Report from the 6th Meeting of the KEK Science Advisory Committee

February 28, 2025

1 Executive Summary

The 6th meeting of the KEK Science Advisory Committee took place at KEK from February 26 to 28, 2025. The agenda of the meeting and the membership of the SAC are provided in the Appendices.

The D-G opened with the timeline shown in figure 1. The SAC was asked to review progress of the ongoing major programs of SuperKEKB, the Photon Factory and J-PARC. The SAC was also requested to review the funding and construction status of the new projects considered by KEK in the PIP2022 document and evaluated during previous SAC meetings. The D-G pointed out that the budget and HR situation is becoming crucial and requested that the SAC discuss possible resolutions. Furthermore, the SAC was asked to start discussion of the next term program, shown in the timeline (years 2026–2028).

The SAC was very happy with the detailed and informed presentations on key elements of the KEK program by senior staff. It congratulates KEK for carrying out such an outstanding program in particle and nuclear physics, and its applications

The KEK/J-PARC program is broad, ambitious and of high quality. The SAC, however, has been shown that the current resources are insufficient to carry out such a broad program with a uniformly high standard.

The base budget is falling by 1% per year and depends on a temporary electricity supplement to meet even sub-minimal annual beam operation hours. The SAC sees as very important that the flagship experiments and facilities be fully supported to ensure optimized operations.

There is also a clearly identified need for a substantial and consistent replacement program for aging equipment, to reduce breakdowns and the subsequent operations time lost. Increasing the laboratory resource base (funding and personnel) or reducing the expenditure and personnel requirements, are both to be considered the highest priority.

The D-G asked that we consider synergies both internal and external. The SAC has considered both. Taking a global approach to optimising science measurements and discovery is considered imperative for the future of particle physics. Below we argue that consideration be given to a cooperative approach across international laboratories, where each develops particular strengths, reducing multiplicity of similar experiments for better overall use of limited resources. Such an approach might allow some rationalization of the program and release resources in doing so. A possible example is the high-precision particle physics area where the major labs, KEK, Fermilab, CERN and PSI might agree to distribute high-precision muon (including COMET and g-2) and kaon (for example, KOTO2) experiments to save resources by reducing redundancy. It is understood that reaching such an international agreement would not be simple, but the SAC sees a long-term advantage in doing so for current and future facilities. The size of future projects envisioned will almost certainly require the consideration of increased globalization and sharing of resources. The effort required to commence such an agreement now will not be wasted.

The operation of the various institutes (IPNS, IMSS, ACCL, ARL) is relatively autonomous and independent. Optimization of the programs within these institutes is important, but it seems that an overall prioritization across these sectors may lead to a better understanding of their internal operation and may more easily provide the opportunity to find synergies across KEK.

Personnel shortages were also highlighted in the presentations as a major issue for the lab. The age profile indicates the need for recruitment of more young staff. Although this has been highlighted previously and some effort in this direction has commenced, the SAC suggests exploring ways to improve the professional environment and future prospects for members of staff. The SAC heard that not only can Japanese industry offer better salaries, but they can also provide longer-term employment security.

To attract high-quality young scientists and engineers, it is critical for the lab to maintain its high status both domestically and internationally. Making more positions tenure-track, apparently not yet common in Japan, is suggested to improve job security competitiveness. It is also suggested that deeper engagement with universities be pursued. Attracting international personnel, postdocs in particular, has been successful. In view of the demographic changes that are experienced in Japan, it is suggested that this source of expertise be increased. The limited tenure imposed by the visa restrictions is problematic but internationals should continue to be a source of talented young staff for KEK.

KEK is making great strides in the Equity, Diversity and Inclusion domain. Broadening the pool of potential employees by being very active in making an inclusive working and research environment is seen as important for KEK's future personnel envelope. It is, however, observed that the pool of new domestic staff, university graduates, already has a large gender imbalance in physics and engineering, which leads to difficulties for domestic staff recruitment. The SAC congratulates KEK for the advertising of some female-only positions. Being sensitive to aspects of the KEK work environment that affect choices by young women in particular is important for their encouragement into the field. The SAC encourages KEK to make it well known to high school and university students (and their parents) that it aims to provide best practice for gender inclusion in the lab.
For the overall KEK program, the SAC sees as imperative several key principles:

- To fully resource the operation of flagship experiments and facilities – SuperKEKB, Belle II, T2K, HyperKamiokande, and MLF
- To maintain and develop a large user community for its multi-user facilities
- To consider a reduction in the number of experiments and operating facilities and smaller projects, so that better resource allocation (personnel and funds) can be made to the highest priority activities.

KEK has an excellent reputation both domestically and internationally. However, recent reduction in beam-time through insufficient funds for the electricity requirements and breakdowns of (mainly) aging equipment, have been noticed internationally. The SAC suggests that immediate action must be taken by management to turn this trend around.

Below, the SAC responses to the status of the laboratory program are provided. Various suggestions are made to bridge the gap between available and required resources.

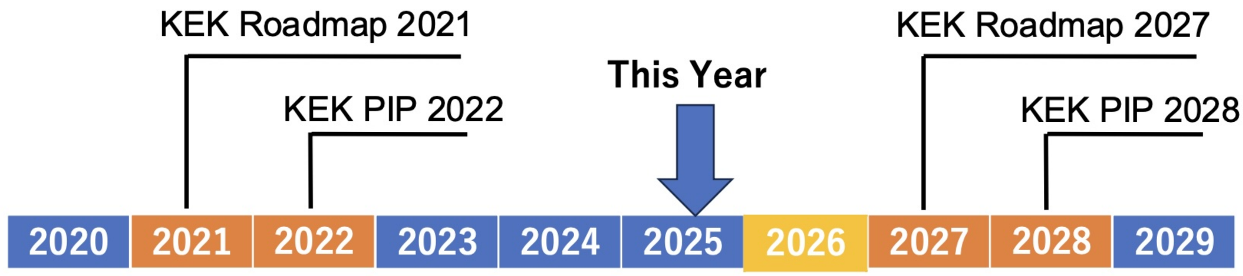

Figure 1: KEK Timeline

2 Accelerators

2.1 *Observations*

SuperKEKB successfully resumed operation in January 2024, running until the end of 2024, with a break during the summer. The emphasis of the run was on increasing the beam currents and luminosity. The value of β_y^* was kept at 1 mm, the β_x^* in LER reduced from 80 to 60 mm, while the beam currents were increased up to new record values of 1354 mA and 1699 mA for the HER and LER, respectively. The beam-beam tune shifts of about 0.03 remained 2–3 times lower than at the former KEKB.

Fast sudden beam losses (SBLs) occur over two to three ring turns with no (or very little) beam centroid motion, but substantial vertical blow up, and they are often associated with local pressure bursts. Evidence for vacuum sealant (VacSeal) intruding into the vacuum chamber, and being exposed to synchrotron radiation and to potentially high temperature, is considered the most likely cause at present.

SuperKEKB is in a 10-months shutdown now. Work during this shutdown comprises the inner cleaning of beam chambers at IR (both rings) and wiggler sections (LER); the reinforcement of radiation shielding, and expanding radiation control area near Oho Exp. Hall; ECS installation at BTe; the replacement of bending magnets at the BTp; linac RF gun replacement; maintenance work carried out by the Plant and Facilities Department.

SuperKEKB will restart operation in November 2025 (run 2025c). The winter shutdown will be shortened as much as possible ($\sim$2 weeks). The 2026a run will continue until the end of JFY2026. Ongoing work is prioritized to focus on increasing both peak luminosity and integrated luminosity in the next run. Human resources and budget are limited.

SuperKEKB needs to overcome several challenges: (1) Sudden beam losses have limited past operation. A likely reason has now been identified and is being mitigated. (2) The specific luminosity and beam-beam parameter are significantly lower than expected. A residual coupling at the collision point could not be corrected, and could be one of the possible reasons, as could be chromatic skew coupling or space-charge effects. (3) The emittances of the injected beams are still too large at the end of the transport line. (4) The vertical emittance of the stored electron beam was too large in run 2024c. (5) Many other sources of frequent beam aborts, roughly one per hour or per 1.5 hours.

