CERN RESEARCH BOARD

MINUTES OF THE 228th MEETING OF THE RESEARCH BOARD
HELD ON FRIDAY 5 MARCH 2019


Invited  H. Meinhard (for item 6)

Items
1. Procedure
2. News and announcements
3. Report from the LHCC meeting of 27-28 February
4. Report from the INTC
5. Report from the SPSC meeting of 22-24 January
6. Report from the REC meeting of 24-25 January
7. Any other business
1 PROCEDURE

1.1 F. Gianotti opened the meeting. The minutes of the last meeting [1] were approved without modification. The matters arising from those minutes are included with the reports from the scientific committees, under items 3.11 and 5.8.

2 NEWS AND ANNOUNCEMENTS

2.1 F. Gianotti reported that there has been an important set of documents submitted to the update of the European Strategy for Particle Physics, including Conceptual Design Reports for the FCC, a Project Implementation Plan for CLIC, and a report from the Physics Beyond Collider study. The latter study includes some proposals for new large-scale projects for the diverse programme of physics at CERN, which will need to wait for the conclusions of the update process. However, it also reviewed a number of small-scale proposals for the use of the LHC injector accelerators, or for fixed-target studies at the LHC, on the timescale of the next few years, and which do not interfere with other proposals that are being considered as part of the strategy update. These small-scale proposals will now be transferred to the SPSC and LHCC for consideration in the normal fashion. The review made as part of the PBC study can inform that process, but otherwise the reviewing within the scientific committees should be of the usual high level, and lead to recommendations for consideration by the Research Board.

2.2 A statement is expected from the Japanese authorities concerning their possible hosting of the ILC, at a meeting of ICFA in Japan this week. The following month there will be a meeting of the Linear Collider community in Lausanne, aiming to develop a common position of the community based on the content of the Japanese statement, in preparation for the discussion at the Open Symposium at Granada in May.

3 REPORT FROM THE LHCC MEETING OF 27-28 FEBRUARY

3.1 F. Forti reported from the latest meeting of the LHCC [2]. The 2018 heavy-ion run was completed successfully despite some initial issues. A record Pb-Pb peak luminosity of $6.1 \times 10^{27}$ cm$^{-2}$s$^{-1}$ was achieved for ATLAS and CMS, approaching the target for HL-LHC running. In total 1.8 nb$^{-1}$ of data was delivered to ATLAS and CMS, 0.9 nb$^{-1}$ to ALICE
and 0.24 nb\(^{-1}\) to LHCb. While the number of days of proton physics in Run 2 were more or less constant around 140 days in the last three years, the luminosity production has steadily increased year-by-year. In total about 160 fb\(^{-1}\) was delivered to ATLAS and CMS in Run 2, 6.7 fb\(^{-1}\) to LHCb and 66 pb\(^{-1}\) to ALICE. The experiments have now moved successfully from data taking into the shutdown activities. At the end of Run 2, the magnets of one LHC sector were trained for higher energy. The number of quenches was higher than expected and 14 TeV was not reached, but no fundamental show-stopper for training to 14 TeV was identified. A decision will need to be taken by the middle of 2019 on how much time to devote to magnet training in 2021, and thus the target beam energy. An LHC working group is working on proposals for beam configurations for Run 3. This work has not yet concluded, but in the most optimistic scenarios all experiments could be luminosity-levelled for the majority of each fill in the second half of Run 3. This could lead to significant luminous region size changes during a fill and changes to acceptance for the forward experiments, the impact of which should be evaluated by the experiments.

3.2 **ALICE:** The inner barrel of the ITS upgrade has been finished and the spare barrel is almost complete. Half of the staves have been produced for the outer barrel. All TPC ROCs have been produced and 76 out of 80 have already been tested either at Point 2 or at GIF\(^{++}\). The signal integrity issue in the CRU reported during the last LHCC meeting has been solved and European mass production has begun. Two boards are currently being produced in India and the final decision on this branch of the production will be taken at the latest in summer. The LHCC urges ALICE to avoid any additional delay on the final decision of the Indian production branch of the CRUs. The DualSampa production for the Muon System upgrade will begin in July after completing extensive testing on pre-series boards. The LHCC acknowledges the progress made on the muon upgrade but requests a more detailed resource-loaded schedule with milestones describing the finalisation of the project and the installation sequence. The document requested by the LHCC answering questions on the O2 upgrade was delivered in February. Issues remain to be resolved on the architecture of the system and the management structure, and an updated document is requested to be submitted before the end of March.

3.3 **ATLAS:** Good progress has been reported on the muon NSW, but there remain major concerns on the reliability of all the system, as the discharge problems from some
Micromegas chambers are still not completely understood. There is a clearly defined path to install NSW-A during LS2, although the project remains on the critical path. The installation of the second NSW on the C-side will not be possible during LS2, with a preferred scenario from ATLAS of installing it during an extended Technical Stop at end-2021. **The Research Board noted that the Technical Stop at end-2021 is currently not foreseen to be an extended stop.** The LHCC strongly encourages the collaboration to prepare a plan in case that also NSW-A cannot be installed in LS2. Significant progress has been made on FTK during the past year, however the project is significantly delayed and did not demonstrate all needed functionality during Run 2, making the work in LS2 essential. The project remains at risk of not being completed in time for Run 3. While FTK does open new triggering possibilities, the current physics motivation is limited to relatively small gains in selected channels. The LHCC requests an updated execution plan for FTK that will enable an informed decision if the project is further delayed and if resources cannot be secured in a timely fashion. An in-depth review of the ATLAS Phase-II upgrade took place during the present session of the LHCC. The committee acknowledges the good progress made on the Phase-II upgrades but notes that there are still several areas of concern. The next months will be critical in particular for the ITk pixel project with a schedule review and many technical reviews. The LHCC strongly encourages the collaboration to invest enough effort into settling remaining technology decisions in a timely fashion. The LHCC is concerned that some of the corresponding working groups are currently understaffed and encourages the collaboration to put in place the necessary resources, in particular to seriously evaluate Hardware Track Trigger alternatives.

### 3.4 CMS:

The pixel detector has been extracted in January and refurbishment activities are on track. Phase-II upgrades are progressing well, with no changes in the established time line of the outstanding TDRs on the MTD and L1 Trigger & DAQ/HLT, with all milestones on track. The submission of the MTD TDR is foreseen at the end of March. The LHCC acknowledges the good progress made on the pixel refurbishment and requests a more detailed resource-loaded milestone schedule for this project, that also addresses interactions with the Phase-II projects. The LHCC notes the intention to extend the running of PPS into the HL-LHC era and invites the collaboration to prepare a letter of
intent addressing the physics case, the detector systems, and the work on the accelerator that would be required.

3.5 **LHCb**: good progress has been reported on the Phase-I upgrades. The LHCC is concerned about the very tight schedule in the VELO project and encourages the collaboration to complete the module production site PRR as soon as possible and to prepare a fully realistic production schedule. LHCb proposes to construct an upgraded SMOG2 system for Run 3 as an addition to the VELO upgrade. The LHCC considers this to be a worthwhile addition, and requests a document detailing the physics case and technical implications on the VELO upgrade and machine configuration. The LHCC is very concerned about the delays in the UT project, and supports the efforts of the LHCb and UT management to optimise the schedule for a still possible installation in LS2, while actively considering back-up scenarios should this not be possible. After the submission of the Upgrade Software and Computing TDR [3] in May 2018, the final version of the related Upgrade Computing Model TDR [4] was submitted in November and evaluated by the LHCC. Clever utilization of the TURBO technique has allowed a rebalancing of storage resources between tape and disk. Although the resource estimates are still somewhat above the flat budget scenario, optimisation is ongoing to reduce requirements even further, and negotiations with the funding agencies should continue to secure the required resources. The LHCC recommends both TDRs for approval. **The Research Board approved the LHCb Upgrade Software and Computing TDR and the LHCb Upgrade Computing Model TDR.**

3.6 The **WLCG** and experiments are congratulated by the LHCC on the successful and efficient use of the computing resources. The committee encourages the experiments to stay in close contact with the funding agencies in discussing what can be purchased under a flat budget requirement and continue to provide realistic infrastructure requirements. The LHCC strongly encourages the experiments to maintain or even increase their efforts on software and computing model development as the most promising method of reducing the resource needs in the future.

3.7 Some items common to the experiments were discussed. The two Phase-II Upgrade Groups (P2UG) have started their activities. The fabrication and installation of CO$_2$ cooling plants are major items in both the ATLAS and CMS upgrade programmes, and the
LHCC encourages CERN to provide sufficient support for this effort. ASIC design and firmware development contribute significantly to the existing technical and schedule risks for upgrades across the experiments, and an increased effort will be made available from CERN to support these activities. The concrete model for this effort still needs to be defined but will include expert advice and integration of new ideas in standard solutions, which may be provided as a library. On chip design, 65 to 250 nm technologies are currently supported, although it is hoped to drop the 250 nm support in the future; support will be limited to specific design tools, such as Cadence. Ownership of equipment subject to irradiation will be transferred to CERN, such that the disposal of radioactive components can be organised centrally by CERN. A procedure to deal with irradiated equipment that requires maintenance by subcontractors needs to be put in place to mitigate extra costs and delays that new regulations could induce.

