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High Energy & High Luminosity Gamma Gamma Colliders

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With the best of modern standard lasers, high-energy gamma gamma (gg) colliders from electron beams of E > 250 GeV are only possible at the expense of photon luminosity, i.e. 10 times lower than for photon colliders at c.m. energies below 0.5 TeV. For existing state-of-the art lasers, an optimistic upper energy limit for x=4.8 is an electron beam of less than 250 GeV. We show how a single FEL design can produce a 10 factor gain in the luminosity of gg colliders as second interaction region of e+e- colliders up to at least 1 TeV c.m., thus paving the way for High Energy and High Luminosity gg colliders. The same electron beams and accelerators of the original e+e- collider are used for two identical high gain SASE FELs. At the appropriate energy required by the FEL, i.e. 2.3 GeV, every other bunch from each beam is diverted to each FEL line where a helical undulator produces circularly polarized 0.5 eV light with 0.1-1 Joules per pulse. The remaining bunches continue down the Linac and collide at their nominal energy with geometric luminosity of 1-6 × 10^34 cm2/s. The central FEL wavelength of 2.4 um, obtained with either standard warm magnet or superconducting technology for the undulator, and an x-factor in the range of 2 to 40, maximize the luminosity of the gg collider as second interaction region of a 0.5–10 TeV c.m. electron-positron collider. We therefore recommend that a gg collider be considered a natural part of all e+e- linear collider proposals.

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