A roadmap towards 2–5 times higher luminosity has been developed. The strategy towards a peak luminosity of 1.0×10^{35} cm^{-1}s^{-1} consists of increasing the beam currents with $\beta_y^* = 0.9$ mm, and target currents of 2.58 A (LER) and 1.83 A (HER). The subsequent path towards a peak luminosity of 2.4×10^{35} cm^{-1}s^{-1} includes (1) β_y^* squeezing down from 0.9 mm to 0.6 mm; with dynamic aperture improvement through sextupole optimization, off-momentum optics tuning, and comparison between simulations and measurement; (2) increasing the beam currents to 2.75 A and

2.2 A; and (3) raising the specific luminosity (beam-beam parameter).

A revised long-term plan has been developed. The long-shutdown 2 (LS2) has been shifted from 2027 to around 2032. The LS2 will allow for major upgrades: possibly new final focusing quadrupoles based on Nb_3Sn superconductor, and installation of the final two RF stations for the HER to permit operation at the design beam current. The projected luminosity evolution has been updated. The target of 50 ab^{-1} is assumed to be achieved by 2042.

The SuperKEKB commissioning effort was strongly supported by other divisions of the KEK Accelerator Laboratory and by Belle II collaborators, especially on: (1) machine-learning-based tuning of injector Linac and injection tuning to the ring; (2) analysis of error sources and development of correction methods for the beam orbit of injector and beam transport lines; (3) portable bunch-by-bunch position monitor based on RFSoC technology to hunt down the SBL source; and (4) large-scale correlation analysis to find the source of SBL. In addition many international collaborators joined the SuperKEKB commissioning after LS1. Existing collaboration frameworks include the Multi-National Partnership Project (KEK MNPP). The Europe-America-Japan Accelerator Development Exchange Program (EAJADE), and the US-Japan Collaboration on High Energy Physics.

J-PARC has reached a major milestone, achieving 1 MW beam power during stable MLF operations. With the new MR main PS successfully constructed and commissioned, the beam power has increased to 800 kW for the neutrino experimental facility and 80 kW for the hadron experimental facility, with an impressive extraction efficiency of 99.6%.

A trend of declining operational user cycles since 2017 (MLF cycles went from 8 in JFY2017 and JFY2018 to only 3 in JFY2024) and concerns over facility availability remain. Challenges include flat operational funding (after inflation), slow resolution of conventional accelerator issues, and budgetary constraints. While many J-PARC components were built after 2000, some components from the former KEK-PS were reused to save on construction costs. The KEK-PS components are now more than 40 years old.

Budget pressures persist due to facility aging, inflation, currency fluctuations, and shifting supplier bases. Supplemental funds have been crucial in addressing urgent facility needs, but a sustained upgrade program is essential. Long-term multi-year planning and funding for workforce and infrastructure are necessary to ensure the continued success of J-PARC.

Several upgrade options are being developed for J-PARC. These include a power upgrade of the RCS to 1.5 MW, where the additional beam power is used in a second target station for neutron production; a muon linac for the g-2 experiment; a doubling of the Linac repetition rate to 50 Hz where the additional intensity would be used in a new Proton Beam Irradiation Facility (PBIF); a booster ring with an energy range from 3 to 8 GeV to increase the beam power from the MR to 2.2 MW with an RCS beam power of 1.4 MW; and a stretcher ring for the slow extraction from the MR; a high intensity 9 MW proton linac for neutrino experiments on the Tsukuba campus; and heavy-ion beams in J-PARC.

A new budget is available from the "K program" (economic security program). R&D for an 800 MeV, 10 mA EUV-FEL has started with the goal of creating a light source for lithography. The R&D effort builds on the experience gained with the KEK cERL (20 MeV, 1 mA). A second activity in the K program focuses on muon beams. Muon cooling by a factor 200 and 400, and re-acceleration to 100 keV has been demonstrated as part of RD for the muon g-2/EDM experiments at J-PARC.

The Tsukuba electron/positron beam campus includes the PF and PF-AR light sources. They serve about 3000 users per year. In JFY2024 the PF and PF-AR met or exceeded the targets for user operating hours, with an average availability of 99%.

For the iBNCT linac in Ibaraki, several Phase 1 clinical trials were successfully carried out in

JFY2024, with plans to continue.

The ILC Technology Network (ITN) is a global program focused on developing key accelerator technology items of ILC: (1) SRF cavities; (2) nanobeam production and stability, and (3) high-flux electron and positron production. Impressive R&D results are achieving a cavity gradient of more than 40 MV/m by two-step baking, and demonstration of a fast rotating target with water cooling. Six young researchers were recruited into this MEXT-funded program.

The main KEK deliverables for HL-LHC include, for the D1 separation dipoles, 1 full-scale prototype cold mass (LMBXFP) and 6 series cold masses (LMBXF1-6). So far, 5 magnets have been tested at KEK. Four series magnets (MBXF1,2,3 &5) successfully reached the ultimate current of 13.2 kA (108% of nominal current). The first D1 prototype (MBXFP1) was delivered to CERN in April 2023, where its cold test was successfully completed in a horizontal cryostat.

KEK is active in various key areas of advanced SC magnet and SRF R&D. On the magnet side, it is developing high performing Nb_3Sn conductor for a future FCC-hh collider in collaboration with CERN, Nb_3Sn quadrupole magnets for a future SuperKEKB upgrade in collaboration with Fermilab, Furukawa Electric Company, and Sophia University, and a 1T HTS pion capture solenoid for J-PARC MLF in the framework of the US-Japan collaboration. As for SRF cavity production, KEK is exploring the use of direct-sliced niobium, hydroforming techniques, and cold spraying, for easier cavity production and possible expansion to high-temperature superconducting cavities.

The KEK Accelerator Laboratory (ACCL) introduced job openings of assistant professors. In 2024, the iCASA has recruited 5 researchers including foreign ones. Most of these are on time-limited posts, but one is a tenure-track position. Also a SOKENDAI special researcher system for postdocs has started.

2.2 *Comments*

The SAC congratulates the J-PARC team for successfully increasing the beam power in the RCS and MR FX and SX. The MR FX beam power follows the 10-year plan that started six years ago without any revision. The MR slow extraction efficiency is a world record.

The SAC also congratulates the SuperKEKB team for achieving a new world-record luminosity of 5.1×10^{34} cm^{-2}s^{-1}. The planned development of a Nb_3Sn quadrupole within the next 4 years, in collaboration with FNAL, is ambitious.

The management and leadership of the SuperKEKB program is not well defined. Three ACCL Division heads and the Belle II spokespersons are engaged. They are complemented by a SuperKEKB commissioning leader and by a special coordinator for reaching the luminosity goals.

Previously the SuperKEKB LS2 coincided with the start-up of HyperK. The modified time line of SuperKEKB, e.g. the shift of LS2, might imply potential conflicts with the HyperK programs.

Additional synergies between SuperKEKB challenges and other KEK accelerators and accelerator teams could be exploited, e.g., with the vacuum team and expertise of the Photon Factory, or in the areas of SRF and magnet developments.

No updated accelerator design proposal for a future light source was presented.

The SAC welcomes the obvious synergies of various SC linac projects, i.e., for ILC, EUV-EFL, positron production, PF-HLS, and 9 GeV proton linac.

High electricity prices and aging components and infrastructure have a visible effect on operating times and facility availability. These effects have been mitigated to some extent through supplemental budgets. To fully use the KEK facilities in the future, the planning and budgeting process needs to include all normal operating items including electricity costs and ongoing upgrade programs.

Many upgrade options were developed, ranging from short-term to long-term. This positions KEK well to respond to the evolving needs of the science community.

As one long-term option, a 9-MW proton linac is envisioned in the SuperKEK tunnel to further extend the neutrino program. The development of a facility with such a high beam power will take decades, and it is not clear if this is still useful for the neutrino program.

KEK is engaged at the forefront of SC accelerator technologies for high-field or radiation-hard magnets and for SRF cavities.

The SAC appreciates the detailed responses to last year's recommendations.

2.3 *Recommendations*

1. *Integrate planning for replacement of obsolete equipment and infrastructure into the annual planning and budget cycles.*

2. *Develop a long-term strategy and implementation plan for the future of the Tsukuba campus after SuperKEKB.*

3 Particle and Nuclear Physics

3.1 ILC

An electron-positron colliding beam Higgs factory has been identified by the world high-energy physics community as the top priority for the next large collider project. For many years the International Linear Collider (ILC) has been one of the prominent candidates for a Higgs factory, with KEK playing a leading role in R&D for the ILC, e.g., on SRF, nanobeams and the positron source. This effort is continuing in the framework of the ILC Technology Network (ITN). Major Japanese funding for the ILC would be beyond the MEXT budget, and seems unlikely to be forthcoming in the near-term.

