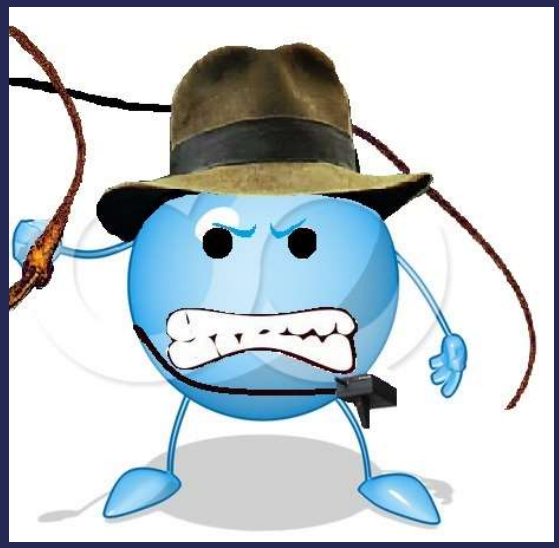


Microfluidic Raman Spectrometer Biosensor

By:
Raiders of the Lost Pathogens
Sharlee Mahoney and Nathan Fletcher

Project Proposal

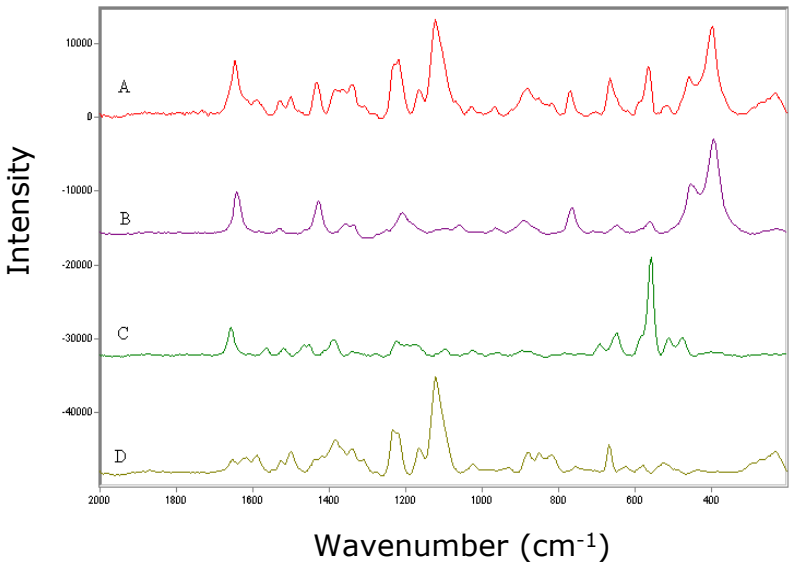
- Microfluidic chip flowing into a handheld Raman spectrometer
  - Used to identify different types of cells or bacteria
    - Possible contaminants to be targeted in water: *E. coli*, *G. lablia*, *V. cholerae*
  - Analysis of obtained Raman spectra to report water contamination

Business Opportunity

- Environmental Firms
  - 119,000 companies
- Water Microbial Research Labs
- Development Stages:
  - Prototype I
    - Manual Operation
  - Prototype II
    - Automatic Operation
  - Prototype III
    - Biomedical Applications
    - Rural Areas—including 3rd world areas
    - Hospitals

