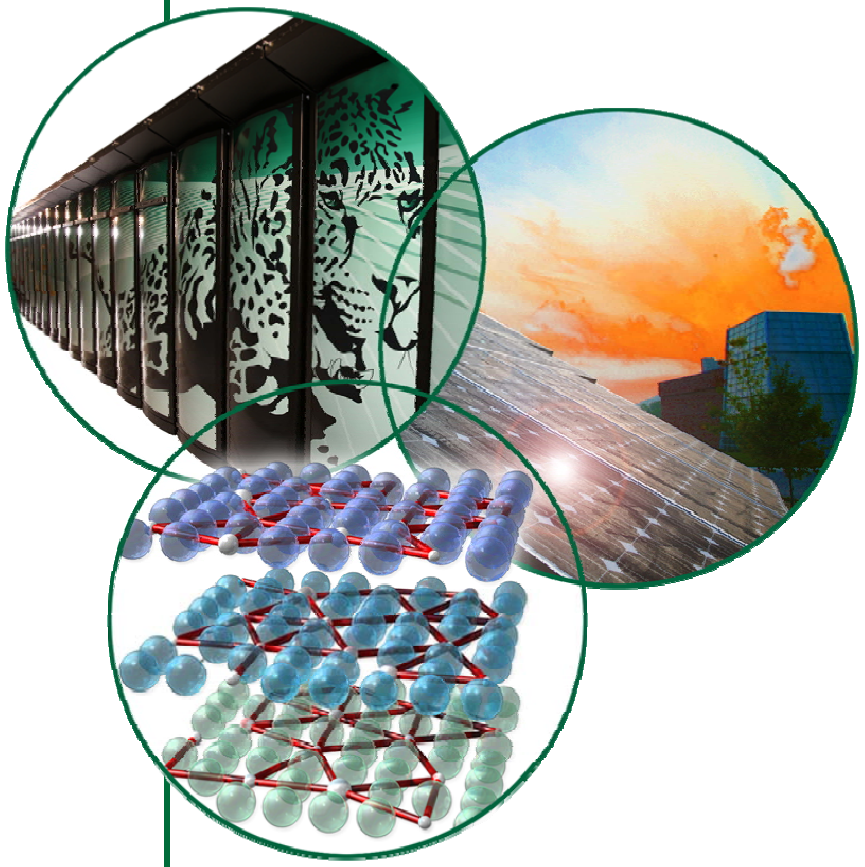
Grand challenges in food safety: full G-U-I engagement needed

