

# Francesco Santanastasio

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Born: 9 February 1980—Roma, Italy  
Nationality: Italian

## Current Position

*Post-Doctoral Research Assistant (Post-Doc) in Particle Physics*  
Department of Physics, University of Maryland, College Park, US

## Areas of specialization

Particle Physics, Data Analysis in High Energy Physics, Physics beyond the Standard Model of Fundamental Interactions, Electromagnetic and Hadronic Calorimetry

## Career

- Dec 2007 - to- **Post-Doctoral Research Assistant (Post-Doc) in Particle Physics**  
day *University of Maryland, College Park, MD, US*  
*Based at CERN, Geneve*
- Nov 2004 - **PhD in Physics**  
Jan 2008 *"Search for Supersymmetry with Gauge-Mediated Breaking using high energy photons at CMS experiment" [21]*  
ADVISORS: Prof. Egidio Longo, Prof. Shahram Rahatlou, Dott. Daniele del Re (Sapienza)  
*Sapienza Università di Roma, Roma, Italy*
- Sept 1998 - **Laurea in Physics** (highest honors)  
May 2004 *"Calibration of an electromagnetic calorimeter using the energy flow method" [22]*  
ADVISORS: Prof. Egidio Longo (Sapienza), Dott. Riccardo Paramatti (INFN)  
Mark: 110/110 *"magna cum laude"*  
*Sapienza Università di Roma, Roma, Italy*

## Talks at Conferences

- 13-20.03.2011 **Moriond/EW 2011** - Rencontres de Moriond on “EW Interactions and Unified Theories”  
La Thuile, Valle D’Aosta, Italy  
Selected for the talk “*Exotica Searches at CMS*”  
Presentation in plenary session on behalf of the CMS Collaboration  
Conference proceedings will be published in date and journal still to be defined
- 19-23.04.2010 **DIS2010** - XVIII International Workshop on Deep-Inelastic Scattering and Related Subjects  
Firenze, Italy  
“*Searches With Early Data At CMS*”  
Presentation in parallel session on behalf of the CMS Collaboration  
Conference proceedings [6]
- 15-17.04.2009 **IFAE2009** - Incontri di Fisica delle Alte Energie, VIII Edizione  
Bari, Italy  
“*Prospects for Exotica Searches at ATLAS and CMS Experiments*”  
Presentation in parallel session on behalf of the ATLAS and CMS Collaborations  
Conference proceedings [7]

## Talks in Plenary Meetings of the CMS Collaboration

- Mar 2010 **CMS General Weekly Meeting GWM11** - Preliminary results, plots, lessons from the first 7 TeV collisions - CERN, Geneve, Switzerland  
“*Report from HCAL/JetMET*”  
Presentation in plenary session on behalf of the HCAL and Jet/MET groups of the CMS experiment
- Jan 2010 **Riunione CMS Italia** - Pisa, Italy  
“*Example of prompt analysis at CERN: Jet/MET commissioning with first collision data*”
- Sept 2009 **CMS Commissioning and Run Coordination meeting** - CRAFT (Cosmic Run At Four Tesla) 2009  
Data Analysis Jamboree - CERN, Geneve, Switzerland  
“*HCAL (Hadronic Calorimeter of CMS experiment) performance during CRAFT09*”  
Presentation in plenary session on behalf of the HCAL group of the CMS experiment
- Nov 2008 **CMS Commissioning and Run Coordination meeting** - CRAFT (Cosmic Run At Four Tesla) 2008  
Data Analysis Jamboree - CERN, Geneve, Switzerland  
“*HCAL (Hadronic Calorimeter of CMS experiment) achievements during CRAFT08*”  
Presentation in plenary session on behalf of the HCAL group of the CMS experiment

## Teaching

- Oct 2005 - **Sapienza Università di Roma** - Roma, Italy  
Feb 2006 *Teaching assistant for the course of “Fisica Generale I - meccanica classica”*  
Exercises of classic mechanics for mathematics majors

## Physics Schools

- 12-22.08.2008 **2008 Joint CERN-Fermilab Hadron Collider Physics Summer School**  
Fermilab, Batavia, Illinois, US

09-14.06.2005 **Italo-Hellenic School of Physics 2005**  
 Martignano, Lecce, Italy  
*"The Physics of LHC: theoretical tools and experimental challenges"*

