3.5 Portable Multicontaminant Detection Instrument for D&D

James R. Butz (**james.butz@adatech.com;** 303.874.8276)
Patrick D. French (**patrick.french@adatech.com;** 303.874.8275)
Clifton H. Brown (**cliff.brown@adatech.com;** 303.792.5615)
ADA Technologies, Inc.
8100 Shaffer Parkway, Suite 130
Littleton, CO 80127

Abstract

At Department of Energy sites (especially closure sites such as the Rocky Flats Environmental Technology Site), hundreds of structures comprising millions of square feet must be demolished and removed. Current clean-up efforts of retired facilities are hampered by an inability to quickly assess various contamination types. The cost, schedule, Environmental Safety and Health (ES&H), and health physics aspects of the Decontamination and Decommissioning (D&D) activities are all driven by the extent to which the facility is contaminated with radionuclides, Resource Conservation and Recovery Act (RCRA) heavy metals, and Toxic Substances Control Act (TSCA) organics. In a Phase I SBIR project, ADA Technologies is planning to demonstrate the use of Laser-Induced Breakdown Spectroscopy (LIBS) technology for identification of contaminants at D&D sites. The instrument will be designed to fit into confined or tight spaces, such as tanks, pipes, and ductwork, to quickly and effectively detect elements of interest. As envisioned, this device will enable environmental experts to match the ES&H/Health Physics approach to D&D with the actual need for the space being treated.

The planned instrument is a qualitative analysis device that can be maneuvered into difficult-to-access locations to determine the nature and levels of contamination prior to actual D&D activities. In the Phase I contract effort, DA will design, fabricate, and test a compact sample probe suitable for D&D work that will easily fit into a pipe or small duct to demonstrate that the necessary elements for this system can be integrated into a sufficiently small package. An existing LIBS instrument built by ADA on a previous contract will be used to make minimum detection limit determinations for each of the key elements including candidate metals (Cr, Be, Pb, Sb, Ba, Cd, Ni, Se, Ag, Tl, V, and Zn), and the non-radioactive isotopes of the typical radionuclides of interest (Co, Cs, U, Tc, Sr, Am). The samples will be placed on substrates likely to be encountered in D&D applications (e.g., stainless steel, wood, drywall) with the expected interferents (e.g., machine oils, grease). At the completion of the Phase I effort, the feasibility of using a field-portable LIBS instrument as a

The proposed instrument will find wide application in D&D at DOE and DOD sites. The instrument will also have similar applications in civilian sector industries.

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Phase I SBIR Project

ADA Technologies, Inc.

Presentation Outline

- Introduction to ADA
- Problem and proposed solution
- Objective
- Approach
- LIBS technology
- Task description
- Schedule

ADA Technologies Overview

- 25-person company in Littleton, CO
- Goal is to leverage government-funded R & D programs to develop pollution control solutions for commercial markets
- Current focus on Hg measurement/control, instrument and software development

Staff & Strategic Relationships

- Currently have 25 employees
  - 6 Ph.D.'s, multiple advanced degrees
  - chemists; physicists; chemical, mechanical, and electrical engineers; technicians
- Use consultants from around the country as needed on special projects.
- Have forged alliances with large and small businesses, universities, and government labs

