SPECIFICATION SHEET

SUPPLY, INSTALLATION AND STARTING-UP OF A TIME-CORRELATED SINGLE PHOTON COUNTING SYSTEM FOR FLUORESCENCE LIFETIME SPECTROSCOPY

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Contents

CLAUSE 1. Object of the contract

The purpose of this contract is the supply, installation, and commissioning of a fluorescence lifetime spectroscopy system based on Time-Correlated Single Photon Counting (TCSPC) for the Post Processing Laboratory Facility of ICFO. The system must be a fully integrated, compact, and user-friendly commercial solution capable of picosecond to second lifetime measurements. It must include excitation, emission, detection, and data processing components in a turnkey configuration.

CLAUSE 2. Needs to satisfy

The required system is a commercial, fully-automated TCSPC fluorescence lifetime spectrometer specifically designed for routine use by non-expert users, and currently not available in the Post Processing Laboratory Facility of ICFO. TCSPC (Time-Correlated Single Photon Counting) is a sensitive time-resolved technique that detects the arrival time of individual photons following excitation, enabling precise measurement of fluorescence and phosphorescence lifetimes across timescales from picoseconds to seconds. This method is essential for investigating light-driven processes in materials, biomolecules, and photoactive systems.

The requested TCSPC system is intended for daily routine operation by researchers and students with varying levels of spectroscopy expertise, from beginner to advanced. The system must provide user-friendly, intuitive, and fully automated operation, requiring no manual optical alignment or adjustments, while also supporting advanced users through custom scripting and flexible control. The system must support fluorescence and phosphorescence lifetime measurements in the picosecond to second range, and be suitable for both steady-state and time-resolved spectroscopic investigations. It must allow the characterization of organic and inorganic compounds.

The system must serve as a turnkey solution, integrating specifications including:

-Two excitation sources operating in pulsed, continuous-wave, and burst modes

-Automated attenuators and emission monochromator

-High-sensitivity detector, capable of handling a broad spectral range with high temporal resolution

-Time-Correlated Single Photon Counting (TCSPC) electronics with picosecond resolution

-Comprehensive system control and analysis software, including application wizards, scripting, and remote support tools

-Temperature control capabilities for samples, with precise regulation between –15 °C and +110 °C, enabling temperature-resolved measurements for thermally sensitive photoactive systems.

-A magnetic stirrer must also be included for homogeneous mixing during measurements.

CLAUSE 3. Technical requirements

Requirements for the TCSPC system, accessories, software, warranty and service to be **provided** are listed below.

The equipment, service and warranty to be offered must include at least the following:

- A **compact and modular fluorescence lifetime spectrometer** based on **Time-Correlated Single Photon Counting (TCSPC)** and **Multi-Channel Scaling (MCS)**.
- **Plug-and-measure**, fully automated compact design, with fully automated optical and mechanical elements.

- **System software** for fully automated data acquisition and routines, featuring wizard-based standard operation also for non-expert users, and a customized scripting mode for advanced control and automation (local and remote).
- **Measurement range**: Measurement of fluorescence / phosphorescence lifetimes ranging from less than 10 ps up to several milliseconds and seconds / minutes
- **Instrument Response Function (IRF)**: typically <50 ps
- **Sensitivity**: detection limit ≤10 pM
- **Excitation sources** with pulsed mode, cw mode and burst mode / fast switching cw and high output power
- **Automated attenuators** in excitation and emission: fully software controlled and no need for further ND filter

Here below the technical specifications that must be satisfied by the system under request:

- **Excitation sources**:
  - Two pulsed diode laser heads at 440 nm and 500 nm: Laser heads for picosecond pulses compatible with pulsed, cw, and burst mode operation, centered at 440 ± 10 nm and 500 ± 10 nm, respectively, with pulse widths shorter than at least 100 ps, including collimator and temperature stabilization for each, with variable repetition rate up to 40 MHz.
  - User-controlled diode laser driver for picosecond pulses with adjustable output power and repetition rate ranging from 196 kHz to 80 MHz, capable of pulsed, cw, and burst mode operation with easy switching between modes.
  - The system must allow future expansion to support additional picosecond laser heads or sub-nanosecond LED excitation
  - Optical Base system with Laser adapter for pulsed, continuous and burst laser heads and sample compartment with UV excitation and emission optics
  - Fully automated signal attenuators in emission and pulsed excitation arm. Permits a continuous adjustment of signal intensity.
  - Fully automated polarizer that can be freely rotated for anisotropy studies
  - Automated filter wheel in the emission light path
  - External trigger input allows combining this setup with external laser sources.
  - Continuously adjustable laser power at constant pulse width and beam shape to ensure stable conditions for each measurement

