



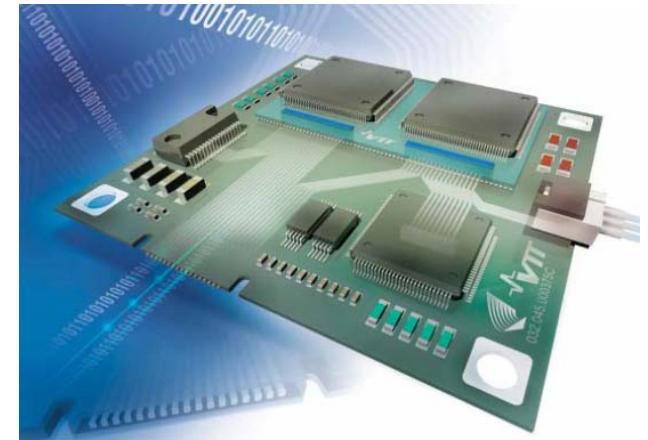
Optics On Future Printed Circuit Board In High Speed Data Transmission Applications

Experiences in OHIDA project
Antti Tanskanen

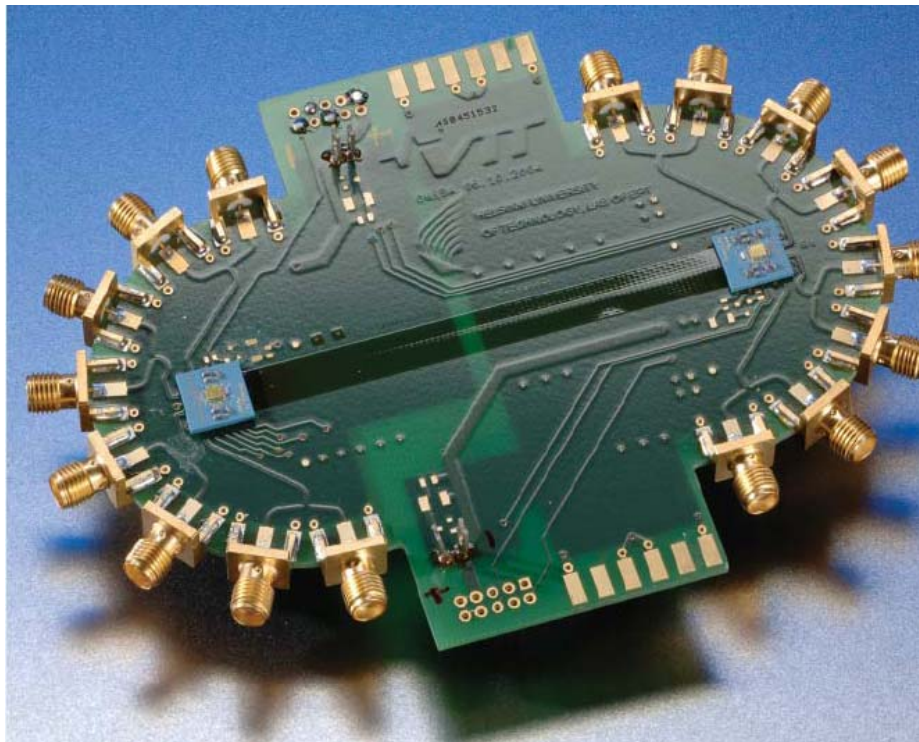


OHIDA

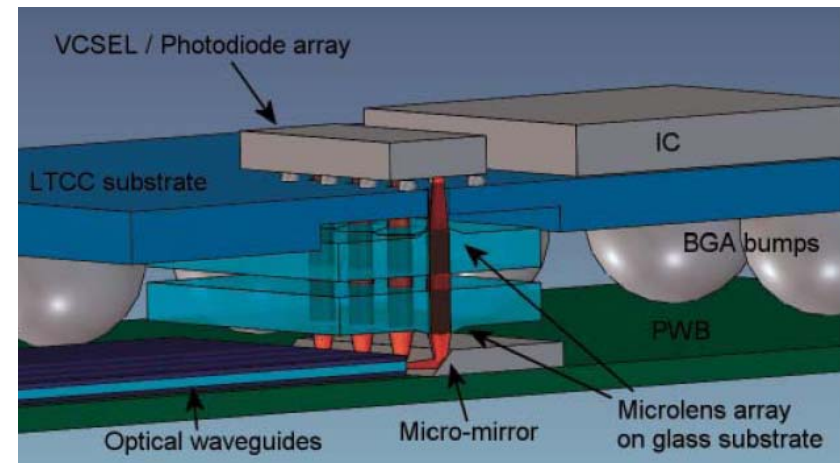
- Joint project of VTT, HUT, Aplac, Aspiration, Aspocomp, Elcoteq and Perlos, funded by TEKES
- **Objective**
Develop technologies to integrate high-speed (~10Gb/s/channel) optical interconnects into electrical wiring board
- **Project results**
