Introduction to the CMS contribution

P. Arce[b], O. Buchmüller[a], F.-P. Schilling[a], I. Vila[d], M. Weber[c]
for the CMS Collaboration

[a] *CERN, Geneva, Switzerland*
[b] *CIEMAT, Madrid, Spain*
[c] *I. Physikalisches Institut B, RWTH Aachen, Germany*
[d] *Instituto de Física de Cantabria (CSIC-UC), Santander, Spain*

18.1 Introduction

The tracking detectors of the Compact Muon Solenoid (CMS) experiment are of unprecedented complexity and require a high-precision alignment in order to exploit the full potential of these devices. The following four papers represent a summary of the CMS contributions to the 1st LHC Detector Alignment Workshop [1]. Each individual contribution corresponds to a presentation at the workshop and reflects the status of the work at the time of the event (September 2006). The papers:

- M. Weber: *The CMS alignment challenge*,
- F.-P. Schilling: *Track-based alignment in the CMS detector*,
- I. Vila: *The CMS Hardware Alignment System*,
- and P. Arce: *COCOA: CMS Object-oriented Code for Optical Alignment*,

are accompanied by a brief introduction to the CMS experiment presented here.

18.2 The Compact Muon Solenoid experiment

The Compact Muon Solenoid [2–11] experiment is a multi-purpose detector featuring precise charged-particle spectrometers and calorimeters with a broad physics programme.

A schematic drawing of CMS is shown in Fig. 18.1. The total weight of the apparatus is 12 500 tons. The detector, which is cylindrical in shape, has a length and diameter of 21.6 m and 14.6 m, respectively. The overall size is set by the muon tracking system, which in turn makes use of the return flux of a 13 m long, 5.9 m diameter, 4 T superconducting solenoid. This rather high field was chosen to facilitate the construction of a compact tracking system on its interior whilst also allowing good muon tracking on the exterior without the need for excessive demands being placed on muon chamber resolution and alignment.

The return field saturates 1.5 m of iron into which are interleaved four muon tracking stations. In the central region (pseudorapidity range $|\eta| < 1.2$) the neutron-induced background, the muon rate, and the residual magnetic fields are all relatively small, whilst in the forward regions ($1.2 < |\eta| < 2.4$) all three quantities are relatively high. As a result, drift tube (DT) chambers and cathode strip chambers (CSC), are used for muon tracking in the central and forward regions, respectively. Resistive plate chambers (RPC) with fast response and good time resolution but coarser position resolution are used in both regions for timing and redundancy.

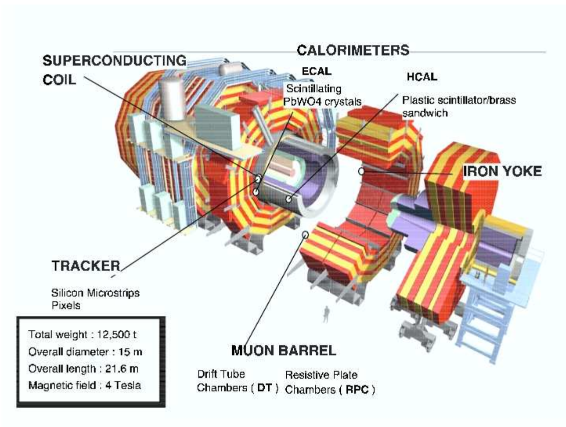

Fig. 18.1: Schematic view of the CMS detector

The bore of the magnet coil is also large enough to accommodate the inner tracker and the calorimetry inside. The tracking volume is given by a cylinder of length 5.8 m and diameter 2.6 m. In order to deal with high track multiplicities, CMS employs 10 layers of silicon microstrip detectors, which provide the required granularity and precision. In addition, three layers of silicon pixel detectors are placed close to the interaction region to improve the measurement of the impact parameter of charged-particle tracks, as well as the position of secondary vertices. The EM calorimeter (ECAL) uses lead tungstate ($PbWO_4$) crystals with coverage in pseudorapidity up to $|\eta| < 3.0$. The scintillation light is detected by silicon avalanche photodiodes (APDs) in the barrel region and vacuum phototriodes (VPTs) in the end-cap region. A preshower system is installed in front of the end-cap ECAL for π^0 rejection. The ECAL is surrounded by a brass/scintillator sampling hadron calorimeter with coverage up to $|\eta| < 3.0$. This central calorimetry is complemented by a 'tail-catcher' in the barrel region ensuring that hadronic showers are sampled with nearly 11 hadronic interaction lengths. Coverage up to a pseudorapidity of 5.0 is provided by an iron/quartz-fibre calorimeter. These forward calorimeters ensure full geometric coverage for the measurement of the transverse energy in the event.

Acknowledgements

We would like to thank all the people in the CMS alignment group whose work has been summarized in these papers. We also would like to express our gratitude to the organizers of the workshop for the opportunity of publishing these proceedings as a CERN Report.

References

[1] `http://lhc-detector-alignment-workshop.web.cern.ch/` .

[2] CMS Collaboration, CERN/LHCC 94-38 (1994).

[3] CMS Collaboration, CERN/LHCC 97-010 (1997).

[4] CMS Collaboration, CERN/LHCC 97-031 (1997).

[5] CMS Collaboration, CERN/LHCC 97-032 (1997).

[6] CMS Collaboration, CERN/LHCC 97-033 (1997); CERN/LHCC 2002-027 (2002).

[7] CMS Collaboration, CERN/LHCC 98-006 (1998); CERN/LHCC 2000-016 (2000).

[8] CMS Collaboration, CERN/LHCC 2000-038 (2000).

[9] CMS Collaboration, CERN/LHCC 2002-026 (2002).

[10] CMS Collaboration, CERN/LHCC 2006-001 (2006).

[11] CMS Collaboration, CERN/LHCC 2006-021 (2006).