



Rzeczpospolita
Polska



Narodowe Centrum
Badań i Rozwoju



NARODOWE CENTRUM NAUKI

artiQ

ARTIQ

ARTIQ - AI Centres of Excellence

Application for a Host Institution

Institution	National Centre for Research and Development, National Science Centre
Project Joint National Project:	ARTIQ – AI Centres of Excellence
Deadline for the submission of applications	8th of April-11th of May 2021

I. HOST INSTITUTION DATA

Identification data of the Host Institution

Name (full)	<i>National Centre for Nuclear Research</i>
Name (short)	<i>NCBJ</i>
Name of the main organisational unit (where applicable)	<i>Department of Complex Systems</i>
Address of the registered office	
Street	Andrzeja Sołtana
Building No.	7
Office No.	<i>Building 88, Room 16 – DUZ/CIS office</i>
Postal code	<i>05-400 Otwock</i>
City/district	<i>Otwock - Świerk</i>
Post office	<i>Otwock</i>
Municipality	<i>Otwock</i>
County	<i>Poland</i>
Province	<i>Mazowieckie</i>

Correspondence address (if different than the address of the registered office)	
Street	
Building No.	
Office No.	
Postal code	
City/district	
Post office	
Municipality	
County	
Province	
EPUAP [Electronic Platform for Public Administration Services] mailbox	/NCBJ/projekty
Legal form	<i>Research institute (polish.: instytut badawczy)</i>
The person appointed for contact with NCBR and with the potential Leader/Project Manager	
First name	<i>Wojciech</i>
Last name	<i>Wiślicki</i>
Position	<i>Professor, Department Director</i>
Phone number	<i>504 180 987, 22 273 2938</i>
E-mail address	<i>wojciech.wislicki@ncbj.gov.pl</i>
The person authorised to represent the applicant	
First name	<i>Krzysztof</i>
Last name	<i>Kurek</i>
Function/Position	<i>Director of NCBJ</i>

II. CAPACITY OF THE HOST INSTITUTION TO PERFORM THE PROJECT

1. Description of major research achievements in the scope of implementation of R&D projects, as well as the commercialisation of deliverables of such projects regarding artificial intelligence for the last 5 years prior to or in the year of the application along with a list of the most important publications and patents of the applicant (max. 1 A4 page).

Scientific and research activities at NCBJ are of a basic as well as application character, with a significant part of them on implementations for practical applications, including industrial ones. For instance, in 2015-2020, the Institute participated in few tens of research and development projects, 22 of them financed by the National Center for Research and Development, and carried out in close cooperation with industrial partners. The projects of these opportunities include the use of the skills and experience of the Institute's employees and their partners, and its extensive research infrastructure (e.g. Maria nuclear reactor, Supercomputing Centre CIS, POLATOM) and those of our partners (CERN accelerator LHC, European XFEL, radiotelescopes).

Methods of Artificial Intelligence (AI) and Machine Learning (ML) are being developed and extensively used at NCBJ. In last 5 years, it was published a large number papers developing AI methods or applying them in research in astrophysics, elementary particle and nuclear physics, medical imaging, medical radiology and research on energy distribution, reactor engineering, energy distribution in energy, cybersecurity and other networks. These are problems of event and anomaly selection, data management, image and non-image pattern recognition, cybersecurity and others, some of them described in selected papers below:

- T. Krakowski et al., *Machine-learning identification of galaxies in the WISE × SuperCOSMOS all-sky catalogue*, *Astr. & Astrophys.*, 596 (2016) A39, <https://www.aanda.org/articles/aa/abs/2016/12/aa29165-16/aa29165-16.html>
- M. Siudek et al., *The VIMOS Public Extragalactic Redshift Survey (VIPERS): The complexity of galaxy populations at $0.4 < z < 1.3$ revealed with unsupervised machine-learning algorithms*, *Astr. & Astrophys.*, 617 (2018) A70, <https://www.aanda.org/articles/aa/abs/2018/09/aa32784-18/aa32784-18.html>
- A. Poliszczuk et al., *Active galactic nucleus selection in the AKARI NEP-Deep field with the fuzzy support vector machine algorithm*, *Pub. Astr. Soc. Japan*, 71 (2019) 65, <https://doi.org/10.1093/pasj/psz043>
- S. Turner et al., *Synergies between low- and intermediate-redshift galaxy populations revealed with unsupervised machine learning*, *Mon. Not. Roy. Astr. Soc.* 503 (2021) 3010 <https://doi.org/10.1093/mnras/stab653>
- CMS Collaboration: A.M. Sinuryan et al., *Identification of heavy, energetic, hadronically decaying particles using machine-learning techniques*, *J. Instrumentation* 15 (2020) 06, P06005, DOI: [10.1088/1748-0221/15/06/P06005](https://doi.org/10.1088/1748-0221/15/06/P06005)
- CMS Collaboration: *A deep neural network to search for new long-lived particles decaying to jets*, *Mach. Learn.: Sci. Technol.* 1 (2020) 035012, DOI: [10.1088/2632-2153/ab9023](https://doi.org/10.1088/2632-2153/ab9023), <https://arxiv.org/abs/1912.12238>
- CMS Collaboration: *Identification of heavy, energetic, hadronically decaying particles using machine-learning techniques*, *JINST* 15 (2020) P06005, DOI: [10.1088/1748-0221/15/06/P06005](https://doi.org/10.1088/1748-0221/15/06/P06005), <https://arxiv.org/abs/2004.08262>
- LHCb, R. Aaij et al.: *A new algorithm for identifying the flavour of B^0_s mesons at LHCb*, *JINST* 11 (2016) 05, P05010, DOI: [10.1088/1748-0221/11/05/P05010](https://doi.org/10.1088/1748-0221/11/05/P05010)

