Recommendations of the 99th Physics Research Committee

15/16 April 2025

General Information and Main Recommendations

At its **99th meeting on 7-9 April 2025**, the PRC reviewed all groups, projects and activities of particle physics at DESY. During this meeting, the **PRC also met with the Astroparticle Physics Committee (APC)** to explore commonalities and to exchange information, particularly addressing the areas of detector development and software. The conclusions from the joint discussions will be published in a separate document.

The PRC recognises that, overall, **all activities are going well**. The PRC takes note of the good performance of the LHC and its experiments, and the committee is particularly pleased about the important progress of HL-LHC upgrades over the past 6 months, about several exciting new LHC results, and about the successful start-up of the ALPS II experiment with first results presented. The testbeam facility has again performed well in 2024. The LUXE experiment is making long strides towards its realisation with the ELBEX EU grant for an extraction beamline from the European XFEL. The experiment now aims at achieving the CD2 (critical decision process step 2) status from the DESY directorate as a next step, which is important for the collaborators to secure construction funding. The Theory group conducts outstanding research, offers direct support and conceptual framing for DESY experiments, and attracts world-leading researchers to Germany.

The FH platforms for detector R&D and for scientific computing are operational and facilitate communication, coordination, and planning. The platforms are important in view of the European strategy for particle physics update (ESPPU), the PoF V strategy evaluation process, and also the engagement in the new DRD collaborations.

Recent FH milestones include

- the very successful PoF review in February 2025: specific recommendations received on the FH activities in the "Matter and the Universe" (MU) and "Matter and Technologies" (MT)_programs comprise to maintain the ability to react to external pressure (e.g. concerning HL-LHC components / schedule), the on-site lab programme, the position of DESY in the field of AI, and the sharpening of the detector R&D profile. The latter two points will specifically be addressed in the forthcoming PoF strategy evaluation process, with central planning roles for the Detector R&D and Scientific Computing platforms.
- DESY scientists had numerous leading roles (e.g. for Higgs factories, non-collider experiments, muon and plasma-based colliders, R&D activities, European networks) in preparing inputs to the update process for the European strategy for particle physics (ESPPU), submitted to the process at the end of March 2025.

Concerning the last point, the PRC takes note of the **strong support to establish a DESY "axion platform"** expressed by the German particle and astroparticle communities in their respective ESPPU inputs. Such a platform and infrastructure would complement the DESY collider activities with a strong and leading non-collider program on axions and ALPS.

With the **expansion of the on-site experimental program,** relatively large collaborations will use DESY as a host lab for an extended length of time (5-10 year). This has consequences to which the PRC wants to direct the attention:

- There is a growing pressure on availability of essential services and infrastructure. These include the cryo-platform and general cryogenic support, magnet services and expertise, the ELBEX beamline, site adaptations, optics expertise, software and operational support, and related topics.

- There is a need to re-discuss and better define the roles of DESY as the host lab and of institutes collaborating in the on-site experiments, for the various phases of the experiments (construction, installation, commissioning, operation). Rules, guidelines and procedures for setting up, approving, and running such international experiment at DESY need to be clarified.

The PRC is voicing a **number of additional general concerns**:

- Care must be taken to fit all essential activities in the available – decreasing – resources, a constraint that currently affects all FH groups. This requires, in particular, a careful planning in preparations of the PoF strategic evaluation.
- These reductions of resources come at a time where it remains a priority to ensure that sufficient technical personnel for the imminent construction projects is maintained or built up – e.g. for the LHC experiments and for the on-site experimental activities. Also key cross-cutting services that are important for a wide international and national community – such as support for future collider project studies, scientific software developments, and testbeam operations – need to be preserved.
- Hiring restrictions are mostly felt in the reduced numbers of Ph.D. students and postdocs and, correspondingly, in the scientific output. In some cases, the retirements of people with long-standing key expertise bring the danger that this expertise is lost completely.
- The future of the testbeam facility in the PETRA IV era should be secured, given its importance for DESY's own R&D activities and also for the European and international HEP physics program and beyond.

The next meeting of the PRC (11/12 November 2025) will be the 100th meeting of the committee, and a special session to celebrate this is being planned.

