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BioQantSense
Project

NEWSLETTER

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Welcome to the second edition of the BioQantSense project's **NEWSLETTER**! The BioQantSense project, Twinning for excellence of the Serbian Research Center for quantum biophotonics, started on the 1st of October 2022. It is a research project funded by the European Commission under the Horizon Europe Programme of the European Union.

The project is coordinated by the Institute of Physics Belgrade, Serbia (IPB) and its partners are:

1) Consiglio Nazionale delle Ricerche - Firenze, Italy (CNR-INO, National Institute of Optics),

2) Friedrich-Schiller University - Jena, Germany (ABBE Center of Photonics), and

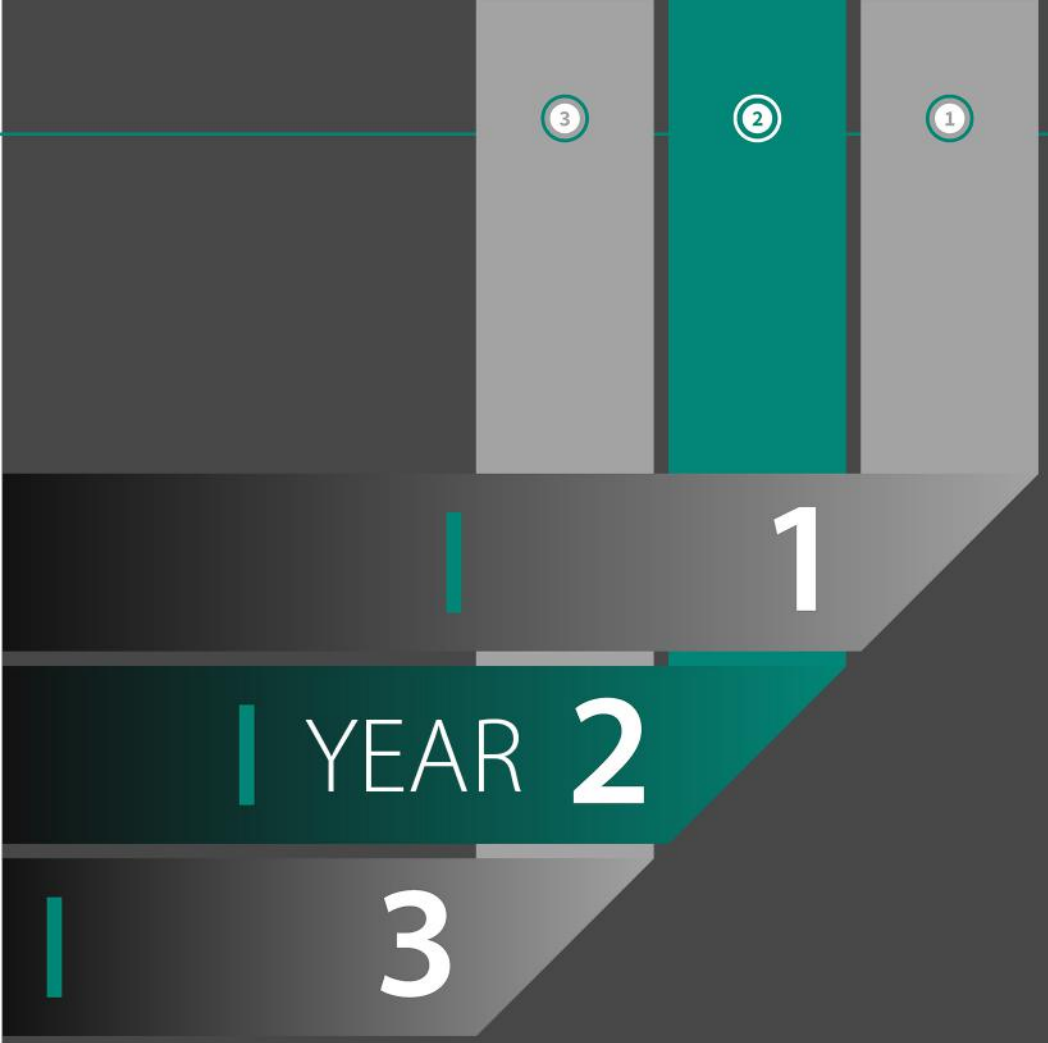
3) Faculty of Biology, University of Belgrade, Serbia (CLM, The Centre for Laser Microscopy).

