Evidence for Associated Production of a Single Top Quark and W Boson in pp Collisions at $\sqrt{s} = 7$ TeV

S. Chatrchyan *et al.**
(CMS Collaboration)

(Received 16 September 2012; published 11 January 2013)

Evidence is presented for the associated production of a single top quark and W boson in pp collisions at $\sqrt{s} = 7$ TeV with the CMS experiment at the LHC. The analyzed data correspond to an integrated luminosity of 4.9 fb^{-1}. The measurement is performed using events with two leptons and a jet originated from a b quark. A multivariate analysis based on kinematic properties is utilized to separate the $t\bar{t}$ background from the signal. The observed signal has a significance of 4.0σ and corresponds to a cross section of 16^{+5}_{-4} pb, in agreement with the standard model expectation of $15.6 \pm 0.4^{+1.0}_{-1.2}$ pb.

DOI: 10.1103/PhysRevLett.110.022003 PACS numbers: 14.65.Ha, 12.15.Hh, 13.85.Qk

Electroweak production of single top quarks has been first observed by the D0 [1] and CDF [2] experiments at the Tevatron. Single top quark production proceeds via three processes: the t-channel exchange of a virtual W boson, the s-channel production and decay of a virtual W boson, and the associated production of a top quark and a W boson (tW). The latter channel, which has a negligible production cross section at the Tevatron, represents a significant contribution to single top quark production at the Large Hadron Collider (LHC). Associated tW production is a very interesting production mechanism because of its interference with top quark pair production [3–5], its sensitivity to new physics [6–8], and its role as a background to SUSY and Higgs searches. The ATLAS and Compact Muon Solenoid (CMS) experiments have measured the cross section for t-channel production [9,10] while evidence for tW associated production has been presented by the ATLAS experiment [11]. This Letter presents the first study from the CMS experiment of tW production in pp collisions at $\sqrt{s} = 7$ TeV.

The production cross section for tW has been computed at approximate next-to-next-to-leading order (NNLO), the theoretical prediction of the cross section for tW in pp collisions at $\sqrt{s} = 7$ TeV, assuming a top quark mass (m_t) of 172.5 GeV, is $15.6 \pm 0.4^{+1.0}_{-1.2}$ pb [12], the first uncertainty corresponds to scale variation and the second to parton distribution function (pdf) sets.

The leading order Feynman diagrams for tW production are shown in Fig. 1. The definition of tW production in perturbative QCD mixes with top quark pair production ($t\bar{t}$) at next-to-leading order (NLO) [4,5]. Two schemes are proposed to describe the tW signal: "diagram removal" (DR) [3], where all NLO diagrams that are doubly resonant, such as those in Fig. 2, are excluded from the signal definition; and "diagram subtraction" (DS) [3,13], in which the differential cross section is modified with a gauge-invariant subtraction term, which locally cancels the contribution of $t\bar{t}$ diagrams. The DR scheme is used in this Letter, but it has been verified that the number of predicted events after full selection is consistent between the two approaches within the statistical uncertainties of the simulated samples. The differences are accounted for in the systematic uncertainties.

In the standard model, top quarks decay almost exclusively to a W boson and a b quark. The study presented here has been performed in the channels in which both W bosons decay leptonically into a muon or an electron and a neutrino, with a branching fraction $\mathcal{B}(W \to \ell\nu) = (10.80 \pm 0.09)\%$, where $\ell = e$ or μ [14]. The dilepton final states of the tW process are characterized by the presence of two isolated leptons with opposite charge, a jet from the fragmentation of a b quark, and a substantial amount of missing transverse energy (E_T^{miss}) due to the presence of the neutrinos. The primary source of background events arise from $t\bar{t}$ production, followed by $Z/\gamma^\star$ + jets processes.

The analysis uses fits to a discriminant variable built from kinematic quantities combined with a multivariate technique. A second analysis, intended as a cross-check of the robustness of the selection, is performed using event counting. In both cases, a sample collected at $\sqrt{s} = 7$ TeV

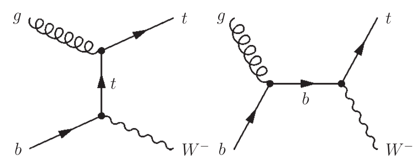

FIG. 1. Leading order Feynman diagrams for single top quark production in the tW mode; the charge-conjugate modes are implicitly included.

*Full author list given at the end of the article.

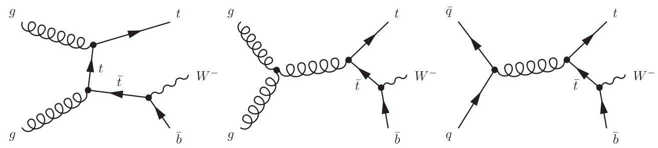

FIG. 2. Feynman diagrams for tW single top quark production at next-to-leading order that are removed from the signal definition in the DR scheme; the charge-conjugate modes are implicitly included.

by CMS, corresponding to an integrated luminosity of 4.9 fb^{-1}, is used.

The central feature of the CMS apparatus is a superconducting solenoid of 6 m internal diameter, providing a magnetic field of 3.8 T. Within the field volume are a silicon pixel and strip tracker, a lead tungstate crystal electromagnetic calorimeter, and a brass or scintillator hadron calorimeter. Muons are measured in gas-ionization detectors embedded in the steel return yoke. Extensive forward calorimetry complements the coverage provided by the barrel and endcap detectors. A more detailed description can be found in Ref. [15].

Single top quark events in all channels have been simulated with the POWHEG event generator version 301 [16], designed to describe the full NLO properties of these processes, while MADGRAPH 5.1.1 [17] is used for $t\bar{t}$ and for the inclusive single-boson production ($V + X$), where $V = W$, Z, and X can indicate light or heavy partons. The remaining background samples are simulated using PYTHIA version 6.4.24 [18], including diboson production and QCD multijet production enriched in events with electrons or muons produced in the decay of b and c quarks, and muons from the decay of long-lived hadrons. The CTEQ 6.6M pdf sets [19] are used for all simulated samples. All generated events undergo a full simulation of the detector response using GEANT4 [20,21]. The value used for the top quark mass is $m_t = 172.5$ GeV.

Approximate NNLO theoretical predictions are used to normalize $t\bar{t}$ production ($\sigma_{t\bar{t}} = 163^{+11}_{-10}$ pb) [22], W + jets and Z/γ^* + jets processes are normalized to complete NNLO calculations for the inclusive cross sections, and NLO cross sections are used for diboson processes [23]. Unless otherwise stated, the theoretical values of the cross section have been used in this Letter to normalize the simulation in figures and tables.

Leptons, jets, and E_T^{miss} are reconstructed by the CMS particle flow (PF) algorithm [24], which performs a global event reconstruction and provides the full list of particles identified as electrons, muons, photons, and charged and neutral hadrons.

Events are collected using dilepton triggers with electrons or muons. The lepton transverse energy thresholds are symmetric, the highest used in these triggers is 17 GeV while the lowest is 8 GeV. The two selected leptons must originate from the same primary vertex and have opposite charge. The primary vertex used is defined as the reconstructed vertex with the highest p_T of associated tracks and is required to have at least four tracks, with longitudinal (radial) distance of less than 24 (2) cm from the center of the detector. Muon (electron) candidates are required to have a transverse momentum $p_T > 20$ GeV and pseudorapidity $|\eta| < 2.4(2.5)$; events with additional leptons passing looser quality criteria are vetoed.

To remove low invariant mass Drell-Yan (Z/γ^*) events, the invariant mass of the lepton pair ($m_{\ell\ell}$) is required to be greater than 20 GeV. In the ee and $\mu\mu$ final states, events are also rejected if $m_{\ell\ell}$ is between 81 and 101 GeV, compatible with the Z boson mass; this veto removes background from Z/γ^* + jets, as well as from ZZ and WZ processes. In the ee and $\mu\mu$ decay channels, a requirement is applied on the E_T^{miss} as well to further reduce the contribution from events without genuine E_T^{miss} (mostly Z/γ^* + jets and QCD multijet production). Since the E_T^{miss} resolution is degraded in events with high pileup, an additional quantity is used (tracker-E_T^{miss}), calculated using only the charged particles associated with the primary vertex. Events are selected if both E_T^{miss} and tracker-E_T^{miss} are larger than 30 GeV.

Jets are defined according to the anti-k_T algorithm [25] with a distance parameter of 0.5. Jets within $|\eta| < 2.4$ and with $p_T > 30$ GeV are considered in the analysis.

Exactly one jet is required to be present in the event, and it must be identified as coming from a b quark. The identification of b jets is done according to an algorithm that reconstructs the secondary vertex of the decay of the b quark [26,27], resulting in a discriminating variable sensitive to the lifetime of b hadrons. The selection on this discriminant yields a b-tagging efficiency of 62% with a mistag rate of 1.4% for jets with p_T between 50 and 80 GeV. Events with additional b-tagged jets with $p_T >$ 20 GeV are removed. After this selection, the sample is dominated by $t\bar{t}$ events and a tW signal.

Additionally, events with exactly two jets, in which either one or both jets have been b tagged, are used in the fit. Three regions are defined per dilepton final state: one region with one jet that is b tagged ($1j1t$) where the tW signal is substantial, and two regions with two jets, where the $t\bar{t}$ background is dominant, and exactly one or two b tags are required ($2j1t$ and $2j2t$, respectively).

A smaller background comes from Z/γ^* events. It is found that in high-pileup scenarios the E_T^{miss} distribution for Z/γ^* events is not properly modeled by the simulation, leading to disagreement between data and simulation. To solve this problem, the Z/γ^* simulation is corrected to match the missing transverse energy distribution observed in the data using events from the Z resonance.

The contributions of other backgrounds, i.e., diboson production (WW, WZ, ZZ), QCD, W + jets, and other single top quark processes, are small, less than 1% of the selected events, and estimated from simulation.

TABLE I. Event yields in the different regions. The simulation is quoted with statistical (first) and systematic uncertainties (second). When only one uncertainty is quoted, it is the total one.

	$1j1t$	$2j1t$	$2j2t$
tW	$336 \pm 5 \pm 16$	$180 \pm 3 \pm 16$	$45 \pm 1 \pm 6$
$t\bar{t}$	$1263 \pm 19 \pm 138$	$2775 \pm 28 \pm 205$	$1488 \pm 21 \pm 222$
$Z/\gamma^* +$ jets	$128 \pm 12 \pm 28$	$113 \pm 10 \pm 22$	$8.5 \pm 1.8 \pm 1.8$
Other	19 ± 3	$8.8 \pm 0.7 \pm 0.2$	4 ± 3
Total estimated	$1746 \pm 23 \pm 141$	$3077 \pm 30 \pm 207$	$1546 \pm 21 \pm 222$
Total data	1699	2878	1507

The number of events in the signal and two control regions is presented for data and simulation in Table I. The approximate composition of the sample at this level is 70% $t\bar{t}$ events with 20% tW events in the signal region. In the $2j1t$ region the $t\bar{t}$ content represents 90% of the events, while tW events are less than 6%. In the $2j2t$ region, more than 95% of the events are $t\bar{t}$ events.

A multivariate analysis based on boosted decision trees ("BDT" analysis) [28,29] is used, testing the overall compatibility of the signal event candidates with the event topology of the tW associated production. Four variables are chosen to train the BDT based on their ability to separate the tW signal from the dominant $t\bar{t}$ background. These variables are H_T, defined as the scalar sum of the transverse momenta of the leptons, jet, and E_T^{miss}, the p_T of the system composed of the leptons, E_T^{miss} and jet, the p_T of the jet with the highest energy, and the difference in angular separation, ϕ, between the direction associated to the E_T^{miss} and the closest of the two selected leptons. The distributions of H_T and the p_T of the system composed of the leptons, E_T^{miss} and the jet, are presented, in the signal region ($1j1t$), in Fig. 3. The presence of the tW signal over the background is visible in all the distributions. The distributions of the other two variables are available in the Supplemental Material [30].

The output of the BDT is a single discriminant value for every event ranging from -1 (backgroundlike) to $+1$ (signal-like). The distribution of the BDT discriminant is shown for the $1j1t$ signal region in Fig. 4. Even if the tW signal does not peak strongly at $+1$, its distribution discriminates it with respect to $t\bar{t}$ and other backgrounds. Maximum signal sensitivity is achieved through a simultaneous fit to 9 categories: the 3 BDT discriminant shapes ($1j1t$, $2j1t$, and $2j2t$) in the three final states (ee, $e\mu$, and $\mu\mu$). The two $t\bar{t}$ enriched regions are included to control the rate of this background in the signal region.

