Measuring plasma density using broadband THz frequency electromagnetic pulses

SUMMARY

This technology allows measuring density, temperature and other parameters of dense localised plasma, using femtosecond laser. Technology does not require external calibration, is much simpler, faster, more precise than alternative methods.

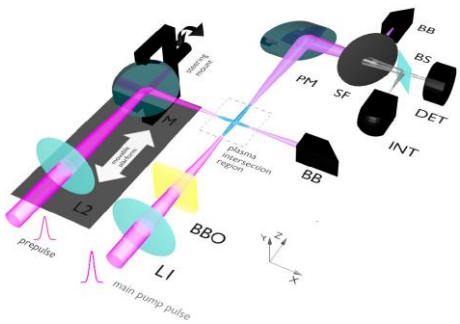
BACKGROUND

Plasma-related phenomena is widely adopted, however plasma-based technologies are still being actively researched and developed. While performing experiments with plasma, it is necessary to precisely monitor plasma temperature and density. Commonly used remote plasma diagnostics methods are mainly based on monitoring parameters of electromagnetic (EM) radiation, transmitted through plasma. So far MW or comparably narrowband THz radiation was used and its parameters were monitored using THz-TDS methods, which allow measuring small phase shifts of radiation. However, interpretation of the experimental results is very complex and in many cases requires external calibration, which makes it impractical.

TECHNOLOGY

We propose a method of characterising plasma using broadband THz EM pulses. Method is based on time-resolved THz spectroscopy. Plasma absorbs part of the EM radiation, which goes through it, and this absorption depends on the frequency of EM radiation and plasma density. By measuring absorption dependence as a function of frequency and delay of the input THz pulses, we can determine plasma density and temperature. Using very short EM pulses allows monitoring very fast plasma density changes (down to sub-ps time scale). Using very broadband THz radiation allows measuring wide range of plasma density.

Broadband THz radiation can be generated by bichromatic fs laser pulses and measured with a regular THz spectrometer. Plasma can be generated by the same fs laser (in a special setup, see picture) or by any other methods.



TECHNOLOGY READINESS LEVEL

1 2 3 **4** 5 6 7 8 9 Validated in lab

INTELLECTUAL PROPERTY

Technology developed at Vilnius University in collaboration with Leibniz University of Hannover.
Patent application filed, patent pending.

PUBLICATIONS

[1] Influence of laser-preformed plasma on THz wave generation in air by bichromatic laser pulses.

Vilnius University

BENEFITS

- Much simpler, faster and more precise method, than alternative methods.
- Allows measuring a wide range of plasma density.
- Does not require external calibration.
- Could be used with regular femtosecond laser and THz spectrometer.

APPLICATION

The present technology can be used in various applications, related to localised plasma:

- Plasma R&D;
- Tokamaks;
- Wakefield accelerators;
- Laser and plasma interaction research.

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