UNIVERSITY OF BELGRADE | INSTITUTE OF PHYSICS | BELGRADE
NATIONAL INSTITUTE OF THE REPUBLIC OF SERBIA

CNR-INO
ISTITUTO NAZIONALE DI OTTICA
CONSIGLIO NAZIONALE DELLE RICERCHE

Abbe Center of Photonics | JENA
Friedrich-Schiller-Universität

The Centre for Laser Microscopy
capacities for the cell and tissue imaging



The BioQantSense project is envisaged to last for 3 years, with a total budget of 1.060.605 EUR. This newsletter looks back on **THE SECOND YEAR** of BioQantSense project.

In this three years our mission is:

- to raise the excellence and reputation of the IPB in management and administrational aspects;

- to raise scientific excellence of the Institute of Physics Belgrade (IPB) through development of the state-of-the-art center for quantum biophotonics;

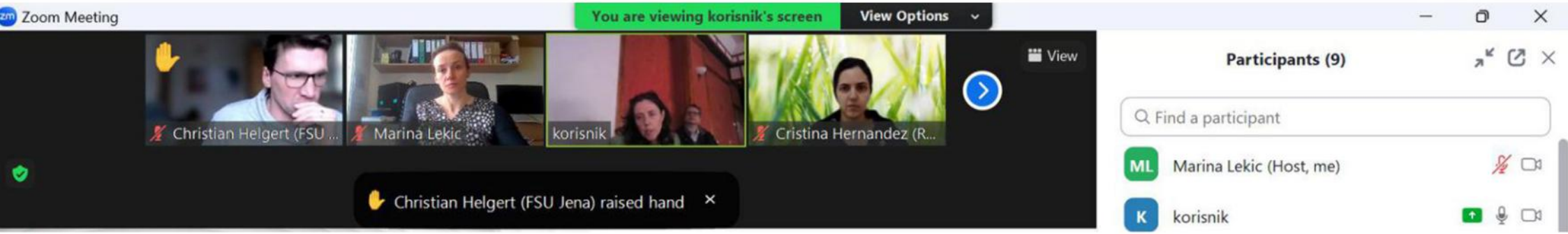
- development of the imaging system based on quantum interference and quantum holography;

- development of a miniaturized functional lab-on-chip platform for imaging micron-sized biological objects;

- integration of the two developments in a compact imaging device for cancer diagnostic purposes.

BioQantSense

FIRST PROGRESS REVIEW MEETING



Online Review meeting on the project progress during the first 16 months took place on Thursday, 21st March 2024. This meeting was based on the Project Progress report submitted to the EC in February 2024, as one of the Project's deliverables. Participants at this meeting were Project Officer and external expert on the side of European Research Executive Agency (REA), and representatives of all BioQantSense project partners – PI, Project Manager, Project Coordinator and WP leaders, on the side of the Partners Consortium. The meeting was complemented by project management staff from CNR and IPB, reflecting on the advancement regarding strategic and administrative impacts. Progress Review Meetings, on the EU level, are accompanied by an external expert from the matching field of research. The expert pronounced good and inspiring energy among the partners, devoted to successful project realization. He acknowledged the notable advancement particularly regarding the progress in the development of the quantum microscopy experimental setup so far. Along with this, specific recommendations for further potential to guide the BioQantSense project towards a complete and successful realization were given both by the project officer and the external expert.

