Measurements of the pp -> ZZ production cross section and the Z -> 4l branching fraction, and constraints on anomalous triple gauge couplings at root s=13TeV

By: Sirunyan, AM (Sirunyan, A. M.)[2]; Tumasyan, A (Tumasyan, A.)[2]; Adam, W (Adam, W.)[3]; Ambrogi, F (Ambrogi, F.)[3]; Asilar, E (Asilar, E.)[3]; Bergauer, T (Bergauer, T.)[3]; Brandstetter, J (Brandstetter, J.)[3]; Brondolin, E (Brondolin, E.)[3]; Dragicevic, M (Dragicevic, M.)[3]; Ero, J (Eroe, J.)[3] ...More

Group Author(s): CMS Collaboration

View ResearcherID and ORCID

EUROPEAN PHYSICAL JOURNAL C
Volume: 78 Issue: 2
Article Number: 165
DOI: 10.1140/epjc/s10052-018-5567-9
Published: FEB 24 2018
Document Type: Article
View Journal Impact

Abstract

Four-lepton production in proton-proton collisions, pp -> (Z/gamma*)(Z/gamma*) -> 4l, where l = e or mu, is studied at a center-of-mass energy of 13 TeV with the CMS detector at the LHC. The data sample corresponds to an integrated luminosity of 35.9 fb(-1). The ZZ production cross section, sigma(pp -> ZZ) = 17.2 +/- 0.5 (stat) +/- 0.7 (syst) +/- 0.4 (theo) +/- 0.4 (lumi) pb, measured using events with two opposite-sign, same-flavor lepton pairs produced in the mass region 60 < m(l+l-) < 120 GeV, is consistent with standard model predictions. Differential cross sections are measured and are well described by the theoretical predictions. The Z boson branching fraction to four leptons is measured to be B(Z -> 4l) = 4.83(-0.22)(+0.23) (stat) (-0.29)(+0.32) (syst) +/- 0.08 (theo) +/- 0.12(lumi) x 10(-6) for events with a four-lepton invariant mass in the range 80 < m(4l) < 100 GeV and a dilepton mass m(ll) > 4GeV for all opposite-sign, same-flavor lepton pairs. The results agree with standard model predictions. The invariant mass distribution of the four-lepton system is used to set limits on anomalous ZZZ and ZZ. couplings at 95% confidence level: -0.0012 < f(4)(Z) < 0.0010, -0.0010 < f(5)(Z) < 0.0013, -0.0012 < f(4)(gamma) < 0.0013, -0.0012 < f(5)(gamma) < 0.0013.

Keywords

KeyWords Plus: FINAL-STATES; NNLO QCD; COLLISIONS; COLLIDERS; LHC; TEV

Author Information

Reprint Address: Sirunyan, AM (reprint author)

+ Yerevan Phys Inst, Yerevan, Armenia.

Addresses:

+ [1] CERN, CH-1211 Geneva 23, Switzerland
+ [2] Yerevan Phys Inst, Yerevan, Armenia
[3] Inst Hochenergiephys, Vienna, Austria
[4] Inst Nucl Problems, Minsk, BELARUS
+ [5] Vrije Univ Brussel, Brussels, Belgium
+ [6] Univ Libre Bruxelles, Brussels, Belgium
+ [7] Univ Ghent, Ghent, Belgium
+ [8] Catholic Univ Louvain, Louvain, Belgium
+ [9] Univ Mons, Mons, Belgium
+ [10] Ctr Brasileiro Pesquisas Fis, Rio De Janeiro, Brazil
+ [11] Univ Estado Rio de Janeiro, Rio De Janeiro, Brazil
+ [12] Univ Estadual Paulista, Sao Paulo, Brazil
+ [13] Univ Fed ABC, Sao Paulo, Brazil

