LESSON D2U3 – Demonstration and case studies

Part 2: Demonstration of portable geochemical devices

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University of Miskolc

DIM ESEE 2: IMPLEMENTING INNOVATIONS
Innovation in Exploration
Dubrovnik, Croatia / hybrid mode – October, 21st 2021

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INTRODUCTION

https://www.atomtrace.com/#products

https://www.rigaku.com/products/wdxrf/simultix?index=1

1. XRF (**X**-ray **f**luorescence spectroscopy)

2. LIBS (**L**aser-**i**nduced **b**reakdown/ **p**lasma **s**pectroscopy)

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HISTORY

1994:NITON XL-309
1st *one piece*, handheld XRF with real-time digital signal processing and silicon PIN diode detectors[1]

1. XRF (X-ray fluorescence spectroscopy)[1]

- **1895** – Discovery of X-rays (Wilhelm Röntgen)
- **1948** – The first commercially available X-ray spectrometer for elemental analysis
- **1967** – The first commercial field portable XRF became available
- **1982** – The first 'handheld' XRF was produced

Field-portable LIBS-based intrument from 1999 (Cremers &Radziemski 2006)

2. LIBS/ LIPS (Laser-induced breakdown/ plasma spectroscopy)[2]

- **1960** – First laser demonstrated (Theodore H. Maiman)
- **1963** – Laser micro-spectral analysis demonstrated, primarily with cross-excitation.
- **1992** – Portable LIBS unit for monitoring surface contaminants developed

[1] https://www.portaspecs.com/the-evolution-of-portable-xrf-instruments/, [2]Cremers & Radziemski (2006)

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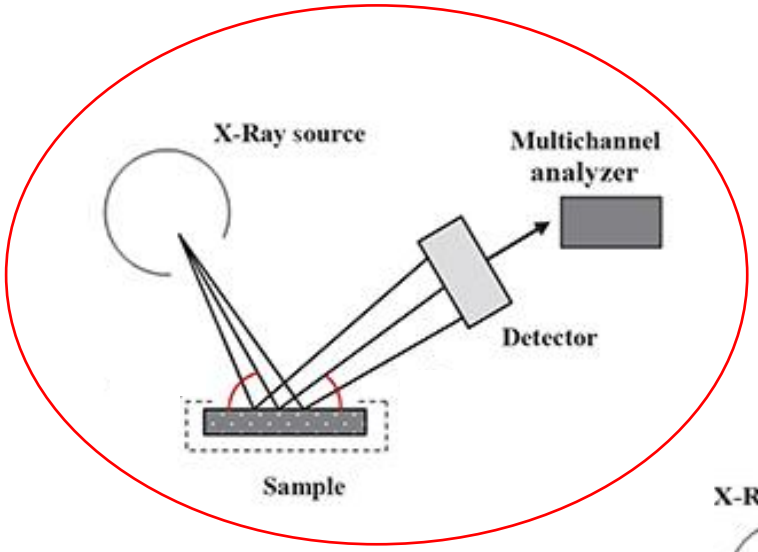
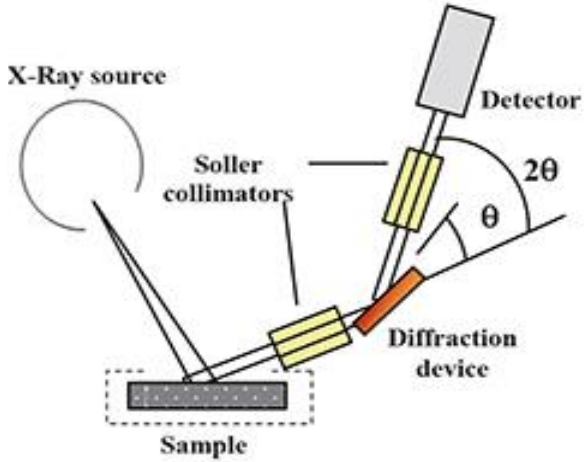
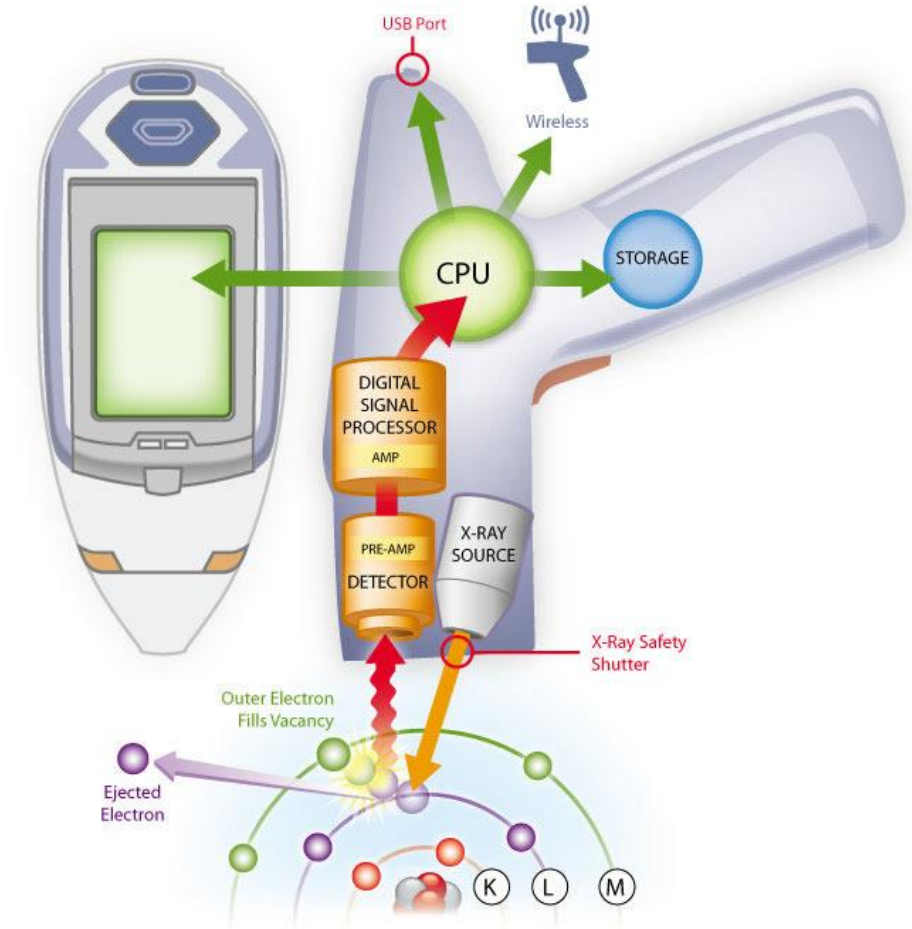
How does XRF work?





