High-speed Directly Modulated Lasers and Highly Efficient Semiconductor Optical Amplifiers

TECHNICAL CHALLENGES

- **Realize ultra-high-speed uncooled directly-modulated lasers (DMLs)**
- **Realize temperature-stable operation in high-speed DMLs**
- **Realize highly efficient semiconductor optical amplifiers (SOAs)**

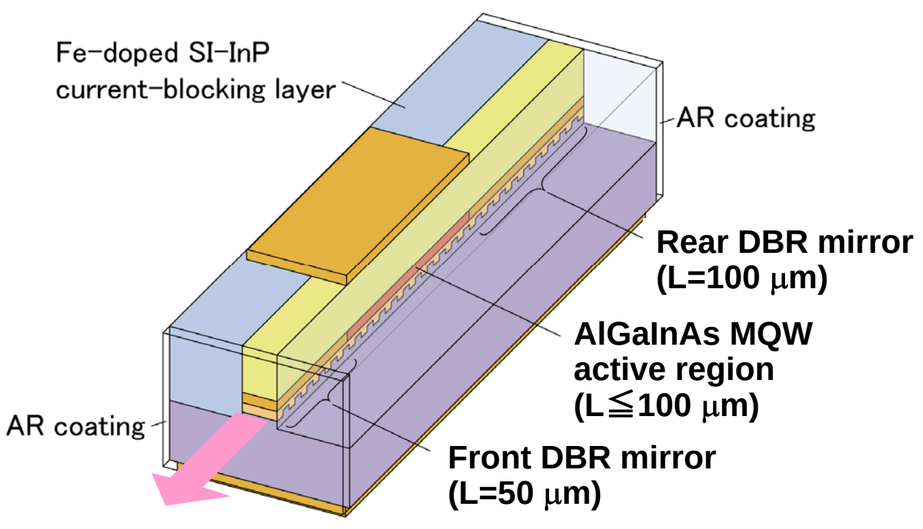
KEY ACCOMPLISHMENTS

Ultra-high-speed directly-modulated lasers with low-power-consumption

Short-cavity AlGaInAs quantum-well SI-BH lasers

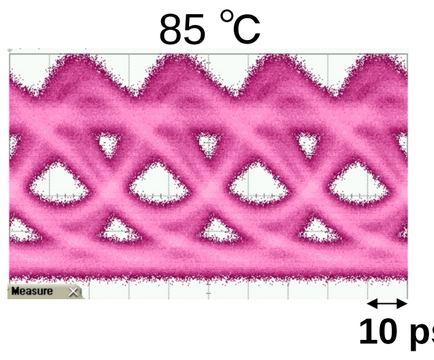
- **Monolithically integrated DBR mirrors on both sides of DFB active region**
- **Uncooled, low-driving-current 40-Gbps operation in 1.5-μm-wavelength DMLs**
- **World's first 40-Gbps optical-fiber transmission up to 70 ºC in 1.3-μm-wavelength DMLs**
- **Reduce power consumption to less than half of commercialized 40-Gbps light sources**

Distributed Reflector (DR) laser



Device structure

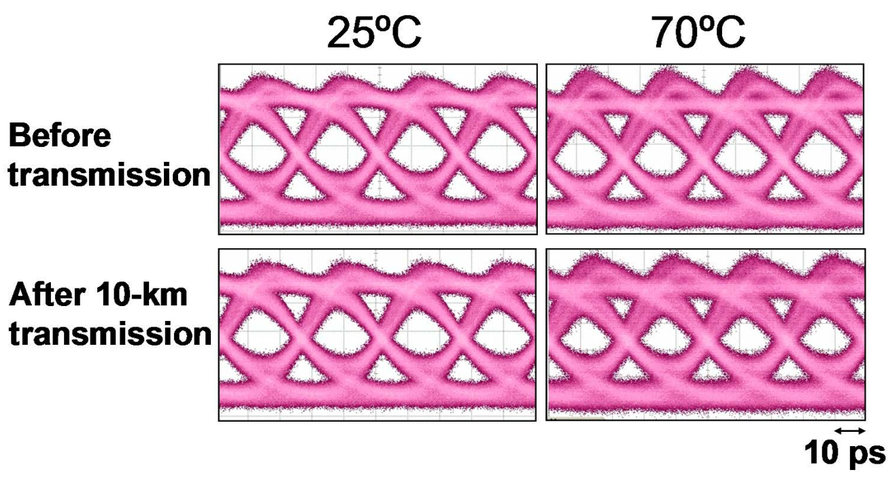
1.5-μm DML
(active region: 75 μm)



