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THE DESIGN OF EEHG CASCADED HARMONIC LASING FOR SXFEL USER FACILITY

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Introduction

The preliminary design and simulation results of EEHG cascaded harmonic lasing for SXFEL user facili-ty have been presented in this paper. Using the basic seeded beamline of SXFEL user facility, the designed parameters are optimized to obtain full coherent FEL output at 90th harmonic of a 265 nm seed laser. Accord-ing to the designed parameters and the layout of SXFEL user facility, the detailed simulations are carried out, the results show that the seeded beamline of SXFEL user facility can generate 2.93 nm full coherent radiation by the proposed method, which indicates that the method can extend the photon energy range of a seeded FEL and the method can be achieved at the SXFEL user facility.

Principle

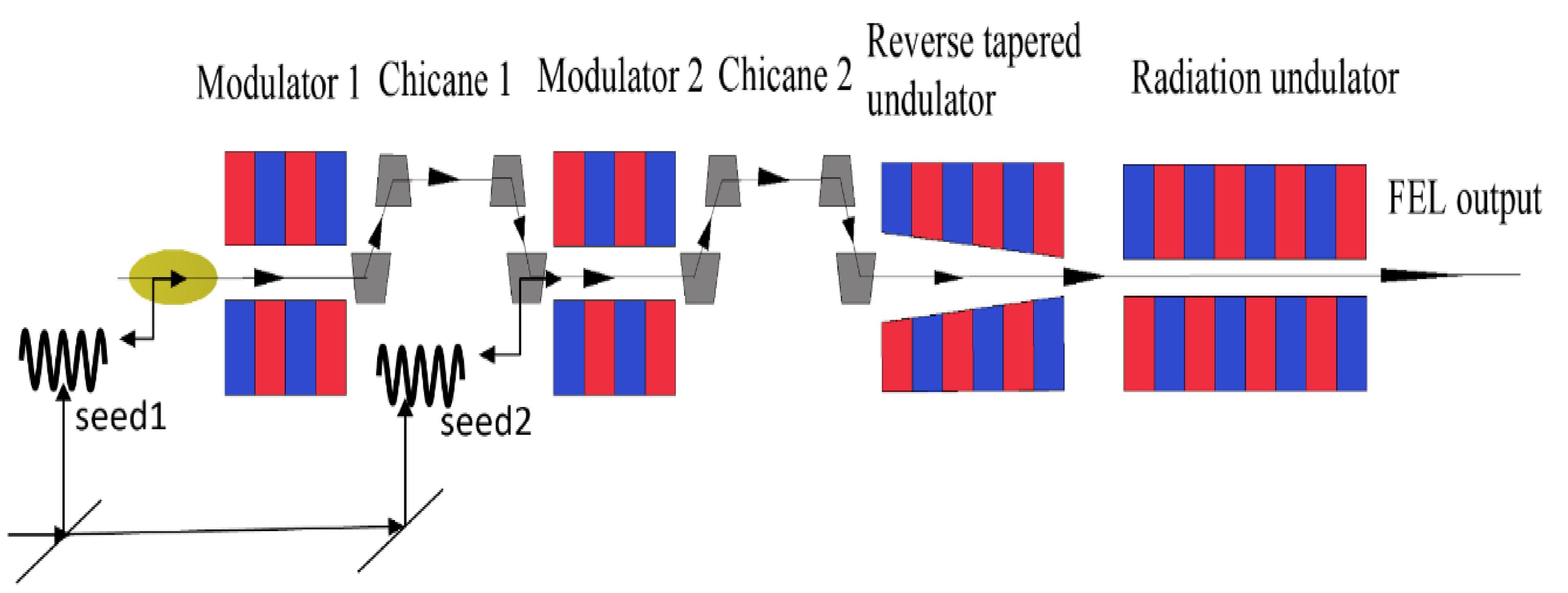

Figure 1: The side view of the proposed technique.