https://www.spectroscopyeurope.com/article/x-ray-fluorescence-spectrometry-trace-element-analysis-vegetation-samples



Thermo Scientific / https://www.911metallurgist.com/blog/x-ray-fluorescence-spectroscopy-xrf-works

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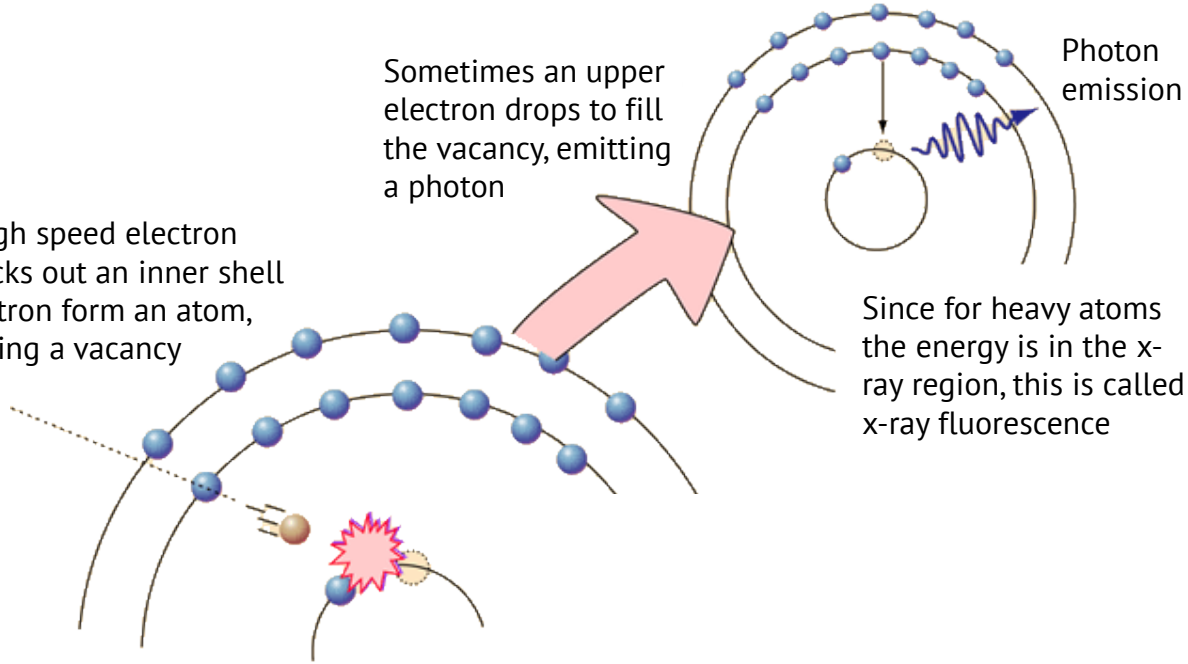
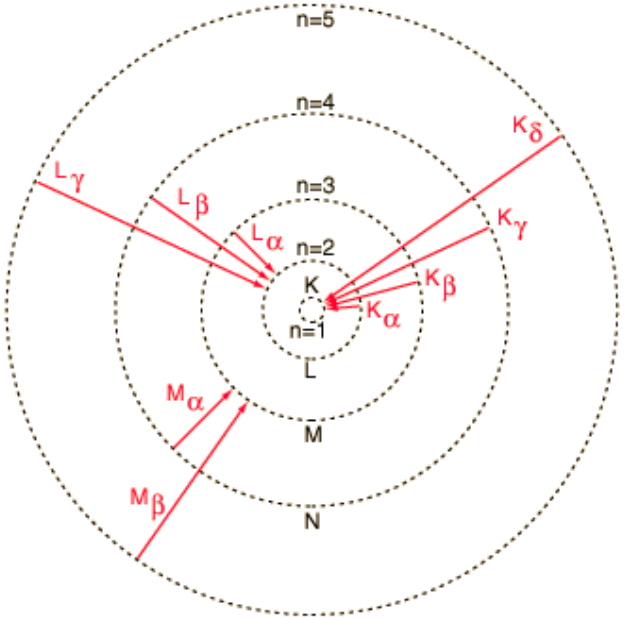
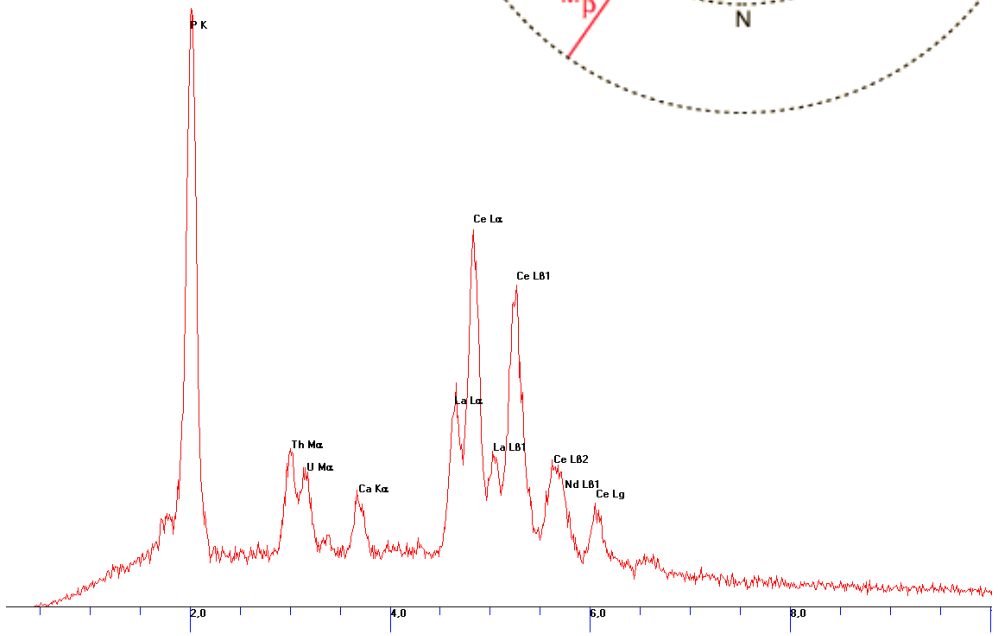
How does XRF work?



