

High quality laser-plasma acceleration with the Resonant Multi-Pulse Ionization injection scheme

P. Tomassini , F. Baffigi, F. Brandi L. Fulgentini, P. Koester, L. Labate , D. Terzani,

*G. Toci, and L.A.Gizzi.

CNR- Istituto Nazionale di Ottica, Pisa (Italy)

*CNR- Istituto Nazionale di Ottica, Firenze (Italy)

The production of high-quality electron bunches in Laser Wake Field Acceleration [1] relies on the possibility to inject ultra-low emittance bunches in the plasma wave. A new bunch injection scheme (Resonant Multi-Pulse Ionization, ReMPI) has been conceived and studied in which electrons extracted by ionization are trapped by a large-amplitude plasma wave driven by a train of resonant ultrashort pulses [2]. Such a train of pulses can be obtained in very efficient, compact and stable way, by phase manipulation in the front-end [3]. The ReMPI injection scheme relies on currently available laser technology [4] and is being considered for implementation of future compact X-ray free electron laser schemes [5]. Simulations show that high-quality electron bunches with energy up to 5 GeV, with normalized emittance below 0.1 mm×mrad and energy spread below 1% can be obtained with a single stage.

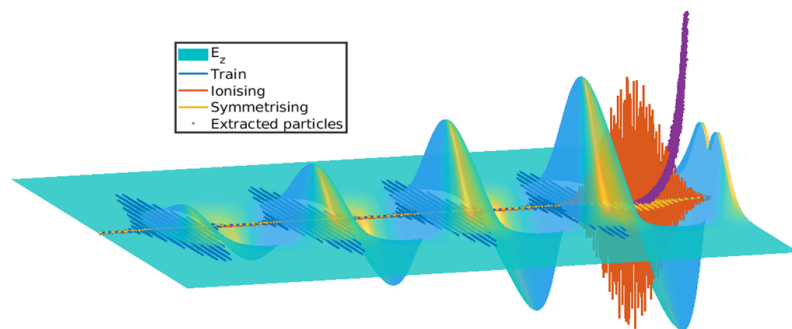


Figure (the ReMPI scheme). A train of four resonant pulses resonantly excites a plasma wave (the longitudinal electric field is shown here). The red line represents the ionization pulse that extract electrons (the purple dots) from the dopant.

References

- [1] T. Tajima and J. M. Dawson, *Laser Electron Accelerator*, Phys. Rev. Lett. 43, 267 (1979)
- [2] P. Tomassini et al., *The Resonant Multi-Pulse Ionization injection*, Physics of Plasmas 24, 103120 (2017)
- [3] L. Labate et al., *Quasi Lossless Pulse Train generation by Early Amplitude division*, submitted
- [4] L.A. Gizzi, *A viable laser driver for a user plasma accelerator*, NIM-A 909 58-66 (2017)
- [5] EuPRAXIA collaboration, <http://www.eupraxia-project.eu/>