Summary of the KET Strategy Workshop 2025 on the ErUM-Pro Funding Period 7/2027-6/2030

8.1.2026

1. Scope of the workshop

In preparation for the PRISMA strategy meeting with the BMFTR for the ErUM-Pro funding period July 2027 to June 2030, scheduled for February 18–19, 2026, the German Committee for Particle Physics KET[1] organized a strategy workshop. The workshop took place on November 21–22, 2025, immediately following the KET annual meeting at the Physics Center in Bad Honnef. Remote participation via videoconference was also possible. In total, 127 participants registered for the workshop. The agenda is available here: https://indico.desy.de/event/50011/timetable/.

This summary presents the key outcomes of the workshop. It was coordinated within KET and agreed upon with the speakers at the workshop. It is attached to the agenda page of the workshop and therefore publicly accessible.

Discussions during the workshop revealed a broad consensus within the community regarding plans for the upcoming funding period. These plans are aligned with the European Strategy for Particle Physics (ESPP), last revised in 2020, which incorporates many of the German community's contributions, and with the German community input[2] to the update of the ESPP in 2026. They also reflect subsequent European initiatives such as the ECFA Detector Roadmap. The funding framework, as outlined in the call for proposals for the current funding period, was considered under the assumption of largely stable conditions.

The following sections outline the plans and priorities of the German particle physics community as represented at the workshop, along with the consensus views that emerged from the discussions. Projects are typically pursued in collaboration between universities, Max Planck Institutes, and Helmholtz Centers. Together, these efforts form a program guided by scientific excellence, showcasing the strengths of the participating researchers and institutions, achieving high international visibility, and providing an outstanding research environment for the next generation of scientists.

The projects of the German particle physics community are aligned with the Federal Government's High-Tech Agenda, as they inherently involve cutting-edge technologies. This is evident in areas such as advanced detector development, artificial intelligence for data analysis, and high-performance computing, all of which not only drive scientific progress but also contribute to broader technological innovation.

The document, like the strategy workshop itself, is structured into four sections:

- Ongoing collider projects
- Studies for future colliders
- Projects complementary to colliders
- Collaboration and Community Matters

[1] www.ketweb.de

[2] www.ketweb.de/stellungnahmen

2. Ongoing Collider Projects

LHC Experiments and Belle II

Maximizing the physics potential of the LHC remains the highest priority for the German and European particle physics communities. The same applies to participation in flavour physics at SuperKEKB. German research groups have made substantial contributions for many years to the LHC experiments ATLAS, CMS, and LHCb, as well as to the Belle II experiment at SuperKEKB. These experiments cover an exceptionally broad spectrum of fundamental questions - ranging from precise measurements of the Higgs boson's properties and systematic tests of the Standard Model to direct and indirect searches for new physics in rare processes involving heavy flavours. Such studies are expected to provide insights into the nature of dark matter, the origin of baryon asymmetry in the universe, and the dynamic structure of the Higgs mechanism.

The size and number of particle physics groups in Germany have remained essentially constant over the years, although new appointments at some institutions have led to shifts in focus. German groups continue to assume central responsibilities - in detector construction, commissioning, and operation, as well as in method development and data analysis - reflecting their extensive expertise. These activities should continue to be supported with high priority within the highly successful Research Focus Programs (Forschungsschwerpunkte, FSPs), ensuring appropriate participation of the German community in the scientific outcomes.

During the upcoming funding period, the LHC will be in the LS3 shutdown phase, with no regular data-taking. Research efforts at ATLAS and CMS will therefore concentrate on completing and commissioning the extensive Phase-II detector upgrades in preparation for HL-LHC operations, currently scheduled to begin in mid-2030. This includes finalizing production of new subdetectors and electronics, integrating components into the full ATLAS and CMS systems, and transitioning step by step from production and system testing to full operation. Embedding numerous new software components into existing analysis and data-taking environments will be a critical and labor-intensive step towards readiness. In addition, the legacy subsystems will have to be maintained and operated at a stand-by level to keep them operational and ready for the restart of data taking in 2030. Due to the rescheduling of Phase-II (postponed in autumn 2024 to mid-2030), additional funding requirements are expected, and their provision will be essential for the successful completion of the ATLAS and CMS upgrades.

