Recommendations of the 81st Physics Research Committee

11 May 2016

LHC Experiments

ATLAS

Staff scientists added in 2015 and 2016 have considerably strengthened the DESY-ATLAS group, with its approximately 60 members. The portfolio of analysis topics has considerably expanded to include exotics and SUSY in addition to the existing efforts in top, Higgs and Standard Model physics. There are also considerable efforts in object reconstruction and tracking. The group members hold numerous leadership positions in areas of physics, operations and computing, management, and upgrades.

In 2015, LHC has delivered 4.5 fb^{-1} of pp collisions, of which 4.0 fb^{-1} were at 25 ns bunch crossing. The ATLAS experiment took data at 87% efficiency during 2015, and the detector was in the process of being closed during the PRC meetings to prepare for data taking; it is hoped that 25 fb^{-1} of data can be accumulated during 2016.

DESY-ATLAS has operational responsibilities in the ALFA and SCT subsystems, and are making contributions in many areas of these systems from gas monitoring and temperature control, to prompt calibration loops.

The group is taking key roles in the FTK upgrade, both in hardware testing and in the generation of patterns, and in data flow tests. For phase II, many R&D activities are underway, from micro-channel cooling, analyses of mechanical stress, to manufacture of structural material and test-beam studies of the strip detectors.

The PRC congratulates the DESY-ATLAS group for their considerable achievements in the last reporting period.

Recommendations for ATLAS:

No specific recommendations are issued.

CMS

The CMS group at DESY consists of 47 staff and postdocs with 28 students. The group provides key leadership to CMS, participating in 15 major coordination roles across the experiment. The DESY CMS group has a strong portfolio of physics analysis topics, including QCD, top and Higgs physics, and SUSY searches. There is active work in research and development for phase 2 outer tracking and good progress for the on-going work on the back-end upgrade for the hadron outer (HO) calorimeter. The group continues to make very significant contributions in all areas of CMS, and the PRC congratulates the group on their accomplishments in this period.

While not a DESY item, a concern of the CMS experiment has been the performance of the solenoid cryogenics over the past year. After the cold box has been cleaned by

the use of a special solvent and with improved filtration added, all indications are that the difficulties have been addressed, with final tests ensuing in early May 2016.

One of the major efforts, involving 22 people, is the production of BPIX modules for the CMS upgrade. The total target for complete production is 256 modules, with an additional 20% modules for spares. While there had been some delays due primarily to quality control issues, production is proceeding. Production completion is now scheduled for June, and this delivery fits into the adjusted overall CMS schedule.

Beam condition monitor & luminometer (BCM1F):
The BCM1F is used to measure online background rates and is particularly critical for determining the start of operations for the pixel detector, and for online and offline luminosity measurements. There are additional monitors and systems that are used to measure luminosity. A single crystal diamond sensor beam condition monitor detector was successfully operated for Run I. An upgraded detector was built and installed with 2×24 single crystal detectors for Run II. After the shutdown, channel response was measured, and 12/48 channels are deemed as unrecoverable, with 9/48 channels deemed as stable or better. This effect appears to be consistent with radiation damage. Currently, even with the reduced number of operational channels and additional channels with low charge collection efficiency (CCE), the online rate measurement remains accurate enough for determining beam backgrounds for the tracking system operations. For the current running period, while increased radiation damage will continue to lead to decreased CCE, it is anticipated that there is sufficient redundancy at the least to provide the online background rate measurement. In the unlikely event that the BMCF1 channels fail altogether, changes to the tracker operational rules will be required. There is an on-going investigation to determine possible options for repairs or replacements to be implemented in the year-end technical stop to improve the situation for 2017/2018 running.

Recommendations for CMS:
No specific recommendations are issued. The PRC would like to hear the plans formulated and actions taken for BCM1F at the next PRC meeting

LHC Infrastructure
The PRC was very happy to learn that the general planning of the infrastructure at DESY for the assembly of the end-caps (for both CMS and ATLAS) has converged and that definite plans for where these will be housed are now also fixed.

