


Silicon Photonic Data Transmission for Detector Instrumentation

Institute for Data Processing and Electronics



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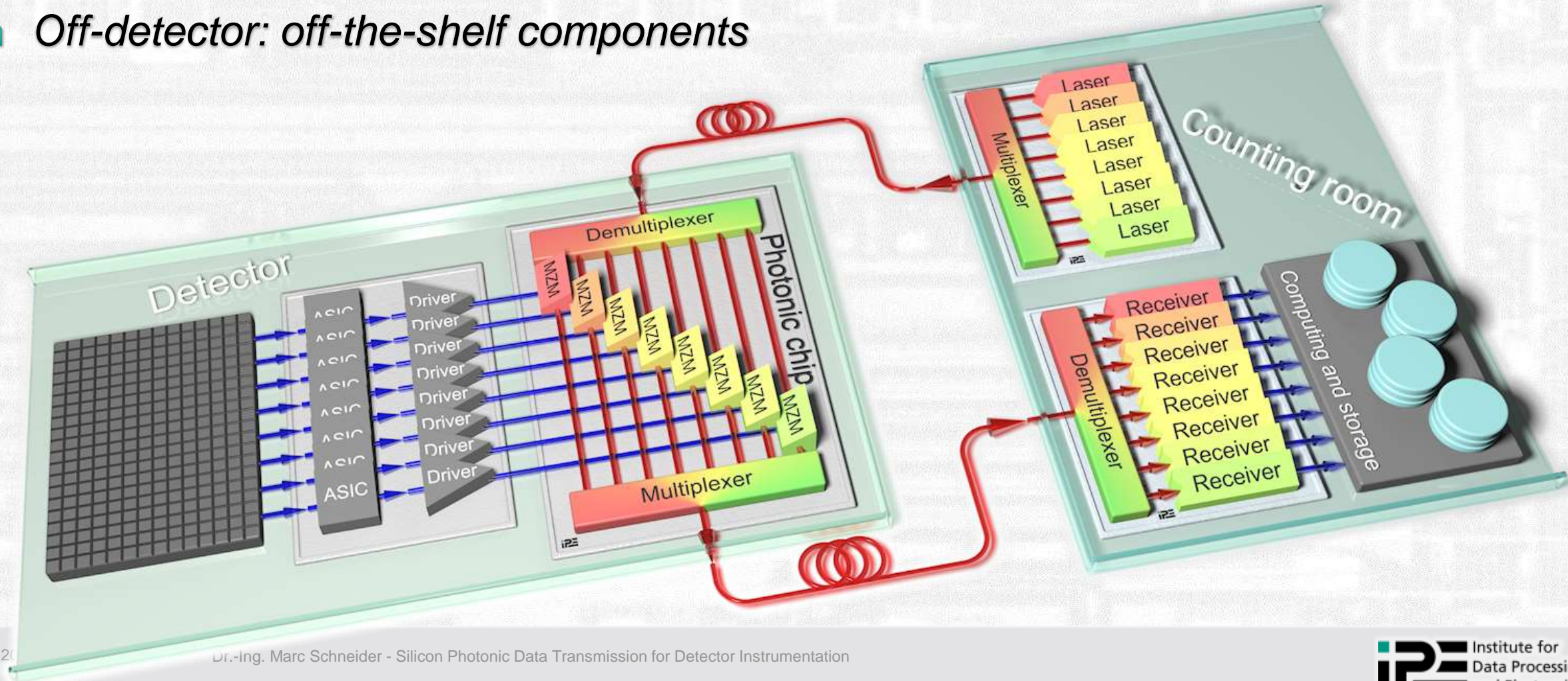
- *Optical data transmission technology is a key enabler of modern HEP detectors*
 - *High bandwidth (multi-Gb/s per link)*
 - *Low mass, low power*
 - *Immunity to electromagnetic interference, electric insulation*
 - *Sufficient radiation tolerance*
- *At the LHC, the general purpose experiments have 50-100k links each*
- *Based on telecom technologies in simple networks*
 - *LHC Phase I upgrades based on datacom technology*

- *Use concepts from telecom industry*
 - *Higher data rate per channel (25, 40, ... Gb/s)*
 - *Higher modulation formats (>2-ASK, PSK, QAM, ...)*
 - *More channels per fiber: wavelength division multiplexing (WDM)*
- *Monolithic integration of photonic components with drivers, ROCs, sensors*
- *Lower power*
- *Challenges in HEP*
 - *Low temperature*
 - *Strong magnetic fields*
 - *Radiation*

