# Recommendations of the 95th Physics Research Committee

May 2023

## General remarks

- The **PRC appreciated the positive reports** on the delivery of the PXD2 to KEK / Japan, on the imminent ALPS II data taking, on LHC restart including first Run 3 results at 13.6 TeV with significant DESY contributions, on the continued high quality of theoretical research, and on the testbeam planning in the framework of the DESY IV implementation in the PETRA IV era.
- The **on-site axion experiments and LUXE** by now represent large still growing collaborations (~100 people) at the 10-20 MEUR scale. They all have significant and important discovery potential in fundamental physics, and they keep attracting national and also international interest, as well as young researchers and public interest. Securing the full project funding for their implementation has very high priority in the coming 2-5 years.
- Concerning **Ph.D. students, post-docs, and technical personnel**, the PRC observes a strain on these groups of personnel in many areas, and priorities need to be made when it comes to filling posts. PRC96 will address this issue in greater detail, with an input presentation by FH management on the 3-4 years planning horizon per group / activity. There are numerous good examples of dealing with the difficult situation to be found in various groups; in particular ensuring that young researchers work on more than one project, further increasing the priority of technical work so that all experimental students and postdocs contribute significantly, and attracting engineering and technical students e.g. from TU Hamburg Harburg, etc. Third-party funding initiatives are also pursued successfully and encouraged.
- The PRC heard examples of **horizontal activities**, with the platform on detector R&D already being setup, the one for scientific computing in the pipeline. These platforms offer potential for synergies and creativity. Also the Future Collider Forum represents a horizontal activity across FH groups, as does the DESY-wide Quantum Technology Task Force that has been presented to the committee earlier.
- The PRC has repeatedly heard about the **magnet situations at MADMAX and BabyIAXO, and about the cryo-platform**. The committee wishes to see a consolidated timeline and a strategy for discussions with major collaborators (i.e. CEA, CERN, MPI) to guide the planning.
- The PRC notes that the groups are adapting to the **difficult travel funds situation**, and it acknowledges that there are specific needs that need to be considered – i.e. the possibility to participate in international experiments, or the necessity for theorists to participate in international networking and exchange events. It is noted that priority should be given to young researchers who need to build a career.
- **Cost increases** emerge in the HL-LHC projects, due to inflation and also to actions needed to deal with missing Russian and Belarus core funding. The financial consequences for the collaboration partners, including DESY, are being clarified within the collaborations. For the LHC detector work at DESY, sufficient availability of technical and physicist expertise remains a concern.
- The PRC is concerned about the future impact of the constrained personnel budget. This has already led to a decline of the number of graduate students. As result it will be more difficult to ensure continuity and knowledge transfer to the next generation of (post)doctoral researchers. Overall, a reduction of the scientific output has to be expected when numbers of Ph.D. students and postdocs are reduced significantly.

## ATLAS

### Findings

The ATLAS group is deeply involved in Run 3 preparations at many levels and has contributed significantly to all early ATLAS Run 3 analyses (luminosity determination, Higgs boson production in $H \rightarrow \gamma\gamma$ decays, top-quark and Z-boson production cross sections). This lays an excellent

foundation for the important science to be extracted from Run 3, and is a very valuable experience, in particular for young researchers, and a good preparation for their future success. The harvest of LHC Run 2 and involvement of group members in further activities have led to twelve publications submitted to, or accepted at peer-reviewed journals and seven public notes released since November 2022. Also, four doctoral researchers have finished their Ph.D.
For the upgrade of the ATLAS silicon strip tracker (ITk), the group has a broad range of responsibilities in production, assembly, and testing. The group has demonstrated very good progress on many fronts, in particular on larger structures (petals, endcap integration) despite constrained staffing levels, with additional staff (recent postdocs and senior staff) being trained on various tasks.