[14] Bulgaria Acad Sci, Inst Nucl Res & Nucl Energy, Sofia, Bulgaria
[15] Univ Sofia, Sofia, Bulgaria
[16] Beihang Univ, Beijing, Peoples R China
[17] Inst High Energy Phys, Beijing, Peoples R China
[18] Peking Univ, State Key Lab Nucl Phys & Technol, Beijing, Peoples R China
[19] Univ Los Andes, Bogota, Colombia
[20] Univ Split, Fac Elect Engn Mech Engn & Naval Architecture, Split, Croatia
[21] Univ Split, Fac Sci, Split, Croatia
[22] Inst Rudjer Boskov, Zagreb, Croatia
[23] Univ Cyprus, Nicosia, Cyprus
[24] Charles Univ Prague, Prague, Czech Republic
[25] Univ San Francisco Quito, Quito, Ecuador
[26] Acad Sci Res & Technol Arab Republ Egypt, Egyptian Network High Energy Phys, Cairo, Egypt
[27] NICPB, Tallinn, Estonia
[28] Univ Helsinki, Dept Phys, Helsinki, Finland
[29] Helsinki Inst Phys, Helsinki, Finland
[30] Lappeenranta Univ Technol, Lappeenranta, Finland
[31] Univ Paris Saclay, IRFU, CEA, Gif Sur Yvette, France
[32] Univ Paris Saclay, Ecole Polytech, CNRS, IN2P3,Lab Leprince Ringuet, Palaiseau, France
[33] Univ Strasbourg, CNRS, IPHC, UMR 7178, F-67000 Strasbourg, France
[34] CNRS, IN2P3, Inst Natl Phys Nucl & Phys Particules, Ctr Calcul, Villeurbanne, France
[35] Univ Claude Bernard Lyon 1, Univ Lyon, CNRS, Inst Phys Nucl Lyon,IN2P3, Villeurbanne, France
[36] Georgian Tech Univ, Tbilisi, Rep of Georgia
[37] Tbilisi State Univ, Tbilisi, Rep of Georgia
[38] Rhein Westfal TH Aachen, Phys Inst 1, Aachen, Germany
[39] Rhein Westfal TH Aachen, Phys Inst A 3, Aachen, Germany
[40] Rhein Westfal TH Aachen, Phys Inst B 3, Aachen, Germany
[41] Deutsch Elekt Synchrotron, Hamburg, Germany
[42] Univ Hamburg, Hamburg, Germany
[43] Inst Expt Kernphys, Karlsruhe, Germany
[44] NCSR Demokritos, Inst Nucl & Particle Phys, Aghia Paraskevi, Greece
[45] Univ Athens, Athens, Greece
[46] Natl Tech Univ Athens, Athens, Greece
[47] Univ Ioannina, Ioannina, Greece
[48] Eotvos Lorand Univ, MTA ELTE, Lendulet CMS Particle & Nucl Phys Grp, Budapest, Hungary
[49] Wigner Res Ctr Phys, Budapest, Hungary
[50] Inst Nucl Res ATOMKI, Debrecen, Hungary
[51] Univ Debrecen, Inst Phys, Debrecen, Hungary
[52] Indian Inst Sci IISc, Bangalore, Karnataka, India
[53] Natl Inst Sci Educ & Res, Bhubaneswar, India
[54] Panjab Univ, Chandigarh, India
[55] Univ Delhi, Delhi, India
[56] Saha Inst Nucl Phys, HBNI, Kolkata, India
[57] Indian Inst Technol Madras, Madras, Tamil Nadu, India
[58] Bhabha Atom Res Ctr, Mumbai, Maharashtra, India
[59] Tata Inst Fundamental Res A, Mumbai, Maharashtra, India
[60] Tata Inst Fundamental Res b, Mumbai, Maharashtra, India
[61] Indian Inst Sci Educ & Res, Pune, Maharashtra, India
[62] Inst Res Fundamental Sci IPM, Tehran, Iran

