

Search for the Higgs Boson in the $H \rightarrow WW \rightarrow \ell\nu jj$ Decay Channel in pp Collisions at $\sqrt{s} = 7$ TeV with the ATLAS Detector

G. Aad *et al.**

(ATLAS Collaboration)

(Received 16 September 2011; published 30 November 2011)

A search for a Higgs boson has been performed in the $H \rightarrow WW \rightarrow \ell\nu jj$ channel in 1.04 fb^{-1} of pp collision data at $\sqrt{s} = 7$ TeV recorded with the ATLAS detector at the Large Hadron Collider. No significant excess of events is observed over the expected background and limits on the Higgs boson production cross section are derived for a Higgs boson mass in the range $240 \text{ GeV} < m_H < 600 \text{ GeV}$. The best sensitivity is reached for $m_H = 400 \text{ GeV}$, where the 95% confidence level upper bound on the cross section for $H \rightarrow WW$ production is 3.1 pb, or 2.7 times the standard model prediction.

DOI: [10.1103/PhysRevLett.107.231801](https://doi.org/10.1103/PhysRevLett.107.231801)

PACS numbers: 14.80.Bn, 12.15.Ji, 13.87.Ce, 14.70.Fm

In the standard model (SM [1–3]), a scalar field vacuum expectation value breaks the electroweak symmetry, gives masses to the W and Z bosons [4–6], and manifests itself directly as the so-called Higgs boson. A primary goal of the Large Hadron Collider (LHC) is to test the SM mechanism of electroweak symmetry breaking by searching for Higgs boson production in high energy proton-proton collisions. Thanks in part to the large gluon luminosity at LHC energies [7,8], the Higgs boson is predominantly produced via gluon fusion ($gg \rightarrow H$) [9–12] and to a lesser extent via vector boson fusion ($qq \rightarrow qqH$) [13–15]. Current limits from direct searches at LEP and the Tevatron exclude Higgs boson masses $m_H < 114.4 \text{ GeV}$ [16] and $156 \text{ GeV} < m_H < 177 \text{ GeV}$ [17] at 95% C.L.

For $m_H \geq 135 \text{ GeV}$, the dominant decay mode of the Higgs boson is $H \rightarrow WW^{(*)}$ [18,19]. The most sensitive Higgs boson search channel in the mass region around $m_H = 160 \text{ GeV}$ is the purely leptonic mode $H \rightarrow WW^{(*)} \rightarrow \ell\nu\ell\nu$. For $m_H \geq 200 \text{ GeV}$, the $H \rightarrow WW \rightarrow \ell\nu jj$ channel, where one W decays to a pair of jets ($W \rightarrow jj$), also becomes important. The advantage of $H \rightarrow WW \rightarrow \ell\nu jj$ over $H \rightarrow WW \rightarrow \ell\nu\ell\nu$ is the ability to fully reconstruct the Higgs boson mass.

This Letter describes a search for a Higgs boson in the $H \rightarrow WW \rightarrow \ell\nu jj$ channel using the ATLAS detector at the LHC, based on 1.04 fb^{-1} of pp collision data at a center-of-mass energy $\sqrt{s} = 7$ TeV collected during 2011. In this analysis, the distribution of the $\ell\nu jj$ invariant mass $m(\ell\nu jj)$, reconstructed using the charged-lepton neutrino invariant mass constraint $m(\ell\nu) = m(W)$ and the requirement that two of the jets in the event are consistent with a $W \rightarrow jj$ decay, is used to search for a Higgs boson signal.

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

Published by the American Physical Society under the terms of the [Creative Commons Attribution 3.0 License](https://creativecommons.org/licenses/by/3.0/). Further distribution of this work must maintain attribution to the author(s) and the published article's title, journal citation, and DOI.

The results of a similar search for $H \rightarrow WW \rightarrow \ell\nu jj$ based on 35 pb^{-1} of data recorded during the 2010 LHC run were presented in Ref. [20].

The present search, based on the measured shape of the $m(\ell\nu jj)$ distribution, is restricted to $m_H > 240 \text{ GeV}$, in order to ensure a smoothly varying nonresonant background, well clear of the effective kinematic cutoff $m(\ell\nu jj) \sim 160 \text{ GeV}$. For $m_H \geq 600 \text{ GeV}$, the jets from $W \rightarrow jj$ decay begin to overlap due to the large W boost, and the natural width of the Higgs boson becomes large. A detailed treatment of these issues is beyond the scope of the present analysis. The best sensitivity in this analysis is expected for $m_H \sim 400 \text{ GeV}$.

