LIBS in Real-Life
–
Practical Aspects and Applications

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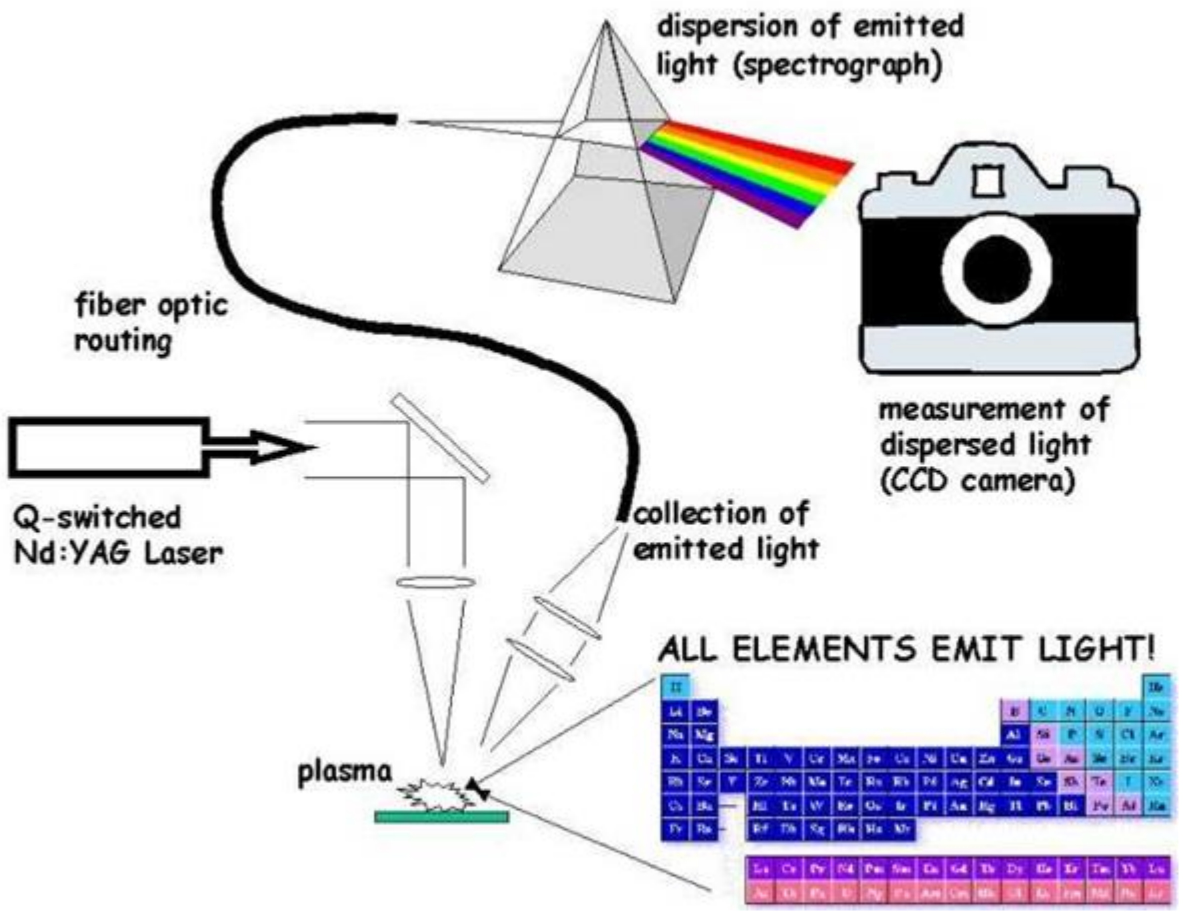
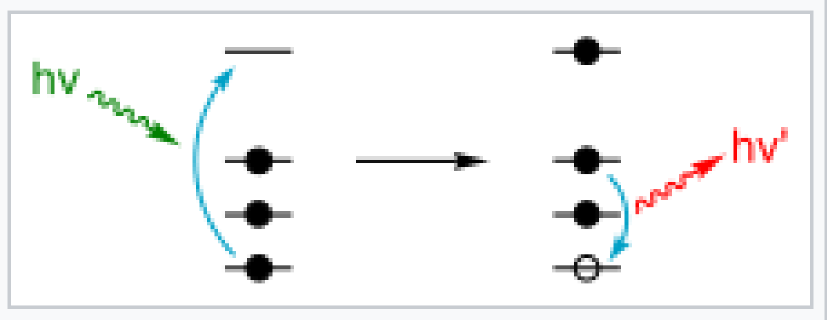
Components Of A LIBS Setup



- Pulsed laser (focused on sample)
- Ablates, superheats, ionizes material
- Light from plasma is collected
- Wavelength dispersed in spectrometer
- Discrete transitions, element and concentration ↔ λ and I
- Timing: Often delayed to avoid thermal background
- Minimal damage to surface, small crater

Why LIBS? Options?

