

## **CHARACTERIZATION OF MATERIALS BY MEANS OF LASER-BASED TECHNIQUES**

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Laser-based techniques are more and more used in the field of materials processing and analysis.

In particular, laser spectroscopic techniques as the Laser Induced Breakdown Spectroscopy (LIBS) and Laser Induced Fluorescence (LIF) have been applied to investigate the chemical-physical properties and the morphological structure of several kinds of materials. Some results in different fields of application are reported.

# CHARACTERIZATION OF MATERIALS BY MEANS OF LASER-BASED TECHNIQUES

**POSTER P\_22**

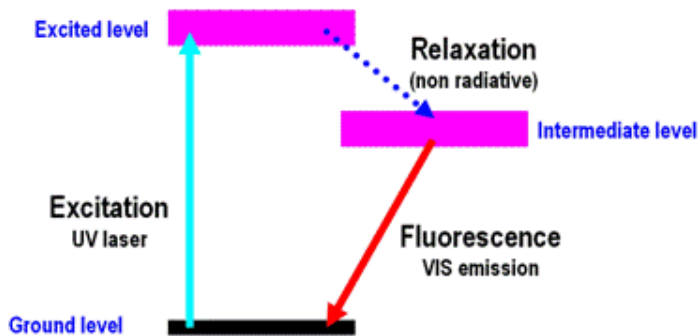
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# LIF TECHNIQUE FOR SURFACE ANALYSIS

Jablonski diagram



## Laser Induced Fluorescence Process

The emission of radiation by luminescent materials is observed whenever an absorption of energy sufficient to activate allowed electronic transitions occurs. Laser Induced Fluorescence is generated after the absorption of UV radiation.

