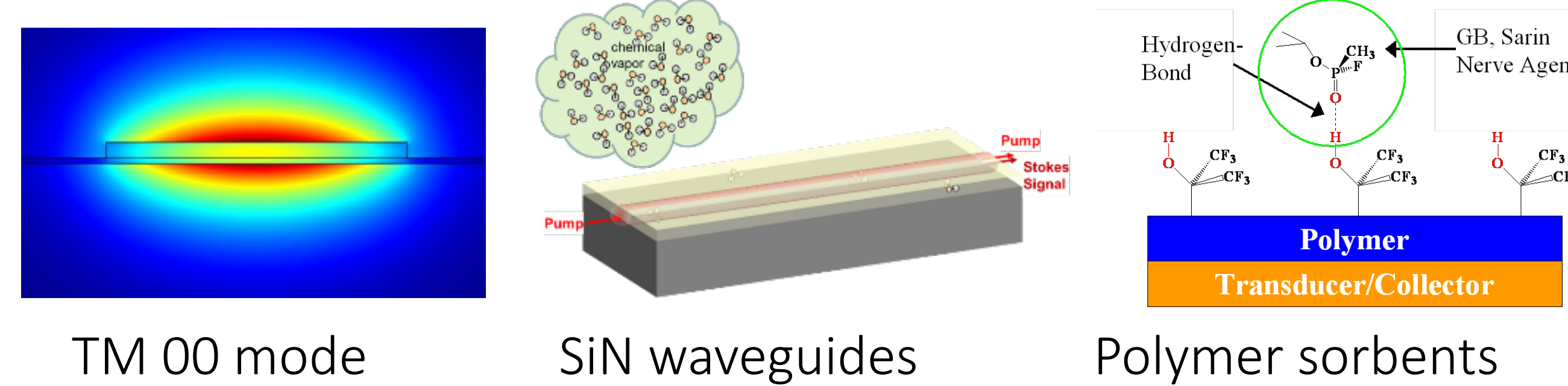


Waveguide-Enhanced Raman Spectroscopy for Field Detection of Vapor Threats

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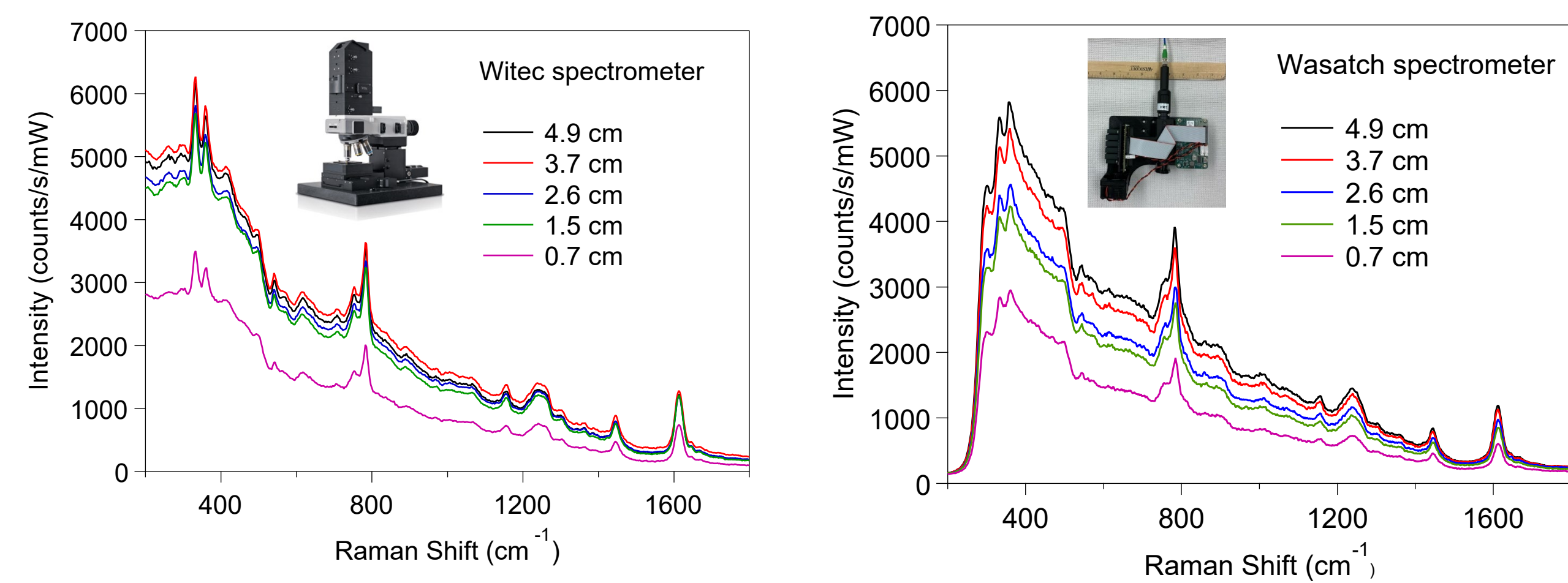
Introduction