Raman Spectroscopy Background

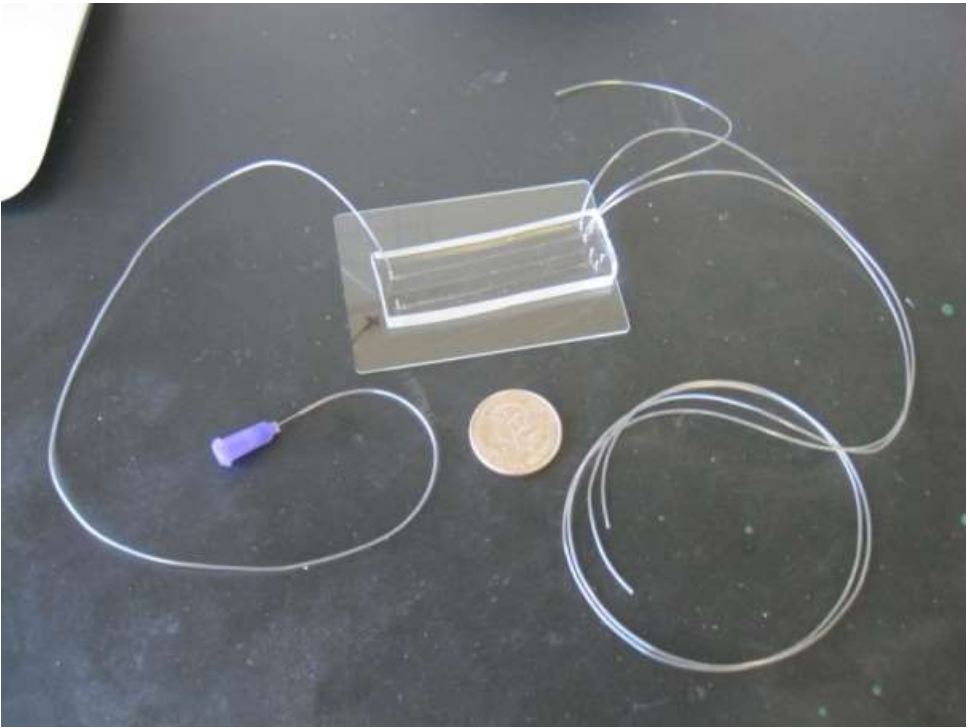
- Spectroscopic technique used to provide quantitative and qualitative data

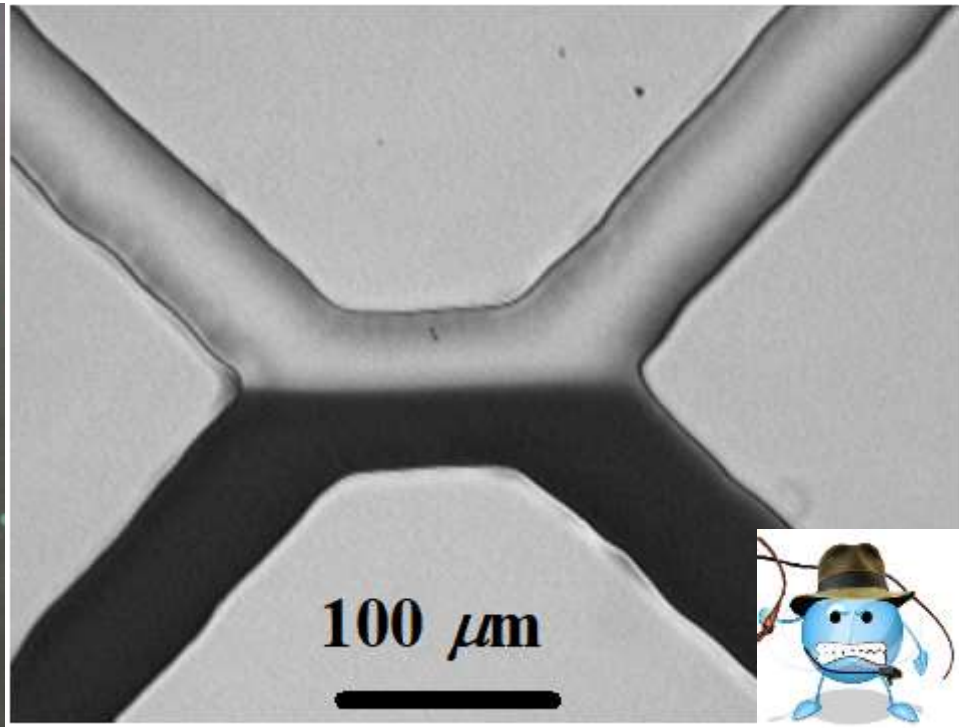


- Multiplex assays
  - Use 3 different dyes
  - Capable of detecting of multiple pathogens at one time

Microfluidic Background

- Flow through microchannels resulting in low Reynolds number fluid mechanics
- Inertial focusing: As Re approaches 1, inertial properties begin to show.

