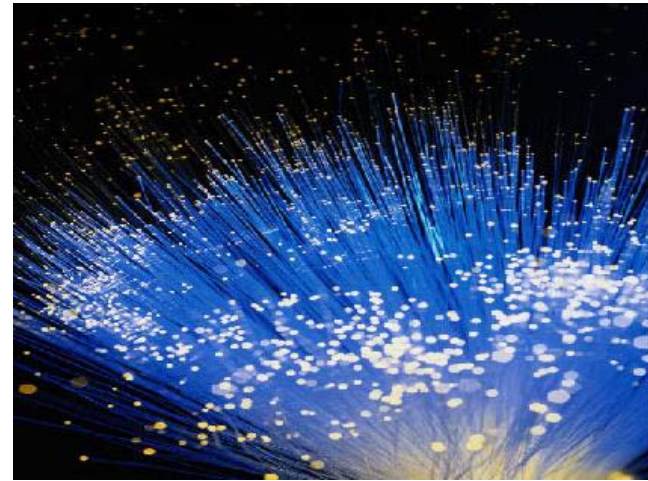




*Using lasers  
to store and share data*

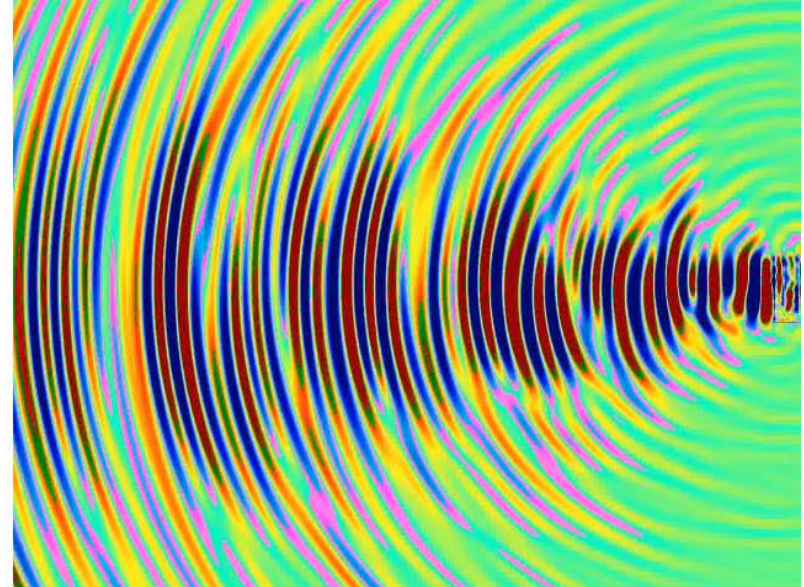


Romain Blanchard

# What's special about laser light?

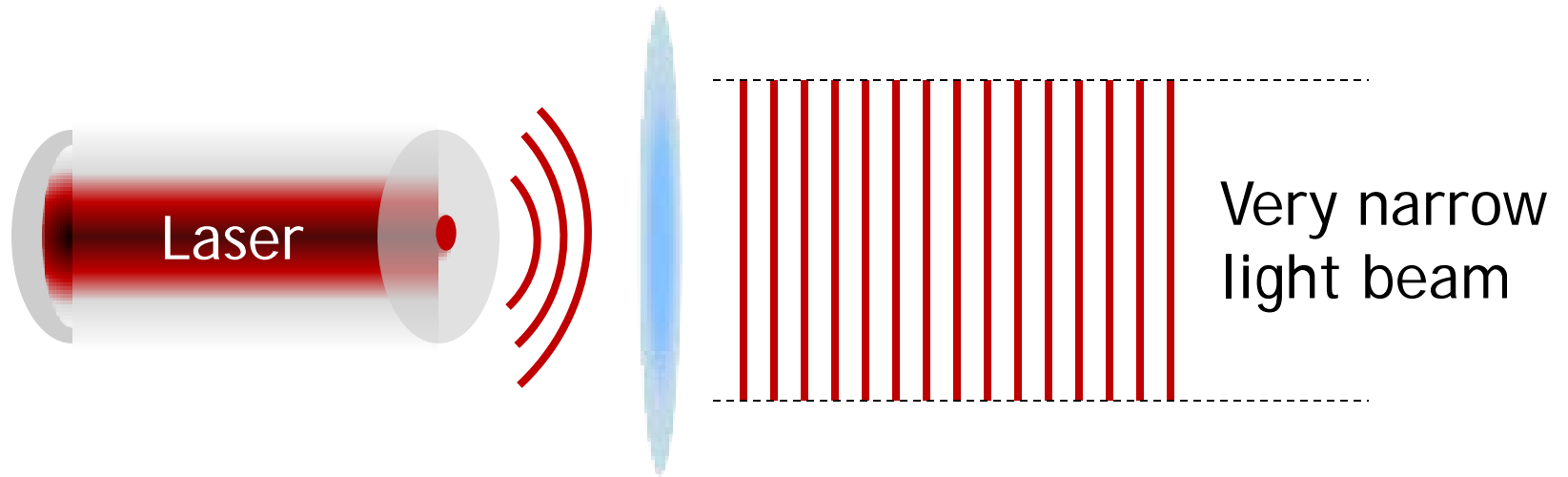


Fully coherent

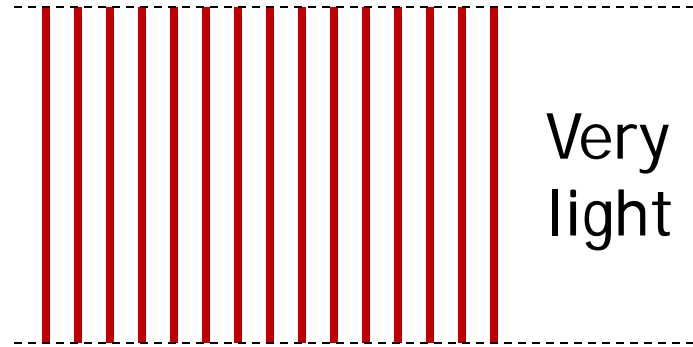
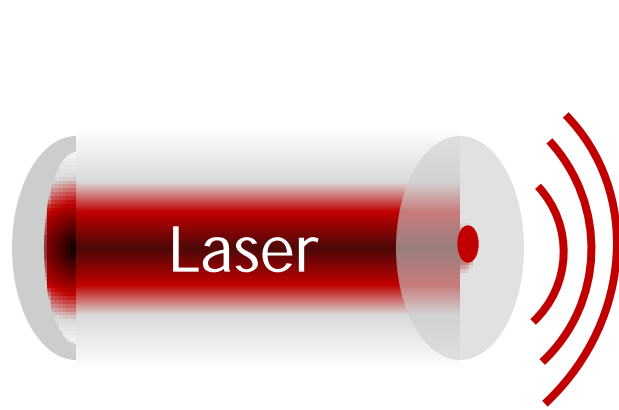


Partially coherent

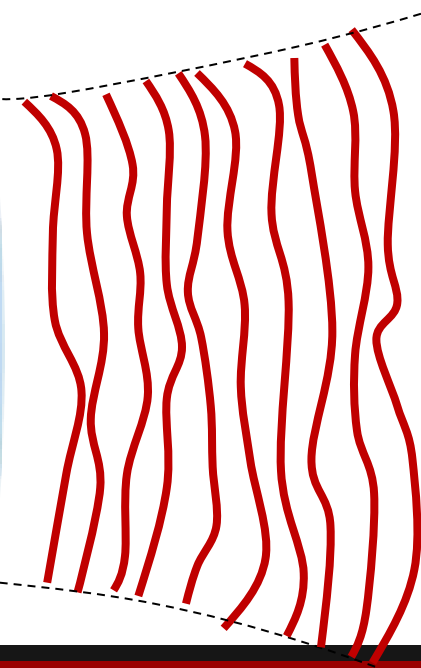
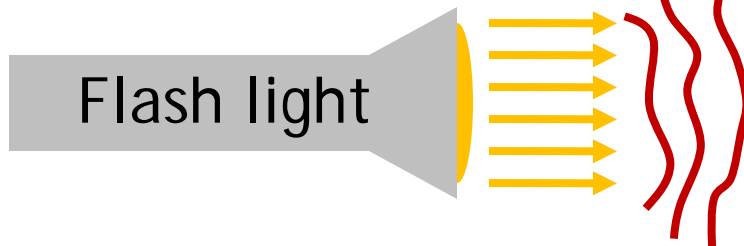
# Lasers can be very directional



# Lasers can be very directional



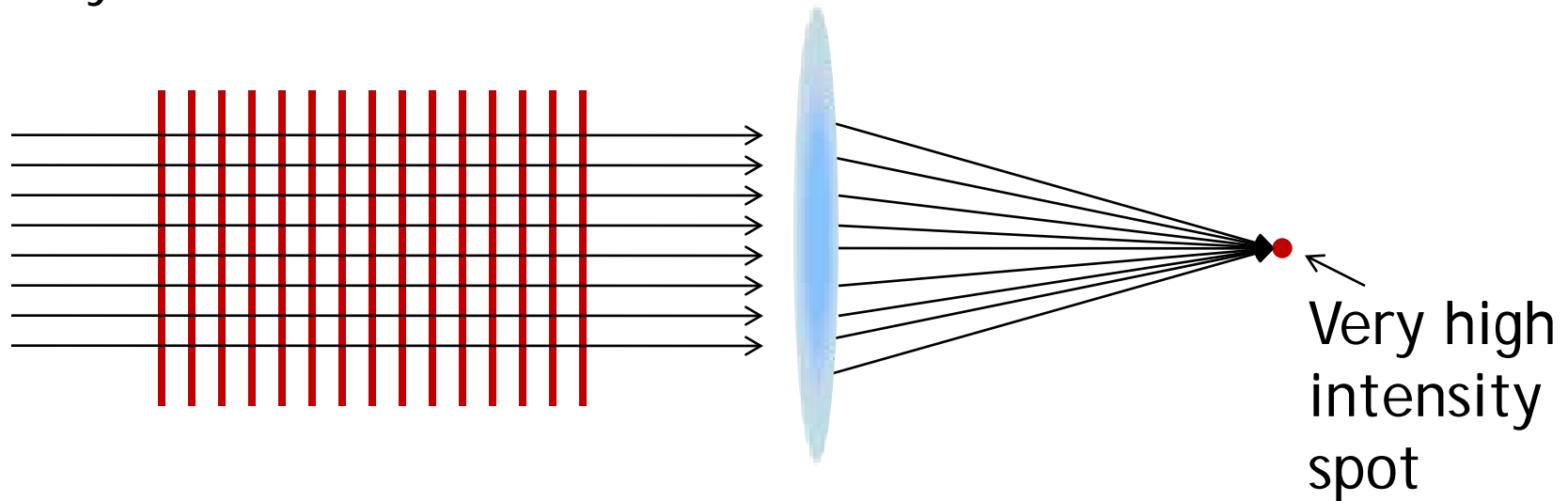
Very narrow  
light beam



Not a very  
directional  
beam...