The ATLAS detector [21] is a multipurpose particle physics apparatus with forward-backward symmetric cylindrical geometry covering the pseudorapidity range $|\eta| < 2.5$ for track and $|\eta| < 4.9$ for jet measurements [22]. The inner tracking detector (ID) consists of a silicon pixel detector, a silicon microstrip detector, and a transition radiation tracker. The ID is surrounded by a thin superconducting solenoid providing a 2 T magnetic field, and by a high-granularity liquid-argon (LAr) sampling electromagnetic (EM) calorimeter. An iron-scintillator tile calorimeter provides hadronic coverage in the central rapidity range. The end-cap and forward regions are instrumented with LAr calorimetry for both electromagnetic and hadronic measurements. The muon spectrometer surrounds the calorimeters and consists of three large superconducting toroids, each with eight coils, a system of precision tracking chambers, and detectors for triggering.

Detailed Monte Carlo (MC) studies of signal and backgrounds have been carried out [23]. The interaction with the ATLAS detector is modeled with GEANT4 [24] and the events are processed using the same reconstruction that is used to perform the reconstruction on data. The effect of multiple pp interactions in the same bunch crossing (pile-up) at the high luminosities achieved by the LHC in 2011 is modeled by superimposing, at the generation stage, several simulated minimum-bias events on the simulated signal

and background events. MC samples were generated with different pile-up levels and subsequently reweighted to match the pile-up conditions observed in the data.

The data used in this analysis were recorded during periods when all ATLAS subdetectors were operating under nominal conditions. The events were triggered by requiring the presence of an electron candidate with transverse energy $E_T > 20$ GeV or a muon candidate with transverse momentum $p_T > 18$ GeV.

Electron candidates are selected from clustered energy deposits in the EM calorimeter with an associated track and are required to satisfy a tight set of identification cuts [25] with an efficiency of $71 \pm 1.6\%$ for electrons with $E_T > 20$ GeV. While the energy measurement is taken from the EM calorimeter, the pseudorapidity η and azimuthal angle ϕ are taken from the associated track. The cluster is required to be inside the range $|\eta| < 2.47$, excluding $1.37 < |\eta| < 1.52$ and small calorimeter regions affected by temporary operational problems. The track associated with the electron candidate is required to point back to a reconstructed primary vertex with a transverse impact parameter significance $d_0/\sigma_{d_0} \leq 10$ and an impact parameter along the beam direction $z_0 \leq 10$ mm. Electrons are required to be isolated: the sum of the transverse energies in cells inside a cone $\Delta R < 0.3$ around [26] the cluster barycenter (excluding the electron itself) must satisfy $\Sigma(E_T^{\text{calo}}) < 4$ GeV.

Muons are reconstructed by combining tracks in the inner detector and muon spectrometer, with efficiency $92 \pm 0.6\%$ for muons with $p_T > 20$ GeV. Muons are required to pass basic quality cuts on the number and type of hits in the inner detector. They must lie in the range $|\eta| < 2.4$, and satisfy the same impact parameter cuts as electrons. They must also be isolated, with the sum of the transverse momenta of all tracks in a cone $\Delta R < 0.2$ around the muon satisfying $\Sigma(p_T^{\text{track}})/p_T^\mu < 0.1$.

Jets are reconstructed from topological clusters using the anti- k_r algorithm [27] with radius parameter $R = 0.4$. The reconstructed jets are calibrated using E_T and η dependent correction factors based on MC simulation and validated with data [28]. They are required to have $E_T > 25$ GeV and $|\eta| < 4.5$. Jets are considered b -tagged if they contain a reconstructed displaced secondary vertex consistent with a b -decay [29]. The operating point chosen for this b -tag selection has an efficiency of 50% for b -jets in $t\bar{t}$ events in MC, and the mistag rate for non- b -jets has been measured to be between 0.1% and 2.0%, depending on the $|\eta|$ and p_T of the jet [29]. The event missing transverse momentum \cancel{E}_T is reconstructed starting from topological energy clusters in the calorimeters calibrated according to the type of the object to which they are associated. The momenta of any muons in the event are also taken into account in the \cancel{E}_T measurement.

For this analysis, events are required to have at least one vertex with at least three associated tracks with

$p_T > 400$ MeV. There must be exactly one reconstructed lepton candidate (electron or muon) with $p_T > 30$ GeV. In order to ensure that this analysis is statistically independent of the ATLAS $H \rightarrow ZZ \rightarrow \ell\ell\nu\nu$ analysis, events are vetoed if there is an additional lepton with $p_T > 20$ GeV, including electrons which only satisfy the looser identification cuts used in the $H \rightarrow ZZ \rightarrow \ell\ell\nu\nu$ analysis [30].

