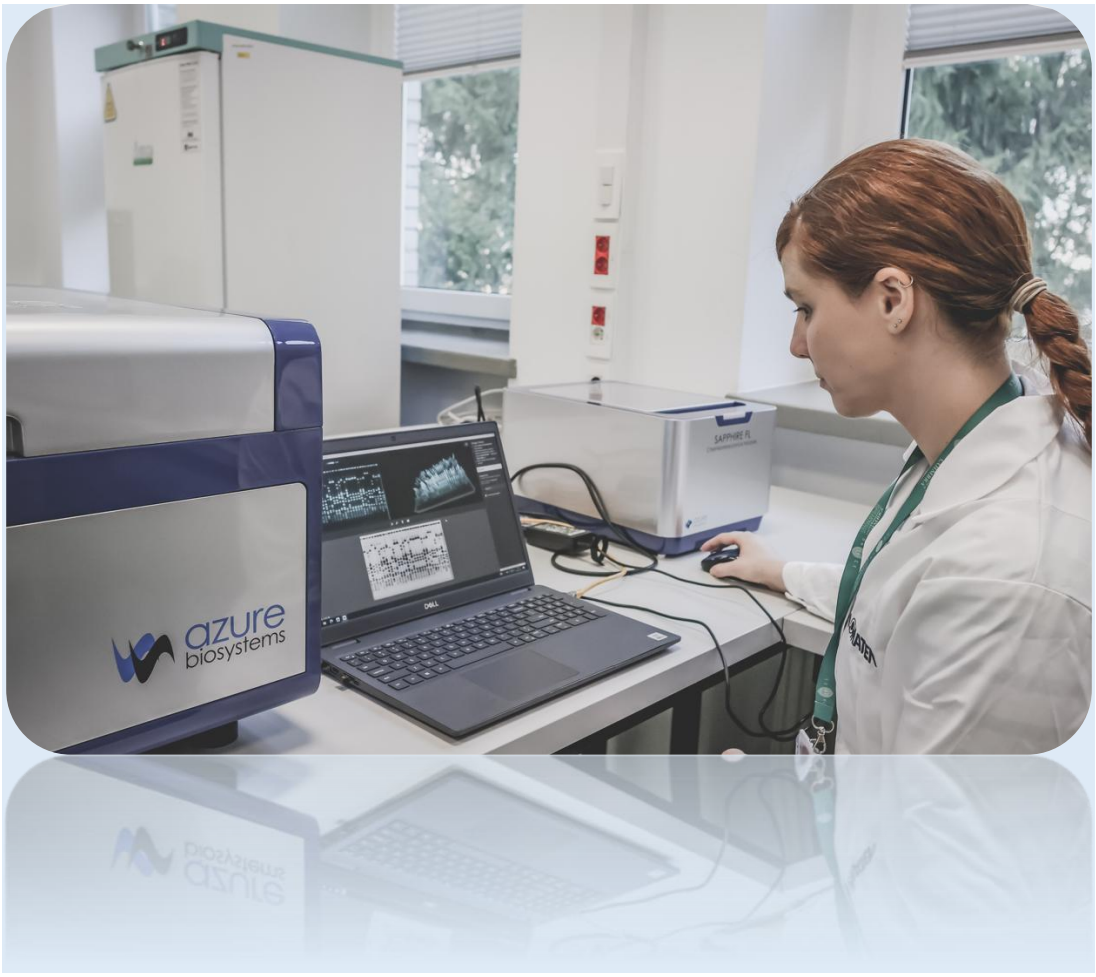
NOMATEN

Centre of Excellence in Multifunctional Materials
for Industrial and Medical Applications

ANNUAL REPORT 2025



European Funds
Republic of Poland
FNP Foundation for Polish Science

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470

NOMATEN Centre of Excellence Partners

The National Centre for Nuclear Research, Poland

The Atomic Energy and Alternative Energy Commission, France

VTT Technical Research Centre, Finland

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CoE NOMATEN Director's Foreword

…At NOMATEN, 2025 marks a defining moment of consolidation, maturity, and strategic growth. Over the past years, we have focused on building strong scientific foundations; today, we are entering a phase in which these foundations translate into stability, expanded capabilities, and long-term sustainability…

The operational continuity of the NOMATEN Centre of Excellence is secured through a diversified funding structure, including the ongoing Teaming project and national complementary financing, a growing portfolio of 24 active research grants, KPO investment support, institutional backing from NCBJ, and increasing income from commercial contracts. This balanced model not only ensures stability until 2027 but also strengthens our independence and resilience beyond that horizon.

At the same time, we are actively shaping the future. Ambitious proposals submitted to international and European programs including CONNECT-NM Partnership, MSCA Doctoral Networks, ERC-type grants, Excellence Hub initiatives, demonstrate our commitment to operating at the forefront of European research. Our engagement in Eurofusion activities and the development of new consortia further underline NOMATEN's growing recognition as a reliable and competitive partner in advanced materials science and radiopharmaceutical research. In 2025, NOMATEN, together with the remaining six Teaming groups in Poland, launched also Polish Teaming Club, an expert group which advises the Ministry of Science and Higher Education on strategic financing in the years after the EU contribution.

Scientifically, 2025 confirms the strength of our interdisciplinary model. The close integration of experimental research, advanced numerical simulations, materials informatics, and radiopharmaceutical development has become a defining feature of NOMATEN. The consolidation of state-of-the-art laboratories including modern materials characterization facilities, sintering technologies, additive manufacturing systems, high-performance computing infrastructure, and newly launched radioisotope laboratories creates a complete technological ecosystem. This ecosystem enables us to model, design, synthesize, and test materials within one coherent research environment. Particular emphasis remains on bridging atomic-scale simulations with macroscopic material performance, shortening the pathway from concept to application. Our work on High Entropy Alloys, ODS steels, complex metallic glasses, irradiation effects, and advanced diagnostic and therapeutic radiopharmaceutical systems reflects both scientific ambition and alignment with strategic priorities such as the Polish Nuclear Energy Program.

Equally important is our investment in people. The growing number of PhD defenses, continued mentoring of young researchers, and structured support for high-impact publications and individual grant acquisition demonstrate that NOMATEN is not only building infrastructure, but also shaping the next generation of scientific leaders. Looking ahead, our objective is clear: to strengthen NOMATEN's position as a European leader in advanced materials research and radiopharmaceutical science, capable of delivering both scientific excellence and tangible societal impact. By combining long-term vision, strong partnerships, and a holistic research approach, we continue to transform scientific potential into real-world solutions.

Łukasz Kurpaska – NOMATEN CoE Director

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Introduction

NOMATEN CoE status

The NOMATEN Centre of Excellence (CoE) has been established at the National Centre for Nuclear Research in Poland as a new research organization, where international world-class research teams design, develop, and assess innovative, multifunctional materials that combine advanced structural and functional properties for industrial and medical applications.

NOMATEN develops partnerships with industry and research organizations to perform and deploy go-to-market solutions in the field of innovative materials and radiopharmaceuticals. NOMATEN's scientists are supported by a team of experts with extensive experience in marketing, communication, human resources, and international cooperation.

At NOMATEN, our world-class scientists perform their activities in 5 dedicated research groups, divided into two pillars (Materials science, Radiopharmaceuticals science):

- FUNCTIONAL PROPERTIES, leader: Prof. Łukasz Kurpaska
- MATERIALS DESIGN AND MANUFACTURING, leader: Dr. Silvia Bonfanti
- MULTISCALE HYBRID MODELLING OF MATERIALS, leader: Prof. Javier Dominguez
- MATERIALS CHARACTERIZATION, leader: Prof. Iwona Jóźwik
- NOVEL RADIOPHARMACEUTICALS FOR MEDICAL PURPOSES, leader: Prof. Marek Pruszyński

The groups focus on developing critical materials for high-temperature applications, investigating the mechanical properties and resistance to chemical environments and radiation, as well as their combined multi-physics effects. Additionally, they develop state-of-the-art radiopharmaceuticals for medical diagnoses and treatments, and collaborate with numerous international research institutions.

In 2024, the Teaming project supporting the organization and operation of CoE NOMATEN was amended to extend its implementation period. The need for extension resulted from delays in implementation related to the COVID-19 pandemic, as well as from the late release of the last tranche of funds from national complementary funds, which were finally awarded in December 2023 and received by NOMATEN CoE in early 2024. The amendment did not increase the costs of the Teaming project. The current projected end date of the project is thus October 31st, 2027. The amendment is also connected to the newly received strategic project, entitled NOMATEN CoRE. It is a multimillion-euro infrastructure investment that will strengthen all groups of the CoE. Its termination is planned in June 2026. Upon completion, newly set-up laboratories equipped with state-of-the-art apparatus will strengthen all the CoE groups.

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Project Partners

The National Centre for Nuclear Research (NCBJ, Narodowe Centrum Badań Jądrowych) fundamental/applied research profile combines nuclear power-related studies with various fields of sub-atomic physics (elementary particle physics, nuclear physics, hot plasma physics, etc.). The Centre is intensely involved in developing nuclear technologies and promoting practical applications of nuclear physics methods. Major market products manufactured at the Centre include radiopharmaceuticals and a range of particle accelerators for scientific research, various industrial sectors, and medical applications. The Centre is an IT and R&D infrastructure indispensable for providing expert support to decision-makers in the project to develop Poland's nuclear power industry in the coming years. The National Centre for Nuclear Research is the largest research Institute in Poland. We are also the only Polish research institution operating a nuclear research reactor (the MARIA reactor). We are currently hiring over 1,100 employees. Our research staff comprises approximately 70 Professors and holders of the title Dr. hab. post-doctoral degree, as well as over 150 PhDs.

The Atomic Energy and Alternative Energy Commission (CEA, Commissariat à l'Énergie Atomique et aux Énergies Alternatives) is a public establishment devoted to scientific, technical, and industrial research and development, under the authority of the Ministries of Energy, Research, Industry, and Defense. The CEA is today a major player in research, development, and innovation in four key areas: defense and security, low-carbon energies (including nuclear and renewable), technological research for industry, and fundamental research (in the sciences and life sciences). CEA conducts a part of its research in the framework of the French nuclear deterrent programme. It also provides technology to strengthen security in the face of new hazards, such as terrorism and cyberattacks, and to enhance response to earthquakes and tsunamis. As a key player in energy research, the CEA leverages its expertise and multidisciplinary competencies to propose innovative technological solutions that address major societal challenges, including the energy transition, nuclear and renewable energy, and understanding the mechanisms of climate change. The CEA follows a research strategy encompassing the whole energy system, focusing simultaneously on means of electrical power production, both nuclear and renewable (solar), improving energy efficiency, and dynamic adjustment of supply and demand through energy storage (batteries), the use of hydrogen as an energy vector, or smart power grids. Besides challenges associated with energy and climate change, the CEA also mobilizes its expertise and multidisciplinary competencies to biotechnologies and biomedical innovations. Challenges linked to personalized medicine and technologies for the medicine of the future are priorities, and dedicated research is conducted in the field of *in vivo* molecular imaging probes, diagnostic tools, and molecules for therapeutic or theranostic uses. Methodologies devoted to radioisotopic labeling remain a specialty of the CEA, both serving drug development and radiopharmaceutical development.

VTT Technical Research Centre of Finland Ltd is one of the leading research institutions in Europe. With over 2,200 employees, VTT advances the utilization and commercialization of research and technology in commerce and society, providing expert services to domestic and international customers and partners across both private and public sectors. The turnover of the VTT Group is approximately EUR 260 million per year. VTT's mission is to help customers and society grow and renew through applied research. With over 80 years of experience supporting clients' growth through top-level research and science-based results, VTT develops new smart technologies, profitable solutions, and innovative services. Through scientific and technological means, VTT transforms large global challenges into sustainable growth for businesses and society, bringing together people, businesses, science, and

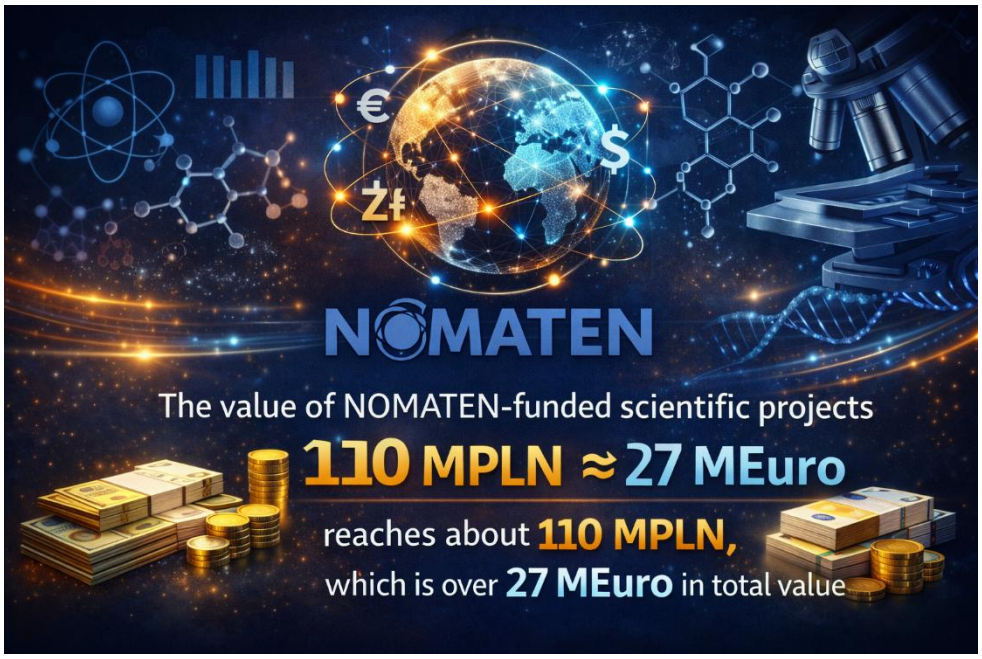
technology to address the biggest challenges of our time. VTT represents a multidisciplinary technological know-how and has strong expertise in materials research and nuclear energy research to support the energy transition and pathway towards a sustainable economy.

