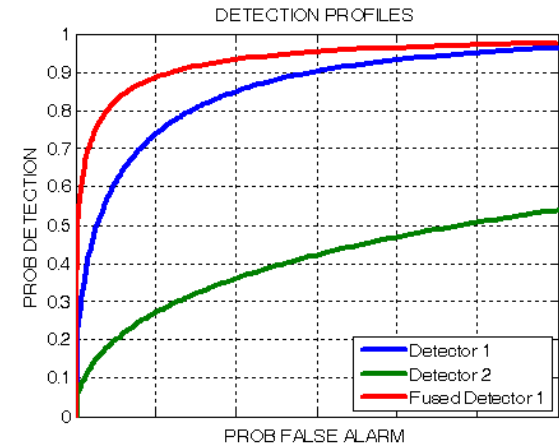
Highlight

- **Mission highlights:**

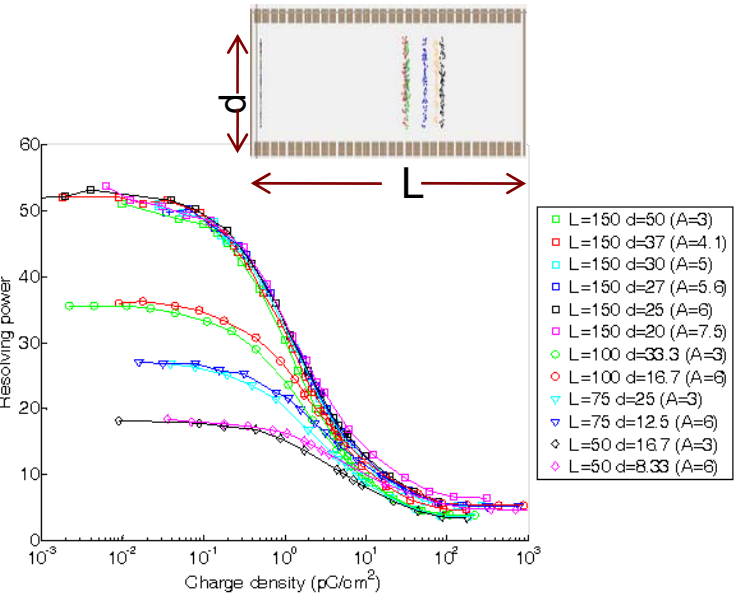
- **Design and build IMS and Surface Enhanced Raman Spectroscopy subcomponents, test and integrate them**
- **Test hybrid system**
- **Develop miniaturization protocol**
- **Collaboration with academe and government labs**



