

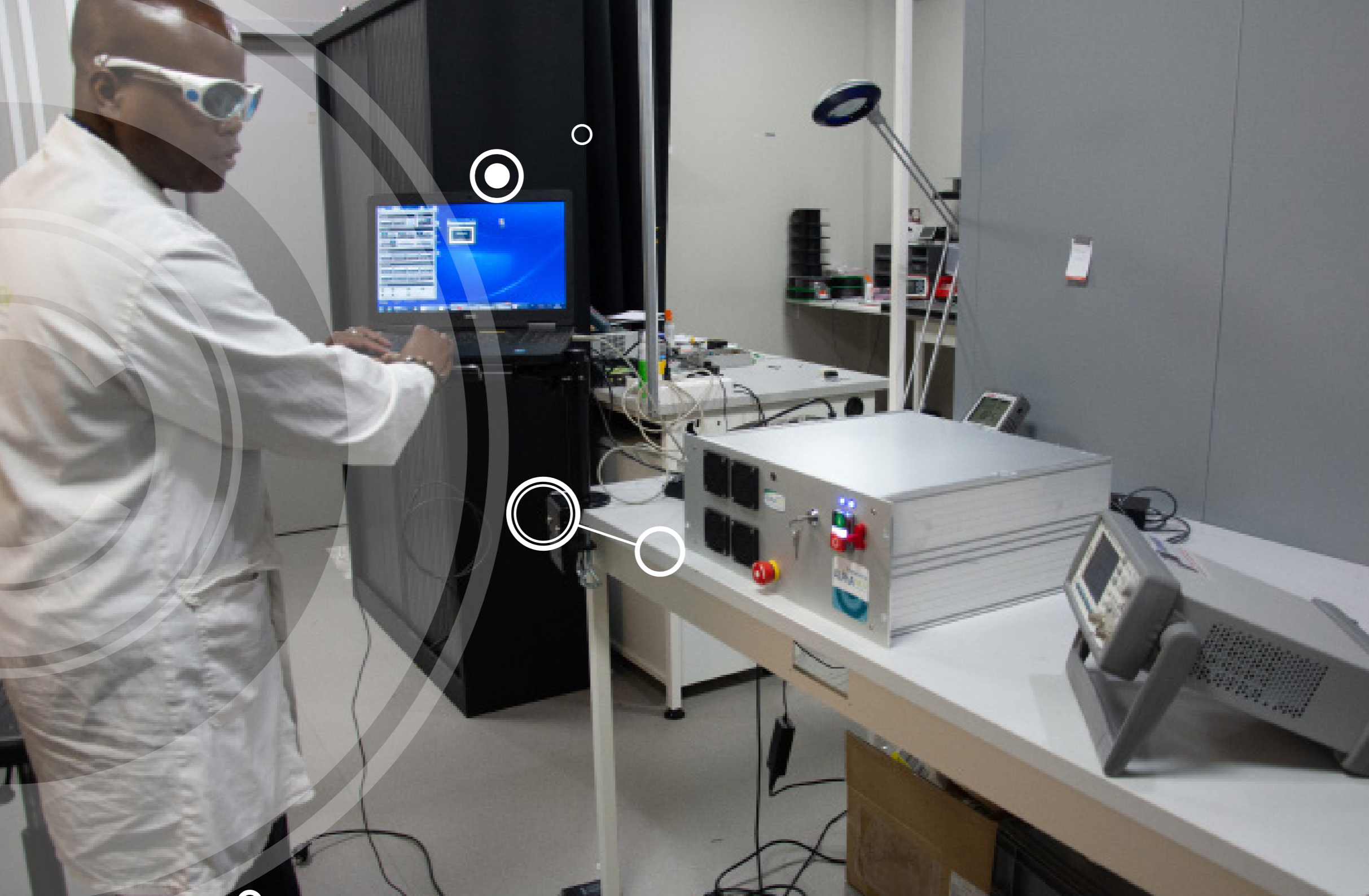
# ALPhA NOV

Optics & Lasers Technology Center



## LASER DEVELOPMENT

FROM R&D MODULES TO FULLY INTEGRATED TURN-KEY SYSTEMS



## Contents

### 04/ Editorial

### 05/ Introduction

Background	5
ALPhANOV at a glance	6

### 08/ Development of custom laser sources

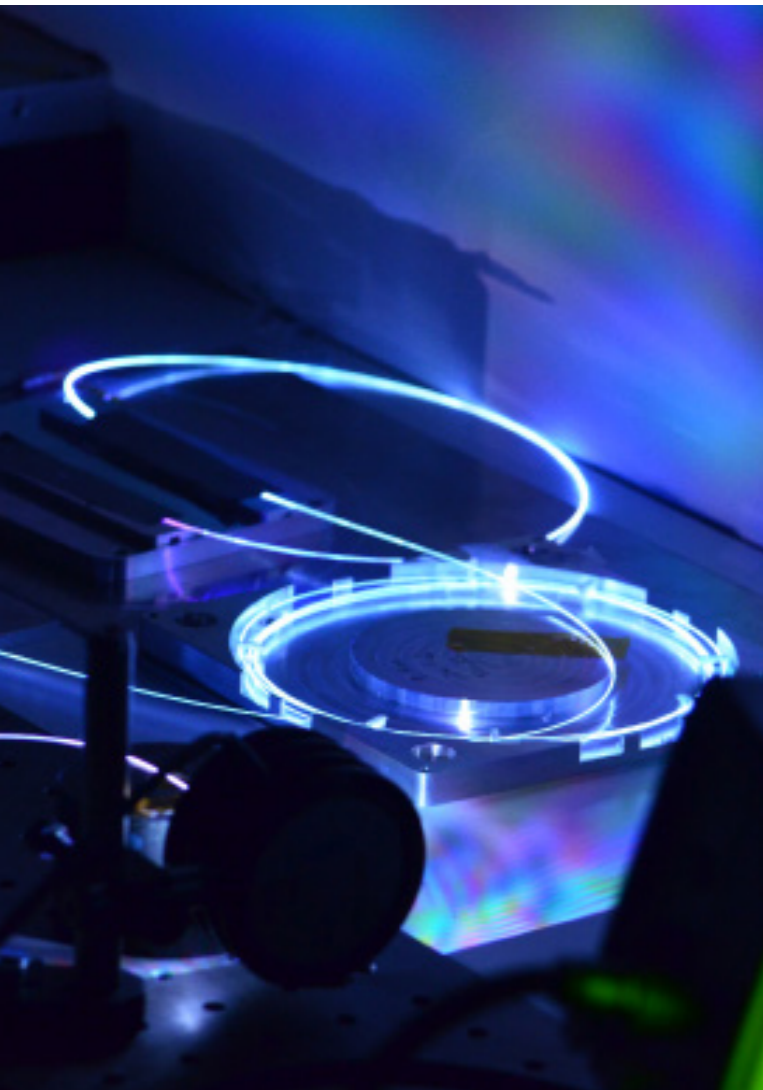
Fiber and bulk laser assembly	9
Modular optical design: endless possibilities	10
Advanced mechanical integration	11
Interface and control	12

### 14/ Laser systems and modules

Ultrafast fiber oscillators	15
High power fiber amplifiers	16
Pulse compressors & dispersion management	17
Frequency conversion & nonlinear modules	18
Beam delivery and shaping	19

### 20/ Testimonials

CEA Tech - A picosecond laser at 780 nm for prostate cancer diagnosis	21
THALES - A compact fiber seeder at 800 nm for Ti:sapphire lasers	22
LEUKOS - A high power supercontinuum laser for spectroscopy	23
ISP System - An air-cooled laser source for material processing	24
CILAS ArianeGroup - An adjustable temporal shape laser for material processing	25
Muquans - A single-frequency laser at 461 nm for atom trapping	26
Azurlight Systems - A 350 W single frequency fiber amplifier for gravitational wave detection	27



## EDITORIAL

« Laser development is at the core of ALPhANOV's DNA. Our world-reknown expertise in fiber laser and components enable us to offer state-of-the-art laser sources in terms of performance and reliability, with an advanced level of optical, mechanical and electronic integration.

