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LASTRONICS

DILAS
The diode laser company.

1kW peak power operation of conduction cooled 940nm single bars, for use as pump source in Peta-Watt applications

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Abstract

- **1kW peak power operation of conduction cooled 940nm single bars, for use as pump source in Peta-Watt applications.**

We describe the results achieved for 50%FF 940nm QCW bars, operated up to 1kW peak power per bar, and look into their usability as pump source for Peta-Watt Laser installations in terms of divergence and spectral properties. The laser diode bar has been optimized for such high power operation, and the mounting scheme allows scalable architectures in stacks with fast axis collimations for dense geometric arrangement and further beam shaping for pump engine applications.

Motivation

- **Future HEC-DPSSL systems need improved pumps**
- **Increased diode laser power**
  - Increased power density for higher performance
  - Reduced cost ($/W or $/J)
- **Increased diode laser efficiency**
  - Simple, low cost (passive) cooling
  - Higher net gain for power generation applications
- **Narrow divergence**
  - For efficient optical coupling / beam shaping

Status from the lab

- **Commercial standard: 300-400W/bar ***
  - Passively cooled single bars with 1...2 mm cavities

- **1.5 kW/bar demonstrated @ FBH (1.2ms 10Hz) ****
  - Leverages FBH research into 9xx-nm lasers
    - High quality device design and technology
    - Laser facets with high damage thresholds

  - Format: passively cooled single bars, 6 mm cavity
    - Long cavity improves cooling, lowers resistance
    - High fill factor (72%) lower resistance

  - Confirms robustness of diode laser technology

Status from the lab

- **Commercial standard: 300-400W/bar ***
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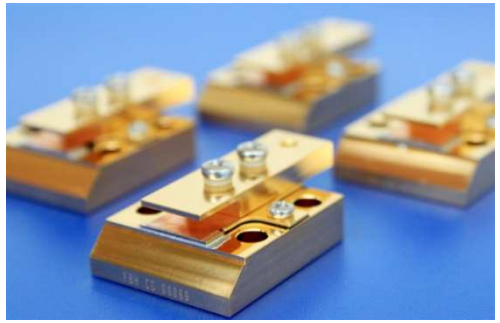
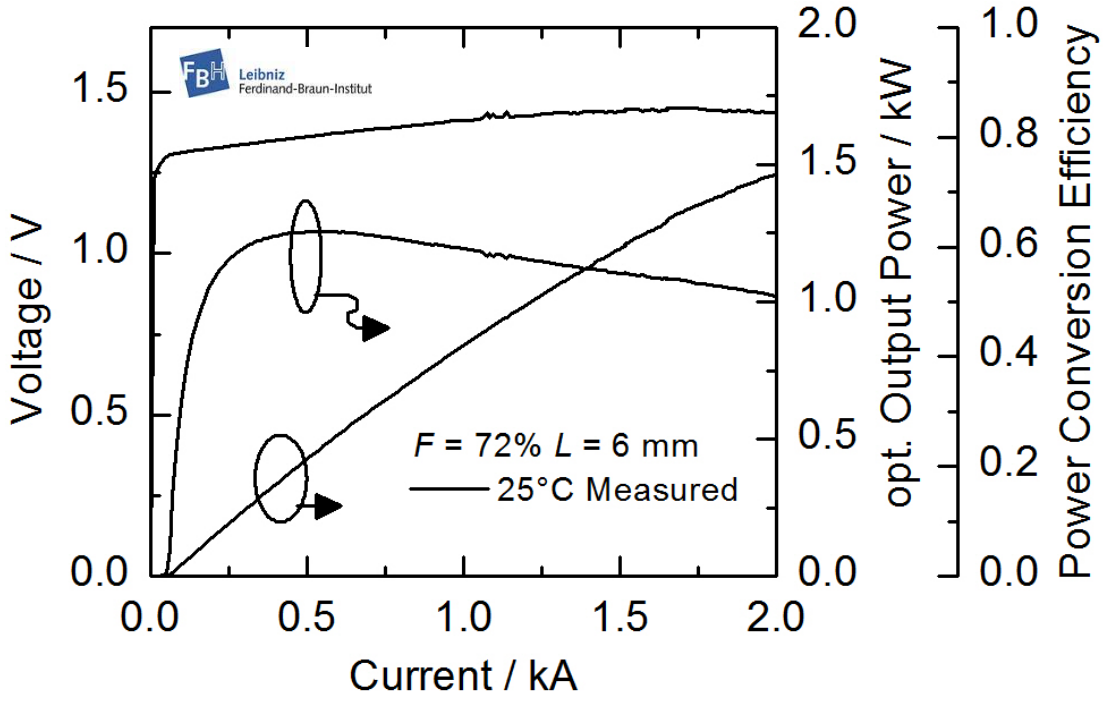




* Sikocinski et al. Proc. SPIE 8965, 896516 (2014)
** Crump *et al.* Proc. SPIE 9002, 90021I (2014)

Status from the Lab

- **Commercial standard: 300-400W/bar ***
  - Passively cooled single bars with 1...2 mm cavities
- **1.5 kW/bar demonstrated @ FBH (1.2ms 10Hz) ****
- **Next steps**
  - FBH Research for further improved performance
  - Commercialize

Commercialization Status

- **Select device configuration for assessment**
  - First trials with 4 mm cavity, 50% fill factor
    - estimated as sufficient for ~1 J/bar (0.8 kW 1.2 ms)
  - Two alternative epitaxial designs compared

- **Select package**
  - Assess using DILAS standard QCW package
  - Increase length of heatsink for 4 mm cavity

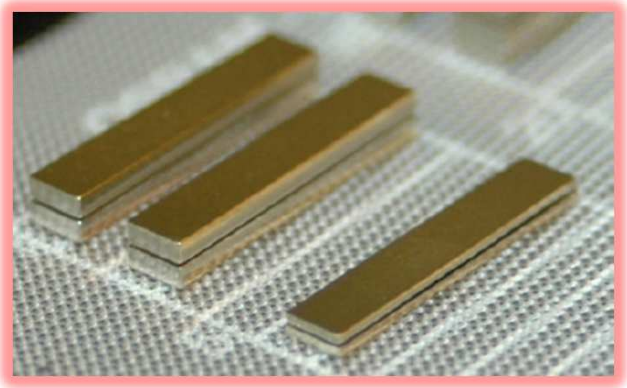
- **Perform baseline analysis**
  - Thermal simulation
  - Construct prototype single bar and stack units
  - Assess performance

