

STFC Accelerator International Review: Report

Preface

In April 2025 STFC charged an independent panel of international experts to perform a review of accelerator science and technology activities within the UK. The review was based around two key charges:

- 1) Why should STFC and the UK continue to invest in accelerator science and technology? What would the impact on the overall accelerator field be if it were to stop or continue with the status quo?
- 2) If STFC/the UK continues to invest, what would a sustainable and world-class accelerator science and technology programme look like, in scope and focus?

The panel received submissions from organisations and institutes from across the UK accelerator science and technology landscape in advance of their meeting. This was held in London during 8-10th October 2025.

This report presents the main findings and outcomes of the review. The panel would like to sincerely thank all of those from across the UK landscape who contributed to this process.

Respectfully submitted,

STFC Accelerator International Review Panel

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Executive summary

The panel has reviewed accelerator science and technology in the United Kingdom. Extensive briefing material and presentations by the Accelerator Science and Technology Centre (ASTeC), the Cockcroft institute (CI), the John Adams Institute (JAI), the Central Laser Facility (CLF) Extreme Photonics Application Centre (EPAC), ISIS Neutron and Muon Source (ISIS), and Diamond Light Source (DLS) provided the panel with detailed input and visions from the accelerator leaders and the community in the UK. The panel was supported and advised by representatives from STFC and EPSRC.

The panel would like to thank the STFC hosts, all presenters and representatives for their hospitality and support for our work. We highly appreciated the outstanding openness to discuss priorities and challenges currently faced by the UK accelerator field. The excellence of the various arguments brought forward in our discussions is strongly acknowledged.

The charge to the panel was broad and bold, including a potential scenario where UK would stop investing into accelerator science. The panel would like to point out that the UK has had a pioneering role in accelerator science and technology from the beginning of our field. We highlight the relevant work of Ernest Rutherford, John Douglas Cockcroft and Ernest Thomas Sinton Walton as examples. The UK currently operates world-class accelerator research infrastructures, is a key member of CERN, and has built up two world class accelerator institutes in the last 25 years. Accelerator science and technology is a field in which the UK holds a leadership role with world-wide recognition.

Our report highlights the potential for major societal benefits and industrial applications, many of which the UK is well positioned to lead. Another important benefit is the training of students with advanced technical skills and access to a world-class international network.

The panel has identified four principal areas in which the UK is competitive at the highest international level and has clear potential to be world leading. Beyond the R&D that sustains existing user facilities, future efforts should focus on:

1. **Sustainable RF accelerator technologies** for high-power accelerators, optimising efficiency and stability.
2. **Expanding application reach** of RF and plasma accelerators in medicine, materials science, defence and industry.
3. **Novel accelerator concepts**, particularly those combining particle and high-power laser technologies.
4. **AI-assisted control and optimisation** to enhance performance, reliability and efficiency.

These areas draw on the UK's unique capabilities and infrastructure and, together, define a coherent and internationally competitive accelerator R&D programme.

While the current overall programme is operating well, the panel has identified several disconnections and areas of possible improvement. Recommendations include the establishment of an official STFC strategy on accelerator science and technology informed by science-political goals consistent with UKRI and government priorities. This strategy should be coordinated and steered through an appropriate and dedicated accelerator governance body inside STFC. Such a strategy can optimize synergies, create focus on major goals and avoid duplication of effort.

In assessing the resources required to deliver a sustainable, world-class programme, the panel concludes that annual funding should rise from approximately £20 million to around £25 million, supplemented by operational support of about £13 million for the new EPAC and CLARA user facilities. As both facilities near completion, their full exploitation will be essential to realise the scientific and technological returns on the significant capital investment already made. Combined with the broader UK accelerator R&D landscape, EPAC and CLARA are poised to drive major breakthroughs. When benchmarked against comparable international programmes—such as the Helmholtz Accelerator R&D initiative in Germany—this proposed funding level is somewhat lower, yet consistent with a world-leading ambition for the UK.

In summary, the panel was presented with, and has identified, a world-leading programme for UK accelerator science and technology, that can be optimised and enhanced through coordinated action. The programme – if adequately funded – will be a pillar in international science and will likely produce several new applications of accelerators with important societal benefits in the coming decade.

High-level remarks

Before responding to the specific charges, the panel wishes to outline several overarching conclusions that emerged from its deliberations and from the constructive and informative exchanges with representatives of the UK accelerator community.

Invest for the long term

If the UK is serious about accelerator science and technology, it must fund the accelerator institutes and national laboratories to levels that ensure sustainable delivery. This includes full life-cycle support — from R&D and construction through to operations and exploitation. Transitions from project to operation must be planned and resourced accordingly. In short, to achieve success, it must be done properly.

Develop a coherent business plan

There should be clear expectations for integrated business plans and sustainability models where appropriate. Planning should extend holistically from early-stage R&D through project execution to exploitation.

Fragmented funding processes can hinder long-term capability retention and undermine the UK's potential to lead in accelerator technologies. A more coherent and life-cycle-based funding approach is essential to sustain strategic investments and support effective project delivery.

Exploit synergies across the accelerator landscape

There is considerable expertise spread across the UK landscape — but fragmentation limits its impact. Synergies between institutes (ASTeC, CI, JAI) and between campuses (DL, RAL) must be actively identified and exploited. Facilities, particularly those geographically co-located, should seek to share and exploit joint capabilities as part of an integrated approach. Coordination should not be left to chance or goodwill. Artificial hurdles for collaboration, such as overhead charged to other STFC funded institutions, should be removed.

Recognise world-class elements, and focus effort

There are clearly world-leading capabilities in the UK. These must be identified and supported with both strategic focus and adequate resources. The present lack of a UK accelerator strategy is preventing this from being realised, and it is not clear who would take responsibility for its implementation should it exist. A strategy with clear ownership is required to deliver a world-leading programme.

Support user communities and sustained facility operations

Facilities such as CLF, DLS and ISIS have large and active user communities and represent major national investments. Sustained operational funding must reflect their scientific and economic value. While internal cross-charging may be discouraged, explicit recognition of each facility's role and associated costs is essential to ensure adequate support. In addition, dedicated R&D funding is required to maintain their competitiveness and to develop future upgrade plans.

