Types of LASERs

- **Solid State LASERS**
  - Ruby LASER
  - Nd : YAG LASER
  - Ti : Sapphire LASER
- **Semiconductor LASERs**
- **Atomic and Ionic Gas LASERs**
  - He-Ne LASER
  - Argon LASER
  - Copper Vapor LASER
- **Molecular Gas LASERs**
  - CO_2 LASER
  - N_2 LASER
- **Chemical LASERs**
  - Iodine LASER
  - Excimer LASER
- **Dye LASERs**

Solid State LASER

- **Ruby LASER**

  - Ruby (0.05% Cr_2O_3 in an Al_2O_3 lattice), was used as active medium to construct first ever LASER.

  - The chromium (Cr^{3+}) ions are excited by the broadband emission from a flash lamp coiled around it, or placed alongside it within an elliptical reflector.

  - The energy level diagram may be regarded as pseudo – three level system.

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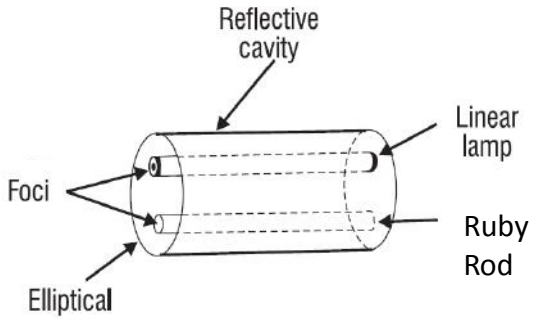
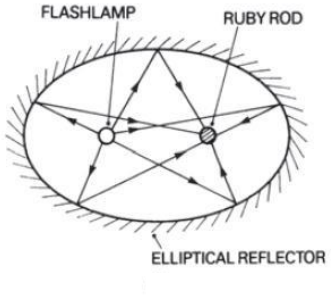
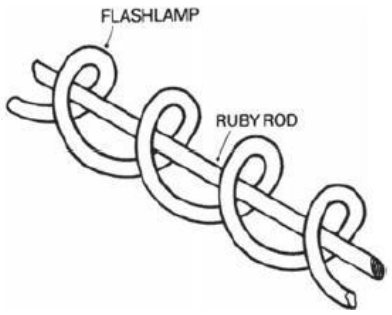
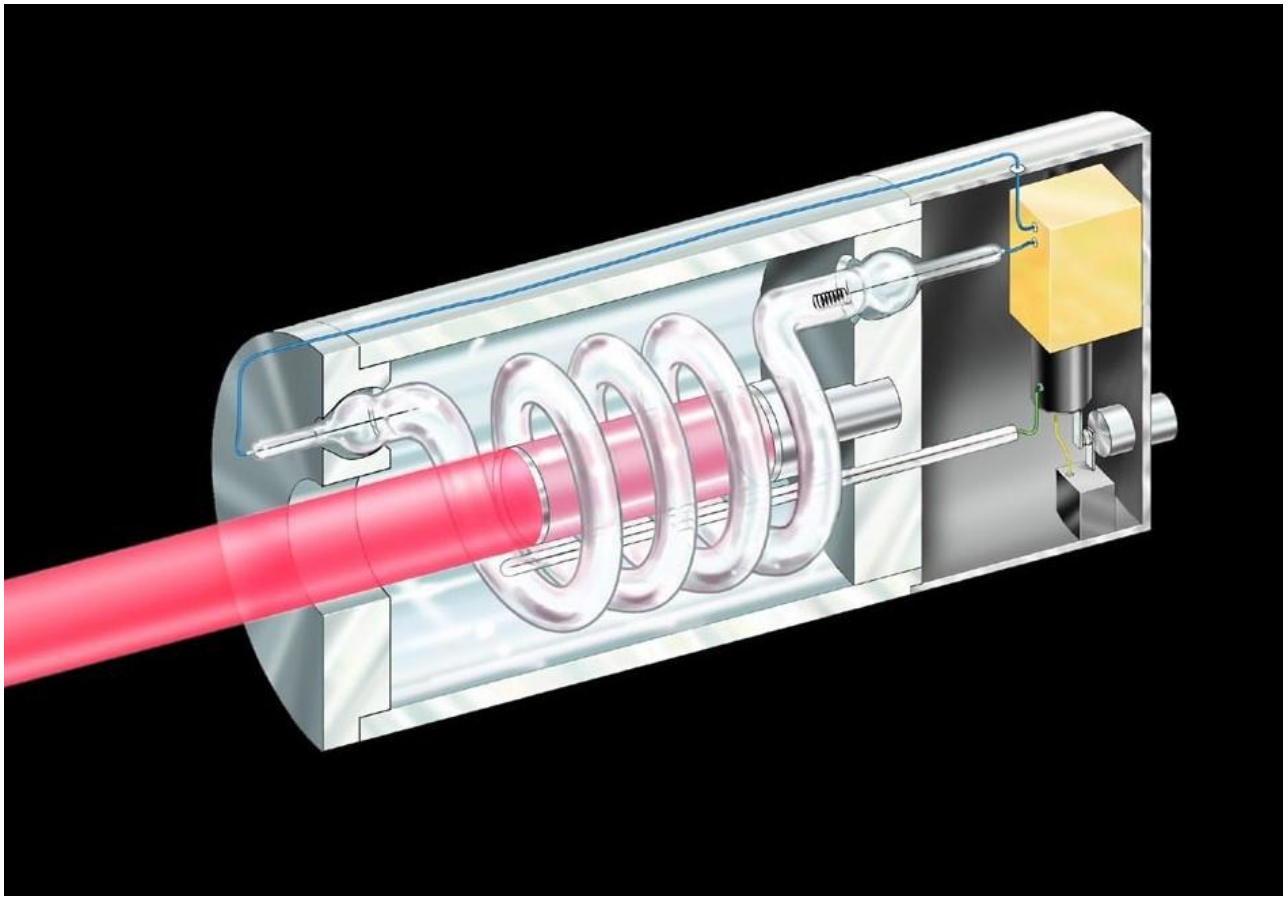
  - The energy level diagram may be regarded as pseudo – three level system.
  - Three Cr^{3+}levels $^4A_2$, $^4T_1$ or $^4T_2$, and ^2E, are involved.