Events are required to have $\cancel{E}_T > 30$ GeV to account for an unobserved neutrino from $W \rightarrow \ell\nu$ decay. There must be exactly two jets ($H + 0$ jet sample) or exactly three jets ($H + 1$ jet sample) with $E_T > 25$ GeV and $|\eta| < 4.5$. The two jets with invariant mass (m_{jj}) closest to the mass of the W boson are required to satisfy $71 \text{ GeV} < m_{jj} < 91 \text{ GeV}$. These two jets are taken as the W decay jets and are required to lie in the range $|\eta| < 2.8$, where the jet energy scale (JES) is best known (to better than $\pm(4-8)\%$ for $E_T > 25$ GeV [28].)

After this event selection, the background is expected to be dominated by $W + \text{jets}$ production. Other important backgrounds are $Z + \text{jets}$, multijets (MJ) from QCD processes, top quark, and diboson (WW , WZ , and ZZ) production. In order to further reject backgrounds from top quark production, events are rejected if any of the jets is b -tagged.

Although the MC is not used to model the background in the final fit used to obtain limits, a combination of MC calculations and data-driven methods is used to better understand the background yields at this intermediate stage. Backgrounds due to $W/Z + \text{jets}$, $t\bar{t}$, and diboson production are modeled using the ALPGEN [31], MC@NLO [32], and HERWIG [33] generators, respectively. A small contribution from $W/Z + \gamma$ events is generated using MADEVENT [34]. The shape of the MJ background is modeled using histograms derived from data samples selected in an identical way to the $H \rightarrow WW \rightarrow \ell\nu jj$ selection except that the electron identification requirements are loosened and the isolation requirement on muons is inverted. In the loosened selection, electrons satisfying the complete set of identification criteria are not included. Expected contributions from non-QCD processes to the MJ shape histogram are subtracted using MC predictions.

To normalize the MJ shape histogram, the loose lepton control sample selection is further relaxed by removing the \cancel{E}_T cut to construct a shape template for the \cancel{E}_T distribution for the MJ background. The normalizations of this MJ template and the corresponding template for $W/Z + \text{jets}$ taken from MC are fit to the observed \cancel{E}_T distribution, and the resulting scale factors are then used to normalize the MJ and $W/Z + \text{jets}$ processes in comparisons between data and expectations. Both the gluon fusion and the vector boson fusion signal production processes are simulated using the POWHEG [35,36] event generator interfaced to PYTHIA [37], normalizing to the NNLO cross sections [19] shown in Table I.

TABLE I. Cross section for standard model Higgs boson production and the branching ratio (BR) for $H \rightarrow WW \rightarrow \ell\nu jj$ ($\ell = e/\mu$) as a function of mass [19].

m_H [GeV]	$\sigma(gg \rightarrow H)$ [pb]	$\sigma(qq \rightarrow H)$ [pb]	BR($H \rightarrow \ell^\pm \nu jj$)
300	2.4 ± 0.4	$0.30 + 0.014 - 0.008$	0.202
400	$2.0 + 0.31 - 0.34$	$0.162 + 0.010 - 0.005$	0.170
500	0.85 ± 0.15	$0.095 + 0.0068 - 0.0032$	0.160
600	$0.33 + 0.063 - 0.058$	$0.058 + 0.005 - 0.002$	0.164

In order to reconstruct the invariant mass $m(\ell\nu jj)$ of the WW system, the mass constraint $m(\ell\nu) = m(W)$ is used, where the neutrino transverse momentum p_T^ν is taken from the event \cancel{E}_T . This equation can have real or complex solutions. In the case of complex solutions, the event is rejected. This requirement rejects 45% of background events in both data and MC, but only 36% of MC signal events with $m_H = 400$ GeV. In the case of two real solutions, the solution with smaller neutrino longitudinal momentum $|p_z^\nu|$ is taken, based on simulation studies. Table II shows the observed and expected numbers of events for signal and background after this full selection.

Figure 1 (top) shows the $m(\ell\nu jj)$ distribution for this final sample. The expected signal for $m_H = 400$ GeV is also shown, scaled up by a factor of 2.7. The $m(\ell\nu jj)$ resolution is $(7.5 \pm 0.6)\%$ at $m_H = 400$ GeV, depending mostly on the jet energy resolution as checked in data versus MC by various jet-balance techniques [38], and shows a $1/\sqrt{m_H}$ dependence over the range of this analysis. Limits are set using a maximum likelihood fit to the shape of the observed $m(\ell\nu jj)$ distribution in the range $200 < m(\ell\nu jj) < 2000$ GeV. The nonresonant background in this fit is modeled by the sum of two exponential functions. The normalization and slope of each exponential are unconstrained parameters in the fit. The double-exponential form for the total background is well justified by fits to the $m(\ell\nu jj)$ distributions obtained by selecting events with m_{jj} just below ($50 < m_{jj} < 60$ GeV) or just above ($100 < m_{jj} < 110$ GeV) the W peak, respectively.

As a consistency check, the background parametrization was altered to use three exponentials and the shift in signal yield as compared to the nominal background shape was found to be small as compared to other uncertainties. The $m(\ell\nu jj)$ distribution for the expected signal at each hypothesized m_H is modeled using the signal MC samples.

The fit includes nuisance parameters which account for the uncertainty in the efficiency of the electron, muon, and jet reconstruction. The electron and muon efficiencies are varied within their uncertainties, leading to an uncertainty in the signal efficiency of $\pm 1.6\%$ and $\pm 0.6\%$, for electrons and muons, respectively. Varying the jet energy scale within its uncertainties yields a corresponding uncertainty of $\pm 17\%$ in the expected signal, and smearing the jet energies within the uncertainty on their resolutions results in a signal uncertainty of $\pm 8.6\%$. The limits also take into account a $\pm 3.7\%$ uncertainty on the luminosity determination [39] and a $\pm 19.4\%$ uncertainty on the predicted cross section [19], taken to be independent of mass. The off-shell effects and interference between the signal and backgrounds, which are discussed in Refs. [19,40,41], have been neglected. A conservative estimate of this uncertainty would be $150 \times m_H^3$ (m_H in TeV), where the m_H^3 form is motivated by the scaling of the Higgs width with m_H and the normalization factor is chosen to give $\sim 30\%$ at $m_H = 600$ GeV, based on Fig. 6 of Ref. [41]. If this were included, it would increase the total systematic error by less than 6% for $m_H \leq 500$ GeV, and as much as 15% for $m_H = 600$ GeV where the limit would be increased by $\sim 18\%$.

TABLE II. Expected and observed numbers of events for an integrated luminosity of 1.04 fb^{-1} after all selection cuts (including the requirement that $m(\ell\nu) = m(W)$ has a real solution) for the signal and the main backgrounds. For the W/Z + jets and MJ backgrounds, the uncertainties are taken from the fit to the \cancel{E}_T distribution used to normalize these backgrounds. For signal, top and diboson, the quoted uncertainties are JES ($\pm 17\%$), jet energy resolution (8.6%), cross section ($\pm 10\%$ for both top and diboson, and $\pm 19.4\%$ for signal), and luminosity ($\pm 3.7\%$), added in quadrature; the total errors in the rightmost column for these processes are the linear sum of the errors for the individual channels since these sources of systematic uncertainty are correlated across channels. Statistical errors are small compared to these uncertainties.

	$H(e\nu jj) + 0j$	$H(\mu\nu jj) + 0j$	$H(e\nu jj) + 1j$	$H(\mu\nu jj) + 1j$	$H + 0j$ or $1j$
W/Z + jets	5580 ± 150	6690 ± 430	3610 ± 140	3940 ± 360	19820 ± 600
Multijet	592 ± 16	222 ± 15	420 ± 16	195 ± 17	1430 ± 30
Top	87 ± 17	87 ± 18	271 ± 54	280 ± 56	730 ± 150
Dibosons	226 ± 45	222 ± 45	89 ± 18	112 ± 23	650 ± 130
Expected background	6490 ± 160	7220 ± 440	4390 ± 150	4530 ± 370	22630 ± 640
Data	6446	7201	4134	4380	22161
Expected Signal ($m_H = 400$ GeV)	11 ± 3.0	9 ± 2.4	13 ± 3.5	10 ± 2.7	43 ± 12

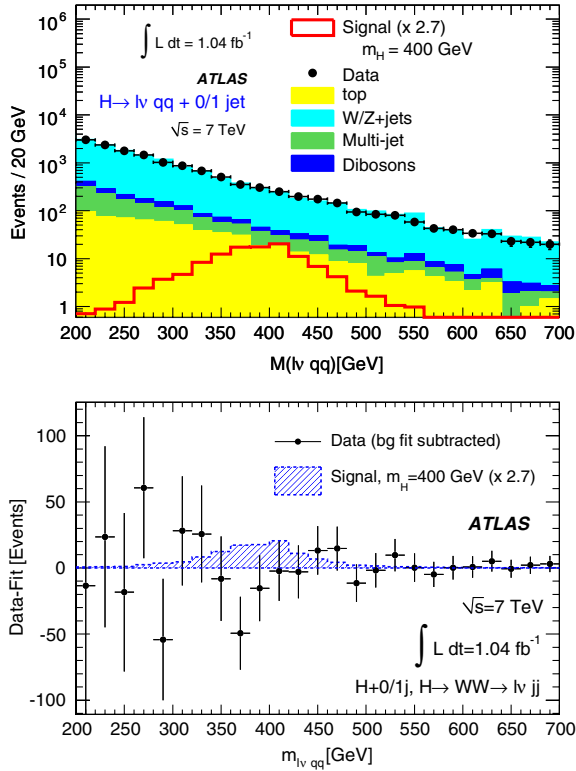


FIG. 1 (color online). Top: the reconstructed invariant mass $m(\ell\nu jj)$ in the data summed over lepton flavor and jet multiplicity. The expected backgrounds are also shown. Bottom: the difference between data and the fitted nonresonant background. The expected contribution from Higgs boson decays for $m_H = 400$ GeV in the SM is also shown, multiplied by a factor of 2.7.

