Recommendations of the 98th Physics Research Committee

November 2024

General information and Main Recommendations

At its 98th meeting on 5/6 November 2024 the PRC reviewed all groups, projects and activities of particle physics at DESY.

The PRC recognizes that overall, all activities are going well. Particularly pleasing are the extremely good performance of the LHC and its experiments – here several exciting new results were presented – and the successful start-up of the ALPS II experiment, where first results are imminent. The testbeam facility has again performed well this year.

However, it is also clear now that the FH groups are all affected by the current funding difficulties and hiring restrictions, which are mostly felt in the reduced numbers of Ph.D. students and postdocs and correspondingly the scientific output. In some cases, the retirements of people with long-standing key expertise bring the danger that this expertise is lost completely. One key example is the maintenance and further development of DESY-led software projects (e.g. Millepede, Key4hep). Third-party funding has become increasingly important – in this respect, the theory group is doing particularly well. It needs to be kept in mind that a healthy balance of base-funded and third-party funded positions needs to be maintained; in particular, it is important that all activities are accompanied by sufficiently many senior researchers to provide supervision, overview and coordination.

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

The IT group is reliably providing its services, pursuing an integrated approach to its many tasks, reflecting the diverse requirements, the rich funding environment, and the complex technology landscape.

The PRC raises a few concerns:

- The LHC upgrade schedules are under massive pressure, and even more so in view of the recent findings on the lpGBT chip issue affecting most systems. A successful implementation of HL-LHC remains the highest priority for the field.
- The aspirations of the Belle II experiment are hampered by the difficulties in the SuperKEKB collider to provide luminosity at the desired level. This issue is being worked on with significant help from European institutions, including DESY. These performance issues also reflect on the discussions on potential future upgrades of the experiment – a question that will have to be addressed in the mid-term future.
- 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 wider international landscape. In addition, the testbeam has been affected by a recent fire in one of the electronics rooms of the DESY II accelerator, and getting back into operations is of crucial importance.
- The personnel situation in some areas is critical. 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.

The PRC suggests a number of specific actions to be taken, in particular concerning the on-site experiments LUXE, ALPS II, BabyIAXO and MADMAX. Here, timelines, decisions points and resource situation need clarifications:

- For the LUXE experiment, PRC suggests moving towards CD2. Given the recent ELBEX grant and the loan of a suitable laser from University of Jena, this is a timely next step towards realization.
- An informed planning with decision points needs to be made for (and between) the BabyIAXO and MADMAX experiments, also in view of PoF V and the relevant ESPPU inputs. The key elements are certainly magnets and the related infrastructure and the external and internal financial and personnel resources required for them. By the next PRC several important aspects should be clarified and presented to the PRC, considering also the resources required to finalise the ALPS II science programme.

The next meeting of the PRC – PRC99 - will be held together with the Astroparticle Physics Committee in Zeuthen on 7-9 April 2025.

ATLAS

Findings

The DESY ATLAS group has approximately kept its size of almost 100 persons. The scientific personnel of the group saw a small reduction in numbers, while the number of undergraduate students increased. Since the last PRC, three new postdoctoral researchers, six new doctoral researchers, two new undergraduate students and one new technician joined. At the same time, six doctoral researchers successfully defended their Ph.D. theses.

The group continues its involvement in a broad range of activities, with some small adjustments. For example, the contributions for electron/photon identification were strengthened, while reducing work on jet calibration and luminosity determination. Leadership positions in the experiment and the LHC community were kept at a high, and high-profile, level. As an example, K. Tackmann has taken over the responsibility of Physics Coordinator. The broad physics portfolio of the group also saw only minimal adjustments. The group has published 17 ATLAS papers, six public notes and ten papers outside the ATLAS Collaboration.

The ATLAS group is providing crucial service and software for the collaboration, in particular for the luminosity measurement and electron/photon reconstruction. The progress in these areas is impressive. Several of these contributions have an impact beyond ATLAS, for example a recent study on training ML algorithms using negative weights (supported by HIDA)

The LHC schedule has recently been adapted to accommodate various delays in the upgrades of the LHC accelerator and the ATLAS and CMS detector upgrades. Run 3 data taking will be extended into 2026 and data-taking in the high-luminosity phase of the LHC (HL-LHC) will only start in 2030.

The preparation for building one of the endcaps of the new ATLAS inner tracker (ITk) for the HL-LHC at DESY continues. About half of the group personnel is involved in the upgrade, with varying proportions of their working time. DESY was recently approved within ATLAS as a site where detector modules can be integrated with their support structure. Further integration and system tests were conducted.

For the “module cracking” problem reported at PRC96 and PRC97, a decision between the two viable solutions is expected for December 2024, and detector module production is expected to commence in the first quarter of 2025. The group was instrumental in uncovering an additional serious problem with a key component (low-power gigabit transceiver, lpGBT) that is used widely in all LHC experiments. In the ITk, the lpGBT is located on the end-of-substructure (EOS) cards, for which DESY

produces 1500 units for the entire ITk project, with about two thirds already fully populated. The EOS production is currently on hold.

Comments

The PRC congratulates the DESY ATLAS group on their continuing excellent contributions to the ATLAS experiment. The group's leadership in research topics over many years is recognized in the particle physics community. As examples, the long-term contributions of the group to associated top-Higgs production resulted in a convenership in the LHC Higgs Working group for Judith Katzy, and Ludovica Aperio Bella's large impact on precision measurements of W and Z boson properties, as well as on many other analyses, was recognized with the DESY-wide Björn Wiik Award 2024.