### Comments

We congratulate DESY on its excellent contributions to the ATLAS Collaboration. The breadth and balance of the portfolio is impressive, adequate for group size, and the publication record is very good. Time scales to publication are generally becoming longer and longer, but the group has managed to publish twelve papers and seven notes in a timely manner. The group should be congratulated on leading contributions to all three of the ATLAS Run 3 physics results so far.
We also acknowledge the group's support for early career researchers despite the limited budget. Opportunities to work on more than one project are beneficial for ECR's careers, and care has been taken to carefully plan travel for junior members of the team. We observe that the entire group has been activated for the upgrade: this is important to making planning more robust.

### Key comments and recommendations for ATLAS

The timely delivery of the DESY contributions to the ATLAS upgrade should continue to have the highest priority. This entails maintaining sufficiently high personnel levels to deliver detectors and services that have been promised. The group's plans should be further developed in case of possible further delays in the LHC upgrade, and adequate access to central technical resources of DESY must be supported.
The group should develop further measures to deal with the reduced budgets for personnel and travel. For example, the portfolio of contributions to the ATLAS collaboration could be further consolidated by concentrating on fewer "flagship" projects.

## CMS

### Findings

The CMS group continues to pursue a broad range of activities. The team reported a stable **size and composition** with only small changes since the last PRC. Joining I. Melzer-Pellmann, who leads the team, are two deputies, A. Meyer and A. Mussgiller. The team reported an increase in CMS "Level-2" responsibility positions, in the trigger and physics performance/analysis areas – in the latter DESY now has three physics group conveners. The group plans to increase the use of the CMS Center at DESY, to enable its use for central CMS data quality shifts. The group continues to make contributions in alignment, luminosity, computing, and other areas.
Four new CMS analysis **papers** in the SUSY search and top physics areas, and two detector papers related to the Outer Tracker, have sizable DESY contributions and have been completed since the last PRC. Further preliminary results have been released. A wide range of further physics analysis is ongoing.
New **fast beam condition monitors (BCM1F)** were installed in the 2019-2021 long shutdown (LS-2). However, there is an unforeseen possibility that the BCM1F will need to be replaced during Run-3, due to irradiation effects causing high voltage trips. There are insufficient spares for a full replacement, solutions are being investigated.
The **HGCAL calorimeter upgrade** for CMS at Phase-II plans to replace the full endcap calorimetry. The outer rear, less radiation-exposed, parts of the HGCAL will have scintillator tiles

as sampling elements. The CMS and FTX groups are working together to construct scintillator tile modules for the Phase-II HGCAL, where there is much expertise from CALICE activities. For the full production, DESY will wrap 125k scintillator tiles for around 1800 HGCAL tile scintillator modules, all in-house at DESY, and assemble them into modules, with the associated quality control tests. Russian groups are no longer participating in the upgrade: their expertise has successfully been transferred to the DESY team. The production timescale for the project is being defined, with an expected duration of production of one year, limited by SiPM deliveries and by test capacity. A high level of automation is required in production, especially in the scintillator tile wrapping, which is now achieved. Two new prototype modules have been produced using the wrapping machine on the tiles, and pick and place machines to place the wrapped tile onto the modules. The DESY team is also working on low-level offline software, especially for simulation and reconstruction.

DESY is to build 1120 pixel-strip (PS) modules for the **Phase-II Outer Tracker**. In addition, the production of 16 endcap Dees will be done in industry, supervised by the group. Modules will be mounted onto the Dee structures in-house in DESY, and the Dees will be further combined into five double disks, before transportation to CERN. It has been recently agreed that the assembly of the double-disks into TEDDs will be done at CERN.

Four more MaPSA's have been delivered to DESY since the last PRC: these have been tested, so that testing of MaPSAs is becoming routine. Assembly of these into modules is planned in the coming months, into four "kick-off" modules, to start the pre-production phase. Preparations for testing of the assembled PS modules is now well advanced. The Dee pre-production in industry is now close to ready, and is in good time. There have been supplier difficulties with the "pre-preg" material required for the Dees – this is being resolved with a new company. A further supplier problem arose with the carbon foam needed for the TEDDs and is making progress. Module mounting onto Dees has been exercised with one or two modules, final tests with four modules are planned in November this year.

The project is exposed to **loss of expertise from technical staff retirements**. Some have happened and further retirements will come. Some replacements have been identified.

