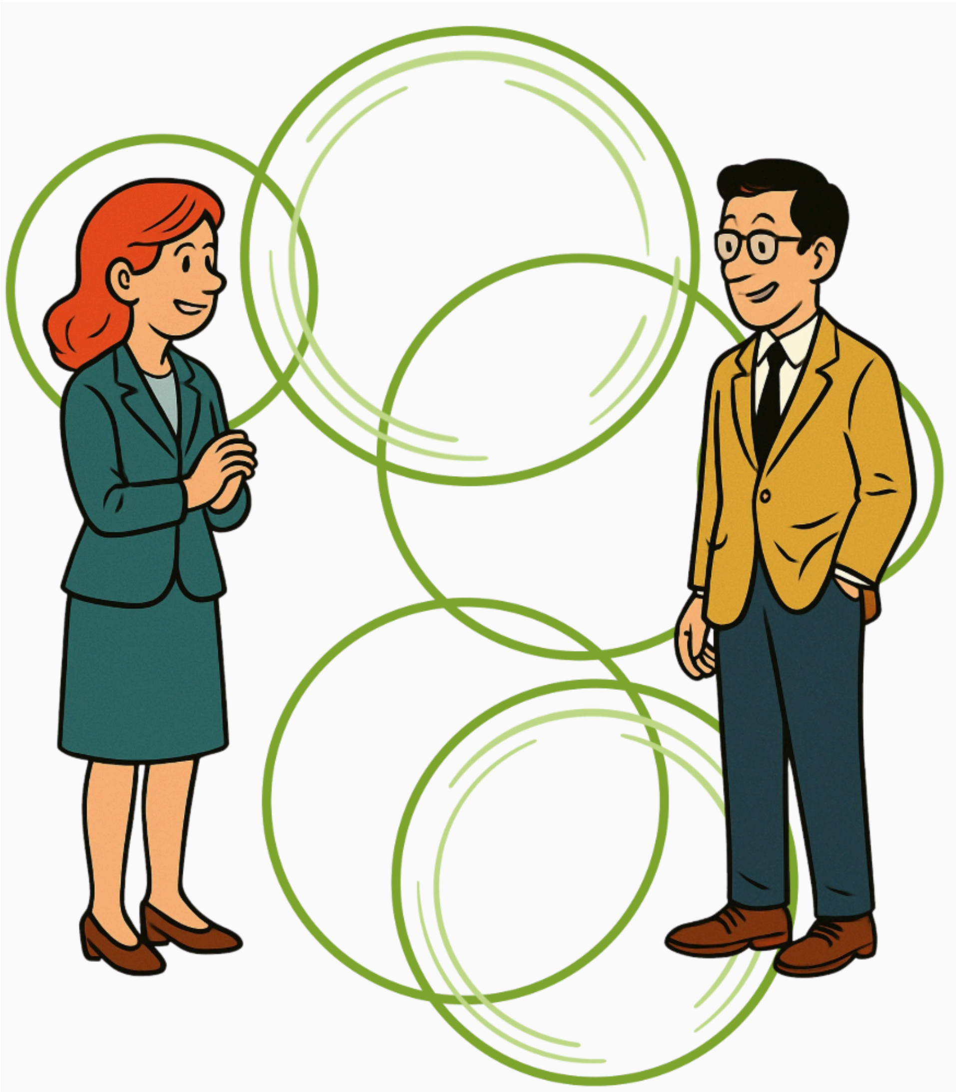

THE CERN MODEL:

TEN KEY PRINCIPLES FOR BIG SCIENCE “MADE IN EUROPE”

CAIRNE

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TEN KEY PRINCIPLES FOR BIG SCIENCE “MADE IN EUROPE”

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(Formerly CLAIRE)

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Summary

CERN was founded in 1954 as a pan-European particle physics laboratory (Kowarski 1961). Over the years, it has established itself as a landmark example of “Big Science” done right. However, it has also become a symbol of what European nations can achieve when they combine their efforts. CERN united countries, scientists and resources under a unique model that has brought to the world decades of sustained, pioneering research and important scientific discoveries.

What is the secret sauce? What is the so-called “CERN model”? In this report, we distil ten key attributes of the model that have underpinned its success. Each attribute is explained in terms of CERN’s experience and why it matters for large-scale scientific collaboration.

Together, these features fostered the critical mass, trust and vision needed to achieve what no single European country or company could attain alone. As policymakers consider new “Big Science” endeavours (for instance advanced AI research and the large research infrastructures required), understanding CERN’s model offers a blueprint for success. In the sections that follow, we delve into ten significant attributes of the CERN model and highlight lessons for future collaborative science initiatives.

