Possible Way of Tandem Free Electron Laser Realization on Channeling Relativistic Particles

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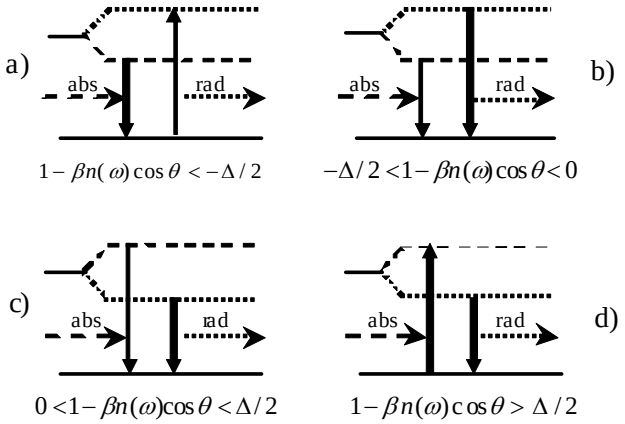
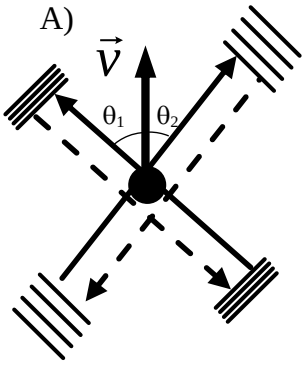
Abstracts: *In the report the possibilities of X-Ray FEL optimization and creation of tandem multiphoton inversionless X-Ray (gamma-Ray) laser are considered.*

One of the optimal ways of generation of coherent hard radiation is connected with Free Electron Laser on relativistic particles. Unfortunately, the effectiveness of "usual" FEL is very low (*dN/dn<0.001* quanta/particle). The possibilities of optimization of FEL and creation of tandem (multiphoton) short wave laser with extremely high efficiency (*dN/dn>>1* quanta/particle) are discussed. The main role in such system plays the full Doppler effect in extreme area of Cherenkov parameters $\beta n(\omega)\cos\theta \approx 1$ (see Fig. a)-d)) that was investigated for the first time in 2006 [1].





For such laser (see Fig. A)) the very effective process of consecutive generation of two types of photons with different frequencies $\omega_{1,2}$ on the same radiating transition is possible and this double photon generation leads to the restoration of the initial state of quantum system. This effect allows predicting the possibility of multiple repeat of radiation cycle on the same pair of energy levels $\varepsilon_2 \to \varepsilon_1 + h\omega_1 \to \varepsilon_2 + h\omega_1 + h\omega_2 \to \varepsilon_1 + 2h\omega_1 + h\omega_2 \to \varepsilon_2 + 2h\omega_1 + 2h\omega_2 \to \ldots \to \varepsilon_2 + Nh\omega_1 + Nh\omega_2 \to \ldots$ This closed loop can be repeated many times, leading to the possibility of multiphoton generation at two-level transition of the same particle [2]. The pumping source for such laser is the kinetic energy of moving particles. In tandem FEL there is no need for inversion and absorption on radiation frequency is totally absent. The main problem of realization of tandem FEL is connected with the need of mediums with positive susceptibility in high frequency range, possible ways to solve this problem are also regarded.

1. Vysotskyy M.V., Vysotskii V.I. Nuclear Instr. Methods in Physics Research B, 2006, v. 252, 75.
2. Vysotskii V.I., Vysotskyy M.V. Jour. of Surface Investigation, X-ray, Synchrotron and Neutron Techniques, 2010, v. 4, 162.