http://hyperphysics.phy-astr.gsu.edu/hbase/atomic/auger.html





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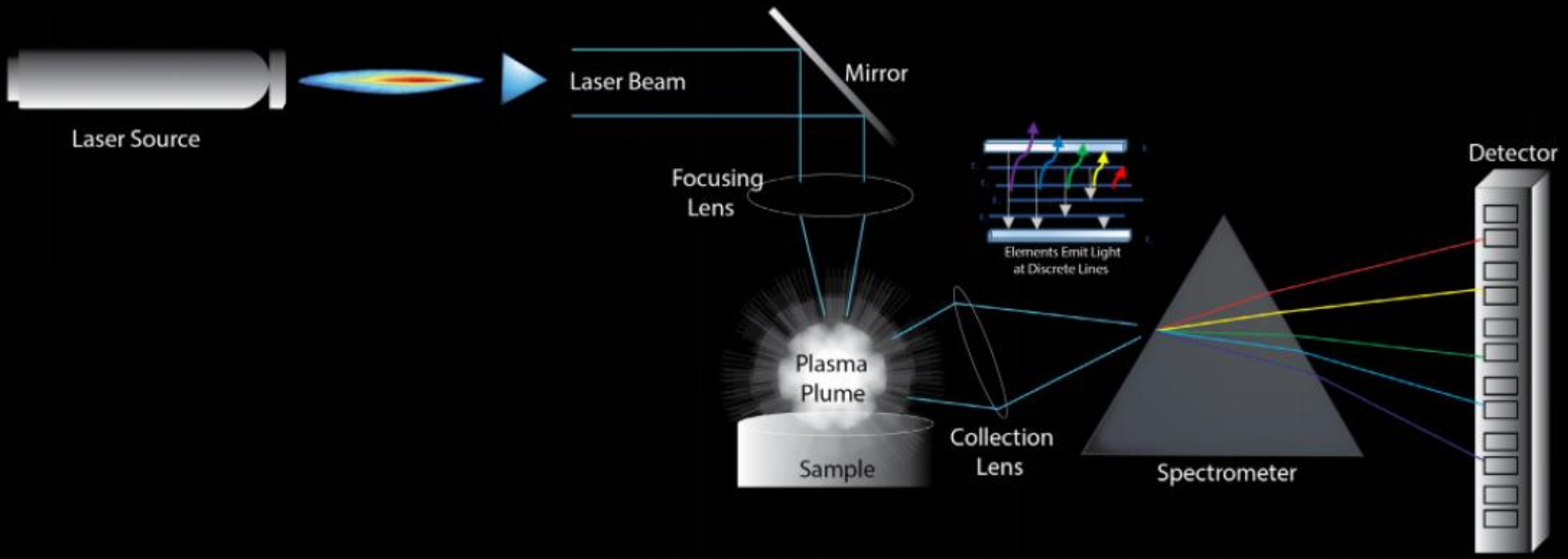
How does LIBS work?



