LPSC 2015 #1406

Developing a relationship between LIBS spectra and pit volume for in situ dating of geologic samples.

Damien Devismes[1] (damien.p.devismes@nasa.gov)
Barbara Cohen[2], P.-Y. Gillot[3], J.-C. Lefèvre[4], C. Boukari[3].

1- NPP Orau - Planetary NSSTC, NASA Marshall S.F.C., 2- Planetary NSSTC, NASA Marshall S.F.C., 3- GEOPS, Université Paris-Sud, France, 4- Archéométrie et Archéologie, Université Lyon2

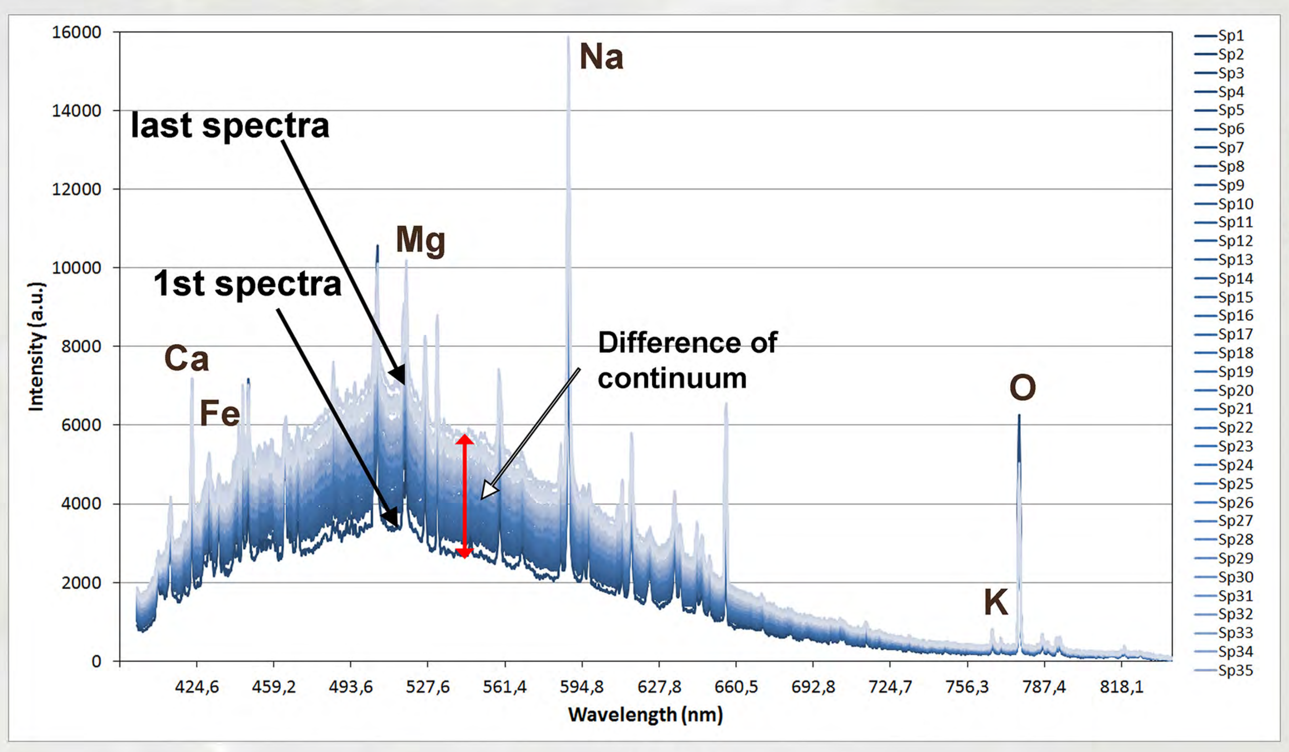
Why?

