CERN/LHCC-2012-021

LHCC-112

6 December 2012

LARGE HADRON COLLIDER COMMITTEE

Minutes of the one-hundredth-and-twelfth meeting held on

Wednesday and Thursday, 5-6 December 2012

OPEN SESSION I - Status Reports

1. LHC Machine Status Report: Steve Myers
2. LHCb Status Report: Nicola Serra
3. ALICE Status Report: Antonin Maire
4. CMS Status Report: Lucia Silvestris
5. ATLAS Status Report: Andreas Hoecker
6. TOTEM Status Report: Nicola Turini
7. LHCf Status Report: Oscar Adriani

CLOSED SESSION:

Present: U. Bassler, S. Bertolucci, P. Bloch, A. Boehnlein, H. Breuker, J.-C. Brient, P. Burrows, C. Cecchi, M. Demarteau, D. Denisov, C. Diaconu*, G. Eigen, E. Elsen (Chairman), D. D'Enterria, B. Gorini, C. Hawkes, R. Heuer*, W. Kuehn, M. Mangano, E. Meschi, S. Miscetti, T. Mori, A.-L. Perrot, B. Panzer-Steindel, D. Pitzl, R. Roser, T. Sjöstrand, E. Tsesmelis (Scientific Secretary), T. Ullrich

* part-time

Apologies: G. Giudice

1. PROCEDURE

The minutes of the one-hundredth-and-eleventh LHCC meeting (LHCC 2012-017 rev / LHCC 111) were approved.

The Chairman thanked warmly the outgoing members of the LHCC, C. Hawkes, W. Kuehn, A. Nomerotski, D. Pitzl, and T. Sjöstrand for their invaluable contributions to the Committee and welcomed the new members, P. Burrows, D. Denisov, C. Diaconu, G. Eigen, and T. Ullrich.

2. REPORT FROM THE DIRECTOR FOR RESEARCH AND COMPUTING

The Director for Research and Computing reported on issues related to the LHC. He stated that the LHCC will be reviewing the upgrades of the LHC experiments and will be providing its recommendations to the Research Board. To this end, a cost review committee is being created for the upgrades of the LHC experiments and it will be composed of members from the LHCC, the Resources Review Board Scrutiny Group and additional external experts. He underlined that the LHC upgrade is a central element of the update of the European Strategy for Particle Physics. Finally, he also reported that the Scientific Policy Committee (SPC) will be organising a workshop in September 2013 to explore the landscape for the future of the LHC, including the physics prospects and the detector options and synergies in technology.

3. REPORT FROM THE LHC PROGRAMME CO-ORDINATORS

The LHCC heard a report from the LHC Programme Co-ordinators. They reported on the status of the proton-proton run, results from recent special machine developments and runs, the plan for the remaining 2012 period and prospects for the proton-Pb run.

The performance of the LHC remains excellent, with good beam availability and record luminosities being recorded. However, some hardware issues have been identified, particularly associated with faults with wire scanners and beam absorbers. There is also some concern about the TOTEM Roman Pots triggering vacuum perturbations and beam dumps when they are brought to about 14σ to the nominal beam. Moreover, the scheme for providing luminosity to ALICE using satellite bunches does not seem to work reliably any longer. All these issues are under investigation.

The Co-ordinators also provided an update of results from the high-β runs and the van der Meer luminosity calibration scans. Initial studies with the 0.5-1 million elastic scattering events in both TOTEM and ALFA indicate that the Coulomb-Nuclear Interference region may have been reached. Moreover, Gaussian beams without coupling in the horizontal and vertical plane were achieved for the van der Meer scans, a key element for lowering the systematics during these luminosity calibration scans.

The Co-ordinators also reported on the plan for the rest of the 2012 running period and looked forward to the proton-Pb run. The remaining proton run for 2012 consists of a beam scrubbing period and a few days for the preparation and running with the 25 ns LHC beams. TOTEM has also requested a low pile-up data-taking period for diffractive physics. The goals for the upcoming proton-Pb run are to a) collect about 30 nb^{-1} of data (for both the proton-Pb and Pb-proton configurations) and b) collect proton-proton reference data at 2.76 TeV. ALICE, ATLAS, CMS and LHCb are expected to participate in this run.

4. REPORT & DISCUSSION WITH LHC EXPERIMENT UPGRADE REFEREES

The LHCC heard a report from the LHC experiment upgrade referees, concentrating on the LHC 12-year plan, the upgrade plans of ALICE and LHCb and the future LHCC review work for the experiment upgrades.

The referees reported on the ALICE and LHCb upgrade activities and plans. The ALICE upgrade aims to enlarge significantly the physics reach of the experiment through increased coverage, enhanced measurement capabilities and an increase in the data rate. The LHCC has received the ALICE Upgrade Letter of Intent and the ALICE Inner Tracking System (ITS) Upgrade Conceptual Design Report. The submission schedule for 2013-2014 for the Technical Design Reports and addenda to the Letter of Intent was presented. The aim of the LHCb upgrade is to increase the physics reach of the experiment by integrating 50 fb^{-1} of proton-proton data at a luminosity of 2×10^{33} cm^{-2} s^{-1} at 25 ns. The upgrade is based on a 40 MHz read-out into the filter farm, an upgraded vertex detector and higher-granularity inner tracking detectors. For the upgrade, LHCb has submitted to the LHCC a Letter of Intent and a Framework Technical Design Report in June 2012. The LHCC has also received a detailed appraisal on the potential increased physics reach of LHCb through the upgrade. The referees also presented the schedule for the Technical Design Reports. Installation of the LHCb upgrade is expected over 18 months in the years 2018/2019.