I_{bias} = 28 mA, I_{mod} = 30 mA_{p-p}
⇒ I_{peak} = 43 mA

40-Gbps eye diagram

1.3-μm DML
(active region: 100 μm)

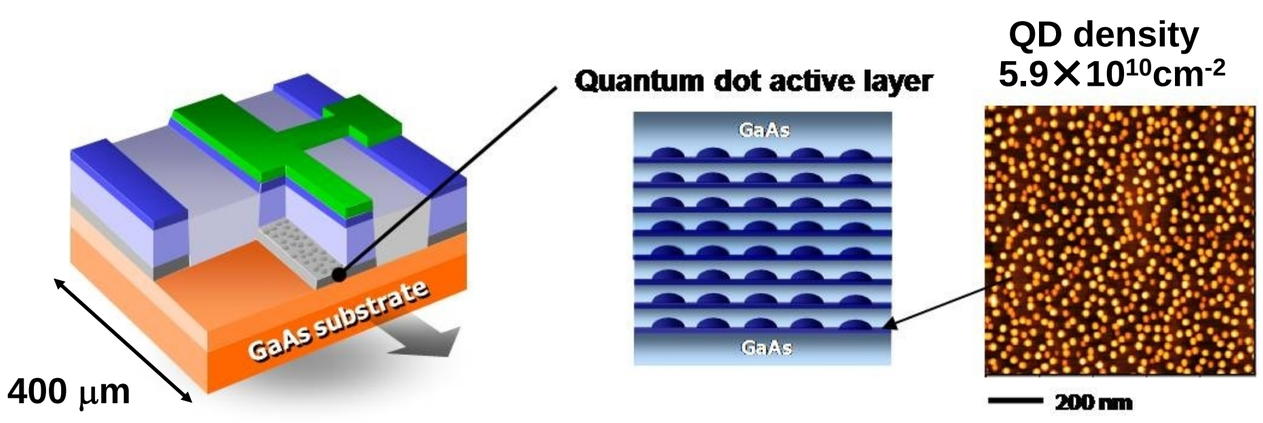


40-Gbps eye diagrams

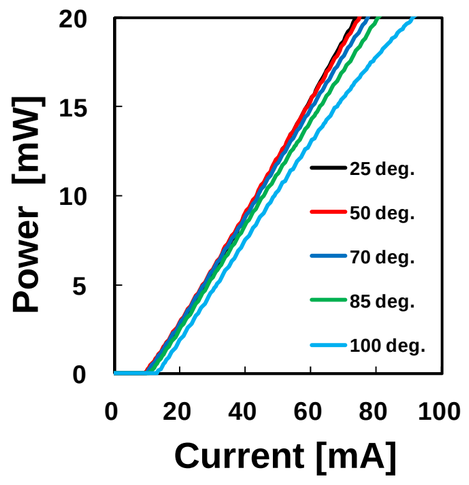
Temperature-stable high-speed directly modulated lasers

1.3-μm high-density quantum-dot (QD) lasers

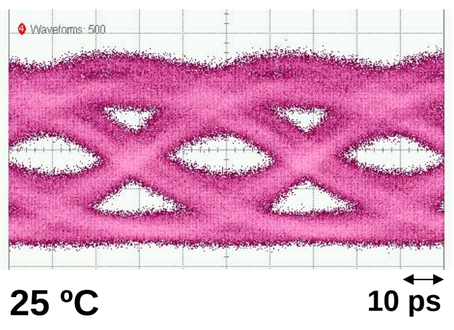
- **Eight-stacked high-density QD layers introduced into active region**
- **Temperature-stable light-current characteristics**
- **World's first 25-Gbps direct modulation in QD lasers**