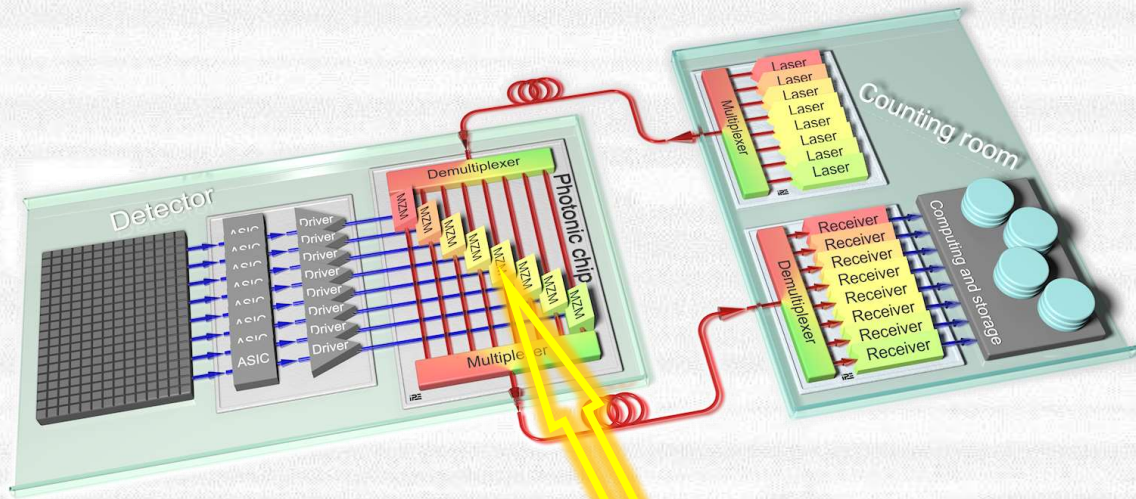
Optical Data Transmission System

WDM system

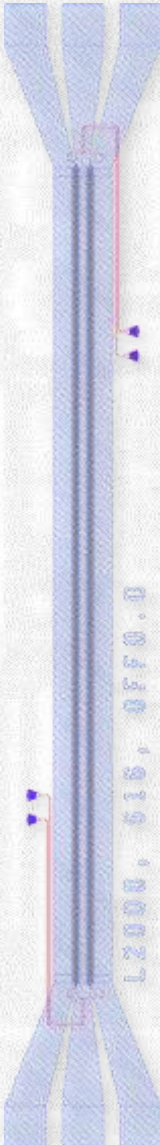
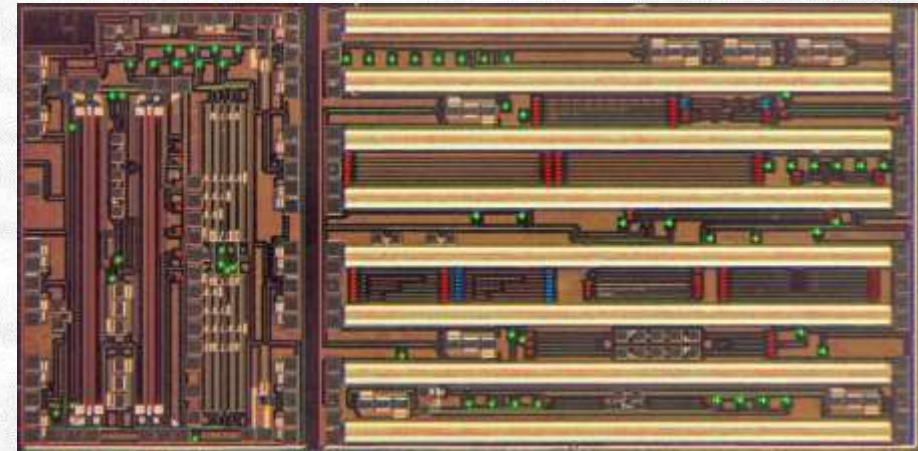
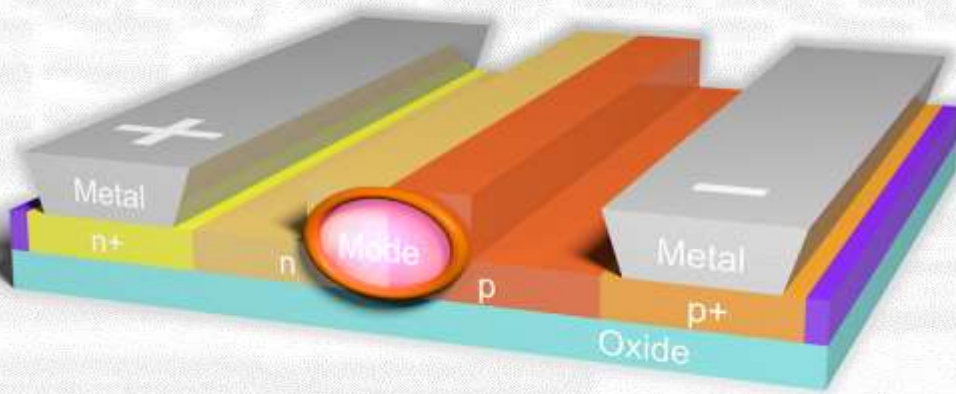
- *On-detector: custom silicon photonic integrated circuit*
- *Off-detector: off-the-shelf components*