Whether you need a high power femtosecond laser for micromachining, or a high finesse CW laser source, our experts will find a custom built solution to your needs. »



Johan BOULLET  
Laser sources and components department

## BACKGROUND

ALPhANOV was created in 2007 as a non-profit organization by the Regional Council of Aquitaine, the CEA, the CNRS, Bordeaux University and the ALPhA association. ALPhANOV is located within the Optics Institute of Aquitaine, on the Talence campus.

ALPhANOV, the Technology center of the ALPHA-RLH competitiveness cluster (Photonics & Microwaves French cluster) supports innovation with its optics and laser expertise.

Its missions include :

- Creating business opportunities in the optics and laser sector
- Building collaborative projects around innovative photonic developments
- Bringing technologies to maturity and accelerating products to market
- Providing resources and services in the field of optics and lasers



Products & Services



Collaborative projects

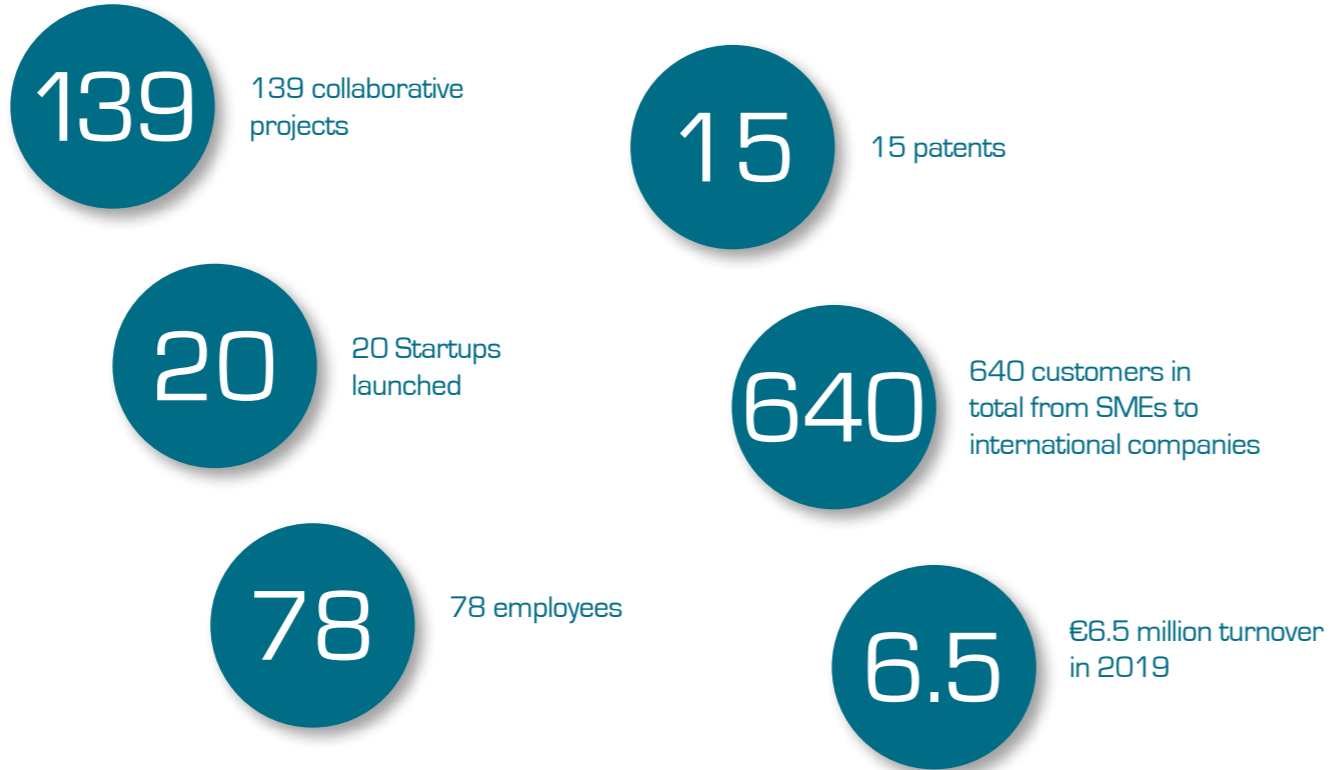


Technology transfer





## ALPhANOV AT A GLANCE



ALPhANOV OFFERS MULTIPLE SERVICES  
ALL ALONG THE LASER VALUE CHAIN



## DEVELOPMENT OF CUSTOM LASER SOURCES

### FIBER AND BULK LASER ASSEMBLY

#### Development of custom laser sources

At the core of ALPhANOV is the development of custom laser sources tailored to your applications. After years of R&D in fiber and bulk lasers, our team of skilled physicists, engineers and technicians are willing to face any challenge.

World-record specifications? Custom software control tailored to your application? Terrifying environmental requirements?

Depending on your needs, we can support you in all of your laser development phases.

We take special care in providing you with different financing schemes: from off-the-shelf solutions to dedicated collaborative project funding, together we will find the best way to move forward with your project.

#### Key features

- Wavelength: from UV to medium infrared
- Pulse duration: from fs to ns
- Power: from a few mW to several hundred W
- Energy: from a few nJ to several hundred mJ
- Repetition rates: from a few Hz to several tens of MHz



Specifications



Design



Assembly & Testing



Final product



## MODULAR OPTICAL DESIGN: ENDLESS POSSIBILITIES

We believe it is possible to develop custom lasers with a level of craftsmanship similar to that of industrial, high-volume products.

Our strategy is to develop highly specialized optical modules, using dedicated engineering methods to make them easily compatible.

Depending on your requirements, your custom laser can then either be integrated into a single housing or into multiple elements.



Laser diode



Laser oscillator



Laser amplifier



Nonlinear module



Dispersion control



Pointing stabilization



Pulse picking



Pulse control



Beam shaping



Fiber delivery

## ADVANCED MECHANICAL INTEGRATION

Laser experts know that demonstrating laser performance on an optical breadboard is not the end of the process, but only the beginning.

Mechanical integration of laser systems is extremely challenging, as very tight specifications must be achieved to ensure consistent performance over a system lifetime.

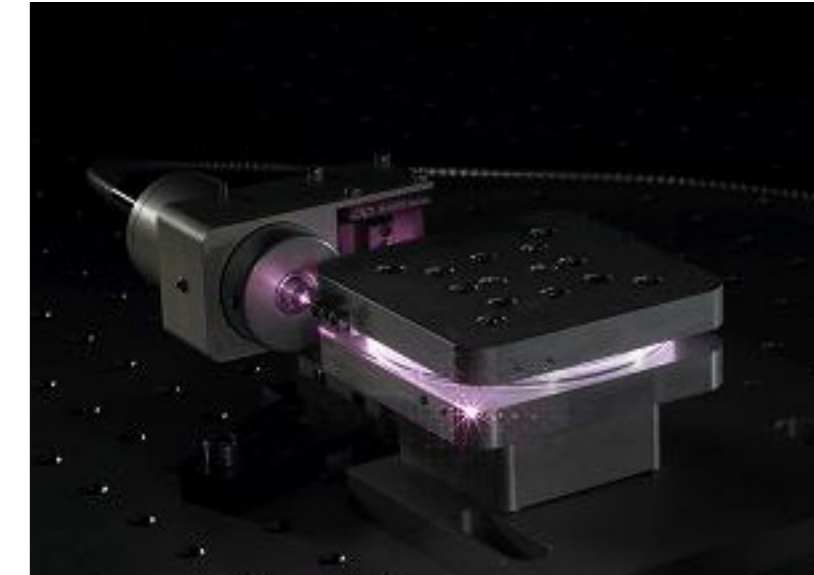
At ALPhANOV, a dedicated mechanical design team works on every new system to provide a cost-effective and rugged design suitable to your use.

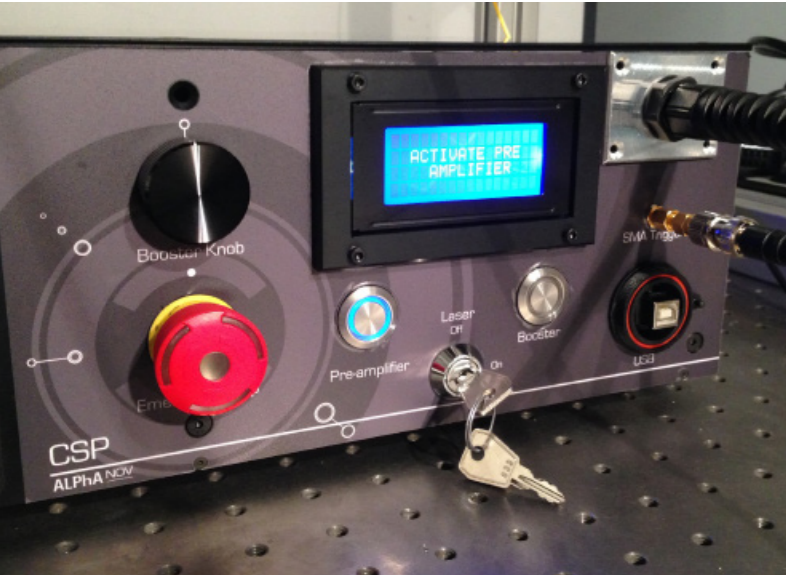
We are particularly proud of the expertise we have developed with high average power, ultrafast laser systems. Thanks to internally designed mechanical mounts, advanced fiber conditioning and global thermal management, we manufacture femtosecond lasers with several hundred watts of average power\*.

\* see fiber amplifier

### Key features

- Modular or custom housing
- Compatible with high average power
- Air or water cooling available
- Shock and vibration tested
- Compatible with clean-room use and space applications





## INTERFACE AND CONTROL

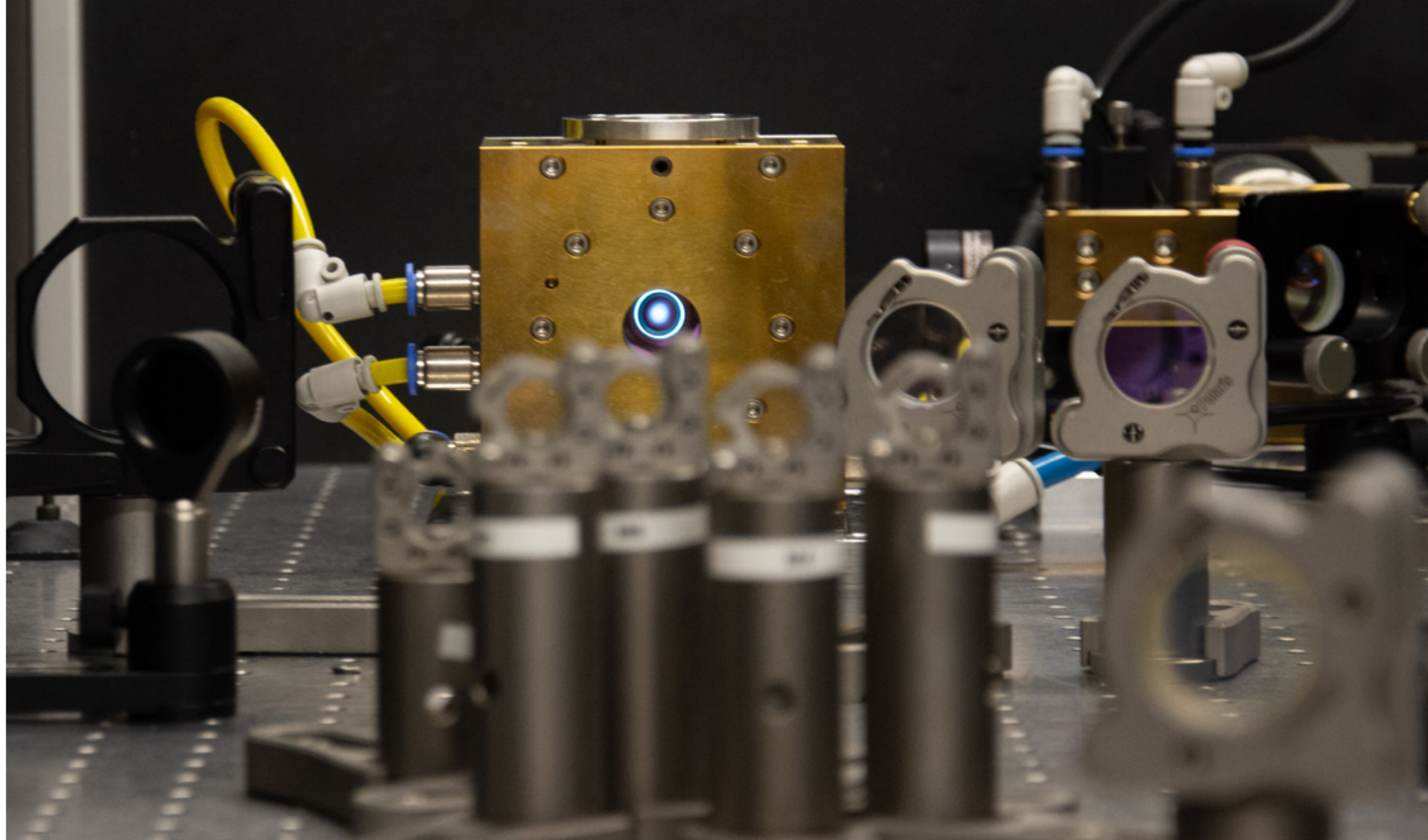
We know that designing a laser interface is key in obtaining user-friendly system. We thoroughly review your application requirements and suggest the best suited control system.

We can provide the following control options:

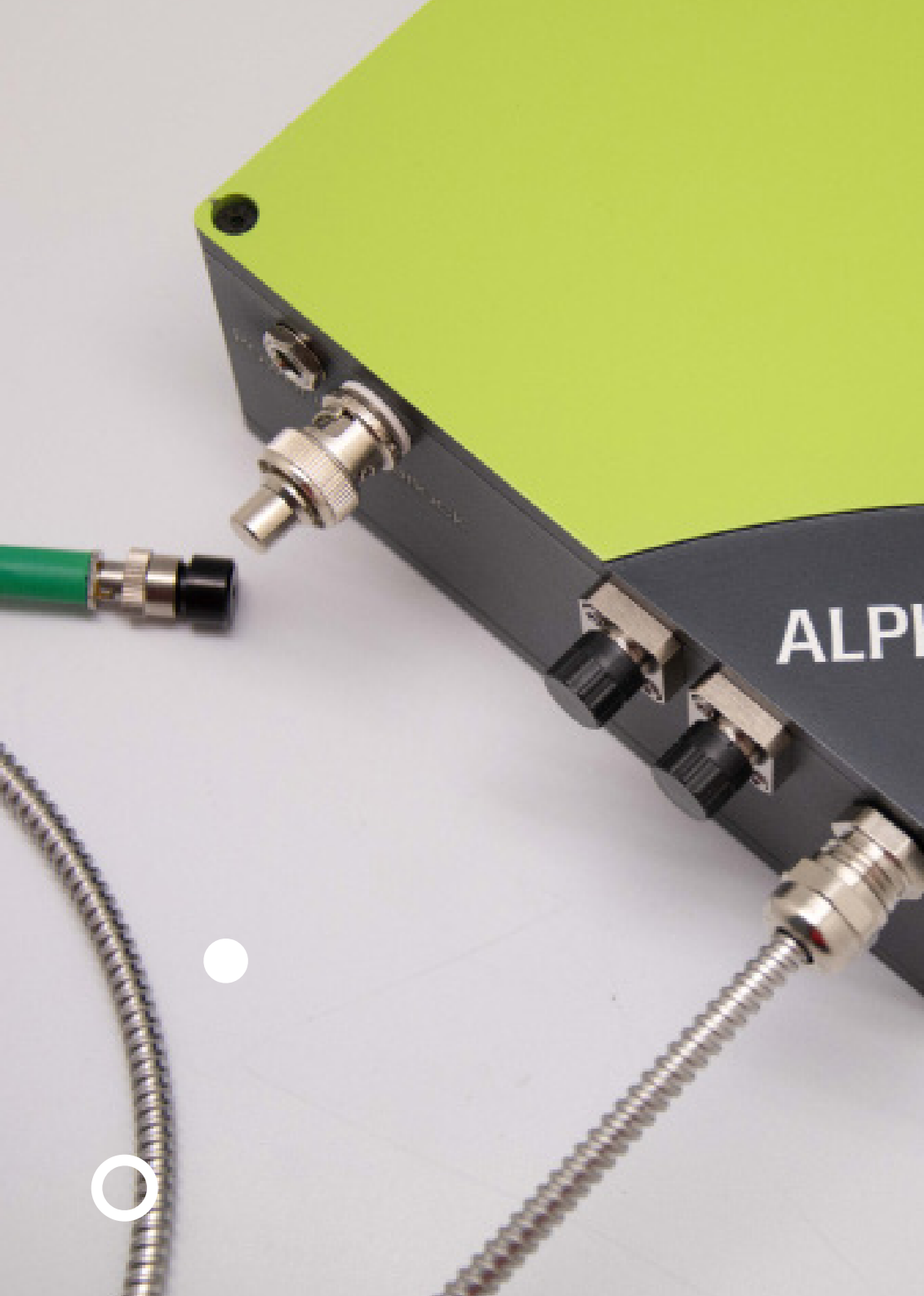
- Simple push-pull knobs
- LCD panel
- Custom software via USB
- Analog Machine type control via RS232

