Purchase Contract

(hereafter the "**Contract"**)

1. CONTRACTUAL PARTIES

1.1 **Fyzikální ústav AV ČR, v. v. i.**,

with seat: Na Slovance 1999/2, 182 21 Praha 8, Czech Republic
represented by: RNDr. Michael Prouza, Ph.D., Director,
registered in the Register of public research institutions of the Ministry of Education, Youth and Sports of the Czech Republic.

Bank: [redacted]
Account No.: [redacted]
ID No.: 68378271
Tax ID No.: CZ68378271

(hereinafter the "**Buyer**")

and

1.2 **OptiXs, s.r.o.,**

with seat: Křivoklátská 37/3, 199 00 Praha 9, Czech Republic
represented by: Ing. Aleš Jandík, CEO,
registered at Municipal court in Prague under No. C212818.

Bank: [redacted]
Account No.: [redacted]
ID No.: 02016770
Tax ID No.: CZ02016770

(hereinafter the "**Seller**"),

(the Buyer and the Seller are hereinafter jointly referred to as the "**Parties**" and each of them individually as a "**Party**").

Institute of Physics of the Czech Academy of Sciences
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Email: info@fzu.cz
Web: www.fzu.cz

2. FUNDAMENTAL PROVISIONS

2.1 The Buyer is a public research institution whose primary activity is scientific research in the area of physics, especially elementary particles physics, condensed systems, plasma and optics.

2.2 The Buyer wishes to acquire the subject of performance hereof in order to perform measurements of spatially-resolved photoluminescence, optical gain parameter, pump and probe and quantum yield at cryogenic temperatures.

2.3 The Seller was selected as the winner of a public procurement procedure announced by the Buyer in accordance with Act No. 134/2016 Coll., on Public Procurement, as amended (hereinafter the "**Act**"), for the public contract called **"Closed-cycle helium cryostat for various spectroscopic techniques – repeated procedure"** (hereinafter the "**Procurement Procedure**").

2.4 The documentation necessary for the execution of the subject of performance hereof consist of

2.4.1 Technical specifications of the subject of performance hereof attached as **Annex No. 1** hereto**.**

2.4.2 The Seller´s bid submitted within the Procurement Procedure in its parts which describe the subject of performance in technical detail (hereinafter the "**Sellers's Bid**"); the Sellers´s Bid forms **Annex No. 2** to this Contract and is an integral part hereof.

2.4.3 The setups for various spectroscopic techniques and relevant technical drawings of the subject of performance hereof attached as **Annex No. 3** hereto**.**

In the event of a conflict between the Contract's Annexes the technical specification / requirement of the higher level / quality shall prevail.

2.5 The Seller declares that he has all the professional prerequisites required for the supply of the subject of performance under this Contract, is authorised to supply the subject of performance and there exist no obstacles on the part of the Seller that would prevent him from supplying the subject of this Contract to the Buyer.

2.6 The Seller acknowledges that the Buyer considers him capable of providing performance under the Contract with such knowledge, diligence and care that is associated and expected of the Seller's profession, and that the Seller's potential performance lacking such professional care would give rise to corresponding liability on the Seller's part. The Seller is prohibited from misusing his qualities as the expert or his economic position in order to create or exploit dependency of the weaker Party or to establish an unjustified imbalance in the mutual rights and obligation of the Parties.

2.7 The Seller acknowledges that the Buyer is not in connection to the subject of this Contract an entrepreneur and also that the subject of this Contract is not related to any business activities of the Buyer.

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2.8 The Seller acknowledges that the production and delivery of the subject of performance within the specified time and of the specified quality, as shown in Annexes No. 1, 2 and 3 of this Contract (including invoicing), is essential for the Buyer.

2.9 The Parties declare that they shall maintain confidentiality with respect to all facts and information, which they learn in connection herewith and / or during performance hereunder, and whose disclosure could cause damage to either Party. Confidentiality provisions do not prejudice obligations arising from valid legislation.

3. SUBJECT-MATTER OF THE CONTRACT

3.1 The subject of this Contract is the obligation on the part of the Seller to deliver and transfer into the Buyer's ownership:

the Closed-cycle helium cryostat for various spectroscopic techniques

(hereafter the **"Equipment"**)

and the Buyer undertakes to take delivery of the Equipment and to pay to the Seller the agreed upon price.

3.2 The following activities form an integral part of the performance to be provided by the Seller:

3.2.1 Formulation of conditions which are recommended to be met at the place of Buyer in order to install the Equipment;

3.2.2 Transport of the Equipment incl. all accessories specified in Annexes 1 and 2 of the Contract to the place of delivery, un-packaging and control thereof;

3.2.3 Installation of the Equipment including connection to installation infrastructure at the site;

3.2.4 Execution of the acceptance test at the site according to Annex 3 hereto;

3.2.5 Delivery of detailed instructions and manuals for operation and maintenance, including list of spare parts, compressed air and electrical connection schemes - all in Czech or English language, in electronic or hardcopy (printed) versions;

3.2.6 Training of operators at the site (at least 1-day training of 1 operator);

3.2.7 Free-of-charge warranty service during the warranty term;

3.2.8 Provision of technical support in the form of consultations.

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3.3 The subject of performance (Equipment) is specified in detail in Annexes No. 1 and No. 2 hereto.

3.4 The Seller shall be liable for the Equipment and related services to be in full compliance with this Contract, its Annexes and all valid legal regulation, technical and quality standards and that the Buyer will be able to use the Equipment for the defined purpose. In case of any conflict between applicable standards it is understood that the stricter standard or its part shall always apply.

3.5 The delivered Equipment and all its parts and accessories must be brand new and unused.

4. PERFORMANCE PERIOD

4.1 The Seller undertakes to manufacture, deliver, install and handover the Equipment to the Buyer within **4 months** of the conclusion of this Contract but no later than December 23, 2020.

4.2 The performance period shall be extended for a period during which the Seller could not perform due to obstacles on the part of the Buyer.

4.3 The Seller acknowledges that the Buyer pays the purchase price from public support with the possibility of drawing and billing it until December 31, 2020; for this reason, he is not interested in the performance of this Contract, which cannot be settled by December 31, 2020.

5. PURCHASE PRICE, INVOICING, PAYMENTS

5.1 The purchase price is based on the Seller's submitted bid and amounts to **5 394 700,- CZK** (in words: five million three hundred ninety four thousand seven hundred Czech crowns) excluding VAT (hereinafter the **"Price"**). VAT shall be paid by the Buyer and settled in accordance with the valid Czech regulation.

5.2 The Price represents the maximum binding offer by the Seller and includes any and all performance provided by the Seller in connection with meeting the Buyer's requirements for the proper and complete delivery of the Equipment hereunder, as well as all costs that the Seller may incur in connection with the delivery, and including all other costs of expenses that may arise in connection with creation of an intellectual property and its protection.

5.3 The Parties agreed that the Seller shall be entitled to invoice the Price as follows:

5.3.1 The Seller is entitled to issue the first advance invoice corresponding to 30 % of the Price excluding VAT after the conclusion of the Contract;

5.3.2 The Seller is entitled to invoice the Price after the handover protocol in accordance with

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Section 10.4 will have been signed.

5.4 All invoices issued by the Seller must contain all information required by the applicable laws of the Czech Republic. Invoices issued by the Seller in accordance with this Contract shall contain in particular following information:

5.4.1 name and registered office of the Buyer,

5.4.2 tax identification number of the Buyer,

5.4.3 name and registered office of the Seller,

5.4.4 tax identification number of the Seller,

5.4.5 registration number of the tax document (invoice),

5.4.6 scope of the performance (including the reference to this Contract),

5.4.7 the date of the issue of the tax document (invoice),

5.4.8 the date of the fulfilment of the Contract,

5.4.9 purchase Price,

5.4.10 registration number of this Contract, which the Buyer shall communicate to the Seller based on Seller's request before the issuance of the invoice,

and must comply with the double taxation agreements, if applicable.

5.5 The Buyer prefers electronic invoicing, with the invoices being delivered to efaktury@fzu.cz. All issued invoices shall comply with any international double taxation agreements, if applicable.

5.6 Invoices shall be payable within thirty (30) days of the date of their delivery to the Buyer. Payment of the invoiced amount means the date of its remittance to the Seller's account.

5.7 If an invoice is not issued in conformity with the payment terms stipulated by the Contract or if it does not comply with the requirements stipulated by law, the Buyer shall be entitled to return the invoice to the Seller as incomplete, or incorrectly issued, for correction or issue of a new invoice, as appropriate, within five (5) business days of the date of its delivery to the Buyer. In such a case, the Buyer shall not be in delay with the payment of the Price or part thereof and the Seller shall issue a corrected invoice with a new and identical maturity period commencing on the date of delivery of the corrected or newly issued invoice to the Buyer.

5.8 The Buyer shall be entitled to unilaterally set off any of his payments against any receivables claimed by the Seller due to:

5.8.1 damages caused by the Seller,

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5.8.2 contractual penalties.

5.9 The Seller shall not be entitled to set off any of his receivables against any part of the Buyer's receivable hereunder.

6. OWNERSHIP TITLE

6.1 The ownership right to the Equipment shall pass to the Buyer by handover. Handover shall be understood as delivery and acceptance of the Equipment duly confirmed by Parties on the Handover Protocol in accordance with Section 10.4.

7. PLACE OF DELIVERY AND HANDOVER OF THE EQUIPMENT

7.1 The place of delivery and handover of the Equipment shall be in the building C of Institute of Physics of the Czech Academy of Sciences, at Cukrovarnická 112/10, 162 00 Praha 6, Czech Republic, room No. 205/1.

8. PREPAREDNESS OF THE PLACE OF DELIVERY AND HANDOVER

8.1 The Seller shall consult in advance the laboratory space requirements with the Buyer.

8.2 The Seller shall notify the Buyer in writing of the exact date of installation of the Equipment at least 15 days prior to such date, ensuring that the deadline for the performance hereunder is maintained.

8.3 The Buyer shall be obliged to allow the Seller, once the deadline set forth in Section 8.1 hereof expires, to install the Equipment at the place of delivery and handover.

9. COOPERATION OF THE PARTIES

9.1 The Seller undertakes to notify the Buyer of any obstacles on his part, which may negatively influence proper and timely delivery of the Equipment.

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10. DELIVERY, INSTALLATION, HANDOVER AND ACCEPTANCE

10.1 The Seller shall transport the Equipment at his own cost to the place of delivery and handover. If the shipment is intact, the Buyer shall issue delivery note for the Seller.

10.2 The Seller shall perform and document the installation of the Equipment and launch experimental tests in order to verify whether the Equipment is functional and meets the technical requirements of Annexes No. 1, 2 and 3 hereof.

10.3 Handover procedure includes handover of any and all technical documentation pertaining to the Equipment, user manuals and certificate of compliance of the Equipment and all its parts and accessories with approved standards.

10.4 The handover procedure shall be completed by handover of the Equipment confirmed by the Handover Protocol containing specifications of all performed tests. The Handover Protocol shall contain the following mandatory information:

10.4.1 Information about the Seller, the Buyer and any subcontractors;

10.4.2 Description of the Equipment including description of all components and serial numbers;

10.4.3 Description of executed tests according to Section 3.2.4 of the Contract: type of test, duration and achieved parameters;

10.4.4 List of technical documentation including the manuals;

10.4.5 Confirmation on training, its participants and extent;

10.4.6 Eventually reservation of the Buyer regarding minor defects and unfinished work including the manner and deadline for their removal and

10.4.7 Date of signature of the Equipment Handover Protocol.

10.5 Handover of the Equipment does not release the Seller from liability for damage caused by its defects.

10.6 The Buyer shall not be obliged to accept Equipment, which would show defects or unfinished work and which would otherwise not form a barrier, on their own or in connection with other defects, to using the Equipment. In this case, the Buyer shall issue a record containing the reason for his refusal to accept the Equipment.

10.7 Should the Buyer not exercise his right not to accept the Equipment with defects or unfinished work, the Seller and the Buyer shall list these defects or unfinished work in the Handover Protocol, including the manner and deadline for their removal. Should the Parties not be able to agree in the Handover Protocol on the deadline for removal of the defects, it shall be understood that any

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defects shall be removed / rectified within 14 days from the handover of the Equipment.

11. TECHNICAL ASSISTANCE – CONSULTATIONS

11.1 The Seller shall be obliged to provide to the Buyer free-of-charge technical assistance by phone or e-mail relating to the subject-matter hereof during the entire term of the warranty period. The Seller undertakes to provide to the Buyer paid consultations and technical assistance relating to the subject-matter hereof also after the warranty period expires.

12. REPRESENTATIVES, NOTICES

12.1 The Seller authorized the following representatives to communicate with the Buyer in all matters relating to the Equipment delivery:

[redacted]

12.2 The Buyer authorized the following representatives to communicate with the Seller in all matters relating to the Equipment delivery:

[redacted]

12.3 All notifications to be made between the Parties hereunder must be made out in writing and delivered to the other Party by hand (with confirmed receipt) or by registered post (to the Buyer's or Seller's address), or in some other form of registered post or electronic delivery incorporating electronic signature (qualified certificate) to epodatelna@fzu.cz in case of the Buyer and to info@optixs.cz in case of the Seller.