Device structure



Light-current characteristics

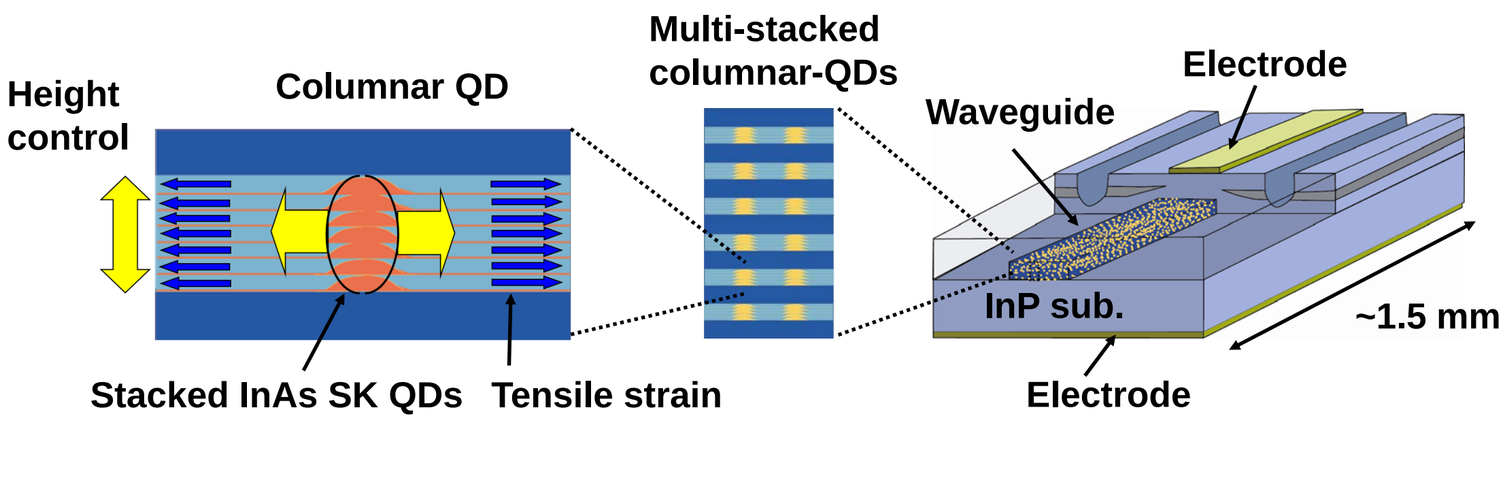


25-Gbps eye diagram

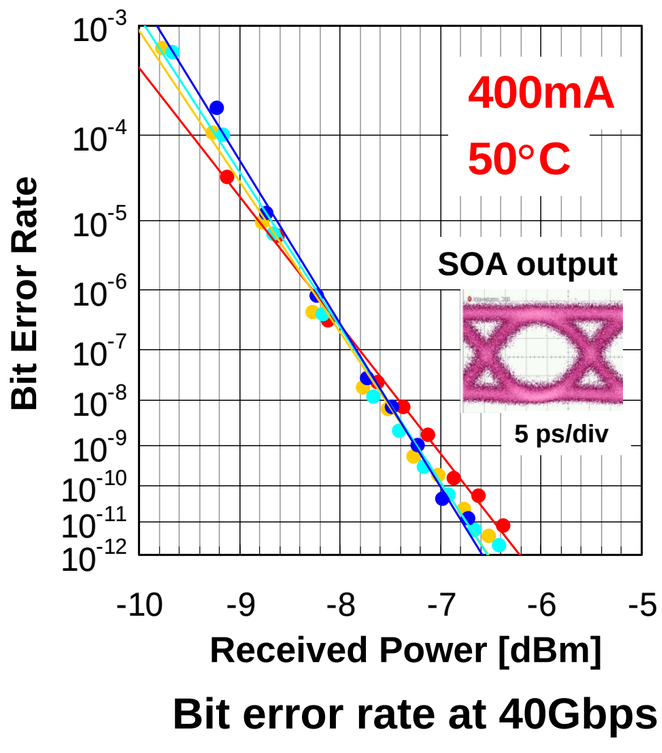
Highly efficient semiconductor optical amplifiers

1.5-μm columnar-QD-based SOAs

- **Flexible wavelength control by columnar-QD height and strain**
- **Amplification of 40-Gbps signals at 50 ºC**
- **Successfully applied to 160-Gbps OTDM NIC**



Device structure



Bit error rate at 40Gbps

FUJITSU

PETRA