A personal perspective from a National Laboratory

Robert F. Standaert

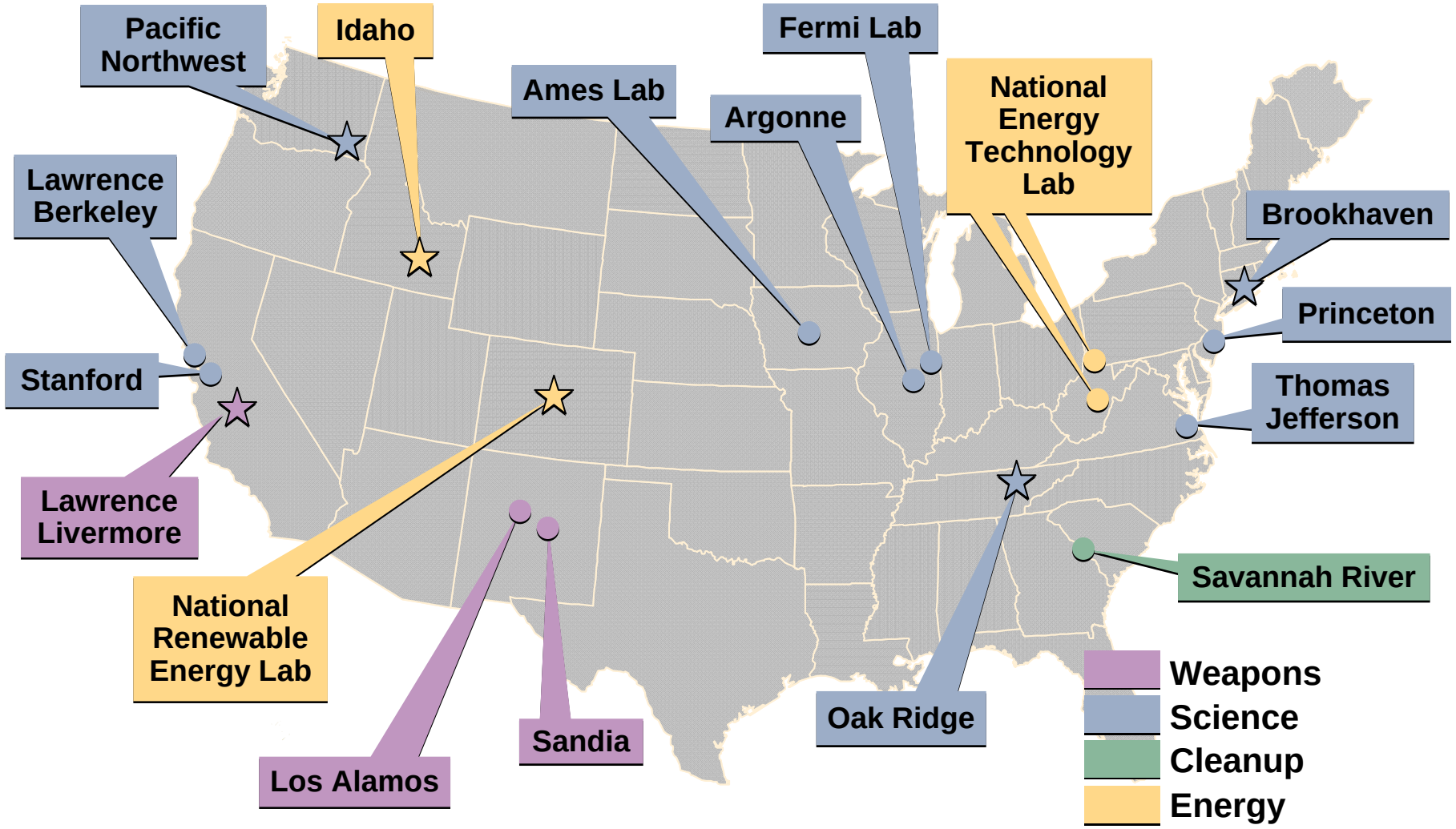
Biosciences Research Staff



U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

The Department of Energy's national laboratories:
A comprehensive R&D system



Oak Ridge National Laboratory

Oak Ridge National Laboratory

DOE's largest multi-purpose science laboratory

- **Microbiology, systems biology and plant biology**
- **Analytical, environmental and forensic chemistry**
- **Sensors, imaging and robotics**
- **Advanced hard and soft materials**
- **Nanoscience**
- **Transportation analysis and GIS**
- **Supply chain security**
- **National Security**
- **Ultrascale Computing**
- **Neutron Science**

Challenge:

Can these assets be engaged for food safety?

Food safety:
A multi-disciplinary, (inter)national challenge

Theses:

Food safety is a big and growing national concern.

New analytical technologies for food safety are needed.

- **Faster, cheaper, more sensitive**
- **Field- or factory-deployable**

The food matrix poses a daunting problem for analysis.

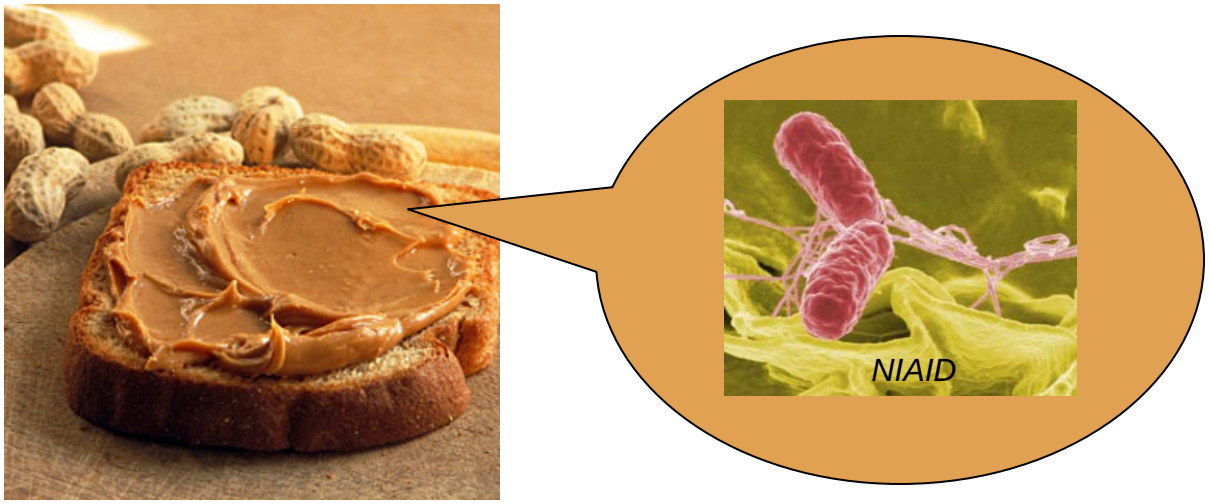
The global supply chain poses a daunting problem for safety and security.

The analytical and supply chain challenges have parallels elsewhere.

National Labs have developed applicable technologies and capabilities through projects for DOE, DOD, DHS, HHS and others.

Key stakeholders from G-U-I sectors are not aligned, mutually informed and engaged to take on the grand challenges!

Example 1: Bacteria in a complex matrix



Scientific American

A grand challenge!