12.4 In all technical and expert matters (discussions on the Equipment testing and demonstration, notification of the need to provide warranty or post-warranty service, technical assistance etc.) electronic communication between technical representatives of the Parties will be acceptable using e-mail addresses defined in Sections 12.1 and 12.2.

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13. TERMINATION

13.1 This Contract may be terminated early by agreement of the Parties or withdrawal from the Contract on the grounds stipulated by law or in the Contract.

13.2 The Buyer is entitled to withdraw from the Contract without any penalty from the Seller in any of the following events:

13.2.1 The Seller is in delay with the delivery of the Equipment pursuant to Section 4.1 hereof.

13.2.2 Technical parameters or other conditions required in the technical specification defined in Annexes No. 1 and 2 hereto and in the relevant valid technical standards will not be achieved by the Equipment at acceptance.

13.2.3 Facts emerge bearing evidence that the Seller will not be able to deliver the Equipment.

13.3 The Seller is entitled to withdraw from the Contract in the event of the Buyer being in default with the payment for more than 2 months with the exception of the cases when the Buyer refused an invoice due to defect on the delivered Equipment or due to breach of the Contract by the Seller.

13.4 Withdrawal from the Contract becomes effective on the day the written notification to that effect is delivered to the other Party. The Party which had received performance from the other Party prior to such withdrawal shall duly return such performance.

14. INSURANCE

14.1 The Seller undertakes to insure the Equipment against all risks, in the amount of the Price of the Equipment for the entire period commencing when transport of the Equipment starts until duly handed over to the Buyer. In case of breach of this obligation, the Seller shall be liable to the Buyer for any damage that may arise.

14.2 The Seller is liable for the damage that he has caused. The Seller is also liable for damage caused by third parties undertaken to carry out performance or its part under this Contract.

15. WARRANTY TERMS

15.1 The Seller shall provide warranty for the quality of the Equipment for a period of **12 months**.

15.2 The warranty term shall commence on the day following the date of signing of the Handover Protocol pursuant to Section 10.4 hereof. The warranty does not cover consumable things.

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15.3 Should the Buyer discover a defect, he shall notify the Seller to rectify such defect using the e-mail address: servis@optixs.cz. The Seller is obliged to notify the Buyer without delay about any change of this email address. The Seller shall be obliged to review any warranty claim within 24 hours (within business days) from its receipt and to propose solution, unless agreed otherwise by the Parties.

15.4 During the warranty period the Seller shall be obliged to rectify any claimed defects within 30 days from receipt of the Buyer's notification. In cases of unusual defects (e.g. when a special component will need to be replaced), the Seller shall be obliged to rectify the defect in the period corresponding to the nature of the defect and to define the deadline for the handover of the rectified Equipment.

15.5 During the warranty period, any and all costs associated with defect rectification / repair including transport and travel expenses of the Seller shall be always borne by the Seller.

15.6 The repaired Equipment shall be handed over by the Seller to the Buyer on the basis of a protocol confirming removal of the defect (hereinafter the "**Repair Protocol**") containing confirmations of both Parties that the Equipment was duly repaired and is defect-free.

15.7 The repaired portion of the Equipment shall be subject to a new warranty term in accordance with Section 15.1 which commences to run on the day following the date when the Repair Protocol was executed. However, the aggregate warranty period shall not exceed 24 months.

15.8 The Seller declares that he shall ensure paid post-warranty [out-of-warranty] service for the period of 7 years after the expiration of the warranty; the service terms shall be identical to those of Sections 15.3 and 15.4.

15.9 The Seller undertakes to provide the Buyer with updates of the software controlling the Equipment for the entire term of warranty service.

15.10 If the Equipment has defects, due to which it cannot be demonstrably used in full for more than 60 days (period of defects) during six or less consecutive months of the warranty period, the Seller is obliged to eliminate the defect by delivering a new Equipment without defects within 60 days from the date on which the Buyer sent a written notice, unless the Parties agree otherwise.

16. CONTRACTUAL PENALTIES

16.1 The Buyer shall have the right to a penalty in the amount of 0.1 % of the Price for each commenced day of delay with the performance pursuant to Section 4.1 hereof.

16.2 The Buyer shall have the right to a penalty in the amount of 0.05 % of the Price for each commenced day of delay with rectifying of defects claimed within the warranty period.

16.3 In case of default in payment of any due receivables (monetary debt) under the Contract, the defaulting Buyer or Seller (the debtor) shall be obliged to pay a contractual penalty in the amount

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of 0.1 % of the owed amount for each commenced day of delay with the payment.

16.4 Contractual penalties are payable within 30 days of notification demanding payment thereof.

16.5 Payment of the contractual penalty does not prejudice the rights of the Parties to claim damages.

16.6 Payment of the contractual penalty cannot be demanded if the breach of the contractual obligation causes force majeure.

17. DISPUTES

17.1 Any and all disputes arising out of this Contract or the legal relationships connected with the Contract shall be resolved by the Parties by mutual negotiations. In the event that any dispute cannot be resolved by negotiations within sixty (60) days, the dispute shall be resolved by the competent court in the Czech Republic based on application of any of the Parties; the court having jurisdiction will be the court where the seat of the Buyer is located. Disputes shall be resolved exclusively by the law of the Czech Republic.

18. FINAL PROVISIONS

18.1 This Contract represents the entire agreement between the Buyer and the Seller. The relationships between the Parties not regulated in this Contract shall be governed by the Act No. 89/2012 Coll., the Civil Code, as amended (hereinafter the **"Civil Code"**).

18.2 In the event that any of the provisions of this Contract shall later be shown or determined to be invalid, ineffective or unenforceable, then such invalidity, ineffectiveness or unenforceability shall not cause invalidity, ineffectiveness or unenforceability of the Contract as a whole. In such event the Parties undertake without undue delay to subsequently clarify any such provision or replace after mutual agreement such invalid, ineffective or unenforceable provision of the Contract by a new provision, that in the extent permitted by the laws and regulations of the Czech Republic, relates as closely as possible to the intentions of the Parties to the Contract at the time of creation hereof.

18.3 This Contract may be changed or supplemented solely by means of numbered amendments in writing, furnished with the details of time and place and signed by duly authorised representatives of the Parties. The Parties expressly reject modifications to the Contract in any other manner.

18.4 The Parties expressly agree that the Contract as a whole, including all attachments and data on the Parties, subject-matter of the Contract, numerical designation of this Contract, the Price and the date of the Contract conclusion, will be published in accordance with Act No. 340/2015 Coll. on

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special conditions for the effectiveness of some contracts, publication of these contracts and Contract Register, as amended (hereinafter the "**CRA**"). The Parties hereby declare that all information contained in the Contract and its Annexes are not considered trade secrets under § 504 of the Civil Code and grant permission for their use and disclosure without setting any additional conditions.

18.5 The Parties agree that the Buyer shall ensure the publication of the Contract in the Contract Register in accordance with CRA.

18.6 This Contract becomes effective as of the day of its publication in the Contract Register.

18.7 The following Annexes form an integral part of the Contract:

Annex No. 1: Technical specification on the subject of performance

Annex No. 2: Technical description of the Equipment as presented in Seller's bid

Annex No. 3: The setups for various spectroscopic techniques and relevant technical drawings of the Equipment

18.8 The Parties, manifesting their consent with the entire contents of this Contract, attach their signature hereunder.

In Prague	In Prague
For the Buyer: 5. 10. 2020	For the Seller: 1. 10. 2020
_____ RNDr. Michael Prouza, Ph.D. Director	_____ Ing. Aleš Jandík CEO

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Annex No. 1 - Technical specification on the subject of performance

Tab. 1 – The Equipment is a closed-cycle helium cryostat for various spectroscopic techniques for performing of measurements of spatially-resolved photoluminescence, optical gain parameter, pump and probe and quantum yield at cryogenic temperatures.

No.	Description and minimum specification of the Equipment as defined by the Buyer	Description and specification of the Equipment offered by the Seller	Complies YES/NO
1	Closed-cycle operation	Closed-cycle operation	**YES**
2	Ability to attach the chamber directly on the optical table	Ability to attach the chamber directly on the optical table	**YES**
3	Temperature range 3.6 K – 350 K with a temperature stability < 20 mK (at the sample chamber base with a standard sample mount) and at least 2 temperature sensors	Temperature range 3.6 K – 350 K with a temperature stability < 20 mK (at the sample chamber base with a standard sample mount) and at least 2 temperature sensors	**YES**
4	Vibrational stability from peak to peak being lower than 15 nm (for standard system without additional options measured at the base platform)	Vibrational stability from peak to peak is lower than 15 nm (for standard system without additional options measured at the base platform)	**YES**
5	Sample space ≥ 190 mm in diameter, height is not specified, however, it must enable to accommodate the spectroscopic techniques described below. The platform is a breadboard with 12.5 mm grid of > M3 holes.	Sample space 190 mm in diameter with height enable to accommodate the spectroscopic techniques described below. The platform is a breadboard with 12.5 mm grid of > M3 holes.	**YES**
6	Access to the sample via optical windows (quartz) – 1 overhead and at least 8 windows in radial. Size of the outer windows ≥ 45 mm, inner windows ≥ 30 mm providing an acceptance cone ≥ 15° full angle for the sample in the middle of the chamber.	Access to the sample via optical windows (quartz) – 1 overhead and 8 windows in radial. Size of the outer windows 45 mm, inner windows 30 mm providing an acceptance cone 15° full angle for the sample in the middle of the chamber.	**YES**
7	Ability to integrate an objective into the cryostat in horizontal configuration for the excitation and the collection of the light emission from the sample – spatially-resolved photoluminescence measurements (setup no. 0 in the Annex No. 3). The objective will be provided by the Buyer, namely the objective Zeiss LD EC Epiplan-Neofluar 100x/0.75 DIC M27.	Ability to integrate an objective into the cryostat in horizontal configuration for the excitation and the collection of the light emission from the sample – spatially-resolved photoluminescence measurements (setup no. 0 in the Annex No. 3).	**YES**
8	The sample holder must be attached to a nanopositioner (Attocube xyz piezo stages with controller will be provided by the Buyer).	The sample holder will be attached to a nanopositioner provided by the Buyer.	**YES**

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9	Integration of the Agile temperature sample mount (provided by the Buyer) for the setup no. 0 and for the other setups if possible.	Integration of the Agile temperature sample mount (provided by the Buyer) for the setup no. 0 and for the other setups if possible.	**YES**
10	Turbo vacuum pump to pump the sample space	Turbo vacuum pump to pump the sample space	**YES**
11	Air-cooled compressor	Air-cooled compressor	**YES**
12	Electrical access via at least 15 connectors	Electrical access via 15 connectors	**YES**
13	Optical fiber access via at least two ports	Optical fiber access via two ports	**YES**
14	The system shall fulfil the requirements specified in the Annex No. 3: The setups for various spectroscopic technique	The system will fulfil the requirements specified in the Annex No. 3: The setups for various spectroscopic technique	**YES**

Tab. 2 – Evaluation criterion according to paragraph 7.2.2 of the Tender Documentation - Technical characteristics of the bid

Feature	Value
Low working distance option for the top window in order to enable excitation from the top via objective outside the chamber	**YES**

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Annex No. 2

The Seller's bid in the extent it describes technical parameters of the Equipment

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OptiXs

Technical description

Custom configuration of optical cryostat based on Cryostation s200 from Montana Instruments Inc.
System consist from following parts:
Cryostation s200 - Cryostat Foundation - Automated, optical cryostat system and sample environment with standard series closed-cycle, cryogen-free cryocooler. Includes base with six (6) side panels and standard sample platform with 25 DC feedthroughs.
Vacuum Control Unit (VC1130 turbopump)
System Control Unit (SC1160) - Temperature Control Module (TCM) and Ancillary Control Module (ACM) peripheral cards
User Interface Touchscreen Display
Cart with Electronics Rack

Helium Compressor (variable speed, air cooled)

Compressor Hose & Cable Set – 30ft (9m) Length

Custom Cryostation s200 housing to accommodate the multiple configurations as specified in **various spectroscopic techniques** description

Custom low working distance style lid to enable excitation of the sample through the top window. Minimum working distance is approximately 5mm.