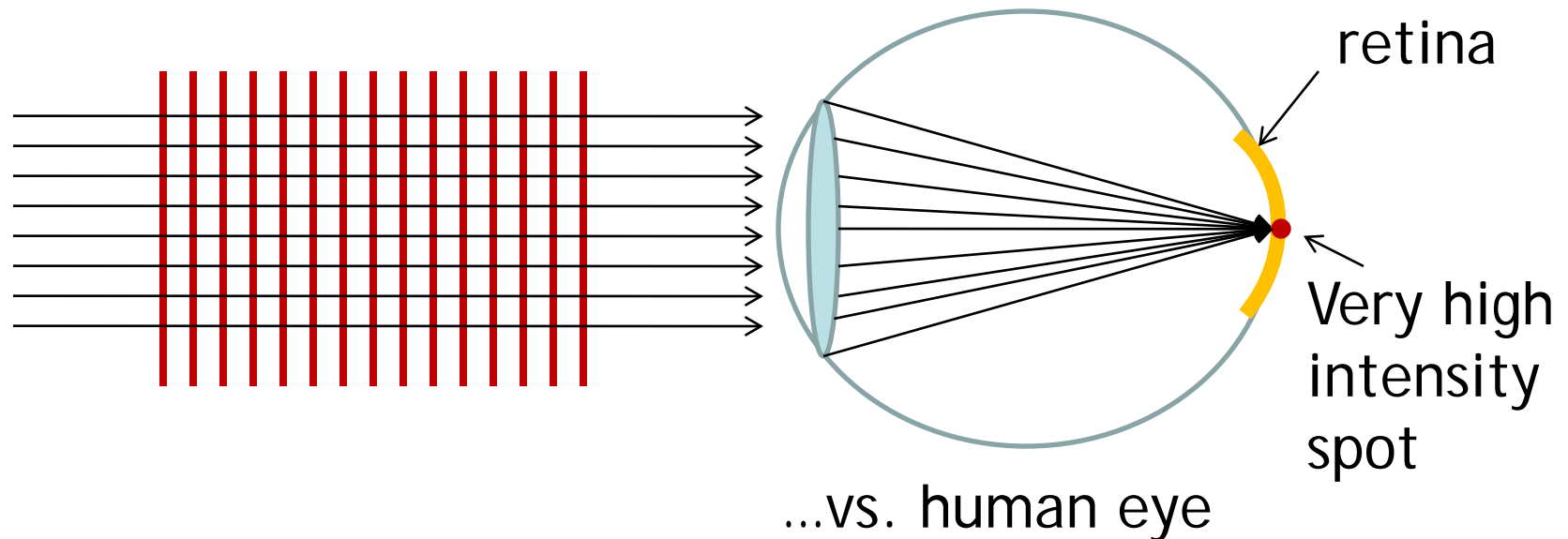
# Laser beams can be focused into tiny spots

Very directional laser beam...



# Attention, danger!

Very directional laser beam...



- The eye focuses the laser beam into a tiny spot with **extremely high intensity**.
- This spot locally heats tissues and creates **burns of the retina**.
- If pulsed, laser light can even create **explosive boiling of water** inside the eye cells...

Attention, danger!

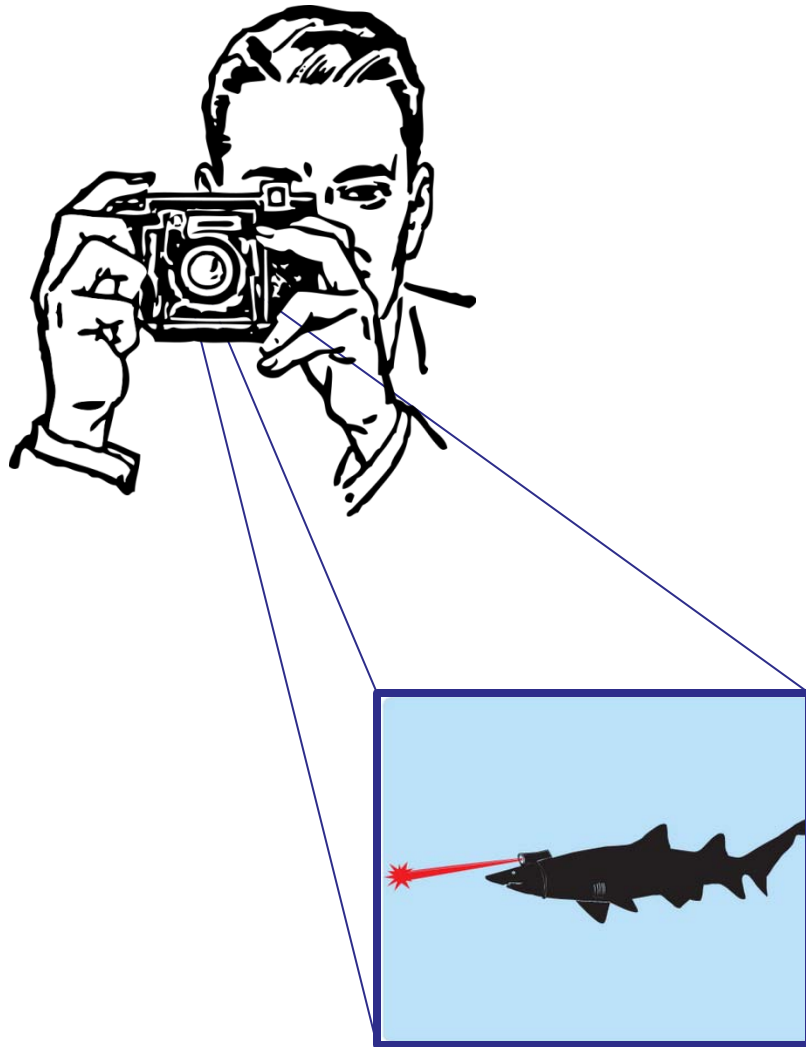
# WARNING



## Laser Radiation

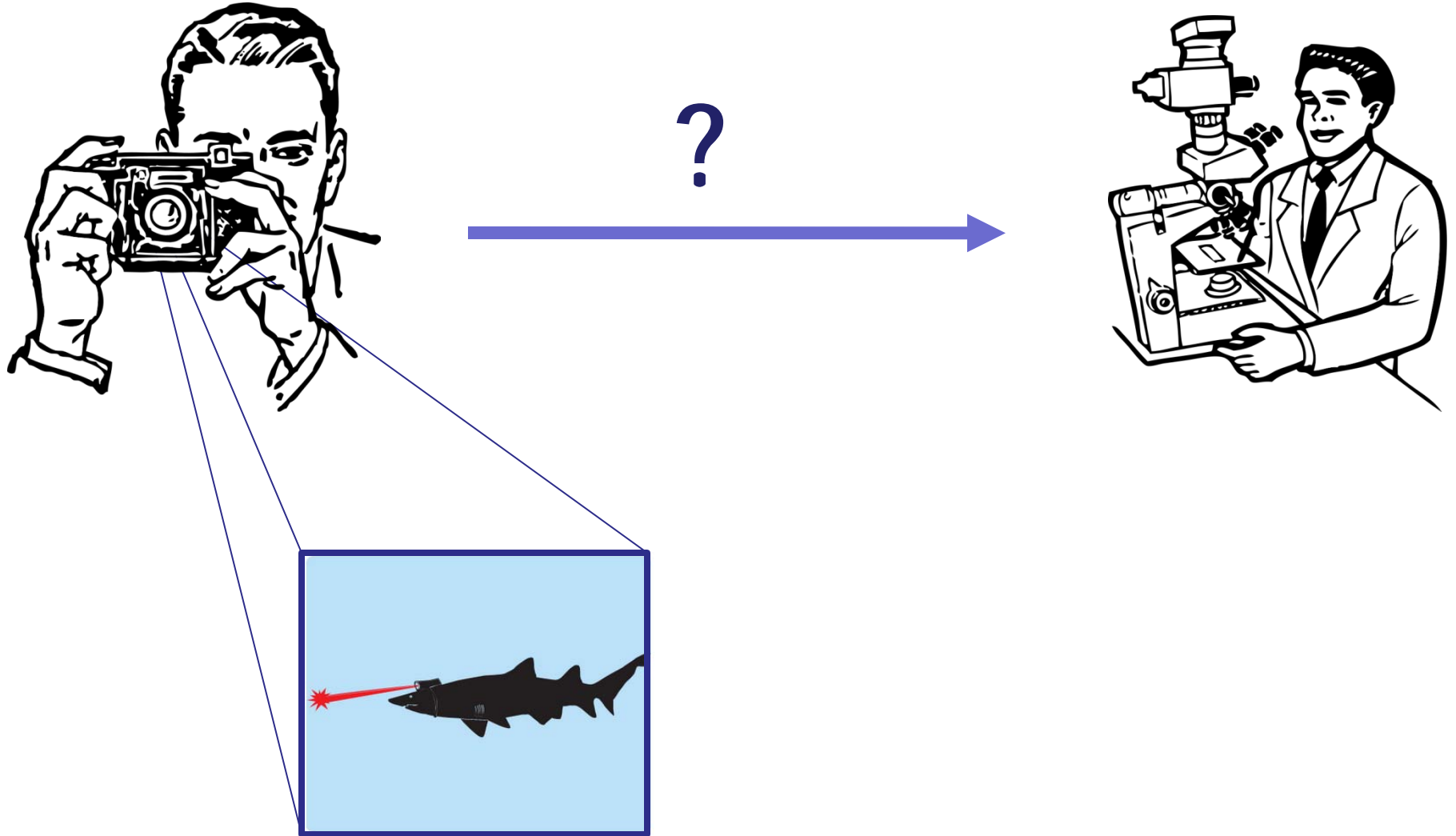
Do Not Look At Laser  
With Remaining Eye