Figure 1 (bottom) shows the difference between the $m(\ell\nu jj)$ distribution in data and the fitted background. There is no indication of any significant excess. Limits are extracted using the Profile Likelihood [42] as a test

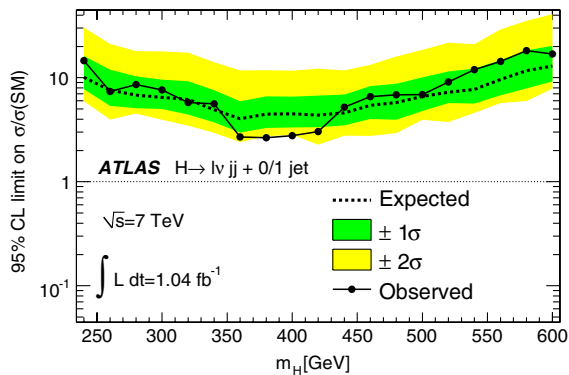


FIG. 2 (color online). The expected and observed 95% confidence level upper limits on the Higgs boson production cross section divided by the SM prediction for an integrated luminosity of 1.04 fb^{-1} . For any hypothesized Higgs boson mass, the background contribution used in the calculation of this limit is obtained from a fit to the $m(\ell\nu jj)$ distribution. The green and yellow bands show the $\pm 1\sigma$ and $\pm 2\sigma$ uncertainties on the expected limit.

statistic and following the CL_s procedure described in Ref. [43].

Figure 2 shows the 95% CL upper bound on the cross-section times branching ratio for Higgs production in units of the Standard Model prediction, $\sigma \times BR_{H \rightarrow WW} / (\sigma \times BR_{H \rightarrow WW})_{\text{SM}}$, as a function of m_H . The observed cross section limit for $m_H = 400$ GeV is 3.1 pb, or 2.7 times the SM prediction, while the corresponding expected limits are 5.2 pb or 4.5 times the SM expectation. In the SM with an additional heavy fourth generation [44,45], the gluon fusion mechanism for production of a Higgs boson is expected to be substantially enhanced. Within the four generation context, a Higgs boson is excluded at 95% CL by the present data over the range $m_H = 310\text{--}430$ GeV.

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; 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] S. Weinberg, *Phys. Rev. Lett.* **19**, 1264 (1967).
- [2] S. L. Glashow, *Nucl. Phys.* **B22**, 579 (1961).
- [3] A. Salam, in *Elementary Particle Theory* (Almqvist and Wiksell, Stockholm, 1968), p. 367.
- [4] F. Englert and R. Brout, *Phys. Rev. Lett.* **13**, 321 (1964).
- [5] P. W. Higgs, *Phys. Rev. Lett.* **13**, 508 (1964).