 - Design and analysis tools for micro-optics and high-bit-rate optoelectronics.
 - Processing of optical waveguides, optical coupling structures and alignment structures.
 - Assembly of micro-optics and optoelectronics.
 - Technology demonstrator for 4x10 Gbps optical interconnects on a PWB



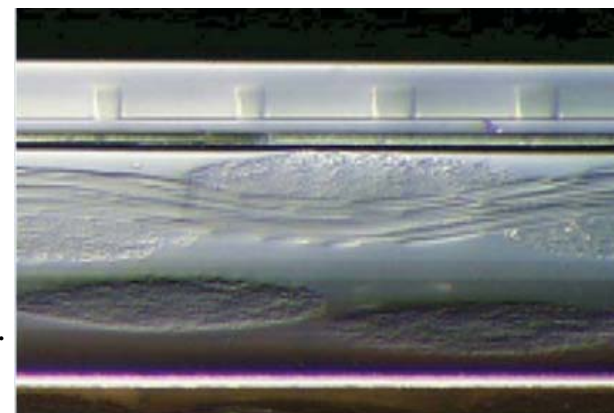
THE DEMONSTRATOR



The demonstrator: 4x10Gbps Receiver and transmitter modules (blue) are connected by 4 optical lines on top of a FR-4 circuit board. The demonstrator was assembled in a standard electronics production plant.

