CENTE

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INSTYTUT FIZYKI PLAZMY I LASEROWEJ MIKROSYNTEZY

Krajowy Punkt Kontaktowy
EURATOM - FUSION

POLISH SCIENCE AND INDUSTRY FOR FUSION ENERGY



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THE MISSION OF THE SCIENTIFIC-INDUSTRIAL CENTRE

„New Energy Technologies" (CeNTE)

CeNTE was established in 2014 to enable Polish research units and industrial partners to participate in European fusion energy programme. CeNTE is to conduct scientific research into new energy technologies and implementing the results of research in practice. The New Energy Technologies Centre aims to identify and address critical challenges facing society, the scientific community, and the economy within the scope of the Centre's activities. These include research and development regarding thermonuclear energy conversion technologies, as well as related and supporting technologies. The partners of the centre „New Energy Technologies" cooperate in R&D in fusion areas, including the development of research infrastructures and fostering industrial sector engagement.

CeNTE is coordinated by Sylwester Kaliski Institute of Plasma Physics and Laser Microfusion (IPPiLM) in Warsaw. The Institute has coordinated the works of Polish research units involved in the European nuclear fusion research programme and served as the national EURATOM-Fusion Contact Point since 2005. In 2026, CeNTE consortium comprises of 27 partnering organisations out of which 21 are the scientific units, 1 is technology park and 5 are industrial partners. Fusion research is interdisciplinary, encompassing a wide range of fields, from plasma physics and materials science to computer science, electronics, and social sciences. Given the potential of Polish scientists and businesses, the range of opportunities for their involvement is broad. This is also reflected in Poland's history, which shows how Polish scientists have made significant contributions to the development of new inventions and have played an important role in scientific discoveries worldwide.

CeNTE

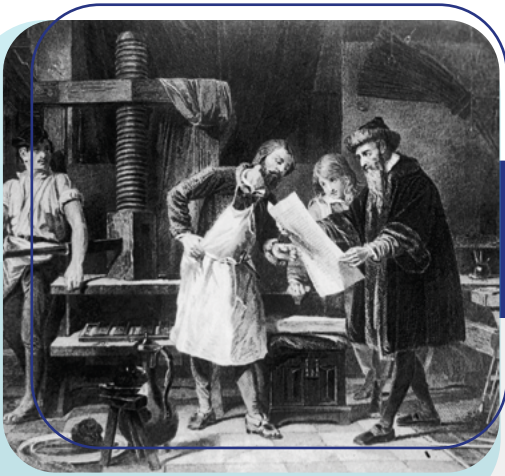
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EURATOM - FUSION

MAP OF EUROPE



WHY POLAND?
HISTORY



Johannes Gutenberg shows his own printing machine.
Photo: Getty Images



A test of a bulletproof vest consisting of layers of synthetic fabric, most often Kevlar. It's designed to gradually reduce kinetic energy as a bullet penetrates by Polish monk from the Congregation of the Resurrection Kazimierz Żegleń In 1893, after the shot of Chicago Mayor Carter Harrison.

Photo: https//en.wikipedia.org/wiki/Bulletproof_vest

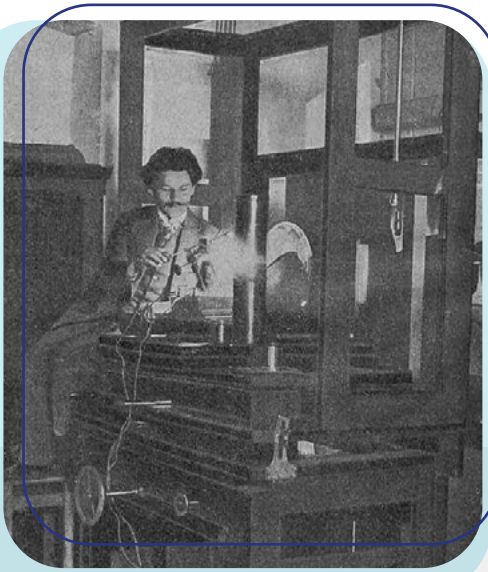
POMNIK HISTORII
Muzeum Przemysłu Naftowego i Gazowniczego im. Ignacego Łukasiewicza w Bóbrce

Łukasiewicz was a pharmacist and entrepreneur, and founder of the world's first crude oil mine. A Pole was also the first to exploit the benefits of crude oil on an indu-strial scale. This was all thanks to the invention of the kerosene lamp, which emitted light by burning kerosene. The scientist developed it in 1853 in Lviv. This discovery had a direct impact on the develop-ment of the petrochemical industry.

Logo: https://bobrka.pl/en

Jan Szczepanik, the author of the prototype of the bulletproof vest registered his invention with the British Patent Office in 1897 as a **„telelectroscope, or apparatus for reproducing images at a distance by means of electricity."**

Photo: https//pl.wikipedia.org/wiki/Jan_Szczepanik#

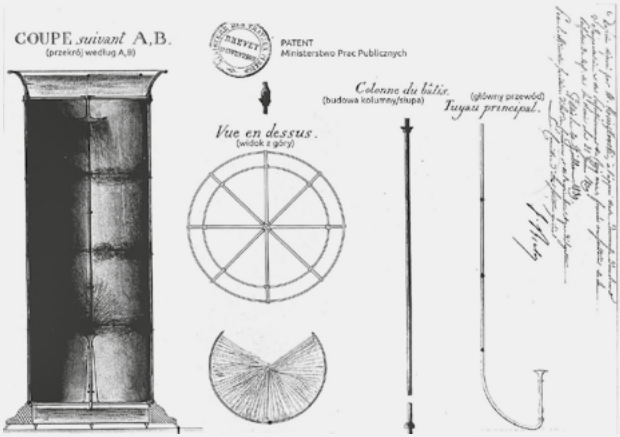




Erythrocyte sedimentation rate (ESR)
is a laboratory test that measures the sedimentation rate of red blood cells in non-clotting blood over a period of 1 hour. In medical diagnostics, it is used as an indicator of inflammatory, rheumatic, and neoplastic processes. Photo: Blood samples, right: freshly drawn; left: treated with EDTA (anticoagulant).

Photo: https://commons.wikimedia.org.wikifile:Blut-ETDA.jpg

Shower cabin
E. Kierzkowski ig. in the 1839 patent memorial.
Photo:https//pl.wikipedia.org/wiki/Kabina_prysznicowa



The first **semaphores**, along with an automatic signaling system, were invented in France by the Polish engineer Jan Józef Baranowski. They were put into operation in 1857 on the Paris-Rouen railway line and in November 1857 on the Paris-Saint Germain line. Baranowski's system was introduced in 1858 in Italy on the Genoa-Turin line and, after modernization, on the Paris-Brussels line. It was presented in 1862 at the World's Fair in London. It was later used in England.

Photo:https://commons.wikipedia.org/wiki/Plik:Jan_Józef_Baranowski)Automatic_Railway_Signals.jpg Jan_Szczepanik#





Photo: https://flexioss.pl

FlexiOss
was developed by biochemists from the Medical University of Lublin and the AGH University of Science and Technology in Krakow by the team of Proffessors: Grażyna Ginalska, Anna Belcarz, Anna Ślósarczyk and Zofia Paszkiewicz. Initially, the substance was tested in veterinary medicine, since 2021 is has been used in human medicine.

The **V-tail** was invented in 1930 by the Polish engineer Jerzy Rudnicki and was tested for the first time on a **Hanriot H-28 trainer,** modified by the Polish aerospace manufacturer Plage and Laśkiewicz in 1931.

Photos: https://en.wikipedia.org/wiki/V-tail





BLIK is the Polish mobile payment system launched in 2015. It enables making instant payments online and in retail stores, withdraw cash from ATMs, and transfer money, primarily using their bank's mobile application.

In 2021, Blik introduced contactless payments, enabling users with NFC-equipped Android devices to make payments at POS terminals using Mastercard virtual tokens. This functionality also extends to Polish users traveling abroad and has been noted as a potential alternative to Google Pay on rooted smartphones. Revolut became the first to integrate Blik in 2024.While Revolut users in the EU with a PLN account can access Blik, its use is currently restricted to transactions with Polish businesses, limiting its practical application outside Poland. In 2025, Blik joined the European Payments Alliance (EuroPA), an initiative to provide **interoperable mobile payment solutions throughout Europe**.

OMEGA is a class of sailing yachts - popular in Poland for both racing and recreational use - designed by Juliusz Sieradzki in 1942. Thanks to its simplicity, stability, and shallow draft, it has served as the primary training vessel in Poland from the post-war decades to the present day; it is the boat on which many Poles learn to sail and take their state - certified sailing examinations.

The history of the Omega begins in occupied Warsaw. The boat was originally created for sailing training within the Home Army (Armia Krajowa), as well as for transporting goods and soldiers across the Vistula River. After the war, the design was taken over by state authorities, and the Omega proved to be a commercial success. These sailboats were used primarily for training purposes. The Omega facilitated the development of both recreational cruising - over both long and short distances - and competitive racing. The latter evolved into the Polish National Championships in 1951. In 1974, the wooden hull was replaced with laminate. In 1980, a sailing event known as „Operation Sail - Masuria" (Mazurska Operacja Żagiel) took place, which helped establish a recurring series of regattas. A few years later, the Polish National Championships for the Omega class yachts were revived, and they continue to be held to this day."



Photo: https://www.czartermazury.pl/images/koje/70.jpg



Melex
A Polish manufacturer of electrical products based in Mielec, operating since 1971

Photo: https://pl.wikipedia.org/Melex#/media



POLISH CONTRIBUTION
MATHEMATICS
PHYSICS

Stanisław Ulam (1909-1984)

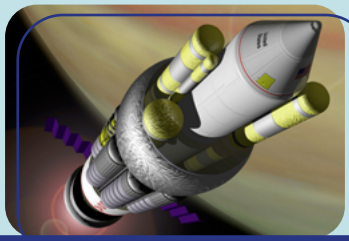
Polish-American mathematician who made significant contributions to mathematics and mathematical physics in the areas of topology, set theory, measure theory, and branch processes. Ulam developed numerical methods, such as **the Monte Carlo method** of computation. He was one of the first scientists to use computers in his work. Ulam used computer methods to model neutron multiplication and to solve the problem of a vibrating string containing a nonlinear element (the Fermi-Pasta-Ulam oscillator).

Ulam participated in the **Manhattan Projec**t at Los Alamos Nuclear Research Center in New Mexico, were he worked on hydrodynamic calculations to predict the behavior of the explosive lenses that were needed by an implosion-type weapon.

