NOMATEN

NCBJ

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VTT

ANNUAL REPORT 2020

European Funds

Republic of Poland

FNP Foundation for Polish Science

European Union

NOMATEN

VISION AND MISSION

NOMATEN Centre of Excellence in Poland is a scientifically autonomous Department of the National Centre for Nuclear Research (NCBJ)in Otwock/Świerk, Poland. It is devoted to research and development on multifunctional materials for industrial and medical applications – topics of significant societal and economic importance. The Centre will exploit the unique nuclear research infrastructure of its Partners, and tap into expertise from Poland and Europe. Our objective is tobecome a world-class research Centre, devoted to materials combining advanced structural and functional properties. The long-term strategy focuses on two strategic research and innovation topics:

- novel high-temperature, corrosion and radiation resistant materials for industrial applications,
- novel radiopharmaceutical materials for medical applications.

NOMATEN

01 NATIONAL AND EU RESEARCH AND INNOVATION

EU Research and Innovation Needs):
H 2020 (Euratom, NMP and Health)
ETPs (SNETP, EuMaT, Nanomedicine,...)
ESFRI (AIDA, HIPER, EURO-BIOMAGING,...)

02 CENTRE OF EXCELLENCE STRATEGIC RESEARCH AND INNOVATION TOPICS

R&I Topic 1:
Novel High-Temperature-, Corrosion- and Radiation-Resistant Materials for Industrial Applications

R&I Topic 2:
Novel Radiopharmaceutical Materials for Medical Applications

03 CENTRE OF EXCELLENCE (CENTRE OF EXCELLENCE) ADDRESSING NATIONAL AND EU NEEDS

National SMART Specialistation (NSS):
NSS "Innovative technologies and Industrial Processes" (NSS 13.IV and NSS 14.V)
NSS "Healthy Society" (NSS 1.IX and NSS 2.II)

04 CENTRE OF EXCELLENCE PARTNERS WITH COMPLEMENTARY FACILITIES AND EXPERTISE

Thanks to the extensive partnership, novel form and research autonomy, the establishment and operation of the NOMATEN will change the R&I performance in Poland, by creating novel organisational structure and increased international presence through strong partnerships. It will help to mitigate the disparities between "widening" and "well-performing" EU countries.

It will also help to exploit the potential of Europe's talent pool in the most efficient way for the purposes of Europe's competitiveness and its ability to address societal challenges in the future by focusing on international participation and cooperation.

PROJECT PARTNERS	FACILITIES	EXPERTISE
NCBJ	• MARIA Reactor • MRL Hot Cells • CIŚ Supercomputer	• ODS Steels • Radiopharmaceutical Development • Preclinical Research
cea	• LECI Laboratory • JANNUS Accelerator • JOLIOT chemistry, radiochemistry and in vivo imaging platforms	• Large Specimen • Characterisation and Simulation • Molecular Labeling and Imaging
VTT	• Centre for Nuclear Safety (Class A, B and C)	• Ageing and Embrittlement • Miniature Specimen Characterisation • Nuclear Waste Management • Molecular Diagnostics

LETTER FROM THE NOMATEN DIRECTOR

The NOMATEN Centre of Excellence has started operating in September of 2018. The effort is a team one, with funding and supporting resources from two main sources, the H2020 Teaming project as a capacity building measure and the Foundation for Polish Science (FNP) as a means of research excellence. The team is built from the partnership of NCBJ as the hosting organization and the French CEA and Finnish VTT, both well known in research and in the exploitation of R&D for industrial cooperation. I myself started as the Director of the Centre of Excellence a year later, in September 2019.

The second year of the Centre of Excellence is ending and what we have achieved, I would summarize by three main achievements. In the background of the success of the initiative, we need to have a smooth cooperation among our supporting team. This means the three Teaming partners, FNP and the International Scientific Committee, overseeing NOMATEN strategic research and innovation agenda. This has been a success. As evidence for this, I refer to the progress of the capacity building operations, from creating NOMATEN its own materials science experimental environment to the recruiting of Research Group Leaders and members. Of course, one must allow for the problems created by the pandemic circumstances in daily science and in recruitment but we have overcome these quite well. Finally, the Centre of Excellence has been already active in networking and in science, as the number of papers and their quality shows.

The next twelve months will be period of rapid growth. The Research Groups will reach the initial "seed" size and initiate their research activities including collaborating with others and reaching out to the Teaming partners. The build-up of our own materials science core is, so I hope, finished during that time. We will initiate new activities across the board. This means showing our flag and contributing to the European materials science effort in particular in cases close to our key mission of multifunctional materials. It includes starting a vigorous effort in radiopharmaceutical research together with the partners and in order to support the key CERAD project (https://www.ncbj.gov.pl/en/cerad). Our growth should be reflected in key areas where we wish to be successful. From doing excellent science to supporting Polish and European nuclear energy programmes and research in materials the important goal is the success of the NOMATEN

Prof. Mikko Alava
NOMATEN Director

> **“ *AS EVIDENCE FOR THIS, I REFER TO THE PROGRESS OF THE CAPACITY BUILDING OPERATIONS, FROM CREATING NOMATEN ITS OWN MATERIALS SCIENCE EXPERIMENTAL ENVIRONMENT TO THE RECRUITING OF RESEARCH GROUP LEADERS AND MEMBERS*

LETTER FROM THE ISC CHAIRMAN

When I was asked to chair the International Scientific Committee (ISC) of NOMATEN, I was thrilled by the opportunity to contribute to the ambitious plan to establish in Poland an international Centre of Excellence in the field of multifunctional materials for industrial and medical applications. At the same times I was fully aware that such an undertaking poses formidable challenges not only depending on the quality of the teams involved, but also on the Centre of Excellence organization, its strategic choices and the effective cooperation among the national and international stakeholders.

The fact that NOMATEN was founded on the partnership of the Polish NCBJ, the French CEA and the Finnish VTT, which all have a strong reputation both in research as well as in its application, was definitely an excellent starting point, complemented by the fact that there was a clear line of funding and support from two main sources, the H2020 Teaming project and the Foundation for Polish Science (FNP), was definitely setting the conditions for a good starting point.

I surely can affirm that throughout all the period of my mandate, I have witnessed a constant and fruitful growth of the cooperation of all the institutions mentioned above, which are proactively contributing to speed up the transition of NOMATEN from a "green field" infrastructure to an established reality.

In this context, the ISC has been central in the setting up of the calls and in the subsequent selection of the NOMATEN Director and of the Group Leaders, which have been completed successfully. Another important process, the selection of a Leader for the Radiopharmaceutical Group, is currently underway, with the aim to be completed by the end of the year, despite the limitations imposed by the Covid-19 pandemics.

As a general comment, the ISC was very positively impressed by the number and the quality of the applicants, which indicate that NOMATEN enjoys already credibility and attractiveness in the international community.

The ISC is also engaged in a continuous dialog with the Centre of Excellence managing bodies, providing its recommendations in accordance to its oversight and evaluation roles defined in the governance rules. As a result of this interaction, we fully endorse the short-term strategy proposed by the Director to bring NOMATEN in the next twelve months to a fully operational condition, populating the seed structure of the Research Groups, while in parallel setting up the necessary logistics and instrumentation to allow them to initiate their research activities. This ambitious and yet realistic plan foresees a strong collaboration with national and international bodies and in particular with the TEAMING partners.

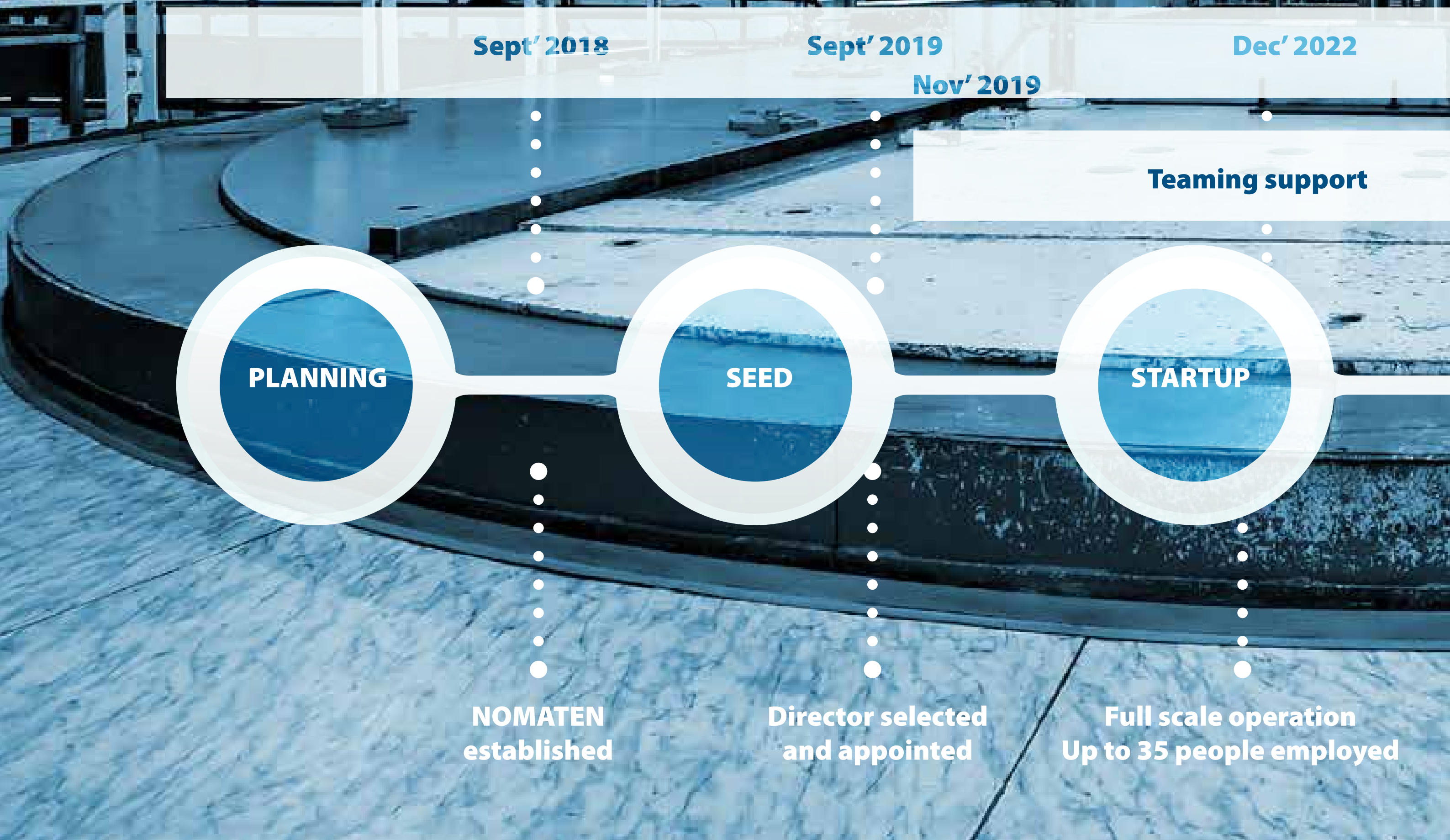
As a final consideration, I want to convey the ISC appreciation for the support and openness that all the stakeholders have provided to us, greatly facilitating our task: we are looking forward to the next steps and we are fully engaged in contributing our best to the success of this initiative, which would be a pristine example of convergence of National and EU values.

Prof. Sergio Bertolucci
International Scientific Committee Chairman
Former Director of CERN

