Technology of LIBS Imaging

Nordic LIBS 2024 slides
available at libsimaging.net/nordiclibs2024
Poster=handout is available

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Technology of LIBS Imaging

1 Context

2 LIBS Imaging devices 1: LIBS-LIDAR

3 LIBS Imaging devices 2: LASOLIBS

4 Spectral analysis simply

5 LIBS resources and tools to share

Context

- Me:
  Automation engineer building LIBS scanners -> LIBS Imaging researcher
- Research goal:
  Give you the tools to do LIBS imaging and explain it clearly

LIBS

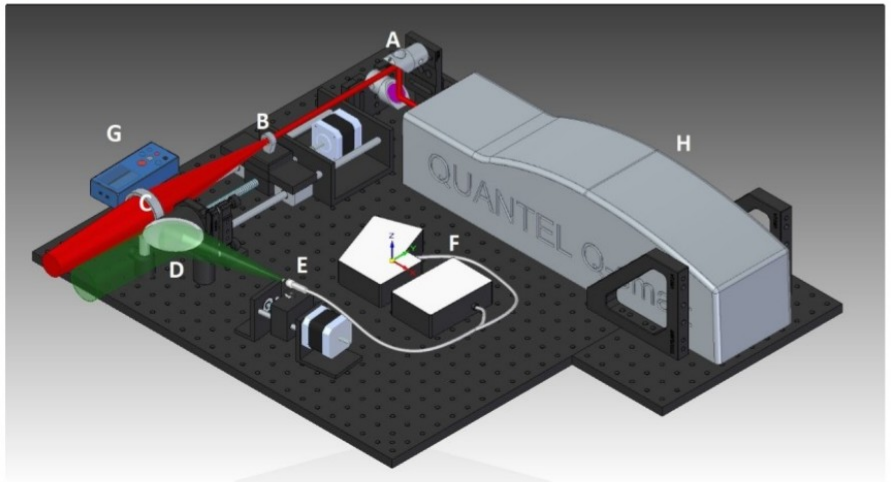
Laser-Induced Breakdown Spectroscopy or Laser spark spectroscopy.

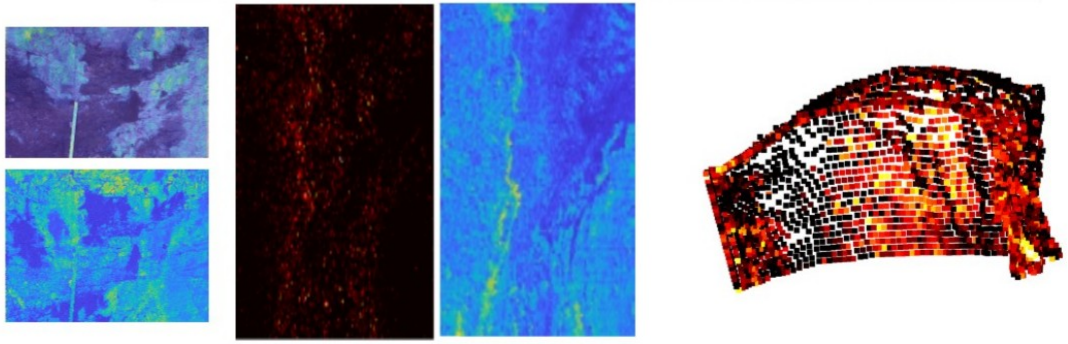
Laser -> spark -> emission spectrum -> elemental content

Imaging means doing many measurements over an area for pretty pictures.

LIBS Imaging Devices 1: LIBS-LIDAR Tunnel Wall Scanner

For remote measurements from 3 to 8 meter distance. Was built to scan mine tunnel walls from safe distance.

