

Recommendations of the 79th Physics Research Committee

16 July 2015

LHC Experiments

ATLAS

The DESY ATLAS group continues to make important contributions to the experiment. The group pursues a strong portfolio covering Standard Model physics, top and Higgs physics (including MSSM Higgs bosons) and has started a ttH effort. The PRC notes with satisfaction that the group has contributed to nine recent papers since the last PRCs. The YIGs play a crucial role in the physics portfolio of the ATLAS group, including leadership in object reconstruction (e-gamma group).

The PRC congratulates the group for their diverse physics analyses program and recommends that a new YIG group should be established in 2015 to further complement the physics program. A search component should be added to exploit the potential of the center of mass energy increase of Run 2. The PRC encourages senior staff to take on leading roles in the physics analysis efforts to complement the YIGs.

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. The group is also heavily involved in the ATLAS phase-0, phase-1 and phase-2 upgrades. For the phase-2 silicon strip endcap detector, the group is moving towards testing larger assemblies, including thermo-electrical tests. The latter are especially important as they include important CO₂ cooling tests. Synergy with the Belle 2 group, that holds expertise in this area, should be exploited.

The PRC notes with concern that funding for the phase-2 upgrade has not yet been secured. This situation becomes a major threat for the project this year. The PRC congratulates the DESY ATLAS group on their many accomplishments.

Recommendations for ATLAS:

- A search component should be added to exploit the potential of the center of mass energy increase of Run 2.
- Synergies with the Belle 2 group on CO₂ cooling should be exploited.

CMS

The PRC notes with pleasure that an exceptionally large number of high-level permanent staff positions, including additional funding, have been successfully appointed, which considerably strengthens the DESY CMS group. Leading contributions with original ideas have been made to many CMS Run 1 physics

analyses, e.g. in the (N)MSSM Higgs sector in several final states. The planning for Run 2 is already far advanced, especially for early analyses, SUSY and top physics. The work for operating CMS after the long shutdown 1 (BCM, HO, Alignment) was successfully accomplished and is already delivering results for first collisions and cosmics. The PRC notes with satisfaction that there are good prospects to keep BCM under DESY responsibility until the long shutdown 2, with technical and workshop support from Zeuthen and newly appointed personpower in Hamburg, which is encouraged to join the project part-time.

The PRC congratulates the pixel upgrade team for having solved the technical bump-bonding problems convincingly. The test procedure for bare modules is established, wire bonding is learned, and the calibration stands are ready. Series production has started and has to be ramped up in speed, since the production time schedule remains extremely tight with little contingency. The PRC recommends that the production is thoroughly and timely monitored to avoid additional delays, and that support of Pactech for solder balling should be kept as a fallback option.

The failed Helmholtz funding application for the phase-2 upgrade is a major concern that endangers the long-term contribution of the DESY group to CMS.

The PRC congratulates the DESY CMS group for their significant accomplishments

Recommendations for CMS:

The PRC recommends that the pixel production be thoroughly and timely monitored to avoid additional delays.

Computing/IT

DESY computing is performing well, operationally supporting a number of experiments including the LHC Tier-2 centre and the NAF, with ATLAS, CMS and Belle/Belle-II as the major users. There is active coordination between IT, ATLAS and CMS, and this communication is helpful and successful.

The PRC open session featured an update on the computing model for the Belle-II experiment. DESY hosts a computing Tier-2 and Monte Carlo production site for the Belle-II experiment. Data collection is currently anticipated for 2017 with full physics capability in 2018. The DESY contribution to a series of five Monte Carlo campaigns is much appreciated by the collaboration. Due to the LHC shutdown, opportunistic use at DESY has supplied more than 25% of the computing needed. The needed global Trans-Pacific and Trans-Atlantic network paths are being tested in readiness for data rates that exceed typical LHC pp rates.

In terms of networking, DESY has been a leader in the adoption of the internet protocol version 6 (IPv6), which is intended to deal with address exhaustion in IPv4. All central DESY IT services are compliant, with test-bed level usage, as well as participating in testing WLCG applications.