Funding

The NOMATEN CoE has received funding from the European Regional Development Fund via Foundation for Polish Science International Research Agenda PLUS program grant No. MAB PLUS/2018/8 (so-called matching fund, which lasted for the first 5 years of the project) and from the European Union Horizon 2020 research and innovation program under grant agreement No. 857470. Currently, the second part of the matching fund is provided directly by the Ministry of Science and Higher Education in the frame of the agreement No. MEiN/2023/DiR/3795 entitled “Wsparcie Działalności Centrów Doskonałości utworzonych w ramach program Horyzont 2020”.

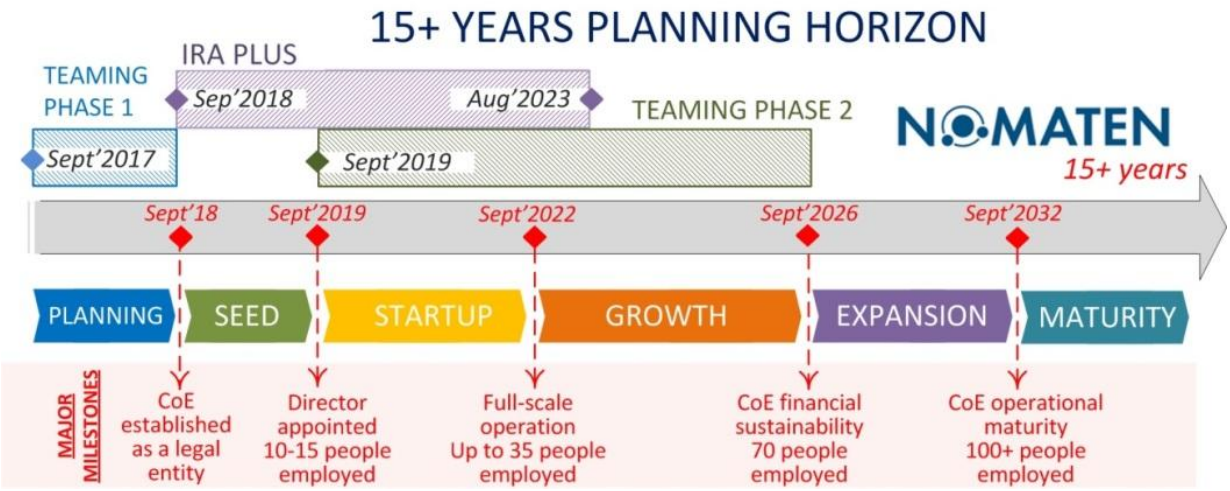
Additionally, NOMATEN activities are funded by numerous external projects acquired individually by the members of the Research Groups and Research Group Leaders. A list of the active and terminated projects, financed via external resources, is provided in the table below. Finally, from the broader perspective, the CoE is actively collaborating with multiple European research organizations via the CONNECT-NM initiative and Eurofusion. Regarding local sources, recently, a strategic project entitled GOSPOSTRATEG-HTR, financed by the National Centre for Research and Development, has been terminated, and currently the CoE activities are aligned with the Nucleostrateg financing (announced by the Ministry of Science 15y research and capacity building program aiming to generate a new cohort of nuclear engineers and experts in Poland – details of the call shall be announced at the end of 2025).

The total value of these grants is about 110 MPLN, hence the total value exceeds 27 MEuro



Organizational activities

Currently, NOMATEN CoE is still in its GROWTH phase (the initial planning horizon for the CoE is shown in the figure below), however, given significant investments into infrastructure and plans related to the participation of the CoE in the Connect NM initiative, as well as the possibility to play an essential role in the Polish Nuclear Energy Program (via e.g, Nucleostrateg program) the group will has a real chance for expansion, as visible be external projects which currently cover operation costs of several PhD students and post-docs.



This stage of development means both further development of the technical resources (which is being done in the frame of NOMATEN CoRE or SPUB projects) and competence of the Centre, but also the need for transformation from financing based on the Teaming project funds and supporting national programs to financing based on competitive funding (which is being done in the frame of the projects financed via NCBiR, NCN and FNP). The obvious goal of this stage is for the Center Centre to achieve financial self-sufficiency to ensure its operation after the completion of the Teaming project. Already, several grants, which employ approximately 10 scientists, will terminate in 2028. Therefore, after the project's completion, this will ensure the continuation of the groups' activities (group of Kurpaska and Bonfanti). It is expected that in the next 2-year period, each RG will acquire its independent financing for at least some key independent research scientists. Finally, both Teaming Project Leader, prof. J. Jagielski and Director of the Nomaten Center of Excellence, Prof. L. Kurpaska, together with other "Teamings" in Poland, are actively addressing the sustainability issue to the Ministry of Science and Higher Education and NCBiR. Several meetings at the NCBiR headquarters have already been organized where performance, quality, and future research direction were presented by each Centre of Excellence Director.

In the middle of 2025, two RGLs resigned from their work and terminated their contracts (Prof. Alava, as of the end of June 2025, and Prof. Papanikolaou, as of the end of May 2025). To maintain the original structure of the CoE, a selection process for two RGL positions has been organized. The whole process was organized in close cooperation with the ISC (International Scientific Committee). As a result of that, at the meeting organized on June 13th, the ISC approved Dr. Bonfanti for an RGL position with the responsibility of taking care of the group after Prof. Alava, while Prof.

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Dominguez was approved as an interim-RGL with the commitment to continue the tasks and activities of the group after Prof. Papanikolaou. The ISC will evaluate both persons in 2-year period. It is worth noting that the nomination of Dr. Bonfanti to the RGL position was also related to her projects, funded by NCN (Sonata Bis) and FNP (First Team), with a combined budget of approximately 1.5 million euros, spanning the period from 2024/2025 to 2028/2029. This was one of the conditions of these competitions, as the goal of these projects is to launch and finance a research group. Regarding Prof. Dominguez, the ISC proposed conducting an internal evaluation of the candidate by the CoE Director after a one-year period and passing the evaluation result to the ISC. This activity will be carried out in the 6th RP.

In early 2025, a detailed analysis of the situation in the CoE was conducted by the new directorate, which identified the need for certain organizational changes aimed at further enhancing the effectiveness of securing financial resources in the form of research grants and funds from industrial contracts. One of the main conclusions from this analysis was the need to link scientists' salaries to the research grants they receive, with the basic idea that those individuals who acquire additional grants receive a bit better remuneration than those who are less active. As of now, the CoE submitted over 20 project applications, 11 European submissions (within the framework of the CONNECT-NM initiative – all projects are currently under evaluation), and multiple applications to NCN, NCBiR or Eurofusion calls.

Next years plans

The basic operational costs of the NOMATEN CoE in the near future will be covered from the following sources:

1. Teaming project till October 31st, 2027;
2. NOMATEN MN, ministerial project, being the remaining tranche of national complementary financing also ending in October 31st, 2027;
3. Research grants received by NOMATEN scientists, currently 24 active grants;
4. KPO (National Recovery Plan, Krajowy Plan Odbudowy, KPO) investment grant (partially covering also personal costs – mentioned in the Tab. 1.1);
5. Financial support from the parent institution – NCBJ;
6. Incomes from commercial contracts.

The main projects currently underway, listed above, will be supplemented by standard research grants obtained through national, European, and international competitions. The most important projects planned for submission in 2025/2026 include:

1. Projects submitted to the second round of the CONNECT-NM Partnership. It is expected that in each financing round the Partnership will finance around 15-18 projects, each worth about 1 MEUR. In the frame of the first round of the proposal submission, the CoE team submitted (in collaboration or as Project Leader) 11 proposals. Broadly speaking the proposals were related to several topics, among many one could name: (i) the influence of stress on the type and concentration of radiation defects in materials, (ii) comparison of defect structure in materials irradiated with ions and neutrons from MARIA reactor, (iii) miniaturization of samples for mechanical properties testing, (iv) modeling and development of destructive and non-destructive testing methods in nuclear technologies and (v) studies of new alloys like ODS or HEA, or combination of both.

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2. MSCA Doctoral Network. European project aiming at the establishment of a joint system for financing Ph.D. theses. The proposed scope refers to radiopharmaceutical studies.
3. We also plan to participate in nationwide, large-scale projects such as the Nucleostrateg initiative (at the National Center for Research and Development, NCBR). Discussions on such a project are currently underway in Poland, the expected total value of the projects equal to 500 MPLN – duration of the program 10 to 15 years (it is expected that details of the program will be announced by the Ministry of Science in 4th quarter of 2025, one of the mandatory conditions will be to establish a strong collaboration with industrial partners with which NOMATEN build significant competences).
4. Based on the discussions held recently during meetings in Brussels, we also decided to build a consortium whose goal would be to prepare a proposal for the Excellence Hub competition. Such a project could be a logical continuation of the Teaming project.
5. From local sources of financing, dedicated to individual scientists, the CoE will be targeting NCN (especially Sonata Bis, Sonatina, Sonata, and Preludium calls), NCBiR (bilateral projects like POL-SWISS or POL-South Korea and Nucleostrateg), and FNP (First Team and TEAM Net calls).
6. It is expected that further attempts to acquire one of the ERC-type grants will be continued (mainly by more senior staff of the CoE).
7. Eurofusion, with its planned program for the years 2026-2027. The Nomaten CoE together with the Materials Research Laboratory, submitted an application for standard operation under the umbrella of WPMAT.

Scientific developments in 2025

Research Agenda

The CoE during the reporting period, as initially planned, had two modeling groups (a group led by Dr. Bonfanti also focuses on materials manufacturing via 3D printing) and two experimental materials science groups working on material synthesis, mechanical properties, and the characterization of materials. Additionally, the radiopharmaceutical group completes the research component of the CoE. To achieve the basic assumption of the NOMATEN project, all research groups must cooperate closely, particularly between the experimental groups and those dealing with structural simulations of materials. A significant effort during 2025 was to improve these links and achieve a holistic approach to the problem of designing, synthesizing, and testing materials. One of the visible effects of these efforts is the experimental validation of material deformation models during nanoindentation or small-scale tensile/compression experiments. Another example of good cooperation across the groups is combining in-situ heating tests in TEM and DFT and MD simulations with an end goal of explaining the growth of He-bubbles created as a result of irradiation. Finally, one should mention the first attempt of a true collaboration between the simulation team led by Prof. Dominguez and the radiopharmaceutical group led by Prof. Pruszyński. In conclusion, combining simulation with experiment will continue to be an essential task in shaping the activities of the NOMATEN CoE in the future and will be advised at every operation level of the CoE.

In 2025, the NOMATEN CoE continued to work on consolidating its research equipment – mainly acquired via the Nomaten CoRE project. These include the creation of a modern materials science laboratory equipped with several high-end apparatus, such as a tribotester, AFM, SEM, FT-IR or systems devoted to materials sintering (SPS and 3D printer – to be installed in the 6th RP). The main achievement here is simply the creation of a complete "technological line" allowing for novel alloys

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manufacturing and testing. The upgrade of capabilities also involves capacity building in the numerical pillar of the CoE – a high-performance cluster is to be installed in the 6th RP. These possibilities are gathered in a single research centre, which eliminates the need for outsourcing and provides a unique and comprehensive foundation for researching new materials. Achieving this state was the primary assumption of the Centre's initial stages of development, and the beneficial effects of its achievement can be seen, for example, in the rapidly growing number of research grants implemented in the NOMATEN CoE.

The next significant milestone achieved in 2025 is both the completion of modernization works in the laboratories of the radiopharmaceutical group (including obtaining agreement from the PAA (Polish Atomic Agency) to utilize class 2 laboratories) and the completion of small research equipment (it is expected that additional purchases will be done in 2026 upon estimation of the available budget). Finally, one cannot forget about the medium infrastructure: PET-SPECT-CT scanner, which was installed at the Polatom facility and will create a possibility to increase active collaboration between the radiopharmaceutical RG of NOMATEN and Polatom. In conclusion, the implementation of the NOMATEN CoRE project and integration of the newly installed equipment at the CoE allows for the commencement of experimental works in NOMATEN CoE's own radiopharmaceutical laboratories, which provides for independent implementation of research works, doctorates, and projects financed within the framework of scientific grants.

During 2025, we continued to develop research activities in complex metal glasses, High Entropy Alloys, oxide-dispersed-strengthened (ODS) steels, and newly discovered HEA-ODS alloys. Computer simulation methods were employed to determine the composition of these materials, and machine learning approaches were utilized to understand the physics of strength and its dependence on material composition. These works will be continued in the future. They will include the next round of structural and functional analyses (for example, the first attempt to model the thermal properties of HEA has recently been completed, and the first article is being prepared). These activities are supported by several grants obtained by the NOMATEN team, mainly financed via NCN and FNP.

Both in the current RP and in future works, we will continue research on the influence of radiation defects on the properties of materials and strengthen our capabilities in active material testing (15 MPLN SPUB application has been submitted to the Ministry in June 2025 and is being review now by the expert panel). This work is motivated by the Polish Nuclear Energy Program. Broadly speaking, NCBJ's goal is to achieve the status of an expert institution for Polish government institutions, specifically the TSO (Technology Support Organization). Both the NOMATEN CoE and the Material Physics Department could play a very significant role in the endeavor. Research on the influence of radiation on materials is conducted within the framework of several externally funded research grants.

An example of the synergy from modeling to materials theory to materials informatics to high-quality experiments is given by several techniques: nanoindentation, HR-TEM, XRD, DSC and others. NOMATEN has access to all of this advanced equipment, which enables the testing of metal alloys, glasses, and coatings at both room and elevated temperatures. One of the goals of this synergy buildup between experiment and simulation is to combine atomic-scale analyses with the mechanical/structural/thermal properties of macroscopic samples, which is the subject of intensive work worldwide. Ultimately, it is expected to develop procedures that enable the effective prediction of the mechanical properties of materials based on their composition and structure, thereby drastically shortening the development period of new materials with specific properties. This topic is also devoted to several grants implemented in the CoE.