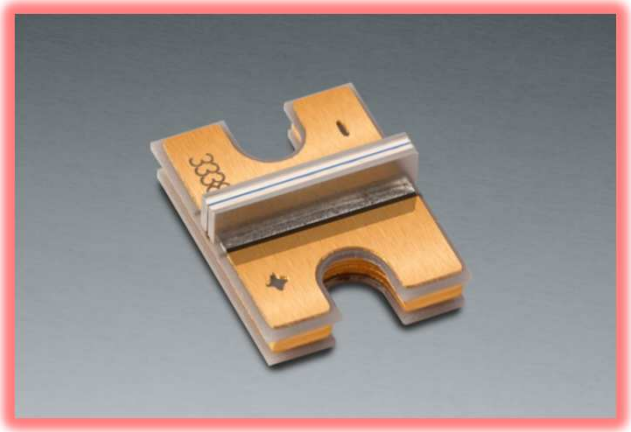
Thermal simulation 4mm CL „SO10”-type

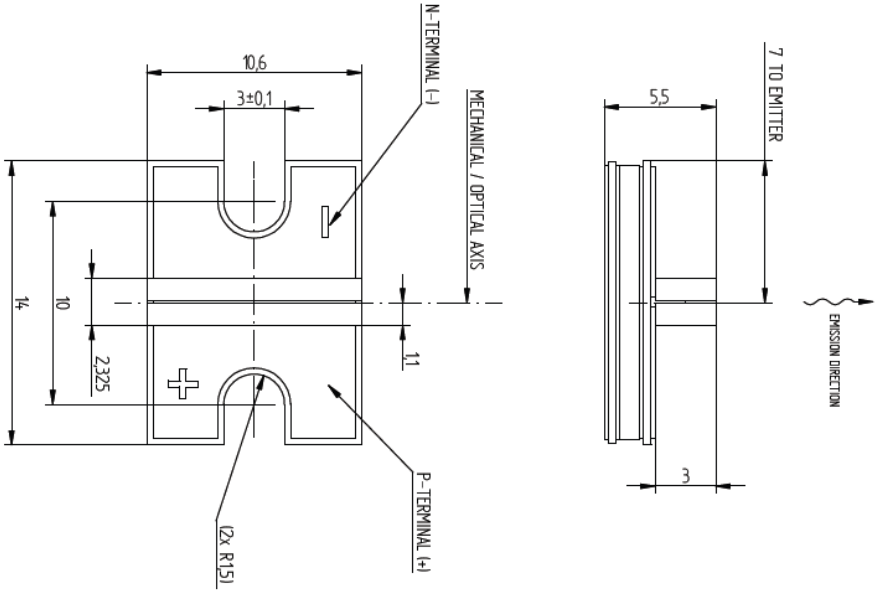
monolithic assembly

hard solder technology

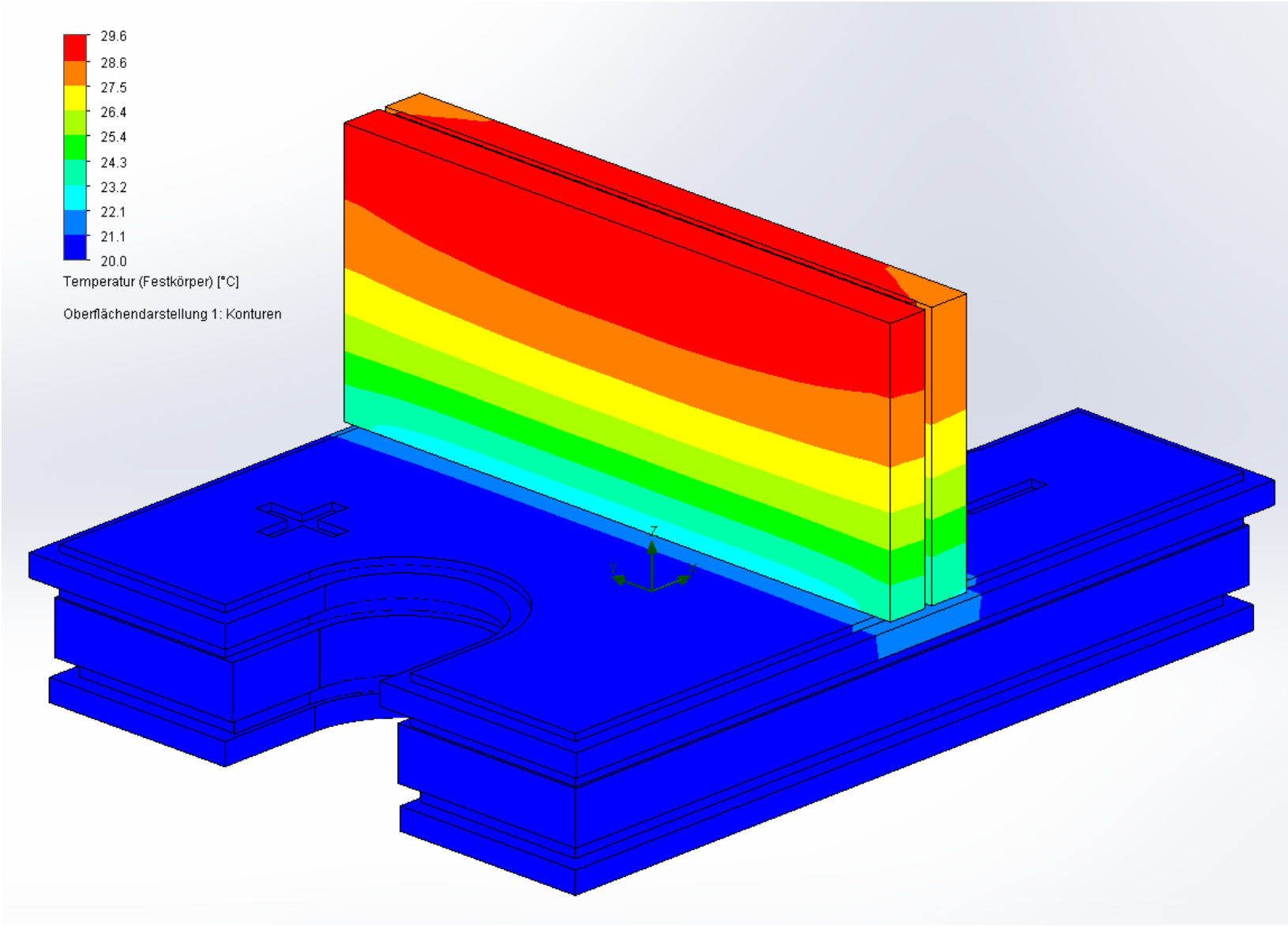
Bar:	50%FF 25 emitter (200/400µm) CL 4000µm
Power:	800/1000/1200W
Operation:	10Hz /1ms /1%dc /@20°C



