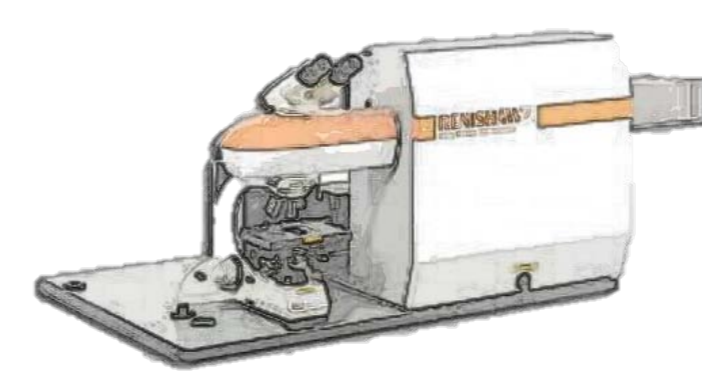


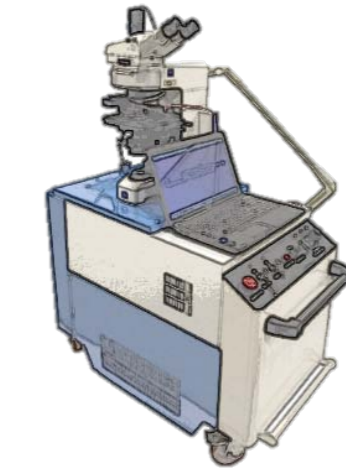
Spectroscopic techniques in cultural heritage diagnostic

Applied Laser Spectroscopy Lab at ICCOM-CNR

- Spectroscopic techniques to solve problems associated with the characterization of historical and modern artworks
- Some of these techniques can be applied without sampling (non-invasive/micro-invasive)
- Many of them can offer spatial resolution up to square microns and in-depth profiles.