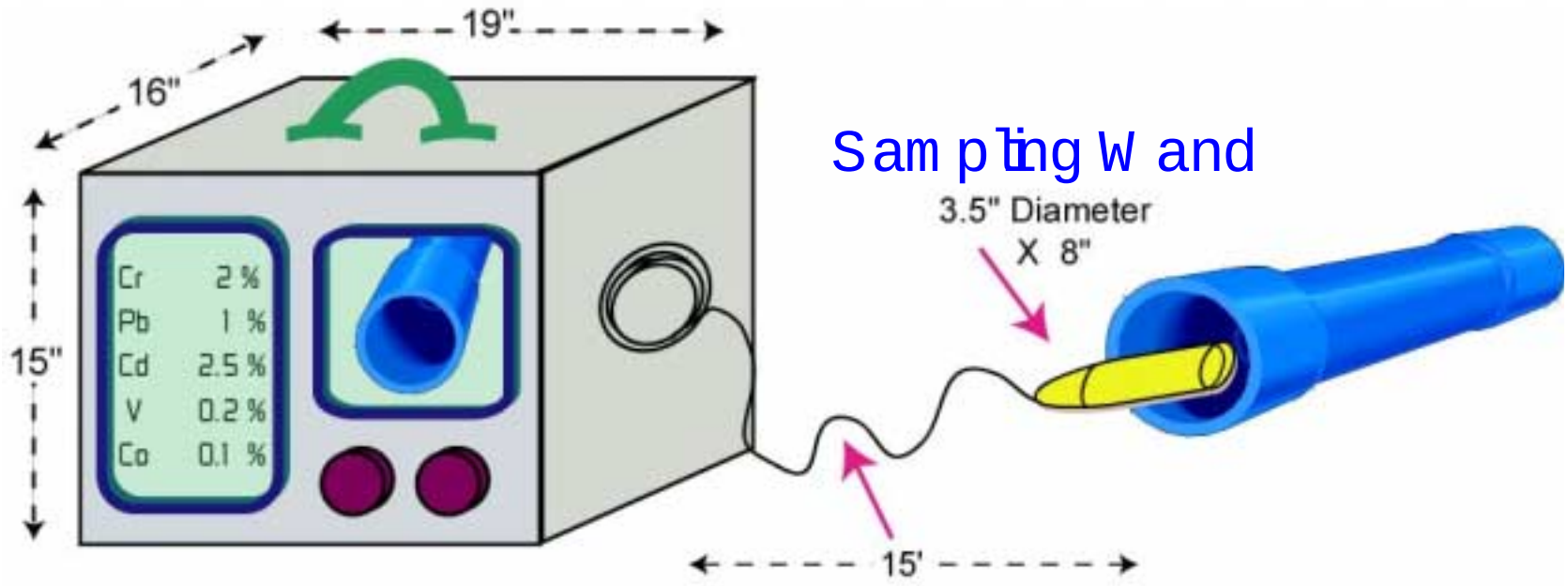
Problem

- In D&D operations, required cleanup technology is a function of contaminants encountered
- Rate of cleanup dramatically affected by selected technology
- Ability to quickly characterize enclosed and tight spaces would improve efficiency of D&D operations

Objective

- Adapt a LIBS analyzer for use in confined spaces to identify local contaminants
  - Design compact sampling wand to permit use in tight spaces
  - Add video capability to view target deposits
- Use information to select appropriate PPE and cleanup technologies
- Reduce cleanup costs by matching technology and PPE to level of contamination

