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PRINCIPAL LHCC DELIBERATIONS

33RD MEETING OF THE CMS RESOURCES REVIEW BOARD

18 OCTOBER 2011

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GENERAL

This document summarizes the principal LHCC deliberations concerning CMS at the Committee's sessions in June 2011 and September 2011.

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
Electromagnetic Calorimeter (ECAL)	Spikes caused by direct ionization of the Avalanche Photo-Diodes (APDs).	Topological and timing information was used to filter the problem.
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

OPERATIONS

CMS is coping well with the current running conditions with peak instantaneous luminosity of 3.3×10^{33} Hz/cm^2 and average pile-up of 16 interactions per crossing. To date, 2570 pb^{-1} of delivered luminosity has been certified, with 84% certified as golden and 91.2% as usable for muon physics. There is active progress on understanding the detector performance, leading to improvements in alignment, calibration and algorithms. Work on a run dependent Monte Carlo is in progress to simulate real detector conditions. The CMS detector channels are operating very stably, with the Preshower having a slight drop due to high leakage current for one sensor type and the effect of some faulty low voltage connectors. Studies of detector performance in most sub-systems are leading to improvements in alignment and calibration. In the tracking systems, radiation damage is compatible with expectations for the strips and pixels. The cooling plants and circuits leak rates remained stable.

There have been two developments in the Electromagnetic Calorimeter (ECAL). The laser monitoring system is fully operational and provides certified corrections in time for the prompt reconstruction. The second development concerns the spikes caused by direct ionization of the Avalanche Photo-Diodes (APDs) that cause a signal in a single crystal of the Barrel ECAL. Topological and timing information was used to filter the problem in the High Level Trigger (HLT) and offline. However, the rate increases proportionally with the luminosity and started to cause problems for the electron-photon triggers at Level-1, as had been anticipated. This was addressed by

some firmware modifications to use topological information. The algorithm is tuned to maintain high efficiency while rejecting the spike events.

For the Hadron Forward Calorimeter (HF), the issue with Cherenkov light in the photomultiplier tube windows was resolved by filtering in software and will be addressed further in the first Long Shutdown LS1.

For the trigger system, CMS is running at ~80 kHz at Level-1 and at ~400 Hz at the output of the High Level Trigger (HLT) with dead time 3-4% at current peak luminosity with HLT-CPU load around 75%. There is stronger pile-up dependence than originally predicted, affecting primarily the triggers that use scalar sums and multi-jets. Studies are ongoing to develop pile-up corrections to enable running at higher luminosities.

Preparations for the 2011 heavy-ion run are well advanced. Luminosities are expected to be 10 times greater compared to 2010 and CMS expects to take up to 3 kHz of PbPb collisions, with a HLT output of ~200 Hz. CMS is preparing and testing an appropriate trigger configuration. Zero suppression will be done at the Front-Ends (Electromagnetic Calorimeter / Hadronic Calorimeter HCAL) and in the HLT (Strip Tracker) farm, with a total expected raw data volume of 250 TB RAW data. The prompt data reconstructed will take place at the Tier-0, RAW data will be shipped to FNAL for permanent storage, reconstructed at the dedicated Tier-2 facility at Vanderbilt University, and data analysis will proceed at participating Tier-2 centres.

COMPUTING

The predictions for the computing parameters such as event size is very close to the estimates for 2011 with a few understood variations caused by the unexpected pile-up. Release 4_2 was deployed at Tier-0 at the end of April 2011, providing a robust and stable version for physics. The reconstruction time is about 20% higher than expected, and has a current 50% CPU utilization at the Tier-0 due to memory constraints on the nodes. Release 4_4 will be validated for use at Tier-0. This release includes code speed improvements, tracking improvements to cope with higher pile-up and a reduction in memory usage. The full 2011 data set will be reprocessed with Release 4_4.

PHYSICS

The LHCC congratulates the CMS Collaboration for producing a rich set of public physics results. CMS has reached the mark of 100 publications and is completing the 2010 analyses while taking full advantage of the 2011 data set. Physics highlights include a measurement of the $B_s \rightarrow \mu^+\mu^-$ branching ratio limit $BR(B_s \rightarrow \mu^+\mu^-) < 1.9 \times 10^{-8}$. This result combined with the LHCb result yields $BR(B_s \rightarrow \mu^+\mu^-) < 1.1\ 10^{-8}$ @ 95% CL, in good agreement with the Standard Model and expectations. There are baseline electroweak and top property measurements, excellent progress towards understanding and using τ leptons as analysis objects and numerous searches for exotica. Searches for supersymmetry show strengthening exclusion limits, far exceeding the Tevatron exclusion contours. There is a focus on searches for Standard Model Higgs. The CMS results presented to the LHCC underscore a good understanding of the detector and the plan and mechanisms are in place to perform these analyses on the complete 2011 data set in a timely way, including preparation to combine the full data set results with the comparable ATLAS results, which depending on the amount of luminosity in the complete data set could give the opportunity for a conclusive statement.

CMS UPGRADE

The LHCC took note of the final version of the Technical Proposal for the Upgrade of the CMS Detector through 2020 (CERN-LHCC-2011-006 / LHCC-P-004).

A detailed status of progress towards the upgrades was presented to the LHCC. The beam pipe diameter is fixed at 43.6 mm and the design has been reviewed by the LHC machine group with a decision to go forward with the tender with a target installation in 2014, thus gaining the flexibility to install the upgraded Pixel Detector during a short shutdown around 2016.

Progress on the construction and electronics for the Muon Systems is good for installation in the first long shutdown (LS1), although there is one point of concern. While construction of the 4th station of Cathode Strip Chambers (CSCs) is progressing with an assembly factory at CERN producing prototypes, there are delays caused by failure of delivery of the panel materials that has led to a cancellation of the contract. The next order for the panels will have to be expedited and it is possible that to meet the schedule the factory production rate will have to be accelerated relative to the original plans.

The progress presented follows the Upgrade Technical Proposal (LHCC-P-004) which sets the overall frame for the upgrade projects. The November 2011 workshop will set the groundwork for detailed Technical Design Reports delivered by summer 2012 for the proposed Pixel Detector, HCAL and Trigger upgrades. These Technical Design Reports will include more comprehensive physics case studies.

CMS will host an upgrade workshop in November 2011 with the goals of building detailed project schedules with milestones and costing profiles for the upgrades planned for installation by 2016. The individual project schedules will be integrated into an overall schedule that will show the dependences between projects and enable the adjudication of conflicts. The workshop will also consider the upgrade landscape after 2020.

The LHCC appreciates the transparency of the overall upgrade activities of CMS. The LHCC acknowledges the consolidation activities for the muon detectors and the forward hadronic calorimeters. The LHCC is looking forward to the Technical Design Reports for the Pixel Detector, Trigger and Hadronic Calorimeter (HCAL) upgrade for which intense R&D is under way.