Developments of optical resonators and optical recirculators for Compton X/$\gamma$ ray machines

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Content

Optical resonators and optical recirculators are key elements of Compton X/$\gamma$-ray machines. Such devices could ultimately be used in the design of polarized positron sources for a future linear electron-positron collider and photon sources for an hypothetical photon-photon collider. With regard to their use in laser physics or in time-frequency metrology, these devices have to obey severe constraints when implemented in the vacuum of an electron accelerator. Our group is developing both types of devices. An original recirculator design is being developed for the ELI-NP $\gamma$ ray source. It is an aberration free device that recirculates 32 times a short and high intensity laser pulse. It also allows synchronizing each of the 32 passes with the electron RF cavities within approximately 100 fs. The second topic is a description of R&D on optical resonators dedicated to laser-electron interactions, in particular the ThomX Compton ring. Two different picosecond laser oscillators have been locked to the highest cavity finesse $F=30000$ ever reached in pulsed regime. We also designed and built a new kind of non-planar cavity, tetrahedron shape, providing circularly polarized eigenmodes. This cavity was installed in the ATF accelerator of KEK and successfully used to produce a high gamma ray flux. Thanks to an original fibre amplifier, 100 kW of average power were stacked inside the cavity.

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