

# Advanced InP DFB Laser Sources for Silicon Photonics Hybrid Integration

# About Us

**UK-based design and manufacturing, located in Glasgow, Scotland**

---

**100mm wafer fab with capacity of 5,000 wafer starts per year (2000m<sup>2</sup> class 50 facility)**

---

**ISO 9001 Certification**

---

**Key strategic supplier to many Fortune 100 and Silicon Valley customers**

**20 year history designing and manufacturing III-V photonic devices**

---

**End-to-end chip solutions from design to volume manufacture**

---

**Over 80 staff and growing rapidly**

The background is a solid teal color with several overlapping, semi-transparent, rounded rectangular shapes in a lighter shade of teal. These shapes are arranged in a pattern that creates a sense of depth and movement, with some shapes appearing to be behind others.

# **InP100 Platform**

# **Si Photonics Integration**

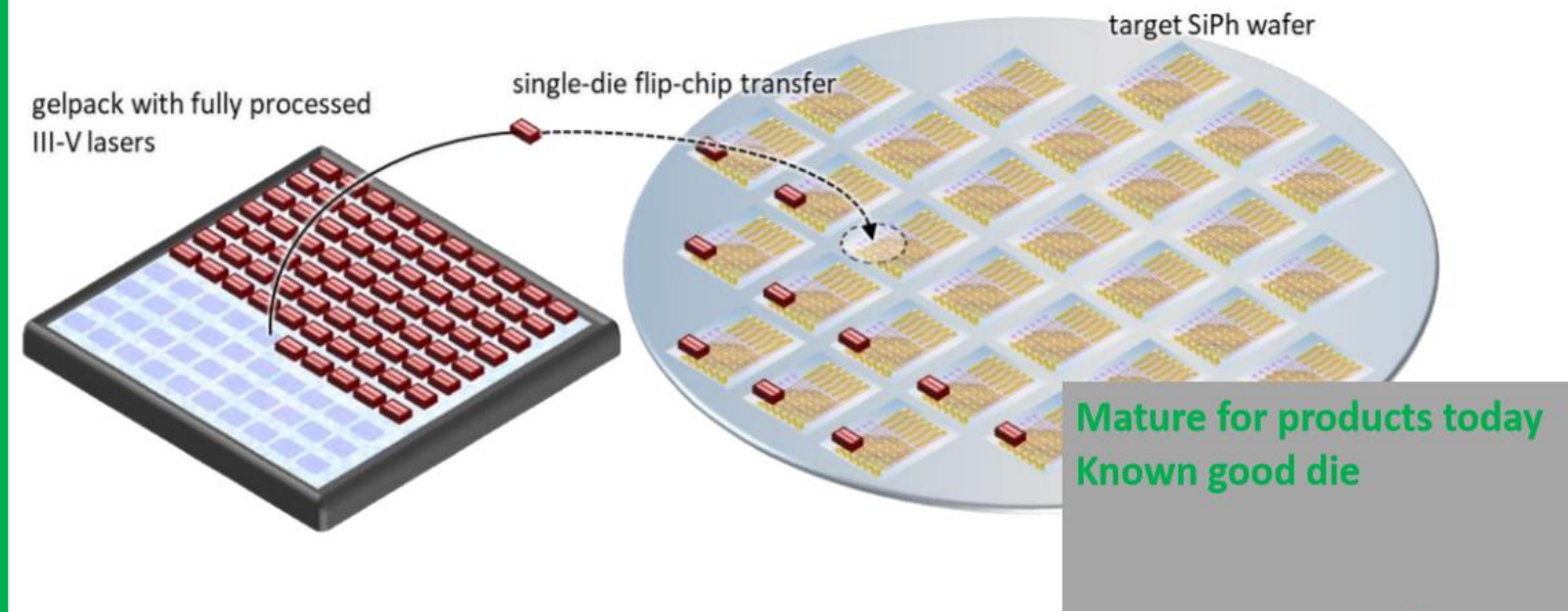
# Technology Expertise

- Integrated design and manufacturing services for a broad range of photonic devices: FP & DFB lasers, SOAs, RSOAs, Detectors
- Key player in the SiPh ecosystem
- World class InP100 manufacturing platform
  - Multiple commercial users
- Established volume supplier shipping over 1 million lasers per month
- **>45 million lasers in the field**
- Supplying into the comms and sensing markets.

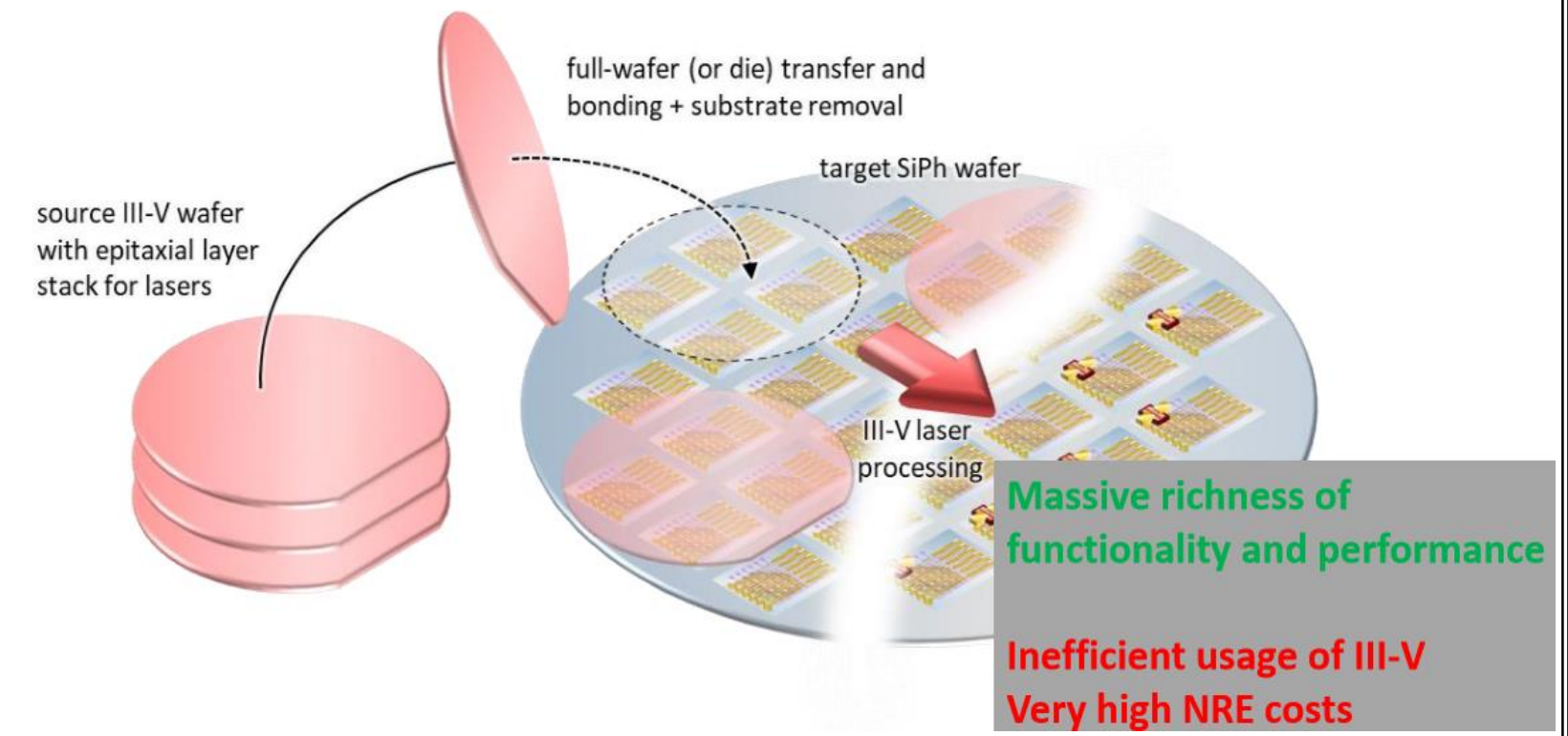


# Integrating III-V with Si Photonics

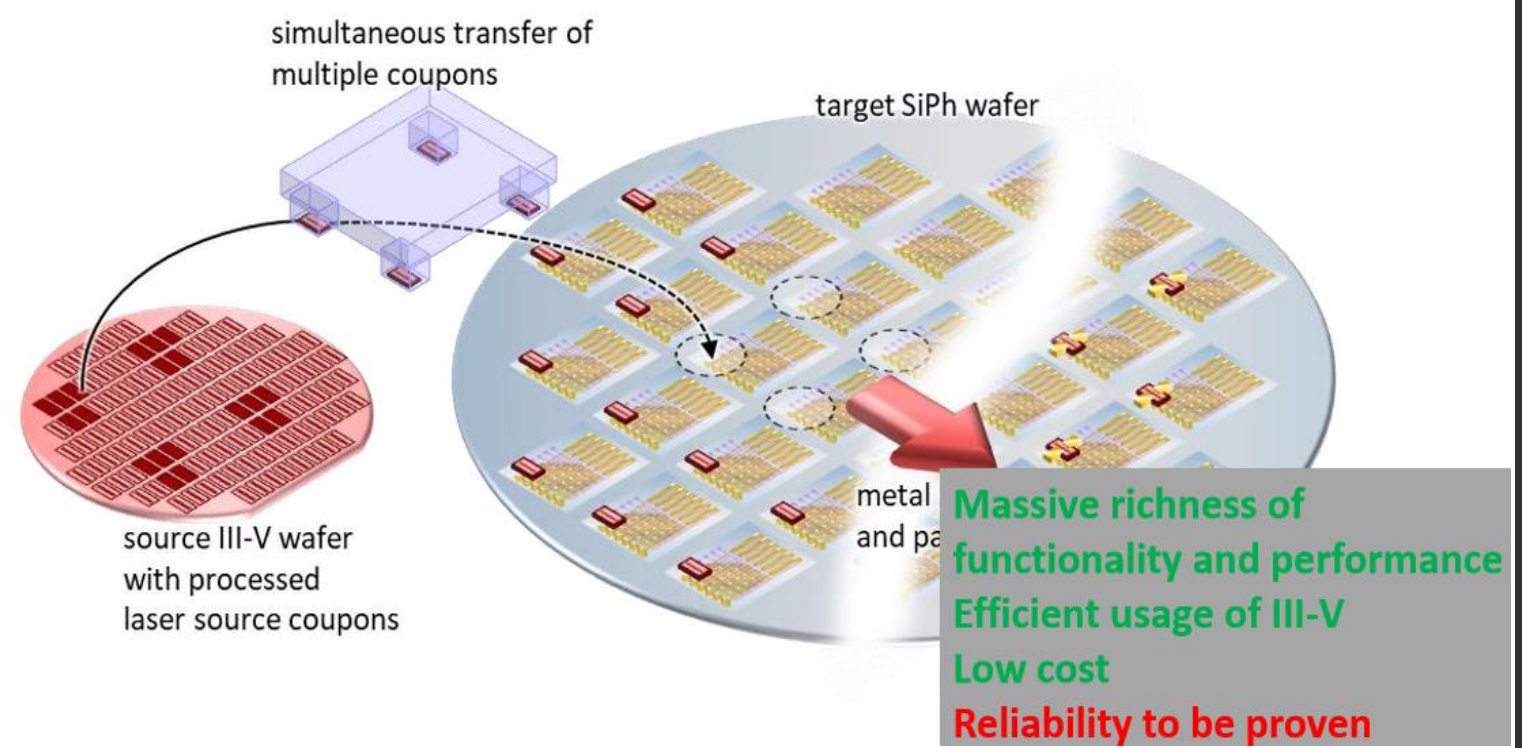
Flip-chip integration of bare dies / pick-and-place of packaged devices



die-to-wafer and wafer-to-wafer bonding + III-V processing in silicon fab

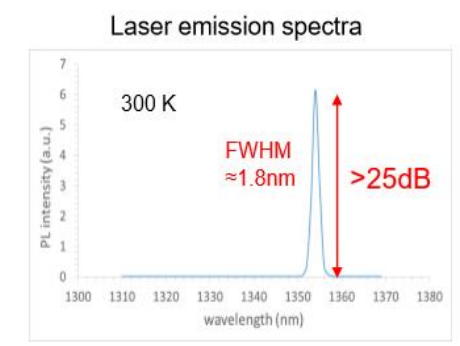
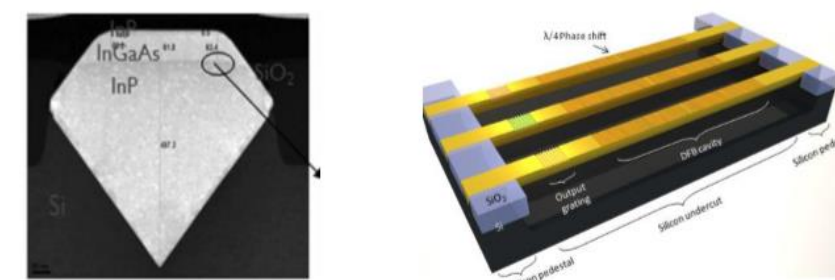