Parallel:
Bioenergy and Systems Biology

Goal:

Improve isolation and cultivation technologies to characterize bacterial communities

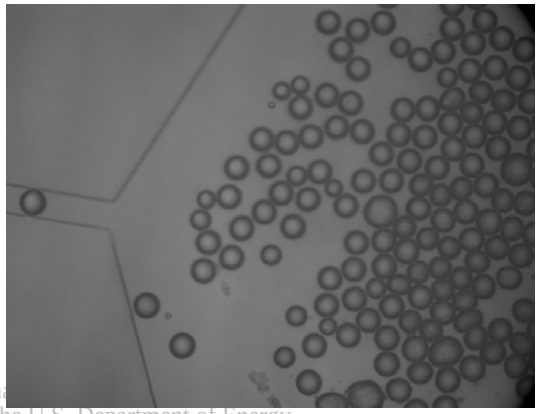
Approach:

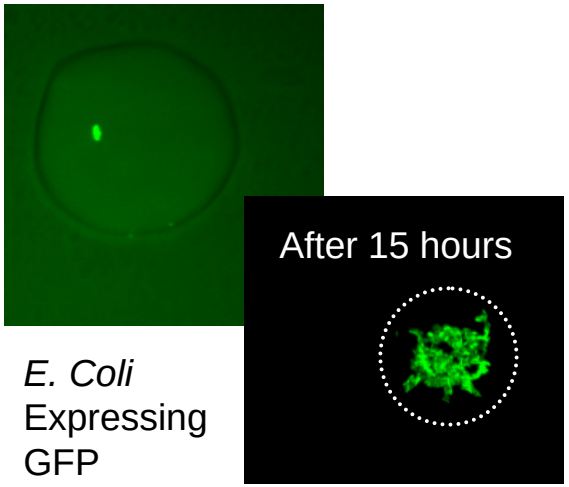
- **Develop microfluidic methods to capture, encapsulate, sort, selectively release, and characterize microbes**
- **Use these methods to cultivate microbes from specific environments and identify the consortium constituents**

Team:

- **Multidisciplinary group of microbiologists, biochemists and engineers**
- **Leaders: Martin Keller and Mitch Doktycz**