In addition, the Run-3 data recorded by ATLAS and CMS until mid-2026 must be thoroughly analyzed - both to fully exploit the more than doubled luminosity compared to Run 2, and to develop and validate new analysis methods suitable for the high-luminosity era. Advancing analysis techniques is indispensable given steadily increasing data rates, more powerful detectors, and more precise theoretical predictions, along with the need to further reduce systematic uncertainties. Only in this way can collider data be optimally utilized.

The same applies to the flavour experiments LHCb at the LHC and Belle II at SuperKEKB. In the upcoming funding period, both experiments have significantly larger datasets to analyse. The improved statistical precision will require advances in reconstruction and calibration methods and the application of new, machine learning based techniques. These activities will form an important part of the scientific program between 2027 and 2030.

Furthermore, the foreseen upgrades of the existing colliders LHC and SuperKEKB will give access to an even larger data sample in the future and offer a unique flavour physics program. Its full exploitation, however, requires detector upgrades of LHCb and Belle II. Current plans for LHCb

Upgrade IIb involve a comprehensive upgrade of the detector, including development of highly granular tracking and vertexing systems, faster front-end electronics, and an expanded software-based trigger architecture. German groups plan to contribute very substantially to the tacking system: the tracker will use key technologies which have been or are being developed to a large extend by German groups. Significant additional personnel and investment resources will be required already in the next funding period to allow German groups to continue their leading contributions and to participate in the detector upgrade. The community appreciates and encourages the ongoing efforts to secure the required additional funding for the Phase-IIb upgrade outside the ErUM-Pro line.

At Belle II, preparations are underway for a coordinated detector upgrade program including the replacement of the vertex detector, the development and construction of a high-precision timing and strip detector between the vertex detector and the drift chamber, major upgrades to the trigger and data-acquisition system based on modern FPGA technologies, and substantially improved track-reconstruction algorithms. The work on tracking detectors builds directly on German detector R&D developments that have been pursued in dedicated R&D lines over many years. These developments are essential not only to ensure stable operation under increasing beam currents and background conditions, but also to significantly extend the experiment's physics reach and discovery potential in the high-luminosity era of SuperKEKB. German groups play a leading role in several of these detector, trigger, and reconstruction developments and contribute key technologies and expertise. Belle II will be in its Run-2 data-taking period during the upcoming funding phase, where uninterrupted operation and timely implementation of the detector upgrades are both critical to fully exploit the unique flavour-physics capabilities of an e^+e^- collider. ErUM-Pro funding including support for the upgrade activities will therefore be essential in the next funding period.

Close integration with modern computing and phenomenological theoretical physics is becoming increasingly important as data grows in volume and precision. Declining funding for "experiment-related theory" and the reduced number of supported projects have already had visible effects on data analysis by German groups and on the broad training of young scientists. To improve alignment with other funding opportunities (e.g., DFG) and to enhance the precision of applications, the term "experiment-related theory" should be more clearly defined.

The contribution of ErUM-Pro research in particle physics to the Federal Government's High-Tech Agenda is substantial and should be emphasized more strongly. The ATLAS, CMS, LHCb, and Belle II experiments provide important advances in microelectronics, hardware-accelerated data processing, and AI-based trigger and analysis algorithms. These technologies feed into transfer projects, for example in AI applications, and strengthen national competencies, including through significant training of specialists in the high-tech sector.

Federated IT Infrastructure

Adequate federated IT infrastructures and their optimized, highly efficient operation are indispensable for fully exploiting the outstanding physics potential of the LHC and SuperKEKB accelerators, and for extracting novel fundamental insights from the very large datasets recorded. Personnel support for operating federated IT infrastructures within the World Wide LHC Computing Grid (WLCG) — which also serves Belle II — including integration of NHR centers, is essential. The required personnel resources are expected to be similar in scale to those of the current funding period. No further hardware funding is needed at university Tier-2 sites, as the necessary German share will be provided by NHR centers. Additional personnel will be required for developing technologies for analysis infrastructures, enabling scalable resources for HL-LHC

data analysis. The necessary hardware resources, particularly GPU-based systems, will not be requested under ErUM-Pro.

Personnel required for experiment-specific computing operations and software development will be requested within the experiment consortia.