Transfer printing

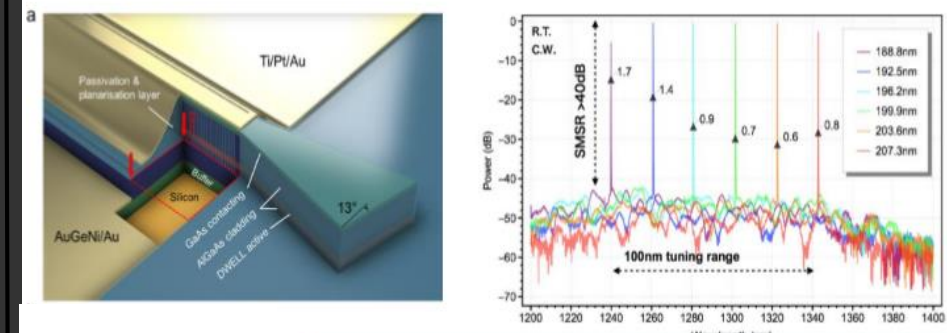


III-V on Silicon Hetero-Epitaxy

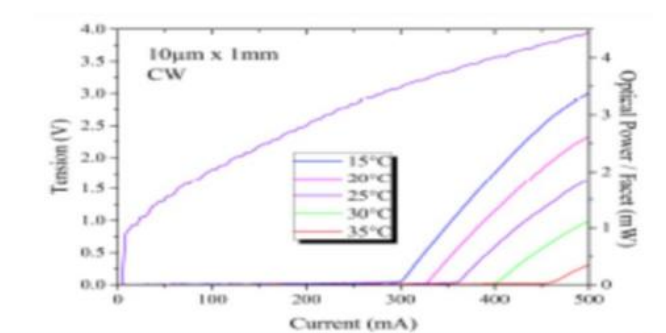
O-pumped InP DFB lasers (RT) @ imec



E-pumped QD DFB lasers (RT, CW) @ UCL



E-pumped GaSb QW lasers (RT) @ U.Montpellier



Remaining big challenge: integration in the SiPh process flow

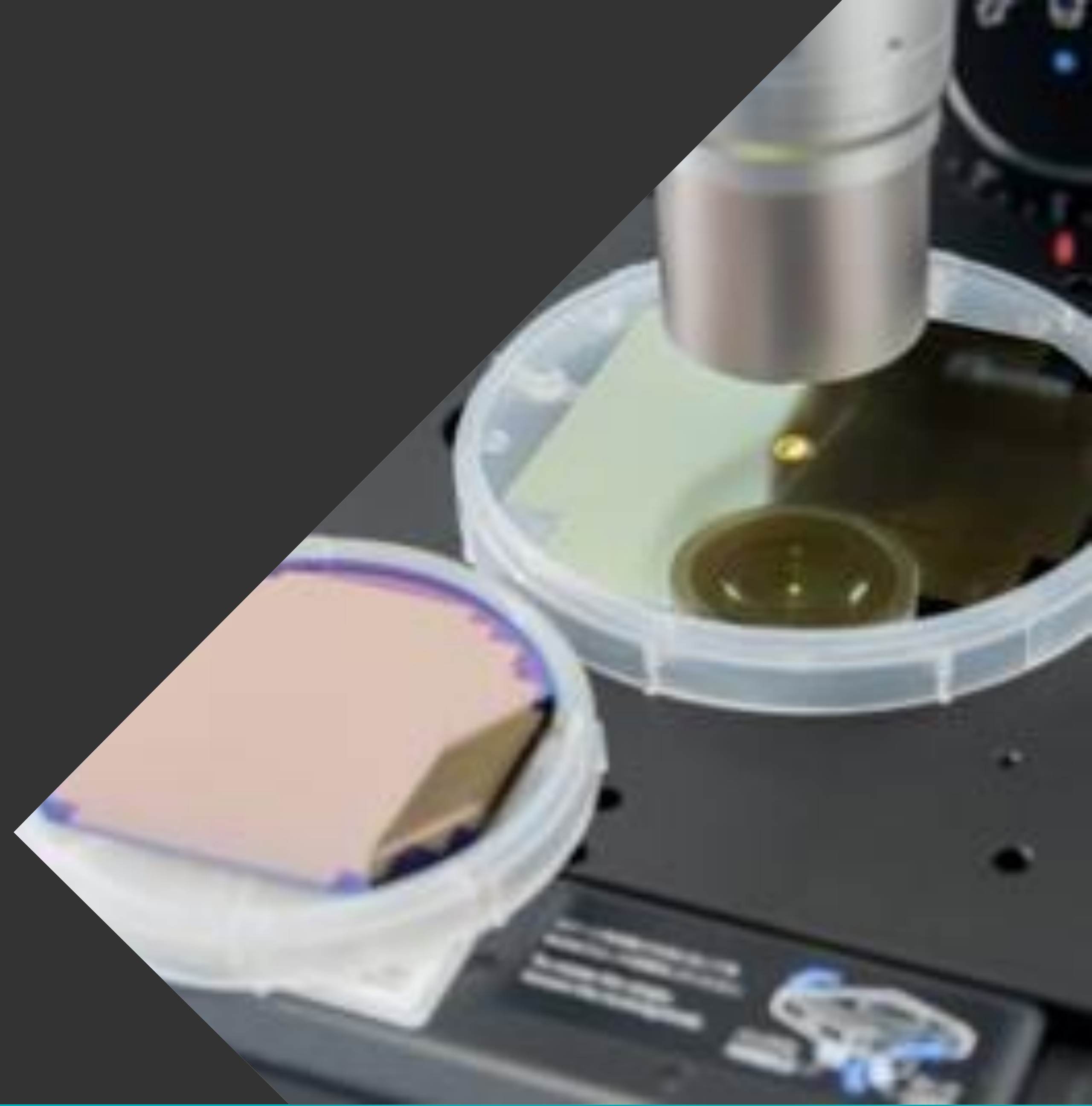
Prof. Roel Baets



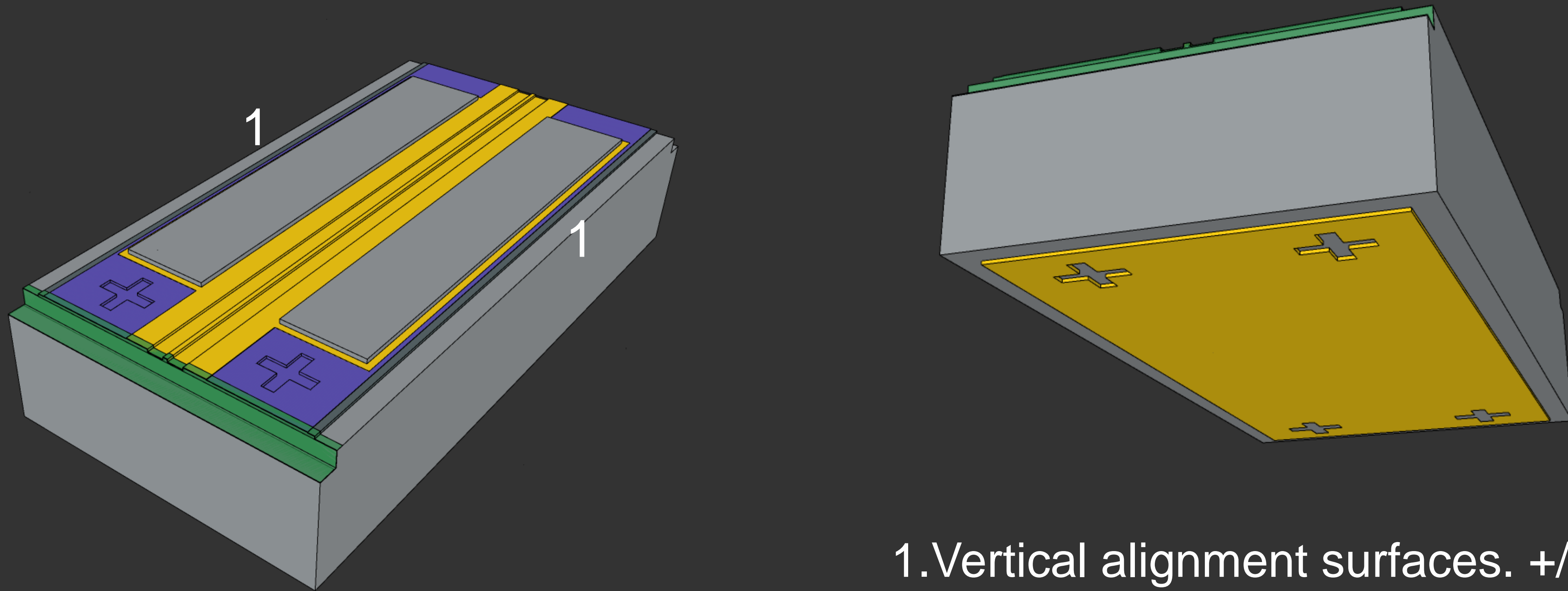
# InP100 Platform

## Key features

- Standardised process modules
- Multiple device types fabricated using a common set of qualified process modules and design rules
- High yield, proven reliability
- 100mm wafer size, up to 125,000 die sites
- Scalable to high volume
- ***Optimised device architecture for SiPh flip-chip bonding***