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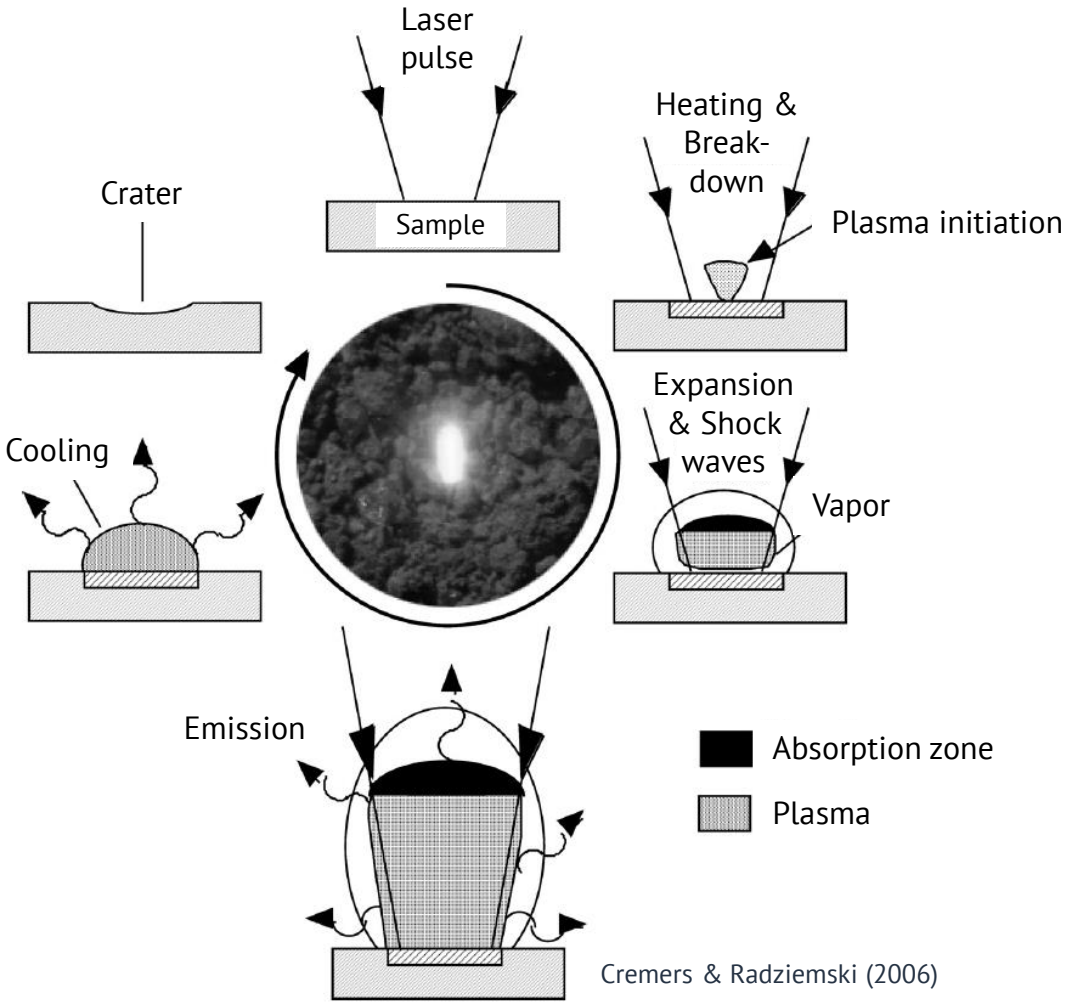
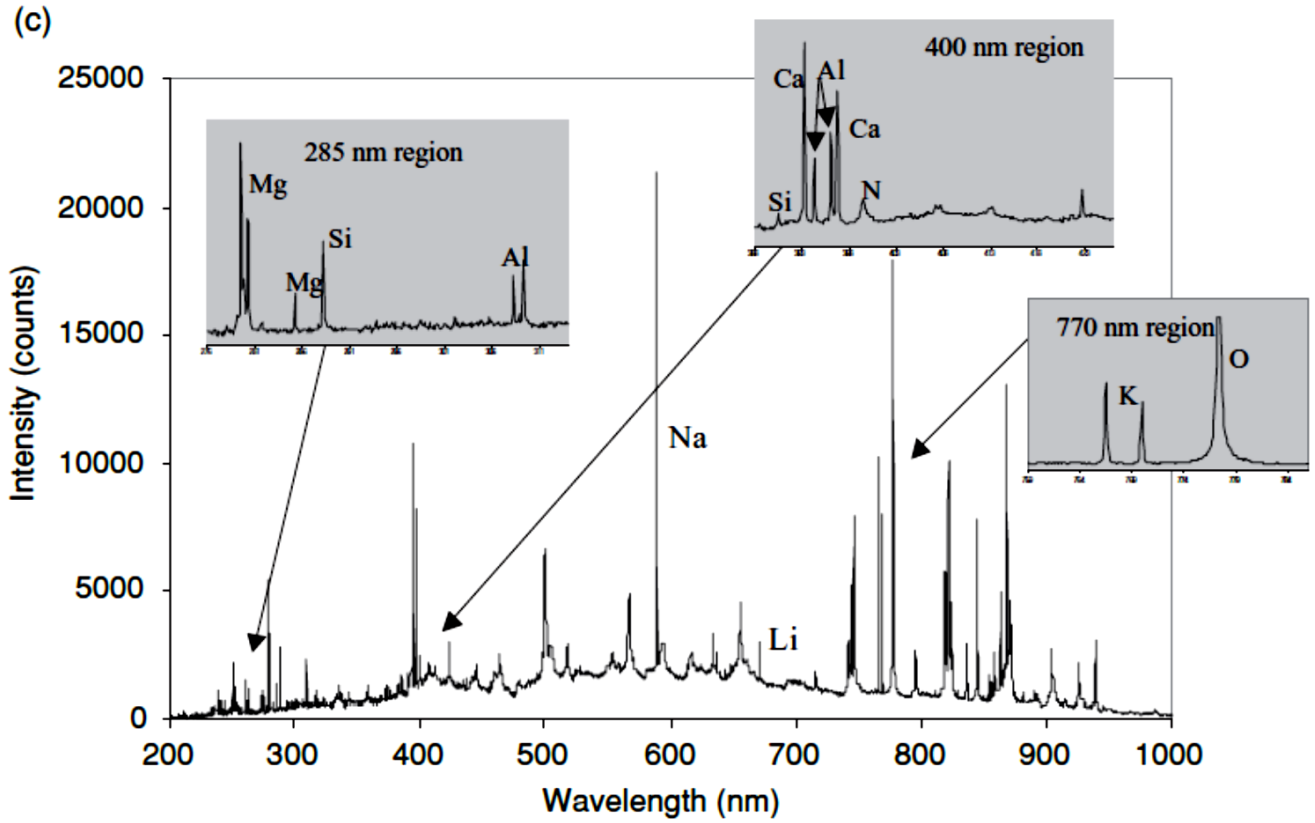
How does LIBS work?