Raman and Surface Enhanced Raman Spectroscopy



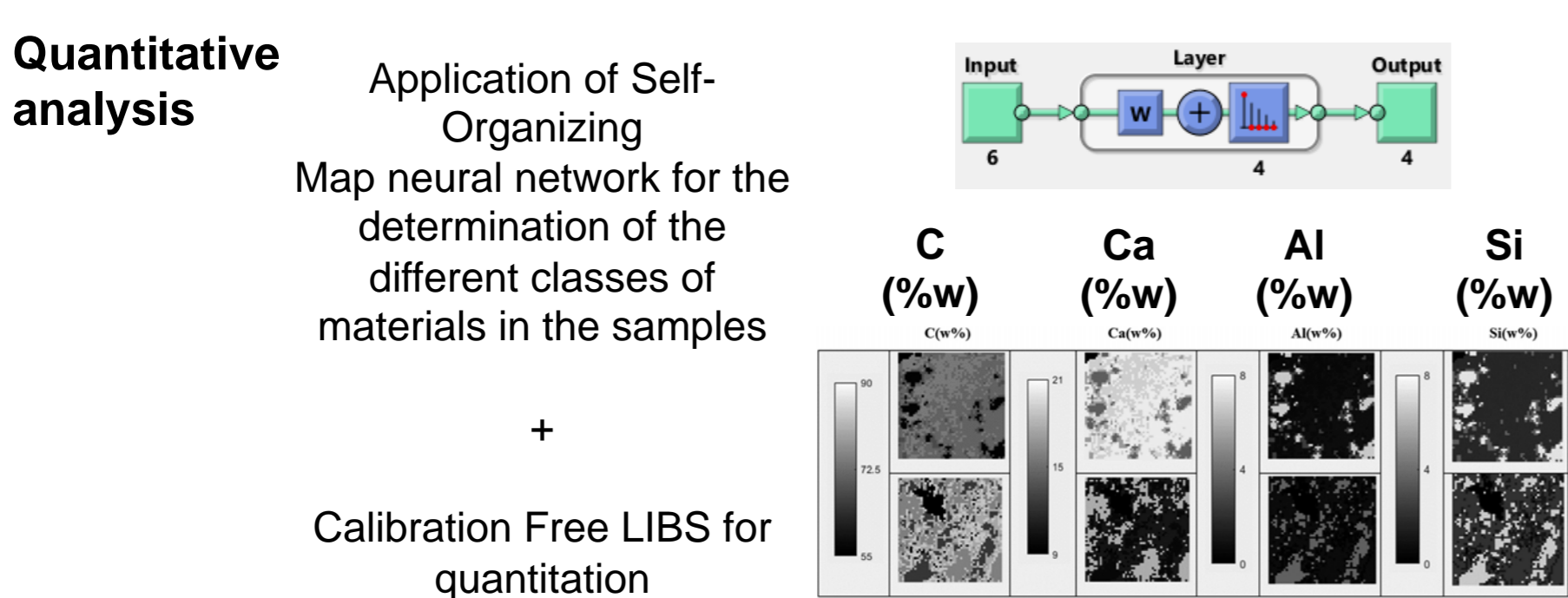
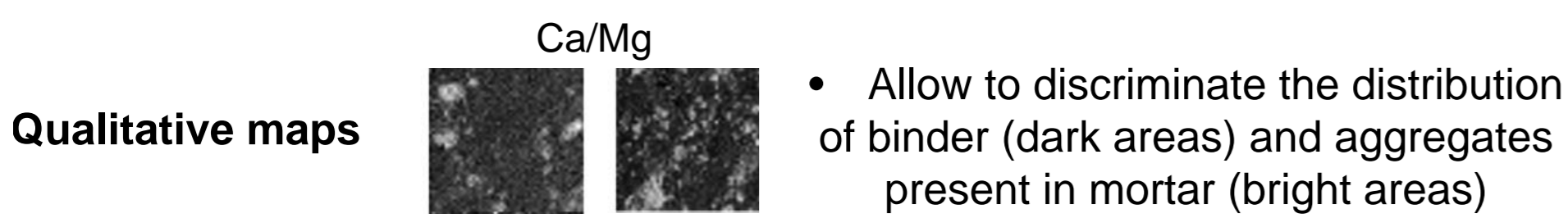
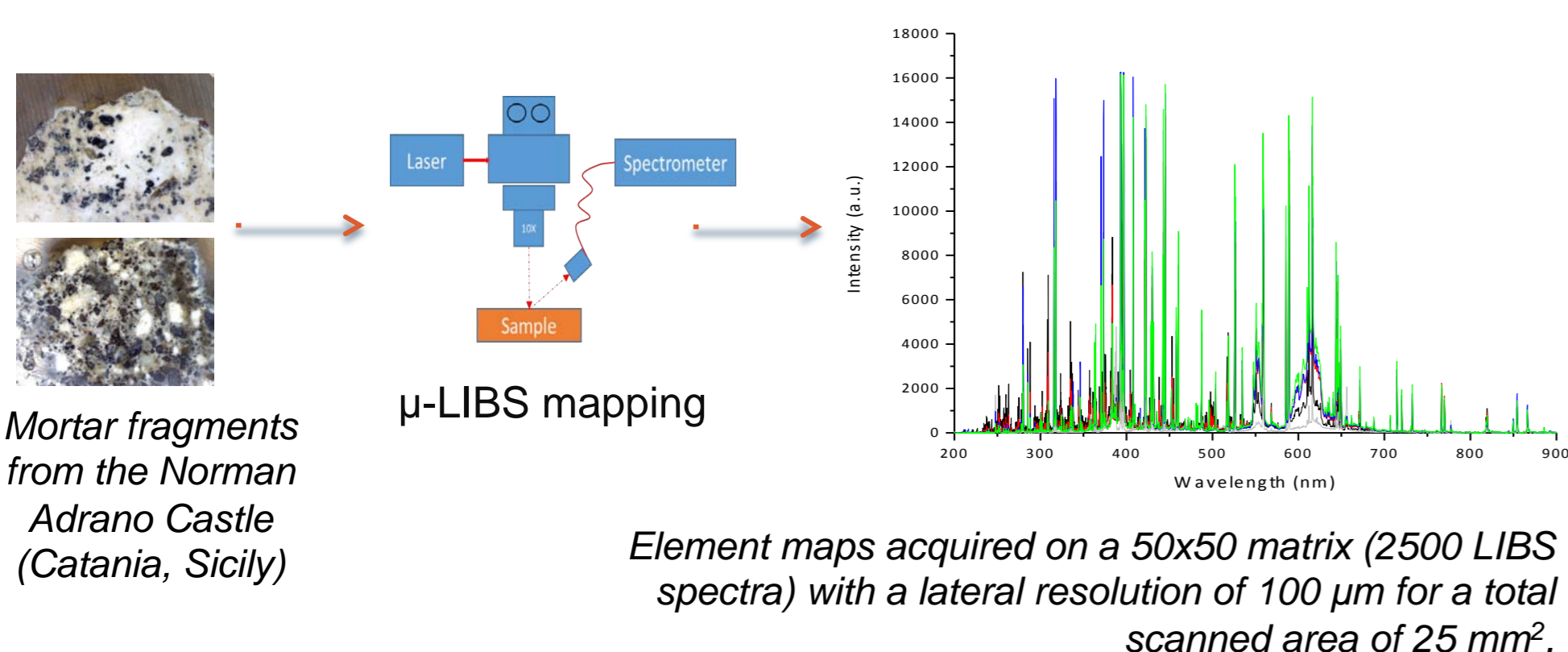
Laser Induced Breakdown Spectroscopy (LIBS)



