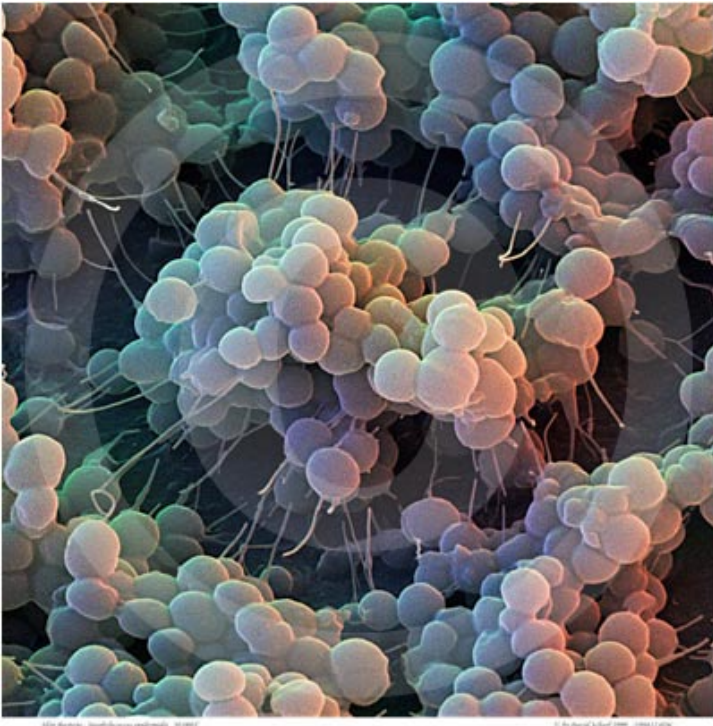


From lasers to the tricorder: The future of pathogen identification

***presented at the 2012 CSWA annual Meeting
Monday, June 4th, 2012***

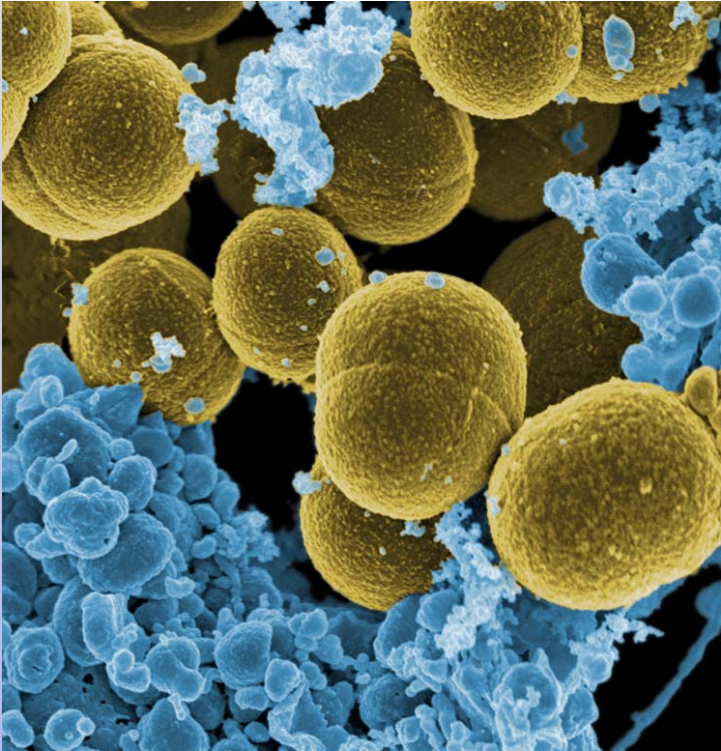
Steven J. Rehse

***The University of Windsor
Department of Physics***

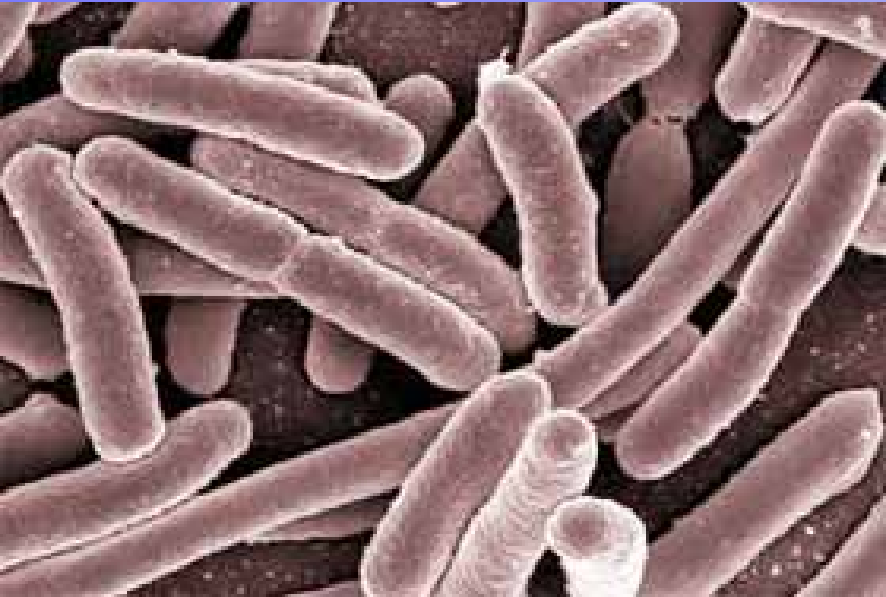


Staph. aureus

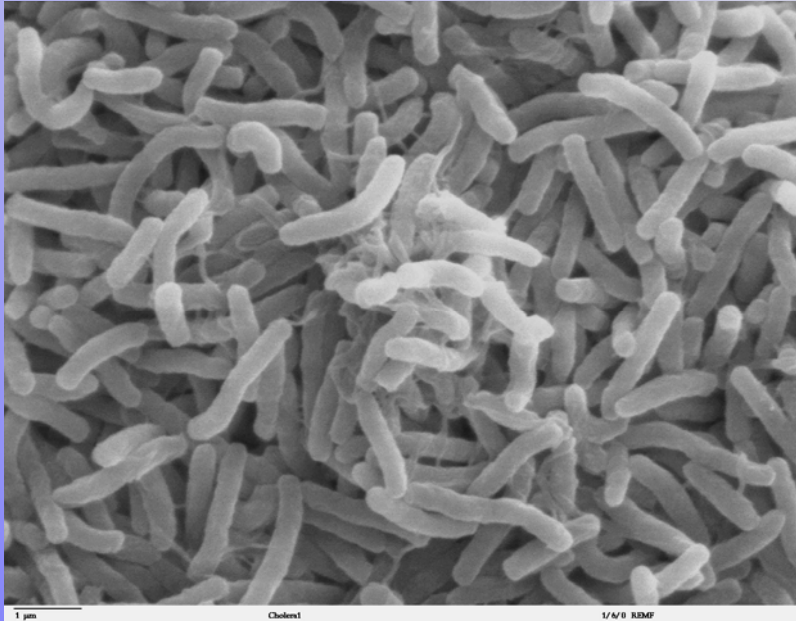
Staph. epidermidis



E. coli



V. cholerae



10x more bacterial cells in your
body than “human” cells!

updated 9:31 a.m. EST, Mon March 2, 2009

Antibiotic-resistant infections among children on the rise



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E. coli kills Idaho toddler; spinach plant probed

