The Future of LIBS-Based Pathogen Identification

Steven J. Rehse[1], Qassem Mohaidat[2], Sunil Palchaudhuri[3], Hossein Salimnia[4]

[1]The University of Windsor, Department of Physics
[2]Wayne State University, Department of Physics & Astronomy
[3]Wayne State University, Department of Immunology & Microbiology
[4]Detroit Medical Center University Laboratories

The History of LIBS-Based Pathogen Identification

University of Windsor
thinking forward

2003-2004 **early days** **feasibility; proof of concept**

Samuels, DeLucia, Jr., Morel, Leone, Amoroux, Miziolek, Harmon, Hybl, Buckley

2005-2008 **advanced days**

Baudelet, Wolf, Laloi, Gottfried, Dixon, Hahn

advanced chemometrics; single particle/bioaerosals; double pulse; femtosecond; use of molecules; stand-off; man-portable

2008-2011 **current days**

Multari, Cremers, Caceres, Marcos-Martinez, Rehse, Mohaidat, Diedrich

discrimination of strains; microbiological diversity to simulate clinical specimens; realistic tests; chemometrics.

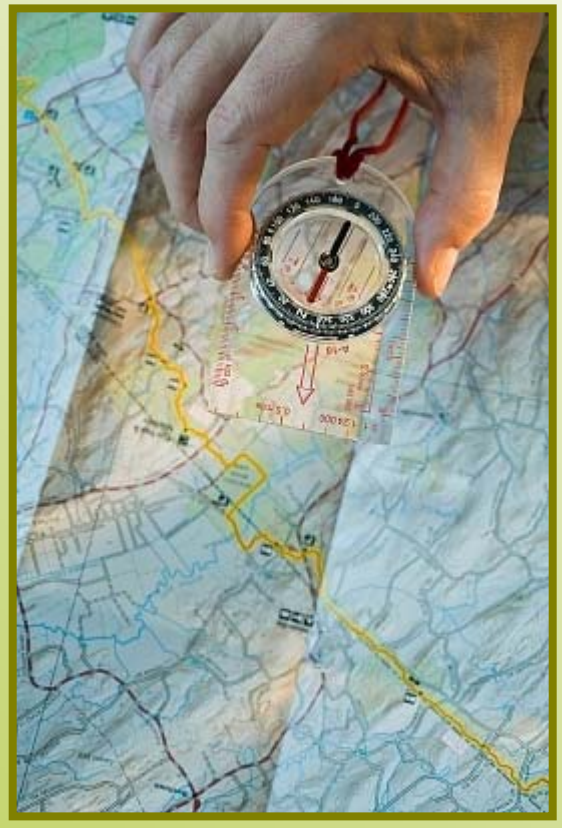
Future Days…

2011-? **future days**

testing of ever greater numbers of bacterial species; testing of clinical specimens; translation of technology to clinical medicine; commercial benchtop instruments.

Why Do I Think This?

