

CERN – THE WORLD’S LARGEST LABORATORY

Poland in the European Organization for Nuclear Research: A remarkable story of cooperation, success, and future opportunities at CERN.



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The European Organization for Nuclear Research (CERN) has unveiled plans to construct a new particle accelerator, surpassing the capabilities of the Large Hadron Collider (LHC). This remarkable research instrument will be available for use also by Polish scientists.

Trying to sum up what CERN (French: *Organisation Européenne pour la Recherche Nucléaire*) is in a single sentence is quite challenging. Merely stepping into this laboratory, situated near Geneva at the border of Switzerland and France, immediately gives one the sense that this is no ordinary facility. The site is encircled by futuristic structures resembling spheres and accelerator tubes, with the flags of all 23 member countries proudly displayed. Founded in 1954 with the vision of establishing a laboratory in war-ravaged, divided Europe to conduct premier scientific research in nuclear and elementary particle physics, and to also act as a collaborative platform for countries and researchers from across the continent, CERN's nearly seven decades of operation exemplify such harmonious collaboration. The ultimate testament to CERN's scientific achievement is its undisputed status as the most prominent and esteemed laboratory in modern physics worldwide. It was here, twelve years ago, that the Higgs boson was discovered – a pivotal, previously undetected part of the standard model of the physical world.

Cooperation

Poland formally joined CERN in 1991 – becoming the first country from our part of Europe, previously isolated behind the Iron Curtain, to do so. Our collaboration with the center began in 1959 when several young Polish physicists undertook internships there, facilitated by the individual contacts and scientific prestige of distinguished Polish Professors Marian Danysz and Marian Mięśowicz. Thanks to their initiatives, Poles have been part of this organization for many years, and Polish is frequently heard in the cafeteria and along the corridors. A testament to our presence is that nearly 600 Polish users are part of CERN, with 167 currently employed at the laboratory and a further 430 or so users regularly visiting CERN to conduct research and engineering work.

Like other member states, Poland contributes annually to the organization's budget, at a rate of 3% of national income, which in our case totals just over

38 million Swiss francs – a considerable sum. One might question whether spending such an amount annually on research outside our country is worthwhile and whether the investment truly pays off. The answer to both these questions is a resounding “yes,” on multiple levels.

In simple terms, this participation ensures our involvement in the most prestigious scientific research. Additionally, there are significant benefits in terms of human resources: collaborating with CERN equips our country with a cadre of elite, highly educated specialists who gain invaluable experience by working in large, distinguished research teams that are shaping the technologies of tomorrow. There is also an economic aspect. Specialized analyses indicate that for CERN member countries, every nominal zloty invested in the center actually returns at least three zlotys in profits, notably in the development of certain modern economic sectors. Furthermore, participation in CERN offers Polish companies a unique opportunity to bid on various contracts needed by the laboratory. Just last year, KrioSystem from Wrocław secured a contract nearly equivalent to Poland's entire annual contribution.

Currently, Polish scientists are involved in virtually every research area at CERN, with a particular focus on projects related to the Large Hadron Collider. We have actively participated as large scientific teams in major projects such as ATLAS (A Toroidal LHC Apparatus – one of seven particle detectors at the LHC at CERN) and CMS (Compact Muon Solenoid – a detector at the Large Hadron Collider primarily used to observe muons) and contributed to the discovery of the Higgs boson. In certain CERN experiments, such as the NA61/SHINE collaboration (an experiment studying proton–proton, hadron–nucleus, and nucleus–nucleus collisions at relativistic energies), which explores strong interactions, we play a leading role. The participation of Polish engineers and computer scientists at CERN is also notably prominent. A significant acknowledgment of Poland's role came with the appointment of Prof. Agnieszka Zalewska as chair of the CERN council, often referred to as the “CERN parliament,” from 2013 to 2015. The notable Poles at CERN also include Dr. Sławosz Uznański, who is currently preparing for a space mission with the European Space Agency (ESA).

Not only physics

The lion's share of the research done at CERN is basic science, not directly aimed at yielding immediate societal benefits. However, CERN can boast of an impressive list of innovations and practical applications. A prime example is the World Wide Web (WWW), which we all use today. The measurements performed at CERN place very high demands on the



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electronic systems used, thereby spurring the development of state-of-the-art electronic components. Medical diagnostics continually benefit from new, advanced imaging and treatment tools, including cancer therapy techniques.

Among the Polish projects that have gained from technology transfer from CERN is the J-PET project led by Prof. Paweł Moskal at Jagiellonian University. This project advances PET (Positron Emission Tomography) imaging technology using plastic scintillators, achieving the world's first positron and photon images. Another advancement in this field is the technology of linear colliders at the National Centre for Nuclear Research in Świerk, which are used in the production of radiopharmaceuticals and scanning cargo in cross-border traffic, among other applications.

CERN also acts as a global center for science popularization, particularly in the realm of the micro-world. Last year, it opened a new, futuristic facility called Science Gateway, an excellent example of how modern science outreach can engage especially young audiences. The site can attract up to 500,000 visitors annually. Additionally, CERN's laboratories are open for tours. Visitors are especially captivated by the descent into the 100-meter-deep tunnel where the LHC and its four gigantic spectrometers, used for detecting elementary particles and their interactions, are located. The Polish community is very active in these initiatives, including leading organized student groups from Polish schools and arranging short stays at CERN for our physics teachers. Nearly 600 teachers have

participated in this program, becoming outstanding ambassadors for CERN upon their return.

Even deeper into the microworld

The physics research community and CERN authorities are actively contemplating the future. Currently, there is a plan for a new flagship accelerator at the laboratory, known as the FCC (Future Circular Collider). This project would be a monumental undertaking, envisioning the construction of two additional circular colliders in a tunnel nearly 91 kilometers in circumference (compared to the current LHC tunnel, which is “merely” 27 kilometers long). The first accelerator would initiate collisions between electrons and positrons, while the second would be a massive proton–proton collider. These devices could be operational by the mid-2040s and could remain functional until the end of the twenty-first century. These modern solutions will allow us to probe even deeper into the structure of the micro-world and explore new phenomena. The FCC studies, in particular, are expected to shed light on some of the greatest mysteries of contemporary physics, such as the nature of so-called dark matter and dark energy, and the imbalance between matter and antimatter. This significant project will undoubtedly result in a plethora of technological innovations, the full impact and utility of which are impossible to fully predict. Polish researchers have been deeply involved in the FCC project from its inception. Thus, the entire CERN community looks forward to its scientific future with great optimism, seeing immense potential benefits for society. ■

Further reading:

Hesketh, G. *Particle Zoo: The Search for the Fundamental Nature of Reality*, 2016.

Randall, L. *Knocking on Heaven's Door: How Physics and Scientific Thinking Illuminate the Universe and the Modern World*, 2011.

Sample I., *Massive: The Missing Particle That Sparked the Greatest Hunt in Science*, 2010.