

**Summary of Principal LHCC Deliberations  
(May, July and October 2001 Sessions)**

**13<sup>th</sup> Meeting of the CMS Resource Review Board  
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## 1. General

This document summarises the principal LHCC deliberations concerning CMS at the Committee's sessions in May, July and October 2001.

The LHCC considers that CMS is progressing well with the construction of the detector, although some critical items have been identified. The Committee noted the impressive progress made towards the realisation of an experimental set-up ready to record data at the beginning of the LHC operation in 2006, although detector installation is foreseen beyond the initial running. The proposed lay-out of the detector at LHC start-up will allow CMS to address satisfactorily the physics issues of Higgs and SUSY.

However, the LHCC noted that the above schedule is known to be limited in certain cases by resources, both in terms of money for installation and integration and in terms of expert manpower available from collaborating institutes for parallel installations.

The conclusions from a recent cost review of CMS were reported to the October 2001 session of the LHCC. The Committee took note that although there is a cost increase as well as a deficit in the funding, it considers that the Collaboration is following strict budgetary control in constructing this technologically demanding detector.

## 2. LHCC Comprehensive Review

The second annual LHCC Comprehensive Review of CMS took place on 1-2 October 2001. The LHCC referees addressed the following areas: Inner Detector, Calorimetry, Muon Spectrometer, Trigger/DAQ/DCS, Physics Studies, Computing, Test Beams and the topics of Management, Technical Coordination, Integration, Schedules and Costs.

Since the first of the CMS Comprehensive Reviews in October 2000, the CMS Collaboration has made very significant progress towards the realisation of an experimental set-up ready to record proton-proton collisions at the LHC in April 2006. In particular, the start of construction of the majority of the final components has either begun or is imminent.

It is realistic to expect CMS to install an initial working experiment for the first collisions of the LHC pilot run starting in April 2006 and for the physics run starting in August 2006, although detector installation can be foreseen beyond this date. The LHCC considers that the CMS schedule to achieve this is challenging. The LHCC notes that additional resources, both in terms of money and manpower, would aid in accelerating the current CMS schedule, and thereby would ensure a timely completion of the initial detector in 2006.

In the event that additional funding is not available to ensure completion of CMS in 2006 as described in the Technical Design Reports, the installation of some components of the Tracker, HCAL, Muon System, and TRIDAS will be deferred in a staging plan which is presently being prepared. Staging of one or both of the ECAL end-caps is also being considered. In these circumstances,

and following a shutdown of a few months in 2007 after the end of the first physics run, the CMS detector as described in the approved Technical Design Reports would be complete.

The proposed staging plan for the experiment is aimed at having a small adverse impact on the Higgs and SUSY sensitivity at a luminosity of order  $10^{33}$   $\text{cm}^{-2} \text{s}^{-1}$ . However, the possible omission of the ECAL end-caps would lead to a major deficiency in the low-mass Higgs search in the favoured  $H \rightarrow \gamma\gamma$  channel. The Committee strongly supports the Collaboration in its efforts to re-optimize the funding profile and to secure additional funding so as not to stage the ECAL end-caps. The LHCC wishes to stress to the CMS Collaboration the importance of having full coverage in acceptance with the ECAL from the start of the first LHC physics run. One of the primary strengths that CMS brings to LHC physics is the high quality of its EM calorimetry, and the excellent sensitivity that it has to the low mass  $H \rightarrow \gamma\gamma$  decay channel. It would be highly inappropriate if this strength was not exploited from the beginning of any discovery window for Higgs that is likely in 2006.

The principal conclusions and concerns of the LHCC are given below. They will allow the Committee to follow-up outstanding issues and to monitor future progress of this project in forthcoming sessions of the LHCC prior to the next CMS Comprehensive Review one year hence.

