TARANIS-X: a joule-level femtosecond upgrade of TARANIS laser

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The multi-Terawatt laser system TARANIS (Terawatt Apparatus for Relativistic and Non-linear Interdisciplinary Science) installed in the Centre for Plasma Physics at the Queen's University Belfast is being utilized for wide ranging research of light-matter interaction. The TARANIS laser is a Nd:Phosphate system operating at 1053 nm which delivers uncompressed 1ns pulses up to 60J in total and subpicosecond 0.8 ps pulses after compression by grating compressors. In order to broaden the range of our research topics and explore new regimes of light-matter interaction, TARANIS laser will be upgraded by adding a Joule-level Optical Parametric Chirped-Pulse Amplification (OPCPA) system named TARANIS-X. The main advantage of noncollinear OPCPA technique is the achievement of phase-matching condition and high gain coefficients of the signal in ultrabroadband spectral range. The TARANIS-X will consist of a front end and two High Energy OPCPA (HE-OPCPA) stages. The front end is the White Dwarf OPCPA system of Class 5 Photonics GmbH. The stretched output of the front end with a pulse duration of ~4ps will seed the HE-OPCPA stages. After compression of TARANIS laser pulses up to ~6ps and conversion to the second harmonic, they will pump HE-OPCPA stages. The use of short pump pulses significantly reduces the stretching factor and consequently the high order dispersion terms. However, a short pulse OPA requires a precise pump-signal synchronization which in TARANIS-X will be achieved by an optical cross-correlation technique.

The amplified output of the HE-OPCPA stages will be compressed by a thick bulk BK7 window and sixteen chirped mirrors installed in a vacuum chamber. The full beam diameter delivered to target area will be 74mm, the energy per pulse about 3J and with an accurate dispersion management the expected pulse duration will reach to ~10fs. The compressed output of the front end as a stand-alone system will have an average power of 0.3W with a repetition rate of 500Hz of laser pulses with a duration of 10fs. The spectral output of both front end and TARANIS-X will range from 700nm to 980nm.