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The launch of laboratories for radioisotope research gave new impetus to the development of this field in the NOMATEN CoE. The primary focus during the reporting period was on two topics: novel prosthetic groups for radiohalogenation of biomolecules and synthesis and characterization of nanomicelles as carriers (of radionuclides and other agents) for cancer diagnosis and therapy. The group successfully continued a co-tutelle project with CEA, with the PhD student (Mathilde Ponchelle). Defense of the candidate was on December 15th 2025.

As part of the work supplementing and supporting scientific activities in the current reporting period, we also carried out activities to utilize another tranche of investment funds. In this topic, a significant success is starting purchases and installations related to the KPO funds, worth 22.7 MEUR. Another important milestone is the submission of the SPUB application for the years 2026-2029 (15 MPLN in total). These funds will be allocated to investments in all RGs as well as to supplement equipment in the field of advanced tests of active materials, thus creating a possibility to build a coherent organization at NCBJ: neutron irradiation and PIE (post-irradiation examination). However, if we are successful, we may create a unique capability worldwide, thereby attracting financing that will support the CoE. One such attempt has been completed in 2025, neutron irradiation of TEM lamellae – the design, manufacture, and commissioning of the probe containing TEM lamellae followed by successful sample removal and structural analysis. This activity is also one of the project proposals to be funded by the CONNECT-NM platform. Efforts related to the neutron irradiation of small samples and PIE will continue in the future as the CoE is strongly encouraged by the scientific community to engage into this type of research.

In addition to our current activities, we are also involved in creating the foundations for the future. These large-scale projects will allow the CoE to obtain unique research capabilities on a European scale. One such activity is the joint development of the MARIA Neutron Laboratory with the Material Physics Department at the NCBJ, which is currently being constructed at the MARIA reactor. The launch of this laboratory will enable material research using neutron beams, a rare and highly sought-after option in Europe. Ultimately, the MNL group could become part of the NOMATEN CoE.

Finally, a consistently developed element of NOMATEN's activities is the provision of services for industry. In 2025, several contracts have been implemented to date, representing a steady number compared to the previous reporting period. The benefits of these analyses extend beyond financial revenues to also, or even mainly, establishing close cooperation with companies interested in participating in the construction and operation of Polish nuclear power plants, which, as we hope, will result in favorable contracts in the future. Also, the goal of this endeavor is to build closer links with the companies, as in the upcoming Nucleoastrateg financing, one of the mandatory conditions will be to collaborate with the industrial partners.

The NOMATEN, as a Centre of Excellence, should also actively promote its staff in their respective careers (a good example of such activity is the defense of three PhD students in the group led by Prof. Dominguez – details provided in the next section), with special attention to ensuring that CoE researchers acquire the skills to obtain their own research grants. By the end of 2025, an additional 3 PhD students defended their dissertations (2x in prof Kurpaska's group and 1 in prof Pruszynski's). Training for working in an international environment has been on the agenda during the reporting period. In the future, we intend to continue organizing professional events to develop our staff's understanding of vital issues such as grant or proposal writing, Intellectual Property Rights, and the exploitation of IPR (one already planned with experts from CEA). Lastly, our senior staff is actively

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pursuing promotions in the national academic system, and the habilitation documentation is being prepared.

Highlights from the NOMATEN Research Groups

In this section, a summary of the highlights from each RG has been prepared. More details related to the group composition, research direction and plans will be presented in the SRIA (Strategic Research and Innovation Agenda) document which will be completed by the end of 2025.

Multiscale Hybrid Modeling of Materials Group (MHMM) Contact Person, group leader: Prof. Javier Dominguez

Group members: Dr. Amil Aligayev, Dr. Karol Frydrych, Dr. Mark Fedorov, Dr. Tymofii Khvan, MSc. Bakhtiyar Mammadli, Dr. A. Naghdi-Dorabati, Dr. D. Massa, and Dr. M. Pecelerowicz

The group achieved major progress in research, training, and dissemination. Three doctoral candidates graduated with high honors: Amirhossein Naghdi (IPPT), Dario Massa (University of Warsaw), and Amil Aligayev (China), with Amil receiving Outstanding PhD Student recognition (summa cum laude). Research advanced in nuclear materials under irradiation, catalysis, and hydrogen storage, AI-driven materials science, and multiscale mechanical modeling, resulting in 30 peer-reviewed publications in leading journals.
A key milestone was the publication in the Chemical Engineering Journal (Vol. 518, 15 Aug 2025, 164510; https://doi.org/10.1016/j.cej.2025.164510): "*Synergistic modulation of band structure and phonon transport for higher thermoelectric performance of WSe_2*" (A. Aligayev, J. Dominguez, et al.), reflecting the prestige of CEJ as one of the top journals in chemical and materials engineering with an impact factor of 13.2.

Collaborations and Networking: The group collaborated with Polish partners (Lodz Technical University, University of Warsaw, IPPT, Technical University of Warsaw, AGH Krakow) and international institutions (CEA, CIEMAT, La Rochelle University, CNRS, Max Planck Institute, University of Oviedo). All members are also active in COST Actions: MECANANO, EUMACE, EUMINE, and DAEMON, reinforcing European networking.

Training and Dissemination: All group members presented at international conferences, with several being invited as keynote or session speakers, thereby strengthening their visibility and recognition. PhD training and participation in COST Actions enhanced capacity building and integration into the European Research Area.

Impact and Exploitation: The work directly supports EU priorities: i) Sustainable Energy: Nuclear materials and catalysis modeling contribute to safer, low-carbon technologies. ii) Digitalisation: AI-based approaches accelerate materials discovery and align with Europe's digital transition. iii) Industry Transfer: AI solutions for predicting mechanical properties of structural materials have strong potential for industrial exploitation.

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Materials Design and Modeling Group (MDM)
Contact Person, group leader: Dr. Silvia Bonfanti

Group members: MSc. A. Wadowski, Dr. A. Parmar, Dr. A. Esfandiarpour, MSc. F. Kaśkosz, MSc. P. Wang, Dr. D. Khomenko

The newly established "Material Design & Manufacturing Group" at NOMATEN CoE, advances computational materials science through integrated simulations and experiments. Led by Dr. Bonfanti, the group combines density functional theory, molecular dynamics, and machine learning with lab-based testing. Supported by competitive grants, the focus is on disordered materials, high-entropy alloys, and mechanical metamaterials to bridge atomic insights with practical designs.
A key achievement is the application of Bayesian methods to explore the composition space of CuZrAl metallic glasses, identifying blends that improve strength and ductility. The study uses simulations and statistical models to find optimal alloy regions, leading to better mechanical performance. Published in npj Computational Materials (Mäkinen et al., 2025), it provides guidance for alloying strategies and experimental prototyping at NOMATEN.
Building on this, the group developed a hybrid simulation method for multi-component metallic glasses, such as ZrCuAl systems. This approach accelerates atomic rearrangements by billions to trillions of times, yielding glasses with lower energies, superior thermal stability, and mechanical responses that align closely with experiments. Detailed in a recent preprint (Kaśkosz et al., 2025), it supports modeling for NOMATEN's coating and future 3D printing validation.
For high-entropy alloys, simulations examined the effects of Ti/Al ratios on nanoprecipitate formation and deformation in CoNiFeAlTi systems. The work shows how balanced compositions increase strength through dislocation interactions while maintaining ductility. Published in Journal of Alloys and Compounds (Esfandiarpour et al., 2025), it highlights mechanisms for tuning alloys in nuclear applications.
A collaboration through the European COST Action DAEMON reviewed uncertainty quantification in machine learning for atomistic modeling, covering methods like Bayesian frameworks and ensembles to improve prediction reliability. Published in Digital Discovery (Grasselli et al., 2025), it addresses challenges in model transferability and benchmarking for materials design.
These advances represent key highlights among the group's broader contributions. Dr. Bonfanti's leadership in the COST Action DAEMON supports ongoing European collaborations on machine learning for materials science.

Materials Characterization Group
Contact person, group leader: Prof. Iwona Jóźwik

Group members: Dr. W. Chromiński, Dr. R. Diduszko, Dr. M. Gawęda, Dr. D. Kalita, Dr. A. Kosińska, Dr. M. Stróżyk, MSc. M. Wilczopolska

The Materials Characterization Group focuses on the study of materials operating under extreme conditions relevant to nuclear, energy, and chemical industries. Our research combines advanced experimental techniques with modeling approaches to improve the performance and reliability of steels, alloys, coatings, and polymers.
We employ a wide range of state-of-the-art characterization tools, including TEM, SEM, FIB, EBSD, EDS, XRD, Raman spectroscopy, and nanoindentation, enabling detailed microstructural, mechanical, and chemical analysis. The group has also recently expanded its infrastructure with high-temperature XRD, Raman spectroscopy, and soon *in situ* SEM nanoindentation and FT-IR capabilities.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470

Our research addresses:

- Influence of external stress on radiation damage in ion-irradiated materials,
- Protective coatings development, in particular amorphous silicon oxycarbide (SiOC) layers on steels for nuclear cladding applications, demonstrating enhanced hardness, elastic modulus, and defect tolerance,
- Radiation tolerance of high-entropy alloys (HEAs), with special emphasis on refractory alloys for fusion applications, where we revealed the role of temperature and chemical complexity on defect accumulation,
- Polymeric materials under irradiation, with investigations of structural and chemical degradation of EPDM rubber used in cable insulation,
- Additive manufacturing of Mg-based alloys and advanced microstructural studies using 3D EBSD combined with molecular dynamics and finite element simulations, providing unique insights into deformation mechanisms.

Key Achievements

- Publication record (since 2021): over 46 scientific papers and active participation in more than 70 conferences and workshops.
- External funding: 2 ongoing research projects financed from NCN (SONATA – D. Kalita, project duration 3 years, total budget: 866 000 PLN; SONATINA – M. Gawęda, project duration: 3 years; total budget: 865 602 PLN). Two CONNECT-NM proposals have been submitted for evaluation (in collaboration with VTT Finland, City University of Hong Kong, China; University of Maria Curie Skłodowska, Poland, Laboratory of the Physics of the two Infinities Irène Joliot-Curie, Orsay, France, and Helmholtz-Zentrum Dresden-Rossendorf, Germany (HZDR).
- International collaborations: established partnerships with VTT (Finland), CEA (France), University of Tennessee, The Dutch Institute for Fundamental Energy Research (DIFFER), Institute of Fundamental Technological Research, Polish Academy of Science (IPPT), University of Gdańsk, and University of Maria Curie Skłodowska (UMCS) in Lublin. Joint research includes in-situ high-temperature TEM studies of additively manufactured stainless steels and pioneering neutron irradiation of TEM lamella specimens in collaboration with the Maria Reactor Technology Division.
- Participation in EMIRA program: within the European EMIR&A network, the group conducted in-situ TEM ion implantation experiments at IJCLab (Paris-Orsay) in May 2025. The approved proposal, “Understanding the Influence of Chemical Complexity on Irradiation-Induced Defect Accumulation in Novel Low-Activation W–Ta–Cr–V Concentrated Solid Solution Alloys (CSA)”, targets fundamental mechanisms of defect formation in fusion-relevant materials.
- Scientific visibility: group members were invited to present their work internationally, including a seminar by Magdalena Gawęda on Silicon Oxycarbide (SiOC) as Polymer-Derived Ceramics at Brock University, St. Catharines (Canada), May 2025.

Through these efforts, the Materials Characterization Group has strengthened its international visibility and contributed to a new understanding of radiation effects, protective coatings, and advanced alloys for extreme environments.

Functional Properties Group
Contact person, group leader: Prof. Lukasz Kurpaska

Group members: Dr. W. Huo, MSc. Y. Li, MSc. A. Olejarz, Dr. M. Zieliński, Dr. M. Frelek-Kozak, MSc. A. Zaborowska, MSc. E. Wyszkowska, MSc. K. Mulewska, MSc. K. Suchorab and MSc. A. Poisvert,

The Functional Properties group in 2025 continued to focus on understanding mechanical property changes triggered by radiation defect and their relation to microstructure. Materials investigated in the group were ion irradiated with heavy ions (mainly Fe or Ni) at high energy (5 to 10 MeV) and at high temperatures (300, 580, and 700°C). The irradiation experiments were carried out in collaboration with laboratories equipped with ion accelerators, including HZDR in Germany, STUBA in Slovakia, and MIT in the US. The described irradiation conditions were always chosen to mimic the true operating conditions of current and next-generation nuclear reactors. The Functional Properties group conducted measurements on various types of materials, including martensitic-ferritic steels, ODS and/or HEAs, binary model alloys (NiFe), protective coatings based on aluminum oxide, zirconium, and nickel alloys. Recently, a new topic has been initiated in the group – investigating high-entropy alloys with additions of precipitates, such as Cu (supported by the project Sonata Bis). This new class of materials, due to the presence of large grain boundary density and the presence of nanoprecipitates with coherent interphase, very effectively annihilates created defects as it has been demonstrated that created vacancies recombine on the interphase.
Currently, the group is involved in the multinational collaboration called INNUMAT, funded by the European Commission. Within the framework of this initiative, the group has begun investigating Co-free HEA (NiFeCrMn) materials manufactured by the Ecole des Mines, Saint-Etienne, France, and CENIM, Madrid, Spain. The group received several external research projects or access to large infrastructure worldwide.
The group established a strong collaboration with Queen's University, the Idaho National Laboratory, and the Massachusetts Institute of Technology in the US. Described institutions play a leading role in developing fundamental as well as applied science of radiation damage resistance and its impact on mechanical properties.
Finally, in 2025, the Research Group Leader and practically all members of the group were involved in the modernization of the Materials Research Laboratory (SPUB and Nomaten Core financing). We installed several high-end devices and mastered their usage – details will be provided in the D4.5. This large (and final) reconstruction project will be implemented in 2025 (covered by the SPUB grant).The group participated in numerous conferences and meetings, including E-MRS, MRS, and NUMAT conferences, and published several articles.
Future plans: It is expected that by the end of 2025 and more generally in the 6th RP, several group members will defend their PhD thesis (at least four members: Olejarz, Zaborowska, Wyszkowska, Mulewska). The group is also actively preparing for the post-Teaming period, and currently several projects are under evaluation: Pol-Swiss, OPUS, Sheng, Prelludium, Eurofusion ENR, SPUB, and 5 project proposals submitted to Connect NM. These efforts will be continued in the future as all members of he group are actively searching for external sources of finances (including external service options).

