



LARGE HADRON COLLIDER COMMITTEE

Minutes of the one-hundredth-and-third meeting held on
Wednesday and Thursday, 22-23 September 2010

OPEN SESSIONS

General Status Reports

1. LHC Machine Status Report: Steve Myers
2. CMS Status Report: Gigi Rolandi
3. ATLAS Status Report: Thomas Le Compte
4. LHCb Status Report: Marta Calvi
5. ALICE Status Report: Jean-Pierre Revol
6. TOTEM Status Report: Karsten Eggert
7. LHCf Status Report: Yasushi Muraki

Special Status Reports on LHC Heavy-ion Programme

8. Theoretical Physics Status Report: Urs Wiedemann
9. Machine Status Report: John Jowett
10. ALICE Status Report: Federico Antinori
11. ATLAS Status Report: Peter Steinberg
12. CMS Status Report: Bolek Wyslouch

CLOSED SESSION:

Present: S. Bertolucci*, J. Blazey, P. Bloch, A. Boehnlein, H. Breuker, C. Cecchi,
D. D'Enterria, E. Elsen, M. Ferro-Luzzi, J.-F. Grivaz, C. Hawkes, R. Heuer*,
W. Kuehn, D. Macina, M. Mangano, P. Mato, T. Mori, A. Nomerotski,
B. Panzer-Steindel, D. Pitzl, R. Roser, E. Tsismelis (Scientific Secretary),
T. Wyatt (Chairman)

*part-time

Apologies: F. Bedeschi

1. PROCEDURE

The minutes of the one-hundredth-and-second LHCC meeting (LHCC 2010-005 / LHCC 102) were approved.

2. REPORT FROM THE DIRECTOR FOR RESEARCH AND SCIENTIFIC COMPUTING

The Director for Research and Scientific Computing reported on issues related to CERN and the LHC.

At its meeting in September 2010, CERN Council approved the Laboratory's revised Medium Term Plan for the period 2011 to 2015. Member State contributions will be reduced by a total 135 MCHF over the five-year period, with measures to consolidate



CERN's social security systems bringing the total reduction to the programme to 343 MCHF. In response, the approved plan protects the LHC programme, achieving cost savings essentially by slowing down the pace of other programmes. CERN Management considers this a good result for the Laboratory given the current financial environment. Among the programmes to be affected is the upgrade to the LHC's beam intensity, which will allow the experiments to accumulate data at a faster rate. This will now proceed later than originally planned, with a new linear accelerator being connected in 2016 instead of 2015. Moreover, there will be no running of CERN's accelerators in 2012 and the whole CERN accelerator complex, including the test beams, will now join the LHC in a year-long shutdown.

He also reported on the excellent performance of the LHC machine, experiments and computing. The LHC is being operated at 7 TeV centre-of-mass energy, with a target integrated luminosity of 1 fb^{-1} by the end of 2011 and with a heavy-ion run at the end of 2010 and 2011. The next LHC Performance Workshop at Chamonix will be held on 24-28 January 2011. The possibility of raising already in 2011 the LHC centre-of-mass energy from 7 TeV to 8 TeV is being considered; a decision is expected to be taken at the latest by the Chamonix workshop.

3. REPORT FROM THE LHC PROGRAMME CO-ORDINATOR

The LHCC heard a report from the LHC Programme Co-ordinator, concentrating on progress since the previous LHCC session in July 2010 and preparations for the heavy-ion run.

He summarized the number of proton-proton interactions delivered by the machine and recorded by the experiments during the 2010 LHC run so far and gave an estimate of the corresponding integrated luminosity. All parameters are considered to be excellent and the data collection efficiencies of the experiments are high. He re-iterated that this year is considered to be the period for reaching a peak instantaneous luminosity of $10^{32} \text{ cm}^{-2} \text{ s}^{-1}$ and to consolidate operational experience, while 2011 will be the year for integrating luminosity, with the aim of reaching 1 fb^{-1} . He presented the proposed evolution in machine parameters and the LHC schedule to reach these goals.

