Soliton compression in silicon photonic crystals

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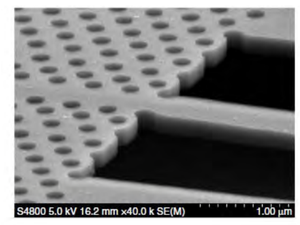
Challenge: Picosecond solitons in Si

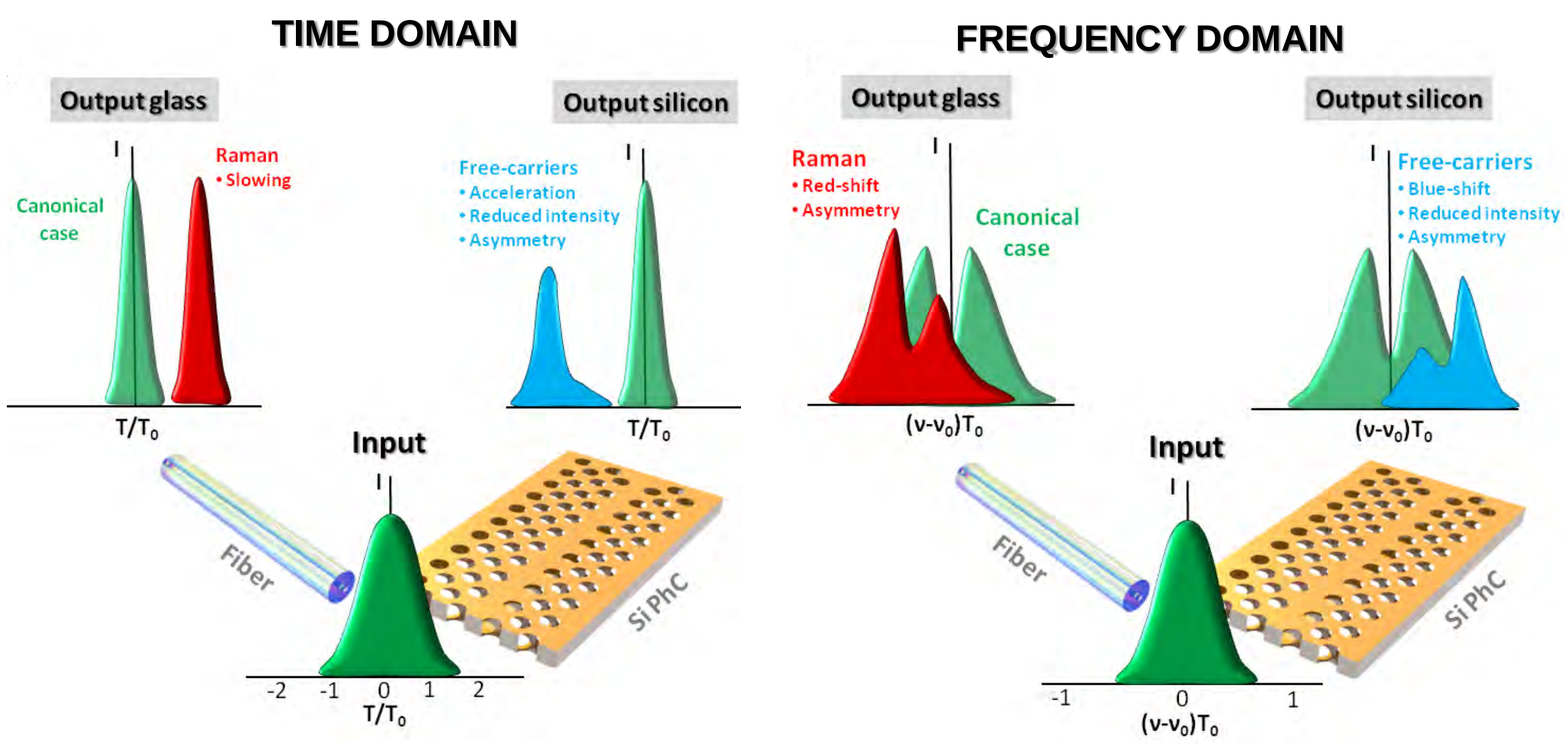
- **Solitons** are nonlinear waves important for fundamental studies of physical processes such as supercontinuum generation or rogue waves and for applications in metrology and optical communications.
- **In Silicon**, two-photon absorption and its accompanying free carriers greatly distort the dynamics of the optical soliton.
- **Picosecond** pulses experience different dynamics compared to fs pulses, as longer pulses experience stronger free-carrier interactions.

