Light-weight, fiber-coupled qcw diode laser pump module for the BepiColombo laser altimeter

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DILAS Diodenlaser GmbH

DILAS GmbH
founded 1994
located in Mainz
Germany

DILAS Inc.
founded 2005
located in Tucson
Arizona
Founded: 1994

Employees: 153

Majority Shareholder: Rofin Sinar Technologies Inc. since 1997 (Nasdaq RSTI)

ISO 9001-2000 certified Quality System

Markets:
- DPSSL pumping
- Material processing
- Graphic Arts
- Medical
- Defence
- Instrumentation

Research:
- 35 academics & engineers

R&D Budget:
- ~11% of revenue

Facilities:
- Mainz / Germany
  - 2 buildings
  - ~3300m² total
  - 500m² clean room
  - other production area of ~700m²

- Tucson / Arizona
  - 300m² facility

Products:
- Laser diode bars
- Laser diode stacks
  - vertical / horizontal
- Fibre coupled LD
- Laser Diode Systems
- custom solutions
- available wavelength
  - 650...690nm
  - 785nm, 792...797nm
  - 808nm
  - 830nm
  - 880nm
  - 915nm
  - 940nm
  - 980nm
  - 1064nm
  - 1470nm

Sales offices:
- representatives in all major market areas or direct sales from headquarter
Quasi-cw Products

Stack

Collimated stack

Fibre coupled module

Large 2D-Array
BepiColombo Mission

- ESA & JAXA Joint Mission
- Launch in 08/2013
- 8.45 years travel time
- >1 year scientific operation

Planetary Orbiter (ESA)
- surface and interior
- Polar Orbit: 400-1500km

Magnetospheric Orbiter (JAXA)
- Magnetic field and magnetosphere
- Polar Orbit: 400-12000km
BELA - BepiColombo Laser Altimeter

BELA 11kg, 40W
BELA Laser Design Concept

- Fiber coupled pump diodes
  - thermal and mechanical separation of pump source and laser head

- Longitudinal pumping scheme
  - long absorption path
  - optimized overlap pump beam / laser mode
  - higher efficiency

- qcw pumping
  - 200ms pump pulse duration as compromise between efficiency and output energy

- Passive Q-switching with Cr\(^{4+}\):YAG
  - simple design
  - low mass
  - low power consumption

- MOPA with 2-stage amplifier
  - avoid self-lasing
  - redundancy
BELA Laser Design Concept

- Wavelength: 1064 nm
- Puls Energy: 50 mJ
- Puls duration: <10 ns
- Beam quality: $M^2 < 1.6$
- Rep. rate: 10 Hz (20 Hz)
**Specifications for BELA Pump Diode Unit**

- **3 sub-units:**
  - 2 x 500 W (660 W)
  - 1 x 100 W (165 W)
- 800 µm fibre coupling
- No liquid cooling
- Wavelength: 806 +/- 3 nm
- Puls duration: 250 µs
- Duty Cycle: 0.25-0.5 %
- Rep. rate: 10 Hz (20 Hz)

- **Electrical power:** < 13.5 W
- **Diode Current:** < 110 A
- **Voltage:** < 32 V
- **Efficiency:** > 70 %
- **Total mass:** < 1.4 kg
- **Vibration:** 26 g_{rms}
- **Radiation:** 100 krad
- **Temperature:**
  - Non-op.: -40 to +60°C
  - Operational: +18 to +33°C
Industrial Module to Space Module

1000 W rated power
16 diodes
Mass: 9.5 kg
Size (l x w x h): 30 x 23 x 11 cm³
Volume: 7590 cm³

1100 W rated power
22 diodes
Mass: 1.3 kg
Size (l x w x h): 17 x 8 x 10 cm³
Volume: 1360 cm³
BELA Pump Diode Unit

- Rear
  - Electrical interface

- Front
  - Optical interface
  - Thermal interface
  - Mechanical interface
The 2nd ESA-NASA Working Meeting on Optoelectronics
21st and 22nd of June 2006 / Noordwijk, The Netherlands

BELA PDU Sub-Module

asymmetrical beam on stack window

Slow-Axis segmentation

symmetrical beam on focussing optics

beam transformation

diode stack

fiber coupling optics
BELA PDU Sub-Module
BELA PDU Sub-Module

- diode stack
- PCB with MOSFETS
- beam transformation
- optics carriers
- SMA fiber socket
Space Aspects

- light weight design / materials
- radiation hard optics, metal coated fiber
- shock / vibration proof according to space specifications
- no / low-rate outgassing materials / adhesives
- space approved diode mounting technology (tbd)
- liquid free cooling system
- multiple redundancy concept for diode failure
- vacuum sealed diode stack
BELA diode stack

- 2 sealed sub-units
- Vacuum sealed housing
- Fast - Axis collimation
- Sapphire window
- 3 vacuum feedthroughs for 2 sub-modules
- Thermal interface to the back
BELA diode stack - redundancy concept

- MOSFETs
- PDU housing
- Electrical connectors
- Diode stack
BELA diode stack - qualification

- 3 integration stages: diode, diode+FAC, stack
- diodes: 50 % fill-factor
- mounting technology: In-free (AuSn) with submount
- FAC mounting: UV adhesive / solder
- FAC: 600 µm
- pitch: 1.6 mm + x
- connectors: 3
- dimensions: see drawing
- vacuum sealed
Thank you for your attention

Dr. Matthias Haag       DL-Systems
Dr. Thomas Brand       Optics

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