

Recommendations of the 78th Physics Research Committee

5 December 2014

LHC Experiments

ATLAS

The DESY ATLAS group continues to make strong contributions to the experiment. The group pursues a strong portfolio covering Standard Model physics, top physics, Higgs and SUSY searches including a new effort searching for the MSSM Higgs in decays with tau-tau final state. The PRC notes with satisfaction that the group has contributed to 11 recent papers out of which 4 have analyzed 8 TeV data. The YIGs play a crucial role in the physics portfolio of the group, including leadership in object reconstruction (e-gamma group).

The PRC congratulates the group for their healthy physics analyses program and recommends that a new YIG group should be established in 2015 to complement the physics program further. The continued involvement of senior staff in physics analysis that complements the core involvements in Higgs, Standard Model and top physics is encouraged, as is an increased focus on Run 2 physics preparation.

The DESY ATLAS group also makes important contributions to the operation of the SCT and ALFA detectors and plays a key role in data preparation and reprocessing. A notable breakthrough was achieved in reducing the tracking reconstruction time by a factor of three – an achievement to which the DESY ATLAS group contributed significantly.

The group is also heavily involved in the ATLAS phase-0, phase-1 and phase-2 upgrades. In particular the small-scale (“petalet”) module tests for the phase-2 upgrade have been very successful and are now moving to the petal scale. The PRC notes that it is crucial that the funding is secured in the coming year (commented on separately below). It is encouraging that the ATLAS DESY Group managed to attract funding from the Initiative and Networking Fund of the Helmholtz Association.

The PRC congratulates the DESY ATLAS group on their many accomplishments.

CMS

The PRC notes with pleasure that there are currently several ongoing high-level appointments (some of them together with universities). All of them are expected to be finalized shortly, and associated junior staff and postdoc positions are already now opening up. This is very good news for the group and its long-term outlook. Both LHC and CMS preparations for Run 2 are proceeding well. BCM1F installation is proceeding and is expected to be ready for beam in 2015. SiPM in HO is now

commissioned and calibration is in progress; based on the good performance so far, HO's inclusion in the L1 trigger is being studied. Strong efforts are being made in physics analysis including activities in Higgs and top physics, SUSY searches and QCD studies. Planning for 13 TeV analyses is also robust. DESY CMS members are taking many important coordinating responsibilities within CMS. PRC will comment on phase-2 upgrade plans for LHC in general below.

The PRC congratulates DESY CMS for their considerable achievements.

While the short-term plans for support of BCM1F are adequate, PRC notes that already in January 2015 the effort begins to lose manpower and expertise. It appears likely that the manpower for this effort will continue to decline; there is a danger that without adequate planning, the future operation of this important beam monitor could be endangered.

PRC recommends that CMS, DESY-CMS and DESY reach a common understanding of how to proceed. A plan needs to be put together soon so that the operation of BCM1F can continue for the foreseen period up to the phase-2 upgrade.

Recently, some technical issues in phase-1 pixel module manufacture have come to light. The wire bonding issue, at this stage, appears minor, and expertise and experience in the pixel community appear adequate for solving this problem. The flip-chip bonding issue, however, has the potential of being more serious. The jet solder ball placement machine is being operated at the edge of tolerance, and there is no experience with similar demands on the machine. It is hoped that the mitigation from the vendor and other measures already underway will solve the problem.

Given the time scales of the project, however, PRC recommends that, in parallel to the mitigation effort currently being made, the group invest effort in looking into the alternative bonding method being used at KIT; namely to outsource the ball placement to the company RTI before using the flip-chip bonding machine, identical to one at DESY, for the final step. It is recommended that the group take adequate steps so that the possibility to switch the workflow to this alternate process is present. The group will then need to develop a plan with milestones that ultimately leads to a decision point between the two alternative workflows.

Computing/IT

The DESY Tier2 continues to perform well. NAF 2.0 is now fully operational and is being used successfully by the DESY groups as well as university groups. The near-term funding appears to be adequate. The cooperative planning with IT and the experimental groups is going well.