Aim: on-chip soliton compression in a silicon photonic crystal waveguide

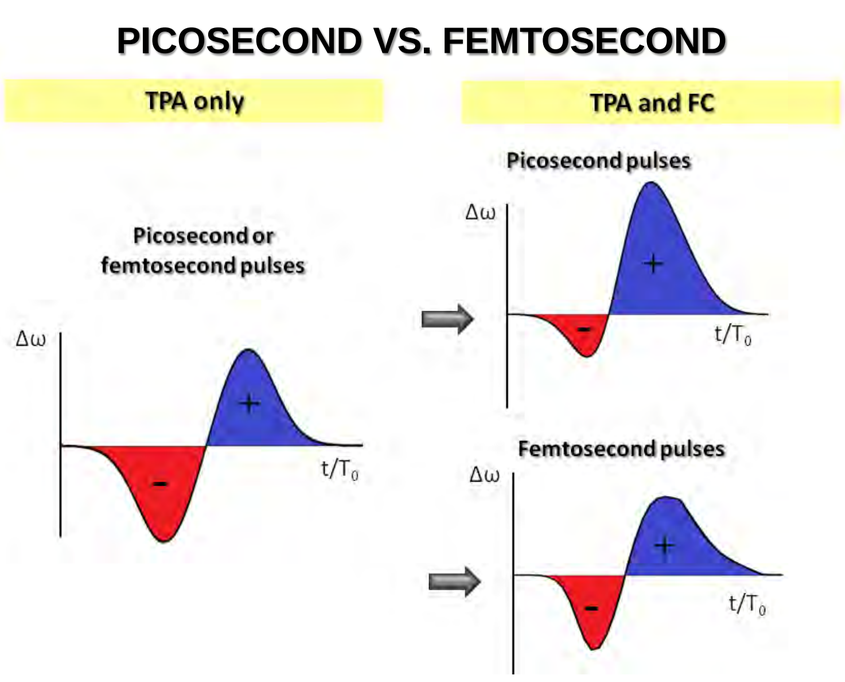
Experimental demonstration of ps soliton compression in a silicon chip and complete (time- and phase-resolved) measurements of the soliton dynamics.