Multispectral Imaging

Case studies

1_ Studies on ancient mortars



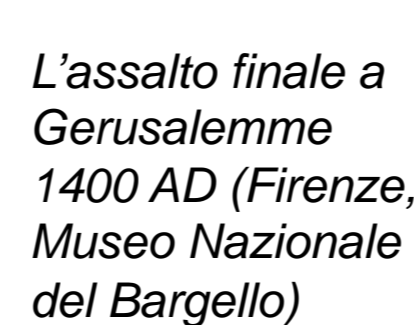
- The composition of the sample can be obtained with a precision of ±1% on the major elements

2_ Studies on historical textiles

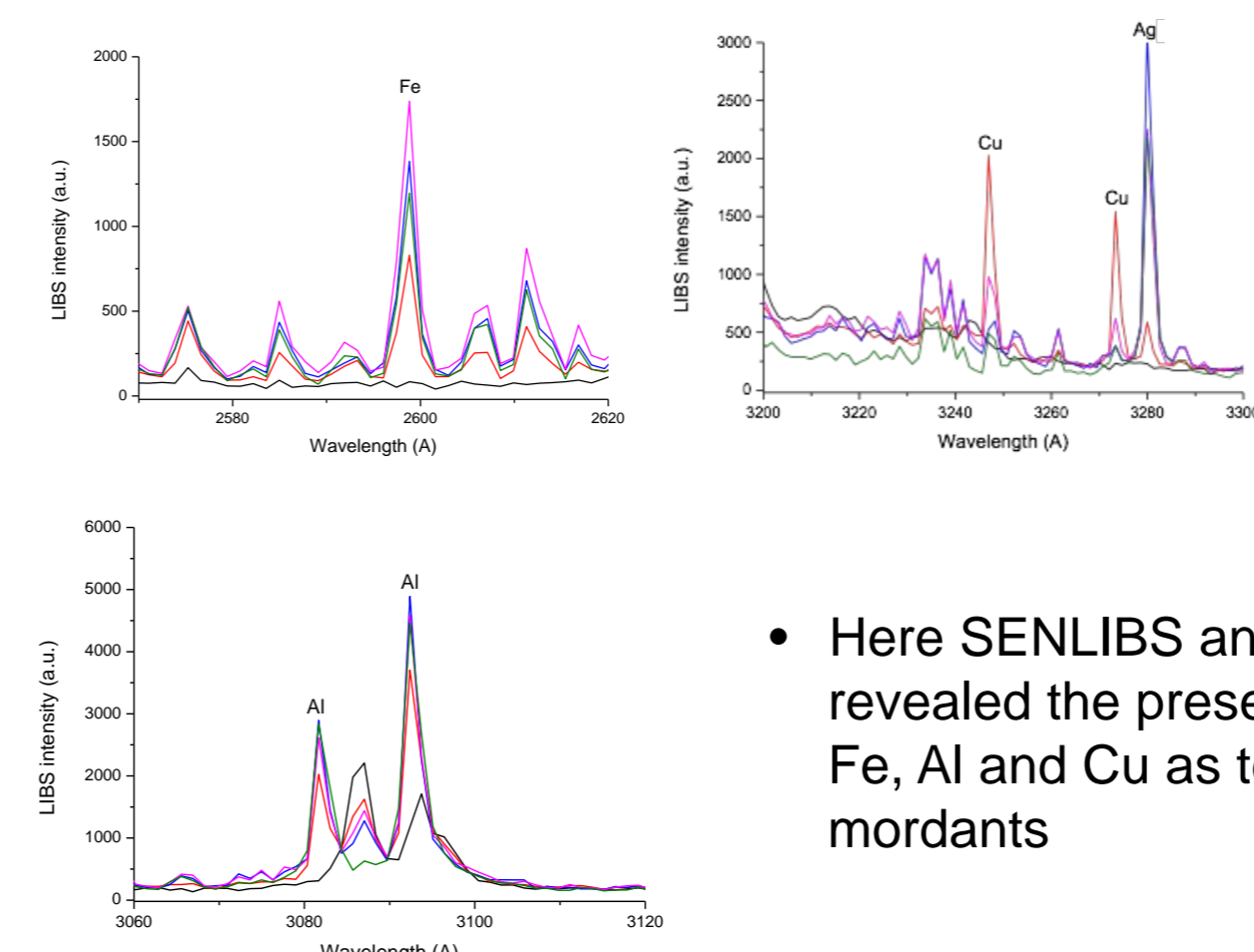
- Identification of **both** the organic and inorganic fraction of colourants for their complete characterization and to assess the technologies used in their production.
- The basic idea of this work: to demonstrate the feasibility of analyzing textiles aqueous extracts by Surface Enhanced Laser-Induced Breakdown Spectroscopy (SENLIBS) for trace elements identification.



