Recent progress in the laser pulse compression experiment using a plasma with a density gradient

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For the past several decades, lasers have evolved dramatically in peak power. Nowadays even PW (petawatt) lasers are available and they are used for diverse applications in science, including the laser wakefield acceleration (LWFA), generation of X-ray/ γ-ray, QED (quantum electrodynamics) research, etc. For these purposes, scientists have used the focused laser intensity up to the level of 10^{23} W/cm^2. If the laser intensity can be increased to a much higher level, for example, by a factor of 10^6, new science can be explored, including the vacuum breakdown phenomenon. So we are very interested in a way to achieve such a high intensity laser pulse. For this purpose, we have studied a new method for laser pulse compression using a plasma [1], where there is no concern about any damage problem in the compression process unlike in the conventional method based on the CPA (chirped-pulse amplification) technique [2].

According to our new method, a plasma with a density gradient can be used for compression of a frequency-chirped laser pulse, and now its experimental demonstration is under way in our laboratory. For this purpose, we need to produce a near-critical high-density plasma. Several ways are considered for this, for example, high density plasmas can be generated by interaction of a laser pulse and targets, which include solids, foams, and high pressure gas. Diagnostics of the high density plasma is also an important issue as the near-critical plasma is not easy to diagnose with convention laser interferometers, for example. So far, we have utilized several solid targets to produce near-critical high-density plasmas and diagnosed their characteristics. In this talk, the on-going research activities are introduced and the recent progress will be reported.

References

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