SYNTHWAVE lasers

GHz laser pulse synthesizers

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Synthwave Lasers designs and manufactures a new generation of pulsed laser sources: **GHz laser pulse synthesizers**.

This innovative technology is engineered to deliver laser pulses at GHz repetition rates with unmatched performance, tunability, and reliability.

Who we are

Founded in 2024 in Bordeaux, France, Synthwave Lasers was born from the expertise of three specialists in fiber lasers, optical amplifiers, and radiofrequency electronics.

Drawing on our experience, know-how, and a decade of academic research, we offer high-performance, robust industrial laser sources, as well as fully tailored systems to meet the most demanding requirements.

Our unique and flexible laser technology enables us to provide laser solutions for applications with no existing commercial alternative, serving both industries and laboratories.

Committed to driving technological advancement, Synthwave Lasers is dedicated helping our customers pursue their visions and ideas.

Technology introduction

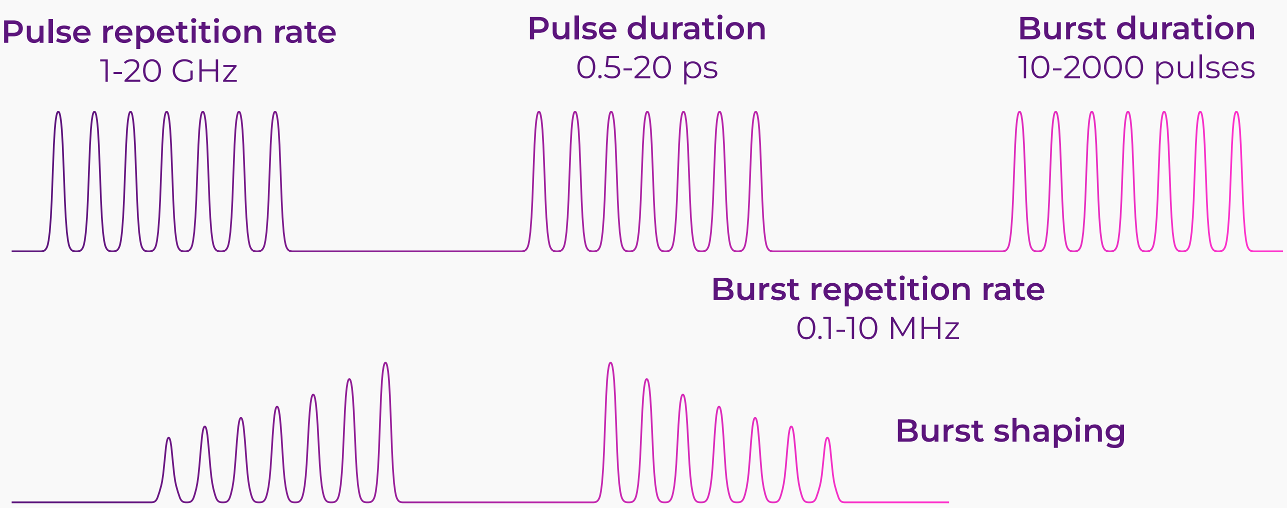
GHz pulse laser synthesizers generate pulsed laser output by harnessing radiofrequency and electronic components.

This **all-electronic synthesis** means:

- Very-high repetition rates up to 20 GHz, with continuous tunability
- Instant and precise adjustment of most laser parameters, allowing on-the-fly optimization of processes.
- Synchronized laser pulse emission without external feedback-loop electronics, using either a 10/100 MHz clock or any repetition rate compatible carrier frequency.
- Fully fiber-coupled architecture, without moving or free-space parts, delivering reliable and robust performance on demand.
- Several wavelengths available : 920 nm, 1 µm, 1.5 µm, 2 µm, and more.

Adjustable parameters includes:

- Pulse repetition rate: 1–20 GHz
- Pulse duration: 0.5–20 ps
- Central wavelength
- Burst emission mode
- Burst repetition rate: 0.1–100 MHz
- Burst duration: 5–2000 pulses
- Spectral shaping & dispersion



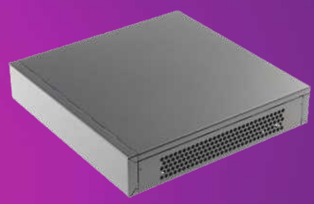
Products

Neon-Seed

Compact GHz laser source to quickly get started

Neon-Seed is our **compact flagship product**. It generates laser pulses at a repetition rate up to 20 GHz and wavelengths of 1 µm or 1.5 µm. Synchronization is straightforward, with a 10/100 MHz input reference.