3.2 SuperKEKB and Belle II

SuperKEKB and Belle II are presently KEK's flagship projects. SuperKEKB has been running constantly above luminosities above $10^{34}\text{cm}^{-2}\text{s}^{-1}$, with a new luminosity record of 5.1×10^{34} $\text{cm}^{-2}\text{s}^{-1}$ set in 2024, and Belle II experiment has collected a data set about half that of Belle. Superior detector performance and analysis methods are allowing the Belle II collaboration to outperform the physics results of Belle. They have also identified a physics topic that is unique to them, i.e., search for hidden sector particles, and are publishing interesting results. However, the SuperKEKB machine has been encountering difficulties to increase luminosities much beyond $10^{34}\text{cm}^{-2}\text{s}^{-1}$ due to various problems such as sudden beam losses (SBLs), unexpected emittance increase in the transfer line and instability in the multi-bunch injection, to name a few.

If the machine luminosity does not achieve luminosities of $> 10^{35}\text{cm}^{-2}\text{s}^{-1}$, Belle II cannot be competitive against the LHCb experiment and it will become difficult to maintain the interest of the collaboration. Achieving this target and the long-term SuperKEKB luminosity goal will require a concerted effort by KEK accelerator physicists, supported by their international colleagues. The SAC is pleased to hear that the SuperKEKB machine development work is now being carried out by a collaboration of three teams at KEK: the injection team, the main ring team and Belle II collaboration. There are also clear indications that people from foreign accelerator laboratories are willing to join the work. On the other hand, strong leadership across these groups is missing.

3.3 LHC and the ATLAS Experiment

Run 3 of the LHC is proceeding very smoothly, and the ATLAS experiment has produced many excellent physics results. Full funding for the planned Japanese contribution to the HL-LHC has been provided, and Japan will retain its status at CERN as a Special Observer for LHC matters. KEK is completing its construction tasks for HL-LHC, including magnets and crab waist equipment. The SAC congratulates KEK on its successful contribution to the HL-LHC project.

3.4 Hyper-Kamiokande

Before Hyper-K starts operation in around 2027, T2K is a leading experiment in investigating the matter-antimatter asymmetry by measuring neutrino CP violation. To have a good chance to detect CP violation, T2K has planned to accumulate 10×10^{21} protons-on-target and to upgrade the near detector ND280. So far, almost 4.5×10^{21} protons-on-target have been accumulated, slightly lower than the planned 5.3×10^{21} due to lack of electricity budget. To reach the targeted statistics, at least 4 months/year beam time should be guaranteed, with the beam power upgrade to 1.3 MW being taken into account. The beam power upgrade has achieved 800 kW stable operation in 2024 as scheduled.

KEK hosts the neutrino beamline and the near detectors for Hyper-K. The near detector ND280 will be updated for both T2K and Hyper-K and a new near detector IWCD will be constructed. The ND280 upgrade has been successfully completed and physics data taking has started since June 2024. The IWCD detector will be built outside the J-PARC campus. The team has made good progress in 2024 in securing the site, thus eliminating one of the largest uncertainties. Civil construction will start from next April. The KEK budget for Hyper-K has been increased from 4.34 to 6.22 billion JPY. International contributions have largely been secured, though there are still some detector responsibilities to be assigned. Although there are some concerns about the missing international contributions to the IWCD and on the schedule due to the complexity of international coordination, the KEK part in the Hyper-K project is in good shape.

3.5 $g_\mu - 2$ and EDM Experiment

The J-PARC $g_\mu - 2$/EDM international collaboration has the goal of performing a precision measurement of the anomalous magnetic moment and of the electric dipole moment of the muon at the H-line of the MLF. The J-PARC $g_\mu - 2$ experiment is of particular interest because it uses a novel technique compared to those previously employed at CERN, BNL and now at Fermilab, which make use of energetic muons at the so-called magic momentum. Currently, the Fermilab experiment has measured the muon anomalous magnetic moment at the level of 0.21 ppm and a final measurement with a precision of 0.14 ppm is expected to be announced soon. For many years there was a substantial discrepancy between the experimental result and theoretical predictions, but this has been reduced significantly with the advent of precise calculations based on lattice QCD techniques as well as a new measurement of $e^+e^- \to \pi^+\pi^-$ by the CMD-3 experiment at Novosibirsk. It remains important to have an independent experimental determination of $g_\mu - 2$, which should aim at high experimental precision.

The J-PARC $g_\mu - 2$ experiment is based on ultraslow (thermal) muons (USM) obtained by laser ionization of muonium generated from a surface muon beam of 30 MeV/c momentum. After cooling, these muons are accelerated and injected into a small storage magnet. The experiment has demonstrated acceleration of the cooled muons, resulting in a significant reduction in the transverse beam emittance. This result has applications beyond the scope of the experiment and is of relevance for the whole field of muon science, e.g., in the development of compact muon sources. An efficient and reliable USM source is crucial to achieve the required statistical accuracy of the $g_\mu - 2$ experiment. The committee is pleased to hear that progress has been made in both the laser ionization system and the USM intensity.

3.6 Theory Center

The Theory Center continues to be successful in its research and in its community roles as a springboard for young theorists and as a hub for contacts with international and experimental communities. The Center is to be congratulated on hiring three young staff theorists, one of them female. However, the age structure of the Center remains a concern, with experienced members departing through retirement or for other reasons.

3.7 COMET

COMET is an interesting experiment to look for the lepton-flavour-violating $\mu \to e$ conversion. The experiment was proposed in two phases, enabling the sensitivity of the measurement to reach that of the current best measurement. However, there has been a significant delay in constructing the detector. Already a decade ago a recommendation was made for the swift completion of Phase 1 followed by an evaluation on how to proceed further in view of a competing US project. The Phase 1 detector is still under construction and even the time scale for completion of Phase 1 is uncertain. There is a potential conflict between the beam time requirements of COMET and Hyper-Kamiokande, which must be resolved with high priority.

3.8 WAKO Nuclear Science Center

Low-energy nuclear properties of exotic species are studied at the Radioactive Beam Facility (RIBF) at RIKEN where KEK runs the WAKO Nuclear Science Center. This Center aims to explore the nuclear chart with KEK Isotope Separation System (KISS) dedicated to high-precision mass measurements. KISS is the first ISOL (isotope Separation On Line) facility using multi-nucleon transfer reactions to reach even more neutron-rich species. In the fiscal year 2023 five experiments have been realized in this facility, three led by KEK scientist, one by Nagoya University, and another by a very prominent European scientist, demonstrating the international character of KISS. The number of recent publications is outstanding with a dozen either submitted or in preparation. The Center has secured a Grant-in-Aid for Specially Promoted Research. New apparatuses are being installed to enhance the efficiency of KISS by a factor of 100 that will allow for the study of very heavy species. The so-called KISS 1.5 is progressing well with the installation of a gas cell chamber, a variable mass range separator, and Multi-reflection Time-of-flight (MRTOF) spectrometer. The SAC is pleased to hear about the advancement of the KISS 1.5 project.

3.9 Hadron Experimental Facility (HEF)

HEF plays a crucial role in advancing our understanding of hypernuclei, rare kaon decays, and muon-related physics, offering valuable insights into the structure of matter and potential physics beyond the Standard Model.

3.9.1 The KOTO experiment

The KOTO and KOTO-II experiments focus on the study of rare kaon decays to explore CP violation beyond the Standard Model. Following the termination of the kaon physics programme at CERN, J-PARC is the only location for dedicated kaon experiments. In July 2024, a dedicated Kaon Workshop was held at J-PARC, bringing together researchers to discuss the next steps for such experiments. As a result of this collaboration, a new proposal for KOTO-II was swiftly formulated and subsequently presented at the J-PARC Program Advisory Committee (PAC) meeting in January 2025.

Following the evaluation, the PAC granted Stage-1 approval for KOTO-II, but with the condition that the Hadron Experimental Facility extension must be realized.

3.9.2 Hypernuclei Studies

Hypernuclei studies at J-PARC aim to explore the fundamental properties of nuclear matter by investigating the role of strangeness in nuclei. These studies provide critical insights into the behavior of hyperons and their interactions with nucleons, which have direct implications for our understanding of dense astrophysical objects such as neutron stars.

One of the key objectives is to elucidate the nature of the generalized nuclear force by examining the interaction between hyperons and nucleons.