Significant **cost increases in the outer tracker** were reported, following a comprehensive CMS review of the tracker costing. Handling these will require discussion with all involved funding agencies.

## Comments

The CMS team are **congratulated** on the award of four CMS awards to members of the group. Furthermore, the continuing coverage of more than the fair-share quota of operations tasks is applauded.

The PRC are pleased to see that the scope of the **HGCAL work** is becoming well defined. The automation of much of the production is a very positive development, reducing production staff effort substantially. The staffing required for production and QC is not yet fully established, and could become a concern, especially for module testing and analysis of test results: however, the team is well aware of this and working to mitigate it. A new DESY fellow has joined the team, which is helping. Steady engagement of students and post-docs from the CMS team will be essential during production. Continuous availability of engineers/technicians for trouble-shooting and problem solving during the production will also be crucial.

For the **Phase-II Outer Tracker**, module pre-production has been delayed by four months since the last PRC, due to shortages of externally-supplied components, with the holding item currently being hybrids, delivered from CERN. It is expected that external component delivery will be the limiting factor during construction, leading to the significant risk of further delays in a schedule with little room for slippage. Local preparations for module testing and burn-in are in good shape. Local DAQ expertise is needed for module testing, and is not available at present – the plan to mitigate by training Ph.D. student(s) must succeed. The carbon foam supplier situation is currently rather unclear, and poses a risk for TEDD assembly downstream in the production project. Overall, the OT endcap production schedule is exposed to serious risks from multiple external sources.

### Key comments and recommendations for CMS

**Phase-II Outer Tracker**: The hybrid and MaPSA supply will limit the production rate, according to current expectations. Accelerating the production of these should be high priority, and thoroughly investigated. The team should analyse by how much production could be accelerated, if these bottlenecks can be ameliorated – the ability to increase from 12 modules per week to 20 per week, if components available, is welcomed.
Across the outer tracker, discussions are needed with funding agencies, including DESY and its funding agency HGF, how to handle the **significant cost increases**.

## FTX

### Findings

The FTX group has an extremely diverse portfolio. There are at least 2 topics per subgroup, most of them related to lepton beams, and scientific and technical staff work on many projects. FTX's activities seed and support many other groups at DESY and beyond. In addition, FTX staff provide and maintain infrastructure such as test beams and computing frameworks.
The PRC observed good progress on all fronts. For example, the Science with Lepton Beams group is leading the ECFA study on Higgs/top/EW factories. The Advanced Software Group leads the Key4HEP, fastMC, and iLCSoft efforts. The Test Beam group has integrated new telescopes, and user demand is increasing every year. The Plasma Wakefield R&D group is making good progress and has presented a new machine concept (HALHF). FTX is a training ground for the next generation of instrument builders, accelerator scientists, and advanced computing experts. A strong list of Ph.D. theses, publications, and conference proceedings was presented.
Staffing levels are low across the board, which is especially critical for the future collider study group and the software frameworks group.

### Comments

The FTX group serves an important purpose at DESY and beyond, as it seeds future instrumentation, accelerators, experiments, computing, and leads future development for the HEP community at large (for example Higgs factory studies, computing frameworks for LUXE, calorimeter upgrades for CMS, etc). There is some correlation with the new "detector platform" (however, FTX's program is much broader). The group has had good success attracting 3$^{rd}$ party funding, e.g. from AIDA, QU, KISS, etc.
The test beam facility continues to be a critical community service and is aligned with the core mission of DESY and has received support to continue through the Petra upgrade. It is essential for detector R&D and serves many groups at DESY and internationally. It is also of great importance for science outreach and runs a very active education program.
The group size has decreased over the last year (due to students graduating, and one staff retirement), and especially the output of future collider study groups, such as software development for lepton colliders, will dramatically decrease if students and technical staff are not replaced.

### Key comments and recommendations for FTX

The PRC recommends to continue the investment in the FTX efforts, strengthening the software group, and maintaining at least a minimal number of scientific and technical staff working on future colliders, since even modest investments have been shown to have a big effect.

