High symbol rate transmissions with SiP modulators

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Outline

- State-of-the-art
- Key components
- Experimental setups
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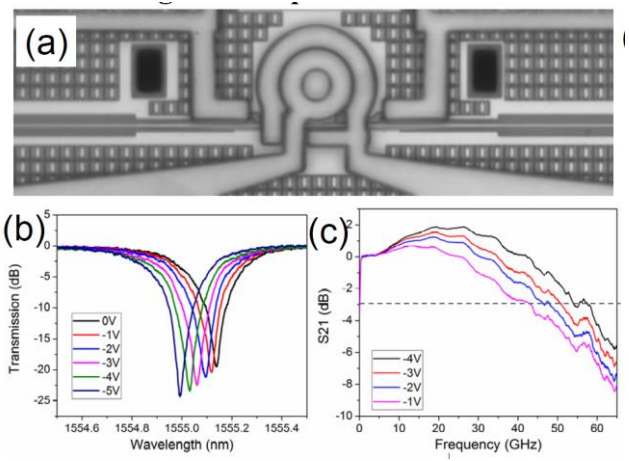
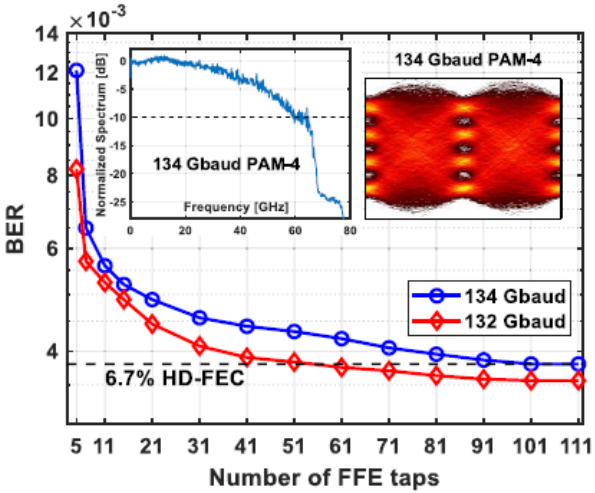
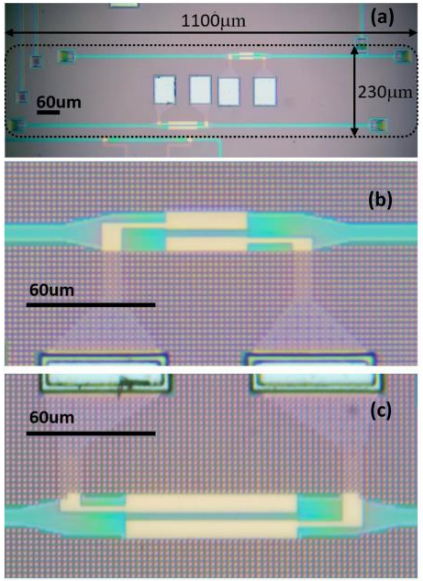
SOTA on SiP modulators



Tun-Yao Hung, et al., 300Gbit/s Si MRM, OFC 2024, W4H.4



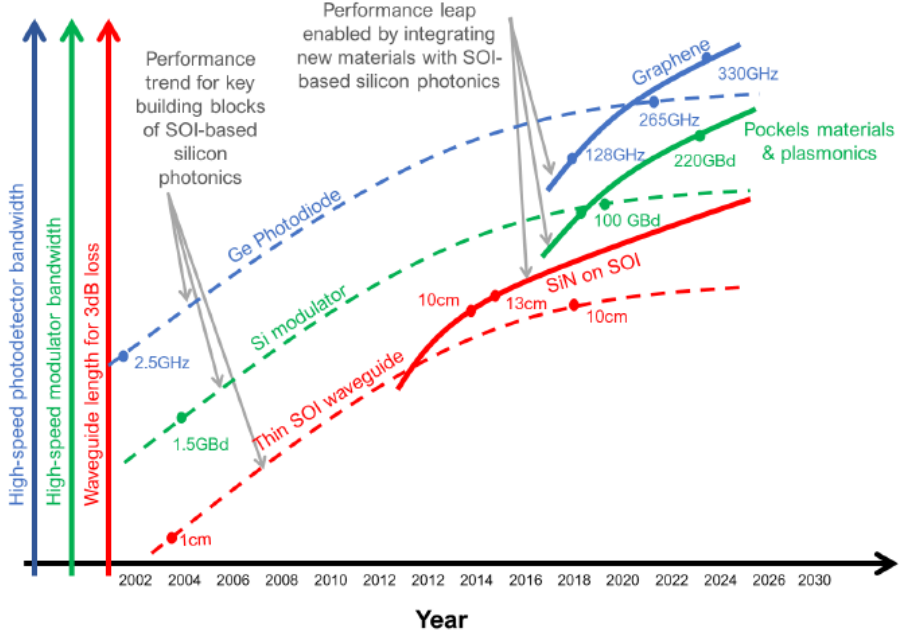
Md Samiul Alam, et al., 300Gbit/s Si MZM, IEEE Photonics Technology Letters, 2021



