

LARGE HADRON COLLIDER COMMITTEE

Minutes of the one-hundredth-and-thirteenth meeting held on
Wednesday and Thursday, 13-14 March 2013

OPEN SESSION - Status Reports

1. LHC Machine Status Report: John Jowett
2. CMS Status Report: Colin Bernet
3. ATLAS Status Report: Brian Petersen
4. ALICE Status Report: Davide Caffarri
5. LHCb Status Report: Thomas Blake
6. TOTEM Status Report: Joachim Baechler

CLOSED SESSION:

Present: U. Bassler, S. Bertolucci, P. Bloch, A. Boehnlein, H. Breuker, H. Burkhardt, P. Burrows, C. Cecchi, M. Demarteau, C. Diaconu, G. Eigen, E. Elsen (Chairman), D. D'Enterria, G. Giudice, B. Gorini, E. Meschi, S. Miscetti, T. Mori, B. Panzer-Steindel, R. Roser, E. Tsesmelis (Scientific Secretary), T. Ullrich

Apologies: J.-C. Brient, D. Denisov, M. Mangano, A.-L. Perrot

1. PROCEDURE

The minutes of the one-hundredth-and-twelfth LHCC meeting (LHCC 2012-021 / LHCC 112) were approved.

The Chairman welcomed H. Burkhardt (Beams Department) to the Committee.



2. REPORT FROM THE DIRECTOR FOR RESEARCH AND COMPUTING

The Director for Research and Computing reported on issues related to the LHC. The performance in 2012-2013 of the LHC machine has been outstanding, delivering integrated luminosities exceeding considerably the expectations for the proton-proton running and matched by record peak luminosities. The LHC proton-proton and Pb-ion operations periods until early 2013 are being followed by the Long Shutdown 1 (LS1) in 2013-2014 for repairs and consolidation of the LHC machine and injectors. The experiments have also entered a phase of repairs, consolidation and upgrades. Following the re-start of the LHC after LS1, in the years 2015 to 2017 the LHC will be operated with an initial energy of 6.5 TeV/beam and which will be progressively increased to 7 TeV/beam with increased intensities and luminosities. It is expected that the LHC will re-start with a 25 ns bunch spacing, and with a fall-back option of 50 ns spacing. Moreover, ATLAS and CMS are proposing an increased output trigger rate to up to 1 kHz for post-LS1 operations. The increase in the corresponding bandwidth is a concern and the computing model needs to be re-visited. Over recent months, the update of the European Strategy for Particle Physics has been prepared, with a view to define the community's direction for the coming years and to prepare for the long-term future of the field. Finally, the SPS and PS Committee has received proposals for a neutrino facility at the SPS North Area. Implications for LHC operations and for test beams are being studied.

Additionally, CMS and ATLAS have jointly initiated the High Luminosity HL-LHC Experiments ECFA Workshop that will also include participation from LHCb and ALICE. The goals of the workshop include identifying key performance parameters and technical questions and establishing areas of technical focus for detector, triggering and computing R&D. Moreover, there will be discussions of the benchmarks necessary to estimate the physics potential and demonstrate Phase-2 scientific capability. A steering committee has been established and the meeting format currently includes a day-long organisational meeting in June 2013 with a three-day workshop planned for October 2013.

3. REPORT FROM THE LHC PROGRAMME CO-ORDINATORS

The LHCC heard a report from the LHC Programme Co-ordinators. They reported on the 2012 and 2013 LHC running periods and reviewed plans for LHC operations as of 2015 following the Long Shutdown 1 (LS1).

In proton-proton mode during 2012, the LHC machine delivered an integrated luminosity exceeding 23 fb^{-1} to each of the experiments, ATLAS and CMS, and with a record instantaneous luminosity of $7.73 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$ at a centre-of-mass energy of 8 TeV. The LHC machine also ran successfully in proton-Pb and Pb-proton modes and physics data was collected by the LHC experiments. Machine availability has been excellent, although increased instances of stops were reported due to hardware issues resulting from a long operation period with reduced maintenance periods. The LHC machine was also operated at a centre-of-mass energy of 2.76 TeV in proton-proton mode for the experiments to collect reference data for the Pb-ion runs. The Co-ordinators also reported on the beam scrubbing runs against the build-up of electron cloud effects and of a pilot physics run with beam bunches separated by 25 ns. There is a strong request from the LHC experiments to start

operations in 2015 with a 25 ns bunch spacing, while keeping the 50 ns as an option only in case of major difficulties. The Co-ordinators also reviewed additional features for the 2015 running period: ALICE operation in proton-proton mode with a 25 ns bunch spacing needs further studies, special runs are scheduled for LHCf and TOTEM, and the heavy-ion programme consists of Pb-Pb collisions at 13Z TeV.

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 and the upgrade plans of ALICE, ATLAS and LHCb.

The referees reported on the upgrade of the ALICE Inner Tracking System (ITS) and Time Projection Chamber (TPC). ALICE has an aggressive upgrade plan for the ITS and TPC, both in terms of technology as well as schedule as it needs to be completed by about 2018. The progress is impressive and is undertaken by dedicated and focused teams. The Technical Design Report (TDR) for the ITS upgrade will be submitted to the LHCC for its session in September 2013. The combined TDR covering the upgrade for the Transition Radiation Detector (TRD), the Time-of-Flight Detector (TOF), the Photon Spectrometer (PHOS) and the Muon System is scheduled to also be submitted to the LHCC for its session in September 2013.

The Committee also heard a report on the status of the LHCb upgrade for the Scintillating Fibre Tracker and detector common electronics. The LHCb Collaboration is making rapid progress on all fronts. The LHCC took note of the LHCb report concerning the insufficient manpower to carry out the upgrade of the Trigger and DAQ upgrades. Detector requirements are still being developed, notably for a number of ASIC electronics, and the physics implications must be understood through comprehensive simulations.

The referees also reported on the ATLAS Letter of Intent (LoI) for the Phase-2 upgrade (CERN-LHCC-2012-022; LHCC-I-023). The Phase-2 upgrade builds on the Phase-1 upgrade and is a long-term evolution of the current ATLAS detector. The ATLAS Collaboration has done a tremendous job putting together a well thought-out plan for the upgrade into the LoI.