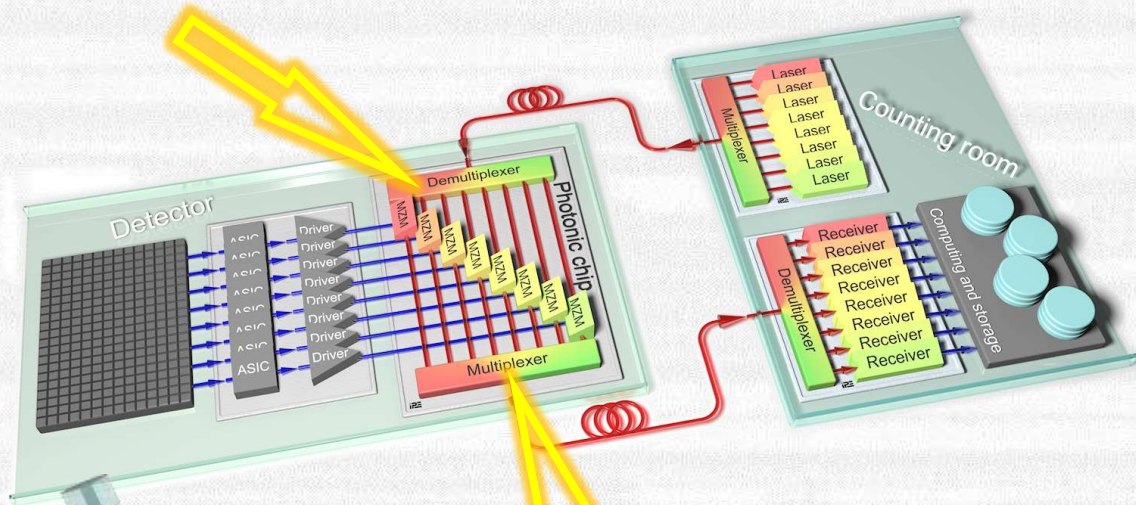
pn-Modulators



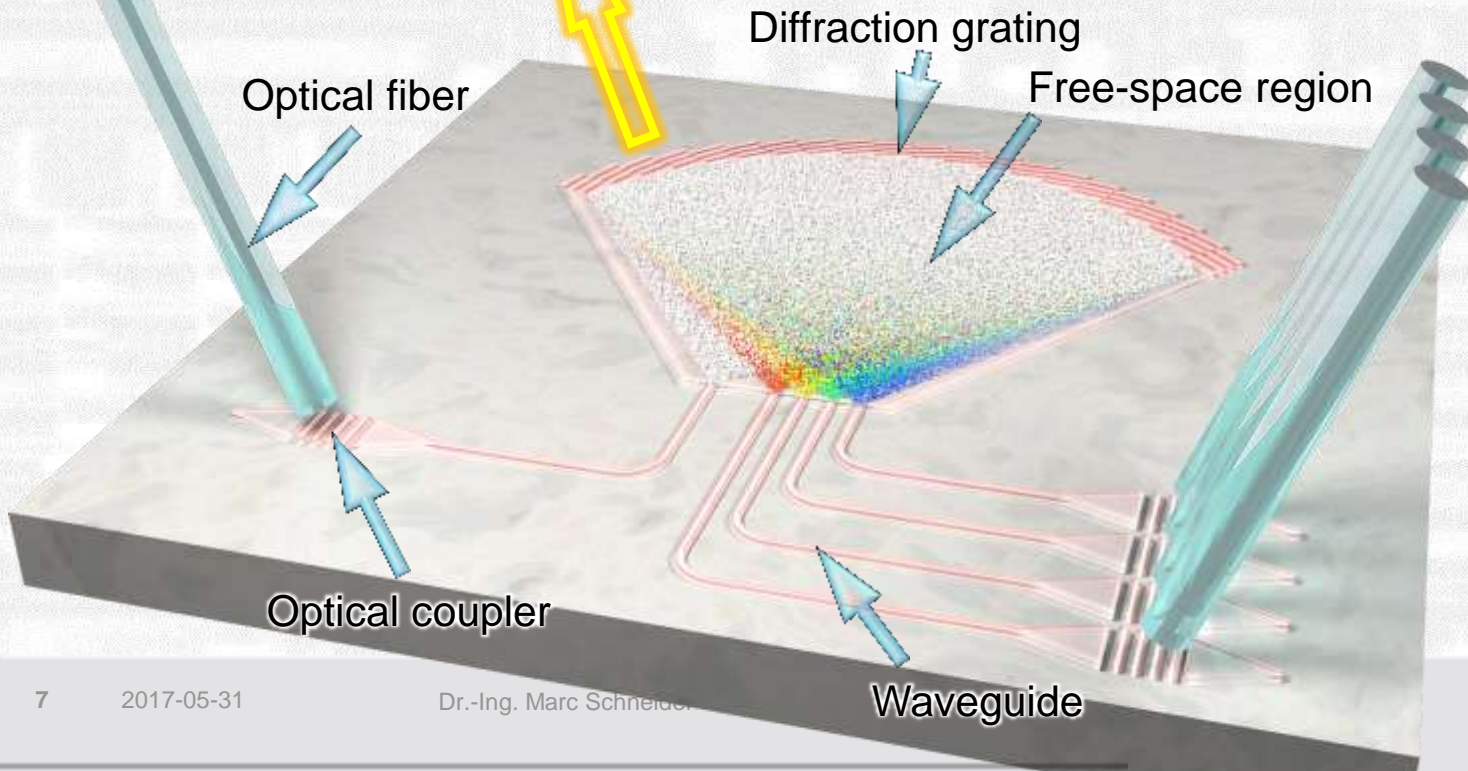
- *Optical mode concentrated around pn-junction*
- *Long term stable*
- *First devices available*
- *Concept studies on radiation hard devices*