Based on where we are now…

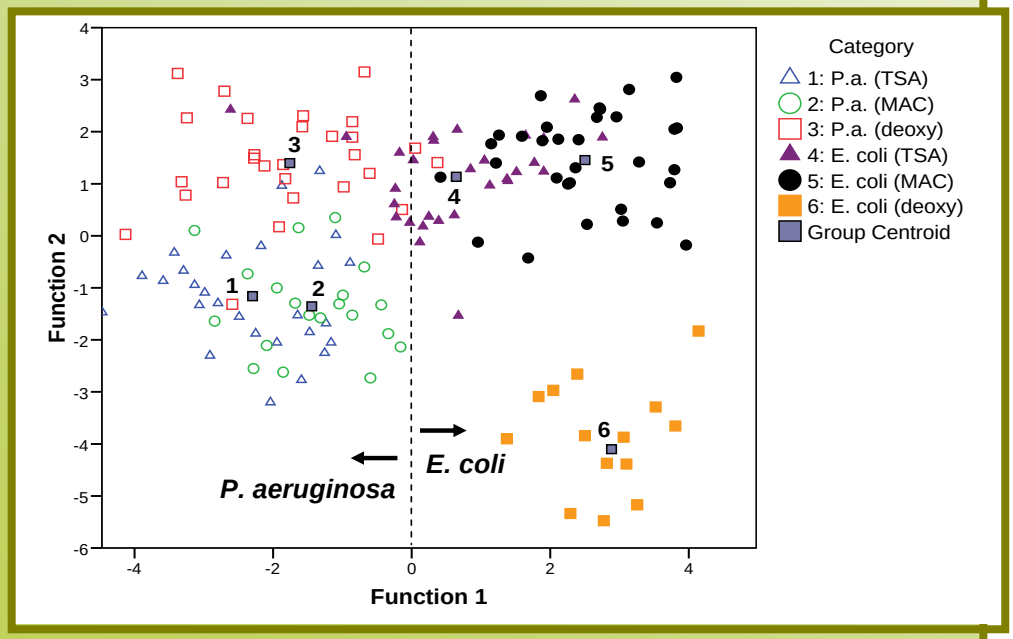


…past trajectory and current position indicate the way forward

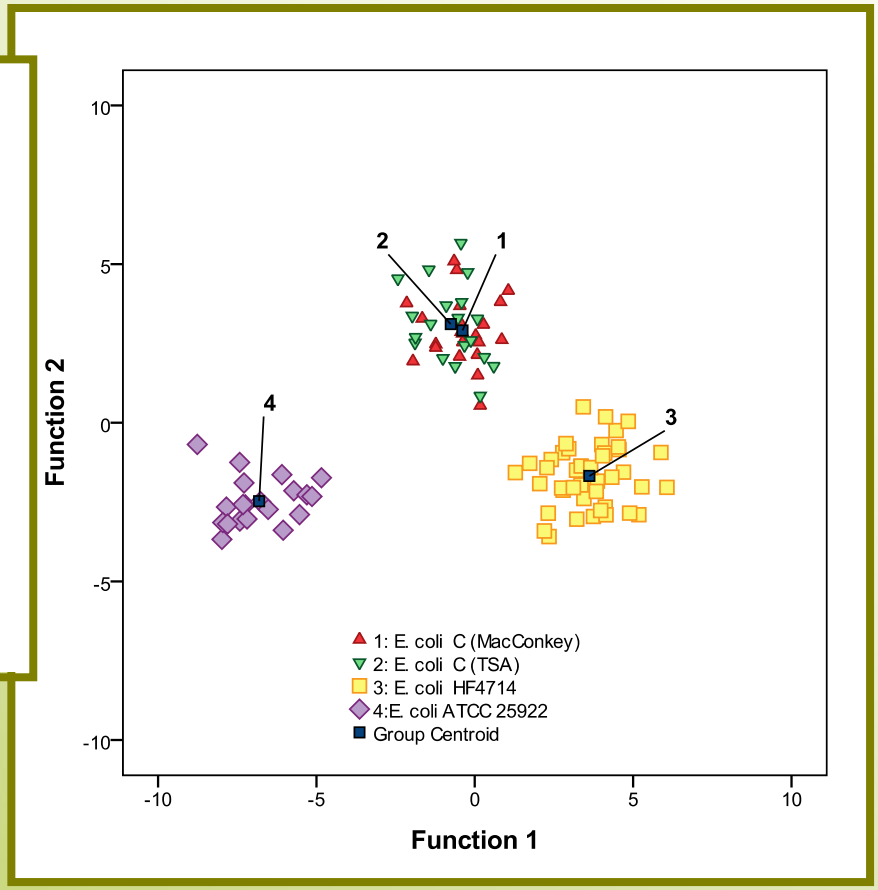
You are not what you eat (if you are a bacterium)

growth medium tests

2009



2011



Confirmation by Caceres Group

Talanta 84 (2011) 730–737

Identification and discrimination of bacterial strains by laser induced breakdown spectroscopy and neural networks

D. Marcos-Martinez [a], J.A. Ayala [b], R.C. Izquierdo-Hornillos [a], F.J. Manuel de Villena [a], J.O. Caceres [a,*]

[a] *Departamento de Química Analítica, Facultad de Ciencias Químicas Universidad Complutense, 28040 Madrid, Spain*
[b] *Centro de Biología Molecular "Severo Ochoa", CSIC, C/Nicolás Cabrera, 1, Cantoblanco, 28049 Madrid, Spain*