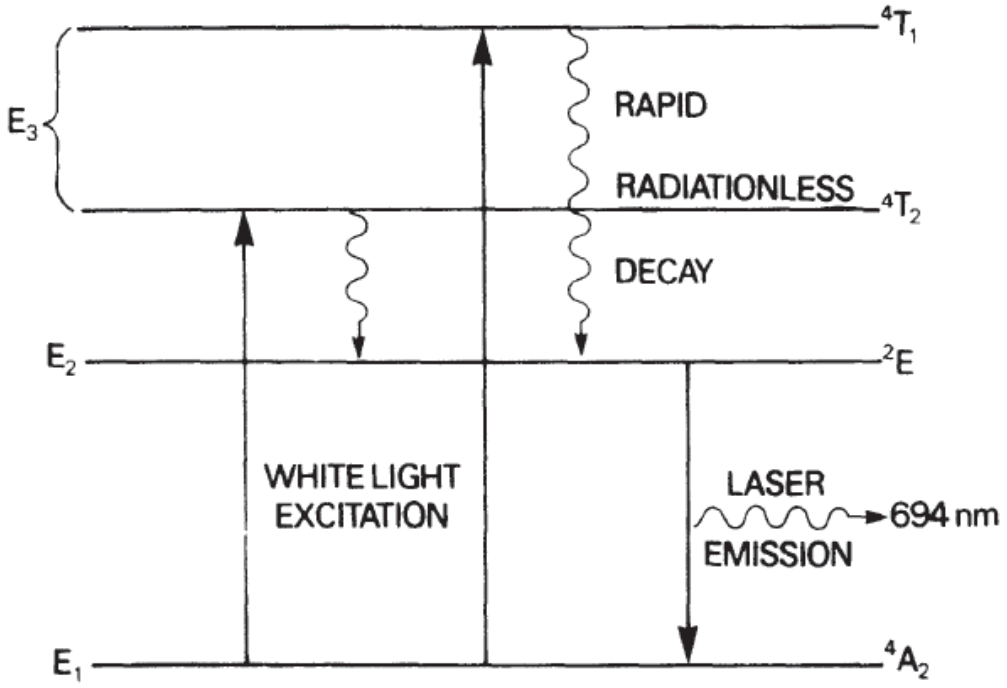








- The initial flash lamp excitation takes the Cr^{3+} ions up from the ground state E_1 ($^4A_2$) to one of the two E_3 (^4T) levels.
- Then they rapidly decay to E_2 level.
- Population inversion is created between the E_2 and E_1 states, leading to laser emission at a wavelength of 694.3 nm.
- Beam duration – 0.3 to 3ms
- Pulse delay – several seconds to a minute.
- Pulse energy - ~ 200 J

