ioNext, a glass-based platform complementing Silicon Photonics

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Adrien BILLAT – Sales and Application Manager

October 5th, 2020

teem PHOTONICS | A little piece of glass can change everything

MASSTART

Teem Photonics – Corporate background

Established in 1998

- Spin-off from Schneider Electric
- Enters the telecommunication market for FTTH applications
- Strong R&D team, several patents

1998 – Pioneer in erbium-doped waveguide amplifiers

2000 – Introduction of glass-based components and sub-systems for telrcommunications

2005 – Acquisition of the Q–switch microchip laser portfolio from Lumentum

2012 – 10,000 lasers shipped worldwide

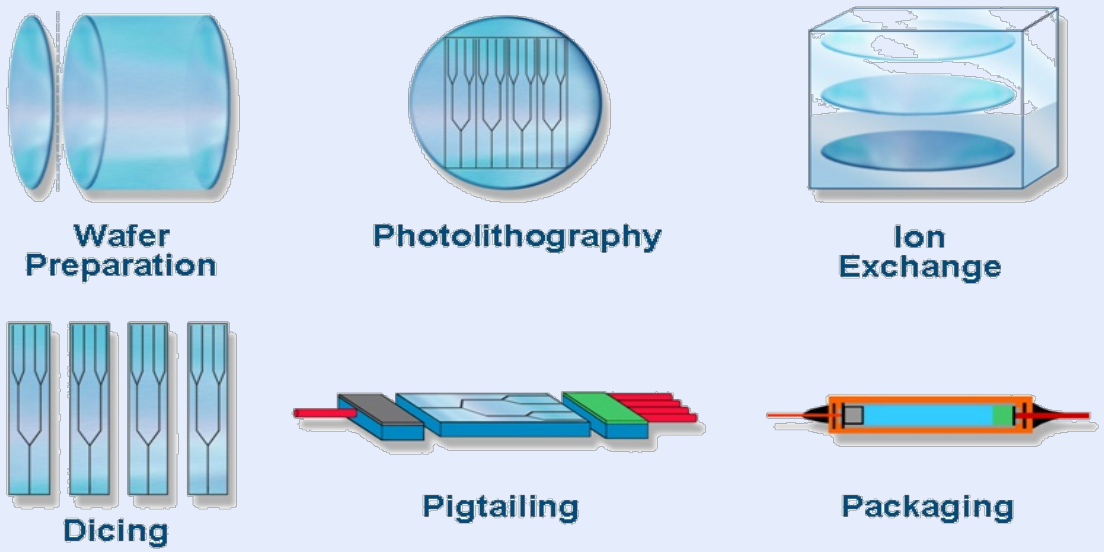
2016 – Introduction of WAFT – interposers for SiPh coupling