HISTORY

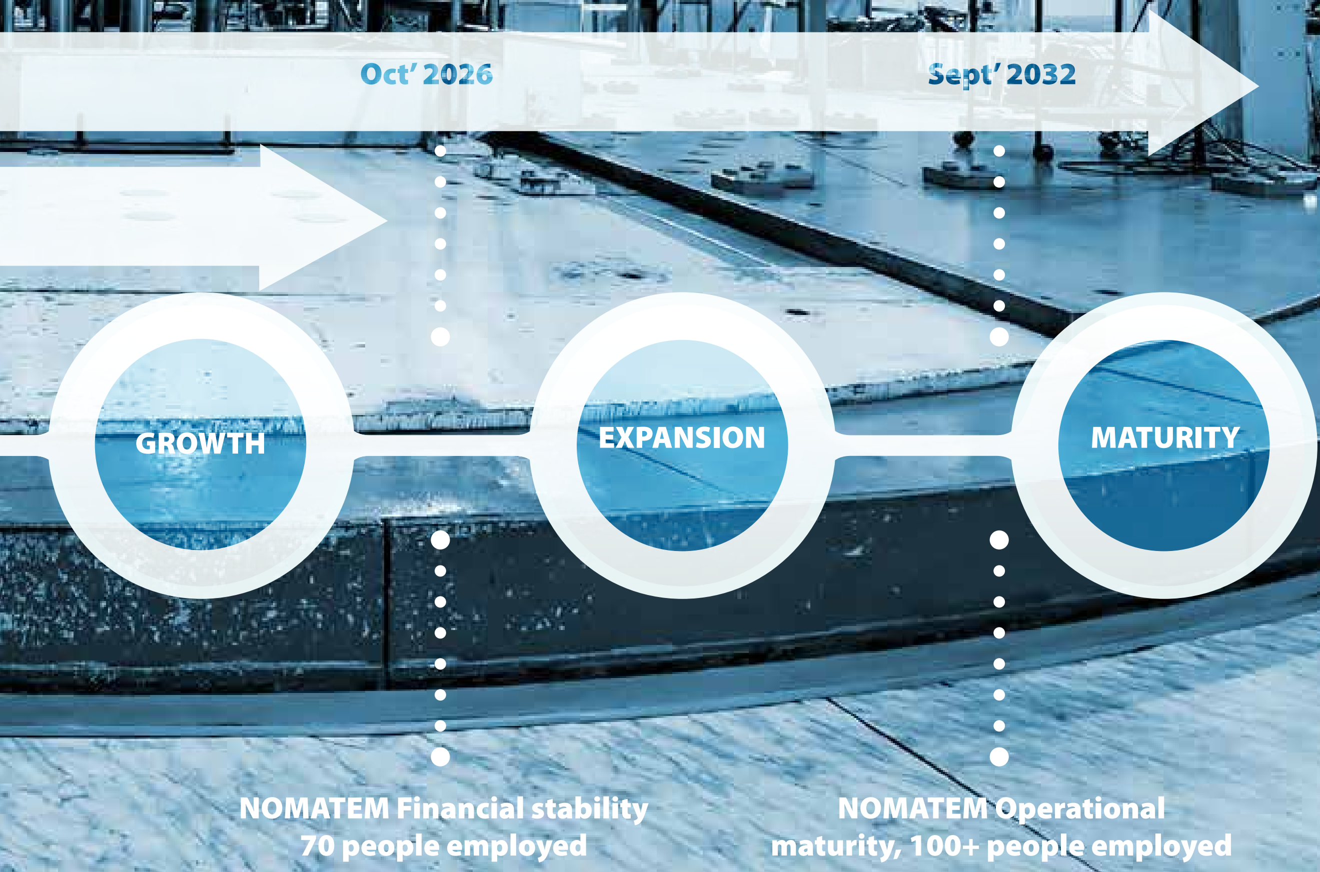
NOMATEN BACKGROUND

The idea behind the NOMATEN Centre of Excellence was born as a result of cooperation between Centre's Partners: the National Centre for Nuclear Research (NCBJ) in Poland, the Commissariat à l´énergie atomique et aux énergies alternatives (CEA) in France and VTT Technical Research Centre of Finland Ltd. Combining their diverse experiences and capacities, using the support of the Teaming framework of the European Commission Horizon 2020 Teaming Phase 1 programme, the Partners have prepared a detailed vision and business plan for the creation of NOMATEN. With the support of the Foundation for Polish Science grant within the International Research Agenda Plus competition, the NOMATEN Centre of Excellence has been established in September 2018, as a scientifically autonomous unit within NCBJ. Since then, the Centre has successfully followed the plan leading to its main goal: the creation of a research institution that will help nurture scientific excellence in Poland and have a significant research and innovation impact on a broader, European scale.



Creation of NOMATEN, almost a year before the award of the Teaming grant, has been a joint decision of the Centre partners, reflecting the perceived importance of the research topics of the Centre and the need to build appropriate organisation and expertise. In this context, the Teaming grant performs the function intended in the original EC Horizon 2020 Widening programme: it supports the initiative to which the partners are truly committed.

The crucial goal for the first year of NOMATEN outset (until September 2019), in addition to organisational and legal activities, was the selection of the Centre Director. This task has been conducted by the International Scientific Committee, on the basis of experience and research excellence. The ISC selected Prof Mikko Alava from Aalto University as the head of NOMATEN . Immediately afterwards, the Centre begun the selection process of the Research Group Leaders. As in the case of the Director, the process has been conducted by the ISC, to ensure not only that the candidates would have the necessary experience and knowledge, but also to provide independent evaluation of their research agendas would form a coherent whole, needed for NOMATEN operation.



NOMATEN PARTNERS

Created in 1945, the French Alternative Energies and Atomic Energy Commission (Commissariat à l'Énergie Atomique et aux énergies alternatives, CEA) is a French government-funded institution. categorised as a public research establishment of an industrial and commercial nature (CEA draws on first-class fundamental research in the fields of low carbon energy, information technologies, health technologies, defence and global security.

As an energy expert, CEA contributes to the implementation of the French nuclear and renewable energy export policy, providing scientific and technical support to the French government as well as to the definition of the short, medium and long-term French energy policies.

CEA conducts key research on carbon-free energy - nuclear and renewables - as part of a sustainable energy strategy aimed at strengthening the national strategic independence by reducing dependence on fossil fuels, encouraging the development of new industrial sectors, minimizing energy costs while meeting the highest requirements in terms of safety and environmental protection.

CEA's Energies Division (DES) provides the French government and industry with technical expertise and innovation in low carbon (nuclear and non nuclear) power generation systems as well as coupling systems to develop sustainable and mixed energy that is both safe and economically competitive

Another division of the CEA is Fundamental Research Division (DRF). Recently created (January 2016), the general objectives of this division are to achieve and make fundamental research in physics, materials including nanosciences, biotechnology and health domains, proposing notably innovative approaches and developments in diagnosis, therapeutics and prophylaxis.

Frédéric Joliot Institute for Life Sciences is one of the nine institutes of DRF. Research performed is fundamental, technological, methodological or applied, which gives the institute a very complete positioning, from research to industry, to respond to societal issues related to health, energy and bio-defense. The Institute expertise thus covers a broad spectrum of skills, ranging from biology to mathematics and computing to medicine, physics and chemistry. This multidisciplinarity enables the Institute to study living objetcs in all their complexity, from molecular instruments to the whole organism.

Long time collaborations exist between CEA, VTT and NCBJ that justifies the participation to NOMATEN. CEA expectations are to continue to be a research partner for the Centre of Excellence , to continue on going collaborations on actual topics as well as to identify new topics and launch new collaborations. CEA also wishes to be a guide along the Centre of Excellence startup and a help for its development. It is also to aggregate forces, organize and use our complementarity, build stronger projects, get fundings and share experimental practices in a win/win relation. CEA also expects to disseminate its computer codes and enlarge community of users & developers on the field of molecular dynamics, dislocations, ab initio, multi-purpose platforms. The CEA expectation for the participation in the NOMATEN project is also to access to Polish R&D already unshared results and topics not addressed by CEA and to access to Polish facilities & resources (i.e. MARIA (irradiation devices, sensor qualification...), POLATOM, material characterization equipment, new investments.

The first year has been mainly devoted to the launch of the Centre of Excellence, the writing of several rules and quality documents, the recruitment of the first new staff (research groups leaders mainly). CEA is now expecting for the second year the development of the scientific aspects of the collaboration, through the identification and the launch of projects of common interest, as well as the sharing of students or junior staff .

More information at https://www.cea.fr/

VTT is one of Europe's leading research institutions, owned by the Finnish state. VTT's task is to advance the utilisation and commercialisation of research and technology in commerce and society. Through scientific and technological means, VTT enables turning large global challenges into sustainable growth for businesses and society. VTT's research is guided by the company's lighthouse themes: climate action, resource sufficiency, good life, safety and security, and industrial renewal. VTT was established in 1942 and has almost 80 years of experience in cutting-edge scientific innovation achieved together with private companies and the public sector. VTT's strategy is to help companies and society in solving global challenges by utilising science and technology. The success of VTT is achieved, when the customers undertake new and sustainable business activities that contribute to a brighter future.

VTT has transformed from governmental, Finnish technical research organisation into a non-profit limited company to support innovation and technology development worldwide and tackle the global grand challenges. With VTT's strong experience on customer work, excellence in science, and commercial and EU level activities VTT supports NOMATEN through the NOMATEN Teaming EU project.

Key figures (2019):

- 245 total revenue, MEUR
- 2,103 number of employees
- 406 patent families
- 27 % of Finnish innovations are completely or in part results of VTT's expertise
- 47 % of our turnover comes from abroad

More information at https://www.vttresearch.com/en

NOMATEN PARTNERS

NOMATEN PARTNERS

NCBJ

The National Centre for Nuclear Research (pol. NCBJ) is the research institute, operating in accordance with the provisions of the Act of April 20, 2010, on research institutes The Institute reports to the Minister of Climate and Environment.

NCBJ is the largest research institute in Poland, with more than 1,100 employees, including over 200 people with a doctoral degree. About 70 people have the status of independent research workers. NCBJ employs more than 200 people with the title of a professional engineer. The headquarters of the institute is in Otwock/Świerk. The Institute conducts scientific research and development and implementation works in an area related to subatomic physics, radiation physics, nuclear and plasma physics and technologies, material physics, particle acceleration devices, and detectors; the use of these devices in medicine and economy, as well as the search and production of radiopharmaceuticals.

The Institute has the highest A+ category awarded as a result of the evaluation of Polish scientific units in 2017. The scientific position of the institute is also determined by the number of publications (approx. 500 per year) and the number of citations measured by the Hirsch index (more than 160). These values place NCBJ in the top five among all research and academic units in Poland carrying out comparable research. The Institute uses the only in Poland research nuclear reactor named Maria and in a unique way combines basic research, with application research, the construction of apparatus and devices and their production, being at the same time a significant producer of radiopharmaceuticals on a global scale.

The Polatom Radioisotope Center operating in NCBJ exports its products to over 80 countries. NCBJ is one of the few manufacturers of radiographic accelerators in the world. It also produces unique equipment for large international research laboratories (CERN, XFEL, ESS ...). Świerk Computer Centre is one of the six largest supercomputing centers in Poland, specializing, in the processing of data from high energy physics experiments. The transfer of technologies developed at NCBJ is supported by Świerk Science and Technology Park, operating within the structure of the institute.

NCBJ conducts both on its own and collaborative doctoral studies, being the leader of two Interdisciplinary Doctoral Studies in national and international cooperation. Every year, the dedicated Department of NCBJ conducts extensive educational activities in the field of radioactivity and nuclear energy for more than 150 entities (schools, universities, public institutions etc ...). It is the only facility of its kind in Poland and in many ways unique in the world.

In recent years, the research infrastructure of the institute has been intensively expanded. At present, it consists of, among others, the Center for the Design and Synthesis of Molecularly Targeted Radiopharmaceuticals "CERAD" equipped with a 30/15 MeV cyclotron, Polish free-electron laser PolFEL, CENTRIX - industrial radiography center, and the newly established Center of Excellence in Multifunctional Materials for Industry and Medical Applications - NOMATEN.

More information at https://www.ncbj.gov.pl/

OBJECTIVES

NOMATEN is aimed to become a world-class international Centre of Excellence in the field of multifunctional materials for industrial and medical applications and a focal point for collaboration between research community, industry and government. A place where multinational, multidisciplinary and versatile team of scientists performs advanced research and create innovations, enjoys academic freedom, has access to world-class research infrastructure and is supported by technical, management and business professionals.

NOMATEN mission is to serve impelling needs of industry and society. Examples of the NOMATEN research include today new types of steels (such as Oxide Dispersion Steels) and alloys (such as High Entropy Alloys), nickel and zirconium alloys and alumina coatings. We intend to focus on materials designed to work in extreme conditions, studies of corrosion and mechanisms of its prevention, modification of material surfaces leading to desired properties. Understanding of the behaviour of materials in such conditions and resulting ideas of new, improved materials, tools and services are important for many branches of industry: processing industry, where high temperatures and aggressive chemical environment are present, energy industry, faced with the need for higher efficiencies and continuity of operations (important, in particular, for the aging Polish energy sector) and nuclear, where the path for fusion and Generation IV reactors requires new, highly radiation resistant materials. Similarly important is the research leading to creation and application of novel radiopharmaceuticals.

Through generation, application and dissemination of break-through research and innovation outputs as well as training of next-generation experts, NOMATEN will improve Poland's scientific excellence, capabilities and competitiveness, advance its research and innovation culture, and provide long-term opportunities for economic development and societal improvements in both Poland and EU. The application of the methods, computational and experimental tools, novel materials and services offered by NOMATEN range from heavy industries, nuclear sector to health services, and directly correspond to the challenges faced by our economy and social life.

NOMATEN IS AIMED TO BECOME A WORLD-CLASS INTERNATIONAL CENTRE OF EXCELLENCE IN THE FIELD OF MULTIFUNCTIONAL MATERIALS FOR INDUSTRIAL AND MEDICAL APPLICATIONS AND A FOCAL POINT FOR COLLABORATION BETWEEN RESEARCH COMMUNITY, INDUSTRY AND GOVERNMENT

STRATEGIC GOALS

There are two sets of NOMATEN strategic goals:

Centre of Excellence development strategic goals:

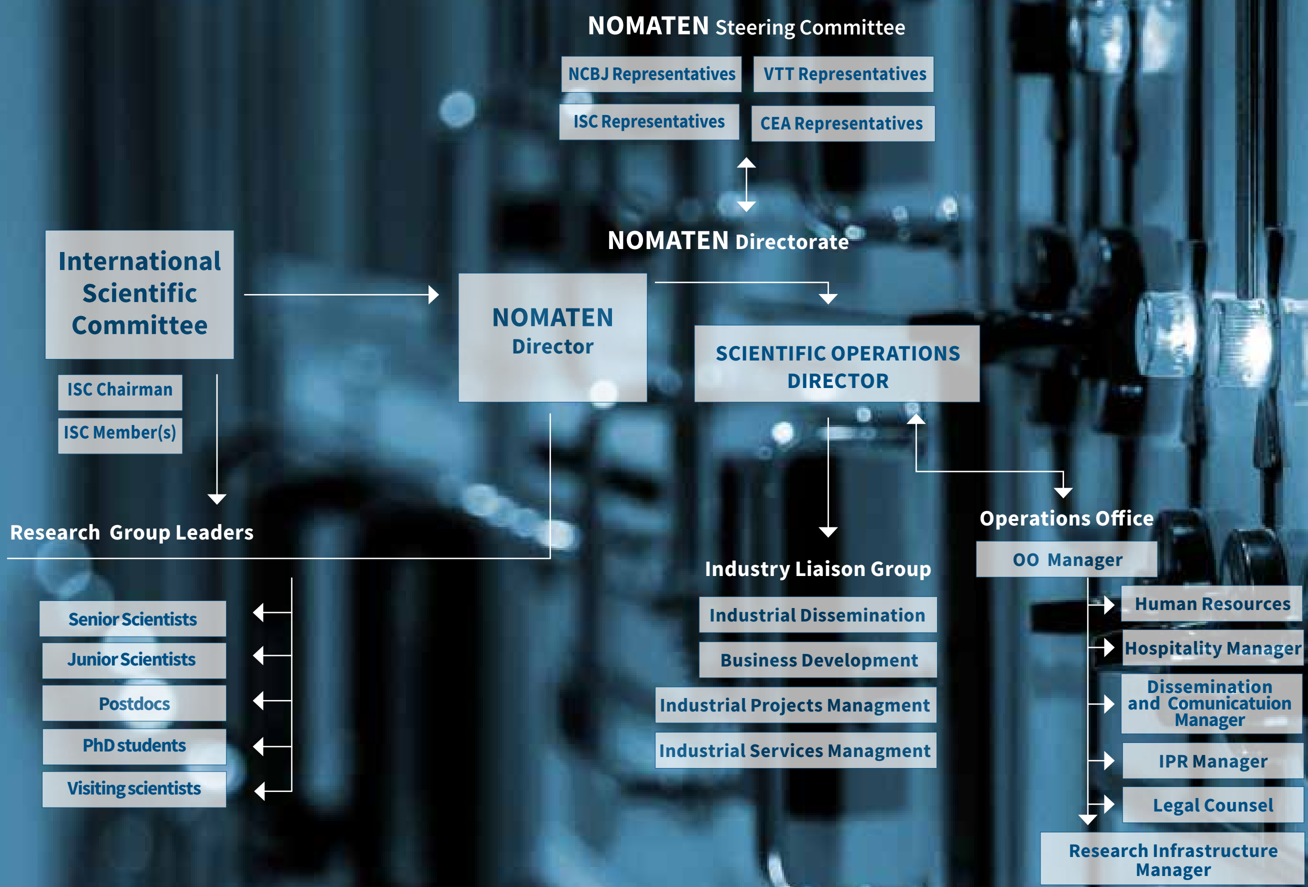
- To create highly professional, multidisciplinary and motivated team of researchers and staff
- To build up, efficiently use and provide access to advanced infrastructure
- To establish long-term mutually beneficial partnership with research establishments, industries and government
- To guarantee operational and financial sustainability of NOMATEN trough efficient management, marketing and technology transfer.

Impact-oriented strategic goals:

- To deliver excellent R&D outputs and services
- To create industrially and socially vital innovations
- To train new generation of professionals in the field of multifunctional materials for industrial and medical applications
- To strengthen research and innovation culture in NOMATEN and beyond

STRUCTURE

While NOMATEN Centre of Excellence is formally a part of NCBJ (since September 2020 having the status of a full Department), it enjoys a significant autonomy, especially in the context of the research and innovation activities. This is ensured by an organisational structure, which reflects the international character of the Centre, and significant supervisory and advisory roles of the bodies outside NCBJ.



INTERNATIONAL SCIENTIFIC COMMITTEE

The International Scientific Committee plays a crucial role in ensuring NOMATEN research excellence, impact and autonomy. Composed of renowned experts in the fields of materials science and radiopharmaceutical research and representatives of the Partners and industry, the ISC is charged with crucial tasks, such as:

- Regular review of the Agenda and introduction of changes as necessary, e.g. on account of advance in global scientific research in a given domain
- Announcing and holding the competitions for research group leaders
- Evaluation of the work of all research group leaders and their teams.

Approval of the hiring competition regulations and criteria prepared by the NOMATEN Directorate.

- The International Scientific Committee, charged with oversight of research activities, hiring and evaluation processes;
- The Steering Committee, charged with financial and legal oversight, composed of the representatives of NOMATEN Centre partners and the ISC;
- NOMATEN Directorate, responsible for day-to-day management and long-term vision execution;
- Research Groups, responsible for planning and conducting research, led by Research Groups Leaders under the supervision of the directorate, selected through international competitions by the ISC;
- Industry Liaison Group, responsible for building bridges to industry. ILG would coordinate research services and industry driven research, as well as manage communication between NOMATEN and relevant industries.
- Support office, responsible for legal, certification, marketing, communication and promotion, IPR management, research data management, project management, HR management and on-boarding services and other administrative issues.

The ISC is currently composed of:

Prof. Sergio Bertolucci, Chairman (M)	Former Director of Research and Scientific Computing at CERN	Experience in managing the largest research centre in Europe
Prof. Renata Mikołajczak (F)	POLATOM Radioisotope Centre	Radiopharmaceutical research and manufacturing
Dr. Petri Kinnunen (M)	VTT, Research Manager	NOMATEN PARTNER
Dr. Yanwen Zhang (F)	Oak Ridge National Laboratory	Worldwide leading lab
Prof. Giovanni Bruno (M)	Bundesanstalt für Materialforschung und -prüfung	European leading material research lab
Dr. Lorenzo Malerba (M)	CIEMAT	Similar Centre of Excellence
Dr. Teresa Pérez Prado (F)	IMDEA Materials	Similar Centre of Excellence
Frédéric Dollé (M)	CEA/DRF - Institut des sciences du vivant Frédéric Joliot	NOMATEN PARTNER
Xavier Averty (M)	CEA, Département de Modélisation des Systèmes et Structures	NOMATEN PARTNER
Dr. Leena Hakalahti (F)	VTT, Team Leader Diagnostic platforms	NOMATEN PARTNER
Prof. Roman Stryjski (M)	ENEA Group	Industrial partnership
Prof. Krzysztof Kurek (M)	NCBJ (non-voting member)	Host institution

Professor Sergio Bertolucci,
Chairman of the NOMATEN International Scientific Committee

NOMATEN ISC is chaired by Professor Sergio Bertolucci, who is a former Pisa scholar. Professor Bertolucci has been Director for Research and Scientific Computing of CERN from January 2009 to December 2015. Before joining CERN, he worked at DESY, Fermilab and Frascati. Bertolucci's career includes roles in the KLOE and CDF experiments leading to the discovery of the top quark, and innovative instrumentation, development and leadership of the DAFNE accelerator. He is co-author of 390 papers on refereed journals, with a global h-index of 92. He has been Director of the LNF in the years 2002-2004 and served/serves in several international panels (DESY PRC, ESFRI, ILCSC, CERN Council Strategy Group, SLAC, JPARC, FAIR, ETH, KEK, Oxford University, ESADE).He was also vicepresident and a member of the Board of the Italian National Institute of Nuclear Physics. He is currently Professor in Physics at the University of Bologna.

PROF. BERTOLUCCI'S EXPERIENCE IN THE MANAGEMENT OF RESEARCH PROJECTS AND INSTITUTIONS NOT ONLY ENSURES THE INDEPENDENCE OF THE ISC, BUT ALLOWS NOMATEN TO TAP INTO HIS EXTENSIVE KNOWLEDGE AND NETWORK OF CONTACTS

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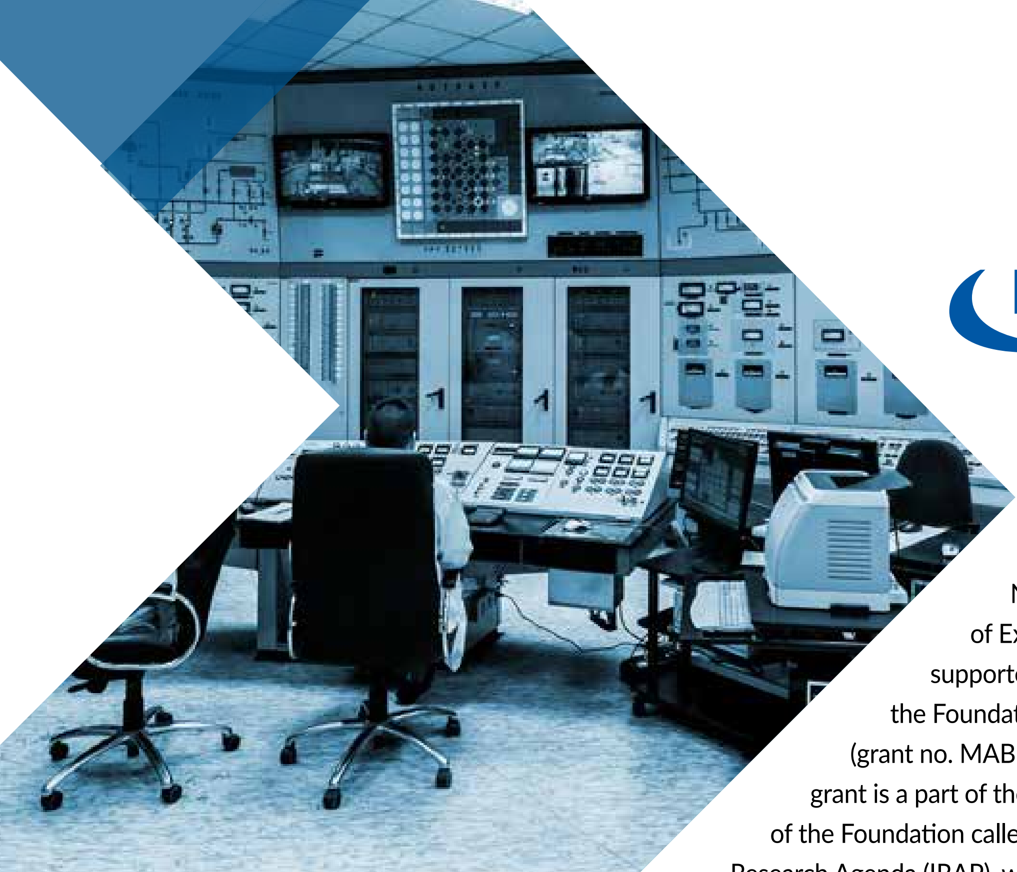
Foundation for Polish Science

SPREADING EXCELLENCE FOUNDATIONS

INTERNATIONAL RESEARCH AGENDA PROGRAMME



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Since its creation, NOMATEN Centre of Excellence has been supported by a grant from the Foundation for Polish Science (grant no. MAB PLUS/2018/8). The grant is a part of the general programme of the Foundation called International Research Agenda (IRAP), whose aim is to enable the creation of research organizations (scientific units), which will be led by scientists with considerable experience in science management as well as their own area of expertise. According to the Foundation the new units – selected via a highly selective competition – are composed of international teams of renowned scientists from different fields who will conduct research in order to solve a specific global scientific challenge.

According to the programme documentation, the research focus of the new centres needs to highlight a specific scientific issue – a challenge and a means of addressing it. The challenge itself as well as the proposed means of solving it must be important enough so that the results of the research will be likely to be published in top scientific journals and presented at prestigious scientific meetings. The intellectual property developed over the course of the research should have the potential for legal protection and the developed solutions should be applicable. The suggested challenge must be contained within the National Smart Specialization framework.

While the ideas and plans for NOMATEN Centre of Excellence are tightly connected to the European Community Teaming initiative within the Spreading Excellence and Widening Participation programme (see the box below), the Partners have recognized the importance of the new centre as way of cooperation, and decided to create NOMATEN on the basis of the FNP grant in September 2018. The IRAP funds, which comprise almost 45 million Polish Zloty (approx. 10 million Euro) for the period until the end of 2023 are focused on supporting the research activities of the NOMATEN Centre of Excellence, including research staff remuneration, covering the costs of access to research infrastructure, open access publishing, participation in conferences etc. For the years 2024-2026, the Polish Ministry of Science and Higher Education has committed additional 5 million Euro, which would extend the FNP grant. The research staff of NOMATEN is expected to actively participate in national and international funding calls and projects. Since its creation, NOMATEN has been an active member of the exclusive community of only fourteen units selected by the Foundation for Polish Science – aiming to provide an example of research excellence within the Polish research community.

TEAMING PROGRAMME

Working on the Horizon 2020 programme, the European Commission has recognized that despite efforts to reduce disparities in country research and innovation performance in the EU, sharp differences among Member States still remain. These disparities are due to, among other reasons, the insufficient critical mass of science and lack of centres of excellence having sufficient competence to engage countries and regions strategically in a path of innovative growth, building on newly developed capabilities. Exploiting the potential of Europe's talent pool by maximising and spreading the benefits of research and innovation across the Union is vital for Europe's competitiveness and its ability to address societal challenges in the future. This could help countries and regions that are lagging behind in terms of research and innovation performance to attain a competitive position in the global value chains.To address this problem, EC has created the Spreading Excellence and Widening Participation programme, and within it, the Teaming call. Teaming goal was to support the creation of new centres of excellence or upgrading the existing ones in low R&I performing countries, building on partnerships between leading scientific institutions and partner institutions in low R&I performing countries, that display the willingness to engage together for this purpose.

The three partners – NCBJ, CEA and VTT – have applied to the Teaming call. The first phase of the Teaming project made it possible to specify the scope of cooperation, define general future research directions and identify areas of cooperation that create a real opportunity for the new Centre to join priority research directions in Europe, taking into account Polish national smart specializations and the specificity of Polish industry. The successful application in Phase 2 of the resulted in Grant Agreement No 857470, covering the funding of nearly 15 million Euro, devoted to provide substantial, long-term (7 year) support for the start-up and implementation phase of the future Centre. This will cover mainly administrative and operational costs as well as personnel costs of the future Centre of Excellence. The Teaming Grant Agreement has been signed on June 14, 2019, and the project has started on November 1st, 2019.

NOMATEN Teaming Phase 2 project brings an essential support to the organization and early phase operation of the newly created Centre of Excellence, develop its operational procedures, helps to establish working contacts between strategic partners of the project and supports operation and administrative costs. The main objectives of the Teaming project are reached accordingly to the project schedule. The funding obtained under the Teaming project made it possible to finance the salaries of Centre of Excellence's operational and administrative staff, approximately 7 people in total. Another very important factor influencing the creation of the Center of Excellence is the fact that the Teaming project is now the main platform of contacts between the project partners enabling the exchange of opinions, continuation of previously established contacts and preparation of action plans for the near future. These activities, which should also be emphasized, are currently difficult due to the COVID 19 pandemic and the ban on business travels, as well as significant sanitary restrictions for face-to-face meetings.