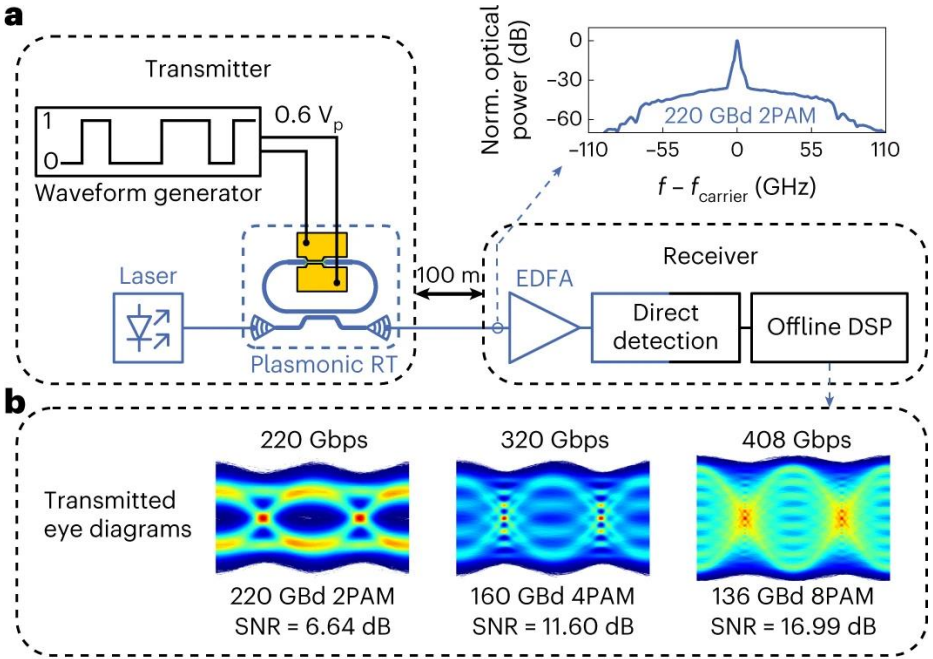
David W. U. Chan, et al., 224Gbit/s SiGe EAM, Journal of Lightwave Technology, 2022

SOTA on heterogenous integration

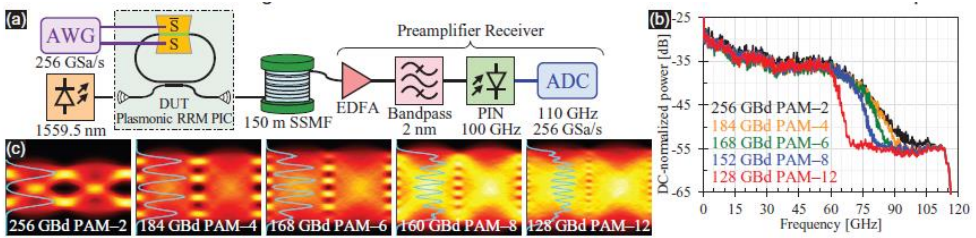
R. Baets, et al., Optical Materials Express, Dec. 2023



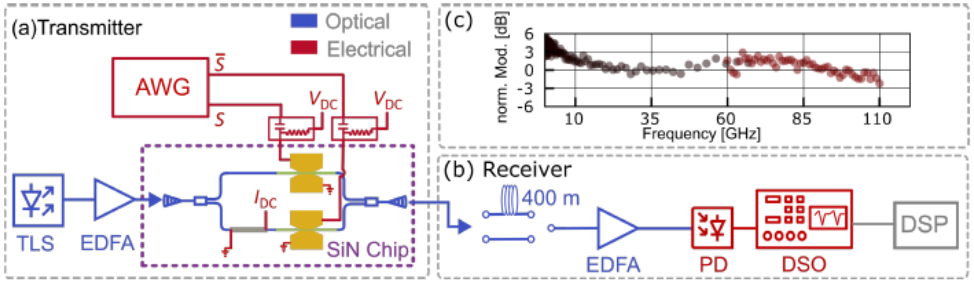
M. Eppenberger, et al., Nat. Photonics, 2023.