Fragment of Coptic textile, (Museo Egizio, Torino)



L'assalto finale a Gerusalemme 1400 AD (Firenze, Museo Nazionale del Bargello)



- Here SENLIBS analysis revealed the presence of Fe, Al and Cu as textile mordants

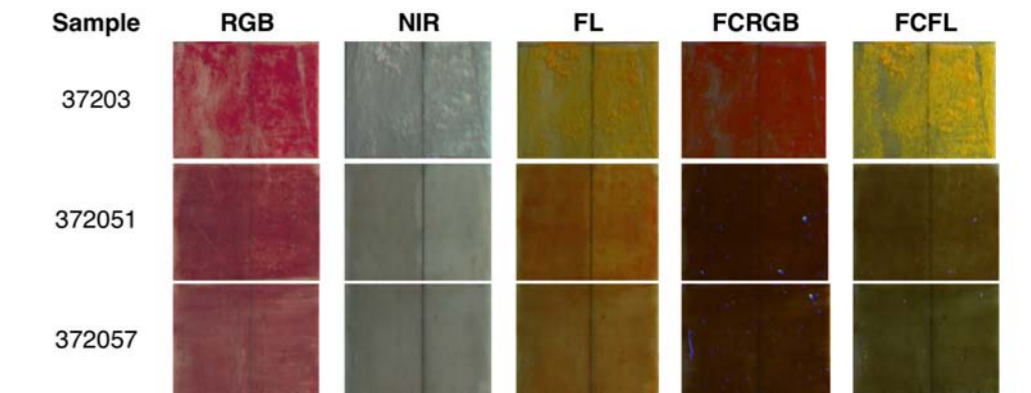
3_ Studies on madder lakes

- Comparison of micro-destructive and non-destructive methods for the comprehensive characterization of the organic and inorganic fraction of reference madder lakes.

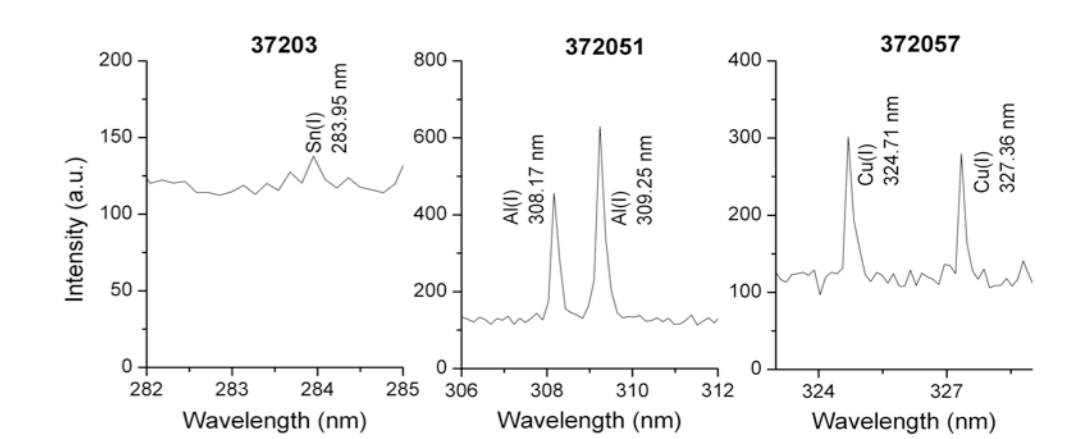
Sample	RGB
37203 (Sn)	
372051 (Al)	
372057 (Cu)	

