Recommendations of the 84th Physics Research Committee

October 2017

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– Particle Astrophysics
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General remarks

As **date for the next PRC meeting (PRC85)**, the time slot 8/9 May 2018 has been chosen, 7 May being reserved for the various pre-meetings. The meeting will take place in Hamburg.

LHC Experiments

ATLAS

The DESY ATLAS group continues to make strong contributions to the collaboration. They have very visible operational, managerial and technical impact. The group recently has significantly been strengthened through senior hires.

The ATLAS group has a very healthy portfolio of physics analyses in top/SM, Exotics/Susy, Higgs, and an altogether good balance between concentration on flagship efforts and complementary analyses. They also manage very well to integrate YIGs and ERC groups with individual senior staff members. The PRC welcomes the consolidation of the physics portfolio (including a new search component).

The group is also very active in the field of upgrades and has significant contributions to operations (SCT, Alfa, FTK). PRC particularly congratulates the group for their role in the phase 2 tracker TDR. PRC feels that the upgrade project (integration of one Endcap, production of 2000 modules in Zeuthen and Hamburg) is challenging, but that adequate resources are available. There are, however, necessary planning steps towards a “resource loaded schedule” that need to be taken soon. Also, schedule slippage should be monitored and contingency plans (e.g. personpower) be developed if milestones slip further.

PRC heard excellent news about recent successful junior hires. Nevertheless PRC feels that the group and its management now need to adapt to a scheme by which new challenges are not easily met by personpower increase.

PRC congratulates the DESY ATLAS group for their significant accomplishments!

Recommendations for ATLAS:
No specific recommendations were issued.

CMS
The PRC commends the DESY CMS group on continued significant contributions to CMS, in technical areas and serving in several prominent leadership roles in the experiment. The DESY CMS group has a strong portfolio of physics analysis topics, including QCD, Top, Higgs and SUSY searches, with highlights recently in H->tau tau. The group makes unique contributions in PDF fitting, a vital contribution to improving searches and precision measurements.
A major DESY CMS group responsibility is the tracking system alignment. In the past six months, the legacy 2016 run data had an alignment pass which improved the tracking resolution and corrected for some known effects. The first pass on 2017 data demonstrated a shift of a forward pixel disk by 3mm, discovered relatively quickly due to the advance preparation of the group.
The Beam Condition Monitor (BCM1F) is used to measure online background rates and is particularly critical for determining the start of operations for the pixel detector. The system was rebuilt for Run 2 with three sensor types: Poly-crystal diamond (pCVD), silicon sensors, and single diamond sensors. The pCVD sensors are working well, as are some of the silicon sensors, while the single diamond sensors experienced a similar failure as previously, demonstrating the prudence of the using multiple types of sensors. DESY is considering participating in building all silicon based system for Run 3, with improving the systematic error on the luminosity as a science driver.
R&D for the CMS Phase 2 tracker upgrade is progressing. One endcap will be built by University of Aachen, University of Karlsruhe and DESY, with DESY responsible for the endcap mechanics and integration at DESY in cooperation with the universities. Encouraging progress has been made in the automated assembly process approaching the necessary precision, with the second prototype of a subsection of the support structure and with the encapsulation process of the wire bonds. The global schedule is delayed by one year relative to the TDR, however at DESY, the progress remains good and within time contingency. The group also pursues generic R&D, and is participating in the strategic planning process. PRC encourages the group to increase communication with other groups from the lab also involved in detector R&D activities.

Recommendations for CMS:
The PRC suggested improved tracking of the careers of students and postdocs to quantify the long-term impact of the group.

Computing / IT

We commend the continuing success of the DESY Computing Large Scale Facility. The Tier-2 compute and disks systems and the NAF are performing very well with good strong utilization and good uptime. The new filesystem, DUST, is in production and currently being expanded. The Belle II collaboration tools are in production, with additional tools being requested for central support. Good progress is being made on all projects, including the use of HTCondor and cloud storage system using an OpenStack environment. DESY IT continues to participate in several EU projects, which bring in third party funds.

Staffing remains tight considering all of the on-going work, increasing requests for central support and balancing the increasing needs of the XFEL.

In the context of DESY's strategy planning, a "Centre for Data and Computer Science" (CDCS) has been suggested. This could extend DESY's IT portfolio into computational sciences, including collaboration with Hamburg University, and thereby potentially address a growing need in IT for additional expertise in areas such as machine learning. The CDCS could also offer the possibility of obtaining additional third-party funding. However, in any model it is vital that the core mission of IT, namely direct support of DESY scientific programs, should remain of paramount importance.