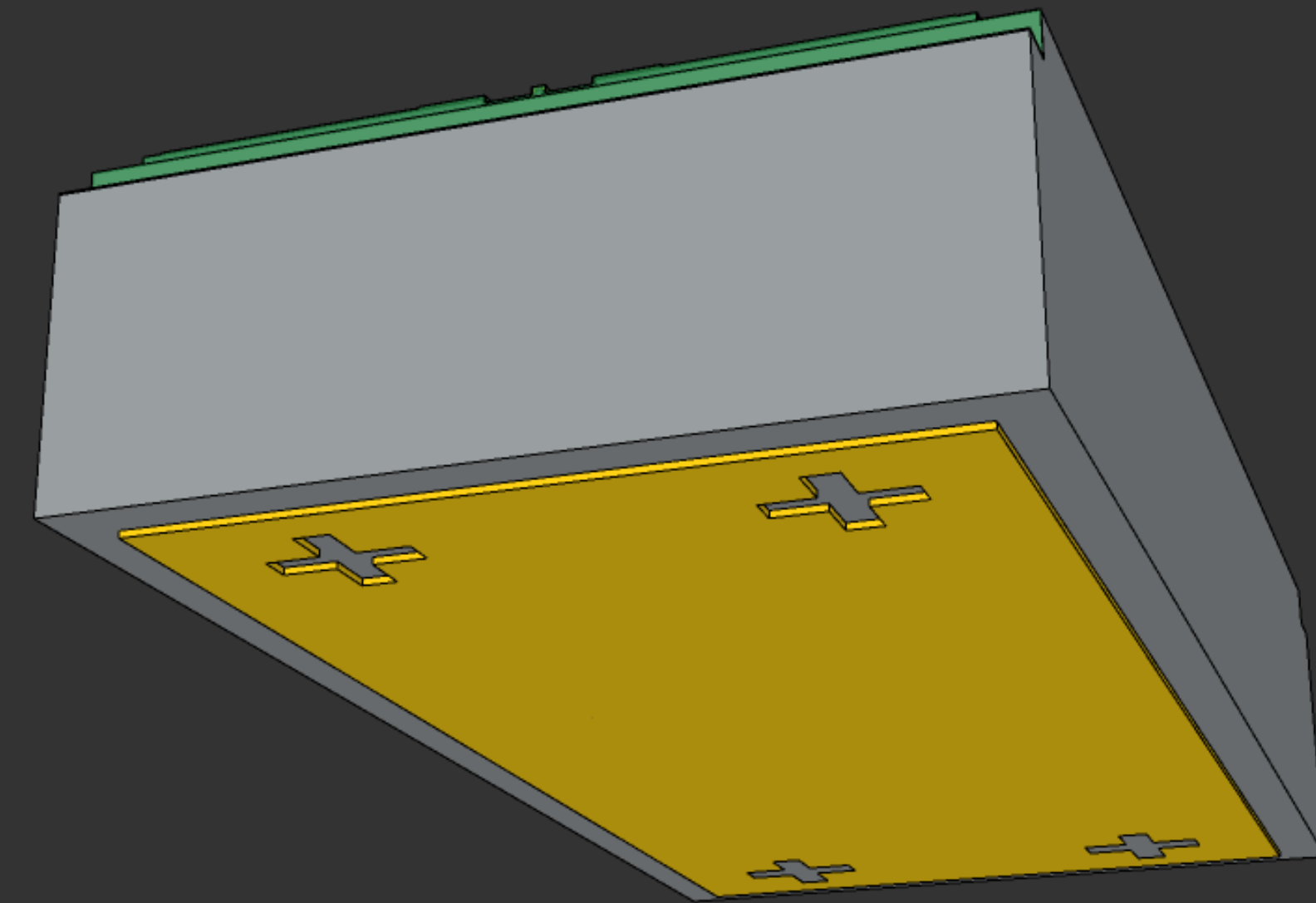
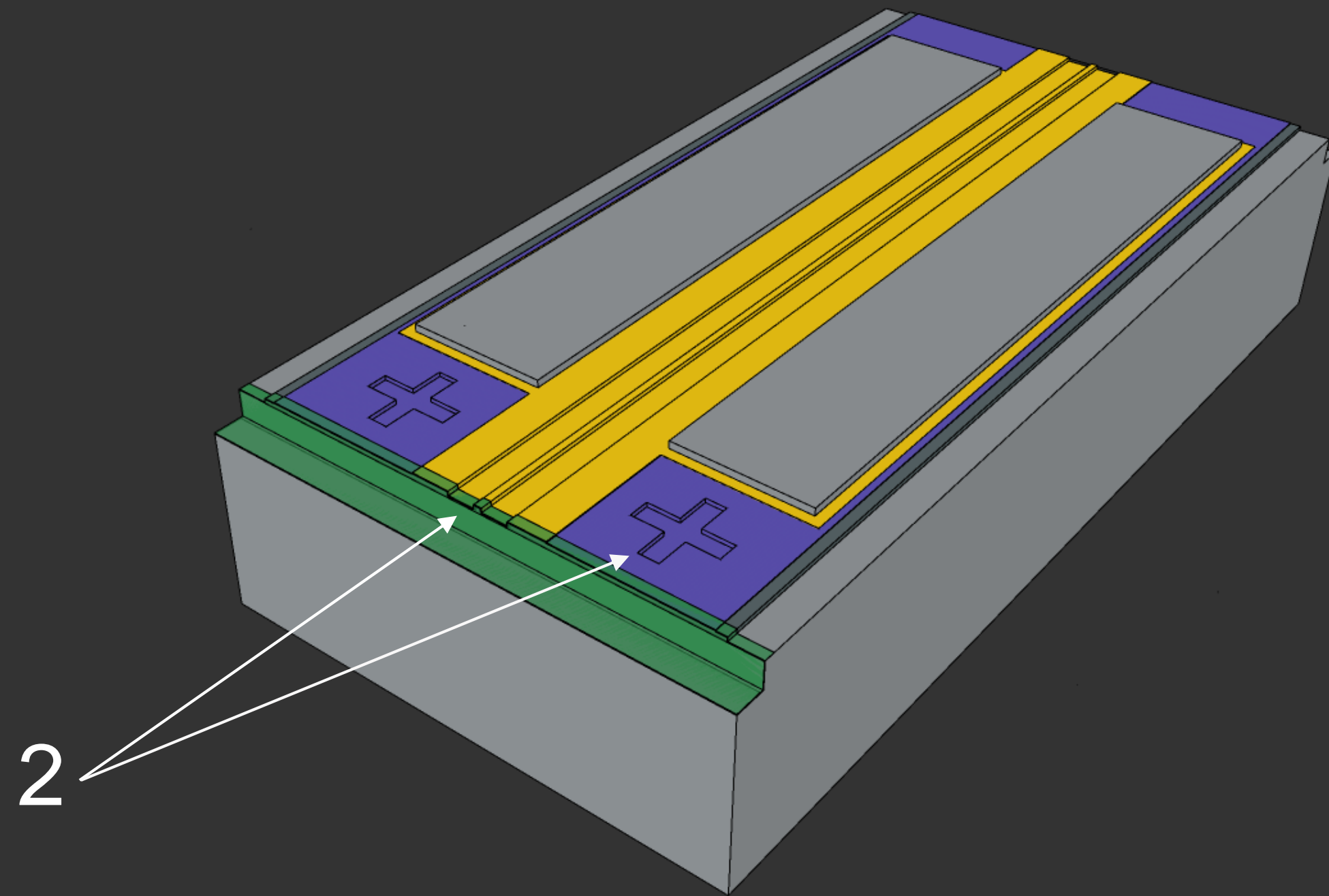


# InP100 DFB Lasers: Optimised for Si Photonic Integration



1. Vertical alignment surfaces. +/- 5nm height accuracy to optical mode centre. (z-axis)

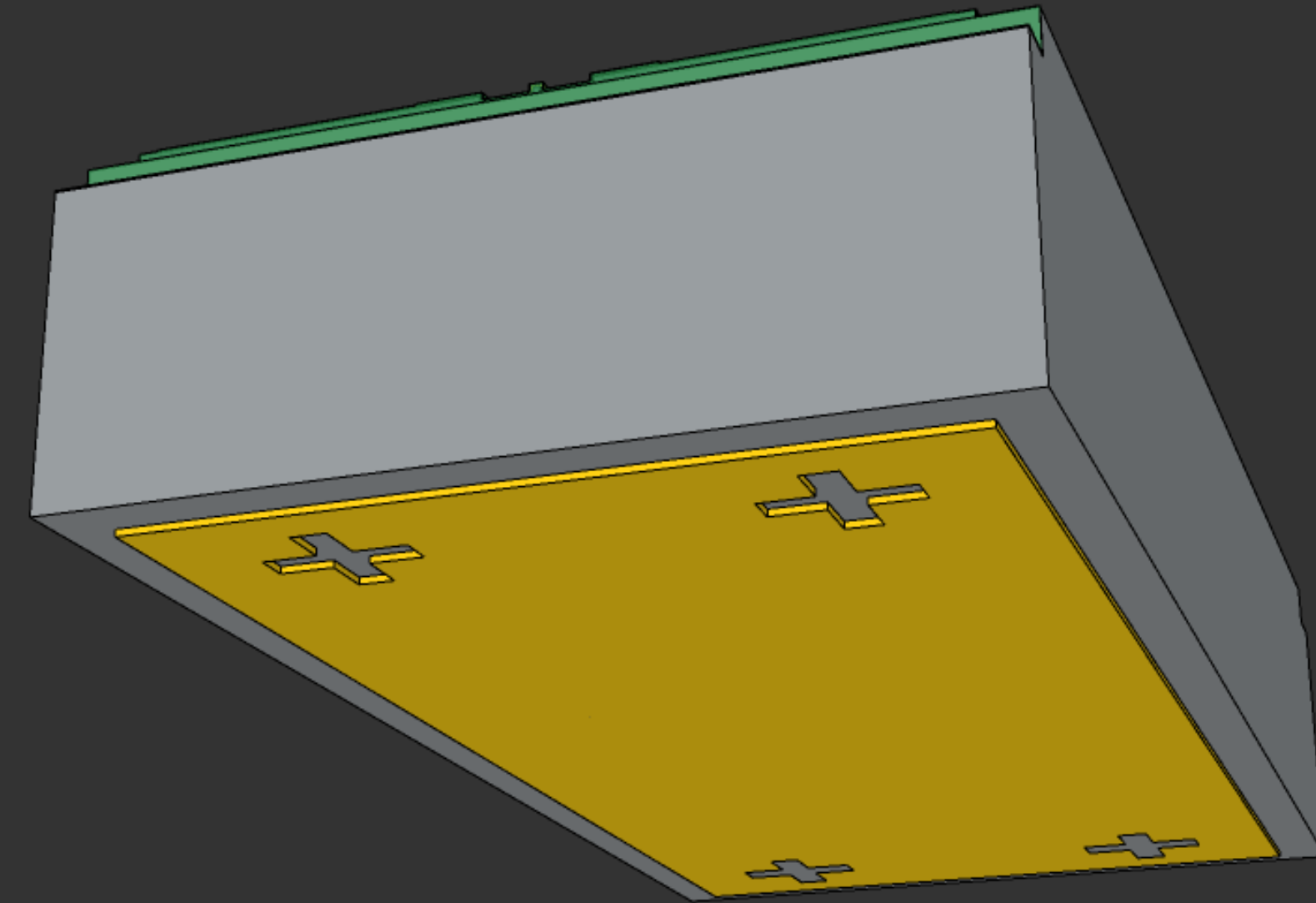
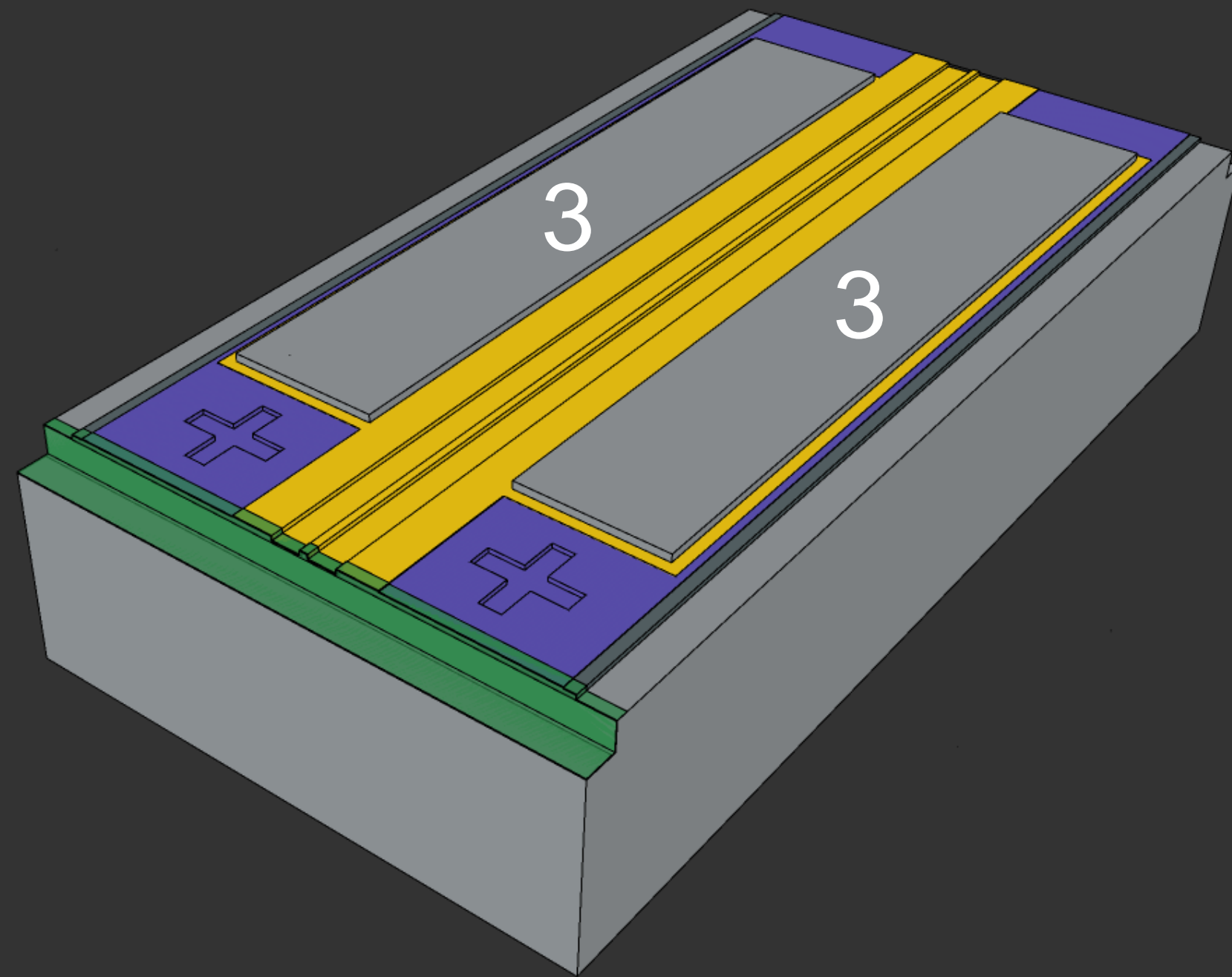
# InP100 DFB Lasers: Optimised for Si Photonic Integration