ATLAS

Findings

The PRC is recognising the contribution to the ATLAS experiment by the DESY group, in the broad area of the operation of the detector, physics analysis and the upgrade projects.

Although the ATLAS group is physically placed in Hamburg and Zeuthen, the group is working very well coherently. Having two location allows them organizing efficient collaborative work with the university groups particularly in Hamburg and Berlin, which allows for an efficient involvement of students, both in analysis and upgrade work.

Comments

The physics portfolio is very broad. The group needs to keep an eye on sufficient student and postdoc involvement in all the efforts especially with decreasing research and travel budgets, so that the individual involvements stay relevant and impactful.

It is crucial to train multiple people on technically expert tasks, such as wire bonding, for redundancy. For the inner tracker, the delays in the EOS card due to the resubmission of the lpGBT chip are putting a lot of pressure on the DESY group.

Identification of critical issues

While the current technical personnel status is adequate for the ongoing ITk upgrade work, there is much reduced flexibility in case of unforeseen incidents,. This may lead to a reduction of personnel, creating serious delays in the upgrade schedule.

The current travel budget is a half of that of the before COVID time. Given the wide usage of remote meetings, much smaller number of travels are now required. However, some face-to-face contacts and in person presence are still required. In particular, presence at CERN for detector operation, shifts and leadership tasks is important.

Specific recommendations

- It is recommended that the group prepare some backup plan for the unforeseen loss of technical personnel.
- A careful evaluation of travel needs is recommended to establish an appropriate level of the travel budget for the discussion with the management.
- The lab should give maximum support for delivering the new EOS cards to ATLAS as fast as possible, since these determine the critical path for the ITk upgrade.

CMS

Findings

Much progress was made since the last PRC on the DESY Phase-II upgrade projects, the outer tracker (OT) and the endcap calorimeter (HGCAL). On the OT, Pixel-strip (PS) module pre-production started, and a pipelined production test is underway. A new wire-bonding technician is trained, and another being recruited. Three staff scientists joined the work and received training. Quality control (QC) is in place and being exercised. Production is limited by component supply, with some positive developments: DESY devised a new method to simplify production of MaPSAs (produced externally); issues with the lpGBT were mitigated by CERN. Problems with hybrid quality and delamination continue. For the endcap structures, Dee pre-production is complete, double-disk assembly exercised successfully, and shipping procedures being defined. The project schedule was adjusted for the one-year HL-LHC startup delay.

For the HGCAL, work proceeded steadily: tileboard production started; the tile-module production is ready to start; QC is defined and largely tested; production and QC staffing is being put in place and both are ramping up; test-beam of a small EM stack was done with the final readout. The schedule was updated to the current status.

The DESY team continues a broad engagement across operations, computing and analysis. As one example, the W mass and top-threshold results shown at PRC98 are submitted for publication. Staff and student numbers continue to decline, though critical positions are being refilled. Eight Ph.D. theses were completed since PRC98.

Comments

The PRC congratulates the CMS team, especially on the substantial progress in entering production stages in the upgrades. The PRC is happy to see the increased focus on the upgrades across the group. At the same time, the group maintains a good profile in non-upgrade areas, despite continuing staffing challenges.

Schedule threats from problems with tracker components have substantially reduced since PRC98 – the team is applauded for their part in resolving problems. Availability of MaPSAs, and especially the poor quality of the hybrids, still pose a major threat to the module schedule. The technical staffing situation for production improved since the last PRC, but there is not yet assurance that sufficient technical staff will be available throughout the production. The PRC is impressed by the progression of HGCAL boards into production, and by the considered plans for production staffing. The PRC recognises the wish of the HGCAL team to follow through to

operation in the HL-LHC period. For both projects, the PRC thanks the teams for the updated schedule information.

Identification of critical issues

Serious issues remain that impact the OT, most significantly the technical problems on hybrids, which may yet lead to further cost and schedule overruns.

Specific recommendations

- The team should continue to pay close attention to the hybrid production problems, assisting with testing and so on, where this can help.

Belle II

Findings

Recent investigations indicate that a major source of Sudden Beam Losses (SBLs) could be the vacuum sealant used at the joints of the beam pipes. Since there will be no run until the autumn, this could not be confirmed yet.

Although the PXD2 is operational, it has been switched off in order to protect the detector against damage due to the SBLs.

