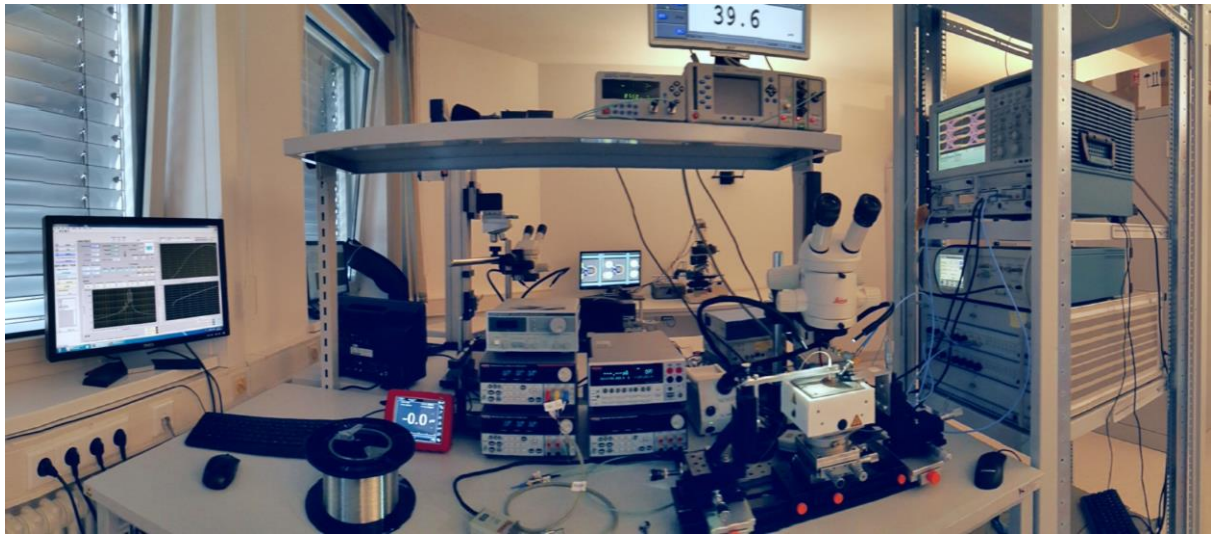
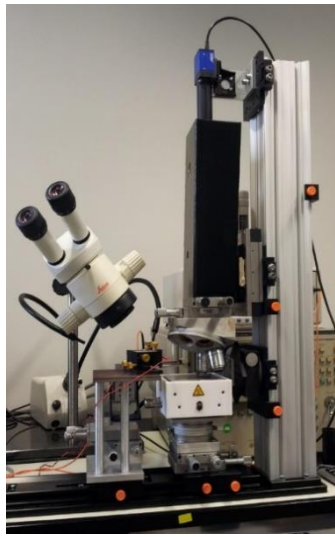
Vertically Integrated Systems

EPIC
European Photonics Industry Consortium

Vertically Integrated Systems

to serve strategic development and manufacturing needs





VIS history

- 13 Years of technology excellence
- 22 issued & 3 pending patents
- 10 EU & National Projects won

2019: first ever 100G-compatible VCSEL
100G driver, 100G TIA, TX-RX assemblies

2019: strategic cooperation with a major III-V foundry (USA, Taiwan)
Customization
Contract manufacturing
Sales directly or through the foundry.

