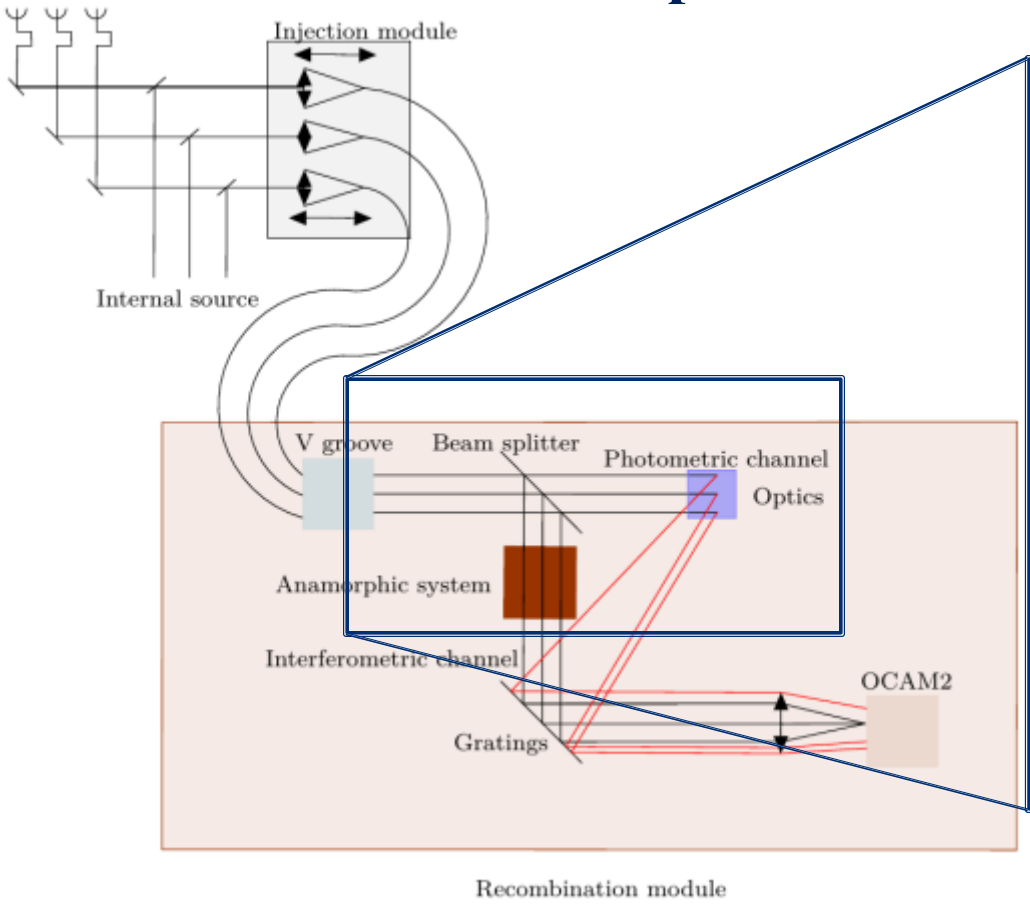
# First results on an integrated optics 3T multiaxial beam combiner in the visible

G. Martin (IPAG, Grenoble)

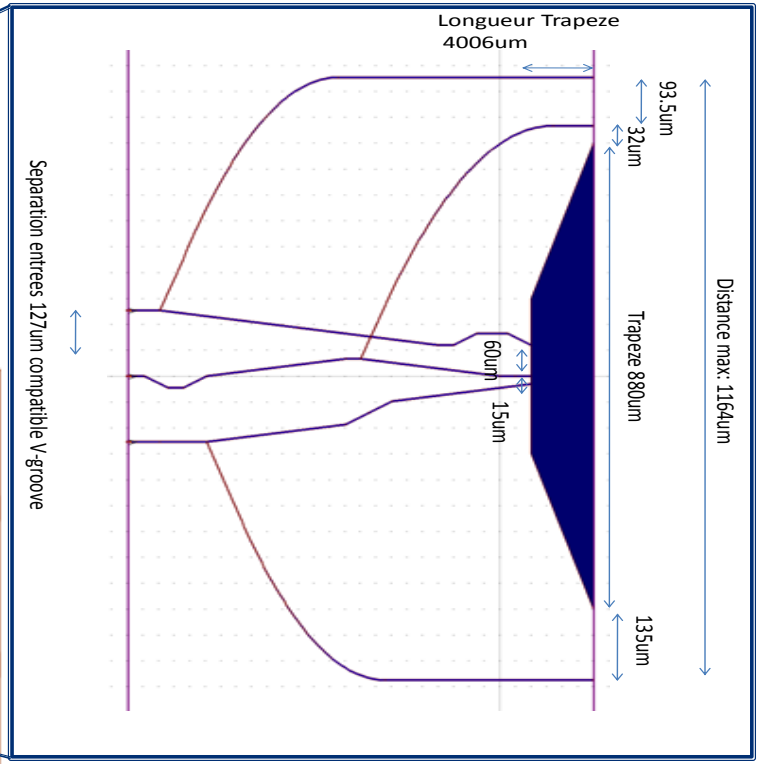
T. Pugnat, F. Hénault, L. Jocou, J.B. Le Bouquin, K. Perraut