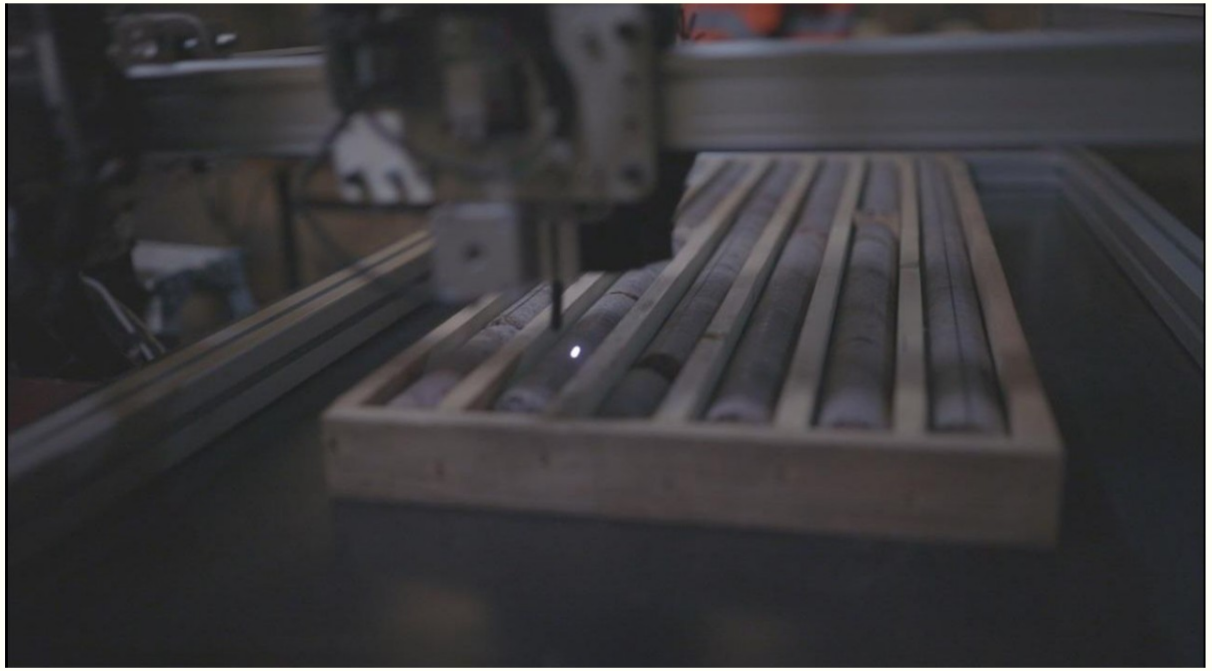




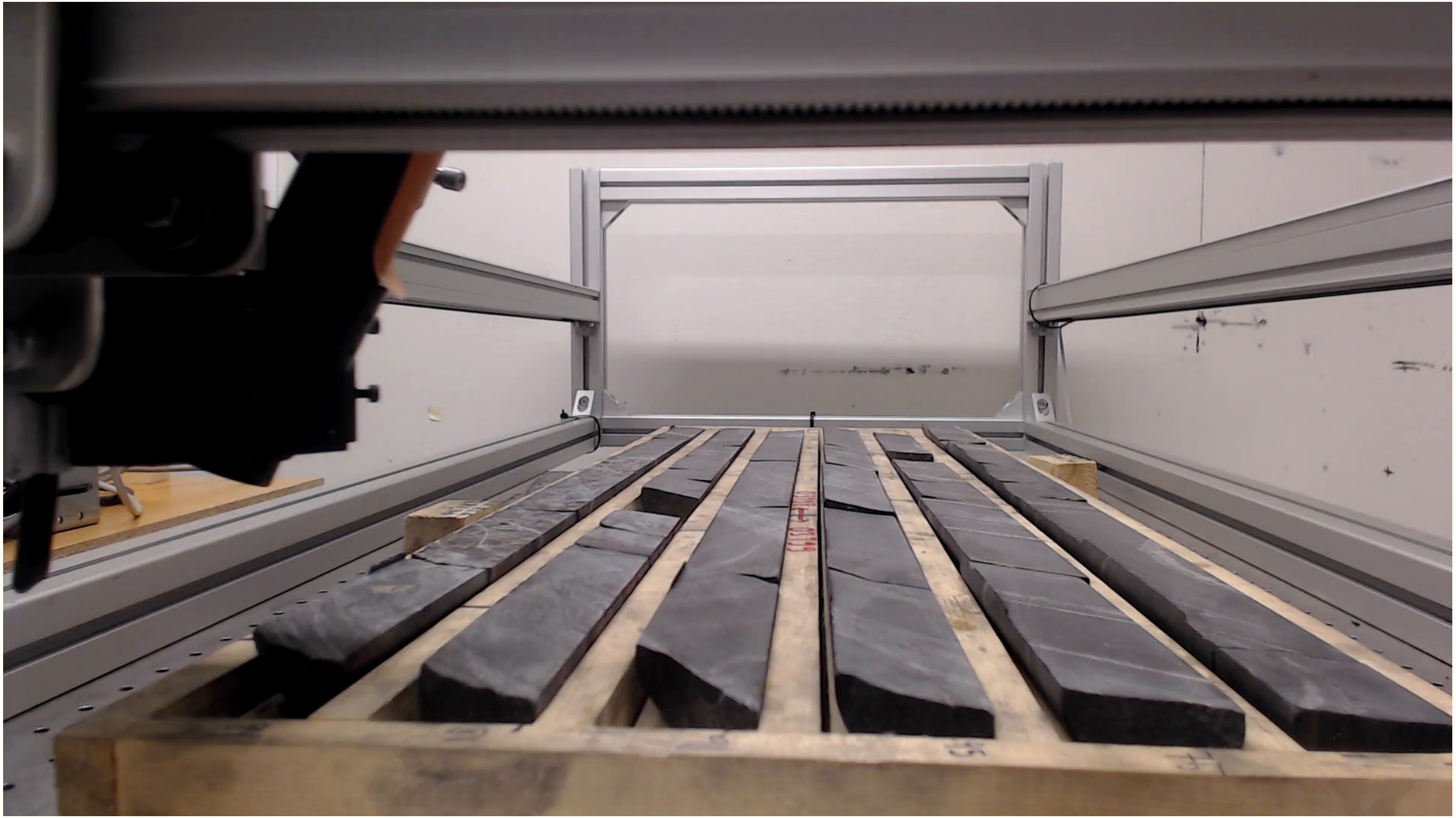
LIBS Imaging Devices 2

Large Area Scanning Open-Source LIBS (LASOLIBS)

Scans boxes of drill core or any other samples that fit on a table.


(Video)

A commercial version by Lumo Analytics is used in multiple mine and ore exploration sites in Finland and USA.



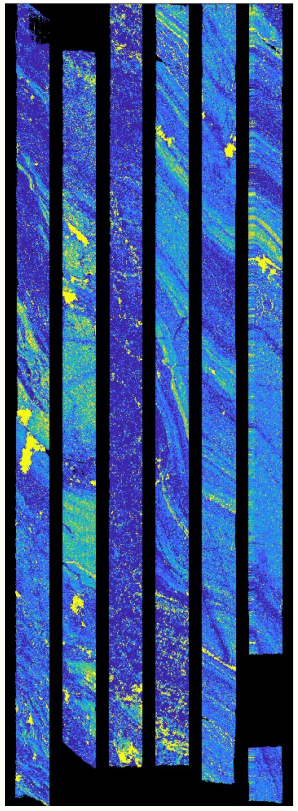
LASOLIBS parts

- 3D-printer like frame to move measurement head, built of MakerSlide
- Measurement head, 3d printed parts
  - Laser (1000Hz)
  - Autofocus with Position Sensitive Detector(PSD)
- Spectrometer
- Teensy microcontroller running Arduino code
- Cost of parts ~10000 euros for a DIY person.