[63] Univ Coll Dublin, Dublin, Ireland
[64] Ist Nazl Fis Nucl, Sez Bari, Bari, Italy
[65] Univ Bari, Bari, Italy
[66] Politecn Bari, Bari, Italy
[67] Ist Nazl Fis Nucl, Sez Bologna, Bologna, Italy
[68] Univ Bologna, Bologna, Italy
[69] Ist Nazl Fis Nucl, Sez Catania, Catania, Italy
[70] Univ Catania, Catania, Italy
[71] Ist Nazl Fis Nucl, Sez Firenze, Florence, Italy
[72] Univ Florence, Florence, Italy
[73] Ist Nazl Fis Nucl, Lab Nazl Frascati, Frascati, Italy
[74] Ist Nazl Fis Nucl, Sez Genova, Genoa, Italy
[75] Univ Genoa, Genoa, Italy
[76] Ist Nazl Fis Nucl, Sezione Milano Bicocca, Milan, Italy
[77] Univ Milano Bicocca, Milan, Italy
[78] Ist Nazl Fis Nucl, Sez Napoli, Naples, Italy
[79] Ist Nazl Fis Nucl, Sez Padova, Padua, Italy
[80] Univ Padua, Padua, Italy
[81] Ist Nazl Fis Nucl, Sez Pavia, Pavia, Italy
[82] Univ Pavia, Pavia, Italy
[83] Ist Nazl Fis Nucl, Sez Perugia, Perugia, Italy
[84] Ist Nazl Fis Nucl, Sez Pisa, Pisa, Italy
[85] Univ Pisa, Pisa, Italy
[86] Ist Nazl Fis Nucl, Sez Roma, Rome, Italy
[87] Univ Rome, Rome, Italy
[88] Ist Nazl Fis Nucl, Sez Torino, Turin, Italy
[89] Univ Turin, Turin, Italy
[90] Ist Nazl Fis Nucl, Sez Trieste, Trieste, Italy
[91] Kyungpook Natl Univ, Daegu, South Korea
[92] Chonhuk Natl Univ, Jeonju, South Korea
[93] Chonnam Natl Univ, Inst Univ & Elementary Particles, Kwangju, South Korea
[94] Hanyang Univ, Seoul, South Korea
[95] Korea Univ, Seoul, South Korea
[96] Seoul Natl Univ, Seoul, South Korea
[97] Univ Seoul, Seoul, South Korea
[98] Sungkyunkwan Univ, Suwon, South Korea
[99] Vilnius Univ, Vilnius, Lithuania
[100] Univ Malaya, Natl Ctr Particle Phys, Kuala Lumpur, Malaysia
[101] Ctr Invest & Estudios Avanzados IPN, Mexico City, DF, Mexico
[102] Univ Iberoamer, Mexico City, DF, Mexico
[103] Benemerita Univ Autonoma Puebla, Puebla, Mexico
[104] Univ Autonoma San Luis Potosi, San Luis Potosi, Mexico
[105] Univ Auckland, Auckland, New Zealand
[106] Univ Canterbury, Christchurch, New Zealand
[107] Quaid I Azam Univ, Natl Ctr Phys, Islamabad, Pakistan
[108] Natl Ctr Nucl Res, Otwock, Poland
[109] Univ Warsaw, Inst Expt Phys, Fac Phys, Warsaw, Poland
[110] Lab Instrumentacao & Fis Expt Particulas, Lisbon, Portugal
[111] Joint Inst Nucl Res, Dubna, Russia