THE TEAM

GOALS AND PRINCIPLES

An essential key for NOMATEN success is to attract and maintain the best talents in all staff categories (research and support). In HR Policy, numerous activities have been planned to create the best workplace for scientists:

- high standards of recruitment procedures,
- building attractiveness for scientist by safe and modern work place (including building infrastructure and nice surroundings, effective leadership - with trust through transparency and an honest approach, the stability of employment and the competitive level of salaries),
- research autonomy for senior researchers,
- participation in a newly created international team,
- exciting topics of research and possibility to focus on research, write publications, participate in conferences,
- collaboration in many contexts – with industry, universities, RTOs abroad,
- a possibility for successful career development built through the procedures for staff evaluation (a bi-annual face-to-face interview with the immediate supervisor, a short self-assessment questionnaire every year, two-years assessment by ISC),
- formal accreditation for PhD degree education, support for processes leading to habilitation and professorship titles
- professional training (technical trainings, soft and management skills).

The aim of the Charter is to ensure that the nature of the relationship between researchers and employers or funders is conducive to successful performance in generating, transferring, sharing and disseminating knowledge and technological development, and to the career development of researchers.

AN ESSENTIAL KEY FOR NOMATEN SUCCESS IS TO ATTRACT AND MAINTAIN THE BEST TALENTS IN ALL STAFF CATEGORIES

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WHO WE ARE

The NOMATEN Centre of Excellence management team comprises at present of Professor Mikko Alava in his dual role of the NOMATEN Director and Research Group Leader, Prof Pawel Sobkowicz as the Director for Scientific Operations and the Industry Liaison Group leader, as well as two leaders of Research Groups, selected by the International Scientific Committee who are already on-board: Prof. Kurpaska and Dr Papanikoloau. The leader of the fourth group, devoted to corrosion studies will join NOMATEN as Research Group Leader upon finalizing his current obligations.

Out of the four groups, the group of Prof. Alava is the most advanced with respect to the team building. It currently comprises of three postdoc researchers, all of whom have been selected through competitive process in accordance with the European Charter & Code for Researchers. Dr Javier Dominguez, Dr Rene Alvarez and Dr Amin Esfandiarpour.

The research team of NOMATEN includes also two researchers from the small group originally incorporated in the Centre in accordance with the Foundation for Polish Science rules in 2018, Dr Iwona Jóźwik and Dr Cyprian Mieszczyński.

Supporting the research team are the members of the Industry Liaison Group (led by the Director for Scientific Operations) as well as the Operations Office, providing legal and financial services, HR expertise, on-boarding help of the Hospitality Manager as well as support in the process of grant application preparation and management. The latest addition to the NOMATEN support team is a dedicated IT specialist, whose tasks include the creation of Open Research Data Pilot infrastructure for the Centre.

Professor Mikko Alava
NOMATEN Director and
Leader of Research Group
Complexity in Functional Material

Professor Mikko Alava is a world-class expert in the physical properties of materials and their dependence on structure, including transport properties. He has worked extensively on materials science data analytics and applications of modern machine learning approaches. Mikko Alava holds a PhD in nuclear engineering (Helsinki University of Technology) in fusion plasma physics, from 1993. He is since 2009 a full professor of physics at Aalto University, Finland. Mikko Alava has worked after a research direction change from fusion to materials on statistical physics applications to the physics of materials and on challenging computational problems in understanding fracture, friction, plasticity and other complex properties, typical of functional materials and their dependence on structure – defects, surfaces and so on. Lately, for 2012-17 he has been in Finland a vice-director of a national Center of Excellence in Computational Nanoscience (COMP) and he has extensive international science manage experience eg. from the European CECAM organization and others. The scientific achievements of the Director of the NOMATEN include over 250 scientific papers including 40 in first rate journals such as Science Advances, Nature Communications, PNAS, and Physical Review Letters. Professor Alava has supervised more than 20 PhD students and more than 20 post-docs, many of which occupy academic positions around world.

Professor Paweł Sobkowicz
NOMATEN Director
for Scientific Operations

Dr Stefanos Papanikoloau
Leader of Research Group
Materials Structure,
Informatic and Functions

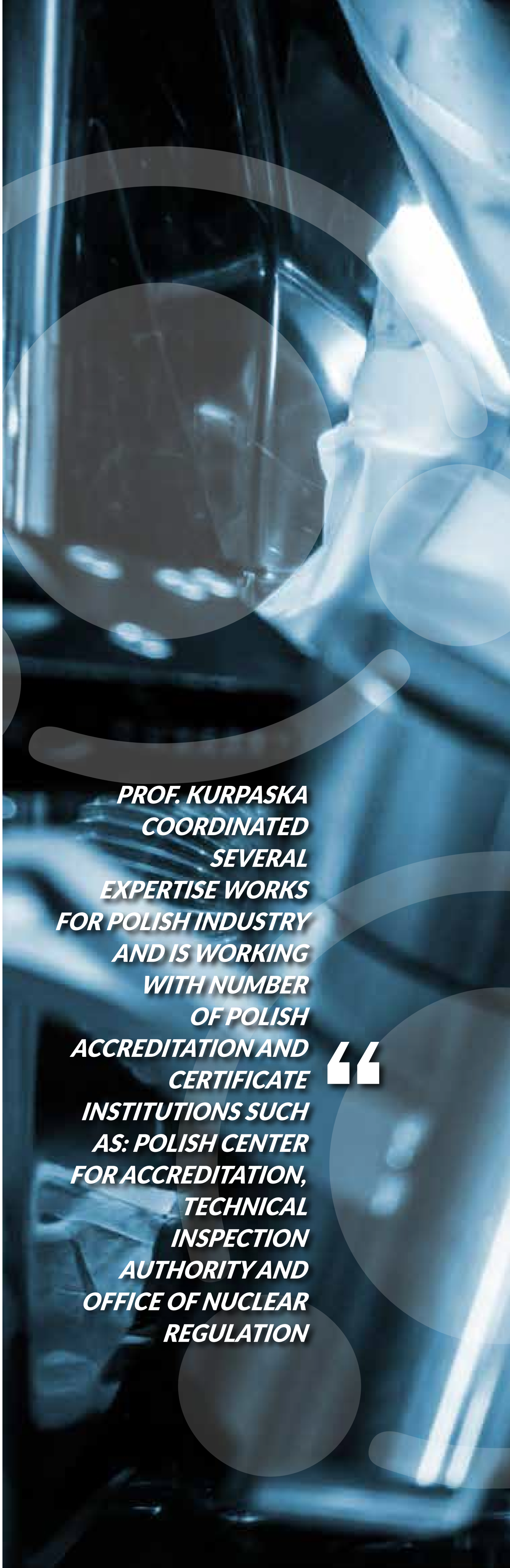
Paweł Sobkowicz holds a PhD in theoretical physics. Between 1982 and 1993 he worked at the Institute of Physics, Polish Academy of Sciences. Since 1993 he has left the academic world and has been a member of management teams of several high-tech companies, both international and Polish. In 2012 he has joined the National Centre for Nuclear Research, with the task of managing the technology transfer processes and management of commercialization efforts, becoming in 2017, the Deputy Director for Innovation and Commercialization of the institute. The experience gathered during the 20 years of commercial career covers many aspects, including human resources management, financial planning, sales management and general understanding of the decision processes in commercial environments. It is especially important in the context of efficient cooperation between the research communities and industry – the differences in language which is used by both communities is one of the most important factors slowing down or inhibiting successful commercialization. This experience complements the understanding of methods typical for research processes, with their inherent risks and uncertainties, as well as practical aspects of doing science. In addition, he has returned to active research, using tools of statistical physics to describe complex social phenomena. In recognition of this work he has obtained the habilitation (D. Sc.) degree in 2016. Author of over 60 papers, cited over 500 times. Since 2018 Dr Sobkowicz is the Scientific Operations Director of the NOMATEN Centre of Excellence and the leader of the Industry Liaison Group.

Dr Stefanos Papanikolaou is the Research Group Leader of the Materials Informatics and Characterization (MINC) Group, in the NOMATEN Center of Excellence for Multifunctional Materials in the National Center for Nuclear Research in Poland. His BSc is in Physics from the National University of Athens. His MS and PhD degrees are in Physics from the University of Illinois, Urbana-Champaign. He performed his postdoctoral work in the Department of Physics at Cornell University, and then he held positions at Yale University, Johns Hopkins University and West Virginia University. His research interest is in the theories and applications of statistical methods for the multiscale modeling of mechanical behavior of materials, with the most critical results possibly being the elucidation of size, rate and stochastic effects in the micromechanics of metallic micropillars, the connections between crystal and amorphous plasticity, as well as the use of machine learning methods, with a recent highlight being the studies of elastic instabilities using deep neural networks, applied to plasticity, damage and fracture.

Professor Łukasz Kurpaska
Leader of Research Group
Functional Properties

Professor Lukasz Kurpaska studied at the Faculty of Material Science and Ceramics AGH University of Science and Technology in Cracow. In 2012, he received a Ph.D. title at the University of Technology of Compiegne, France. In 2019 he obtained habilitation (D.Sc.) in materials engineering. In his works he mainly dealt with structural and mechanical properties of ion modified materials and effect of high temperature corrosion. His prime material fields of interests are steels, nickel and zirconium alloys, alumina coatings and ODS. He published over 50 journal papers.

Prof. Łukasz Kurpaska is a Head of Materials Research Laboratory (MRL) in the National Center for Nuclear Research (NCBJ). He coordinated several expertise works for Polish industry and is working with number of Polish accreditation and certificate institutions such as: Polish Center for Accreditation, Technical Inspection Authority and Office of Nuclear Regulation. MRL is the only laboratory in Poland equipped in set of 12 Hot Cells able to handle radioactive materials, while mechanical division of MRL is the only laboratory in Poland providing services in the field of fracture mechanics in accordance with ASTM, BS and ISO standards. Since September 2020, Prof. Łukasz Kurpaska has been selected as the leader of the Structure and Function Research Group at NOMATEN.



PROF. KURPASKA COORDINATED SEVERAL EXPERTISE WORKS FOR POLISH INDUSTRY AND IS WORKING WITH NUMBER OF POLISH ACCREDITATION AND CERTIFICATE INSTITUTIONS SUCH AS: POLISH CENTER FOR ACCREDITATION, TECHNICAL INSPECTION AUTHORITY AND OFFICE OF NUCLEAR REGULATION

ON-BOARDING DURING PANDEMIC

Ms Magdalena Jędrkiewicz
NOMATEN HR Manager

Ms Barbara Paprocka
Hospitality Manager

One of the major problems to be handled by contemporary organizations is a high rotation among employees – after the first 6 months of work. The decision made by employees is mainly affected by the organisation's care for adaptation process. NOMATEN is a project where a critical role is played by human resources. It is an institution which strives for acquiring and maintaining excellent scientists and research and technical employees, which in fact does not prove to be an easy task to do.

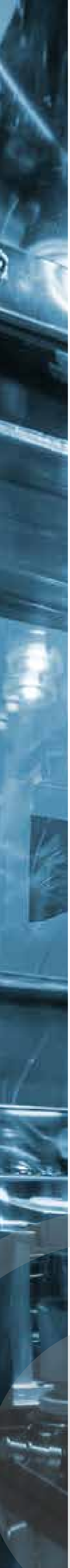
On-boarding means actions whose purpose is to introduce to a newly hired employee the most important issues concerning nature and functioning of the organisation, and consequently assist them in better accommodation in the company and integration within the environment. What proves important in the process is to satisfy basic needs of a newly hired employee in terms of safety, recognition, autonomy and cooperation. All these activities positively affect the employee's involvement and reduce stress factors, and then positively affect their efficiency and likelihood of staying in the NOMATEN. The COVID 19 pandemic has impacted social and economic life in many ways. In the context of the recruitment, on-boarding and integration of newly hired researchers, especially those coming from abroad this was not an easy task. The challenges ranged from rapidly changing travel restrictions, through the need for efficient processing of the formal processes required by law (made doubly difficult by the shut-down of the normal procedures by the state authorities), to the guiding through the everyday actions, such as establishing a bank account, renting a flat, or ensuring medical services access. The NOMATEN HR Team of Ms Magdalena Jędrkiewicz and Ms Barbara Paprocka have risen to the challenge admirably, providing personal help and advice to all our new researchers.

OUR RESEARCH
RESEARCH AGENDA

In the start-up phase of NOMATEN it is instructive to consider the current paradigm of developing and studying new materials and candidates for industrial applications. The challenge of the field is that both from the modelling and experimental materials science viewpoints the range of scales is enormous. Atomistic level phenomena govern the strength and ductility of materials in often unexpected ways and improving the functionality of materials means moving down from the engineering applications scales downwards. Additional problems are posed by the duration of some typical applications, up to tens of years for structural materials. To be able to predict material properties – failure or corrosion resistance – in harsh conditions is then a question of how to extrapolate reliably from laboratory scales, in particular in time scale. Altogether these facts mean that the cycle of introducing a novel material from “scratch” takes often years. One recent partial solution is the use of Artificial Intelligence for speeding up the development. Materials informatics intends to cut down the trial and error cycle on one hand and to accelerate research. Recently various frameworks have started to appear to this end, e.g. demonstrating novel materials, combinations of excellent material properties, and much faster research. The next step will be the completion of the cycle in that this research reaches industrial material production.