3.8 **TOTEM** is congratulated by the LHCC for the recently released physics analysis, looking forward to the completion of the full set of measurements made possible by the rich Run 2 data. The committee welcomes the efforts to upgrade the T2 detector and invites TOTEM to complete the TDR for submission to the June LHCC.

3.9 **LHCf** presented their interest in further data taking during Run 3, following an upgrade of the detector electronics to allow operations at higher luminosity. The LHCC finds that the physics case for the continuation of LHCf running is of interest and invites the collaboration to prepare a Technical Proposal in time for the next session of the LHCC.

3.10 A working group on **LHC Forward Physics and Diffraction** has studied a possible continued programme using forward detectors during the HL-LHC period. The LHCC recommends that the working group should continue and document the exploration of the physics potential, in relation to the detector performance in HL-LHC running conditions, vis a vis machine and optics constraints, under the various possible scenarios. This is particularly true of the newly proposed detectors at 400 m, where the Higgs physics case must be considered in view of the value added to the standard HL-LHC Higgs programme. The LHCC urges that the interest, commitment and plans of the experimental collaborations be clarified as soon as possible. The planning for the HL-LHC, including the final design and construction of critical components such as the crab cavities, requires some decisions to be taken on the time scale of this year, for example on the orientation of
the crossing planes. It may not be possible to accommodate the experimental requirements at a later stage, in case of conflicts with what has been previously established. The LHCC notes that in order to prepare for these final decisions, experiments and accelerator experts must strengthen their collaboration to establish the feasibility of suitable running conditions, define needs in relation to a possible instrumentation of the regions at ±400 m and clarify other related points.

3.11 The FASER experiment was recommended for approval by the LHCC at the previous Research Board. At that time the interest of the physics case was recognized along with the availability of funding, but some technical issues were noted that still required scrutiny, such as possible influence on LHC operation and compatibility of installation with the LS2 work; decision on final approval was deferred to this meeting. F. Gianotti reported that input had now been received from the relevant technical committees, and the installation was compatible with the constraints. However, the estimate of resources requested from CERN had increased compared to those mentioned in the Technical Proposal [5], in particular for the civil engineering work, due in part to modification of the design. J.M. Jimenez commented that it was essential that the end-date for this work be respected, due to constraints related to transport over the LHC machine during installation.

The Research Board approved FASER, on the understanding that the design would now be frozen and that every effort should be made to stay within the original resource request to CERN.

3.12 As this would be his last report to the Research Board from the LHCC, F. Gianotti thanked F. Forti for his excellent work as chairperson of the committee, where he has played an instrumental role in coordinating the review of the experiment upgrades, and for his clear and extensive presentations to the board.

4 REPORT FROM THE INTC

4.1 K. Riisager gave a short verbal report from the INTC, as there had not been a meeting of the committee since the last Research Board. The INTC is in the process of evaluating all of the experiments at ISOLDE that are currently active, about half of which wish to continue and take beam after (LS2. The work foreseen on the facility during the shutdown
is proceeding well, on schedule. One of the cryomodules for HIE-ISOLDE will be repaired and is being removed, and work is being done on the RF system.

5 REPORT FROM THE SPSC MEETING OF 22-24 JANUARY

5.1 J. Nash reported from the latest meeting of the SPSC [2], including the annual reports of the AD experiments BASE, GBAR, ASACUSA, ALPHA, AEgIS and ATRAP. The SPSC proposes that a special review of the AD experiments should be prepared in view of the start of the ELENA era at the AD facility. This will be held together with the annual review of the AD experiments in early 2020; it will judge the prospects and competitiveness of the current experiments and make recommendations concerning their continuation. **The Research Board endorsed this initiative, and recommended that all active AD experiments should provide a document in good time for the review, which should also consider aspects such as the machine schedule and liquid helium usage.**

5.2 **BASE** made tremendous progress in 2018, improving their experimental apparatus and understanding and controlling the statistical and systematic uncertainties of the cyclotron frequency measurements.