Recognise and support accelerator skills as a strategic asset

The development of skilled accelerator scientists and engineers should be a national priority. Institutes must be supported not only for their research, but as pillars of training and talent development – especially for sovereign capabilities. The world-leading education programmes led by JAI and CI should be considered strategic assets, directly benefitting UK facilities, international collaborations such as CERN but also UK industry in many sectors (high-tech, AI, finance, defence, ...).

Funding should be sustained and clearly structured

The abrupt cessation of accelerator project funding has disrupted momentum and morale, and had a particular impact on the CI and JAI. Strategic and sustained investment is required if the UK is to remain competitive. Flagship proposals are only feasible with significant national or international contributions. Funding mechanisms should allow early-phase studies (e.g., science case development, costing, technical scoping) and a well-defined and funded path to a full proposal.

Funding mechanisms must recognise and achieve clearer separation between operations funding (stable, predictable) and competitive R&D funding (open to UK academia). Dedicated programmes are needed to promote industrial engagement and improve the return on the UK's investment in CERN, ESRF, European XFEL, ESS and other facilities. Without such focused support, UK institutions (academic and industrial) will be unable to realise their full potential for innovation and economic impact.

Charges to the panel

Why should STFC and the UK continue to invest in accelerator science and technology?

Accelerators are foundational to critical research infrastructure

Particle accelerators underpin a vast range of national and international research infrastructures. Light sources (DLS, CLF, ESRF, European XFEL) and neutron sources (ISIS, ESS) enable major advances in condensed matter physics, materials science, structural biology, and fundamental physics. Particle physics facilities (LHC, PIP-II–DUNE, EIC, etc.) provide deep insights into the fundamental nature of matter and the universe.

The UK's major accelerator facilities - and the access secured through its contributions to international facilities - are key drivers of scientific and socioeconomic impact. For example:

- **ISIS:** new materials, energy conversion and storage, pharmaceuticals, cultural heritage.
- **Diamond Light Source:** catalysis, advanced materials, engineering solutions, life sciences, energy research, cultural heritage.
- **Central Laser Facility:** laser technologies and applications in fusion energy, extreme environments, defence, and security.
- **UK contributions to international projects:** detector and ion technology, microelectronics, computing, artificial intelligence, and high-performance computing.

Sustaining a national accelerator capability ensures scientific autonomy, supports future facility upgrades, underpins UK leadership in next-generation international projects, and strengthens industrial competitiveness. Access to accelerator-based infrastructures also safeguards sovereign capabilities in key areas such as sustainability, energy transformation, biological sciences, and quantum or nanomaterials.

The **STFC-commissioned Technopolis study**, *“Evaluation of the Benefits that the UK has Derived from CERN,”* found that the UK's sustained investment in accelerator-based science yields measurable returns across research, innovation, skills, and science diplomacy. The report highlighted significant benefits through industrial contracts, technology transfer, training of highly skilled personnel, and the UK's enhanced influence in international science policy. This underscores the broader value of maintaining a coherent, long-term national capability in accelerator science and technology.

To retain the ability to build, upgrade, and operate such facilities — and to help shape future global projects (e.g. the next major new project at CERN) — the UK must invest across the full accelerator technology value chain: beam physics, RF systems, cryogenics, magnets, vacuum, controls, diagnostics, and related disciplines.

Global influence and strategic partnerships

The UK has earned international standing as a valuable scientific and technical partner (e.g. CERN, HiLumi LHC, future collider studies e.g. Future Circular Collider (FCC), ESRF, European XFEL, ESS). This depends on competence of UK scientists and engineers as well as real delivery capability, not just financial contributions. Without a strong accelerator base at home, the UK risks diminishing its influence and reputation.

Skills, innovation and industrial spillover

Accelerator science trains multi-disciplinary physicists and engineers who are essential to:

- **Medical technology** – particle therapy, isotope production, and advanced imaging.
- **Green technology** – sustainable energy systems, superconductivity, and high-efficiency RF power.
- **Defence and advanced industries** – aerospace, artificial intelligence, high-speed computing, and quantum technologies.

A well-focused and strategically targeted programme in accelerator science and technology is a vital component of the UK's wider industrial and innovation strategy, driving skills development, technological leadership, and economic impact.

Accelerators as innovation platforms

Accelerators are not just scientific tools — they are platform technologies enabling economic growth:

- Accelerator science and technology is a powerful bridge between fundamental research – such as particle physics – and real-world applications, such as advanced medical imaging and particle therapy.
- Technology transfer from accelerator development into high-tech areas such as medical, electronics, computing, defence, etc. can create economic growth.

Conclusion

Accelerator science is not a niche specialism — it is a valuable strategic capability for the UK.

What would the impact on the overall accelerator field be if it were to stop or to continue with the status quo?

The cessation of the UK accelerator R&D programme would have profound and far-reaching consequences for both the UK and the international accelerator community.

In the immediate term, other accelerator laboratories would be forced to absorb the UK's key capabilities which would cause delays in project execution. The loss of UK expertise and facilities would create visible void in the global research landscape, particularly impacting international collaborations such as those at CERN, European XFEL, ESS and major US laboratories.

Long-term effects would be more severe. The UK would lose its capacity to construct new accelerator facilities domestically, critically hampering its scientific sovereignty and future research potential. Furthermore, the pipeline that currently supplies a highly skilled workforce supporting both scientific endeavours and UK industry would dry up. This brain drain would not only impact the accelerator field but would have cascading effects across multiple sectors, diminishing the UK's capacity for technological innovation and its standing in the global scientific community for years, if not decades, to come.

Maintaining the status quo would avoid the most profound consequences outlined before, it would nonetheless have significant drawbacks. This approach would impede the development of innovative accelerator applications, lead to a diminished skill pipeline, and fail to align with the advancement and implementation of new facilities required for a world-leading national research programme.