## Languages

*Italian* (native speaker)

*English* (fluent)

## Highlights of Research Activities

- Dec 2007 - to-  
day      Search for pair production of first generation scalar Leptoquarks ( $LQ$ ) in the decay channels  $LQ\overline{LQ} \rightarrow eeqq$  [8, 9, 10, 14, 15] and  $LQ\overline{LQ} \rightarrow evqq$  [13] with the CMS detector. Involved in the research activities of the exotic physics group (Exotica) of the CMS experiment [see "Talks at Conferences"].
- Sept 2008 -      Coordination of the "*Prompt Feedback Group*" of the hadronic calorimeter (HCAL) of the CMS ex-  
Sept 2010      periment: monitoring and data analysis concerning problems in the HCAL detector during data-  
taking of cosmic rays [see "Talks in Plenary Meetings of the CMS Collaboration" → presentations  
on behalf of the HCAL group].
- Nov 2009 -      Commissioning of missing transverse energy (MET) reconstructed with the first proton-proton ( $pp$ )  
today      collisions at  $\sqrt{s} = 0.9, 2.36$  and 7 TeV collected by the CMS experiment [11, 12, 16, 17].
- Nov 2009 -      Development and implementation of algorithms for the identification of anomalous, beam-induced  
May 2010      signals ("noise") in the Hadronic Forward Calorimeter (HF) of the CMS experiment, observed in  
the first  $pp$  collisions at  $\sqrt{s} = 0.9, 2.36$  and 7 TeV [18].
- Jun 2009 - Jul      Contribution to the test beam of the hadronic calorimeter of the CMS experiment (HCAL Test Beam  
2009 [1]): commissioning and calibration of the "*delay wire chambers*" installed along the H2 beam  
2009      line (CERN, Preveessin site) for beam position measurements.
- Jan 2008 - Jul      Commissioning of the hadronic calorimeter (HCAL) of the CMS experiment: "on-call" support for  
2008      data acquisition (DAQ) and trigger configurations of HCAL during early periods of cosmic-ray  
data-taking.
- Dec 2006 -      Feasibility study of the search for Gauge Mediated Supersymmetry Breaking (GMSB) models in the  
Dec 2007      prompt photon decay channel  $pp \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 + X \rightarrow \tilde{G}\tilde{G}\gamma\gamma + X$  [21], with full simulation of the  
CMS detector.
- Jul 2006 -      Monitoring of the high voltage system of the CMS electromagnetic calorimeter (ECAL) and data-  
Sept 2006      taking shifts in the combined ECAL+HCAL test beam at CERN, Preveessin site (H2 Test Beam 2006  
[3]).
- Mar 2006 -      Analysis and test of stability of ECAL high voltage system including development of software tools  
Nov 2006      for data analysis [5].

- Oct 2005 - Study of the calibration of the CMS electromagnetic calorimeter using  $\pi^0 \rightarrow \gamma\gamma$  decays with full  
Oct 2006 detector simulation [4, 19, 20].
- Jan 2003 - Study and implementation of the energy flow technique applied to the calibration of the electro-  
May 2004 magnetic calorimeter of the L3 experiment at LEP (CERN) [22].

## Summary of Research Activities

In December 2007, I started an appointment as post-doctoral research assistant (*post-doc*) in Particle Physics at the University of Maryland. Since then I have been based at CERN, working in the CMS experiment on i) data analysis within the exotic physics group (Exotica), ii) commissioning, “*prompt analysis*” and detector performance studies of the hadronic calorimeter (HCAL), and iii) commissioning of missing transverse energy (MET) with first collision data at LHC.

At CMS, the hadronic calorimeter HCAL is mainly employed, together with electromagnetic calorimeter ECAL, for the reconstruction of “*jets*” (the experimental signature of the hadronization of partons) and the missing transverse energy in the event, hence playing an important role for many physics analyses feasible at a hadron collider as LHC. The very forward part of the HCAL is also used for luminosity measurement.

For the first six months of my appointment with the University of Maryland, I was involved in the HCAL commissioning, providing on-call support for data acquisition (DAQ) and trigger configurations during the early period of cosmic-ray data-taking by the CMS detector. In Summer 2009, I contributed to test beam studies of the hadronic calorimeter (HCAL Test Beam 2009 [1]) by commissioning and calibrating the “*delay wire chambers*” installed along the H2 beam line (CERN, Preessin site) for beam position measurements.