He was assigned to Edward Teller's group, where he worked on Teller's „Super" bomb for Teller and Enrico Fermi. After war he left to become a professor at the University of Southern California, but returned to Los Alamos in 1946 to work on thermonuclear weapons. With the aid of computers he found out that Teller's „Super" design was unworkable. In 1951, Ulam and Teller came up with the **Teller–Ulam design**, which became the basis for all thermonuclear weapons.



The Sausage device of Mike nuclear test (yield 10.4 Mt) on Enewetak Atoll. The test was part of the Operation Ivy. The Sausage was the first true H-Bomb ever tested, meaning the first thermonuclear device built upon the Teller-Ulam principles of staged radiation implosion.



An artist's conception of the NASA reference design for the Project Orion spacecraft powered by nuclear propulsion

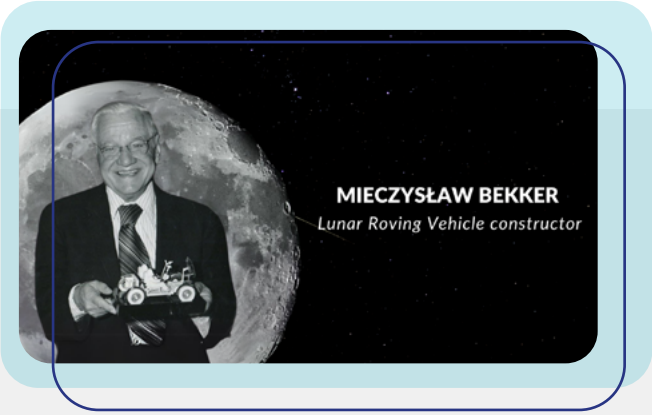
Ulam considered the problem of **nuclear propulsion of rockets**, which was pursued by Project Rover, and proposed, as an alternative to Rover's nuclear thermal rocket, to harness small nuclear explosions for propulsion, which became Project Orion. With Fermi, John Pasta, and Mary Tsingou, Ulam studied the **Fermi–Pasta–Ulam–Tsingou** problem, which became the inspiration for the field of nonlinear science. He is probably best known for realizing that electronic computers made it practical to apply statistical methods to functions without known solutions, and as computers have developed, the Monte Carlo method has become a common and standard approach to many problems.

Source: https://en.wikipedia.org/wiki/Stanislaw_Ulam

Mieczysław Grzegorz Bekker (1905-1989)

Polish engineer, scientist and designer, considered a pioneer of themodern theory of off-road vehicle motion. He specialized in vehicle mechanics and interaction of chassis systems with the ground. He laid the foundations for **terramechanics** – a field of science that studies the interactions between vehicles and the ground. The mathematical models he developed enabled the prediction of the behaviour of wheeled and sponge-based vehicles on sand, mud, snow, and other difficult surfaces.

Bekker was distinguished by mathematical abilities. After passing Matura exam, he began studies at the Warsaw University of Technology, Faculty of Mechanical Engineering. When NASA announced a vehicle design competition that could navigate the Moon as part of the Apollo mission General Motors turned to Professor Mieczysław Bekker to develop such a construction. It was in 1961. Eight years later the winner was chosen. It was the **Lunar Roving Vehicle (LRV)**, whose entire technical solutions allowing for movement were authored by Mieczysław Bekker.



For the first time this vehicle touched the surface of the Moon on July 30, 1971. During the **Apollo 15 mission** three rides were held. In total the astronauts beat 27.9 km in the LRV with an average speed of 9.2 and a maximum of 14 km/h. The second LRV during Apollo 16 defeated 27.1 km and the third (Apollo 17) 36.1 km.

All three vehicles remained on the Moon. One more LRV was produced but unfortunately due to the interruption of the flight program to the silver globe it never left the Earth.
Bekker's electric vehicle had a range of up to one hundred kilometres and could carry up to 500 kilos of cargo (taking into consideration the Moon's gravity). It could fold in half and had room for two astronauts. In recognition of Bekker's contributions to space travel, his name is part of the Space Walk of Fame Museum in Titusville, Florida.

Bekker's books, particularly **„Theory of Land Locomotion"**, became a reference point for engineers designing specialized, military, and space vehicles. Bekker's achievements have had impact on the development of transportation engineering, military technology, and space exploration technology.

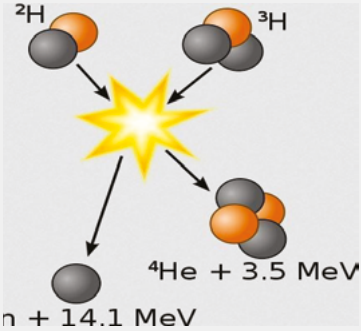
Source:
https://steemit.com/news/@szrociak/is-elon-musk-s-tesla-the-first-car-in-space-no
https://culture.pl/en/article/out-there-7-poles-who-advanced-space-travel
https://www.smithsonianmag.com/air-space-magazine/first-car-moon-180977805/

Sylwester Kaliski (1925–1978)

Physicist, rector of the Military University of Technology. In 1973 he conducted an experiment in controlled thermonuclear microfusion, achieving plasma temperature of 10 million degrees (the so-called „Focus" experiment). He was a leading specialist in the theory of coupled fields and thermonuclear research, and a founder of Polish electronic phononics.

He proposed the theory of continuous amplification of ultrasound and hypersonics in semiconductor crystals. He initiated research on thermonuclear microfusion using a laser — today known as controlled thermonuclear fusion. Research is currently developed within the framework of the European Atomic Energy Community (Euratom) research and training programme by the EUROfusion consortium towards ITER project to prove controlled nuclear fusion as a future source of clean, safe, and virtually inexhaustible energy, which in the future could contribute to reducing greenhouse gas emissions and increasing energy security.

Thermonuclear research aims to either create weapons of mass destruction or an ecological energy source. Although the first hydrogen reaction was detonated in 1952, a stable and peacefully applicable thermonuclear reaction has not yet been achieved. Kaliski proposed a method based on the use of high-power lasers. These would heat a pellet of deuterium while simultaneously using shaped charges to maintain the appropriate density. Kaliski conducted experiments on so-called An explosive method based on pulsed compression and heating of plasma, the goal of which was to achieve the conditions necessary for thermonuclear fusion reactions to occur. This research reported the achievement of very high plasma temperatures and significant neutron emission. Results were reported ia in a book **„Lasers – Nuclear Fusion"** over 500 scientific publications. Professor was included in the generation of strong electromagnetic pulses, plasma-electromagnetic field interactions and techniques for initiating high-temperature processes in plasma.



Thermonuclear fusion
(auth. Wykis, public domain).
Source: www. histmag.org

Sylwester Kaliski's Roles:

- Rector of the Military University of Technology (WAT): from 1967 to 1974
- Founder of the Institute of Plasma Physics and Laser Microfusion (January 1, 1976)
- Minister of Science, Higher Education, and Technology from 1974 to 1978

CENTE

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INSTYTUT FIZYKI PLAZMY I LASEROWEJ MIKROSYNTEZY
IM. SYLWESTRA KALISKIEGO

POLISH CONTRIBUTION CENTRE FOR NEW ENERGY TECHNOLOGIES



CeNTE

Centre for New Energy Technologies

MISSION

The New Energy Technologies Scientific and Industrial Centre is to achieve long-term goals for the state and society by conducting scientific research in the field of new energy technologies and implementing the results of this research into industrial practice. The New Energy Technologies Centre aims to identify and address the challenges facing society, science and economy, particularly regarding research and development of thermonuclear energy conversion technologies, related and supporting technologies.

VISION

Members of CeNTE collaborate in R&D in fusion technologies, including the development of infrastructures for the needs of this research, as well as the development of the involvement of the industrial sector in fusion tokamaks.

AREAS OF ACITVIITES

The Centre's activities in the field of R&D include thermonuclear energy conversion technologies, related and supporting technologies.

The tasks of the Centre include:

- supporting and coordinating the activities of entities collaborating in the Centre in the scope of tasks performed by the Centre;
- cooperation in implementing the results of the Centre's scientific and technical work; initiating the creation and use of large research infrastructure;
- organizing exchanges of employees and students between institutes, universities and entrepreneurs;
- implementation of internship programs for research workers within the Centre Members, with particular emphasis on entrepreneurs;
- initiating and coordinating the participation of institutes, entrepreneurs and universities in international research programs; acquiring and handling international research projects, joint research projects

OBJECTIVES

- raising funds to finance research, training and investments;
- organizing trainings for employees of the Centre Members and conducting information and promotional activities;
- creating and operating an information and experience exchange system aimed at establishing and developing scientific and economic contacts;
- promotion of enterprises and the sector of scientific units;
- cooperation with domestic and foreign organizations whose goals and scope of activities are consistent with those of the Centre;
- providing expert opinions, analyses and legal opinions to Members.

Members


IFPiLM
INSTYTUT FIZYKI PLAZMY I LASEROWEJ MIKROSYNTEZY


NCBJ


POLITECHNIKA MORSKA
PM
SZCZECIN




UNIVERSITAS CARDINALIS STEPHANI WYSZYŃSKI
VARSOVIAE


WPT
WROCŁAWSKI PARK TECHNOLOGICZNY


POLITECHNIKA POZNAŃSKA
POZNAN UNIVERSITY OF TECHNOLOGY


WUT


UNIWERSYTET OPOLSKI
UNIVERSITAS OPOLIENSIS


Lodz University
of Technology


PK
Politechnika Krakowska
im. Tadeusza Kościuszki


VoiceLab


UNIWERSYTET
SZCZECIŃSKI


Instytut Geofizyki
Polskiej Akademii Nauk


photech
INNOVATION PHOTONICS TECHNOLOGY


NICOLAUS COPERNICUS
UNIVERSITY
IN TORUŃ


Łukasiewicz
IMiF


s²innovation
Software solutions


IPPT
PAN


BIMO
TECH


INTiBSPAN


Politechnika
Wrocławska


SPETECH


AGH


PCSS


unipress


Zachodniopomorski
Uniwersytet Technologiczny
w Szczecinie

Coordinator

Coordinator of the Centre for New Energy Technologies (CeNTE) research activities is the Sylwester Kaliski Institute of Plasma Physics and Laser Microfusion (IPPLM) designated by the Minister of Science and Higher Education to manage the European EUROfusion programme in Poland.