2. A list of 5 research and development projects within national and international competitions in the area of artificial intelligence and implemented within the last 5 years prior to or in the year of the application (title, manager, source of financing, amount of financing) (max. 1 A4 page).

1. PraceLab2 - Współpraca w zakresie zaawansowanych obliczeń w Europie (tasks related to image and network traffic analysis using artificial intelligence (AI) in conjunction with BigData)

manager: dr. inż. Norbert Meyer

source of financing: European Regional Development Fund, Program Operacyjny Inteligentny Rozwój 04.02.00-00-C003/19-00

amount of financing: 168 957 280,00 zł

2. Krajowy Magazyn Danych. Uniwersalna infrastruktura dla składowania i udostępniania danych oraz efektywnego przetwarzania dużych wolumenów, danych w modelach HPC, BigData i sztucznej inteligencji.

manager: dr. inż. Norbert Meyer

source of financing: European Regional Development Fund, Program Operacyjny Inteligentny Rozwój 04.02.00-D010/20-00

amount of financing: 190 819 117.31 zł

3. Development and construction of a system for the implementation of real-time 3D visualization of football matches for the needs of interactive television and internet transmission together with the implementation of the virtual reality system and verification of disputes in accordance with the FIFA VAR standards.

(the institute is a subcontractor responsible for all work on image processing from high-performance cameras (up to 65MPx) in real time using Artificial Intelligence)

manager: Marek Pleskot

source of financing: The National Centre for Research and Development

amount of financing: 46 455 265.40 zł

4. National Cybersecurity Platform

(The Institute has developed tools for detecting network security threats using Artificial Intelligence)

manager: prof. dr. hab. Marek Amanowicz

source of financing: The National Centre for Research and Development,

amount of financing: 16 571 395,73 zł

5. Software for Calo upgrade using YOLO for Run-3 LHCb detectors

(Development of algorithms for pattern recognition in real and simulated data from EM Calo detector, using deep learning and deep insight)

manager: dr. Vladimir Gligorov

source of financing: institutions participating in the LHCb experiment

amount of financing: 21 500 000 zł

3. Available research equipment, apparatus/infrastructure and intangible assets held in the context of implementation of a project regarding artificial intelligence (max. 1 A4 page).

Research equipment, apparatus and infrastructure

The Department of Complex Systems NCBJ includes i.a. Świerk Computing Centre (CIŚ). It constitutes one of the few High Power Computers in Poland (the so-called Super Computers), ensuring efficient processing of large data sets (including for the Large Hadron Collider at CERN, as Tier1 for LHCb experiment. CIŚ runs an HPC (High Performance Computing) cluster consisting of over 1,500 servers equipped with a total of 36,600 physical computing cores and 206 TB of RAM and over 26 PB of disk resources. Including experimental cluster for AI purposes, equipped with GPU accelerators with a total computing power of about 100 Teraflops, 5120 GB RAM and 960 GB GPU RAM. Internet access is provided through a symmetrical 10 Gbit / s fiber optic link and dedicated 100 Gbps for XFEL.

