

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE  
**CERN** EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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**CERN RESEARCH BOARD**

**MINUTES OF THE 233<sup>rd</sup> MEETING OF THE RESEARCH BOARD  
HELD ON WEDNESDAY 10 JUNE 2020**

Present F. Bordry, T. Cass, P. Collier, C. Delamare (replacing D. Forkel-Wirth), E. Elsen, R. Forty (Secretary), F. Gianotti (Chair), G. Giudice, F. Hemmer, J.M. Jimenez, K. Johnston, M. Krammer, R. Losito, L. Miralles, J. Nash, B. Petersen, M. Pfutzner, F. Simon, H. Wilkens

Apologies D. Forkel-Wirth

Items

1. Procedure
2. News and announcements
3. Report from the LHCC of 4-5 June
4. Report from the SPSC of 7 April
5. Report from the INTC
6. Any other business



## 1 PROCEDURE

- 1.1 F. Gianotti opened the meeting, welcoming the board members to the Research Board that was being held remotely, for the first time, due to the COVID-19 pandemic. The **minutes** of the last meeting [1] were approved without modification. There were two **matters arising**, listed in the following paragraphs.
- 1.2 Under item 3.3 of the minutes of the Research Board held on 18 September 2019, concerning the **GRADE** programme at CERN, it was requested that a report of the IdeaSquare Advisory Board-GRADE (ISAB-G), which was set up to assist the Director for Research and Computing in reviewing the projects and proposals in the programme, be made to the Research Board following the next ISAB-G meeting. E. Elsen reported from the meeting held on 31 January 2020, where the ISAB-G expressed its support for the proposed CBI project within the GRADE framework, given its strong educational component. A journal has been set up, the “CERN IdeaSquare Journal of Experimental Innovation”, and the ISAB-G considers that it provides an important contribution to the goals of IdeaSquare, in shedding light on how ideas emerge and how best to feed them further along the innovation chain. F. Gianotti commented that an appropriate reviewing scheme should be considered for the journal, to ensure that high quality is maintained. The relationship between the GRADE and ATTRACT programmes should be handled carefully given their separate funding, and any proposed coupling between them should come back to the Research Board for approval. **The Research Board endorsed the continuation of the CBI and AUGMENT projects within the GRADE framework. Rotation of membership of the ISAB-G Advisory Board is recommended.**
- 1.3 Under item 1.2 of the minutes of the last meeting, the final run of **CAST** had been approved to finish in September 2020. Given the delay imposed by the COVID-19 pandemic, **the Research Board deferred the end of the CAST run to the end of 2020.**

## 2 NEWS AND ANNOUNCEMENTS

- 2.1 F. Gianotti discussed the issue that has dominated the recent weeks, the COVID-19 pandemic and CERN’s response. CERN moved to safe mode in March as the pandemic reached the local area, with the facilities and experiments shutdown in a controlled manner

that would facilitate their later restart, and activity on site reduced to the minimum required for safety. The majority of the personnel moved to teleworking. As a result, there has been no outbreak on the CERN site. In total 15 members of personnel have tested positive for the virus, and are closely monitored by the medical service and, sadly, there has been one death of a CERN User in his home country. A number of initiatives were taken to help support the fight against the virus, such as the production of sanitising gel and face shields for the local populations, the development of low-cost ventilators and making some of CERN's computing resources available to scientists working on COVID-19 research. As the pandemic receded activity at CERN has ramped up in a controlled and cautious manner, with priority given to the long shutdown (LS2) activities and the upgrades of the accelerators and experiments, and with stringent COVID-19-specific safety measures put in place. The aim is to return to "full access" to the CERN site by September, if there is no resurgence of the virus in the local region.