Coordination activities

- Since 2005, the Institute has coordinated nuclear fusion research conducted under the European Atomic Energy Community (Euratom) research program, bringing together national entities of the Euratom-Fusion association
- Since 2014, IPPLM has coordinated the Science--Industry Centre for New Energy Technologies (CENTE), which pools research and industrial resources from across Poland (**cente.ifpilm.pl**)
- Since 2014, the Institute has been conducting information activities in the capacity of the EURATOM-Fusion National Contact Point (**kpk.ifpilm.pl**).

The Institute conducts scientific R&D in the following areas:

- Physics of plasma generated by high--current discharges and laser pulses
- Laser plasma physics and laser radiation interaction
- Nuclear fusion via inertial plasma confinement
- Nuclear fusion via magnetic plasma confinement
- Development of plasma generation and diagnostics
- Development of plasma technologies, including electric satellite propulsion
- Materials physics

Activities within the innovation ecosystem

- Since 2023, the Institute has been a partner of the European Innovation Council (**eic.ec.europa.eu**).
- As of 2025, the Institute has collaborated with Academic Technology Transfer Centres (**pactt.pl**).
- Since 2026, the Institute has been operating within Enterprise Europe Network (**een.ec.europa.eu**)

Outreach activities

- Study visits for school and university students
- Participation in science festivals and congresses
- Outreach activities targeting primary and secondary school students and university students
- Organization of the Kudowa Summer School
- Organization of scientific events: International Stellarator-Heliotron Workshop (ISHW) and International Conference on Plasma.


CeNTE

Institute of Plasma Physics and Laser Microfusion

PRODUCT / SERVICE	MANUFACTURING OF EQUIPMENT AND DEVICES RELATED TO R&D	CONDUCTING TECHNICAL TESTS & ANALYSES	EXPERTISE OTHER THAN SCIENTIFIC RESEARCH AND DEVELOPMENT WORKS
NEEDS	Diagnostic systems design, construction and operation	Access to infrastrucure and R&D support	Access to expertise Access to infrastructure
SOLUTION	Design Construction Operation	Running technical and material tests for infrastructural facilities, mostly stellarators, accelerators.	Access to expertise Access to infrastructure
VALUE PREPOSITION	Design Conctuction Operation and Development of diagnostic systems and facilities required to perform materialneutron and plasma testing and diagnostics (diagnostic systems and constructios, generators of a simulated lightning discharge).	Plasma diagnostics Laser spectroscopy (LIBS) Laser interferometry Shadowgraphy, schlierenography Neutron and gamma radiation diagnostics X-ray diagnostics Resistance testing against thunder strikes.	▪Room for experiments and R&D ▪Design and construction of devices / facilities of high resolution/resistance / etc. ▪Research projects: planning, management and implementation ▪R&I collaboration: ie. development of Hall-type thrusters towards future exploitation as electric rocket propulsion.
TARGET GROUPS	Private and public product and service providers, positioning in technology development, manufacturing, material engineering	Aviation & Space Safety & Security, Defence, Healthcare, Energy, Transport, Environment	Commercial and Public entities in technology development in any sector.

CUSTOMER REFERENCES: Liftero, Mesko, Aliena General, Universo, RGBTechnik, ITER, W7X, CERN

SDG GOALS:



INSTYTUT FIZYKI PLAZMY I LASEROWEJ MIKROSYNTEZY IM. SYLWESTRA KALISKIEGO (IFPILM)

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www.ifpilm.pl

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NAME OF THE SOLUTION:

Construction of diagnostic systems and running technical Tests and Analyses

THE NEED / THE CHALLENGE

01 Optimization of facility operation and plasma operational scenarios in thermonuclear systems

02 Ensuring safety standards of flying objects

THE SOLUTION PROPOSED

01 Plasma diagnostics (neutron/gamma-ray spectroscopy, X-ray tomography, LIBS) and plasma modelling

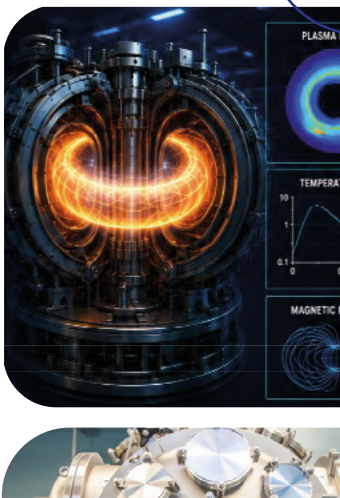
02 Vulnerability tests of flying objects to transient indu ced by ligthning strokes - simulations of ligthning discharges, erosion/deposition of plasma-facing materials.

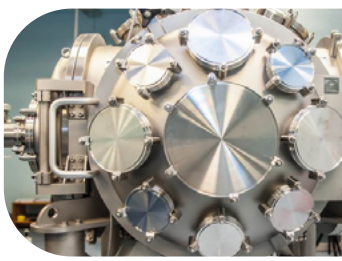
WHY TO CHOOSE TO WORK WITH IPPLM

- Research infrastructure including 10 TW laser, laboratory of Simulated Lightning Discharges, PF-1000 DPF facility, PF-6 DPF facility
- Expertise of International Centre for Dense Magnetised Plasma
- Experience of EUROfusion Consortium Beneficiary
- Experience of EURATOM-Fusion National Contact Point
- Experience accross multiple European tokamaks (JET, ASDEX, ITER, WEST, JT-60, W7X

BENEFITS FOR THE CUSTOMER / KEY FIGURES AND FACTS

- Enabling optimization of facility operation and plasma operational scenarios in thermonuclear systems
- Enabling safety standards according to reference standards and laboratory accreditations







National Center for Nuclear Research

NCBJ

PRODUCT / SERVICE

Destructive and non-destructive analysis of steels and alloys in accordance with international reference standards.

Product qualification and assistance in optimizing joining processes of structural materials intended for the construction of nuclear fission and fusion reactors.

NEEDS

Development of new high-strength steels and alloys resistant to temperature and radiation.

Component qualification.

SOLUTION

Design and construction

TARGET GROUPS

Companies from metallurgy and energy sectors involved in the production and processing of materials intended for high-temperature applications.

National Laboratories working on component qualification and process-property optimization of materials.

CUSTOMER REFERENCES: Research infrastructures, Industry

SDG GOALS:



NATIONAL CENTER FOR NUCLEAR RESEARCH
MATERIALS RESEARCH LABORATORY

ADDRESS: st. Andrzeja Sołtana 7,
05-400 Otwock-Świerk, Poland

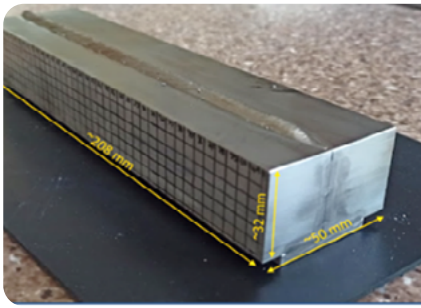
www.ncbj.gov.pl

NAME OF THE SOLUTION:

(I) Verification of welded joint quality – optimization of joining technology for large steel components.
(II) Assessment of the alloying addition effects on the high-temperature mechanical properties of a new type of ODS steel characterized by enhanced properties.

THE NEED / THE CHALLENGE

01 Determination of welded joint quality, development of a non-destructive technique for detecting discontinuities in real-size constructions, optimization of the manufacturing process and chemical composition of a new type of oxide-dispersion-strengthened steel.

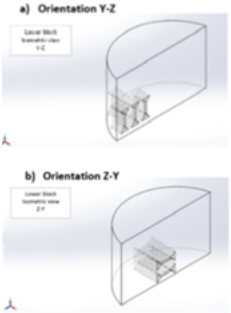


THE SOLUTION PROPOSED

01 Proposed idea: construction elements of the fusion reactor

WHY TO CHOOSE TO WORK WITH NCBJ

- New high-end technical facilities
- Laboratory accreditation
- Material testing in accordance with international reference standards
- A team experienced in high-temperature testing
- A team experienced in research collaboration in international groups





KEY FIGURES AND FACTS

- Improvement of material strength at the operating temperature by approximately 10%, optimization of the joining process for large-scale components

Institute of Nuclear Physics
Polish Academy of Sciences

PRODUCT / SERVICE

Plasma diagnostics: neutron/gamma-ray spectroscopy, X-ray tomography

Neutron and proton test facilities (PF-24, IGN-14, 60 MeV proton beam), thermoluminescent detector production, and a short-sample superconducting test stand

Radiation-transport, activation and nuclear-safety modelling (MCNP, GEANT4, FISPACT-II); gamma spectrometry for isotopic characterisation of activated materials

Engineering analyses: thermal-hydraulic (ANSYS, SUPERMAGNET), structural and electromagnetic (ANSYS)

NEEDS

The transition from an engineering concept to functioning fusion hardware depends on how materials, electronics and diagnostics respond to high radiation fields, activation, thermal and magnetic loads. This requires a strong foundation in nuclear and radiation physics, both theoretical and experimental — including the isotopic characterisation of activated materials, essential for radiological safety, dose evaluation and waste classification.

SOLUTION

Neutron sources (Plasma Focus PF-24, fast neutron generator IGN-14), Proton source (AIC-144), Monte Carlo and numerical methods (MCNP, GEANT4, Ansys, SUPERMAGNET, FISPACT-II), detector-response and synthetic-diagnostics modelling supported by machine learning, and non-destructive gamma-ray spectrometry for isotopic characterisation of activated materials.

VALUE PREPOSITION

The experience covers JET, ASDEX, ITER, WEST, COMPASS, and the EUROfusion, F4E and IFMIF-DONES programmes. An assessment conducted by an independent research institute provides scientific credibility for investors and regulators.

TARGET GROUPS

Private fusion companies, instrumentation manufacturers, public fusion programmes, regulatory and accreditation authorities.

CUSTOMER REFERENCES: ITER, IFMIF-DONES, WEST, W7-X, JET

SDG GOALS:



INSTITUTE OF NUCLEAR PHYSICS, POLISH ACADEMY OF SCIENCES (IFJ PAN)

ADDRESS: Radzikowskiego 152 31-342 Kraków, Poland
TEL. +48 12 662 81 63 | EMAIL: urszula.wiacek@ifj.edu.pl

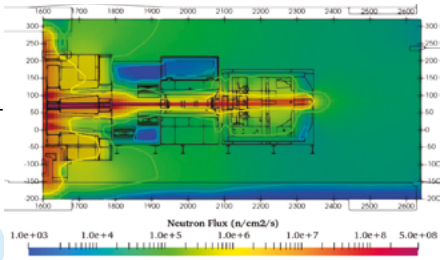
www.ifj.edu.pl

NAME OF THE SOLUTION:

Plasma Diagnostics: Radiation Testing and Validation for Fusion Hardware Development

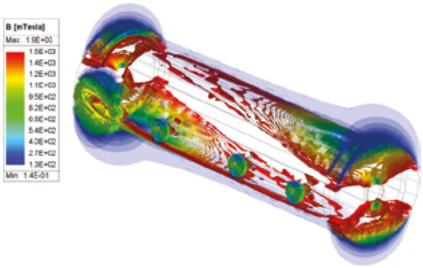
THE NEED / THE CHALLENGE

01 A tokamak component must operate reliably under high neutron and gamma radiation, activation, heat, structural and magnetic loads. Demonstrating its performance under these conditions requires access to radiation physics expertise and real neutron sources — capabilities that extend beyond standard engineering practice.