For two years, starting from September 2008, I coordinated the HCAL “*Prompt Feedback Group*” (PFG) of the CMS collaboration, composed of about 5-10 people. The PFG worked on data analysis related to anomalies found in the detector, including problems in the firmware of electronics boards, data-format and trigger issues, as well as the support to groups devoted to the online (“*Data Quality Monitoring*”, DQM) and offline (“*Run Certification*”) control of data quality.

On various occasions, I presented to the CMS collaboration the status of the detector on behalf of the HCAL group, including talks in plenary meetings that followed the two main cosmic-ray data-taking periods in 2008 and 2009 [see “*Talks in Plenary Meetings of the CMS Collaboration*” → talks on behalf on the HCAL group].

At the beginning of 2010, I coordinated the HCAL PFG in preparation to the first LHC  $pp$  collisions at  $\sqrt{s} = 7$  TeV, which occurred on 30 March 2010. For this event we provided results in real time giving evidence of the collisions. The following day, I presented to a CMS plenary meeting the results of the very first detector performance analyses based on the  $pp$  collisions on behalf of the HCAL and Jet/MET groups [see “*Talks in Plenary Meetings of the CMS Collaboration*” → talks on behalf on the HCAL and Jet/MET group].

In conclusion, the PFG provided a relevant contribution to both the HCAL commissioning in 2008-2009, and to the regular operation of the detector during the physics data-taking in 2010.

In addition to the research activities related to electromagnetic and hadronic calorimeters, I joined in November 2009 the Jet/MET group of CMS, that is employed in development and performance studies of jets and MET reconstruction. In the first months of 2010, I played a relevant role in

the MET commissioning, using the first  $pp$  collision data at  $\sqrt{s}=0.9, 2.36$  [12] and 7 TeV [11]. In particular, I am the main author of the following works: study of performance of the “*uncorrected calorimeter*” MET [17], classification of events in the non-gaussian tails of the MET distribution [16], and development and implementation of algorithms for the identification of anomalous, beam-induced noise in the Hadronic Forward Calorimeter (HF) [18]. The anomalous signals observed in HF can produce large apparent MET in the event; therefore it’s crucial to identify and reject them during the event reconstruction, since such uncharacteristic signals can worsen the precision of some physics measurements, or even simulate a fake signature of new physics beyond the Standard Model. The understanding of the performance of jets and MET reconstruction is an important point for the physics analyses I’m currently working on.

Since the beginning of my post-doctoral appointment, I have been involved in the research activities of the CMS Exotica group, which is devoted to search for exotic physics beyond the Standard Model. I presented the results of these analyses in international conferences on behalf of the CMS collaboration [see “Talks at Conferences”].

I started my activities in the Exotica group in 2008 with the search for pair production of first generation scalar “*leptoquarks*” (LQ) in the  $LQ\bar{L}Q \rightarrow eeqq$  decay channel ( $eejj$ ). Leptoquarks are conjectured particles foreseen by some well-motivated theories beyond of the Standard Model, in which transitions between leptonic and baryonic sectors are allowed. The process under study has a very characteristic signature, with two high transverse momentum ( $p_T$ ) electrons and two high  $p_T$  jets, and a peak in the electron-jet invariant mass spectrum corresponding to the LQ mass.

The feasibility study, done in 2009 with full simulation of the CMS detector [10, 15], aimed to the optimization of selection criteria to reject the Standard Model backgrounds, and study techniques to estimate them directly from data. This work showed that the existence of LQ with mass about twice higher than the current limit set by Tevatron experiments, could be excluded at CMS with about  $100 \text{ pb}^{-1}$  of data in  $pp$  collisions at  $\sqrt{s} = 10$  TeV.

The analysis has been performed with  $33 \text{ pb}^{-1}$  of  $pp$  collisions at  $\sqrt{s} = 7$  TeV collected by the CMS experiment in 2010 [8, 9, 14]. The data is in good agreement with the Standard Model predictions. Therefore a 95% “*confidence level*” lower limit is set on the mass of first generation scalar LQ at  $384 \text{ GeV}/c^2$ , assuming a branching ratio of 100% for the decay  $LQ \rightarrow eq$ . This result exceed the existing Tevatron limit on the LQ mass of  $300 \text{ GeV}/c^2$ , obtained with  $1 \text{ fb}^{-1}$  of proton-antiproton collisions at  $\sqrt{s} = 1.96$  TeV, hence extending the search for leptoquarks in an unexplored mass region. The paper has been submitted to Phys. Rev. Lett.

