

HANDS-ON COMPUTER LAB SILICON PHOTONIC CIRCUITS

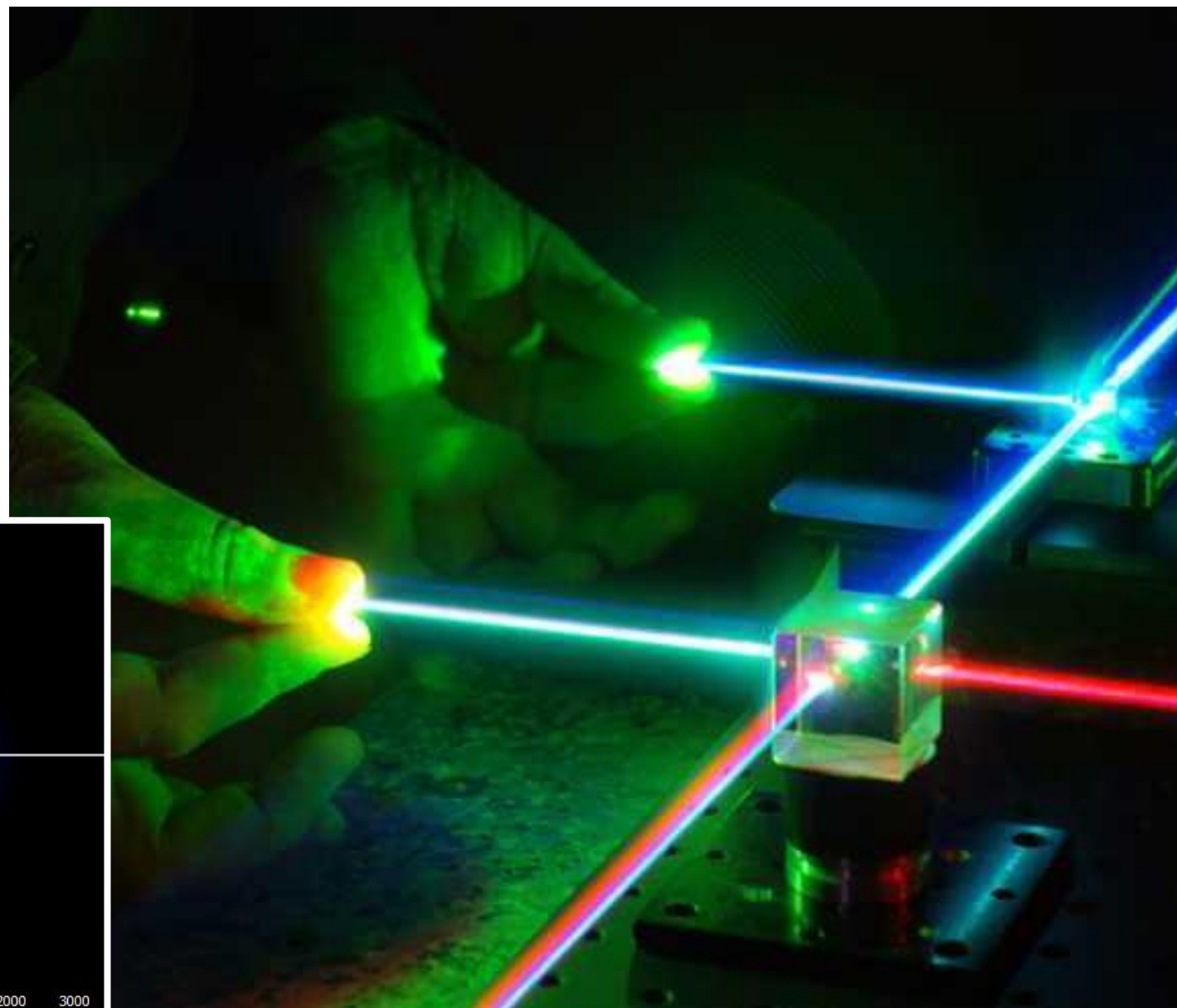
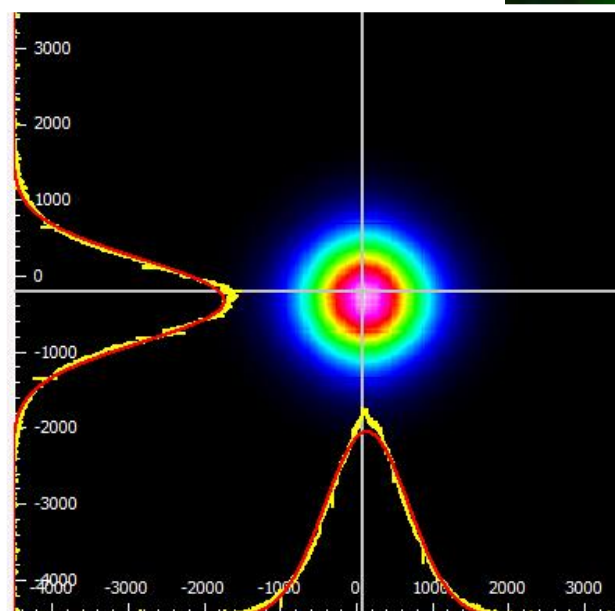
Wim Bogaerts, Lukas Van Iseghem