The current allocation for accelerator R&D within STFC's core budget is not sustainable. For example, the status quo is not consistent with keeping and further growing the world-leading capabilities in UK accelerator science and technology that we list in this report. Also, the status quo does not address the opportunities in the upcoming CLARA and EPAC facilities and other approved accelerator-based projects. As another example, the absence of a funded accelerator programme in collaboration with CERN could severely limit the UK's ability to contribute to the design and R&D phases of the FCC or other flagship projects.

In light of these considerations, the panel concludes that preserving the status quo would be inadequate to effectively address the evolving science needs, both domestically and on the international stage. A more proactive and robust approach is necessary to ensure the UK's continued relevance and leadership in this critical field.

If STFC/the UK continues to invest, what would a sustainable and world-class accelerator science and technology programme in the UK look like, in scope and focus?

If STFC and the UK are to continue investing meaningfully in accelerator science and technology, the resulting programme should be:

Mission-led and coherent

- Decisions and funding should be aligned with a national accelerator roadmap following UKRI and government strategic priorities.
- Be guided by a common strategy and a dedicated accelerator governance body to prevent fragmentation and ensure synergies.
- Activities towards facilities, R&D, skills, and industrial impact should be coherent and planned together, rather than in isolation.

Anchored in facilities that deliver

- Sustain and evolve key national facilities (e.g. ISIS, Diamond, EPAC, CLARA) as anchors for science and innovation.
- Ensure full life-cycle funding: from design and construction, to upgrade and sustainable operation.
- Clearly separate and protect **competitive R&D funding** from operational budgets to allow effective planning and maximum utilisation of facilities.

Backed by strategic technology R&D

- Focus on enabling technologies in which the UK has recognised strength. We refer to the list below.
- Ensure R&D is goal-oriented and is linked to long-term facility development and societal applications.

Delivers a sustained skills pipeline

- Expand and stabilise training led by CI and JAI
- Work towards a fully coherent programme at RAL, that strongly links into the JAI, amongst others.
- Support PhD programmes and early-career talent through visibility, funding, and project involvement.
- Provide access to operating facilities to ensure experiential, hands-on training.
- Consider establishing a **competitive postdoctoral programme** to retain and develop the most promising PhD graduates within national R&D efforts.

Engaged with industry and impact

- Build structured mechanisms for industry collaboration and knowledge transfer.

- Encourage accelerator-based innovation in health, energy, security, quantum, and other sectors and provide funding pipelines to enable innovation and to cover the "valley of death" (transition between Technology Readiness Levels of ca. 3 to 7).
- Take inspiration from international models (e.g. CERN KT, PSI Tech Transfer).
- Involve industry in training.

Internationally visible and connected

- Retain national capability while participating actively in international programmes.
- Participate in future frontier initiatives and in European and OECD frameworks.
- Ensure UK technologies and facilities are seen as attractive international partners.
- Use both CERN membership and broader diplomatic channels to enhance global visibility and influence.

In summary

A sustainable and world-leading accelerator programme is not just a set of excellent facilities or research groups. It should be a joined-up national endeavour with a clear sense of direction, the capacity to deliver, and an ambition to lead and a determination to profit economically. Such an endeavour should be grounded in national priorities, supported by long-term funding, and recognised internationally for its scientific, technological, and societal impact.

What would this programme look like with respect to equivalent activity within other comparable (e.g. European) nations?

The UK accelerator programme should avoid pursuing topics or facilities that are already delivered at world-leading level elsewhere, particularly where the UK already plays an active role, unless there is a clearly defined national user need.

The UK accelerator programme should reflect the national science policy framework, which places strong emphasis on applications, impact, and return on investment. Over the past decade, UK accelerator science and technology has adapted to this focus and developed internationally recognised capabilities aligned with these priorities.

We recommend that the UK continue to pursue an **application-oriented approach**, likely more focused than in other European nations. This aligns with national strengths and policy objectives.

The UK should also continue its **successful contribution to international projects**, particularly through in-kind delivery of technologies and components (e.g. to future CERN collider programmes).

In what areas could a UK programme be competitive at the highest international standards with the potential to be world-leading?

The panel has identified several areas in which UK accelerator science and technology is competitive at the highest international standards and holds clear potential to be world leading:

Sustainable RF accelerator technologies for high-power or high-brightness particle accelerators

The UK is already a trusted and sought-after supplier of concepts and devices that enable high-power, high-energy accelerators with exceptional efficiency — for example, superconducting RF accelerating structures delivered to **PIP-II** and **ESS**, and **crab cavity** systems that optimise luminosity at the **HiLumi LHC**. Environmentally sustainable RF technologies in development include e.g. thin-film SRF, fast reactive tuners and high efficiency klystrons. The achievements, supported by world-class infrastructure at **ASTeC**, position the UK to make major contributions to future national and international projects and to secure strong returns on investment.

Expanding application reach of RF and plasma accelerators in medicine, materials science, defence and industry

The UK has developed strong expertise in applying RF and plasma-based accelerator technologies to **medicine, materials science, defence, and industry**. Multiple approaches are being explored, several of which are likely to lead to economically valuable applications. In particular, the panel highlights work on **advanced tumour treatment** (e.g. FLASH therapy and VHEE) and **high-resolution medical imaging** using betatron radiation. The emerging capabilities of **CLARA** and **EPAC** offer strong potential to accelerate progress in these areas.

Novel accelerator concepts, particularly those combining particle and high-power laser technologies.

The UK has invented and pioneered various game-changing technologies for plasma accelerators over the last 20 years; most recently the HOFI plasma channel that has allowed guiding high power lasers and achieving new energy records. The upcoming EPAC facility will provide a unique testbed to advance laser-driven plasma accelerators towards user readiness up to several GeV of beam energy.

AI-assisted control and optimisation to enhance performance, reliability and efficiency.

The UK has begun applying **AI-driven optimisation and control** techniques to accelerator operation, with early success at **SCAPA** and **CLARA**. Extending these approaches across other national facilities could significantly improve operational efficiency, reliability, and beam quality, while strengthening UK expertise in this emerging global frontier.

Accelerator R&D enabling the operation of national facilities, in particular the user facilities ISIS and DLS.