Advanced electronic functions can also be implemented, such as :

- Mode-locked oscillators with pulse picking up to 80 MHz
- Single mode laser diodes control down to 100 ps regime
- Laser diode current control and thermal regulation up to several hundred watts
- Common interlock system with programmable alarm system
- External system or machine synchronization



AT ALPhANOV'S CORE IS THE DEVELOPMENT OF CUSTOM LASER SOURCES, TAILORED TO YOUR APPLICATIONS



## LASER SYSTEMS AND MODULES

### ULTRAFast FIBER OSCILLATORS

Mode-locking is a fundamental phenomenon that allows a single, ultrashort pulse to propagate without losses inside a laser cavity. Femtosecond and picosecond pulses can then be obtained at tens of megahertz of repetition rates.

The design of such lasers is a very specific expertise that requires a deep understanding of ultrafast optical pulse propagation. ALPhANOv has dedicated experts who have contributed over the years to the development of several types of ultrafast fiber oscillators.

Specific engineering designs have been implemented to ensure maximum reproducibility and reliability throughout series production.

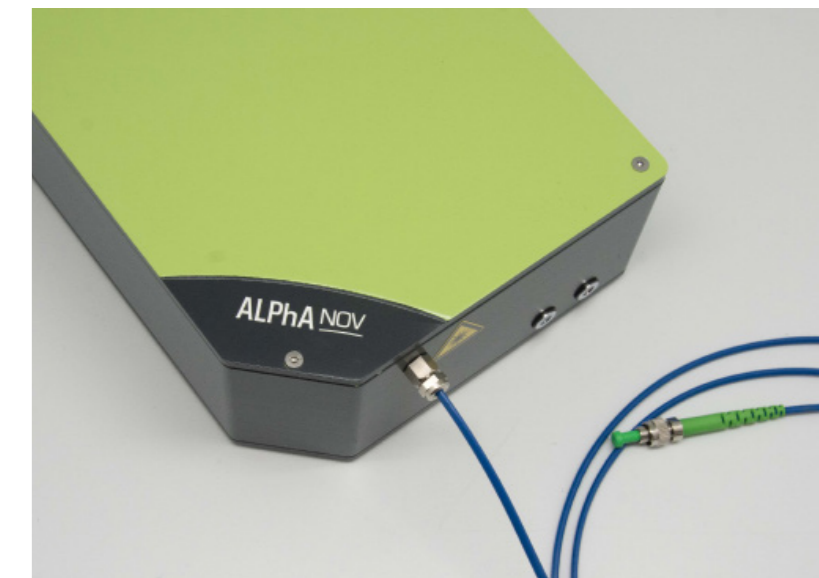
Some of these laser sources are now offered as standard off-the-shelf products, covering the full spectrum from visible to mid-IR.

	Wavelength	Pulse duration	Repetition rate	Average power <sup>(1)</sup>
<b>Ti-PULS</b>	800 nm +/- 1 nm	<40 fs	40 - 80 MHz	Up to 200 mW
<b>Yb-PULS-ps</b>	1064 nm +/- 1 nm	<10 ps	20 - 60 MHz	Up to 20 mW
<b>Er-PULS-fs</b>	1560 nm +/- 10 nm	<100 fs	40 - 50 MHz	Up to 100 mW
<b>MIR-PULS-fs</b>	Tunable 1800 - 2100 nm	<300 fs	40 - 50 MHz	20 mW

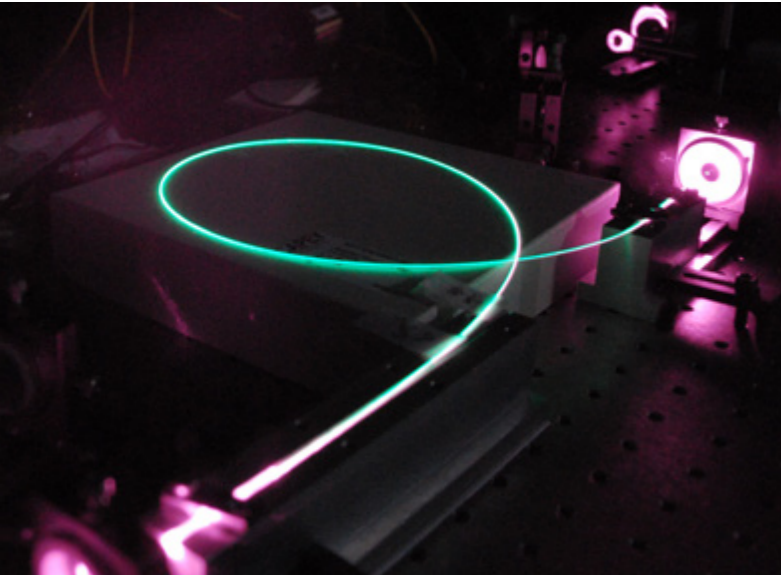
<sup>(1)</sup> Depending on the repetition rate

#### Key features

- All-PM fiber laser
- Near transform-limited output pulses
- Environmentally stable output
- Low power consumption
- Pocket-size or OEM version
- Electronics in OEM version







## HIGH POWER FIBER AMPLIFIERS

Optical fiber is the go-to technology for lasers whenever stability and reliability are required. It replaces solid-state lasers whenever comparable performances can be achieved in various industries (laser processing, life science, etc).

ALPhANOV has world-renown expertise in the interfacing and processing of the most advanced optical fibers lasers: microstructured, photonic crystal fibers (PCF).

Most of our fiber amplifiers use internally produced optical components such as pump combiners, mode-field adaptator, end-caps, etc.

Based on its expertise in laser design and state-of-the-art fiber interfacing, ALPhANOV can build custom turn-key multi-100-Watt monolithic laser amplifiers with superior stability.

Our amplifiers rely on Yb-doped microstructured fiber architectures. They can be tailored to meet specific requirements in terms of power, temporal regime and other functionalities.

### Key features

- High average power up to 300 W
- High energy up to 200  $\mu$ J
- Femtosecond compatible
- Available at 1030, 1064, 1550 and 1950 nm\*

*\* Contact us for available performance at specific wavelengths*



## PULSE COMPRESSORS & DISPERSION MANAGEMENT

ALPhANOV has developed industrial pulse compressors, which are easy to implement into R&D set-ups and OEM products.

