



UvA-DARE (Digital Academic Repository)

Search for scalar diphoton resonances in the mass range 65-600 GeV with the ATLAS detector in pp collision data at $\sqrt{s} = 8$ TeV

Aad, G.; et al., [Unknown]; Aben, R.; Angelozzi, I.; Beemster, L.J.; Bentvelsen, S.C.M.; Berge, D.; Bobbink, G.J.; Bos, K.; Boterenbrood, H.; Butti, P.; Castelli, A.; Colijn, A.P.; de Jong, P.J.; de Nooij, L.; Deigaard, I.; Deluca, C.; Deviveiros, P.O.; Dhaliwal, S.; Ferrari, P.; Gadatsch, S.; Geerts, D.A.A.; Hartjes, F.G.; Hessey, N.P.; Hod, N.; Igonkina, O.; Kluit, P.M.; Koffeman, E.N.; Lee, H.C.; Linde, F.L.; Mahlstedt, J.; Mechnich, J.; Oussoren, K.P.; Pani, P.; Salek, D.; Valencic, N.; van den Wollenberg, W.; van der Deijl, P.C.; van der Geer, R.; van der Graaf, H.; van der Leeuw, R.H.L.; van Vulpen, I.B.; Verkerke, W.; Vermeulen, J.C.; Vranjes Milosavljevic, M.; Vreeswijk, M.; Weits, H.

Published in:
Physical Review Letters

DOI:
[10.1103/PhysRevLett.113.171801](https://doi.org/10.1103/PhysRevLett.113.171801)

[Link to publication](#)

Citation for published version (APA):

Aad, G., et al., U., Aben, R., Angelozzi, I., Beemster, L. J., Bentvelsen, S., ... Weits, H. (2014). Search for scalar diphoton resonances in the mass range 65-600 GeV with the ATLAS detector in pp collision data at $\sqrt{s} = 8$ TeV. *Physical Review Letters*, 113(17), [171801]. <https://doi.org/10.1103/PhysRevLett.113.171801>

General rights

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

Disclaimer/Complaints regulations

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

UvA-DARE is a service provided by the library of the University of Amsterdam (<http://dare.uva.nl>)

Search for Scalar Diphoton Resonances in the Mass Range 65–600 GeV with the ATLAS Detector in pp Collision Data at $\sqrt{s} = 8$ TeV

G. Aad *et al.**

(ATLAS Collaboration)

(Received 25 July 2014; published 20 October 2014)

A search for scalar particles decaying via narrow resonances into two photons in the mass range 65–600 GeV is performed using 20.3 fb^{-1} of $\sqrt{s} = 8$ TeV pp collision data collected with the ATLAS detector at the Large Hadron Collider. The recently discovered Higgs boson is treated as a background. No significant evidence for an additional signal is observed. The results are presented as limits at the 95% confidence level on the production cross section of a scalar boson times branching ratio into two photons, in a fiducial volume where the reconstruction efficiency is approximately independent of the event topology. The upper limits set extend over a considerably wider mass range than previous searches.

DOI: 10.1103/PhysRevLett.113.171801

PACS numbers: 14.80.Da, 13.85.Qk, 14.70.Bh, 14.80.Ec

In July 2012, the ATLAS and CMS collaborations reported the discovery of a new particle [1,2] whose measured couplings and properties are compatible with the standard model Higgs boson (H) [3–6]. However, several extensions to the standard model—in particular, models featuring an extended Higgs sector [7–13]—predict new scalar resonances below or above the H mass which may be narrow when their branching ratio to two photons is non-negligible.

This Letter presents a search for a scalar particle X of mass m_X decaying via narrow resonances into two photons. It extends the method developed for the measurement of the H couplings in the $H \rightarrow \gamma\gamma$ channel [3] to the range $65 < m_X < 600$ GeV. Analytical descriptions of the signal and background distributions are fitted to the measured diphoton invariant mass spectrum $m_{\gamma\gamma}$ to determine the signal and background yields. The result is presented as a limit on the production cross section times the branching ratio $BR(X \rightarrow \gamma\gamma)$, restricted to a fiducial volume where the reconstruction efficiency is approximately independent of the event topology. The resonance with mass m_X is considered narrow when its intrinsic width is smaller than $0.09 \text{ GeV} + 0.01m_X$. This upper limit is defined such that the bias in the number of fitted signal events is kept below 10%. This ensures that the diphoton invariant mass width is dominated by the experimental resolution in the ATLAS detector. Model-dependent interference effects between the resonance and the continuum diphoton background are not considered.

The ATLAS detector [14] at the LHC [15] covers the pseudorapidity [16] range $|\eta| < 4.9$ and the full azimuthal

angle ϕ . It consists of an inner tracking detector covering the pseudorapidity range $|\eta| < 2.5$, surrounded by electromagnetic and hadronic calorimeters and an external muon spectrometer.

The search is carried out using the $\sqrt{s} = 8$ TeV pp collision data set collected in 2012, with stable beam conditions and all ATLAS subsystems operational, which corresponds to an integrated luminosity of $\mathcal{L} = 20.3 \pm 0.6 \text{ fb}^{-1}$ [17]. The data were recorded using a diphoton trigger that required two electromagnetic clusters with transverse energies E_T above 20 GeV, both fulfilling identification criteria based on shower shapes in the electromagnetic calorimeter. The efficiency of the diphoton trigger [18] is $(98.7 \pm 0.5)\%$ for signal events passing the analysis selection.

The event selection requires at least one reconstructed primary vertex with two or more tracks with transverse momenta $p_T > 0.4$ GeV, and at least two photon candidates with $E_T > 22$ GeV and $|\eta| < 2.37$, excluding the barrel and end cap transition region of the calorimeter, $1.37 < |\eta| < 1.56$.

Photon reconstruction is seeded by clusters of electromagnetic calorimeter cells. Clusters without matching tracks are classified as unconverted photons. Clusters with matched tracks are considered as electron candidates but are classified as converted photons if they are associated with two tracks consistent with a $\gamma \rightarrow e^+e^-$ conversion process, or a single track leaving no hit in the innermost layer of the inner tracking detector. The photon energy calibration procedure is the same as in Ref. [3].

Photon candidates are required to fulfill identification criteria based on shower shapes in the electromagnetic calorimeter, and on energy leakage into the hadronic calorimeter [19]. Identification efficiencies, averaged over η , range from 70% to above 99% for the E_T range under consideration. To further reduce the background from jets, the calorimeter isolation transverse energy E_T^{iso} is required

* 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. Further distribution of this work must maintain attribution to the author(s) and the published articles title, journal citation, and DOI.

to be smaller than 6 GeV, where E_T^{iso} is defined as the sum of transverse energies of the positive-energy topological clusters [20] within a cone of size $\Delta R = \sqrt{(\Delta\phi)^2 + (\Delta\eta)^2} = 0.4$ around the photon candidate. The core of the photon shower is excluded, and E_T^{iso} is corrected for the leakage of the photon shower into the isolation cone. The contributions from the underlying event and pileup are subtracted using the technique proposed in Ref. [21] and implemented as described in Ref. [22]. In addition, the track isolation—defined as the scalar sum of the p_T of the primary vertex tracks with $p_T > 1$ GeV in a $\Delta R = 0.2$ cone around the photon candidate, excluding the conversion tracks—is required to be smaller than 2.6 GeV.

The $m_{\gamma\gamma}$ invariant mass is evaluated using the leading photon (γ_1) and subleading photon (γ_2) energies measured in the calorimeter, the azimuthal angle $\Delta\phi$ and the pseudorapidity $\Delta\eta$ separations between the photons determined from their positions in the calorimeter, and the position of the reconstructed diphoton vertex [3].

After selection, the data sample consists of a continuum background with dominantly $\gamma\gamma$, γ -jet, and jet-jet events and Drell–Yan (DY) production of electron pairs where both electrons are misidentified as photons. Two peaking backgrounds arise from the Z boson component of the DY and from $H \rightarrow \gamma\gamma$.

To increase the sensitivity, the search is split into two analyses: a categorized low-mass analysis covering the range $65 < m_X < 110$ GeV and an inclusive high-mass analysis covering $110 < m_X < 600$ GeV. To provide sidebands on both sides of the tested mass point m_X , the $m_{\gamma\gamma}$ ranges are wider than the m_X ranges probed and overlap at the transition between the two analyses.

The low-mass analysis requires a precise modeling of the DY background, dominated by the Z boson resonance, where both electrons are misidentified as photons, mostly classified as converted photons. The loss of signal sensitivity is mitigated by separating the events into three categories with different signal-to-background ratios, according to the conversion status of the photon pair: two unconverted (UU), one converted and one unconverted (CU), or two converted (CC) photons. Table I shows the fractions of signal and DY events expected in each category.

TABLE I. Number of diphoton events in data (N_{data}), number of expected Drell–Yan events (N_{DY}), fractions of expected signal (f_X), and Drell–Yan (f_{DY}) in each conversion category for the low-mass analysis. The signal fraction is given for $m_X = 90$ GeV but the mass dependence is negligible.

$\gamma\gamma$ category	UU	CU	CC
N_{data}	272184	253804	63224
N_{DY}	1080 ± 260	3400 ± 600	2700 ± 250
f_{DY}	15.0%	47.3%	37.7%
f_X	48.7%	42.5%	8.8%

In each category, the Z resonance shape is described by a double-sided Crystal Ball function [23]. Because of the limited size of the fully simulated $Z \rightarrow ee$ sample [25,26] where both electrons are misidentified as photons, the shape parameters are determined by a fit to a dielectron data sample, where both electrons are required to fulfill shower shape identification criteria and the same E_T thresholds as the photons.

Since most of the electrons misidentified as photons underwent large bremsstrahlung, the invariant mass distribution of the Z boson reconstructed as a photon pair is wider and shifted to lower masses by up to 2 GeV with respect to the Z boson mass reconstructed as an electron pair. The $Z \rightarrow ee$ invariant mass distributions extracted from data in each category are transformed by applying E_T -dependent shifts and smearing factors to the electron E_T and ϕ , to match the kinematics of the electrons misidentified as photons. Two sets of transformations are derived for γ_1 and γ_2 depending on their conversion status, using a $Z \rightarrow ee$ sample generated with POWHEG [27,28], interfaced with PYTHIA8 [29] for showering and hadronization. Figure 1 illustrates the effect of the electrons' transformations on the invariant mass shapes in the fully simulated $Z \rightarrow ee$ sample. Systematic uncertainties on the template shapes and the Z peak position are evaluated by varying the parameters of the electrons' transformations by $\pm 1\sigma$.

The DY normalization is computed from the $e \rightarrow \gamma$ fake rates, defined as the ratios of $e\gamma$ to ee pairs measured in $Z \rightarrow ee$ data, separately for γ_1 and γ_2 and each conversion status. A correction factor obtained from fully simulated $Z \rightarrow ee$ events is applied to account for additional effects, mainly the differences in isolation efficiencies and vertex reconstruction efficiency between $\gamma\gamma$ and ee events. The associated uncertainties (9% to 25%) are dominated by the

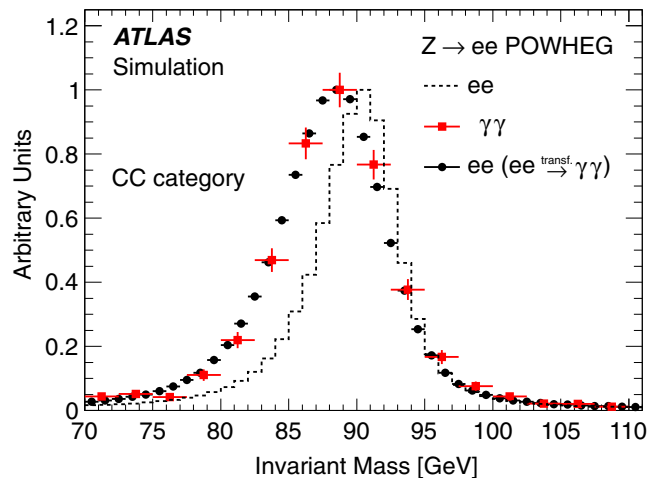


FIG. 1 (color online). Invariant mass distributions in the CC category for fully simulated $Z \rightarrow ee$ events reconstructed as ee (dotted lines), reconstructed as $\gamma\gamma$ (squares), and reconstructed as ee after transforming the electrons to match the kinematics of the electrons misidentified as converted photons (circles).

subtraction of the continuum background and the detector material description.

The determination of the analytical form of the continuum background and the corresponding uncertainties follow the method detailed in Ref. [1]. The sum of a Landau distribution and an exponential distribution is used over the full $m_{\gamma\gamma}$ range. The bias on the signal yield induced by the analytical shape function is required to be lower than 20% of the statistical uncertainty on the fitted signal yield for the background-only spectrum. This bias is measured from a large sample generated from a parametrized detector response and is accounted for by a mass-dependent uncertainty. Figure 2 shows background-only fits to the data in the low-mass analysis for the three conversion categories.

In the high-mass analysis, relative cuts $E_T^{\gamma_1}/m_{\gamma\gamma} > 0.4$ and $E_T^{\gamma_2}/m_{\gamma\gamma} > 0.3$ are added to the selection requirements to reduce the continuum backgrounds and thereby increase the signal sensitivity. In total, 108 654 events with $100 < m_{\gamma\gamma} < 800$ GeV are selected.

To determine the continuum background shape over this large mass range, an exponential of a second-order polynomial is fitted inside a sliding $m_{\gamma\gamma}$ window of width $80 \cdot (m_X - 110 \text{ GeV})/110 + 20 \text{ GeV}$, centered on the mass point m_X . The analytical shape and the fit window width are chosen to fulfill the signal yield bias criterion, as defined for the low-mass analysis, to minimize the statistical uncertainty on the background.

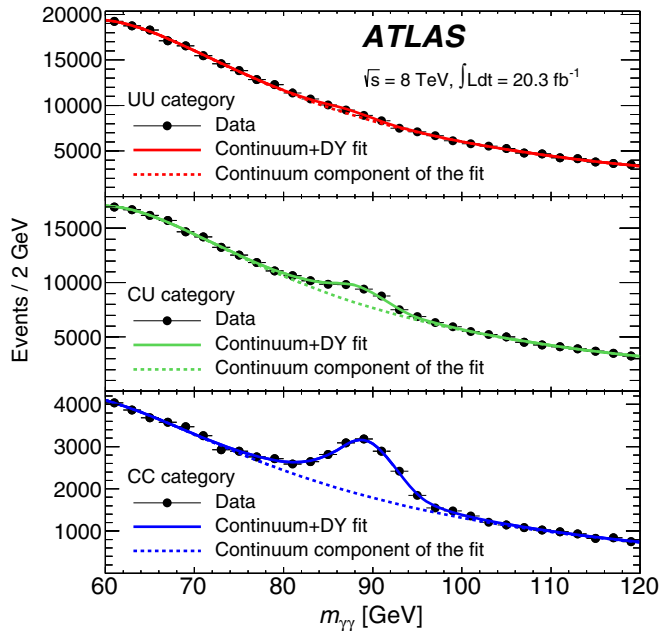


FIG. 2 (color online). Background-only fits to the data (black dots) as functions of the diphoton invariant mass $m_{\gamma\gamma}$ for the three conversion categories in the low-mass range. The solid lines show the sum of the Drell–Yan and the continuum background components. The dashed lines show the continuum background component only.

The H background shape is modeled by a double-sided Crystal Ball function and normalized for $m_H = 125.9$ GeV [30,31] using the most up-to-date standard model cross-section calculations and corrections [34] of the five main production modes: gluon fusion (ggF), vector-boson fusion (VBF), Higgsstrahlung (WH, ZH), and associated production with a top quark pair ($t\bar{t}H$). The ggF and VBF samples [3] are simulated with the POWHEG generator interfaced with PYTHIA8. The WH, ZH , and $t\bar{t}H$ samples [3] are simulated with PYTHIA8. Figure 3 shows background-only fits to the data in the high-mass analysis.

The expected invariant mass distribution of the narrow resonance signal X is also modeled with a double-sided Crystal Ball function in the mass range $65 \leq m_X \leq 600$ GeV, using fully simulated ggF(X) samples generated as for H , where H is replaced by a scalar boson with a constant width of 4 MeV. Polynomial parametrizations of the signal shape parameters as a function of m_X are obtained from a simultaneous fit to all the generated mass points m_X , separately for the high-mass analysis and the three low-mass analysis categories. The signal shape parameters extracted from ggF(X) are compared to the other production modes: VBF(X), WX, ZX , and $t\bar{t}X$; the bias on the signal yield due to the choice of ggF(X) shape is negligible. The systematic uncertainty on the signal shape due to the photon energy resolution uncertainty ranges from 10% to 40% as a function of m_X [3]. The systematic uncertainty on the X peak position due to the photon energy scale uncertainty is 0.6% [3].

The fiducial cross section $\sigma_{\text{fid}}BR(X \rightarrow \gamma\gamma)$ includes an efficiency correction factor C_X through

$$\sigma_{\text{fid}}BR(X \rightarrow \gamma\gamma) = \frac{N_{\text{data}}}{C_X \mathcal{L}} \quad \text{with} \quad C_X = \frac{N_{\text{MC}}^{\text{reco}}}{N_{\text{MC}}^{\text{fid}}}$$

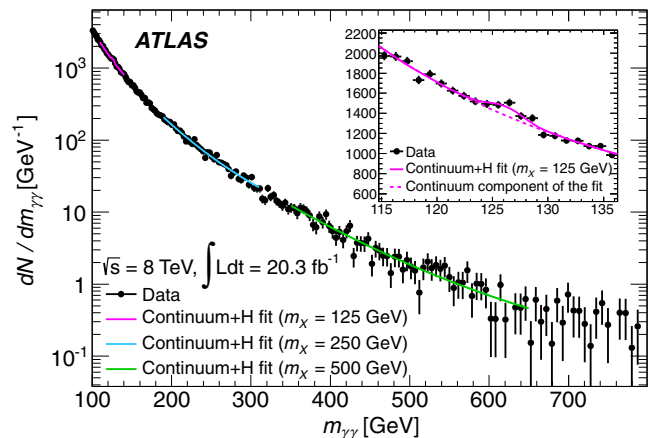


FIG. 3 (color online). Background-only fits to the data (black dots) as functions of the diphoton invariant mass $m_{\gamma\gamma}$ for the inclusive high-mass analysis. The solid line shows the sum of the Higgs boson and the continuum background components. The dashed line shows the continuum background component only.

TABLE II. Summary of the systematic uncertainties.

Signal and Higgs boson yield		Z component of Drell-Yan	
Luminosity	2.8%	Normalization ^b	9%–25%
Trigger	0.5%	Peak position ^b	1.5%–3.5%
γ identification ^a	1.6%–2.7%	Template shape ^b	1.5%–3%
γ isolation ^a	1%–6%	<i>Higgs boson background</i>	
Energy resolution ^{a,b}	10%–40%	Cross section ^c	9.6%
<i>Signal and Higgs boson peak position</i>		Branching ratio	4.8%
Energy scale	0.6%	C_X factor	
<i>Continuum $\gamma\gamma$, γj, jj, DY</i>		Topology ^a	3%–15%
Signal bias ^a	1–67 events	Pileup and U.E. ^a	1.4%–3.2%

^aMass dependent.^bCategory dependent.^cFactorization scale plus parton density function uncertainties [34].

where N_{data} is the number of fitted signal events in data, $N_{\text{MC}}^{\text{reco}}$ the number of simulated signal events passing the selection criteria and $N_{\text{MC}}^{\text{fid}}$ the number of simulated signal events generated within the fiducial volume. The fiducial volume, defined from geometrical and kinematical constraints at the generated particle level, is optimized to reduce the model dependence of C_X using fully simulated samples of the five X production modes to cover a large variety of topologies. The photon selection at generation level is similar to the selection applied to the data: two photons with $E_T > 22$ GeV and $|\eta| < 2.37$ are required; for m_X greater than 110 GeV, the relative cuts $E_T^{\gamma 1}/m_{\gamma\gamma} > 0.4$ and $E_T^{\gamma 2}/m_{\gamma\gamma} > 0.3$ are imposed. The particle isolation, defined as the scalar sum of p_T of all the stable particles (except neutrinos) found within a $\Delta R = 0.4$ cone around the photon direction, is required to be less than 12 GeV. The C_X factor is parametrized from the $ggF(X)$ samples and ranges from 0.56 to 0.71 as a function of m_X . Systematic uncertainties include the maximum difference between the

C_X of the five production modes, the effect of the underlying event (U.E.) and pileup.

The statistical analysis of the data uses unbinned maximum likelihood fits. The DY and H shapes and normalizations are allowed to float within the uncertainties. In the low-mass analysis, a simultaneous fit to the three conversion categories is performed. Only two excesses with 2.1σ and 2.2σ local significances above the background are observed over the full mass range 65–600 GeV, for $m_X = 201$ GeV and $m_X = 530$ GeV, respectively. This corresponds to a deviation of less than 0.5σ from the background-only hypothesis. Consequently, a 95% limit on $\sigma_{\text{fid}} BR(X \rightarrow \gamma\gamma)$ is computed using the procedure of Ref. [1]. The systematic uncertainties listed in Table II are accounted for by nuisance parameters in the likelihood function. In the low-mass analysis, the dominant uncertainties are the DY normalization and the residual topology dependence of C_X . In the high-mass analysis, the largest uncertainties arise from the energy resolution and the

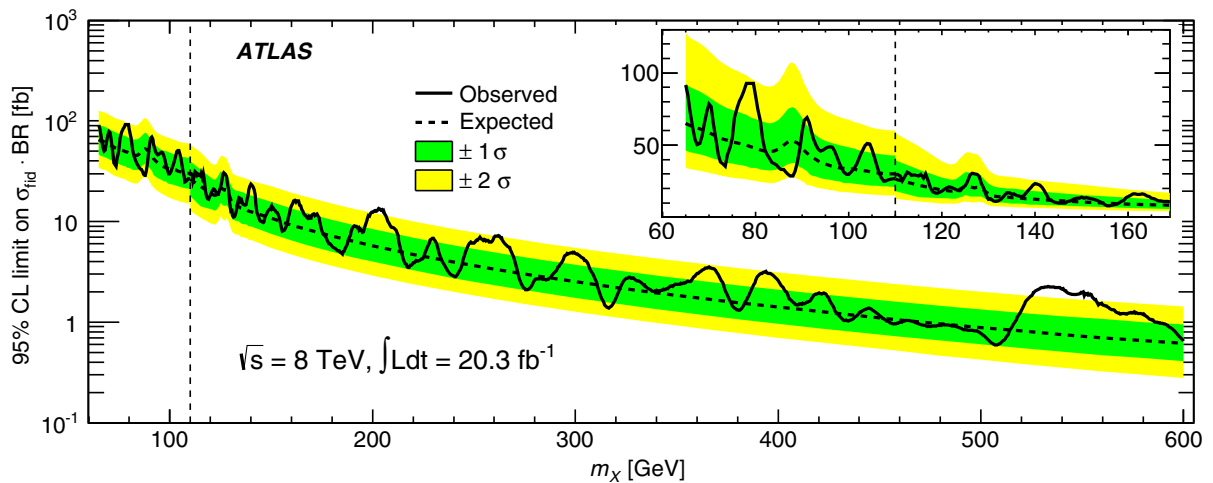


FIG. 4 (color online). Observed and expected 95% C.L. limit on the fiducial cross section times branching ratio $BR(X \rightarrow \gamma\gamma)$ as a function of m_X in the range $65 < m_X < 600$ GeV. The discontinuity in the limit at $m_X = 110$ GeV (vertical dashed line) is due to the transition between the low-mass and high-mass analyses. The green and yellow bands show the $\pm 1\sigma$ and $\pm 2\sigma$ uncertainties on the expected limit. The inset shows a zoom around the transition point.

theoretical uncertainty on the production rate of the standard model Higgs boson around 126 GeV.

The observed and expected limits, shown in Fig. 4, are in good agreement, consistent with the absence of a signal. The limits on $\sigma_{\text{fid}}BR(X \rightarrow \gamma\gamma)$ for an additional scalar resonance range from 90 fb for $m_X = 65$ GeV to 1 fb for $m_X = 600$ GeV. These results extend over a considerably wider mass range than the previous searches by the ATLAS and CMS collaborations [1,35], are complementary to spin-2 particles searches [36,37], and are the first such limits independent of the event topology.

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 and FWF, 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; EPLANET, ERC, and NSRF, European Union; IN2P3-CNRS and CEA-DSM/IRFU, France; GNSF, Georgia; BMBF, DFG, HGF, MPG, and AvH Foundation, Germany; GSRT and NSRF, Greece; ISF, MINERVA, GIF, I-CORE, and Benoziyo Center, Israel; INFN, Italy; MEXT and JSPS, Japan; CNRST, Morocco; FOM and NWO, Netherlands; BRF and RCN, Norway; MNiSW and NCN, Poland; GRICES and FCT, Portugal; MNE/IFA, Romania; MES of Russia and ROSATOM, Russian Federation; JINR; MSTP, Serbia; MSSR, Slovakia; ARRS and MIZŠ, Slovenia; DST/NRF, South Africa; MINECO, 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, U.S. 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, and Sweden), CC-IN2P3 (France), KIT/GridKA (Germany), INFN-CNAF (Italy), NL-T1 (Netherlands), PIC (Spain), ASGC (Taiwan), RAL (United Kingdom) and BNL (U.S.), and in the Tier-2 facilities worldwide.

-
- [1] ATLAS Collaboration, *Phys. Lett. B* **716**, 1 (2012).
 [2] CMS Collaboration, *Phys. Lett. B* **716**, 30 (2012).
 [3] ATLAS Collaboration, *Phys. Lett. B* **726**, 88 (2013).
 [4] CMS Collaboration, *J. High Energy Phys.* **06** (2013) 081.
 [5] ATLAS Collaboration, *Phys. Lett. B* **726**, 120 (2013).

- [6] CMS Collaboration, *Phys. Rev. Lett.* **110**, 081803 (2013).
 [7] A. Hill and J. J. van der Bij, *Phys. Rev. D* **36**, 3463 (1987).
 [8] M. Veltman and F. Yndurain, *Nucl. Phys.* **B325**, 1 (1989).
 [9] T. Binoth and J. J. van der Bij, *Z. Phys. C* **75**, 17 (1997).
 [10] R. Schabinger and J. D. Wells, *Phys. Rev. D* **72**, 093007 (2005).
 [11] B. Patt and F. Wilczek, [arXiv:hep-ph/0605188](https://arxiv.org/abs/hep-ph/0605188).
 [12] G. M. Pruna and T. Robens, *Phys. Rev. D* **88**, 115012 (2013).
 [13] T. D. Lee, *Phys. Rev. D* **8**, 1226 (1973).
 [14] ATLAS Collaboration, *JINST* **3**, S08003 (2008).
 [15] L. Evans and P. Bryant, *JINST* **3**, S08001 (2008).
 [16] 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 along the beam line. 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, with ϕ being the azimuthal angle around the beam line. Observables labeled transverse are projected into the x - y plane. The pseudorapidity is defined in terms of the polar angle θ as $\eta = -\ln[\tan(\theta/2)]$.
 [17] ATLAS Collaboration, *Eur. Phys. J. C* **73**, 2518 (2013).
 [18] ATLAS Collaboration, Report No. ATLAS-CONF-2012-048, 2012.
 [19] ATLAS Collaboration, Report No. ATL-PHYS-PUB-2011-007, 2011.
 [20] ATLAS Collaboration, *Phys. Rev. D* **83**, 052005 (2011).
 [21] M. Cacciari, G. P. Salam, and S. Sapeta, *J. High Energy Phys.* **04** (2010) 065.
 [22] ATLAS Collaboration, *Phys. Rev. D* **85**, 012003 (2012).
 [23] A double-sided Crystal Ball function is composed of a Gaussian distribution at the core, connected with two power-law distributions describing the lower and upper tails [24].
 [24] M. Oreglia, Ph.D. thesis, Stanford University [SLAC Report No. SLAC-R-0236, Appendix D, 1980].
 [25] S. Agostinelli *et al.* (GEANT4 Collaboration), *Nucl. Instrum. Methods Phys. Res., Sect. A* **506**, 250 (2003).
 [26] ATLAS Collaboration, *Eur. Phys. J. C* **70**, 823 (2010).
 [27] S. Alioli, P. Nason, C. Oleari, and E. Re, *J. High Energy Phys.* **04** (2009) 002.
 [28] P. Nason and C. Oleari, *J. High Energy Phys.* **02** (2010) 037.
 [29] T. Sjostrand, S. Mrenna, and P. Z. Skands, *J. High Energy Phys.* **05** (2006) 026.
 [30] J. Beringer *et al.* (Particle Data Group), *Phys. Rev. D* **86**, 010001 (2012) and 2013 partial update for the 2014 edition.
 [31] Differences between this choice of reference mass and the new mass measurements [32,33] are covered by the energy scale uncertainties listed in Table II.
 [32] ATLAS Collaboration, *Phys. Rev. D* **90**, 052004 (2014).
 [33] CMS Collaboration, Report No. CMS-PAS-HIG-14-009, 2014.
 [34] S. Heinemeyer *et al.* (LHC Higgs Cross Section Working Group), [arXiv:1307.1347](https://arxiv.org/abs/1307.1347).
 [35] CMS Collaboration, [arXiv:1407.0558](https://arxiv.org/abs/1407.0558).
 [36] ATLAS Collaboration, *Phys. Lett. B* **710**, 538 (2012).
 [37] CMS Collaboration, *Phys. Rev. Lett.* **108**, 111801 (2012).

G. Aad,⁸⁴ B. Abbott,¹¹² J. Abdallah,¹⁵² S. Abdel Khalek,¹¹⁶ O. Abdinov,¹¹ R. Aben,¹⁰⁶ B. Abi,¹¹³ M. Abolins,⁸⁹
O. S. AbouZeid,¹⁵⁹ H. Abramowicz,¹⁵⁴ H. Abreu,¹⁵³ R. Abreu,³⁰ Y. Abulaiti,^{147a,147b} B. S. Acharya,^{165a,165b}
L. Adamczyk,^{38a} D. L. Adams,²⁵ J. Adelman,¹⁷⁷ S. Adomeit,⁹⁹ T. Adye,¹³⁰ T. Agatonovic-Jovin,^{13a}
J. A. Aguilar-Saavedra,^{125a,125f} M. Agustoni,¹⁷ S. P. Ahlen,²² F. Ahmadov,^{64,c} G. Aielli,^{134a,134b} H. Akerstedt,^{147a,147b}
T. P. A. Åkesson,⁸⁰ G. Akimoto,¹⁵⁶ A. V. Akimov,⁹⁵ G. L. Alberghi,^{20a,20b} J. Albert,¹⁷⁰ S. Albrand,⁵⁵
M. J. Alconada Verzini,⁷⁰ M. Aleksa,³⁰ I. N. Aleksandrov,⁶⁴ C. Alexa,^{26a} G. Alexander,¹⁵⁴ G. Alexandre,⁴⁹ T. Alexopoulos,¹⁰
M. Alhroob,^{165a,165c} G. Alimonti,^{90a} L. Alio,⁸⁴ J. Alison,³¹ B. M. M. Allbrooke,¹⁸ L. J. Allison,⁷¹ P. P. Allport,⁷³ J. Almond,⁸³
A. Aloisio,^{103a,103b} A. Alonso,³⁶ F. Alonso,⁷⁰ C. Alpigiani,⁷⁵ A. Altheimer,³⁵ B. Alvarez Gonzalez,⁸⁹ M. G. Alviggi,^{103a,103b}
K. Amako,⁶⁵ Y. Amaral Coutinho,^{24a} C. Amelung,²³ D. Amidei,⁸⁸ S. P. Amor Dos Santos,^{125a,125c} A. Amorim,^{125a,125b}
S. Amoroso,⁴⁸ N. Amram,¹⁵⁴ G. Amundsen,²³ C. Anastopoulos,¹⁴⁰ L. S. Ancu,⁴⁹ N. Andari,³⁰ T. Andeen,³⁵ C. F. Anders,^{58b}
G. Anders,³⁰ K. J. Anderson,³¹ A. Andreazza,^{90a,90b} V. Andrei,^{58a} X. S. Anduaga,⁷⁰ S. Angelidakis,⁹ I. Angelozzi,¹⁰⁶
P. Anger,⁴⁴ A. Angerami,³⁵ F. Anghinolfi,³⁰ A. V. Anisenkov,¹⁰⁸ N. Anjos,^{125a} A. Annovi,⁴⁷ A. Antonaki,⁹ M. Antonelli,⁴⁷
A. Antonov,⁹⁷ J. Antos,^{145b} F. Anulli,^{133a} M. Aoki,⁶⁵ L. Aperio Bella,¹⁸ R. Apolle,^{119,d} G. Arabidze,⁸⁹ I. Aracena,¹⁴⁴
Y. Arai,⁶⁵ J. P. Araque,^{125a} A. T. H. Arce,⁴⁵ J-F. Arguin,⁹⁴ S. Argyropoulos,⁴² M. Arik,^{19a} A. J. Armbruster,³⁰ O. Arnaez,³⁰
V. Arnal,⁸¹ H. Arnold,⁴⁸ M. Arratia,²⁸ O. Arslan,²¹ A. Artamonov,⁹⁶ G. Artoni,²³ S. Asai,¹⁵⁶ N. Asbah,⁴² A. Ashkenazi,¹⁵⁴
B. Åsman,^{147a,147b} L. Asquith,⁶ K. Assamagan,²⁵ R. Astalos,^{145a} M. Atkinson,¹⁶⁶ N. B. Atlay,¹⁴² B. Auerbach,⁶
K. Augsten,¹²⁷ M. Aurousseau,^{146b} G. Avolio,³⁰ G. Azuelos,^{94,e} Y. Azuma,¹⁵⁶ M. A. Baak,³⁰ A. Baas,^{58a} C. Bacci,^{135a,135b}
H. Bachacou,¹³⁷ K. Bachas,¹⁵⁵ M. Backes,³⁰ M. Backhaus,³⁰ J. Backus Mayes,¹⁴⁴ E. Badescu,^{26a} P. Bagiacchi,^{133a,133b}
P. Bagnaia,^{133a,133b} Y. Bai,^{33a} T. Bain,³⁵ J. T. Baines,¹³⁰ O. K. Baker,¹⁷⁷ P. Balek,¹²⁸ F. Balli,¹³⁷ E. Banas,³⁹ Sw. Banerjee,¹⁷⁴
A. A. E. Bannoura,¹⁷⁶ V. Bansal,¹⁷⁰ H. S. Bansil,¹⁸ L. Barak,¹⁷³ S. P. Baranov,⁹⁵ E. L. Barberio,⁸⁷ D. Barberis,^{50a,50b}
M. Barbero,⁸⁴ T. Barillari,¹⁰⁰ M. Barisonzi,¹⁷⁶ T. Barklow,¹⁴⁴ N. Barlow,²⁸ B. M. Barnett,¹³⁰ R. M. Barnett,¹⁵ Z. Barnovska,⁵
A. Baroncelli,^{135a} G. Barone,⁴⁹ A. J. Barr,¹¹⁹ F. Barreiro,⁸¹ J. Barreiro Guimarães da Costa,⁵⁷ R. Bartoldus,¹⁴⁴ A. E. Barton,⁷¹
P. Bartos,^{145a} V. Bartsch,¹⁵⁰ A. Bassalat,¹¹⁶ A. Basye,¹⁶⁶ R. L. Bates,⁵³ J. R. Batley,²⁸ M. Battaglia,¹³⁸ M. Battistin,³⁰
F. Bauer,¹³⁷ H. S. Bawa,^{144,f} M. D. Beattie,⁷¹ T. Beau,⁷⁹ P. H. Beauchemin,¹⁶² R. Beccherle,^{123a,123b} P. Bechtel,²¹
H. P. Beck,¹⁷ K. Becker,¹⁷⁶ S. Becker,⁹⁹ M. Beckingham,¹⁷¹ C. Becot,¹¹⁶ A. J. Beddall,^{19c} A. Beddall,^{19c} S. Bedikian,¹⁷⁷
V. A. Bednyakov,⁶⁴ C. P. Bee,¹⁴⁹ L. J. Beemster,¹⁰⁶ T. A. Beermann,¹⁷⁶ M. Begel,²⁵ K. Behr,¹¹⁹ C. Belanger-Champagne,⁸⁶
P. J. Bell,⁴⁹ W. H. Bell,⁴⁹ G. Bella,¹⁵⁴ L. Bellagamba,^{20a} A. Bellerive,²⁹ M. Bellomo,⁸⁵ K. Belotskiy,⁹⁷ O. Beltramello,³⁰
O. Benary,¹⁵⁴ D. Benchechroun,^{136a} K. Bendtz,^{147a,147b} N. Benekos,¹⁶⁶ Y. Benhammou,¹⁵⁴ E. Benhar Noccioli,⁴⁹
J. A. Benitez Garcia,^{160b} D. P. Benjamin,⁴⁵ J. R. Bensinger,²³ K. Benslama,¹³¹ S. Bentvelsen,¹⁰⁶ D. Berge,¹⁰⁶
E. Bergeaas Kuutmann,¹⁶ N. Berger,⁵ F. Berghaus,¹⁷⁰ J. Beringer,¹⁵ C. Bernard,²² P. Bernat,⁷⁷ C. Bernius,⁷⁸
F. U. Bernlochner,¹⁷⁰ T. Berry,⁷⁶ P. Berta,¹²⁸ C. Bertella,⁸⁴ G. Bertoli,^{147a,147b} F. Bertolucci,^{123a,123b} C. Bertsche,¹¹²
D. Bertsche,¹¹² M. I. Besana,^{90a} G. J. Besjes,¹⁰⁵ O. Bessidskaia,^{147a,147b} M. Bessner,⁴² N. Besson,¹³⁷ C. Betancourt,⁴⁸
S. Bethke,¹⁰⁰ W. Bhimji,⁴⁶ R. M. Bianchi,¹²⁴ L. Bianchini,²³ M. Bianco,³⁰ O. Biebel,⁹⁹ S. P. Bieniek,⁷⁷ K. Bierwagen,⁵⁴
J. Biesiada,¹⁵ M. Biglietti,^{135a} J. Bilbao De Mendizabal,⁴⁹ H. Bilokon,⁴⁷ M. Bindi,⁵⁴ S. Binet,¹¹⁶ A. Bingul,^{19c}
C. Bini,^{133a,133b} C. W. Black,¹⁵¹ J. E. Black,¹⁴⁴ K. M. Black,²² D. Blackburn,¹³⁹ R. E. Blair,⁶ J.-B. Blanchard,¹³⁷ T. Blazek,^{145a}
I. Bloch,⁴² C. Blocker,²³ W. Blum,^{82,a} U. Blumenschein,⁵⁴ G. J. Bobbink,¹⁰⁶ V. S. Bobrovnikov,¹⁰⁸ S. S. Bocchetta,⁸⁰
A. Bocci,⁴⁵ C. Bock,⁹⁹ C. R. Boddy,¹¹⁹ M. Boehler,⁴⁸ T. T. Boek,¹⁷⁶ J. A. Bogaerts,³⁰ A. G. Bogdanchikov,¹⁰⁸
A. Bogouch,^{91,a} C. Bohm,^{147a} J. Bohm,¹²⁶ V. Boisvert,⁷⁶ T. Bold,^{38a} V. Boldea,^{26a} A. S. Boldyrev,⁹⁸ M. Bomben,⁷⁹
M. Bona,⁷⁵ M. Boonekamp,¹³⁷ A. Borisov,¹²⁹ G. Borissov,⁷¹ M. Borri,⁸³ S. Borroni,⁴² J. Bortfeldt,⁹⁹ V. Bortolotto,^{135a,135b}
K. Bos,¹⁰⁶ D. Boscherini,^{20a} M. Bosman,¹² H. Boterenbrood,¹⁰⁶ J. Boudreau,¹²⁴ J. Bouffard,² E. V. Bouhova-Thacker,⁷¹
D. Boumediene,³⁴ C. Bourdarios,¹¹⁶ N. Bousson,¹¹³ S. Boutouil,^{136d} A. Boveia,³¹ J. Boyd,³⁰ I. R. Boyko,⁶⁴ J. Bracinik,¹⁸
A. Brandt,⁸ G. Brandt,¹⁵ O. Brandt,^{58a} U. Bratzler,¹⁵⁷ B. Brau,⁸⁵ J. E. Brau,¹¹⁵ H. M. Braun,^{176,a} S. F. Brazzale,^{165a,165c}
B. Brelief,¹⁵⁹ K. Brendlinger,¹²¹ A. J. Brennan,⁸⁷ R. Brenner,¹⁶⁷ S. Bressler,¹⁷³ K. Bristow,^{146c} T. M. Bristow,⁴⁶ D. Britton,⁵³
F. M. Brochu,²⁸ I. Brock,²¹ R. Brock,⁸⁹ C. Bromberg,⁸⁹ J. Bronner,¹⁰⁰ G. Brooijmans,³⁵ T. Brooks,⁷⁶ W. K. Brooks,^{32b}
J. Brosamer,¹⁵ E. Brost,¹¹⁵ J. Brown,⁵⁵ P. A. Bruckman de Renstrom,³⁹ D. Bruncko,^{145b} R. Bruneliere,⁴⁸ S. Brunet,⁶⁰
A. Bruni,^{20a} G. Bruni,^{20a} M. Bruschi,^{20a} L. Bryngemark,⁸⁰ T. Buanes,¹⁴ Q. Buat,¹⁴³ F. Bucci,⁴⁹ P. Buchholz,¹⁴²
R. M. Buckingham,¹¹⁹ A. G. Buckley,⁵³ S. I. Buda,^{26a} I. A. Budagov,⁶⁴ F. Buehrer,⁴⁸ L. Bugge,¹¹⁸ M. K. Bugge,¹¹⁸
O. Bulekov,⁹⁷ A. C. Bundock,⁷³ H. Burckhart,³⁰ S. Burdin,⁷³ B. Burghgrave,¹⁰⁷ S. Burke,¹³⁰ I. Burmeister,⁴³ E. Busato,³⁴
D. Büscher,⁴⁸ V. Büscher,⁸² P. Bussey,⁵³ C. P. Buszello,¹⁶⁷ B. Butler,⁵⁷ J. M. Butler,²² A. I. Butt,³ C. M. Buttar,⁵³