Cremers & Radziemski (2006)



Cremers & Radziemski (2006)

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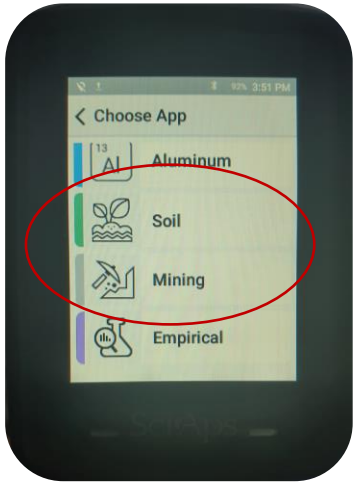
SciAps X-550 XRF

- **Measures:**
  - Low-atomic number elements: **Mg, Al, Si, P, S, K, Ca**
  - Transition/pathfinder elements: **Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Sr, Rb, Zr, Nb, Mo, Te, Ag, Cd, Sn, Sb, Ba**
  - Heavy metals: **Ta, W, Au, Hg, Tl, Pb, Bi, U**
- applications for geological, etc. samples:



SciAps X-550

Specifications

Simply the best handheld XRF ever made

The SciAps X-550 sets a new performance standard for handheld XRF. It's the lightest, fastest, most articulate X-ray gun ever made — 2.98 lbs. with battery — and delivers the small size, blazing speed and high precision of the SciAps X Series in a perfectly balanced device. The X-550 was especially designed for NDT, PMI users who must access hard-to-reach test locations and welds. The X-550 also features a powerful, miniaturized X-ray tube designed to excel at measuring low atomic number elements Si, P, S, Mg and Al. This tube combined with highly optimal internal geometry yields fast, precise results on previously challenging applications like measuring silicon for sulfidic corrosion, and low magnesium in aluminum alloys.

- **Fast on all alloys, including aluminums**
- **Optimized for sulfidic corrosion (low Si)**
- **Designed for residuals analysis, per API 751 and 5L specifications**

Fast, precise tests with SciAps X-550

SciAps X-550 analyzes common alloys in 1 second or less. For alloys requiring longer test times or two-beam analysis, pre-configured on-board apps assure quality testing by every operator. Tap the Residuals App, for example, and the analyzer uses pre-set testing times to measure low concentrations of Cr, Cu and Ni, then calculates the sum. Operators won't be adjusting test times in the field, or generating insufficient data quality due to incorrect testing times. Our patent-pending Aluminum App is optimized for both low atomic number elements and transition metals for ultra-fast, highly specific verification of the many similar aluminum grades. **Grades 3003/3004/3005, Cast 356 and 357, and 2014/2024 are just a few examples that are easy for the X but often confound other X-ray guns.**

Connectivity and Android

The X Series is built on Google's Android platform for real-time data exporting. The user interface has the feel of a smartphone with results easily viewed on a vibrant display and reversible light/dark for all lighting conditions. **Built-in Wifi, Bluetooth, GPS and USB** mean that users can print and email from the X and connect to virtually any information management system for efficient test data and reporting.

Need Carbon?

For users who need to also measure carbon in steels, stainless and cast iron, SciAps manufacturers the Z — the world's only handheld laser system (LIBS) capable of measuring carbon content low enough to separate L and H grade stainless. SciAps Z has achieved global acceptance with nearly 1,000 units delivered. The Z also analyzes beryllium, boron and lithium in alloys. Packaged together with shared accessories in the One Box, the X and Z provide optimal performance for virtually every alloy and element, and for less money than a comparable spark OES system.

New X-550
X Series XRF

XRF & LIBS

For more information, or to schedule a demonstration:
www.sciaps.com
339.927.9455

SciAps

SciAps X-550 Handheld XRF

Specifications

Ultra Fast, Precise X-ray Fluorescence Analyzer

Weight	2.98 lbs. with battery
Dimensions	8.5" x 9.5" x 2.4"
Excitation Source	5 W X-ray tube. Typical: 40 kV, 200 uA Rh anode and 10kV, 500 uA for alloy testing, 50 kV, 200 uA Au anode for most other apps
Detector	20 mm² silicon drift detector (active area), 140 eV resolution FWHM at 5.95 Mn K-alpha line
Available Apps	Alloy, Geochem (Mining), Empirical, Environmental apps. New apps are added regularly, please check with company or website.
X-ray Filtering	4 position filter wheel for beam optimization
Environmental Temperature Range	10F to 130F at 25% duty cycle
Analytical Range	32 elements standard, specific elements vary by app. Additional elements may be added upon user request. Precious metals app is 22 elements standard.
Processing Electronics and Host Processing	1.2GHz quad ARM Cortex A53 64/32-bit, RAM: 2GB LP-DDR3, Storage: 16 GB eMMC (storage)
Pulse Processor	12 bit with digitization rate of 80 MSPS 8K channel MCA USB 2.0 for high-speed data transfer to host processor. Digital filtering implemented in FPGA for high throughput pulse processing 20 nS - 24 uS peaking time.
Power	On-board rechargeable Li-ion battery, rechargeable inside device or with external charger, AC power, hot-swap capability (60 s max swap time)
Display	2.7-inch color capacitive touchscreen — 400 MHz Qualcomm Adreno 306 2D/3D graphics accelerator
Comms/Data Transfer	Wifi, Bluetooth, USB connectivity to most devices, including SciAps ProfileBuilder PC software
Calibration	Fundamental parameters. For Geochem and Environmental Soil apps, users may also choose "Compton Normalization" method and/or use empirically derived calibrations.
Calibration Check	External 316 stainless check standard for calibration verification and energy scale validation
Grade Library	Standard library contains 500+ grades, no practical size limit. Multiple libraries supported, grades may be added on analyzer or via PC software package (ProfileBuilder)
Security	Password protected usage (user level) and internal settings (admin)
Regulatory	CE, RoHS, USFDA registered, Canada RED Act

