



Academic Computer Centre  
CYFRONET AGH

2026



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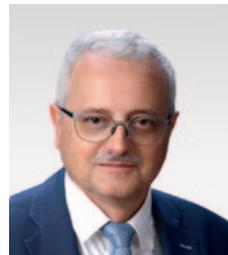
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## Term of office: 2025-2028

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The Academic Computer Center CYFRONET AGH is the longest-operating and one of the largest supercomputing and networking centres in Poland, with a history of providing access to supercomputing resources dating back to 1975.

For years, ACC Cyfronet AGH has been the operator of the fastest supercomputers in Poland, repeatedly listed on the TOP500 world list, as well as very high-capacity data storage systems. It has three data centres, its own fibre-optic network, as well as technical facilities, personnel and competencies, allowing it to operate 24 hours a day, 365 days a year. The centre is an administrator of the MAN network in Krakow and is an essential node of the PIONIER academic network, connected to the European GÉANT network.

Cyfronet is the organiser and leader of the PLGrid Consortium, consolidating national computing resources and providing a range of unique computing and IT support services for science, as well as the leader of the National Competence Center in HPC, which acts as a contact and access point for HPC for both academia and innovative entities in the economy and public administration.

ACC Cyfronet AGH plays a coordinating role in the projects included in the Polish Research Infrastructure Map (PMIB): National Supercomputing Infrastructure for EuroHPC and PLGrid National Cloud Infrastructure for EOSC. It is also a member of consortia implementing programs listed on the PMIB: CTA, EPOS, KMD, PIONIER-LAB, PRACE and Virgo, and additionally provides the computing infrastructure of High-Performance Computers along with the resources of storage systems and the computing infrastructure of the Metropolitan Area Network in Krakow (MAN) for conducting research work in other PMIB projects.

Cyfronet is actively involved in leading European projects related to the development of supercomputing technologies and services based on them, including WLCG (The Worldwide LHC Computing Grid), EGI (Advanced Computing Services for Research), PRACE (Partnership for Advanced Computing in Europe), EuroHPC JU (The European High Performance Computing Joint Undertaking), EOSC (European Open Science Cloud), EPOS (European Plate Observing System), LUMI (The Large Unified Modern Infrastructure), LUMI AI, LUMI-Q, Digital Twins in Earth and Health Sciences.

At the same time, Cyfronet participates in many other national and international research and development projects, which use both hardware resources and unique experience in building and developing integrated service platforms for scientific users. The Laboratories operating at Cyfronet bring together specialists who develop IT tools to support the development of science and technology, including modern medical diagnostics and therapy.

The centre also works with SMEs and large companies to enable the effective implementation of HPC (High-Performance Computing) and AI (Artificial Intelligence) in logistics, medicine, satellite image processing, CFD, drug research and the automotive industry.

An important aspect of Cyfronet's activities is the organisation of scientific events and specialised training and workshops related to HPC.

## Infrastructure

We offer computing services for science and business. Take advantage of our supercomputing infrastructure to conduct research and design innovations. Benefit from guaranteed data security and professional support while working with cutting-edge technologies.



- Data storage
- Cloud computing
- Supercomputers



- Network access
- Network services
- Colocation

## Network and data centres

We provide network services for Krakow and scientific institutions – benefit from the expertise of a unit that established some of the first internet connections in Poland. Through our equipment colocation service, you can entrust us with hosting your IT devices in our professional data center.

## Cybersecurity

Our offer includes comprehensive cybersecurity services – from penetration testing and compliance implementation to 24/7 threat monitoring and employee training.



- Audits and training
- Security Operations Center

 Do you have any questions about the offer? Contact us at: [helpdesk \(at\) plgrid.pl](mailto:helpdesk@plgrid.pl)



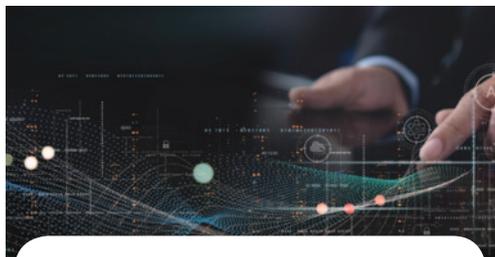
- AI resources
- AI services
- Polish LLMs

## Artificial Intelligence

Take advantage of computing resources and expertise dedicated to the development of artificial intelligence. We provide professional support at every stage of implementation. We are actively involved in the development of Bielik and PLLuM (HIVE AI). Our platform enables the use of large language models for data analysis, modeling, and automation of research processes.

## Development of innovation

Collaboration is part of our DNA, and we are a trusted partner in Big Data projects. Discover the initiatives we are involved in and how we support the development of Polish and European innovations.



- Collaboration within projects
- Research and development activities
- Software



- Training
- Experts

## Consultations

Expand your knowledge and skills in the field of supercomputing and AI. We organize events and training sessions dedicated to researchers, entrepreneurs, and public sector representatives. We offer support in solving challenges that require computing power, memory resources, scientific software, or cloud infrastructure.

 More information about the offer at: <https://www.cyfronet.pl>

## Data Storage System

The center addresses the continuously growing demand from users for fast access to ever-larger datasets. It also supports efficient analysis through an advanced data storage system integrated with supercomputing and cloud computing resources.

Thanks to its infrastructure distributed across three Data Centers, Cyfronet enables automatic backup creation in multiple physical locations, significantly enhancing data storage security.

 *To request data storage services described below, please send your inquiry to: [helpdesk \(at\) plgrid.pl](mailto:helpdesk@plgrid.pl)*

### **SAN network**

The core communication component of the Data Storage System is a dedicated SAN (Storage Area Network). It is characterized by high performance and availability, achieved through redundancy of devices and access paths as well as reliable power supply. The solution implemented at ACC Cyfronet AGH is resistant to the failure of a single switch, RAID controller in the disk array, disk loop failure, and power supply failure. The installed software provides the function of automatic path failover, switching the data transmission path from a failed channel to another channel. Load balancing technology allows the simultaneous use of redundant paths under normal operating conditions, resulting in increased connection throughput.

### **Disk arrays and servers**

The most commonly used type of disk space is the resources designated for storing users' home directories. This space must offer a very high level of availability and data security, enhanced by snapshots and backups to external tape libraries. Currently, all supercomputers at Cyfronet use scratch space implemented by Lustre. For Prometheus, this space has a capacity of 5 PB and a speed of 120 GB/s. Ares has a space with a capacity of 4 PB and a speed of 80 GB/s. In both of these computers, scratch space is implemented using mechanical disks. For Athena and Helios, user data is stored on solid-state drives. The use of this type of solution significantly increases system performance. The capacity of this type of space for Athena is 1.5 PB and achieves a throughput of 400 GB/s. For Helios, the scratch space has a capacity of 1.5 PB and a speed of 1.8 TB/s.

### **Tape libraries**

Cyfronet currently has three tape libraries with over 9,000 slots for LTO standard magnetic tapes and 44 drives of generations 6, 7, and 9. A single LTO-9 magnetic tape has a physical capacity of 18 TB and allows writing at speeds up to 400 MB/s. These resources are used for creating current backups and archiving important informational resources of the Center's users.

### **Service servers**

Service servers, along with specialized service and virtualization software, provide users with functionalities such as automatic backups and archives, hierarchical data storage systems, high-performance hardware file platforms, or distributed network file systems.

# Cloud computing

## Cloud

We offer access to several thousand cores and dozens of terabytes of RAM in the Openstack cloud. It is possible to use several different types of virtual machines and a range of operating systems. It is possible to connect additional POSIX disk resources (hard disk drives or NVMe) and store data in S3 object storage.

 For more information, please write to: [helpdesk \(at\) plgrid.pl](mailto:helpdesk@plgrid.pl)



## The Object Storage service

The Object Storage service allows users to store object data. Its interface is compatible with the Amazon S3 API and existing tools that support it. Access is available from anywhere via the public network. User data is stored as objects within buckets (containers). Typical use cases of the Object Storage service include: transferring data between computing centers and external systems, storing source data and computation results, public content sharing, backups, and CI (Continuous Integration) / CD (Continuous Delivery) artifact repositories.

 Check out the *Object Storage service technical documentation* and learn how to get access to the service: [https://guide.plgrid.pl/en/resources/storage/object\\_storage](https://guide.plgrid.pl/en/resources/storage/object_storage)

## Helios – a new light for innovation in Polish science and economy

🔗 The resources of the ACC Cyfronet AGH, including high-performance computers, are part of the PLGrid infrastructure: <https://www.plgrid.pl>.

🔗 Access to the PLGrid infrastructure resources is obtained electronically by registering in the PLGrid Portal: <https://portal.plgrid.pl/>

Helios has 37 PFlops of theoretical computing power, more than 131 thousand computing cores, 393 TB of RAM, and 17.5 PB of disk system capacity, which together offer performance of almost 2 TB/s.

The supercomputer was built according to Cyfronet’s design by Hewlett-Packard Enterprise based on the HPE Cray EX4000 platform. It consists of three computing partitions:

- CPU equipped with 98 304 AMD Zen4 computing cores and 288.8 TB of DDR5 RAM,
- GPU equipped with 440 NVIDIA Grace Hopper GH200 superchips,
- INT for interactive work, equipped with 24 NVIDIA H100 accelerators and fast local NVMe memory.

### Helios’ computing power for AI computing is almost 1.8 ExaFlops.

The Helios disk subsystem consists of two types of Lustre file systems: *scratch* with a capacity of 1.5 PB and a speed of over 1.8 TB/s and *project* with a capacity of 16 PB and a speed of almost 200 GB/s. All supercomputer components are connected via the Slingshot network with a speed of 200 Gb/s. Thanks to direct liquid cooling of the CPU and GPU partitions, it is possible to achieve a very low PUE (Power Usage Effectiveness) for the system, increasing its energy efficiency and reducing operating costs.

Helios in numbers	
Number of computing cores	131 136
Number of GPGPUs	464
Computing power	37 PFlops
TOP500 – the list of the world’s fastest computers (November 2025 edition)	96 <sup>th</sup> position (the GPU partition)
Green500 – the list of the world’s most energy-efficient computers (November 2025 edition)	8 <sup>th</sup> position (the GPU partition)



## Athena – strong support for scientific calculations

Athena achieves the theoretical computing power of over **7.7 PFlops** and provides the Polish scientific community with the computing resources based on the latest generation GPGPU processors and accelerators, along with the necessary data storage subsystem based on very fast flash memories.

Athena’s configuration includes 48 servers with AMD EPYC processors and 1 TB of RAM (6,144 CPU compute cores in total), as well as 384 NVIDIA A100 GPGPU cards.

Athena in numbers	
Number of computing cores	6 144
Number of GPGPUs	384
Computing power	7.7 PFlops
TOP500 – the list of the world’s fastest computers (November 2025 edition)	278 <sup>th</sup> position

The indispensable element enabling the effective use of such high computing power is the provision of a high-performance internal network of a supercomputer (Infiniband HDR with 4x200 Gb/s bandwidth per server) and a very fast disk subsystem. It is built on the basis of the Lustre open-source software, currently used in Ares and Prometheus supercomputers, and dedicated disk servers equipped with flash memory in the NVMe standard. The system was installed in the existing Cyfronet data centre and integrated with the PLGrid infrastructure.

This type of infrastructure meets the needs of users of Cyfronet supercomputers, who use the computing infrastructure both to perform standard high-performance scientific simulations (HPC) and to apply artificial intelligence (AI) and machine learning (ML) methods to conduct research in the field of medicine, pharmacology, biology, chemistry, physics and many other fields of science. **Athena’s computing power for AI computing is over 240 PFlops!**



## Ares – towards shorter computation time

The Ares supercomputer offers a total computing power of over 4 PFlops (the theoretical performance of the CPU part is over 3.5 PFlops, and the GPU part is over 0.5 PFlops). Ares' power is obtained from computing servers with Intel Xeon Platinum and Xeon Gold processors (37,824 computing cores) and 72 NVIDIA Tesla V100 computing cards.

Ares' computing servers can be divided into three groups:

- 532 servers, each equipped with 192 GB of RAM,
- 256 servers, each equipped with 384 GB of RAM,
- 9 servers, each with 8 NVIDIA Tesla V100 cards.

Ares in numbers	
Number of computing cores	37 824
RAM	147.7 TB
Number of GPGPUs	72
Computing power	4 PFlops

Ares is also supported by a disk system with a capacity of over 11 PB. InfiniBand EDR network is used for data transmission. The supercomputer is equipped with a liquid cooling system.



## Future technology cluster Faeton

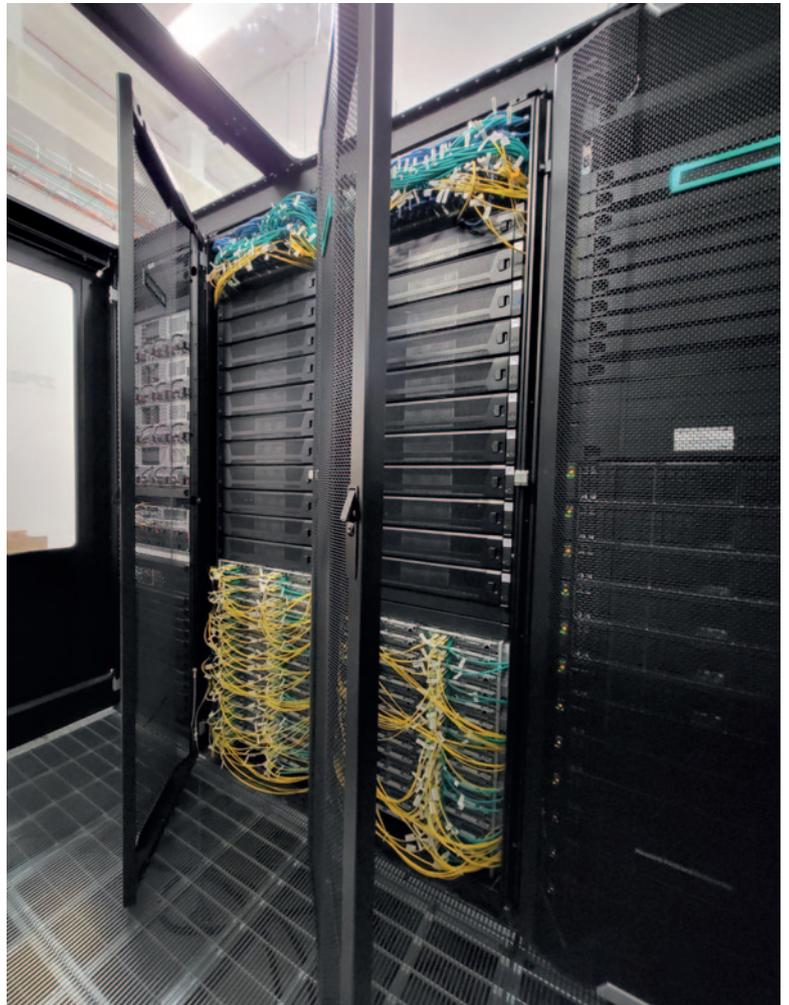
Faeton reaches 288 TFlops of computing power. It consists of 64 compute servers, each equipped with two Intel Xeon Platinum 8352s processors supporting application memory encryption, 1 TB of RAM, and 100 Gbps Ethernet low-latency network adapters. In addition, the four compute servers are equipped with 8 TB of Intel Optane SCM memory.

Faeton also includes service servers and 12 disk servers, offering more than 1 PB of NVMe disk storage and 12 TB of SCM memory.

This configuration provides an excellent environment for developing innovative software, especially in data analytics (data science) and running applications in a high-performance, high-security cloud environment.

Faeton is used to verify the applicability of new technologies, especially SCM (Storage Class Memory) in computing applications. The installation of such a system will enable work on the application of future technologies in the applications of Polish scientists and enterprises, giving them a competitive advantage by providing a platform using solutions at an early stage of development with a high innovation potential.

 To gain access to the Faeton supercomputer, please send your request to: [helpdesk \(at\) plgrid.pl](mailto:helpdesk@plgrid.pl)



# The record year 2024: four supercomputers from Cyfronet together on the TOP500 list of the fastest supercomputers in the world



In 2024, for the first time in history, the TOP500 list (the June edition) simultaneously included four supercomputers from one Polish computing centre. These were those operating in Cyfronet: Helios GPU (55<sup>th</sup> place), Athena (177), Helios CPU (305), and Ares (442). This success was repeated in November 2024, when the same four computers re-appeared on the TOP500 list, taking 69<sup>th</sup>, 212<sup>th</sup>, 348<sup>th</sup> and 490<sup>th</sup> place, respectively.

The story of the machines installed in Cyfronet that were on the TOP500 list began in 1996 when the SPP1200/XA-32 computer took 408<sup>th</sup> place. After a long time without records, the Zeus supercomputer appeared on the list in 2010 and remained there until 2015. From then on, until 2022, Cyfronet has been represented by Prometheus, which was joined by Ares in June 2021, Athena in June 2022, and Helios in November 2023.

## Zeus supercomputer

- 2010 - VI, 161<sup>st</sup> place,
- 2010 - XI, 85<sup>th</sup> place,
- 2011 - VI, 80<sup>th</sup> place,
- 2011 - XI, 88<sup>th</sup> place,
- 2012 - VI, 89<sup>th</sup> place,
- 2012 - XI, 106<sup>th</sup> place,
- 2013 - VI, 114<sup>th</sup> place,
- 2013 - XI, 146<sup>th</sup> place,
- 2014 - VI, 176<sup>th</sup> place,
- 2014 - XI, 211<sup>th</sup> place,

## Prometheus and Zeus supercomputers

- 2015 - VII, 49<sup>th</sup> and 269<sup>th</sup> place,
- 2015 - XI, 38<sup>th</sup> and 387<sup>th</sup> place,

## Prometheus supercomputer

- 2016 - VI, 49<sup>th</sup> place,
- 2016 - XI, 60<sup>th</sup> place,
- 2017 - VI, 72<sup>nd</sup> place,
- 2017 - XI, 78<sup>th</sup> place,
- 2018 - VI, 103<sup>rd</sup> place,
- 2018 - XI, 131<sup>st</sup> place,
- 2019 - VI, 174<sup>th</sup> place,
- 2019 - XI, 241<sup>st</sup> place,
- 2020 - VI, 288<sup>th</sup> place,
- 2020 - XI, 324<sup>th</sup> place,

## Ares and Prometheus supercomputers

- 2021 - VI, 216<sup>th</sup> and 373<sup>rd</sup> place,
- 2021 - XI, 267<sup>th</sup> and 440<sup>th</sup> place,

## Athena, Ares, and Prometheus supercomputers

- 2022 - VI, 105<sup>th</sup>, 290<sup>th</sup> and 475<sup>th</sup> place,

## Athena and Ares supercomputers

- 2022 - XI, 113<sup>th</sup> and 323<sup>rd</sup> place,
- 2023 - VI, 123<sup>rd</sup> and 362<sup>nd</sup> place,

## Athena, Helios CPU, and Ares supercomputers

- 2023 - XI, 154<sup>th</sup>, 290<sup>th</sup> and 403<sup>rd</sup> place,

## Helios GPU, Athena, Helios CPU, and Ares supercomputers

- 2024 - VI, 55<sup>th</sup>, 177<sup>th</sup>, 305<sup>th</sup> and 442<sup>nd</sup> place,
- 2024 - XI, 69<sup>th</sup>, 212<sup>th</sup>, 348<sup>th</sup> and 490<sup>th</sup> place,

## Helios GPU, Athena and Helios CPU supercomputers

- 2025 - VI, 85<sup>th</sup>, 246<sup>th</sup>, 386<sup>th</sup> place
- 2025 - XI, 96<sup>th</sup>, 278<sup>th</sup> i 413<sup>th</sup> place

*Supercomputers from Cyfronet on the TOP500 list*

### The world's top energy efficiency

In 2024, four of Cyfronet's supercomputers that took place on the TOP500 list have also been ranked on the Green500 list of the most ecological supercomputers. The main criterion (energy efficiency) is calculated as the ratio of the number of floating-point operations per second (computing power of a supercomputer) to energy consumption: Gflops/W. Helios GPU partition's **3<sup>rd</sup> place** in the June edition and 7<sup>th</sup> place in the November edition of the Green500 list was a particular success. This means Helios became the most energy-efficient supercomputer from the top hundred of the TOP500 list. This position proves an excellent ratio of the provided computing power to the electricity consumption. So high energy efficiency means Helios offers more computing power for each kilowatt-hour consumed than less efficient systems. Hence, calculations using Helios are cheaper than those using other machines and have a smaller environmental impact. In 2024, the remaining supercomputers from Cyfronet – Athena, Helios CPU, and Ares – were also listed on the Green500 list and took 32<sup>nd</sup>, 95<sup>th</sup>, and 129<sup>th</sup> place in the June edition, and 53<sup>th</sup>, 113<sup>th</sup> and 145<sup>th</sup> place in the November edition, respectively.



## Supercomputers usage

Supercomputers in Cyfronet are part of the PLGrid nationwide computing infrastructure – the platform for conducting *in silico* research and enabling calculations with the use of high-performance computers, also within the cloud and grid architecture.

Scientists can access the supercomputers' resources via the PLGrid infrastructure. Dedicated computing environments and specialised IT platforms enable the conduction of increasingly complex research problems. The research portfolio carried out with the help of Cyfronet supercomputers is quite reach. It includes:

- testing the spectral properties of chemical compounds,
- development of artificial intelligence models for segmentation of lesions on CT images of the lungs and MRI of the liver,
- pedestrian detection based on the signal from the event camera, using quantized neural networks,
- prediction of gravitational waves using machine learning,
- modeling of phase separation of proteins and polypeptides,
- analysis of meteorological data using machine learning,
- modeling the properties of polymers and nanomaterials,
- molecular dynamics simulations of electrolytes,
- the use of artificial intelligence to support the diagnostic process in veterinary medicine.

A wide range of research topics is evidence of a constantly increasing number of scientists aware of supercomputers' advantages. With their help, one can get the final results of massive simulations many, many times faster compared to the case of an ordinary desktop computer. Supercomputers can significantly reduce the time of computations that using a single computer would often take many years. Here, they may be usually performed within a few days. What is essential is that Cyfronet users can benefit from professional support – from complete documentation through training to individual consultations with experts.

In addition to individual scientists and small research groups, even international consortia carry out calculations from many different scientific disciplines with the help of supercomputers – of course, with the participation of Polish scientists. Scientific computations do not include simulations only.

Computing power is utilised by Polish researchers also within international scientific projects, including experiments like CTA, LOFAR, EPOS, Large Hadron Collider in CERN and the gravitational waves in LIGO and VIRGO detectors.

Obviously, even the highest positions in the TOP500 list, or the latest technologies used to build high-performance computers do not fully reflect the importance of this kind of computing resources for the Polish scientific community. The usefulness of supercomputers provided by ACC Cyfronet AGH as a tool for conducting research is best evidenced by statistical data on their use.

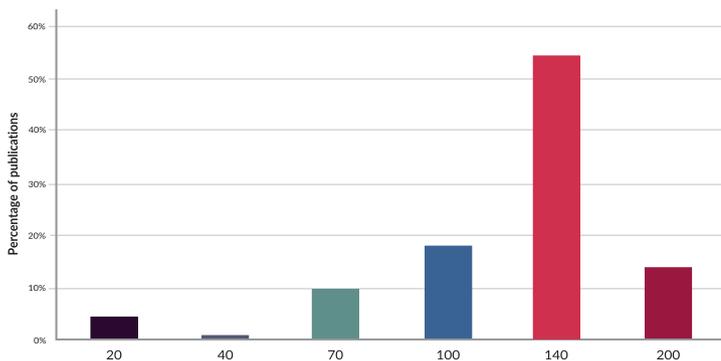
The table presents the aggregated key data on the number of computational tasks and their duration, performed by Cyfronet for other units.

It is worth mentioning that huge users’ demands for computing power and space for data storage would not be fulfilled without continuous extension of computing resources and disk storage. Therefore, we carefully analyze users’ suggestions and statistical data related to carrying out computations together with the world’s trends in computing.

The scientific level of the tasks carried out with the use of the infrastructure provided by ACC Cyfronet AGH is very high. This is evidenced by the results of scientific and research works carried out in 2024 using this infrastructure, which were presented in many publications.

