

Addendum to ‘Measurement of the $t\bar{t}$ production cross-section using $e\mu$ events with b -tagged jets in pp collisions at $\sqrt{s} = 7$ and 8 TeV with the ATLAS detector’

ATLAS Collaboration*

CERN, 1211 Geneva 23, Switzerland

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Abstract The ATLAS measurement of the inclusive top quark pair ($t\bar{t}$) cross-section $\sigma_{t\bar{t}}$ in proton–proton collisions at $\sqrt{s} = 8$ TeV has been updated using the final 2012 luminosity calibration. The updated cross-section result is:

$$\sigma_{t\bar{t}} = 242.9 \pm 1.7 \pm 5.5 \pm 5.1 \pm 4.2 \text{ pb},$$

where the four uncertainties arise from data statistics, experimental and theoretical systematic effects, knowledge of the integrated luminosity and of the LHC beam energy. The result is consistent with theoretical QCD calculations at next-to-next-to-leading order. The measurement of the ratio of $t\bar{t}$ cross-sections at $\sqrt{s} = 8$ TeV and $\sqrt{s} = 7$ TeV, and the $\sqrt{s} = 8$ TeV fiducial measurement corresponding to the experimental acceptance of the leptons, have also been updated.

The most precise measurement of the $t\bar{t}$ cross-section ($\sigma_{t\bar{t}}$) in proton–proton collisions at $\sqrt{s} = 8$ TeV from the ATLAS Collaboration was made using events with an opposite-charge electron–muon pair and one or two b -tagged jets [1], and used a preliminary calibration of the integrated luminosity. The luminosity calibration has been finalised since [2] with a total uncertainty of 1.9%, corresponding to a substantial improvement on the previous uncertainty of 2.8%. Since the uncertainty on the integrated luminosity contributed 3.1% of the total 4.3% uncertainty on the $\sigma_{t\bar{t}}$ measurement reported in [1], a significant improvement in the measurement is possible by using the new luminosity calibration, as documented in this Addendum.

The new calibration corresponds to an integrated luminosity of 20.2 fb^{-1} for the $\sqrt{s} = 8$ TeV sample, a decrease of 0.2%. The cross-section was recomputed taking into account the effects on both the conversion of the $t\bar{t}$ event yield to a cross-section, and the background estimates, giving a result of:

$$\sigma_{t\bar{t}} = 242.9 \pm 1.7 \pm 5.5 \pm 5.1 \pm 4.2 \text{ pb},$$

where the four uncertainties arise from data statistics, experimental and theoretical systematic effects, knowledge of the integrated luminosity, and of the LHC beam energy, giving a total uncertainty of 8.8 pb (3.6%). The result is consistent with the theoretical prediction of $252.9^{+13.3}_{-14.5}$ pb, calculated at next-to-next-to-leading-order with next-to-next-to-leading-logarithmic soft gluon terms with the `top++ 2.0` program [3] as discussed in detail in Ref. [1].

The updated value of the ratio of cross-sections $R_{t\bar{t}} = \sigma_{t\bar{t}}(8 \text{ TeV})/\sigma_{t\bar{t}}(7 \text{ TeV})$ is:

$$R_{t\bar{t}} = 1.328 \pm 0.024 \pm 0.015 \pm 0.038 \pm 0.001,$$

with uncertainties defined as above, adding in quadrature to a total of 0.047. The largest uncertainty comes from the uncertainties on the integrated luminosities, considered to be uncorrelated between the $\sqrt{s} = 7$ TeV and $\sqrt{s} = 8$ TeV datasets. This result is 2.1σ below the expectation of 1.430 ± 0.013 calculated from `top++ 2.0` as discussed in Ref. [1].

The updated fiducial cross-sections, for a $t\bar{t}$ decay producing an $e\mu$ pair within a given fiducial region, are shown in Table 1, updating Table 5 of Ref. [1]. The results are given both for the analysis requirements of $p_T > 25$ GeV and $|\eta| < 2.5$ for both leptons, and for a reduced acceptance of $p_T > 30$ GeV and $|\eta| < 2.4$. They are given separately for the two cases where events with either one or both leptons coming from $t \rightarrow W \rightarrow \tau \rightarrow \ell$ rather than the direct decay $t \rightarrow W \rightarrow \ell$ ($\ell = e$ or μ) are included, or where the contributions involving τ decays are subtracted. The results shown for the $\sqrt{s} = 7$ TeV data sample are unchanged with respect to those in Ref. [1]. The results for the top quark pole mass and limits on light supersymmetric top squarks presented in Ref. [1] are derived from $\sqrt{s} = 7$ TeV and $\sqrt{s} = 8$ TeV cross-section measurements taken together, and would be only slightly improved by the luminosity update described here.

* e-mail: atlas.publications@cern.ch

Table 1 Fiducial cross-section measurement results at $\sqrt{s} = 7$ TeV and $\sqrt{s} = 8$ TeV, for different requirements on the minimum lepton p_T and maximum lepton $|\eta|$, and with or without the inclusion of leptons from $W \rightarrow \tau \rightarrow \ell$ decays, with the final 2012 luminosity calibration.