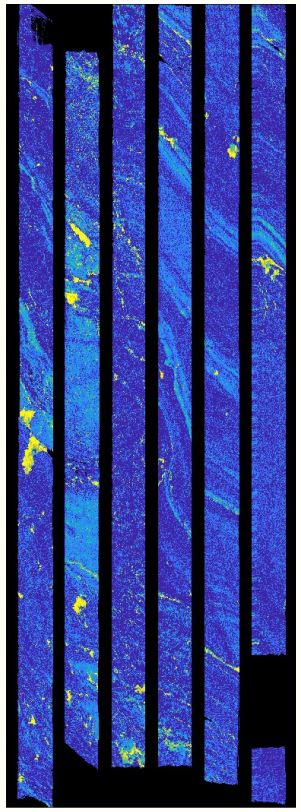
LIBS Images 1: Drill cores

RGB

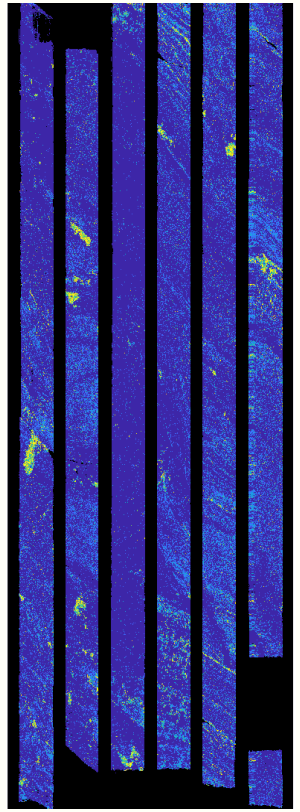
Fe II – 266.47nm

