Recommendations of the 85th Physics Research Committee

May 2018

General remarks

The PRC noted the draft report of the PoF evaluation panel and endorsed the finding that DESY is an outstanding laboratory in the ‚Matter and the Universe' and related 'Matter and Technologies' research units (Rus).

The PRC was grateful to the KET Chair, Christian Zeitnitz, for his open-session presentation and for joining the closed session for a discussion of the preparation of the German community input to the European Particle Physics Strategy Update (ESU). The PRC noted in particular the strong community interest in participation in ILC and DUNE and recognised that DESY has relevant leading scientific and technical capabilities that could form a backbone for German participation in both projects.
The PRC noted the outstanding operation of the DESY test-beam facility and the large number of users across a variety of communities which it serves. The PRC welcomed discussions on future upgrades to the facility including feasibility studies for a direct-extraction beamline.
The PRC also noted that a search is ongoing for a common W2 professorship on detector development with U Bonn.

As date for the next PRC meeting (PRC86), the time slot 16/17 October 2018 has been chosen. The meeting will take place in Zeuthen.

ATLAS

Within the ATLAS group, five Ph.D. students defended their theses since last PRC, and seven papers and four public ATLAS notes with substantial DESY contribution were published. It was shown that the large majority of DESY's ATLAS Ph.D. students and postdocs successfully apply for subsequent positions in particle physics.
The PRC recognises that the DESY ATLAS group continues to make strong and very visible operational, managerial and technical contributions. Group members hold several leadership positions (general management, computing, physics working groups, object performance groups, detector operation).
There is a balanced portfolio of physics analyses in top/SM, BSM/dark matter searches, and Higgs physics. The group makes important contributions to physics object reconstruction and performance studies (e.g. jet calibration, e/gamma, inner tracking, b-tagging, luminosity, MC production, software, simulation). There is good

integration of YIGs, ERC groups and individual senior staff. All this leads to a continuing flow of publications on Run II data with DESY contribution or under DESY leadership.
The group makes strong contributions to detector operations (SCT, Alfa, FTK). The upgrade projects in which DESY is participating are well on track (integration of one tracker end-cap, production of 2000 modules in Zeuthen and Hamburg), and they are currently experiencing a ramp-up of strip end-cap module building and test procedures. The planning of the "Z-DAF" module assembly facility in Zeuthen is finished.
Junior groups and senior staff, postdocs and students are well integrated; there is a new recent staff hire and a pending YIG application. The group has continuing success in attracting young investigator groups (new Zeuthen YIG).

Recommendations for ATLAS:
No specific recommendations were issued.

CMS
CMS – Findings
Within the DESY CMS group, three Ph.D. theses were defended since the last PRC meeting, and seven publications on physics plus two on instrumentation with heavy influence from DESY were published.
PRC acknowledges the excellent survey on Ph.D. students' and postdocs' career paths. In general, young people do have high visibility and responsibility in their activities and in the experiment. It is altogether very attractive for young researchers worldwide to get a position at DESY.
The DESY CMS group continues to make strong contributions to the experiment. Group members hold leadership positions and coordination roles across all aspects of the experiment.

CMS – PRC comments
- PRC congratulates CMS and LHC for the successful start of operations in 2018.
- PRC recognizes the DESY CMS group for their significant accomplishments and publication record.
- The DESY CMS group provides an excellent choice for the career path of young researchers (Ph.D. students, postdocs).
- The DESY CMS group continues to make strong contributions to physics in topics such as QCD, top, Higgs and searches for new physics. At this PRC to be recognized is its contribution to the ttH production in the H → bb decay channel and to the search for neutral MSSM Higgs bosons decaying into pairs of taus. This success also implies that travel money is getting tight (conference invitations, working group meetings at CERN).