Both ISIS and DLS operate world-class science programmes. This is enabled by the successful operation of both ISIS and DLS and will be enhanced by the DLS-II upgrade. Successful and world-wide competitive operation is only possible because of the excellence of the accelerator teams in these facilities and their R&D activities, along with activities at the collaborating accelerator institutes and other UK partners.

What unique capabilities and strengths does the UK have which would support this?

The UK accelerator community has developed a number of unique capabilities and world-class strengths that support the above identified areas. We describe those below, grouped by area, with some examples.

Technology and systems innovation

- Advanced RF device prototyping, including crab cavities for HiLumi LHC and high-efficiency klystrons
- Ultra-fast beam feedback and high-resolution beam diagnostics
- Innovative **plasma-based design concepts**, such as the HALHF Higgs-factory study and exploratory R&D at the 10 TeV energy frontier.
- Electron plasma-based acceleration technologies: HOFI channels, betatron sources, staging concepts
- Capabilities in **THz generation, manipulation, and acceleration** for advanced beam control and diagnostics.
- World-class permanent magnet development (e.g. ZEPTO)

Core infrastructure and enabling technologies

- Leading SRF technology and infrastructure (contributions to e.g. PIP-II, ESS, HiLumi LHC), including thin-film R&D and cryogenics
- Vacuum surface technologies: NEG coatings, laser-engineered surfaces
- Sustainability-driven accelerator components: thin-film SRF, efficient klystrons, vacuum, permanent magnets
- Dedicated test stands and infrastructure supporting green accelerator R&D
- Outstanding high-power laser expertise at CLF supporting LWFA research
- CLARA as a development platform supporting electron-laser interaction capability including THz manipulation/acceleration.

Applications: medical, industrial and defence

- Proven accelerator-based proton therapy (RF and plasma): Christie PBT, SCAPA, Beamline B (FLASH)
- CLARA as test bed for VHEE, FLASH, and radiobiology, and accelerator applications, and EPAC as a platform for security and defence applications
- ASTeC's role in translating accelerator R&D into applied contexts (medical, industrial)

Education, talent and networks

- Strong university base and continuous pipeline of skilled students and researchers contributing to science, industry, and innovation
- The combined efforts of the academic training at JAI and CI as well as the professional training by ASTeC offer a globally recognized pipeline in accelerator science and engineering — already supporting the national facilities, industry and international labs.

Established national facilities

- The UK hosts a robust portfolio of accelerator-based research infrastructures — **Diamond Light Source, ISIS, CLARA, and the CLF (including EPAC)** — providing operational platforms, expert teams, and user bases on which to build future developments.

Strong international partnerships

- The UK is an influential **CERN Member State** and an active contributor to **HiLumi LHC, FCC, ESRF, European XFEL, PIP-II/Dune and ESS**, ensuring access, credibility, and long-standing collaboration channels across Europe and beyond.

Interdisciplinary reach and industrial opportunity

- UK accelerator science is deeply connected to applications in **health, energy, advanced materials, quantum technologies, advanced manufacturing, and defence**.
- Programmes such as **STELLA, MedTech, and LhARA** exemplify the UK's capacity to translate accelerator R&D into societal and industrial benefit.

Proven delivery capability

- UK teams have an outstanding track record in **delivering key accelerator systems** — including magnets, beam instrumentation, and cryogenics — to large-scale international projects, often under tight schedules and constrained budgets.

Geographic co-location

- The co-location of ASTeC and CI (with its four university partners) at DL and the facilities at RAL with the JAI (with its three university partners) is a strength to form collaborations and to exploit local buy-in and support.
- The co-location of several major facilities at the Rutherford Appleton Laboratory campus creates potential for integration, shared services, and stronger operational synergies.

What would a sustainable skills pipeline look like, which could ensure the UK has the skills to meet the needs of future and long-term accelerator project requirements?

A highly successful skills pipeline has been established through the John Adams and Cockcroft accelerator institutes with more than 50 academics in seven connected UK universities. Their training programme is world leading. The panel finds it important that support for this pipeline is continued, especially by providing sufficient funding for a strong PhD program.

In order to take full advantage of this resource, a competitive research programme on top of the core grants should be made available. This is required to build critical mass around R&D activities which can meet the needs of future accelerator projects.

A sustainable UK skills pipeline in accelerator science and technology should:

- **Support national training** through the activities at the JAI, CI (academic), and ASTeC (apprenticeships and practical training) as long-term, stable pillars — with predictable, multi-year funding for PhD cohorts, postdocs, and technical apprenticeships.
- **Ensure hands-on access** to operational facilities (e.g. CLARA, DLS, ISIS, EPAC) to complement academic training with practical experience in beam delivery, diagnostics, operations, and systems integration.
- **Enable continuity across career stages**, with clear progression from graduate education through postdoctoral roles, fellowships, and technical staff positions — including competitive retention packages to keep the brightest young minds engaged in science.
- **Align training with national and international needs**, ensuring that skills are relevant to emerging technologies (e.g. SRF, high-field magnets, AI-based diagnostics and controls, medical applications) and global project participation (e.g. CERN, European XFEL, ESRF, ESS, EIC, etc).
- **Foster industrial engagement and cross-sector mobility**, by embedding industry placements, co-supervision, and joint innovation projects into PhD and early-career programmes.

- **Coordinate nationally**, to avoid duplication, maintain critical mass, and ensure coverage across technical disciplines. A dedicated accelerator governance body should monitor gaps and adjust support accordingly.

How could this programme best support and facilitate industry involvement, (particularly) as an integral component of future accelerator construction projects?

The technologies and skills available in the field of accelerator science are better matched to transferring science results to industry, as compared to many other fields. Industry should be involved both as facility user and as co-developer for technologies with potential for industrialisation. The panel has seen that both ISIS and DLS generate income from industry. ASTeC has hosted several industrial companies for tests or co-development and currently has the potential to secure a large contract related to cryogenic infrastructure for quantum computing. Industrial potential is already at an impressive level, but the panel has identified missing aspects: there appears to be a gap in transferring research results to industrial products (i.e. the 'valley of death' - transfer from TRL4 to TRL7). Similarly, the early involvement of industry in the design and production of accelerator components is missing and has the potential to strengthen this sector.