Finally, the LHCC heard a summary of the experiment upgrade documents submitted by the experiments and the schedule for reviewing the submitted documents in the coming years.

5. DISCUSSION WITH ALICE

The LHCC discussed the ALICE pp run during the current period. Over the year, the performance of the experiment was severely hampered by background from beam-gas interactions, varying satellite populations and collision conditions. As a result, about 50% of the planned pp events could be collected, corresponding to 5 pb^{-1} rare triggers and 500M minimum bias events. The background situation will be addressed during the long shutdown LS1 by refurbishing the TDI beam absorber, located 80 m from the ALICE interaction point.

During the upcoming proton-Pb running, ALICE plans to run 12 days proton-Pb collisions and 12 days Pb-proton collisions with a maximum luminosity of 10^{29} cm^{-2} s^{-1}, collecting a total number of 10^{8} minimum-bias events and 30 nb^{-1} rare triggers. No significant background problems are expected running with the 500 proton and 500 Pb-ion bunches following the initial earlier test runs.

Since the September 2012 LHCC meeting, ALICE has published three papers. Six papers have been accepted for publication and four papers were submitted to journals. Fourty-four contributions to conferences have been accepted. Many new physics results have been shown during the December 2012 Open Session of the LHCC, which include (i) a study of strangeness enhancement confirming the trend to smaller enhancement at higher collision energies and (ii) first results of $dN_{ch}/d\eta$ and dN_{ch}/dp_T from the proton-Pb pilot run. The LHCC **congratulates** ALICE on these achievements.

Furthermore, the referees presented the ALICE plans for long shutdown LS1. The baseline plan includes (i) adding five Transition Radiation Detector (TRD) super-modules, thereby completing the TRD detector; (ii) installing eight Dijet Calorimeter (DCal) super-modules; and (iii) installing one Photon Spectrometer (PHOS) super-module as well as various detector consolidation efforts. In addition, significant improvements and a consolidation effort regarding infrastructure and services are scheduled, including the replacement of the UPS systems for all the online systems and DAQs. The Committee concluded that the plans are extensive but realistic.

Finally, the LHCC also discussed the upgrade plans currently under study by ALICE. For the Time Projection Chamber (TPC) upgrade with Gas Electron Multiplier (GEM) readout, d*E*/d*x* measurements have been carried out at the CERN PS and preliminary results are encouraging. More detailed results will be presented at the next LHCC session. For the January proton-Pb run, a test for the TPC upgrade in the ALICE cavern is planned. For the Inner Tracking System (ITS) upgrade, a Technical Design Report (TDR) can be expected by September 2013. ALICE will form an internal editorial board for the TDR in January 2013.

The Committee also discussed the additional ALICE detector upgrades currently under study, including a muon forward tracker (MFT), a Ring Imaging Cherenkov (RICH) detector for particle identification at very high momenta (VHMPID) and FOCAL, a forward electromagnetic calorimeter.

For the MFT, simulations show a potential improvement of significance for ψ' by almost a factor of two when compared to running without the MFT. For the VHMPID, the current plan is to combine the detector with the DCal, thus providing a similar coverage. For FOCAL, two options are currently studied - placing the detector at the position of the current Photon Multiplicity Detector (PMD) or alternatively at z=8 m. The latter choice would provide additional space for the installation of an optional hadronic calorimeter.

The LHCC **encourages** further simulation studies to explore the physics potential and technical feasibility of the additional upgrades under discussion.

The following milestones are envisaged: (i) 22 March 2013: internal ALICE decision about additional upgrade projects; (ii) 28 May 2013: submission of the ALICE upgrade Letter of Intent (LoI) to the LHCC with a presentation at the June 2013 session of the LHCC; and (iii) LHCC recommendation at the September 2013 LHCC session.

The Committee is looking forward to receiving the Inner Tracking System TDR and the LoI on the additional ALICE upgrades.

6. DISCUSSION WITH CMS

The LHCC **congratulates** CMS on the publication of its 200th physics paper on collision data and on the continued high physics productivity. The physics priorities of the experiment are shifting towards studying the properties of the newly-discovered boson with the first study of the spin-parity and further updates to information about the mass and the couplings. The SUSY programme has been redirected toward the 3rd generation and other "natural" (*i.e.*, non-fine-tuned) model searches, and a focus is renewed on precision

Standard Model measurements. Preparations for updates and new results at the spring and summer conferences are on track. The physics groups are continuing to provide crucial input to the upgrade projects, with the Level-1 Trigger Technical Design Report as the current short-term goal, while preparations for long-term planning activities are receiving increasing attention for reporting to the European Particle Physics Strategy Group and Snowmass 2013, and to prepare a CMS Phase-2 Technical Proposal by end 2014.