One of the most important pieces of data we need to acquire on Mars is the absolute age of its surface. Currently, we can only estimate the age of the surface with crater counting. The uncertainty in these estimates in absolute ages can be considerable, particularly for surfaces 2-3 Ga.

What are the goals?

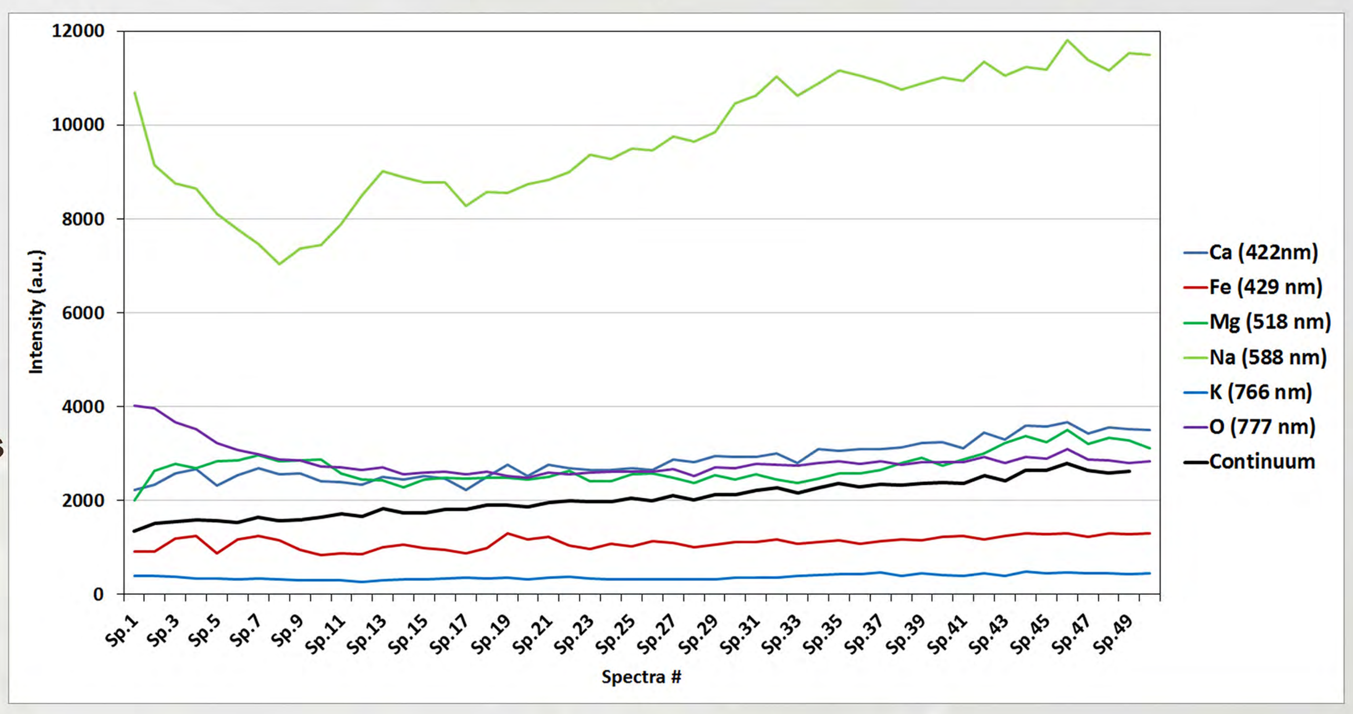
In situ age dating using LIBS-MS techniques requires volume measurement
-> Determining if we can use the relationship between the LIBS spectra and the pit volume of the sample for rock dating.

Evolution of the spectra during the ablation



Evolution of 50 spectra acquired during 50 seconds of ablation on 93-PP-120 (500 pulses at 100 mW, 10 Hz, laser wavelength: 266 nm).

Evolution of the intensities of the peak of the main elements and of the continuum for the ablation of 50 seconds. Each spectrum is the sum of 10 pulses



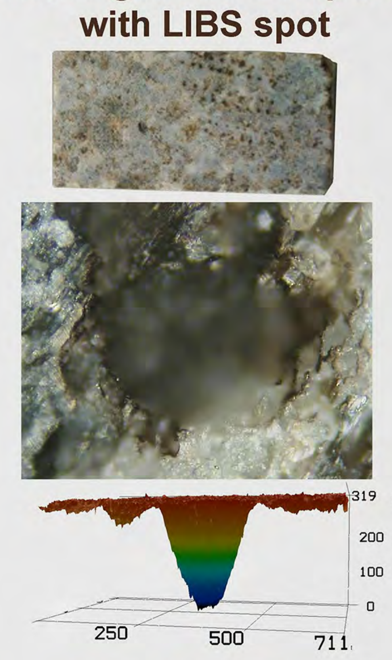
Protocol of this work:

- Using different rocks representative of Martian geology
1- Acquiring LIBS spectra for the ablations of 500 pulses (50s at 10Hz, 266 nm laser wavelength, 0.1W)
2- Examining LIBS spectra, their continuum and the ablation volumes
3- Understand the most important parameters for accurate measurement

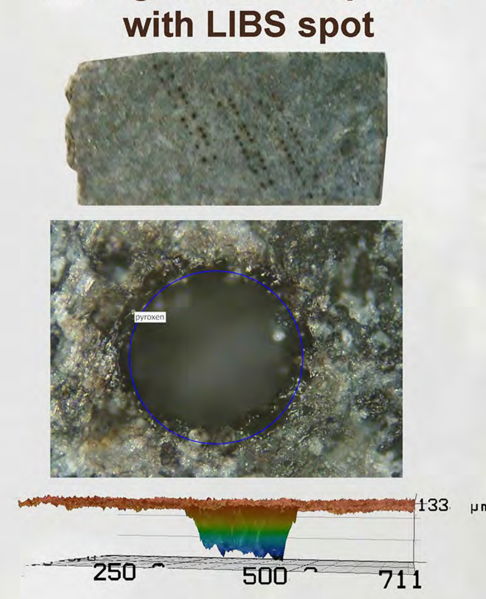
The samples:

Basaltic sill samples from the Dry Valleys, Antarctica (courtesy B. Marsh), gneiss and jarosite-limestone samples.

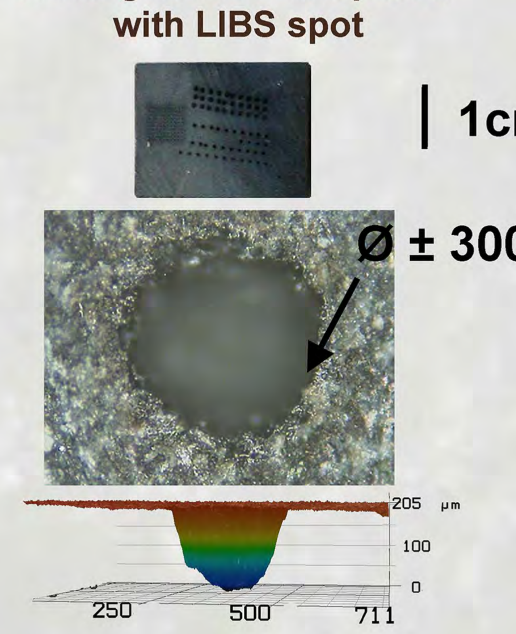
94-LV-191
Mean grain size: 2-4 mm
Coarse-grained compared with LIBS spot



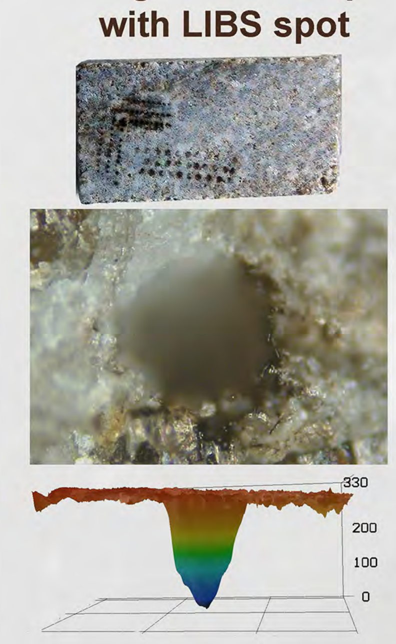
93-PP-115
Mean grain size: ~50 µm
Fine-grained compared with LIBS spot



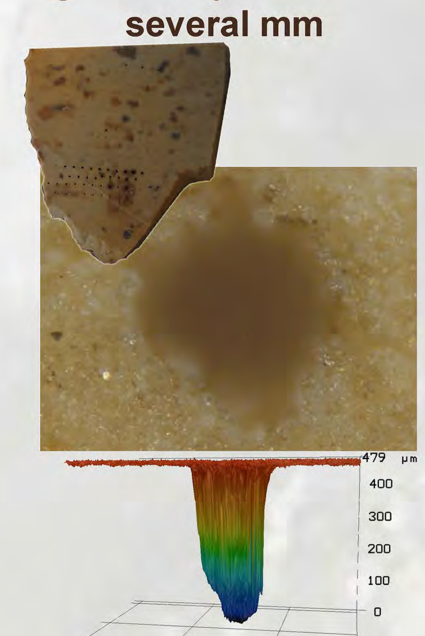
93-PP-120
Mean grain size: ~20 µm
Homogeneous compared with LIBS spot



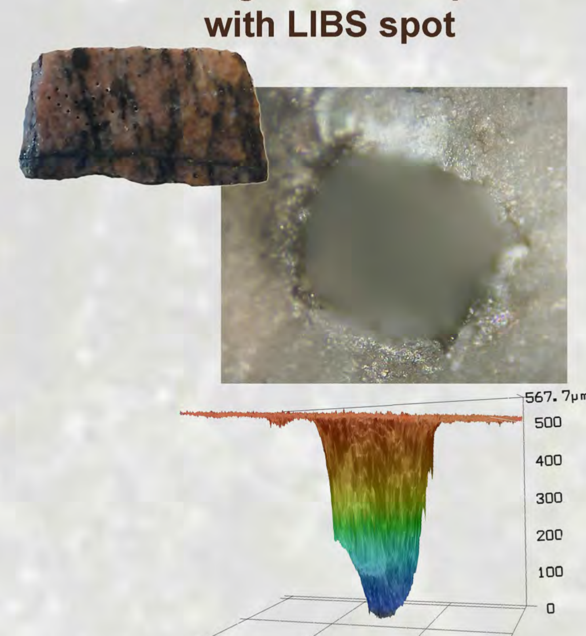
94-LV-182
Mean grain size: 2-6 mm
Coarse-grained compared with LIBS spot