Parameters

Parameter	Value
Beam energy	1.3GeV
Energy spread	0.01%
Emittance	1.5mm.mrad
Peak current	800A
Laser wavelength	265 nm
Modulator amplitude	$A_1 = 1.5, A_2 = 1.5$
Dispersion strength	$B_1 = 23.2, B_2 = 0.8$
Undulator	U30, U235
EEHG wavelength	8.8 nm
Final wavelength	2.93 nm

Table 1: The designed parameters of the EEHG cascaded har-monic lasing technique.

The optimized values of B_1, B_2 vary by using different combination of n and m, Here, we adopt $n = -1, m = 1$. The relations between bunching factor at 30th harmonic and A_1, A_2, B_1, B_2 are shown in Fig. 2. According to the results in Figure 2, the EEHG parameters are optimized as $A_1 = 1.5, A_2 = 1.5, B_1 = 23.2, B_2 = 0.8$

Parameters optimization

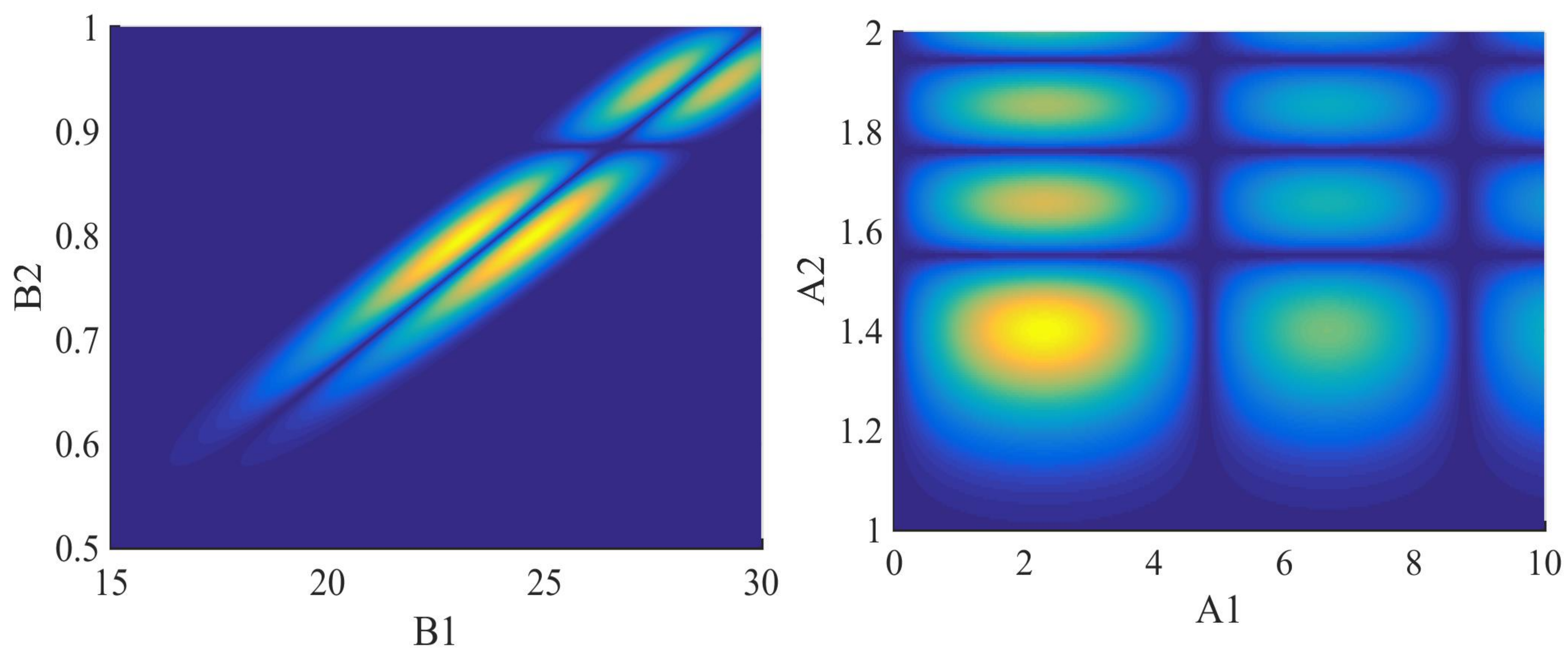

Figure 2: The relation between the bunching factor and A_1,A_2,B_1,B_2

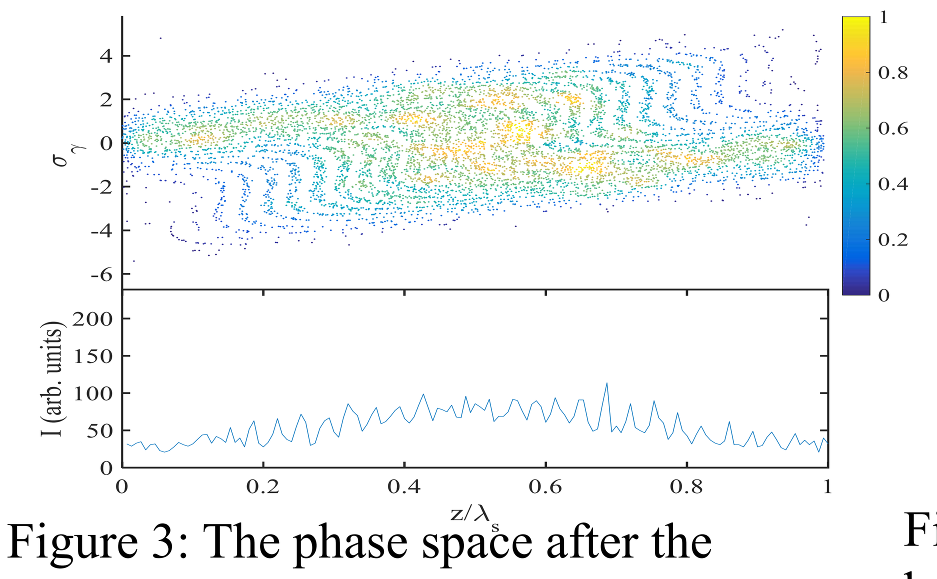

