Experiments using extreme parameters of the NovoFEL radiation

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Three different types of experimental investigations using unique extreme NovoFEL parameters [1] are presented in the report. The first one is continuous terahertz laser discharge which was developed from an effective demonstration of the NovoFEL power [2] to detailed investigation of its physical process [3-5] and creation of a point-like atmospheric-pressure discharge with record temperature of 28 000 °K at plasma density of $2 \cdot 10^{17}$ cm^{-3} [6](Fig.1-2).

Second set of the experiments is ultrafast time-domain spectroscopy [7-18] used now both for a single-pulse diagnostics of the NovoFEL radiation [11] and in free-induction-decay molecular spectroscopy including a magnetic spectroscopy [15,17](Fig. 3) and spectral "cinema" of the generation/decay dynamics of shot-lived molecular OH-radicals (Fig. 4).

Third type of the experiments is high-resolution spectroscopy based on very good coherency between NovoFEL pulses and very narrow lines of the fine structure of its radiation [19,20] (Fig. 5). One-mode filtration by a set of three resonance Fabry-Perot interferometers allows creation a source of powerful ultramonochromatic tunable radiation for high-resolution molecular spectroscopy [20] (Fig.6).

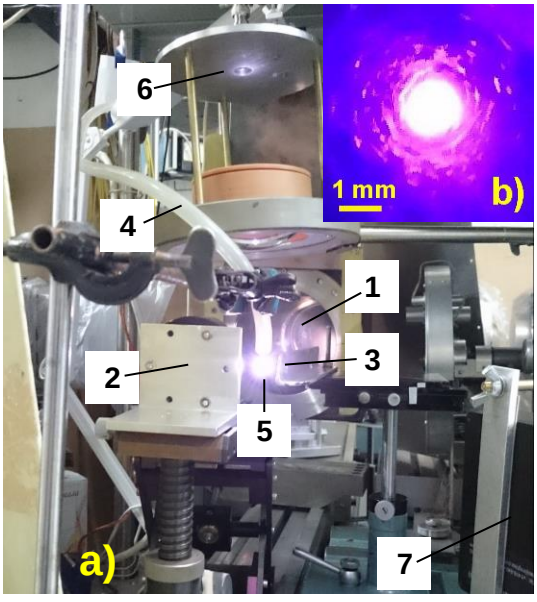

Fig. 1. Experimental setup for investigation of the THz laser discharge (a): 1 – output window of the NovoFEL optical beamline, 2 – main parabolic focusing mirror, 3 – stabilizing spherical mirror, 4 – gas tube, 5 – optical discharge, 6 – ultrafast optical photodiode, 7 – Mightex optical spectrometer. Insert (b) – photo of the point-like high-temperature laser discharge through a navy-blue glass filter

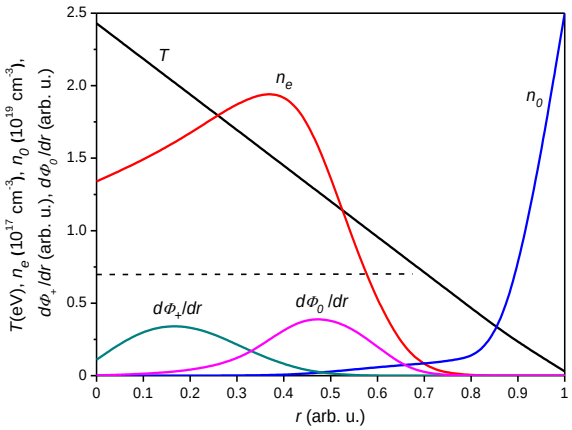

Fig. 2. Radial distributions of temperature T, plasma and gas densities n_e and n_0, and integral radiation of radial spherical layers for ionic $d\Phi_+/dr$ and atomic $d\Phi_0/dr$ lines of argon in the point-like high-temperature laser discharge. The dashed line indicates the critical plasma density (boundary of reflection of THz radiation from plasma)

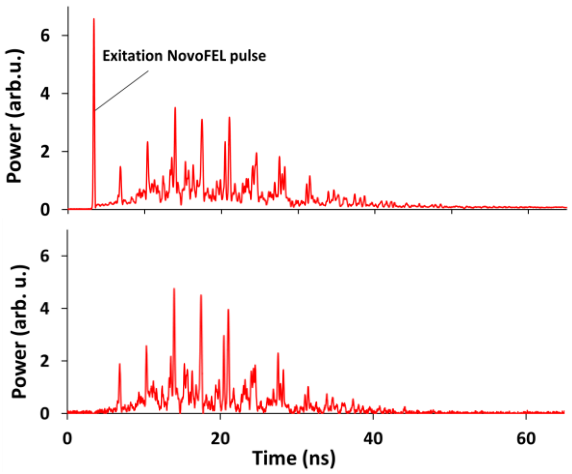

Fig. 3. Polarization separation of powerful excitation NovoFEL pulse and week FID signal of NO_2 molecules in magnetic field: upper – slightly misaligned cross input and output polarizers, lower – exactly aligned cross input and output polarizers (excitation pick is fully dumped)

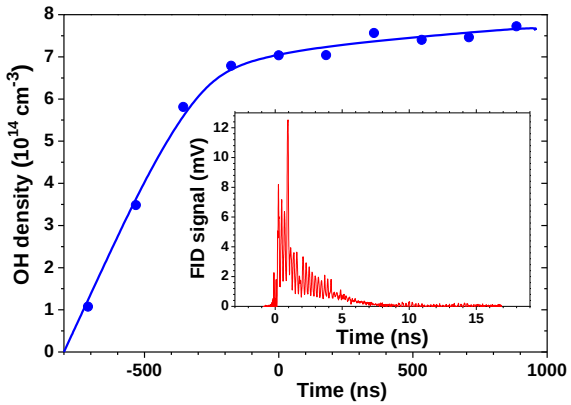

Fig. 4. Dynamics of OH-radical generation after shot pulse of UV radiation: points - treatment of the FID signals (insert) after series of ten NovoFEL excitation diagnostic pulses

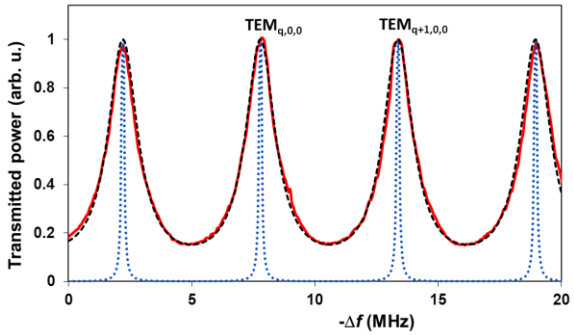

Fig. 5. Fine mode structure of the NovoFEL radiation measured by ultra-long waveguide vacuum mesh resonance FPI: solid red line – experiment, dash black line - instrumental function of the FPI, point blue line – reconstructed longitudinal mode structure of the NovoFEL

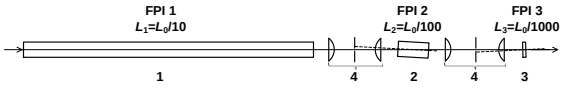

Fig. 6. Optical scheme of setup for one-mode filtration of the NovoFEL radiation: 1-3 – resonance FPI's (1 - ultra-long waveguide vacuum mesh resonance FPI), 4 – optical isolators

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