

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

CERN RESEARCH BOARD

**MINUTES OF THE 230th MEETING OF THE RESEARCH BOARD
HELD ON WEDNESDAY 18 SEPTEMBER 2019**

Present T. Cass, P. Collier, E. Elsen, D. Forkel-Wirth, R. Forty (Secretary),
F. Gianotti (Chair), G. Giudice, F. Hemmer, J.M. Jimenez, K. Johnston,
M. Krammer, R. Losito, J. Nash (via video), B. Petersen, K. Riisager, F. Simon,
H. Wilkens

Apologies F. Bordry, L. Miralles

Items

1. Procedure
2. News and announcements
3. Status of the GRADE programme
4. Report from the LHCC meeting of 11-12 September
5. Report from the INTC meeting of 2-3 July
6. Report from the SPSC meeting of 13-14 June
7. Any other business



1 PROCEDURE

- 1.1 F. Gianotti opened the meeting. The **minutes** of the last meeting [1] were approved without modification. There were two matters arising, concerning the proposed oxygen-ion run and approval of the LHCb SMOG2 TDR, which were taken under the LHCC report in items 4.2 and 4.5.

2 NEWS AND ANNOUNCEMENTS

- 2.1 F. Gianotti reported that the Medium-Term Plan (MTP) of CERN was approved by the Council in June. Given the financial constraints, it will be challenging to find additional funding over the period 2021-2025 for any new projects that may be recommended in the ongoing update of the European Strategy for Particle Physics (ESPP), but that efforts will be made in the framework of the 2020 MTP.
- 2.2 The Physics Preparatory Group, that oversees the scientific aspects of the ESPP update process, has released the Physics Briefing Book providing an overview of the current status of particle physics and of proposed future projects to inform the drafting of the updated strategy. The book will be made public after the forthcoming Council week.
- 2.3 Some developments have taken place concerning the possible approval of the ILC in Japan. The Japanese ministry (MEXT) has asked for the project to be assessed by the Scientific Council of Japan. However, no decision is expected before the meeting devoted to the drafting of the ESPP update in January.

3 STATUS OF THE GRADE PROGRAMME

- 3.1 E. Elsen reported on the status of the GRADE programme. It was set up to perform pre-R&D and training on detector and related technologies at CERN's IdeaSquare, and was approved by the Research Board in December 2015 for early-stage R&D efforts on new promising detector concepts and technologies for possible use in future experiments. There is a strong educational component and the goal of exploring potential use also outside HEP, e.g. in society, including the involvement of industry and students.

Participating Institutes contribute in-kind (people and hardware), whilst IdeaSquare provides space, infrastructure and administrative support.

- 3.2 To date there have been four experiments participating in GRADE: **SIMPLE** (GR1), **TT-PET** (GR2), **AUGMENT** (GR3) and **HEALTH** (GR4). SIMPLE was closed in April this year, and AUGMENT will close at the end of 2019. For some of the projects, there has been synergy with the EC-funded ATTRACT programme for detector and imaging R&D. In addition, there is a new proposal for “Challenge Based Innovation” (**CBI**), a platform rather than a specific project, with a strong educational component.
- 3.3 An Advisory Board (ISAB-G) has been set up to assist the Director for Research and Computing in reviewing the projects and proposals in the programme. Its next meeting will take place in Spring 2020, and a report will be made at the following Research Board meeting. **The Research Board agreed that decisions on the future of the GRADE and CBI programmes would be deferred to that meeting.**