Picosecond soliton dynamics in silicon photonic crystal waveguides



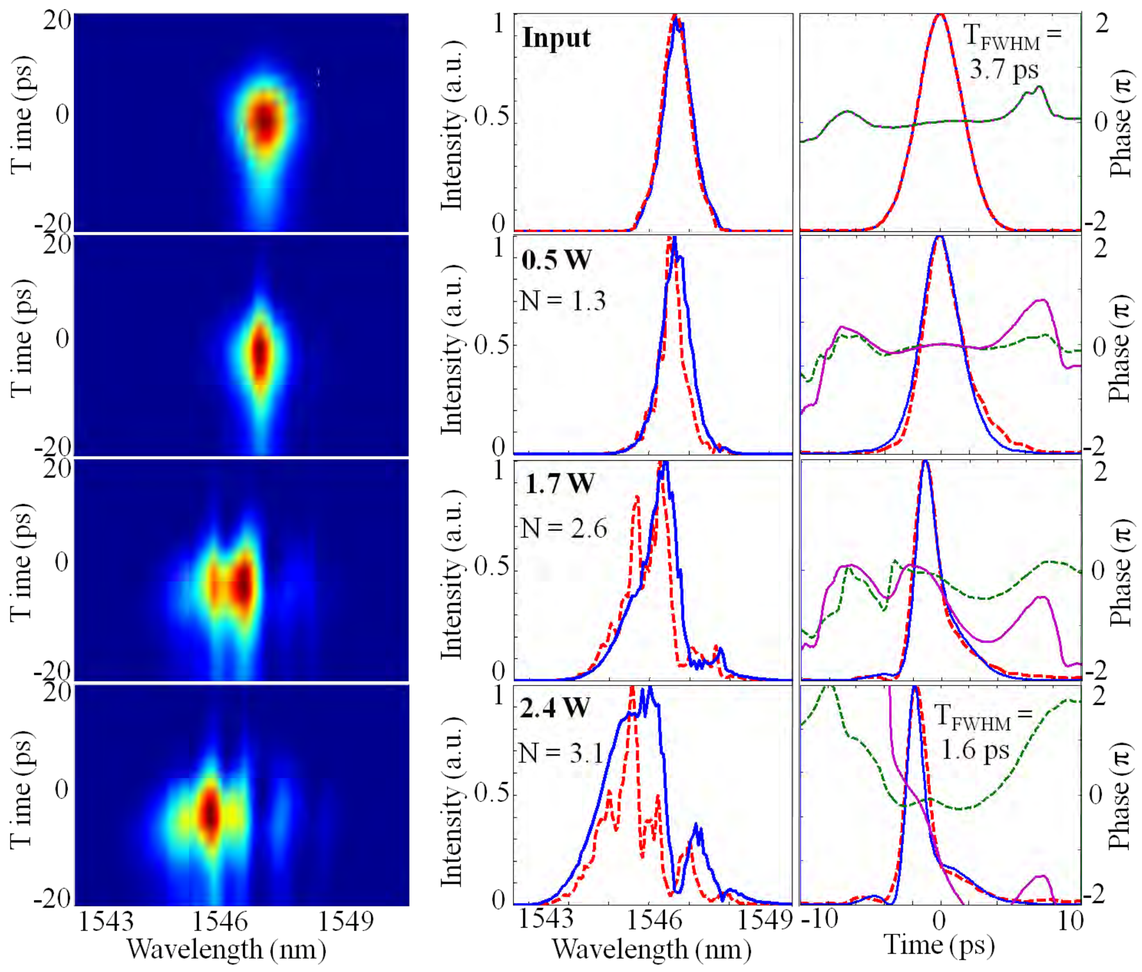
- Dramatically different behaviour between glass and silicon solitons



- Picosecond pulses experience strong interaction with free-carriers

A. Blanco-Redondo, C. Husko et al., *Nature Commun*. **5,** 3160 (2014)

Phase-resolved FREG measurements



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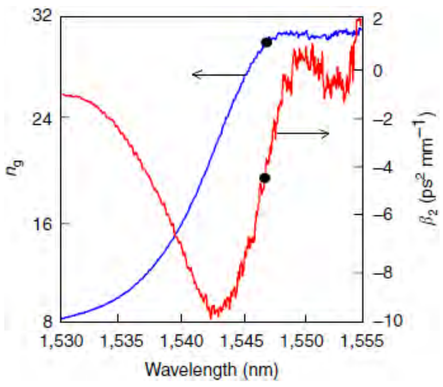
--- I exp. --- Phase exp.
— I sim. — Phase sim.

Results: Soliton compression in silicon

- C**ompression** of 3.7-ps pulses to 1.6 ps at **9 pJ** energy in **silicon,** using a **slow-light PhC-wg**:
  - Huge anomalous dispersion
  - Slow-light enhanced Kerr effect



- **1 ps pulse acceleration** due to the interaction of the optical soliton with the free carriers
- **Ultra-sensitive (sub-pJ)** time and frequency domain characterization
  - Frequency resolved electrical gating **(FREG) technique**
- Confirmed by Nonlinear Schrodinger Equation (**NLSE) modelling**
- These **results** further our understanding of nonlinear waves in silicon, opening the way to soliton functionalities in a **monolithic CMOS platform.**

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