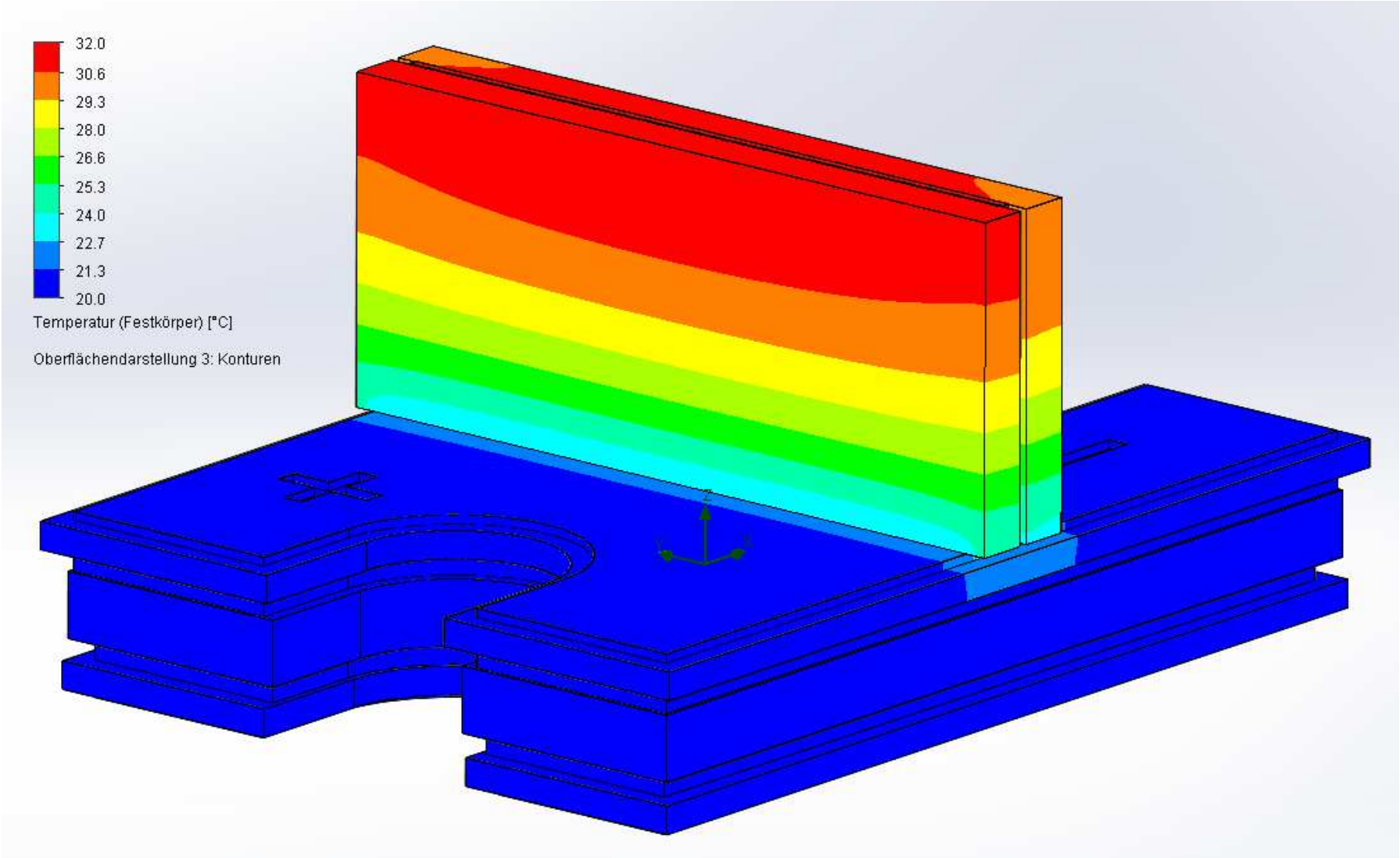




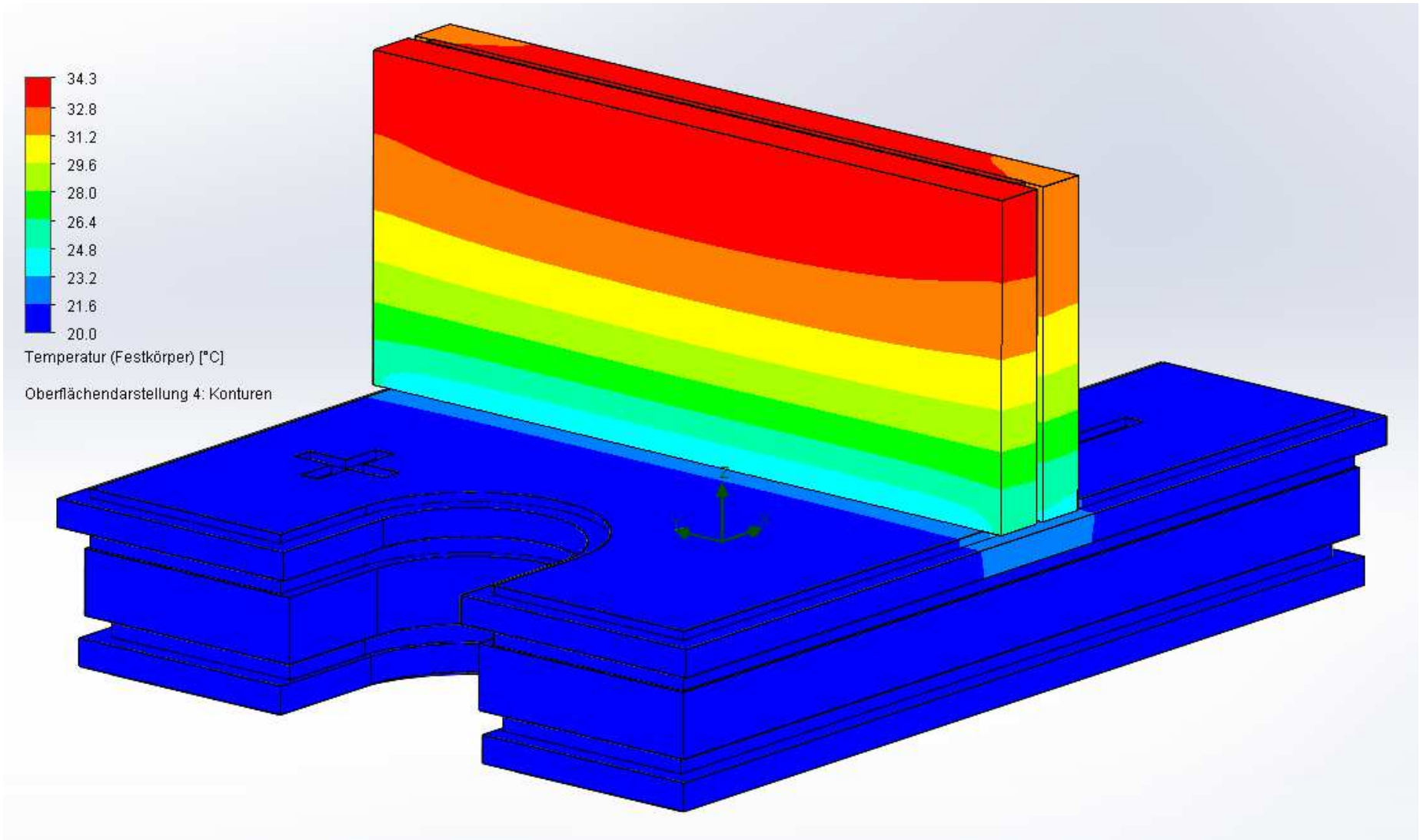
Thermal simulation 4mm CL <8W>



Thermal simulation 4mm CL <10W>



Thermal simulation 4mm CL <12W>