J. M. Butterworth,⁷⁷ P. Butti,¹⁰⁶ W. Buttinger,²⁸ A. Buzatu,⁵³ M. Byszewski,¹⁰ S. Cabrera Urbán,¹⁶⁸ D. Caforio,^{20a,20b}
O. Cakir,^{4a} P. Calafiura,¹⁵ A. Calandri,¹³⁷ G. Calderini,⁷⁹ P. Calfayan,⁹⁹ R. Calkins,¹⁰⁷ L. P. Caloba,^{24a} D. Calvet,³⁴
S. Calvet,³⁴ R. Camacho Toro,⁴⁹ S. Camarda,⁴² D. Cameron,¹¹⁸ L. M. Caminada,¹⁵ R. Caminal Armadans,¹² S. Campana,³⁰
M. Campanelli,⁷⁷ A. Campoverde,¹⁴⁹ V. Canale,^{103a,103b} A. Canepa,^{160a} M. Cano Bret,⁷⁵ J. Cantero,⁸¹ R. Cantrill,^{125a}
T. Cao,⁴⁰ M. D. M. Capeans Garrido,³⁰ I. Caprini,^{26a} M. Caprini,^{26a} M. Capua,^{37a,37b} R. Caputo,⁸² R. Cardarelli,^{134a}
T. Carli,³⁰ G. Carlino,^{103a} L. Carminati,^{90a,90b} S. Caron,¹⁰⁵ E. Carquin,^{32a} G. D. Carrillo-Montoya,^{146c} J. R. Carter,²⁸
J. Carvalho,^{125a,125c} D. Casadei,⁷⁷ M. P. Casado,¹² M. Casolino,¹² E. Castaneda-Miranda,^{146b} A. Castelli,¹⁰⁶
V. Castillo Gimenez,¹⁶⁸ N. F. Castro,^{125a} P. Catastini,⁵⁷ A. Catinaccio,³⁰ J. R. Catmore,¹¹⁸ A. Cattai,³⁰ G. Cattani,^{134a,134b}
S. Caughron,⁸⁹ V. Cavaliere,¹⁶⁶ D. Cavalli,^{90a} M. Cavalli-Sforza,¹² V. Cavasinni,^{123a,123b} F. Ceradini,^{135a,135b} B. Cerio,⁴⁵
K. Cerny,¹²⁸ A. S. Cerqueira,^{24b} A. Cerri,¹⁵⁰ L. Cerrito,⁷⁵ F. Cerutti,¹⁵ M. Cerv,³⁰ A. Cervelli,¹⁷ S. A. Cetin,^{19b} A. Chafaq,^{136a}
D. Chakraborty,¹⁰⁷ I. Chalupkova,¹²⁸ P. Chang,¹⁶⁶ B. Chapleau,⁸⁶ J. D. Chapman,²⁸ D. Charfeddine,¹¹⁶ D. G. Charlton,¹⁸
C. C. Chau,¹⁵⁹ C. A. Chavez Barajas,¹⁵⁰ S. Cheatham,⁸⁶ A. Chegwiddden,⁸⁹ S. Chekanov,⁶ S. V. Chekulaev,^{160a}
G. A. Chelkov,^{64,g} M. A. Chelstowska,⁸⁸ C. Chen,⁶³ H. Chen,²⁵ K. Chen,¹⁴⁹ L. Chen,^{33d,h} S. Chen,^{33c} X. Chen,^{146c} Y. Chen,⁶⁶
Y. Chen,³⁵ H. C. Cheng,⁸⁸ Y. Cheng,³¹ A. Cheplakov,⁶⁴ R. Cherkaoui El Moursli,^{136e} V. Chernyatin,^{25a} E. Cheu,⁷
L. Chevalier,¹³⁷ V. Chiarella,⁴⁷ G. Chiefari,^{103a,103b} J. T. Childers,⁶ A. Chilingarov,⁷¹ G. Chiodini,^{72a} A. S. Chisholm,¹⁸
R. T. Chislett,⁷⁷ A. Chitan,^{26a} M. V. Chizhov,⁶⁴ S. Chouridou,⁹ B. K. B. Chow,⁹⁹ D. Chromek-Burckhart,³⁰ M. L. Chu,¹⁵²
J. Chudoba,¹²⁶ J. J. Chwastowski,³⁹ L. Chytka,¹¹⁴ G. Ciapetti,^{133a,133b} A. K. Ciftci,^{4a} R. Ciftci,^{4a} D. Cinca,⁵³ V. Cindro,⁷⁴
A. Ciocio,¹⁵ P. Cirkovic,^{13b} Z. H. Citron,¹⁷³ M. Citterio,^{90a} M. Ciubancan,^{26a} A. Clark,⁴⁹ P. J. Clark,⁴⁶ R. N. Clarke,¹⁵
W. Cleland,¹²⁴ J. C. Clemens,⁸⁴ C. Clement,^{147a,147b} Y. Coadou,⁸⁴ M. Cobal,^{165a,165c} A. Coccaro,¹³⁹ J. Cochran,⁶³ L. Coffey,²³
J. G. Cogan,¹⁴⁴ J. Coggeshall,¹⁶⁶ B. Cole,³⁵ S. Cole,¹⁰⁷ A. P. Colijn,¹⁰⁶ J. Collot,⁵⁵ T. Colombo,^{58c} G. Colon,⁸⁵
G. Compostella,¹⁰⁰ P. Conde Muño,^{125a,125b} E. Coniavitis,⁴⁸ M. C. Conidi,¹² S. H. Connell,^{146b} I. A. Connelly,⁷⁶
S. M. Consonni,^{90a,90b} V. Consorti,⁴⁸ S. Constantinescu,^{26a} C. Conta,^{120a,120b} G. Conti,⁵⁷ F. Conventi,^{103a,i} M. Cooke,¹⁵
B. D. Cooper,⁷⁷ A. M. Cooper-Sarkar,¹¹⁹ N. J. Cooper-Smith,⁷⁶ K. Copic,¹⁵ T. Cornelissen,¹⁷⁶ M. Corradi,^{20a}
F. Corriveau,^{86,j} A. Corso-Radu,¹⁶⁴ A. Cortes-Gonzalez,¹² G. Cortiana,¹⁰⁰ G. Costa,^{90a} M. J. Costa,¹⁶⁸ D. Costanzo,¹⁴⁰
D. Côté,⁸ G. Cottin,²⁸ G. Cowan,⁷⁶ B. E. Cox,⁸³ K. Cranmer,¹⁰⁹ G. Cree,²⁹ S. Crépe-Renaudin,⁵⁵ F. Crescioli,⁷⁹
W. A. Cribbs,^{147a,147b} M. Crispin Ortuzar,¹¹⁹ M. Cristinziani,²¹ V. Croft,¹⁰⁵ G. Crosetti,^{37a,37b} C.-M. Cuciu,^{26a}
T. Cuhadar Donszelmann,¹⁴⁰ J. Cummings,¹⁷⁷ M. Curatolo,⁴⁷ C. Cuthbert,¹⁵¹ H. Czirr,¹⁴² P. Czodrowski,³ Z. Czyczula,¹⁷⁷
S. D'Auria,⁵³ M. D'Onofrio,⁷³ M. J. Da Cunha Sargedas De Sousa,^{125a,125b} C. Da Via,⁸³ W. Dabrowski,^{38a} A. Dafinca,¹¹⁹
T. Dai,⁸⁸ O. Dale,¹⁴ F. Dallaire,⁹⁴ C. Dallapiccola,⁸⁵ M. Dam,³⁶ A. C. Daniells,¹⁸ M. Dano Hoffmann,¹³⁷ V. Dao,⁴⁸
G. Darbo,^{50a} S. Darmora,⁸ J. A. Dassoulas,⁴² A. Dattagupta,⁶⁰ W. Davey,²¹ C. David,¹⁷⁰ T. Davidek,¹²⁸ E. Davies,^{119,d}
M. Davies,¹⁵⁴ O. Davignon,⁷⁹ A. R. Davison,⁷⁷ P. Davison,⁷⁷ Y. Davygora,^{58a} E. Dawe,¹⁴³ I. Dawson,¹⁴⁰
R. K. Daya-Ishmukhametova,⁸⁵ K. De,⁸ R. de Asmundis,^{103a} S. De Castro,^{20a,20b} S. De Cecco,⁷⁹ N. De Groot,¹⁰⁵
P. de Jong,¹⁰⁶ H. De la Torre,⁸¹ F. De Lorenzi,⁶³ L. De Nooij,¹⁰⁶ D. De Pedis,^{133a} A. De Salvo,^{133a} U. De Sanctis,^{165a,165b}
A. De Santo,¹⁵⁰ J. B. De Vivie De Regie,¹¹⁶ W. J. Dearnaley,⁷¹ R. Debbe,²⁵ C. Debenedetti,¹³⁸ B. Dechenaux,⁵⁵
D. V. Dedovich,⁶⁴ I. Deigaard,¹⁰⁶ J. Del Peso,⁸¹ T. Del Prete,^{123a,123b} F. Deliot,¹³⁷ C. M. Delitzsch,⁴⁹ M. Deliyergiyev,⁷⁴
A. Dell'Acqua,³⁰ L. Dell'Asta,²² M. Dell'Orso,^{123a,123b} M. Della Pietra,^{103a,i} D. della Volpe,⁴⁹ M. Delmastro,⁵ P. A. Delsart,⁵⁵
C. Deluca,¹⁰⁶ S. Demers,¹⁷⁷ M. Demichev,⁶⁴ A. Demilly,⁷⁹ S. P. Denisov,¹²⁹ D. Derendarz,³⁹ J. E. Derkaoui,^{136d} F. Derue,⁷⁹
P. Dervan,⁷³ K. Desch,²¹ C. Deterre,⁴² P. O. Deviveiros,¹⁰⁶ A. Dewhurst,¹³⁰ S. Dhaliwal,¹⁰⁶ A. Di Ciaccio,^{134a,134b}
L. Di Ciaccio,⁵ A. Di Domenico,^{133a,133b} C. Di Donato,^{103a,103b} A. Di Girolamo,³⁰ B. Di Girolamo,³⁰ A. Di Mattia,¹⁵³
B. Di Micco,^{135a,135b} R. Di Nardo,⁴⁷ A. Di Simone,⁴⁸ R. Di Sipio,^{20a,20b} D. Di Valentino,²⁹ F. A. Dias,⁴⁶ M. A. Diaz,^{32a}
E. B. Diehl,⁸⁸ J. Dietrich,⁴² T. A. Dietzsch,^{58a} S. Diglio,⁸⁴ A. Dimitrievska,^{13a} J. Dingfelder,²¹ C. Dionisi,^{133a,133b} P. Dita,^{26a}
S. Dita,^{26a} F. Dittus,³⁰ F. Djama,⁸⁴ T. Djobava,^{51b} M. A. B. do Vale,^{24c} A. Do Valle Wemans,^{125a,125g} T. K. O. Doan,⁵
D. Dobos,³⁰ C. Doglioni,⁴⁹ T. Doherty,⁵³ T. Dohmae,¹⁵⁶ J. Dolejsi,¹²⁸ Z. Dolezal,¹²⁸ B. A. Dolgoshein,^{97a} M. Donadelli,^{24d}
S. Donati,^{123a,123b} P. Dondero,^{120a,120b} J. Donini,³⁴ J. Dopke,¹³⁰ A. Doria,^{103a} M. T. Dova,⁷⁰ A. T. Doyle,⁵³ M. Dris,¹⁰
J. Dubbert,⁸⁸ S. Dube,¹⁵ E. Dubreuil,³⁴ E. Duchovni,¹⁷³ G. Duckeck,⁹⁹ O. A. Ducu,^{26a} D. Duda,¹⁷⁶ A. Dudarev,³⁰
F. Dudziak,⁶³ L. Dufлот,¹¹⁶ L. Duguid,⁷⁶ M. Dührssen,³⁰ M. Dunford,^{58a} H. Duran Yildiz,^{4a} M. Düren,⁵² A. Durglishvili,^{51b}
M. Dwuznik,^{38a} M. Dyndal,^{38a} J. Ebke,⁹⁹ W. Edson,² N. C. Edwards,⁴⁶ W. Ehrenfeld,²¹ T. Eifert,¹⁴⁴ G. Eigen,¹⁴
K. Einsweiler,¹⁵ T. Ekelof,¹⁶⁷ M. El Kacimi,^{136c} M. Ellert,¹⁶⁷ S. Elles,⁵ F. Ellinghaus,⁸² N. Ellis,³⁰ J. Elmsheuser,⁹⁹
M. Elsing,³⁰ D. Emelianov,¹³⁰ Y. Enari,¹⁵⁶ O. C. Endner,⁸² M. Endo,¹¹⁷ R. Engelmann,¹⁴⁹ J. Erdmann,¹⁷⁷ A. Ereditato,¹⁷

D. Eriksson,^{147a} G. Ernis,¹⁷⁶ J. Ernst,² M. Ernst,²⁵ J. Ernwein,¹³⁷ D. Errede,¹⁶⁶ S. Errede,¹⁶⁶ E. Ertel,⁸² M. Escalier,¹¹⁶ H. Esch,⁴³ C. Escobar,¹²⁴ B. Esposito,⁴⁷ A. I. Etienvre,¹³⁷ E. Etzion,¹⁵⁴ H. Evans,⁶⁰ A. Ezhilov,¹²² L. Fabbri,^{20a,20b} G. Facini,³¹ R. M. Fakhruddinov,¹²⁹ S. Falciano,^{133a} R. J. Falla,⁷⁷ J. Faltova,¹²⁸ Y. Fang,^{33a} M. Fanti,^{90a,90b} A. Farbin,⁸ A. Farilla,^{135a} T. Farooque,¹² S. Farrell,¹⁵ S. M. Farrington,¹⁷¹ P. Farthouat,³⁰ F. Fassi,^{136e} P. Fassnacht,³⁰ D. Fassouliotis,⁹ A. Favareto,^{50a,50b} L. Fayard,¹¹⁶ P. Federic,^{145a} O. L. Fedin,^{122,k} W. Fedorko,¹⁶⁹ M. Fehling-Kaschek,⁴⁸ S. Feigl,³⁰ L. Felgioni,⁸⁴ C. Feng,^{33d} E. J. Feng,⁶ H. Feng,⁸⁸ A. B. Fenyuk,¹²⁹ S. Fernandez Perez,³⁰ S. Ferrag,⁵³ J. Ferrando,⁵³ A. Ferrari,¹⁶⁷ P. Ferrari,¹⁰⁶ R. Ferrari,^{120a} D. E. Ferreira de Lima,⁵³ A. Ferrer,¹⁶⁸ D. Ferrere,⁴⁹ C. Ferretti,⁸⁸ A. Ferretto Parodi,^{50a,50b} M. Fiascaris,³¹ F. Fiedler,⁸² A. Filipčić,⁷⁴ M. Filipuzzi,⁴² F. Filthaut,¹⁰⁵ M. Fincke-Keeler,¹⁷⁰ K. D. Finelli,¹⁵¹ M. C. N. Fiolhais,^{125a,125c} L. Fiorini,¹⁶⁸ A. Firan,⁴⁰ A. Fischer,² J. Fischer,¹⁷⁶ W. C. Fisher,⁸⁹ E. A. Fitzgerald,²³ M. Flechl,⁴⁸ I. Fleck,¹⁴² P. Fleischmann,⁸⁸ S. Fleischmann,¹⁷⁶ G. T. Fletcher,¹⁴⁰ G. Fletcher,⁷⁵ T. Flick,¹⁷⁶ A. Floderus,⁸⁰ L. R. Flores Castillo,^{174,l} A. C. Florez Bustos,^{160b} M. J. Flowerdew,¹⁰⁰ A. Formica,¹³⁷ A. Forti,⁸³ D. Fortin,^{160a} D. Fournier,¹¹⁶ H. Fox,⁷¹ S. Fracchia,¹² P. Francavilla,⁷⁹ M. Franchini,^{20a,20b} S. Franchino,³⁰ D. Francis,³⁰ L. Franconi,¹¹⁸ M. Franklin,⁵⁷ S. Franz,⁶¹ M. Fraternali,^{120a,120b} S. T. French,²⁸ C. Friedrich,⁴² F. Friedrich,⁴⁴ D. Froidevaux,³⁰ J. A. Frost,²⁸ C. Fukunaga,¹⁵⁷ E. Fullana Torregrosa,⁸² B. G. Fulsom,¹⁴⁴ J. Fuster,¹⁶⁸ C. Gabaldon,⁵⁵ O. Gabizon,¹⁷³ A. Gabrielli,^{20a,20b} A. Gabrielli,^{133a,133b} S. Gadatsch,¹⁰⁶ S. Gadowski,⁴⁹ G. Gagliardi,^{50a,50b} P. Gagnon,⁶⁰ C. Galea,¹⁰⁵ B. Galhardo,^{125a,125c} E. J. Gallas,¹¹⁹ V. Gallo,¹⁷ B. J. Gallop,¹³⁰ P. Gallus,¹²⁷ G. Galster,³⁶ K. K. Gan,¹¹⁰ J. Gao,^{33b,h} Y. S. Gao,^{144,f} F. M. Garay Walls,⁴⁶ F. Garberson,¹⁷⁷ C. García,¹⁶⁸ J. E. García Navarro,¹⁶⁸ M. Garcia-Sciveres,¹⁵ R. W. Gardner,³¹ N. Garelli,¹⁴⁴ V. Garonne,³⁰ C. Gatti,⁴⁷ G. Gaudio,^{120a} B. Gaur,¹⁴² L. Gauthier,⁹⁴ P. Gauzzi,^{133a,133b} I. L. Gavrilenko,⁹⁵ C. Gay,¹⁶⁹ G. Gaycken,²¹ E. N. Gazis,¹⁰ P. Ge,^{33d} Z. Gecse,¹⁶⁹ C. N. P. Gee,¹³⁰ D. A. A. Geerts,¹⁰⁶ Ch. Geich-Gimbel,²¹ K. Gellerstedt,^{147a,147b} C. Gemme,^{50a} A. Gemmell,⁵³ M. H. Genest,⁵⁵ S. Gentile,^{133a,133b} M. George,⁵⁴ S. George,⁷⁶ D. Gerbaudo,¹⁶⁴ A. Gershon,¹⁵⁴ H. Ghazlane,^{136b} N. Ghodbane,³⁴ B. Giacobbe,^{20a} S. Giagu,^{133a,133b} V. Giangiobbe,¹² P. Giannetti,^{123a,123b} F. Gianotti,³⁰ B. Gibbard,²⁵ S. M. Gibson,⁷⁶ M. Gilchriese,¹⁵ T. P. S. Gillam,²⁸ D. Gillberg,³⁰ G. Gilles,³⁴ D. M. Gingrich,^{3,e} N. Giokaris,⁹ M. P. Giordani,^{165a,165c} R. Giordano,^{103a,103b} F. M. Giorgi,^{20a} F. M. Giorgi,¹⁶ P. F. Giraud,¹³⁷ D. Giugni,^{90a} C. Giuliani,⁴⁸ M. Giulini,^{58b} B. K. Gjelsten,¹¹⁸ S. Gkaitatzis,¹⁵⁵ I. Gkialas,^{155,m} L. K. Gladilin,⁹⁸ C. Glasman,⁸¹ J. Glatzer,³⁰ P. C. F. Glaysher,⁴⁶ A. Glazov,⁴² G. L. Glonti,⁶⁴ M. Goblirsch-Kolb,¹⁰⁰ J. R. Goddard,⁷⁵ J. Godfrey,¹⁴³ J. Godlewski,³⁰ C. Goeringer,⁸² S. Goldfarb,⁸⁸ T. Golling,¹⁷⁷ D. Golubkov,¹²⁹ A. Gomes,^{125a,125b,125d} L. S. Gomez Fajardo,⁴² R. Gonçalves,^{125a} J. Goncalves Pinto Firmino Da Costa,¹³⁷ L. Gonella,²¹ S. González de la Hoz,¹⁶⁸ G. Gonzalez Parra,¹² S. Gonzalez-Sevilla,⁴⁹ L. Goossens,³⁰ P. A. Gorbounov,⁹⁶ H. A. Gordon,²⁵ I. Gorelov,¹⁰⁴ B. Gorini,³⁰ E. Gorini,^{72a,72b} A. Gorišek,⁷⁴ E. Gornicki,³⁹ A. T. Goshaw,⁶ C. Gössling,⁴³ M. I. Gostkin,⁶⁴ M. Goughri,^{136a} D. Goujdami,^{136c} M. P. Goulette,⁴⁹ A. G. Goussiou,¹³⁹ C. Goy,⁵ S. Gozpinar,²³ H. M. X. Grabas,¹³⁷ L. Graber,⁵⁴ I. Grabowska-Bold,^{38a} P. Grafström,^{20a,20b} K.-J. Grahn,⁴² J. Gramling,⁴⁹ E. Gramstad,¹¹⁸ S. Grancagnolo,¹⁶ V. Grassi,¹⁴⁹ V. Gratchev,¹²² H. M. Gray,³⁰ E. Graziani,^{135a} O. G. Grebenyuk,¹²² Z. D. Greenwood,^{78,n} K. Gregersen,⁷⁷ I. M. Gregor,⁴² P. Grenier,¹⁴⁴ J. Griffiths,⁸ A. A. Grillo,¹³⁸ K. Grimm,⁷¹ S. Grinstein,^{12,o} Ph. Gris,³⁴ Y. V. Grishkevich,⁹⁸ J.-F. Grivaz,¹¹⁶ J. P. Grohs,⁴⁴ A. Grohsjean,⁴² E. Gross,¹⁷³ J. Grosse-Knetter,⁵⁴ G. C. Grossi,^{134a,134b} J. Groth-Jensen,¹⁷³ Z. J. Grout,¹⁵⁰ L. Guan,^{33b} F. Guescini,⁴⁹ D. Guest,¹⁷⁷ O. Gueta,¹⁵⁴ C. Guicheney,³⁴ E. Guido,^{50a,50b} T. Guillemin,¹¹⁶ S. Guindon,² U. Gul,⁵³ C. Gumpert,⁴⁴ J. Gunther,¹²⁷ J. Guo,³⁵ S. Gupta,¹¹⁹ P. Gutierrez,¹¹² N. G. Gutierrez Ortiz,⁵³ C. Gutsche,⁷⁷ N. Guttman,¹⁵⁴ C. Guyot,¹³⁷ C. Gwenlan,¹¹⁹ C. B. Gwilliam,⁷³ A. Haas,¹⁰⁹ C. Haber,¹⁵ H. K. Hadavand,⁸ N. Haddad,^{136e} P. Haefner,²¹ S. Hageböck,²¹ Z. Hajduk,³⁹ H. Hakobyan,¹⁷⁸ M. Haleem,⁴² D. Hall,¹¹⁹ G. Halladjian,⁸⁹ K. Hamacher,¹⁷⁶ P. Hamal,¹¹⁴ K. Hamano,¹⁷⁰ M. Hamer,⁵⁴ A. Hamilton,^{146a} S. Hamilton,¹⁶² G. N. Hamity,^{146c} P. G. Hamnett,⁴² L. Han,^{33b} K. Hanagaki,¹¹⁷ K. Hanawa,¹⁵⁶ M. Hance,¹⁵ P. Hanke,^{58a} R. Hanna,¹³⁷ J. B. Hansen,³⁶ J. D. Hansen,³⁶ P. H. Hansen,³⁶ K. Hara,¹⁶¹ A. S. Hard,¹⁷⁴ T. Harenberg,¹⁷⁶ F. Hariri,¹¹⁶ S. Harkusha,⁹¹ D. Harper,⁸⁸ R. D. Harrington,⁴⁶ O. M. Harris,¹³⁹ P. F. Harrison,¹⁷¹ F. Hartjes,¹⁰⁶ M. Hasegawa,⁶⁶ S. Hasegawa,¹⁰² Y. Hasegawa,¹⁴¹ A. Hasib,¹¹² S. Hassani,¹³⁷ S. Haug,¹⁷ M. Hauschild,³⁰ R. Hauser,⁸⁹ M. Havranek,¹²⁶ C. M. Hawkes,¹⁸ R. J. Hawkings,³⁰ A. D. Hawkins,⁸⁰ T. Hayashi,¹⁶¹ D. Hayden,⁸⁹ C. P. Hays,¹¹⁹ H. S. Hayward,⁷³ S. J. Haywood,¹³⁰ S. J. Head,¹⁸ T. Heck,⁸² V. Hedberg,⁸⁰ L. Heelan,⁸ S. Heim,¹²¹ T. Heim,¹⁷⁶ B. Heinemann,¹⁵ L. Heinrich,¹⁰⁹ J. Hejbal,¹²⁶ L. Helary,²² C. Heller,⁹⁹ M. Heller,³⁰ S. Hellman,^{147a,147b} D. Hellmich,²¹ C. Hensens,³⁰ J. Henderson,¹¹⁹ R. C. W. Henderson,⁷¹ Y. Heng,¹⁷⁴ C. Hengler,⁴² A. Henrichs,¹⁷⁷ A. M. Henriques Correia,³⁰ S. Henrot-Versille,¹¹⁶ C. Hensel,⁵⁴ G. H. Herbert,¹⁶ Y. Hernández Jiménez,¹⁶⁸ R. Herrberg-Schubert,¹⁶ G. Herten,⁴⁸ R. Hertenberger,⁹⁹ L. Hervas,³⁰ G. G. Hesketh,⁷⁷ N. P. Hesse,¹⁰⁶ R. Hickling,⁷⁵ E. Higón-Rodríguez,¹⁶⁸ E. Hill,¹⁷⁰ J. C. Hill,²⁸ K. H. Hiller,⁴² S. Hillert,²¹ S. J. Hillier,¹⁸ I. Hinchliffe,¹⁵ E. Hines,¹²¹

M. Hirose,¹⁵⁸ D. Hirschbuehl,¹⁷⁶ J. Hobbs,¹⁴⁹ N. Hod,¹⁰⁶ M. C. Hodgkinson,¹⁴⁰ P. Hodgson,¹⁴⁰ A. Hoecker,³⁰
M. R. Hoferkamp,¹⁰⁴ F. Hoenig,⁹⁹ J. Hoffman,⁴⁰ D. Hoffmann,⁸⁴ J. I. Hofmann,^{58a} M. Hohlfeld,⁸² T. R. Holmes,¹⁵
T. M. Hong,¹²¹ L. Hooft van Huysduynen,¹⁰⁹ J.-Y. Hostachy,⁵⁵ S. Hou,¹⁵² A. Houmada,^{136a} J. Howard,¹¹⁹ J. Howarth,⁴²
M. Hrabovsky,¹¹⁴ I. Hristova,¹⁶ J. Hrivnac,¹¹⁶ T. Hryn'ova,⁵ C. Hsu,^{146c} P. J. Hsu,⁸² S.-C. Hsu,¹³⁹ D. Hu,³⁵ X. Hu,²⁵
Y. Huang,⁴² Z. Hubacek,³⁰ F. Hubaut,⁸⁴ F. Huegging,²¹ T. B. Huffman,¹¹⁹ E. W. Hughes,³⁵ G. Hughes,⁷¹ M. Huhtinen,³⁰
T. A. Hülsing,⁸² M. Hurwitz,¹⁵ N. Huseynov,^{64,c} J. Huston,⁸⁹ J. Huth,⁵⁷ G. Iacobucci,⁴⁹ G. Iakovidis,¹⁰ I. Ibragimov,¹⁴²
L. Iconomidou-Fayard,¹¹⁶ E. Ideal,¹⁷⁷ P. Inengo,^{103a} O. Igonkina,¹⁰⁶ T. Iizawa,¹⁷² Y. Ikegami,⁶⁵ K. Ikematsu,¹⁴² M. Ikeno,⁶⁵
Y. Ilchenko,^{31,p} D. Iliadis,¹⁵⁵ N. Ilic,¹⁵⁹ Y. Inamaru,⁶⁶ T. Ince,¹⁰⁰ P. Ioannou,⁹ M. Iodice,^{135a} K. Iordanidou,⁹ V. Ippolito,⁵⁷
A. Irls Quiles,¹⁶⁸ C. Isaksson,¹⁶⁷ M. Ishino,⁶⁷ M. Ishitsuka,¹⁵⁸ R. Ishmukhametov,¹¹⁰ C. Issever,¹¹⁹ S. Istin,^{19a}
J. M. Iturbe Ponce,⁸³ R. Iuppa,^{134a,134b} J. Ivarsson,⁸⁰ W. Iwanski,³⁹ H. Iwasaki,⁶⁵ J. M. Izen,⁴¹ V. Izzo,^{103a} B. Jackson,¹²¹
M. Jackson,⁷³ P. Jackson,¹ M. R. Jaekel,³⁰ V. Jain,² K. Jakobs,⁴⁸ S. Jakobsen,³⁰ T. Jakoubek,¹²⁶ J. Jakubek,¹²⁷ D. O. Jamin,¹⁵²
D. K. Jana,⁷⁸ E. Jansen,⁷⁷ H. Jansen,³⁰ J. Janssen,²¹ M. Janus,¹⁷¹ G. Jarlskog,⁸⁰ N. Javadov,^{64,c} T. Javůrek,⁴⁸ L. Jeanty,¹⁵
J. Jejelava,^{51a,q} G.-Y. Jeng,¹⁵¹ D. Jennens,⁸⁷ P. Jenni,^{48,r} J. Jentzsch,⁴³ C. Jeske,¹⁷¹ S. Jézéquel,⁵ H. Ji,¹⁷⁴ J. Jia,¹⁴⁹ Y. Jiang,^{33b}
M. Jimenez Belenguer,⁴² S. Jin,^{33a} A. Jinaru,^{26a} O. Jinnouchi,¹⁵⁸ M. D. Joergensen,³⁶ K. E. Johansson,^{147a,147b}
P. Johansson,¹⁴⁰ K. A. Johns,⁷ K. Jon-And,^{147a,147b} G. Jones,¹⁷¹ R. W. L. Jones,⁷¹ T. J. Jones,⁷³ J. Jongmanns,^{58a}
P. M. Jorge,^{125a,125b} K. D. Joshi,⁸³ J. Jovicevic,¹⁴⁸ X. Ju,¹⁷⁴ C. A. Jung,⁴³ R. M. Jungst,³⁰ P. Jussel,⁶¹ A. Juste Rozas,^{12,o}
M. Kaci,¹⁶⁸ A. Kaczmarek,³⁹ M. Kado,¹¹⁶ H. Kagan,¹¹⁰ M. Kagan,¹⁴⁴ E. Kajomovitz,⁴⁵ C. W. Kalderon,¹¹⁹ S. Kama,⁴⁰
A. Kamenshchikov,¹²⁹ N. Kanaya,¹⁵⁶ M. Kaneda,³⁰ S. Kaneti,²⁸ V. A. Kantserov,⁹⁷ J. Kanzaki,⁶⁵ B. Kaplan,¹⁰⁹ A. Kapliy,³¹
D. Kar,⁵³ K. Karakostas,¹⁰ N. Karastathis,¹⁰ M. Karnevskiy,⁸² S. N. Karpov,⁶⁴ Z. M. Karpova,⁶⁴ K. Karthik,¹⁰⁹
V. Kartvelishvili,⁷¹ A. N. Karyukhin,¹²⁹ L. Kashif,¹⁷⁴ G. Kasieczka,^{58b} R. D. Kass,¹¹⁰ A. Kastanas,¹⁴ Y. Kataoka,¹⁵⁶
A. Katre,⁴⁹ J. Katzy,⁴² V. Kaushik,⁷ K. Kawagoe,⁶⁹ T. Kawamoto,¹⁵⁶ G. Kawamura,⁵⁴ S. Kazama,¹⁵⁶ V. F. Kazanin,¹⁰⁸
M. Y. Kazarinov,⁶⁴ R. Keeler,¹⁷⁰ R. Kehoe,⁴⁰ M. Keil,⁵⁴ J. S. Keller,⁴² J. J. Kempster,⁷⁶ H. Keoshkerian,⁵ O. Kepka,¹²⁶
B. P. Kerševan,⁷⁴ S. Kersten,¹⁷⁶ K. Kessoku,¹⁵⁶ J. Keung,¹⁵⁹ F. Khalil-zada,¹¹ H. Khandanyan,^{147a,147b} A. Khanov,¹¹³
A. Khodinov,⁹⁷ A. Khomich,^{58a} T. J. Khoo,²⁸ G. Khorauli,²¹ A. Khoroshilov,¹⁷⁶ V. Khovanskiy,⁹⁶ E. Khrarov,⁶⁴
J. Khubua,^{51b} H. Y. Kim,⁸ H. Kim,^{147a,147b} S. H. Kim,¹⁶¹ N. Kimura,¹⁷² O. Kind,¹⁶ B. T. King,⁷³ M. King,¹⁶⁸ R. S. B. King,¹¹⁹
S. B. King,¹⁶⁹ J. Kirk,¹³⁰ A. E. Kiryunin,¹⁰⁰ T. Kishimoto,⁶⁶ D. Kisielewska,^{38a} F. Kiss,⁴⁸ T. Kittelmann,¹²⁴ K. Kiuchi,¹⁶¹
E. Kladiva,^{145b} M. Klein,⁷³ U. Klein,⁷³ K. Kleinknecht,⁸² P. Klimek,^{147a,147b} A. Klimentov,²⁵ R. Klingenberg,⁴³
J. A. Klinger,⁸³ T. Klioutchnikova,³⁰ P. F. Klok,¹⁰⁵ E.-E. Kluge,^{58a} P. Kluit,¹⁰⁶ S. Kluth,¹⁰⁰ E. Kneringer,⁶¹
E. B. F. G. Knoop,⁸⁴ A. Knue,⁵³ D. Kobayashi,¹⁵⁸ T. Kobayashi,¹⁵⁶ M. Kobel,⁴⁴ M. Kocian,¹⁴⁴ P. Kodys,¹²⁸ P. Koevesarki,²¹
T. Koffas,²⁹ E. Koffeman,¹⁰⁶ L. A. Kogan,¹¹⁹ S. Kohlmann,¹⁷⁶ Z. Kohout,¹²⁷ T. Kohriki,⁶⁵ T. Koi,¹⁴⁴ H. Kolanoski,¹⁶
I. Koletsou,⁵ J. Koll,⁸⁹ A. A. Komar,^{95,a} Y. Komori,¹⁵⁶ T. Kondo,⁶⁵ N. Kondrashova,⁴² K. Köneke,⁴⁸ A. C. König,¹⁰⁵
S. König,⁸² T. Kono,^{65,s} R. Konoplich,^{109,t} N. Konstantinidis,⁷⁷ R. Kopeliansky,¹⁵³ S. Koperny,^{38a} L. Köpke,⁸² A. K. Kopp,⁴⁸
K. Korcyl,³⁹ K. Kordas,¹⁵⁵ A. Korn,⁷⁷ A. A. Korol,^{108,u} I. Korolkov,¹² E. V. Korolkova,¹⁴⁰ V. A. Korotkov,¹²⁹ O. Kortner,¹⁰⁰
S. Kortner,¹⁰⁰ V. V. Kostyukhin,²¹ V. M. Kotov,⁶⁴ A. Kotwal,⁴⁵ C. Kourkoumelis,⁹ V. Kouskoura,¹⁵⁵ A. Koutsman,^{160a}
R. Kowalewski,¹⁷⁰ T. Z. Kowalski,^{38a} W. Kozanecki,¹³⁷ A. S. Kozhin,¹²⁹ V. Kral,¹²⁷ V. A. Kramarenko,⁹⁸ G. Kramberger,⁷⁴
D. Krasnopevtsev,⁹⁷ M. W. Krasny,⁷⁹ A. Krasznahorkay,³⁰ J. K. Kraus,²¹ A. Kravchenko,²⁵ S. Kreiss,¹⁰⁹ M. Kretz,^{58c}
J. Kretzschmar,⁷³ K. Kreutzfeldt,⁵² P. Krieger,¹⁵⁹ K. Kroeninger,⁵⁴ H. Kroha,¹⁰⁰ J. Kroll,¹²¹ J. Kroseberg,²¹ J. Krstic,^{13a}
U. Kruchonak,⁶⁴ H. Krüger,²¹ T. Kruker,¹⁷ N. Krumnack,⁶³ Z. V. Krumshteyn,⁶⁴ A. Kruse,¹⁷⁴ M. C. Kruse,⁴⁵ M. Kruskal,²²
T. Kubota,⁸⁷ S. Kudah,^{4a} S. Kuehn,⁴⁸ A. Kugel,^{58c} A. Kuhl,¹³⁸ T. Kuhl,⁴² V. Kukhtin,⁶⁴ Y. Kulchitsky,⁹¹ S. Kuleshov,^{32b}
M. Kuna,^{133a,133b} J. Kunkle,¹²¹ A. Kupco,¹²⁶ H. Kurashige,⁶⁶ Y. A. Kurochkin,⁹¹ R. Kurumida,⁶⁶ V. Kus,¹²⁶ E. S. Kuwertz,¹⁴⁸
M. Kuze,¹⁵⁸ J. Kvita,¹¹⁴ A. La Rosa,⁴⁹ L. La Rotonda,^{37a,37b} C. Lacasta,¹⁶⁸ F. Lacava,^{133a,133b} J. Lacey,²⁹ H. Lacker,¹⁶
D. Lacour,⁷⁹ V. R. Lacuesta,¹⁶⁸ E. Ladygin,⁶⁴ R. Lafaye,⁵ B. Laforge,⁷⁹ T. Lagouri,¹⁷⁷ S. Lai,⁴⁸ H. Laier,^{58a} L. Lambourne,⁷⁷
S. Lammers,⁶⁰ C. L. Lampen,⁷ W. Lampl,⁷ E. Lançon,¹³⁷ U. Landgraf,⁴⁸ M. P. J. Landon,⁷⁵ V. S. Lang,^{58a} A. J. Lankford,¹⁶⁴
F. Lanni,²⁵ K. Lantzsch,³⁰ S. Laplace,⁷⁹ C. Lapoire,²¹ J. F. Laporte,¹³⁷ T. Lari,^{90a} M. Lassnig,³⁰ P. Laurelli,⁴⁷ W. Lavrijsen,¹⁵
A. T. Law,¹³⁸ P. Laycock,⁷³ O. Le Dortz,⁷⁹ E. Le Guirriec,⁸⁴ E. Le Menedeu,¹² T. LeCompte,⁶ F. Ledroit-Guillon,⁵⁵
C. A. Lee,¹⁵² H. Lee,¹⁰⁶ J. S. H. Lee,¹¹⁷ S. C. Lee,¹⁵² L. Lee,¹⁷⁷ G. Lefebvre,⁷⁹ M. Lefebvre,¹⁷⁰ F. Legger,⁹⁹ C. Leggett,¹⁵
A. Lehan,⁷³ M. Lehmacher,²¹ G. Lehmann Miotto,³⁰ X. Lei,⁷ W. A. Leight,²⁹ A. Leisos,¹⁵⁵ A. G. Leister,¹⁷⁷
M. A. L. Leite,^{24d} R. Leitner,¹²⁸ D. Lellouch,¹⁷³ B. Lemmer,⁵⁴ K. J. C. Leney,⁷⁷ T. Lenz,²¹ G. Lenzen,¹⁷⁶ B. Lenzi,³⁰
R. Leone,⁷ S. Leone,^{123a,123b} K. Leonhardt,⁴⁴ C. Leonidopoulos,⁴⁶ S. Leontsinis,¹⁰ C. Leroy,⁹⁴ C. G. Lester,²⁸