PROGRESS REPORT NUMBERS

15 Deliverables

2 Workshops

16 Visits

30 Online meetings

2 Scientific papers

5 Conference attendings

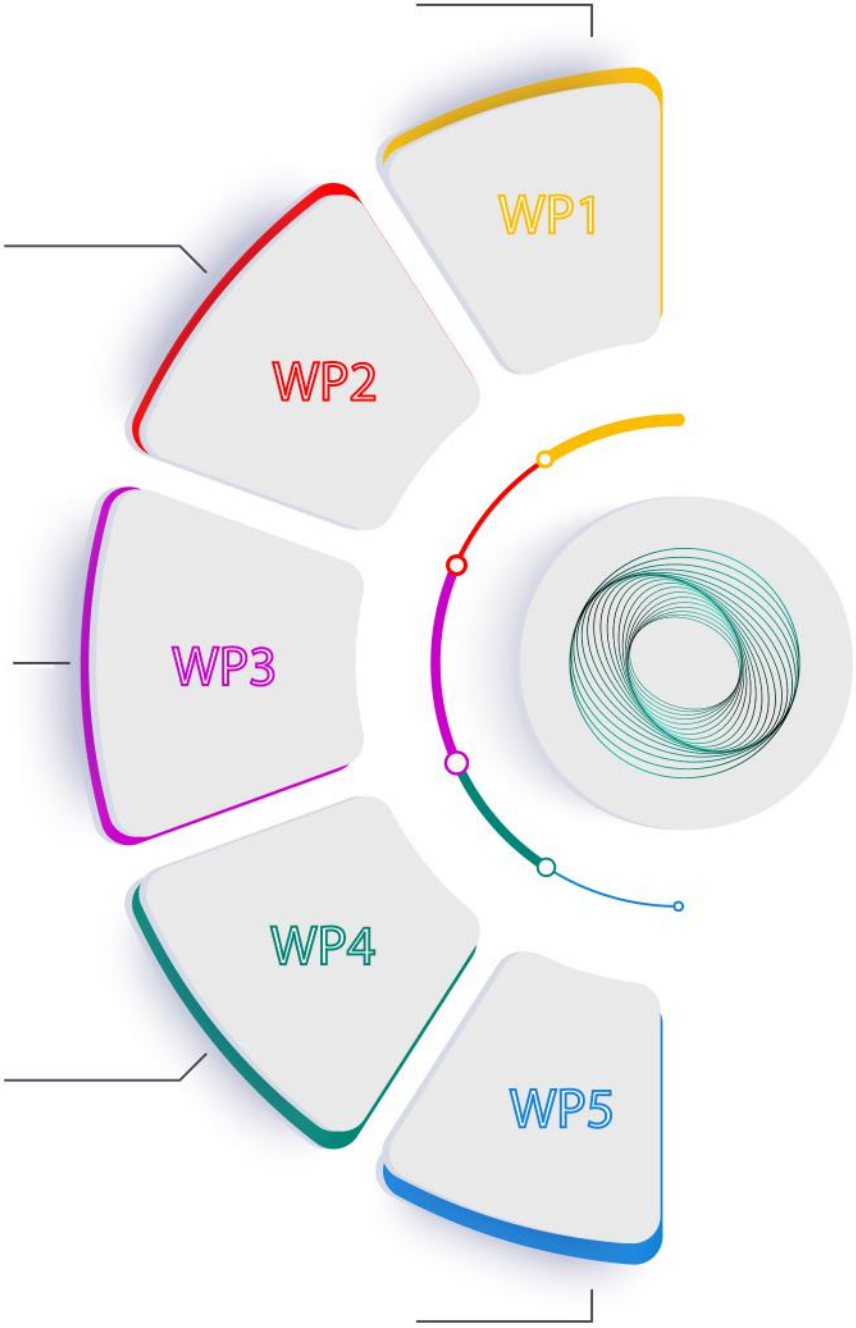
THE PROJECT UP TO NOW

To achieve the BioQantSense objectives, a work plan of the project is divided into five Work Packages (WPs):