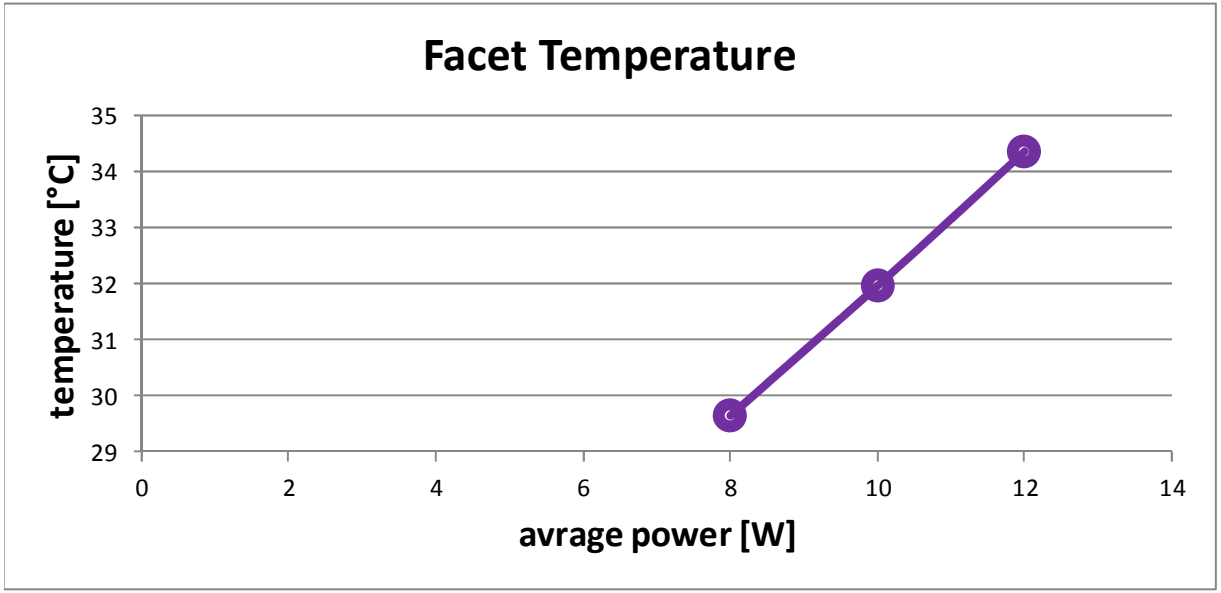


Thermal simulation

SO10-package with 4mm CL bar

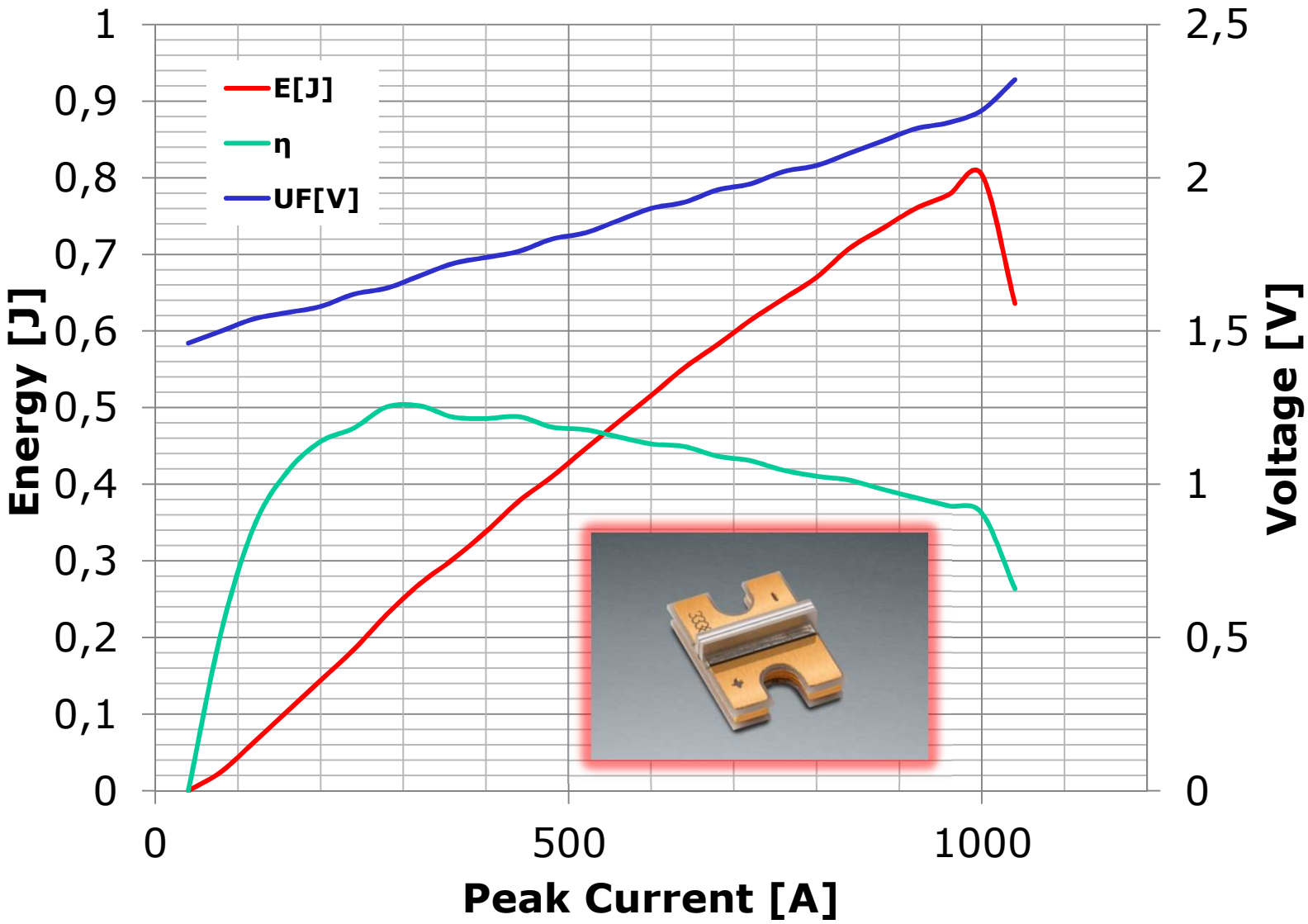
Zielname	Leistung (W)	Temperatur [°C]
8W	8	29,65
10W	10	31,95
12W	12	34,35