[112] Petersburg Nucl Phys Inst, Gatchina, Russia
[113] Inst Nucl Res, Moscow, Russia
[114] Inst Theoret & Expt Phys, Moscow, Russia
[115] Moscow Inst Phys & Technol, Moscow, Russia
[116] Natl Res Nucl Univ, Moscow Engn Phys Inst MEPhI, Moscow, Russia
[117] PN Lebedev Phys Inst, Moscow, Russia
[118] Lomonosov Moscow State Univ, Skobeltsyn Inst Nucl Phys, Moscow, Russia
[119] NSU, Novosibirsk, Russia
[120] State Res Ctr Russian Federat, Inst High Energy Phys, Protvino, Russia
[121] Univ Belgrade, Fac Phys, Belgrade, Serbia
[122] CIEMAT, Madrid, Spain
[123] Univ Autonoma Madrid, Madrid, Spain
[124] Univ Oviedo, Oviedo, Spain
[125] Univ Cantabria, CSIC, Inst Fis Cantabria IFCA, Santander, Spain
[126] CERN, European Org Nucl Res, Geneva, Switzerland
[127] Paul Scherrer Inst, Villigen, Switzerland
[128] Swiss Fed Inst Technol, Inst Particle Phys & Astrophys, Zurich, Switzerland
[129] Univ Zurich, Zurich, Switzerland
[130] Natl Cent Univ, Chungli, Taiwan
[131] NTU, Taipei, Taiwan
[132] Chulalongkorn Univ, Dept Phys, Fac Sci, Bangkok, Thailand
[133] Middle East Tech Univ, Phys Dept, Ankara, Turkey
[134] Bogazici Univ, Istanbul, Turkey
[135] Istanbul Tech Univ, Istanbul, Turkey
[136] Natl Acad Sci Ukraine, Inst Scintillat Mat, Kharkov, Ukraine
[137] Kharkov Inst Phys & Technol, Natl Sci Ctr, Kharkov, Ukraine
[138] Univ Bristol, Bristol, Avon, England
[139] Rutherford Appleton Lab, Didcot, Oxon, England
[140] Imperial Coll, London, England
[141] Brunel Univ, Uxbridge, Middx, England
[142] Baylor Univ, Waco, TX 76798 USA
[143] Catholic Univ Amer, Washington, DC USA
[144] Univ Alabama, Tuscaloosa, AL USA
[145] Boston Univ, Boston, MA 02215 USA
[146] Brown Univ, Providence, RI 02912 USA
[147] Univ Calif Davis, Davis, CA 95616 USA
[148] Univ Calif Los Angeles, Los Angeles, CA USA
[149] Univ Calif Riverside, Riverside, CA 92521 USA
[150] Univ Calif San Diego, La Jolla, CA 92093 USA
[151] Univ Calif Santa Barbara, Dept Phys, Santa Barbara, CA USA
[152] CALTECH, Pasadena, CA 91125 USA
[153] Carnegie Mellon Univ, Pittsburgh, PA USA
[154] Univ Colorado, Boulder, CO USA
[155] Cornell Univ, Ithaca, NY USA
[156] Fermilab Natl Accelerator Lab, POB 500, Batavia, IL 60510 USA
[157] Univ Florida, Gainesville, FL USA
[158] Florida Int Univ, Miami, FL 33199 USA
[159] Florida State Univ, Tallahassee, FL USA
[160] Florida Inst Technol, Melbourne, FL 32901 USA

