



Radio Frequency Excited, Waveguide Carbon Dioxide Lasers

16th September 2026

Introduction

› Device engineering

- › RF excitation
- › Resonator design

› Important operating parameters

- › Output power
- › Beam quality
- › Wavelength

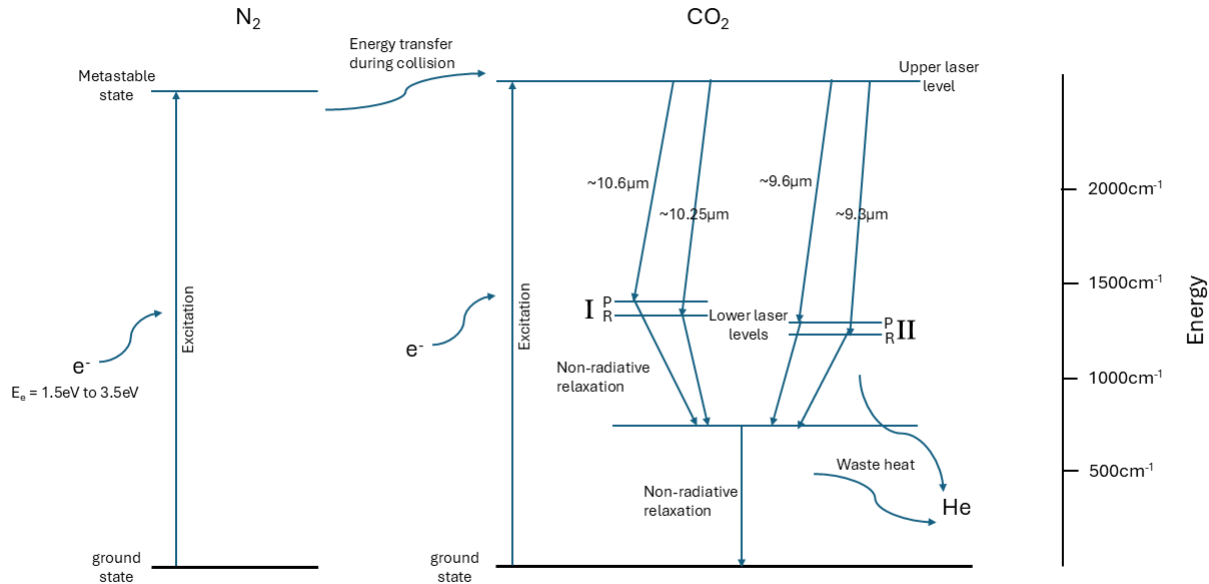
› Installation considerations

- › Technical and environmental considerations
- › Compliance

› Application examples

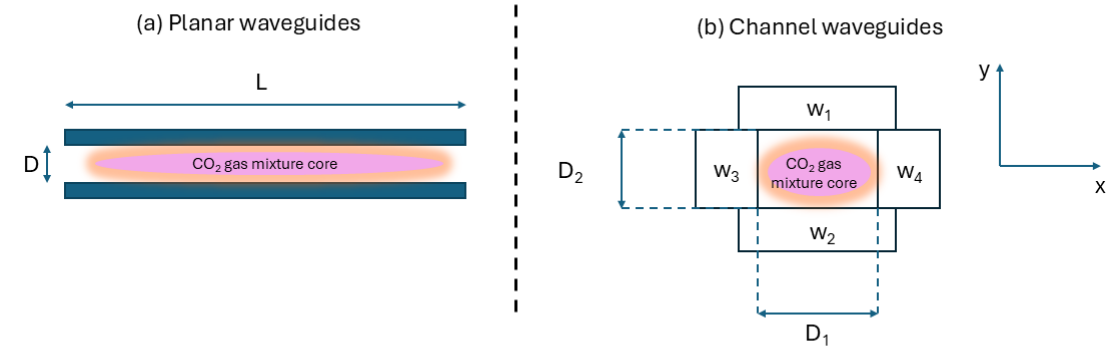
Device engineering

RF excitation



- RF discharge excites active laser molecules
- Large area, small gap discharges
- Low voltages, increased switching speed
- High pulse repetition frequencies

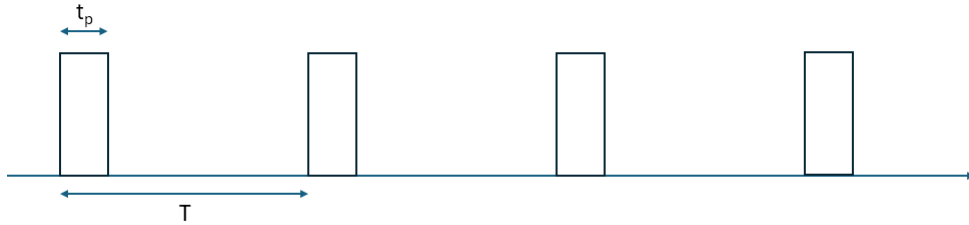
Resonator design



- Waveguide, free-space propagation
- Hybrid resonator
- Waveguide mode selection, free-space filtering
- Area scalable, kW's
- Waveguide propagation
- Waveguide resonator
- Waveguide mode selection
- Length scalable, 100's W