- 2.2 The overall schedule of LS2 work and the restart of the accelerator complex has clearly been affected by the pandemic, with a "linear" three months delay introduced by the period of reduced activity on site. For the upgrade work on the experiments the potential delays are longer, due to their stronger reliance on contributions from the user community around the world, affected by lockdowns of other institutes and the ongoing travel restrictions. One of the key items is the progress on the ATLAS New Small Wheels (NSW) for their muon detector upgrade. If it is possible for both NSWs to be installed within an extended LS2, this would avoid the need for a later extended year-end technical stop to install the second one. In that case there would only be a short pilot run with low-intensity beams in the LHC in 2021, and the restart for physics would be early in 2022. A decision on the revised schedule for LS2 will be taken in November 2020, once the planning for the NSW construction and ongoing work in the other experiments has been clarified.

### **3 REPORT FROM THE LHCC MEETING OF 4-5 JUNE**

- 3.1 F. Simon reported from the latest meeting of the LHCC [2]. The committee congratulated CERN and the experiments for their handling of the COVID-19 crisis so far, which has successfully prevented the spread of the coronavirus in the CERN community, while

keeping essential activities running. The experiments have proven successful in implementing telework, keeping the scientific output high, and making progress in key areas of detector work. There has been a rich physics harvest, with 72 physics papers submitted by the LHC experiments since the last LHCC meeting. The LHCC also appreciates the many contributions made across the experiments to the “CERN against COVID-19” effort. Nevertheless, the committee notes that the pandemic-induced safe-mode period has a significant impact on the overall schedule of the experiments. Concerning the planning of LS2 and Run 3, the LHCC re-affirms its earlier statements, namely a call for the highest possible collision energy (with appropriate pragmatism) and a significant integrated luminosity goal, while also respecting the needs of the experiments in the progress of their upgrade programmes. The possibility to install ATLAS NSW-C in an extended LS2, in case the progress of the project in the coming months makes a timely completion likely, presents a significant opportunity to begin Run 3 with fully completed Phase-I upgrades and avoid additional significant interruptions during the running time. The LHCC notes that the capped subsistence rate combined with uncertainty over the documentation concerning taxation may discourage collaboration-funded experts from staying at CERN for essential work on the detectors, and the efforts made to stabilize this situation are welcome. The LHCC also welcomes the CHIPS initiative of CERN for the support of ASIC design and is pleased that the service is well used by the experiments. However, the lack of senior ASIC engineers continues to be a threat to the upgrade programme, and the LHCC encourages additional experienced ASIC engineering effort to be made available in the near term.

- 3.2 **ALICE** continues to have a rich physics output and has made progress on its upgrade programme and in preparing for Run 3 under the difficult circumstances caused by the COVID-19 crisis. The LHCC acknowledges the plan of ALICE to present an extensive physics programme for high-energy pp collisions, and once this has been endorsed by the collaboration a document should be submitted in time for review by the committee at its next meeting. The ITS3 groups have made a successful start of the project, with a TDR planned for mid-2023. The LHCC commends the thorough simulation studies, promising design and R&D of the FoCal upgrade project, a highly granular forward calorimeter optimised for direct photon measurements. The LHCC endorses the plan presented in a

Letter of Intent to carry out the necessary R&D studies to demonstrate the technical feasibility of the project and to submit a TDR on a time-scale compatible with installation in LS3. **The Research Board supported the LHCC recommendation regarding the FoCal TDR, but underlined that before the project can be approved any longer-term plan of ALICE beyond Run 4 must be submitted to the LHCC and the Research Board for consideration.**

3.3 **ATLAS** has produced a wealth of interesting new physics results and made good progress on its upgrades and in preparing for Run 3, successfully continuing LS2 activities under the current circumstances. The LHCC recognises the advantages of installing both muon NSWs before the start of Run 3 but considers it too early to recommend extending the shutdown at this stage, while encouraging CERN and ATLAS managements to keep this option in mind during the schedule discussions over the coming months. The LHCC recommends that ATLAS closely follows the multithreading computing migration. The committee is pleased to see the progress on detailed understanding of the Phase-II upgrade schedule and the improved definition of LS3 activities, resulting in a reduction of the estimated overall time needed to carry out the installation of the upgrades. The LHCC is concerned by the very small schedule contingency in the ITk-Strip project, and the absence of any remaining schedule contingency in the ITk-Pixel project, while noting that a detailed analysis of the latter schedule is still in progress. Regional readout for ITk-Pixel has been studied, with a decision imminent, which would allow the services needed in the ITk-Pixel volume to be defined and the pixel design to be decoupled from the further development of the trigger strategy crucial for the progress of the TDAQ project. A TDR for the High-Granularity Timing Detector (HGTD) Phase-II upgrade [3], based on low-gain avalanche detector technology, has been reviewed by the LHCC. The physics goals and technical implementation were found to be well matched to the HL-LHC programme, but the schedule looks unrealistically tight. The TDR will now be reviewed by the Upgrade Cost Group (UCG), towards approval in September.

3.4 **CMS** has a productive physics programme, as well making substantial progress on the upgrade projects and in preparing for Run 3, successfully proceeding with their LS2 programme both before and during the CERN safe-mode period. The Run 2 Legacy Programme has been completed, providing high-quality and homogeneous (data and

Monte Carlo) datasets spanning the whole of Run 2. The LHCC encourages CERN and CMS to sustain their efforts aimed at the timely readiness of the required Phase-II site infrastructures. The LHCC appreciates the updated schedule for the upgrade project, which makes use of the time gained with the shift of LS3 by adding contingency. The committee notes the progress made in all areas of the projects, despite the difficulties due to COVID-19. The LHCC is pleased that the size of the pixels and the sensor technologies in the inner tracker have been chosen, allowing the project to proceed. The LHCC is concerned by the observed backplane fragility of the silicon sensors for the HGAL, where a final solution has not yet been found, and by the limited information on the radiation tolerance of the 8-inch sensors to date. The LHCC is also concerned by the apparent tendency to relax performance specifications in some areas, such as the time resolution of the MTD-BTL ASIC and the signal-to-noise ratio in some areas of the scintillator section of the HGAL, and urges the collaboration to fully evaluate the physics impact prior to accepting such changes, to ensure the science reach of the upgrades is not compromised.

- 3.5 A TDR has been submitted for the **CMS Level-1 Trigger Phase-II upgrade** [4]. To match the goals and requirements of the HL-LHC programme, the L1 Trigger upgrade uses technological advances to enhance the physics selectivity at the hardware level of the data acquisition. The harsh environment with up to 200 simultaneous collisions per beam crossing imposes challenging requirements to the system in order to maintain its performance. The design maximum output bandwidth is 750 kHz, and, to profit from the extended coverage and increased granularity of the upgraded CMS detector, the latency of the system is extended to 12.5  $\mu$ s. Tracking and high-granularity calorimeter information is used for the first time at L1, and modern processors will implement sophisticated algorithms including machine-learning based approaches to target the selection of specific final states. The TDR is recommended for approval by the LHCC, following successful review by the UCG. **The Research Board approved the CMS L1 Trigger Phase-II upgrade TDR.**
- 3.6 **LHCb** has a rich scientific output and has made progress on its Phase-I upgrade programme. The LHCC however notes the significant delay and associated uncertainty in completion of some detector components (in particular for the VELO and SciFi) resulting

from the COVID-19 safe-mode period and encourages the collaboration to retain sufficient commissioning time when updating the schedule. The LHCC commends LHCb for significant progress on HLT1, including the decision to adopt the GPU architecture [5], and the Real Time Analysis group for the increased involvement of the physics groups in HLT2, although significant work remains to be done, given the current factor of 8 performance gap. The committee looks forward to an update on the performance at the next meeting, and to the successful resumption of VELO module production. The LHCC suggests that the timetable for the Upgrade-2 framework TDR be revisited.

