



Hidden Phases in 2D Quantum Materials

First Reporting Period Highlights

HIP-2D-QM Project Facts

Project title: Hidden phases in 2D quantum materials

Acronym: HIP-2D-QM

Project Coordinator: Center for Solid State Physics and New Materials,
Institute of Physics Belgrade

Program: Horizon Europe

Call: HORIZON-WIDERA-2023-TALENTS-01-01

Type of action: CSA (Coordination and support action)

Grant agreement ID: 101185375

Start date: 1 November 2024

End date: 1 November 2029

Overall budget/EU contribution: € 2.499.855,50

HIP-2D-QM Project Mission and Vision



Mission: Reinforcing institutional expertise by adding complementary thrusts and excelling in two-dimensional quantum materials research via understanding and utilization of hidden phases



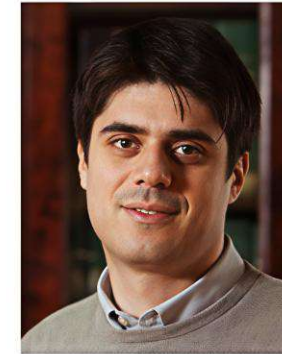
Vision: Opening a path for IPB to becoming a distinguished leader in 2D-QM research in Serbia, and in Southeast Europe, projecting employment & collaboration attractiveness by excellence

Project Launch

The ERA Chair holder, Prof. Dr. Emil S. Božin, took up his position at IPB. The project kick-off meeting was held on 11 February 2025 in hybrid format, bringing together all participants around the project objectives, roadmap, and governance structure.

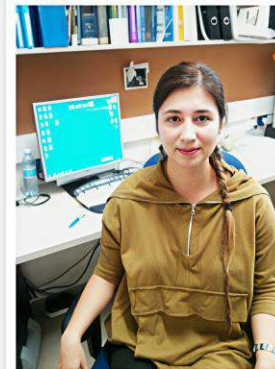


IPB Project Team



[Dr Nenad Lazarević](#)

HIP-2D-QM Project Coordinator



[Dr Bojana Višić](#)

HIP-2D-QM Data Manager



[Dr Jelena Pešić](#)

HIP-2D-QM Diversity and Gender
Manager



[Dr Zorica Konstantinović](#)

HIP-2D-QM Training Manager

ERA Chair Team Formation

The first reporting period focused on building the HIP-2D-QM team, with recruitment activities underway and new members gradually joining the project.



ERA Chair Holder
Dr Emil Božin

ERA Chair Research Team



Postdoctoral Researcher
Dr Borislav Petrović



Postdoctoral Researcher
Recruitment ongoing



PhD Student Researcher
Teodora Milenković



PhD Student Researcher
Recruitment ongoing

Administration Team



Project Manager
MSc Željka Dukić



Liaison Officer
LL.M. Nina Novaković



IPR and Risk Manager
MSc Katarina Katić

Structural Characterization Unit established

Capacity Building Fellows

Local early-career researchers
designated as training
beneficiaries



Dr Ana Milosavljević



Dr Jasmina Lazarević



Dr Andrijana Šolajić



Jovan Blagojević
Research Assistant



MSc Tea Belojica
Research Assistant



Ana Kanjevac PhD
Student



Lenka Filipović PhD



Barbara Bekić PhD

Strategy for sustainable development of CSSPNM-IPB - draft Research and Capacity Enhancement Strategy (RCES) prepared

Acquiring know-how and utilizing large-scale research infrastructure research modality:

Infrastructure Access



Technical visit to Anton Paar (Graz) for PDF-capable X-ray diffractometer assessment (2 attendees)



EuXFEL facility visits in Hamburg (2024 and 2025)



Training



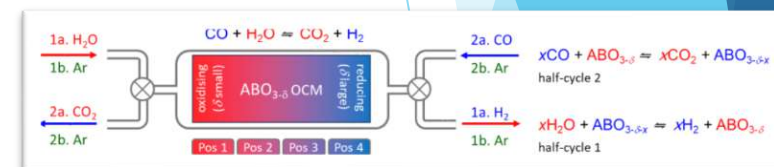
Early-career researchers trained via scattering schools in Stuttgart (2 PhDs and 2 ESRs) and Tallinn (1 ESR)