2. Etched facet with self-aligned front-side fiducials to both ridge (x-axis) and facet (y-axis).

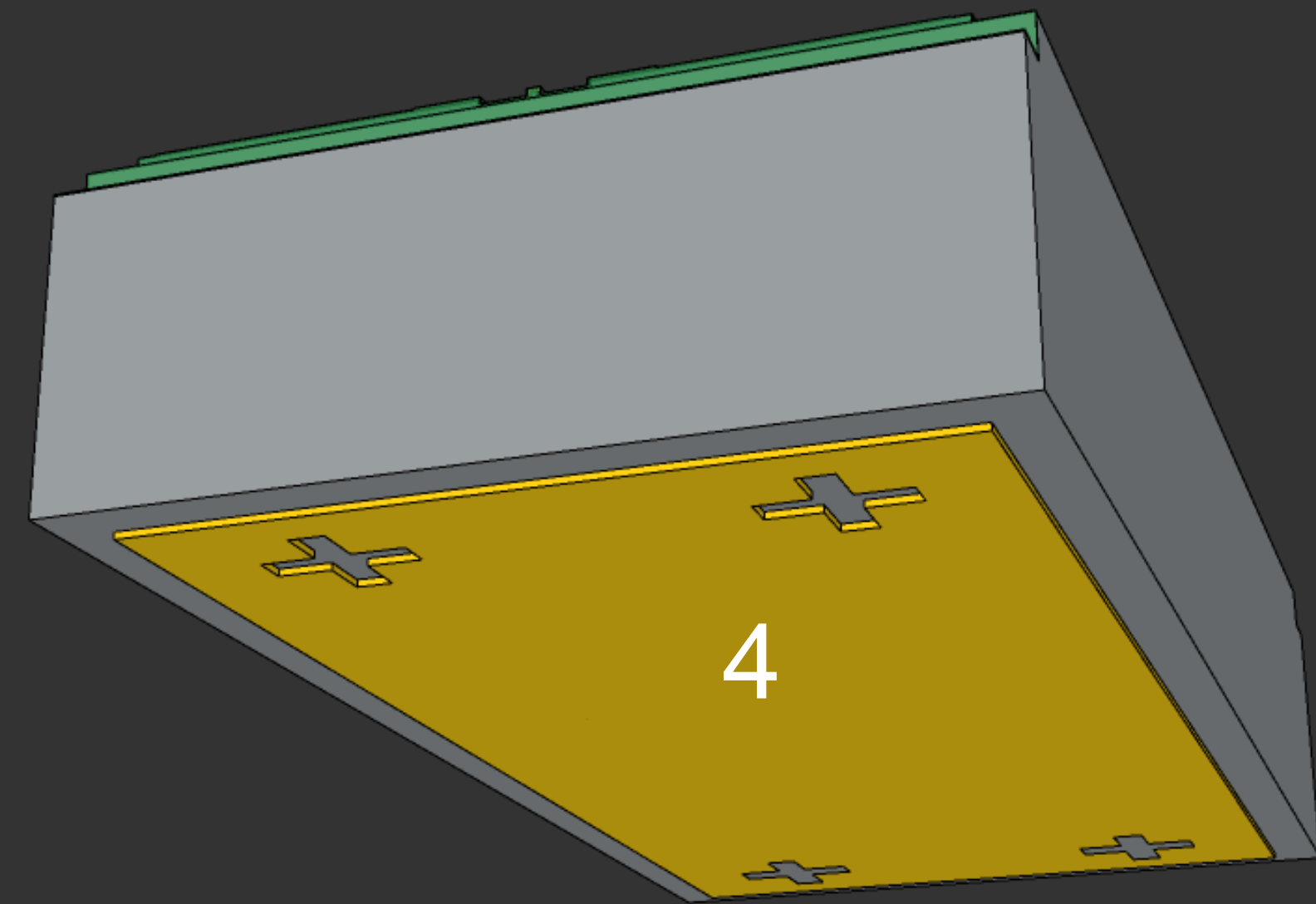
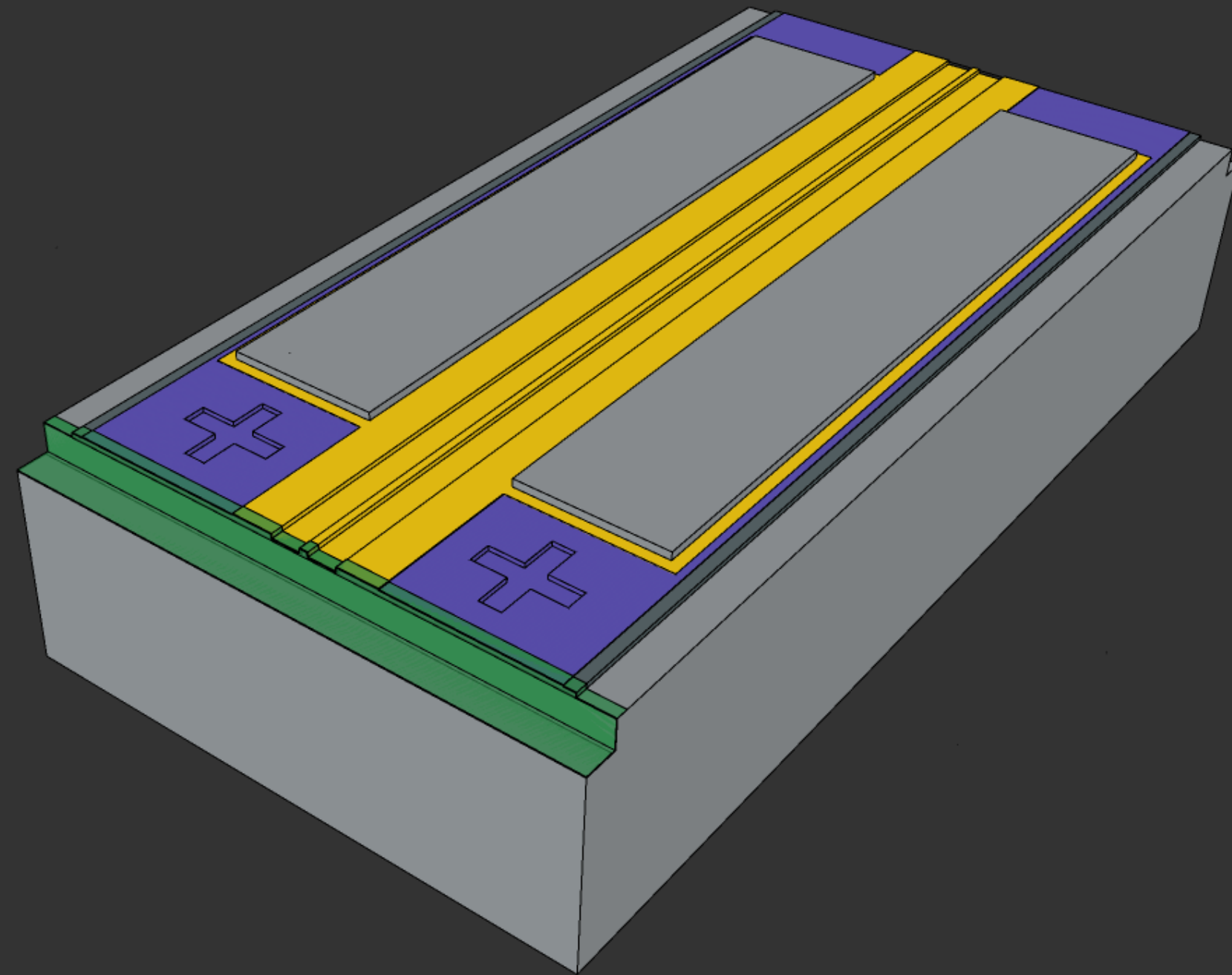


# InP100 DFB Lasers: Optimised for Si Photonic Integration



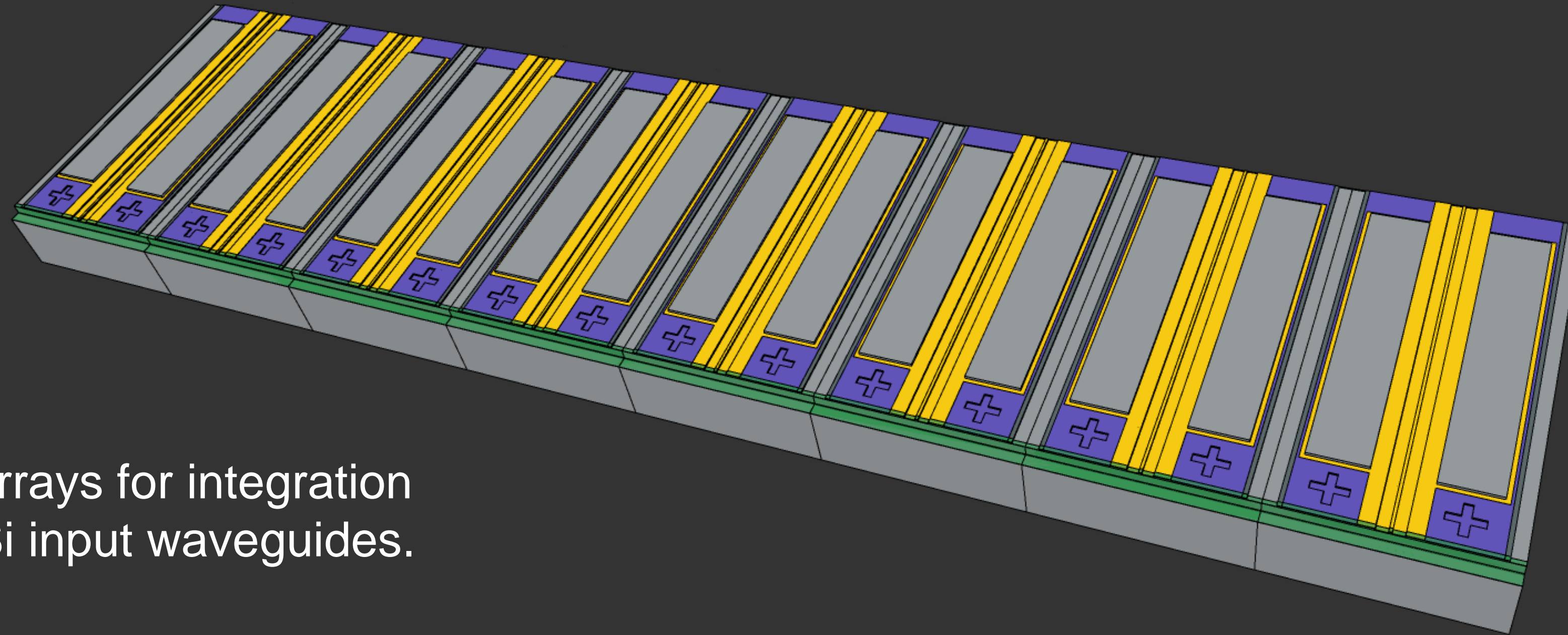
3. Metal pads optimised for flip chip bonding. Optional AuSn solder.

# InP100 DFB Lasers: Optimised for Si Photonic Integration



4. Back side alignment fiducials and chip IDs

# InP100 DFB Lasers: Optimised for Si Photonic Integration



Multi emitter arrays for integration  
with multiple Si input waveguides.