The group structure changed slowly due to the budget constraints, with the number of scientists slowly decreasing. On the other hand, due to the recent changes in the LHC schedule, the personnel required for the ITk upgrade increases slightly and must be available for longer. A solution for the lack of wire-bonding personnel mentioned at PRC97 seems in reach. The group remains attractive for early-career researchers, and the number of undergraduate students is increasing; the DESY summer student program as well as schools organized at DESY (e.g., the 2024 CERN School of Computing, which was organized by an ATLAS scientist) played an important role in acquiring undergraduate students and doctoral researchers.

The group's recent publication record is impressive. The non-ATLAS publications show the group's strength in focus areas such as joint phenomenology studies with theoretical physicists, monolithic active pixel sensors, and generally the scientific programmes of the Helmholtz Investigator Groups. A recent physics highlight is the world-leading measurement of the associated top-Higgs production, a process that probes the top-quark Yukawa coupling directly.

The ITk upgrade project has made progress on all fronts but is facing the recently discovered issues due to the lpGBT ASIC. A variety of problems, none of which were caused by the DESY ATLAS group, have led to a significant delay in the ITk project with no contingency left. It is possible that the recent shift in the LHC schedule is not sufficient to absorb the anticipated delay.

Identification of critical issues

A further delay in the ITk project is possible, in particular due to issues that were discovered on the lpGBT chip. More details will emerge over time, as work on the lpGBT, such as irradiations and the submission of a new prototype, continue at CERN with high priority. A further (v2) production round has been launched, with delivery expected in August 2025. An intensive programme of study has been launched by CERN-ESE with the user community of the chip. The EOS production schedule will need to be updated as soon as the situation is clearer, and it remains to be seen if the overall schedule will need further adjustments.

Specific recommendations (unchanged since PRC96)

The timely delivery of the DESY contributions to the ATLAS upgrade should continue to have the highest priority. The PRC recommends that the group keeps its focus and staffing levels. The group shall pay close attention to critical issues arising in the sub-projects and avoid loss of momentum on the many tasks to be accomplished.

CMS

Findings

The DESY CMS team continues to play a major role in CMS physics analyses across many areas: Higgs measurements and searches, electroweak, QCD and top physics measurements, and many BSM searches. Striking highlights are the measurement of the W boson mass with a precision below 10 MeV for the first time at the LHC and the observation of an enhancement of *tt* production close to threshold. The new M_W measurement is consistent with the Standard Model expectation and strongly disfavours the CDF 2022 result. DESY now provides the CMS Physics Coordinator (A. Meyer) and Collaboration Board Chair (E Gallo) as well as a host of subsidiary leadership roles and responsibilities. The size of the team continues to decrease, with a reduction of Ph.D. student numbers from 28 to 22 in the past year. The team continues to contribute substantially to CMS computing and is actively participating in the FH Scientific Computing Platform.

The preparation of PS (pixel-strip) module production continues to be affected by problems. During the period since the last PRC, it has become clear, as acknowledged by the vendor, that hybrid manufacturing is not yet at production readiness – in addition to cleanliness problems reported at the last PRC, pre-production hybrids have delaminated. The CMS upgrades are also affected by the CERN lpGBT chip problems reported above in the ATLAS section. In addition, the supply of MaPSAs continues to be very limited. The second pre-production Dee has been tested almost completely and is judged to be sufficiently close to specification to be installable into CMS. Two more pre-production Dees will follow by early 2025 – the schedule is on track, although the production cost is anticipated to increase somewhat. The overall CORE cost of the CMS outer tracker has increased by 23% compared to the MoU estimates. DESY has explained to CMS the limited cost increases that can be afforded, keeping limited resources available for further R&D. On the personnel side, a newly fully trained wire-bonder has left the group: new bonders are being trained. There continue to be problems with engineer availability: a solution is being sought within FH, or if unsuccessful, by outsourcing tasks to the DESY central engineering service.

Wrapping of HGCal endcap hadronic calorimeter tiles is in the pre-production phase and proceeding well. Tiles are being tested with a 20% sampling fraction at present, which will drop to 5% in full production. The first pre-production tileboard PCBs have been received. Extensive test beam studies continue at DESY and are proceeding at CERN with a 3T field and stacks to measure the calorimetric performance.

Comments

The PRC congratulates the CMS team for the continuing large amount of physics output, their strong leadership roles in the collaboration, and on their successful delivery of operations shifts above their fair share. The team is commended for its key role in the W boson mass and *tt* threshold analyses, working together with DESY theorists. The PRC applauds the focussing of the analysis work of the team on CMS physics results and detector papers. The continuing drop in numbers of staff and students stretches the group, who are handling it as well as they can, but eventually this will impact the output of the group

The newly observed problems with hybrids and lpGBTs are very serious for the tracker production and its schedule. The DESY CMS team is strongly encouraged to continue to follow up, actively supporting necessary R&D to understand and address the ongoing hardware problems.

The technical staffing situation on the outer tracker remains critical in terms of numbers and the need for training new people. The continuing and repeated loss of wire-bonder personnel poses a major threat for module production, once it does eventually start.
While HGCal work continues to progress well, the PRC repeats its request to see high-level schedule information at each meeting, to be better able to assess progress.

Identification of critical issues

There are multiple issues in the outer tracker upgrade work, e.g. the technical problems on hybrids and the lpGBT ASIC. This leaves the potential for further cost and schedule overruns.

Specific recommendations

The team is strongly supported in their desire to assist with R&D to understand and solve hybrid production problems as far as possible.
The team, together with FH management, is urged to find a solution to improve retention of wire-bonding expertise within the group.
The PRC wishes to see schedule information reported at each meeting, for both CMS upgrade projects.

