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LHCC-123
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DRAFT

LARGE HADRON COLLIDER COMMITTEE

Draft Minutes of the one-hundredth-and-twenty third meeting held on

Wednesday and Thursday, 23-24 September 2015

OPEN SESSION – STATUS REPORTS

1. LHC Machine Status Report: Matteo Solfaroli
2. ATLAS Status Report: Richard Polifka
3. CMS Status Report: Tulika Bose
4. WLCG and Experiment Computing for Run II: Ian Bird
5. LHCb Status Report: Sean Benson
6. ALICE Status Report: Jan Fiete Grosse-Oetringhaus
7. TOTEM Status Report: Mario Deile
8. LHCf Status Report: Alessia Tricomi

CLOSED SESSION:

Present: S. Bertolucci, C. Bloise, H. Burkhardt, P. Burrows, M. Demarteau, D. Denisov, C. Diaconu, G. Eigen, F. Forti (Chairperson), F. Gianotti*, G. Giudice, B. Gorini, R. Heuer*, T. Kuhr, F. Kunne, M. Lancaster, M. Mangano, L. Mapelli, E. Meschi*, S. Miscetti, P. Newman, B. Panzer-Steindel, B. Ratcliff, C. Sfienti, S. Smith, C. Touramanis*, E. Tsesmelis (Scientific Secretary), T. Ullrich, H. Wilkens, H. Yamamoto.

* part-time

1. EXECUTIVE SUMMARY

Report from the Director for Research and Computing

The Director for Research and Computing reported on issues related to the LHC. He stated that commissioning the LHC at 13 TeV centre-of-mass collision energy is proceeding exceptionally well. The experiments have also started well, with the exception of the concern regarding the contamination of the cryogenic circuit of the CMS solenoid magnet. This first year of Run II is considered to be a running-in year with the commissioning of the new machine and ramping-up of the intensity in view of a luminosity run in 2016.

The emphasis of this LHCC session is on the ATLAS and CMS Scoping Documents for the Phase-2 upgrades. The LHCC position will be submitted to the upcoming Research Board in preparation for the Resources Review Boards in October 2015.

Report from the LHC Programme Co-ordinators

The LHCC heard a report from the LHC Programme Co-ordinators on the plans regarding the proton-proton and heavy-ion running periods for the remainder of 2015. The remaining special run in proton-proton mode for TOTEM and ALFA will include only the 90 m high-β programme and will be held over a 5-day period (data-taking and commissioning), currently planned for Week 42. The LHCC endorsed the plan for the proton-proton run to collect low-energy reference data to be scheduled for a 5-day period (including setting-up, the van der Meer scan and data-taking). The LHCC also endorsed the plan for a further squeeze at the two high-luminosity interaction points at ATLAS and CMS. The final planning for the remainder of 2015 should be made after the full intensity ramp-up, in order to find the best solution to accommodate the low-energy reference data run and the 90 m run considering that priority should be given to commission fully the machine so that the 2016 run is at the highest possible luminosity. The apparent mismatch between the ATLAS and CMS instantaneous luminosity should be investigated.

ALICE

Since the LHCC meeting of June 2015, eight ALICE papers have been published and two have been accepted for publication by journals. A further 17 new papers have been submitted to journals. They cover a broad range of topics in all three collision systems, proton-proton, proton-Pb, and Pb-Pb. Among them is a measurement of the mass difference between deuteron and anti-deuteron as well as between Helium-3 and anti-Helium-3, improving previous measurements by one-to-two orders of magnitude.

ALICE presented their first results from the 13 TeV centre-of-mass proton-proton collision data. More than 30 new results will be shown at the upcoming Quark Matter Conference in Japan.

All detectors of the ALICE experiment are integrated in the online system. All sub-systems and triggers are in operation and the detector shows stable operation and run efficiency. The upgraded Higher Level Trigger (HLT) is fully operational.

The calibration of the new Di-jet Calorimeter (DCAL), installed during Long Shutdown 1 (LS1), is progressing well. Together with the existing Electromagnetic Calorimeter (ECAL) it will allow ALICE to conduct comprehensive di-jet measurements. Both calorimeters, ECAL and DCAL, are now capable of running at 50kHz in Pb-Pb collisions and are thus ready for Run III conditions.

