



MERLIN

space transceivers

EU FP7 MERLIN Research Project

Overview – Objectives – First results

Mikko Karppinen, VTT

Intra-satellite Fibre Optic Links Workshop,
at ESTEC, 10 Dec 2015

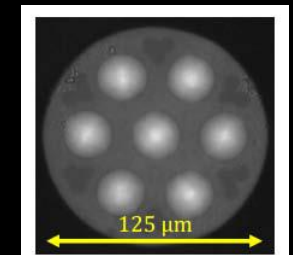
Multi-gigabit, energy-efficient, ruggedized Lightwave engines for advanced on-board digital processors



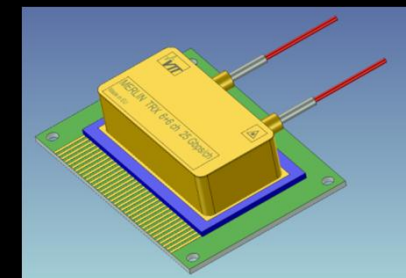
MERLIN project in a nutshell

Title: *Multi-Gigabit, Scalable & Energy Efficient on-board Digital Processors Employing Multicore, Vertical, Embedded Optoelectronic Engines*

- EU FP7 Space project grant for 2013–2016
- Objectives include:
 - Ruggedized optical transceiver “engines” with
 - record-high data rate of 150 Gb/s, in single fibre
 - record wide temp range; rad hard; low power
 - Very dense integration by the use of:
 - Novel multicore fibers
 - Custom VCSEL & PD arrays
 - Custom multi-channel ASICs



Multicore fiber
(©OFS)



Transceiver Vision



A Furukawa Company



Project coordinator: Leontios Stampoulidis, G&H

Project Objectives

- Space transceivers for optical interconnects on board Tb/s satellite payloads
- Board level optical interconnection of digital transparent processors with the integration of:

Targets:

- 1. 850 nm circular VCSEL/PDs
- 2. Rad-hard MM MC fibers
- 3. Rad-hard electronics

Power

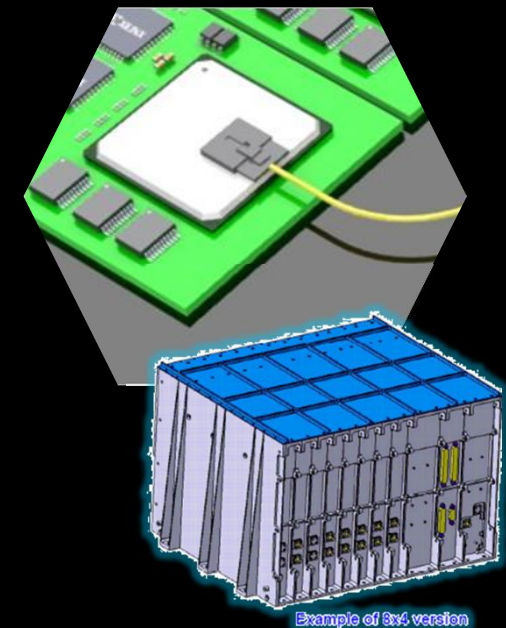
- $<10\text{mW} / \text{Gb/s}$

Speed

- 10-25 Gb/s line-rates
- 150 Gb/s (6x 25 Gb/s) aggregate

Packaging

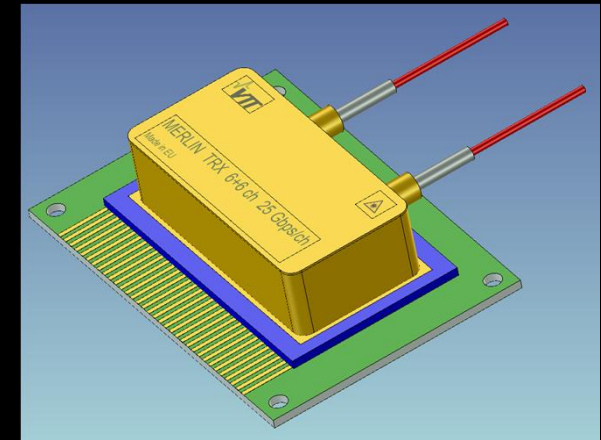
- Hermetic
- 10x fiber count decrease



Example of 8x4 version

Transceiver integration & packaging baseline targets

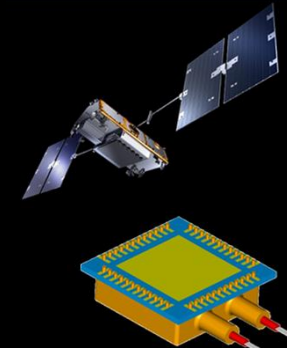
- VCSEL & PD arrays coupled to 6-core multimode fibers
- Fibre input/output parallel to PCB plane
- Radiation-resistant
- Hermetically sealed
- $T_{\text{stor.}} = -55 \dots +125 \text{ }^{\circ}\text{C}$
- $T_{\text{oper.}} = -40 \dots +85 \text{ }^{\circ}\text{C}$ or up to $+100 \text{ }^{\circ}\text{C}$
 - MERLIN targeting state-of-the-art
- Small footprint and mass
- Surface-mountable on PCB at 25 Gb/s/channel



Project development phases

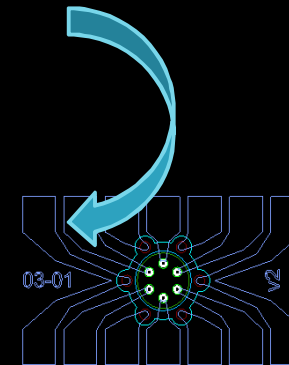
1st year:

- Define mission scenarios
- Define system requirements & module specifications
- Develop device & system level modeling toolkit
- Define component blueprint & fabrication methodology



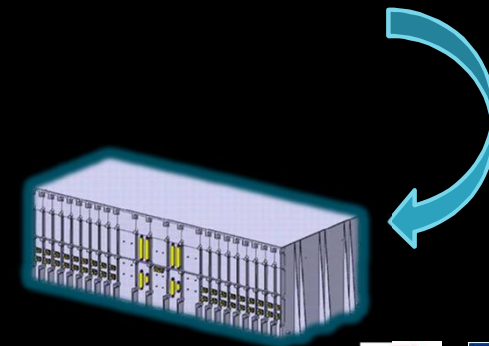
2nd year:

- Fabricate gen-1 components (VCSEL, PD, fibers & Electronics)
- Evaluate gen-1 components address 10-25 Gb/s
- Define gen-2
- Define test plan



3rd year:

- Fabricate & test gen-2
- Package & module integrate components
- System integration
- Functional & environmental trials



MERLIN Work Packages

WP2

LEADER: TAS

SPECIFICATIONS: Application – System – Module –Component –
Integration method

WP3

LEADER: CHALMERS

OPTO-ELECTRONICS: VCSELs, PDs, BiCMOS ICs

WP4

LEADER: OFS

FIBERS: MM, MC FIBER & FANOUT

WP5

LEADER: VTT

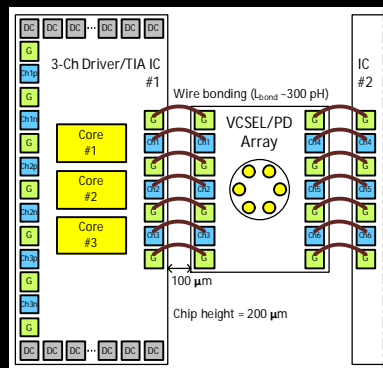
MODULES & INTEGRATION: Transmitter & Transceiver module,
prototype system development, testing

Some Key Achievement so far

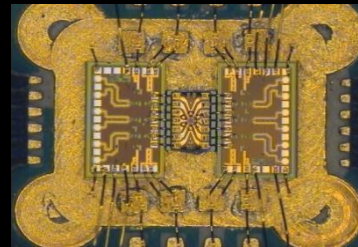
- VCSELs demonstrated up to 25 Gb/s @ 100 degC and 40Gb/s @ 85 degC
- PDs up to 25 Gb/s
- 1st Gen Driver and TIA chips up to 25 Gb/s
- 6-ch Tx and Rx Optical Engines demonstrated using the aforementioned devices

MERLIN evolution

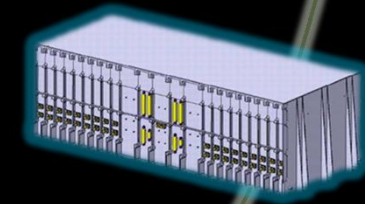
Integration
Functionality



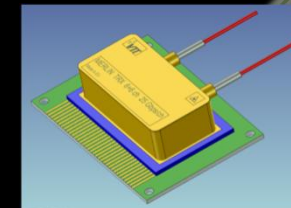
Integration concept
TOSA/ROSA



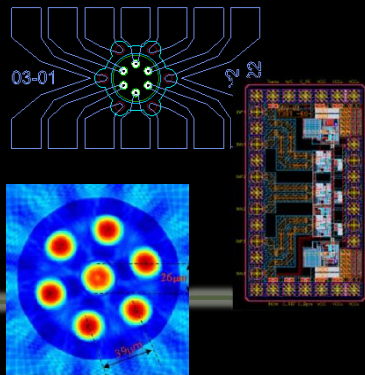
System concept



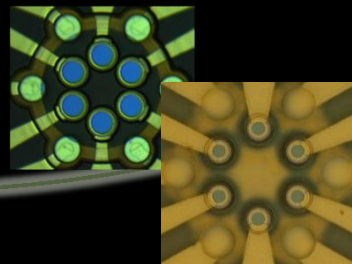
Module assembly



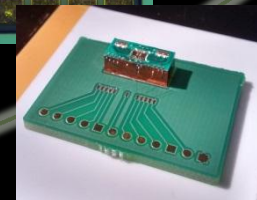
Component design
Integration design



Gen-1



Gen-2



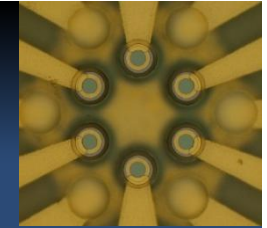
Engines

M12

M24

M36

VCSELs



Specification	MERLIN high-speed HE-VCSELs Gen 1	MERLIN high-speed HE-VCSELs Gen 2	MERLIN Gen-1	MERLIN Gen-2
Technology platform	GaAs	GaAs	GaAs	GaAs
Operating wavelength (nm)	850	850	850	850
Bandwidth @ max operating temperature (GHz)	≥ 15	≥ 23	19	>25 GHz @ RT >20 GHz @ 100 degC
Modulation speed @ max operating temperature (Gb/s)	25	Up to 40	25 & 40 G demonstrated	Up to 40 G demonstrated
Maximum operating temperature (°C)	100	85	85 demonstrated	100 degC demonstrated @ 25 Gb/s 85 degC demonstrated @ 40 Gb/s
Dissipated electrical energy per bit @ RT (fJ/bit)	≤ 200	<300	245	<200
Array & module integration	Circular 6-VCSEL array	Circular 6-VCSEL array	Circular 6-VCSEL array	Circular 6-VCSEL array Integration with drivers demonstrated