Belle II

Findings

After Long Shutdown 1 (LS1) of SuperKEKB, the second data-taking run of Belle II (Run 2) started in early 2024, with two segments until the end of June and a third segment that started in late October 2024. The instantaneous luminosity was limited to below 10 fb^{-1} per week by events in which the beam was suddenly lost (sudden beam loss, SBL), by low injection efficiency, and by short beam lifetimes. The current Run 2 dataset corresponds to approximately 100 fb^{-1}. Two SBL events in April and May damaged the pixel detector (PXD2), which was switched off in consequence while the incidents were investigated. As of PRC98, the PXD2 is still off, and measures to mitigate the SBLs are being put in place.
Upgrade plans of the Belle II Collaboration presented at PRC97 are being revised: the current internal status of Belle II upgrade planning was shared with the committee.
The size of the DESY Belle II group is decreasing: By the end of 2024, seven scientists (staff or postdoctoral researchers) will have left the group, while two new DESY fellows and one doctoral researcher have joined the group since the last PRC. During the PRC meeting, it was learned that this will be complemented by two additional postdocs through the OCPC programme with China. Members of the group contribute to a wide range of topics in Belle II, both in physics and detector performance working groups, and hold several leadership positions. Several Belle II physics results with key contributions from the group are now published. A number of new results, also based on data taken before LS1, is expected for 2025.
DESY continues to provide unique infrastructure and tools for Belle II, including various computing services and a data acquisition test stand. The DESY NAF remains a crucial analysis centre for Belle II, and DESY delivers around 10-15% of Belle II Grid resources.

Comments

The operation of SuperKEKB and Belle II bears uncertainties, even on short time scales, where – due to high electricity prices – data taking in December 2024 depends on additional money to be found at KEK. Furthermore, data taking at SuperKEKB is still plagued by sudden beam losses and limitations in beam currents due to heating. KEK is working on a deeper understanding of the problems as well as on mitigation strategies. The DESY Belle II group plans to be involved and is encouraged to look into further ways to help together with DESY management, for example by assigning a long-term associate from the accelerator division to KEK. The consequences of the SuperKEKB problems lead to a data set size that is factors of (at least) two below expectations. For the time being, the beam conditions prohibit operation of the PXD2, which is crucial for parts of the physics programme, e.g., time-dependent asymmetries, while other physics studies do not depend as much on the PXD2. The recent Belle II publications with leading DESY contributions underline the group's significant impact on the early physics output of the experiment.

The PRC appreciates that the team shared early Belle II upgrade planning information. The planning process will further illuminate physics and technology opportunities and give a clearer perspective on possible DESY contributions to upgrade projects and the competencies required. The group made first steps towards an involvement in the new vertex detector (VTX). The tentative upgrade schedule could match well to the availability of construction effort at DESY after the HL-LHC upgrade construction.

The B-factory Programme Advisory Committee (BPAC) recently released comments and recommendations on Belle II short-term run plans, detector operations, and physics analysis planning, that are very well aligned with the impressions of the PRC.

The DESY Belle II group reduced substantially in size, losing key expertise, with a substantial turn-over of senior scientists with leadership positions. It is, however, still one of the largest groups within the Belle II collaboration.

Identification of critical issues

The SuperKEKB collider performance remains disappointing, with high risk to successful operation of the PXD2. Extended engagement of one or more DESY accelerator experts with KEK would be desirable.

Specific recommendations

The Belle II team, together with the FH management, should consider the strategy for long-term engagement in Belle II, in consultation with the German university Belle-II groups. In particular, a timescale should be considered on when to judge whether SuperKEKB performance is sufficient to justify a long-term programme.

In the preferred scenario that the collider performance improves sharply, DESY together with the German university groups should develop their engagement in the Belle II upgrade.

An increase of the number of postdocs is essential for the success of the Belle II experiment, and the group is encouraged to consult with management on ways to facilitate this.

ALPS-II

Findings

A first science run of the ALPS II experiment has been carried out successfully, exploring substantial novel scientific territory.

The work by the collaboration also led to much progress on the understanding and calibration of the ALPS II setup and operation: For example, new robust methods based on so-called “open shutter runs” and on de-modulations of the heterodyne signal at different frequencies have been developed. In parallel, mitigation measures to reduce noise sources at ALPS II were identified and will be implemented for the next science runs.

The development of transition edge sensors (TES) has also advanced: new sensors with a new SQUID readout are characterized, simulating the TES response to black body radiation photons (the last background source to be mitigated to qualify the TES for data taking at ALPS II), and guiding the path towards mitigation measures. Furthermore, a first data run to search for WIMP-like dark matter in the MeV mass range via electron scattering has been conducted successfully.

The helium transfer line from the cryo-plant on the DESY campus to the HERA North area, the location of ALPS II, is now operating stably.

Comments

The PRC warmly congratulates the ALPS II Collaboration for the first science run that finished on 6 May 2024. The PRC also appreciates the intensive phase that followed, systematically testing and checking the performance of the optics system and its calibration.

The PRC regrets that in the ALPS II data there is no evidence for the existence of new lightweight bosons with masses below 0.1 meV. However, the committee notes with pleasure that new limits on the coupling strength of scalar and pseudoscalar bosons to photons around $g_{a\gamma\gamma} < 1 \bullet 10^{-9}$ GeV^{-1} have set by ALPS II, a factor of more than 30 below the results of previous experiments. The PRC is looking forward to the publication of the results.

The PRC appreciates that measures are taken to improve the stability of the magnet string operation, which will further gain operation time. The committee congratulates the team on the TES progress.

The PRC notes that due to the limited number of optics experts, ALPS II milestones get delayed by about another half a year compared to the schedule presented at the previous PRC meeting. The schedule now foresees to install and commission the production cavity system from February to August 2025, followed by a full system engineering run from September to December 2025. The full system science runs are now foreseen from January to June 2026.