WP1 - Development of institutional strategy;
WP2 - Knowledge and skill transfer/exchange;
WP3 - Dissemination, exploitation and communication;
WP4 - Project management, coordination and monitoring;
WP5 - Exploratory project: Quantum microscope for bioimaging;

Till the end of the second year, **60%** of the deliverables foreseen in the project were completed. The progress of each WP, of the BioQantSense project, is shown through their **realized**/**unrealized** deliverables, in the following graphical presentation.

D 1.1. Benchmarking analyses
D 1.2. Report on recommendations
D 1.3. Catalogue of measures implement at IPB
D 1.4. Overview of evaluation measures
D 1.5. White paper / roadmap on IPB strategy
D 2.1. Implemented measures and processes to improve strengthen IPB capabilities
D 2.2. Mid-term Reports on visits at CNR
D 2.3. Mid-term reports on visits at FSU
D 2.4. Improved methods and techniques at IPB
D 2.5. Final report on visits at CNR
D 2.6. Final report on visits at FSU
D 3.1. Plan communication, dissemination and exploitations
D 3.2. Project website, logo
D 3.3. Project newsletter
D 3.4. Final report on participation at conferences, submitted publications
D 3.5. Plan for dissemination and exploitation including communication - update
D 4.1. Project kick-off
D 4.2. Schedule for project meetings
D 4.3. Data Management Plan
D 4.4. Progress report
D 4.5. Mid-project Data Management Plan updated
D 5.1. Quantum holography system
D 5.2. Microcantilever array
D 5.3. Lab-on-chip
D 5.4. Quantum and classical holography



BioQantSense

INTERVIEW

Dr. Marina Lekić

Project Manager / IPB, Belgrade

Q: What, in brief, is Quantum Biophotonics?

A: Quantum biophotonics is a new field of research, and the level of precision and control provided by recent advances in quantum technologies makes this multidisciplinary field very exciting. In quantum biophotonics, we apply methods developed for the characterization and manipulation of the quantum state to make sensitive, reliable and traceable measurements in the ever-changing bio-environment.

The basic "tool" is a single isolated photon or an entangled pair of photons, which is first generated, then transmitted, transformed and finally absorbed. From a photon absorbed by a biological system, we can potentially read a lot of information. Today, our capabilities in the field of single-photon quantum coherence are limited, but it is a huge field of research for quantum biophotonics.

Q: What is the main goal of your twinning project?

A: The goal of the project is to raise the excellence, reputation and international competitiveness of the Photonics Center (PC), one of the Institute of Physics' four centers of excellence, as well as to strenghten management and administrative capacities of the Institute's staff relevant to international project, research and innovation activities. Within the scientific-research part of the project, a new scientific field – quantum biophotonics – will be developed, and all aspects of classical biophotonics will be significantly improved.

The ultimate goal of the project is the establishment of a Center for Quantum Biophotonics at the Institute of Physics Belgrade, as a result of knowledge transfer through strategic networking with two high-profile European partners, the Friedrich Schiller University of Jena (FSU) and the Italian National Research Council (CNR).

The Faculty of Biology of the University of Belgrade, a long-term partner of the Institute, is another project partner that will help the biologists of our Institute in the selection, preparation and cultivation of appropriate biospecimens.

Q: How will the new field of quantum biophotonics be established at the Institute?

A: Introducing a new research area takes place in several steps. The first step is certainly the existence of a research infrastructure and then the transfer of knowledge and skills between the coordinator (Institute of Physics) and the leading partner institutions.

The second part of the BioQantSense project envisages a research project whose goal is the development of a microscope based on quantum holographic interferometry and the recording of biological samples that are delivered to the recording site via microfluidic channels as parts of a lab-on-a-chip.