5.3 **GBAR** has made progress installing the experiment into the AD experimental zone, and both the GBAR collaboration and the ELENA team were congratulated by the SPSC for the successful commissioning of the first transfer line.

5.4 **ASACUSA** has made progress on two-photon spectroscopy of cold antiprotonic helium, and the measurement of the antiproton-to-electron mass ratio with improved precision. The SPSC looks forward to the publication of these results.

5.5 **ALPHA** has achieved the first demonstration of laser cooling of antihydrogen and its first application to the 1s-2s spectroscopy of antihydrogen. The SPSC is enthusiastic about the laser cooling development for future spectroscopic and gravitational studies with antihydrogen. The installation of the ALPHA-g set-up for gravitational measurements proceeded smoothly, and the SPSC is looking forward to the first results soon after the end of LS2.
5.6 **AEgIS** has made progress in the handling and monitoring of positronium. The SPSC supports the intention of the collaboration to further develop their set-up during LS2 to enhance the production rate of antihydrogen.

5.7 The long-term potential of **ATRAP** for the study of antihydrogen at the level of precision achieved for hydrogen is recognized by the SPSC. The committee supports the efforts being made to strengthen the collaboration and upgrade the apparatus so that this goal can be competitively achieved.

5.8 **NA61** running in 2021 was conditionally approved at the Research Board of 14 September 2018, to be confirmed when the required funding for the upgraded detector from the collaboration has been established. The current status of the funding requests was presented, and about one third of the required funding remains to be secured. **The Research Board reaffirmed that final approval of the NA61 run in 2021 will take place once formal confirmation has been received from the collaboration of the availability of the outstanding funding.**

5.9 As discussed in item 2.1, following the Physics Beyond Collider study the SPSC expects to receive documents during 2019-20 concerning proposals for post-LS2 fixed-target running with limited resource implications. This includes **NA61, NA62** (in standard and beam-dump mode), **COMPASS** (on the measurement of the proton radius), and **MUonE** (on studies of the elastic scattering of muons on electrons). As COMPASS, MUonE and a recently submitted proposal by the **NA64** collaboration compete for the use of the M2 beam-line, the SPSC will set up a working group to provide recommendations on the future use of the EHN2 experimental hall and its unique muon beam.

5.10 Proposals for the future use of the **Neutrino Platform** of CERN were reviewed at a dedicated meeting of the SPSC on 23 January, following an open call. Three proposals had been received: for the continued operation of the DUNE prototypes [6], **ENUBET** [7], and the upgrade of the ND280 near-detector of **T2K** [8], which are discussed in the following paragraphs. **The Research Board clarified that the scope of this call relates to the next three years of the Neutrino Platform operation, and that further operation of experiments as part of the facility beyond that time would be subject to a future call to be held on that timescale.**
5.11 The strong physics case of the DUNE experiment and the novel detector technology of LAr TPCs is recognized by the SPSC, and the ProtoDUNE-DP (NP02) and ProtoDUNE-SP (NP04) detectors’ request to remain as participants in the Neutrino Platform is supported. The projects are expected to request beam time via the standard annual beam request procedure. The Research Board approved the continued participation of NP02 and NP04 in the Neutrino Platform, until the end of 2021 in this instance. Before their detailed run schedule can be approved, given the substantial cost implications of independent warm-up and cool-down cycles of the two prototypes, an updated, coordinated proposal should be submitted to the SPSC. This should contain a schedule in which sequential operation of the two cryostats is considered, with re-use of the liquid argon to avoid its loss, and include a clear statement of the needs from the related services at CERN.

5.12 The physics case of the ENUBET project and the exciting possibilities of a tagged neutrino beam are recognized by the SPSC. The committee recognizes the technological development for a neutrino beam without a horn using a quadrupole-based solution, and appreciates the close collaboration of the ENUBET collaboration with the CERN accelerator sector. The SPSC supports the proposed programme, and welcomes the opportunity to continue reviewing the experiment; test-beam requests will be considered via the standard annual procedure. The Research Board approved the participation of ENUBET in the Neutrino Platform, with reference NP06, on the understanding that this is an R&D experiment to study the possibilities for future tagged neutrino beams, i.e. without commitment for such a neutrino beam facility at CERN. The requested support and consultation from CERN accelerator experts in the design of the ENUBET beamline, in collaboration with personnel employed by the project, will be provided on a best-effort basis, and should not entail a significantly higher level of resources than has been the case during the preparatory phase of the project.