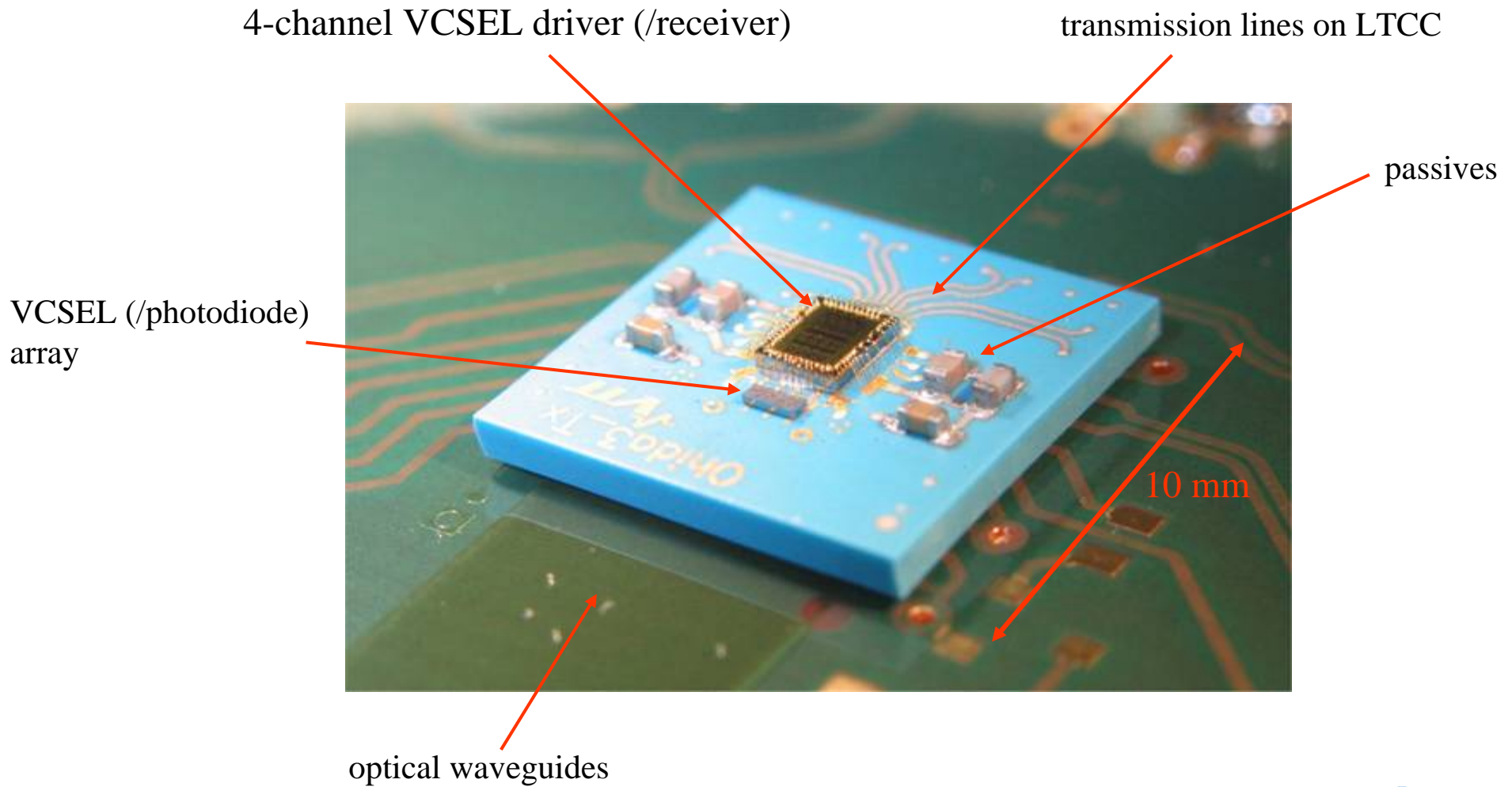


Optical coupling + integration on LTCC module



PCB cross-section, four 50/75 um optical channels visible

Tx/Rx MODULE OF OHIDA DEMO



RESULTS

- For comparison, 25Gbps electrical transmission using equalization and duobinary encoding has been reported over 60cm of FR-4 (Adamiecki et al., Electron.Letters v.41, no.14, Jul. 2005)
- Total optical path loss of the demonstrator 19dB, measured propagation loss 0.15dB/cm for acrylate waveguides, 0.55dB/cm for SU8 guides, mirror losses <2.5dB
- Alignment tolerances:
 - +-40..60um for the LTCC module (-1dB optical loss)
 - +-5um for the microlenses, VCSEL's and detectors
 - Special alignment schemes were developed
- Bit rate density 42Gbps/mm²
- Power/Bit rate (transmitter and receiver combined) 30mW/Gbps

DISCUSSION

- Electric transmission on FR-4 has been going out of fashion for a long time...
- Optoelectronics is straightforward approximately up to 10..12Gbps/channel, 20..45Gbps range demands special components (optical modulators, InP) etc.
- Alignment of the optics is still somewhat critical in standard electronics production environments.
- Power dissipation in optical data transmission is now comparable or lower to the electric transmission
- Virtually no cross-talk in optical transmission
- Propagation losses are the main constraint for transmission distances on PCB (the jitter is negligible)
- No “optical pins” yet, electronic and optics must be integrated on a module
- Few or none readily space qualified components available