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Introduction

In the aftermath of World War II, Europe faced tremendous scientific brain drain. Many leading physicists had left for countries with superior research facilities. The idea of CERN was born from a desire to reverse this trend by creating a European centre for fundamental nuclear physics research that could rival the large laboratories in the United States. The concept was to pool resources across nations to build accelerators that no single European country could afford, and to pursue fundamental science for the public good.

In 1950, at a UNESCO conference, the Nobel laureate Israel Isaac Rabi urged that the time had come to set up regional cooperative laboratories in Europe, and in 1954, CERN officially came into being: Twelve European countries[1] established "Conseil Européen pour la Recherche Nucléaire," CERN, as an intergovernmental research organisation with a mandate to advance fundamental physics research in a spirit of openness and peace.

From this start, CERN grew into the world's largest particle physics laboratory, hosting thousands of scientists from across the globe. It has been the cradle of major scientific discoveries (such as the W and Z bosons in 1983 and the Higgs boson in 2012) and technological innovations (most famously, the World Wide Web, invented at CERN in 1989 as a tool for information-sharing among scientists).

Today, as we contemplate new "moonshot" initiatives in fields such as artificial intelligence and climate science, there is growing interest in replicating the "CERN model". CAIRNE, at its inception in 2018, described a vision for Europe that included a European CERN for AI: a central hub where top researchers can jointly tackle foundational AI research, much as CERN has done for physics (CAIRNE 2018). That vision was borne from an understanding of the strong transformative effect the technology has on our society, and Europe's weak ability to build the technology that will shape our future (CAIRNE 2023a; CAIRNE 2023b)

Recently, this vision has started to get much more attention (Juijn Et al. 2024). The CERN model offers a template for achieving critical mass and long-term impact in science and technology. But what exactly are the defining features of this model? The following sections outline ten key attributes of CERN's approach, each of which has been essential to its success. We also explore

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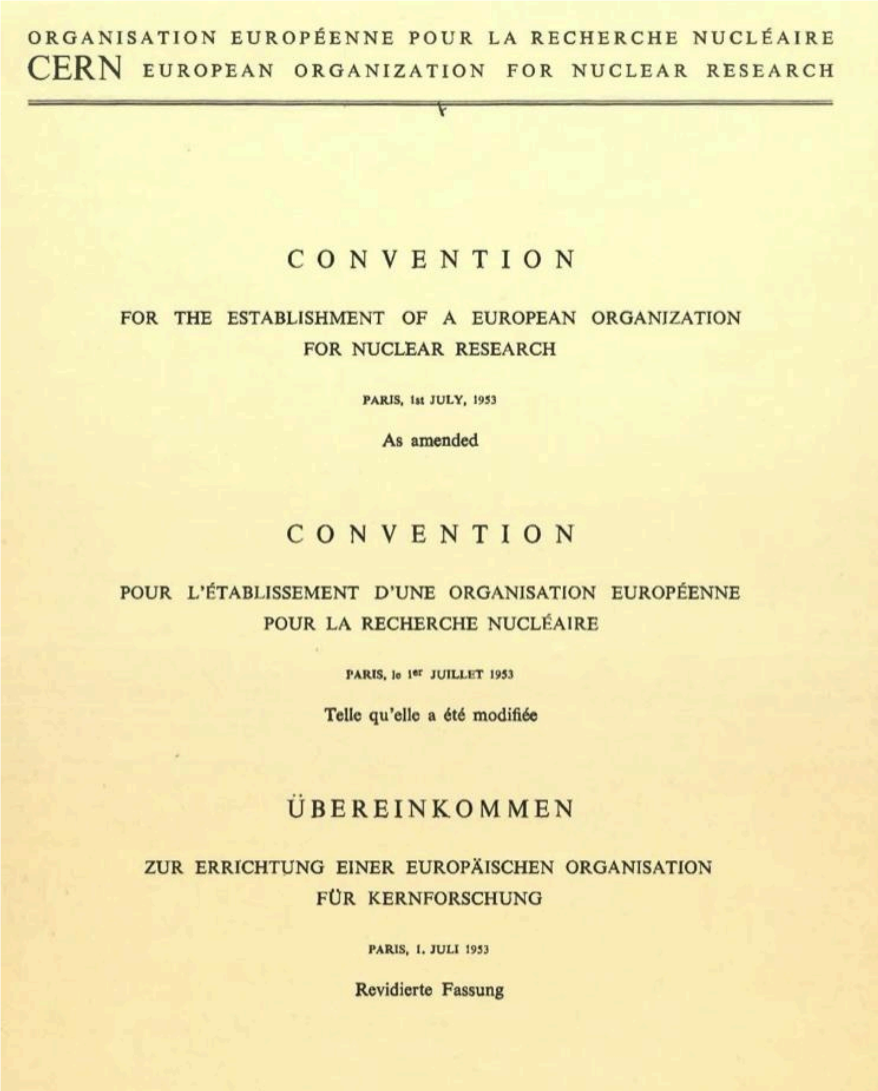
[1] Belgium, Denmark, France, the Federal Republic of Germany, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom and Yugoslaviareceived much more attention (Juijn et al.,.