## Methodology

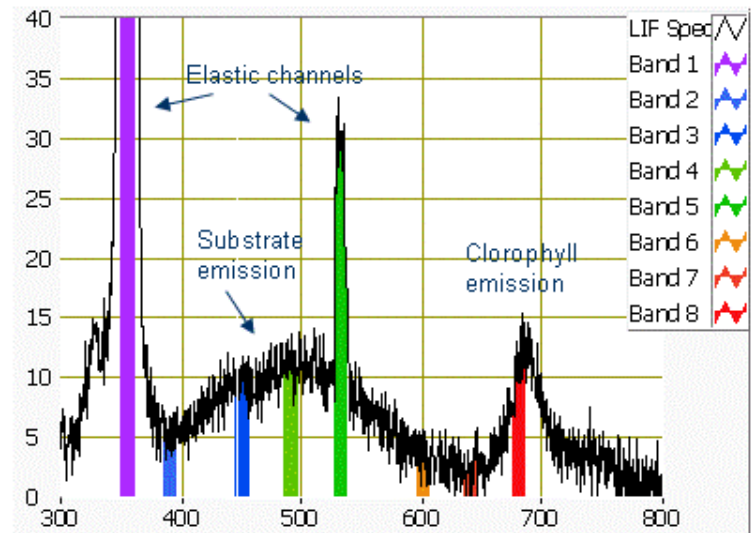
### Emission

Specific bands of the material

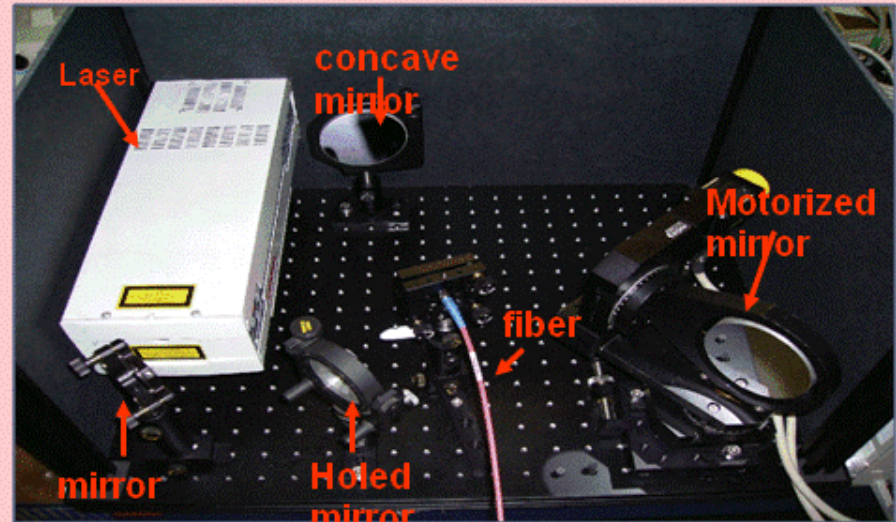
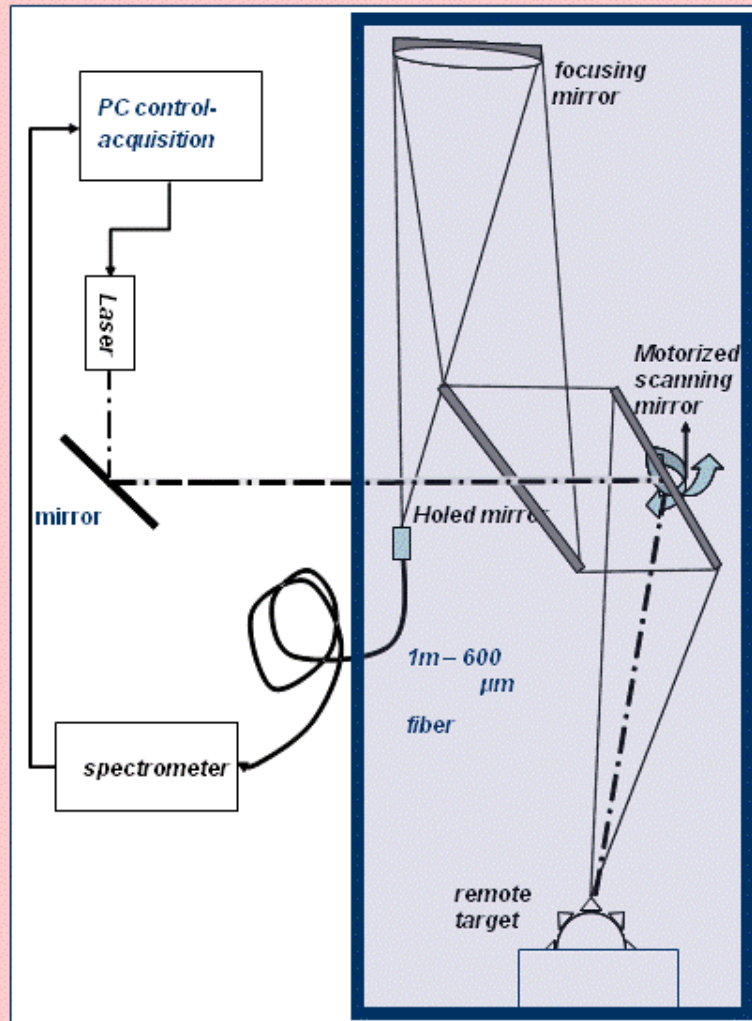
Excitation  
UV laser

SAMPLE

Typical LIF spectrum



# LIF APPARATUS



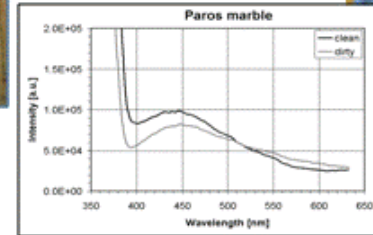
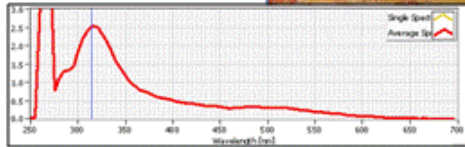
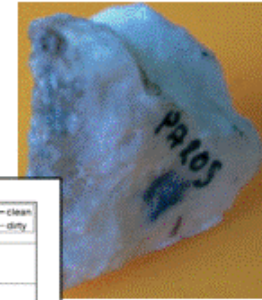
**Laser Nd:YAG** 266 nm, 355 nm  
3 mJ, 10 ns, 20 Hz