The breadth of the field of materials science requires particular attention and focus on the part of managing the research strategy. The key components are:

- Ability to conduct top-class research in materials – the NOMATEN centre should demonstrate and maintain excellence by a continuous stream of high profile publications in high-impact factor journals. This will eventually be accompanied by talks in first-rate conferences and workshops.
- Capacity to exploit joint research strengths and doing this by collaborating with external complementarity of partners – including CEA and VTT – both for specific projects and to build up forward-looking collaborative networks. This is the best way to show that NOMATEN is more than a sum of its parts and will prepare us for future challenges.
- Develop a strategy and concrete actions for the handshake with commercial customers and the related R&D. Apart from the importance of such for the sustainability of the Centre of Excellence NOMATEN should both be able to offer modern research methods and to be able to benefit from the contact with industrial needs to develop its research strategy. Details of the plan are developed in the NOMATEN Marketing Strategy Plan, co-created by all the project partners under the support of the Teaming action.



COMPLEXITY IN FUNCTIONAL MATERIALS RESEARCH GROUP, LED BY PROFESSOR MIKKO ALAVA

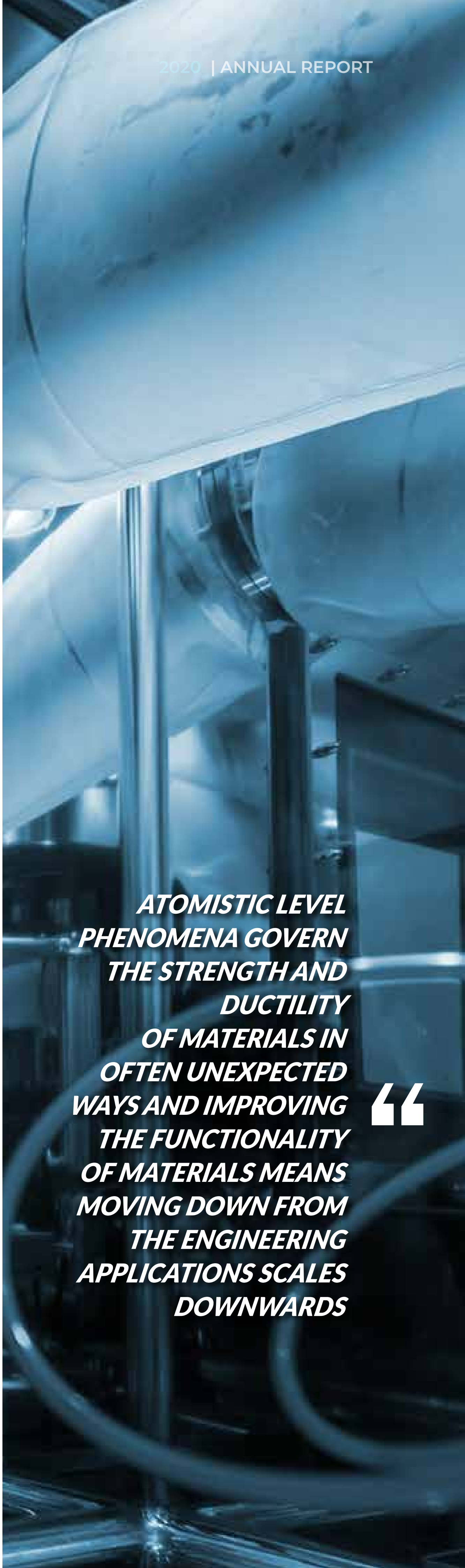
Background of the group is in fracture, plasticity, statistical mechanics of materials and the structure-property relationship. Alava has also worked on lifetime and prediction issues in materials. The group has expertise in machine learning and multiscale models and connections to European HPC and materials modelling (CECAM).

Plans include plasticity of complex alloys (HEA, PLC effect), and collaborations with the other groups (plasticity, Machine Learning, multiscale models, mechanical properties across scales, corrosion using eg. phase field techniques). The RG may have a potential contribution to NDA/experimental analysis (DIC, Digital Image Correlation) using also Machine Learning methods to classify data and predict. The group has hired three postdocs, of which two have arrived (September 2020). The group has potential collaboration partners at the Teaming partners and capabilities for industrial collaborations.

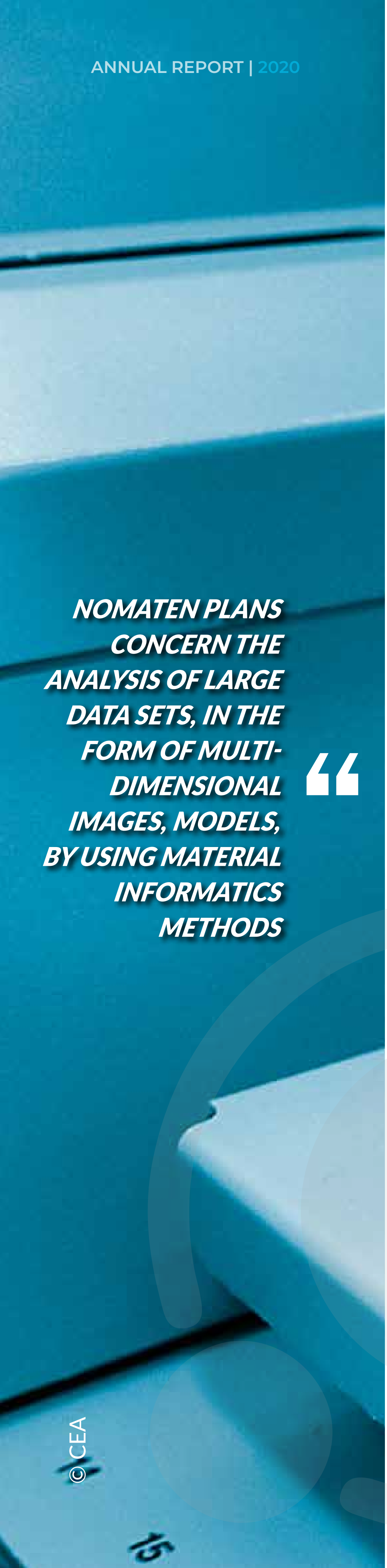
ANALYTICS AND CHARACTERIZATION GROUP RESEARCH GROUP

The RGL has background in fusion materials, corrosion, and in general phenomena at surfaces and has now an appointment in China with potential collaborations. The main issue is the set-up and establishment of a laboratory with a test rig for magnetism and corrosion (Magnificor). In general, the mission is to look for solutions to realise complementary, in-situ study of phenomena between surface of functional materials and environment, including but not limited to aqueous solutions. Key challenges are: elevated temperature, varying temperature duty cycles, radiation and magnetic fields. The research methodology combines high resolution microscopy, mass spectrometry and electrochemistry.

This research has nuclear applications, and will benefit from materials solutions, modelling (NOMATEN RGs and Partners) and data analytics and material informatics.



“ *ATOMISTIC LEVEL PHENOMENA GOVERN THE STRENGTH AND DUCTILITY OF MATERIALS IN OFTEN UNEXPECTED WAYS AND IMPROVING THE FUNCTIONALITY OF MATERIALS MEANS MOVING DOWN FROM THE ENGINEERING APPLICATIONS SCALES DOWNWARDS*



NOMATEN PLANS CONCERN THE ANALYSIS OF LARGE DATA SETS, IN THE FORM OF MULTI-DIMENSIONAL IMAGES, MODELS, BY USING MATERIAL INFORMATICS METHODS

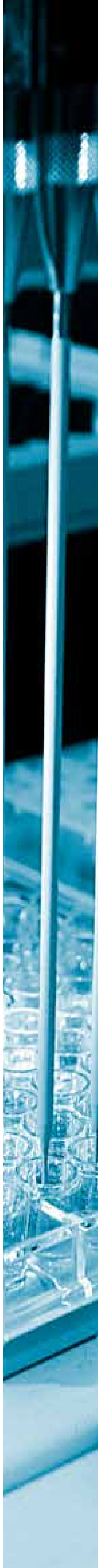
MATERIALS STRUCTURE, INFORMATICS AND FUNCTION RESEARCH GROUP, LED BY DR STEFANOS PAPANIKOLOAU

The RGL brings in essential knowledge about US materials science efforts across the board. The expertise is particularly heavy in materials deformation and Artificial Intelligence applications, including material characterization and analytics.

NOMATEN plans concern the analysis of Large Data sets, in the form of multi-dimensional images, models, by using material informatics methods. This is in order to describe in a physics-based way, experimental systems, and detailed characterization tests for irradiated and non-irradiated structural materials using both destructive and non-destructive sampling methods. The generic nature of ML methods offers collaboration possibilities with all the other groups (including the future radiopharmaceutical one) and the industry. In addition to the Research Groups, NOMATEN offers also the possibility of a Senior postdoctoral researcher positions, necessary to acquire vital R&D competences. Their contributions would complement the competencies developed in the Research Groups

FUNCTIONAL PROPERTIES RESEARCH GROUP, LED BY PROFESSOR ŁUKASZ KURPASKA

The group has wide experience of multiscale methods for mechanical property measurements and their relation to microstructure. At NOMATEN, Functional Properties measurements efforts will be made to study the following materials: stainless steels, ODS and/or HEAs, protective coatings based on Al_2O_3, zirconium and nickel alloys. We chose these materials because they are planned to be used in next generation nuclear power plants. Also, studies on austenitic steels and alumina coatings are supported by EU through M4F and GEMMA projects, respectively. This shows, that planned in the frame of NOMATEN studies are in line with the current trends in EU, and are of interest for the international community. These will be subjected to a systematic and comprehensive ion implantation process (at for example Oslo University), and the functional properties will be determined. We choose these materials because they are planned to be used in next generation nuclear power plants. Also, studies on austenitic steels and alumina coatings are supported by EU through M4F and GEMMA projects, respectively.



FUTURE OUTLOOK

– DIRECTOR'S PERSPECTIVE

In the first Agenda of NOMATEN we adapt to the timescales applicable to the start-up phase of the Centre of Excellence. Thus, we consider briefly the future of the center on three timescales: what is the vision and what this needs. In the future versions the outlook will take on more concrete features as new openings take shape and the Centre of Excellence reaches a critical mass.

THE TWO-YEAR FUTURE

In 2022, NOMATEN will be close to the end of its initial build-up phase, three years into the Teaming project. The Centre will have established a culture of scientific excellence and it will have 6-7 groups including the one in radiopharmaceuticals. New experimental capabilities and the exploitation of partner facilities becomes standard. The Centre is successful in terms of publishing regularly in first-rate journals and in attracting funding in particular in the partnerships in national and EU calls. NOMATEN will have made real, substantial steps in public-private collaborations. We will have 35-40 scientific staff.

FIVE YEARS

By 2025, the FNP funding has finished and the NOMATEN has become mature. The first two cohorts of PhD students have graduated. NOMATEN contributes to the Polish research landscape by several means including having a prominent role in the nuclear energy sector development in Poland. The funding stream from applied research has become a substantial part of the total (30 %). The growth phase has led to a research strength of some 50-60 staff. The birth of other RGs depends on needs and opportunities and we do not exclude it. The large-scale infrastructures such as CERAD, JHR, and ESS are of importance.

LONG-TERM PERSPECTIVE – 10 YEARS

At this scale, the large-scale developments of the energy sector are of paramount importance. NOMATEN should have educated of the order of 100 researchers – postdocs, PhD students – who are available to support the resurgence of nuclear energy in Poland. NOMATEN has become one of the fundamental dimensions of NCBJ and the future is secured by a financial income stream divided among 1/3 statutory funding, 1/3 from public research calls, and 1/3 from applied research collaborations, where NOMATEN is an established brand and wanted partner.

Prof. Mikko Alava
NOMATEN Director

CURRENT RESEARCH HIGHLIGHTS

> “ THE INTEREST IN STUDIES OF MATERIALS AND PHENOMENA, IMPORTANT FOR ALL THREE PARTNERS OF NOMATEN WOULD CONTINUE IN THE FUTURE, WITH PLANNED ADDITIONS OF SENIOR SCIENTISTS AND POTENTIAL FOR GROWTH, ESPECIALLY IN THE LIGHT OF THE RENEWED INTEREST OF POLISH STATE IN THE NUCLEAR ENERGY PROGRAMME

During the SEED phase of operation of NOMATEN, in accordance with the rules of the Foundation for Polish Science IRAP grant, the Centre research team was limited to a small, three-person initial group. The reason for this limitation was to force the focus on creation of a new Centre, based on globally competitive selection process. Despite these limitations, this small NOMATEN team has been active in multiple materials science fields. While the main focus of the research conducted during this time was on materials related to the nuclear applications, it included such diverse topics as:

- Studies of effects of radiation on various types of materials
- Nanomechanical properties of thin films and coatings
- Properties of graphite in nuclear applications Au implantations in alumina thin films
- He implantations in W and W-3%Re samples
- Ni implantations in steels and in the cast and 3D printed Inconel alloys
- Preliminary Ni implantations and RBS/C analysis of NiFe alloys

In particular, the research of Dr Iwona Jóźwik focused on structural, topographical and compositional properties of functional materials i.e. ferritic-martensitic steels, metallic alloys, graphite, polymers, thin-film coatings) subjected to irradiation and high temperature conditions, using scanning electron microscopy (SEM), electron backscattered diffraction (EBSD) and energy dispersive X-ray spectrometry (EDS) techniques. The studied materials included steels and metallic alloys, and the potential application of these materials in the GenIV fission and fusion reactors. Another topic was graphite - currently used as a core structural component for High Temperature Gas Cooled Reactors (HTGR), as well as polymers, and their reaction to radiation, heat and humidity, which can cause ageing and degradation of their functional properties.