Concept



LIBS Enclosure with
Video and LIBS Readout

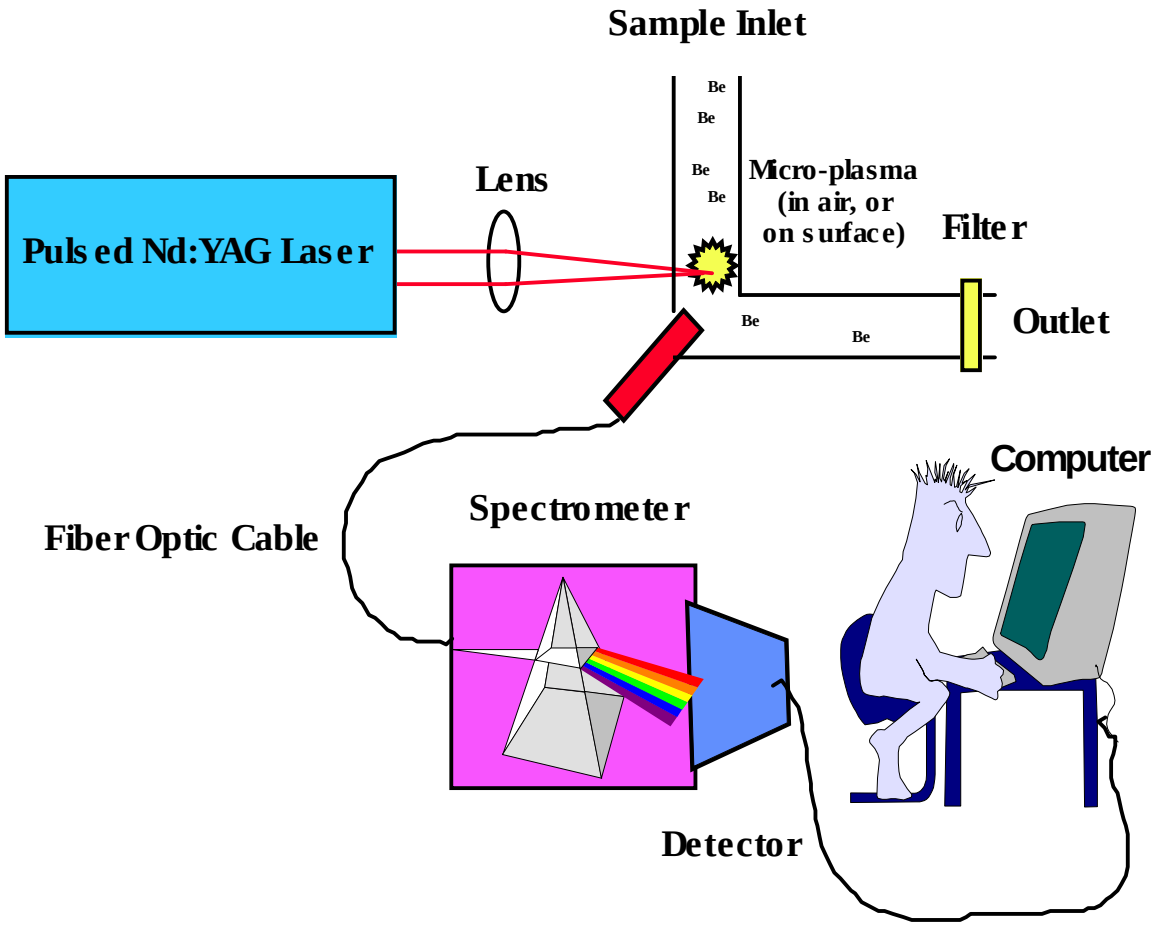
Approach

- Use laser-induced breakdown spectroscopy (LIBS) to identify contaminants
- Adapt existing LIBS instrument for use in Phase I
- Develop samples with variety of contaminants to evaluate use of LIBS
- Design custom sampling wand for access to tight spaces

LIBS Technology

- Use pulsed laser to generate microplasma from suspected contaminants
- Fiber optic pickup routes emissions to spectrographs
- Spectra acquired and analyzed to determine presence of contaminants
- Specialized techniques to extract signals of interest from noisy spectral data