Iterationen: 40
Analyseintervall: 20

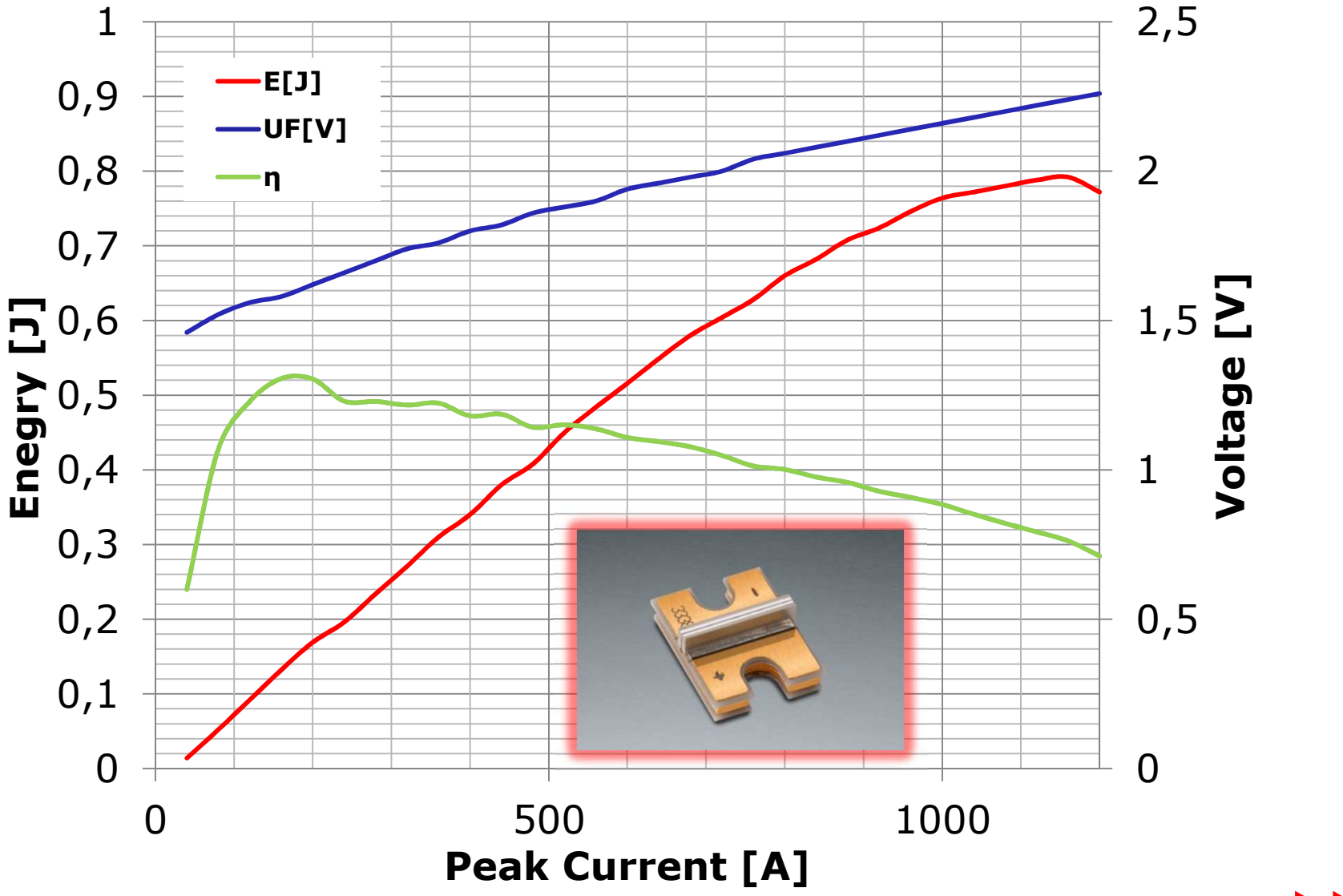


Temperatur rise
8W 9,65°C
10W 11,95°C
12W 14,35°C

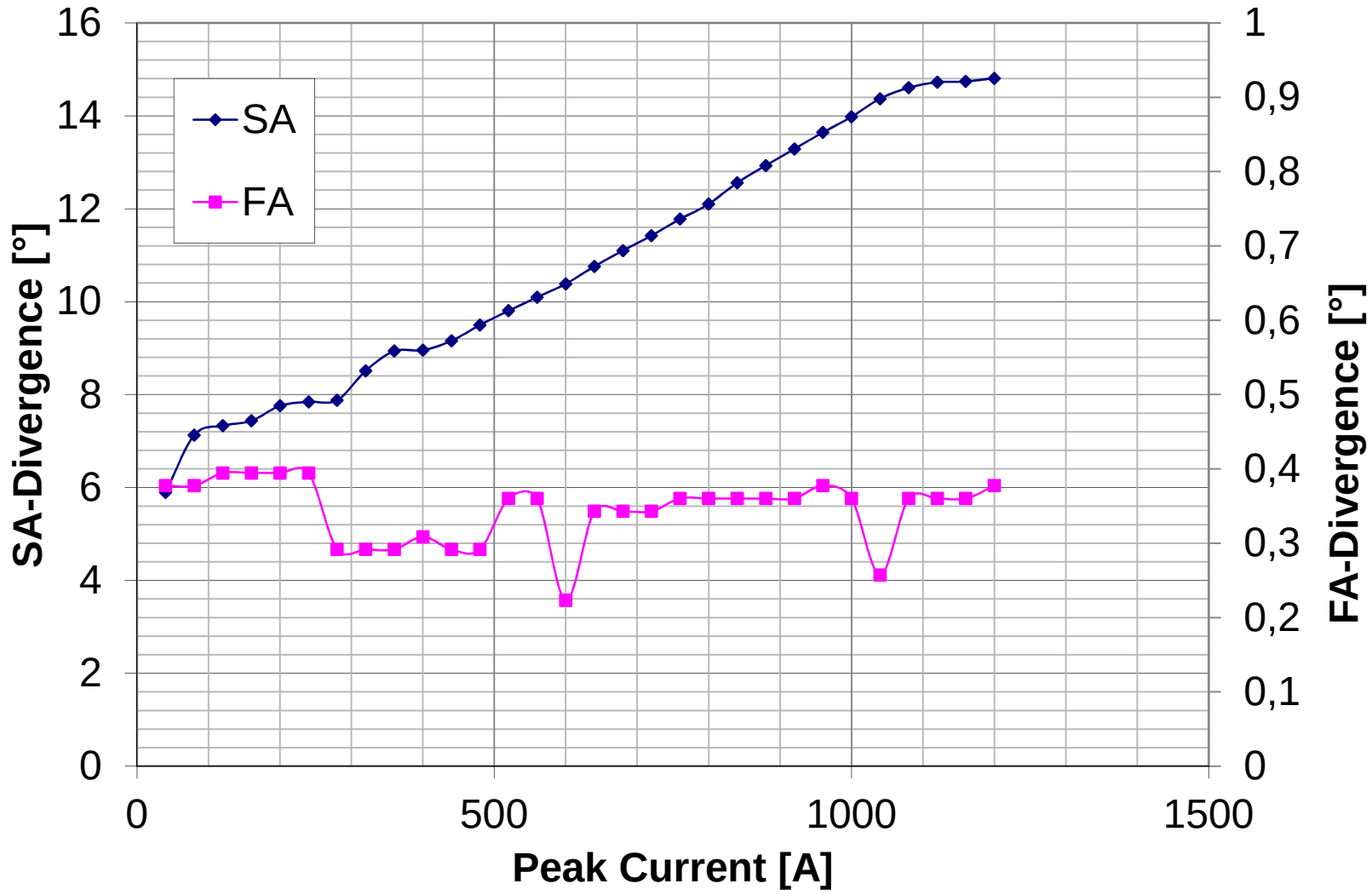
Stack 5206


E[J]
η
UF[V]
Energy [J]
Voltage [V]
Peak Current [A]
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