Hardware investments are being made in computing at DESY Zeuthen to support the astrophysics program. Continuing computing strength at DESY Zeuthen makes for a strong case for computing as in-kind contribution to CTA and to the bid for the CTA data center to complement the Scientific Data Management Center.

We commend DESY IT on continuing excellent support of the NAF and T2, especially while the support of the XFEL computing is growing rapidly.

Recommendations for computing / IT:

The capacity of the wide area network is being significantly strained by the current LHC load, both on the dedicated LHCone network and on the general-purpose WAN. In the short term, the PRC supports the CMS and ATLAS request to double the general-purpose WAN to 2X x 10Gb at a cost of $100Keuro/year. The roadmap for the LHCOne upgrade to 100Gb is a longer-term solution.

Theory

The PRC congratulates the Theory Group on their very successful physics programme in particle cosmology and collider phenomenology. The groups are very active and have strong links to the experimental collaborations and to the international community. There is a strong engagement in the organisation of

international meetings & training of young students and Ph.D.s, both internationally and at local universities.
The DESY Theory Group plays a key role in the German theory community, both as "aggregation" centre with sufficient critical mass / expertise to cover the whole particle theory and beyond (connection to solid state / mathematics / computational physics) and as meeting centre / think tank, e.g. during the yearly DESY Theory Workshop. The group has been also very successful in acquiring third-party funding and in attracting very promising young researchers as Ph.D.s, Post-Docs, young staff. We congratulate the group on their contribution to the Excellence Initiative, which passed the first round of evaluation.

Recommendations for theory:

- The PRC supports the proposed conversion of a 5-year position in string theory into a tenure-track / permanent post, to maintain a critical mass of permanent staff in this area. The PRC would like the Theory Group to develop a policy for how to treat future five year and permanent hirings and consider what is the right balance between permanent and five-year staff.
- The PRC recommends that DESY explores how to strengthen the Excellence Initiative proposal "Quantum Universe" in theoretical physics in the field of gravitational physics. The PRC identifies theoretical studies of gravitational waves as a potential area of future strategic growth.
- We endorse the idea to have a building for the Wolfgang Pauli Centre, in which all theorists in the Hamburg region can be co-located, to benefit from the synergies between the different fields.
- The PRC recognises the unique expertise and very visible impact on the field of the DESY Zeuthen collider phenomenology group, and we recommend that DESY develops a strategic plan to maintain a critical mass for this activity within DESY.

e+e- experiments

Belle / Belle II

PRC congratulates the DESY Belle group for the significant progress achieved since the last PRC meeting. The second B field measurement was finished successfully. The analysis of the recent beam test data was completed. The Remote Vacuum Connection and the BEAST II system have been delivered to KEK on time. The closure of Belle II for Phase 2 running (without the vertex detector) is still planned for January 2018. DESY physicists and engineers are playing an essential role in the preparatory work for the closure of Belle II.
On the other hand the PXD ladder assembly has suffered a delay by 3-4 months due to a by now understood and resolved problem during ladder testing. PXD

commissioning at DESY can therefore only start in January 2018 and will take until April 2018. Delivery of the PXD to KEK is now foreseen for May 2018 (4 months late including 1month of contingency) which puts the VXD installation into Belle II (now planned for October 2018) on a very tight schedule. The Belle II collaboration still aims at a start of the Phase 3 running in January 2019. It will be very important to put all required effort and resources into the PXD commissioning at DESY so that it can run as efficiently as possible.
PRC takes note that the collaboration plans to build a PXD replacement detector for a possible installation in 2021/22. Given that the PXD relies on a very novel detector technology and given that a lot of machine optimization will need to happen with the (first) PXD in place it seems prudent to plan for such a replacement. DESY's role would again be to host the PXD commissioning.

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

International Linear Collider Activities and Preparations for Future Experiments
The PRC feels the DESY FLC group is a leader in the worldwide effort to develop future projects of accelrator-based particle physics beyond the LHC. The group makes sensible use of the resources provided from DESY and other sources (e.g., EU funds from AIDA2020, E-JADE, etc.). In view of the next European Strategy Update, the participation of the group will be crucial for this initiative. In particular the group is a major participant in the Linear Collider Collaboration with its main contribution to the development of International Linear Collider (ILC) project. Their activities also overlap the Compact Linear Collider (CLIC) project.
Key responsibilities are held by members of the groups in the Linear Collider project, detector development (ILD and SiD management, etc.), and EU projects. We are pleased to see the excellent progress and achievements across the all the tasks of the group.