THE SOLUTION PROPOSED

01 The assessment combines neutron sources (PF-24, IGN-14), Monte Carlo/activation and engineering modelling (MCNP, GEANT4, FISPACT-II, Ansys), detector response function and synthetic diagnostics calculations, and integration into the tokamak design (CAD). It draws on experience from JET, ASDEX, ITER, WEST and COMPASS.



WHY TO CHOOSE TO WORK WITH IFJ PAN

- A leading research institute with years of experience in plasma diagnostics, collaborating with European research institutes and taking an active role in projects such as ITER, W7-X and IFMIF-DONES.

BENEFITS FOR THE CUSTOMER / KEY FIGURES AND FACTS

- Radiation behaviour is assessed before the design is translated into hardware
- Lower risk of costly late-stage redesign
- Independent verification is provided by a research institute
- Direct experience across multiple European tokamaks (JET, ASDEX, ITER, WEST, COMPASS)

Poznan Supercomputing and Natworking Centre

A Leader in Digital Innovation and the Future of Science

PRODUCT / SERVICE	High-Performance Infrastructure and Computing Power
NEEDS	Digital innovations
SOLUTION	**Provision of advanced digital infrastrucutres** PSNC offers state of the art Supercomputing (HPC) resources, cloud environments, and specialized infrastructure for Artificial Intelligence and Big Data analytics including PIAST-AI Factory
VALUE PREPOSITION	**Pioneering Fields of Research** PSNC experts lead advanced research in quantum computing, cyber security, AI and data management. We are a member of EUROfusion for more than 16 years. **Global Reach & Integration** PSNC is integrated into key European research initiatives (such as GÉANT, EOSC, and EuroHPC), providing domain-specific labs for researchers worldwide.
TARGET GROUPS	**Interdisciplinary Impact** PSNC drives innovation across diverse sectors - from medicine and healthcare, supporting plasma physicists, to smart agriculture, and cultural heritage preservation.

CUSTOMER REFERENCES: ITER, LOFAR, EC, ENEA

SDG GOALS:



POZNAN SUPERCOMPUTING AND NETWORKING CENTRE

ADDRESS: Jana Pawła II 10, 61-139 Poznań, Poland

www.oferta.pcss.pl

NAME OF THE SOLUTION:
Data Management Plan for plasma physics research

THE CHALLENGE

01 A Provide FAIR (findable – accessible – interoperable – reusable) data for EUROfusion.

THE SOLUTION PROPOSED

01 PSNC team has developed a robust Web application that runs in every modern Web browser. The application makes it possible to collect, browse, filter, and share metadata coming from various fusion experiments. It utilizes EUROfusion Software Stack and Long Term Data Storage - services provided by PSNC to all EUROfusion members.



WHY TO CHOOSE TO WORK WITH PCSS

Poznan Supercomputing and Networking Center takes an active part in supporting plasma related research for more than 16 years. Our main activities are maintaining computing cluster software, supporting and training users, and developing scientific software.

- Provision of advanced digital infrastrucutres
- Global Reach and Integration
- Interdisciplinary Impact

BENEFITS FOR THE CUSTOMER / KEY FIGURES AND FACTS

- 268 completed EU projects
- 400 PB data storage capacity
- 23.7 PFLOPS - PROXIMA computing power
- 20 programmable qubits – PIAST-Q

Warsaw University of Technology, Faculty of Electronics and Information Technology

PRODUCT / SERVICE	COMPLETE MULTICHANNEL REAL-TIME SYSTEMS DESIGN, AUTOMATION, DETECTOR SYSTEMS	HIGH SPEED DATA STREAMING SYSTEMS	FPGA DEVELOPMENT
NEEDS	Various distributed or local systems working with high speed analog or digital signals. Integration with detector systems	High speed or real-time data analysis, custom network hardware Real-time custom network switches	All kind of deterministic systems for real-time analysis of data
SOLUTION	▪ Design Construction ▪ Real-time SXR plasma diagnostics at JET CCFE tokamak ▪ Real-time GEM FPGA--based SXR plasma impurities diagnostic at WEST CEA tokamak ▪ Sub-millisecond real-time tokamak protection system (FPGA and communication) for MAST CCFE tokamak	▪ New advanced soft X-ray spectroscopy based on FPGA, 3000 channels including real-time Ethernet network streaming. ▪ System can be adapted to any kind of the input data	All present developed systems for high physics and tokamak plasma experiments
VALUE PREPOSITION	▪ Novel approach for registration of very high statistic raw signal data for further postprocessing, ▪ Real-time systems	High throughput streaming system >80Gbps with exceptionally utilized FPGAs supporting >200 channels each	Custom hardware design with complete software/ firmware adapted to client needs and working environment
TARGET GROUPS	Industry, Research centres	Industry, Research centres	Industry, Research centres

SDG GOALS:

WARSAW UNIVERSITY OF TECHNOLOGY, FACULTY OF ELECTRONICS AND INFORMATION TECHNOLOGY (WUT-WEITI-ISE)

ADDRESS: Nowowiejska 15/19, 00-665 Warsaw, Poland
TEL. +48 22 234 7986 | **CONTACT:** PhD Eng Andrzej Wojenski, Andrzej.Wojenski@pw.edu.pl

www.elka.pw.edu.pl/eng

NAME OF THE SOLUTION:

Development and installation real-time soft X-ray spectroscopy system FPGA and GEM-detector based on WEST tokamak for fusion plasma experiments

THE CHALLENGE

01 Delivery of soft X-ray diagnostic system for tokamak fusion plasma, radiation hard, capable of measuring the plasma radiation in real-time manner over 100 channels to detect impurities in tokamak with 10ms time resolution. Intense signal burst during data acquisitions.

THE SOLUTION PROPOSED

01 Unique system that is registering full signal waveforms during plasma—huge unique database, above 500 mln events (signal windows per plasma)

02 Full custom hardware designed for system at WUT (electronics, PCBs, FPGA firmware and embedded software)

03 Spectra computation in two modes:
Real-time system—spectra computation online (10ms) or offline

04 128-channel system integrated with custom GEM detector

05 Radiation-hard part of the acquisition stage due to radiation

06 One system installed at CEA WEST tokamak (France), delivering data for international scientific community

WHY TO CHOOSE TO WORK WITH WUT

- Experts in the field of electronic systems
- Experts in FPGA development including: high speed data distribution (PCIe, 10/25GbEthernet, custom networking solutions); real-time algorithms, embedded development (Zynq, UltraScale MPSoC), hardware video encoding on FPGAs, HLS-type systems
- Experience in collaboration with international groups

KEY FIGURES AND FACTS

- Over 30 year's experience in delivering hardware systems to various international research institutes
- Extensive experience supported by numerous publications in international reviewed scientific journals
- High involvement in delivering systems for fusion experiments: 3 systems installed in Europe, 2 under development and installation stages
- Experience in systems installations in challenging environments, like tokamaks

University of Opole
Institute of Physics

INSTYTUT FIZYKI
UNIWERSYTET OPOLSKI

PRODUCT / SERVICE	Spectroscopic system for plasma diagnostics		
NEEDS	Non-invasive method of plasma diagnostics	Determining plasma chemical composition	Determining changes in impurity level
SOLUTION	Quantitative optical spectroscopy (determining temperature based on line intensities, determining electron density based on the Stark broadening of spectral lines)	Detecting chemical elements present in plasma, based on the line emission of their atoms and ions	Monitoring changes in the impurity level based on the emissivity of spectral lines
TARGET GROUPS	Research infrastructures	Research infrastructures	Research infrastructures

CUSTOMER REFERENCES: MAX-PLANCK Institut fuer Plasma Physics

SDG GOALS:



UNIVERSITY OF OPOLE, INSTITUTE OF PHYSICS

ADDRESS: Kopernika pl. 11a, 45-040 Opole, Poland
TEL. +48 77 452 72 50 | **EMAIL:** instfiz@uni.opole.pl

www.uni.opole.pl

INSTYTUT FIZYKI
UNIWERSYTET OPOLSKI

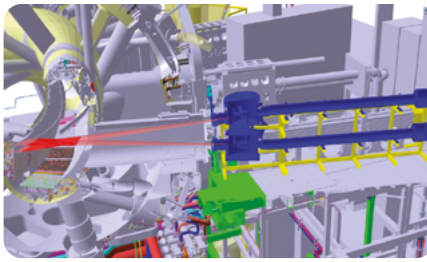
IFPiLM

NAME OF THE SOLUTION:

Plasma diagnostic system for monitoring impurities — „C/O monitor for W7-X"

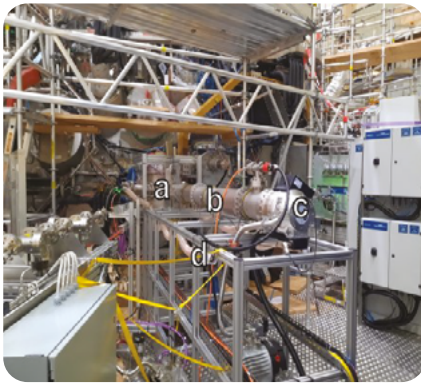
THE NEED / THE CHALLENGE

01 Impurities are one of the main problems in MCF facilities. To monitor their levels, a dedicated diagnostic system operating at a high time resolution is necessary.



THE SOLUTION PROPOSED

01 It was decided that the task will be solved using a Johan-type XUV spectrometer designed for monitoring Lyman-a emission of hydrogen-like ions of O,C,N and B.

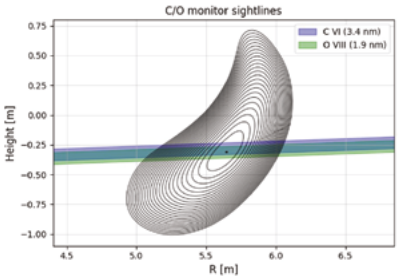


WHY IPP CHOOSE TO WORK WITH UO

- Professional team of scientists with many years of experience in plasma physics
- Cooperation with partners such as NIST, CNRS, CCFE, and MPI-IPP
- Experience in research performance within EUROfusion Consortium as Affiliated Entity

BENEFITS FOR THE CUSTOMER

- Enabling optimization of MCF operation and operational scenarios in thermonuclear systems.