In each case, the first uncertainty is statistical, the second due to analysis systematic effects, the third due to the integrated luminosity and the fourth due to the LHC beam energy

p_T^ℓ (GeV)	$ \eta^\ell $	$W \rightarrow \tau \rightarrow \ell$	$\sqrt{s} = 7$ TeV (pb)	$\sqrt{s} = 8$ TeV (pb)
>25	<2.5	Yes	$2.615 \pm 0.044 \pm 0.056 \pm 0.052 \pm 0.047$	$3.455 \pm 0.025 \pm 0.070 \pm 0.073 \pm 0.059$
>25	<2.5	No	$2.305 \pm 0.039 \pm 0.049 \pm 0.046 \pm 0.041$	$3.043 \pm 0.022 \pm 0.061 \pm 0.064 \pm 0.052$
>30	<2.4	Yes	$2.029 \pm 0.034 \pm 0.043 \pm 0.040 \pm 0.036$	$2.667 \pm 0.019 \pm 0.054 \pm 0.056 \pm 0.046$
>30	<2.4	No	$1.817 \pm 0.031 \pm 0.039 \pm 0.036 \pm 0.033$	$2.385 \pm 0.017 \pm 0.048 \pm 0.050 \pm 0.041$

ATLAS Collaboration

G. Aad⁸⁴, B. Abbott¹¹², J. Abdallah¹⁵², S. Abdel Khalek¹¹⁶, O. Abdinov¹¹, R. Aben¹⁰⁶, B. Abi¹¹³, M. Abolins⁸⁹, O. S. AbouZeid¹⁵⁹, H. Abramowicz¹⁵⁴, H. Abreu¹⁵³, R. Abreu³⁰, Y. Abulaiti^{147a,147b}, B. S. Acharya^{165a,165b,a}, L. Adamczyk^{38a}, D. L. Adams²⁵, J. Adelman¹⁷⁷, S. Adomeit⁹⁹, T. Adye¹³⁰, T. Agatonovic-Jovin^{13a}, J. A. Aguilar-Saavedra^{125a,125f}, M. Agustoni¹⁷, S. P. Ahlen²², F. Ahmadov^{64,b}, G. Aielli^{134a,134b}, H. Akerstedt^{147a,147b}, T. P. A. Åkesson⁸⁰, G. Akimoto¹⁵⁶, A. V. Akimov⁹⁵, G. L. Alberghi^{20a,20b}, J. Albert¹⁷⁰, S. Albrand⁵⁵, M. J. Alconada Verzini⁷⁰, M. Aleksa³⁰, I. N. Aleksandrov⁶⁴, C. Alexa^{26a}, G. Alexander¹⁵⁴, G. Alexandre⁴⁹, T. Alexopoulos¹⁰, M. Alhroob^{165a,165c}, G. Alimonti^{90a}, L. Alio⁸⁴, J. Alison³¹, B. M. M. Allbrooke¹⁸, L. J. Allison⁷¹, P. P. Allport⁷³, J. Almond⁸³, A. Aloisio^{103a,103b}, A. Alonso³⁶, F. Alonso⁷⁰, C. Alpigiani⁷⁵, A. Altheimer³⁵, B. Alvarez Gonzalez⁸⁹, M. G. Alvigi^{103a,103b}, K. Amako⁶⁵, Y. Amaral Coutinho^{24a}, C. Amelung²³, D. Amidei⁸⁸, S. P. Amor Dos Santos^{125a,125c}, A. Amorim^{125a,125b}, S. Amoroso⁴⁸, N. Amram¹⁵⁴, G. Amundsen²³, C. Anastopoulos¹⁴⁰, L. S. Ancu⁴⁹, N. Andari³⁰, T. Andeen³⁵, C. F. Anders^{58b}, G. Anders³⁰, K. J. Anderson³¹, A. Andreazza^{90a,90b}, V. Andrei^{58a}, X. S. Anduaga⁷⁰, S. Angelidakis⁹, I. Angelozzi¹⁰⁶, P. Anger⁴⁴, A. Angerami³⁵, F. Anghinolfi³⁰, A. V. Anisenkov¹⁰⁸, N. Anjos^{125a}, A. Annovi⁴⁷, A. Antonaki⁹, M. Antonelli⁴⁷, A. Antonov⁹⁷, J. Antos^{145b}, F. Anulli^{133a}, M. Aoki⁶⁵, L. Aperio Bella¹⁸, R. Apolle^{119,c}, G. Arabidze⁸⁹, I. Aracena¹⁴⁴, Y. Arai⁶⁵, J. P. Araque^{125a}, A. T. H. Arce⁴⁵, J.-F. Arguin⁹⁴, S. Argyropoulos⁴², M. Arik^{19a}, A. J. Armbruster³⁰, O. Arnaez³⁰, V. Arnal⁸¹, H. Arnold⁴⁸, M. Arratia²⁸, O. Arslan²¹, A. Artamonov⁹⁶, G. Artoni²³, S. Asai¹⁵⁶, N. Asbah⁴², A. Ashkenazi¹⁵⁴, B. Åsman^{147a,147b}, L. Asquith⁶, K. Assamagan²⁵, R. Astalos^{145a}, M. Atkinson¹⁶⁶, N. B. Atlay¹⁴², B. Auerbach⁶, K. Augsten¹²⁷, M. Aurousseau^{146b}, G. