

Recommendations of the 80th Physics Research Committee

24 November 2015

LHC Experiments

ATLAS

The DESY ATLAS group has made significant contributions to ten recent ATLAS papers. Strong contributions are being made also to the 13 TeV data analyses in the Standard Model, top and Higgs areas, including efforts in relevant object reconstruction and tracking. PRC notes with pleasure that the new staff scientists added in 2015 considerably strengthen the group. This has helped to expand the analysis portfolio to exotics and SUSY, in line with a previous PRC recommendation. DESY holds operational responsibilities for ALFA and SCT and is carrying out a large effort in SCT calibration and monitoring, as well as in the SONAR gas analysis. They continue to contribute to the data preparation and reconstruction. The group is heavily involved in the tracker commissioning with new data, and has increased visibility in the FTK project. The group continues to hold many coordinating and leadership roles in ATLAS.

For the phase 2 upgrade, large-scale module testing is progressing well. The CO₂ cooling tests that came up at the last meeting did not yet become an issue during this period. However, PRC still recommends exploitation of synergies with the Belle II group for this. We will comment on the infrastructure readiness for both ATLAS and CMS separately below.

The referees congratulate the DESY ATLAS group for their considerable achievements in this period.

Recommendations for ATLAS:

PRC still recommends exploitation of synergies with the Belle II group for the CO₂ cooling option.

CMS

The DESY CMS group continues to make strong contributions to the experiment and holds many coordinating and leadership roles. The physics analysis portfolio is broad, covering top and Higgs physics as well as QCD and SUSY. The group has made significant contributions to eleven papers and public results in this period, including those for 13 TeV data. The commissioning of the Run II detector elements under the group's responsibility (BCM, HO) with cosmic rays had already been at hand at the time of the last review, and the detectors continue to perform well. The tracker alignment is already in a good shape.

The complete production and testing chain for the pixel production has now been established, and there were ~45 modules in hand at the time of the PRC meeting. The production goals appear to be achievable if the current production rates for all

steps are maintained. There are small contingencies in the schedule of the order of several weeks. While precautions, e.g. against single-point tool failures, have been taken, the schedule is tight and should be carefully monitored. In case of issues, immediate actions may need to be taken.

The phase 2 tracker upgrade R&D is now well underway. We will comment on the infrastructure readiness for phase 2 below.

The referees congratulate the DESY CMS group for their considerable achievements in this period.

Recommendations for CMS:

The schedule for the pixel module production needs to be carefully monitored so that in case of issues, immediate actions can be taken.

LHC Phase 2 Upgrades

The CERN LHC Research Review Board process for the phase 2 upgrade is well underway. Indeed, the time scale for the upgrade is such that ATLAS and CMS must finalise the tracker design in 2017, with module pre-production starting in the same year. The contribution of the German LHC community to the upgrades of ATLAS and CMS by DESY and research groups at German universities as well as international partners consists of one tracker end-cap for ATLAS and one for CMS. These hardware contributions need to be formalised in the corresponding technical design reports including a matrix of financial contributions and responsibilities. Securing Helmholtz funding for these plans in the very near future is now imperative.

At the same time, planning and construction of the needed infrastructure at DESY (Detector Assembly Facility, DAF), long-planned to be financed internally, is now close to being on the critical path for the phase 2 plans. The production and integration of the trackers will require approximately 1350 m² of which about half should be clean-room space. These requirements are determined from extensive experience gained by the LHC community in building the existing trackers. The PRC recommends a timely start of construction of this infrastructure.

Recommendations for the LHC Phase 2 Upgrades:

Securing Helmholtz funding for the end-cap construction plans is now imperative. In addition, PRC recommends the timely start of the construction of the Detector Assembly Facility.

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.

We note that the major sources of funding for hardware for the LHC programme are secured within the POF III DESY budget.

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. The IBM Sonas system will be replaced in 2016 — currently two other file system options are being evaluated. As part of the migration away from Sonas, it would be prudent to address obsolete user data, which have lead currently to the Sonas system being nearly full. Additionally, work continues on the development of a DESY cloud storage system using an OpenStack environment.

The Helmholtz Data Federation proposal 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 HEP and Photon Science needs.

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 Virtualisation, 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. 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.