Novel Radiopharmaceuticals for Medical Purposes Group: Contact person, group leader: Prof. M. Pruszyński

Group members: Dr. M. Zieliński, Dr. A. Krzyczmonik, MSc. M. Ponchelle, Dr. K. Zajdel, MSc. I. Shokair, Dr. G. Elumalai.

During 2025, one of the most significant achievements of the Novel Radiopharmaceuticals group was the completion of the renovation of our laboratory spaces. The group now has three dedicated laboratories: one for radiochemical work, one for *in vitro* biological assays (including work with radioactivity), and a third for analytical measurements and quantification. With support from the NOMATEN CoRE project, funded under the *Investments in Expanding Research Capacity* program of the *National Recovery and Resilience Plan*, the laboratories are being equipped with modern

infrastructure. While the outfitting process is ongoing, experimental work has already commenced over the last few months.
The new facilities have also accelerated collaboration within the group and with external partners, including CEA (France), VTT (Finland), and other national and international research institutes. Thanks to these collaborations, in 2025 the group has so far published five articles, plus two under review and three in preparation for submission by the end of the year. Notably, one publication is based on the work of Ms. Mathilde Ponchelle, who completed a joint doctorate under the supervision of Dr. Eric Doris (CEA, France) and Dr. Marek Pruszyński (NOMATEN, Poland). The defense of her doctoral thesis, entitled "*Design and synthesis of micellar nanocarriers for internal radiotherapy*", was on December 15th 2025.
During the evaluation period, members of the group were awarded three research projects:

- *Radiolabelled up-converting nanoparticles as theranostic agents for multimodal imaging and targeted therapy*, funded by National Science Centre Poland (NCN) / SONATINA 8 / 2024/52/C/ST5/00208.
- *Accelerate.EU - Elevating the Future of Cancer Care with Alpha Theranostics*, under the EC HORIZON-JU-RIA / HORIZON-JU-IHI-2023-05-02 call, proposal number 101165857, involving 17 collaborators across Europe, including: Ion Beam Applications; Institut De Cancerologie De L'ouest; Erasmus Universitair Medisch Groupement Interet Public Arronax; Forschungszentrum Julich; Region Hovedstaden; Kobenhavns Universitet; Institut National De La Sante Et De La; Universidade De Coimbra; Tetrakit Technologies; Fundacion Centro De Tecnologias; Lablogic Systems Limited; Oncidium Foundation; Tecnomed - Fondazione Dell'università.
- *Complementary Methods for the Synthesis of Radioiodinated Prosthetic Groups to Couple with Biomolecules via Disulfide Re-bridging*, funded by NCN / MINIATURA 9 / 2025/09/X/ST5/00361.

In addition to these projects, the group submitted two proposals in 2024 (granted access in 2025) to gain access to exotic radionuclides through the PRISMAP consortium, which provides isotopes not commercially available:

- *Novel prosthetic groups for the ^{211}At-astatination of biomolecules via disulfide rebridging* - access to 2 production batches of At-211 at the GIP ARRONAX cyclotron (Nantes, France), with the first visit planned for mid-October 2025 and subsequent visits in 2026.
- *The Marvel of Advanced Radiolanthanides: Next-Generation Radio-Optical Nanoparticles in Modern Nuclear Medicine* - access to 2 production batches of Er-169 from MEDICIS (CERN, Geneva, Switzerland); the first batch was received in mid-August 2025 for initial UCNPs synthesis, with the second batch expected in 2026.

International presence

In 2025, NOMATEN researchers participated in numerous conferences in Poland and abroad, presenting their results, expanding existing and establishing new collaboration contacts. Among them the most notable are:

- 4th International Workshop on Plasticity, Damage and Fracture of Engineering Materials, 24-26 September 2025, İstanbul, Turkey
- TMS 2025 Annual Meeting & Exhibition, 23-27 March 2025, Las Vegas, Nevada, USA
- Materials Today Conference 2025, 23-26 June 2025, Sitges, Spain
- The 14th symposium on Electrochemical Methods in Corrosion Research (EMCR 2025), 15 – 19 June 2025, Venice, San Servolo, Italy
- 23rd Advanced Nano Materials Conference, 23-25 July 2025, Aveiro, Portugal

NOMATEN researchers also participated in numerous working meetings, some examples are:

- Seventh International Workshop on Structural Materials for Innovative Nuclear Systems (SMINS-7), 31 March to 3 April 2025, Madrid, Spain
- FREDMANS: Hands-On Training on Fuel Fabrication and Characterization, 27-31 January, Chalmers University, Gothenburg, Sweden 2025
- Strengthening safer nuclear technology through innovation, 21-22 May 2025, JRC Petten, Netherlands
- ICSID 2025 - International Conference on Structural Integrity and Durability Summer School - Fatigue and Fracture Modeling and Analysis, Dubrovnik, Croatia, 15 - 19 September 2025

Most notable papers

The current list of peer-reviewed papers authored by NOMATEN researchers exceeds 160 papers. Some selected examples of publications in top world journals are shown below:

Chemical Engineering Journal
Volume 518, 15 August 2025, 164510

Synergistic modulation of band structure and phonon transport for higher thermoelectric performance of WSe_2

Mazhar Hussain Danish [a b c], Amil Aligayev [a b e], Zahir Muhammad [d], Tao Chen [a b], Adil Mansoor [c], Zia Ur Rahman [c], F.J. Dominguez-Gutierrez [e], Di Li [a], Jian Zhang [a] ✉, Zhuang-Hao Zheng [c] ✉, Xiaoying Qin [a] ✉

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Article | Open access | Published: 07 April 2025

Bayesian exploration of the composition space of CuZrAl metallic glasses for mechanical properties

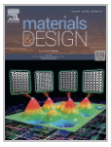
Tero Mäkinen, Anshul D. S. Parmar, Silvia Bonfanti & Mikko J. Alava

npj Computational Materials 11, Article number: 96 (2025) | Cite this article

4762 Accesses | 3 Citations | Metrics

ELSEVIER

Materials & Design
Volume 252, April 2025, 113751



High temperature He bubble evolution and thermal stability of the WTaCrV refractory concentrated solid solution alloy

Damian Kalita [a], Amin Esfandiarpour [a], Iwona Jóźwik [a], Yanwen Zhang [b c], Jesper Byggmästar [d], Mikko J. Alava [a], Łukasz Kurpaska [a], William J. Weber [c], Philip D. Rack [c], Jacek Jagielski [a]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470

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Article | Open access | Published: 24 July 2025

Nanostructured NiCoFeCr alloy with superior high-temperature irradiation resistance

Sri Tapaswi Nori, Pedro A. Ferreirós, Damian Kalita, Ruben Bjørge, Per Erik Vullum, Katarzyna Mulewska, Witold Chrominski, Mingyang Li, Yongqin Chang, Yanwen Zhang, Randi Holmestad & Lukasz Kurpaska

npj Materials Degradation **9**, Article number: 91 (2025) | Cite this article

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Issue 43, 2025 Previous Article Next Article

From the journal: Nanoscale

May the target be with you: polysaccharide-coated upconverting nanoparticles for macrophage targeting

Check for updates

Karolina Zajdel, † *a Volodymyr Lobaz, † b Martin Ondra, † cd Rafal Konefał, be Oliver Moravec, b Ognen Pop-Georgievski, b Jiří Pánek, b Damian Kalita, a Bożena Sikora-Dobrowolska, f Lukáš Lenart, c Marián Hajdúch, cd Martin Hrubý b and Marek Pruszyński ag

Author affiliations

Abstract

Upconversion nanoparticles (UCNPs) based on β-$NaYF_4$ doped with Yb^{3+} and Er^{3+} are promising candidates for multimodal bioimaging and theranostic applications, owing to their unique optical properties and favourable safety profile. However, their limited stability under physiological conditions and lack of effective cellular targeting continue

Most important presentations given by the members of the NOMATEN research Groups in 2025

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470

D. Kalita, K. Mulewska, I. Jóźwik, A. Esfandiarpour, Ł. Kurpaska, Y. Zhang, W.J. Weber, J. Jagielski, High-Temperature Evolution of Irradiation Defects in WTaCrV Refractory High-Entropy Alloy for Nuclear Fusion Applications, TMS 2025 Las Vegas, USA, 2025-03-23 - 2025-03-27

M. Gawęda, P. Jeleń, D. Kalita, F.J. Domínguez-Gutiérrez, M. Sitarz, I. Jóźwik, Amorphous SiOC Coatings: Polymer-Derived Ceramics for Nuclear Applications, 16th Pacific Rim Conference on Ceramic and Glass Technology/GOMD 2025, Vancouver, Canada, 2025-05-04 - 2025-05-09

Anshul D. S. Parmar | talk: Quantifying and Predicting Plasticity in Metallic Glasses | Workshop: Driven and active amorphous matter | Max-Planck-Institutes and University of Göttingen | (20-26).07.2025

Filip Kaśkosz, talk: "Facilitating Molecular Dynamics Simulations via Monte Carlo Methods for Metallic Supercooled Liquids and Glasses", 10th International Discussion Meeting on Relaxations in Complex Systems, Barcelona, Spain, 20-25 July 2025.

Bakhtiyar Mammadli; Applying unsupervised machine learning to analyze local strain fields in materials mechanics;26th International Conference on Computer methods in mechanics; Lodz, Poland; July 8-11th, 2025.

Amil Aligayev; Vacancy Confined single atom catalysts on MXenes for enhanced CO2 reduction; 18th European congress and exhibition on advanced materials and processes EUROMAT 25; Granada, Spain; September 14-18, 2025.

Activities within Associations and Partnerships

New Strategic Memberships and Partnerships

The Royal Society of Chemistry (RSC) is the United Kingdom's professional body for chemical scientists and one of the world's leading chemical societies. Headquartered at Burlington House in London, the RSC was formed in 1980 through the merger of several historic chemical institutions, some dating back to the 19th century. The RSC's mission is to advance excellence in the chemical sciences. It supports researchers, educators, students, and industry professionals by promoting scientific knowledge, fostering collaboration, and influencing science policy. The Society works globally to address major challenges such as sustainability, energy transition, healthcare innovation, and advanced materials development. The RSC is internationally recognized for its high-impact scientific publishing program. It publishes a broad portfolio of peer-reviewed journals, books, and databases covering all areas of chemistry and related disciplines – from fundamental molecular science to applied materials, nanotechnology, catalysis, and chemical biology. Many RSC journals are ranked among the top titles in their respective fields. With tens of thousands of members worldwide, the RSC provides professional accreditation (e.g., Chartered Chemist status), career development resources, networking opportunities, and training programs. It actively supports early-career researchers and students through grants, awards, and mentoring initiatives. Although rooted in the UK, the Royal Society of Chemistry operates internationally, maintaining offices and partnerships across Europe, Asia, and the Americas. Through conferences, policy engagement, and collaborative programs, it serves as a platform connecting academia, industry, and government.

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The Materials Research Society (MRS) is an international, interdisciplinary scientific society dedicated to the advancement of materials research. Founded in 1973 in the United States, MRS was established with a clear mission: to promote goal-oriented basic research on materials of technological importance through cross-disciplinary collaboration. Unlike traditional discipline-based societies, MRS was built around the idea that materials research thrives at the intersection of physics, chemistry, engineering, biology, and computational science. Its community includes researchers working on metals, ceramics, polymers, semiconductors, biomaterials, nanomaterials, energy materials, quantum materials, and advanced functional systems. This interdisciplinary structure has made MRS a leading platform for integrating modeling, synthesis, characterization, and applications – particularly in areas such as energy storage, nuclear materials, electronics, sustainability, and advanced manufacturing. MRS is widely known for organizing large, highly regarded international meetings – especially its Spring and Fall Meetings in the United States. These events gather thousands of researchers from academia, national laboratories, and industry, fostering scientific exchange across diverse subfields of materials science. The meetings are structured into thematic symposia, reflecting emerging trends such as: High-Entropy Alloys and complex materials, Radiation effects in materials, Additive manufacturing and 3D printing, Materials informatics and machine learning, Advanced characterization techniques. MRS strongly supports early-career scientists and students through awards, travel grants, professional development workshops, and mentoring programs. It also promotes diversity, equity, and inclusion within the materials science community. Materials Research Society is one of the most influential organizations in the field of materials science, distinguished by its interdisciplinary philosophy and its strong integration of fundamental research with technological innovation.

In 2025, the NOMATEN Centre of Excellence joined the Engineering Academy in Poland (Akademia Inżynierska w Polsce AIP). This newly established national association brings together representatives of academia, research institutes, and industry to promote the development of modern engineering in Poland. The Academy's mission is to strengthen collaboration between scientific institutions and the industrial sector, support innovation and advanced technologies, and contribute to engineering education and professional excellence. Through expert panels, training programs, and technical conferences, AIP creates a platform for exchanging knowledge and best practices across multiple engineering disciplines. By becoming a member of the Engineering Academy in Poland, NOMATEN expands its cooperation network within the national engineering community, gaining new opportunities for joint events, specialized training, and collaborative R&D initiatives in the field of advanced materials, nuclear technologies, and sustainable industrial solutions.

The Polish Materials Society (PTM, Polskie Towarzystwo Materiałoznawcze) is a leading national scientific and professional association that unites experts, researchers, and enthusiasts in materials science and engineering. Its mission encompasses the promotion and dissemination of materials research, the advancement of educational programmes in material science, and the facilitation of collaboration between academic institutions and industry. PTM works to integrate the materials science community across Poland and abroad, fostering innovation,

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the exchange of expertise, and the development of modern materials technologies. PTM organizes regular seminars, conferences, and events on materials science topics. It supports young scientists through competitions, jury evaluations, and engagement in national and international materials-related forums. By becoming a member of PTM, NOMATEN strengthens its connection to Poland's materials science community, enabling closer cooperation with academic departments, research institutes, and industrial partners working in metallurgy, ceramics, composites, and advanced materials. This membership opens new avenues for co-organizing seminars, joint research calls, and knowledge exchange in materials characterization, irradiation effects, and advanced alloy development.

