



UvA-DARE (Digital Academic Repository)

Search for a Standard Model Higgs Boson in the $H \rightarrow ZZ \rightarrow \ell + \ell - \nu \bar{\nu}$ Decay Channel with the ATLAS Detector

Aad, G.; et al., [Unknown]; Bentvelsen, S.; Colijn, A.P.; de Jong, P.; de Nooij, L.; Doxiadis, A.D.; Ferrari, P.; Garitaonandia, H.; Geerts, D.A.A.; Gosselink, M.; Kayl, M.S.; Koffeman, E.; Lee, H.; Linde, F.; Mechnich, J.; Mussche, I.; Ottersbach, J.P.; Tsiakiris, M.; van der Kraaij, E.; van der Leeuw, R.; van Kesteren, Z.; van Vulpen, I.; Vermeulen, J.C.; Vreeswijk, M.

DOI

[10.1103/PhysRevLett.107.221802](https://doi.org/10.1103/PhysRevLett.107.221802)

Publication date

2011

Document Version

Final published version

Published in

Physical Review Letters

[Link to publication](#)

Citation for published version (APA):

Aad, G., et al., U., Bentvelsen, S., Colijn, A. P., de Jong, P., de Nooij, L., Doxiadis, A. D., Ferrari, P., Garitaonandia, H., Geerts, D. A. A., Gosselink, M., Kayl, M. S., Koffeman, E., Lee, H., Linde, F., Mechnich, J., Mussche, I., Ottersbach, J. P., Tsiakiris, M., ... Vreeswijk, M. (2011). Search for a Standard Model Higgs Boson in the $H \rightarrow ZZ \rightarrow \ell + \ell - \nu \bar{\nu}$ Decay Channel with the ATLAS Detector. *Physical Review Letters*, 107(22), [221802]. <https://doi.org/10.1103/PhysRevLett.107.221802>

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library, <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

Search for a Standard Model Higgs Boson in the $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ Decay Channel with the ATLAS Detector

G. Aad *et al.**

(ATLAS Collaboration)

(Received 15 September 2011; published 22 November 2011)

A search for a heavy standard model Higgs boson decaying via $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$, where $\ell = e, \mu$, is presented. It is based on proton-proton collision data at $\sqrt{s} = 7$ TeV, collected by the ATLAS experiment at the LHC in the first half of 2011 and corresponding to an integrated luminosity of 1.04 fb^{-1} . The data are compared to the expected standard model backgrounds. The data and the background expectations are found to be in agreement and upper limits are placed on the Higgs boson production cross section over the entire mass window considered; in particular, the production of a standard model Higgs boson is excluded in the region $340 < m_H < 450$ GeV at the 95% confidence level.

DOI: [10.1103/PhysRevLett.107.221802](https://doi.org/10.1103/PhysRevLett.107.221802)

PACS numbers: 14.80.Bn, 13.85.Rm

The search for the standard model (SM) Higgs boson [1–3] is one of the most important aspects of the Large Hadron Collider (LHC) physics program. Direct searches at the CERN LEP e^+e^- collider have set a lower limit of 114.4 GeV on the Higgs boson mass, m_H , at 95% confidence level [4]. Searches by the CDF and D0 experiments at the Fermilab Tevatron $p\bar{p}$ collider have explored the mass range up to 200 GeV and exclude the additional region $156 < m_H < 177$ GeV [5]. For m_H greater than twice the Z boson mass, m_Z , a significant fraction of Higgs bosons decay to two Z bosons. The $ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ decay channel offers a substantial branching fraction in combination with a good separation from potential background processes owing to the high transverse momentum, p_T , of the electron or muon pair from the leptonic Z decay and the high missing transverse momentum, E_T^{miss} , from the Z decaying to neutrinos.

The first cross section limits for a SM Higgs boson in the mass region $200 < m_H < 600$ GeV were set by the ATLAS and CMS collaborations in Refs. [6,7]. This letter extends the $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ results therein, with a 30-fold increase in the integrated luminosity, as well as a significant improvement in the event reconstruction and background rejection.

The data sample considered in this search was recorded by the ATLAS experiment during the first half of the 2011 LHC run at a center-of-mass energy $\sqrt{s} = 7$ TeV. The integrated luminosity of the data sample, considering only data-taking periods where all relevant detector subsystems were operational, is 1.04 fb^{-1} .

The ATLAS detector has been described elsewhere [8]. Simulated signal and background event samples are produced with Monte Carlo (MC) event generators, passed through a full GEANT4 [9] simulation of the ATLAS detector [10] and reconstructed with the same reconstruction software as the data.

$H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ ($\ell = e, \mu, \tau$) events are modeled using the POWHEG [11,12] event generator, which includes matrix elements for the gluon fusion and the vector-boson fusion production mechanisms of the Higgs boson up to next-to-leading order. POWHEG is interfaced to PYTHIA [13] for the modelling of parton showers. The Higgs boson p_T spectrum is reweighted to the calculation of Ref. [14], which provides QCD corrections up to next-to-leading order and QCD soft-gluon resummations up to next-to-next-to-leading logarithms. An alternative sample of signal events is produced using the PYTHIA event generator, which includes only leading order matrix elements. In both cases PHOTOS [15] is used to model final-state radiation and TAUOLA [16] for the simulation of τ decays.

$H \rightarrow ZZ \rightarrow \ell^+ \ell^- \ell^+ \ell^-$ and $H \rightarrow ZZ \rightarrow \ell^+ \ell^- q \bar{q}$ samples are also simulated using the same generators as for the $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ samples, while $H \rightarrow W^+ W^- \rightarrow \ell^+ \nu \ell^- \bar{\nu}$ events are produced using the MC@NLO generator [17], interfaced to HERWIG [18] and JIMMY [19] in the gluon fusion channel and the SHERPA [20] generator in the vector-boson fusion channel. These channels contribute to the signal yield and are considered as part of the signal. In particular, $H \rightarrow W^+ W^- \rightarrow \ell^+ \nu \ell^- \bar{\nu}$ decays contribute as much as 77% to the signal expectation after the full selection for $m_H = 200$ GeV decreasing to 13% at $m_H = 300$ GeV. Independence of the analysis with respect to other ATLAS Higgs boson searches [21–23] is ensured through mutually exclusive selection requirements on the dilepton invariant mass, the number of leptons or the event missing transverse momentum.

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

The cross sections for Higgs boson production, the associated branching fractions [24], as well as their uncertainties, are compiled in Ref. [25]. They correspond to next-to-next-to-leading order in QCD for the gluon fusion [26–31] and the vector-boson fusion [32] processes. In addition, QCD soft-gluon resummations up to next-to-next-to-leading logarithms are available for the gluon fusion process [33], while next-to-leading order electroweak corrections are applied to both the gluon fusion [34,35] and the vector-boson fusion [36,37] processes. These cross section calculations do not account for the width of the Higgs boson, which is implemented through an *ad hoc* Breit-Wigner line shape applied at the event generator level. Recent studies [25,38] have indicated that effects due to off-shell Higgs boson production and interference with other SM processes may become sizeable at the highest masses ($m_H > 400$ GeV) considered in this search. In the absence of a full calculation, a conservative estimate of the possible size of such effects was made and the impact on the obtained limits in this channel was found to be less than 2% for $m_H = 400$ GeV growing to about 25% at $m_H = 600$ GeV.

Different event generators are chosen to model a range of important background processes. The ALPGEN generator [39] interfaced with HERWIG for parton showers and hadronisation is used to simulate W/Z + jets backgrounds. MC@NLO, interfaced to HERWIG and JIMMY, is used for the production of top-pair, single top and diboson (WW , WZ and ZZ) backgrounds. PYTHIA is used to simulate $b\bar{b}$ and $c\bar{c}$ samples as well as alternative samples for the Z and ZZ backgrounds. All simulated background samples are scaled to the highest available precision calculations for the relevant process. An overview of the used predictions and their uncertainties is given in Ref. [40].

Data used for the search in the electron and muon channels were collected primarily using single lepton triggers with p_T thresholds of 20 and 18 GeV, respectively. The expected trigger efficiency is close to 100% in the electron channel and about 95% in the muon channel for signal events passing all the selection criteria described below.

Electron candidates are reconstructed from electromagnetic calorimeter clusters, with shapes consistent with those expected from electromagnetic showers, matched to tracks reconstructed in the inner detector. Details of the electron reconstruction and identification can be found in Ref. [41]. The electron candidates are required to pass the standard ATLAS “medium” selection criteria and have $p_T > 20$ GeV and pseudorapidity $|\eta| < 2.47$.

Muons are identified by reconstructing tracks in the muon spectrometer. These tracks are then extrapolated back to the beam line to find a matching inner detector track. Details of muon reconstruction and identification can be found in Ref. [41]. Only muons with $p_T > 20$ GeV and $|\eta| < 2.5$ are considered.

Jets are used in this analysis to reject backgrounds from events with heavy quark decays or from events with fake E_T^{miss} due to mismeasured jets. For this purpose jets are reconstructed from clusters of energy deposits in the calorimeters using the anti- k_r algorithm [42] with a radius parameter $R = 0.4$. Only jets with $p_T > 25$ GeV and $|\eta| < 2.5$ are considered.

To remove leptons associated with jets, such as those originating from semileptonic decays of b hadrons, leptons are not considered in the analysis if the sum of inner detector track momenta in a cone $\Delta R < 0.2$ around the lepton direction is greater than 10% of the p_T of the lepton itself or if the lepton is within a distance $\Delta R < 0.4$ of the nearest jet.

The missing transverse momentum is measured as the (negative) vectorial sum of the transverse momenta of all clusters in the calorimeters within $|\eta| < 4.5$ and all selected muons in the event. Calorimeter deposits associated with muons are subtracted to avoid double counting.

Events are required to contain a reconstructed primary vertex formed from at least 3 tracks and exactly two oppositely charged electrons or muons, consistent with originating from the primary vertex. The dilepton mass distribution is shown in Fig. 1. Inclusive Z boson production is the dominant background at this stage of the analysis. To suppress backgrounds from top, W , and QCD multijet production, the dilepton invariant mass, $m_{\ell\ell}$, is required to satisfy $|m_Z - m_{\ell\ell}| < 15$ GeV.

To reduce the background from events with fake E_T^{miss} due to mismeasured jets, events are rejected if the azimuthal angle between the missing transverse momentum vector, \vec{p}_T^{miss} , and the leading jet in the event satisfies $\Delta\phi(\vec{p}_T^{\text{miss}}, \vec{p}_T^{\text{jet}}) < 0.3$. To reduce the background from top quark production, events with one or more b -tagged jets are rejected, where the b tagging is based on a single

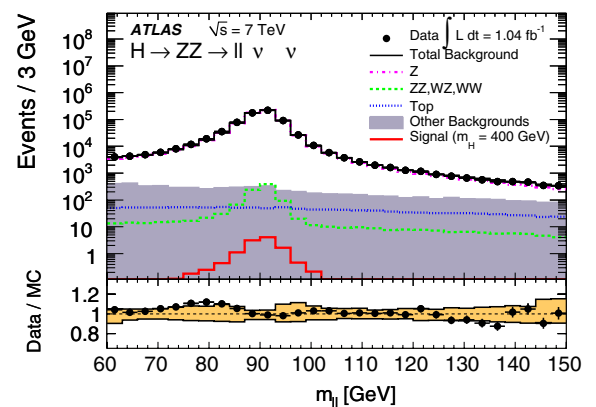


FIG. 1 (color online). The dilepton invariant mass distribution for events with exactly two oppositely charged electrons or muons. The inset at the bottom of the figure shows the ratio between the data and the combined background expectations as well as a band corresponding to the combined systematic uncertainties of the analysis.

discriminant combining information from both the impact parameter with respect to the primary vertex of tracks associated to the jet and the presence of displaced secondary vertices associated to the jet's tracks. The chosen cut achieves an efficiency of about 70% for identifying real b jets, with a light-quark jet rejection of about 80 [43].

To exploit the mass dependent kinematic features of $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ production, the search is subdivided into a low Higgs boson mass ($m_H < 280$ GeV) and a high Higgs boson mass ($m_H \geq 280$ GeV) search region, where dedicated cuts are applied to two important discriminating variables used to reduce the background contributions: E_T^{miss} and the azimuthal angle between the two leptons, $\Delta\phi(\ell, \ell)$. Figure 2 shows the distributions of these variables after the application of the $m_{\ell\ell}$ window cut. Since inclusive Z production gives rise to a steeply falling E_T^{miss} distribution, systematic uncertainties on the E_T^{miss} reconstruction are particularly important to estimate this background correctly. The dominant contributions to the E_T^{miss} uncertainty come from the knowledge of the jet energy scale and the modelling of inclusive Z production. Figure 2 shows that a good agreement within systematic uncertainties is observed between data and the combined background expectation. In the low m_H region, events are required to satisfy $E_T^{\text{miss}} > 66$ GeV, while in the high m_H region the requirement is $E_T^{\text{miss}} > 82$ GeV. These cuts reduce significantly the backgrounds from processes with no or modest genuine missing transverse momentum originating from unobserved neutrinos.

The boost of the Z bosons originating from a Higgs boson decay increases with m_H , thus reducing the expected opening angle between the leptons. In the low m_H region this boost is expected to be modest and a cut $1 < \Delta\phi(\ell, \ell) < 2.64$ is applied. In the high m_H region an upper limit $\Delta\phi(\ell, \ell) < 2.25$ is required.

Finally, in the high m_H region, events are also rejected if the azimuthal angle between the missing transverse momentum vector and the direction of the $Z \rightarrow \ell\ell$ boson candidate is $\Delta\phi(\vec{p}_T^{\text{miss}}, \vec{p}_T^{\ell\ell}) < 1$. The efficiency of the

event selection is very similar in the electron and muon channels, ranging from 3% for $m_H = 200$ GeV to about 48% for $m_H = 600$ GeV.

SM pair production of Z bosons has a final state identical to the signal, and is therefore expected to survive most of the applied selection criteria and form a continuum in the transverse mass distribution (defined below). The normalization for this background is obtained from a calculation including next-to-leading order terms [44] with an additional 6% term to account for missing quark-box diagrams ($gg \rightarrow ZZ$) [45]. A 11% normalization uncertainty is assigned to this background, estimated from scale, PDF and model uncertainties. WW and WZ backgrounds are normalized in a similar way.

The background from inclusive Z production is derived from MC, after checking that the simulation describes well the data in samples selected by requiring the presence of a lepton pair. The background from top events is also taken from the MC prediction. This prediction is verified to agree with data, within systematic uncertainties, in two independent control samples: the first one requires at least one identified b -jet, while the second selects events containing electron-muon pairs.

Additional backgrounds can arise from QCD multijet events or inclusive W production due to heavy flavour decays or jets faking leptons. The normalization of the W background is obtained from the ratio between data and MC in control samples of like-sign electron-electron and electron-muon events with high E_T^{miss} . The QCD multijet background in the electron channel is determined using a data sample based on a loosened electron selection, thus dominated by jets; this sample is scaled to describe the tails of the $m_{\ell\ell}$ distribution. In the muon channel, the background from heavy flavour decays is studied using simulation, whereas other muon sources from multijet events are constrained using a sample of like-sign muon pairs in data. In both cases the background is found to be negligible.

The signal efficiencies and overall background expectations are similar in the electron and the muon channels,

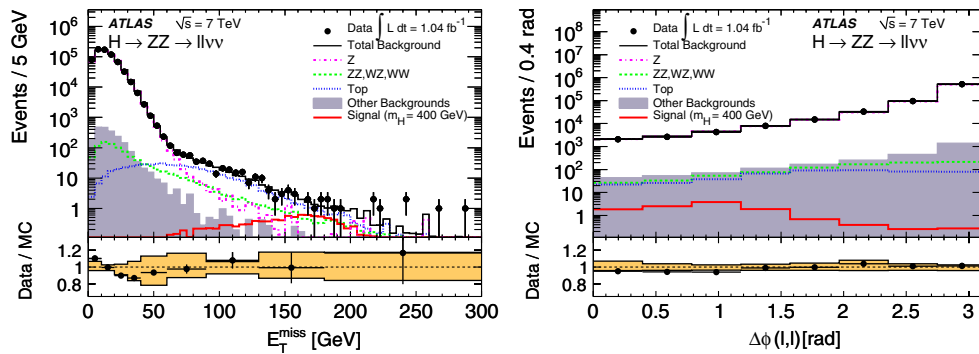


FIG. 2 (color online). The E_T^{miss} (left) and $\Delta\phi(\ell, \ell)$ (right) distributions for events with exactly two oppositely charged electrons or muons inside the Z mass window. The insets at the bottom show the ratio between data and the combined background expectations as well as a band corresponding to the combined systematic uncertainties of the analysis.

therefore only combined results are presented. The numbers of candidate $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ events selected in data and the expected yields from signal and background processes are shown in Table I.

The systematic uncertainties include experimental uncertainties related to the selection and calibration of electrons, muons, jets and b jets, which are also explicitly propagated to the E_T^{miss} calculation. Shape uncertainties for the signal and for the single Z and ZZ backgrounds are estimated using PYTHIA as an alternative MC generator.

Normalization uncertainties for signal (gluon fusion $+14\%$ and VBF 4%) and diboson backgrounds (11%) are obtained from theory [25]; uncertainties for the inclusive Z boson production (2.5%), top quark production (9%), inclusive W boson production (100%) and QCD multijet production in the electron channel (50%) are estimated from data. A 3.7% luminosity uncertainty [46] is included for those processes for which the normalization is not obtained from the data. The dominant systematic uncertainties in the analysis are the E_T^{miss} uncertainties for the Z background, the b -tagging uncertainty for the top background and the normalization uncertainties for the signal and the W and diboson backgrounds.

After the event selection, the Higgs boson search is performed by looking for an excess of data over the SM background expectation in the transverse mass distribution of the selected $ee\nu\nu$ and $\mu\mu\nu\nu$ events. The transverse mass is calculated from the lepton pair and the \vec{p}_T^{miss} vector as

$$m_T^2 \equiv \left[\sqrt{m_Z^2 + |\vec{p}_T^{\ell\ell}|^2} + \sqrt{m_Z^2 + |\vec{p}_T^{\text{miss}}|^2} \right]^2 - [\vec{p}_T^{\ell\ell} + \vec{p}_T^{\text{miss}}]^2.$$

TABLE I. The expected number of background and signal events for the Higgs boson search in the $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ channel, along with the observed numbers of candidates in data, for an integrated luminosity of 1.04 fb^{-1} . The quoted uncertainties are statistical and systematic, respectively. Signal to background ratios are also given for various masses (see text).

Source	low m_H search	high m_H search
Z	$19.1 \pm 2.6 \pm 0.9$	$6.0 \pm 1.4 \pm 1.8$
W	$8.5 \pm 2.3 \pm 8.5$	$3.1 \pm 1.0 \pm 3.1$
top	$29.9 \pm 1.3 \pm 6.0$	$14.9 \pm 0.8 \pm 3.1$
multijet	$0.4 \pm 0.4 \pm 0.2$	$0.0 \pm 0.0 \pm 0.0$
ZZ	$17.6 \pm 0.4 \pm 2.1$	$14.7 \pm 0.4 \pm 1.7$
WZ	$16.7 \pm 0.6 \pm 2.0$	$12.1 \pm 0.5 \pm 1.4$
WW	$12.4 \pm 0.4 \pm 1.5$	$4.6 \pm 0.3 \pm 0.5$
Total	$104.6 \pm 3.8 \pm 16.0$	$55.3 \pm 2.0 \pm 7.8$
Data	85	47
m_H (GeV)	Signal expectation	s/b
200	$5.0 \pm 0.1 \pm 0.9$	7%
300		$10.2 \pm 0.2 \pm 1.8$
400		$10.0 \pm 0.2 \pm 1.7$
500		$4.5 \pm 0.1 \pm 0.8$
600		$1.8 \pm 0.0 \pm 0.3$

Figure 3 shows the m_T distribution in the high m_H search region. Signal to background ratios for different m_H values, determined in a m_T window defined to enclose 95% of the corresponding signal events, are listed in Table I.