Within the framework of Horizon 2020, the INDIGO data cloud project (**IN**tegrating **D**istributed data **I**nfrastructures for **G**lobal **Exp**loitation) has been approved for 11ME. This pan-European consortium of 22 academic institutes and 4 industrial partners is targeted towards large-scale research data including life sciences, physical sciences, humanities, and earth science. DESY and KIT will lead the resource virtualization work package.

For small-scale use for individuals and small groups, commercial cloud services have become popular. However, they also have compliance issues when used for official business. In order to provide local cloud services comparable to commercial services, the DESYCloud project, built on dCache, is in the final pilot stage with 219 users and 2.4 TB of data, with full production expected soon.

Recommendations for computing / IT:
No specific recommendations are issued.

e+e- experiments

Belle / Belle-II

The PRC was pleased to hear about Germany's continued very significant role in Belle, and in particular, DESY's major contribution of the pixel detector for Belle II. The PRC looks forward to hearing about the results of the sensor/ASIC tests planned for early 2016. The PRC notes that the schedule delay, after negotiations, is now set at nine months, still allowing Belle II's integrated luminosity to exceed that of LHCb by 2019.

The PRC was encouraged to see the Belle analyses involving DESY to be approaching the publication stage, and to learn about DESY's plans for involvement in Belle II analyses.

The PRC congratulates the DESY Belle team on its significant accomplishments in detector development and physics analyses, and reemphasizes the critical importance to Belle of DESY's continued contributions in engineering and computing.

Recommendations for Belle / Belle II:
No specific recommendations are issued.

ILC

The PRC congratulates DESY on the many significant efforts to develop and promote the physics case for the ILC. This work has provided much valuable input to the MEXT Working Group on Particle and Nuclear Physics. A good understanding has been achieved of the achievable precision on a range of Higgs branching ratios as a function of time/luminosity, and interesting scenarios explored in which the ILC could

discover new physics, not seen by the LHC. Overall, DESY, via its participation in the ILC concept groups, is playing an essential role in strengthening the ILC physics case. The PRC supports the continuation of this work through a decision on the ILC project.

The PRC acknowledges the ongoing valuable contributions of DESY to ILC detector development in the areas of hadron calorimetry and TPC studies. DESY's provision of support for test beam activities, software, and machine-detector interface studies is a critical contribution to the ILC community and should be continued. The PRC also strongly supports the unique and important role of DESY-Zeuthen in developing a positron source, and endorses the continuation of this work.

Recommendations for ILC:

DESY's provision of support for test beam activities, software, and machine-detector interface studies is a critical contribution to the ILC community and should be continued. The PRC also strongly supports the unique and important role of DESY-Zeuthen in developing a positron source, and endorses the continuation of this work.

HERA Experiments

H1, ZEUS and HERMES

The PRC congratulates all three collaborations for their still high number of high impact publications, results and the large number of visible presentations at several conferences, despite reduced person power. It is recognized that in all three experiments the analysis continues successfully in data preservation mode, which started after the end of HERA funding at DESY at the end of 2014. An especially outstanding result is the inclusive data combination of H1+ZEUS with full correlation treatment, leading to a new HERAPDF 2.0. The HERA workshop at DESY in November 2014 showed that several interesting physics topics are still ahead and that there is a clear view in all collaborations on which analyses should be prioritized in the next years.

Recommendations for the HERA experiments:

In order to maintain the possibility to invite active HERA researchers, especially from Eastern Europe, we recommend seeking third party support for travel money. We encourage DESY to support such applications and to further support travels to workshops and conferences, when synergies of HERA with present DESY projects allow financing via these projects.

Data Preservation

All three HERA collaborations essentially finalized preserving their data and Monte Carlo ("Bit Preservation") on the new DESY-SE online store and archive. Likewise, the archiving of documentation ("Documentation Preservation") is well advanced. The PRC stresses the importance, that also the documentation of the HERA machine and accelerator complex should not be forgotten in this archiving process. Unfortunately, the loss of SP-system for the automatic validation of the software for new operating systems, compilers or compatibility with external packages ("Software Preservation") means that DESY lost its lead in the global DPHEP effort. The PRC attributes this loss in part to the fact that the SP-System effort was not sufficiently integrated into DESY IT. The PRC finds that the loss of the SP-System changed DESY's previous global role in software preservation, reaching far beyond the scope of HERA, into a local effort, seeking a solution just for HERA. DESY and especially DESY IT therefore needs to redefine their role in the global DPHEP effort. The local solution offers virtual machines and disks, but so far no further validation structure of the experiments, which was lost together with the SP-System. This renders the current data preservation mode very fragile with respect to changes of external software or operating systems. A sustainable solution, even only for local HERA software preservation, needs a constructive collaboration between DESY IT and remaining long-term ex-HERA personnel at DESY.