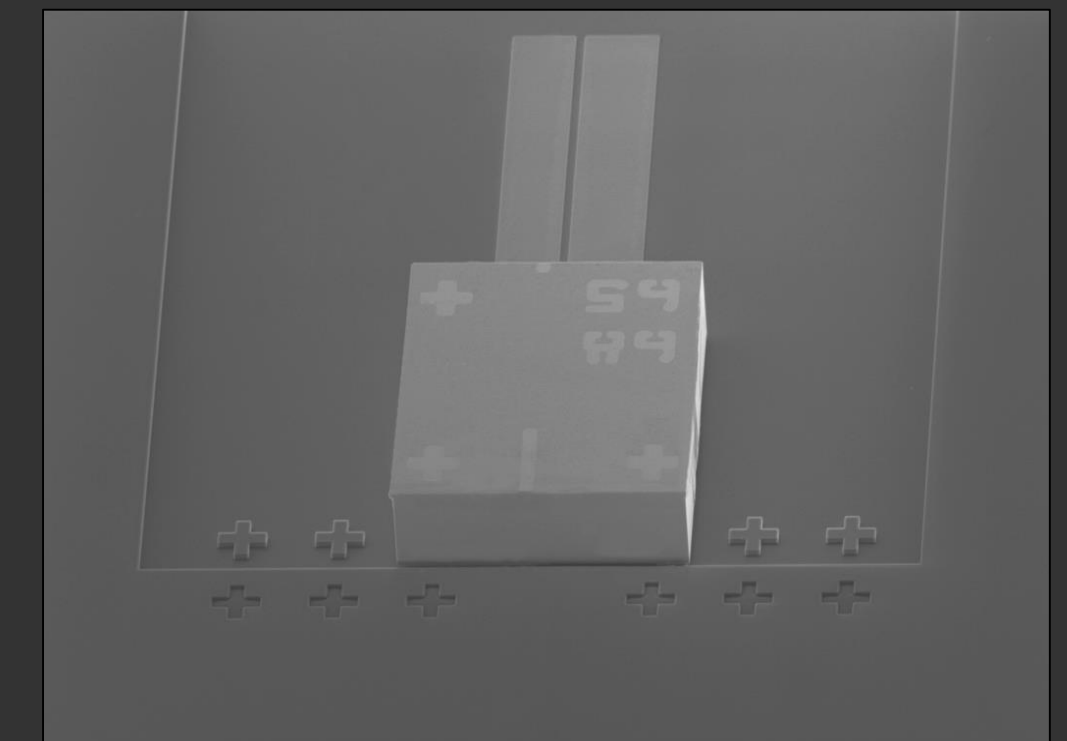
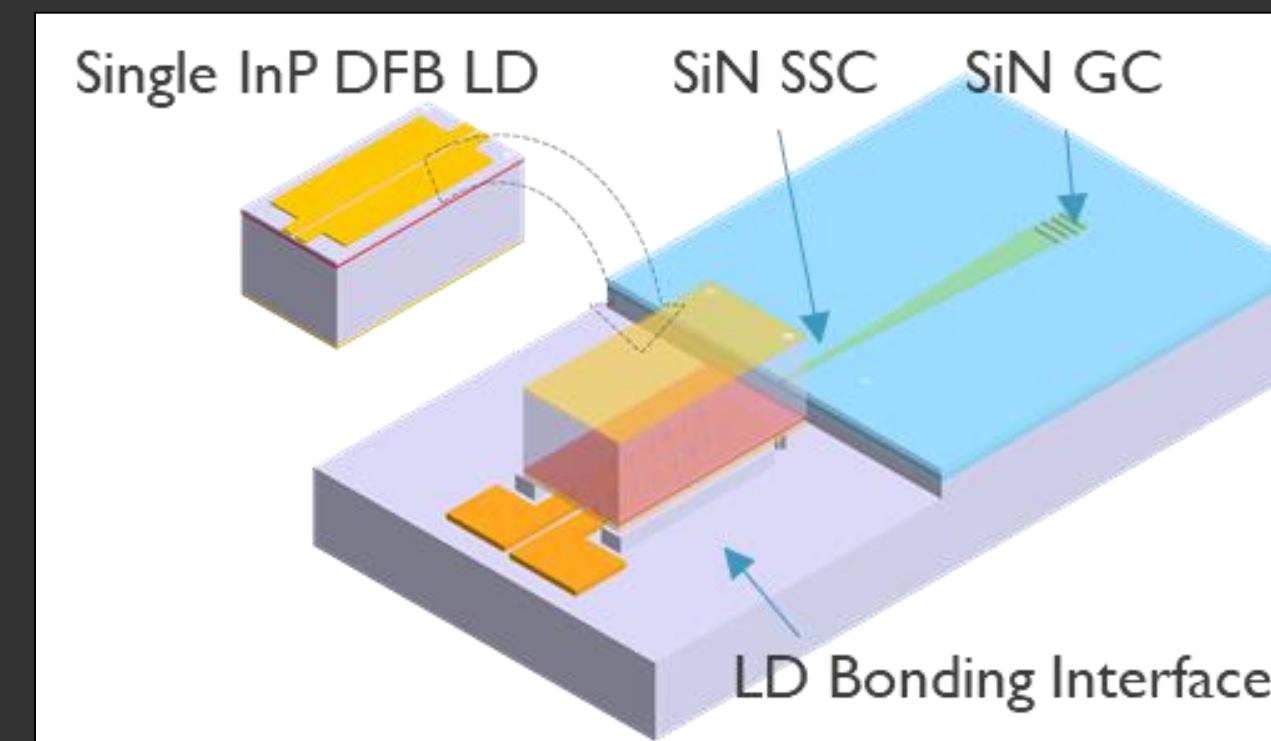
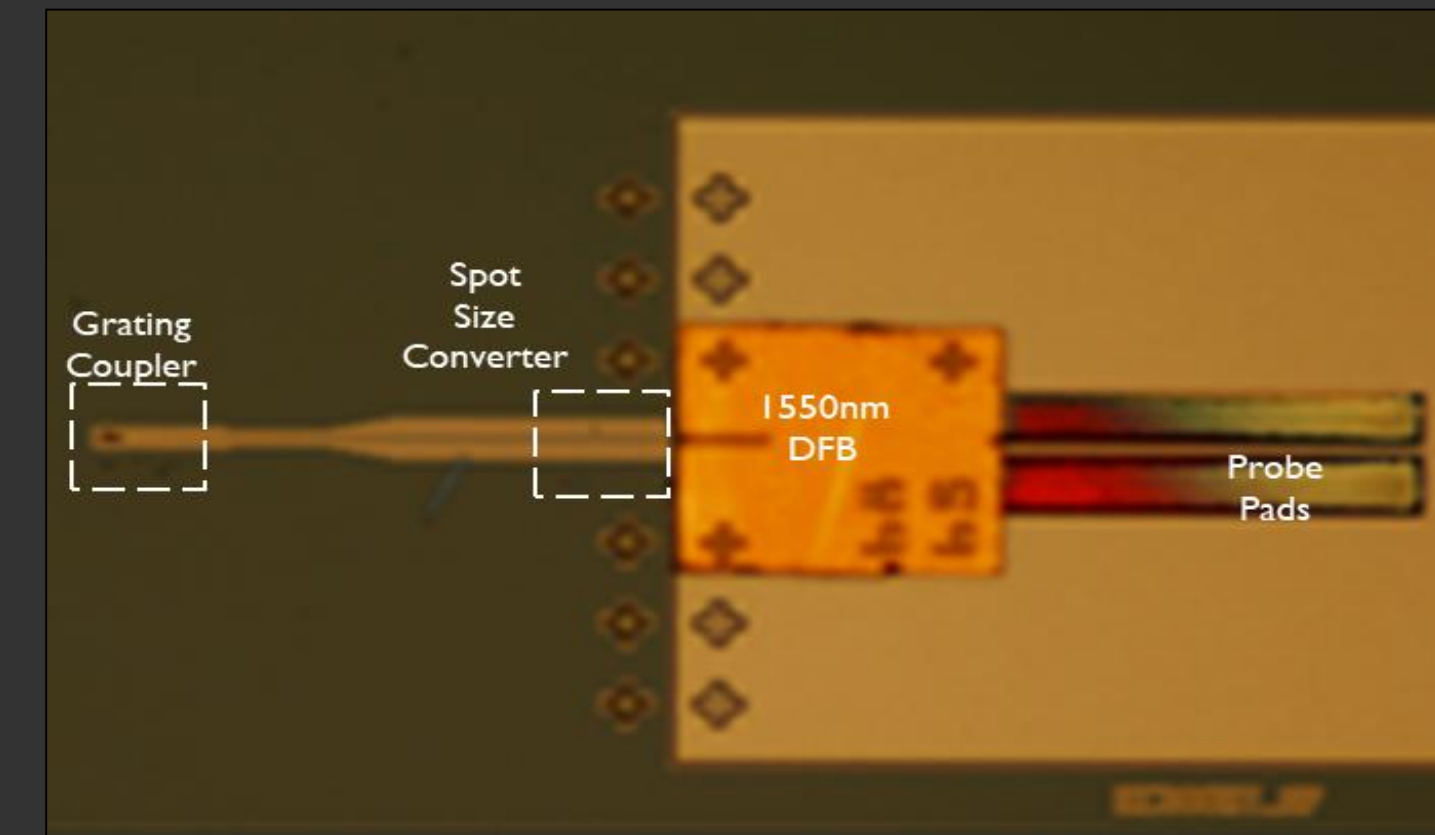
Sivers Photonics InP laser sources are being integrated into all commercial SiPh Platforms

# **Example DFB Lasers for Current and Future Si Photonics Applications**

## InP DFB lasers bonded onto imec Si/SiN Platform wafers

### Initial results from first bonded devices:

- Single InP DFB lasers at wavelength ~1550nm
- Optical Power up to 40mW coupled into SiN waveguide
- High-Precision ( $\leq 0.3\mu\text{m}$ ) Laser Assisted FC Bonder Tool
- High mechanical stability with epoxy underfill process
- FC-bonding of 4 and 8-channel O-band RSOA arrays (with 200GHz channel spacing) underway
- **Coupling efficiency of  $1.5\pm 0.5$  dB achieved**



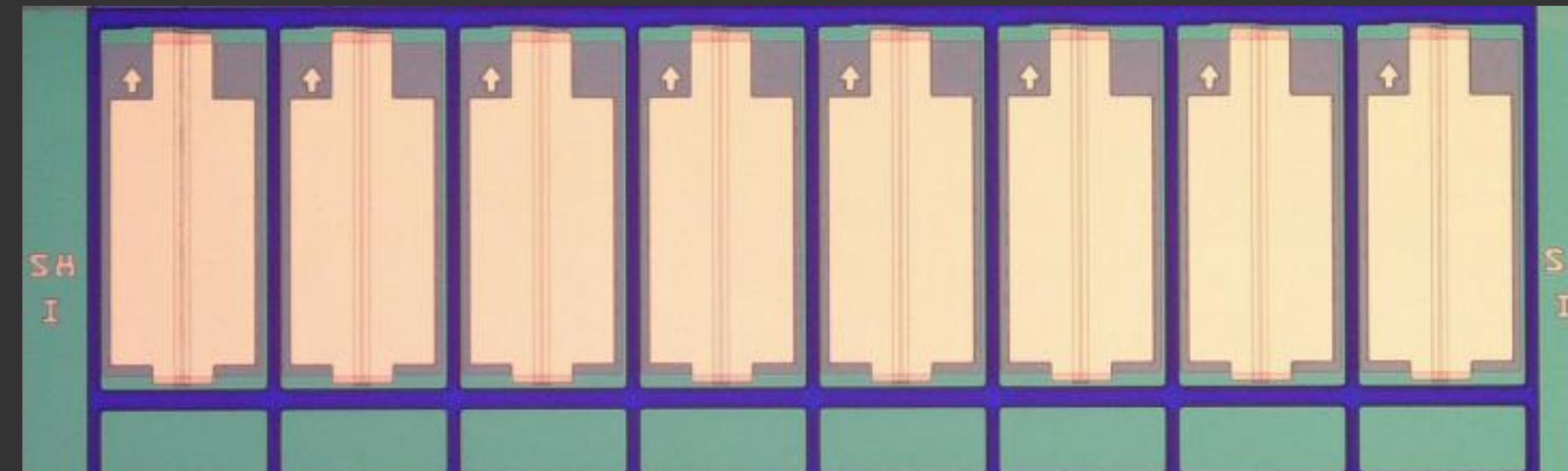
# DFB laser diode arrays designed for use in CW-WDM MSA compliant applications

CW-WDM MSA

An Industry consortium dedicated to defining and promoting specifications for multi-wavelength advanced integrated optics