- For the upgrades, there is excellent progress on the preparation/planning for the construction of the phase-II tracker (infrastructure – DAF, module assembly, disk assembly). There is strong need for personnel with the right instrumentation profile in the next years.
- There are numerous R&D projects, nice ideas and promising tests around, e.g. in sensor R&D (ELAD), in calorimetry (HGCAL joint effort with the CALICE/FLC group), ...

Recommendations for CMS:
No specific recommendations are issued.

Computing / IT

We commend the continuing success of the DESY computing large-scale facility. The Tier-2 compute and disks systems and the NAF are performing very well with good strong utilization and good uptime. The DESY Zeuthen computing facility has good performance and utilization, primarily supporting the astrophysics program. In the near term, there is a growing need in IT for additional scientific computing expertise required to directly support DESY programs.

As also noted in the PRC84, the capacity of the wide-area network is being significantly strained by the current LHC load, both on the dedicated LHCone network and on the general-purpose WAN. In summer 2018, the general-purpose WAN will increase capacity at no cost, which will address part of the problem.

DESY IT continues to participate in several EU projects. In addition, DESY is involved in proposals for the Helmholtz incubator “Information & Data Science”. As part of the DESY strategy planning, a proposed “Centre for Data and Computer Science” (CDCS) would extend DESY’s portfolio into computational sciences featuring collaboration with Hamburg University.

The lean staffing situation is intensifying, considering all of the on-going work, the increasing requests for central support and balancing the increasing needs of the XFEL. It is particularly important to be able to adapt for future projects while continuing with excellence in operations of the current program.

Recommendations for computing / IT:
While DESY IT has been through a number of planning exercises recently, given all of the positive outcomes, we suggest reviewing the proposed increases in scope to refine the staffing plan and work plans for the next five years. These plans would form the basis of negotiation for concrete actions to position DESY IT in this time of opportunity.

Theory

The PRC fully endorses the finding of the POF:

> "*In all its fields of activity, the Theory RU is performing research of absolute excellence according to international standards. Indeed, the theory RU is widely recognized as one of the top centres in theoretical physics in the world, thanks to the intellectual brilliance, originality, and creativity of its members.*"

We congratulate the DESY Theory group on the very good evaluation!

There has been also excellent progress on three of the four recommendations from the PRC 84. The PRC is pleased to hear about the advancing developments for a new building for the Wolfgang Pauli Centre in which it is now planned to host both the DESY theory group and the II. Institute for Theoretical Physics of Hamburg University.

We comment here further on the issue of the Zeuthen precision collider phenomenology group: It will be a real loss for the community if the unique activity of the Zeuthen group in precision collider phenomenology will be lost (5-loop beta function, PDFs, massive splitting functions, …). This is an outstanding group with activity that is no less world-leading than the rest of the theory group. The current policy of doing nothing seems to be the implementation of a strategy with a long-term aim of reducing (eliminating) the collider phenomenology activity.
If a decision in principle has already been made then that needs to be communicated clearly and sensitively to the current members of the group. In particular, a rescue strategy for the remaining staff needs to be developed. If a decision has not been made yet, then the current policy of doing nothing is damaging.
A better plan could be, for example, to use the Riemann position to support short-term positions in the collider physics group to maintain its world leading position. Alternatively, the future of the group could be secured by filling Riemann's position as soon as possible through a permanent hire in phenomenology (thereby maintaining a viable activity with at least two permanent scientists in collider physics) and then developing a strategy in the longer term for the subsequent replacement of Blümlein.

Recommendations for theory:

The PRC recommends that a strategy for the development of the Zeuthen theory group be discussed and presented at the next PRC.

Belle / Belle II

PRC is pleased to see that Phase 2 operation of Belle II has started, with first collisions observed on 25 April 2018. A prerequisite was the successful integration and commissioning of the Remote Vacuum Connection and the BEAST II system. DESY personnel were vital in the preparatory work at KEK (BEAST II cabling, bellows etc.). The observed photon background originating from the High-Energy Ring is more than an order of magnitude higher than expected and would present a serious risk to the PXD and SVD detectors to be installed for Phase 3. Understanding and controlling this background is a critical goal for the Phase 2 running.