- [6] G. S. Guralnik, C. R. Hagen, and T. W. B. Kibble, *Phys. Rev. Lett.* **13**, 585 (1964).
- [7] H.-L. Lai, M. Guzzi, J. Huston, Z. Li, and P. M. Nadolsky *et al.*, *Phys. Rev. D* **82**, 074024 (2010).
- [8] A. Sherstnev and R. S. Thorne, *Eur. Phys. J. C* **55**, 553 (2008).
- [9] C. Anastasiou, R. Boughezal, and F. Petriello, *J. High Energy Phys.* **04** (2009) 003.
- [10] D. de Florian and M. Grazzini, *Phys. Lett. B* **674**, 291 (2009).
- [11] U. Aglietti, R. Bonciani, G. Degrossi, and A. Vicini, *Phys. Lett. B* **595**, 432 (2004).
- [12] S. Actis, G. Passarino, C. Sturm, and S. Uccirati, *Phys. Lett. B* **670**, 12 (2008).
- [13] P. Bolzoni, F. Maltoni, S.-O. Moch, and M. Zaro, *Phys. Rev. Lett.* **105**, 011801 (2010).
- [14] M. Ciccolini, A. Denner, and S. Dittmaier, *Phys. Rev. Lett.* **99**, 161803 (2007).
- [15] M. Ciccolini, A. Denner, and S. Dittmaier, *Phys. Rev. D* **77**, 013002 (2008).
- [16] LEP Collaborations, *Phys. Lett. B* **565**, 61 (2003).
- [17] CDF and D0 Collaborations, arXiv:1107.5518v1.
- [18] A. Bredenstein, A. Denner, S. Dittmaier, and M. M. Weber, *J. High Energy Phys.* **02** (2007) 080.
- [19] LHC Higgs Cross Section Working Group, S. Dittmaier, C. Mariotti, G. Passarino, and R. Tanaka (Eds.), Report No CERN-2011-002 (CERN, Geneva, 2011).
- [20] ATLAS Collaboration, arXiv:1106.2748 [Eur. Phys. J. C (to be published)].
- [21] ATLAS Collaboration, *JINST* **3**, S08003 (2008).
- [22] ATLAS uses a right-handed coordinate system with its origin at the nominal interaction point (IP) in the center of the detector and the z axis coinciding with the axis of the beam pipe. The x axis points from the IP to the center of the LHC ring, and the y -axis points upward. Cylindrical coordinates (r , ϕ) are used in the transverse plane, ϕ being the azimuthal angle around the beam pipe. The pseudorapidity is defined in terms of the polar angle θ as $\eta = -\ln \tan(\theta/2)$.
- [23] ATLAS Collaboration, *Eur. Phys. J. C* **70**, 823 (2010).
- [24] S. Agostinelli *et al.*, *Nucl. Instrum. Methods Phys. Res., Sect. A* **506**, 250 (2003).
- [25] ATLAS Collaboration, *J. High Energy Phys.* **12** (2010) 060.
- [26] $\Delta R = \sqrt{(\Delta\phi)^2 + (\Delta\eta)^2}$, where $\Delta\phi$ and $\Delta\eta$ are the relevant separations in ϕ and η , respectively.
- [27] M. Cacciari, G. P. Salam, and G. Soyez, *J. High Energy Phys.* **04** (2008) 063.
- [28] ATLAS Collaboration, ATLAS Conference Note Report No ATLAS-CONF-2011-032, available online at <https://cdsweb.cern.ch/record/1337782>, 2011.
- [29] ATLAS Collaboration, ATLAS Conference Note Report No ATLAS-CONF-2011-089, available online at <http://cdsweb.cern.ch/record/1356198>, 2011.
- [30] ATLAS Collaboration, ATLAS Conference Note Report No ATLAS-CONF-2011-026, available online at <http://cdsweb.cern.ch/record/1336759>, 2011.
- [31] M. L. Mangano *et al.*, *J. High Energy Phys.* **07** (2003) 001.
- [32] S. Frixione and B. Webber, *J. High Energy Phys.* **08** (2003) 007.
- [33] G. Corcella *et al.*, *J. High Energy Phys.* **01** (2001) 010.
- [34] J. Alwall *et al.*, *J. High Energy Phys.* **09** (2007) 028.
- [35] S. Alioli *et al.*, *J. High Energy Phys.* **04** (2009) 002.
- [36] P. Nason and C. Oleari, *J. High Energy Phys.* **02** (2010) 037.
- [37] T. Sjöstrand *et al.*, *J. High Energy Phys.* **05** (2006) 026.
- [38] ATLAS Collaboration, ATLAS Conference Note Report No ATLAS-CONF-2010-054, available online at <http://cdsweb.cern.ch/record/1281311?ln=en>, 2011.
- [39] ATLAS Collaboration, ATLAS Conference Note Report No ATLAS-CONF-2011-116, available online at <http://cdsweb.cern.ch/record/1376384>, 2011.
- [40] C. Anastasiou, S. Buehler, F. Herzog, and A. Lazopoulos, arXiv:1107.0683.
- [41] J. M. Campbell, R. K. Ellis, and C. Williams, *J. High Energy Phys.* **10** (2011) 005.
- [42] G. Cowan *et al.*, *Eur. Phys. J. C* **71**, 1554 (2011).
- [43] A. L. Read, Modified frequentist analysis of search results (the CL_s method), Report No CERN-OPEN-2000-205, available online at <http://cdsweb.cern.ch/record/451614>, 2000.
- [44] G. D. Kribs, T. Plehn, M. Spannowsky, and T. M. Tait, *Phys. Rev. D* **76**, 075016 (2007).
- [45] N. Becerici Schmidt, S. A. Çetin, S. Istin, and S. Sultansoy, *Eur. Phys. J. C* **66**, 119 (2010).

G. Aad,⁴⁷ B. Abbott,¹¹⁰ J. Abdallah,¹¹ A. A. Abdelalim,⁴⁸ A. Abdesselam,¹¹⁷ O. Abidinov,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,^{a23b,b} M. Aharrouche,⁸⁰ S. P. Ahlen,²¹ F. Ahles,⁴⁷ A. Ahmad,¹⁴⁷ M. Ahsan,⁴⁰ G. Aielli,^{132a,132b} 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,c} 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,d} G. Arabidze,⁸⁷ I. Aracena,¹⁴² Y. Arai,⁶⁵ A. T. H. Arce,⁴⁴ J. P. Archambault,²⁸ S. Arfaoui,^{29,e}