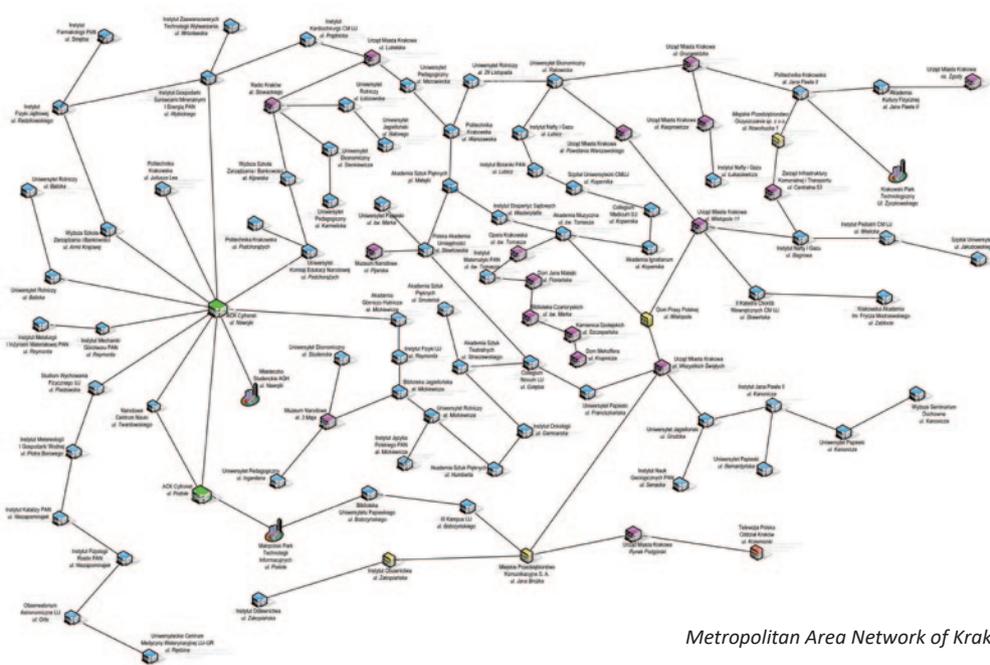
Year	No. of jobs	CPU time in years
<b>Cyfronet supercomputers</b>		
2008	603 525	207
2009	2 227 804	876
2010	4 009 049	990
2011	7 557 817	5 052
2012	8 126 522	7 923
2013	7 932 978	11 016
2014	7 694 224	12 980
2015	7 505 763	15 952
2016	7 748 677	24 653
2017	9 066 892	39 232
2018	8 342 686	42 436
2019	4 993 639	44 027
2020	5 696 919	41 761
2021	5 549 582	43 409
2022	6 227 244	48 716
2023	11 468 532	52 722
2024	11 664 594	50 752
2025	25 019 708	75 897

Ministry marks of articles published in 2024 by Cyfronet Users in scientific journals



## Metropolitan Area Network

One of the major characteristics of the present science is the complexity of research challenges, including their multidisciplinary character, use of heterogeneous models, resources and massive amount of data produced by a variety of sources. Research is not performed by a small group of scientists anymore, but by international consortia. Fast and reliable network connectivity is essential to bind those usually geographically distributed resources together. Therefore, one of the principal tasks of the ACC Cyfronet AGH is developing and maintaining the Metropolitan Area Network (MAN) to achieve its availability 24/7.



*Metropolitan Area Network of Krakow*

Fiber-optic infrastructure is the foundation of the MAN operation. As the administrator of the MAN in Krakow, Cyfronet continuously expands and modernizes the network, adapting it to the needs and expectations of its users. Currently, MAN operates its own fiber-optic infrastructure with a total length of over 200 kilometers. The MAN network's fiber-optic cables are laid in the Old Town area, around the AGH University campus, and extend to Bronowice, Krowodrza, as well as Czyzyny and Nowa Huta. Connections have also been established to remote institutes in Prokocim, the Borek Falecki area, and the Jagiellonian University's Third Campus in Pychowice. The fiber-optic cables are installed in proprietary ducts, leased telecommunication ducts, and via overhead lines.

The MAN in Krakow is an important node of the academic PIONIER network (Polish Optical Internet); a nationwide broadband optical network that serves as a vital foundation for scientific research and development in Poland. The PIONIER academic network is connected from Krakow towards Warsaw and Katowice via Nx400 Gbps links, and towards Rzeszów and Kielce via Nx100 Gbps links. The installed DWDM system, along with the switches, additionally enables fast configuration of 10/100/400 Gbps connections to any PIONIER network node, and allows for 2x400

Gbps communication with High-Performance Computing Centers in Poland.

Through the PIONIER network, communication is established with many national and international centers. International connectivity is provided via the European research network GEANT with Nx100 Gbps bandwidth. In addition to the main connection to the GEANT network, a backup connection is also provided.

A dynamic routing protocol configured at the international connection interface allows automatic rerouting of all traffic through an operational link in case of a failure. To improve service quality, in addition to the mentioned connections, internet traffic exchange with many operators in Poland is carried out through direct connections. Moreover, access to key traffic exchange points is ensured via the PIONIER network.

 Please send any questions regarding the operation of the MAN network to the following address: [helpdesk \(at\) plgrid.pl](mailto:helpdesk@plgrid.pl).



## Network services

Since the beginning of the Polish Internet (mid-1991), ACC Cyfronet AGH has actively participated in developing telecommunications infrastructure and, what is very important, the wide range of Web services. Those include:



- **e-mail** – accessed via SMTP protocol or web interface <http://poczta.cyfronet.pl>,
- **dns** – domain name system servers – performing translations of network domain names to IP addresses for users of the Krakow MAN,
- **eduroam** – provides the academic network access at all locations on eduroam in the world with a single authorised account,
- **box** – a network drive (<http://box.cyfronet.pl>) allowing file exchange and synchronisation. The drive can also be accessed from mobile devices via a dedicated application.

👉 Please send any comments regarding the functioning of the email service to the following address: [postmaster \(at\) cyfronet.pl](mailto:postmaster@cyfronet.pl)

👉 Please direct any questions regarding technical domain support, DNS server configuration, or issues accessing domains registered with ACC Cyfronet AGH to the following address: [dns \(at\) cyfronet.pl](mailto:dns@cyfronet.pl)

👉 For access to the eduroam service, please contact the Computer Network Department: phone (+48 12) 632 33 55, int. 116, e-mail: [eduroam \(at\) cyfronet.pl](mailto:eduroam@cyfronet.pl)

👉 The Box file exchange server can be used by users of ACC Cyfronet AGH email services.

## Colocation

As part of our colocation service, we enable institutions or companies to place their own servers or other IT equipment in our professional data center, which provides optimal technical and environmental conditions.

### We offer

01  
Diverse technical  
space options

3 modern data centers in different locations across Krakow,  
12 technical halls of various sizes,  
approximately 325 m<sup>2</sup> of technical space per hall.

02  
Colocation  
possibilities

any type of rack cabinets,  
in dedicated spaces,  
in isolated enclosures.

03  
Security of entrusted  
resources

infrastructure stability: guaranteed power supply,  
redundant internet links,  
immediate response time in case of failure,  
24/7 monitoring and protection throughout the year.

04  
User-friendly  
access

unlimited, logged physical access to resources 24/7,  
own backbone fiber optic link with  
bandwidth up to 100 Gb/s,  
technical support and training.

 To request the above-mentioned services (including commercial ones), please send your inquiry to: [helpdesk \(at\) plgrid.pl](mailto:helpdesk@plgrid.pl).



## Cybersecurity Department - effective security in action

The Cybersecurity Department was established in August 2023 with a clear mission: to implement and maintain the highest possible level of information protection within the organization, while supporting clients in building mature and effective security measures. Within a short period, a comprehensive Information Security Management System (ISMS) was developed, which in 2024 was officially certified under **PN-EN ISO/IEC 27001:2023-08** standard. This certification serves as proof that the processes and practices in place meet the requirements of the international standard.



ACC Cyfronet AGH is certified in accordance with PN-EN ISO/IEC 27001:2023-08

### 1. Services:

- data processing and storage,
- HPC,
- cloud computing,
- artificial intelligence,
- colocation and data centre,
- cyber security,
- networking,
- data transmission.

### 2. Software development.

### 3. Security audits.

### 4. IT training and consulting.

The awarding of the certificate is a confirmation that ACC Cyfronet AGH meets the high requirements of international standards.



## Standards and achievements

- **Certified ISMS (PN-EN ISO/IEC 27001:2023-08 standard)** – confirmed compliance of risk management processes, policies, and safeguards.
- **Operational SOC capabilities** – hands-on experience with **SIEM** and **XDR** platforms, including incident analysis and investigation of malicious communications.
- **Risk-based approach** – decision-making driven by vulnerability scans, event correlation, and threat analysis.
- **Education and awareness** – proprietary training programs and a recurring newsletter titled “Cyfrobezpiecznik”.



## Internal daily operations

- **XDR operations** – detecting and blocking advanced threats on workstations and servers.
- **SIEM monitoring** – collecting logs, correlating events, creating detection rules, and responding to alerts.
- **Malicious email analysis** – triaging suspicious messages, analyzing attachments and URLs, and providing action recommendations.
- **Cybersecurity training** – tailored to roles (end users, IT staff, management), including phishing simulations and best practices.
- **Risk management** – asset inventory, risk assessment, planning of safeguards, and risk acceptance strategies.
- **Vulnerability scanning** – regular infrastructure reviews, remediation prioritization, and patch verification.
- **Leak monitoring** – verifying exposed data in open sources and responding to data-related incidents.

## Offer for external clients

### 1) Scanning infrastructure for vulnerabilities

A thorough assessment of servers, workstations, and network services using industry-recognized vulnerability scanners.

**What you get:** a clear, prioritized risk report (CVSS + contextual insights), quick wins for immediate improvements, a tailored remediation plan, post-audit consultations.

**Benefits:** reduced time from detection to resolution of critical vulnerabilities, better preparation for audits and penetration tests.

### 2) Implementation of ISMS and preparation for ISO/IEC 27001 certification

Support from gap analysis to internal audit – practical, without excess bureaucracy.

**Scope:** Policies and procedures, registers, risk management framework, roles and responsibilities, effectiveness metrics.

**Benefits:** Structured security, compliance with business and regulatory requirements, and full readiness for certification.

### 3) Training and awareness program

Modules customized to industry specifics and organizational roles - from foundational knowledge to hands-on technical workshops.

**Formats:** On-site and online sessions, e-learning materials, phishing simulations, and incident response scenarios.

**Benefits:** A measurable reduction in risky behaviors, increased resilience against social engineering, and accessible language with practical examples.

### 4) Security monitoring with SIEM and XDR

Configuration, tuning, and operational management of the monitoring environment for real threats.

**Scope:** integration of log sources, creation of correlation rules, incident analysis and actionable recommendations.

**Benefits:** faster detection of anomalies, reduced number of false positives, measurable improvement in response time.



## How collaboration works - in brief

- **Discovery** – short workshops and environment review to understand goals and constraints.
- **Diagnosis** – risk assessment, vulnerability scans, log and process analysis.
- **Implementation** – design and execution of changes (policies, configurations, integrations, training).
- **Monitoring & improvement** – measuring outcomes, conducting reviews, refining plans, and continuous enhancement.

## Our competitive advantage

- **Proven maturity** – certified ISMS and hands-on operational experience.
- **Pragmatism over slides** – focus on measurable outcomes and risk prioritization.
- **No unnecessary complexity** – minimal formalities, maximum security.
- **Transparency** – clear reports, readable metrics, and actionable recommendations.
- **Flexibility** – seamless alignment with the client's tools and processes.

## A newsletter

"Cyfrobezpiecznik" is an original, recurring newsletter that concisely covers the most important developments and trends in cybersecurity.

**For whom:** executives, IT departments, and compliance professionals.

**What's inside:** key vulnerabilities and security bulletins, practical implementation recommendations, concise checklists, links to trusted sources.

**The result:** faster decisions and sharper priorities - without sifting through hundreds of alerts.



Contact us: e-mail: [cyber \(at\) cyfronet.pl](mailto:cyber@cyfronet.pl), phone: 515 053 199

## PLGrid – advanced computing solutions for Polish science and economy

PLGrid is a state-of-the-art computing infrastructure coordinated by ACC Cyfronet AGH, which was built and developed to support the Polish sectors of science, economy, and public administration. Its advanced supercomputing, quantum and cloud resources enable research and development at the highest global level, supporting innovation and development of new technologies in many areas of science and economy.

### The PLGrid Consortium

The origins of the PLGrid infrastructure date back to January 2007, when the PLGrid Consortium was established on the initiative of ACC Cyfronet AGH. It includes Poland's largest computing centres:

- Academic Computer Centre CYFRONET AGH in Krakow (the Consortium leader),
- Centre of Informatics Tricity Academic Supercomputer and networkK GUT in Gdansk,
- Interdisciplinary Centre for Mathematical and Computational Modelling UW in Warsaw,
- National Centre for Nuclear Research in Świerk (from 2019),
- Poznan Supercomputing and Networking Center IBCh PAS in Poznan,
- Wrocław Centre for Networking and Supercomputing WUST in Wrocław.

The infrastructure was built in a series of PLGrid projects (PL-Grid, PLGrid Plus, PLGrid NG, PLGrid Core). The original goal was to provide Polish scientists with modern IT tools and services based on supercomputing resources. In 2009-2012, a national grid infrastructure was created to support scientific research carried out by geographically dispersed teams. Since 2011, specialised tools and services for various scientific fields have been developed.

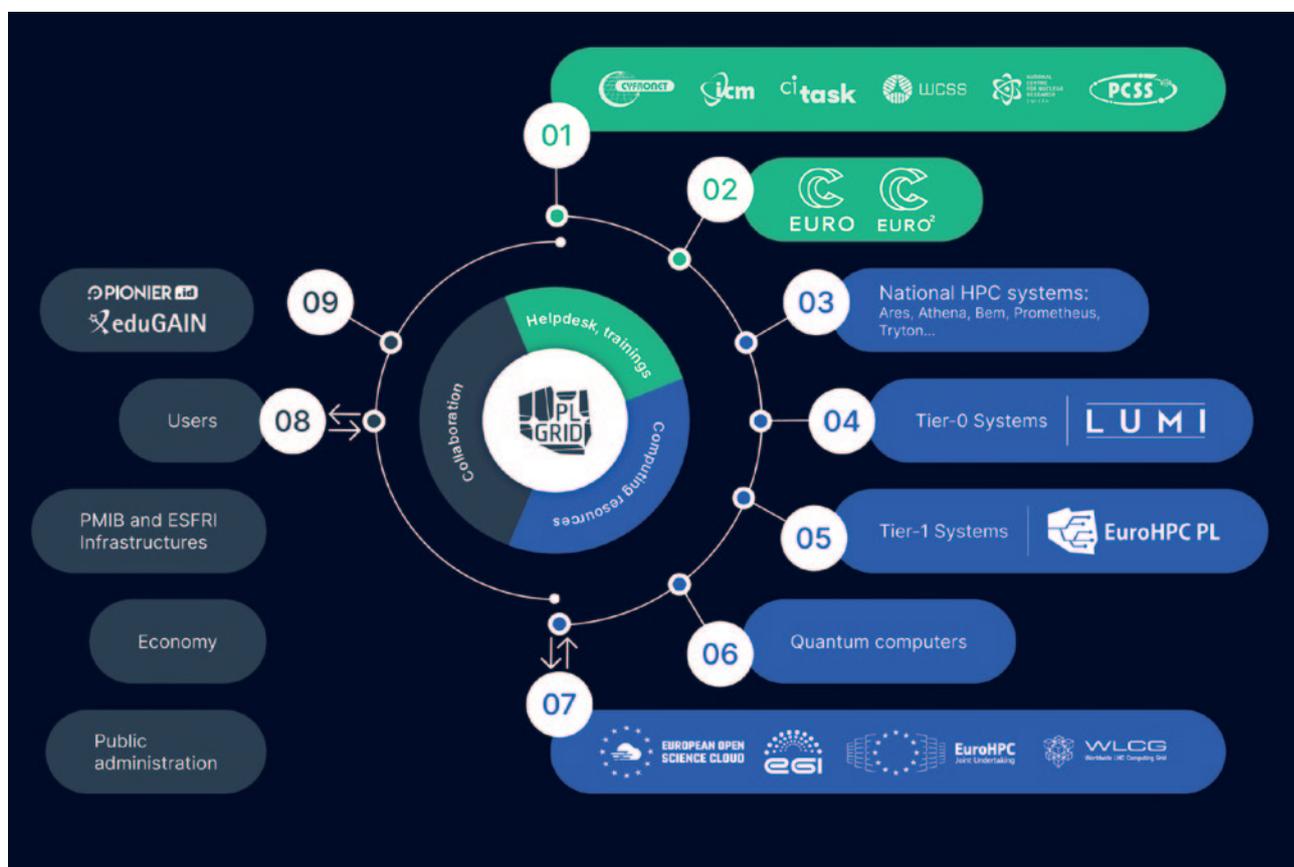
Following the expansion of the PLGrid's national computing infrastructure in 2014, also made possible by its integration with the European infrastructure within the EGI organisation of computing and storage resource providers, PLGrid users gained access to cloud computing and new tools to support computing on big data, among other things. New dedicated computing services were also implemented in the following years for research groups from various scientific disciplines, identified as priorities in the National Research Program.

Beginning in 2020, PLGrid has been conducting activities related to the EuroHPC JU, a European effort to develop an exascale computing infrastructure. Under the aegis of the EuroHPC JU, EuroHPC National Competence Centers have been established to provide access to world-class supercomputers and provide technological and training support for HPC, big data collection, storage, processing and analysis, and artificial intelligence.

### Constant development

From 2023 to 2025, carrying out the tasks of the EuroCC 2 project, the identification and filling of competence deficits in the European EuroHPC infrastructure is being conducted. In Poland, access to European HPC resources has also been provided to users from the private and public sectors. Support for implementing HPC services in the field of artificial intelligence is being provided, and since 2023, PLGrid has offered its users access to a platform that allows computing with quantum accelerators.

The PLGrid National Cloud Infrastructure for EOSC - PLGrid ICON project was launched in 2024. The project aims to build a state-of-the-art cloud infrastructure to enable research and development in accordance with the Open Science paradigm. PLGrid ICON will be a part of the European Open Science Cloud (EOSC). The PLGrid ICON cloud will provide an environment for R&D work, with a particular focus on data science and artificial intelligence applications.



## Fastest supercomputers in Poland and Europe

The PLGrid infrastructure offers access to all modern HPC resources belonging to ACC Cyfronet AGH (including Athena and Helios – the fastest machines in Poland) and supercomputers located in the computing centres of consortium members. In addition, ACC Cyfronet AGH represents Poland in the LUMI consortium, within the framework of which, thanks to the financial contribution of the state and the cooperation of our specialists, Polish scientists can use the resources of this fastest European supercomputer to conduct research based on large-scale computing, parallel processing of massive data sets and multifaceted analyses, including with the use of artificial intelligence.

Supercomputers provided in the PLGrid infrastructure have for years earned high, prestigious places on TOP500 lists – the fastest supercomputers and Green500 – the most energy-efficient supercomputers. It is worth noting that the June 2017 TOP500 list included 4 PLGrid supercomputers: Prometheus, Eagle, Triton, and Bem. And in June 2025, the new machines made available in PLGrid were also ranked in 4 positions: Helios GPU, Lem, Athena and Helios CPU.

In turn, on the Green500 list in 2022, Athena was ranked 10<sup>th</sup>, and in 2024, Helios GPU was ranked 3<sup>rd</sup>.

## Offer and benefits

Access to HPC means, for anyone doing scientific or economic computing, the possibility of accelerating computational processes many times over. This makes it possible to run complex simulations and analyses, even on massive data sets, in a much shorter time and on a much larger scale, which is now crucial in fields such as physics, chemistry, molecular biology or the manufacture of new materials. With their quantum resources and parallel processing of vast amounts of data, supercomputers also support the development of AI and ML algorithms as well as discoveries and innovations in big data.

PLGrid offers excellent computing power, cloud and disk resources, and access to numerous scientific software packages and world-class data storage services. Access to these resources is entirely free of charge for Polish scientists and all those engaged in scientific activities associated with a Polish university or research centre, including students and PhD students.

The infrastructure is not only the most modern computing machines in Europe but also people – and their expert knowledge. The cooperation with PLGrid provides comprehensive technical support through the continuous development of documentation and daily advice to PLGrid users by experts in the Helpdesk system. IT consulting and training are also offered.

To provide Users with convenient and intuitive use of resources, and based on modern technologies, the PLGrid Portal (<https://portal.plgrid.pl>) was created. It enables a quick and secure application for

computational grants. An intuitive and user-friendly interface makes navigating and using our services easy, and the highest security standards protect Users' data and privacy.

Daily support in calculations is also provided by a new, unified, more precise and continuously updated documentation – the PLGrid Guide, available at <https://guide.plgrid.pl/en/>. Thanks to its simple navigation, you will find the information you need even faster.

For more advanced Users, there is also a Compendium of knowledge necessary to create more efficient applications, optimally utilising the computational capabilities of our computer systems (<https://kompendium.plgrid.pl/>).



## Application examples

Access to state-of-the-art technologies significantly improves the quality and efficiency of ongoing research, resulting in nearly four thousand publications produced with PLGrid's participation. Among them, you can find many important and groundbreaking works in today's key fields of knowledge, including AI, medicine, and projects aimed at counteracting the effects of climate change on the Earth.



### Artificial intelligence

Our users conduct much research on artificial intelligence algorithms and the possibility of their practical use. With the support of PLGrid, language models and natural language processing works are being developed.

### Computing power in modern medicine

Scientists at the Sano Center for Computational Medicine (ACC Cyfronet AGH) use artificial intelligence, advanced bioinformatics algorithms and simulations to support doctors in the diagnostic and treatment process. State-of-the-art supercomputers make it possible to precisely select the most beneficial treatment for a given patient and speed up the development of new drugs, vaccines and medical procedures.

### Weather and climate change

Thanks to supercomputers, Polish scientists are not only improving digital weather models for more accurate and verifiable weather forecasts but also assessing global climate change and conducting research to develop mitigating methods.

### Reaching for the stars

Modern astronomy instruments scan the sky daily, generating vast amounts of data, often counted in giga and terabytes. On the other hand, modelling astrophysical processes requires extensive resources and advanced computational methods. Polish astronomers are successfully using PLGrid to explore the mysteries of the universe.

## Gain new opportunities with PLGrid

Joining PLGrid Users enables you to conduct world-class research using state-of-the-art IT tools with the support of a team of experts.

 Please visit: <https://www.plgrid.pl/>.



## Advanced computing platforms and services for research domains

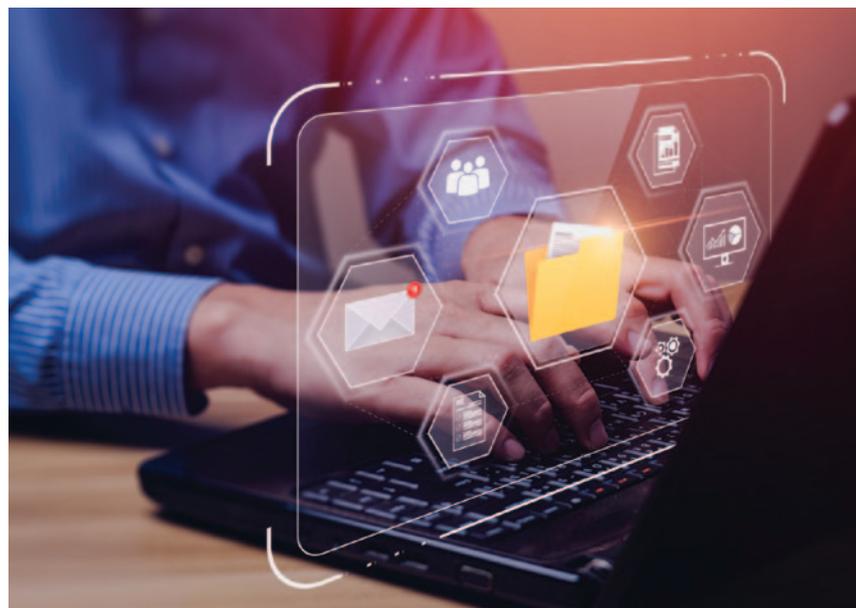
Among the scientists conducting research with the use of high-performance computers and large storage resources there is a need for different types of interaction with a computer or with the infrastructure. The consolidated, comprehensive computing environment provided by ACC Cyfronet AGH, along with full competency support, offers scientific users a wide range of unique services that

enable efficient and effective execution of scientific computations across virtually every field of science. Below are examples of such services.

**The LLM Lab Platform** is available to PLGrid infrastructure users as a dedicated service, enabling the use of large language models tailored to various needs such as data analysis, modeling, and automation of research processes. Users can apply for access through computational grants via the PLGrid Portal, within which, they define the number of credits required. Credits are directly mapped to the input and output tokens that the model analyzes or generates. Language models vary in size, and therefore in the amount of computational resources needed to run them. This

means that the number of credits consumed depends on the specific model and its size. As a result, the user can flexibly adjust their use of the platform to suit their needs by selecting the appropriate model. The platform offers access to various language models. One of the key models available on the platform is Bielik, optimized for Polish morphology and syntax, making it particularly useful for research related to the Polish language and local data. The LLM Lab Platform is accessible from anywhere in the world, allowing researchers to use its resources regardless of their location. Additionally, the API interface complies with the OpenAI API standard, facilitating integration with existing applications and research tools.

 Access to LLM Lab: <https://portal.plgrid.pl>



**JupyterHub** is a platform that enables launching JupyterLab servers as computational tasks on Cyfronet clusters. Users gain access to JupyterLab instances via a web browser. This solution significantly simplifies working with Jupyter notebooks - an interactive coding method especially popular among users involved in data analysis and artificial intelligence methods. The platform also allows direct execution of computations within an active task. Additionally, through JupyterLab servers, it is possible to launch a remote instance of the Visual Studio Code editor running on the cluster, with a browser-based interface for remote access.