Recommendations for data preservation:

DESY needs to redefine its role in the global DPHEP effort.

HERAFitter and PROSA

General:

The PRC acknowledges the unique expertise in theory and experiment at DESY, in collaboration with scientists at the University of Hamburg, in precision standard model physics. This comprises the development of new tools for the HEP community and spearheads new analysis techniques and topics in this field. It is strongly suggested that DESY utilizes and possibly expands this expertise to support QCD physics and BSM searches at LHC.

HERAFitter:

The PRC congratulates the proponents of the HERAFitter project for the continued accomplishments since the last PRC.

HERAFitter continues to be a well-integrated tool in the HEP community used for many analyses of the LHC-experiments and papers on independent studies by the HERAFitter group. Integrating new tools and the effective collaboration between experimentalist and theorists continuously advances HERAFitter. HERAFitter provides an excellent precision QCD tool necessary for SM measurements and could prove a vital asset in the search for new physics at the LHC. DESY scientists

continue to play a leading role in the intellectual leadership and in hosting key infrastructures.

Recommendations for HERAFitter:

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

PROSA:

The PRC acknowledges the recent publication by the PROSA collaboration. The goals of PROSA comprise to expand the analyses techniques and tools needed for precision standard model physics at LHC. The PRC emphasizes that there could be high synergy with the HERAFitter effort, if the newly developed “PROSA tools” are integrated into HERAFitter, which already now represents an important tool for PROSA.

Recommendations for PROSA:

We recommend to DESY to support the PROSA effort. The PROSA collaboration is recommended to find a more flexible organizational structure and seek more visibility in the HEP community.

Other experiments

OLYMPUS

The PRC acknowledges the steady progress of the OLYMPUS collaboration since the last PRC meeting and that currently the MIT group together with several single individuals are the remaining force behind the OLYMPUS data analysis. The collaboration made quite some progress to understand in detail several of the points, which worried the PRC at its last meeting in October 2014. This brings the collaboration much closer to release a preliminary result in autumn 2015.

The progress includes,

- an improved tracking performance
- many further details have been added to the already detailed MC model of the experiment, these improvements have been crucial for a better description of the data
- the 12° luminosity monitor based on the MWPC shows an excellent performance and provides a stable and reliable way to determine the luminosity in the different data taking periods.
- a first estimate of the systematic uncertainties has been done

The PRC has still some remaining concerns,

- there remain still issues understanding the luminosity determination of the symmetric Moeller/Bhabha detector. The PRC feels it is important to clarify why the detector does not provide the best luminosity measurement as projected before the experiment
- the collaboration has still not yet analyzed the entire data set in a first pass. The PRC urges the collaboration again to expand their analysis as fast as possible to ensure there are no bad surprises in the other 80% of the data, which might impact the usefulness of some part of the statistics for the final result.

The PRC awaits with eagerness the first results at the next PRC meeting.

Recommendations for OLYMPUS:

The PRC feels it would be important to clarify why the symmetric Moeller / Bhabha detector does not provide the best luminosity measurement as projected before the experiment.

The PRC urges the collaboration again to expand their analysis as fast as possible to ensure there are no bad surprises in the other 80% of the data so far not analysed.

ALPS II

The physics case for ALPS is largely unchanged. There remain astrophysical hints of BSM physics with relevance to ALPS II. Further, there are theoretical ideas of BSM physics that may address axions/ALPS of the type probed by ALPS II. Hence, the PRC sees that the ALPS II experiment remains attractive, although the search is speculative. The ALPS II group is has a worldwide high profile, and is considered the leader in laser-ALPS searches, one of the “flagship” axion/ALPS experimental initiatives.