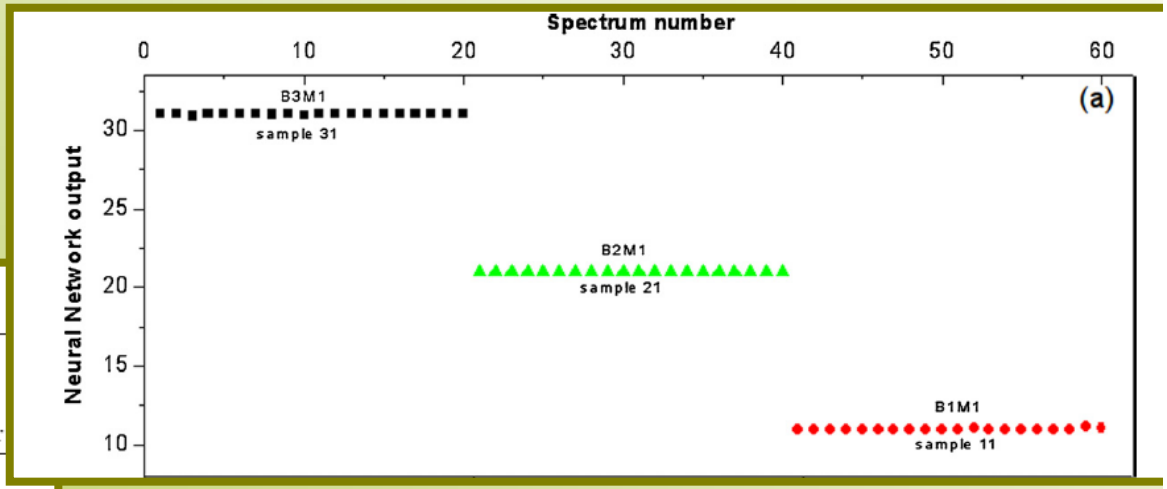


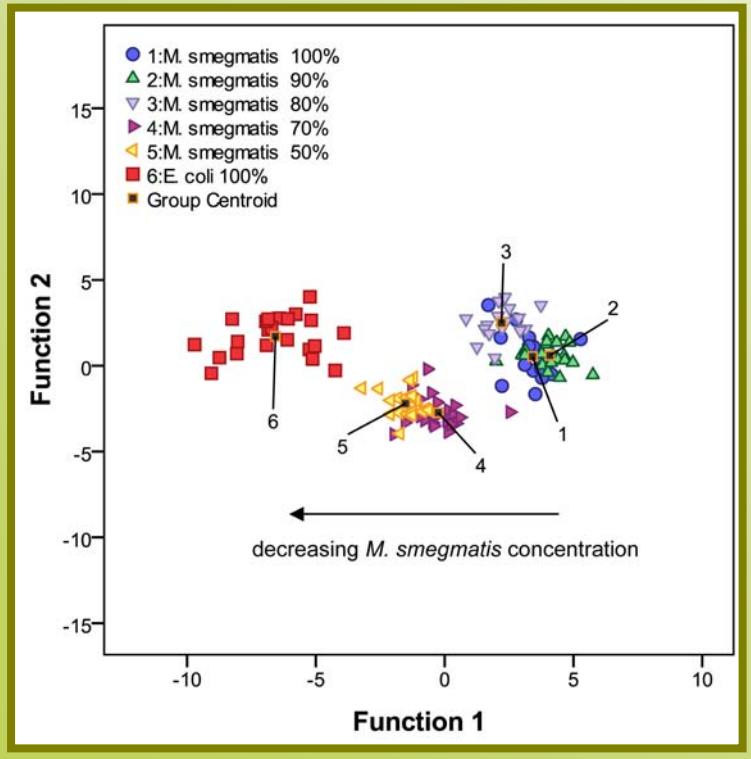
Table 1
Nomenclature used for the samples.

Bacterial strains	Culture media 1 LB agar	Culture media 2 MacConkey agar	Culture media 3 Brucella anaerobic agar
Pseudomonas aeruginosa (B1)	B1M1 (11)	B1M2 (12)	B1M3 (13)
Escherichia coli (B2)	B2M1 (21)	B2M2 (22)	B2M3 (23)
Salmonella typhymurium (B3)	B3M1 (31)	B3M2 (32)	B3M3 (33)

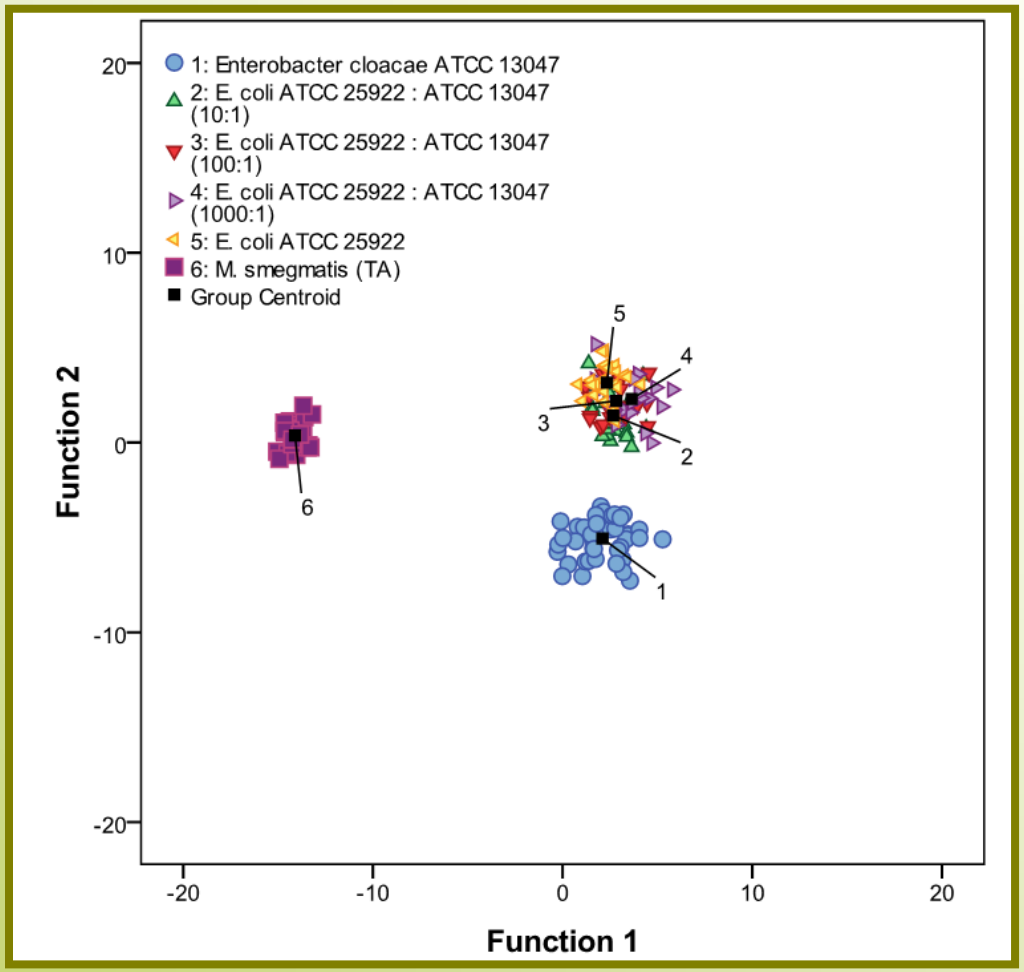
Contamination of samples will <u>not</u> degrade specificity

