

Introduction to lasers

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Course outline

Chapter 1: Introduction, some examples of applications / main features of laser light

Chapter 2: Amplifier gain

Chapter 3: Laser Oscillator

Chapter 4: Features of laser emission

- ✓ Laser efficiency
- ✓ Spatial characteristics
- ✓ Spectral characteristics

Chapter 5: Laser operating regimes

- ✓ Continuous-wave regime
- ✓ Q-switch regime
- ✓ Mode-locked regime

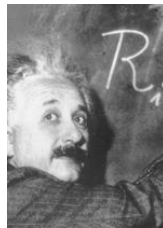
Chapter 6: Some solid-state lasers

Chapter 1 - Introduction

❑ Laser: acronym of **L**aser **A**mplification by **S**timulated **E**mission of **R**adiation

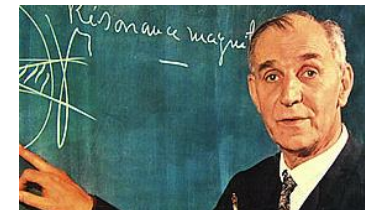
❑ Scientific milestones

- 1917: Stimulated emission



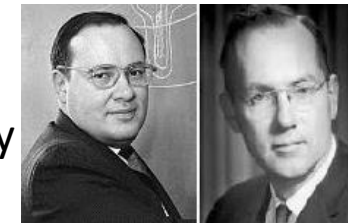
A. Einstein

- 1949: First optical pumping and first population inversion



A. Kastler

- 1958: Confinement of the electromagnetic field in an open cavity: Fabry-Perot cavity



A. Shawlow
and C. Townes

- 1960: First laser (Ruby laser)



T. Maiman



3 main elements

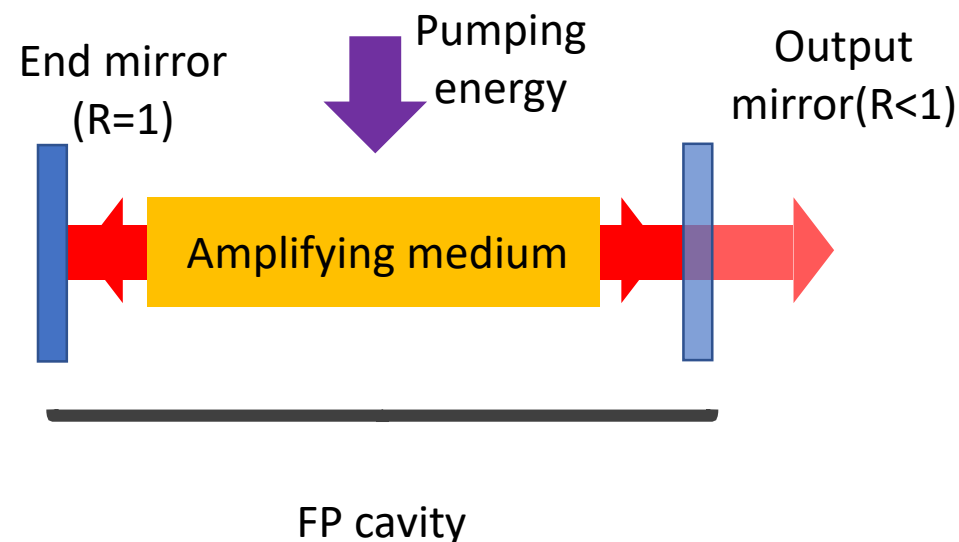
① Amplifying medium (stimulated emission)