- **Hybrid photomultiplier detector**:
  - Hybrid photomultiplier tube including Peltier cooling, preamplifier, shutter and power supply
  - Spectral range: 220–850 nm
  - Detection efficiency >10% between 400 and 600 nm, up to 25 % at 280 nm
  - Temporal resolution: typically <50 ps
  - Stable count rates >30 million counts/s
  - IRF independent from detection count rate and from spectral range
  - No after pulsing peaks, enables accurate fitting
  - Security shutter for overload protection
  - Simple 12 V DC power supply
  - Active temperature stabilization ensuring very low dark counts
  - Sensitivity: detection limit ≤10 pM

- **Optics and monochromator**:
  - Emission monochromator with 150 mm focal length, including one grating with 1200 lines / mm, blazed at 500 nm
  - Automated entrance and exit slits
  - mechanical and optical adaptation
  - Wavelength calibration of the emission channel
  - Calibration with calibrated standard lamp
  - Slit width adjustable from 0 to 10 mm, (0 - 54 nm BP)
  - Aperture F / 4.6

- Stray light rejection 1:10^{-5}
- Spectral resolution: 0.3 nm
- Dispersion: 5.4 nm / mm
- 0 Order position of monochromator
- Filter selection via automated filter wheel (25 mm or 1" emission filters)
- Emission light path: Software-controlled filter wheel with 6 position is included. Filter can be changed by the customer.
- Integrated thin-film polarizer, spectral range 370 nm to NIR
    - Automated excitation and emission attenuators
    - Automated filter wheel for 25 mm or 1" emission filters. It can be used for 2nd order suppression or for bypassing the monochromator.
    - High NA collection quartz optics for maximum sensitivity

- **Sample chamber and holders**:
    - 1 quartz 1x1 cm cuvette
    - Large multifunctional sample chamber
    - Sample compartment with UV excitation and emission optics
    - Exchangeable sample mounting units which must include temperature-controlled 1x1 cm cuvette holder with inbuilt magnetic stirrer (beam height: 8 mm above base) and precise, computer-controlled temperature regulation between -15 and 110 °C and water bath for cooling Peltier element, while operation below ambient dew point temperature requires dry gas purge
    - Possibility to integrate cryostats (to be purchased optionally in the future) for low temperature measurements

- **TCSPC electronics**:

TCSPC module with USB 3.0 connection, 4 independent input channels with 1 ps temporal resolution, of which 1 only is active, suited for 1 sync and 1 detector, or, if in the future are activated the other 3 input channels, up to 1 sync and 4 detectors upgradable.

TCSPC electronics features must include:

- Time bin resolution: 1 ps
- Timing precision: 2 ps RMS for single channel, 3 ps RMS between channels
- Choice of edge triggers or Constant Fraction Discriminators (CFD)
- Dead time: <680 ps (edge trigger), 4.2 ns (CFD)
- Adjustable programmable time offset: ±100 ns in 1 ps steps
- Maximum sync rate: 640 MHz
- Histogramming and time-tagged modes
- Multichannel scaling (MCS) for long-lifetime measurements
- FIFO buffer depth: ≥256 million events
- Acquisition time: 1 ms to 100 hours
- Peak count rate per input channel: ≥1.47×10^{7} counts/sec
- Sustained time tagging with up to 85 Mcps via USB 3.0

- **Software must allow instrument control, data acquisition and analysis, and must feature**:
- Combined instrument control and data analysis software with workspace archiving and automatic logging of all system parameters in each data file
- Wizard-guided protocols for automated system optimization and user guidance, plus a customizable measurement mode for advanced control
- Multi-exponential decay fitting, anisotropy analysis, global and batch fitting
- Mathematical function processor including: basic arithmetic operations (subtraction, multiplication, etc.), smoothing, derivatives, integrations, and trigonometry, data normalization and display in linear or logarithmic plots, freely zoomable plots with presentation-ready or multi- column ASCII export functions
- Interface for remote execution of scripts which allows coupling the system to third-party devices
- Remote support capability for assistance and diagnostics
- 5 additional software licenses included