Dr Cyprian Mieszczyński focused his research mainly on the Monte Carlo (MC) simulations of spectra collected using Rutherford Backscattering Spectroscopy (RBS) in random and towards channeling direction (RBS/C). The results of the studies of the effects of radiation on various Ni alloys show that the more complex structure of alloy is, the higher is its radiation resistance, i.e., the concentration of dislocations is lower than in pure nickel. The most resistant material found was the four-component alloy NiFeCoCr. The interest in studies of materials and phenomena, important for all three partners of NOMATEN would continue in the future, with planned additions of senior scientists and potential for growth, especially in the light of the renewed interest of Polish state in the nuclear energy programme.

Since joining NOMATEN as its Director, Prof Mikko Alava has continued his research along the lines described in his proposed research agenda. This included

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studies of complex deformation processes in various materials. These offer a rich playground for experimental physics and modelling efforts. In a collaboration with VTT, we contributed Acoustic Emission measurement expertise and the knowledge of the analysis of "crackling noise" or AE burst data. We could show that low-density foams at larger strains exhibit collective deformation bursts, which seem to offer a different universality class compared to earlier findings. A long-standing question has been that in tertiary (the final) phase of tensile creep various materials seem to exhibit a power-law acceleration of creep strain. We addressed this by high-resolution Digital Image Correlation and combined the experimental data with a material model, in which shear-band localization is dominant. Our conclusion is that such creep behavior is due to the rheology of the material at hand, and it is not a conclusion – at least in our case – of critical phenomena or in simple terms that the sample would approach a "critical point" at its lifetime.

Another topic of research was the use of mesoscale Discrete Dislocation Dynamics (DDD) simulations to study how and when precipitates strengthen metals and alloys. The work shows that a considerable increase in the yield strength can be fitted with the so-called BKS theory of precipitate hardening, but the real physics is due to the dislocation-precipitate interactions becoming dominant. This is seen also in the avalanche statistics and thus in the stress-strain curves. The implication is that material design may exploit a phase transition – at the yield point. Continuing on this line, using Machine Learning was used to show that the dislocation assembly, its geometry and correlations, may be used to distinguish in samples between the normal and precipitate controlled phases. This points out to future possibilities of strength prediction using experimental signatures.

Yet another direction of research were plastic instabilities in metals. Dynamic Strain Aging, Strain-Rate Sensitivity and the Portevin-LeChatelier effect are some of the features of complex alloys when deformed. The main challenge from the materials science perspective is that alloys exhibit serrations (stress-strain curves) and shear bands, complicating materials engineering and design. Combining experimental work on a typical aluminum alloy and modelling, we show that such bursts are archetypical "avalanches" and can be understood via statistical mechanics. This presents several questions for further study, from the importance of alloy composition to the physics of avalanche (shear-band) nucleation, and how to avoid that in engineering materials.

Selected papers authored by the NOMATEN researchers in 2019 and 2020

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- A. Azarov, A. Galeckas, C. Mieszczyński, A. Hallén, and A. Kuznetsov, Effects of annealing on photoluminescence and defect interplay in ZnO bombarded with heavy ions: crucial role of the ion dose, Journal of Applied Physics 127, 025701 (2020);
- Book: H. H. Radamson, A. Hallén, I. Sychugov, and A. Azarov, Analytical methods and instruments for micro- and nanomaterials, Springer, submitted to be published in 2020.
- A. Kosińska, J. Jagielski, M. Wilczopolska, D. M. Bieliński, I. Jóźwik, Ł. Kurpaska. K. Nowakowska-Langier , Study of the electrical properties of ion irradiated polymer materials Surface and Coatings Technology, volume 38825 April 2020 Article 125562
- A. Azarov, A. Galeckas, C. Mieszczyński, A. Hallén, and A. Kuznetsov, Effects of annealing on photoluminescence and defect interplay in ZnO bombarded with heavy ions: crucial role of the ion dose, Conference presentation (poster): IBA-2019, Antibes, France, October 13-18, 2019.
- R. Ratajczak, C. Mieszczynski, S.Prucnal, T. A. Krajewski, E. Guziewicz, W. Wozniak, K. Kopalko, R. Heller, S. Akhmadaliev Correlations between the structural transformations and concentration quenching effect for RE-implanted ZnO systems, Appl. Surf. Sci. 521 (2020) 146421.
- L. Nowicki, J. Jagielski, C. Mieszczynski, K. Skrobas, P. Jóźwik, O. Dorosh, McChasy2: new Monte Carlo RBS/C simulation code designed for use with large crystalline structures, Nucl. Instrum. Methods Phys. Res. B, [accepted].
- C. Mieszczynski R.Ratajczak J.Jagielski G.Velişa H.Bei B.C.Sales E.Wendler W.J.Weber Y.Zhang Defect evolution in Ni and solid-solution alloys of NiFe and NiFeCoCr under ion irradiation at 16 and 300 K, Journal of Nuclear Materials, Volume 534, June 2020, 152138
- A. Zaborowska, Ł. Kurpaska, E. Wyszkowska, M. Clozel, M. Vanazzi, F. Di Fonzo, M. Turek, I. Jożwik, A. Kosińska, J. Jagielski, "Influence of ion irradiation on the nanomechanical properties of thin alumina coatings deposited on 316L SS by PLD", Surface & Coatings Technology 386 (2020) 125491, https://doi.org/10.1016/j.surfcoat.2020.125491
- A. Kosińska, J. Jagielski, M. Wilczopolska, D. M. Bieliński, I. Jóźwik, Ł. Kurpaska. K. Nowakowska-Langier , Study of the electrical properties of ion irradiated polymer materials, Surface and Coatings Technology, volume 38825 April 2020 Article 125562, https://doi.org/10.1016/j.surfcoat.2020.125562
- M. Clozel, L. Kurpaska, I. Jóźwik, J. Jagielski, M. Turek, R. Diduszko, E. Wyszkowska, Nanomechanical properties of low-energy Fe-ion implanted Eurofer97 and pure Fe, Surface and Coatings Technology Volume 393, 15 July 2020, 125833 https://doi.org/10.1016/j.surfcoat.2020.125833
- L.Kurpaska, M.Frelek-Kozak, M.Wilczopolska, W.Bonicki, R.Diduszko, A.Zaborowska, E.Wyszkowska, M.Clozel, A.Kosinska, I.Cieslik, M.Duchna, I.Jozwik, W.Chmurzynski, G.Olszewski, B.Zajac, J.Jagielski, Structural and mechanical properties of different types of graphite used in nuclear applications, Journal of Molecular Structure, Volume 1217, 5 October 2020, 128370 https://doi.org/10.1016/j.molstruc.2020.128370
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- T. Mäkinen, J. Koivisto, L. Laurson, and M. Alava, Scale-free features of temporal localization of deformation in late stages of creep failure, Physical Review Materials, in press.
- H. Salmenjoki, A. Lehtinen, L. Laurson, and M. Alava, Plastic yielding and deformation bursts in the presence of disorder from coherent precipitates, Physical Review Materials. 4, 083602 (2020).
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OPEN SCIENCE

In the context of the NOMATEN Teaming Grant, the NOMATEN Partners have opted to participate in the Open Research Data Pilot (ORDP). The ORDP applies primarily to the data needed to validate the results presented in scientific works published under Open Access scheme. Other data can also be provided by the collaborating institutions on basis of the dedicated joint decisions.

The broad range of the research covered by NOMATEN will result not only in a large variety of dataset types required for scientific analysis, but also in various data repository sizes and metadata required for the goals of accessibility, interoperability and re-use.

The research activities conducted by the NOMATEN would also be done in the broad range of contexts: from research fully supported by public funds, through R&D projects realized in partnership with commercial and industrial partners under partial public funding, to R&D&I projects and services funded solely from private funds. Depending on the formal requirements of the funding scheme and on the specific situation, **NOMATEN**, consortium partners and other stakeholders would be able, in compliance with the NOMATEN Teaming Grant Agreement, to make decisions case by case whether to publish the results or to exploit the results commercially, e.g. through patenting or make the research data openly accessible.

The specific rules for the decision processes related to the accessibility or protection of data would be decided by the NOMATEN Centre of Excellence Management stated in the subsequent versions of the DMP, after consulting with the NOMATEN consortium partners and Research Group Leaders of NOMATEN. These decisions will take into account the data, know-how and other information brought into the NOMATEN Centre by the project Partners, in particular the existing protection status of such information. To support an effective data management, the Centre has recruited a dedicated IT specialist with experience in materials sciences.

INFRASTRUCTURE

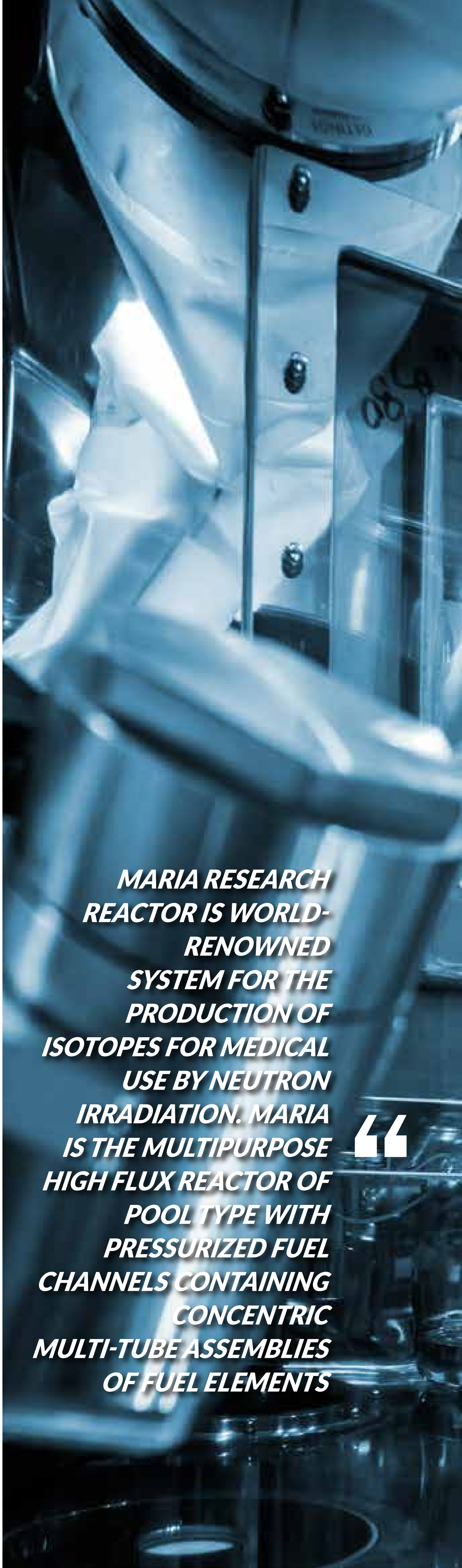
The NOMATEN Centre of Excellence is located within the NCBJ campus at Otwock-Świerk , about 30 kilometers east of Warsaw. The location provides direct access to the NCBJ infrastructure, including recently renovated office space and amenities, but also, most importantly, the use of the NCBJ research facilities. Moreover, thanks to the close cooperation between the Centre Partners, the infrastructure available to the NOMATEN researchers is unique on the European scale. Examples of the large-scale research facilities of importance for NOMATEN are presented below.

NCBJ – NOMATEN HOSTING INSTITUTION

MARIA Reactor: MARIA Research Reactor is world-renowned system for the production of isotopes for medical use by neutron irradiation. MARIA is the multipurpose high flux reactor of pool type with pressurized fuel channels containing concentric multi-tube assemblies of fuel elements. The operational power is 30 MW and thermal neutron flux in the centre of the core is around 2.5x1014 n/cm2s (max 3x1014 n/cm2s), epithermal neutron flux is around 3x1013 n/cm2s. The MARIA reactor is currently the sole research nuclear reactor operated in Poland. This is one of the few research reactors in the world that can provide irradiation of uranium fission targets for the commercial production of molybdenum 99, the parent radionuclide of technetium-99m, the radionuclide most often used for diagnostic imaging in nuclear medicine.

MARIA Neutron Laboratory - Neutron diffractometers and spectrometers currently being transferred from HZB Berlin (BER II Reactor) to NCBJ to form Neutron Laboratory will include 4 individual devices (diffractometers and spectrometers). The Neutron Laboratory will consist of five advanced diffractometers, greatly enhancing the range of research possibilities offered by Maria reactor.

Radioisotope Centre POLATOM and its facilities: The laboratories of Radioisotope Centre POLATOM are specialized for radiochemical processing of radionuclides irradiated in MARIA research reactor and in other irradiation sites and for the manufacture of radiopharmaceuticals according to the current Good Manufacturing Practice. There are dedicated hot-cell lines equipped for preparation of medicinal products at the radioactivity level of several thousand Ci. The pharmaceutical laboratories



are cGMP certified radiopharmaceutical manufacture facilities. The research and quality control laboratories are well equipped in instrumental techniques (e.g. HPLC systems, ICPO-ES, LCMS-IT-TOF mass spectrometer) as well as for microbiological testing. There are also dedicated laboratories for synthesis and characterization of Active Pharmaceutical Ingeredients (API) which are the main constituent of medicinal products.