Linseed oil, rabbit glue and gypsum were used for mock-ups preparation

Step 1: Visual examination by multispectral imaging



Step 2: Non-destructive (XRF) and micro-destructive (LIBS) analysis



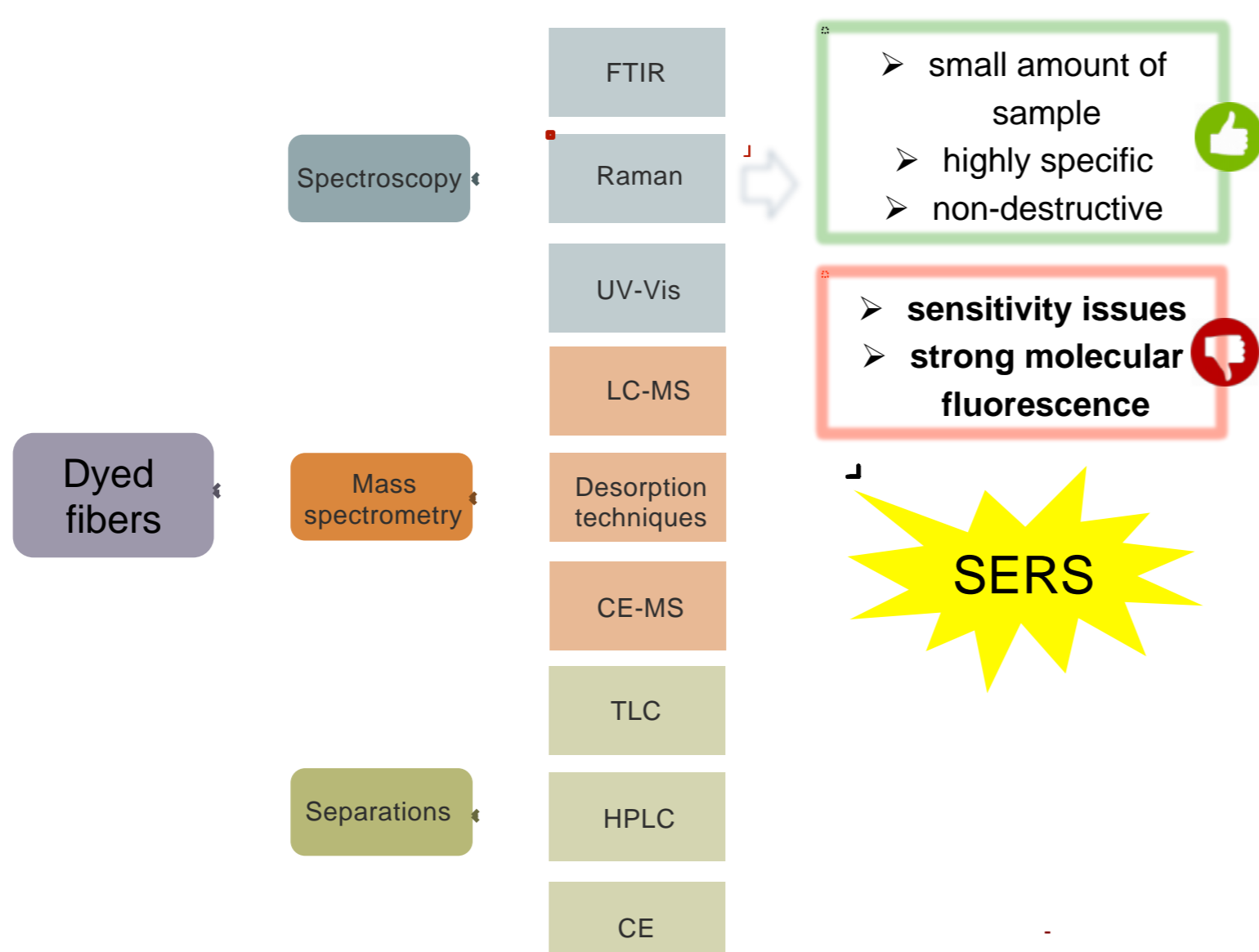
Step 3: Destructive analysis (HPLC-DAD-Fluorescence)