Updated 10/5/2006 8:57 PM ET



updated 12:52 p.m. EDT, Sun August 24, 2008

Canada links Toronto plant to deadly listeriosis outbreak

December 8, 2003

Staph Infection Kills Football Player

By Norm Jones, Newswatch 16, Scranton, PA

E-mail | Save | F

Denver News

CU's Nobel Prize Winner Loses Arm To Flesh-Eating Bacteria

Eric Cornell Remains In Critical Condition

The New York Times

Peanut Product Recall Grows in Salmonella Scare

GARDINER HARRIS
Published: January 28, 2009



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CDC: 756 ill from salmonella-tainted tomatoes

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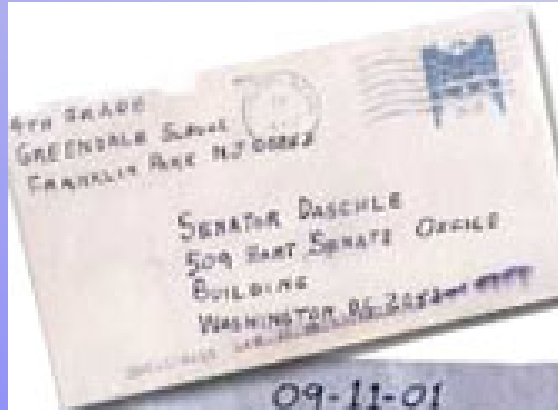
New superbugs emerge in U.K., Asia