**Spectrometer** 250-1100 nm  
CCD Array

## System advantages

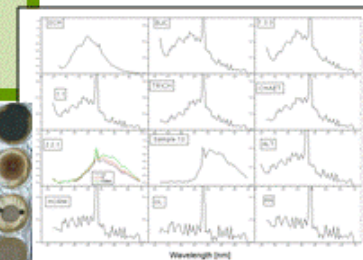
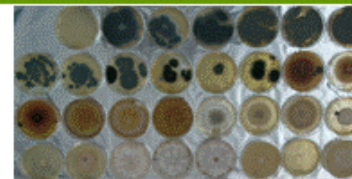
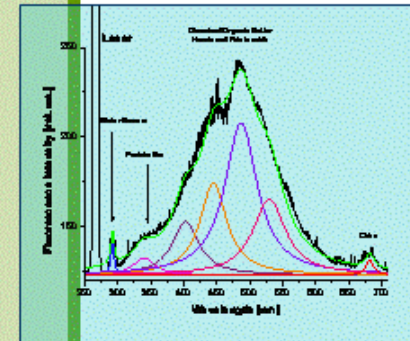
- Compact (58x43x36 cm)
- Remote (10m)
- Light (15kg)

LIF scanning Instrumentation for field campaigns  
Range 2 - 20 m      Resolution  $\approx$  mm



## LIF APPLICATIONS

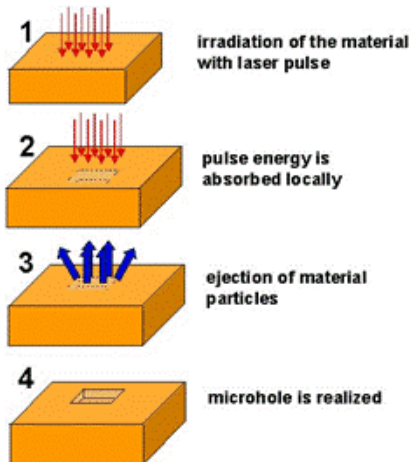
- Cultural Heritage materials: stones, painted woods, decorated ceramics, frescoes, pigments (inorganic, organic), binders (historical, modern)
- Building materials (marble, tuff)
- Biodegrading agent (fungi, algae, lichens)
- Environment (LIDAR Fluorosensor)



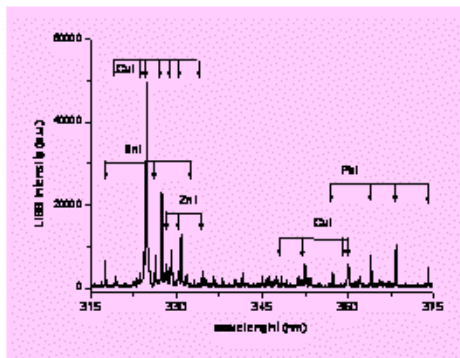
## **LIF specific advantages**

- Real time
- In situ, no sample preparation
- Non destructive, minimal invasiveness
- Not expensive

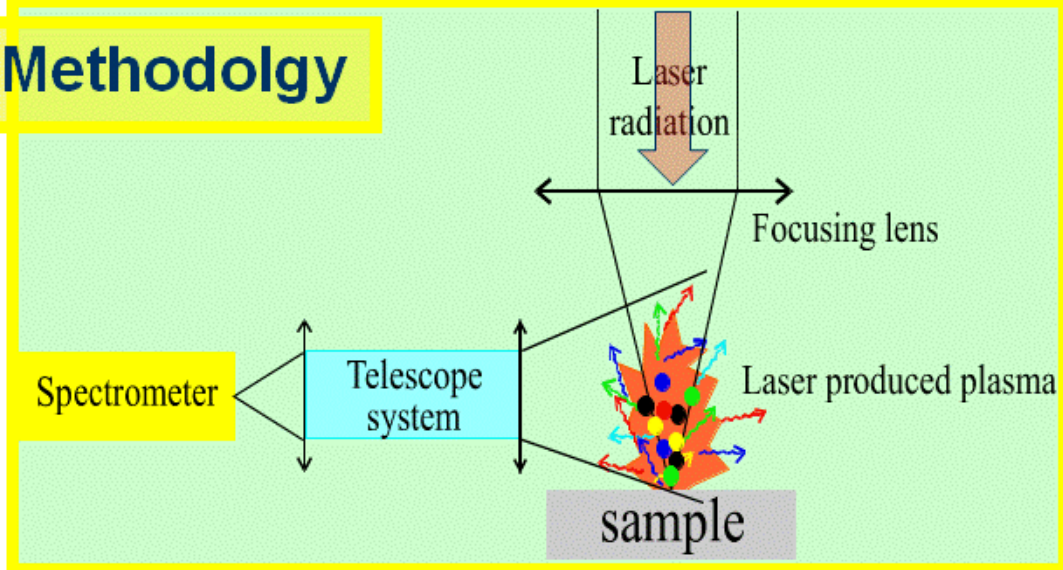
# LIBS TECHNIQUE FOR SURFACE AND SUBLAYERS ANALYSIS