On-fiber SERS analysis of natural dyes in historical textiles

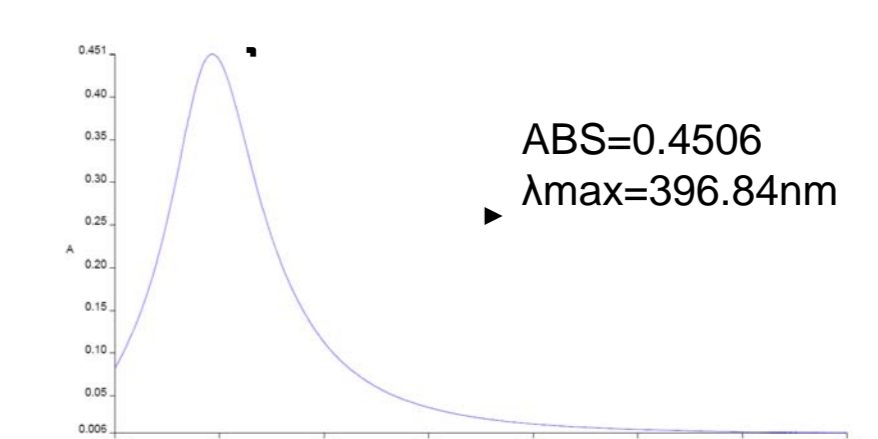
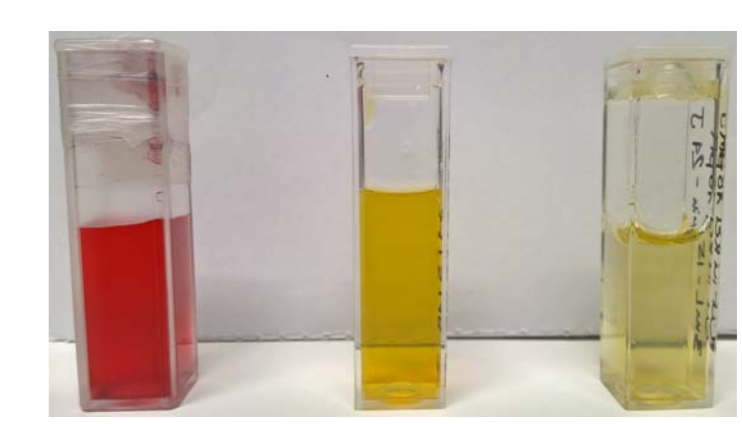
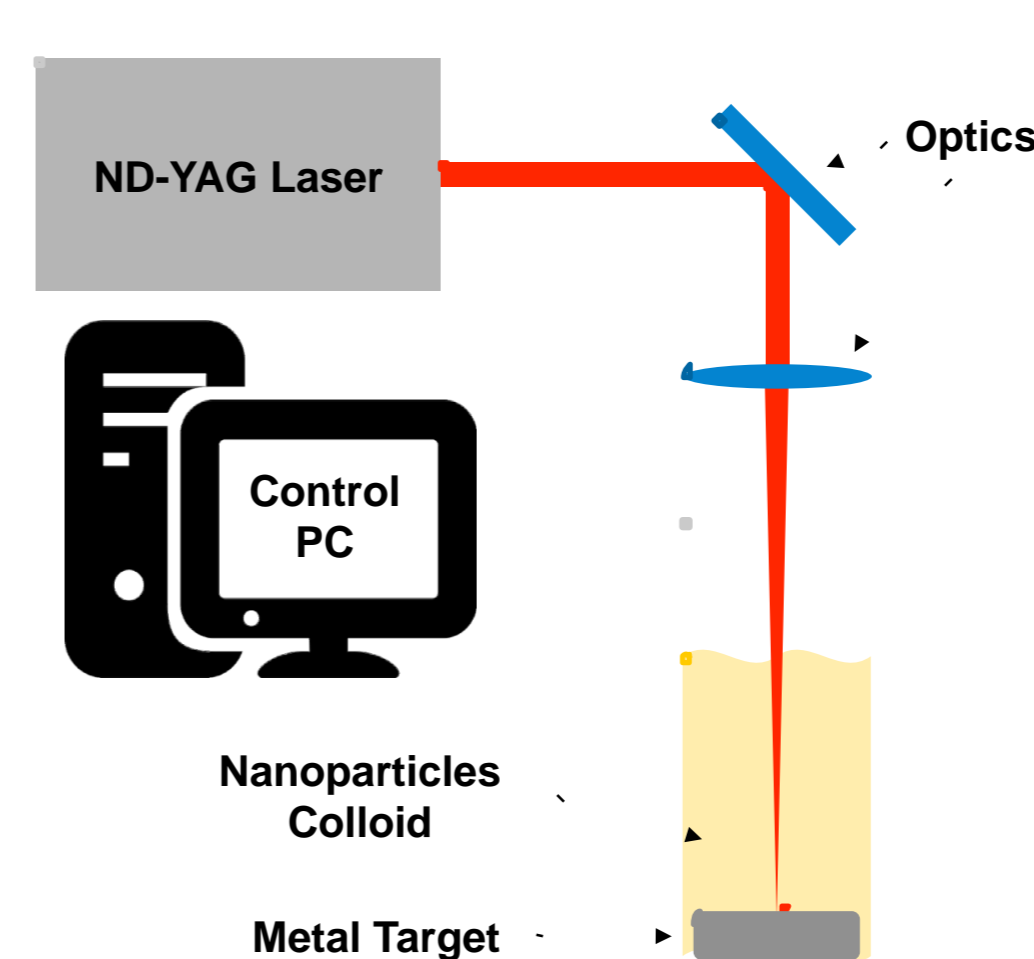
Chemical analysis of organic colorants

