OPEN SESSION I - Status Reports

1. LHC Machine Status Report: Mike Lamont
2. CMS Status Report: Joao Varela
3. ATLAS Status Report: Fabio Cerutti
4. LHCb Status Report: Anton Poluektov
5. ALICE Status Report: Francesco Prino
6. TOTEM Status Report: Valentina Avati
7. LHCf Status Report: Yoshitaka Ito
8. MoEDAL Status Report: James Pinfold

CLOSED SESSION:


* part-time


1. PROCEDURE

The minutes of the one-hundredth-and-eighth LHCC meeting (LHCC 2012-002 / LHCC 108) were approved.

2. REPORT FROM THE DIRECTOR FOR RESEARCH AND SCIENTIFIC COMPUTING

On behalf of the Director for Research and Scientific Computing, the Head of the PH Department reported on issues related to the LHC. He reported on the conclusions from the LHC Performance Workshop in Chamonix. The conclusions were discussed at the Machine Advisory Committee and then considered by CERN Management. It was decided that the LHC will be operated in 2012 at 4 TeV proton beam energy and with 50 ns bunch spacing. For the 2012 proton-proton run, the machine aims to deliver an instantaneous luminosity of $6 \times 10^{33}$ cm$^{-2}$ s$^{-1}$ and an integrated luminosity of at least 15 fb$^{-1}$ to each of the experiments ATLAS and CMS. A general review of progress in the collection of luminosity will be made in June and September 2012. CERN has decided to locate the first remote Tier-0 computing centre in Budapest. Finally, the LHCC took note that the October 2012 sessions of the Resources Review Boards are considered to be important in that they will consider the LHC experiment upgrades and the corresponding recommendations from the LHCC.
3. REPORT FROM THE LHC PROGRAMME CO-ORDINATORS

The LHCC heard a report from the LHC Programme Co-ordinators. They reported on the progress since the previous LHCC session, focusing on the conclusions from the LHC Performance Workshop in Chamonix, on the LHC Lumi Days 2012 workshop, and on the LHC schedule for the coming three months.

The Co-ordinators gave a report from the LHC Performance Workshop held in Chamonix. They presented an overview of the proton-proton physics programme for 2012 and the required target luminosity. The 2012 proton-proton physics runs will be at 8 TeV centre-of-mass energy and the experiments supported the decision of running with 50 ns bunch spacing and smaller values of $\beta^*$, perhaps down to 0.6 m. The 2012 proton-proton physics run is expected to provide data to either discover a light Higgs boson or exclude the Standard Model Higgs boson at 95% CL down to a mass of 115 GeV. A 5$\sigma$ discovery per experiment ATLAS and CMS down to 115 GeV at a centre-of-mass energy of 8 TeV requires at least 15 fb$^{-1}$. In addition to the search for the Higgs boson, the 2012 proton-proton run will provide data for SUSY searches, flavor physics, exotics and forward physics. The heavy-ion run in 2012 will consist of proton-Pb collisions. This run has the aim to provide baseline measurements for the Pb-Pb heavy-ion programme and to carry out QCD studies such as parton saturation at low $x$. LHCb will also participate in the proton-Pb run. Moreover, special runs have been requested. They include data taking for luminosity calibration, high-$\beta$ (500 m) physics runs, very high and/or low pile-up runs and some stable beams at 25 ns bunch spacing. In order to maximize luminosity production, only essential special runs will be planned and will be scheduled towards the end of the year.

The LHC Lumi Days 2012 workshop concentrated on the measurement of the luminosity at the LHC. The uncertainty on the luminosity measurement has reached a remarkably low value with all experiments reporting an extrapolated uncertainty of less than 2%. A key factor in the successful measurement has been the strong co-operation of the machine and experiment groups.

The Co-ordinators also reported on the status of the LHC machine start-up for 2012. They reported that the machine commissioning is advancing well and according to the LHC overall schedule.

4. TEST BEAMS

The PS and SPS Physics Co-ordinator reported on the LHC test beams. Planning for 2012 is underway, with the call for beam requests launched on 4 October 2011 and a deadline for submission set to 19 December 2011. Many requests were received and the allocation of beam-time is currently under preparation. The PS East Hall fixed-target programme is scheduled to start on 16 April 2012 and that at the SPS North Area on 7 May 2012. The PS and SPS fixed-target beams will run until 3 December 2012.

5. DISCUSSION WITH ATLAS

Introduction

The period since the December 2011 LHCC session has been a very busy and productive one for ATLAS and the LHCC congratulates ATLAS on all its achievements. They successfully navigated the 2011-2012 Technical Stop and were able to accomplish the full list of work planned as well as some additional items. The ATLAS detector is in excellent shape and ready for physics collisions. The Letter of Intent (LoI) for the Phase-1 (2018) shutdown was given to the LHCC in late December 2011, and the Committee was very supportive of this document as a whole. Excellent progress is being made on the Insertable B-Layer (IBL), the evaporative cooling plant and other planned upgrades, which will be installed in 2013-2014. Finally, in terms of physics, the experiment had a very successful winter conference season where it presented a full suite of Higgs results with its total 5 fb$^{-1}$ data sample as well as some...
40 other new results. The experiment is off to a fast start in 2012 with nearly 30 papers submitted to the journals thus far.

**Status of the ATLAS Experiment**

The year-end 2011-2012 Technical Stop was both a busy and productive one for the ATLAS Collaboration. A number of detector improvement projects as well as consolidation efforts were undertaken. Forty new low-voltage power supplies were installed for the Tile Calorimeter and 10 new power supplies for the LAr Calorimeter. The Tile Calorimeter now has less than 1% dead channels (this includes one power supply that recently failed in a drawer that was not touched in the Technical Stop). The End-cap EE muon chambers were installed on the IBL insertion side and a partial system of EE chambers was installed on the opposite side. The magnet cryogenic compressors were refurbished at the construction firm. The compressors now show 20% less power, implying that all four of them have to operate simultaneously (only three were used in the past). This is not a concern for this year as there is enough headroom. Radiation measurements were also performed in the hall and in most cases agree to within 30% of what simulations show. This gives the Collaboration confidence that the simulations provide an important tool to understand and predict long-term detector ageing. Finally, additional neutron shielding between the calorimeter and muon spectrometer in the forward region was added to address a problem in that region.