Recommendations for LHC Infrastructure:
No specific recommendations are issued. The PRC looks forward to hearing more about the detector assembly facility at the next PRC meeting.

Computing / IT and Data Preservation

The Tier-2 compute and disks systems and the NAF are currently performing well with strong utilisation and good uptime. The FY16 pledges to WLCG and to Belle are in hand.

The current technical projects include a consolidation of the batch systems to use HTCondor as a common batch system for NAF, grid WF and the batch farm. Initial testing shows good results. The IBM SONAS system will be replaced by an IBM GPFS system. The initial procurement will be 1400 TB and will be commissioned in summer 2016, with a phased rollout for migration, likely starting with either ATLAS or CMS. As part of the migration away from SONAS, it would be prudent to address obsolete user data that has led currently to the SONAS system being nearly full. Additionally, work continues on the development of a DESY cloud storage system using an OpenStack environment.

For funding the hardware, there is a Helmholtz Data Federation (HDF) proposal that is intended to fund hardware across many scientific disciplines. KIT is the lead institute and this proposal, if funded, would supply the hardware for the Tier-1 at Karlsruhe. Some hardware for DESY is included in the proposal, covering some for particle physics and photon science needs. The original proposal was for 8.5Me, which has been reduced to 6.5 Me. The preliminary decision has been positive with final approval soon. The funding situation for the university Tier-2s in Germany remains uncertain.

DESY IT is also participating in several EU projects. There is strong DESY participation in the Indigo data cloud project, with 3 FTE for 3 years, with DESY as a leader-partner in the work package on Resource Virtualization, building on dCache. DESY IT is serving as a “Big Data” consultant for the CREMLIN project, which involves all six of the Russian MegaScience projects, and will participate in preparing a big data workshop in September in Moscow. Finally, the HNSciCloud project is a pilot effort between research organisations and commercial cloud service providers to investigate and develop a prototype architecture for a cloud environment that is a hybrid between research institution resources and commercial cloud resources.

European Open Science Cloud is a European Commission project that is getting underway to provide large-scale cloud resources to the research community. While usage seems targeted especially towards “long tail” disciplines, there are also roles to play for experienced large computer centers such as DESY. This project is in the formative stages.

We note the importance of these external projects. While it is very time-consuming to build the collaborations and connections required to write successful proposals, participating in such projects enables the staff to stay on the cutting edge of research computing. This maintains vitality in the IT division.

Data Preservation
The system is complete and the H1 data have been migrated. We congratulate and commend DESY IT, H1 and ZEUS on delivering this landmark system.

Recommendations for computing / IT:
As part of the migration away from SONAS, it would be prudent to address obsolete user data that has led currently to the SONAS system being nearly full.

e+e- experiments

Belle / Belle II
The DESY-Belle group plays a central role in thermal management of the Belle II vertex detector (VXD). The remote vacuum connection (RVC) is also a DESY responsibility and is central to the deployment strategy of the VXD in Belle II. These are extremely challenging technical projects. The group also hosts the test beam studies of the integrated VXD system (currently underway), and it oversees the integration of the "BEAST II" system that is to be installed (in the "Phase II" running in JFY 2017) for the purpose of monitoring the conditions and performance of detectors in the central area of the Belle II detector. The group is also leading the field mapping efforts that have been stepped up after discrepancies were found between expectations and the actual field around the beam axis.

The group is coming up on a phase of intense activity, according to the current schedule, beginning with the VXD test beam studies at DESY followed by the field mapping at KEK, and then the integration and installation of the BEAST II in early 2017. The integration of the VXD at KEK follows soon after towards the end of 2017. The VXD installation into Belle II is scheduled for mid 2018.