The physics programme in 2013 will be enhanced with the analysis of 2.2 B events of so-far parked data. A prioritised plan for reconstruction is being developed; first samples of multi-jet data for the SUSY group are already being reconstructed. One recent result shows evidence for Z boson production via Vector Boson Fusion, an encouraging milestone for the Higgs VBF studies that will utilise the parked data.

The LHCC **congratulates** CMS for a successful 3-year running period with excellent operations and physics productivity. The CMS Collaboration has collected an integrated luminosity of 21.5 fb^{-1} out of 23 fb^{-1} at 8 TeV delivered for an overall efficiency of 94%. After data certification, 91% overall of the recorded luminosity remains for physics analysis with 96.5% for golden muons.

The data collection efficiency steadily increased over time. This was achieved by carefully analysing the sources of inefficiency and adopting mitigations to solve issues. The development of better monitoring and alarm tools, and the improvement of automatic recovery mechanisms have contributed to increase the efficiency this year. The dead-time during data taking was reduced by a factor two compared to 2011 due to the optimisation of the automatic recovery procedures, and fine tuning of sub-detector operations to run at high pile-up and high Level-1 rates. Another contribution to maintaining this overall efficiency was the introduction of an automatic soft-error recovery system to cope with radiation-induced single event issues. During high instantaneous luminosity conditions and the high Level-1 rate, hundreds of automated recovery events were observed.

At the September 2012 LHCC session, there was a report of the three operational issues in August 2012 that led to a loss of 0.5 fb^{-1}. In summary, one event was a primary cooling failure caused by a faulty temperature sensor. When reconnecting the cold-box, a safety system correctly initiated a magnet fast discharge that then caused serious beam instabilities. In the future, the beam will be automatically dumped in case of a fast discharge of the CMS magnet. Fast discharges warm up the CMS magnet to about 70 K, requiring about a 4-day recovery time. To avoid fast discharges when reconnecting the cold box, this operation is performed since October 2012 at a reduced field of 2 T. The other two episodes were human-initiated and resulted in a laboratory-wide committee report in improved procedures, labeling and improved physical security.

The status of the data collection, detectors, triggers, and offline were presented in detail. The operational channel count continues to be very high. Computing systems are performing well. The High-level Trigger (HLT) rate at the start of fill is roughly 1500 Hz with 600-700 Hz promptly reconstructed, and the remainder is parked. The average data rate is 1 kHz over the entire fill. Accommodating this rate, including the repacking of the parked data, consumes all of the Tier-0 resources, spilling over (by design) into the analysis

resources. For the most part, the production and reconstruction of simulation events required for 2012 data analyses is largely complete. Generally, the computing plans for 2013, including reprocessing with improved calibrations and alignment constants, are on track to support the analysis priorities. Other plans include switching to write out the Analysis Object Data (AOD) format for analysis, which will make better use of the storage space.

On another note, the prototyping activity using the HLT resources as a 'cloud' to provide additional resources during the shutdown is making significant progress. This activity has involved collaborations with ATLAS and cloud middleware providers. The LHCC **congratulates** CMS computing and DAQ for continuing to incorporate new ideas and methodologies and fostering collaboration.

CMS computing continues to plan for running after the long shutdown LS1, with framework changes that will enable better use of computing architectures. With that in mind, CMS computing may face some possibly challenging conditions after LS1. The scale of the challenges depends on some factors which are not known at this point, including the beam conditions which influence the pile-up and the overall CMS HLT output rate. It is prudent to plan for a range of possibilities to enable CMS to make the most of the available computing resources.

The planning for the heavy-ion run is going well. The detector, DAQ and computing configurations for the proton-Pb run have already been successfully tested during the pilot run. The computing and data operations strategy as well as the trigger menus have been set up to fully exploit the maximum proton-Pb luminosity the LHC can deliver. The physics prospects for the 2013 proton-Pb run include nuclear modification factors out to high p_T; charged particle rapidity distributions over a large η range; and quarkonia production with Pb-Pb equivalent statistics. The collaboration with TOTEM continues with the exchange of Level-1 triggers that will enable combined offline analysis.

The planning for the year-end technical stop and the first long shutdown LS1 is well advanced and is progressing in detail. The major tasks for the technical stop are to prepare and reconfigure for the heavy ion run. Tasks include the re-installations of CASTOR and the Zero Degree Calorimeter (ZDC). The ZDC crane will not be commissioned at this time and the reinstallation will use the Palfinger crane, as was done for the de-installation.

The work scheduled for LS1 is considered as underpinning for the long term of CMS. As outlined in previous LHCC minutes, the programme of work has the following major elements: (1) muon upgrades, including the installation of the 4th layer end-cap Cathode Strip Chamber (CSC) and Resistive Plate Chambers (RPCs) and the YE4 shielding wall, plus displacement off-detector of part of the barrel muon electronics; (2) the first stage of Hadron Calorimeter (HCAL) photo transducer consolidation and upgrade (Hadronic Outer HO and Hadronic Forward HF); (3) installation of the 45 mm outer diameter beam pipe, necessary for the subsequent pixel tracker upgrade; and (4) installation of optical splitters in the Electromagnetic Calorimeter and CSC read-out to allow commissioning of the trigger upgrade in parallel to operation. CMS has recently prioritised the work and resources for LS1, however, at this point it appears that all planned activities can be accommodated. The

costs of LS1 common consolidation and upgrade work are estimated at 15 MCHF. For the most part, the funds are in hand, with successful presentations to the October 2012 Resource Review Board, the M&O contributions and the CERN contribution. Currently, there is a shortfall of 2 MCHF of the pledges to the upgrade common fund.