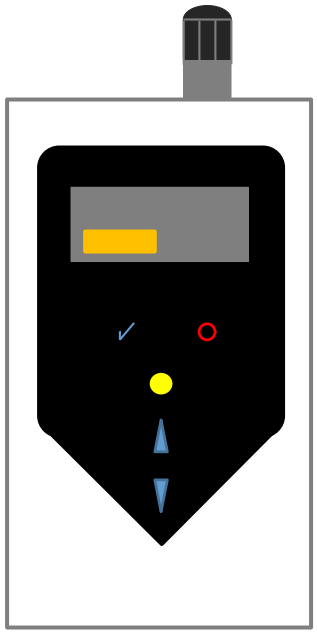


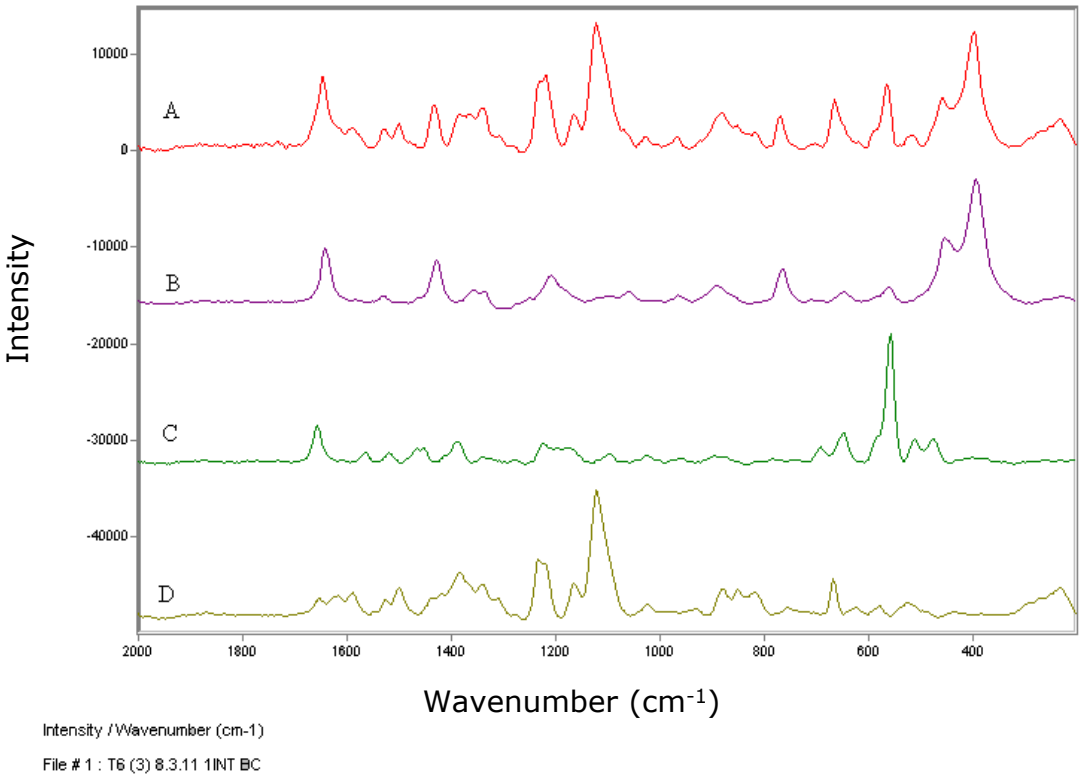


Biosensor Components

- Raman Spectrometer
  - Handheld
  - Can be used anywhere
- Sample Syringe
  - Triple syringe with 1 plunger
    - Water Sample to be analyzed
    - Sample Preparation
    - Deionized Water
- Microfluidic Device
- Collection Well