- The majority of detector sub-systems are now well into the construction phase, have just entered it or are approaching this stage.
- The construction of the large solenoid magnet, a time-critical component of the Common Projects of CMS, is well-underway and progressing satisfactorily.
- Progress on problems reported at the previous CMS Comprehensive Review has been clearly demonstrated. However, some issues remain critical. The most critical item is that of completing the ECAL with its two end-caps. The Committee took note of the delays in the procurement of the ECAL front-end electronics, an incomplete calibration of all supermodules in a high-energy electron beam and a non-optimized funding profile for the inclusion of both end-caps in 2006. Furthermore, the LHCC noted the critical issues concerning the on-detector electronics for the muon chambers and the rate of production of the DT chambers. The Collaboration is addressing these difficulties in order to recover as much as possible the incurred delays.
- The overall CMS construction and installation schedule with its milestones were presented. An initial detector can be completed, albeit within a challenging schedule, to meet the start of physics data taking in August 2006, although, without additional resources, detector installation for staged systems can be foreseen beyond this date.
- The predominant source of uncertainty in the time planning for installation of CMS is now the date of completion of the underground civil engineering at LHC Point 5. Thus, particular emphasis is being given by CMS to the

integration issues that are on the critical path and which are influenced by the availability of surface and underground halls, such as the commissioning and integration of TRIDAS, and to the preparation for the assembly and installation phases before the pilot LHC run.

- The LHCC noted the short-fall in resources to complete the detector, both the initial detector for August 2006 and the final detector as described in the Technical Design Reports. The remaining resource issues for CMS are being discussed with the funding agencies in view of developing a plan for completion. A progress report will be submitted to the CMS Resource Review Board in October.
- Widespread and coherent computing and trigger/DAQ projects are in progress.
- CMS has confirmed with extensive simulation studies the Collaboration's motivation to exploit the physics at the LHC and the detector's excellent potential for major discoveries.
- The LHCC noted that the availability of test beams, including LHC-type beams with the 25 ns bunch structure, are essential for the successful completion of the experiment.

### **3. Magnets**

The Magnet Advisory Group to the LHCC (MAG) reported orally its conclusions on the review of the CMS solenoid magnet to the October 2001 session of the Committee. The review is not yet finalised and agreed by the LHCC.

However, the MAG is fully-satisfied with the progress on the CMS yoke and end-caps as exhibited by the well-advanced state of the assembly on the surface at the CMS area at Point 5. Substantial progress was reported for the conductor and coil, highlighted by the successful demonstration of the continuous welding process. The MAG commends the Collaboration for exercising strict budgetary control, as the magnet project was shown to be almost within budget with about 85% of the costs having been already committed.

### **4. Resistive Plate Chambers**

The LHCC recommends that all LHC experiments produce a detailed document illustrating the individual tasks to be undertaken in the manufacturing phase of the Resistive Plate Chambers (RPCs). The report should also address Quality Assurance and Control. This document should be reviewed within each of the experiments and should also be communicated to the LHCC. The LHCC will use this information to review and monitor the production of the RPCs. The task list should also serve as a basis to prepare the contract with the manufacturing firm. The LHCC also recommends that the experiments should not move hastily into production of the chambers before ensuring both their functionality and the manufacturing process. The LHCC will continue monitoring the progress in the RPCs.

## 5. Computing

The LHCC considers that the LHC Computing Review, which was held under the chairmanship of S. Bethke, has set out a sound model for the future LHC Computing. The LHCC also endorses the identification of a potential lack of resources – hardware, infrastructure and related manpower – while noting the limited maturity of the current planning and resource estimates for the production of the software, the development and support of simulation packages and the support and future evolution of analysis tools.

The LHC Computing Review has recommended the instigation of the LHC Software and Computing Steering Committee (SC2) to help facilitate the deployment of the entire LHC hierarchical computing structure, and the LHCC concurs with this conclusion as the next step forward.

The LHCC considers that plan for the LHC Computing Grid Project, which includes the required additional resources both at CERN and in the Member States and Non Member States, is reasonable and endorses it as the next step forward in proceeding with the LHC Computing.