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.

Concerning data preservation we see that the system is complete and that all of the ZEUS data have been converted, and that conversion of the H1 data is ongoing.

Recommendations for computing / IT:

[In the process of moving away from Sonas, obsolete user data should be addressed.](#)

e+e- experiments

Belle / Belle II

The PRC was very pleased to hear about the DESY group’s many ongoing contributions to Belle and Belle II, and congratulates the group for significant advances in all areas.

For the pixel detector there is good progress in wafer production towards a full test with final ASICs in mid-2016. Although the wafer yield is high, there is some concern over the number of (fixable) faults. The PRC looks forward to hearing about the first results from the test beam at its next meeting. DESY is playing a critical role in the development and optimisation of the cooling system for the PXD and VXD, and in the provision of the innovative remote vacuum connection – created at DESY. The PRC is also pleased to note DESY's role in the estimate of synchrotron radiation background, and leadership in alignment and calibration.

Good progress is being made in Belle analyses, with several papers in internal review prior to publication. DESY is also playing a significant role in preparations for Belle II analyses.

Recommendations for Belle / Belle II:

No specific recommendations are issued.

ILC

The PRC congratulates the DESY ILC group for its continued and significant efforts to develop critical components of an ILC detector, and for carrying out many studies to support the realization of the ILC project. The DESY efforts to investigate and highlight the benefits of the ILC physics program are widely recognised and critical to the project. This review focused mainly on FCAL, the hadronic calorimeter, and TPC developments.

The FCAL collaboration, based in Zeuthen, is making very good progress in the development of a LumiCal, with newly acquired test beam results from a prototype. Due to a retirement, the appointment of a new FCAL spokesperson is an urgent matter. The continuation of FCAL work at Zeuthen is important to the ILC project.

Excellent progress is being made towards the development of a scalable module prototype for a hadronic calorimeter based on scintillator tile and silicon photomultipliers (SiPM). The prototype will take advantage of greatly improved SiPMs and innovative tile designs with direct coupling to the SiPM. Technical support should be maintained, at least at the present level.

TPC development for ILD is progressing well with a demonstration in test beam data that the required point resolution can be achieved. Four new GEM-based modules are planned for testing in 2016.

Recommendations for ILC:

Maintain at least the present level of support for the FCAL, hadronic calorimeter, and TPC activities, and plan for increased support depending on the overall progress of the ILC project.

Other experiments

OLYMPUS

The PRC acknowledges the continued progress of the OLYMPUS collaboration since the last PRC meeting. The PRC recognises that the Olympus manpower is very limited and that 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 that have been worrying the PRC for quite some time. This brings the collaboration much closer to releasing a preliminary result in the next year.

The progress includes

- the analysis of 80% of the Olympus dataset;
- the achievement of good agreement between the luminosity measurement of the 12° MWPC and the slow control luminosity;
- a further improvement of the calibration and the description of the TOF and tracking chambers;
- the achievement of reasonably good agreement for the MC–data comparison.

The PRC has still some remaining concerns:

- There is still no understanding why the symmetric Moeller/Bhabha detector does not provide the best luminosity measurement in the experiment. The PRC feels it is extremely important to clarify the reason for this mismatch.
- There is unfortunately not yet a detailed idea what type of systematic precision can be achieved at the end.

The PRC awaits with eagerness the first results.

ALPS II

The science case for ALPS II is largely unchanged. We believe there has been a slowly increasing interest in axion-like-particles (ALPs) over the last several years, but the weak astrophysical hints of ALPs remain weak. The ALPS II group is recognised worldwide by the ALP community as one of the “flagship” ALP searches.

On the technical side: The cavity mirrors are a problem, evidenced by their poor finesse. There is reason to think this is due to a surface-roughness problem. New mirrors are on order.

The risk of leakage through the filter causing excess noise counts would be significantly reduced by using the heterodyne receiver being developed by the University of Florida group. The new receiver is therefore a welcome addition.

The issue of vibrations is not yet resolved: The group has yet to estimate their allowable acceleration envelope that would allow long-term lock. They are planning accelerometry studies in the tunnel. The ADR and cryogenics seem on track and capable of regular operations.