J-F. Arguin,¹⁴ E. Arik,^{18a,a} M. Arik,^{18a} A. J. Armbruster,⁸⁶ O. Arnaez,⁸⁰ C. Arnault,¹¹⁴ A. Artamonov,⁹⁴ G. Artoni,^{131a,131b} 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. Astvatsatourov,⁵¹ G. Atoian,¹⁷⁴ B. Aubert,⁴ E. Auge,¹¹⁴ K. Augsten,¹²⁶ M. Arousseau,^{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,^{32a} 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,¹⁴⁸ 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. Bechtle,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. Bencheekroun,^{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,a} 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. Borissoy,⁷⁰ I. Borjanovic,^{12a} S. Borroni,^{131a,131b} 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. Brelier,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,¹⁴⁷ 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,a} 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,132b} 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. Chappleau,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,⁵⁰ 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. Cicio,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. Clift,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,¹¹⁶ 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,d} M. Davies,⁹² A. R. Davison,⁷⁶ Y. Davygora,^{57a} E. Dawe,¹⁴¹ I. Dawson,¹³⁸ J. W. Dawson,^{5,a}
 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,¹⁴⁸ J. B. De Vivie De Regie,¹¹⁴
 S. Dean,⁷⁶ R. Debbe,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,¹⁴⁷ S. Demers,¹⁷⁴
 M. Demichev,⁶⁴ B. Demirkoz,^{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,¹⁴⁷ P. O. Deviveiros,¹⁵⁷ A. Dewhurst,¹²⁸ B. DeWilde,¹⁴⁷ 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,⁵⁰ M. A. B. do Vale,^{23a}
 A. Do Valle Wemans,^{123a} T. K. O. Doan,⁴ M. Dobbs,⁸⁴ R. Dobinson,^{29,a} D. Dobos,⁴² E. Dobson,²⁹ M. Dobson,¹⁶²
 J. Dodd,³⁴ C. Doglioni,¹¹⁷ T. Doherty,⁵² Y. Doi,^{65,a} J. Dolejsi,¹²⁵ I. Dolenc,⁷³ Z. Dolezal,¹²⁵ B. A. Dolgoshein,^{95,a}
 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. Dufloc,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. Ehrlich,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,¹⁴⁷ 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,¹⁴⁷ 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. Filipič, ⁷³ A. Filippas, ⁹ F. Filthaut, ¹⁰³ M. Fincke-Keeler, ¹⁶⁸ M. C. N. Fiolhais, ^{123a,j} 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. Garberon, 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. Gilewsky, 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,c} 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, ¹⁴⁷ 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. Grahn, ⁴¹ F. Grancagnolo, ^{71a}
S. Grancagnolo, ¹⁵ V. Grassi, ¹⁴⁷ V. Gratchev, ¹²⁰ N. Grau, ³⁴ H. M. Gray, ²⁹ J. A. Gray, ¹⁴⁷ 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. Hawkins, 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. Herten, ⁴⁷ R. Hertenberger, ⁹⁷ L. Hervas, ²⁹
N. P. Hesse, ¹⁰⁴ A. Hidvegi, ^{145a} E. Higón-Rodríguez, ¹⁶⁶ D. Hill, ^{5,a} 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. Hoefkamp, 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-Golfin,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,c} 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,¹⁰ H. Khandanyan,¹⁶⁴ A. Khanov,¹¹¹ D. Kharchenko,⁶⁴ A. Khodinov,⁹⁵ A. G. Kholodenko,¹²⁷ A. Khomich,^{57a} T. J. Khoo,²⁷ G. Khorauli,²⁰ A. Khoroshilov,¹⁷³ N. Khovanskiy,⁶⁴ V. Khovanskiy,⁹⁴ E. Khramov,⁶⁴ J. Khubua,⁵⁰ 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,⁴⁴ 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. Larner,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,f} X. Li,⁸⁶ Z. Liang,³⁹
Z. Liang,^{117,s} H. Liao,³³ 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,t} 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,c} 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,c} 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,a} 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,¹⁴⁸ 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,d} 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,⁵⁰ R. A. McLaren,²⁹ T. Mclaughlan,¹⁷
S. J. McMahan,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. Mikesstikova,¹²⁴ M. Mikuž,⁷³ D. W. Miller,¹⁴² 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. Mohrdeieck-Möck,⁹⁸ A. M. Moiseev,^{127,a}
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,⁵⁰
J. Moss,¹⁰⁸ R. Mount,¹⁴² E. Mountricha,¹³⁵ S. V. Mouraviev,⁹³ E. J. W. Moyses,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,d} 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,a} 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,c}
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. Papadopoulou,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. Patariaia,¹⁷¹ 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. Piegaiia,²⁶ J. E. Pilcher,³⁰ A. D. Pilkington,⁸¹ J. Pina,^{123a,c}
M. Pinamonti,^{163a,163c} A. Pinder,¹¹⁷ J. L. Pinfold,² J. Ping,^{32c} B. Pinto,^{123a,c} O. Pirote,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 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. Przysieznik,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. Rebuzzi,^{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,ff} M. Ridel,⁷⁷ S. Rieke,⁸⁰ M. Rijpstra,¹⁰⁴ M. Rijssenbeek,¹⁴⁷ 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,⁴⁸ 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,¹⁴⁸ 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,b} 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,¹⁴⁸ 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,c} 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. Scallon,⁹² D. A. Scannicchio,¹⁶² J. Schaarschmidt,¹¹⁴ P. Schacht,⁹⁸ U. Schäfer,⁸⁰ S. Schaepe,²⁰ S. Schaezel,^{57b} A. C. Schaffer,¹¹⁴ D. Schaile,⁹⁷ R. D. Schamberger,¹⁴⁷ 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. Sellden,^{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. Sevir,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,c} 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. Sivoklov,⁹⁶ J. Sjölin,^{145a,145b} T. B. Sjursen,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,l} 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. Spiwoкс,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. Stanescu,^{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,a} R. Stroynowski,³⁹ J. Strube,¹²⁸ B. Stugu,¹³ I. Stumer,^{24,a} J. Stupak,¹⁴⁷ 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,¹⁴⁸ 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. Talyshev,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. Tatar Khanov,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. Toczek,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. Torr  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. Trocm ,⁵⁴ C. Troncon,^{88a} M. Trotter-McDonald,¹⁴¹ A. Trzupek,³⁸ C. Tsarouchas,²⁹ J. C.-L. Tseng,¹¹⁷ M. Tsiakiris,¹⁰⁴ P. V. Tsiarashka,⁸⁹ D. Tsiouou,⁴ G. Tsiopolitis,⁹ V. Tsiskaridze,⁴⁷ E. G. Tskhadadze,⁵⁰ I. I. Tsukerman,⁹⁴ V. Tsulaia,¹⁴ J.-W. Tsung,²⁰ S. Tsuno,⁶⁵ D. Tsybychev,¹⁴⁷ 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. Tyrva inen,²⁹ G. Tzanakos,⁸ K. Uchida,²⁰ I. Ueda,¹⁵⁴ R. Ueno,²⁸ M. Ugland,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. Vassilakopoulos,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,aa} 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,a} 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. Vossebeld,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,bb} 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,s} T. Wengler,²⁹ S. Wenig,²⁹ N. Wermes,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. Wicke,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,¹¹⁷ 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,cc} 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,dd} 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. Yoosofmiya,¹²² K. Yorita,¹⁶⁹ R. Yoshida,⁵ C. Young,¹⁴² S. Youssef,²¹ D. Yu,²⁴ J. Yu,⁷ J. Yu,^{32c,dd} L. Yuan,^{32a,gg} A. Yurkewicz,¹⁴⁷ 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,bb} 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,ee} 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,a} 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, USA