3.9.3 Extension of the HEF hall

Over the past year, there has been little progress towards realizing the extension of the HEF hall. The extension of the HEF, a secondary beam facility, will significantly enhance the value of J-PARC by allowing the hosting of new experiments. In order to achieve the diversification of funding sources required by MEXT, KEK should seek to strengthen collaborations with top domestic universities to realize this extension, mitigating present financial shortage and enhancing human resources. This could take the form of the direct provision of instrumentation upgrades or staffing either via direct university support or via funding schemes available to research universities of high standing. At the same time, the shared operation of beamlines shared by laboratory and university staff, depending on the strengths of each collaborating university, would make possible the support of a larger number of users from small and medium-sized universities.

3.10 QUP

QUP was established in December 2021 as a WPI institute with the vision "New Eyes to Humanity". Following the withdrawal of KEK from the LiteBIRD satellite experiment and the resignation of the Director of QUP, a new Director is being appointed. They will prepare a new vision for the future research programme of QUP, which will be evaluated by WPI in October 2025. We look forward to a presentation of the vision and progress of QUP at the next SAC meeting in 2026.

3.11 *Recommendations*

3.11.1 *Recommendations for Particle Physics*

1. *In view of the uncertainties concerning the realisation of the ILC, it is important to identify synergies between the ongoing ILC R&D efforts and other projects at KEK and elsewhere.*

2. *We recommend that KEK engage with other laboratories working on muon physics, such as Fermilab, PSI and TRIUMF, with a view to optimizing muon research programmes worldwide.*

3. *The completion of the NA62 represents CERN's last approved kaon physics experiments. It is recommended that KEK continues to support its kaon physics program as a unique opportunity worldwide.*

4. *It is important to establish clear leadership of SuperKEKB. This is particularly important for the participants from the foreign laboratories, who require a clear focal point to establish formal partnerships. The committee urges the KEK management to appoint a project leader with authority to manage resources.*

5. *There has been a few months' delay in excavating the Hyper-K cavern, but it is still expected that the detector will be ready to take data by the end of 2027. Hyper-K will then become a flagship project for KEK, and it is essential that providing it with maximum beam be given top priority.*

6. *The efficiency of the laser system and the intensity of the source remain critical points for the $g_\mu - 2$ experiment. These issues should remain the focus of development effort, and we recommend that a timeline be established with milestones to achieve the design parameters. Since a measurement with an accuracy similar to that of the Fermilab experiment will require additional R&D, this should also be prioritised.*

7. *Beyond the $g_\mu - 2$ experiment the high power laser is critical for the muon microscope and other applications. Its development should be supported.*

8. *We encourage the KEK management to initiate a discussion among worldwide particle physics accelerator laboratories such as CERN, FNAL, KEK, PSI and TRIUMF with the aim of constructing a global strategy how and where to realise next-generation muon experiments in the most efficient way.*

9. *It is important that the losses of experienced staff in the Theory Center be compensated through recruitments of young staff.*

10. *The COMET collaboration should make a resource-loaded project plan to demonstrate the timely completion of Phase 1. Anything beyond Phase 1 should be discussed in a global context with other laboratories interested in muon physics, including Fermilab, PSI and TRIUMF.*

11. *The KEK management should consider ways to coordinate its plans for the KOTO experiment with other interested laboratories and the international community of physicists interested in kaon physics.*

12. *The KEK management should prepare a proposal how the QUP research programme could be continued when WPI funding is no longer available.*

3.11.2 *Recommendations for Nuclear Physics*

1. *The committee recommends that the Hadron Hall Extension project be revisited taking into account the potential of experiments and activities to produce important scientific outcomes whilst giving consideration to the resource requirements and constraints.*

2. *KEK should strengthen the collaboration with top domestic universities in order to realize the HEF project, mitigating the current financial shortage and enhancing human resources for the project. This might be included in the provision of upgrades or staffing either via direct university support or via funding schemes available to research universities of high standing.*

4 Material and Life Science

The activities of KEK in material and life sciences can be summarized into three equally important roles:

1. Development of beamlines and instruments for synchrotron radiation (Section 4.2), neutron (Section 4.3), muon (Section 4.4), and positron facilities.
2. Operation of user programs.
3. Research in condensed matter, material and life sciences using the quantum beam facilities.

4.1 Institute of Materials Structure Science (IMSS)

4.1.1 *Observations*

KEK offers multi-modal research instruments with different probing beams of photons, positrons, neutrons and muons together with cryo-electron microscopes (Cryo-EM) all at separate KEK locations. These fall under the responsibility of the Institute of Materials Structure Science and are operated under the Center for integrative Quantum Beam Science (CIQuS) and the Structural Biology Research Center (SBRC). A reorganisation and expansion of the CIQus and the scientific innovation centre is planned in order to streamline and consolidate operations under IMSS control.

There has been a concerted effort since 2021 to develop protocols for combining measurements from two or more quantum beam sources. Data presented suggest a 22% increase in user uptake with analyses with photons together with one or more neutron, positron and muon analyses compared to the previous 2 years. Interestingly, while most two-beam studies utilise photon and neutrons there has been steady growth in photon + muon analyses and 19% of measurements with photons + neutrons + muons. However, compared to the total number of single beam analyses across all quantum beam facilities the user access to multi-beams appears to still be quite small (<< 10%).

4.1.2 *Comments*

The promotion of multi-beam access should continue to be adopted as a matter of importance. This is highlighted in the proposed quantum beam education programme for users and also university students. The progress of this unique national “toolbox” utilising multi-quantum beam analysis is to be congratulated.

A colloquium was organised in 2024 which brought together scientists using SR and FEL photon beams, neutron beams, and cryo-EM. The resulting plan was presented for a quantum multi-beam facility project allowing KEK to move from sequential to simultaneous use of quantum beams, using beams from SR and FEL radiation, a compact accelerator-driven neutron source (CANS), as well as muons and positrons using a superconducting linac.

There is certainly a scientific case to be made for the simultaneous use of neutron and photon beams in specific applications, as already done at a few leading neutron facilities internationally. However, the scientific case for the quantum multibeam facility at KEK using simultaneous photon and neutron beams from a CANS was not made.

Although a CANS facility would represent a large investment, its performance cannot approach that of the MLF instruments. It might, however, provide other opportunities not available there, such as rapid informal access and enhanced training for early-career scientists. This might help build up the Japanese neutron community which would eventually provide scientific return on investment through the user program at MLF.

The US Department of Energy counts the unique users at its user facilities, tracking the crossover users among different facilities, and counting on-site and remote users separately. The SAC considers this to be a useful tool which KEK could use to quantify the combined use of PF and other quantum beam facilities.

4.1.3 *Recommendations*

1. *There is a proposal to streamline the CIQuS further through establishing one center focused on future simultaneous measurement using an integrated quantum beam facility. The SAC considers this initiative is not supported, as yet, by the current metrics for sequential multi-beam access and should be reconsidered in coming years.*

2. *Further refine statistics on unique users at the KEK facilities to quantify the combined use of different quantum beam facilities and their evolution.*

3. *Beamline staff exchange between quantum beam facilities would assist in better integration of the multi-beam access offerings to users.*

4. *If a project to build a compact accelerator-driven neutron source is further pursued, a business case should be developed and presented.*

4.2 PF status and development of a new light source

4.2.1 *Observations*

Good progress has been made on two beamline upgrades related to PF-HLS. BL-12A—a wide-wavelength-range soft x-ray beamline—was completed in late 2024 and is open to users. BL-11—a multifunctional R&D beamline for multi-beam experiments—is currently under construction and is expected to be completed in a few months.

BL-11 is intended as a demonstration of the utility of experiments with multiple simultaneous photon beams. In the R&D applications given in the presentation, it was stated that "the required spatial and temporal resolution is lacking." PF-HLS will resolve this deficiency.

The PF-HLS concept has three main characteristics: a circumference of about 750 m, operation at either 2.5 GeV or 5.0 GeV, and simultaneous presence of stored beam and short-pulse beam from a superconducting linac. At 2.5 GeV, it would deliver a natural emittance of 210 pm, while at 5 GeV it would deliver 830 pm.

The first step in implementing PF-HLS would be construction of the superconducting linac, which would serve as a dedicated injector for PF and as the driver for a high-repetition-rate soft x-ray FEL.