ALICE is taking data since January 2015. During the early beam runs with isolated bunches the experiment accumulated 165M diffractive events. During the 50 ns and 25 ns ramp-up ALICE switched to muon data. For the latter, the experiment also recorded a substantial amount (500M) of minimum bias events. During the remainder of the proton-proton run, ALICE plans to record 4 pb^{-1} muon triggers and 2 pb^{-1} high multiplicity triggers. Currently, ALICE is running at sustained read-out rates of 5 GB/s.

For the 25 ns bunch spacing operation in proton-proton collisions, ALICE needs to level its luminosity to 10^{29} $cm^{-2}s^{-1}$. This is achieved by a beam separation of 5σ. The width was successfully measured in a van der Meer scan. This offset provides stable running conditions and sufficiently low backgrounds.

Planning for a new read-out control unit (RCU2) for the ALICE Time Project Chamber (TPC) started in Summer 2013. The RCU2 would improve the TPC read-out rate by a factor two and would mitigate radiation issues by implementing the full functionality

into single radiation-tolerant FPGA (SmartFusion2 (SF2) from the firm Microsemi). First prototypes showed an unacceptable rate of single event latch-ups in the SF2. A new prototype of the RCU2 with a new pre-production version of the SF2 solved these issues. For testing purposes, one TPC sector was equipped with RCU2 during LS1 and mass production of all boards was started, although the complete FPGA design with full functionality was not completed. After completion of the design, ALICE noticed that the required 4.25 Gb/s cannot be achieved due to timing problems with the SF2 caused by erratic placement of the FPGA elements by the provided vendor software. After an intensive debugging phase, the new RCU2s installed on one TPC sector were replaced by the old RCU1s to provide maximal TPC acceptance for the Pb-Pb run. Further debugging by ALICE and Microsemi experts is continuing but can be conducted in the laboratory. ALICE is confident to solve the issue soon and plans to install all RCU2 units during the upcoming winter shutdown.

To compensate for the higher dead time (factor two in peripheral collisions and a factor three in central collisions), ALICE plans to run a mix of minimum bias and rare triggers, and postponing the recording of central Pb-Pb events with a dedicated central trigger to a later run.

Based on the review of the Technical Design Report for the Online+Offline (O^2) Upgrade, intensive discussion with the proponents, and following the endorsement of the Upgrade Cost Group (UCG), the LHCC **recommends for approval** the ALICE O^2 Technical Design Report defined by the requested budget. In making this recommendation, the Committee is expecting that ALICE will secure the funds asserted in the Technical Design Report and that the O^2 computing arrangements are also acceptable to the WLCG. Moreover, the implementation of O^2 involves several CERN support groups and might require additional personnel, infrastructure and/or costs not covered in the cost presented in the Technical Design Report.. A clear agreement on the division of these responsibilities between ALICE and CERN should be reached prior to the actual implementation of the project.

Following the review of the cost, manpower, milestones, and schedule for the Muon Forward Tracker (MFT), the LHCC **recommends for approval** the ALICE MFT Technical Design Report. Due to its relatively low cost, the MFT cost review was conducted by the LHCC referees and not by the UCG.

ATLAS

The LHCC took note that ATLAS has to date submitted for publication a total of 470 papers from Run I and that the first paper from Run II (on the energy ridge measurement) has been submitted for publication.

The ATLAS detector is working extremely well during Run II. About 0.8 fb^{-1} have been recorded to date.

Following approval by the ATLAS Collaboration Board and endorsement by the LHC Machine Committee (LMC), ATLAS plans to install one arm of the ATLAS Forward Physics (AFP) detector during the upcoming Year-End-Technical-Shutdown (YETS).

Good progress was reported on the Phase-1 upgrades for the Fast TracKer (FTK), LAr Calorimeter, Trigger, and New Small Wheel (NSW).

The LHCC discussed the ATLAS Scoping Document for the experiment's Phase-2 upgrade that updates and completes the ATLAS Letter of Intent submitted in 2012. The ATLAS Reference Scenario (271 MCHF) provides a fully-performant detector capable

of addressing the physics at the HL-LHC. The Reference Scenario provides manageable performance degradation between 140 interactions per crossing, which is the baseline HL-LHC luminosity, and 200 interactions per crossing, which is currently considered as the ultimate HL-LHC luminosity. The limitations of the Low Scenario (200 MCHF) are very apparent, especially in terms of the reduced tracking/muon coverage and its consequences on the physics, offering significantly worse detector capabilities. The Middle Scenario (229 MCHF) is generally less performant than the Reference Scenario, reducing redundancy and robustness of the apparatus and it is noticeably worse in the detector's physics capabilities, especially in the presence of even a small fraction of detector inefficiency. In some physics cases, the reduced detector capability is equivalent to requiring a factor two (Middle Scenario) or a factor four (Low Scenario) in additional luminosity (and thus running time) to compensate for the reduced performance.