Beyond the contribution to the machine related studies and PXD2, the DESY Belle II team has been making well-recognised contributions to many different areas, such as tracking, issues related to offline computing and detector performance monitoring.

Comments

The PRC is happy to observe the increased engagement of the DESY Belle-II and machine groups in collaborating with the KEK machine group for stable machine running and progress towards the luminosity goal of well above 10^{35} $cm^{-2}s^{-1}$.

The committee strongly supports the DESY Belle II team in keeping the PXD2 detector ready for physics, and in developing the strategy for safely switching on, and off, the PXD2.

The group pursues physics analysis in areas unique to Belle II, such as inclusive semi-leptonic B decays, B to K neutrino anti-neutrino decays and tau decays, and should continue to do so.

Identification of critical issues

The sudden beam losses (SBLs) remain an unsolved problem, also affecting machine studies for increasing the luminosities.

The DESY team has not yet further developed their plans for engagement in the long-term operation of Belle-II beyond LS2.

Specific recommendations

- It is strongly recommended that the DESY Belle II and accelerator groups continue to collaborate with the SuperKEKB team in machine related issues.
- The Belle II group should develop their plans to engage in the major detector upgrade being discussed for around 2032 in conjunction with other German Belle II groups, considering expertise which may wish to join the project, in view of the future development plan of DESY.

DESY Axion Platform – General Comments

The PRC takes note of the **strong support to establish a DESY "axion platform"** expressed by the German particle and astroparticle communities in their respective ESPPU inputs. The PRC also notes that the ultimate sensitivity of the DESY axion platform will not only explore a wide region of the ALP parameter space but, most remarkably, include a sizeable stretch of the ``QCD axion band''. This has the potential to ultimately solve the strong CP problem, ultimately explaining all dark matter in the universe. Not least in view of this scientific promise and the high expectations towards DESY, the PRC suggests that a particular urgency is to define a construction model for the BabyIAXO magnet and to make progress on its funding within such a model. The PRC strongly encourages DESY management to support the funding process and to establish a realisation plan together with CERN and industry.

ALPS II

Findings

The PRC recognises the progress on the analysis and looks forward to the publication of the results. The committee is also looking forward to the next science runs on ALPs. The timeline set in the previous PRC is well maintained. Furthermore, the exploration of vacuum magnetic birefringence (VMB) have been successfully initiated, improving already the sensitivity by one order of magnitude.

Comments

The PRC comments that ALPS II provides a unique probe of the QCD axion, whether or not the axion is a significant component of dark matter. This is a very important contribution to the axion community and provides key leadership for the DESY program. In addition, the collaboration has credibly argued to have a realistic chance to reach the QED expected VMB signal - which tests the quantum vacuum polarization, for the first time ever. The PRC notes that this VMB program would be carried out without conflict with the BabyIAXO or MadMAX projects.

Identification of critical issues

The PRC notes that the subcritical level of optical expertise available to the experiment has not improved since the last PRC meeting. This is a major risk to its future operation as there is currently a single point of failure if one scientist becomes unavailable for any reason.

Specific recommendations

- The PRC recommends that the DESY management together with the collaboration, prepares a plan to mitigate the risk imposed by the subcritical optical expertise. In particular, the immediate implementation of a tenure-track position in this domain is urgent.

MADMAX

Findings

The MADMAX collaboration has continued its satisfactory progress, sailing now through a consolidating phase to prepare and validate the next steps. PRL has accepted their paper on dark photon limits, and a paper on MORPURGO measurements is on referee process. A technical paper on the G10 cryostat has been published in JINST in collaboration with CERN colleagues. Further data analysis is ongoing. Work towards the important milestone of proving that booster system

with many disks can be used has advanced, including the interactions with Fermilab colleagues. Also, novel approaches on single photon detection are in development.

Comments

It is pertinent to remind that the MADMAX ultimate sensitivity will cover a sizeable stretch of the "QCD band": it has thus the potential to solve the strong CP problem, which is a major issue, and furthermore in a region where the axion would completely account for dark matter.
The PRC congratulates the collaboration on their progress. It is satisfactory that new detector technologies are being developed as well (e.g. TWPA). The use of graphene as a dark count free detector material may turn into a paradigm shift.
The PRC notes with regret that the (previously recommended) informed plan with decision points could not be delivered by the collaboration, as it depends on pending funding decisions and discussions among DESY and the Max Planck society. The PRC regrets that the funding of the MADMAX magnet remains unclear, and the same applies to the cryo-platform for which the expertise will vanish soon. The PRC also notes that only 10% of funding is missing for the cryoplatform.

