Empa
Materials Science and Technology

EPFL

# Laser Processing of Materials

## Introduction

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# Applications

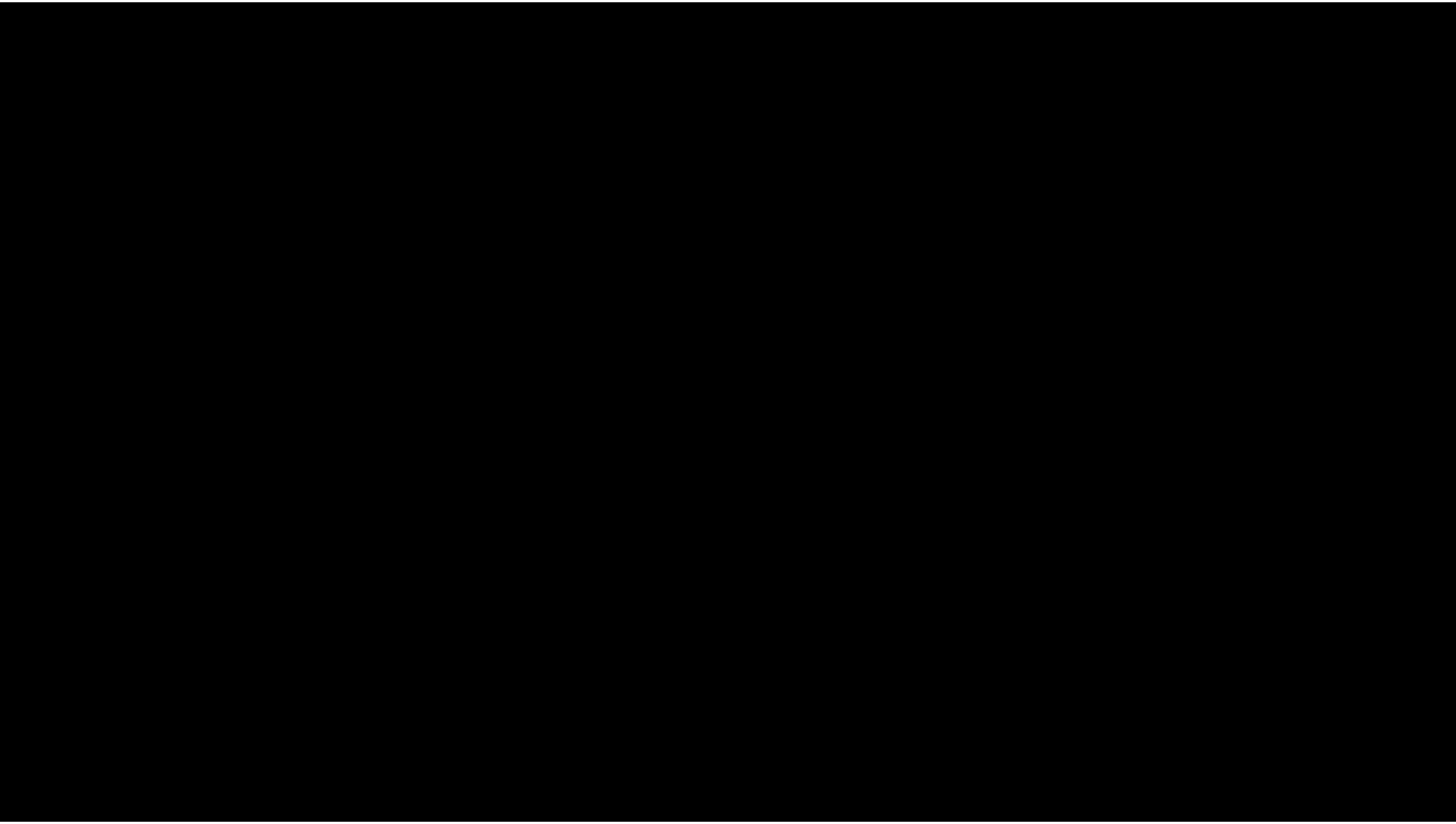
Classical Laser Processing:

- Cutting
- Drilling
- Bending
- Welding
- Marking
- Ablation

Generative Techniques:

- Sintering
- Polymerization

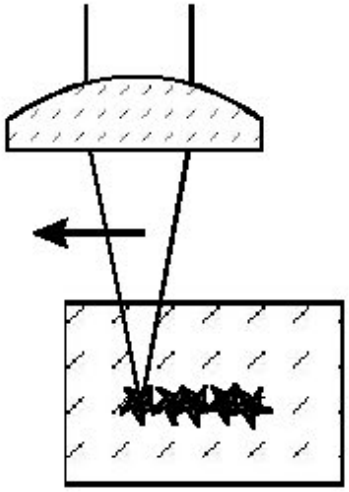
# Some Nice Examples

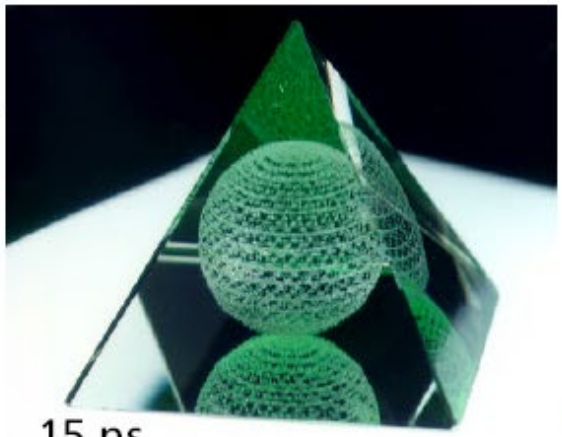


# Some Puzzles

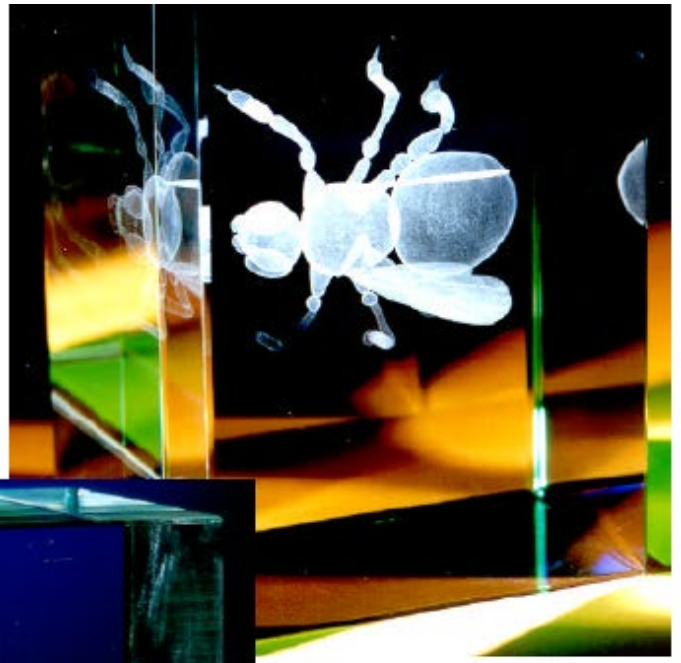
How does it work in transparent glass???

- DPSSL, Stab/Innoslab
- Process Intensity > $10^9$ W/cm$^2$
- Q-switch, f bis 20 kHz
- Pulse duration: 15ns / 6ns / 100ps
- $M^2 = 1$, $r_F = 50$ - 200 µm