Jarosite
Dolomite with dispersed grains of jarosite of several mm

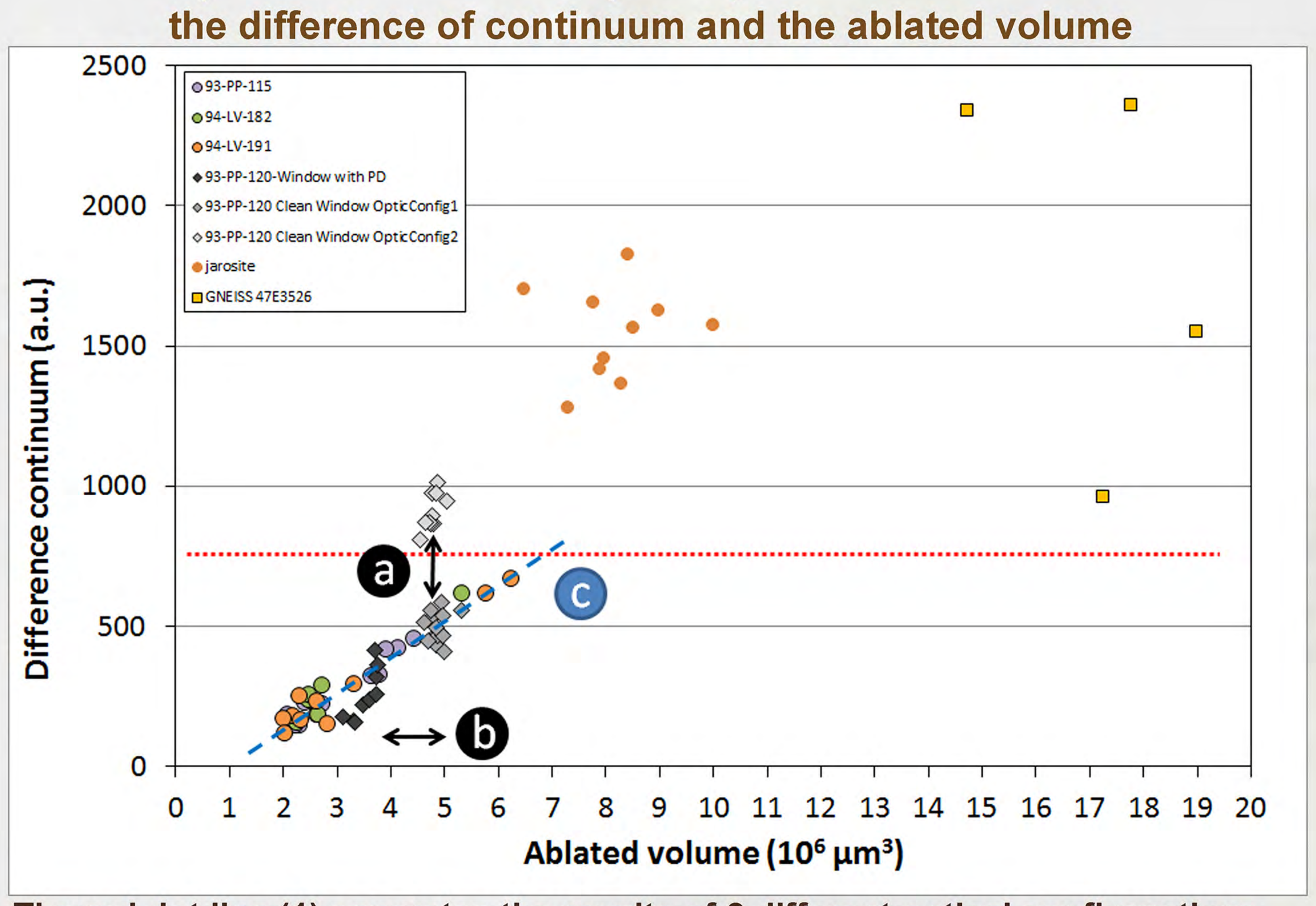


Gneiss 47E3526
Mean grain size: 2-5 mm
Coarse-grained compared with LIBS spot