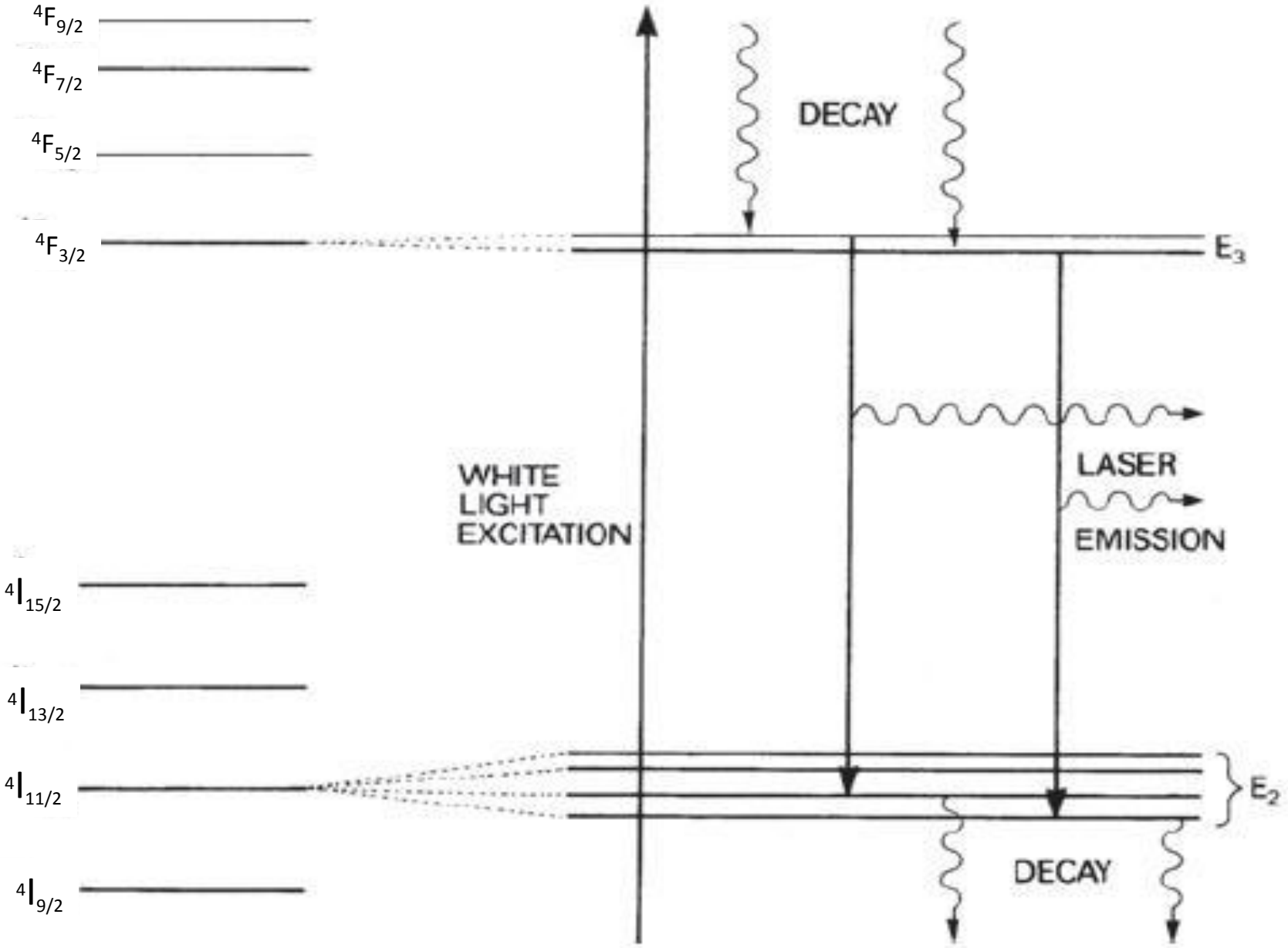


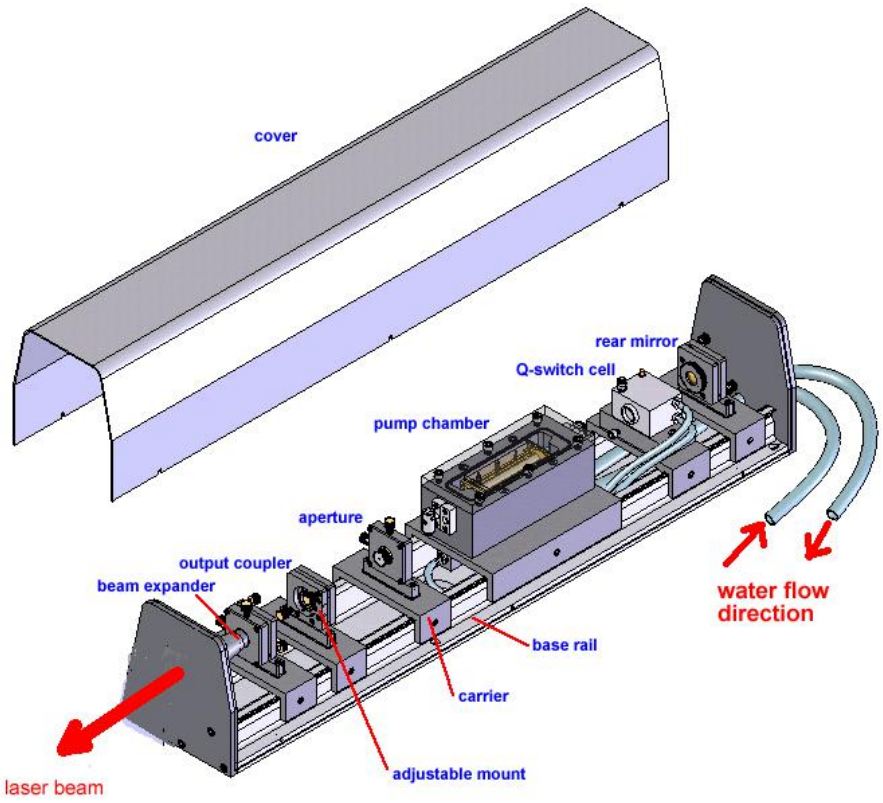
Nd:YAG LASER