To effectively integrate industry into future accelerator construction projects, the UK programme should:

- **Involve industry early in project lifecycles**, from concept design to technical studies and prototyping — ensuring industrial capabilities help shape specifications, costings, and delivery models.
- **Provide predictable project pipelines**, with clear timelines and procurement roadmaps that allow UK industry to plan investments in staff, tooling, and facilities.
- **Maintain UK design and systems integration capacity**, allowing UK labs and institutes to lead complex subsystems and interface with industry as intelligent, capable supplier — a model that has worked well in CERN collaborations.
- **Restore and increase the programmes that are designed to facilitate knowledge transfer and skills exchange**, through secondments, co-supervised students, and joint training programmes that build long-term capacity in both the research and industrial sectors.
- **Promote continuity and follow-through**, especially between large-scale projects, to retain experienced industrial partners and avoid loss of know-how between funding cycles.
- **Encourage strategic industrial alignment**, identifying areas where UK industry strengths (e.g. cryogenics, RF power, precision engineering, diagnostics) match long-term accelerator needs — nationally and internationally.

There should be dedicated programmes for making UK industry fit and for leveraging accelerator technology for society. Activities could be directed along two strands:

Strand 1: Making UK industry fit for taking advantage of future UK investments into large international accelerator-based projects.

This will require identifying a few companies who are willing and able to embark on delivering the very specialized components and services: for example, those required by the next project at CERN. It will need a clear division of research, development and production. The STFC funded accelerator institutions must take leadership of the research component, that they can provide expert capabilities for. It is their role to complete a physics design and to build first prototypes demonstrating feasibility of a design. But while doing this they should identify and consult companies who can later take up series production. The final series production should happen in industry with oversight from STFC specialists.

The key step is getting a small number of selected of companies engaged with a project from its beginning. This requires predictable incentives and funding in the path leading up to the final procurement of the product. One example for this could be paid-for design studies given to several companies. This would allow those companies to spend resources and get them familiarized with the challenges of the specific technology. In return, STFC would get proposals for technical solutions, as well as estimates for cost and delivery time.

Strand 2: Levering accelerator technology for society

The existing innovation activities within UKRI and STFC should be adapted to better respond to the scale (cost and duration) of industrialising accelerator projects. This might require selecting fewer projects, but with larger funding volume per project. This also needs coordination across the different UKRI agencies.

Convincing industry to take up a project like a medical accelerator project for example will require an initial investment on the scale of millions and take several years, before industry is willing to co-fund the hundreds of millions needed for a first machine located in a hospital.

How should the programme tension the delivery of large-scale UK national accelerator infrastructure against contributions to overseas infrastructure?

The panel strongly believes that the **combination** of a strong national UK accelerator programme together with strategic UK subscriptions to international accelerator facilities provides the best benefit to the UK. Only a strong accelerator community in the UK can contribute to international accelerator projects, can create return value both economically and in technological capabilities, and can exploit the unique

capabilities of international facilities. The domestic programme must not however be compromised by international engagements.

Concerning support of national projects: large-scale UK national accelerator infrastructure is driven by science needs and priorities. Once a project is approved the panel finds it important that all UK accelerator bodies with relevant capabilities are included into the project planning and delivery. The UK accelerator institutes and national laboratories should assign priority to the support of national projects, as this fosters synergy and a spirit of collaboration. It is important that duplication of capabilities and expertise is avoided during the execution of large UK accelerator projects.

Contributions to overseas infrastructures are nevertheless important, as they can create a national return on subscriptions to international research organisations. It should be investigated if in the future part of the subscription fees to outside UK can be paid through in-kind deliveries instead of cash payments.

This (important) tension should be managed through:

- **A coherent national roadmap** that explicitly defines the UK's long-term infrastructure vision and identifies where international partnerships offer better scientific or economic leverage.
- **Strategic criteria** to assess value-for-money, scientific return, skills impact, and industrial opportunity for both domestic and overseas investments; care is required, particularly towards identifying longer-term risks and commitments.
- **Flexible funding mechanisms** that allow the UK to lead in selected areas at home, while remaining a respected and visible contributor abroad. A healthy balance enables the UK to remain globally connected while sustaining national capabilities and delivering clear domestic benefit.

How should the UK accelerator 'ecosystem' (national laboratories, large scale facilities, accelerator institutes and higher education institutes) be optimally configured to deliver this programme?

The UK has two geographically separated centres of excellence already. One clustered around the RAL site and the universities in and around Oxford and London. The other clustered around DL and nearby universities in the North West of England. Both centres and their identity need to be retained.

The collaboration between national institutes and universities across the UK is institutionalised via the John Adams and the Cockcroft accelerator institutes. It is already working well.

On the RAL campus the collaboration between the facilities (ISIS, DLS, CLF, Ada Lovelace, etc.) has room for significant improvement. From the panel's perspective,

there are multiple potentials for synergies (better output at same or even lower cost) which are not exploited because of historical and institutionalized siloing.

Examples of areas with unexploited synergies are:

- RF, magnet, vacuum technology
- Control systems
- Alignment and radiation safety
- User office
- Technical infrastructure (building maintenance, media, access control, radiation safety, etc.)
- Engineering (CAD design, simulation, prototyping, testing, metrology, etc.)
- Computing and data storage (which is becoming ever more important and costly)

The panel strongly recommends considering a reorganisation of facilities and institutes not only allowing but encouraging collaboration between the organizations and their technical groups including STFC's Technology Department (TD). This includes minimising any administrative barriers such as the charging of overhead costs.

What are the advantages and disadvantages to how the current UK accelerator 'ecosystem' is configured? What should change?

The panel has discussed advantages and disadvantages in the configuration of the UK accelerator 'ecosystem'.