how these principles might be applied in future Big Science projects, thereby providing guidance for the design of a new AI research centre or similar large-scale collaborative ventures.


ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CONVENTION

FOR THE ESTABLISHMENT OF A EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

PARIS, 1st JULY, 1953

As amended

CONVENTION

POUR L'ÉTABLISSEMENT D'UNE ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE

PARIS, le 1er JUILLET 1953

Telle qu'elle a été modifiée

ÜBEREINKOMMEN

ZUR ERRICHTUNG EINER EUROPÄISCHEN ORGANISATION FÜR KERNFORSCHUNG

PARIS, 1. JULI 1953

Revidierte Fassung

Image 1: The front page of the CERN convention from 1953 and amended in 1971.

1st Attribute: A Scientific Focus and Purpose

CERN was established with a clear scientific mission: to advance nuclear and particle physics through fundamental research. This purpose is enshrined in CERN's founding Convention, which states that "The Organization shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto" (CERN, 1953, Article II). In essence, CERN's aim is focused on a single field (high-energy physics) and on foundational science rather than applied or commercial work. This clear scientific focus has been essential in shaping CERN's priorities and culture. All member states and scientists, despite their diverse backgrounds, unite around a common goal: exploring the deep structure of matter and the universe. The emphasis on fundamental research ensures that short-term political or industrial interests do not distract from CERN's core purpose. It also means CERN's work remains largely pre-competitive and openly shared, which encourages cooperation: everyone benefits from shared fundamental knowledge.

CERN did not spread itself thin across disciplines. Its singular scientific drive and disciplinary focus led to the construction of specialised facilities and to the concentration of expertise in particle physics. The payoff has been tremendous. CERN became the world leader in its niche and spawned a long string of Nobel Prizes and landmark discoveries that have expanded human knowledge[2].

2nd Attribute: Intergovernmental Legal Status

Legally, CERN is an intergovernmental organisation, created by an international treaty. This legal status sets CERN apart from national laboratories or ad-hoc collaborations. By design, CERN is "multigovernmental": it is collectively owned by its member states, not by any single country. The Convention of 1953, signed in Paris, granted CERN legal authority under international law[3]. CERN is a shared enterprise, not owned by one nation.

This status offers significant benefits. **First,** it grants political legitimacy and support: member governments formally commit to CERN's mission and governance. **Second**, it offers financial

[2] For example, the Higgs boson's discovery in 2012 validated a cornerstone of the Standard Model of physics. This is a triumph made possible only by decades of focused effort on a problem of great scientific importance. Such achievements reinforce the idea that a clear mission yields results.

[3] Similar to that of organisations such as the European Space Agency and United Nations agencies.

stability. Each state's participation is embedded in the Convention: it is more difficult to withdraw from an international treaty than to cancel a national project. **Third,** CERN holds certain privileges and immunities that facilitate its operations. For example, CERN can appoint international staff and procure equipment across borders without the usual bureaucratic obstacles. **Fourth**, it operates under its own regulations to a certain extent, which simplifies scientific cooperation among nations. Researchers from member states enter CERN as part of an international zone dedicated to science. **Fifth**, it encourages trust: no single government can simply seize CERN or repurpose it unilaterally[4].

Today, CERN’s member list includes most of Europe, including non-EU countries such as Switzerland and Norway. It also has members beyond Europe, and many non-member nations participate as observers or through experiments. The legal status gives these players a framework for collaboration, with defined rights and obligations.