Technical Design Reports (TDRs) for the proposed upgrades to the pixel tracker and to the electronics of the HCAL were presented to the LHCC in September 2012, providing a complete and comprehensive roadmap for delivering the detectors. Following the endorsement of the Pixel and HCAL TDRs by the LHCC at its last session, the cost estimates and funding plans for the projects were presented at the Resource Review Board meeting in October 2012. The proposals were positively received and CMS is in the process of drafting Memoranda of Understanding, with the goal of circulating drafts early in the new year. Both projects will undergo initial CMS Engineering Design Reviews in early 2013. Those reviews will cover technical scope, critical decision points and the schedule for follow-up sub-reviews.

The envisaged Level-1 Trigger upgrade design calls for the signal splitting to be installed in LS1 to allow the new trigger to be developed and commissioned in parallel to operations. The L1 TDR is following the same steps as the Pixel Tracker and HCAL with a Conceptual Design Review, in which an internal CMS Committee reviews project strategy and plan, and technical content of the TDR. The physics performance studies of the established upgrade TDR benchmark channels will be approved by the standard physics group procedures. The cost estimates and funding considerations will be reviewed by the CMS Finance Board. The intention is to complete the document in time for review in the March 2013 LHCC session. This TDR will be structured as a concise stand-alone summary with following sections providing details.

7. TEST BEAMS

The PS and SPS Physics Co-ordinator reported on the LHC test beams. He summarised the excellent performance and operation of the accelerators and experimental areas, resulting in the provision of a large variety of beams that were requested for beam tests for the LHC experiment upgrades for the long shutdowns LS1 and LS2. He also thanked the LHC testbeam co-ordinators for the excellent collaboration in 2012. During LS1 the test beams will be available again in August 2014.

8. DISCUSSION WITH ATLAS

The LHCC **congratulates** ATLAS on its current achievements. Since the previous LHCC session in September 2012, ATLAS had an excellent running period. The detector is performing well and collecting data efficiently with 88% of all data delivered available for physics analysis. The ATLAS Collaboration has moved beyond quoting a significance of the “Higgs-like” particle to measuring its properties and characterising it. There are two issues of note, one that concerns the operation of the current detector system and the other has to do with the construction of the Insertable B-Layer (IBL) that is expected to be installed in the upcoming shutdown. The detector issue that has arisen since the previous LHCC session has to do with the increase in the leak rate of the Transition Radiation

Tracker (TRT). The problem is now no longer just a nuisance; both the leak rate and the number of leaks have increased. Furthermore, in the pending upgrade, an issue was identified with the bump-bonding failures of the IBL. Both issues will be discussed below.

ATLAS has submitted for publication or published 222 papers and 432 conference notes. ATLAS had a successful Hadron Collider Physics conference in Japan where many new results were shown. The Standard Model continues to remain intact and little evidence exists at the moment for signs of new physics beyond the Standard Model. The 2013 winter conferences (Moriond and La Thuile) will be challenging. Each of the conferences is earlier in the year by a few weeks and data taking has been extended into December 2012. The LHC collaborations will have approximately 50% less time to prepare for the winter conferences this year when compared to last. That said, ATLAS does have aggressive physics aspirations with many new updated analyses planned.

ATLAS had collected 21.6 fb^{-1} of 8 TeV data with about 23 fb^{-1} delivered. Data taking efficiency has been steady at about 94% with data quality at 93%. As mentioned above, the TRT is developing a problem.

At the March 2012 session of the LHCC, three TRT detector leaks were reported – one in the end-cap and two in the barrel. These leaks had no impact on data quality and there were no changes in the September 2012 meeting. In the December 2012 LHCC session, the deterioration in the TRT leak was reported. There are now 13 leaks in the system. Most can be controlled but there are a handful now that are difficult to manage. The detector is now losing 150-170 liters of Xenon/day. At the moment, the leaks have not impacted data quality. However, if things continue to deteriorate, then the affected lines will be switched from Xenon to Argon and the TRT electron identification will suffer. The leaks in the end-cap can be addressed in the coming shutdown but those in the barrel region will not. The cause of the leaks remains a mystery though there is speculation that leaks are luminosity dependent and ozone created from the collisions could make the peek pipes brittle and susceptible to leaks. Once long shutdown LS1 starts, the team will be able to examine the leaks in the end-cap and determine the cause and corrective action. In other operational issues, things have been very stable. There have been no changes to the trigger since the September 2012 LHCC session.

Preparations for LS1 are going well. The new beam-pipe has arrived and is now being certified. There are currently 250 work packages that ATLAS expects to execute in the coming 20 months. No decision has been made regarding the replacement of the service quarter panels (SQPs) of the Pixel Detector in order to deal with the potentially problematic optical couplers. Replacement SQPs are now complete and fully tested and ready to be installed. The decision will be made in January 2013 based on the overall level of risk to replace the SQPs versus the risk of trying to install the IBL with the Pixel Detector *in situ*. As mentioned above, there is a problem with the IBL bump bonding – a problem that was not detected during all of the prototyping. The problem is difficult to diagnose – it is only seen with electrical tests, which is the final quality control check – it is not seen during any of the quality control checks throughout the assembly process. The bump-bonding problem is seen for both planar and 3D technologies. The IBL team has recently changed to a new

bump bonding machine/technology and no problems have been detected. Furthermore, a second round of bump bonding with the old technology has not shown problems either. With sufficient spares and still some time, there is every expectation that this problem will be solved and not impact the IBL installation schedule or performance in any way.