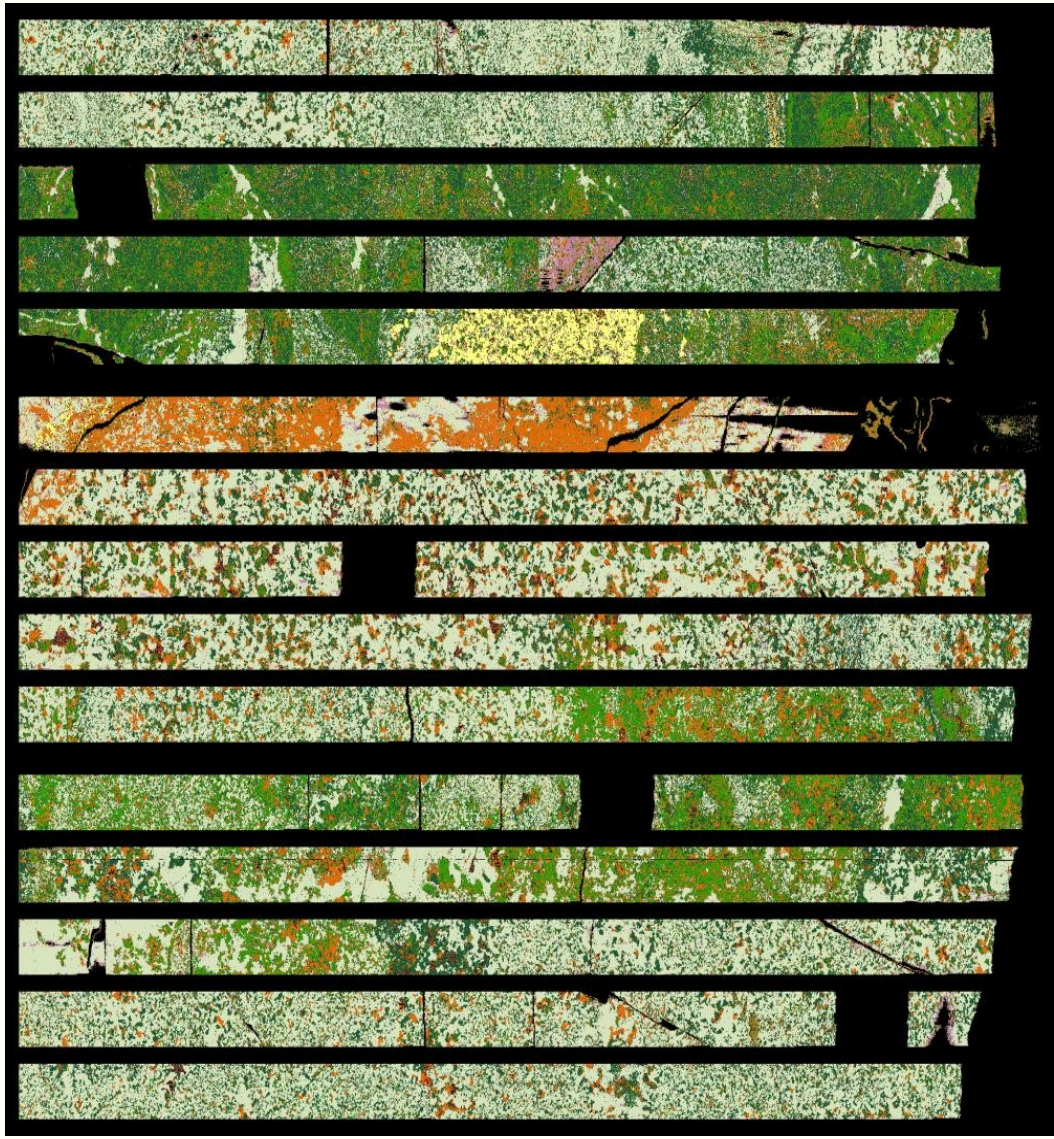


S I – 921.30nm



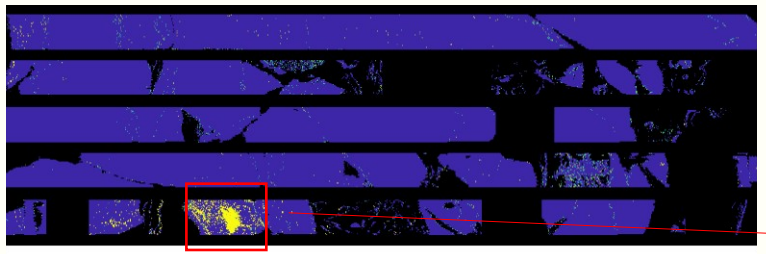
Ni I – 341.60nm

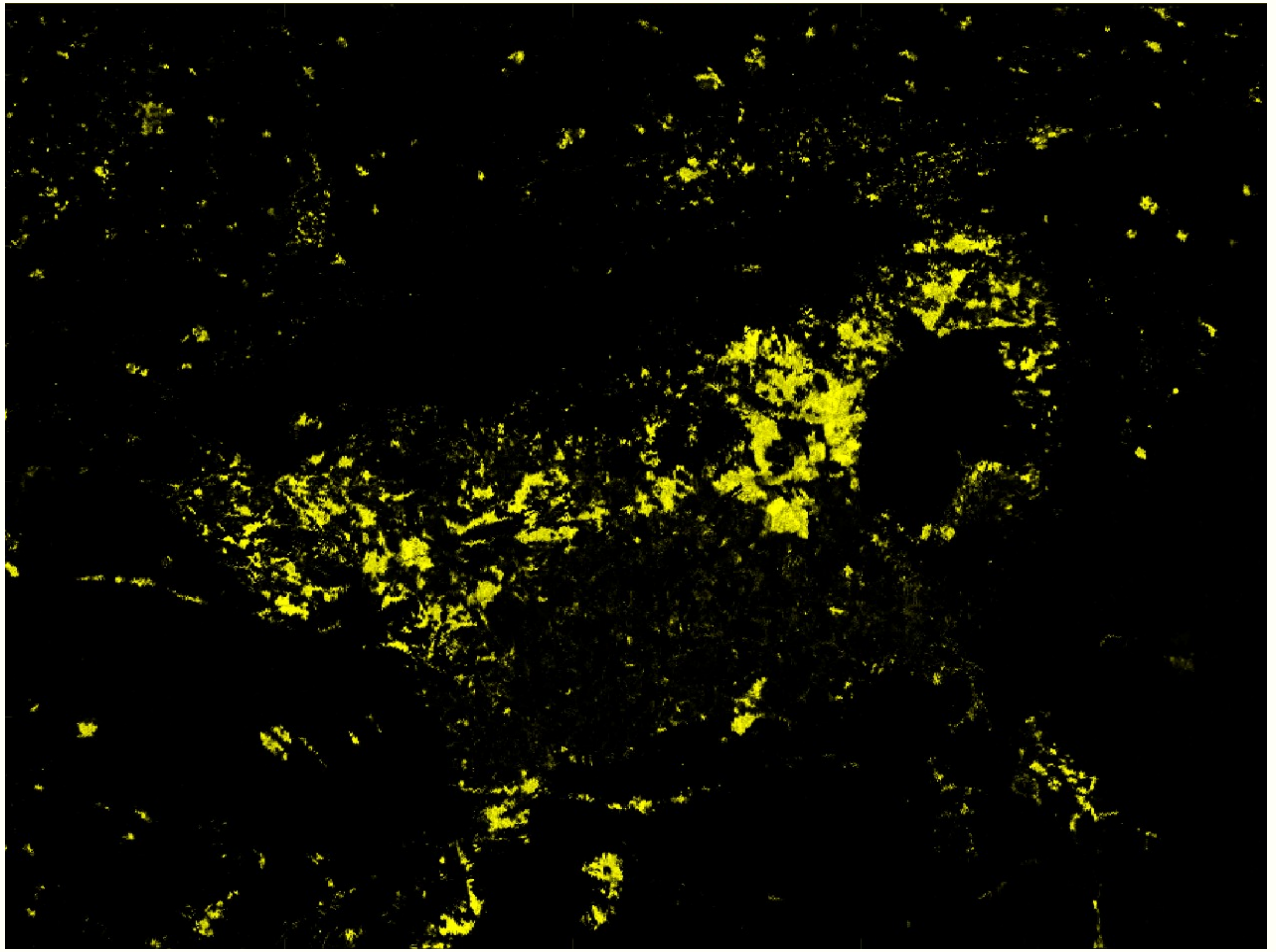