2018 – ioNext product line

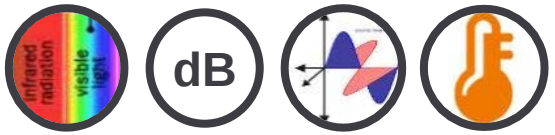
2020 – First PDK release

ioNext, a unique photonics process on glass

ioNext Process flow



Value proposal

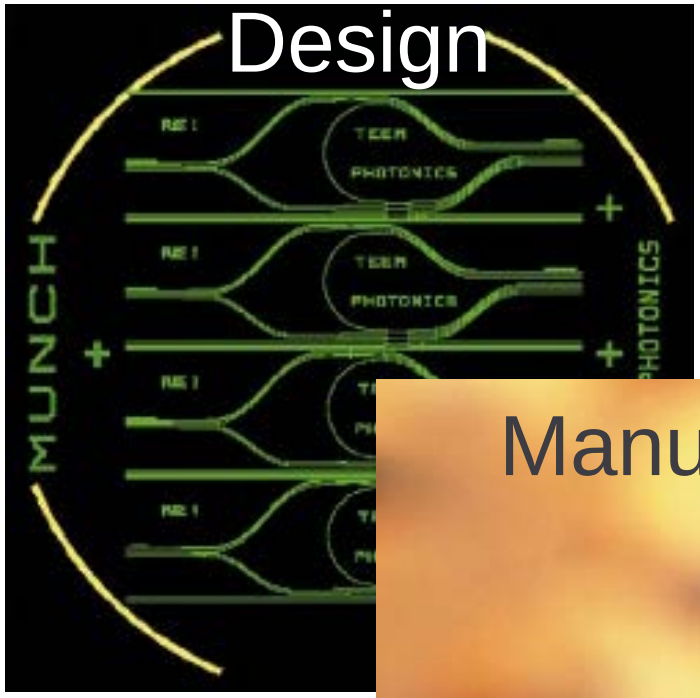


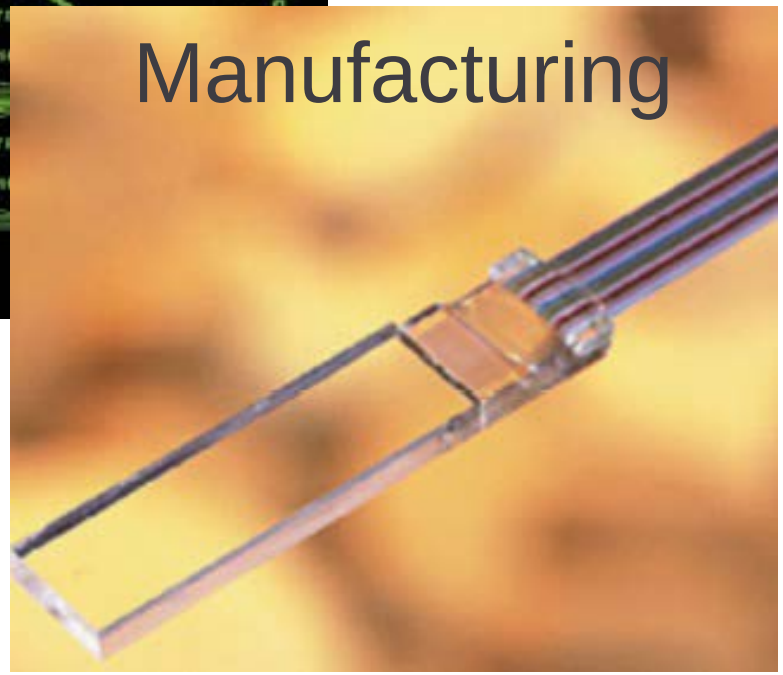
- Glass technology
  - Large optical bandwidth: 400 – 2000 nm
  - Ultra-low propagation loss: 0.05 – 0.12 dB/cm
  - Low PDL: < 0.1dB
  - Low temperature dependence: 0.01 nm/K

- ioNext specific
  - Low fiber coupling loss : < 0.2dB
  - Compactness : radius of curvature 800µm
  - 2.5D waveguide engineering

ioNext, a complete photonics platform

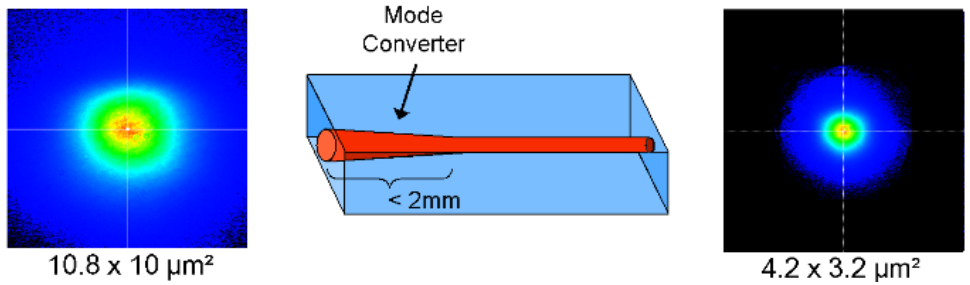
- Splitters 1xN (up to 512)
- Taps
- Couplers
- Taper/Mode converters
- MUX/DEMUX
- Interferometers (MZ, MMI, Michelson)
- Waveguide crossing