Finally in terms of detector operations and shutdown preparation issues, a new set of van der Meer scans were conducted since the LHCC last met. The ATLAS analysis team determined the previous scans taken just before the previous LHCC session were problematic because beam quality was poor (non-Gaussian tails) and there was a coupling between X and Y directions. Beam quality for latest scans was much improved and steps such as reduction in octupole magnet currents were taken to minimise X/Y coupling. Analysis of most recent scans is now underway and the LHCC expects a report at its next session.

The ATLAS offline computing systems are performing well. Their design is sufficiently flexible to respond to changing demands. Most of the 2012 prompt data has been reprocessed and one of the delayed streams is now being processed. A new Monte Carlo framework is under development that will allow greater flexibility; full/fast simulation can be specified within an event at the detector level. In the most recent Resources Review Board (RRB) meeting, the Computing Resources Scrutiny Group (CRSG) stressed that computing budgets will remain roughly flat in the coming years and increased capacity that can be counted on should only be the 20-30% improvements each year as outdated equipment is replaced with more modern versions. Both ATLAS and CMS are working on adapting their software to better utilise the emerging parallel computing architectures, which required significant additional manpower as also stressed by the CRSG report to the RRB.

Finally, in terms of the upcoming shutdowns, a Letter of Intent is currently under preparation for the ATLAS Phase-2 upgrades. LHCC expects to get an advanced copy to read and comment on prior to the March 2013 session.

9. DISCUSSION WITH LHCb

The LHCC **congratulates** LHCb on its current achievements. The LHC produced very stable proton-proton running conditions at $\sqrt{s}$ = 8 TeV in 2012. For a peak luminosity of about 4×10^{32} cm^{-2} s^{-1}, the data-taking efficiency averaged 94.2% by keeping the readout-related dead-time contribution at 2.4%. LHCb reached its target luminosity goal for 2012 by collecting an integrated luminosity of 2.2 fb^{-1} at the beginning of December.

In addition to the standard proton-proton data-taking and before the start of the proton-Pb programme, LHCb has planned to complete various special runs. LHCb already carried out tests at increased luminosity, up to 6×10^{32} cm^{-2} s^{-1}, to emulate as closely as possible the post-LS1 conditions (higher energy corresponds to higher multiplicity), studying rate and event size bottlenecks, checking the detector performance, and identifying any trigger and reconstruction problems. Most detector systems performed well. LHCb encountered some bandwidth limitation on the Tell1 board and found a few farm processors that did not work correctly when running at 450 kHz input rate. LHCb will run up to 10^{33} cm^{-2} s^{-1} to test the

behaviour of specific detector components such as the Muon System. LHCb has collected Minimum Bias events to study event multiplicities, and production cross sections for b-quark jets and other quark jets. The most demanding test consists of operating LHCb with a 25 ns bunch crossing. LHCb aims to run with μ=1 and expects to obtain the existing detector performance with 25 ns bunch crossing after LS1. LHCb will check the efficiency of the present trigger configuration and will collect J/ψ and D_s events with a few pb^{-1} of collected statistics.

After completing a successful pilot run in September 2012, LHCb will participate also in the upcoming proton-Pb run, which is planned with a β^* squeeze in LHCb of 2 m. Realistic luminosity estimates range between 2 and 6×10^{27} cm^{-2} s^{-1}. The foreseen trigger will imply no bias, sending all beam-beam crossings to Higher Level Trigger (HLT). LHCb plans to exploit both the proton-Pb and the Pb-proton configuration in the detector, which satisfy quite different physics interests.

The LHCC **congratulates** the LHCb Collaboration for their high-quality physics results. To date, LHCb has produced 82 articles that have been submitted, accepted or published in refereed journals in comparison to 67 articles presented at the previous LHCC meeting. One of the highlights consists of the first evidence of the very rare decay $B^0_s \rightarrow \mu^+\mu^-$. Using a data sample of 2.2 fb^{-1}, consisting of 1 fb^{-1} of fully reprocessed 2011 data and 1.2 fb^{-1} of promptly processed 2012 data, LHCb measures a branching fraction of 3.2×10^{-9} with 43% statistical and 15% systematic uncertainties. This 3.5σ significant result is in excellent agreement with Standard Model predictions and contributes to limit the new physics parameter space. Many other physics results using 2011 data are still in progress. Since the reprocessing of the 2012 data is scheduled for completion by January 2013, many results planned for the winter conferences will include the 2012 data. Furthermore, LHCb will update analyses and test new ideas with newly implemented stripping lines. In 2013, LHCb plans also to promptly process the collected proton-Pb data and start a 2011 data reprocessing. A reprocessing of the full data set (2011 and 2012) will be achieved in 2014.