One other area of concern is with the detector Read-Out Subsystem (ROS). The ROS read-out system is based on commercial PCs with custom buffers that read out the detector. As the experiment pushed this system to its design specification and beyond by installing higher performance PCs, intermittent problems arose toward the latter part of the 2011 data run resulting in some ROS failures. To address this issue, ATLAS replaced all of the network interface cards, and so far this new hardware configuration is working reliably. Alternate PC motherboards have been purchased and will soon be available in case the problem recurs.

In terms of the LHC Long Shutdown 1 (LS1 in 2013-2014), the IBL is on track. For ATLAS to have a chance of installing this device over a year earlier than it was originally foreseen everything had to go right. The wafers (sensors) needed to be produced, cut and tested with good efficiency, a read-out chip needed to be fabricated that worked, and low mass cables needed to be procured, amongst other tasks. To date everything is still on track. The plan of installing a hybrid technology with 75% planar detectors and 25% 3D is still the default. Sufficient quantities of both technologies exist now. The group is busy making fixtures for the case in which the entire detector is planar and for the case in which the detector is a hybrid. The group is now beginning the fabrication process, and there are no showstoppers expected.

Other Phase-0 work such as the new evaporative cooling plant, shielding, improved magnet cryogenics and calorimeter low-voltage power supplies are also on track. ATLAS expects each of these to be ready for installation in LS1 beginning next year.

The Collaboration continues actively to pursue the work needed for the Service Quarter Panel (SQP) replacement. This work was begun to address a potential danger with failing optical links and the current inability to make repairs should they fail. Furthermore, currently the Pixel Detector has between 4–5% dead channels due to module electrical or mechanical failures. Replacement of the SQPs would provide the opportunity to repair most of these. The new SQPs give a more uniform mass distribution in this very important region and allow the Collaboration to increase the read-out bandwidth by doubling the fibre read out – something that could be critical if the accelerator performs above expectation. The fabrication and testing of the new SQPs is going well and they will be ready should the Collaboration decide to execute this plan.

The decision will be made this summer based on a complete risk assessment. ATLAS has performed a number of mock-up exercises and has convinced itself that it can insert the IBL successfully with the Pixel Detector *in situ* if need be. The only
downside to delaying the SQP installation decision till summer is that it may be using more resources than might otherwise be needed. The Collaboration feels it has sufficient resources to do both and thus the extra measures of care in making this decision seem prudent.

One topic that came up for the first time within ATLAS is the idea of “data parking”. The idea here is that the experiment would open its trigger bandwidth beyond its current processing bandwidth and collect a data sample that it would not otherwise have access to. This data would just be stored and processed in 2013 and not in real time. This works because in 2013, beam operation is suspended for the energy upgrade. ATLAS’s current thinking is to park up to approximately 150 Hz of data, about half of which would be from J/ψ triggers and the other half a mixture of other triggers. By comparison ATLAS operated with 350 Hz in 2011 and plans to operate at 400 Hz this year. The LHCC applauds the experiment for thinking outside the box and for finding ways to make optimal use of the provided collisions.

The ATLAS Collaboration has done a lot of work in its offline and reconstruction algorithms. The Monte Carlo simulation time is now 50% faster than it was at the start of 2011. Furthermore, the “fast” simulation effort is maturing and is now being used for some physics analyses. A new software release was recently cut which has many new tracking, lepton identification, and electron/photon improvements, mostly aimed at better performance in a high pile-up environment. This new release also has the modern release of the various event generators. ATLAS recently launched its 8 TeV Monte Carlo effort utilising this release.

**ATLAS Letter of Intent for Phase-1**

Finally, at the LHCC session in December 2011, the ATLAS LoI for the Phase-1 upgrades was presented to the LHCC for review. This set of upgrades is planned for the Long Shutdown 2 (LS2) scheduled for 2018 and will prepare the experiment for 2-3 × 10^{34} cm^{-2} s^{-1} running with 25 ns bunch spacing. With one exception, all of the upgrades put forward in this LoI are designed to maintain the physics capability of the experiment in ever more challenging beam conditions. These upgrades include new muon wheels with greater trigger granularity, a fast track trigger (FTK) for use with the silicon and pixel detectors, a higher-granularity calorimeter Level-1 (LVL1) trigger, a new tile “crack-gap” scintillator and a full suite of Trigger/DAQ upgrades needed to take full advantage of the above hardware changes.

The one exception is the introduction of an ATLAS Forward Physics (AFP) detector. This is a new detector planned to be installed at 210 m at both sides from the interaction point. It is designed to give the experiment new diffractive physics capabilities and complement the existing ALFA programme.

The Committee considers that the LoI presented was excellent. It is very well written and the thought process behind was already quite mature. The LHCC considers that the physics justification was very well made for all of the upgrades that were designed to maintain capability.

The Committee also considers that the technology options or choices were sound and sensible and considers that this programme could be executed and with it the Collaboration would be able to accomplish its physics goals.

The physics case for the AFP detector rests on the capability of using a proton double tag to constrain the centrally produced system and includes Higgs production and WW final states in a high-luminosity environment. Superb timing, at the 10 ps-level, will be required to associate the proper primary vertex and remove accidentals. Whereas the technical viability of the approach will have to be demonstrated, this detector extends the physics capabilities without interfering with the upgrade work on the detector proper.

The LHCC endorses the LoI and encourages the Collaboration to present its plans to the Resources Review Boards and Funding Agencies and to proceed to the next step of detailed Technical Design Reports for each upgrade.
6. **LHC EXPERIMENT STUDENT POSTER SESSION**

An exhibition of student posters was held in Main Building 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 first such session in 2011, this event was again deemed to be a great success and is expected to be repeated in the future.

7. **DISCUSSION WITH CMS**

**Introduction**

The LHCC congratulates the CMS Collaboration on their activities in producing a rich set of physics results with many important analyses presented for the winter conferences, including updates to Higgs channels. The Collaboration has results from many searches in which the limits were pushed to new records severely constraining SUSY and other Beyond the Standard Model (BSM) theories. CMS has also successfully looked at alternative searches, which traditionally have been the domain of dedicated experiments, such as the dark matter (DM) searches. Results from the 2011 heavy-ion run were shown and include elliptic flow with 2010 and 2011 data and jet-quenching with 2011 statistics and the observation of W production in PbPb collisions. The intention is to finalise the majority of the 2011 publications of search results by May 2012 to then focus on the 2012 data.

