Investigating Raman Linearity and Multiplexing

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SHINE
Summer High School Intensive in Next-Generation Engineering

Introduction

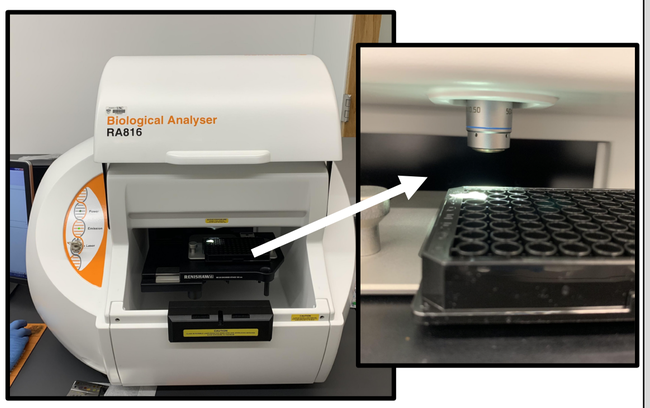
- Nano-based contrasting agents to localize cancer
- Fluorescent dyes allow us to identify the nanoparticles once injected

Green 8
PC: Nova Dea

Objective & Impact of Mentor's Research

Raman Spectroscopy

- Technique for detecting and qualifying analytes in chemical mixtures by receiving spectra
- Can identify tags with distinct spectra on nanoparticles
- Working towards making breast cancer tumor resection effective by allowing clinicians to see where the malignant tumor ends and where the healthy tissue begins



Raman Spectrometer PC: Nova Dea

Methods

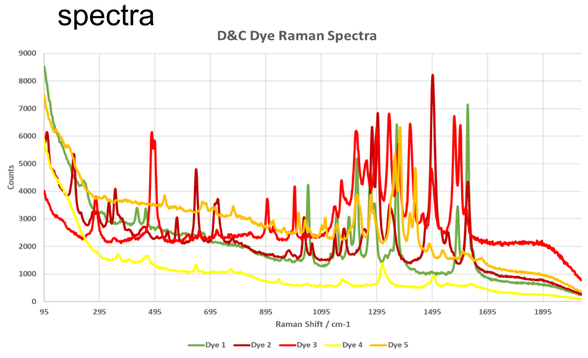
Direct Classical Least Squares Algorithm
(Motivation)

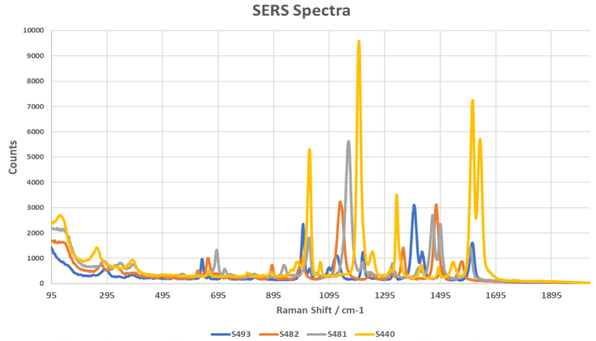
$$\alpha \begin{bmatrix} a_1 \\ a_2 \\ a_2 \end{bmatrix} + \beta \begin{bmatrix} b_1 \\ b_2 \\ b_2 \end{bmatrix} + \gamma \begin{bmatrix} c_1 \\ c_2 \\ c_2 \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ y_2 \end{bmatrix}$$

$$\begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix} \begin{bmatrix} \alpha \\ \beta \\ \gamma \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} \qquad Ax = y$$

$$(A^T A)^{-1} A^T y = x$$

- Raman Spectra = distinct, narrow peaks
- When multiplexing, choose distinct spectra



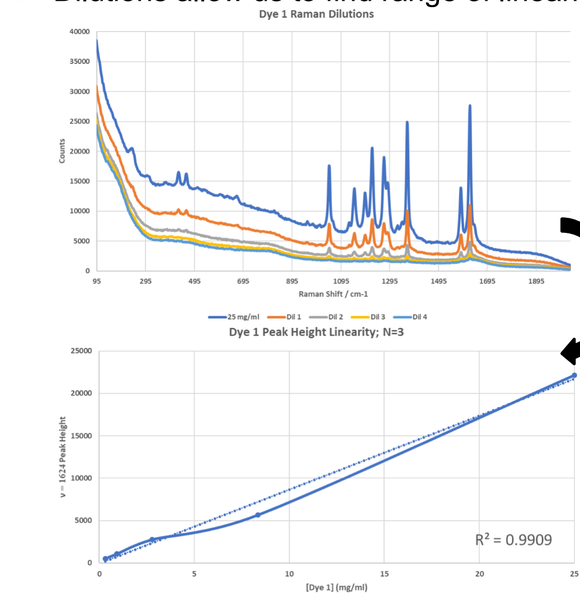


- Surface Enhanced Raman Scattering (SERS) nanoparticles are intended to make for distinct spectra and high counts
- SERS particles can be used *ex-vivo* to proceed with our task

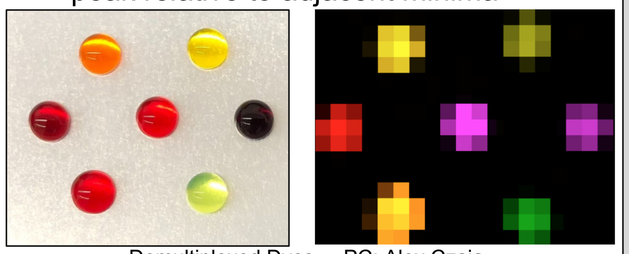
Results and Discussion

Linearity and Demultiplexing

- In order to multiplex, optimal range for linearity (concentration vs. peak height) must be found for each dye
- Dilutions allow us to find range of linearity

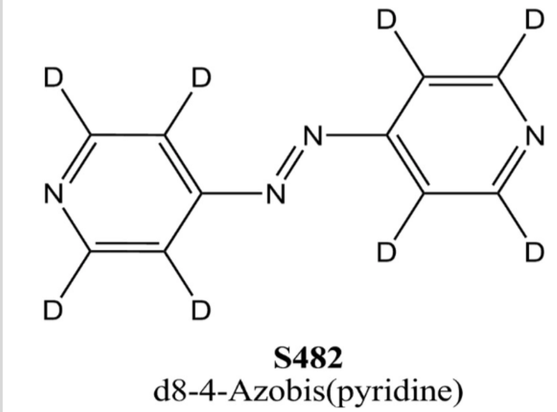


- Peak height is defined by height of each peak relative to adjacent minima



Demultiplexed Dyes PC: Alex Czaja

- Demultiplexing involves finding the right dyes that are properly distinct from one another (trial and error process)
- Ability to use multiple dyes (possibly tagged with different antibodies) and distinguish each one
- Future studies may involve colocalization, fine tuning the selection process, and creating a clean, systemic process to gather data



S482
d8-4-Azobis(pyridine)

References

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