INFIERI Summer School

MANIPULATING BEAMS OF LIGHT

Beams of light contain information

- Total power
- Intensity profile
- Phase profile
- Wavelength
- Polarization

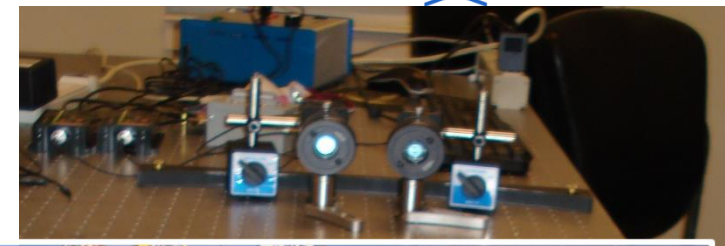


MANIPULATING BEAMS OF LIGHT

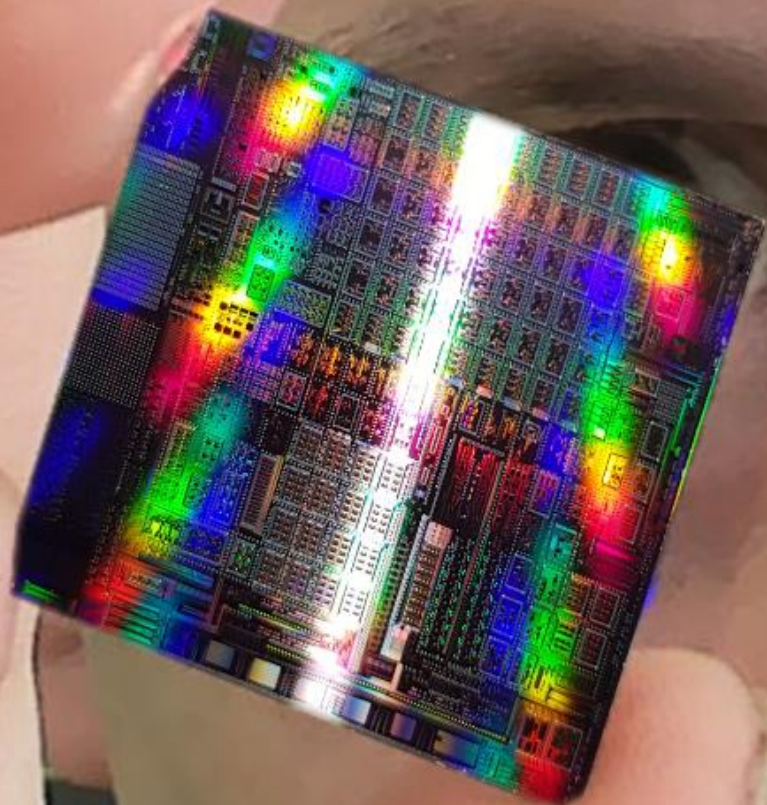
Using optical elements

- Lenses
- Mirrors
- Polarizers
- Shutters
- Spatial filters
- Wavelength filters
- Phase plates
- SLM