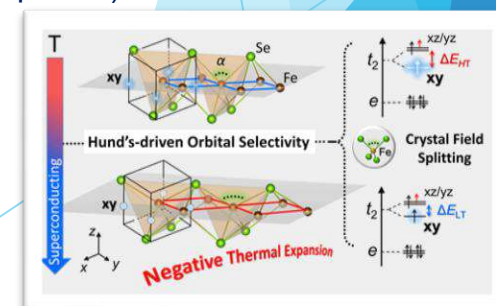
LSRF workshop at *Advances in Solid State Physics and New Materials* conference (11 invited speakers from 6 LSRF, over 50 participants)



Networking



Additional high-impact activities enhanced visibility and capabilities (hosted sabbatical of Prof. John S. O. Evans, invited ADD 2026 lecture, Raman-PDF studies and MAX IV proposals)



ERA Chair joined „ultrafast PDF“ consortium and participated in XFEL-based experiments (resulted in open-access publication)

A New Structural Characterization Laboratory

A Landmark Infrastructure Investment

On 12 December 2025, CSSPNM-IPB inaugurated its new Structural Characterization (SC) Laboratory, the first in-house advanced structural characterization facility in the history of the Centre, built around a €350,000 PDF-capable X-ray diffractometer with full temperature control.

Capabilities

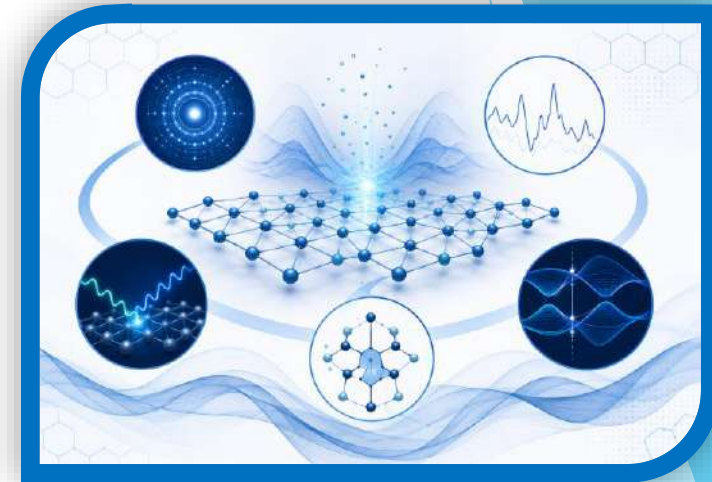
- Conventional powder X-ray diffraction (XRD)
- Total scattering and Pair Distribution Function (PDF) analysis
- Temperature-dependent measurements (low to elevated)
- A future regional training hub in total scattering and PDF methods



Research Excellence and Strategic Partnerships

Research Focus

The scientific programme targets hidden structural and electronic phases in 2D quantum materials, with an initial focus on kagome metals and charge-density-wave instabilities, combining total scattering, PDF, Raman spectroscopy, and theory.



Strategic Partnerships and Funding



Capacity Building and Training

Building Skills

- 3 Horizon Europe workshops (Open Calls, Twinning, Financial aspects)
- ORNL proposal-writing workshop for 7 early-career researchers



Equality, Inclusion and Innovation

- Panel „Focus on: Women’s Challenges in Science“ (36 participants) and online Gender Strategy Training (17 participants)
- First research-to-innovation internship completed with spin-off company Nanotul (Slovenia)



Dissemination and the Flagship Conference

Advances in Solid State Physics and New Materials

Hosted by IPB and SANU (19–23 May 2025) to mark the 30th anniversary of CSSPNM. The conference was chaired by Dr. Nenad Lazarević, Prof. Dr. Emil S. Božin, and Dr. Rudi Hackl.