**Status of the CMS Experiment**

All publications sensitive to luminosity were temporarily put on-hold in February 2012 when it was discovered that the luminosity measurement had been affected by a loss in the Hadronic Forward (HF) calorimeter photomultiplier tube gains that is almost linear with integrated luminosity and by a variation in pile-up correction initially obtained from a low pile-up fill. A dedicated task force was convened to study the luminosity. A result of this task force was that the Pixel Detector is now the main luminometer for physics as it has low occupancy and is largely unaffected by pile-up and is continuously monitored with no sign of gain change during the year. Vertex counting is used as an independent cross-check, and Standard Model electroweak processes are used as standard candles to independently verify the stability of the luminosity measurements. The conclusion of the task force is that the integrated luminosity was determined to be approximately 7% higher than previously reported, resulting in a “certified” integrated luminosity of 5 fb\(^{-1}\) (was 4.7 fb\(^{-1}\)). The systematic uncertainty is quoted at 2.2% and is dominated by Van der Meer scans (1.5%) and “afterglow” correction (1%). Looking to the future, this issue emphasises the importance of multiple independent luminometers, including dedicated devices within the experiment and also detailed comparison of the CMS and ATLAS luminosities including the pile-up dependence.

The LHCC fully supports the multi-path approach to the measurement of the luminosity and to minimise its uncertainty. The LHCC notes that a demonstrator for the Pixel Luminosity Telescope (PLT) was installed during the year-end 2011-2012 Technical Stop and the LHCC fully supports the completion and installation of the final PLT.

The LHCC encourages a comparison and tracking of the instantaneous luminosities for ATLAS and CMS to ascertain the independence of the luminosity measurement from effects beyond beam size.

The year-end 2011-2012 Technical Stop accomplished an extensive programme of work. To investigate the occasional observed beam-induced pressure spikes at Point 5, a radiography survey was performed, and verified that the spike problem was caused by RF fingers that were located inside the flared beam pipe instead of outside of it. Expertise gained in repairing other RF finger problems at Point 2 and Point 8 enabled the problem to also be repaired at Point 5.
The handling mechanism to remove the Zero Degree Calorimeter (ZDC) had to be improvised as the planned mechanism, a custom-built crane, was delivered later than scheduled and was not ready for installation. Further, the crane will not be operational in time to reinsert the ZDC prior to the 2012 heavy-ion run, and so the handling will once again be improvised for insertion, provided there are no significant radiation issues that would prevent doing so. In that event, the ZDC would not be reinstalled.

It was discovered that de-ionised water was leaching the zinc out of brass connectors. Currently, a single connector (of 222) has failed, and it could be that all will eventually fail. If connectors fail during 2012, it would impact the Electromagnetic Calorimeter (ECAL) cooling.

Water ingress due to heavy rain/snow melt provoked leaks in the top (untreated) 10 m of PX56 (20.5 m main shaft). Sealing of the shaft had been suspended in 2008 for the LHC start, however, given the observed water ingress, it was clearly prudent to resume the sealing. Resin injection had to be re-scheduled several times due to still high water tables, but was completed.

The preparations for the 2012 data-taking period are well advanced. All of the CMS sub-detectors are operational, and CMS has been taking cosmic-ray data since mid-February 2012 to provide samples for Tracker alignment studies. The fraction of live channels is currently similar to 2011. Notable accomplishments in preparation for running include a firmware upgrade to fix a Cathode Strip Chamber (CSC) inefficiency at high Level-1 trigger rates traced to be due to out-of-sync errors in the data path, and an optimisation of the event builder configuration to enable the DAQ system throughput for anticipated 2012 running conditions of 35 pile-up events. An expansion of 50% to the High-Level Trigger (HLT) farm will be deployed by the end of April 2012 and will be sufficient for a peak online recording throughput of 2 kHz and 220 TB buffer space.

As beam intensities increased in 2011, CMS experienced some downtime attributed to Single Event Upsets (SEUs), primarily in the Pixel, ECAL, Hadronic Calorimeter (HCAL) and muon systems. Significant effort was invested to identify and mitigate the SEUs. Periodic hard resets have been introduced for 2012 operation. In addition, a generalised mechanism for software SEU recovery has been implemented centrally on the DAQ and is being tested.

Computing continues to perform well. An 800M Monte Carlo event sample at 8 TeV was generated to enable studies with the 2012 running conditions. The new reconstruction release CMSSW-5-2 features a factor of 2.5 speed-up of the reconstruction and reduced memory footprint by one-third. This enables CMS to make use of all available cores and to maintain a prompt reconstruction rate at the Tier-0 centre of 300 Hz (not including overlaps). Maintaining the 300 Hz capability may require shifting some of the Tier-0 analysis computing to reconstruction and will require that CMS utilise the time between fills. CMS is also introducing the concept of a global analysis queue that will enable them to prioritise analysis jobs.

For the 2012 running, the highest priority is for the LHC to produce enough integrated luminosity to allow ATLAS and CMS to independently discover or exclude the Higgs before the start of Long Shutdown 1 (LS1). Within the 2012 running schedule, there are two checkpoints at which it would be possible to consider an extension of up to two months to achieve this primary physics goal. In the case of CMS, the impact of extending the 2012 running period by two months would have a minimal impact on the schedule for LS1 due to the current delivery schedule for key components such as the beam pipe. With respect to the running strategy, CMS has been studying high pile-up conditions, using Monte Carlo samples and the high pile-up special run from 2011. With an average pile-up of 25, there is no significant impact on precision top physics or on $B_{d/s} \rightarrow \mu\mu$ and the impact on low-mass Higgs search is tolerable, with $H \rightarrow \gamma\gamma$ suffering a 15% equivalent luminosity loss. The situation is somewhat worse for $H \rightarrow \tau\tau$ and $H \rightarrow WW$. However, it is important to note that possible optimisations have not yet been studied.
Assessing the benefits of luminosity leveling is a complicated optimisation process, with concerns that since currently the majority of fills terminate prematurely, one does not profit from the improved proton beam lifetime and the result of luminosity leveling will be less luminosity. However, much work remains to understand various scenarios, such as fill lifetime as a function of instantaneous luminosity at the start of the fill, and detailed understanding of the trade-offs of inefficiencies incurred by high pile-up conditions. During the CMS Physics Week (16-20 April 2012), all analysis groups will present results on the useful integrated luminosity versus the instantaneous luminosity to understand the physics side of the equation. In case it is needed, the mechanism for luminosity leveling that allows CMS to specify maximum instantaneous luminosity has been implemented and can be enabled.