👉 Access to JupyterHub at Cyfronet and documentation: <https://portal.plgrid.pl>

**The pro-viz tool** enables users of computing clusters to run applications in graphical mode (GUI) based on the XFCE environment directly on the cluster's compute nodes, with optional GPU acceleration. It operates using TurboVNC - one of the fastest VNC clients - and allows comfortable use of scientific software (e.g. Matlab, Mathematica, Maple, Ansys Workbench/Mechanical/Fluent/Electronic Desktop) even over low-bandwidth networks. Moreover, the tool is integrated with a convenient web-based access service, so cluster resources in graphical mode can be used without installing a dedicated VNC client, simply through an HTML5-compatible web browser.

👉 More information about the service: [https://guide.plgrid.pl/computing/pro\\_viz/](https://guide.plgrid.pl/computing/pro_viz/)



**ONEDATA** Onedata is a global data management system, which provides transparent access to data stored on distributed storage resource managed by multiple providers. Onedata can scale to meet the needs of small user communities or large federations of users and storage providers, making it a perfect solution for large research initiatives, long-tail of science as well as for commercial purposes. Onedata allows users to rely on a single solution for managing their personal as well as research data sets and access them efficiently on any machine, from personal laptop as well as from a Cloud virtual machine.



Onedata provides a unique federation system based on zones, which enables storage providers to organize into trusted federations and allows users to easily request storage resources from providers within a zone.

#### Features for users

- Unified access to data stored on heterogeneous storage systems distributed across the infrastructure. With Onedata, users can access their data from anywhere, as the system automatically replicates and transfers necessary blocks on demand.
- All data is organized into *space*, which can be regarded as virtual folders or volumes, accessible from any client machine via POSIX protocol.
- Easy to use web based Graphical User Interface for data access, discovery and management.
- Support for easy data sharing and collaboration with other users, while ensuring security through custom Access Control Lists and creation and management of user groups.

- Open data publishing functionality integrated into the user interface, enabling publication of prepared datasets, registration of DOI identifiers and indexing in open access portals.

#### Features for administrators

- Simple deployment based on Docker containers using a friendly command line client.
- Easy storage support for user requests based on secure tokens.
- Complex monitoring information available on all aspects of the system, accessible through REST API or directly visualized in the administration panel of the Graphical User Interface.
- Support for multiple storage backends including POSIX based storage (e.g. Lustre), Amazon S3, Ceph, OpenStack SWIFT, and GlusterFS.

#### Features for developers

- Easy integration with Onedata services using REST API and CDMI protocols.
- Flexible authentication and authorization of requests based on Macaroon tokens.
- Complete reference documentation of the REST API including sample clients for several programming environments.

#### Onedata users

Onedata has been deployed and evaluated in several initiatives in Europe including Polish National Grid infrastructure PLGrid, INDIGO-DataCloud, EGI DataHub, Human Brain Project and Helix Nebula Science Cloud. In HBP it has proven to meet the users' hard requirements of real-time brain visualization use case.



👉 More information: <https://onedata.org>.

## Model Execution Environment

The Model Execution Environment (MEE) is a software stack which facilitates the execution of computational workflows on high-performance computing infrastructures, including those available at ACC Cyfronet AGH. The platform's goal is to ensure that computations can be executed straightforwardly by domain scientists, i.e. researchers who do not possess intimate knowledge of the specifics of interaction with computing clusters and other large-scale computing systems.



### Pipelines, steps, and models

Within MEE, computational workflows are represented by the so-called pipelines, i.e., collections of computations (each of which is called a step) where the outcome of one computation provides input for another. MEE provides a wide range of facilities enabling users to design steps, arrange them into pipelines, and execute these pipelines on the available computational resources.

Each step is based upon a collection of computational artefacts (executable code) stored in a Git repository. This is referred to as the model. When a step is called for execution, MEE automatically uploads the requested model to the HPC infrastructure and monitors its performance on the input data provided. Users can select a specific version of the given model when launching the pipeline (based on Git versioning mechanisms), thus facilitating traceability and repeatability of computations.

In addition, pipelines can be executed in either automatic or manual mode. An automated pipeline will be executed in its entirety, while a manual pipeline contains a breakpoint at the end of each step, asking the user to manually request the processing of any subsequent steps. This enables users to

download and review interim results and potentially cancel the execution of pipelines which are not expected to yield useful output, thus preserving computational resources.

All MEE features can be accessed via a user-friendly web-based UI. Furthermore, MEE provides programmatic access, which enables integration with higher-level software tools.

### **Research data management**

As MEE schedules and monitors the execution of computational pipelines on HPC resources, care must be taken to manage the associated research data, ensuring that the appropriate input is made available to the underlying models, and that results can be retrieved from the HPC infrastructure. To this end, MEE provides a set of data management interfaces where users of the infrastructure can upload input files and download results. The platform itself manages HPC data storage resources and provides automatic stage-in and stage-out capabilities for research data, along with a set of top-level UI interfaces for its users.

### **Security**

The Model Execution Environment is integrated with PLGrid authentication and authorisation mechanisms. All users of the PLGrid infrastructure can use their login to authenticate themselves with MEE and subsequently schedule and run computations using their PLGrid accounts. Moreover, MEE makes use of PLGrid computational grants assigned to researchers. Pending computations are executed in the context of specific computational grants, which can be predefined within the platform.

### **Organisations**

Externally, MEE provides a set of distinct workspaces dedicated to individual research teams. These are referred to as organisations. Each organisation has a distinct entry point to MEE (i.e., a distinct URL) and can define its own pipelines and pipeline steps, as well as manage its own set of research data. MEE implements compartmentalisation, where each organisation can be managed separately, providing access to a distinct group of users.

### **Applications**

European projects, the POLVAS consortium, and the Sano Centre for Computational Medicine, along with several ad-hoc research collaborations for which individual MEE organisations have been defined. MEE platform was also used as a prototype implementation of the simulation platform for the virtual human twin, developed in the scope of the EU roadmap created by the EDITH project.

 *More information: <https://mee.cyfronet.pl>*



The software installed on the ACC Cyfronet AGH computers includes:

- scientific software packages (licensed and Open Source ones),
- special architectures based on GPGPU graphic accelerators,
- Big Data processing tools.

👉 The full list of offered software can be found in the PLGrid Documentation: <https://guide.plgrid.pl/applications/>

👉 We also invite you to the knowledge compendium (<https://kompendium.plgrid.pl/>), on the subject of creating efficient applications that are able to use the computational capabilities of supercomputers.

👉 To obtain assistance or to report a need for computational software (including commercial software), please contact us via the Helpdesk system: <https://helpdesk.plgrid.pl/>



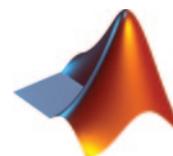
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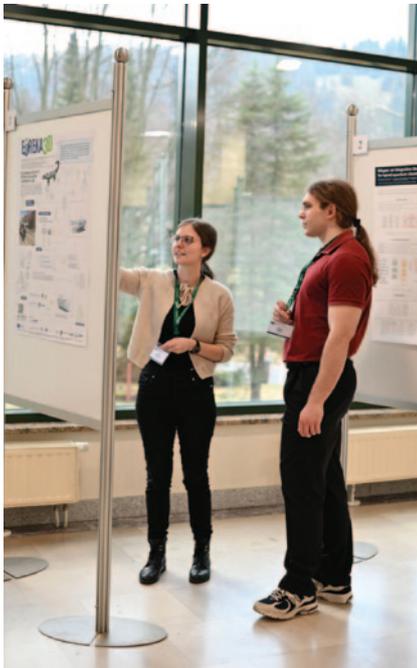
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## HPC Users' Conference (KU KDM) 2025



The basic premise of the HPC Users' Conference was to initiate annual scientific meetings devoted to users performing computations in ACC Cyfronet AGH with the use of high-performance computers, computing clusters and installed software.

The conference was launched in 2008 and included several presentations by Cyfronet employees – describing the resources available in the Centre, as well as numerous lectures of researchers – presenting the scientific results achieved using Cyfronet hardware and software. In addition, two invited speeches were given – by Norbert Attig from Jülich Supercomputing Centre and Jaap A. Kaandorp from the University of Amsterdam.

The first edition of the conference attracted much attention and increased the interest of users in Cyfronet resources. It proved that this type of event was much awaited and needed.

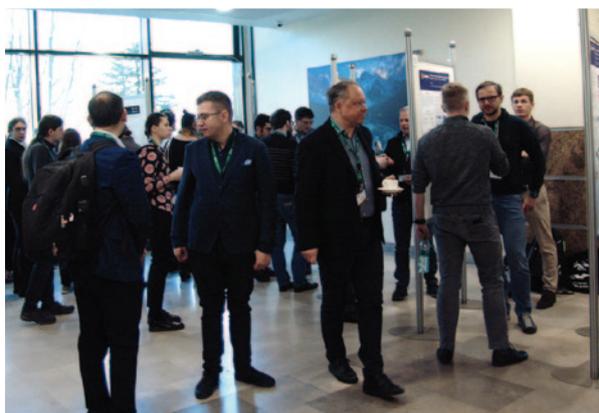
Nowadays, the HPC Users' Conference focuses on large-scale computations and simulations, novel algorithms in computer science, tools and techniques relevant to high-performance computing, teaching in computer science, databases. However, the main aim of the conference is the overview of research results carried out using the computer resources of Cyfronet. It is also an opportunity to familiarize the users with the Centre and its resources, including the PLGrid infrastructure.

The conference includes a series of talks by scientists who perform research using Cyfronet resources and can present the role of these resources, typical usage scenarios and performance aspects. The event is an important opportunity for Cyfronet representatives to meet with these scientists and acquire the knowledge necessary to take the proper actions in order to adapt the computing infrastructure to scientists' needs and fulfil their requirements. On the other hand, the conference also gives a possibility for researchers representing various disciplines to exchange experience and become familiar with the new technologies and services currently being deployed at the Centre.



The crucial parts of the conference are meetings with suppliers of Cyfronet hardware and software, as well as the panel discussion on the efficient use of these resources. The latter is always attended by users – researchers, who use the chance to get familiar with news regarding the computing infrastructure in the Centre and to inform Cyfronet experts about issues encountered while interacting with this infrastructure.

This year's edition has adopted a revised format compared to previous years, offering participants expanded opportunities to improve their use of supercomputers in scientific research through group training sessions and individual consultations with the PLGrid support team. We also presented new possibilities for Polish SMEs and startups to leverage European supercomputers.



## Cyfronet Open Day 2025

Every year, the Academic Computer Center Cyfronet AGH organises an Open Day for the scientific community of Krakow and the Małopolska region.

The program of the event includes:

- presentation of Cyfronet's activities and information about hardware resources, software and ongoing projects,
- presentation of the latest trends in the development of computer and network architectures, including resources that allow performing quantum calculations,
- speeches on the computational capabilities of supercomputers and their application for the analysis of research results, simulations, visualization, and parallel analysis of huge data sets (big data), including for the development of artificial intelligence,
- announcement of the results of the competition for the best doctoral thesis based on the Cyfronet computing resources and presentations of the winners.

Participants of the Open Day have the opportunity to get acquainted directly with the unique services of Cyfronet and the possibility of using them in research for the synergy of science and economy.







## Gaia AI Factory

Gaia AI Factory  
 official website:  
<https://gaia.plgrid.pl/>

**The European High Performance Computing Joint Undertaking (EuroHPC JU) has selected the consortium led by the Academic Computer Centre Cyfronet AGH in Kraków to establish the Gaia AI Factory – a state-of-the-art artificial intelligence factory in Poland.**

The project, with a total budget of 70 million, is co-financed in equal parts by Poland and the European Union under the European High Performance Computing Joint Undertaking, EuroHPC JU. The initiative aims to create an infrastructure and an ecosystem that supports the development of advanced artificial intelligence technologies aligned with European values of trust, transparency, and responsibility. The Gaia AI Factory project includes the expansion of supercomputing infrastructure, broader access to large-scale data repositories, and the strengthening of AI-related skills and competencies through a wide range of training programs, advisory services, and a talent development initiative.

### Computing infrastructure for AI

The Polish AI Factory will become the national center of excellence in artificial intelligence, offering state-of-the-art infrastructure featuring the Gaia AI supercomputer. Equipped with over a thousand GPU accelerators, the system will enable large-scale training and deployment of AI models, surpassing the current leader (Helios) in computing power. The Gaia AI supercomputer will be located in Kraków, managed by ACC Cyfronet AGH, and integrated with the PLGrid infrastructure, allowing the use of national expertise and resources.

### Consortium

The Gaia AI Factory consortium consists of leading research institutions, domain experts, and technology partners representing AI stakeholder groups from across the country.

The work of the Gaia AI Factory consortium, led by ACC Cyfronet AGH, is carried out with coordinated support from several key ministries: the Ministry of Science and Higher Education, the Ministry of Digital Affairs, the Ministry of Finance, and the Ministry of Development and Technology. Poland’s financial contribution to the project comes from the budgets of the Ministry of Science and Higher Education and the Ministry of Digital Affairs.

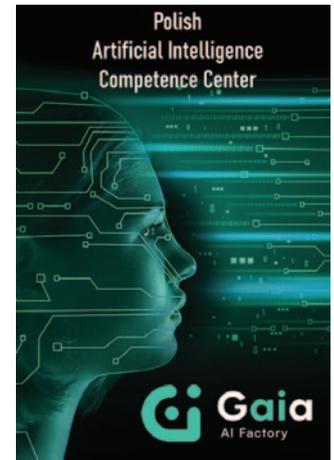


### New opportunities for society and the economy

Gaia AI Factory is not only an infrastructure, but also a collaboration platform for science, industry, and the public sector. It will offer a set of tools and services supporting the entire lifecycle of AI projects – from data preparation to model training and deployment. Thanks to the new infrastructure and science-business collaboration, AI-based solutions will be developed more quickly, accelerating scientific research, simplifying everyday life, improving public services, and boosting economic growth.

Examples of practical benefits:

- **Healthcare:** faster and more accurate imaging diagnostics, medical data analysis, personalized therapies, and decision support for doctors.
- **Security and public administration:** intelligent data analysis systems enabling quicker threat response, improved citizen services in offices, multilingual translations in public services.
- **Education:** access to open AI tools and training to develop digital competencies and foster the talents essential for a modern knowledge-based economy.
- **Environment and space:** satellite data analysis to monitor climate change, air quality, and natural disasters.
- **Economy:** support for startups and companies in creating new AI-based products and services – from industry to the creative sector.



### Access to the Gaia AI Factory

Once the Gaia computer is fully installed and running, access will be provided within the PLGrid infrastructure: <https://plgrid.pl/>.

**The Gaia AI Factory not only strengthens Poland’s position in the European AI ecosystem, but also provides a foundation for future initiatives, enabling scalable computations and the development of advanced language models and AI applications.**





## Polish Large Language Models (LLM)

Cyfronet actively participates in the development of two Polish Large Language Models (LLMs): **Bielik** and **PLLuM (HIVE AI)**. Polish language models are trained on Polish data and therefore are better adapted to the Polish language than foreign models. This significantly facilitates their use in various sectors, such as education, business, or public administration. From a broader perspective, the development of Polish language models can help protect and promote the Polish language, which is important for national and cultural identity.

The development of large language models (LLM) requires vast computational resources, particularly modern GPUs, which significantly accelerate data processing and operations on large matrices. Machine learning libraries such as TensorFlow and PyTorch are specifically optimized to work with these processors, allowing their capabilities to be fully leveraged during training.

For this reason, Cyfronet provides access to its supercomputing resources - especially Helios - for training Bielik and PLLuM. Additionally, Cyfronet experts offer substantive support throughout the process.

### **Bielik**

Bielik is a family of Polish language models that was created through the collaboration of the SpeakLeash Foundation and ACC Cyfronet AGH. Bielik comes in various versions, ranging from 1.5 to 11 billion parameters. Scientists affiliated with Polish research institutions can use Bielik as part of the services available through the PLGrid Portal (<https://portal.plgrid.pl/>).

### **SpeakLeash – group of enthusiasts and creators of Bielik**

The SpeakLeash Foundation brings together people from various professions who aim to create the largest Polish text dataset. The project team consists of employees from Polish companies, researchers from scientific centers, and students of AI-related fields. After more than a year of work on the Bielik-11B-v2 model, its subsequent versions - 2.5 and 3 - were released in 2025.

### **Open model and availability for business use**

Bielik is an open-source project and can therefore be used for both private and business purposes. It can be used to support business development and business processes. Examples of applications include:

- Customer service automation: chatbots, answering frequently asked questions.
- Data analysis: processing and analysis of large datasets, generating reports.
- Content creation: articles, product descriptions, marketing materials.
- Support in decision-making processes: scenario generation, risk analysis, recommendations.

### PLLuM (HIVE AI)

In 2025, Cyfronet joined the HIVE consortium, which was established as a continuation of the PLLuM consortium, developing a family of language models with the same name. PLLuM is being developed at the request of the Ministry of Digitization. Versions using 8 to 70 billion parameters have been released, providing a high degree of flexibility in application.

#### Ethical and for society

Like Bielik, PLLuM is based on ethically sourced data – the training data was used in accordance with copyright regulations. Additionally, data directly obtained from owners who granted a license for their use was used in the project. The PLLuM model is, by its nature, a safe and harm-free model. It is planned to be widely made available to society in the form of an Assistant integrated into the mObywatel application. In this way, PLLuM is intended to facilitate access to regulations and provide more convenient handling of official matters.

#### The HIVE Consortium

8 leading units are currently engaged in the HIVE AI project development:

- Wrocław University of Science and Technology (leader)
- Institute of Computer Science, Polish Academy of Sciences
- Institute of Slavic Studies, Polish Academy of Sciences
- Research and Academic Computer Network (NASK)
- National Information Processing Institute
- University of Łódź
- Centre for Information Technology
- ACC Cyfronet AGH.



ACC **Cyfronet AGH** as a consortium member is involved in the following activities:

- Building language data corpora for pre-training, fine-tuning, and instruction of large language models
- Training large language models, including pre-training, fine-tuning, and instruction
- Pilot deployments of models in the public sector.

#### Useful links:

 Talk to Bielik: <https://chat.bielik.ai/>

 Talk to PLLuM: [https://pllum.clarin-pl.eu/pllum\\_8x7b](https://pllum.clarin-pl.eu/pllum_8x7b)



## VIRGO-PL

**VIRGO official website:**

<https://www.virgo-gw.eu/>

Virgo is a laser interferometer with two perpendicular arms, each 3 km long: its goal is to detect gravitational waves from astrophysical sources. It is located at the European Gravitational Observatory in the countryside near Pisa, Italy. The Virgo detector enables the recording of gravitational waves emitted, among others, during the merging of binary systems of neutron stars or black holes, or supernova explosions. The direct detection of gravitational waves allows the study of objects that do not emit electromagnetic radiation, as well as the direct study of the interiors of neutron stars. This makes it possible to investigate phenomena undetectable by other methods and to explore distant corners of the Universe.

**Polish Collaboration for Virgo**

We are part of the Polish Virgo Project Consortium, which contributes to the development of the Virgo gravitational wave observatory. ACC Cyfronet AGH supports computational tasks for the Virgo gravitational wave detector and assists in integrating with the International Gravitational-Wave Observatory Network. These activities are carried out under the project "Virgo-PL: Polish Participation in the Virgo Gravitational Wave Observatory."



*One of the 3-kilometer-long tunnels of the Virgo detector, through which laser light travels  
© Cyril FRESILLON / Virgo / CNRS Photothèque.*

## CTAO



CTAO will be the world's largest gamma-ray astronomy observatory. The unmatched precision and wide energy range of CTAO (20 GeV - 300 TeV) will help answer some of the most puzzling questions in astrophysics, covering three main topics: understanding the origin and role of relativistic cosmic particles; studying extreme systems such as black holes or neutron stars; and exploring the frontiers of physics, searching for dark matter or deviations from Einstein's theory of relativity.

**CTAO official website:**

<https://www.ctao.org/>

### Cyfronet's role in CTAO

Cyfronet's involvement mainly concerns providing supercomputing infrastructure for processing research data used by project partners. Additionally, Cyfronet is engaged in work on the Science Portal as part of the Science User Support System package.

The Science Portal is an application that includes a range of tools for scientists using CTAO, including:

- requesting observation time for specific objects;
- checking the status of observations;
- quick analysis of initial results;
- reviewing past, completed observations.

In this case, Cyfronet's role is to integrate various components of the Science Portal so that the end user can access all the necessary resources in one place.



*Visualization of the future CTAO-North observatory at the Roque de los Muchachos Observatory on La Palma (Spain). The planned telescope network layout includes 13 telescopes: four Large-Sized Telescopes (LST) and nine Medium-Sized Telescopes (MST). Source: CTAO, CC BY-NC-ND 2.0.*



## EPOS – multidisciplinary platform supporting Earth sciences research

### Introduction

The EPOS Project – European Plate Observing System – is a program dedicated to multidisciplinary research into phenomena occurring within the Earth's crust. The goal of EPOS is to facilitate understanding of Earth's dynamics and tectonic processes through the analysis of seismological, satellite, geological, petrochemical, and laboratory data.

### Objectives

The main objective of EPOS is to integrate diverse and distributed European Research Infrastructures in the field of solid Earth sciences, based on modern IT technologies. This integration enables innovative and multidisciplinary research aimed at better understanding the physical and chemical processes on Earth that contribute to the occurrence of earthquakes, volcanic eruptions, ground instabilities, tsunamis, as well as tectonic movements and dynamic surface deformations.

### Thematic structure

The initiative focuses on ten main, linked with each other, Thematic Core Services (TCS): Seismology, Near-Fault Observatories, GNSS Data and Products, Volcano Observations, Satellite Data, Geomagnetic Observations, Anthropogenic Hazards, Multi-scale Laboratories, Geological Information and Modeling, Tsunami.

### Cyfronet's activities for EPOS

ACC Cyfronet AGH is participating in successive projects building EPOS, supporting the initiative with both hardware resources and the knowledge and skills of specialists. Parallel activities include several spheres, one of which is the development of the EPISODES digital platform for one of the EPOS thematic nodes – the Thematic Core Service Anthropogenic Hazards (TCS AH) node.

The platform is available at <https://EpisodesPlatform.eu> and provides a tool for analysing anthropogenic seismicity and associated hazards and for assessing the potential environmental impact of geo-resource exploitation. With data from seismic stations and shared industry information, the platform makes it easier to analyse processes such as the flooding of artificial reservoirs and extraction of raw materials, shale gas or groundwater. In addition to sharing and visualising data, the EPISODES Platform provides a virtual workspace for running applications from different vendors and organising data. It also makes it possible to create your own applications and use them on the aforementioned data, as well as to combine applications into larger experiments – creating a so-called workflow. The functionality was created thanks to the



Image: EPOS - European Plate Observing System

national project – EPOS-PL, while within the framework of another project – EPOS-PL+, the EPISODES Platform was enriched with the possibility of conducting experiments using artificial intelligence.

In addition to creating and maintaining the EPISODES Platform, as well as providing the infrastructure for calculations involving it, Cyfronet specialists take care of maintaining the integration elements between the TCS AH thematic node and the central EPOS Data Portal, which allows access to the results of activities at all EPOS thematic nodes.

In the framework of subsequent European projects, the EPISODES Platform is also being developed in terms of increasing the amount of data available on the platform, adapting the platform's capabilities for industrial research, and integrating the platform's services with those of the European Open Science Cloud (EOSC) – the Geo-INQUIRE (Geosphere INfrastructures for QUEStions into Integrated REsearch) and EPOS ON (EPOS Optimization and Evolution) projects. The platform is also being developed to adapt to study extreme geophysical conditions within the framework of the “digital twin” being built within the DT-GEO project.



We invite you to visit the official website of the EPOS initiative: <https://www.epos-eu.org/>

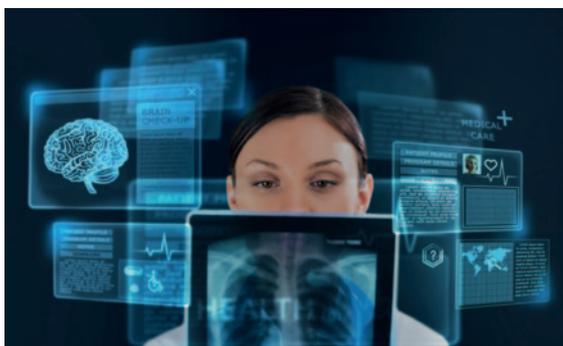


## Sano: Centre for Computational Personalised Medicine - International Research Foundation

Owing to a unique initiative carried out in 2019-2026 by the Academic Computing Centre Cyfronet AGH along with five partner institutions in the framework of the EU Horizon 2020 *Teaming for Excellence* programme, the International Research Agendas programme implemented by the Foundation for Polish Science, and with financial support from the Ministry of Science and Higher Education, a new entity called **Sano** – Centre for Computational Personalised Medicine was established in Krakow.

The mission of Sano involves:

- development of new computational methods, algorithms, models and technologies for personalized medicine,
- introducing new diagnostic and therapeutic solutions based on computerized simulations into clinical practice,
- fostering the creation and growth of enterprises which develop cutting-edge diagnostic and therapeutic technologies,
- contributing to novel training and education curricula which meet the needs of modern personalised medicine.



The **Sano Centre** (<https://sano.science/>) is situated in Krakow: a city well known for educating top-class medical practitioners and IT experts, whose teaching hospitals are well regarded among the academic community and whose life science technology sector is continually expanding.