There were notable advances on:

- the TPC two-track separation and dE/dx studies, development of the Silicon Strip telescope as test-beam facility for the TPC;
- contributing to the development of the Data Acquisition system;
- on hadronic-calorimeter development, construction of the Next-Big-Prototype is reasonably-well on schedule.There are successful beam-test results, plus R&D for the new CMS end-cap and mechanical structure studies;
- on the MDI and integration for ILC, there were site studies, detector (ILD) integration, and investigation of backgrounds;
- there were studies on the ILC positron source for high luminosity electron-positron colliders;

- on re-evaluation and on-going studies of the physics for future e+e- colliders, they are considering realistic detector and accelerator conditions at 250 GeV and 500 GeV centre-of-mass energy;
- the physics processes under study include Higgs and several new physics models;
- they made progress on software development on core components, including generic implementation of detector geometry (DD4hep) and event reconstruction.

Overall, thus is very significant progress.

In addition, we recognize their high productivity of physics and instrumental publications, plus a number of theses and conference submissions.
We also recognize the high productivity of the group and their profile in the next-generation accelerator particle-physics community. We note the important role of the group in the next European Strategy and are gratified to see the group plans a very active involvement. We also note the importance of exploiting overlaps and common applications with other future projects of the field, for example with CLIC, CMS in calorimetry and the development of common software tools. This diversity of applications allows the group to move into a leading role in whichever project does move forward.

Recommendations:
This PRC update did not include a discussion of the group's strategy going forward, likely because the situation with respect to the relevant accelerator initiatives remains too open and yet undecided. The next year may yield greater clarity for these initiatives. Whether there is indeed clarity or not over the next year, things like the European Strategy will move forward regardless and it is imperative the group develop a strategy on this timescale, recognizing it will be a challenge to develop their strategy absent clarity in the accelerator initiatives.
Meanwhile the strategic decision on future involvements of the group is taken the PRC recommends to continue the effort in looking for synergies and common application to other future projects of the field as it is doing and it is the case for CLIC in general, CMS in calorimetry or the development of software tools. Therefore, the support of the lab should be continued in both technical and scientific aspects.

Particle Astrophysics

DESY Particle astrophysics has become the main focus at DESY-Zeuthen with activity in three main areas: gamma-rays, neutrinos, and theory. Joint professorships with Humboldt University and Potsdam University are vital to the program and a new

strategic partnership with Erlangen has been established. Links to national and international networks are also in place.

The Cherenkov Telescope Array (CTA) gamma-ray project is the main particle astrophysics effort and DESY has significant presence at the Consortium and Observatory level and as a provider of in-kind contributions (IKC). It is planned to invest 6 MEuro into the project as part of the German contribution and at least 1.2 MEuro per year, to come from the base budget, for operating costs.

There is some concern about the slow start to CTA activities stemming from difficulties with setting up the legal structure of the organization, IKC agreements, and other issues. It is expected that the pace will improve with the arrival of a new project manager (Wolfgang Wild) and a revitalized CTA Council. Hardware items with a DESY focus (medium-sized telescopes and cameras for the small-sized telescopes) are in good shape but there are uncertainties in the area of software; clarity is needed on the value of central software as an IKC and there is a general lack of manpower. DESY scientists remain active in the three existing Cherenkov collaborations, H.E.S.S., MAGIC and VERITAS but their efforts will need to ramp down in the transition to CTA. This should happen in 2021 although uncertainties in the CTA schedule affect this number. In the meantime, planning for effective participation in CTA science by the group has begun.

DESY maintains a strong effort in IceCube. The main issue at present is the status of the “Gen-2 Phase 1” proposal. This involves the installation of six strings of multi-sensor (mDOM) detectors in a dense configuration in the interior of the existing detector. These will be used to improve the calibration of IceCube and also allow measurements at energies in the GeV range; these are important for neutrino particle physics questions. DESY has committed 2 MEuro, enough for two strings (200 mDOM detectors), and can set up a production line in Zeuthen to make strings. The proposal is for $20 M from the (US) National Science Foundation (NSF), with a further $10 M to come from partners. It received very supportive reviews but the NSF has requested a white paper to further clarify the science case. A decision on funding is expected in approximately six months.

The neutrino group has started working on strategic planning, with some thought as to a path forward in the unfortunate case that IceCube Phase-II is not approved. A significant development is the idea to investigate radio detection of neutrinos as a complementary, to optical, technique. This would be to supplement IceCube, not compete with it. However if upgrading IceCube is not supported by the NSF, it may be possible to install a stand-alone detector in Greenland and this will be studied. Anna Nelles, a new Emmy Noether fellow, due to start at Humboldt University in

March 2018, could take a leadership role in this. She is currently a member of the ARIANNA collaboration, currently conducting research in this area.

There is a strong team of four permanent staff covering a range of topics in theoretical astroparticle physics. They have substantial third-party funding and are able to support seven postdocs and six doctoral students. Long-term stability of this critical mass will require continued success with funding competitions. There is cooperation with Hamburg universities on the Excellence-Centre initiative “Quantum Universe”.