5. DISCUSSION ON NEW R&D LETTERS OF INTENT

The LHCC received submissions of two Letters of Intent for detector R&D: a) on the development of pixel read-out integrated circuits for extreme rate and radiation (CERN-LHCC-2013-002 / LHCC-I-024) and b) on 3D sensors and micro-fabricated detector systems (CERN-LHCC-2013-003 / LHCC-I-025).

Given the challenges of the high-luminosity LHC, the Committee welcomes the common approach to addressing some of the critical experimental issues. The Committee would like the proponents of the two R&D initiatives to proceed to the next step and to give a presentation at the June 2013 session of the LHCC to describe the programme in more detail. The LHCC will evaluate the request at this session within the context of the LHC upgrade programme and the Committee will provide feedback shortly thereafter.

6. LHC EXPERIMENT STUDENT POSTER SESSION

An exhibition of student posters was held in Building 40 and covered students' work on a wide variety of LHC physics topics. The LHCC Members had ample opportunity to interact with the students and there was broad participation in the event from interested parties. As for the previous such sessions in 2011 and 2012, this event was again deemed to be a great success and is expected to be repeated in future.

7. DISCUSSION WITH ATLAS

The LHCC considers that ATLAS has made excellent progress in all aspects of the experiment and the Committee **congratulates** the ATLAS Collaboration on its achievements. The highlight of the recent period has been the further understanding of the recently-discovered new particle that is consistent with a Higgs boson.

ATLAS changed its management team on 1 March 2013. Dave Charlton is the incoming Spokesperson, Beate Heinemann and Thorsten Wengler are the two Deputy Spokespersons, Beniamino Di Girolamo is the Technical Coordinator and Fido Dittus is the Resources Coordinator.

Physics

ATLAS has submitted or published 240 papers with collision data to date with a total of 470 conference notes. Approximately 30 new and updated analyses were shown at the Moriond Conference, including a full update of Higgs decays in the vector boson channels. Spin-parity 0^+ is favoured, and the signal strength continues to look Standard Model-like. ATLAS expects to release many more search results with the full data set in the coming weeks and months.

ATLAS published its 2011 luminosity paper with a final 1.8% uncertainty. The 2012 uncertainty is 2.8% but will be reduced as the differences between the various relative luminosity estimators versus time are better understood.

Operations

The ATLAS detector reached the end of LHC Run I operating well. ATLAS has completed a very successful 2012 proton-proton run, during which the LHC machine delivered an integrated luminosity to ATLAS exceeding 23 fb^{-1} . Around 90% of all proton-proton data delivered is good for physics analysis. ATLAS also completed a very successful proton-Pb run at the start of 2013 (with 95% efficiency). A very important few days of low-energy proton-proton running at the start of 2013 and 13 pb^{-1} of proton-proton collision data with 25 ns bunch spacing were also accumulated. The Long Shutdown 1 (LS1) is underway and the ATLAS detector is being opened up.

Computing

ATLAS is using its computing resources fully. In preparation for Run II, the experiment is reviewing its analysis model in an attempt to merge derived analysis formats back into the Analysis Object Data (AOD). ATLAS is planning a 1 kHz trigger rate for 2015. This will enable them to maintain current trigger thresholds in the expected higher energy and higher luminosity environment. With this 1 kHz trigger output rate, the challenge is to use substantially less CPU per event, and to gain more in terms of storage. The experiment is trying to reduce the number of copies of data in order to fit within a “flat” computing budget.

Long Shutdown 1

The experiment has two significant challenges to deal with during the LS1 in addition to the consolidation plans and installation of the Insertable B-Layer (IBL): 1) remove the Pixel Detector to install new Service Quarter Panels (SQPs) to provide better access to the read-out opto-boards, and 2) address the Transition Radiation Tracker (TRT) leaks in the end-cap.

There was not a significant change in the TRT leak rate since December 2012. However, the experiment did fill a few small sections of TRT with argon during the proton-Pb run with some positive effect on the electron identification in those regions. The working hypothesis is that the leaks result from brittle plumbing caused by ozone either at or close to the elbows. ATLAS is optimistic that the end-cap leaks can be fixed during LS1, but the ones in the barrel are inaccessible.

The decision to remove the Pixel Detector and bring it upstairs to replace the SQPs and prepare for IBL installation was made on the basis of risk. It was deemed a much safer operation to do that than to install the IBL support tube *in situ*. Furthermore, not replacing the SQPs has been estimated to impact the b-tagging efficiency by 20% or more by the end of the decade. Finally, after careful studies and measurements, the experiment decided to remove insulation material between the central region of the IBL and the beam pipe, being convinced that its presence is not necessary for safe cooling of the detector during the beam-pipe bake-out. A bump-bonding problem for the IBL modules has been resolved, although the original cause is not fully understood. The production has now been switched to a more modern bump bonder that is solderless. This is working well thus far. The time lost solving the bump-bonding problems means the IBL schedule is tight but achievable.

There are more than 250 work packages that are planned for execution during LS1. The main project includes the IBL and SQP installation. The Tracker will also get a new evaporative cooling plant. There will be new power supplies installed in the calorimeter, new muon chambers, and a rework of the cryogenic and electrical systems. The ATLAS teams are working 12-hour shifts from 7am to 7pm leaving overnights and weekends as contingency.

Upgrades

The experiment presented the LHCC with its Phase-2 Letter of Intent (LoI). The LoI covers the upgrades planned for installation in the early 2020s, during Long Shutdown 3 (LS3), in preparation for the High-Luminosity LHC (HL-LHC) phase of operation. The LoI content is consistent with previous presentations and discussions. The physics case includes improving substantially the measurements of the Higgs boson properties, as well as significantly increasing sensitivity to new physics. The upgrades are well motivated. They are designed to handle the HL-LHC machine goals, maintain complete physics reconstruction capability and partially even improve the resolution. The case is compelling.

ATLAS intends to replace the inner tracker, adapt the calorimeter read-out for the high luminosities, add a track trigger, upgrade the forward calorimetry (if conditions require it), and maintain as far as possible the current trigger thresholds. The various detector upgrades are of varying sizes and degree, with the inner tracker taking more than half the required resources. The entire CORE cost of the upgrade is estimated to be 230 MCHF.