Wavelength Division Multiplexers

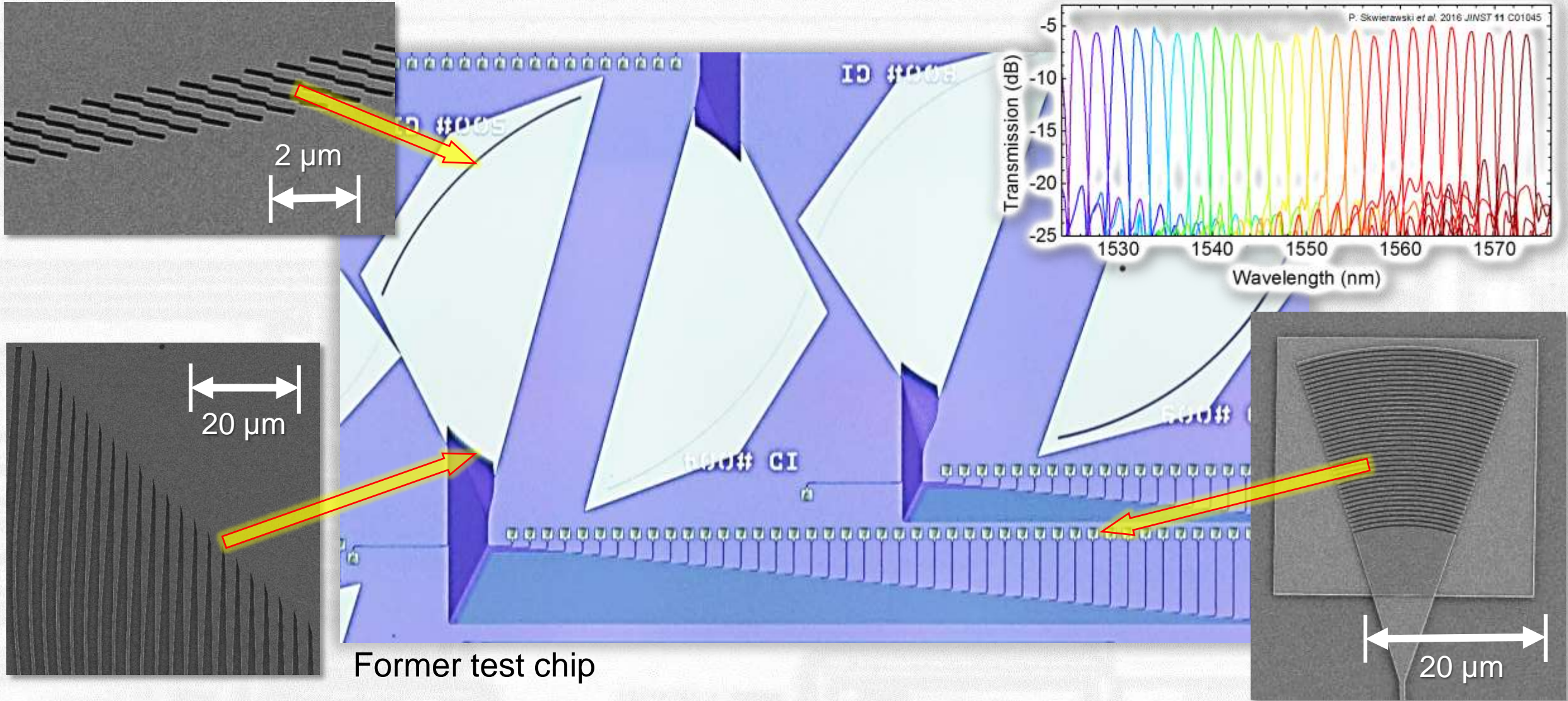


- *Planar Concave Gratings (PCG):
Echelle gratings*
- *Compact*
- *Insensitive to edge roughness*

