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# Handheld LIBS Options for Beryllium Analysis

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# Disclaimer

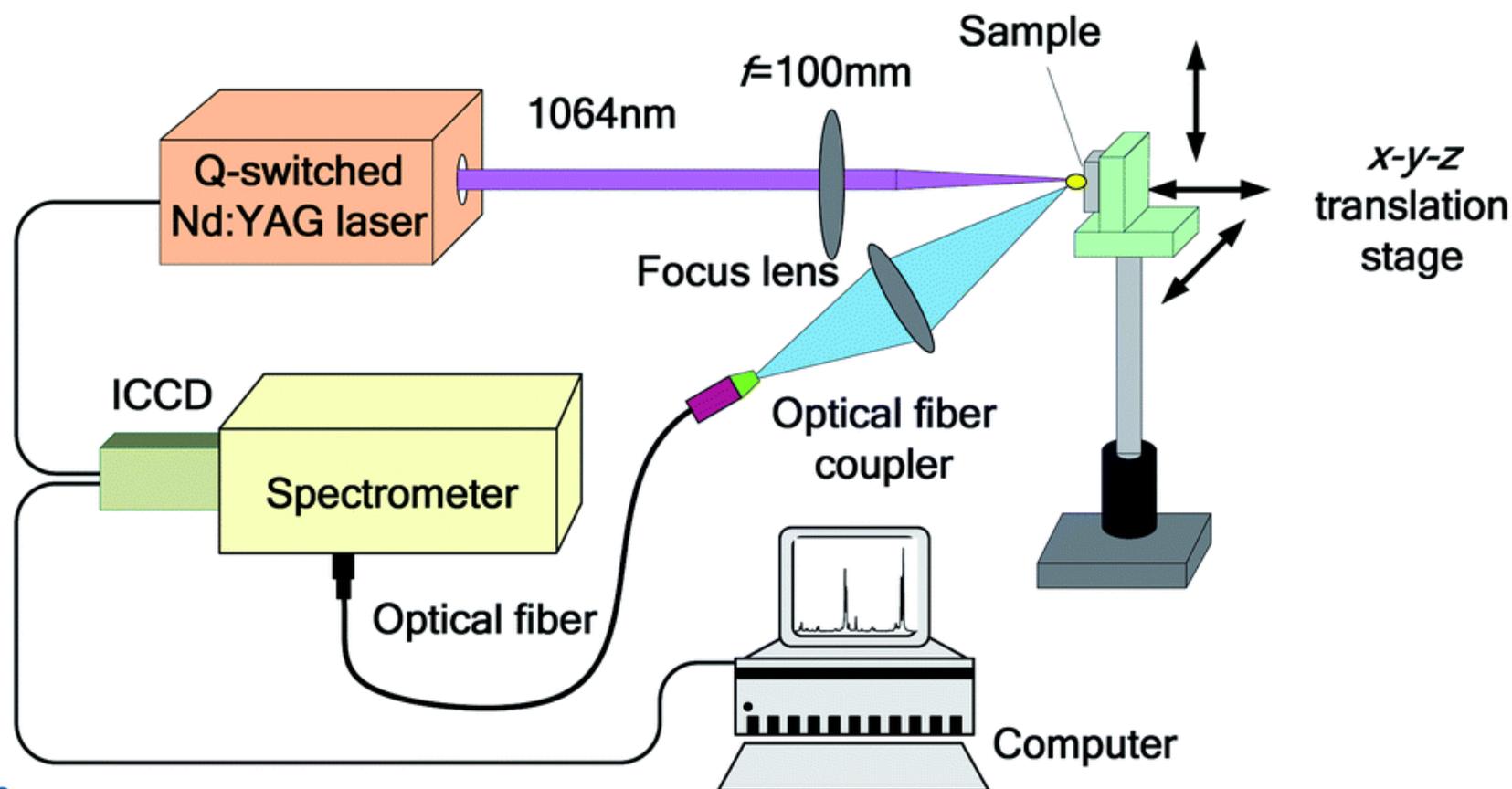
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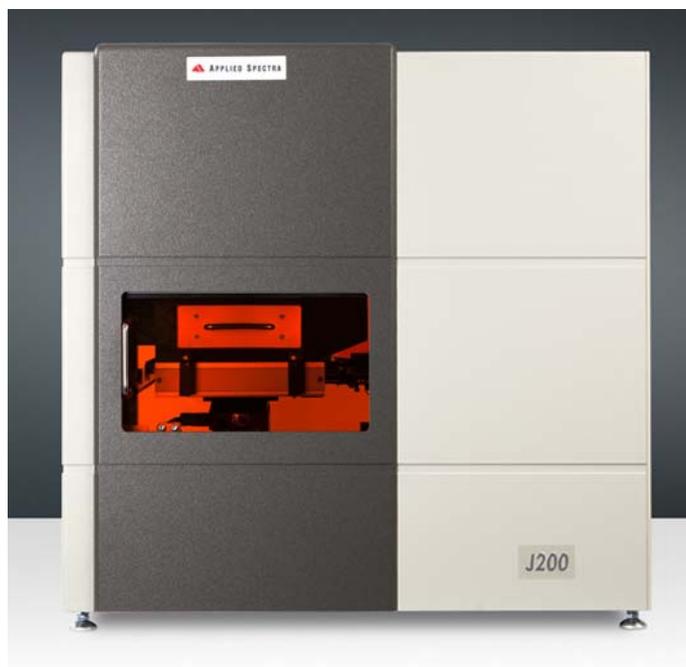
# What is LIBS?