²Department 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, Turkey

⁴LAPP, CNRS/IN2P3 and Université de Savoie, Annecy-le-Vieux, France

⁵High Energy Physics Division, Argonne National Laboratory, Argonne Illinois, USA

⁶Department of Physics, University of Arizona, Tucson Arizona, USA

⁷Department of Physics, The University of Texas at Arlington, Arlington Texas, USA

⁸Physics Department, University of Athens, Athens, Greece

⁹Physics Department, National Technical University of Athens, Zografou, Greece

¹⁰Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan

¹¹Institut 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, Serbia

¹³Department for Physics and Technology, University of Bergen, Bergen, Norway

¹⁴Physics Division, Lawrence Berkeley National Laboratory and University of California, Berkeley California, USA

¹⁵Department of Physics, Humboldt University, Berlin, Germany

¹⁶Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland

¹⁷School 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

²⁰Physikalisches Institut, University of Bonn, Bonn, Germany

²¹Department of Physics, Boston University, Boston Massachusetts, USA

²²Department 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 Física, Universidade de Sao Paulo, Sao Paulo, Brazil

²⁴Physics 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

²⁶Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina

²⁷Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom

²⁸Department of Physics, Carleton University, Ottawa ON, Canada

²⁹CERN, Geneva, Switzerland

³⁰Enrico 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*
- ⁵⁰*Institute of Physics and HEP Institute, Georgian Academy of Sciences and 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 Autónoma 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*
- ^{a23b}*Departamento de Fisica Teorica y del Cosmos and CAFPE, Universidad de Granada, Granada, Spain*
- 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 LPTPM, 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 à 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*
¹⁴⁷*Department of Physics and Astronomy, Stony Brook University, Stony Brook New York, USA*
¹⁴⁸*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*

^aDeceased.

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

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

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

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

^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 Fisica, 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 Department of Physics, Oxford University, Oxford, United Kingdom.

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

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

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

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

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

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