# Integrated optics concept

## FRIEND concept

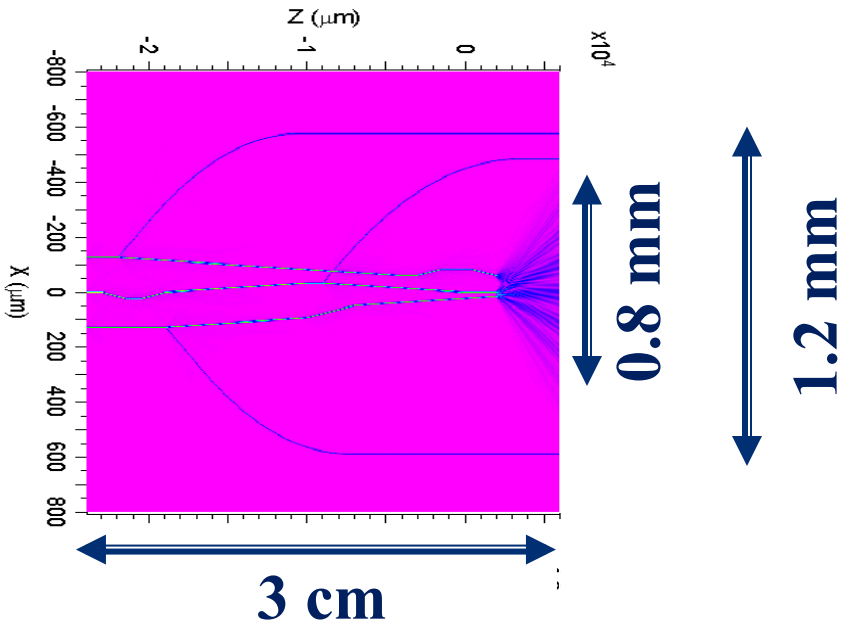


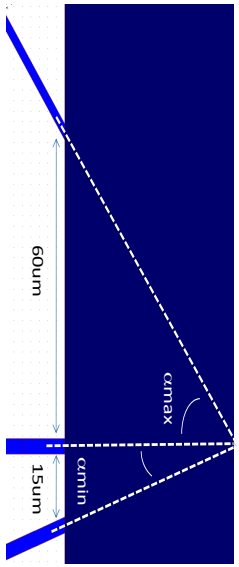

## Integrated optics chip



# Integrated optics concept

- Singlemode waveguides
- 3 photometric channels extracting 1/8 of the flux
- Overlapping of the signals in the multiaxial flat waveguide
- Non redundant angles: (0, $\alpha_{min}$, $\alpha_{max} = 4\alpha_{min}$)