Nicolaus Copernicus University in Toruń
Atomic Spectroscopy Group

NICOLAUS COPERNICUS
UNIVERSITY
IN TORUŃ

PRODUCT / SERVICE

- **Studies of the structure** of satellites, hypersatellites, and hypersatellite lines in the K, L, and M series X-ray spectra of various elements. Natural width of the Khα 1,2 hypersatellite line as an indicator of the mechanism generating K-shell double-hole states.
- **Diagnostics of high-temperature** plasma parameters based on heavy-metal X-ray spectra recorded in tokamak-type thermonuclear reactors.
- **Design of optimal conditions** for the first experimental observation of nuclear excitation via atomic electron capture for various nuclear isomers.
- **Investigation** of shake-up and shake-off processes resulting from single and double photoionization and nuclear decays.
- **Study of depopulation of isomeric states** via atomic nucleus excitation resuling from electron capture into high-lying Rydberg states.



Nicolaus Copernicus University in Toruń
Atomic Spectroscopy Group

NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ

TARGET GROUPS

CH: Physics Department, University of Fribourg

UK: CCFE Culham Science Centre, EFDA-JET CSU, Abingdon, Oxfordshire

FR: CEA, IRFM, F-13108 St Paul Les Durance, Sorbonne Université's

Jap: Laboratory of Atomic and Molecular Physics, Institute of Chemical Research, Kyoto, University, Department of Physics, Faculty of Science, Kobe University, Kobe Material Testing Laboratory

PT: Departamento de Física, Faculdade de Ciências e Tecnologia FCT, Universidade Nova de Lisboa,
Centro de FisicaAtomica, CFA, Departmento de Fisica,
Faculdade de Ciencias, FCUL, Universidade de Lisboa,

USA: Ecopulse Inc., 7844 Vervain Court, Springfield,
Artep Inc., 2922 Excelsior Springs Ct,
Naval Research Laboratory, Washington DC,
Sandia National Laboratory, Albuquergue,
National Institute of Standards and Technology, Gaithersburg,
Army Research Laboratory, Adelphi, Maryland
United States Naval Academy, Annapolis
Oak Ridge Associated Universities, Physics Division,
Argonne National Laboratory, Argonne, Illinois

SDG GOALS:



NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ

ADDRESS: Gagarina st. 11, 87-100 Toruń, Poland
TEL. +48 22 234 7986

www.umk.pl

University of Szczecin
Centre for Experimental Physics

PRODUCT / SERVICE

- Surface modification using low-energy light-ion irradiation.
- Ion implantation for modification of thin-film physicochemical properties.
- Surface and near-surface chemical composition analysis of ultra-thin layers using Auger Electron Spectroscopy (AES).
- Low-level gamma and alpha spectroscopy for detection and isotopic characterization of trace radioactive materials.
- Experimental determination of electron screening energy in materials for low-energy nuclear reactions.

NEEDS

- Development and characterization of advanced materials for fusion and nuclear technologies.
- Investigation of radiation-induced and ion-implantation-induced changes in materials.
- Reliable characterization of surface and ultra-thin-layer chemical composition.
- Detection and identification of trace radioactive isotopes and activation products.
- Experimental investigation of material-dependent electron screening effects in low-energy ion–matter interactions.

SOLUTION

- Access to a specialized 26 kV ion accelerator system coupled with an ultra-high-vacuum, analytical chamber and AES.
- Controlled low-energy ion irradiation and implantation for surface and thin-film modification.
- Integrated surface analysis enabling characterization of irradiation - and implantation-induced changes.
- Dedicated low-level gamma and alpha spectroscopy with high-purity lead shielding for suppression of environmental background radiation.
- Experimental measurements of electron screening energy using solid-state samples in the 5–20 keV incident-particle energy range.



University of Szczecin
Centre for Experimental Physics

VALUE PREPOSITION

- Combination of material modification and advanced analytical characterization within one experimental laboratory.
- Capability to investigate surfaces and ultra-thin layers from sub-nanometre to several-nanometre thicknesses.
- Controlled low-energy ion irradiation and implantation tailored to material-research requirements.
- Sensitive detection and isotopic characterization of trace radioactive materials with reduced environmental background.
- Specialized experimental capabilities supporting research on advanced materials for fusion and nuclear technologies.

TARGET GROUP

- Research institutions and laboratories working in fusion and nuclear science.
- Large-scale fusion and nuclear research infrastructures.
- Research teams developing plasma-facing and radiation-resistant materials.
- Universities and R&D organizations working on ion–matter interactions, thin films and surface engineering.
- Commercial companies requiring surface modification, thin-film characterization or low-level radioisotope analysis.
- Organizations involved in material screening and characterization for fusion technology development.

SDG GOALS:



CENTRE FOR EXPERIMENTAL PHYSICS ELBRUS – UNIVERSITY OF SZCZECIN

ADDRESS: Wielkopolska st. 15, 70-451 Szczecin, Poland
TEL. +48 91 444 1227
Prof. dr hab. Konrad Czerski: konrad.czerski@usz.edu.pl
Dr Natalia Targosz-Ślęczka: natalia.targosz-sleczka@usz.edu.pl

www.elbrus.usz.edu.pl

Institute of Low Temperature and Structure Research Polish Academy of Sciences – Wrocław

Measuring superconductors where they actually work –at liquid helium temperature, under current, field and radiation

PRODUCT / NEEDS

1. Cryogenic characterisation of superconducting materials and components
Critical current and critical temperature, current-voltage characteristics, magnetisation and AC losses, measured from room temperature down to liquid helium and in applied magnetic field. Wires, tapes, cable samples, joints and impregnation systems - measured as components, not only as materials.

2. Development of new superconducting materials
Synthesis, crystal growth and structural characterisation of superconducting and functional materials, including candidates intended to replace NbTi and Nb_3Sn in the next generation of high-field magnets.

3. Independent qualification and contract research
Reference characterisation before and after service or irradiation, expert assessment, and joint development of European projects with industrial and institutional partners.

SOLUTION

Superconducting magnets are the single most expensive and least replaceable part of a fusion reactor, a particle accelerator, or a spacecraft shielding system. Yet the materials they are built from are usually tested under conditions that do not resemble service: warm, unloaded, and after the fact. The properties that decide whether a magnet survives - how a joint behaves, whether an impregnation resin cracks, how a stabiliser degrades under irradiation - can only be measured cold, under current, and ideally while the radiation is still present.

TARGET GROUPS

Fusion. Developers of tokamaks and stellarators, public and private magnet systems

Accelerators and large infrastructures. Magnet and cryogenics groups at facilities such as DONES, CERN, ESS and FAIR.

Industry. Manufacturers of superconducting wires, tapes, cables, magnets and cryogenic equipment.

Space. Spacecraft materials and instruments face energetic protons and heavy ions, and increasingly operate cold - cryogenic detectors in space astronomy, and superconducting magnets studied for active radiation shielding of crewed missions.

CUSTOMER REFERENCES: DONES, CERN, ESS and FAIR

SDG GOALS:



INSTITUTE OF LOW TEMPERATURE AND STRUCTURE RESEARCH POLISH ACADEMY OF SCIENCES

ADDRESS: st. Okolna 2, 50-422 Wrocław, Poland
TEL. +48 71 343 5021 | **EMAIL:** intibs@intibs.pl

www.intibs.pl

Customer Case Study

NAME OF THE SOLUTION:
Advanced Superconducting Components and Materials Laboratory

Proposed for IFMIF-DONES, Granada, with a Reference Laboratory at INTiBS PAN in Wrocław.

THE CHALLENGE

01 When DONES was designed, no laboratory for superconductors was foreseen. At the time this was reasonable: NbTi and Nb_3Sn, and the technology for winding magnets from them, are mature, and the magnets were not seen as the open question. Yet superconducting magnets are the core of every tokamak now being built, and how far their properties deteriorate under fusion neutrons has never been established. The behaviour that matters can be observed only while the superconductor is working: cold, carrying current, in high magnetic field, under irradiation. The only place able to provide a fusion-like neutron spectrum is DONES, which has no laboratory able to use it for superconductors.

THE SOLUTION PROPOSED

01 The laboratory for in-beam measurement of superconducting wires, joints and impregnated winding pack composed of the three elements: an in-beam cryogenic module inside the DONES Test Cell, where components are held at liquid-helium temperature and measured during irradiation; a cryogenic characterisation laboratory, reached without warming the samples; and a Reference Laboratory, where every conductor, joint and impregnation sample is characterised before irradiation and analysed afterwards.

WHY TO CHOOSE TO WORK WITH INTIBS

- **Complete measurement chain.** From material synthesis to cryogenic transport measurement in one place, by one team, using one set of instruments - so that results taken years apart remain comparable.
- **Independence.** A public research institute with no commercial stake in the outcome. Results confidential or publishable, as the partner requires.
- **European experience.** Leader of the Advanced Superconducting Components and Materials Laboratory at IFMIF-DONES in Granada, with a Reference Laboratory in Wrocław.
- **Capability of the consortium.** INTiBS together with NCBJ Świerk, Wrocław University of Science and Technology, IFJ PAN Kraków and Kriopan have capability to design, build and operate the laboratory.
- **Made in Poland.** Equipment designed and built in Poland, with Polish industry, as a national in-kind contribution to European research infrastructure.

BENEFITS FOR THE CUSTOMER

- Design on measurement rather than estimation. Fusion magnets are today specified using extrapolated radiation limits. Replacing extrapolation with data taken under real operating conditions allows lower cost, better-chosen materials, and more ambitious reactor designs.
- Lower risk for power plant construction. Magnets are the least replaceable part of a fusion reactor. Knowing where their true limits lie removes one of the largest uncertainties in planning commercial fusion power.
- Value beyond fusion. The same measurements required by the space sector, where superconducting components are exposed to cosmic radiation.
- Polish contribution to European infrastructure. Equipment designed and built in Poland, delivered as a national in-kind contribution, with the expertise and the Reference Laboratory remaining in the country.