FEB2020

VIDEO www.youtube.com/sciaps

For more information, or to schedule a demonstration:
www.sciaps.com
339.927.9455

SciAps

RawMaterials ACADEMY
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SciAps Z-200 LIBS

- measuring every element except:
  H, F, Br, Cl, O, N, Rb, Cs, S.
- Geochem and GeochemPro applications for geology, etc.

SciAps Z Series LIBS

Specifications

The most advanced, most precise laser-based (LIBS) analyzer available.

Weight	4 lbs with battery
Dimensions	8.25" x 11.5" x 4.5"
Excitation Source	5-6 mJ/pulse, 50 Hz repetition rate, 1064 nm laser source.
Spectrometer/Range	Multiple CCD based spectrometers: Z-200 range 190 nm – 625 nm, Z-300 range 190 nm – 950 nm.
Available Apps	Alloy, Geochem (Mining), Empirical, Environmental Apps. New Apps are added regularly please check with company or website.
Spectral Data Acquisition	Spectral data collected in either ungated or gated operation, with user settable gate delays
Operation/Argon Purge	On-board, user replaceable argon cartridges for operating in argon purge environment. Air-based operation optional. Argon canister provides approximately 600 tests before replacement.
Analytical Range	Z-200: One or more lines from all elements except H, F, Cl, Br, N, O, Rb, Cs, S. Z-300: One or more lines from all elements in periodic table.
Laser Raster	On-board XY stage for rastering laser to discrete locations for targeted analysis or averaging. Raster pattern up to 16 x 16 grid, 256 locations.
Processing electronics	ARM Cortex -A9 dual-core / 1.2 GHz Memory: 1 GB DDR2 RAM, 1 GB NAND
Auto-focus	Z-direction stage, computer controlled for manually or automatically adjusting laser focus location on sample. Essential for liquids analysis.
Power	On board rechargeable Li-ion battery, rechargeable inside device or with external charger, AC power.
Display	5" color touchscreen Smartphone type display - PowerVR SGX540 3D graphic
Data Storage	Results Storage: 8 GB SD
Comms/Data Transfer	Wifi, Bluetooth, USB. Connectivity to most devices, including SciAps ProfileBuilder PC software.
Sample viewing	On-board camera/video for viewing sample before, during analysis, laser spot finder to show where laser strikes sample.
Apps	Alloy, Geochem factory calibrated, Empirical App for user-generated calibrations, ElementPro for qualitative analysis of any sample.
Calibration check	Internal shutter is also 316 stainless for totally automated calibration and wavelength scale validation.
Drift Correction	Only needed for higher accuracy analysis (argon purge). Automated drift correction using factory provided or user provided reference materials.
Grade library (alloy)	500+ grades, multiple libraries supported, grades may be added on analyzer or via PC software package (ProfileBuilder).
Security	Password protected usage (user level) and internal settings (admin).
Regulatory	CE, RoHS, USFDA registered. Class 3b laser. Sample sensor on-board, allows for operation under Class 1 conditions, subject to local LSO approval. CE, RoHS, USFDA registered.

Standard Accessories
Waterproof carrying case, 2 Li-ion batteries, charger, USB cable, Standard ProfileBuilder software for importing, editing alloy grade libraries (alloy App), viewing, saving results, data display. Wrist strap, Factory start-up training and support, Lifetime free software upgrades, Spare Prolene windows.

VIDEO http://goo.gl/EmIBKp

SciAps.com
For more information, or to schedule a demonstration.
339.927.9455
SciAps

SEE VIDEO http://goo.gl/EmIBKp

The Z Models

The Z-200
Spectral range 190 nm to 625 nm, 5-6 mJ/pulse, 50 Hz laser, argon purge. The Z-200 offers in-field analysis of key elements Li, Be, C, B, Na, Mg, Al, Si, Ca in addition to transition and heavy metals. The Z-200 analyzes may be calibrated to measure every element EXCEPT H, F, Br, Cl, O, N, Rb, Cs, S.

The Z-300
Full periodic table coverage. Spectral range 190 – 950 nm, 5-6 mJ/pulse, 50 Hz laser, argon purge. The Z-300 analyzes every element in the periodic table, including elements not available on the Z-200 including H, F, S, Br, Cl, O, N, Rb, Cs

The Z-50
Our basic air-burn analyzer. Operates in an air, rather than argon-purge environment. You can upgrade any Z-50 to an argon-purge version at any time.

Unique Features of the Z

Most Powerful Laser

High speed laser cleaning shots. Eliminates most surface sample prep.

Argon Purge. Precision and detection limits improve by up to 10x with argon purge.

Eliminates bad burns. On-board camera and laser targeting eliminates poor quality "burns."

Android OS and Data SHARE Apps. Share data direct to phone, sync with any computer globally, print to wireless printers. Eliminate inefficient data downloading forever

SciAps Z Series

Specifications

The most advanced, most precise laser-based (LIBS) analyzer available.

The Z uses the LIBS technique – laser induced breakdown spectroscopy. Like OES, LIBS delivers very accurate chemistry provided it's operated in an argon purge environment, although it is available with a lower cost air-burn option.