3. Studies for Future Colliders

The European Strategy for Particle Physics aims to soon define the next major collider project after the HL-LHC as well as a list of possible alternative projects. The German particle-physics community wants to position itself to be a major contributor in shaping the future detector concepts for this flagship project. To achieve this, a significant strengthening of strategic detector R&D, supported by detector-optimization studies is vital. Given the timeline for the upcoming Conceptual Design Reports (CDRs) around 2032, the next funding period is critical to advancing and consolidating detector concepts.

There is general consensus that the strategic detector R&D consortia in the next funding phase should continue to align with the ECFA Detector R&D Roadmap, with clear links to the relevant DRD collaborations. This approach was shown to be very successful in the last funding period. Germany's strong contributions to calorimeters, silicon detectors, and gaseous detector technologies continue to remain obvious choices of contributions for the upcoming period. However, the community emphasised that Germany should become more visible in the international landscape when shaping next-generation detector concepts. In calorimetry the German contributions are already well focused whereas areas like silicon and gaseous detectors could benefit from stronger coordination and, in places, consolidation. It is universally agreed that while it is too early to unite behind a single detector concept, the Germany community strives to use the upcoming funding period to accelerate its contributions in key technologies.

One critical aspect in achieving this strategic move is the top-level reconstruction software. The community recognises the necessity of software support—expressed already in the previous funding round—but no funding was allocated. While CERN and DESY support is vital, the German community itself must carry a significant part of this effort. This includes both novel reconstruction algorithms and the development of core software. Efforts in this direction would help maximize the impact of the hardware-R&D efforts.

In addition to the three core detector-technology topics, the development of neutrino, axion, and dark-matter experiments remains of central importance for the German community. These include liquid-scintillator detectors, ultra-sensitive single-photon detectors, and cryogenic and quantum sensors, provided that the development is strategically oriented toward use in large-scale experiments. Work on quantum sensors, including completely new observables, is an emerging field that requires further discussion but holds strong strategic potential.

The German community strongly supports the building of a future collider detector consortium so that all of these effects can be more centrally guided. The community supports funding for university detector-R&D groups for the future particle-physics projects defined in the ECFA Roadmap, to be financed by the BMFTR under the new call for proposals. It was emphasised that many of the infrastructures and technologies for future colliders have strong connections to the High-Tech agenda of Germany and play a key role to that agenda.

4. Projects Complementary to Colliders

The Beyond Collider activities of the German particle-physics community span neutrino physics, axion and feebly-interacting particle searches, strong-field QED, and rare-kaon experiments. These programs complement the collider-based activities and represent areas of strong scientific engagement, technological innovation, and international collaboration.

Accelerator-Based Neutrino Physics

Accelerator neutrino experiments aim at precision measurements of oscillation parameters, the determination of the neutrino mass ordering, and most importantly the measurement of the leptonic CP-violating phase δ(CP), the only experimental method to access this quantity. In addition, they offer sensitivity to non-standard interactions and other signatures of new physics.

Contributions from RWTH Aachen and Mainz focus on the ND280 near detector at **T2K / Hyper-K (Japan)**. Groups from Hamburg, Tübingen, TUM, and Mainz contribute to the water-based liquid scintillator deployment, LAAPD characterization and reconstruction efforts for the **ANNIE** experiment at Fermilab. German activities from Mainz and MPI Heidelberg concentrate on the Near Detector PRISM, including movement systems, cross-section and oscillation analyses, and machine-learning methods for anomaly detection. Hamburg groups lead key roles in target-station coordination and technical design at **ESSnuSB** in Europe.

Across all these activities, no ErUM-Pro funding is requested for the coming period, as the German contributions are supported through DFG, PRISMA+ and European programmes.

Axions and Light New Particles

Axions and axion-like particles (ALPs) are motivated by fundamental questions in particle physics, cosmology, and astrophysics. The German axion community maintains a broad and internationally visible program spanning laboratory searches, helioscopes, and haloscopes, anchored in the DESY Axion Platform, supporting in particular the flagship projects ALPS-2, MADMAX and IAXO.