## Belle

### Findings

The new **Belle II pixel detector (PXD2)** was found a very critical item at PRC94. A major issue with the mechanical design had led to temperature-dependent bending of two PXD2 ladders during tests of the PXD half-shells at DESY. The group has answered the recommendation of the BPAC and PRC and carried out lots of tests to establish the margin of safety. It was shown that the bending effect is under control, and three damaged ladders have been replaced. In early 2023, the PXD2 has been successfully shipped to KEK and is currently being commissioned. With respect to the beam pipe delivery, there was a delay in PXD2 delivery of only five weeks.
**Beam backgrounds** have been a major constraint for SuperKEKB and Belle II to further increase the instantaneous luminosity. DESY has contributed to a careful study of the expected backgrounds and the safety margins of the Belle II subdetectors up to Long Shutdown 2 (LS2). The study has been published recently. It shows that Belle II is confident to be able to take data at luminosities up to $2.8\times10^{35}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$.
Several scenarios for **upgrades of SuperKEKB and Belle II during LS2** are currently being investigated, weighing the instantaneous luminosity gain from upgrades against the integrated luminosity from continuous data taking. The LS2 planning is subject of much attention internationally, including machine experts from DESY. The earliest start of LS2 would be in 2027.
DESY has been strongly involved in **Belle II computing**. The DESY computing facilities have been used to derive 100% of the calibrations for Belle II. A substantial fraction of analysis workflows that require fast turnaround are currently using the National Analysis Facility (NAF) at DESY, also by groups outside Germany. In view of the large datasets expected from Belle II running, the collaboration is working on the evolution of their computing model, with a DESY scientist serving as the deputy computing coordinator for Belle II.
The DESY Belle II group has contributed to several **data analysis results**. Among them is the world's best measurement of the tau lepton mass, which was released recently. Another recent Belle II result on the determination of the CKM matrix element $|V_{ub}|$ allowed additional insights on the discrepancy between inclusive and exclusive measurements of $|V_{ub}|$ that was reported previously.

## Comments

The PRC is pleased to observe that the DESY Belle II group is well positioned in the collaboration and continues to have multiple leadership positions in Belle II. With the installation of the PXD2, the staffing level of the group will be amenable to forward planning.
The PRC is pleased to see progress with shipping of the Belle II PXD2 and its assembly and commissioning at KEK. The PRC is impressed with the level of scrutiny of the ladder bending problem, including a clear risk mitigation strategy. Likewise, it was very impressive to learn of the detailed cold test at KEK.
The PRC is pleased to see an international task force in place that very actively evaluates plans for the upgrade of SuperKEKB and Belle II in LS2. However, the three scenarios presented so far were not yet well developed.
The PRC is impressed with the Belle II calibration capabilities demonstrated at DESY and is looking forward to their further development into grid tools. The use of the NAF for fast-turnaround data analysis is a good success for DESY, but it does not scale well with the expected amount of data.
The PRC congratulates the group on the impressive tau mass analysis, leading to the world's most precise measurement. The change in physics analysis focus coming with the Young Investigator Group starting in May 2023 is supported by the PRC.

## Key comments and recommendations for Belle II

**Operation and long-term planning**: The PRC recommends that the DESY Belle II group ensures enough effort and expertise in the PXD2 project for future Belle II running. The group should draw up an explicit plan (i) for the group once PXD2 is commissioned and Belle II is taking data again and (ii) to establish their interests in the Long Shutdown 2 upgrade.
**Computing**: The PRC encourages the group to collaborate further with the Worldwide LHC Computing Grid (WLCG) to evolve the Belle II computing model. We encourage the group to take

an active part in the discussions around the DESY computing infrastructure towards IDAF, to ensure that their requirements are sufficiently taken into account.