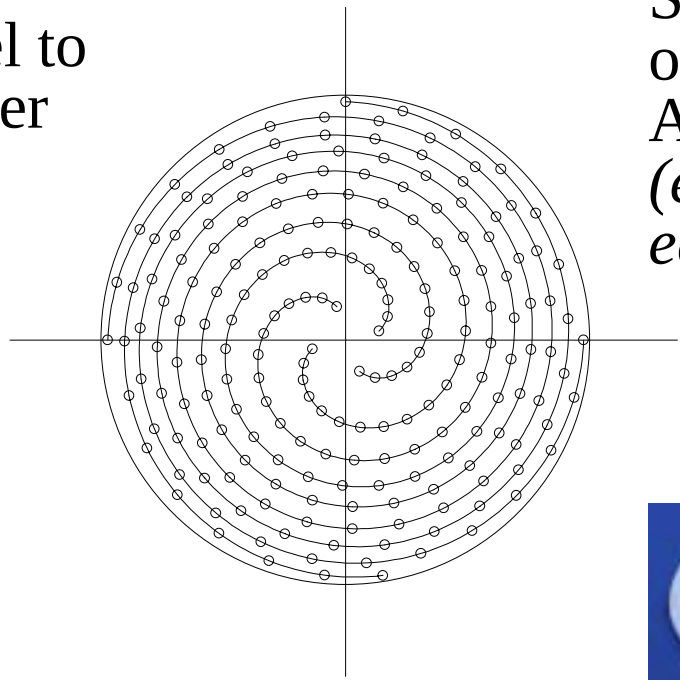
Schematic of LIBS Process



ADA LIBS Instrument

Sample Carousel

Sampling carousel to index sample under sampling wand



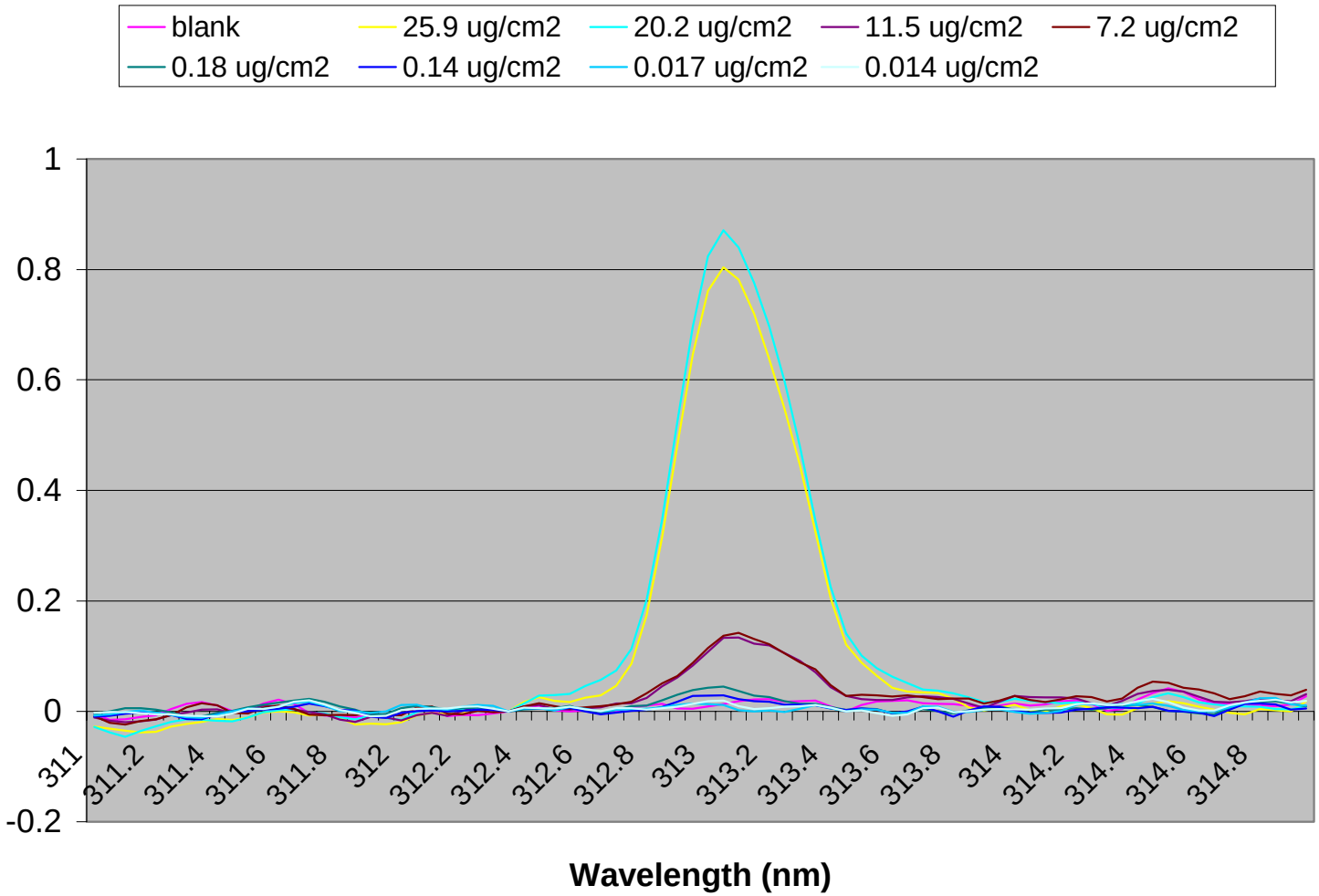
Sampling occurs on four interlocking Archimedes spirals *(each shot samples equal area)*