Custom sample mounts required for each of the configurations:

1. Variable stripe length method
2. Transmission measurements
3. Photoluminescence detected in 90° configuration
4. Photoluminescence quantum yield of a bulk sample - top excitation
5. Photoluminescence quantum yield of µm-scaled objects
6. Photoluminescence quantum yield of nm-scaled objects

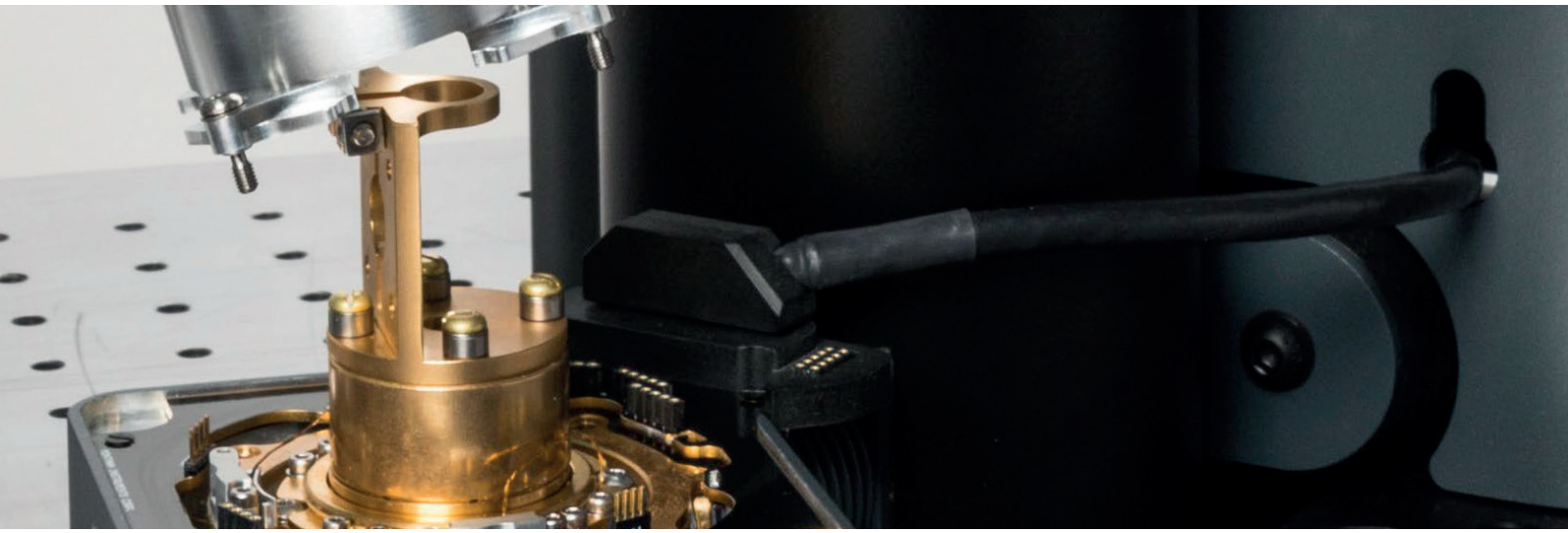
In setup number 5. And 6. Buyer proposed certain type of objective lenses to be used. Offered configuration has certain requirements for objective lens:

- The lens should be vented (if possible) for vacuum compatibility
- The lens should have a length between 1.2in. – 2.25in (=3 - 5,6 cm)
- The diameter should be < 1.4in (=3,5cm)
- The Cryo-Optic assembly can accept objective lenses with quite a few different thread sizes (with appropriate adapter).

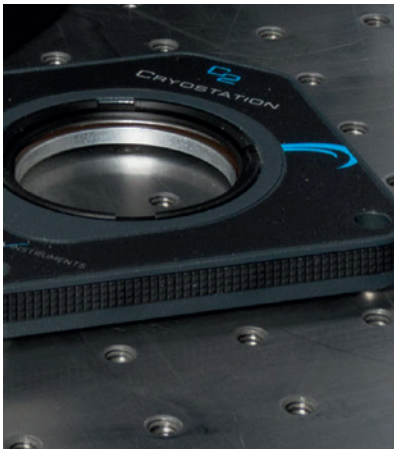
Custom mount for integration sphere. Integration sphere will not be at 4K due to thermal gradients.
Horizontal Cryo-Optic for Cryostation s200 Foundation. Does not include objective or sample mount.
Custom objective mount for integration sphere configuration.
Side panel with dual 5/16-24 SAE compression fittings for bare fiber optic cables. Includes Teflon inserts. Includes 5 Teflon inserts with one 125 um and 5 inserts with 250um ID hole each.
Detailed description of Cryostation s200 is in attached datasheet.

OptiXs, s.r.o.
IČ: 02 016 770, DIČ: CZ 02 016 770, Křivoklátská 37, CZ, 199 00 Praha 9

Variable temperature research platforms
Integrated cryogenic application solutions



Cold science made simple



Quantum Design EUROPE

Quantum Design GmbH
Im Tiefen See 58
D-64293 Darmstadt
www.qd-europe.com

David Appel: ✆ +49 6151 8806-499,
appel@qd-europe.com
Dr. Tobias Adler: ✆ +49 6151 8806-479,
adler@qd-europe.com

MONTANA INSTRUMENTS

Variable temperature research platforms
Integrated cryogenic application solutions

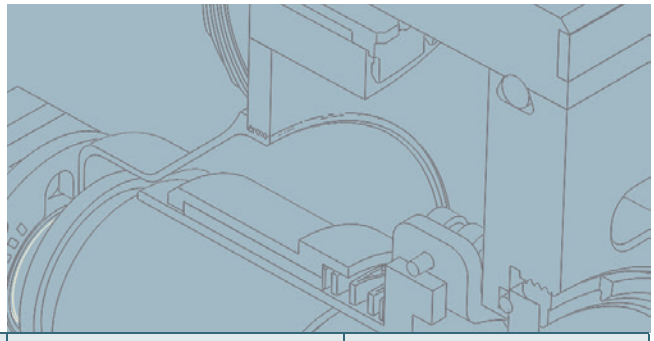
"We serve pioneers of science with technologies that will help change the world – we are truly grateful for the opportunity we've been given to create instruments which help propel the advancement of society. Our number one priority is to ensure your success, and we will do everything we can to continue to bring the most innovative technologies to your lab."

Luke Mauritsen,
CEO & founder, Montana Instruments

We promise to serve you by	
Becoming your	experimental partner & consultant
Focusing on	dedicated & responsive customer service
Designing	intuitive, accessible, & easy-to-use platforms
Offering	personalized solutions & custom engineering support
Building a	world-class engineering & product development team

Getting started
Low vibration optical cryostats

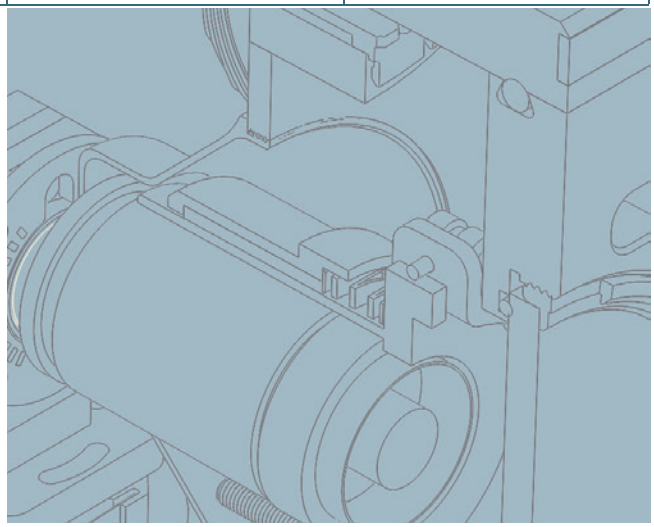
Selecting the proper variable temperature instrument should be straightforward. The engineers at Montana Instruments can assist in the selection of the appropriate platform given your performance requirements, sample and experimental set-up, and desired features and capabilities.



Platform configurations & product models

Choose from an available combination of the following attributes to create a system tailored to your research demands and budget.

Research platform	Platform architecture	Size class number #	Add on modules
Core sample platform technology	System design & mounting schemes, cooling technology, performance & feature levels	Size & features inside the sample chamber and on the cold platform	Integrated modules which add additional capabilities for specific applications
Cryostation	s - standard	50 I 100 I 200	CO - Cryo-Optic MO - Magneto-Optic



Integrated solutions

Our integrated solutions combine proven third-party technology with our research platforms for high-performance, application specific solutions.

Configurable options, customization and accessories

Each platform can be configured with an array of standard options and accessories to meet various application requirements.

Leverage a team of dedicated application specialists and custom design engineers to create personalized solutions with custom designed parts and other special modifications.

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Variable temperature research platforms
Standard series

Simplicity with unmatched stability

The standard s-series platform architecture utilizes a versatile tabletop mounting architecture which makes it easy to move the system without being tied to the table or an external support structure. Optimized performance parameters accommodate a wide range of configuration options and operating abilities.

Cryostat class	**High-end closed-cycle**
Performance class	**Low vibration, fully-automated**
Application areas	**Microscopy & spectroscopy, condensed matter, photonics, quantum information, materials science**

Cryostation S50

- Closed-cycle operation means no helium is consumed, so users avoid the high costs, uncertain supply, and challenging operation associated with liquid cryogens.
- Fully-integrated, turn-key design gets you up and running quickly with minimal effort.
- Straightforward user interface and fully-automated control system increases experimental efficiency.
- Tabletop design integrates into existing set-ups and can be moved easily.
- Patented vibration damping technology isolates cryocooler vibrations without the need for external support structures.

Thermal & vibrational stability

Active & passive thermal stabilization is used to achieve greater than a 20x reduction in cryocooler induced thermal fluctuations at the sample. Sample stage positional drift is virtually eliminated with the use of a thermal contraction canceling cryogenic support. This stability ensures great sample alignment throughout the full temperature range and dramatically reduces focal drift for each new temperature setpoint.

A patented vibration damping architecture isolates both the sample and the sensitive equipment on the optical table from the cryocooler vibrations. No dedicated table or external support structure is needed.

User interface laptop PC with control software

- simply press a button for fully automated cool down, warmup, temperature control & more
- monitor the status of system parameters with real time temperature & temperature stability readouts
- remote interface via TCP/IP for automation scripting, convenient external control, & instant remote support

Closed-cycle cryostat & vacuum space

- sample platform rigidly mounts at either 45° or parallel to the hole pattern in an inch or metric optical table for increased flexibility & modularity

Control unit: built-in electronics

- complete process automation & system monitoring to save time & complexity while protecting the system & sample
- self-activated dry nitrogen gas purge during warm up keeps the sample space clean

Variable speed helium compressor

- provides pressurized helium to the cryostat via the supply/return hoses, automatically adjusting parameters for optimal cool down time
- single-phase 50/60 Hz, 200-240 VAC, air cooled, 3 kW

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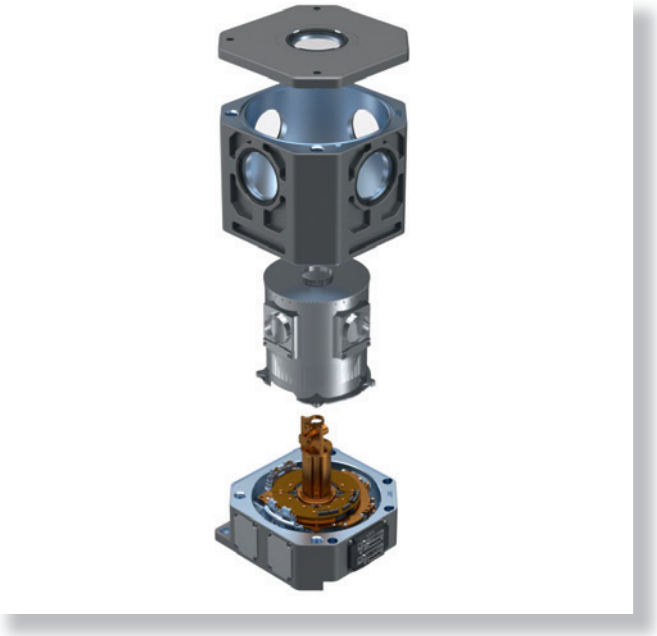
Variable temperature research platforms
Cryostation®

General purpose optical cryostats

The CRYOSTATION line of general purpose optical cryostats offer a superior level of performance, flexibility, and usability in a closed-cycle system. The sample chambers are designed to accommodate a variety of configurations and experimental set-ups.

Cryostat class	**High-end closed-cycle**
Performance class	**Low vibration, fully-automated**
Application areas	**Quantum information, 2D & topological materials, quantum dots, electrical transport, photoluminescence, THz spectroscopy, micro raman, on-chip photonics**

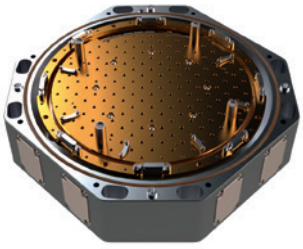


Cryostation S100

- Low thermal fluctuations and < 5 nm vibrations provide a stable measurement environment.
- Wide temperature ranges (3.2 K to 350 K) with fast cool downs make the instrument more productive.
- Incredible sample, electrical, and optical access provides total experiment flexibility. Simply lift off the window assembly and radiation shield for unobstructed access to the sample & wiring.
- Configurable sample space with RF, DC, fiber & gas tube interfacing options.
- Cold circuit board (s100 & s200) is pre-lagged for simple & robust sample wiring & optimized vacuum performance.