He also reported on preparations for the upcoming 2010 heavy-ion run. Preparations are well in hand. ATLAS, ALICE and CMS are requested to provide for the next LHCC session quantitative estimates of the amount of Pb-Pb and proton-proton events at 2.76 TeV centre-of-mass energy necessary for a successful first Pb-Pb physics run in 2010. In the case of ATLAS and CMS, which do not at this stage officially support a proton-proton run at this lower energy, this includes an estimate of the number of proton-proton events that they would need if such a run would be scheduled.

The Co-ordinator also presented the plan for two sets of van der Meer luminosity scans – the ‘exploratory’ scans of 2010 and the ‘optimal conditions’ scans that will take place in 2011.

4. DISCUSSION WITH TOTEM

Introduction

Good progress was reported on the completion of the TOTEM experiment. The LHCC **commends** the work of the Collaboration, in particular for the positive collaboration with the LHC machine experts and for the CMS and TOTEM Technical Co-ordinations’ constructive collaboration during preparations for the installation of the TOTEM T1 Telescope.

Detector

The LHCC received from TOTEM the document "TOTEM Results and Perspectives for 2010/2011" (CERN-LHCC-2010-014 / LHCC-G-154). The Committee acknowledges the timely submission of this report, whose main contents were presented during the LHCC Open Session, and which was reviewed during a dedicated

meeting with the LHCC referees. The review led to the following remarks and recommendations.

The LHCC considers that more work is desirable to better define the scope and reach of the 2011 TOTEM run and to fully exploit the potential of the full TOTEM detector system. On the other hand, TOTEM is quickly ramping up the understanding of the collected data, showing a continuously improving control of the detectors' behaviour and of the beam-related systematics.

The LHCC also welcomes the great technical progress made after the T1 Telescope's installation Engineering Design Review of July 2010. All recommendations from the review have been or are being followed up, including modifications of the mechanical structures, a review of grounding and electrical integration, leak tests, and the validation of the T1 Telescope envelope. The latest estimate of the work schedule is compatible with the installation of the negative side of the T1 Telescope within the foreseen 2010-2011 LHC technical stop, while the complete installation, including the positive side, would require an extra two weeks.

The LHCC acknowledges that the TOTEM physics programme in 2011 would benefit from the additional acceptance and redundancy offered by the complete T1 Telescope. Among other issues, this will better enable the characterization of single diffractive (SD) and double diffractive (DD) events, as needed to extrapolate to the unobservable cross section.

Therefore, the Committee **endorses** the request to install the full T1 Telescope during the forthcoming technical stop, subject to the positive outcome of the final Installation Readiness Review, which is scheduled to take place in early November 2010. Nevertheless, the Committee would like to see at its November 2010 meeting results from the full simulation to quantify the improved characterization obtained with the full T1 Telescope installation (for example by demonstrating the improved resolution on the mass of the observable system in SD and DD events). The LHCC insists on its earlier recommendation that TOTEM works towards a full integration with the CMS detectors, trigger and DAQ in view of the runs beyond 2011.

Operations

The LHCC acknowledges the need for runs with special conditions or optics (e.g. the runs at $\beta^*=90\text{m}$). Therefore, the Committee **recommends** the continued collaboration of the accelerator physicists with TOTEM to prepare and work out realistic running scenarios satisfying these needs. The Committee will need to review the readiness of the experiment to take full benefit of these runs, before it can endorse them, if so requested.

5. DISCUSSION WITH CMS

Introduction

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 Committee is pleased with the open sharing of the information and the responsiveness of the CMS Collaboration to questions raised by the LHCC. Despite the large size of the Collaboration, CMS manages to maintain an open-minded spirit as indicated by the implementation of the high-multiplicity trigger and the willingness to read non-suppressed data during the heavy-ion run.

Detector

Detector operation is excellent and CMS continues to operate its experiment in a very efficient manner.

Trigger & Data Taking

The detector has been operated smoothly throughout. The dead-time has been further reduced since the last LHCC meeting and the origin of the remaining dead-time arises from multiple small sources. The largest single contributor is the silicon Pixel Detector, where large events caused long tails in the read-out time distribution. This was initially amended by a 300 μs trigger time-out and in the meantime with an update of the Pixel Detector firmware.

Typically, 86% of the recorded data has been used in analyses where in most cases the on-status of all detector components has been requested.

