Phase Sensitive Amplification using Parametric Processes in Optical Fibers

Phase sensitive amplification using the parametric processes in fiber has the potential of delivering high gain and broadband operation with ultralow noise. It is able to regenerate both amplitude and phase modulated signals, simultaneously, with the appropriate design. This thesis concerns, in specific, the design and optimization of such phase sensitive amplifiers (PSAs). For phase sensitive amplification in highly nonlinear fibers, optima points of operation have been identified for both the standard and the novel high stimulated Brillouin scattering (SBS) threshold highly nonlinear fiber types. The regeneration capability of PSAs on phase encoded signal in an optical link has been optimized. Flat-top phase sensitive profile has been synthesized. It is able to provide simultaneous amplitude and phase noise squeezing, with enhanced phase noise margin compared to conventional designs. Further, phase sensitive parametric processes in a nano-engineered silicon waveguide have been measured experimentally for the first time. Numerical optimizations show that with reduced waveguide propagation loss and reduced carrier life time, larger signal phase sensitive extinction ratio is achievable. Finally, preliminary simulations were carried out to investigate the inline amplification properties of such PSAs, and their pulse shaping capabilities.