- X-Ray Fluorescence
- Non-destructive technique
- Discrete transitions: element and concentration ↔ λ and I
- XRF has trouble: Light elements cannot be measured due to x-ray excitation energy
- Li, Be, B, C, Na and Mg not doable
- Al or Steel alloys: Mg and Si content define alloy type
- C analysis (as low as 100 ppm needed for correct steel ID)



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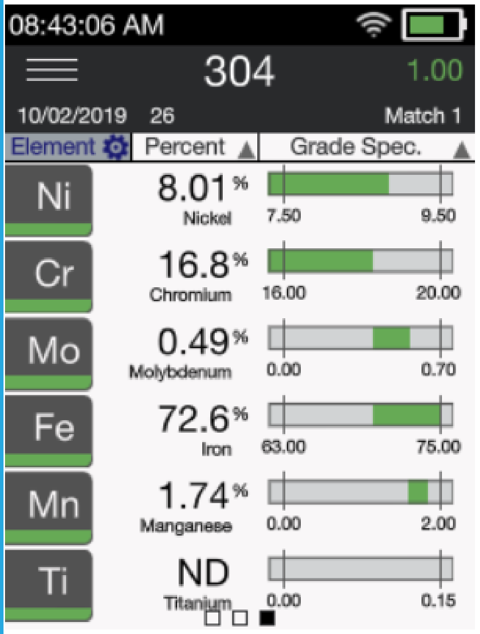
Compact LIBS Analysers

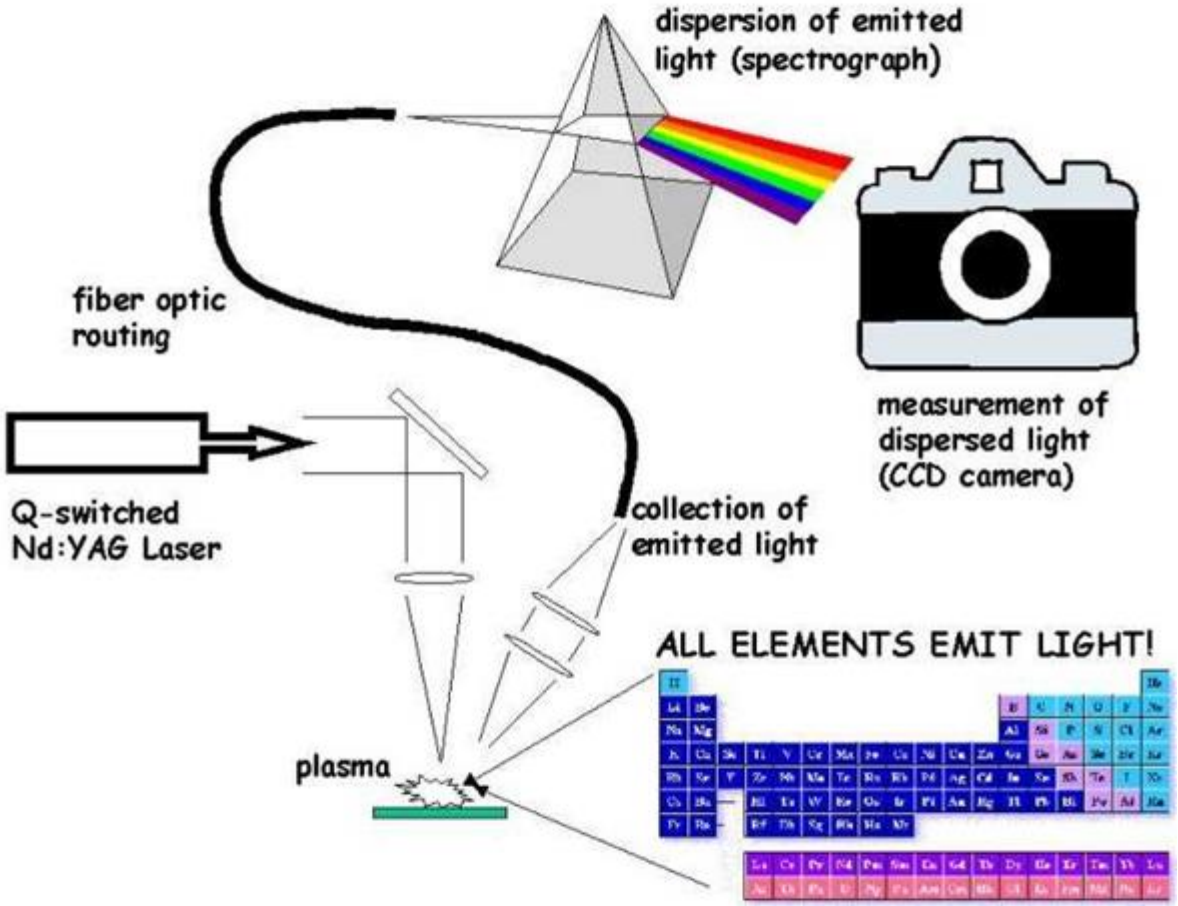
- Available as standard products
- About the size of a battery power drill
- MIL-STD-810-G compliant (drop & topple)
- Long battery lifetime
- Short NOHD (3B laser)

- In other words:

Done!



Components Of A LIBS Setup



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Laser Impacts Performance

- Laser Energy per Pulse is critical
- General rule of Thumb: A lot helps a lot!
- BUT: Too much is not good.
- Higher pulse energy = higher background
- Higher pulse energy = more destructive
- Higher pulse energy = higher shockwave