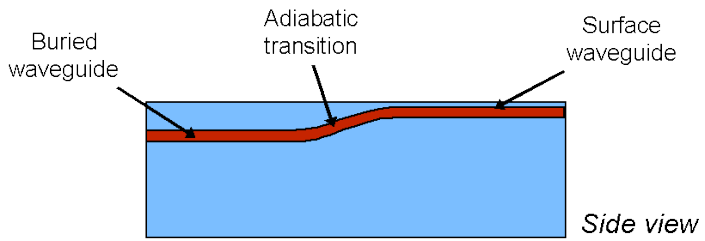


2.5D building blocks

Spot size converter



Depth modulation

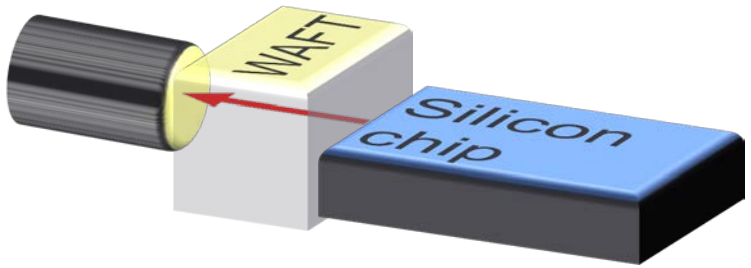


Extended optical library

- Spot size converter
- Surface interaction

WAFT: three coupling solutions

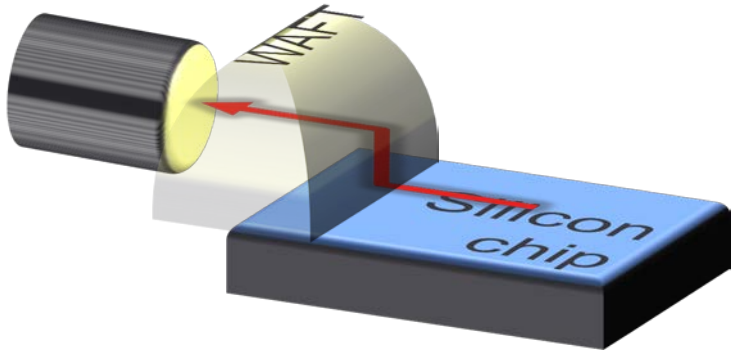
Edge coupling



Low loss solution
Compatible with WDM

Wafer level incompatible
Alignment accuracy

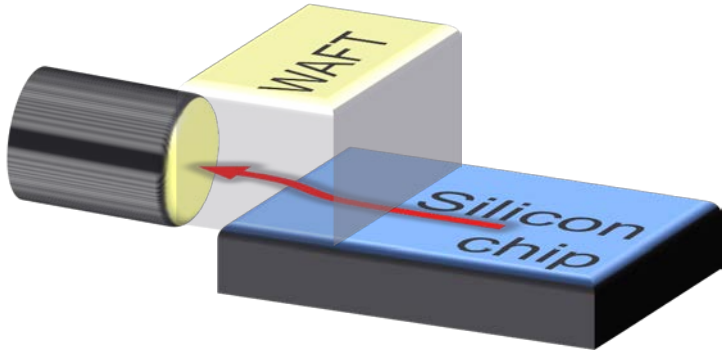
Top coupling



Compatible with grating couplers
Wafer level compatibility

Grating coupler loss
WDM-limited

Evanescent coupling

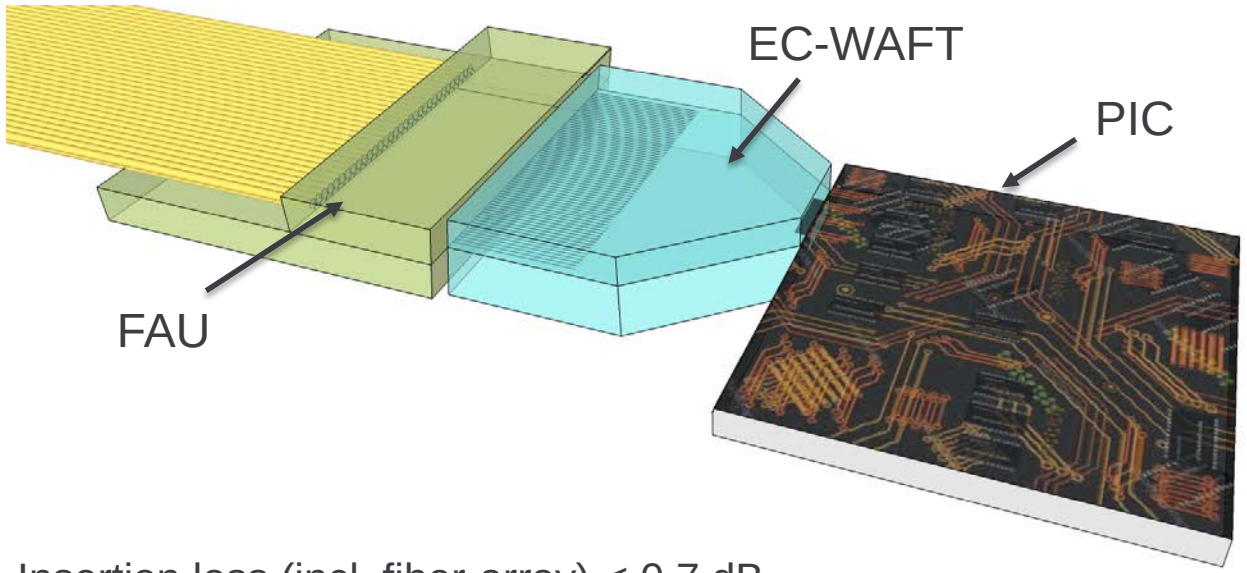


Low loss solution
Compatible with WDM
Alignment tolerant
Wafer level compatibility

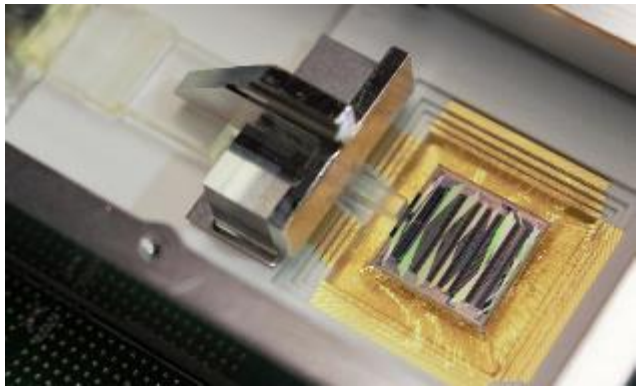
BEOL constraint

EC-WAFT series for facet coupling

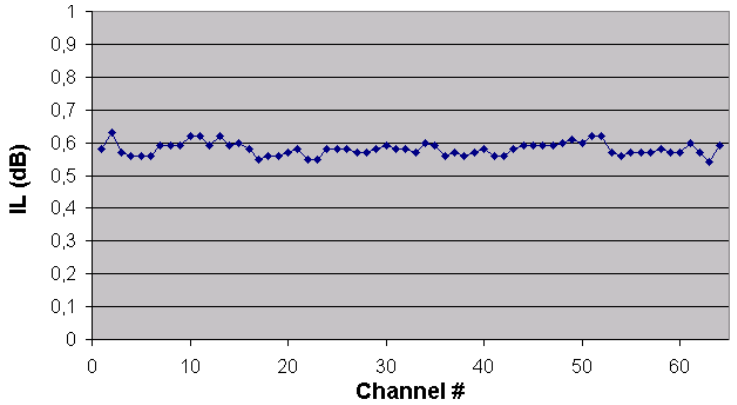
MFD matching to PIC edge couplers



Insertion loss (incl. fiber-array) < 0.7 dB
PIC side MFD 4x3 µm (1/e²)
PIC-side pitch >25 µm
SM and PM fiber-compatible