Efforts have been made to get support for PF-HLS from the broader synchrotron radiation community. Four academic synchrotron radiation facilities—Photon Factory, UVSOR, HiSOR, and ISSP-SOR—agreed to give top priority to KEK's next light source project. Should PF-HLS fail to make it onto MEXT's 2026 Roadmap, the committee has been advised that support for KEK's bid may be withdrawn.

The success of the PF-HLS project depends upon developing a strong framework of arguments based on a well formed Technical case centred around accelerator and beamline design. A science case addressing not only user requirements and demonstrating scientific problems to be addressed but also unique positioning of this project within the Japanese scientific (user/potential user) community. A strong business case outlining amongst other things the overall benefits of the approach taking into account risk management and transition from the existing PF arrangements.

Human resource and budget constraints are serious and would suggest reducing the number of operating PF beam lines to provide better support and reduce costs. For the longer term, the SAC suggests collaboration with major laboratories (Spring-8, Nanoteras) to develop a unique, internationally competitive proposal that goes beyond the capabilities of these laboratories. This may be a way of advancing the case for the PF-HLS (or similar) by sharing the development and broadening the appeal.

The SAC suggests that such a unique development is essential for attracting future international users as well as to expand the domestic user base at the PF.

In regard to facility response from the 2024 SAC report there are still some items that need to be clarified. These will be restated in the recommendations (4.2.3)

4.2.2 *Comments*

1. The concept of PF-HLS is very unconventional. Worldwide, storage ring light sources are upgrading to maximize brightness and, in some cases, increase capacity. No other facility is taking the PF-HLS approach.

2. The emittance of 210 pm at 2.5 GeV is not state-of-the-art for a ring with a 750 m circumference even today. It will be even less remarkable by the time the ring is funded, built, and commissioned. Scaling of the APS upgrade lattice to the proposed energy and circumference would give an order-of-magnitude reduction in emittance. Scaling of the more conservative ESRF-EBS lattice would give a six-fold reduction in emittance. SLS 2.0, with a 288-m circumference, delivers 158 pm at 2.7 GeV. APS and ESRF are in operation with their new lattices, while SLS 2.0 has stored beam, which suggests these are not risky designs.

3. Building the PF-HLS superconducting linac as the first stage of the project would have significant advantages, providing a high-repetition-rate, short-pulse, soft x-ray capability that does not exist in Japan at present. It would also be advantageous as a dedicated injector for PF and could permit exploration of using short- and long-pulse x-rays in combination at PF beamlines. Completion of this step would take some time, which could be used to refine the overall PF-HLS concept.

4. Operating at two electron beam energies would make PF-HLS unique, but seems unnecessary. There is an issue related to the optimization of insertion devices, x-ray optics, and x-ray detectors for both electron-beam energies. KEK staff stated that to overcome this, in some cases, branch lines would be optimized for each electron beam energy; in other cases, beamline optics and detectors could be reconfigured for each beam energy. This may reduce efficiency, increase cost, and require more beamline staff.

5. It is not clear that constructing and using different branch lines for different electron beam energies is an efficient way to use resources, as opposed to building separate, simultaneously operating beamlines that are optimized for a single electron beam energy.

6. Other approaches exist to increase the span of accessible x-ray energies, e.g., short-period cryogenic in-vacuum devices, revolver undulators, and superconducting undulators. For comparison, APS—a 6-GeV ring—has insertion-device beamlines that reach as low as 184 eV while others reach above 130 keV. There seems to be no reason an intermediate energy light source operating at, say, 3 GeV, could not simultaneously cover the 50 eV to 30 keV range at a set of beamlines, which appears to encompass the range proposed for PF-HLS.

7. Operation with two electron beams, one stored and one single-pass from a superconducting linac, would be unique. It would provide the option for high-repetition-rate pump-probe studies with two x-ray beams. Accelerator technology exists to accomplish this, albeit at a significant cost for construction and operation.

8. It is unclear to SAC if KEK can expect to obtain the necessary budget to build and operate PF-HLS as proposed, given the current economic and funding climate.

9. A ~3-GeV, ultralow-emittance ring using the existing injector would provide a very significant upgrade at a much lower cost and complexity. It could be augmented by a superconducting linac in the future, which will capitalize on KEK's expertise in superconducting technology—expertise that few synchrotron radiation facilities possess.

10. For the BL-11 R&D applications, it is unclear whether the lack of required spatial and temporal resolution will affect the ability to demonstrate the utility of simultaneous use of hard and soft x-rays.

11. The proposed use of two (non-simultaneous) beam energies in PF-HLS does not address the need to simultaneously use hard and soft x-rays. Indeed, it probably makes it more difficult. Use of a single electron beam energy with appropriate undulator technology does address this need.

12. The early science case development points to the ability for simultaneous observation of spatio-temporally heterogeneous structures and electronic states. This would be a unique and important scientific outcome. Combining wide-field observations on long timescales with local observations on short timescales will lead to a better understanding of the mechanisms of for example, photocatalysts and photosynthesis.

4.2.3 *Recommendations*

1. *Reduce the number of operating PF beam lines to enable better support for users and to reduce costs.*

2. *Clarify and pursue a staged approach to PF-HLS, starting with the 2.5-GeV superconducting linac as the first step.*

3. *Development of an alternative design concept to the level that it could be presented for the 2026 MEXT roadmap will be challenging in the available time, but should be given high priority. Existing, proven approaches (ESRF-EBS, APS-U, SLS 2, IHEP) can be used as reference designs.*

4. *Consider alternative, cost-effective methods to provide the desired photon energy span for the facility.*

5. *Significant development of the science case should be addressed immediately. In particular, highlighting the relevance of the outcomes of experiments undertaken at the newly constructed beamlines together with an aggressive program of National user workshops prior to any 2026 MEXT roadmap proposal.*

6. *To demonstrate the importance of the PF-HLS project there should be a clear strategy outlining the level of the related National academic facility support (UVSOR, HiSOR, and ISSP-SOR) and the appeal to the broader Japanese user community interest.*

7. *Previous year recommendations have highlighted the need for a contingency plan. SAC reiterates that this still needs to be addressed and now with some urgency. With the reduction in University power user beamline support this becomes even more critical for beamline staff management. In addition, rationalisation of beamline operations must become a priority.*

8. *For such a large development as the PF-HLS (or similar), it is suggested that collaboration be carried out with other major laboratories (Spring-8, Nanoteras) to develop a unique, internationally competitive proposal, whilst potentially expanding the development resources.*

9. *Seek international collaborators in the development of such a proposal as well as international users to help define its science case.*

10. *In view of the significance the PF-HLS proposal and the many questions raised, the SAC strongly recommends that PF-HLS proponents hold a workshop for all interested parties with the aim of agreeing on plans for the PF-HLS. An agreed program documenting a formal proposal should be prepared for the SAC in advance of the KEK-SAC 2026 meeting for review and comment.*

4.3 Neutron Beam Science

4.3.1 *Observations*

The neutron source and instruments at MLF are world-class. The beam power at MLF reached its target performance of stable operation at 1 MW in 2024, resulting in their neutron source reaching the world's highest neutron intensity.

KEK operates eight beamlines at MLF of varying degrees of maturity. There are promising signs of their scientific productivity in terms of numbers of publications and citations, even with less than optimal beam power and limited users and collaborations. Considering the small number of staff per instrument operating these beamlines compared to other major neutron facilities, their scientific output is good.

The MLF roadmap includes an upgrade program for MLF called MLF Double which is foreseen to double the effectiveness of MLF by upgrading the existing beamlines and constructing new instruments on the few remaining unused beamports. MLF Double includes R&D for a second, lower-repetition-rate target station, TS2, with potentially transformative performance for cold neutron beams. We have not seen details of these plans yet, but we expect they will be available in the coming years.

The organisational structure of J-PARC was presented with multiple lines of responsibility between the organisations within MLF and KEK and JAEA leadership. Operational funding and staffing runs through several organisations including KEK, JAEA and CROSS.

Present and future operation of MLF is limited by substantial increases to electricity prices over the last few years which have attracted supplemental funding that only partially covers the cost increases. The resulting budget shortfall is exacerbated by the emerging obsolescence issues faced by both beamlines at MLF and the J-PARC accelerator more generally. Many of the components are now more than 20 years old and are starting to affect the safety and stability of operation. A renewal program has been prepared to mitigate the aging issue, funded from the KEK and JAEA operational budgets. The number of operating cycles will likely need to be reduced so as to save electricity costs and free up funding for the obsolescence replacement program.