NCBJs DUZ participates in projects developing computing infrastructure, i.a.:

- *PraceLab2 implemented as part of the pan-European PRACE (Partnership for Advanced Computing in Europe) program, including the HPC computing infrastructure dedicated to artificial intelligence (AI) applications. The computing resources planned to be implemented equipped with accelerators for AI are 1.6 Petaflops.*
- *EuroHPC - aimed at building a European network of exascale supercomputers, i.e. capable of performing over one trillion operations per second.*
- *EuroCC dedicated to establishing EuroHPC National Competence Centers aimed i.a. increasing the potential for the development of artificial intelligence (AI), which is a joint venture of the EU Member States and the European Commission.*
- *National Data Store KMD3 aiming to set an intelligent data storage infrastructure supporting large-scale scientific and industrial projects.*

Intangible assets

NCBJ participated in and participates in many application and research and development projects, both financed from domestic sources (NCBR, regional programs) and international (e.g. Horizon 2020, bilateral agreements with the USA, Japan and others, participation in large organizations and research projects) such as CERN or the European Free Electron Laser XFEL). In the consortium agreements concerning these projects, a special role is attached to the issues of intellectual property protection and gaining access to new solutions developed within the entire consortium. Thanks to this, the institute has a wide range of intangible assets created as a result of its own work and in international consortia. In particular, the following can be mentioned:

- *Annotator software developed under the project subcontracting for the preparation of training and validation data for artificial intelligence algorithms for the analysis and recognition of image data and equipped with mechanisms that automate the preparation of such data using artificial intelligence.*
- *Proprietary neural networks models designed for security threats detection spotted in industrial networks based on Ethernet networks, achieving > 99% efficiency on the test data provided by NASK, and developed as part of the "National Cybersecurity Platform" project. The results are currently being prepared for publication.*

In both of the above-mentioned cases, the institute has all intellectual property rights to the solutions developed at the institute.

4. Facilities or incentives to establish an AI Centre of Excellence in the entity (max. 1 A4 page).

Due to the wide range of research and development works focused on the application and implementation issues, NCBJ uses a variety of approaches in commercialization, tailored to the needs and maximizing benefits.

Firstly, the regulations on intellectual property in force at NCBJ encourage employees to actively create innovative solutions (including through financial incentives), participate in their development and commercialization, and adequately protect the interests of NCBJ.

Secondly, the institute actively uses various methods of commercialization. These include:

- Direct implementation of the developed solutions into production in specialized NCBJ units.*
- Supporting commercialization based on employee companies and licensing NCBJ intellectual property to such companies. In this context, it is important to mention the positive role of the Science and Technology Park (polish: Park Naukowo- Technologiczny (PNT)) operating in NCBJ*
- NCBJ participation in application and research and development projects, both financed from national sources (NCBR, regional programs) and international (e.g. Horizon 2020, bilateral agreements with the USA, Japan and others, participation in large organizations and research projects such as CERN or the European XFEL Free Electron Laser).*
- Research and development, implementation and commercialization works based on contracts concluded directly with industrial partners. Due to the confidential nature of these agreements, it is not possible to present their scope and subject in detail, but in many cases they range from preliminary research to the implementation of the finished product in the practice of the industrial partner's business (i.e. the range from TRL 3 to TRL 9). Such projects are implemented both on the basis of contracts related to specific issues as well as long-term cooperation within the jointly established Scientific and Industrial Centres.*

The Świerk Science and Technology Park (PNT), operating within the structure of the institute, has attracted a large number of high-tech external companies to the Institute, and actively supports technology transfer and newly created employee companies.. NCBJ developed a flexible commercialization methodology for solutions delivered by the Institute, accomodating to the market conditions and preferences of the partners involved.

Important incentives for the Excellence Centres is an excellent conditions for companies regarding office space, space for new infrastructure, energy security, communication, IT- and physical security. The institute owns vast terrains and offices at Swierk near Otwock, including ample space for development of external companies. Redundant energy supply is secured by 3 independent energy lines and its own transformer statio, providing redundancy needed for continuity of energy supply event in case of local blackouts. Supercomputing Centre CIŚ is thus well secured, in addition to its routine UPS and diesel generator providing independent supply for service machines. An IT security is taken care of by a dedicated security team. Physical security at the level required for a nuclear reactor centre is provided by armed guards and fire brigade, in addition to the usual alarm and monitoring, and control of personal and goods traffic.

5. Other information concerning internationalisation of the entity, foreign scientists employed in this institution, availability of seminars in English, etc. (max. 1 A4 page).