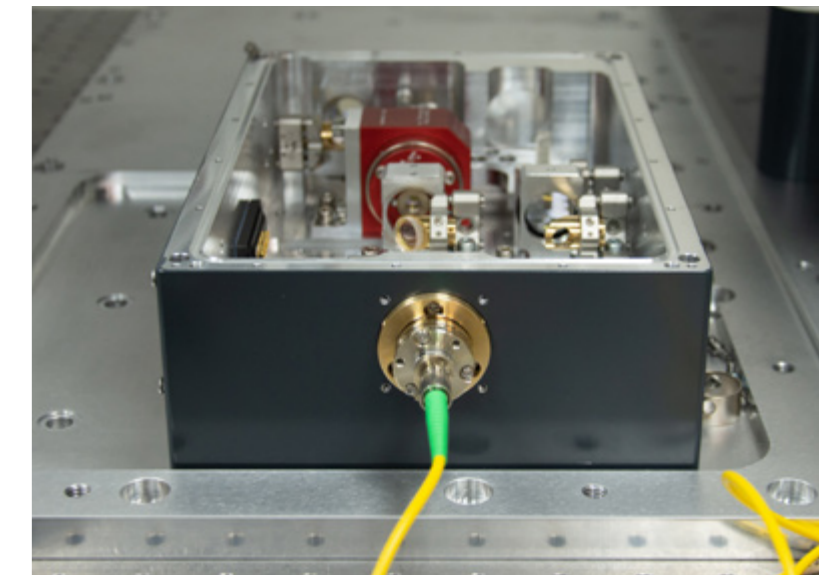
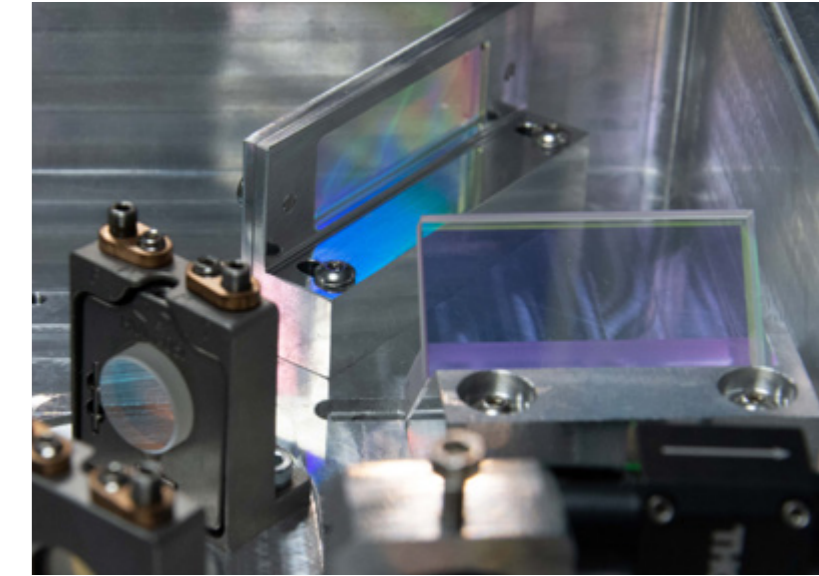
Our compressors are designed for up to 100 W average power, and have built-in motorized tuning to enable easy alignment and maintenance

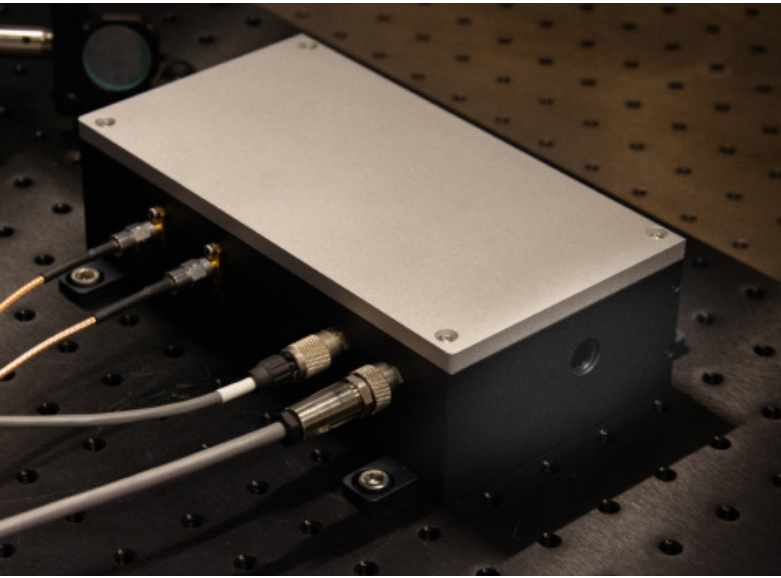
These modules can be made in both positive and negative dispersion configurations, allowing them to be used in various configurations such as stretchers, compressors, pre-chirp compensation.



### Key features

- Compatible with high average power up to 100 W
- Positive (stretcher) or negative dispersion (compression)
- Hands-free automated tuning
- Free space or fibre-coupled input





## FREQUENCY CONVERSION & NONLINEAR MODULES

When your application requires a wavelength not covered by standard lasers, we can add nonlinear modules to reach the optimum wavelength and bandwidth required.

### Fiber coupled or free-space frequency conversion

ALPhANOV has cultivated a unique understanding of resonant frequency doubling. In partnership with MUQUANS, we are able to build fiber-coupled frequency doubling suited for single-frequency lasers with over 70% conversion efficiency, operating in the visible spectrum.

The same technological platform is also used to build frequency doubling modules adapted for ultrashort femtosecond pulses with over 60% conversion efficiency.

And what's more, these modules can be made compatible with high average powers, allowing users to obtain > 100 W of visible laser power.

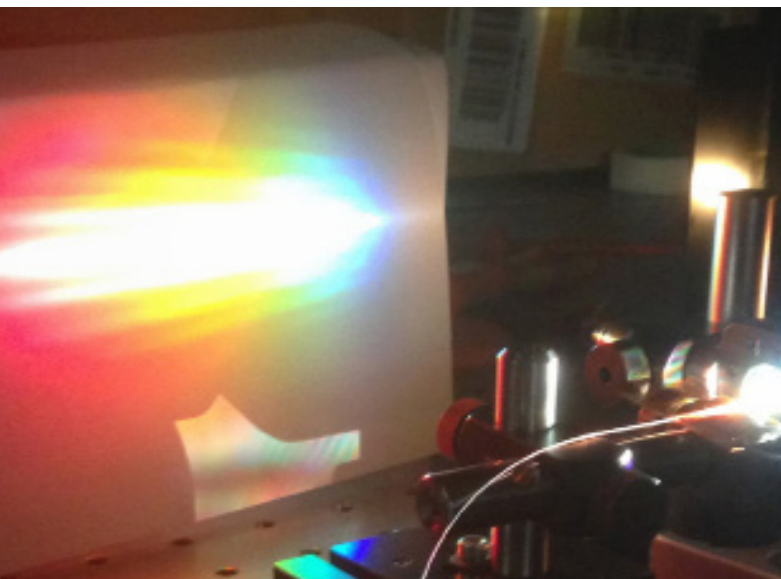
### Fiber-based nonlinear modules

Thanks to our expertise in PCF fiber processing and our strong connection with LEUKOS, we are able to integrate supercontinuum and nonlinear shift modules in our fiber lasers in a fully monolithic assembly. Generation of broad supercontinuum from the UV to the mid-IR is possible with up to several watts of average power.

Nonlinear soliton shift can also be used to access hard to reach wavelength ranges. Based on the stimulated Raman effect, this phenomenon shifts a short laser pulse to higher wavelengths.

### Key features

- Fiber based nonlinear modules
- Highly efficient frequency conversion
- High average power supercontinuum
- Unusual wavelengths reachable with nonlinear soliton-shift



## BEAM DELIVERY AND SHAPING

It is often necessary in laser applications to have their light output as close as possible to the delivery target. Fiber delivery offers the perfect solution for beam transport with its durability, flexibility and resistance against mechanical bending.

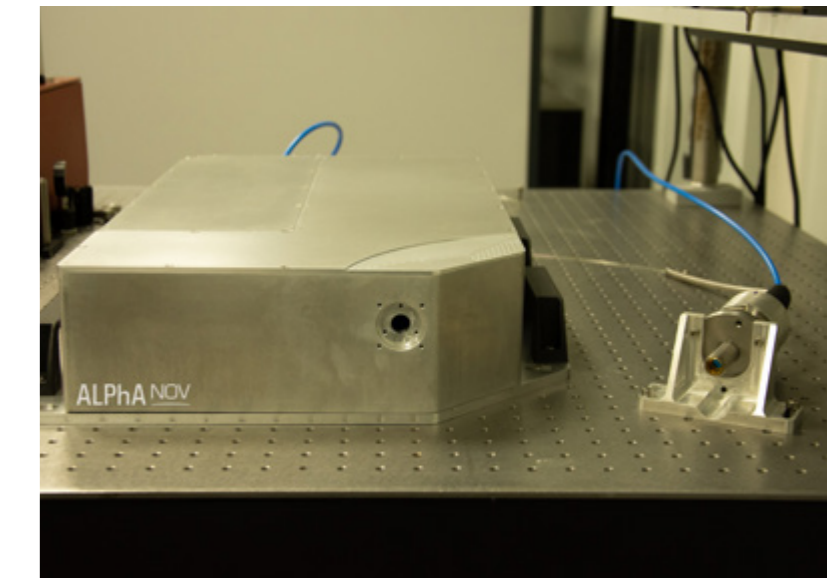
Assembly of a fiber with a high precision mechanical connector requires a tight control of mechanical tolerances, and considerable knowledge of fiber processing.

