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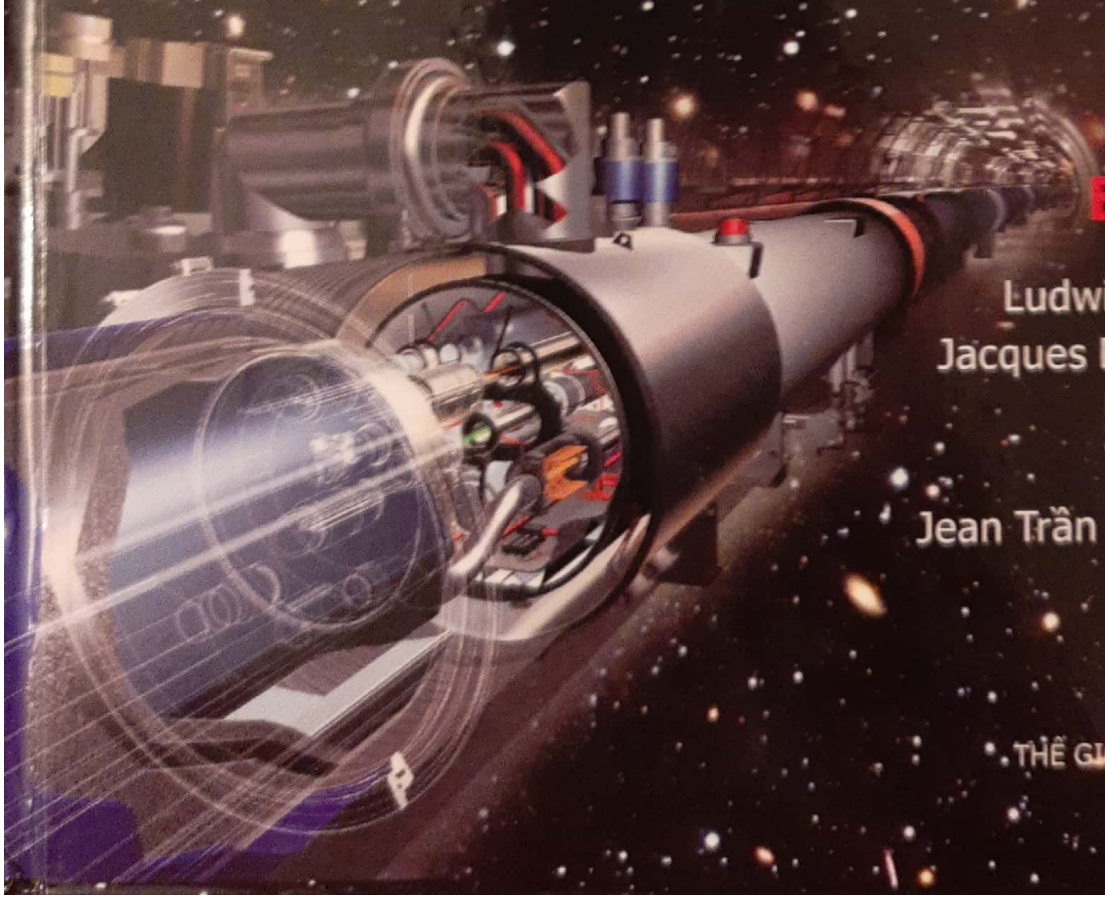
PARTICLE PHYSICS AND COSMOLOGY

First results from the LHC



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Commissioning and performance of the CMS detector

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The Compact Muon Solenoid detector at the LHC accelerator was extensively tested and commissioned during the years 2008 and 2009 using cosmic muons and being prepared for collision data. With the LHC start-up and the first runs at 7 TeV in the years 2009 and 2010 CMS started to record its first collision events. These data has been used to perform detailed studies on the performance of the detector, ranging from the efficiency of the data taking to the study of the first observed mass resonances. In this process, the calibration and commissioning of CMS was shown to be well advanced, and the detector prepared for the first Standard Model measurements.

1 Introduction

The Compact Muon Solenoid collaboration (CMS) [1] started a large-scale commissioning campaign during the years 2008 and 2009. Several millions of cosmic muons and thousands of beam halo muons were recorded and used to test the performance of the different subdetectors and the complete data-taking procedure. This process included the understanding of the magnetic field, alignment of the tracking detectors, individual performance of the subdetectors and the trigger system, the performance of the data workflows and timing and resolution studies. A total of 23 papers describing these studies were published by JINST [2]. In parallel with the commissioning and calibration of the detector, CMS was able to measure the charge ratio of atmospheric muons [3], yielding the most precise measurement up to date in the $p < 850$ GeV range, and showing that the detector was ready for collision data.

CMS recorded the first proton-proton collision event in November 2009. In the following weeks CMS collected a total of 350 thousands events from collisions with a center of mass energy of $\sqrt{s} = 900$GeV and 20 thousands events with a center of mass energy of $\sqrt{s} = 2356$ GeV. This amount was approximately 85% of the total number of events produced by the LHC [4]. The first physics results were available a few weeks after (see [5] and [6]).

In the year 2010 the LHC started to produce collisions with a center of mass energy of $\sqrt{s} =$ 7 TeV. At the moment of this conference the integrated luminosity accumulated by the CMS experiment was 88.39 nb^{-1} out of 99.89 nb^{-1} delivered by the accelerator. A large increase in the instantaneous luminosity was produced from a starting value of about $10^{27}cm^{-2}s^{-1}$ to $10^{30}cm^{-2}s^{-1}$.