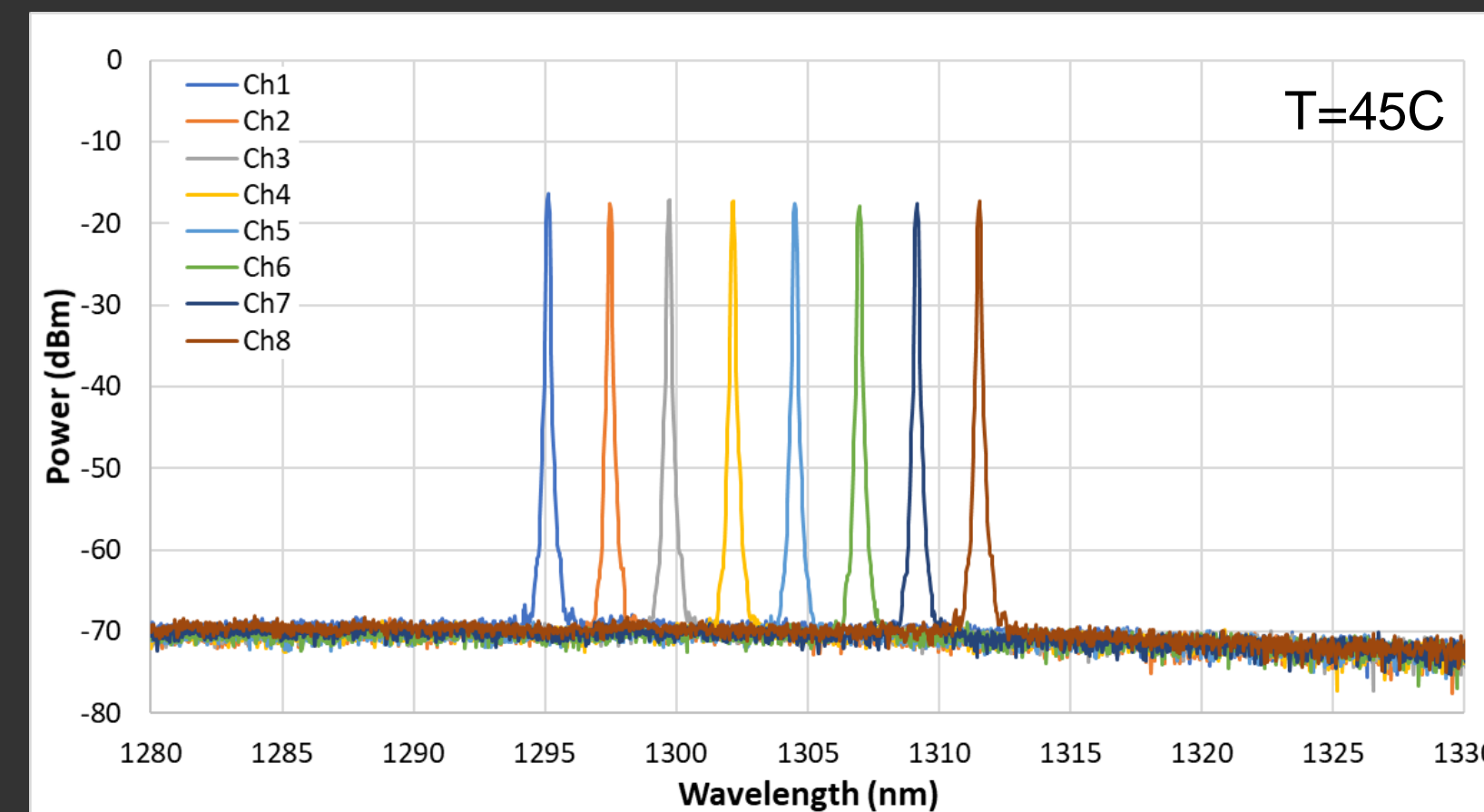
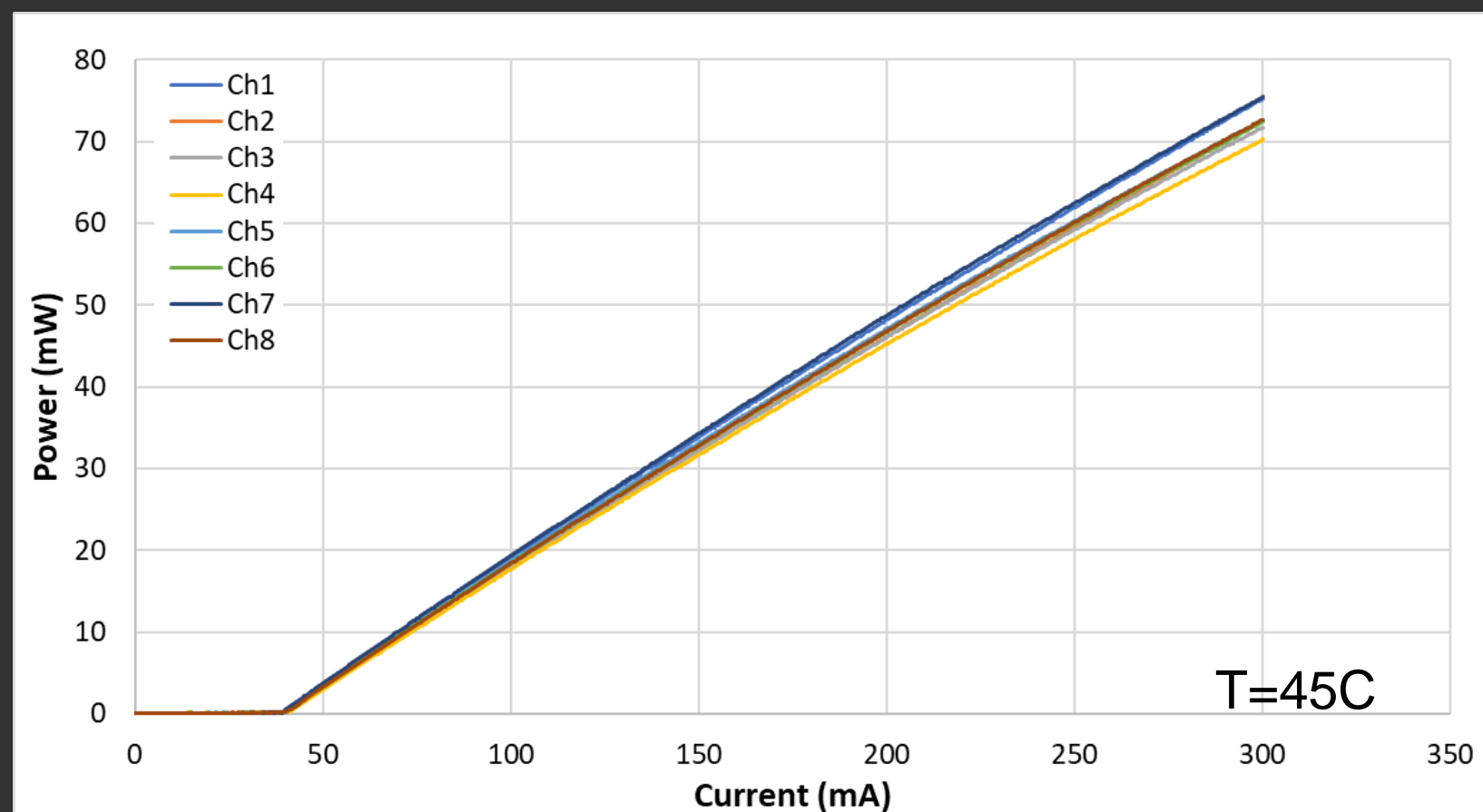
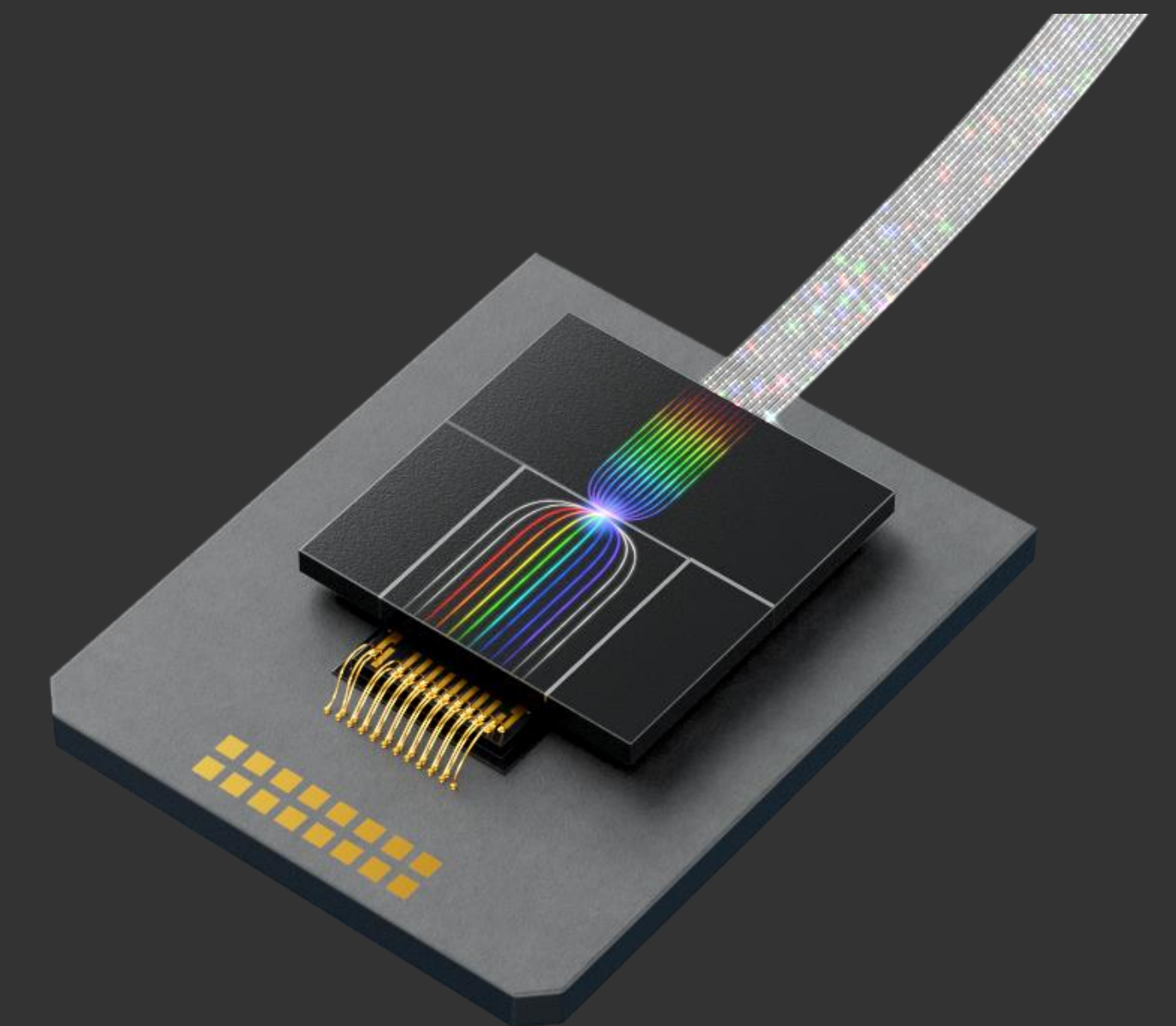
## Key features

- 8 Discrete channels per chip
- > 50mW per channel CW operation
- 400GHz channel spacing around 1300nm
- Operating temp 20°C - 70°C
- Suitable for non-hermetic applications