The impact of each individual source of uncertainty on the analysis has been estimated in every region and final state. The dominant systematic uncertainty that affects the rate of the tW signal is associated with the b-tagging efficiency, with values between 3% and 6% for the different final states. The b-tagging efficiency uncertainty is also important for the $t\bar{t}$ background yield, with values between 1.5% and 4.0%. The main systematic uncertainty for the $t\bar{t}$ background is due to the factorization/renormalization scale used in the simulation, up to 11%, with values around 2% for the tW signal. Also for $t\bar{t}$, the uncertainties due to jet energy scale (7%) and the threshold used to match the matrix element generator to the parton shower model in

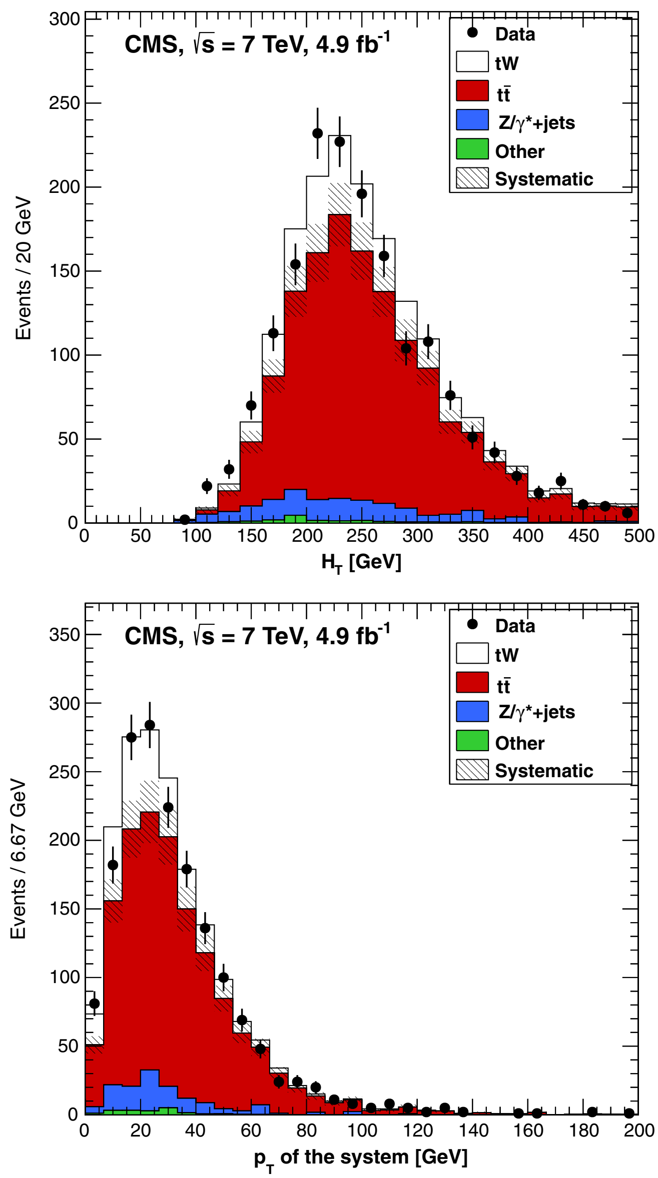

FIG. 3 (color online). Distributions of H_T and the p_T of the system composed of the leptons, E_T^{miss} and the jet, in data and simulation after jet selection in the signal region ($1j1t$).

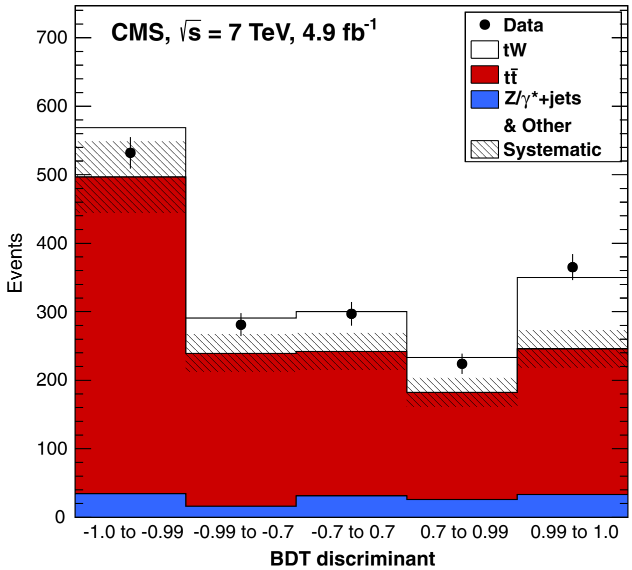

FIG. 4 (color online). Distribution of the BDT discriminant in the signal region ($1j1t$) in data and simulation.

simulation (3%) are important. The statistical uncertainty is the largest contribution to the uncertainty of the measured cross section, with a 20% effect. The complete information about the systematic uncertainties is available in tabulated form in the Supplemental Material [30].

A binned likelihood fit is performed on the distributions of the BDT discriminant. Template shapes for the signal and backgrounds are taken from simulation. Distributions are included separately in the fit for each of the three dilepton channels (ee, $e\mu$, and $\mu\mu$) in the signal region ($1j1t$) and control regions ($2j1t$ and $2j2t$). Signal and background rates are allowed to vary in the fit, using the systematic uncertainties on the background rates as constraint terms in the likelihood function. The signal rate and 68% confidence level (C.L.) interval is determined using the profile likelihood method. The sources of theoretical uncertainty that affect the template shape are then considered. For each uncertainty, $\pm 1\sigma$ systematic shifts are applied to the simulated samples to obtain revised templates. Differences in signal rates found using the revised templates are taken as systematic uncertainties and are added in quadrature to the 1σ interval from the fit using the baseline templates. The expected significance is evaluated using the median and central 68% of the values obtained from pseudoexperiments generated using the theoretical prediction of the standard model tW cross section.

An excess of events over the expected background is observed with a significance of 4.0σ, compatible with the expected significance of the tW signal, $3.6^{+0.8}_{-0.9}\sigma$. The measured cross section, including both statistical and systematic uncertainties, is 16^{+5}_{-4} pb, in agreement with the standard model prediction.

The measurement can be used to determine the absolute value of the Cabibbo-Kobayashi-Maskawa matrix element $|V_{tb}|$, following the same technique as in [10], assuming that $|V_{td}|$ and $|V_{ts}|$ are much smaller than $|V_{tb}|$:

$$|V_{tb}| = \sqrt{\frac{\sigma_{tW}}{\sigma_{tW}^{\rm th}}} = 1.01^{+0.16}_{-0.13}({\rm exp.})^{+0.03}_{-0.04}({\rm th.}), \qquad (1)$$

where $\sigma_{tW}^{\rm th}$ is the standard model prediction computed assuming $|V_{tb}| = 1$. Using the standard model assumption of $0 \le |V_{tb}|^2 \le 1$, a value of $|V_{tb}| = 1.00$ is inferred, with a 90% confidence level interval of [0.79,1.00]. This is based on profile likelihood intervals, the same method used for the cross section measurement and intervals. Studies with pseudoexperiments were performed, showing the validity of the profile likelihood method in presence of the boundary $|V_{tb}| \le 1.0$.

A second analysis (“count-based” analysis), used as a cross-check, is performed using event counts. After the jet selection step, instead of building the BDT discriminant, events are required in addition to having $H_{\rm T} > 60$ GeV in the $e\mu$ channel, where no invariant mass and $E_{\rm T}^{\rm miss}$ requirements are applied. The analysis uses a statistical model of Poisson event counts in the three dilepton final states in the signal region ($1j1t$) and control regions ($2j1t$ and $2j2t$). The event yield for each process in every region is affected by different sources of systematic uncertainties, equivalent to the ones calculated for the BDT analysis. These are included in the model as nuisance parameters. The same methods for the cross section measurement and the significance calculation as in the BDT analysis have been used. Figure 5 shows the event yields selected by the count-based analysis for each region, in data and simulation, in which

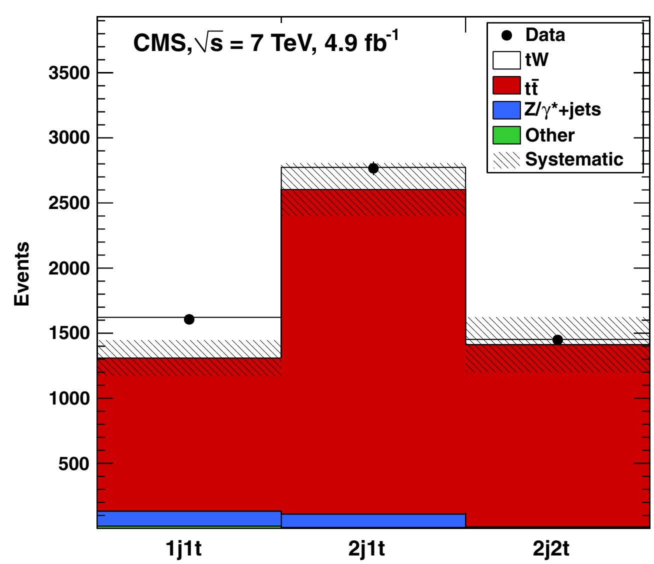

FIG. 5 (color online). Event yields in data and simulation in the signal region ($1j1t$) and the two $t\bar{t}$-enriched control regions for the count-based analysis. Simulation yields are scaled to the outcome of the fit.

the simulation yields have been normalized to the outcome of the maximum likelihood fit. The observed significance of the tW signal obtained with the count-based analysis is 3.5σ, with an expected significance of $3.2 \pm 0.9\sigma$. The count-based analysis measures a cross section of 15 ± 5 pb. These results are consistent with those obtained with the BDT analysis.

In summary, using 4.9 fb^{-1} of data collected with the CMS experiment at the LHC, evidence has been found for the associated production of a single top quark and W boson in pp collisions at $\sqrt{s} = 7$ TeV with a significance of 4.0σ and a measured cross section of 16^{+5}_{-4} pb.

We congratulate our colleagues in the CERN accelerator departments for the excellent performance of the LHC machine. We thank the technical and administrative staff at CERN and other CMS institutes, and acknowledge support from BMWF and FWF (Austria); FNRS and FWO (Belgium); CNPq, CAPES, FAPERJ, and FAPESP (Brazil); MES (Bulgaria); CERN; CAS, MoST, and NSFC (China); COLCIENCIAS (Colombia); MSES (Croatia); RPF (Cyprus); MoER, SF0690030s09, and ERDF (Estonia); Academy of Finland, MEC, and HIP (Finland); CEA and CNRS/IN2P3 (France); BMBF, DFG, and HGF (Germany); GSRT (Greece); OTKA and NKTH (Hungary); DAE and DST (India); IPM (Iran); SFI (Ireland); INFN (Italy); NRF and WCU (Korea); LAS (Lithuania); CINVESTAV, CONACYT, SEP, and UASLP-FAI (Mexico); MSI (New Zealand); PAEC (Pakistan); MSHE, and NSC (Poland); FCT (Portugal); JINR (Armenia, Belarus, Georgia, Ukraine, Uzbekistan); MON, RosAtom, RAS, and RFBR (Russia); MSTD (Serbia); SEIDI and CPAN (Spain); Swiss Funding Agencies (Switzerland); NSC (Taipei); TUBITAK and TAEK (Turkey); STFC (United Kingdom); and DOE and NSF (USA).

[1] V. M. Abazov *et al.* (D0 Collaboration), Phys. Rev. Lett. **103**, 092001 (2009).
[2] T. Aaltonen *et al.* (CDF Collaboration), Phys. Rev. Lett. **103**, 092002 (2009).
[3] S. Frixione, E. Laenen, P. Motylinski, C. White, and B. R Webber, J. High Energy Phys. 07 (2008) 029.
[4] A. S. Belyaev, E. E. Boos, and L. V. Dudko, Phys. Rev. D **59**, 075001 (1999).
[5] C. D. White, S. Frixione, E. Laenen, and F. Maltoni, J. High Energy Phys. 11 (2009) 074.
[6] T. M. P. Tait and C.-P. Yuan, Phys. Rev. D **63**, 014018 (2000).
[7] Q.-H. Cao, J. Wudka, and C.-P. Yuan, Phys. Lett. B **658**, 50 (2007).
[8] V. Barger, M. McCaskey, and G. Shaughnessy, Phys. Rev. D **81**, 034020 (2010).
[9] G. Aad *et al.* (ATLAS Collaboration), Phys. Lett. B **717**, 330 (2012).
[10] S. Chatrchyan *et al.* (CMS Collaboration), Phys. Rev. Lett. **107**, 091802 (2011).
[11] G. Aad *et al.* (ATLAS Collaboration), Phys. Lett. B **716**, 142 (2012).
[12] N. Kidonakis, Phys. Rev. D **82**, 054018 (2010).
[13] T. M. P. Tait, Phys. Rev. D **61**, 034001 (1999).
[14] J. Beringer *et al.* (Particle Data Group), Phys. Rev. D **86**, 010001 (2012).
[15] S. Chatrchyan *et al.* (CMS Collaboration), JINST **3**, S08004 (2008).
[16] S. Frixione, P. Nason, and C. Oleari, J. High Energy Phys. 11 (2007) 070.
[17] J. Alwall, M. Herquet, F. Maltoni, O. Mattelaer, and T. Stelzer, J. High Energy Phys. 06 (2011) 128.
[18] T. Sjöstrand, S. Mrenna, and P. Z. Skands, J. High Energy Phys. 05 (2006) 026.
[19] J. Pumplin, D. R. Stump, J. Huston, H.-L. Lai, P. Nadolsky, and W.-K. Tung, J. High Energy Phys. 07 (2002) 012.
[20] S. Agostinelli *et al.* (GEANT4 Collaboration), Nucl. Instrum. Methods Phys. Res., Sect. A **506**, 250 (2003).
[21] J. Allison *et al.*, IEEE Trans. Nucl. Sci. **53**, 270 (2006).
[22] N. Kidonakis, Phys. Rev. D **82**, 114030 (2010).
[23] R. Gavin, Y. Li, F. Petriello, and S. Quackenbush, Comput. Phys. Commun. **182**, 2388 (2011).
[24] CMS Collaboration, *Particle-Flow Event Reconstruction in CMS and Performance for Jets, Taus, and* E_T^{miss}, CMS Physics Analysis Summary CMS-PAS-PFT-09-001 (2009) [http://cds.cern.ch/record/1194487].
[25] M. Cacciari, G. P. Salam, and G. Soyez, J. High Energy Phys. 04 (2008) 063.
[26] CMS Collaboration, *Commissioning of b-jet identification with pp collisions at* $\sqrt{s} = 7$ TeV, CMS Physics Analysis Summary CMS-PAS-BTV-10-001 (2010) [http://cds.cern.ch/record/1279144].
[27] CMS Collaboration, *Performance of b-jet identification in CMS*, CMS Physics Analysis Summary CMSPAS-BTV-11-001 (2011) [http://cds.cern.ch/record/1366061].
[28] L. Breiman, J. Friedman, C. J. Stone, and R. A. Olshen, *Classification and Regression Trees* (Chapman and Hall, London, 1984).
[29] Y. Freund and R. E. Schapire, J. Comput. Syst. Sci. **55**, 119 (1997).
[30] See Supplemental Material at http://link.aps.org/supplemental/10.1103/PhysRevLett.110.022003 for kinematic distributions and complete systematic tables.