Advantages:

- Strong regional clusters enhanced by the accelerator institutes, linking regional laboratories, accelerator facilities and universities.
- The option to have competition that reward best performance (presently absent due to the discontinuation of project grants).
- Strong in-house capabilities that allow to move fast and strong on operation and projects.
- High degree of academic freedom for researchers who (to a large extent) can define by themselves their research direction, collaborations and project involvement, both nationally and internationally.
- Massive contribution by the Wellcome Trust as a 14 percent funder of Diamond Light Source since its inception.
- ASTeC as a powerhouse for accelerator science and technology in the UK with its ability to connect accelerator R&D to national and international projects/priorities.

Disadvantages:

- Lack of a body that discusses, defines, communicates and tracks a UK national strategy on accelerator science and technology.
- Lack of science-political guidance for UK accelerator science and technology.
- Disconnection between the national accelerator facilities and the technology and engineering capabilities at ASTeC and TD. This leads to build-up of duplicate structures and increases cost.
- Disconnection between DLS and ISIS facilities with other bodies in the accelerator landscape (e.g., ASTeC, CI, JAI).

The following configuration changes are proposed:

- Definition of science-political goals for UK accelerator science and technology.
- Establishment of an **STFC dedicated accelerator governance body and formulation of a UK accelerator strategy**, including oversight on projects and execution of strategic decisions. It should be ensured that the wider accelerator community view is included through the accelerator governance body, which should also be connected to UKRI and its wider agencies. The dedicated accelerator governance body should be mandated to ensure:
 - Long-Term vision encompassed with the international large project landscape (European XFEL, ESS, EIC, next CERN collider...)
 - Medium-term commitment planning and associated financial planning
 - Coherent forward planning and tailored uptake of proposals from a creative community
 - Provide advice to UKRI on prioritisation of national needs over localised initiatives, given finite resources. Be prepared to be honest, if a large project doesn't have a realistic chance on medium term timeframe (ISIS-II, UK XFEL) - curtail effort.
- Establishment of an informal and strategic industry advisory board for accelerator science and technology.

What role should STFC play?

To ensure the UK remains at the forefront of both discovery and delivery, STFC should fully embrace its role as the UK's strategic steward for accelerator science and technology, with responsibilities to:

- **Set and maintain a national accelerator roadmap**, aligned with UKRI, government and international priorities.
- **Coordinate the national accelerator programme**, ensuring synergy across facilities, institutes, and R&D efforts, while engaging the broader community such that all parts recognise the value of the ecosystem.
- **Secure and provide stable operations funding** for key facilities, **while enabling open, competitive project-based R&D funding**.
- **Support skills and training**, sustaining the PhD and early-career pipeline across the landscape.

- **Drive industrial engagement and impact**, translating accelerator technologies into societal and economic benefit.
- **Strengthen UK presence in global programmes**, and enable leadership in CERN, European XFEL, ESS and beyond.
- **Encourage integration on the RAL campus** of the accelerator facilities departments (particularly Diamond and ISIS), both together and with other departments (e.g., STFC TD, SCD) reducing duplication and improving strategic coherence.

How should the UK best utilise the capabilities of the Cockcroft and John Adams accelerator institutes?

Both institutes already provide an outstanding value on the very limited core grant they receive. The core STFC budget is roughly tripled through additional funding obtained. A high number of students, publications and patents is achieved.

The utilisation of the two institutes can be further optimised by agreeing a common strategy and roadmap, to be discussed and implemented through various bodies. The process to create a strategy and roadmap should be led by STFC level but fully engage all accelerator institutes, national laboratories, facilities, user communities and connected universities.

What level of resource would be required to deliver this sustainable and world class programme?

Based on the information provided, the panel understands that today (financial year 2025/2026) the following approximate full cost budget is spent annually from the STFC core budget against activities we characterise as accelerator R&D:

Organisation	£m
ASTeC	12.0
Cockcroft Institute ¹	2.9
ISIS	3
John Adams Institute ²	1.9
Total	19.8

Table 1: STFC core funding committed against accelerator science and technology R&D, FY 2025/2026, by organisation, as presented to the panel. The ASTeC number refers to the sum of 'STFC Allocation' and 'STFC for CLARA Capital'.

Here it is assumed that there is no accelerator R&D at the Diamond Light Source, as it was presented to the panel. After the end of DLS-II, accelerator R&D will likely be resumed at DLS with possibly a comparable cost as at ISIS. We do not include this here.

As context, the panel were presented with the following figures for current STFC annual commitments/subscriptions to the operation (as distinct from accelerator R&D) of national and international accelerator facilities, totalling ~340 MGBP. The information excludes potential future commitments.

Organisation	£m
National	
Diamond Light Source	76
ISIS	86
International	
CERN	166
European XFEL	7
ESRF	8.9
Total	343.9

Table 2: STFC commitments (annual) to accelerator facility operations costs and associated subscriptions (national, international), as presented to the panel.

The panel notes that the accelerator science & technology programmes at the national laboratories and accelerator institutes ("Programmes Directorate (project) funding") have delivered several world-leading activities in line with international engagements

¹ Estimated, based on total averaged over grant duration

² Estimated, based on total averaged over grant duration

of the UK. We mention as two examples the UK leading contributions to the CERN HiLumi projects and the UK construction of central ESS equipment, among many other examples. This creates major return value for the UK from international engagements. Furthermore, these national programmes have promoted strong engagement with international projects and facilities on which broader UKRI research efforts depend.

This motivates the re-implementation of a competitive funding program for accelerator R&D projects, accessible to the UK accelerator community and aligned with national priorities and international engagements. In line with the charged world-class programme we would conservatively propose funding at ~5 MGBP.

Of special note are two upcoming UK facilities that will have unique impact on accelerator science and technology development:

- **CLARA at DL**, a dedicated Accelerator R&D facility, which would require ~5.5 MGPB to operate (with indexation). Full exploitation by UK scientists of this facility for accelerator R&D would likely require an additional 1 MGBP funding. This figure is included in the ASTeC £12m operating costs in Table 1; ASTeC are currently committed to running costs associated with machine commissioning, and these would transition into operations costs for user exploitation following completion of the project.
- **EPAC at RAL**, a CLF science facility with separately funded operational costs of ~8 MGBP, which will enable unique exploration of advanced accelerator concepts. Full exploitation by UK scientists of this facility for accelerator R&D would likely require an additional 1 MGBP funding.