The development of a system for quantum imaging of biological samples and quantum sensing of traces of molecules in an environment is based on the quantum entanglement of photon pairs created in appropriate non-linear crystals through the spontaneous parametric down conversion. Measurements are realized by detecting one photon (signal photon) that hasn't even "seen" the sample, but whose phase and amplitude were changed in proportion to the changes that occurred with the other (idler photon), when passing through the sample. The special importance of this type of quantum microscope is that the two photons are in different wave regions, the mid- and near-infrared regions, so imaging in the mid-IR region is enabled by detecting photons in the near-IR region.

This innovative project, the improved skills, as well as the modern equipment that we acquire as part of the project, which is necessary to keep pace with the world's leading institutions in this field, are a prerequisite for the establishment of a new field of quantum biophotonics at the Institute of Physics.

Q: What is the biggest benefit of quantum biophotonics?

A: Quantum biophotonics has the potential to lead to significant discoveries and innovations in various fields, such as medicine, technology and environmental

protection through innovative research and progress. New research in the field of quantum biophotonics results in diagnostic and therapeutic instruments. For example, quantum biophotonics can be used in nanomedicine to develop new nanoscale devices and sensors that use light-matter interaction to monitor and manipulate biological processes.

Photonic biosensors in nanomedicine can revolutionize medical diagnostics and therapy by enabling rapid and accurate disease detection, monitoring of disease progression, and targeted delivery of drugs and treatments. Photonic biosensors can detect specific biomolecules such as individual proteins, DNA, and other cellular components, making them useful for on-site diagnostics and monitoring.

The special importance of the BioQantSense project is that it introduces research with results belong to quantum technologies, which are already advanced in Europe, into the Institute of Physics. The second quantum revolution is well underway in the EU countries, while in Serbia there is no awareness of the already important results of that revolution.

Q: How is the cooperation with researchers from Italy and Germany going?

A: In order to increase the scientific excellence as well as to strengthen the scientific and administrative /management skills of the Institute on the European scene of research and innovation, the following goals of cooperation were defined:

- Improving the project management and administration skills regarding to the Institute's projects financed primarily from EU sources, as well as greater competitiveness in the very process of applying and attracting grants;
- Identification of suitable quantum imaging experimental setups, designs and materials for Lab-on-a-chip;
- Training of the Institute's researchers for the implementation of the research project planned for the third project year.

Cooperation with partners, i.e. the transfer of scientific and administrative/management knowledge and skills, is realized through a large number of scientific and management visits, which we previously defined with

partners through a detailed plan of visits. Our partners are leaders in Europe in the field of quantum biophotonics, so we are very grateful for the scientific and operational knowledge they are sharing with us, and we hope that our Center for Quantum Biophotonics will be a partner of CNR-INO and FSU in some new research and commercial projects in the future.

Q: In what way will the work of the people involved in the project contribute to the improvement of science, HR potentials and institution itself?

A: The future Center for Quantum Biophotonics, with competent and trained researchers and modern equipment, will form a very attractive research infrastructure and will significantly contribute to the development of this branch of photonics in Serbia.

It will also open the door for the Institute of Physics to participate in many EU and international calls currently open only to institutions dealing with this extremely current and promising scientific branch. The Institute's increased participation in international projects will attract innovators and small and medium-sized enterprises, which will facilitate the commercialization or research results and, finally, provide new employment opportunities. With the successful implementation of the BioQantSense project, we will create an extremely competitive research infrastructure that, we hope, will contribute to attracting young staff from the country and the world to the Center for Quantum Biophotonics and the Institute of Physics.

The BioQantSense project gives us the opportunity to learn from more experienced partners about Grant Management, as well, and to apply the good practice and expertise of the developed departments of our partner institutions to us. During the management visits within the project, many ideas and models emerged for the improvement of our Department for International Cooperation and Projects, as well as opportunities for future project cooperation in terms of management support for innovation and research infrastructure. The skills of the people employed in the Department, which is being developed on the model of the Grant Offices of our partners, will contribute to greater visibility of EU funding opportunities, higher quality and more successful applications and easier implementation of received projects.