The enabling ALPS II infrastructure at DESY is the pool of HERA dipole magnets, which for ALPS II need to be straightened. The issue of the bending yield remains critical. Magnet studies should therefore continue to ensure that the plan of straightening HERA magnets is indeed sensible. Several magnet-related issues carried over from the last review: i) DESY lacks personnel in the near term to work on the magnets. ii) Personnel with relevant magnet expertise are retiring from the Lab, and no plans were presented at the PRC to deal with this. iii) Currently, ALPS II has no standing to use or schedule lab resources. We reiterate the project recommendations on these issues from the last PRC: the Lab and the ALPS group should transition ALPSII to a lab project, and a plan should be established to modify and commission HERA magnets.

The tunnel acceleration spectral density was presented at PRC78 with the conclusion the motions are tolerable. At PRC79 the ALPS II team felt that the motions would prevent long-term optical lock. We reiterate the recommendation from PRC78 that an estimate be made of the tolerable motions and that estimate be overlaid on the acceleration measurements.

The University of Florida group is joining ALPS II. This Florida group has deep optics experience with LIGO and will be valuable. The mirror coatings may not meet specification, and this is an area where the experience of the Florida group would be useful.

The idea was presented for a precursor to the full ALPS IIc consisting of a short magnet string (with a pair of LHC dipoles) sited at CERN. This could perhaps advance the project and maintain momentum, though this precursor would lack the sensitivity of ALPS IIc. ALPS is identified with DESY, and ALPS II is viewed as the laser flagship axion project worldwide. By moving the project to CERN for the precursor, there is a significant risk that ALPS II will not return to DESY and that therefore the association of ALPS with DESY will be diluted. Thus, DESY and ALPS II should think carefully about risk and payoff of relinquishing the ALPSII program before moving the precursor project phase to CERN.

The number of personnel working on ALPS II is small, and there is a need for additional DESY personnel on the project.

The idea was presented for adapting ALPS II for measuring the standard model QED vacuum birefringence in a magnetic field. This is very attractive as it is a known signal and has not yet been measured. Hence, the group might consider a strategy of advancing this QED measurement to happen before ALPS IIc.

Recommendations for ALPS:

- (reiterated from last PRC): The Lab and the ALPS group should transition ALPS II to a lab project, and a plan should be established to modify and commission HERA magnets.
- (reiterated from last PRC): An estimate shall be made of the tolerable motions and that estimate be overlaid on the acceleration measurements. It may be that more measurements at low frequencies are needed. If the measured motions prevent lock of many hours, then remediation should be incorporated into ALPS II.
- DESY and ALPS II should think carefully about risk and payoff of relinquishing the ALPSII program before moving the precursor project phase to CERN.
- There should be a plan to increase the number of lab personnel on the project.

Astroparticle physics

Neutrino Astrophysics

Notable results by DESY scientists presented at the PRC meeting covered analyses on the combination of various channels showing an astrophysical flux to obtain best precision and to constrain the neutrino flavor ratios at the acceleration source and an IceTop based, high statistics measurement of the cosmic ray energy spectrum showing interesting structures in the PeV – EeV range. A recently published measurement of Θ_{23} and $|\Delta m_{23}^2|$ has competitive precision with SuperKamiokande; it is expected that a precision comparable to T2K and Nova can be reached soon. Several R&D efforts to improve the properties of the light sensors for future upgrades were also presented.

In the closed session, the vision of the IceCube-Gen2 extension, incorporating a 10 Gton high-energy array with multi-TeV threshold, a 4 Mton infill array with GeV threshold as well as an extended 100 km² surface area, were laid out. The cost would be around 130-170 M\$ when counting only investments; the costs of operating IceCube-Gen2 are projected to be similar to the current level operating IceCube. A proto-collaboration was recently inaugurated, which encompasses several new strong groups from the US and Europe. Discussions with the MPI-Munich have also started. A recent meeting of representatives of the NSF and funding institutions in Europe resulted in the advice to start IceCube-Gen2 planning soon to present a convincing case for the funding agencies. While a MREFC initiative would at this time be in conflict with the Antarctic infrastructure proposal, there are some indications that an MREFC IceCube-Gen2 proposal could go forward after the infrastructure proposal. In addition to the plan to contribute 50% of all optical sensors from Germany, a 20-25 M€ investment, there is a proposal that DESY would take responsibility for various electronics and readout components. In the discussion it was again pointed out that the MREFC process is likely to be competitive (and slow) and that efforts to lobby for German funding should start soon in a way that does not depend too strongly on the NSF process.