Canadian cases reported in Vancouver, Alberta

Last Updated: Sunday, August 15, 2010 | 10:18 PM ET Comments 447
CBC News



Salmonella bacteria have identified as S. enterica serotype Enteritidis, an enzyme that forms biofilms and is highly resistant to antibiotics, in 100 patients in the U.S., India and Pakistan. (CBC)



09-11-01
YOU CAN NOT STOP US.
WE HAVE THIS ANTHRAX.
YOU DIE NOW.
ARE YOU AFRAID?
DEATH TO AMERICA.
DEATH TO ISRAEL.
ALLAN IS GREAT.



MYSTERIOUS POWDER INVESTIGATED



NICK BRANCACCIO/The Windsor Star

A hazardous materials team with Windsor Fire Services take readings and samples from the contents of a recycling box at the Transit Windsor garage located beside the Essex-Windsor Solid Waste Authority Central Avenue transfer station on Tuesday. Windsor police, fire and ambulance personnel descended on the garage on North Service Road Tuesday after an employee discovered white powder inside a pencil case that had been left behind on a bus. Police said an employee found the pencil case while cleaning the bus. Just after 4 p.m., two firefighters donned white hazmat suits, rubber boots, oxygen tanks and masks to prepare to handle the material. The workers sifted through the found objects and took samples of the powder to be examined by police. Police have not yet determined the origin or makeup of the powder. It has been taken to a laboratory in Etobicoke for testing.

'Suspicious Powder' Scare Empties Building In Downtown Windsor

April 18, 2012. 8:03 am • Section: Downtown Windsor

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Firefighters and hazardous material specialists gather on Pitt Street West in response to a report of a suspicious white powder at the Canada Post building on Ouellette Avenue in Windsor, Ont. on April 18, 2012. (Nick Brancaccio / The Windsor Star)

The Reason? It's hard to ID a Pathogen



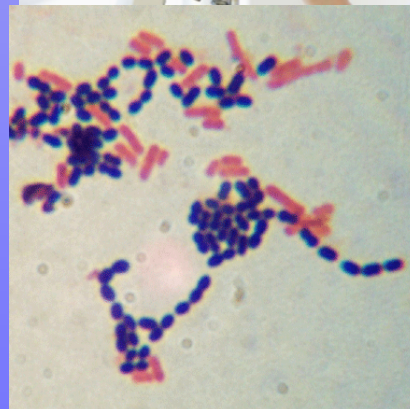
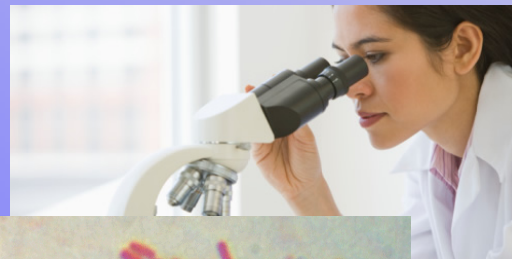
Random samples
or
when illness appears



