European Organization for Nuclear Research
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Price Enquiry

Technical Specification

Supply of one dual Narrow band broadly tunable dye Nanosecond Laser for CERN-AEgIS

Abstract

This Technical Specification concerns the supply of one nanosecond laser operating between 543 and 920 nm with doubling (206 – 450 nm), tripling (197 – 260 nm) and sum frequency mixing (360 – 442 nm) capabilities that can be operated in narrow band broadly tunable and in single mode seeded (producing 30 mJ at 730 nm in single mode emission when seeding with 300 mW) configurations. The pump and seed lasers for the dye system are not part of this Price Enquiry.

The delivery is foreseen within seven months from notification of the Contract.

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Table of Acronyms

Acronym	Definition
FAT	Factory Acceptance Tests
LHC	Large Hadron Collider
SAT	Site Acceptance Tests

1. INTRODUCTION

The Contract will be performed in accordance with the General Conditions of CERN Contracts (CERN/FC/6674-II). However, this Technical Specification prevails over the General Conditions of CERN Contracts with regard to the particular provisions specified in this document, and this without prejudice to any other provision in the General Conditions of CERN Contracts.

Capitalised terms in the body text are defined either in the General Conditions of CERN Contracts or in the present document.

1.1 Introduction to CERN

CERN, the European Organization for Nuclear Research, is an intergovernmental organization with over 30 Member States[1]. Its seat is in Geneva but its premises are located on both sides of the French-Swiss border (https://maps.web.cern.ch/). CERN's mission is to enable international collaboration in the field of high-energy particle physics research and to this end it designs, builds and operates particle accelerators and the associated experimental areas. At present, more than 10 000 scientific users from research institutes all over the world are using CERN's installations for their experiments. Further information is available on the CERN website: http://cern.ch.

The accelerator complex at CERN is a succession of machines with increasingly higher energies. Each machine injects the beam into the next one, which takes over to bring the beam to an even higher energy, and so on. The flagship of this complex is the Large Hadron Collider (LHC) (see Figure 1).

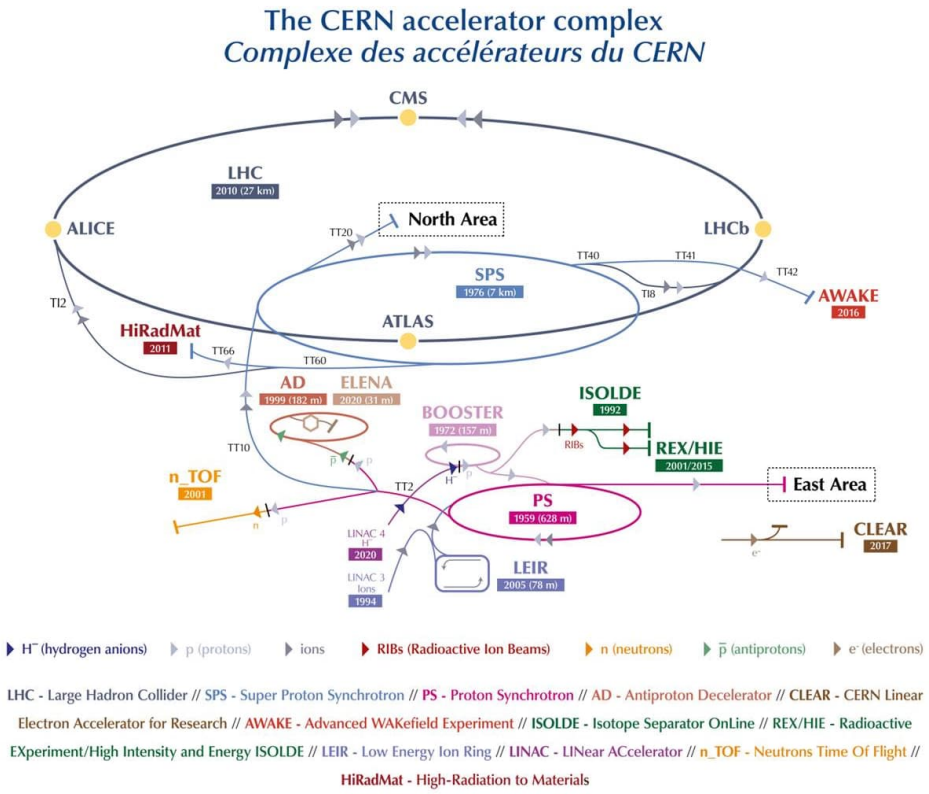

Figure 1: CERN Accelerator Complex

[1] http://home.web.cern.ch/about/member-states

1.2 Introduction to AEgIS

AD is CERN's antimatter factory where antiprotons are produced, decelerated and delivered to different experiments (ALPHA, AEgIS, ASACUSA, BASE, PUMA, GBAR).
At AEgIS, in the frame of the Quantum sensing projects, the formation of single-electron Rydberg Highly Charge Ions (HCI) requires a new pulsed powerful Laser system to photoionize and excite anions trapped together with antiprotons in order to form the antiprotonic atoms which can then be used to produce HCIs. Broad spectral tunability is required to cover different anions species while precision narrowband operation is required to saturate electronic transitions.