S. Chatrchyan,[1] V. Khachatryan,[1] A. M. Sirunyan,[1] A. Tumasyan,[1] W. Adam,[2] E. Aguilo,[2] T. Bergauer,[2] M. Dragicevic,[2] J. Erö,[2] C. Fabjan,[2,b] M. Friedl,[2] R. Frühwirth,[2,b] V. M. Ghete,[2] J. Hammer,[2] N. Hörmann,[2] J. Hrubec,[2] M. Jeitler,[2,b] W. Kiesenhofer,[2] V. Knünz,[2] M. Krammer,[2,b] I. Krätschmer,[2] D. Liko,[2] I. Mikulec,[2] M. Pernicka,[2,a] B. Rahbaran,[2] C. Rohringer,[2] H. Rohringer,[2] R. Schöfbeck,[2] J. Strauss,[2] A. Taurok,[2]

W. Waltenberger,[2] G. Walzel,[2] E. Widl,[2] C.-E. Wulz,[2,b] V. Mossolov,[3] N. Shumeiko,[3] J. Suarez Gonzalez,[3] M. Bansal,[4] S. Bansal,[4] T. Cornelis,[4] E. A. De Wolf,[4] X. Janssen,[4] S. Luyckx,[4] L. Mucibello,[4] S. Ochesanu,[4] B. Roland,[4] R. Rougny,[4] M. Selvaggi,[4] Z. Staykova,[4] H. Van Haevermaet,[4] P. Van Mechelen,[4] N. Van Remortel,[4] A. Van Spilbeeck,[4] F. Blekman,[5] S. Blyweert,[5] J. D'Hondt,[5] R. Gonzalez Suarez,[5] A. Kalogeropoulos,[5] M. Maes,[5] A. Olbrechts,[5] W. Van Doninck,[5] P. Van Mulders,[5] G. P. Van Onsem,[5] I. Villella,[5] B. Clerbaux,[6] G. De Lentdecker,[6] V. Dero,[6] A. P. R. Gay,[6] T. Hreus,[6] A. Léonard,[6] P. E. Marage,[6] A. Mohammadi,[6] T. Reis,[6] L. Thomas,[6] G. Vander Marcken,[6] C. Vander Velde,[6] P. Vanlaer,[6] J. Wang,[6] V. Adler,[7] K. Beernaert,[7] A. Cimmino,[7] S. Costantini,[7] G. Garcia,[7] M. Grunewald,[7] B. Klein,[7] J. Lellouch,[7] A. Marinov,[7] J. Mccartin,[7] A. A. Ocampo Rios,[7] D. Ryckbosch,[7] N. Strobbe,[7] F. Thyssen,[7] M. Tytgat,[7] P. Verwilligen,[7] S. Walsh,[7] E. Yazgan,[7] N. Zaganidis,[7] S. Basegmez,[8] G. Bruno,[8] R. Castello,[8] L. Ceard,[8] C. Delaere,[8] T. du Pree,[8] D. Favart,[8] L. Forthomme,[8] A. Giammanco,[8,c] J. Hollar,[8] V. Lemaitre,[8] J. Liao,[8] O. Militaru,[8] C. Nuttens,[8] D. Pagano,[8] A. Pin,[8] K. Piotrzkowski,[8] N. Schul,[8] J. M. Vizan Garcia,[8] N. Beliy,[9] T. Caebergs,[9] E. Daubie,[9] G. H. Hammad,[9] G. A. Alves,[10] M. Correa Martins Junior,[10] T. Martins,[10] M. E. Pol,[10] M. H. G. Souza,[10] W. L. Aldá Júnior,[11] W. Carvalho,[11] A. Custódio,[11] E. M. Da Costa,[11] D. De Jesus Damiao,[11] C. De Oliveira Martins,[11] S. Fonseca De Souza,[11] D. Matos Figueiredo,[11] L. Mundim,[11] H. Nogima,[11] V. Oguri,[11] W. L. Prado Da Silva,[11] A. Santoro,[11] L. Soares Jorge,[11] A. Sznajder,[11] T. S. Anjos,[12,d] C. A. Bernardes,[12,d] F. A. Dias,[12,e] T. R. Fernandez Perez Tomei,[12] E. M. Gregores,[12,d] C. Lagana,[12] F. Marinho,[12] P. G. Mercadante,[12,d] S. F. Novaes,[12] Sandra S. Padula,[12] V. Genchev,[13,f] P. Iaydjiev,[13,f] S. Piperov,[13] M. Rodozov,[13] S. Stoykova,[13] G. Sultanov,[13] V. Tcholakov,[13] R. Trayanov,[13] M. Vutova,[13] A. Dimitrov,[14] R. Hadjiiska,[14] V. Kozhuharov,[14] L. Litov,[14] B. Pavlov,[14] P. Petkov,[14] J. G. Bian,[15] G. M. Chen,[15] H. S. Chen,[15] C. H. Jiang,[15] D. Liang,[15] S. Liang,[15] X. Meng,[15] J. Tao,[15] J. Wang,[15] X. Wang,[15] Z. Wang,[15] H. Xiao,[15] M. Xu,[15] J. Zang,[15] Z. Zhang,[15] C. Asawatangtrakuldee,[16] Y. Ban,[16] Y. Guo,[16] W. Li,[16] S. Liu,[16] Y. Mao,[16] S. J. Qian,[16] H. Teng,[16] D. Wang,[16] L. Zhang,[16] W. Zou,[16] C. Avila,[17] J. P. Gomez,[17] B. Gomez Moreno,[17] A. F. Osorio Oliveros,[17] J. C. Sanabria,[17] N. Godinovic,[18] D. Lelas,[18] R. Plestina,[18,g] D. Polic,[18] I. Puljak,[18,f] Z. Antunovic,[19] M. Kovac,[19] V. Brigljevic,[20] S. Duric,[20] K. Kadija,[20] J. Luetic,[20] S. Morovic,[20] A. Attikis,[21] M. Galanti,[21] G. Mavromanolakis,[21] J. Mousa,[21] C. Nicolaou,[21] F. Ptochos,[21] P. A. Razis,[21] M. Finger,[22] M. Finger, Jr.,[22] Y. Assran,[23,h] S. Elgammal,[23,i] A. Ellithi Kamel,[23,j] S. Khalil,[23,i] M. A. Mahmoud,[23,k] A. Radi,[23,l,m] M. Kadastik,[24] M. Müntel,[24] M. Raidal,[24] L. Rebane,[24] A. Tiko,[24] P. Eerola,[25] G. Fedi,[25] M. Voutilainen,[25] J. Härkönen,[26] A. Heikkinen,[26] V. Karimäki,[26] R. Kinnunen,[26] M. J. Kortelainen,[26] T. Lampén,[26] K. Lassila-Perini,[26] S. Lehti,[26] T. Lindén,[26] P. Luukka,[26] T. Mäenpää,[26] T. Peltola,[26] E. Tuominen,[26] J. Tuominiemi,[26] E. Tuovinen,[26] D. Ungaro,[26] L. Wendland,[26] K. Banzuzi,[27] A. Karjalainen,[27] A. Korpela,[27] T. Tuuva,[27] M. Besancon,[28] S. Choudhury,[28] M. Dejardin,[28] D. Denegri,[28] B. Fabbro,[28] J. L. Faure,[28] F. Ferri,[28] S. Ganjour,[28] A. Givernaud,[28] P. Gras,[28] G. Hamel de Monchenault,[28] P. Jarry,[28] E. Locci,[28] J. Malcles,[28] L. Millischer,[28] A. Nayak,[28] J. Rander,[28] A. Rosowsky,[28] I. Shreyber,[28] M. Titov,[28] S. Baffioni,[29] F. Beaudette,[29] L. Benhabib,[29] L. Bianchini,[29] M. Bluj,[29,n] C. Broutin,[29] P. Busson,[29] C. Charlot,[29] N. Daci,[29] T. Dahms,[29] M. Dalchenko,[29] L. Dobrzynski,[29] R. Granier de Cassagnac,[29] M. Haguenauer,[29] P. Miné,[29] C. Mironov,[29] I. N. Naranjo,[29] M. Nguyen,[29] C. Ochando,[29] P. Paganini,[29] D. Sabes,[29] R. Salerno,[29] Y. Sirois,[29] C. Veelken,[29] A. Zabi,[29] J.-L. Agram,[30,o] J. Andrea,[30] D. Bloch,[30] D. Bodin,[30] J.-M. Brom,[30] M. Cardaci,[30] E. C. Chabert,[30] C. Collard,[30] E. Conte,[30,o] F. Drouhin,[30,o] C. Ferro,[30] J.-C. Fontaine,[30,o] D. Gelé,[30] U. Goerlach,[30] P. Juillot,[30] A.-C. Le Bihan,[30] P. Van Hove,[30] F. Fassi,[31] D. Mercier,[31] S. Beauceron,[32] N. Beaupere,[32] O. Bondu,[32] G. Boudoul,[32] J. Chasserat,[32] R. Chierici,[32,f] D. Contardo,[32] P. Depasse,[32] H. El Mamouni,[32] J. Fay,[32] S. Gascon,[32] M. Gouzevitch,[32] B. Ille,[32] T. Kurca,[32] M. Lethuillier,[32] L. Mirabito,[32] S. Perries,[32] L. Sgandurra,[32] V. Sordini,[32] Y. Tschudi,[32] P. Verdier,[32] S. Viret,[32] V. Roinishvili,[33] G. Anagnostou,[34] C. Autermann,[34] S. Beranek,[34] M. Edelhoff,[34] L. Feld,[34] N. Heracleous,[34] O. Hindrichs,[34] R. Jussen,[34] K. Klein,[34] J. Merz,[34] A. Ostapchuk,[34] A. Perieanu,[34] F. Raupach,[34] J. Sammet,[34] S. Schael,[34] D. Sprenger,[34] H. Weber,[34] B. Wittmer,[34] V. Zhukov,[34,p] M. Ata,[35] J. Caudron,[35] E. Dietz-Laursonn,[35] D. Duchardt,[35] M. Erdmann,[35] R. Fischer,[35] A. Güth,[35] T. Hebbeker,[35] C. Heidemann,[35] K. Hoepfner,[35] D. Klingebiel,[35] P. Kreuzer,[35] M. Merschmeyer,[35] A. Meyer,[35] M. Olschewski,[35] P. Papacz,[35] H. Pieta,[35] H. Reithler,[35] S. A. Schmitz,[35] L. Sonnenschein,[35] J. Steggemann,[35] D. Teyssier,[35] M. Weber,[35] M. Bontenackels,[36] V. Cherepanov,[36] Y. Erdogan,[36] G. Flügge,[36] H. Geenen,[36] M. Geisler,[36] W. Haj Ahmad,[36] F. Hoehle,[36] B. Kargoll,[36] T. Kress,[36] Y. Kuessel,[36] J. Lingemann,[36,f] A. Nowack,[36] L. Perchalla,[36] O. Pooth,[36] P. Sauerland,[36] A. Stahl,[36] M. Aldaya Martin,[37] J. Behr,[37] W. Behrenhoff,[37] U. Behrens,[37] M. Bergholz,[37,q] A. Bethani,[37] K. Borras,[37] A. Burgmeier,[37] A. Cakir,[37] L. Calligaris,[37] A. Campbell,[37] E. Castro,[37] F. Costanza,[37] D. Dammann,[37]