Following up on discussions in December 2011, CMS has further explored the concept of data scouting and data parking to take advantage of the special circumstance of a year of data accumulation, followed by a two-year shutdown. This proposal would make use of the data-recording capacity of CMS to record additional data samples that would not be processed immediately. Instead, these samples would be “parked” during the 2012 run period, awaiting their processing at a later stage. The “parking” would be complemented by a “scouting” programme, which writes a restricted set of event information at a very high rate at HLT. Data scouting in HLT is an extension of an existing monitoring workflow—well tested and well motivated.

Some of B Physics, SUSY and Higgs proposals for “parked” data have been studied in detail to establish the physics case and feasibility of data parking/scouting in CMS. For example, in SUSY, the increased thresholds for the core physics triggers will render a significant fraction of parameter space inaccessible in 2012 for compressed spectra (without 3rd generation squarks). Maximising the possible exclusions of parameter space is estimated to require an additional 50 Hz. A two-jet trigger with a large rapidity gap trigger would provide an inclusive trigger for Vector Boson Fusion production of Higgs, independent of the decay of the Higgs. In case of Higgs discovery in the gluon fusion channels, writing this data could facilitate the study of Higgs properties during the shutdown. The estimated rate for this trigger is between 100-150 Hz. An estimated ~75 Hz would enable additional B-physics precision measurements and searches. Additional data parking possibilities are currently under study (e.g. lowering single lepton trigger thresholds to record more W, Z and top decays). CMS expects total data parking proposals could reach a level of approximately 500 Hz, which will be categorised in short- and long-term parking and prioritised using the standard processes for developing the core trigger menu. To accommodate the computing needs of the long-term parked data sample, CMS is undertaking a data clean-up programme, so no additional storage resources are required, with an estimate of a modest increase of computing resources at the Tier-1 and Tier-2 centres. That modest increase could conceivably be covered by improved performance due to standard life-cycle replacement of compute nodes.

The LHCC commends CMS for thinking broadly about maximising the physics programme under special circumstances. The LHCC notes that some elements of the proposed physics case are more compelling than others in terms of taking advantage of the unique nature of the opportunity (as doubling the rate to tape is unlikely to be sustainable after LS1) and notes that there will be many competing priorities during the shutdown. The Committee is confident that CMS will work through the priority and resource issues between the requests and continue to show ingenuity to optimise physics programmes.

**CMS Upgrade Plans**

Preparations for LS1 are ongoing with scheduled workshops in May and September 2012, along with planning for expenditures required in 2012 to ensure success during the LS1. Given the extensive nature of the work during the long shutdown, CERN and CMS are encouraged to work with the other experiments to minimise the scheduling conflicts for key technical personnel.
Upgrade and consolidation tasks include enabling the Tracker cooling fluid to circulate at $-20\,^\circ\text{C}$, completing the muon upgrade tasks that must be performed during a shutdown, completing the first stage of HCAL phototransducer consolidation, and installing the 45 mm outer diameter beam pipe. All known detector faults affecting physics performance will be corrected to eliminate major CMS-specific risks to data quality and acquisition efficiency. Common elements such as the beam pipe are supported from contributions to the CMS common fund associated with the upgrade project. These items are critical to the success of all potential upgrades and future running scenarios and CMS is actively procuring funding to complete these tasks in LS1. The LHCC is supportive of the CMS LS1 programme of work.

Generally, the upgrades are making good progress and CMS continues to develop a strategy for the upgrade programme that allows CMS to adapt to changes in LHC projections and plans. The new structure of organisation has succeeded in engaging the Physics Analysis Groups in simulation studies. Pixel Detector and HCAL Technical Design Reviews are in preparation for the September 2012 LHCC meeting with previews of the physics cases in June 2012. Anticipating LHC operation at instantaneous luminosities of $2 \times 34\,\text{cm}^{-2}\,\text{s}^{-1}$ or higher before Long Shutdown 3 (LS3), and possibly near this by Long Shutdown 2 (LS2), CMS intends to have the new Pixel Detector ready to install by 2016. An extended year-end Technical Stop (LS1.5) to tie in the new linac may provide a possible opportunity for the early insertion of the Pixel Detector. The Level-1 Trigger Technical Design Report will be ready for March 2013.

8. DISCUSSION WITH TOTEM

The Committee congratulates TOTEM for the completion of the charged-multiplicity measurement with the T2 detector, and for the important progress towards the luminosity-independent measurement of the total proton-proton cross section at 7 TeV centre-of-mass energy, including an in-depth assessment of the systematics. The preliminary results are consistent with those obtained earlier through the determination of the elastic slope at $t=0$ via the optical theorem and the luminosity provided by CMS, and through the direct determination of the total inelastic rate. The LHCC nevertheless encourages TOTEM to review, in collaboration with CMS, the impact of the revised luminosity calibration by CMS, which was used by TOTEM in the already published cross-section measurement.

The work planned for the year-end 2011-2012 Technical Stop has been successfully achieved. In particular, the hardware installations required to enable the electrical trigger, which should deliver to the CMS Level-1 trigger the Roman Pots (RP) trigger signals, has been completed, and the trigger is ready for commissioning at the earliest opportunity. Minor issues on the RP vacuum system and cooling, on the T1 detector trigger and high-voltage partition, and water leaks and low-voltage connector problems with the T2 detector, have likewise been fixed. Work has also taken place to improve the reliability of the RP movement controls, following the requests of the Machine Protection Panel, and the new controls will be in place for both TOTEM and ALFA for the 2012 runs.

The Committee supports the request by TOTEM to benefit from the upcoming LHC runs dedicated to the alignment of the tertiary collimators and to begin the work of alignment of the TOTEM RP detectors. However, to minimise the number of dedicated fills, these runs should be limited to the alignment of the minimum number of RP detectors necessary to allow the commissioning of the electrical triggers, during the low pile-up runs scheduled for the first week of April 2012.

