PROCEEDINGS OF SCIENCE

Bringing Research Infrastructure to the Public: an outreach case study from the CERN Science Gateway

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Astrophysics and particle physics rely on large-scale infrastructures, including telescopes, detectors, and accelerators, that are central to scientific inquiry yet often remain inaccessible to the public. These instruments pose specific challenges for engagement: how can they enable encounters with science as an ongoing process rather than a finished product? Recent initiatives have begun to explore how laboratory-based research can be made visible beyond static display. However, meaningful engagement with such infrastructure requires more than proximity or authenticity; it depends on mediation, narrative framing, and situated interaction.

This paper reflects on the development of ELISA, a functioning proton accelerator integrated into the exhibitions at CERN's Science Gateway. Rather than offering a replicable model, the installation is presented as a negotiated arrangement shaped by technical constraints, safety considerations, and the need for meaningful public engagement. Its hybrid use as a demonstrator, exhibit, and occasional research tool offers a space where scientific practice becomes visible and open to interpretation. Through live demonstrations and guided facilitation, the project invites visitors to witness scientific work in action. Drawing on science communication and STS perspectives, this case contributes to broader reflections on how research infrastructures can be mobilised as sites of learning, encounter, and epistemic negotiation.

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1. Introduction

Astrophysics and particle physics both explore fundamental questions about the universe. Both face the challenge of making abstract and technical science accessible and meaningful to broader publics. Astrophysics has inspired successful outreach through citizen science and immersive planetariums. Meanwhile, public engagement in particle physics has often involved mediated visits to research sites, offering proximity to working infrastructure but constrained by capacity and logistical demands. This tension provided the rationale for a new kind of project: integrating a working accelerator into a permanent science exhibition.

This paper reflects on the collaborative development of such an initiative [1]: ELISA (Experimental LInac for Surface Analysis), a compact Radio Frequency Quadrupole proton accelerator installed within CERN's Science Gateway [2]. Rather than displaying a simplified model, ELISA is a functioning research instrument placed in a public space.

Inspired by science and technology studies (STS), this paper offer a reflexive perspective on the development of ELISA as an outreach infrastructure. It builds on work such as Molinié and Boudia's analysis of the Palais de la Découverte [3], which shows how spectacular public demonstrations have historically negotiated tensions between displaying settled knowledge and staging science in the making. The following sections examine the process of collaboratively developing ELISA's outreach experience. It begins by outlining a methodology that embeds research and practice in science communication. It then presents comparative case studies that informed the project's design. Finally, it discusses the ELISA mediation itself, focusing on how decisions about mediation, access and authenticity shaped its temporary form.

2. Methodology: a collaborative process embedding outreach research and practice

This paper is based on a collaborative inquiry into the development of ELISA as a public-facing research infrastructure. The analysis draws on ethnographic observation, design participation, and ongoing reflection on the affordances and constraints of making a scientific instrument public. Science communication is approached here as a situated practice, shaped by institutional logics, spatial arrangements, and representational strategies [4].

A comparative case study approach was used to analyse the dynamics of exhibiting research infrastructure. Three types of engagement settings were examined: stand-alone displays, live demonstration formats, and operational laboratories open to visitors. In each case, attention was given to how instruments were materially and symbolically framed, how they were positioned in relation to audiences, and what forms of mediation they involved, whether through human guidance, spatial design, or interpretive content. The analysis also drew on public feedback, internal documents, and design discussions.

Direct involvement in the development of ELISA provided insight into how curatorial, scientific, and communicative priorities were negotiated in practice. Design and analysis developed iteratively: observations informed mediation, and constraints shaped analytical focus. What follows is a situated reflection on the socio-material process of making a research instrument public.

3. How can scientific instruments be exhibited to the public?

This section explores how scientific instruments have been presented to the public in different institutional and curatorial contexts. It draws on published literature in museum and science studies and interviews with practitioners. The aim is not to define fixed models but to reflect on how the form, function and meaning of scientific instruments are shaped through different modes of exhibition. We identify three broad approaches: stand-alone display, live demonstration and laboratory setting. They raise distinct questions about mediation, visibility and interpretation. Across all settings, This analysis focuses on how instruments are perceived, as either legible or opaque, spectacular or mundane, depending on the narratives, spatial arrangements and institutional logics that shape them.