C. Diez Pardos,[37] G. Eckerlin,[37] D. Eckstein,[37] G. Flucke,[37] A. Geiser,[37] I. Glushkov,[37] P. Gunnellini,[37] S. Habib,[37] J. Hauk,[37] G. Hellwig,[37] H. Jung,[37] M. Kasemann,[37] P. Katsas,[37] C. Kleinwort,[37] H. Kluge,[37] A. Knutsson,[37] M. Krämer,[37] D. Krücker,[37] E. Kuznetsova,[37] W. Lange,[37] W. Lohmann,[37,q] B. Lutz,[37] R. Mankel,[37] I. Marfin,[37] M. Marienfeld,[37] I.-A. Melzer-Pellmann,[37] A. B. Meyer,[37] J. Mnich,[37] A. Mussgiller,[37] S. Naumann-Emme,[37] O. Novgorodova,[37] J. Olzem,[37] H. Perrey,[37] A. Petrukhin,[37] D. Pitzl,[37] A. Raspereza,[37] P. M. Ribeiro Cipriano,[37] C. Riedl,[37] E. Ron,[37] M. Rosin,[37] J. Salfeld-Nebgen,[37] R. Schmidt,[37,q] T. Schoerner-Sadenius,[37] N. Sen,[37] A. Spiridonov,[37] M. Stein,[37] R. Walsh,[37] C. Wissing,[37] V. Blobel,[38] J. Draeger,[38] H. Enderle,[38] J. Erfle,[38] U. Gebbert,[38] M. Görner,[38] T. Hermanns,[38] R. S. Höing,[38] K. Kaschube,[38] G. Kaussen,[38] H. Kirschenmann,[38] R. Klanner,[38] J. Lange,[38] B. Mura,[38] F. Nowak,[38] T. Peiffer,[38] N. Pietsch,[38] D. Rathjens,[38] C. Sander,[38] H. Schettler,[38] P. Schleper,[38] E. Schlieckau,[38] A. Schmidt,[38] M. Schröder,[38] T. Schum,[38] M. Seidel,[38] J. Sibille,[38,r] V. Sola,[38] H. Stadie,[38] G. Steinbrück,[38] J. Thomsen,[38] L. Vanelderen,[38] C. Barth,[39] J. Berger,[39] C. Böser,[39] T. Chwalek,[39] W. De Boer,[39] A. Descroix,[39] A. Dierlamm,[39] M. Feindt,[39] M. Guthoff,[39,f] C. Hackstein,[39] F. Hartmann,[39] T. Hauth,[39,f] M. Heinrich,[39] H. Held,[39] K. H. Hoffmann,[39] U. Husemann,[39] I. Katkov,[39,p] J. R. Komaragiri,[39] P. Lobelle Pardo,[39] D. Martschei,[39] S. Mueller,[39] Th. Müller,[39] M. Niegel,[39] A. Nürnberg,[39] O. Oberst,[39] A. Oehler,[39] J. Ott,[39] G. Quast,[39] K. Rabbertz,[39] F. Ratnikov,[39] N. Ratnikova,[39] S. Röcker,[39] F.-P. Schilling,[39] G. Schott,[39] H. J. Simonis,[39] F. M. Stober,[39] D. Troendle,[39] R. Ulrich,[39] J. Wagner-Kuhr,[39] S. Wayand,[39] T. Weiler,[39] M. Zeise,[39] G. Daskalakis,[40] T. Geralis,[40] S. Kesisoglou,[40] A. Kyriakis,[40] D. Loukas,[40] I. Manolakos,[40] A. Markou,[40] C. Markou,[40] C. Mavrommatis,[40] E. Ntomari,[40] L. Gouskos,[41] T. J. Mertzimekis,[41] A. Panagiotou,[41] N. Saoulidou,[41] I. Evangelou,[42] C. Foudas,[42] P. Kokkas,[42] N. Manthos,[42] I. Papadopoulos,[42] V. Patras,[42] G. Bencze,[43] C. Hajdu,[43] P. Hidas,[43] D. Horvath,[43,s] F. Sikler,[43] V. Veszpremi,[43] G. Vesztergombi,[43,t] N. Beni,[44] S. Czellar,[44] J. Molnar,[44] J. Palinkas,[44] Z. Szillasi,[44] J. Karancsi,[45] P. Raics,[45] Z. L. Trocsanyi,[45] B. Ujvari,[45] S. B. Beri,[46] V. Bhatnagar,[46] N. Dhingra,[46] R. Gupta,[46] M. Kaur,[46] M. Z. Mehta,[46] N. Nishu,[46] L. K. Saini,[46] A. Sharma,[46] J. B. Singh,[46] Ashok Kumar,[47] Arun Kumar,[47] S. Ahuja,[47] A. Bhardwaj,[47] B. C. Choudhary,[47] S. Malhotra,[47] M. Naimuddin,[47] K. Ranjan,[47] V. Sharma,[47] R. K. Shivpuri,[47] S. Banerjee,[48] S. Bhattacharya,[48] S. Dutta,[48] B. Gomber,[48] Sa. Jain,[48] Sh. Jain,[48] R. Khurana,[48] S. Sarkar,[48] M. Sharan,[48] A. Abdulsalam,[49] R. K. Choudhury,[49] D. Dutta,[49] S. Kailas,[49] V. Kumar,[49] P. Mehta,[49] A. K. Mohanty,[49,f] L. M. Pant,[49] P. Shukla,[49] T. Aziz,[50] S. Ganguly,[50] M. Guchait,[50,u] M. Maity,[50,v] G. Majumder,[50] K. Mazumdar,[50] G. B. Mohanty,[50] B. Parida,[50] K. Sudhakar,[50] N. Wickramage,[50] S. Banerjee,[51] S. Dugad,[51] H. Arfaei,[52,w] H. Bakhshiansohi,[52] S. M. Etesami,[52,x] A. Fahim,[52,w] M. Hashemi,[52] H. Hesari,[52] A. Jafari,[52] M. Khakzad,[52] M. Mohammadi Najafabadi,[52] S. Paktinat Mehdiabadi,[52] B. Safarzadeh,[52,y] M. Zeinali,[52] M. Abbrescia,[53a,53b] L. Barbone,[53a,53b] C. Calabria,[53a,53b,f] S. S. Chhibra,[53a,53b] A. Colaleo,[53a] D. Creanza,[53a,53c] N. De Filippis,[53a,53c,f] M. De Palma,[53a,53b] L. Fiore,[53a] G. Iaselli,[53a,53c] G. Maggi,[53a,53c] M. Maggi,[53a] B. Marangelli,[53a,53b] S. My,[53a,53c] S. Nuzzo,[53a,53b] N. Pacifico,[53a,53b] A. Pompili,[53a,53b] G. Pugliese,[53a,53c] G. Selvaggi,[53a,53b] L. Silvestris,[53a] G. Singh,[53a,53b] R. Venditti,[53a,53b] G. Zito,[53a] G. Abbiendi,[54a] A. C. Benvenuti,[54a] D. Bonacorsi,[54a,54b] S. Braibant-Giacomelli,[54a,54b] L. Brigliadori,[54a,54b] P. Capiluppi,[54a,54b] A. Castro,[54a,54b] F. R. Cavallo,[54a] M. Cuffiani,[54a,54b] G. M. Dallavalle,[54a] F. Fabbri,[54a] A. Fanfani,[54a,54b] D. Fasanella,[54a,54b,f] P. Giacomelli,[54a] C. Grandi,[54a] L. Guiducci,[54a,54b] S. Marcellini,[54a] G. Masetti,[54a] M. Meneghelli,[54a,54b,f] A. Montanari,[54a] F. L. Navarria,[54a,54b] F. Odorici,[54a] A. Perrotta,[54a] F. Primavera,[54a,54b] A. M. Rossi,[54a,54b] T. Rovelli,[54a,54b] G. P. Siroli,[54a,54b] R. Travaglini,[54a,54b] S. Albergo,[55a,55b] G. Cappello,[55a,55b] M. Chiorboli,[55a,55b] S. Costa,[55a,55b] R. Potenza,[55a,55b] A. Tricomi,[55a,55b] C. Tuve,[55a,55b] G. Barbagli,[56a] V. Ciulli,[56a,56b] C. Civinini,[56a] R. D'Alessandro,[56a,56b] E. Focardi,[56a,56b] S. Frosali,[56a,56b] E. Gallo,[56a] S. Gonzi,[56a,56b] M. Meschini,[56a] S. Paoletti,[56a] G. Sguazzoni,[56a] A. Tropiano,[56a,56b] L. Benussi,[57] S. Bianco,[57] S. Colafranceschi,[57,z] F. Fabbri,[57] D. Piccolo,[57] P. Fabbricatore,[58a] R. Musenich,[58a] S. Tosi,[58a,58b] A. Benaglia,[59a,59b] F. De Guio,[59a,59b] L. Di Matteo,[59a,59b,f] S. Fiorendi,[59a,59b] S. Gennai,[59a,f] A. Ghezzi,[59a,59b] S. Malvezzi,[59a] R. A. Manzoni,[59a,59b] A. Martelli,[59a,59b] A. Massironi,[59a,59b,f] D. Menasce,[59a] L. Moroni,[59a] M. Paganoni,[59a,59b] D. Pedrini,[59a] S. Ragazzi,[59a,59b] N. Redaelli,[59a] S. Sala,[59a] T. Tabarelli de Fatis,[59a,59b] S. Buontempo,[60a] C. A. Carrillo Montoya,[60a] N. Cavallo,[60a,aa] A. De Cosa,[60a,60b,f] O. Dogangun,[60a,60b] F. Fabozzi,[60a,aa] A. O. M. Iorio,[60a,60b] L. Lista,[60a] S. Meola,[60a,bb] M. Merola,[60a] P. Paolucci,[60a,f] P. Azzi,[61a] N. Bacchetta,[61a,f] D. Bisello,[61a,61b] A. Branca,[61a,f] R. Carlin,[61a,61b] P. Checchia,[61a] T. Dorigo,[61a] F. Gasparini,[61a,61b] U. Gasparini,[61a,61b] A. Gozzelino,[61a] K. Kanishchev,[61a,61c] S. Lacaprara,[61a] I. Lazzizzera,[61a,61c] M. Margoni,[61a,61b] A. T. Meneguzzo,[61a,61b] J. Pazzini,[61a,61b] N. Pozzobon,[61a,61b] P. Ronchese,[61a,61b] F. Simonetto,[61a,61b] E. Torassa,[61a] M. Tosi,[61a,61b] S. Vanini,[61a,61b] P. Zotto,[61a,61b] A. Zucchetta,[61a,61b] G. Zumerle,[61a,61b] M. Gabusi,[62a,62b] S. P. Ratti,[62a,62b]