2. SCOPE OF THE SUPPLY

CERN intends to place a contract (the "Contract") for the supply of one dual Narrow band broadly tunable dye Nanosecond Laser for CERN-AEgIS (in whole or in part, the "Supply").

The successful bidder (the "Contractor") shall provide the Supply as defined in this Technical Specification.

2.1 Content of the Supply

The Supply shall include:

- *Technical deliverables* as specified in § 3:
  - Resonator, 5x amplifier, single mode amplification stage, third harmonic module, second harmonic module, sum frequency module, wavelength separator.

- *Activities* as specified in § 4:
  - On the Contractor's site:
    - Manufacturing;
    - Packing, and shipping (see § 4.1.1);
    - Laser repair during the warranty period if it cannot be performed at CERN;
    - Factory Acceptance tests (see § 4.1.2).
  - On the CERN site:
    - Remote Service (see § 4.2.2).
    - Maintenance Service (see § 4.2.3)

- *Documentation* as specified in § 5:
  - Factory Acceptance Test report (see § 5.1.1);
  - Technical documentation (see § 5.1.2);
  - Maintenance documentation (see § 5.1.3).

3. SPECIFICATION OF THE TECHNICAL DELIVERABLES

The Supply shall include the technical deliverables as specified in the present section.

3.1 Technical Deliverable of the Supply

All interested Bidders are strongly encouraged to contact CERN (see § 8) and discuss details of this Technical Specification before submitting a tender. In particular, CERN wishes to ensure that no doubt exists as to the interpretation of this Technical Specification.

3.1.1 Characteristics and Performances of the Supply

Table 1: Supply's requirements

	Value	**Comments**
Wavelength	543 – 920 nm doubling (206 – 450 nm) tripling (197 – 260 nm) sum frequency mixing (360 – 442 nm)	
Laser material	dye	
Wavelength control/tunability	Yes	
Pulse duration	few ns	
Repetition rate	10 Hz	The laser will be operated most of the time in single shot modality.
External trigger	Yes	TTL pulse for both laser emission and laser shutter
Timing jitter	<1 ns	Jitter between the external TTL trigger and the output peak power of the laser pulse.
Polarization	Linear, Stable, purity 1:100	
Beam Shape	Gaussian, M^2<1.2	If possible TEM00 mode
Pulse energy	>30 mJ @ 730 nm in seeded mode with 300 mW of seed power	>100 mJ in non-seeded mode from 543 to 920 nm
Pulse-to-Pulse Energy Stability (RMS 1σ) at 10Hz	<2	
Beam divergence	<0.5 mrad	
Beam pointing stability	< 20 μrad	
Input for the interlock	yes	

The Supply shall comply with the following requirements:

- The Supply must be triggered by an external master-clock TTL pulse generator.
- The resonator grating's ruling plane must be mounted vertically to protect against dust buildup and stray beams. Since the resonator itself is mounted horizontally, it must be pumped with the correct polarization to achieve optimal conversion efficiency (polarization-optimized).