The establishment of the **Sano Centre** directly contributes to regional scientific excellence by fostering new research collaborations and creating top-tier educational opportunities for postgraduate students. It will also improve knowledge and technology transfer by promoting the creation of new commercial enterprises which deal

with advanced technologies. The Centre's impact will transcend regional boundaries, contributing to advancements in medical research and thereby to the quality of medical care.

The Centre's objectives are based, among others, on the National Smart Specialisation Strategy. **Sano** aims to enhance collaboration between academic and commercial institutions on an international scale. Key performance indicators include the number of highly cited scientific publications and grants obtained by the Centre, the number of solutions based on computational models which have been introduced into clinical practice, and the number of innovative, marketable products and services.

The Centre for Computational Personalised Medicine represents a joint international collaboration of the following institutions: ACC Cyfronet AGH, LifeScience Cluster Krakow – a Key National Cluster, University of Sheffield and Insigneo Institute, Forschungszentrum Jülich, Fraunhofer Institute for Systems and Innovation Research ISI, and National Center for Research and Development.

## Digital Twins

The concept of Digital Twins (DT) assumes the creation of a virtual model that reflects the features of the object adopted as a model as faithfully as possible. This makes it possible to conduct computer analyses to take effective, model-tested actions in reality. Through its infrastructure and expertise, Cyfronet supports the creation of the “Digital Twin” model in various fields of science.

The EDITH project (An Ecosystem for Digital Twins in Healthcare) developed an integrated system architecture to implement the human “Digital Twin” concept and a vision for its further development. The Cyfronet team coordinated the development of a demonstration prototype of the simulation platform.

In turn, within the DT-GEO project (A Digital Twin for GEOphysical extremes) a “Digital Twin” prototype was implemented to study extreme geophysical conditions, such as earthquakes (natural or anthropogenic), landslides, volcanic eruptions and tsunamis. In this case, Cyfronet specialists were working on the part related to anthropogenic threats.

Within the InterTwin project (An interdisciplinary Digital Twin Engine for Science) a prototype of an interdisciplinary solution called Digital Twin Engine (DTE) was co-designed and implemented. This open-source platform provides generic and customized modeling and simulation software components to integrate Digital Twins (DTs) specific to the application. In the project, the Cyfronet team introduced integration with the proprietary OneData platform.

The GEMINI project (A Generation of Multi-scale Digital Twins of Ischaemic and Haemorrhagic Stroke Patients) aims to provide validated multi-organ and multi-scale computational models to support therapeutic decisions and improve fundamental understanding of ischemic and hemorrhagic acute strokes. Virtual twin models will be created, which will then be tested on a large scale by the Cyfronet team the same model will be used for a large group of patients using the HPC infrastructure.





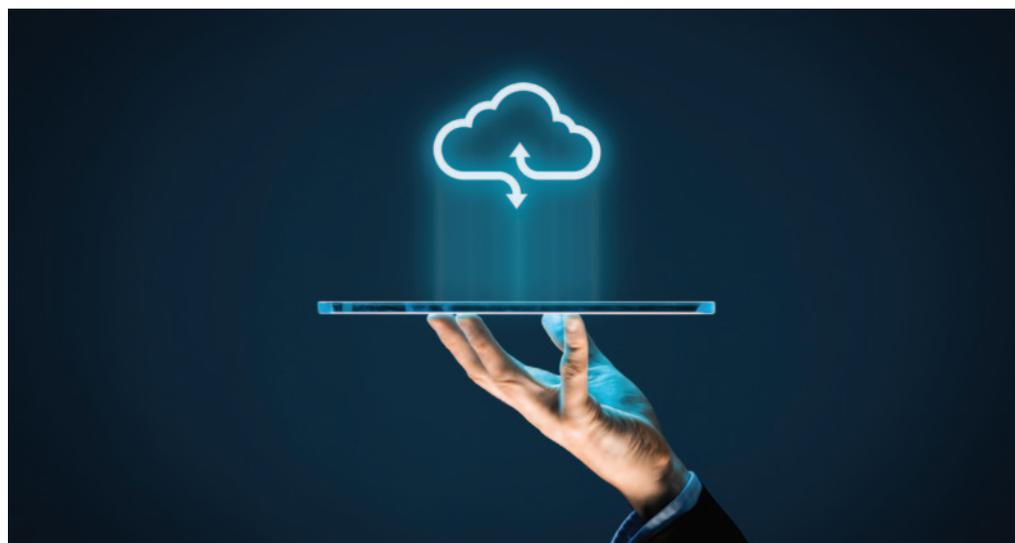
## The cloud environment

The ability to run a complete work environment in the cloud, with access to distributed hardware resources and software packages, facilitates research in international teams. Cyfronet has been developing cloud “ecosystems” for years based on available open-source tools and proprietary technologies.

The main goal of the INDIGO-DataCloud project (INtegrating Distributed data Infrastructures for Global ExpLOitation) was to develop a PaaS (Platform as a Service) environment enabling large-scale computing by integrating grid and cloud resources and providing uniform access to both computing resources and data storage resources. The role of ACC Cyfronet AGH was mainly to implement a consistent system of access to geographically dispersed data stored in heterogeneous repositories.

Based on the project’s achievements mentioned above, another project was carried out: XDC (eXtreme DataCloud), which aimed to build specialised solutions for large-scale data management and processing in a hybrid cloud, thus introducing the issues of data access and migration in distributed cloud environments. Cyfronet was responsible for implementing a distributed data management system in a cloud environment.

One of the currently implemented projects is DOME (A Distributed Open Marketplace for Europe Cloud and Edge Services). Based on the assumptions of the Gaia-X program and open standards, tools and procedures are being developed to support the development and adoption of trusted Cloud and Edge services in Europe. The DOME project will be an access point for broadly understood software and data processing services developed under EU programs such as Digital Europe, Horizon 2020, or Horizon Europe.



## EOSC – transnational integration of scientific resources



The European Open Science Cloud (EOSC) is an initiative aiming to create a virtual environment that would complete the assumptions of the Open Science paradigm. EOSC aims to share (easily and transparently) research data and advanced tools and resources to store, share, process, and manage this data.

Within EOSC, the connections between currently existing research e-infrastructures are made, and the integration takes place, i.a., by the unification of access and authorisation rules for researchers from different countries. Thanks to the achievements of EOSC-Hub, belonging to the family of EU-funded EOSC-building projects, a platform was created to do this. The EOSC-Portal is the interface between providers of scientific services and resources, and researchers who can benefit from those. ACC Cyfronet AGH team played a crucial role in this regard, becoming the Portal host and developing the Marketplace website, an extensive catalogue of services and documentation provided by EOSC partners.

### Further development of EOSC

Development of the Portal and integration of services from the larger group of deliverers are the core assumptions of the planned enhancement of EOSC.

The EOSC Enhance project (<https://www.eosc-portal.eu/enhance>), which was realised from 2019 to 2021, aimed to improve the Portal in terms of convenience and speed of use. The works carried out by our specialists concerned, among others, advanced analysis of user behaviour in order to create and implement the best user experience practices. At the same time, new functionalities have been implemented.



The EOSC Synergy project (<https://www.eosc-synergy.eu/>), which lasted until the end of October 2022, has been underway to implement EOSC standards for another nine national e-infrastructures. Cyfronet, in addition to coordinating activities at the national level, supported the planning process by looking for new, effective solutions for integration in other countries.



The EOSC Future project (<https://eoscfuture.eu/>), which finished in 2024, improved the quality of the EOSC ecosystem so that it supported European research even better and convinced researchers to use the offered resources.



Cyfronet participated in other initiatives building EOSC: FAIRCORE4EOSC and EuroScience-Gateway. In the first project, our role was to provide expert support in the field of data management and personalised search of EOSC resources (including scientific objects) using AI methods. As part of EuroScienceGateway, Cyfronet was responsible for integrating the solutions of the Onedata distributed data management platform with the project infrastructure being built. In the latest projects: EOSC Beyond – Cyfronet is responsible for providing expert support and delivering solutions related to new EOSC functionalities for researchers, EOSC Data Commons – Cyfronet participates as a technology provider and expert in data management and resource discovery for science within federated, heterogeneous environments.

# RODBUK

Repository homepage:

<https://rodbuk.pl/>

## RODBUK - Cracow Open Research Data Repository

RODBUK is a research data deposit platform initiated by the Board of Directors of the Krakow Library Group. ACC Cyfronet AGH is responsible for the technical implementation of the project, including the development of the user access interface and the long-term storage of entrusted data.

Currently, the repository is co-created by 6 Krakow universities:

- AGH University of Krakow
- Jagiellonian University
- Cracow University of Technology
- Krakow University of Economics
- Commission of National Education University in Krakow
- University of Physical Education in Krakow

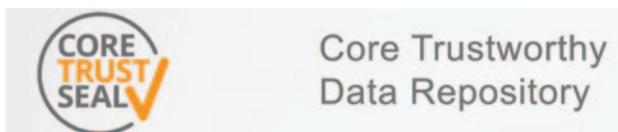
and:

- University of Wrocław
- Sano – Centre for Computational Personalised Medicine
- Henryk Niewodniczański Institute of Nuclear Physics

RODBUK enables the collection and sharing of research data across various disciplines and formats. This allows data to be indexed and cited, which positively impacts dissemination and visibility. All published metadata comply with OpenAIRE guidelines and the Dublin Core format, and more broadly – with the FAIR principles, which are one of the foundations of the Open Science paradigm. The RODBUK repository is open to all research institutions wishing to deposit their research data. Use of the repository is free of charge for both data depositors and data users.

### CoreTrustSeal Certificate

The Repository of Open Research Data of Krakow Universities (RODBUK) has been awarded the CoreTrustSeal certification, confirming its compliance with international standards for so-called trusted data repositories.



The CoreTrustSeal certification is awarded after meeting strict requirements for trusted digital data and metadata repositories. The evaluation covers, among other aspects:

- the technical capability for long-term and secure data storage, including the durability and security of physical infrastructure, system and software updates, and technical support,
- a formal structure and operational procedures that ensure the long-term sustainability of the repository,
- the types of data that can be stored and the methods of access,
- the availability of qualified personnel dedicated to repository operations,
- ensuring appropriate access to data, from searchability to reuse, including the automatic assignment of proper citation formats.

The awarding of the CoreTrustSeal certification to RODBUK is a remarkable distinction, confirming the high quality of the repository's implementation and maintenance. Data stored in RODBUK are guaranteed long-term preservation on specially prepared servers at the Academic Computer Centre Cyfronet AGH, in accordance with the highest standards of protection against data loss.



*Representatives of Cyfronet promoting RODBUK during the Digital Research Tools Fair, November 2024.*



**EuroHPC**  
Joint Undertaking

## EuroHPC – European data-processing Infrastructure

The European High Performance Computing Joint Undertaking (EuroHPC JU) aims to establish a world-leading, secure, and hyper-connected supercomputing and quantum infrastructure across the EU. It focuses on developing innovative, user-driven supercomputing systems with a resilient supply chain, expanding access to both public and private users, and enhancing HPC skills. Additionally, AI Factories will be developed around EuroHPC centres to foster a competitive AI ecosystem in Europe.

The initiative brings together 36 countries, including Poland, and private members. ACC Cyfronet AGH is a part of many projects coordinated or supported by EuroHPC JU (including EuroCC, LUMI, LUMI AI, DARE, Fortissimo Plus, EUMaster4HPC, EPICURE), giving Polish researchers and entrepreneurs the possibility to benefit from their outcomes.

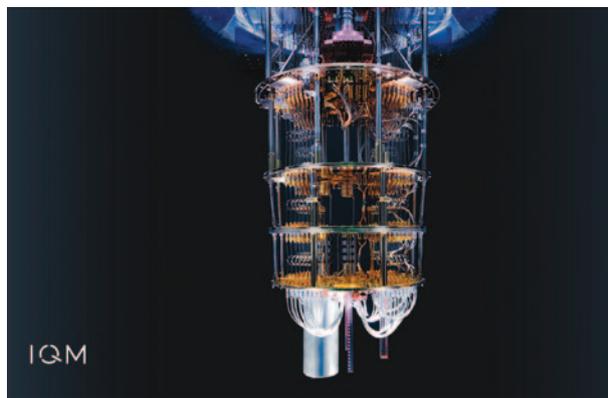
Currently, the flagship supercomputer of EuroHPC JU, and the fastest in Europe, is JUPITER at the Jülich Supercomputing Center in Germany. In November 2025, JUPITER was ranked 4th on the world's TOP500 list. A second supercomputer exceeding 1 EFlops will be installed at the TGCC computer centre in France.

Before that, however, subsequent lower-power supercomputers have been launched, creating an infrastructure that allows the technology and software to be scaled. By the time this publication was prepared, EuroHPC JU had delivered 3 pre-exascale supercomputers: LUMI (Finland), Leonardo (Italy), Mare Nostrum 5 (Spain). Additionally, 5 petascale supercomputers were successfully put into operation: Discoverer (Bulgaria), Karolina (Czech Republic), MeluXina (Luxembourg), Vega (Slovenia) and Deucalion (Portugal). The next in this class of computers will be Daedalus (Greece). EuroHPC JU also finances the purchase of quantum computers. Polish scientists will have access to one of them, installed in the Czech Republic, via the PLGrid infrastructure coordinated by Cyfronet.

 More about EuroHPC JU at: <https://eurohpc-ju.europa.eu/>.



JUPITER supercomputer, photo: Forschungszentrum Jülich / Sascha Kreklau



VLQ quantum computer, photo: IT4Innovations, IQM

## National Competence Centre in HPC

ACC Cyfronet AGH is coordinating the activities of the Polish National Competence Centre in HPC.

The National Competence Centres (NCC) were established as part of the European High-Performance Computing Joint Undertaking (EuroHPC JU). The EuroHPC JU was established to develop, deploy, expand and maintain Europe's world-class supercomputing and data infrastructure. The joint activities are intended to support the development of innovative technologies in Europe and increase the use of HPC (High-Performance Computing) infrastructure by academic users, governments and entrepreneurs in Europe.

In this light, the NCCs, funded through a series of EuroCC projects, are to serve as focal points for HPC and related technologies in their respective countries. They aim to improve and equalise European advanced computing capabilities and provide access to infrastructure and expertise.

EuroCC Poland is based on the partners of the PLGrid Consortium (ICM, PSNC, WCNS, CI TASK, NCBJ), whose leader is ACC Cyfronet AGH. The main tasks of the National Competence Centre include:

- supporting stakeholders from industry, the public sector and academia in the implementation of HPC technologies,
- increasing the use of HPC technologies among SMEs to raise their innovation potential,
- improving the visibility of existing HPC centre offerings and services for SMEs and industry,
- expanding the training portfolio,
- creating a catalogue of services that includes offerings from HPC centres and other key HPC services and technologies from vendors in Poland,
- raising awareness among various stakeholders, including Centers of Excellence (CoEs) and European Digital Innovation Hubs (eDIHs) in Poland and abroad.

 Details on the activities of the National HPC Competence Centre can be found on a dedicated webpage: <https://cc.eurohpc.pl>



*Representatives of NCC Poland during the EuroHPC Summit 2024. From the left (in the second row): Marek Magryś, Cyfronet; Mateusz Tykierko, WCSS; Mariusz Sterzel, Cyfronet; (in the first row): Marta Maj, Cyfronet; Szymon Mazurek, Cyfronet*



## The LUMI supercomputer

### **LUMI – No. 4 in Europe, No. 9 in the world**

In November 2025 the subsequent TOP500 list of supercomputers with the highest computing power in the world was announced.

The LUMI supercomputer installed in the CSC data centre in Finland took the ninth place there and the fourth position in Europe. This undoubted success in the HPC (High-Performance Computing) environment is the result of the cooperation of 11 countries, including Poland, which form a consortium operating under the wings of a larger initiative, the EuroHPC Joint Undertaking. Importantly, thanks to the activities coordinated by ACC Cyfronet AGH and the Ministry, Poles have already gained access to LUMI resources.

### **LUMI among the world leaders in computing power and energy efficiency**

Together with other petascale and pre-exascale systems in which EuroHPC JU is involved, LUMI is a part of the pan-European infrastructure to which fully exascale computers will also be incorporated in the coming years. Obtaining a place at the TOP10 of supercomputers is a great success for European countries because it shows the possibility of competing with systems from the USA, China and Japan. In High-Performance Linpack (HPL) tests, the LUMI supercomputer showed an actual power of 380 PFlops and a theoretical performance of up to 531 PFlops. This performance is made possible thanks to the LUMI hardware architecture:

- the GPU partition is composed of 2560 nodes, each of which contains a 64-core AMD Trento processor and four AMD MI250X cards,
- a single MI250X card can deliver 42.2 TFlop/s of performance in High-Performance Linpack tests,
- each GPU node contains four 200 Gb/s network connection cards,
- the addition to the GPU partition is the CPU partition, which uses the 3rd generation AMD EPYC™ 64-core general purpose processors.

However, during the design and construction of the LUMI infrastructure, a strong emphasis was put not only on the computing power, but also on the efficient use of energy. For this reason, the LUMI supercomputer also took the high, 38<sup>th</sup> place on the Green500 list of supercomputers with the highest energy efficiency.

 *More information about LUMI at: <https://lumi-supercomputer.eu>.*

### **Access to LUMI for Polish scientists**

ACC Cyfronet AGH coordinates work related to providing Polish scientists with the resources offered by LUMI. The aim is to ensure an efficient and user-friendly environment for working with a supercomputer, based on good practices developed within the PLGrid infrastructure. Access is provided via the PLGrid Portal (<https://portal.plgrid.pl>), and additional information is available at <https://cyfronet.pl/lumi>.

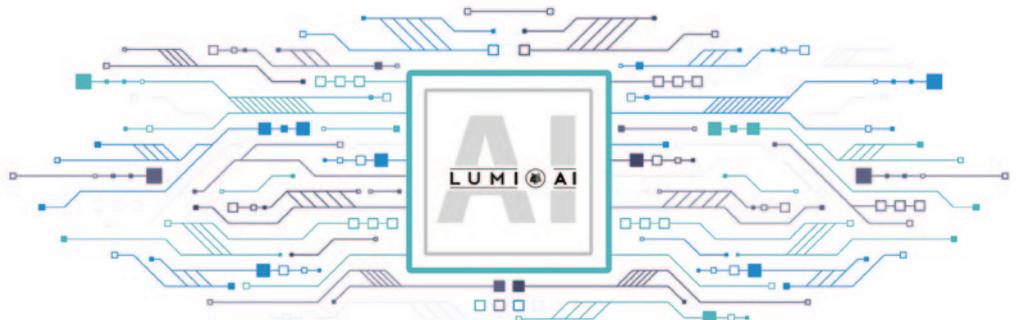
## LUMI AI Factory Service Center



**The LUMI AI Factory** (LAIF) project aims to provide supercomputing service infrastructure for artificial intelligence needs, along with an open AI ecosystem built around the LUMI AI supercomputer. The LUMI AI supercomputer represents the next stage in the development of the EuroHPC supercomputing ecosystem. Its construction will enable a seamless transition in computing services from the current LUMI system. Activities within LAIF will be open to both public users and businesses, with particular attention to the needs of startups and small and medium-sized enterprises.

**The LUMI AI Factory Service Center** project will integrate computing power, data, and artificial intelligence expertise accumulated by the LUMI Consortium, resulting in a broad and comprehensive range of services for public and private users, AI startups, and small and medium-sized enterprises. All member countries of the LUMI Consortium have been invited to participate in the development of the AI computing ecosystem surrounding the LUMI AI supercomputer:

- Finland (coordinator)
- Belgium
- Czech Republic
- Denmark
- Estonia
- Iceland
- The Netherlands
- Norway
- Poland
- Sweden



Among the invited institutions are HPC computing centers and partners specializing in artificial intelligence research and education. These partners provide essential links to AI research at the European level – carried out through Testing and Experimentation Facilities (TEF), Centers of Excellence (CoE), and European digital infrastructure consortia – thereby creating a tightly integrated artificial intelligence ecosystem across Europe.

 *Project website: <https://lumi-ai-factory.eu/>*

### Role of ACC Cyfronet AGH

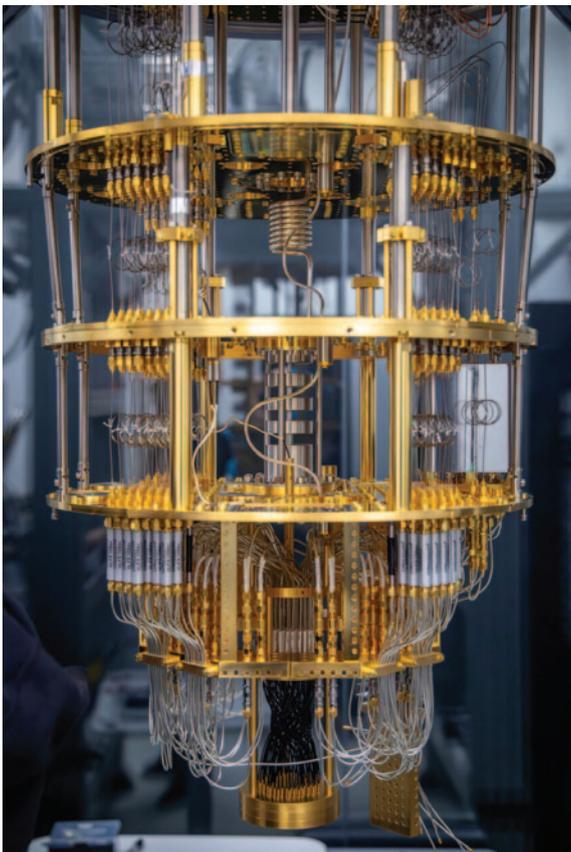
Cyfronet is involved in all tasks of the project. The main work will focus on training, adapting artificial intelligence software to the LUMI supercomputer, and integrating data and services with the LUMI AI supercomputer infrastructure.



## The VLQ Quantum Computer

VLQ is a quantum computer integrated into the European EuroHPC infrastructure, providing a state-of-the-art environment for quantum computing for representatives from scientific institutions, businesses and government.

The computer is built on a star topology, consists of 24 physical qubits, and is designed to support scientific research, and innovation development. The VLQ quantum computer has been installed in Ostrava, Czech Republic, at the IT4Innovations National Supercomputing Center, which is part of VSB - Technical University of Ostrava. However, it is intended for use by all countries participating in the consortium.



*VLQ quantum computer of the LUMI-Q consortium installed at IT4Innovations National Supercomputing Center, VSB-TUO.*

### **What can a quantum computer be used for?**

Quantum computers have the revolutionary potential to introduce a new approach to computing and solve extremely complex computational problems. Unlike classical computers that work with binary bits, quantum computers use quantum bits (qubits) to perform parallel calculations and manipulate quantum phenomena such as superposition and quantum entanglement. This gives them the unique ability to efficiently solve problems that are too difficult for classical computers. These can be optimization problems to solve the travel problem, as well as problems with traffic and port management. Other applications are currently being developed that can be found in almost all areas of science and economy, such as the automotive industry, the development of new electric batteries, energy, finance, pharmaceuticals, quantum chemistry, cryptography, quantum machine learning and many others. Quantum computers can radically affect scientific research and technological development in everything from physics and chemistry to artificial intelligence and bioinformatics.

### **Access to the VLQ quantum computer for Polish scientists**

After the VLQ quantum computer is fully installed and operational, access for Polish entities will be provided within the PLGrid infrastructure.

## The LUMI-Q Consortium

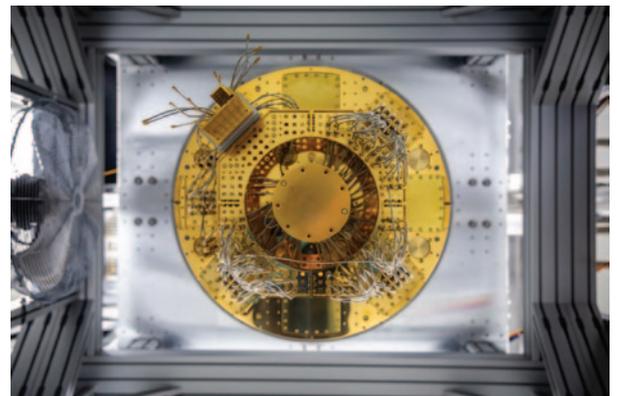
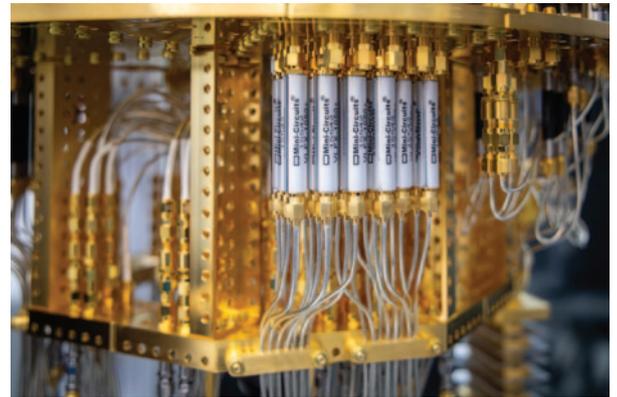
The **LUMI-Q** Consortium is an international initiative of nine European countries, whose goal is to develop a quantum computing infrastructure in Europe. The consortium's primary goal is to build and provide access to a quantum computer.