C. Riccardi,[62a,62b] P. Torre,[62a,62b] P. Vitulo,[62a,62b] M. Biasini,[63a,63b] G. M. Bilei,[63a] L. Fanò,[63a,63b] P. Lariccia,[63a,63b] G. Mantovani,[63a,63b] M. Menichelli,[63a] A. Nappi,[63a,63b,a] F. Romeo,[63a,63b] A. Saha,[63a] A. Santocchia,[63a,63b] A. Spiezia,[63a,63b] S. Taroni,[63a,63b] P. Azzurri,[64a,64c] G. Bagliesi,[64a] T. Boccali,[64a] G. Broccolo,[64a,64c] R. Castaldi,[64a] R. T. D'Agnolo,[64a,64c,f] R. Dell'Orso,[64a] F. Fiori,[64a,64b,f] L. Foà,[64a,64c] A. Giassi,[64a] A. Kraan,[64a] F. Ligabue,[64a,64c] T. Lomtadze,[64a] L. Martini,[64a,cc] A. Messineo,[64a,64b] F. Palla,[64a] A. Rizzi,[64a,64b] A. T. Serban,[64a,dd] P. Spagnolo,[64a] P. Squillacioti,[64a,f] R. Tenchini,[64a] G. Tonelli,[64a,64b] A. Venturi,[64a] P. G. Verdini,[64a] L. Barone,[65a,65b] F. Cavallari,[65a] D. Del Re,[65a,65b] M. Diemoz,[65a] C. Fanelli,[65a] M. Grassi,[65a,65b,f] E. Longo,[65a,65b] P. Meridiani,[65a,f] F. Micheli,[65a,65b] S. Nourbakhsh,[65a,65b] G. Organtini,[65a,65b] R. Paramatti,[65a] S. Rahatlou,[65a,65b] M. Sigamani,[65a] L. Soffi,[65a,65b] N. Amapane,[66a,66b] R. Arcidiacono,[66a,66c] S. Argiro,[66a,66b] M. Arneodo,[66a,66c] C. Biino,[66a] N. Cartiglia,[66a] M. Costa,[66a,66b] N. Demaria,[66a] C. Mariotti,[66a,f] S. Maselli,[66a] E. Migliore,[66a,66b] V. Monaco,[66a,66b] M. Musich,[66a,f] M. M. Obertino,[66a,66c] N. Pastrone,[66a] M. Pelliccioni,[66a] A. Potenza,[66a,66b] A. Romero,[66a,66b] M. Ruspa,[66a,66c] R. Sacchi,[66a,66b] A. Solano,[66a,66b] A. Staiano,[66a] A. Vilela Pereira,[66a] S. Belforte,[67a] V. Candelise,[67a,67b] M. Casarsa,[67a] F. Cossutti,[67a] G. Della Ricca,[67a,67b] B. Gobbo,[67a] M. Marone,[67a,67b,f] D. Montanino,[67a,67b,f] A. Penzo,[67a] A. Schizzi,[67a,67b] S. G. Heo,[68] T. Y. Kim,[68] S. K. Nam,[68] S. Chang,[69] D. H. Kim,[69] G. N. Kim,[69] D. J. Kong,[69] H. Park,[69] S. R. Ro,[69] D. C. Son,[69] T. Son,[69] J. Y. Kim,[70] Zero J. Kim,[70] S. Song,[70] S. Choi,[71] D. Gyun,[71] B. Hong,[71] M. Jo,[71] H. Kim,[71] T. J. Kim,[71] K. S. Lee,[71] D. H. Moon,[71] S. K. Park,[71] M. Choi,[72] J. H. Kim,[72] C. Park,[72] I. C. Park,[72] S. Park,[72] G. Ryu,[72] Y. Cho,[73] Y. Choi,[73] Y. K. Choi,[73] J. Goh,[73] M. S. Kim,[73] E. Kwon,[73] B. Lee,[73] J. Lee,[73] S. Lee,[73] H. Seo,[73] I. Yu,[73] M. J. Bilinskas,[74] I. Grigelionis,[74] M. Janulis,[74] A. Juodagalvis,[74] H. Castilla-Valdez,[75] E. De La Cruz-Burelo,[75] I. Heredia-de La Cruz,[75] R. Lopez-Fernandez,[75] R. Magaña Villalba,[75] J. Martínez-Ortega,[75] A. Sánchez-Hernández,[75] L. M. Villasenor-Cendejas,[75] S. Carrillo Moreno,[76] F. Vazquez Valencia,[76] H. A. Salazar Ibarguen,[77] E. Casimiro Linares,[78] A. Morelos Pineda,[78] M. A. Reyes-Santos,[78] D. Krofcheck,[79] A. J. Bell,[80] P. H. Butler,[80] R. Doesburg,[80] S. Reucroft,[80] H. Silverwood,[80] M. Ahmad,[81] M. H. Ansari,[81] M. I. Asghar,[81] J. Butt,[81] H. R. Hoorani,[81] S. Khalid,[81] W. A. Khan,[81] T. Khurshid,[81] S. Qazi,[81] M. A. Shah,[81] M. Shoaib,[81] H. Bialkowska,[82] B. Boimska,[82] T. Frueboes,[82] R. Gokieli,[82] M. Górski,[82] M. Kazana,[82] K. Nawrocki,[82] K. Romanowska-Rybinska,[82] M. Szleper,[82] G. Wrochna,[82] P. Zalewski,[82] G. Brona,[83] K. Bunkowski,[83] M. Cwiok,[83] W. Dominik,[83] K. Doroba,[83] A. Kalinowski,[83] M. Konecki,[83] J. Krolikowski,[83] N. Almeida,[84] P. Bargassa,[84] A. David,[84] P. Faccioli,[84] P. G. Ferreira Parracho,[84] M. Gallinaro,[84] J. Seixas,[84] J. Varela,[84] P. Vischia,[84] I. Belotelov,[85] P. Bunin,[85] M. Gavrilenko,[85] I. Golutvin,[85] I. Gorbunov,[85] A. Kamenev,[85] V. Karjavin,[85] G. Kozlov,[85] A. Lanev,[85] A. Malakhov,[85] P. Moisenz,[85] V. Palichik,[85] V. Perelygin,[85] S. Shmatov,[85] V. Smirnov,[85] A. Volodko,[85] A. Zarubin,[85] S. Evstyukhin,[86] V. Golovtsov,[86] Y. Ivanov,[86] V. Kim,[86] P. Levchenko,[86] V. Murzin,[86] V. Oreshkin,[86] I. Smirnov,[86] V. Sulimov,[86] L. Uvarov,[86] S. Vavilov,[86] A. Vorobyev,[86] An. Vorobyev,[86] Yu. Andreev,[87] A. Dermenev,[87] S. Gninenko,[87] N. Golubev,[87] M. Kirsanov,[87] N. Krasnikov,[87] V. Matveev,[87] A. Pashenkov,[87] D. Tlisov,[87] A. Toropin,[87] V. Epshteyn,[88] M. Erofeeva,[88] V. Gavrilov,[88] M. Kossov,[88] N. Lychkovskaya,[88] V. Popov,[88] G. Safronov,[88] S. Semenov,[88] V. Stolin,[88] E. Vlasov,[88] A. Zhokin,[88] A. Belyaev,[89] E. Boos,[89] V. Bunichev,[89] M. Dubinin,[89,e] L. Dudko,[89] A. Gribushin,[89] V. Klyukhin,[89] O. Kodolova,[89] I. Lokhtin,[89] A. Markina,[89] S. Obraztsov,[89] M. Perfilov,[89] S. Petrushanko,[89] A. Popov,[89] L. Sarycheva,[89,a] V. Savrin,[89] A. Snigirev,[89] V. Andreev,[90] M. Azarkin,[90] I. Dremin,[90] M. Kirakosyan,[90] A. Leonidov,[90] G. Mesyats,[90] S. V. Rusakov,[90] A. Vinogradov,[90] I. Azhgirey,[91] I. Bayshev,[91] S. Bitioukov,[91] V. Grishin,[91,f] V. Kachanov,[91] D. Konstantinov,[91] V. Krychkine,[91] V. Petrov,[91] R. Ryutin,[91] A. Sobol,[91] L. Tourtchanovitch,[91] S. Troshin,[91] N. Tyurin,[91] A. Uzunian,[91] A. Volkov,[91] P. Adzic,[92,ee] M. Djordjevic,[92] M. Ekmedzic,[92] D. Krpic,[92,ee] J. Milosevic,[92] M. Aguilar-Benitez,[93] J. Alcaraz Maestre,[93] P. Arce,[93] C. Battilana,[93] E. Calvo,[93] M. Cerrada,[93] M. Chamizo Llatas,[93] N. Colino,[93] B. De La Cruz,[93] A. Delgado Peris,[93] D. Domínguez Vázquez,[93] C. Fernandez Bedoya,[93] J. P. Fernández Ramos,[93] A. Ferrando,[93] J. Flix,[93] M. C. Fouz,[93] P. Garcia-Abia,[93] O. Gonzalez Lopez,[93] S. Goy Lopez,[93] J. M. Hernandez,[93] M. I. Josa,[93] G. Merino,[93] J. Puerta Pelayo,[93] A. Quintario Olmeda,[93] I. Redondo,[93] L. Romero,[93] J. Santaolalla,[93] M. S. Soares,[93] C. Willmott,[93] C. Albajar,[94] G. Codispoti,[94] J. F. de Trocóniz,[94] H. Brun,[95] J. Cuevas,[95] J. Fernandez Menendez,[95] S. Folgueras,[95] I. Gonzalez Caballero,[95] L. Lloret Iglesias,[95] J. Piedra Gomez,[95] J. A. Brochero Cifuentes,[96] I. J. Cabrillo,[96] A. Calderon,[96] S. H. Chuang,[96] J. Duarte Campderros,[96] M. Felcini,[96,ff] M. Fernandez,[96] G. Gomez,[96] J. Gonzalez Sanchez,[96] A. Graziano,[96] C. Jorda,[96] A. Lopez Virto,[96] J. Marco,[96] R. Marco,[96] C. Martinez Rivero,[96] F. Matorras,[96] F. J. Munoz Sanchez,[96] T. Rodrigo,[96] A. Y. Rodríguez-Marrero,[96] A. Ruiz-Jimeno,[96] L. Scodellaro,[96] I. Vila,[96] R. Vilar Cortabitarte,[96] D. Abbaneo,[97] E. Auffray,[97] G. Auzinger,[97] M. Bachtis,[97] P. Baillon,[97] A. H. Ball,[97]

D. Barney,[97] J. F. Benitez,[97] C. Bernet,[97,g] G. Bianchi,[97] P. Bloch,[97] A. Bocci,[97] A. Bonato,[97] C. Botta,[97] H. Breuker,[97] T. Camporesi,[97] G. Cerminara,[97] T. Christiansen,[97] J. A. Coarasa Perez,[97] D. D'Enterria,[97] A. Dabrowski,[97] A. De Roeck,[97] S. Di Guida,[97] M. Dobson,[97] N. Dupont-Sagorin,[97] A. Elliott-Peisert,[97] B. Frisch,[97] W. Funk,[97] G. Georgiou,[97] M. Giffels,[97] D. Gigi,[97] K. Gill,[97] D. Giordano,[97] M. Girone,[97] M. Giunta,[97] F. Glege,[97] R. Gomez-Reino Garrido,[97] P. Govoni,[97] S. Gowdy,[97] R. Guida,[97] M. Hansen,[97] P. Harris,[97] C. Hartl,[97] J. Harvey,[97] B. Hegner,[97] A. Hinzmann,[97] V. Innocente,[97] P. Janot,[97] K. Kaadze,[97] E. Karavakis,[97] K. Kousouris,[97] P. Lecoq,[97] Y.-J. Lee,[97] P. Lenzi,[97] C. Lourenço,[97] N. Magini,[97] T. Mäki,[97] M. Malberti,[97] L. Malgeri,[97] M. Mannelli,[97] L. Masetti,[97] F. Meijers,[97] S. Mersi,[97] E. Meschi,[97] R. Moser,[97] M. U. Mozer,[97] M. Mulders,[97] P. Musella,[97] E. Nesvold,[97] T. Orimoto,[97] L. Orsini,[97] E. Palencia Cortezon,[97] E. Perez,[97] L. Perrozzi,[97] A. Petrilli,[97] A. Pfeiffer,[97] M. Pierini,[97] M. Pimiä,[97] D. Piparo,[97] G. Polese,[97] L. Quertenmont,[97] A. Racz,[97] W. Reece,[97] J. Rodrigues Antunes,[97] G. Rolandi,[97,gg] C. Rovelli,[97,hh] M. Rovere,[97] H. Sakulin,[97] F. Santanastasio,[97] C. Schäfer,[97] C. Schwick,[97] I. Segoni,[97] S. Sekmen,[97] A. Sharma,[97] P. Siegrist,[97] P. Silva,[97] M. Simon,[97] P. Sphicas,[97,ii] D. Spiga,[97] A. Tsirou,[97] G. I. Veres,[97,t] J. R. Vlimant,[97] H. K. Wöhri,[97] S. D. Worm,[97,jj] W. D. Zeuner,[97] W. Bertl,[98] K. Deiters,[98] W. Erdmann,[98] K. Gabathuler,[98] R. Horisberger,[98] Q. Ingram,[98] H. C. Kaestli,[98] S. König,[98] D. Kotlinski,[98] U. Langenegger,[98] F. Meier,[98] D. Renker,[98] T. Rohe,[98] L. Bäni,[99] P. Bortignon,[99] M. A. Buchmann,[99] B. Casal,[99] N. Chanon,[99] A. Deisher,[99] G. Dissertori,[99] M. Dittmar,[99] M. Donegà,[99] M. Dünser,[99] J. Eugster,[99] K. Freudenreich,[99] C. Grab,[99] D. Hits,[99] P. Lecomte,[99] W. Lustermann,[99] A. C. Marini,[99] P. Martinez Ruiz del Arbol,[99] N. Mohr,[99] F. Moortgat,[99] C. Nägeli,[99,kk] P. Nef,[99] F. Nessi-Tedaldi,[99] F. Pandolfi,[99] L. Pape,[99] F. Pauss,[99] M. Peruzzi,[99] F. J. Ronga,[99] M. Rossini,[99] L. Sala,[99] A. K. Sanchez,[99] A. Starodumov,[99,ll] B. Stieger,[99] M. Takahashi,[99] L. Tauscher,[99,a] A. Thea,[99] K. Theofilatos,[99] D. Treille,[99] C. Urscheler,[99] R. Wallny,[99] H. A. Weber,[99] L. Wehrli,[99] C. Amsler,[100,mm] V. Chiochia,[100] S. De Visscher,[100] C. Favaro,[100] M. Ivova Rikova,[100] B. Millan Mejias,[100] P. Otiougova,[100] P. Robmann,[100] H. Snoek,[100] S. Tupputi,[100] M. Verzetti,[100] Y. H. Chang,[101] K. H. Chen,[101] C. M. Kuo,[101] S. W. Li,[101] W. Lin,[101] Z. K. Liu,[101] Y. J. Lu,[101] D. Mekterovic,[101] A. P. Singh,[101] R. Volpe,[101] S. S. Yu,[101] P. Bartalini,[102] P. Chang,[102] Y. H. Chang,[102] Y. W. Chang,[102] Y. Chao,[102] K. F. Chen,[102] C. Dietz,[102] U. Grundler,[102] W.-S. Hou,[102] Y. Hsiung,[102] K. Y. Kao,[102] Y. J. Lei,[102] R.-S. Lu,[102] D. Majumder,[102] E. Petrakou,[102] X. Shi,[102] J. G. Shiu,[102] Y. M. Tzeng,[102] X. Wan,[102] M. Wang,[102] B. Asavapibhop,[103] N. Srimanobhas,[103] A. Adiguzel,[104] M. N. Bakirci,[104,nn] S. Cerci,[104,oo] C. Dozen,[104] I. Dumanoglu,[104] E. Eskut,[104] S. Girgis,[104] G. Gokbulut,[104] E. Gurpinar,[104] I. Hos,[104] E. E. Kangal,[104] T. Karaman,[104] G. Karapinar,[104,pp] A. Kayis Topaksu,[104] G. Onengut,[104] K. Ozdemir,[104] S. Ozturk,[104,qq] A. Polatoz,[104] K. Sogut,[104,rr] D. Sunar Cerci,[104,oo] B. Tali,[104,oo] H. Topakli,[104,nn] L. N. Vergili,[104] M. Vergili,[104] I. V. Akin,[105] T. Aliev,[105] B. Bilin,[105] S. Bilmis,[105] M. Deniz,[105] H. Gamsizkan,[105] A. M. Guler,[105] K. Ocalan,[105] A. Ozpineci,[105] M. Serin,[105] R. Sever,[105] U. E. Surat,[105] M. Yalvac,[105] E. Yildirim,[105] M. Zeyrek,[105] E. Gülmez,[106] B. Isildak,[106,ss] M. Kaya,[106,tt] O. Kaya,[106,tt] S. Ozkorucuklu,[106,uu] N. Sonmez,[106,vv] K. Cankocak,[107] L. Levchuk,[108] J. J. Brooke,[109] E. Clement,[109] D. Cussans,[109] H. Flacher,[109] R. Frazier,[109] J. Goldstein,[109] M. Grimes,[109] G. P. Heath,[109] H. F. Heath,[109] L. Kreczko,[109] S. Metson,[109] D. M. Newbold,[109,jj] K. Nirunpong,[109] A. Poll,[109] S. Senkin,[109] V. J. Smith,[109] T. Williams,[109] L. Basso,[110,ww] K. W. Bell,[110] A. Belyaev,[110,ww] C. Brew,[110] R. M. Brown,[110] D. J. A. Cockerill,[110] J. A. Coughlan,[110] K. Harder,[110] S. Harper,[110] J. Jackson,[110] B. W. Kennedy,[110] E. Olaiya,[110] D. Petyt,[110] B. C. Radburn-Smith,[110] C. H. Shepherd-Themistocleous,[110] I. R. Tomalin,[110] W. J. Womersley,[110] R. Bainbridge,[111] G. Ball,[111] R. Beuselinck,[111] O. Buchmuller,[111] D. Colling,[111] N. Cripps,[111] M. Cutajar,[111] P. Dauncey,[111] G. Davies,[111] M. Della Negra,[111] W. Ferguson,[111] J. Fulcher,[111] D. Futyan,[111] A. Gilbert,[111] A. Guneratne Bryer,[111] G. Hall,[111] Z. Hatherell,[111] J. Hays,[111] G. Iles,[111] M. Jarvis,[111] G. Karapostoli,[111] L. Lyons,[111] A.-M. Magnan,[111] J. Marrouche,[111] B. Mathias,[111] R. Nandi,[111] J. Nash,[111] A. Nikitenko,[111,ll] A. Papageorgiou,[111] J. Pela,[111] M. Pesaresi,[111] K. Petridis,[111] M. Pioppi,[111,xx] D. M. Raymond,[111] S. Rogerson,[111] A. Rose,[111] M. J. Ryan,[111] C. Seez,[111] P. Sharp,[111,a] A. Sparrow,[111] M. Stoye,[111] A. Tapper,[111] M. Vazquez Acosta,[111] T. Virdee,[111] S. Wakefield,[111] N. Wardle,[111] T. Whyntie,[111] M. Chadwick,[112] J. E. Cole,[112] P. R. Hobson,[112] A. Khan,[112] P. Kyberd,[112] D. Leggat,[112] D. Leslie,[112] W. Martin,[112] I. D. Reid,[112] P. Symonds,[112] L. Teodorescu,[112] M. Turner,[112] K. Hatakeyama,[113] H. Liu,[113] T. Scarborough,[113] O. Charaf,[114] C. Henderson,[114] P. Rumerio,[114] A. Avetisyan,[115] T. Bose,[115] C. Fantasia,[115] A. Heister,[115] J. St. John,[115] P. Lawson,[115] D. Lazic,[115] J. Rohlf,[115] D. Sperka,[115] L. Sulak,[115] J. Alimena,[116] S. Bhattacharya,[116] D. Cutts,[116] Z. Demiragli,[116] A. Ferapontov,[116] A. Garabedian,[116] U. Heintz,[116] S. Jabeen,[116] G. Kukartsev,[116] E. Laird,[116] G. Landsberg,[116] M. Luk,[116] M. Narain,[116] D. Nguyen,[116] M. Segala,[116] T. Sinthuprasith,[116] T. Speer,[116] K. V. Tsang,[116] R. Breedon,[117] G. Breto,[117]