The PRC congratulates DESY for their important contributions, in particular in the area of neutrino oscillation parameters and the statistical combination of various astrophysical flux measurements. The PRC also recognizes the leading role that DESY is taking in organizing a German contribution for future IceCube extensions.

Recommendations for neutrino astrophysics:

No specific recommendations were given.

Gamma-ray Astrophysics

Notable recent developments and results shown covered the Fermi-LAT all-sky variability analysis issuing Astronomer's Telegrams whenever a flaring source is detected and a long-term deep-exposure observing plan for VERITAS, covering

approximately 70% of the available observing time over five years. VERITAS also observed an historically bright flare in October 2014 of the binary system LS I +61 303. In MAGIC, DESY is concentrating on its AGN and Target-of-Opportunity programs. H.E.S.S. observed an exceptionally powerful TeV emitter in the Large Magellanic cloud. They also demonstrated that particle acceleration in supernova remnants is more efficient than previously assumed and that the environment is very important for gamma-ray production. Superbubbles, which for the first time were observed at TeV energies, are suspected to be main cosmic-ray accelerators.

The first H.E.S.S.-I camera will be upgraded in July, with cameras 2-4 to follow mid-2016. The installation of the first 28 HISCORE stations, optimized for the detection of > 10 TeV gamma-rays, is finished and the completion of the 1 km² array is expected for 2015/16. HISCORE also serves as a test-bed for the sub-nsec array time synchronization proposed for CTA. Very early CTA science may be possible in 2017-18, with the first telescopes installed at the Southern site in late 2016. In the meantime, DESY is providing significant contribution to the key science projects of CTA, in particular, to the Galactic and extragalactic surveys and to star-forming systems.

An overview of the CTA organizational structure, responsibilities and schedule as well as DESY's main contributions in the construction of the medium-size telescopes and the array control and data acquisition were given in the closed session. The Critical Design Review is scheduled for late-June 2015 and the site selections could be taken in July (Southern site) and November (Northern site). The baseline southern CTA consists of 4 large, 25 medium and 70 small telescopes and the baseline northern CTA comprises 4 large and 15 medium telescopes. A call for the CTA Headquarters will come later in 2015 and DESY plans to submit a bid to host the Headquarters.

The PRC congratulates DESY for its strong program in gamma-ray astrophysics and for the excellent scientific results from the four experiments that it is involved in. DESY is playing a major role in the development of CTA with a strong contribution in telescope design and in array control. In addition, it is good to see that the CTA design is becoming close to reality and that some of the critical decisions will be taken in 2015.

Recommendations for gamma-ray astrophysics:

No specific recommendations were given.

Theory

The Theory group has been very successful in the Helmholtz Recruitment Initiative and in acquiring ERC grants. This puts the group in the position to strengthen its research profile in a new and important field.

The Theory group proposes a hiring on the Leading Scientist level (succession Buchmüller) in the field of dark energy and gravitation, and it presented a concept for the position with a list of possible candidates.

The PRC declares its strong support and sees this as a unique opportunity. There is an especially large potential for synergy with particle physics in the area of gravitational aspects of cosmology and structure formation.

Recommendations for theory:

No specific recommendations are issued.

Unresolved recommendations from previous PRC meetings

From PRC 78:

- The PRC requests a review of the particle cosmology (Hamburg) and astroparticle theory (Zeuthen) and phenomenology activities (Hamburg and Zeuthen) in fall 2015.
- ALPS: The Lab and the ALPS group should transition ALPS II to a lab project, and a plan should be established to modify and commission HERA magnets.
- ALPS: An estimate shall be made of the tolerable motions and that estimate be overlaid on the acceleration measurements. It may be that more measurements at low frequencies are needed. If the measured motions prevent lock of many hours, then remediation should be incorporated into ALPS II.