ADVANCES 2025 BY THE NUMBERS

 **120+ SPEAKERS**

 From **25 COUNTRIES**

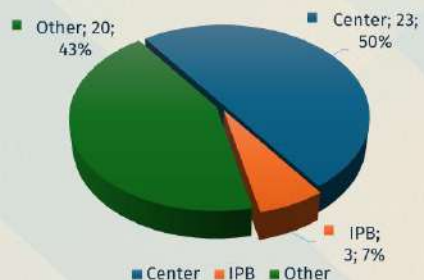
 and **76 INSTITUTIONS**

 **40+ POSTERS**

 **300+ PARTICIPANTS**

 **5 WORKSHOPS**

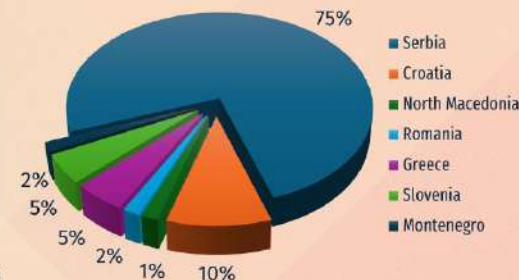
Serbian institutions



Speakers by continent

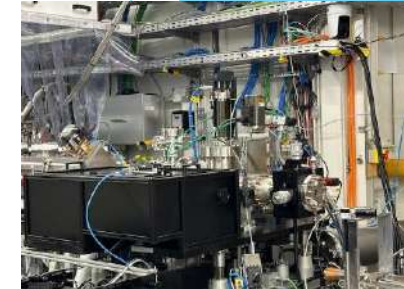
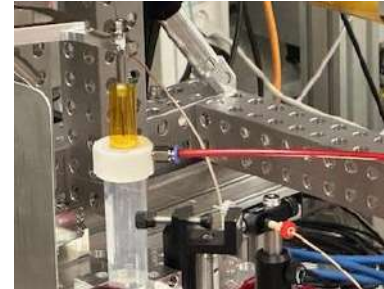


Southeastern Europe



Catching Atoms in Motion

A core ambition of HIP-2D-QM is to reveal „hidden phases“ — fleeting structural and electronic states that ordinary measurements miss. To capture them, the ERA Chair team uses one of the world's most powerful X-ray sources, the European XFEL in Hamburg, which can film atomic motion on timescales of less than a trillionth of a second.



Selected Research Highlights

- Establishing ultra-fast total scattering / PDF techniques at the European XFEL for time-resolved studies of (dis)ordering
- Tracking atomic motion during ion hopping in sodium superionic conductors — relevant to next-generation batteries
- Charge ordering and lattice distortions in the quantum material 1T-TaS₂
- Hidden local symmetry breaking as a route to ultralow thermal conductivity



Scientific Publications

Four peer-reviewed articles were published by CSSPNM-IPB researchers in leading international journals.

High-quality ultra-fast total scattering and pair distribution function data using an X-ray free-electron laser

Sapnik, A. F., ..., Bozin, E. S., ... & Keen, D. A. — *IUCrJ*, 12, 531–547 (2025) | DOI: 10.1107/S205225252500538X

Orbital-Selective Instabilities and Spin Fluctuations at the Verge of Superconductivity in Interlayer-Expanded Iron Selenide

Lappas, A., Kaitatzi, M., Deltsidis, A., ... & Bozin, E. S. — *Chemistry of Materials*, 37, 8581–8594 (2025) | DOI: 10.1021/acs.chemmater.5c01488

Imaging junctions in two-dimensional semiconductor nanosheet networks

Pešić, J., Leitner, S., Neilson, J., Stanković, I., ... & Matković, A. — *npj 2D Materials and Applications*, 9, 90 (2025) | DOI: 10.1038/s41699-025-00609-6

2D materials: advances in regenerative medicine and human health sensing

Lazarević, J. & Višić, B. — *2D Materials*, 12, 042001 (2025) | DOI: 10.1088/2053-1583/adf5d4

In the Media

Most major Serbian media outlets reported on the launch of the HIP-2D-QM ERA Chair project and its significance for research on 2D quantum materials in Serbia.

A dedicated media event introduced ERA Chair holder Dr. Emil Božin to the public.

The opening of the laboratory was also widely covered across Serbian media (Politika, N1, Svet nauke, eKapija and others), highlighting the €350,000 instrument and capabilities not previously available in the region.



Interviews, Lectures and Outreach

- “What Do Two-Dimensional Materials Hide?” — interview with Dr. Jelena Pešić
- Dr. Emil Božin on the Regional Training Center for Advanced Structural Analysis
- CSSPNM researchers featured in the IPB lecture series “A Look into Physics”
- Policy dialogue with the Serbian Government, Global Research Council and Science Fund of Serbia

Connect with HIP-2D-QM

We welcome collaboration proposals, joint experiment inquiries, and interest in training access from researchers, institutions, and industry partners.