Since the start of data taking CMS has used 10 sets of trigger selections (menus) to cope with the exponentially increasing luminosity. The accuracy of trigger rate prediction is good and shows that the overlap in a given trigger group (of some 30%) is well understood. CMS is ready to absorb another factor 10 luminosity increase with the prepared trigger menus. The physics groups are closely involved in the definition of the trigger selection. Monitor triggers take a considerable fraction of the budget. Methods should be in place to eventually reduce the dependence on, for example, calibration procedures using these triggers when rates become prohibitive.

Physics

The integrated luminosity has exceeded 3 pb^{-1} and hence increased by an order of magnitude since the International Conference on High Energy Physics (ICHEP) in July 2010. Many new analyses have thus become possible.

The di-muon mass spectrum reaches from zero to beyond the mass of the Z-boson and shows much detail; it resolves for example the three radial excitations of the Y and demonstrates the superb momentum resolution of the tracking system. In contrast, the di-electron mass reconstruction depends on both the Tracker and Calorimeter. The jet and missing transverse energy distributions are used in many physics channels. The b-analyses use the reconstructed vertices. The b-tagging efficiency is known to about 10% using data driven methods. The distributions are well described by the simulation even in the far tails.

CMS set up a high-multiplicity High Level Trigger several months ago to select events with >70 charged tracks. This trigger led to the analysis presented in a special seminar at the time of the LHCC session on two-particle correlation studies for events with many particles; the publication was accepted on the same time scale.

Heavy-ion Run

The heavy-ion programme of CMS was introduced to the LHCC in much detail. The programme is in many aspects complementary to that of ALICE. The hermeticity of the CMS detector will provide full coverage for reconstruction of the final state. The DAQ and trigger are very flexible.

The multiplicities will be very high in heavy-ion scattering. CMS plans to read out non-zero suppressed data for all events. The reason is that the baseline of the Tracker readout will shift with occupancy which affects resolution and efficiency. Depending on the actual value of occupancy the baseline correction is expected to change. Consequently, a 1.5 PByte data volume will be written to Tier-0 by CMS during the heavy-ion run, a substantial fraction of the annual volume. At the same time ALICE expects to have the CERN resources available. An initial stress test of the system performed during the LHCC week showed that the computing centre will be able to cope with the recording and networking if everything goes according to plan. CMS is prepared to throttle back should the need arise. The LHCC supports these plans of CMS and encourages CMS to negotiate a policy for relief actions with ALICE beforehand in case a bottleneck arises during the heavy-ion run.

The heavy-ion run is an effort well supported by the entire CMS Collaboration; the data taking is well prepared. Heavy-ion experts will be deeply involved in the data taking.

6. DISCUSSION WITH ATLAS

Introduction

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.

Detector

The detector is performing exceptionally well, collecting data with 95% efficiency. The trigger continues to successfully adapt to the changing beam conditions and collecting its physics data sample with minimum dead-time. The specification for the ATLAS trigger is to provide the DAQ system with 200 Hz of data. The trigger is sufficiently powerful and flexible that as of late, the ATLAS team has gone well above the 200 Hz limit to maximize both its physics and its ability to monitor the detector/trigger performance without violating the computing model.

At its previous meeting in July 2010, the LHCC highlighted two issues which it now followed up; one had to do with the read-out of the Cathode Strip Chamber (CSC) detector and the other with failing optical links in the Semiconductor Tracker (SCT) and Pixel detectors.

- CSC trigger/readout – The CSC is currently capable of being read out at 66 kHz with negligible dead-time – up from the previous LHCC session. During high-rate trigger tests using “simulated triggers”, a problem was identified in processing the third trigger decision. This problem has not presented itself during normal data-taking operations. This problem has been corrected and is no longer an issue.
- SCT and Pixel Detector Optical Links – These links transfer clock and command information to the detector. There are 632 links in total. This hardware has been stable for the past year or so – but in the few weeks prior to the July 2010 LHCC session, 40 links had failed hard. These devices are located off-detector so they can be replaced on short detector accesses. Since then another 60 or so have failed on both the SCT and Pixel detectors. The reason for the mortality is still under investigation.

ATLAS Management is aggressively pursuing this problem and has established a task force to address what corrective action is needed. The results of that task force are summarized below.

There are identical optical links to the ones failing in the DAQ racks on the Pixel Detector. Those links continue to operate perfectly. The working hypothesis is that the failures are related to the number of times an optical link “flashes”. The ones in the DAQ racks transfer clock information and thus flash at 40 MHz. The ones on the detector only flash when there is data to be read out. Bench tests are now well underway to determine if this hypothesis is true. The results of these tests will be known in a matter of months.

Given the above, the ATLAS team is concerned that the optical links on the Pixel Detector will fail before the 2016 LHC shutdown based on a simplistic extrapolation given the data at hand. Thus, ATLAS is working to find a solution that can be implemented in the 2012 LHC shutdown. The 2012 shutdown has the further advantages that the radiation dose is minimal and annealing issues are not a concern (detector can be warmed up for a significant period of time).

The plan is to build new Service Quarter Panels (service bulkheads on the Pixel Detector) which locate the optical links in an area where they are easy to access. Installation of these panels would require removal of the Pixel detector and transport to the surface. The shutdown starting in 2012 is currently scheduled to last for 15 months, which is sufficient time to do repairs and complete all the necessary checkouts. An additional bonus of executing this

plan is that a carbon fiber sleeve would be installed on the inner radius of the Pixel Detector which would greatly simplify the installation of the Insertable B-Layer (IBL) in the 2016 shutdown.

This status is still in its early stages of understanding – other teams are working to understand the root cause of the failures. However, this is an excellent plan and provides the experiment with “insurance”. The LHCC commends the ATLAS team for their aggressive pursuit of this problem. ATLAS does not have to decide whether to execute it or not until December 2011. The LHCC notes that ATLAS has sufficient resources that the implementation of the above course of action does not jeopardize the readiness of the IBL.

The LHCC also covered a number of other issues. They include:

- Solenoid Cryogenics – air dryer was installed in July 2010 and the cryogenic systems have been stable and functioning well ever since.
- LAr Calorimeter and Tile Calorimeter Power Supplies – plan is being executed. No changes.
- Beampipe Upgrade - progressing steadily, no issues with the pipe, flanges or aluminum ion pumps.
- Hadron Calorimeter Noise Bursts – ATLAS is monitoring the situation and made some dedicated studies with runs taken with high-voltage off or at intermediate values. It does not appear to scale with the luminosity. Exact cause not yet known, but most likely due to charges trapped in the electrodes that discharge with time.
- Control Room Shifts – working well. Plan is to revise at the end of the 2010 run the control room shift operations with the goal of a significant reduction in the number of people needed to collect data.

Physics

ATLAS has had an outstanding summer conference season in which they presented a large number of results using the full data set of up to 3 pb^{-1} . They have already achieved sensitivity that in select channels either competes with or surpasses the Tevatron programme. Equally important, they have made significant progress in understanding their physics objects like the jet energy scale, muon and electron identification, and b-tagging that will position them well for future success. While further improvements will no doubt be made, the maturity of the physics analyses is impressive given the short period of time the Collaboration has had access to the data.

To date, ATLAS has made 93 physics results public in 2010 with three papers published and another three expected to be submitted in the coming week. ATLAS submitted over 30 abstracts to the International Conference on High Energy Physics (ICHEP) in Paris in July 2010 and over 1000 collaborators are successfully submitting analysis jobs to the World-wide LHC Computing Grid (WLCG) demonstrating the enthusiasm and commitment the Collaboration is making to its physics programme. One billion Monte Carlo events with full simulation were produced this year alone on the WLCG. The offline systems and WLCG computing architecture is performing well; the data is processed in a very timely manner and made available to the analysis teams.

Heavy-ion Run

ATLAS is prepared for the upcoming heavy-ion run. This programme is an important part of the Collaboration’s overall physics goal and is an integral part of their physics programme. The entire Collaboration is expected to share in the load of shifts, detector operations and maintenance.

2010-2011 LHC Technical Stop

The Committee had a short discussion with ATLAS Management regarding the upcoming 2010-2011 LHC technical stop. ATLAS currently has a plan in place to open up one side of its detector and do a series of maintenance and repair work in the nine available weeks. ATLAS has other work it could accomplish but does not want to drive the length of the upcoming stop. However, if it had advanced knowledge that the technical stop would be lengthened, it would make effective use of the available time.

7. DISCUSSION WITH LHCb

Introduction

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.

