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Plan de Recuperación, Transformación y Resiliencia

PLEC DE PRESCRIPCIONS TÈCNIQUES

“SUPPLY, INSTALLATION AND STARTING-UP OF A HIGH-POWER 405 NM FINE-LINEWIDTH BENCHTOP LASER SYSTEM BASED ON SECOND-HARMONIC GENERATION", MITJANÇANT PROCEDIMENT OBERT SIMPLIFICAT PREVIST ALS ARTICLES 159.1 A 159.5 DE LA LCSP

Aquest equip estarà finançat pel programa <Hub Nacional de Excelencia en Comunicaciones Cuánticas> finançat pel Ministeri per a la Transformació Digital i de la Funció Pública a la Unió Europea-NextGenerationEU/PRTR.

NÚMERO D’EXPEDIENT: ICFO-2026-009

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ANTECEDENTES

The Optoelectronics Group at ICFO is developing advanced protocols in the field of quantum cryptography and quantum communications. In particular, several experimental implementations of quantum communication protocols, such as Quantum Key Distribution (QKD), as well as next-generation sources of entangled quantum light, require stable, high-power laser sources operating in the near-ultraviolet spectral region.

Spontaneous parametric down-conversion (SPDC)–based sources pumped at 405 nm enable the generation of polarization-entangled photon pairs at 810 nm, which are well suited for free-space quantum communication links. The acquisition of a reliable, high-power 405 nm laser source is therefore essential to support metropolitan-scale free-space quantum communication experiments and ICFO's broader research activities in this field.

1. Needs to satisfy

The requirement of a high-power, narrow-linewidth 405 nm benchtop laser system is essential to advance ICFO's research in quantum secure networks and quantum communications. The laser will be used to pump advanced quantum light sources based on nonlinear optical processes, in particular spontaneous parametric down-conversion (SPDC), enabling the generation of polarization-entangled photon pairs at 810 nm. These sources constitute a fundamental building block for entanglement-based quantum communication protocols and quantum networking architectures.

The primary use case of the system will be its integration into a next-generation entangled photon source designed to achieve high pair-generation rates over a broad SPDC emission bandwidth. Access to high optical pump power is required to sustain strong nonlinear conversion efficiency across a wide spectral range, allowing the selection of multiple wavelength channels. This capability is essential for the implementation of wavelength-division multiplexing (WDM) schemes, in which entanglement can be distributed simultaneously to multiple, independent pairs of users, rather than being restricted to a single point-to-point link.

In such WDM architectures, spectral filtering inherently introduces additional optical losses, as only a fraction of the total SPDC bandwidth is allocated to each user pair. These filtering losses significantly reduce the detected coincidence rates and therefore place stringent requirements on the brightness of the entangled photon source. Consequently, high pump power at the laser level is critical to compensate for these losses and to maintain high-quality entanglement across all wavelength channels. Such multiplexed operation is a key requirement for the realization of metropolitan-scale entanglement distribution networks, where photons must be transmitted over long free-space or hybrid free-space/fiber links. In this regime, optical losses increase drastically, and high pump power at the source becomes critical to maintain usable coincidence rates and high-quality entanglement across all wavelength channels. The laser system must therefore provide sufficient output power to support scalable, multi-user quantum communication experiments under realistic network conditions.
In addition, the laser must exhibit fine spectral linewidth and precise wavelength tunability. These characteristics are crucial to achieve and maintain proper SPDC phase matching over the targeted wavelength range, particularly when operating across a broad spectrum and when selecting specific wavelength channels for multiplexed distribution.

In order to demonstrate the feasibility of metropolitan-scale, multi-user entanglement distribution in realistic communication scenarios, the Optoelectronics Group requires a high-power, narrow-linewidth 405 nm benchtop laser source suitable for integration into SPDC-based quantum optics setups. The system will serve as the optical pump for next-generation entangled photon sources, enabling stable, high-brightness generation of polarization-entangled photon pairs over a broad spectral bandwidth.