The PXD production schedule has suffered an additional delay of about 4 months w.r.t. the schedule presented at the last PRC meeting in October. The main reason is difficulties in ladder assembly caused by insufficient cleanliness. Start of half-shell assembly and commissioning at DESY had to be postponed from January to May 2018 and will be shortened to a test of only the layer 1 ladders mounted to the mechanics. Delivery of the PXD to KEK is now foreseen for June 2018, roughly unchanged w.r.t. the October schedule. The new schedule implies that mounting of the layer 2 ladders and commissioning of the whole PXD has to take place at KEK during August and September, in parallel to BEAST II removal and preparation of cabling for VXD installation. For the latter a second set of cables has been ordered, which is on the critical path, and support from DESY would be highly welcome to finish them on time. The relocation of the final assembly and test of the PXD to Japan appears to add a significant new risk to the project because of the limited access to experts and equipment in case of unforeseen difficulties. On the other hand, it will allow to find problems in the integration of the PXD with the beam pipe without further delay. Presence of DESY personnel at KEK during this end game will be essential to accomplish the task. PRC strongly supports DESY in its efforts to successfully complete, install and commission the PXD detector.

VXD installation and check-out is planned for October and November. The Belle II collaboration currently aims at a start of the Phase 3 running in February 2019, one month later than in the October schedule.

PRC notes with pleasure that the DESY Belle group has recently been substantially strengthened, mainly in the area of software development and data analysis, by a Young Investigator Group, a Helmholtz W3 group, and three new fellows, which will also increase further the visibility of DESY in the Belle II collaboration. Nevertheless, it remains important to keep the person-power in the area of detector commissioning and operation at the required level.

Recommendations for Belle / Belle II:

No specific recommendations are given.

International Linear Collider Activities and Preparations for Future Experiments

FLC - Findings

The PRC recognises the DESY FLC group as one of the major players in the common worldwide international effort to develop the future projects of accelerator-based particle physics beyond the LHC programme. We note the excellent use of the resources provided from the lab and congratulate the group for also getting additional external sources which mainly come from EU funds (AIDA2020, E-JADE, etc., ...). In this context the leadership of the group is very high as for instance in the structure of the Linear Collider Collaboration, in detector developments (ILD and SiD management, etc., ...), and in EU projects like AIDA2020.
The period 2018-2019 is of great importance for the European particle physics community to develop the next European Strategy Update. A strong participation of the DESY FLC group in this process is expected and should be supported in the context of a future linear collider proposal especially after the long investment of the laboratory in this project. The contribution of the DESY FLC group is seen as critical to formulate the European proposal given its central role in the development of International Linear Collider (ILC). All synergies with CLIC should be exploited also.
At this time the PRC discussion covered the recent results and activities reported by the group on detector development (time projection chamber, hadron calorimetry, silicon strip telescope, data acquisition), site studies, detector integration and machine-detector-Interface, beam-related studies on backgrounds and positron source, software developments, and physics studies.
The excellent and complete report provided by the FLC group prior to the PRC meeting is very much acknowledged.

PRC notes continued effort and specific advances on the following subjects:

- the TPC two-track separation and dE/dx studies;
- development of the silicon strip telescope as test-beam facility for the TPC and data acquisition system along with UK and Prague groups, under the LCTPC Collaboration for testing purposes;
- hadronic calorimeter: construction of the next big prototype, successful beam-test results, mechanical studies on static and dynamic stability and R&D for the new CMS end-cap (HGCAL);
- MDI and integration for ILC: site studies, detector (ILD) integration, background sources, muon background (1st time) involving ILC250&ILC500;
- studies on the ILC positron source for high-luminosity electron-positron colliders. (PRC notes that this issue is getting critical as support at Zeuthen is at risk);
- on-going studies of the physics (Higgs+new physics) for future e+e- colliders considering realistic detector and accelerator conditions. Recent efforts cover the physics case at 250 GeV and the role of polarization;

- software development on core software components, generic implementation of detector geometry (DD4hep), event reconstruction.