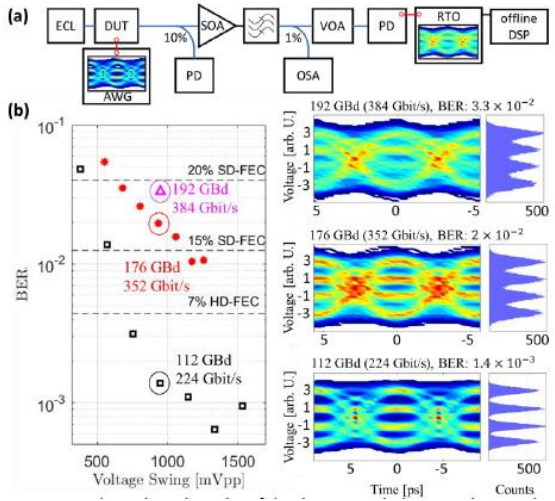
SOTA on heterogenous integration



Qian Hu, et al., 373 Gbit/s Plasmonics RRM,
ECOC 2023, Th4B.6

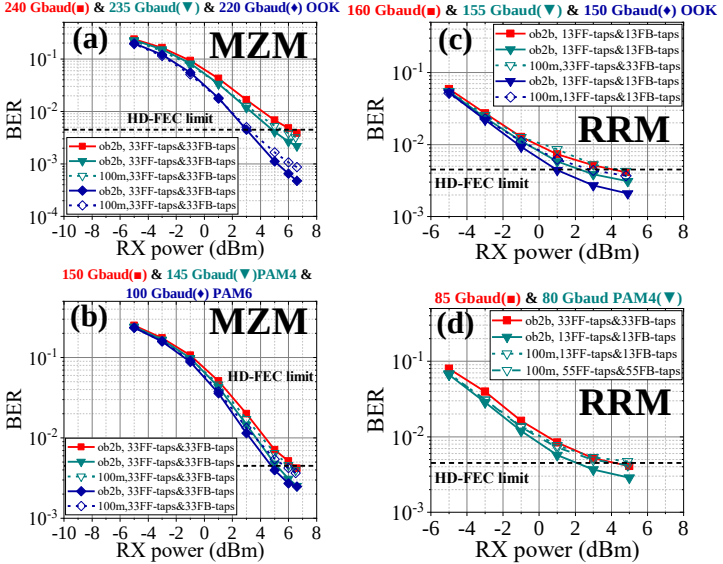


Manuel Kohli, et al., 340 Gbit/s BTO MZM,
OFC 2024, M3K.5

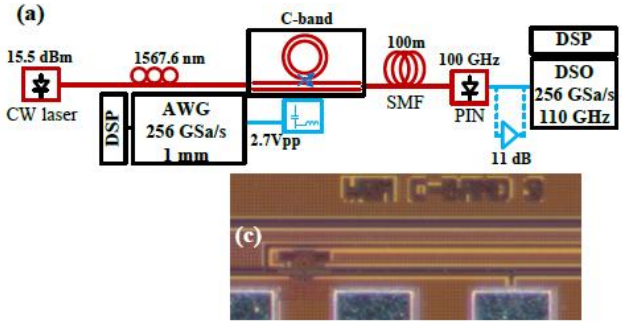


A. Schwarzenberger, et al., 384Gbit/s SOH MZM, OFC 2024, Th4B.6

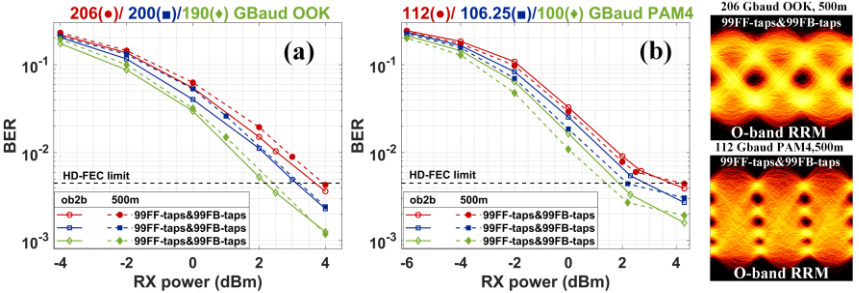
Our contributions to SOTA



A.Ostrovskis, et al., 300/160 Gbit/s Si MZM/RRM, SiPhotonics 2023, PD.3



A.Ostrovskis, et al., 280 Gbit/s Si C-band RRM, Advanced Photonics Congress 2024