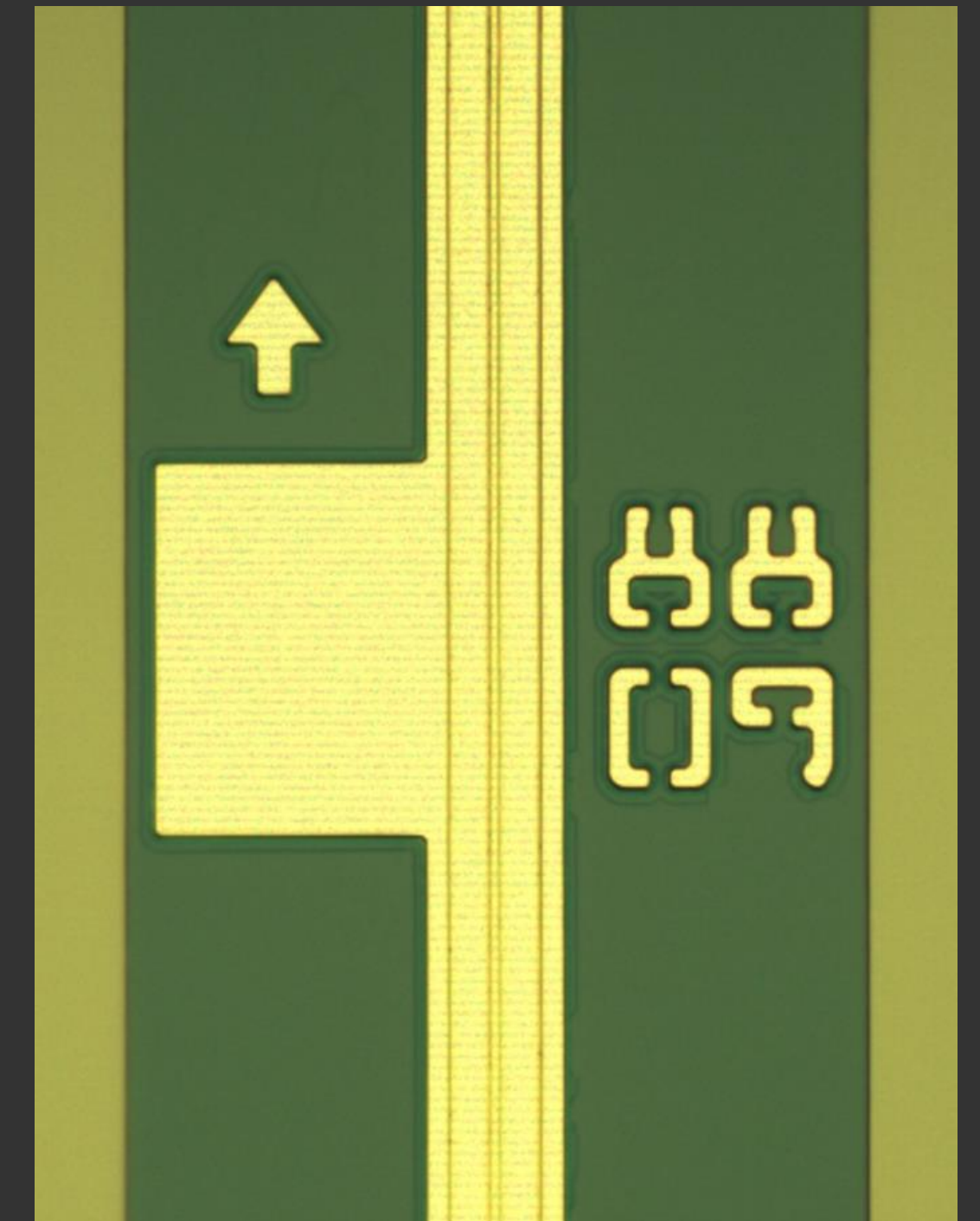
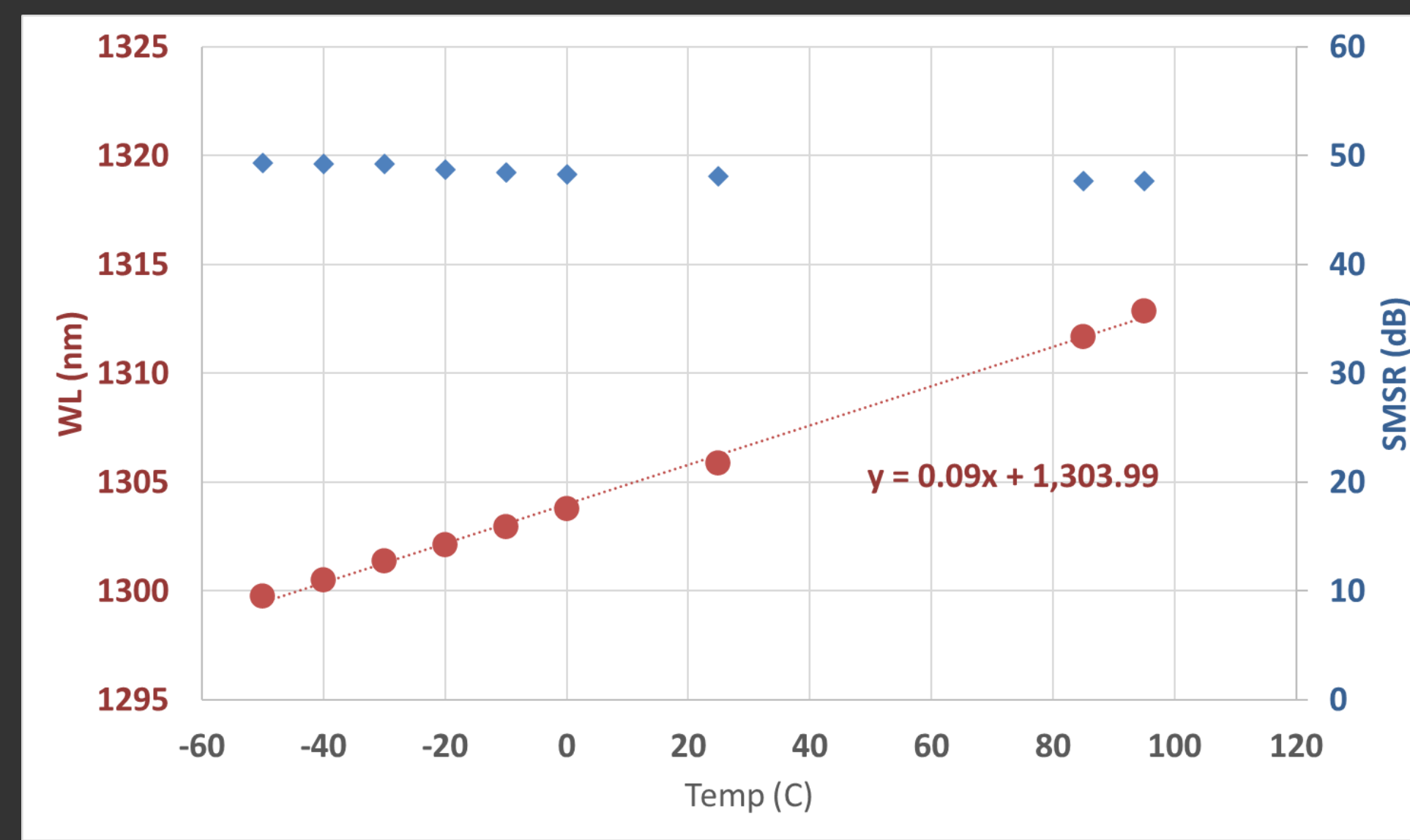
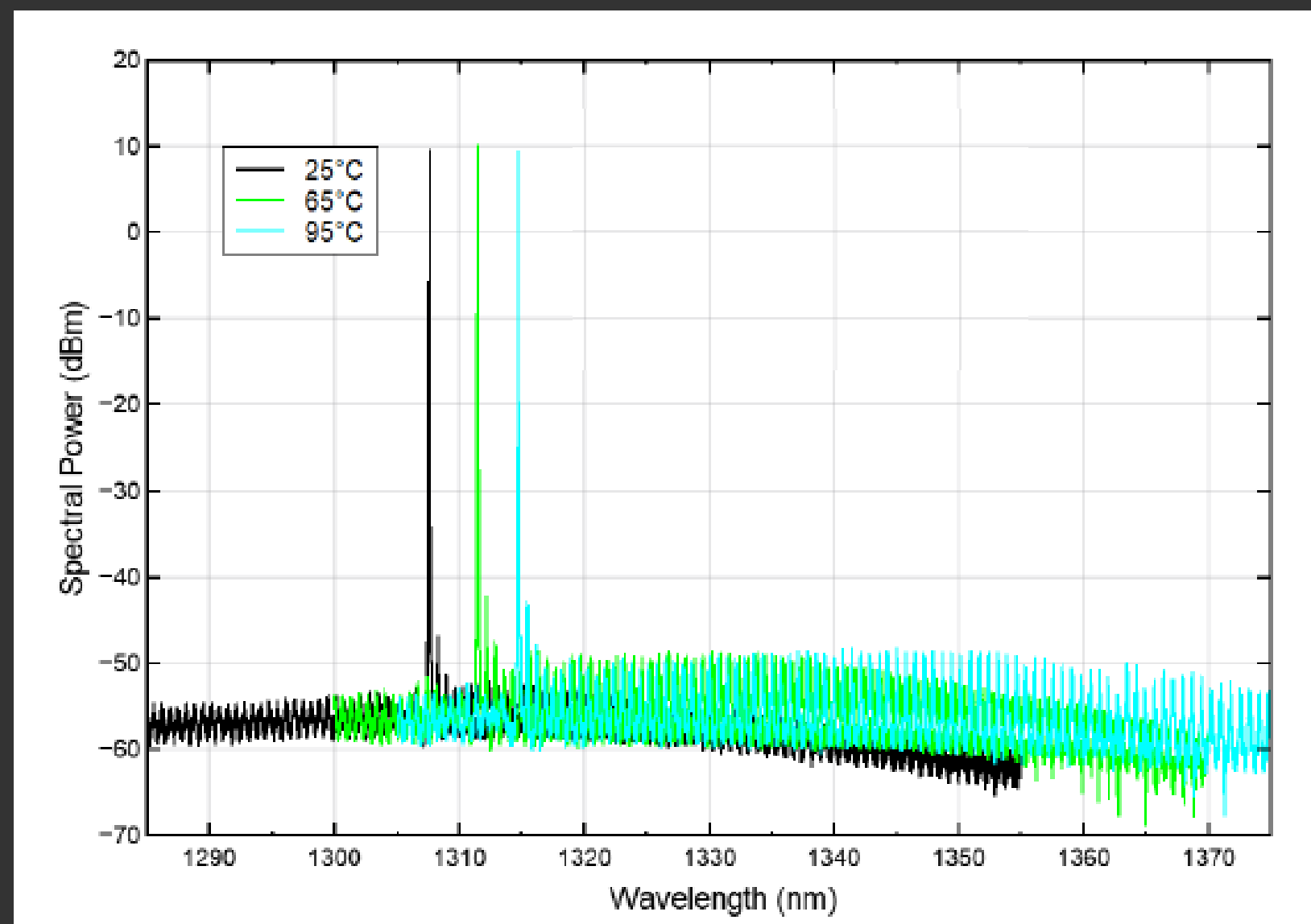
 **Ayar Labs**