The laser will be deployed in experimental testbeds connecting multiple quantum nodes in real-world quantum communication networks. In this context, high optical power, long-term wavelength stability, and fine linewidth control are essential to compensate for propagation and spectral-filtering losses, and to maintain stable phase-matching conditions when distributing entanglement. The laser source therefore constitutes a critical enabling component for scalable quantum communication architectures pursued by the group.

2. Technical specifications

The required equipment is a benchtop continuous-wave optical laser source operating at 405 nm, designed for single-frequency, narrow-linewidth operation. The system must be fiber-coupled, turnkey, and include optical monitoring ports and electrical synchronization and control outputs. It must be suitable for integration into ICFO's laboratories for quantum optics and photonics experiments, including applications requiring high spectral purity and long-term frequency stability. In particular, the device must fulfil the following criteria:

A benchtop continuous-wave narrow-linewidth laser system operating at 405 nm, with single-frequency emission and fiber-coupled output, featuring the following characteristics:

- Design centre wavelength: 405 nm +/- 0.5nm
- Laser type: Continuous-wave frequency-doubled diode laser system based on a grating-stabilized external-cavity diode laser (ECDL), tapered amplifier (TA), and resonant SHG stage
- Output power (free-space): 1000 mW
- Coarse wavelength tuning range: ±2 nm (from design centre wavelength, i.e. 403nm – 407nm)
- Coarse wavelength tuning precision: <0.1nm
- Mode-hop-free tuning range: > 15 GHz
- Linewidth: [Instantaneous < 2.5 kHz], [5 μs integration < 100 kHz]
- Frequency stability: < 200 MHz/K
- 405nm single spectral mode output (with linewidth as above) can be maintained automatically, modehop-free (in laboratory-like conditions at room temperature), for >4 hours
- Frequency stabilization: Digital Pound–Drever–Hall (PDH) stabilization of the SHG resonator length with automatic relocking
- Frequency locking and control: fully digitally controlled frequency locking (i.e. no need for manual control)
- Main optical output: Free-space, and removable fibre-coupling to PM single-mode fiber with FC/APC connector (with coupling efficiency >60%); PER 20 dB
- Monitoring and auxiliary outputs: Probe beam output at the fundamental wavelength; TA and SHG probe outputs
- Control and interfaces: Touchscreen, PC GUI, USB, TCP/IP, and analog remote control
- Laser head dimensions < 500 × 450 × 100 mm³
- Explicit exclusions: The system is continuous-wave, not pulsed, and not mode-locked

3. Transport, installation and start-up

The awarded supplier must provide transport, customs clearance, and delivery to ICFO facilities in Castelldefels. On-site installation, verification, and acceptance testing are mandatory. The supplier will also provide training sessions for ICFO personnel on the operation and maintenance of the system.

List of essential requirements:

1. The proposal should include transportation to ICFO's facilities and all export/import and customs duties.

2. The equipment should be placed in the selected locations by ICFO. Contract winner should cover all costs, organization and coordination of devices' placement.

3. Support for Installation and start-up of the system, including for system checking, functional tests and process qualification (Preferably in person)

4. Warranty and Support

Minimum 1-year Full warranty.
The warranty will include the replacement of any faulty or damaged part(s) upon delivery during normal use of the system, no matter the manufacturer of the component(s). It will cover any cost related with the disassembly, transportation, reparation and re-assembly of the damaged component(s), including all travelling and living costs of the required service engineer(s). An on-site repair, or a justified alternative to reduce the system down time to the minimum, will always be the first service option. A team of properly qualified and skilled service engineers will have to be available.

5. Target price

The reference maximum budget for this procurement is set at 94.000 EUR (VAT excluded).

6. Delivery Time

Delivery time is defined as the time elapsed since the signature of the contract until the system delivery at ICFO facilities. It includes the manufacture of the system, the acceptance test at company's premises and the transportation.

The equipment must be delivered at ICFO within a maximum period of **17 weeks** from from the PO issued by ICFO. **Without prejudice to the above, the deadline of the contract will be 15TH August 2026.** In the event that this date is exceeded, the contract will be automatically terminated, without the contractor being able to claim from ICFO any concept linked to the contract.

Castelldefels, at date of digital signature

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