The group also plays leadership roles in alignment and calibration as well as in many other areas of Belle II. DESY is also leveraging its computing infrastructure to provide Tier-2 computing services for the experiment as well as collaboration tools and services. Also several Belle physics analyses are nearing completion, and preparation for Belle II physics is continuing.

The PRC congratulates the group for the very significant contributions to Belle and Belle II made during this reporting period.

Recommendations for Belle / Belle II:
No specific recommendations are issued. The PRC would like to hear, at the next PRC meeting, about the test beam results, the results of the magnetic field mapping and the BEAST II preparations.

ILC
The PRC acknowledges the DESY ILC group for its valuable and critical contributions to keep developing the ILC project in both accelerator and detector fields. The group is one of the worldwide key components of this effort and constitutes the basic common pillar for the European groups participating in the project. The work being developed at DESY is central and at the core of the most relevant accelerator technologies, detector developments and physics studies.

At this PRC meeting the committee has mainly heard about the contributions to the software development area. The group gathers a wide expertise in most of the software tools and actively collaborates with CLIC in the context of the Linear Collider Collaboration. This cooperation is now extending to other projects such as LHC, FCC, CEPC and neutrino physics. The team has also been able to get additional resources through European grants such as EUDET and AIDA in the past and presently within AIDA2020. Main activities cover the construction of a common Event Data Model (EDM) for the Linear Collider community (ILD, SiD and CLICdp, in the future also FCC and JLab experiments), a generic detector description toolkit for HEP based on GEANT4 and ROOT (joint project with CERN) and the development of other specific tools such as DDDetectors-lcgeo, DDG4, DDRec and track reconstruction.

The group is a key element in building up the linear collider software infrastructure and represents the driving force in many of the core tools. It keeps a very successful collaboration with CLIC and has the vision to extend it to other projects.

Recommendations for ILC:
Maintain the present level of activity and support for the software development in view of possible future increase depending on the overall progress of the ILC project. Cooperation with CLIC is highly supported. Extensions of the collaboration to other future projects is seen positively but should be performed with care in order not to dilute the effort.

Other experiments

OLYMPUS

The PRC notes that the OLYMPUS collaboration continues to make progress in the analysis. The symmetric Moeller/Bhabha measurement inconsistency has not been understood, and for the moment at least, a solution is not within sight. In addition, a left/right rate asymmetry that is oscillatory as a function of Q^2 has been discovered, which is likely related to the time to distance algorithm for the wire chamber, the vertical position calibration of the time of flight detector, and tracking issues. The analysers have possible solutions to this problem and are in the process of implementing them. At this stage, it seems likely, unfortunately, that SYMB luminosity measurements will not be used in the final result given the time scale of the students among the analysers.

The PRC commends the large effort by the MIT group and several single individuals in OLYMPUS data analysis over the last several years, and we look forward to the first preliminary results soon.

Recommendations for OLYMPUS:

No specific recommendations are issued.

ALPS II

The DESY-ALPS group is a relatively strong one. They recently added the University of Florida to the collaboration, bringing in considerable optics expertise. The group has a high international profile in ALPS and axion physics. ALPS II is one of three flagship ALPS/axion projects (the others are RF-cavity-based or solar-based). The ALPS II project is closely identified with DESY.

The physics case for ALPS II is largely unchanged from PRC80. However, there remain weak astrophysical hints of ALPS. Since PRC80, a new FERMI-LAT bound cuts into the ALPS II search space, though the bound has considerable model dependence.

The group has made good progress. In particular, the FP cavity auto-alignment was demonstrated. The new mirrors have losses consistent with air losses, and thus the anomalously poor reflectance of the earlier mirrors has been resolved. The central table construction has advanced, and this table platform will be repurposed for ALPS IIc. The TES quantum efficiency now looks ok. The group has discovered what seem to be magnetic fields creeping into the SQUID space. The group may therefore want to incorporate aggressive magnetic shielding into the base design.