# How can we transfer data ?

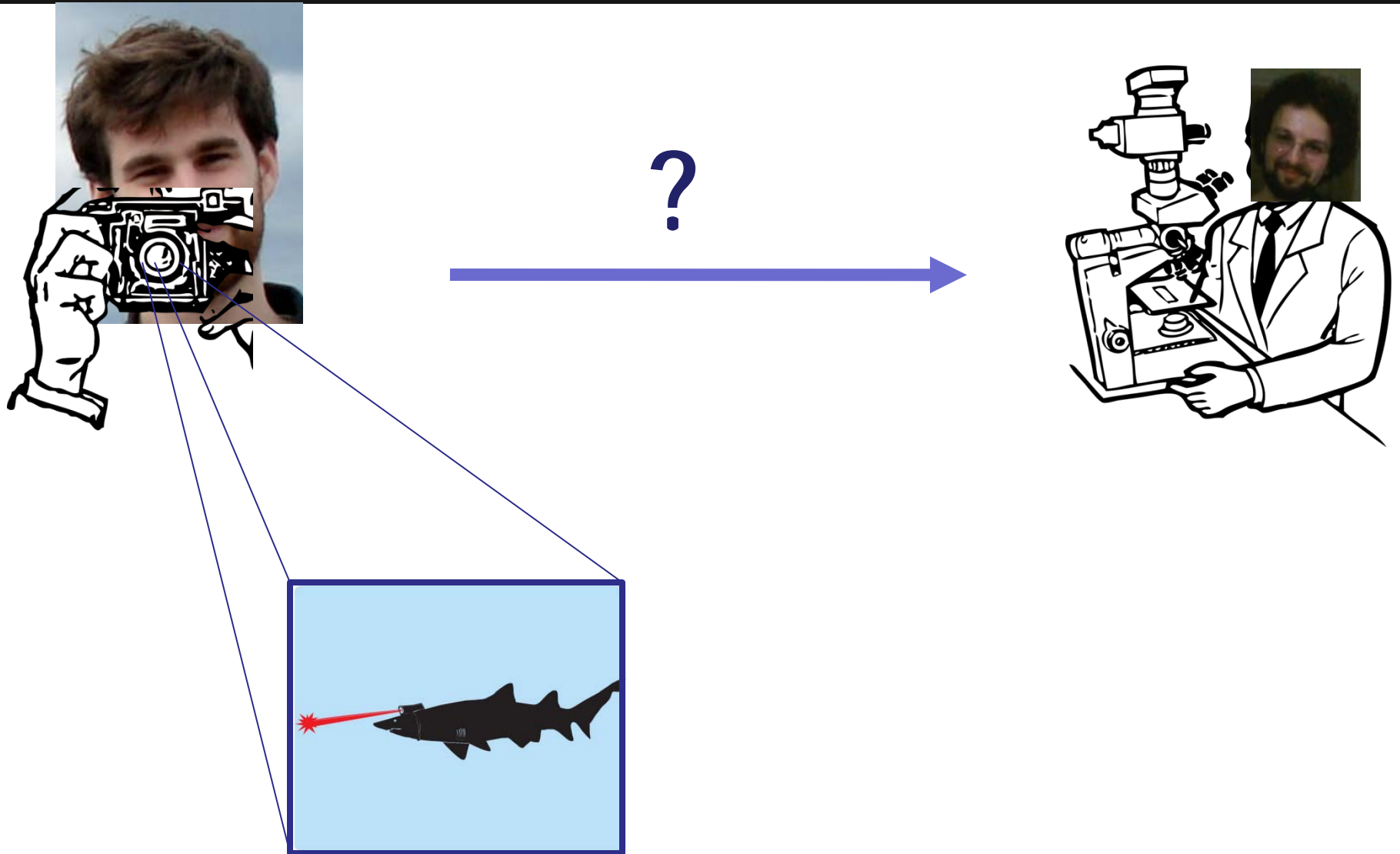




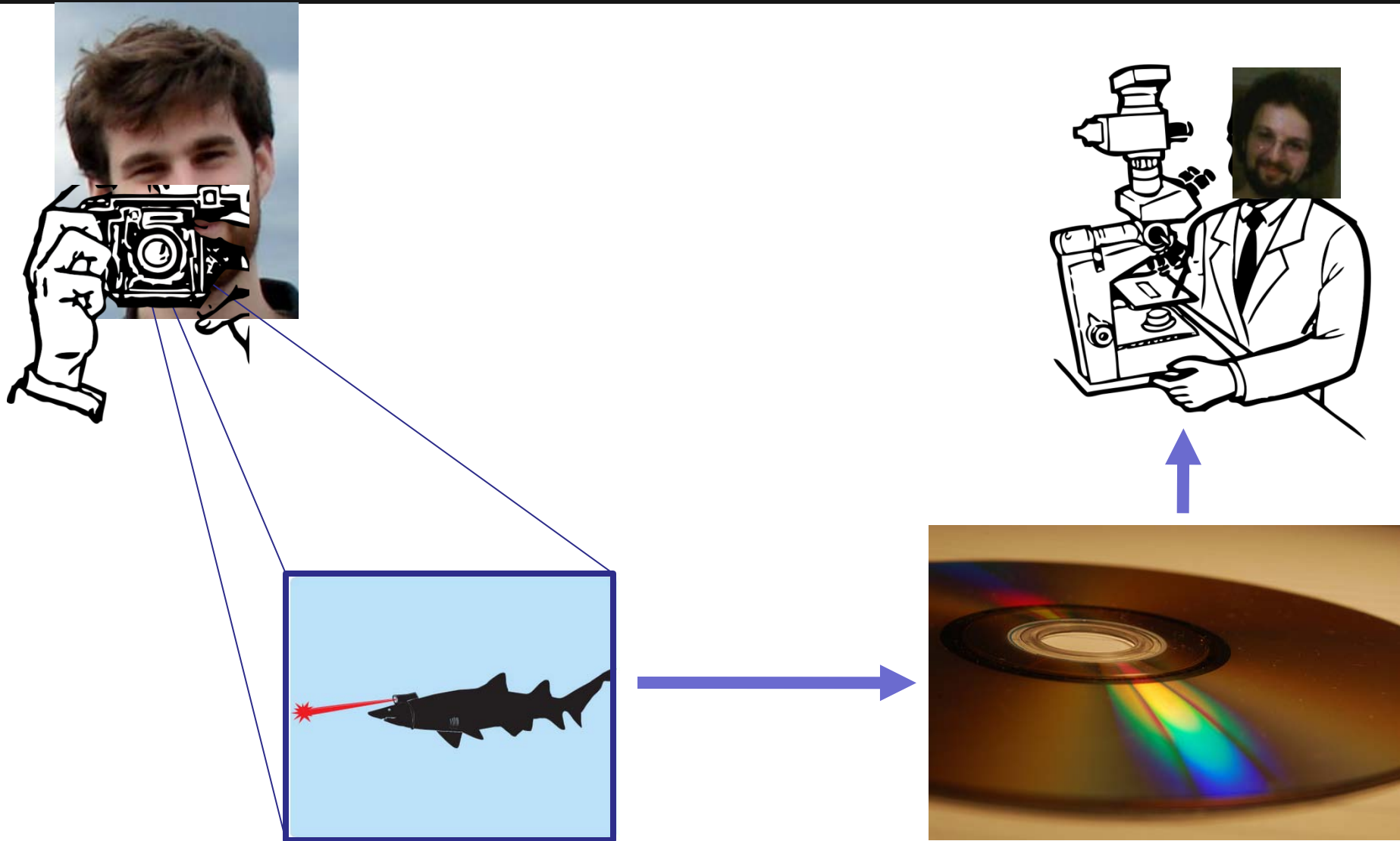
# How can we transfer data ?