User selectable number of shots *(single dial)*

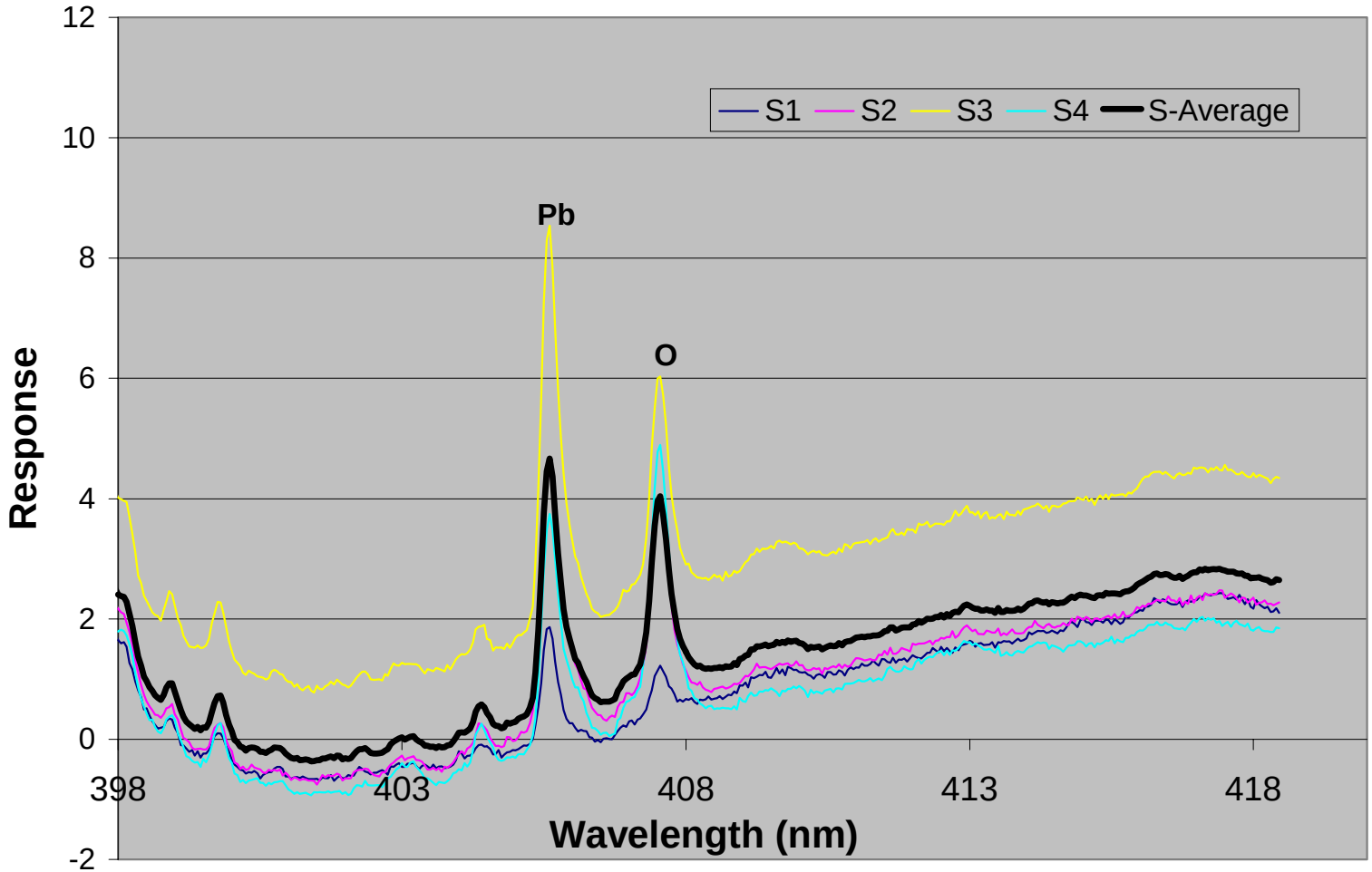
Carousel accommodates both soil samples and filter paper *(swipes)*

