BISER experiments with the Astra and J-KAREN-P lasers

QST [1], LPI RAS [2], Osaka Univ. [3], IAP RAS [4], CLF RAL [5], Hiroshima Univ. [6], ELI beamlines [7], Nat. Taiwan Univ. [8], Strathclyde Univ. [9]　◦A. S. Pirozhkov [1], A. N. Shatokhin [2], A. Sagisaka [1], K. Ogura [1], T. A. Pikuz [3], A. V. Kotov [4], T. Dzelzainis [5], A. Bierwage [1], Ko. Kondo [1], H. Ohiro [6], S. Lorenz [7], Y.-K. Liu [8], G. M. Grittani [7], T. M. Jeong [7], N. Nakanii [1], K. Huang [1], A. Kon [1], Y. Miyasaka [1], G. Hull [5], S. Dann [5], E. A. Vishnyakov [7], A. O. Kolesnikov [2], M. Koike [1], P. Chen [8], T. Zh. Esirkepov [1], J. K. Koga [1], R. Gray [9], A. A. Soloviev [4], E. N. Ragozin [2], S. V. Bulanov [7], S. Namba [6], H. Kiriyama [1], M. Kando [1], K. Kondo [1], T. Kawachi [1], P. McKenna [9], D. R. Symes [5], and D. Neely [5]

E-mail: pirozhkov.alexander@qst.go.jp

Burst Intensification by Singularity Emitting Radiation (BISER) in relativistic plasma is an ultrabright temporally and spatially coherent x-ray source [1-3]. We report on two recent BISER experiments performed with the Astra laser [4] at CLF RAL, UK and J-KAREN-P laser [5] at KPSI QST, Japan.

In the Astra experiment performed with a 7 TW laser, as reported earlier, we obtained unusually bright BISER, with a two order-of-magnitude higher x-ray yield compared with earlier experiments with 10-20 TW lasers. In particular, we obtained ~μJ pulse energies in the 17-34 nm spectral range within the 0.3° × 0.2° spectrograph acceptance angle. Understanding interaction physics leading to such bright coherent x-ray generation is an outstanding scientific problem. In this presentation, we report on our efforts to perform time-resolved diagnostics of relativistic plasma singularities.

Another outstanding task is to measure the total energy of the BISER pulse, for which we need to know its near-axis angular distribution. This requires placing x-ray diagnostics as close as possible to the interaction point. The main challenge is to avoid x-ray filter damage, as this would result in the focusing of a multi-TW laser onto an x-ray CCD. In the J-KAREN-P experiment, we performed x-ray filter damage threshold studies, followed by the successful (filter-damage-free) BISER angular distribution measurements in the ±2.5° cone. The results showed that under optimum conditions BISER pulses had ~100 μJ energy.

We acknowledge support from the J-KAREN-P Laser Team, Astra Laser Group, and the CLF Target Fab, Mechanical, and Electrical. Financial support: JSPS Kakenhi JP 19KK0355 and 19H00669, CLF, Russian Science Foundation (20-62-46050), IAP RAS, ELI-Beamlines, MŠMT project "Advanced Research Using High Intensity Laser Produced Photons and Particles" (CZ.02.1.01/0.0/0.0/16_019/0000789), High Field Initiative (CZ.02.1.01/0.0/0.0/15_003/0000449) from the European Regional Development Fund, and the Strategic Grants by the QST President: IRI and 創成的研究 #20.

1. A. S. Pirozhkov *et al.* "Soft-X-Ray Harmonic Comb from Relativistic Electron Spikes" *PRL* **108**, 135004 (2012).
2. A. S. Pirozhkov, *et al.*, "High order harmonics from relativistic electron spikes," *NJP* **16**, 093003 (2014).
3. A. S. Pirozhkov, T. Zh. Esirkepov, *et al*., "Burst intensification by singularity emitting radiation in multi-stream flows," *Sci. Reports* **7**, 17968 (2017).
4. D. R. Symes, *et al*., "Operation of the Astra TA2 hollow fibre pulse compressor with increased pump energy," *CLF Annual Report* S7 229 (2008/2009).
5. H. Kiriyama, *et al*., "Enhancement of pre-pulse and picosecond pedestal contrast of the petawatt J-KAREN-P laser," *High Power Laser Sci. Eng.* **9**, e62 (2021).