The VLQ quantum computer is being built based on joint funding provided by the LUMI-Q consortium and the EuroHPC JU. Thanks to Poland's financial contribution and the substantive contributions of the Polish entities building the consortium, Polish scientists will be able to use the VLQ quantum computer's resources. It is worth noting that Cyfronet is one of two national partners in the consortium, which includes a total of 13 entities from eight European countries.

### The members of the LUMI-Q consortium are:

- Coordinator: VSB – Technical University of Ostrava, IT4Innovations National Supercomputing Center, Czech Republic
- CSC – IT Center for Science, Finland
- VTT Technical Research Centre of Finland Ltd, Finland
- Chalmers University of Technology, Sweden
- Danish e-Infrastructure Consortium (DeiC), Denmark
- ACC Cyfronet AGH, Poland
- Nicolaus Copernicus Astronomical Centre, Poland
- Sigma2 AS, Norway
- Simula Research Lab, Norway
- SINTEF AS, Norway
- University of Hasselt, Belgium
- TNO Netherlands Organisation for Applied Scientific Research, Netherlands
- SURF BV, Netherlands

 Consortium coordinator website: <https://www.it4i.cz/>



*VLQ quantum computer of the LUMI-Q consortium installed at IT4Innovations National Supercomputing Center, VSB-TUO.*



## DARE Digital Autonomy with RISC-V in Europe

**The Digital Autonomy with RISC-V in Europe**, DARE project is a program to build European processors for high performance computing (HPC) and artificial intelligence (AI) based on the open RISC-V processor architecture.



The project is supported by the EuroHPC JU and coordinated by the Barcelona Supercomputing Center, with the participation of 37 leading partners from across Europe. The project involves the development of next-generation European processors and computing systems. Part of the work will also include a system software ecosystem as well as dedicated RISC-V architecture versions of scientific software packages.

The project involves the development of three RISC-V-based chiplets, each playing a crucial role in HPC and AI computing:

- **VEC** – a vector accelerator for high-precision HPC computations and HPC-AI applications (Openchip)
- **AIPU** – an AI processing unit designed to accelerate inference in HPC applications (Axelera AI)
- **GPP** – a general-purpose processor optimized for HPC workloads (Codasip)

Chiplets are used instead of traditional monolithic systems, offering improved performance, scalability, and cost efficiency thanks to advanced CMOS technology. In parallel, a complete software stack will be developed, tailored to the DARE SGA1 hardware, using architecture emulation and simulation

### Role of ACC Cyfronet AGH

The Academic Computer Centre Cyfronet AGH contributes to the project with expertise in adapting applications to processor architectures. Cyfronet will support project partners in tailoring PyTorch software to the processor architectures developed within the project. In parallel, Polish LLM models will be tested on processors dedicated to artificial intelligence.

 Project website: <https://dare-riscv.eu/home/>

# EUMaster4HPC

## European Consortium for HPC Education



The development of education and training in large-scale computing is key to strengthening a world-class European supercomputing ecosystem, aimed at driving the digital transformation of priority economic sectors. However, the labor market lacks well-trained professionals in the design, development, deployment, and operation of HPC-class systems. As a result, many research institutions and businesses struggle to find suitably qualified personnel. This significantly limits their growth, as they are often forced to conduct additional training - frequently over extended periods following employment.

The goal of the **EUMaster4HPC** project (European Master for High Performance Computing) is to define and develop a new and innovative European master's program focused on HPC. The program is designed to equip students with the skills and knowledge in high-performance computing required by both academia and industry.

The specific objectives of the project are:

- effective dissemination of fundamental knowledge in the field of High-Performance Computing (HPC) across scientific and industrial domains through master's-level education of specialists and future leaders in HPC technologies and applications, aimed at bridging the human resources gap in the market,
- synthesis and transfer of scientific knowledge that enables broader adoption of HPC for the benefit of European society and economy,
- definition of a sustainable master's degree program in HPC applicable across all European countries.

 More information on the website: <https://eumaster4hpc.uni.lu/>

### Role of ACC Cyfronet AGH

AGH will serve as the project coordinator responsible for preparing training materials for remote learning. Together with Cyfronet, AGH will also develop prototype HPC training laboratories, which will be used to train academic instructors and enable students to test and apply their acquired knowledge. AGH and Cyfronet will be supported in this task by other technical universities and Polish supercomputing centers.





**FORTISSIMO**  
PLUS

**Project website:**

<https://ffplus-project.eu>

## Fortissimo Plus

**The Fortissimo Plus** project is a European initiative promoting the use of supercomputing power by startups and small and medium-sized enterprises across Europe.

The project is a continuation of Fortissimo initiatives, which have resulted in the creation of over 120 solutions using supercomputers in a wide range of fields, such as energy and renewable energy sources, the automotive industry, construction, the financial sector, pharmaceuticals and biotechnology, environmental and marine engineering, e-commerce and others.

By leveraging High Performance Computing (HPC) systems and Artificial Intelligence (AI), companies can accelerate the development of innovative solutions such as modeling, simulations, digital prototyping, data analysis, or generative AI.

This enables businesses from various sectors - from medicine, manufacturing, and finance to climate data processing - to speed up the development of innovative services and products.

The project will organize six open calls for experiments, three of which will be dedicated to HPC applications, and another three will target SMEs and start-ups working on generative AI.

The project's deliverables include the regular publication of success stories from the experiments that will show the benefits of HPC in SMEs' business models, and innovation reports that will demonstrate the impact of generative AI applications on company growth. In addition, the project will help understand the needs of SMEs and industry in the use of HPC and AI, which will provide valuable information not only to the participants of the experiments, but also to the entire European HPC ecosystem.

### **The role of Cyfronet**

ACC Cyfronet AGH is responsible for conducting R&D work in support of experiments using supercomputing infrastructure.





## Cyfronet is the leader of projects included on the Polish Research Infrastructure Map

Among the strategic infrastructures included in January 2020 on the Polish Research Infrastructure Map there are two projects proposed by ACC Cyfronet AGH as the initiator and coordinator of the PLGrid consortium: *National Supercomputing Infrastructure for EuroHPC* and *National Cloud Infrastructure PLGrid for EOSC*.



### National Supercomputing Infrastructure for EuroHPC – EuroHPC PL



The initiative aims to support scientific research by building and providing the Polish scientific community with supercomputing resources that enable large-scale computations, directly aligned with the framework of the international EuroHPC – European High-Performance Computing initiative, as outlined in a communication by the European Commission. The goal of EuroHPC is to establish a European system of exascale-class high-performance computers, globally unique, based on technologies developed in Europe. The computing power delivered by supercomputers is a fundamental component necessary for conducting scientific research across many fields, significantly accelerating and reducing the cost of research processes.

EuroHPC PL is the Polish component of the EuroHPC initiative. The project's objective is to build a specialized, general-purpose infrastructure for large-scale computations, addressing key research challenges from the perspective of Polish society, the scientific community, and the economy. EuroHPC PL will offer a hybrid computing infrastructure, with its core consisting of supercomputers supported by quantum and neuromorphic accelerators. The project envisions the development of an extensive catalog of easily accessible services related to scientific software scaling, support for multi-faceted modeling, and conducting research based on high-performance and quantum computing.

 *More about EuroHPC PL: <https://eurohpc.pl>.*



## National Cloud Infrastructure PLGrid for EOSC – PLGrid ICON



In the EOSC initiative "National PLGrid Cloud Infrastructure for EOSC", ACC Cyfronet AGH serves as the coordinator and provides high-performance computing infrastructure along with storage systems for research conducted under this initiative.

The aim of the initiative is scientific research conducted using the established cloud infrastructure to develop solutions addressing current and future needs of Polish society, the scientific community, and the economy. The scope of this research includes, among others, data, infrastructures and processing platforms, efficient algorithms and their applications to address specific challenges. Approved by the European Commission, the European Open Science Cloud (EOSC) is a project of a federated, globally accessible, and multidisciplinary environment where researchers, innovators, companies, and society can publish, find, use, and reuse collected data, tools, software, publications, and other research outputs.

One of the technological solutions shaping the future EOSC is the proprietary OneData platform provided by the Cloud Technology Laboratory at Cyfronet. Its main role is to ensure transparent and secure access to data in a distributed cloud environment – through multiprotocol support (including POSIX, CDMI, and HTTP). Additionally, the platform facilitates easy sharing of databases and metadata management.

In 2019, as part of the EOSC-Hub project – one of the EOSC milestones – the Data Processing Laboratory at Cyfronet developed the EOSC Portal along with the Marketplace catalog. The portal allows providers, including European e-infrastructures and research infrastructures, to promote their services and thus expand their user base. On the other hand, researchers gain not only access to diverse resources but also direct support from the providers.

The Marketplace is a convenient service catalog covering computing, data storage and management, processing and analysis, security, and training. Using a search engine with practical filters, users can quickly find services that meet their scientific needs.

 *More about EOSC: <https://eosc.gov.pl/>.*

 *More info about PLGrid ICON: <https://plgrid.pl/about-us/plgrid-icon>.*

## Other initiatives

Other initiatives from the list supported by Cyfronet either directly (through consortium membership) or indirectly (through computing resources):

- CCB – Bronowice Cyclotron Centre, coordinator: H. Niewodniczański Institute of Nuclear Physics, Polish Academy of Sciences (IFJ PAN), Krakow,
- CTA – Cherenkov Telescope Array (Gamma-ray TeV Astronomy Observatory), coordinator: Jagiellonian University,
- EPOS – European Plate Observing System, coordinator: Institute of Geophysics, Polish Academy of Sciences (IGF PAN),
- ESS – European Spallation Source, coordinator: H. Niewodniczański Institute of Nuclear Physics, PAN, Krakow,
- KMD – National Data Repository. A universal infrastructure for data storage and sharing as well as efficient processing of large volumes of data in HPC, BigData, and AI models, coordinator: Institute of Bioorganic Chemistry, PAN,
- PIONIER-LAB – National Platform for Integration of Research Infrastructures with Innovation Ecosystems, coordinator: Institute of Bioorganic Chemistry, PAN,
- POLFAR – Low-frequency radio interferometer. System development: LOFAR 2.0, coordinator: Jagiellonian University,
- PRACE – Partnership for Advanced Computing in Europe, coordinator: Institute of Bioorganic Chemistry, PAN,
- SOLARIS – National Synchrotron Radiation Centre, coordinator: Jagiellonian University,
- Virgo – Gravitational wave observatory, coordinator: Institute of Mathematics, PAN.

ACC Cyfronet AGH serves as the coordinator of initiatives listed on the Polish Research Infrastructure Map (PMIB): EOSC and EuroHPC, and is also a member of consortia implementing programs listed on the PMIB: CTA, EPOS, KMD, PIONIER-LAB, PRACE, and Virgo. Additionally, it provides high-performance computing infrastructure along with storage systems and IT infrastructure of the Krakow Metropolitan Academic Network (MAN) for research activities within other PMIB projects.

 See the full list of Research Infrastructures on the Ministry website: <https://www.gov.pl/web/nauka/wyniki-naboru-wnioskow-o-wpisanie-strategicznej-infrastruktury-badawczej-na-polska-mape-infrastruktury-badawczej>

 **BEYOND** The project aims to provide a new alternative to open science and tools for science in the European Open Science Cloud (EOSC) context by giving a new EOSC Core platform feature. The planned improvements are intended to enable scientific applications to find, compose, and access open science resources and offer them as integrated solutions.

 The goal of the project is to create a computational medicine centre in Krakow. The Centre will be the main driver of European progress in this fast-growing sector, developing advanced engineering methods for the prevention, diagnosis, and treatment of diseases and meeting the global need for radically improved healthcare systems.

 **DVPS** The DVPS project aims to develop multimodal fundamental model (MMFM) technologies that use different data types and modalities to efficiently solve tasks in multiple domains. *Diversibus Viis Plurima Solvo*

 SAGE is a part of bigger idea to use data to support sustainable development and environmental goals across Europe. The project will create and manage a common data infrastructure that enables access to environmental data for processing and use in new areas, supporting data-driven decision-making, promoting innovation and supporting sustainable development.

 The project assumes the development of next-generation European processors and computing systems. Part of the work will also include preparations of a new software ecosystem and RISC-V versions of scientific software packages.

**LUMI**  **AI** The project aims to provide a supercomputing service infrastructure for artificial intelligence (AI), along with an open AI ecosystem built around the LUMI AI supercomputer. The main work will focus on training, adapting AI software to the LUMI supercomputer, integrating data and services with the LUMI AI supercomputer infrastructure.

 The EPOS ON project is part of the operational phase of EPOS, with the aim of consolidating and optimizing its research infrastructure, as well as evolving it towards new fields of science, new users, and meeting new societal needs.

 The project aims to enable small and medium-sized enterprises (SMEs) and startups in Europe to conduct experiments using High Performance Computing (HPC) infrastructure and artificial intelligence (AI) methods to improve their competitiveness and innovation potential.

 The mission of the project was to continue the creation of the EuroHPC National Competence Centers (NCCs) network in Europe through cooperation, exchange of best practices and knowledge, and upgrading the national and European levels of HPC service delivery.

 The main objective of the project is to establish support activity for EuroHPC user applications at Level 2 and Level 3. As part of the project, an Application Support Team (AST) will be established, whose main task will be to cooperate with the EuroHPC JU application evaluation office and directly support projects that have obtained computing time on EuroHPC JU resources.

 The project aims to build the science-based technology solutions needed to power Europe's next generation of video conferencing platforms and support and facilitate business collaboration across the European Union.

 The GEMINI project aims to provide validated multi-organ and multi-scale computational models to support therapeutic decisions and improve fundamental understanding of ischemic and hemorrhagic acute strokes.



The aim of the project was to build a specialized general-purpose infrastructure for large-scale computing, enabling the undertaking of research challenges in key areas from the point of view of Polish society, the scientific community, and the economy. The project was the Polish stage of development of the EuroHPC program.



The goal of the project was to develop and provide production services for storing, accessing, securing data and managing metadata, as well as integrating solutions for processing large and complex data volumes on the basis of a distributed e-infrastructure.



Within the project the construction of unique research laboratories based on the national PIONIER fiber optic network was realised. The main goal of the project was to build and make available platforms for research units, entrepreneurs and other entities interested in conducting scientific research and development works based on a new, nationwide research infrastructure.



The direct goal of the project was to create a specialized e-infrastructure for data processing, enabling the optimal use of specialized and new generation services to stimulate new areas of application in science, economy, education and social life.



As part of the project, the functionalities of the EPOS-PL research infrastructure were increased. A new Research Infrastructure Center (Center for Research Infrastructure of Satellite Data – CIBDS) was established, a new test site (Geophysical Safety System for mining protection pillars) was created, and the WNiP was established: "IT Platform for Research with Artificial Intelligence Methods (EPOS-AI)".



The goal of the project was to create computing infrastructure services and data storage services for the purposes of the PRACE project, within six dedicated laboratories.



The project mission is to support the establishment of the EOSC as the European Research Commons, a global trusted ecosystem that provides seamless access to high-quality, interoperable research results and services, enabling European researchers to collaborate more easily, be more productive and achieve higher levels of excellence.



The aim of the Project was to support the digitalization and automation of repetitive official activities in Poland through the pilot implementation of Polish Large Language Models (LLMs) into public administration systems.



The project will design, build and implement: infrastructure, services and applications for the storage and collection of scientific and business-related data, as well as their processing and analysis. This data will be made available effectively and with compliance with good practices and requirements and regulations - for the needs of the scientific community and the economy.



The objective of the project was the development of the specialized technological competence centre in the field of distributed computing infrastructures, with particular emphasis on grid technologies, cloud computing and the infrastructures supporting calculations on large data sets. As a result, great computing power and huge storage for digital data were offered to users.



The project aims to provide a quantum critical distribution infrastructure and a quantum communication network using the existing fibre infrastructure of the PIONIER network.



The project built a cloud environment for content from the CH (Cultural Heritage) area, processing and collecting high-quality content, allowing the launching of virtual spaces for an interdisciplinary and cross-sector community cooperating with the CH area.



The project will provide new or significantly improved access to key observations, data products, and services that enable the monitoring and simulation of dynamic processes in the geosphere at an unprecedented level of detail and precision, both spatially and temporally.



*The laureates of previous editions of the Contest*

## Work of young scientists in Cyfronet

The annual contest for the best PhD thesis conducted with the help of computing resources of ACC Cyfronet AGH is a tradition in our Centre. The scientific value of the submitted doctoral dissertation is assessed, as well as the possibility of its practical application and the scope of use of computing resources and disk storage in Cyfronet. In recent years, the Contest has become an important event promoting research conducted by young scientists. To subsequent editions of the Contest, participants submitted many PhD theses focused on various scientific problems in chemistry, biophysics, physics, and computer science. Also, the utilisation of the resources varies, as the contestants use different tools running on a wide range of computing architectures offered by Cyfronet.

The laureates of the Contest are invited to give a talk during Cyfronet's Open Day. We are honoured to present here selected interviews with the Contest participants.

**Join the next Contest edition!**

<https://www.cyfronet.pl>



*The laureate of the Contest in 2025*



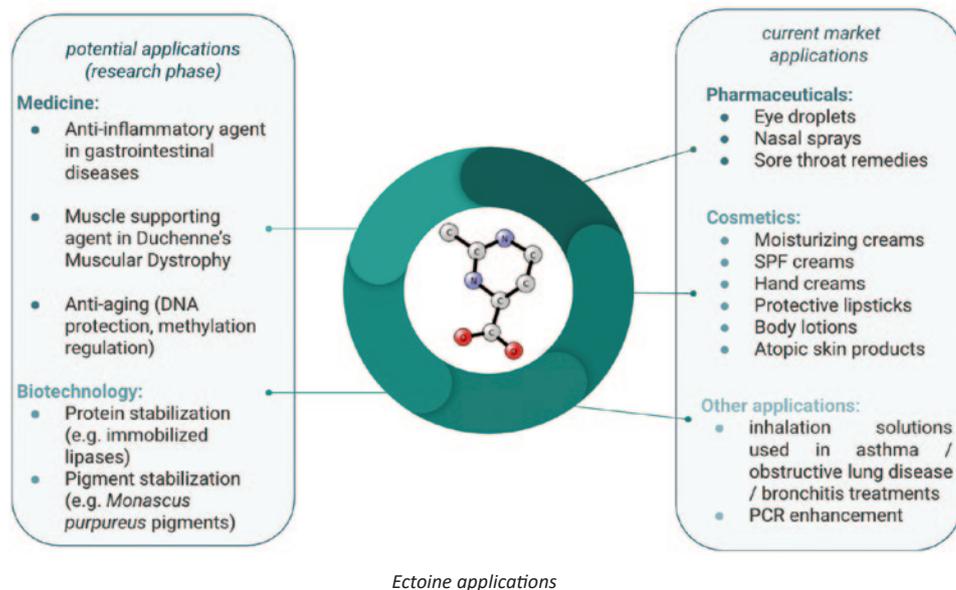
## Justyna Andryś-Olek, PhD

### Jerzy Haber Institute of Catalysis and Surface Chemistry PAS

#### The interview with the author of the PhD thesis: „Computational studies on ectoine synthase”

*What inspired you to dedicate yourself to research on ectoine synthase?*

What really inspired me to get into research were the amazing scientists I had the chance to work with. During my master's studies, Dr. Anna Wójcik-Augustyn was the one who first sparked my passion for computational chemistry. It was later fuelled by Professor Tomasz Borowski and the amazing Theoretical and Experimental Biocatalysis group at the Institute of Catalysis and Surface Chemistry (IKIFP PAN). They played a big role in supporting my growth as I dove deeper into enzyme research. Professor Borowski's mentorship played a key role throughout my research journey. It helped me push through the more challenging parts of my PhD and made the small and big wins even more rewarding. The project itself was incredibly motivating, as it presented a real challenge: first, I needed to figure out the unusual coordination of the iron ion in the enzyme's active site and determine its spin state; then, model the actual movements of the protein using molecular dynamics simulations; and finally, run quantum mechanical calculations to uncover the fine details of the chemical reaction taking place in the enzyme. There was also a practical side to all of this that I found exciting. The reaction's product, ectoine, is used in many skincare products, which I personally use as well. Knowing that my research could help deepen our understanding of natural production of ectoine and its role in bacterial systems was an extra source of inspiration for me.



*Could you briefly introduce this topic to our readers?*

Ectoine synthase is a protein primarily found in bacteria adapted to survive in extreme conditions, such as high salinity or temperature, where it catalyses the production of ectoine, a natural compound known for its protective role in cells. Although ectoine was discovered back in the 1980s, it has been gaining increasing interest, primarily due to its moisturizing and anti-inflammatory properties. As

a result, it is now used as an ingredient in pharmaceuticals and skincare products, while the new potential applications are still being explored. The bacterial biosynthesis of ectoine is well understood, but the final step of the pathway, being the conversion of the N- $\gamma$ -ADABA substrate into ectoine, which takes place in the active site of ectoine synthase, remains unclear. In my research, I used molecular simulations and quantum mechanical calculations to uncover the three-step reaction mechanism, along with the associated energy barriers. It includes ring closure with deprotonation of the substrate's amino group, proton transfer from a tyrosine residue (one of the iron-coordinating amino acids) to the product's oxygen, and finally, the elimination of a hydroxyl group leading to the formation of ectoine. A better understanding of the reaction catalysed by ectoine synthase could support the development of more efficient biocatalysts for industrial scale ectoine production.

*How did the Cyfronet resources help in your research?*

The resources provided by Cyfronet were essential for my research on ectoine synthase. Series of simulations and quantum mechanical calculations consumed hundreds of computing hours from grants, for which I expressed my gratitude in publications and conference presentations. Among the most critical tools in my research were three computational chemistry tools: the AMBER suite, Gaussian, and ORCA.

*What are the biggest myths or misconceptions about your field?*

I've heard many times, especially from scientists working in laboratory, that computational biochemistry seems too difficult or inaccessible. In reality, once you grasp the basics and carry out your first calculations on real protein models, you begin to see the logic and find your way in the world of modeling. Patience and persistence are key, as quantum mechanical calculations can take weeks and often require corrections or revisiting earlier assumptions, sometimes it results in bringing the researcher back to square one. Still, I believe that every mistake is a valuable lesson and experience that enriches the research toolbox.

*What advice would you give to someone planning to start a scientific career?*

Before starting a scientific career, especially a PhD, it's essential to carefully choose the research environment. Getting to know your supervisor and the project is crucial, as it can determine whether your experience is fulfilling or frustrating. Inspiring mentors are one of the most important factors in a research career. Perseverance is also key: a PhD is a constant balance between successes and failures, so it's important to seek support from peers who share similar experiences and build mental resilience together. Recognizing that failure is part of the process helps you better appreciate progress and achievements. Networking is another vital aspect, offering practical insights not always found in textbooks. And while it's important to set realistic goals and work toward them, maintaining a healthy work-life balance is just as crucial. My advice to aspiring scientists is simple: don't forget there's life beyond the lab. Sometimes, taking a break and spend some time in the nature can be more rewarding than expected, and even spark new ideas.

*What are your future goals in the context of scientific research?*

Currently, I'm expanding my knowledge in data analysis, both in medical and biochemical contexts, as a postdoctoral researcher in data science. Given the rapid technological advancements, I believe it's crucial to add programming, machine learning, and other AI tools to my skill set. I think these skills are increasingly valuable in biochemistry and biotechnology, as IT industry and biomedical sciences are becoming more integrated.



## Hubert Józwiak, PhD

### Nicolaus Copernicus University in Toruń

#### The interview with the author of the PhD thesis:

#### „Collisions of simple molecules and atoms in fundamental studies”

*Your work concerns a very specialized topic. Could you briefly explain what your research is about?*

My work focuses on collisions between simple molecules and atoms – processes that are constantly present all around us, even though we usually don't pay attention to them. At room temperature, nitrogen and oxygen molecules in the air move at astonishing speeds, colliding billions of times per second. We don't usually think about it, but these processes are incredibly important – for example, in Earth's atmosphere, in outer space, or in precise laboratory experiments.

In my work, I examined such collisions at the level of individual molecules, performing precise calculations using quantum mechanics. I focused on two main goals: first, to generate accurate data that can support, for example, the monitoring of greenhouse gases and pollutants in Earth's atmosphere; and second, to explore several more fundamental questions in quantum theory – such as how to interpret collisions of indistinguishable molecules in the presence of electromagnetic field, or how weak interactions between nuclei influence molecular collisions.

*In what ways might the findings of your research be applied within the field of astrophysics?*

In two ways. First – in the interstellar medium, where stars are born, the conditions are extreme: there are very few molecules, and both temperature and pressure are extremely low. To understand what's happening there, we need to know precisely how individual molecules collide and how they interact with electromagnetic field. Without this knowledge, it's easy to misinterpret observations made, for example, by the James Webb Space Telescope. Second – my research helps analyze the atmospheres of planets and exoplanets. In those environments, there are vast numbers of molecules constantly colliding, which distorts the signals we observe. Thanks to the accurate data provided in my thesis, these observations can be better „decoded”: we can determine the chemical composition of the atmosphere, physical conditions, and even chemical processes or, to some extent, the planet's history.