Detector options are spelled out in the LoI while exact technologies and final detector configurations are not yet chosen. The LoI describes a technically sound and realistic programme with the options and risks well defined. The upgrades are well matched to the HL-LHC physics programme and its new and challenging environment. The LoI provides

an excellent summary of the planned design and will allow the ATLAS Collaboration to proceed to the next steps, including continuing R&D where needed to consolidate the remaining options. The LHCC **supports** the continuing exploration of innovative solutions, in particular in the areas of sensors and front-end processing, especially in cases where early technology decisions are not needed.

The LHCC **welcomed** the LoI, which provides excellent guidance for the required R&D and which is well motivated by the required physics capability of the detector. The Committee **fully endorses** the strategy outlined and recognises the urgency for R&D on the technologies, both because of sheer scope and because of their innovative character. The overall plan will be presented to the Resources Review Boards and Funding Agencies to support the R&D. Technical Design Reports for each upgrade are expected in the coming years, which will describe the technology selection and outline the particular physics benefit for that detector implementation.

8. DISCUSSION WITH CMS

The LHCC considers that CMS has made excellent progress in all aspects of the experiment and the Committee **congratulates** the CMS Collaboration on its achievements. The highlight of the recent period has been the further understanding of the recently-discovered new particle that is consistent with a Higgs boson.

Physics

CMS is in the midst of an intense period of activity spanning multiple areas for harvesting the full 2011-2012 dataset for physics. CMS has solid plans for accomplishing the major physics objectives. Forty analyses were approved for the 2013 Moriond conferences with another eighteen analyses expected to be approved imminently. CMS has 224 publications, with 18 in preparation, and has completed a long-range assessment of analyses that will be taken to publication. Timely completion of full dataset analyses with final alignments and calibrations is a priority to enable groups to shift effort towards preparations for LHC Run II as the shutdown progresses. Preliminary combined CMS and TOTEM results on diffractive dijet production and inelastic $dN_{\text{ch}}/d\eta$ are expected before summer 2013.

Operations

The CMS detector reached the end of Run I operating well. CMS has completed a very successful 2012 proton-proton run, during which the LHC machine delivered an integrated luminosity to CMS exceeding 23 fb^{-1} . A very important few days of low-energy proton-proton running at the start of 2013 and proton-proton collision data with 25 ns bunch spacing were also accumulated.

The positive effect of the CMS automated recovery campaign to improve overall data-taking efficiency is clearly seen in the 2012 proton-proton data collection, where 93.5% of the luminosity delivered by the LHC to CMS was recorded (compared with 90.5% in 2011). It is encouraging to note that the Level-1 Trigger and the High-Level Trigger (HLT) were able to run with negligible dead-time up to the highest luminosities, always with full physics acceptance. 94.8 % of the recorded 2012 data have subsequently been certified as golden quality. For the 2013 proton-Pb data collection, 98.2% of delivered luminosity was recorded, with 97.5% of this recorded data certified as golden. Similar figures of 98.2% (98.4 %) were achieved for the 2013 low energy proton-proton data.

The Physics Performance and Datasets (PPD) group had a big impact in its first year of existence. The PPD coordinated and reviewed the validation efforts of the Detector

Performance Group (DPG) and the Physics Object Group (POG) to assure a high certification efficiency and physics performance.

The Long Shutdown 1 (LS1) is underway and the CMS detector is being opened up.

Computing

The data reprocessing is on schedule with 20k processor cores used in parallel at the Tier-1 centres plus the CERN Tier-0 resources. There has been some reconfiguration of several of the larger Tier-2 centres to accommodate reconstruction of simulation events. On another note, the prototyping activity using the High Level Trigger (HLT) resources as a Cloud to provide additional resources at the scale of an additional Tier-1 during the shutdown is making significant progress. This activity has involved collaborations with ATLAS and Cloud middleware providers. In parallel, CMS is conducting its first test of large scale opportunistic computing temporarily using 8k processor cores at the San Diego Super Computing Center to process some of the 2013 parked data.

On 21 February 2013 Academia Sinica, Taipei, informed the CERN Director-General that they intended to withdraw support for CMS as a Tier-1 and as a Tier-2 at ASGC due to a loss of some funding and a lack of CMS physicists in Taiwan.

Long Shutdown 1

The work scheduled for LS1 is considered an underpinning for the long-term operation of CMS. 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 Chamber (RPC) detectors and the YE4 shielding wall, plus the upgrade of the M1/1 CSC front-end electronics and displacement to outside the cavern of part of the electronics of the barrel muon Drift Tube detector; (2) the first stage of the Hadron Calorimeter (HCAL) phototransducer consolidation/upgrade (for the Hadron Calorimeter Outer HO and the Hadron Calorimeter Forward HF); (3) installation of the 45mm outer diameter beam pipe, necessary for the subsequent Pixel Tracker upgrade; and (4) installation of optical splitters in the Electromagnetic Calorimeter (ECAL) and CSC read-out to allow commissioning of the trigger upgrade in parallel to operation and (5) installation of a new central DAQ system (DAQ2) addressing the replacement of computing and network equipment which has reached the end of its life cycle and the support of sub-detectors with new μ TCA back-end electronics.

The highlights of the on-going work include reviews of the CSC upgrade. The ME4/2 construction is going well and some concerns were identified with the ME1/1 construction, notably, the feasibility of the cabling plan due to a choke point on the nose. Additionally, some patch panels and read-out boards still need to be produced. For the chambers themselves, the increased current leads to a small low voltage margin that constrains future firmware. The status of the RPC upgrade is that 17 RE4 chambers have been produced at CERN and in Ghent. The preliminary test of those chambers demonstrates a plateau and very low current and noise.

The components for the replacement of Photomultiplier Tube (PMT) and Silicon Photomultiplier (SiPM) photon detectors for the HF and HO are at CERN and are undergoing quality control. The μ TCA back-end electronics had a successful slice test using prototype boards in parallel with the regular data stream using optical splitters during the proton-Pb run.