In addition to the  $eejj$  analysis, I am the contact person of the search for pair production of first generation scalar leptoquarks in the  $LQ\bar{L}Q \rightarrow e\nu qq$  decay channel ( $e\nu jj$ ) [13]. The combination of the results from these two channels can be used to improve the sensitivity to the new physics in the space of the unknown parameters of the theory model:  $M_{LQ}$  vs  $\beta$ , where  $M_{LQ}$  is the LQ mass, and  $\beta$  ( $1 - \beta$ ) is the branching ratio of the decay  $LQ \rightarrow eq$  ( $LQ \rightarrow \nu q$ ). The  $e\nu jj$  analysis aims to publish the results with  $\sqrt{s} = 7$  TeV  $pp$  collision data in the first months of 2011.

#### RESEARCH ACTIVITIES DURING MY UNDERGRADUATE AND GRADUATE STUDIES

My interest in elementary particle physics drove me to choose this field when I was an undergraduate student in Rome and, more recently, to do research as part of the Compact Muon Solenoid (CMS) collaboration at the Large Hadron Collider (LHC) of CERN (Conseil Européen pour la Recherche Nucleaire).

In 2003, I started working on my undergraduate thesis at *Sapienza*, Università di Roma. The work concerned the study of the calibration of an electromagnetic calorimeter using the energy flow

method [22], which allows to inter-calibrate calorimeter crystals by using the  $\phi$  symmetry of energy deposits at a collider.

In October 2004, I was admitted to the graduate school in physics to work with the CMS group. The Rome group was heavily involved in the construction of the electromagnetic calorimeter (ECAL), as well as in monitoring and calibration. In my three years as a graduate student I worked on the calibration of the calorimeter, the stability of the ECAL high voltage (HV) system and feasibility studies for physics analysis on the search for Supersymmetry.

In 2006, I worked on the feasibility study of using  $\pi^0 \rightarrow \gamma\gamma$  decays for the calibration of the ECAL crystals [19, 20]. This method has the advantage of high statistics, since  $\pi^0$  are produced in abundance at hadron colliders, and does not rely on information from the detectors measuring tracks from charged particles, and hence could be performed “*in situ*” in the early periods of data-taking of LHC if the alignment and calibration of the high precision tracking system are not yet understood. The real challenge of this analysis is finding a satisfactory signal to noise ratio while maintaining high selection efficiency for such events in order to achieve a calibration of the entire ECAL in a short period of data-taking. In 2010 the CMS experiment collected enough data to calibrate the central part (barrel) of ECAL using  $\pi^0$ ’s. The plans for 2011 foresee the extension of the method to the forward region of the detector (endcaps), as well as the combination of different calibration techniques that are available, in order to achieve the design precision on the ECAL calibration.

During summer of 2006, I participated in the combined test beam of the electromagnetic and hadronic calorimeters of the CMS experiment at the H2 area of CERN, Preessin site (H2 Test Beam 2006 [3]), mainly performing data-taking shifts. An important feature of the H2 test facility was the possibility to produce a secondary beam of  $\pi^0$ ’s by inserting a target along the primary charged pion beam line. This data [4] was used to verify and improve the  $\pi^0 \rightarrow \gamma\gamma$  reconstruction algorithm developed for the calibration studies with simulated events. During this period, I also worked on the monitoring of the ECAL high voltage system, which is under the direct responsibility of the Rome group.

My other activities included both development and implementation of the analysis software for the stability test of HV boards, and the relative analysis of data collected since 2003 [5]. The stability of the HV system is very important for the operation of ECAL because it affects directly the energy resolution of the electromagnetic calorimeter.