→ Enough to get a signal, but try to be minimum invasive / just fast enough

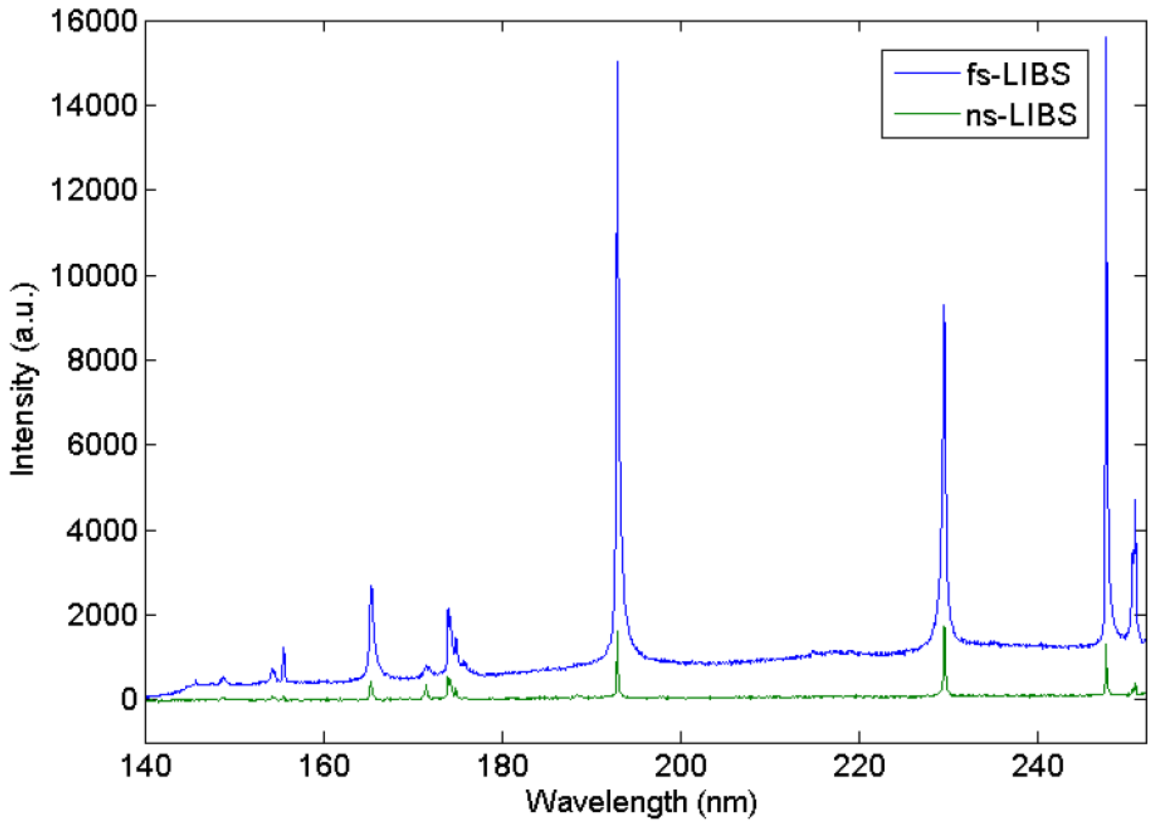

Image courtesy to CREOL, UCF, Orlando, FL, US.

One Word About Fibers

- Light still needs to get to the spectrometer!
- Fibers limited to 185nm +
- All else needs to be free space!

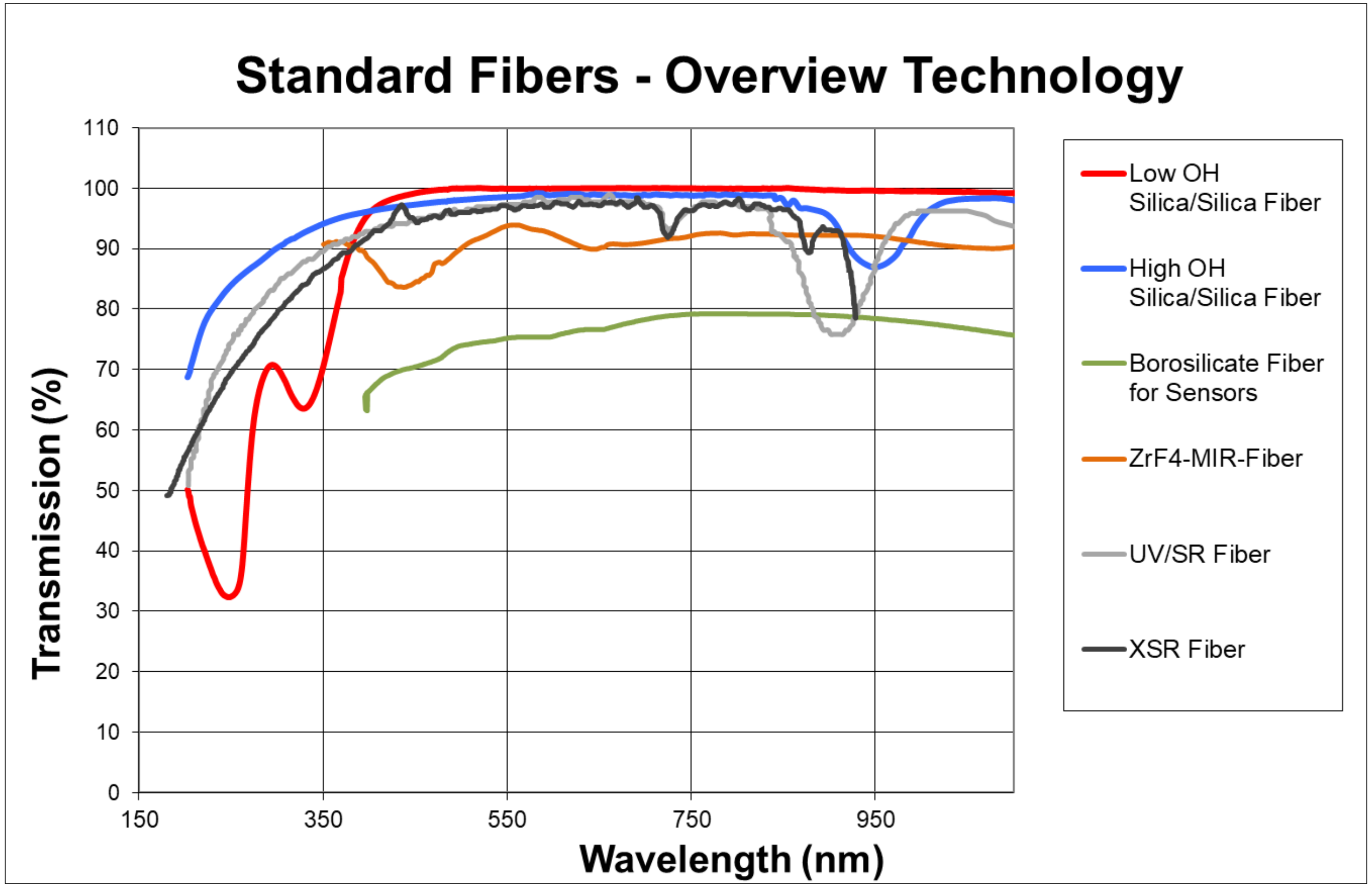

Image courtesy to CREOL, UCF, Orlando, FL, US.