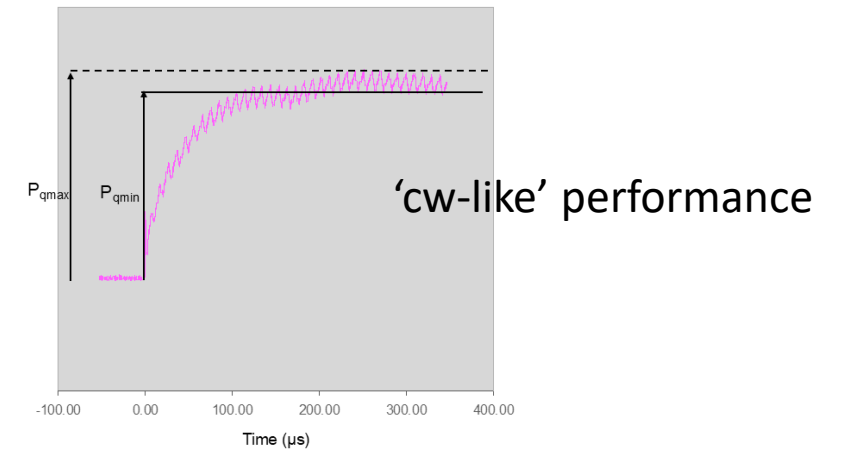
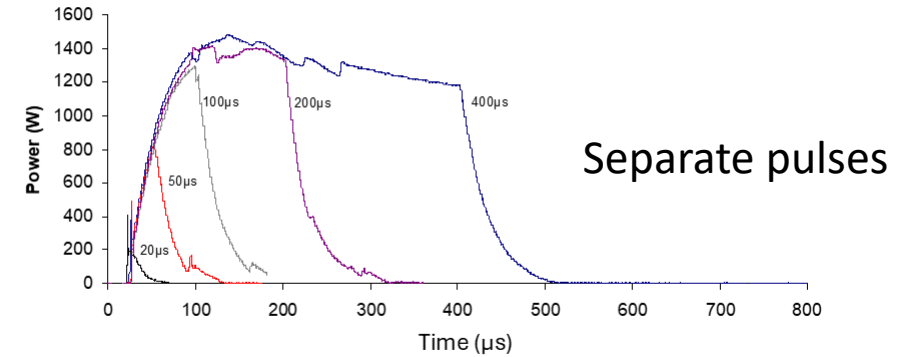
Important operating parameters

Pulsed operation



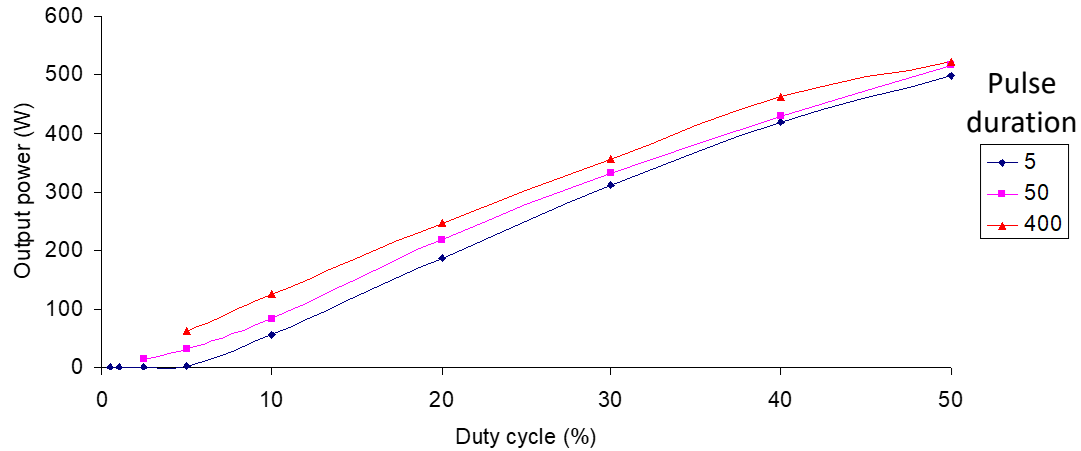
- Power varied by $t_p : T$ (duty cycle)
- If $T - t_p > t_{\text{fall}}$, separate pulses
 - drilling/ perforating
- If $T - t_p \ll t_{\text{fall}}$, 'cw-like' performance
 - cutting/ scribing