Role of dyes analysis in cultural heritage applications:

- determination of the artwork provenance
- determination of original appearance of the materials
- planning of a proper conservation intervention

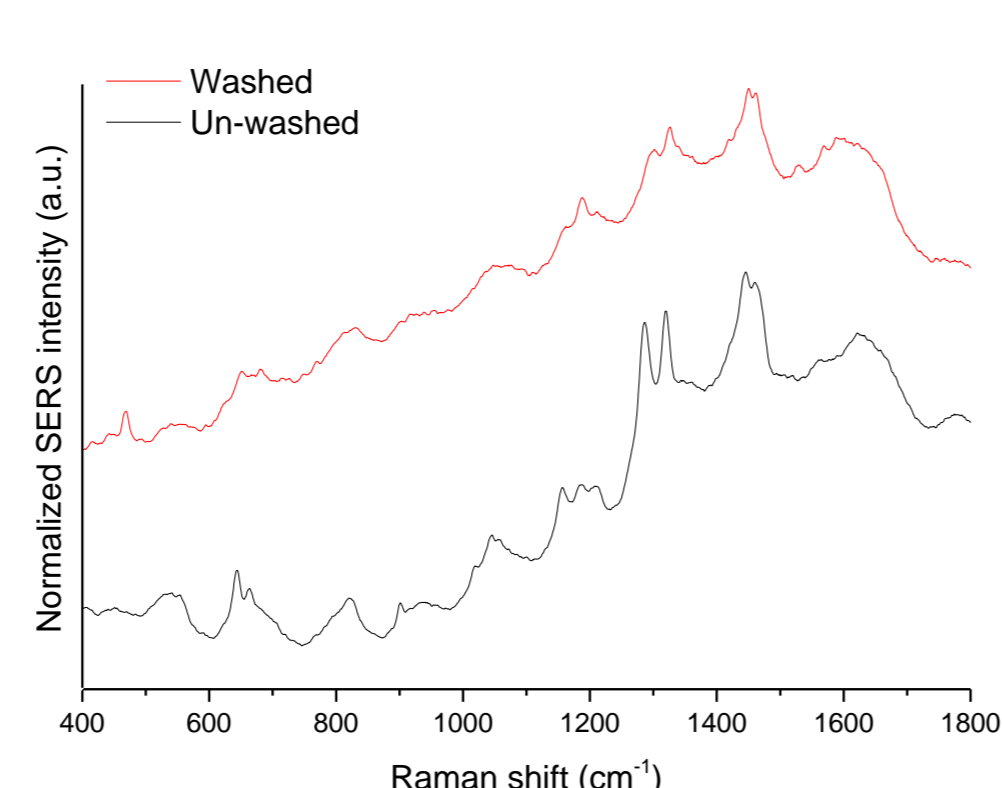
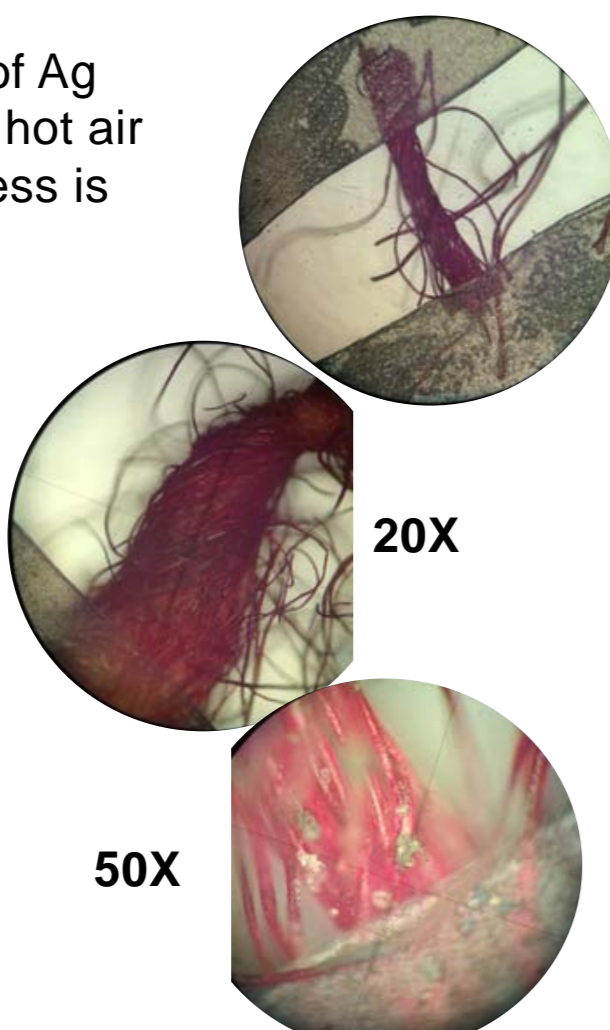