The TOTEM running strategy for 2012 foresees RP data-taking during the high-luminosity runs, as well as a few special runs. The top priority for the latter is a study of hard diffraction events, in parallel with CMS, using the 90 m optics and 156 bunches. TOTEM is also requesting to take part in a possible run with the 500 m optics, which is expected to become available later in the year. The Committee recognises the scientific value of these runs, and endorses the requests provided they
can fit within the time frame and the allocation for special runs postponed to later in the year that emerged from the LHC Performance Workshop in Chamonix.

9. DISCUSSION WITH LHCb

Status of the LHCb Experiment

As planned, the LHCb Collaboration used the year-end 2011-2012 Technical Stop to bring all detector sub-systems back to full efficiency. Moreover, this period was also used to install the new aerogel box for the Ring Image Cherenkov detector RICH-1, which finally separated the gas volume from the aerogel. The LHCb experiment then went through a global re-commissioning, in the last two weeks of February 2012 to power all systems and test the DAQ reliability by means of long runs with high “random” trigger rates. All work on the detector was completed on time and the cavern was closed on 9 March 2012. Shifts have also been under re-commissioning to restart training of personnel and of on-call experts, 24 hour/day shifts are expected to start in the first week of April 2012. Completion of the re-commissioning will also include testing of Level-0 and High-Level Trigger (HLT) with test collisions and one day of calibration (timing and ageing tests) with beams.

LHCb plans to operate with luminosity leveling, as they did at the end of the 2011 run, keeping the instantaneous luminosity at $\sim 4 \times 10^{32}$ cm$^{-2}$ sec$^{-1}$, aiming to integrate to 1.5 fb$^{-1}$ by the end of the year. The 8 TeV centre-of-mass energy operations correspond to a net increase of $\sim 10\%$ in signal event rate and a similar increase in track multiplicity. In order not to become critical on dead-time, some work has been done to mitigate this: the Beetle de-randomizer read-out chip was partly corrected, lowering the maximum contribution of the related dead-time from 8% to 3%, a limitation in the Tell1 acquisition board was fixed and the farm operations were ameliorated by improving the HLT code (from 27 to 23 ms/event) and increasing the farm CPU by 10%. Usage of a deferred HLT triggering scheme has been proposed in order to increase the through-put to disk by an additional $\sim 10\%$. All of this makes an overall HLT output rate of 4.5 kHz feasible. Specifically, the proposal of the deferred HLT trigger is based on the observation that the online farm remains essentially idle during inter-fill periods and each node is provided with 200 GB of disk space (which will be upgraded). The scheme works by overrunning the farm processing capacity and storing the additional fraction of raw data on local disks. During inter-fill periods the surplus of acquired data will be processed and the run closed. This scheme has been tested and in case of the appearance of bottlenecks, such as saturating or exceeding the disk capacity, the old standard triggering and processing scheme can quickly be restored. Assuming a fast intensity ramp-up of the machine, LHCb expects to start with high luminosity leveling at an early phase of the upcoming run and is therefore paying special attention to the preparation and tuning of the online and offline monitoring.

LHCb expects to have one dedicated Van der Meer scan to calibrate its luminosity around June 2012, in order to have the SMOG system available and fully working. (SMOG deliberately injects gas in the VELO to trace the beams via beam-gas interactions). However, LHCb plans to get a preliminary estimate of the luminosity by participating in the early scans assigned to ATLAS/CMS. LHCb has also agreed with the machine on moving of the IP8 interaction point crossing angle. The external crossing will be changed from horizontal to vertical, so as to decouple the machine crossing-angle from the change of horizontal angles when switching field polarity. A technical solution (“tilting after squeeze”) exists and has to be carried forward. Once successful, the requirement of LHCb is to get 3 polarity switches in between technical stops, corresponding to $2 \times 2$ equivalent data sets of 100-150 pb$^{-1}$, each obtained after around 1.5 weeks of running.

The LHCC congratulates the LHCb Collaboration for the impressive high quality of physics results achieved. The publication rate has been kept high, and an additional 19 papers have been accepted or submitted since the last LHCC session, with most of the planned results presented at the Moriond Conferences based on the full acquired sample of 1 fb$^{-1}$. To date 24 papers have been published in refereed journals, with
another 15 submitted, 14 papers still under collaboration-wide review and many other analyses soon to be turned into publications. One of the highlights at Moriond has surely been the great improvement to the upper limit for $B_s \rightarrow \mu \mu$ decays, which was set to $4.5 \times 10^{-9}$ at 95% CL, thus vastly improving the exclusion plots for simple TeV-scale SUSY models at large $\tan(\beta)$, which now look practically ruled out. In view of the importance of the result, the processing plans for 2012 have also been discussed and look adequate for the goal of proceeding rapidly with the data analysis by basing it on the first pass of data reconstruction. LHCb aims to perform a complete re-processing of the entire 2012 sample only at the end of the year, when data taking will have been completed. Assuming an overall sample of 2.5 fb$^{-1}$ at the end of 2012 and a Standard Model production rate, a reasonable chance of a 3$\sigma$ observation of $B_s \rightarrow \mu \mu$ decays exists. Moreover, the increased HLT rate, from 3.5 to 4.5 kHz, will allow the selection efficiency for dedicated channels to be improved, for example a factor of 3.5 gain in $D \rightarrow K_s \pi \pi$, the golden mode used for mixing and CPV in the charm system. In order to maintain the reconstruction output to disk within available resources, LHCb is extending the usage of the micro-DST format to most analyses and working on improving the compression (the current size is around 1/10 of the full DST). However, there are specific measurements, whose precision is limited by systematic uncertainties, that can be based only on full DST information and which, in case of the absence of additional disk space, will have to be deferred. A request for an ~20% increase of the disk space in 2013 has been put forward by LHCb and the LHCC endorses such a request.