At least
24 – 72 hours



SCIENCEPHOTOLIBRARY



A trained professional
makes the diagnosis

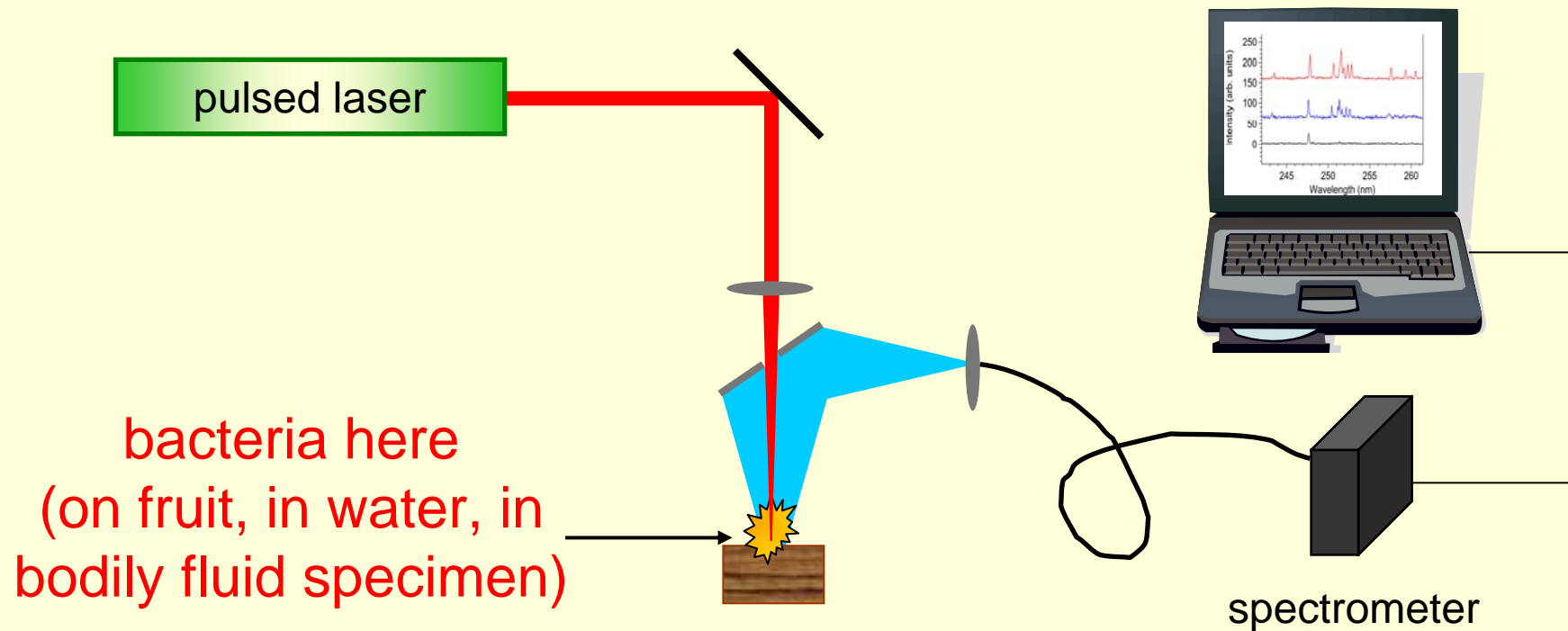
Our vision...an instantaneous diagnosis



DANGER!
pathogen
detected

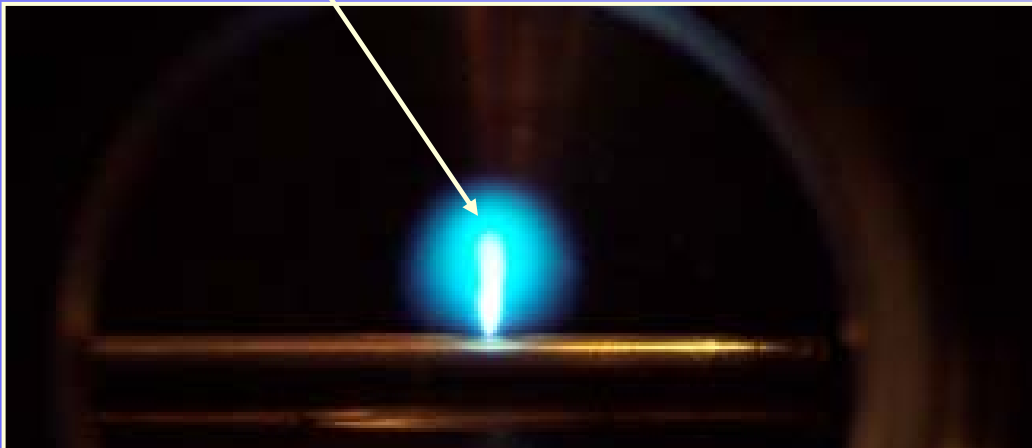
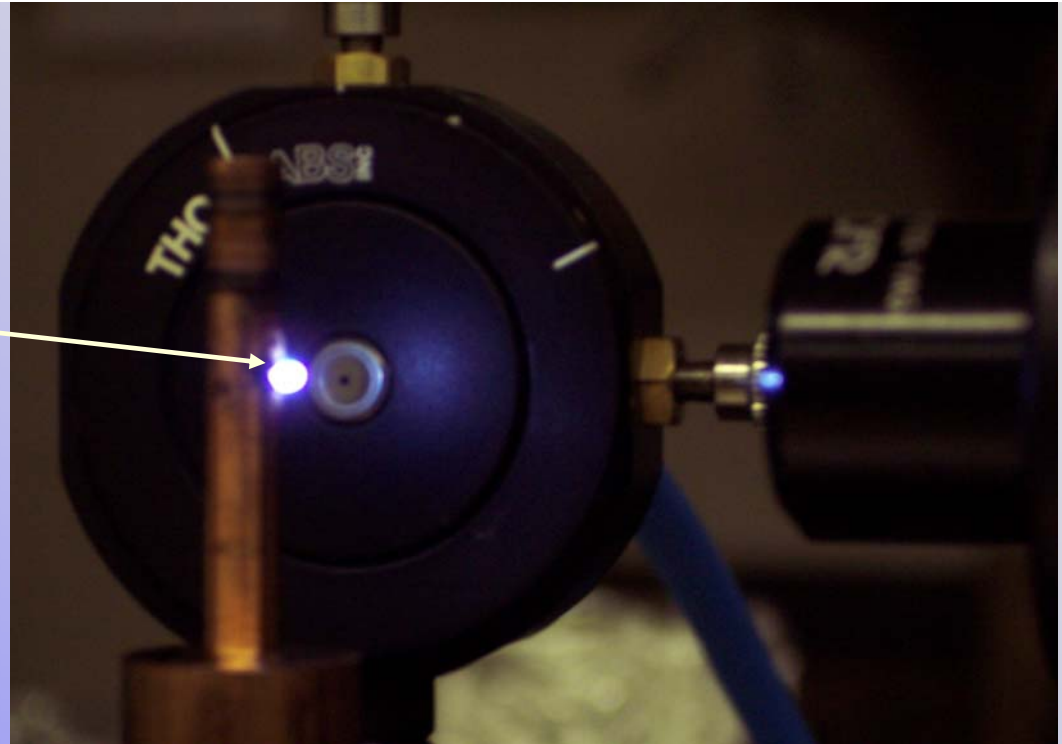