The institute conducts a number of seminars in English, often the speakers are scientists from abroad:

- *Seminar of the Department of Complex Systems (DUZ)*
- *Seminars of the Division of Nuclear Energy and Environmental Studies (DUZ)*
- *Colloquium of the Department of Fundamental Research*
- *Seminars of the Astrophysics Division*
- *Seminars of the Theoretical Physics Division*
- *PhD seminars*
- *NOMATEN seminars*
- *Seminars of the Nuclear Facilities Operations Department*
- *NCBJ seminars and colloquiums*
- *Seminars of the Material Physics Department*
- *Seminars of the Department of Nuclear Techniques & Equipment*
- *HECA (High Energy, Cosmology and Astro-particle physics) seminars (conducted jointly with the Faculty of Physics at the University of Warsaw)*
- *Others carried out jointly with Polish and foreign institutions.*

Systematically, several times a month, the Institute also hosts lectures by invited scientists from abroad, of course in English. In addition, the institute currently runs three doctoral study programs, including two in English: the Graduate School of Physics and Chemistry program and the Phd4gen program run by the Department of Complex Systems (DUZ) NCBJ in cooperation with the Japan Atomic Energy Agency, and a significant number of students are foreigners. The institute employs 32 foreign scientists, and 20 foreign doctoral students attend doctoral studies.

In addition, in 2021 NCBJ has won two grants in the framework of NAWA – Welcome Poland, for international propagation of Polish institutions of higher education and research. The first is for organizing of two international conferences and the second one for setting up a Welcome Point, i.e. organizing a friendly environment for employing researchers at NCBJ.

NCBJ Complex Systems Department participates in numerous international projects and consortia, apart from the aforementioned ones, they also include: European XFEL (European X-ray Free Electron Laser), EuroFEL (Free-Electron Laser of Europe).

NCBJ cooperates with many foreign research units, selected of them include: CERN - CMS experiments, LHCb, is a member of WLCG (Worldwide LHC Computing Grid), JRC (Joint Research Centre- Joint Research Centre of the European Union, DESY (Deutsches Elektronen-Synchrotron), JAEA (Japan Atomic Energy Agency), CEA (Commissariat à l'énergie atomique et aux énergies alternatives), IAEA (International Atomic Energy Agency), GSI (GSI Helmholtzzentrum für Schwerionenforschung), INFN (Istituto Nazionale di Fisica Nucleare), KEK (The High Energy Accelerator Research Organization). Of course, these are only selected institutions, listing all of them is not possible due to the scarce amount of space available.

6. Other significant information confirming the experience and resources of the institution (max. 1 A4 page).

The National Centre for Nuclear Research (NCBJ) is the largest research institute in Poland, employing over 1,100 employees, including over 200 people with doctoral degrees, 60 employees with the status of independent research workers and over 200 people with the engineer title working at NCBJ. The headquarters of the institute are located in the Świerk district of Otwock, where the NCBJ nuclear centre covering an area of over 40 ha is located. The Institute conducts research and development and implementation works in the area related to the broadly understood subatomic physics, radiation physics, nuclear and plasma physics and technologies, material physics, devices for particle acceleration and detectors, the use of these devices in medicine and economy as well as research and production of radiopharmaceuticals as well as work in the field of high performance computing (HPC).

The Institute has the highest A + category awarded as a result of the evaluation of Polish research units in 2017. The scientific position of the institute is also determined by the number of publications (approx. 500 annually) and the number of citations measured by the Hirsch index (over 140). These values place NCBJ in the top five among all research and academic units in Poland conducting comparable research. Świerk Computing Centre (CIŚ) is one of the six largest supercomputing centers in Poland.

The Institute also produces unique equipment for the needs of large international research laboratories (CERN, XFEL, ESS).

NCBJ is the official research partner of the Joint Research Centre (JRC) of the European Union.

NCBJ is actively involved in the implementation of various types of international projects, both those related to participation in experiments taking place abroad (usually as part of large international research teams), and in Poland. High assessment of the scientific level, research potential and project experience of NCBJ makes it a valued scientific partner and is invited to participate in multinational projects financed directly by the European Commission. In many cases, NCBJ is the initiator of these projects, and having specialized support departments, it undertakes the role of their coordinator.

Statistics of projects being realized at NCBJ, classified by source of financing:

National Centre for Research and Development - 13,

Foundation for Polish Science - 1,

European Commission - 26,

Ministry of Education and Science - 28,

National Science Centre - 35,

Mazovian Unit for Implementation of EU Projects - 2,

European Program for Interregional Cooperation - 1,

National Agency of the Academic Interchange - 8.

Moreover, in 2021, NCBJ obtained two projects under the NAWA - Welcome Poland call for the internationalization of Polish institutions of higher education and science. One project concerns the organization of two international, scientific conferences, the other project is based on the organization of the NCBJ - Welcome Point, i.e. creating an environment friendly to the employment of scientists at NCBJ.

In the above spectrum of research and development, the use of machine learning and artificial intelligence methods by our employees is growing. The Świerk Computing Centre, part of the Complex Systems Department, already employs employees and associates who have gained experience in working on artificial intelligence both in the largest research centers in the world and global corporations.