**LHCb Upgrade Plans**

The LHCC appreciates the work done for the upgrade proposal by the LHCb Steering Panel and by the Collaboration. LHCb is progressing towards completion of an addendum to the Letter of Intent (LoI and which from now on will be referred to as the Framework Technical Design Report or FTDR), whose first draft is expected to be released in time for the June 2012 LHCC session. The LHCC agreed on the time scale and on the overall skeleton of this addendum. The FTDR will contain an update of the expected physics performance and of the running requirements, the evolution of the R&D for all subsystems since the LoI, and an evaluation of costs together with an overall schedule, milestones, both for all sub-systems and for the common projects. The schedule will be important to evaluate its integration into the general framework of the LHC shutdown schedule, with plans to install the upgrade in time for the Long Shutdown 2 (LS2). The scientific interests of each participating institution will also be stated. On the physics performance, more information will be provided by a physics paper, which will be written on the same time scale. Supplemental documents will be added if needed. The second chapter will describe the evolution of the R&D for all sub-systems since the LoI. Finally, in the third chapter, for all sub-systems and for the common projects, a breakdown of costs will be reported, together with an overall schedule, including milestones. The schedule will be important to evaluate its integration into the general framework of the LHC shutdown schedule, with plans to install the LHCb upgrade during LS2. This FTDR will be helpful for a discussion with the national funding agencies and, after a first informal presentation to the Resource Review Boards (RRBs) in the upcoming April 2012 meeting, aims for LHCC endorsement followed by RRB approval next autumn. LHCb has been invited to, and has already started participating in, the High-Luminosity LHC (HL-LHC) coordination group between the machine and the experiments. The LHCC considers this to be an important decision in pushing forward the LHCb upgrade.

**10. DISCUSSION WITH ALICE**

**Status of the ALICE Experiment**

The LHCC congratulates the ALICE Collaboration for the accomplishments during the year-end 2011-2012 Technical Stop. Major achievements include the resolution of the Silicon Pixel Detector (SPD) cooling problem and the installation of two Electromagnetic Calorimeter (EMCal) modules and three Transition Radiation Detector (TRD) modules. The SPD efficiency improved from 62.5 % to 94 % after
remotely drilling holes into clogged filters which were only accessible via the thin cooling pipes themselves. As a consequence, the relocation of the Time Projection Chamber (TPC) for access to the Inner Tracking System (ITS) during the upcoming Long Shutdown 1 (LS1) is no longer required.

The Committee also discussed additional technical issues including a new problem with the V0 detectors hampered by signal loss. The muon detector alignment continues to be considerably worse than expected in spite of significant efforts by the sub-detector group in charge.

Since the last LHCC review, seven manuscripts have been submitted for publication and 15 drafts are at various stages of review within the Collaboration. First results from the Pb-Pb running show that $J/\psi$ statistics will be sufficient for a measurement of the elliptic flow. Furthermore, increased statistics for open charm will provide an improved measurement of the nuclear modification factor $R_{AA}$ and of the elliptic flow $v_2$ for heavy flavours.

**ALICE Upgrade Plans**

The Committee discussed the upgrade plans that emerged as a consensus of the ALICE Collaboration after careful consideration. The Committee received the documents: (i) “Upgrade Strategy for ALICE at High Rate” (CERN-LHCC-2012-04) and (ii) “Conceptual Design Report for the Upgrade of the ALICE ITS” (CERN-LHCC-2012-05) submitted to this LHCC session. The LHCC acknowledges the effort made by the Collaboration to engage the Committee in this early phase of the discussion of the ALICE upgrade, an upgrade that will have far-reaching implications.

In essence, the proposed upgrades improve the vertex and momentum reconstruction capability with a new ITS and dramatically increase the data taking rate whilst maintaining the particle identification capabilities. The upgraded experiment would be run without a trigger bias and will maintain high efficiency at low transverse momenta. The physics topics for the upgrade include heavy flavour and quarkonia, especially at low transverse momentum, low-mass di-leptons, jet and jet-$\gamma$ studies, as well as searches for exotica like hyper-nuclei and di-baryons.

The proposed upgrade of ALICE would facilitate read-out at 50kHz, which necessitates a major upgrade of the TPC, namely the replacement of the existing read-out chambers with Gas Electron Multiplier (GEM) detectors. Furthermore, all central detectors will require an (electronics) upgrade by switching to a fully pipelined read-out complemented by a new event selection system with improved filtering features.

The LHCC welcomes the studies detailed in the ITS Conceptual Design Report and recognises the effort of the Collaboration. The LHCC concentrated on the physics aspects of the report, which also contains a detailed discussion on the Si-detectors and the read-out. The main objective of the upgraded ITS is to improve by a large factor ($\approx 2$ and varying with transverse momentum) the resolution in impact parameter, and to boost particle reconstruction even at low momenta ($\leq 0.2$ GeV). As an example, such a detector provides the resolution for charmed baryon reconstruction with good statistical significance even on a background of typically $10^{10}$ particles. The LHCC remains concerned about the experimental uncertainties of such a measurement and encourages further R&D with respect to the ITS upgrade as well as more detailed studies on the physics performance, in particular with respect to the systematic errors expected for the proposed open charm measurements.

The upgrade strategy is largely founded on particle identification and the superb resolution at low momenta provided by the upgraded ITS, an area where the two general-purpose detectors ATLAS and CMS suffer from their higher material budget. The LHCC would like to understand how this advantage eventually translates into an improved and realistic physics analysis capability both at low integrated luminosities of $1$ nb$^{-1}$ with the current TPC and beyond together with the upgraded read-out. The considerations should address the complementarity to ATLAS and CMS.
For the high-luminosity option the Committee recommends identifying a set of between five to ten unique benchmark physics processes for ALICE showcasing the need for running beyond an integrated luminosity of \(1\text{nb}^{-1}\). The fundamental significance of the chosen examples should be outlined and contrasted with quantitative theoretical predictions where applicable. For each of the processes the actual threshold statistics should be indicated together with a realistic assessment of the associated systematic uncertainties. The uniqueness and complementarity should be demonstrated by indicating the reach expected of the experiments ATLAS, CMS and LHCb until Long Shutdown 2 (LS2). The role and need for further proton-proton reference data should be commented on.

Finally, the Committee stresses the importance to engage in a broader discussion on future perspectives of high-energy heavy-ion physics, including with the other LHC experiments, and to contrast the programme with that of lower-energy experiments.

11. DISCUSSION WITH LHCf

The Committee congratulates LHCf for the continued progress in understanding the implications of the data collected so far. The most recent results include the single photon spectrum from the 900 GeV centre-of-mass energy run, and the transverse energy spectrum of neutral pions at 7 TeV centre-of-mass energy. Both these results confirm the inadequacy of the current event generators to describe the production dynamics at these very forward rapidities.