We're a long way away, but...
*Laser-Induced **B**reakdown **S**pectroscopy*



LIBS Spectrum is like a Bar Code: Unique for Each Sample
Entire procedure can take under one second!

The colors in the clearly visible high temperature plasma...



...tell us what kind of atoms are present in the target (including bacteria) and how many atoms.

A “spectral” fingerprint!

LIBS is currently being investigated for...

rapid identification of:

chemical threats }
explosive threats } US Army
biological threats } ME!

rapid sample analysis/quality assurance in:

factories (glass, alloys) }
nuclear facilities } private industry
recycling facilities } government agencies

and many more things...!

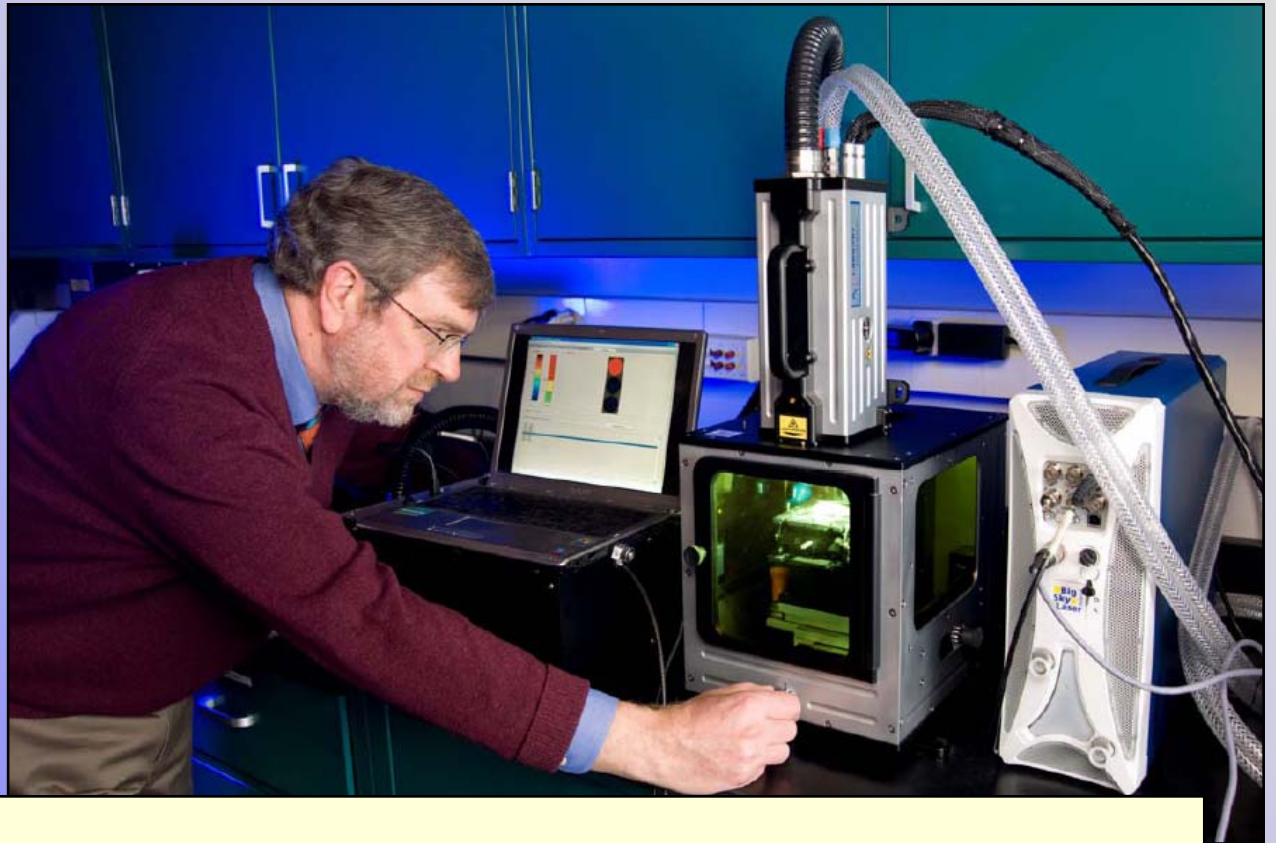
All experiments have demonstrated that LIBS is a potentially very powerful modality for pathogen identification...