LIBS Images high resolution

Cu I – 327.41nm





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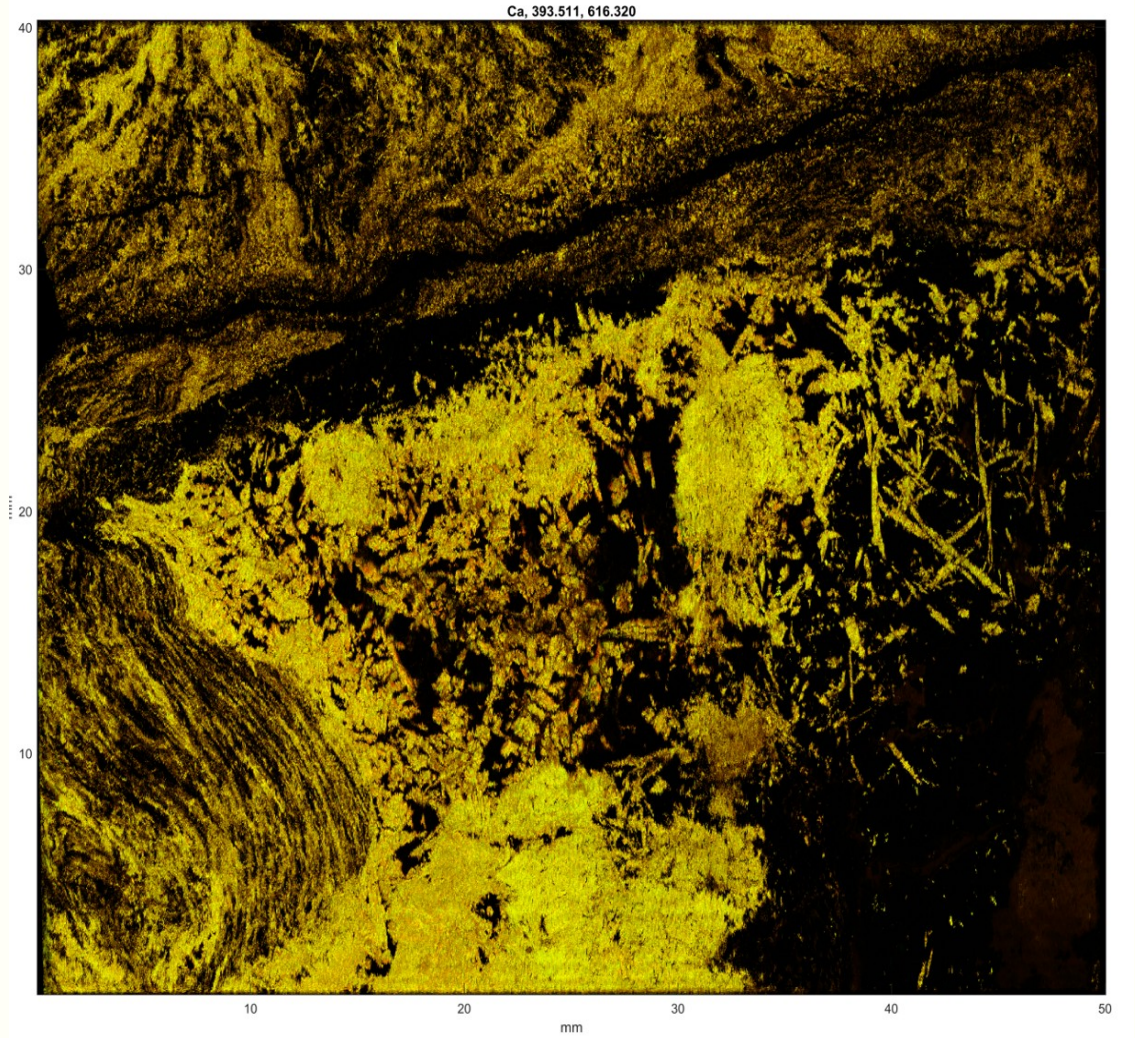
