

Confidentiality Level	<i>BL - Restricted for internal use</i>	TC ID / Revision	00301148/D
Document Status	<i>Document Released</i>	Document No.	N/A
OBS code	88 Department of Structural Dynamics		
PBS code	EBIO.EQBL.TCSP.5, EBIO.EQBL.TCSP.6		
Project branch	<i>Engineering & Scientific documents (E&S)</i>		
Document Type	<i>Specification (SPE)</i>		

[RSD product category A]

EXP_QBIO Single photon counting detectors for NIR TP21_301



Keywords

Counting detectors, Elibio, photon

	Position	Name
Responsible person	Scientist	Miroslav Kloz
Prepared by	Scientist	Miroslav Kloz

<i>RSS TC ID/revision</i>	<i>RSS - Date of Creation</i>	<i>RSS - Date of Last Modification</i>	<i>Systems Engineer</i>
022419/A.001	12.05.2021	12.05.2021	D. Hanusková
022419/A.003	12.07.2021	12.07.2021	D. Hanusková

Reviewed By

<i>Name (Reviewer)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>
Daniel Kramer	Group leader of Optical Materials Development / Senior Scientist	<i>INFORMED (Category A)</i>	
Radek Toman	Legal Group leader	<i>INFORMED (Category A)</i>	
Birgit Plötzeneder	Central Control Systems Group Leader	<i>INFORMED (Category A)</i>	
Roman Kuřátko	Head of Department of Building Infrastructure and IT	<i>INFORMED (Category A)</i>	
Ladislav Půst	Group Leader of Installations	<i>INFORMED (Category A)</i>	
Lucie Kaletusová	Cleanroom Group Leader	<i>INFORMED (Category A)</i>	
Martin Laub	Head of department of Construction and Design Support	<i>INFORMED (Category A)</i>	
Veronika Olšovcová	Group Leader of Safety	<i>INFORMED (Category A)</i>	
Viktor Fedosov	Group Leader of Quality and Planning	<i>INFORMED (Category A)</i>	

Approved by

<i>Name (Approver)</i>	<i>Position</i>	<i>Date</i>	<i>Signature</i>
Martin Přeček assigned by Jakob Andreasson	Head of department of Structural Dynamics / Senior Scientist	assignment Via TC	

Revision History / Change Log

<i>Change No.</i>	<i>Made by</i>	<i>Date</i>	<i>Change description, Pages, Chapters</i>	<i>TC rev.</i>
1	Kloz M.	2021-05-12	Draft	A
2	Hanusкова D.	2021-05-12	Update of the RSD, version for internal review	B
3	Toman, R., Hanusková D.	2021-05-20	Final version	C
4	M. Kloz	2021-07-12	Final version after author's	D

Table of Content

1. Introduction	4
1.1. Purpose	4
1.2. Scope	4
1.3. Terms, Definitions and Abbreviations	4
1.4. References to Standards	5
2. Requirements on the System Level	5
2.1. General System Requirements	5
2.2. Controller and operation requirements	6
2.3. Environmental Conditions	6
3. System Electrical and Electronics Requirements	6
4. Transportation and Installation requirements	7
5. Safety Requirements	7
6. Quality Requirements	8
6.1. General Quality Requirements	8
7. Acceptance	9

1. Introduction

1.1. Purpose

This Requirements Specification Document (RSD) lists the technical requirements and constraints for the instrumentation: **“Time correlated single-photon counting detectors for near infrared region”**. This purchase targets the key detector and electronic components that allows “home-built” implementation of versatile TCSPC experiments, not any specialized solution.

The requested equipment is outlined by the following main parts:

- a pair of Single photon sensitive avalanche photodiodes (SPAD) with sensitivity 900 – 1700 nm (either as two separate units or in form of two optical input channel unit)
- front-end electronic driving circuits and a controller for operation of the detectors through PC software interface or SDK library.

1.2. Scope

This RSD contains all of the technical requirements: functional, performance and design, delivery, safety and quality requirements for the following product (tender number: **TP21_301**): **Time correlated single-photon counting detectors for near infrared region** (further **“Detectors”**).