Identification of critical issues

The PCR underlines that one of the main challenges for the future progress of the experiment arises from a potential shortage of people. Many experts are on short-term postdoctoral contracts, in particular three optics fellows have finished their contracts and left the collaboration. The difficulty and challenge to identify suitable candidates and to continuously train new experts will hamper the efficiency of the experiment.

Specific recommendations

The PRC strongly recommends DESY to explore various possibilities of increasing permanent optics expertise at DESY. This would avoid or palliate further personnel-related ALPS-II delays and might in future also be beneficial for other DESY experiments.

MADMAX

Findings

The MADMAX collaboration has taken significant steps since the last report: they have improved the dark photon limits by about three orders of magnitude even if in a narrow mass range, just from 11 days running. They have also produced a technical paper on the first mechanical realization of a tuneable dielectric haloscope for MADMAX. The focus of the MADMAX collaboration is shifting now towards up-scaling prototypes in order to reach the design sensitivity for benchmark axion models.
The collaboration secured the possibility for continuing their measurements at CERN with the Morpurgo magnet during the Long Shutdown 3 (LS3) between 2026 and 2029, with a prototype booster inside a cryostat. Complementary measurements are planned with the already existing prototype inside an ADMX-EFR 9.4 T solenoid magnet presently being installed at FNAL.
For the dedicated MADMAX magnet, the collaboration plans to have two demonstrator coils (for which the funding is secured) ready by 2028. If funding for the final magnet were to be identified, this would allow to start building the full magnet, which could be available at DESY roughly in 2032, assuming that the demonstrators can be shown to work.

Comments

The PRC warmly congratulates the collaboration on the submission for publication of the first limits on dark photons and ALPs, as well as on the technical paper. The committee appreciates that for the first time it is shown that the signal amplification of a dielectric haloscope can be thoroughly determined by a combination of measurement and modelling, and competitive limits can be extracted even using a small proof-of-principle prototype.
The PRC also congratulates the collaboration on the securing of the Morpurgo magnet during LS3, and it notes with satisfaction the diversified international cooperation with CERN and Fermilab. The collaboration has also stressed the fact that the LS3 delay will not change MADMAX plans.
The PRC notes that the MADMAX Collaboration has investigated the potential benefits of usage of the BabyIAXO magnet, concluding that at present there is no strong motivation for it. The nominal B-field of the BabyIAXO magnet will be only slightly higher than the B-field of the Morpurgo magnet, ≈ 2 T instead of 1.6 T, while the diameter of the warm bore is significantly smaller, 70 cm instead of 160 cm. Therefore, a new cryostat would have to be built to use a cold MADMAX booster in the BabyIAXO magnet. Also, the magnet would not be available before 2030, not much before the expected availability of the MADMAX final magnet. Nevertheless, other synergies are under exploration, e.g. on cryostat-MPC and read-out technologies, including a MADMAX-IAXO-RADES collaboration meeting foreseen for next year.

Identification of critical issues

The PRC notes that the funding of the MADMAX magnet remains unclear.

BabyIAXO

Findings

After the magnet TDR, the BabyIAXO collaboration has achieved important steps towards detailed manufacturing, and progress has been made in clarifying the funding scenario for the magnet as well as its construction strategy. A follow-up magnet review is planned for early 2025.

The production of the first big fraction (~40%) of the Rutherford cable progresses on schedule, and first samples of Al-stabilized conductor produced in China are being characterized, with two different companies involved (one for production and the other for coextrusion). The vacuum equipment of the detection beamlines has been purchased, and the tendering for the actual vacuum sections is about to start. Plans to start soon the installation of detectors at DESY for background measurements are ongoing. Further insight on background limits in Micromegas has been obtained as well, in particular regarding a possible effect from Rn emanation in the gas system. Several campaigns at the SOLEIL light source have been carried out to characterize various BabyIAXO detector prototypes. Furthermore, preparations for the construction of the inner-core X-ray telescope, as well as the next prototype of the outer corona modules, are ongoing. The haloscope, a first 10-times scaled-down prototype RF cavity for BabyIAXO has already been in cryogenics, and the design of a larger prototype (50 cm diameter, 1 m long) has started.

Comments

The PRC appreciates the determined, sustained and consistent steps achieved since the last PRC, which are consolidating the experiment's path towards construction and funding.
The PRC is looking forward to learn about the results of the characterization of the first samples of Al-stabilized conductor. It is encouraging to explore the possibility of an increased CERN involvement indicating new options for the production of the remaining 60% of the Rutherford cable, as well as exploring companies in Europe who master the coextrusion process for the Al-stabilized cables.
Similarly, the PRC notes with satisfaction that the option of a new technology for the inner-core optics (based on Al foil mirrors) in collaboration with NASA experts has picked up new momentum.
The PRC appreciates the "easy-to-read" concise BabyIAXO physics potential document.

The collaboration emphasizes the desire of a magnet-less commissioning of the experiment. This activity would ensure that the collaboration can test and operate the movable platform and the detectors, which would allow important tests and some physics results (e.g. on dark photons) and would be very important to keep the collaboration motivated and together. To be able to have a magnet-less commissioning of the experiment, setting up of the HERA South Hall would need to start.

Identification of critical issues

The PRC notes the challenges to keep the collaboration together in view of the uncertainties in the schedule of the experiment towards first operation.

Specific recommendations

- The PRC recommends the BabyIAXO Collaboration to prepare a detailed schedule, including resource needs, to understand better the path to carry through the magnet-less commissioning.
- The PRC encourages the management to explore the path to ensure that the infrastructure to install magnet-less BabyIAXO would be ready in case all foreseen funds materialize in 2025 as expected.
- The PRC suggests to the collaboration to add to the ``easy-to-read'' document the plans of the collaboration in case of a discovery.