[161] UIC, Chicago, IL USA

[162] Univ Iowa, Iowa City, IA USA

[163] Johns Hopkins Univ, Baltimore, MD USA

[164] Univ Kansas, Lawrence, KS 66045 USA

[165] Kansas State Univ, Manhattan, KS 66506 USA

[166] Lawrence Livermore Natl Lab, Livermore, CA USA

[167] Univ Maryland, College Pk, MD 20742 USA

[168] MIT, Cambridge, MA 02139 USA

[169] Univ Minnesota, Minneapolis, MN USA

[170] Univ Mississippi, Oxford, MS 38677 USA

[171] Univ Nebraska, Lincoln, NE USA

[172] SUNY Buffalo, Buffalo, NY USA

[173] Northeastern Univ, Boston, MA 02115 USA

[174] Northwestern Univ, Evanston, IL USA

[175] Univ Notre Dame, Notre Dame, IN 46556 USA

[176] Ohio State Univ, Columbus, OH 43210 USA

[177] Princeton Univ, Princeton, NJ 08544 USA

[178] Univ Puerto Rico, Mayaguez, PR USA

[179] Purdue Univ, W Lafayette, IN 47907 USA

[180] Purdue Univ Northwest, Hammond, LA USA

[181] Rice Univ, Houston, TX USA

[182] Univ Rochester, Rochester, NY 14627 USA

[183] Rockefeller Univ, 1230 York Ave, New York, NY 10021 USA

[184] Rutgers State Univ, Piscataway, NJ USA

[185] Univ Tennessee, Knoxville, TN USA

[186] Texas A&M Univ, College Stn, TX USA

[187] Texas Tech Univ, Lubbock, TX 79409 USA

[188] Vanderbilt Univ, 221 Kirkland Hall, Nashville, TN 37235 USA

[189] Univ Virginia, Charlottesville, VA USA

[190] Wayne State Univ, Detroit, MI USA

[191] Univ Wisconsin, Madison, WI USA

[192] Vienna Univ Technol, Vienna, Austria

[193] Univ Estadual Campinas, Campinas, SP, Brazil

[194] Univ Fed Pelotas, Pelotas, Brazil

[195] Suez Univ, Suez, Egypt

[196] British Univ Egypt, Cairo, Egypt

[197] Fayoum Univ, Al Fayyum, Egypt

[198] Helwan Univ, Cairo, Egypt

[199] Univ Haute Alsace, Mulhouse, France

[200] Brandenburg Tech Univ Cottbus, Cottbus, Germany

[201] Indian Inst Technol Bhubaneswar, Bhubaneswar, Orissa, India

[202] Inst Phys, Bhubaneswar, Orissa, India

[203] Visva Bharati Univ, Santini Ketan, W Bengal, India

[204] Univ Ruhuna, Matara, Sri Lanka

[205] Isfahan Univ Technol, Esfahan, Iran

[206] Yazd Univ, Yazd, Iran

[207] Islamic Azad Univ, Sci & Res Branch, Plasma Phys Res Ctr, Tehran, Iran

[208] Univ Siena, Siena, Italy

[209] Ist Nazl Fis Nucl, Sez Milano Bicocca, Milan, Italy

[210] Univ Milano Bicocca, Milan, Italy
[211] Int Islamic Univ Malaysia, Kuala Lumpur, Malaysia
[212] MOSTI, Malaysian Nucl Agcy, Kajang, Malaysia
[213] Consejo Nac Ciencia & Tecnol, Mexico City, DF, Mexico
[214] Warsaw Univ Technol, Inst Elect Syst, Warsaw, Poland
[215] St Petersburg State Polytech Univ, St Petersburg, Russia
[216] Budker Inst Nucl Phys, Novosibirsk, Russia
[217] Univ Belgrade, Fac Phys, Belgrade, Serbia
[218] Scuola Normale Super Pisa, Pisa, Italy
[219] Ist Nazl Fis Nucl, Sez Pisa, Pisa, Italy
[220] Univ Athens, Athens, Greece
[221] Riga Tech Univ, Riga, Latvia
[222] Stefan Meyer Inst Subat Phys SMI, Vienna, Austria
[223] Adiyaman Univ, Adiyaman, Turkey
[224] Istanbul Aydin Univ, Istanbul, Turkey
[225] Mersin Univ, Mersin, Turkey
[226] Cag Univ, Mersin, Turkey
[227] Piri Reis Univ, Istanbul, Turkey
[228] Izmir Inst Technol, Izmir, Turkey
[229] Necmettin Erbakan Univ, Konya, Turkey
[230] Marmara Univ, Istanbul, Turkey
[231] Kafkas Univ, Kars, Turkey
[232] Istanbul Bilgi Univ, Istanbul, Turkey
[233] Univ Southampton, Sch Phys & Astron, Southampton, Hants, England
[234] Inst Astrofis Canarias, San Cristobal la Laguna, Spain
[235] Utah Valley Univ, Orem, UT USA
[236] USABeykent Univ, Istanbul, Turkey
[237] Bingol Univ, Bingol, Turkey
[238] Erzincan Univ, Erzincan, Turkey
[239] Sinop Univ, Sinop, Turkey
[240] Mimar Sinan Univ, Istanbul, Turkey
[241] Texas A&M Univ Qatar, Doha, Qatar
[242] Kyungpook Natl Univ, Taegu, South Korea

E-mail Addresses: cms-publication-committe-chair@cern.ch

Funding

Funding Agency	Grant Number
BMWFW (Austria)	
EWE (Austria)	
FNRS (Belgium)	
FWO (Belgium)	
CNPq (Brazil)	
CAPES (Brazil)	
FAPERJ (Brazil)	
FAPESP (Brazil)	
MES (Bulgaria)	
CERN	
CAS (China)	
MoST (China)	