PRC notes a high scientific production on physics and instrumental publications, theses and contributions to conferences.

FLC – Referees' comments and recommendations:

PRC recognizes the key role that the group will play in the next European Strategy Update and encourages the group to actively contribute taking a leading role in the activities to provide a proposal of the Linear Collider Collaboration. In this context support of the lab should be continued in both technical and scientific aspects including personnel.
The FLC group should keep the present effort in finding synergies and common applications with other projects of the field. The PRC notices in this respect the excellent cooperation with CLIC in general, CMS in calorimetry (CALICE) or the development of software tools.
The long-term strategy of the group depends on the outcome of the Japanese decision on ILC and of the European Strategy Update.
PRC congratulate the group for the excellent progress and high-quality achievements reached in all areas in which the group participates.

Particle Astrophysics

DESY Zeuthen is on track to be the leading centre for particle astrophysics in Germany. There has been impressive growth from 2009 to 2018, with staff numbers increasing from less than 15 scientists to more than 50.
DESY is well integrated into the astroparticle physics community. It is one of 18 Helmholtz laboratories and has a significant share in Helmholtz's astroparticle activities; it has had impact on the European coordination through APPEC, and on the German roadmap through KAT. It is thus fair to say that DESY is a key player at all scales from Berlin-Brandenburg to the international level. Universities are playing an increasingly important role as strategic partners, with Erlangen the newest partner, joining Humboldt and Potsdam.

Astroparticle physics at DESY has four "pillars": i) gamma-ray astronomy; ii) neutrino astronomy; iii) multi-messenger approaches; iv) astroparticle physics theory.
PRC congratulates the IceCube and TeV gamma-ray groups on the detection of a coincidence between a neutrino event and a gamma-ray flare from an AGN – an excellent example of multi-messenger particle astrophysics. This news was announced during the PRC meeting and was one of the scientific highlights of the open session.

Findings: Gamma-ray astronomy – present

- The DESY team has recently completed the upgrade of the cameras on the four original H.E.S.S. telescopes. This will significantly improve the sensitivity of the instrument. DESY has also taken on numerous analysis and administrative leadership roles within H.E.S.S. and concentrates on advanced analysis and transient observations.
- A strong group from DESY is a very important component of the VERITAS collaboration. Members of this team hold leadership roles on the time allocation committee (TAC) and in science working groups. They also develop and support one of the collaboration's two data pipelines.
- The DESY effort in MAGIC is of smaller size but equally valuable. The lead DESY scientist on the project (Bernardini) is moving to Padua, but strong ties will be maintained on the postdoc / student level.

Findings: Gamma-ray astronomy – future and transition period

- The next big gamma-ray project is the Cherenkov Telescope Array (CTA).
- It has recently experienced encouraging progress in administrative and legal aspects: there is a new observatory director and a new project manager, both with valuable experience in international telescope projects. CTA is moving towards European Research Infrastructure Consortium (ERIC) status a legal structure that will allow progress in proposals and construction. It is good news that DESY will host the CTA Science Data Management Centre (SDMC) although the details concerning the role and the responsibilities are as yet not precisely defined. All in all, DESY seems ready to make important contributions, and project time schedules are firming up.
- During the construction and commissioning years CTA will not surpass the existing detectors in sensitivity. It makes sense to run them until at least 2023.
- Accordingly, three-year extensions to H.E.S.S. and VERITAS observations will be proposed this year (2018). It will be important for DESY management to support these proposals.
- DESY's strategy to attract and retain students and postdocs with a mix of science with present-generation telescopes and preparation of CTA (the challenge is to get the mix right) should be maintained.

