Future ultra-fast high power lasers will deliver unprecedented accelerating power and efficiency

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Few technologies have the power that particle accelerator technology has to touch upon such a broad range of applications at the many frontiers of modern science. Today, thanks to improvements in laser technology, a new generation of accelerators could soon emerge to replace accelerators relying on radio frequencies.

In this new special issue, the journal *EPJ Special Topics* explores the requirements necessary to make such laser accelerators a reality, by presenting the work of the International Coherent Amplification Network (ICAN) research collaboration. Potential applications include future colliders, solutions for vacuum physics, design of Higgs-particle factories, creation of sources of high-flux protons and of neutrons, among others. Further, such accelerators open the door to solutions in nuclear pharmacology and proton therapy as well as orbital debris remediation.

The idea for laser pulse-based accelerators dates back to 1979. Picture a laser pulse in a plasma made up of an ionised gas combining positive ions and electrons. It leaves a wake in which electrons are violently accelerated. Accelerators of the future could exploit this concept to accelerate particles over much shorter distances with greater power levels. They will also have an unprecedented electrical-to-optical power conversion efficiency greater than 30%—compared to much less than 1% with RF accelerators.

In this special issue, ICAN experts explore ways of achieving power generation reaching the 100 kilowatts to megawatt level instead of the 50 watts current technology offers. This greater than average power is achieved thanks to the much higher frequency repetition rate of the laser pulse in CAN systems. Others focus on improving the acceleration efficiency limit by reaching a frequency over 10 kilohertz; investigate improving the capability to synchronise a large number of fibre amplifiers or look into improving the quality of accelerated beams—be they spatial and temporal.

More information: Gérard Mourou. Science and applications of the coherent amplifying network (CAN) laser, *The European Physical Journal Special Topics* (2015). DOI: 10.1140/epjst/e2015-02561-1

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