- 3.7 **TOTEM** has continued to deliver interesting physics results and made a prompt restart of activities at CERN following the end of the safe-mode period. The LHCC notes that a prompt decision on the timescale for a high- $\beta^*$  run during Run 3 would allow TOTEM to set a concrete target for the completion of the new T2 detector, optimizing its allocation of resources between this project and other ongoing LS2 activities. The possible operation of the PPS in Run 4 and beyond, currently being discussed internally in CMS-TOTEM, will be considered at the September LHCC meeting together with future plans for forward physics in the HL-LHC era.
- 3.8 **FASER** has made progress in securing additional funds and made a rapid restart of activities since mid-May. The LHCC notes that the delivery of components and the current schedule are aggressive, but consistent with the timely completion, installation and commissioning of the detector to be ready for the start of Run 3. The committee recognizes that the schedule may be affected by further delays caused by COVID-19 work restrictions, and that minor modifications to the LHC schedule (namely the starting date of the powering tests in sector 81) may be necessary to allow the completion of the installation and commissioning work.
- 3.9 **MoEDAL** has made progress on the Technical Proposal for Run 3 operation, in the construction of the MAPP-mQP detector and in securing the required financial support. The LHCC encourages the MoEDAL and LHCb collaborations to continue their discussions to complete the definition of pending items in the design and planning of the extended MoEDAL detector. MoEDAL should also continue its interaction with CERN's

safety and technical groups, to clear the path for approval of the project. The LHCC expects to receive the Technical Proposal in time for review at its meeting in September.

3.10 **WLCG** and the experiments have continued to make successful and efficient use of the computing resources and are also commended for having made resources available for COVID-19 studies. The way forward for these studies should be discussed, possibly transitioning from contributions of computing time and hardware to contributions of expertise and the transfer of technologies. WLCG and the experiments are urged by the LHCC to closely monitor the situation arising from the COVID-19 crisis to estimate any impact on the 2021 pledges as early as possible. A first HL-LHC Computing Review was held in May with the goal of focusing on experiment-specific issues and R&D and of assessing the state of plans. The experiments have agreed on a common set of parameters and a promising list of R&D activities to close the resource gap, among which data management, reduction of data size, accessing new hardware classes (e.g. GPUs) and exploring integration of High-Performance Computing. Common software has been recognised as a key factor, where significant effort is needed on various aspects, but funding and young-peoples' career schemes remain a challenge.

#### **4 REPORT FROM THE SPSC MEETING OF 7 APRIL**

- 4.1 J. Nash reported from the last meeting of the SPSC [2], which included the annual review of experiments at the Neutrino Platform and NA62.
- 4.2 **ProtoDUNE-DP** (NP02): the SPSC reaffirmed the interest in the detector technology of a LAr Double Phase TPC, and appreciates the opportunity NP02 offers to the neutrino community in Europe and worldwide to develop the technology further. Significant technical difficulties have been experienced by NP02 during their first run period (including HV short-circuits, reduced readout gain, and bubbles in the liquid argon at various places inside the cryostat). The SPSC agrees with the collaboration that costly cycles of prototypes in the large cryostat are not an efficient and timely way to address these problems in future tests, and at this time is not recommending further running in the  $6\times 6\times 6$  m<sup>3</sup> cryostat. The SPSC supports the collaboration in continuing R&D with a smaller volume prototype.



- 4.3 **ProtoDUNE-SP** (NP04) has made continuous progress on the detector operation and data analysis, and the SPSC looks forward to publication of the results on the detector performance. The committee recognises the benefits in continuing the studies for a second run in order to test the new technologies selected for the first full scale DUNE-SP module. Prior to a recommendation for future running beyond 2021, the SPSC looks forward to receiving details of the physics goals.
- 4.4 **ENUBET** (NP06) has made progress on the design of a kaon-tagged neutrino beam, as well as on background optimisation studies, the addition of muon tagging to improve the muon neutrino cross-section measurements at low energies, and beam monitoring. The SPSC looks forward to progress in the construction of the decay tunnel demonstrator.
- 4.5 **T2K ND280** (NP07) has made progress on all components of the near detector upgrade for T2K. The SPSC looks forward to publication of results from the Super-FGD prototype.
- 4.6 **NA62** has published studies on the violation of lepton number and lepton flavour conservation laws. The SPSC notes the effort by the collaboration to finalise the analysis of the 2017 data and is looking forward to the publication of the results, as well as the analysis of the 2018 data. The committee appreciates the ongoing effort to optimise the experiment and improve the single-event sensitivity for the next run after LS2. **The Research Board endorsed the recommendation from the SPSC that the improvement in sensitivity achieved by NA62 at the end of the first year of running after LS2 should be reviewed, before a decision is taken on further extension of the run.**
- 4.7 **MADMAX**, an experiment to be performed at DESY, has submitted a Letter of Intent for a prototype detector to be installed and operated at CERN. The SPSC recognises the physics interest of the proposal to search for axions and ALPs in the mass range 40–400  $\mu\text{eV}$  and looks forward to receiving a full proposal for the prototype to be installed in the CERN MORPURGO magnet during the SPS shutdowns in 2022-25.
- 4.8 **GBAR** has provided the SPSC with additional information and established a timeline for their future running including major milestones. The SPSC recommends the continuation of the GBAR programme after LS2. **The Research Board approved the continuation of GBAR for the forthcoming run until LS3, when the programme will be reviewed.**