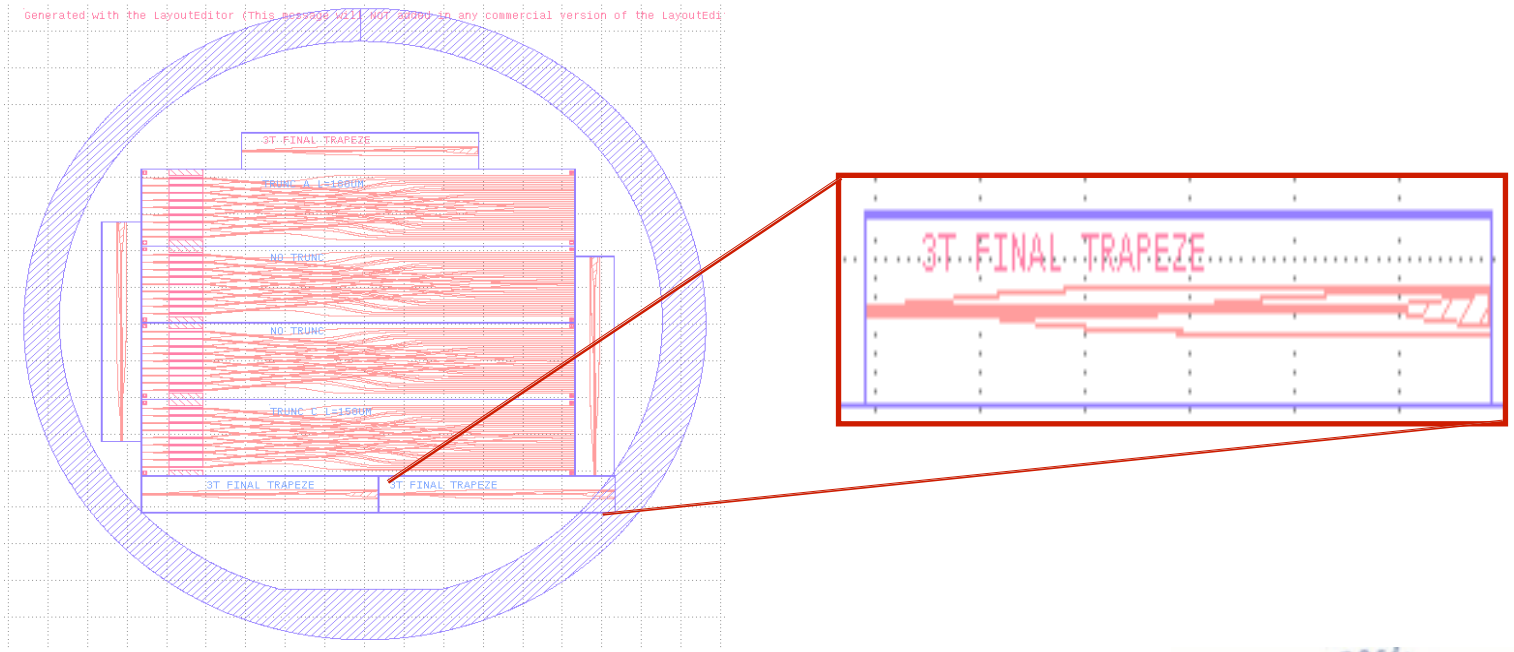



*Le Bouquin, PhD*

# Conception and manufacturing

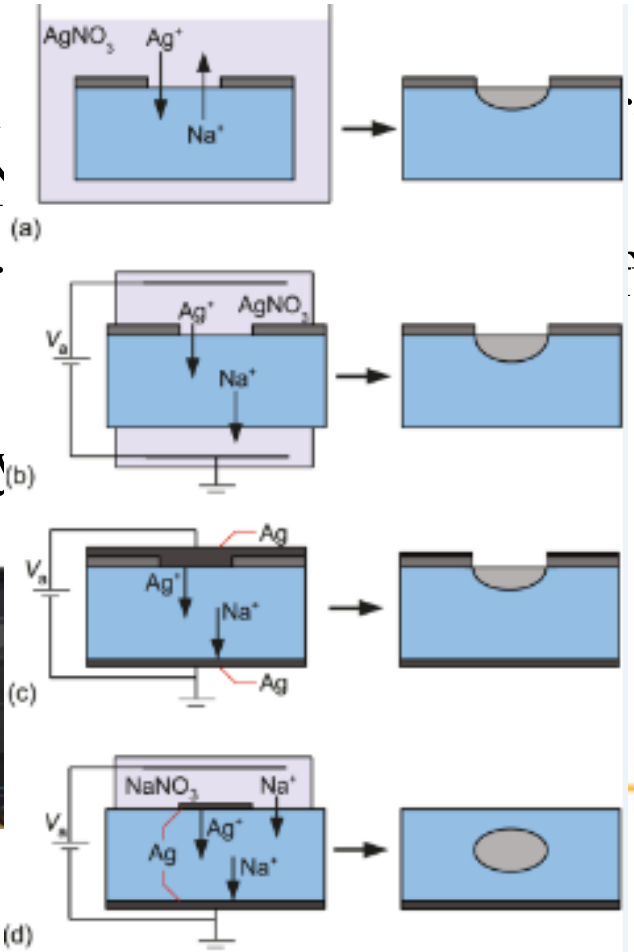
- Simulations and mask design at IPAG




- Manufacturing by the Teem Photonics company

# Teem Photonics technology

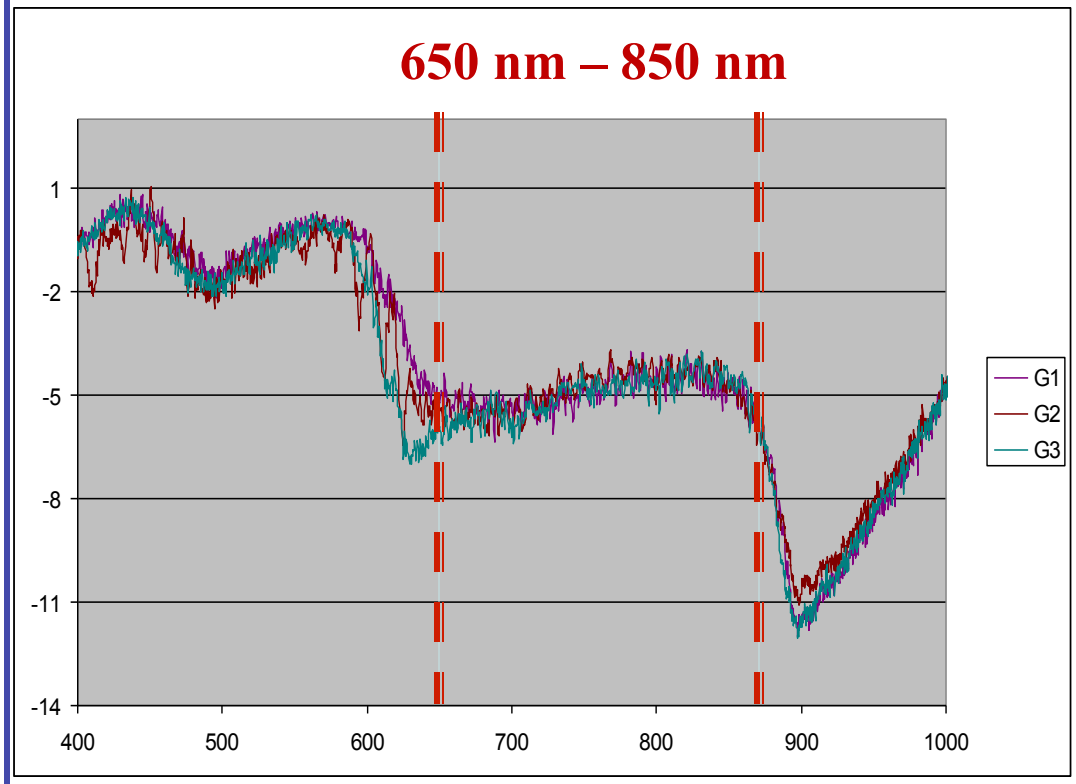
- Commercial technology of ion (K, Ag) exchange in high quality transparent glasses
- Well adapted to match e of commercial optical fibers (typical N
- Single-mode spectral r usion parameters
- 3 manufactured prototy




Composing with light
teem photonics