C. M. Lester,¹²¹ M. Levchenko,¹²² J. Levêque,⁵ D. Levin,⁸⁸ L. J. Levinson,¹⁷³ M. Levy,¹⁸ A. Lewis,¹¹⁹ G. H. Lewis,¹⁰⁹ A. M. Leyko,²¹ M. Leyton,⁴¹ B. Li,^{33b,v} B. Li,⁸⁴ H. Li,¹⁴⁹ H. L. Li,³¹ L. Li,⁴⁵ L. Li,^{33e} S. Li,⁴⁵ Y. Li,^{33c,w} Z. Liang,¹³⁸ H. Liao,³⁴ B. Liberti,^{134a} P. Lichard,³⁰ K. Lie,¹⁶⁶ J. Liebal,²¹ W. Liebig,¹⁴ C. Limbach,²¹ A. Limosani,⁸⁷ S. C. Lin,^{152,x} T. H. Lin,⁸² F. Linde,¹⁰⁶ B. E. Lindquist,¹⁴⁹ J. T. Linnemann,⁸⁹ E. Lipeles,¹²¹ A. Lipniacka,¹⁴ M. Lisovyi,⁴² T. M. Liss,¹⁶⁶ D. Lissauer,²⁵ A. Lister,¹⁶⁹ A. M. Litke,¹³⁸ B. Liu,¹⁵² D. Liu,¹⁵² J. B. Liu,^{33b} K. Liu,^{33b,y} L. Liu,⁸⁸ M. Liu,⁴⁵ M. Liu,^{33b} Y. Liu,^{33b} M. Livan,^{120a,120b} S. S. A. Livermore,¹¹⁹ A. Lleres,⁵⁵ J. Llorente Merino,⁸¹ S. L. Lloyd,⁷⁵ F. Lo Sterzo,¹⁵² E. Lobodzinska,⁴² P. Loch,⁷ W. S. Lockman,¹³⁸ T. Loddenkoetter,²¹ F. K. Loebinger,⁸³ A. E. Loevschall-Jensen,³⁶ A. Loginov,¹⁷⁷ T. Lohse,¹⁶ K. Lohwasser,⁴² M. Lokajicek,¹²⁶ V. P. Lombardo,⁵ B. A. Long,²² J. D. Long,⁸⁸ R. E. Long,⁷¹ L. Lopes,^{125a} D. Lopez Mateos,⁵⁷ B. Lopez Paredes,¹⁴⁰ I. Lopez Paz,¹² J. Lorenz,⁹⁹ N. Lorenzo Martinez,⁶⁰ M. Losada,¹⁶³ P. Loscutoff,¹⁵ X. Lou,⁴¹ A. Lounis,¹¹⁶ J. Love,⁶ P. A. Love,⁷¹ A. J. Lowe,^{144,f} F. Lu,^{33a} N. Lu,⁸⁸ H. J. Lubatti,¹³⁹ C. Luci,^{133a,133b} A. Lucotte,⁵⁵ F. Luehring,⁶⁰ W. Lukas,⁶¹ L. Luminari,^{133a} O. Lundberg,^{147a,147b} B. Lund-Jensen,¹⁴⁸ M. Lungwitz,⁸² D. Lynn,²⁵ R. Lysak,¹²⁶ E. Lytken,⁸⁰ H. Ma,²⁵ L. L. Ma,^{33d} G. Maccarrone,⁴⁷ A. Macchiolo,¹⁰⁰ J. Machado Miguens,^{125a,125b} D. Macina,³⁰ D. Madaffari,⁸⁴ R. Madar,⁴⁸ H. J. Maddocks,⁷¹ W. F. Mader,⁴⁴ A. Madsen,¹⁶⁷ M. Maeno,⁸ T. Maeno,²⁵ E. Magradze,⁵⁴ K. Mahboubi,⁴⁸ J. Mahlstedt,¹⁰⁶ S. Mahmoud,⁷³ C. Maiani,¹³⁷ C. Maidantchik,^{24a} A. A. Maier,¹⁰⁰ A. Maio,^{125a,125b,125d} S. Majewski,¹¹⁵ Y. Makida,⁶⁵ N. Makovec,¹¹⁶ P. Mal,^{137,z} B. Malaescu,⁷⁹ Pa. Malecki,³⁹ V. P. Maleev,¹²² F. Malek,⁵⁵ U. Mallik,⁶² D. Malon,⁶ C. Malone,¹⁴⁴ S. Maltezos,¹⁰ V. M. Malyshev,¹⁰⁸ S. Malyukov,³⁰ J. Mamuzic,^{13b} B. Mandelli,³⁰ L. Mandelli,^{90a} I. Mandić,⁷⁴ R. Mandrysch,⁶² J. Maneira,^{125a,125b} A. Manfredini,¹⁰⁰ L. Manhaes de Andrade Filho,^{24b} J. A. Manjarres Ramos,^{160b} A. Mann,⁹⁹ P. M. Manning,¹³⁸ A. Manousakis-Katsikakis,⁹ B. Mansoulie,¹³⁷ R. Mantifel,⁸⁶ L. Mapelli,³⁰ L. March,¹⁶⁸ J. F. Marchand,²⁹ G. Marchiori,⁷⁹ M. Marcisovsky,¹²⁶ C. P. Marino,¹⁷⁰ M. Marjanovic,^{13a} C. N. Marques,^{125a} F. Marroquim,^{24a} S. P. Marsden,⁸³ Z. Marshall,¹⁵ L. F. Marti,¹⁷ S. Marti-Garcia,¹⁶⁸ B. Martin,³⁰ B. Martin,⁸⁹ T. A. Martin,¹⁷¹ V. J. Martin,⁴⁶ B. Martin dit Latour,¹⁴ H. Martinez,¹³⁷ M. Martinez,^{12,o} S. Martin-Haugh,¹³⁰ A. C. Martyniuk,⁷⁷ M. Marx,¹³⁹ F. Marzano,^{133a} A. Marzin,³⁰ L. Masetti,⁸² T. Mashimo,¹⁵⁶ R. Mashinistov,⁹⁵ J. Masik,⁸³ A. L. Maslennikov,¹⁰⁸ I. Massa,^{20a,20b} L. Massa,^{20a,20b} N. Massol,⁵ P. Mastrandrea,¹⁴⁹ A. Mastroberardino,^{37a,37b} T. Masubuchi,¹⁵⁶ P. Mättig,¹⁷⁶ J. Mattmann,⁸² J. Maurer,^{26a} S. J. Maxfield,⁷³ D. A. Maximov,^{108,u} R. Mazini,¹⁵² L. Mazzaferro,^{134a,134b} G. Mc Goldrick,¹⁵⁹ S. P. Mc Kee,⁸⁸ A. McCann,⁸⁸ R. L. McCarthy,¹⁴⁹ T. G. McCarthy,²⁹ N. A. McCubbin,¹³⁰ K. W. McFarlane,^{56,a} J. A. McFayden,⁷⁷ G. Mchedlidge,⁵⁴ S. J. McMahon,¹³⁰ R. A. McPherson,^{170,j} A. Meade,⁸⁵ J. Mechnich,¹⁰⁶ M. Medinnis,⁴² S. Meehan,³¹ S. Mehlhase,⁹⁹ A. Mehta,⁷³ K. Meier,^{58a} C. Meineck,⁹⁹ B. Meirose,⁸⁰ C. Melachrinou,³¹ B. R. Mellado Garcia,^{146c} F. Meloni,¹⁷ A. Mengarelli,^{20a,20b} S. Menke,¹⁰⁰ E. Meoni,¹⁶² K. M. Mercurio,⁵⁷ S. Mergelmeyer,²¹ N. Meric,¹³⁷ P. Mermod,⁴⁹ L. Merola,^{103a,103b} C. Meroni,^{90a} F. S. Merritt,³¹ H. Merritt,¹¹⁰ A. Messina,^{30,aa} J. Metcalfe,²⁵ A. S. Mete,¹⁶⁴ C. Meyer,⁸² C. Meyer,¹²¹ J-P. Meyer,¹³⁷ J. Meyer,³⁰ R. P. Middleton,¹³⁰ S. Migas,⁷³ L. Mijović,²¹ G. Mikenberg,¹⁷³ M. Mikestikova,¹²⁶ M. Mikuž,⁷⁴ A. Milic,³⁰ D. W. Miller,³¹ C. Mills,⁴⁶ A. Milov,¹⁷³ D. A. Milstead,^{147a,147b} D. Milstein,¹⁷³ A. A. Minaenko,¹²⁹ I. A. Minashvili,⁶⁴ A. I. Mincer,¹⁰⁹ B. Mindur,^{38a} M. Mineev,⁶⁴ Y. Ming,¹⁷⁴ L. M. Mir,¹² G. Mirabelli,^{133a} T. Mitani,¹⁷² J. Mitrevski,⁹⁹ V. A. Mitsou,¹⁶⁸ S. Mitsui,⁶⁵ A. Miucci,⁴⁹ P. S. Miyagawa,¹⁴⁰ J. U. Mjörnmark,⁸⁰ T. Moa,^{147a,147b} K. Mochizuki,⁸⁴ S. Mohapatra,³⁵ W. Mohr,⁴⁸ S. Molander,^{147a,147b} R. Moles-Valls,¹⁶⁸ K. Mönig,⁴² C. Monini,⁵⁵ J. Monk,³⁶ E. Monnier,⁸⁴ J. Montejo Berlingen,¹² F. Monticelli,⁷⁰ S. Monzani,^{133a,133b} R. W. Moore,³ A. Moraes,⁵³ N. Morange,⁶² D. Moreno,⁸² M. Moreno Llácer,⁵⁴ P. Morettini,^{50a} M. Morgenstern,⁴⁴ M. Morii,⁵⁷ S. Moritz,⁸² A. K. Morley,¹⁴⁸ G. Mornacchi,³⁰ J. D. Morris,⁷⁵ L. Morvaj,¹⁰² H. G. Moser,¹⁰⁰ M. Mosidze,^{51b} J. Moss,¹¹⁰ K. Motohashi,¹⁵⁸ R. Mount,¹⁴⁴ E. Mountricha,²⁵ S. V. Mouraviev,^{95,a} E. J. W. Moyse,⁸⁵ S. Muanza,⁸⁴ R. D. Mudd,¹⁸ F. Mueller,^{58a} J. Mueller,¹²⁴ K. Mueller,²¹ T. Mueller,²⁸ T. Mueller,⁸² D. Muenstermann,⁴⁹ Y. Munwes,¹⁵⁴ J. A. Murillo Quijada,¹⁸ W. J. Murray,^{171,130} H. Musheghyan,⁵⁴ E. Musto,¹⁵³ A. G. Myagkov,^{129,bb} M. Myska,¹²⁷ O. Nackenhörst,⁵⁴ J. Nadal,⁵⁴ K. Nagai,⁶¹ R. Nagai,¹⁵⁸ Y. Nagai,⁸⁴ K. Nagano,⁶⁵ A. Nagarkar,¹¹⁰ Y. Nagasaka,⁵⁹ M. Nagel,¹⁰⁰ A. M. Nairz,³⁰ Y. Nakahama,³⁰ K. Nakamura,⁶⁵ T. Nakamura,¹⁵⁶ I. Nakano,¹¹¹ H. Namasivayam,⁴¹ G. Nanava,²¹ R. Narayan,^{58b} T. Nattermann,²¹ T. Naumann,⁴² G. Navarro,¹⁶³ R. Nayyar,⁷ H. A. Neal,⁸⁸ P. Yu. Nechaeva,⁹⁵ T. J. Neep,⁸³ P. D. Nef,¹⁴⁴ A. Negri,^{120a,120b} G. Negri,³⁰ M. Negrini,^{20a} S. Nektarijevic,⁴⁹ A. Nelson,¹⁶⁴ T. K. Nelson,¹⁴⁴ S. Nemecek,¹²⁶ P. Nemethy,¹⁰⁹ A. A. Nepomuceno,^{24a} M. Nessi,^{30,cc} M. S. Neubauer,¹⁶⁶ M. Neumann,¹⁷⁶ R. M. Neves,¹⁰⁹ P. Nevski,²⁵ P. R. Newman,¹⁸ D. H. Nguyen,⁶ R. B. Nickerson,¹¹⁹ R. Nicolaidou,¹³⁷ B. Nicquevert,³⁰ J. Nielsen,¹³⁸ N. Nikiforou,³⁵ A. Nikiforov,¹⁶ V. Nikolaenko,^{129,bb} I. Nikolic-Audit,⁷⁹ K. Nikolics,⁴⁹ K. Nikolopoulos,¹⁸ P. Nilsson,⁸ Y. Ninomiya,¹⁵⁶ A. Nisati,^{133a} R. Nisius,¹⁰⁰ T. Nobe,¹⁵⁸ L. Nodulman,⁶ M. Nomachi,¹¹⁷ I. Nomidis,²⁹ S. Norberg,¹¹² M. Nordberg,³⁰ O. Novgorodova,⁴⁴ S. Nowak,¹⁰⁰ M. Nozaki,⁶⁵