Laboratory for pre-clinical studies operating in the research structure of NCBJ's Radioisotope Centre POLATOM is authorised to carry out biodistribution studies of radiopharmaceuticals in laboratory animals according to Good Laboratory Practice (GLP). The laboratory carries out pre-clinical investigations of new developed radiopharmaceuticals for biodistribution and pharmacokinetics in animals and investigations of physiologic distribution of radiopharmaceuticals in real time and in the specialised animal models using complementary radioisotope and optical probes. It's one of the most modern laboratories in Poland, built in line with the latest recommendations of European and global organizations with regard to the protection of animals used for scientific purposes. CIS Computing Center: CIŚ mission is to deliver high-quality modern IT services to all entities involved in development of nuclear power industry sector in Poland, as well as to Polish government agencies and research institutions. Currently, it can provide11680 computing cores, 47872 GB (47,8 TB) RAM and disk space of more than 1,5 PB. The theoretical performance of this configuration is 163 TFLOPS New facilities currently under construction, to be finished within the duration of the project (funding secured):

CERAD, Center of Design and Synthesis of Radiopharmaceuticals for Molecular Targeting, the aim of the project is to create a modern research infrastructure in the field of searching for new radiopharmaceuticals for diagnostics and therapy, based on biologically active ligands active at the cellular and molecular level. The combination of isotopic techniques with molecular markers of the disease enables earlier detection of the diseases and implementation of appropriate therapeutic procedures. The CERAD project is therefore a response to the global socio-demographic trends and challenges related to the development of effective methods of cancer diagnostics and therapy. The CERAD investment, currently underway from the PoiR funds, includes the construction of a three-storey building in which the modern cyclotron will be installed accelerating protons and α particles to 30 MeV and deuterons to 15 MeV energy as well as dedicated laboratories for processing cyclotron produced radionuclides and for research. According to the PoiR funding conditions, the CERAD infrastructure being built will be equally used for scientific and economic purposes.

POLFEL – The Polish Free Electron Laser, PolFEL1 was proposed more than decade ago and at that time was accepted for the Polish Research Infrastructure Roadmap. The facility was proposed to be built in two stages, at first, with fewer accelerating sections and lower beam energy and the second one, with more accelerating sections, delivering 600 MeV electrons to VUV undulator, generating in the Self Amplified Spontaneous Emission process coherent radiation at wavelength ranged down to 27 nm and 9 nm in the first and third harmonic mode, respectively. Over past decade new experimental methods have been proposed and developed, delivering interesting results obtained with relatively low energy coherent and non-coherent photon beams, for example with IR-UV and THz radiation.

CentriX - New center for industrial radiation techniques Laboratories created as a result of the Project will be used by industry (the economic purpose of the project) and science (the non-economic purpose of the project). CentriX project will increase the productivity and innovation of enterprises by supporting them with access to ultra-modern non-destructive testing techniques specifically design for their needs. Non-destructive testing (NDT), which will be carried out in the Central CentriX laboratory will be based on radiation techniques.

CEA

THE JANNUS TRIPLE BEAM IRRADIATION FACILITY

At CEA Paris-Saclay, a triple beam irradiation facility has been installed for simultaneous ballistic damage, gas implantation and electronic excitation. Samples can be irradiated in a wide temperature range from liquid nitrogen to 800°C. Evolution of the ion-irradiated material microstructure and properties (mechanical, thermal, ...) can be characterized by on line Raman spectrometry or by post mortem tests or examinations. Simulation can help in validating the transposition of material laws derived from ion irradiations (formation and evolution of defect loops and cavities, segregation, ...) to in-reactor conditions.

The JANNuS facility comprises three electrostatic accelerators (respectively named Épiméthée, Japet and Pandore) connected to a triple beam chamber for single-, dual- or triple beam irradiations. Three other chambers are linked to Épiméthée and Pandore for single beam irradiation and/or Ion Beam Analysis (IBA). The layout is divided into six linked rooms, separated by suitable concrete walls for radioprotection.

THE SAMANTA PLATFORM: ADDITIVE MANUFACTURING / 3D PRINTING / PVD

Additive manufacturing makes it possible to produce quickly and inexpensively objects with complex shapes. It revolutionizes the use of materials and their shaping for industrial applications. In Saclay, CEA develops skills in this field and operates important 3D equipment on which many novel additive manufacturing processing methods are developed in order to respond to the needs of the industrial partners involved in the energy sector and in many other fields.

THE JOLIOT CHEMISTRY AND RADIOCHEMISTRY PLATFORMS

At CEA Paris-Saclay, chemistry and radiochemistry facilities are distributed over two infrastructures.

SCBM on one side - located within the Saclay nuclear center - is considered today as a unique infrastructure in Europe as regards chemical biology (drug design and synthesis), nanosciences (nano-carriers for drug delivery) or labelling platforms) and isotopic labelling capacity of organic molecules with either stable (deuterium, carbon-13) or radioactive isotopes (tritium, carbon-14) of hydrogen and carbon. Platforms dedicated to chemistry are located within 6 laboratories, representing a total of 28 conventional fumehoods, also benefit from an extra and dedicated area for chemical purification of compounds

“THE JANNUS FACILITY COMPRISES THREE ELECTROSTATIC ACCELERATORS (RESPECTIVELY NAMED ÉPIMÉTHÉE, JAPET AND PANDORE) CONNECTED TO A TRIPLE BEAM CHAMBER FOR SINGLE-, DUAL- OR TRIPLE BEAM IRRADIATIONS based on (semi)preparative HPLC systems, as well as areas devoted to chemical characterization (analytical HPLCs, spectrometers); the SCBM also operates a High Throughput Screening (HTS) automated platform (TECAN-robotic station, with appropriate liquid handling systems and various microplate reader systems (fluorescence-luminescence-TRF, UV-VIS, radioactive (beta and gamma)), allowing preparation of targeted compound libraries. Platforms dedicated to tritium / carbon-14 radioactive labeling operate dedicated glove boxes, preparative HPLC systems, scintillation counting systems, and have access to MS analysis for isotopic enrichment measurement and structural elucidation.

SHFJ on the other side - located in Orsay, 10 km away the CEA' Saclay nuclear center - is also a unique infrastructure in France as regards radiopharmaceutical development (radiotracer design and synthesis) and labelling of molecules (macromolecules included) with positron- (carbon-11, fluorine-18, oxygen-15, copper-64, zirconium-89) and gamma-emitters (lutetium-177). Chemistry facilities includes 6 fumehoods for chemical synthesis and/or LC purification. Radiochemistry facilities are distributed over two separated zones, one for radiotracer R&D, and one for GMP manufacturing of radiopharmaceuticals. The R&D zone includes three laboratories: the first one being equipped with 4 hot cells, each one having a dedicated synthesizer, the second one being equipped with 5 hot cells and a glove box for manual handling of low amounts of radioactivity for development purposes and the third one running chromatographic devices for control and analyses (HPLC / TLC). The GMP zone includes: 1) a reception area for radioactive packages (D class), 2) a storage area for raw materials, reagents and sterile materials (D class), 3) a conditioning area for raw materials (C class) equipped with biosafety cabinets, 4) a production area (C class) with 4 hot cells equipped with synthesizers, 5) a distribution hot cell (A class) with 2 handling tongs for fluorine-18- and carbon-11-labelled radiopharmaceutical manipulation, 6) a leaded hot cell for the manufacturing of radiopharmaceutical solutions with zirconium-89, copper-64 and lutetium-177 (C class), 7) a distribution hot cell (A class), 8) a sampling area (D class) and 9) an expedition area of radioactive packages. Dedicated laboratories for the quality control (radiophysical, chemical and microbiological) are also associated to this zone. The infrastructure also operates a Cyclone-18/9 (IBA) cyclotron as well as an Isotrace (PMB) cyclotron as part of a fully integrated and automated solution for the manufacturing of radiopharmaceuticals (iMiGiNE).

The SHFJ imaging platforms

Beside chemistry and radiochemistry facilities, the SHFJ infrastructure also gathers on the same site all the required facilities for the technological and translational development of new radiotracers and radiopharmaceuticals for PET and multimodal imaging. Preclinical platforms are organized and equipped to take in charge in vitro and in vivo preliminary evaluations of a novel radiotracer / radiopharmaceutical, comprising its biodistribution, its metabolism and its pharmacokinetic modeling. PET equipments include: i) an Inveon µPET scanner (SIEMENS), ii) an Inveon µPET/CT scanner (SIEMENS) and iii) an ECAT Exact HR+ (SIEMENS) for larger animals. A wide range of animal models in oncology (syngenic or xenograft tumor models) and neurology (mainly in neuroinflammation) are routinely used but new models can also be implemented and characterized. As such, the infrastructure also operates an animal facility allowing for the long-term housing of rodents and temporary housing of other animals (pigs, dogs, NHP). Other preclinical imaging modalities can be setup (MRI, US or optical) to add anatomical or functional information to PET. Clinical PET-imaging facilities are distributed over 3 additional platforms and operate the following equipments : i) a PET/CT Biograph 6 scanner (SIEMENS), ii) a PET/MRI Signa scanner (GE HEALTHCARE) and iii) a high resolution PET scanner ECAT HRRT (SIEMENS). These scanners are dedicated for routine nuclear medicine examinations as well as clinical trials. All participants (healthy volunteers and patients) to clinical studies provide written informed consent. The protocols are approved by the Regional Medical Bioethics Committee and are in accordance with French legislation and the Declaration of Helsinki 1975 (revised in 1983).

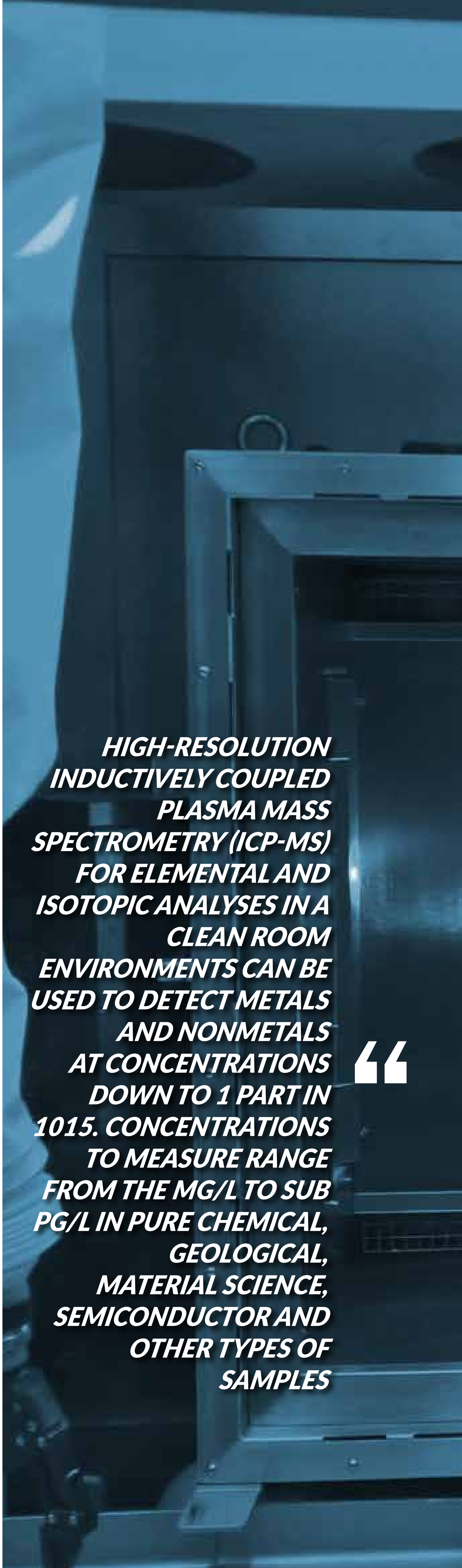
VTT

Novel **Hot Cell laboratory** for irradiated samples provideS mechanical testing and microstructural characterisation in high-end facilities. They include cell and glove box for fabrication of SEM and TEM test specimens, isolated cell for light optical microscopy, scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Heavily-shielded protective cells are for fabrication operations by electric discharge machining (EDM) for cutting and drilling, and electron beam welding, metallography, Vickers hardness tester and fractography macroscope. Mechanical testing cells consist impact tester with tempering chamber and semi-auto feed, hydraulic universal test machine, semi-automatic pre-fatiguing device and universal test machine with environmental chamber; more specific list below. There is also a unity cell for transport cask docking system; horizontal and vertical ports for transport casks of different size and orientations, weight up to 10 metric tons. Nuclear fuel is excluded from the treatment at VTT hot cell laboratory.

Hot microscopy laboratory provides material characterization from macro-structures down to micro- and nano-scale structures, and include analytical scanning electron micoscope Zeiss Crossbeam 540 FIB/FEG-SEM with EDAX Trident system (EDS/EBSD/WDS) and analytical scanning/transmission electron microscope FEI TalosTM F200X FEG (S)TEM with Bruker/FEI Super-X EDS analyser and Gatan Enfinium SE/976 EEELS for chemical and compositional analysis.

High-Resolution Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for elemental and isotopic analyses in a clean room environments can be used to detect metals and non-metals at concentrations down to 1 part in 1015. Concentrations to measure range from the mg/L to sub pg/L in pure chemical, geological, material science, semiconductor and other types of samples. The Sector Field-ICP-MS device includes of Thermo Scientific ELEMENT 2TM ICP-MS with ESI Autosampler, quartz double pass spray chamber and Peltier cooling unit, installed in ISO 7 class clean room.

Radiochemistry laboratory is applied for radionuclide composition analyses and tests, and characterisation of decommissioning waste in certified laboratories of A-, B- and C-types (STUK ST6.1). The facilities of the lab include Liquid Scintillation Counters for alpha, beta and X-ray emitting nuclides, Hidex 300 SL liquid scintillation counter with a TDCR technology, a Guard and Eu-152 external standard for beta measurements


"HIGH-RESOLUTION INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY (ICP-MS) FOR ELEMENTAL AND ISOTOPIC ANALYSES IN A CLEAN ROOM ENVIRONMENTS CAN BE USED TO DETECT METALS AND NONMETALS AT CONCENTRATIONS DOWN TO 1 PART IN 1015. CONCENTRATIONS TO MEASURE RANGE FROM THE MG/L TO SUB PG/L IN PURE CHEMICAL, GEOLOGICAL, MATERIAL SCIENCE, SEMICONDUCTOR AND OTHER TYPES OF SAMPLES

and 2D alpha/beta plots; and Gamma spectrometers, Canberra ISOCS with an HPGe detector (5 keV-2700 keV), Inspector 2000, Genie 2000 and efficiency calibrations with Geometry Composer; and alpha spectrometers.