- The resonator must be mounted on a thermally stable stainless-steel plate, independent of the Laser housing. This setup minimizes mechanical stress from the Laser housing and enables quick and easy resonator replacement. Calibration and configuration parameters must be stored within the resonator assembly's driving electronics. The system must automatically detect the connection of the resonator electronics to the Supply.
- The resonator must allow for grating replacement in a grazing position without requiring realignment. Grating replacement must be tool-free and performed via an automated grating exchange mechanism (grating lift option) to accommodate different groove densities.
- A high-power ASE-cleaning optical component must be installed between the resonator and the preamplifier to enhance polarization and reduce ASE. This optical element must support the complete tuning range of the dye.
- The resonator must feature a precision sine-bar drive mechanism with a high-resolution direct-drive stepper motor, eliminating backlash by avoiding pulleys and gears.
- The resonator and system scan control software must be open-source, with updates readily available online.
- The system must include LabVIEW® drivers and virtual instruments (VIs) for controlling the Supply. A programmer's guide must be provided.
- The system must incorporate interchangeable dye cells for rapid and straightforward dye exchange, without requiring system realignment. Dye cell replacement must be tool-free, and exchanging amplifier and resonator cells should take no longer than two minutes.
- The Supply must feature a touch-panel remote control, enabling stand-alone operation without an external computer.
- The dye circulator must be quiet, compatible with non-polar solvents (such as dioxane), and support an operational range of 1–100 Hz. For safety, it must include an illuminated main switch indicating active operation.
- All critical manual adjusters of the Supply must be top-accessible, allowing adjustments from either side of the Laser. The Laser housing's lid must be reversible, enabling operation from both sides.
- An optional integrated frequency doubler must include a Look-Up Table and an auto-tracker function for scanning.
- The Supply must support modular upgrades for non-linear processes, covering wavelengths from 190 nm to 13 μm.
- The system must be modular, allowing field upgrades or modifications with interchangeable resonator, amplifier, and frequency conversion modules. Installed modules (excluding amplifiers) must be automatically detected by the electronic system and control software.
- The system must allow quick switching of pump optics for fast adaptation to different pump laser wavelengths, including a Double-Wavelength Option.
- Long-term compatibility must be guaranteed between older and newer versions of mechanical, optical, and software components.
- Free factory training must be available (excluding travel and accommodation costs).

- Before the final amplification stage, a phase-conjugate mirror (using an SBS-active fluid) must be implemented to suppress unwanted ASE, continuous-wave (CW) and pulsed multimode radiation, as well as CW single-mode radiation.

3.1.2 Operational and Environmental Conditions

The Supply will be installed on the special optical bread-board table in CERN's laser laboratory with a stable environment: 20 °C +/- 2, <50% humidity.

4. SPECIFICATION OF THE ACTIVITIES

The Supply shall include the activities listed in the present section. These activities shall comply with the requirements specified below.

4.1 Activities at the Contractor's Premises

During the Contract, CERN shall have free access, during normal working hours, to the Contractor's premises, including manufacturing and assembly sites and Subcontractor's premises. The change of manufacturing place is subject to prior written approval by CERN.

4.1.1 Packing and Shipping

The Contractor shall be responsible for the packing and, for the transport to CERN. The Contractor shall take up a dedicated all-risk transport insurance for the Supply concerned in accordance with the provisions of DAP Incoterms 2020 conditions, CERN Meyrin (CH).

In all cases, the Contractor shall comply with the packing and shipping instructions available under: https://procurement.web.cern.ch/system/files/document/packing-and-shipping-instructions_0.pdf and, in particular, ensure that the Supply is packed in a way that guarantees the absence of any contamination and that no damage or any possible deterioration in performance due to transport conditions can occur.

4.1.2 Factory Acceptance Tests

The Contractor shall carry out the tests in order to verify the compliance of the Supply with this Technical Specification.

The Contractor shall compile the FAT results in a FAT report (see § 5.1.1) to be submitted to CERN for written approval prior to shipment of the Supply.

4.2 Activities on the CERN site

4.2.1 Site Acceptance Tests

CERN, or a representative of its choice, will carry out the following SAT on its site. The Contractor may attend such tests:

- Laser specifications as defined in this document;
- Test of the Laser operation and control functions;
- Remote control via supplied software and ability to communicate via a third-party application.

4.2.2 Remote Service

The Supply shall include a remote service allowing:

- An IP connection between the Supply and the remote service centre including a soft key in the user interface in order to diagnose the cause of any malfunctions that may occur;
- Interactive diagnostics for default, operating and status messages;
- Installation of software updates (where needed).

4.2.3 Maintenance Service

The Supply shall include field replaceable laser diodes (see § 3.1.1). Therefore, when an exchange of the laser diodes become necessary, the Contractor shall intervene on the CERN site in order to perform the replacement of the laser diodes.

5. SPECIFICATION OF THE DOCUMENTATION

The Supply shall include the documentation related to the Supply (§ 5.1). This documentation shall comply with the requirements specified below.

5.1 Documentation Related to the Supply

The documentation related to the Supply shall include:

- Factory Acceptance Test (FAT) report (see § 5.1.1);
- Technical Documentation (see § 5.1.2);
- Maintenance Documentation (see § 5.1.3).

5.1.1 Factory Acceptance Test report

The Contractor shall submit a FAT report in accordance with the schedule defined in § 7.1, including:

- All tests performed;
- All test results;
- All non-conformities;
- All modifications performed;
- Anything else of interest for CERN.

5.1.2 Technical Documentation

The Contractor shall submit technical documentation including:

- As-built documentation;
- Safety documentation;
- EC/EU declaration of conformity;
- Quality Control (QC) reports;
- User manual;
- List of any hazardous materials used.