2016: >160 Gb/s 850nm VCSEL,
128Gb/s testbed, mapping

Qualified 850nm 28G VCSEL

2008: first ever 40G VCSEL
40G driver, 40G TIA
40G TX-RX assemblies

2017 **Revenues 2.6 M€**

2016 Investment **2.7 M€**

2015 EU Horizon 2020 **2M€**

25G VCSEL

At break even since 2008

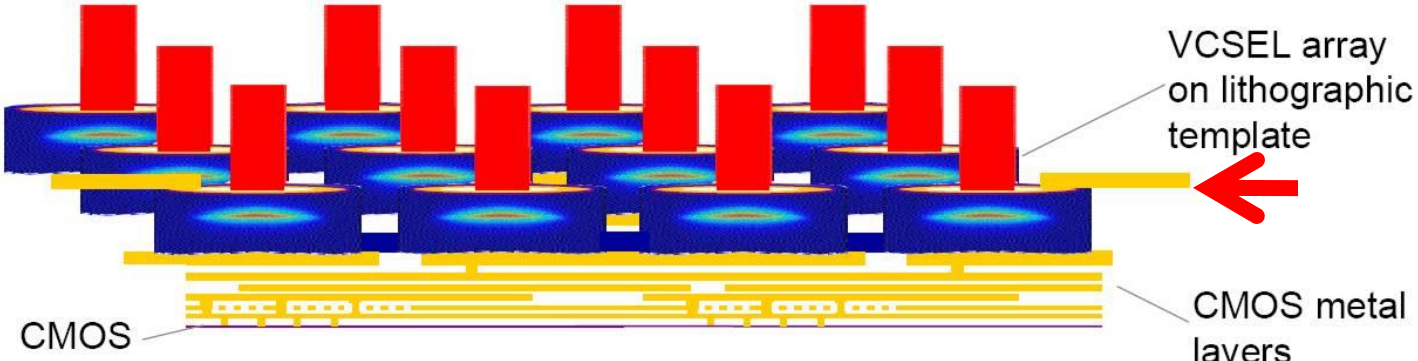
Support from Berlin (IBB, Berlin Partners)

2007 VC Investment **1M€**

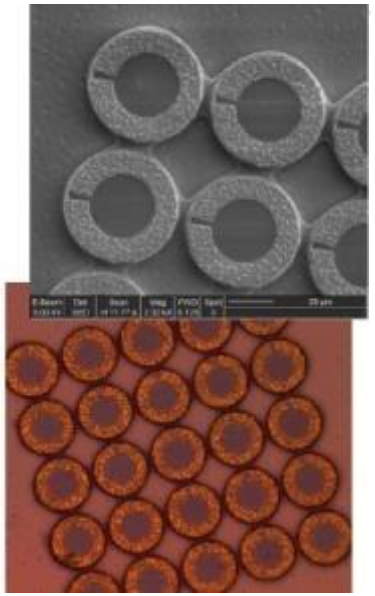
Est. Dec 2006

Why VCSELs?

N. Ledentsov, J.A. Lott, invited talk at OFC 2009



patent US 8313962



Demonstration of reliable 10µm
VCSEL flakes
(SPIE 4649 203 (2002))

- Silicon scaling (5nm, 2019) drives I/O bandwidth: speed per channel doubles each 24 months, bandwidth density each 18 months
- 112Gb/s per channel copper is due 2020-2021 (Infiniband, Ethernet)
- Copper signaling over PCB becomes extremely expensive

- When I/O goes optical **trillions** of light-emitting devices will be needed in the upper IC levels, …
- VCSEL: 25Gb/s at 180°C (850nm, VIS).
- VCSEL: size takes a few micrometers only, energy efficient, cost can be in milli-cents
- Upper level coper Interconnects do not scale and are not on CMOS surface. VCSEL lamination into IC or PCB is possible