3.2 K	<10 mK	<5 nm	~2 hrs	**Cryostation S50**
Base temp	Temp stability	Vibrations	Cool down	
				Well-suited for a variety of experimental set-ups requiring the lowest possible temperatures, vibrations, and cool down times. This smallest platform offers 5 optical access ports which can be configured for low working distance applications.
Cold space				ø53 mm x 63 mm (can enlarge vertically)
Add on options				Cryo-optic | Magneto-optic

3.4 K	<10 mK	<15 nm	~3 hrs	**Cryostation S100**
Base temp	Temp stability	Vibrations	Cool down	
				Volume optimized to provide room for additional equipment with integrated, pre-lagged wiring. This mid-sized platform offers 5 optical access ports and 4 interface side panels with plug-and-play connections directly into the sample space.
Cold space				ø95 mm x 100 mm (can enlarge vertically)
Add on options				Cryo-optic

3.6 K	<20 mK	<15 nm	~10 hrs	**Cryostation 200**
Base temp	Temp stability	Vibrations	Cool down	
				A large, flexible sample space with the ability to integrate components directly onto the cold breadboard platform. This largest platform offers 9 optical access ports and 7 interface side panels. User wiring is pre-lagged into the cold space.
Cold space				ø195 mm x 72 mm (can enlarge vertically)
Add on options				Cryo-optic

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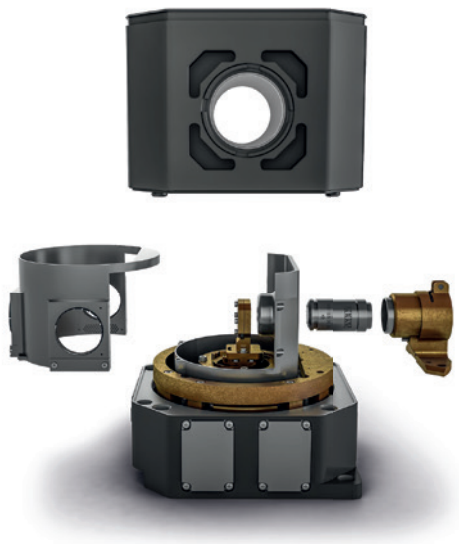
Variable temperature research platforms
Cryo-Optic®

High NA imaging at low temperatures

The CRYO-OPTIC® products integrate an optical objective into the sample space of the Cryostation for high NA imaging at low temperatures. The revolutionary design of the room temperature objective mount eliminates the alignment and drift challenges associated with using high performance optics in a cryogenic set-up.

Cryostat class	**High-end closed-cycle**
Performance class	**Low vibration, fully-automated, low drift**
Application areas	**Scanning confocal microscopy, Raman Spectroscopy, Surface plasmon polariton physics, Tunable cavities, Single photon emitters**

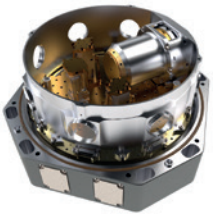
- Proprietary technology allows the objective to be held at room temperature within the sample space for highly stabilized position and focus control.
- The temperature of the high magnification objective and the sample are actively controlled to better than 10 mK, eliminating the need to refocus after small temperature changes.
- Time required to reach a stable measurement condition is drastically reduced by isolating the objective from both the cryostat & the laboratory environments.
- Optional Agile Temperature Sample Mount provides rapid temperature control and reduces drift.
- Built-in XYZ nanopositioners for sample translation & focus.



Cryostation S100 - CO

3.7 K	<10 mK	<1 µm /K	~20 min	**Cryostation S50 - CO**
Base temp	Temp stability[1]	Sample drift[2]	Stabilization[3]	
				The vertical mounting scheme in this model was designed for confocal microscopy, with side optical access to allow the user to see the sample and approximate focal distance.
Cold space				ø53 mm x 63 mm (can enlarge vertically)
Objectives				0.75 NA, 4mm WD | 0.90 NA, 310 µm WD

3.7 K	<10 mK	<1 µm /K	~30 min	**Cryostation S100 - CO**
Base temp	Temp stability	Sample drift[2]	Stabilization[3]	
				The horizontal mounting scheme of this model provides seamless integration with other optical measurement systems while maintaining easy access to the sample. A unique radiation shield design allows for quick, unobstructed sample exchange while leaving the objective in place and aligned to the optical system.
Cold space				ø95 mm x 100 mm (can enlarge vertically)
Objectives				0.75 NA, 4 mm WD | 0.85 NA, 850 µm WD

Multiple example set-ups	**Cryostation S200 - CO**
with 45° adjustable objective orientation	
	the Cryo-Optic objective is available as a customization on the largest platform. The objective is mounted horizontally, with ample room remaining on the cold breadboard for free space optics, enabling transmission experiments and piezo interface control.
Cold space	ø195 mm x 72 mm (can enlarge vertically)
Objectives	0.75 NA, 4 mm WD | 0.85 NA, 310 µm WD

1 With ATSM 2. Sample Drift measurement taken over full temperature range.
2 Time to positional stability defined as the time required before which the sample position drifts by no more than 250 nm in 30 mins. Measurement taken with ATSM for 50 K temperature change over the full temperature range.
3 With ATSM for 50 K temperature change.

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Variable temperature research platforms
Magneto-Optic®

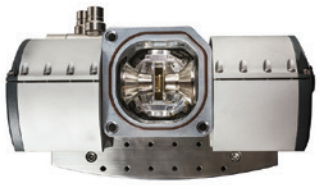
Bipolar magnetic field integration

The MAGNETO-OPTIC modules integrate a magnetic field directly into the cryogenic sample chamber. This add-on module provides the same stability, automation, and control found in all Montana Instruments closed-cycle cryostats.

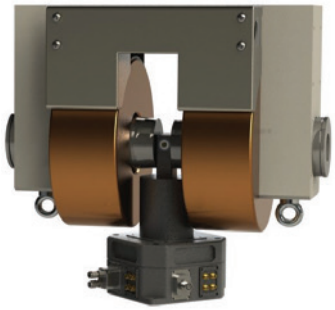
Cryostat class	**High-end closed-cycle**
Performance class	**Low vibration, fully-automated**
Application areas	**Spintronics, Magnon spectroscopy, Magneto-optical effects, 2D & topological materials, Magneto-transport, Nanomagnetics**

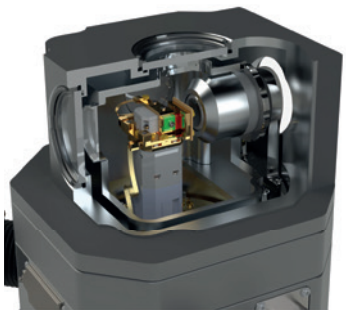
- Demanding magneto-optic applications are simple to set-up, with unique designs to preserve full sample and optical access.
- Exchangeable pole tips allow for flexible field strengths and sample configurations.
- Automatic zero function reduces remnant field in the iron poles by using an alternating decreasing field to degauss the magnet and reduce hysteresis effects.
- Systems include a Hall Probe calibration fixture for field calibration.
- A bipolar power supply and chiller unit are controlled via the software.

Cryostation S50 - MO

3.4 K	<10 mK	<5 nm	0.7 T	**Cryostation S50 - MO**
Base temp[1]	Temp stability	Vibrations	Field[2]	
				Most chambers can be configured for use with external high field superconducting magnets & electromagnets. Specially designed castles extend the housing, allowing external magnet poles to be integrated close to the sample. These integrations can accommodate large sample sizes and low working distance. The magnet designs provide a good uniformity of the magnetic field.
Field strength				0.45 - 1 Tesla (depends on pole configuration)

1. Base temperature with radiation shield
2. 0.7 Tesla Magnetic Field achieved with 12 mm pole spacing

1.6 T	1.0 T	2.0 T	**Integration External magnets**
5403 @ 20 mm	3470 @ 10 mm	3480 @ 10 mm	
			The unit inserts magnet poles into two of the four standard optical ports, with bores through the magnet cores to allow laser illumination of the sample. The top optical access port can be configured with a recessed objective for low working distance applications. An adjustable radiation shield accommodates various sample sizes and optical access configurations: ø 7-15 mm x 23 mm
Options			GMW 5403, 3470, 3480 & custom

Fields up to 500 mT	**Integration Permanent magnets**
	For certain applications, permanent magnets can be used to achieve the necessary field requirements. These offer a cost-effective solution and can be integrated into most sample chamber set-ups. These magnets provide consistent fields at various field strengths. Adjustable & custom mounting options are available.
Compatible with	Cryo-optic objective

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Im Tiefen See 58
D-64293 Darmstadt
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appel@qd-europe.com
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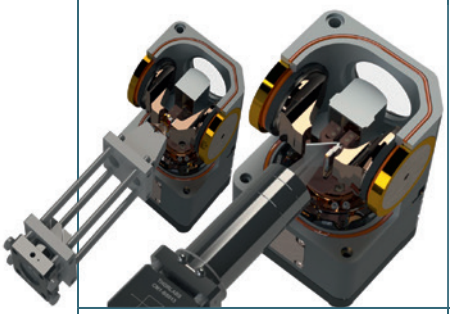
MONTANA INSTRUMENTS

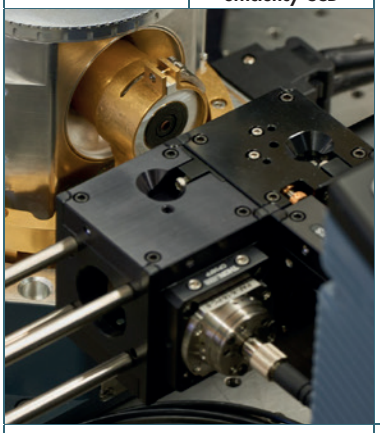
Variable temperature research platforms
Solutions

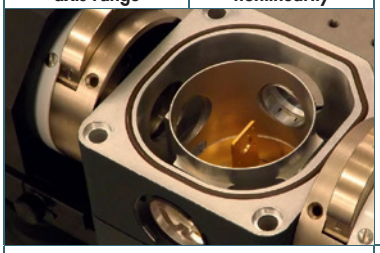
Third-party measurement integrations

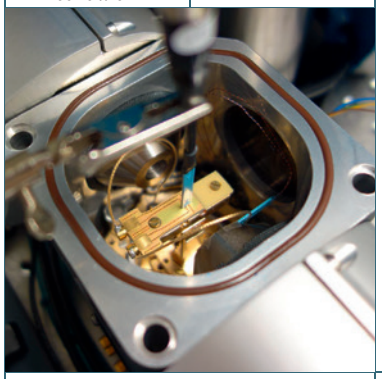
Montana Instruments has partnered with various third-party suppliers to offer integrated application specific solutions. Each system leverages Montana Instrument's closed-cycle platform technology to ensure high-performance variable temperature measurements.

The platform is pre-modified with the necessary options and design details to integrate seamlessly with the third-party equipment. All integrations are tested prior to shipment.

0.3 T	4.5 K	**Cryo Nanomoke + Magneto-optic**
Field strength (Polar & LT)	Base temperature	This system combines the powerful capabilities of the NanoMOKE3 with the flexibility of the Cryostation s50 - MO for low temperature Magneto-Optic Kerr Effect (MOKE) applications. This option allows the user to take measurements in the longitudinal and polar orientations. All optics, electronics, and software are included with the integration.
		
Partner		Durham Magneto Optics

0.75 NA	95%	**Cryo Raman + Cryo-optic**
Objective	Peak Quantum efficiency CCD	This low temperature Raman microscope integration is optimized for high collection efficiency and throughput, offering free space Raman signal collection via the Princeton Instruments FERGIE™ spectroscopy system. The ultra-stable optical design of the Cryostation s100 - CO allows for long, drift-free exposures. The ATSM™ enables rapid and precise explorations of temperature dependent phase transitions, frequency shifts, and linewidth sharpening.
		
Partner		Princeton Instruments

±20 mm/s	0.1%	**Cryo Mössbauer + Cryostation**
Standard veolcity axis range	Maximum nonlinearity	The Cryo Mössbauer offers a complete, integrated solution for variable temperature transmission Mössbauer spectra measurements. The MS96 spectrometer is coupled with the Montana Instruments Cryostation s50 sample chamber in a straightforward and user-friendly design.
		
Partner		Palacky University, RCPTM

2 - 17 GHz	±21 μT	**Cryo FMR + Magneto-optic**
Frequency bandwidth	Field resolution	The CryoFMR integrates the Cryostation s50 - MO with a Coplanar Waveguide Ferromagnetic Resonance (CPW-FMR) spectrometer for sample characterization from 4 K - 350 K. The system boasts a low signal-to-noise ratio for applications that involve characterizing thin films and structures. The system comes with all electronics and software to take measurements and run the analysis.
		