University of Windsor
thinking forward

2010

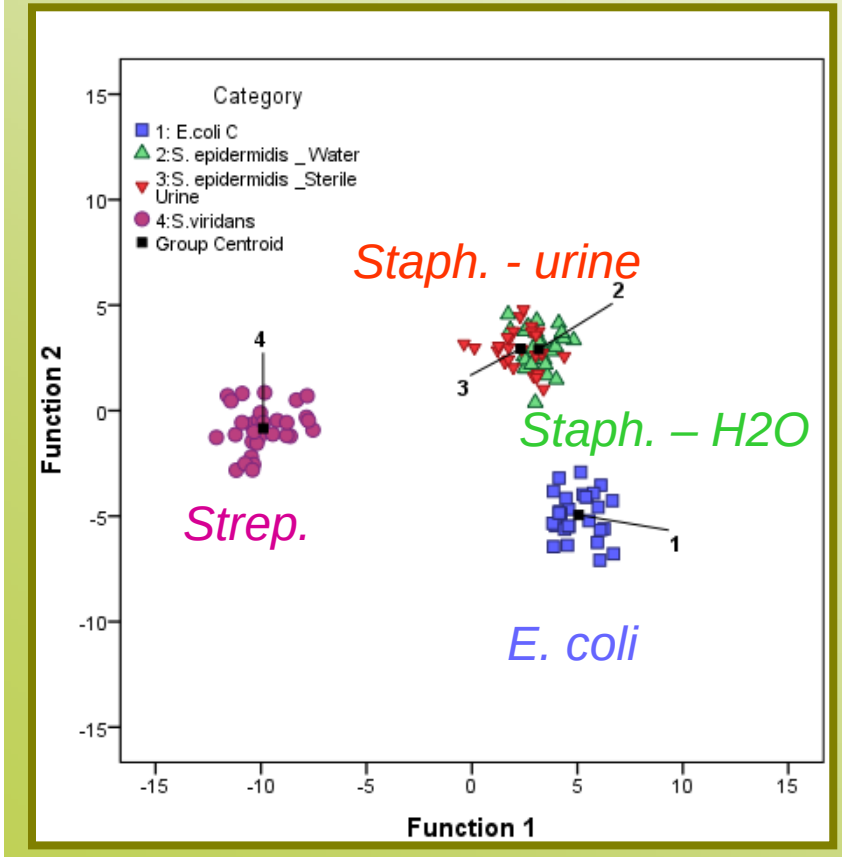


2011

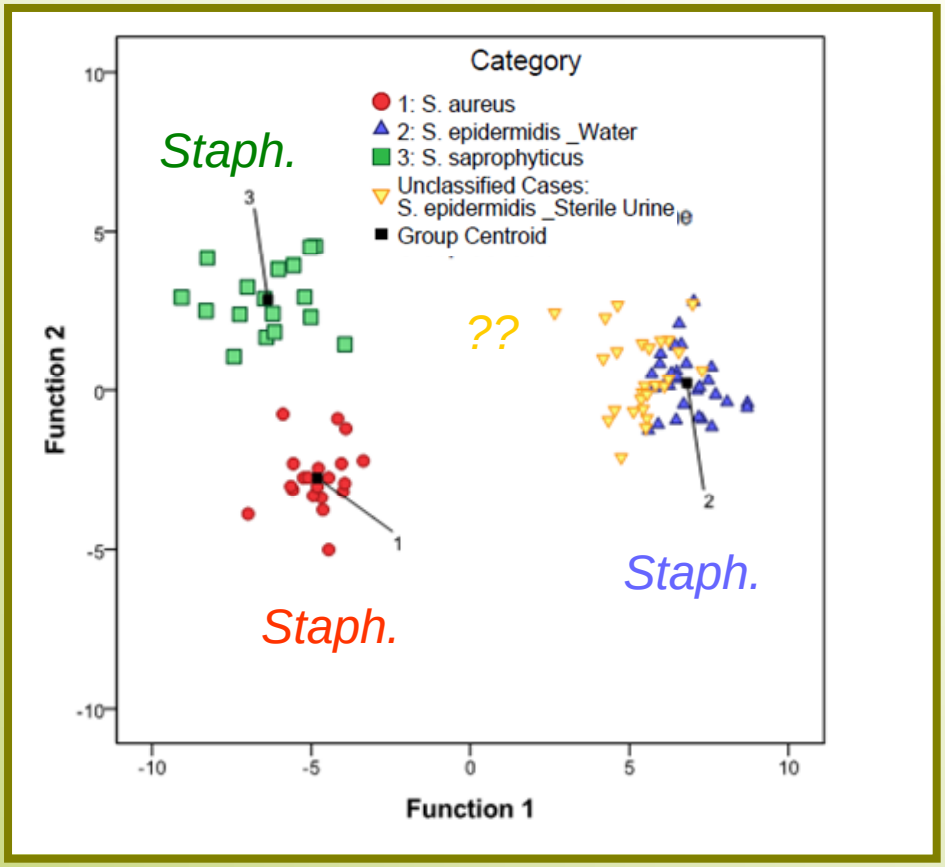


Simulated Clinical Specimens:
sterile urine

2011



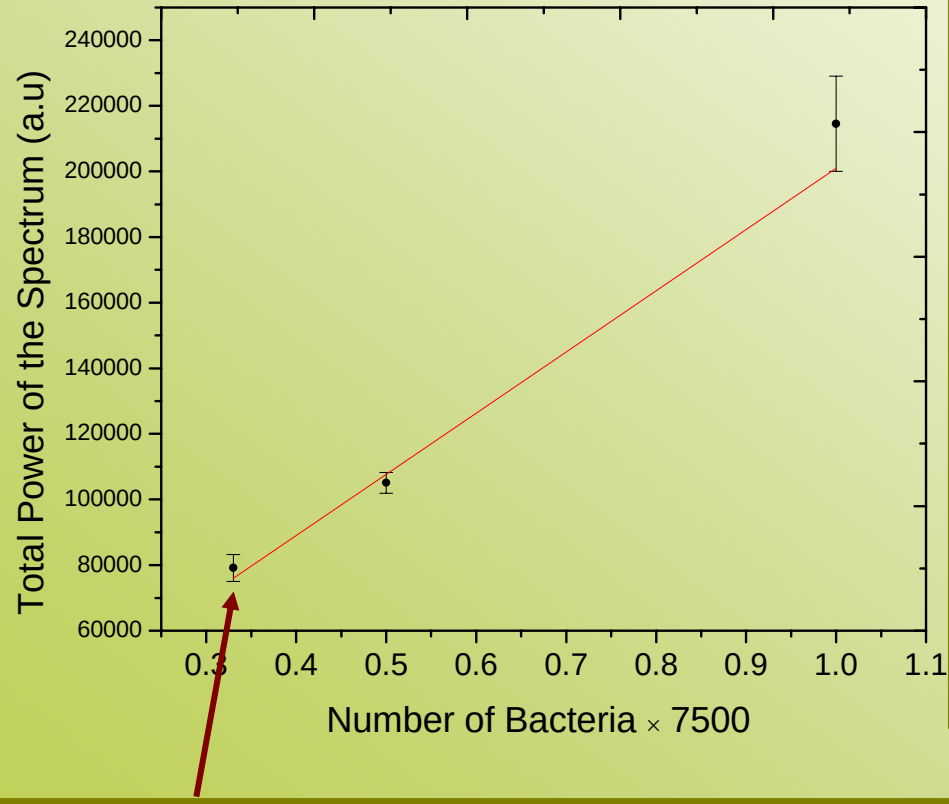
2011

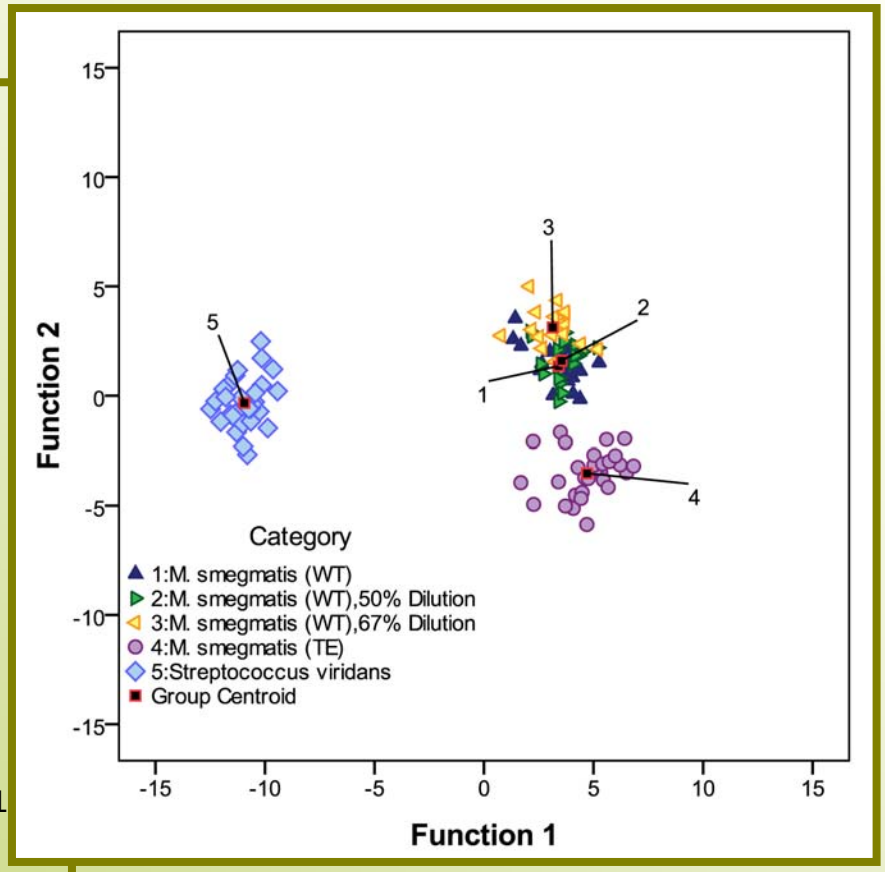


Dilution

specimens of various titer

2010

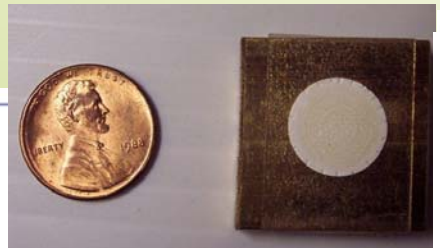




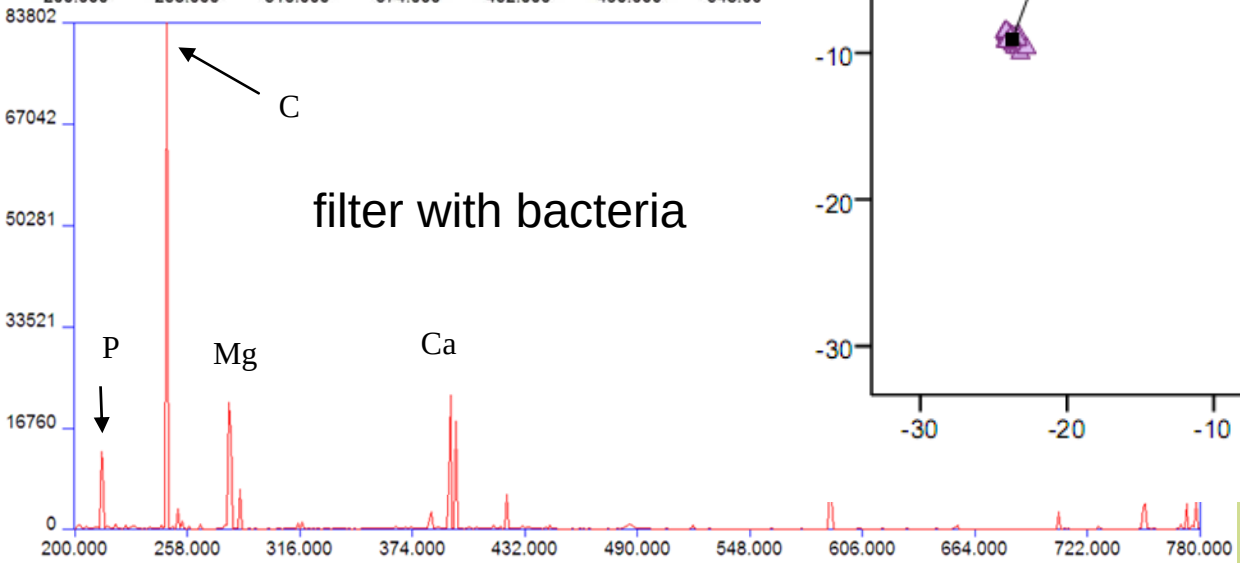
5 laser sampling locations

~500 bacteria per locations

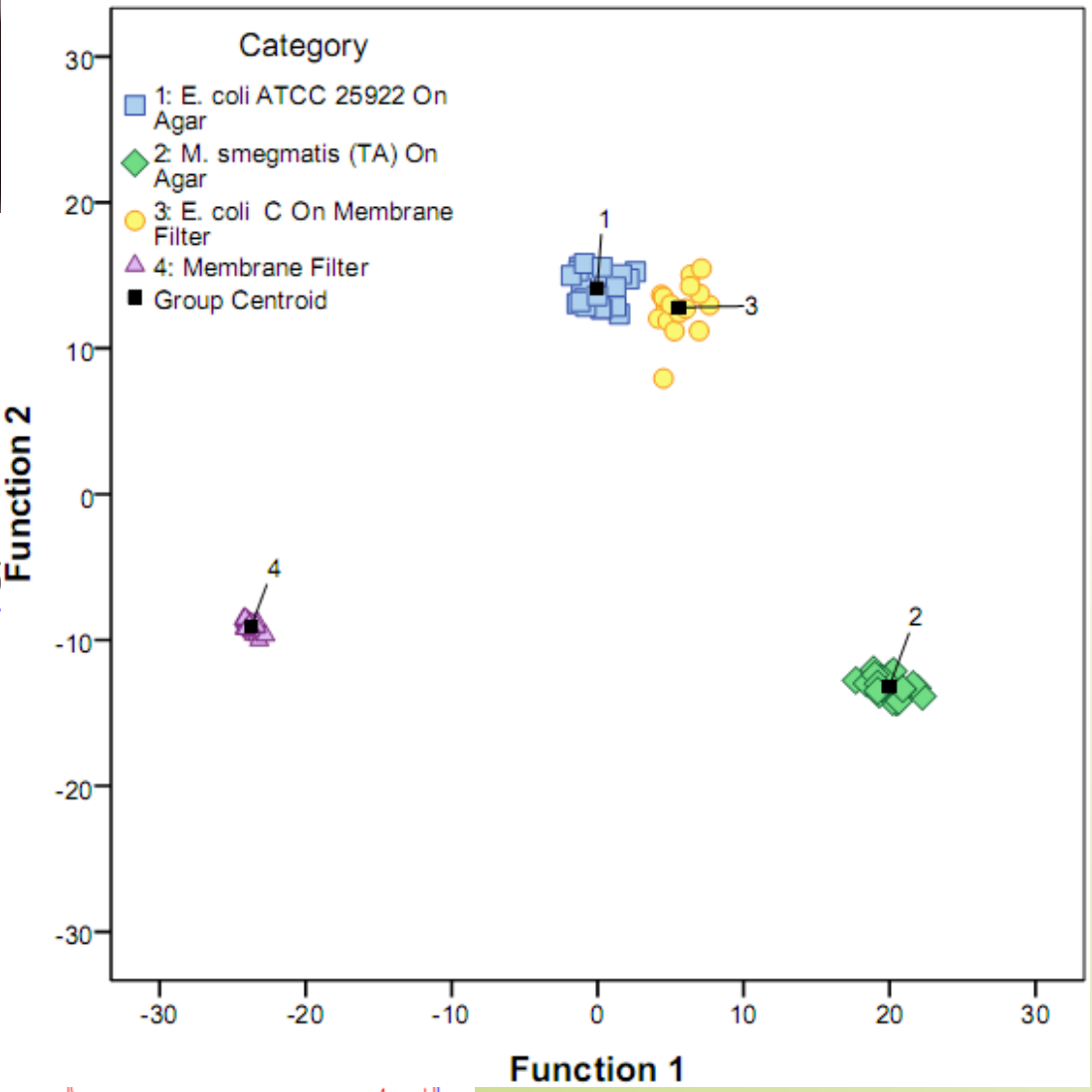