Inside the Spectrometer

- Detectors are usually surprizingly sensitive outside their operating range
- One Example:

  Hamamatsu S10420-1106-01

- Quartz Window is limiting performance

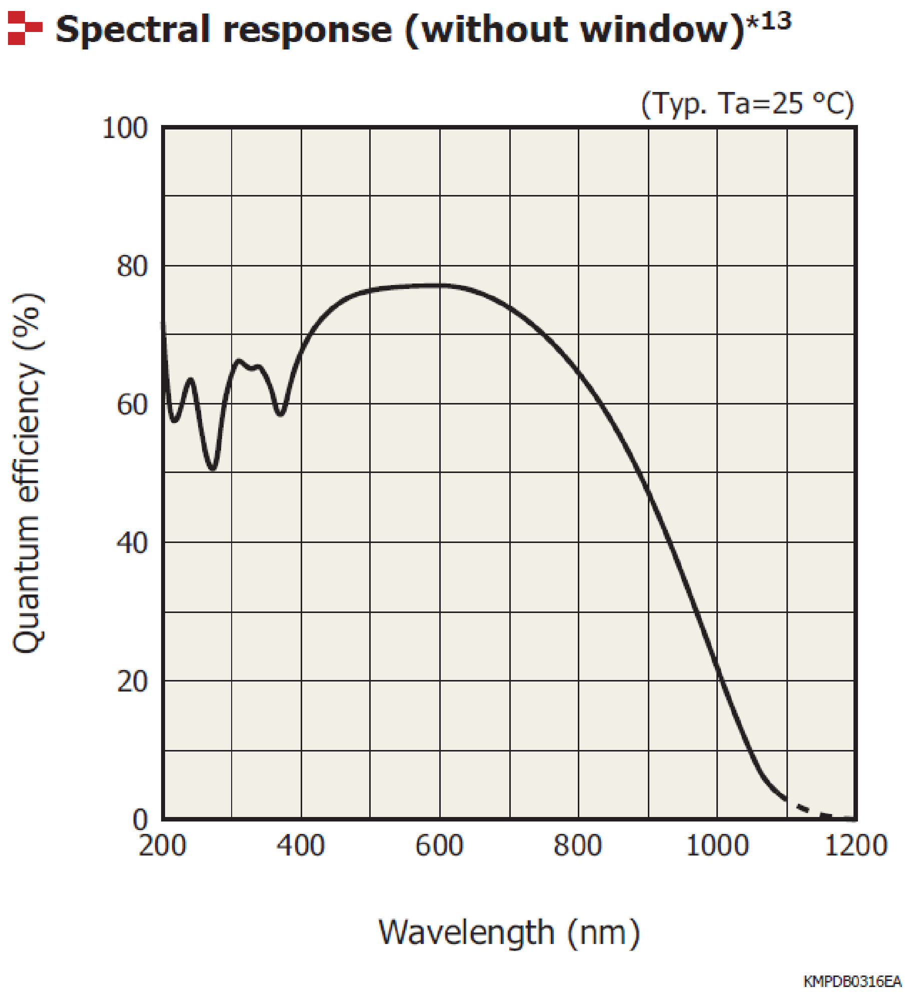

Image courtesy to CREOL, UCF, Orlando, FL, US.

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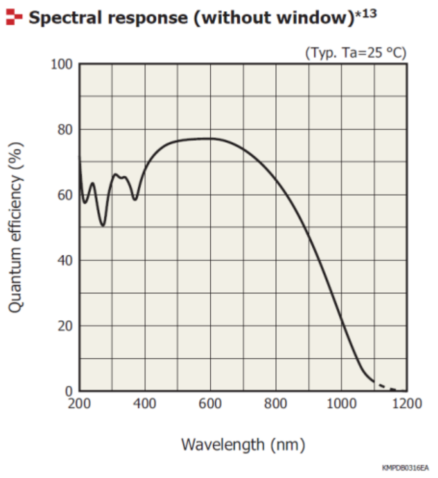
Free-Space Optics

- Detectors are usually surprizingly sensitive outside their operating range
- (with modifications)



- Here: Hamamatsu S10420-1106-01 with alternative MgF cover glass (for dust protection)

Image courtesy to CREOL, UCF, Orlando, FL, US.