CMS

The CMS experiment published 428 papers based on LHC Run I data and recently submitted for publication its first physics paper based on 13 TeV centre-of-mass energy collision data describing the measurement of charged particle multiplicity distributions.

CMS systems, including detectors, trigger, on-line and off-line reconstruction and analysis, are operating well during Run II data collection. Activities during Long Shutdown 1 (LS1) were successful and are providing improved experiment performance in Run II.

The CMS solenoid cooling system is not working stably since March of 2015 and is most probably due to contamination of the system with compressor oil. The magnet itself is not compromised while the cooling system requires often regeneration and allows for only ~50% of 13 TeV collision data to be collected with magnet ON. In parallel with trying various recovery options over the next one-to-two months, CMS, with support from CERN, is planning an extensive clean-up and replacement programme of the cooling system components during the upcoming winter shutdown.

The CMS Phase-1 upgrade is progressing as planned. The LHCC plans an in-depth review of this upgrade at its December 2015 session.

The proposed CMS Phase-2 upgrade is described in the Technical Proposal (representing the Reference Scenario) and two scoping options are described in the Scoping Document. The Reference Scenario with total CORE cost of 265 MCHF is a well-developed proposal that can fully exploit the physics potential of HL-LHC, providing manageable performance degradation between 140 interactions per crossing, which is the baseline HL-LHC luminosity, and 200 interactions per crossing, which is currently considered as the ultimate HL-LHC luminosity. Scoping Scenario 1 (242 MCHF), while preserving the main experiment performance, significantly reduces the CMS physics capabilities, especially in the presence of the unavoidable detector inefficiencies. Scoping Scenario 2 (208 MCHF) has a significantly adverse effect on the HL-LHC physics programme with reductions in coverage and performance that for some channels would require more than a factor of four in additional luminosity, and thus running time, to obtain the same physics measurement precision.

Report from the Upgrade Cost Group (UCG)

The UCG reported on its deliberations regarding the ATLAS and CMS Scoping Documents describing the Phase-2 detector upgrade configurations for three cost scenarios (~275 MCHF, ~235 MCHF and ~200 MCHF). The UCG finds that the cost estimates are very well-developed for this stage of the projects. They are based on experience with successful detectors at the LHC and on an evolution of technologies from the LHC rather than totally new technologies. The Collaborations have worked extremely hard and effectively to understand the scoping trade-offs, capabilities of the collaboration and the funding possibilities. The experiments have also made a large effort on risk analysis and mitigation strategies. An important role in this respect will be played by the development of common, possibly centralized, approaches to large procurements. The UCG recommends that a common approach is developed between the experiments and with CERN regarding the costing of the infrastructure improvements and of the upgrade of the High-Level Trigger (HLT) farms needed for the Phase-2 running.

The position of the LHCC to be submitted to the Research Board and the Resources Review Boards is given in the respective ATLAS and CMS sections above.

LHCb

LHCb operations for Run II have started smoothly. An integrated luminosity of 6 pb^{-1} has been acquired with the 50 ns beam and 60 pb^{-1} has been acquired with the 25 ns beam up to this week. No major problems of the detector were reported.

The LHCb stable running conditions require an average event multiplicity / per bunch-crossing of 1.1, in order to obtain a similar multiplicity per event at 13 TeV as at 7 TeV centre-of-mass collision energies. This is accomplished through luminosity levelling, which for nominal LHC filling corresponds to a luminosity of 4×10^{32} cm^{-2} s^{-1}.

LHCb now has fully implemented the split High-Level Trigger (HLT) with a HLT-1 fast algorithm delivering 150 kHz in output stored in a local disk followed by an online calibration algorithm and a HLT-2 process that uses this calibration to perform an offline-like reconstruction. Out of the final 12.5 kHz, 5 kHz are reconstructed with the offline, 5 kHz use a Turbo-stream and 2.5 kHz are parked. The Turbo-stream saves only HLT-2 information on disk that are promptly used for data analysis. This allows large data reduction and fast access to physics data (turn-around of 24 hours). A physics paper (cross section of J/ψ at 13 TeV collision energy) has been already produced based on this Turbo- stream data.

