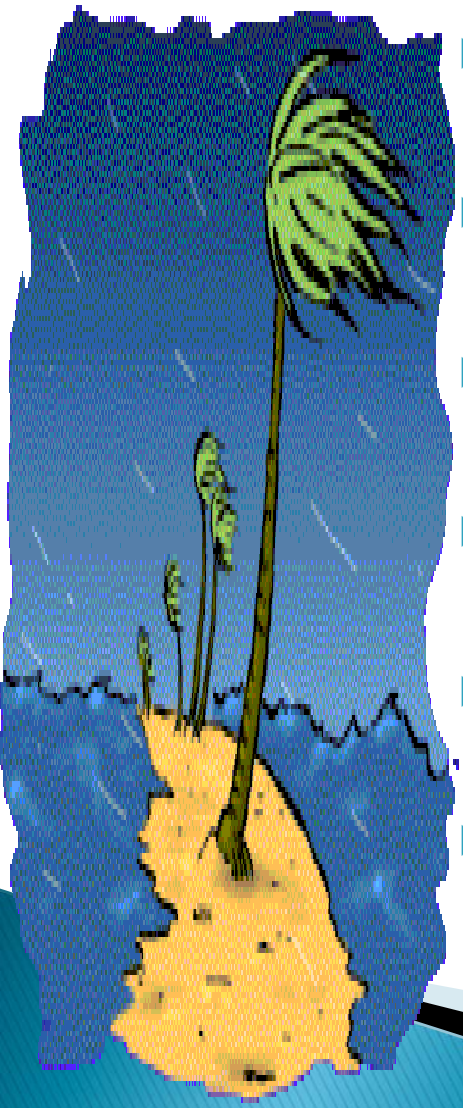
Design and Fabrication of Prototype Transversely Excited Atmospheric (TEA) Nitrogen Laser

Mukhtar Hussain

CONTENT



- Laser and history of lasers
- Types of lasers
- High tension power supply
- What is TEA N_2 laser
- Design and fabrication of TEA N_2 laser
- Future work

What is Laser ?

L ⇒ Light

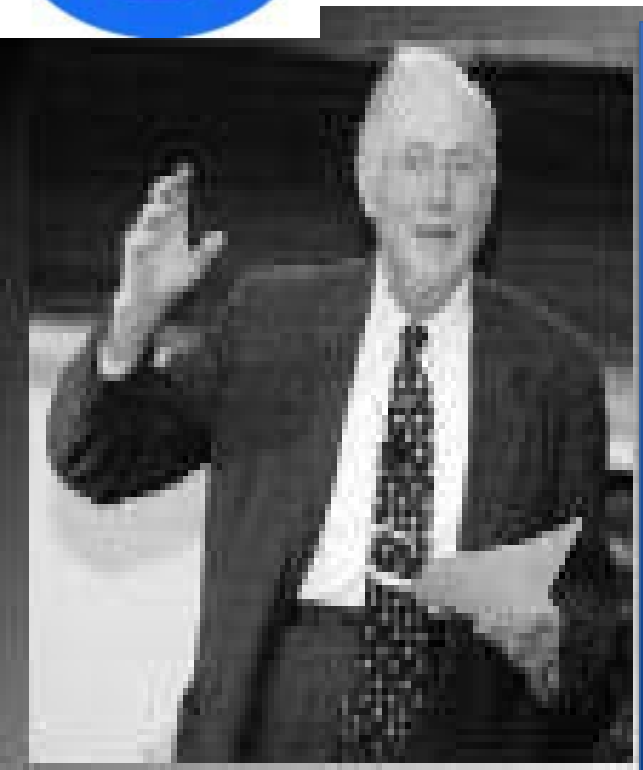
A ⇒ Amplification by

S ⇒ Stimulated

E ⇒ Emission of

R ⇒ Radiation

History of Laser



- The idea of stimulated emission was given by Einstein 1916
- The basic scientific principle behind a laser was first put forward by DR. Charles H.Townes in 1954.
- In 1960, Theodore Maiman invented the ruby_laser
- In 1960 Gas laser made by Ali Javan
- 1n 1962 Robert Hall invented Semiconductor Injection laser
- In 1963 N_2 laser by Heard