Free-Space Optics

- Detectors are usually surprizingly sensitive outside their operating range
- (with modifications)
- Here: Hamamatsu S10420-1106-01 with MgF cover glass
- Issue: Oxygen absorption from ambient air

Graphite sample

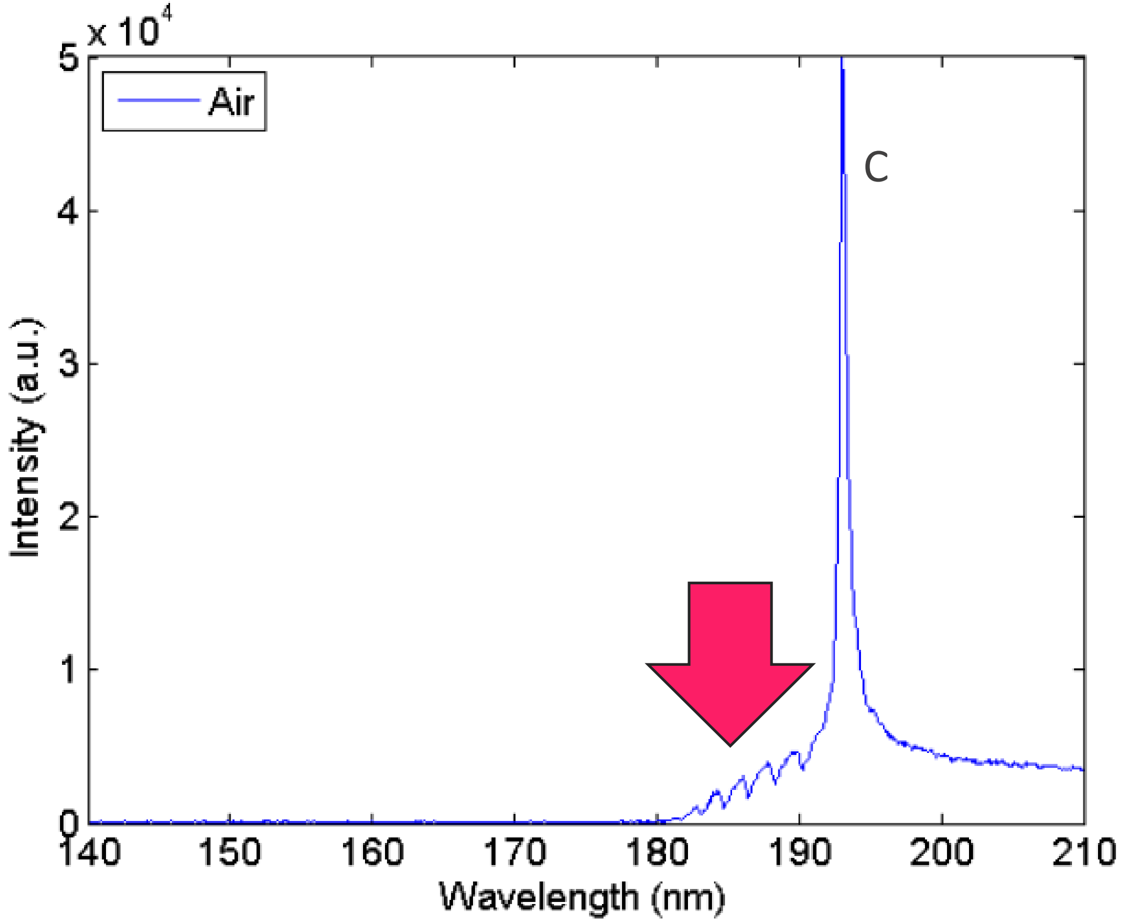


Image courtesy to CREOL, UCF, Orlando, FL, US.

Free-Space Optics & Purging

- Detectors are usually surprizingly sensitive outside their operating range
- (with modifications)
- Here: Hamamatsu S10420 with MgF protective glass