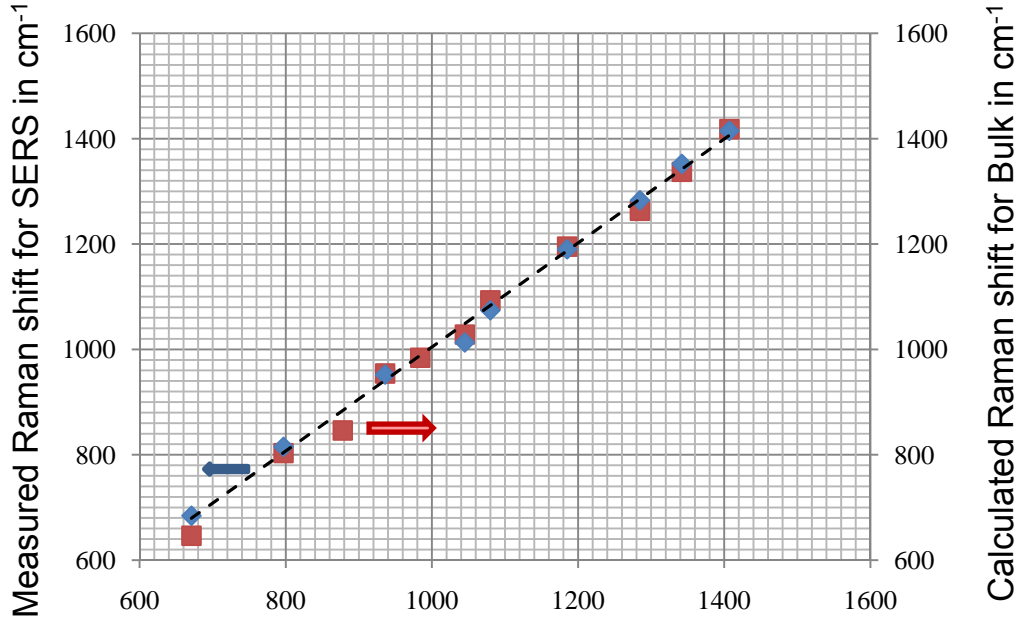
Improved
Threat
Classification



Demonstration: Designed and Fabricated a Modular IMS and Obtained SERS Spectra



IMS Performance from M&S



SERS Measurements and Comparison with bulk Raman signatures

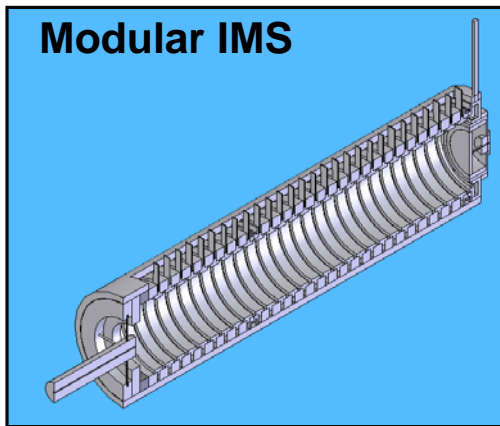
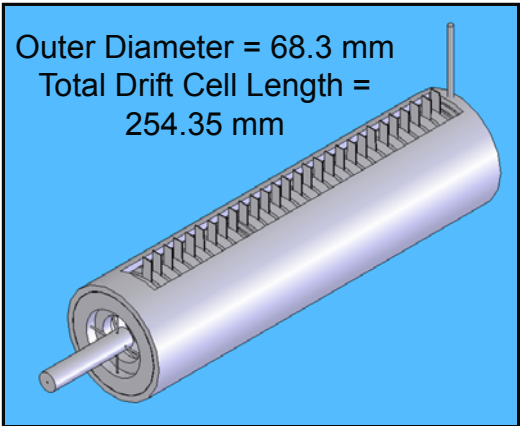
This comprehensive M&S and experimental work at MITRE enables development of an in-house technology base for trace explosives detection and also building a novel sensor for effective checkpoint screening.

Impacts

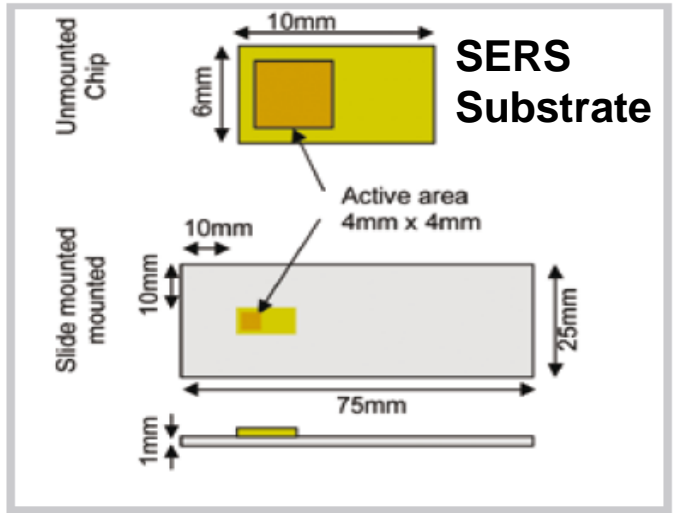


- Provides a rugged, miniaturized detection system for homeland security and defense, force protection, law enforcement, and public health
 - Immediately improves the performance of open environment trace explosives detectors.
- Provides the technology basis to detect a broad-range of explosive threat substances
 - Rapidly (almost in real time, ~ seconds)
 - With high sensitivity (sub-picogram level) and specificity.
- Provides differentiated value
- Aligns with respect to Multiple Sponsors' needs and strengthens MITRE mission to strengthen National Security.