M. Calderon De La Barca Sanchez,[117] S. Chauhan,[117] M. Chertok,[117] J. Conway,[117] R. Conway,[117] P. T. Cox,[117] J. Dolen,[117] R. Erbacher,[117] M. Gardner,[117] R. Houtz,[117] W. Ko,[117] A. Kopecky,[117] R. Lander,[117] O. Mall,[117] T. Miceli,[117] D. Pellett,[117] F. Ricci-tam,[117] B. Rutherford,[117] M. Searle,[117] J. Smith,[117] M. Squires,[117] M. Tripathi,[117] R. Vasquez Sierra,[117] R. Yohay,[117] V. Andreev,[118] D. Cline,[118] R. Cousins,[118] J. Duris,[118] S. Erhan,[118] P. Everaerts,[118] C. Farrell,[118] J. Hauser,[118] M. Ignatenko,[118] C. Jarvis,[118] C. Plager,[118] G. Rakness,[118] P. Schlein,[118,a] P. Traczyk,[118] V. Valuev,[118] M. Weber,[118] J. Babb,[119] R. Clare,[119] M. E. Dinardo,[119] J. Ellison,[119] J. W. Gary,[119] F. Giordano,[119] G. Hanson,[119] G. Y. Jeng,[119,yy] H. Liu,[119] O. R. Long,[119] A. Luthra,[119] H. Nguyen,[119] S. Paramesvaran,[119] J. Sturdy,[119] S. Sumowidagdo,[119] R. Wilken,[119] S. Wimpenny,[119] W. Andrews,[120] J. G. Branson,[120] G. B. Cerati,[120] S. Cittolin,[120] D. Evans,[120] F. Golf,[120] A. Holzner,[120] R. Kelley,[120] M. Lebourgeois,[120] J. Letts,[120] I. Macneill,[120] B. Mangano,[120] S. Padhi,[120] C. Palmer,[120] G. Petrucciani,[120] M. Pieri,[120] M. Sani,[120] V. Sharma,[120] S. Simon,[120] E. Sudano,[120] M. Tadel,[120] Y. Tu,[120] A. Vartak,[120] S. Wasserbaech,[120,zz] F. Würthwein,[120] A. Yagil,[120] J. Yoo,[120] D. Barge,[121] R. Bellan,[121] C. Campagnari,[121] M. D'Alfonso,[121] T. Danielson,[121] K. Flowers,[121] P. Geffert,[121] J. Incandela,[121] C. Justus,[121] P. Kalavase,[121] S. A. Koay,[121] D. Kovalskyi,[121] V. Krutelyov,[121] S. Lowette,[121] N. Mccoll,[121] V. Pavlunin,[121] F. Rebassoo,[121] J. Ribnik,[121] J. Richman,[121] R. Rossin,[121] D. Stuart,[121] W. To,[121] C. West,[121] A. Apresyan,[122] A. Bornheim,[122] Y. Chen,[122] E. Di Marco,[122] J. Duarte,[122] M. Gataullin,[122] Y. Ma,[122] A. Mott,[122] H. B. Newman,[122] C. Rogan,[122] M. Spiropulu,[122] V. Timciuc,[122] J. Veverka,[122] R. Wilkinson,[122] S. Xie,[122] Y. Yang,[122] R. Y. Zhu,[122] B. Akgun,[123] V. Azzolini,[123] A. Calamba,[123] R. Carroll,[123] T. Ferguson,[123] Y. Iiyama,[123] D. W. Jang,[123] Y. F. Liu,[123] M. Paulini,[123] H. Vogel,[123] I. Vorobiev,[123] J. P. Cumalat,[124] B. R. Drell,[124] W. T. Ford,[124] A. Gaz,[124] E. Luiggi Lopez,[124] J. G. Smith,[124] K. Stenson,[124] K. A. Ulmer,[124] S. R. Wagner,[124] J. Alexander,[125] A. Chatterjee,[125] N. Eggert,[125] L. K. Gibbons,[125] B. Heltsley,[125] A. Khukhunaishvili,[125] B. Kreis,[125] N. Mirman,[125] G. Nicolas Kaufman,[125] J. R. Patterson,[125] A. Ryd,[125] E. Salvati,[125] W. Sun,[125] W. D. Teo,[125] J. Thom,[125] J. Thompson,[125] J. Tucker,[125] J. Vaughan,[125] Y. Weng,[125] L. Winstrom,[125] P. Wittich,[125] D. Winn,[126] S. Abdullin,[127] M. Albrow,[127] J. Anderson,[127] L. A. T. Bauerdick,[127] A. Beretvas,[127] J. Berryhill,[127] P. C. Bhat,[127] I. Bloch,[127] K. Burkett,[127] J. N. Butler,[127] V. Chetluru,[127] H. W. K. Cheung,[127] F. Chlebana,[127] V. D. Elvira,[127] I. Fisk,[127] J. Freeman,[127] Y. Gao,[127] D. Green,[127] O. Gutsche,[127] J. Hanlon,[127] R. M. Harris,[127] J. Hirschauer,[127] B. Hooberman,[127] S. Jindariani,[127] M. Johnson,[127] U. Joshi,[127] B. Kilminster,[127] B. Klima,[127] S. Kunori,[127] S. Kwan,[127] C. Leonidopoulos,[127] J. Linacre,[127] D. Lincoln,[127] R. Lipton,[127] J. Lykken,[127] K. Maeshima,[127] J. M. Marraffino,[127] S. Maruyama,[127] D. Mason,[127] P. McBride,[127] K. Mishra,[127] S. Mrenna,[127] Y. Musienko,[127,aaa] C. Newman-Holmes,[127] V. O'Dell,[127] O. Prokofyev,[127] E. Sexton-Kennedy,[127] S. Sharma,[127] W. J. Spalding,[127] L. Spiegel,[127] L. Taylor,[127] S. Tkaczyk,[127] N. V. Tran,[127] L. Uplegger,[127] E. W. Vaandering,[127] R. Vidal,[127] J. Whitmore,[127] W. Wu,[127] F. Yang,[127] F. Yumiceva,[127] J. C. Yun,[127] D. Acosta,[128] P. Avery,[128] D. Bourilkov,[128] M. Chen,[128] T. Cheng,[128] S. Das,[128] M. De Gruttola,[128] G. P. Di Giovanni,[128] D. Dobur,[128] A. Drozdetskiy,[128] R. D. Field,[128] M. Fisher,[128] Y. Fu,[128] I. K. Furic,[128] J. Gartner,[128] J. Hugon,[128] B. Kim,[128] J. Konigsberg,[128] A. Korytov,[128] A. Kropivnitskaya,[128] T. Kypreos,[128] J. F. Low,[128] K. Matchev,[128] P. Milenovic,[128,bbb] G. Mitselmakher,[128] L. Muniz,[128] M. Park,[128] R. Remington,[128] A. Rinkevicius,[128] P. Sellers,[128] N. Skhirtladze,[128] M. Snowball,[128] J. Yelton,[128] M. Zakaria,[128] V. Gaultney,[129] S. Hewamanage,[129] L. M. Lebolo,[129] S. Linn,[129] P. Markowitz,[129] G. Martinez,[129] J. L. Rodriguez,[129] T. Adams,[130] A. Askew,[130] J. Bochenek,[130] J. Chen,[130] B. Diamond,[130] S. V. Gleyzer,[130] J. Haas,[130] S. Hagopian,[130] V. Hagopian,[130] M. Jenkins,[130] K. F. Johnson,[130] H. Prosper,[130] V. Veeraraghavan,[130] M. Weinberg,[130] M. M. Baarmand,[131] B. Dorney,[131] M. Hohlmann,[131] H. Kalakhety,[131] I. Vodopiyanov,[131] M. R. Adams,[132] I. M. Anghel,[132] L. Apanasevich,[132] Y. Bai,[132] V. E. Bazterra,[132] R. R. Betts,[132] I. Bucinskaite,[132] J. Callner,[132] R. Cavanaugh,[132] O. Evdokimov,[132] L. Gauthier,[132] C. E. Gerber,[132] D. J. Hofman,[132] S. Khalatyan,[132] F. Lacroix,[132] M. Malek,[132] C. O'Brien,[132] C. Silkworth,[132] D. Strom,[132] P. Turner,[132] N. Varelas,[132] U. Akgun,[133] E. A. Albayrak,[133] B. Bilki,[133,ccc] W. Clarida,[133] F. Duru,[133] J.-P. Merlo,[133] H. Mermerkaya,[133,ddd] A. Mestvirishvili,[133] A. Moeller,[133] J. Nachtman,[133] C. R. Newsom,[133] E. Norbeck,[133] Y. Onel,[133] F. Ozok,[133,eee] S. Sen,[133] P. Tan,[133] E. Tiras,[133] J. Wetzel,[133] T. Yetkin,[133] K. Yi,[133] B. A. Barnett,[134] B. Blumenfeld,[134] S. Bolognesi,[134] D. Fehling,[134] G. Giurgiu,[134] A. V. Gritsan,[134] Z. J. Guo,[134] G. Hu,[134] P. Maksimovic,[134] S. Rappoccio,[134] M. Swartz,[134] A. Whitbeck,[134] P. Baringer,[135] A. Bean,[135] G. Benelli,[135] R. P. Kenny Iii,[135] M. Murray,[135] D. Noonan,[135] S. Sanders,[135] R. Stringer,[135] G. Tinti,[135] J. S. Wood,[135] V. Zhukova,[135] A. F. Barfuss,[136] T. Bolton,[136] I. Chakaberia,[136] A. Ivanov,[136] S. Khalil,[136] M. Makouski,[136] Y. Maravin,[136] S. Shrestha,[136] I. Svintradze,[136] J. Gronberg,[137] D. Lange,[137] D. Wright,[137] A. Baden,[138] M. Boutemeur,[138] B. Calvert,[138] S. C. Eno,[138] J. A. Gomez,[138] N. J. Hadley,[138] R. G. Kellogg,[138]