NSFC (China)	
COLCIENCIAS (Colombia)	
MSES (Croatia)	
CSF (Croatia)	
RPF (Cyprus)	
SENESCYT (Ecuador)	
MoER (Estonia)	
ERC IUT (Estonia)	
ERDF (Estonia)	
Academy of Finland (Finland)	
MEC (Finland)	
HIP (Finland)	
CEA (France)	
CNRS/IN2P3 (France)	
BMBF (Germany)	
DFG (Germany)	
HGF (Germany)	
GSRT (Greece)	
OTKA (Hungary)	
NIH (Hungary)	
DAE (India)	
DST (India)	
IPM (Iran)	
SFI (Ireland)	
INFN (Italy)	
MSIP (Republic of Korea)	
NRF (Republic of Korea)	
LAS (Lithuania)	
MOE (Malaysia)	
UM (Malaysia)	
BUAP (Mexico)	
CINVESTAV (Mexico)	
CONACYT (Mexico)	
LNS (Mexico)	
SEP (Mexico)	
UASLP-FAI (Mexico)	
MBIE (New Zealand)	
PAEC (Pakistan)	
MSHE (Poland)	
NSC (Poland)	
FCT (Portugal)	
JINR (Dubna)	
MON (Russia)	
RosAtom (Russia)	
RAS (Russia)	
RFBR (Russia)	
RAEP (Russia)	

MESTD (Serbia)	
SEIDI (Spain)	
CYAN (Spain)	
PCTI (Spain)	
FEDER (Spain)	
Swiss Funding Agencies (Switzerland)	
MST (Taipei)	
ThEPCenter (Thailand)	
IPST (Thailand)	
STAR (Thailand)	
NSTDA (Thailand)	
TUBITAK (Turkey)	
TAEK (Turkey)	
NASU (Ukraine)	
SEER (Ukraine)	
STFC (United Kingdom)	
DOE (USA)	
NSF (USA)	
Marie-Curie program	
Horizon Grant (European Union)	675440
European Research Council (European Union)	
Leventis Foundation	
A. P. Sloan Foundation	
Alexander von Humboldt Foundation	
Belgian Federal Science Policy Office	
Fonds pour la Formation a la Recherche dans l'Industrie et dans l'Agriculture (FRIA-Belgium)	
Agentschap voor Innovatie door Wetenschap en Technologie (IWT-Belgium)	
Ministry of Education, Youth and Sports (MEYS) of the Czech Republic	
Council of Science and Industrial Research, India	
HOMING PLUS program of the Foundation for Polish Science	
European Union, Regional Development Fund	
Mobility Plus program of the Ministry of Science and Higher Education	
National Science Center (Poland)	Harmonia 2014/14/M/ST2/00428 Opus 2014/13/B/ST2/02543 2014/15/B/ST2/03998 2015/19/B/ST2/02861 Sonata-bis 2012/07/E/ST2/01406
National Priorities Research Program by Qatar National Research Fund	
Programa Severo Ochoa del Principado de Asturias	
Thalis program - EU-ESF	
Aristeia program - EU-ESF	
Thalis program - Greek NSRF	
Aristeia program - Greek NSRF	
Rachadapisek Sompot Fund	
Chulalongkom University	
Chulalongkom Academic into Its 2nd Century Project Advancement Project (Thailand)	
Welch Foundation	C-1845

Weston Havens Foundation (USA)	

View funding text

Publisher

SPRINGER, 233 SPRING ST, NEW YORK, NY 10013 USA

Categories / Classification

Research Areas: Physics

Web of Science Categories: Physics, Particles & Fields

See more data fields

Cited References: 55

Showing 30 of 55 **View All in Cited References page** *(from Web of Science Core Collection)*

1. **Measurement of the ZZ Production Cross Section in pp Collisions at root s=13 TeV with the ATLAS Detector** — Times Cited: 18
By: Aad, G.; Abbott, B.; Abdallah, J.; et al.
Group Author(s): ATLAS Collaboration
PHYSICAL REVIEW LETTERS Volume: 116 Issue: 10 Article Number: 101801 Published: MAR 10 2016

2. **Combined Measurement of the Higgs Boson Mass in pp Collisions at root s=7 and 8 TeV with the ATLAS and CMS Experiments** — Times Cited: 510
By: Aad, G.; Abbott, B.; Abdallah, J.; et al.
PHYSICAL REVIEW LETTERS Volume: 114 Issue: 19 Article Number: 191803 Published: MAY 14 2015