A key priority for the shutdown is enabling the Tracker to eventually operate with a coolant 30 degrees colder than its current operating temperature. This intervention, designed to

mitigate the damaging effects of radiation, is an essential part of the programme aimed at maintaining the performance of the tracking system up to a delivered integrated luminosity of around 500 fb^{-1} , after which replacement will become necessary. The preparatory work is going according to plan. The refurbishment of the cooling plant is going well and installation of new racks and pipe distribution and dedicated sniffer lines are on schedule. The new high performance dry gas plant has arrived at CERN and vapour barrier sealing concepts have been developed. In addition to this work, the shutdown period will be used for maintenance of the existing Pixel Detector, to evaluate the installation of a new Pixel Detector, and to get the evaporative cooling infrastructure ready for the new Pixel Detector. The aim is to be able to install the new Pixel Detector in an extended year-end Technical Stop in 2016-2017 within a period of about 4.5 months.

Radiation levels in the pit are a hindrance but not a concern. The individual dose levels in the first few weeks were well within the target range. However, decay times have been measured that are longer than expected, indicative of the presence of unknown materials.

Preparations for Run II are well underway with programmes of work being established by the technical and physics analysis groups. The HLT group has begun reviewing the online reconstruction of physics objects, aiming at improving their resolution and bringing it closer to the offline level, thus reducing the impact of tighter cuts. The use of more advanced algorithms may require an increase in the computing power of the HLT filter farm. With the improved algorithms in place, work in 2014 will be devoted to the physics filter optimisation and menu design. Additional dedicated manpower will be assigned during this time period to update infrastructures such as DAQ-related interfaces and configuration database infrastructure.

A high priority task for the Offline during LS1 includes rewriting of the core software to support different levels of parallelism to make better use of emerging computer architectures. Plans to improve the simulation include optimising CMS's use of Geant4 as well as commissioning data mixing (to simulate pile-up effects) for the FastSim and finishing the implementation for FullSim. Development is also needed to support physics and detector studies for the Phase-1 and Phase-2 upgrades. In terms of adapting algorithms for higher luminosity and energy, there will be new tracking algorithms and tuning of existing ones. The algorithm that only uses silicon clusters for seeding the iterations, for example, is under evaluation for the effect of increasing the tracking cluster charge thresholds. Such modifications will have consequences that will lead to retuning the tracking and Particle Flow algorithms.

For Run II, CMS is currently preparing for the possible need to continue to write out data from the HLT at 1 kHz in order to preserve thresholds, particularly for the Higgs research programme. The ramifications to the offline computing are estimated to be roughly a factor of 12.5 increase in offline CPU due to changes in the beam conditions. To counteract that factor in the context of the CMS request for computing resources submitted to the Computing Scrutiny Group and the CMS Resources Review Board, CMS anticipates algorithmic improvements as well as a limiting of full dataset re-processing to year-end technical stops. The latter provides stability for analyses while enabling the use of some Tier-1 resources for prompt processing during data collection. Other compromises could include reducing the number of Monte Carlo events generated per logged event and using the HLT farm as a computing resource during the year-end Technical Stops. These and other anticipated improvements leave the net effect of a factor of two increase needed for the Tier-0 and Tier-1 CPU plus ~30-50% for Tier-2 in 2015 plus a modest increase in storage. As the needs for 2014 are modest, the increase could be accommodated by combined spending of the 2014 and 2015 computing budgets in 2015.

Several other computing system activities are planned for the long shutdown to achieve a more flexible computing system such as deploying an *xrootd* based data federation that will allow sites to fall back to an alternate location while allowing users to interactively access anything stored on disk. Improved disk management at Tier-1 centres could increase the flexibility of where workflows can run, and to allow opening the Tier-1 centres for analysis workflows. Additional automation of data management could achieve a more dynamic system.

Upgrades

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. The last TDR, the Level-1 Trigger System TDR, has been reviewed by the CMS Collaboration and is currently being prepared for wider distribution after responses to the Collaboration comments are incorporated. Additionally, physics studies with a realistic trigger menu are being completed. The document contains a complete technical description. The motivation for the upgrade to the Level-1 Trigger system is to preserve excellent performance for searches, precision Higgs studies and heavy-ion physics during higher luminosity running expected after LS1. The TDR outlines projected trigger rates and representative physics studies to demonstrate the need for the upgrade. The 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 project organisation, cost and schedule are summarised in the TDR and the cost & schedule are now under internal review. The TDR is expected to be delivered to the LHCC shortly and will be reviewed prior to its June 2013 session.

The fifth focal area is the preparation for the Phase-2 upgrades. CMS is developing detector concepts to serve as baselines for a Technical Proposal in 2014. The simulation efforts required to support this activity have begun with a target to produce samples during summer 2013 to test concept designs, with the possibility of studying a few benchmark channels. More comprehensive physics studies are expected in the Technical Proposal.

Finally, the LHCC reviewed the upgrade plans for the forward region. CMS is reviewing proposals to implement a high-precision proton spectrometer, which could include collaboration with TOTEM. The progress of this review process will be reported to the LHCC at its session in June 2013.

9. DISCUSSION WITH TOTEM

The LHCC **congratulates** TOTEM for their successful physics runs and for the experiment's physics results.

Physics

The LHCC took note of the new data analyses currently being carried out by the TOTEM Collaboration, including the measurement of the nuclear-Coulomb interference at $t < 0.002 \text{ GeV}^2$ (with proton-proton data at 8 TeV taken during the $\beta^* = 1 \text{ km}$ run), and the soft single-diffraction t -distributions in proton-proton collisions at 7 TeV. Moreover, the Committee welcomed, in particular, the advanced stage of two measurements collected during common CMS and TOTEM data-taking in proton-proton collisions at 8 TeV: (i) inelastic $dN_{\text{ch}}/d\eta$ over the acceptance of the TOTEM forward T2 Telescope and the central CMS detector, and (ii) diffractive dijet production with protons tagged in the TOTEM Roman Pot (RP) detectors. Preliminary combined CMS and TOTEM results for both these topics are

expected before summer 2013. The Committee **congratulates** both Collaborations for the excellent progress.

TOTEM collected data during the proton-Pb run at 5.02 TeV in January-February 2013 together with CMS. The T2 Telescope and the vertical RPs (aligned and operated at a distance of 4.5σ and 13σ from the beam in the proton direction, respectively) collected a few hundred million events in both proton-Pb and Pb-proton configurations. A few million events were also collected (with the T1 and T2 Telescopes and the vertical RPs positioned at a distance of 4.5σ , 13σ and 22σ from the beam, respectively) during the short intermediate-energy proton-proton run at centre-of-mass energy 2.76 TeV, just before the LHC Long Shutdown 1 (LS1).