# IO prototype performance

- Single-mode spectral range

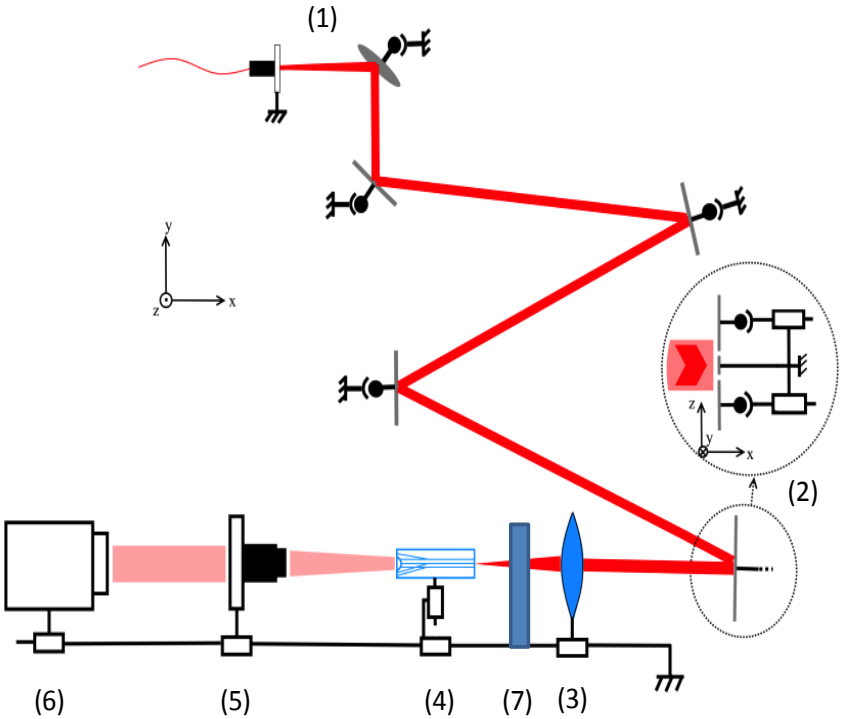



Throughput budget:

Propagation losses:
0.2 dB/cm
*(T=87% for L=3cm)*

Fresnel losses:
0.4 dB/face
*(losses = 8%/face)*

# IO prototype performance




1) Fibered Source (laser or broad band source) at the focus of the off-axis parabola
(2) 3-part segmented mirror (2 independent movable mirrors, one fixed)
(3) Focusing lens f=50mm
(4) IO multiaxial device
(5) Imaging optics (x10 microscope objective)
(6) Lumenera Camera LM135 1392x1040 pixels (pixel size 4.65um)
(7) Glan-Thomson polarizer