Microfluidically generated alginate beads



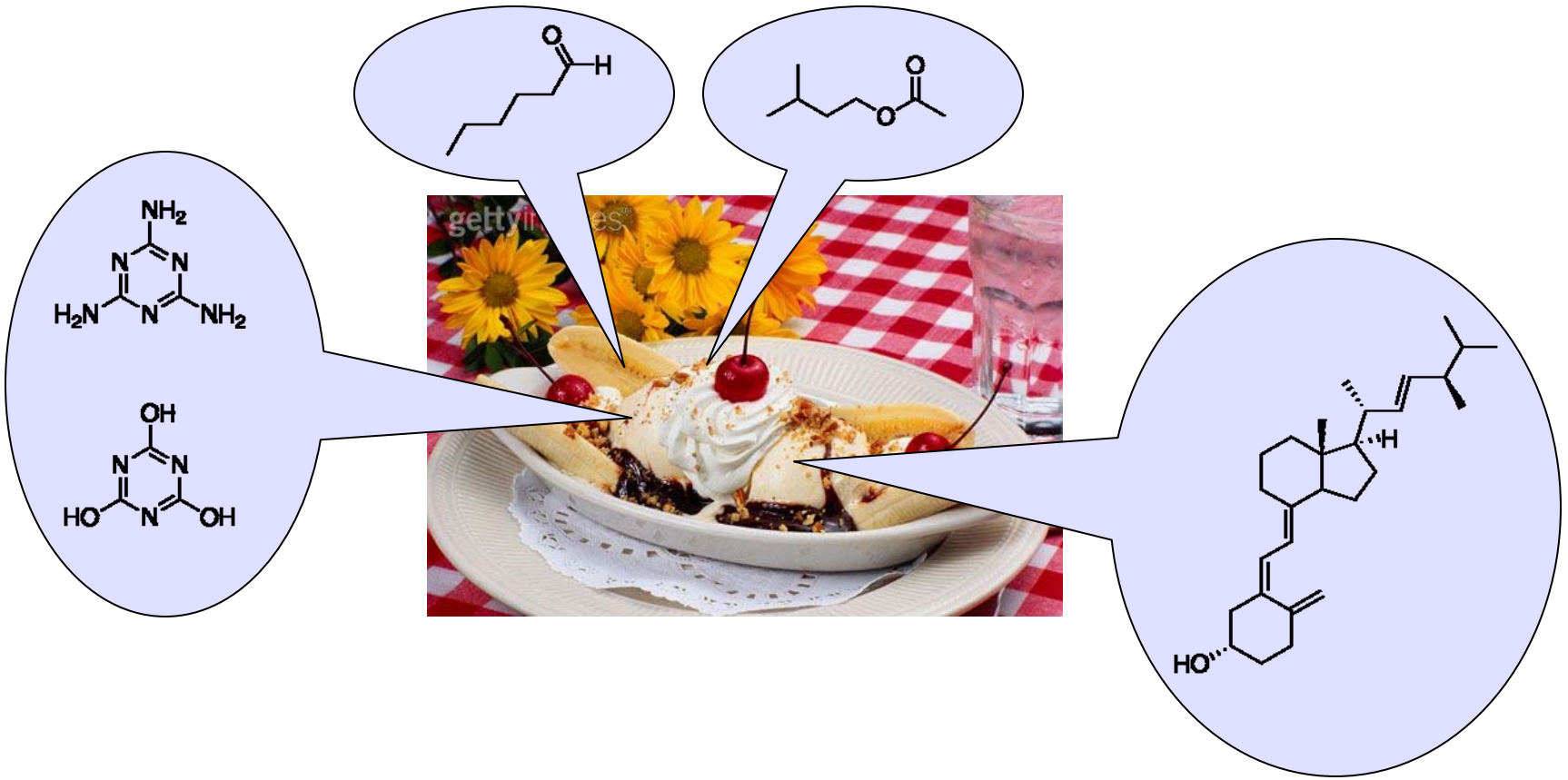


E. Coli Expressing GFP

Downstream Functions

- Media exchange
- Labeling
- Flow cytometry
- Electroosmotic sorting
- Metabolic assays
- Cell lysis
- Genome amplification
- More!

Example 2: Direct analysis of small molecules in a complex matrix



A grand challenge!

Parallel: Environmental analysis

Goal:

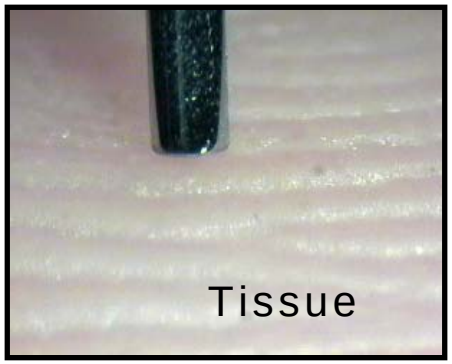
Rapidly detect substances of interest with little or no sample preparation

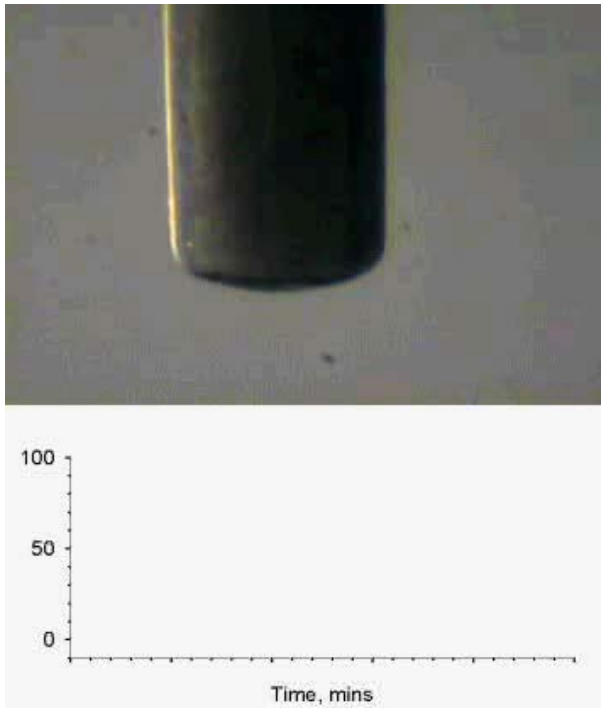
Approach:

Self-aspirating probe for ambient analysis on a variety of surfaces

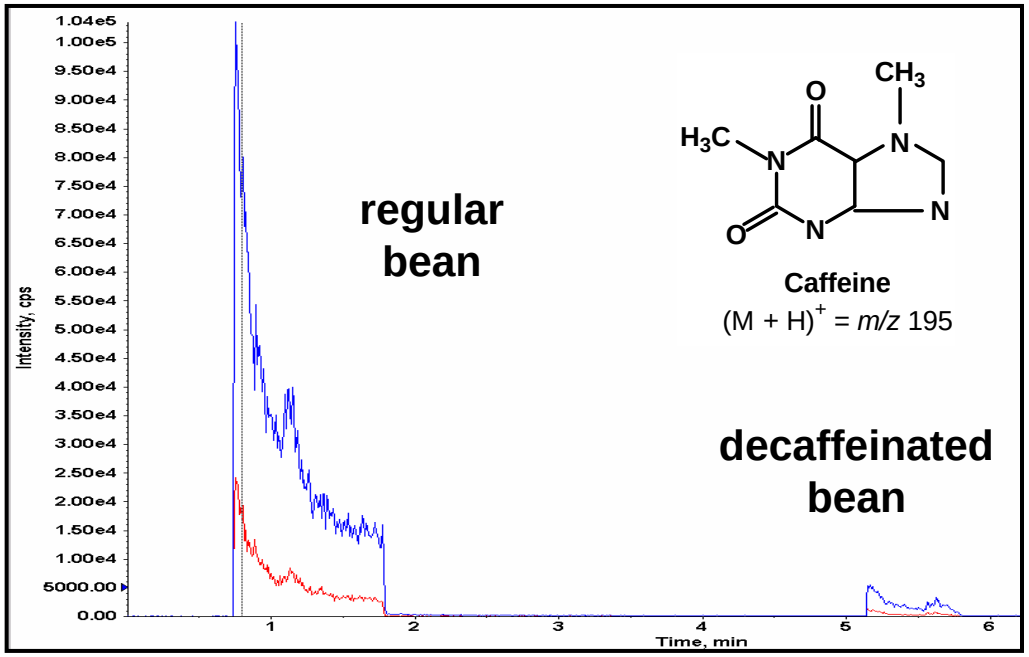
Team:

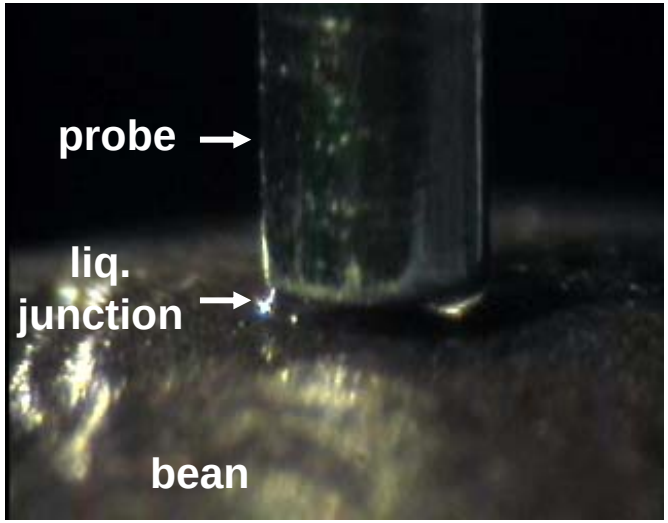
- **Leader: Gary van Berkel**





Detection of caffeine in coffee beans





Gary van Berkel

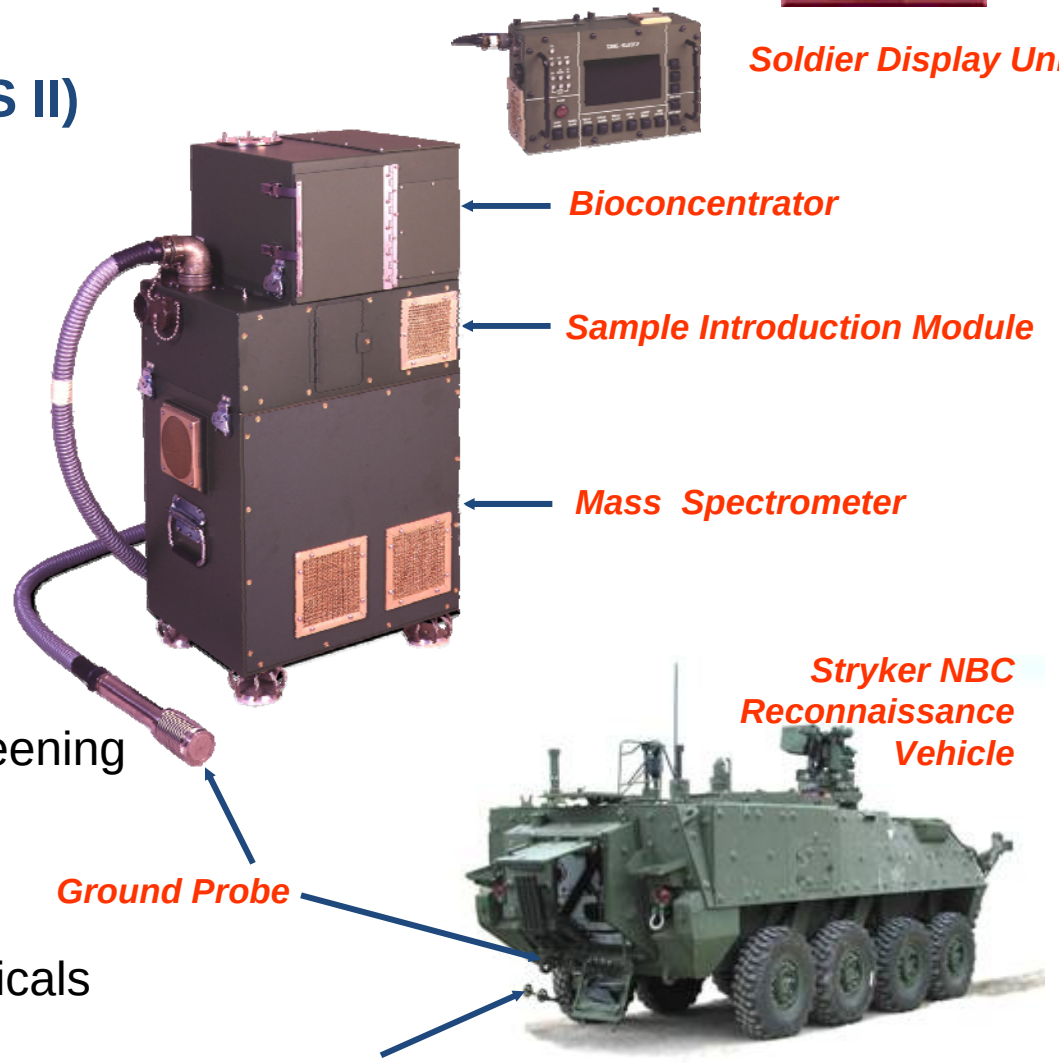
Fieldable analytical technologies
Parallel: military CBWA detection