The **Detectors** will be placed in the BIOLAB hall and will be used as a standalone system. The product is registered in the PBS database under the PBS codes: **EBIO.EQBL.TCSP.5, EBIO.EQBL.TCSP.6**.

This pair of SPAD detectors is expected to function as a self-standing instrument that allows TCSPC experiment when connected to time tagging module.

This product is a **Category A product** according to the ELI Beamlines RSD categories. All verification activities performed by the Supplier shall be executed in accordance with the Supplier’s plan of outgoing inspection and tests. The verification of all specified parameters listed in this RSD shall be undertaken by the Supplier before delivery to the ELI Beamlines facility and all items shall be furnished with a verification protocol and a declaration of conformity, to reflect their proper characteristics. Furthermore, all items may be subject to testing and verification upon delivery to the ELI Beamlines facility by qualified personnel. All non-conformances (if any) must be addressed by the supplier in a timely manner.

1.3. Terms, Definitions and Abbreviations

For the purpose of this document, the following abbreviated terms are applied.

Abbreviation	Meaning
CA	Contracting Authority (Fyzikální ústav AV ČR, v.v.i.)
ELI	Extreme Light Infrastructure

Abbreviation	Meaning
RA4 (and 2)	Research activity 4 (and 2)
nm	Nano meter
ps, ns, ms	Pico/nano/mili -second
RSD	Requirement Specification Document
NA	Not Applicable
SI	International System of Units
SPAD	Single-photon sensitive avalanche photodiode
FZU	Institute of Physics of the Czech Academy of Sciences
FWHM	Full width half maximum
MHz	Megahertz

1.4. References to Standards

If this document includes references to standards or standardized/standardizing technical documents the CA allows/permits also another equal solution to be offered. If a supplier offers another equal solution the CA shall not reject its bid, once the supplier by appropriate means in the bid proves that the offered supplies, services or works meet in an equivalent manner the requirements including references to standards or technical documents.

2. Requirements on the System Level

The requirements are presented with the following structure: First the requirement is given. The verbal form "shall" is used whenever a provision is a requirement. The verbal form "should" is used whenever a provision is a recommendation.

2.1. General System Requirements

REQ-031746/A

The pair of SPAD shall be delivered with all the necessary electronics required to run it as a single photon counting detectors with sub 225 ps time spread jitter resolution.

NOTICE: This includes front-end circuit for SPAD's avalanche sensing, including means to set a gating window, bias voltage, accepting external TTL trigger for gating and produce TTL output signaling detection of a photon.

REQ-031747/A

The detector pair shall be compatible with the device HydraHarp 400 (©PicoQuant) that the lab is already equipped with.

REQ-031748/A

The near-infrared photon counting detector shall be based on a pair of InGaAs single photon avalanche photodiodes with an inbuilt Peltier or alternative cooling.

REQ-031749/A

Input of the detector shall be based on FC / PC or FC/APC fiber interface.

REQ-031750/A

Detector shall accept both periodic and aperiodic trigger signals.

REQ-031751/A

Detector shall have single photon sensitivity and when in a gate-on mode it shall generate a macroscopic "photon out" electronic trigger signal after detection of a single photon.

REQ-031752/A

The "photon out" low jitter photon detection output defined above shall be compatible with HydraHarp 400 (©PicoQuant) event time tagging module.

REQ-031753/A

The performance of the detector shall follow or exceed these specifications (I):

Wavelength sensitivity range	900 nm - 1700 nm
Dark counts (cooled)	< 5000 cps
Timing jitter (FWHM)	< 225 ps
Operation ambient temperature	+15°C to +25°C
Quantum efficiency 1250-1550 nm	>25%
Quantum efficiency 1100-1650 nm	>5%
Minimal gate width	< 3 ns
Internal/external trigger	CW – 20MHz selectable

2.2. Controller and operation requirements

REQ-031754/A

Controller shall allow operation of the detectors via PC with operation systems Microsoft Windows 7/10 64-bit version. That holds both for software and SDK library.

REQ-031755/A

Controller shall fit into area 300 x 300 x 200 mm.

2.3. Environmental Conditions

REQ-031756/A

System shall fulfil ISO 7 cleanliness condition (10,000 dust particles per cubic meter).