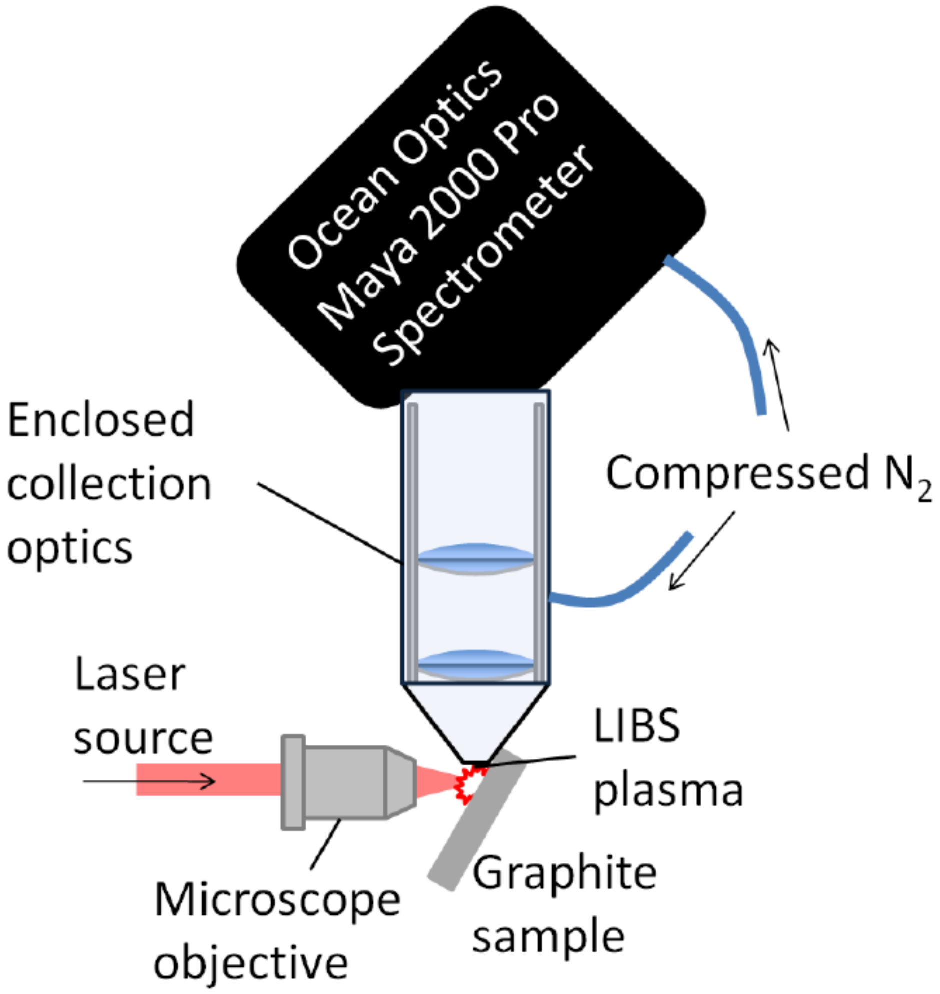


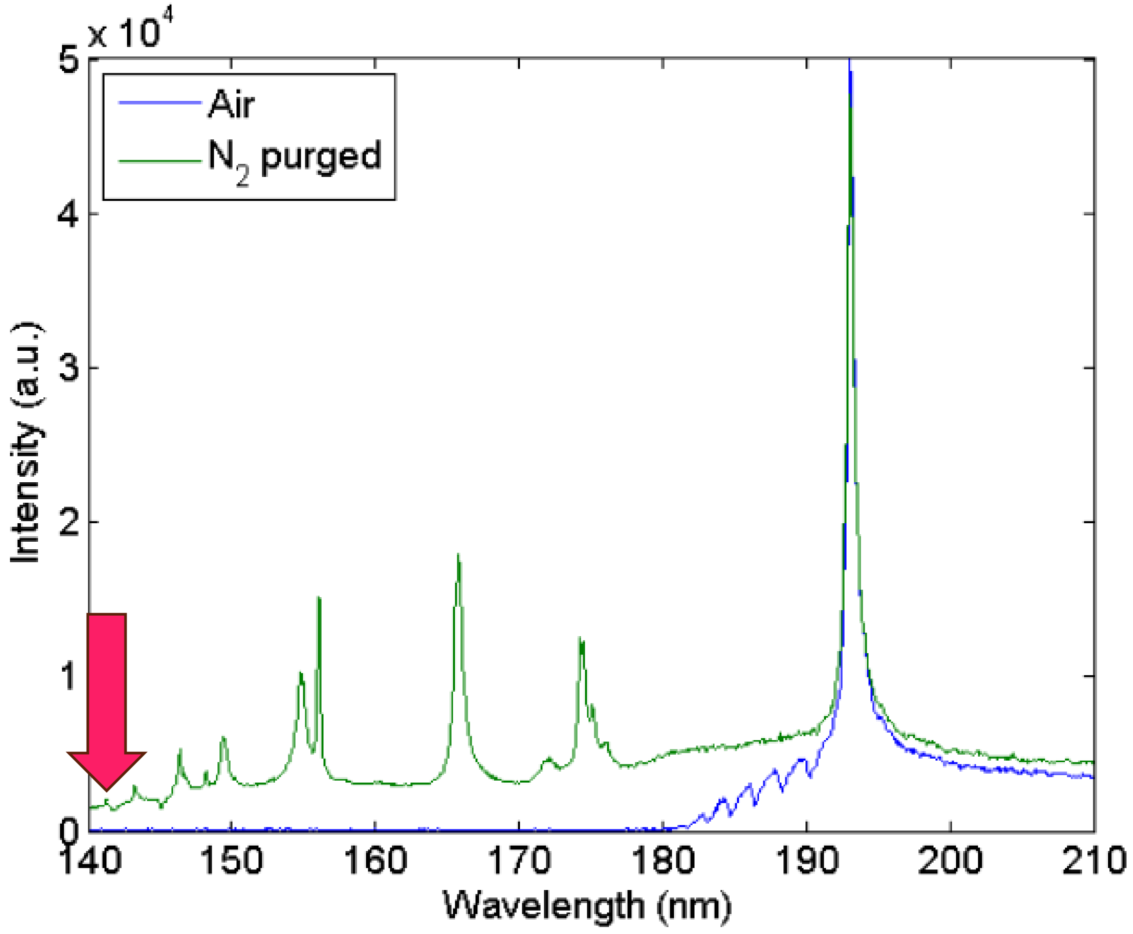
Image courtesy to CREOL, UCF, Orlando, FL, US.

Free-Space Optics & Purging

- Detectors are usually surprizingly sensitive outside their operating range
- (with modifications)
- Here:

  Hamamatsu S10420 w/o cover glass
- MgF slide installed instead
- Whole system (including MgF lenses) purged with oxygen-free Nitrogen
- Sensitivity down to 142nm