LHCb physics production is excellent. So far in 2015 the experiment has produced 41 papers. The highlight of this LHCC session has been the observation of the penta-quark.

Much progress was reported on the LHCb upgrade and no major concerns were identified . A general adjustment of the milestones has been performed to better reflect the schedule shift and prolongation of Long Shutdown 2 (LS2) as well as the better understanding of the detector schedule after the Engineering Design Reports.

TOTEM

The LHCC took note of the successful TOTEM running period during Run II. TOTEM performed successfully the alignment and insertion tests at each LHC intensity step, and collected data jointly with CMS during the van der Meer scan in August 2015. All TOTEM detectors and triggers are ready for the β*=90m high-beta run.

Good progress was reported on the CMS-TOTEM Precision Proton Spectrometer (CT-PPS), including for the timing detectors, tracking detectors and DAQ. Readiness for installation during the Year-End-Technical-Stop (YETS) is on the critical path, but installation can proceed during the first Technical Stop in 2016, resulting in an operating detector by Summer 2016.

Installation in the LHC tunnel of the first set of Vertical Roman Pot Timing Detectors will be carried-out during Technical Stop 3 (TS3) in November 2015, making this first stage available for the 2016 LHC special run. TOTEM will mount and test the four-pot detector packages in early 2016 and will install them in the LHC tunnel in Spring 2016.

WLCG

The LHCC took note of the WLCG and experiment computing systems for Run II. Both the WLCG and the computing systems of the experiments were well-prepared for Run II and a successful start-up due to many improvements made during LS1.

Due to the expected increase in data rates in the coming years of LHC operation, new computing models and projects for computing beyond Run II are being investigated. The LHCC plans to organize a dedicated review of the future computing models, in particular for the HL-LHC running, in the second half of 2016.

TEST BEAMS

The LHCC took note of the report from the PS and SPS Physics Co-ordinator on the LHC test beams. A very successful 2015 fixed-target run was reported. The East Area Irradiation Facility (EA-IRRAD) and the Gamma Irradiation Facility (GIF++) in the EHN1 experimental hall are in operation. The 2016 fixed-target schedules include a 30-week proton run at the SPS and a 29-week proton run at the PS. The call for beam-time requests for 2016 will go out soon. The Committee also took note of the successful Beamline for Schools experimental physics project for 2016, undertaken over a 10-day period at the PS.

2. REFEREES

The LHCC referee teams for this session are as follows:

ALICE: C. Bloise, P. Newman, C. Sfienti, T. Ullrich (Co-ordinator)
ATLAS: P. Burrows (Co-ordinator), F. Kunne, M. Lancaster, B. Ratcliff
CMS: M. Demarteau, D. Denisov (Co-ordinator), H. Yamamoto
LHCb: C. Diaconu, G. Eigen, T. Kuhr, S. Miscetti (Co-ordinator)
LHCf, MoEDAL, TOTEM: M. Mangano (Co-ordinator), C. Bloise, P. Newman
LCG: C. Diaconu (Co-ordinator), T. Kuhr, M. Lancaster, H. Yamamoto
Experiment Upgrades:
- General: M. Demarteau (Co-ordinator)
- RD39: G. Eigen
- RD42: M. Demarteau
- RD50: G. Eigen
- RD51: D. Denisov
- RD52: P. Burrows
- RD53: M. Demarteau

3. The LHCC received the following documents:

CERN-LHCC-2015-011	Minutes of 122nd meeting held on 3-4 June 2015
CERN-LHCC-2015-016/A123	Agenda of the 123rd LHCC Meeting – Wednesday and Thursday, 23-24 September 2015
CERN-LHCC-2015-018/UCG-014	UCG Report on the Technical Design Report for the Upgrade of the ALICE Online-Offline (O^2) Computing System (CERN-LHCC-2015-006)

DATES FOR LHCC MEETINGS

Dates for **2015**
2 – 3 December

Dates for **2016**
2 - 3 March
1 - 2 June
21 - 22 September
30 November - 1 December

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