# ALPS

## Findings

ALPS II is preparing for its initial science run and is in good shape to take first data. The optical system of the experiment has taken several important steps forward toward beginning a first science run, i.e., the stray-light background was successfully suppressed with a light-blocking box by over four orders of magnitude and is now nearly at a level where the first science run can begin. The collaboration undertakes strongest efforts to further reduce the stray-light rate to one photon every few hours (less than about $10^{-23}$ W), suitable for the initial science run.
The collaboration manages to measure and optimise the coupling between the Local Oscillator (LO) laser and the Regeneration Cavity (RC). All other preparations are well advanced.
The DESY support teams ensure that the infrastructure for the experiment is up and running. In February 2023, a new safety system by the DESY group MKS was demonstrated to ensure a smooth operation of FLASH even in case of all ALPS II magnets quenching. On 22/23 March, the string of 24 superconducting and straightened HERA dipole magnets was tested again with full success.
The prospects for the longer-term operation of ALPS II have not changed since the last PRC report (PRC94). I.e., the world-wide availability and affordability of Helium remains to be a project risk, thus is closely monitored by the DESY MKS group in close contact with the ALPS II collaboration.
The collaboration is about to gain two new partner institutes: M. Meyer, previously at Hamburg University, has taken a professorship at the University of Southern Denmark (SDU Odense). Hamburg University will stay in the collaboration. G. Müller became Max Planck Director at the AEI in Hannover. With both institutes, SDU and MPG, negotiations on signing the collaboration agreement are ongoing.

## Comments

The PRC congratulates the ALPS II collaboration and DESY for having successfully prepared the experiment and its infrastructure for an initial science run. This success underlines the ambition at DESY to exploit on-site axion experiments as goldmines for fundamental research in particle physics.
The committee notes that with the setup for the initial run, exploration of uncovered phase space for axions is within reach. The PRC is looking forward to the start of the run and is also looking forward to the reports of the first results.
The committee considers it to be important that sufficient resources, i.e., Helium and operation time for a successful initial run are made available to allow the collaboration to fully benefit from the run. The presented schedule for operation of ALPS II in 2023 and 2024 will allow the ALPS II experiment to foster its world-leading research on axions and should as well receive strongest support from DESY.

## Key comments and recommendations for ALPS

Preparation by the ALPS II collaboration and the DESY support teams was successful and the ALPS II initial science run can start soon.
A successful initial run will provide first physics results, and enable gaining experience with the setup, that in turn will lead to further improvements of the experiment. Sufficient resources, i.e., helium and operation time, will be required to fully benefit from all efforts made by the collaboration and DESY as host laboratory. First results of the ALPS II initial science run will be highly welcome by the experimental physics community.

# MADMAX

## Findings

Significant progress has been reached in many areas of the MADMAX dielectric haloscope development. The roadmap towards an open booster system becomes clearer also thanks to the newly developed method to measure the electric field and to have direct access to the nominal power boost factor. This allows for over-constrained measurements, thus for important systematic checks. The collaboration continues its R&D, key facility is DESY's cryo-platform. In parallel the collaboration is actively using the MORPURGO magnet at the CERN SPS H8 beam line as a test site for prototype setups that can be described in their RF behaviour.
Stable data have been taken with the CB100 prototype booster – aiming for a final experiment booster consisting of a mirror at the far end and the ~80 dielectric disks that can be positioned within a few μm precision by motors. These data are presently being analysed to derive first limits on ALPs and hidden photons using a dielectric haloscope.
For the next year(s) several setups are being prepared to be used inside MORPURGO, improving the sensitivity such that competitive ALP dark matter limits can be extracted. The cryostat for the first prototype booster setup is being produced and according to current schedule should be available for first measurements in March 2024. Until then a first prototype setup with 300 mm diameter discs will be available.

## Comments

The PRC stresses the unique and trendsetting concept of the MADMAX technology and method, which is considered to be leading and important for the entire field.
Steady and constant progress is achieved by the collaboration, which ensures that the method develops further. The committee notes the active role of DESY as leading partner in the MADMAX collaboration during the R&D phase, which is essential to bring forward the technology and in addition to support German and International funding applications.
We congratulate the collaboration for identifying limitation and issues with the prototypes and to work out or implement solutions to improve the experiment. The PRC notes that all tests and results achieved demonstrate the feasibility of the MADMAX method, and no showstoppers to reach the final goal are identified.
The PRC congratulates the collaboration for the successful data taking at the MORPURGO magnet at the CERN SPS H8 beam line and is looking forward to seeing the results of the campaign.
The committee recommends that the collaboration continues their detector hardware development at both, DESY's cryo-platform and the MORPURGO magnet at CERN. Steady progress of the R&D will help that the momentum being build up in the collaboration will remain high, which is mandatory in view of the uncertainties on the funding of the experiment’s magnet.
The need of a large aperture strong B-field dipole magnet for the "final" MADMAX experiment, remains a huge challenge from the funding perspective. The situation will remain unclear in the future. Further discussions between all stakeholders, the collaboration, DESY and the Max Planck Institute in Munich, are needed to establish a timeline for funding decisions.