Crystal, optical fiber, semiconductor, gas

② Optical pumping system

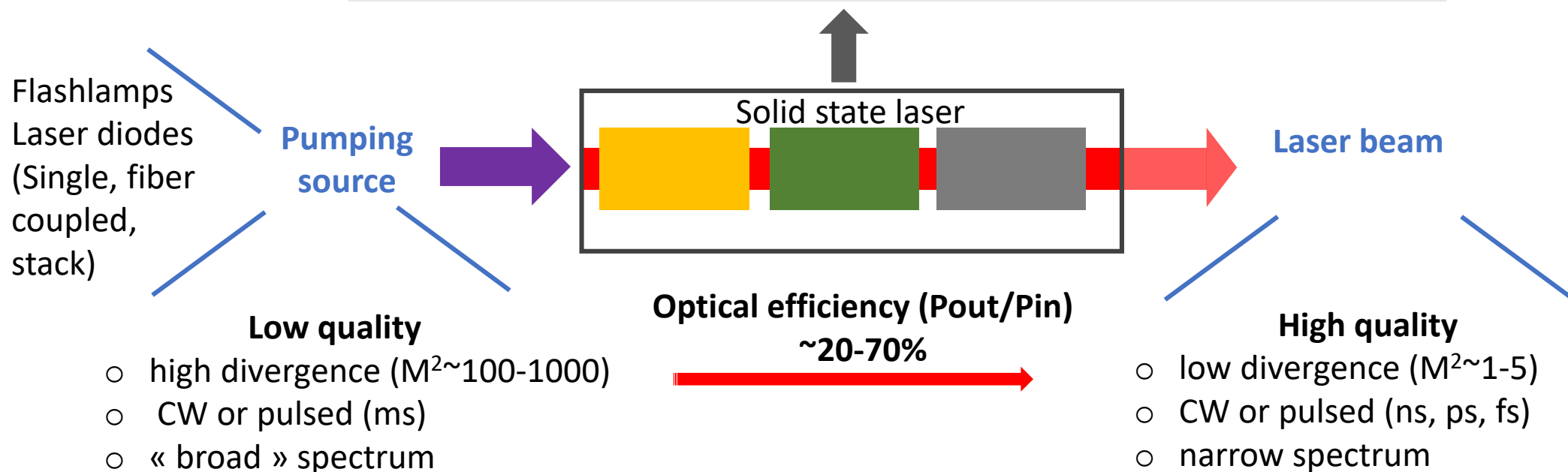
Photon absorption, electrical discharge, carrier injection (laser diode)

③ Resonant cavity: Fabry Perot, ring cavity



Laser: « transformer box for light »

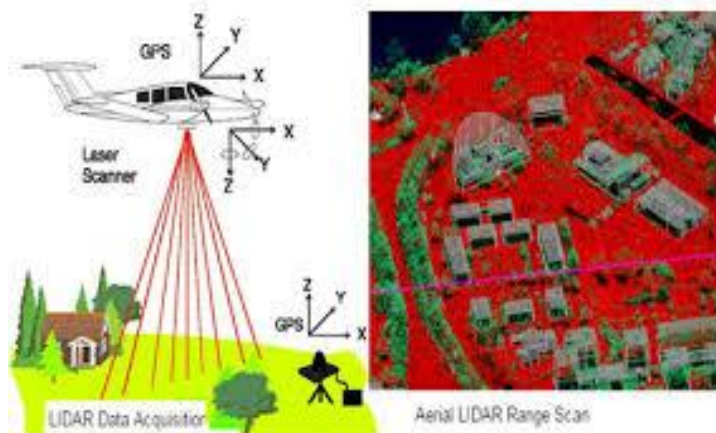
- Spatial Mode selection → Space concentration
- Pulse generation → Time concentration
- Frequency shift + frequency mode selection → Spectral concentration



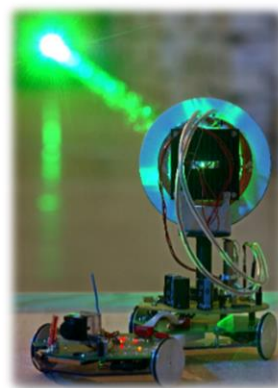
A few applications / laser light features

□ space concentration

- Low divergence beam



LIDAR (Light detection and ranging): determination of the type or concentration of gas in the atmosphere, wind speed, distance measurement to a target....