...the hardware is being developed to exploit this potential.

Field portable

Applied Photonics
hand-held field
portable unit.





Into the Lab!

We are communicating with other entities, (private companies, the Army Research Laboratory) to develop standardized equipment for testing in laboratories, emergency rooms, corporate quality control labs, diagnostic labs, etc. Here Dr. Andrzej Miziolek of ARL is shown testing a sample with their Applied Photonics prototype apparatus.

First responder CBRNE prototypes have been built...

Backpack contains broadband high-resolution spectrometer, laser power supply, computer, and battery



Head's-up display

Hand-held probe contains laser, joystick for control, and focus optics

Microplasma/
LIBS Event

courtesy of Ocean Optics.

First responder CBRNE prototypes have been built...





the new “Mars Science Laboratory” (MSL), Mars Rover “**Curiosity**”, blasted off for Mars on Nov. 25th, 2011

<http://mars.jpl.nasa.gov/msl/>



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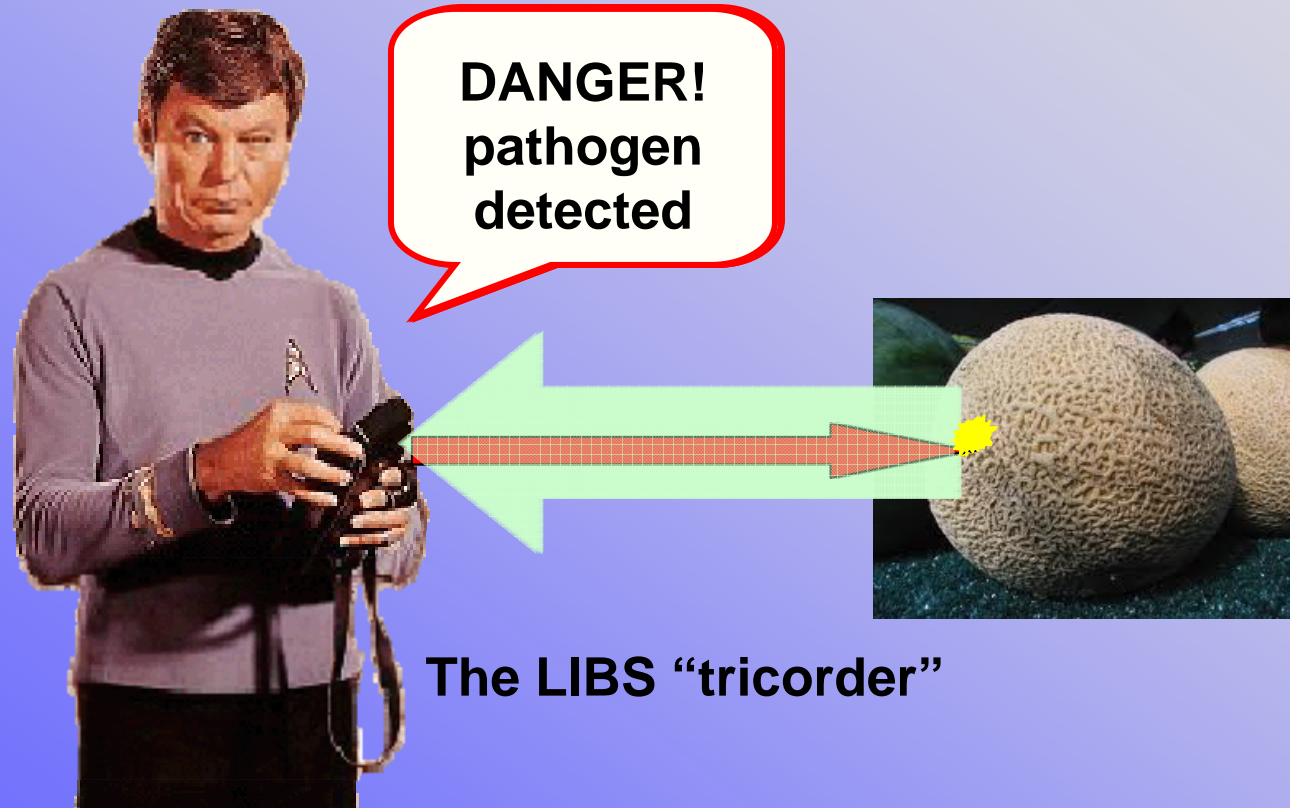
New Lasers Fight Crime, Martians