LUXE

Findings

The LUXE collaboration remains attractive for institutes from all over the world, with currently more than 100 collaboration members from 20 institutes. Beate Heinemann has stepped down as spokesperson, Matthew Wing has been elected by the collaboration as new spokesperson, taking over on 1 November 2024.

Since the last PRC (PRC97), there have been several positive developments on many aspects of the project. The LUXE TDR is now published. On the resources side, all partners in the successful application for an EU Infrastructure grant "ELBEX" to develop an electron beam line at XFEL have signed the accession forms for the grant agreement. The partners are in the preparation phase for the consortium agreement, aiming to start in January 2025.

Furthermore, the LUXE Collaboration received from the University of Jena a donation/long loan of a semi-commercial high-intensity laser system capable of providing pulse peak powers of up to 40 TW for experimental studies (JETI – Jena Titanium). All equipment can be transferred to DESY except the final pump laser for the final step of 10 TW to 40 TW. Transfer costs are ~50kEur, the plan is a transfer in the next 6 months.

The collaboration estimated, that ~2 MEUR invest for laser beamline, infrastructure, diagnostics, computing etc. are needed to be able to do LUXE@10 TW in 2030. To bring the laser from 10 TW to 40 TW (LUXE Phase-0) will require an additional 0.5 MEUR. Important detector parts are provided as deliverables by collaboration partners. The collaboration continues to consider upgrades, extensions and higher laser powers for LUXE Phase-1 is with 350 TW.

Detector development proceeds, with tests of the backscattering calorimeter at DESY-II and FLASHForward, and beam tests of the LUXE electron detection system (EDS) at E320 at SLAC.

The collaboration continues to explore synergies with the LUPE collaboration, which is proposing to perform high-density QED experiments using a "low energy" plasma generated with an electron beam and plasma mirrors. If successful, from an ERC synergy grant application of LUPE, also LUXE will benefit for detector developments.

An international Strong Field QED workshop will be arranged at DESY in early December 2024.

Comments

The PRC notes that with the start of the funding of ELBEX from Horizon Europe, resources are available to build the electron beamline. With the donation of the high-power laser of 10 TW another key component is now available for the experiment. An investment of ~2 MEUR in 2028/2029 is required to have the entire infrastructure prepared for an initial LUXE@TW run in 2030. The PRC considers it an overall priority to secure funds and reach agreement (with EuXFEL, DESY management and Council) on the installation of the beampipe prior to 2030, i.e. to make a special request for an up-to-now not planned longer shutdown before 2030.

A full plan for the LUXE delivery and schedule should be worked out by the collaboration, including recruitment of fellows and students. A plan for securing ~2 MEUR to make full use of the 10 TW laser system should be discussed with the DESY management. Once this is agreed, a CD2 approval at DESY should be envisaged, if possible, in 2025.

The PRC notes that DESY and EuXFEL approvals are vital for the experiment and collaboration to successfully apply for third-party and institute funding.

In this context, the PRC further notes that the process of the update of the European Strategy for Particle Physics offer an excellent opportunity for the LUXE Collaboration to present their experiment

and attract new collaborators. The PRC recommends the collaboration to submit a document to the process.

Identification of critical issues

The committee notes that significant progress has been made by the collaboration to secure resources, i.e. electron beamline and laser. However, the committee remains concerned as approvals by DESY and EuXFEL are still required for a start of operation in 2030. The committee remains concerned that any further shift of the start will impact on the motivation of the collaboration as well as on the process to secure funding for the rest of experiment.

Specific recommendations

- A full plan for the LUXE delivery and schedule should be worked out by the collaboration and a DESY CD2 approval should be aimed for in 2025.
- Once the ELBEX Consortium is operational and a solid plan for the electron beamline worked out, the collaboration should request to the EuXFEL management and Council a longer shutdown before 2030 to install the beamline.
- The LUXE collaboration should promote the experiment in the process of the update of the European Strategy for Particle Physics.

FTX

Findings

The FTX group is structured in five main “units”, each covering several activities: SLB: Science with Lepton Beams (from future colliders to LUXE and polarimetry); SFT: Software and Computing (core and ML); DTA Detector Technology Activities (Calorimetry); TBT: Test Beam and Telescopes; AST: Accelerator Science and Technology (FLASHForward and plasma source test stand ADVANCE). Group members have key roles in the recently established platforms for scientific computing and for detector R&D. These platforms are strategically important for-lab wide coordination and knowledge exchange, and also for addressing and exploiting future scientific and funding opportunities.

The group’s total size is 55, among them 4 postdocs and 10 Ph.D. students, with a moderate increase foreseen for next year (+1 and +3). The group has implemented a 6-month gap between graduating and new students in order to deal with reductions in funding. Engineering resources are shared with other groups (ALPS, ATLAS, Belle II) and thus support projects outside the range of FTX scientific activities.

For the test beam facility, 83% of 111 available slots are used, with 452 users in 2024 up to this PRC (where a “slot” is a week in one of the three beamlines). The pixel telescopes are widely used. The R-Weg (High Intensity beam line) is making progress towards realization. While there are changes in some cases in support personnel the overall collaboration with the M-division is functioning well.

For AST (Flashforward and ADVANCE lab), the personnel situation is stable and the support/collaboration with the new organisational structure in the M division is working well. FLASH is in shutdown for maintenance until August 2025, and FLASHForward is also shut down for this period. Usage of the EuXFEL for twin bunch studies (driver and witness bunch) was reported.