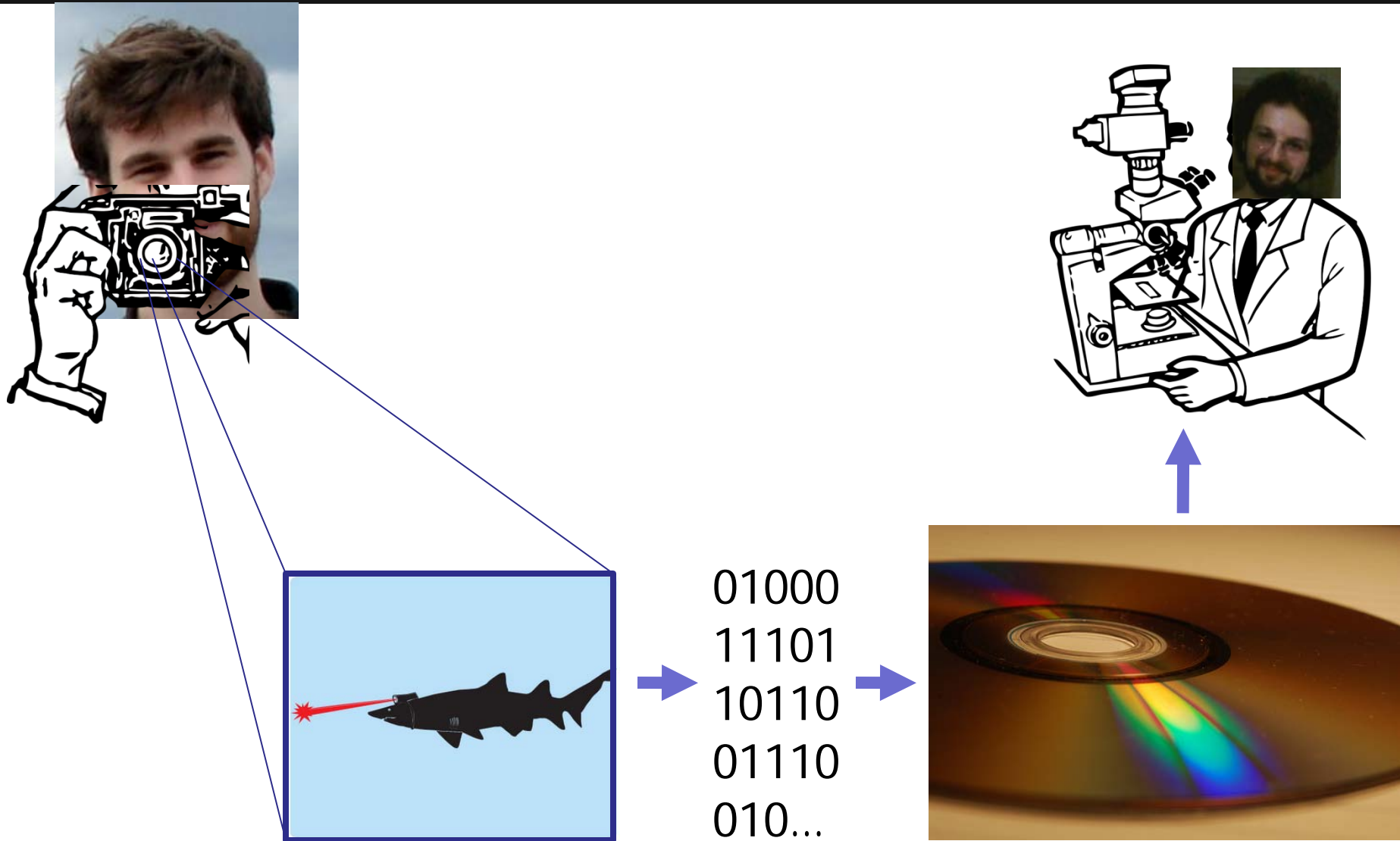
# How can we transfer data ?



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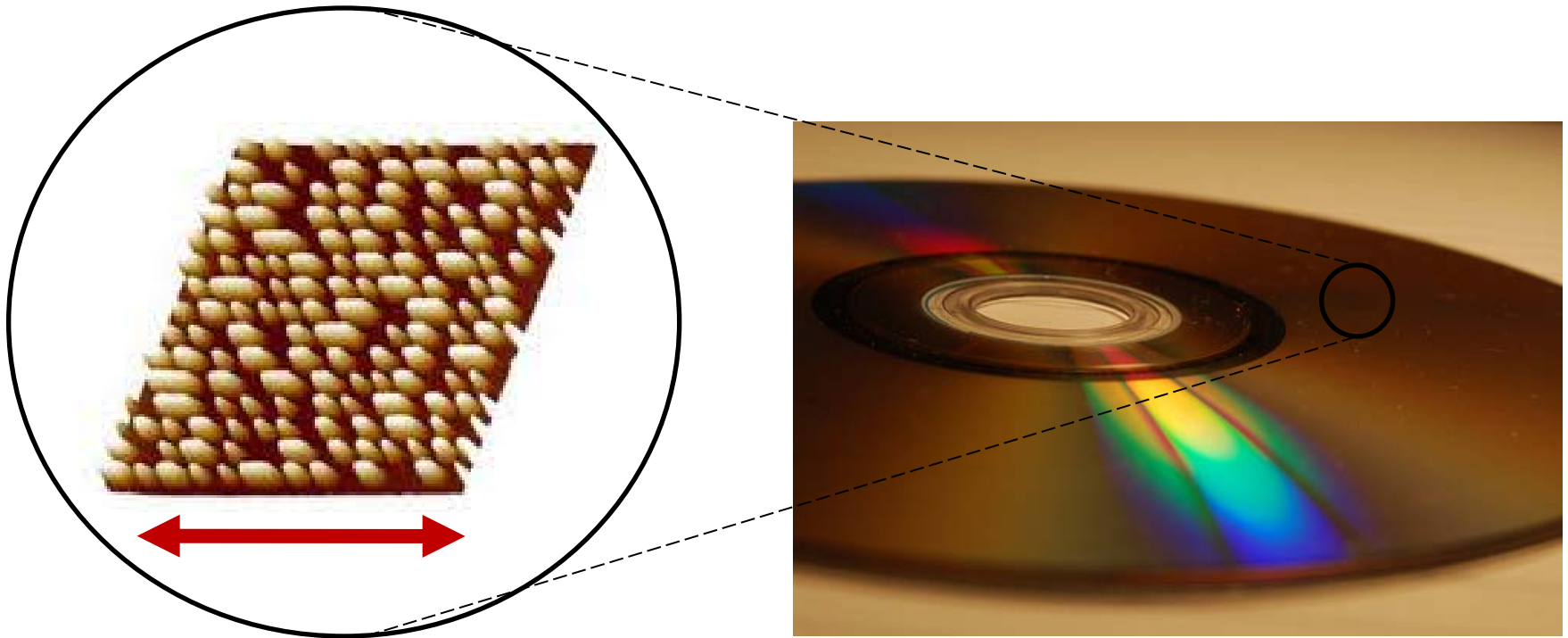


# How can we transfer data ?



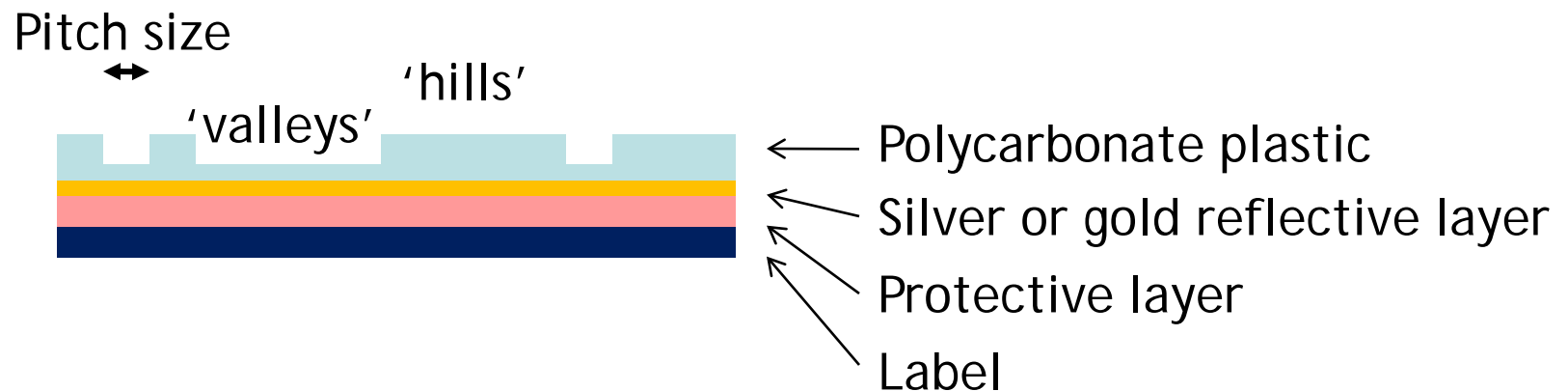
# Optical data storage (Compact discs)

Zoom-in of the surface of a CD

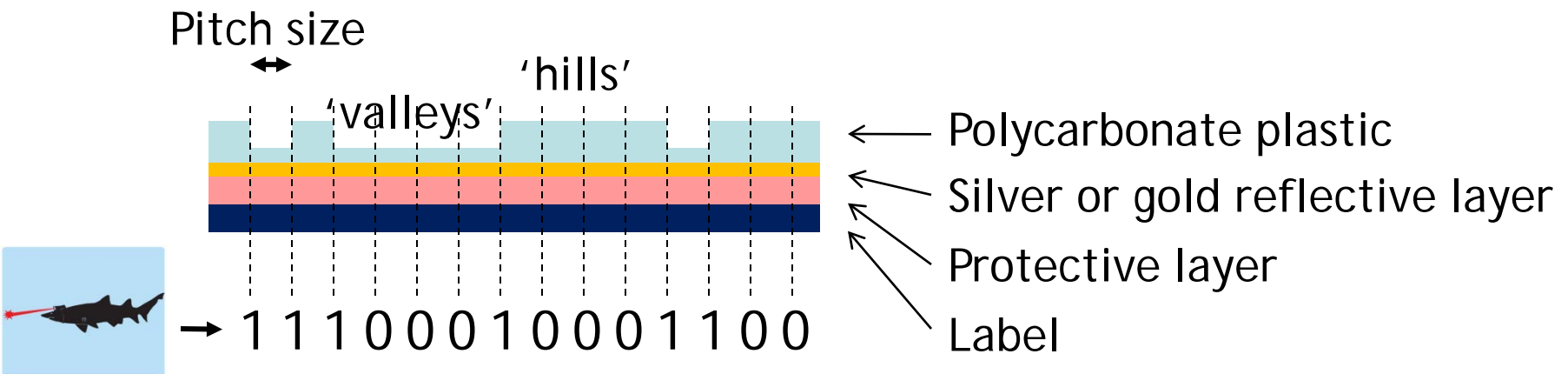


~1/10<sup>th</sup> of a human hair!