*To what extent did the resources provided by Cyfronet support the computational part of your dissertation?*

Although the underlying theory is encapsulated in a single-line equation, solving it requires substantial computational power. In research on greenhouse gases, for example, we aim to determine the concentration of specific molecules with a precision better than one part in a thousand. That means millions of hours of CPU time and advanced software for solving the Schrödinger equation, which we develop in our research group. Thanks to the resources of Cyfronet, I was able to carry out such large-scale calculations, studying molecules that lie at the edge of what is considered feasible in this kind of research. In their absence, my research would have been restricted to the simplest systems with minimal practical relevance.

*Which phase of your research turned out to be the most demanding?*

The most technically demanding part was, of course, the quantum scattering calculations – it's a highly complex process. But once the program, scripts, and computational strategy are in place, running the calculations themselves is not particularly challenging.

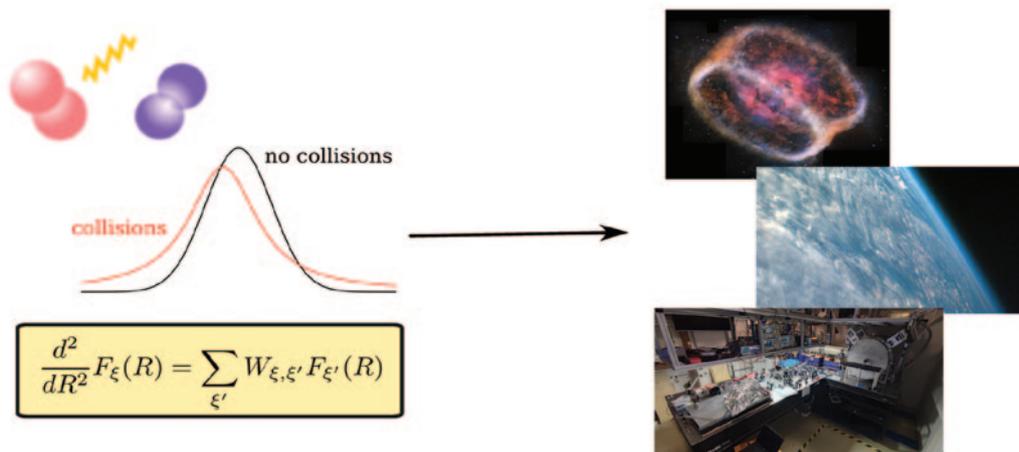
What brought the most challenges (and joy!) was solving the physical problems themselves. Finding the best approach – sometimes an entirely new path – was the most intellectually rewarding part. And the difficulties I treated more like puzzles that simply needed to be solved.

*What mindset helped you get through the more difficult moments in your research work, and what advice would you give to young researchers who are struggling at the beginning of their journey?*

In research work, it's impossible to avoid moments when you get stuck – something doesn't work, the code crashes, or the theory produces absurd results. It's frustrating. That's why collaboration is the key – talking to other researchers, even those outside your field, often brings new ideas.

It's also good to have a break – a smaller project, a hobby, sports, or music. The brain needs different kinds of stimulation to work effectively.

To young researchers, I would give one piece of advice: start as early as possible. The sooner you get involved in real research work, the more you'll gain – in knowledge and in confidence.



**Molecular collisions affect how they interact with light.** They cause broadening and shifting of spectral lines (see the two curves on the left side). Describing these effects requires complex quantum calculations (bottom left formula).

Such studies are crucial for:

- **interpreting astrophysical observations** (top right image: NGC 1514 nebula, James Webb Space Telescope, [www.webbtelescope.org](http://www.webbtelescope.org))
- **Earth's atmosphere research** (center right image, NASA EarthKAM, [www.images.nasa.gov](http://www.images.nasa.gov))
- **high-precision molecular spectroscopy** used for testing quantum theory (bottom right image, cryogenic molecular spectroscopy lab at KL FAMO, Toruń).



## Jakub Kamiński, PhD Eng.

AGH University of Krakow

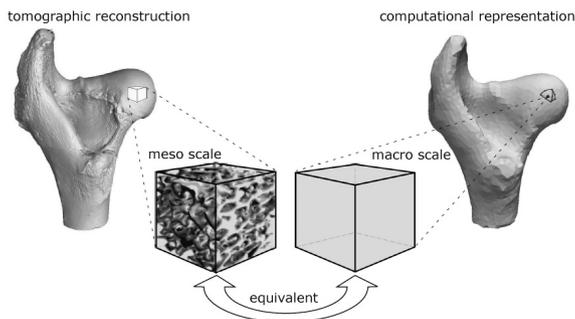
The interview with the author of the PhD thesis:

**„Computer simulation of the mechanical properties of bone tissue based on a biomechanical bone model using microtomographic measurements of animal bones”**

*Your work is highly interdisciplinary. What was your path to this topic?*

My interest in computer science and programming dates back to my high school days, but it was only during my university studies that I started focusing on engineering computer graphics, including methods of analyzing and visualizing data from 3D scanners and tomographic imaging. Through individual studies under the supervision of Dr. Jacek Tarasiuk and cooperation with Dr. Sebastian Wroński, I was able to personalize my academic path, which resulted in award-winning research projects and theses related to 3D data. This led me to join bone biomechanics research, including an internship at ENIM in Metz, France under the Erasmus program, where I conducted my master’s research. In the case of interdisciplinary collaborations with other research centers, exchange of ideas and joint discussions are crucial for development and combining diverse expertise. Gaining knowledge and experience from this project, I continued research on modeling the microstructure and mechanical properties of bones as part of the faculty’s PhD studies and research-teaching assistantship, taking advantage of research opportunities of LMINT-AGH and the Cyfronet’s infrastructure.

*Your research has potential applications in medicine. Could you explain how the results might benefit patients?*



*Multiscale modeling of the femur based on the equivalence of computational representation and apparent properties through homogenization of tomographic imaging data*

For the purposes of personalizing medical therapies, it is essential to expand the use of computer models that can predict the mechanical properties of bone based on precise, non-destructive measurements, so they can be adapted to be directly applied in clinical practice. The computational methodology developed in my work was created with the aim of predicting changes in the mechanical properties of bones that occur during remodeling under external loads. The obtained measurement data and computer models can serve as a valuable input for further specialized analysis. In particular, it may be important to adapt the methodology to data from modern high-resolution *in vivo* imaging of human bones, which allows for precise capture of the orthotropic microstructure of cancellous bone.

A patient imaged using traditional tomography, even if it were technically possible and precise, would be exposed to excessively high doses of X-ray radiation. To provide a better assessment of cancellous bone mechanics *in vivo*, research focuses on imaging devices and methods used to improve the precision of volume fraction measurement and to better account for bone anisotropy. Proper understanding of bone behavior under various loads also improves the design and construction of implants and endoprostheses. Another possible application for the defined modeling method is related to the multiscale analysis of bone remodeling in osteoporosis. With modern modeling approaches and computing clusters, it can be assumed that simulations in personalized medicine will become increasingly useful, cost-effective, and accessible. The development of models predicting bone mechanical properties based on non-destructive tomographic imaging, supported by *ex vivo* studies of prepared bones, may contribute to a deeper understanding of bone behavior and the processes occurring in the body, including implant integration.

*How did the resources provided by Cyfronet support your computations?*

Access to Cyfronet's resources was invaluable, both for test simulations using the Finite Element Method (FEM), including the selection of the size and type of computational meshes, and for final multiscale modeling, taking into account the micro and macro structure of the bone and other elements (muscles, tendons, cartilage, acetabulum). The larger the numerical problem, the greater the need to use computational clusters to significantly reduce simulation time and handle resource-intensive FEM meshes with numerous degrees of freedom, thanks to large shared memory and parallel computing. In my work I used Abaqus package for FEM simulations based on input data in the INP format. The unique capabilities of Abaqus package and the computational resources provided by Cyfronet ultimately allowed me to achieve all the goals of my doctoral thesis.

*What limitations did you encounter during your research and how did you overcome them?*

The main challenge was to obtain measurement data of the internal bone structure and to conduct demanding analyses and simulations. In the case of human bone samples, they are often affected by osteoporosis to a certain extent, because the bones usually come from endoprosthetic procedures in elderly individuals. The use of animal bones allowed access to diverse samples differing in terms of microstructure, but required development of advanced analysis based on many different computational tools. However, the effort put into the work enabled the development of an approach applicable to human bones. A digital registration method for femoral bone samples from micro-CT imaging was developed as an adaptation of the method based on local descriptors. The methodology was designed to rely mainly on standard file formats for easy pipeline processing and further analysis. For multiscale simulations, which are computationally intensive, I used the possibilities of advanced workstations and clusters, and commercial software thanks to faculty grants and research licenses.



## Fatemeh Kayanikhoo, PhD

### Nicolaus Copernicus Astronomical Center PAS

#### The interview with the author of the PhD thesis:

#### „Radiative simulations of moderately magnetized accreting pulsars as ultraluminous X-ray sources“

*What first sparked your interest in the universe and astrophysics?*

I developed an interest in physics when I first studied it in school. It felt exciting to me immediately, and I knew I wanted to become a physicist. Later, during my bachelor's studies, I explored astronomy, which sparked my curiosity about space and celestial objects, and I became an amateur astronomer. Later, in my master's study, I was drawn to compact objects like neutron stars and exotic ones like quark stars – very dense and extreme systems where the laws of physics extend far beyond what we know and can experience on Earth.

Over time, I became more interested in high-energy astrophysics and began working with numerical simulations during my PhD. I was fascinated by how powerful computational methods can assist us in exploring these extreme environments and answering complex scientific questions that would otherwise remain out of reach.

*What has been the biggest challenge in your research?*

One of the biggest challenges in my research has been integrating complex physics with numerical methods. I study extreme environments, such as extremely high accretion rates onto neutron stars. These systems involve very strong magnetic fields and high-energy processes, which make it challenging to model.

To study these astrophysical systems properly, we need a deep understanding of fundamental physics, along with advanced computational techniques. Ensuring that the simulations are stable, accurate, and realistic takes considerable effort. It also requires access to powerful computers and well-optimised code.

*How have the resources of the ACC Cyfronet AGH contributed to the part of your research involving numerical simulations?*

The computational resources provided by ACC Cyfronet AGH were essential for my research. Having access to high-performance supercomputers allowed me to run large and complex simulations that would not have been possible on regular computers.

I utilised Cyfronet's resources to conduct a detailed parameter study of my model, resulting in findings with significant impact in the field of ultraluminous X-ray sources (ULXs). The capacity to run a number of large-scale simulations efficiently enabled me to explore various physical scenarios and gain a much deeper understanding of these systems. This played a central role in shaping my PhD research and the scientific conclusions I reached.

*What's the most surprising thing you've learned through your research?*

The focus of my PhD research is understanding ULXs through numerical simulation. These objects seem to emit more X-rays than expected from typical accreting stellar-mass compact objects, but less than the accreting supermassive black holes found at the centre of galaxies. Although numerous models have been proposed to explain their unusual luminosity, their nature remains not fully understood. One of the possible scenarios is Super-Eddington accretion onto magnetized neutron stars. Simulating such systems is very challenging due to the presence of a solid surface and the strong magnetic fields of the neutron stars. This is one reason why only a few realistic simulation models exist for these systems.

What surprised me in my research was the role of the neutron star’s magnetic field strength in determining whether the object appears as a ULXs. In my simulations, I found that neutron stars with moderate magnetic field strength, on the order of  $10^{10}$  Gauss, can appear as ULXs if they accrete above the Eddington limit. However, if the magnetic field is about one order of magnitude stronger, the apparent luminosity is significantly reduced, and the system no longer falls into the ULXs category.

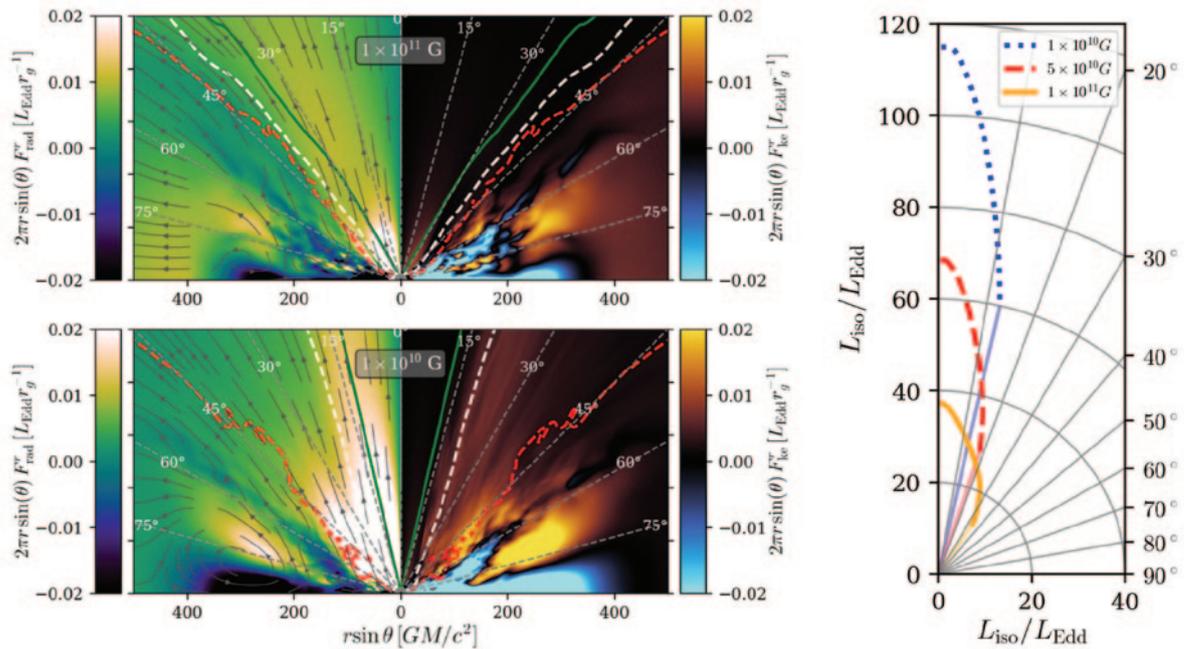
This result was particularly interesting because a theoretical model suggests that magnetars, which have extremely strong magnetic fields, could power ULXs. However, these models are somewhat inconsistent with observational data. An alternative model, more aligned with the observations, proposes that ULXs are powered by neutron stars with moderate magnetic fields. In this scenario, the extraordinary luminosity arises from radiation beaming rather than extreme magnetic strength. Our simulations provided new support for this latter idea and showed how the strength of the magnetic field influences the system.

*What advice would you give to young scientists entering the field today?*

Stay curious and don’t give up easily. Astrophysics needs both creativity and deep thinking. Don’t be afraid to ask bold questions or take on difficult problems.

Modern science works best when analytical models, simulations, and observations come together, so be open to collaborating with people from different areas of science. It’s also important to learn how to code and analyse data.

And once again, be patient with yourself. Science takes time, and progress doesn’t always follow a straight path. Things won’t always go as planned, but even those moments can teach you something valuable. Every step you take helps you grow as a scientist.



*Kinetic and radiation flux of simulations with two different magnetic dipole strengths for the neutron star, along with the polar diagram of apparent luminosity  $L_{\text{iso}}$  computed for three models, which indicates that ULXs can be accreting neutron stars with a magnetic dipole of  $10^{10}$  Gauss. (From: Kayanikhoo et al., 2025)*



## Grzegorz Łazarski, PhD

Jagiellonian University

The interview with the author of the PhD thesis:

**„Molecular dynamics simulations of interactions between polymeric nanoparticles and lipid membranes”**

*Your work touches upon many distinct areas of scientific study. What caused you to give it such an interdisciplinary character?*

Like every child, I was often asked: „Who do you want to be in the future?”. At that time, I always tried to answer the question unambiguously. The truth is, however, that even now, I have not arrived at a single, satisfactory answer. This is reflected in my research work, as it enables me to combine all the fields of study that interest me. I’m fortunate enough that it is my research that was inspired by my interests, and not the other way around. Therefore, the diversity in my research work results from the diversity of my interests. At the end of primary school, synthetic chemistry and growing crystals piqued my interest. Of course, at that age I was not able to (safely) carry out any major experiments, but these subjects fascinated me nonetheless. At the same time, I began learning programming, in order to create simple modifications for computer games. This also entailed learning 3D modeling (which is useful in visualizations), learning how to color them (or „texturing”, as it is known in the jargon) and learning to use programs such as GIMP or Inkscape. These foundations, along with my decision to pursue a second degree in computer science when I enrolled at university, made it much easier for me to find my way in the field of computer simulations.

*What do you think posed the greatest challenge in your research?*

It took me a while to come up with a good answer to this question, but I think that the biggest problem was remaining focused on what was important at a given moment. When waiting for results of your simulations, you keep coming up with ever newer and better ideas on how to solve a given problem. I often found myself thinking „this could have been solved this way”; „a slightly larger system would be useful here”; „here several smaller ones would have been more fitting”... *ad infinitum*. In extreme cases, I sometimes focused on solving completely artificial problems of my own making. Preparing and starting a simulation is a matter of a couple of days, but it takes significantly more time from an idea for a study to its publication. Due to this difference in time-scales, the design of the project, the available literature, and the understanding of the problem can change significantly. I’ve had to (rather quickly, I might add) learn to predict in advance what would be interesting and what exact settings would allow for the most efficient use of computing resources.

*In what way access to Cyfronet’s supercomputing resources facilitated your research?*

The word „facilitated”, in my opinion, does not fully express the impact access to these resources had on my work, as this access is what *enabled* me to carry out this research in the first place. When I started my adventure with computer simulations in 2017, I tried to use my personal computer to run the simulations. If I recall, it was technically possible to finish them, but it would have taken about 3 months, 24/7. That would have been 3 months spent on just the simulations themselves. The same simulations on a cluster (back then, it still was *Prometheus*) could have been carried out and completed in 3-4 days. That’s more than a 22-times improvement! After only 8 short years, these simulations could be successfully carried out on a fairly powerful desktop computer in a similar amount of time, by utilising graphics cards. However, technological progress makes it possible to realize greater am-

bitions for the creation of more complex and larger systems. While the preparation of systems and testing of parameters is now possible on a personal computer, Cyfronet's resources (in particular, clusters equipped with graphics cards, such as *Athena* and *Helios*) are still extremely important and needed in this field.

*What are the practical applications of your research?*

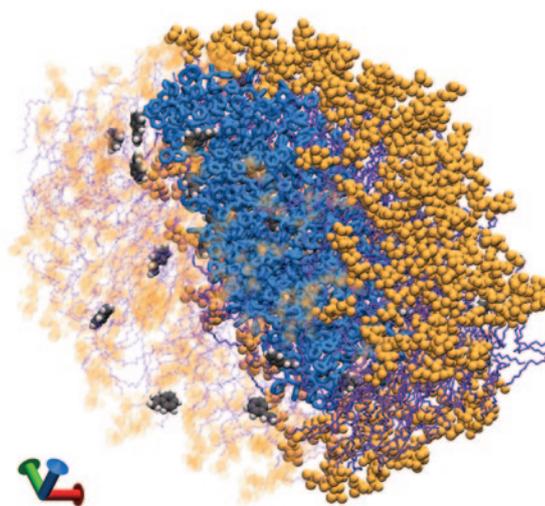
This is a fairly difficult question to answer, as my doctoral research project was conducted on many fronts. Some of them concerned polymer-based drug delivery systems based on a specific type of carriers. More specifically, it was the study of their behaviour in the presence of model cell membranes. The whole group worked on this project – people involved in experiments and simulation-oriented people, like me. My results allowed the experimental group to decide in which way to go when it comes to changes in the structure of these carriers.

The second part of my research involved nanoplastics, and in particular their ability to release the impurities contained in them, as well as pollutants adsorbed from the environment directly into cell membranes. At the time when the project was beginning, there was very little literature on this subject. At that stage, it was necessary to improve the understanding of cases in which these substances can harm us, as well as to attract more attention to the problems they pose. Our latest paper on the subject, which contains slightly extended results of this part of my PhD research, is accessed fairly often, at least according to the data received from the journal.

The last part of my research involved the development of simulation techniques themselves. Specifically, I am currently working on the development of the so-called SPICA force field, in order to add the ability to simulate systems containing sugars and glycosaminoglycans. Without going into too much detail, this technique is subtly different from those currently in use and can potentially offer more accurate results. As a part of my doctoral project, I attempted to prepare a set of parameters to facilitate this, but I have not yet received results of satisfactory quality. When the process is complete, it will significantly expand the scope of application of the SPICA force field. In addition, along with the parameterization process itself, I have created and improved many tools that will improve the work with this force field.

*What advice could you give to people who are just starting their scientific careers?*

By far the best advice I can offer is to focus mainly on your own personal and academic development rather than arbitrary metrics. Publishing, grants, conferences, citations – all these aspects are important for advancing one's scientific career, but in my opinion, the value of a scientist should not be judged solely based on these metrics, especially when it comes to someone who is just starting out. With a good scientific attitude and conscientious work, these „numbers“ will come naturally. Of course, one should also not forget to apply for awards for one's achievements.



*Nanoplastic (polystyrene, blue lines) in a lipid membrane (orange beads and violet lines). Pollutants (in the form of residues remaining from the production process, here: styrene; shown as black and white beads) are released into the bilayer and can alter its properties.*



## Tomasz Szofdra, PhD

### Jagiellonian University

#### The interview with the author of the PhD thesis:

#### „Ergodicity breaking in quantum systems: from exact time evolution to machine learning”

*Could you describe in simple terms the main objective of your research, which formed the basis of your doctoral thesis?*

Referring to the classical world we know, let us imagine a situation in which we place a large number of gas molecules in one corner of a sealed, cubic box. After releasing the particles, after a short time they will fill the box evenly in its volume, and the chance that they will all return to their initial state is practically equal to zero.

Although this principle generally applies to the quantum world, some models for which the memory of the initial conditions is very persistent have recently been discovered. This phenomenon is called many-body localization because it results from the complex, but in a sense coordinated, interaction of quantum objects isolated from their environment. It could potentially be used in quantum computers as a stable memory.

However, not everything is known about the mechanisms leading to many-body localization or its destruction. The main goal of the research that forms the basis of my doctoral thesis was to understand whether an initially small area of such a „frozen” system of a dozen to several dozen qubits, which accidentally lost its special, „frozen” properties (it is referred to as an „ergodic bubble”), will be able to „unfreeze” the rest of the localized system. This is a fundamental question if we ever want to create a large quantum system with long-term memory. On a large scale, such a bubble will certainly occur, the only question is how the rest of the system will react with it. As part of my PhD, I researched, among other things, how not only spontaneous but also „planted” bubbles grow over time, how they connect with each other, and under what conditions they lead to the destruction of the localization phenomenon.

*How did the resources offered by Cyfronet contribute to the use of machine learning in your research?*

Firstly, as the name suggests, in many-body localization research, we are dealing with a system with a large number of degrees of freedom, governed by the laws of quantum mechanics. In theoretical physics, we often make approximations and simplifications to describe and understand an initially complex system, but in this case, the effects of interactions are so subtle that such attempts typically fail. Therefore, we are left with a brute force approach: computer simulations taking into account all microscopic interactions. Access to large-scale CPU computing clusters at Cyfronet enabled me to

obtain datasets for further analysis. Secondly, even when we have the data, it is not always obvious how to extract the information we are interested in. Some signals, especially those coming from such counterintuitive areas as quantum mechanics, sometimes prove too complex for humans to analyze. This is where machine learning comes in handy, allowing us to automate data analysis processes to a certain extent. I used a neural network to track how ergodic bubbles grow over time based on their quantum observations over time. Here, in turn, I used GPU cards available at Cyfronet to train and test my models.

*Did you encounter any challenges in combining theoretical physics with artificial intelligence methods?*

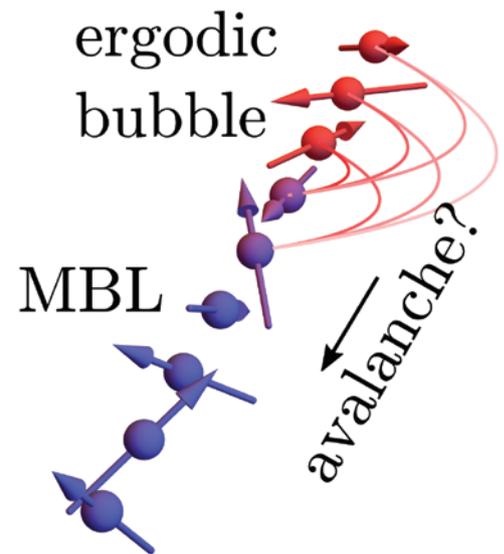
I believe that one should be very careful when „delegating“ data analysis to a deep neural network. It is easy to fall into the trap of thinking that we have solved the problem when the model gives us correct answers based on the training and test data available to us. However, all this comes at the cost of interpretability – we rarely know exactly how the mechanisms inside large networks work. Methods for explaining the basis on which a neural network made a particular decision are still being developed. It is always necessary to thoroughly analyze how the model works, preferably by comparing the obtained results with other, better understood methods of analysis. Ultimately, it is always the scientist who is responsible for the reliability of the results obtained in this way.

*During your research, were you able to observe new phenomena or confirm existing theories?*

By studying the behavior of ergodic bubbles, we were able, at least to a limited extent, to confirm earlier hypotheses by other researchers that even a small, spontaneously formed ergodic bubble can grow over time, destroying the localization in the entire system. We also demonstrated that a strongly localized system, even after a very long time, delocalizes very slowly when a relatively small bubble is connected to it, which was quite surprising.