Partner		NanOsc AB

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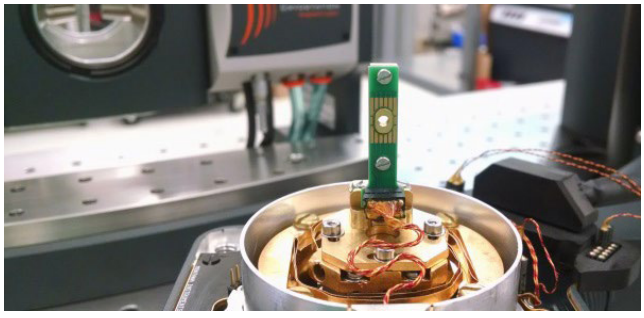
Variable temperature research platforms
Standard options & customization

System accessories & configurations

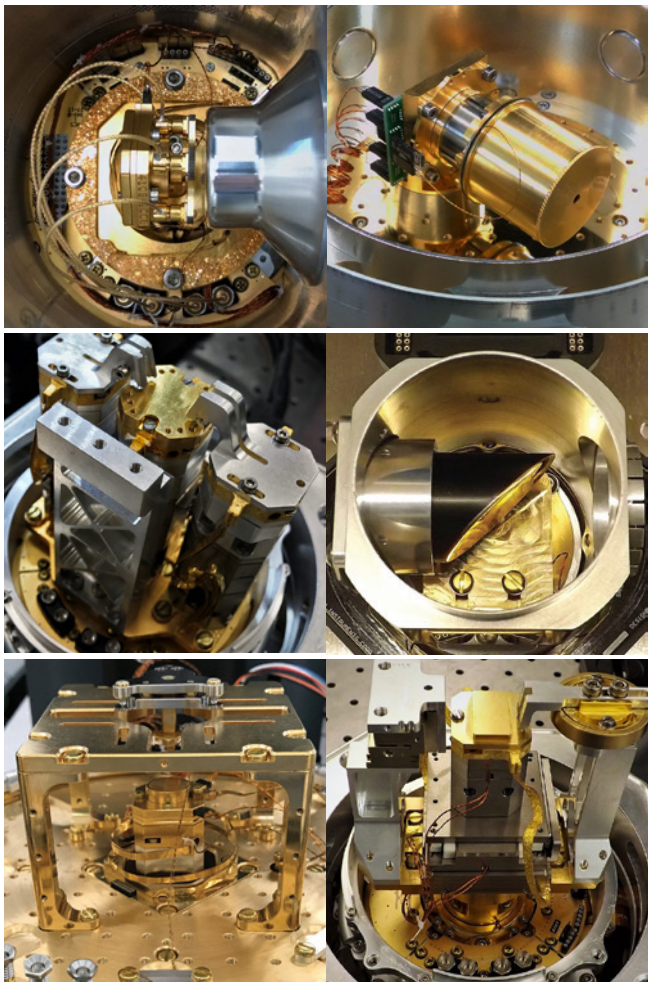
Various configuration options and add-ons allow the system to fit the unique needs of each researcher and experiment. Configuration examples include mechanical designs to enable the use of external superconducting magnets, optical options for low working distance applications, feedthroughs for signal interfacing, and specially designed mounts for sample motion, electrical connections, and rapid temperature changes.

A system design engineer will help determine the set of standard options that are best suited to your application requirements.



One-of-a-kind application specific solutions

For researchers working on cutting-edge techniques, standard options may be limiting for certain applications. In these cases, custom designed parts and modifications are required to enable new measurements. A team of dedicated application specialists and custom design engineers are available to create a one-of-a-kind solution for your needs.



You will be paired with a design engineer who will work with you to understand your requirements and modify existing options or create personalized solutions to best meet your needs. Our team of cryogenic engineers specialize in creating mechanical designs to optimize the thermal performance of your set-up, with the ability to:

- Incorporate custom equipment (internal and external) into the sample chamber design
- Design special sample mounts for unique set-ups or experimental requirements
- Optimize the set-up for specific applications or performance requirements tion requirements.

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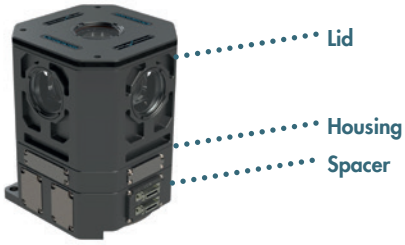
Variable temperature research platforms
Configurable options

Mechanical sample chamber configurations

Montana Instruments research platforms are designed to provide the user flexibility in configuring the sample space and optical access. Depending on the platform, a range of both standard and custom sample space enclosure options (vacuum housing and corresponding parts) are available.

The temperature controlled sample platform is centered within the vacuum space. A radiation shield surrounds the sample space and insulates it from room temperature radiation. The vacuum housing & lid surrounds the radiation shield and defines the outer optical interface to the system.

Housings and Lids



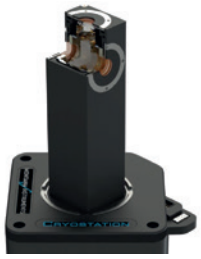
The Cryostation design allows for flexible configurations of the sample space to accommodate various internal working volumes, beam heights, and optical access. There are several standard outer vacuum housing and lid options, with further customizations available.

- Low profile housing with 30 mm windows
- Tall housing with or without side windows
- 45° housing to rotate window orientation

A housing spacer can also be used to raise the height of the platform and housing an additional 25 mm.

Castles

Castle options are upward extensions of the sample housing which have been designed to accommodate various configurations and application requirements.



- Provide more room vertically for internal components, such as piezo positioners
- Allow external components close proximity to the sample, such as for low working distance transmission or external magnets

System engineers will work with users to determine the design that works best for the experimental set-up.

Optical window configurations

Montana Instruments research platforms offer unobstructed optical access to the sample space through window ports on the side and top of the sample housing. The number of available optical ports is dependent on the base platform (refer to individual product specifications for details).

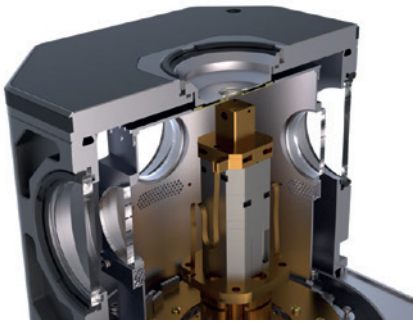
The window ports can be further customized for unique optical experiments. A custom tilted window holder can be incorporated to eliminate fringe patterns and avoid unwanted cavity feedback. Modifications for additional optical ports, such as a bottom window holder for vertical transmission, are also available. Please inquire for custom window configuration requests.

Window substrates

Both the outer vacuum housing (warm) and inner radiation shield (cold) windows may be easily replaced by the user within minutes. A variety of optical materials are available for different wavelengths and applications. The standard option is a Fused Silica VIS-NIR (400-1000 nm) AR coating.

Typical sizes required are ø50 mm, 30 mm, and 20 mm. Not all windows are available in all sizes.

Low working distance



The low working distance (LWD) options allow users to use external optics and achieve a working distance as low as 1mm. The components to achieve the LWD configuration include a thin vacuum window, a radiation aperture, and a thin radiation window.

The sample can be placed close to the overhead optic. A variation of this option allows translation of a larger sample. The low working distance option has a very thin window and can be fused silica, BK7, sapphire, or other materials upon request.

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MONTANA INSTRUMENTS

Variable temperature research platforms
Configurable options

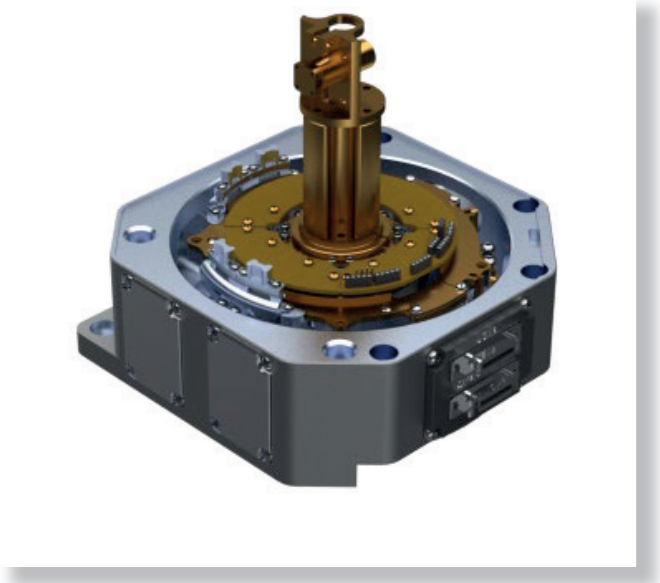
Interfacing connections, feedthroughs & user wiring

Montana Instruments research platforms support a variety of options for interfacing connections to the sample space. Along with these options, each platform includes several preinstalled electrical connections intended for low frequency and low power applications.

The 100 & 200 class models provide 25 electrical feedthroughs pre-routed directly to the 4 K sample space circuit board via flexible circuit connectors. This design eliminates the need to route and thermally lag wiring and reduces overall heat load to the sample.

Visit our website for a comprehensive cryogenic wiring guide with tips on how to choose and install wiring to reduce unnecessary heat loads.

Base side panels



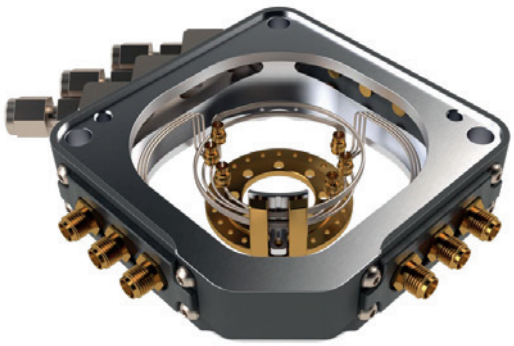
Interfacing plates on the base of the sample chamber provide options for routing connections to the sample. The number of available interface panels is dependent on the base platform. The side panels are designed to preserve sample chamber vacuum.

Window feedthroughs

Some options can be routed through unused optical ports. These connections are typically easier to route, but must be removed when removing the housing for sample access.

Note: This option is often more difficult to use.

Interface extension housing



Signal interfaces can be added above the lower housing using a 25 mm spacer with four user specified side panels. The IEH configuration provides more room to the sample space and is useful when the user wants to easily add or remove the RF, fiber, and DC connections. It is also the preferred method for adding options to the Magneto-optic module.

Quantum Design EUROPE

Quantum Design GmbH
Im Tiefen See 58
D-64293 Darmstadt
www.qd-europe.com

David Appel: ✆ +49 6151 8806-499,
appel@qd-europe.com
Dr. Tobias Adler: ✆ +49 6151 8806-479,
adler@qd-europe.com

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Variable temperature research platforms
Configurable options

Wiring options

Simple low conduction DC cable harnesses are available with 2, 3, 4 or 5 pins. These generally have a straight section for thermal lagging.

New 12 and 25 pin flexible circuit connector options provide superior thermal anchoring and keep the wiring clean and organized. These flexible circuits come standard on the 100 & 200-class chambers, and are also used in various other options, such as the R2D12 electrical sample mount and platform heaters.

	RF Coax	Fiber	Gas tube		Electrical		
Option	SMA/SMP	Fiber optics	1/16" Gas tube	Micro D25	MDR26	Fischer 24	R2D12
							
Overview	for high frequency signals, SMA to SMP coax connectors	FC style connectors or compression (Swagelok) fittings	compression fitting for 1/16" gas tube, includes tube routed to sample chamber	welded Micro D25 connector with integrated internal wiring	soldered 26 pin connector with internal headers	standard Fischer 105 series 24 pin connector	soldered 14 pin connector + SMA to SMP coax connectors
Side panels	quad RF	dual Swagelok or dual compression	single tube compression	single D25 connector	single MDR26 connector	single Fischer 24	single MDR14 connector + dual RF
Window feedthroughs	single & quad RF	single & dual FC, dual Swagelok	n/a	n/a	n/a	n/a	n/a
Innterface extension	triple or quad RF	dual or triple Swagelok	n/a	single D25 connector	n/a	n/a	n/a
Sample mounts	R2D12 R4	custom	n/a	ESM	ESM	ESM	R2D12
Notes	1-4 coax cables 20 GHz semi-rigid	several fiber sizes & types can be supported	multiple routing options in chamber	internal wires are 12" phosphor bronze	wiring harnesses plug into back/ internal headers	internal solder cups, uses panel mount o-ring connector	flexible circuits route to R2D12 electrical sample mount

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Quantum Design GmbH
Im Tiefen See 58
D-64293 Darmstadt
www.qd-europe.com
David Appel: ✆ +49 6151 8806-499,
appel@qd-europe.com
Dr. Tobias Adler: ✆ +49 6151 8806-479,
adler@qd-europe.com

Variable temperature research platforms
Sample mounting

Orientation, positioning, interfacing & motion

Sample mounting is an integral part of the successful use of any cryogenic platform. Several options have been designed to fit a range of application requirements. Most sample mounting options are compatible with all research platforms.

For unique applications and configurations, custom designed sample mounts are commonly used to achieve the desired experimental requirements. System engineers have extensive experience designing custom mounting solutions to maximize the thermal and vibrational performance of the set-up.

Contact us for a detailed cryogenic sample mounting guide with tips on how to achieve optimal thermal performance.

Standard damped

This mount provides an easily configurable way to position samples at various distances and angles with respect to the side and top optical ports. It includes a thermally damped post with standard interface bolt pattern that can be mounted vertically or horizontally to position the sample near any of the windows.

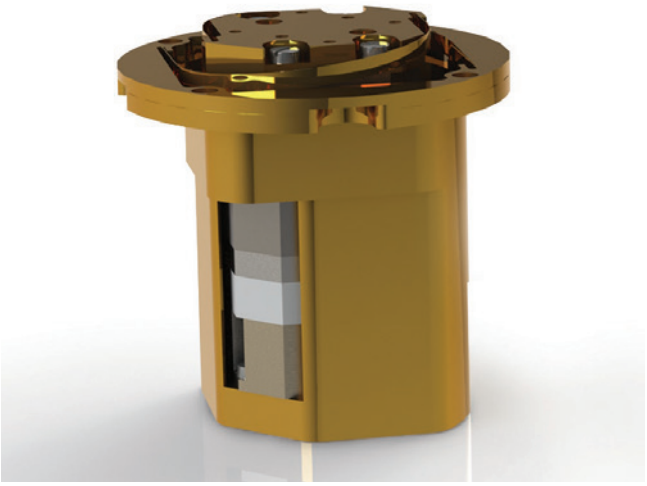
Stock designs

This family of mounts are sized specifically to work with castles, magnets, or other special configurations.