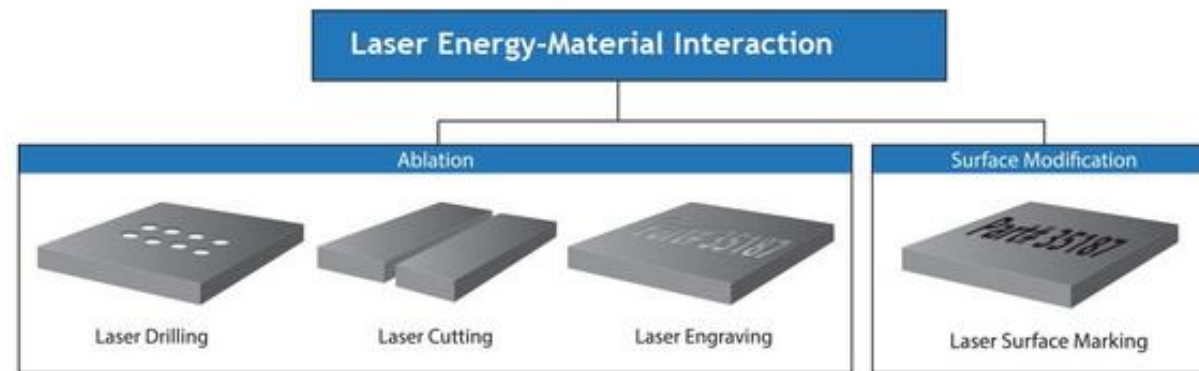
wireless power transmission



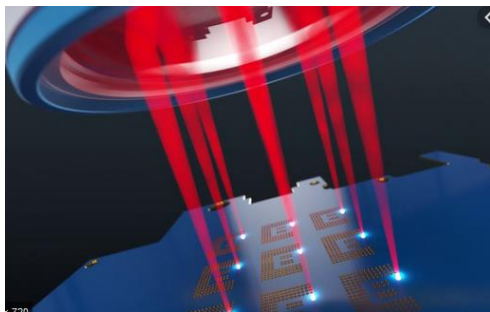
Interstellar travel using laser-powered sails
(20-30% of the speed of light)

□ Space concentration

- Focusing



Material processing



Drilling in parallel



Cutting

Time concentration

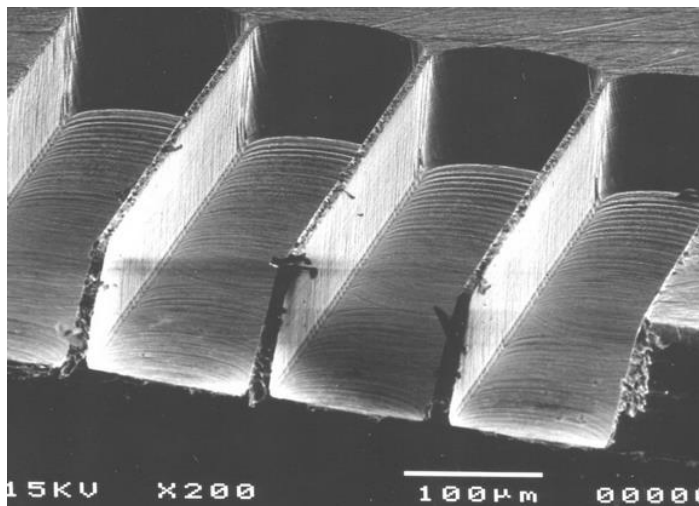


tattoo removal

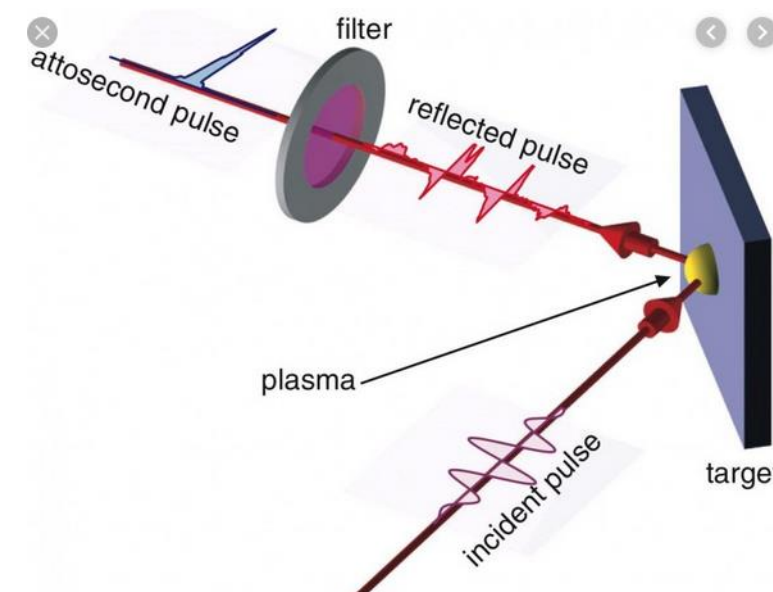


Tissue Ablation and
Micro & Nano Surgery

Femtosecond to nanosecond Pulses



Micro and nanostructuring:
waveguide writing, microfluidic
channeling, Silicon scribing



High harmonic generation (due to strong nonlinear interactions when a laser light is focused into a gas (usually at reduced pressure))
Instead of synchrotron radiation

□ Spectral concentration

- Capability to control the laser frequency with high accuracy $\Delta\nu/\nu \# 10^{-14}$
 - frequency reference
 - Atom manipulation, atom cooling (Atom optics)