Typical LIBS spectrum



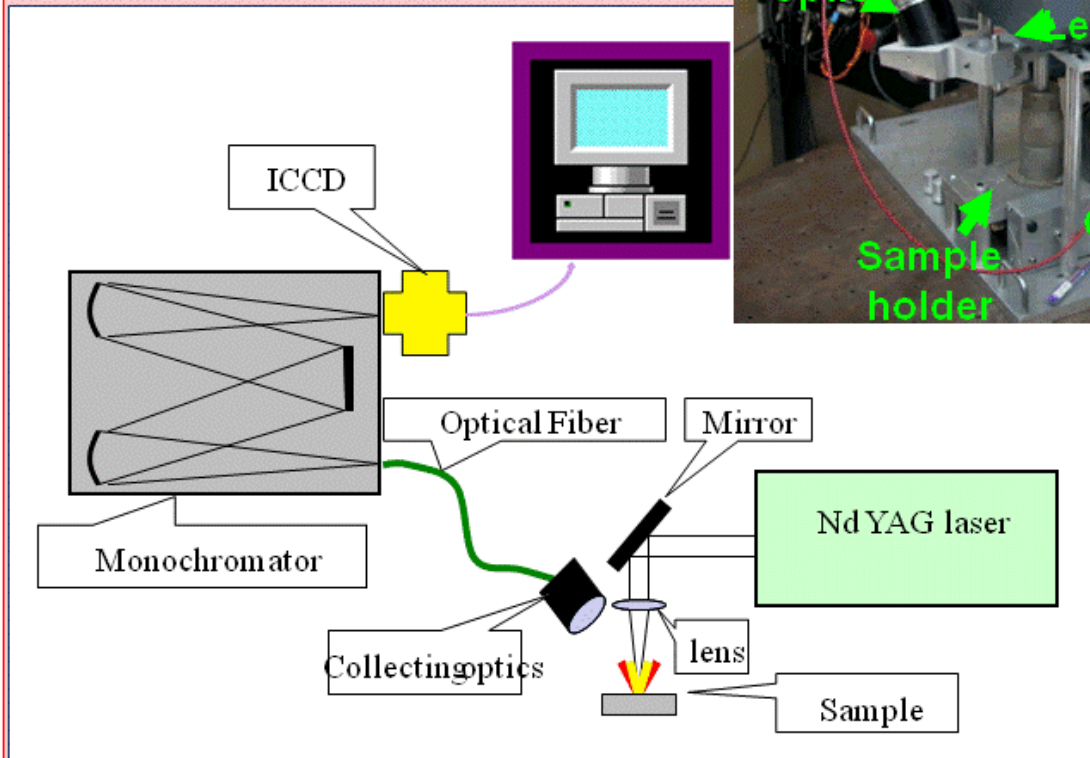
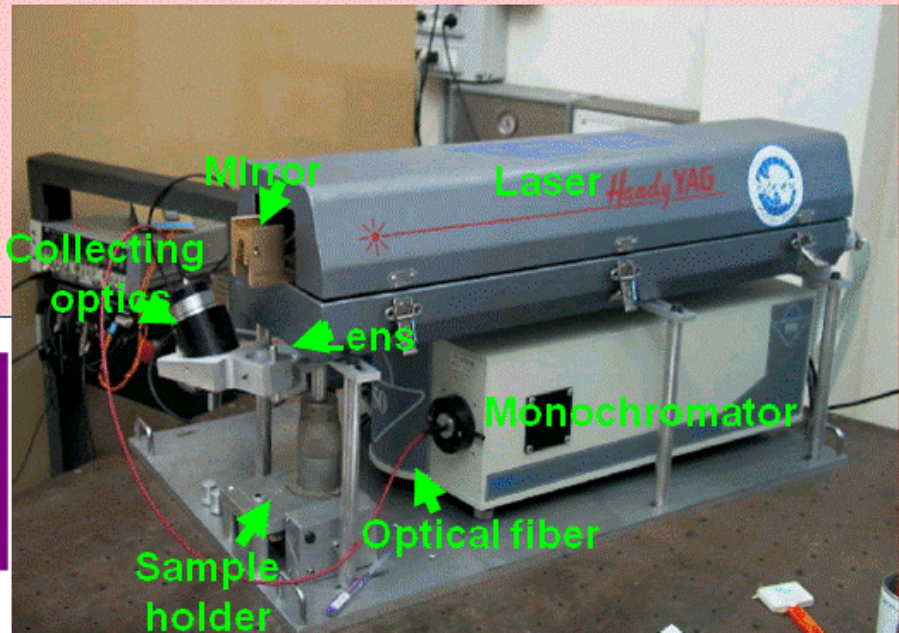
## Methodology