VIS TX: VIS Driver + VIS TX VIS Amplifier

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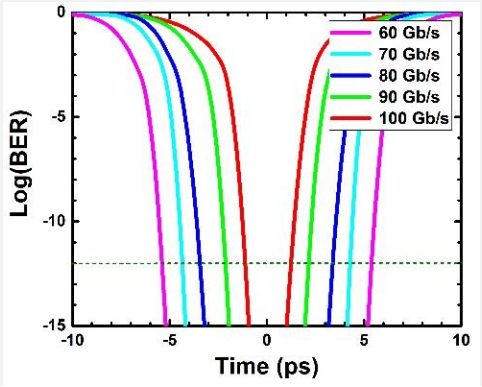
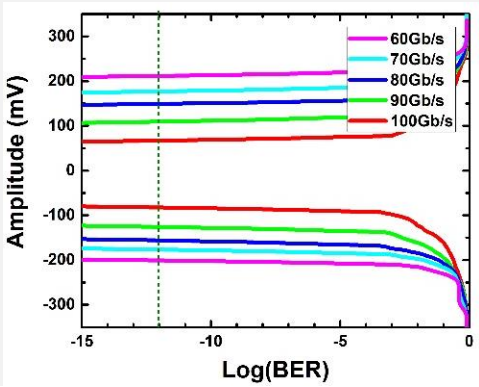
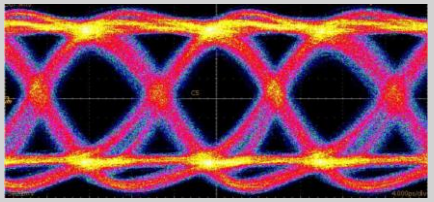




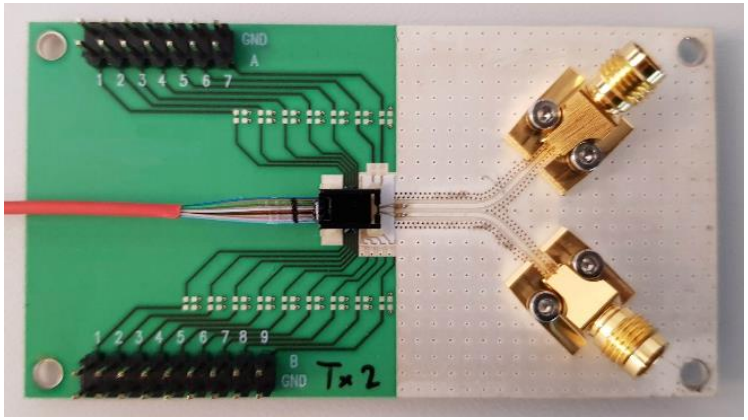
VCSEL Driver IC: error free up >90 Gbit/s

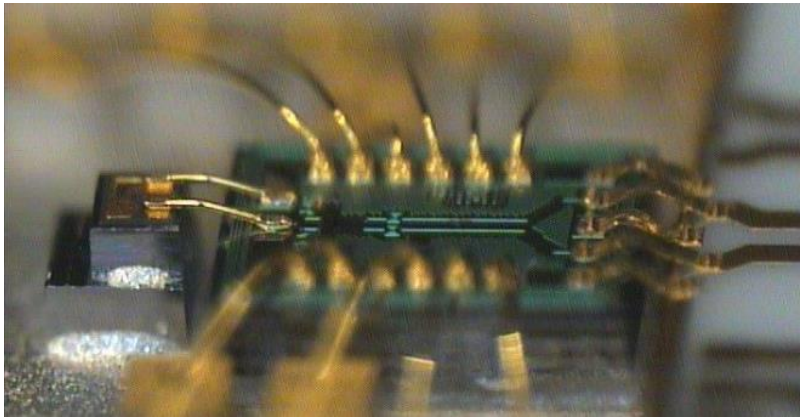
90 Gb/s setup limited



- Low current and low VCSEL capacitance results energy efficient electronics
- VIS ICs (amplifier + driver): 255 mW dissipated power per 100Gb/s link
- Good for >50Gb/s low latency links

VIS transmitter (TX)/ VIS receiver (RX) Testboard:





60 Gbit/s TX-RX PRBS11 data transmission

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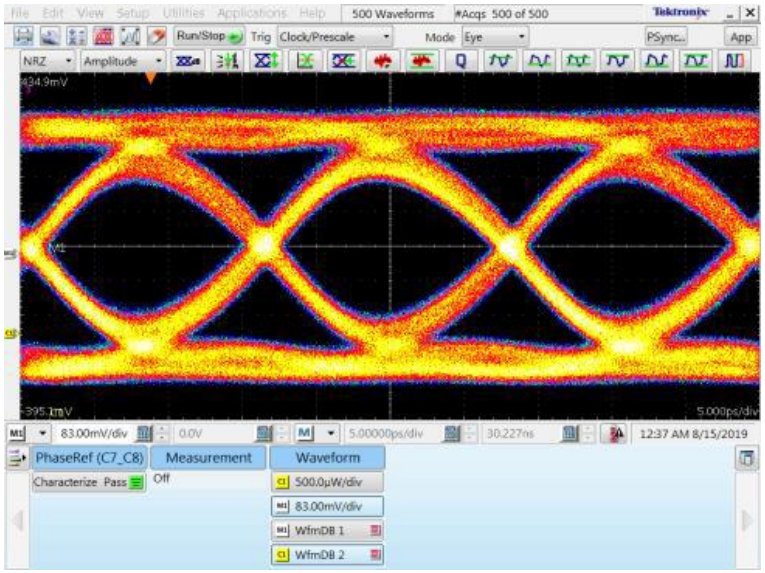
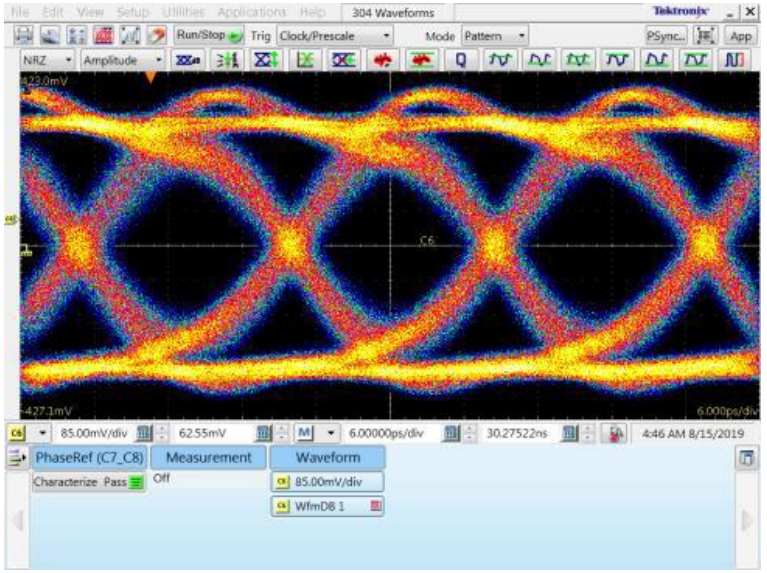
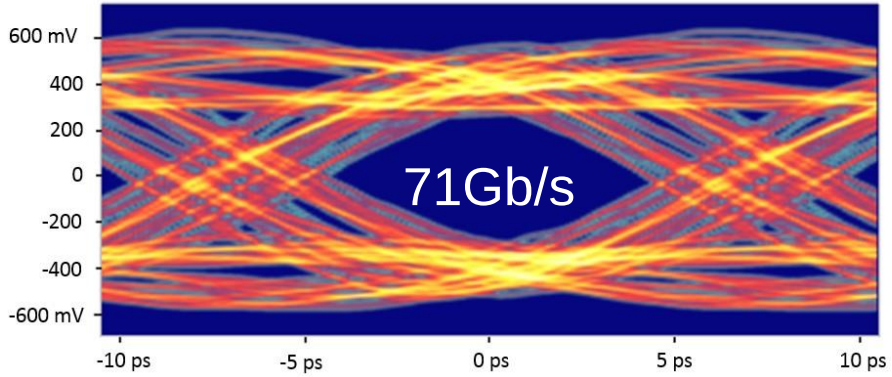


60Gbaud electrical input signal



60Gbaud VIS Transmitter/VIS Receiver link

- No equalization up to 70Gb/s
- No reclocking at the receiver
- Input signal is not corrected
- 6mW/Gbps vs 35mW/Gbps for IBM
- 2-tap equalization to get >70Gb/s