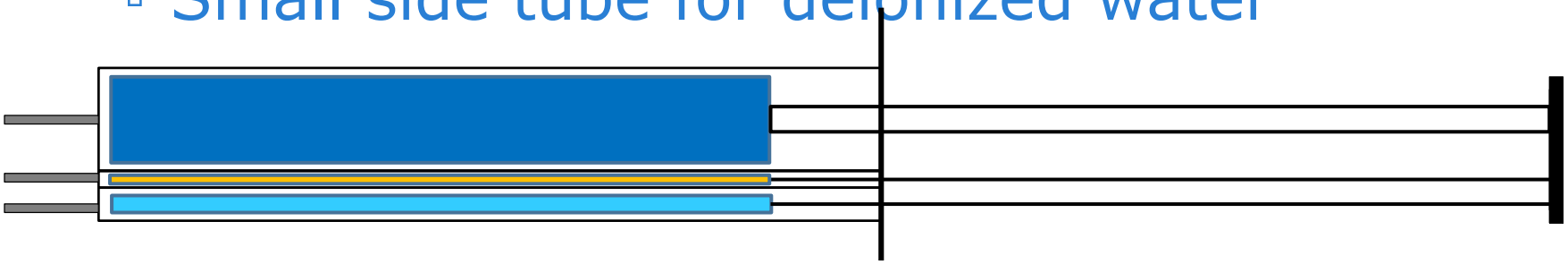
Flow Diagram





Sample Syringe

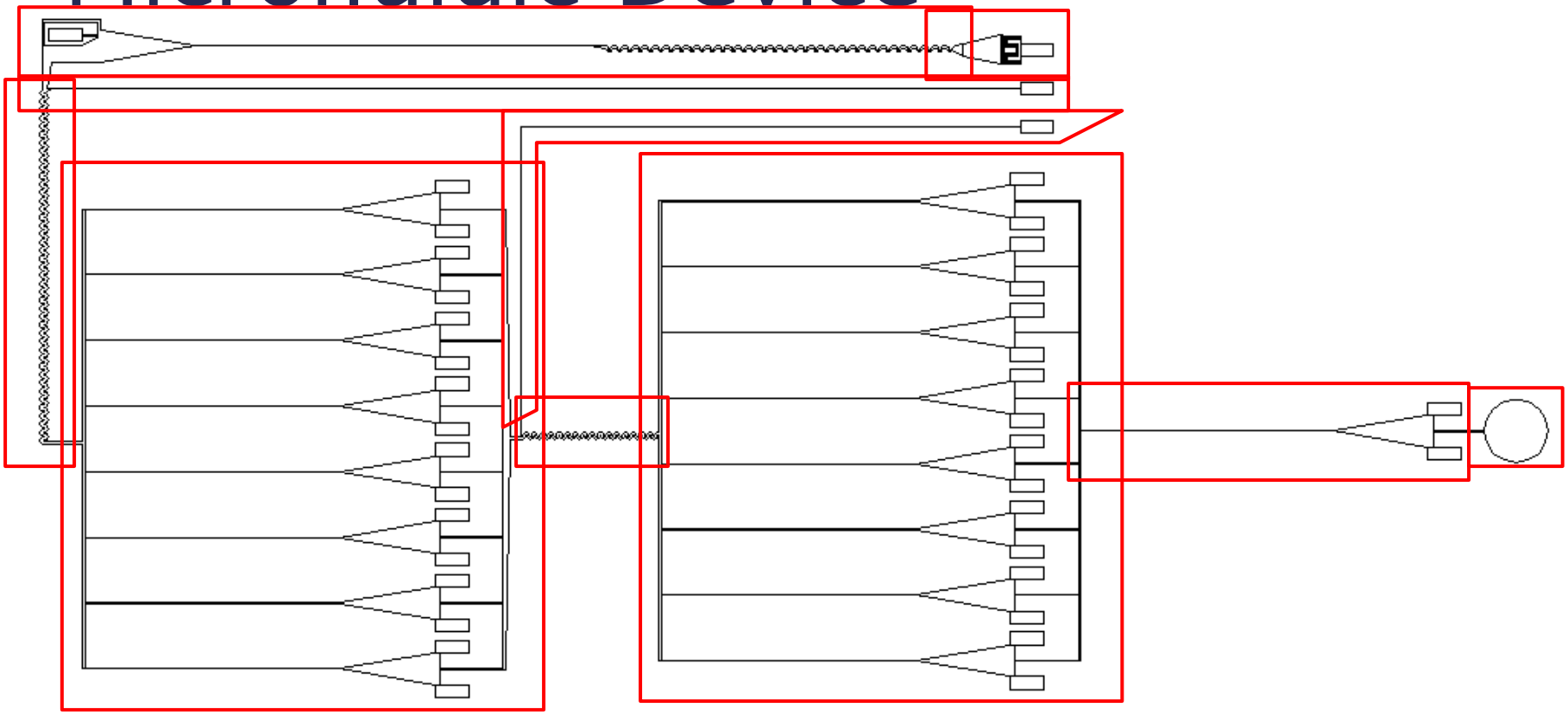
- Triple syringe with 1 plunger
  - Larger diameter tube for water sample to be analyzed
  - Small side tube for GNP sample preparation
  - Small side tube for deionized water