INTERVIEW

Giulia Adembri
Project Manager at CNR, Florence

We spoke with Giulia Adembri, project manager from the National Institute of Optics at CNR, and asked her to share with us their view on project's development.

Q: What is the role of CNR in BioQantSense project implementation?

A: The National Research Council (CNR) is the largest public research institution in Italy, the only one under the Research Ministry performing multidisciplinary activities.

CNR participates to BioQantSense activities through the National Institute of Optics in Florence with the aim of supporting the Photonics Center at the Institute of Physics Belgrade to increase scientific excellence in biophotonics and project management capacity.

The scientific training takes place in CNR-INO laboratories located at the European Laboratory for Non-Linear Spectroscopies (LENS) at "Sesto Fiorentino University Campus", while management training takes place at the offices of CNR-INO headquarters in Arcetri.

Q: Do you believe that a project like this can genuinely transform and enhance a research organization such as the Photonics Center at the Institute of Physics Belgrade?

A: I think that this project represents an excellent opportunity for the IPB Photonics Center to analyze its position in the European scientific panorama in relation to biophotonics and quantum biophotonics, comparing itself with two different European realities of scientific excellence, such as CNR-INO and FSU-JENA.

The intense program of transfer of scientific skills allows us to implement new methodologies for imaging and sensing to be integrated into the already available set-ups of the IPB Photonics Center and to set up new facilities for

completely new lines of research. The project also constitutes an opportunity to reflect on how to strengthen the organizational aspects of the IPB Photonics Center to increase the ability to attract and manage external funding, European in particular. The fact that the training program involved not only young and senior researchers but also the management and administrative staff of IPB will allow IPB-PC to achieve the transformation it has set itself, that is to extent the skills and capacity of the Photonics Center also to Quantum Biophotonics and to consolidate scientific advancement in new lines of research in the coming years.

Q: What do you think about the progress of the Institute of Physics Belgrade?

A: IPB is the recipient of important structural investments that will facilitate the scientific excellence and the capacity to attract funding. Moreover, the organizational structure has been retailored and strengthen to better support researchers in search funding and collaborating with national and international stakeholders. BioQantSense project has come at a favorable time for the advancement of IPB-PC.

Q: What can you tell us about working with colleagues from the Institute? What do you think about this cooperation?

A: I found a lot of willingness to collaborate on the part of the IPB staff with whom I interfaced, both with the research and administrative staff. In addition to the numerous online meetings, the physical interaction offered by the exchange visits was fundamental.

About my management exchange visit in Belgrade, I found an excellent welcome. I could explore working people in the institute and expose them CNR and CNR-INO practices in the whole life cycle project management. I believe that the exchange of management practices in the BioQantSense collaboration is particularly important for both institutes, CNR-INO and IPB: explaining the functioning of an organizational - managerial structure to people external to the organization is a very useful exercise to identify critical issues and improve processes.

Q: What is the greatest comparative strength of the IPB?

A: The fact of being the national reference center for

physics in Serbia and also the recipient of large investments at the national level, and at the same time having researchers who have an excellent international reputation, constitutes a strong competitive advantage of IPB to be an attractor of ever-increasing European funding.

Q: How do you see future collaboration with the Institute in terms of management and administration?

A: I believe that the experience of the exchange visits has laid the foundation for other possible future collaborations beyond that of BioQantSense. I would like to continue collaborating with IPB management staff also in other projects, for example aimed at valorizing research results, for innovation and technology transfer.

Dr. Christian Helgert

CEO & Scientific Manager
ABBE Center of Photonics, FSU, Jena

Q: You are the CEO and Scientific Manager at the Abbe Center of Photonics, with a background in optics and photonics, particularly in nanooptics and nanostructure technology. What are your impressions and experiences working with IPB-PC?