Chemical Biological Mass Spectrometer Block II (CBMS II)

- Chemical Warfare Agents
- Toxic Industrial Chemicals
- Biological Agents

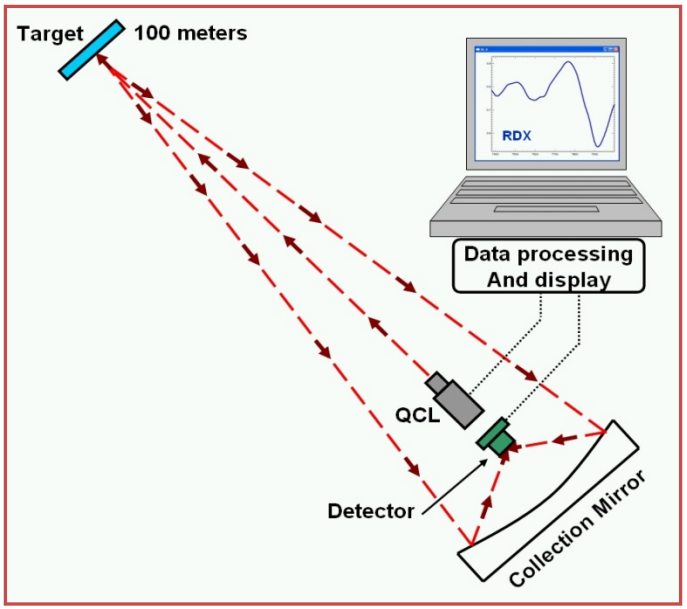
Important features for food safety applications:

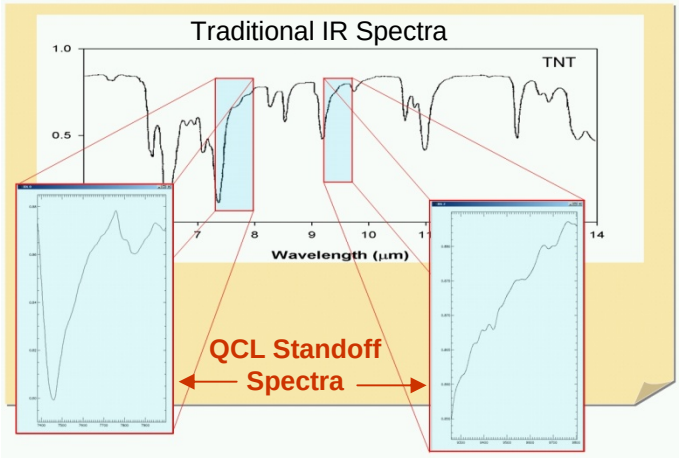
- Rapid response (15–30s)
- Little or no sample prep
- Can detect trace chemicals in a complex matrix
- Can be used as a broad screening method similar to NIR or an electronic nose
- Can be used to detect and identify specific target chemicals
- Operated by ***non-experts***