# Optical data storage (Compact discs)

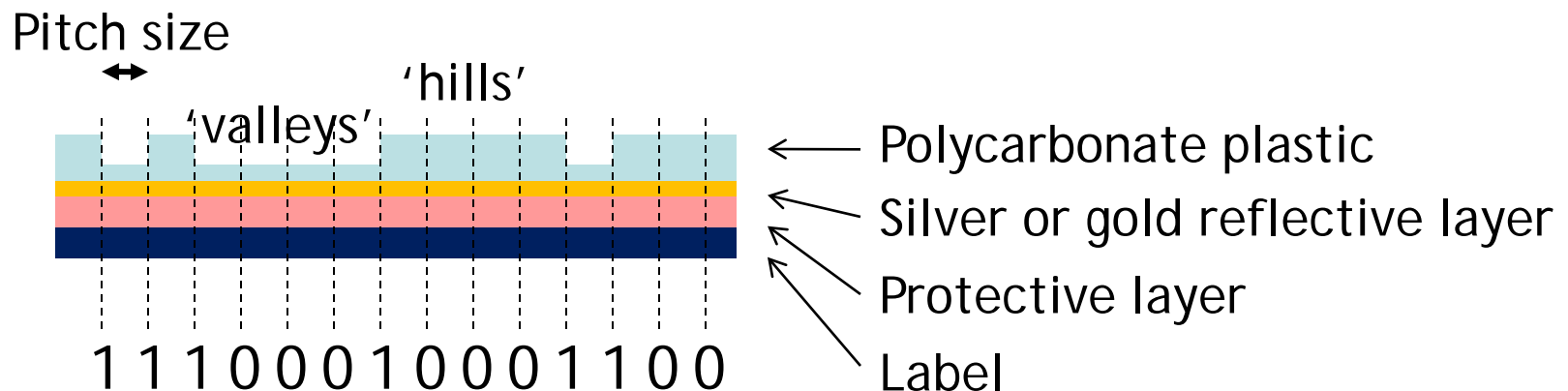


# Optical data storage (Compact discs)



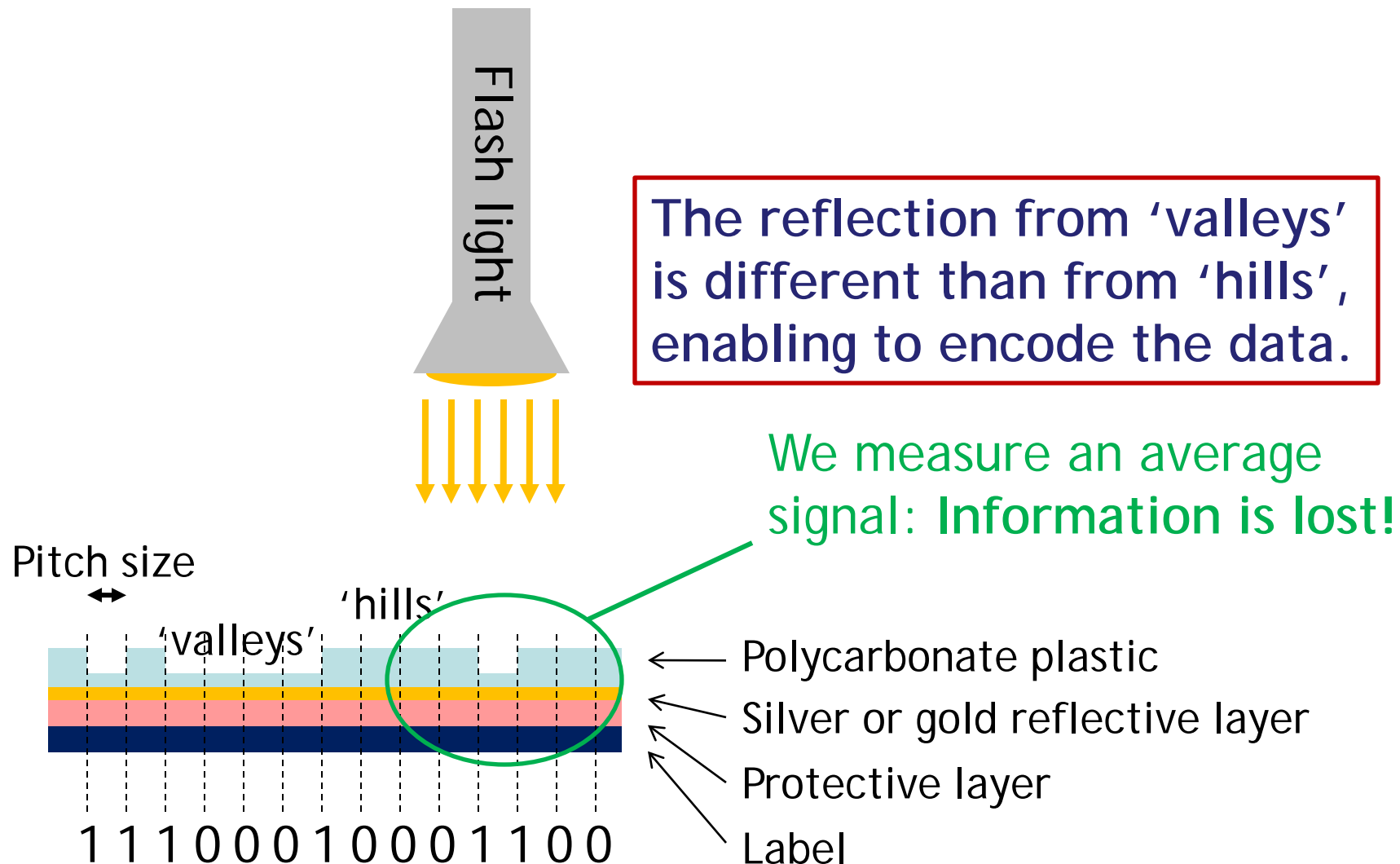
# Optical data storage (Compact discs)

The reflection from 'valleys' is different than from 'hills', enabling to encode the data.



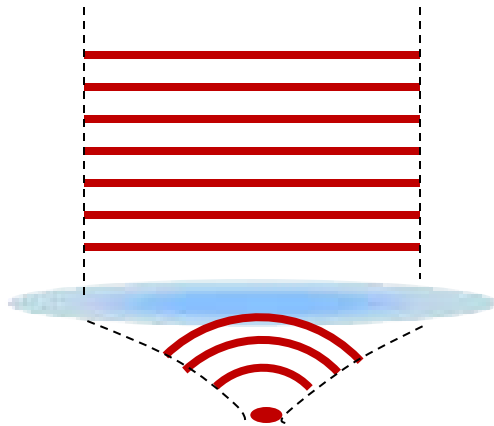


# Optical data storage (Compact discs)



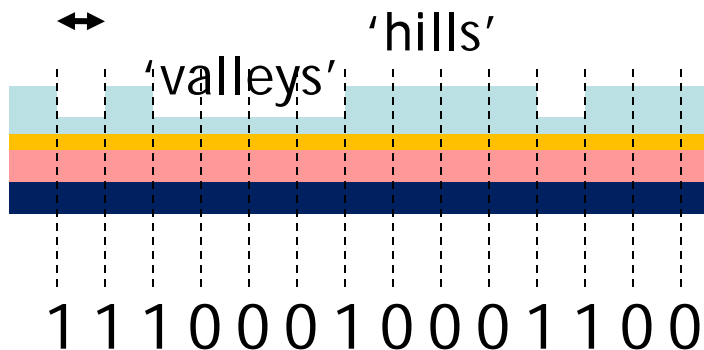
# Optical data storage (Compact Discs)

Laser beams can be focused into tiny spots !



The reflection from 'valleys' is different than from 'hills', enabling to encode the data.