CSSPNM, Institute of Physics Belgrade, Serbia

Funded by the European Union, Horizon Europe ERA Chairs, GA No. 101185375



Seminar Programme and Scientific Exchange

A Vibrant Seminar and Workshop Programme

Throughout the reporting period, CSSPNM-IPB hosted a rich programme of scientific seminars and hands-on workshops, bringing international and national experts to Belgrade and creating regular opportunities for knowledge exchange across the research community.

Hands-on Methodological Workshops

- Visualization and Analysis of Crystal Structures
- Integrating Simulations and Experiments for Advanced Applications
- Bridging Theory and Experiment
- Research Opportunities at Large-Scale User Facilities



Selected Scientific Seminars

- Altermagnets — Dr. Srđan Stavić
- Van der Waals Nanotubes — Dr. Bojana Višić
- Atomic Layer Deposition — Dr. Ivna Kavre Piltaver
- Raman Spectroscopy & Spin-Phonon Coupling — Dr. Bojan Stojadinović
- Symmetry-Based Dispersions in 2D Materials — Dr. Vladimir Damjanović
- Embedded Dynamical Mean Field Theory — Dr. G. L. Pascut
- Structural Heterogeneity in Lead Halide Perovskites — Dr. Milos Dubajic



Industry Engagement

Technical meetings with Anton Paar representatives on Raman spectroscopy instrumentation, strengthening ties between research and industry.



Public Engagement and Recognition

Bringing Physics to the Public

- Public lecture „The 2D Materials Revolution: Potential of Semiconductor Nanonetworks“ by Dr. Jelena Pešić
- Public lecture „The Iron Age of Superconductivity – the Case of Fe(Se:S)“ by Dr. Nenad Lazarević
- Project presentation to students at the Mathematical Grammar School in Belgrade
- Lecture Series on Solid State Physics and New Materials officially launched



Recognition of Excellence

On 16 May 2025, Dr. Jelena Pešić received the Institute of Physics Belgrade Annual Prize for her contributions to understanding how defects and structural modifications shape the electronic and magnetic properties of low-dimensional and topological materials.



The Instrument Up Close

How the New Diffractometer Works

The heart of the new laboratory is a state-of-the-art X-ray diffractometer. It directs X-rays at a sample which can be a powder or thin film, and the beam scatters from the crystalline structure at characteristic angles. A detector records this scattered radiation to produce a diffraction pattern, revealing structural features that were previously „invisible“ with earlier equipment.

Key Capabilities

- Two types of X-ray sources for versatile measurements
- Wide temperature range from $-190\text{ }^{\circ}\text{C}$ to $+600\text{ }^{\circ}\text{C}$
- Advanced temperature-dependent and in-situ structural studies



Watch the [Training Center Presentation](#) on IPB YouTube channel.

Impact and Legacy

A Structural Leap for Serbian Science

Before HIP-2D-QM, the Centre had no in-house advanced structural characterization capability and no systematic access to large-scale research facilities. In just over a year, the project has transformed CSSPNM-IPB from a spectroscopy-centred group into a multiprobe research platform for 2D quantum materials.

Reversing the Brain Drain

Through open, international recruitment, the project has attracted researchers from the diaspora, thus creating attractive high-level career opportunities at home and helping reverse talent outflow.

Benefiting the Wider Region

The new laboratory is designed to serve as a regional training hub in total scattering and PDF methods, sharing best practices in research management and facility access with other institutions across Serbia and Southeast Europe and strengthening Serbia's integration into the European Research Area.

Lasting Institutional Change

- Formal governance, quality-assurance and risk-management systems established
- New rulebooks adopted on researcher mobility and professional development in project management
- IP framework and academia–industry links created, aligned with national Smart Specialization priorities

First Reporting Period in Numbers

1st

advanced structural
lab at the Centre

4

peer-reviewed
publications

133

talks at our
flagship conference

9.7/10

team satisfaction
score

Discover more about HIP-2D-QM



Visit our website to explore the latest news, research highlights and project activities.