UMBC Computational Photonics Laboratory

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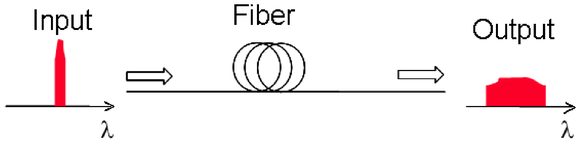
Computational Photonics Laboratory, Directed by Curtis R. Menyuk

Research topics include:

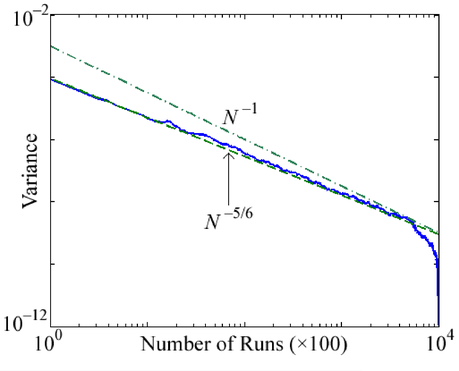
- Optical fiber communications
- Quantum cascade lasers
- Time/frequency transfer
- Fiber lasers
- Photodetectors
- Novel and nonlinear optical fibers
- Frequency combs/micro-ring resonators

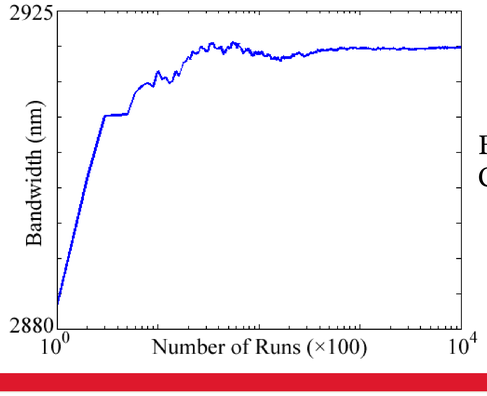
Supercontinuum generation

Supercontinuum generation uses a highly nonlinear and dispersive optical fiber to broaden the bandwidth of an input laser pulse. Because this process is extremely sensitive to small variations in the input, a single numerical simulation does not accurately replicate the experimentally-expected output. There may be 1,000,000 independent realizations in a 10% range of parameter variations. We show the realizations are not completely independent, and that we can find the experimentally-expected output spectrum with only 5,000 samples.



Variance reduction



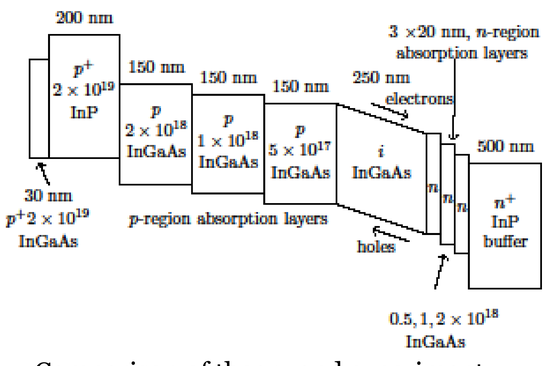


Bandwidth Convergence

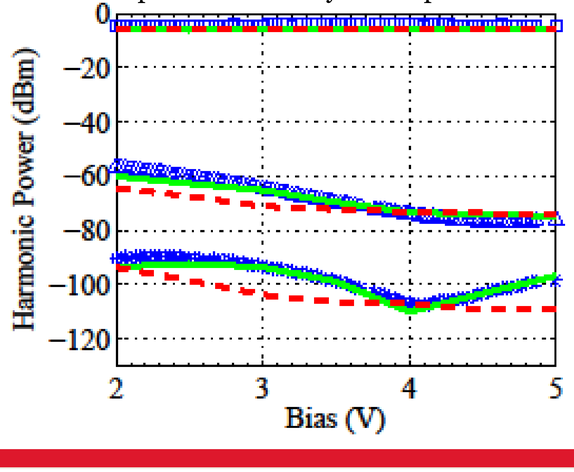
Photodetectors

The nonlinear response of high-current photodetectors plays an important role in limiting the performance of RF-photonic devices. Yet, the physical reasons for this nonlinear response remain poorly understood. In particular, almost all prior work used a simple one-dimensional model of the photodetector, which ignored the radial dependence of the light beam. We solve the drift-diffusion equations, taking into account radial effects for a high-current p-i-n and PDA (partially depleted absorber) photodetector using finite-difference methods.

Photodetector structure



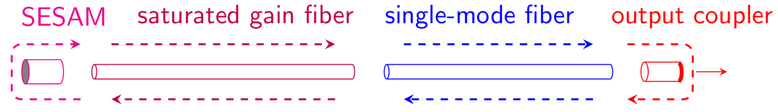
Comparison of theory and experiment



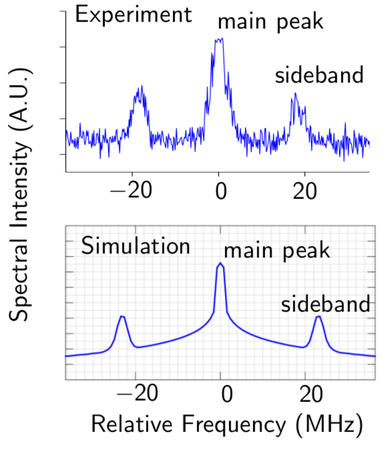
Fiber laser modeling

A fieldable fiber laser has been reported using telecom-grade polarization maintaining components and a semiconductor saturable absorber mirror (SESAM). We simulate this laser using a realistic model, which including a complete description of the erbium-doped fiber. We are able to obtain an agreement with the experimental results within 5%. This model allows us to optimize the system parameters. With a full EDFA model, good agreement is achieved. We are able to describe the soliton wake instability that induces sidebands around the frequency comb lines, and further introduces quasi-periodic creation and destruction of pulses.

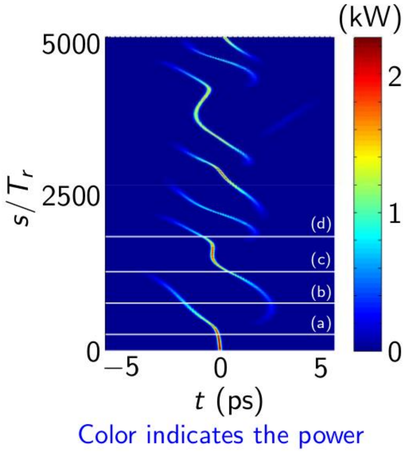
Laser system setup



Sidebands



Soliton wake instability



Color indicates the power

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