Graphite sample



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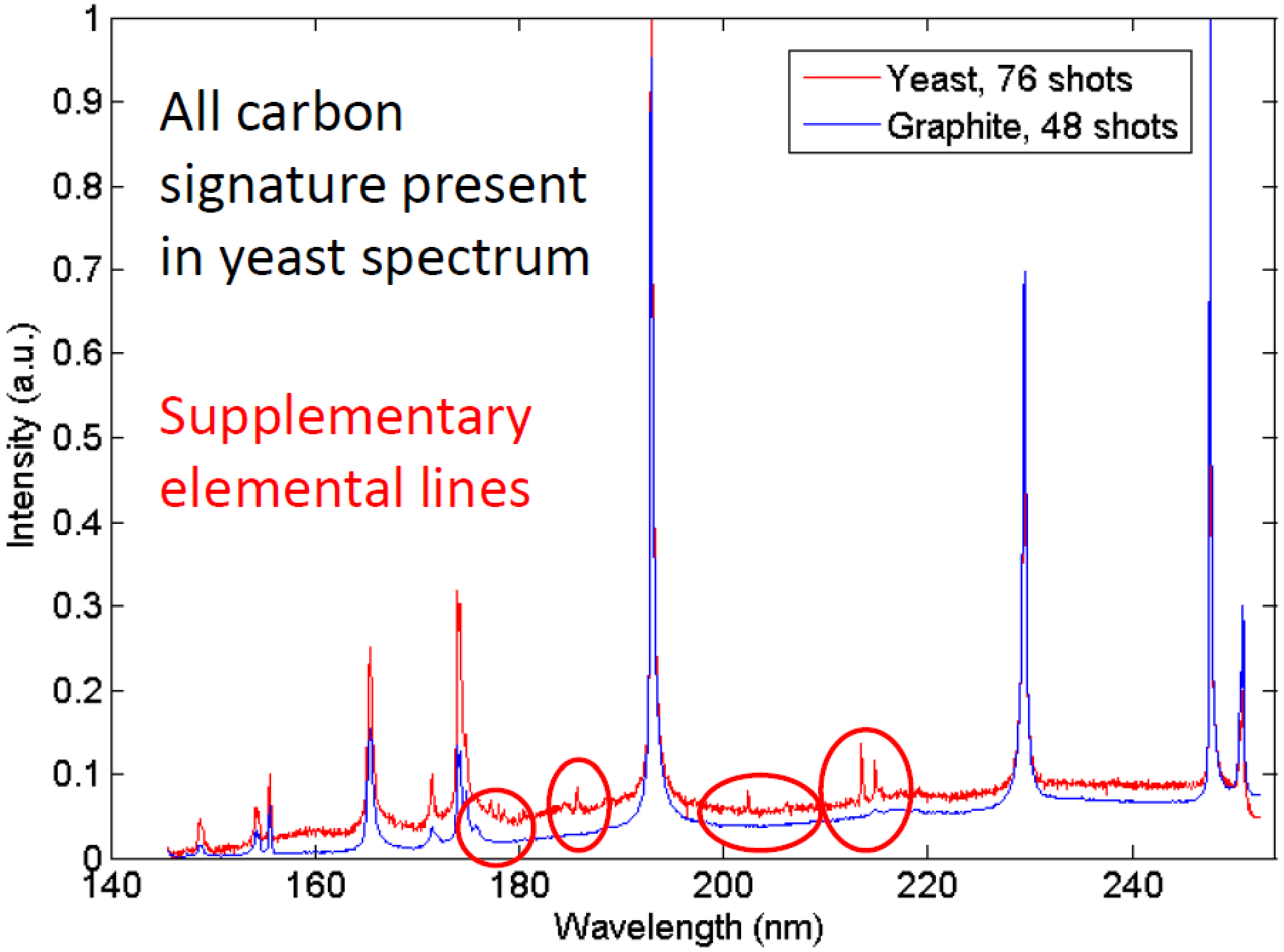
Contamination Detection



This sample is biologically contaminated!

Image courtesy to CREOL, UCF, Orlando, FL, US.

