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From Research Hubs to Innovation Partners: The Hi-Acts Platform Model for Co-Creation and Societal Impact

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Short Report

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Abstract

Fundamental research accelerators generate technologies, expertise and experimental capabilities with significant potential for innovation and societal impact. However, particle accelerators remain difficult for many external partners to access because their capabilities are distributed across specialised facilities and are often communicated in technical rather than application-oriented terms. This paper presents the Helmholtz Innovation Platform for Accelerator-Based Technologies and Solutions (Hi-Acts), which reframes accelerator facilities from providers of one-way technology transfer to capability hubs supporting industrial co-creation.

Hi-Acts coordinates capabilities across five German accelerator centres while preserving their autonomy. The platform aligns complementary expertise, connects industrial challenges with accelerator capabilities through a single access point and application-oriented use cases, and enables collaboration through targeted early-stage support. Two example cases, a coordinated radiation testing service for the space sector and an integrated operando battery testing workflow, illustrate how this approach broadens industrial access, creates new collaborative services, and accelerates the translation of research capabilities into societal benefit.

The Hi-Acts model provides a practical, transferable platform principle that can be adapted by other accelerator facilities to strengthen innovation and societal impact by coordinating existing capabilities around real-world challenges while preserving their primary research mission.

1. Introduction

Large-scale particle accelerators are powerful scientific research instruments. While their primary mission is to advance fundamental research, the pursuit of this mission leads to the development of technologies, expertise and experimental capabilities that have repeatedly enabled innovations relevant to society. Their broader societal impact therefore depends not only on their contribution to the advancement of human knowledge, but also on how effectively these capabilities can be connected to technological and societal needs (Autio, et al., 1996).

Accelerators present a specific challenge: as general-purpose research tools with applications across diverse sectors, their capabilities can be difficult for non-specialists to understand and access. Many companies are therefore unaware of their relevance, creating an access gap between accelerator capabilities and industrial needs (ESFRI, 2021).

At the same time, industry represents an important pathway through which accelerators contribute to innovation and societal impact (Gastrow, et al., 2025). Traditional models of technology transfer often describe a one-way process in which discoveries move from academia into application by industry. However, innovation also originates from industry, where companies develop solutions in response to technological and societal challenges (Florio, et al., 2018).

Accelerators derive much of their innovation potential not from individual technologies, but from unique combinations of infrastructure, personnel and tacit expertise. Accelerator facilities can therefore act as capability hubs (Eggleton, 2023). By combining these capabilities with industrial knowledge, co-creation approaches can strengthen connections between accelerators and technological and societal challenges.

The Helmholtz Innovation Platform for Accelerator-Based Technologies and Solutions (Hi-Acts) was established to address these challenges across five German accelerator facilities within the Helmholtz Association. Rather than centralising budgets or harmonising missions, Hi-Acts introduces a coordination layer that aligns capabilities, facilitates access and enables collaborative innovation while preserving the autonomy of participating accelerators.

This paper presents the platform model, its implementation and representative examples, and identifies organisational principles transferable to other accelerator facilities and regional innovation ecosystems. The central premise is that increasing impact does not necessarily require building new infrastructure, but better connecting and coordinating existing capabilities.

2. Beyond technology transfer: accelerators as capability hubs

Technology transfer has long shaped how research accelerators have understood and organised their contribution to innovation and societal impact. In its conventional form, technology transfer describes the movement of intellectual property or technologies from academia to external users, who develop them into products, processes or services. This remains an important pathway through which accelerator facilities create societal impact. However, innovation scholarship has increasingly recognised that innovation emerges through interactions between academia, industry and users, with knowledge flowing in multiple directions rather than along a single trajectory (Chesbrough, 2003) (Amesse & Cohendet, 2001).

Alongside transferring accelerator-generated technologies to industry, accelerator facilities provide unique capabilities that help companies to develop and validate their own technologies. The distinctive innovation asset of accelerators is the combination of advanced instrumentation, highly specialised personnel and tacit operational expertise (Eggleton, 2023) relevant across a wide range of industrial sectors (Charisopoulos, et al., 2019). Activating particle accelerators as capability hubs that address problems in partnership with industry results in additional, co-created innovation.

The very characteristics that make accelerators powerful research instruments also make them difficult for non-specialists to discover, understand and navigate (OECD, 2017). The central challenge is therefore an access gap: connecting industrial and societal needs with accelerator capabilities.

