TOWARDS A COMMUNITY OF PRACTICE IN PROJECT MANAGEMENT OF PARTICLE ACCELERATOR AND BIG-SCIENCE PROJECTS: THE ACCELERTATEPM INITIATIVE

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Abstract

Across Europe, several large-scale particle accelerator and big-science projects — each exceeding hundreds of millions of euros and extending over a decade — are under design or construction, with comparable initiatives underway in the US and China. Despite remarkable scientific achievements, many of them face cost and schedule drift, even when scientific performance targets haven't been scaled down to maintain cost and timeline. Managing these complex, R&D-driven scientific facility projects require approaches distinct from even the largest conventional infrastructure undertakings. Recognizing this need, a group of project management (PM) professionals active in particle accelerator initiatives has launched AcceleratePM, the first international workshop dedicated to PM for accelerator and big-science projects. The first workshop, held at CERN in January 2026, gathered all major laboratories and projects to exchange methods, identify common challenges, and define best practices. This contribution presents the workshop scheme, themes, key-findings and outcomes, showcasing the largest recent projects – amongst which HL-LHC, ESS, FAIR, F4E – and aiming at informing the management of next-generation initiatives such as the Future Circular Collider (FCC). By building on common issues and most effective solutions, AcceleratePM intends to establish a lasting community of practice, shaping how large scientific projects are conceived, planned, and delivered.

INTRODUCTION

Several large-scale scientific projects around the world are currently in preparation, underway, or recently completed. Despite their diversity, they share key features: ambitious scientific goals with never reached performance, interlinked international scientific collaborations with in-kind contributions and personnel exchange, long-term anticipatory R&D programs, and the adoption of cutting edge, innovative technologies.

Project management for these first-of-a-kind, highly R&D-intensive initiatives in scinetific setting cannot follow the same approaches used for conventional infrastructure projects [1]. The AcceleratePM network was founded to create a community of practice in project management (PM) for big science projects. This paper summarizes the outcomes of the first AcceleratePM workshop, held at CERN from 26 to 28 January 2026 [2]. The event gathered more than 100 project managers and scientists representing major international projects – including CERN, FAIR, ESS, EuPRAXIA, the Einstein Telescope, EuXFEL, ITER, and the EIC – from over 20 laboratories and institutions worldwide. The program, constructed following a project's lifecycle, from initiation, through execution and monitoring, to closing, featured 25 presentations and 15 posters, and was interleaved with Q&A sessions and visits to CERN test facilities. Table 1 shows the 2026 consolidated budget of some large projects and time from groundbreaking to first beam.

Table 1: Large Projects Comparative Table

Project	Budget	Timeline
ITER	20 B€	14 yrs
FCC	15 B€	15 yrs
FAIR	3.3 B€	15 yrs
EIC	< 2.8 B$	12 yrs
HLLHC	1.2 B€	14 yrs
ESS	2.4 B€	11 yrs
EuXFEL	1.2 B€	10 yrs
ET	~2.3 B€	7 yrs

A WALK THROUGH THE CONFERENCE

Figure 1 shows a group picture of the participants to the workshop. The EIC at BNL advances through DoE critical decision gates each defining requirements, cost ranges, and performance baselines. To align with annual funding release and enable early physics delivery, the project is split into five independently baselined subprojects. A central integration office ensures overall coherence. CERN has completed the FCC-ee feasibility study amid mixed stakeholder support, aiming for project approval in 2028 for first collisions in 2048. The study provides cost estimates using standardized uncertainty classes and challenges bottom-up estimates with parametric models. Long term technical expertise must be secured along the 14 years of construction. A central Project Office will oversee cost, risk, and procurement across the over 100 contributors. The project's approval will require demonstrating scientific, economic, and societal value within an environmentally sustainable framework, as well as obtaining social license from host countries, engaged through formal public debate.

Einstein Telescope (ET) suffers from friction between extreme scientific requirements and competitors acting both as referees and bidders and interfering with the definition of rules and processes. In this context, it is difficult to apply conventional PM frameworks. Minimal consensus is sought across stakeholder's groups, to defend the project identity and technical requirements, targeting an order-of-magnitude sensitivity gain over current instruments. Model-based system engineering evolves with configuration management, to ensure traceability and future scalability. In this early phase, risk management does not focus on project execution or failure, but on the ability to make coherent, well-informed configuration decisions, where uncertainty itself is the dominant challenge.