3. **Measurements of Four-Lepton Production at the Z Resonance in pp Collisions at root s=7 and 8 TeV with ATLAS** — Times Cited: 32
By: Aad, G.; Abbott, B.; Abdallah, J.; et al.
Group Author(s): ATLAS Collaboration
PHYSICAL REVIEW LETTERS Volume: 112 Issue: 23 Article Number: 231806 Published: JUN 13 2014

4. **Measurements of four-lepton production in pp collisions at root s=8 TeV with the ATLAS detector** — Times Cited: 15
By: Aad, G.; Abbott, B.; Abdallah, J.; et al.
Group Author(s): ATLAS Collaboration
PHYSICS LETTERS B Volume: 753 Pages: 552-572 Published: FEB 10 2016

5. **Unfolding algorithms and tests using RooUnfold** — Times Cited: 71
By: Adye, T.
CERN-2011-006 Pages: 313 Published: 2011
Publisher: CERN, Geneva, Switzerland

6. **GEANT4-a simulation toolkit** — Times Cited: 10,211
By: Agostinelli, S; Allison, J; Amako, K; et al.
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT Volume: 506 Issue: 3 Pages: 250-303 Published: JUL 1 2003

7. Title: [not available] — Times Cited: 15
By: ALIOLI S
J HIGH ENERGY PHYS Published: 2008

8. **A general framework for implementing NLO calculations in shower Monte Carlo programs: the POWHEG BOX** — Times Cited: 836
By: Alioli, Simone; Nason, Paolo; Oleari, Carlo; et al.
JOURNAL OF HIGH ENERGY PHYSICS Issue: 6 Article Number: 043 Published: JUN 2010

9. **The automated computation of tree-level and next-to-leading order differential cross sections, and their matching to parton shower simulations** — Times Cited: 1,798
By: Alwall, J.; Frederix, R.; Frixione, S.; et al.
JOURNAL OF HIGH ENERGY PHYSICS Issue: 7 Article Number: 079 Published: JUL 17 2014

10. **Constraining anomalous HVV interactions at proton and lepton colliders** — Times Cited: 61
By: Anderson, Ian; Bolognesi, Sara; Caola, Fabrizio; et al.
PHYSICAL REVIEW D Volume: 89 Issue: 3 Article Number: 035007 Published: FEB 19 2014

11. **Study of the four-fermion final state at the Z resonance** — Times Cited: 1
By: [Anonymous]
Zeitschrift fur Physik C (Particles and Fields) Volume: 66 Issue: 1-2 Pages: 3-18 Published: March 1995

12. **Measurement of the ZZ production cross v section in proton-proton collisions at &RADIC;s = 8TeV using the ZZ &RARR; l⁺l⁻l'⁺l'⁻and ZZ &RARR; l⁻l⁺vv channels with the ATLAS detector** — Times Cited: 5
Group Author(s): ATLAS Collaboration
JHEP Volume: 01 Article Number: 099 Published: 2017

13. **Measurement of ZZ production in pp collisions at p s = 7 TeV and limits on anomalous ZZZ and ZZ couplings with the ATLAS detector** — Times Cited: 36
Group Author(s): ATLAS collaboration
JHEP Volume: 3 Pages: 128 Published: 2013

14. **ZZ cross-section measurements and search for anomalous triple gauge couplings in 13 TeV pp collisions with the ATLAS detector** — Times Cited: 3
Group Author(s): ATLAS collaboration
Phys.Rev D Volume: 97 Article Number: 032005 Published: 2018
INSPIRE

15. **Parton distributions for the LHC run II** — Times Cited: 581
By: Ball, Richard D.; Bertone, Valerio; Carrazza, Stefano; et al.
Group Author(s): NNPDF Collaboration
JOURNAL OF HIGH ENERGY PHYSICS Issue: 4 Article Number: 040 Published: APR 8 2015

16. **PHANTOM: A Monte Carlo event generator for six parton final states at high energy colliders** — Times Cited: 32
By: Ballestrero, Alessandro; Belhouari, Aissa; Bevilacqua, Giuseppe; et al.
COMPUTER PHYSICS COMMUNICATIONS Volume: 180 Issue: 3 Pages: 401-417 Published: MAR 2009