Its small footprint makes it a perfect candidate to quickly get started with synchronized GHz pulses.



Neon-Burst

GHz laser source for next-generation materials processing

Neon-Burst is our high-power laser **dedicated to material processing**. It embeds all the features for the newest and most demanding applications in material processing. Perfectly suited for silicon and glass vias (TGV).

Neon-Flex

The modular platform to meet every request

Our laser technology allows for **extensive customization and tunability**, including wavelength, pulse/burst repetition rate, output power, and synchronization. We design and supply laser systems for requirements without existing commercial solution.

Inquire about your specific use case and requirements.

Specifications

	Neon-Seed-10	Neon-Seed-15	Neon-Burst	Neon-Flex
Central wavelength	1030-1070 nm	1500-1600 nm	1030 nm	Several
Tunable wavelength			Optional	Optional
Repetition rate	12-20 GHz	12-20 GHz	1-20 GHz	1-20 GHz
Tunable rep. rate			Yes	Yes
Min. pulse duration	800 fs	500 fs	800 fs	typ. < 1000 fs
Synchronization	10/100 MHz	10/100 MHz	10/100 MHz	Any frequency
Output power	200 mW	200 mW	Up to 60 W	typ. 200 mW
Burst mode			Yes	Yes
Burst rep. rate			100-200 kHz	Down to 10 kHz
Burst duration			5-1000 pulses	> 5 pulses
Burst shaping			Yes	Option

Examples of Neon-Flex

Wavelength: 1520-1580 nm
Repetition rate: 3 GHz
Pulse duration: 5 ps
Pulse energy: 150 pJ
Synchronized (10 MHz)

Wavelength: 1047 nm
Repetition rate: 1.5 or 12 GHz
Pulse duration: 5 ps
Spectral profile, tunable dispersion
Synchronized (1.5 GHz)

Wavelength: 920-935 nm
Repetition rate: 1 or 3 GHz
Pulse duration: 3-10 ps
Pulse energy: 150 pJ
Synchronized (10 MHz)

Wavelength: 1030 nm
Repetition rate: 16 GHz
Pulse duration: 1 ps
Burst repetition rate: 1 MHz
Burst duration: 50-200 pulses
Average power: 10 W

Applications

Thanks to their high flexibility and unique specifications, GHz laser pulse synthesizers are used across a wide range of domains, from mature industries to emerging sciences.

Their versatility and unprecedented performance open up solutions for the newest and most demanding applications, beyond the reach of conventional pulsed lasers.

Material processing

Quantum technologies

Photoinjection

Dual-Comb spectroscopy

Astrocombs

Lidar & Space tracking

Non-destructive testing

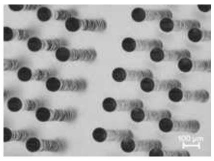
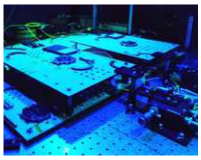
Spintronics

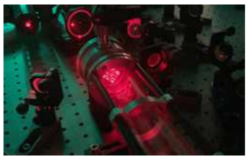
Side-channel attacks

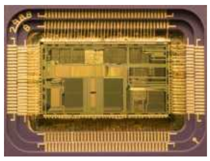
Optical links

Fusion & Radiation sources

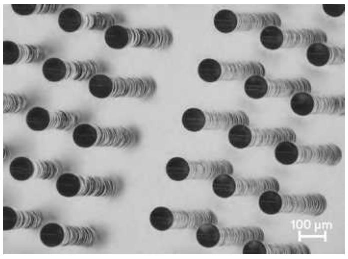
THz & Telecom

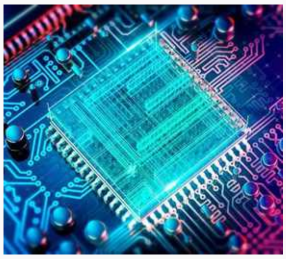
Material processing



Burst laser emission allows the laser to interact more efficiently with the material as it heats and transforms, removing material faster while producing cleaner, higher-quality results than conventional single-pulse processing. In particular, this regime is well suited to **via drilling in glass** (TGV) and to **microelectronic manufacturing**, notably for glass interposers and advanced electronic packaging.