Figure 1: Group picture at AcceleratePM [2], CERN, 26th to Jan. 26-28, 2026.

The project management framework for the distributed EUPRAXIA facility was presented as emerging initiative. The transition from an informal collaboration to a structured project included in the ESFRI roadmap has increased its attractiveness for funding and shaped it as a program, developed in phases with independent funding sources and governance, but shared resources, and unified management of risk, schedule, and constraints. Project management and systems engineering are tightly integrated in EuPRAXIA@SPARC_LAB.

ITER is one of the world's largest scientific projects, aiming to demonstrate fusion as large-scale carbon free energy source, with operations targeted for 2035. About 90% of ITER is delivered through in-kind contributions from its members. Fusion for Energy (F4E) provides roughly 45% of the total budget, making Europe the largest contributor. Estimates at Completion (EACs) are revised at each project approval gate. Changes arise from scope evolution, low technology readiness levels, incomplete integration of technical requirements, initial over optimism, but also stakeholder-imposed ceilings. Risk assessment criteria are supported by a regularly updated risk and opportunity register to reduce exposure, prioritize key risks, define mitigation actions, and assign ownership, via a risk management board installed in 2024.

At GSI, the organization is engaged into a major extension of the accelerator complex with the international project FAIR, a future ESFRI landmark, with a complex of accelerators, production targets and experiments for protons, antiprotons and unstable ions. Civil engineering was completed in 2024 and commissioning began in 2025 for a staged physics delivery. To face the multiplicity of objectives on the campus, a portfolio management office was implemented, managing all aspects of PM across all subprojects. An integrated software tool enables progress reporting, cost scenarios analysis and risk management. The expeditor is a key function at FAIR, allowing schedule and cost control, interacting with all services and sub-projects, aiming at timely delivery of right quality supply at the right cost, from vendors and collaborating institutes.

The European XFEL completed an innovative beam facility, with a 75% share of in-kind contribution from 10 EU countries. The success rate of PM was outstanding, relying on tools and processes applied only when, and as, needed, flexibly adapted to the complexity required at every stage, managed by a small office. Visualization was made accessible to all teams via digital models, allowing early detection of interferences. Review and approval processes were highly tailored. System engineering was translated into a system-of-systems vision, where every sub-system or deliverable was seen in its lifecycle, from definition to commissioning. While work-package leaders were autonomously managing their internal milestones, the PM office focused on interface milestones and interdependencies. Ultimately, success rested on a simple insight: if the engineering works, the project works.

The HL-LHC is a major upgrade aimed at significant increase of luminosity through technology driving new components, delivered by CERN and in-kind collaborations. Notable scope adjustments were applied to contain cost drift, while schedule drift remains a persistent challenge, driven by delays from in-kind partners and industry. Cost and schedule control was made possible by the project's intermediate scale relative to CERN's strong end-to-end engineering capacity, which enabled extensive insourcing of drifting tasks, from design to fabrication. An open budget framework – where budget is aligned with the evolving estimate at completion – supports rapid corrective action. The project is threatened by schedule drift, as margins between components readiness and installation dates are shrinking.

F4E showed the benefit of dual reference scheduling: a long-term baseline with the highest-level deliverables is maintained to match stakeholders' expectations, while a short-term reference reflects changes or warning. In probabilistic scheduling, Monte-Carlo calculation of task durations is corrected by the impact of random risks. Opposite to a deterministic schedule, a probabilistic approach shows stable finish dates in milestones trend analysis.

Operation and site activities schedule are the backstage along which projects are planned. At CERN, the coordination team manages all activities in the accelerator complex, together with the schedule of the largest projects. Two different schedules are computed: one, for the project deliverables and one, for installation. The forecasted readiness is compared with the installation "needed-by" date, with the margin providing time contingency. Similarly, at PSI the scheduling office interfaces all projects, like the SLS 2.0 upgrade and the IMPACT project. A highly detailed, resource-loaded schedule is established early, with procurement, pre-assembly, installation, and resource plannings being gradually linked as the activity nears. The bottom-up schedule is challenged by the scheduling team, ensuring coherence of methodologies and realistic estimates.