M. Kirn,[138] T. Kolberg,[138] Y. Lu,[138] M. Marionneau,[138] A. C. Mignerey,[138] K. Pedro,[138] A. Skuja,[138] J. Temple,[138] M. B. Tonjes,[138] S. C. Tonwar,[138] E. Twedt,[138] A. Apyan,[139] G. Bauer,[139] J. Bendavid,[139] W. Busza,[139] E. Butz,[139] I. A. Cali,[139] M. Chan,[139] V. Dutta,[139] G. Gomez Ceballos,[139] M. Goncharov,[139] K. A. Hahn,[139] Y. Kim,[139] M. Klute,[139] K. Krajczar,[139,fff] P. D. Luckey,[139] T. Ma,[139] S. Nahn,[139] C. Paus,[139] D. Ralph,[139] C. Roland,[139] G. Roland,[139] M. Rudolph,[139] G. S. F. Stephans,[139] F. Stöckli,[139] K. Sumorok,[139] K. Sung,[139] D. Velicanu,[139] E. A. Wenger,[139] R. Wolf,[139] B. Wyslouch,[139] M. Yang,[139] Y. Yilmaz,[139] A. S. Yoon,[139] M. Zanetti,[139] S. I. Cooper,[140] B. Dahmes,[140] A. De Benedetti,[140] G. Franzoni,[140] A. Gude,[140] S. C. Kao,[140] K. Klapoetke,[140] Y. Kubota,[140] J. Mans,[140] N. Pastika,[140] R. Rusack,[140] M. Sasseville,[140] A. Singovsky,[140] N. Tambe,[140] J. Turkewitz,[140] L. M. Cremaldi,[141] R. Kroeger,[141] L. Perera,[141] R. Rahmat,[141] D. A. Sanders,[141] E. Avdeeva,[142] K. Bloom,[142] S. Bose,[142] D. R. Claes,[142] A. Dominguez,[142] M. Eads,[142] J. Keller,[142] I. Kravchenko,[142] J. Lazo-Flores,[142] H. Malbouisson,[142] S. Malik,[142] G. R. Snow,[142] A. Godshalk,[143] I. Iashvili,[143] S. Jain,[143] A. Kharchilava,[143] A. Kumar,[143] G. Alverson,[144] E. Barberis,[144] D. Baumgartel,[144] M. Chasco,[144] J. Haley,[144] D. Nash,[144] D. Trocino,[144] D. Wood,[144] J. Zhang,[144] A. Anastassov,[145] A. Kubik,[145] L. Lusito,[145] N. Mucia,[145] N. Odell,[145] R. A. Ofierzynski,[145] B. Pollack,[145] A. Pozdnyakov,[145] M. Schmitt,[145] S. Stoynev,[145] M. Velasco,[145] S. Won,[145] L. Antonelli,[146] D. Berry,[146] A. Brinkerhoff,[146] K. M. Chan,[146] M. Hildreth,[146] C. Jessop,[146] D. J. Karmgard,[146] J. Kolb,[146] K. Lannon,[146] W. Luo,[146] S. Lynch,[146] N. Marinelli,[146] D. M. Morse,[146] T. Pearson,[146] M. Planer,[146] R. Ruchti,[146] J. Slaunwhite,[146] N. Valls,[146] M. Wayne,[146] M. Wolf,[146] B. Bylsma,[147] L. S. Durkin,[147] C. Hill,[147] R. Hughes,[147] K. Kotov,[147] T. Y. Ling,[147] D. Puigh,[147] M. Rodenburg,[147] C. Vuosalo,[147] G. Williams,[147] B. L. Winer,[147] N. Adam,[148] E. Berry,[148] P. Elmer,[148] D. Gerbaudo,[148] V. Halyo,[148] P. Hebda,[148] J. Hegeman,[148] A. Hunt,[148] P. Jindal,[148] D. Lopes Pegna,[148] P. Lujan,[148] D. Marlow,[148] T. Medvedeva,[148] M. Mooney,[148] J. Olsen,[148] P. Piroué,[148] X. Quan,[148] A. Raval,[148] B. Safdi,[148] H. Saka,[148] D. Stickland,[148] C. Tully,[148] J. S. Werner,[148] A. Zuranski,[148] E. Brownson,[149] A. Lopez,[149] H. Mendez,[149] J. E. Ramirez Vargas,[149] E. Alagoz,[150] V. E. Barnes,[150] D. Benedetti,[150] G. Bolla,[150] D. Bortoletto,[150] M. De Mattia,[150] A. Everett,[150] Z. Hu,[150] M. Jones,[150] O. Koybasi,[150] M. Kress,[150] A. T. Laasanen,[150] N. Leonardo,[150] V. Maroussov,[150] P. Merkel,[150] D. H. Miller,[150] N. Neumeister,[150] I. Shipsey,[150] D. Silvers,[150] A. Svyatkovskiy,[150] M. Vidal Marono,[150] H. D. Yoo,[150] J. Zablocki,[150] Y. Zheng,[150] S. Guragain,[151] N. Parashar,[151] A. Adair,[152] C. Boulahouache,[152] K. M. Ecklund,[152] F. J. M. Geurts,[152] W. Li,[152] B. P. Padley,[152] R. Redjimi,[152] J. Roberts,[152] J. Zabel,[152] B. Betchart,[153] A. Bodek,[153] Y. S. Chung,[153] R. Covarelli,[153] P. de Barbaro,[153] R. Demina,[153] Y. Eshaq,[153] T. Ferbel,[153] A. Garcia-Bellido,[153] P. Goldenzweig,[153] J. Han,[153] A. Harel,[153] D. C. Miner,[153] D. Vishnevskiy,[153] M. Zielinski,[153] A. Bhatti,[154] R. Ciesielski,[154] L. Demortier,[154] K. Goulianos,[154] G. Lungu,[154] S. Malik,[154] C. Mesropian,[154] S. Arora,[155] A. Barker,[155] J. P. Chou,[155] C. Contreras-Campana,[155] E. Contreras-Campana,[155] D. Duggan,[155] D. Ferencek,[155] Y. Gershtein,[155] R. Gray,[155] E. Halkiadakis,[155] D. Hidas,[155] A. Lath,[155] S. Panwalkar,[155] M. Park,[155] R. Patel,[155] V. Rekovic,[155] J. Robles,[155] K. Rose,[155] S. Salur,[155] S. Schnetzer,[155] C. Seitz,[155] S. Somalwar,[155] R. Stone,[155] S. Thomas,[155] M. Walker,[155] G. Cerizza,[156] M. Hollingsworth,[156] S. Spanier,[156] Z. C. Yang,[156] A. York,[156] R. Eusebi,[157] W. Flanagan,[157] J. Gilmore,[157] T. Kamon,[157,ggg] V. Khotilovich,[157] R. Montalvo,[157] I. Osipenkov,[157] Y. Pakhotin,[157] A. Perloff,[157] J. Roe,[157] A. Safonov,[157] T. Sakuma,[157] S. Sengupta,[157] I. Suarez,[157] A. Tatarinov,[157] D. Toback,[157] N. Akchurin,[158] J. Damgov,[158] C. Dragoiu,[158] P. R. Dudero,[158] C. Jeong,[158] K. Kovitanggoon,[158] S. W. Lee,[158] T. Libeiro,[158] Y. Roh,[158] I. Volobouev,[158] E. Appelt,[159] A. G. Delannoy,[159] C. Florez,[159] S. Greene,[159] A. Gurrola,[159] W. Johns,[159] P. Kurt,[159] C. Maguire,[159] A. Melo,[159] M. Sharma,[159] P. Sheldon,[159] B. Snook,[159] S. Tuo,[159] J. Velkovska,[159] M. W. Arenton,[160] M. Balazs,[160] S. Boutle,[160] B. Cox,[160] B. Francis,[160] J. Goodell,[160] R. Hirosky,[160] A. Ledovskoy,[160] C. Lin,[160] C. Neu,[160] J. Wood,[160] S. Gollapinni,[161] R. Harr,[161] P. E. Karchin,[161] C. Kottachchi Kankanamge Don,[161] P. Lamichhane,[161] A. Sakharov,[161] M. Anderson,[162] D. Belknap,[162] L. Borrello,[162] D. Carlsmith,[162] M. Cepeda,[162] S. Dasu,[162] E. Friis,[162] L. Gray,[162] K. S. Grogg,[162] M. Grothe,[162] R. Hall-Wilton,[162] M. Herndon,[162] A. Hervé,[162] P. Klabbers,[162] J. Klukas,[162] A. Lanaro,[162] C. Lazaridis,[162] J. Leonard,[162] R. Loveless,[162] A. Mohapatra,[162] I. Ojalvo,[162] F. Palmonari,[162] G. A. Pierro,[162] I. Ross,[162] A. Savin,[162] W. H. Smith,[162] and J. Swanson[162]

(CMS Collaboration)

[1]*Yerevan Physics Institute, Yerevan, Armenia*
[2]*Institut für Hochenergiephysik der OeAW, Wien, Austria*
[3]*National Centre for Particle and High Energy Physics, Minsk, Belarus*

[4]Universiteit Antwerpen, Antwerpen, Belgium
[5]Vrije Universiteit Brussel, Brussel, Belgium
[6]Université Libre de Bruxelles, Bruxelles, Belgium
[7]Ghent University, Ghent, Belgium
[8]Université Catholique de Louvain, Louvain-la-Neuve, Belgium
[9]Université de Mons, Mons, Belgium
[10]Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil
[11]Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil
[12]Instituto de Fisica Teorica, Universidade Estadual Paulista, Sao Paulo, Brazil
[13]Institute for Nuclear Research and Nuclear Energy, Sofia, Bulgaria
[14]University of Sofia, Sofia, Bulgaria
[15]Institute of High Energy Physics, Beijing, China
[16]State Key Lab. of Nucl. Phys. and Tech., Peking University, Beijing, China
[17]Universidad de Los Andes, Bogota, Colombia
[18]Technical University of Split, Split, Croatia
[19]University of Split, Split, Croatia
[20]Institute Rudjer Boskovic, Zagreb, Croatia
[21]University of Cyprus, Nicosia, Cyprus
[22]Charles University, Prague, Czech Republic
[23]Academy of Scientific Research and Technology of the Arab Republic of Egypt,
Egyptian Network of High Energy Physics, Cairo, Egypt
[24]National Institute of Chemical Physics and Biophysics, Tallinn, Estonia
[25]Department of Physics, University of Helsinki, Helsinki, Finland
[26]Helsinki Institute of Physics, Helsinki, Finland
[27]Lappeenranta University of Technology, Lappeenranta, Finland
[28]DSM/IRFU, CEA/Saclay, Gif-sur-Yvette, France
[29]Laboratoire Leprince-Ringuet, Ecole Polytechnique, IN2P3-CNRS, Palaiseau, France
[30]Institut Pluridisciplinaire Hubert Curien, Université de Strasbourg,
Université de Haute Alsace Mulhouse, CNRS/IN2P3, Strasbourg, France
[31]Centre de Calcul de l'Institut National de Physique Nucleaire et de Physique des Particules,
CNRS/IN2P3, Villeurbanne, France, Villeurbanne, France
[32]Université de Lyon, Université Claude Bernard Lyon 1, CNRS-IN2P3,
Institut de Physique Nucléaire de Lyon, Villeurbanne, France
[33]E. Andronikashvili Institute of Physics, Academy of Science, Tbilisi, Georgia
[34]RWTH Aachen University, I. Physikalisches Institut, Aachen, Germany
[35]RWTH Aachen University, III. Physikalisches Institut A, Aachen, Germany
[36]RWTH Aachen University, III. Physikalisches Institut B, Aachen, Germany
[37]Deutsches Elektronen-Synchrotron, Hamburg, Germany
[38]University of Hamburg, Hamburg, Germany
[39]Institut für Experimentelle Kernphysik, Karlsruhe, Germany
[40]Institute of Nuclear Physics "Demokritos," Aghia Paraskevi, Greece
[41]University of Athens, Athens, Greece
[42]University of Ioánnina, Ioánnina, Greece
[43]KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary
[44]Institute of Nuclear Research ATOMKI, Debrecen, Hungary
[45]University of Debrecen, Debrecen, Hungary
[46]Panjab University, Chandigarh, India
[47]University of Delhi, Delhi, India
[48]Saha Institute of Nuclear Physics, Kolkata, India
[49]Bhabha Atomic Research Centre, Mumbai, India
[50]Tata Institute of Fundamental Research-EHEP, Mumbai, India
[51]Tata Institute of Fundamental Research-HECR, Mumbai, India
[52]Institute for Research in Fundamental Sciences (IPM), Tehran, Iran
[53a]INFN Sezione di Bari, Bari, Italy
[53b]Università di Bari, Bari, Italy
[53c]Politecnico di Bari, Bari, Italy
[54a]INFN Sezione di Bologna, Bologna, Italy
[54b]Università di Bologna, Bologna, Italy
[55a]INFN Sezione di Catania, Catania, Italy
[55b]Università di Catania, Catania, Italy
[56a]INFN Sezione di Firenze, Firenze, Italy