Our **Neon-Burst** gives access to a wide range of repetition rates from 1 to 20 GHz, with burst mode and effortless synchronization. **It allows optimized processes for any variety of glasses and materials.**

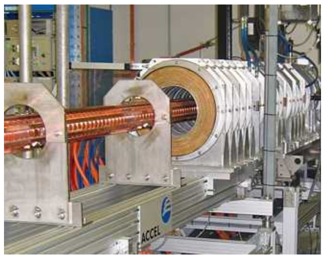
Quantum technologies



Photonic qubits can be generated via either spontaneous parametric down-conversion (**SPDC**) or spontaneous four-wave mixing (**SFWM**). **In both cases, a pulsed laser is required, as it drives the nonlinear process**. Its pulsed nature is what allows photon pairs to be generated with the precise timing needed for downstream applications such as heralding, synchronization between multiple sources, and interference-based operations in quantum photonic circuits.

GHz laser pulse synthesizers increase the qubit generation rate and quality through synchronized GHz pulse emission. In addition, the central wavelength can be tuned for pumping process optimization.

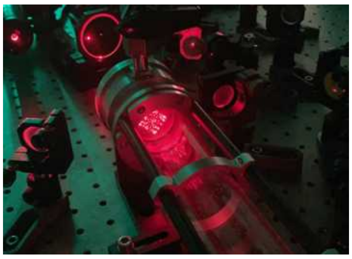
Photoinjection



Linear particle accelerators with photo-injected cathodes use **ultrafast laser pulses to generate electron bunches via the photoelectric effect**, allowing precise control over bunch timing, charge, and shape. **To increase the average brightness** of the accelerator, one can increase the laser's pulse repetition rate, synchronized to the RF frequency of the accelerating cavity, up to that RF frequency itself.

This use-case is particularly adapted to our technology which can generate laser pulses at **very high repetition rates** (covering X-Band frequencies), **synchronized on a GHz-range external clock frequency.**

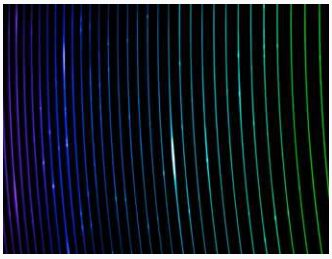
Dual-Comb spectroscopy



Dual-comb spectroscopy uses **two frequency combs with slightly different repetition rates** to probe a sample, generating a radio-frequency comb via heterodyne detection that maps the optical spectrum down to easily measurable frequencies. This enables fast, high-resolution, broadband spectroscopy giving the technique a strong edge over traditional spectroscopic methods in terms of speed, robustness, and reliability.

Achieving coherence between two laser pulse synthesizers is straightforward, as both GHz laser pulse synthesizers can easily share the same optical and radio-frequency references.

Astrocombs



Astrocombs are optical frequency combs specifically engineered to **calibrate astronomical spectrographs**, providing an ultra-precise set of reference lines spaced in the multi-GHz range. A key practical challenge is that standard mode-locked laser combs have repetition rates of hundreds of MHz. Conventional astrocombs work around this by adding filter cavities at the expense of complexity, insertion loss, and calibration overhead to the system.

Our technology can directly generate evenly spaced, GHz-range reference lines eliminating this extra layer of hardware and simplifying the path to a resolvable, spectrograph-ready calibration source.

Lidar & Space tracking

In lidar and space tracking, the laser's pulse repetition rate fundamentally limits the achievable range update rate and resolution. This becomes especially **critical for tracking uncooperative high-velocity objects** like satellites or debris. The field has moved to kHz-range repetition rate lasers, supporting safer space situational awareness and collision avoidance.

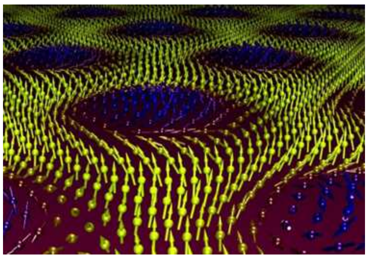
Our technology enables **burst emission with a varying pulse repetition rate**, allowing each burst to be individually distinguished even at the MHz-range. With a dedicated radio-frequency setup, each burst is discriminated through demodulation, while time of flight is measured via phase mixing.

Non-destructive testing

Picosecond ultrasonics technique uses a pump-probe layout to detect subtle changes in optical reflectivity. Scanning delay gives non-contact access to acoustic phonon dynamics, from which properties like **film thickness, sound velocity, and elastic constants** can be extracted at the nanoscale.

GHz laser pulse synthesizers can resonantly excite, detect and measure the material parameters, as they can adjust their pulse repetition rate over a very broad GHz range. **Tuning the repetition rate directly matches the excitation to the sample's acoustic resonances**, offering a faster, purely optical route to the same material information without any moving parts.