In 2007, I worked mainly on feasibility study of the search for Supersymmetry with Gauge-Mediated Breaking (GMSB) in the prompt photon decay channel  $pp \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 + X \rightarrow \tilde{G} \tilde{G} \gamma \gamma + X$  (see PhD thesis [21]). The presence of two high energy photons and large missing transverse energy in the final state due to gravitinos makes the experimental signature of such events very clear. This feasibility study, aimed at the optimization of selection criteria to reject Standard Model backgrounds, showed that GMSB models, with parameters just above the limit fixed by Tevatron experiments, could be an early discovery at the CMS experiment with a few tens  $\text{pb}^{-1}$  of data and  $\sqrt{s} = 14$  TeV. This result was significantly better than the one shown by previous studies reported in the CMS collaboration. At the current energy of LHC,  $\sqrt{s} = 7$  TeV, the search for new physics in GMSB models could extend beyond the limit set by previous experiments with a few hundreds  $\text{pb}^{-1}$  of data.

## References

### PUBLICATIONS (RELATIVE TO RESEARCH ACTIVITIES)

- [1] **“Study of various photomultiplier tubes with muon beams and Cherenkov light produced in electron showers”**  
S. Chatrchyan *et al.* [CMS HCAL Collaboration]  
JINST 5, P06002 (2010)  
The data were collected during the HCAL Test Beam 2009. I contributed to commissioning and calibration of the “*delay wire chambers*” installed along the H2 beam line (CERN, Prevessin site) for beam position measurements.
- [2] **“Identification and Filtering of Uncharacteristic Noise in the CMS Hadron Calorimeter”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03014 (2010) [arXiv:0911.4881 [physics.ins-det]]
- [3] **“The CMS Barrel Calorimeter Response To Particle Beams From 2-Gev/C To 350-Gev/C”**  
S. Abdullin *et al.* [USCMS Collaboration and ECAL/HCAL Collaboration]  
Eur. Phys. J. C **60**, 359 (2009) [Erratum-ibid. C **61**, 353 (2009)]
- [4] **“Intercalibration of the barrel electromagnetic calorimeter of the CMS experiment at start-up”**  
P. Adzic *et al.* [CMS Electromagnetic Calorimeter Group]  
JINST 3, P10007 (2008)  
I performed a feasibility study of using  $\pi^0 \rightarrow \gamma\gamma$  decays for the calibration of the ECAL crystals, with full detector simulation.
- [5] **“High voltage system for the CMS electromagnetic calorimeter”**  
A. Bartoloni *et al.*  
Nucl. Instrum. Meth. A **582**, 462 (2007)  
I performed part of the stability tests on the high voltage boards at CERN laboratory and most of the data analysis

### CONFERENCE PROCEEDINGS

- [6] **“Searches With Early Data At CMS”**  
F. Santanastasio  
PoS DIS2010, 206 (2010)  
*Prepared for 18th International Workshop on Deep Inelastic Scattering and Related Subjects (DIS 2010), Florence, Italy, 19-23 Apr 2010*
- [7] **“Prospects for Exotica Searches at ATLAS and CMS Experiments”**  
F. Santanastasio  
Il Nuovo Cimento Vol.32 C, N.3-4 ncc9484 (2009)  
*Prepared for Incontri di Fisica delle Alte Energie (IFAE 2009), Bari, Italy, Apr 2009*

### PRELIMINARY RESULTS OF THE CMS COLLABORATION (RELATIVE TO RESEARCH ACTIVITIES)

- [8] **“Search for Pair Production of First-Generation Scalar Leptoquarks in pp Collisions at  $\sqrt{s} = 7$  TeV”**  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1012.4031 [hep-ex], Submitted to the journal *Phys. Rev. Lett.*  
I am one of the four analysts (from University of Maryland group) of this public CMS pre-print based on collision data.
- [9] **“Search for Pair Production of First Generation Leptoquarks Using Events Containing Two Electrons and Two Jets Produced in pp Collisions at  $\sqrt{s} = 7$  TeV”**  
[CMS Collaboration]  
CMS PAS EXO-10-005 (2010), <http://cdsweb.cern.ch/record/1289514/files/EXO-10-005-pas.pdf>  
I am co-author and one of the four analysts (from University of Maryland group) of this public CMS Physics Analysis Summary based on collision data.
- [10] **“Search for Pair Production of First Generation Scalar Leptoquarks at the CMS Experiment”**  
[CMS Collaboration]  
CMS PAS EXO-08-010 (2009), <http://cdsweb.cern.ch/record/1196076/files/EXO-08-010-pas.pdf>  
I am co-author and one of the four analysts (from University of Maryland group) of this public CMS Physics Analysis Summary based on MC simulation.
- [11] **“Missing Transverse Energy Performance in Minimum-Bias and Jet Events from Proton-Proton Collisions at  $\sqrt{s}=7$  TeV”**  
[CMS Collaboration]  
CMS PAS JME-10-004 (2010), <http://cdsweb.cern.ch/record/1279142/files/JME-10-004-pas.pdf>
- [12] **“Performance of Missing Transverse Energy Reconstruction in  $\sqrt{s}=900$  and 2360 GeV pp Collision Data”**  
[CMS Collaboration]  
CMS PAS JME-10-002 (2010), <http://cdsweb.cern.ch/record/1247385/files/JME-10-002-pas.pdf>  
I worked mostly on the section related to calorimeter MET cleaning algorithms and performances.