4 REPORT FROM THE LHCC MEETING OF 5-6 JUNE

- 4.1 F. Simon reported from the latest meeting of the LHCC [2]. Steady progress has been made on LS2 activities for all elements of the accelerator chain. The LHC activities are generally well on track, with the magnet consolidation activity (DISMAC) globally one week ahead of schedule, despite minor additional issues that had been discovered. The test of an 11T magnet for HL-LHC has been successful. Bunch-to-bunch luminosity variations have been observed to increase substantially towards the end of the fills with luminosity levelling in 2018, and the experiments are studying the possible impact.
- 4.2 Concerning the proposed injection of **oxygen ions** into the LHC during Run 3, no show-stoppers have been found on the accelerator side, with challenges primarily in the injector chain and connected to radiation protection. The expectation is for 2–3 days of setup time in the LHC for O-O, plus a further day for p-O, and the overall run should be completed in a total of one week. There is a broad interest in the oxygen run, with well-motivated physics: O-O has a similar number of participants as p-Pb but a completely different geometry; p-O can provide key input for cosmic-ray physics. The per-nucleon energy for O-O should ideally match the Pb-Pb energy. The LHCC acknowledges the interest

expressed by the experiments in oxygen running and supports for such a run to take place during Run 3. This will be considered as a special run, and not part of the time allocated for the baseline Pb-Pb/p-Pb programme. The LHCC suggests anticipating this run to 2022 if possible, to reduce the impact on the pp dataset under the assumption that the pp luminosity and data taking efficiency will rise towards the end of Run 3.

- 4.3 **ALICE** has continued to have a rich physics output, and has made progress on its upgrade programme, with all projects progressing well and on schedule, as well as preparing for Run 3. The LHCC is impressed by the new concept for the ITS3 with significantly reduced material budget, recognises the physics case as presented in the LoI and in a dedicated LHCC session, and appreciates the on-going simulations on various physics channels to further demonstrate the expected gain from better resolution and efficiency at low transverse momentum. The LHCC endorses the plan of ALICE to carry out the necessary R&D studies to demonstrate the technical feasibility of this upgrade project. A TDR, to be submitted on a timescale compatible with installation in LS3, will have to include in addition a comprehensive study of the physics gains with respect to the ITS2 detector that is currently being installed. The LHCC recognizes the good progress made in the muon upgrade but remains concerned about continuing shifts in the schedule and reduction of contingency. The LHCC expects, at the next session, a set of benchmarks of the final algorithms on the final hardware options in preparation for the production readiness review of the Event Processing Nodes in December. The LHCC is extremely concerned about the schedule for finalising the production of the CRUs. Additional delays will jeopardise the ALICE upgrade, so it is crucial that no further delays are accumulated. With the necessary move to a European vendor for the second production batch, the LHCC deems it essential that the resources pledged for this production are transferred immediately, to ensure all CRUs can be produced, tested and installed within LS2. **The Research Board shares the significant concerns for the CRU production. The preparation of a TDR for the ITS3 was endorsed although it was noted that, as the approved programme of ALICE will be complete at the end of Run 4, it would be necessary for the new detector to be ready for installation in LS3 for it to have a significant physics impact. Any impact of the ITS3 on machine-detector interface aspects due to the associated change of beam-pipe should also be studied.**

- 4.4 **ATLAS** has produced a large number of new physics results, as well as making good progress on the upgrades and in preparing for Run 3. In particular, HV stability problems in the Micromegas have been understood to come from sparking in some low-resistivity spots. The LHCC endorses the plan of the ATLAS management to make a go/no-go decision for the installation of the NSW-A in LS2 after the review in November. The LHCC also endorses the plan developed by the ATLAS management to deal with the problems posed by slow progress in FTK, due to shortage of appropriate effort, and for moving ahead on determining the impact of pixel materials on the forward detectors. The LHCC looks forward to the presentation of key results of the study at its next meeting.
- 4.5 **CMS** has had a very productive physics programme as well as making substantial progress on the upgrade projects and in preparing for Run 3. The LHCC recommends that CMS clearly defines a long-term strategy to deal with the occurrence and implications of leaks in some of the muon-system RPC chambers. The CMS MIP Timing Detector has been designed to provide 30–50 ps timing resolution for minimum-ionising particles, effectively reducing pile-up to Run 2 levels. Its TDR [3] has been updated and improved following the LHCC review in June, providing additional information in key areas such as the clock distribution. Following review by the UCG, the TDR is recommended for approval. The LHCC is pleased to see that the work on the radiation model for HL-LHC, which was started in the context of the MTD review, is becoming a longer-term effort extending to all systems. **The Research Board approved the CMS MIP Timing detector TDR.**
- 4.6 **LHCb** has produced a rich scientific output and made progress on its Phase-I upgrade programme as well as preparing for Run 3 and running beyond LS4. The LHCC commends the collaboration on reaching a major milestone with the operation of the Real Time Analysis at the required HLT1 rate. The committee is concerned about the delays in the UT upgrade project and supports the LHCb and UT managements in considering alternative solutions, should problems appear with the latest version of the SALT chip. The LHCC encourages LHCb to proceed with the preparation of a framework TDR for its Upgrade-II, to be submitted in 2021. The SMOG2 TDR [4] had been recommended for approval by the LHCC at the previous Research Board, but approval had been postponed pending discussion of installation and operational issues with the technical committees