Identification of critical issues

The PRC stresses that it is essential to keep the momentum of the collaboration, solving the present funding and decision impasse. Lack of technical cryoplatfom personnel is also a concern.

Specific recommendations

- The DESY management should work closely with the collaboration to keep its present momentum.
- The PRC strongly recommends the DESY management not to wait with the finalisation of the infrastructure for a PETRA IV decision.
- The PRC recommends the DESY management to redouble its efforts to guarantee the cryostat technical personnel essential to the project success.

BabyIAXO

Findings

The PRC notes with pleasure the progress achieved by the BabyIAXO Collaboration over the last months, in particular

- preparing the start of work at DESY for detector tests, beamline assembly & tests, towards a possible magnet-less commissioning of the experiment.
- the magnet project, to finalyse the magnet design, to identity, schedule and secure conductor as well as magnet assembly and procurement strategy, and to identify and secure required funds.

Since the last review, progress on the cable procurement and backup solutions have been made, the follow-up of the magnet Conceptual Design Review has been held, discussions with CERN Technical Sector took place, progress with beamline equipment, detectors, optics, experiment structure and drive, haloscope as well as well as software and analysis preparations have been made. For the magnet project, fund applications have been made with the DFG "Large Equipment" application in preparation (6.5 M€) and two German Cluster of Excellence proposals (UHH/DESY + UBo/UDo/USi).

Comments

BabyIAXO is an important project which not only will cover a wide region of the ALP parameter space, but it will also touch the axion ``QCD band'' as a first step towards IAXO, thus targeting the outstanding strong QCD problem of the Standard Model.
Concerning the magnet project, the PRC notes the progress achieved on the purchase of the aluminum stabilised conductor for the magnet. The PRC appreciates the preliminary outcome of the follow-up review of the magnets conceptual design, where the review committee considered the conceptual design to be mature to prepare a procurement plan and to proceed towards a TDR. The reviewers further consider the construction of the magnet at CERN to be the most attractive option.
The PRC also notes that there are still uncertainties on the procurement strategy of the magnet as well as on the magnet schedule and costs.
The PRC considers a positive outcome of the funding applications for the magnet and infrastructure of high importance for the experiment.
The PRC takes note that the collaboration stresses the need to proceed towards a magnet-less commissioning, targeting a start at mid-2028. The BabyIAXO Collaboration considers this commissioning as vital to keep the collaboration engaged and together.

Identification of critical issues

The PRC considers the magnet project on a critical path. The design of the magnet is proceeding well, however the uncertainties on its fabrication, procurement, budget and schedule remain.
The PRC considers a positive outcome of the funding applications for the magnet and infrastructure of high importance for the experiment.
A further delay in the DESY funding availability would be very harmful to the project.

Specific recommendations

- The PRC recommends the collaboration to finalise all cost estimates.
- The PRC urges the DESY management to specify the formal requirements for a full approval and a release of DESY resources. Both, DESY and the BabyIAXO collaboration should agree and follow those steps.
- The PRC considers the ongoing funding applications (DFG, Cluster of excellence) for the BabyIAXO magnet to be vital for the project, thus recommends DESY and the BabyIAXO collaboration to explore the possibilities for DESY to support the applications.
- The PRC would appreciate if discussions and agreements between the managements of DESY and CERN could clarify CERN's involvement for the BabyIAXO magnet.

LUXE

Findings

The PRC notes with pleasure that the JETI40 laser, a TiSa 40TW laser decommissioned in Jena is delivered to Hamburg and DESY in May 2025 and that it is considered to have the laser running towards end of the year. The committee considers the laser to be a good commissioning system and learning ground for the LUXE Collaboration.
The PRC notes that the project ELBEX (An Electron Beamline at the European-XFEL) to install a beamline to extract 16.5 GeV electron beam and provide beams to the users (LUXE, plasma, testbeam) has started. The PRC appreciates the development and opportunity to move ELBEX in

the EuXFEL fan, which for LUXE would have the advantages of improved access and more longitudinal space. The synergy with the other experiment in the line might allow the collaboration to explore the potential to co-use of aPW laser.
The committee supports that the decision to consider the new location as a new baseline for ELBEX and LUXE.
The PRC notes that funding for the experiment is challenging as well as planning for resources. The committee considers that the DESY CD2 status will bring advantages.