Finally, these programmes could be more strongly leveraged for direct industry engagement through the funding of ~10 joint PhD students with industry at a cost of ~0.3 MGPB per annum.

Thus, the panel concludes that sustainable delivery of this world class programme requires 33.1 MGBP per annum which would include operating costs 13.5 MGBP for CLARA and EPAC.

The proposed funding scenario for a world-class UK programme in accelerator science and technology, as charged to the panel, is summarized in Table 3.

Organisation / Programme	£m
ASTeC including CLARA operating costs	12.0
Cockcroft Institute ³	2.9
ISIS	3.0
John Adams Institute ⁴	1.9
Competitive funding line for continuing accelerator science & technology work in line with national priorities and international UK involvements, with reserved parts for work at EPAC and CLARA	5.0
Funding line for PhD programme with industry (10 PhD)	0.3
EPAC operating costs	8.0
Total	33.1

Table 3: Proposed annual funding scenario for a world-class UK programme in accelerator science and technology, that builds on and exploits unique UK capabilities and past investments. Budget numbers are 2025 reference, material plus personnel, except for PhD students.

As requested by the charge, we compare the UK effort to the Helmholtz programme on accelerator R&D in Germany. This programme is a coordinated multi-centre program, placed as a “topic” ARD within the Matter & Technology programme in the research field Matter of Helmholtz. The participating centres are DESY, GSI with HI-Jena & HI-Mainz, HZB, HZDR, KIT and FZJ (the latter only contributing 1% to the total. Resources in the year 2021 were amounting to 139 FTE core-funded scientists with core-financed costs of 60.2 MEUR or 52.4 MGBP (full cost basis). This is pure accelerator R&D (so-called work category 1) and is separated from the much higher yearly operational costs for the accelerator user facilities that are in the work category 2.

It is noted that in addition there are multi-million Euro programmes for supporting accelerator R&D work in the universities (“Verbundforschung”). Accelerator R&D does exist in Max-Planck-Institutes and Fraunhofer Institutes but at a much smaller scale compared to Helmholtz and focusing on novel accelerator R&D (see for example the Max-Planck initiated AWAKE project at CERN).

It is seen that the level of proposed yearly level of UK investment towards a world-class accelerator R&D program, including operational costs for CLARA and EPAC, (37-38 MGBP) is in line with investments as they take place in Germany (52-60 MGBP). Given the very strong UK position in applications and delivery of technology, we consider it an excellent investment option for UK and STFC budgets. Based on Table 2 such a programme would constitute ~10 % of the total STFC commitment against accelerator facility operations, nationally and internationally.

³ Estimated, based on total averaged over grant duration

⁴ Estimated, based on total averaged over grant duration

Accounting for both high impact activities, and those required to fundamentally underpin overall delivery of the programme, what would the priority areas be?

The high impact activities should be, as identified above:

- **Sustainable RF accelerator technologies** for high power particle accelerators that have optimized power efficiency and stability, including the use of advanced super-conducting technology.
- **Expanding application reach** of RF and plasma accelerators in medicine, materials science, defence and industry.
- **Novel accelerator concepts**, particularly those combining particle and high-power laser technologies.
- **AI-assisted control and optimisation** to enhance performance, reliability and efficiency.

We mention that developing meaningful maximum impact will require significant help from the wider scientific, industrial and technological communities – particularly the more interdisciplinary that it is.

The activities that fundamentally underpin the overall delivery of the programme include in our assessment:

- Design and numerical simulation of particle accelerators.
- Clean-room, cryogenic and vacuum technologies plus facilities to be used for developing super-conducting accelerator elements.
- Advanced beam instrumentation, feedback, and manipulation techniques.
- R&D on plasma accelerator concepts and technology, in particular laser-driven.
- The operation of EPAC as a required test facility for plasma accelerators.
- The operation of CLARA for developing low energy accelerator applications and exploring industrial user cases.
- A continued activity towards accelerator technologies and concepts for colliders, including a significant contribution to CERN's flagship accelerator project (presently HiLumi LHC, in future possibly FCC-ee and FCC-hh).
- Community building and networking activities across the UK accelerator science and technology R&D community.

Higher level view priority areas are:

- **Sustain and upgrade national facilities** (ISIS, Diamond, CLF, CLARA/EPAC) with full lifecycle funding to support user science and technology platforms.
- **Invest in enabling technologies** (SRF, beam diagnostics, AI controls, high-rep lasers) to underpin future facilities and global collaborations.
- **Support the skills pipeline** through stable PhD programmes, hands-on training, and coordinated national education at JAI, CI, ASTeC and STFC labs.



- **Improve coordination and integration** across RAL-campus facilities and national institutes to increase efficiency, share resources, and avoid duplication.
- **Maximise societal and industrial impact** by creating clear pathways for translating accelerator technologies into health, energy, security, and innovation.

Annexes

Annex 1 – Terms of Reference, STFC Accelerator International Review



STFC Accelerator International Review: Report

Annex 1: Terms of Reference

1. Background

- 1.1 STFC is performing a review to evaluate what a world-class accelerator science and technology programme in the UK could look like, in scope and focus, and what role STFC as an organisation should play in its delivery.
- 1.2 The need for a review is driven by an absence of a functional STFC accelerator strategy. There have been three initiatives to develop an accelerator strategy; the most recent being the [STFC Strategic Framework for Future Accelerator Science and Technology Development](#), published in 2022. This work has unfortunately been insufficient in supporting STFC decision making.
- 1.3 The review will be the first part of a two-stage process to set a strategic direction of travel for future UK accelerator activities. This first stage will be led and performed by a panel of external experts, referred herein as the Accelerator Review Panel, which will culminate in a set of recommendations to STFC.
- 1.4 In the second stage, recommendations will be considered by STFC Executive Board, with input from STFC's advisory structure. They will define a forward route beginning April 2026, accounting for the position of accelerators within the broader STFC portfolio and funding constraints.