3rd Attribute: Autonomy and Independence

One of CERN’s key traits is its independence from narrow or unilateral interests, whether from individual governments, corporations, or military programmes. CERN is insulated from direct political or commercial control. The organisation is autonomous in its operations. Member states fund CERN, but they do not micromanage its scientific decisions. Such decisions are guided by scientific committees. There is no single “owner” nation of CERN; even the host nations do not have extra authority by right. This distributed ownership helps to prevent the politics of any one government from unduly influencing CERN’s agenda. Likewise, CERN does not depend on industry funding and does not conduct for-profit research. CERN collaborates with industry to develop technologies and purchases equipment from companies, but companies do not set CERN’s research goals. The lack of a profit motive liberates CERN to pursue knowledge for its own sake and to share it freely and widely. It also means that researchers from universities feel at home: CERN is not a corporate laboratory, but a public institution.

CERN’s Convention explicitly states that “the Organization shall have no concern with work for military requirements” (CERN, 1953, Article II, paragraph 1). Written in the aftermath of WWII, this clause ensured that CERN would focus solely on peaceful science. Its effects were twofold: it

[4] The host states (Switzerland and France) even accord CERN special diplomatic status; for instance, CERN stamps its own mail and its facilities straddle the Swiss-French border with no internal customs, symbolising how it sits above national divisions.

increased willingness among member states to collaborate, since no one needed to fear research being diverted to weaponry against them, and it committed CERN to openly publish results for the benefit of all. Specifically, the Convention mandates that CERN’s experimental and theoretical work be published or made generally accessible, emphasising an ethos of open science.

This independence has great value. It builds trust in the scientific community that CERN’s results are objective and openly accessible. It supports long-term projects that may not yield immediate commercial gains. It also helps prevent conflicts of interest. CERN has become a sort of “neutral Switzerland” of science (aptly situated in neutral Switzerland), where collaboration can thrive without geopolitical or corporate competition tainting the atmosphere. The results speak for themselves: thousands of scientists from over 100 nations collaborate at CERN each year, motivated by a shared curiosity rather than by contract or coercion.

4th Attribute: Governance Structure Balancing Science and States

CERN’s governance model is often seen as a key part of its success. It carefully balances scientific independence and political control. The main decision-making body at CERN is the CERN Council, which represents each member state. Each country sends two delegates to the Council: one is a scientific delegate (usually a senior physicist), and the other is a government or diplomatic representative. This dual representation makes sure both viewpoints (scientific and political/financial) are considered when making decisions. The Council manages major issues like budget, programmes, and approvals for new facilities, typically reaching decisions by consensus or with qualified majorities. By design, no single state (not even the largest funders) dominates the Council; each member has one vote. Smaller countries therefore have a voice and tend to stay committed, as they are genuine participants in governance rather than just paying for someone else’s project or infrastructure.

To strengthen scientific guidance, CERN has a Scientific Policy Committee (SPC) composed of eminent scientists, often including members from non-member countries to benefit from global expertise. The SPC advises the Council and the Director-General on scientific priorities and assesses proposals. According to CERN, the SPC consists of the world’s most eminent particle physicists, whose advice carries significant weight. This helps uphold CERN’s scientific credibility and ambitions. Major decisions are based not only on political or financial considerations but also on thorough scientific merit.

CERN's Director-General (DG), who is the chief executive, is elected by the Council for a five-year term. He or she is usually a respected physicist-manager, is accountable to the Council, and, together with their team, handles day-to-day management and long-term planning.

CERN's leadership has traditionally been highly distinguished in science. Many DGs were leading physicists, but also skilled in diplomacy. This reflects the governance ethos: science-led leadership balanced with accountability to member states. The system promotes dialogue: scientists identify what is needed for discovery; delegates from member states consider resources and political factors. The outcome is often a creative compromise that advances innovation while maintaining consensus[5].

5th Attribute: Stable and Long-Term Funding Model

CERN's financing model has proven to be robust. CERN is mainly funded by its member states, which contribute annual dues roughly based on their national GDP. This ensures fairness, as larger economies pay more and smaller ones pay less, and it scales contributions according to ability[6]. The total CERN budget in recent years is around 1.1 billion Swiss Francs annually (approximately 1.2 billion Euros), supporting the operations of accelerators, experimental programmes, and a staff of about 2.500–3.000.

Importantly, these contributions are agreed upon as part of the founding treaty and are adjusted by mutual consent. They are mandatory and stable, not subject to annual decisions by national parliaments. Changing CERN's funding model or reducing contributions requires renegotiation with all members. This ensures a strong, long-term[7] financial commitment. It has enabled CERN to plan projects over decades, from proposal to construction and data collection.

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[5] For example, when approving the Large Hadron Collider (LHC) project in the 1990s, the Council had to balance the bold scientific vision with each country's budget constraints. The govlidernances mechanism allowed hashing out contributions and the construction schedule in a cooperative, rather than a top-down manner.