# IO prototype performance

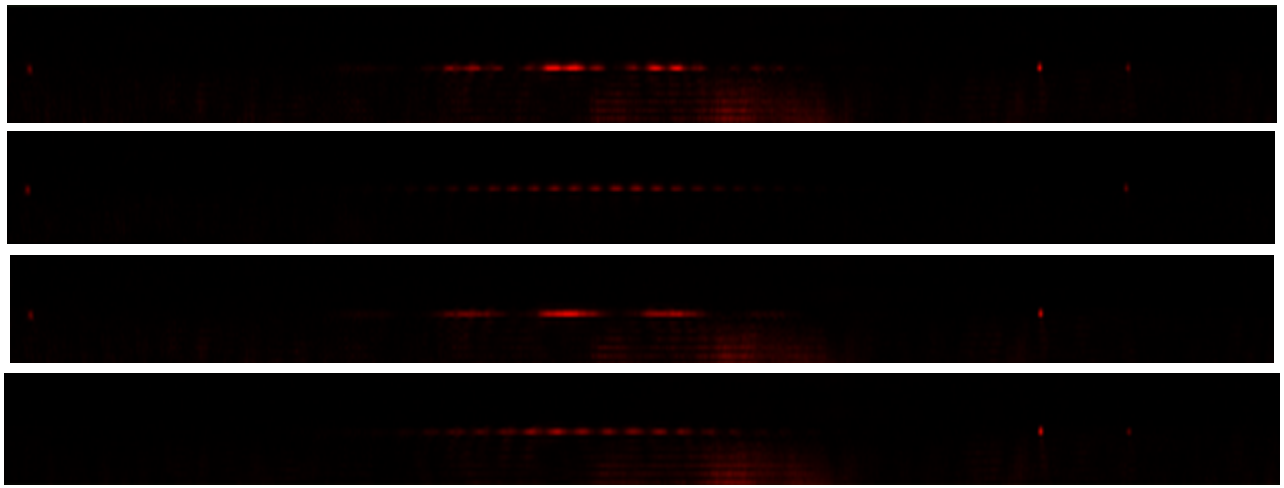
- Fringes in monochromatic light (633 nm)