Pitch size



- ← Polycarbonate plastic
- ← Silver or gold reflective layer
- ← Protective layer
- ← Label

# Optical data storage

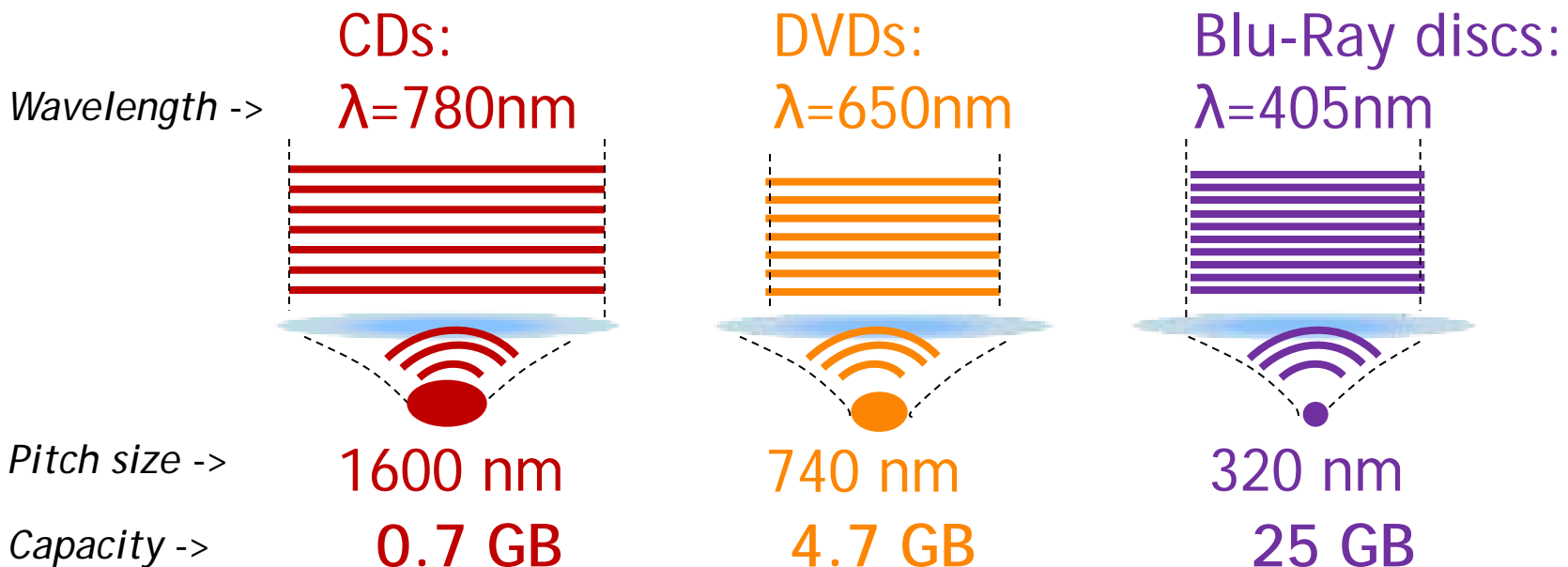
- The laser spot size gives the minimum pitch size:  
**The smaller the spot, the more data you can store in a disc!**

# Optical data storage

- The laser spot size gives the minimum pitch size:  
**The smaller the spot, the more data you can store in a disc!**
- How can we reduce the spot size ?  
**The smaller the wavelength (and the better the lenses...) the smaller the spot size**

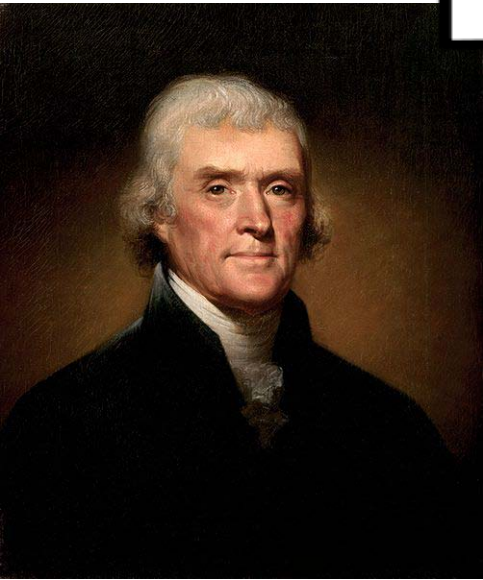
# Optical data storage

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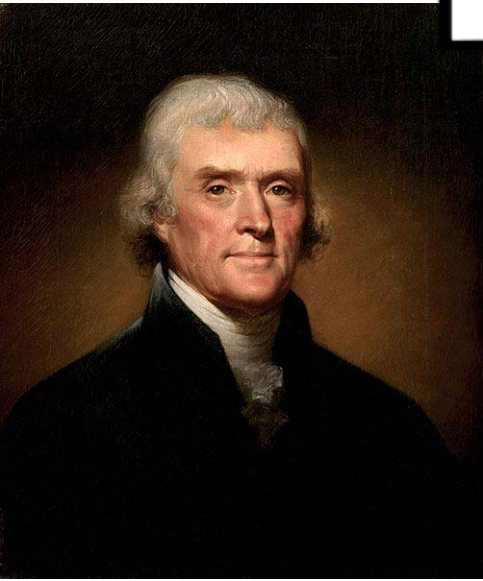
# We want more... and faster...

I have a lot of books. Let's make a HUGE library out of this collection: [the Library of Congress](#)\* ...-

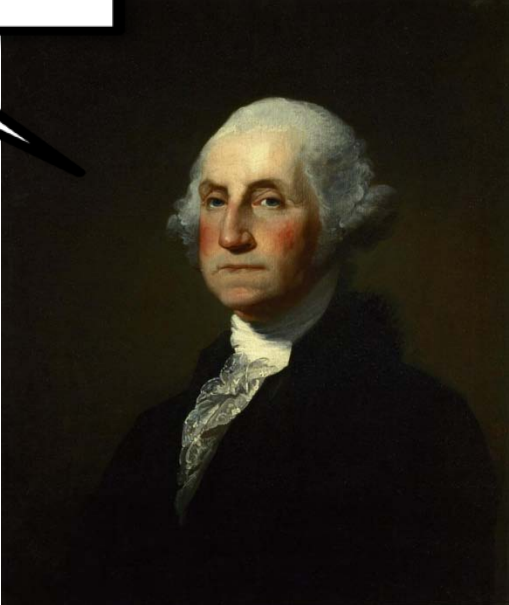


\*: 142,544,498 items... or approx. 10 TB  
Largest Library on earth...

# We want more... and faster...



I have a lot of books. Let's make a HUGE library out of this collection: [the Library of Congress](#)\*...-



I'm so smart I want to know ALL of it. Send it to me, and fast!

\*: 142,544,498 items... or approx. 10 TB  
Largest Library on earth...

# We want more... and faster...

No problem, just wait a second!

And add a few movies of sharks with laser beams attached to their heads!

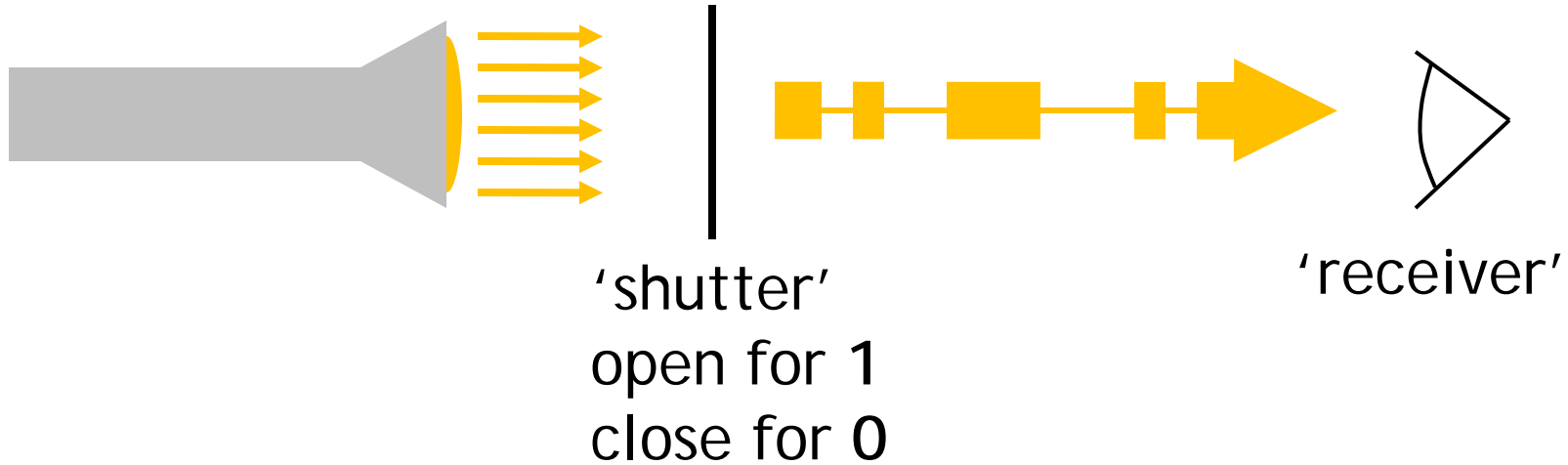


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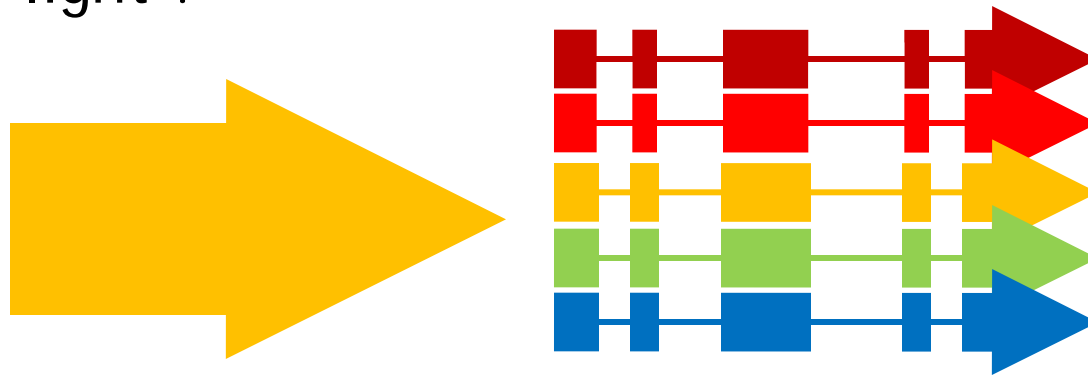


# How can lasers help us ?

Transmitting signals with light

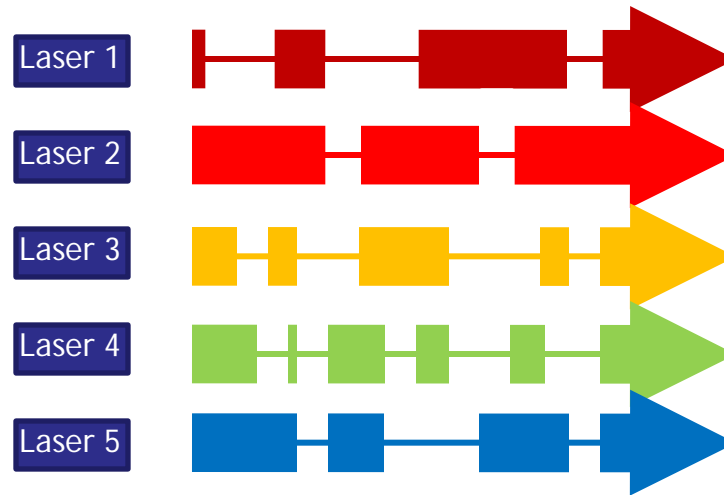


What is 'white' light ?