Detector

Most of the LHCb sub-systems have an operation efficiency higher than 99% and are performing without any major problems.

The aerogel radiators of the Ring Imaging Cherenkov (RICH) detectors, which were contaminated with freon gas, still show a lower light yield. However, a better alignment and improved calibration of the aerogel tile refractive indices have resulted in significantly better angular resolution. The LHCb Collaboration is currently evaluating ways to proceed with this issue, possibly forming a gas enclosure around the aerogel which can be flushed with neutral gas.

A failure rate that is higher than specified has been observed in a particular type of the optical transmitters used in several sub-systems. Some of these transmitters are easily accessible and can be replaced during short technical stops but some are not. The number of failed devices is not significant but the situation should be carefully monitored. The servicing of noisy Hybrid Photon Detectors (HPDs) has become a routine operation which does not affect the data quality.

Operations

LHCb has an efficient shift model with only two people – the Shift Leader and the Data Manager – on shift in the control room at any one time and around the clock. This works well due to the advanced training of the people on shift and good support from sub-system experts. Since the previous LHCC session an effective shift recruitment process has been put in place based on institutional shift quotas as opposed to quotas for individuals. The LHCb Collaboration aims to benefit from the best LEP practices in the organization of shifts.

The LHCb experiment ran successfully at $\beta^* = 3.5$ m, although it resulted in a considerable pile-up with the average number of interactions per beam crossing reaching up to 1.5, whereas the nominal value in the present configuration is 0.4. This strained the LHCb trigger system and processing capabilities very much due to the higher number of tracks in the detector and only 20% of the online CPUs being available at this time. The present running conditions also stretch the capabilities of the offline CPU farm, including the available disk space. On the other hand, it was a great opportunity to study the trigger performance and define trigger strategies for the 40 MHz upgrades. The current trigger strategy has been adjusted to move as much as possible to the High Level Trigger (HLT). This required much work from many people and the Collaboration should be congratulated for pulling it off successfully.

Physics

With the currently-available statistics the experiment has accumulated large samples of charm and bottom data and can make reliable projections of the yields. The vertex separation algorithm works well and allows data with multiple interactions per beam crossing to be analyzed. An improved version of the Silicon Tracker alignment is

available; the detector has been realigned with the J/ψ mass constraint, which considerably improves the previous disagreement between data and Monte Carlo in track resolution parameters. The first papers have been submitted and accepted by journals.

For the immediate running plan LHCb favours as much data as possible in 2010, since an integrated luminosity of 50 pb^{-1} would allow very interesting results by the spring conferences in 2011 for the $B_s \rightarrow \mu\mu$ channel, for the measurement of the B-meson CP Violation phase and for constraints on CP Violation in charm mixing and decay.

Future Plans

Activities during the upcoming 2010-2011 technical stop will have a limited scope and will include the replacement of some HPDs and transmitters, together with other minor maintenance of the LHCb sub-systems.

Due to the crucial importance of the 2011 data-taking period, which may bring major physics results, the LHCC recommends a detailed mini-review of LHCb during the November 2010 session of the Committee. A draft agenda has been discussed with the Collaboration addressing the following main issues: luminosity optimization and trigger strategies, installation plans for the 2012 LHC shutdown, upgrade plans and documentation, formalization of institutional responsibilities for operations, together with the usual review of operations and physics results.

8. DISCUSSION WITH ALICE

Introduction

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.

Detector

Most detector components are operating smoothly. The loss of channels of the Silicon Pixel Detector (SPD) due to failures in the cooling has not increased and 80% of the half-staves are in a working condition. Pedestal instabilities in several sub-systems will require further attention. Time Projection Chamber (TPC) trips have been observed which are most likely due to charging-up of insulators inside the TPC. To improve the situation, the amount of water vapor in the detector gas has been increased and an additional RC-filter has been added to the high-voltage supply.

Trigger

The LHCC also reviewed the current hardware and software status of the ALICE High-Level-Trigger (HLT) system. During the current proton-proton run, ALICE has recorded about 700M minimum bias events (equivalent to 10 nb^{-1} integrated luminosity and about 70% of the 2010 goal of 10^9 events), plus 50M muon triggers (50 nb^{-1}), and 15M high-multiplicity (30 nb^{-1}) triggers. Starting next year, ALICE will integrate larger proton-proton luminosities for small cross-section processes needed as reference for future Pb-Pb runs at the nominal Pb-Pb luminosity. A trigger menu including both low level (L0, L1, L2) and high level (HLT) triggers should be presented in coming meetings of the LHCC, such that sufficient proton-proton statistics for all relevant rare processes can be recorded.