For the SLB activities, personnel was reduced from 8.1 to 4.6 FTE in the period 2022-2024. A new Ph.D. student is foreseen for 2025. The group relies on the continued core software activity (see

below), which also has a critical personnel situation. Important studies of Higgs self-coupling from di-Higgs were reported at the PRC.
The core software activities are limited by the personnel situation, which after 2025 gets very critical. The activities have been going on for 20 years and have reached a very good status and wide adaptation now. Especially the key4HEP effort is by now used by "all" future collider studies and is also employed by LUXE and for test beam analyses. The machine learning activities (Q)ML, linking to QML cluster with UHH, are moving ahead well with important third-party funding and would also be affected if the personnel situation is not resolved.
The calorimeter R&D for highly granular SiPM-on-tile calorimeters and the related construction activities in CMS (HGCAL, reported elsewhere), are performing well and the personnel situation has improved here. The R&D branch, CALICE, is continuing in the newly founded CERN DRD6. It will be both valuable and important to bring the construction experience gained in the HGCAL project back to the R&D branch in the future.

Comments

The FTX group's wide expertise and the forward-looking R&D are very important for strategic planning (e.g. for PoF V or the ESPPU) and new initiatives in upcoming experiments, both locally and related to future collider experiments. Previous R&D investments continue to bear fruit for a number of project proposals. LUXE and HALHF are good examples. Operation and R&D in FLASHForward and the test beam provide a backbone of local experimental facilities. The application of calorimeter R&D in a large construction project like the CMS HGCAL is a very good development and provides another recent example of the importance of a cross-disciplinary group as FTX with a strong R&D component. In general, the work is progressing well and the group has been able to deal with the limitation in funds that impacts in particular the postdoc and Ph.D. hiring possibilities.
The test beam facility continues to be a critical community and outreach service and is aligned with the core mission of DESY. It is a major asset for detector R&D and serves many groups at DESY and internationally, and it is important that it will continue to run in parallel to PETRA IV. The facility continues to perform well, and the long shutdown at CERN will further increase demands.
The recent fire has interrupted operation of the test beam and of PETRA III for almost two weeks. Thanks to hard work by all the expert groups, it was possible to resume operations on 21 November.
The plasma wakefield R&D group is making good progress and has been instrumental in developing a new Higgs factory machine concept (HALHF) using plasma acceleration to accelerate electrons to 500 GeV. The HALHF concept is being followed up also on the physics and detector side.
The Science with Lepton Beams subgroup maintains its leading role in the ECFA study on Higgs/top/EW factories and has been driving the submission of the LUXE TDR. The LUXE project has recently received a boost with the ELBEX grant, the laser donation and the E320/LUPE studies (reported in previous meeting). The future colliders work is impressive given the limited resources covering physics studies and LC vision leadership, and "Physics Beyond Collider" inputs to the ESPP.
The key4HEP framework is used very actively in the international community with DESY in a leading role, but staffing levels will not be sufficient to maintain the service at the current level (beyond 2025).
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 this field. In the present situation departures not replaced will hurt some parts of the activities more than others, and with limited hiring possibilities imbalances have occurred, special affecting areas where external funding is difficult to obtain.

Specific recommendations

PRC recommends making sure that staff levels especially on the postdoc and Ph.D. levels are sufficient to maintain the important community-wide activities related to future colliders and core software.

PRC further recommends working with the relevant M division groups to establish one or two scenarios for the future of the test beam facility.

Detector R&D Platform

Findings

Two new horizontal activities at DESY, the platforms on detector R&D and on scientific computing were introduced to the PRC in May 2023. These activities - similar to the Future Collider Forum and the DESY-wide Quantum Technology Task Force - bring experts and interested students, postdocs and staff from the various DESY groups together in order to enhance communication and collaboration across groups and to establish common and synchronised strategies for future projects.

During PRC98, the committee received a report from the DESY Detector R&D Platform and reviewed the project for the first time. The goal of this platform is to nurture communication and collaboration across the DESY groups and to help establishing a common DESY detector R&D strategy, as well as to synchronise projects to attract additional funding. Examples are (in the context of the Helmholtz Innovation Pool) the support of the Tangerine silicon detector R&D and the ongoing application for monolithic electronic-photonic transceiver EPICs.

There are currently 5 main areas of detector R&D at DESY in particle physics:

1) Silicon detectors, focussing on monolithic active sensor 65 nm CMOS technology. Collaborations exist with ALICE, EP R&D, DRD3.1, building on strong contributions from expertise gained by DESY ATLAS and CMS groups from HL-LHC upgrades. With Allpix^2 DESY provides and maintains a commonly used simulation programme for semiconductor simulations.
2) Calorimeters, with the goal to adapt the CALICE concept to a circular collider, collaborating with many German and international institutes and DRD. There is strong expertise available by DESY staff from CALICE.
3) Data transfer and silicon photonics, with strong expertise and contributions from the DESY electronics team already working on EPIC. There are collaborations with GSI, KIT and DRD7.
4) Mechanics and integration, profiting from expertise gained during the HL-LHC upgrade. The goal is to provide to the community a material data base, bringing in knowledge on mechanical strength and conductivity testing. There is collaboration with the upstarting DRD8. There are ideas to also carry out R&D on micro-channel cooling.

The common goal behind these four areas is to build a demonstrator vertex detector based on CMOS technology.

5) Cryogenic detectors, which includes usage of transition edge sensors, simulations, the goal of reducing black body radiation as well as development, improvement and application of quantum sensor technologies.

The platform currently manages ~150kEur/year from MT-DTS material funds, which in 2024 was sufficient to support smaller activities.
The platform is active and e.g. organised two retreats with the aim of learning about existing capabilities in groups, with guests from the photon science area and the M division.