5.13 The strong physics interest of the upgrade of the ND280 detector at the T2K experiment is supported by the SPSC, with the recommendation that it is formally recognised as a Neutrino Platform activity. The committee welcomes the opportunity to review the proposed activities up to the installation and commissioning of the detector in Japan. The SPSC notes that in the current proposal no request for test beam has been made, however
the committee will consider possible requests favourably if they match the overall beam time scheduling. The Research Board approved the participation of the ND280 detector upgrade in the Neutrino Platform, with reference NP07. Since T2K is a CERN Recognized Experiment (see item 6.4 below), in that capacity it should only involve marginal use of CERN resources for the other parts of the experiment; participation in the Neutrino Platform concerns specifically the ND280 upgrade, and any other proposed detector development at CERN for T2K would be subject to a separate proposal being submitted to the SPSC.

6 REPORT FROM THE REC MEETING OF 24-25 JANUARY

6.1 H. Meinhard reported from the latest meeting of the Recognized Experiment Committee [2]. There were two new requests for recognized experiment status, from DAMIC-M and sPHENIX, and 13 requests for extension, listed in the following paragraphs. M. Krammer commented that office space is currently in very short supply at CERN, and there would not be any automatic assignment of dedicated offices to Recognized Experiments; usually space may be found in shared offices or burotels, subject to individual agreement.

6.2 DAMIC-M is an approved experiment that will search for Dark Matter by detecting low-energy nuclear and electron recoils, and photon absorption in CCDs. It will cover many orders of magnitude of Dark Matter mass, reaching down to the very low mass region via detection of single ionisations with high efficiency. The detector will be located at the Modane underground laboratory in the Frejus road tunnel of France, and should start data taking in 2023. Many collaborators are also members of CERN approved experiments. There are active contacts with the RD50 collaboration on extremely low noise and high position resolution CCDs; these contacts could be formalised following the recognition. The requests to CERN include access to CERN expertise and facilities, including access to the CERN bonding lab if possible, test beam, irradiation facilities, measurement of the ionisation response of nuclear recoils at nTOF, and possibly data storage once the experiment starts taking data. The Research Board granted the status of Recognized Experiment to DAMIC-M as RE38, initially for a period of three years.
6.3 **sPHENIX** aims to study the structure of QCD in the Quark-Gluon Plasma in a phase-space region complementary to ALICE and the other LHC experiments (with different initial densities and temperatures). It is scheduled for commissioning at the RHIC facility at BNL in 2022. Purchase of long-lead items for the experiment has been approved, and the review leading to general construction approval is expected in the first half of 2019. Nine of the 70 member institutes are from CERN Member States. Agreements have been established with ALICE concerning tracking detectors: sPHENIX will use the ALICE production facilities for Inner Barrel MAPS staves once the ALICE production is over, and will join the ALICE purchase order for readout units; the experiment is looking to purchase GEM foils from CERN, and a collaboration has been established for tracker calibration and readout software. Once data are available, common analysis efforts are envisaged. Requests from CERN beyond the agreements already in force include occasional usage of meeting rooms and support for purchase orders. The Research Board granted the status of Recognized Experiment to sPHENIX as RE39, initially for a period of three years.

6.4 Extension of their Recognized Experiment status was approved by the Research Board for the following experiments, for a further three years unless otherwise stated: **AUGER** (RE3), **Fermi LAT** (RE7), **IceCube** (RE10), **MEG** (RE12), **CREAM** (RE19), **Advanced Virgo** (RE28), **EUCLID** (RE31), and **LIGO** (RE33). A final extension was granted to **PAMELA** (RE2b) for two years until 31 March 2021, with the understanding that any request for test beam in 2021 and beyond is unlikely to be satisfied. An extension was granted to **LISA** (RE8) with the understanding that recognition does not imply any larger CERN involvement than in the past, given the long timescale of experiment’s preparation. A final extension was granted to **MICE** (RE11) for three years. An extension of Recognized Experiment status was granted to **T2K** (RE13), without additional office space and on the understanding that such approval only concerns the aspects that the REC is following; participation in the Neutrino Platform or more general detector R&D must be requested and followed up independently of this request. Extension was granted to **NEXT** (RE27) with the understanding that a potential collaboration with ISOLDE for the development of Ba²⁺ beams would need to be followed up by a separate request.
7 ANY OTHER BUSINESS

7.1 The next meeting of the Research Board will be held on 12th June 2019.

ENCLOSURES


3. Draft minutes of the 11th REC meeting held on 24-25 January 2019.

REFERENCES