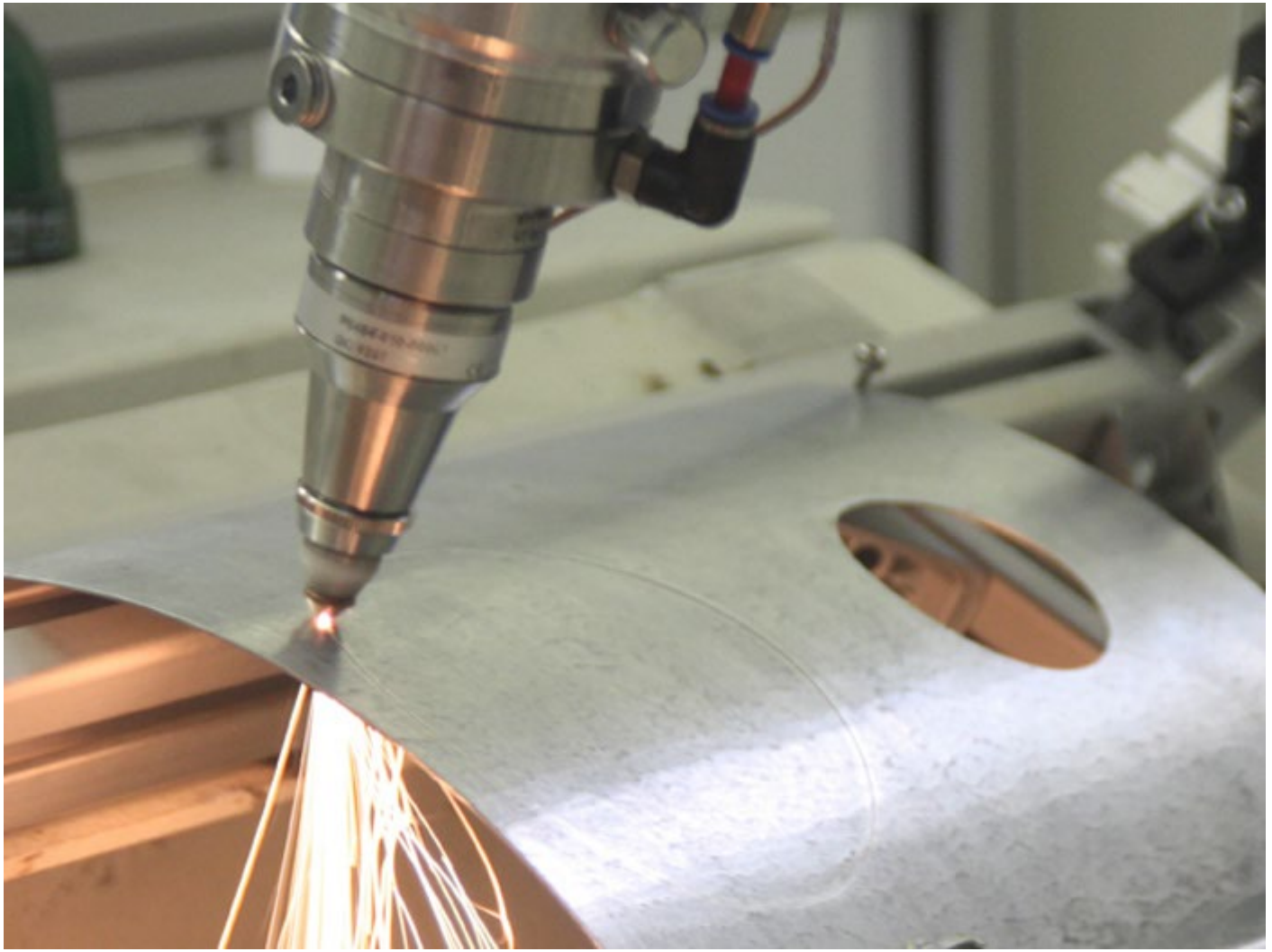


15 ns



100 ps

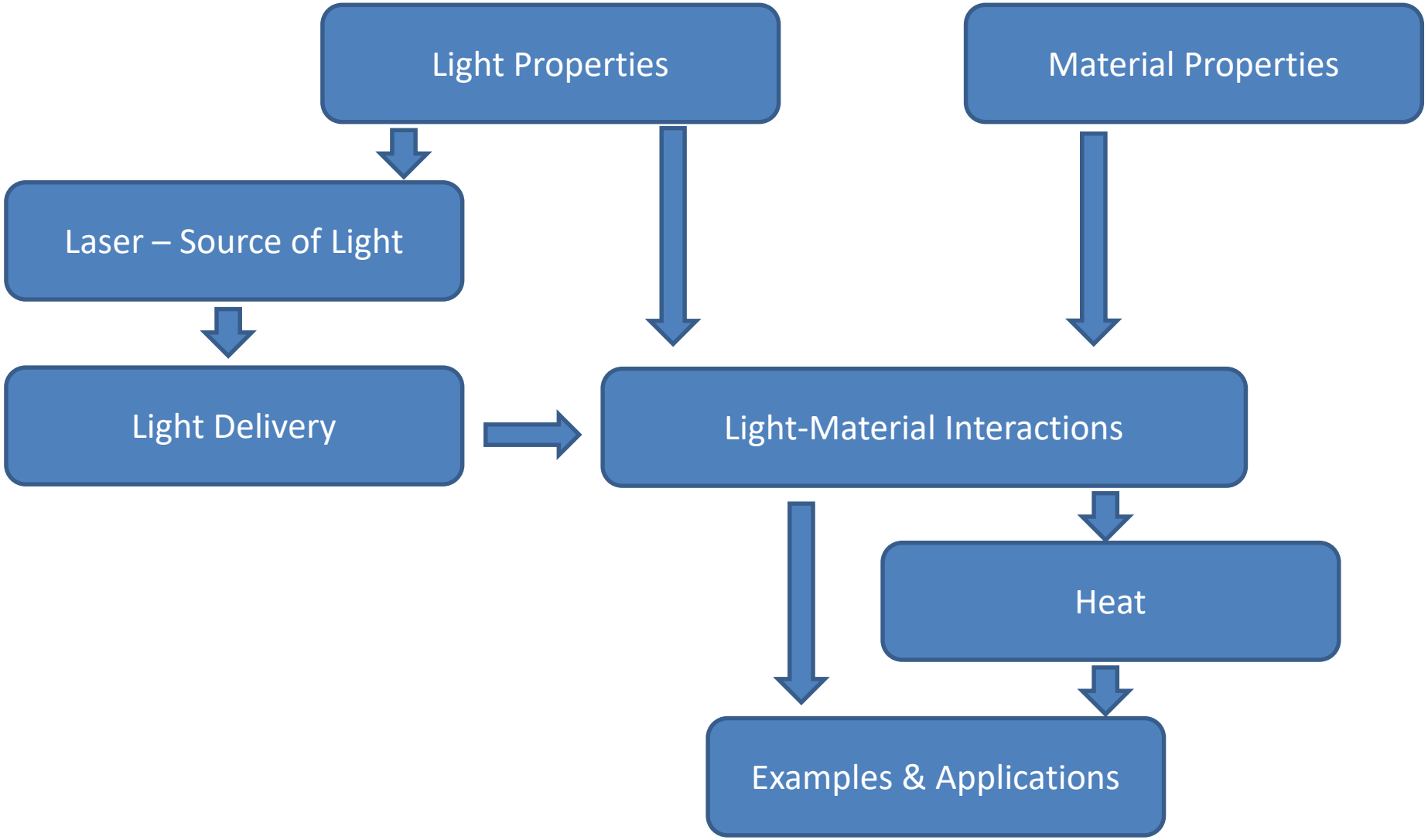
# What do you think are the important questions of laser processing?



# What do you think are the important questions of laser processing?

- Where (and how) the light is absorbed?
- Where the heat goes?
- What happens to the material due to heating?

# Content of the Course



# Literature


- D. Bäuerle; Laser Processing and Chemistry, 3rd ed. Springer, Berlin, 2000
- The Theory of Laser Materials Processing, ed. John Dowden, Springer, 2009
- Laser Processing of Materials, ed. Peter Schaaf, Springer, 2010

- S.M Sze; Semiconductor Devices Physics and Technology, Wiley&Sons, 1985
- W.M. Steen; Laser Material Processing, Springer, 1991
- Born & Wolf; Principles of Optics, Pergamon, 1999
- B.E.A. Saleh and M.C. Teich, Fundamental of Photonics, John Wiley & Sons, New York., 1991
- Hecht; Optik, Addison- Wesley, 1999
- Siegman; Lasers, University Science Books, 1986
- Carslaw & Jäger; Conduction of Heat in Solids, Claredon, 1997

# Some information on the web

- **Scienceworld:**

  *http://scienceworld.wolfram.com/physics/Laser.html*
  *http://scienceworld.wolfram.com/physics/topics/Optics.html*

- **Encyclopedia of Laser Physics and Technology**:
  www.rp-photonics.com/encyclopedia.html