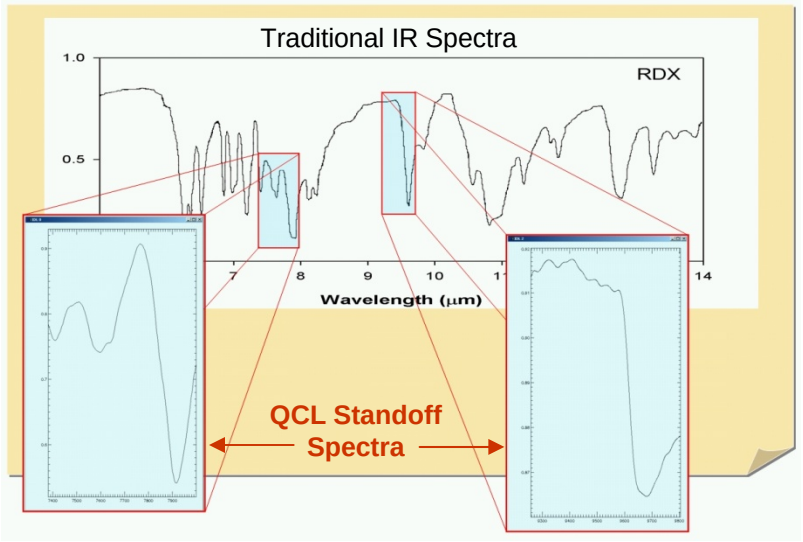
Marc Wise and Kevin Hart

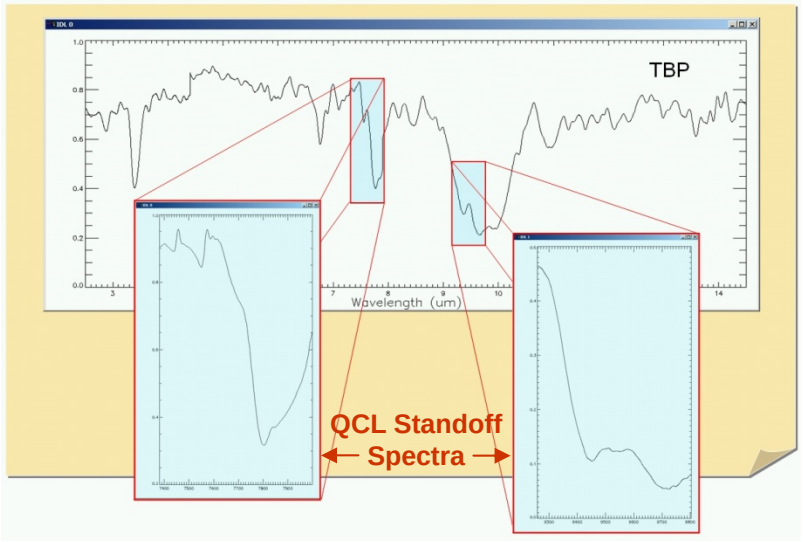
Standoff photo-acoustic spectroscopy





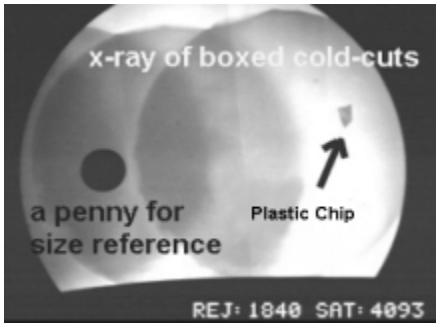
- **Standoff Detection of CB&E compounds at 100m**
- **Mid-IR Molecular Fingerprint Region**
- **Eye-Safe Quantum Cascade Laser**
- **LOD of 100 ng/cm^2**
- **Compact Low power consumption System**

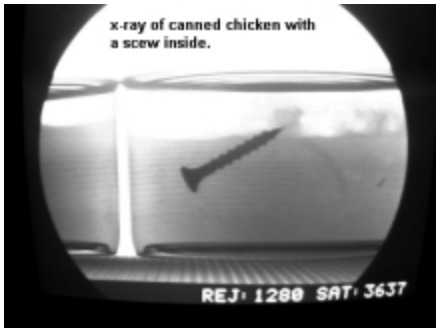


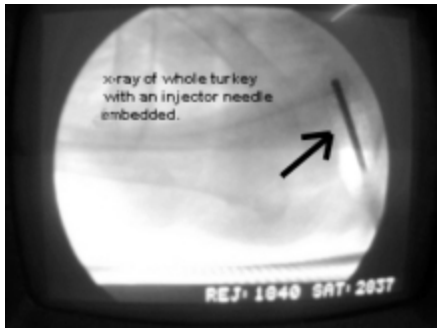


Thomas Thundat

Example 3:
Non-metallic object detection







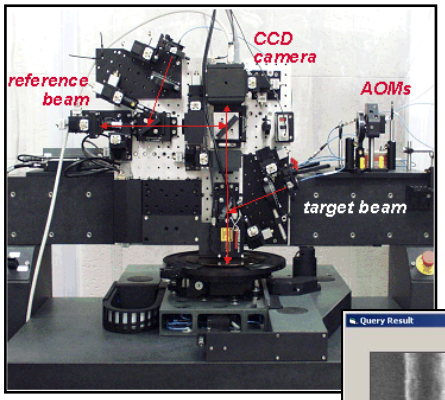
Atlas Inspection

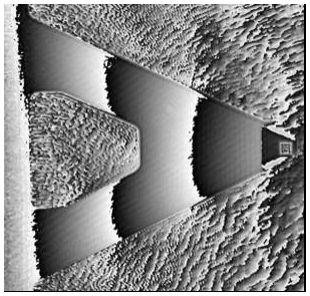
A Grand Challenge!