Does not scale very well



PHOTONIC CHIPS



Chips for manipulating light

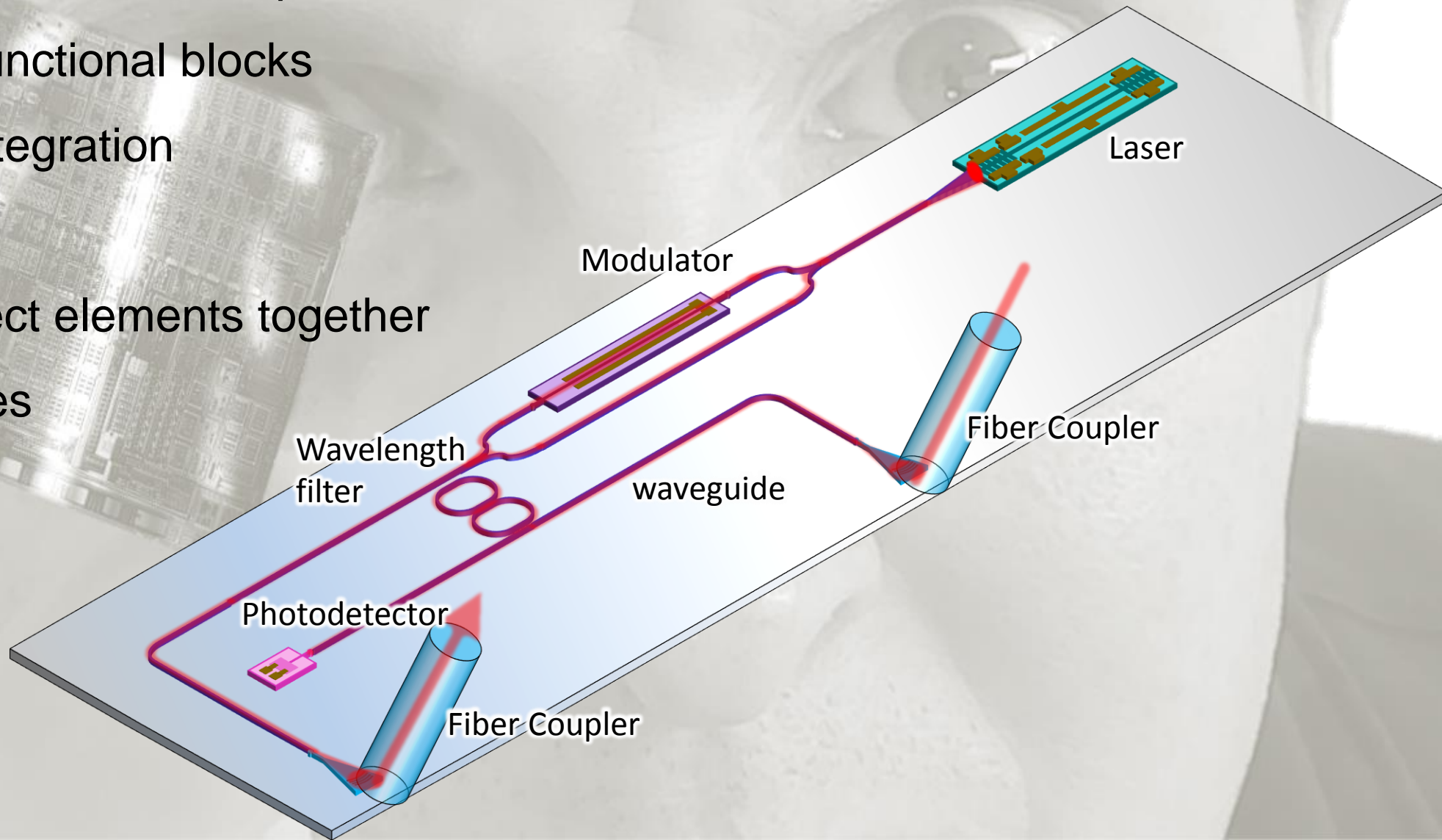
- fabricated on semiconductor wafers
- generating, modulating, filtering, detecting of light
- Application in communications, sensing,....

