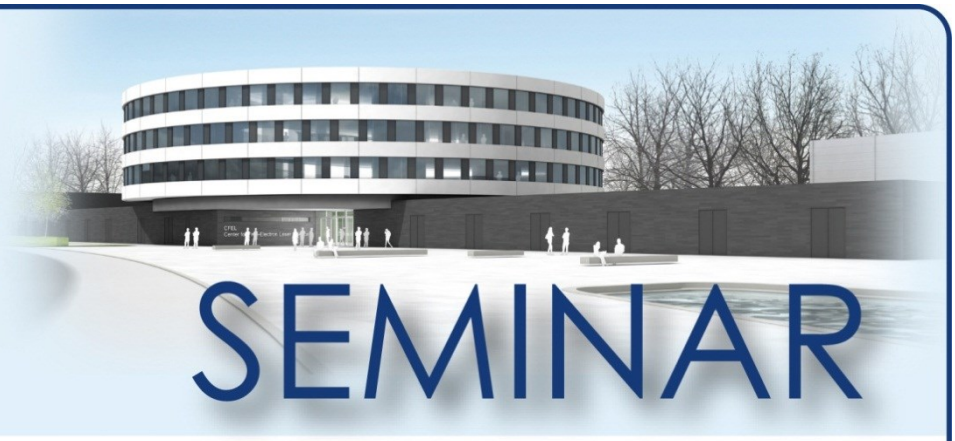
CFEL SCIENCE



SEMINAR

11th February, 2015 - 02:00 pm
CFEL-bldg. 99, seminar room SR II

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Phase-mismatch free nonlinear propagation in zero-index materials

Phase matching is a critical requirement for coherent nonlinear optical processes such as frequency conversion and parametric amplification. Phase-matching allows microscopic nonlinear sources to combine constructively, resulting in more efficient far field emission. The most widely used methods for phase-mismatch compensation are Birefringence phase matching, angle phase matching and Quasi-phase-matching, which allow to achieve phase matching either in the forward or backward directions, but not both. *Zero index materials*, a class of metamaterial, have a constant phase throughout the material, allowing nonlinear sources at all positions within the material to add up constructively. These materials create a phase-mismatch free environment for nonlinear propagation, where in contrast to existing phase matching techniques, zero index metamaterials *eliminate* the requirement for phase matching compensation.

In my talk, I will share with you our recent experimental demonstration of phase mismatch-free nonlinear propagation in a bulk fishnet metamaterial, which exhibits regimes of positive, zero, and negative refractive indices. Using intrapulse four-wave mixing (FWM), we have shown that at the zero crossing of the refractive index, the forward-backward FWM ratio is nearly unity, indicating perfect phase matching for both directions. This first observation of phase-mismatch free nonlinear propagation in zero-index materials, which was verified also by numerical simulation of the propagation dynamics, could allow efficient bi-directional nonlinear generation, a capability which is lacking in conventional nonlinear materials. The removal of the phase matching requirement may lead to new applications of nonlinear optical metamaterials.

Host: Franz X. Kärtner, CFEL UX seminar