3.1 Stand-alone setting

Science museums have long featured instruments as part of their collections, yet the framing of these objects shapes how visitors interpret them. In stand-alone settings, instruments are typically exhibited without active mediation or operational use. These displays can evoke a sense of historical continuity or technological awe, but they also risk opacity when context is lacking.

A telling example is the Cockcroft–Walton accelerator exhibited in a gallery space alongside other objects of industrial and scientific heritage at the Musée des Confluences in Lyon. While visually striking, the exhibit provides limited narrative context. Labels and signage refer to general themes such as subatomic physics or nuclear history but offer little biographical detail about the instrument itself, its prior use, its users or how it came to be part of the museum collection.

As Derolez has argued [5], the result is a kind of black-box effect: the object is closed to interpretation because its internal logic and sociotechnical trajectory are not made accessible. Visitors are invited to observe, but not to connect the object to specific practices or institutions.

In contrast, immersive design can reframe static instruments as narrative devices. At the Magna Science Adventure Centre in Rotherham, for example, large-scale industrial machinery is embedded within spatial scenographies that evoke the atmosphere of a working steel plant. One installation, "The Big Melt," uses projections to recreate the operation of a steel furnace, situating the object within a sensory and historical context. As Jin notes [6], such contextualisation increases memorability and helps visitors imagine how instruments were embedded in the worlds of work, labour and expertise.

The contrast between these two cases highlights a core tension in stand-alone settings: when instruments are displayed without narrative anchors, their scientific significance may be lost or reduced to aesthetics. At the same time, narrative-rich environments risk theatricalisation. The challenge is not merely to show objects, but to situate them within frames that invite curiosity, interpretation and connection.

3.2 Demonstration setting

Functional demonstrations offer an alternative model, where instruments are activated in front of an audience and interpreted through live narration. This format foregrounds performance and temporality, with demonstrators guiding visitors through scientific principles, historical references and moments of visual or auditory spectacle. Demonstrations can serve both didactic and affective purposes, but they also depend heavily on the skill of the presenter and the robustness of the device.

One case that illustrates this dynamic is the electrostatic accelerator at the Palais de la Découverte in Paris. From 1964 until the museum's recent renovation, this deuteron accelerator was used in auditorium-style demonstrations to reproduce foundational experiments in nuclear physics. The events were led by physicists and historians of science who wove together technical explanation with humour and theatrical timing.

Although the demonstrations were educational, their primary goal was often to stimulate fascination. Molinié and Boudia [3] have shown that, in the broader history of the Palais, priority was frequently given to spectacular displays over detailed engagement with contemporary science. This was a deliberate curatorial choice to stage science as impressive and alive, even if the demonstrations did not reflect the actual state of scientific practice.

A second example, drawn from the fieldwork, involved a group of retired physicists who built a working model of a circular accelerator to demonstrate magnetic beam bending. Despite its pedagogical potential, the model was fragile and prone to breakdowns, highlighting the material challenges of staging live science in public contexts.

These cases point to both the power and precarity of demonstration settings. On the one hand, they can make abstract processes visible and engaging. On the other, they risk oversimplification or technological failure. They also shift attention from the instrument itself to the person operating it, making the demonstrator a central figure in the narrative. What is shown, how it is shown and by whom are all part of the communicative process.

3.3 Laboratory setting

In recent years, some science museums and centres have moved beyond static or staged representations of science by integrating active laboratories into public spaces. In these settings, research is not re-enacted or simulated but carried out in real time, in full view of visitors. This approach reframes the museum not as a space for representation alone, but as a site of transparency, where scientific work is opened to observation and, occasionally, interaction.

The "open labs" model is exemplified by the nanotechnology research facility at the Deutsches Museum in Munich, where visitors can observe scientists conducting actual experiments. In some cases, researchers engage directly with the public to explain their procedures, motivations and the broader implications of their work. As Meyer argues [4], this type of setting does not simply exhibit science; it reveals science in the making, with all its uncertainties, constraints and contingencies.

This mode of exhibition can foster a deeper sense of authenticity and trust, as visitors are invited to witness science not as a process rather than a product. However, it also introduces tensions. Maintaining research productivity while remaining accessible to non-specialists requires careful negotiation of space, time and roles. Researchers must adapt to performing their work under intermittent observation and institutions must decide how much openness is possible without compromising either science or communication.