SuperNova™ Multi-Wavelength Optical Source with Sivers DFB Laser Arrays Inside



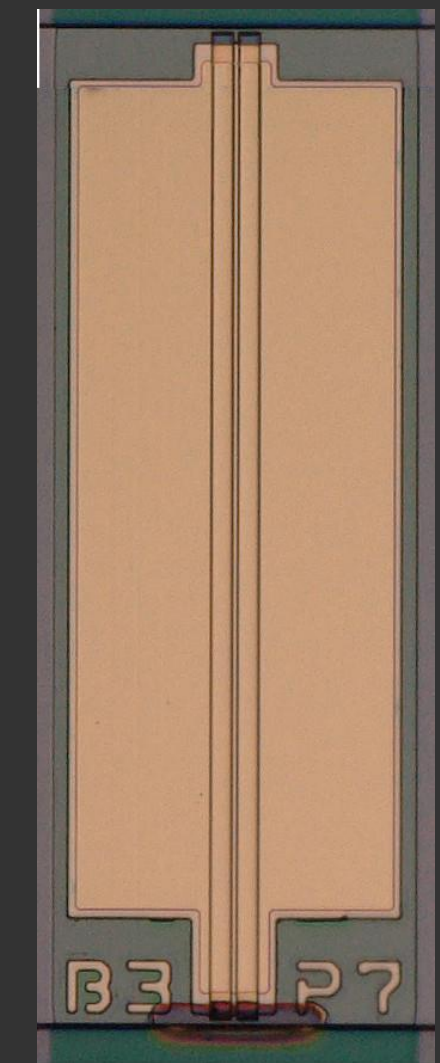
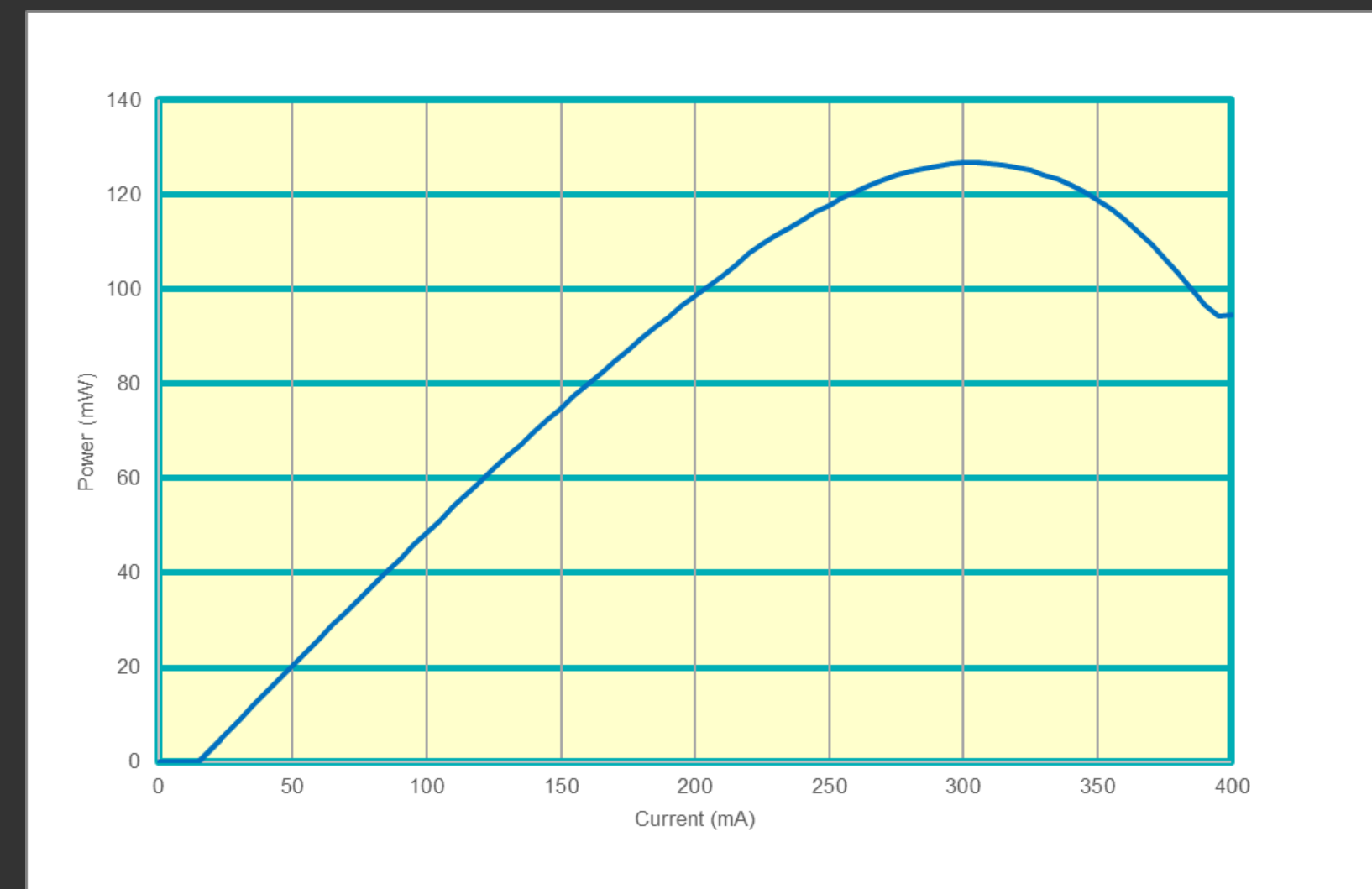
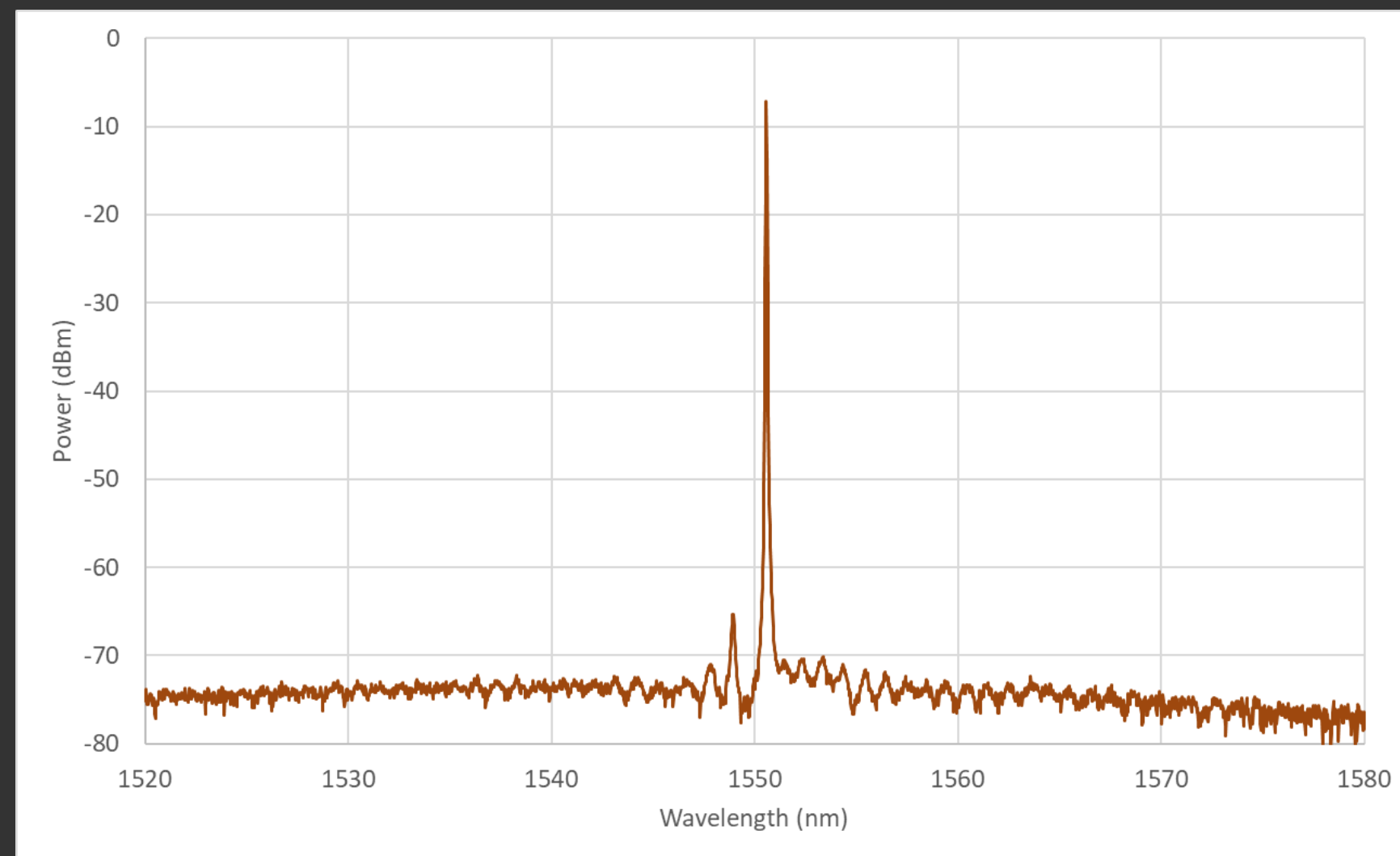
# Wide operating temperature 1310nm DFB Lasers

- Increasing operation temperature range without reduction in spectral performance
- Designed for CW operation at 25mW ex-facet output power
- Functional from -50C to +95C - tested in TOSA packages
- Optimised MQW active region, grating design, and cavity length



# High Power 1310/1550nm DFB Lasers for FMCW LiDAR

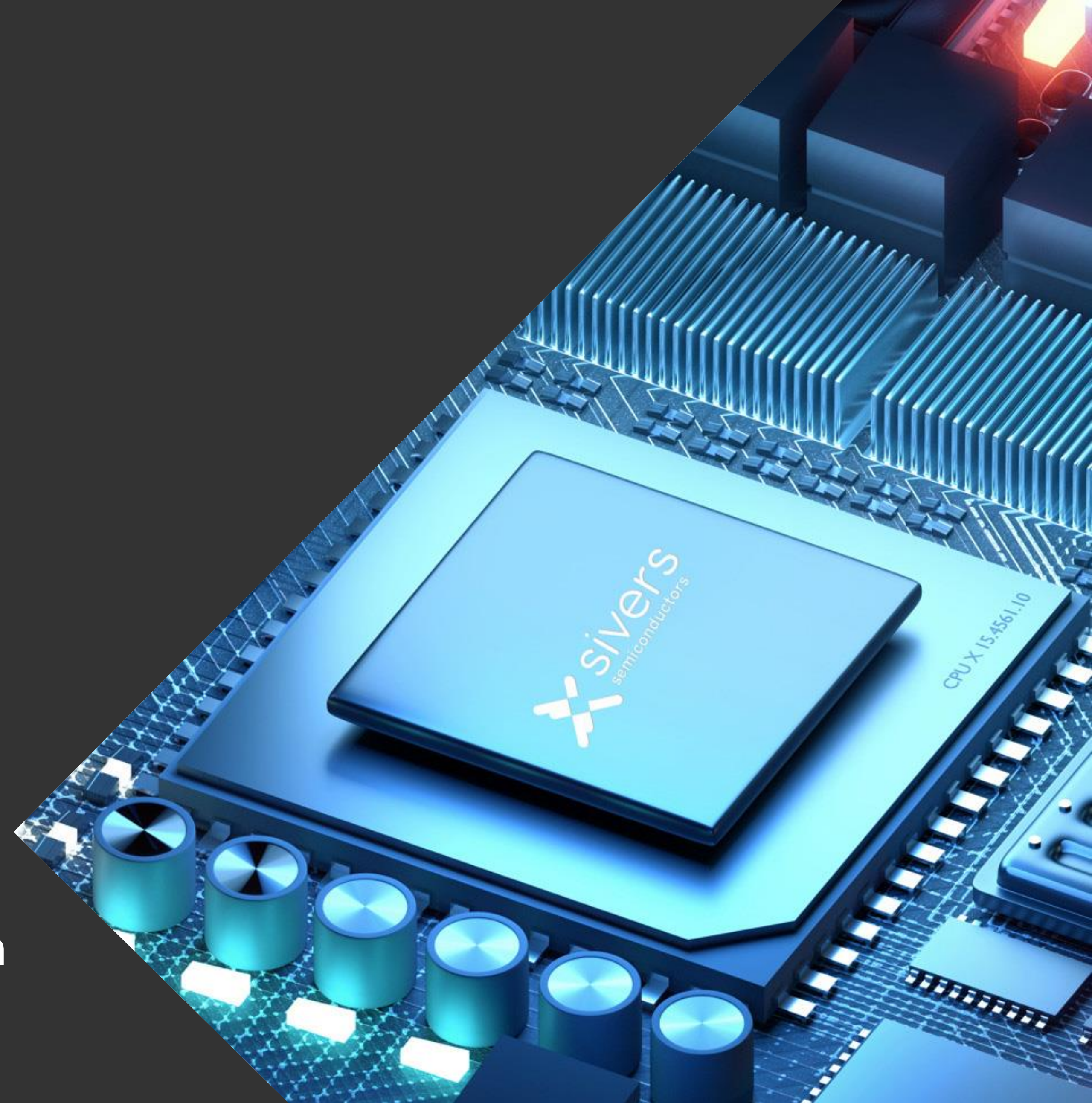
- Increasing optical power, maintaining low linewidth and spectral performance
- >100mW output at 25°C, LWs <200kHz (measured by Self-Het with AOM/delay-line)
- SMSR > 50dB
- Working towards 200mW output powers, <100kHz LW through further optimised epi/grating/chip designs





# Summary

- Sivers Photonics has complete in-house capability for III-V chip design, fabrication, test, reliability and qualification
- Our InP100 platform provides advanced customised III-V devices for SiPh hybrid integration
- Sivers Photonics form a vital part of the SiPh ecosystem and are a key strategic supplier to many Fortune 100 and Silicon Valley customers.



**Thank you.**