System engineers will help pick the most appropriate mount to match your options, the window beam height, and your intended optical access.

Note: These mounts are not thermally damped, so the temperature stability may be slightly higher than the specification of the base platform.

Piezo positioning



Precision nano-positioning stages are used for translating, rotating, or tilting your sample. These are integrated into the cold space either on the standard platform or by using an optional recessed platform (as shown).

A proprietary flexible thermal link is used to thermally connect the cold stage to the sample mount.

Note: All stages are integrated and tested prior to shipment.

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D-64293 Darmstadt
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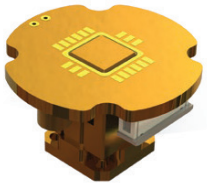
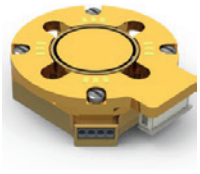
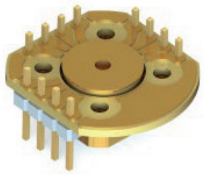
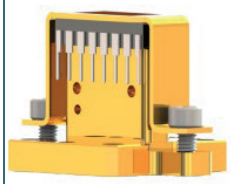
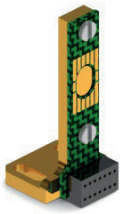
David Appel: ✆ +49 6151 8806-499,
appel@qd-europe.com
Dr. Tobias Adler: ✆ +49 6151 8806-479,
adler@qd-europe.com

Variable temperature research platforms
Sample mounting

Electrical sample mounts

A family of electrical mounts allow the user to pre-mount samples on small chips or circuit boards to easily make electrical connections. These have been specially designed to work with other mounts and configurations, with an emphasis on preserving thermal performance.

	R2D12	ASTM D12	CB12	DIP 16	MO14
Overview	circuit board with electrical contact pads, coax connections & flexible circuit	circuit board with electrical contact pads & flexible circuit	circuit board with electrical contact pads & pins	holds standard DIP16 chip carriers	wire bonding pads on narrow circuit board with pitch connector
					
Low voltage connections	12 DC	12 DC	12 DC	16 DC	14 DC
High frequency connections	2 RF coax	n/a	n/a	n/a	n/a
Customizable	yes	no	no	no	yes
Configurations	standard mount or piezo mount	mounts on ASTM	standard mount or fixed mount	fixed mount or piezo mount	parallel, normal, or 45° to lateral field
Best for	coplanar waveguides, microwave excitation, & low signal level experiments		low working distance, high impedance, & compact areas such as castles	use with chip carriers & quick sample changes	use with magneto-optic module

Agile temperature sample mount

<30 µm	<50 mK	300 K/5 min	0.2 K
Drift over full temp range *measured at center and edge of 3x3 mm calibration grating*	p-p Temp stability *stability over 15 minutes*	Typical heating/ cooling rate	Temp gradient above platform
			

The ATSM™ provides the solution for the highest level of positional stability for step-static and dynamic temperature changes from 4K to 350K while improving the speed to each set point.

- Eliminates the need to re-focus after small temp changes
- Local heating of the sample for rapid thermal response & time to stability
- Optimizes high NA and low working distance set-ups, such as when used with the Cryo-optic products

A family of electrical mounts allow the user to pre-mount samples on small chips or circuit boards to easily make electrical connections. These have been specially designed to work with other mounts and configurations, with an emphasis on preserving thermal performance.

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Dr. Tobias Adler: ✆ +49 6151 8806-479,
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Applications

Featured customer applications*

Xiaodong Xu | UNIVERSITY OF WASHINGTON
Ligand-field helical luminescence in a 2D ferromagnetic insulator
Nature Physics (2017) doi: 10.1038

Ania Jayich | UNIVERSIT Y OF CALIFORNIA SANTA BARBARA
Scanned probe imaging of nanoscale magnetism at cryogenic temperatures with a single-spin quantum sensor
Nature Nanotechnology 11, 700–705 (2016)

David Awschalom | UNIVERSIT Y OF CHICAGO
Accelerated quantum control using superadiabatic dynamics in a solid-state lambda system
Nature Physics 13, 330–334 (2017)

H. S. J. van der Zant | KAVLI INSTITUTE OF NANOSCIENCE, DELFT UNIVERSITY OF TECHNOLOGY
Direct and parametric synchronization of a graphene self-oscillator
Appl. Phys. Lett. 110, 073103 (2017)

Kartik Srinivasan | NIST GAITHERSBURG
Cryogenic photoluminescence imaging system for nanoscale positioning of single quantum emitters
Review of Scientific Instruments 88, 023116 (2017)

Douglas Natelson | RICE UNIVERSITY
Photothermoelectric Effects and Large Photovoltages in Plasmonic Au Nanowires with Nanogaps
J. Phys. Chem. Lett. 8, 1739–1744 (2017)

Jie Shan | PENNSYLVANIA STATE UNIVERSIT Y
Valley magnetoelectricity in single-layer MoS2
Nature Materials 16, 887-891 (2017)

Ping-Heng Tan | CHINESE ACADEMY OF SCIENCES
Observation of forbidden phonons, Fano resonance and dark excitons by resonance Raman scattering in few-layer WS2
2D Materials, 2017, 4 (3)

Hugues de Riedmatten | INSTITUTO DE CIENCIAS FOTÓNICAS (ICFO)
Photonic quantum state transfer between a cold atomic gas and a crystal
Nature 551, 485-488 (2017)

Andrei Faraon | CALIFORNIA INSTITUTE OF TECHNOLOGY
Interfacing broadband photonic qubits to on-chip cavity-protected rare-earth ensembles
Nature Communications 8, 14107 (2017)

Mikhail Lukin, Hongkun Park | HARVARD UNIVERSIT Y
Probing dark excitons in atomically thin semiconductors via near-field coupling to surface plasmon polaritons
Nature Nanotechnology 12, 856–860 (2017)

Jun Ye | JILA AND UNIVERSIT Y OF COLORADO
A silicon cavity in a 4 K closed-cycle cryostat with 1 x 10^{-16} instability
Phys. Rev. Lett. 119 (2017) no.24, 243601

*Primary author referenced, et al. implied.
List of publications and researchers does not represent an official endorsement of Montana Instruments products

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Quantum Design GmbH
Im Tiefen See 58
D-64293 Darmstadt
www.qd-europe.com
David Appel: ✆ +49 6151 8806-499,
appel@qd-europe.com
Dr. Tobias Adler: ✆ +49 6151 8806-479,
adler@qd-europe.com
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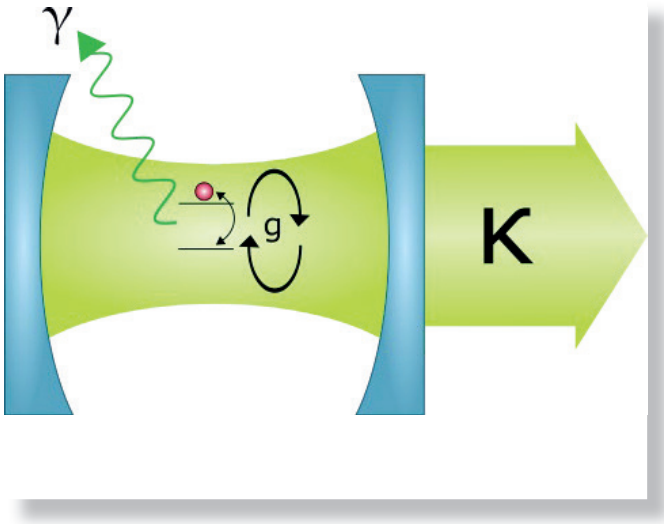
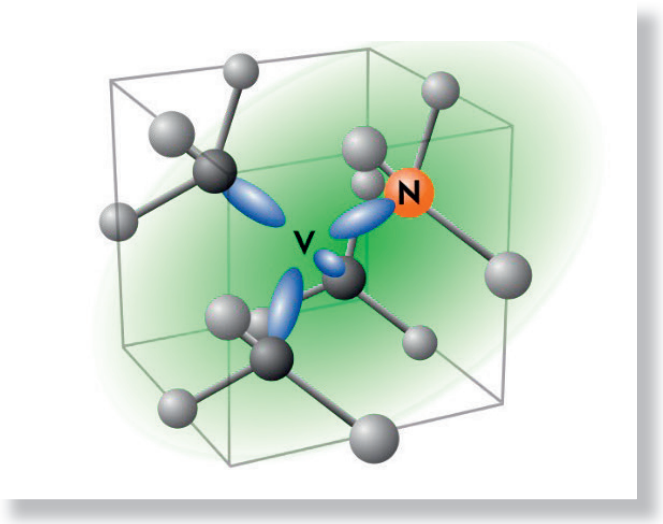
Variable temperature research platforms
Resources

System information

Visit the manufactorer website at www.montanainstruments.com for a full list of product specifications, detailed performance data, dimensions drawings, and in-depth overviews of components & features.

The website has a fairly extensive list of available options, but due to the highly configurable nature of the system, please consult with a sales representative for a full list of accessories.





Help & how-to information

For set-up, maintenance, and service information, an extensive directory of how-to articles and videos are available online at
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A worldwide service network is available to support systems in the field. For general questions or real-time troubleshooting, contact your local service representative.

General cryogenic resources

A new series of White Papers, Application Notes & Technical Guides cover cutting-edge techniques, breakthrough technology developments, and best practices for various cryogenic research applications and measurements.

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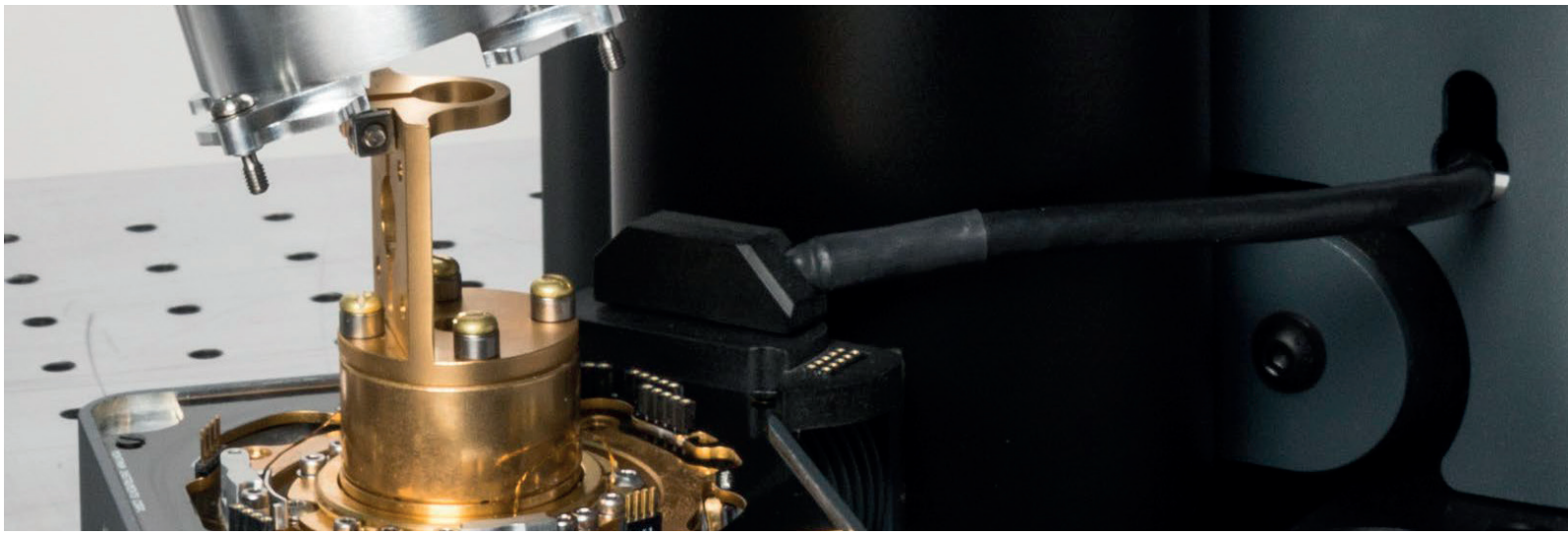

Cold science made simple

Quantum Design EUROPE

Quantum Design GmbH
Im Tiefen See 58
D-64293 Darmstadt
www.qd-europe.com

David Appel: ✆ +49 6151 8806-499,
appel@qd-europe.com
Dr. Tobias Adler: ✆ +49 6151 8806-479,
adler@qd-europe.com

Annex No. 3

The setups for various spectroscopic techniques and relevant technical drawings of the Equipment

1) Setup no. 1: Variable stripe length method.