Material performance in simulated environments can be performed in gloveboxes with controlled atmosphere. The facilities include anaerobic gloveboxes such as over-pressure <10 mbar; under-pressure <10 mbar, equipped with filtering system to allow use of -radioactive material; continuous O2 measurement in atmosphere (<0.1 ppm guaranteed); orbisphere O2 detector to measure dissolved O2 in solutions inside the box (below 0.01 ppb); feed-throughs with Lemo, electrical, Ar 6.0, vacant flanges and analytical scales; and alternative atmospheres of Ar, N2, He and other inert gases or gas mixes.

Clay laboratory is used to assess materials performance for geotechnical barrier structural design. Facilities have environments with simulated conditions such as controlled atmosphere boxes with oxic or anoxic conditions, THMC (Thermo-Hydro-Mechanical-Chemical) devices including heater, cooler, data acquisition systems, hydration system, sensors, diffusion cells, squeeszing cells and hydraulic pressures. The clay laboratory has following devices for microstructure measurements and chemical analyses of clay matrices: Small-angle X-ray scattering (SAXS), nuclear magnetic resonance spectroscopy (NMR), spectrophotometer, inductively coupled plasma spectrometry (HR-ICP-MS, ICP-OES). VTT's computational knowhow can be applied to analysis of bentonite clay performance.

3D metal printing equipment

VTT's additive manufacturing facilities cover the whole production chain from powder to finished product. The equipment related to metal printing covers a wide range of devices, capable of processing various materials and 3D printing technologies.

Antibody development

VTT has a comprehensive collection of up-to-date technologies and equipment for antibody development. VTT has facilities for mammalian cell culture, phage display screening, cost-efficient microbial host production and downstream processing, as well as excellent facilities for the characterization of binding properties and assay development.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IMPACT SUSTAINABILITY THROUGH ADDED VALUE

Advanced materials have been selected by the European Commission as a key enabling technology (KET) that can provide the basis for innovations across many industrial sectors. Advanced materials can introduce new functionalities and improved properties, while adding value to existing products and processes, in a sustainable approach. They help the transition to a greener economy, are instrumental in modernizing Europe's industrial base, and drive the development of entirely new industries. Among the major challenges that advanced materials research must tackle is the development of materials resistant to harsh environments. For example, corrosion and oxidation are ubiquitous problems across many different industries, which affect efficiency of production, product purity, energy usage and maintenance costs.

Advanced manufacturing processes, such as modification of surface properties through irradiation or additive manufacturing, are key enabling technologies for new and improved uses of existing materials. In combination with new materials, they may open new possibilities, not achievable or uneconomic through standard manufacturing processes. Besides industrial processes, advanced materials are also needed in modern medical technologies, like new solutions for diagnostics and therapy of cancer, which are developed to meet objectives of health and well-being improvement, to promote medical market growth, job creation, and positioning of the EU as a global leader in the health area.

The mission of NOMATEN is to serve impelling needs of industry and society in **multifunctional materials for industrial and medical applications**. The development of multifunctional materials resistant to harsh environment are vital for high-tech industries, like **energy industry, chemical industry, and nuclear medicine**. All three target industrial sectors are fast growing both in Europe and in Poland and heavily rely on innovations. Serving these market segments requires handling of the long path from concept of a new material, through laboratory studies and improvements to industrial application and the need to understand requirements and actions necessary to cross the `Valley of Death' between academic and industrial worlds. The gap between academic innovation and industrial applications varies between countries, but has

been especially significant in the Widening countries, including Poland.

Understanding the needs of the high-tech industries will be crucial for the success of NOMATEN. The process of getting to know industrial needs was initiated in the first phase of NOMATEN as part of creating the **Business Plan for the Centre of Excellence**. Major market segments were identified and initially studied through desktop market research. For example, the Polish energy industry, still to a large extent dependent on traditional technology, is changing as major players are merging. While the development of the existing energy infrastructure is crucial for supplying the country with energy, the industry is also looking for opportunities in the area of renewable energy.

In Poland, nuclear energy is yet in an early phase of development. Here the role of NOMATEN is to support the authorities and industry by providing excellent research outputs consistent with societal and economic challenges, and expert opinion in high-tech fields to support policy development process. NOMATEN's interdisciplinary research teams and state of the art research infrastructure will also serve the needs of research community to gain new knowledge and practical skills and advance research projects and research careers.

To understand the market, NOMATEN is investigating the needs and developments in key players in the Polish market. A central aim of the customer relationship activities in NOMATEN is to have a direct and continuous dialogue with key, large players in each market segment, but also with small and medium sized companies, authorities and other major stakeholders in the key market segments. Due to Covid-19 the direct dialogue with companies in year 2020 has so far been limited. Dialogue has continued with several previously known actor and some new contacts have been made regardless of limited possibilities to physical visits and meetings with people from industry and other customer segments. In this area, we expect to see a strong growth of activity in NOMATEN and partnering organisations as the present pandemic has passed.

International networking in the research community aim at position NOMATEN as a reputed player in the European research market. The International Scientific Committee and the partnering organisations play a central role in building the international network of contacts to other parties in the European and international research community. In 2020, the Covid-19 pandemic has had a profound impact on all types of networking and creation of new international contacts. However, through existing networking contacts of key persons in the organization and of the partnering organisations, NOMATEN has developed contacts with international networks and been invited to participate in international workshops. As in the case of networking with industry, also these activities are expected to increase once Europe and the world is opening up after the Covid-19 pandemic.

In the radiopharmaceutical market, the trends identified in the initial market study in 2018 was confirmed by the results reported for 2019. Key identified market drivers are:

- PET remains an important diagnostic tool in molecular imaging,
- growing interest in beta-radiation emitters for therapy continues as expected,
- more evidence of the therapeutic efficacy of alpha-emitters, hence the interest not only in 223Ra but also 213Bi, 225Ac and Tb radionuclides
- despite emerging problems with 99Mo supplies from nuclear reactors, there are new technologies being developed, which help to overcome the issue of access to 99Mo for regular production of 99mTc generators,
- new tracers for 99mTc are being developed, the growth of 99mTc labelled radiopharmaceuticals is sustained, despite earlier predictions of decline,
- there are new developments in scanners for SPECT and PET, hybrid technologies, whole-body PET etc.
- the role of artificial intelligence, AI, as the support to nuclear medicine/radiologist is growing, making the nuclear techniques very attractive.

NOMATEN can contribute to several of these

SOCIETAL IMPORTANCE

When one analyses the current research and development landscape from the point of view of technologies, one can notice that there are three major technological revolutions which will determine the shape of the future global economy: digital, bio-economic, and energy. To adequately tackle challenges related to on-going technological changes it is necessary to intensify actions oriented towards the spread of technologies of horizontal application in all sectors: micro- and nanoelectronics, nanotechnologies, industrial biotechnology, advanced materials, photonics as well as advanced production technologies.

All these technological changes must not be considered without taking into account their societal impacts. In fact, the Horizon 2020 programme, which is the basis of the NOMATEN Teaming grant, is organized around societal challenges and addresses major concerns shared by citizens in Europe and elsewhere.

This challenge-based approach will bring together resources and knowledge across different fields, technologies and disciplines. It needs to cover activities from research to market with a new focus on innovation-related activities, such as piloting, demonstration, test-beds, and support for public procurement and market uptake. Among the list of challenges identified by the following challenges:

- Health, demographic change and wellbeing;
- Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the bioeconomy;
- Secure, clean and efficient energy;
- Smart, green and integrated transport;
- Climate action, environment, resource efficiency and raw materials;
- Europe in a changing world - inclusive, innovative and reflective societies;
- Secure societies - protecting freedom and security of Europe and its citizens.
- The focus on society's needs and our global future continues with the Horizon Europe mission area definitions:
- Adaptation to climate change including societal transformation
- Cancer
- Climate-neutral and smart cities
- Healthy oceans, seas, coastal and inland waters
- Soil health and food

NOMATEN research and innovation agenda is fully in line with several of these challenges. New, advanced materials are needed to increase the energy efficiencyand to minimize environmental impact of industries and transport. This is particularly important in countries like Poland, whichrely on aging technologies and infrastructurein many domains. Research and innovation activities towards advanced materials are needed to ensure and facilitate development and deployment of cost-effective low carbon technologies.

The radiopharmaceutical research can be a crucial component in ensuring longer, healthier life through more efficient cancer diagnosis and new therapeutic treatments. While, of course, NOMATEN is not intended to be a source of solutions to all these challenges, we hope to become an important part of the scientific, social and entrepreneurial community addressing them.

PLANS FOR THE FUTURE

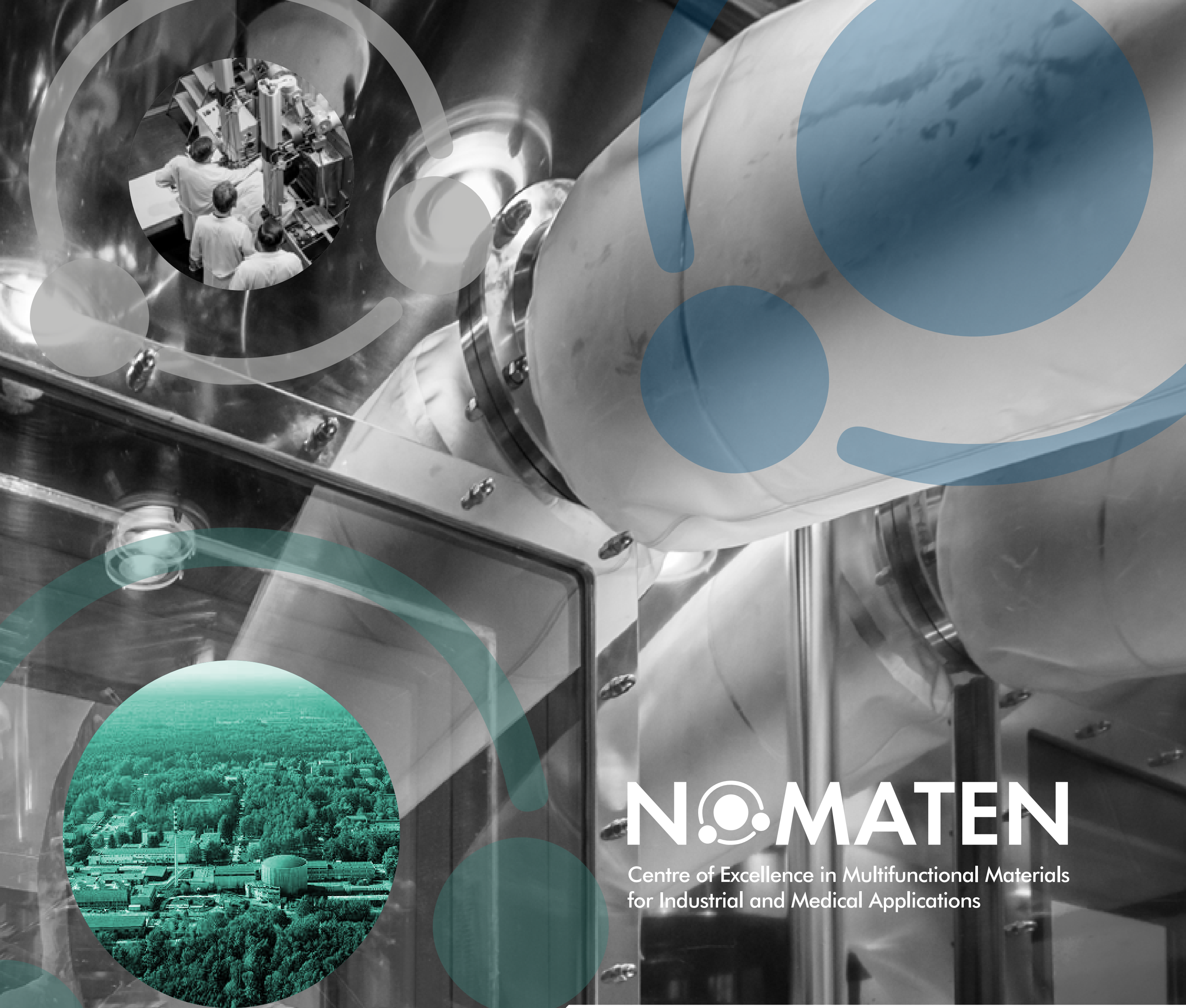
The next two years (2021-2022) are the final years of the NOMATEN Centre STARTUP phase. At the end of this period NOMATEN Centre of Excellence workforce will reach more than 30 persons, and the centre would reach full R&D&I capacity planned for the FNP IRAP Grant Agreement: at least five active Research Groups, with a significant participation of researchers from outside Poland, and an already established position among the international research community. We plan to actively pursue research projects funded from the national funds (National Science Center, National Center for Research and Development, Foundation for Polish Science) as well as the international (e.g. Horizon Europe).

The four research groups whose leaders have been selected by the International Scientific Committee in 2020 provide a starting point for further development of the Centre. The final vision of NOMATEN encompasses five to seven groups – a number which might be increased if the research activity and funding streams allow.

In addition to the research facilities made available to NOMATEN scientists by the Centre Partners, one of the crucial tasks for the coming period is to complement them by NOMATEN's own key equipment. These plans include several new facilities, including a modern SEM with FIB/EBSD/EDS facilities, an advanced HR X-Ray diffractometer and several other pieces of equipment.

In addition to these plans, NOMATEN would actively pursue new opportunities to ensure funding of additional equipment, through the Polish Ministry of Science and Education funds, FNP infrastructure grant programme or via Regional Development funding.

"THIS CHALLENGE-BASED APPROACH WILL BRING TOGETHER RESOURCES AND KNOWLEDGE ACROSS DIFFERENT FIELDS, TECHNOLOGIES AND DISCIPLINES



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