Remote LIBS with femtosecond laser pulses

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We have demonstrated remote laser induced breakdown spectroscopy (R-LIBS) with femtosecond laser pulses, using a container-integrated mobile femtosecond terawatt laser system with integrated detection unit (Teramobile). The detected fluorescence exhibited a clear spectral signature of the sample due to the ablation induced by laser pulses on the targets located at a distance up to 180 m away from the laser system. The ability of our laser system to generate pulses in the femtosecond, picosecond and nanosecond regimes allowed us to perform direct comparisons between these three pulse durations.

The spectra obtained in the femtosecond regime exhibited a low and clean background, while those obtained with picosecond or nanosecond pulses were superimposed on a background with oxygen and nitrogen atomic spectral lines from ambient air. A decay time of several microseconds was observed for fluorescence excited by both femtosecond and nanosecond pulses. The fluorescence yield depended on the laser pulse energy in a nonlinear way with a threshold, which is consistent with the previous observations for laser ablation. Such nonlinear behavior leads to a dependence of the LIBS signal on the temporal-spectral shape of the laser pulse. We showed especially that a transform-limited pulse did not optimize the fluorescence. A properly applied chirp allowed an increase of the LIBS signal. Understanding and optimizing of the chirp effect would improve the detection limit of the LIBS using femtosecond laser (Femto-LIBS) and lead to a larger detection distance.