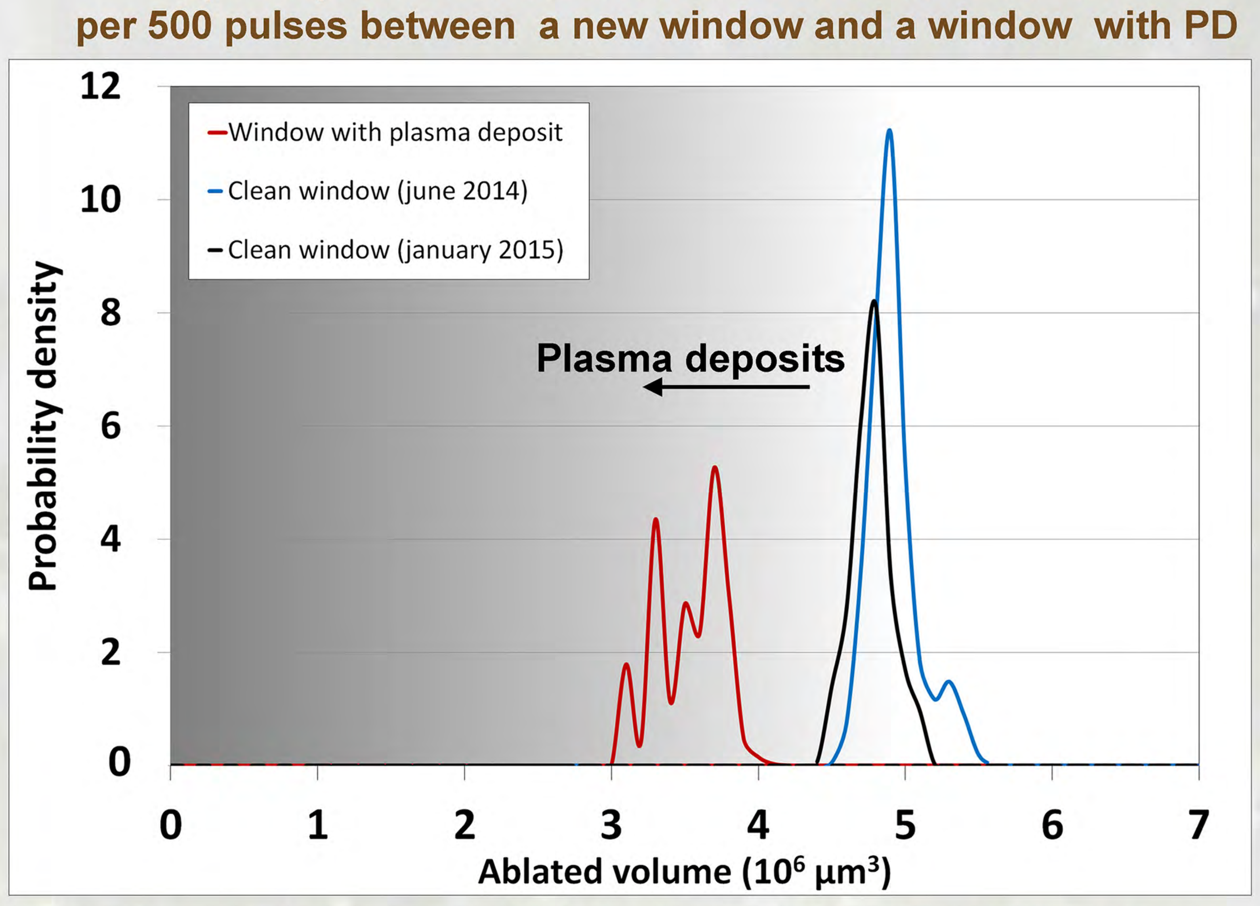
EFFECTS OF PLASMA DEPOSITS AND OF THE OPTICAL CONFIGURATION

1) For ablations of 500 pulses, correlation between the difference of continuum and the ablated volume