Another HERA magnet is being bent. This bending test is crucial for estimating the bending-operation yield. There are risks that DESY may not have the needed cryo/magnet engineering support when needed for the project. Hence the group and lab should have a plan for ensuring that expertise and documentation remains available.

The seismic noise is still in need of study. The allowed seismic envelope needs to be established. If noise is found to exceed this, then active correction needs to be deployed. An alternative implementation is to incorporate active correction in the base design.

The main ALPS IIc construction start is late 2016. Operations start of 2019 may be overly optimistic, given the work that needs to happen on the site, magnets, optics and commissioning.

We understand DESY management asked ALPS II for a costing and a project timeline so that ALPS II can potentially transition to a lab project. We encourage the Lab and ALPS II to continue to make progress on these discussions.

Recommendations for ALPS:

The vacuum birefringence measurement is attractive and of interest to a broader audience than that for ALPS. ALPS II should consider moving this forward in the project timeline.

The group might want to incorporate aggressive magnetic shielding of the SQUIDs into the base design. The group might want to incorporate active optics correction into the base design.

The group and Lab should have a plan to ensure adequate cryo/magnet expertise continues to be available for the project. The group should ensure the magnet documentation is preserved.

Progress should continue with discussions with the lab on transitioning ALPS II into a project.

Astroparticle physics

Neutrino Astrophysics

The IceCube detector continues to operate well and the management/operations contract with the US National Science Foundation (NSF) has been renewed for an additional five years. Among the recent science results relating to particle physics are oscillation measurements made by the dense Deep Core array of IceCube and

constraints on sterile neutrino mixing. Recent results relating to astroparticle physics are the first observation of a triplet of neutrino events (from a consistent direction and within 100 seconds) and a multi-channel analysis of the flavour ratio of the astrophysical neutrino events. The PRC learned about the multi-messenger extension to the optical sky, where DESY is involved in the Zwicky Transient Facility on Mt. Palomar in California.

A considerable effort is now underway to plan for the future of the IceCube facility, with DESY playing a leading role in the development of the next generation (Gen-2) detector and in working out the physics case for such a detector. IceCube Gen-2 could incorporate multiple components, including a surface air shower detector, an expanded high-energy array, a sub-surface radio detector and the dense PINGU array for measurements of neutrino properties. A new, more realistic schedule for Gen-2 allows a few years of R&D work to be carried out. Studies of several detector string layouts are now underway to optimise efficient coverage of the fiducial volume. Work on new sensor designs has started with the aim of lower cost, improved photon collection and/or directional information. Several new designs are being considered, with DESY playing a role in two different approaches.

The PRC learned about the strategic planning within IceCube to develop a timeline for Gen-2 that builds on the analysis of the NSF MREFC process and on experience with previous projects. An R&D phase until 2018 is envisioned, followed by the completion of the Gen-2 proposal and entry into the MREFC track. With this revised timeline, there is concern that PINGU may come somewhat late, relative to other projects targeting the neutrino hierarchy (e.g. JUNO, ORCA), but there is also time to revisit the scope of the Gen-2 facility.

Recommendations for neutrino astrophysics:
The PRC congratulates the DESY group for the continued excellent science coming from IceCube. We note the forward progress on the planning for IceCube Gen-2 and on a realistic schedule for the project. We support the effort to take a serious look at new technologies that could have a real impact on the upgrade costs and we encourage the collaboration to not make any premature decisions about the components of Gen-2; all aspects that have strong scientific motivation should continue to be pursued for the time being.

Gamma-Ray Astrophysics
DESY maintains a strong program in gamma-ray astrophysics, with participation in all of the major operating experiments (Fermi-LAT, H.E.S.S., MAGIC, VERITAS) as well as key involvement in the future Cherenkov Telescope Array (CTA). An emerging physics focus for DESY relates to the study of transient phenomena, with two recent

internal meetings that included participants from the various gamma-ray, neutrino and cosmology groups. For H.E.S.S, the camera upgrade continues its progress with the commissioning and calibration of the first camera. Plans call for the deployment of the remaining three cameras during autumn 2016. The paper describing the H.E.S.S. observations of the Galactic center, arguing for a steady Pevatron source and discussed at the last PRC meeting, has now been published in Nature. A new interesting result from MAGIC is the detection of the VHE transient S4 0954+65, and a result from observations of the supernova remnant W44 is expected soon.