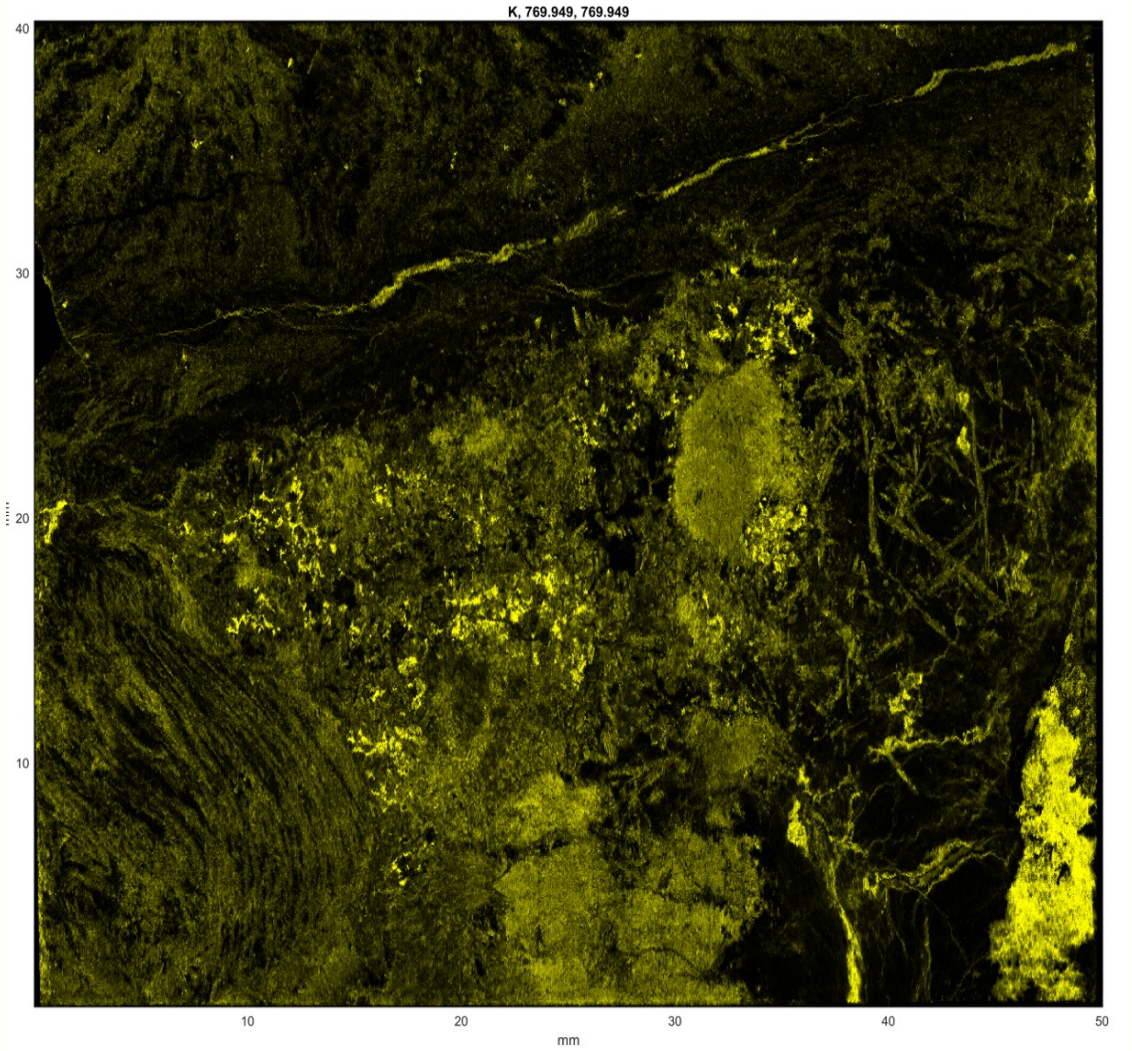
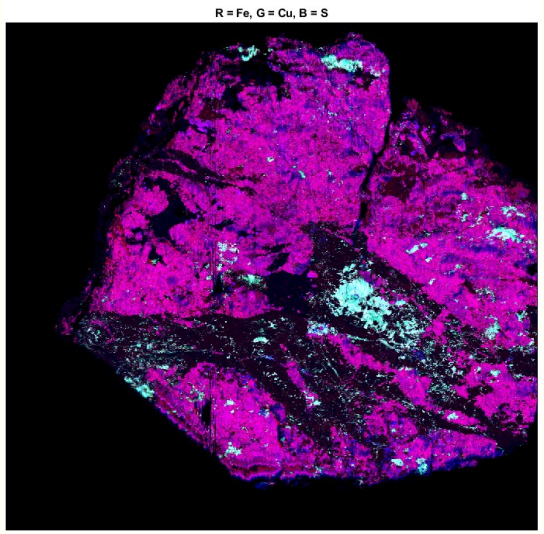
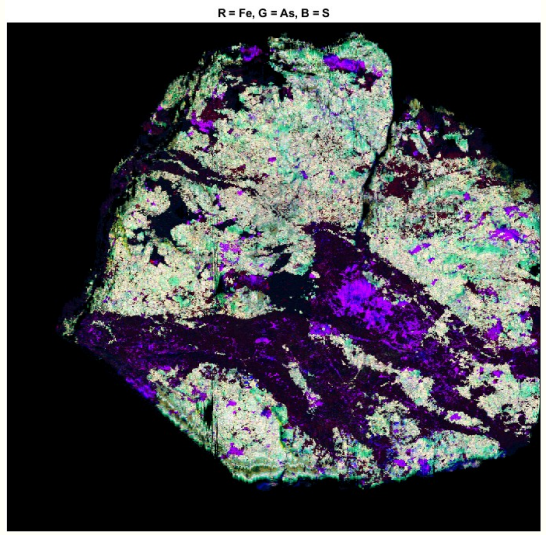
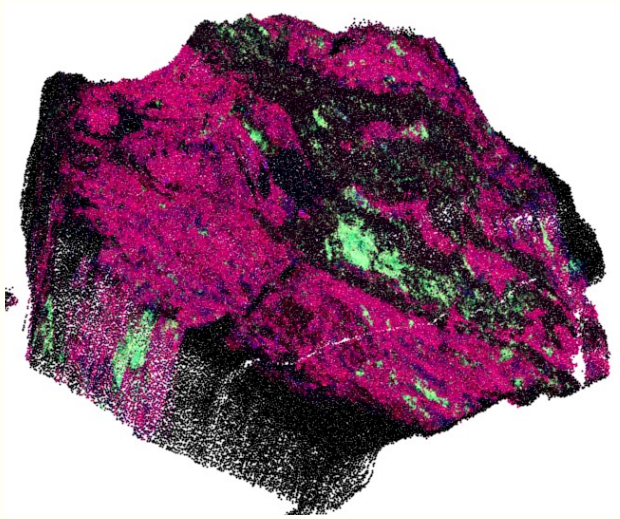