5.1.3 Maintenance Documentation

The Contractor shall submit maintenance documentation including a Preventive Maintenance Plan.

5.2 Creation, Updating and Control of Documents

The Contractor shall apply professional standards and codes in matters of document editing, design/drawing process, design reviews and approval, naming conventions and tagging, quality assurance/control.

The full documentation supplied in the framework of the Contract (including all drawings and schematics) shall be in English and optionally also in French.

The Contractor shall submit all documents produced exclusively in the following electronic formats:

- Text documents in PDF® format.

6. APPLICABLE RULES, NORMS AND STANDARDS

The Supply shall comply with Laws. For the purpose of the Contract, Laws shall include all relevant rules, norms and standards and, and in particular:

6.1 Rules

- CERN Safety rules, available under: http://cern.ch/safety-rules;
- Swiss rules.

6.2 Norms and Standards

- CE certification for Electrical and laser safety, IEC 60825;
- RoHS 2011/65/EU.

7. PERFORMANCE OF THE CONTRACT

7.1 Schedule

The Contractor shall deliver the Supply in accordance with the following schedule, starting from the date of notification of the Contract to the Contractor:

Table 2: Schedule

	Milestones	Weeks	Indicative Date
T_0	Notification of the award of the Contract to the Contractor		End of April 2025
	Delivery of FAT report (see § 5.1.1) for written approval by CERN	T_0 + 24	End of October 2025
	Delivery of the Supply and related technical and maintenance documentation (see § 5.1.2 and § 5.1.3)	T_0 + 28	End of November 2025

7.2 Contractor's Personnel

The Contractor shall assign an appropriate number of qualified personnel for the performance of the Contract. The personnel assigned by the Contractor shall at all times remain under the sole direction and responsibility of the Contractor.

7.3 Contract Follow-Up and Progress Monitoring

The Contractor shall assign a person in charge of the technical execution of the Contract and its follow-up, as well as a person in charge of the commercial follow-up, during the whole duration of the Contract. These persons shall be able to communicate (spoken AND/OR written) in at least one of the official languages of CERN (English and/or French).

7.4 Working on the CERN Site

For any intervention on the CERN site, the Contractor shall take into account and implement the rules and provisions defined in the document *Working on the CERN Site* available under: https://procurement.web.cern.ch/document-category/key-reference-documents

- The Contractor shall take into account the following features of the CERN site: Custom formalities since the installations straddle the Swiss-French border;
- Radiation areas.

7.4.1 Location of the Activities

The Contract will be performed on the French part only of the CERN site.

7.4.2 Safety Requirements related to Activities on the CERN Site

In accordance with the provisions of § 3.1 of the document *Working on the CERN site*, the activities performed by the Contractor on the CERN site will be classified as "Category 2" worksite or activity.

The Contractor shall inform CERN in writing of any change in the potential risks as and when they arise.

Some activities are subject to a notice of start of works to be issued by CERN (*Impact* system).

The Contractor shall comply with the following specific safety requirements:

- Activities in radiation areas;
- Activities in an experimental areas;
- Activities in confined space;
- Specific worksite rules.

In accordance with § 7 of the Safety regulation CERN SR – SO "*Responsibilities and Organisational Structure in Matters of Safety at CERN*"[2], the Contractor shall appoint a Safety Correspondent who shall act as its representative at CERN in matters of Safety.

7.5 Acceptance of the Supply by CERN

The Contractor shall deliver to CERN for acceptance the Supply as specified in § 3 and according to the schedule defined in § 7.1.

[2] Available at https://www.cern.ch/safety-rules.

The acceptance of the Supply will be defined by clause 22 of the General Conditions of CERN Contracts.

In addition, such acceptance of the Supply will be subject to:

- The successful completion of the FAT performed by the Contractor and the submission by the Contractor of the FAT report (see § 5.1.1) for CERN's written approval;
- All compliant tests results or other certificates requested by CERN;
- The conformity of the Supply with this Technical Specification.

CERN reserves the right to repeat any or all the FAT performed by the Contractor onsite. In such case, the acceptance of the Supply shall also be subject to the successful completion of such Site Acceptance Tests (SAT).

7.6 Warranty

The warranty period shall be of two years from the date of acceptance (see § 7.5).

8. CERN REPRESENTATIVES

All commercial and technical correspondence concerning the Price Enquiry shall be communicated to the CERN Procurement officer and in copy to the Technical officer. Any communication by or to any other person than the CERN Procurement Service shall not be valid and have no effect.

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