Coherent plasma x-ray laser by injection of a parametrically amplified high-order harmonic light

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Abstracts: *The injection of high-order harmonics light into plasma laser medium (x-ray amplifier) is one of the attractive means to improve the beam quality. The lasing wavelength we focus on is 13.9 nm (Transient Collisional Excitation scheme of Ni-like Silver) and the plasma amplifier is created by a grazing incidence pump of the target. The seed harmonic light tuned at the laser transition is generated by parametric amplification. By using the seed-amplifier scheme, we are to demonstrate a spatial and temporal coherent plasma x-ray laser with a repetition rate of 10 Hz.*

Conventional plasma x-ray lasers have the characteristics of spatial coherence, while less temporal one. In order to realize fully coherent plasma x-ray lasers, we have employed a seed-amplifier scheme [1]. In this setup, a high-order harmonics light as the seeder is injected into an amplifier plasma medium. As a result, the harmonics is amplified while maintaining its original coherencies [2,3].

In this study, for generation of a narrow beam divergence and intense high-order harmonics, we focus on the x-ray parametric amplification [4]. The high-order harmonics generated in neon gas are further amplified due to high-order parametric interaction in helium gas. During the amplification, the quality of the harmonic pulses are improved by means of the harmonic lines became narrower and the divergence of the harmonic beam dramatically decreases, making the seed beam much suitable for efficient seeding of the x-ray lasers. On the other hand, the plasma amplifier is created by using a Ti:Sapphire laser (~80 fs, ~1 J) by means of a grazing incident pumping. Here a beam splitter divides the incoming beam into two branches: one of the beams is used to generate the harmonics, while the other is for the plasma amplifier. To meet the requirements on the spatial and spectral coupling between both beams is essential to achieve the efficient amplification. Therefore, the central wavelength of the Ti: Sapphire laser is tuned at 792.3 nm, by which the lasing transition (13.9 nm) matches the wavelength of 57^{th} order harmonics. As for the spatial overlap, we compensate the effect of x-ray refraction of the harmonic light in dense plasma medium by slightly tilting the target surface.

In the presentation, we will show the preliminary results of the parametric amplification of the harmonics and the injection of the seed beam in the plasma amplifier conducted at the JEAE.

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