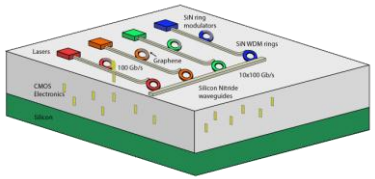
Ultra-Low Power CMOS-compatible Integrated Photonic Platform for Terabit-Scale Communications

Team

Columbia University

Keren Bergman (Project Lead)

Michal Lipson (Co-PI)



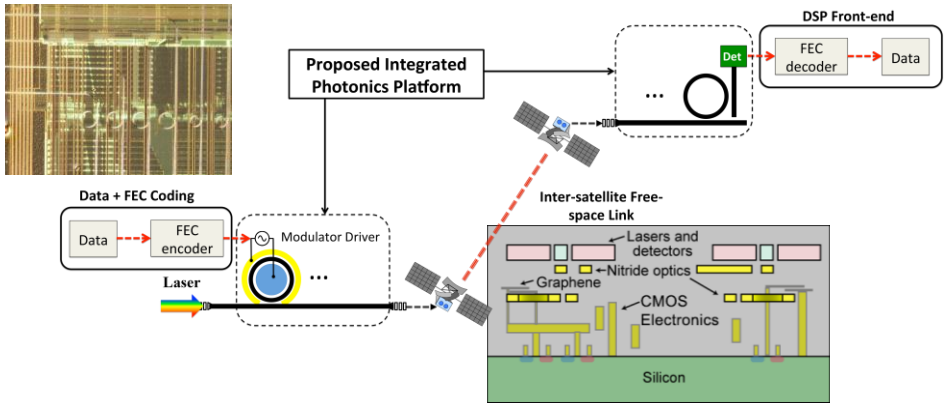
Research Objectives

- Current state-of-the-art free space laser links at telecommunications wavelengths are limited in bandwidth to < 1Gbps mainly due to the high energy consumption of optical transceivers.
- Realize fully CMOS-compatible platform for ultra-low power Terabit-scale optical communications
- Optical space communication of user-programmable variable data rates ranging from 10's of MHz to 100's of GHz within the critical ultra low power (1–10W) envelope
- Build complete suite of fabrication and simulation tools needed to integrate and design photonics and electronics components in 3D CMOS-compatible platform
- Demonstrate fully operational free space link **with variable bandwidth from 10Mbps to 100Gbps** and forward error correction under 10W total power consumption

Approach

- Novel **3D deposited nanophotonic platform**. Enables complex photonics devices combining modulators, detectors, switches, waveguides, lasers, and routers with **full and seamless integration with CMOS electronics**
- Fabrication of photonic structures directly ***on top*** of standard CMOS electronics
- 3D integration of active photonics: TRL 1 at program initiation to TRL 3.

Ultra-low power Terabit-Scale Optical Communications



Ultralow power 100's GHz transceiver based on monolithically integrated photonic devices with state of the art CMOS electronics. Bottom right: 3D photonics platform integrated directly on the CMOS. Top Left: Preliminary results demonstrating monolithically integrated silicon nitride rings within 90nm process CMOS die. (photonic ring components and the metal vias visible underneath)

Potential Impact

- **Ultrafast data upload/download** to revolutionize scientific instrumentation in space
- **Ultra-low power, high speed communications** enables inter-satellite communications networks
- **Dramatic decrease** in size, mass, and power consumption
- Drastically reduced power consumption for broad optical communications and large data networking