Figure 3: The phase space after the modulation

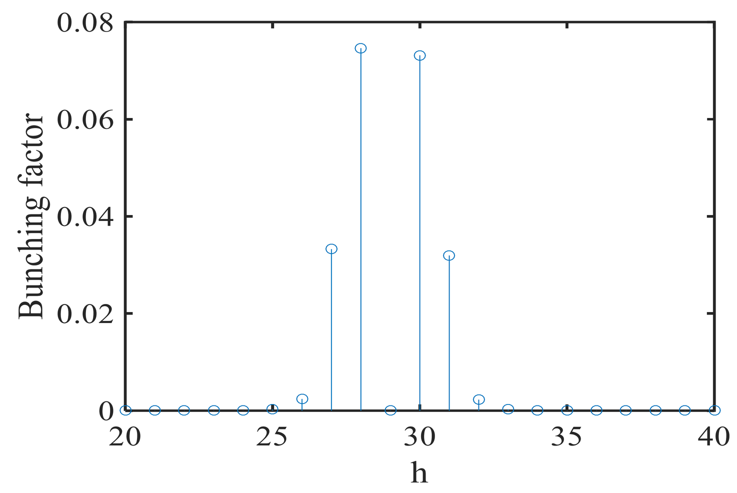

Figure 4: The bunching factor at different harmonics

Simulation results

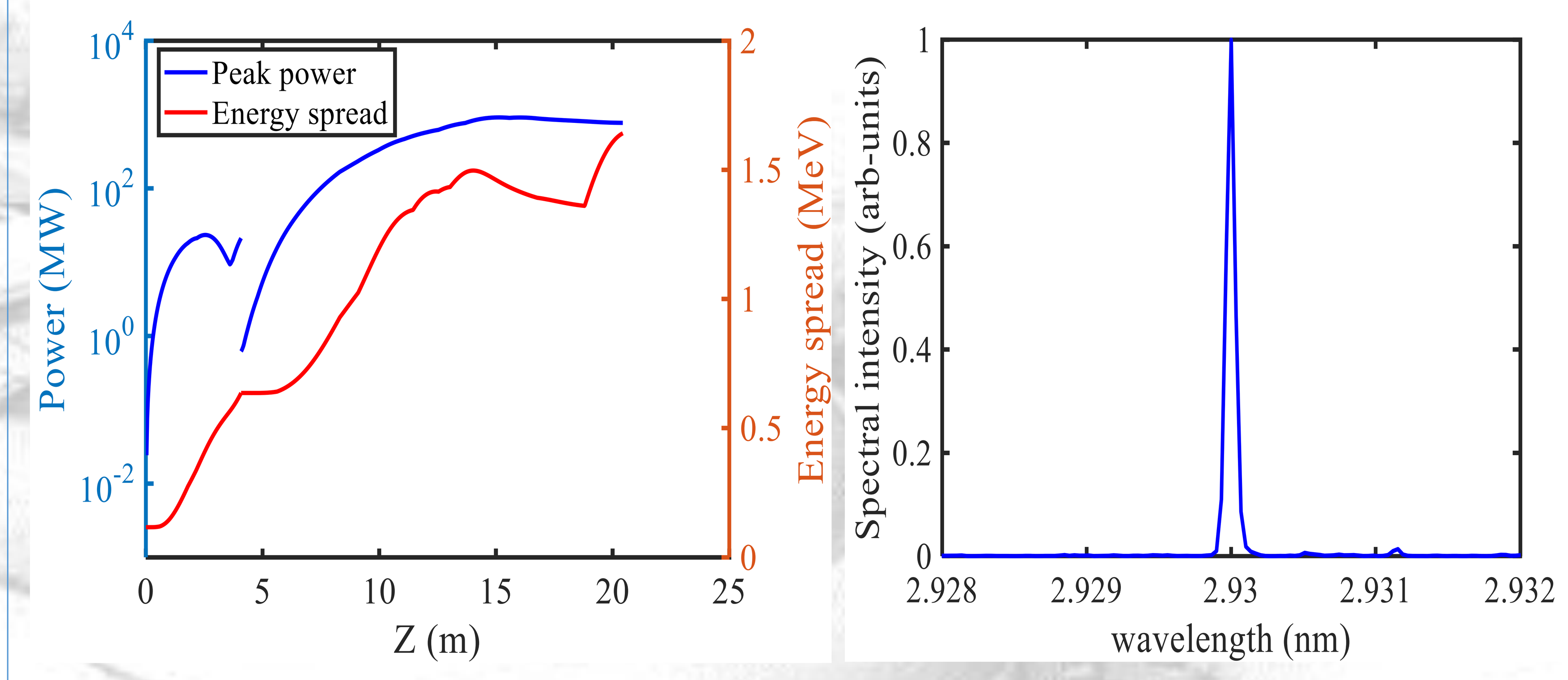

Figure 5: The peak power and the energy spread evolutions along the undulator, and the spectrum.

The electron beam with bunching is lastly sent into the final radiator, which is tuned at the wavelength of 2.93 nm. The signal of bunching will be amplified in the radiator. The radiation peak power as well as the energy spread are also shown in Figure 5. From Figure 5, one can easily observe that the FEL radiation get saturation with a peak power of 300MW at a distance of 10 m. Besides, the final spectrum is also shown in Figure 5, where one can find that the spectrum has a smooth structure and the spectral bandwidth is near the Fourier transform limitation.

Conclusion

The design of EEHG cascaded harmonic lasing for SXFEL user facility is preliminary studied and optimized. The simulations of the proposed technique are performed with the parameters of SXFEL user facility, the results show that the proposed technique can extend the frequency up-conversion efficiency of EEHG. As Ref [10] mentioned, the technique can significantly reduce the various three-dimensional effects of beam by radiating at relatively lower harmonic of EEHG, it can furtherly extend the photon energy coverage to hard X-ray by increasing the harmonic number, and it also has a relatively simpler configure than two stage seeded FEL while achieving similar FEL radiation. Most im-portantly, the technique can be easily achieved at SXFEL user facility consider that the EEHG undulator beamline has two type undulators with two undulator periods. Further works will focus on the experim

lasing tech-nique.