Operations

As a summary of the 2012-2013 run campaigns, TOTEM stressed that the RP alignments and insertions are now carried out without beam losses or other problems, that the alignments are performed rapidly (record time of 1h30 for eight RPs), and that the insertions in standard fills were fully automated. However, the experiment regretted that the opportunity for an insertion of the horizontal RPs to study further the heating/vacuum effects observed in October / November 2012 was not fulfilled, and that physics in high-luminosity fills (8 TeV, $\beta^* = 0.6$ m) with the RPs was not obtained. TOTEM presented simulation studies that show that the RP temperature increase due to the LHC beam and the LHC vacuum degradation in the RP147 and RP220 regions, could be solved by optimising the RP ferrite and RP housing, respectively.

Consolidation and upgrades

TOTEM provided a detailed description of the consolidation and upgrade plans, to be carried out during LS1. The consolidation work approved by the Collaboration includes: (i) the removal of the RP147 stations and patch panels (allowing installation of the TCL4 collimator), (ii) the relocation of the RP147 stations (with Si-strip detectors rotated by 8° to improve tracking performance) to the ± 210 m region, and (iii) the exchange of ferrites of all RPs to avoid beam-induced heating and vacuum degradation. Associated work-packages and scheduling had been defined with all relevant CERN groups.

Upgrade plans for the RP stations have also been reviewed by the LHCC. TOTEM proposes the installation, in a few months during LS1, of two new additional RP horizontal stations in the ± 220 m region, followed by the integration of new pixel detectors in the relocated RPs in the ± 210 m region, as well as of new timing detectors in the ± 220 m horizontal RPs (downstream relative to the tracking detectors to avoid the large material budget of the former). The new tracking and timing detectors can be installed inside the RPs during end-of-year Technical Stops after LS1 (as the installations require a vacuum break).

The physics case of the upgrade plans was only generically justified as having the goal to be capable of doing diffractive and exclusive (gluon- or gamma- induced) physics at low β^* and high luminosity. TOTEM will present the required upgrade project documentation (Letter of Intent and Technical Design Report) to the LHCC following deliberations with CMS on similar forward-physics plans (including tracking and timing detectors in the LHC tunnel). TOTEM insisted that, in any case, the present RP220 stations must not be affected by any upgrade activity, until the high- β special runs after LS1 are complete and the approved baseline TOTEM physics programme is fulfilled.

The specific request from TOTEM to the LHCC with respect to the experiment's consolidation plans includes the following points:

- Relocation of the RP147 full station to upstream of RP220, which would allow for enhanced physics opportunities for a minimal cost through improved proton momentum tracking by a simple 8° rotation.
- Provision of services and infrastructure (patch-panels and cooling) for the installation of possible new RP stations at 220 m to host detector upgrades such as the pixel and timing detectors currently under discussion with CMS.
- Installation of the TCL6 collimator during LS1.

The LHCC concluded that the consolidation requests seem reasonable as all work-packages are ready and there is enough time available during LS1. The TOTEM upgrade plans, however, require further deliberations. In particular, the LHCC requests the submission of precise physics motivations for the upgrade, including associated simulations for all relevant measurements that also address key detector performance issues such as the expected tracking momentum and timing resolutions. The convergence with the CMS upgrade plans for the forward region needs to be finalised on a short time-scale given that preparing all required upgrade documentation (Letter of Intent, Conceptual Design Report and Technical Design Report) before the end of LS1 is a challenging goal. CMS has promised to provide its own upgrade plans for the forward region by the LHCC session in June 2013.

10. DISCUSSION WITH LHCb

The LHCC considers that LHCb has made excellent progress in all aspects of the experiment and the Committee **congratulates** the LHCb Collaboration on its achievements.

Physics

The LHCb Collaboration has published about 100 physics papers. Many new exciting results have been shown, such as the measurement of new B_c decay modes, the J^{PC} measurement for the $\chi(3872)$, the first search for mixing-induced CP violation in $B_s \rightarrow \phi\phi$, the observation of the rare charm decay $D \rightarrow \pi\mu\mu$ and a search for Higgs-like particles. However, the recent highlight was the status report on the CP violation in the charm system. LHCb updated the pion-tagged analysis using 1 fb^{-1} of fully reprocessed data compared to the previous analysis using 600 pb^{-1} done with fast processing. The significance for ΔA_{CP} was reduced from $>3\sigma$ to 2σ . Furthermore, a new muon-tagged channel was added that yields a positive value for ΔA_{CP} . The new world average only has a significance of 2.2σ and thus does not confirm the evidence for CP violation in the charm system. The reprocessing of the full dataset has been completed. Most of the results for the summer conferences will be based on this new dataset. Another important work in progress is the implementation of different detector geometries for the study of alternative technologies in the LHCb simulation. This was accomplished together with the choice of four physics channels to be used as a baseline for the comparison. A new document on the LHCb upgrade physics and trigger is being prepared that will serve as supporting documentation for the upgrade reviews.

Operations

The LHCb experiment has completed its 2012-2013 data-taking period with special proton-proton, proton-Pb, and Pb-proton runs. For the proton-proton collisions, the most important special runs were the physics runs at 25 ns (2.56 pb^{-1}) and at high luminosity (5.55 pb^{-1}), both having been acquired with the magnet down polarity. Considering the increase in average multiplicity, the running at $5\text{--}6 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$ at 8 TeV is equivalent to running at

$4 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$ at 13 TeV so that these tests can shed light on the experiment performance in Run II starting in 2015. The reconstruction of (i) $B \rightarrow J/\psi K, K_s$ (ii) $J/\psi \rightarrow \mu\mu$ and (iii) $D \rightarrow K\pi$ has been compared in different running conditions. The background level, resolution and reconstruction yields are essentially unchanged with respect to the standard LHCb running. The only noticeable exception is in events of type (iii), where the yield at 25 ns is better than that for standard running. However, the yield at high luminosity is slightly deteriorated. These changes are related to the current RICH performance with respect to the channel occupancy.