0
0,5
1
1,5
2
2,5
0
500
1000

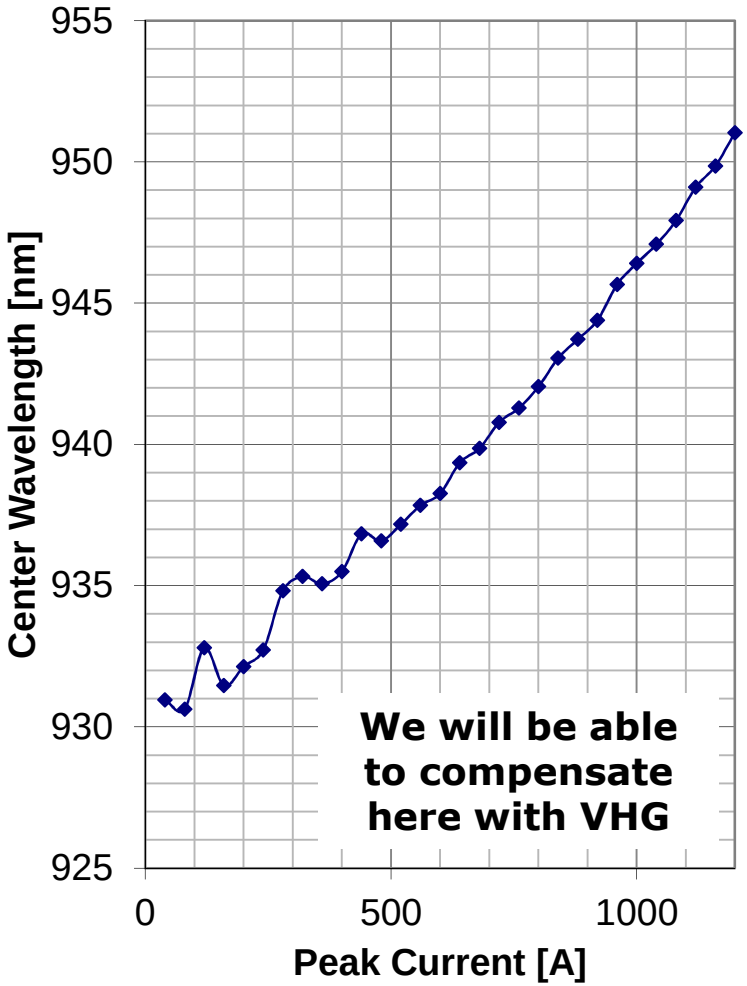
Stack 5205

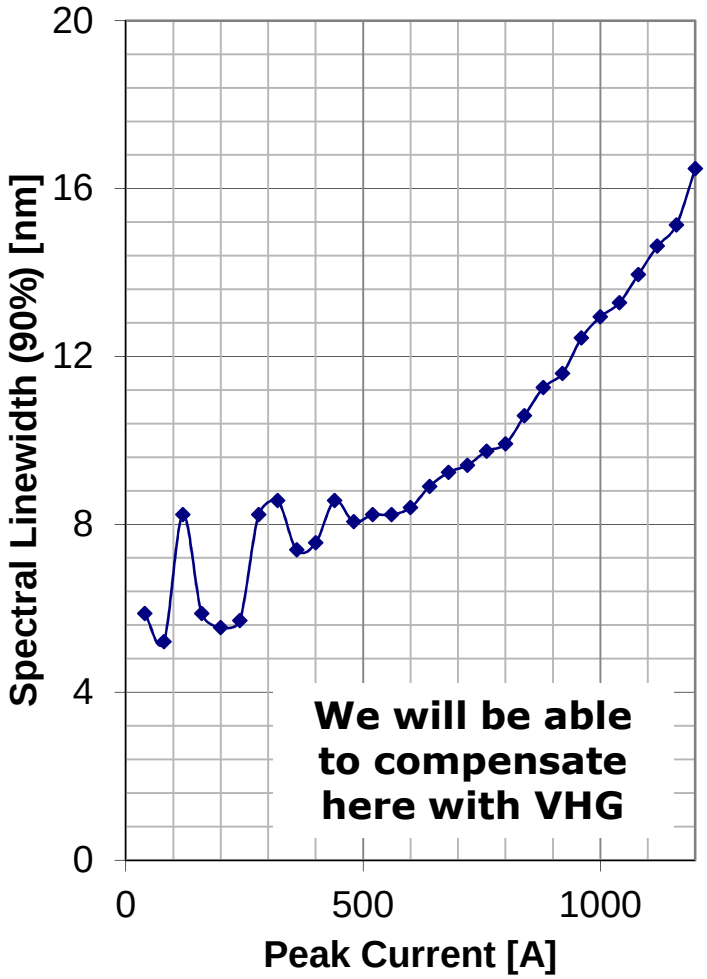

E[J]
UF[V]
η
Enegry [J]
Voltage [V]
Peak Current [A]
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
0
0,5
1
1,5
2
2,5
0
500
1000

