



Contribution ID: 159

Type: **not specified**

Contribution of ALEGRO to the Update of the European Strategy on Particle Physics

Advanced and novel accelerators (ANAs), driven by a laser pulse or a relativistic particle bunch, have made remarkable progress over the last decades. They accelerated electrons by 10 GeV in 30 cm (laser driven) and by 42 GeV in 85 cm (particle bunch driven). Rapid progress continues with lasers, plasma sources, computational methods, and more. In this document we highlight the main contributions made by the various major collaborations, facilities, and experiments that develop ANAs for applications to particle and high-energy physics. These include: ALiVE, ANL-AWA, AWAKE, BNL-ATF, CEPC Injector, DESY-KALDERA, ELI ERIC, EuPRAXIA, HALHF, LBNL-BELLA, LBNL-kBELLA, LCvison, PETRA IV Injector, 10 TeV Collider design, SLAC-FACET II, as well as the development of structures, lasers and plasma sources, and sustainability, and demonstrate the intense activities in the field.

ANAs can have, and already have, applications to particle and high-energy physics as subsystems, the so-called intermediate applications: injectors, lower energy experiments, beam dump experiments, test beds for detectors, etc. Additionally, an ANA could be an upgrade for any Higgs factory based on a linear accelerator, as proposed in the LCvison project. ANAs have advantages over other concepts for reaching multi-TeV energies: lower geographical and environmental footprints, higher luminosity to power ratio, and are thus more sustainable than other accelerators.

However, ANAs must still meet a number of challenges before they can produce bunches with parameters and the luminosity required for a linear collider at the energy frontier. It is therefore extremely important to strongly support vigorous R&D of ANAs, because they are, at this time, *the most sustainable acceleration scheme to reach very high energies with a linear accelerator*.

They also have numerous lower energy applications as light and particle sources for research, industrial, medical, and security applications.

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