Findings for particle astrophysics:

The PRC congratulates the DESY scientists on the excellent results coming from all the operating experiments; their impact at the 2017 International Cosmic Ray Conference is impressive. The theory group is clearly vital and productive. It was good to see the smooth connection between observations and theory in the open session talk. A dedicated astroparticle theory presentation, perhaps in a pre-meeting, at the next PRC meeting could be worthwhile.

An idea from the theory group to foster laboratory experimentation in questions of astrophysical interest was noted but needs to be defined more clearly to merit further consideration. Likewise, efforts on smaller projects, like TAIGA and MeVCube, are worth maintaining in the interests of diversity and long-term options but growth should be contingent on a strong scientific case.

The PRC appreciates the detailed discussion on the long-term plans for DESY-Zeuthen in terms of astroparticle physics. The general plan (continuing focus on major efforts of CTA and IceCube) makes sense. It would be good to continue the strategic planning efforts started in these two areas and we would welcome updates at future PRC meetings. We agree with the point made that it is a bit premature for a detailed staffing plan, given uncertainties in both CTA and IceCube.

The presentation and discussion on the impact of the CTA Science Data Management Centre (SDMC) was very useful. The new building will have a big (positive) impact on the campus, housing both scientific and data management staff for CTA as well as a large part of the existing gamma-ray group. The funding for personnel was discussed (by default it should come from the CTA Observatory, but there is potential to explore IKC for the operating costs) and seems sensible. We share the concern within DESY about the slow development of CTA and we encourage DESY scientists and management to continue to work effectively within the Consortium, the Project and the Observatory (Council) to resolve issues and move things forward. In this regard, the long-term, consensus view of CTA as a

powerful scientific facility should be maintained. Remember that CTA has a great scientific potential!

The discussion on the roadmap forward for astrophysical neutrinos at DESY provided good context for the relevant issues. We understand the difficulty (and frustration) of coping with uncertainty in the NSF funding and we support the plan to explore complementary approaches to address the key science questions.

We agree that the radio detection of neutrinos could be a sensible way to diversify and remain complementary to optical detection by IceCube. This is a promising area of research that has been under study for years and may soon be ready for exploitation in a practical detector. In this regard we suggest involvement in, and critical examination of, the prototype data-taking and simulation efforts.

Theory is in good shape but suffers somewhat from geographic dispersal. The distance between the universities and DESY can't be helped but efforts to find contiguous office space for those spending time on the Zeuthen Campus should be strengthened.

Other experiments

ALPS-II

The The group continues to maintain a high-profile in the axion-like-particle and axion community. Over the last year ALPSII scientists have given key talks on ALPS and ALPS physics. ALPSII is 1 of 3 worldwide axion flagship projects (along with laser and RF-cavity), and ALPS is identified with DESY and an on-site experiment.

The state of ALPS science is largely unchanged from the last PRC. There remain weak astrophysical hints the axion may be accessible in ALPSII. There also seems to be increasing interest in axions and ALPs. We are very impressed by the technical progress and we are gratified to see ALPSII being more deeply integrated into DESY project planning and schedules. The new Florida group brings much-needed optics expertise into the group and the Florida heterodyne receiver may be a good alternative for the TES detection. The hang-ups in straightening the magnets and preparing the infrastructure seem largely solved. The momentum of the project seems to be increasing. More people in and out of DESY are becoming involved with the project.

Recommendations for ALPS:

- Data-taking is scheduled to start 2020. This is a significant delay from even a year ago. Holding to this new schedule requires timely availability of DESY technical resources, especially people, for the infrastructure deployment. Delays in supplying infrastructure personnel will translate into project delays.
- The group argues they do not need active vibration isolation. This conclusion is encouraging, but it may be the case that in the final site/configuration more aggressive vibration and motion control is needed. Space and supports for the associated vibration-isolation hardware would need to be designed into the vacuum system, e.g. in the ALPSII optics-table and vacuum-chamber design. It would therefore be helpful to have an estimate of the allowed acceleration spectrum envelope.
- There is a possibility ALPSII could measure vacuum birefringence. This is attractive science and we did not get an update in their report. Is this in the project plan?
- We are pleased that the ALPSII group and DESY is contemplating expanding their axion/ALPS program into MADMAX and IAXO. This would increase the experiment and theory particle-astrophysics profile of DESY. But on the other hand, there may be issues with the infrastructure overlaps and conflicts among the projects and there are surely budget and resources consequences. We defer making a recommendation until the MADMAX and IAXO projects are sufficiently scientifically and technically defined. Clearly a successful ALPSII would provide a strong and credible foundation to realizing MADMAX & IAXO at DESY.