The development of CTA continues on an upward trajectory. CTA is currently in the pre-construction phase with a number of key issues to be settled this year and next. Negotiations with the hosts of the two proposed CTA sites (Paranal, La Palma) are ongoing, with the completion of the site-hosting agreements expected later this year or early next year. CTA member institutes have now completed Expressions of interest (EOI) for the construction of CTA, and the process to meld the initial interests of the institutes with the construction needs has now begun. Optimisation of the layout for the two CTA arrays is ongoing with scheduled completion later this year. Progress continues on the Medium-Size Telescope (MST), in which experience has been gained from the prototype in Adlershof and the Schwarzschild-Couder Telescope (SCT) in Arizona, and on the array control system (ACTL), in which DESY is playing a key role in the software architecture and in the development of the software for the instrument control and central services.

An aspect of CTA that is important for DESY is the proposal to site the CTA headquarters at the DESY-Zeuthen site. A well-crafted proposal was submitted late last year, and the decision on the Headquarters is expected by June, 2016. Should DESY's proposal be successful, it would have a significant impact on the Zeuthen site, allowing the construction of additional space/facilities to lead to a better campus design.

The PRC also learned about the current governance of CTA, with the observatory (CTAO) administered by a limited-liability company (GmbH) under the control of the CTA Council, in which Germany, and DESY in particular, play an important role. The Council has asked for a plan for the staging of CTA, in which the first phase could be carried out with a reduced fraction of the baseline cost, while still preserving most of the science case. The CTA project and consortium are now actively working to formulate this plan.

Recommendations for gamma-ray astrophysics:

The PRC congratulates the gamma-ray astrophysics effort at DESY for the steady stream of high-quality scientific results from the existing gamma-ray telescopes and for the imminent completion of the H.E.S.S. camera upgrade. We note the continued

progress towards the realisation of CTA. We hope for a positive result on the DESY proposal for CTA headquarters and appropriate progress this year on sites, funding, and plans for staging to allow for the start of pre-production. If the headquarters proposal is successful, we encourage DESY to develop a medium-term plan for the utilisation of the Zeuthen campus.

Theory

In the closed session the PRC was given a presentation of all branches of the theory group and a summary of the importance of the Zeuthen QFT group. The PRC is impressed by the forceful activity of the DESY theory group in research, organising conferences and teaching, and by the key-role played by the Zeuthen theory group in higher-loop computations for precision physics.

The discussion on the Zeuthen theory group in particle phenomenology was postponed to the next PRC meeting for technical reasons.

Recommendations for Theory:

The PRC suggests to the DESY-Zeuthen lab to explore and evaluate all possibilities to maintain the DESY-Zeuthen theory phenomenology group at the current critical number of three staff positions and to review them at the next PRC meeting. The PRC wants to discuss the role of the Zeuthen theory group in particle phenomenology at the next PRC.

HERA

The official support for HERA experiments has ended. Nevertheless, twelve papers have been published by the collaborations HERMES, H1, and ZEUS, including the definitive paper on the proton structure from H1 and ZEUS (EPJC 75 (2015)). Small on-going analyses remain in all collaborations. Encouragingly, there has been an interest from the US Electron-Ion Collider community to possibly participate in HERA analyses. The data preservations of all of the experiments are nearly complete, and most of the analyses have been utilising these "preserved data" for some years already. In this system, the data are accessible with minimum overhead. It is a world-leading system of its kind. All of the HERA experiments are to be congratulated for their recent achievements, accomplished despite the small manpower still available.

Recommendations:

None