Operational modes



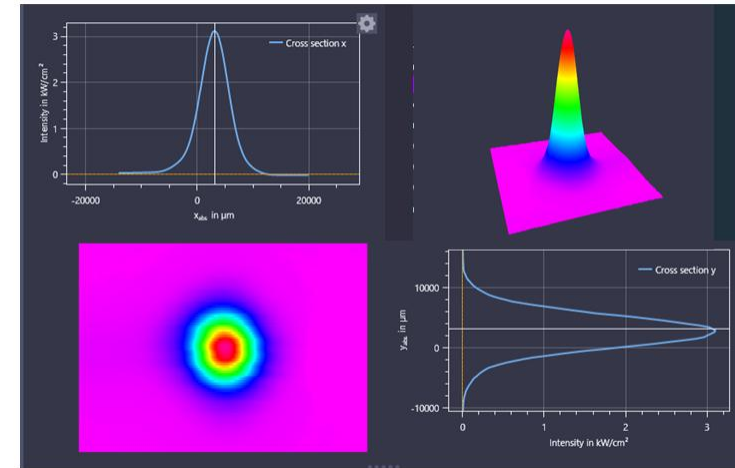
Important operating parameters

Output power



- Near linear transfer characteristic
- Pulsed and 'cw-like' operation

Mode quality



- Beam quality $M^2 < 1.2$ (typically ~ 1.1)
- Circular output maintained over large operating range

Wavelength: 10.6µm, 10.25µm, 9.6µm or 9.3µm

Installation considerations

Technical and environmental considerations

- Installation hints and tips
- Technical considerations
 - Apertureing
 - Back reflection
 - Thermal lensing
 - Mitigation
- Environmental considerations
 - Humidity/ airborne contaminants
 - Application by products
 - Outgassing within enclosed beam path
 - Mitigation

Compliance

Minimise risk to people, property (and animals)

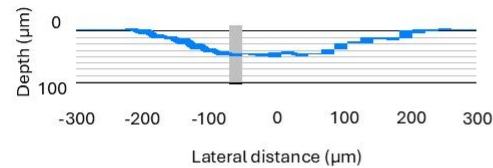
- Directives and regulations
- Effect of emissions
 - Laser/ electromagnetic/ heat/ acoustic
- Prevention of unsafe events
 - Unexpected operation
- Electrical design
- IEC and ISO standards

Application examples

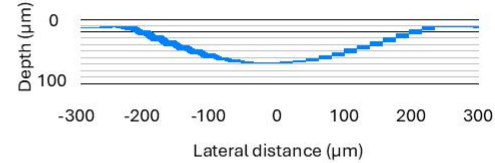
Machining PMMA

10.6 μ m wavelength, 8.0mJ pulse energy and 300 μ m incident spot radius

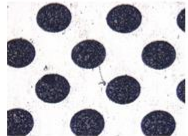
Extruded



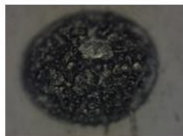
Cast



HOLE INPUT

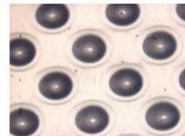


5 $\times$ magnification



20 $\times$ magnification

HOLE INPUT



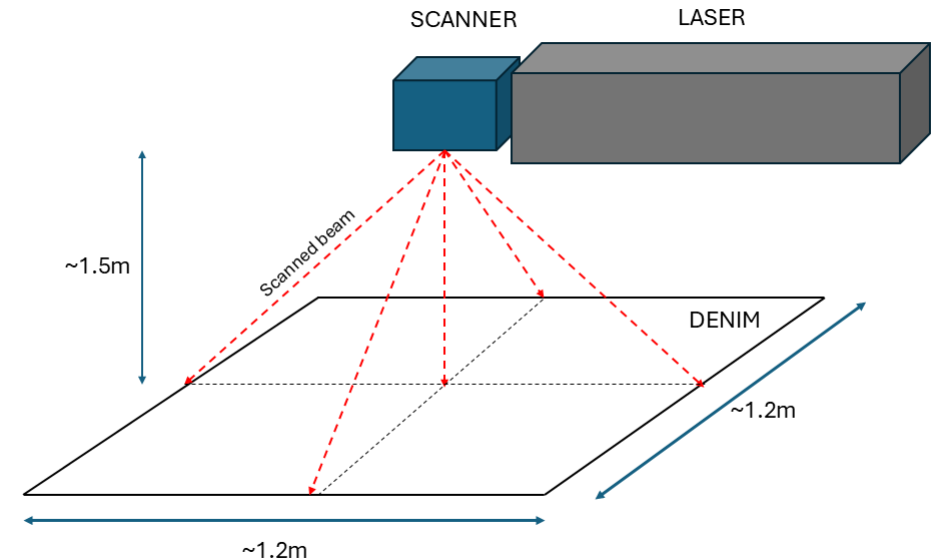
5 $\times$ magnification



20 $\times$ magnification

- Scattering centres in BLU
- Similar machining conditions, dissimilar effects

Marking denim



- Large area scanning
- Individual machined spots
- Image = combination of spots

Summary

› Mature technology

- › Reliable and robust

› Unique parameter combination

- › Power (10's W to multi kW), beam quality and wavelength

› Flexible and cost effective

- › Enables a large range of applications

LUXINAR

Industrial lasers that last