Findings: Neutrino astronomy

- DESY is the second-largest institute (after the University of Wisconsin) in the IceCube neutrino collaboration. The lab has a leading role in analysis work (e.g. the PRC is looking forward to the forth-coming publication in "Science" with a corresponding authorship by DESY) and hardware contributions. It provides important contributions to the proposed detector upgrade called "IceCube Gen2" and participates in its leadership. In the first of these upgrades (still called IceCube upgrade), seven strings with 125 optical modules of the new mDOM-

type (24 3-inch PMTs in each mDOM) each will be deployed; DESY will produce two of the strings. In addition to testing new technologies for Gen2 (mDOM) and enhancing the low-energy capabilities of IceCube, this upgrade will allow to calibrate the IceCube detector in a better way improving the quality of past and future IceCube data. Progress however hinges on the imminent US National Science Foundation (NSF) funding decision, which is expected to be positive. Indeed, just after the PRC meeting we learned that the IceCube collaboration management had been inofficially informed that the NSF director had endorsed the proposal and that full funding will be forthcoming. With this upgrade NSF will do a substantial contribution by installing the upgraded drilling machine at the south pole. Therefore, there is good reason to expect green light for IceCube Gen2 in the future.

- In the field of radio detection of neutrinos, A. Nelles, who was recruited from UC Irvine to Humboldt University as an Emmy Noether fellow, will take up a joint appointment at the professor level at the University of Erlangen and DESY. She brings substantial radio-detection experience and her strong interests to apply it to neutrino detection. Radio detection can extend the energy range and improve the sensitivity of IceCube – the ultimate goal would be the detection of GZK neutrinos. There is also a possible option to install a radio-only detector in Greenland. Greenland could serve as an R&D site facilitating access to a test site. It could also be an option for a radio-only detector if IceCube Gen2 will not realize.

Findings: Astroparticle theory

- The theory group pursues stand-alone studies of acceleration, transport, and interactions of non-thermal particles. It shows active involvement in and theoretical support of the experimental groups. The group has healthy demographics and activities. With a recent addition there are now four staff scientists plus postdocs and students. Group members produced 47 publications in 2016/17.
- There are continuing challenges related to geographic dispersion of the faculty members and limited office space at DESY. The situation is under study and possible improvements could occur once CTA infrastructure is installed.
- A limited program of `laboratory astrophysics' has been initiated and an experiment is in progress. It involves an electron gun and plasma cell to explore current-driven instabilities. The effort is being carried by a single postdoc so this activity might be considered sub-critical. We suggest expansion and closer links to other groups (like the UHH plasma group) if the initiative is to go forward in this field. We ask for a more comprehensive report/plan at PRC86.

Astroparticle physics: Other findings

- PRC congratulates DESY for its hiring strategy. David Berge and Anna Nelles are only two recent examples for promising young researchers that joined the lab.
- DESY is a collaborator in the Zwicky Transient Facility (ZTF) project. ZTF is a 1.2 m Schmidt camera with 47 square-degree field of view on Mt Palomar in California. It is intended for a comprehensive supernova survey which will provide support for cosmology. It will also be used for follow-up observations of IceCube neutrino events, and is therefore a good example of multimessenger science.
- MeVCube is a satellite-based experiment for gamma-ray astronomy in the MeV range, the least-explored part of the gamma-ray spectrum. It is based on CdZnTe crystals, which allows particle physics expertise to be used. MeVCube is developed in collaboration with TU Berlin who have experience with cubesats and launch proposals.
- TAIGA is a programme of research involving detectors in the Tunka valley in Russia; this activity has historical roots in the Lake Baikal neutrino detector and is good for variety but is possibly sub-critical from the DESY perspective.