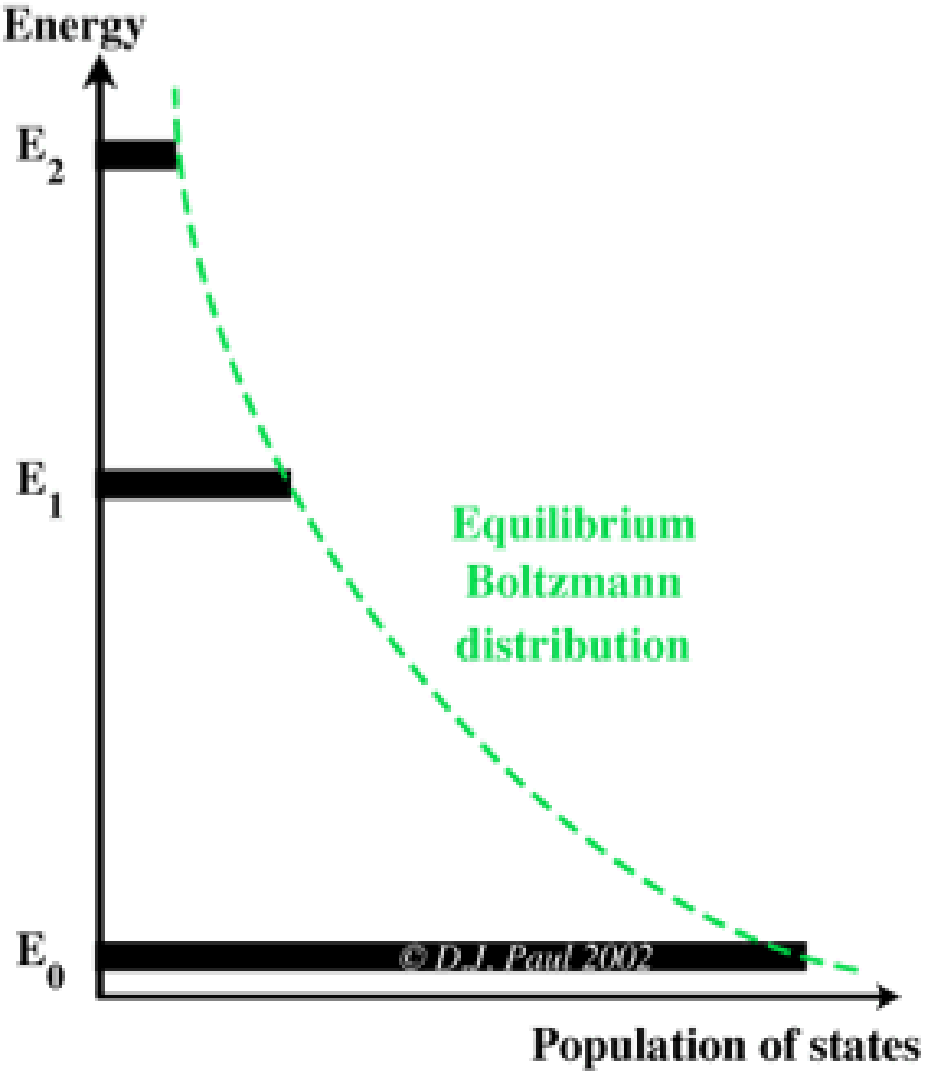
Perquisites of Laser

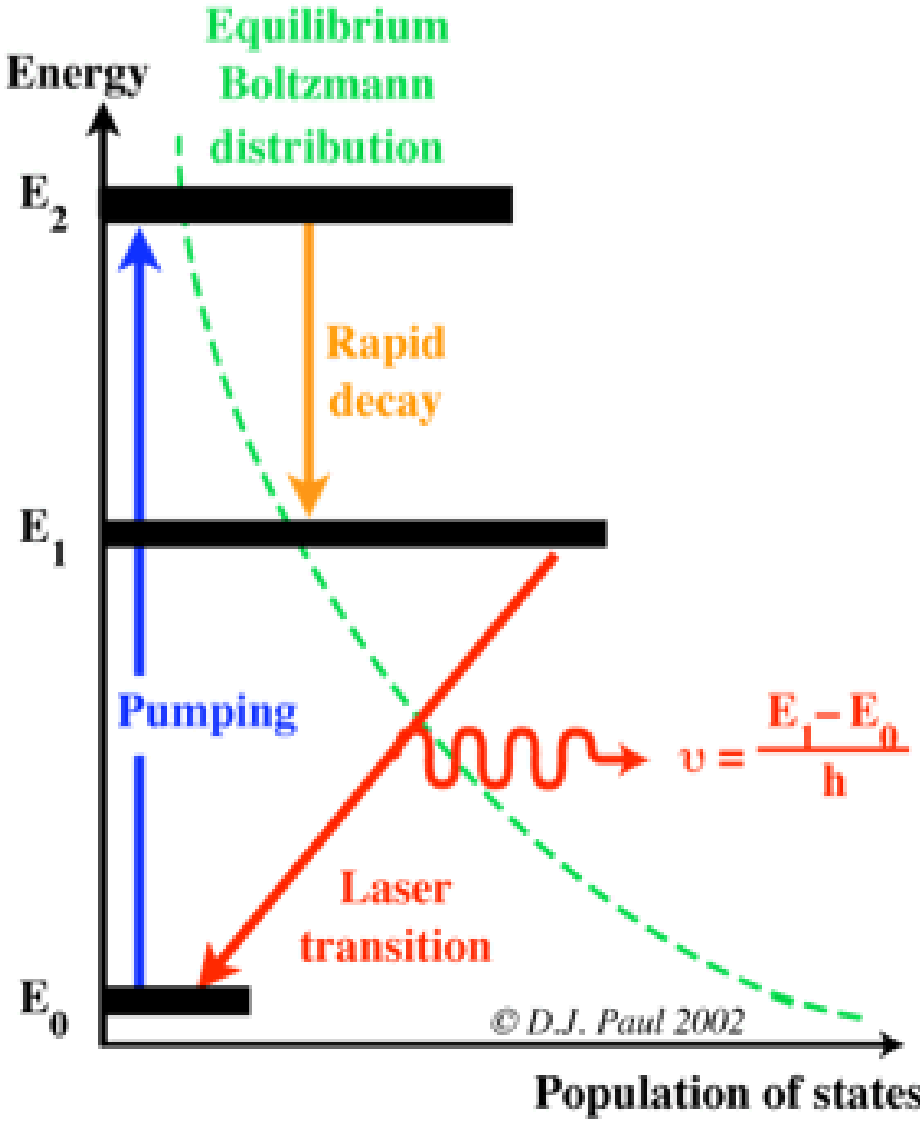
- An energy source
- Gain medium or laser medium (for population inversion)
- Two or more mirror that form optical resonator