[6] For instance, in recent budgets, Germany and France each contributed about 15–20% of CERN's budget, while smaller countries contributed only a few percent or less.

[7] In practice, member states have maintained or slightly increased CERN's budget over decades, shielding it from short-term political changes.

There is also a principle of "juste retour" in an informal sense: a good fraction of CERN's budget benefits member states' economies through industrial contracts and employment. Approximately half of CERN's expenditures go towards procuring equipment and services, often sourced from member countries[8]. Furthermore, the cost-sharing model ensures no single country bears an excessive burden; each contributes a fraction towards a collective effort far beyond what they could afford alone.

The stability of funding has been a critical enabler of CERN's scientific achievements. Projects like ´ the Large Hadron Collider required significant upfront capital investment over approximately 10 years, followed by operational expenses for twenty years or more. Because CERN could depend on long-term funding pledged by its members, it was able to undertake these projects with confidence. Moreover, during economic downturns, a treaty-based commitment helped shield CERN from severe cuts[9]. The result is an organisation and laboratory that have maintained CERN's scientific productivity and collaborative spirit through changing political landscapes, economic fluctuations, and shifts in research priorities.

6th Attribute: Long-Term Planning and Stability

The long-term stability of CERN deserves special emphasis, even though it is closely linked to funding, which we have just discussed.

CERN is not a short-term project but a permanent institution that has now operated for over 70 years. This longevity results from its stable governance and funding model but also reflects a deliberate long-term planning approach. CERN works with multi-year "Medium-Term Plans" and even 20-year roadmaps for its scientific strategy. For example, the decision to build the Large Hadron Collider was part of a vision that extended well beyond the tenure of any single government or CERN Director-General: it was conceived in the 1980s, approved in the 1990s, constructed during the early 2000s, and became operational in 2008, with physics results peaking in the 2010s. Such a timeline can only be managed by an institution that is structurally prepared to endure and adapt over decades.

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[8] Although CERN does not strictly assign contracts by country, it tracks the distribution to ensure each member receives tangible benefits (such as technology development and orders for domestic firms). This approach has likely been vital in maintaining political support: governments recognise that funding CERN not only produces scientific achievements but also stimulates industry and innovation locally.

[9] Although there were occasional delays driven by budget issues; the overall trajectory remained steady

The structure of the CERN Council and the legal basis provided by the Convention mean that short-term national politics rarely derail the organisation. There is a strong culture of consensus and continuity. Even when member states face elections or budget crises, CERN's mission continues[10].

An important advantage of long-term stability is the ability to undertake large infrastructure projects and research and development that span many years. CERN's accelerators and detectors generally have lifespans of several decades[11]. Additionally, long-term operations allow CERN to serve as a training ground for successive generations of scientists; many arrive as students or postdocs and return later, creating a continuous flow of knowledge.

7th Attribute: High Centrality and Physical Co-location

A notable feature of CERN is its physical centralisation. CERN's main campus on the Franco-Swiss border near Geneva is where much of the magic happens. It is a sprawling site that hosts accelerators, experimental halls, offices, workshops, and the renowned cafeteria, where ideas exchange freely. By bringing together talent, funding, and infrastructure in one location, CERN generates a critical mass and a lively intellectual community. The value of this co-location is difficult to quantify but widely recognised. When thousands of scientists work nearby, informal interactions thrive: a chance encounter can spark a new idea, and quick face-to-face discussions can resolve issues that emails or scheduled meetings might struggle with.

Research literature overwhelmingly indicates that while the marginal cost of transmitting codified knowledge[12] has approached zero, the cost of transmitting tacit knowledge[13] remains high, requiring the high-bandwidth channel of physical presence. Simply put, sporadic encounters are highly important for innovation, and they just don't happen in the virtual world.

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[10] CERN has famously withstood times of geopolitical tension. For example, in the mid-1960s, the United Kingdom (one of CERN's largest financial contributors) formally considered withdrawing due to domestic budget pressure, but ultimately reaffirmed its long-term commitment. Short-term national politics did not override the shared European investment in CERN. More recently, despite the UK's exit from the EU, its commitment to CERN remained unchanged, highlighting CERN's independence even amid major political upheaval.

[11] The laboratory can upgrade and reuse infrastructure; for example, CERN's 27 km circular tunnel was initially used for the LEP collider in 1989 and was later, as planned, repurposed for the LHC in 2008.

[12] Codified knowledge is information that can be written down, digitized, and transmitted without loss of fidelity, as for instance blueprints, code, and technical specifications.

[13] Tacit knowledge is the accumulation of intuition, complex skills, and context that resists articulation.