Cellulose Filter



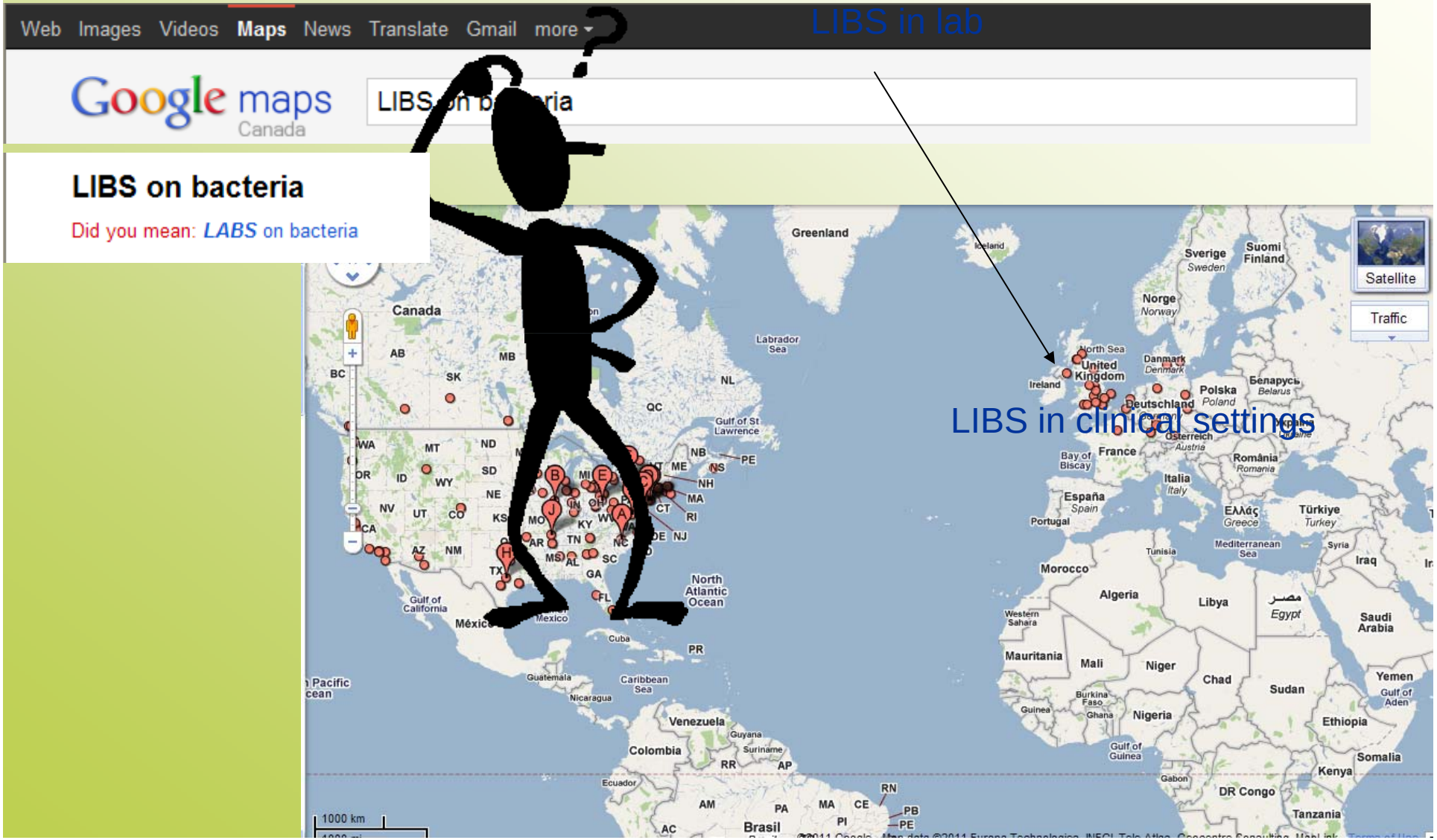
filter



filter with bacteria



Where Should We Go Now?



Where I Think We Should Go

(1) Clinical specimens that should be normally sterile and contain minimal other cellular components (i.e. urine, cerebral spinal fluid)

- detect the presence of bacteria
- make a rapid classification of that bacteria.

(2) Strain classification (particularly antibiotic-resistant pathogen strains such as MRSA).