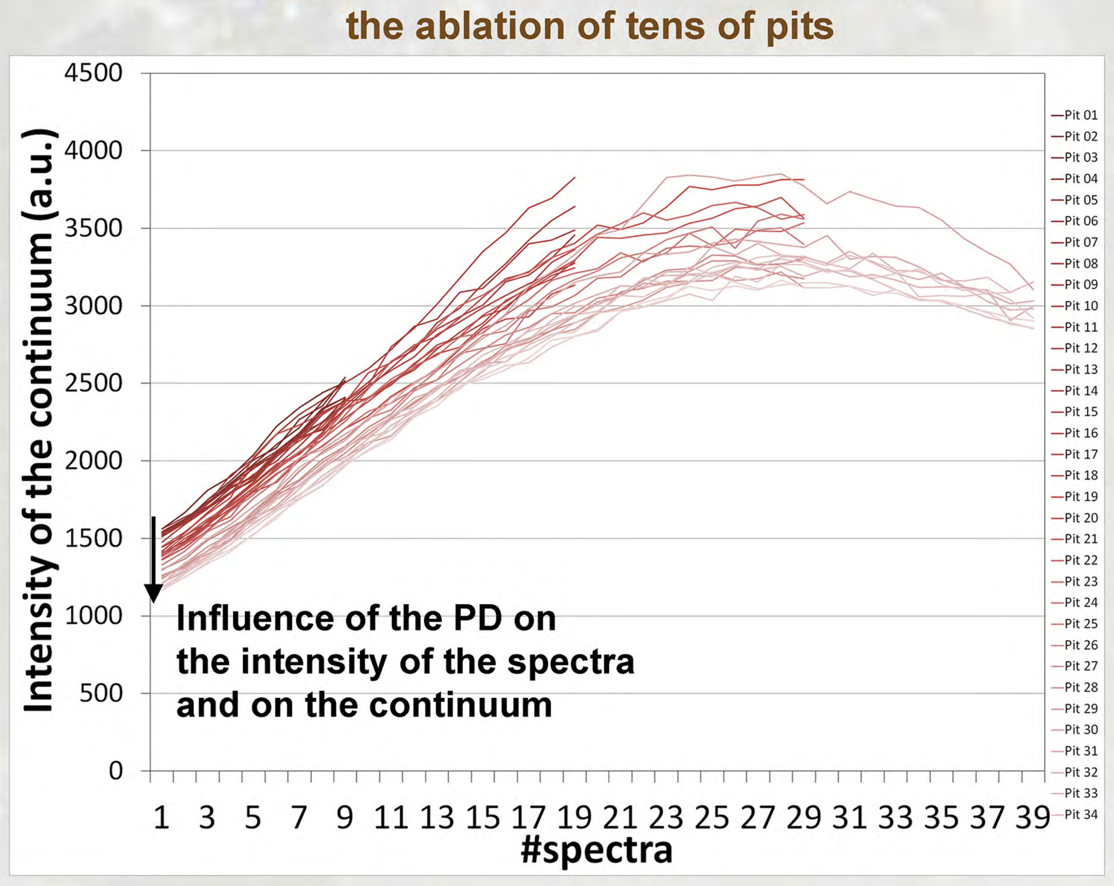
The red dot line (1) separates the results of 2 different optical configurations.
The 'difference of continuum' parameter increases by a factor of 2 (a).
The effects of the plasma deposits (PD) is to decrease the volume for the same number of shots (b). Both of these effects modify the correlation (c).

2) Comparison of the ablated volume on 93-PP-120 per 500 pulses between a new window and a window with PD



The difference between the ablated volume with or without PD can have a difference of 30% and even more. It also decreases the reproducibility.

3) Evolution of the continuum during the ablation of tens of pits



The intensity of the continuum decreases as the number of shots (and therefor PD) increases. Each line represents the continuum during the ablation of one pit of hundreds of pulses.

Conclusion

- We continue to use various samples with many different parameters in order to determine, understand and use the continuum data to estimate the ablated volume.

- In this setup, the window is at 8 cm from the standard sample and so the deposits easily cover the window. The consequences are multiple. First the LIBS spectra intensity reduces with the PD (it could reduce the intensity of the spectra by 2 after about 110 ablations of 1000 pulses). The PD also reduced the efficiency of the ablation.

- The correlation between the continuum and the volume only works with well defined parameters. It needs to be enhanced to extend the possibilities and the quality of this approach. Nevertheless several limits have been defined and we could already use this approach to complete the experiment.

- The implications of these results on the design of the experiment are important even if this setup (University Paris Sud) is different than the setup planned to do in situ measurement.