Physical workplace proximity has been shown to increase the frequency of interaction between office workers (Allen and Fustfeld, 1975; Peponis et al., 2007, Sailer and McCulloh, 2012). MIT’s Thomas Allen famously demonstrated that collaboration frequency drops off sharply as the distance between offices increases[14], reinforcing the importance of physical proximity for teamwork (Allen, T. J., 1977). Physical workplace proximity also broadens the extent of professional collaboration between scientists (Kabo et al., 2015; Claudel et al., 2017; Catalini, 2018) and increases the impact of research produced in teams (Lee et al., 2010). In short, research teams that sit together tend to produce more innovative work than those that are dispersed.

Physical workplace proximity builds trust among collaborators, since they see each other daily. Sociologically, it fosters a shared identity and culture that transcends nationality: everyone at the site is “in the trenches” together, which creates a powerful bonding force. Physical co-location also means researchers have direct access to on-site facilities. An experimental physicist can literally walk from their office to the control room of the Large Hadron Collider, or to a laboratory where detector components are being assembled, and collaborate hands-on. Proximity speeds up the feedback loop between theory and experiment, hardware and software. In CERN’s environment, those serendipitous encounters are routine. People from different teams and nations constantly exchange ideas, whether over coffee or during a seminar.

There is evidence that geographic clustering boosts scientific output. CERN leveraged this by providing an environment where an experimentalist from Italy, a theorist from the UK and an engineer from Germany might all share adjacent offices or at least walk through the same corridors. The result is a unique collaborative culture that remote interaction alone cannot replicate.

To illustrate, consider the ATLAS and CMS experiments at CERN. Each of them involves thousands of scientists from hundreds of institutions worldwide. While much work is done remotely at the home universities, the core assembly, data-taking, and analysis coordination take place at CERN, where large teams gather. During critical periods[15], having everyone on site enabled rapid problem-solving and excitement that simply would not have been possible over video links.

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[14] The so-called Allen Curve.

[15] For instance, when the LHC first began colliding protons in 2010.

Image 2: An aerial view of CERN’s main site, with the 27 km Large Hadron Collider (LHC) tunnel and experiment locations (ATLAS, CMS, ALICE, LHCb) marked.

8th Attribute: Distributed Competence and Knowledge Sharing

While CERN concentrates its activities at a single site, it also achieves a broad distribution of knowledge and expertise. It achieves this by functioning primarily as a host laboratory rather than as a permanently staffed institute. CERN’s directly employed staff is around 2500 people, including many engineers, technicians, computing personnel, and support staff. The scientific research is largely conducted by visiting researchers. There are over 12,000 so-called “users” from universities and institutes worldwide. These users come to CERN for weeks, months, or a few years to work on experiments, then return to their home institutions.

This approach was deliberately chosen: rather than maintaining a large permanent research staff, CERN brings in external teams for collaboration. CERN has no permanent scientific armies; instead, researchers rotate through, sharing knowledge globally. Scientists visit for weeks, months or years to collaborate with the best minds in the world before returning to their home institutions, bringing back innovative ideas and invaluable connections.

The effect of this rotation system is that CERN serves as a hub-and-spoke network for knowledge. It brings people together for collaboration, then spreads expertise back to its member states and beyond. European countries benefit because their researchers acquire cutting-edge skills at CERN and then take them home. This approach strengthens national universities and laboratories; in fact, it was one of the main reasons for establishing CERN: to elevate the overall standard of

European science by training people on the most advanced equipment and methods, and then having them share that expertise.

Indeed, many leaders in science and technology across Europe (and globally) spent part of their formative years at CERN. Even after leaving CERN, they often continue to participate in experiments from their home institute, maintaining a lifelong connection. This circulation prevents CERN from "brain-draining" its member states; instead, it continually refreshes the talent pool and spreads new ideas. It is a virtuous cycle: CERN acts as a "force multiplier" for human capital, with scientific expertise and experience radiating outward through alumni and collaborations.

Another aspect of competence distribution concerns how CERN's projects are organised across various institutions. Large experiments are inherently international collaborations, with components built by universities and laboratories from different countries. Member states frequently contribute "in-kind" hardware or expertise.

For instance, institutes from one country might design and build a detector subsystem, while a team from another country might produce a different part, and all these components come together at CERN. This results in technical capabilities, such as in precision engineering, cryogenics, and software, being developed across the member states rather than solely at CERN. During the LHC construction, many countries ensured components were manufactured domestically, both to reduce costs and to support their national industries and laboratories through high-tech development. CERN coordinated these contributions by establishing common standards and integrating the parts. Ultimately, not only is the scientific reward shared, but also the technological and educational benefits.