(such as any risk for pollution of the vacuum) and the clarification of the required CERN resources. These discussions had concluded successfully. **The Research Board approved the LHCb SMOG2 TDR. The recommendation to prepare a framework TDR for the LHCb Upgrade-II was endorsed, noting that LHCb is expected to run throughout the HL-LHC era.**

- 4.7 **TOTEM** has made progress on physics analysis and in preparing the TDR for the T2 detector [5]. This will replace the old T2 detector, and will contribute to the acceptance for inelastic events, whose rate is one of the ingredients of the luminosity-independent measurement of the total cross-section using the optical theorem. The LHCC recommends the approval of the TDR. The committee notes that the pending issue of the positioning of the PPS Roman Pot units has become of critical urgency, and a formal documentation must be provided as soon as possible. **The Research Board approved the TOTEM T2 TDR. The LHC Physics Coordinator will follow-up with TOTEM concerning the missing documentation for the Roman Pots positioning.**
- 4.8 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 in each country, under a flat budget requirement. The LHCC strongly encourages the experiments to maintain and even increase their efforts on software and computing model development as the most promising method of reducing the resource needs in the future. In particular, solutions should be searched for that are common to all experiments whenever possible, to further optimise the use of resources and effort.
- 4.9 **FASER** is congratulated by the LHCC on the great progress achieved in all areas of the project. **XSEN** is a new proposal for an experiment using OPERA-style emulsion bricks to measure the cross-section of high energy neutrinos, in particular also ν_τ . Its proposed location is in a mirror position to FASER, on the other side of IP1. FASER is also proposing to add a neutrino detector to their apparatus, FASERv. The two neutrino experiments would be complementary, covering different angular regions, and the LHCC recommends that both submit a Technical Proposal for the LHCC meeting in November. They are encouraged to cooperate with each other on issues of common interest, e.g. the

simulation of particle transport through the machine elements and rock, and its impact on backgrounds and neutrino flux.

4.10 **R&D collaborations:** The LHCC is pleased that, as requested last year, the information and results on the **RD42** website have been updated. The committee encourages RD42 to keep sustaining close links and commonalities with the LHC and future collider infrastructures and experiments, and to take the opportunity of their new collaboration with CMS to gain access to FNAL test beams, in particular while the CERN test beams are in shutdown. The committee considers the structure of **RD50**, with a small but focussed core team and corresponding infrastructure at CERN, and many expert collaborators from around the world, to be an excellent setup; it also considers the working mode of **RD51**, with a small but focussed core team and corresponding infrastructure at CERN, attracting contributions and bright ideas from collaborators around the world, to be excellent. The LHCC strongly supports that the current operation of **RD53** as a single design team be continued and reinforced. The institutions involved are urged to keep the current experienced people fully committed until the end of the project, i.e. until fully functional production chips are available for both ATLAS and CMS. The LHCC recommends continuing all four of the R&D collaborations, including CERN support at the level currently provided, which is crucial to them. **Longer-term extensions were already approved by the Research Board in 2018 for either 3 years (RD42, RD53) or 5 years (RD50, RD51), so no formal prolongation decision is required this time, but the good progress was noted.**

