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**HL 14: Invited Talk James Lott**

Time: Monday 11:45–12:15

Location: POT 151

**Invited Talk**

HL 14.1 Mon 11:45 POT 151

**Vertical-cavity surface-emitting lasers (VCSELs) for optical interconnects** — •JAMES A. LOTT — Zentrum für Nanophotonik, Institut für Festkörperphysik, Technische Universität Berlin, Sekr. EW 5-2, Hardenbergstraße 36, D-10623 Berlin, Germany

Vertical-cavity surface-emitting lasers (VCSELs) are at present the smallest practical breed of laser. Mass-produced 10 Gbit/s VCSELs with an energy efficiency of about 400-800 fJ/bit are the workhorses of modern short-reach (SR < 300 m) optical interconnects (OIs) in data centers and peta-FLOPS-class supercomputers. In this presentation we disclose our methods and wavelength-independent "Principles" of VCSEL design and operation, based on our many years of extensive experimental and numerical materials and device studies, that simul-

taneously lead to the optimization of three critical VCSEL attributes: 1) energy efficiency; 2) temperature stability; and 3) directly current-modulated bit rate. Our 850 nm VCSELs operate error-free across multi-mode fiber at 25-40 Gbit/s with energy efficiencies in the range 56-108 fJ/bit. We next disclose the results of our work on ultrafast 980 nm VCSELs targeted for very-short-reach (VSR < 1 m) and ultra-short-reach (USR < 1 mm) OIs for on-chip, inter-chip, free-space, and exa-FLOPS-class supercomputers of circa 2020-2030, where billions of OIs are envisioned in each supercomputer. We present record ~179 fJ/bit operation at 42 and 38 Gbit/s at 25 and 85°C, respectively. We conclude with our perspectives on a practical OI roadmap to guide our work through circa 2050. \* in collaboration with: D. Bimberg, W. Hofmann, G. Larisch, H. Li, A. Liu, P. Moser, and P. Wolf.