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Double Plasma Mirror System For the 4 PW Ti:Sapphire Laser at CoReLS

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With the development of ultrahigh power lasers the interactions of superintense laser-matter can be explored at extreme conditions. In the operation of a high power chirped pulse amplification (CPA) laser, an amplified laser pulse can contain amplified spontaneous emission (ASE) and unwanted spurious pulses, forming a prepulse in front of the main pulse. This prepulse may have high enough intensity on a target surface, which could destroy the target material and generate a preplasma, changing the dynamics of laser-plasma interaction. In addition, the back reflection of the focused main pulse from the plasma could induce damages to optical components. This kind of problems should be properly handled when the interaction of an ultrahigh intensity laser pulse with a solid or high density target is investigated.

A double plasma mirror (DPM) system is frequently adopted to suppress prepulses and back reflection [1]. The DPM system is designed for the 4 PW laser developed at Center for Relativistic Laser Science (CoReLS) [2] by modifying the one used for the 1 PW laser. The low intensity prepulse just passes through the plasma mirror made of an AR-coated glass block, but as the intensity of the prepulse grows, temporally close to the main pulse, it generates plasma on the surface of the mirror with electron density over the critical density. The main pulse is reflected by the plasma generated on the mirror surface, improving the contrast ratio by a factor of $10^2 – 10^4$. [3]

The DPM system consists of two mirror blocks, two off-axis parabolic mirrors (OAPs) and two periscopes. The 4-PW laser pulse from the pulse compressor comes to the DPM system, after going through a deformable mirror (DM) with 128 actuators to control the wavefront of the laser pulse. The laser with 290mm diameter enters the DPM system. The first periscope pair changes the p-polarized beam to the s-polarized beam to enhance the reflectivity from the plasma mirror by using the p-polarized beam [4]. The beam is then focused to the first plasma mirror with the first OAP. The focal point of the first OAP is positioned between the first and the second plasma mirrors so that the beam can be reflected from the two plasma mirrors with comparable beam size on each surface. The focused beam is re-collimated by the second OAP and goes through another pair of periscope to convert the polarization to p-polarization, same as the input state.

After installing the DPM system, after precise alignment of this system, the characterization and scaling of the DPM for 4 PW laser pulses has been performed while controlling the wavefront with the DM. A near field and far field monitoring system for DPM system is installed so that repetitive operation can be done by comparing images obtained at near and far fields. This system will be applied for ultraintense laser-plasma interactions, such as ultrathin solid target experiments for producing high energy protons.

References
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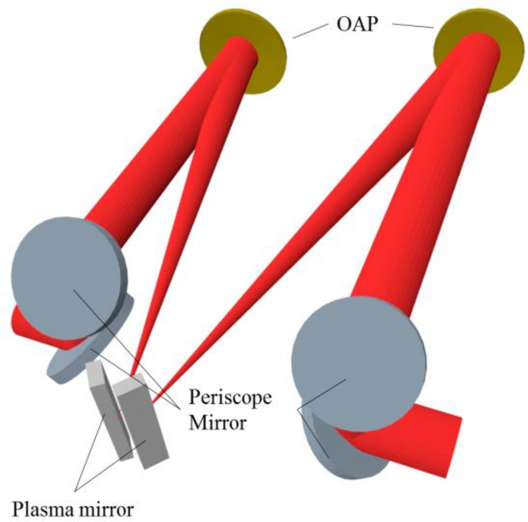

Figure 1. Scheme for the double plasma mirror system. The first OAP (yellow, right) focuses the beam to the middle of the two plasma mirrors (light grey). The focused beam is recollimated by the second OAP (yellow, left).