4.11 F. Simon ended his report with general comments that concern more than one experiment. The LHCC is pleased that the frame contract was signed in August between CERN and Hamamatsu for the production of the silicon sensors for the CMS and ATLAS trackers and the CMS HGAL. The committee encourages CERN to keep strengthening its effort and support to the community in microelectronics: special care should be taken that common projects like the lpGBT do not cause schedule delays. The LHCC notes that the CERN contribution as host-lab should be clarified for the coming years as soon as possible between CERN and the experiments, with clear priorities defined. A particularly critical area is infrastructure work related to services (e.g. cooling) for the HL-LHC detectors already under way in LS2, such as the surface building at P5. F. Gianotti commented that

the existing agreement concerning host-lab resources covers the period up to the end of LS2, and that discussions are in progress with the experiments concerning the needs up to the end of LS3, which will be the subject of an updated agreement.

5 REPORT FROM THE INTC MEETING OF 2-3 JULY

- 5.1 K. Riisager reported from the latest meeting of the INTC [2]. There has been a concern with the re-design of the ISOLDE extraction electrode, which encountered difficulties at MEDICIS where a similar implementation was installed. This has resulted in reverting to the previous design for ISOLDE, which has cost some time in the construction of the new front-ends. There is currently a 10-month delay, but this should not delay the final installation. The new tape-station at ISOLDE has now been installed following its commissioning in 2018, and HT modulators have been changed at both front-ends. There have been many activities on the post-accelerator side, including maintenance of the REX accelerator; progress towards the new REX EBIS; consolidation of the LINAC RF and preparation for the installation of the new REX diagnostic boxes. HIE-ISOLDE was affected in 2018 by the performance of the fourth cryo-module, which had a faulty cavity; this has now been repaired in SM18 and is foreseen to return to ISOLDE early in 2020. A programme of “winter physics” has taken place, allowing targets which had previously being irradiated at ISOLDE to be used to deliver long-lived isotopes to a variety of set-ups. LS2 activities at nTOF included installation of a new sweeping magnet in EAR1; both experimental areas will implement recommendations concerning safety from the Swiss and French authorities; the main control room will be moved close to EAR2; and a new electronics laboratory will be installed for the development of detectors.
- 5.2 Most nuclear physics facilities have a time-out policy for approved experiments, and the INTC believes this to be appropriate as general policy. The CERN pattern of runs separated by Long Shutdowns provides a natural time structure, although in special cases longer time-scales may be needed, in which case experiments may request to retain the remaining shifts. The INTC recommends that retained shifts (as discussed in the following paragraph) are approved for the duration of Run 3 and will be cancelled if not taken before the end of the run. **The Research Board endorsed this policy.**

5.3 The review of experiments with outstanding shifts at ISOLDE continued at this INTC meeting. Ten experiments have been recommended to retain shifts: **IS521** (SR-061, 5 shifts), **IS563** (SR-064, 12 shifts), **IS587** (SR-072, 15 shifts), **IS586** (SR-068, 6 shifts), **IS591** (SR-069, 21 shifts), **IS595** (SR-062, 21 shifts), **IS597** (SR-063, 12 shifts), **IS643** (SR-073, 8 shifts), **IS654** (SR-065, 22 shifts), **IS656** (SR-066, 15 shifts). Three experiments have been recommended for closure—any further running would require a new proposal: **IS572** (SR-060), **IS548** (SR-070), and **IS549** (SR-071). **The Research Board approved these recommendations.**