Laser Ablation Synthesis in Solution of metal nanoparticles

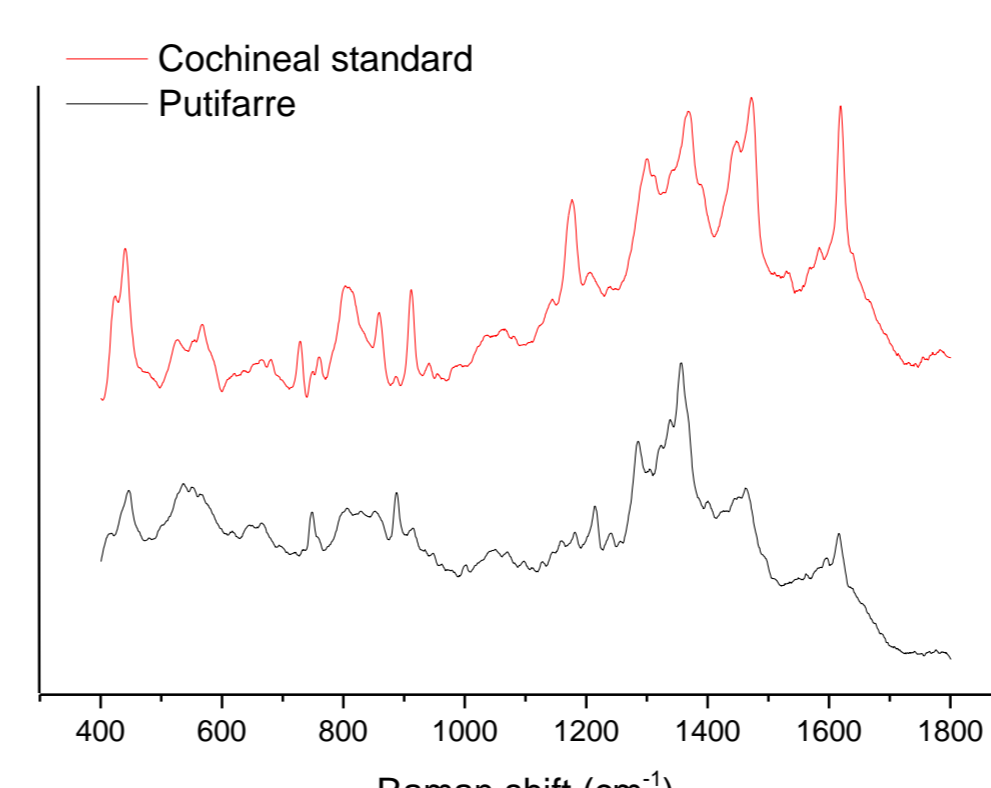


On-fiber analysis

- For SERS analysis, 5 μL of Ag nanoparticles are dried with hot air on a glass slide. The process is repeated 5 times.
- The dried nanoparticles are rubbed on the fiber surface
- The fiber is then fixed to a glass side and analyzed.



- Al³⁺ mordanted alizarin on wool: the SERS signal is obtained from un-mordant colorant molecules. If we clean the fiber with methanol, the signal decreases



- Real sample analysis (fragment of "Giuseppe scappa dalla moglie di Putifarre")

On-fiber LIBS analysis to evaluate the amount of silver on the sample: after SERS, the fiber is cleaned with few microliters of sodium citrate solution