Attend VIS invited talks at OFC2020: D1 and D3 sections

120 Gbit/s PAM-4 VIS VCSEL Transmission

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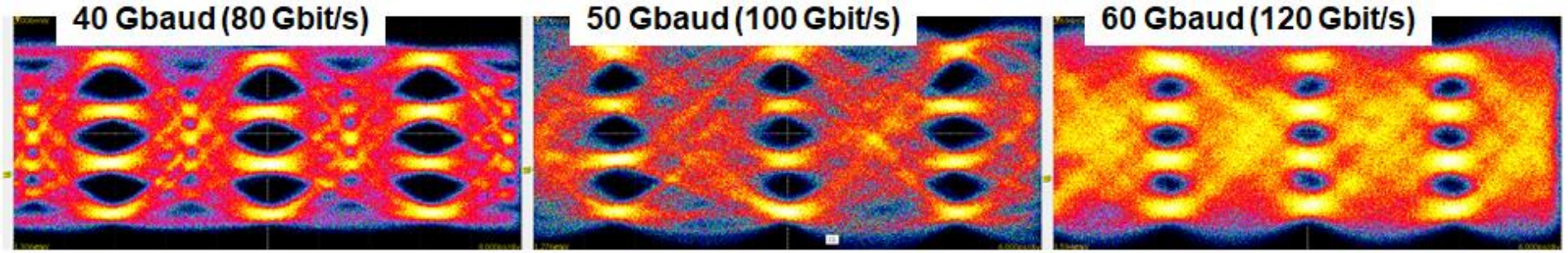
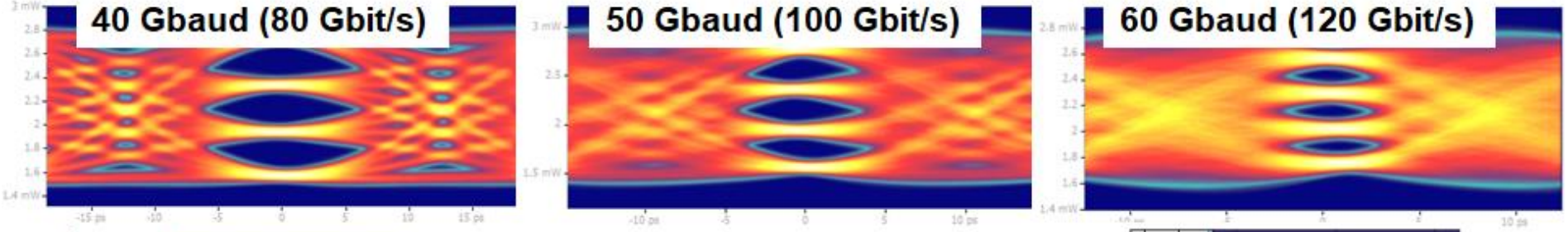
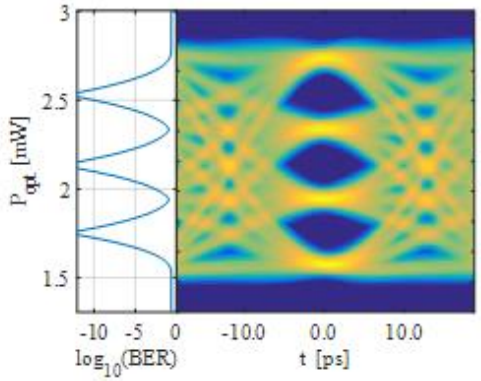
Tx: Keysight AWG w 6-tap FFE pre-emphasis

Rx: Tektronix Oscilloscope 30 GHz receiver **w/o equalization**



Tx: … Rx: Tektronix Oscilloscope 30 GHz receiver w. **5-tap FFE equalization** **(like for copper)**