PHOTONIC CHIPS

Complexity of the circuits depends on

- number of functional blocks
- density of integration

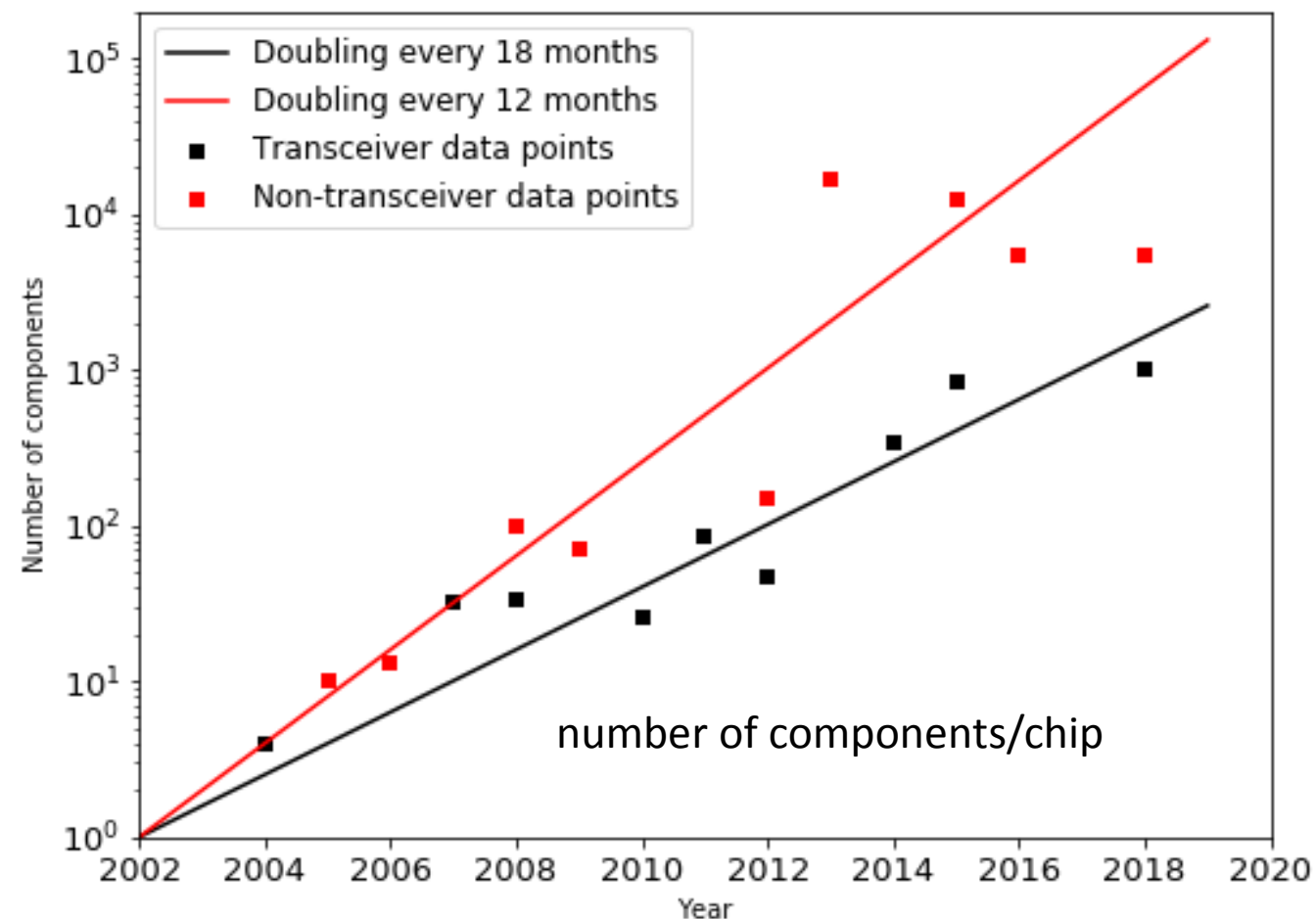
Circuits connect elements together
with waveguides