## 5 REPORT FROM THE INTC

- 5.1 M. Pfutzner gave a very short report on the status of ISOLDE and nTOF, as there had not been a meeting of the INTC since the last Research Board. Since mid-May activities have resumed gradually following the CERN-wide plan for work and personnel on site, with COVID-19 mitigation measures included in work practices. Priority has been given to the target front-ends, with FE10 planned to be ready for stable beam at GPS early in September and FE11 ready for stable beam at HRS at the end of November. Approval has been obtained for the installation of three new diagnostic boxes in REX and the restarting of the HIE-ISOLDE cryoplant. It is aimed to close the tunnel and perform crucial hardware tests still in 2020: HIE-ISOLDE cool-down, cryomodule recommissioning, and commissioning using beam from REX and GPS. Extensive machine studies had been foreseen but have had to be postponed. With the revised schedule, it is expected that beams for physics in ISOLDE will now be available mid-2021. Civil engineering for the extension of Building 179 (the ISOLDE nuclear laboratory) for the production of uranium carbide pills with nano-size grains was suspended only for a few weeks during the pandemic. Work resumed after CERN management approval, following guidelines for construction and COVID-19 risks in the host states. nTOF will be ready to restart as soon as the new target number 3 is installed and beam is available; a delay of 3-4 months with respect to the original plan is anticipated. An updated plan for the new target commissioning and proposals for new experiments will be presented at the INTC meeting in November.
- 5.2 The current status of requests for beam time from ISOLDE was shown, where there are 490 shifts (318 of which at high energy) from 35 experiments remaining for Run 3 following the recent review, and no backlog for nTOF. At the next INTC meeting in June only low-energy proposals will be considered: requests for a further 378 shifts have been received, from 22 proposals. At the subsequent INTC meeting in November the focus will be on high-energy and nTOF.

## 6 ANY OTHER BUSINESS

- 6.1 The **next meeting** will be held on 16<sup>th</sup> September 2020. F. Gianotti expressed hope that it will be possible for the board to meet in person but depending on the evolution of the pandemic remote attendance may again be necessary, to be decided nearer the date.

## ENCLOSURES

1. Minutes of the 142<sup>nd</sup> LHCC meeting held on 4-5 June 2020 (CERN-LHCC-2020-008/LHCC-142).
2. Minutes of the 137<sup>th</sup> SPSC meeting held on 7 April 2020 (CERN-SPSC-2020-013/SPSC-137).

## REFERENCES

- [1] Minutes of the 232<sup>nd</sup> meeting of the Research Board (CERN-DG-RB-2019-495/M-232).
- [2] Copies of the transparencies are available at <https://indico.cern.ch/event/920095/>.
- [3] A High-Granularity Timing Detector for the ATLAS Phase-II Upgrade TDR (CERN-LHCC-2020-007).
- [4] The Phase-2 Upgrade of the CMS Level-1 Trigger TDR (CERN-LHCC-2020-004).
- [5] LHCb Upgrade GPU High Level Trigger TDR (CERN-LHCC-2020-006).