Second harmonics generation by LFEX laser

Yasunobu ARIKAWA [1], Zhanggui HU [2], Yin ZHAO[2], Heng Tu[2], Feidi Fan[2], Sadaoki KOJIMA [3], Masayasu HATA [1], Yasuhiko SENTOKU [1], Hitoshi SAKAGAMI [4], Shohei SAKATA [1], Yuki ABE [1], Seungho LEE [1], King Fai Farley LAW [1], Hidetaka KISHIMOTO [1], Hiroki MORITA [1], Yohei KANBAYASHI [1], Morace ALESSIO [1], Shigeki TOKITA [1], Junji KAWANAKA [1], Noriaki MIYANAGA [1], Masashi YOSHIMURA [1], Akifumi YOGO [1], Hiroaki NISHIMURA [1], Hiroshi AZECHI [1], Hiroyuki SHIRAGA [1], Mitsuo NAKAI [1], LFEX-group [1], Shinsuke FUJIOKA [1], and Ryosuke KODAMA [1],

1) Institute of Laser Engineering, Osaka University, Japan

E-mail: arikawa-y@ile.osaka-u.ac.jp

2) Technical Institute of Physics and Chemistry, Chinese academy of science, China

3)Advanced Research Center for Beam Science, Institute for Chemical Research, Kyoto University

4), National Institute for Fusion Science

The second harmonic generation (SHG) of a petawatt laser is one of the greatest interest in the ultra high intense laser sciences. For instance, a second harmonics laser can reduce the required laser energy for fast ignitior heating because it can generate lower energy electron beam than that of fundamental ($T_e \sim I^{1/2}\lambda$, where T_e is the hot electron slope temperature, I is the laser intensity, λ is the laser wavelength) then the heating efficiency is expected to be improved ($\eta \sim \rho R/0.6T_e$, where η is the electron absorption efficiency, ρR is the areal density of the compressed core) [1]. Fundamental and Second harmonics mixed beam shows further improvement on the electron beam angular distribution because a channel structure [2] on electro-magnetic field created by a beam is smeared out by the other beam. This fact was confirmed by 2D-PIC simulation.

Here we report a new design of the SHG for LFEX. SHG crystals such as KDP, DKDP, BBO have narrow matching acceptances angle thus they are suitable to be inserted in the parallel beam. However, it costs a lot to fabricate a full beam size SHG-crystal (~ 40 cm). LBO crystal has a wide matching angle; a LBO crystal with 2-mm thickness has 5-degree acceptance angle in FWHM therefor it can generate second harmonics in a F number10 focusing beam, thus crystal can be on after the off axis parabola of LFEX. For LFEX, having 1-ps pulse duration, LBO crystal can be used at half-beam size position (crystal size is 20 cm×20 cm, laser fluence is up to ~1 J/cm^2) without significant beam wave front distortion.

The principle was demonstrated by using LFEX beam and a 1-cm sized LBO crystal. A partially converted SHG and fundamental mixed beam was successfully generated. Experimentally measured damage threshold exceeded 2.4 J/cm^2 for 1.2-ps pulse duration. 10-cm square 2-mm thickness LBO crystals were fabricated [3] (world largest size) at Technical Institute of Physics and Chemistry, Chinese academy of science and it will be installed to LFEX soon. In this scheme we can expect an order of increment in the fast heating efficiency.

References

[1] J.J. Honrubia, et al., Nuclear fusion, **46**, (11), L25, (2006)

[2] A. Debayle, et al., Physical Review E, **82**, 036405, (2010)

[3] Zhanggui Hu, et al., Journal of Crystal Growth, **335**, 133–137, (2011)