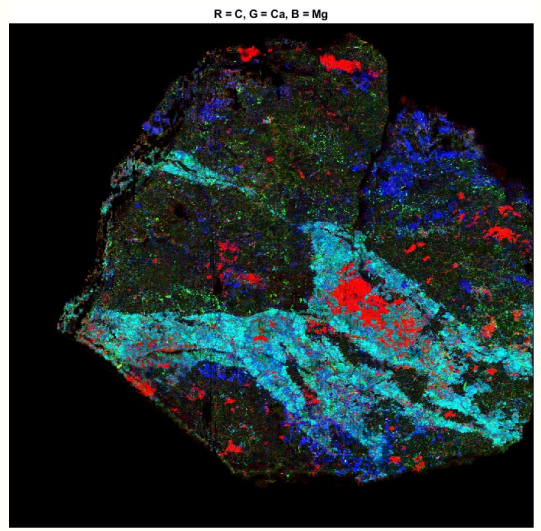


LIBS Images: Hand sample









LIBS Analysis Methodology Simply

From Spectra to results

Spectrum -> Identify elemental peaks with reference list -> Measure peak heights -> Compare them

LIBS Analysis Methodology With computer

Simple elemental heatmaps by selecting a channel with an elemental peak.

Spectral Angle Mapping(SAM) compares similarity of two measurements. Great for classifying materials/minerals to a reference.

Resources 1: spectra

Peaks

All elemental peaks from NIST ASD scraped into convenient excel files.

Elemental library

Experimental LIBS spectra of many elements, soon including a full set of REE elements.

Mineral library

Experimental LIBS spectra of mineral collections.

Will be available from libsimaging.net (sry not yet) and uploaded to Zenodo.

Resources 2: LIBS imaging demos

I'm happy to do a LIBS imaging demo if you send me a sample.

Thanks!

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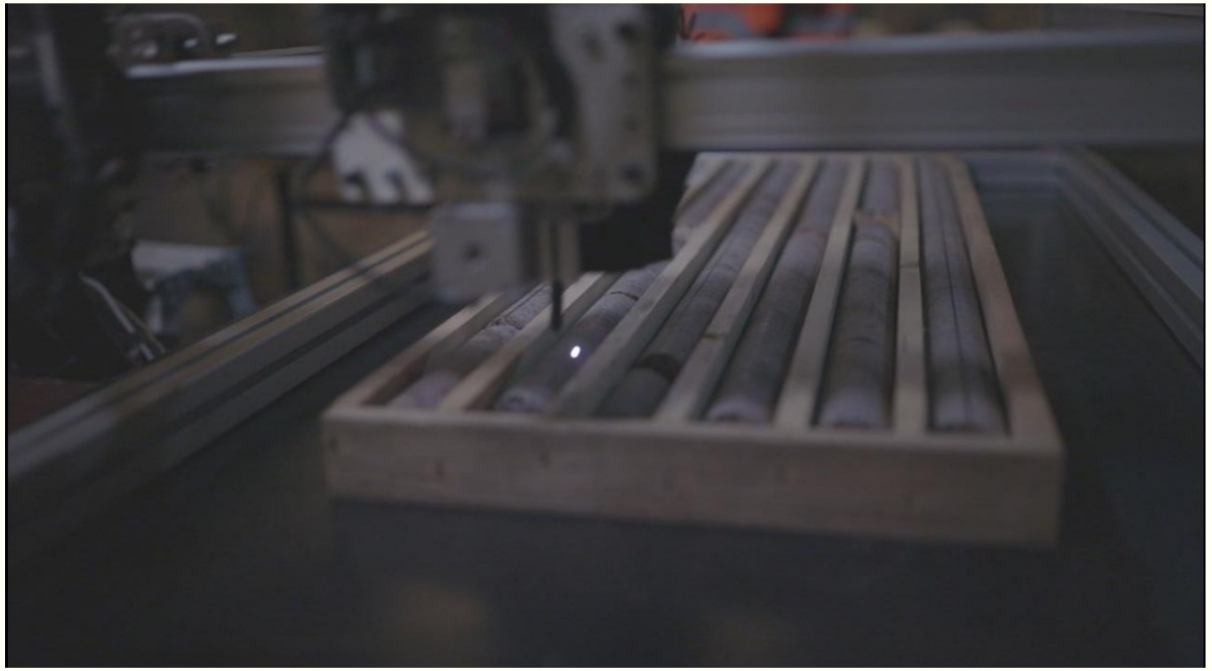
(Video)

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Extra slides:

Contacts

Resources 3: tools

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For commercial geological/mining projects

Lumo Analytics

info@lumoanalytics.com

For research related or any other inquiries

ilkka.laine@aalto.fi (me)

+358 50 490 5909

Resources 3: tools

Analysis tools software library

Free software tools available!

- MATLAB and Julia scripts

Hyperspectral tools work with LIBS data often as well.

Thanks!

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