SILICON PHOTONIC CHIP AND CIRCUIT SCALING

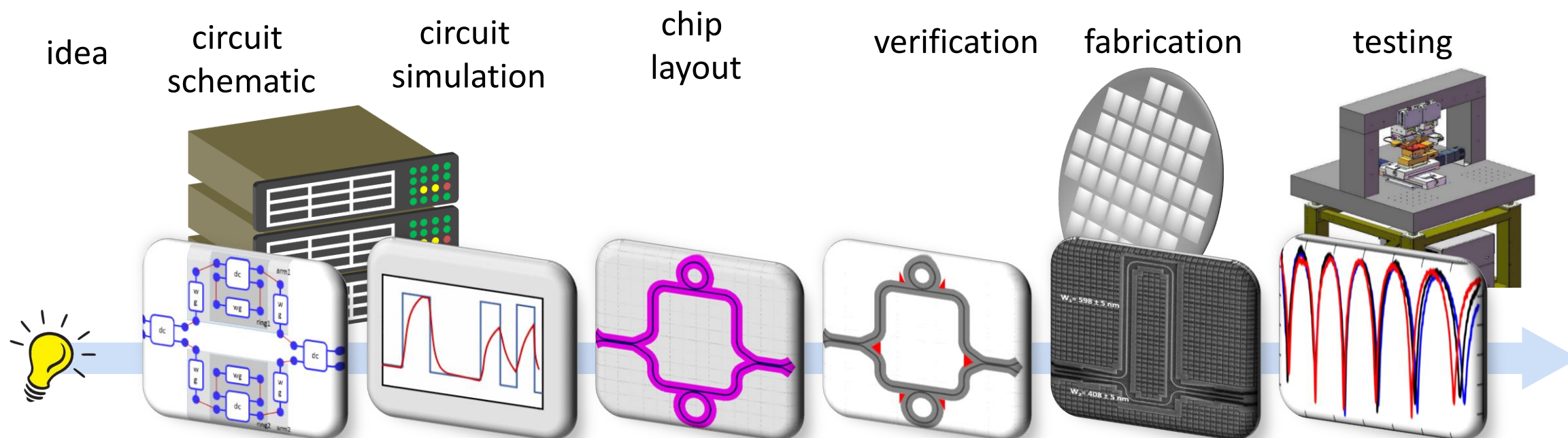
Rapidly growing integration

- $O(1000)$ components on a chip
- photonics + electronic drivers
- different applications (mostly comms)
- Relatively small chip volumes (compared to electronics)