9th Attribute: Privileged Access to World-Class Infrastructure

CERN offers something no university or company can: access to unique research infrastructure on a scale that is simply impossible elsewhere. Its flagship, the Large Hadron Collider (LHC), is the world's largest and most powerful particle accelerator – a 27 km ring capable of accelerating protons to unparalleled energies. Building and operating such a machine required remarkable engineering, billions in investment, and a collaborative effort from many nations. By pooling resources, CERN created this world-class infrastructure. Because CERN is a user facility, scientists from any member state (and many non-member states) can utilise it for their experiments.

Essentially, CERN democratises access to cutting-edge infrastructure: a physicist from, say, Portugal or Poland has the same right to propose an experiment at the LHC as one from France or Germany, something they could not imagine if each country had to rely solely on its own national infrastructure. This model of a shared mega-facility multiplies scientific opportunities.

The LHC is not the only example. CERN's infrastructure includes an entire complex of accelerators (smaller accelerators that serve as injectors to the LHC and for other experiments), advanced detectors that act like gigantic high-speed cameras to capture particle collisions, and massive computing resources. In fact, CERN was a pioneer of distributed computing: the Worldwide LHC Computing Grid connects hundreds of computing centres around the globe to process the vast amount of data from the collider. Member states contribute computing power, which, when combined, provides all researchers with a "supercomputer" of global scale for analysing data collected at CERN. Once again, a single institution could never assemble such capacity alone, but CERN's collaborative model made it feasible and offers all partners the benefit of the whole.

Importantly, the presence of unique facilities also attracts the best talent. Scientists are drawn to CERN because of the instruments available only there. If you want to discover new particles, the site of the LHC is the place to be. This creates a virtuous cycle: excellent infrastructure attracts brilliant minds, which in turn leads to remarkable science. Moreover, having shared cutting-edge scientific infrastructure encourages collaboration rather than competition. Instead of each country building smaller colliders and competing (wasting resources and duplicating effort), they build one outstanding collider and collaborate within a shared framework.

10th Attribute: Commitment to Peaceful, Open Science

Finally, the CERN model is built on a strong ethical and cultural foundation: CERN was explicitly established as a peaceful scientific endeavour, separate from military ambitions and welcoming to the world. While Article II of the Convention states that no military work should take place at CERN, this principle is not just a formal rule; it has become a core part of CERN's identity.

CERN's scientific findings are published openly and often made accessible to all. CERN has embraced open access publishing and, for some experiments, open data policies. The World Wide

Web, invented at CERN, was famously made available to the public for free in 1993[16]. CERN therefore exemplifies the principle that publicly funded fundamental research should serve humanity as a whole. Researchers at CERN work collaboratively across borders, and share recognition in author lists that sometimes include thousands of names[17].

CERN’s avoidance of military or classified research also means that young scientists from any country can participate without legal barriers, and results can be freely shared at international conferences. This keeps the science on a purely academic footing – the competition is for scientific discovery, not strategic advantage. The reward system is publications and prizes, not patents or weapons. This has arguably made CERN more innovative, not less, because ideas flow freely. An independent assessment in 2020 noted that CERN’s exemplary contributions to science for peace were a significant part of its legacy, leading to recognition at the UN (Technopolis, 2020).

During its formation in the 1950s, many of CERN’s driving forces were motivated by the idea that science could unite a divided post-war Europe. CERN's intergovernmental status allowed it to serve as a neutral ground, even when geopolitics outside were strained. Israeli and Arab scientists have long worked side by side on CERN experiments. Even during the height of the Cold War, scientists from both Western and Eastern blocs collaborated at CERN despite intense political tensions, making it one of the very few places where East–West scientific cooperation continued unbroken (Krige, 2008).

This ethos has valuable soft power. It inspired initiatives like the SESAME synchrotron light source in the Middle East, which explicitly follows “the CERN model” by bringing together countries[18] to collaborate in science to build peace and trust[19] (SESAME, 2017). Similarly, a proposed South-East Europe International Institute for Sustainable Technologies (SEEIIST) aims to bring Balkan nations together through a joint research facility, again citing CERN as the template.

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[16] It is a remarkable example of openly sharing innovation for the common good. That decision exponentially increased the Web's impact on societies worldwide.

[17] This collective approach contrasts with the proprietary and often secretive research carried out, and is well-suited to fundamental science, where progress is accelerated by broad scrutiny and cumulative knowledge.