After the LHCC endorsement of the LHCb upgrade, as shown in the Framework Technical Design Report (FTDR), the Collaboration has kept working on the preparation of sub-systems TDRs and started preparing the Memoranda of Understanding (MoUs) for the upgrade. The MoU for the Common Items has already been presented to the Resources Review Board (RRB) in October 2012 while the sub-system MoUs will follow the individual TDRs. The RRB has responded requesting the LHCb Collaboration to provide an overall provisional funding situation. The LHCb upgrade resource board, URB, is addressing this issue and interactions with funding agencies are in progress. The funding agencies need to understand both the total amount of core contribution from each agency and specific details of the spending profile. The URB expects to have an overall view of the situation for April 2013. Questions about manpower issues were posed during this LHCC session. LHCb replied that they are confident to manage the situation due to the large collaboration size and to the positive trend of new joining institutions. Moreover, the two-year shutdown period will free people from other obligations while the assignment of responsibility for large items will follow the final choice of alternative designs. In order to

improve the control over the TDRs, a new working document is being written in which all milestones will be defined for each sub-system and for the common items. The LHCC agrees that this will be a useful tool for the referees, the review committees and the collaboration to closely follow the progress in the upgrade.

The upgrade meeting focused on two big issues: the Vertex Locator (VELO) and the scintillating fibre (SCiFi) option for the Central Tracker.

Concerning the VELO, LHCb presented a full system report where they showed many details on simulation, cooling options, RF foil, sensor and readout chains. A critical issue is the proposal of reducing the VELO active area from an inner radius of 7.5 to 5.1 mm. Though the VELO will indeed gain a large factor on interaction point resolution, the closer proximity to the beam may cause some issues due to an increased exposure to wake fields, which LHCb foresees to overcome with a RF-shield milled from a single slab of aluminium. LHCb, however, is confident that their design will work due to their operational experience of the VELO in the past years and due to detailed knowledge of the location of detector obtained by surface tomography via reconstruction of nuclear interactions. The presentation of this proposal occurred at the LHC Machine Committee (LMC) meeting on 12 December 2012 and the feasibility will be further discussed. The schedule for the VELO is proceeding well. Both options for the sensors expect to have a TDR ready by the third quarter of 2013.

LHCb addressed the feasibility of the SCiFi option for the Central Tracker focusing on problems related to radiation hardness of the selected fibres and silicon photomultiplier (SiPMs). LHCb have tested the scintillating fibers (SCSSF78 of 250 μm diameter) before and after irradiation to a dose equivalent to 50 fb^{-1} by measuring the response and attenuation length after illuminating the fibre with UV light. They observed a relative light loss (after/before irradiation) of a factor of three at the far edge of the fibre. This provides a marginal light yield working point. These results, however, can be ameliorated by using a mirror at the fibre end. The radiation hardness of SiPMs is still under study. Different samples of Hamamatsu SiPM arrays are being irradiated with proton and neutron sources to reach an equivalent dose of 50 fb^{-1}. A compilation of all acquired data will be available for January 2013.

The LHCC appreciates the work accomplished by the LHCb Collaboration on the upgrade so far and expects to have an update of the funding situation as soon as it will be presented and discussed at the next RRB.

10. DISCUSSION WITH TOTEM

The LHCC welcomed the release of articles documenting the complete and final analyses of the cross section measurements at 7 TeV and of total crocs-section at 8 TeV using the luminosity-independent method. The results show an excellent overall consistency of the independent measurements, which provide the most accurate determination of total, elastic and inelastic cross sections at these energies, with a precision on the total rate just below 3%. TOTEM showed also preliminary studies of the elastic scattering distributions in the region of $|t| <$ few $\times 10^{-3}$ GeV^2, obtained from the data collected during the successful run at

8 TeV with a β* of 1 km. The data show a clear evidence for the onset of the interference between Coulomb and nuclear amplitudes. Finally, the Committee was briefed on the status of the analysis of the data taken jointly with CMS, which include the measurement of the $dN_{ch}/d\eta$ over the acceptance of the CMS Tracker and TOTEM T2 telescope, as well as the study of the dijet invariant mass spectrum in dijet events with protons tagged by the Roman Pot detectors. The Committee **congratulates** TOTEM for these achievements, and looks forward to the completion of all the ongoing analyses.

Special runs at low β* were conducted in November 2012 to test the insertion limits of Roman Pots at high luminosity. In collision mode, the limit with a single Roman Pot was achieved at ~30σ, when a beam dump was triggered. Subsequently, and with separated beams, three Roman Pots were inserted without problems down to 14σ. However, following this successful test, the LHC beams were dumped several times, in spite of the Roman Pots resting in their garage position. Studies to understand this behaviour have started, and were planned to be continued during possible beam time at the very end of the 2012 operations. Joint TOTEM and CMS data-taking, aiming at the measurement of electromagnetic and diffractive proton-nucleus interactions at energies never studied before, will also take place during the coming proton-Pb run at 5 TeV expected in January-February 2013. The Committee counts on an update on the result of these studies at the next meeting.