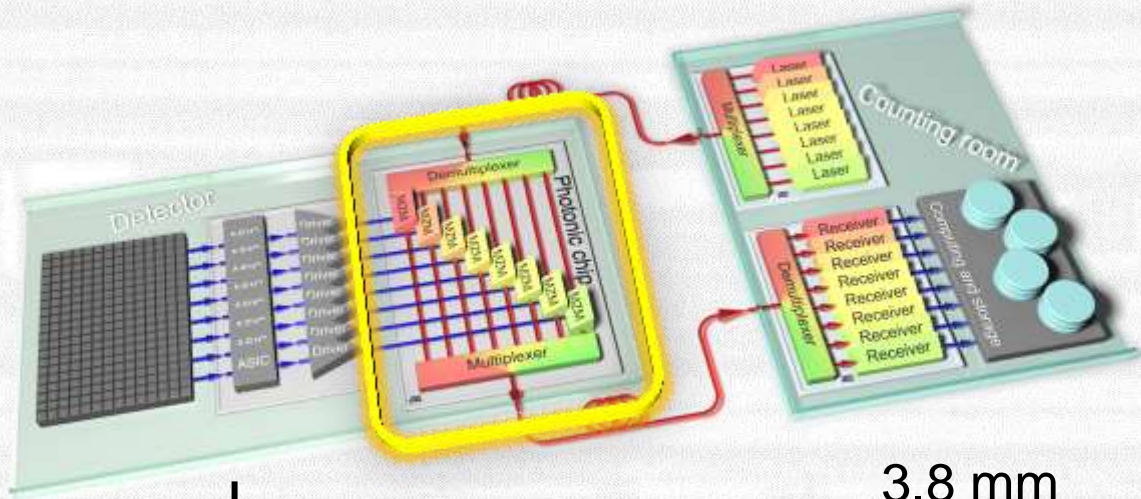


- *Multi- λ input signal diverges
in 2D-free-space region*
- *Concave grating reflects
and focuses optical radiation
depending on wavelength*