Detection of chemical threats such as chemical warfare agents, explosives, and narcotics is important for protection of soldiers and civilians. In waveguide-enhanced Raman spectroscopy (WERS), waveguides in photonic-integrated circuits are used to tightly confine the excitation light over a long path length, leading to large signal levels from molecules present in the evanescent field just above the waveguide. Sorbent polymers are used to concentrate vapors in the evanescent field to enhance detection.



Compact Raman Spectrometers

Compact Raman spectrometers enable field detection of chemical vapors. They are compared to a (benchtop) Witec Raman chemical imaging microscope system at 785 nm

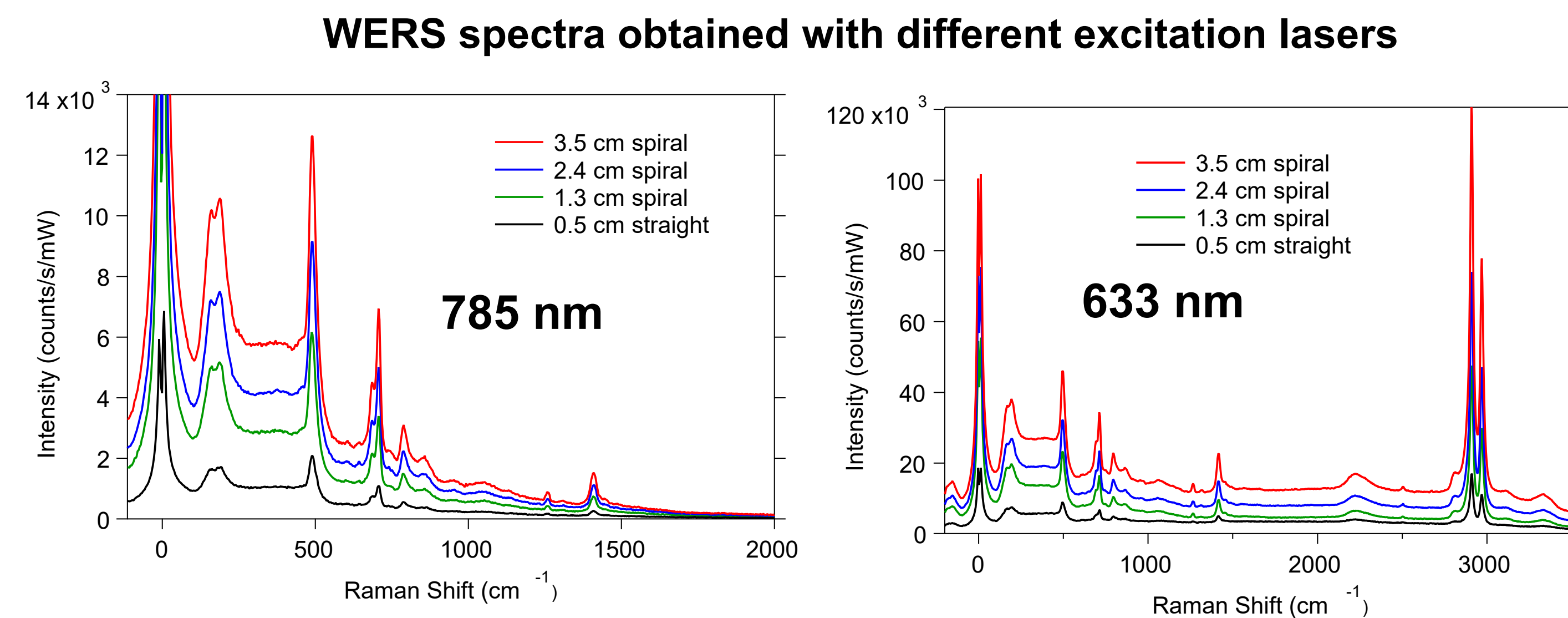


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WERS Excitation Wavelength Study