The magnet-bending studies are critical to allow better estimation of the bending yield. These bending tests are on hold until technical personnel are available; this is a high priority.

The TES quantum efficiency is anomalously low. It is not clear what is the source of this problem. New chips are ordered and studies will continue.

Overall, the technical progress is acceptably aligned with the rough estimate of the project schedule presented.

On the project side: The projected planning (schedule, costs, etc.) is still very preliminary. Hopefully soon DESY management will clarify their intent with the ALPS II programme. After this clarification, ALPS II should rapidly attend to the programme cost and schedule planning. We encourage DESY and ALPS II management to rapidly conclude these discussions.

The PRC notes the addition of expertise from the University of Florida group.

The decision has been made not to proceed with the joint development with OSQAR at CERN. This will not negatively impact the ALPS II schedule.

We congratulate the ALPS II team on their continued good progress.

Recommendations for ALPS:

DESY management should clarify their intent with the ALPS II programme. ALPS II should make heavy use of the competencies of the collaborators in Hannover and Florida. ALPS II and DESY management should ensure an adequate documentation of the HERA dipole magnets for use by future cryo engineers.

Astroparticle physics

Neutrino Astrophysics

In the open session, the highest energy neutrino event seen so far by IceCube (with 2.6 PeV deposited energy and better than 0.3° pointing accuracy) was highlighted. DESY is strongly involved in the real-time reconstruction of ν_μ interactions and broadcasting corresponding alerts. Plans to disseminate further classes of alerts are under discussion. These plans concern the public announcement of events with a high probability to be of astrophysical nature and the issuing of sub-threshold alerts to partners that have signed a memorandum of understanding.

The envisaged IceCube Gen-2 facility, possibly encompassing high-energy, low-energy and surface-veto arrays, is being discussed in the framework of a larger

collaboration. New collaborators, such as KIT and the MPI for Physics in Munich, applied to join Gen-2, making the new project a match to CTA in terms of institutional strength in Germany. The detector is in a conceptual-design phase and alternative sensor concepts are being explored, notably at DESY. The Gen-2 science case is being developed, and an important consideration is the exploration of the distant very high energy sky, where gamma-ray astronomy is limited above 10 TeV due to interactions with ambient photons. Figures of merit, quantifying, e.g. the improvements on studies of diffuse, galactic, and point-source fluxes, are being examined.

Funding scenarios as well as a letter of intent are being worked out under the lead of DESY and the University of Wisconsin. It is hoped that a strategy meeting of German astroparticle groups in November 2015 will give IceCube the mandate to talk directly to the BMBF to discuss German funding opportunities. In the U.S., the support through NFS MREFC funding, a highly competitive funding line and a process needing patience, is critical. The NFS is reluctant to discuss a new large proposal in polar programmes before 2017 to avoid competition with refurbishments to the south pole station. A smaller NFS MRI proposal for IceCube and Gen-2 R&D is also under consideration.

The PRC congratulates DESY for the steady progress in the analysis of IceCube data and the leading role it plays in the preparation of the Gen-2 upgrade. It is important to further develop the dissemination of alerts (either through public broadcasts or to specific partner facilities).

Recommendations for neutrino astrophysics:

Keep faith in the process, which is likely to be slow, and secure intermediate R&D funding to demonstrate movement to international partners. Proceed to a coherent plan of German groups beyond the envisaged funding of in-ice and surface detector sensors, to encompass, e.g. scientific aspects as well.

Gamma-Ray Astrophysics

The HESS-I upgrade camera for telescope 1 saw first light, and cameras 2-4 will tentatively be deployed by fall 2016. The end of HESS data taking is foreseen to be in 2019. Notable new HESS results on the galactic center argue for the continuous injection and diffusion of cosmic rays powered by a „PeVatron“ accelerator. Very high redshift (~ 1) AGN sources were detected by MAGIC, and the experiment has perfected an "industry" of sending alerts for flaring objects.