CARBON
C

CARBON!
You want to measure carbon in alloys, and the Z is the only handheld analyzer on the planet that accomplishes this.

Also from SciAps

The X, our industry leading family of handheld XRF analyzers.

The **"One-Box"** - Analyze any element in the periodic table, any sample type, with optimal performance.

New
Z Series **LIBS**

SciAps.com
For more information, or to schedule a demonstration.
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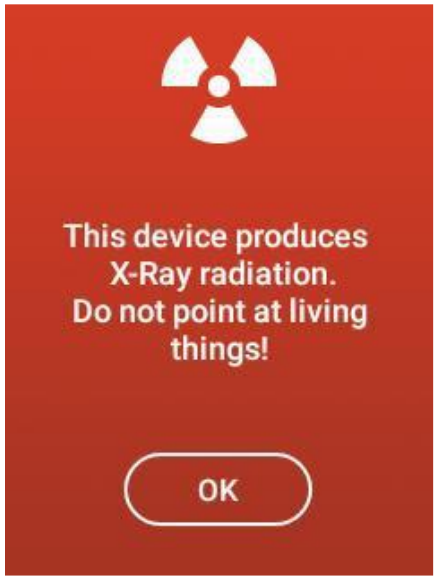
DEMONSTRATION...



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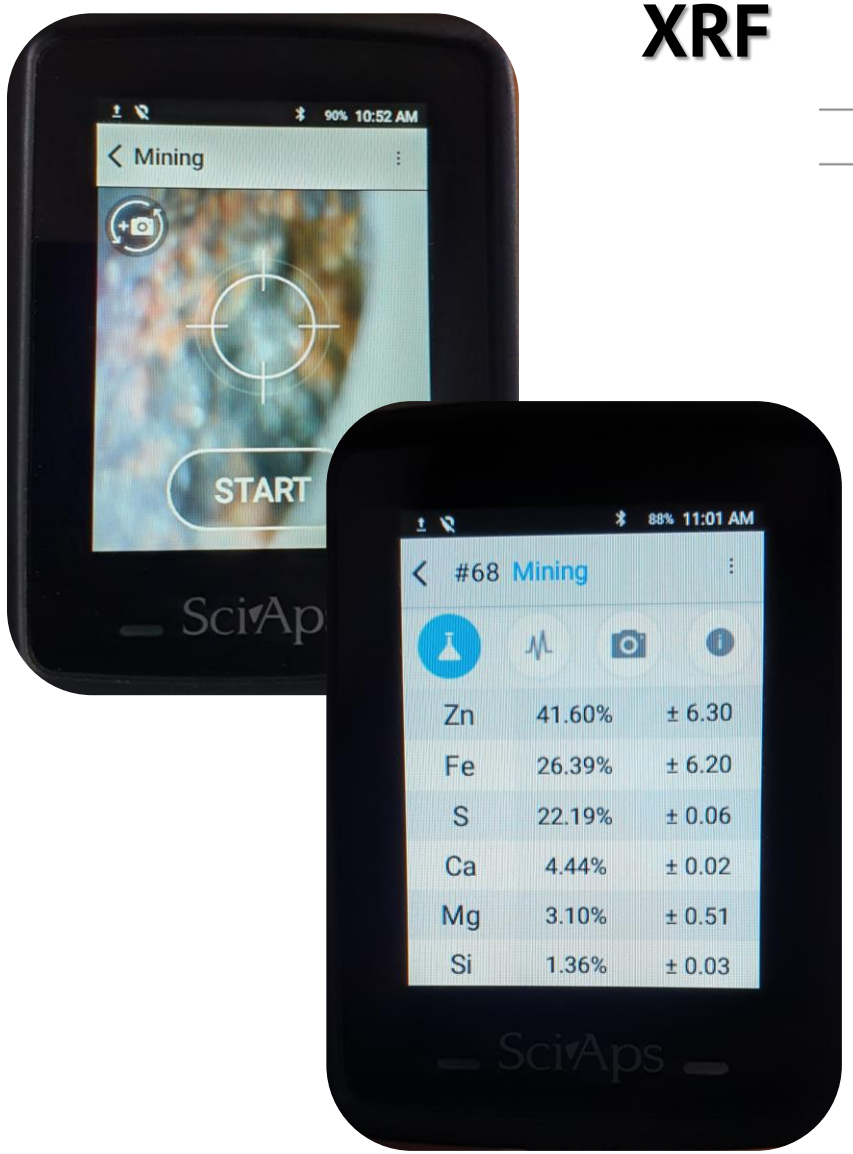
XRF



SciAps
ANALYZE YOUR WORLD

Material Test Report

Test #68 10:38AM, 10/21/2021

Mining

Sample ID : Nb. 01

Mg Magnesium 3.10% +/-0.513%	**Al** Aluminum 0.675% +/-0.078%
Si Silicon 1.36% +/-0.035%	**S** Sulfur 22.19% +/-0.055%
K Potassium 0.249% +/-0.007%	**Ca** Calcium 4.44% +/-0.018%
Fe Iron 26.39% +/-6.20%	**Zn** Zinc 41.60% +/-6.30%

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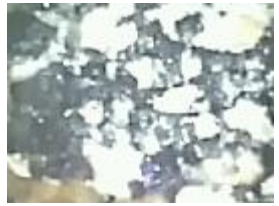
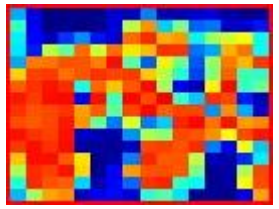
LIBS