Comments

The PRC considers the platform to be a useful instrument at DESY to

- profit from unique expertise in the groups,
- attract and train future experimental physicists, allowing them to "keep their fingers warm and their expertise up-to-date,
- identify and profit from additional funding,
- profit from unique infrastructure (labs, workshops, testbeams…), and
- prepare strategic contributions for future projects and to remain a "big player".

The PRC considers it important that the detector platform engages in areas that will allow DESY to continue its role as national laboratory and as hub for the German universities.
Test-beams at DESY are an integral part of the detector platform. Such a facility is world-wide unique and a core competency of DESY.
The PRC would appreciate to understand better the R&D on transition edge sensors.

Identification of critical issues

The committee notes that core R&D activities aim at a future Higgs factory. However, as it is a guiding principle in the platform to have scientists contributing who also have an interest at the physics aspects of a project, the PRC considers that in addition new projects need to be identified which are suitable to a shorter time scale, e.g. compatible with PoF V. To identify potential future projects, the platform needs input, discussion within the wider FH sector as well as guidance by the DESY management.
On the test beams facility, with AIDAInnova ending in March 2025, the position of a telescope expert providing test beam support will not be funded anymore. With the possible stop of PETRA III in 2030, the future of the DESY test beam is not clear.

Specific recommendations

The PRC strongly recommends aiming for a continuation of the DESY test beam also after the start of PETRA IV.

Theory

Findings

The theory group keeps producing excellent science, enhancing the international reputation of the whole laboratory and strengthening its ties with Hamburg University. The PCR congratulates the theory group on its achievements in the important and growing field of cosmology. PRC heard a detailed and very impressive report on this topic. Cosmology is an extremely active field, increasingly important in recent decades within the broader area of fundamental physics. The research at DESY

covers many topics in this domain in which the group is traditionally strong, and it keeps fostering new ideas.

The theory group has since a long time been a driving force concerning the study of the impact of gravitational wave data on particle physics, including the possible testing of BSM physics involving phase transitions. With this topic now being in the focus of world-wide attention, DESY theory has rightfully taken a centre-stage role. A key novel point of interest is in particular the high-frequency regime.

A highlight and beacon of the success of their work in gravitational wave physics is the fact that a DESY theory postdoc (A. Mitridate) is one of the main authors of the NANOGrav data interpretation, which has shown hints of primordial gravitational waves. He is also one of the leading authors of the PTArcade code extensively used in this context. Furthermore, members of the group contributed significantly to several white papers on gravitational waves.

New ideas exploring the interface between particle physics and cosmology have also been put forward at DESY, such as dilaton-driven electroweak baryogenesis, or the ALP-neutrino connection for leptogenesis (with the right-handed neutrinos resulting from ALP decay). Overall, the DESY Theory research on cosmology represents creative work, with many successes and promising new directions.

New arrivals at DESY Theory include Matthias Pierre, who joined the Theory group this September together with his Emmy Noether group devoted to “Identifying the dark sector of the universe: imprints from early dynamics to late time signatures”. Moreover, Elina Fuchs will officially start her HGF W3 professorship (with U Hannover) on 1 January 2025. These two new arrivals come with funding for postdocs and/or students. Independently, many other recent successful applications for third-party funding contribute to the growing ratio of third-party to core funding. One noteworthy example is the SFB1624 in string theory / mathematics, which started last April. In this context, a key role is played by the reapplication for the Quantum Universe excellence cluster, which is ongoing at this very moment. DESY Theory is making a very significant contribution to this cluster and, if the application is successful, it will contribute very significantly to the DESY Theory group’s budget for research positions. One may be confident that the outstanding success of DESY Theory in attracting 3rd-party funding is going to continue, with five ERC applications (one for an Advanced Grant by Georg Weiglein) and two ENG applications having been submitted very recently.

It is to be noted that the ERC applications include two Synergy grants: one with the participation of Christophe Grojean (focused on collider physics and in particular FCC) and the other by K. Jansen. The latter is in connection with the CQTA (Center for Quantum Technology and Applied Physics), which is riding the wave of the ``second quantum revolution''.

Karl Jansen has reached retirement age this year (his contract has been exceptionally extended to 2026), Andreas Ringwald will officially retire at the end of this year.

The Wolfgang Pauli Center is now at the important stage of detailed discussions with the architect, aiming at a top-quality auditorium and atrium among other infrastructure.

Comments

It is satisfactory that no further budgetary cuts are planned and that a reasonable amount of travel funding is available.

At the moment, most of the effort is focused on the application for the “Quantum Universe” excellence cluster where, as noted above, DESY Theory plays central role.

The long-term maintenance of the CQTA is not guaranteed, as its present and foreseen running is mainly based on third-party funding (except for two permanent positions). This is not a pressing issue

in the short run. Nevertheless, it is appropriate to keep in mind this fragility of CQTA whenever brainstorming long-term development.

The replacement of Andreas Ringwald by another excellent scientific leader, capable of bringing focus to the theoretical efforts on axion and ALP physics, is still a pending task. This search is highly important for the consolidation and success of the role of DESY as the major European hub for axion and ALP searches.

The progress towards constructing the WPC is satisfactory, which is encouraging given its urgent need and crucial importance to the Theory Group. This importance arises from the poor condition of the old building, the somewhat dispersed locations of its members, and, most notably, the scientific benefits that the research hostel and expanded visitor program of the WPC will bring. The WPC will also be an important tool for the successful implementation of the Quantum Universe cluster if, as we all expect, it is granted again.

It is also very satisfactory that new SFB is strengthening the connection with Hamburg University, and especially with its mathematics department.

Recommendations

DESY Theory continues to be extremely successful in research and in attracting 3rd party funding. It is nevertheless important to maintain enough core funding, making sure that there are always enough "matching funds" for applications where this is required and guaranteeing continuity, stability and an independent long-term research strategy of the group.