A.Ostrovskis, et al., 224 Gbit/s Si O-band RRM, CLEO-PR 2024

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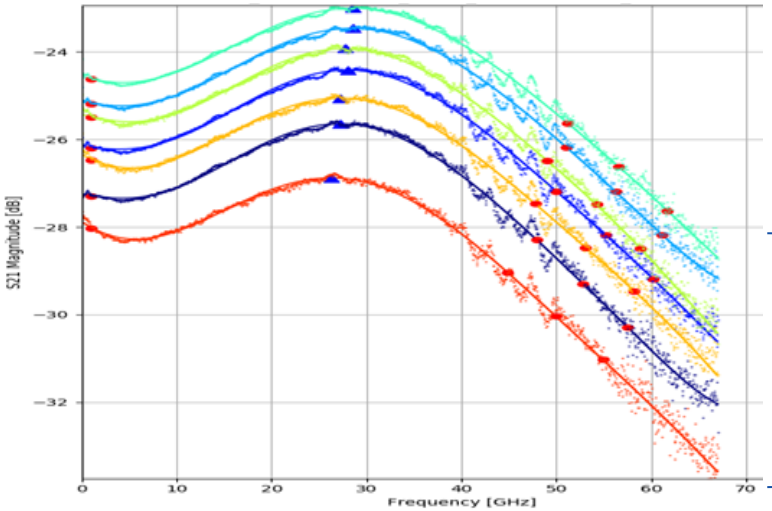
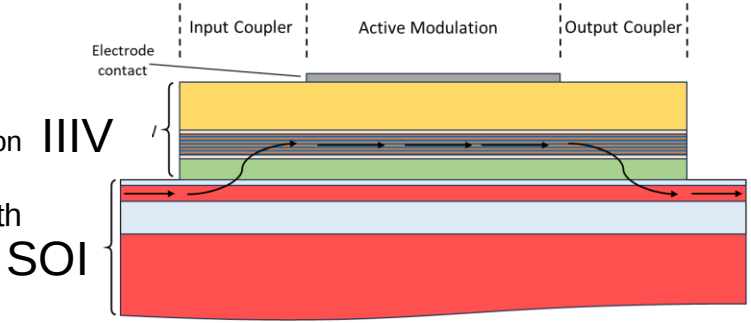
Heterogenous IIIV EAM on Silicon

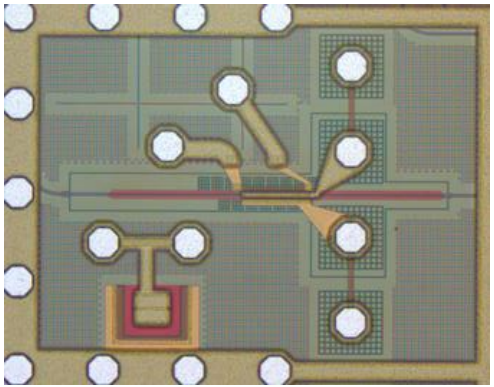
- IIIV-EAM on Silicon fabricated at Tower Semiconductors
  - Design available in open market PDK
  - PDK/Process also includes integrated IIIV lasers and full suite of silicon photonics components
- EAM designed for either single ended or differential drive, with on-PIC resistive and inductive termination
- EAM bandwidth >60GHz