## Laser-Induced Breakdown Spectroscopy (LIBS)



# Laboratory Instruments

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Not field portable, but sensitive, accurate, and precise.

# Self-Portable, but not Handheld

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*CREDIT: NASA/JPL-Caltech, Malin Space Science Systems, James Sorenson*

# Handheld Instruments

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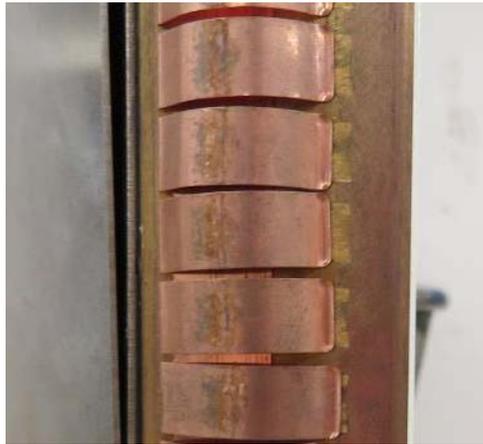
Multiple instruments available. They look cool!

# Typical Specifications

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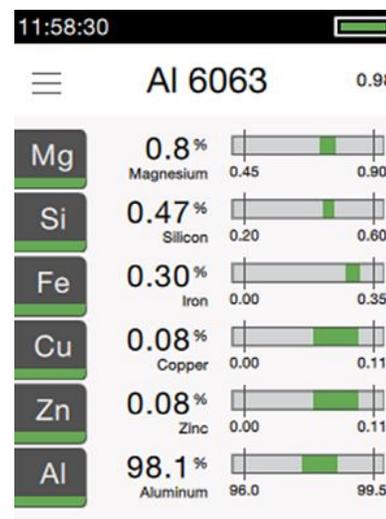
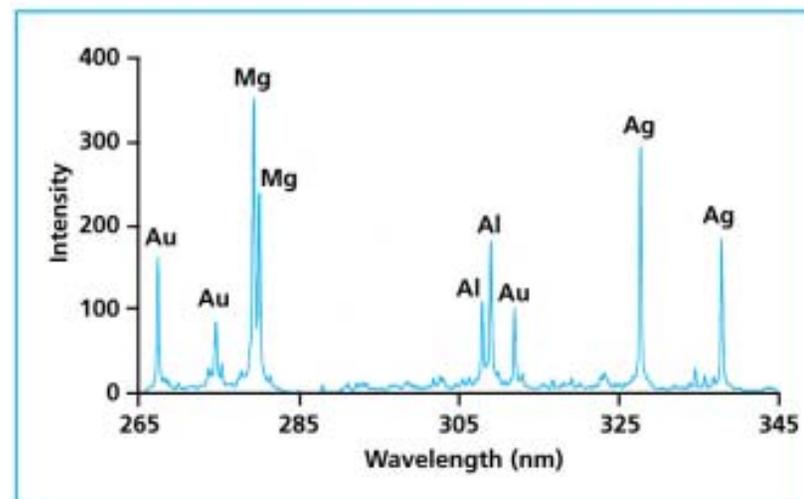
- Laser: 1532 nm or 1064 nm, 5 to 6 mJ, Class 1M to 3B
- Beam Size: 50 to 300 um spot
- Spectra: 170 to 860 nm wavelength
- Elements: Hydrogen to Uranium ( $Z = 1$  to 92)
- Sensitivity: 10 to 300 ppm (element and instrument dependent)
- Accuracy: 5% to 15%
- Response: 1 to 3 seconds per reading
- Battery Life: 4 to 12 hours
- Weight: 3 to 6 pounds
- Cost: \$35,000 to \$50,000
- Features: Argon purge to shield plasma; Camera to document samples; Assay and screening modes; Data software;

