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Laser-driven particle beamlines, challenges and bottlenecks

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Laser –generated particles are more and more considered to become a competitor to particle beams generated by traditional accelerator facilities such as Linac or synchrotrons. In particular, the high accelerating gradient that can be reached with laser-acceleration mechanisms, almost 1000 times stronger than for conventional accelerators, makes them an attractive alternative. A stronger accelerating gradient would reduce potentially the size and hence the costs of big accelerator facilities (e.g the LHC accelerator ring at CERN-Geneva, where the electron storage ring is around 27 km long). Unfortunately, the quality of the laser-generated beam parameters is currently not sufficient for replacing traditional facilities based on radiofrequency technology.
In this paper we present the key issues and bottlenecks that we have identified in order to make laser-generated beams competitive to traditional accelerators. Results have been obtained using different particle-tracking codes commonly in use in the conventional accelerator community and coupling laser-generated beams to conventional accelerator devices in order to generate a traditional beam line. The particle tracking codes allow studying the relevant parameters needed for an efficient capture, transport and control of those beams. This would then generate reliable and controllable particles sources based on higher power laser systems, such as foreseen e.g. by the Extreme Light Infrastructure (ELI).

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