- **Data acquisition and methods**:
  - The software and purchased system, altogether must be capable of acquiring:

  - Photon counts recorded as time stamps, with a time resolution of 1 ps (temporal resolution = bin width of 1 ps)
  - Time tagging with sustained count rates up to 65 Mcps
  - Adjustable input delay (offset) for each channel with 1 ps resolution
  - Multi-stop capability for high counting efficiency at slow repetition rates
  - Common sync for all input channels
  - Measurement principle based on Time-Correlated Single Photon Counting (TCSPC) in forward start-stop mode
  - Steady state emission spectra and anisotropy by laser excitation
  - Fluorescence intensity
  - Temperature resolved fluorescence and phosphorescence emission spectra by laser excitation
  - Fluorescence decays
  - Phosphorescence decays (up to second scale)
  - Time-resolved anisotropy
  - Time-resolved emission spectra
  - Lifetime kinetics up to minutes
  - Dead time of < 680 ps
  - Average count rates of 85 million counts/sec per timing channel in histogramming mode for superior data quality
  - Histogramming with 65535-time bins and 32-bit depth
  - Photon counts recorded as time stamps with a resolution of 1 ps (temp resolution = bin width of 1 ps)
  - Electronic jitter of 2-3 ps RMS
  - Multi-channel scaling capability for measuring fluorescence phosphorescence decays with lifetimes of up to several hundred milliseconds and seconds

CLAUSE 4. Power distribution and safety

The system must be compatible with the EU (Spain) power grid, CE marked, and include safety features such as overload protection and secure interlocks. Restart after power interruptions must be straightforward and safe.

CLAUSE 5. System layout and services

The supplier will provide:

- Full technical documentation including system layout and dimensions
- Clear description of all optical, electronic, and software modules.

CLAUSE 6. Transport, installation and start-up

- The proposal will include transportation to ICFO's facilities and all export/import and customs duties. DAP incoterms will apply.
- The machines will be placed in the selected location by ICFO. Contract winner will cover all costs, organization and coordination of machine placement, including any required specialized equipment or

vehicle, and any required component dis-assembly and re-assembly for systems unloading and transportation inside the building to the target lab location.

- Onsite system starts up included followed by the acceptance tests specified below.
- System training to ICFO personnel included.

CLAUSE 7. Acceptance test

Contract winner will install and carry the necessary test to verify that the technical requirements above mentioned are met and the correct functioning of the equipment. A service report, a list of all the specifics of the equipment provided, and acceptance test will be provided by the contract winner and signed by our institute, certifying from that moment the start of the warranty period.

CLAUSE 8. Warranty and Follow-on Support

The system must include a limited **5-year warranty for the core time-resolved electronics and laser drivers**, including: Multichannel TCSPC timing modules, Dual-channel TCSPC units for picosecond-resolved photon counting, High-throughput photon timing electronics, Laser driver units used for picosecond pulsed excitation.

All other components of the system must be covered by a **minimum of 2-year full warranty.** Additional years of warranty for all these other components will be evaluated positively as stated in the Annex núm. 2.

The warranty will include the replacement of any faulty or damaged part(s) 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.

The technical service team must be based in Europe and should provide, **free of charge, during the first three years annual preventive maintenance** on all acquired products and annual curative visits on all the components here purchased.

Commitment includes priority assistance on working days. Also, preventive maintenance including travel, materials and labor are included. Labor in preventive maintenance inspections is included without limit.

Spare parts will be available during, at least, 10 years after system supply and, in case of failure, will be delivered within 10 working days.

CLAUSE 9. Delivery and Installation Time

The system must be delivered and installed at ICFO within a maximum period of **1 month.**

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 transportation, the installation and the acceptance test at ICFO's premises.

CLAUSE 10. Target price

- The target price for the system is 77.600,00 € (VAT excluded).
- Payment terms:

  30% upon order,
  20% upon shipment from manufacturer
  50% after installation training and acceptance.

Castelldefels, on the date of its digital signature

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