Basic Principle of Laser

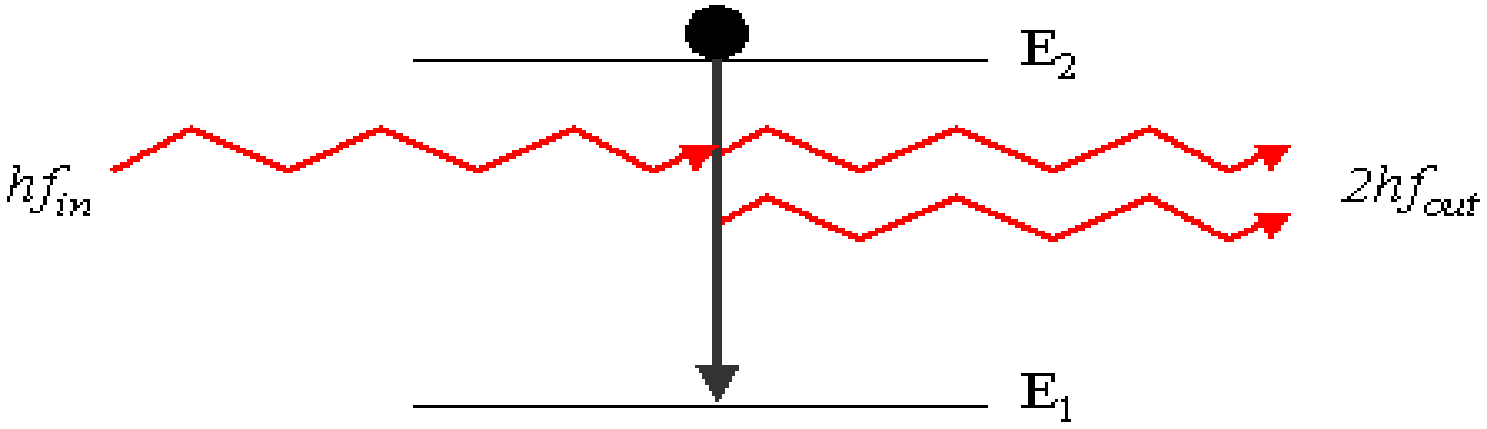
- Laser is based upon
- The stimulated emission process
- The population inversion.

Population Inversion

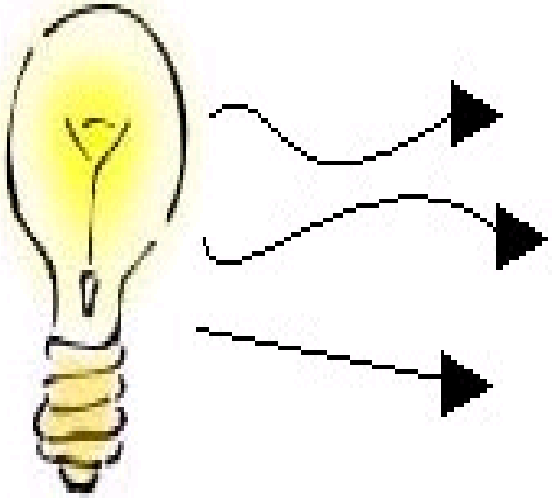


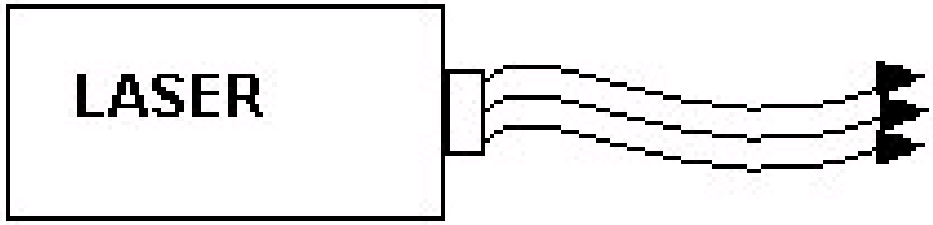


Stimulated Emission

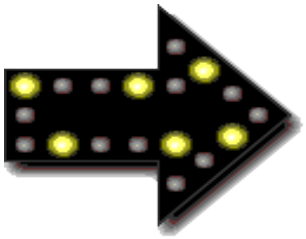


Characteristics of Laser Beam

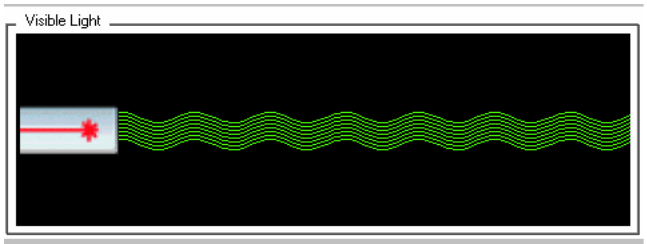




- Multi Wavelengths
- Multi Direction
- Incoherent



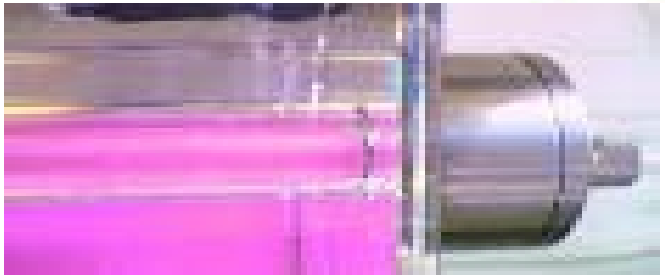
- Monochromatic
- Directional
- Coherent