**3-T**

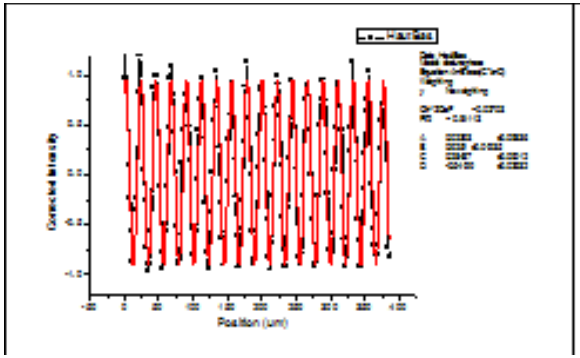
**2-3**

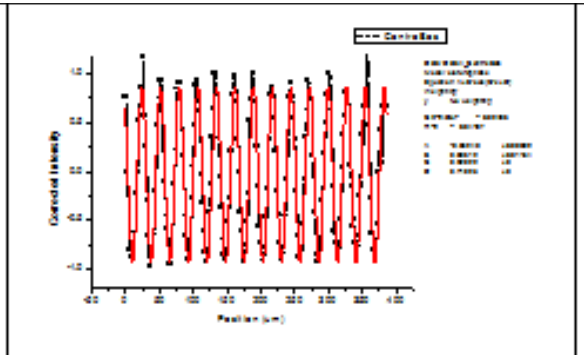
**1-2**

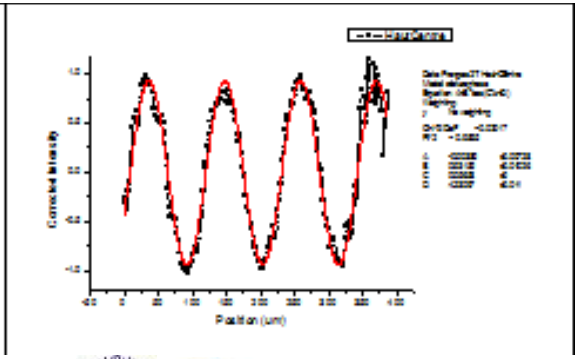
**1-3**



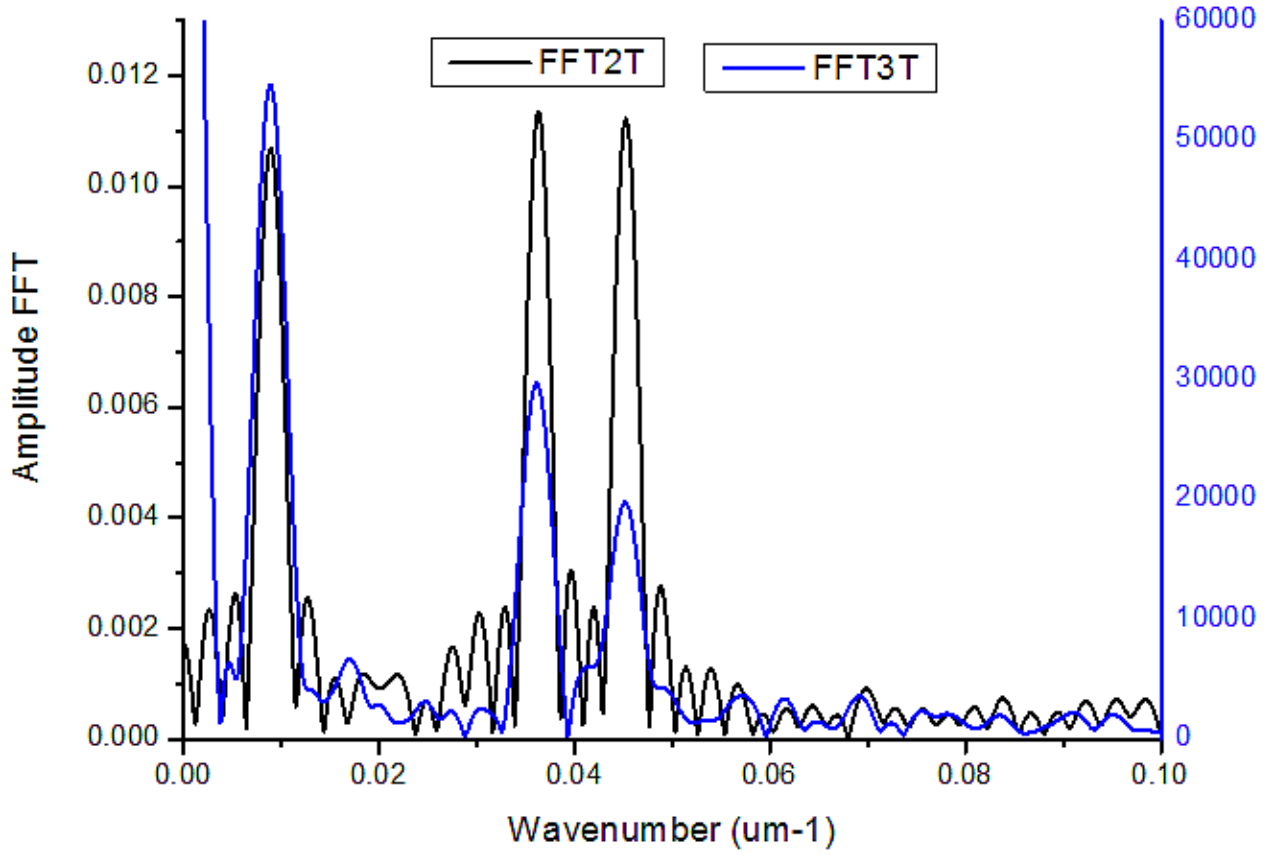
**C > 89%**



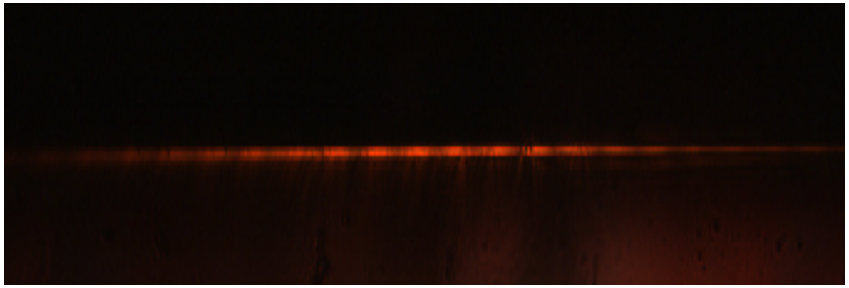



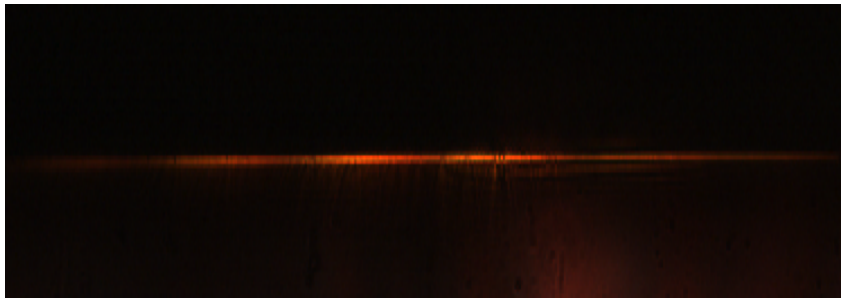
# IO prototype performance

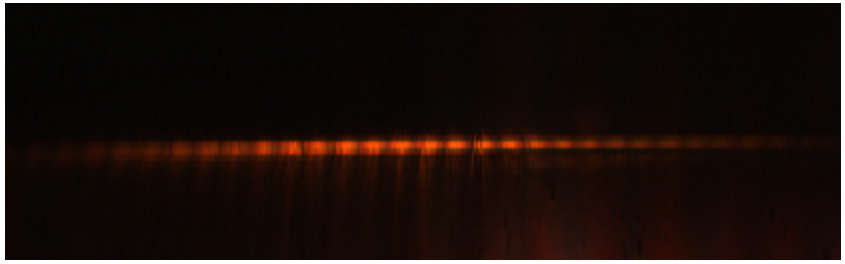


# IO prototype performance

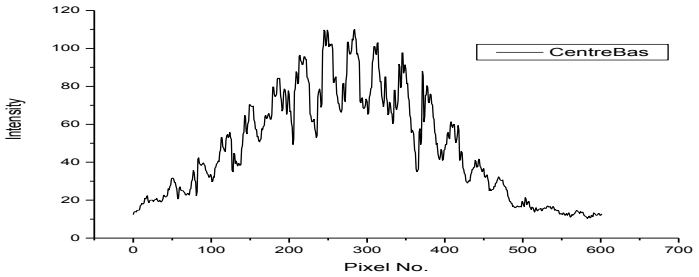
- Fringes with a white-light source