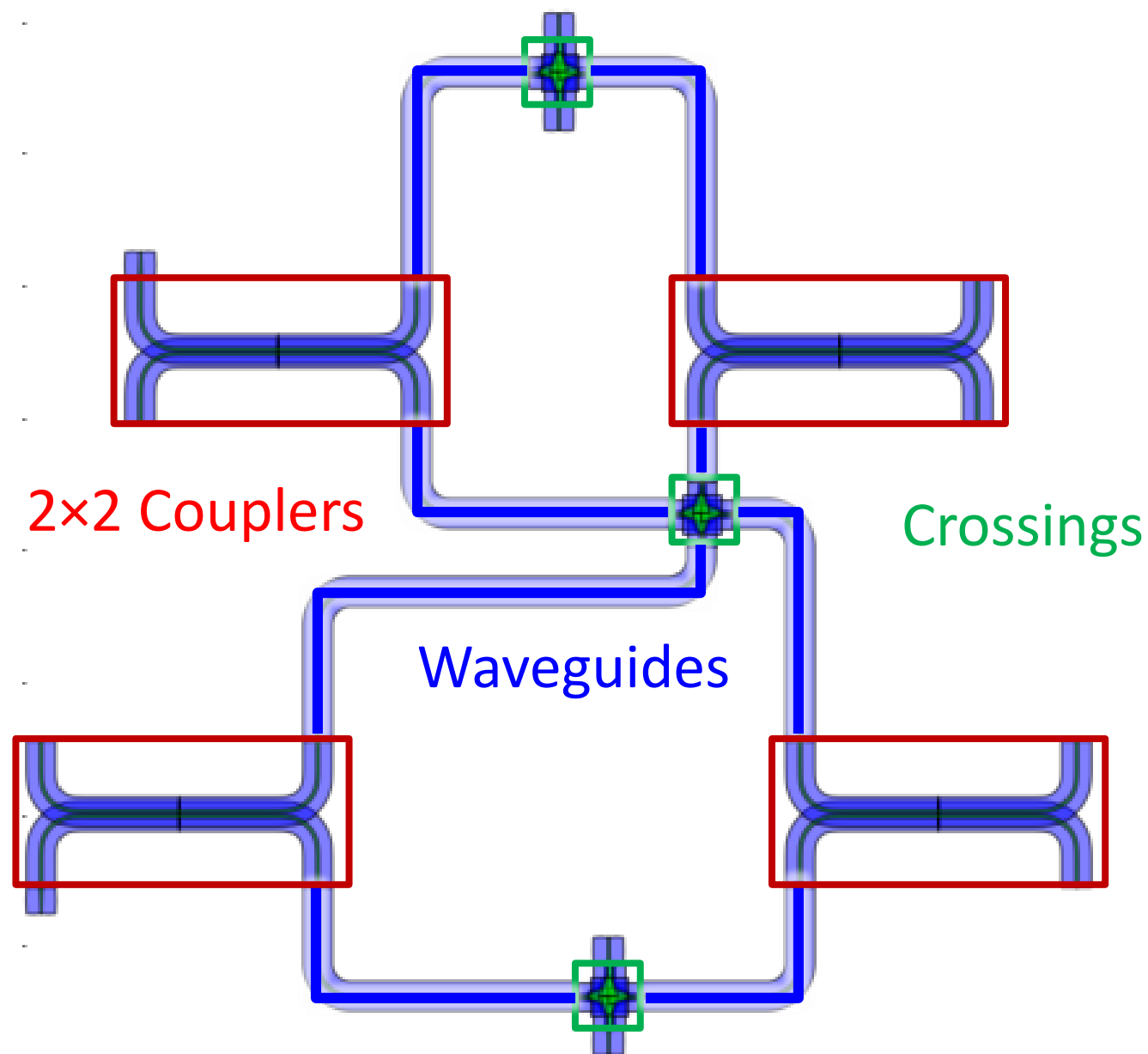
MAKING PHOTONIC CIRCUITS

Translating an idea into a chip?