The number and distribution of candidate $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ events observed in the data agree with the expected backgrounds within the uncertainties, with no indication of an excess. Upper limits are set on the Higgs boson production cross section relative to its predicted SM value as a function of m_H . The limits are extracted from a maximum likelihood fit to the m_T distribution following the CL_s modified frequentist formalism with the profile likelihood test statistic [47,48]. All systematic uncertainties are taken into account.

Figure 4 shows the expected and observed limits at the 95% confidence level. The expected limit is lowest around $m_H = 380 \text{ GeV}$ where it is 1.1 times the SM Higgs boson cross section. Fluctuations in the background can lead to better or worse expected limits. Over the entire mass range the observed limits agree with the expectations within the $\pm 2\sigma$ band. A SM Higgs boson in the range $340 \text{ GeV} < m_H < 450 \text{ GeV}$ is excluded at the 95% confidence level.

In summary, results of a search for a heavy SM Higgs boson with a mass in the range $200 < m_H < 600 \text{ GeV}$ decaying to $ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ have been presented. These results are based on a data sample corresponding to an integrated luminosity of 1.04 fb^{-1} , recorded with the ATLAS detector at the LHC. No evidence for a signal is observed and cross section limits are placed over the entire mass range, excluding the production of a SM Higgs boson in the region $340 < m_H < 450 \text{ GeV}$ at the 95% confidence level.

We thank CERN for the very successful operation of the LHC, as well as the support staff from our institutions without whom ATLAS could not be operated efficiently. We acknowledge the support of ANPCyT, Argentina;

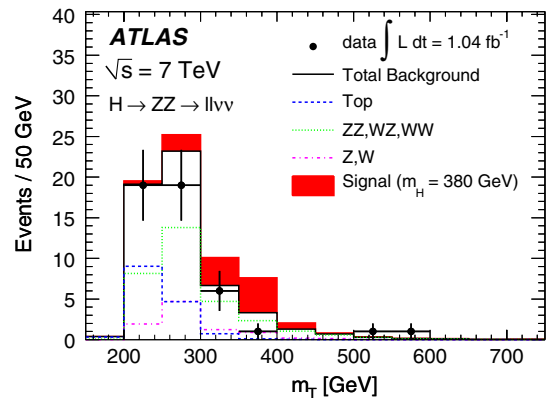


FIG. 3 (color online). The transverse mass distribution of $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$ candidates in the high m_H search region for the data (dots), the expected backgrounds (histograms) and a Higgs boson of mass 380 GeV (filled histogram). The electron and muon channels are combined.

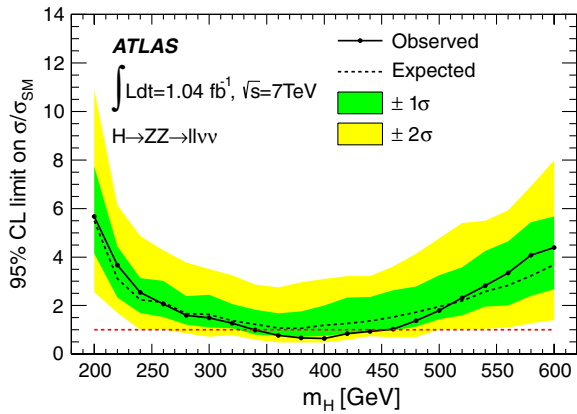


FIG. 4 (color online). Observed and expected 95% confidence level upper limits on the Higgs boson production cross section divided by the SM prediction. The green and yellow bands indicate the $\pm 1\sigma$ and $\pm 2\sigma$ fluctuations, respectively, around the median sensitivity. The limits are based on 1.04 fb^{-1} of data at $\sqrt{s} = 7 \text{ TeV}$.

YerPhI, Armenia; ARC, Australia; BMWF, Austria; ANAS, Azerbaijan; SSTC, Belarus; CNPq and FAPESP, Brazil; NSERC, NRC and CFI, Canada; CERN; CONICYT, Chile; CAS, MOST and NSFC, China; COLCIENCIAS, Colombia; MSMT CR, MPO CR and VSC CR, Czech Republic; DNRF, DNSRC and Lundbeck Foundation, Denmark; ARTEMIS, European Union; IN2P3-CNRS, CEA-DSM/IRFU, France; GNAS, Georgia; BMBF, DFG, HGF, MPG and AvH Foundation, Germany; GSRT, Greece; ISF, MINERVA, GIF, DIP and Benoziyo Center, Israel; INFN, Italy; MEXT and JSPS, Japan; CNRST, Morocco; FOM and NWO, Netherlands; RCN, Norway; MNiSW, Poland; GRICES and FCT, Portugal; MERYS (MECTS), Romania; MES of Russia and ROSATOM, Russian Federation; JINR; MSTD, Serbia; MSSR, Slovakia; ARRS and MVZT, Slovenia; DST/NRF, South Africa; MICINN, Spain; SRC and Wallenberg Foundation, Sweden; SER, SNSF and Cantons of Bern and Geneva, Switzerland; NSC, Taiwan; TAEK, Turkey; STFC, the Royal Society and Leverhulme Trust, United Kingdom; DOE and NSF, United States of America. The crucial computing support from all WLCG partners is acknowledged gratefully, in particular, from CERN and the ATLAS Tier-1 facilities at TRIUMF (Canada), NDGF (Denmark, Norway, Sweden), CC-IN2P3 (France), KIT/GridKA (Germany), INFN-CNAF (Italy), NL-T1 (Netherlands), PIC (Spain), ASGC (Taiwan), RAL (UK) and BNL (USA) and in the Tier-2 facilities worldwide.

[1] F. Englert and R. Brout, *Phys. Rev. Lett.* **13**, 321 (1964).
 [2] P. W. Higgs, *Phys. Rev. Lett.* **13**, 508 (1964).
 [3] G. S. Guralnik, C. R. Hagen, and T. W. B. Kibble, *Phys. Rev. Lett.* **13**, 585 (1964).

[4] LEP Working Group for Higgs boson searches, *Phys. Lett. B* **565**, 61 (2003).
 [5] CDF and D0 Collaborations, arXiv:1107.5518.
 [6] ATLAS Collaboration, *Eur. Phys. J. C* **71**, 1728 (2011).
 [7] CMS Collaboration, *Phys. Lett. B* **699**, 25 (2011).
 [8] ATLAS Collaboration, *JINST* **3**, S08003 (2008).
 [9] S. Agostinelli *et al.* (GEANT4 Collaboration), *Nucl. Instrum. Methods Phys. Res., Sect. A* **506**, 250 (2003).
 [10] ATLAS Collaboration, *Eur. Phys. J. C* **70**, 823 (2010).
 [11] S. Alioli, P. Nason, C. Oleari, and E. Re, *J. High Energy Phys.* **04** (2009) 002.
 [12] P. Nason and C. Oleari, *J. High Energy Phys.* **02** (2010) 037.
 [13] T. Sjöstrand *et al.*, *J. High Energy Phys.* **05** (2006) 026.
 [14] G. Bozzi, S. Catani, D. de Florian and M. Grazzini, *Nucl. Phys.* **B737**, 73 (2006).
 [15] P. Golonka and Z. Was, *Eur. Phys. J. C* **45**, 97 (2006).
 [16] Z. Was, *Nucl. Phys. B, Proc. Suppl.* **98**, 96 (2001).
 [17] S. Frixione and B. Webber, *J. High Energy Phys.* **06** (2002) 029.
 [18] G. Corcella *et al.*, *J. High Energy Phys.* **01** (2001) 010.
 [19] J. M. Butterworth, J. R. Forshaw, and M. H. Seymour, *Z. Phys. C* **72**, 637 (1996).
 [20] T. Gleisberg *et al.*, *J. High Energy Phys.* **02** (2009) 007.
 [21] ATLAS Collaboration, Report No. ATLAS-CONF-2011-134, 2011.
 [22] ATLAS Collaboration, Report No. ATLAS-CONF-2011-131, 2011.
 [23] ATLAS Collaboration, arXiv:1108.5064 [Phys. Lett. B (to be published)].
 [24] A. Djouadi, J. Kalinowski, and M. Spira, *Comput. Phys. Commun.* **108**, 56 (1998).
 [25] LHC Higgs Cross Section Working Group, S. Dittmaier, C. Mariotti, G. Passarino, and R. Tanaka (Eds.), Report No. CERN-2011-002, 2011).
 [26] R. V. Harlander and W. B. Kilgore, *Phys. Rev. Lett.* **88**, 201801 (2002).
 [27] C. Anastasiou and K. Melnikov, *Nucl. Phys.* **B646**, 220 (2002).
 [28] V. Ravindran, J. Smith, and W. L. van Neerven, *Nucl. Phys.* **B665**, 325 (2003).
 [29] C. Anastasiou, R. Boughezal, and F. Petriello, *J. High Energy Phys.* **04** (2009) 003.
 [30] D. de Florian and M. Grazzini, *Phys. Lett. B* **674**, 291 (2009).
 [31] J. Baglio and A. Djouadi, *J. High Energy Phys.* **03** (2011) 055.
 [32] P. Bolzoni, F. Maltoni, S.-O. Moch and M. Zaro, *Phys. Rev. Lett.* **105**, 011801 (2010).
 [33] S. Catani, D. de Florian, M. Grazzini, and P. Nason, *J. High Energy Phys.* **07** (2003) 028.
 [34] U. Aglietti, R. Bonciani, G. Degrossi, and A. Vicini, *Phys. Lett. B* **595**, 432 (2004).
 [35] S. Actis, G. Passarino, C. Sturm, and S. Uccirati, *Phys. Lett. B* **670**, 12 (2008).
 [36] M. Ciccolini, A. Denner, and S. Dittmaier, *Phys. Rev. Lett.* **99**, 161803 (2007).
 [37] M. Ciccolini, A. Denner, and S. Dittmaier, *Phys. Rev. D* **77**, 013002 (2008).

- [38] C. Anastasiou, S. Buehler, F. Herzog, and A. Lazopoulos, [arXiv:1107.0683](#).
- [39] M. L. Mangano *et al.*, *J. High Energy Phys.* **07** (2003) 001.
- [40] ATLAS Collaboration, Report No. ATLAS-CONF-2011-042, 2011.
- [41] ATLAS Collaboration, *J. High Energy Phys.* **12** (2010) 060.
- [42] M. Cacciari, G. P. Salam, and G. Soyez, *J. High Energy Phys.* **04** (2008) 063.
- [43] ATLAS Collaboration, Report No. ATLAS-CONF-2011-102, 2011.
- [44] J. M. Campbell and R. K. Ellis, *Phys. Rev. D* **60**, 113006 (1999).
- [45] T. Binoth, N. Kauer, and P. Mertsch, [arXiv:0807.0024](#).
- [46] ATLAS Collaboration, Report No. ATLAS-CONF-2011-116, 2011.
- [47] A. L. Read, *J. Phys. G* **28**, 2693 (2002).
- [48] G. Cowan *et al.*, *Eur. Phys. J. C* **71**, 1554 (2011).

G. Aad,⁴⁷ B. Abbott,¹¹⁰ J. Abdallah,¹¹ A. A. Abdelalim,⁴⁸ A. Abdesselam,¹¹⁷ O. Abdinov,¹⁰ B. Abi,¹¹¹ M. Abolins,⁸⁷ H. Abramowicz,¹⁵² H. Abreu,¹¹⁴ E. Acerbi,^{88a,88b} B. S. Acharya,^{163a,163b} D. L. Adams,²⁴ T. N. Addy,⁵⁵ J. Adelman,¹⁷⁴ M. Aderholz,⁹⁸ S. Adomeit,⁹⁷ P. Adragna,⁷⁴ T. Adye,¹²⁸ S. Aefsky,²² J. A. Aguilar-Saavedra,^{123b,a} M. Aharrouche,⁸⁰ S. P. Ahlen,²¹ F. Ahles,⁴⁷ A. Ahmad,^{a147} M. Ahsan,⁴⁰ G. Aielli,^{132a,131b} T. Akdogan,^{18a} T. P. A. Åkesson,⁷⁸ G. Akimoto,¹⁵⁴ A. V. Akimov,⁹³ A. Akiyama,⁶⁶ M. S. Alam,¹ M. A. Alam,⁷⁵ J. Albert,¹⁶⁸ S. Albrand,⁵⁴ M. Aleksa,²⁹ I. N. Aleksandrov,⁶⁴ F. Alessandria,^{88a} C. Alexa,^{25a} G. Alexander,¹⁵² G. Alexandre,⁴⁸ T. Alexopoulos,⁹ M. Alhroob,²⁰ M. Aliev,¹⁵ G. Alimonti,^{88a} J. Alison,¹¹⁹ M. Aliyev,¹⁰ P. P. Allport,⁷² S. E. Allwood-Spiers,⁵² J. Almond,⁸¹ A. Aloisio,^{101a,101b} R. Alon,¹⁷⁰ A. Alonso,⁷⁸ M. G. Alviggi,^{101a,101b} K. Amako,⁶⁵ P. Amaral,²⁹ C. Amelung,²² V. V. Ammosov,¹²⁷ A. Amorim,^{123a,b} G. Amorós,¹⁶⁶ N. Amram,¹⁵² C. Anastopoulos,²⁹ L. S. Ancu,¹⁶ N. Andari,¹¹⁴ T. Andeen,³⁴ C. F. Anders,²⁰ G. Anders,^{57a} K. J. Anderson,³⁰ A. Andreazza,^{88a,88b} V. Andrei,^{57a} M-L. Andrieux,⁵⁴ X. S. Anduaga,⁶⁹ A. Angerami,³⁴ F. Anghinolfi,²⁹ N. Anjos,^{123a} A. Annovi,⁴⁶ A. Antonaki,⁸ M. Antonelli,⁴⁶ A. Antonov,⁹⁵ J. Antos,^{143b} F. Anulli,^{131a} S. Aoun,⁸² L. Aperio Bella,⁴ R. Apolle,^{117,c} G. Arabidze,⁸⁷ I. Aracena,¹⁴² Y. Arai,⁶⁵ A. T. H. Arce,⁴⁴ J. P. Archambault,²⁸ S. Arfaoui,^{29,d} J-F. Arguin,¹⁴ E. Arik,^{18a,e} M. Arik,^{18a} A. J. Armbruster,⁸⁶ O. Arnaez,⁸⁰ C. Arnault,¹¹⁴ A. Artamonov,⁹⁴ G. Artoni,^{131a,132b} D. Arutinov,²⁰ S. Asai,¹⁵⁴ R. Asfandiyarov,¹⁷¹ S. Ask,²⁷ B. Åsman,^{145a,145b} L. Asquith,⁵ K. Assamagan,²⁴ A. Astbury,¹⁶⁸ A. Astvatsaturov,⁵¹ G. Atoian,¹⁷⁴ B. Aubert,⁴ E. Auge,¹¹⁴ K. Augsten,¹²⁶ M. Aourousseau,^{144a} N. Austin,⁷² G. Avolio,¹⁶² R. Avramidou,⁹ D. Axen,¹⁶⁷ C. Ay,⁵³ G. Azuelos,^{92,f} Y. Azuma,¹⁵⁴ M. A. Baak,²⁹ G. Baccaglioni,^{88a} C. Bacci,^{133a,133b} A. M. Bach,¹⁴ H. Bachacou,¹³⁵ K. Bachas,²⁹ G. Bachy,²⁹ M. Backes,⁴⁸ M. Backhaus,²⁰ E. Badescu,^{25a} P. Bagnaia,^{131a,131b} S. Bahinipati,² Y. Bai,³³ D. C. Bailey,¹⁵⁷ T. Bain,¹⁵⁷ J. T. Baines,¹²⁸ O. K. Baker,¹⁷⁴ M. D. Baker,²⁴ S. Baker,⁷⁶ E. Banas,³⁸ P. Banerjee,⁹² Sw. Banerjee,¹⁷¹ D. Banfi,²⁹ A. Bangert,¹³⁶ V. Bansal,¹⁶⁸ H. S. Bansil,¹⁷ L. Barak,¹⁷⁰ S. P. Baranov,⁹³ A. Barashkou,⁶⁴ A. Barbaro Galtieri,¹⁴ T. Barber,²⁷ E. L. Barberio,⁸⁵ D. Barberis,^{49a,49b} M. Barbero,²⁰ D. Y. Bardin,⁶⁴ T. Barillari,⁹⁸ M. Barisonzi,¹⁷³ T. Barklow,¹⁴² N. Barlow,²⁷ B. M. Barnett,¹²⁸ R. M. Barnett,¹⁴ A. Baroncelli,^{133a} G. Barone,⁴⁸ A. J. Barr,¹¹⁷ F. Barreiro,⁷⁹ J. Barreiro Guimarães da Costa,⁵⁶ P. Barrillon,¹¹⁴ R. Bartoldus,¹⁴² A. E. Barton,⁷⁰ D. Bartsch,²⁰ V. Bartsch,^{a148} R. L. Bates,⁵² L. Batkova,^{143a} J. R. Batley,²⁷ A. Battaglia,¹⁶ M. Battistin,²⁹ G. Battistoni,^{88a} F. Bauer,¹³⁵ H. S. Bawa,^{142,g} B. Beare,¹⁵⁷ T. Beau,⁷⁷ P. H. Beauchemin,¹¹⁷ R. Beccherle,^{49a} P. Bechtel,⁴¹ H. P. Beck,¹⁶ M. Beckingham,⁴⁷ K. H. Becks,¹⁷³ A. J. Beddall,^{18c} A. Beddall,^{18c} S. Bedikian,¹⁷⁴ V. A. Bednyakov,⁶⁴ C. P. Bee,⁸² M. Begel,²⁴ S. Behar Harpaz,¹⁵¹ P. K. Behera,⁶² M. Beimforde,⁹⁸ C. Belanger-Champagne,⁸⁴ P. J. Bell,⁴⁸ W. H. Bell,⁴⁸ G. Bella,¹⁵² L. Bellagamba,^{19a} F. Bellina,²⁹ M. Bellomo,²⁹ A. Belloni,⁵⁶ O. Beloborodova,¹⁰⁶ K. Belotskiy,⁹⁵ O. Beltramello,²⁹ S. Ben Ami,¹⁵¹ O. Benary,¹⁵² D. Benchekroun,^{134a} C. Benchouk,⁸² M. Bendel,⁸⁰ N. Benekos,¹⁶⁴ Y. Benhammou,¹⁵² D. P. Benjamin,⁴⁴ M. Benoit,¹¹⁴ J. R. Bensinger,²² K. Benslama,¹²⁹ S. Bentvelsen,¹⁰⁴ D. Berge,²⁹ E. Bergeas Kuutmann,⁴¹ N. Berger,⁴ F. Berghaus,¹⁶⁸ E. Berglund,⁴⁸ J. Beringer,¹⁴ K. Bernardet,⁸² P. Bernat,⁷⁶ R. Bernhard,⁴⁷ C. Bernius,²⁴ T. Berry,⁷⁵ A. Bertin,^{19a,19b} F. Bertinelli,²⁹ F. Bertolucci,^{121a,121b} M. I. Besana,^{88a,88b} N. Besson,¹³⁵ S. Bethke,⁹⁸ W. Bhimji,⁴⁵ R. M. Bianchi,²⁹ M. Bianco,^{71a,71b} O. Biebel,⁹⁷ S. P. Bieniek,⁷⁶ K. Bierwagen,⁵³ J. Biesiada,¹⁴ M. Biglietti,^{133a,133b} H. Bilokon,⁴⁶ M. Bindi,^{19a,19b} S. Binet,¹¹⁴ A. Bingul,^{18c} C. Bini,^{131a,131b} C. Biscarat,¹⁷⁶ U. Bitenc,⁴⁷ K. M. Black,²¹ R. E. Blair,⁵ J.-B. Blanchard,¹¹⁴ G. Blanchot,²⁹ T. Blazek,^{143a} C. Blocker,²² J. Blocki,³⁸ A. Blondel,⁴⁸ W. Blum,⁸⁰ U. Blumenschein,⁵³ G. J. Bobbink,¹⁰⁴ V. B. Bobrovnikov,¹⁰⁶ S. S. Bocchetta,⁷⁸ A. Bocci,⁴⁴ C. R. Boddy,¹¹⁷ M. Boehler,⁴¹ J. Boek,¹⁷³ N. Boelaert,³⁵ S. Böser,⁷⁶ J. A. Bogaerts,²⁹ A. Bogdanchikov,¹⁰⁶ A. Bogouch,^{89,e} C. Bohm,^{145a} V. Boisvert,⁷⁵ T. Bold,^{162,h} V. Boldea,^{25a} N. M. Bolnet,¹³⁵ M. Bona,⁷⁴ V. G. Bondarenko,⁹⁵ M. Bondioli,¹⁶² M. Boonekamp,¹³⁵ G. Boorman,⁷⁵ C. N. Booth,¹³⁸ S. Bordononi,⁷⁷ C. Borer,¹⁶ A. Borisov,¹²⁷ G. Borissov,⁷⁰ I. Borjanovic,^{12a} S. Borroni,⁸⁶ K. Bos,¹⁰⁴ D. Boscherini,^{19a} M. Bosman,¹¹ H. Boterenbrood,¹⁰⁴ D. Botterill,¹²⁸ J. Bouchami,⁹² J. Boudreau,¹²²