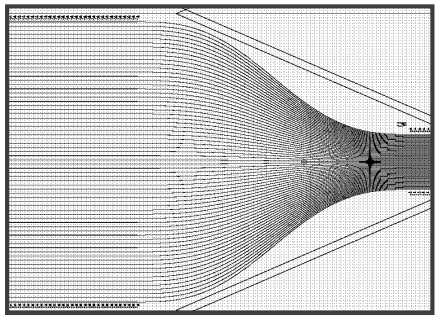
High channel count uniformity



Large pitch adaptation

64 channels

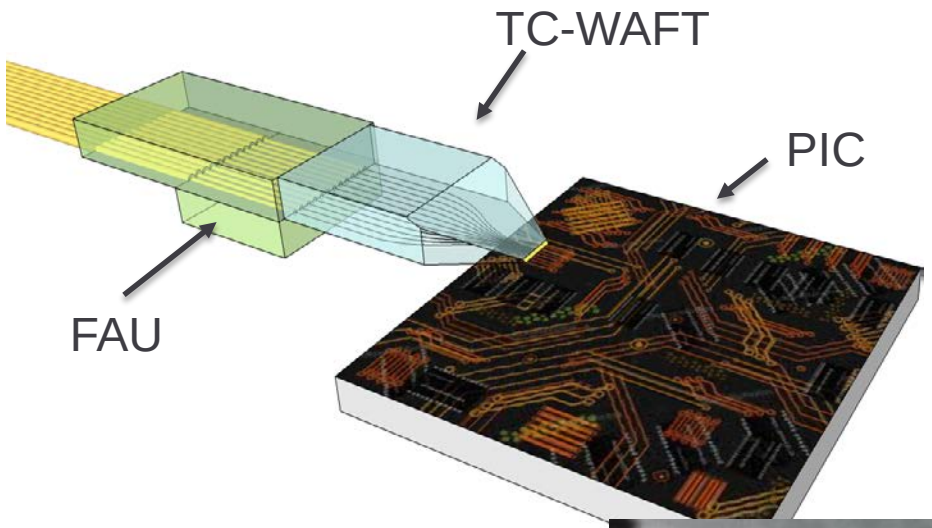
127 µm

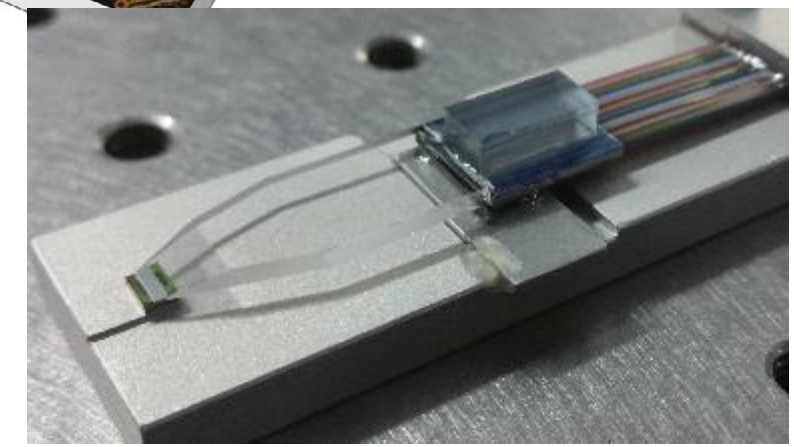


25 µm

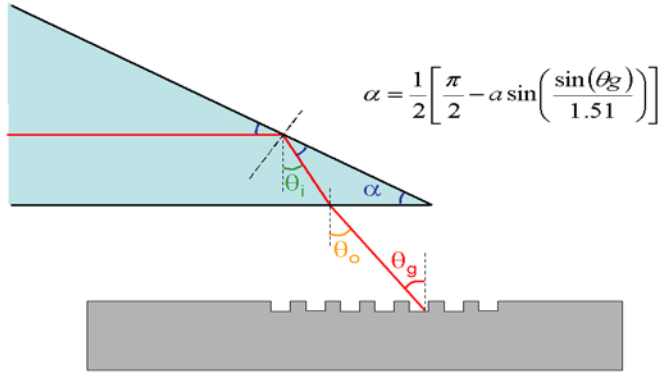
TC-WAFT series for top coupling

Low profile solution for grating couplers

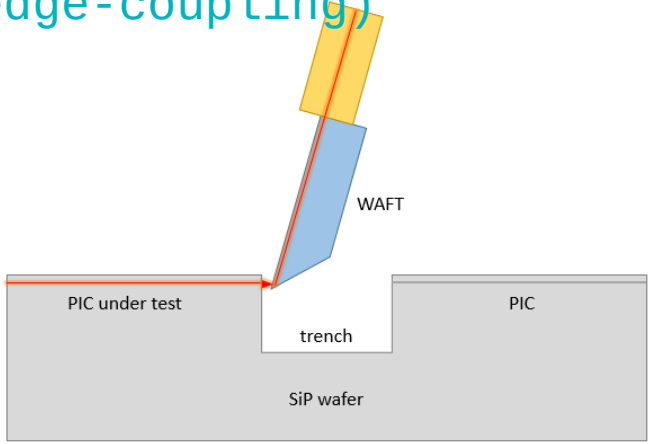




- Packaging



- Wafer-level PIC testing (edge-coupling)



