

## Coherent short-wavelength sources and their applications in QST-KPSI

Tetsuya Kawachi

Kansai Photon Science Institute (KPSI),  
National Institutes for Quantum and Radiological Science and Technology (QST),  
8-1-7, Kizugawa, Kyoto, 619-0215, Japan  
kawachi.tetsuya@qst.go.jp

This paper reviews recent progress of development of ultra-intense short-wavelength sources and their application in Kansai Photon Science Institute (KPSI) of National Institutes for Quantum and Radiological Science Technology (QST).

In J-KAREN-P, a PW-class CPA Ti:Sapphire laser with 30J energy, 30 fs duration, in order to realize real-time measurement of pre-pulse level in PW-pulse, we have developed and installed the single-shot self-referenced spectral interferometry with extended time excursion (SRSI-ETE) under the collaboration with Helmholtz-Zentrum Dresden Rossendorf (HZDR)[2]. SRSI-ETE reveals that the pre-pulse level very close to the main pulse is proportional to the square of the B-integral of the amplifier chain [1]. We have also been developing a 100 TW-class, 100 Hz-rep-rate multi-purpose compact pumping laser: the front-end system including the pre-amplifier has been completed. The main amplifier is being developed under the collaboration with Institute of Laser Engineering (ILE), Osaka University. This compact laser is expected to be a complementary device to J-KAREN-P in the wide variety of research fields such as high average power soft x-ray lasers, HHG from plasma, particle acceleration and laser-matter interaction.

In the development of x-ray source in keV or higher region, recent progress in HHG from ions in relativistic plasma (BISER: Burst Intensification by Singularity Emitting Radiation [3]) in keV region and preliminary result of gamma-ray generation experiment will be presented. In soft x-ray region, parametric amplification of attosecond coherent pulses around 100 eV from the single-atom level is demonstrated for the first time [4].

In the application of the coherent x-rays, we found that nano-size modification on substances is quite sensitive to the wavelength of soft x-rays by the experiment combining wavelength selection near the excitation threshold and the energy fluence dependence in the vicinity of damage threshold [5]. The result implies interesting tips for a deep understanding toward direct soft x-ray laser processing.

- [1] A. Kon et al., *Crystals* **2020**, 10, 657.
- [2] T. Oksenhendler et al., *Opt. Express*, **2017**, 25, 12588.
- [3] A. Pirozhikov et al., *Scientific Rep.* **2017**, 7, 17968.
- [4] C. Serrat et al., *Opt. Express* **2020**, 28, 24252.
- [5] T. -H. Dinh et al., *Commun. Phys.* **2019**, 2, 150.