Physics

Six papers have already been published and a few more are under internal review.

Heavy-ion Run

The ALICE experiment is ready for the first LHC heavy-ion run later this year.

In order to accumulate the largest amount of minimum-bias events during the heavy-ion run, ALICE intends to collect data at a rate of 200 Hz. After discussions with the CERN IT Department, it was decided to produce two records of raw data at Tier-0 (one

on tape and one on disk) in order to make sure that no data loss occurs. In conjunction with the request of CMS to run without zero suppression during the heavy-ion run, the LHCC recommends a stress test with simultaneous running of ALICE and CMS with the maximum foreseen data transfer rate in order to make sure that there will be no bandwidth bottleneck at Tier-0 during the heavy-ion run.

ALICE's request for a proton-proton run at the equivalent heavy-ion energy per nucleon was discussed. This is an important reference run for heavy-ion physics, in particular for the measurement of the nuclear suppression factor R_{AA} . ALICE had previously agreed that the required beam time would be taken in part from the heavy-ion contingent and the Committee recommends to schedule this run as early as convenient in order to ensure a speedy analysis and publication of the heavy-ion results.

2010-2011 Technical Stop

ALICE intends to install the remaining Electromagnetic Calorimeter (EMCal) modules and three additional Transition Radiation Detector (TRD) modules during the 2010-2011 technical stop.

9. DISCUSSION WITH LHCf

In the LHCC Open Session, the LHCf Collaboration reported on the recent and successful data taking at 3.5 TeV centre-of-mass energy (for a total of 100 Mevents) and at 7 TeV centre-of-mass energy (for a total integrated luminosity of 85 nb^{-1} , 105 Mevents without crossing angle and about 300 Mevents with a $100 \mu\text{rad}$ crossing angle to enhance the detector acceptance). The Collaboration has shown a π^0 mass reconstructed with $\Delta M/M=2.3\%$. Preliminary energy spectra have also been shown for photons and a good identification for photons and hadrons has also been reported. These preliminary results demonstrate the excellent functioning and understanding of the LHCf detector. The Committee **congratulates** the LHCf Collaboration for the excellent data-taking that has taken place, and for how the Collaboration has taken advantage of the run with beam crossing angle. The removal of the detector from the TAN region took place in July 2010 in a very short time (1 day). The LHCf Collaboration has scheduled a beam test at CERN for 15-17 October 2010, and at present they have three dedicated days of beam, and 11 days of parasitic running at SPS H4. This test beam is of high importance for the experiment to perform the absolute energy scale calibration, and the Committee therefore strongly **recommends** an extension by two additional days the dedicated LHCf test beam running period.

10. REPORT AND DISCUSSION FROM THE LCG REFEREES

The World-wide LHC Computing Grid (WLCG) continues to operate very well. The LHCC congratulates the WLCG project team and the experiments in their successes at processing and analyzing the data from the first five months of the 2010 LHC run. Grid resources are used heavily, with over a million jobs and 100k CPU-days per day and several hundred users from each of the Collaborations. Large simulation production continues in parallel with data taking and uses a large fraction of the CPU resources. The distribution of usage is roughly as planned, with over 50% of CPU delivered by Tier-2 sites. Tier-0 usage is a little below expectation, but is expected to increase with the delivered luminosity. Data transfer from Tier-0 to Tier-1 sites has mostly been at the expected rate, but has exceeded the target of 1.3 GB/day without any problem on many occasions. For all the experiments data has been available for analysis within hours of data taking. About 5 PB of data has been stored by the CASTOR mass-storage system so far this year, with 70 TB/day written to tape and 1 PB/day transferred in and out of storage.