*What are the next steps in your scientific career? Do you plan to continue your research in the field covered by your doctoral dissertation?*

I am currently at a postdoctoral fellowship at the University of Hamburg, where I am also working on many-body quantum physics, in this case focused on practical applications of quantum computers. I am investigating how classical data, such as tables or photos, can be loaded onto a quantum computer for further processing. I will definitely use my experience with many-body localization in my current research. I am also continuing the projects I started during my doctoral studies.



*An ergodic bubble, in contact with a many-body localized system (MBL), can destroy localization in the so-called quantum avalanche process.*



## Elżbieta Wątor-Wilk, PhD Eng. Jagiellonian University

### The interview with the author of the PhD thesis: „Molecular basis of deoxyhypusination”

*Could you briefly introduce your field of research to our readers?*

I can answer this question from two different perspectives. From a technical point of view, I work in the field of structural biology – a discipline that literally allows us to „see” proteins: their structure, how they function, and how they interact with other molecules. In my work, I primarily use macromolecular crystallography and cryo-electron microscopy, which enable us to capture proteins in action. I complement these methods with techniques from molecular biology, biochemistry, and biophysics in order to understand the studied processes as thoroughly as possible.

From a biological point of view, my main area of interest is hypusination – an extremely rare and unique post-translational modification of a lysine residue, which occurs exclusively in a single protein: the translation factor eIF5A. This modification is essential for the proper functioning of cells – both healthy and cancerous. It proceeds in two steps and is catalyzed by two enzymes: deoxyhypusine synthase (DHS) and deoxyhypusine hydroxylase (DOHH). As part of my doctoral project, I focused mainly on the first step – the reaction catalyzed by the DHS protein.

*How can your research contribute to the development of new drugs?*

The hypusination process plays a crucial role in maintaining cellular homeostasis. Its excessive activity is observed in cancer cells, while its deficiency is associated with neurodevelopmental disorders. A better understanding of the mechanism behind this modification, especially at the structural level, enables the design of selective inhibitors or modulators of the enzymes responsible for the process. My research therefore paves the way for the development of targeted therapies that could be used in the treatment of cancer or rare diseases.

*What has been the biggest challenge in your work?*

The biggest challenge was developing and optimizing the preparation of samples for both crystallographic experiments and those using cryo-electron microscopy. Working with proteins is often unpredictable – their production, purification, crystallization, or imaging requires a great deal of precision, patience, and consistency. However, I must admit that these difficult moments have been the most valuable – they taught me the most, and the experience I gained continues to benefit me in future projects.

*How did the resources provided by Cyfronet support your research?*

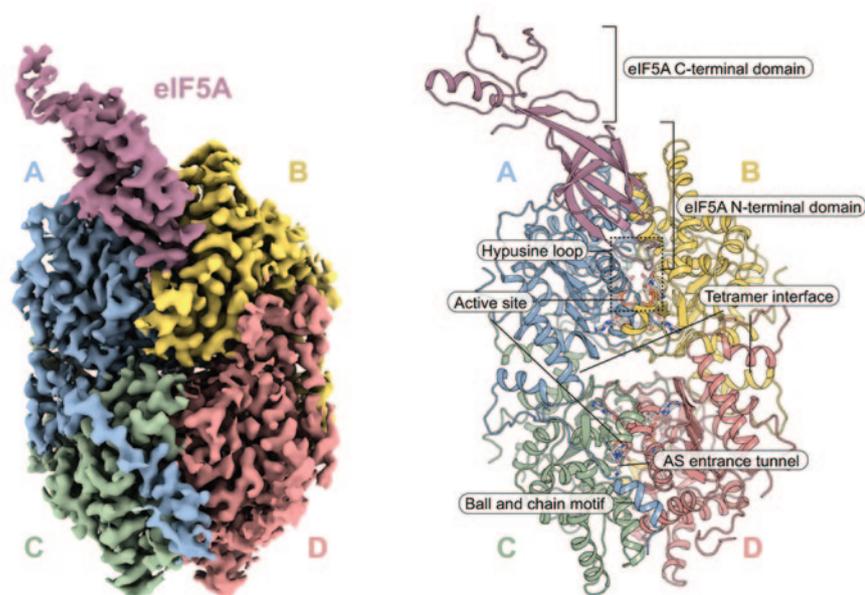
The computational resources offered by Cyfronet played a crucial role, especially during the analysis of structural data. In cryo-electron microscopy, we generate vast amounts of data, and processing

them requires access to high-performance computing systems. Thanks to Cyfronet’s infrastructure, I was able to efficiently analyze cryo-EM data, which significantly accelerated the progress of my research.

I directly used these resources while working on the structure of the parasitic DHS–eIF5A protein complex, which was published in *The FEBS Journal* in 2024. This publication is one of three papers that make up my doctoral dissertation. However, it’s worth emphasizing that only a small portion of the structures we obtained have been published, so the results presented in the papers reflect just part of the use of the infrastructure. It’s also important to highlight the “behind the scenes” aspect of the publication process – namely, the multi-step optimization of samples. The Ares and Athena supercomputers were my everyday tools, used, among other things, to validate successive iterations of optimized cryoEM samples.

*What advice would you give to those just beginning their scientific careers?*

Scientific work is about constantly pushing your own limits – it often means stepping out of your comfort zone, for example through international stays or participation in new projects. My motto is: “*Feel the fear and do it anyway.*” It’s worth exploring different paths, getting involved in diverse initiatives, and testing your ideas. I also encourage applying for all kinds of grant and scholarship programs – they’re a great way to grow and build your research independence. Even if something doesn’t work out the first time, every attempt teaches you something valuable.



*Cryo-EM map and corresponding molecular model of human eIF5A-DHS complex solved by cryoEM.*



## Yizhi Xu, PhD

University of Warsaw

**The interview with the author of the PhD thesis:  
„Computational crystal structure and property prediction of metal-organic frameworks”**

*Could you tell our readers about your journey into this field of research?*

My journey into this field of research has been driven by a deep curiosity about the materials that make up our world and how we can engineer them for impactful applications. During my academic path, I was especially drawn to computational chemistry because of its ability to model and predict different material properties with remarkable precision and efficiency. This interest led me to focus on metal-organic frameworks (MOFs), which are incredibly versatile materials with tunable properties. What excited me most was their potential in a diverse range of areas like gas storage, separation, and even energetic materials – applications that have real-world impact for clean energy, environmental sustainability, and safety. The fundamental motivation for my research is to apply theoretical insights to pursue practical solutions that can address some of today’s most pressing challenges.

*Could you explain in simple terms what metal-organic frameworks are and why predicting their structures is particularly challenging?*

Metal-organic frameworks (MOFs) are a class of highly versatile material which consists of metal centres or clusters joined by organic molecule linkers to form 3D porous polymeric structures. There are already so many exciting applications of MOFs from a diverse range of industries that are beneficial for our society, such as fuel transportation, greenhouse gases absorption, water purification, platforms for drug delivery, catalysts, hypergolic fuels and many more.

Since the key principle behind all various application of MOFs is directly related to the chosen metal node and linker composition, in principle, there are unlimited combinations one can try for desired properties. Moreover, compared to molecular crystals or inorganic materials, MOFs are polymeric, meaning that the whole repeating framework is a single molecule without any inter- or intramolecular separations. Such a phenomenon has made predicting MOF structures more challenging as well as computationally demanding than aforementioned structures. From my research along with my co-workers, we have addressed this prediction challenge using the *ab initio* random structure search (AIRSS) method along with Wyckoff Alignment of Molecules (WAM) algorithm which utilise symmetry to dramatically increase the overall computational efficiency to obtain accurate MOF structures with desired properties in a systematic manner.

*What was the most interesting discovery you made during your research?*

The most interesting discovery of my research was the prediction of a series of previously unseen hypergolic MOFs, for the potential replacement of highly toxic and carcinogenic hydrazine-based rocket fuels. This breakthrough was achieved through our *ab initio* crystal structure prediction (CSP) method for MOFs supported by experimental validations, marking a significant advancement in the design of safer and more sustainable propellants.

In the study, we utilized CSP to explore the structural landscape of MOFs composed of energetic ligands and hypergolic linkers. By systematically varying organic linkers, we identified novel MOF structures exhibiting spontaneous ignition upon contact with oxidizers – a hallmark of hypergolic behavior. These computational predictions were subsequently confirmed through experimental synthesis and testing, demonstrating the efficacy of CSP in guiding the discovery of functional materials. The implications of this work extend beyond aerospace propulsion, highlighting a pathway toward the design of advanced materials for a variety of technological applications.

*In what ways can your research findings be translated into practical applications or real-world solutions?*

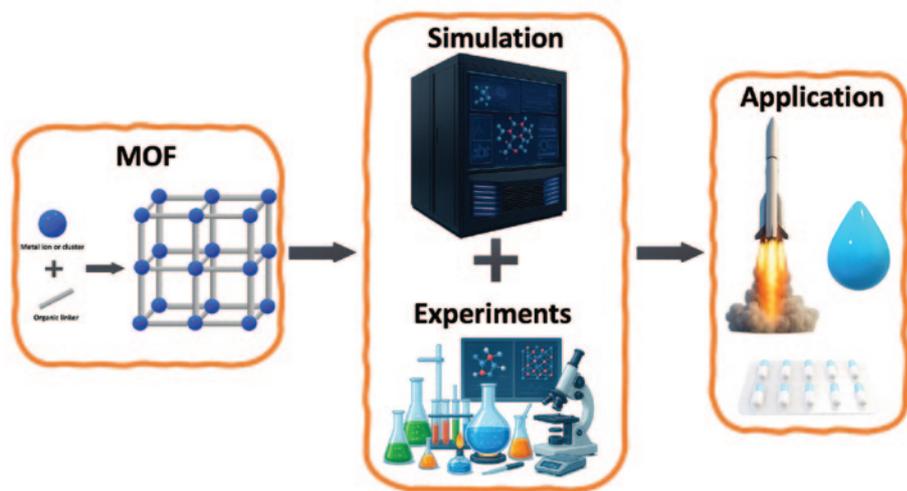
The major driving force for my research is to improve the efficiency of designing MOFs with tailored applications. By developing computational tools and predictive models, my work aims to streamline the discovery of MOFs with specific properties – whether it's for gas storage, separation, catalysis, energetic materials and many more. These findings can be directly translated into practical applications by reducing the time and cost associated with experimental trial-and-error. So far, such idea of designing MOFs has already been showcased from one of my latest published works (DOI: 10.1021/jacs.2c12095) where novel non-toxic MOF-based propellants have been found. Overall, my research can support a more targeted and efficient path from molecular theory to functional MOF design.

*What was the contribution of the Cyfronet supercomputing infrastructure to your research?*

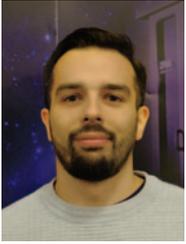
Cyfronet's supercomputing infrastructure played a critical role in my research for executing all necessary calculations for the design of MOFs computationally with desired properties. Specifically, I used CPU core clusters on both the Prometheus and Ares supercomputers to perform the majority of crystal structure prediction (CSP) calculations for MOFs, which are computationally intensive and require exploring vast configurational spaces with high accuracy. These resources enabled me to run thousands of periodic density functional theory (DFT) simulations in parallel, significantly accelerating the structure generation and screening processes. Moreover, the GPU cores offered by the Ares supercomputer were essential for training machine learning potentials, in order to further speed up the CSP calculations for MOF design. These models require handling large datasets and optimizing complex neural network architectures, which would be infeasible on standard hardware. By leveraging GPU acceleration, I was able to efficiently train models that can predict MOF structure and properties with near DFT-level accuracy, but at a fraction of the computational cost.

*What advice would you give to those considering a career in science?*

My biggest piece of advice is to follow your passion and let your curiosity lead the way. A career in science goes beyond memorizing facts or solving equations – it's about asking and solving the questions that matter to you. If there's a topic that fascinates you or a problem you can't stop thinking about, that's a strong indication you're on the right path. More importantly, please remember it's okay not to have everything figured out from the start and focus on solving one question at a time. Finally, keep in mind that science is not just a solo game, and don't be afraid to reach out the others for help.



*Schematic overview of the design workflow for tailored metal-organic frameworks (MOFs): computational simulations via crystal structure prediction (CSP) method, guiding the discovery of promising MOF candidates, followed by experimental validation to realize targeted applications.*



## Storage systems for large data sets

ACC Cyfronet AGH is primarily recognized as the operator of some of Poland's fastest supercomputers. Their computing power is impressive both nationally and across Europe, and their energy efficiency is also remarkable globally. However, to effectively process large data sets, servers equipped with modern processors alone are not enough. Sufficiently large memory systems are also required, both for short-term storage and long-term, secure data archiving.

**We are discussing this with Adrian Marszalik, Head of the Storage Department at ACC Cyfronet AGH.**

### **Goal: universality**

At Cyfronet, we strive to address the most critical needs of users, including those of international research projects, in the development of our data storage systems. Therefore, our systems utilize disk storage, tape media, and semiconductor memory. We place great emphasis not only on data performance and security, but also on convenient resource management and easy sharing.

Our storage services are based on open-source software, including Lustre, Ceph, and EOS. Thanks to the constant technological evolution of our resources, we can provide users with solid support for projects that involve processing large amounts of data.

Cyfronet's currently most efficient resource – the Scratch storage on Helios – has a throughput of 1.8 TB/s. Our infrastructure includes presently 140 PB of disk resources, 120 PB of tape resources, and 10 PB of flash resources.

### **Major challenges**

One of the most significant challenges associated with managing such an extensive data storage infrastructure is its scale. Hundreds of storage servers, thousands of drives, and dozens of switches that connect the system are all operational simultaneously. The system is monitored continuously, and all maintenance and expansion work must be transparent to the user. However, thanks to planned scalability, storage systems can be constantly expanded and upgraded. This is both necessary and desirable.

And here we come to the most critical challenge: providing high-quality services to a diverse audience. The resources of Cyfronet AGH are made available to thousands of users with diverse business profiles, and must be able to handle a variety of tasks running simultaneously. Therefore, we maintain an active dialogue with our users and ensure their needs are taken into account when developing our solutions.

### **Big Data for Important Projects**

Cyfronet has been a partner in various initiatives of significant scientific importance. For many years, we have been part of the WLCG (World LHC Computing Grid) – an international infrastructure for storing and analyzing data from experiments conducted at CERN using the Large Hadron Collider. CERN generates an estimated 200 PB of data annually – several percent of which is stored at Cyfronet.

In Krakow, on a smaller scale, the Solaris Synchrotron operates, which we also support with infrastructure. It's also worth mentioning the vast amount of data storage space needed for imaging diagnostics, for example, for the J-PET positron emission tomograph operating at the Jagiellonian University. Another example is satellite data processing – for example, for the Sat4Envi project, whose portal provides data from, among others, the European Copernicus satellite network. Additionally, Cyfronet hosts the Rodbuk scientific data repository, where scientists from various Polish institutions can store their research data free of charge. We also provide space for cultural collections that have been digitized as part of the PAUART and DRC AI projects, among others. These are just a few, albeit significant, examples. Cyfronet's data storage infrastructure is used daily by thousands of projects, individual researchers, and businesses.

### **Data security is a priority**

Measurement results from particle detectors or satellite data are experimentally irreproducible information because they record a specific phenomenon at a particular time.

In many cases, they can be used for data analysis and comparison; however, additional time may be needed to develop a method or algorithm that fully enables this. Such data is archived along with all other data that does not require constant access, but only occasional access. Cyfronet utilizes a vast array of tape media for archiving. Magnetic tapes are more durable than disks and are more resistant to external factors. Additionally, they can be physically separated from computer networks for off-site backups – a crucial measure when processing sensitive data (e.g., medical data) and effectively protects against the risk of malicious use of ransomware.

Cyfronet's data is stored in two data centers located in separate areas, connected by its own super-fast fiber-optic network. This ensures secure backup and recovery. Cyfronet operates under an ISO 27001-certified data processing policy. Internal departments ensure constant infrastructure monitoring and respond to any potential threats. Our systems ensure that large datasets are secure, and we ensure that their processing is as convenient as possible for users.



## Supercomputers for high-energy astrophysics research

Humankind has always observed the cosmos and sought to uncover its unexplored mysteries. Some of these secrets can be unraveled thanks to modern telescopes, detectors, particle accelerators, advanced measuring instruments, and theoretical calculations – but above all, through the curiosity of scientists who relentlessly pursue answers to fundamental questions about the universe. Supercomputers also play a vital role in this research, significantly accelerating complex numerical computations and enabling the processing of vast datasets.

**We are discussing this with Professor Jacek Niemiec, head of the Department of Gamma-Ray Astrophysics at the Institute of Nuclear Physics of the Polish Academy of Sciences.**

*How would you describe the main focus of your research in simple terms?*

In my scientific work, I study the processes of particle acceleration to high energies in cosmic plasma. These particles are responsible for the emission of astronomical objects across a broad range of electromagnetic radiation – from radio waves to gamma rays – as well as for the production of high-energy neutrinos in cosmic sources. Particles accelerated in these objects also reach the vicinity of Earth, where we detect them as cosmic rays.

My work focuses primarily on theoretical modeling of particle acceleration processes. I concentrate on phenomena occurring near shock waves in various cosmic plasma environments – such as supernova remnants, jets of active galactic nuclei and gamma-ray bursts, as well as shock waves resulting from galaxy cluster collisions. To better understand these processes, I also participate in observational projects in the field of very-high-energy gamma-ray astronomy – including the currently operating HESS and SST-1M experiments, as well as the next-generation CTAO project. Within SST-1M and CTAO, I am also involved in instrumentation work.

My research involving supercomputers focuses on the theoretical component of my scientific work.

*What do you find most interesting in this area of research? What motivates you to investigate this field more deeply?*

My motivation to pursue research in high-energy astrophysics stems primarily from the fact that high-energy emission from many classes of astronomical objects constitutes the dominant component of their energy balance. This means that it is precisely in the high-energy domain where we must look for answers about the nature of individual sources and the processes occurring within them.

An additional source of motivation for me is the decades-old unresolved mystery of the origin of ultra-high-energy cosmic rays. In fact, all major areas of modern high-energy astrophysics and particle astrophysics are united by the common goal of addressing this fundamental question.

In my research on particle acceleration, I'm particularly interested in the microphysical processes that accompany acceleration – such as plasma instabilities that lead to the formation of waves and

turbulence, and their impact on the macroscopic properties of astronomical objects and the observed high-energy emission. At the level of individual particles, these processes are highly complex, because plasma – a rarefied gas of charged particles, primarily protons (hydrogen nuclei) and free electrons – behaves very differently from the neutral gases we encounter in everyday life. What fascinates me in plasma astrophysics is this complexity, which gives rise to a wide variety of mechanisms capable of accelerating particles to extreme energies in environments with diverse physical conditions, such as plasma temperature or magnetic field strength.

*What are the key challenges in this area regarding data processing and computation? How do supercomputers help?*

As I mentioned, plasma is a highly complex system. Unlike ordinary gases, where interactions between particles occur through collisions, in plasma the interactions are collective in nature – they take place simultaneously among many particles, often involving various types of plasma waves. Plasma systems are complex, unstable, and nonlinear. This complexity can be described to some extent using semi-analytical methods, provided the plasma is only weakly perturbed. However, these methods fail in typical plasma scenarios, where instabilities and waves emerge across various time scales and then transform into a nonlinear phase. In such cases, numerical simulations performed on supercomputers become essential, as they enable the study of complex physical systems under realistic conditions – that is, during the nonlinear development phase in which they actually occur in nature.

A key challenge in first-principles studies of plasma microphysics, conducted using Particle-in-Cell (PIC) simulations – which I specialize in – is the vast disparity between the physical scales that can be represented in simulations and the actual macroscopic scales. This stems from the fact that PIC simulations must accurately capture plasma behavior at the dynamic level of electrons, while the macroscopic state of the system is governed by proton dynamics. As a result, the spatial and energy scales achieved in simulations differ by many orders of magnitude from those of real astronomical objects. This forces researchers to use reduced physical parameters and appropriately scale the results to match real-world conditions. Even with such approximations, the computational resource demands remain enormous – ranging from the number of CPU cores, RAM, disk space, and computation time to the subsequent analysis of very large data volumes. Without these resources, and their growing availability, progress in the study of astrophysical plasma systems would be impossible.

*Which machines provided by Cyfronet have you worked on so far?*

Together with members of my team, we have been conducting research on supercomputers at Cyfronet since 2015. The first machine we used for PIC simulations was Prometheus, followed by Ares, and since 2024 we have been using the Helios system. This year and last year, we also carried out year-long computations on the LUMI supercomputer. For research related to PIC simulations –

specifically the application of machine learning methods to analyze data from these simulations – we have also used the Athena system.

*How do you view the changes that have occurred over the years, both in terms of astrophysics research and the technological resources required to carry it out?*

Over the past twenty years, since I began working with numerical simulations, there has been tremendous progress in the development and accessibility of computational power – both globally and in Poland, where much of it is due to the advancement of Cyfronet’s infrastructure. This progress has enabled significant breakthroughs across all areas of computational astrophysics, including research in plasma astrophysics.

We have progressed from small-scale one-dimensional and two-dimensional simulations to large-scale two-dimensional and even three-dimensional simulations, which allow us to track the evolution of physical systems into the late stages of nonlinear development – phases that were completely beyond computational reach two decades ago. The 2000s were the era of teraflop machines, whereas today we are entering the era of exaflop systems.

Simply increasing computational power is not enough to meet the challenges of modeling astrophysical plasma. This is why numerical methods and algorithms are continuously being developed, enabling researchers to undertake increasingly ambitious and complex projects. In the near future, computational plasma astrophysics will evolve in these directions – extensive use of acceleration capabilities through the implementation of existing algorithms on GPU processors, refinement of numerical methods, and the search for new approximate plasma models capable of capturing the essence of physical processes occurring under specific conditions.

*Thank you very much for the conversation!*

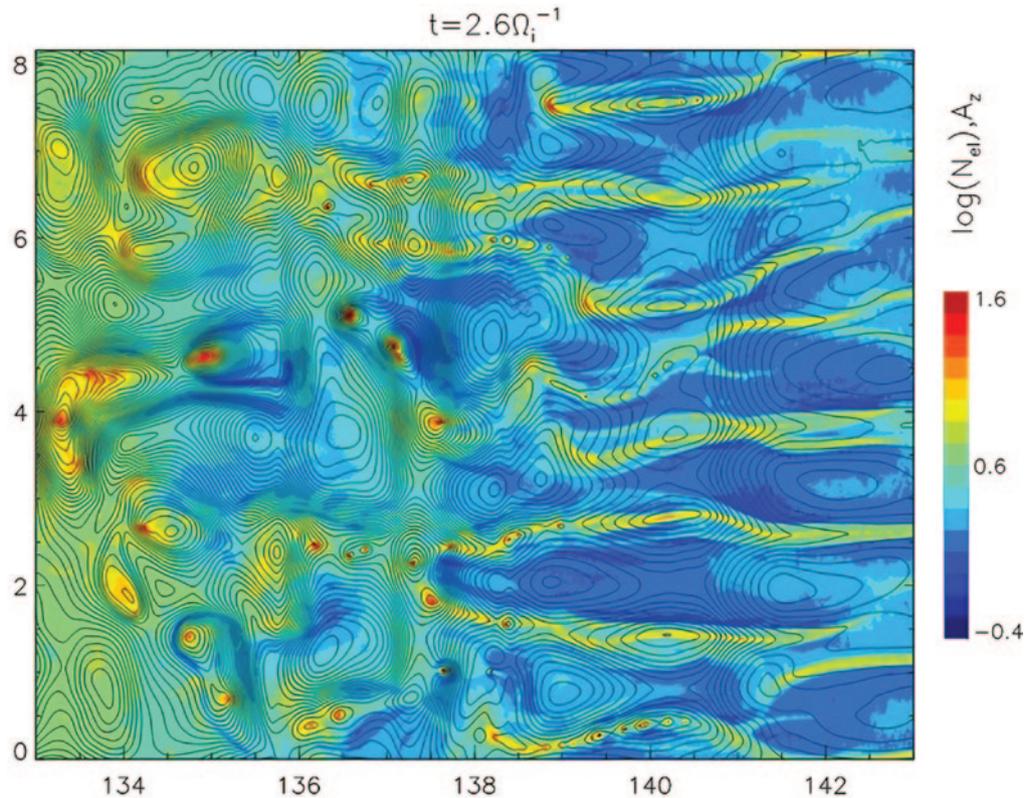
—

Prof. Jacek Niemiec, DSc, has access to Cyfronet’s supercomputers as well as the LUMI supercomputer via the PLGrid portal.

We invite you to visit the website of the Department of Gamma-Ray Astrophysics at IFJ PAN, where the unit’s research activities are described in detail: <https://www.ifj.edu.pl/oddzialy/no1/nz12.php>.

**H.E.S.S.** (High Energy Stereoscopic System) is a ground-based gamma-ray observatory operating in the teraelectronvolt energy range. It employs Cherenkov telescopes to image atmospheric showers initiated by gamma ray photons. IFJ PAN is a member of the Polish Consortium of the H.E.S.S. and MAGIC experiments. More information about the observatory is available at: <https://www.mpi-hd.mpg.de/HESS/>.