4.3.2 *Comments*

Although MLF operations suffered some difficulties over the last year, the achievement of stable 1 MW operation and world-leading neutron brightness represent major milestones which deserve celebration.

The eight KEK neutron beamlines have much more to show in the future now that the beam power has increased and the instruments have matured, as expected from world-class neutron scattering instruments at such a powerful neutron source. The MLF Double program represents a welcome opportunity to ensure future productivity by capitalizing on the existing investments and ensuring that MLF remains at the forefront of neutron science. It is timely to start the process now to develop the upgrade program for the existing instruments, select instruments for populating the remaining unused beamports, and start R&D and design studies for Target Station 2.

The SAC is concerned that the complicated organisational structure at MLF may be preventing it from reaching its full potential. The complexity of the structure risks diluting the role of leadership, muddying the lines of responsibility, creating unnecessary redundancy, and complicating attempts to effect operational changes. This may stand in the way of KEK leadership's objective to realise the many potential synergies between different parts of the organisation.

Though the scientific output of the KEK beamlines at KEK is good, there is significant room for improvement when compared to the scientific productivity of beamlines at other neutron facilities world-wide. This is not due to the instrument performance which is generally excellent, but rather reflects the much lower number of scientific and technical staff suppporting operation of the instruments.

At the current staffing level, it will be very challenging to satisfy the many different needs of the facility, such as instrumentation, user service, and conducting own scientific projects, let alone participating in the design process of TS2. Without a significant increase in staffing levels, KEK Neutron Science will not be able to maintain its world-class reputation. Experiences from other major sources show that 6 - 8 staff members per beamline, including technical and administrative staff, is a minimum required to operate beamlines at a level of around 150 days a year. The current staff level at KEK beamlines is about half of that number.

The low level of staffing on the instruments reflects the operational funding level which is now being further squeezed by the increased electricity price and looming obsolescence issues on the beamlines and accelerator, bringing further urgency to the problem.

The decreasing number of university quantum beam science groups is a concern, although the reason for it is not apparent yet. It will negatively affect not only efforts to broaden the user base, but also the hiring of future staff at MLF. With a shrinking population and the growing tendency to favor secure private firm jobs, the situation could worsen. Actively seeking international collaboration might provide a partial solution to this situation, and all possibilities, such as having foreign scientists and students stationed at MLF and bringing foreign funding to the facility, must be explored, especially since international users use a significant portion of MLF beamtime.

4.3.3 *Recommendations*

1. *Prepare a strategy to increase the staffing level at the KEK instruments to a level on a par with other world-class neutron facilities.*

2. *Consider the viability of a structural reorganisation to simplify and reinforce the lines of responsibility. Such an organisational change should be designed to support the recommended increase in staffing levels.*

3. *Consider increased staffing for operational support be prioritized when balancing limited resources for MLF and PF. Scientific impact of these user facilities limited by staffing levels which are very low compared to international benchmarks.*

4. *The SAC suggests consideration be given to establishing alliances with universities or pursuing international collaborations to strengthen the permanent presence of scientists and technicians.*

5. *Continue development of MLF Double and TS2 with a view to including them in the next update of the KEK Roadmap*

4.4 Muon Beam Science

4.4.1 *Observations*

The KEK muon facility at J-PARC (Muon Science Establishment, MUSE) consists of four beam lines: the decay muon line (D-line) with two instruments, the slow muon line (S-line) with two instruments, the ultra-slow muon line (U-line) with two instruments. These six instruments are used for μSR research with positive muons and for elemental analysis with negative muons at the D2 instrument. The high-momentum beamline (H-line) will have two branches in its final realization. This beamline is the basis for the $g_\mu - 2$/EDM experiment and will host the final version of the Transmission Muon Microscope (TμM) instrument. There are other experiments to be accommodated by the H-line such as the MuSEUM experiment, which aims to make a high-field measurement of the muonium hyperfine splitting at the two ppb level, which would improve a previous measurement at LAMPF by a factor of six, a muon-electron conversion experiment (DeeMe), and a high-precision x-ray spectroscopy measurement of muonic atoms. Currently, the H1 branch is available for user operation while the components of the H2 branch are being installed and commissioned.

The committee is pleased to see that instruments of the S and D lines utilizing positive and negative muons are producing a sustained scientific output of good level in basic as well as applied science with publications in high-impact journals.

The U-line with its source of ultra-slow muons (USM) obtained by laser ionization of muonium is the flagship line for depth-dependent μSR investigations in materials and life sciences at the nanometer scale. A prototype version of the TμM is under development in the second area of the U-line. A very compact cyclotron for accelerating USM to 5 MeV procured in the previous years has been made ready for testing, but the tests had to be postponed due to beam-time cancelations caused by neutron target problems.

Overall, the U-line has made steady progress. In order to ensure an optimal temporal and spatial overlap of the muonium cloud with the ionizing laser beam and thus enhance the generation of USM, the surface muon beam provided by the U-line has been characterized. Moreover, the complex laser system for the Lyman-α muonium transition has been significantly improved, resulting in increased power and operating stability. We acknowledge the steady progress of this challenging endeavor and congratulate the teams on these results.

However, the intensity of the source remains the most critical point for the success of the projects on the U-line such as the nanoscale μSR and of key instruments such as the transmission muon microscope listed in PIP 2022, and of the $g_\mu - 2$/EDM experiment (listed in the PIP2016) at the H-line.

The acquisition of external funding for muon science has been very successful, and we congratulate the team on securing significant new funding. In addition to a large-scale grant for Scientific Research, the newly established K-program has allocated funding for three muon projects, reflecting the growing recognition of muon science at KEK.

4.4.2 *Recommendations*

1. *Continue to focus on optimizing the USM production, which plays a key role in a wide range of programs from nanoscale material science to particle physics.*

2. *With the current USM source intensity, first experiments in nanoscience are possible and should be performed. Scientific results will strengthen the case of all USM-based activities.*

3. *Given the successful acquisition of funding for new projects, we recommend a careful planning of the use of the limited manpower in the different muon activities.*

5 Social Issues

In the past year, KEK has implemented an impressive number of changes, including the implementation of structural changes to the organisational chart by adding a DE&I Strategy Promotion Committee and DE&I Coordination Committee that works with the leadership teams within and outside KEK. The former consists of laboratory directors and members of the executive board, and the latter consists of laboratory members.

5.1 Research Ethics, Diversity and Gender Equality

The DE&I Coordination Committee works to collect and exchange feedback, implement DE&I-related projects within KEK, and host workshops for staff. A Code of Conduct was drafted by a working group that was released to the KEK community and is now posted on a publicly accessible website, https://www.kek.jp/en/about/compliance. Previously, KEK has been implementing various supports for female staff to enhance the DE&I, such as maternity and parental leave, children's room in KEK, babysitting assistance and substitute personnel for those on parental leave, and flexible teleworking policies. However, the opportunity of DE&I education to the KEK community remained at a low level. The new DE&I structure will improve significantly the KEK working environment. In 2024, the group ran a series of educational programs for the KEK community. The group ran a series of educational programs for the KEK community.

The new DE&I structure is inspired by a similar organisation at CERN . Mihoko Nojiri, Professor of IPNS visited CERN to meet with the CERN DG, HR, DI coordinator and the ombudsperson in FY2023 and proposed the current structure. She is now DE&I Promoter of KEK. While the DE&I structure is improved, the female fraction of KEK remains low. The number of female staff (researchers and technicians) are 21 and 21 in 2019, and 29 and 33 in 2024. The number of female staff has been increasing, partly due to the female-specific hiring The new DE&I structure enhances the outreach towards female students by adding more support from the KEK administration. Under the new DE&I program, differently-abled personnel are surveyed and interviews of international staff members are conducted to further enhance the support. The DE&I Promoter also communicates with Belle II and T2K DE&I coordinators routinely.

SAC is pleased to see that KEK has made significant progress as per last year's recommendations. The DE&I coordinator faces some difficulties, but the issues are identified. SAC is confident that KEK is now on track to become a welcoming workplace for all types of people, regardless of sex, disability, or nationality. These efforts will help alleviate the problems caused by Japan's declining and aging population.

However, SAC finds that KEK needs to formulate a long-term strategic plan to counter the difficulties of hiring scientists due to the declining Japanese population. The plan could include changing KEK's work culture to hire and retain foreign-born scientists.

