Research on Laser Acceleration and Coherent X-ray Generation using J-KAREN-P laser

M. Kando[1], A. S. Pirozhkov[1], M. Nishiuchi[1], H. Kiriyama[1], A. Kon[1], H. Sakaki[1], Y. Fukuda[1], N. Dover[1], K. Sekiguchi[1], K. Nishitani[1,2], A. Sagisaka[1], T. A. Pikuz[3], A. Ya. Faenov[4], K. Ogura[1], Y. Hayashi[1], H. Kotaki[1], T. Zh. Esirkepov[1], K. Huang[1], N. Nakanii[1], K. Kondo[1], J. K. Koga[1], S. V. Bulanov[1], K. Kondo[1]

[1] *Kansai Photon Science Institute, National Institutes for Quantum and Radiological Science and Technology (QST), Kizugawa, Kyoto, Japan*
[2] *Kyusyu University*
[3] *Photon Pioneers Center in Osaka University, Suita, Osaka, Japan*
[4] *Institute for Academic Initiatives, Osaka University, Suita, Osaka, Japan*

**E-mail: kando.masaki@ qst.go.jp*

Abstract: We present the progress on the upgrade status of the J-KAREN-P, which is a Ti:sapphire laser aiming a focused intensity of 10^{22} W/cm^2 at the repetition rate of 0.1 Hz. The upgrade includes two pilot experiments in order to show the availability of the laser performance on target. The first experiment is to generate high-energy ions from thin-foil target. The second experiment is the high order harmonic at a relativistic intensity. Currently, laser acceleration of protons is being tested and we have obtained 32 MeV protons from a 5-μm stainless steel target irradiated by a 14-J, 30-fs laser pulse.

In order to explore high-field science including laser particle acceleration [1,2] and photon beam generation [3] the upgrade of the J-KAREN laser [4] is in progress at Kansai Photon Research Institute, National Institutes for Quantum and Radiological Science and Technology (QST). The J-KAREN-P laser is Ti:sapphire, with double chirped pulse amplification (CPA) system enabling high-contrast ratio of 10^{-10} at -500 ps. The laser system successfully produces the pulse energy of 55 J after the final amplifier. The compressed pulse duration is ~30 fs at full width at half maximum (FWHM). Two target chambers allow us to perform short-focal-length (f/1.4) and long-focal-length (f/5-f/20) experiments.

Currently we increase the laser energy on target gradually in order to check the total system. In the March 2016 run the maximum proton energy of 32 MeV was achieved both with a stack of radio chromic films and a time-of-flight detector when a 14-J, 30-fs laser pulse irradiated a 5-μm stainless steel foil. A typical electron temperature was ~10 MeV.

In the presentation, detail of the ion acceleration experiment and planned HHG X-ray generation [3] and electron acceleration experiments will be reported.

1. K. Ogura et al.," Proton acceleration to 40 MeV using a high intensity, high contrast optical parametric chirped-pulse amplification/Ti:sapphire hybrid laser system " *Opt. Lett.* **37**, 2868 (2012).
2. M. Nishiuchi et al., " Acceleration of highly charged GeV Fe ions from a low-Z substrate by intense femtosecond laser", *Phys. Plasmas* **22**, 033107 (2015).
3. A. S. Pirozhkov, et al., "Soft-X-Ray Harmonic Comb from Relativistic Electron Spikes," *Phys. Rev. Lett.* **108**, 135004-5 (2012); "High order harmonics from relativistic electron spikes," *New J. Phys.* **16**, 093003-30 (2014).
4. H. Kiriyama, et al., "High-Contrast, High-Intensity Petawatt-Class Laser and Applications," *IEEE J. Sel. Topics Quantum Electron.* **21**, 1601118-18 (2015).