Resources are being used in accordance with the planned computing models, with some variations in the light of experience. Networks have been used at the anticipated scale, and a working group has been established to plan for future needs. ATLAS has tested data caching, in addition to the data placement of their computing model. The number of interactions per bunch crossing (μ) is higher than had been expected in the

first year of LHC running. The LHCb experiment and computing model were designed to handle $\mu=0.4$, but $\mu=1.4$ has been observed. This results in a larger event size and pressure on the available disk space, in order to record data without loss of efficiency for the charm and beauty physics channels. In response the LHCb Collaboration has distributed the data across their Tier-1 sites, rather than keeping a full copy at each site as originally planned, and they have modified their event selection and analysis strategies to cope with the multiple interactions. For all experiments, more analysis than anticipated has used Event Summary Data-level (ESD-level) data, but use of Analysis Object Data (AOD) and derived data formats is increasing. All groups plan full reprocessing of the complete 2010 proton-proton sample before the end of the year.

Installed resources meet the levels pledged for this year, although delays and hardware problems have occurred at some sites, especially for disks. Use of disk storage is good, while further CPU and tape capacity remain for the additional data expected in 2010-2011. Procurement cycles for the equipment are long and planning is required well in advance to ensure that pledged resources are available on schedule. The Computing Resources Review Board will meet in October 2010 and will receive a report from the Computing Resources Scrutiny Group, which is reviewing the use made by each experiment of the resources provided. Requirements for 2012-2013 should also be discussed, but precise evaluations are impossible without details of running conditions and better analysis of the experience so far. Plans for 2013 running have been discussed by the Research Board.

Operational problems at sites remain the main stability issue. There are typically 5-6 service incidents per month, lasting a few hours or sometimes more extended, and caused by power, cooling or other hardware failures or by database problems, rather than by specific Grid middleware. In the last two weeks the necessary response to a general security alert reduced capacity by up to 50%. These incidents are largely unavoidable, but lessons are learnt to mitigate similar problems in the future. Computing models must evolve to become resilient to outages at some sites.

As part of CERN's agreed Medium Term Plan, budget reductions of 8.25 MCHF over 5 years will come from WLCG materials. Cutbacks include changing from a 3-year to a 4-year equipment replacement cycle and reducing the increase in Tier-0 resources from 30% each year to about 25% per year. The implications require further detailed planning, but there will be a strict limit to the growth of overall computing resources at Tier-0. This also affects the strategy for Tier-0 infrastructure. The planned new Tier-0 building has been cancelled and the containers are delayed by a year to 2014. There are plans to upgrade the existing Building 513 power from 2.9 MW to 3.5 MW, including up to 600 kW of diesel-backed power, together with the use of local hosting in Geneva (100 kW today, potentially more). A call for bids to host a remote Tier-0 data centre, in the longer term, has been issued and 6-7 countries have expressed an interest.

Planning for the heavy-ion (HI) running in November 2010 is in hand, but there are concerns over some very recent requests for increases in requirements. ALICE want to record 200 TB/day, at twice the rate originally planned, to compensate for the reduced length of the HI running period. CMS plan to record HI data without zero suppression in their silicon tracker and calorimeter and with a minimum-bias trigger, which will increase their data rate to about 150 TB/day. The ATLAS rate is expected to be 10-20 TB/day and LHCb will not participate in HI running. ALICE will export 20% of their raw data during the HI run and the remainder during the technical stop. It has already been agreed to keep two copies of the ALICE HI data at CERN until the export has been completed, to reduce the risk of data loss. CMS will export all their HI data to FNAL after software zero suppression and ATLAS will export all raw data to Tier-1 sites. These requests significantly exceed the foreseen data rates and there has been no readiness test for combined HI operations at these rates. CASTOR has some headroom, but also needs to maintain a sustained and reliable service for other users, including non-LHC experiments. Some 2011 resources have been pre-purchased and can be implemented to help match the needs. A combined test including ALICE and CMS (and perhaps also ATLAS) must be arranged in good time before the start of the HI run. In case of problems during the run, archiving of data to tape must take priority and

the experiments may be asked to make use of their data buffers, which can hold around a day's data, to spread the load over time. The LHCC encourages all Collaborations to work in a cooperative and constructive way together with CASTOR staff to test the system thoroughly. The LHCC recognizes the benefit to CMS of recording HI data without zero suppression, but given the impact of this late request on Tier-0 operations it encourages CMS in particular to develop contingency plans to ensure that heavy-ion data taking can continue in case problems arise during the run.