The SAC is concerned that women are being tasked with doing the work of improving gender equity and equality, as well as promoting those who are underrepresented in science. Because there are so few women, those women are having to spend much of their effort supporting the DE&I programs at KEK. There are too few women faculty, and the pool to draw from is also small (roughly 10% of graduate applicants for Physics PD programs in Japan are female). There is a concern that women will burn out shouldering the burden of this work while carrying on their own research programs, and the current level of activities is not sustainable.

KEK has taken steps to establish a framework to address harassment issues. As recommended in our 2024 report, potential harassment cases should be dealt with by people who are independent of the management hierarchy. Furthermore, harassment policies should apply equally to members of the user community, as well as to staff.

5.2 Engagement, Public Relations and Outreach Activities

KEK's communication office depends directly of the D-G and is in charge of disseminating research results to the general public and to the media. This office aims to increase the visibility of KEK, strengthen the ties with society by organising visits, take care of the web and social media networks. We note in particular the production and publication in 2024 of a braille book entitled "Origin of the Universe and Matter: Understanding the invisible". The office is aware of the challenges to effectively publicize the scientific results to monitor and learn from the impact of such a communication.

The facility visit statistics and open house participation are outstanding. Regular facility visits in groups of at least 10 people occur weekday mornings or afternoons. Beyond this, they organise the "KEK Caravan", a programme in which they travel and visit high schools. The number of such visits amounted to 37 in 2024, which is a remarkable number. In addition, KEK organises sessions for infants and the *Rikei-jyoshi* Camp for high school girls as a joint project of the Gender Equality Promotion Office, the Toshiko Yuasa Laboratory (TYL), Ochanomizu University and Nara Women's University. The Camp focuses on scientific experiments, visits to the facilities, and lectures by female researchers who are active at the forefront of their fields. For undergraduates, they organise *the Summer Challenge* aiming to educate third-year university students to become leaders in basic science. The 18th edition of the Summer Challenge was held in August 2024. The programme includes lectures and facility tours, as well as hands-on training in particle and nuclear physics. The last two programmes have run for more than a decade, and it is desirable to review and assess the impacts of these great programmes in attracting PhD students, technicians or engineers to KEK.

KEK should establish a sustainable framework for its outreach activities, which could include partnerships with external foundations and/or the establishment of its own "KEK and Society" foundation to support activities that lie beyond its scientific mandate.

5.3 *Recommendations*

1. *There is a concern that women will burn out shouldering the burden of this work while carrying on their own research programs, and the current level of activities is not sustainable. We recommend that KEK spreads the workload more evenly across men and women wherever appropriate, and considers bringing in external advisors to oversee the DE&I program.*

2. *The SAC recommends that KEK formulates a long-term strategic plan to counter the difficulties of hiring scientists due to the declining Japanese population. The plan could include changing KEK's work culture to hire and retain foreign-born scientists.*

3. *The committee recommends that KEK commit more resources toward outreach programs including funding, administrative support, materials, and outside partnerships. KEK should seek external sources of funds including private foundations and government grants.*

4. *Develop a peer mentoring program, where people can support one another. In addition to mentoring those who are more junior, create opportunities for people at similar career stages to connect, share experiences, and support one another.*

5. *Create professional development opportunities for all staff at all career stages by bringing in experts from within and outside KEK. Women and those who are underrepresented will especially benefit from such programs as they often have fewer role models and fewer opportunities for informal mentoring.*

6. *Due to the amplifying effect that an enthusiastic teacher has on the student year after year, the program of visits to high schools should be extended to organise a course for high school teachers at KEK. We recommend looking to programs such as those at CERN to bring teachers to KEK who could bring the science and excitement for science back to their schools.*

7. *As both the Summer Challenge and the Rikei-jyoshi Camp has been running for more than a decade, we recommend to learn which has been the impact of that efford both in attracting them to study physics and/or to join KEK.*

8. *The SAC learnt that two out of the three female professors are retiring next year, we recommend KEK to open a female position at the level of professor*

9. *KEK should establish a sustainable framework for its outreach activities, which could include partnerships with external foundations and/or the establishment of its own "KEK and Society" foundation to support activities that lie beyond its scientific mandate.*

6 Appendices

7 Progress on KEK-SAC Recommendations, 2024

7.1 2024 KEK-SAC Recommendations - Executive Summary

1. *Maintain a laboratory-wide focus on staff renewal;*
2. *Continue to seek effective ways of replacing company hired staff with new KEK positions;*
3. *Further develop programs to enhance female participation in STEM generally, and more specifically in KEK;*
4. *Seek an extension of the electricity power subsidy currently provided by MEXT;*
5. *Continue to monitor the progress of high-priority projects in the KEK-PIP 2022;*

7.2 2024 KEK-SAC Recommendations - Accelerator Facilities

1. *When end-of-life equipment needs to be replaced, continue to use these opportunities to upgrade to more energy efficient equipment wherever possible.*

   Response: We received supplemental budget for the countermeasures to aging and improved efficiency for J-PARC and SuperKEKB in JFY2024/2025. Various replacements of aging components with newly manufactured ones are planned for magnets power supply systems, RF systems, control systems including interlock and timing system at J-PARC in JFY2025. Much of new equipment has higher energy efficiencies. SuperKEKB are also currently replacing the old magnet power supplies in both rings with more energy-efficient ones. In addition, the cooling water circulation control system is being updated from on-off control to inverter control which is more energy-efficient. In electron/positron linac, replacement of accelerating structures fabricated in 1980s with newly developed ones with higher accelerating gradient is underway and will continue in JFY 2025 and 2026. The power supplies manufactured in 1993-1994 in the PF ring were replaced with new ones, which feature improved energy efficiency and enhanced stability. R&D on making higher efficiency klystron and solid-state RF amplifier is in progress in Accelerator Laboratory.

2. *Install more and especially faster beam instrumentation ($\sim$1 turn), including turn-by-turn, bunch-by-bunch beam-position monitors at several places around the SuperKEKB rings, distributed fast beam loss monitors, and fast beam-size measurements, to determine the origin of the very fast beam losses.*

   Response: We have installed temporally bunch-by-bunch position monitors on several places and observed the bunch position behaviors at the sudden beam loss. As the position change before the beam loss was always very tiny, around O(0.1mm) per bunch, we understand it will not yield useful information with the simple detection circuits. We are still trying to modify the system.

3. *Review and refine the plan for SuperKEKB LS2 in light of the challenges for constructing the QC1P.*

   Response: We are working with FNAL to develop a new compact QC1P using Nb3Sn. It is four-year R&D program from JFY2024- 2027. Fabrication and cold test of the mirror magnet to verify thermal and mechanical performance will be done during the next fiscal year. Optimization of the schedule for LS2 is under discussion.

4. *The SAC encourages KEK to continue to expend major efforts to prepare appealing future career options, in order to attract a talented and diverse generation of researchers and engineers in a timely way, so as to assure that unique knowledge is transferred to the next generation.*

   Response: With the aim of securing talented young people, ACCL introduced a tenure track system for job openings of assistant professors. Term is limited 4 years, but after an evaluation in the third year or earlier considering candidate's career, the candidate may be offered the permanent employment. We have various intern programs related to accelerators for young researchers and students. They have been seen to be effective in appealing to young people.

7.3 2024 KEK-SAC Recommendations - Particle Physics

1. *The SAC acknowledges the KEK's leading role in the realization of a Higgs factory and supports the continuation of its effort. The Committee also encourages KEK, together with the Japanese community, to pursue a solution for realizing the ILC.*

2. *In order to stay competitive with the LHCb experiment, it is essential that sufficient beam time will be allocated to SuperKEKB/Belle II. In parallel, investigations must continue to achieve the full design luminosity.*

3. *Being such an important part of the Japanese particle physics program the success of the contribution to HL-LHC is of the utmost importance.*

4. *As KEK is taking the lead responsibility for new Hyper-K near detector, IWCD, it should provide strong oversight for the coherent construction of the detector and its timely completion.*

5. *It is important for the Theory Center to be able to recruit new young staff. Opportunities for interchanges and joint appointments with universities should be pursued, as well as international exchange visits.*

6. *KEK should develop a strategy for the future of the KOTO experiment.*

7.4 2024 KEK-SAC Recommendations - Nuclear Physics

1. *The planned upgrade of KISS towards KISS-II should not be delayed. For the next meeting a detailed plan of the upgrade should be presented.*

   Response: KISS 1.5 has been progressed.

2. *The planned upgrade of KISS 1.5 should be realised without any delay.*

   Response: Response: KISS 1.5 has been progressed.