COST is a European intergovernmental framework that supports the creation and networking of collaborative research communities, known as COST Actions. COST focuses on enabling interdisciplinary exchange, capacity-building, and the rapid dissemination of research outcomes across Europe and beyond. COST Actions are bottom-up, four-year networks that allow researchers to propose and implement research agendas across all scientific and technological domains. These Actions facilitate mobility, knowledge exchange, training schools, short-term scientific missions, and integration of European research efforts. By engaging with COST, the NOMATEN Centre of Excellence gains access to a pan-European network of researchers, opportunities for joint proposals, and mechanisms to increase visibility. Participation in COST Actions allows NOMATEN to leverage collaborative platforms for materials science, nuclear technologies, and related fields, aligning with its mission to integrate into the European Research Area and support sustainable innovation.

Through its participation in these associations, partnerships, and industrial networks, the NOMATEN Centre of Excellence reinforces its role as an interface between research, industry, and policy in both Poland and Europe. The Centre's involvement in standardization, nuclear materials partnerships, and industrial collaborations not only enhances its research visibility but also contributes to building a sustainable foundation for knowledge transfer, innovation, and support for the European and Polish nuclear programmes.

NOMATEN CoE Seminars, Conferences and Workshops

In 2025, the NOMATEN Centre of Excellence continued to expand its international visibility and strengthen its position as a leading research hub for materials science, radiopharmaceuticals, and nuclear technologies. A series of scientific, training, and promotional events organized throughout the year reflected the Centre's active engagement in European cooperation, innovation, and education.

One of the major event of 2025 was the NOMATEN Autumn School, held from September 29th to October 2nd, 2025 at the VTT Centre for Nuclear Safety (CNS) in Espoo, Finland, under the theme "Innovation through Collaboration: Where are we? – Where are we going?" Organized jointly by VTT, CEA, and NCBJ, the event brought together over 60 researchers, postdocs, and PhD students from Finland, France, and Poland. The program included keynote lectures, research sessions, and group work activities, promoting cross-institutional collaboration and strengthening the trilateral partnership between NOMATEN, CEA, and VTT within the Teaming for Excellence framework.

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In January 2025, NOMATEN researchers participated in the Symposium on Complex Metallic Glasses: From Modeling to Experiments, hosted at the Faculty of Materials Science and Engineering, Warsaw University of Technology. The symposium featured prominent international experts, including Prof. Isabella Gallino (TU Berlin) and Prof. Jamie J. Kruzic (University of New South Wales, Australia), who also delivered hybrid lectures at NOMATEN. The event fostered the exchange of expertise on modelling, mechanical behavior, and additive manufacturing of metallic glasses. NOMATEN scientists contributed with presentations and discussions highlighting their work on amorphous materials and structural alloys.

A specialized technical training was organized by NOMATEN and NCBJ teams focusing on the adaptation of the biological shielding and mechanical assemblies of the E6 diffractometer from HZB for installation at the MARIA research reactor (H3 beamline). The training covered the design principles of biological shielding, integration with the reactor hall infrastructure, and necessary modifications to sample and detector tables due to differences in beam height between the BER II and MARIA reactors. The event was part of the Neutrons for Science Alliance initiative, led by NOMATEN, which supports the development of Poland's neutron research capabilities.

On February 19th, 2025, representatives of the NOMATEN Centre of Excellence and partner institutions, including AGH University of Science and Technology and IPPT PAN, visited the head office of Telefonika Kable S.A. in Bydgoszcz. The technical visit focused on exploring potential cooperation in cable materials research, durability testing, and advanced metallurgical applications for the nuclear and energy industries. Participants toured the production lines and the High Voltage Cable and Wire Testing Laboratory, accredited by the Polish Centre for Accreditation (PCA) under PN-EN ISO/IEC 17025:2018-02. The visit laid the foundation for future research collaboration between NOMATEN and Telefonika Kable in the field of high-performance polymer materials.

The NOMATEN CoE also hosted a technical workshop with Bechtel Poland, a global leader in nuclear engineering and construction. Discussions focused on cooperation in testing, certification, and qualification of materials for PWR (Pressurized Water Reactor) technology. Bechtel, in consortium with Westinghouse, is responsible for the design and construction of Poland's first nuclear power plant in Pomerania. During the visit, Bechtel experts were introduced to NOMATEN's research infrastructure, laboratories, and accreditation procedures, which comply with ASTM and international nuclear quality standards. The workshop also included a visit to the MARIA reactor and the MARIA Neutron Laboratory, reinforcing NOMATEN's strategic role in Poland's emerging nuclear energy sector.

In March 2025, NOMATEN and NCBJ hosted a group of students from the Gdańsk University of Technology (GUT) representing the BioPhoton and MNKN interdisciplinary student research groups. The visit included presentations on NOMATEN's research areas, tours of the Laboratory of Basic Research (LBM), and a guided tour of the MARIA reactor control room. The students, specializing in biomedical engineering, physics, automation, and energy, showed strong interest in internship and PhD opportunities at NOMATEN, reflecting growing engagement between the Centre and Polish technical universities.

During the high-level conference "EU Research and Innovation Framework Programs and Europe's Technological Sovereignty" held at the University of Warsaw, NOMATEN participated in a discussion panel. The panel, titled "Success stories of H2020 and Horizon Europe projects – examples of science–

industry cooperation and implementation of high technologies," included Professor Jacek Jagielski, Coordinator of NOMATEN, who presented the Centre's mission and achievements. Prof. Jagielski emphasized the Centre NOMATEN's impact on science, research, and industry, as well as the importance of Teaming for Excellence projects in building sustainable European research collaborations and innovation ecosystems.

In May 2025, NOMATEN participated in the 11th International Euratom Research and Training Conferences on Fission Safety (FISA) and Radioactive Waste Management (EURADWASTE), organised under the Polish Presidency of the Council of the EU. The event gathered European policymakers, researchers, and industry representatives to discuss nuclear safety, SMR development, and future directions for Euratom research. NOMATEN showcased its research portfolio and infrastructure at a dedicated exhibition booth, presenting its expertise in materials science, radiopharmaceuticals, and computational modelling.

A major highlight of the conference was the official signing of the cooperation memorandum between NCBJ and CEA, attended by Prof. Agnieszka Pollo (Acting Director of NCBJ), Stéphane Sarrade (Director of Low Carbon Energy Programs, CEA), and Ambassador Étienne de Poncins. The agreement formalized new areas of collaboration between Poland and France in civil nuclear research and training, complementing the long-standing partnership within the NOMATEN Centre of Excellence.

NOMATEN Autumn School 2025 – Innovation through Collaboration Where are we? Where are we going? VTT Headquarters in Espoo, Finland

The NOMATEN Autumn School 2025 was held from September 29th to October 2nd 2025 at the VTT Centre for Nuclear Safety (CNS) in Espoo, Finland, under the motto "Innovation through Collaboration: Where are we? – Where are we going?" The event, organized by VTT Technical Research Centre of Finland, the French Alternative Energies and Atomic Energy Commission (CEA), and the NOMATEN Centre of Excellence at the National Centre for Nuclear Research (NCBJ, Poland), brought together researchers, engineers, and young scientists to discuss progress and future directions within the framework of the EU-funded Teaming for Excellence project (Horizon 2020, Grant No. 857470).

The School began on Monday, September 29th, 2025, with the closed session "Innovation through Research Groups" at VTT, where representatives from NOMATEN, CEA, and VTT discussed ongoing collaborations and strategies for long-term research integration. The day concluded with an informal walking tour of Helsinki, encouraging networking among participants from the three institutions.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470

Tuesday, September 30th, 2025: The first full conference day began with registration and poster setup at the VTT CNS facilities, followed by the Introductory Session, chaired by Dr. Maria Oksa and Dr. Wade Karlsen (VTT). Opening remarks were delivered by Maria Oksa, who outlined the objectives and scientific framework of the Autumn School and introduced the group work activities. Prof. Jacek Jagielski, the Coordinator of the NOMATEN Centre of Excellence, presented the latest developments within the Teaming for Excellence project, emphasizing the importance of international collaboration and interdisciplinary innovation. Prof. Łukasz Kurpaska, the Director of NOMATEN CoE, followed with an overview of NOMATEN's recent activities, infrastructure expansion, and ongoing R&D initiatives. Subsequent presentations by Wade Karlsen (VTT), Christophe Gallé and Frédéric Dollé (CEA), focused on collaborative opportunities across the partner institutions and mechanisms for sustainable research networking beyond the Teaming funding horizon.

Two invited keynote talks from the University of Helsinki concluded the introductory session, Assoc. Prof. Mirkka Sarparanta discussed Preclinical radiopharmaceutical development for diagnostics, therapy, and radiobiology studies, highlighting Finland's contribution to cutting-edge medical isotope research. Prof. Mikko Ritala presented Atomic Layer Deposition (ALD), Stepwise Growth of Thin Films through Saturative Surface Reactions, emphasizing the versatility of ALD for materials engineering in nuclear and biomedical applications.

After the coffee break, researchers from all NOMATEN Research Groups presented updates on their scientific achievements, followed by the panel discussion "Innovation Towards Industry", moderated by Maria Oksa (VTT). The panelists, Kostas Sarakinos (University of Helsinki), Frédéric Dollé (CEA), Łukasz Kurpaska (NCBJ), Arto Kotipelto (VTT), and Markus Forsback (Fortum) discussed the challenges of transferring scientific results into industrial practice and of fostering innovation ecosystems that link academia and technology companies.

The afternoon Session 2 – Materials Science (Nuclear), chaired by Łukasz Kurpaska (NCBJ) and Christophe Gallé (CEA), featured eight technical presentations focusing on radiation effects, alloy performance, and advanced characterization of nuclear materials:

Damian Kalita (NCBJ) – The Role of Chemical Complexity in the Radiation Resistance of WTaCrV Refractory High-Entropy Alloy

Cloé Schneider (CEA) – X-rays for the Characterization of Irradiated Materials

Tymofii Khvan (NCBJ) – Correlating Ion- and Neutron-Induced Hardening in Eurofer97 Using Nanoindentation and CPFEM Modeling

Guillaume Josserand (CEA) – Advances in the Development of ODS Steels

Pedro Ferreiros (VTT) – Advanced Characterisation of Inclusions Acting as Brittle Fracture Initiators in RPV Welds

Karol Frydrych (NCBJ) – Continuum-Level Modelling of Berkovich Indentation in Ion-Implanted Stainless Steel

Eloa Lopes Maia (CEA) – Internal Corrosion Mechanisms in Fuel Cladding Induced by Fission Products

Nidhin Mathews (VTT) – Oxidation Behaviour of LPBF 316L Stainless Steel in Supercritical CO_2.

The day concluded with a networking dinner at Bastion Bistro, Suomenlinna, after a scenic ferry ride from Helsinki's Kauppatori.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470

The second day, Wednesday, October 1st, 2025, began with Session 3 – Materials Science (Non-Nuclear), chaired by Mikko Vepsäläinen (VTT) and Javier Dominguez (NCBJ), featuring six diverse presentations on catalytic materials, corrosion, additive manufacturing, and structural assessment:

Amil Aligayev (NCBJ) – Design and Multiscale Simulation of Nanostructured Catalysts for Hydrogen Production and Biomedical Applications

Javier Dominguez (NCBJ) – A Data-Driven Machine Learning Approach for Predicting High-Temperature Mechanical Behaviour of Structural and Composite Materials

Wilfried Pacquentin (CEA) – Laser Additive Manufacturing for Repair and Embedded Functionality

Suvi Lamminmäki (VTT) – Non-Sacrificial Anodic Deposition of Ni-HITP 2D MOFs

Ahsan Chonche (VTT) – Corrosion of Steels for Cavern Thermal Energy Storage Applications

Nithin Puthiyaveettil (VTT) – Non-Destructive Testing for Hydrogen and Ammonia Storage Tanks.

The mid-morning Group Work Session divided participants into six working groups addressing cross-institutional collaboration beyond the Teaming project. Topics included radiopharmaceuticals, materials cooperation, research infrastructure, training opportunities, joint publications, and commercialization strategies, with facilitators from VTT, CEA, and NOMATEN.

The afternoon Session 4, Radiopharmaceutical Sciences, chaired by Marek Pruszyński (NOMATEN/NCBJ) and Frédéric Dollé (CEA), included twelve joint and individual presentations covering radiochemistry, nanocarriers, isotope labelling, and novel therapeutic strategies. Highlights included:

Radiolabeling of Biomolecules with Scandium Isotopes (M. Richard, CEA / M. Pruszyński, NCBJ),

UCNPs Grafted with Antibodies (K. Iljin, VTT / K. Zajdel, NCBJ),

Boron-Rich Nanoparticles for Ultra-Targeted Tumoricidal Activity (E. Gravel, CEA),

Disulfide Rebridging Strategies for Radiolabeling (M. Richard, CEA / A. Krzyczmonik, NCBJ), and

Development of New Bioconjugation Techniques for Pretargeting Approaches (C. Marre, CEA / M. Pruszyński, NCBJ).

Two invited lectures completed the radiopharmaceuticals session: Prof. Olof Solin (Turku PET Centre) – Radiopharmaceuticals for PET in Finland: A Brief Overview, and Risto Ahorinta (Curium Pharma) – What Breaks When You Scale? Radiopharmaceuticals from Lab to Market.

Professor Olof Solin from the Turku PET Centre (Finland) delivered a lecture entitled “Radiopharmaceuticals for PET in Finland: A Brief Overview.” His presentation gave participants an in-depth look at Finland’s advanced infrastructure for positron emission tomography (PET) research and radiopharmaceutical production. He discussed the evolution of PET imaging in Finland, highlighting the country’s unique integration of academic research, clinical application, and national isotope production capabilities. Professor Solin emphasized the crucial role of cooperation among university laboratories, hospital facilities, and commercial suppliers in maintaining a continuous pipeline of innovation in diagnostic radiopharmaceuticals. He also presented examples of novel radiotracers under development at the Turku PET Centre, demonstrating how translational research can rapidly progress from the experimental stage to clinical trials, particularly in oncology and neurology.