For very high average powers, ALPhANOV can create custom high-power fiber delivery modules using either standard connection output such as LLK, or others on demand. Since our connector design includes collimation optics, we can easily include beam shaping components to obtain specific beam profiles such as flat-top beams, or even squared beams.

Fiber-based transport is usually not compatible with high peak power, femtosecond pulses. Our PowerPAC connector offers a high precision beam transport solution for femtosecond pulses. Based on hollow-core fiber technology, our components can withstand more than 100 Watts of injected average power.

### Key features

- Custom fiber delivery options
- Compatible with average power >100 W
- PowerPAC for femtosecond laser pulse delivery
- Custom beam shaping possible





## TESTIMONIALS



### A PICOSECOND LASER AT 780 nm FOR PROSTATE CANCER DIAGNOSIS



Today's prostate cancer diagnosis is an invasive procedure carried out by means of successive biopsies. This is due to the lack of imaging techniques able to detect tumors in the early stages of cancer. Time-resolved fluorescence measurement is a particularly interesting approach for tumor localization.

As part of this project, ALPhANOv has developed a compact laser prototype that perfectly meets this specific need and delivers picosecond pulses at 780 nm at repetition rate of 80 MHz, by using a technological brick developed by the Gironde startup Irisiome Solutions.

Benefiting from the support of the Nouvelle-Aquitaine Region, promoted by CEA Tech and implemented with the University Hospital of Bordeaux and the IMOTION laboratory (University of Bordeaux), this solution makes it possible to focus precisely on biopsy locations.

*C. Handschin et al, « Guiding prostate cancer biopsies using time resolved 3D fluorescence tomography combined with ultrasound imaging, » in 2019 (CLEO).*

Wavelength	780 nm
Regime	80 MHz, 30 ps
Power	30 mW

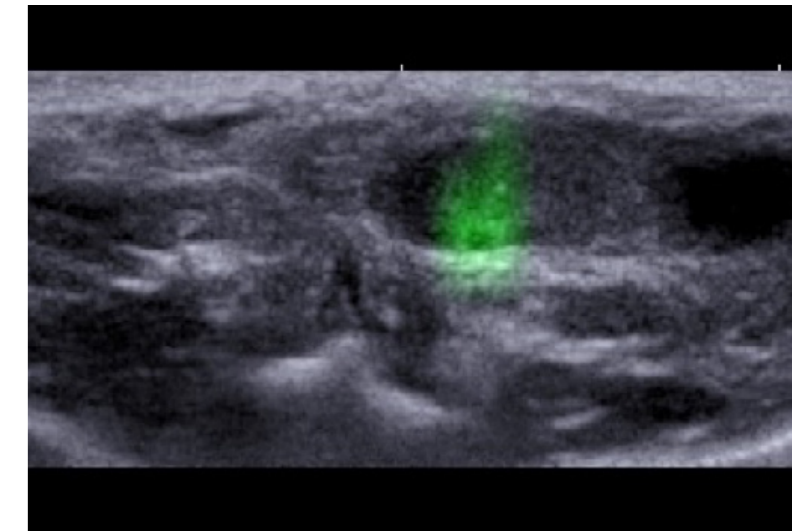
*"ALPhANOv fully understood our needs for this project and proposed the appropriate solution. They were very professional in overseeing the development of the laser, kept to schedule and lived up to expectations. Since its installation in the machine, the laser has been fully satisfactory and very stable."*

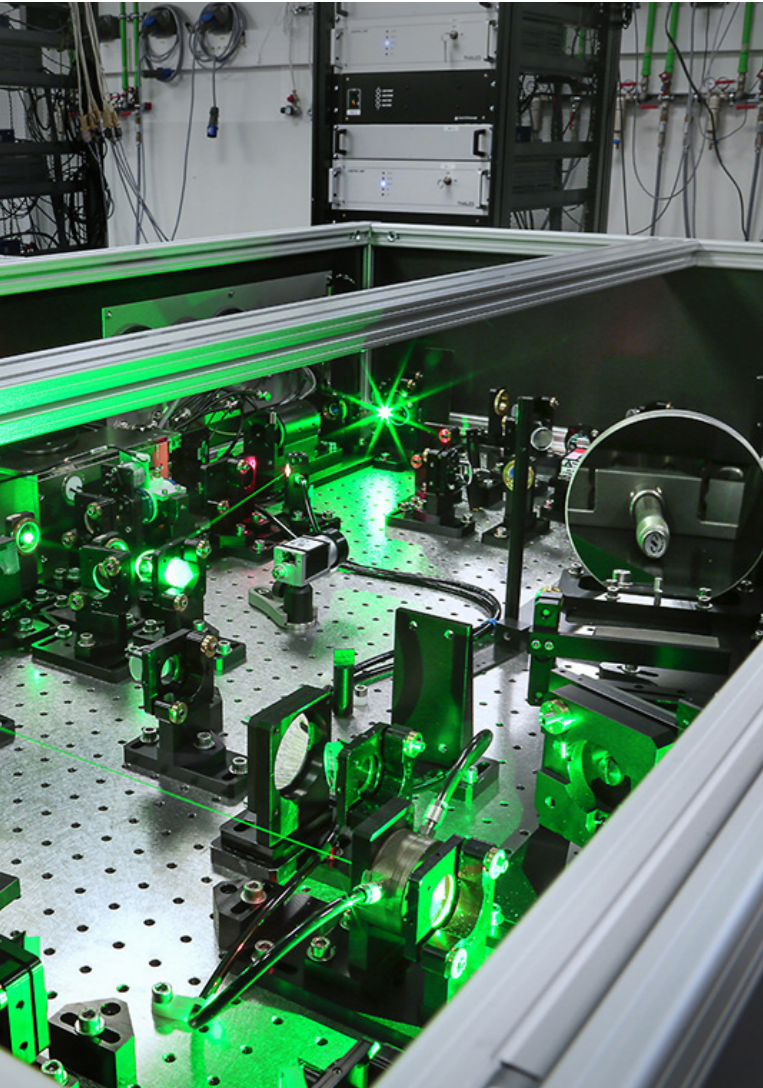
Olivier Redon, Innovative Thematic Coordinator, CEA Tech



IRISIO ME  
ARTHEC LASER DEVICES

IBIO Institut de Bio-imagerie / université BORDEAUX





## A COMPACT FIBER SEEDER AT 800 nm FOR Ti:SAPPHIRE LASERS

The next revolution in high energy particle sources may be achieved with laser-plasma acceleration of electrons or ions, enabling high Electric fields on cm-scale instead of km-large facilities.

In order to make these laser-based processes reliable, strong and hands-free multi-TW systems are necessary. ALPhANOV partnered with Thales to improve its preexisting high energy systems femtosecond laser systems.

Ti-PULS is a new generation of fiber laser with unique performances, delivering sub-40 fs pulses at 800 nm with nanojoule energy (> 2 nJ). It was designed as an economical and compact alternative to Ti: Sapphire oscillators. Thanks to its passively cooled, monolithic fiber design, it provides an industrial grade seeder for all TiSa laser systems which are used, for instance, in future laser-plasma accelerators.