A: I have known IPB-PC for quite some time. My connection with them dates back to 2008, when I was a young PhD student. We collaborated as part of a European consortium that was researching nanostructured optical surfaces with extraordinary properties enabled by graphene. At that time, this was an innovative and highly relevant topic. I had the privilege of leading the Jena side of the consortium. Since then, various research groups from the Abbe Center of Photonics have been continuously involved in joint research and exchange programs with IPB-PC. Over the years, my colleagues and I have frequently visited IPB-PC, and vice versa, contributing

INTERVIEW

to numerous projects and co-authoring many joint publications. Our partnership with IPB-PC is both long-standing and highly productive, and our latest collaboration, the BioQantSense project, is an exciting new chapter in our scientific journey together.

Q: Where do you see the role of FSU and the Abbe Center of Photonics in implementing the BioQantSense project?

A: Throughout the project, I have had the opportunity to meet many dedicated PhD students from Belgrade. They are often the driving force behind research projects, as they are deeply involved in the hands-on lab work. IPB-PC, with its strong foundation and state-of-the-art equipment, particularly in nonlinear optics, is now stepping into new territory by building its own quantum microscopy setup. We are thrilled to be a partner in the BioQantSense project, contributing our expertise and insights gained from our research in this field. I am confident that with the commitment of IPB-PC and its outstanding PhD students, we will achieve our objectives and demonstrate quantum microscopy of biological samples for the first time in Serbia.

Q: In your opinion, what will be the main impact of the project on IPB-PC's organizational structure, management, and administrative capacities?

A: Having observed many scientific institutions and facilities across Europe and beyond, I believe that broadening one's perspective and being open to learning from different scientific cultures is invaluable. This is also true for the management and organizational aspects of both our institutions. The BioQantSense project offers an excellent opportunity for mutual learning. A significant

outcome of the project would be if IPB could establish and sustainably support a new Center for Quantum Biophotonics within its existing structures. This would position IPB as a competitive player in upcoming European calls for advanced research in quantum photonics and technology.

Q: Why is the establishment of a Center for Quantum Biophotonics important for IPB's competitive edge, and what opportunities will it unlock?

A: We are in the midst of the second quantum revolution, with new applications emerging rapidly, leveraging quantum phenomena like superposition and entanglement. Quantum computers are already handling basic tasks, and the economic potential in this area is immense, driving global competition among technology platforms. To keep pace, there is a need for dynamic progress, not only in scientific research but also within industrial sectors.

It's crucial for all stakeholders to recognize the significance of quantum technologies for their future. Establishing a Center for Quantum Biophotonics would enable IPB-PC to contribute significantly to this field on both national and European levels.

Q: What are your thoughts on the collaboration with the project team and colleagues from the Institute?

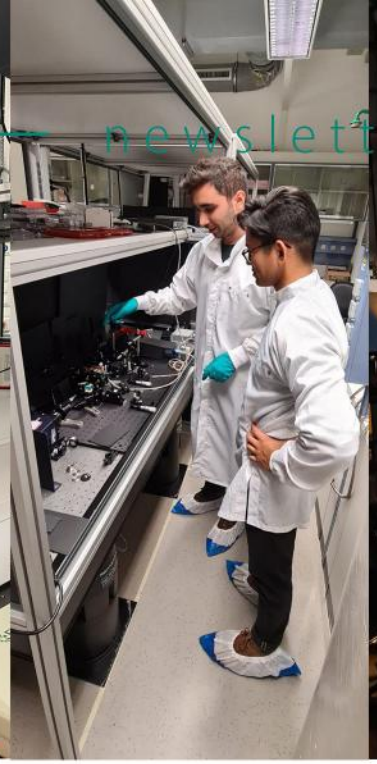
A: I thoroughly enjoy our collaboration! I particularly hope that the early-career scientists and PhD students involved can build lasting scientific and personal connections that will benefit them throughout their careers.