Phase 2 Upgrades and Computing

For the ATLAS and CMS groups, the plans for DESY's part in the phase-2 upgrades have been established for some time, and the necessary infrastructure is being planned. The funding outlook is not pessimistic. However, PRC notes that it is likely that the funding will not begin to flow until 2018. This funding gap will likely impact R&D for the upgrade. Also computing upgrades for phase-2 are tied to this funding and might suffer from funding shortages in the years before 2018.

e+e- experiments

Belle

It is a great pleasure for the PRC to see the significance of Germany's and DESY's participation in and contributions to the Belle collaboration in various aspects including computing facilities. Further participation in the coming construction period is secured thanks to the new "JENNIFER" grant under Horizon2020. The PRC also congratulates the group on the recent successful demonstration of Remote Vacuum Connection (RVC) and the new installation procedure that was developed following DESY's initiative and that has been adopted by the KEKB IR group.

Continuing support from DESY in engineering and computing is indispensable for the Belle II experiment.

During the next PRC session, the PRC would like to hear more about ongoing and planned physics analyses including possible systematics and the strategies to overcome them; furthermore a clear plan towards publication of Belle I data should be laid out.

ILC

PRC congratulates DESY on the dramatic progress in SRF cavity production R&D and on the enormous efforts that are made in parallel to the cavity fabrication for the European XFEL. This progress became possible thanks to several inspection techniques newly developed at and around DESY.

The PRC acknowledges the leading role of the DESY team in the ILC community for many years in fields as diverse as detector R&D (including HCAL, TPC, FCAL), positron source development, physics studies, common software, detector integration issues, machine-detector interface and management of global activities. PRC takes note that DESY-Zeuthen hosts important activities for FCAL and positron source R&D. The PRC assumes that the world community expects DESY to keep up the momentum to materialize the design/R&D study for ILC in many areas.

The PRC suggests that DESY maintain its strong support for infrastructures like the DESY test beam or the high-field test magnet at DESY that are vital for the world detector R&D network for ILC, LHC and Belle and other activities.

HERA Experiments

H1, ZEUS and HERMES

The PRC congratulates all three collaborations for their still high number of produced results and high-impact publications, and for the large number of highly visible presentations at several conferences. It is recognized that – due to the declining person power in the collaborations and the end of HERA funding at DESY at the end of 2014 – it becomes extremely challenging to maintain this output level.

We encourage all three collaborations to seek third party funding. It is especially suggested to investigate if common funding for HERA data analysis and for invitations of foreign collaborators to DESY can be found (with the specific goal of finalizing the remaining high-profile publications). A common prioritizing of analyses might be helpful for a successful application. The planned HERA workshop in November presents an excellent venue to seek manpower outside the current collaborations. It would also be extremely helpful for all three collaborations if DESY could find some resources that would enable DESY members of the HERA collaborations to continue to give talks on the remaining high-impact publications and results. The PRC welcomes that new MoUs will be signed between DESY and the HERA collaborations for the years after 2014, ensuring continued understanding and collaboration after the end of the HERA funding.

Data Preservation

Until April 2014, all three collaborations had made good progress to preserve their data, Monte Carlo event samples and analysis software for the years to come. Unfortunately, the loss of the validation system set the whole process back significantly.

The collaborations are asked to find manpower in the permanent staff of the collaborations to help to offset this set back. It would be extremely helpful if DESY could find additional resources (money or/and manpower) in addition to the one provided through IT to compensate for this loss and to reach the original goals of each of the collaborations to preserve their data and software. Measures should be taken to professionally protect the restored software preservation system against loss or damage.

HERAFitter

The PRC congratulates the proponents of the HERAFitter project on having successfully integrated HERAFitter in high energy physics analyses. HERAFitter is a unique open-source QCD and PDF framework that is complementary to global fits. The emphasis of experimental uncertainties and benchmarks for the application of HERAFitter have the potential to lead to a new standardized set of PDFs. In addition to being a precision QCD tool necessary for SM measurements and a superb tool to preserve the HERA legacy, HERAFitter could also prove a vital asset in the search for new physics at the LHC. The PRC notices with satisfaction that the publication record increased since the last PRC meeting. A second paper was released by the HERAFitter group and 7 new results have been presented based on HERAFitter. DESY scientists continue to play a leading role in the intellectual leadership and in hosting key infrastructures.

The PRC recommends that DESY should continue to play a leading role in supporting HERAFitter intellectually and technically in the context of the LHC groups at DESY.

Other experiments

OLYMPUS

The PRC acknowledges the steady progress of the OLYMPUS collaboration since the last PRC meeting and understands that OLYMPUS is a precision experiment that requires a careful and therefore slower pace achieving the final result. But there remain several concerns that the analysis will converge on a reasonable time frame:

- There is still no procedure to determine a reliable and stable time-to-distance relation for the entire data set.
- There still remain significant issues in bringing the different luminosity measurements into agreement and to the precision required for the final result.
- The collaboration has still not yet analyzed the entire data set, which makes it very difficult to judge whether or not the entire data set is useable for analysis and the projected statistical uncertainty can be reached.