By Alexis Madrigal February 16, 2010 | 6:26 pm | Categories: Physics, Space

Jean-Luc LACOUR / 2004 (C&A)

A new technique that uses a laser to vaporize materials like rocks and steel to analyze their chemical composition is finding new applications from Mars to forensics.

Results have been very encouraging,
so we are on our way!



The LIBS "tricorder"

Thank you so much for your attention!

Questions?

Table 1. Demonstrated LIBS capabilities with relevance to medical applications and specific potential future medical applications.

Demonstrated LIBS capability....	...can lead to this capability....	...which could be applied in these medical applications
<p>delivery of laser pulses & collection of plasma emission through optical fibre</p> <p>spectra obtained underwater (via fibre coupling) and in high-pressure environments</p> <p>differentiation of malignant / healthy tissues & classification of different malignancies</p> <p>elemental analysis of calcified tissues ("stones")</p> <p>elemental analysis of bone/tooth tissue; discrimination of dental caries from healthy tissue</p> <p>sensitivity to all heavy metals (e.g. lead, chromium) and sensitive detection of metals in human tissue and surrogates</p>	<p>LIBS <i>in vivo</i> analysis of tissue for real-time analysis</p>	<p><i>in vivo</i> or <i>in vitro</i> "optical biopsies" (discrimination of cancerous / malignant / pre-cancerous tissues)</p> <p><i>in vivo</i> identification of ulcerated tissue</p> <p><i>in vivo</i> stone analysis</p> <p>real-time (during procedure) identification of dental caries tissue</p> <p><i>in vivo</i> measurement of heavy metal concentrations in tissues with high-spatial resolution (i.e. in different parts of bone, in joints, in different regions of liver, etc.)</p>
<p>rapid bacterial identification based on elemental composition</p> <p>rapid discrimination of closely-related bacterial strains</p> <p>enhancement of specificity/sensitivity using LIBS/Raman fusion</p> <p>enhancement of LIBS specificity by multi-element tagging of macromolecules</p>	<p>real-time diagnosis of pathogen presence in human fluids (blood, urine, CSF, sputum)</p>	<p>autonomous (no expertise required) identification of bacteria in human fluid specimen</p> <p>rapid screening for MRSA infections in hospital</p> <p>real-time meningitis test</p> <p>rapid strain-classification for epidemic control in hospitals/other</p> <p>on-line sensing of water for purity/contamination monitoring</p> <p>screening of asymptomatic persons via swab or saliva contribution for early infection detection (e.g. airport screening)</p> <p>monitoring of surface contamination for hygiene compliance</p> <p>office based UTI test</p> <p>remote operation (i.e. on a medical robot) for real-time patient analysis in hostile / battlefield environments</p>