Different bias values



Schematic cross-section of IIIV on Si



Optical image of fabricated EAM on Si

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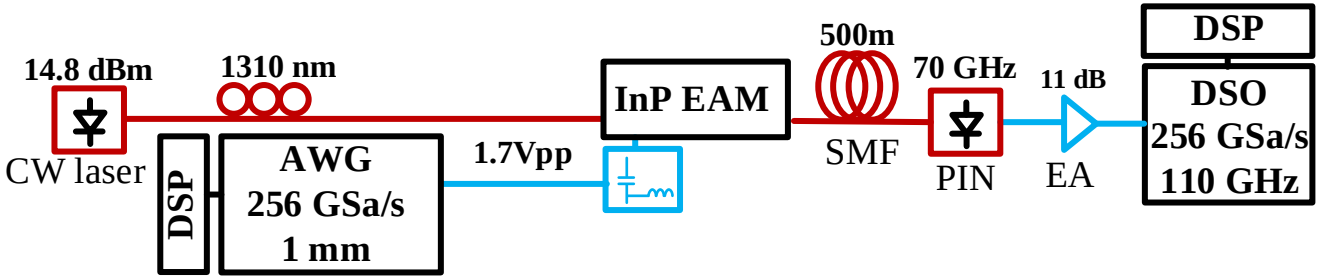
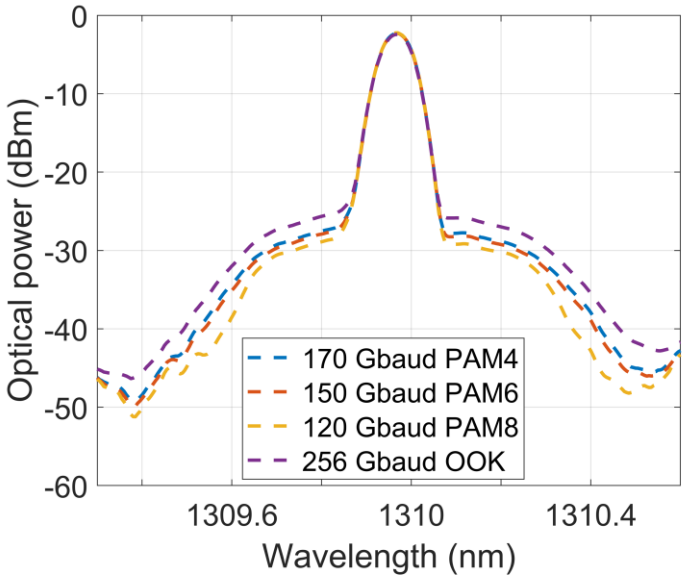
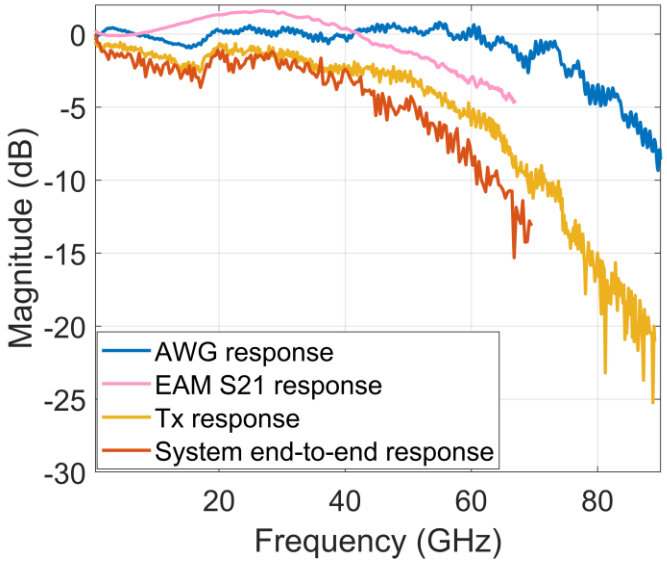
Experimental setup