LHCb integrated 1.4 nb^{-1} (0.6 nb^{-1}) of proton-Pb (Pb-proton) collisions and the detector performed well in the very busy high-multiplicity environment. The reconstruction of K_S , Λ and Λ_{bar} shows very clean signals emerging over a uniform combinatorial background. In the Pb-proton runs, the combinatorial background is almost a factor of three larger than that in the proton-Pb runs due to the detector acceptance. By injecting Ne in the SMOG system, LHCb also succeeded to record a short Pb-Ne run, which is equivalent to collisions with a center-of-mass energy of 54 GeV.

Long Shutdown 1

The LHCC reviewed the Long Shutdown 1 (LS1) activities for LHCb and focused on three high-priority goals: i) how to retain the knowledge acquired so far in running the detector; ii) how to improve the running conditions, and iii) what running conditions can be tolerated at the start-up of Run II. Concerning the first goal, a dedicated workshop will be organised on a regular basis and in the second half of 2013 additional commissioning weeks will be held. In this long shutdown period, experts will carry out continuous improvement on monitoring, triggering and data quality. During Run II, running conditions are assumed to be 25 ns bunch crossing (lower average number of interactions per crossing, μ), a levelled luminosity of $4 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$ and 13 TeV energy (yielding a higher multiplicity and higher b-quark and c-quark production cross-sections). It is clear that the increase in cross-section and multiplicity requires an improvement in data quality, a refinement of the High-Level Trigger (HLT) and a higher CPU usage. Thus, a discussion on a new computing model has started. In the current model, the prompt processing was done on 100 % (30% from June 2013) of the collected sample followed by a lengthy procedure of alignment and calibration of the detectors and a dedicated reprocessing. The new proposal is to change the order, i.e. run the calibration (and the Data Quality Monitoring) on a 100 Hz dedicated express stream, store the data waiting for the calibration to be completed and then run the full reconstruction. This avoids the prompt processing, *i.e.* reduces the CPU needs but increases the need for disk and tape.

Upgrades

The LHCb upgrade is advancing well. After the LHCC endorsement in September 2012 and Research Board approval in November 2012, the LHCb Upgrade Resource Board is addressing resources and funding from the agencies. So far, from informal feedback from funding agencies, the Collaboration expects to count on about 70% of the requested funds. This will be a continuous process that will take at least five to six additional months before completion. A clearer and more official status will be available in April 2013. The manpower of the Collaboration is also increasing with new groups joining from the USA, Netherlands and Italy, thus improving the potential and strength of the Collaboration. In the meanwhile, the document on the upgrade milestones for the Technical Design Report (TDR) of the subsystems has been released to the LHCC. So far, the number of milestones reached is consistent with expectations. In the next months, however, the slope (number of milestones/month) will dramatically increase. Just as an example, at least three other major

pre-TDR reviews are expected in the next six months, together with a final decision on the electronics architecture for the sub-systems. The LHCC confirms that the milestone document is a useful tool for referees and the Collaboration for monitoring the progress on the upgrade.

The LHCC has reviewed plans for the Scintillating Fiber (SCiFi) Tracker and the DAQ.

- For the SCiFi upgrade, an external independent review was carried out to determine the viability of this option. The basic question was the radiation hardness of the scintillating fibers (Kuraray SCSF-78MJ) and of the Silicon Photomultipliers (SiPM). Radiation damage of the scintillating fibers was found to increase logarithmically with dose. Extrapolating the light-yield loss to 50 fb^{-1} , the worst damage is located at the fiber end close to the beam where the light yield is reduced to 28% with respect to light yield observed at the end close to the SiPM. However, by selecting signals within a narrow time window and by adding a mirror on the end close to the beam, the light yield can be almost fully (80%) recovered. For the SiPM, a comparison between Ketek and Hamamatsu demonstrated that the Ketek photosensors have better Photon Detection Efficiency than the Hamamatsu type and that they still can be operational at a dose produced by a luminosity of 50 fb^{-1} . The external review concluded that radiation damage is not a show-stopper for this option and urged the proponents to carry on with the necessary R&D: constructing a Module-0 at full length (2.5 m) and completing the design for the front-end electronics (FEE) and the overall detector. In this respect, the review was positive and LHCb is considering replacing the overall Outer Tracker with a SCiFi tracker.
- An independent technical review also was carried out for the DAQ and Front-end Electronics (FEE) system. The upgrade architecture is based on the 40 MHz read-out of the FEE. This is accomplished by means of modified FEE boards (with zero suppression) linked to a 40 MHz acquisition board, TELL40, that has a rate control from an external Low Level Trigger and transmits data to the HLT farm. The reviewers found that the obsolescence of the old system should be addressed and reviewed. They advocate the need for buffering on the TELL40 board and to organise the TELL40 firmware. They also suggested of using links from the TELL40 to the DAQ. The risks connected with the very tight schedule for the ASICs were also shown. A strengthened and enlarged collaboration is crucial for this item.

The LHCC **congratulates** the LHCb Collaboration for its success in being compliant with the upgrade milestones and hopes that this continues smoothly also in the very busy schedule expected next year.

11. DISCUSSION WITH ALICE

The LHCC considers that ALICE has made excellent progress in all aspects of the experiment and the Committee **congratulates** the ALICE Collaboration on its achievements.

Physics

Since the December 2012 LHCC meeting, ALICE has published one paper on long-range angular correlations in p-Pb collisions, and submitted five papers to journals. Of those, two present results from pp collisions, and three on data from Pb-Pb collisions: centrality determination, the centrality dependence of π , K, p production, and charge correlations. The LHCC **congratulates** ALICE on these achievements.

Operations

The LHCC **congratulates** ALICE on the completion of a very successful proton-Pb run. With the minor exception of a magnet polarity change during the Pb-proton configuration, all goals were achieved or even exceeded. Over a four-day period during which the LHC luminosity at the ALICE interaction period was levelled at $5 \times 10^{27} \text{ cm}^{-2} \text{ s}^{-1}$, ALICE recorded 10^8 minimum bias events with a running efficiency of 96% and a saturated detector read-out rate of $\sim 1 \text{ kHz}$. During the high-luminosity run with peak luminosities slightly in excess of $10^{29} \text{ cm}^{-2} \text{ s}^{-1}$, ALICE collected 31.9 nb^{-1} . Despite an extremely high load on the detectors, that at times exceeded that of the 2011 Pb-Pb run by a factor 3.5, all detectors performed satisfactorily. To compensate for the shortening of the proton-Pb run by one day (to accommodate the $\sqrt{s} = 2.76 \text{ TeV}$ proton-proton reference run), two very successful ALICE-only fills were performed by optimising the pattern of colliding bunches.