The laboratory setting thus raises important questions about epistemic visibility, institutional responsibility and the ethics of exposure. When visitors encounter science as practice rather than product, they may come away with a more nuanced understanding of what science is and what it is not. But such encounters are fragile, shaped by institutional will, logistical feasibility and the willingness of researchers to share not just results, but their working selves.

3.4 Beyond authenticity

The presence of authentic scientific instruments in exhibitions is often assumed to enhance credibility and emotional engagement. Authenticity is frequently invoked to convey epistemic authority, institutional legitimacy, or historical value. However, studies of visitor experience suggest that authenticity alone rarely ensures understanding, relevance, or emotional connection.

Hampp and Schwan [7] found that many museum visitors preferred didactic models over original objects when trying to understand how an instrument works. In their study, a simulation of an electron microscope was perceived as more "real" than the actual device, which remained static and uncontextualised behind glass.

These findings highlight a central tension: authenticity is not an inherent property of objects, but a relational effect produced through mediation, interpretation, and interaction. A scientific instrument becomes meaningful not simply because it is real, but because it is framed in ways that help visitors make sense of it. Guides, textual cues, spatial context, and institutional narratives all contribute to this process. Without these interpretive supports, even highly significant objects can remain opaque or disengaging.

This has direct implications for the design of exhibitions that incorporate functioning research instruments. The key question is not whether the object is authentic, but how its authenticity is made accessible and relevant. As Gauvin argues [8], the absence of narrative and contextualisation can render even powerful instruments functionless in the eyes of the public. Authenticity, in this sense, is not a guarantee of impact, but a potential to be cultivated through thoughtful mediation, situated storytelling, and responsive engagement.

4. ELISA: a functional proton accelerator in a science communication and outreach centre

4.1 Making a particle accelerator for a museum

The ELISA project emerged from a desire to make accelerator physics more accessible to diverse publics. The decision was made to integrate a functioning research instrument into a permanent exhibition space at CERN's Science Gateway. This move was not only technically ambitious but also conceptually significant: it positioned a working proton accelerator as a communicative object, a bridge between scientific infrastructure and public imagination.

The development of ELISA brought together a range of actors: engineers, physicists, technicians, exhibition designers, and communicators. Each has its own priorities, institutional constraints, and timelines. While some points of convergence emerged, these collaborations were shaped by differing logics: technical performance, safety, accessibility, institutional visibility, and pedagogical clarity. Rather than full alignment, what occurred was a pragmatic negotiation of partial overlaps resulting in a hybrid installation that incorporates elements of a stand-alone object, a demonstration device, and a laboratory in use.

From the outset, everyone involved resisted reducing the machine to a passive display. Instead, the design foregrounded ELISA's technical reality while embedding it in a scenographic environment that evokes the material culture of particle physics 1. The accelerator is installed inside a cylindrical space reminiscent of CERN's underground tunnels. Its visibility is carefully staged, but its function remains active, this is not just a symbol of research, but an infrastructure that still produces measurable results.

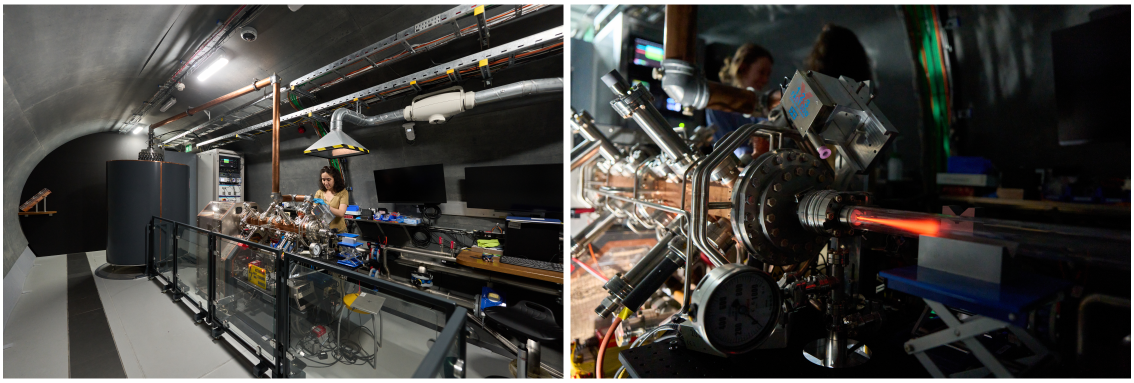

Figure 1: View of ELISA, featuring the designated visitor area (left) and a moment from the beam demonstration (right).