REQ-031757/A

System shall be fitting to be operated at humidity level within an interval from 45% to 55%.

3. System Electrical and Electronics Requirements

REQ-031758/A

System shall be designed according the valid Czech and European norms.

4. Transportation and Installation requirements

REQ-031759/A

Individual components shall be transportable in boxes with dimensions not exceeding (L x W x H) 2m x 2m x 1m.

REQ-031760/A

The transportation to the final destination shall be conducted by the Supplier.

NOTE: The bid price will be considered by the CA as the final price, including transportation cost.

REQ-031761/A

The technologies and instruments shall be delivered in protective package preventing damage and contamination and a minimum of two plies separate clean packaging. The technologies shall be cleaned and packaged in compliance with the cleanliness of class 7 according to ČSN EN ISO 14644 (equivalent to EN ISO 14644).

5. Safety Requirements

REQ-031762/A

The supplier shall supply a **Declaration of Conformity** for each product type if the appropriate legislation determines the supplier's obligation to have a Declaration of Conformity for the purposes of a Device sale in the Czech Republic. In such a case the Declaration of Conformity shall comply with:

- Act No. 90/2016 Coll., as amended
- Act No. 20/1997 Coll., as amended
- The equivalent legal regulation of another EU member state so that the conditions for the sale of the product in the Czech Republic are met, and/or
- the relevant EU/EC regulation

NOTE: The compliance with these obligations will be demonstrated by the (EU/EC) Declaration of conformity, other relevant documents and the CE/CCZ marking, if required by the relevant regulations. If a delivered product is not required to assess conformity according to specific legislation, the supplier declares by concluding the contract that the product complies with the general safety requirement of EU Directive 2001/95 / EC on general product safety and that the supplier duly complies their obligations under this Regulation.

6. Quality Requirements

6.1. General Quality Requirements

REQ-031763/A

The Supplier shall provide the **Product Manual** as part of the delivered System. Completeness of the Manual shall be approved by the CA. The Manual shall include the instructions and descriptions regarding the following procedures:

- transport, handling, storage, disassembling, cleaning;
- installation
- safe operation, maintenance and disposal procedures;
- list of spare parts, specialized tools, equipment and materials for proper maintenance or repair (if relevant);
- software or libraries, communication protocols.

NOTE: The manual can be supplied in the hardcopy or PDF formats.

REQ-031764/A

The Supplier shall provide information of **outgoing check control** of the Product. At least this information shall comprise a report about execution of outgoing check and fulfillment of the technical requirements defined by the product RSD, and completeness of the product.

REQ-031765/A

The Supplier shall establish and maintain a **nonconformity control system** compatible with ČSN EN ISO 9001 (or equivalent, e.g. EN ISO 9001).

REQ-031766/A

Documentation shall be supplied as **hardcopy** and electronically in formats specified in REQ-031738/A.

REQ-031767/A

Formal communication between Supplier and CA and supplied documentation shall be in the following formats:

- *.JPG
- *.PDF/A
- CAD 2D: *.dwg
- CAD 3D: STEP type files (*.stp;*.ste;*.step)
- text processors *.doc, *.docx, OpenDocument
- spreadsheet processors *.xls, *.xlsx, OpenDocument
- presentations *.ppt, *.pptx; OpenDocument
- *.HTML

REQ-031768/A

Wherever possible, the Supplier shall use the most innovative products, services or procedures when performing the contract.

7. Acceptance

Acceptance will be carried out by the CA on the delivered and complete product. The basis for acceptance will be a declaration of conformity with the technical requirements defined by the product RSD together with relevant documentation supporting the verification.

In case of successful acceptance phase the CA shall provide to the Supplier signed acceptance protocol. In case of unsuccessful acceptance stage the CA shall provide to the Supplier Nonconformity Report (NCR) and ELI nonconformity control process shall be applied (see REQ-031765/A).

REQ-031769/A

The Acceptance phase shall demonstrate the following:

1. Final product has been successfully verified by the Supplier and this process has been documented in an appropriate way
2. All detected nonconformities have been solved in accordance with REQ-031765/A;
3. The final product is free of fabrication errors and is ready for the intended operational use.