Most projects rely on in-kind contributions, often in a chain of interlinked deliverables. At ESS, over 40 institutes contribute by 60% to 15 neutron beam instruments in multiple institute collaborations, showcasing the complexity of in-kind management. Collecting contractual documents for all instruments took 5 years to complete. Common needs (choppers, beam monitors, shielding, utilities) were centrally managed by the host-lab. The user community will grow from the in-kind contributor's community, attesting the need to establish trust and communication early on.

A survey of soft PM aspects – knowledge transfer and learning curve, incentives, transmission, workload, team construction and problem solving – built the bridge to the lean approach to projects and PM training at EuXFEL, where a culture of doing things well is taught as key to success. Ultimately, projects do not fail out of wrong choice of software, methodologies, certifications, but because of bad communication, unclear roles, poor preparation and planning, optimistic assumptions, time pressure or complex scope.

FROM TALKS TO TAKEAWAYS

The workshop delivered valuable insight. While the first edition focused on large infrastructure projects, smaller projects—common in science—can also benefit from these insights, though methods often need adaptation to scale effectively. PM frameworks must be continuously adapted along the project lifecycle. Project office structure, for instance, like risk registers or requirements management, must evolve to match the needs of each phase.

In initiation phase, procurement is guided by industrialization strategies defined since prototyping, long-lead items are identified in advance and procurement timelines are integrated into make-or-buy strategies. While not part of the PM framework, system-engineering should be integrated since the early phases. Experience from the execution phase shows that a broad range of control tools is vital, not hesitating to micro-manage, as exemplified by the expediting practice at FAIR. Also, the wilful capability at EuXFEL and CERN to insource high-technology components – in projects characterized by in-kind and industrial partnerships for complex components – is essential to control drifts, even when the in-house production is limited to single units and slower pace. In the absence of such competences, the range of control actions is reduced to rebaselining budget, schedule, or even scope.

Uncertainties and risk are part of the lifecycle – their correct understanding is essential in stakeholders' management. Initially, the main risk is not in project failure, but in the ability to take early coherent configuration decisions. Later into execution, risk and opportunity management must be dynamical and continuous; its cost and usefulness should also be addressed by appropriate Key Performance Indicators. Including contingencies is a managerial choice but should be a deliberate one. When schedules are treated deterministically, without contingency, then milestones are destined to slip.

In addition to insufficient Technology Readiness Levels or undefined design, cost estimates might slip due to estimates done to match stakeholders' initial expectations. Contingency ownership must be well understood by directors. For instance, when workforce is not included in cost, schedule slips because it is the strongest contingency reserve. Probabilistic estimates in cost and schedule align better to stakeholders' expectations. As part of expenditure but also of stakeholder's management, some projects are delivered in staged segments of scope. Investing early in good practices consistently pays off: today's project team will become tomorrow's operations team, just as tomorrow's user community will emerge from today's in-kind partnerships. A lean approach is implemented in successful projects: processes are implemented only when needed, work-package leaders are entrusted, the project office adopts a supportive attitude, managing only interfaces and common services. The minimum size of a project office is debated in scientific settings, partly due to scientists' scepticism toward project management. Therefore, transitioning career paths from science to PM need to be accompanied. Lighter, more self-conscious portfolio management schemes are often implemented wherever a large project is superimposed on an existing research infrastructure. A centralized portfolio management ensures single sources of truth for data, single shared utilities management (host lab), single coordination and scheduling, ensuring coherency across the lab for cost and schedule estimates. It also allows a better management of interfaces and resource conflicts and ensures the best choice of tools to implement across the lab, reducing training and improving technical service. A lesson conveyed by big projects is that risk, cost engineering, expediting, and other PM domains should be learnt from more conventional, yet equally gigantic projects. Ultimately, funding release is based on trust – and trust is built up when there is a PM scheme and structured PM practices.

CONCLUSION & OUTLOOK

The first AcceleratePM workshop convened a thriving and animated community and addressed a wide range of shared challenges. In the interactive session, participants largely called for an annual gathering. They identified key themes to address in future editions: the dissemination of project-management knowledge, decision-making models, AI application to PM, shared cost databases for an improved realism of cost and schedule estimates, comparative software tools. The audience asked for more interactive formats and thematic working groups and roundtables. The community is now established and aims to create PM value, within the large-scale science project landscape.

REFERENCES

[1] European Commission, PM^2 Methodologies. https://pm2.europa.eu/index_en

[2] AcceleratePM Workshop. https://indico.cern.ch/event/1583093