Significant German contributions to **ALPS II** - a laboratory-based light-shining-through-wall experiment producing and detecting axions - are coming from DESY, Mainz, Hamburg, Leibniz and MPI for Gravitational Physic. Additionally, the University of Hamburg is involved in **WISPFI** and **WINTER** which use interferometry to search for axion-photon couplings. **BabyIAXO**, currently in construction phase at DESY with planned operation during 2027–2030, includes participation from Bonn, Dortmund, Hamburg, Siegen, DESY, CERN, KIP Heidelberg, and multiple MPI institutes. Beyond 2030 this is followed by **IAXO**. Additionally, Dortmund university is working on other approaches, namely **NuSTAR** to observe the sun and other stars. Germany contributes across a broad range of axion dark matter detection techniques using Haloscopes. Higher-mass searches such as **MADMAX** use dielectric haloscopes and are supported within the German community by DESY, MPP Munich, MPI Radioastronomy, RWTH Aachen, Hamburg and Tübingen. Lower-mass approaches include **RADES/BabyIAXO-RADES** supported by Bonn, DESY, MPI-Physik, KIT. Future experiments across mass such as **BRASS**, **ADAMOS**, **WISPCAV** and **WISPLC** are supported by Hamburg and MPIfR. New setups for resonant cavity experiments include **RADES** and **SUPAX** are supported by Bonn, DESY, MPI Physics, KIT and Mainz.

The German axion program is growing and internationally integrated, leveraging expertise in superconducting magnets, cryogenic platforms, and quantum sensors. Current support comes from DFG, Horizon Europe, and excellence clusters. BMFTR funding will not be requested in the

forthcoming ErUM-Pro funding period but will be revisited as the national program becomes more consolidated in the future.

LUXE

LUXE remains a flagship European initiative probing QED in the strong-field regime using DESY and European XFEL infrastructure. The experiment is well embedded in Horizon Europe and benefits from synergies with plasma-based accelerator technology and fusion-related high-power laser R&D. A redesign is underway to allow shared beam operation with fusion-research infrastructure. For the funding period 2027-2030, no BMFTR funding will be requested.

ECN3 Experiments - NA62 and SHiP

The underground hall ECN3 in the CERN North Area can be supplied with a high-intensity proton beam from the CERN SPS and offers excellent conditions both for experiments investigating extremely rare kaon decays in a high-intensity secondary beam and for searches for new feebly interacting particles (FIPs) using a beam-dump facility (BDF).

Until LS3, the ECN3 cavern continues to be used by the NA62 experiment, whose data-taking has now been extended until the end of 2026; the subsequent analysis phase is expected to run until 2028. Following the completion of the North Area Consolidation, CERN has decided not to upgrade ECN3 and the associated beamline TCC8 into a High-Intensity Kaon Experiment (HIKE) facility. Groups involved previously in HiKE have joined efforts at J-PARC in Japan.

The CERN research board has taken a decision to build a dedicated future beam-dump facility in ENC3, with SHiP as the experiment exploiting the high-intensity proton beam to search for feebly interacting particles (FIPs). A large number of German groups across several institutes are engaged in the preparation for and future use of the SHiP infrastructure. This research is complementary to the LHC physics programme and has strong links to Germany.

Kaon Physics

Mainz and MPI Munich contribute to **NA62 (CERN)**, which continues operation until 2026, with further analysis expected through 2028 for which modest support from ErUMPro - primarily for analysis work - is anticipated. Decommissioning will be financed through the experiment's common fund, not ErUM-Pro.

The ongoing kaon experiment in J-PARC, namely KOTO has no German involvement. However, groups previously involved in HiKE have joined efforts towards KOTO-II, where the collaboration is just being formed and the experiment is expected to receive a formal decision in Japan in 2027. European groups, including the University of Mainz, are currently joining the collaboration. For the funding period 2027-30, no ErUM-Pro application is planned.

SHiP at ECN3

SHiP at the new Beam-Dump Facility (BDF) in ECN3 will provide world-leading sensitivities in FIP searches, complemented by a high-statistics neutrino programme. The experiment contributes to the full exploitation of the SPS physics potential, will reuse where possible existing infrastructure and materials (e.g. liquid-scintillator equipment, PS-neutrino facility, OPERA magnetic iron), and includes development of new technologies such as the low-power HTS spectrometer magnet. In addition, the target system enables applications to electronics and aviation safety through a possible irradiation facility.

As a result of the KET strategy meeting in 2022, German SHiP and SHADOWS groups prepared a common R&D proposal (not funded for FP24-27). In March 2024, the CERN Research Board approved the BDF + SHiP TDR phase, and most German SHADOWS groups joined SHiP. The CERN Medium-Term Plan 2025 (July 2024) allocated ~60 MCHF for the BDF.