Wavelength Division Multiplexers



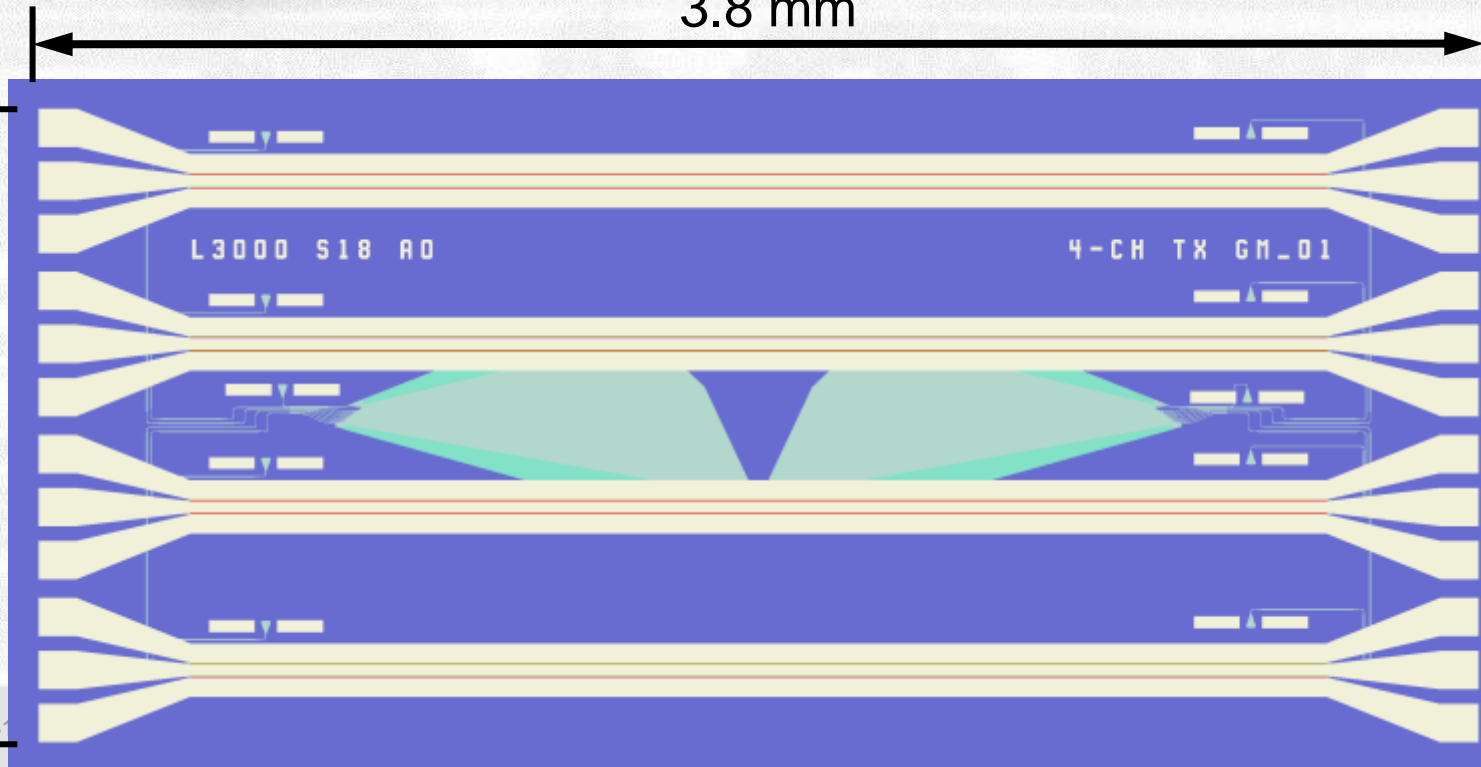
Integrated 4-Channel WDM-System Chip



- *New chip submitted*
- *4-channel WDM system*
- *Channels fit into ITU-T G.694.1 DWDM channel grid*