The PRC urges the collaboration to extend their analysis to the entire data set as fast as possible and to decide whether the final result can come close to the statistical and systematic uncertainties advertised in the original proposal.

The PRC takes note that currently the MIT group is the main remaining force behind the OLYMPUS data analysis.

The PRC urges the OLYMPUS management again to make another effort to revitalize other collaborators to participate in the analysis. The manpower situation will become even more severe with DESY funding ending in December 2014.

For its next meeting in spring 2015, the PRC strongly requests concrete numbers on the different systematic contributions to the final result and an estimate on what fraction of the entire data set has the quality to be used for the final result.

ALPS II

The ALPSII science program remains compelling, and astrophysical hints continue to point to the ALPS II search-space. The group has a high world-wide profile. Group members have given invited plenary talks and have been invited to write review articles. The group continues to have strong theory support. Right now, ALPS II has no serious competition.

Technical issues and comments:

1. The mirrors have been delivered, a concern at the last PRC, and metrology studies are underway.
2. The initial report on tunnel vibrations is that vibrations are tolerable and do not require active correction.
3. In this PRC meeting, the group reported that there are enough spare magnet of Italian design for the ALPS IIc string. Further, a second Italian magnet is undergoing bending and the results are promising. *If two such samples are indeed bent successfully, then the PRC would reduce the yield-risk of this procedure. Nonetheless, the magnets are a critical enabling hardware for the project, and these studies should continue.* The technical risk would increase if skilled magnet personnel on these particular magnets were no longer available.
4. There is some excess noise in the TES's, but this does not at this point appear serious. Further, the ALPS II sensitivity scales weakly with the TES noise. Hence, these sensors do not appear now to have substantial technical risk.
5. The possible collaboration with the LIGO group at the University of Florida would be very powerful. That group is proposing a spectral receiver instead of photon counting. This is more complicated but may reduce leakage risk.
6. The ALPS IIb descoping plan has ALPS IIc now commissioning the magnet string and the optics. *The PRC would therefore expect that ALPS IIc commissioning will need to be extended.*

Technically, the ALPS II program is progressing well.

Programme issues and comments:

1. The project is delayed, and the pacing delay is tied to limited manpower resources required to prepare magnet and tunnel. Further delays would endanger the project.
2. The group stated concerns about key personnel retiring from the lab before the magnets are deployed. It would be a steep learning curve to understand these magnets anew. *Hence, DESY should accept either that key personnel would need*

to be retained through this phase, or that resources would be needed to pass the specialized technical information to new magnet personnel.

3. The recommendations from the last PRC called for an MoU between ALPS II and DESY management regarding resources and the timetable. This issue has sharpened in this PRC meeting, *and the PRC recommends that ALPS IIc and DESY management reach agreement on a project and operations plan, and the key technical personnel needed for success of the project.*

Astroparticle physics

Neutrino Astrophysics

Notable results presented at the PRC meeting covered analyses aimed at understanding the source class contributions to the observed astrophysical neutrino flux by combining various data sets and a competitive measurement of neutrino mixing parameters. In both areas, DESY made leading contributions.

Given the success of the IceCube experiment, plans to extend the detector to register up to ten times more events at the highest energies and to determine the neutrino mass hierarchies and mixing angles at low energies are currently being worked out. To accompany the envisaged NSF MREFC (major equipment) proposal, German and European funding strategies as well as potential hardware contributions are being discussed. DESY is playing an initiating role. With Germany (O(80) members) being the second largest country in the IceCube collaboration, a substantial contribution – such as the provision of 50% of the optical sensors, roughly equivalent to an investment of 20M Euro – is expected. This investment can not be achieved within the present BMBF funding scheme and with secured DESY contributions. The goal therefore is to place IceCube on the German roadmap for research infrastructures, similarly to what was achieved for CTA. There is tentative agreement among the German astroparticle community to follow this challenging path. As requested by the PRC, a first timeline was shown. The PINGU addition to investigate neutrino properties could start in 2019 at the earliest, with the high energy extension to follow. During the PRC discussion, caution was expressed concerning the likelihood of getting rapid funding of a US MREFC (Major Research Equipment and Facilities Construction Funding) proposal. In particular, funding decisions may take more time than initially envisioned.