1. Laser induced ablation at the sample surface
2. Plasma expansion and decay
3. Time resolved acquisition of the spectrally resolved signal

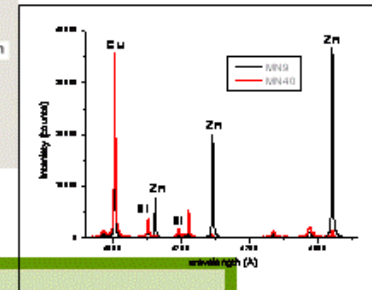
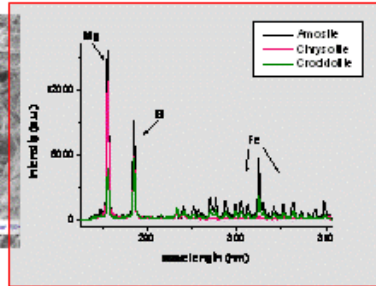
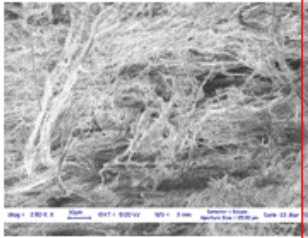
# LIBS APPARATUS

**Laser Nd:YAG** 1064 nm, 8 ns  
20-400 mJ,  
10 Hz  
**Detection unit** 180-850 nm



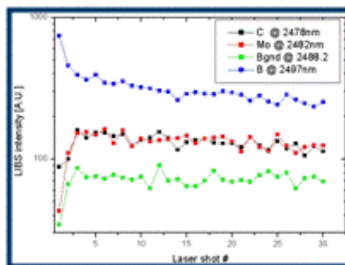
Acquisition parameters (Energy laser, shots number, Delay, gate) depend on the specific application.



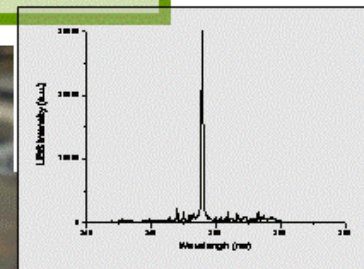


## LIBS APPLICATIONS

- **Environment** (soils, sediments, asbestos) and planetary exploration (rocks, dust)
- **Artwork** (ceramics, pigments, bronze alloys, marble, fragile substrates)
- **Security** (Explosives, Bacteria, nuclear isotopes)
- **Fusion machine analysis**



Stratigraphic analysis



## **LIBS relevant advantages :**

- Quick technique
- no sample preparation is required
- It is sufficient to ablate less than 1  $\mu\text{g}$  of material at the sample surface
- *in-situ* measurements
- possible use in hostile environment
- on-line data analysis

# CONCLUSIONS

- Laser-based techniques can be used in the field of materials analysis with good results
- Many fields of applications are possible
- The experimental conditions need to be improved and optimized according to the specific application.