3. The Hi-Acts platform model: coordinating innovation capabilities without centralisation

Hi-Acts (Helmholtz Innovation Platform for Accelerator-based Technologies and Solutions) addresses the access gap through a platform model across five German accelerators within the Helmholtz Association, bringing together their capabilities based on X-rays, electrons, positrons, neutrons, protons, ions and gamma radiation for innovation[1]. Rather than replacing existing technology transfer activities, it coordinates access to accelerator capabilities, enables industrial co-creation and lowers barriers to collaboration while preserving accelerator autonomy. The distinctive feature of Hi-Acts is that it operates across institutional boundaries, combining capabilities from multiple accelerator facilities and presenting them to external partners as integrated solutions rather than as individual facility offerings. The platform operates through three functions: **alignment, connectivity and enabling co-creation.**

3.1. Alignment: Building a shared capability portfolio

Before the platform could improve external access, a shared understanding of internal capabilities was needed. The participating accelerators identified three common domains - energy, materials and biomedicine – to which they mapped expertise, instrumentation and potential industrial applications. The resulting portfolio was then published on a shared website.

3.2. Connectivity: Use case framing and a single access point

The Organisation for Economic Co-Operation and Development OECD (OECD, 2017) and Research Infrastructure Technology Infrastructure for Impact RITIFI (Tukainen, et al., 2024) recognise that the utility of accelerators cannot be sufficiently communicated to industry through capabilities alone. Companies seek solutions to problems rather than access to, say, X-ray scattering or ion irradiation. This calls for a problem-oriented rather than technique-oriented perspective.

Hi-Acts therefore adopted a use-case framing to connect capabilities to concrete challenges, such as space electronics, battery testing, pharmaceutical screening and hydrogen storage. These use cases provide a translation layer between industry need and accelerator expertise.

Hi-Acts also established a single point of entry for industrial enquiries. Companies contact the platform with a technical challenge. The challenge is matched with expertise at participating accelerators, with capabilities being combined where appropriate. Together with the shared capability portfolio and use case framing, this simplifies access and reduces the burden on companies to identify appropriate accelerators or methods.

3.3. Enabling: supporting early collaboration

Connectivity does not guarantee co-creation. Hi-Acts uses targeted seed funding to initiate selected use cases. These investments are intentionally limited in scale. Their purpose is not to finance new infrastructure, but to overcome early barriers that prevent promising collaborations from developing, unlocking access and demonstrating utility to industrial partners.

4. Empirical example cases: creating new access and impact pathways

The following two example cases illustrate how the Hi-Acts platform puts the functions described in the previous section into practice. The cases share three characteristics: they respond to a concrete industry challenge; they require expertise and infrastructure from industry and more than one accelerator; and they would not have been realised without Hi-Acts.

4.1. Hi-Acts Space Services: a coordinated radiation testing service for the space sector

Challenge

Electronics must be radiation qualified before they can be used in space missions (Poivey & Day, 2002). The challenge is that radiation test facilities are sparse and fragmented, lead times are long and the field is highly regulated (RADNEXT, 2024). These barriers make radiation testing a critical bottleneck for space innovation.

Response

Hi-Acts responded to this problem by launching Hi-Acts Space Services, initially a collaboration between two accelerator facilities and a private company, the GSI Helmholtzzentrum für Schwerionenforschung (“GSI”), the Helmholtzzentrum Berlin (“HZB”) and Datzmann Interact and Innovate GmbH (“DINI”). DINI contributes knowledge of market needs and industry standards. GSI provides a low volume of access to rare high-energy heavy-ion beams suitable for deep-penetration testing, while HZB provides regular, routine access to complementary proton and gamma radiation. For industrial users, GSI and HZB had separate points of access and were ill matched in terms of service offer.

Intervention: Hi-Acts Space Services

- Alignment: Hi-Acts brought together complementary radiation testing capabilities from both accelerators and matched them to industry intelligence from DINI
- Connectivity: Hi-Acts established Hi-Acts Space Services as a coordinated access pathway for companies seeking radiation qualification support.
- Enabling: Infrastructure and administration changes:
    - Seed funding supported technical changes needed to establish the service: a robotic arm, a standardised testing frame and new user interfaces and workflows.
    - At GSI, new service procedures for dedicated industry access.

Outcomes: While system-level performance metrics are not yet available, a study demonstrates early outcomes of Hi-Acts Space Services (Know.Space, 2025a). The pilot phase reduced preparation time by

several working days and increased beamtime use efficiency by 10–15%. Two follow-up proposals with industrial partners have been initiated. Small companies new to accelerator-based radiation testing also participated. The Space Services pilot now serves as the blueprint for adding capabilities from two further accelerators to the service. **Impact**: The service contributes to applications dependent on reliable space electronics, which are essential for communication, navigation, and Earth observation, for example of ocean currents and deforestation. It also strengthens the EU space sector and contributes to satellite security (European Commission, 2025).