Germany has a long-standing and strong role in SHiP (since 2014), with groups in Berlin, Bremen, Freiburg, Hamburg, KIT, Mainz, and Siegen (with a currently rough estimate of ~15% of the collaboration). German teams lead major components (Surround Background Tagger, Straw Tracker, Calorimeter/PID) and also contribute to computing and the measurement of charm production in the beam-dump target (SHiP-Charm).

The German community supports SHiP as a key element to diversify the experimental landscape and to ensure full scientific use of the new CERN BDF, noting the strong national participation and complementary physics reach beyond collider experiments. The German SHiP community will apply for sustained ErUM-Pro funding from FP2027-30 onwards, which is crucial to realize an experiment setup that allows for validation of the backgrounds, the commissioning of all sub-detector systems and a first physics run before LS4. Depending on the overall funding situation, a staged approach will be put in place.

5. Collaboration and Community Matters

Sustainability Sustainability is a very important aspect of future research projects in ErUM, and the community is eager to contribute to the global efforts. It is considered reasonable to integrate sustainability in the ErUM research projects themselves ('sustainable research') rather than extra funded positions for sustainability ('research for sustainability'). The inclusion of these aspects in the new ErUM call seems to be reasonable (similar to the past call for funding period (FP) 24-27).

Timeline of new call It is very important for the groups and their early career researchers (ECRs) to receive the approval grants ('Bewilligungen') early enough: three months before the end of the current FP, so that ECRs with positions financed by the projects can plan their future sufficiently early. The currently foreseen schedule for FP 27-30 appears reasonable.

Funding cycle Taking into consideration a decent balance of the long-lasting nature of the ErUM research projects and the shorter-term need for adaptation of project plans (e.g. due to local changes [by e.g. changes in the person power] or schedule adaptation in international projects), a funding cycle of three years seems reasonable for most of the project leaders. A few prefer a longer cycle of four years.

FSPs The FSPs are very essential structures for the community internally and towards external stakeholders. The FSPs support the community in important areas; among them: outreach, transfer, education, central administration tasks (applications, reports, control of finances, e.g. of the FIS upgrade projects for ATLAS, CMS), organisation of scientific exchange, representation inside the collaborations, inside the larger community and towards the BMFTR. The load of running the FSPs (e.g. person power and travel resources) is taken by the spokesperson and their team, supported by BMFTR funding for the respective offices (Belle-2 office for all aspects, and LHC-office for outreach, education and transfer). It should be considered if the FSP label (i.e. the structure, not the funding) could be established as a structure that lasts longer than just a single

FP but rather spans over the full foreseen participation of BMFTR/Germany in the respective research project.

Travel budgets The amount of travel budgets as granted in FP 24-27 seems to be sufficient.

Theory projects A strong connection between theory and experiment is necessary for the success of the ErUM research programme. For this reason, the continued support by BMFTR for theory projects close to experiment is an important ingredient for FP 27-30.

Analysis work in ErUM projects Analysis work is considered an integral part of the ErUM projects to enable a research programme that spans from technical work (detector construction, operation, computing, simulation, calibration) to the harvest of high-level science results ('Physikausbeute'). Only with a tight connection between the two is world-class research in HEP possible. In FP 27-30, adequate resources must be made available for analysis.

Outreach/education/transfer A broad and sustained community commitment to science communication is vital to the future of the field. ErUM-Pro currently includes two successful science communication structures (Netzwerk Teilchenwelt, LHC/Belle2 office), which are complementary in scope as they target different groups. **Netzwerk Teilchenwelt** (NTW) is an in-person science communication programme, nurturing a talent pipeline through its fellows initiative and supporting masterclasses, teacher training, and travelling exhibits. However, in FP 24-27 the NTW has seen severely reduced resources. In FP 27-30, adequate resources should be made available for NTW. The **LHC-ErUM-FSP and Belle-II Offices** provide complementary communication to industry, society, and policymakers, maintain digital and visual communications, and meet growing social-media demands, yet current fractional contracts limit continuity and capacity. To meet BMFTR expectations and emerging responsibilities, the FP 27-30 must either consolidate staffing or prioritise tasks, supported by stronger coordination and more efficient information flow between offices and FSPs. Synergy effects seem to be possible and should be further explored.