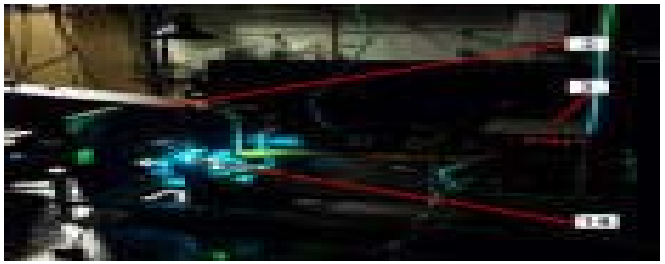
Types of Lasers

SOLID STATE LASERS

EX: RUBY LASER

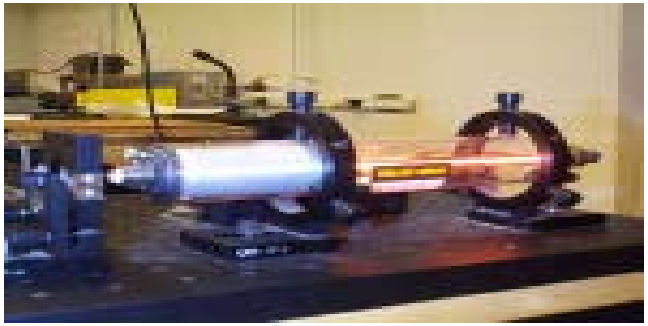


LIQUID AND DYE LASERS

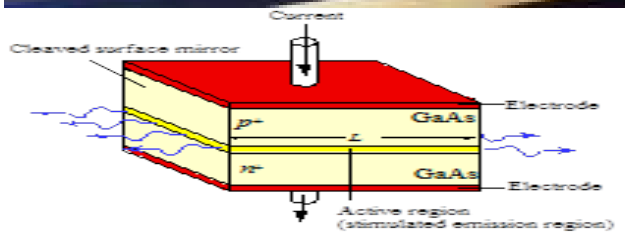


GASEOUS LASERS

EX:HE-NE LASER



Semiconductor Laser
EX: GaAs



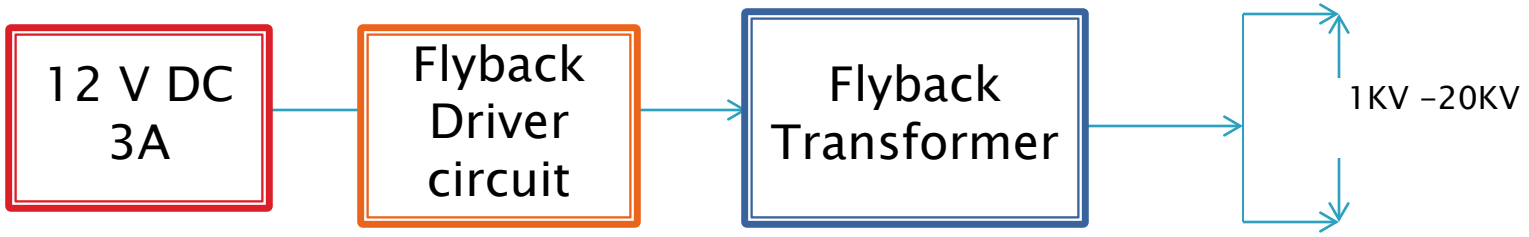
A schematic illustration of a GaAs homojunction laser diode. The cleaved surfaces act as reflecting mirrors.

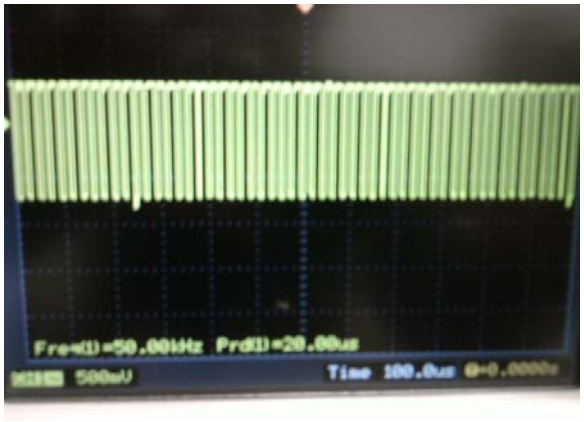
My Work

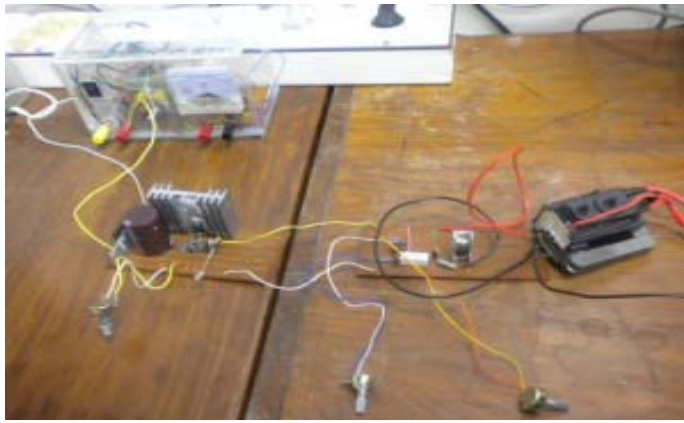
- I will design and fabricate the Gas laser Transversely Excited Atmospheric(TEA) N_2)
- High Tension Power Supply using Flyback transformer
- Then Design and Fabrication of TEA N_2 Laser