[18] Including Israel, Iran, Jordan, Egypt, and Turkey.

[19] SESAME opened in 2017 under UNESCO auspices and is a testament to how CERN’s principles can be exported to benefit regions beyond Europe.

CERN institutionalised science diplomacy as an operational reality, not merely an abstract ideal. This was internationally recognised when CERN was granted observer status at the United Nations (CERN, 2012).

However, sometimes external realities become too overwhelming, even for the most well-intentioned ideals. By 2024, all relations between CERN and institutions from the Russian Federation were severed, including CERN's International Cooperation Agreement with Russia (Petrakou, E.,2023). Of course, this does not mean that CERN's science-for-peace approach is a failure; rather, it shows that some events (like one member country invading another) cannot be ignored.

Conclusion

CERN's journey from a post-war vision to a global leader in scientific discovery offers a rich template for organising "Big Science". Each of the significant features we have discussed plays a distinct role in CERN's success. Together, they created an institution that could achieve what was once thought impossible: it unlocked scientific mysteries of the universe by uniting countries and researchers on a grand scale. Crucially, CERN turned competition into collaboration. Rather than nations racing separately (as they did in the early nuclear era), CERN channelled their ambitions into a single, shared enterprise. The payoffs have been scientific breakthroughs (such as the discovery of the Higgs boson) and technological innovations (such as the World-Wide Web and advances in detectors and computing) that reverberate far beyond particle physics.

For policymakers and academics looking to the future, CERN illustrates that big challenges demand equally big collaborations. Whether the goal is to ensure that AI benefits humanity, to develop fusion energy or to map the human brain, the principles behind CERN provide crucial guidance:

- A clear scientific mission keeps efforts focused and inspires long-term commitment.
- International treaty status and joint governance provide legitimacy, stability and a voice for all partners.
- Autonomy from military or commercial agendas builds trust and open exchange of knowledge.
- Stable, shared funding over decades allows truly ambitious projects to flourish.
- Physical co-location of expertise, talent and unique infrastructure creates synergy and rapid innovation.
- Rotation of talent and tasks spreads the benefits, training countless experts and providing benefits to all member states and regions.
- Access to singular, top-tier facilities lets scientists anywhere do cutting-edge work and push technology frontiers.
- A culture of openness and peace elevates the project beyond narrow interests and engenders global goodwill.

These principles are not just idealistic; CERN's concrete achievements prove their effectiveness. The CERN model offers ten key attributes that collectively have given it impact and resilience unmatched in the scientific world. Indeed, many other collaborations have drawn inspiration from CERN.

CAIRNE has already publicly welcomed the first wave of large-scale European AI infrastructure investments explicitly framed around this CERN-for-AI vision (CAIRNE 2025b). However, as the European Commission increasingly refers to its AI initiatives as being “akin to a CERN for AI” or based on the idea of a “CERN for AI”, it is important to remind the Commission and ourselves that this phrase carries significance. It means something. The reason thousands of AI scientists and technologists across Europe have been calling for a CERN for AI for nearly ten years is that it means something. It means a specific way to enhance Europe’s capability and capacity to take control of a key technology of our time and to help Europe shape its own future.

The CERN Model means something. In this report, we have shown what it means.

The CERN model is a proven recipe for successful “big science”. It teaches us that if we want to tackle monumental scientific quests, we should borrow the best ingredients from CERN’s playbook: secure stable, long-term support from many members, centre it in one unifying mission and organisation, keep it free for peaceful exploration, and plan for the long run. With those conditions met, what seems too big to attempt can indeed be achieved. As the history and success of CERN demonstrate, when we get the model right, the sky is not the limit, but only the beginning.

About CAIRNE

The Confederation of Laboratories for Artificial Intelligence Research in Europe (CAIRNE) was established by the European AI community to strengthen European excellence in AI research and innovation, with a focus on human-centred AI. Launched as CLAIRE on June 18 2018, with a vision supported by over 600 AI researchers, CAIRNE officially incorporated as an international non-profit association (AISBL) in 2020. CAIRNE’s mission is to promote European AI, foster cross-border collaboration, and position Europe as a global leader in AI innovation. The CAIRNE Network now includes over 500 research groups and companies, covering 27,000 employees across 41 countries. CAIRNE also maintains offices across Europe in The Hague, Saarbrücken, Prague, Rome, Brussels, Guimarães, Paris, Oslo and Zürich.

To find more relevant information, including the Vision, recommendations to the EC, and the proposal for a Moonshot in Artificial Intelligence developed with euRobotics, please visit https://cairne.eu/documentation/.

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