L. Nozka,¹¹⁴ K. Ntekas,¹⁰ G. Nunes Hanninger,⁸⁷ T. Nunnemann,⁹⁹ E. Nurse,⁷⁷ F. Nuti,⁸⁷ B. J. O'Brien,⁴⁶ F. O'grady,⁷ D. C. O'Neil,¹⁴³ V. O'Shea,⁵³ F. G. Oakham,^{29,e} H. Oberlack,¹⁰⁰ T. Obermann,²¹ J. Ocariz,⁷⁹ A. Ochi,⁶⁶ M. I. Ochoa,⁷⁷ S. Oda,⁶⁹ S. Odaka,⁶⁵ H. Ogren,⁶⁰ A. Oh,⁸³ S. H. Oh,⁴⁵ C. C. Ohm,¹⁵ H. Ohman,¹⁶⁷ W. Okamura,¹¹⁷ H. Okawa,²⁵ Y. Okumura,³¹ T. Okuyama,¹⁵⁶ A. Olariu,^{26a} A. G. Olchevski,⁶⁴ S. A. Olivares Pino,⁴⁶ D. Oliveira Damazio,²⁵ E. Oliver Garcia,¹⁶⁸ A. Olszewski,³⁹ J. Olszowska,³⁹ A. Onofre,^{125a,125e} P. U. E. Onyisi,^{31,p} C. J. Oram,^{160a} M. J. Oreglia,³¹ Y. Oren,¹⁵⁴ D. Orestano,^{135a,135b} N. Orlando,^{72a,72b} C. Oropeza Barrera,⁵³ R. S. Orr,¹⁵⁹ B. Osculati,^{50a,50b} R. Ospanov,¹²¹ G. Otero y Garzon,²⁷ H. Otono,⁶⁹ M. Ouchrif,^{136d} E. A. Ouellette,¹⁷⁰ F. Ould-Saada,¹¹⁸ A. Ouraou,¹³⁷ K. P. Oussoren,¹⁰⁶ Q. Ouyang,^{33a} A. Ovcharova,¹⁵ M. Owen,⁸³ V. E. Ozcan,^{19a} N. Ozturk,⁸ K. Pachal,¹¹⁹ A. Pacheco Pages,¹² C. Padilla Aranda,¹² M. Pagáčová,⁴⁸ S. Pagan Griso,¹⁵ E. Paganis,¹⁴⁰ C. Pahl,¹⁰⁰ F. Paige,²⁵ P. Pais,⁸⁵ K. Pajchel,¹¹⁸ G. Palacino,^{160b} S. Palestini,³⁰ M. Palka,^{38b} D. Pallin,³⁴ A. Palma,^{125a,125b} J. D. Palmer,¹⁸ Y. B. Pan,¹⁷⁴ E. Panagiotopoulou,¹⁰ J. G. Panduro Vazquez,⁷⁶ P. Pani,¹⁰⁶ N. Panikashvili,⁸⁸ S. Panitkin,²⁵ D. Pantea,^{26a} L. Paolozzi,^{134a,134b} Th. D. Papadopoulos,¹⁰ K. Papageorgiou,^{155,m} A. Paramonov,⁶ D. Paredes Hernandez,³⁴ M. A. Parker,²⁸ F. Parodi,^{50a,50b} J. A. Parsons,³⁵ U. Parzefall,⁴⁸ E. Pasqualucci,^{133a} S. Passaggio,^{50a} A. Passeri,^{135a} F. Pastore,^{135a,135b,a} Fr. Pastore,⁷⁶ G. Pásztor,²⁹ S. Patarraia,¹⁷⁶ N. D. Patel,¹⁵¹ J. R. Pater,⁸³ S. Patricelli,^{103a,103b} T. Pauly,³⁰ J. Pearce,¹⁷⁰ M. Pedersen,¹¹⁸ S. Pedraza Lopez,¹⁶⁸ R. Pedro,^{125a,125b} S. V. Peleganchuk,¹⁰⁸ D. Pelikan,¹⁶⁷ H. Peng,^{33b} B. Penning,³¹ J. Penwell,⁶⁰ D. V. Perepelitsa,²⁵ E. Perez Codina,^{160a} M. T. Pérez García-Estañ,¹⁶⁸ V. Perez Reale,³⁵ L. Perini,^{90a,90b} H. Pernegger,³⁰ R. Perrino,^{72a} R. Peschke,⁴² V. D. Peshekhonov,⁶⁴ K. Peters,³⁰ R. F. Y. Peters,⁸³ B. A. Petersen,³⁰ T. C. Petersen,³⁶ E. Petit,⁴² A. Petridis,^{147a,147b} C. Petridou,¹⁵⁵ E. Petrolo,^{133a} F. Petrucci,^{135a,135b} N. E. Pettersson,¹⁵⁸ R. Pezoa,^{32b} P. W. Phillips,¹³⁰ G. Piacquadio,¹⁴⁴ E. Pianori,¹⁷¹ A. Picazio,⁴⁹ E. Piccaro,⁷⁵ M. Piccinini,^{20a,20b} R. Piegaiia,²⁷ D. T. Pignotti,¹¹⁰ J. E. Pilcher,³¹ A. D. Pilkington,⁷⁷ J. Pina,^{125a,125b,125d} M. Pinamonti,^{165a,165c,dd} A. Pinder,¹¹⁹ J. L. Pinfold,³ A. Pingel,³⁶ B. Pinto,^{125a} S. Pires,⁷⁹ M. Pitt,¹⁷³ C. Pizio,^{90a,90b} L. Plazak,^{145a} M.-A. Pleier,²⁵ V. Pleskot,¹²⁸ E. Plotnikova,⁶⁴ P. Plucinski,^{147a,147b} S. Poddar,^{58a} F. Podlyski,³⁴ R. Poettgen,⁸² L. Poggioli,¹¹⁶ D. Pohl,²¹ M. Pohl,⁴⁹ G. Polesello,^{120a} A. Policicchio,^{37a,37b} R. Polifka,¹⁵⁹ A. Polini,^{20a} C. S. Pollard,⁴⁵ V. Polychronakos,²⁵ K. Pommès,³⁰ L. Pontecorvo,^{133a} B. G. Pope,⁸⁹ G. A. Popeneciu,^{26b} D. S. Popovic,^{13a} A. Poppleton,³⁰ X. Portell Bueso,¹² S. Pospisil,¹²⁷ K. Potamianos,¹⁵ I. N. Potrap,⁶⁴ C. J. Potter,¹⁵⁰ C. T. Potter,¹¹⁵ G. Poulard,³⁰ J. Poveda,⁶⁰ V. Pozdnyakov,⁶⁴ P. Pralavorio,⁸⁴ A. Pranko,¹⁵ S. Prasad,³⁰ R. Pravahan,⁸ S. Prell,⁶³ D. Price,⁸³ J. Price,⁷³ L. E. Price,⁶ D. Prieur,¹²⁴ M. Primavera,^{72a} M. Proissl,⁴⁶ K. Prokofiev,⁴⁷ F. Prokoshin,^{32b} E. Protopapadaki,¹³⁷ S. Protopopescu,²⁵ J. Proudfoot,⁶ M. Przybycien,^{38a} H. Przysieszniak,⁵ E. Ptacek,¹¹⁵ D. Puddu,^{135a,135b} E. Pueschel,⁸⁵ D. Pudson,¹⁴⁹ M. Purohit,^{25,ee} P. Puzo,¹¹⁶ J. Qian,⁸⁸ G. Qin,⁵³ Y. Qin,⁸³ A. Quadt,⁵⁴ D. R. Quarrie,¹⁵ W. B. Quayle,^{165a,165b} M. Queitsch-Maitland,⁸³ D. Quilty,⁵³ A. Qureshi,^{160b} V. Radeka,²⁵ V. Radescu,⁴² S. K. Radhakrishnan,¹⁴⁹ P. Radloff,¹¹⁵ P. Rados,⁸⁷ F. Ragusa,^{90a,90b} G. Rahal,¹⁷⁹ S. Rajagopalan,²⁵ M. Rammensee,³⁰ A. S. Randle-Conde,⁴⁰ C. Rangel-Smith,¹⁶⁷ K. Rao,¹⁶⁴ F. Rauscher,⁹⁹ T. C. Rave,⁴⁸ T. Ravenscroft,⁵³ M. Raymond,³⁰ A. L. Read,¹¹⁸ N. P. Readioff,⁷³ D. M. Rebuffi,^{120a,120b} A. Redelbach,¹⁷⁵ G. Redlinger,²⁵ R. Reece,¹³⁸ K. Reeves,⁴¹ L. Rehnisch,¹⁶ H. Reisin,²⁷ M. Relich,¹⁶⁴ C. Rembser,³⁰ H. Ren,^{33a} Z. L. Ren,¹⁵² A. Renaud,¹¹⁶ M. Rescigno,^{133a} S. Resconi,^{90a} O. L. Rezanova,^{108,u} P. Reznicek,¹²⁸ R. Rezvani,⁹⁴ R. Richter,¹⁰⁰ M. Ridel,⁷⁹ P. Rieck,¹⁶ J. Rieger,⁵⁴ M. Rijssenbeek,¹⁴⁹ A. Rimoldi,^{120a,120b} L. Rinaldi,^{20a} E. Ritsch,⁶¹ I. Riu,¹² F. Rizatdinova,¹¹³ E. Rizvi,⁷⁵ S. H. Robertson,^{86,j} A. Robichaud-Veronneau,⁸⁶ D. Robinson,²⁸ J. E. M. Robinson,⁸³ A. Robson,⁵³ C. Roda,^{123a,123b} L. Rodrigues,³⁰ S. Roe,³⁰ O. Røhne,¹¹⁸ S. Rolli,¹⁶² A. Romaniouk,⁹⁷ M. Romano,^{20a,20b} E. Romero Adam,¹⁶⁸ N. Rompotis,¹³⁹ M. Ronzani,⁴⁸ L. Roos,⁷⁹ E. Ros,¹⁶⁸ S. Rosati,^{133a} K. Rosbach,⁴⁹ M. Rose,⁷⁶ P. Rose,¹³⁸ P. L. Rosendahl,¹⁴ O. Rosenthal,¹⁴² V. Rossetti,^{147a,147b} E. Rossi,^{103a,103b} L. P. Rossi,^{50a} R. Rosten,¹³⁹ M. Rotaru,^{26a} I. Roth,¹⁷³ J. Rothberg,¹³⁹ D. Rousseau,¹¹⁶ C. R. Royon,¹³⁷ A. Rozanov,⁸⁴ Y. Rozen,¹⁵³ X. Ruan,^{146c} F. Rubbo,¹² I. Rubinskiy,⁴² V. I. Rud,⁹⁸ C. Rudolph,⁴⁴ M. S. Rudolph,¹⁵⁹ F. Rühr,⁴⁸ A. Ruiz-Martinez,³⁰ Z. Rurikova,⁴⁸ N. A. Rusakovich,⁶⁴ A. Ruschke,⁹⁹ J. P. Rutherford,⁷ N. Ruthmann,⁴⁸ Y. F. Ryabov,¹²² M. Rybar,¹²⁸ G. Rybkin,¹¹⁶ N. C. Ryder,¹¹⁹ A. F. Saavedra,¹⁵¹ S. Sacerdoti,²⁷ A. Saddique,³ I. Sadeh,¹⁵⁴ H. F.-W. Sadrozinski,¹³⁸ R. Sadykov,⁶⁴ F. Safai Tehrani,^{133a} H. Sakamoto,¹⁵⁶ Y. Sakurai,¹⁷² G. Salamanna,^{135a,135b} A. Salamon,^{134a} M. Saleem,¹¹² D. Salek,¹⁰⁶ P. H. Sales De Bruin,¹³⁹ D. Salihagic,¹⁰⁰ A. Salnikov,¹⁴⁴ J. Salt,¹⁶⁸ D. Salvatore,^{37a,37b} F. Salvatore,¹⁵⁰ A. Salvucci,¹⁰⁵ A. Salzburger,³⁰ D. Sampsonidis,¹⁵⁵ A. Sanchez,^{103a,103b} J. Sánchez,¹⁶⁸ V. Sanchez Martinez,¹⁶⁸ H. Sandaker,¹⁴ R. L. Sandbach,⁷⁵ H. G. Sander,⁸² M. P. Sanders,⁹⁹ M. Sandhoff,¹⁷⁶ T. Sandoval,²⁸ C. Sandoval,¹⁶³ R. Sandstroem,¹⁰⁰ D. P. C. Sankey,¹³⁰ A. Sansoni,⁴⁷ C. Santoni,³⁴ R. Santonico,^{134a,134b} H. Santos,^{125a} I. Santoyo Castillo,¹⁵⁰ K. Sapp,¹²⁴ A. Saponov,⁶⁴ J. G. Saraiva,^{125a,125d} B. Sarrazin,²¹ G. Sartisohn,¹⁷⁶ O. Sasaki,⁶⁵ Y. Sasaki,¹⁵⁶ G. Sauvage,^{5,a} E. Sauvan,⁵ P. Savard,^{159,e} D. O. Savu,³⁰ C. Sawyer,¹¹⁹ L. Sawyer,^{78,n} D. H. Saxon,⁵³ J. Saxon,¹²¹

C. Sbarra,^{20a} A. Sbrizzi,³ T. Scanlon,⁷⁷ D. A. Scannicchio,¹⁶⁴ M. Scarcella,¹⁵¹ V. Scarfone,^{37a,37b} J. Schaarschmidt,¹⁷³ P. Schacht,¹⁰⁰ D. Schaefer,³⁰ R. Schaefer,⁴² S. Schaepe,²¹ S. Schaezel,^{58b} U. Schäfer,⁸² A. C. Schaffer,¹¹⁶ D. Schaile,⁹⁹ R. D. Schamberger,¹⁴⁹ V. Scharf,^{58a} V. A. Schegelsky,¹²² D. Scheirich,¹²⁸ M. Schernau,¹⁶⁴ M. I. Scherzer,³⁵ C. Schiavi,^{50a,50b} J. Schieck,⁹⁹ C. Schillo,⁴⁸ M. Schioppa,^{37a,37b} S. Schlenker,³⁰ E. Schmidt,⁴⁸ K. Schmieden,³⁰ C. Schmitt,⁸² S. Schmitt,^{58b} B. Schneider,¹⁷ Y. J. Schnellbach,⁷³ U. Schnoor,⁴⁴ L. Schoeffel,¹³⁷ A. Schoening,^{58b} B. D. Schoenrock,⁸⁹ A. L. S. Schorlemmer,⁵⁴ M. Schott,⁸² D. Schouten,^{160a} J. Schovancova,²⁵ S. Schramm,¹⁵⁹ M. Schreyer,¹⁷⁵ C. Schroeder,⁸² N. Schuh,⁸² M. J. Schultens,²¹ H.-C. Schultz-Coulon,^{58a} H. Schulz,¹⁶ M. Schumacher,⁴⁸ B. A. Schumm,¹³⁸ Ph. Schune,¹³⁷ C. Schwanenberger,⁸³ A. Schwartzman,¹⁴⁴ Ph. Schwegler,¹⁰⁰ Ph. Schwemling,¹³⁷ R. Schwienhorst,⁸⁹ J. Schwindling,¹³⁷ T. Schwindt,²¹ M. Schwoerer,⁵ F. G. Sciacca,¹⁷ E. Scifo,¹¹⁶ G. Sciolla,²³ W. G. Scott,¹³⁰ F. Scuri,^{123a,123b} F. Scutti,²¹ J. Searcy,⁸⁸ G. Sedov,⁴² E. Sedykh,¹²² S. C. Seidel,¹⁰⁴ A. Seiden,¹³⁸ F. Seifert,¹²⁷ J. M. Seixas,^{24a} G. Sekhniaidze,^{103a} S. J. Sekula,⁴⁰ K. E. Selbach,⁴⁶ D. M. Seliverstov,^{122,a} G. Sellers,⁷³ N. Semprini-Cesari,^{20a,20b} C. Serfon,³⁰ L. Serin,¹¹⁶ L. Serkin,⁵⁴ T. Serre,⁸⁴ R. Seuster,^{160a} H. Severini,¹¹² T. Sfiligoj,⁷⁴ F. Sforza,¹⁰⁰ A. Sfyrla,³⁰ E. Shabalina,⁵⁴ M. Shamim,¹¹⁵ L. Y. Shan,^{33a} R. Shang,¹⁶⁶ J. T. Shank,²² M. Shapiro,¹⁵ P. B. Shatalov,⁹⁶ K. Shaw,^{165a,165b} C. Y. Shehu,¹⁵⁰ P. Sherwood,⁷⁷ L. Shi,^{152,ff} S. Shimizu,⁶⁶ C. O. Shimmin,¹⁶⁴ M. Shimojima,¹⁰¹ M. Shiyakova,⁶⁴ A. Shmeleva,⁹⁵ M. J. Shochet,³¹ D. Short,¹¹⁹ S. Shrestha,⁶³ E. Shulga,⁹⁷ M. A. Shupe,⁷ S. Shushkevich,⁴² P. Sicho,¹²⁶ O. Sidiropoulou,¹⁵⁵ D. Sidorov,¹¹³ A. Sidoti,^{133a} F. Siegert,⁴⁴ Dj. Sijacki,^{13a} J. Silva,^{125a,125d} Y. Silver,¹⁵⁴ D. Silverstein,¹⁴⁴ S. B. Silverstein,^{147a} V. Simak,¹²⁷ O. Simard,⁵ Lj. Simic,^{13a} S. Simion,¹¹⁶ E. Simioni,⁸² B. Simmons,⁷⁷ R. Simoniello,^{90a,90b} M. Simonyan,³⁶ P. Sinervo,¹⁵⁹ N. B. Sinev,¹¹⁵ V. Sipica,¹⁴² G. Siragusa,¹⁷⁵ A. Sircar,⁷⁸ A. N. Sisakyan,^{64,a} S. Yu. Sivoklov,⁹⁸ J. Sjölin,^{147a,147b} T. B. Sjursen,¹⁴ H. P. Skottowe,⁵⁷ K. Yu. Skovpen,¹⁰⁸ P. Skubic,¹¹² M. Slater,¹⁸ T. Slavicek,¹²⁷ K. Sliwa,¹⁶² V. Smakhtin,¹⁷³ B. H. Smart,⁴⁶ L. Smestad,¹⁴ S. Yu. Smirnov,⁹⁷ Y. Smirnov,⁹⁷ L. N. Smirnova,^{98,gg} O. Smirnova,⁸⁰ K. M. Smith,⁵³ M. Smizanska,⁷¹ K. Smolek,¹²⁷ A. A. Snesarev,⁹⁵ G. Snidero,⁷⁵ S. Snyder,²⁵ R. Sobie,^{170,j} F. Socher,⁴⁴ A. Soffer,¹⁵⁴ D. A. Soh,^{152,ff} C. A. Solans,³⁰ M. Solar,¹²⁷ J. Solc,¹²⁷ E. Yu. Soldatov,⁹⁷ U. Soldevila,¹⁶⁸ A. A. Solodkov,¹²⁹ A. Soloshenko,⁶⁴ O. V. Solovyanov,¹²⁹ V. Solovyev,¹²² P. Sommer,⁴⁸ H. Y. Song,^{33b} N. Soni,¹ A. Sood,¹⁵ A. Sopczak,¹²⁷ B. Sopko,¹²⁷ V. Sopko,¹²⁷ V. Sorin,¹² M. Sosebee,⁸ R. Soualah,^{165a,165c} P. Soueid,⁹⁴ A. M. Soukharev,¹⁰⁸ D. South,⁴² S. Spagnolo,^{72a,72b} F. Spanò,⁷⁶ W. R. Spearman,⁵⁷ F. Spettel,¹⁰⁰ R. Spighi,^{20a} G. Spigo,³⁰ L. A. Spiller,⁸⁷ M. Spousta,¹²⁸ T. Spreitzer,¹⁵⁹ B. Spurlock,⁸ R. D. St. Denis,^{53,a} S. Staerz,⁴⁴ J. Stahlman,¹²¹ R. Stamen,^{58a} S. Stamm,¹⁶ E. Stanecka,³⁹ R. W. Stanek,⁶ C. Stanescu,^{135a} M. Stanescu-Bellu,⁴² M. M. Stanitzki,⁴² S. Stapnes,¹¹⁸ E. A. Starchenko,¹²⁹ J. Stark,⁵⁵ P. Staroba,¹²⁶ P. Starovoitov,⁴² R. Staszewski,³⁹ P. Stavina,^{145a,a} P. Steinberg,²⁵ B. Stelzer,¹⁴³ H. J. Stelzer,³⁰ O. Stelzer-Chilton,^{160a} H. Stenzel,⁵² S. Stern,¹⁰⁰ G. A. Stewart,⁵³ J. A. Stillings,²¹ M. C. Stockton,⁸⁶ M. Stoebe,⁸⁶ G. Stoicea,^{26a} P. Stolte,⁵⁴ S. Stonjek,¹⁰⁰ A. R. Stradling,⁸ A. Straessner,⁴⁴ M. E. Stramaglia,¹⁷ J. Strandberg,¹⁴⁸ S. Strandberg,^{147a,147b} A. Strandlie,¹¹⁸ E. Strauss,¹⁴⁴ M. Strauss,¹¹² P. Strizenc,^{145b} R. Ströhmer,¹⁷⁵ D. M. Strom,¹¹⁵ R. Stroynowski,⁴⁰ S. A. Stucci,¹⁷ B. Stugu,¹⁴ N. A. Styles,⁴² D. Su,¹⁴⁴ J. Su,¹²⁴ R. Subramaniam,⁷⁸ A. Succurro,¹² Y. Sugaya,¹¹⁷ C. Suhr,¹⁰⁷ M. Suk,¹²⁷ V. V. Sulin,⁹⁵ S. Sultansoy,^{4c} T. Sumida,⁶⁷ S. Sun,⁵⁷ X. Sun,^{33a} J. E. Sundermann,⁴⁸ K. Suruliz,¹⁴⁰ G. Susinno,^{37a,37b} M. R. Sutton,¹⁵⁰ Y. Suzuki,⁶⁵ M. Svatos,¹²⁶ S. Swedish,¹⁶⁹ M. Swiatlowski,¹⁴⁴ I. Sykora,^{145a} T. Sykora,¹²⁸ D. Ta,⁸⁹ C. Taccini,^{135a,135b} K. Tackmann,⁴² J. Taenzer,¹⁵⁹ A. Taffard,¹⁶⁴ R. Tafirout,^{160a} N. Taiblum,¹⁵⁴ H. Takai,²⁵ R. Takashima,⁶⁸ H. Takeda,⁶⁶ T. Takeshita,¹⁴¹ Y. Takubo,⁶⁵ M. Talby,⁸⁴ A. A. Talyshev,^{108,u} J. Y. C. Tam,¹⁷⁵ K. G. Tan,⁸⁷ J. Tanaka,¹⁵⁶ R. Tanaka,¹¹⁶ S. Tanaka,¹³² S. Tanaka,⁶⁵ A. J. Tanasijczuk,¹⁴³ B. B. Tannenwald,¹¹⁰ N. Tannoury,²¹ S. Tapprogge,⁸² S. Tarem,¹⁵³ F. Tarrade,²⁹ G. F. Tartarelli,^{90a} P. Tas,¹²⁸ M. Tasevsky,¹²⁶ T. Tashiro,⁶⁷ E. Tassi,^{37a,37b} A. Tavares Delgado,^{125a,125b} Y. Tayalati,^{136d} F. E. Taylor,⁹³ G. N. Taylor,⁸⁷ W. Taylor,^{160b} F. A. Teischinger,³⁰ M. Teixeira Dias Castanheira,⁷⁵ P. Teixeira-Dias,⁷⁶ K. K. Temming,⁴⁸ H. Ten Kate,³⁰ P. K. Teng,¹⁵² J. J. Teoh,¹¹⁷ S. Terada,⁶⁵ K. Terashi,¹⁵⁶ J. Terron,⁸¹ S. Terzo,¹⁰⁰ M. Testa,⁴⁷ R. J. Teuscher,^{159,j} J. Therhaag,²¹ T. Theveneaux-Pelzer,³⁴ J. P. Thomas,¹⁸ J. Thomas-Wilsker,⁷⁶ E. N. Thompson,³⁵ P. D. Thompson,¹⁸ P. D. Thompson,¹⁵⁹ R. J. Thompson,⁸³ A. S. Thompson,⁵³ L. A. Thomsen,³⁶ E. Thomson,¹²¹ M. Thomson,²⁸ W. M. Thong,⁸⁷ R. P. Thun,^{88,a} F. Tian,³⁵ M. J. Tibbetts,¹⁵ V. O. Tikhomirov,^{95,hh} Yu. A. Tikhonov,^{108,u} S. Timoshenko,⁹⁷ E. Tiouchichine,⁸⁴ P. Tipton,¹⁷⁷ S. Tisserant,⁸⁴ T. Todorov,⁵ S. Todorova-Nova,¹²⁸ B. Toggerson,⁷ J. Tojo,⁶⁹ S. Tokár,^{145a} K. Tokushuku,⁶⁵ K. Tollefson,⁸⁹ L. Tomlinson,⁸³ M. Tomoto,¹⁰² L. Tompkins,³¹ K. Toms,¹⁰⁴ N. D. Topilin,⁶⁴ E. Torrence,¹¹⁵ H. Torres,¹⁴³ E. Torró Pastor,¹⁶⁸ J. Toth,^{84,ii} F. Touchard,⁸⁴ D. R. Tovey,¹⁴⁰ H. L. Tran,¹¹⁶ T. Trefzger,¹⁷⁵ L. Tremblet,³⁰ A. Tricoli,³⁰ I. M. Trigger,^{160a} S. Trincaz-Duvold,⁷⁹ M. F. Tripiana,¹² W. Trischuk,¹⁵⁹ B. Trocmé,⁵⁵ C. Troncon,^{90a} M. Trotter-McDonald,¹⁴³ M. Trovatelli,^{135a,135b} P. True,⁸⁹ M. Trzebinski,³⁹ A. Trzupek,³⁹ C. Tsarouchas,³⁰ J. C.-L. Tseng,¹¹⁹ P. V. Tsiarshka,⁹¹ D. Tsiou, ¹³⁷ G. Tsipolitis,¹⁰ N. Tsirintanis,⁹