High Tension Power Supply

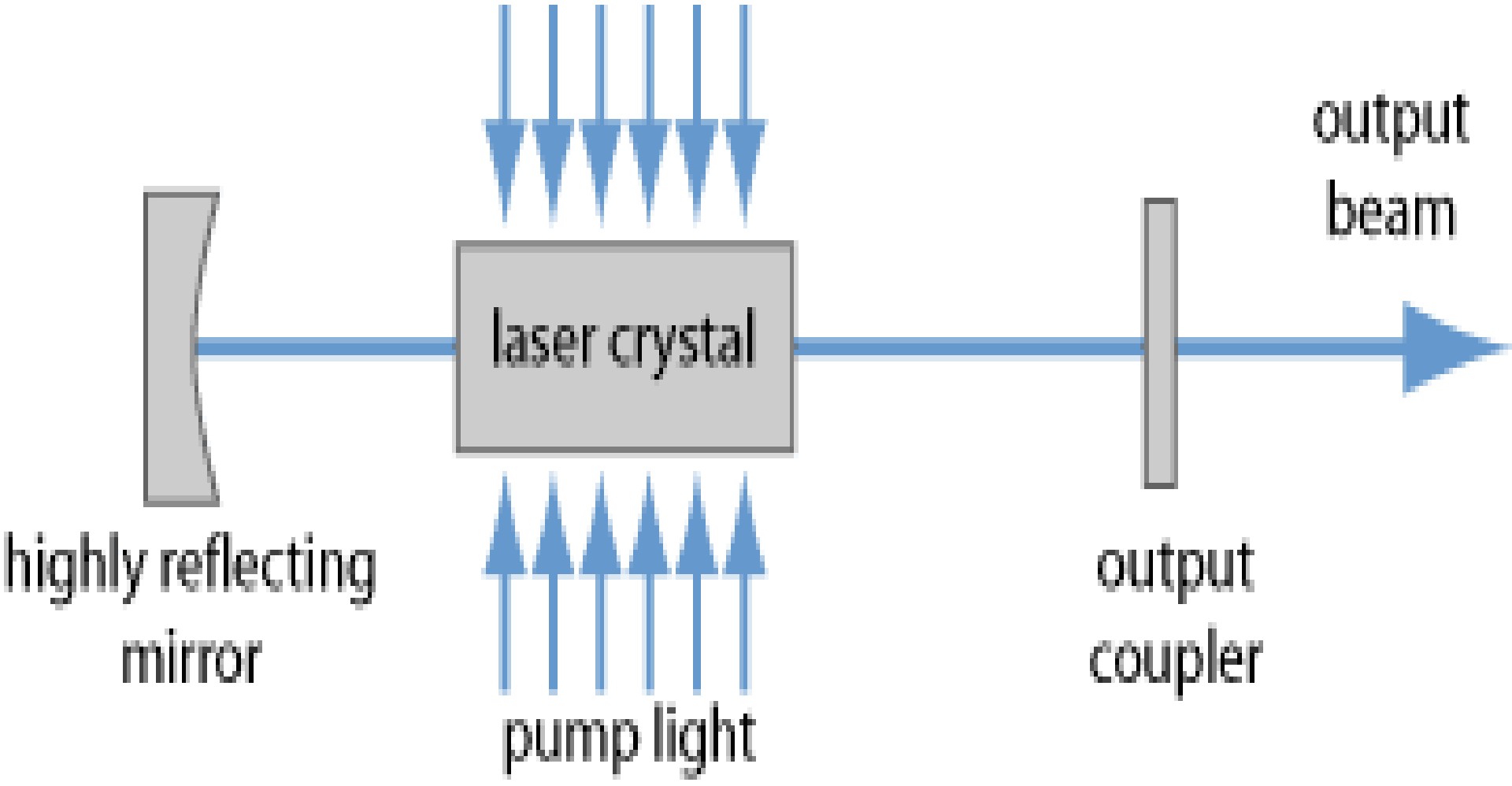
- Schematic diagram of HT power supply



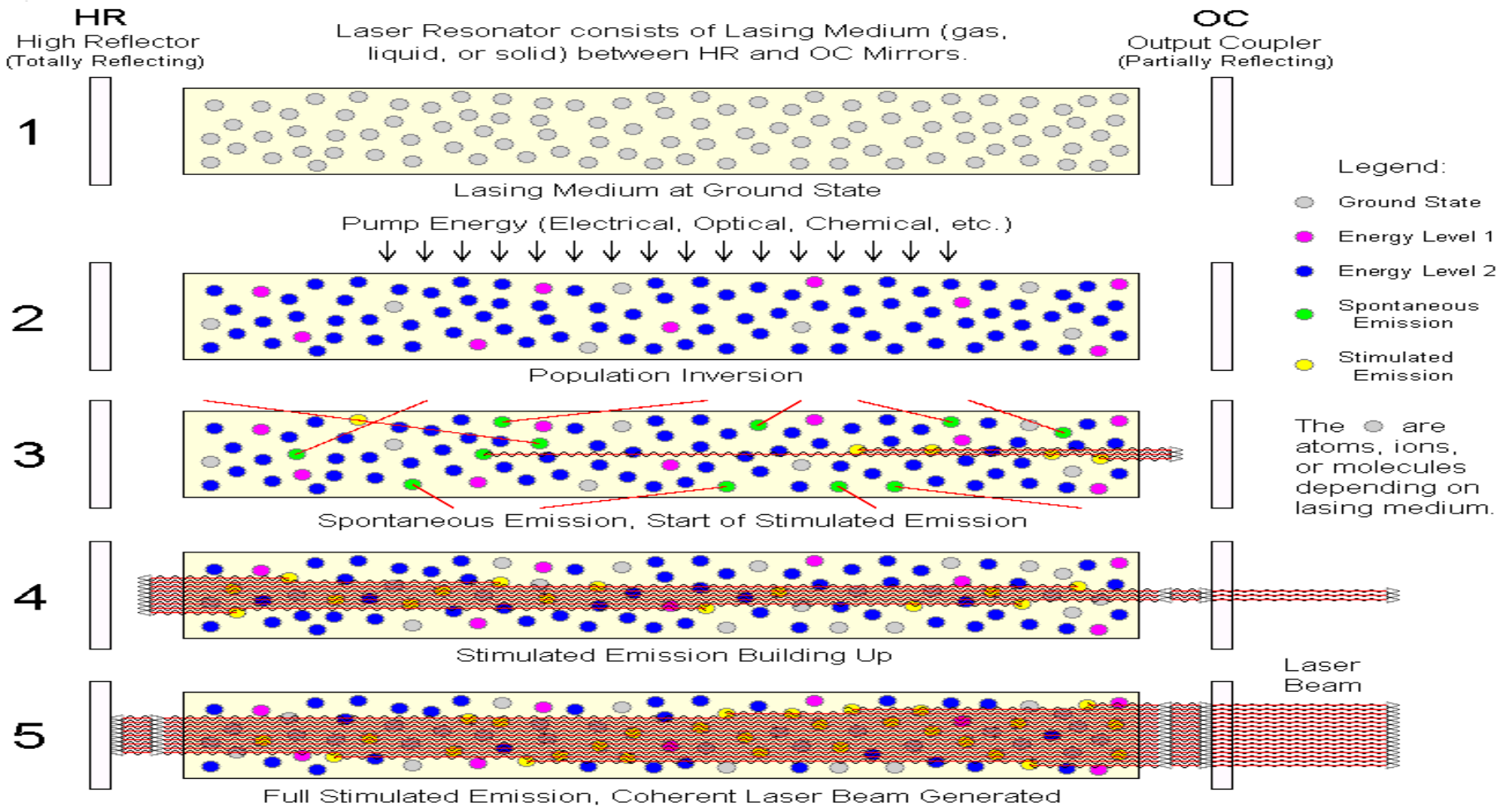




Typical setup of Laser



Basic Laser Operation



Basic Laser Operation

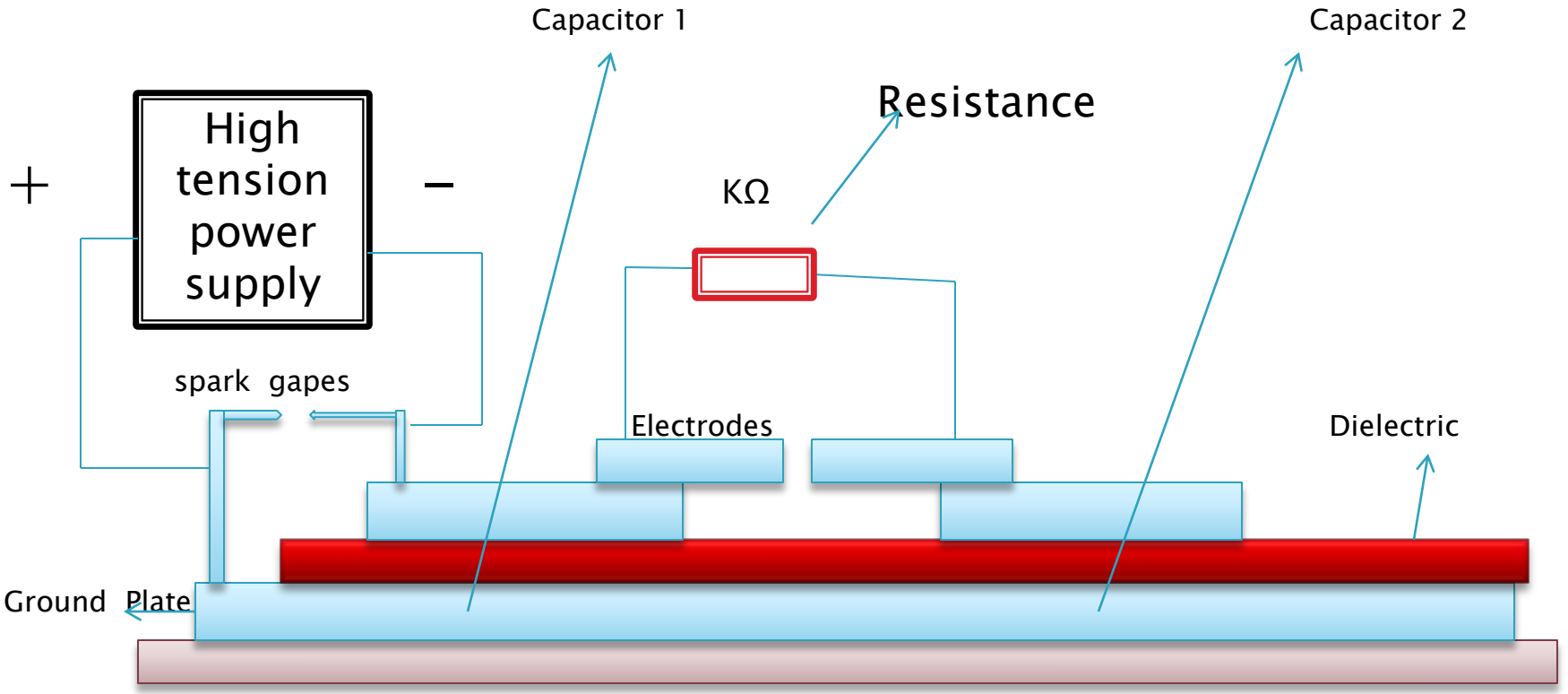
Lasing Action

- Energy is applied to a medium raising electrons to an unstable energy level.
- These atoms spontaneously decay to a relatively long-lived, lower energy, metastable state.