## Key comments and recommendations

The PRC congratulates the MADMAX collaboration for their continuous R&D effort at the institutes, the DESY cryo-platform and the CERN MORPURGO magnet. Up to now all progress indicates the technical feasibility of the unique MADMAX concept and method. The committee is looking forward to the results of the campaign at the MORPURGO magnet.
The PRC considers the uncertainty of possible funding for the large aperture strong B-field dipole magnet for the "final" MADMAX experiment to be critical, and encourages all involved stakeholders to develop a possible timeline for the funding decision.

# BabyIAXO

## Findings

The IAXO/BabyIAXO collaboration continues to progress on all aspects of the experiment, detectors and infrastructure. DESY collaborators and DESY support teams continue their vital roles to reach that progress. On the detector and instrumentation side, the collaboration started with the construction of parts of the experiments, i.e., the acquisition of the X-ray optics of the axion helioscope, the optics the XMM Newton flight spare telescope, is progressing, a first CSGO prototype for outer corona optics has been built and tested, two Micromegas prototypes have been build and are tested.
Important stepping stones as the preparation of a tendering for 650 k€ superconducting cable and the design of beamline components for sending out the order have been reached. As well, the software ray-tracer signal model has been finished and is ready for acceptance studies and updated sensitivity calculations. The design of the movable platform, holding the magnet and coolers, has been finished, and the platform is ready to be build. In the collaboration, a physics group has been created and physics coordinators are nominated.
The BabyIAXO magnet is driving the project's timeline and remains the main risk. The main reason is the unavailability of aluminium-stabilised superconducting cable, which is required for the magnet. To progress in the BabyIAXO magnet project, as well as in other experiments in need of an experimental magnet, the possibility to produce aluminium-stabilised superconducting cable of sufficient quality is necessary. Plans to overcome the present lack of suppliers are currently pursued at CERN, where a working group has been formed to set up a co-extrusion line at CERN or in industry. A possible start of the production of cables is optimistically expected in 2-3 years.
Progress has been made on the magnet design, where technical risks have been identified (e.g., cryogenic concept). There remains the need to further refine design in view of a more reliable cost estimate. A cost increase with respect to the initial plans can be expected.
In view of the lack of aluminium-stabilised superconducting cable as well as because of design issues, important uncertainties remain to define magnet timetable, preventing to progress to the TDR.

## Comments

The PRC notes with pleasure the progress achieved by the IAXO/BabyIAXO collaboration, and that the collaboration remains very active on all fronts, also strengthening the physics programme.
The committee notes the difficulty to keep the motivation of the collaboration up and high in view of the delays in the magnet system caused by the lack of aluminium-stabilised superconducting cable. The PRC appreciates that the collaboration continues to tackle important stepping stones and recommends to progress further in this organised manner; i.e. the collaboration should be encouraged and supported to continue their detector work including tests at the DESY site, helped to start construction the experiments movable platform.
The unavailability of aluminium-stabilised superconducting cable for the BabyIAXO magnet is driving the projects timeline and remains the main experiment's risk.

## Key comments and recommendations for BabyIAXO

The BabyIAXO collaboration should be encouraged and supported to continue their detector work including tests at the DESY site, and helped to start construction the experiment's movable platform.
The unavailability of aluminium-stabilised superconducting cable for the BabyIAXO magnet is driving the project time line and remains the main risk for the experiment. Plans to overcome the present lack of suppliers for aluminium-stabilised superconducting cable are currently being pursued at CERN. PRC recommends that the BabyIAXO collaboration, together with the DESY management, synchronises with the stakeholders at CERN and with the CERN management to ensure that a robust schedule for the cable development and production as well as high priority for the BabyIAXO experiment to receive such cable can be reached.