3. *The unique hypernuclei research program should continue. The expected beamtime in 2024 should be realised in its entirety. This is very important as it should enable the puzzle of the* $^{3}_{\Lambda}H$ *half-life to be resolved.*

   Response: Consideration is presented in this report.

4. *KEK should seek solutions to realise the extension of the J-PARC Hadron Hall with reduced cost, such as de-scoping the building dimensions or facility staging, or by seeking resource-sharing opportunities.*

   Response: Discussions of the future of the extension continue.

7.5 2024 KEK-SAC Recommendations - QUP

1. *The SAC recommends continuation of the successful program at QUP to push the frontier of its high-impact scientific program, taking advantage of its ability to make rapid progress to publish in new areas of detector development and fundamental science.*
2. *We also recommend that QUP develops a cohesive story that ties together the components of its program.*
3. *We also recommend that QUP continues its effort to recruit a diverse cohort of successful researchers.*

   The QUP is under review following the change in Director.

7.6 2024 KEK-SAC Recommendations - Materials and Life Science

1. *The new twin beamline construction program should be funded adequately as a matter of priority, to assure timely completion.*
2. *Approval of the PF-HLS should await completion of the PF multibeam project and R&D studies;*

   Response: The future of the PF-HLS is under consideration
3. *The laboratory should outline a contingency plan should the PF-HLS project not progress.*

   Response: The future of the PF-HLS is under consideration
4. *The SAC requests a report on the strategy for engaging users beyond the PF.*
5. *The laboratory should outline the strategy to establish the importance of the HLS project within overall Japanese synchrotron science.*
6. *The laboratory should consider carefully how the proposed dual-energy and multi-beam approaches are optimal to position PF for scientific relevance and impact for the long-term.*

   Response: The response to these recommendation is ongoing. See details in this report

7.7 2024 KEK-SAC Recommendations - Neutron Beam Science

1. *Prepare a strategy to increase the staffing level at the KEK instruments to a level on a par with other world-class neutron facilities.*
2. *The SAC suggests consideration be given to establishing alliances with universities or pursuing international cooperation to have a permanent presence of scientists and technicians.*

7.8 2024 KEK-SAC Recommendations - Muon Beam Science

1. *Considering the limited manpower and resources available at the MUSE facility, the SAC encourages KEK to maintain an efficient balance between new developments, user support, and research.*
2. *Recognising the central role played by the USM source for the TμM and the g-2/EDM experiment, the SAC calls for strengthening and focusing the efforts to meet its design parameters.*
3. *The SAC recommends a regular review of the overall progress.*

7.9 2024 KEK-SAC Recommendations - Social Issues

1. *The laboratory should develop a comprehensive program and policy to prevent workplace harassment, which could include training for new hires and existing staff as well as investigation of all complaints by a group that is independent of line management.*

2. *SAC recommends that KEK keep track of improvements and complaints over time and address repeat offenders.*

3. *SAC commends KEK for developing a comprehensive Code of Conduct for its user base. The laboratory should make the Code of Conduct public and accessible to signal its commitment to safety and a welcoming working environment for all.*

   The SAC welcomes a report from the point of contact in future SAC meetings.

4. *The laboratory should continue reporting statistics on gender proportionality at all levels of management and devise steps to encourage women into managerial positions.*

5. *The laboratory should work with experts in the area to develop programs to improve the professional climate. This will help in recruiting and retaining the best and the brightest while helping to recruit and retain more women at KEK.*

6. *The laboratory should continue to develop public outreach and education programs to help develop a pipeline of future researchers and engineers. The KEK should also make a careful survey on the needs of female researchers, young researchers, and other minority groups for career development to help improve the diversity of KEK. See the relevant sections in the 2025 meeting*

Agenda of the Sixth KEK Science Advisory Committee Meeting, Feb.26-Feb.28 2025

Day 1 Wednesday, February 26, 2025

9:00 - 9:05 (5) Executive session(closed)

9:10 - 9:25 (15) Introduction to KEK and mandate of the committee (S. Asai, KEK D.G.)

9:30 - 9:45 (15) Status of the KEK Roadmap 2021 and KEK PIP2022.
(K. Hanagaki Executive Director)

9:55 - 10:25 (30) Future planning for Institute of Particle and Nuclear Studies
(N. Saito, Director, IPNS)

10:30 - 10:50 (20) (Break)

Status reports of the selected topics

10:55 - 11:15 (20) SuperKEKB and BelleII (M. Tobiyama, Prof., ACCL / K. Matsuoka, Prof., IPNS)

11:25 - 11:45 (20) T2K-HyperKamiokande (T. Nakadaira, Prof., IPNS)

11:50 - 12:00 (10) Photo Session

12:00 - 12:50 (50) (Lunch)

13:00 - 13:30 (30) Future planning for Institute of Materials Structure Science
N. Funamori, Director, IMSS)

Status reports of the selected topics

13:40 - 14:00 (20) Development of new light source (N. Igarashi, Prof., IMSS)

14:10 - 14:40 (30) Future planning for the Accelerator Laboratory (T. Koseki, Director, ACCL)

Status reports of the selected topics

14:45 - 15:05 (20) ILC (H. Sakai, Prof., ACCL)

15:10 - 15:30 (20) (Break)

15:35 - 16:05 (30) Future planning for the Applied Research Laboratory
(Y. Namito, Director, ARL)

16:15 - 16:45 (30) Future planning for the J-PARC Center (T. Kobayashi, Director, J-PARC Center)

16:55 - 17:15 (20) Future Planning for QUP (K. Hanagaki, Acting Director, QUP)

17:30 - 18:30 (60) Transportation to Hotel

19:00 - 21:00 (120) (Welcome dinner at Hotel Nikko Tsukuba)

Day 2 Thursday, February 27, 2025

9:00 - 9:05 (5) Executive session(closed)

Issues outside scientific program

9:10 - 9:40 (30) Diversity Equity & Inclusion
(S. Michizono, Executive Director / M. Nojiri, DE & I Promoter, Prof., IPNS)

9:50 - 10:10 (20) Retaining staff/employees/personnel (S. Michizono, Executive Director)

10:20 - 10:40 (20) Education at KEK (K. Hanagaki, Executive Director)

10:45 - 11:05 (20) (Break)

Issues outside scientific program

11:05 - 11:25 (20) Industry-academia collaboration and joint research
(S.Adachi, Executive Director)

11:30 - 11:50 (20) Diversification of financial resources,
Soaring electricity price and procurement issues. (S. Asai, KEK D.G.)

11:55 - 12:15 (20) Public Relations (S. Adachi, Executive director)

12:30 - 13:30 (60) (Lunch)

13:30 - 15:00 (90) Executive session and drafting

15:00 - 15:30 (30) (Break)

15:30 - 16:30 (60) Discussion with KEK members

16:30 - 17:00 (30) Executive session and drafting

17:00 - 18:00 (60) Transportation to Hotel

Day 3 Friday, February 28, 2025

9:00 - 12:00 (180) Executive session

12:00 - 13:00 (60) (Lunch)

13:00 - 15:00 (120) Executive session

15:00 Adjourn

Figure 2: 2025 KEK-SAC Meeting Agenda

Members of the KEK Science Advisory Committee

Field	Name	Affiliation	
HEP	Reina Maruyama	Yale University	**
	Jun Cao	Institute of High Energy Physics, Chinese Academy of Science	*
	Geoffrey Taylor	The University of Melbourne	**
	Tatsuya Nakada	EPFL, Ecole polytechnique fédérale de Lausanne	*
Theory	John Ellis	King's College, London	**
Nuclear	Takashi Nakano	Osaka University	*
	Maria Jose-Borge	Consejo Superior de Investigaciones Científicas, Spain	**
Accelerator	Frank Zimmermann	CERN, European Organization for Nuclear Research	*
	Wolfram Fischer	Brookhaven National Laboratory(BNL)	**
PF (Synchrotron Radiation)	Michael David Borland	Argonne National Laboratory	**
	Robert Norman Lamb	The University of Melbourne	*
Neutron	Ken Andersen	The Institut Laue-Langevin (ILL)	**
	Sungil Park	Korea Atomic Energy Research Institute (KAERI)	**
Muon	Elvezio Morenzoni	PSI, Paul Scherrer Institute	*

* Term ; April 1, 2023 - March 31, 2025

** Term ; April 1, 2023 - March 31, 2027

Figure 3: KEK-SAC Members, 2025

Figure 4: KEK-SAC Meeting Participants, 2025