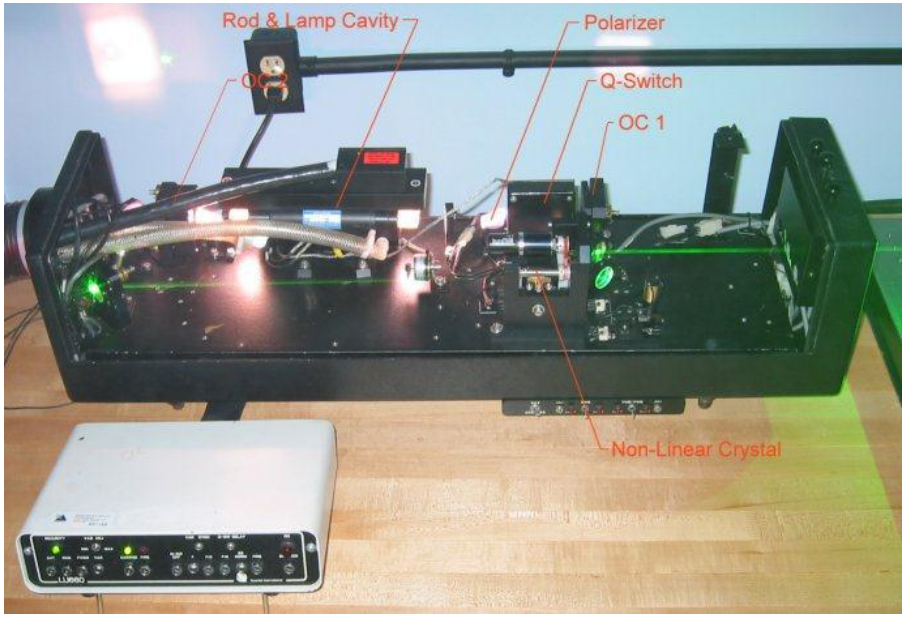
- Yttrium Aluminium Garnet crystal ($Y_3AI_5O_2$), act as a host for neodymium ions.