A SIMPLE PASSIVE CIRCUIT

- Four 2×2 couplers
- 3 Crossings
- Connection waveguides



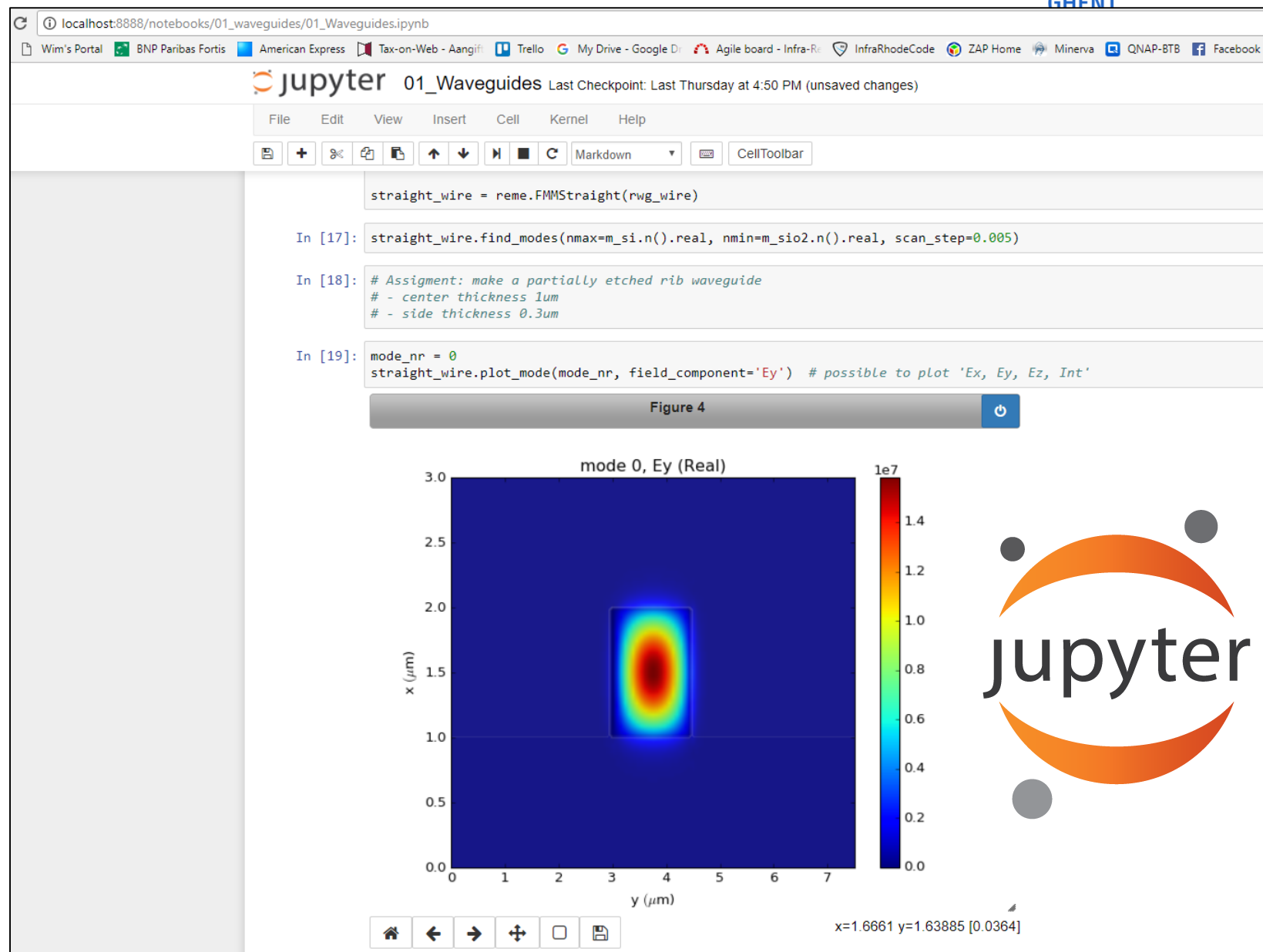
JUPYTER NOTEBOOKS

interactive notebook

- text, figures
- formulas
- python code

simulation and design

- built-in IPKISS



The screenshot shows a Jupyter Notebook interface for a file named '01_Waveguides.ipynb'. The notebook contains three code cells:

```

straight_wire = reme.FMMStraight(rwg_wire)

In [17]: straight_wire.find_modes(nmax=m_si.n().real, nmin=m_sio2.n().real, scan_step=0.005)

In [18]: # Assigment: make a partially etched rib waveguide
# - center thickness 1um
# - side thickness 0.3um

In [19]: mode_nr = 0
straight_wire.plot_mode(mode_nr, field_component='Ey') # possible to plot 'Ex, Ey, Ez, Int'
  
```

Below the code cells, a figure titled "Figure 4" is displayed. It is a heatmap showing the real part of the electric field component E_y for mode 0. The x-axis is labeled x (μm) and ranges from 0.0 to 3.0. The y-axis is labeled y (μm) and ranges from 0 to 7. A color bar on the right indicates the field magnitude, ranging from 0.0 to 1.4, with a multiplier of $1e7$. The plot shows a localized field distribution centered around $x \approx 1.67$ and $y \approx 3.64$. The Jupyter logo is visible in the bottom right corner of the notebook interface.

PHOTONIC DESIGN NOTEBOOKS

Explore your designs in a browser

Very rapid experimentation

Interactive code and plots

Widely supported community



PRACTICAL

30 minutes intro: basics of photonics

(by me or Lukas)

Hands-on, self-paced use of notebooks

You can use the notebooks afterwards

Use your laptop or lab computer

You will get a log-in and password

Connect to the server

Get started



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