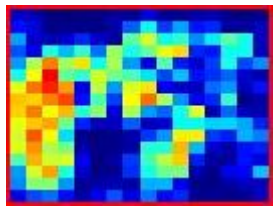


before

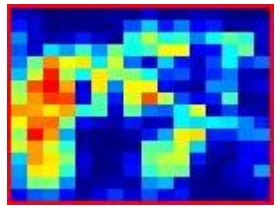
after



Zn



Fe



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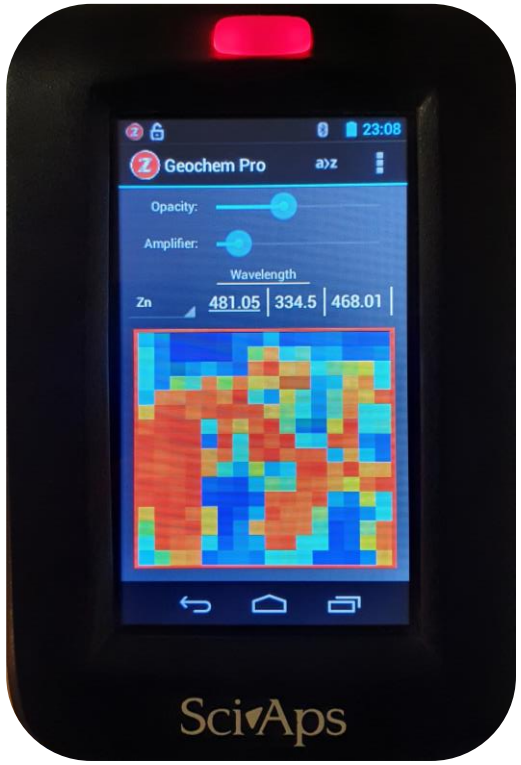

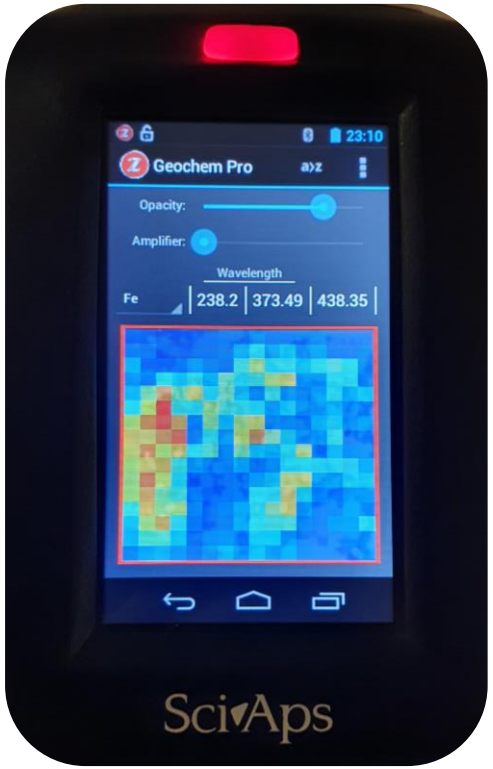

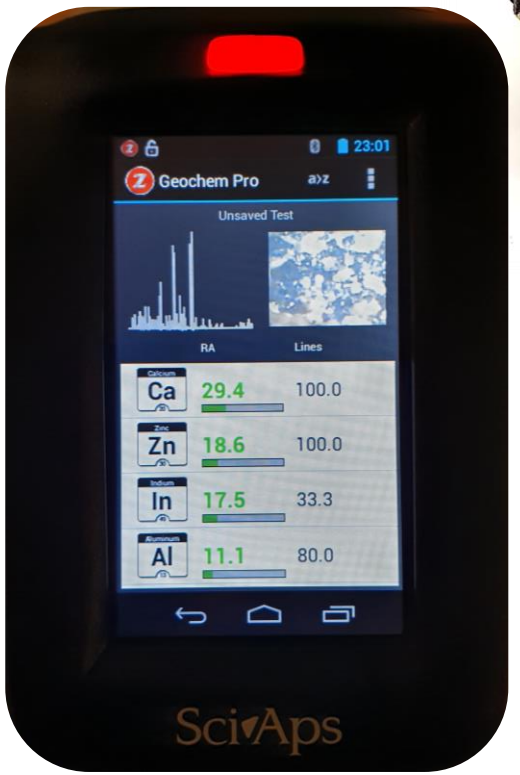

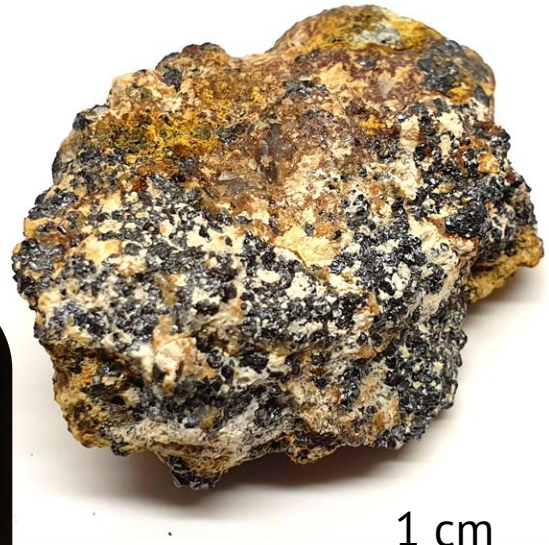

sphalerite
Kammerhof,
Nagybörzsony, Hungary

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DEMONSTRATION...

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Thank You for Your kind attention!

And thanks to Judit Jeney PhD, Máté Haraszti and Krisztina Abrusán (GL Europe Ltd.) for providing the devices and to our colleagues for the samples!

https://sciaps.com/libs-handheld-laser-analyzers/z-300/

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