TOTEM has presented the plans for the activities during long shutdown LS1. The planning of the activities relative to the removal of the T1 and T2 telescopes, and the reinstallation of T1, have been coordinated with and approved by the CMS technical management. Technical issues for the removal of the T1 include the availability of cranes, and the limited exposure time allowed near the activated beam pipe. Repairs on the T1 and T2 are foreseen: the replacement of the 11th card and checks on the cooling circuits of T2, and for T1 the replacement of 20-30 VFATs showing a loss of synchronisation. This will be done in the Roman Pot area at surface building SX5. The plan for the Roman Pot detectors presented at the previous LHCC meeting is confirmed: complete removal of the stations at 147 m, and use of their detectors as spares. Part of these Roman Pot detectors, after being equipped with fast-timing and pixel detectors, could then be installed in a new region at 200 m from the interaction point. This upgraded Roman Pot system should allow to do tracking and sub-10 ps timing in conditions of low-β* and high luminosity, appropriate for the study, jointly with CMS, of hard processes in diffractive and double-pomeron collisions. The upgrade plan is being discussed with CMS, which is expected to provide its assessment by the end of 2012.

11. DISCUSSION WITH LHCf

The LHCC **congratulates** the LHCf Collaboration for the continued progress in the analysis and the work done so far for the preparation for the future 14 TeV proton-proton run as well as for the proton-Pb run in 2013.

For the 14 TeV proton-proton run, the LHCf Arm1 detector has been completely reassembled after the replacement of plastic scintillator with GSO in the calorimeter. After reassembly in Florence, the detector has been put in a test beam with muons, electrons and

protons at the SPS during summer 2012. Performance studies of the upgraded detector have been carried out, showers in longitudinal and lateral directions have been reconstructed and detailed analysis of the overall performance is ongoing. The Arm2 detector will follow the same procedure of upgrading during 2013 after the proton-Pb run.

Saturation problems in silicon sensors, when the photon energy is greater than 1.5 TeV, have been observed. The problem is related to the dynamic range of the electronics. A solution has been found proposing a new bonding scheme: the floating strip of the silicon sensor has been connected to ground. In this configuration the pulse height of the signal is slightly reduced (by a factor 1.5), but the solution will be adopted for new modules, since at 14 TeV saturation could be an issue.

The Arm 2 detector, not yet upgraded, has been also put in the same beam test in order to check the energy scale.

A known shift in the π^0 mass reconstruction (by 3.8%) has also been studied and a temperature dependence has been observed. During the beam test, the temperature has been controlled using a chiller and changing its temperature from 18 to 33 °C the π^0 mass shift has been reproduced. Arm2 shows a dependence of about -0.25 % per °C consistent with the temperature coefficient of the used photomultipliers.

The Arm2 detector will be reinstalled in the TAN absorber for the proton-Pb run during the year-end technical stop just after the end of the proton-proton run. In order to maximise the physics outcome from this run, contacts with ATLAS Collaboration have been established and an agreement for a common trigger and data sharing has been reached. LHCf will send its Level-1 trigger signal to ATLAS. This will allow the experiment to benefit from the knowledge of the impact parameter (centrality) in the proton-Pb collision in order to disentangle between models when studying spectra distribution.

For the proton-Pb running mode, the LHCf detector arm on the proton remnant side will take good data in every condition but would benefit from some special runs with optimal conditions for β^*. In particular, a β^* larger than the nominal value of 0.6 m would result in a small beam divergence projection at LHCf and to a better transverse momentum measurement. The Collaboration has requested some runs at β^* of 11 m. The discussion with the machine groups suggest that the LHC will run with a β^* of 3 m. (new proposed nominal value instead of 0.6 m). The LHCf Collaboration was requested by the LHCC to evaluate if this proposal is acceptable and what is the impact on the momentum measurement. The LHCf detector arm on the Pb remnant side will need to be slightly moved vertically in order to be outside the core of the neutrons produced at zero degrees. If moved vertically, the detector could still collect good data with a reasonable number of hits. This point is still under discussion with the ATLAS Collaboration.

12. REPORT AND DISCUSSION WITH THE LCG REFEREES

Since the September 2012 LHCC session, the Computing Resources Scrutiny Group (CRSB) has reported to the October Computing Resources Review Board meeting. The SRSB recommended small adjustments, at the 5% level, but otherwise approved the requests for computing resources in 2013 and 2014 as made by the four collaborations.

The pledges generally match the requirements to within about 10%, except that ALICE has an overall shortfall of about 30% and LHCb has a shortfall of about 20% for storage at Tier-1 sites. Problems have arisen if a site has been unable to meet its pledge, and then other sites have reacted by scaling down their pledges in order to maintain their provision at the same fraction of the overall resources. This leads to a downward spiral of resources provided, which propagates from one year to the next. ALICE has been affected by this in the past (now corrected) and it has impacted on LHCb this time. Sites should continue to provide their share of the overall requirements, rather than of the final pledges.

ALICE expects to complete reconstruction of the 2012 data by January 2013. Work continues to manage within the resources available, by deleting old data files, reducing the numbers of copies and using the Analysis Object Data (AOD) data format for analysis. Movement away from separate end-user analysis towards “analysis trains”, along with improved analysis tools and data buffering, has helped to improve the overall ALICE efficiency from 62% in September to 86% in November. Excellent network provision through LHCone and very good performance at all sites has allowed ALICE to make efficient use of storage and CPU resources at all levels, blurring the boundaries between different Tiers. There will soon be a new ALICE Tier-1 site in Korea, and good progress has been made towards another new Tier-1 site in Mexico.