# Lasers in optical communications

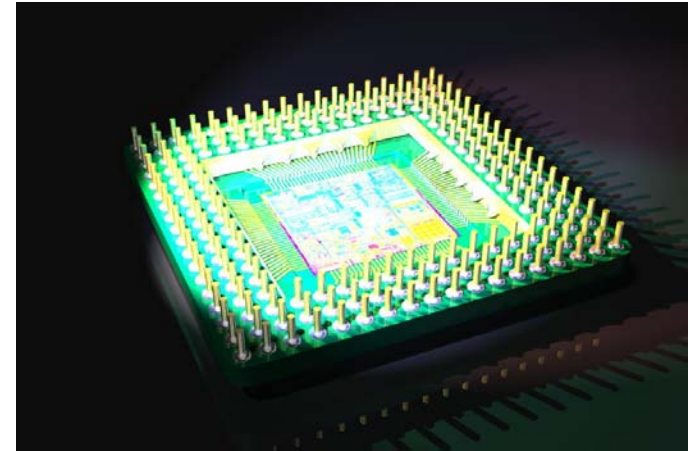
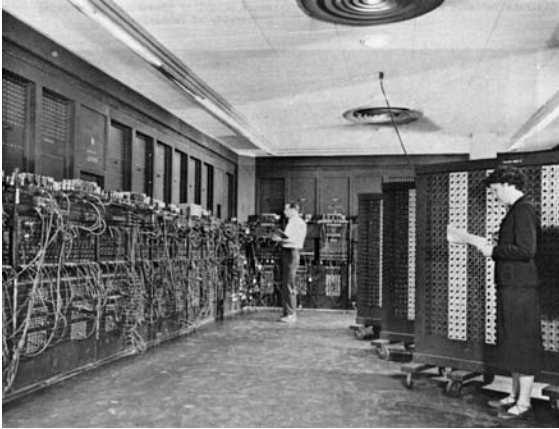
Lasers are **monochromatic** light sources:



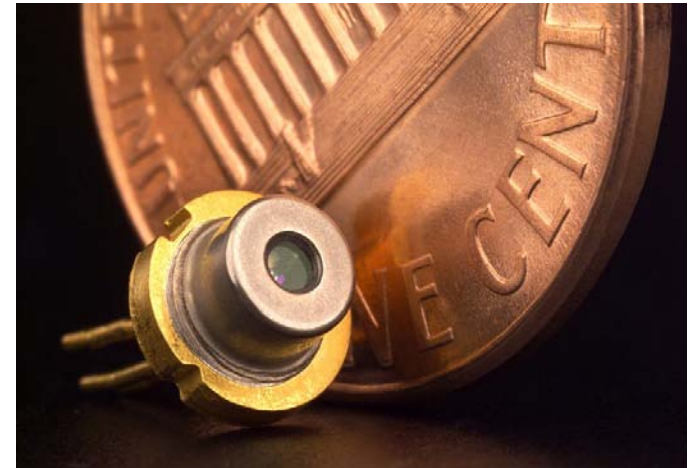
-> Potential for ultra-fast propagation of signals  
with ultra-high data carrying capacity

# Laser technology for communication

The technology that made possible modern computers...

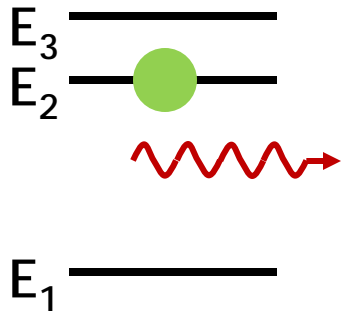


... also made possible modern communication



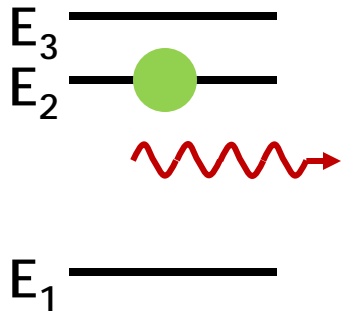
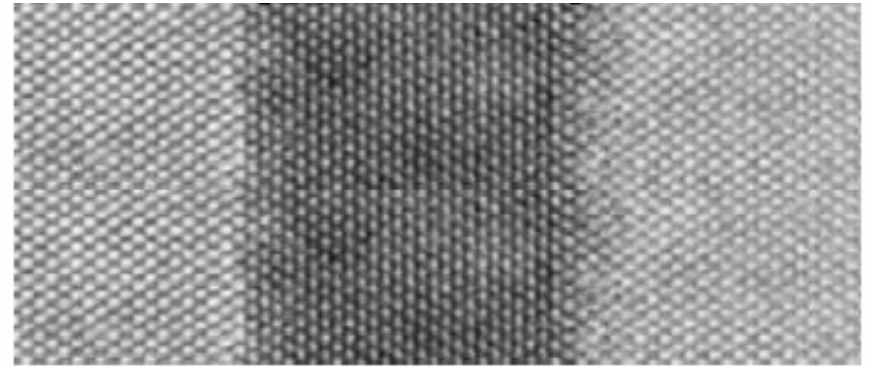
# Laser technology for communication

We can grow materials almost atom by atom and create artificial crystals with 'laser-compatible' energy levels:



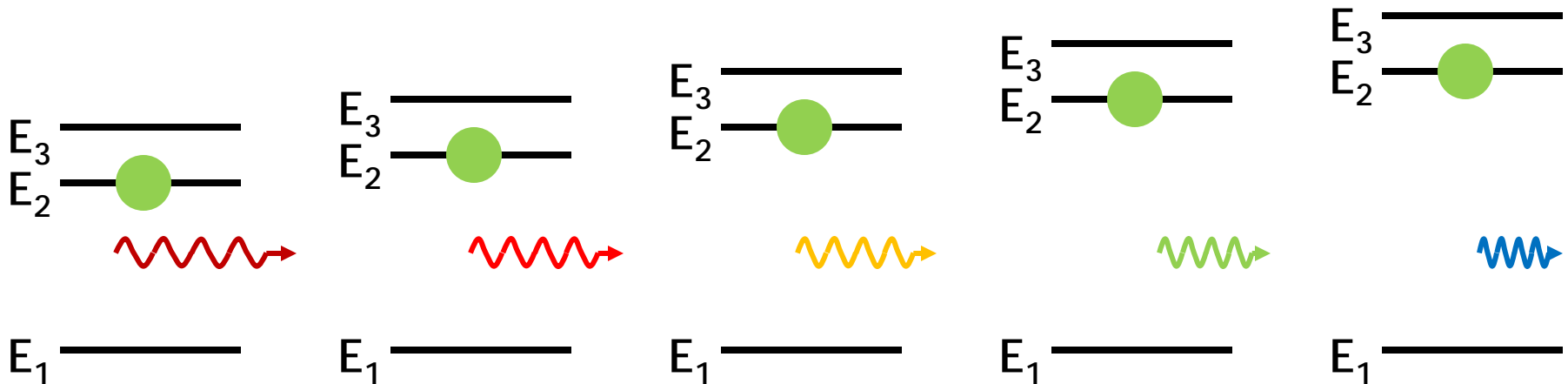
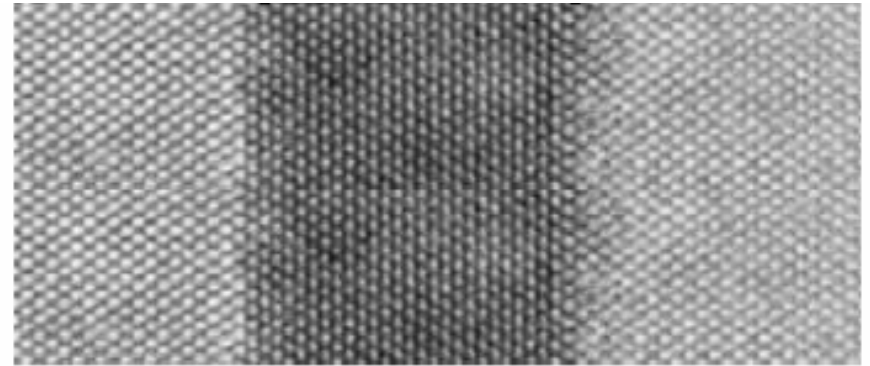
# Laser technology for communication

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# Laser technology for communication

We can grow materials almost atom by atom and create artificial crystals with 'laser-compatible' energy levels:



# Optical communication



# Optical communication



What would be the 'cable' for light signals?