Lodz University of Technology
Department of Microelectronics and Computer Science

Lodz University of Technology

DMCS

PRODUCT / SERVICE	REAL-TIME IMAGE ACQUISITION AND PROCESSING SYSTEM FOR MACHINE PROTECTION	X-RAY SPECTROSCOPY FOR PLASMA CONTROL AND MACHINE PROTECTION	CUSTOM REAL-TIME NEUTRON AND GAMMA RADIATION IMMUNE HARDWARE AND SOFTWARE
NEEDS	Plasma Facing Components (PFCs) or divertor protection against thermal overload, thermal events, detection, classification and analysis in real-time using CPU or GPU.	Detection of runaway electrons or other crucial plasma parameters based on X-ray measurements for real-time fusion machine control or protection.	Real-time data acquisition and processing (Instrumentation and Control) system developed for customer using a dedicated radiation tolerant methodology and components.
SOLUTION	Scalable real-time solution for image acquisition from Visible or Infrared cameras and processing using CPUs /GPUs.	Low-latency data acquisition and processing system from various detectors, such as: Photomultiplier tube, Photo Diode, Gas Electron Multiplier, Silicon or Diamond detectors, etc.	Custom hardware and software designed according to customer requirements developed with radiation tolerant or immune components.
TARGET GROUPS	Tokamaks, Stellarators	W7-X, ITER, DESY, ESS Tokamaks, Stellarators	W7-X, ITER, DESY, ESS Tokamaks, Stellarators

CUSTOMER REFERENCES: W7-X, ITER, DESY, ESS

SDG GOALS:



LODZ UNIVERSITY OF TECHNOLOGY, DEPARTMENT OF MICROELECTRONICS AND COMPUTER SCIENCE (TUL-DMCS)

www.k22.p.lodz.pl

| **ADDRESS:** Wolczanska 221, 93-005 Lodz, Poland
| **TEL.** +48 42631 27 20 6 | **E-MAIL: dariusz.makowski@p.lodz.pl**

Customer Case Study

Lodz University of Technology

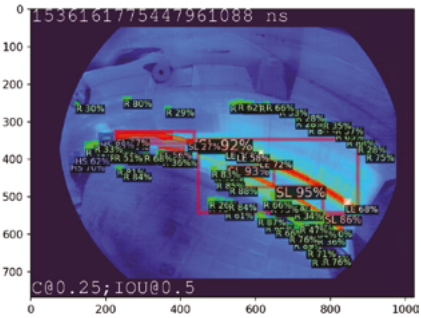
NAME OF THE SOLUTION:
Wendelstein 7-X Stellarator

THE CHALLENGE

01 The need for a real-time image acquisition and processing system for machine protection.

THE SOLUTION PROPOSED

01 **PROJECT W7-X DIVERTOR PROTECTION SYSTEM**
Thermal events detection and classification in real-time, for machine (divertor) protection based on a scalable MicroTCA.4 hardware and low-latency, real-time software.



THE INSTALLATION PROPOSED

01 Thermal Overload Detection system for W7-X, acquire images from VIS and IR cameras, detect and classify thermal events and decide if detected event is dangerous or not, trigger interlock system.

WHY W7-X CHOOSE TO WORK WITH TUL-DMCS

- Developes a custom solution
- Supports various VIS and IR cameras
- Scalable and reliable solution
- Hard real-time operation
- Hardware and software co-design

Wendelstein 7-X

THE INSTALLATION PROPOSED

- Developed according to W7-X requirements and needs
- Solution fits to existing infrastructure
- Delivered hardware and software
- Delivered on time, mitigated problems and constraints

- Hard real-time operation
- Supports various cameras
- Reliable, AI algorithms
- Custom solution solving problem

S2Innovation

s²innovation
Software solutions

PRODUCT / SERVICE	End-to-end control systems, scientific software and data platforms for Big Science facilities.
NEEDS	BIG Science facilities such as accelerators, radio telescopes, lasers, and experiments depend on non-standard devices, evolving requirements and multiple control environments. Integration difficulties with diverse devices and instruments, manual procedures and fragmented data tools delay commissioning, consume valuable research time and increase operational risk.
SOLUTION	S2Innovation takes ownership of clearly defined work packages—from architecture and device integration to testing, deployment and handover. We connect equipment with EPICS, TANGO Controls, FESA, UNICOS, PLC/SCADA and MXCuBE; automate operator workflows; and build scalable control, acquisition, archiving and analysis solutions.
VALUE PREPOSITION	Clients gain faster commissioning, greater operational repeatability, fewer manual errors and systems that are easier to maintain and extend. Our delivery model combines Big Science domain knowledge with measurable outcomes such as: reliable SCADA and Distributed Control Systems allowing seamless operation, faster measurements and easy access to experimental results, scalable data archiving platforms handling over 100 GB of new data per day.
TARGET GROUPS	synchrotrons, neutron and laser facilities, accelerator centres, fusion devices, universities, scientific equipment manufacturers, system integrators and consortia delivering systems for research infrastructures.

CUSTOMER REFERENCES: CERN, MAX IV, EUROPEAN XFEL, ESRF, SKAO, FAIR

SDG GOALS:

S2INNOVATION SP. Z O. O. (S2I)

ADDRESS: Podole str. 60, 30-394 Kraków, Poland
TEL. +48 795 794 676

www.s2innovation.com

s²innovation
Software solutions

NAME OF THE SOLUTION:

ESS Operational Sequencer – High-Level Automation for Accelerator Operations

A scalable high-level sequencing tool for safer, faster and more repeatable Main Control Room procedures.

THE NEED / THE CHALLENGE

01 The European Spallation Source required a solution to automate complex accelerator procedures performed in its Main Control Room. Without a dedicated sequence-management tool, operators had to coordinate multiple steps and system states manually. As commissioning progressed, procedures and operational requirements continued to evolve, increasing the need for a solution that could reduce workload and human-error risk while improving repeatability and safety. The tool had to be intuitive enough for daily control-room use, yet flexible and extensible enough to support new procedures. It also needed to work with ESS operational practices and its EPICS-based control environment.

THE SOLUTION PROPOSED

01 S2Innovation contributed to the system Architecture and delivered selected backend and graphical-interface components, EPICS integration, testing and deployment support. The solution provides extensible task types, logical conditions and snapshots, while YAML/Jinja2 templates enable new sequences to be prepared and maintained efficiently. A clear PySide6 interface gives operators transparent control over sequence execution and status. ESS gained an operational automation platform that converts complex, repetitive procedures into controlled and repeatable workflows. The solution reduces dependence on manual coordination and provides a scalable foundation for expanding accelerator automation as operational needs develop.

WHY ESS CHOOSE TO WORK WITH S2INNOVATION

- Practical experience with EPICS-based accelerator control systems and Big Science operations.
- Ability to cover complete delivery path: architecture, backend, GUI, integration, testing and deployment support.
- Close collaboration with control-room operators, ensuring that technical decisions reflected real operational workflows.
- Flexible engineering approach suited to requirements evolving during commissioning.
- Focus on maintainable, open and extensible solutions
-

BENEFITS FOR THE CUSTOMER

- Reduced execution time for operational procedures even up to 40%
- Lower risk of operator errors during complex, multi-step activities.
- Greater repeatability and consistency of accelerator operations.
- Faster sequence creation and modification using readable, open YAML/Jinja2 definitions.
- An operator-oriented interface that makes execution easier to understand and supervise.

Łukasiewicz Research Network Institute of Microelectronics and Photonics (Ł-IMiF)

GB Technologie | Graphene Epitaxy Technologies (GET®)

PRODUCT / SERVICE	HIGH-TEMPERATURE GRAPHENE-ON-SIC HALL EFFECT SENSOR	GRAPHENE-ON-SIC FAST-NEUTRON DOSIMETER
NEEDS	Radiation-resilient magnetic diagnostics in confinement-type thermonuclear reactors	Human- and environment-friendly fast-neutron dosimetry in fissile and fusion reactors
SOLUTION	• Hall effect sensor in graphene-on-SiC technology. • Three-dimensional ceramic sensor head	• Fast-neutron dosimeter in the graphene-on-SiC technology. • Dedicated ceramic casing
VALUE	• High current-mode sensitivity (75 V/AT)	• Tested for fast-neutron fluence between 1E16 and 6.5E18 cm^{-2}
PREPOSITION	• Termal stability (0.03—0.15%/K) • Wide magnetic-field range (11T), • Broad temperature range (770 K)	• No secondary particles, • Easy Raman spectroscopic readout • No radioactive waste
TARGET GROUP	Magnetic-confinement thermonuclear reactors (tokamaks)	Traditional fissile reactors and fusion reactors

CUSTOMER REFERENCES: graphene2get.com/references/

SDG GOALS:

GRAPHENE EPITAXY TECHNOLOGIES (GET®)

ADDRESS: Wólczyńska 133, 01-919, Warsaw, Poland
TEL. +48 515 749 952

www.imif.lukasiewicz.gov.pl
www.graphene2get.com

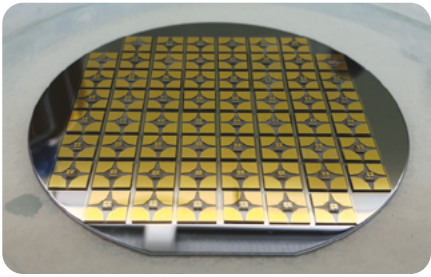
NAME OF THE SOLUTION:
High-temperature graphene-on-SiC Hall effect sensor

THE CHALLENGE

01 The growing demand for electrical energy is accelerating applied research on thermonuclear fusion, with recent U.S. Department of Energy planning identifying fusion commercialization as a strategic priority for deployment in the 2030s. The demonstration of fusion power plants requires paradigm-shifting advancements in Key Enabling Technologies, including diagnostics for plasma measurements and control in hostile environments.

THE SOLUTION PROPOSED

01 A ceramic head with embedded Hall effect sensors based on the α-Al_2O_3/QFS-graphene/H^+:4H-SiC(0001) heterostructure. The sensors withstand hostile environments and are 100 times more sensitive than thin-film metallic Hall effect sensors.



NAME OF THE SOLUTION:
Graphene-on-SiC fast-neutron dosimeter

THE CHALLENGE

01 The passive Raman methodology is intended as a safe alternative to indirect neu-tron dosimetry based on excited radioactivity and emission of secondary particles (gamma rays or beta-minus radiation) from activation foils and their counting with semiconductor detectors, scintillators, or gas-filled detectors (activation methods).

THE SOLUTION PROPOSED

01 A ceramic container with miniature dosimeters and dedicated software to read the fast-neutron fluence from Raman spectra. The platform is rated for temperatures up to 770 K; its miniature size allows incorporation into irra-diation capsules used in fissile and fusion nuclear facilities, enabling precise fluence control without radiological hazards.