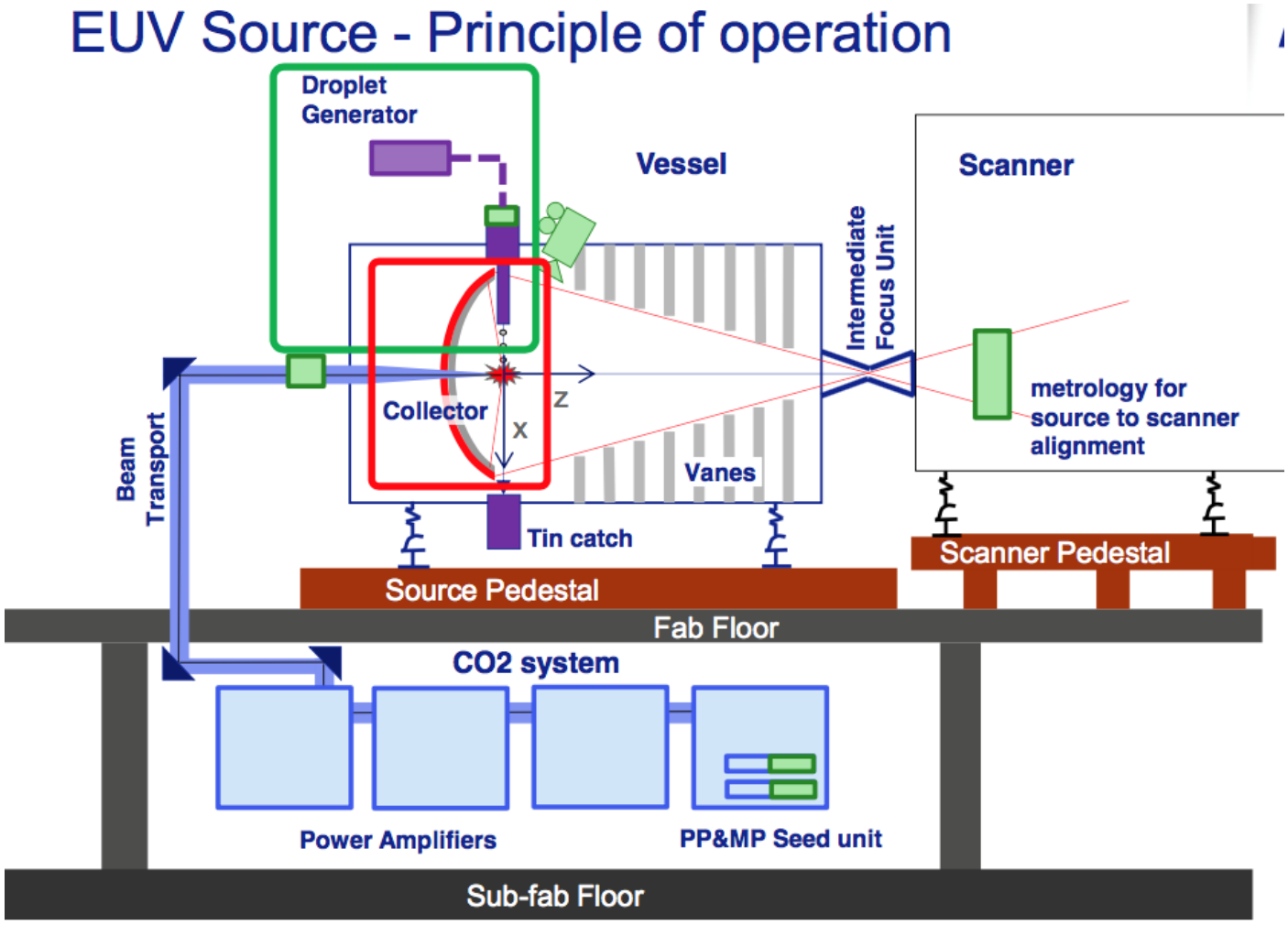
- **Laser history:**

  *http://www.bell-labs.com/history/laser/*

- **TheTech:**

  *http://www.thetech.org/exhibits/online/lasers/overview.html*

# New topics


EUV Source - Principle of operation
Droplet Generator
Vessel
Scanner
Intermediate Focus Unit
Collector
z
x
Beam Transport
Vanes
metrology for source to scanner alignment
Tin catch
Source Pedestal
Scanner Pedestal
Fab Floor
CO2 system
Power Amplifiers
PP&MP Seed unit
Sub-fab Floor