6 REPORT FROM THE SPSC MEETING OF 13-14 JUNE

- 6.1 J. Nash reported from the latest meeting of the SPSC [2], including the annual reports of CLOUD, NA63, NA64 and COMPASS.
- 6.2 **CLOUD** had successful operation and data taking in 2018, and preparations for the 2019 run have progressed well. The SPSC appreciates the science output of the CLOUD experiment and the relevance of its measurements for global climate modelling, and will continue to review the plan of a 10-year programme presented by the CLOUD consortium with the help of external experts.
- 6.3 **NA63** has made progress in analysing the data taken in 2017 and 2018 for the study of the radiation reaction effect using a crystal target, and the SPSC looks forward to the publication of the final results.
- 6.4 **NA64** has updated the analysis of the vector-mediated Dark Matter production in the invisible decay mode, based on the full 2016–18 data sample, and presented preliminary results in the search for a $17 \text{ MeV}/c^2$ X boson decaying to e^+e^- with the 2017 and 2018 data. The SPSC is looking forward to the publication of these results.
- 6.5 **COMPASS** has run successfully for Drell-Yan studies in 2018 and presented first preliminary results from that data set. The SPSC notes with satisfaction the progress on the analysis of the 2016 and 2017 DVCS dataset and looks forward to publications of the preliminary results presented.

- 6.6 The SPSC has received with interest a proposal (P-360) from the COMPASS++/AMBER collaboration for measurements at the M2 beam line of the SPS in 2022, 2023 and 2024. This is considered as a proposal for a new experiment, that could follow the COMPASS experiment after it has completed its approved programme of measurements with deuterons in 2021. The physics programme of AMBER includes measurement of the proton radius, and inclusive antiproton production cross-sections in pp and p-He collisions. The SPSC will further review the proposal. A working group has been established to study the needs and possible coexistence of experiments that have expressed interest in using the M2 beamline during Run 3: AMBER, NA64 and MUonE.
- 6.7 The SPSC has received documents concerning other new proposed experiments and facilities: a Letter of Intent (I-251) from the MADMAX collaboration for searches for Axion Like Particles with a prototype in the SPS H8 beam line, using the Morpurgo magnet; an Expression of Interest (EOI-019) from the NA60+ collaboration for a new experiment at the SPS; an Expression of Interest (EOI-020) from the CENF-Neutrino Detector Forum for a sub-GeV low energy charged-particle beam line in the North Area; and a Letter of Intent (I-252) from the MUonE collaboration for measuring the running of the electromagnetic coupling α through the elastic scattering of high energy muons on atomic electrons. The SPSC will further review the proposed experiments and facilities.

7 ANY OTHER BUSINESS

- 7.1 J.M. Jimenez reported on the status of planning for the rest of LS2. **ISOLDE** has requested to resume operation four months earlier than the initial schedule, in particular to help with their commissioning. F. Gianotti mentioned that there would be a discussion in November with representatives of the LHC experiments concerning possible adjustment of the LS2 schedule, and there may be similar requests from other groups. It was therefore not possible to decide on this change now, but **it should be re-discussed at the next Research Board.**
- 7.2 The **next meeting** of the Research Board will be held on 4th December.

ENCLOSURES

1. Minutes of the 139th LHCC meeting held on 11-12 September 2019 (CERN-LHCC-2019-010/LHCC-139).
2. Minutes of the 61st INTC meeting held on 2-3 July 2019 (CERN-INTC-2019-016/INTC-061).
3. Minutes of the 134th SPSC meeting held on 13-14 June 2019 (CERN-SPSC-2019-029/SPSC-134).

REFERENCES

- [1] Minutes of the 228th meeting of the Research Board (CERN/DG/RB/2019-489/M-229).
- [2] Copies of the transparencies are available at <https://indico.cern.ch/event/839053/>.
- [3] A MIP Timing Detector for the CMS Phase-2 Upgrade TDR (CERN-LHCC-2019-003).
- [4] LHCb SMOG Upgrade TDR (CERN-LHCC-2019-020).
- [5] Upgrade of the TOTEM T2 Telescope TDR (CERN-LHCC-2019-007).