Q: Based on your experience and cooperation with IPB-PC, how do you envision future collaboration with the Institute in terms of EU project realization?

A: At the Abbe Center of Photonics in Jena, we are committed to advancing our research in quantum imaging, quantum sensing, quantum communication, and quantum computing. We are also developing new research infrastructures and have recently established a Master's program to train the next generation of scientists in these fields.

Our strong background in biophotonics and its applications makes us an ideal partner. If a Center for Quantum Biophotonics were to be established in Belgrade, it would be a perfect fit for future collaborations!

VISITS



According to the plan defined in project WP2 the visits from IPB to CNR and FSU include 20 visits and partner's visits to IPB include 8 visits. During the second year of the project duration, BioQantSense realized 8 visits.

VISIT TO Technical University of Darmstadt

Researchers from the Photonics Center, IPB were on a short-term visit to the Institute of Applied Physics, Technical University of Darmstadt from 27th of February to 29th of February. The goal of this scientific visit was to exchange knowledge in the fields of quantum optics and to discuss future collaboration.

VISIT FROM the Institute of Biophysics - Biological Research Centre, Szeged

Researchers from the Institute of Biophysics, Biological Research Centre, Szeged, Hungary, visited the IPB PC on 11th and 12th of July 2024 within the SASA - MTA collaboration established through the BioQantSense project activities. This two days visit was organized with the aim of networking and knowledge and ideas exchange regarding the field of Quantum Biophotonics, the main topic of the BioQantSense project. The guests from Hungary held seminars at IPB and visited PC and its laboratories.

GATHERING AND ACHIEVEMENTS

ONLINE MEETINGS - During the second year of the project, the partners held more than 20 online meetings where they discussed the experimental activities and the upcoming exchange visits between the partners. Work plans for the scientific stays were developed, potential problems during the experimental activities and solutions to them were also defined. Three online meetings of the Project Management Board were held to discuss activities, such as Project review report, deliverables, scientific visits, and dissemination of the project results. Plans/opportunities for IPB to submit one (or more) BioQantSense follow-up proposals (EU, international, domestic) were also discussed.

STUDENTS - Members of our BioQantSense team have achieved great success in their PhD studies.

Marija Ćurčić, successfully defended her PhD thesis in December 2023, at the School of Electrical Engineering, University of Belgrade.

Filip Krajinić, successfully defended his project related PhD preparatory paper in June 2024, at the School of Electrical Engineering, University of Belgrade.

Tanja Pajić, successfully defended her PhD thesis in September 2024, at the University of Belgrade.

On behalf of the BioQantSense team, we congratulate them on this occasion.

CONFERENCES - BioQantSense Partners participated in the 17th Photonics Workshop, organized by the Institute of Physics Belgrade. The 17th Photonics Workshop was held between 10 - 14 March 2024 at Kopaonik, Serbia.

Team member, Dr. Danica Pavlović participated as an Invited Speaker at the ABS2024 - 10th International Conference on Agricultural and Biological Sciences, held from 29.7. - 1.8. 2024 in Gyor, Hungary. Her talk, under the title "The new age sensorics - biological and bioinspired structures", has received the Award for the best oral presentation at this scientific event.

Dr. Branislav Jelenković, BioQantSense Project Coordinator, participated at the 24th International Conference on Transparent Optical Networks (ICTON 2024), held in Bari, Italy from 14 – 18 July 2024, where he gave an invited talk titled „Quantum imaging with undetected photons“.

WORKSHOP - The second BioQantSense workshop was held on March 11th, 2024, as a joint event of the Photonics Workshop. It was attended by 40 participants from 22 organizations in 7 countries. This workshop was a great opportunity to present projects' progress so far, delve into common challenges and opportunities faced, foster strong collaborations and consider future steps.

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