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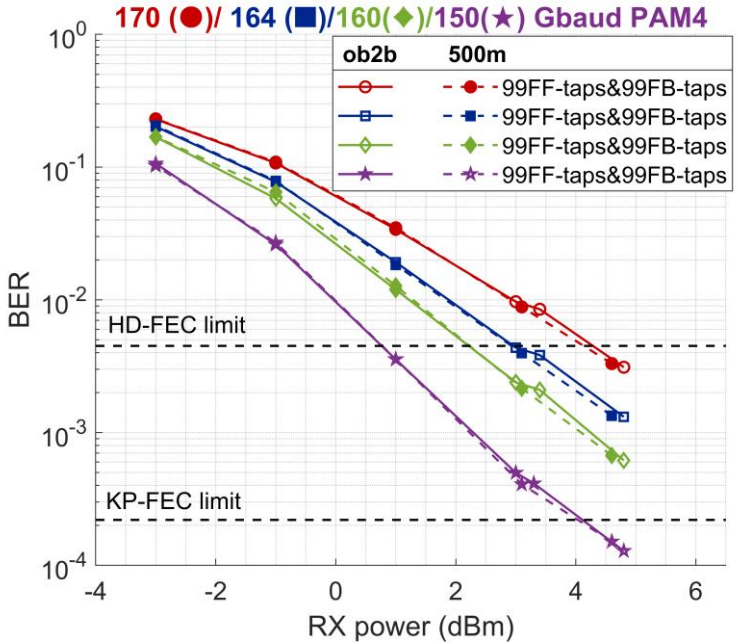
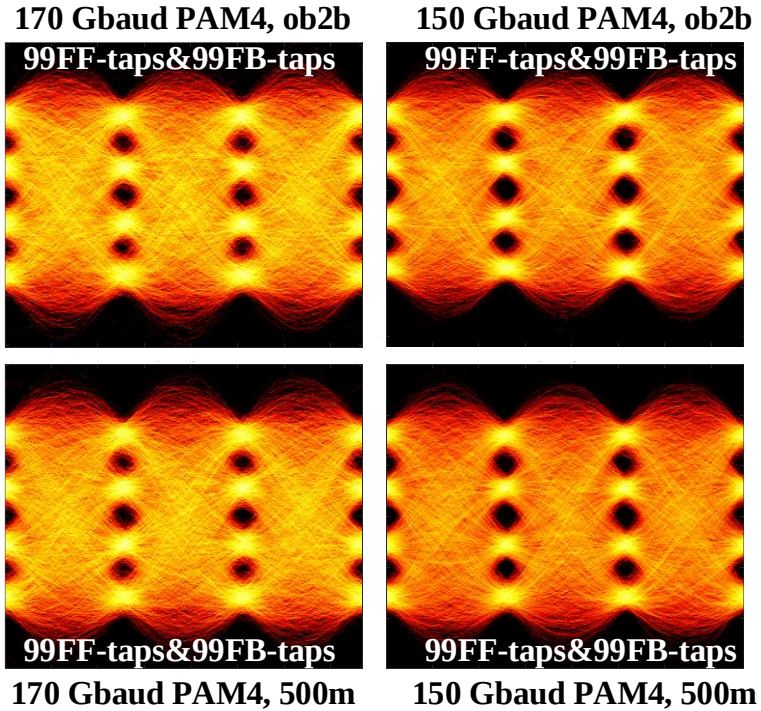
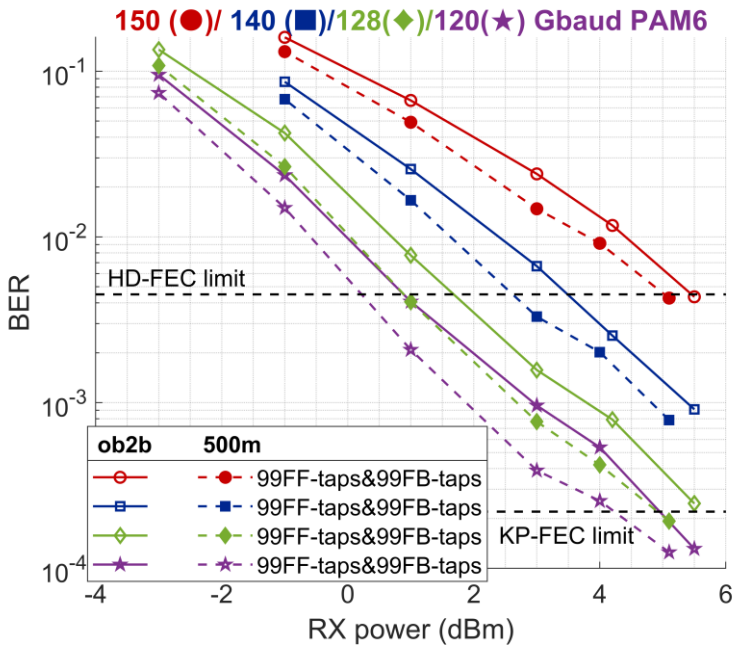
BER curves and eye diagrams of PAM4