EV-WAFT series for evanescent coupling

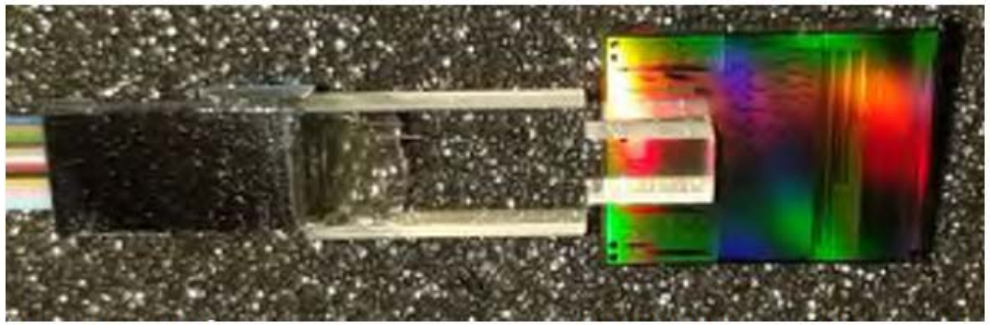
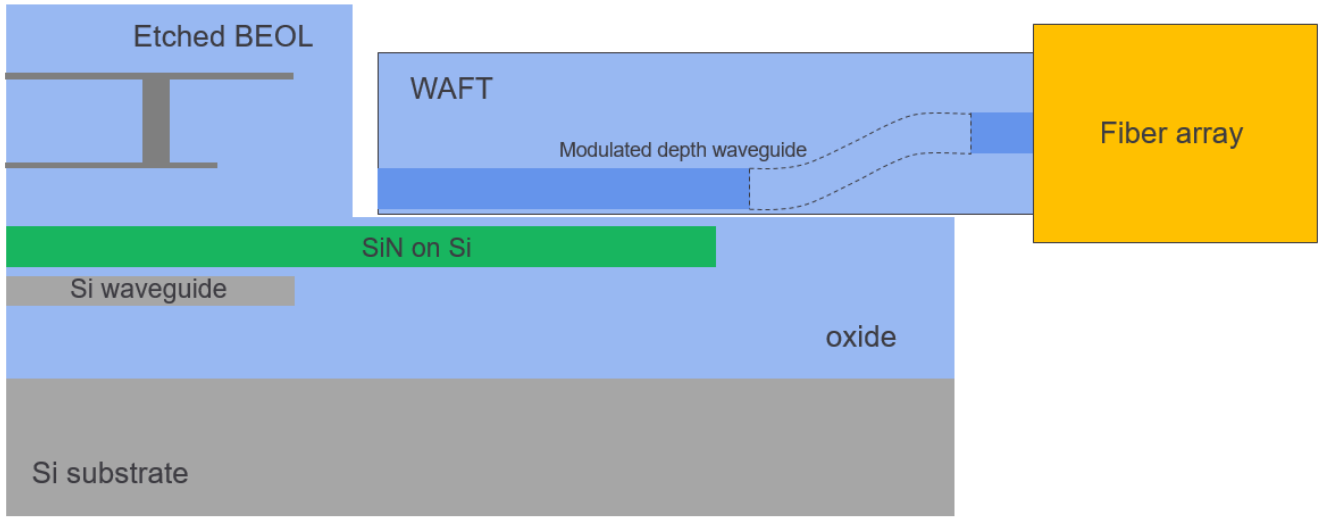


Fig 15 Glass interposer assembled Silicon Photonics Device with Cavity Etched BEOL

Evanescent coupling to SiN-on-Si waveguide layer:

- **Broadband and single-mode** in O-band and C-band
- **Low loss** (< 1.5 dB from fiber to SiN)
- **Low PDL** (< 0.2 dB)
- **Alignment tolerant**