17. **Spin and parity of a single-produced resonance at the LHC** — Times Cited: 136
By: Bolognesi, Sara; Gao, Yanyan; Gritsan, Andrei V.; et al.
PHYSICAL REVIEW D Volume: 86 Issue: 9 Article Number: 095031 Published: NOV 29 2012

18. **PDF4LHC recommendations for LHC Run II** — Times Cited: 255
By: Butterworth, Jon; Carrazza, Stefano; Cooper-Sarkar, Amanda; et al.
JOURNAL OF PHYSICS G-NUCLEAR AND PARTICLE PHYSICS Volume: 43 Issue: 2 Article Number: 023001 Published: FEB 2016

19. Title: [not available] — Times Cited: 330
By: CACCIARI M
J HIGH ENERGY PHYS Published: 2008

20. **FastJet user manual** — Times Cited: 1,560
By: Cacciari, Matteo; Salam, Gavin P.; Soyez, Gregory
EUROPEAN PHYSICAL JOURNAL C Volume: 72 Issue: 3 Article Number: 1896 Published: MAR 2012

21. **Pileup subtraction using jet areas** — Times Cited: 458
By: Cacciari, Matteo; Salam, Gavin P.
PHYSICS LETTERS B Volume: 659 Issue: 1-2 Pages: 119-126 Published: JAN 17 2008

22. **MCFM for the Tevatron and the LHC** — Times Cited: 362
By: Campbell, John M.; Ellis, R. K.
NUCLEAR PHYSICS B-PROCEEDINGS SUPPLEMENTS Volume: 205-06 Pages: 10-15 Published: AUG-SEP 2010

23. **QCD corrections to ZZ production in gluon fusion at the LHC** — Times Cited: 35
By: Caola, Fabrizio; Melnikov, Kirill; Roentsch, Raoul; et al.

PHYSICAL REVIEW D Volume: 92 Issue: 9 Article Number: 094028 Published: NOV 23 2015

24. **ZZ production at hadron colliders in NNLO QCD** Times Cited: 119
By: Cascioli, F.; Gehrmann, T.; Grazzini, M.; et al.
PHYSICS LETTERS B Volume: 735 Pages: 311-313 Published: JUL 30 2014

25. **Performance of CMS muon reconstruction in pp collision events at root s=7Tev** Times Cited: 337
By: Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M.; et al.
Group Author(s): CMS Collaboration
JOURNAL OF INSTRUMENTATION Volume: 7 Article Number: P10002 Published: OCT 2012

26. **The CMS experiment at the CERN LHC** Times Cited: 1,505
By: Chatrchyan, S.; Hmayakyan, G.; Khachatryan, V.; et al.
Group Author(s): CMS Collaboration
JOURNAL OF INSTRUMENTATION Volume: 3 Article Number: S08004 Published: AUG 2008

27. **Measurement of the properties of a Higgs boson in the four-lepton final state** Times Cited: 219
By: Chatrchyan, S.; Khachatryan, V.; Sirunyan, A. M.; et al.
Group Author(s): CMS Collaborat
PHYSICAL REVIEW D Volume: 89 Issue: 9 Article Number: 092007 Published: MAY 14 2014

28. **Technical Prpposal for the Phase-II Upgrade of the Compact Muon Solenoid** Times Cited: 52
Group Author(s): CMS Collaboration
CERN-LHCC-2015-010, LHCC-P-008 Published: 2015

29. **CMS luminosity Measurement 115T the 2016 Data Period, CMS Physics Analysis Summary** Times Cited: 20
Group Author(s): CMS Collaboration
CMS-PAS-LUM 17 001 Published: 2017
in preparation.
Publisher: CERN

30. **Measurements of the Z Z production cross sections in the 2l2 channel in proton- proton collisions at p s = 7 and 8TeV and combined constraints on triple gauge couplings** Times Cited: 14
Group Author(s): CMS collaboration
Eur. Phys. J. Volume: C 75 Pages: 511 Published: 2015

Showing 30 of 55 View All in Cited References page