INTERNAL NOTES OF THE CMS COLLABORATION (RELATIVE TO RESEARCH ACTIVITIES)

- [13] **“Search for Pair Production of First-Generation Scalar Leptoquarks Using Events Produced in pp Collisions at  $\sqrt{s}=7$  TeV Containing One Electron, Two Jets and Large Missing Transverse Energy”**  
F. Santanastasio *et al.*  
CMS AN-2010/361 (2010)  
I am the contact person and one of the two analysts (from University of Maryland group) of this CMS analysis based on collision data. This analysis is currently under approval process within the CMS Collaboration.
- [14] **“Search for Pair Production of First Generation Leptoquarks Using Events Containing Two Electrons and Two Jets Produced in pp Collisions at  $\sqrt{s}=7$  TeV”**  
F. Santanastasio *et al.*  
CMS AN-2010/230 (2010)
- [15] **“Search for Pair Production of First Generation Scalar Leptoquarks at the CMS Experiment”**  
F. Santanastasio *et al.*  
CMS AN-2008/070 (2009)



- [16] “Results of a visual scan of high MET events in 7 TeV pp collision data”  
F. Santanastasio *et al.*  
CMS AN-2010/219 (2010)
- [17] “Commissioning of Uncorrected Missing Transverse Energy in Zero Bias and Minimum Bias Events at  $\sqrt{s}=900$  GeV and 2360 GeV”  
F. Santanastasio *et al.*  
CMS AN-2010/029 (2010)
- [18] “Optimization and Performance of HF PMT Hit Cleaning Algorithms Developed Using pp Collision Data at  $\sqrt{s}=0.9, 2.36$  and 7 TeV”  
F. Santanastasio *et al.*  
CMS DN-2010/008 (2010)
- [19] “InterCalibration of the CMS Barrel Electromagnetic Calorimeter Using Neutral Pion Decays”  
F. Santanastasio *et al.*  
CMS DN-2007/013 (2007)
- [20] “Study of ECAL calibration with  $\pi^0 \rightarrow \gamma\gamma$  decays”  
F. Santanastasio, D. del Re, S. Rahatlou  
CMS IN-2006/050 (2006)

THESES ( LAUREA AND PHD)

- [21] “Search for Supersymmetry with Gauge-Mediated Breaking using high energy photons at CMS experiment”  
F. Santanastasio  
PhD thesis at *Sapienza Università di Roma* (2007)  
<http://www.roma1.infn.it/cms/tesiPHD/santanastasio.pdf>
- [22] “Calibrazione di un calorimetro elettromagnetico tramite il flusso totale di energia”  
F. Santanastasio  
Laurea thesis at *Sapienza Università di Roma* (2004)  
<http://www.roma1.infn.it/cms/tesi/santanastasio.pdf>

OTHER PUBLICATIONS AND PRE-PRINTS OF THE CMS COLLABORATION

- [23] “Dijet Azimuthal Decorrelations in pp Collisions at  $\sqrt{s} = 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1101.5029 [hep-ex]  
CMS-QCD-10-026(2011)
- [24] “Search for Heavy Stable Charged Particles in pp collisions at  $\sqrt{s}=7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1101.1645 [hep-ex]  
CMS-EXO-10-011(2011)
- [25] “Search for Supersymmetry in pp Collisions at 7 TeV in Events with Jets and Missing Transverse Energy”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1101.1628 [hep-ex]  
CMS-SUS-10-003(2011)