ATLAS has consistently high CPU usage and is close to filling the disk space, especially at Tier-1, but will manage through improved monitoring, cleaning and placement strategies. Reprocessing of data has almost finished, and reprocessing of the delayed streams is planned. 2.5B Monte Carlo events have been fully simulated and 1.2B events produced using the fast simulation. ATLAS plans to use fast simulation more in the future. A full reprocessing of data and Monte Carlo is planned for 2013, to benefit from better reconstruction and simulation quality, and a further reprocessing is foreseen for 2014 to use the evolved data format for high-energy data. Many improvements are being worked on to speed up the code, lower the memory footprint and optimize the analysis workflow.

CMS computing has performed well and made full use of the available resources. Data complexity and instantaneous luminosity are high, leading to large volumes of data and simulation. Analysis activity remains high, but is difficult to fit within the available Tier-2 disk space. Better use of popularity information (usage frequency) would help in the choice of what to clean up to free space. CMS currently records 700 Hz of parked data, averaged over a fill, with 2.2B parked events collected so far in 2012. Reprocessing of 2012 data will start as soon as final calibrations are available. Simulated data is produced at 400M events per month. The next generation of analysis tools is being tested.

LHCb started full reprocessing of the 2012 data in September, using most of the available resources, and allowing only 30% of new raw data to be processed for data quality and calibration purposes. Monte Carlo events are produced mostly at Tier-2 sites, but also at lower priority at Tier-0 and Tier-1 sites when available. Further reprocessing passes are planned for 2013 and 2014. As anticipated, LHCb is short of tape storage, but this has been mitigated by removal of non-CERN archival copies at some Tier-1 sites, an additional 1 PB

of tape provided by RAL, and a loan of tapes from ALICE, if required. Pledges of LHCb disk space for 2013 fall below the requirements, for the reasons discussed above.

In April 2013 the EMI and EGI-Inspire-SA3 projects will finish, followed by the end of EGI-Inspire in April 2014, with no prospect of equivalent funding in the near future. This will result in a reduction of staff at CERN working on Grid-related activities and requires a re-prioritisation of the remaining effort. In addition to maintaining operational support, the focus will be on work towards common solutions that will be of benefit to more than one experiment.

The LHCC **congratulates** the Worldwide LHC Computing Grid (WLCG) team and the experiments on their continued impressive performance. In preparation for the next phase of LHC running, after Long Shutdown 1 (LS1), the LHCC requests that the current working of the computing models be documented, along with the anticipated changes for the higher-energy data. This should include the expected evolutions of the respective computing models, plans for the exploitation of new technologies, such as modern CPU architectures, and the use of common tools and strategies, as well as any differences. As far as possible, the same terminologies and tables should be used, to allow a clear comparison among the different experiments. The aim is to have a report ready for the Computing Resources Review Board meeting in October 2013, which means that a good draft should be available for discussion at the LHCC meeting in September 2013.

13. CLOSE-OUT WITH THE DIRECTOR-GENERAL AND DIRECTOR FOR RESEARCH AND COMPUTING

The LHCC informed and discussed with the Director-General and the Director for Research and Computing the status of the experiments and their plans for the future. The discussion concentrated on the status of the LHC machine and experiments, the activities for the upgrade of the experiments and the sustainable funding the computing in the long term.

14. ANY OTHER BUSINESS

Following the highly successful events in 2011 and 2012, the LHCC agreed that the next LHC experiment student poster session will be held on Wednesday, 13 March 2013. As for the past sessions, the LHC Physics Centre at CERN (LPCC) will organize this year’s event.

15. REFEREES

The LHCC referee teams for this session are as follows:

ALICE: J.-C. Brient, D. D’Enterria, W. Kuehn (Co-ordinator), T. Ullrich (Co-ordinator 1.1.2013)

ATLAS: U. Bassler, P. Burrows, C. Cecchi, D. Pitzl, R. Roser (Co-ordinator)

CMS: A. Boehnlein (Co-ordinator), M. Demarteau, D. Denisov, T. Mori

LHCb: C. Diaconu, G. Eigen, C. Hawkes, S. Miscetti (Co-ordinator), T. Sjöstrand

TOTEM, LHCf, MoEDAL: U. Bassler, C. Cecchi, D. D’Enterria, M. Mangano

LCG: A. Boehnlein, J.-C. Brient, C. Diaconu (Co-ordinator 1.1.2013), C. Hawkes (Co-ordinator),T. Mori, T. Sjöstrand

Experiment Upgrades:

General: J.-C. Brient, D. Pitzl (Co-ordinator), M. Demarteau (Co-ordinator 1.1.2013)

RD39: D. Pitzl, G. Eigen

RD42: M. Demarteau

RD50: G. Eigen

RD51: D. Denisov, W. Kuehn

16. The LHCC received the following documents:

Minutes of the one-hundredth-and-eleventh meeting held on Wednesday and Thursday, 26-27 September 2012, CERN-LHCC-2012-017 / LHCC-M-111

Letter of Intent for the Phase-II Upgrade of the ATLAS Experiment, CERN-LHCC-2012-022/LHCC-I-023

DATES FOR LHCC MEETINGS

Dates for **2013**

13-14 March

12-13 June

25-26 September

4-5 December

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