ALICE conducted a careful evaluation of the various subsystems during the proton-Pb run, monitoring the frequency and causes for data-taking interruptions. Frequent problems with the Time-of-Flight (TOF) system were identified early and were solved during the run. The most frequent Single Event Upsets (SEUs) were related to the Muon System and to the Time Projection Chamber (TPC). The Muon System read-out electronics suffered from SEUs that are presently not or only partly recoverable in an automatic way. Special investigations on this are scheduled during LS1. The TPC electronics also suffered from some SEUs that were difficult to recover quickly, but interruptions due to TPC chamber trips were not negligible. The latter are hard to avoid for wire chambers in a hadron collider environment and tuning and observing TPC trip conditions will stay with ALICE in the future. All detector issues that were observed during the proton-Pb run are now followed up in detail.

The LHCC is very pleased with the achievements of ALICE during the proton-Pb run and looks forward to the completion of the on-going data analyses. The proton-Pb run is of special importance for the heavy-ion programme at the LHC since it provides crucial insight into initial state and other cold matter nuclear effects. These results will help verify that the observed signals attributed to the QGP in Pb-Pb collisions are in fact final- and not initial- state effects.

Long Shutdown 1

The plans for LS1 were presented in detail by ALICE at the LHCC session in December 2012. The three major work projects are (i) the completion of the Transition Radiation Detector (TRD) by adding the last 5 supermodules, (ii) the installation of the Dijet Calorimeter (DCal; 8 supermodules) including the support structure and support beams, and (iii) the installation of an additional Photon Spectrometer (PHOS) supermodule. These main projects are accompanied by numerous detector and infrastructure consolidation efforts, such as the replacement of the UPS uninterrupted power supply system, chilled water upgrade at LHC Point 2, and L3 magnet ventilation upgrades. After four weeks of access the works are progressing according to schedule: The L3 magnet doors are open since 2 March 2013, the Photon Multiplicity Detector (PMD) and PHOS have been taken out, and numerous items were removed from the mini-frame such as RB24 beam pipe and supports, the zero-degree electromagnetic calorimeter ZEM, the ADA, the Beam Loss Monitors (BLMs), and the Beam Condition Monitor (BCM). The DCal installation tooling is in place. ALICE expressed slight concern about the on-going production of the remaining 5 TRD modules as a delay in the production of electronic boards might affect the installation schedule.

Upgrades

ALICE is following an aggressive upgrade schedule. The upgrade programme so far comprises (i) a new low-mass high-resolution Inner Tracking System (ITS), (ii) an upgrade of the TPC with the replacement of the Multi-Wire Proportional Chamber (MWPC) with Gas Electron Multiplier (GEM) detectors and new pipelined read-out, (iii) read-out electronics upgrades of the TRD, TOF, PHOS, and Muon System, and (iv) upgrades of the online, high-level trigger, and offline systems. ALICE is planning to submit Technical Design Reports (TDRs) for items (i)-(iii) by September 2013 and the TDR for the latter item by the end of 2014. The decision on additional upgrades is imminent (end of March 2013). Internal Letters of Intent (LoIs) were submitted to the ALICE Collaboration on 15 February 2013 for 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. Depending on the final decisions by the ALICE Management and Collaboration Board, the additional approved upgrade project(s) will be submitted to the LHCC by 28 May 2013 as addenda to the existing ALICE LoI. ALICE plans to submit the corresponding TDR(s) by the end of 2014. Eighteen institutions expressed their interest in participating in the Time Projection Chamber (TPC) upgrade. The writing and study teams for the TPC TDR are in place and editors and writers are assigned to the various chapters. The same holds for the ITS upgrade. The project organisation for the ITS is largely in place and most sub-projects have a coordinator assigned. The LHCC recommends assigning coordinators to the remaining sub-projects in a timely fashion.

ALICE reported several changes to their electronic read-out upgrade plans since the December 2012 LHCC meeting: (i) the Muon System will not be read out upon a muon trigger but upon a minimum bias trigger, the muon trigger chambers will be used as a muon identifier only, (ii) the TPC and Muon Tracking Chambers will now use a common front-end chip, and (iii) the intention to use a Common Readout Module for at least the ITS, TPC, and Muon Tracker. ALICE plans to have a final decision on the read-out architecture by June 2013. So far no editors and writers for the TDR are assigned. Although the document will be shorter than that for the ITS and TPC upgrades, the LHCC recommends that the ALICE Collaboration puts the editorial team in place soon.

ALICE made good progress on the TPC R&D, presenting test results that indicate that the dE/dx resolution with a 3-layer GEM stack is close to that of a MWPC. Observed ion backflow levels at the desired gain of 1000-2000 are still too high ($\sim 1\%$), but ALICE is optimistic that the targeted 0.25% is achievable. Further tests with 4-layer stacks and alternative gases will be made soon. Silicon pixel R&D is making excellent progress. An engineering run was recently submitted to produce 25 wafers with many chip variants for further testing. Two test beam campaigns at DESY are planned. The LHCC congratulates ALICE, especially the R&D teams, for impressive overall progress.

12. REPORT AND DISCUSSION WITH THE WLCG REFEREES

The WLCG continues to operate very well. The LHCC **congratulates** the WLCG and the experiments for the efficient data processing and for the successful completion of the first LHC running period.

The completion in April 2013 of the European projects – the European Middleware Initiative EMI (for middleware) and the European Grid Initiative EGI-SA3 (for support to communities of heavy computing users) - will have a significant impact on CERN groups supporting the experiments. In the short term, the measures are oriented towards the optimisation and consolidation of activities at CERN, including re-prioritisation of

functions and common solutions on WLCG operations, service and support. These improvements have already started, but there is a gap of about one year between the funding programmes. In the longer term, the overall organisation needs to take into account the new features expected from the continuation of the European Union funding programmes. In particular, the multi-disciplinary aspects are considered as a necessary ingredient of the future European Union funding programmes and they have to be considered during the building of the next round of project proposals.