Recommendations for particle astrophysics:

- The PRC suggests involving German universities in the IceCube upgrade, especially the thorough testing of components of the optical modules.
- For the radio-detection of neutrinos, PRC encourages the development and maintenance of links with other radio-technology groups.
- For laboratory astrophysics, the PRC suggests expansion and closer links to other groups (like the UHH plasma group) if the initiative is to be maintained. We request a more comprehensive report/plan at PRC86.
- For astroparticle theory, we would like to ask a more detailed presentation of the activity of the group, of the impact of their research, and of their future strategy (along the lines of what is done by the DESY Theory group) at the next PRC meeting. Based on the material presented, we see an opportunity to further strengthen the links with the Theory group in DESY-Hamburg, especially with colleagues involved in particle phenomenology, physics beyond the standard model, and cosmology. Multi-messenger studies at DESY-Zeuthen would greatly benefit from closer connections with numerical relativity experts in the Potsdam area, and it might be worth considering to hire a numerical relativity expert as a junior leader or on a staff member position.

ALPS-II

There are weak astrophysical hints that axions (or axion-like-particles) may be in the search window of ALPS II, and the case for ALPS searches is largely unchanged from the last PRC and still very timely. The "shining-light-through-walls" ALPS II is one of three flagship axion-search projects worldwide. ALPS is identified with DESY as an on-site experiment. The ALPS group continues to maintain a high profile in the axion-like-particle and axion community, giving talks on ALPS and ALPS physics worldwide and contributing also to shape the future of the field within the MADMAX and IAXO collaborations.
We are very impressed by the technical progress and we are gratified to see ALPS II being now solidly integrated into DESY project planning and schedules. The momentum of the project has substantially increased since the last PRC with five more dipoles straightened and so nine available dipoles at present, on a good way to the goal. The PRC discussion covered recent progress by the group on optical-cavity length stabilization (key deliverable), development of AEI 1m optics prototype, development of heterodyne receiver, TES system build-up (key deliverable), magnet bending (key deliverable).

The enabling key technology for the experiment is the optical system, and the group argues for the necessity of having specialized on-site optics expertise and a guaranteed continuity. The project has two world-class optics groups (AEI & U. Florida), but these groups do not contribute on-site optics personnel. The current DESY optics expertise (via 2 postdocs) may leave soon. The group sees the disappearance of this expertise as a significant project risk. It may be necessary to offer some longer-term perspective to key people to ensure the success of the experiment and keep a core group with ALPS expertise for the future.

Specific recommendations for ALPS:

- Data-taking is scheduled to start 2020. Given the project's technical challenges and the history of delays, this is a very aggressive timetable. The recent success in bending more dipole magnets has significantly reduced the technical risk of delay, and this is good news, but we recommend to keep up with the momentum to avoid further delays. The timely success of ALPS II is a key element and a solid basis for DESY's participation in future projects in axion physics.
- There are two parallel photo-detectors under development (TES and heterodyne). The group argues this duplication reduces the separate technical risks inherent in each method. It may be that in the next few months the risks are retired, in which case a detector baseline can be selected. In any case local optics expertise at DESY is crucial for the experiment and should be guaranteed.
- There may be other next-generation axion and axion-like-particle searches at DESY (MADMAX and IAXO) and we recommend DESY to consider carefully these opportunities.

HERA

The HERA collaborations are still working well in “volunteer mode”. Since their last PRC presentation in spring 2016, the collaborations H1, ZEUS and HERMES produced seven publications. They still show impressive presence at conferences, confirming community interest in HERA physics.

The HERA work is strongly supported by the DESY Directorate and by DESY LHC group leaders; this is gratefully acknowledged.

There are, however, a few challenges to the groups: First, person power limits activity, and that means that some useful activities like HEPDATA and RIVET analysis cannot be performed. The situation is not improved by the fact that the LHC experiments do not acknowledge “time share” of collaborators on other experiments.

An additional concern is that DESY travel support with matching funds for outside collaborators cannot be used due to lack of matching funds in the outside institute. Furthermore, the upcoming AFS phase-out will increase work load, and here IT support will be crucial.