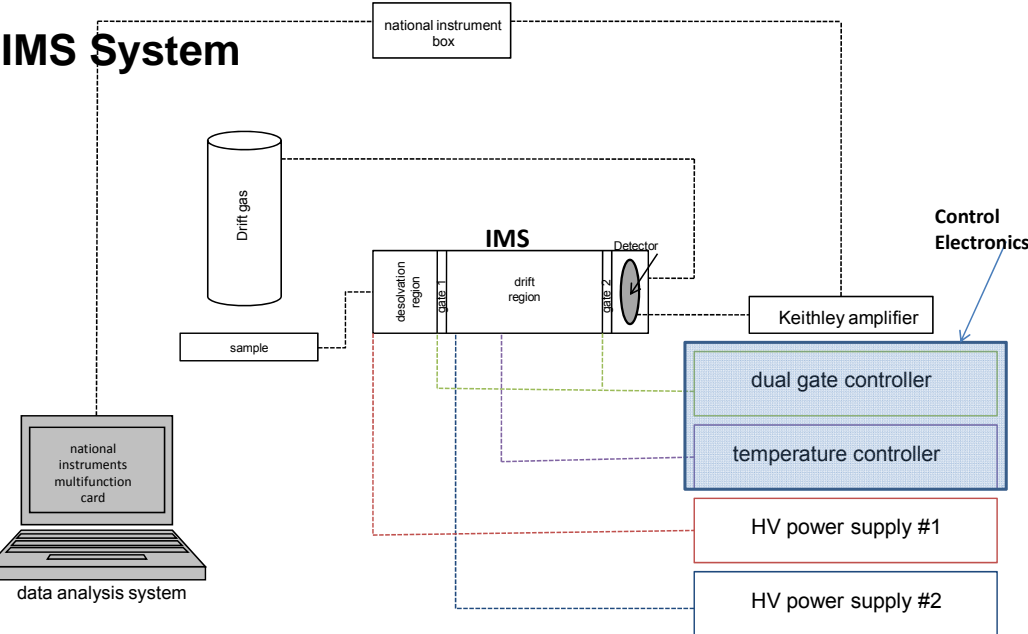
Future Plans: Establish that IMS-SERS Provides Desirable Technology Solution



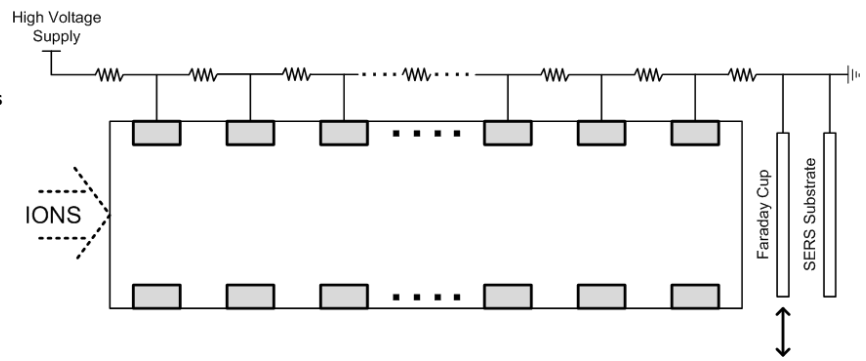
Chip & Slide Dimensions



IMS System



IMS + SERS



IMS is being developed in collaboration with Washington State University.