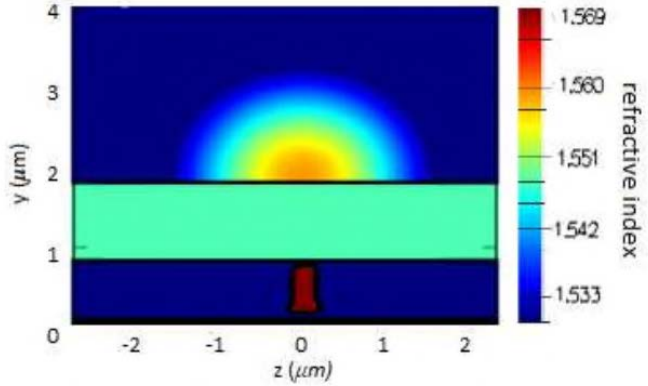
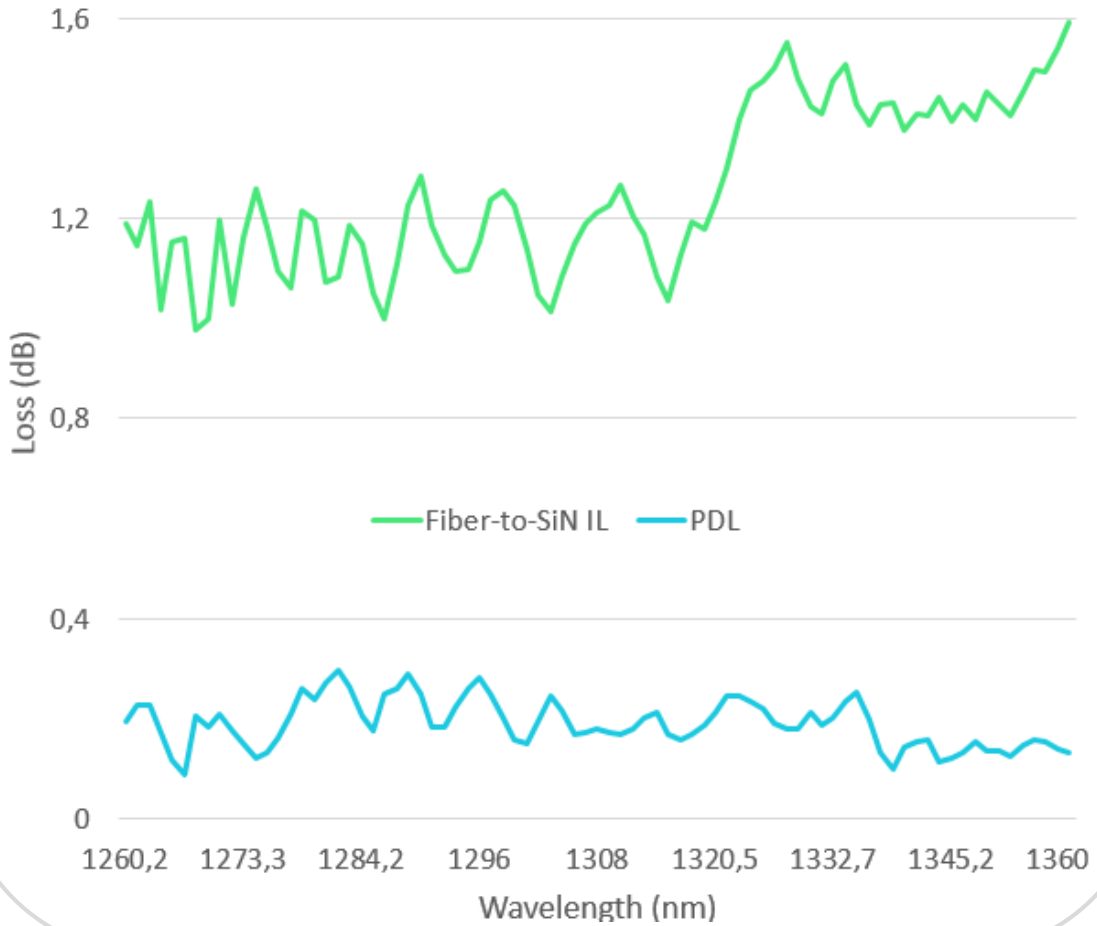


Fig. 11 Refractive index profile of the transversal cross-section of an Ion-Exhange interposer with mask width 1.7μm, on top of the glue layer (light green) and the SiN waveguide (red)

From Binda et al, EMPC 2019

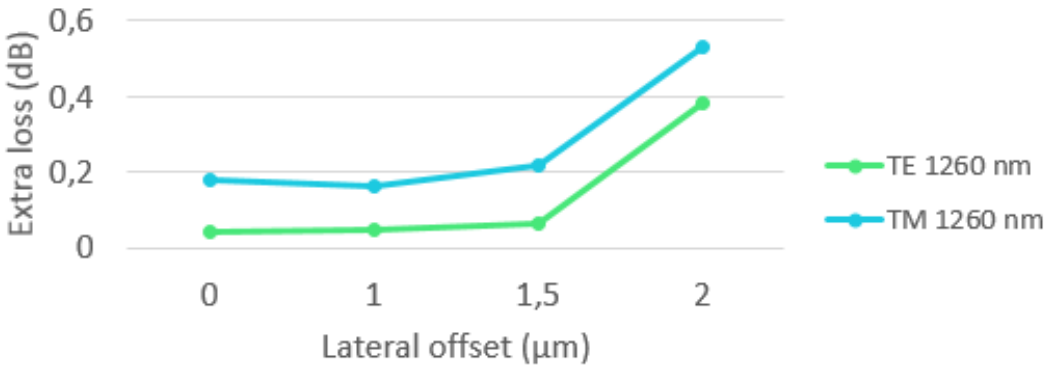
EV-WAFT: a broadband and alignment-tolerant solution

Minimum Insertion Loss and Polarization Dependent Loss over a broad spectral band

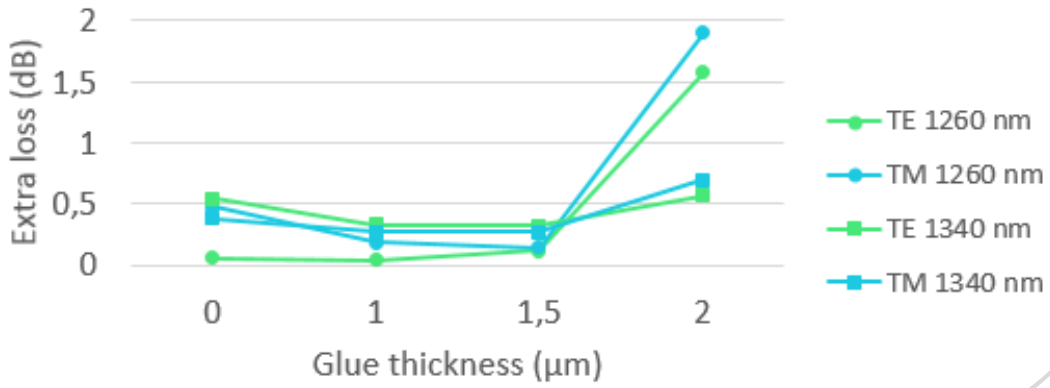


An alignment-tolerant solution:

-tolerant to lateral offset

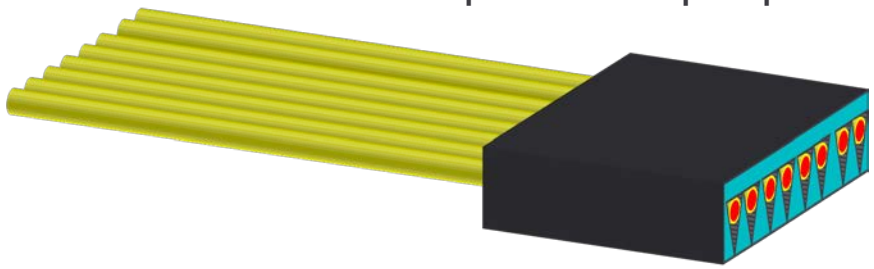


-tolerant to proximity error

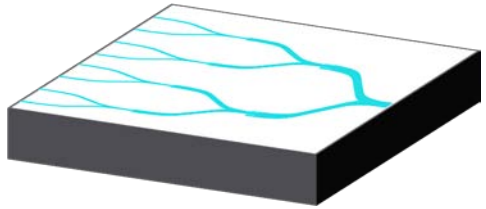


Fiber to chip assembly services

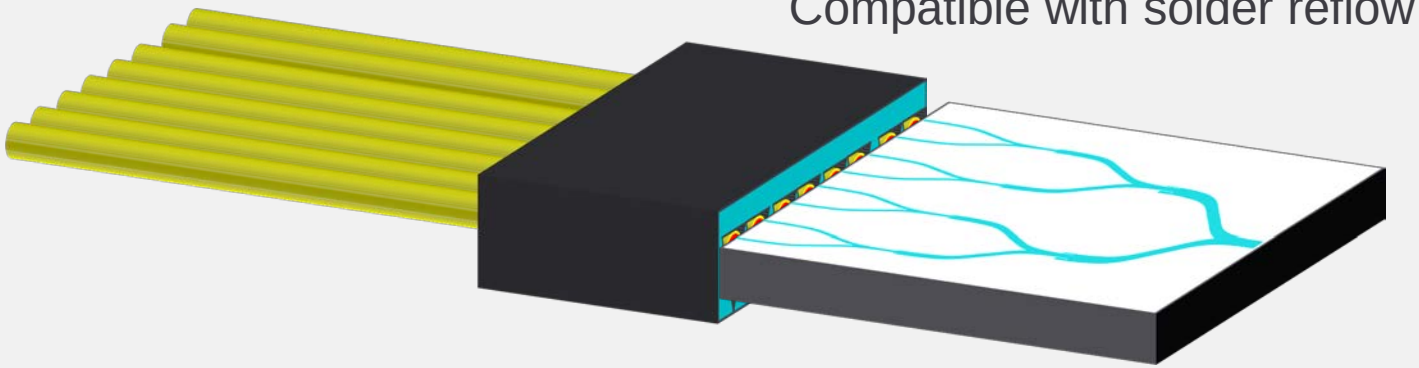
Fiber Array (FA)
SMF or PM fiber
250µm or 127µm pitch



ioNext chip
Polarization maintaining waveguides
250µm or 127µm pitch



Fiber to chip assembly
Up to 64 fibers per FA
Insertion loss uniformity <0.2dB
Compatible with solder reflow



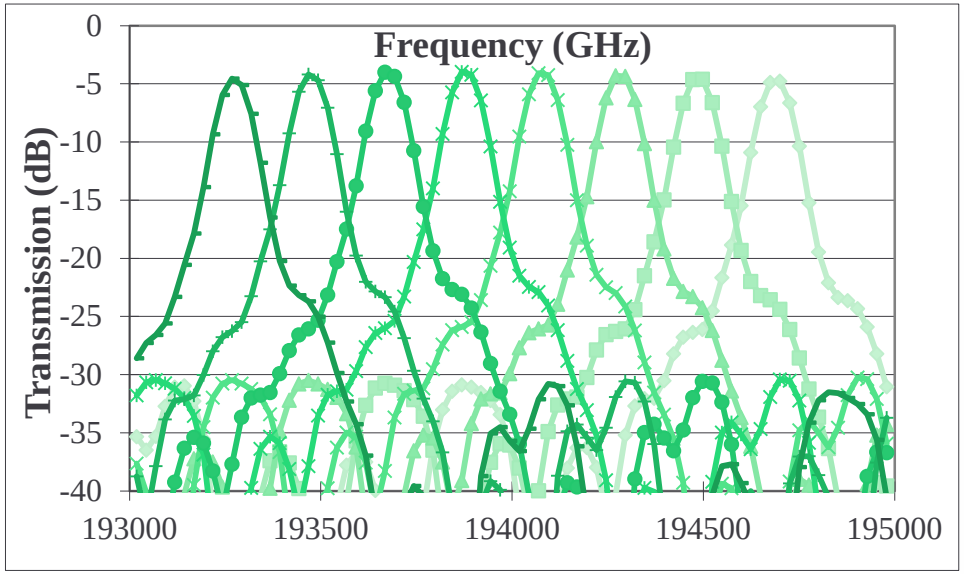
ioNext building blocks

Building block	Key spec	VIS	NIR
Straight waveguide	<0.15 dB/cm, PM, very low PDL	🟢	🟢
S-bend	No additional loss, no PDL	🟢	🟢
Arc circle	No additional loss, no PDL	20 mm	0.8 mm
Spot Size Converter	10µm MFD to 4x3µm MFD	🔴	🟢
Symetrical Y junction	0.1 dB extra loss	🟢	🟢
Asymetrical Y junction	Ratio on request, 0.1 dB extra loss	🟡	🟢
Splitter	1x2 → 1x512	🟢	🟢
Coupler 2x2	Ratio on request, 0.1 dB extra loss	🟡	🟢
Tap	5-95%, < 0.05dB extra loss	🟡	🟢
Slab structures	Negligible extra loss	🟢	🟢
Surface interacting waveguide	Localized for NIR, full chip for VIS	🟡	🟢
Waveguide crossing	Negligible loss and crosstalk	🟢	🟢