- A population inversion is achieved when the majority of atoms have reached this metastable state.
- Lasing action occurs when an electron returns to its ground state and produces a photon.
- If the energy from this photon is of the precise wavelength, it will stimulate the production of another photon of the same wavelength and resulting in a cascading effect.
- Laser radiation will continue as long as energy is applied to the lasing medium.

Theory of TEA N_2 Laser

- No special gas, no chemical products, no vacuum and no glass work
- Simply use air at Atmospheric pressure
- Two electrodes placed parallel to each other separated few mm and high voltage is applied
- A high-current electric discharge between the two electrodes excites the air Nitrogen and produces a pulse of coherent radiation
- It operates at gas pressure of 1atm

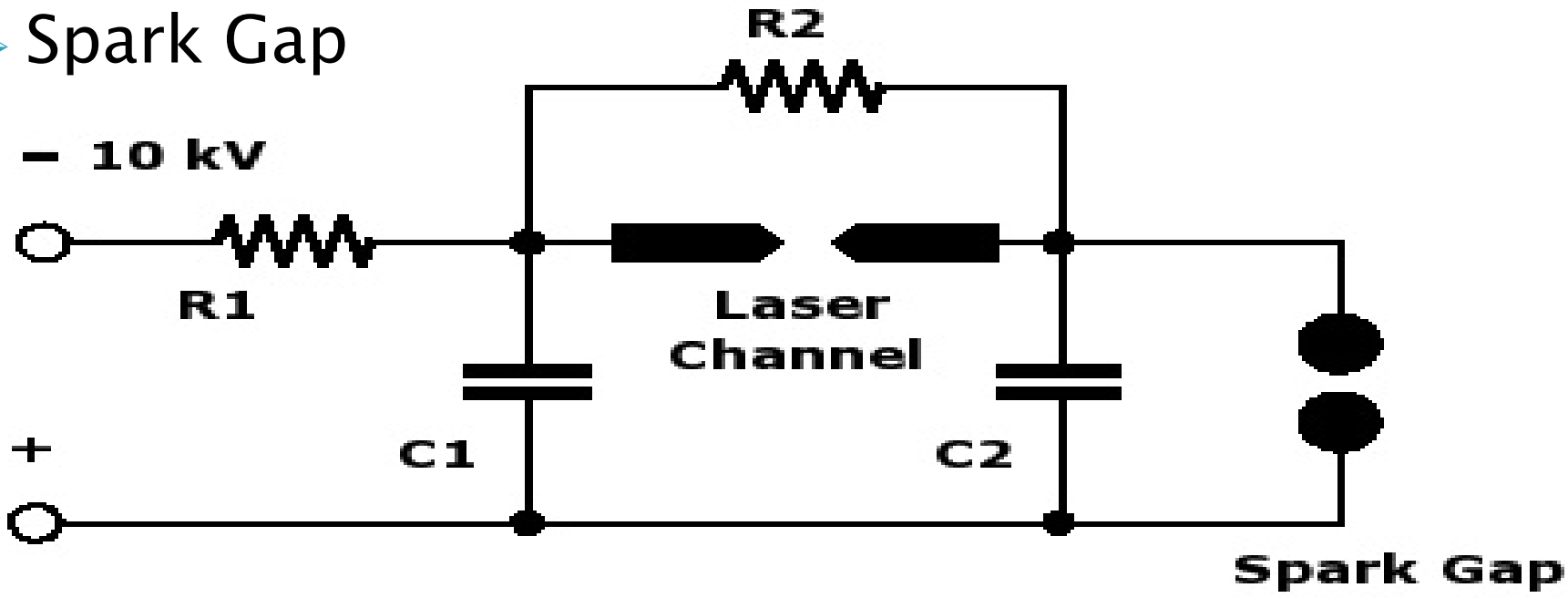
TEA N_2 Setup


Capacitor 1
Capacitor 2
Resistance
KΩ
+
High tension power supply
−
spark gapes
Electrodes
Dielectric
Ground Plate