E. V. Bouhova-Thacker,⁷⁰ C. Bourdarios,¹¹⁴ N. Bousson,⁸² A. Boveia,³⁰ J. Boyd,²⁹ I. R. Boyko,⁶⁴ N. I. Bozhko,¹²⁷ I. Bozovic-Jelisavcic,^{12b} J. Bracinik,¹⁷ A. Braem,²⁹ P. Branchini,^{133a} G. W. Brandenburg,⁵⁶ A. Brandt,⁷ G. Brandt,¹⁵ O. Brandt,⁵³ U. Bratzler,¹⁵⁵ B. Brau,⁸³ J. E. Brau,¹¹³ H. M. Braun,¹⁷³ B. Breljer,¹⁵⁷ J. Bremer,²⁹ R. Brenner,¹⁶⁵ S. Bressler,¹⁵¹ D. Breton,¹¹⁴ D. Britton,⁵² F. M. Brochu,²⁷ I. Brock,²⁰ R. Brock,⁸⁷ T. J. Brodbeck,⁷⁰ E. Brodet,¹⁵² F. Broggi,^{88a} C. Bromberg,⁸⁷ G. Brooijmans,³⁴ W. K. Brooks,^{31b} G. Brown,⁸¹ H. Brown,⁷ P. A. Bruckman de Renstrom,³⁸ D. Bruncko,^{143b} R. Bruneliere,⁴⁷ S. Brunet,⁶⁰ A. Bruni,^{19a} G. Bruni,^{19a} M. Bruschi,^{19a} T. Buanes,¹³ F. Bucci,⁴⁸ J. Buchanan,¹¹⁷ N. J. Buchanan,² P. Buchholz,¹⁴⁰ R. M. Buckingham,¹¹⁷ A. G. Buckley,⁴⁵ S. I. Buda,^{25a} I. A. Budagov,⁶⁴ B. Budick,¹⁰⁷ V. Büscher,⁸⁰ L. Bugge,¹¹⁶ D. Buirra-Clark,¹¹⁷ O. Bulekov,⁹⁵ M. Bunse,⁴² T. Buran,¹¹⁶ H. Burckhart,²⁹ S. Burdin,⁷² T. Burgess,¹³ S. Burke,¹²⁸ E. Busato,³³ P. Bussey,⁵² C. P. Buszello,¹⁶⁵ F. Butin,²⁹ B. Butler,¹⁴² J. M. Butler,²¹ C. M. Buttar,⁵² J. M. Butterworth,⁷⁶ W. Buttinger,²⁷ T. Byatt,⁷⁶ S. Cabrera Urbán,¹⁶⁶ D. Caforio,^{19a,19b} O. Cakir,^{3a} P. Calafiura,¹⁴ G. Calderini,⁷⁷ P. Calfayan,⁹⁷ R. Calkins,¹⁰⁵ L. P. Caloba,^{23a} R. Caloi,^{131a,131b} D. Calvet,³³ S. Calvet,³³ R. Camacho Toro,³³ P. Camarri,^{132a,132b} M. Cambiaghi,^{118a,118b} D. Cameron,¹¹⁶ S. Campana,²⁹ M. Campanelli,⁷⁶ V. Canale,^{101a,101b} F. Canelli,^{30,i} A. Canepa,^{158a} J. Cantero,⁷⁹ L. Capasso,^{101a,101b} M. D. M. Capeans Garrido,²⁹ I. Caprini,^{25a} M. Caprini,^{25a} D. Capriotti,⁹⁸ M. Capua,^{36a,36b} R. Caputo,^{a147} R. Cardarelli,^{132a} T. Carli,²⁹ G. Carlino,^{101a} L. Carminati,^{88a,88b} B. Caron,^{158a} S. Caron,⁴⁷ G. D. Carrillo Montoya,¹⁷¹ A. A. Carter,⁷⁴ J. R. Carter,²⁷ J. Carvalho,^{123a,j} D. Casadei,¹⁰⁷ M. P. Casado,¹¹ M. Cascella,^{121a,121b} C. Caso,^{49a,49b,e} A. M. Castaneda Hernandez,¹⁷¹ E. Castaneda-Miranda,¹⁷¹ V. Castillo Gimenez,¹⁶⁶ N. F. Castro,^{123a} G. Cataldi,^{71a} F. Cataneo,²⁹ A. Catinaccio,²⁹ J. R. Catmore,⁷⁰ A. Cattai,²⁹ G. Cattani,^{132a,131b} S. Caughron,⁸⁷ D. Cauz,^{163a,163c} P. Cavalleri,⁷⁷ D. Cavalli,^{88a} M. Cavalli-Sforza,¹¹ V. Cavasinni,^{121a,121b} F. Ceradini,^{133a,133b} A. S. Cerqueira,^{23a} A. Cerri,²⁹ L. Cerrito,⁷⁴ F. Cerutti,⁴⁶ S. A. Cetin,^{18b} F. Cevenini,^{101a,101b} A. Chafaq,^{134a} D. Chakraborty,¹⁰⁵ K. Chan,² B. Chapleau,⁸⁴ J. D. Chapman,²⁷ J. W. Chapman,⁸⁶ E. Chareyre,⁷⁷ D. G. Charlton,¹⁷ V. Chavda,⁸¹ C. A. Chavez Barajas,²⁹ S. Cheatham,⁸⁴ S. Chekanov,⁵ S. V. Chekulaev,^{158a} G. A. Chelkov,⁶⁴ M. A. Chelstowska,¹⁰³ C. Chen,⁶³ H. Chen,²⁴ S. Chen,^{32c} T. Chen,^{32c} X. Chen,¹⁷¹ S. Cheng,^{32a} A. Cheplakov,⁶⁴ V. F. Chepurinov,⁶⁴ R. Cherkaoui El Moursli,^{134e} V. Chernyatin,²⁴ E. Cheu,⁶ S. L. Cheung,¹⁵⁷ L. Chevalier,¹³⁵ G. Chiefari,^{101a,101b} L. Chikovani,^{50a} J. T. Childers,^{57a} A. Chilingarov,⁷⁰ G. Chiodini,^{71a} M. V. Chizhov,⁶⁴ G. Choudalakis,³⁰ S. Chouridou,¹³⁶ I. A. Christidi,⁷⁶ A. Christov,⁴⁷ D. Chromek-Burckhart,²⁹ M. L. Chu,¹⁵⁰ J. Chudoba,¹²⁴ G. Ciapetti,^{131a,131b} K. Ciba,³⁷ A. K. Ciftci,^{3a} R. Ciftci,^{3a} D. Cinca,³³ V. Cindro,⁷³ M. D. Ciobotaru,¹⁶² C. Ciocca,^{19a,19b} A. Ciocio,¹⁴ M. Cirilli,⁸⁶ M. Ciubancan,^{25a} A. Clark,⁴⁸ P. J. Clark,⁴⁵ W. Cleland,¹²² J. C. Clemens,⁸² B. Clement,⁵⁴ C. Clement,^{145a,145b} R. W. Clifft,¹²⁸ Y. Coadou,⁸² M. Cobal,^{163a,163c} A. Cocco,^{49a,49b} J. Cochran,⁶³ P. Coe,¹¹⁷ J. G. Cogan,¹⁴² J. Coggeshall,¹⁶⁴ E. Cogneras,¹⁷⁶ C. D. Cojocar,²⁸ J. Colas,⁴ A. P. Colijn,¹⁰⁴ C. Collard,¹¹⁴ N. J. Collins,¹⁷ C. Collins-Tooth,⁵² J. Collot,⁵⁴ G. Colon,⁸³ P. Conde Muiño,^{123a} E. Coniavitis,¹¹⁷ M. C. Conidi,¹¹ M. Consonni,¹⁰³ V. Consorti,⁴⁷ S. Constantinescu,^{25a} C. Conta,^{118a,118b} F. Conventi,^{101a,k} J. Cook,²⁹ M. Cooke,¹⁴ B. D. Cooper,⁷⁶ A. M. Cooper-Sarkar,¹¹⁷ N. J. Cooper-Smith,⁷⁵ K. Copic,³⁴ T. Cornelissen,^{49a,49b} M. Corradi,^{19a} F. Corriveau,^{84,1} A. Cortes-Gonzalez,¹⁶⁴ G. Cortiana,⁹⁸ G. Costa,^{88a} M. J. Costa,¹⁶⁶ D. Costanzo,¹³⁸ T. Costin,³⁰ D. Côté,²⁹ L. Courneyea,¹⁶⁸ G. Cowan,⁷⁵ C. Cowden,²⁷ B. E. Cox,⁸¹ K. Cranmer,¹⁰⁷ F. Crescioli,^{121a,121b} M. Cristinziani,²⁰ G. Crosetti,^{36a,36b} R. Crupi,^{71a,71b} S. Crépe-Renaudin,⁵⁴ C.-M. Cuciuc,^{25a} C. Cuenca Almenar,¹⁷⁴ T. Cuhadar Donszelmann,¹³⁸ M. Curatolo,⁴⁶ C. J. Curtis,¹⁷ P. Cwetanski,⁶⁰ H. Czirr,¹⁴⁰ Z. Czynzula,¹⁷⁴ S. D'Auria,⁵² M. D'Onofrio,⁷² A. D'Orazio,^{131a,131b} P. V. M. Da Silva,^{23a} C. Da Via,⁸¹ W. Dabrowski,³⁷ T. Dai,⁸⁶ C. Dallapiccola,⁸³ M. Dam,³⁵ M. Dameri,^{49a,49b} D. S. Damiani,¹³⁶ H. O. Danielsson,²⁹ D. Dannheim,⁹⁸ V. Dao,⁴⁸ G. Darbo,^{49a} G. L. Darlea,^{25b} C. Daum,¹⁰⁴ J. P. Dauvergne,²⁹ W. Davey,⁸⁵ T. Davidek,¹²⁵ N. Davidson,⁸⁵ R. Davidson,⁷⁰ E. Davies,^{117,c} M. Davies,⁹² A. R. Davison,⁷⁶ Y. Davygora,^{57a} E. Dawe,¹⁴¹ I. Dawson,¹³⁸ J. W. Dawson,^{5,e} R. K. Daya,³⁹ K. De,⁷ R. de Asmundis,^{101a} S. De Castro,^{19a,19b} P. E. De Castro Faria Salgado,²⁴ S. De Cecco,⁷⁷ J. de Graat,⁹⁷ N. De Groot,¹⁰³ P. de Jong,¹⁰⁴ C. De La Taille,¹¹⁴ H. De la Torre,⁷⁹ B. De Lotto,^{163a,163c} L. De Mora,⁷⁰ L. De Nooij,¹⁰⁴ D. De Pedis,^{131a} A. De Salvo,^{131a} U. De Sanctis,^{163a,163c} A. De Santo,^{a148} J. B. De Vivie De Regie,¹¹⁴ S. Dean,⁷⁶ R. Debebe,²⁴ D. V. Dedovich,⁶⁴ J. Degenhardt,¹¹⁹ M. Dehchar,¹¹⁷ C. Del Papa,^{163a,163c} J. Del Peso,⁷⁹ T. Del Prete,^{121a,121b} M. Deliyergiyev,⁷³ A. Dell'Acqua,²⁹ L. Dell'Asta,^{88a,88b} M. Della Pietra,^{101a,k} D. della Volpe,^{101a,101b} M. Delmastro,²⁹ P. Delpierre,⁸² N. Delruelle,²⁹ P. A. Delsart,⁵⁴ C. Deluca,^{a147} S. Demers,¹⁷⁴ M. Demichev,⁶⁴ B. Demirköz,^{11,m} J. Deng,¹⁶² S. P. Denisov,¹²⁷ D. Derendarz,³⁸ J. E. Derkaoui,^{134d} F. Derue,⁷⁷ P. Dervan,⁷² K. Desch,²⁰ E. Devetak,^{a147} P. O. Deviveiros,¹⁵⁷ A. Dewhurst,¹²⁸ B. DeWilde,^{a147} S. Dhaliwal,¹⁵⁷ R. Dhullipudi,^{24,n} A. Di Ciaccio,^{132a,132b} L. Di Ciaccio,⁴ A. Di Girolamo,²⁹ B. Di Girolamo,²⁹ S. Di Luise,^{133a,133b}