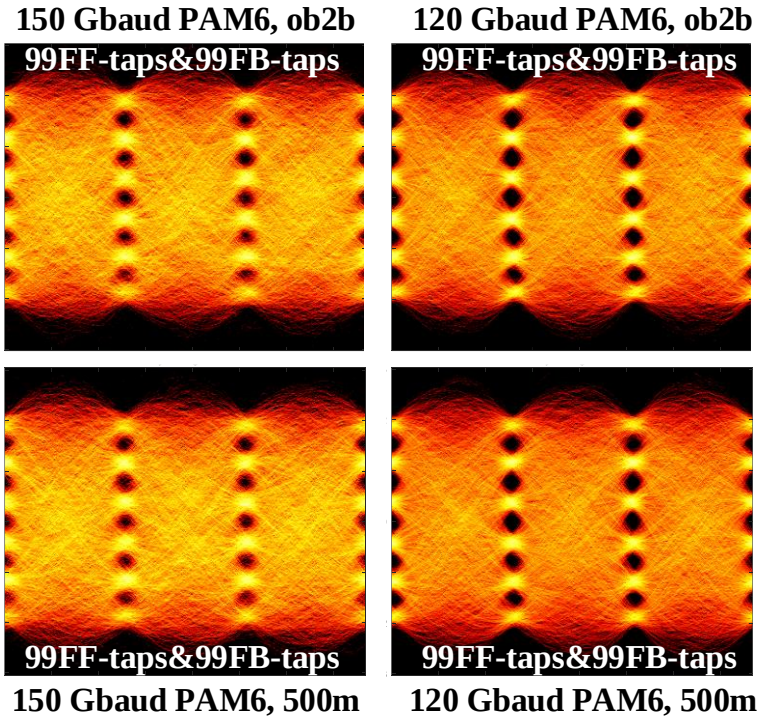
Post-equalization only with DFE



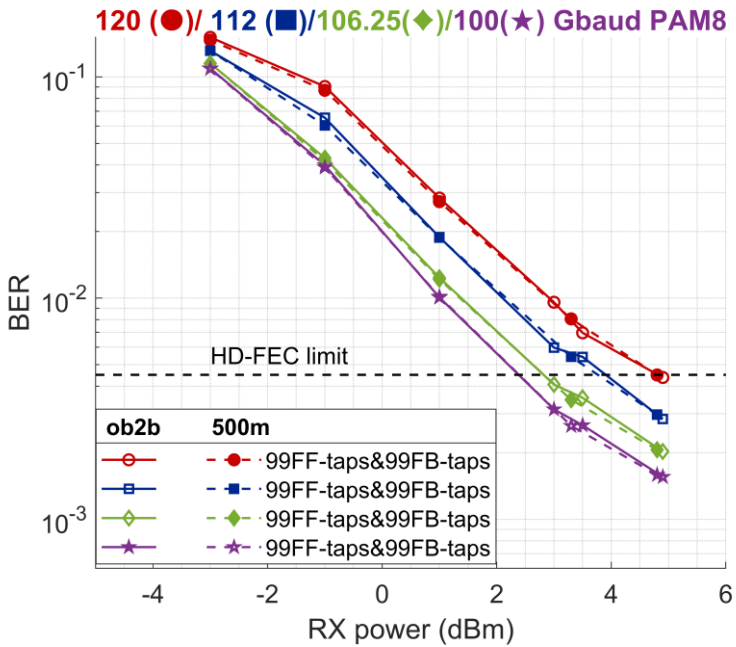
BER curves and eye diagrams of PAM6

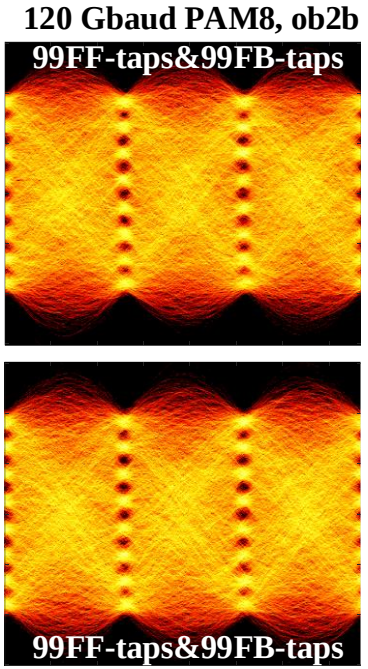


Post-equalization only with DFE



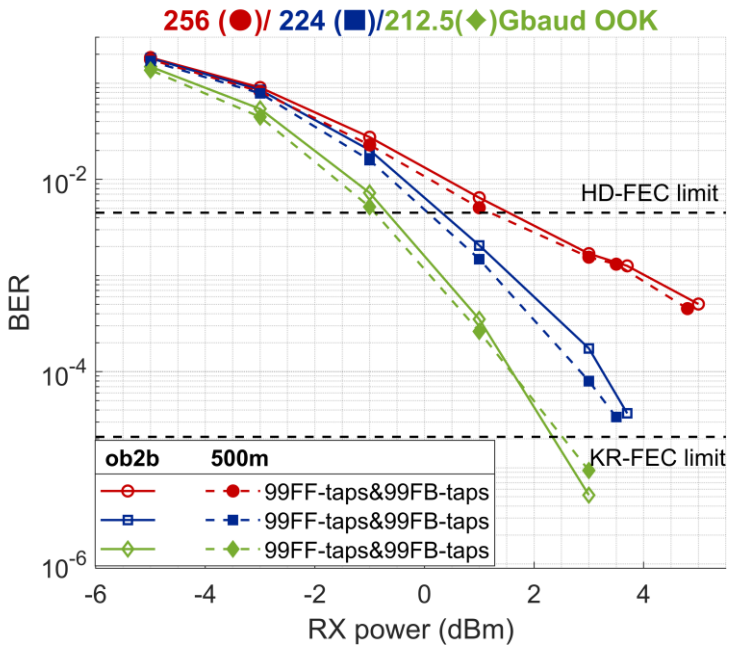
BER curves and eye diagrams of PAM8



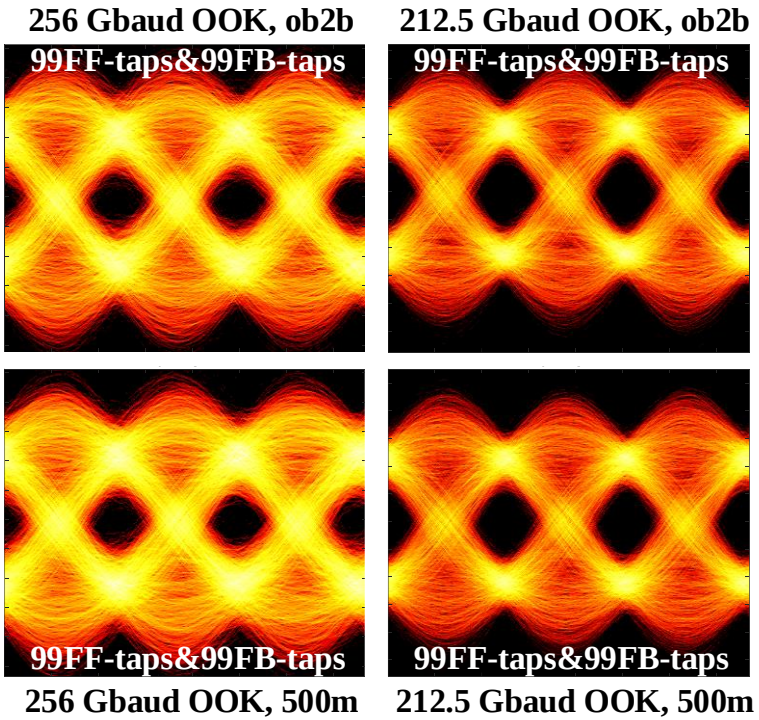


Post-equalization only with DFE

BER curves and eye diagrams of OOK



Post-equalization only with DFE



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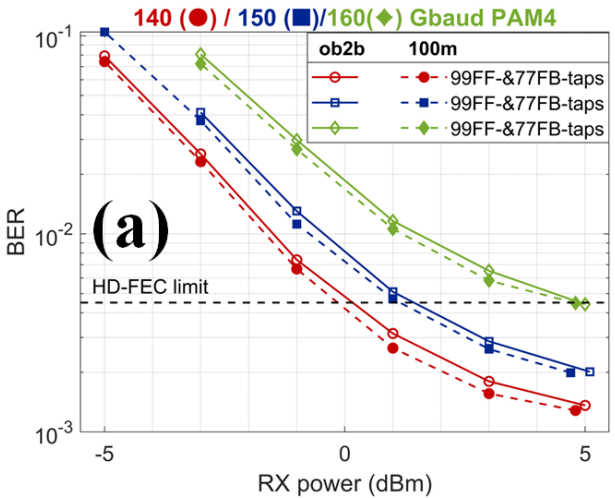
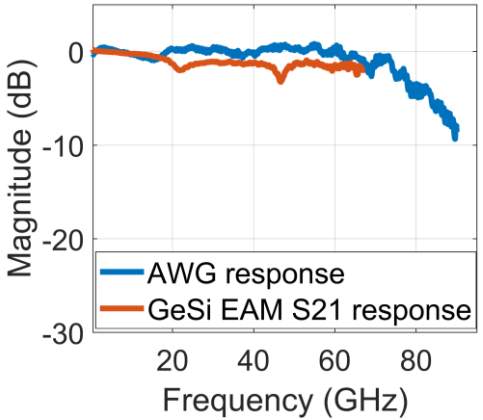
Conclusions

- We demonstrate optical amplification-free O-band links with InP EAM with Si waveguides achieving up to 256 Gbaud OOK, 170 Gbaud PAM4 (**340 Gb/s**), 150 Gbaud PAM6 (**375 Gb/s**), and 120 Gbaud PAM8 (**360 Gb/s**) performance below the 6.25% overhead HD-FEC threshold after 500 m SMF transmission.
- We show 212.5 Gbaud OOK with performance satisfying KR-FEC requirements and 150 Gbaud PAM4 (**300 Gb/s**) as well as 120 Gbaud PAM6 (**300 Gb/s**) satisfying KP-FEC requirements.
- This paves the way for O-band DR and FR-compliant transceivers achieving a net bit rate beyond 200 Gbps/λ.

Advertisement break





Armands Ostrovskis, et al., **Silicon Photonics GeSi Electro Absorption Modulator for Beyond 300 Gb/s Per λ Links ,** ECOC 2024, Tu1D: Intra-Data Center Systems **Tuesday 9:45, Harmonie 4**

Acknowledgement: EQUIPMENT

We thank **OpenLight Photonics** and **Tower Semiconductor** for the chips and components. The complete components list including on-chip lasers are available to the open market for the design of 200G/Lane heterogeneous silicon photonics PIC (DR and FR PIC) through **Tower Semiconductor PH18DA process design kit (PDK)**.

We also thank **Keysight Technologies** in Böblingen, Germany for hosting the experiment and for loaning the **N7776C-013 High Power Tunable Laser Source,** the **M8199B Arbitrary Waveform Generator** and the **UXR1104A Infiniium UXR-Series Oscilloscope.**

Acknowledgement: FUNDING

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- Swedish Research Council (VR) project 2019-05197 and 2022-04798
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