S. Tsiskaridze,¹² V. Tsiskaridze,⁴⁸ E. G. Tskhadadze,^{51a} I. I. Tsukerman,⁹⁶ V. Tsulaia,¹⁵ S. Tsuno,⁶⁵ D. Tsybychev,¹⁴⁹ A. Tudorache,^{26a} V. Tudorache,^{26a} A. N. Tuna,¹²¹ S. A. Tupputi,^{20a,20b} S. Turchikhin,^{98,gg} D. Turecek,¹²⁷ I. Turk Cakir,^{4d} R. Turra,^{90a,90b} P. M. Tuts,³⁵ A. Tykhonov,⁴⁹ M. Tylmad,^{147a,147b} M. Tyndel,¹³⁰ K. Uchida,²¹ I. Ueda,¹⁵⁶ R. Ueno,²⁹ M. Ughetto,⁸⁴ M. Ugland,¹⁴ M. Uhlenbrock,²¹ F. Ukegawa,¹⁶¹ G. Unal,³⁰ A. Undrus,²⁵ G. Unel,¹⁶⁴ F. C. Ungaro,⁴⁸ Y. Unno,⁶⁵ C. Unverdorben,⁹⁹ D. Urbaniec,³⁵ P. Urquijo,⁸⁷ G. Usai,⁸ A. Usanova,⁶¹ L. Vacavant,⁸⁴ V. Vacek,¹²⁷ B. Vachon,⁸⁶ N. Valencic,¹⁰⁶ S. Valentinetti,^{20a,20b} A. Valero,¹⁶⁸ L. Valery,³⁴ S. Valkar,¹²⁸ E. Valladolid Gallego,¹⁶⁸ S. Vallecorsa,⁴⁹ J. A. Valls Ferrer,¹⁶⁸ W. Van Den Wollenberg,¹⁰⁶ P. C. Van Der Deijl,¹⁰⁶ R. van der Geer,¹⁰⁶ H. van der Graaf,¹⁰⁶ R. Van Der Leeuw,¹⁰⁶ D. van der Ster,³⁰ N. van Eldik,³⁰ P. van Gemmeren,⁶ J. Van Nieuwkoop,¹⁴³ I. van Vulpen,¹⁰⁶ M. C. van Woerden,³⁰ M. Vanadia,^{133a,133b} W. Vandelli,³⁰ R. Vanguri,¹²¹ A. Vaniachine,⁶ P. Vankov,⁴² F. Vannucci,⁷⁹ G. Vardanyan,¹⁷⁸ R. Vari,^{133a} E. W. Varnes,⁷ T. Varol,⁸⁵ D. Varouchas,⁷⁹ A. Vartapetian,⁸ K. E. Varvell,¹⁵¹ F. Vazeille,³⁴ T. Vazquez Schroeder,⁵⁴ J. Veatch,⁷ F. Veloso,^{125a,125c} S. Veneziano,^{133a} A. Ventura,^{72a,72b} D. Ventura,⁸⁵ M. Venturi,¹⁷⁰ N. Venturi,¹⁵⁹ A. Venturini,²³ V. Vercesi,^{120a} M. Verducci,^{133a,133b} W. Verkerke,¹⁰⁶ J. C. Vermeulen,¹⁰⁶ A. Vest,⁴⁴ M. C. Vetterli,^{143,e} O. Viazlo,⁸⁰ I. Vichou,¹⁶⁶ T. Vickey,^{146c,ij} O. E. Vickey Boeriu,^{146c} G. H. A. Viehhauser,¹¹⁹ S. Viel,¹⁶⁹ R. Vigne,³⁰ M. Villa,^{20a,20b} M. Villaplana Perez,^{90a,90b} E. Vilucchi,⁴⁷ M. G. Vincter,²⁹ V. B. Vinogradov,⁶⁴ J. Virzi,¹⁵ I. Vivarelli,¹⁵⁰ F. Vives Vaque,³ S. Vlachos,¹⁰ D. Vladouiu,⁹⁹ M. Vlasak,¹²⁷ A. Vogel,²¹ M. Vogel,^{32a} P. Vokac,¹²⁷ G. Volpi,^{123a,123b} M. Volpi,⁸⁷ H. von der Schmitt,¹⁰⁰ H. von Radziewski,⁴⁸ E. von Toerne,²¹ V. Vorobel,¹²⁸ K. Vorobev,⁹⁷ M. Vos,¹⁶⁸ R. Voss,³⁰ J. H. Vossebeld,⁷³ N. Vranjes,¹³⁷ M. Vranjes Milosavljevic,¹⁰⁶ V. Vrba,¹²⁶ M. Vreeswijk,¹⁰⁶ T. Vu Anh,⁴⁸ R. Vuillermet,³⁰ I. Vukotic,³¹ Z. Vykydal,¹²⁷ P. Wagner,²¹ W. Wagner,¹⁷⁶ H. Wahlberg,⁷⁰ S. Wahrmund,⁴⁴ J. Wakabayashi,¹⁰² J. Walder,⁷¹ R. Walker,⁹⁹ W. Walkowiak,¹⁴² R. Wall,¹⁷⁷ P. Waller,⁷³ B. Walsh,¹⁷⁷ C. Wang,^{152,kk} C. Wang,⁴⁵ F. Wang,¹⁷⁴ H. Wang,¹⁵ H. Wang,⁴⁰ J. Wang,⁴² J. Wang,^{33a} K. Wang,⁸⁶ R. Wang,¹⁰⁴ S. M. Wang,¹⁵² T. Wang,²¹ X. Wang,¹⁷⁷ C. Wanotayaraj,¹¹⁵ A. Warburton,⁸⁶ C. P. Ward,²⁸ D. R. Wardrope,⁷⁷ M. Warsinsky,⁴⁸ A. Washbrook,⁴⁶ C. Wasicki,⁴² P. M. Watkins,¹⁸ A. T. Watson,¹⁸ I. J. Watson,¹⁵¹ M. F. Watson,¹⁸ G. Watts,¹³⁹ S. Watts,⁸³ B. M. Waugh,⁷⁷ S. Webb,⁸³ M. S. Weber,¹⁷ S. W. Weber,¹⁷⁵ J. S. Webster,³¹ A. R. Weidberg,¹¹⁹ P. Weigell,¹⁰⁰ B. Weinert,⁶⁰ J. Weingarten,⁵⁴ C. Weiser,⁴⁸ H. Weits,¹⁰⁶ P. S. Wells,³⁰ T. Wenaus,²⁵ D. Wendland,¹⁶ Z. Weng,^{152,ff} T. Wengler,³⁰ S. Wenig,³⁰ N. Wermes,²¹ M. Werner,⁴⁸ P. Werner,³⁰ M. Wessels,^{58a} J. Wetter,¹⁶² K. Whalen,²⁹ A. White,⁸ M. J. White,¹ R. White,^{32b} S. White,^{123a,123b} D. Whiteson,¹⁶⁴ D. Wicke,¹⁷⁶ F. J. Wickens,¹³⁰ W. Wiedenmann,¹⁷⁴ M. Wielers,¹³⁰ P. Wienemann,²¹ C. Wiglesworth,³⁶ L. A. M. Wiik-Fuchs,²¹ P. A. Wijeratne,⁷⁷ A. Wildauer,¹⁰⁰ M. A. Wildt,^{42,ll} H. G. Wilkens,³⁰ J. Z. Will,⁹⁹ H. H. Williams,¹²¹ S. Williams,²⁸ C. Willis,⁸⁹ S. Willocq,⁸⁵ A. Wilson,⁸⁸ J. A. Wilson,¹⁸ I. Wingerter-Seez,⁵ F. Winklmeier,¹¹⁵ B. T. Winter,²¹ M. Wittgen,¹⁴⁴ T. Wittig,⁴³ J. Wittkowski,⁹⁹ S. J. Wollstadt,⁸² M. W. Wolter,³⁹ H. Wolters,^{125a,125c} B. K. Wosiek,³⁹ J. Wotschack,³⁰ M. J. Woudstra,⁸³ K. W. Wozniak,³⁹ M. Wright,⁵³ M. Wu,⁵⁵ S. L. Wu,¹⁷⁴ X. Wu,⁴⁹ Y. Wu,⁸⁸ E. Wulf,³⁵ T. R. Wyatt,⁸³ B. M. Wynne,⁴⁶ S. Xella,³⁶ M. Xiao,¹³⁷ D. Xu,^{33a} L. Xu,^{33b,mmm} B. Yabsley,¹⁵¹ S. Yacoob,^{146b,nn} R. Yakabe,⁶⁶ M. Yamada,⁶⁵ H. Yamaguchi,¹⁵⁶ Y. Yamaguchi,¹¹⁷ A. Yamamoto,⁶⁵ K. Yamamoto,⁶³ S. Yamamoto,¹⁵⁶ T. Yamamura,¹⁵⁶ T. Yamanaka,¹⁵⁶ K. Yamauchi,¹⁰² Y. Yamazaki,⁶⁶ Z. Yan,²² H. Yang,^{33e} H. Yang,¹⁷⁴ U. K. Yang,⁸³ Y. Yang,¹¹⁰ S. Yanush,⁹² L. Yao,^{33a} W-M. Yao,¹⁵ Y. Yasu,⁶⁵ E. Yatsenko,⁴² K. H. Yau Wong,²¹ J. Ye,⁴⁰ S. Ye,²⁵ I. Yeletsikh,⁶⁴ A. L. Yen,⁵⁷ E. Yildirim,⁴² M. Yilmaz,^{4b} R. Yoosoofmiya,¹²⁴ K. Yorita,¹⁷² R. Yoshida,⁶ K. Yoshihara,¹⁵⁶ C. Young,¹⁴⁴ C. J. S. Young,³⁰ S. Youssef,²² D. R. Yu,¹⁵ J. Yu,⁸ J. M. Yu,⁸⁸ J. Yu,¹¹³ L. Yuan,⁶⁶ A. Yurkewicz,¹⁰⁷ I. Yusuff,^{28,oo} B. Zabinski,³⁹ R. Zaidan,⁶² A. M. Zaitsev,^{129,bb} A. Zaman,¹⁴⁹ S. Zambito,²³ L. Zanello,^{133a,133b} D. Zanzi,¹⁰⁰ C. Zeitnitz,¹⁷⁶ M. Zeman,¹²⁷ A. Zemla,^{38a} K. Zengel,²³ O. Zenin,¹²⁹ T. Ženiš,^{145a} D. Zerwas,¹¹⁶ G. Zevi della Porta,⁵⁷ D. Zhang,⁸⁸ F. Zhang,¹⁷⁴ H. Zhang,⁸⁹ J. Zhang,⁶ L. Zhang,¹⁵² X. Zhang,^{33d} Z. Zhang,¹¹⁶ Z. Zhao,^{33b} A. Zhemchugov,⁶⁴ J. Zhong,¹¹⁹ B. Zhou,⁸⁸ L. Zhou,³⁵ N. Zhou,¹⁶⁴ C. G. Zhu,^{33d} H. Zhu,^{33a} J. Zhu,⁸⁸ Y. Zhu,^{33b} X. Zhuang,^{33a} K. Zhukov,⁹⁵ A. Zibell,¹⁷⁵ D. Zieminska,⁶⁰ N. I. Zimine,⁶⁴ C. Zimmermann,⁸² R. Zimmermann,²¹ S. Zimmermann,²¹ S. Zimmermann,⁴⁸ Z. Zinonos,⁵⁴ M. Ziolkowski,¹⁴² G. Zobernig,¹⁷⁴ A. Zoccoli,^{20a,20b} M. zur Nedden,¹⁶ G. Zurzolo,^{103a,103b} V. Zutshi,¹⁰⁷ and L. Zwalinski³⁰

(ATLAS Collaboration)

¹Department of Physics, University of Adelaide, Adelaide, Australia²Physics Department, SUNY Albany, Albany, New York, USA³Department of Physics, University of Alberta, Edmonton, Alberta, Canada^{4a}Department of Physics, Ankara University, Ankara, Turkey^{4b}Department of Physics, Gazi University, Ankara, Turkey