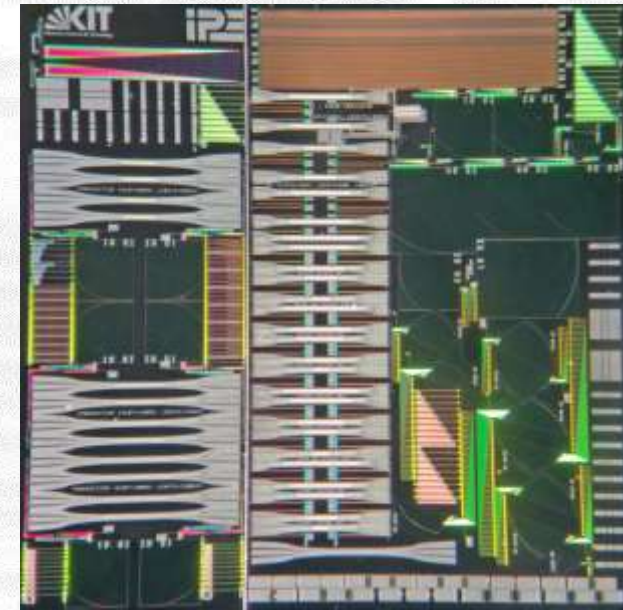
3.8 mm

1.7 mm

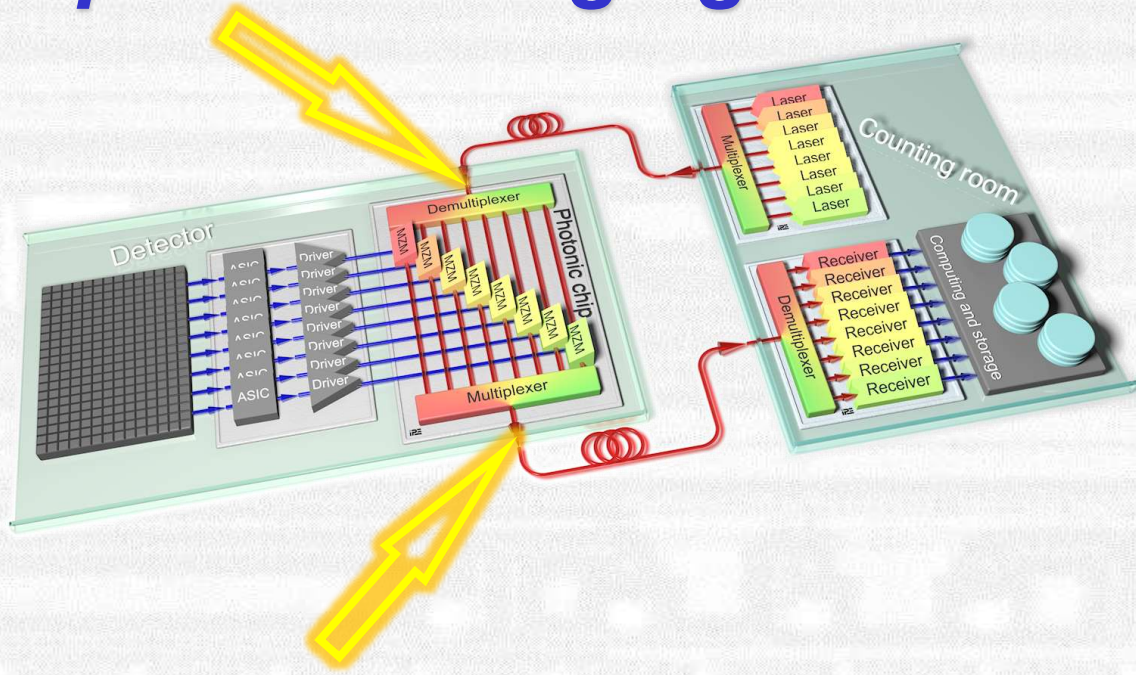


New design

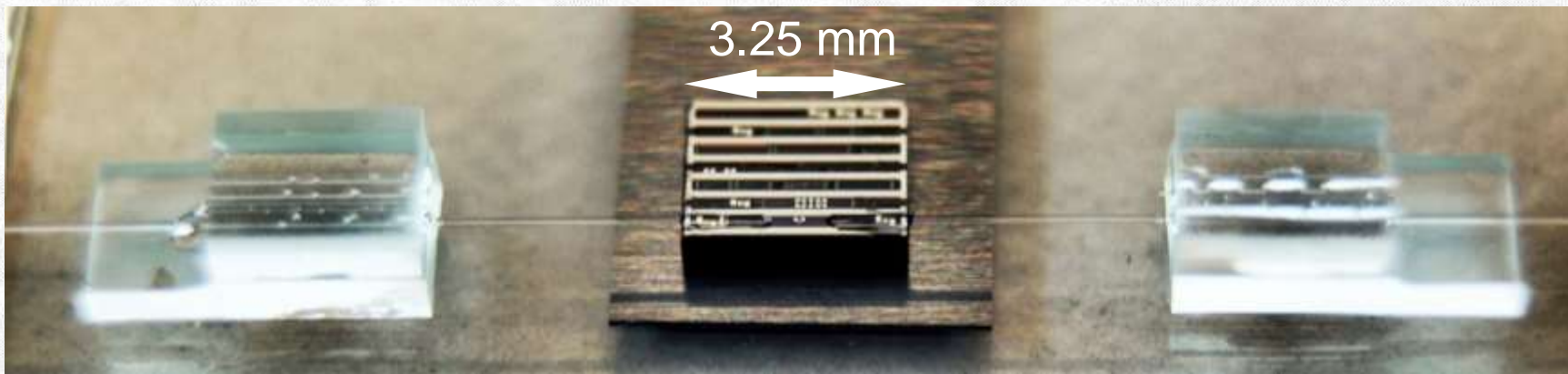
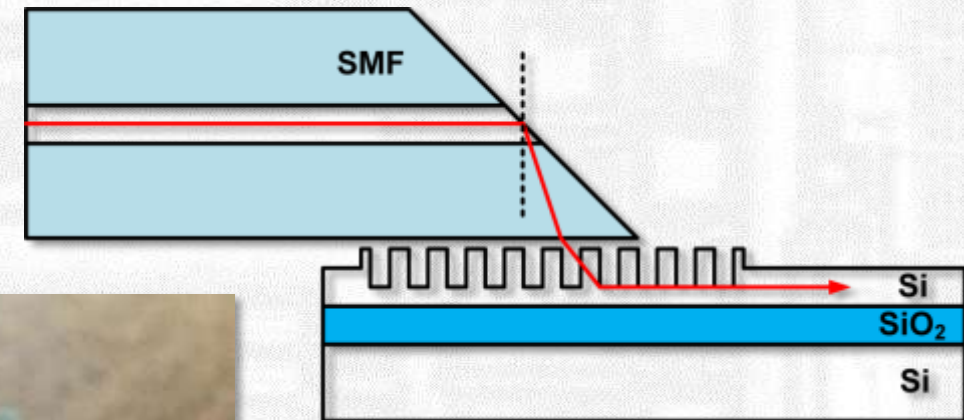
Former test chip