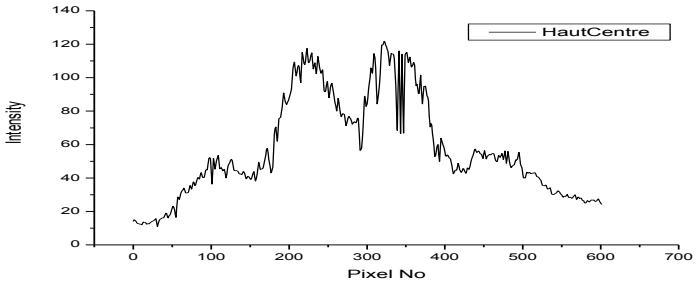


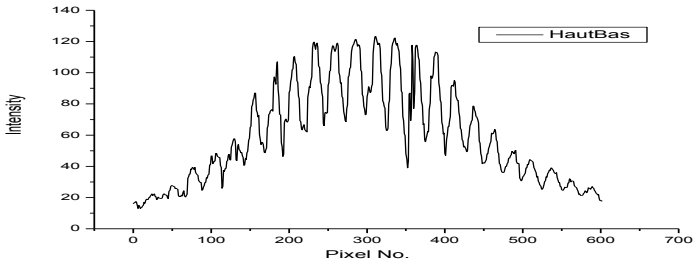




$\Delta\lambda \sim 20$ nm



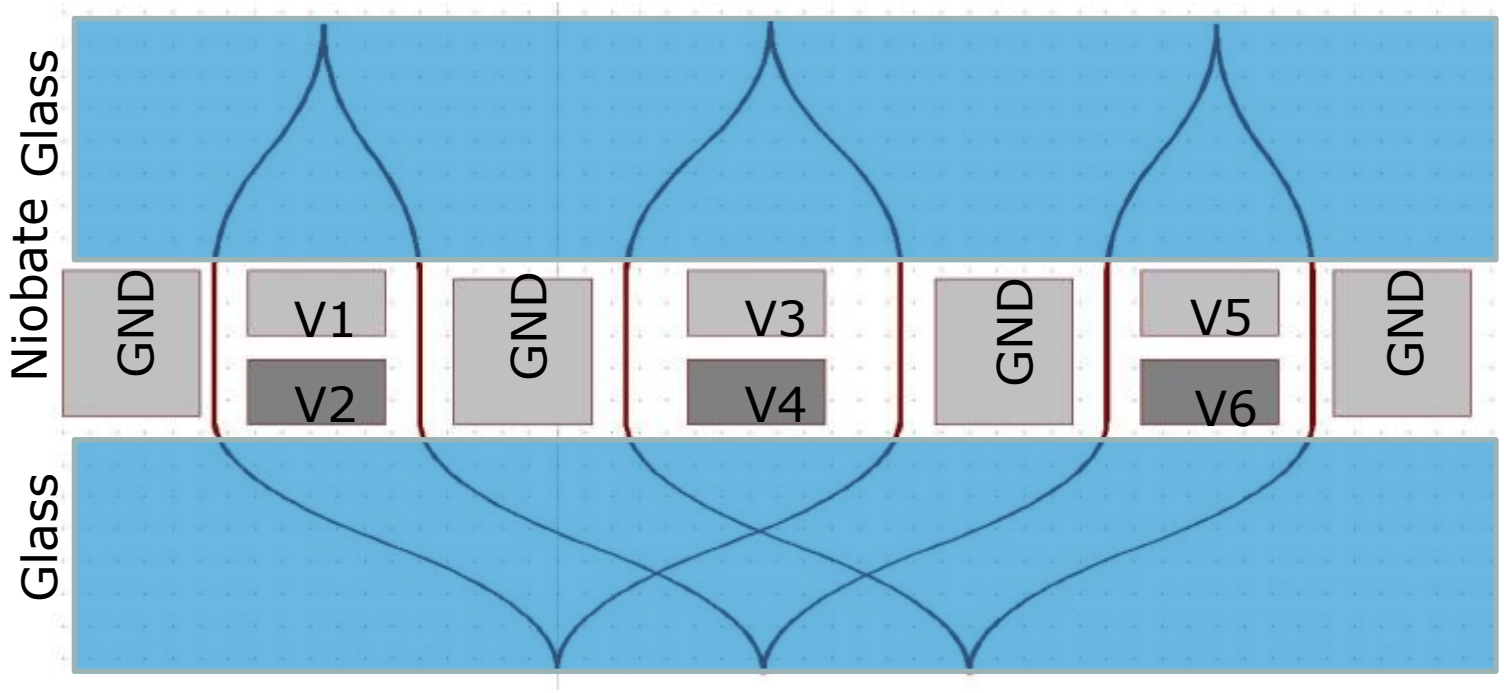



# Summary

- Mature technology
- Manufactured by a company
- 3T concept easily extendable to 6T → need for pixels
- Performance of the one-shot prototype are very encouraging:
  - Throughput > 80 %
  - Contrast > 90 % in monochromatic light
- Next steps:
  - Further characterizations: dispersed fringes, closure phase, cross-talk, …