4.2 Mediating science in practice

Drawing on collaborative inputs during ELISA's development, a central design decision was to ensure sustained human mediation. A trained facilitator is present at all times, serving as an interpreter between the accelerator and the public. These facilitators are prepared not only in ELISA's technical functioning, but also in responsive science communication, transforming visits from passive encounters into adaptive conversations.

As originally envisioned, short live demonstrations are held regularly throughout the day. Lasting around ten minutes, they introduce key concepts in beam physics, explain ELISA's applications in surface analysis, and highlight its relevance in fields such as archaeology and medicine. Visitors often remark on the visibility of the beam and the impression of witnessing "real" science in action, echoing the importance of authenticity discussed in Section 3.4.

A particularly illustrative moment occurred during a visit by researchers analysing pigments from prehistoric cave paintings. The accelerator was temporarily reconfigured as a shared space of investigation, where scientific practice and public interpretation coexisted. Such events reveal the conditions under which ELISA functions not only as a communication device, but also as an infrastructuring tool that supports research within new constraints.

This case illustrates that making research infrastructure public depends not only on access or visibility, but on situated practices of mediation, design, and negotiation. As the case studies in Section 3.4 suggest, instruments do not communicate on their own; meaning emerges through framing and interaction. ELISA exemplifies these dynamics in its current, evolving form.

While some interactions, particularly those involving dialogue or live research, open space for co-production of meaning, such moments remain contingent. Not all visitors engage in the same way, and the interpretive tools are still being developed. The exhibition enables co-construction in principle, but its effectiveness depends on ongoing work in facilitation, framing, and design.

5. Discussion and recommendations

From an STS perspective, ELISA can be understood as a boundary object [9], flexible enough to support different forms of engagement. Yet in some contexts, it functions more as an intermediary object [10], shared between groups but not infrastructuring, especially when research and public interaction remain separate. Its mediating role depends on how it is activated, by whom, and under what conditions.

For researchers, it is a functional accelerator. For visitors, it is a site of scientific imagination. For communicators, it becomes a platform for dialogue. These roles are not always aligned. The tensions between them are not signs of failure, but reflections of the complex negotiations involved in making research infrastructure public.

Institutionally, the project exposes shifting boundaries between education, outreach, and research. Installing a working accelerator in a public exhibition required new collaborations, safety protocols, and revised expectations about how science is shared. These negotiations unfolded not only in planning documents, but also in spatial layout, facilitator training, and demonstration design.

In this sense, ELISA is not simply an exhibition about science. It is an exhibition of the conditions under which science becomes public. It reveals science communication as a space where meanings, values, and institutional roles are actively performed and contested. Researchers are also invited to work in modified conditions, shaped by audience presence, safety requirements, and communicative framing. Research is not only made visible to the public; it is also recontextualised through that very visibility.

As a case, this initiative is less a model to replicate than a lens through which to examine the complexity of engaging publics with research infrastructure. Outreach and research do not naturally align; they must be brought into contact through spatial, institutional, and discursive negotiation. Its value lies in precisely this tension. As both a scientific instrument and a communicative interface, it challenges simple boundaries between science and society.

This paper argues that such tensions should be embraced. The installation does not resolve the ambiguity between research and communication; it turns that ambiguity into a resource. It invites publics to encounter science not as fixed knowledge, but as situated practice shaped by technical constraints, human labour, and institutional context. At the same time, it invites researchers to conduct experiments under public observation and within a space designed for visibility and interpretation.

For institutions considering similar initiatives, several reflections emerge. First, functional instruments require active mediation. They do not speak for themselves; their communicative value depends on framing, facilitation, and narrative design. Second, authenticity should be treated as a relational property. It is not embedded in objects but co-constructed through interaction with visitors. Third, interdisciplinary collaboration is essential. Projects like ELISA depend on the ability to navigate technical, epistemic, and institutional differences.

More broadly, ELISA encourages a shift in how science communication is understood. It is not merely a vehicle for delivering facts, but a form of infrastructure, built and maintained through relationships, design decisions, and shared public engagement.

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