2. Terms of reference

- 2.1 The Accelerator Review Panel is tasked to provide recommendations on the following topics, linked to a strategic direction of travel for future UK accelerator activities:
 - Why should STFC and the UK continue to invest in accelerator science and technology? What would the impact on the overall accelerator field be if it were to stop or to continue with the status quo?
 - If STFC/the UK continues to invest, what would a sustainable and world-class accelerator science and technology programme in the UK look like, in scope and focus? For example:
 - What would this programme look like with respect to equivalent activity within other comparable (e.g. European) nations?
 - In what areas could a UK programme be competitive at the highest international standards with the potential to be world-leading?
 - What unique capabilities and strengths does the UK have which would support this?
 - What would a sustainable skills pipeline look like, which could ensure the UK has the skills to meet the needs of future and long-term accelerator project requirements?

- How could this programme best support and facilitate industry involvement, (particularly) as an integral component of future accelerator construction projects?
- How should the programme tension the delivery of large-scale UK national accelerator infrastructure against contributions to overseas infrastructure?
- How should the UK accelerator ‘ecosystem’ (national laboratories, large-scale facilities, accelerator institutes and higher education institutes) be optimally configured to deliver this programme?
 - What are the advantages and disadvantages to how the current UK accelerator ‘ecosystem’ is configured? What should change?
 - What role should STFC play?
 - How should the UK best utilise the capabilities of the Cockcroft and John Adams accelerator institutes?
- What level of resource would be required to deliver this sustainable and world class programme?
 - Accounting for both high impact activities, and those required to fundamentally underpin overall delivery of the programme, what would the priority areas be?

2.2 STFC expects these recommendations to be informed by:

- Evidence on the current accelerator science and technology programme in the UK, including commitments to international projects and encompassing both activities funded by STFC and those funded from elsewhere
- The current long-term (5-10 years) vision of the contributing departments and institutes, including views on priorities and funding development
- The views of relevant user communities, e.g. as expressed via the UK position on the European Strategy for Particle Physics
- Best international practice
- Relevant components of the broader STFC science programme
- The facilities and skillset available in the UK (across national laboratories, academia, and industry)

2.3 The Review must encompass the activities of:

- The UK Accelerator Institutes (Cockcroft, John Adams), accelerator projects, and programmatic calls (e.g., aligned with the ESPP and PPAN roadmap), managed by STFC Programmes Directorate
- The Accelerator Science and Technology Centre (ASTeC), part of STFC National Laboratories: Science and Technology
- Accelerator R&D from within STFC National Laboratories: Large Scale Facilities, e.g., a subset of activities within the ISIS Neutron and Muon Source, and the Central Laser Facility (CLF)
- Accelerator R&D at Diamond Light Source (DLS)

- 2.4 The review should place recommendations in context of a ten-year period beginning April 2026.
- 2.5 To ensure a comprehensive view is taken, the review should account for activities in which the remit of STFC may overlap or meet with other UKRI Councils (e.g. EPSRC, MRC, etc.). This includes:
 - Activities focussed on the application of accelerators in non-particle physics domains (e.g., medical applications)
 - R&D which could be classified as physical sciences and engineering research (e.g., plasma acceleration)

3. Membership

- 3.1 The Panel should be chaired by a knowledgeable, independent, and senior member of the international accelerator community.
- 3.2 The Panel membership is expected to comprise of established experts from relevant fields with experience of providing strategic direction. They should be primarily independent to both STFC and the UK accelerator institutes. The membership is expected to be predominantly international, although not limited to this.
- 3.3 The panel will include non-voting members including (but not limited to) representatives of STFC's advisory board structure, and other councils within UKRI. Non-voting members are expected to:
 - Offer factual and contextual information to aid the panel during open sessions, for example, regarding the status of the UK accelerator landscape and other funders of accelerator science and technology within the UK
 - Provide input in an unbiased manner, being conscious to recognise possible conflicts of interest
- 3.4 The Panel Chair is expected to commit to:
 - Work with the secretariat and Panel members to augment and finalise these Terms of Reference
 - Ensure that the final review is performed in accordance with the Terms of Reference
 - Provide advice to the secretariat in advance of the review, working in partnership to develop an agenda which can deliver the review objectives
 - Ensure that all Panel member views are heard at meetings, the recorded advice is representative of the views expressed, and that all present discharge their roles appropriately
- 3.5 Panel members are expected to commit to:
 - Act objectively and in accordance with the developing overall UK position, and not to engage in advocacy for specific areas of work
 - Operate in accordance with the [seven principles of public life](#)

4. Operation

- 4.1 STFC expects the Accelerator Review Panel to develop their recommendations in a meeting taking place over consecutive days. Attendance in person will be required for the Review to proceed efficiently.
- 4.2 Comprehensive briefing material will be made available to the panel in advance of the meeting. To allow time to focus on discussion, the panel will be asked to read and fully digest all material in advance.
- 4.3 Key stakeholders (e.g., the directors of ASTeC, the UK accelerator institutes) will be asked to present to the panel and made available to answer questions at specific points during the meeting.
- 4.4 Before the end of the meeting, the Panel will generate a preliminary set of recommendations and present these to STFC. This will precede the formal publication of recommendations in a written report.
- 4.5 The final written report must include the rationale for the recommendations given and a summary of the evidence considered. This report should be made available to STFC Executive Board no later than 09.11.25.
- 4.6 Panel members will be eligible to claim travel, subsistence, and meeting fees, as outlined in the [STFC Panel Handbook](#).

5. Support

- 5.1 A small group of cross-directorate STFC staff will act as secretariat for the Panel. The secretariat will:
 - Work across relevant parts of STFC, UKRI, and affiliated institutes to provide information in advance of meetings and other activities, so that Panel members are adequately briefed and can contribute meaningfully
 - Provide the means through which Panel members can give appropriate, high-quality strategic advice and make recommendations
 - Liaise closely with the Panel Chair to support them to discharge their responsibilities
 - Be clear about the information Panel members can share more widely and that which is provided in confidence
 - Be responsible for taking the recommendations from the Panel and presenting these to STFC Council and Executive Board for consideration