Improving the self-injection of electrons in a LWFA


GoLP/Instituto de Plasmas e Fusão Nuclear – Laboratório Associado,
Instituto Superior Técnico, Lisboa, Portugal

We propose a new scheme that facilitates the self-injection and enhance the self-injected charge of electrons in a laser wake-field accelerator (LWFA) that use a long plasma channel. Plasma channels can guide intense laser pulses for a distance many times longer than the Rayleigh length [1]. For this reason, they are usually used in LWFA experiments to extend the acceleration length in order to achieve a higher energy gain.

In general, a plasma channel is an efficient waveguide when the spot radius of the beam matches the characteristic propagation radius of the channel. On the other hand, self-injection occurs best when the laser is very intense, i.e., when the spot radius is very small. Experimentally, this poses a great challenge, as it is hard to simultaneously obtain very long plasma channels and small radius [2].

We used the PIC code OSIRIS [3] to demonstrate that, under specific laser and plasma parameters, a channel can guide an initially tightly focused laser beam. At the beginning, the beam is sufficiently intense to allow self-injection of electrons, whereas later, the combined effect of external guiding and non-linear focusing will smoothly match the beam radius to the radius of the channel. We shows that this scheme may lead to multi-GeV nC-class electron beams in 10 cm scale propagation distances using a TW-class laser.

References