- ^{4c}*Division of Physics, TOBB University of Economics and Technology, Ankara, Turkey*
^{4d}*Turkish Atomic Energy Authority, Ankara, Turkey*
⁵*LAPP, CNRS/IN2P3 and Université de Savoie, Annecy-le-Vieux, France*
⁶*High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois, USA*
⁷*Department of Physics, University of Arizona, Tucson, Arizona, USA*
⁸*Department of Physics, The University of Texas at Arlington, Arlington, Texas, USA*
⁹*Physics Department, University of Athens, Athens, Greece*
¹⁰*Physics Department, National Technical University of Athens, Zografou, Greece*
¹¹*Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan*
¹²*Institut de Física d'Altes Energies and Departament de Física de la Universitat Autònoma de Barcelona, Barcelona, Spain*
^{13a}*Institute of Physics, University of Belgrade, Belgrade, Serbia*
^{13b}*Vinca Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia*
¹⁴*Department for Physics and Technology, University of Bergen, Bergen, Norway*
¹⁵*Physics Division, Lawrence Berkeley National Laboratory and University of California, Berkeley, California, USA*
¹⁶*Department of Physics, Humboldt University, Berlin, Germany*
¹⁷*Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland*
¹⁸*School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom*
^{19a}*Department of Physics, Bogazici University, Istanbul, Turkey*
^{19b}*Department of Physics, Dogus University, Istanbul, Turkey*
^{19c}*Department of Physics Engineering, Gaziantep University, Gaziantep, Turkey*
^{20a}*INFN Sezione di Bologna, Italy*
^{20b}*Dipartimento di Fisica e Astronomia, Università di Bologna, Bologna, Italy*
²¹*Physikalisches Institut, University of Bonn, Bonn, Germany*
²²*Department of Physics, Boston University, Boston, Massachusetts, USA*
²³*Department of Physics, Brandeis University, Waltham, Massachusetts, USA*
^{24a}*Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro, Brazil*
^{24b}*Federal University of Juiz de Fora (UFJF), Juiz de Fora, Brazil*
^{24c}*Federal University of Sao Joao del Rei (UFSJ), Sao Joao del Rei, Brazil*
^{24d}*Instituto de Física, Universidade de Sao Paulo, Sao Paulo, Brazil*
²⁵*Physics Department, Brookhaven National Laboratory, Upton, New York, USA*
^{26a}*National Institute of Physics and Nuclear Engineering, Bucharest, Romania*
^{26b}*National Institute for Research and Development of Isotopic and Molecular Technologies, Physics Department, Cluj Napoca, Romania*
^{26c}*University Politehnica Bucharest, Bucharest, Romania*
^{26d}*West University in Timisoara, Timisoara, Romania*
²⁷*Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina*
²⁸*Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom*
²⁹*Department of Physics, Carleton University, Ottawa, Ontario, Canada*
³⁰*CERN, Geneva, Switzerland*
³¹*Enrico Fermi Institute, University of Chicago, Chicago, Illinois, USA*
^{32a}*Departamento de Física, Pontificia Universidad Católica de Chile, Santiago, Chile*
^{32b}*Departamento de Física, Universidad Técnica Federico Santa María, Valparaíso, Chile*
^{33a}*Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China*
^{33b}*Department of Modern Physics, University of Science and Technology of China, Anhui, China*
^{33c}*Department of Physics, Nanjing University, Jiangsu, China*
^{33d}*School of Physics, Shandong University, Shandong, China*
^{33e}*Physics Department, Shanghai Jiao Tong University, Shanghai, China*
³⁴*Laboratoire de Physique Corpusculaire, Clermont Université and Université Blaise Pascal and CNRS/IN2P3, Clermont-Ferrand, France*
³⁵*Nevis Laboratory, Columbia University, Irvington, New York, USA*
³⁶*Niels Bohr Institute, University of Copenhagen, Kobenhavn, Denmark*
^{37a}*INFN Gruppo Collegato di Cosenza, Laboratori Nazionali di Frascati, Italy*
^{37b}*Dipartimento di Fisica, Università della Calabria, Rende, Italy*
^{38a}*AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland*
^{38b}*Marian Smoluchowski Institute of Physics, Jagiellonian University, Krakow, Poland*
³⁹*The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland*
⁴⁰*Physics Department, Southern Methodist University, Dallas, Texas, USA*
⁴¹*Physics Department, University of Texas at Dallas, Richardson, Texas, USA*
⁴²*DESY, Hamburg and Zeuthen, Germany*
⁴³*Institut für Experimentelle Physik IV, Technische Universität Dortmund, Dortmund, Germany*

- ⁴⁴*Institut für Kern- und Teilchenphysik, Technische Universität Dresden, Dresden, Germany*
- ⁴⁵*Department of Physics, Duke University, Durham, North Carolina, USA*
- ⁴⁶*SUPA—School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom*
- ⁴⁷*INFN Laboratori Nazionali di Frascati, Frascati, Italy*
- ⁴⁸*Fakultät für Mathematik und Physik, Albert-Ludwigs-Universität, Freiburg, Germany*
- ⁴⁹*Section de Physique, Université de Genève, Geneva, Switzerland*
- ^{50a}*INFN Sezione di Genova, Italy*
- ^{50b}*Dipartimento di Fisica, Università di Genova, Genova, Italy*
- ^{51a}*E. Andronikashvili Institute of Physics, Iv. Javakhishvili Tbilisi State University, Tbilisi, Georgia*
- ^{51b}*High Energy Physics Institute, Tbilisi State University, Tbilisi, Georgia*
- ⁵²*II Physikalisches Institut, Justus-Liebig-Universität Giessen, Giessen, Germany*
- ⁵³*SUPA—School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom*
- ⁵⁴*II Physikalisches Institut, Georg-August-Universität, Göttingen, Germany*
- ⁵⁵*Laboratoire de Physique Subatomique et de Cosmologie, Université Grenoble-Alpes, CNRS/IN2P3, Grenoble, France*
- ⁵⁶*Department of Physics, Hampton University, Hampton, Virginia, USA*
- ⁵⁷*Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge, Massachusetts, USA*
- ^{58a}*Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany*
- ^{58b}*Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany*
- ^{58c}*ZITI Institut für technische Informatik, Ruprecht-Karls-Universität Heidelberg, Mannheim, Germany*
- 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*Department of Physics, Kyushu University, Fukuoka, Japan*
- ⁷⁰*Instituto de Física La Plata, Universidad Nacional de La Plata and CONICET, La Plata, Argentina*
- ⁷¹*Physics Department, Lancaster University, Lancaster, United Kingdom*
- ^{72a}*INFN Sezione di Lecce, Italy*
- ^{72b}*Dipartimento di Matematica e Fisica, Università del Salento, Lecce, Italy*
- ⁷³*Oliver Lodge Laboratory, University of Liverpool, Liverpool, United Kingdom*
- ⁷⁴*Department of Physics, Jožef Stefan Institute and University of Ljubljana, Ljubljana, Slovenia*
- ⁷⁵*School of Physics and Astronomy, Queen Mary University of London, London, United Kingdom*
- ⁷⁶*Department of Physics, Royal Holloway University of London, Surrey, United Kingdom*
- ⁷⁷*Department of Physics and Astronomy, University College London, London, United Kingdom*
- ⁷⁸*Louisiana Tech University, Ruston, Louisiana, USA*
- ⁷⁹*Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France*
- ⁸⁰*Fysiska institutionen, Lunds universitet, Lund, Sweden*
- ⁸¹*Departamento de Física Teórica C-15, Universidad Autónoma de Madrid, Madrid, Spain*
- ⁸²*Institut für Physik, Universität Mainz, Mainz, Germany*
- ⁸³*School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom*
- ⁸⁴*CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France*
- ⁸⁵*Department of Physics, University of Massachusetts, Amherst, Massachusetts, USA*
- ⁸⁶*Department of Physics, McGill University, Montreal, Quebec, Canada*
- ⁸⁷*School of Physics, University of Melbourne, Victoria, Australia*
- ⁸⁸*Department of Physics, The University of Michigan, Ann Arbor, Michigan, USA*
- ⁸⁹*Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan, USA*
- ^{90a}*INFN Sezione di Milano, Italy*
- ^{90b}*Dipartimento di Fisica, Università di Milano, Milano, Italy*
- ⁹¹*B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Republic of Belarus*
- ⁹²*National Scientific and Educational Centre for Particle and High Energy Physics, Minsk, Republic of Belarus*
- ⁹³*Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA*
- ⁹⁴*Group of Particle Physics, University of Montreal, Montreal, Quebec, Canada*
- ⁹⁵*P.N. Lebedev Institute of Physics, Academy of Sciences, Moscow, Russia*
- ⁹⁶*Institute for Theoretical and Experimental Physics (ITEP), Moscow, Russia*

- ⁹⁷*Moscow Engineering and Physics Institute (MEPhI), Moscow, Russia*
- ⁹⁸*D.V. Skobeltsyn Institute of Nuclear Physics, M.V. Lomonosov Moscow State University, Moscow, Russia*
- ⁹⁹*Fakultät für Physik, Ludwig-Maximilians-Universität München, München, Germany*
- ¹⁰⁰*Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München, Germany*
- ¹⁰¹*Nagasaki Institute of Applied Science, Nagasaki, Japan*
- ¹⁰²*Graduate School of Science and Kobayashi-Maskawa Institute, Nagoya University, Nagoya, Japan*
- ^{103a}*INFN Sezione di Napoli, Italy*
- ^{103b}*Dipartimento di Fisica, Università di Napoli, Napoli, Italy*
- ¹⁰⁴*Department of Physics and Astronomy, University of New Mexico, Albuquerque, New Mexico, USA*
- ¹⁰⁵*Institute for Mathematics, Astrophysics and Particle Physics, Radboud University Nijmegen/Nikhef, Nijmegen, Netherlands*
- ¹⁰⁶*Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam, Netherlands*
- ¹⁰⁷*Department of Physics, Northern Illinois University, DeKalb, Illinois, USA*
- ¹⁰⁸*Budker Institute of Nuclear Physics, SB RAS, Novosibirsk, Russia*
- ¹⁰⁹*Department of Physics, New York University, New York, New York, USA*
- ¹¹⁰*Ohio State University, Columbus, Ohio, USA*
- ¹¹¹*Faculty of Science, Okayama University, Okayama, Japan*
- ¹¹²*Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman, Oklahoma, USA*
- ¹¹³*Department of Physics, Oklahoma State University, Stillwater, Oklahoma, USA*
- ¹¹⁴*Palacký University, RCPTM, Olomouc, Czech Republic*
- ¹¹⁵*Center for High Energy Physics, University of Oregon, Eugene, Oregon, USA*
- ¹¹⁶*LAL, Université Paris-Sud and CNRS/IN2P3, Orsay, France*
- ¹¹⁷*Graduate School of Science, Osaka University, Osaka, Japan*
- ¹¹⁸*Department of Physics, University of Oslo, Oslo, Norway*
- ¹¹⁹*Department of Physics, Oxford University, Oxford, United Kingdom*
- ^{120a}*INFN Sezione di Pavia, Italy*
- ^{120b}*Dipartimento di Fisica, Università di Pavia, Pavia, Italy*
- ¹²¹*Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania, USA*
- ¹²²*Petersburg Nuclear Physics Institute, Gatchina, Russia*
- ^{123a}*INFN Sezione di Pisa, Italy*
- ^{123b}*Dipartimento di Fisica E. Fermi, Università di Pisa, Pisa, Italy*
- ¹²⁴*Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennsylvania, USA*
- ^{125a}*Laboratorio de Instrumentacao e Fisica Experimental de Particulas—LIP, Lisboa, Portugal*
- ^{125b}*Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal*
- ^{125c}*Department of Physics, University of Coimbra, Coimbra, Portugal*
- ^{125d}*Centro de Física Nuclear da Universidade de Lisboa, Lisboa, Portugal*
- ^{125e}*Departamento de Física, Universidade do Minho, Braga, Portugal*
- ^{125f}*Departamento de Física Teórica y del Cosmos and CAFPE, Universidad de Granada, Granada (Spain), Portugal*
- ^{125g}*Dep Física and CEFITEC of Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Caparica, Portugal*
- ¹²⁶*Institute of Physics, Academy of Sciences of the Czech Republic, Praha, Czech Republic*
- ¹²⁷*Czech Technical University in Prague, Praha, Czech Republic*
- ¹²⁸*Faculty of Mathematics and Physics, Charles University in Prague, Praha, Czech Republic*
- ¹²⁹*State Research Center Institute for High Energy Physics, Protvino, Russia*
- ¹³⁰*Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom*
- ¹³¹*Physics Department, University of Regina, Regina, Saskatchewan, Canada*
- ¹³²*Ritsumeikan University, Kusatsu, Shiga, Japan*
- ^{133a}*INFN Sezione di Roma, Italy*
- ^{133b}*Dipartimento di Fisica, Sapienza Università di Roma, Roma, Italy*
- ^{134a}*INFN Sezione di Roma Tor Vergata, Italy*
- ^{134b}*Dipartimento di Fisica, Università di Roma Tor Vergata, Roma, Italy*
- ^{135a}*INFN Sezione di Roma Tre, Italy*
- ^{135b}*Dipartimento di Matematica e Fisica, Università Roma Tre, Roma, Italy*
- ^{136a}*Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies—Université Hassan II, Casablanca, Morocco*
- ^{136b}*Centre National de l’Energie des Sciences Techniques Nucleaires, Rabat, Morocco*
- ^{136c}*Faculté des Sciences Semlalia, Université Cadi Ayyad, LPHEA-Marrakech, Morocco*
- ^{136d}*Faculté des Sciences, Université Mohamed Premier and LPTPM, Oujda, Morocco*
- ^{136e}*Faculté des sciences, Université Mohammed V-Agdal, Rabat, Morocco*
- ¹³⁷*DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l’Univers), CEA Saclay (Commissariat à l’Energie Atomique et aux Energies Alternatives), Gif-sur-Yvette, France*
- ¹³⁸*Santa Cruz Institute for Particle Physics, University of California Santa Cruz, Santa Cruz, California, USA*

- ¹³⁹*Department of Physics, University of Washington, Seattle, Washington, USA*
- ¹⁴⁰*Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom*
- ¹⁴¹*Department of Physics, Shinshu University, Nagano, Japan*
- ¹⁴²*Fachbereich Physik, Universität Siegen, Siegen, Germany*
- ¹⁴³*Department of Physics, Simon Fraser University, Burnaby, British Columbia, Canada*
- ¹⁴⁴*SLAC National Accelerator Laboratory, Stanford, California, USA*
- ^{145a}*Faculty of Mathematics, Physics & Informatics, Comenius University, Bratislava, Slovak Republic*
- ^{145b}*Department of Subnuclear Physics, Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice, Slovak Republic*
- ^{146a}*Department of Physics, University of Cape Town, Cape Town, South Africa*
- ^{146b}*Department of Physics, University of Johannesburg, Johannesburg, South Africa*
- ^{146c}*School of Physics, University of the Witwatersrand, Johannesburg, South Africa*
- ^{147a}*Department of Physics, Stockholm University, Sweden*
- ^{147b}*The Oskar Klein Centre, Stockholm, Sweden*
- ¹⁴⁸*Physics Department, Royal Institute of Technology, Stockholm, Sweden*
- ¹⁴⁹*Departments of Physics & Astronomy and Chemistry, Stony Brook University, Stony Brook, New York, USA*
- ¹⁵⁰*Department of Physics and Astronomy, University of Sussex, Brighton, United Kingdom*
- ¹⁵¹*School of Physics, University of Sydney, Sydney, Australia*
- ¹⁵²*Institute of Physics, Academia Sinica, Taipei, Taiwan*
- ¹⁵³*Department of Physics, Technion: Israel Institute of Technology, Haifa, Israel*
- ¹⁵⁴*Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel*
- ¹⁵⁵*Department of Physics, Aristotle University of Thessaloniki, Thessaloniki, Greece*
- ¹⁵⁶*International Center for Elementary Particle Physics and Department of Physics, The University of Tokyo, Tokyo, Japan*
- ¹⁵⁷*Graduate School of Science and Technology, Tokyo Metropolitan University, Tokyo, Japan*
- ¹⁵⁸*Department of Physics, Tokyo Institute of Technology, Tokyo, Japan*
- ¹⁵⁹*Department of Physics, University of Toronto, Toronto, Ontario, Canada*
- ^{160a}*TRIUMF, Vancouver, British Columbia, Canada*
- ^{160b}*Department of Physics and Astronomy, York University, Toronto, Ontario, Canada*
- ¹⁶¹*Faculty of Pure and Applied Sciences, University of Tsukuba, Tsukuba, Japan*
- ¹⁶²*Department of Physics and Astronomy, Tufts University, Medford, Massachusetts, USA*
- ¹⁶³*Centro de Investigaciones, Universidad Antonio Narino, Bogota, Colombia*
- ¹⁶⁴*Department of Physics and Astronomy, University of California Irvine, Irvine, California, USA*
- ^{165a}*INFN Gruppo Collegato di Udine, Sezione di Trieste, Udine, Italy*
- ^{165b}*ICTP, Trieste, Italy*
- ^{165c}*Dipartimento di Chimica, Fisica e Ambiente, Università di Udine, Udine, Italy*
- ¹⁶⁶*Department of Physics, University of Illinois, Urbana, Illinois, USA*
- ¹⁶⁷*Department of Physics and Astronomy, University of Uppsala, Uppsala, Sweden*
- ¹⁶⁸*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*
- ¹⁶⁹*Department of Physics, University of British Columbia, Vancouver, British Columbia, Canada*
- ¹⁷⁰*Department of Physics and Astronomy, University of Victoria, Victoria, British Columbia, Canada*
- ¹⁷¹*Department of Physics, University of Warwick, Coventry, United Kingdom*
- ¹⁷²*Waseda University, Tokyo, Japan*
- ¹⁷³*Department of Particle Physics, The Weizmann Institute of Science, Rehovot, Israel*
- ¹⁷⁴*Department of Physics, University of Wisconsin, Madison, Wisconsin, USA*
- ¹⁷⁵*Fakultät für Physik und Astronomie, Julius-Maximilians-Universität, Würzburg, Germany*
- ¹⁷⁶*Fachbereich C Physik, Bergische Universität Wuppertal, Wuppertal, Germany*
- ¹⁷⁷*Department of Physics, Yale University, New Haven, Connecticut, USA*
- ¹⁷⁸*Yerevan Physics Institute, Yerevan, Armenia*
- ¹⁷⁹*Centre de Calcul de l'Institut National de Physique Nucléaire et de Physique des Particules (IN2P3), Villeurbanne, France*

^aDeceased.

^bAlso at Department of Physics, King's College London, London, United Kingdom.

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

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

^eAlso at TRIUMF, Vancouver BC, Canada

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

^gAlso at Tomsk State University, Tomsk, Russia.

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

ⁱAlso at Università di Napoli Parthenope, Napoli, Italy.

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

- ^kAlso at Department of Physics, St. Petersburg State Polytechnical University, St. Petersburg, Russia.
- ^lAlso at Chinese University of Hong Kong, China.
- ^mAlso at Department of Financial and Management Engineering, University of the Aegean, Chios, Greece.
- ⁿAlso at Louisiana Tech University, Ruston LA, USA.
- ^oAlso at Institutio Catalana de Recerca i Estudis Avancats, ICREA, Barcelona, Spain.
- ^pAlso at Department of Physics, The University of Texas at Austin, Austin TX, USA.
- ^qAlso at Institute of Theoretical Physics, Ilia State University, Tbilisi, Georgia
- ^rAlso at CERN, Geneva, Switzerland
- ^sAlso at Ochadai Academic Production, Ochanomizu University, Tokyo, Japan
- ^tAlso at Manhattan College, New York NY, USA.
- ^uAlso at Novosibirsk State University, Novosibirsk, Russia.
- ^vAlso at Institute of Physics, Academia Sinica, Taipei, Taiwan.
- ^wAlso at LAL, Université Paris-Sud and CNRS/IN2P3, Orsay, France,
- ^xAlso at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan,
- ^yAlso at Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France,
- ^zAlso at School of Physical Sciences, National Institute of Science Education and Research, Bhubaneswar, India,
- ^{aa}Also at Dipartimento di Fisica, Sapienza Università di Roma, Roma, Italy,
- ^{bb}Also at Moscow Institute of Physics and Technology State University, Dolgoprudny, Russia,
- ^{cc}Also at Section de Physique, Université de Genève, Geneva, Switzerland,
- ^{dd}Also at International School for Advanced Studies (SISSA), Trieste, Italy,
- ^{ee}Also at Department of Physics and Astronomy, University of South Carolina, Columbia SC, USA.
- ^{ff}Also at School of Physics and Engineering, Sun Yat-sen University, Guangzhou, China
- ^{gg}Also at Faculty of Physics, M.V.Lomonosov Moscow State University, Moscow, Russia.
- ^{hh}Also at Moscow Engineering and Physics Institute (MEPhI), Moscow, Russia.
- ⁱⁱAlso at Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Budapest, Hungary.
- ^{jj}Also at Department of Physics, Oxford University, Oxford, United Kingdom.
- ^{kk}Also at Department of Physics, Nanjing University, Jiangsu, China.
- ^{ll}Also at Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany.
- ^{mm}Also at Department of Physics, The University of Michigan, Ann Arbor MI, USA.
- ⁿⁿAlso at Discipline of Physics, University of KwaZulu-Natal, Durban, South Africa.
- ^{oo}Also at University of Malaya, Department of Physics, Kuala Lumpur, Malaysia.