# ID of Metals: Be or Not Be, That is the Question



# LIBS Identification of Base Metals and Alloys

- Identification of elements is easy using X-axis spectral lines.
- Quantification of each element is difficult. Requires certified reference standards. Y-axis peak height has no meaning without reference standard.
- Libraries of known alloys are needed.
- Currently most manufacturers do not have libraries of spectra for beryllium containing alloys based on standard reference materials.
- Manufacturers inquired if DOE sites had certified reference standards for beryllium alloys.



# Surface Contamination Screening Problems

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- Laser beam spot that is analyzed is only 50 to 300  $\mu\text{m}$  in diameter. Our standard for surface contamination is  $100 \text{ cm}^2$ . Many orders of magnitude difference.
- Surface contamination is often unevenly distributed.
- Particle size influences measurement. A surface with larger particles might exceed the surface contamination limit, but less likely to get a “hit” with a few random samples. Might miss significant contamination.
- A random sample on a larger particle may indicate heavy contamination when the actual contamination is below the standard.

# Surface Contamination Screening Possibilities

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- Collect multiple, quick LIBS samples on surfaces as a preliminary screening method. May quickly and cheaply identify areas needing traditional surface wipe sampling.
- Concentrate the particles on a 100 cm<sup>2</sup> area down to a smaller area with a wipe sample. More chance of seeing beryllium with a few random checks on a small wipe filter.
- Bias LIBS sampling locations to those more likely to be contaminated.

## Current prognosis:

Preliminary handheld LIBS sampling of workplace surfaces may quickly identify areas with clear contamination, but cannot be used to determine that a surface is “clean”.

# Current Conditions

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- Handheld LIBS instruments can definitely be used to identify beryllium containing alloys, however, more work by instrument manufacturers is needed to develop libraries of beryllium alloys in order to quantify beryllium content.
- Handheld LIBS instruments have potential for quickly identifying areas with beryllium contamination, but may never be practical for determining that areas are “clean”.
- Increased demand due to an OSHA beryllium standard may drive research and development into improved instruments, well characterized beryllium spectral libraries, and lower cost instruments.

# This is What We Really Need

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## Tricorder



Proper hand position for elemental scanning as demonstrated by Mr. Spock.



- **Advantage:** Can measure almost anything, almost anywhere.
- **Drawback:** Will not be available until early 23<sup>rd</sup> 22<sup>nd</sup> century.

# References

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- Rosemarie Chinni et al. (2010) “Analysis of materials collected on swipes using laser-induced breakdown spectroscopy” *Applied Optics* 49 (13): C143-152.
- Mark Sutton, *et. al.* Laser Induced Breakdown Spectroscopy (LIBS): Rapid Screening of Beryllium Surface Contamination 4th International Symposium on Beryllium Particulates and Their Detection, Wednesday October 3rd 2012.

# Questions

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