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The following presentation, given by Risto Ahorinta from Curium Pharma, entitled “What Breaks When You Scale? Radiopharmaceuticals from Lab to Market,” focused on the industrialization and regulatory aspects of radiopharmaceutical development. Ahorinta shared the company’s extensive experience in scaling up production processes for clinical-grade radiopharmaceuticals, addressing the complex challenges of ensuring product stability, quality control, regulatory compliance, and logistical safety. He highlighted how even minor differences between laboratory synthesis and full-scale production can significantly affect radiochemical purity and clinical performance. His talk illustrated the importance of early collaboration between academic research groups and industry partners to anticipate technical and regulatory constraints at the design stage of new radiopharmaceutical compounds.

Together, both lectures provided participants with a holistic understanding of the radiopharmaceutical value chain – from fundamental isotope chemistry and laboratory innovation to clinical translation and large-scale manufacturing. The discussions underscored the importance of multidisciplinary collaboration, bridging chemistry, radiobiology, medical imaging, and pharmaceutical engineering to accelerate the development of next-generation radiopharmaceuticals in Europe.

The day concluded with Session 5, PhD Presentations and Poster Session, chaired by Frédéric Dollé (CEA) and Iwona Jóźwik (NCBJ), featuring eleven 3-minute flash talks from young researchers representing NOMATEN, VTT, and CEA. Awards were presented to the best PhD talk and best poster, with a closing summary by Maria Oksa and Kristiina Iljin (VTT).

The final day, Thursday, October 2nd, 2025, was devoted to laboratory visits at the University of Helsinki (Kumpula Campus), where participants explored the Accelerator Laboratory, Radiochemistry Laboratory, X-ray Laboratory, and Detector Laboratory, gaining firsthand experience of Finnish research infrastructure supporting nuclear, materials, and radiopharmaceutical sciences.

The Autumn School concluded with the final closed session “Innovation Through Research Groups”, dedicated to planning the next phase of joint research and Teaming sustainability beyond 2027.

The NOMATEN Autumn School 2025 successfully combined scientific presentations, collaborative workshops, and industrial dialogue, thereby strengthening trilateral cooperation among NOMATEN (NCBJ, Poland), VTT (Finland), and CEA (France). The event fostered interdisciplinary research, showcased progress in nuclear materials and radiopharmaceutical sciences, and provided a platform for young scientists to develop skills and networks essential for the future European Research Area.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 857470

Participants of the NOMATEN Autumn School 2025 Innovation through Collaboration Where are we? Where are we going? VTT at the Headquarters in Espoo, Finland

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470

Workshop on Safety and Materials Research in the Nuclear Industry

The Workshop on Safety and Materials Research in the Nuclear Industry was successfully held on 11–12 December 2025 at the National Centre for Nuclear Research (NCBJ) in Otwock, Poland. The event was organized by the NOMATEN Centre of Excellence together with the Division of Nuclear Energy and Environmental Studies, under the patronage of the Polish Ministry of Energy and the Polish Atomic Energy Agency. The workshop brought together approximately 120 participants representing research institutions, regulatory bodies, industry stakeholders, and international experts from several European countries. Its primary objective was to strengthen national competencies in nuclear safety and advanced materials research – two pillars essential for the development of Poland's nuclear energy program.

The scientific program focused on:
Nuclear safety frameworks and regulatory oversight
Risk assessment and safety culture in nuclear installations
Materials performance under irradiation and extreme operating conditions
Post-irradiation examination (PIE) and advanced testing methods
Cooperation between research institutions and industrial partners

A key element of the workshop was the integration of materials science with nuclear safety considerations. Discussions emphasized the importance of understanding radiation-induced defects, structural degradation mechanisms, and advanced diagnostic techniques to ensure the long-term reliability of nuclear infrastructure. The event also served as a platform for fostering collaboration between academia, government agencies, and companies involved in nuclear energy projects in

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Poland. It aligned with broader strategic efforts to build domestic expertise and technological capacity in support of the Polish Nuclear Energy Program.

Overall, the workshop confirmed NCBJ's and NOMATEN's growing role as national hubs for advanced materials research and safety-oriented nuclear science, while strengthening international scientific and regulatory cooperation.

The NOMATEN CoE Director, Prof. Łukasz Kurpaska presenting the NOMATEN research capabilities during Workshop

Participants of the Workshop on Safety and Materials Research in the Nuclear Industry

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470

Symposium on Complex Metallic Glasses: From Modeling to Experiments

The first scientific workshop organized by the NOMATEN Centre of Excellence in 2025 brought together leading international experts in the field of metallic glasses and advanced metallic materials, focusing on the relationship between atomic structure, glass transition phenomena, and mechanical performance.

The workshop featured Prof. Isabella Gallino (Technical University of Berlin, Chair of Metallic Materials) and Prof. Jamie J. Kruzic (University of New South Wales, Sydney), both internationally recognized researchers in the physics and engineering of amorphous metals. The event was organized in a hybrid format, hosted by CoE NOMATEN at the National Centre for Nuclear Research (NCBJ) on January 8th 2025, and continued on January 9th, 2025 as a joint scientific symposium at the Warsaw University of Technology.

Prof. Anna Boczkowska and Prof. Tomasz Wejrzanowski opened the scientific programme at the Warsaw University of Technology. The session included presentations by Silvia Bonfanti, Isabella Gallino, Piotr Błyskun, Łukasz Kurpaska, Jamie J. Kruzic, Łukasz Zrodowski, Jan Wróbel, Anshul Parmar, and Antoni Wadowski. Discussions during the symposium focused on the modeling, thermal behavior, and mechanical characterization of metallic glasses, including new experimental results and analytical approaches developed in ongoing Polish international collaborations.

The two keynote lectures were: Prof. Jamie J. Kruzic, *"Enhancing the mechanical properties of an additive manufactured Zr-based bulk metallic glass,"* presenting recent advances in laser powder bed fusion (LPBF) processing of bulk metallic glasses, including control of amorphous structure, defect minimization, and optimization of mechanical strength and fracture toughness and Prof. Isabella Gallino, *"On the glass transition of metallic glasses studied via fast scanning calorimetry,"* discussing novel insights into vitrification kinetics and the decoupling of relaxation processes in metallic glasses, based on results obtained using fast differential scanning calorimetry (FDSC) over a wide range of cooling rates (100–50,000 K/s).

The symposium provided an excellent opportunity for scientific exchange between NOMATEN researchers and the Warsaw University of Technology community, fostering discussion on experimental methodologies and theoretical approaches in metallic glass research. The participation of NOMATEN's early-career researchers underscored the Centre's commitment to developing new expertise and strengthening international collaboration in advanced metallic materials research.

This event marked the first NOMATEN scientific workshop of 2025 and continued NOMATEN's broader mission to promote international cooperation, knowledge transfer, and interdisciplinary research at the interface of materials science, physics, and engineering.

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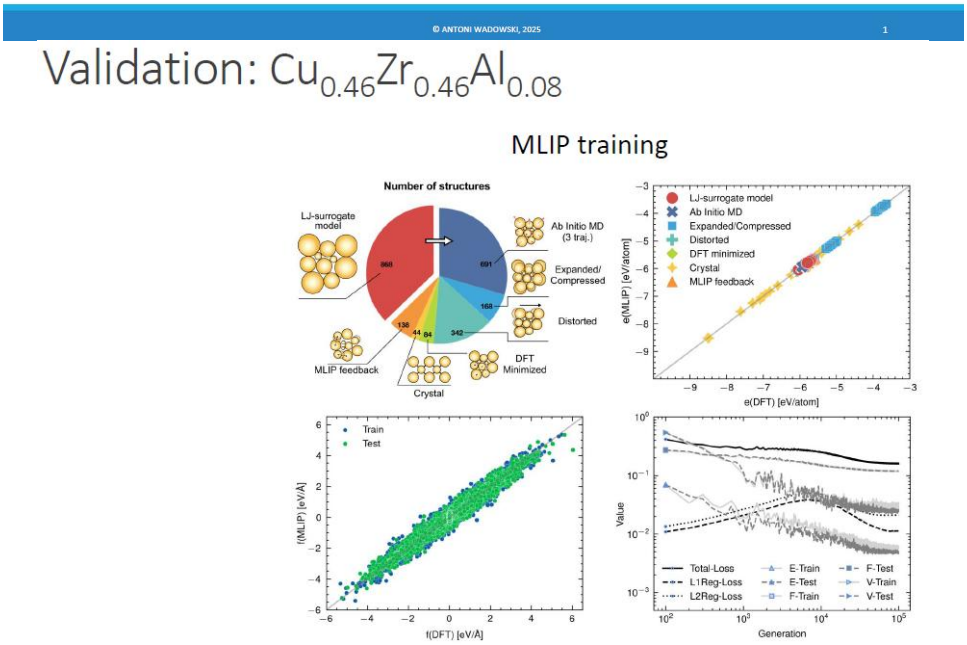
NOMATEN

Warsaw University of Technology

Machine Learning Potentials for Metallic Glasses

Antoni Wadowski, Anshul D.S. Parmar, Jesper Byggmästar, Jan S. Wróbel, Mikko J. Alava, Silvia Bonfanti



Excerpt from presentation by NOMATEN scientists during the research seminar, showcasing recent results in advanced metallic glass materials

Training on the Design of Biological Shields and Structural Components of the E6 Diffractometer (HZB) and Its Installation at the MARIA Reactor (H3 Beamline)

The training focused on adapting the biological shielding of the E6 diffractometer, originally operated at the Helmholtz-Zentrum Berlin (HZB), to the conditions in the physical hall of the MARIA research reactor at the National Centre for Nuclear Research (NCBJ). In particular, it addressed the necessary modifications of the E6 shielding to match the geometry and dimensions of the MARIA reactor's

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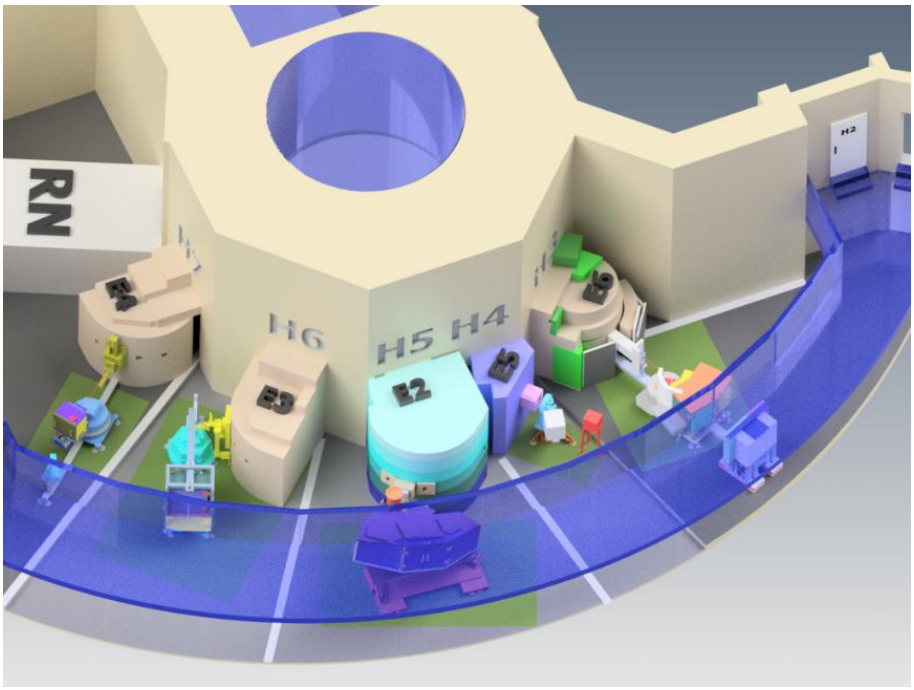
biological shield and the configuration of the horizontal channel H3, where the instrument is planned to be installed.

The technical requirements for the biological shield were discussed, including aspects of radiation protection, mechanical stability, and compatibility with the existing reactor infrastructure. The training also covered physical hall components that affect system integration, such as mounting interfaces, alignment axes, rail systems, and service space arrangements.

Special attention was devoted to the mechanical adaptation of key diffractometer assemblies, including the sample stage, detector table, and neutron beam stop, which must be redesigned due to the difference in neutron beam height between the H3 channel of the MARIA reactor and the former E6 position at the BER II reactor. This requires new support structures and positioning mechanisms to ensure precise alignment with the neutron beam.

The training also included the analysis of technical documentation, 3D models, and assembly plans, as well as discussions of potential engineering solutions to enable the effective integration of the instrument with the reactor infrastructure. Radiation safety considerations during installation and future operation were also addressed.

This training constituted one of the events organized within the framework of the Neutron for Science Alliance, an initiative launched by the NOMATEN Centre of Excellence to promote the development of research using neutron beams and to strengthen national competencies in the design and operation of advanced research instruments based on neutron techniques.



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Schematic view of the diffractometers installation and alignment within the MARIA reactor hall, with integration of mechanical assemblies and shielding structures

Technical visit of the NOMATEN CoE to the head office of Telefonika Kable S.A.

On February 19th, 2025, the NOMATEN Centre of Excellence team operating at the National Centre for Nuclear Research (NCBJ), together with scientific teams from the Faculty of Non-Ferrous Metals of the AGH University of Science and Technology in Kraków, the Institute of Fundamental Technological Research of the Polish Academy of Sciences (IPPT PAN), and the Jan Długosz University in Częstochowa, visited the headquarters of Telefonika Kable S.A. in Bydgoszcz. Telefonika Kable is a global market leader in the design and manufacture of medium-, high-, and extra-high-voltage cables and cable systems serving key sectors of the economy, including construction, energy (renewable and nuclear), and transport (rail and automotive).