  - New beam combiners?

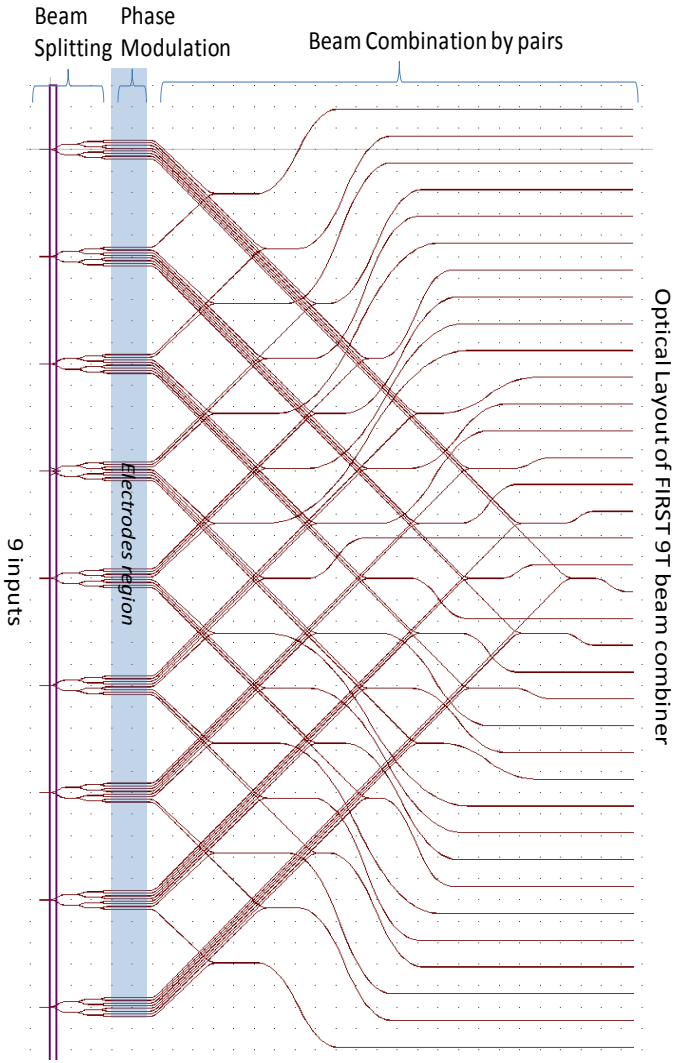
# Towards more complex devices

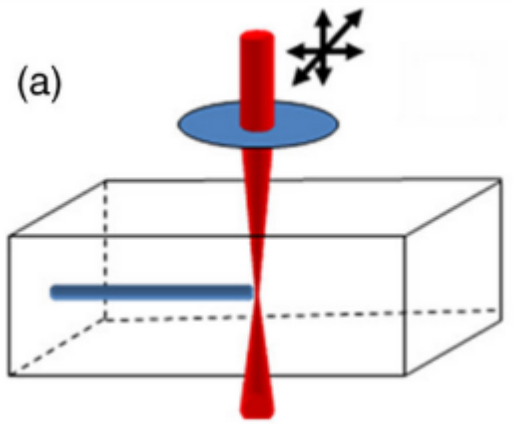
- Coupling active and passive materials




Glass: Short bending radius (8 mm)
Niobate: Active Phase/Intensity Modulation

# Towards more complex devices




*FIRST 9T electro-optic beam combiner*
*9 inputs → 36 outputs*
*Collaboration with S. Lacour (Obs. Paris)*

# Towards more complex devices

Photline TECHNOLOGIES

Composing with Light teem photonics