*S. Boivinet et al « 3.5nJ femtosecond pulses at 792 nm generated by frequency doubling of an all-PM fiber high energy 48 fs laser » Proc. SPIE 10897, Fiber Lasers XVI: Technology and Systems, 108971J.*



Wavelength	800 nm
Regime	Pulsed, 40 MHz
Power	> 20 mW
Pulse duration	< 35 fs

*"Working with ALPhANOV was a great experience. They demonstrated high level laser and photonics skills, together with excellent competency in R&D project management, and commitment respect."*  
 Sebastien Laux, Business Development Manager, THALES LAS France



THALES



## A HIGH POWER SUPERCONTINUUM LASER FOR SPECTROSCOPY



Wavelength	500 - 2300 nm
Regime	Pulsed, 20 MHz
Power	Up to 4 W
Pulse duration	6 ps (seed laser)

*"The collaboration with ALPhANOV has allowed Leukos to introduce a new high power supercontinuum laser to the market. ALPhANOV's skills in terms of high power fiber laser, electronics and fiber integration, were very important for this new range of Leukos products. This work with ALPhANOV has helped Leukos strengthen its position as a world-leading supplier of supercontinuum lasers."*

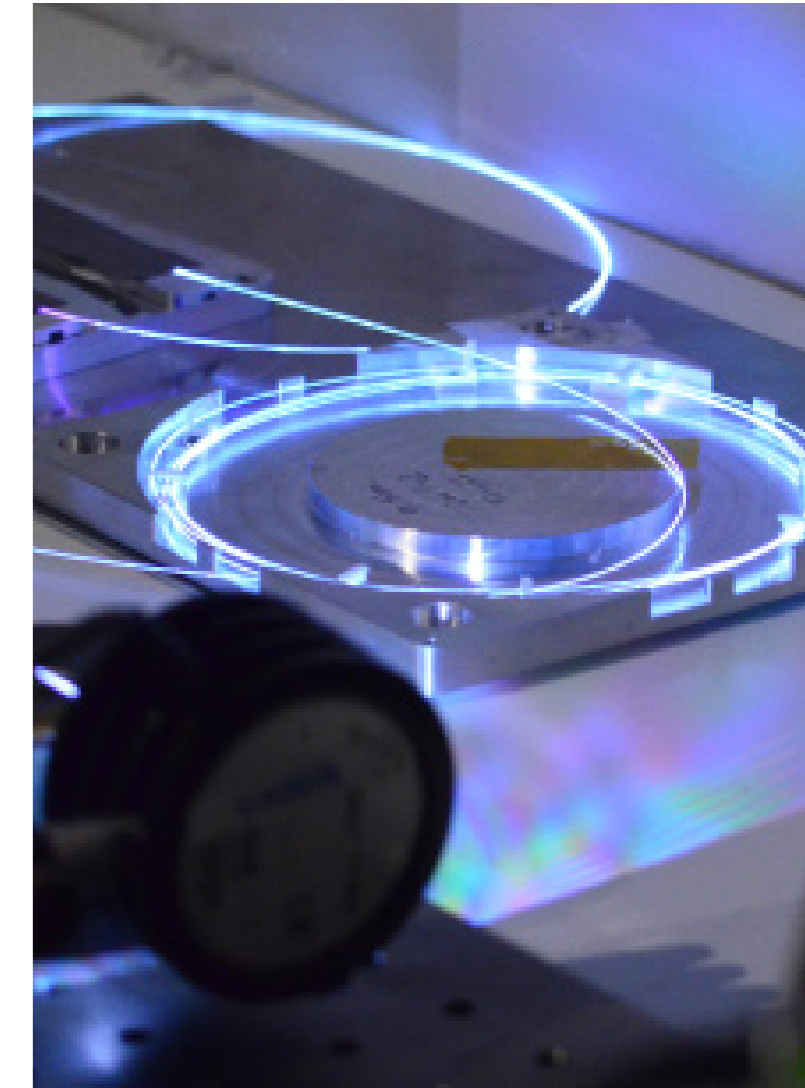
Guillaume Huss, CEO - founder, Leukos



LEUKOS  
 Make a bright future

With LEUKOS, we developed a high power Supercontinuum OEM platform emitting up to 2 W of laser light from 400 nm to 2400 nm. LEUKOS benefited from our specific expertise in industrial laser integration: the laser was integrated into a newly developed, single OEM housing containing both optical and electronic components.

We are proud not only to have successfully developed the product, but also to have transported the product in its entirety to the LEUKOS team.



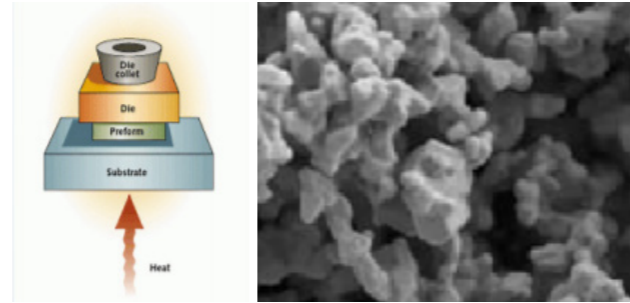


## AN AIR-COOLED LASER SOURCE FOR MATERIAL PROCESSING

With the company ISP System, we developed an air-cooled, fiber based 200 W laser system, with squared and flat-top beam profiles, delivered with a custom built fiber delivery connector.

The whole system was integrated into a rackable unit, and delivered with custom built software and its associated DLL commands.

This laser is currently being tested for a new heat-based bonding process for microelectronic and optical bonding applications.



Wavelength	940 nm
Regime	CW
Power	> 200 W
Fiber output	Squared, flat-top profile with LLK delivery

"ALPhANOV developed this laser for the TALSO collaborative project, during which partners developed a high-performance assembly process for optical components based on sintered nano-porous silver particles. This laser was especially designed to be integrated inside our commercial laser-based assembly machine: it delivers a top-hat beam of 8 x 8 mm<sup>2</sup> with 200 W of average power, which allows us to heat the assembly zone quickly and homogeneously. This system is essential to reach an optimum sintering process."

Paul Sauvageot, CEO, ISP System



## AN AJUSTABLE TEMPORAL SHAPE LASER FOR MATERIAL PROCESSING



The specific laser treatment of aerospace materials called Laser Shock Peening requires high energy lasers above the Joule level.

In partnership with CILAS, ALPhANOV developed a temporally shaped fiber laser designed to seed high energy amplifier up to 400 mJ.

The laser was fully integrated and tested in real-conditions inside the ALPhANOV application laboratory. Top-tier hardening performances were successfully demonstrated.

A. Jolly et al « SBS management in Yb-fiber-amplifiers using multimode seeds and pulse-shaping, » *Opt. Express* 22, 20326-20346 (2014).

Wavelength	1064 nm
Regime	Nanosecond pulses with adjustable temporal profile
Energy	Up to 200 μJ

"The collaborative development undertaken in the HELIAM project was very ambitious in view of the expected performance of the laser. The ALPhANOV and CILAS teams worked jointly on the solution and achieved a very innovative result. This is a fine example of successful collaboration."

Jean-Paul Dufour, Business Development Manager, CILAS ArianeGroup

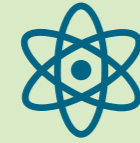
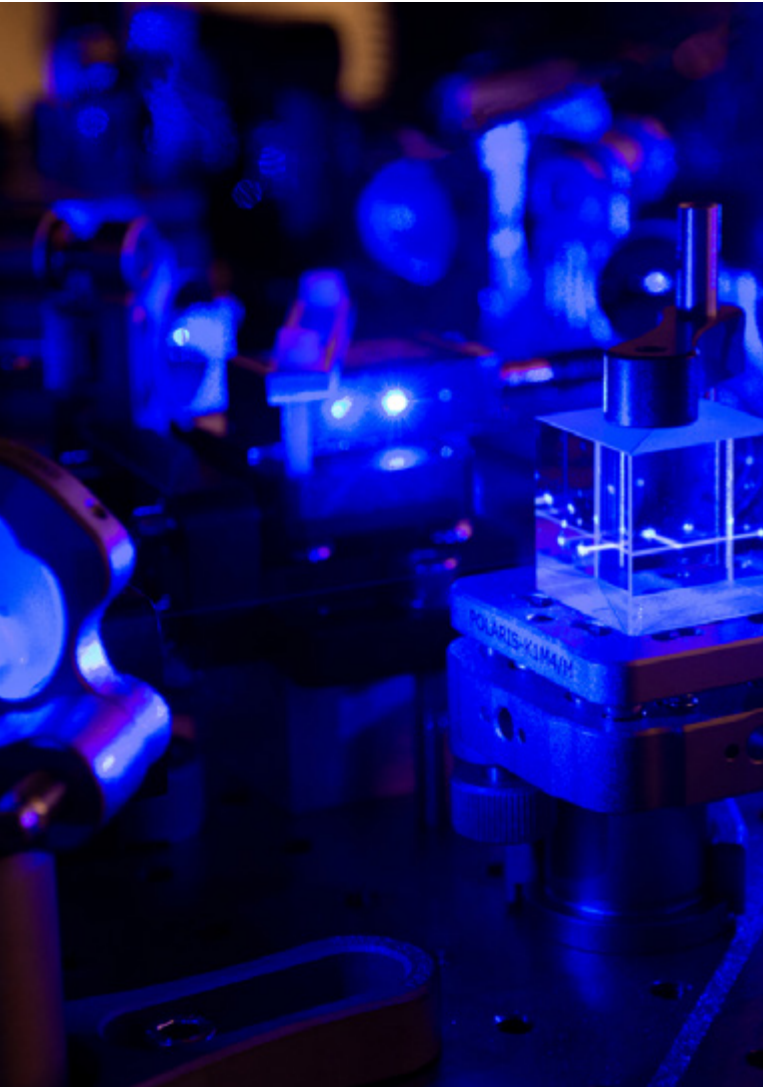