Following up the CTA milestones discussed at the last PRC, the CTA critical design review was successfully passed in June 2015. In July, the preferred sites for the CTA arrays were selected and negotiations are now ongoing with ESO/Paranal and IAC/La Palma to serve as hosts for CTA. The deadline for proposals for the CTA headquarters is 22 November 2015. DESY will propose to host the centre, which would include a new building and infrastructure serving approximately 30 people. A

decision is expected in spring 2016. This decision, as well as the completion of the founding agreement, is eagerly awaited, particularly in countries that have their funding secured. The operations costs for CTA and potential contributions to the headquarters will necessitate some reduction of personnel at Zeuthen. For the DESY medium-sized telescope (MST), work concentrates on mirror testing, positioning and alignment. The array control system (ACTL), which is challenging due to the heterogeneous nature of the CTA array, is progressing as well, with substantial contribution from DESY.

The PRC congratulates DESY for the steady progress with CTA and for the completion of key milestones. The PRC hopes that the decision on the hosting of the CTA headquarters will be in favour of DESY-Zeuthen.

Recommendations for gamma-ray astrophysics:

Continue the positive forward progress of CTA, working towards the goal of completing the site negotiations and founding agreement.

Theoretical Astroparticle Physics

This area roughly tripled in size at DESY, in particular by the hiring of Walter Winter (neutrino physics), who recently won an ERC grant, and Huirong Yan (cosmic ray physics), who was recently appointed as a leading scientist, a position funded by the Helmholtz recruitment initiative. Interesting new developments, such as reacceleration in supernova remnants, the "ex-nihilio" appearance of the cosmic ray anisotropy, and the inclusion of turbulent effects in the propagation of cosmic rays, were presented. Cosmic ray propagation codes will need to be augmented to reflect such effects, and the interpretation of proposed indirect dark matter signals of gamma rays and cosmic rays need to be adjusted. An interesting move is an exploratory initiative in laboratory astrophysics that connects astroparticle research to photon physics research at DESY.

The group would like to have its structural role elevated. A workshop of common interests with particle and astroparticle theorists at Hamburg is under consideration, as is a white paper discussing German science perspectives.

The PRC congratulates DESY on the substantial strengthening of theoretical astroparticle physics, working towards a prominent centre in Germany, and it supports initiatives to improve the networking among theorists at DESY and the University of Hamburg.

Recommendations for theoretical astroparticle physics:

The PRC suggests to investigate whether the theoretical efforts at DESY can be better promoted and cross-linked on the DESY web pages.

Theory

The open session featured three theory presentations from the DESY Hamburg particle cosmology group, the DESY Zeuthen and Hamburg particle phenomenology group, and the astroparticle theory group in Zeuthen (see the section on astroparticle physics for the latter). The presentations summarised the research achievements in the past year. The spectrum of research activities is truly impressive. The PRC is particularly pleased to recognise the involvement of DESY theorists in some of the highlight topics in theoretical particle physics in the past months, both in the area of precision physics and electroweak symmetry breaking / cosmology.

In the previous review the PRC expressed strong support for the concept paper for a leading scientist position (succession Buchmueller) in the emerging field that connects gravitational to particle physics, where the DESY theory group could take world-wide leadership, while also strengthening the activities within the Wolfgang Pauli Centre (WPC). The PRC learnt at this meeting that, meanwhile, the DESY directorate decided to transfer the position including attached funding to another field of science at DESY. We received the impression that the decision to abolish the replacement of Buchmueller, who has been a pillar of the DESY theory group and its international reputation, has been taken without sufficient consultation of relevant committees and scientists, and there seems to be a lack of explanation or communication – a fact that is potentially harmful to the internal workings of a diverse lab. It is a pity that the science case of the proposed concept could not be further discussed. The PRC sees the course of action taken by the directorate as a lost opportunity.

Another critical issue arose in the discussion of the DESY Zeuthen particle theory phenomenology group, which currently has three staff positions. Tord Riemann will retire in October 2016, and the PRC learnt that his replacement is currently not guaranteed or planned due to funding commitments for astroparticle physics. The PRC considers that this would make the theory phenomenology group at DESY Zeuthen undercritical, and it emphasizes its scientific impact and unique expertise in the area of precision calculations in quantum field theory, as well as its structural importance for the science landscape and diversity in the eastern German states. While the PRC understands funding constraints, there is also an impression that not all options have been pursued with equal priority. We urge the DESY-Zeuthen lab to take all necessary steps to secure the continuation of theoretical particle physics phenomenology in Zeuthen at current strength.

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.