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Wakefield Acceleration: Ascent toward 100GeV, "TeV on a chip" and Zeptoscience , and to Astrophysics

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At IZEST we have been marshalling the world's most powerful lasers to drive wakefield acceleration toward 100GeV [1]. Theis asecnt was described by Nakajima et al. [2]. We describe this program. In this Conference we see several talks highlighting on such efforts.
An additional frontier of extreme light at Exawatt level is discussed. This frontier has approached to us much closer than we thought till only recently. We now see the possibility to create fs super-PW optical laser pulses from PW lasers [3]. Such laser pulses can be further converted into (1˜10) EW (≥10keV) X-ray laser pulses in attoseconds (as) via the known method [4]. Such X-ray laser pulses simultaneously achieve the highest intensity and shortest laser pulses, in fact consistent with the Conjecture [5], opening the new laser frontier at EW multi-keV in as (or perhaps even zeptoseconds).

This possibility to amplify laser to such extreme peak power offers a new paradigm unifying the atomic and subatomic worlds, to include nuclear physics, high energy physics, astrophysics and cosmology. This development stimulated the concept of wakefield acceleration in solid materails such as carbon nanotubes [6]. This makes the leap of the electric field from GeV to TeV per cm, the size of the interaction domian decreases from microns to nanometers, the time scales from femtoseconds to zeptoseconds.

Recent studies also show that wakefield acceleration is in the work in astrophysical jets of active galactic nuclei (AGN) [7]. Observed phenomenologies from Blazars seem to be consistent with such wakefield mechanism.

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