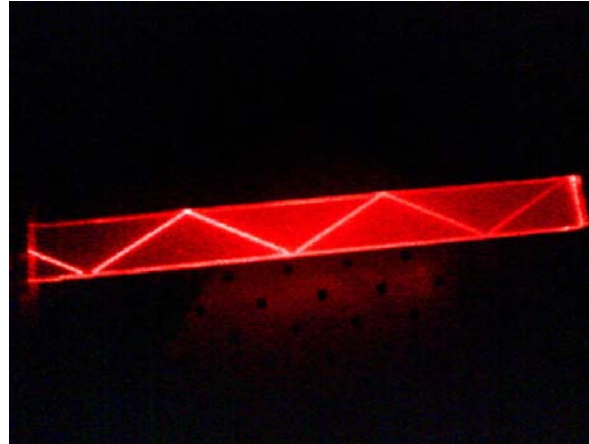
# Optical communication



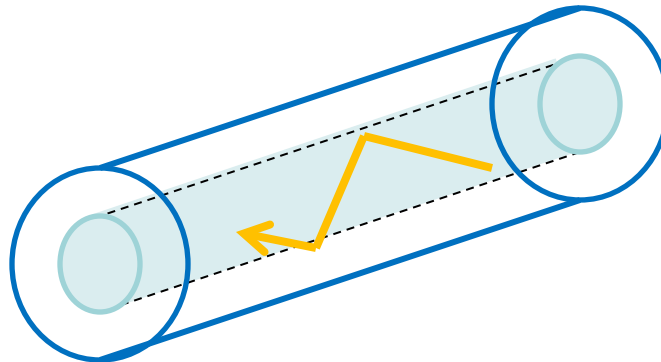
What would be the 'cable' for light signals? **Optical fibers!**

# Optical fibers

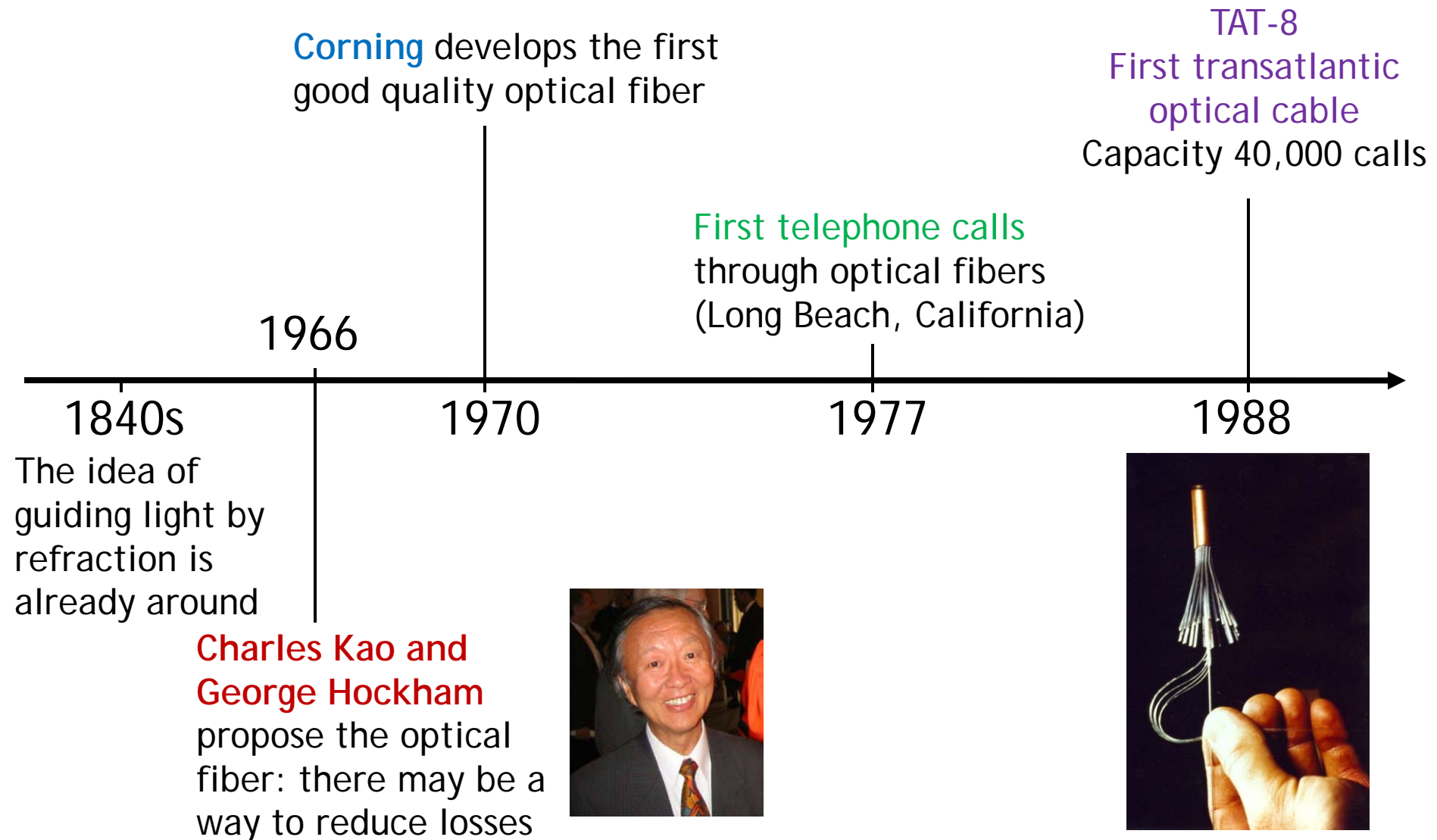
Light is reflected off the walls of a glass rod



An optical fiber is basically **a long, thin glass string**, along which light bounces back and forth!



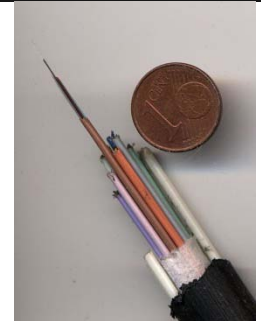
# Optical fibers: timeline



# Optical fibers: timeline

4<sup>th</sup> generation:

Optical amplification and  
wavelength-division multiplexing



Standard:  
14 Tbits/s over  
160km!

2010

1988 ← 1992

Change to 1550 nm wavelength  
Very low attenuation reached



World record (Nippon Telegraph and Telephone):  
**One Library of Congress per second**  
with 432 wavelengths over a single 240km-long fiber

# Optical fibers: timeline

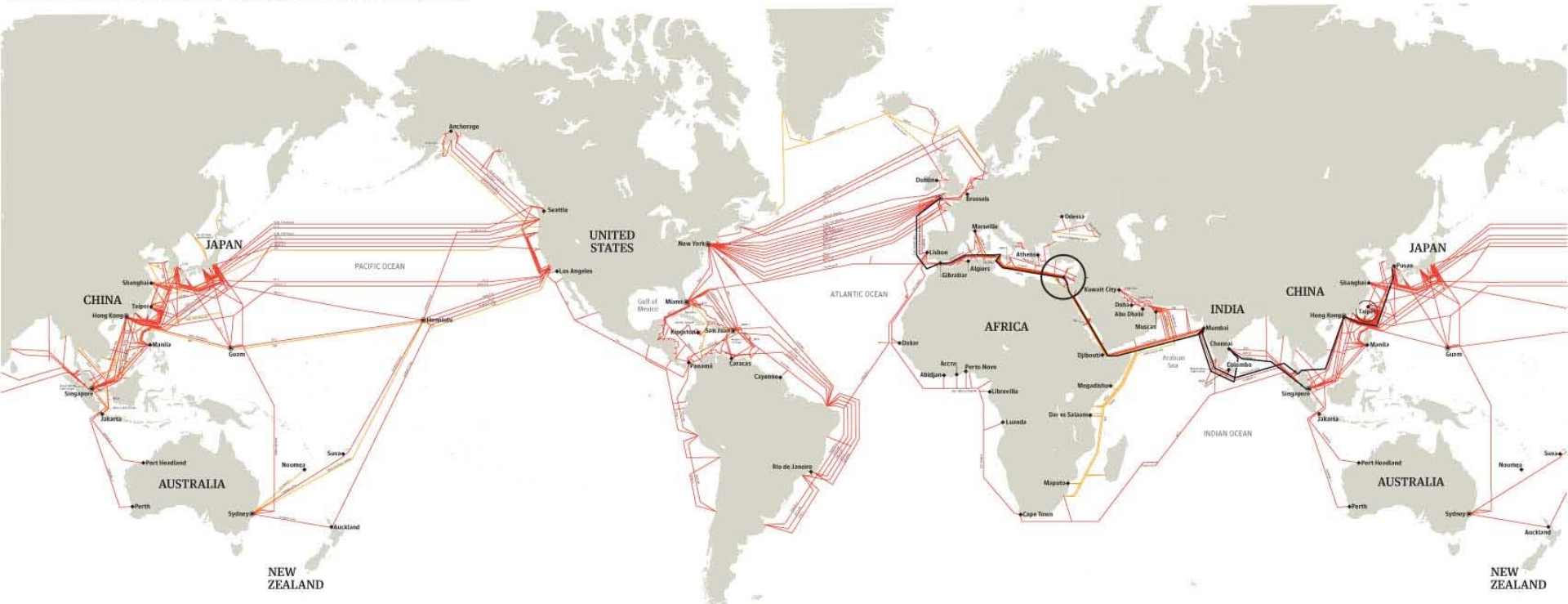


Nice !

One Library of Congress per second  
with 432 wavelengths over a single 240km-long fiber

# Optical fibers: Undersea cables

## The internet's undersea world



- Optical fibers are mainly used for **long distance communications**.
- They constitute major communication 'highways'

# Summary