   Please refer to the Figure of the Setup no. 1 in the Annex. The concept is such that the photoluminescence of a solid sample is excited with a laser beam focused in a thin long stripe and detected from the edge of the sample. The sample will be typically a solid plate with the dimensions: up to 15x15x2 mm (length x width x thickness). The sample is attached to the holder on a xyz piezo-stack (the piezo-stack is provided by the Buyer). The sample holder shall have a stripe-shaped aperture (> 10 mm in length) to transmit the excitation stripe in order to avoid reflection of the laser beam into the objective and/or excitation of the holder material. The height of the aperture shall be determined (e.g. 3 mm) depending on the thickness of the holder such that it will to enable transmit the excitation beam through the aperture. The objective must enable to collect the photoluminescence (ASE) from the edge of the sample, i.e. it must be possible to set the focal point of the objective on the edge of the sample. The objective that will be employed here is the Zeiss LD EC Epiplan-Neofluar 100x/0.75 DIC M27 (provided by the Buyer). The setup shall enable the excitation of the sample with > 10 mm stripe length.

2) Setup no. 2: Transmission measurements.

   Please refer to the Figure of the Setup no. 2 in the Annex. A sample is attached to the sample holder on a movable piezo-stack (the piezo-stack is provided by the Buyer). The sample holder will have a circular aperture with the diameter of > 5 mm. The sample is placed approximately in the middle of the sample chamber in order to enable excitation via one window and the detection via the window in the opposite side of the chamber as sketched in the Figure. The acceptance cone must be > 15°.

3) Setup no. 3: Photoluminescence detected in 90° configuration.

   Sample will be placed in the middle of the chamber and attached to the holder on a xyz piezo-stack (provided by the Buyer). Sample dimensions are up to 10x10x3 mm. The position of the sample should be as sketched in Figure of the Setup no. 3 in the Annex. The optical axis of the excitation beam and of the emission cone should be passing through the middle of the optical windows and they shall be positioned in the angle of 90° with respect to each other. The holder shall have a circular aperture in order to enable the excitation beam pass through it. The excitation beam will be focused on the sample with the excitation cone of 15 degrees full-angle.

4) Setup no. 4: Photoluminescence quantum yield of a bulk sample - top excitation.

   Sample will be placed in the customized integration sphere. The customized sphere is based on the sphere model No. 4P - GPS - 020 -SL (spectralon) manufactured by the LABSPHERE. The Seller will provide the Buyer detailed CAD models for the customization of the sphere in order to be able to integrate the sphere into the chamber of the cryostat as sketched in Figure of the Setup no. 4 in the

Institute of Physics
of the Czech Academy
of Sciences
Na Slovance 1999/2
182 21 Prague 8
Czech Republic
Tel.: +420 266 052 110
Email: info@fzu.cz
Web: www.fzu.cz

Annex. The Seller will provide holder for such customized sphere to fit it into the cryostat. The purchase of the sphere is not part of this tender and will be purchased separately by the Buyer. The sample will be excited from the top via the top window of the cryostat chamber. The optical axis of the excitation beam will be in the middle of the sample holder. The sample holder will be placed on the bottom of the sphere and attached to the xyz piezo-stack. The movement of the holder, however, will not be required and thus the entrance on the sphere for this holder may be as small as the holder itself. The size of the holder will be 1x1 cm or 1 cm in diameter and it will be covered with a highly reflective material in the range of 450 – 900 nm (to be specified – but ideally silver). The sample will be placed on the holder such that it will be fully settled inside the sphere. Additional space of > 2 cm is required above the sphere in order to accommodate possible fiber excitation via the upper port of the sphere.

5) Setup no. 5: Photoluminescence quantum yield of μm-scaled objects.

This setup is designed for the photoluminescence quantum yield measurements of objects with dimensions in the range of micrometers, for example, a powder of light-emitting material deposited on a substrate. Please refer to the Figure of the Setup no. 5 in the Annex. The same sphere as for the Setup no. 4 will be used with different ports and holders. The sample will be attached the holder made of highly reflective material in the range of 450 – 900 nm. The sample will have dimensions up to 5x5 mm. The holder should have comparable size as the sample and in ideal case also an aperture (not mandatory) in order not to disturb the quantum yield measurements. The holder shall be attached to the movable piezo-stack and the bottom port of the sphere must enable movement of this holder at least by 2x2 mm in the vertical plane. The sample can be misplaced from the center of the sphere by max. 5 mm towards the objective. The objective shall have a numerical aperture in the interval of 0.2 – 0.3. The objective will be placed in the horizontal direction as sketched in the Figure. The Buyer proposes the 10x Mitutoyo Plan APO NA 0.28 with a working distance of 34 mm. The Seller will consult the details about the objective with the Buyer. The purchase of this objective is not part of this tender and will be purchased separately by the Buyer. The Buyer takes responsibility for the cryogenic performance of the objective. The Seller will design a holder for this objective that will enable to accommodate the objective into the cryostat as sketched in the Figure and will enable to use it at cryogenic temperatures by including heated holder of the objective. The left (input) port must be designed such that the excitation cone will not be cut by its edges. We do not require temperature anchoring of the sphere itself.

6) Setup no. 6: Photoluminescence quantum yield of nm-scaled objects

This setup combines large NA objective for the excitation of a sample (typically single objects – nanocrystals, optical centers). The sample is placed inside an integration sphere. The photoluminescence detection is via an optical fiber attached to the sphere. Please refer to the Figure of the Setup no. 6 in the Annex. The integration sphere will be based on the model 3P - GPS - 010 – SL (Labsphere) with 1 inch interior diameter. A solution providing compromise between the high NA of the objective and the parameters of the sphere will be proposed by the Seller. It will be discussed with the Buyer in order to meet the requirements for spatial resolution (<0.7 □m) and reliability of the method (most importantly, the size of the input port must be smaller than 10 mm) to avoid extensive

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of the Czech Academy
of Sciences
Na Slovance 1999/2
182 21 Prague 8
Czech Republic
Tel.: +420 266 052 110
Email: info@fzu.cz
Web: www.fzu.cz

losses. The purchase of the sphere is not part of this tender and will be purchased separately by the Buyer. The sample will be attached the holder made of highly reflective material in the range of 450 – 900 nm (ideally silver). The sample will have dimensions up to 2x2 mm and the holder should have comparable size in order not to disturb the photoluminescence quantum yield measurements. The holder shall be attached to the movable piezo-stack and the bottom port of the sphere must enable movement of this holder at least by 1x1 mm in the vertical plane. The sample can be misplaced from the middle of the sphere by max. of 2 mm towards the objective. The objective shall have a numerical aperture > 0.4. The objective will be placed in horizontal direction as sketched in Fig. 6 in the Annex. The Buyer proposes the 50x Mitutoyo Plan APO NA 0.42 with a working distance of 20 mm or the 100x Mitutoyo Plan APO NA 0.55 with a working distance of 13 mm. The Seller will consult the details about the objective with the Buyer. The purchase of the objective is not part of this tender and will be purchased separately by the Buyer. The Buyer takes responsibility for the cryogenic performance of the objective. The Seller will design a holder for this objective that will enable to accommodate the objective into the cryostat (heated holder) and will enable to excite the sample via the left (input) port of the sphere. The input port must be designed such that the excitation cone will not be cut by its edges. We do not require temperature anchoring of the sphere itself.

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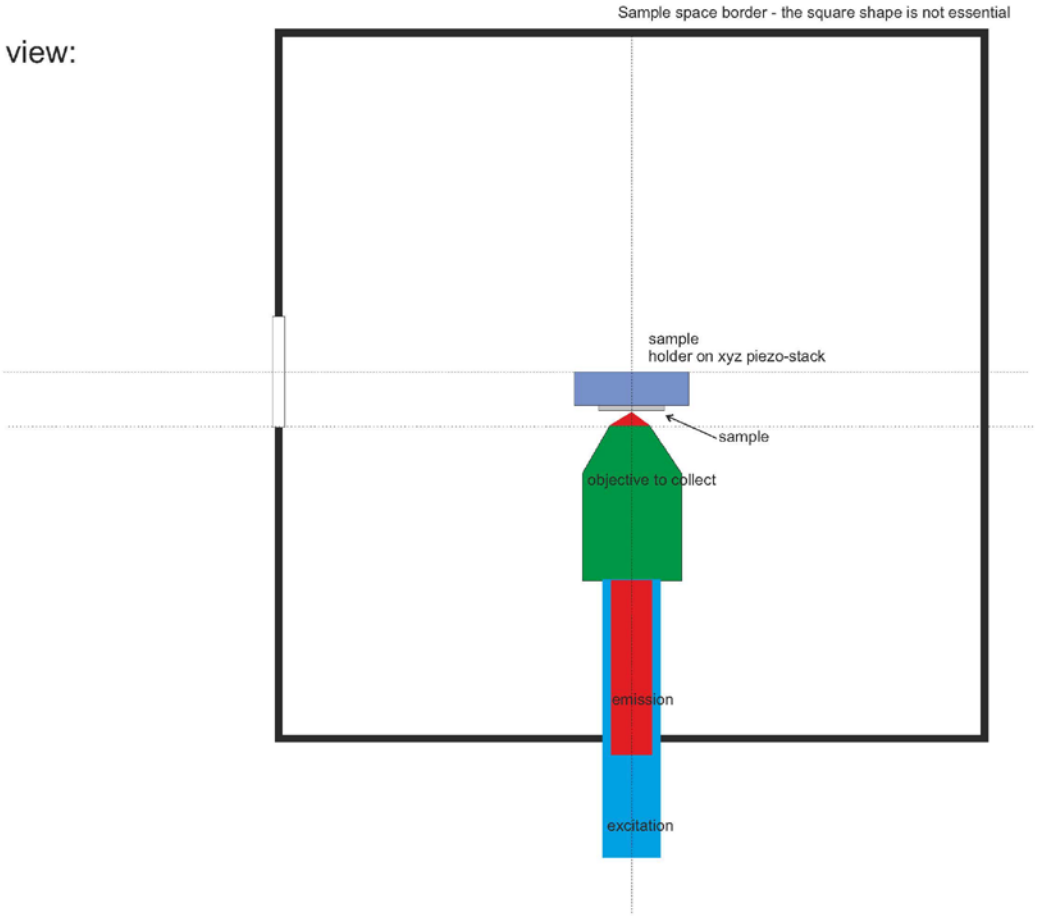
Setup no. 0 : Basic setup for spatially-resolved photoluminescence

Top view:



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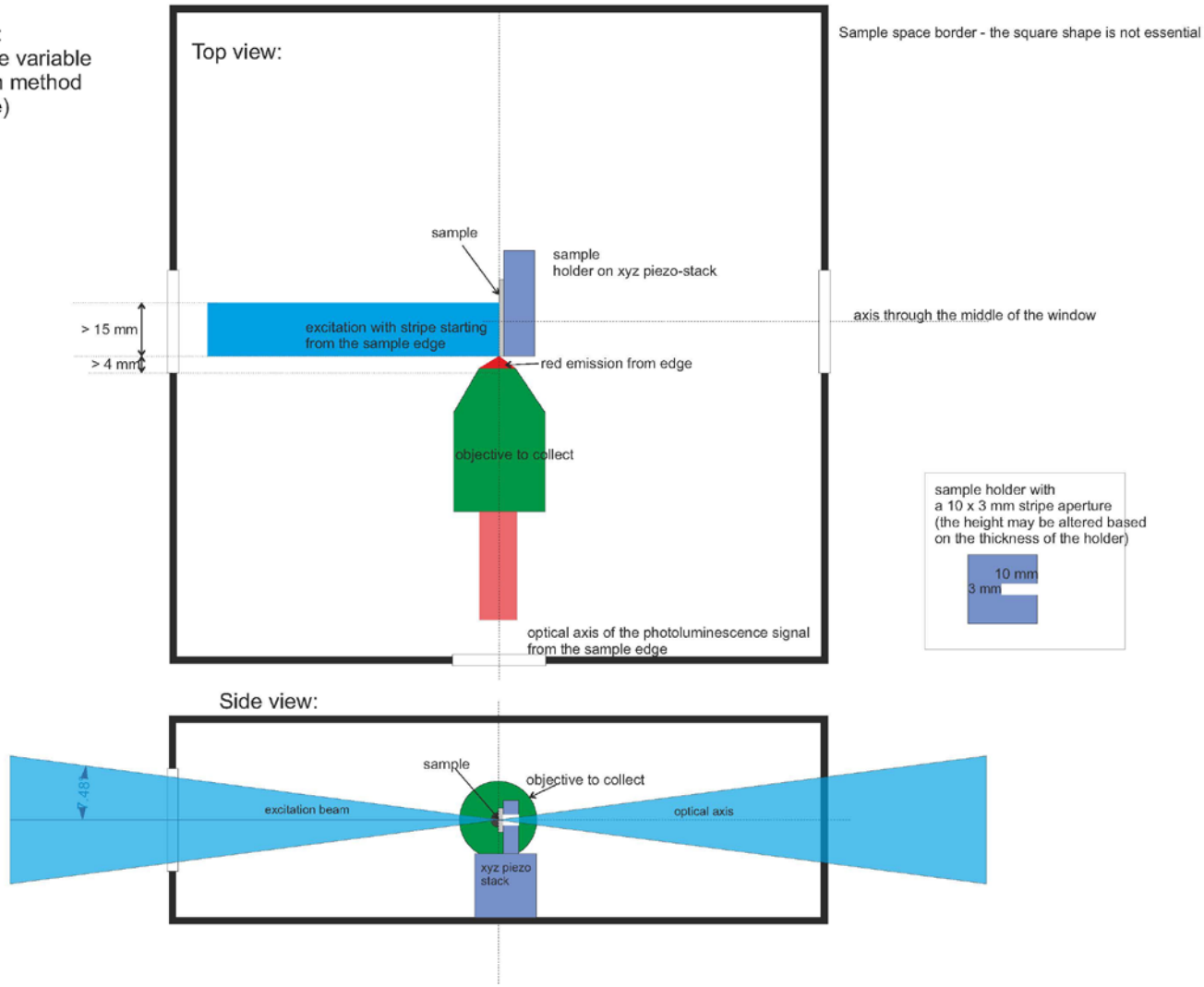
Setup no.1 :
Setup for the variable stripe length method (not in scale)