Comments

The committee notes that if LUXE data taking is to start in 2029 or later, the collaboration should search for opportunities to bridge the time gap e.g. CLARA, laser facilities, like E320, etc.

Specific recommendations

The PRC recommends that DESY and the LUXE collaboration develop and agree on a path and schedule towards the CD2 approval of the LUXE experiment.

FTX

Findings

The FTX group has five main topical groups: SLB (Science with Lepton Beams), covering future colliders, LUXE, and polarimetry; SFT (Software and Computing), focusing on future collider software and machine learning; DTA (Detector Technology Activities), concentrating on calorimetry; TBT (Test Beam and Telescopes), managing the test beam facility; and AST (Accelerator Science and Technology), the FLASHForward facility and plasma source testing. The group consists of 55 members, including 5 postdocs and 13 Ph.D. students. The personnel situation in some of the activities remains an issue, with potentially detrimental effects on important projects (e.g. key4HEP).
Beyond the R&D topics and operation and programmes at testbeam and plasma facilities within the group, it has important roles in coordinating scientific computing and detector R&D, that are crucial for lab-wide strategy and future opportunities. Engineering resources are shared with other groups, such as ALPS, ATLAS, and Belle II.
The test beam facility utilized 85% of its 111 available slots, with 514 users in 2024. The pixel telescopes are heavily used, and the R-Weg (High Intensity beam line) is progressing. Collaboration with the M-division is effective. The aftermath of a fire end of October in a power supply was very impressively dealt with and operation was resumed within less than a month.

Comments and identification of critical issues

FTX's diverse expertise is essential for strategic planning and work for future projects, such as LUXE, ELBEX and Higgs factory project studies, including HALHF. The test beam facility remains critical for a wide international and national community and also outreach. In general, staffing levels are very low in several areas, most critically for core software and future collider studies. DESY has an important mandate to provide support to German universities working in these fields.

Specific recommendations

Ensure adequate staffing, especially at the postdoc and Ph.D. levels, to sustain community-wide activities related to future collider and core software, as well as testbeam operation and infrastructure. All of these “community” services need stability and long-term commitment.

The PRC asks for a presentation and SWOT / risk analysis of the various options for the future of the TB facility in the PETRA IV era.

Detector R&D Platform

Findings

The PRC notes that the platform for detector R&D are facilitating the common work for future silicon detectors, calorimeters and cryogenic detectors as well as for development of data transfer electronics and detector mechanics. The committee notes that this R&D is important for the laboratory as well as for the German and European HEP communities. The detector platform also offers an excellent opportunity for collaboration with the themes and work-packages (DRDs) of the ECFA detector roadmap.
The PRC notes the recommendation of the PoF review in February 2025, to sharpen DESYs R&D profile, and appreciates that the process to define detector R&D goals for the next funding period (PoF V) have started with the goal to have the application ready by the end of this year.
the recommendation of the PoF review in February 2025, to sharpen DESYs R&D profile, and appreciates that the process to define detector R&D goals for the next funding period (PoF V) have started with the goal to have the application ready by the end of this year.
The PRC also notes the recommendation from the PoF review to consider to (re)submit a proposal for a distributed detector lab (DDL), adapted to the new landscape, taking into account the outcome of the ESPPU.

Comments

The PRC supports the recommendations from the PoF review to (re)consider an updated DDL proposal and to define a detector R&D strategy for the next funding period (PoF V). The PRC is looking forward to the presentation and discussion of the proposed detector R&D strategy at the next meeting.
The Committee underlines the importance of the DESY test beam facility for the detector platform, all comments and identification of critical issues as well as recommendations from the previous paragraph (FTX) on the test beam are valid for the detector platform, too.
The PRC suggests to consider if and how existing AI/ML expertise at DESY might be leveraged and included to future detectors, applications like quasi autonomous, self-calibrating detectors with smart sensors and large data suppression on-detector.