The different CMS subsystems were fully operational (> 98%) during the collision runs at a center of mass energy of $\sqrt{s} = 7$ TeV. The Level-1 trigger [7] and the DAQ system performed very well, with a rate set to 45 kHz and a typical size of the event of 0.5 MB. The High Level Trigger [7] had also a very good performance, using 49 ms of process time per event. The High-Level Trigger menus were successfully deployed for an increasing evolution of the instantaneous luminosity. Collision data accumulated was utilized to continue commissioning the detector and

and for the MonteCarlo, distinguishing between the signal and the different backgrounds. The agreement is quite good within the corresponding errors.

7 Conclusions

The commissioning and calibration of the CMS detector is very well advanced. Between the years 2008 and 2009 a large commissioning campaign based on cosmic muons was performed, giving place to a very good understanding of the detector even before the start-up of the LHC accelerator. In the collision data era, the commissioning and calibration of the detectors has continued and a lot of progress has been achieved even only a few months after the start up. In these proceedings a few highlights have been presented, although many other analysis are in progress. The conclusion of these analysis is that CMS is in a very good shape, and preparing for the first Standard Model measurements.

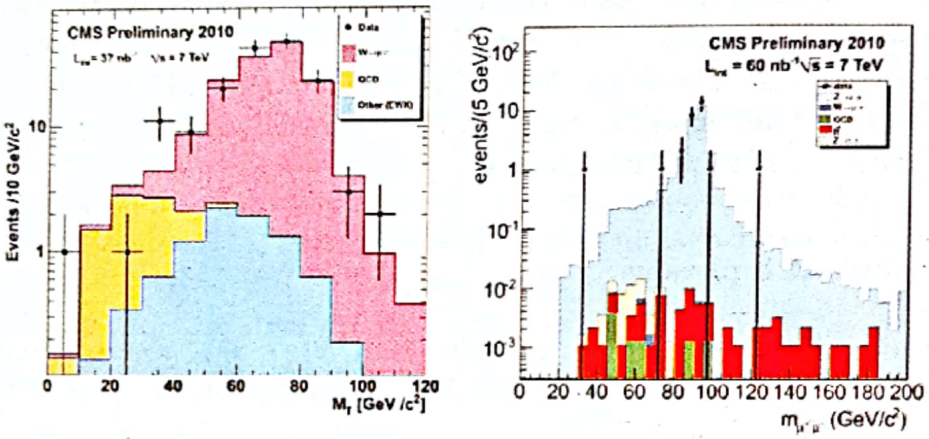

Figure 3: Invariant mass peak for the W$\rightarrow \mu\nu$ decay with an integrated luminosity of 37 nb^{-1} (left), and for the $Z^0 \rightarrow \mu^+\mu^-$ decay with an integrated luminosity of L=60 nb^{-1} (right).

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To Whom It May Concern

Geneva, 07.01.2010

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Certificate of Presence

We hereby certify that Pablo Martínez Ruiz del Árbol, member of the CMS Collaboration, has given the following oral presentations at conferences, workshops, and seminars on the dates and places indicated below:

"Precision Timing with the CMS MIP Timing Detector" at "LP2019: 29th International Symposium on Lepton Photon Interactions at High Energies, 5-10 Aug 2019, University of Toronto, Toronto (Canada)".

"Dark matter at LHC" at "Split2018: 2018 LHC days in Split, 17-22 Sep 2018, University of Split - FESB and Faculty of Science, Split (Croatia)".

"Searches for BSM physics in the 2 leptons y MET final state" at "IX CPAN days: IX CPAN days, Centro Nacional de Partículas, Astropartículas y Nuclear, 23-25 Oct 2017, CPAN, Santander (Spain)".

"Review of Supersymmetry Searches at 13 TeV with the CMS experiment" at "DM2016: Dark Matter 2016: From the smallest to the largest scales, 27 Jun-1 Jul 2016, Santander (Spain)".

"CMS SUSY searches at 13 TeV" at "LPCC Seminar: CERN LPCC EP-LHC Seminar Series, 9 Feb 2016, Geneva (Switzerland)".

"Search for Beyond the Standard Model Physics in multi-leptonic and photonic final states with the CMS detector" at "ICHEP 2014: 37th International Conference on High Energy Physics, 2-9 Jul 2014, Valencia (Spain)".

"Searches for SUSY in events with two or more leptons at CMS" at "ICHEP 2012: International Conference on High Energy Physics, 4-12 Jul 2012, Melbourne, VIC (Australia)".

"Susy searches in the Z+Jets+MET final state in 7 TeV pp collisions with the jet-z balance method" at "Bienal RSEF: XXXIII Reunión Bienal de la Real Sociedad Española de Física, 19-23 Sep 2011, Universidad de Cantabria, Santander (Spain)".

"Commissioning and Performance of the CMS Detector" at "Blois2010: 22nd Rencontres de Blois on "Particle Physics and Cosmology; First Results from the LHC", 15-20 Jul 2010, Blois (France)".

"The CMS Muon System Alignment: First results from commissioning runs " at "BIENALFISICA09: XXXII Bienal de Física, 7-11 Sep 2009, Ciudad Real (Spain)".

"Muon Alignment in ATLAS and CMS" at "Detector Understanding with First LHC Data, 29 Jun-3 Jul 2009, DESY, Hamburg (Germany)".

"The CMS Muon System Alignment" at "CHEP09: International Conference On Computing In High Energy Physics And Nuclear Physics, 21-27 Mar 2009, Prague (Czech Republic)".

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