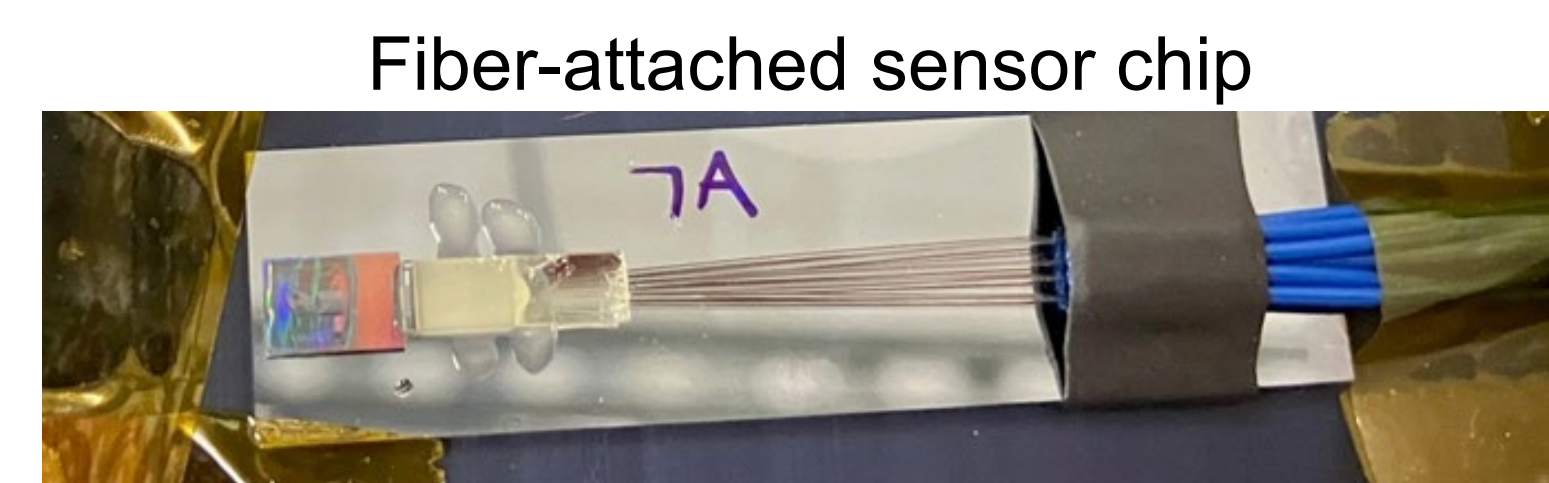
Benchmark measurements were performed with a Witec Raman microscopy system with 532 nm, 633 nm, and 785 nm lasers to understand the tradeoffs of different excitation wavelengths

- ▲ Raman scattering cross-section (signal) increases with decreasing wavelength
- ▼ Waveguide losses increase with decreasing wavelength
- ▼ Waveguide fluorescence increases with decreasing wavelength
- **633 nm and 785nm excitation gave the best performance**



Spectrometer System Development

- 1st Generation prototype spectrometers have been developed to allow for proof of concept demonstration and surety assessments
- 2nd Generation prototype in FY25
 - Battery operated system for hazardous vapor detection (chemical warfare agents and explosives related threats)
 - Handheld, UAV or UGV mounted, or be fixed site (i.e. FOB) usage
 - Directly coupled to sensor chips with fiber optics