The purpose of the technical visit was to explore potential areas of scientific and industrial cooperation in advanced materials and cable technologies for nuclear power and energy applications. Discussions focused on the possibilities of conducting joint research projects aimed at improving the radiation resistance and long-term durability of cables and insulation materials used in nuclear environments, as well as on the development of advanced metallic materials and protective coatings to extend the service life of tools, dies, and process equipment in wire and cable manufacturing.

During the visit, the NOMATEN CoE delegation toured production halls and testing laboratories, gaining valuable insight into the technological processes and quality assurance systems used by Telefonika Kable. A particular highlight was the visit to the company's state-of-the-art High Voltage Cable and Wire Testing Laboratory, accredited by the Polish Centre for Accreditation (PCA) in accordance with PN-EN ISO/IEC 17025:2018-02, enabling the company to perform advanced electrical, mechanical, and environmental testing in accordance with international standards.

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The meeting provided a solid foundation for initiating collaborative R&D efforts and knowledge exchange between the scientific partners and industrial experts. It also aligns with NOMATEN's strategic objective to strengthen industry-to-science cooperation in nuclear materials research, thereby contributing to the development of innovative solutions for next-generation energy systems.

The NOMATEN Centre of Excellence looks forward to further developing its cooperation with Telefonika Kable S.A., particularly in radiation-resistant materials, neutron and ion irradiation studies, and materials characterization under extreme operating conditions.

Participants of the NOMATEN Centre of Excellence technical visit to Telefonika Kable S.A. in Bydgoszcz during a tour of the production facilities and accredited High Voltage Cable and Wire Testing Laboratory (PCA ISO/IEC 17025:2018-02), on February 19th, 2025.

BECHTEL & CoE NOMATEN Workshop Meeting on Nuclear Materials Testing and Certification

On February 3rd, 2025, the NOMATEN Centre of Excellence at the National Centre for Nuclear Research (NCBJ) hosted a delegation of experts from Bechtel Poland, one of the world's leading engineering, construction, and project management companies. The purpose of the visit was to explore opportunities for collaboration in research, testing, certification, and qualification of materials intended for use in pressurized water reactor (PWR) technology. Bechtel, in consortium with Westinghouse Electric Company, is responsible for the design and construction of Poland's first nuclear power plant, located in the Pomeranian region, based on three AP1000 Gen. III/III+ reactors. The project is being developed on behalf of the investor, Polskie Elektrownie Jądrowe (PEJ). During the visit, Bechtel Poland's representatives were introduced to the research infrastructure and technical capabilities of the NOMATEN CoE laboratories, including advanced facilities for mechanical, microstructural, and radiation testing of structural materials.

The guests were also presented with the quality management system implemented at NOMATEN and the scope of accreditation of the Materials Research Laboratory (LBM), which operates in compliance with international standards. A central topic of the meeting was the discussion on the qualification and certification of materials for nuclear applications. Particular emphasis was placed on testing procedures and quality assurance practices performed at LBM in accordance with ASTM standards (American Society for Testing and Materials) and other international frameworks relevant to the nuclear industry. The participants exchanged views on the requirements for material validation, traceability, and documentation, which are essential for components used in safety-class systems. The programme also included a technical visit to the MARIA research reactor and the MARIA Neutron Laboratory, where the Bechtel experts learned about neutron irradiation experiments, post-irradiation examination techniques, and NOMATEN's growing competencies in materials behavior under extreme conditions.

This meeting served as an important step in establishing a foundation for future collaboration between Bechtel and NOMATEN CoE, focusing on R&D support for the Polish nuclear programme, as well as on training and knowledge exchange in materials science, testing, and nuclear quality assurance. Strengthening research and development capabilities in nuclear materials is a key driver of innovation and safety in the emerging Polish nuclear power sector. The NOMATEN Centre of Excellence looks forward to continuing cooperation with Bechtel and contributing to the development of a strong scientific and industrial ecosystem supporting Poland's first nuclear power plant.

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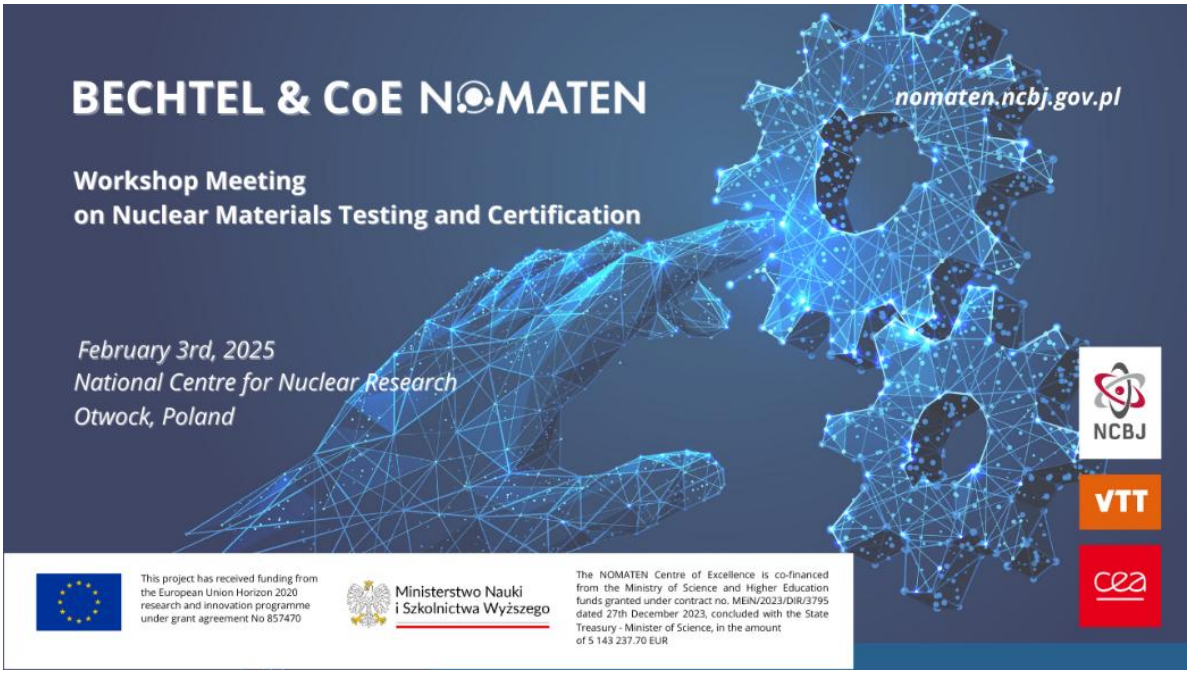

Bechtel Poland Experts and CoE NOMATEN Team visiting the NOMATEN Centre of Excellence laboratories, including the Materials Research Laboratory (LBM), during a study visit focused on material qualification and certification for PWR technology.

Strategic Industry–Research Alignment: Technical Visit and Project Training

On November 14th, 2025, Budimex S.A., Mostostal Kraków S.A., and NOMATEN conducted a joint Technical Visit and Project Training in Kraków in preparation for a collaborative proposal under the NUKLEOSTRATEG Programme, to be submitted in partnership. The event began with a technical visit to the Steel Structures Fabrication Plant (WKS) of Mostostal Kraków. During the visit, participants reviewed the company's production infrastructure, manufacturing processes, and quality assurance systems. The on-site discussions allowed the research team to better understand industrial constraints, certification requirements, and implementation challenges associated with nuclear-sector projects. This practical exposure helped align planned R&D activities with real production conditions and expected technology readiness levels. Following the site visit, the partners proceeded with the Project Training session, which focused on the strategic and technical preparation of a competitive proposal.

The meeting concluded with the definition of next steps, including the establishment of working teams, allocation of responsibilities, and agreement on a timeline for proposal development. The event strengthened the operational alignment between industry and research partners and laid the foundation for a high-quality, implementation-oriented project aimed at supporting the development of nuclear-sector competencies in Poland.

The CoE NOMATEN Team during a technical visit to the Steel Structures Fabrication Plant of Mostostal Kraków S.A. in Kraków

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Visit of Students from Gdansk University of Technology (GUT)

In March 2025, the NOMATEN Centre of Excellence at the National Centre for Nuclear Research (NCBJ) hosted a group of students from the Gdańsk University of Technology (GUT), representing two interdisciplinary student scientific associations: BioPhoton, focusing on biomedical engineering and medical physics, dedicated to nuclear energy and related technological applications. The visiting group included students of biomedical engineering, technical physics, automation, and energy engineering, mainly from the 3rd to 5th year of their bachelor's and master's programmes.

During the visit, the students were introduced to the diverse research and development activities conducted at the NOMATEN Centre of Excellence and NCBJ. The programme began at the ZDAJ division, where Ms. Joanna Walkiewicz presented the bunker dedicated to experiments with radiation detectors, with applications in both medical research and industrial innovation. The students expressed strong interest in the versatility of nuclear technologies and their potential cross-sectoral applications.

The next stop was the Materials Research Laboratory (LBM) of the NOMATEN Centre of Excellence, where Prof. Łukasz Kurpaska presented the laboratory's development, research capabilities, and plans. He encouraged students to consider potential collaboration with NOMATEN, including opportunities for doctoral studies, internships, and joint research projects. The visitors explored the material preparation and testing areas, observing methods of structural, mechanical, and microstructural analysis.

The visit concluded with a tour of the MARIA nuclear reactor, where the students had the opportunity to see the control room and learn about the reactor's operation principles. The reactor operator explained the fundamentals of reactor control, safety procedures, and the role of research reactors in scientific and industrial innovation.

The students showed great curiosity about career opportunities at NOMATEN and NCBJ, asking about internships, research collaborations, and employment opportunities during their graduate studies. Their enthusiasm highlighted the growing interest of young scientists in nuclear science and advanced materials research.

The visit served as an excellent opportunity to showcase the NOMATEN Centre of Excellence's research infrastructure and expertise, and to inspire the next generation of engineers and researchers to pursue careers in nuclear and interdisciplinary research. NOMATEN looks forward to continuing cooperation with the Gdańsk University of Technology through future educational and research initiatives.

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Students visiting the Materials Research Laboratory (LBM) of the NOMATEN Centre of Excellence, learning about materials testing and analysis techniques.

NOMATEN CoE Discussion Panel during Conference EU Research and Innovation Framework Programs and Europe's Technological Sovereignty

The first of two conference days at the University of Warsaw, organized under the Polish Presidency of the Council of the European Union, was dedicated to the event "EU Research and Innovation Framework Programs and Europe's Technological Sovereignty." The conference gathered representatives from European institutions, academia, and industry to discuss Europe's technological competitiveness, innovation policies, and the strategic role of research in strengthening the continent's technological sovereignty.

Dr. Katarzyna Jodko-Piórecka chaired the thematic panel "Success stories of H2020 and Horizon Europe projects – examples of science–industry cooperation and implementation of high technologies." The discussion focused on the importance of close collaboration between science and industry to

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accelerate innovation, commercialize advanced technologies, and deliver tangible impacts on industrial development and European research excellence.

The panel featured distinguished speakers: Krzysztof Samp, Vice-President, ITTI Sp. z o.o.; Jacek Olszański, Board Member, XTPL S.A.; Katarzyna Materka, EU Projects Manager, 7bulls.com Sp. z o.o. and Professor Jacek Jagielski, Coordinator of the NOMATEN Centre of Excellence, National Centre for Nuclear Research (NCBJ);

During his contribution, Prof. Jacek Jagielski highlighted the mission of the NOMATEN Centre of Excellence, emphasising its positive impact on science, research, and industry. He highlighted NOMATEN's role in bridging the gap between fundamental research and practical applications, thereby advancing high-tech materials and innovative solutions for key industrial sectors.

Prof. Jagielski also underlined the importance of building strong European collaborations through EU Projects and Networks, with a special role for Teaming for Excellence projects, stressing the need for this type of funding instrument to support the development of European and global research networks, foster innovation-driven scientific environments, and strengthen the long-term competitiveness of the European Research Area.

The session provided valuable insights into successful Horizon projects, showcasing how strategic partnerships between research institutions and industry foster the development and deployment of breakthrough technologies across Europe.

Prof. Jacek Jagielski, during the panel discussion on Horizon Europe success stories at the University of Warsaw conference, EU Research and Innovation Framework Programs and Europe's Technological Sovereignty.

CoE NOMATEN at FISA–EURADWASTE 2025 - International Euratom Research and Training Conference

The 11th edition of the International Euratom Research and Training Conferences on Fission Safety of Reactor Systems (FISA) and Radioactive Waste Management (EURADWASTE) was held in May 2025 as one of the flagship scientific events of the Polish Presidency of the Council of the European Union. The conference was organised by the European Commission (DG Research & Innovation) in cooperation with the National Centre for Nuclear Research (NCBJ), the Sustainable Nuclear Energy Technology Platform (SNETP), the European Nuclear Education Network (ENEN), the European Nuclear Society (ENS), and the ENS Young Generation Network (ENS-YGN).

The event gathered policymakers, research organisations, industrial leaders, and representatives of international institutions such as the IAEA, OECD/NEA, and WNA, providing a high-level forum for discussions on nuclear safety, radioactive waste management, small modular reactors (SMRs), and Euratom-funded research and innovation. The conference presented the progress of projects implemented under the Euratom Research and Training Programme since 2022 and fostered dialogue on strategic directions for Europe's nuclear R&D in the context of the forthcoming European framework programme.

The NOMATEN Centre of Excellence at the National Centre for Nuclear Research played an active role throughout the event, presenting its research infrastructure and scientific expertise at a dedicated exhibition booth. NOMATEN's stand showcased its core competencies in advanced and radiation-resistant materials, radiopharmaceutical sciences, and computational modelling, as well as its role as a Teaming for Excellence Centre jointly established with CEA (France) and VTT (Finland). Visitors to the booth included representatives of European research institutions, Euratom project coordinators, and policy experts, who expressed strong interest in NOMATEN's potential for collaborative projects and technology transfer.

