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THz pulse doubler at FLASH: double pulses for pump-probe experiments at X-ray FELs

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At FLASH, the free electron laser in Hamburg, an unique scheme is used to laser X-ray pulse and THz pulse by the same electron bunch for pump-probe experiment. However the timing overlap is achieved at the price of losing pulse energy and bandwidth of the X-ray pulse in a back reflection, since the THz beamline is longer in optical path. A new scheme of lasing the X-ray and THz pulses are proposed here. To solve this issue, two electron bunches separated by 21.5 ns are generated. The first electron bunch is used to generate THz pulse and the second one is used to generate the X-ray pulse. The delay in the beamlines is compensated by the delay between the electron bunches. The feasibility of the double pulses scheme is demonstrated. In order to optimize the X-ray and THz pulses individually, suppressing the X-ray pulse energy down to one-sixth in the first bunch is achieved, and ~20fs (r.m.s.) timing jitter is measured by electro-optic spectral decoding method between the THz pulses generated by the two electron bunches.

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