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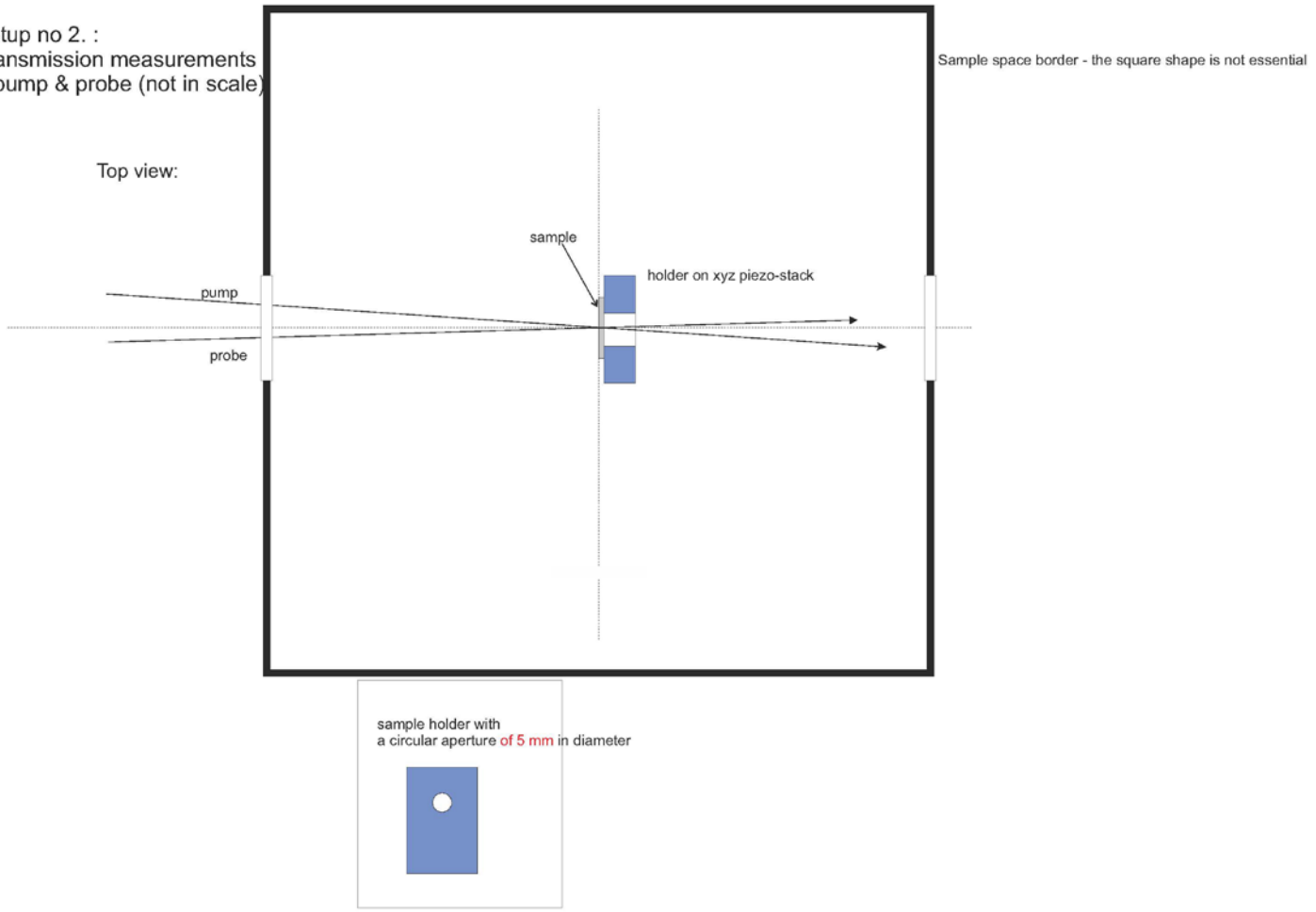
Setup no 2. :
Transmission measurements
- pump & probe (not in scale)



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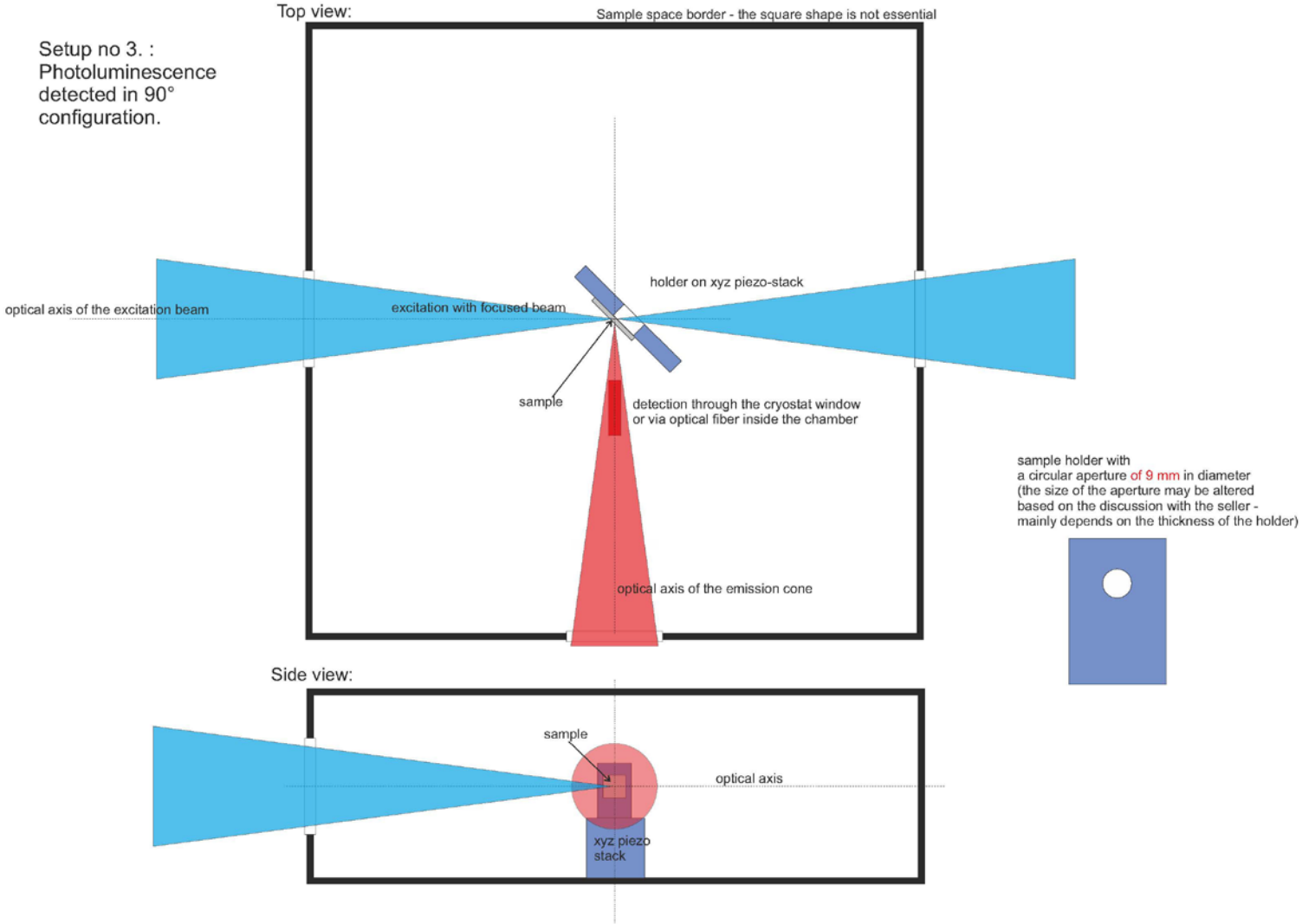
Setup no 3. :
Photoluminescence
detected in 90°
configuration.



sample holder with
a circular aperture of 9 mm in diameter
(the size of the aperture may be altered
based on the discussion with the seller -
mainly depends on the thickness of the holder)

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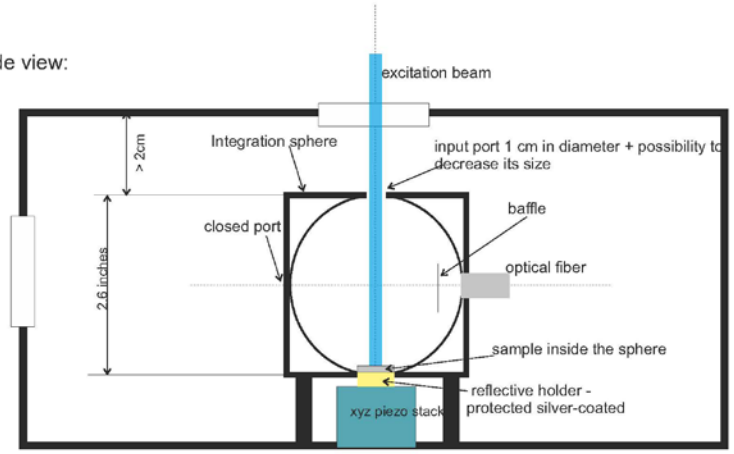
Setup no 4. : Photoluminescence quantum yield of a bulk sample - top excitation.

Side view:



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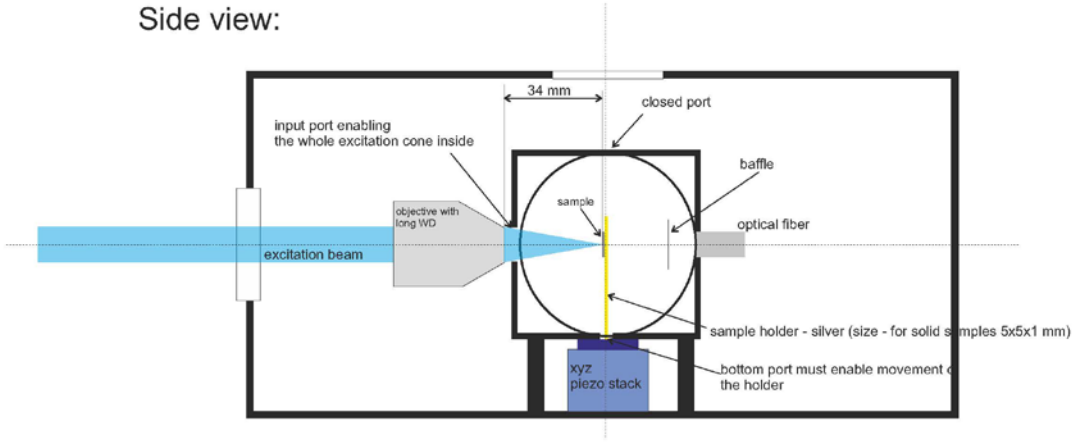
Setup no 5. : Quantum yield of μm scaled objects.

Side view:



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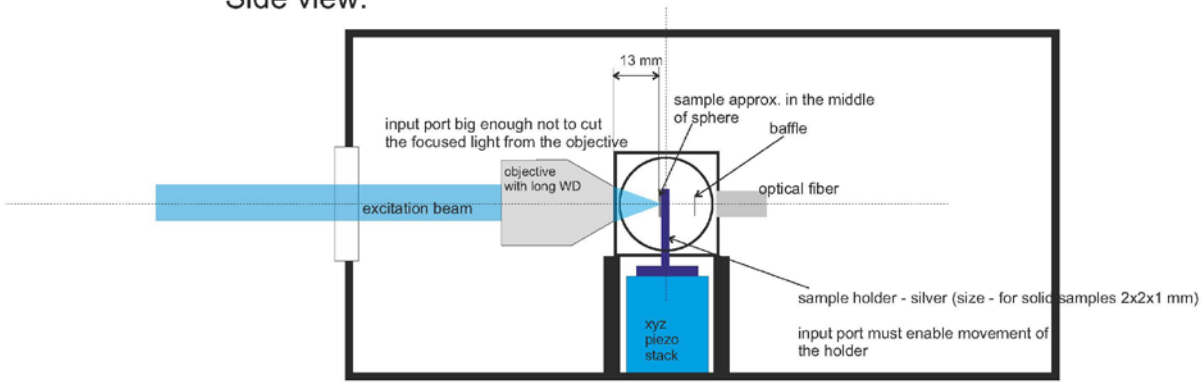
182 21 Prague 8
Czech Republic

Tel.: +420 266 052 110
Email: info@fzu.cz
Web: www.fzu.cz

Setup no 6. : Photoluminescence quantum yield of nm scaled objects.

Side view:



Institute of Physics
of the Czech Academy
of Sciences

Na Slovance 1999/2
182 21 Prague 8
Czech Republic

Tel.: +420 266 052 110
Email: info@fzu.cz
Web: www.fzu.cz