The design of the BabyIAXO magnet system is progressing. The PRC recommends that a robust timeline and roadmap for the magnet construction be prepared.

## LUXE

### Findings

For **LUXE**, the various collaborators have already secured or are in the process of securing funding – various applications for grants were made (ERC synergy grant, EU-INFRA call, …). A DESY strategic investment of 3 MEUR is foreseen for LUXE in the lab's mid-term planning. This will however only be released if a major fraction of the required funding gets secured.
There is good progress towards a TDR. The conversion of technical notes into a TDR document is nearly complete, and it is planned to publish this as a journal paper. The collaboration-wide review will be started soon.
First beamline elements have been ordered (four septa magnets for the extraction beamline). There are long lead times, which makes the item critical. An order of 310 kEuro was approved by the DESY directorate, and the tendering is to start soon.
There are plans to collaborate with the ASPECT project on a laser surface building of around 200 $m^2$.

### Comments

The PRC notes with pleasure the progress achieved by the LUXE collaboration. The PRC notes that several items of the TD20 extraction beamline remain on the critical path towards reaching the shutdown 2025 and encourages orders to be made in a timely way.
PRC noted with satisfaction the increased interest for strong QED physics / studies by the European XFEL.

### Key comments and recommendations for LUXE

The committee is looking forward to the finalisation and publication of the TDR.
The committee notes with satisfaction the progress in preparing the beam line for the experiment, i.e. the purchasing of the beam line magnets. The PRC notes that several items of the TD20 extraction beamline are on the critical path to meet shutdown 2025 and urges all involved parties to start the order soon (Septa, Dipoles) to be ready for installation during shutdown 2025.

## Theory

### Findings

The DESY Theory group continues to produce highly original and successful work in particle phenomenology. Especially impressive are the contributions that, e.g. through the analysis of higher-order QCD processes, lead to better precision at the LHC experiment. This in particular directly affects the investigation of the Higgs potential, which may also have implications for phase transitions of relevance for cosmology and the baryon asymmetry of the Universe. Also, the work on the model-independent effective field theory approach keeps being of high quality, which includes novel analyses of CP violation. A wide range of further activities, concerning for example neutrino physics and dark matter, continuously leads to important physics progress and fruitful interactions with collider and non-collider experimental groups.
The Theory group is very successful in attracting third party funding, in particular in attracting successful young researchers with ERC and Emmy Noether Grants. Recent examples include E. Pomoni and F. Tackmann, and further applications now under review. We congratulate on the successful hiring of Jeremy Green in Zeuthen.
A successor to Prof. Bluemlein has still not been hired.

### Comments

DESY Theory continues to be a leading centre for theoretical particle physics in Germany and on a worldwide scale. It gives DESY a high visibility for relatively limited funding.

The success in attracting third party funding, especially junior research groups, should not be taken as justification of further cuts. The problem is that the staff scientists can not apply for standard DFG funding and it is hence absolutely necessary to maintain appropriately base funding.
The importance of hiring a successor to Bluemlein has been emphasized by this committee in many previous meetings. Such a hire is essential for maintaining a visible phenomenology group at DESY Zeuthen, which would be complementary to the Hamburg activities through its focus on very high order perturbation theory, potentially with a strong connection to gravitational wave physics. It could also play a key role in linking DESY Zeuthen more strongly to experimental research than this can be realised with a pure lattice group. In addition, a precision phenomenology group provides an ideal contact point to related activities at Humboldt University, e.g. in the groups of Jan Plefka and Peter Uwer. In this perspective, the hiring of a strong successor to Prof. Bluemlein is a strategic decision. Such a hire would be crucial for the phenomenology group in Zeuthen.