These two applications alone (MRSA infections and UTI's) are responsible for over $2 billion of medical costs worldwide every year.

Most deaths from meningitis occur in less than a day from onset of the fever. It is most commonly caused by one of three types of bacteria: *Haemophilus influenzae*, *Neisseria meningitidis*, and *Streptococcus pneumoniae*.

Long-Term Objectives

(1) LIBS-based pathogen identification must be applicable to blood samples.

- The cellular components of blood?
- More complex sample-preparation steps for bacterial separation and identification needed.
- New sample-handling techniques needed.
- Advances made in the application of LIBS to liquid samples should be integrated to allow the rapid testing of the bacteria in fluid media.

(2) In all cases, efforts should now be made to include clinical collaborators.

- Allows the testing of clinical specimens in blind tests.
- All results initially confirmed by more traditional but rigorous microbiological (genetic and molecular microbiology) methods.

(3) Results published in medical journals.

Motivation of Long-Term Objectives

- Only in this way will the technique gain acceptance and the required traction in the medical community.
- We've got a great story to tell; let's tell it!

Seeking Employment

My student Qassem Mohaidat has earned his Ph.D., seeking employment right now.

(contact him at mohaidat@wayne.edu) or get in touch with me.)

My new contact info:
rehse@uwindsor.ca
519-253-3000, x2656

Thank you.