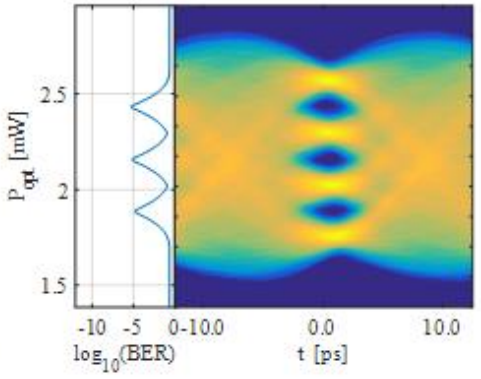


→ 120 Gbit/s 4-PAM eyes

→ 6-tap pre-emphasis

→ Realized with VIS G3

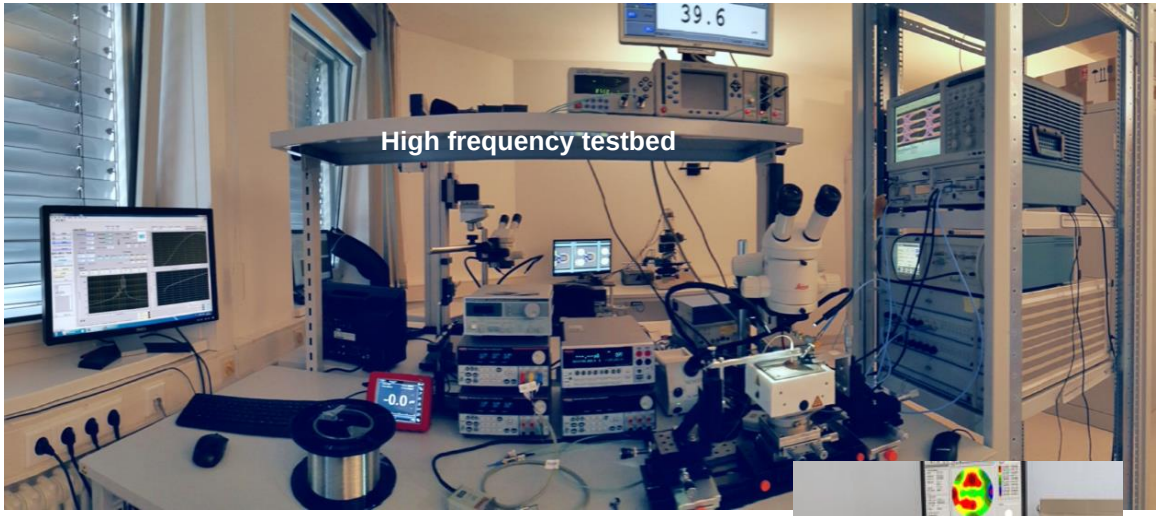
U. Hecht et al ECOC 2019



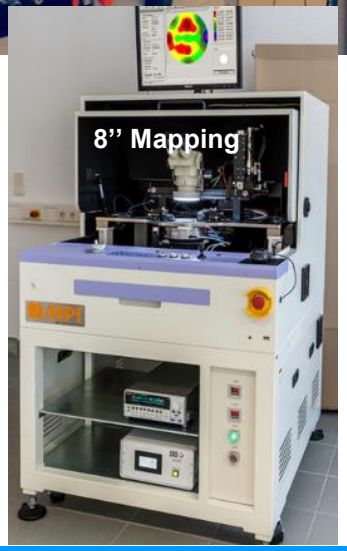
Welcome to VIS

High temperature, fast time response, reliability, high brightness are needed for sensing and automotive not less than for datacom

- **3D Modeling**
  - Opto-thermo-electric (drift diffusion)
- **Microscopy**
  - IR & visible light
- **Wafer mapping station**
  - Light-Current-Voltage
  - Optical Spectra
- **Static characterization**
  - Near Field, Far Field
  - CW, Pulsed,
  - Temperature,
- **High Frequency set up up to 128 Gb/s**
  - PAM2, PAM4
  - BER, S-parameters



High frequency testbed



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