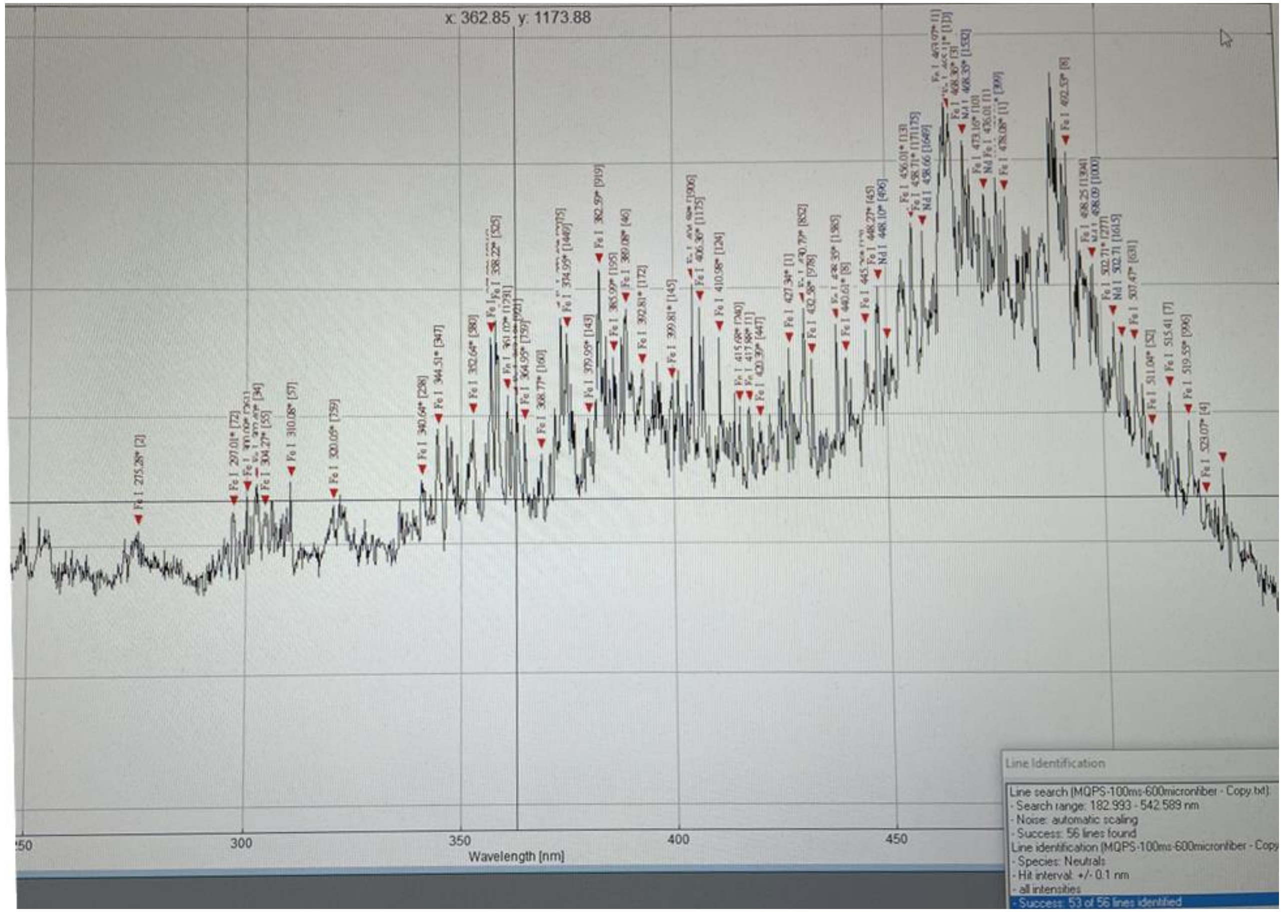
3D Printing Online Monitor

Image Source: https://www.slm-solutions.com/

Source: https://www.3dsystems.com/

Insitu Quality Data

- Use the process emitted light
- Obtain a spatially resolved map of composition (per layer)
- Typically 100 000 points per layer
- 8+kHz data rate with 2 Ocean-FX
- Typical data cube >200 GiB
- Identify and quantify all relevant elements in the powder mixture / resulting alloy
- Try running that with XRF. ☺

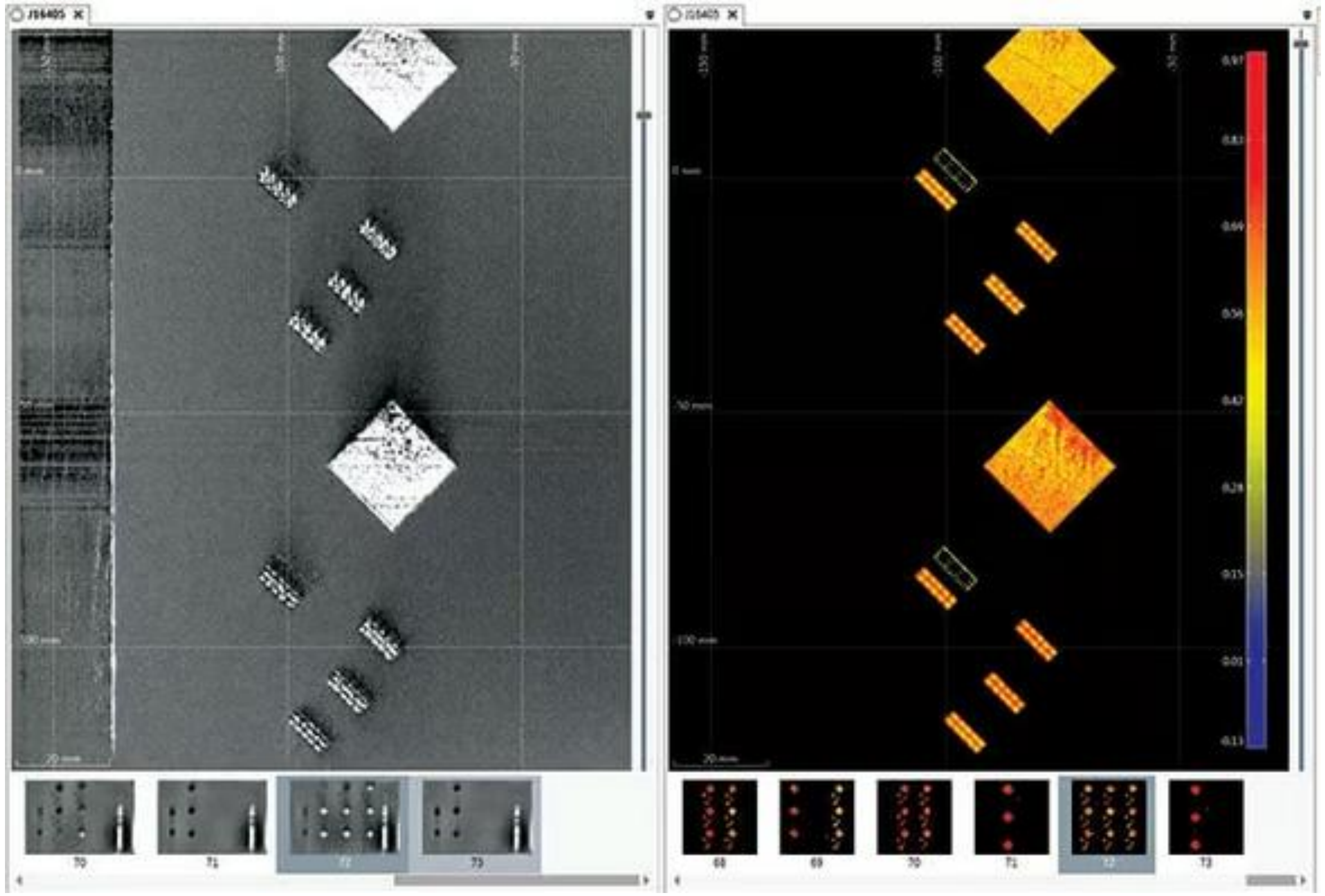


3D Printing Online Monitor

- Obtain a map of each elements relative distribution
- User-Interface similar to melt pool monitors
- Allows Zooming, layer-by-layer view

  & Outlier detection (limits)

→ Full Quality Control by Design



*Concept Illustration of GUI

Image Source Source: https://www.3dsystems.com/; Melt Pool Monitor

I am sure there are questions!

Find Our Products, Me and My Swiss Colleagues at Booth H116

GMP
PHOTONICS & MICROTECHNOLOGY

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