Contribution ID: **12** Type: **not specified**

Applications of filaments generated by high-power spaceborne lasers

Friday, 16 October 2015 08:30 (20 minutes)

A novel concept for global atmosphere monitoring was studied and will be presented. The concept relies on laser pulse filamentation in the atmosphere from a powerful laser embarked in an Earth-orbiting satellite. Filamentation leads to white light generation. Light reflected by different species of air at different altitudes is collected by a space-borne receiver and analyzed. The concept is tantamount to a multispectral LIDAR technique to measure pollutants in the atmosphere from space. Combined with a controllable altitude for the generation filaments, it provides a global solution with broad degree of freedom to analyze the dependence of the density of air constituents upon altitude, time and location. The white light source generated by filamentation covers a large number of absorption bands of air species and atmospheric pollutants while the spaceborne moving source enables to globally monitor the atmosphere. Numerical simulation of femtosecond filamentation in the atmosphere provides a range of laser parameters such as power, pulse duration and initial beam diameter for generation of white light at predefined height. Numerical investigation also provided the spectral width of generated supercontinuum which spans from 300 nm to 1200 nm. Another potential application of spaceborne high-power laser will be discussed, relying on the fact that filamentation is accompanied by plasma generation and local heating of air. This effect, combined with the long range propagation property of filaments can be used to generate waveguides in the atmosphere so as to facilitate high-average-power beam propagation through air and increase laser beam pointing stability. This radiation can be further collected and focused onto space debris to deorbit them. Waveguides can be designed in various ways so as to guide beams of different wavelengths, fired from the surface of the earth. The proposed applications of spaceborne laser filamentation require a high efficiency, lightweight, durable laser which could produce high energy and high repetition femtosecond pulses. The ICAN laser concept fulfills these requirements.

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Session Classification: Bridging High Energy Physics and Space technology (NEXT)

Track Classification: Presentations