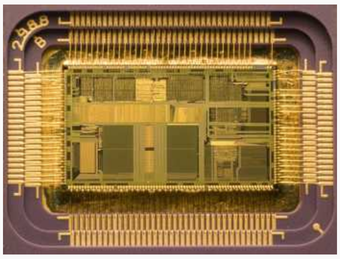
Spintronics



Spin precession in materials is typically measured using pump-probe time-resolved techniques. This conventional approach reconstructs the full precession dynamics by delay scanning, which requires a dedicated delay line and can be time-consuming to fully map out.

Our technology enables an alternative **spectral-domain approach**, in which the incident laser acts as both pump and probe under resonant excitation. When the pulse repetition rate is tuned to match the material's precession frequency, successive pulses reinforce one another, **producing a resonance that directly reveals the spin dynamics.**

Side-channel attacks



Laser-assisted side-channel attacks enable **contactless probing of on-chip data**, allowing secret keys and other sensitive information to be extracted from secure integrated circuits. As a result, optical probing is now regarded as one of the most credible **physical threats to secure hardware**.

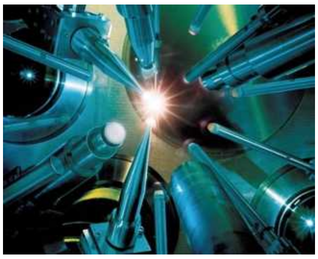
Our technology enables **both pulse-on-demand operation** with exceptionally low temporal jitter (< 10 ps) for single-shot probing/injection, and **continuous pulse emission** with a tunable repetition rate **synchronized to the chip's clock frequency**, within a single flexible system.

Optical links

Synchronizing apparatus across very large scientific installations cannot be achieved with coaxial cables, as they suffer from significant group velocity variation along kilometer-scale cable runs. The state-of-the-art solution relies on stabilized links correcting accumulated phase noise. Another approach is to generate optical pulses **with very low jitter** relative to the reference carrier and propagate them through non-stabilized fiber.

Our technology **directly synthesizes optical pulses** from a RF reference carrier, with exceptionally low jitter levels. It offers a simpler route to distributing precise timing across large-scale scientific installations

Fusion & Radiation source



Inertial confinement fusion driven by lasers has become a major area of interest, with numerous startups pursuing bold, unconventional designs for the next generation of fusion reactors. One promising strategy involves driving the target at its **elastico-mechanical resonance frequency**, typically in the multi-GHz range, using a train of picosecond pulses, rather than relying on a single high-energy nanosecond pulse.

GHz laser pulse synthesizers offer the ability to **continuously tune the pulse repetition rate**, while ensuring robust, straightforward synchronization across all pilot lasers.

THz & Telecom

In the spectral domain, GHz laser pulse synthesizers generate **equally spaced sidebands** with fine-grained control over line spacing, central wavelength, phase coherence, and bandwidth. These comb lines enable the generation of tunable, **narrowband THz radiation**, while also providing a platform for the **design and qualification of next-generation telecom components**.

As RF synthesizers, GHz laser pulse synthesizers stand out as an **essential analysis tool** for laboratories working on development of next-gen coherent optical communication systems and THz-band wireless links beyond 5G/6G.

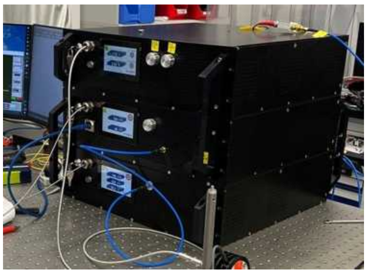
Beyond a supplier

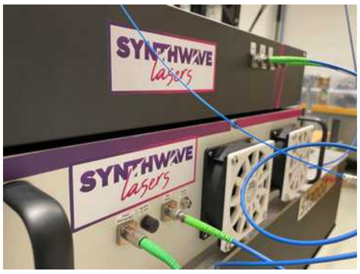
As experts in laser and radiofrequency technologies, Synthwave Lasers doesn't just provide standard laser sources and custom-designed systems, we also support the global scientific community in turning new ideas into reality.

We're committed to being more than a laser source supplier: **we aim to be a trusted strategic and scientific partner** for the developments still to come.

GHz laser pulse synthesizers can be adapted in countless ways, and we've successfully delivered solutions to customers who had no commercial alternative available.

Get in touch with your use case, we'll be glad to share our success stories and design a flexible, high-repetition-rate laser source tailored to your needs.





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