

Filament Induced Breakdown Spectroscopy for Long Distance Applications

Kamil Stelmaszczyk^{1,*}, Philipp Rohwetter¹, Roland Ackermann², Guillaume Méjean², Jin Yu², Estelle Salmon², Jérôme Kasparian², Jean-Pierre Wolf², and Ludger Wöste¹

¹*Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany*

²*LASIM, Université Claude Bernard Lyon 1, 43 bd du 11 Novembre 1918, F-69622 Villeurbanne Cedex, France*

**corresponding author: stelmas@physik-fu-berlin.de*

Abstract: Remote Laser Induced Plasma Spectroscopy with filaments was demonstrated at distances up to 180 m. Recorded spectra exhibited clear chirp dependence, opening a perspective for the optimization by pulse shaping techniques.

Filament Induced Breakdown Spectroscopy for Long Distance Applications

Kamil Stelmaszczyk¹, Philipp Rohwetter¹, Roland Ackermann², Guillaume Méjean², Jin Yu², Estelle Salmon², Jérôme Kasparian², Jean-Pierre Wolf², and Ludger Wöste¹

¹*Institut für Experimentalphysik, FU Berlin, Arnimallee 14, D-14195 Berlin, Germany*

²*LASIM, Université Claude Bernard Lyon 1, 43 bd du 11 Novembre 1918, F-69622, France*

e-mail: stelmas@physik.fu-berlin.de

Recent development of femtosecond lasers, which today can deliver pulses of intensities a few thousand times above the filamentation threshold in air, has driven a strong interest in practical applications of filaments [1-2]. One of first successful realizations of this idea was the broadband atmospheric absorption spectroscopy using a super continuum from these plasma channels [3]. There are, however, much more remarkable features, which make filaments interesting for various applications. For example, a highly collimated propagation mode, which remains practically unaffected even at long, few hundred meters, distances [4]. A high intensity flux (above the ablation threshold of most materials) confined inside a filament and its ability to overcome the diffraction limit of linear optics provides the opportunity for the long distance Laser Induced Breakdown Spectroscopy (LIBS).

Using filaments generated by a femtosecond laser system - Teramobile, we demonstrated for the first time Remote Filament Induced Breakdown Spectroscopy (R-FIBS) [5]. In this novel approach, no sophisticated beam expanders or even focusing optics was necessary to detect atomic and molecular emission of samples located 180 m from the laser. Recorded spectra exhibited no interference from ambient air, a feature which could not be reproduced with nanosecond pulses. Detailed analysis of the fluorescence signal in a focused beam configuration revealed strong non-linear features manifested by the clear chirp dependence [6]. This observation suggests that an adequate spectro-temporal shape of the pulse could lead to the increase of fluorescence efficiency, opening the perspective for pulse-shaping LIBS. The pulse optimization according to the specific emission line or a specific material would not only improve the sensitivity, but could also lead to the selective elemental detection incase of multi-component materials.

1. G.G. Matvienko et al., *Atmos. Oceanic Opt.* 16, 1013-1019 (2003)
2. J. Kasparian et al., *Science* 301, 61-64 (2003)
3. P. Rairoux et al., *App. Phys. B* 71, 573-580 (2000)
4. G. Méchain et al., to be published in *Optics Communications*
5. K. Stelmaszczyk et al., *Appl. Phys. Lett.* 85, 3977-3979 (2004)
6. P. Rohwetter et al., *J. Anal. Atom. Spectrom.* 19, 437-444 (2004)