- [26] “Measurement of the B+ Production Cross Section in pp Collisions at  $\sqrt{s} = 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1101.0131 [hep-ex]  
CMS-BPH-10-004(2011)
- [27] “Search for a heavy gauge boson W’ in the final state with an electron and large missing transverse energy in pp collisions at  $\sqrt{s} = 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1012.5945 [hep-ex]
- [28] “Measurement of the Inclusive Upsilon production cross section in pp collisions at  $\sqrt{s}=7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1012.5545 [hep-ex]  
CMS-BPH-10-003(2010)
- [29] “Search for Pair Production of Second-Generation Scalar Leptoquarks in pp Collisions at  $\sqrt{s} = 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1012.4033 [hep-ex]  
CMS-EXO-10-007(2010)
- [30] “Search for Microscopic Black Hole Signatures at the Large Hadron Collider”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1012.3375 [hep-ex]  
CMS-EXO-10-017(2010)
- [31] “Measurements of Inclusive W and Z Cross Sections in pp Collisions at  $\sqrt{s}=7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
JHEP 1101, 080 (2011) [arXiv:1012.2466 [hep-ex]]
- [32] “Measurement of the Isolated Prompt Photon Production Cross Section in pp Collisions at  $\sqrt{s} = 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1012.0799 [hep-ex]
- [33] “Search for Stopped Gluinos in pp collisions at  $\sqrt{s} = 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
Phys. Rev. Lett. 106, 011801 (2011) [arXiv:1011.5861 [hep-ex]]
- [34] “Charged particle multiplicities in pp interactions at  $\sqrt{s} = 0.9, 2.36, \text{ and } 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
JHEP 1101, 079 (2011) [arXiv:1011.5531 [hep-ex]]
- [35] “Prompt and non-prompt J/psi production in pp collisions at  $\sqrt{s} = 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
arXiv:1011.4193 [hep-ex]  
CMS-BPH-10-002(2010)
- [36] “First Measurement of the Cross Section for Top-Quark Pair Production in Proton-Proton Collisions at  $\sqrt{s}=7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
Phys. Lett. B 695, 424 (2011) [arXiv:1010.5994 [hep-ex]]

- [37] “Search for Quark Compositeness with the Dijet Centrality Ratio in pp Collisions at  $\sqrt{s}=7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
Phys. Rev. Lett. **105**, 262001 (2010) [arXiv:1010.4439 [hep-ex]]
- [38] “Search for Dijet Resonances in 7 TeV pp Collisions at CMS”  
V. Khachatryan *et al.* [CMS Collaboration]  
Phys. Rev. Lett. **105**, 211801 (2010) [arXiv:1010.0203 [hep-ex]]
- [39] “Observation of Long-Range Near-Side Angular Correlations in Proton-Proton Collisions at the LHC”  
V. Khachatryan *et al.* [CMS Collaboration]  
JHEP **1009**, 091 (2010) [arXiv:1009.4122 [hep-ex]]
- [40] “CMS Tracking Performance Results from early LHC Operation”  
V. Khachatryan *et al.* [CMS Collaboration]  
Eur. Phys. J. C **70**, 1165 (2010) [arXiv:1007.1988 [physics.ins-det]]
- [41] “Measurement of the Underlying Event Activity in Proton-Proton Collisions at 0.9 TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
Eur. Phys. J. C **70**, 555 (2010) [arXiv:1006.2083 [hep-ex]]
- [42] “Measurement of the charge ratio of atmospheric muons with the CMS detector”  
V. Khachatryan *et al.* [CMS Collaboration]  
Phys. Lett. B **692**, 83 (2010) [arXiv:1005.5332 [hep-ex]]
- [43] “Transverse-momentum and pseudorapidity distributions of charged hadrons in pp collisions at  $\sqrt{s} = 7$  TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
Phys. Rev. Lett. **105**, 022002 (2010) [arXiv:1005.3299 [hep-ex]]
- [44] “Measurement of Bose-Einstein correlations with first CMS data”  
V. Khachatryan *et al.* [CMS Collaboration]  
Phys. Rev. Lett. **105**, 032001 (2010) [arXiv:1005.3294 [hep-ex]]
- [45] “Transverse momentum and pseudorapidity distributions of charged hadrons in pp collisions at  $\sqrt{s} = 0.9$  and 2.36 TeV”  
V. Khachatryan *et al.* [CMS Collaboration]  
JHEP **1002**, 041 (2010) [arXiv:1002.0621 [hep-ex]]
- [46] “Commissioning and Performance of the CMS Pixel Tracker with Cosmic Ray Muons”  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST **5**, T03007 (2010) [arXiv:0911.5434 [physics.ins-det]]
- [47] “Performance of the CMS Level-1 Trigger during Commissioning with Cosmic Ray Muons”  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST **5**, T03002 (2010) [arXiv:0911.5422 [physics.ins-det]]
- [48] “Measurement of the Muon Stopping Power in Lead Tungstate”  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST **5**, P03007 (2010) [arXiv:0911.5397 [physics.ins-det]]
- [49] “Commissioning and Performance of the CMS Silicon Strip Tracker with Cosmic Ray Muons”