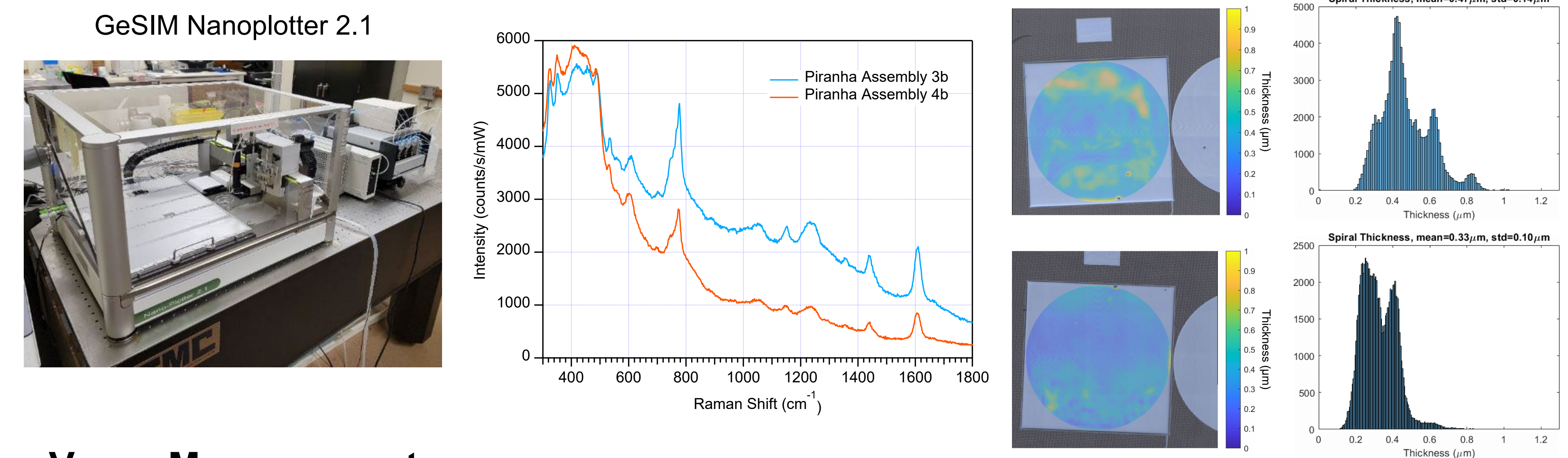
Current prototypes

Future desired SWAP

Sorbent Deposition

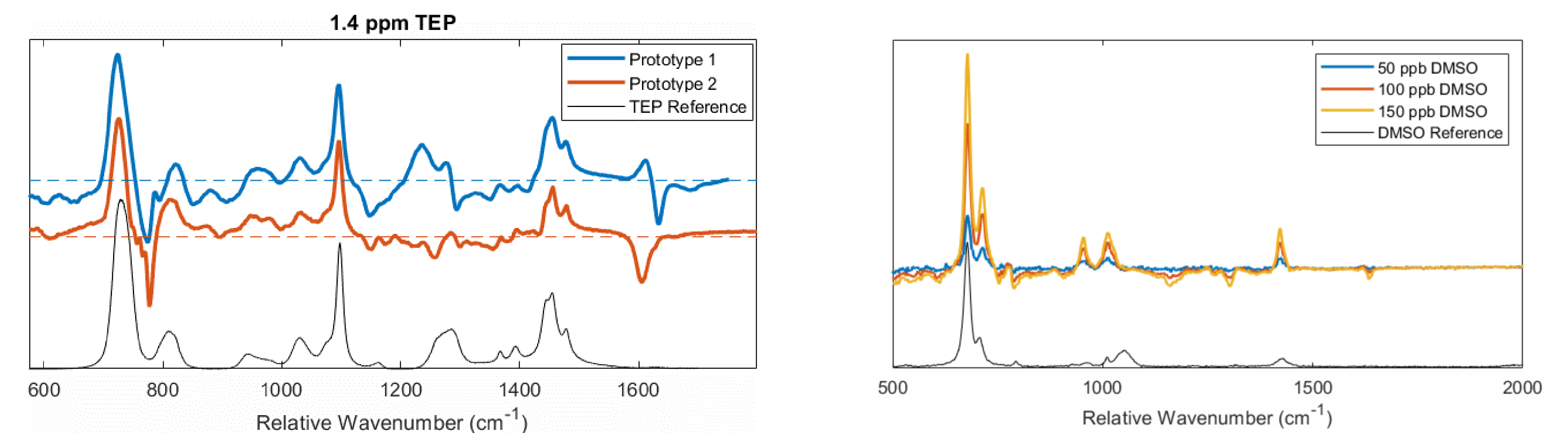
Piezoelectric droplet dispensers are being used to deposit sub-micron thin films of polymers on PIC sensor chips. This allows for multiplexing of sensors with different polymers (for enhancement of multiple chemical classes) as well as deposition on fiber-attached chips.

Microscope images reveal continuous nanoplotter-deposited films. White light reflectivity was measured using a Witec microscope to determine thickness as a function of position.



Vapor Measurements

Measurement of simulant materials such as dimethyl sulfoxide (DMSO) and triethyl phosphate (TEP) show low limits of detection in the vapor phase.



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