Sub-Hertz-Linewidth Semiconductor Laser for Isolator-Free Silicon Photonics

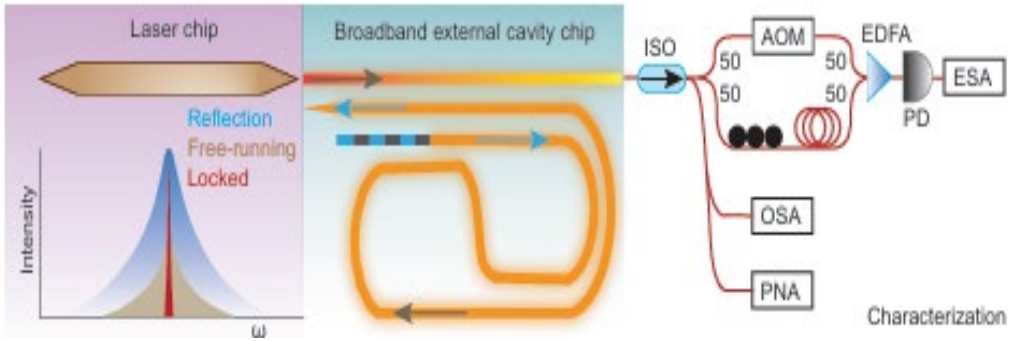

Figure: Experimental setup. ISO: opticalisolator; AOM: acousto-optic modulator; PD: photodiode; ESA: electrical spectrum analyzer; OSA: optical spectrum analyzer; PNA: phase noise analyzer

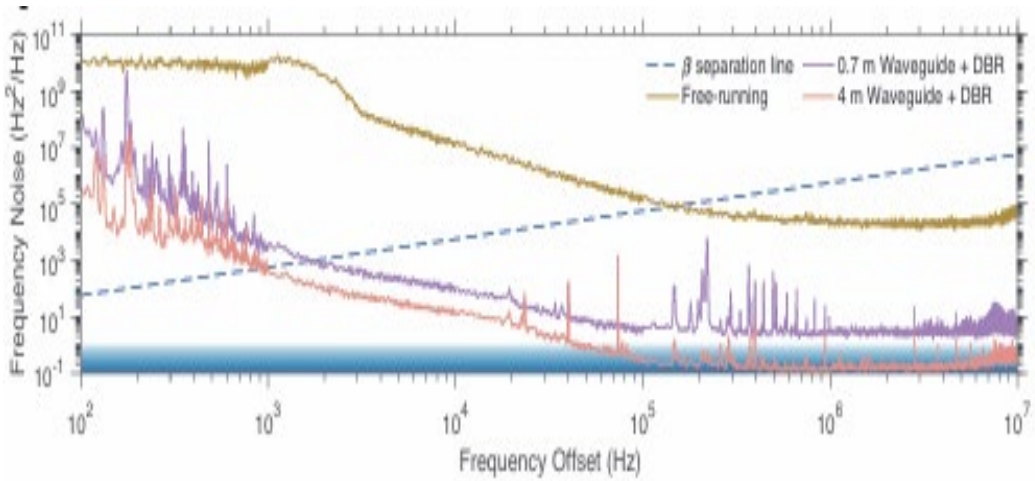

Figure: Frequency noise spectra under three operating conditions: free-running (gold), external-cavity locking with 0.7 m delay (purple), and external-cavity locking with 4 m delay (pink).

Scientific Achievement

Demonstrated 0.45 Hz lasing linewidth with exceptional feedback tolerance up to -8.1 dB.

Significance and Impact

This hybrid-integrated external cavity laser enables isolator-free III-V and silicon photonics integration and ensures stable operation by mitigating thermorefractive noise and mode-hopping. This laser is an ideal candidate for large-scale heterogeneous photonic integration, with applications in optical and quantum computing, precision sensing and communication systems. There is potential for commercializing with an onshore foundry.

Research Details

- High-performance semiconductor lasers and turnkey components provide scalable, integration platforms to demonstrate approach
- First-principle theory allows understanding and experimental design at band structure, many-body and cavity quantum electrodynamics (cQED) physics level

This work was performed, in part, at the Center for Integrated Nanotechnologies.

Dong, B.; Jin, W.; Prokoshin, A.; Chow, W. W.; Wan, Y.; Bowers, J. E. Sub-Hertz-Linewidth Hybrid-Integrated Laser for Isolator-Free Silicon Photonics. *Optica.* 2025.