[56b]*Università di Firenze, Firenze, Italy*
[57]*INFN Laboratori Nazionali di Frascati, Frascati, Italy*
[58a]*INFN Sezione di Genova, Genova, Italy*
[58b]*Università di Genova, Genova, Italy*
[59a]*INFN Sezione di Milano-Bicocca, Milano, Italy*
[59b]*Università di Milano-Bicocca, Milano, Italy*
[60a]*INFN Sezione di Napoli, Napoli, Italy*
[60b]*Università di Napoli "Federico II," Napoli, Italy*
[61a]*INFN Sezione di Padova, Padova, Italy*
[61b]*Università di Padova, Padova, Italy*
[61c]*Università di Trento (Trento), Padova, Italy*
[62a]*INFN Sezione di Pavia, Pavia, Italy*
[62b]*Università di Pavia, Pavia, Italy*
[63a]*INFN Sezione di Perugia, Perugia, Italy*
[63b]*Università di Perugia, Perugia, Italy*
[64a]*INFN Sezione di Pisa, Pisa, Italy*
[64b]*Università di Pisa, Pisa, Italy*
[64c]*Scuola Normale Superiore di Pisa, Pisa, Italy*
[65a]*INFN Sezione di Roma, Roma, Italy*
[65b]*Università di Roma "La Sapienza," Roma, Italy*
[66a]*INFN Sezione di Torino, Torino, Italy*
[66b]*Università di Torino, Torino, Italy*
[66c]*Università del Piemonte Orientale (Novara), Torino, Italy*
[67a]*INFN Sezione di Trieste, Trieste, Italy*
[67b]*Università di Trieste, Trieste, Italy*
[68]*Kangwon National University, Chunchon, Korea*
[69]*Kyungpook National University, Daegu, Korea*
[70]*Chonnam National University, Institute for Universe and Elementary Particles, Kwangju, Korea*
[71]*Korea University, Seoul, Korea*
[72]*University of Seoul, Seoul, Korea*
[73]*Sungkyunkwan University, Suwon, Korea*
[74]*Vilnius University, Vilnius, Lithuania*
[75]*Centro de Investigacion y de Estudios Avanzados del IPN, Mexico City, Mexico*
[76]*Universidad Iberoamericana, Mexico City, Mexico*
[77]*Benemerita Universidad Autonoma de Puebla, Puebla, Mexico*
[78]*Universidad Autónoma de San Luis Potosí, San Luis Potosí, Mexico*
[79]*University of Auckland, Auckland, New Zealand*
[80]*University of Canterbury, Christchurch, New Zealand*
[81]*National Centre for Physics, Quaid-I-Azam University, Islamabad, Pakistan*
[82]*National Centre for Nuclear Research, Swierk, Poland*
[83]*Institute of Experimental Physics, Faculty of Physics, University of Warsaw, Warsaw, Poland*
[84]*Laboratório de Instrumentação e Física Experimental de Partículas, Lisboa, Portugal*
[85]*Joint Institute for Nuclear Research, Dubna, Russia*
[86]*Petersburg Nuclear Physics Institute, Gatchina (St. Petersburg), Russia*
[87]*Institute for Nuclear Research, Moscow, Russia*
[88]*Institute for Theoretical and Experimental Physics, Moscow, Russia*
[89]*Moscow State University, Moscow, Russia*
[90]*P.N. Lebedev Physical Institute, Moscow, Russia*
[91]*State Research Center of Russian Federation, Institute for High Energy Physics, Protvino, Russia*
[92]*University of Belgrade, Faculty of Physics and Vinca Institute of Nuclear Sciences, Belgrade, Serbia*
[93]*Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), Madrid, Spain*
[94]*Universidad Autónoma de Madrid, Madrid, Spain*
[95]*Universidad de Oviedo, Oviedo, Spain*
[96]*Instituto de Física de Cantabria (IFCA), CSIC-Universidad de Cantabria, Santander, Spain*
[97]*CERN, European Organization for Nuclear Research, Geneva, Switzerland*
[98]*Paul Scherrer Institut, Villigen, Switzerland*
[99]*Institute for Particle Physics, ETH Zurich, Zurich, Switzerland*
[100]*Universität Zürich, Zurich, Switzerland*
[101]*National Central University, Chung-Li, Taiwan*
[102]*National Taiwan University (NTU), Taipei, Taiwan*
[103]*Chulalongkorn University, Bangkok, Thailand*

[104]Cukurova University, Adana, Turkey
[105]Middle East Technical University, Physics Department, Ankara, Turkey
[106]Bogazici University, Istanbul, Turkey
[107]Istanbul Technical University, Istanbul, Turkey
[108]National Scientific Center, Kharkov Institute of Physics and Technology, Kharkov, Ukraine
[109]University of Bristol, Bristol, United Kingdom
[110]Rutherford Appleton Laboratory, Didcot, United Kingdom
[111]Imperial College, London, United Kingdom
[112]Brunel University, Uxbridge, United Kingdom
[113]Baylor University, Waco, Texas, USA
[114]The University of Alabama, Tuscaloosa, Alabama, USA
[115]Boston University, Boston, Massachusetts, USA
[116]Brown University, Providence, Rhode Island, USA
[117]University of California, Davis, Davis, California, USA
[118]University of California, Los Angeles, Los Angeles, California, USA
[119]University of California, Riverside, Riverside, California, USA
[120]University of California, San Diego, La Jolla, California, USA
[121]University of California, Santa Barbara, Santa Barbara, California, USA
[122]California Institute of Technology, Pasadena, California, USA
[123]Carnegie Mellon University, Pittsburgh, Pennsylvania, USA
[124]University of Colorado at Boulder, Boulder, Colorado, USA
[125]Cornell University, Ithaca, New York, USA
[126]Fairfield University, Fairfield, Connecticut, USA
[127]Fermi National Accelerator Laboratory, Batavia, Illinois, USA
[128]University of Florida, Gainesville, Florida, USA
[129]Florida International University, Miami, Florida, USA
[130]Florida State University, Tallahassee, Florida, USA
[131]Florida Institute of Technology, Melbourne, Florida, USA
[132]University of Illinois at Chicago (UIC), Chicago, Illinois, USA
[133]The University of Iowa, Iowa City, Iowa, USA
[134]Johns Hopkins University, Baltimore, USA
[135]The University of Kansas, Lawrence, Kansas, USA
[136]Kansas State University, Manhattan, Kansas, USA
[137]Lawrence Livermore National Laboratory, Livermore, California, USA
[138]University of Maryland, College Park, Maryland, USA
[139]Massachusetts Institute of Technology, Cambridge, Massachusetts, USA
[140]University of Minnesota, Minneapolis, Minnesota, USA
[141]University of Mississippi, Oxford, Mississippi, USA
[142]University of Nebraska-Lincoln, Lincoln, Nebraska, USA
[143]State University of New York at Buffalo, Buffalo, New York, USA
[144]Northeastern University, Boston, Massachusetts, USA
[145]Northwestern University, Evanston, Illinois, USA
[146]University of Notre Dame, Notre Dame, Indiana, USA
[147]The Ohio State University, Columbus, Ohio, USA
[148]Princeton University, Princeton, New Jersey, USA
[149]University of Puerto Rico, Mayaguez, Puerto Rico, USA
[150]Purdue University, West Lafayette, Indiana, USA
[151]Purdue University Calumet, Hammond, Indiana, USA
[152]Rice University, Houston, Texas, USA
[153]University of Rochester, Rochester, New York, USA
[154]The Rockefeller University, New York, New York, USA
[155]Rutgers, the State University of New Jersey, Piscataway, New Jersey, USA
[156]University of Tennessee, Knoxville, Tennessee, USA
[157]Texas A&M University, College Station, Texas, USA
[158]Texas Tech University, Lubbock, Texas, USA
[159]Vanderbilt University, Nashville, Tennessee, USA
[160]University of Virginia, Charlottesville, Virginia, USA
[161]Wayne State University, Detroit, Michigan, USA
[162]University of Wisconsin, Madison, Wisconsin, USA

[a]Deceased.
[b]Also at Vienna University of Technology, Vienna, Austria.
[c]Also at National Institute of Chemical Physics and Biophysics, Tallinn, Estonia.
[d]Also at Universidade Federal do ABC, Santo Andre, Brazil.
[e]Also at California Institute of Technology, Pasadena, USA.
[f]Also at CERN, European Organization for Nuclear Research, Geneva, Switzerland.
[g]Also at Laboratoire Leprince-Ringuet, Ecole Polytechnique, IN2P3-CNRS, Palaiseau, France.
[h]Also at Suez Canal University, Suez, Egypt.
[i]Also at Zewail City of Science and Technology, Zewail, Egypt.
[j]Also at Cairo University, Cairo, Egypt.
[k]Also at Fayoum University, El-Fayoum, Egypt.
[l]Also at British University, Cairo, Egypt.
[m]Also at Ain Shams University, Cairo, Egypt.
[n]Also at National Centre for Nuclear Research, Swierk, Poland.
[o]Also at Université de Haute Alsace, Strasbourg, France.
[p]Also at Moscow State University, Moscow, Russia.
[q]Also at Brandenburg University of Technology, Cottbus, Germany.
[r]Also at The University of Kansas, Lawrence, USA.
[s]Also at Institute of Nuclear Research ATOMKI, Debrecen, Hungary.
[t]Also at Eötvös Loránd University, Budapest, Hungary.
[u]Also at Tata Institute of Fundamental Research - HECR, Mumbai, India.
[v]Also at University of Visva-Bharati, Santiniketan, India.
[w]Also at Sharif University of Technology, Tehran, Iran.
[x]Also at Isfahan University of Technology, Isfahan, Iran.
[y]Also at Plasma Physics Research Center, Science and Research Branch, Islamic Azad University, Tehran, Iran.
[z]Also at Facoltà Ingegneria Università di Roma, Roma, Italy.
[aa]Also at Università della Basilicata, Potenza, Italy.
[bb]Also at Università degli Studi Guglielmo Marconi, Roma, Italy.
[cc]Also at Università degli Studi di Siena, Siena, Italy.
[dd]Also at University of Bucharest, Faculty of Physics, Bucuresti-Magurele, Romania.
[ee]Also at Faculty of Physics of University of Belgrade, Belgrade, Serbia.
[ff]Also at University of California, Los Angeles, Los Angeles, California, USA.
[gg]Also at Scuola Normale e Sezione dell' INFN, Pisa, Italy.
[hh]Also at INFN Sezione di Roma, Università di Roma "La Sapienza," Roma, Italy.
[ii]Also at University of Athens, Athens, Greece.
[jj]Also at Rutherford Appleton Laboratory, Didcot, United Kingdom.
[kk]Also at Paul Scherrer Institut, Villigen, Switzerland.
[ll]Also at Institute for Theoretical and Experimental Physics, Moscow, Russia.
[mm]Also at Albert Einstein Center for Fundamental Physics, Bern, Switzerland.
[nn]Also at Gaziosmanpasa University, Tokat, Turkey.
[oo]Also at Adiyaman University, Adiyaman, Turkey.
[pp]Also at Izmir Institute of Technology, Izmir, Turkey.
[qq]Also at The University of Iowa, Iowa City, USA.
[rr]Also at Mersin University, Mersin, Turkey.
[ss]Also at Ozyegin University, Istanbul, Turkey.
[tt]Also at Kafkas University, Kars, Turkey.
[uu]Also at Suleyman Demirel University, Isparta, Turkey.
[vv]Also at Ege University, Izmir, Turkey.
[ww]Also at School of Physics and Astronomy, University of Southampton, Southampton, United Kingdom.
[xx]Also at INFN Sezione di Perugia, Università di Perugia, Perugia, Italy.
[yy]Also at University of Sydney, Sydney, Australia.
[zz]Also at Utah Valley University, Orem, USA.
[aaa]Also at Institute for Nuclear Research, Moscow, Russia.
[bbb]Also at University of Belgrade, Faculty of Physics and Vinca Institute of Nuclear Sciences, Belgrade, Serbia.
[ccc]Also at Argonne National Laboratory, Argonne, USA.

[ddd]Also at Erzincan University, Erzincan, Turkey.
[eee]Also at Mimar Sinan University, Istanbul, Istanbul, Turkey.
[fff]Also at KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary.
[ggg]Also at Kyungpook National University, Daegu, Korea.