Identification of critical issues

None.

Specific recommendations

None.

Theory

Findings

The PRC recognizes the outstanding performance of the DESY Theory Group, which continues to be a leading global player in key research areas, including lattice gauge theory, string theory and mathematical physics, cosmology (gravitational waves), and particle phenomenology (axions, LHC searches, QCD). Crucially, it provides the expertise to support, frame, and give conceptual depth to ongoing experimental efforts. It also has the international standing required to attract world-leading theorists to Germany (e.g. E. Witten's WPC Masterclass lectures). The proportion of third-party funding remains high and has increased in the categories of junior staff and Ph.D. students. However, the absolute number of Ph.D. students has slightly decreased, as third-party funding has not fully compensated for inflation and rising salaries. The WPC and the construction of its new building remain central priorities. These developments appear to be well-managed. In particular, we appreciate that, thanks to DESY's short-term financial support, preparations for the WPC building are progressing well, with the remodeling project now having been transferred to UHH.

Comments

The search for a successor to Andreas Ringwald will be announced soon. This hire is crucial, as it is closely linked to DESY's ambition to become the world's leading center for axion research. The DESY Theory Group in Zeuthen has a well-defined focus on lattice gauge theory and makes outstanding contributions to this important field. Additionally, it hosts a smaller-scale research activity in particle phenomenology.

Identification of critical issues

The PRC is concerned about ongoing difficulties in finding a satisfactory solution for the WPC plenary room. A ceiling height of 2.90 meters is highly problematic for a space designed to accommodate at least 150 people—the expected number of on-site users, excluding visitors and other attendees. This capacity is essential for ensuring optimal connectivity between the DESY and Hamburg Theory groups, as well as for supporting a robust visitor program.

Specific recommendations

- In the process of designing the WPC, care should be taken to identify a plenary room solution that meets the needs of the DESY Theory group. It is required to engage with the group, taking their requirements and ideas seriously.
- In future strategic planning, consider strengthening the Zeuthen Theory Group to maintain its world-leading position—further developing its expertise in lattice gauge theory and potentially enhancing its connection to the phenomenology section.
- Prevent further reductions in the number of Ph.D. students (or other positions) in the Theory Group due to inflation and rising salaries. However, we support the current policy of not converting postdoctoral positions into Ph.D. positions, as the former are more difficult to secure through third-party funding. In this context, earlier notification of DESY Theory regarding its annual budget would be beneficial.
- Continue to closely monitor the renovation of the new WPC building and ensure that no delays occur.

IT

Findings

The PRC finds, generally, that DESY IT has the operations in order, and that there are interesting and promising developments in the division's other focus areas. Efforts to improve coherence in the division are showing success. The PRC endorses the increasing collaboration between IT groups at DESY-Hamburg and DESY-Zeuthen, who both run data centers. Belle II seeks to increase its use of the DESY National Analysis Facility (NAF). DESY IT views this favorably, decisions (and potential formalizations) are currently pending.

Comments

DESY IT has to serve multiple ecosystems, and this presents interesting challenges, which are being dealt with pragmatically. The issues of user support and "Analysis Facility" (AF) require continued attention; DESY's impact here could be large due to the NAF, but is limited by the available (human) resources in IT. The PoF review for FH recommended clarifying the strategy for AI and ML, which will impact the DESY IT focus AI/ML focus area. IT's strong participation in the Scientific Computing Platform (SCP) is valuable in moving towards a coherent computing program at FH.

Identification of critical issues

The PRC sees that continuous attention is needed to the interaction between users and IT. These arise both bottom-up (individual users) and top-down (analysis facilities). We see the need to make choices in order to fit the activities into the available person power.

Specific recommendations

- Approaches to handling the user / AF support topic, and definition of FH-wide computing priorities, should be explored within the SCP.
- Clarify the mandate of IT to support Belle II computing
- Reserve ample time for sharing DESY IT research and development results with the community (to the benefit of both).
- Together with the SCP, define a strategy for AI/ML, including attention to the balance between "own developments" where DESY is a leading provider of some AI technology, vs providing expert AI/ML support to DESY scientists in the application of this technology.

Scientific Computing Platform

Not reviewed in this PRC meeting.