The PRC iterates the importance of an active and intense search for a theory successor to Andreas Ringwald, in the interests of both the group and of the whole laboratory. It is hard to overestimate the growing importance of axion physics and of related research fields. Hence, the present search represents a unique opportunity to strengthen this key research direction. The search should be pursued with all necessary energy.

The PRC also stresses the importance of keeping the momentum in the WPC after the "Quantum Universe" cluster is (hopefully) approved, aiming to a prompt and safe implementation.

In parallel to the ongoing SFB evolution, it would be useful to further strengthen the connections of particle physics/cosmology with string theory. Having a group that covers, in this way, the wide range from particle physics /cosmology / phenomenology to mathematics is a particular strength of DESY that should be further developed.

IT

Findings

DESY IT has made significant strides in enhancing how the group is organised internally and collaborates externally, under the leadership of its new head P. Neumann. Communication with local users has been strengthened, resulting in increased usage of the NAF facility. Positive developments have been observed in the Tier-2 transition with NHR centers, and funding for internationally-oriented infrastructure looks optimistic. New funding opportunities for R&D projects are being explored, and the FH Scientific Computing Platform is effectively providing an integrated view of computing activities across FH.

Comments

Since the last PRC meeting, DESY IT has made advances in internal integration of the department.

First, an analysis was made to identify gaps in services, redundant efforts, and missing communication lines. This analysis led to some restructuring as well as to the creation of horizontal platforms for common themes spanning all subgroups, for example a platform on authentication and authorization infrastructure. Knowledge distribution will also be addressed, ensuring that no essential knowledge is possessed by only one colleague.
Communication lines with local users have also been augmented, resulting in a higher usage of the NAF facility by this community. Note there is still work to be done for some local user groups (e.g. ALPS and IAXO), that tend to operate as islands.
The international scientific computing ecosystem is transitioning to a new AAI scheme, and DESY IT will have to follow. However, there is still a need to integrate smaller experiments and to address local user groups that operate independently. There are two candidate infrastructures for the new AAI scheme at DESY, presenting implications that require careful consideration. DESY IT is well-positioned to follow the AARC blueprint, ensuring wide interoperability.
The LHC experiments are exploring analysis facilities for the HL-LHC era. The initial developments are experiment-specific. This maps poorly onto an experiment-agnostic facility such as the NAF. The challenge is to be effective for HEP analysis while remaining as generic as possible. The close contacts within DESY between IT and the FH Scientific Computing Platform can help, as the platform is better positioned to take these concerns back to the experiments' computing management structure.
One positive development are the concrete steps that are taken with NHR center in Goettingen as pioneer in the Tier-2 transition in Germany. The challenges arising are being addressed, and similar work with NHR centers in Wuppertal and Hamburg are planned.
For the internationally-oriented infrastructure, funding for pledges looks optimistic. The 2024 pledges are fulfilled, and those for 2025 are safe. For 2026 and further, things are unknown. A (cost-neutral) solution to the bandwidth problems mentioned at PRC97 is converging.
The FH Scientific Computing Platform is working well from the IT perspective. It provides e.g. an integrated view of computing for DESY for both ongoing activities and new initiatives. This integrated view does not exist for PETRA IV, and is outside the mandate of the FH platform. If funding for PETRA IV is secured, DESY management should consider how to organise this integrated view.

Identification of critical issues

Funding for pledges for 2026 and further needs to be identified.

Specific Recommendations

- Token transition: Interoperability is part of the AARC blueprint, and staying within that blueprint gives the widest interoperability. HIFIS and Base4NFDI are following this closely, which positions DESY IT well (also with respect to EOSC).
- Analysis Facilities: PRC recommends to use the connection with the FH Scientific Computing Platform to send a clear message to experiment computing managements about the incompatibility of the current Analysis Facility developments with the cross-experiment facility organisation common in European centers.

Scientific Computing Platform

Findings

The FH Scientific Computing Platform (SCP) has been operating for about one year as of this writing.

The members (the chair and the steering committee) have taken the mandate seriously, starting a number of initiatives. A pan-FH scientific computing workshop was organised in which people working on similar topics across DESY FH met (in some cases discovered) each other.
DESY management arranged the possibility to have a few postdocs working on projects defined within the platform; the condition is that at least two FH departments need to support the project (also in part financially).

Comments

This progress is laudable for such a short period. DESY FH has a strong group structure, which does not easily lend itself to horizontal activities like the SCP. The same can be said about aligning group activities along the priorities identified by the FH SCP. Harmonisation and rationalisation of activities (i.e. consolidating in cases of duplication) can free up talent to work on newer initiatives, which can increase the impact both internally and externally (DESY within Helmholtz and as a research hub). The ranking of the platform projects (for receiving funding) is inversely correlated with chance of external funding, we applaud this choice.
There is some pressure from management to only support projects that benefit DESY as a whole. Widely-applicable software infrastructure is a good thing, it is however not always applicable. A "generic, unless" policy could be an interesting alternative, generic software (useful to all) being the default, unless the proposer can convincingly explain why this is not feasible for some case quite important to department X.

Identification of Critical Issues

Nothing critical.

Recommendations

The SCP mandate is up for review in December 2024, and this is an excellent opportunity to add some text about rationalisation and harmonisation in service of effectiveness and impact. We recommend also a new mandate sentence about the importance of sufficient contact with end users; the real impact of the SCP comes from increasing user effectiveness.
The SCP should investigate to what extent it can help the DESY IT colleagues with their campaign for experiment-generic HL-LHC analysis facilities.
The committee looks forward to meeting again with the SCP in fall 2025.