

Nanosecond lasers

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Types of pulsed lasers

1) Long pulse lasers (typically* μs – ms range)

The laser output is pulsed because the 'pump' is pulsed.

Examples: flash lamp, high pressure discharge, pulsed electrical current.

Alternative laser name: free running laser

2) Q-switched lasers (ns – µs range)

The laser output is pulsed because a high amount of 'inversion' is suddenly released.

Alternative laser name: nanosecond laser

3) Mode-locked lasers (fs – ps range)

The laser output is pulsed because many laser modes are oscillating simultaneously in the cavity and are coherently superposed.

Alternative laser name: femtosecond laser

* Except for laser diodes and excimer lasers.

Spiking

Q-switched lasers: Working principle



Aix*Marseille

niversite

Q-switched lasers: switching devices



Q-switched lasers: mode competition 1

Lasing starts from spontaneous emission (quantum noise)

Due to high inversion, many modes have enough gain to start oscillating.

The different modes have arbitrary phase relation (different in each pulse) Interference between modes: mode beating : ps-duration intensity spikes



FIGURE 26.21

Axial-mode beating in the output from a Q-switched laser running in two axial modes.



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For a reasonable budget measurement is not possible (>15 GHz bandwidth). In average the peak intensity is two times higher than for the mono-mode pulse.



Q-switched lasers: mode competition 2

The only way to get a high-power single longitudinal mode (SLM) output from a qswitched laser is to give the best starting conditions to the most amplified mode.

Keyword: injection seeding (The reliability depends on the laser manufacturers.)



The pulse build-up time is reduced when the laser is seeded.

https://www.rp-photonics.com/injection_seeding.html

Marseille

Q-switched lasers: Peak power

Is much higher than the average power of the same laser without q-switch



Not exactly the same average power in q-switched mode compared to cw or free running mode: higher fluorescence losses

Q-switched lasers: continuous pumping



Giant pulse suppression avoids damage during switch-on.

	Nd:YAG	Nd:YVO ₄
Maximum pulse repetition rate depends on the host material:	25 kHz	200 kHz
Maximum average power:	150 W	200 W



Q-switched lasers: typical applications

Nonlinear optics, material processing, ...

Capacitor trimming





Marking, engraving



Medical skin treatment





Master POESII

Q-switched lasers: application movies

Capacitor trimming



Marking, engraving