Several publications have already emerged, and a fruitful collaboration with the cosmic-ray community, particularly with the experts in Monte Carlo (MC) simulations of the primary cosmic-ray interactions with the atmosphere, has started. Tunings of the MCs have been performed to improve the agreement with the LHCf photon energy spectra.

Work has continued in preparation of the proton-Pb 2012 run. In particular, LHCf has responded to the previous LHCC requests to review the plan for mounting during the year-end 2011-2012 Technical Stop the multi-channel connectors that will speed up the detector installation before the proton-Pb run. Joint work with ATLAS has also started, to ensure smooth operations in parallel with the ZDC installation and to share trigger signals. The upgrade of the Arm-1 detector will be completed with more test-beam data to be taken this summer. The upgrade of the Arm-2 detector will be completed as soon as the SPS test beam becomes available after the 2013-2014 shutdown.

The planning for the 2012 data taking requires a minimum of \(10^8\) events, which should correspond to about 50 \(\mu\text{b}^{-1}\) of luminosity. With the current luminosity estimates, this could be achievable within 6 days of data taking.

12. REPORT & DISCUSSION WITH LHC EXPERIMENT UPGRADE REFEREES

The LHCC heard a report from the LHC experiment upgrade referees, concentrating on the upgrade plans for ATLAS and ALICE.

The ATLAS upgrades are scheduled as Phase-0 (installation during 2013-2014), Phase-I (installation during or before Long Shutdown 2 (LS2) in 2018) and Phase-II (installation planned for Long Shutdown 3 (LS3) in 2022). The LHCC considers that ATLAS has a coherent overall upgrade programme up to and including Phase-II. Detailed plans for Phase-I have been accepted within the ATLAS Collaboration and the Letter of Intent has been submitted and reviewed by the LHCC. The core costs have been estimated for Phase-I and presented to the ATLAS Resources Review Board and to the national contact physicists. The Insertable B-Layer (IBL) project is progressing well and the team is on target to deliver the fourth and inner-most layer for the Pixel Detector for Phase-0. ATLAS has thus successfully started the standard formal process for approval of its upgrade plans through to 2022. The process is underway and includes the Letter of Intents, then Technical Design Reports and Memoranda of Understanding for each of the major project components.
The ALICE plans beyond their approved physics programme consists of various physics topics. Firstly, it includes studies for the characterisation of the quark-gluon properties by studying multi-differential observables (flavor, centrality, transverse momentum and reaction plane). This requires high statistics (high luminosity). Secondly, ALICE proposes physics studies focused on observables where the experiment is unique, such as precision measurements of spectra, correlation and flow of heavy flavor hadrons and quarkonia at low transverse momenta. This requires high statistics (high luminosity) and precision measurements. For the above physics cases, the standard trigger strategy is mostly not applicable. ALICE has submitted to the LHCC a document prepared to define the physics goals and the experimental approach for a run of at least 10 nb$^{-1}$ with Pb-Pb collisions running ALICE at the high rate of 50 kHZ. This programme is aimed for the period after LS2. ALICE has also submitted to the LHCC the Conceptual Design Report for the Inner Tracking System (ITS) upgrade, which is a central component of the general strategy for the ALICE upgrade. Furthermore, three major proposals are under consideration to extend the scope of ALICE – the Very High Momentum Particle Identification Detector (VHMPID), the Muon Forward Tracker (MFT) and the Forward Electromagnetic Calorimeter (FoCal). R&D continues for the various proposed upgrades and ALICE has started negotiations with Funding Agencies to define the resource boundaries.

13. REPORT & DISCUSSION WITH THE WLCG REFEREES

The Committee congratulates the Worldwide LHC Computing Grid (WLCG) team and the experiments on their continued impressive performance. Since the previous LHCC session the 2011 heavy-ion data have been processed, much of the proton-proton data have been reprocessed, large samples of simulated data at both 7 TeV and 8 TeV centre-of-mass energies have been generated and reconstructed, and many physics analyses have been completed and published. The experiments have invested a great deal of effort to improve the speed and efficiency of their reconstruction code and to limit the amount of stored data, by compressing event sizes, reducing the numbers of copies kept on disk and aggressively deleting old versions. This has allowed them to operate within the limits imposed by the resources available, but only by developing flexible strategies that allow data and processing tasks to be moved around to make the most effective use of disks and CPU power.

The shortage of disk supplies, which had been anticipated due to flooding in Thailand, has turned out not to be a major problem. However, funding for computing resources is likely to remain under severe pressure, as major equipment purchased some years ago will need to be replaced, in addition to providing any increase in capacity. This could limit the ability of some sites to honour the pledges made to install disk, tape and CPU resources in the future. The LHCC is concerned that these pledges, which have been agreed to following careful scrutiny and review of the resources requested, should be fulfilled. This applies as much to the Tier-2 sites as to the larger Tier-1 and Tier-0 centres. The WLCG was designed to be a distributed computing facility with the Tier-2 sites forming an essential part of the model.

CERN has decided to locate the remote Tier-0 centre in Budapest. Prototyping will begin in 2013, ramping up to full production in 2014. Tendering is now being launched for a dedicated high-speed network connection to CERN. Consolidation work to provide additional critical power to the existing CERN Tier-0 building is also in progress.

ALICE has improved its efficiency for production jobs to over 80%, lowered the number of reconstruction passes and the amount of simulated data and had a campaign to delete obsolete files. As a result the requirements for computing resources have been reduced since the December 2011 LHCC session. New prototype ALICE Tier-1 centres have been established in South Korea and in Mexico, with discussions in progress for an Indian Tier-1 site. Resources are still tight, but the LHCC is pleased to see that there has been a significant improvement to the long-standing shortfall between the resources available to ALICE and the requirements.
The LHC run in 2012 is expected to be followed by a period of well over a year without any data-taking. During this long shutdown many of the computing resources that would normally be in use to process new data will be available for other purposes. CMS, ATLAS and LHCb all propose to take advantage of this opportunity by significantly increasing their trigger rates during the 2012 run, opening up their acceptance to record additional physics events that would otherwise fall outside their normal trigger thresholds. This would allow a broader physics programme, increased sensitivity in searches for new physics and more detailed systematic studies in high-precision measurements. The full analysis of these extra data would be delayed until the 2013-2014 shutdown, when the computing resources would become available to handle the additional processing and storage. Increases of around 10-20% in the requests for resources in 2013-2014 are required in some cases. The details for each experiment are given below.