References T. Ciuk, C. Nouvellon, F. Monteverde, B. Stańczyk, K. Przyborowska, D. Czołak, S. El-Ahmar, High-temperature thermal stability of a graphene Hall effect sensor on defect-engineered 4H-SiC(0001), IEEE Electron Device Letters 45 (10) (2024) 1957–1960.
J. Jagiełło, A. Dobrowolski, T. Ciuk, R. Prokopowicz, B. Bieńkowska, J. Włodarczyk, S. El-Ahmar, M. J. Szary, M. Szybowicz, Dosimetric platform and a genuine Raman protocol for pas-sive estimation of fast-neutron fluence in irradiated SiC and SiC topped with epitaxial graphe-ne, Results in Physics 75 (2025) 108332.

VoiceLab AI

VoiceLab AI for Industry and Research
AI and ML solutions for industrial applications

PRODUCT / SERVICE	Vera is an AI employee for analytical and operational tasks: data analysis, trend identification, forecasting support, reporting and workflow execution, with a focus on Revenue Intelligence and Conversation- al Intelligence. Moonlight ASR and our Conversational Intelligence platform transform speech and conversations into searchable knowledge. VoiceLab also develops tailored AI models and integrations for industrial and research needs.
NEEDS	Fragmented information across documents, conversations and operational systems makes analysis and reporting time-consuming. Organisations need to extract knowledge from large datasets, anticipate risks and automate repetitive work.
SOLUTION	Connection authorised data sources and combines ML, speech and language processing with AI agents. Vera retrieves information, analyses data, prepares documents and reports, and turns findings into tasks and actions within existing systems. Models and integrations are adapted to the customer s requirements.
VALUE PREPOSITION	• Faster access to knowledge and less manual analysis and reporting • Earlier identification of trends, opportunities and risks • Technologies with EU hosting and on-premises deployment options. • Traceable sources, configurable permissions and approval for actions.
TARGET GROUPS	Industrial enterprises, technology companies, research institutions and large research infrastructures. Users include analysts, specialists, project managers, operations teams, sales leaders and compliance teams

CUSTOMER REFERENCES: WIP — telemarketing and customer service operations

SDG GOALS:



VOICELAB.AI SP Z O.O. (VOICELAB)

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NAME OF THE SOLUTION:

VoiceLab Conversation Analytics, Automated Quality, Cost and Compliance Monitoring at WIP

THE NEED / THE CHALLENGE

01 WIP outsourced telemarketing operations involving approximately 1.5 million customer records annually. Monitoring covered only 1% of calls, limiting visibility into billing discrepancies, sales quality and customer requests. The company needed to verify call durations, monitor sales procedures and identify requests concerning trial-period reminders and personal data erasure.

THE SOLUTION PROPOSED

01 VoiceLab deployed a speech transcription and conversation analytics system with monitoring cards tailored to WIP s processes. The solution detected voicemail calls, compared reported and recorded call durations, identified missed reminder and data-erasure requests, and assessed sales conversations against predefined criteria. Reports provided findings by call centre, consultant and product. Selected quality scores were made available in WIP s CRM, supporting customer service and complaint handling.

WHY WIP CHOSE TO WORK WITH VOICELAB

VoiceLab tailored the monitoring criteria to WIP's requirements, including four sales-quality scorecards for different offer types and customer segments. The implementation combined transcription, automated checks and actionable reports, enabling teams to identify specific issues and follow up with external call centres.

BENEFITS FOR THE CUSTOMER

- Call monitoring coverage increased from 1% to 100%.
- PLN 25,000 in cost reductions through billing claims, equivalent to approximately 1% of telemarketing costs during the reported period.
- 940 events not reported by external call centres were identified and handled thanks to VoiceLab.
- Staff assigned to checking GDPR request statuses decreased from two to one.
- Additional benefits included stronger billing control, more consistent sales sales-quality monitoring and better visibility into customer requests.

KEY FIGURES AND FACTS

- 100%: Calls monitored up from 1%
- PLN 25,000: Cost reductions through billing claims
- 940: Unreported events identified and handled
- 2 → 1: Staff checking GDPR request statuses

Krakow University of Technology, Faculty of Mechanical Engineering

Krakow University of Technology
Faculty of Mechanical Engineering

PRODUCT / SERVICE	**THERMAL MANAGEMENT OF NUCLEAR DIAGNOSTIC SYSTEMS.** **DESIGN AND EM OPTIMIZATION OF MAGNETIC SHIELDING.**	**CO2 OIL-FREE 2PACL COOLING TECHNOLOGY.** **LABORATORY CO2 CHILLER.**
NEEDS	Nuclear diagnostic systems contain various sensitive components and works in an environment with different thermal and magnetic field conditions.	Precise detector temperature control through CO_2 evaporation in micro-channels, covering a temperature range from ambient down to –40°C.
SOLUTION	Design and numerical flow analyses and optimization of cooling loops to verify pressure loss and temperature. Detailed cooling fluid flow distribution. Design and EM optimization of magnetic shielding.	Laboratory chillers and complete cooling plants based on proven 2PACL CO_2 cooling technology. Designed for precise CO_2 temperature control in scientific experiments with stringent requirements for thermal stability and operational flexibility.
VALUE PREPOSITION	Cost-effective and highperformance temperature stabilization system for detectors. Advanced protection system for sensitive electronics and detectors operating in high magnetic field environments.	Validated and deployed by CERN and leading High Energy Physics (HEP) research institutes. It enables the testing and operation of electronic components, detectors, and processors with high power densities, at user-selected temperatures over a wide range, from very low temperatures up to ambient conditions.
TARGET GROUP	Fusion, nuclear and HE physics plants, tokamaks, stellarators, CERN, ITER, DESY, ESS, DONES	Fusion, nuclear and HEP plants, R&D groups, CERN, ITER, DESY, ESS, DONES

CUSTOMER REFERENCES: CERN, ITER, TRIUMF, SLAC, DESY

SDG GOALS:



KRAKOW UNIVERSITY OF TECHNOLOGY, FACULTY OF MECHANICAL ENGINEERING (PK-KUT)
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Krakow University of Technology
Faculty of Mechanical Engineering

NAME OF THE SOLUTION:

MARTA CO2 oil-free 2PACL transportable laboratory chiller
Baby DEMO 2PACL experimental plant (CERN)

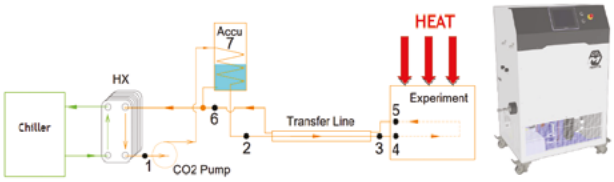
THE CHALLENGE

01 Precise and stable maintenance of a constant, user-defined temperature during the testing of silicon detectors for CERN applications (ATLAS, CMS). The required user-accessible temperature range is +20°C to -35°C. High-powerpower-density detectors require a system that utilizes refrigerant evaporation within microchannels.

THE SOLUTION PROPOSED

01 The unit operates in a circulation loop, supplying saturated CO2 oil-free liquid to the experiment at the user-defined temperature. As the liquid evaporates, it highly efficiently absorbs the heat generated by the detector and returns to the chiller as wet vapor.

MARTA Cooling capacity 300 W @ -30°C



BABY DEMO Cooling capacity 2 kW @ -40°C



WHY CERN CHOOSE TO WORK WITH KRAKOW UNIVERSITY OF TECHNOLOGY

PK-KUT and CERN maintain a long long-standing research collaboration focused on technology development, including cooling and temperature stabilization systems. The MARTA and Baby DEMO projects were developed through close cooperation between the two institutions.

BENEFITS FOR THE CUSTOMER / KEY FIGURES AND FACTS

The proposed system, based on 2PACL technology, is scalable to allow for increased cooling capacity if needed. It enables the testing of prototype or final electronic components (such as detectors or processors) that generate heat during operation, at user-selected temperatures across a very wide range. A unique feature is the use of a completely clean CO2 working fluid, free from oil contamination, which allows for microchannel cooling.

Multidisciplinary Research Centre of Cardinal Stefan Wyszynski University in Warsaw

FROM QUANTUM MECHANICS TO INDUSTRIAL PROTOTYPES

MCB UKSW designs new materials from the atomic scale using quantum-mechanical simulations, then casts, characterizes, and 3D-print them into functional prototypes and industrial parts — all in one interdisciplinary centre.

PRODUCT / SERVICE	**AI/ML SUPPORTED OPTIMIZATION OF PBF-LB METAL 3D PRINTING PARAMETERS FOR NEW ALLOYS AND CUSTOMERCUSTOMER-SUPPLIED MATERIALS.**
NEEDS	A fast, cost-effective way to qualify new alloys and powders for PBF-LB — without wasting expensive material and machine time on trial-andand-error testing. Custom-designed (*ab initio*) and cast alloys with special properties (strength, conductivity, etc.) are highly needed in industry.
SOLUTION	Test builds on a heated-bed system (up to 850°C), powder analysis, and full density/microstructure/defect characterization. Custom alloy casting via arc-melter furnace and powder atomization enabling tailor tailor-made compositions before PBF PBF-LB testing.
VALUE PREPOSITION	10+ years of experience in laser powder bed fusion (metal 3D printing) parameter optimization with manymetals and its alloys (Ti, Ni,Cu, W). Possibility to transfer parameters from our equipment to your industrial machine. First parameters screening from a few hundred grams of powder material.
TARGET GROUP	PBF-LB equipment makers/ integrators and aerospace, automotive, medical and tooling manufacturers adopting metal 3D printing.

CUSTOMER REFERENCES: Academy and industrial partners from different countries (Poland, USA, Germany, Ukraine, Republic of South Africa) in the aerospace, automotive, and medical sectors

SDG GOALS:

MULTIDISCIPLINARY RESEARCH CENTRE, CARDINAL STEFAN WYSZYNSKI UNIVERSITY

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TEL. +48 22 380 96 22 | **CONTACT:** Dr inż. Bartłomiej Wysocki b.wysocki@uksw.edu.pl

www.mcb.uksw.edu.pl

NAME OF THE SOLUTION:

PBF-LB Process Parameter Development for Ni Ni-MoMo-Co alloy (Client: International Additive Manufacturing Group Sp. z o.o.)