**Cherenkov Telescope Array Observatory – ERIC** (CTAO-ERIC) is a next-generation ground-based very high energy gamma-ray observatory, whose construction has recently begun. IFJ PAN and ACC Cyfronet AGH are members of the Polish Consortium of the “Cherenkov Telescope Array” project. More information about the observatory can be found at: <https://www.ctao.org/>.



*Map of the electron density distribution and magnetic field lines obtained from a PIC simulation of shock formation under conditions corresponding to plasma in supernova remnant shocks. The figure shows a fragment of the shock front structure, where the interaction of protons reflected from the shock with the incoming ambient plasma leads to the development of a filamentary magnetic field structure due to the Weibel instability. Within these filaments, spontaneous magnetic reconnection occurs, forming magnetic islands along the filaments. In these structures, electrons are accelerated.*

*Courtesy of Artem Bohdan. For more details, see Bohdan et al. 2020, Astrophysical Journal 893:6*

*(<https://iopscience.iop.org/article/10.3847/1538-4357/ab7cd6>).*



## Development of projects and processes based on artificial intelligence through specialized expertise

In the field of creating artificial intelligence, Cyfronet is primarily associated as an operator of infrastructure dedicated to **big data processing**. This infrastructure includes, among others, Helios, whose GPU partition comprises 440 NVIDIA GH200 cards, and Athena, with its 384 NVIDIA A100 cards. Modern GPUs, together with an efficient data storage and transmission system, enable the effective development of artificial intelligence models – including the advancement of Polish large language models PLLuM and Bielik.

These capabilities are expected to expand significantly with the planned installation of a new super-computer under the **Gaia AI Factory** project, which is set to include approximately 1,000 state-of-the-art GPU cards.

At the same time, “**Cyfronet for AI**” is not only about resources, not only hardware and software. The specialized expertise developed over the years by our teams enables the creation of advanced, AI-based tools that are implemented in initiatives of both national and international scope.

On this topic, experts from ACC Cyfronet AGH share their insights: **Marek Kasztelnik** – coordinator of Cyfronet’s activities within the Gaia AI Factory, Meetween, DVPS, and Gemini projects, and **Joanna Kocot** – head of Cyfronet’s Laboratory of Interdisciplinary Scientific Computing and leader of activities related to EPOS.

### Tools for integrating speech, text, and image for the needs of videoconference participants

Multimodal artificial intelligence models are gaining increasing importance in areas such as real-time speech translation, the creation of virtual meeting assistants, and linguistically transparent communication. A major challenge related to these models is their comprehensive evaluation. Existing benchmarks often focus on unimodal tasks, such as automatic speech recognition (ASR), text summarization, or machine translation. Due to the complexity of multimodal models, in which synchronized processing of text, speech, audio, and image streams is crucial, there has arisen a need to develop dedicated benchmarking tools.

The pursuit of a solution to this problem emerged within the **Meetween project – a Personal AI Mediator for virtual meetings**.

One of Cyfronet’s teams is developing, within this project, the **SPEECHM** platform (Speech Performance Evaluation Criteria and Holistic Metrics), which offers an innovative solution for evaluating multimodal artificial intelligence models, eliminating the limitations of existing benchmarks. Within SPEECHM, standardized and extensible frameworks are being developed for assessing models in multimodal tasks of speech perception and generation. Care has been taken to ensure that the tool’s

architecture and diverse test sets enable scalable and fair evaluations. In this way, the development of advanced artificial intelligence models for real-world applications is supported.

The key components of the platform are:

- 1) Web application that organizes and presents tasks, test sets, models, and rankings.
- 2) HPC backend that leverages high-performance computing resources to execute and scale benchmarking tests, even for evaluations with intensive GPU usage.

*– To harness the computing power offered by Cyfronet’s Ares, Athena, and Helios clusters, the knowledge and expertise of our team were essential. In the course of the work, mechanisms were developed that enable the integration of web applications with the PLGrid ecosystem and the delegation of user privileges to supercomputers, where the evaluation of individual AI models takes place. By combining these solutions with the evaluation methods for multimodal models developed within the Meetween project, we were able to successfully use this platform during the organization of the IWSLT 2025 competition (<https://iwslt.org/2025>) – explains **Marek Kasztelnik**.*

Meetween is a project funded under the Horizon Europe framework programme.

### **The use of neural networks for studying and predicting anthropogenic seismicity**

For many years, Cyfronet has been carrying out activities within **EPOS (European Plate Observing System)**. EPOS is a pan-European initiative that integrates national and international research infrastructures in support of Earth sciences. One of EPOS’s thematic nodes concerns the impact of human activities on seismic processes. While numerous machine learning tools have so far been developed for studying naturally occurring phenomena such as earthquakes, there has been a clear lack of such tools for anthropogenic events, which differ in their characteristics.

A solution to this problem co-developed by the Cyfronet team is the **EPOS AI** platform, whose purpose is to facilitate the use and creation of machine learning applications in the field of seismology.

*– During the work, our team focused, among other things, on training models using seismic data from the Legnica-Głogów Copper District, the Bogdanka Coal Basin, and the Czorsztyn Reservoir – says **Joanna Kocot**. – As a result, the platform streamlines the process of applying artificial intelligence algorithms in research projects, enabling the execution of pre-trained models.*

EPOS AI also provides the capability to retrain these models using custom, including private, datasets. Researchers can conduct training experiments and easily compare them with previous results, which facilitates the optimization of methods to identify the most effective model.

These functions were developed within EPOS PL+, a Polish national project co-funded by the European Regional Development Fund.



## Dawid Dąbrowski

**Interview with a user of the PLGrid infrastructure, a member of the Quantum Molecular Systems Group operating within the Institute of Theoretical Physics at the University of Warsaw, led by Professor Michał Tomza.**

*How did your research interests develop? What led you to pursue them in the field of molecular physics?*

I have always been fascinated by two scientific disciplines: physics and chemistry. During my studies within the Inter-faculty Individual Studies in Mathematics and Natural Sciences at the University of Warsaw, I discovered that molecules are the perfect domain for exploring the intersection of these two fields.

My decision to pursue molecular physics was driven by a desire to understand how the world around us is built from fundamental quantum interactions. Molecular physics bridges these two realms – it allows us to build connections between theoretical frameworks and state-of-the-art experiments.

*How would you explain, in simple terms, what the Quantum Molecular Systems Group does? What is your role within the team?*

We use supercomputers to understand how individual atoms and molecules behave. This is fundamental knowledge that can be applied to designing new materials, understanding processes occurring in stars, and developing future quantum information technologies. Research within Professor Michał Tomza's group focuses on the precise description of ultracold systems, where – at temperatures on the order of  $\mu\text{K}$  and  $\text{nK}$  – quantum effects dominate.

My primary role in the team is to carry out complex numerical computations using HPC infrastructure. My work involves selecting the appropriate computational method, implementing it, running simulations on computing clusters, and ultimately analyzing terabytes of resulting data. I'm a quantum physicist for whom the supercomputer is an essential tool – without it, my research would be impossible.

*You began using Cyfronet's infrastructure at a very early stage of your academic path. What does access to supercomputers look like from a student's perspective? What specific resources did you use, and how?*

I began using Cyfronet's infrastructure in the second year of my undergraduate studies, when I started conducting research under the supervision of Professor Michał Tomza. Naturally, running computations on a cluster can be challenging at first, but thanks to the support from Helpdesk experts and more experienced members of the research group, the entry barrier is reduced to a minimum.

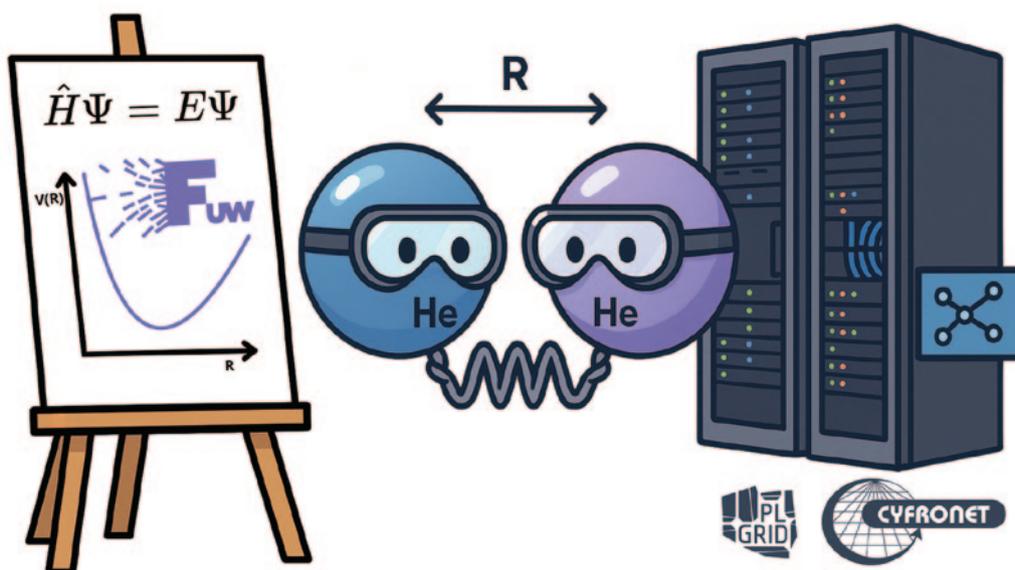
*What impact did this have? What became achievable thanks to access to computational power?*

The computational power available through Cyfronet's infrastructure made it possible to take on research challenges that were previously out of reach – ranging from highly accurate modeling of

quantum systems to achieving new world records in the accuracy of theoretical calculations. This has led to concrete scientific outcomes, including my first publications and conference presentations.

*Could you share your impressions of working with Cyfronet?*

It's important to highlight the technical support provided by Cyfronet's experts. As a student taking my first steps in HPC, I had highly non-standard implementation requirements – both in terms of code and node configuration. On top of that, I needed massive resources: nearly 10 million computing hours and 150 TB of data storage. That's why collaboration with Cyfronet's experts turned out to be essential and was crucial for making effective use of this computing power.





CDC CYBER 72



Convex C3840



Exemplar SPP1600/XA

- 1973** CYFRONET is established
- 1975** A CDC CYBER 72 computer is deployed at the Centre
- 1990** The first Krakow node of the EARN / BITNET network is deployed at CYFRONET (on an IBM 4381 computer)
- 1991** CYFRONET installs a Convex 120 machine – the first vector computer in Central and Eastern Europe. The first Polish national Internet link is established between Krakow and Warsaw. Construction begins in the Krakow MAN
- 1994** A 2 Mbps link is deployed between Krakow and Warsaw
- 1996** An Exemplar SPP1600/XA computer deployed at CYFRONET took a position on the TOP500 list. The first automatic tape library (ATL 2640) is installed at the Centre
- 1997** The ATM communications subnet is deployed within the Krakow MAN. CYFRONET joins the POL-34 national backbone
- 1998** An SGI Origin2000 computer is deployed at the Centre
- 2000** Increasing the Centre network connection bandwidth to 155 Mbps
- 2002** A RackSaver PC computer is deployed at CYFRONET as part of the CrossGrid project
- 2003** An HP Integrity SuperDome computer is deployed at CYFRONET (the first such computer in Poland)
- 2005** An HP Storage Works XP12000 disk array is deployed at CYFRONET. Increasing the Centre network connection bandwidth to 622 Mbps
- 2006** An HP Storage Works EVA 8000 disk array and an SGI ALTIX 3700 supercomputer (Baribal), with 0.8 TFlops of theoretical peak performance, is deployed at CYFRONET

- 2007** An agreement concerning the creation of the Polish Grid (PLGrid) Consortium was signed.  
An SGI ALTIX 4700 supercomputer with the SGI RASC acceleration module is deployed at CYFRONET.  
IBM BladeCenter HS21 servers are deployed at CYFRONET (6.2 TFlops).  
An HP Storage Works EVA 8100 disk array is deployed at CYFRONET



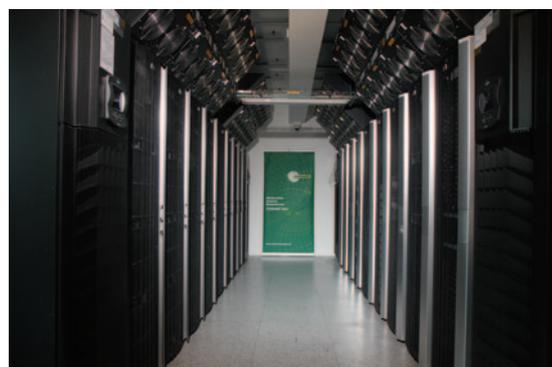
SGI Origin2000

- 2008** The configuration of SGI ALTIX 3700 supercomputer is extended to 1.5 TFlops.  
MAN 10 Gbps started.  
The Metropolitan Area Network is directly connected to Warsaw and Bielsko-Biała through the PIONIER network links, each of 2x10 Gbps capacity.  
Zeus supercomputer (HP Cluster Platform 3000 BL) with 2 048 cores is deployed at CYFRONET



SGI ALTIX 3700

- 2009** Start of the PL-Grid project – Polish Infrastructure of Supporting Computational Science in the European Research Space
- 2010** The configuration of Zeus supercomputer is extended to 9,544 Intel Xeon cores, Zeus has been placed on 161<sup>st</sup> position on the TOP500 list
- 2011** Deployment of Hitachi Data Systems High Performance NAS Platform for computing infrastructure.  
Total amount of installed disk space exceeds 2 PB.  
The configuration of Zeus supercomputer is extended to 12,032 Intel Xeon cores.  
Zeus has been placed on 80<sup>th</sup> position on the TOP500 list



HP Cluster Platform 3000 BL

- 2012** Start of the PLGrid Plus project – domain-oriented services and resources in the PL-Grid.  
In April, ScaleMP, a leading provider of virtualisation solutions for high-end computing, announced that Zeus-vSMP system at CYFRONET is the largest virtual SMP system in Europe.  
Zeus among 100 fastest supercomputers on the TOP500 list.  
The Metropolitan Area Network is directly connected to Rzeszów through the PIONIER network link of 2x10 Gbps capacity



*Anniversary Medal*



*New Machine Hall*



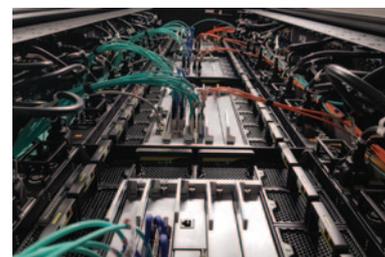
*Prometheus supercomputer*

- 2013** After upgrading of Zeus supercomputer configuration to 25,468 cores, its theoretical peak performance reached 374 TFlops.  
Anniversary Medal has been minted
- 2014** The new Machine Hall is completed.  
Start of two new projects – PLGrid NG and PLGrid Core.  
The Metropolitan Area Network is directly connected to Katowice through the PIONIER network link of 2x10 Gbps capacity
- 2015** The Prometheus supercomputer (41,472 cores) is deployed at CYFRONET, and ranks high, 49<sup>th</sup> place on the TOP500 list (the July edition), and next (after upgrading to 53,568 cores) 38<sup>th</sup> place (the November edition).  
For the first time in history two supercomputers from Cyfronet (Prometheus and Zeus) are ranked on the TOP500 list, in one edition.  
The new backup Data Center is completed.  
CYFRONET starts active participation in INDIGO-DataCloud, EGI-Engage, EPOS-IP and PRACE-4IP projects.  
High Performance Computing centres in Poland (Gdansk, Krakow, Poznan, Warsaw and Wroclaw) are integrated with links of 2x100 Gbps capacity
- 2016** Prometheus ranks 48<sup>th</sup> (the June edition) and 59<sup>th</sup> place (the November edition) on the TOP500 list
- 2017** Prometheus ranks 71<sup>st</sup> (the June edition) and 77<sup>th</sup> place (the November edition) on the TOP500 list.  
Further dynamic development of the Centre, including establishment of 6 new laboratories.  
Sat4Envi, Gliomed, EPOS-PL and eXtreme DataCloud projects launched
- 2018** Prometheus (53,604 cores, 2.4 PFlops) ranks 103<sup>rd</sup> place (the June edition) and 131<sup>st</sup> (the November edition) on the TOP500 list.  
EOSC-Hub and PRIMAGE projects have been launched

**2019** Cyfronet represents Poland in the LUMI consortium, composed of eight countries that will jointly build one of the fastest European supercomputers.  
 Prometheus ranks 174<sup>th</sup> place (the June edition) and 241<sup>st</sup> place (the November edition) on the TOP500 list.  
 Cyfronet exhibition stand at the ISC'19 conference.  
 Cyfronet provides a new computational system for research using AI methods, with computational power over 4 PFlops for tensor operations and 256 TFlops for standard calculations.  
 PRACE-LAB, PRACE-6IP, SANO, EOSC-Synergy and EOSC Enhance projects launched



**2020** Among the strategic infrastructures included in January 2020 on the Polish Research Infrastructure Map there are two projects proposed by ACC Cyfronet AGH as the initiator and coordinator of the PLGrid consortium: *National Supercomputing Infrastructure for EuroHPC* and *National Cloud Infrastructure PLGrid for EOSC*.  
 Prometheus (53,748 cores, 2.7 PFlops) ranks 288<sup>th</sup> place (the June edition) and 324<sup>th</sup> (the November edition) on the TOP500 list.  
 The Prometheus supercomputer supports scientists in the fight against coronavirus.  
 EPOS PL +, PRACE-LAB2, EPOS SP, PROTEUS-RS and EUROCC projects launched



**2021** The Ares supercomputer with theoretical peak performance over 4.0 PFlops is deployed in Cyfronet. Prometheus ranks 373<sup>th</sup> and 440<sup>th</sup> place, and Ares ranks 216<sup>th</sup> and 267<sup>th</sup> place on the TOP500 list.  
 A new version of the ACC Cyfronet AGH website has been launched.  
 EuroHPC PL, PIONIER-LAB, KMD3, AGH - PANDA3, EGI ACE, EOSC Future and FINDR projects launched





**2022** Athena supercomputer with theoretical peak performance 7.7 PFlops is deployed in Cyfronet.

Opening of the Data Center Podole.

For the first time in the history of Polish computer science, three supercomputers from one Polish computing centre (Athena, Ares and Prometheus) are ranked on the TOP500 list.

Prometheus (53,748 cores, 2.7 PFlops) ranks 475<sup>th</sup> place, Ares (37,824 cores, 4 PFlops) ranks 290<sup>th</sup> and 323<sup>rd</sup> place and Athena (6,144 cores, 7.7 PFlops) ranks 105<sup>th</sup> and 113<sup>th</sup> place on the TOP500 list.

Inauguration of the LUMI supercomputer.

EUMaster4HPC, FAIRCORE4EOSC, EuroScienceGateway, InterTwin, DT-GEO, Geo-INQUIRE and EDITH projects launched



**2023** Celebration of the 50th anniversary of Cyfronet AGH with the participation of President Andrzej Duda, who presented state decorations to distinguished employees of Cyfronet.

Athena ranks 123<sup>rd</sup> place and Ares ranks 362<sup>nd</sup> place on the TOP500 list.

Cyfronet AGH honored with the Polonia Minor Award.

The EuroHPC PL project team was the winner of the Polish Smart Development Award 2023.

For the second time in the history of Polish computer science, three supercomputers from one Polish computing centre (Athena, Helios CPU and Ares) are ranked on the TOP500 list (the November edition) in places 154<sup>th</sup>, 290<sup>th</sup> and 403<sup>rd</sup> respectively.

DOME, EUROCC 2, EUreka3D, PIONIER-Q and GEMINI projects launched



**2024** For the first time in the history of Polish computer science, four supercomputers from one Polish computing centre (Helios GPU, Athena, Helios CPU and Ares) are ranked on the TOP500 list (the June edition) in places 55<sup>th</sup>, 177<sup>th</sup>, 305<sup>th</sup> and 442<sup>nd</sup>, respectively.

Helios GPU ranked 3<sup>rd</sup> place on the Green500 list (the June edition).

Four supercomputers from Cyfronet (Helios GPU, Athena, Helios CPU and Ares) are again ranked on the TOP500 list (the November edition) in places 69<sup>th</sup>, 212<sup>th</sup>, 348<sup>th</sup> and 490<sup>th</sup>, respectively.

Meetween, EOSC Beyond, EPICURE, FFplus, PLGrid ICON and EPOS ON projects launched



**2025** Marek Magryś was appointed the Acting Director of ACC Cyfronet AGH.

A letter of intent was signed at the headquarters of ACC Cyfronet AGH regarding cooperation between the City of Krakow and the AGH University of Krakow on the construction of Krakow's Digital Shield.

Three supercomputers from Cyfronet (Helios GPU, Athena, and Helios CPU) were listed in the June edition of the TOP500, ranked respectively at positions 85, 246, and 386.

The European High Performance Computing Joint Undertaking (EuroHPC JU) has selected the consortium led by the ACC Cyfronet AGH to establish the Gaia AI Factory – a state-of-the-art artificial intelligence factory in Poland.

A new version of the ACC Cyfronet AGH website has been launched.

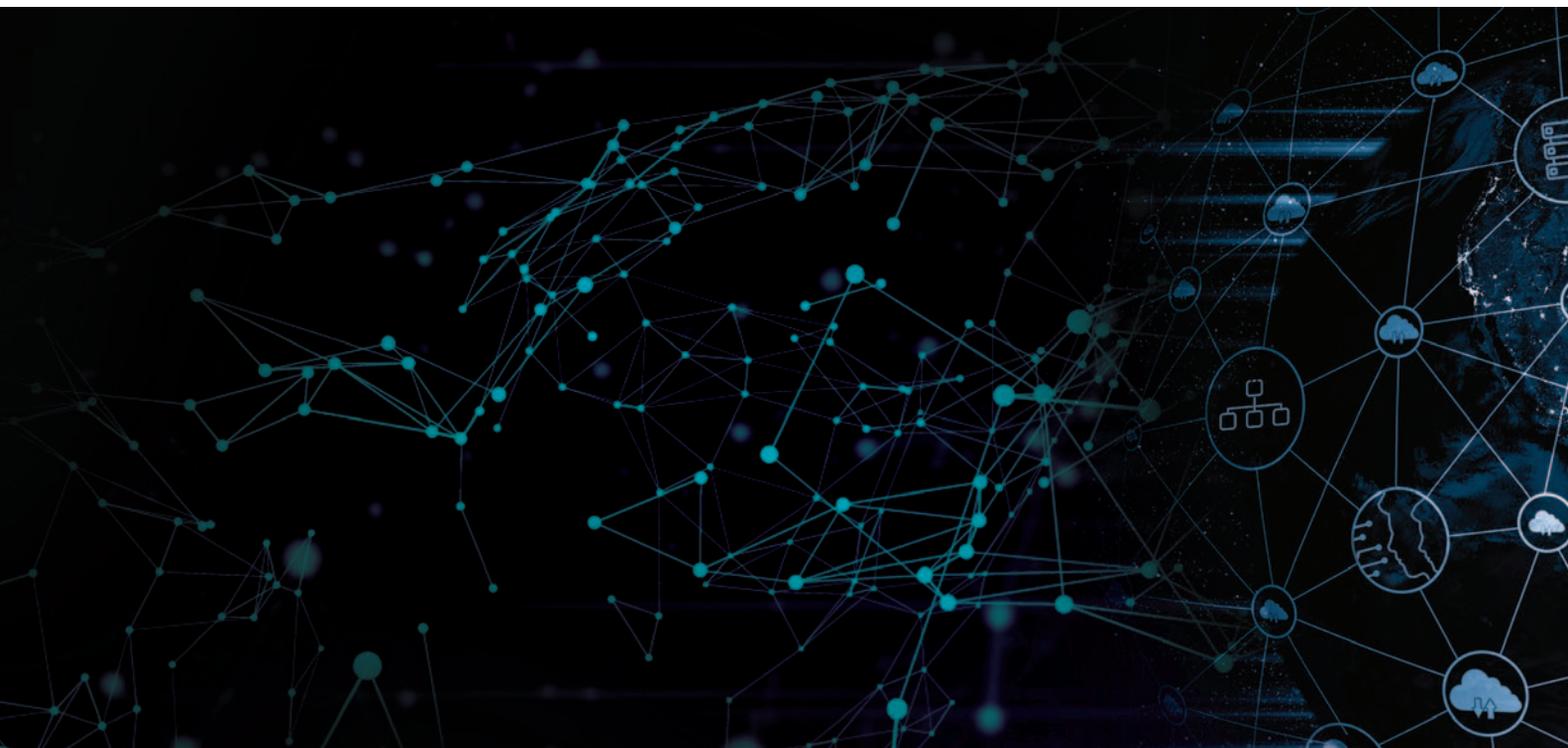
Three supercomputers from Cyfronet (Helios GPU, Athena, and Helios CPU) are again listed in the November edition of the TOP500, ranked respectively at positions 96, 278, and 413.

Implementation of the following projects began: KMD4EOSC, SAGE, DARE SGA 1, EOSC Data Commons, LAIF Service Center, DVPS, HIVE AI, DRC AI, UNCAN-Connect.



*photo: AGH*





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