A. Di Mattia,⁸⁷ B. Di Micco,²⁹ R. Di Nardo,^{132a,132b} A. Di Simone,^{132a,132b} R. Di Sipio,^{19a,19b} M. A. Diaz,^{31a}
 F. Diblen,^{18c} E. B. Diehl,⁸⁶ J. Dietrich,⁴¹ T. A. Dietzsch,^{57a} S. Diglio,¹¹⁴ K. Dindar Yagci,³⁹ J. Dingfelder,²⁰
 C. Dionisi,^{131a,131b} P. Dita,^{25a} S. Dita,^{25a} F. Dittus,²⁹ F. Djama,⁸² T. Djobava,^{50b} M. A. B. do Vale,^{23a}
 A. Do Valle Wemans,^{123a} T. K. O. Doan,⁴ M. Dobbs,⁸⁴ R. Dobinson,^{29,e} D. Dobos,²⁹ E. Dobson,²⁹ M. Dobson,¹⁶²
 J. Dodd,³⁴ C. Doglioni,¹¹⁷ T. Doherty,⁵² Y. Doi,^{65,e} J. Dolejsi,¹²⁵ I. Dolenc,⁷³ Z. Dolezal,¹²⁵ B. A. Dolgoshein,^{95,e}
 T. Dohmae,¹⁵⁴ M. Donadelli,^{23d} M. Donega,¹¹⁹ J. Donini,⁵⁴ J. Dopke,²⁹ A. Doria,^{101a} A. Dos Anjos,¹⁷¹ M. Dosil,¹¹
 A. Dotti,^{121a,121b} M. T. Dova,⁶⁹ J. D. Dowell,¹⁷ A. D. Doxiadis,¹⁰⁴ A. T. Doyle,⁵² Z. Drasal,¹²⁵ J. Drees,¹⁷³
 N. Dressnandt,¹¹⁹ H. Drevermann,²⁹ C. Driouichi,³⁵ M. Dris,⁹ J. Dubbert,⁹⁸ T. Dubbs,¹³⁶ S. Dube,¹⁴ E. Duchovni,¹⁷⁰
 G. Duckeck,⁹⁷ A. Dudarev,²⁹ F. Dudziak,⁶³ M. Dührssen,²⁹ I. P. Duerdoth,⁸¹ L. Dufлот,¹¹⁴ M.-A. Dufour,⁸⁴
 M. Dunford,²⁹ H. Duran Yildiz,^{3b} R. Duxfield,¹³⁸ M. Dwuznik,³⁷ F. Dydak,²⁹ M. Düren,⁵¹ W. L. Ebenstein,⁴⁴
 J. Ebke,⁹⁷ S. Eckert,⁴⁷ S. Eckweiler,⁸⁰ K. Edmonds,⁸⁰ C. A. Edwards,⁷⁵ N. C. Edwards,⁵² W. Ehrenfeld,⁴¹ T. Ehrich,⁹⁸
 T. Eifert,²⁹ G. Eigen,¹³ K. Einsweiler,¹⁴ E. Eisenhandler,⁷⁴ T. Ekelof,¹⁶⁵ M. El Kacimi,^{134c} M. Ellert,¹⁶⁵ S. Elles,⁴
 F. Ellinghaus,⁸⁰ K. Ellis,⁷⁴ N. Ellis,²⁹ J. Elmsheuser,⁹⁷ M. Elsing,²⁹ D. Emeliyanov,¹²⁸ R. Engelmann,^{a147} A. Engl,⁹⁷
 B. Epp,⁶¹ A. Eppig,⁸⁶ J. Erdmann,⁵³ A. Ereditato,¹⁶ D. Eriksson,^{145a} J. Ernst,¹ M. Ernst,²⁴ J. Ernwein,¹³⁵
 D. Errede,¹⁶⁴ S. Errede,¹⁶⁴ E. Ertel,⁸⁰ M. Escalier,¹¹⁴ C. Escobar,¹²² X. Espinal Curull,¹¹ B. Esposito,⁴⁶ F. Etienne,⁸²
 A. I. Etievre,¹³⁵ E. Etzion,¹⁵² D. Evangelakou,⁵³ H. Evans,⁶⁰ L. Fabbri,^{19a,19b} C. Fabre,²⁹ R. M. Fakhruddinov,¹²⁷
 S. Falciano,^{131a} Y. Fang,¹⁷¹ M. Fanti,^{88a,88b} A. Farbin,⁷ A. Farilla,^{133a} J. Farley,^{a147} T. Farooque,¹⁵⁷
 S. M. Farrington,¹¹⁷ P. Farthouat,²⁹ P. Fassnacht,²⁹ D. Fassouliotis,⁸ B. Fatholahzadeh,¹⁵⁷ A. Favareto,^{88a,88b}
 L. Fayard,¹¹⁴ S. Fazio,^{36a,36b} R. Febbraro,³³ P. Federic,^{143a} O. L. Fedin,¹²⁰ W. Fedorko,⁸⁷ M. Fehling-Kaschek,⁴⁷
 L. Felgioni,⁸² D. Fellmann,⁵ C. U. Felzmann,⁸⁵ C. Feng,^{32d} E. J. Feng,³⁰ A. B. Fenyuk,¹²⁷ J. Ferencei,^{143b}
 J. Ferland,⁹² W. Fernando,¹⁰⁸ S. Ferrag,⁵² J. Ferrando,⁵² V. Ferrara,⁴¹ A. Ferrari,¹⁶⁵ P. Ferrari,¹⁰⁴ R. Ferrari,^{118a}
 A. Ferrer,¹⁶⁶ M. L. Ferrer,⁴⁶ D. Ferrere,⁴⁸ C. Ferretti,⁸⁶ A. Ferretto Parodi,^{49a,49b} M. Fiascaris,³⁰ F. Fiedler,⁸⁰
 A. Filipčič,⁷³ A. Filippas,⁹ F. Filthaut,¹⁰³ M. Fincke-Keeler,¹⁶⁸ M. C. N. Fiolhais,^{123aj} L. Fiorini,¹⁶⁶ A. Firan,³⁹
 G. Fischer,⁴¹ P. Fischer,²⁰ M. J. Fisher,¹⁰⁸ S. M. Fisher,¹²⁸ M. Flechl,⁴⁷ I. Fleck,¹⁴⁰ J. Fleckner,⁸⁰ P. Fleischmann,¹⁷²
 S. Fleischmann,¹⁷³ T. Flick,¹⁷³ L. R. Flores Castillo,¹⁷¹ M. J. Flowerdew,⁹⁸ M. Fokitis,⁹ T. Fonseca Martin,¹⁶
 D. A. Forbush,¹³⁷ A. Formica,¹³⁵ A. Forti,⁸¹ D. Fortin,^{158a} J. M. Foster,⁸¹ D. Fournier,¹¹⁴ A. Foussat,²⁹ A. J. Fowler,⁴⁴
 K. Fowler,¹³⁶ H. Fox,⁷⁰ P. Francavilla,^{121a,121b} S. Franchino,^{118a,118b} D. Francis,²⁹ T. Frank,¹⁷⁰ M. Franklin,⁵⁶
 S. Franz,²⁹ M. Fraternali,^{118a,118b} S. Fratina,¹¹⁹ S. T. French,²⁷ F. Friedrich,⁴³ R. Froeschl,²⁹ D. Froidevaux,²⁹
 J. A. Frost,²⁷ C. Fukunaga,¹⁵⁵ E. Fullana Torregrosa,²⁹ J. Fuster,¹⁶⁶ C. Gabaldon,²⁹ O. Gabizon,¹⁷⁰ T. Gadfort,²⁴
 S. Gadomski,⁴⁸ G. Gagliardi,^{49a,49b} P. Gagnon,⁶⁰ C. Galea,⁹⁷ E. J. Gallas,¹¹⁷ M. V. Gallas,²⁹ V. Gallo,¹⁶
 B. J. Gallop,¹²⁸ P. Gallus,¹²⁴ E. Galyaev,⁴⁰ K. K. Gan,¹⁰⁸ Y. S. Gao,^{142,g} V. A. Gapienko,¹²⁷ A. Gaponenko,¹⁴
 F. Garbersson,¹⁷⁴ M. Garcia-Sciveres,¹⁴ C. García,¹⁶⁶ J. E. García Navarro,⁴⁸ R. W. Gardner,³⁰ N. Garelli,²⁹
 H. Garitaonandia,¹⁰⁴ V. Garonne,²⁹ J. Garvey,¹⁷ C. Gatti,⁴⁶ G. Gaudio,^{118a} O. Gaumer,⁴⁸ B. Gaur,¹⁴⁰ L. Gauthier,¹³⁵
 I. L. Gavrilenko,⁹³ C. Gay,¹⁶⁷ G. Gaycken,²⁰ J.-C. Gayde,²⁹ E. N. Gazis,⁹ P. Ge,^{32d} C. N. P. Gee,¹²⁸ D. A. A. Geerts,¹⁰⁴
 Ch. Geich-Gimbel,²⁰ K. Gellerstedt,^{145a,145b} C. Gemme,^{49a} A. Gemmell,⁵² M. H. Genest,⁹⁷ S. Gentile,^{131a,131b}
 M. George,⁵³ S. George,⁷⁵ P. Gerlach,¹⁷³ A. Gershon,¹⁵² C. Geweniger,^{57a} H. Ghazlane,^{134b} P. Ghez,⁴
 N. Ghodbane,³³ B. Giacobbe,^{19a} S. Giagu,^{131a,131b} V. Giakoumopoulou,⁸ V. Giangiobbe,^{121a,121b} F. Gianotti,²⁹
 B. Gibbard,²⁴ A. Gibson,¹⁵⁷ S. M. Gibson,²⁹ L. M. Gilbert,¹¹⁷ M. Gilchriese,¹⁴ V. Gilevsky,⁹⁰ D. Gillberg,²⁸
 A. R. Gillman,¹²⁸ D. M. Gingrich,^{2,f} J. Ginzburg,¹⁵² N. Giokaris,⁸ M. P. Giordani,^{163c} R. Giordano,^{101a,101b}
 F. M. Giorgi,¹⁵ P. Giovannini,⁹⁸ P. F. Giraud,¹³⁵ D. Giugni,^{88a} M. Giunta,⁹² P. Giusti,^{19a} B. K. Gjelsten,¹¹⁶
 L. K. Gladilin,⁹⁶ C. Glasman,⁷⁹ J. Glatzer,⁴⁷ A. Glazov,⁴¹ K. W. Glitza,¹⁷³ G. L. Glonti,⁶⁴ J. Godfrey,¹⁴¹
 J. Godlewski,²⁹ M. Goebel,⁴¹ T. Göpfert,⁴³ C. Goeringer,⁸⁰ C. Gössling,⁴² T. Göttfert,⁹⁸ S. Goldfarb,⁸⁶ T. Golling,¹⁷⁴
 S. N. Golovnia,¹²⁷ A. Gomes,^{123a,b} L. S. Gomez Fajardo,⁴¹ R. Gonçalves,⁷⁵ J. Goncalves Pinto Firmino Da Costa,⁴¹
 L. Gonella,²⁰ A. Gonidec,²⁹ S. Gonzalez,¹⁷¹ S. González de la Hoz,¹⁶⁶ M. L. Gonzalez Silva,²⁶ S. Gonzalez-Sevilla,⁴⁸
 J. J. Goodson,^{a147} L. Goossens,²⁹ P. A. Gorbounov,⁹⁴ H. A. Gordon,²⁴ I. Gorelov,¹⁰² G. Gorfine,¹⁷³ B. Gorini,²⁹
 E. Gorini,^{71a,71b} A. Gorišek,⁷³ E. Gornicki,³⁸ S. A. Gorokhov,¹²⁷ V. N. Goryachev,¹²⁷ B. Gosdzik,⁴¹ M. Gosselink,¹⁰⁴
 M. I. Gostkin,⁶⁴ I. Gough Eschrich,¹⁶² M. Gouighri,^{134a} D. Goujdami,^{134c} M. P. Goulette,⁴⁸ A. G. Goussiou,¹³⁷
 C. Goy,⁴ I. Grabowska-Bold,^{162,h} V. Grabski,¹⁷⁵ P. Grafström,²⁹ C. Grah,¹⁷³ K.-J. Grahm,⁴¹ F. Grancagnolo,^{71a}
 S. Grancagnolo,¹⁵ V. Grassi,^{a147} V. Gratchev,¹²⁰ N. Grau,³⁴ H. M. Gray,²⁹ J. A. Gray,^{a147} E. Graziani,^{133a}
 O. G. Grebenyuk,¹²⁰ D. Greenfield,¹²⁸ T. Greenshaw,⁷² Z. D. Greenwood,^{24,n} K. Gregersen,³⁵ I. M. Gregor,⁴¹
 P. Grenier,¹⁴² J. Griffiths,¹³⁷ N. Grigalashvili,⁶⁴ A. A. Grillo,¹³⁶ S. Grinstein,¹¹ Y. V. Grishkevich,⁹⁶ J.-F. Grivaz,¹¹⁴

J. Grognez,²⁹ M. Groh,⁹⁸ E. Gross,¹⁷⁰ J. Grosse-Knetter,⁵³ J. Groth-Jensen,¹⁷⁰ K. Grybel,¹⁴⁰ V. J. Guarino,⁵ D. Guest,¹⁷⁴ C. Guicheney,³³ A. Guida,^{71a,71b} T. Guillemain,⁴ S. Guindon,⁵³ H. Guler,^{84,o} J. Gunther,¹²⁴ B. Guo,¹⁵⁷ J. Guo,³⁴ A. Gupta,³⁰ Y. Gusakov,⁶⁴ V. N. Gushchin,¹²⁷ A. Gutierrez,⁹² P. Gutierrez,¹¹⁰ N. Guttman,¹⁵² O. Gutzwiller,¹⁷¹ C. Guyot,¹³⁵ C. Gwenlan,¹¹⁷ C. B. Gwilliam,⁷² A. Haas,¹⁴² S. Haas,²⁹ C. Haber,¹⁴ R. Hackenburg,²⁴ H. K. Hadavand,³⁹ D. R. Hadley,¹⁷ P. Haefner,⁹⁸ F. Hahn,²⁹ S. Haider,²⁹ Z. Hajduk,³⁸ H. Hakobyan,¹⁷⁵ J. Haller,⁵³ K. Hamacher,¹⁷³ P. Hamal,¹¹² A. Hamilton,⁴⁸ S. Hamilton,¹⁶⁰ H. Han,^{32a} L. Han,^{32b} K. Hanagaki,¹¹⁵ M. Hance,¹¹⁹ C. Handel,⁸⁰ P. Hanke,^{57a} J. R. Hansen,³⁵ J. B. Hansen,³⁵ J. D. Hansen,³⁵ P. H. Hansen,³⁵ P. Hansson,¹⁴² K. Hara,¹⁵⁹ G. A. Hare,¹³⁶ T. Harenberg,¹⁷³ S. Harkusha,⁸⁹ D. Harper,⁸⁶ R. D. Harrington,²¹ O. M. Harris,¹³⁷ K. Harrison,¹⁷ J. Hartert,⁴⁷ F. Hartjes,¹⁰⁴ T. Haruyama,⁶⁵ A. Harvey,⁵⁵ S. Hasegawa,¹⁰⁰ Y. Hasegawa,¹³⁹ S. Hassani,¹³⁵ M. Hatch,²⁹ D. Hauff,⁹⁸ S. Haug,¹⁶ M. Hauschild,²⁹ R. Hauser,⁸⁷ M. Havranek,²⁰ B. M. Hawes,¹¹⁷ C. M. Hawkes,¹⁷ R. J. Hawkings,²⁹ D. Hawkins,¹⁶² T. Hayakawa,⁶⁶ D. Hayden,⁷⁵ H. S. Hayward,⁷² S. J. Haywood,¹²⁸ E. Hazen,²¹ M. He,^{32d} S. J. Head,¹⁷ V. Hedberg,⁷⁸ L. Heelan,⁷ S. Heim,⁸⁷ B. Heinemann,¹⁴ S. Heisterkamp,³⁵ L. Helary,⁴ M. Heller,¹¹⁴ S. Hellman,^{145a,145b} D. Hellmich,²⁰ C. Helsens,¹¹ R. C. W. Henderson,⁷⁰ M. Henke,^{57a} A. Henrichs,⁵³ A. M. Henriques Correia,²⁹ S. Henrot-Versille,¹¹⁴ F. Henry-Couannier,⁸² C. Hensel,⁵³ T. Henß,¹⁷³ C. M. Hernandez,⁷ Y. Hernández Jiménez,¹⁶⁶ R. Herrberg,¹⁵ A. D. Hershenhorn,¹⁵¹ G. Hertel,⁴⁷ R. Hertenberger,⁹⁷ L. Hervas,²⁹ N. P. Hessey,¹⁰⁴ A. Hidvegi,^{145a} E. Higón-Rodríguez,¹⁶⁶ D. Hill,^{5,e} J. C. Hill,²⁷ N. Hill,⁵ K. H. Hiller,⁴¹ S. Hillert,²⁰ S. J. Hillier,¹⁷ I. Hinchliffe,¹⁴ E. Hines,¹¹⁹ M. Hirose,¹¹⁵ F. Hirsch,⁴² D. Hirschbuehl,¹⁷³ J. Hobbs,¹⁴⁷ N. Hod,¹⁵² M. C. Hodgkinson,¹³⁸ P. Hodgson,¹³⁸ A. Hoecker,²⁹ M. R. Hoferkamp,¹⁰² J. Hoffman,³⁹ D. Hoffmann,⁸² M. Hohlfeld,⁸⁰ M. Holder,¹⁴⁰ S. O. Holmgren,^{145a} T. Holy,¹²⁶ J. L. Holzbauer,⁸⁷ Y. Homma,⁶⁶ T. M. Hong,¹¹⁹ L. Hoof van Huysduynen,¹⁰⁷ T. Horazdovsky,¹²⁶ C. Horn,¹⁴² S. Horner,⁴⁷ K. Horton,¹¹⁷ J.-Y. Hostachy,⁵⁴ S. Hou,¹⁵⁰ M. A. Houlden,⁷² A. Hoummada,^{134a} J. Howarth,⁸¹ D. F. Howell,¹¹⁷ I. Hristova,¹⁵ J. Hrivnac,¹¹⁴ I. Hruska,¹²⁴ T. Hryn'ova,⁴ P. J. Hsu,¹⁷⁴ S.-C. Hsu,¹⁴ G. S. Huang,¹¹⁰ Z. Hubacek,¹²⁶ F. Hubaut,⁸² F. Huegging,²⁰ T. B. Huffman,¹¹⁷ E. W. Hughes,³⁴ G. Hughes,⁷⁰ R. E. Hughes-Jones,⁸¹ M. Huhtinen,²⁹ P. Hurst,⁵⁶ M. Hurwitz,¹⁴ U. Husemann,⁴¹ N. Huseynov,^{64,p} J. Huston,⁸⁷ J. Huth,⁵⁶ G. Iacobucci,⁴⁸ G. Iakovidis,⁹ M. Ibbotson,⁸¹ I. Ibragimov,¹⁴⁰ R. Ichimiya,⁶⁶ L. Iconomidou-Fayard,¹¹⁴ J. Idarraga,¹¹⁴ M. Idzik,³⁷ P. Iengo,^{101a,101b} O. Igonkina,¹⁰⁴ Y. Ikegami,⁶⁵ M. Ikeno,⁶⁵ Y. Ilchenko,³⁹ D. Iliadis,¹⁵³ D. Imbault,⁷⁷ M. Imhaeuser,¹⁷³ M. Imori,¹⁵⁴ T. Ince,²⁰ J. Inigo-Golfín,²⁹ P. Ioannou,⁸ M. Iodice,^{133a} G. Ionescu,⁴ A. Irles Quiles,¹⁶⁶ K. Ishii,⁶⁵ A. Ishikawa,⁶⁶ M. Ishino,⁶⁷ R. Ishmukhametov,³⁹ C. Issever,¹¹⁷ S. Istin,^{18a} A. V. Ivashin,¹²⁷ W. Iwanski,³⁸ H. Iwasaki,⁶⁵ J. M. Izen,⁴⁰ V. Izzo,^{101a} B. Jackson,¹¹⁹ J. N. Jackson,⁷² P. Jackson,¹⁴² M. R. Jaekel,²⁹ V. Jain,⁶⁰ K. Jakobs,⁴⁷ S. Jakobsen,³⁵ J. Jakubek,¹²⁶ D. K. Jana,¹¹⁰ E. Jankowski,¹⁵⁷ E. Jansen,⁷⁶ A. Jantsch,⁹⁸ M. Janus,²⁰ G. Jarlskog,⁷⁸ L. Jeanty,⁵⁶ K. Jelen,³⁷ I. Jen-La Plante,³⁰ P. Jenni,²⁹ A. Jeremie,⁴ P. Jež,³⁵ S. Jézéquel,⁴ M. K. Jha,^{19a} H. Ji,¹⁷¹ W. Ji,⁸⁰ J. Jia,¹⁴⁷ Y. Jiang,^{32b} M. Jimenez Belenguer,⁴¹ G. Jin,^{32b} S. Jin,^{32a} O. Jinnouchi,¹⁵⁶ M. D. Joergensen,³⁵ D. Joffe,³⁹ L. G. Johansen,¹³ M. Johansen,^{145a,145b} K. E. Johansson,^{145a} P. Johansson,¹³⁸ S. Johnert,⁴¹ K. A. Johns,⁶ K. Jon-And,^{145a,145b} G. Jones,⁸¹ R. W. L. Jones,⁷⁰ T. W. Jones,⁷⁶ T. J. Jones,⁷² O. Jonsson,²⁹ C. Joram,²⁹ P. M. Jorge,^{123a,b} J. Joseph,¹⁴ T. Jovin,^{12b} X. Ju,¹²⁹ V. Juranek,¹²⁴ P. Jussel,⁶¹ A. Juste Rozas,¹¹ V. V. Kabachenko,¹²⁷ S. Kabana,¹⁶ M. Kaci,¹⁶⁶ A. Kaczmarek,³⁸ P. Kadlecik,³⁵ M. Kado,¹¹⁴ H. Kagan,¹⁰⁸ M. Kagan,⁵⁶ S. Kaiser,⁹⁸ E. Kajomovitz,¹⁵¹ S. Kalinin,¹⁷³ L. V. Kalinovskaya,⁶⁴ S. Kama,³⁹ N. Kanaya,¹⁵⁴ M. Kaneda,²⁹ T. Kanno,¹⁵⁶ V. A. Kantserov,⁹⁵ J. Kanzaki,⁶⁵ B. Kaplan,¹⁷⁴ A. Kapliy,³⁰ J. Kaplon,²⁹ D. Kar,⁴³ M. Karagoz,¹¹⁷ M. Karnevskiy,⁴¹ K. Karr,⁵ V. Kartvelishvili,⁷⁰ A. N. Karyukhin,¹²⁷ L. Kashif,¹⁷¹ A. Kasmi,³⁹ R. D. Kass,¹⁰⁸ A. Kastanas,¹³ M. Kataoka,⁴ Y. Kataoka,¹⁵⁴ E. Katsoufis,⁹ J. Katzy,⁴¹ V. Kaushik,⁶ K. Kawagoe,⁶⁶ T. Kawamoto,¹⁵⁴ G. Kawamura,⁸⁰ M. S. Kayl,¹⁰⁴ V. A. Kazanin,¹⁰⁶ M. Y. Kazarinov,⁶⁴ J. R. Keates,⁸¹ R. Keeler,¹⁶⁸ R. Kehoe,³⁹ M. Keil,⁵³ G. D. Kekelidze,⁶⁴ M. Kelly,⁸¹ J. Kennedy,⁹⁷ C. J. Kenney,¹⁴² M. Kenyon,⁵² O. Kepka,¹²⁴ N. Kerschen,²⁹ B. P. Kerševan,⁷³ S. Kersten,¹⁷³ K. Kessoku,¹⁵⁴ C. Ketterer,⁴⁷ J. Keung,¹⁵⁷ M. Khakzad,²⁸ F. Khalil-zada,¹¹ H. Khandanyan,¹⁶⁴ A. Khanov,¹¹¹ D. Kharchenko,⁶⁴ A. Khodinov,⁹⁵ A. G. Kholodenko,¹²⁷ A. Khomich,^{57a} T. J. Khoo,²⁷ G. Khoraiuli,²⁰ A. Khoroshilov,¹⁷³ N. Khovanskiy,⁶⁴ V. Khovanskiy,⁹⁴ E. Khramov,⁶⁴ J. Khubua,^{50b} H. Kim,⁷ M. S. Kim,² P. C. Kim,¹⁴² S. H. Kim,¹⁵⁹ N. Kimura,¹⁶⁹ O. Kind,¹⁵ B. T. King,⁷² M. King,⁶⁶ R. S. B. King,¹¹⁷ J. Kirk,¹²⁸ L. E. Kirsch,²² A. E. Kiryunin,⁹⁸ T. Kishimoto,⁶⁶ D. Kisielewska,³⁷ T. Kittelmann,¹²² A. M. Kiver,¹²⁷ E. Kladiva,^{143b} J. Klaiber-Lodewigs,⁴² M. Klein,⁷² U. Klein,⁷² K. Kleinknecht,⁸⁰ M. Klemetti,⁸⁴ A. Klier,¹⁷⁰ A. Klimentov,²⁴ R. Klingenberg,⁴² E. B. Klinkby,³⁵ T. Klioutchnikova,²⁹ P. F. Klok,¹⁰³ S. Klous,¹⁰⁴ E.-E. Kluge,^{57a} T. Kluge,⁷² P. Kluit,¹⁰⁴ S. Kluth,⁹⁸ N. S. Knecht,¹⁵⁷ E. Kneringer,⁶¹ J. Knobloch,²⁹ E. B. F. G. Knoops,⁸² A. Knue,⁵³ B. R. Ko,⁴⁴ T. Kobayashi,¹⁵⁴ M. Kobel,⁴³ M. Kocian,¹⁴² A. Kocnar,¹¹² P. Kodys,¹²⁵ K. Köneke,²⁹ A. C. König,¹⁰³ S. Koenig,⁸⁰