### Recommendations

Everything possible should be done to ensure a maximal quality renovation of the WPC building that is hopefully to be rented in the near future. This has to be done with a focus on the specific needs of theorists (offices, discussion rooms, blackboards, suitable seminar rooms, etc.). This would create an environment where informal encounters can happen which sometimes lead to truly new ideas and breakthrough discoveries.
In spite of unavoidable budget cuts and $CO_2$ emission concerns, maintaining an appropriate amount of travel funding, especially for younger member of the Theory group (postdocs, Ph.D. students), is crucial. For a theorist, the possibility of communicating with top scientists worldwide is, to some extent, the equivalent of a high-quality experimental laboratory. Easy access to conferences and workshops is essential to remain competitive in attracting top postdocs and Ph.D. students.
To maintain DESY's unique position as a centre for axion physics it is advisable to start early on searching for a strong successor to Andreas Ringwald, an established world-leader in this field.

## IT

### Findings

DESY IT provides local, national, and international communities with abundant high-quality resources. Aside from being a large multidisciplinary computing center, DESY carries out important activities in the focus areas of Data Management and Analysis, and in AI/Machine Learning and Imaging.
For the resource provision area, the DESY activities are expanding; DESY will become (together with KIT) a Data Centre for the new German WLCG Tier-2 system, provide tape support for ATLAS and CMS by taking over resources previously provided by the Russian and Ukrainian Tier centers, and increased support for local DESY physics experiments. Significant progress has been made on sustainability issues, made even more relevant by the pressure of increasing energy costs for the IDAF. DESY also plays a key role in the developing federated ICT platform of the Helmholtz association.
For data management, DESY plays a central (and laudable) role in various national initiatives and frameworks regarding research data. The same can be said for WLCG due to the extensive use of the dCache storage management software across WLCG centers. Developments in IT are being made to be able to handle the enormous data bursts expected (and now already to some extent experienced) from Photon Science.
PRC acknowledges that a candidate successor for Volker Gülzow as IT head has been identified, and it encourages DESY to facilitate a smooth and swift start of that person at DESY.

### Comments

Financing of resources remains challenging; investment money is fixed, but the requests expand and the investment costs per resource unit have also increased. Investment money is sufficient to maintain the capacity for the coming year, that is replacement hardware can be purchased; as DESY was operating above pledge levels last year, the pledge increases can be accommodated this year; this cannot continue indefinitely. The other challenge here is the energy costs, and DESY has taken some creative steps to reduce these costs.
With regards to the PETRA IV project, for which IT will provide very significant computing support, it is important that the scientists on the PETRA IV side make use of the expertise present in DESY IT; otherwise, there is a risk of designing a system that will require significant additional work on the IT side, where the person power situation is already quite stretched.
The centralisation of the Tier-2 data infrastructure in part at DESY is a good choice; provision of high-quality and high-performance data infrastructure requires a high degree of competence, and this is certainly present at DESY IT. Location of the compute part of the Tier-2 infrastructure at NHR centers will require additional actions at those centers, likely being specific to each center. This should be made clear at the outset that the additional effort will need to be present at, and supplied by, those centers.
DESY IT is doing a lot for the amount of person power they have; it is not a small team, but it is a very broad programme. Some of the things on the horizon have the potential to generate lots of work, like the Tier-2 consolidation, increased support for local experiments and for the Photon Science (and upgrade) communities. This requires attention from DESY IT, but also from DESY management, like facilitating coordination between groups regarding the PETRA IV support.
DESY IT is doing a lot in the area of federated AAI, and it is very good to see that DESY is implementing a system that on the one hand implements the AARC blueprint and on the other hand tries to support as much synergy as possible between the national (e.g. Helmholtz) and international (e.g. WLCG) infrastructures.

## Key comments and recommendations for DESY IT

PRC asks DESY to encourage PETRA IV scientists to make use of the competences present in DESY IT for designing and implementing a computing model.
DESY IT should ensure that the division of Tier-2 responsibilities between NHR computing centers and DESY/KIT data centers is clearly understood.
DESY IT should make contingency plans for 2024, where the capacity buffer may not be sufficient to accommodate the pledge increases: how will investments be funded if prices remain high? An alternative is to discuss with the WLCG experiments, what resource choices they wish to make in light of insufficient funds to follow the requests.