Stack 5205 Divergence



Stack 5205 - Spectral Performance



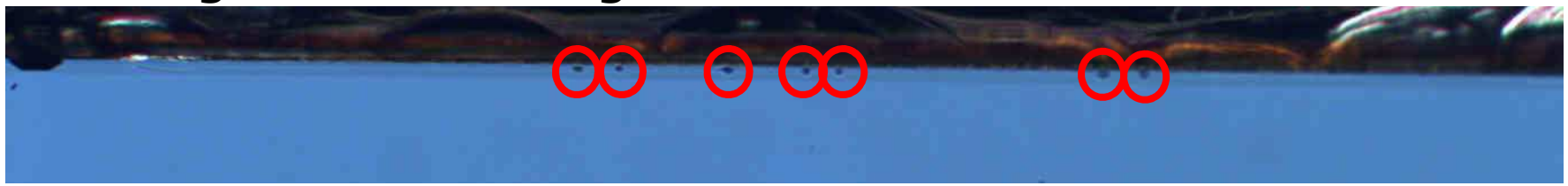


Front Facet in LED Mode

good emitters

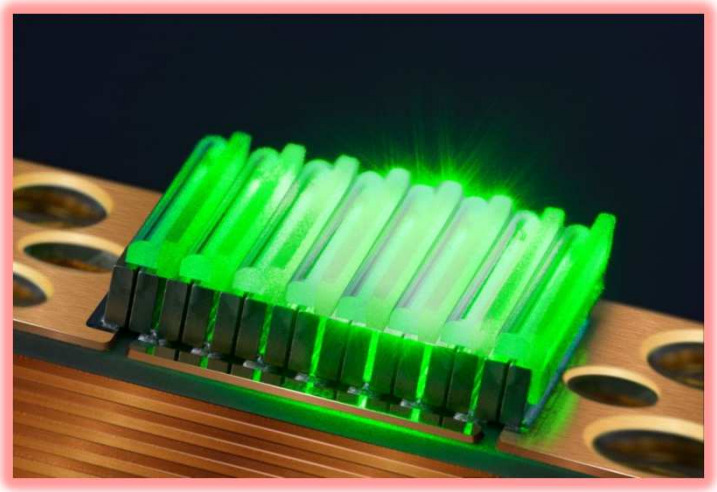
damaged emitters

a damaged emitter - magnified

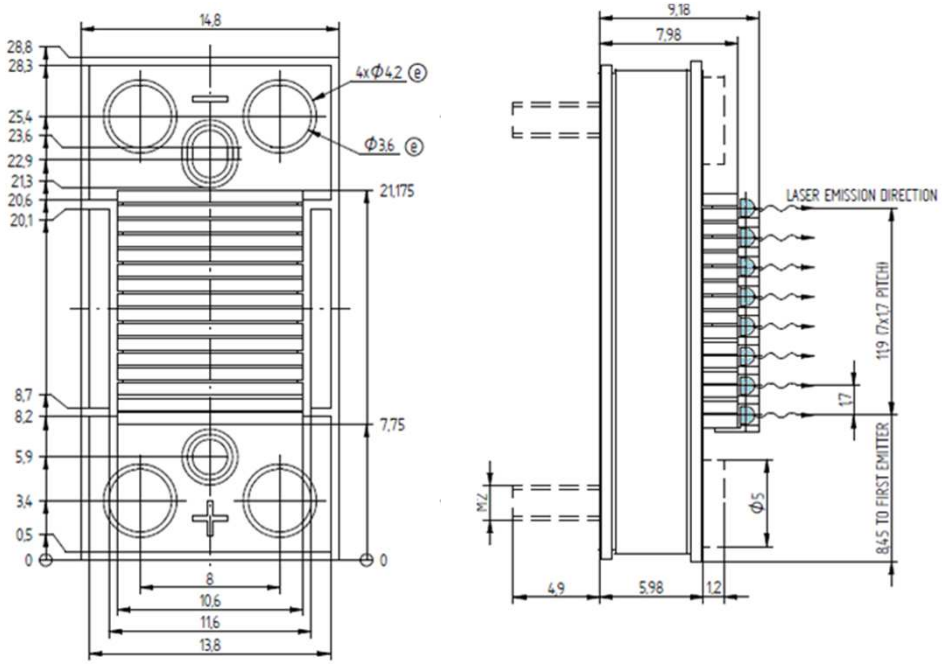


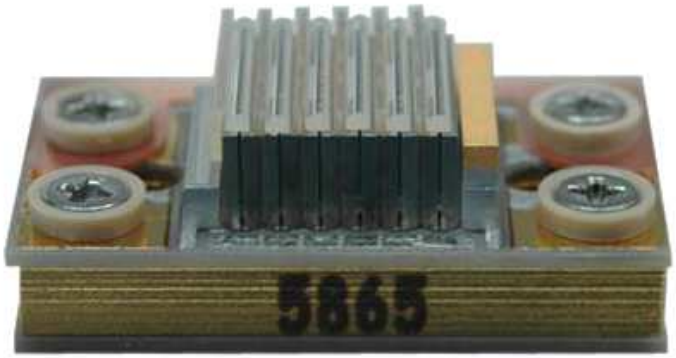
C-Stack

DILAS



Standard 8-bar C-Stack

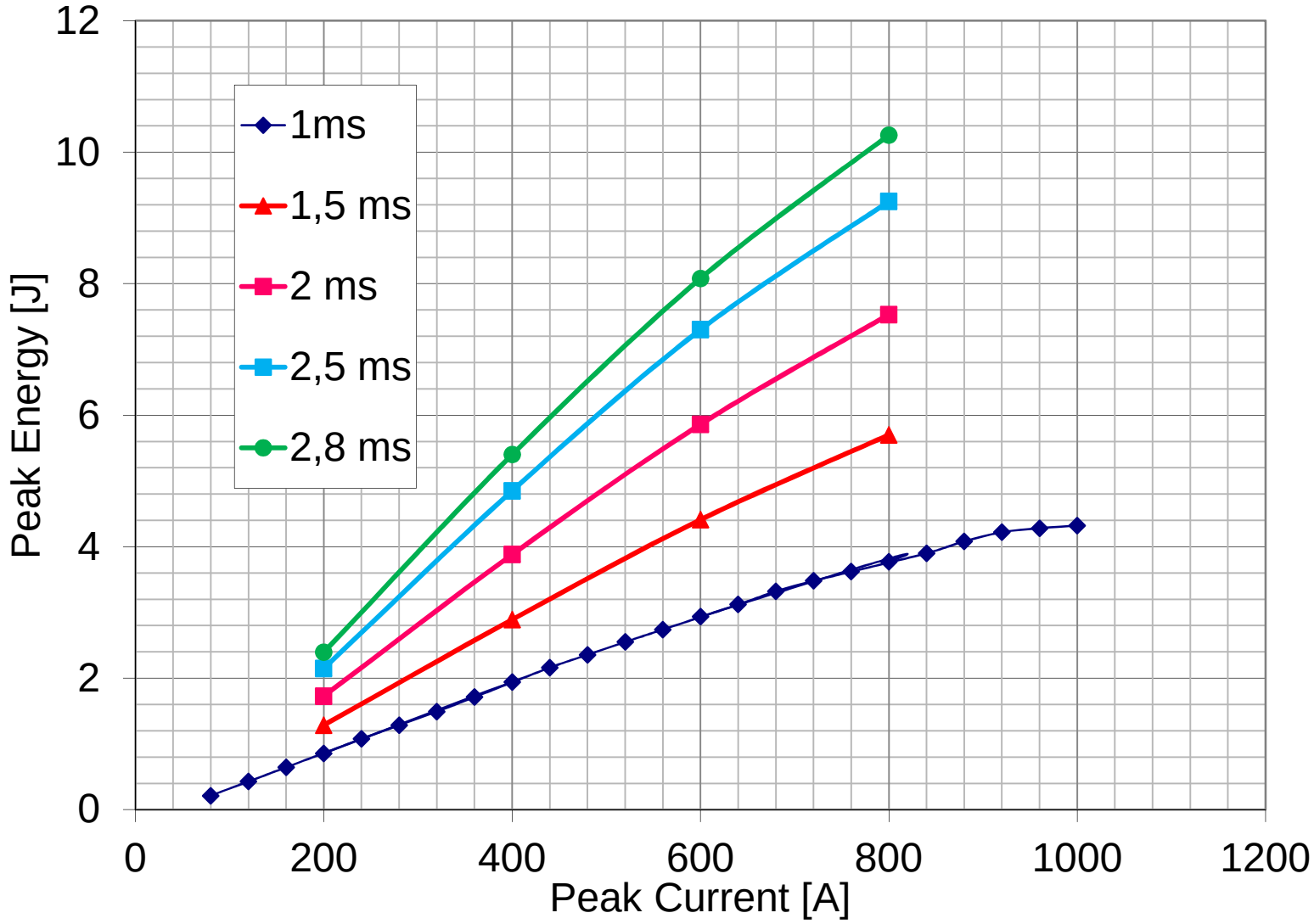




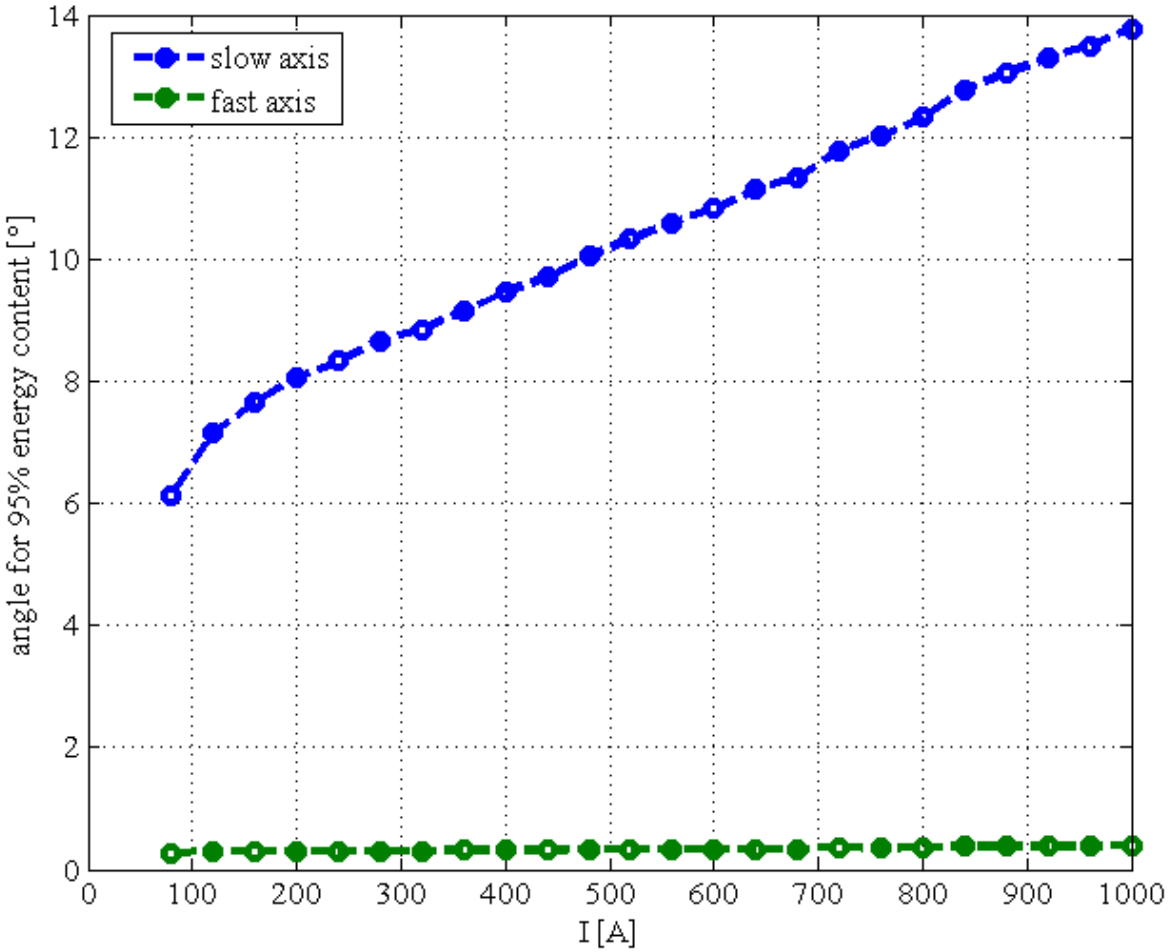
Modified 6-bar C-Stack

- monolithic stack
- hard solder technology
- 1.7mm pitch
- up to 8 laser bars

6-bar Stack - Performance



6-bar stack - Divergence



Summary

- Higher per-bar power needed for future systems
- FBH lab tests demonstrate at least 1.5 J/bar
  - Long cavity (6mm), 72% fill factor, single bar package
- DILAS prototype QCW package confirms 1 J/bar
  - Stack, single emitter package adapted for 4mm cavity
  - Two FBH designs tested with 50% fill factor
    - Both reach ~ 1 J/bar
  - Good divergence, spectral width, efficiency confirmed
  - Some yield for facet failure observed
- Promising results for near term commercialization

Outlook

- **Optimize bars for 25°C 1 J/bar application**
  - **Reliability trials**
  - **Enhance margin against facet failure (higher fill factor)**

- **Continue studies for higher powers and efficiencies**
  - **Project Cryolaser* seeks efficiency >80% at 1.6 kW/bar**
    - **Leverages designs optimized for T < 0°C operation**

* www.fbh-berlin.com/business-areas/diode-lasers/ba-lasers-bars/cryolaser
Recent overview presented at Photonics West: Crump *et al.* Proc. SPIE 9002, 90021I (2014)

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Thank you for your attention !

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