L. Köpke,⁸⁰ F. Koetsveld,¹⁰³ P. Koevesarki,²⁰ T. Koffas,²⁸ E. Koffeman,¹⁰⁴ F. Kohn,⁵³ Z. Kohout,¹²⁶ T. Kohriki,⁶⁵ T. Koi,¹⁴² T. Kokott,²⁰ G. M. Kolachev,¹⁰⁶ H. Kolanoski,¹⁵ V. Kolesnikov,⁶⁴ I. Koletsou,^{88a} J. Koll,⁸⁷ D. Kollar,²⁹ M. Kollefrath,⁴⁷ S. D. Kolya,⁸¹ A. A. Komar,⁹³ Y. Komori,¹⁵⁴ T. Kondo,⁶⁵ T. Kono,^{41,q} A. I. Kononov,⁴⁷ R. Konoplich,^{107,r} N. Konstantinidis,⁷⁶ A. Kootz,¹⁷³ S. Koperny,³⁷ S. V. Kopikov,¹²⁷ K. Korcyl,³⁸ K. Kordas,¹⁵³ V. Koreshev,¹²⁷ A. Korn,¹¹⁷ A. Korol,¹⁰⁶ I. Korolkov,¹¹ E. V. Korolkova,¹³⁸ V. A. Korotkov,¹²⁷ O. Kortner,⁹⁸ S. Kortner,⁹⁸ V. V. Kostyukhin,²⁰ M. J. Kotamäki,²⁹ S. Kotov,⁹⁸ V. M. Kotov,⁶⁴ A. Kotwal,⁴⁵ C. Kourkoumelis,⁸ V. Kouskoura,¹⁵³ A. Koutsman,¹⁰⁴ R. Kowalewski,¹⁶⁸ T. Z. Kowalski,³⁷ W. Kozanecki,¹³⁵ A. S. Kozhin,¹²⁷ V. Kral,¹²⁶ V. A. Kramarenko,⁹⁶ G. Kramberger,⁷³ M. W. Krasny,⁷⁷ A. Krasznahorkay,¹⁰⁷ J. Kraus,⁸⁷ A. Kreisel,¹⁵² F. Krejci,¹²⁶ J. Kretschmar,⁷² N. Krieger,⁵³ P. Krieger,¹⁵⁷ K. Kroeninger,⁵³ H. Kroha,⁹⁸ J. Kroll,¹¹⁹ J. Kroseberg,²⁰ J. Krstic,^{12a} U. Kruchonak,⁶⁴ H. Krüger,²⁰ T. Kruker,¹⁶ Z. V. Krumshteyn,⁶⁴ A. Kruth,²⁰ T. Kubota,⁸⁵ S. Kuehn,⁴⁷ A. Kugel,^{57c} T. Kuhl,⁴¹ D. Kuhn,⁶¹ V. Kukhtin,⁶⁴ Y. Kulchitsky,⁸⁹ S. Kuleshov,^{31b} C. Kummer,⁹⁷ M. Kuna,⁷⁷ N. Kundu,¹¹⁷ J. Kunkle,¹¹⁹ A. Kupco,¹²⁴ H. Kurashige,⁶⁶ M. Kurata,¹⁵⁹ Y. A. Kurochkin,⁸⁹ V. Kus,¹²⁴ W. Kuykendall,¹³⁷ M. Kuze,¹⁵⁶ P. Kuzhir,⁹⁰ J. Kvita,²⁹ R. Kwee,¹⁵ A. La Rosa,¹⁷¹ L. La Rotonda,^{36a,36b} L. Labarga,⁷⁹ J. Labbe,⁴ S. Lablak,^{134a} C. Lacasta,¹⁶⁶ F. Lacava,^{131a,131b} H. Lacker,¹⁵ D. Lacour,⁷⁷ V. R. Lacuesta,¹⁶⁶ E. Ladygin,⁶⁴ R. Lafaye,⁴ B. Laforge,⁷⁷ T. Lagouri,⁷⁹ S. Lai,⁴⁷ E. Laisne,⁵⁴ M. Lamanna,²⁹ C. L. Lampen,⁶ W. Lampl,⁶ E. Lancon,¹³⁵ U. Landgraf,⁴⁷ M. P. J. Landon,⁷⁴ H. Landsman,¹⁵¹ J. L. Lane,⁸¹ C. Lange,⁴¹ A. J. Lankford,¹⁶² F. Lanni,²⁴ K. Lantzsch,²⁹ S. Laplace,⁷⁷ C. Lapoire,²⁰ J. F. Laporte,¹³⁵ T. Lari,^{88a} A. V. Larionov,¹²⁷ A. Lerner,¹¹⁷ C. Lasseur,²⁹ M. Lassnig,²⁹ P. Laurelli,⁴⁶ A. Lavorato,¹¹⁷ W. Lavrijsen,¹⁴ P. Laycock,⁷² A. B. Lazarev,⁶⁴ O. Le Dortz,⁷⁷ E. Le Guirriec,⁸² C. Le Maner,¹⁵⁷ E. Le Menedeu,¹³⁵ C. Lebel,⁹² T. LeCompte,⁵ F. Ledroit-Guillon,⁵⁴ H. Lee,¹⁰⁴ J. S. H. Lee,¹⁴⁹ S. C. Lee,¹⁵⁰ L. Lee,¹⁷⁴ M. Lefebvre,¹⁶⁸ M. Legendre,¹³⁵ A. Leger,⁴⁸ B. C. LeGeyt,¹¹⁹ F. Legger,⁹⁷ C. Leggett,¹⁴ M. Lehmacher,²⁰ G. Lehmann Miotto,²⁹ X. Lei,⁶ M. A. L. Leite,^{23d} R. Leitner,¹²⁵ D. Lellouch,¹⁷⁰ M. Leltchouk,³⁴ B. Lemmer,⁵³ V. Lendermann,^{57a} K. J. C. Leney,^{144b} T. Lenz,¹⁰⁴ G. Lenzen,¹⁷³ B. Lenzi,²⁹ K. Leonhardt,⁴³ S. Leontsinis,⁹ C. Leroy,⁹² J-R. Lessard,¹⁶⁸ J. Lesser,^{145a} C. G. Lester,²⁷ A. Leung Fook Cheong,¹⁷¹ J. Levêque,⁴ D. Levin,⁸⁶ L. J. Levinson,¹⁷⁰ M. S. Levitski,¹²⁷ M. Lewandowska,²¹ A. Lewis,¹¹⁷ G. H. Lewis,¹⁰⁷ A. M. Leyko,²⁰ M. Leyton,¹⁵ B. Li,⁸² H. Li,¹⁷¹ S. Li,^{32b,d} X. Li,⁸⁶ Z. Liang,³⁹ Z. Liang,^{117,s} H. Liao,³⁴ B. Liberti,^{132a} P. Lichard,²⁹ M. Lichtnecker,⁹⁷ K. Lie,¹⁶⁴ W. Liebig,¹³ R. Lifshitz,¹⁵¹ J. N. Lilley,¹⁷ C. Limbach,²⁰ A. Limosani,⁸⁵ M. Limper,⁶² S. C. Lin,^{150,i} F. Linde,¹⁰⁴ J. T. Linnemann,⁸⁷ E. Lipeles,¹¹⁹ L. Lipinsky,¹²⁴ A. Lipniacka,¹³ T. M. Liss,¹⁶⁴ D. Lissauer,²⁴ A. Lister,⁴⁸ A. M. Litke,¹³⁶ C. Liu,²⁸ D. Liu,^{150,u} H. Liu,⁸⁶ J. B. Liu,⁸⁶ M. Liu,^{32b} S. Liu,² Y. Liu,^{32b} M. Livan,^{118a,118b} S. S. A. Livermore,¹¹⁷ A. Lleres,⁵⁴ J. Llorente Merino,⁷⁹ S. L. Lloyd,⁷⁴ E. Lobodzinska,⁴¹ P. Loch,⁶ W. S. Lockman,¹³⁶ T. Loddenkoetter,²⁰ F. K. Loebinger,⁸¹ A. Loginov,¹⁷⁴ C. W. Loh,¹⁶⁷ T. Lohse,¹⁵ K. Lohwasser,⁴⁷ M. Lokajicek,¹²⁴ J. Loken,¹¹⁷ V. P. Lombardo,⁴ R. E. Long,⁷⁰ L. Lopes,^{123a,b} D. Lopez Mateos,⁵⁶ M. Losada,¹⁶¹ P. Loscutoff,¹⁴ F. Lo Sterzo,^{131a,131b} M. J. Losty,^{158a} X. Lou,⁴⁰ A. Lounis,¹¹⁴ K. F. Loureiro,¹⁶¹ J. Love,²¹ P. A. Love,⁷⁰ A. J. Lowe,^{142,g} F. Lu,^{32a} H. J. Lubatti,¹³⁷ C. Luci,^{131a,131b} A. Lucotte,⁵⁴ A. Ludwig,⁴³ D. Ludwig,⁴¹ I. Ludwig,⁴⁷ J. Ludwig,⁴⁷ F. Luehring,⁶⁰ G. Luijckx,¹⁰⁴ D. Lumb,⁴⁷ L. Luminari,^{131a} E. Lund,¹¹⁶ B. Lund-Jensen,¹⁴⁶ B. Lundberg,⁷⁸ J. Lundberg,^{145a,145b} J. Lundquist,³⁵ M. Lungwitz,⁸⁰ A. Lupi,^{121a,121b} G. Lutz,⁹⁸ D. Lynn,²⁴ J. Lys,¹⁴ E. Lytken,⁷⁸ H. Ma,²⁴ L. L. Ma,¹⁷¹ J. A. Macana Goia,⁹² G. Maccarrone,⁴⁶ A. Macchiolo,⁹⁸ B. Maček,⁷³ J. Machado Miguens,^{123a} R. Mackeprang,³⁵ R. J. Madaras,¹⁴ W. F. Mader,⁴³ R. Maenner,^{57c} T. Maeno,²⁴ P. Mättig,¹⁷³ S. Mättig,⁴¹ L. Magnoni,²⁹ E. Magradze,⁵³ Y. Mahalalel,¹⁵² K. Mahboubi,⁴⁷ G. Mahout,¹⁷ C. Maiani,^{131a,131b} C. Maidantchik,^{23a} A. Maio,^{123a,b} S. Majewski,²⁴ Y. Makida,⁶⁵ N. Makovec,¹¹⁴ P. Mal,⁶ Pa. Malecki,³⁸ P. Malecki,³⁸ V. P. Maleev,¹²⁰ F. Malek,⁵⁴ U. Mallik,⁶² D. Malon,⁵ C. Malone,¹⁴² S. Maltezos,⁹ V. Malyshev,¹⁰⁶ S. Malyukov,²⁹ R. Mameghani,⁹⁷ J. Mamuzic,^{12b} A. Manabe,⁶⁵ L. Mandelli,^{88a} I. Mandić,⁷³ R. Mandrysch,¹⁵ J. Maneira,^{123a} P. S. Mangeard,⁸⁷ I. D. Manjavidze,⁶⁴ A. Mann,⁵³ P. M. Manning,¹³⁶ A. Manousakis-Katsikakis,⁸ B. Mansoulie,¹³⁵ A. Manz,⁹⁸ A. Mapelli,²⁹ L. Mapelli,²⁹ L. March,⁷⁹ J. F. Marchand,²⁹ F. Marchese,^{132a,132b} G. Marchiori,⁷⁷ M. Marcisovsky,¹²⁴ A. Marin,^{21,e} C. P. Marino,⁶⁰ F. Marroquim,^{23a} R. Marshall,⁸¹ Z. Marshall,²⁹ F. K. Martens,¹⁵⁷ S. Marti-Garcia,¹⁶⁶ A. J. Martin,¹⁷⁴ B. Martin,²⁹ B. Martin,⁸⁷ F. F. Martin,¹¹⁹ J. P. Martin,⁹² Ph. Martin,⁵⁴ T. A. Martin,¹⁷ V. J. Martin,⁴⁵ B. Martin dit Latour,⁴⁸ S. Martin-Haugh,^{a148} M. Martinez,¹¹ V. Martinez Outschoorn,⁵⁶ A. C. Martyniuk,⁸¹ M. Marx,⁸¹ F. Marzano,^{131a} A. Marzin,¹¹⁰ L. Masetti,⁸⁰ T. Mashimo,¹⁵⁴ R. Mashinistov,⁹³ J. Masik,⁸¹ A. L. Maslennikov,¹⁰⁶ I. Massa,^{19a,19b} G. Massaro,¹⁰⁴ N. Massol,⁴ P. Mastrandrea,^{131a,131b} A. Mastroberardino,^{36a,36b} T. Masubuchi,¹⁵⁴ M. Mathes,²⁰ P. Matricon,¹¹⁴ H. Matsumoto,¹⁵⁴ H. Matsunaga,¹⁵⁴ T. Matsushita,⁶⁶ C. Mattravers,^{117,c} J. M. Maugain,²⁹ S. J. Maxfield,⁷² D. A. Maximov,¹⁰⁶ E. N. May,⁵ A. Mayne,¹³⁸ R. Mazini,¹⁵⁰ M. Mazur,²⁰ M. Mazzanti,^{88a}

- E. Mazzoni,^{121a,121b} S. P. Mc Kee,⁸⁶ A. McCarn,¹⁶⁴ R. L. McCarthy,¹⁴⁷ T. G. McCarthy,²⁸ N. A. McCubbin,¹²⁸
 K. W. McFarlane,⁵⁵ J. A. McFayden,¹³⁸ H. McGlone,⁵² G. Mchedlidze,^{50b} R. A. McLaren,²⁹ T. McLaughlan,¹⁷
 S. J. McMahon,¹²⁸ R. A. McPherson,^{168,1} A. Meade,⁸³ J. Mechnich,¹⁰⁴ M. Mechtel,¹⁷³ M. Medinnis,⁴¹
 R. Meera-Lebbai,¹¹⁰ T. Meguro,¹¹⁵ R. Mehdiyev,⁹² S. Mehlhase,³⁵ A. Mehta,⁷² K. Meier,^{57a} J. Meinhardt,⁴⁷
 B. Meirose,⁷⁸ C. Melachrinou,³⁰ B. R. Mellado Garcia,¹⁷¹ L. Mendoza Navas,¹⁶¹ Z. Meng,^{150,u} A. Mengarelli,^{19a,19b}
 S. Menke,⁹⁸ C. Menot,²⁹ E. Meoni,¹¹ K. M. Mercurio,⁵⁶ P. Mermod,¹¹⁷ L. Merola,^{101a,101b} C. Meroni,^{88a}
 F. S. Merritt,³⁰ A. Messina,²⁹ J. Metcalfe,¹⁰² A. S. Mete,⁶³ S. Meuser,²⁰ C. Meyer,⁸⁰ J-P. Meyer,¹³⁵ J. Meyer,¹⁷²
 J. Meyer,⁵³ T. C. Meyer,²⁹ W. T. Meyer,⁶³ J. Miao,^{32d} S. Michal,²⁹ L. Micu,^{25a} R. P. Middleton,¹²⁸ P. Miele,²⁹
 S. Migas,⁷² L. Mijović,⁴¹ G. Mikenberg,¹⁷⁰ M. Mikestikova,¹²⁴ M. Mikuž,⁷³ D. W. Miller,³⁰ R. J. Miller,⁸⁷
 W. J. Mills,¹⁶⁷ C. Mills,⁵⁶ A. Milov,¹⁷⁰ D. A. Milstead,^{145a,145b} D. Milstein,¹⁷⁰ A. A. Minaenko,¹²⁷ M. Miñano,¹⁶⁶
 I. A. Minashvili,⁶⁴ A. I. Mincer,¹⁰⁷ B. Mindur,³⁷ M. Mineev,⁶⁴ Y. Ming,¹²⁹ L. M. Mir,¹¹ G. Mirabelli,^{131a}
 L. Miralles Verge,¹¹ A. Misiejuk,⁷⁵ J. Mitrevski,¹³⁶ G. Y. Mitrofanov,¹²⁷ V. A. Mitsou,¹⁶⁶ S. Mitsui,⁶⁵
 P. S. Miyagawa,¹³⁸ K. Miyazaki,⁶⁶ J. U. Mjörnmark,⁷⁸ T. Moa,^{145a,145b} P. Mockett,¹³⁷ S. Moed,⁵⁶ V. Moeller,²⁷
 K. Mönig,⁴¹ N. Möser,²⁰ S. Mohapatra,¹⁴⁷ W. Mohr,⁴⁷ S. Mohrdieck-Möck,⁹⁸ A. M. Moiseev,^{127,e}
 R. Moles-Valls,¹⁶⁶ J. Molina-Perez,²⁹ J. Monk,⁷⁶ E. Monnier,⁸² S. Montesano,^{88a,88b} F. Monticelli,⁶⁹
 S. Monzani,^{19a,19b} R. W. Moore,² G. F. Moorhead,⁸⁵ C. Mora Herrera,⁴⁸ A. Moraes,⁵² N. Morange,¹³⁵ J. Morel,⁵³
 G. Morello,^{36a,36b} D. Moreno,⁸⁰ M. Moreno Llácer,¹⁶⁶ P. Morettini,^{49a} M. Morii,⁵⁶ J. Morin,⁷⁴ Y. Morita,⁶⁵
 A. K. Morley,²⁹ G. Mornacchi,²⁹ S. V. Morozov,⁹⁵ J. D. Morris,⁷⁴ L. Morvaj,¹⁰⁰ H. G. Moser,⁹⁸ M. Mosidze,^{50b}
 J. Moss,¹⁰⁸ R. Mount,¹⁴² E. Mountricha,¹³⁵ S. V. Mouraviev,⁹³ E. J. W. Moyse,⁸³ M. Mudrinic,^{12b} F. Mueller,^{57a}
 J. Mueller,¹²² K. Mueller,²⁰ T. A. Müller,⁹⁷ D. Muenstermann,²⁹ A. Muir,¹⁶⁷ Y. Munwes,¹⁵² W. J. Murray,¹²⁸
 I. Mussche,¹⁰⁴ E. Musto,^{101a,101b} A. G. Myagkov,¹²⁷ M. Myska,¹²⁴ J. Nadal,¹¹ K. Nagai,¹⁵⁹ K. Nagano,⁶⁵
 Y. Nagasaka,⁵⁹ A. M. Nairz,²⁹ Y. Nakahama,²⁹ K. Nakamura,¹⁵⁴ I. Nakano,¹⁰⁹ G. Nanava,²⁰ A. Napier,¹⁶⁰
 M. Nash,^{76,c} N. R. Nation,²¹ T. Nattermann,²⁰ T. Naumann,⁴¹ G. Navarro,¹⁶¹ H. A. Neal,⁸⁶ E. Nebot,⁷⁹
 P. Yu. Nechaeva,⁹³ A. Negri,^{118a,118b} G. Negri,²⁹ S. Nektarijevic,⁴⁸ A. Nelson,⁶³ S. Nelson,¹⁴² T. K. Nelson,¹⁴²
 S. Nemecek,¹²⁴ P. Nemethy,¹⁰⁷ A. A. Nepomuceno,^{23a} M. Nessi,^{29,v} S. Y. Nesterov,¹²⁰ M. S. Neubauer,¹⁶⁴
 A. Neusiedl,⁸⁰ R. M. Neves,¹⁰⁷ P. Nevski,²⁴ P. R. Newman,¹⁷ V. Nguyen Thi Hong,¹³⁵ R. B. Nickerson,¹¹⁷
 R. Nicolaidou,¹³⁵ L. Nicolas,¹³⁸ B. Nicquevert,²⁹ F. Niedercorn,¹¹⁴ J. Nielsen,¹³⁶ T. Niinikoski,²⁹ N. Nikiforou,³⁴
 A. Nikiforov,¹⁵ V. Nikolaenko,¹²⁷ K. Nikolaev,⁶⁴ I. Nikolic-Audit,⁷⁷ K. Nikolics,⁴⁸ K. Nikolopoulos,²⁴ H. Nilsen,⁴⁷
 P. Nilsson,⁷ Y. Ninomiya,¹⁵⁴ A. Nisati,^{131a} T. Nishiyama,⁶⁶ R. Nisius,⁹⁸ L. Nodulman,⁵ M. Nomachi,¹¹⁵
 I. Nomidis,¹⁵³ M. Nordberg,²⁹ B. Nordkvist,^{145a,145b} P. R. Norton,¹²⁸ J. Novakova,¹²⁵ M. Nozaki,⁶⁵ M. Nožička,⁴¹
 L. Nozka,¹¹² I. M. Nugent,^{158a} A.-E. Nuncio-Quiroz,²⁰ G. Nunes Hanninger,⁸⁵ T. Nunnemann,⁹⁷ E. Nurse,⁷⁶
 T. Nyman,²⁹ B. J. O'Brien,⁴⁵ S. W. O'Neale,^{17,e} D. C. O'Neil,¹⁴¹ V. O'Shea,⁵² F. G. Oakham,^{28,f} H. Oberlack,⁹⁸
 J. Ocariz,⁷⁷ A. Ochi,⁶⁶ S. Oda,¹⁵⁴ S. Odaka,⁶⁵ J. Odier,⁸² H. Ogren,⁶⁰ A. Oh,⁸¹ S. H. Oh,⁴⁴ C. C. Ohm,^{145a,145b}
 T. Ohshima,¹⁰⁰ H. Ohshita,¹³⁹ T. K. Ohska,⁶⁵ T. Ohsugi,⁵⁸ S. Okada,⁶⁶ H. Okawa,¹⁶² Y. Okumura,¹⁰⁰ T. Okuyama,¹⁵⁴
 M. Olcese,^{49a} A. G. Olchevski,⁶⁴ M. Oliveira,^{123a,j} D. Oliveira Damazio,²⁴ E. Oliver Garcia,¹⁶⁶ D. Olivito,¹¹⁹
 A. Olszewski,³⁸ J. Olszowska,³⁸ C. Omachi,⁶⁶ A. Onofre,^{123a,w} P. U. E. Onyisi,³⁰ C. J. Oram,^{158a} M. J. Oreglia,³⁰
 Y. Oren,¹⁵² D. Orestano,^{133a,133b} I. Orlov,¹⁰⁶ C. Oropeza Barrera,⁵² R. S. Orr,¹⁵⁷ B. Osculati,^{49a,49b} R. Ospanov,¹¹⁹
 C. Osuna,¹¹ G. Otero y Garzon,²⁶ J. P. Ottersbach,¹⁰⁴ M. Ouchrif,^{134d} F. Ould-Saada,¹¹⁶ A. Ouraou,¹³⁵ Q. Ouyang,^{32a}
 M. Owen,⁸¹ S. Owen,¹³⁸ V. E. Ozcan,^{18a} N. Ozturk,⁷ A. Pacheco Pages,¹¹ C. Padilla Aranda,¹¹ S. Pagan Griso,¹⁴
 E. Paganis,¹³⁸ F. Paige,²⁴ K. Pajchel,¹¹⁶ G. Palacino,^{158b} C. P. Paleari,⁶ S. Palestini,²⁹ D. Pallin,³³ A. Palma,^{123a,b}
 J. D. Palmer,¹⁷ Y. B. Pan,¹⁷¹ E. Panagiotopoulou,⁹ B. Panes,^{31a} N. Panikashvili,⁸⁶ S. Panitkin,²⁴ D. Pantea,^{25a}
 M. Panuskova,¹²⁴ V. Paolone,¹²² A. Papadelis,^{145a} Th. D. Papadopolou,⁹ A. Paramonov,⁵ W. Park,^{24,x}
 M. A. Parker,²⁷ F. Parodi,^{49a,49b} J. A. Parsons,³⁴ U. Parzefall,⁴⁷ E. Pasqualucci,^{131a} A. Passeri,^{133a} F. Pastore,^{133a,133b}
 Fr. Pastore,⁷⁵ G. Pásztor,^{48,y} S. Pataria,¹⁷³ N. Patel,¹⁴⁹ J. R. Pater,⁸¹ S. Patricelli,^{101a,101b} T. Pauly,²⁹ M. Pecszy,^{143a}
 M. I. Pedraza Morales,¹⁷¹ S. V. Peleganchuk,¹⁰⁶ H. Peng,^{32b} R. Pengo,²⁹ A. Penson,³⁴ J. Penwell,⁶⁰ M. Perantoni,^{23a}
 K. Perez,^{34,z} T. Perez Cavalcanti,⁴¹ E. Perez Codina,¹¹ M. T. Pérez García-Estañ,¹⁶⁶ V. Perez Reale,³⁴ L. Perini,^{88a,88b}
 H. Pernegger,²⁹ R. Perrino,^{71a} P. Perrodo,⁴ S. Perseme,^{3a} V. D. Peshekhonov,⁶⁴ B. A. Petersen,²⁹ J. Petersen,²⁹
 T. C. Petersen,³⁵ E. Petit,⁸² A. Petridis,¹⁵³ C. Petridou,¹⁵³ E. Petrolo,^{131a} F. Petrucci,^{133a,133b} D. Petschull,⁴¹
 M. Petteni,¹⁴¹ R. Pezoa,^{31b} A. Phan,⁸⁵ A. W. Phillips,²⁷ P. W. Phillips,¹²⁸ G. Piacquadio,²⁹ E. Piccaro,⁷⁴
 M. Piccinini,^{19a,19b} A. Pickford,⁵² S. M. Piec,⁴¹ R. Piegai,²⁶ J. E. Pilcher,³⁰ A. D. Pilkington,⁸¹ J. Pina,^{123a,b}
 M. Pinamonti,^{163a,163c} A. Pinder,¹¹⁷ J. L. Pinfold,² J. Ping,^{32c} B. Pinto,^{123a,b} O. Pirotte,²⁹ C. Pizio,^{88a,88b}