Preparation Sample

- Multiplex Assay
  - 60 nm Gold Nanoparticle (GNP)
  - Nile Blue, Methylene Blue and Janus Green
  - Silica shell with antibody attached
- Possible antigens to target
  - *E. coli*: 0111 antigen of lipopolysaccharide
  - *G. lamblia*: CWP1, CWP2, GCSA-1 spikes
  - *V. Cholerea*: O1 spike

Microfluidic Device



- Concentrate the solution from 5 mL to <30 µL
- Increase concentration >166x
- Manufacture with a hot embossing system

Economic Plan

- Product Incentive
  - Give away one handheld Raman spectrometer per company
- Cartridges
  - 100 per Raman spectrometer
- Expect 10% increase per year in sales

Biosensor Economics

- Start-up Cost
  - 5 Microfluidic Molds: $5,000
  - 3 Hot embossing machines: $30,000
- Individual Cost
  - Raman Spectrometer: $10,000
  - Microfluidic Device: $1
  - GNP preparation sample: $5
- Revenue
  - Raman Spectrometer: $0 from incentive plan
  - Cartridge: $30

Economic Comparison

- E. Coli sampling: $10
- Gas Chromatography-Mass Spectroscopy: >$40,000
  - Current environmental lab procedure
- Ondavia: $50-$100/sample

Aqua Jones:
$30/sample

Economic Sensitivity

NPV10:
$36MM
IRR: 18%

Sensitivity	NPV10	IRR
Cost of Cartridge		
+10%	$34M	17%
- 10%	$37M	19%
Price of Cartridge		
+10%	$43M	22%
- 10%	$28M	14%

Prototypes

Manual Operation

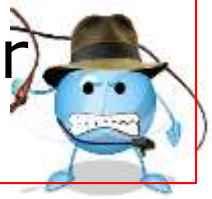
- Collect water Sample in syringe
- Connect syringe and depress plunger
- Move prepared sample well to Raman laser sight
- User must interpret Raman Spectra
- A lot of room for human error

Automatic Operation

- Water sample collection vessel
- Insert into device
- Digital display of results of order of magnitude

Biomedical Pathogen Detector

- Collect blood sample
- Insert sample and fresh solvent into device
- Digital display positive or negative results



Disposal

- No specific EPA guidelines
- Syringe
  - Sharps container
- Microfluidic device
  - Empty water from collection ports
  - Trash
- Preparation solution
  - Collect in waste bottle
  - Give to Environmental Health & Safety

Conclusion

- Versatile handheld Raman spectrometer that allows detection of 3 bacteria at once
- Cartridge for preparation
  - Unique triple syringe with 1 plunger
  - Gold nanoparticle preparation solution
  - Microfluidic Device
- PROFITABLE ENDEAVOR!

Acknowledgements

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Questions?