NOMATEN's participation in FISA–EURADWASTE 2025 strengthened the visibility of Polish research within the European nuclear innovation landscape and highlighted the success of international cooperation supported by the European Commission. The Centre's presence also underlined its contribution to the goals of the European Research Area, particularly in integrating scientific excellence with industrial applications.

A key highlight of the conference was the official signing of a memorandum of cooperation between the National Centre for Nuclear Research (NCBJ) and the French Commissariat à l'énergie atomique et aux énergies alternatives (CEA) on May 13th, 2025, in Warsaw. The agreement was signed by Professor Agnieszka Pollo, Acting Director of NCBJ, and Stéphane Sarrade, Director of Low Carbon Energy Programs at CEA, in the presence of representatives of both institutions and the Embassy of France in Poland, including Ambassador Étienne de Poncins.

The memorandum defines new areas of collaboration between NCBJ and CEA, including the exchange of scientists, joint training programmes, and R&D cooperation, and establishes the framework for future activities. It complements the long-standing and fruitful collaboration between both institutions, including the partnership within the NOMATEN Centre of Excellence. The signing also follows directly from the Polish-French Treaty of Nancy and the French-Polish Nuclear Cooperation

Plan, both signed on May 9th, 2025, reaffirming the strong bilateral commitment to advancing civil nuclear research and technology.

The agreement and the overall context of the FISA-EURADWASTE 2025 conference reflect the dynamic development of Polish–French cooperation in nuclear energy and reinforce NOMATEN's role as a bridge between scientific research, technological innovation, and international collaboration toward Europe's sustainable nuclear future.

Exhibition booth of the National Centre for Nuclear Research (NCBJ) and the NOMATEN Centre of Excellence at the FISA-EURADWASTE 2025 conference, showcasing scientific and research achievements in nuclear materials and advanced technologies

Signing of the cooperation memorandum between NCBJ and CEA in the presence of Ambassador Étienne de Poncins, Warsaw, May 13th, 2025.

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CoE NOMATEN Team

During 2025 the NOMATEN Centre of Excellence continued to develop its staff resources, building on the strong foundations established in previous years. The team is composed of leading scientists, specialists, and technical and administrative staff, together forming an international and multidisciplinary work environment supporting advanced research in materials science and radiopharmaceuticals.

Team diversity: NOMATEN's team is multidisciplinary and international, comprising employees from diverse scientific backgrounds and nationalities. This diversity enriches the work environment, facilitates innovative approaches, and strengthens NOMATEN's position as an internationally recognized research centre. We are also committed to achieving gender balance. It reflects a strong commitment to diversity and inclusion within the NOMATEN team, fostering an equitable and supportive work environment. Achieving such a balanced representation of 18 women and 30 men is a significant accomplishment that enhances innovation, collaboration, and overall organizational performance.

Age structure and career development: Almost 70% of staff are under the age of 35, which supports dynamic development and succession planning. The NOMATEN invests in developing early career researchers and fostering an open, inclusive atmosphere, organising both mentoring and professional development events.

Recruitment and staffing changes: Between November 2024 and October 2025, several new scientists and technical/administrative employees joined the team, including postdoctoral researchers and PhD students, in line with the Centre's research agenda and ongoing grant activities. Periodic performance reviews are conducted, and the most successful fixed-term staff are offered permanent contracts. Staff turnover results mainly from the completion of fixed - term research and support projects.

Internationalisation and support for foreigners: A significant portion of activities are dedicated to supporting the internationalisation of the team and the effective onboarding and support of foreign employees. The NOMATEN provides comprehensive assistance with legalisation of stay, adaptation processes, and promotion of a culturally open, multilingual workplace. The proportion of foreign staff remains stable and is a strategic focus for Centre's future growth.

In accordance with the rules in force in NOMATEN CoE, all employments are for a fixed term; in the case of a positive recommendation after passing a periodic employment assessment, the employment may be changed to permanent position.

New NOMATEN Team Members

In the 2025, five new scientists were employed in NOMATEN CoE, namely: M. Fedorov (post-doc), F. Kaśkosz (post-doc), D. Khomenko (post-doc), M. Ponchelle (PhD student), and W. Peichen (PhD student).

Four recruitment positions are still open, and the CoE is actively seeking new talent. New positions are financed from newly acquired funding: Sonata BIS projects (led by Prof. Kurpaska and Dr. Bonfanti), First Team (led by Dr. Bonfanti), and Sonatina (led by Dr. Kalita).

1. Dr. Dmytro Khomenko has been employed in the Materials Design and Manufacturing Group, led by Dr. Bonfanti, as a postdoctoral researcher.

2. Dr. Mark Fedorov has been employed in the Functional Properties Group led by Prof. Ł. Kurpaska in a post-doc position. Due to the numerical background of this person, Dr. Fedorov is led by Prof. Dominguez, who is leading the Multiscale Hybrid Modeling of Materials Group.
3. MSc. Peichen Wang has been employed in the Materials Design and Manufacturing group led by Dr. Bonfanti as a PhD Student.
4. Dr. Filip Kaśkosz has been employed in the Materials Design and Manufacturing Group led by Dr. Bonfanti as a post-doc.
5. MSc. M. Ponchelle has been temporarily employed at Novel Radiopharmaceuticals for modeling purposes, group led by Prof. M. Pruszyński.

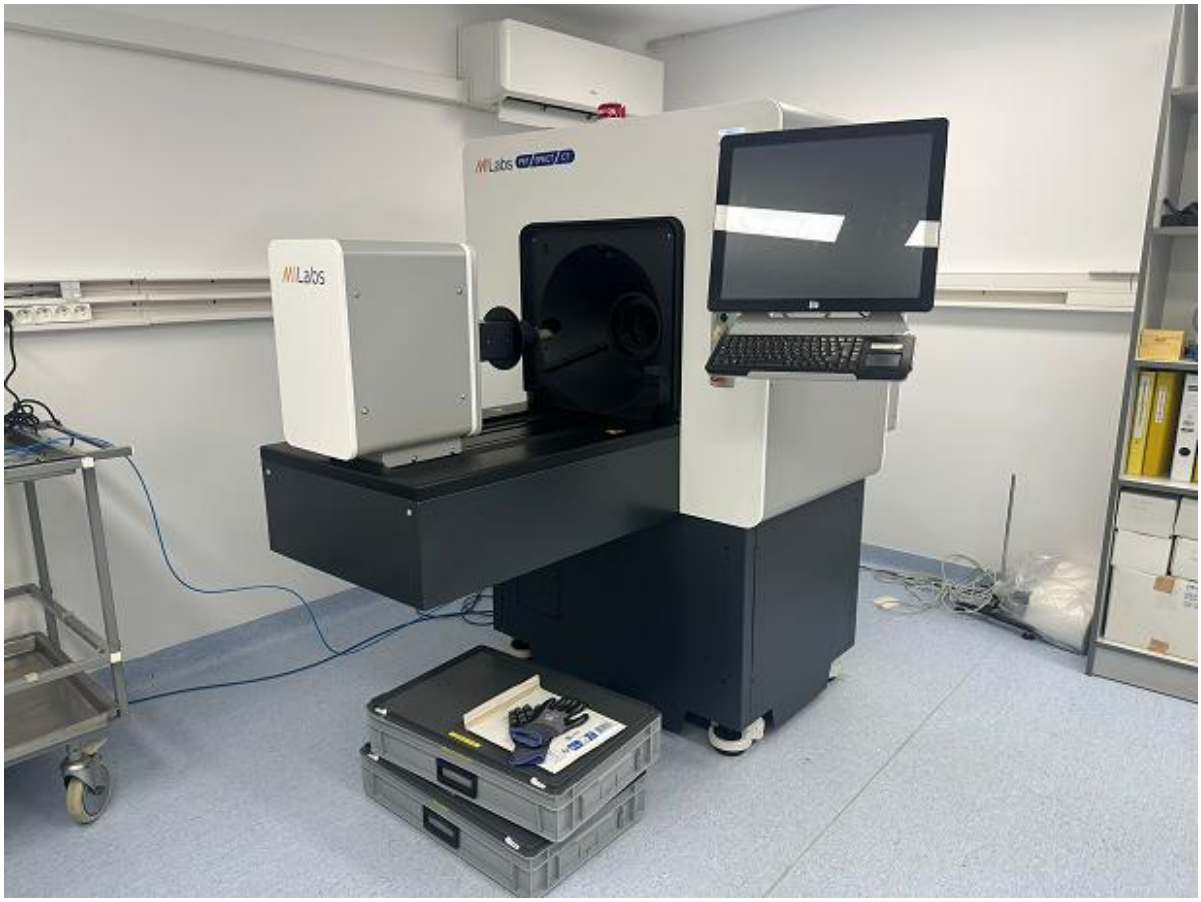
Infrastructure news

The most critical task undertaken in the 4th RP was undoubtedly the initiation of a large investment grant under the KPO program, worth 22.7 million EUR, and the completion of the modernization of research laboratories for the radiopharmaceutical group (with an investment value of approximately 250,000 EUR – including getting a green light from Polish National Atomic Agency to use the labs dedicated to radioactive studies, class II laboratories). Both of these Milestones are an obvious step on the way to achieving a state that allows independent scientific research at a world level.

It is also worth emphasizing the launch of a joint research project with the MARIA reactor team and the realization of the first structural studies of samples irradiated with neutrons in a nuclear reactor. Considering the dramatically low availability of this type of capability in Europe, the launch of this program is an excellent opportunity for NOMATEN to join the higher level of research on materials for nuclear applications. Finally, one should mention advancements in Maria Neutron Laboratory (another KPO-funded project), which will allow, in the future, the use of neutrons not only to activate the material, but also to study its structural properties via neutron diffraction.

The materials research laboratory of CoE NOMATEN has been significantly expanded through the NOMATEN CoRE project funded by the National Reconstruction Plan (KPO). The newly acquired infrastructure includes a tribotester, an optical profilometer, and a scanning electron microscope (SEM) with EDS and EBSD systems, enabling advanced mechanical, surface, and microstructural analyses. The tribotester allows simulations of wear processes in air or liquids, with the option to combine with a potentiostat/galvanostat for controlled tribocorrosion studies. It supports tests at elevated temperatures (above 300 °C), enabling investigation of high-entropy alloys, coatings, and biomedical materials such as Ti-based implants. Additional laboratory equipment includes systems for corrosion testing, material synthesis, and sample preparation – such as a heating stirrer, ultrasonic cleaner, temperature-controlled incubator, deionized water purification system, and an installation for producing spherical ceramic grains. Together, this infrastructure supports NOMATEN's advanced research on material degradation, corrosion, and wear, serving industrial and scientific applications in projects such as INNUMAT and Eurofusion.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857470



The VECTor7 PET/SPECT/CT system from MiLabs – an advanced multimodal device for preclinical imaging of small animals, integrating PET, SPECT, and CT techniques.

The Radiopharmaceutical Group has been equipped with a comprehensive range of modern laboratory instruments supporting research in radiochemistry, molecular imaging, and cell biology. The facilities are designed to cover the entire workflow, from radiotracer synthesis and quality control to in vitro and in vivo evaluation.

The laboratories include specialized infrastructure for sample preparation, chemical synthesis, and radiochemical analysis, ensuring precision and reproducibility in experimental work. Advanced imaging and analytical systems enable high-sensitivity detection and quantification of radioactive and non-radioactive compounds. Dedicated equipment for cell culture, microscopy, and biological assays provides controlled environments for studying radiopharmaceutical interactions at the cellular level.

For preclinical research, the group is equipped with state-of-the-art multimodal imaging technology that allows simultaneous acquisition of functional and anatomical data in small animals, supporting quantitative evaluation of tracer distribution and pharmacokinetics. Complementary instruments ensure proper sample storage, sterilization, and biosafety, creating an integrated ecosystem for translational radiopharmaceutical research.

Together, this infrastructure provides a robust platform for the development and evaluation of new radiopharmaceuticals, combining precision analytics, biological experimentation, and advanced imaging capabilities within a single, well-coordinated research environment.

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Summary

The NOMATEN Centre of Excellence has successfully moved beyond its initial start-up and consolidation phase and has entered a stage of structural maturity and strategic expansion. Built within the framework of the National Centre for Nuclear Research, the NOMATEN has developed a strong scientific foundation, established international collaborations, and positioned itself as a credible partner for advanced materials research supporting nuclear and high-technology sectors.

As highlighted, during recent Technical Visits and Project Trainings organized together with industrial partners such as Budimex S.A. and Mostostal Kraków S.A., the NOMATEN is increasingly operating at the interface of fundamental science and industrial implementation. The Centre has demonstrated readiness to respond to strategic opportunities, including large-scale proposals submitted under FENG competitions, contributions to the refreshment of the Polish Strategic Infrastructural Roadmap, participation in Nucleostrateg initiatives, and engagement in CONNECT-NM projects. These activities confirm that NOMATEN is no longer building its identity, it is actively shaping it.

At the same time, NOMATEN recognizes that its greatest asset is its people. The Centre remains open to ambitious and creative researchers from external institutions who are eager to grow in an environment that values independence, innovation, and responsibility. Unlike many established laboratories where structural barriers may limit career progression, NOMATEN offers space for development, leadership, and long-term scientific impact. The strategy is clear: publish more high-quality papers, graduate more PhD students, empower emerging research leaders, and attract increasingly competitive national and international projects.

Looking forward, the Directorate of the CoE has identified several priority areas that will determine long-term sustainability. These include strengthening collaboration between research groups, increasing the quality and impact of scientific publications, expanding participation in high-prestige funding schemes (including ERC calls), supporting the establishment of a PhD programme in materials engineering within the NCBJ doctoral school, intensifying joint applications with strategic partners, particularly in Horizon Europe, and deepening cooperation with companies seeking entry into the Polish Nuclear Power Programme supply chain.

Building a new Centre of Excellence is inherently complex and demanding, often accompanied by both challenges and achievements. However, by continuously improving internal integration, scientific excellence, funding competitiveness, doctoral education, and industrial engagement, NOMATEN is positioning itself as a sustainable, high-impact research centre capable of delivering both fundamental breakthroughs and practical technological solutions for the nuclear and advanced materials sectors.

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