- S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03008 (2010) [arXiv:0911.4996 [physics.ins-det]]
- [50] **“Performance of CMS Muon Reconstruction in Cosmic-Ray Events”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03022 (2010) [arXiv:0911.4994 [physics.ins-det]]
- [51] **“Performance of the CMS Cathode Strip Chambers with Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03018 (2010) [arXiv:0911.4992 [physics.ins-det]]
- [52] **“Performance of the CMS Hadron Calorimeter with Cosmic Ray Muons and LHC Beam Data”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03012 (2010) [arXiv:0911.4991 [physics.ins-det]]
- [53] **“Fine Synchronization of the CMS Muon Drift-Tube Local Trigger using Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03004 (2010) [arXiv:0911.4904 [physics.ins-det]]
- [54] **“Calibration of the CMS Drift Tube Chambers and Measurement of the Drift Velocity with Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03016 (2010) [arXiv:0911.4895 [physics.ins-det]]
- [55] **“Performance of the CMS Drift-Tube Local Trigger with Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03003 (2010) [arXiv:0911.4893 [physics.ins-det]]
- [56] **“Commissioning of the CMS High-Level Trigger with Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03005 (2010) [arXiv:0911.4889 [physics.ins-det]]
- [57] **“Performance of CMS Hadron Calorimeter Timing and Synchronization using Test Beam, Cosmic Ray, and LHC Beam Data”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03013 (2010) [arXiv:0911.4877 [physics.ins-det]]
- [58] **“Performance of the CMS Drift Tube Chambers with Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03015 (2010) [arXiv:0911.4855 [physics.ins-det]]
- [59] **“Commissioning of the CMS Experiment and the Cosmic Run at Four Tesla”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03001 (2010) [arXiv:0911.4845 [physics.ins-det]]
- [60] **“CMS Data Processing Workflows during an Extended Cosmic Ray Run”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03006 (2010) [arXiv:0911.4842 [physics.ins-det]]
- [61] **“Aligning the CMS Muon Chambers with the Muon Alignment System during an Extended Cosmic Ray Run”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03019 (2010) [arXiv:0911.4770 [physics.ins-det]]

- [62] **“Performance Study of the CMS Barrel Resistive Plate Chambers with Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03017 (2010) [arXiv:0911.4045 [physics.ins-det]]
- [63] **“Time Reconstruction and Performance of the CMS Electromagnetic Calorimeter”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03011 (2010) [arXiv:0911.4044 [physics.ins-det]]
- [64] **“Alignment of the CMS Muon System with Cosmic-Ray and Beam-Halo Muons”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03020 (2010) [arXiv:0911.4022 [physics.ins-det]]
- [65] **“Precise Mapping of the Magnetic Field in the CMS Barrel Yoke using Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03021 (2010) [arXiv:0910.5530 [physics.ins-det]]
- [66] **“Performance and Operation of the CMS Electromagnetic Calorimeter”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03010 (2010) [arXiv:0910.3423 [physics.ins-det]]
- [67] **“Alignment of the CMS Silicon Tracker during Commissioning with Cosmic Rays”**  
S. Chatrchyan *et al.* [CMS Collaboration]  
JINST 5, T03009 (2010) [arXiv:0910.2505 [physics.ins-det]]
- [68] **“The CMS experiment at the CERN LHC”**  
R. Adolphi *et al.* [CMS Collaboration]  
JINST 3, S08004 (2008)