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PRINCIPAL LHCC DELIBERATIONS

34TH MEETING OF THE CMS RESOURCES REVIEW BOARD

23 APRIL 2012

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GENERAL

This document summarizes the principal LHCC deliberations concerning CMS at the Committee's sessions in December 2011 and March 2012.

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.

CONCERNS FROM THE PREVIOUS CMS RESOURCES REVIEW BOARD

SUB-SYSTEM	CONCERN	STATUS
Hadronic Forward Calorimeter (HF)	Cherenkov light in the photomultiplier tube windows.	Resolved by filtering in software and will be addressed further in the first Long Shutdown LS1.

STATUS OF THE EXPERIMENT

TECHNICAL STOP

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 rains and 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.

All of the CMS sub-detectors are operational for the 2012 LHC run, 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 an inefficiency for the Cathode Strip Chambers (CSCs) 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 through-put 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 through-put of 2 kHz and 220 TB buffer space. Significant effort was invested to identify and mitigate the Single Event Upsets (SEUs).

MEASUREMENT OF LUMINOSITY

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%). 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 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.

COMPUTING

Computing continues to perform well. An 800M Monte Carlo event sample at 8 TeV centre-of-mass energy 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.

CMS has 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.

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.

PHYSICS

CMS has produced a rich set of public physics results with a well-understood detector. The CMS search for the Standard Model Higgs boson is well underway, with CMS currently reporting an excess of events being observed around a Higgs mass of ~124-125 GeV. The 2012 LHC run will allow CMS to either discover or exclude the Standard Model Higgs boson. The 2011 physics analyses are going well—with results shown for top, SUSY, Exotics, and Higgs channels as well as a successful heavy-ion set of publications. A comprehensive status of physics objects was presented, including tracking, jets, electromagnetic objects, and b-tagging. Tau-leptons are well understood, as demonstrated by the tag and probe studies in $Z \rightarrow \tau\tau$. Another notable success in object identification is that the Particle Flow algorithm is now in use in many analyses and is available in the HLT. The effects of pile-up are demonstrated to be largely understood and have been mitigated.

CMS UPGRADES

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 deg 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 upgrades 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 **supports** 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 Hadronic Calorimeter (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 2×10^{34} cm^{-2} 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. A possible extended year-end Technical Stop (LS1.5) to tie in the new LINAC4 may provide an opportunity for the early insertion of the Pixel Detector. The Level-1 Trigger Technical Design Report will be ready for March 2013.