Sampling Carousel

LIBS Calibration Spectra: Be



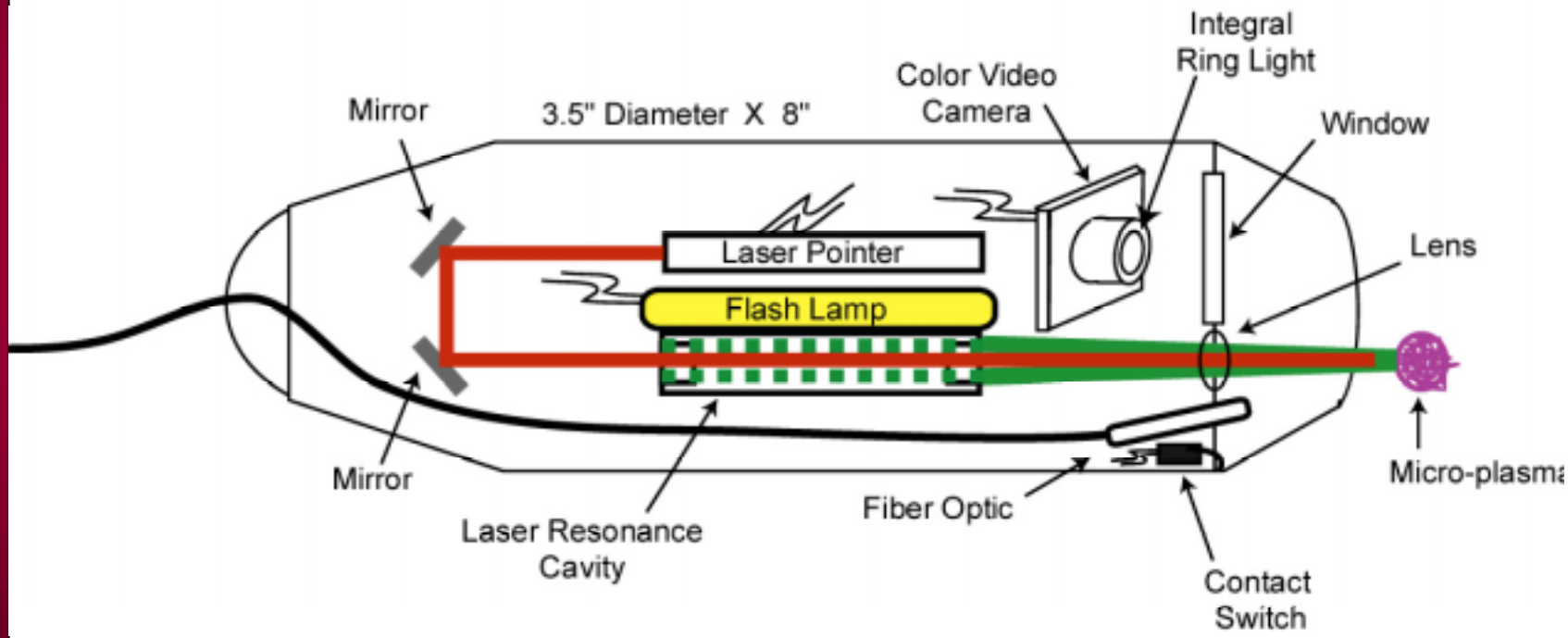
LIBS Field Test Spectra-Soil



Task Description

- Design and fabricate new sample probe
- Prepare contaminant samples for testing
- Use existing instrument and new probe to evaluate contaminant samples
- Calculate detection limits
- Prepare prototype design

Concept for New Sample Probe



Contaminant Elements of Interest

Cr	Ba	Ag	Co*	Sr*
Be	Cd	Tl	Cs*	Am*
Pb	Ni	V	U*	
Sb	Se	Zn	Tc*	

*Radionuclides

Substrates

Materials	Interferents
Stainless steel	Grease
Carbon steel	Machine Oil
Cast iron	Water
Wallboard	
Wood	

Test Procedure

- Characterize each contaminant at several concentrations with LIBS instrument
- Use results to show identification of multiple contaminants in blind samples
- demonstrate separation of spectra from multiple contaminants
- Also show detection on range of substrates

Schedule