THE CHALLENGE

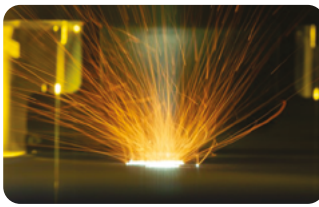
01 IAMG needed a PBF-LB parameter set for Ni Ni-MoMo-Co alloy to additively manufacture a porosity porosity- and crack crack-free engine parts with internal conformal cooling channels.

THE SOLUTION PROPOSED

01 To minimize equipment downtime at the company and reduce the amount of material required for process optimization to only a few hundred grams, it was decided to carry out the optimization work at MCB UKSW.

WHY IAMG CHOSE TO WORK WITH MCB UKSW

- Proven ML ML-guided PBF PBF-LB parameter parameter-development methodology, already validated and published in peer peer-reviewed journals
- Deep experience qualifying alloys for laser beam powder bed fusion
- InIn-house PBF PBF-LB system, powder characterisation equipment, XCT for porosity validation, and mechanical properties testing for full process process-toto-property qualification





BENEFITS FOR THE CUSTOMER / KEY FIGURES AND FACTS

- Parameters can be adjusted for any commercial PBF-LB system
- Structured, ML-guided parameter-development methodology replaces slow, costly trial-andand-error qualification — minimizing the number of physical print trials
- InIn-house PBF-LB system (Aconity3D) with possibility to set stable oxygen content in a range 0-400 ppm;
- Elevated build-plate preheating capability (up to 850 °C) — enabling reliable processing of crac-sensitive, hard-toto-weld alloys that standard PBF-LB systems (typically limited to 200–250 °C) cannot
- Methodology already peer-reviewed and published in journals

Institute of Fundamental Technological Research
Polish Academy of Sciences

MASy: Measure tension. Optimise adjustment

PRODUCT / SERVICE	**WIRELESS VIBRATION-BASED TENSION MEASUREMENT IN RODS, TIES AND CABLES IN SUSPENDED STRUCTURES. MASY ASSESSES EXISTING LOADS WITHOUT UNLOADING INDIVIDUAL ELEMENTS AND INCLUDES AN ALGORITHM FOR OPTIMISING TENSION ADJUSTMENT IN COUPLED ROD SYSTEMS**

NEEDS

MASy enables rapid identification of the current tension in rods, ties and cables in suspended structures without unloading individual elements. Unlike strain gauges and FBG sensors installed on already loaded elements, which typically measure strain changes and require a known force reference to establish existing tension, MASy estimates the current tensile force from vibration measurements using calibrated mechanical models.

SOLUTION

MASy determines tensile forces from natural vibration frequencies using calibrated models that account for rod geometry, material properties, bending stiffness and support conditions. Calibration is based on reference force measurements, such as lift-off, or finite element analysis. Mechanical models and an elastic interaction matrix describe load redistribution between coupled rods: adjusting one rod changes the tension in neighbouring elements. MASy s optimization algorithm selects the sequence and magnitude of adjustments to improve load balance within specified force limits.

VALUE PREPOSITION

Rapid assessment of current tensile forces during short maintenance shutdowns, without unloading individual rods or ties. For the same number of adjustment steps, MASy achieves a 50% greater reduction in the force difference between the most and least loaded elements than the conventional adjustment procedure.

The optimization accounts for interactions between coupled elements.
Measurements verify the resulting forces against target values and specified limits.

Calibration enables adaptation to different rod geometries, mounting conditions and suspension arrangements.

TARGET GROUP

Power and CHP operators, boiler manufacturers and maintenance providers;
fusion developers, research laboratories and large infrastructure operators;
engineering and structural health monitoring companies.

CUSTOMER REFERENCES: Sumitomo SHI FW Energia Polska Sp. z o.o.

SDG GOALS:



INSTITUTE OF FUNDAMENTAL TECHNOLOGICAL RESEARCH, POLISH ACADEMY OF SCIENCES

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TEL. +48 22 826 12 81 EXT. 407 | **E-MAIL:** jtabin@ippt.pan.pl | **CONTACT:** Jakub Tabin, PhD

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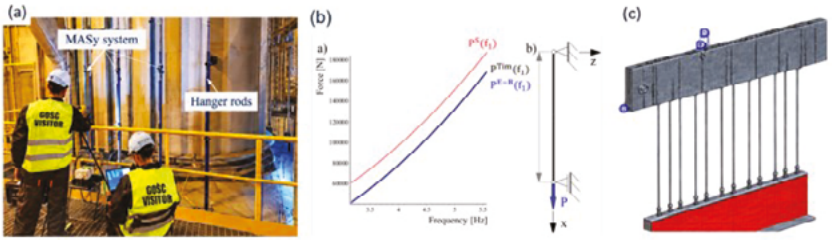
NAME OF THE SOLUTION:
Boiler suspension rods

THE CHALLENGE

01 Assess boiler suspension loads during short shutdowns. Uneven tension can overstress rods and supported components; adjusting one rod redistributes loads in neighbouring elements

THE SOLUTION PROPOSED

01 A wireless sensor system was used to measure vibration acceleration amplitudes in the rods (a). The recorded signals were analysed to identify natural vibration frequencies, which were then used with analytical models to determine the tensile force in each rod (b).



(a) In -house developed, battery-powered wireless accelerometers on hanger rods.
(b) Axial force versus first natural frequency and pinned-pinned rod model.
(c) Finite element analysis of a suspended boiler wall.

INDUSTRIAL RESULTS

MASy was used to measure the force distribution in suspension rods supporting the boiler combustion chamber (c) and separators. These measurements identified heavily loaded rods before start-up, providing a basis for planning tension adjustments.

PROJECT AND FUNDING

Partly funded by NCBR under LIDER: LIDER14/0317/2023 - MASy 2.0, monitoring and adjusting tension in suspended power boiler hanger rods.

KEY FIGURES AND FACTS

Since 2018 Industrial Cooperation
+50% Greater reduction in rod force imbalance
5 Facilities tested

BIMO TECH Sp. z o.o.

Advanced alloy development and manufacturing
for fusion, nuclear, space and high-performance industries

PRODUCT / SERVICE	ADVANCED MATERIALS	PRECISION COMPONENTS	ENGINEERING & INDUSTRIALISATION
	Tungsten & W-alloys; RHEA, HEA, HESA; nickel superalloys; 316LN-IG; copper/refractory systems for first-wall, plasma-facing, high-heat-flux, diagnostic and shielding applications.	Vacuum melting, powder metallurgy, refractory-material machining and finishing, powder-tocomponent routes.	Alloy design, material selection, prototyping, metallurgical analysis, qualification support and industrial scale-up.
NEED	Extreme environments require alloys resistant to high temperature, heat flux, thermal cycling, radiation and surface degradation.	Many critical parts must be converted into geometry-specific and repeatable, traceable and made from refractory qualification-ready or high-value materials manufacturing routes.	Advanced R&D materials must be converted into repeatable, traceable and qualificationready manufacturing routes.
SOLUTION	Develop and manufacture material systems tailored to fusion and nuclear operating conditions.	Turn alloy concepts into manufacturing routes manufacturable combining alloy components through preparation, powder screening, prototypes, routes, machining, process validation, inspection qualification support.	Turn alloy concepts into manufacturable components through screening, prototypes, process validation and qualification support.
VALUE PREPOSITION	Advanced refractory and high-entropy alloys for extreme environments.	European manufacturing of difficult-to-process, high-value metallic components.	One partner from alloy concept to qualified, traceable component.
TARGET GROUP	Fusion & nuclear laboratories; research institutes; materials programmes	Big Science suppliers, Engineering centres; Space companies and OEMs; European buyers specialised component seeking critical alloy and manufacturers. component supply.	Engineering centres; OEMs; European buyers seeking critical alloy and component supply.

SDG GOALS:

BIMO TECH SP Z O.O.

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CEO & R&D MANAGER: Marcin Orzechowski | **E-MAIL:** info@bimotech.pl

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NAME OF THE SOLUTION:

Manufacturing a high-value, non-standard metallic component for demanding technical applications

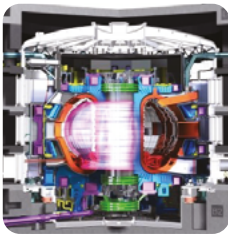
THE CHALLENGE

01 Requirement of a custom rhodium target manufactured from a high-value platinumgroup metal that is costly and difficult to process. The component required controlledmaterial handling, accurate geometry, surface quality and full manufacturing traceability. Key priorities were minimising material loss, maintaining dimensional accuracy and delivering a functional component for the customer's technical process.



APPLIED SOLUTION

01 Bimo Tech implemented a controlled production route tailored to rhodium and the target geometry. The work covered material handling, process planning, machining, finishing and dimensional/quality control, with particular attention to material utilisation. The project demonstrated the ability to manufacture high--value, nonstandard metallic components for demanding technical applications - capability directly relevant to fusion and Big Science supply chains.



WHY THE CUSTOMER CHOSE BIMO TECH

Bimo Tech combines metallurgical expertise with practical manufacturing capability for difficult and high-value metallic materials. The process route can be adapted when standard commercial methods are unsuitable. The project also required a supplier able to manage high-value material responsibly, reduce processing risk and deliver a finished component rather than only a research sample.



RELEVANCE TO FUSION & BIG SCIENCE

Transferable to tungsten/W-alloy parts, refractory plasma facing and high-heat-flux components, RHEA/HEA/HESA systems and 316LN-IG nuclear-grade components.

KEY BENEFITS

- custom component
- controlled high-value material route
- reduced process risk
- transferable fusion & Big Science know-how







MAP OF CENTE MEMBERS:



CENTE MEMBERS

in Alphabetical order

50	BIMO TECH Sp. z o. o
48	Institute of Fundamental Technological Research Polish Academy of Sciences
22	Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences
34	Institute of Low Temperature and Structure Research
18	Institute of Plasma Physics and Laser Microfusion
44	Krakow University of Technology
36	Lodz University of Technology
40	Łukasiewicz Research Network Network— Institute of Microelectronics and Photonics (Ł-IMiF)
46	Multidisciplinary Research Centre of Cardinal Stefan Wyszynski University in Warsaw
21	National Center for Nuclear Research
28	University of Opole
24	Poznan Supercomputing and Networking Centre
38	S2Innovation
30	Niclolaus Copernicus Univerisity in Toruń
32	University of Szczecin
26	Warsaw University of Technology
42	VoiceLabAI





CENTRE FOR NEW ENERGY TECHNOLOGIES (CENTE)

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euro-fusion.org/eurofusion/roadmap

INSTYTUT FIZYKI PLAZMY I LASEROWEJ MIKROSYNTEZY

Krajowy Punkt Kontaktowy

EURATOM - FUSION