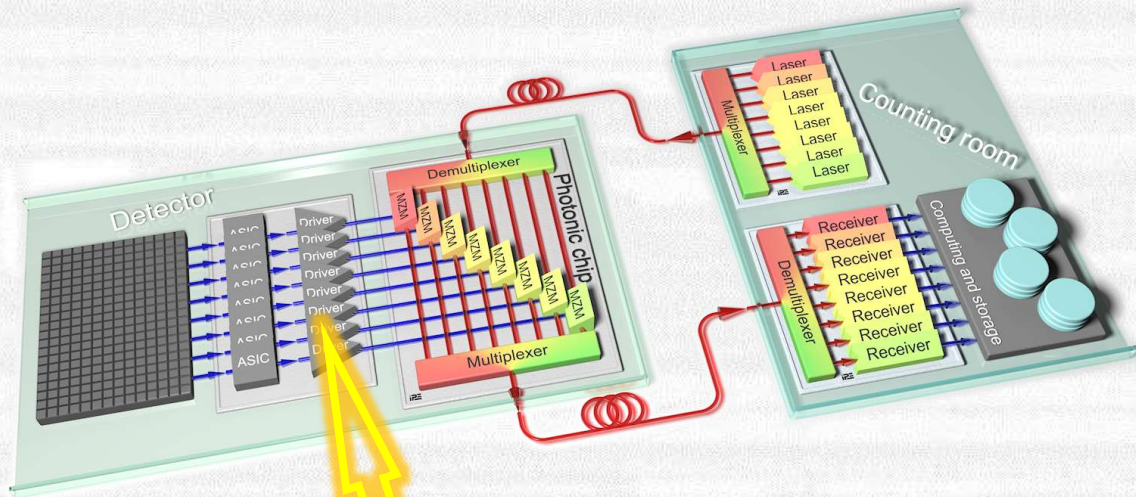


Optical Packaging

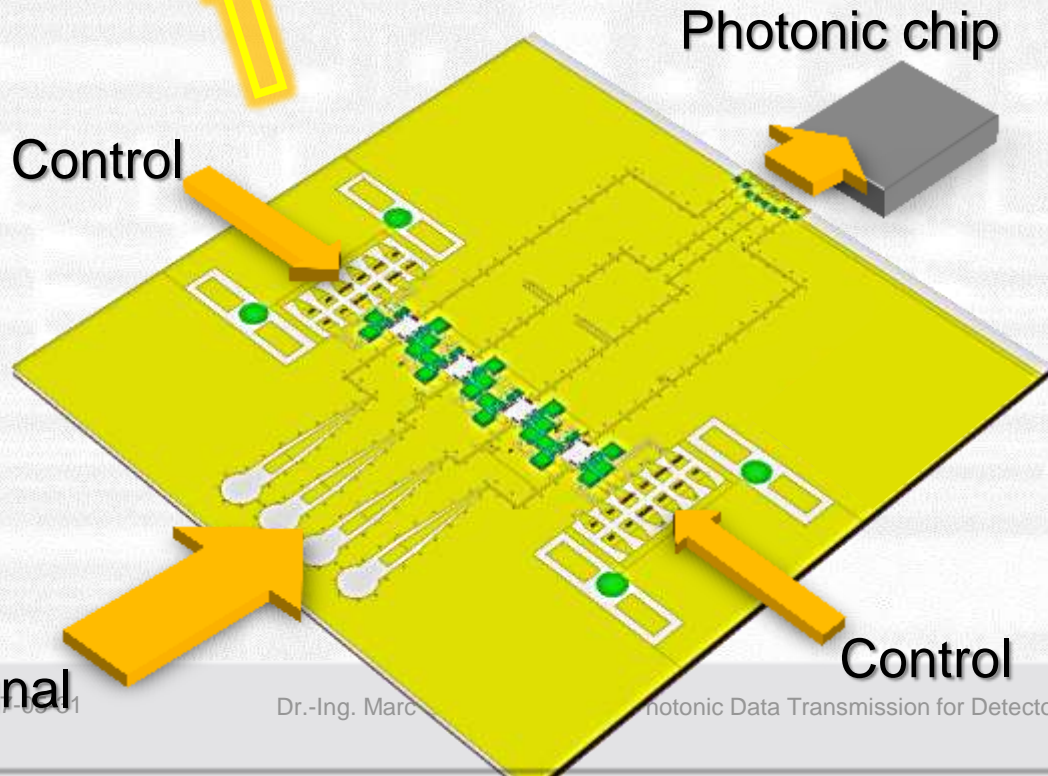


- *Fiber-chip-coupling using angle-polished fibers*
- *Space-saving design, no power penalty, very good long term stability*





- Design and layout of driver board using commercial driver ICs
- Plan: custom ASIC to
 - Increase power efficiency
 - Reduce space requirements
 - Achieve radiation hardness



Silicon Photonics for HEP

- *Just starting a fledgling collaboration*
 - *Bristol, CERN, INFN Pisa, KIT*
- *Effort to be split into work packages*
 - *Link requirements & system design*
 - *Radiation testing & device modeling*
 - *Photonic component & chip design*
 - *Electronic chip design (modulator driver & TIA)*
 - *Packaging and testing*



Thank you!

Q&A

Who How Questions How Why How When What Who Who Where Why Answers Who How much Who