Still, the PRC agrees that a unique opportunity exists at the present time to push for IceCube extensions. We encourage DESY to advance the plan and give it an honest try. The alignment of funding lines, including Helmholtz and DESY in close cooperation with the DESY management should be studied further, keeping in mind likely time delays in the decision processes.

Gamma-ray Astrophysics

Among the appealing results shown was the first ground-based detection of the Vela pulsar with the new large HESS II telescope that has a low energy threshold of 30 GeV and a VERITAS result on a gamma-ray excess in the Galactic center. VERITAS is moving towards a good dark-matter limit. A method to study dark-matter substructure using CTA tools was also demonstrated. Fermi-LAT has measured the extragalactic isotropic gamma-ray background with significantly improved precision. CTA science studies are now well underway. A scheme for a faster all-sky survey using a divergent pointing strategy was presented. Also covered were the current plans for the CTA Key Science Projects, the flagship science investigations to be carried out by the CTA Consortium.

In terms of detector construction and preparation, we note that the first new HESS camera will be ready by June 2015, with cameras 2-4 following in 2016. The technical design report for CTA should be completed by early 2015, and around the same time the site selection for the southern CTA site is expected to be announced. As recommended by the PRC, DESY has applied for the CTA headquarters. Some delay in funding is likely to occur as the BMBF will free money only when sufficient parties are on board and contracts are made. This delay allows DESY to improve, for example, the telescope mechanics in detail. The distributed funding in CTA tends to lead to a non-uniform design; however, the medium size telescope (MST), which is DESY's responsibility, is little affected. Subject to the time of the funding decision, the preproduction phase may start in 2016, with 3-4 MSTs to be built. The production phase will commence a year later with a production of 15 MSTs to be installed in the North and 20 MSTs foreseen in the South.

The PRC congratulates DESY for the steady progress on CTA and hopes that the BMBF will release funds as soon as the major contributors to CTA are on board.

No specific recommendations were formulated.

Theory

The theory groups both at DESY Hamburg and at DESY Zeuthen cover a very broad spectrum of fundamental particle physics topics.

The PRC would like to congratulate DESY for the (apparently) successful negotiations to recruit Geraldine Servant and Christophe Grojean as new leading scientists, appointed to joint professorships together with Hamburg University and Humboldt University Berlin, respectively. Both represent a very significant addition to the phenomenology and cosmology activities and enhance the international visibility of the theory group.

The theory groups are continuously active in acquiring collaborative grants, hosting workshops, organizing schools and teaching regular courses at HU, FU Berlin, TU Dortmund, U Hamburg, U Potsdam. These activities enrich the intellectual life of the

laboratory and contribute substantially to the academic level of the local universities. The DESY Theory Workshop is an important annual event that brings together the German theory community and attracts many foreign researchers as well. The PRC wishes to reiterate the statements by the POF review panel -- “vibrant, world-class research activities, very visible in the international community”

The PRC reviewed specifically the activities of the string theory/mathematics physics group and the lattice group.

The string theory/mathematical physics group uses string theory as a tool to understand non-perturbative properties of quantum field theories (rather than a theory of everything). The PRC strongly endorses this motivation. We heard a number of interesting results following from weak coupling-strong coupling dualities. The work of the string theory group at DESY is internationally recognized. At present the results seem to be more influential for the mathematical community than for direct physics applications. A concrete connection to non-perturbative results of interest e.g. for QCD is difficult and has yet to be demonstrated. Still, the PRC emphasizes the importance of this goal, especially for a group associated to a national laboratory. The lattice group at DESY Zeuthen (NIC) is one of the two pillars of the particle theory activities at Zeuthen. It contributed many interesting new results in the past few years. The group pursues an attractive mix of pioneering/exploratory investigations/simulations (such as light-by-light, $g-2$, Higgs phenomenology) and precision computations of fundamental parameters of the SM (chiral condensate, decay constants, α_s). Work proceeds slowly and carefully towards the physically relevant case with solid uncertainty estimates, and when finally completed, will set the standard in the field for some time. The DESY lattice group is an important member of two international lattice collaborations and highly visible. The PRC further recognizes its unique standing in the German lattice community.

The PRC requests a review of the particle cosmology (Hamburg) and astroparticle theory (Zeuthen) and phenomenology activities (Hamburg and Zeuthen) in fall 2015.