4.2. Hi-Acts Operando Battery Testing: an integrated accelerator–industry workflow

Challenge

The transition towards sustainable energy systems requires improved battery performance, safety and lifetime (European Commission, 2023). A major challenge in battery development is moving beyond post-mortem analysis to understanding degradation processes during operation (operando testing) (Gervillié-Mouravieff, 2024).

Response

The high-speed X-ray tomography capabilities of accelerators could address this gap if they could be made accessible to battery companies. Together with a battery company, Hi-Acts piloted a battery testing service. HZB contributed expertise in operando battery testing, while the Helmholtz-Zentrum Hereon (“Hereon”) provided access to synchrotron-based X-ray tomography at beamlines hosted by Deutsches Elektronen-Synchrotron (“DESY”).

Intervention: Hi-Acts Operando Battery Testing

- **Alignment**: Hi-Acts matched the needs of battery companies to capabilities at HZB and Hereon.
- **Connectivity**: The platform supported the integration of these capabilities into a workflow adapted for industrial requirements
- **Enabling: infrastructure changes**
    - HZB designed and built an operando battery test stand for all major cell formats, with automated sample handling and a plug-and-play workflow tailored to industry.
    - Hereon integrated the test stand with its synchrotron X-ray tomography beamline at DESY, enabling high-resolution 3D imaging of batteries during operation.

Outcomes: The resulting service allowed industrial partners to investigate battery behaviour during charging and discharging through a combination of capabilities that neither accelerator centre could provide independently. Measurement throughput increased by more than 300%, with measurement times reduced to approximately 20 minutes per cell. The capability enabled engagement with industrial partners and created a foundation for further scale-up activities (Know.Space, 2025b). **Impact**: By

enabling high-resolution operando imaging during realistic cycling, Hi-Acts supports the development of safer, longer-lasting and higher-performance batteries. This contributes to applications including electrification of transport, integration of renewable energy and the broader low-carbon transition (European Commission, 2023).

4.3. Additional applications: Extending the model across sectors

Hi-Acts has applied the same approach to further use cases. In pharmaceutical research, Hi-Acts supported the adaptation of existing X-ray powder diffraction capabilities towards high-throughput industrial screening of drug candidates. In hydrogen storage research, the platform enabled industry access to advanced materials testing capabilities for evaluating polymers and composites under realistic operating conditions.

4.4. Lessons from the cases

These examples demonstrate that the transferable contribution of Hi-Acts is not a technology or application area, but an organisational platform model for coordinating diverse accelerator capabilities around industrial challenges. By extending traditional technology transfer towards industrial co-creation, the platform enables accelerator facilities to become innovation partners whilst preserving their primary mission of fundamental research. The cases show that coordinated capabilities, application-oriented use cases and targeted early-stage support can unlock existing potential without major infrastructure or organisational change. In doing so, Hi-Acts provides a route for connecting accelerator capabilities with innovation and societal needs.

5. The perspective of a participating accelerator: GSI

To see how the Hi-Acts platform model transfers, consider the perspective of a participating accelerator. GSI is a heavy-ion accelerator with over fifty years of operation in fundamental nuclear research. Its primary mission is scientific research (GSI Helmholtzzentrum für Schwerionenforschung, 2026). GSI is the host of and majority shareholder in the International Facility for Antiproton and Ion Research in Europe (FAIR) under construction. GSI is primarily a research facility rather than being a user facility with established, routine external access. Creating impact beyond the fundamental research mission therefore requires deliberate mechanisms to connect GSI capabilities with societal needs. GSI's engagement with industry is diverse, but mainly bilateral and case-by-case.

Through Hi-Acts, GSI gained access to a broader industrial network, increased visibility and, hosted its first dedicated industry beamtime under the auspices of Hi-Acts. The scientific and transfer missions of the accelerator did not change; rather, Hi-Acts created an additional pathway through which GSI capabilities could contribute to industrial and societal challenges.

6. Transferability and replication potential

The transferable element of Hi-Acts is its platform coordination model: aligning accelerator capabilities with industry needs and enabling early co-creation. The platform combines capabilities around specific challenges while preserving the autonomy and scientific missions of individual facilities. Hi-Acts is about coordinating what we have, not creating more.

6.1. Lessons from Hi-Acts: what works

1. Start from industrial needs, not available technologies

The example cases show that successful industrial engagement begins with clearly identified challenges rather than by marketing capabilities. Involving industrial partners early – such as the space and battery companies in the examples - helps define technical requirements, shape workflows and create societal impact by addressing real-world needs.