The latest version of the CMS reconstruction code shows excellent performance with high pile-up events. It is much faster than the previous version and uses less memory. This allows events to be reconstructed at 300 Hz, with the time between LHC fills being used to complete the processing. In 2012 CMS proposes roughly to double the rate of recording data, for the reasons explained above, with about half the data reconstructed promptly and the remainder “parked” in storage, to be reconstructed later at Tier-1 centres during the long shutdown. They will need about 20% more Tier-1 CPU than in 2012 and 15% more Tier-2 CPU than estimated in 2011. No further increases in tape or disk requirements over those requested are anticipated, due to reductions in the size of events and the number of raw Monte Carlo events stored and the deletion of old data files.

ATLAS has compressed the raw event size on disk, reduced the number of reprocessing passes to one per year and steadily improved the software to reconstruct high pile-up events more quickly. In 2012 the baseline rate in physics streams will be at 400 Hz averaged over a fill, with another 15 Hz of zero-bias events for pile-up overlay studies. ATLAS proposes, in addition, to record 75 Hz or more in a stream for which the processing would be delayed until 2013, in order to allow a broader programme of B physics, for example. This requires 400 TB of tape storage and 200 TB of disk in 2013.

LHCb suffers from a disk space shortage due to the larger event sizes with high pile-up and the increase of trigger rate from 2 to 3 kHz agreed in 2011 to accommodate a charm physics stream. Installation of the resources pledged for 2012 should improve this situation. LHCb proposes a further increase in trigger rate to 4.5 kHz in 2012. The pledged resources for 2012 are insufficient to exploit the full physics potential at this rate and so they will initially write to disk only the micro-DST for some physics channels. In 2013, if about 20% more storage were available at Tier-1 and Tier-2, then the full DST could be “unlocked” for further selected channels, increasing the output by 50% and allowing enhanced analyses with detailed systematic studies as well as data-mining searches.

The LHCC supports the strategies for delayed analyses of part of the 2012 data, to maximize the physics potential from the 2012 LHC run, taking advantage of the unique situation provided by the long 2013-2014 shutdown. This is consistent with the Committee’s previous recommendations to have a more prioritized approach to data processing, with compromises in the speed at which some channels can be analysed. However, the proposals are for additional data to be recorded on top of the baseline trigger rates. These strategies do require some extra computing resources, but the experiments should understand that funding is restricted. It might prove difficult to satisfy all the requests for storage and CPU resources in 2013-2014, in which case priorities must be set to allow the physics analysis to proceed along with simulation and other work, within the limits set by the resources available.
14. DISCUSSION WITH MOEDAL

The LHCC was informed by the MoEDAL Collaboration on the progress made in the construction and deployment of the MoEDAL detector. MoEDAL is an experiment designed to search for highly-ionising particles at the LHC (monopoles/dyons) as well as stable and pseudostable singly- and multi-charged heavy particles. The detector is based on track-etched detectors and is housed in the LHCb Vertex Locator (VELO) cavern. The MoEDAL detector is made of an array of plastic Nuclear Track Detectors (NTDs) for a total surface of 10 stack sheets of 25 m² each, the largest passive array ever deployed at an accelerator.

The Collaboration deployed in January 2011 one-third of the full detector. At the same time they removed the plastic deployed for tests in 2009 (1 m²) to be etched in Bologna and to be calibrated at the NASA Space Radiation Laboratory (NSRL) in BNL with a Fe heavy-ion beam in April 2012. The setting up of the process to get the beam has taken more time than expected, but future exposures can be pipelined allowing a constant flow of calibration results.

The goal of the Collaboration is to have the full deployment during the Long Shutdown 1 (LS1) and then collect data during the following run in order to reach an integrated luminosity of 10 fb⁻¹ at 14 TeV. The construction and installation of the detector is proceeding within the presented timescale, and the analysis and calibration of the removed detectors is also progressing well.

In addition, a test system of two (out of 10) TimePix pixel detectors, used for the measurement of the background from radiation/spallation, were installed in February 2012.

The Very High Charge Catcher (VHCC), designed to double the acceptance for very highly-ionising particles, has also been presented. This can be installed in a new area previously not accessible.

No special request has been presented by the Collaboration for the 2012 data taking. At the same time, having deployed one-third of the full detector, MoEDAL aims to collect data and remove their detector at the end of 2012. The results of the 2011-2012 run will be available in 2013.

MoEDAL has also started a collaboration with the GEANT4 group to implement the simulation of damaged track formation in NTDs. This simulation activity is completely new with respect to last MoEDAL report to the LHCC.

A paper on the physics goals of the MoEDAL experiment is also in preparation. Furthermore, new institutions have joined the collaboration, in particular King’s College London (UK), Université de Genève and other members from the University of Alberta (Canada), while applications from Spain and Russia are in progress.

15. CLOSE-OUTS WITH THE DIRECTOR-GENERAL

The LHCC informed and discussed with the Director-General the status of the experiments and their plans for the future. Amongst the issues discussed were the LHC machine and experiment status, and the ongoing work and preparations for the upgrades of the LHC experiment.

16. REFEREES

The LHCC referee teams are as follows:

ALICE: J.-C. Brient, D. D’Enterria, W. Kuehn (Co-ordinator)


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

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

TOTEM, LHCf, MoEDAL: U. Bassler, C. Cecchi, D. D’Enterria, M. Mangano
17. The LHCC received the following documents:

- Minutes of the one-hundred-and-seventh meeting held on Wednesday and Thursday, 7-8 December 2011 (LHCC-2012-002 / LHCC 108)
- The ATLAS Phase-1 Letter of Intent (LHCC-2011-012 LHCC-I-020)
- Upgrade Strategy for ALICE and High Rate, ALICE Collaboration (CERN-LHCC-2012-004)
- Conceptual Design Report for the Upgrade of the ALICE ITS, ALICE Collaboration (CERN-LHCC-2012-005)

18. DATES FOR LHCC MEETINGS

Dates for 2012
13-14 June
26-27 September
5-6 December

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