11. REPORT FROM THE LHC EXPERIMENT UPGRADE REFEREES

The LHCC heard a report on the LHC experiment upgrades. The report focused on the upgrade plans and shutdown requirements for ALICE, ATLAS, CMS and LHCb until 2020 and the corresponding machine upgrade plans.

The draft Technical Design Report for the ATLAS Insertable B-Layer (IBL) has been submitted to the LHCC for review. The LHCC is currently reviewing the IBL Technical Design Report and will provide its recommendation in an upcoming session of the Committee.

A preliminary copy of the CMS Technical Proposal for the Upgrade of the CMS Detector Through 2020 has been made available to the LHCC shortly before the Committee's September 2010 session. The aim of the document is to cover all updates for the current decade, and whose timing is largely driven by the LHC shutdowns in 2012 and 2016. The time plan for the upgrade initiatives is largely driven by the LHC shutdown schedule and to a lesser extent by the status or the requirements of the detectors. The LHCC is currently reviewing the CMS upgrade plan and will provide its recommendation in an upcoming session of the Committee. The LHCC would like to understand better the character of (preventive) maintenance and true performance upgrades of the detector as the document evolves. The LHCC would like to receive the complete CMS upgrade document well in advance of the Committee's next session in November 2010 with a solid physics motivation (where applicable) and the matrix of maintenance and upgrade activities. The priorities should be indicated in appropriate form.

The Letter of Intent for the LHCb upgrade is in the final phase of preparation with a draft planned to be submitted to the LHCC for its November 2010 session. The main activities planned for the 2012 LHC shutdown are replacement of a beampipe section, installation of the optical cable required for the 40 MHz trigger upgrade, significant extension of the CPU farm and possibly the aerogel intervention.

Plans for the upgrade of ALICE are underway. It is expected that this will include a beam pipe with reduced radius, an upgraded pixel detector and an extension of the momentum for particle identification. The plans will be finalized once the first LHC heavy-ion run has been completed and experience from this run can be taken on board for the ALICE upgrade plans.

The LHCC encourages the LHC experiments to further their studies and continue developing their experimental design. The LHCC will continue discussing extensively the LHC experiment upgrade plans in its upcoming sessions. The Committee also encourages preliminary discussions with the funding agencies on possible commitments to be addressed at future sessions of the Resources Review Boards.

12. TEST BEAMS

The PS and SPS Physics Co-ordinator reported on the LHC test beams. He reported that the planned test beam programme at the PS and SPS has been successfully achieved so far in 2010, with more than 50% of the beam time requests related to the LHC experiments. The call for beam requests for 2011 will be sent shortly. It is expected that more users will request beam time for 2011 than in 2010. Implications of the approved shutdown of the PS and SPS complex in 2012 were also discussed.

13. LHCC CLOSE-OUT WITH THE DIRECTOR-GENERAL

The LHCC discussed with the Director-General the status of the LHC experiments and their plans for the future.

14. REFEREES

The LHCC referee teams are as follows:

ALICE: D. D’Enterria, J.-F. Grivaz, W. Kuehn (Co-ordinator)

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

CMS: J. Blazey, A. Boehnlein, E. Elsen (Co-ordinator), T. Mori

LHCb: F. Bedeschi (Co-ordinator), C. Hawkes, A. Nomerotski

TOTEM, LHCf, MoEDAL: C. Cecchi, D. D’Enterria, E. Elsen, M. Mangano, P. Mato

LCG: A. Boehnlein, J.-F. Grivaz, C. Hawkes (Co-ordinator), T. Mori

Experiment Upgrades:

Co-ordinator: D. Pitzl

RD39: D. Pitzl

RD42: A. Nomerotski, J. Blazey

RD50: A. Nomerotski

RD51: W. Kuehn

15. The LHCC received the following documents:

TOTEM Results and Perspectives for 2010/2011

(LHCC-2010-014; LHCC-G-154)

Minutes of the one hundred and second meeting held on Wednesday and Thursday, 7 and 8 July 2010

(LHCC-2010-010; LHCC-102)

16. DATES FOR LHCC MEETINGS

Dates for **2010**

17-18 November

Dates for **2011**

23-24 March

15-16 June

21-22 September

7-8 December

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