TEA N_2 Circuit

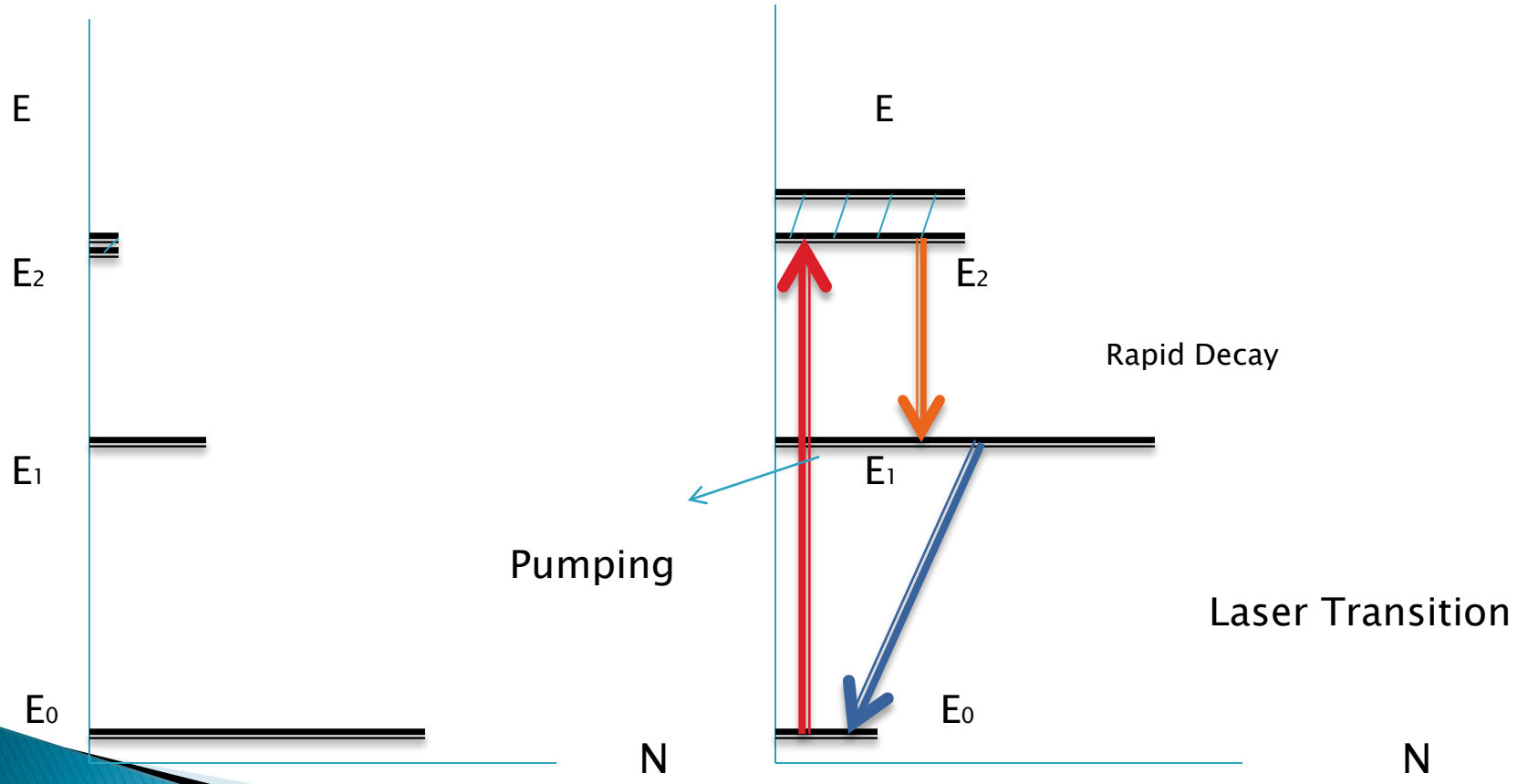
Fundamental parts of TEA N2Laser

- Electrodes
- Capacitors
- Resistance
- Spark Gap



Transition in TEA N_2 Laser

- In three level system laser transition ends up on ground state.



Proposed Components Description

- A High Voltage DC Power Supply
- A4 size main Aluminium Plate (1.5-2.5mm)thick .
- A4 size plastic film as dielectric
- Two Aluminium sheets (3″ × 10″)
- Two Aluminium electrodes(1″×1″)
- Electrode gap=1.3mm
- Spark gap 3mm
- Resistance 100kohm of 1Watt

Properties of TEA N_2 Laser

- The life time of the upper state of Nitrogen is $t=36/(1+p/58)$[1]
- At p=1atm (760 torr)
- t=2.5ns
- Output of TEA N_2 Laser is 337.1nm
- Peak power up to 1.2MW

[1] Compact high-power TEA N2 laser B.S. Patel
Review Of Scientific Instruments, 49(9), Sept 1978

Application of TEA N_2 Laser

- Transverse optical pumping of dye lasers[2]
- Fluorescent lifetime measurement
- Spark gap triggering
- Ultrahigh-speed photography
- Plasma diagnostics

[2] F. J. Duarte and L. W. Hillman, *Dye Laser Principles* (Academic, New York, 1990) Chapter 6

Summary

- The laser describe here is a gas laser, and we will use high voltage power supply as a pumping source
- Air is used as lasing material with some specific arrangement of Aluminium plates.
- Lasing output lies in the ultraviolet region ,can be seen by using fluoresence as target.

Future Work

- Vacuum Nitrogen Laser
- Nd:YAG laser

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THANK
YOU