Parallels:
Biomedical and Industrial Imaging

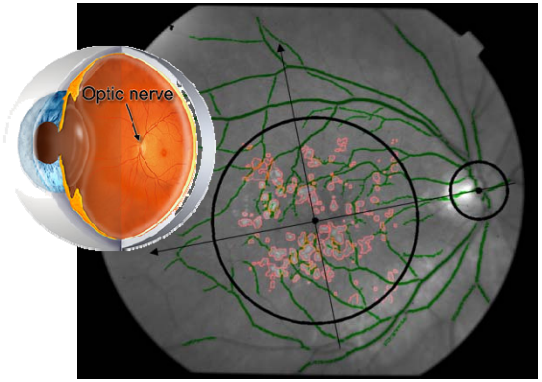
Micro CT Imaging and Visualization

Holography for MEMS Inspection

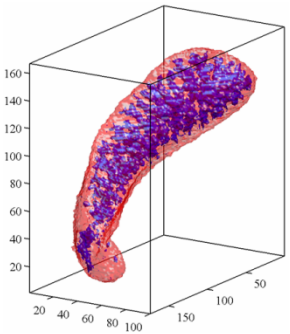




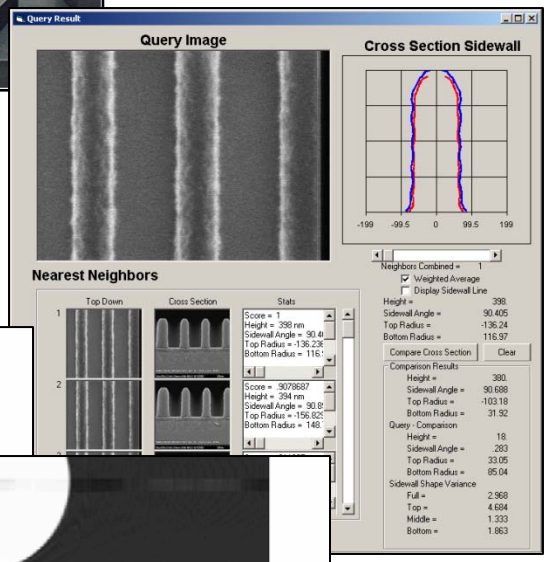
Retinal Diagnostics

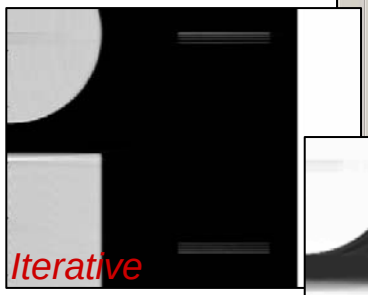


Organ Segmentation



Sidewall shape metrology





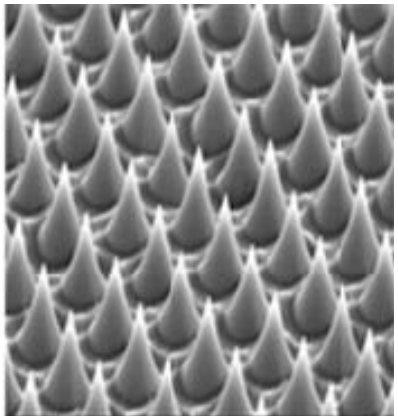
Industrial X-ray Tomography

Tim McIntyre and Shaun Gleason

Out of the box…
Ten year horizon, full peripheral vision

Super-hydrophobic Surfaces (John Simpson)

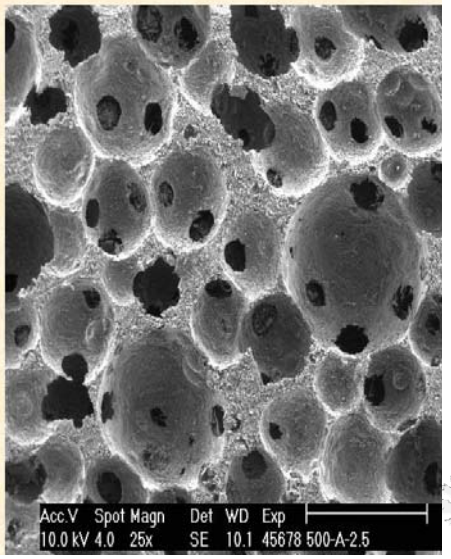




Graphite foam (James Klett)

- 11 patents, 15 pending, 2000 R&D 100 Award Winner

- Highly ordered graphitic ligaments
  - Graphite-like properties
  - As thermally conductive as aluminum, at 1/5th the weight
  - λ up to 180 W/mK
- Dimensionally stable
  - low CTE - ~2 - 4 μin/in/°C
- Open porosity
  - Permeable to fluids
- Excellent thermal management material



All I'm saying is now is the time to develop the technology to deflect an asteroid.

Frank Cotham
New Yorker
1998