Experiments General

The LHC experiments have expressed their satisfaction concerning the availability of WLCG resources in the past year, which made possible the timely processing of the largest LHC data sample collected thus far as well as the completion of a large number of physics publications in 2012.

The LHCC noted some changes in the distribution of resources distribution: The Tier-1 at ASGC (Taiwan) will stop to deliver resources for CMS as a consequence of reduced funding. Two new Tier-1 centres are being implemented, namely KISTI (Korea) as resource provider for ALICE and Russia (JINR and Kurchatov) for all four LHC experiments. New resources are planned for ALICE from Mexico, which together with KISTI will provide 7-8% of the ALICE needs.

In general, the profile of the expected needs for resources in the 2013-2015 period are influenced by the imbalance between the moderate requirements over the shutdown period followed by a significant increase for 2015. The levelling requested by the funding agencies needs to be carefully implemented, such that the longer-term perspectives are not jeopardised and the production of physics results continue with similar efficiency as in the past years. The increase in the request for resources for 2015 are mostly due to the scaling factors induced by the increase in cross-sections, off-time overlays etc. and there are several ideas on how to reduce the usage of resources by optimising the computing models. The LHCC has recommended in its session in December 2012 a coordinated action to update the computing models before the start of LHC running in 2015 and work has started along these lines. The LHCC will monitor closely the technical improvements as well as the physics studies which have to underline the decisions for data taking configurations after Long Shutdown 1 (LS1).

The WLCG resources are complemented during the shutdown by using the available resources from the High-Level Trigger (HLT) farms of the experiments. The LHCb farm is already in production and delivered close to 50% of the CPU for Monte Carlo production in January 2013. Technical developments are actively pursued by ATLAS and CMS using Cloud-like software to aid deployment, integration, and future reconfiguration of farms. These efforts will lead to significant gains, but the farms will not be continually available during LS1 due to various upgrades and interventions.

In addition, ATLAS and CMS have used non-standard resources in an opportunistic mode. CMS profited from a few weeks of running at the San Diego Supercomputer Centre (SDSC), while ATLAS had access to the Amazon Cloud resources. This demonstrates the advantage of being prepared to rapidly make use of such resources (e.g. via Cloud interfaces and smartly packaged and deployable services).

The LHCC **congratulates** the WLCG and the experiments for the efficient data processing and for the successful completion of the first LHC running period. It encourages the experiments to continue the optimisation of their computing models in preparation for the next running period and to pursue the studies on the impact on physics. A common

document on computing is expected for the September 2013 LHCC session, in time to be presented to the Computing Resources Review Board session in October 2013. The LHCC also supports the arrangements to continue the middleware and support projects and recommends that a common vision be installed in preparation of the next European Union funding plan. The LHCC acknowledges the progress towards using the available resources from HLT farms during LS1 and recommends the installation of a longer-term solution, also allowing for intensive use of these resources during the short technical stops after LS1. The usage of opportunistic resources by the experiments (on supercomputing centres or private Clouds), already demonstrated on a few occasions, in conjunction with the need to place the WLCG in a multi-disciplinary context, may open new opportunities for LHC computing.

ALICE

For ALICE, the request for resources is essentially flat for 2014 and 2015, assuming the KISTI and Mexico Tier-1 centres become available. The close collaboration of the experiment with the computing experts at the Tier-1 and Tier-2 centres has led to a dramatic improvement in the efficiency of the CPU usage for analysis (from about 65% in September 2012 to about 85% in February 2013). In addition, the experiment has introduced a new processing scheme, requiring a redubbed number of full-processing passes.

ATLAS

The ATLAS needs fit within a flat budget for 2014 and 2015 with the assumption that the event sizes and CPU/event remain at 2012 levels. Since these assumptions are expected to be significantly affected by the new running conditions, new ideas have to be deployed during LS1 to optimise the CPU use, event sizes, memory, etc. These efforts have already started and an ambitious plan for improvements has been presented.

CMS

CMS estimates a large increase in CPU resources in the case that the parameters from 2012 are unchanged. In particular, there is an increase in the reconstruction time due to off-time overlays from the previous bunch occurring in the 25 ns configuration. A few solutions for optimisation are already considered, consisting of software tuning; the use of the Tier-1 centres for prompt reconstruction; only one full reprocessing per year; the commissioning of Tier-2 centres for Monte Carlo reconstruction; and usage of remote data access as a result of data federation work in the last 18 months. The remaining factor of two in CPU seems to be to very hard to gain, but the work on further optimisation has started. The increase in the required storage is more modest and is concentrated on data only.

LHCb

LHCb has sufficient CPU for LS1 needs but is limited by the available disk space. This situation may lead to an under usage of the CPU in 2014 and to disturbances in 2015 since the Monte Carlo production is delayed. A significant effort is needed to reduce disk consumption, so both the size of the Data Summary Tapes (DSTs) and the replication policies are being considered. The software is now under scrutiny, with the ambitious objective to efficiently exploit the new hardware capabilities (parallelisation etc.).

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 for the computing in the long term.

14. REFEREES

The LHCC referee teams for this session are as follows:

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

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

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

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

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

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

Experiment Upgrades:

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

RD39: G. Eigen

RD42: M. Demarteau

RD50: G. Eigen

RD51: D. Denisov

15. The LHCC received the following documents:

CERN-LHCC-2012-021/M-112 Minutes of the one hundred and twelfth meeting of LHCC held on 5 and 6 December 2012

CERN-LHCC-2013-002/LHCC-I-024 Development of pixel readout integrated circuits for extreme rate and radiation

CERN-LHCC-2013-003/LHCC-I-025 RD on 3D Sensors and Micro-Fabricated Detector Systems

DATES FOR LHCC MEETINGS

Dates for **2013**

12-13 June

25-26 September

4-5 December

Emmanuel Tsismelis

E-mail: LHCC.secretary@cern.ch

Tel. 78949, 164057

LHCC Secretariat: Patricia Mage (Bldg. 3/R-018) Tel. 78135
patricia.mage@cern.ch