R. Placakyte,⁴¹ M. Plamondon,¹⁶⁸ W. G. Plano,⁸¹ M.-A. Pleier,²⁴ A. V. Pleskach,¹²⁷ A. Poblaguev,²⁴ S. Poddar,^{57a} F. Podlyski,³³ L. Poggioli,¹¹⁴ T. Poghosyan,²⁰ M. Pohl,⁴⁸ F. Polci,⁵⁴ G. Polesello,^{118a} A. Policicchio,¹³⁷ A. Polini,^{19a} J. Poll,⁷⁴ V. Polychronakos,²⁴ D. M. Pomarede,¹³⁵ D. Pomeroy,²² K. Pommès,²⁹ L. Pontecorvo,^{131a} B. G. Pope,⁸⁷ G. A. Popeneciu,^{25a} D. S. Popovic,^{12a} A. Poppleton,²⁹ X. Portell Bueso,²⁹ R. Porter,¹⁶² C. Posch,²¹ G. E. Pospelov,⁹⁸ S. Pospisil,¹²⁶ I. N. Potrap,⁹⁸ C. J. Potter,¹⁴⁸ C. T. Potter,¹¹³ G. Poulard,²⁹ J. Poveda,¹⁷¹ R. Prabhu,⁷⁶ P. Pralavorio,⁸² S. Prasad,⁵⁶ R. Pravahan,⁷ S. Prell,⁶³ K. Pretzl,¹⁶ L. Pribyl,²⁹ D. Price,⁶⁰ J. Price,⁷² L. E. Price,⁵ M. J. Price,²⁹ P. M. Prichard,⁷² D. Prieur,¹²² M. Primavera,^{71a} K. Prokofiev,¹⁰⁷ F. Prokoshin,^{31b} S. Protopopescu,²⁴ J. Proudfoot,⁵ X. Prudent,⁴³ H. Przysieszniak,⁴ S. Psoroulas,²⁰ E. Ptacek,¹¹³ E. Pueschel,⁸³ J. Purdham,⁸⁶ M. Purohit,^{24,x} P. Puzo,¹¹⁴ Y. Pylypchenko,¹¹⁶ J. Qian,⁸⁶ Z. Qian,⁸² Z. Qin,⁴¹ A. Quadt,⁵³ D. R. Quarrie,¹⁴ W. B. Quayle,¹⁷¹ F. Quinonez,^{31a} M. Raas,¹⁰³ V. Radescu,^{57b} B. Radics,²⁰ T. Rador,^{18a} F. Ragusa,^{88a,88b} G. Rahal,¹⁷⁶ A. M. Rahimi,¹⁰⁸ D. Rahm,²⁴ S. Rajagopalan,²⁴ M. Rammensee,⁴⁷ M. Rammes,¹⁴⁰ M. Ramstedt,^{145a,145b} A. S. Randle-Conde,³⁹ K. Randrianarivony,²⁸ P. N. Ratoff,⁷⁰ F. Rauscher,⁹⁷ E. Rauter,⁹⁸ M. Raymond,²⁹ A. L. Read,¹¹⁶ D. M. Rebutzi,^{118a,118b} A. Redelbach,¹⁷² G. Redlinger,²⁴ R. Reece,¹¹⁹ K. Reeves,⁴⁰ A. Reichold,¹⁰⁴ E. Reinherz-Aronis,¹⁵² A. Reinsch,¹¹³ I. Reisinger,⁴² D. Reljic,^{12a} C. Rembser,²⁹ Z. L. Ren,¹⁵⁰ A. Renaud,¹¹⁴ P. Renkel,³⁹ M. Rescigno,^{131a} S. Resconi,^{88a} B. Resende,¹³⁵ P. Reznicek,⁹⁷ R. Rezvani,¹⁵⁷ A. Richards,⁷⁶ R. Richter,⁹⁸ E. Richter-Was,^{4,aa} M. Ridel,⁷⁷ S. Rieke,⁸⁰ M. Rijpstra,¹⁰⁴ M. Rijssenbeek,^{a147} A. Rimoldi,^{118a,118b} L. Rinaldi,^{19a} R. R. Rios,³⁹ I. Riu,¹¹ G. Rivoltella,^{88a,88b} F. Rizatdinova,¹¹¹ E. Rizvi,⁷⁴ S. H. Robertson,^{84,1} A. Robichaud-Veronneau,¹¹⁷ D. Robinson,²⁷ J. E. M. Robinson,⁷⁶ M. Robinson,¹¹³ A. Robson,⁵² J. G. Rocha de Lima,¹⁰⁵ C. Roda,^{121a,121b} D. Roda Dos Santos,²⁹ S. Rodier,⁷⁹ D. Rodriguez,¹⁶¹ A. Roe,⁵³ S. Roe,²⁹ O. Røhne,¹¹⁶ V. Rojo,¹ S. Rolli,¹⁶⁰ A. Romaniouk,⁹⁵ V. M. Romanov,⁶⁴ G. Romeo,²⁶ L. Roos,⁷⁷ E. Ros,¹⁶⁶ S. Rosati,^{131a,131b} K. Rosbach,⁴⁸ A. Rose,^{a148} M. Rose,⁷⁵ G. A. Rosenbaum,¹⁵⁷ E. I. Rosenberg,⁶³ P. L. Rosendahl,¹³ O. Rosenthal,¹⁴⁰ L. Rosselet,⁴⁸ V. Rossetti,¹¹ E. Rossi,^{131a,131b} L. P. Rossi,^{49a} L. Rossi,^{88a,88b} M. Rotaru,^{25a} I. Roth,¹⁷⁰ J. Rothberg,¹³⁷ D. Rousseau,¹¹⁴ C. R. Royon,¹³⁵ A. Rozanov,⁸² Y. Rozen,¹⁵¹ X. Ruan,¹¹⁴ I. Rubinskiy,⁴¹ B. Ruckert,⁹⁷ N. Ruckstuhl,¹⁰⁴ V. I. Rud,⁹⁶ C. Rudolph,⁴³ G. Rudolph,⁶¹ F. Rühr,⁶ F. Ruggieri,^{133a,133b} A. Ruiz-Martinez,⁶³ E. Rulikowska-Zarebska,³⁷ V. Rumiantsev,^{90,e} L. Romyantsev,⁶⁴ K. Runge,⁴⁷ O. Runolfsson,²⁰ Z. Rurikova,⁴⁷ N. A. Rusakovich,⁶⁴ D. R. Rust,⁶⁰ J. P. Rutherford,⁶ C. Ruwiedel,¹⁴ P. Ruzicka,¹²⁴ Y. F. Ryabov,¹²⁰ V. Ryadovikov,¹²⁷ P. Ryan,⁸⁷ M. Rybar,¹²⁵ G. Rybkin,¹¹⁴ N. C. Ryder,¹¹⁷ S. Rzaeva,¹⁰ A. F. Saavedra,¹⁴⁹ I. Sadeh,¹⁵² H. F.-W. Sadrozinski,¹³⁶ R. Sadykov,⁶⁴ F. Safai Tehrani,^{131a,131b} H. Sakamoto,¹⁵⁴ G. Salamanna,⁷⁴ A. Salamon,^{132a} M. Saleem,¹¹⁰ D. Salihagic,⁹⁸ A. Salnikov,¹⁴² J. Salt,¹⁶⁶ B. M. Salvachua Ferrando,⁵ D. Salvatore,^{36a,36b} F. Salvatore,^{a148} A. Salvucci,¹⁰³ A. Salzburger,²⁹ D. Sampsonidis,¹⁵³ B. H. Samset,¹¹⁶ A. Sanchez,^{101a,101b} H. Sandaker,¹³ H. G. Sander,⁸⁰ M. P. Sanders,⁹⁷ M. Sandhoff,¹⁷³ T. Sandoval,²⁷ C. Sandoval,¹⁶¹ R. Sandstroem,⁹⁸ S. Sandvoss,¹⁷³ D. P. C. Sankey,¹²⁸ A. Sansoni,⁴⁶ C. Santamarina Rios,⁸⁴ C. Santoni,³³ R. Santonico,^{132a,132b} H. Santos,^{123a} J. G. Saraiva,^{123a,b} T. Sarangi,¹⁷¹ E. Sarkisyan-Grinbaum,⁷ F. Sarri,^{121a,121b} G. Sartisohn,¹⁷³ O. Sasaki,⁶⁵ T. Sasaki,⁶⁵ N. Sasao,⁶⁷ I. Satsounkevitch,⁸⁹ G. Sauvage,⁴ E. Sauvan,⁴ J. B. Sauvan,¹¹⁴ P. Savard,^{157,f} V. Savinov,¹²² D. O. Savu,²⁹ P. Savva,⁹ L. Sawyer,^{24,n} D. H. Saxon,⁵² L. P. SAYS,³³ C. Sbarra,^{19a,19b} A. Sbrizzi,^{19a,19b} O. Scallan,⁹² D. A. Scannicchio,¹⁶² J. Schaarschmidt,¹¹⁴ P. Schacht,⁹⁸ U. Schäfer,⁸⁰ S. Schaepe,²⁰ S. Schaezel,^{57a,57b} A. C. Schaffer,¹¹⁴ D. Schaile,⁹⁷ R. D. Schamberger,^{a147} A. G. Schamov,¹⁰⁶ V. Scharf,^{57a} V. A. Schegelsky,¹²⁰ D. Scheirich,⁸⁶ M. Schernau,¹⁶² M. I. Scherzer,¹⁴ C. Schiavi,^{49a,49b} J. Schieck,⁹⁷ M. Schioppa,^{36a,36b} S. Schlenker,²⁹ J. L. Schlereth,⁵ E. Schmidt,⁴⁷ K. Schmieden,²⁰ C. Schmitt,⁸⁰ S. Schmitt,^{57b} M. Schmitz,²⁰ A. Schöning,^{57b} M. Schott,²⁹ D. Schouten,¹⁴¹ J. Schovancova,¹²⁴ M. Schram,⁸⁴ C. Schroeder,⁸⁰ N. Schroer,^{57c} S. Schuh,²⁹ G. Schuler,²⁹ J. Schultes,¹⁷³ H.-C. Schultz-Coulon,^{57a} H. Schulz,¹⁵ J. W. Schumacher,²⁰ M. Schumacher,⁴⁷ B. A. Schumm,¹³⁶ Ph. Schune,¹³⁵ C. Schwanenberger,⁸¹ A. Schwartzman,¹⁴² Ph. Schwemling,⁷⁷ R. Schwienhorst,⁸⁷ R. Schwierz,⁴³ J. Schwindling,¹³⁵ T. Schwindt,²⁰ W. G. Scott,¹²⁸ J. Searcy,¹¹³ E. Sedykh,¹²⁰ E. Segura,¹¹ S. C. Seidel,¹⁰² A. Seiden,¹³⁶ F. Seifert,⁴³ J. M. Seixas,^{23a} G. Sekhniaidze,^{101a} D. M. Seliverstov,¹²⁰ B. Selliden,^{145a} G. Sellers,⁷² M. Seman,^{143b} N. Semprini-Cesari,^{19a,19b} C. Serfon,⁹⁷ L. Serin,¹¹⁴ R. Seuster,⁹⁸ H. Severini,¹¹⁰ M. E. Sevier,⁸⁵ A. Sfyrla,²⁹ E. Shabalina,⁵³ M. Shamim,¹¹³ L. Y. Shan,^{32a} J. T. Shank,²¹ Q. T. Shao,⁸⁵ M. Shapiro,¹⁴ P. B. Shatalov,⁹⁴ L. Shaver,⁶ K. Shaw,^{163a,163c} D. Sherman,¹⁷⁴ P. Sherwood,⁷⁶ A. Shibata,¹⁰⁷ H. Shichi,¹⁰⁰ S. Shimizu,²⁹ M. Shimojima,⁹⁹ T. Shin,⁵⁵ A. Shmeleva,⁹³ M. J. Shochet,³⁰ D. Short,¹¹⁷ M. A. Shupe,⁶ P. Sicho,¹²⁴ A. Sidoti,^{131a,131b} A. Siebel,¹⁷³ F. Siegert,⁴⁷ J. Siegrist,¹⁴ Dj. Sijacki,^{12a} O. Silbert,¹⁷⁰ J. Silva,^{123a,b} Y. Silver,¹⁵² D. Silverstein,¹⁴² S. B. Silverstein,^{145a} V. Simak,¹²⁶ O. Simard,¹³⁵ Lj. Simic,^{12a} S. Simion,¹¹⁴ B. Simmons,⁷⁶ M. Simonyan,³⁵ P. Sinervo,¹⁵⁷ N. B. Sinev,¹¹³ V. Sipica,¹⁴⁰ G. Siragusa,¹⁷² A. Sircar,²⁴ A. N. Sisakyan,⁶⁴