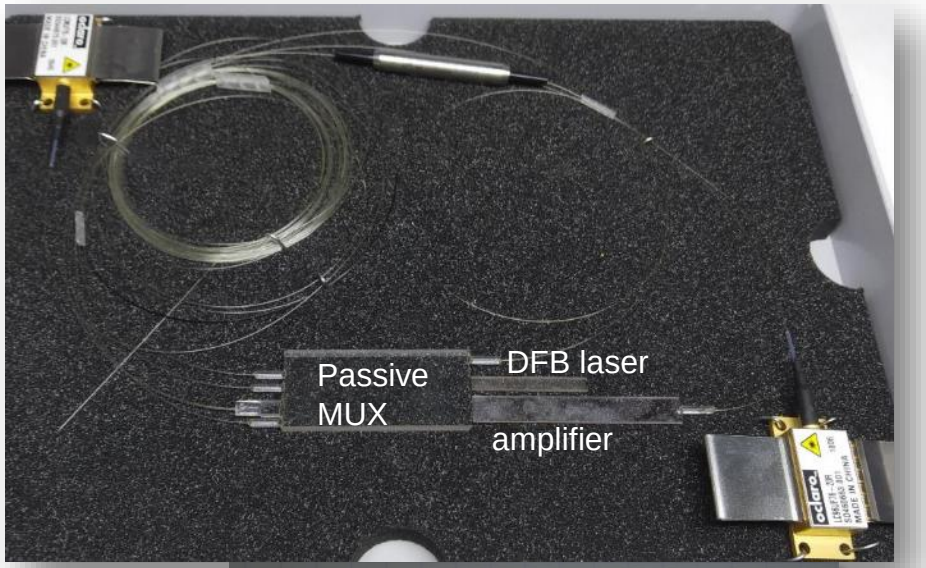
🔴 : not feasible 🟡 : under optimization 🟢 : available

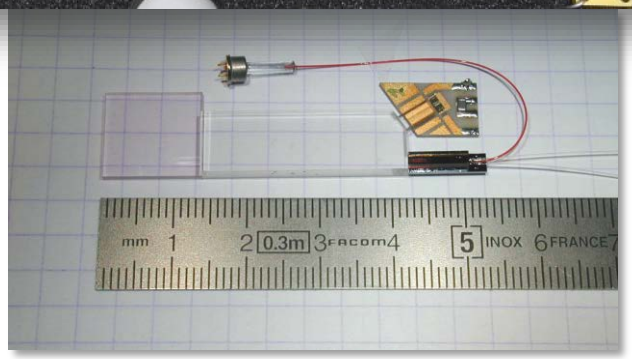
Advanced PICs and hybrid modules

- Er-doped lasers and amplifier modules
- E-O modulation
- AWGs
- …



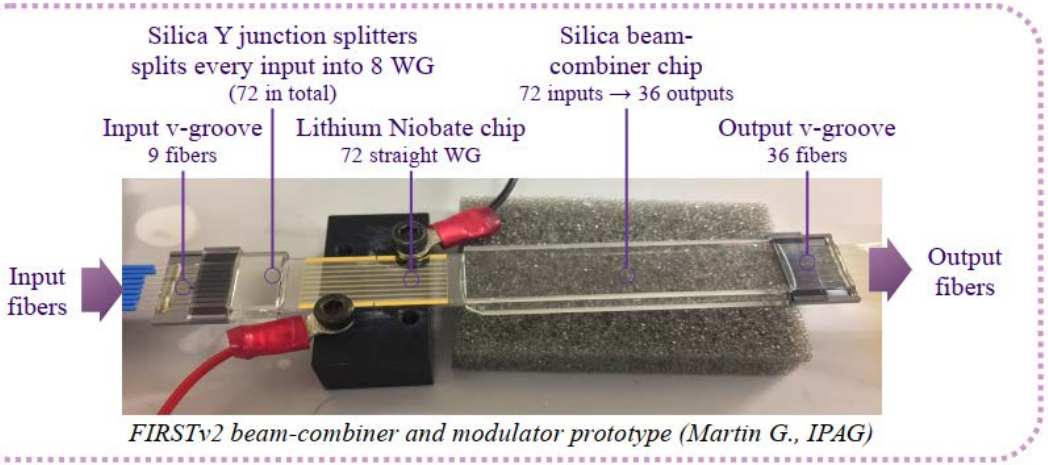
Amplified 1550nm laser





Integrated Er-waveguide amplifier

VIS interferometric combiner



FIRSTv2 beam-combiner and modulator prototype (Martin G., IPAG)

From E. Huby et al, 2019

Thank you for your attention

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CONSORTIUM

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