Union Européenne



RÉGION Nouvelle-Aquitaine  
La Nouvelle-Aquitaine et l'Europe agissent ensemble pour votre territoire





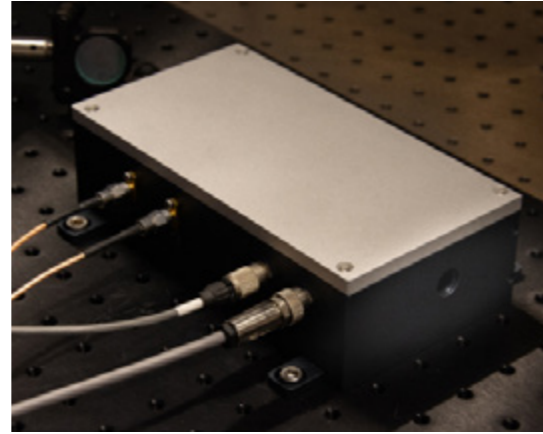
## A SINGLE-FREQUENCY LASER AT 461 nm FOR ATOM TRAPPING

ALPhANOV, MUQUANS and the LP2N laboratory partnered to develop a new laser source for quantum technologies. This laser source, operating at 461 nm, delivers up to 1 W of average power.

In this collaboration, ALPhANOV used its expertise in laser cavity design, nonlinear optics and optical bonding to produce a fiber-coupled, state of the art resonant frequency doubling module with a record conversion efficiency of 70%.

This system will be delivered to LP2N, where it will be used to manipulate and cool Strontium (Sr) atoms.

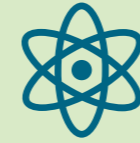
*Patent FR3042073A1 « Utilisation d'une source laser à balayage en fréquence rapide pour la manipulation d'atomes ».*



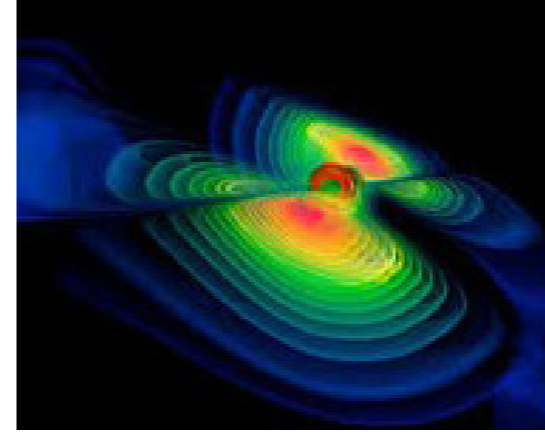
<b>Wavelength</b>	461 nm
<b>Regime</b>	CW, single-frequency
<b>Power</b>	1 W

*"The collaboration with ALPhANOV has been exemplary in all respects. Faced with an ambitious technological challenge, my colleagues at Alphanov demonstrated an always constructive attitude, great perseverance and first-rate scientific and technical skills. These qualities were essential to solve the many technical difficulties that we had to overcome during the project, and this work led to a prototype with first-class performance. I thank them and congratulate them for their help."*

Bruno Desruelle, CEO, MUQUANS



## A 350 W SINGLE FREQUENCY FIBER AMPLIFIER FOR GRAVITATIONAL WAVE DETECTION



<b>Wavelength</b>	1030/1064 nm
<b>Regime</b>	CW, single-frequency
<b>Power</b>	> 350 W

*"The collaboration with ALPhANOV was extremely fruitful, with very complementary skillsets coming from ALPhANOV and our partner lab, LP2N, with whom we have a joint laboratory facility in the Aquitaine Optical Institute. By leveraging this wide ranging expertise, all housed "under one roof", the project was focussed and efficient, with technical results of the very highest order."*

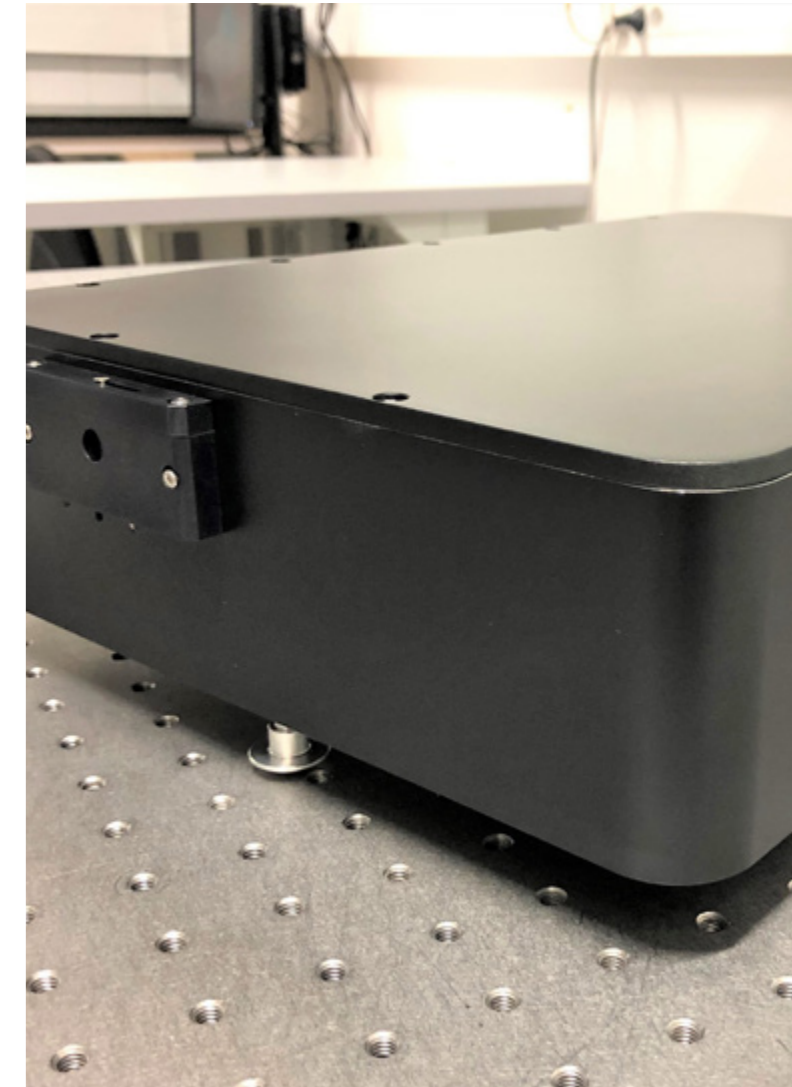
Nick Traynor, CEO, Azurlight Systems

The detection of a black hole merge at LIGO and VIRGO through gravitational wave measurement was definitely one of the most exceptional milestones in modern science. At the core of these facilities lies an interferometer that uses ultra-stable, high power single frequency lasers.

Azurlight Systems, a leading manufacturer of single frequency and ultra-low noise fiber lasers and amplifiers, worked with ALPhANOV to develop a new fiber amplification platform that has potential use in advanced interferometry, holography and various other applications.

Up to 365 W, single-frequency was obtained from the laser, opening the use of this platform to high power interferometry applications. The corresponding turnkey industrial product offers generous power level of 130 W.

*C. Dixneuf et al « Ultra-low intensity noise, all fiber 365 W linearly polarized single frequency laser at 1064 nm, » Opt. Express 28, 10960-10969 (2020).*



Tel.: +33 (0)5 24 54 52 00  
info@alphanov.com

[www.alphanov.com](http://www.alphanov.com)

# ALPhA NOV

Optics & Lasers Technology Center

## **ALPhANOV headquarters in Bordeaux-Talence**

Institut d'optique d'Aquitaine  
Rue François Mitterrand  
33400 Talence - France

## **ALPhANOV office in Limoges**

Xlim  
123 avenue Albert Thomas  
87060 Limoges