S.Yu. Sivoklokov,⁹⁶ J. Sjölin,^{145a,145b} T. B. Sjørnsen,¹³ L. A. Skinnari,¹⁴ K. Skovpen,¹⁰⁶ P. Skubic,¹¹⁰ N. Skvorodnev,²² M. Slater,¹⁷ T. Slavicek,¹²⁶ K. Sliwa,¹⁶⁰ T. J. Sloan,⁷⁰ J. Sloper,²⁹ V. Smakhtin,¹⁷⁰ S. Yu. Smirnov,⁹⁵ L. N. Smirnova,⁹⁶ O. Smirnova,⁷⁸ B. C. Smith,⁵⁶ D. Smith,¹⁴² K. M. Smith,⁵² M. Smizanska,⁷⁰ K. Smolek,¹²⁶ A. A. Snesarev,⁹³ S. W. Snow,⁸¹ J. Snow,¹¹⁰ J. Snuverink,¹⁰⁴ S. Snyder,²⁴ M. Soares,^{123a} R. Sobie,^{168,1} J. Sodomka,¹²⁶ A. Soffer,¹⁵² C. A. Solans,¹⁶⁶ M. Solar,¹²⁶ J. Solc,¹²⁶ E. Soldatov,⁹⁵ U. Soldevila,¹⁶⁶ E. Solfaroli Camillocci,^{131a,131b} A. A. Solodkov,¹²⁷ O. V. Solovyanov,¹²⁷ J. Sondericker,²⁴ N. Soni,² V. Sopko,¹²⁶ B. Sopko,¹²⁶ M. Sorbi,^{88a,88b} M. Sosebee,⁷ A. Soukharev,¹⁰⁶ S. Spagnolo,^{71a,71b} F. Spanò,⁷⁵ R. Spighi,^{19a} G. Spigo,²⁹ F. Spila,^{131a,131b} E. Spiriti,^{133a} R. Spiwoaks,²⁹ M. Spousta,¹²⁵ T. Spreitzer,¹⁵⁷ B. Spurlock,⁷ R. D. St. Denis,⁵² T. Stahl,¹⁴⁰ J. Stahlman,¹¹⁹ R. Stamen,^{57a} E. Stanecka,²⁹ R. W. Stanek,⁵ C. Stancu,^{133a} S. Stapnes,¹¹⁶ E. A. Starchenko,¹²⁷ J. Stark,⁵⁴ P. Staroba,¹²⁴ P. Starovoitov,⁹⁰ A. Staude,⁹⁷ P. Stavina,^{143a} G. Stavropoulos,¹⁴ G. Steele,⁵² P. Steinbach,⁴³ P. Steinberg,²⁴ I. Stekl,¹²⁶ B. Stelzer,¹⁴¹ H. J. Stelzer,⁸⁷ O. Stelzer-Chilton,^{158a} H. Stenzel,⁵¹ K. Stevenson,⁷⁴ G. A. Stewart,²⁹ J. A. Stillings,²⁰ T. Stockmanns,²⁰ M. C. Stockton,²⁹ K. Stoerig,⁴⁷ G. Stoicea,^{25a} S. Stonjek,⁹⁸ P. Strachota,¹²⁵ A. R. Stradling,⁷ A. Straessner,⁴³ J. Strandberg,¹⁴⁶ S. Strandberg,^{145a,145b} A. Strandlie,¹¹⁶ M. Strang,¹⁰⁸ E. Strauss,¹⁴² M. Strauss,¹¹⁰ P. Strizenec,^{143b} R. Ströhmer,¹⁷² D. M. Strom,¹¹³ J. A. Strong,^{75,e} R. Stroynowski,³⁹ J. Strube,¹²⁸ B. Stugu,¹³ I. Stumer,^{24,e} J. Stupak,^{a147} P. Sturm,¹⁷³ D. A. Soh,^{150,s} D. Su,¹⁴² HS. Subramania,² A. Succurro,¹¹ Y. Sugaya,¹¹⁵ T. Sugimoto,¹⁰⁰ C. Suhr,¹⁰⁵ K. Suita,⁶⁶ M. Suk,¹²⁵ V. V. Sulin,⁹³ S. Sultansoy,^{3d} T. Sumida,²⁹ X. Sun,⁵⁴ J. E. Sundermann,⁴⁷ K. Suruliz,¹³⁸ S. Sushkov,¹¹ G. Susinno,^{36a,36b} M. R. Sutton,^{a148} Y. Suzuki,⁶⁵ Y. Suzuki,⁶⁶ M. Svatos,¹²⁴ Yu. M. Sviridov,¹²⁷ S. Swedish,¹⁶⁷ I. Sykora,^{143a} T. Sykora,¹²⁵ B. Szeless,²⁹ J. Sánchez,¹⁶⁶ D. Ta,¹⁰⁴ K. Tackmann,⁴¹ A. Taffard,¹⁶² R. Tafirout,^{158a} N. Taiblum,¹⁵² Y. Takahashi,¹⁰⁰ H. Takai,²⁴ R. Takashima,⁶⁸ H. Takeda,⁶⁶ T. Takeshita,¹³⁹ M. Talby,⁸² A. Talyshv,¹⁰⁶ M. C. Tamssett,²⁴ J. Tanaka,¹⁵⁴ R. Tanaka,¹¹⁴ S. Tanaka,¹³⁰ S. Tanaka,⁶⁵ Y. Tanaka,⁹⁹ K. Tani,⁶⁶ N. Tannoury,⁸² G. P. Tappern,²⁹ S. Tapprogge,⁸⁰ D. Tardif,¹⁵⁷ S. Tarem,¹⁵¹ F. Tarrade,²⁸ G. F. Tartarelli,^{88a} P. Tas,¹²⁵ M. Tasevsky,¹²⁴ E. Tassi,^{36a,36b} M. Tatarkhanov,¹⁴ Y. Tayalati,^{134d} C. Taylor,⁷⁶ F. E. Taylor,⁹¹ G. N. Taylor,⁸⁵ W. Taylor,^{158b} M. Teinturier,¹¹⁴ M. Teixeira Dias Castanheira,⁷⁴ P. Teixeira-Dias,⁷⁵ K. K. Temming,⁴⁷ H. Ten Kate,²⁹ P. K. Teng,¹⁵⁰ S. Terada,⁶⁵ K. Terashi,¹⁵⁴ J. Terron,⁷⁹ M. Terwort,^{41,q} M. Testa,⁴⁶ R. J. Teuscher,^{157,1} J. Thadome,¹⁷³ J. Therhaag,²⁰ T. Theveneaux-Pelzer,⁷⁷ M. Thioye,¹⁷⁴ S. Thoma,⁴⁷ J. P. Thomas,¹⁷ E. N. Thompson,⁸³ P. D. Thompson,¹⁷ P. D. Thompson,¹⁵⁷ A. S. Thompson,⁵² E. Thomson,¹¹⁹ M. Thomson,²⁷ R. P. Thun,⁸⁶ F. Tian,³⁴ T. Tic,¹²⁴ V. O. Tikhomirov,⁹³ Y. A. Tikhonov,¹⁰⁶ C. J. W. P. Timmermans,¹⁰³ P. Tipton,¹⁷⁴ F. J. Tique Aires Viegas,²⁹ S. Tisserant,⁸² J. Tobias,⁴⁷ B. Toczec,³⁷ T. Todorov,⁴ S. Todorova-Nova,¹⁶⁰ B. Toggerson,¹⁶² J. Tojo,⁶⁵ S. Tokár,^{143a} K. Tokunaga,⁶⁶ K. Tokushuku,⁶⁵ K. Tollefson,⁸⁷ M. Tomoto,¹⁰⁰ L. Tompkins,¹⁴ K. Toms,¹⁰² G. Tong,^{32a} A. Tonoyan,¹³ C. Topfel,¹⁶ N. D. Topilin,⁶⁴ I. Torchiani,²⁹ E. Torrence,¹¹³ H. Torres,⁷⁷ E. Torró Pastor,¹⁶⁶ J. Toth,^{82,y} F. Touchard,⁸² D. R. Tovey,¹³⁸ D. Traynor,⁷⁴ T. Trefzger,¹⁷² L. Tremblet,²⁹ A. Tricoli,²⁹ I. M. Trigger,^{158a} S. Trincz-Duvoid,⁷⁷ T. N. Trinh,⁷⁷ M. F. Tripania,⁶⁹ W. Trischuk,¹⁵⁷ A. Trivedi,^{24,x} B. Trocmé,⁵⁴ C. Troncon,^{88a} M. Trotter-McDonald,¹⁴¹ A. Trzupek,³⁸ C. Tsarouchas,²⁹ J. C.-L. Tseng,¹¹⁷ M. Tsiakiris,¹⁰⁴ P. V. Tsiarshka,⁸⁹ D. Tsiou,⁴ G. Tsiopolitis,⁹ V. Tsiskaridze,⁴⁷ E. G. Tskhadadze,^{50a} I. I. Tsukerman,⁹⁴ V. Tsulaia,¹⁴ J.-W. Tsung,²⁰ S. Tsuno,⁶⁵ D. Tsybychev,^{a147} A. Tua,¹³⁸ J. M. Tuggle,³⁰ M. Turala,³⁸ D. Turecek,¹²⁶ I. Turk Cakir,^{3e} E. Turlay,¹⁰⁴ R. Turra,^{88a,88b} P. M. Tuts,³⁴ A. Tykhonov,⁷³ M. Tylmad,^{145a,145b} M. Tyndel,¹²⁸ H. Tyrvaäinen,²⁹ G. Tzanakos,⁸ K. Uchida,²⁰ I. Ueda,¹⁵⁴ R. Ueno,²⁸ M. Uglund,¹³ M. Uhlenbrock,²⁰ M. Uhrmacher,⁵³ F. Ukegawa,¹⁵⁹ G. Unal,²⁹ D. G. Underwood,⁵ A. Undrus,²⁴ G. Unel,¹⁶² Y. Unno,⁶⁵ D. Urbaniec,³⁴ E. Urkovsky,¹⁵² P. Urrejola,^{31a} G. Usai,⁷ M. Uslenghi,^{118a,118b} L. Vacavant,⁸² V. Vacek,¹²⁶ B. Vachon,⁸⁴ S. Vahsen,¹⁴ J. Valenta,¹²⁴ P. Valente,^{131a} S. Valentinetti,^{19a,19b} S. Valkar,¹²⁵ E. Valladolid Gallego,¹⁶⁶ S. Vallecorsa,¹⁵¹ J. A. Valls Ferrer,¹⁶⁶ H. van der Graaf,¹⁰⁴ E. van der Kraaij,¹⁰⁴ R. Van Der Leeuw,¹⁰⁴ E. van der Poel,¹⁰⁴ D. van der Ster,²⁹ B. Van Eijk,¹⁰⁴ N. van Eldik,⁸³ P. van Gemmeren,⁵ Z. van Kesteren,¹⁰⁴ I. van Vulpen,¹⁰⁴ W. Vandelli,²⁹ G. Vandoni,²⁹ A. Vaniachine,⁵ P. Vankov,⁴¹ F. Vannucci,⁷⁷ F. Varela Rodriguez,²⁹ R. Vari,^{131a} D. Varouchas,¹⁴ A. Vartapetian,⁷ K. E. Varvell,¹⁴⁹ V. I. Vassilikopoulos,⁵⁵ F. Vazeille,³³ G. Vegni,^{88a,88b} J. J. Veillet,¹¹⁴ C. Vellidis,⁸ F. Veloso,^{123a} R. Veness,²⁹ S. Veneziano,^{131a} A. Ventura,^{71a,71b} D. Ventura,¹³⁷ M. Venturi,⁴⁷ N. Venturi,¹⁶ V. Vercesi,^{118a} M. Verducci,¹³⁷ W. Verkerke,¹⁰⁴ J. C. Vermeulen,¹⁰⁴ A. Vest,⁴³ M. C. Vetterli,^{141,f} I. Vichou,¹⁶⁴ T. Vickey,^{144b,bb} O. E. Vickey Boeriu,^{144b} G. H. A. Viehhauser,¹¹⁷ S. Viel,¹⁶⁷ M. Villa,^{19a,19b} M. Villaplana Perez,¹⁶⁶ E. Vilucchi,⁴⁶ M. G. Vincker,²⁸ E. Vinek,²⁹ V. B. Vinogradov,⁶⁴ M. Virchaux,^{135,e} J. Virzi,¹⁴ O. Vitells,¹⁷⁰ M. Viti,⁴¹ I. Vivarelli,⁴⁷ F. Vives Vaque,² S. Vlachos,⁹ M. Vlasak,¹²⁶ N. Vlasov,²⁰ A. Vogel,²⁰ P. Vokac,¹²⁶ G. Volpi,⁴⁶ M. Volpi,⁸⁵ G. Volpini,^{88a} H. von der Schmitt,⁹⁸ J. von Loeben,⁹⁸ H. von Radziewski,⁴⁷ E. von Toerne,²⁰ V. Vorobel,¹²⁵

A. P. Vorobiev,¹²⁷ V. Vorwerk,¹¹ M. Vos,¹⁶⁶ R. Voss,²⁹ T. T. Voss,¹⁷³ J. H. Vosseveld,⁷² N. Vranjes,^{12a} M. Vranjes Milosavljevic,¹⁰⁴ V. Vrba,¹²⁴ M. Vreeswijk,¹⁰⁴ T. Vu Anh,⁸⁰ R. Vuillermet,²⁹ I. Vukotic,¹¹⁴ W. Wagner,¹⁷³ P. Wagner,¹¹⁹ H. Wahlen,¹⁷³ J. Wakabayashi,¹⁰⁰ J. Walbersloh,⁴² S. Walch,⁸⁶ J. Walder,⁷⁰ R. Walker,⁹⁷ W. Walkowiak,¹⁴⁰ R. Wall,¹⁷⁴ P. Waller,⁷² C. Wang,⁴⁴ H. Wang,¹⁷¹ H. Wang,^{32b,cc} J. Wang,¹⁵⁰ J. Wang,^{32d} J. C. Wang,¹³⁷ R. Wang,¹⁰² S. M. Wang,¹⁵⁰ A. Warburton,⁸⁴ C. P. Ward,²⁷ M. Warsinsky,⁴⁷ P. M. Watkins,¹⁷ A. T. Watson,¹⁷ M. F. Watson,¹⁷ G. Watts,¹³⁷ S. Watts,⁸¹ A. T. Waugh,¹⁴⁹ B. M. Waugh,⁷⁶ J. Weber,⁴² M. Weber,¹²⁸ M. S. Weber,¹⁶ P. Weber,⁵³ A. R. Weidberg,¹¹⁷ P. Weigell,⁹⁸ J. Weingarten,⁵³ C. Weiser,⁴⁷ H. Wellenstein,²² P. S. Wells,²⁹ M. Wen,⁴⁶ T. Wenaus,²⁴ S. Wendler,¹²² Z. Weng,¹⁵⁰ T. Wengler,²⁹ S. Wenig,²⁹ N. Vermes,²⁰ M. Werner,⁴⁷ P. Werner,²⁹ M. Werth,¹⁶² M. Wessels,^{57a} C. Weydert,⁵⁴ K. Whalen,²⁸ S. J. Wheeler-Ellis,¹⁶² S. P. Whitaker,²¹ A. White,⁷ M. J. White,⁸⁵ S. R. Whitehead,¹¹⁷ D. Whiteson,¹⁶² D. Whittington,⁶⁰ F. Wicek,¹¹⁴ D. Wicke,¹⁷³ F. J. Wickens,¹²⁸ W. Wiedenmann,¹⁷¹ M. Wielers,¹²⁸ P. Wienemann,²⁰ C. Wiglesworth,⁷⁴ L. A. M. Wiik,⁴⁷ P. A. Wijeratne,⁷⁶ A. Wildauer,¹⁶⁶ M. A. Wildt,^{41,q} I. Wilhelm,¹²⁵ H. G. Wilkens,²⁹ J. Z. Will,⁹⁷ E. Williams,³⁴ H. H. Williams,¹¹⁹ W. Willis,³⁴ S. Willocq,⁸³ J. A. Wilson,¹⁷ M. G. Wilson,¹⁴² A. Wilson,⁸⁶ I. Wingerter-Seez,⁴ S. Winkelmann,⁴⁷ F. Winklmeier,²⁹ M. Wittgen,¹⁴² M. W. Wolter,³⁸ H. Wolters,^{123a,j} W. C. Wong,⁴⁰ G. Wooden,⁸⁶ B. K. Wosiek,³⁸ J. Wotschack,²⁹ M. J. Woudstra,⁸³ K. Wraight,⁵² C. Wright,⁵² B. Wrona,⁷² S. L. Wu,¹⁷¹ X. Wu,⁴⁸ Y. Wu,^{32b,dd} E. Wulf,³⁴ R. Wunstorf,⁴² B. M. Wynne,⁴⁵ L. Xaplanteris,⁹ S. Xella,³⁵ S. Xie,⁴⁷ Y. Xie,^{32a} C. Xu,^{32b,ee} D. Xu,¹³⁸ G. Xu,^{32a} B. Yabsley,¹⁴⁹ S. Yacoub,^{144b} M. Yamada,⁶⁵ H. Yamaguchi,¹⁵⁴ A. Yamamoto,⁶⁵ K. Yamamoto,⁶³ S. Yamamoto,¹⁵⁴ T. Yamamura,¹⁵⁴ T. Yamanaka,¹⁵⁴ J. Yamaoka,⁴⁴ T. Yamazaki,¹⁵⁴ Y. Yamazaki,⁶⁶ Z. Yan,²¹ H. Yang,⁸⁶ U. K. Yang,⁸¹ Y. Yang,⁶⁰ Y. Yang,^{32a} Z. Yang,^{145a,145b} S. Yanush,⁹⁰ Y. Yao,¹⁴ Y. Yasu,⁶⁵ G. V. Ybeles Smit,¹²⁹ J. Ye,³⁹ S. Ye,²⁴ M. Yilmaz,^{3c} R. Yoosoofmiya,¹²² K. Yorita,¹⁶⁹ R. Yoshida,⁵ C. Young,¹⁴² S. Youssef,²¹ D. Yu,²⁴ J. Yu,⁷ J. Yu,^{32c,ee} L. Yuan,^{32a,ff} A. Yurkewicz,^{a147} V. G. Zaets,¹²⁷ R. Zaidan,⁶² A. M. Zaitsev,¹²⁷ Z. Zajacova,²⁹ Yo. K. Zalite,¹²⁰ L. Zanello,^{131a,131b} P. Zarzhitsky,³⁹ A. Zaytsev,¹⁰⁶ C. Zeitnitz,¹⁷³ M. Zeller,¹⁷⁴ M. Zeman,¹²⁴ A. Zemla,³⁸ C. Zender,²⁰ O. Zenin,¹²⁷ T. Ženiš,^{143a} Z. Zenonos,^{121a,121b} S. Zenz,¹⁴ D. Zerwas,¹¹⁴ G. Zevi della Porta,⁵⁶ Z. Zhan,^{32d} D. Zhang,^{32b,cc} H. Zhang,⁸⁷ J. Zhang,⁵ X. Zhang,^{32d} Z. Zhang,¹¹⁴ L. Zhao,¹⁰⁷ T. Zhao,¹³⁷ Z. Zhao,^{32b} A. Zhemchugov,⁶⁴ S. Zheng,^{32a} J. Zhong,^{150,gg} B. Zhou,⁸⁶ N. Zhou,¹⁶² Y. Zhou,¹⁵⁰ C. G. Zhu,^{32d} H. Zhu,⁴¹ J. Zhu,⁸⁶ Y. Zhu,¹⁷¹ X. Zhuang,⁹⁷ V. Zhuravlov,⁹⁸ D. Zieminska,⁶⁰ R. Zimmermann,²⁰ S. Zimmermann,²⁰ S. Zimmermann,⁴⁷ M. Ziolkowski,¹⁴⁰ R. Zitoun,⁴ L. Živković,³⁴ V. V. Zmouchko,^{127,e} G. Zobernig,¹⁷¹ A. Zoccoli,^{19a,19b} Y. Zolnierowski,⁴ A. Zsenei,²⁹ M. zur Nedden,¹⁵ V. Zutshi,¹⁰⁵ and L. Zwalinski²⁹

(ATLAS Collaboration)

¹University at Albany, Albany New York, USA²Department of Physics, University of Alberta, Edmonton AB, Canada^{3a}Department of Physics, Ankara University, Ankara, Turkey^{3b}Department of Physics, Dumlupinar University, Kutahya, Turkey^{3c}Department of Physics, Gazi University, Ankara, Turkey^{3d}Division of Physics, TOBB University of Economics and Technology, Ankara, Turkey^{3e}Turkish Atomic Energy Authority, Ankara, Turkey⁴LAPP, CNRS/IN2P3 and Université de Savoie, Annecy-le-Vieux, France⁵High Energy Physics Division, Argonne National Laboratory, Argonne Illinois, USA⁶Department of Physics, University of Arizona, Tucson Arizona, USA⁷Department of Physics, The University of Texas at Arlington, Arlington Texas, USA⁸Physics Department, University of Athens, Athens, Greece⁹Physics Department, National Technical University of Athens, Zografou, Greece¹⁰Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan¹¹Institut de Física d'Altes Energies and Departament de Física de la Universitat Autònoma de Barcelona and ICREA, Barcelona, Spain^{12a}Institute of Physics, University of Belgrade, Belgrade, Serbia^{12b}Vinca Institute of Nuclear Sciences, Belgrade, Serbia¹³Department for Physics and Technology, University of Bergen, Bergen, Norway¹⁴Physics Division, Lawrence Berkeley National Laboratory and University of California, Berkeley California, USA¹⁵Department of Physics, Humboldt University, Berlin, Germany¹⁶Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland¹⁷School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom

- ^{18a}*Department of Physics, Bogazici University, Istanbul, Turkey*
^{18b}*Division of Physics, Dogus University, Istanbul, Turkey*
^{18c}*Department of Physics Engineering, Gaziantep University, Gaziantep, Turkey*
^{18d}*Department of Physics, Istanbul Technical University, Istanbul, Turkey*
^{19a}*INFN Sezione di Bologna, Italy*
^{19b}*Dipartimento di Fisica, Università di Bologna, Bologna, Italy*
²⁰*Physikalisches Institut, University of Bonn, Bonn, Germany*
²¹*Department of Physics, Boston University, Boston Massachusetts, USA*
²²*Department of Physics, Brandeis University, Waltham Massachusetts, USA*
^{23a}*Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro, Brazil*
^{23b}*Federal University of Juiz de Fora (UFJF), Juiz de Fora, Brazil*
^{23c}*Federal University of Sao Joao del Rei (UFSJ), Sao Joao del Rei, Brazil*
^{23d}*Instituto de Fisica, Universidade de Sao Paulo, Sao Paulo, Brazil*
²⁴*Physics Department, Brookhaven National Laboratory, Upton New York, USA*
^{25a}*National Institute of Physics and Nuclear Engineering, Bucharest, Romania*
^{25b}*University Politehnica Bucharest, Bucharest, Romania*
^{25c}*West University in Timisoara, Timisoara, Romania*
²⁶*Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina*
²⁷*Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom*
²⁸*Department of Physics, Carleton University, Ottawa ON, Canada*
²⁹*CERN, Geneva, Switzerland*
³⁰*Enrico Fermi Institute, University of Chicago, Chicago Illinois, USA*
^{31a}*Departamento de Física, Pontificia Universidad Católica de Chile, Santiago, Chile*
^{31b}*Departamento de Física, Universidad Técnica Federico Santa María, Valparaíso, Chile*
^{32a}*Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China*
^{32b}*Department of Modern Physics, University of Science and Technology of China, Anhui, China*
^{32c}*Department of Physics, Nanjing University, Jiangsu, China*
^{32d}*High Energy Physics Group, Shandong University, Shandong, China*
³³*Laboratoire de Physique Corpusculaire, Clermont Université and Université Blaise Pascal and CNRS/IN2P3, Aubiere Cedex, France*
³⁴*Nevis Laboratory, Columbia University, Irvington New York, USA*
³⁵*Niels Bohr Institute, University of Copenhagen, Kobenhavn, Denmark*
^{36a}*INFN Gruppo Collegato di Cosenza, Italy*
^{36b}*Dipartimento di Fisica, Università della Calabria, Arcavata di Rende, Italy*
³⁷*Faculty of Physics and Applied Computer Science, AGH-University of Science and Technology, Krakow, Poland*
³⁸*The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland*
³⁹*Physics Department, Southern Methodist University, Dallas Texas, USA*
⁴⁰*Physics Department, University of Texas at Dallas, Richardson Texas, USA*
⁴¹*DESY, Hamburg and Zeuthen, Germany*
⁴²*Institut für Experimentelle Physik IV, Technische Universität Dortmund, Dortmund, Germany*
⁴³*Institut für Kern- und Teilchenphysik, Technical University Dresden, Dresden, Germany*
⁴⁴*Department of Physics, Duke University, Durham North Carolina, USA*
⁴⁵*SUPA-School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom*
⁴⁶*INFN Laboratori Nazionali di Frascati, Frascati, Italy*
⁴⁷*Fakultät für Mathematik und Physik, Albert-Ludwigs-Universität, Freiburg i. Br., Germany*
⁴⁸*Section de Physique, Université de Genève, Geneva, Switzerland*
^{49a}*INFN Sezione di Genova, Italy*
^{49b}*Dipartimento di Fisica, Università di Genova, Genova, Italy*
^{50a}*E. Andronikashvili Institute of Physics, Georgian Academy of Sciences, Tbilisi, Georgia*
^{50b}*High Energy Physics Institute, Tbilisi State University, Tbilisi, Georgia*
⁵¹*II Physikalisches Institut, Justus-Liebig-Universität Giessen, Giessen, Germany*
⁵²*SUPA-School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom*
⁵³*II Physikalisches Institut, Georg-August-Universität, Göttingen, Germany*
⁵⁴*Laboratoire de Physique Subatomique et de Cosmologie, Université Joseph Fourier and CNRS/IN2P3 and Institut National Polytechnique de Grenoble, Grenoble, France*
⁵⁵*Department of Physics, Hampton University, Hampton Virginia, USA*
⁵⁶*Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge Massachusetts, USA*
^{57a}*Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany*
^{57b}*Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany*
^{57c}*ZITI Institut für technische Informatik, Ruprecht-Karls-Universität Heidelberg, Mannheim, Germany*
⁵⁸*Faculty of Science, Hiroshima University, Hiroshima, Japan*

- ⁵⁹*Faculty of Applied Information Science, Hiroshima Institute of Technology, Hiroshima, Japan*
- ⁶⁰*Department of Physics, Indiana University, Bloomington Indiana, USA*
- ⁶¹*Institut für Astro-und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria*
- ⁶²*University of Iowa, Iowa City Iowa, USA*
- ⁶³*Department of Physics and Astronomy, Iowa State University, Ames Iowa, USA*
- ⁶⁴*Joint Institute for Nuclear Research, JINR Dubna, Dubna, Russia*
- ⁶⁵*KEK, High Energy Accelerator Research Organization, Tsukuba, Japan*
- ⁶⁶*Graduate School of Science, Kobe University, Kobe, Japan*
- ⁶⁷*Faculty of Science, Kyoto University, Kyoto, Japan*
- ⁶⁸*Kyoto University of Education, Kyoto, Japan*
- ⁶⁹*Instituto de Física La Plata, Universidad Nacional de La Plata and CONICET, La Plata, Argentina*
- ⁷⁰*Physics Department, Lancaster University, Lancaster, United Kingdom*
- ^{71a}*INFN Sezione di Lecce, Italy*
- ^{71b}*Dipartimento di Fisica, Università del Salento, Lecce, Italy*
- ⁷²*Oliver Lodge Laboratory, University of Liverpool, Liverpool, United Kingdom*
- ⁷³*Department of Physics, Jožef Stefan Institute and University of Ljubljana, Ljubljana, Slovenia*
- ⁷⁴*Department of Physics, Queen Mary University of London, London, United Kingdom*
- ⁷⁵*Department of Physics, Royal Holloway University of London, Surrey, United Kingdom*
- ⁷⁶*Department of Physics and Astronomy, University College London, London, United Kingdom*
- ⁷⁷*Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France*
- ⁷⁸*Fysiska institutionen, Lunds universitet, Lund, Sweden*
- ⁷⁹*Departamento de Física Teórica C-15, Universidad Autonoma de Madrid, Madrid, Spain*
- ⁸⁰*Institut für Physik, Universität Mainz, Mainz, Germany*
- ⁸¹*School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom*
- ⁸²*CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France*
- ⁸³*Department of Physics, University of Massachusetts, Amherst Massachusetts, USA*
- ⁸⁴*Department of Physics, McGill University, Montreal QC, Canada*
- ⁸⁵*School of Physics, University of Melbourne, Victoria, Australia*
- ⁸⁶*Department of Physics, The University of Michigan, Ann Arbor Michigan, USA*
- ⁸⁷*Department of Physics and Astronomy, Michigan State University, East Lansing Michigan, USA*
- ^{88a}*INFN Sezione di Milano, Italy*
- ^{88b}*Dipartimento di Fisica, Università di Milano, Milano, Italy*
- ⁸⁹*B. I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Republic of Belarus*
- ⁹⁰*National Scientific and Educational Centre for Particle and High Energy Physics, Minsk, Republic of Belarus*
- ⁹¹*Department of Physics, Massachusetts Institute of Technology, Cambridge Massachusetts, USA*
- ⁹²*Group of Particle Physics, University of Montreal, Montreal QC, Canada*
- ⁹³*P. N. Lebedev Institute of Physics, Academy of Sciences, Moscow, Russia*
- ⁹⁴*Institute for Theoretical and Experimental Physics (ITEP), Moscow, Russia*
- ⁹⁵*Moscow Engineering and Physics Institute (MEPhI), Moscow, Russia*
- ⁹⁶*Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow, Russia*
- ⁹⁷*Fakultät für Physik, Ludwig-Maximilians-Universität München, München, Germany*
- ⁹⁸*Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München, Germany*
- ⁹⁹*Nagasaki Institute of Applied Science, Nagasaki, Japan*
- ¹⁰⁰*Graduate School of Science, Nagoya University, Nagoya, Japan*
- ^{101a}*INFN Sezione di Napoli, Italy*
- ^{101b}*Dipartimento di Scienze Fisiche, Università di Napoli, Napoli, Italy*
- ¹⁰²*Department of Physics and Astronomy, University of New Mexico, Albuquerque, New Mexico, USA*
- ¹⁰³*Institute for Mathematics, Astrophysics and Particle Physics, Radboud University Nijmegen/Nikhef, Nijmegen, Netherlands*
- ¹⁰⁴*Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam, Netherlands*
- ¹⁰⁵*Department of Physics, Northern Illinois University, DeKalb Illinois, USA*
- ¹⁰⁶*Budker Institute of Nuclear Physics (BINP), Novosibirsk, Russia*
- ¹⁰⁷*Department of Physics, New York University, New York New York, USA*
- ¹⁰⁸*Ohio State University, Columbus Ohio, USA*
- ¹⁰⁹*Faculty of Science, Okayama University, Okayama, Japan*
- ¹¹⁰*Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman Oklahoma, USA*
- ¹¹¹*Department of Physics, Oklahoma State University, Stillwater, Oklahoma, USA*
- ¹¹²*Palacký University, RCPTM, Olomouc, Czech Republic*
- ¹¹³*Center for High Energy Physics, University of Oregon, Eugene, Oregon, USA*
- ¹¹⁴*LAL, Univ. Paris-Sud and CNRS/IN2P3, Orsay, France*
- ¹¹⁵*Graduate School of Science, Osaka University, Osaka, Japan*
- ¹¹⁶*Department of Physics, University of Oslo, Oslo, Norway*

- ¹¹⁷*Department of Physics, Oxford University, Oxford, United Kingdom*
- ^{118a}*INFN Sezione di Pavia, Italy*
- ^{118b}*Dipartimento di Fisica Nucleare e Teorica, Università di Pavia, Pavia, Italy*
- ¹¹⁹*Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania, USA*
- ¹²⁰*Petersburg Nuclear Physics Institute, Gatchina, Russia*
- ^{121a}*INFN Sezione di Pisa, Italy*
- ^{121b}*Dipartimento di Fisica E. Fermi, Università di Pisa, Pisa, Italy*
- ¹²²*Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennsylvania, USA*
- ^{123a}*Laboratorio de Instrumentacao e Fisica Experimental de Particulas-LIP, Lisboa, Portugal*
- ^{123b}*Departamento de Fisica Teorica y del Cosmos and CAFPE, Universidad de Granada, Granada, Portugal*
- ¹²⁴*Institute of Physics, Academy of Sciences of the Czech Republic, Praha, Czech Republic*
- ¹²⁵*Faculty of Mathematics and Physics, Charles University in Prague, Praha, Czech Republic*
- ¹²⁶*Czech Technical University in Prague, Praha, Czech Republic*
- ¹²⁷*State Research Center Institute for High Energy Physics, Protvino, Russia*
- ¹²⁸*Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom*
- ¹²⁹*Physics Department, University of Regina, Regina SK, Canada*
- ¹³⁰*Ritsumeikan University, Kusatsu, Shiga, Japan*
- ^{131a}*INFN Sezione di Roma I, Italy*
- ^{131b}*Dipartimento di Fisica, Università La Sapienza, Roma, Italy*
- ^{132a}*INFN Sezione di Roma Tor Vergata, Italy*
- ^{132b}*Dipartimento di Fisica, Università di Roma Tor Vergata, Roma, Italy*
- ^{133a}*INFN Sezione di Roma Tre, Italy*
- ^{133b}*Dipartimento di Fisica, Università Roma Tre, Roma, Italy*
- ^{134a}*Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies-Université Hassan II, Casablanca, Morocco*
- ^{134b}*Centre National de l'Energie des Sciences Techniques Nucleaires, Rabat, Morocco*
- ^{134c}*Université Cadi Ayyad, Faculté des sciences Semlalia Département de Physique, B. P. 2390 Marrakech 40000, Morocco*
- ^{134d}*Faculté des Sciences, Université Mohamed Premier and LTPM, Oujda, Morocco*
- ^{134e}*Faculté des Sciences, Université Mohammed V, Rabat, Morocco*
- ¹³⁵*DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l'Univers), CEA Saclay (Commissariat a l'Energie Atomique), Gif-sur-Yvette, France*
- ¹³⁶*Santa Cruz Institute for Particle Physics, University of California Santa Cruz, Santa Cruz, California, USA*
- ¹³⁷*Department of Physics, University of Washington, Seattle, Washington, USA*
- ¹³⁸*Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom*
- ¹³⁹*Department of Physics, Shinshu University, Nagano, Japan*
- ¹⁴⁰*Fachbereich Physik, Universität Siegen, Siegen, Germany*
- ¹⁴¹*Department of Physics, Simon Fraser University, Burnaby BC, Canada*
- ¹⁴²*SLAC National Accelerator Laboratory, Stanford, California, USA*
- ^{143a}*Faculty of Mathematics, Physics & Informatics, Comenius University, Bratislava, Slovak Republic*
- ^{143b}*Department of Subnuclear Physics, Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice, Slovak Republic*
- ^{144a}*Department of Physics, University of Johannesburg, Johannesburg, South Africa*
- ^{144b}*School of Physics, University of the Witwatersrand, Johannesburg, South Africa*
- ^{145a}*Department of Physics, Stockholm University, Sweden*
- ^{145b}*The Oskar Klein Centre, Stockholm, Sweden*
- ¹⁴⁶*Physics Department, Royal Institute of Technology, Stockholm, Sweden*
- ^{a147}*Department of Physics and Astronomy, Stony Brook University, Stony Brook, New York, USA*
- ^{a148}*Department of Physics and Astronomy, University of Sussex, Brighton, United Kingdom*
- ¹⁴⁹*School of Physics, University of Sydney, Sydney, Australia*
- ¹⁵⁰*Institute of Physics, Academia Sinica, Taipei, Taiwan*
- ¹⁵¹*Department of Physics, Technion: Israel Inst. of Technology, Haifa, Israel*
- ¹⁵²*Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel*
- ¹⁵³*Department of Physics, Aristotle University of Thessaloniki, Thessaloniki, Greece*
- ¹⁵⁴*International Center for Elementary Particle Physics and Department of Physics, The University of Tokyo, Tokyo, Japan*
- ¹⁵⁵*Graduate School of Science and Technology, Tokyo Metropolitan University, Tokyo, Japan*
- ¹⁵⁶*Department of Physics, Tokyo Institute of Technology, Tokyo, Japan*
- ¹⁵⁷*Department of Physics, University of Toronto, Toronto ON, Canada*
- ^{158a}*TRIUMF, Vancouver BC, Canada*
- ^{158b}*Department of Physics and Astronomy, York University, Toronto ON, Canada*
- ¹⁵⁹*Institute of Pure and Applied Sciences, University of Tsukuba, Ibaraki, Japan*
- ¹⁶⁰*Science and Technology Center, Tufts University, Medford, Massachusetts, USA*
- ¹⁶¹*Centro de Investigaciones, Universidad Antonio Narino, Bogota, Colombia*

¹⁶²*Department of Physics and Astronomy, University of California Irvine, Irvine California, USA*

^{163a}*INFN Gruppo Collegato di Udine, Italy*

^{163b}*ICTP, Trieste, Italy*

^{163c}*Dipartimento di Fisica, Università di Udine, Udine, Italy*

¹⁶⁴*Department of Physics, University of Illinois, Urbana, Illinois, USA*

¹⁶⁵*Department of Physics and Astronomy, University of Uppsala, Uppsala, Sweden*

¹⁶⁶*Instituto de Física Corpuscular (IFIC) and Departamento de Física Atómica, Molecular y Nuclear and Departamento de Ingeniería Electrónica and Instituto de Microelectrónica de Barcelona (IMB-CNM), University of Valencia and CSIC, Valencia, Spain*

¹⁶⁷*Department of Physics, University of British Columbia, Vancouver BC, Canada*

¹⁶⁸*Department of Physics and Astronomy, University of Victoria, Victoria BC, Canada*

¹⁶⁹*Waseda University, Tokyo, Japan*

¹⁷⁰*Department of Particle Physics, The Weizmann Institute of Science, Rehovot, Israel*

¹⁷¹*Department of Physics, University of Wisconsin, Madison, Wisconsin, USA*

¹⁷²*Fakultät für Physik und Astronomie, Julius-Maximilians-Universität, Würzburg, Germany*

¹⁷³*Fachbereich C Physik, Bergische Universität Wuppertal, Wuppertal, Germany*

¹⁷⁴*Department of Physics, Yale University, New Haven, Connecticut, USA*

¹⁷⁵*Yerevan Physics Institute, Yerevan, Armenia*

¹⁷⁶*Domaine scientifique de la Doua, Centre de Calcul CNRS/IN2P3, Villeurbanne Cedex, France*

^aAlso at Laboratório de Instrumentação e Física Experimental de Partículas-LIP, Lisboa, Portugal.

^bAlso at Faculdade de Ciências and CFNUL, Universidade de Lisboa, Lisboa, Portugal.

^cAlso at Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom.

^dAlso at CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France.

^eDeceased.

^fAlso at TRIUMF, Vancouver BC, Canada.

^gAlso at Department of Physics, California State University, Fresno CA, USA.

^hAlso at Faculty of Physics and Applied Computer Science, AGH-University of Science and Technology, Krakow, Poland.

ⁱAlso at Fermilab, Batavia IL, USA.

^jAlso at Department of Physics, University of Coimbra, Coimbra, Portugal.

^kAlso at Università di Napoli Parthenope, Napoli, Italy.

^lAlso at Institute of Particle Physics (IPP), Canada.

^mAlso at Department of Physics, Middle East Technical University, Ankara, Turkey.

ⁿAlso at Louisiana Tech University, Ruston LA, USA.

^oAlso at Group of Particle Physics, University of Montreal, Montreal QC, Canada.

^pAlso at Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan.

^qAlso at Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany.

^rAlso at Manhattan College, New York NY, USA.

^sAlso at School of Physics and Engineering, Sun Yat-sen University, Guanzhou, China.

^tAlso at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan.

^uAlso at High Energy Physics Group, Shandong University, Shandong, China.

^vAlso at Section de Physique, Université de Genève, Geneva, Switzerland.

^wAlso at Departamento de Física, Universidade de Minho, Braga, Portugal.

^xAlso at Department of Physics and Astronomy, University of South Carolina, Columbia SC, USA.

^yAlso at KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary.

^zAlso at California Institute of Technology, Pasadena CA, USA.

^{aa}Also at Institute of Physics, Jagiellonian University, Krakow, Poland.

^{bb}Also at Department of Physics, Oxford University, Oxford, United Kingdom.

^{cc}Also at Institute of Physics, Academia Sinica, Taipei, Taiwan.

^{dd}Also at Department of Physics, The University of Michigan, Ann Arbor MI, USA.

^{ee}Also at DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l'Univers), CEA Saclay (Commissariat à l'Énergie Atomique), Gif-sur-Yvette, France.

^{ff}Also at Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France.

^{gg}Also at Department of Physics, Nanjing University, Jiangsu, China.