2. Communicate through use cases, not just capabilities

Accelerator facilities are capability hubs whose broad range of applications can make them difficult for external users to navigate. Technical descriptions of methods and instruments are insufficient in communicating their utility. A use-case framing connects capabilities to needs, such as space electronics, battery testing, pharmaceutical screening and hydrogen storage. These use cases provide a translation layer between societal need and accelerator expertise.

3. Adapt existing infrastructure, workflows and administration rather than creating new

Small, targeted adaptations of existing capabilities enable new industrial applications with low cost and effort. These can be hardware, like the standardised testing frame for radiation qualification; adapted workflows, like the operando battery testing service; or service provision, such as industry access to heavy ions.

4. Align capabilities and define a single entry point

Many industrial challenges need combinations of expertise and infrastructure that are not available at a single facility. Hi-Acts creates value by aligning and combining capabilities across accelerators and giving industrial partners a single route to access them.

6.2. Lessons from Hi-Acts: what remains challenging

5. Recognise the limits of coordination

Accelerator facilities are heterogeneous organisations with diverse scientific and transfer missions, access conditions and operational constraints. Successful collaboration therefore depends on mechanisms that enable coordination whilst preserving institutional autonomy.

6. Access requires more than technical availability

Even the best capabilities will remain underused if industry is not aware of them or if access takes too long. Reducing this visibility and cultural service gap is an ongoing challenge.

6.2. A minimal viable platform

The Hi-Acts model can be adapted to different accelerator groups by starting small and scaling according to need. A minimal platform does not require extensive new structures. It requires:

- A single entry point through which external partners can communicate challenges without needing prior knowledge of accelerator techniques.
- A shared portfolio of capabilities across participating accelerators, expressed via use cases.
- Support for early pilot activities that allow workflows to be developed together with industry.

The platform can grow by adding partners and use cases. Additional elements, such as standardised documentation, training and outreach activities or dedicated funding schemes, can be added as the network and demand grow. The objective is to provide a lean coordination layer that connects existing activities for more impact.

7. Conclusion

Hi-Acts demonstrates how accelerator facilities can increase their contribution to innovation and societal impact without centralisation or mission drift. Accelerators are capability hubs, combining advanced infrastructure, specialised expertise and operational knowledge. However, this potential is not fully realised when capabilities are difficult for external users to discover, access and combine. By combining the capabilities of several accelerators with the needs of industry, Hi-Acts creates new pathways for collaboration and impact.

Technology transfer remains an important mechanism for impact, but it is not sufficient to capture the full innovation potential of accelerator facilities. Industry provides an important pathway to societal impact because companies identify technological challenges arising from real-world needs and develop solutions in application contexts. Through co-creation with industry, accelerators can become impactful innovation partners while continuing to fulfil their primary role as centres of fundamental research.

The Hi-Acts platform model addresses this through three functions: alignment of distributed capabilities, connectivity between facilities and external partners, and enabling support for early collaboration. The

cases demonstrate that these principles create new access pathways without centralising resources or changing the missions and governance of participating facilities.

The transferable contribution of Hi-Acts is not a specific technology or application area, but an organisational platform model for coordinating existing accelerator capabilities around industrial challenges. Its added value lies in coordinating distributed capabilities into a coherent offering for external users.

As researchers, our impact comes not only from the accelerators we build and operate, but from how we connect the capabilities they create to society. From research hubs, accelerators become innovation partners. By connecting scientific capabilities with societal challenges, we can contribute more effectively to technological progress and the Sustainable Development Goals.

Declarations

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Data availability: The authors regret that they cannot make raw data for the example use cases (space electronics testing and operando battery testing) available publicly, since it is protected by non-disclosure agreements. Non-disclosure agreements are in place to protect the potential for the economic exploitation of certain Hi-Acts activities by industry; as the manuscript explains, this is the most significant route to social and innovation impact. Consolidated and anonymised data as well as non-proprietary methodology is publicly available in citations (Know.Space, 2025a) and (Know.Space, 2025b).

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Author Contribution

Sonia Utermann wrote the main manuscript text. Jakob Peters is responsible for the two impact studies presented in the example use cases (space electronics testing and operando battery testing). All authors reviewed the manuscript.

Data Availability

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Footnotes

1. The five participating accelerators are Deutsches Elektronen-Synchrotron DESY, GSI Helmholtzzentrum für Schwerionenforschung, Helmholtz-Zentrum Hereon, Helmholtzzentrum Berlin and Helmholtzzentrum Dresden Rossendorf.