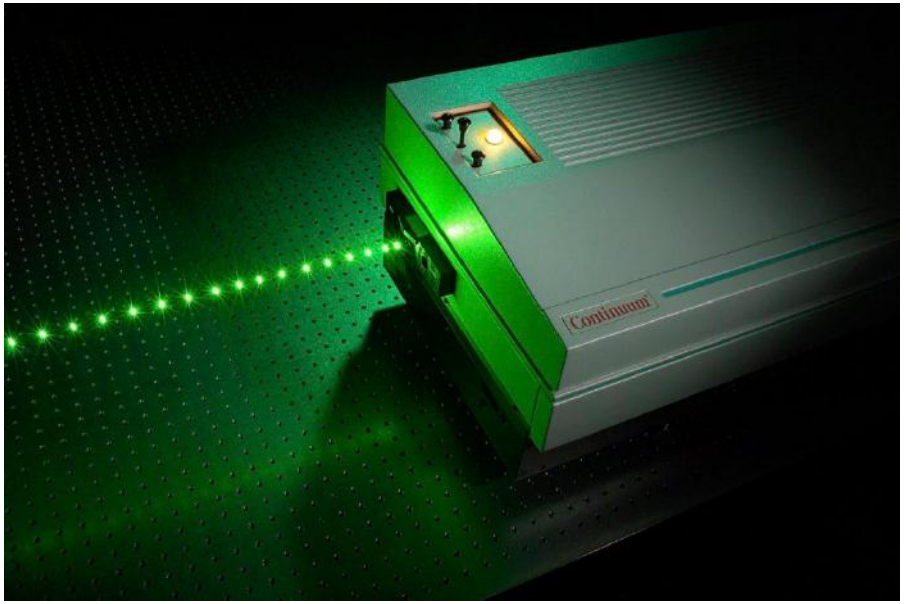
- the energy levels of neodymium ions (Nd^{3+}) which are naturally degenerate in the free state, are split by interaction with the crystal field.

- Transitions between components of the $^4F_{3/2}$ and $^4I_{11/2}$ states, which are forbidden in the free state, become allowed due to crystal field splitting and can give rise to laser emission.


$^4F_{9/2}$
$^4F_{7/2}$
$^4F_{5/2}$
$^4F_{3/2}$
DECAY
E_3
WHITE
LIGHT
EXCITATION
LASER
EMISSION
$^4I_{15/2}$
$^4I_{13/2}$
$^4I_{11/2}$
$^4I_{9/2}$
E_2
DECAY


cover
rear mirror
Q-switch cell
pump chamber
aperture
output coupler
beam expander
water flow direction
base rail
carrier
adjustable mount
laser beam


Rod & Lamp Cavity
Polarizer
OC 2
Q-Switch
OC 1
Non-Linear Crystal


Continuum

- The $^4F_{3/2}$ levels are initially populated following nonradiative decay from higher energy levels.

- $^4I_{11/2}$ laser level lies above the $^4I_{9/2}$ ground state, we thus have a *pseudo-four-level system.*

- The principal emission wavelength for neodymium laser is around 1.064 *μm,* in the near-infra-red region.

- The output power of a Nd:YAG laser, in CW mode is several watts and can exceed to 200 W.

- In pulse modes energy depends on method of pulsing but it can vary from several to 100 J for single pulse.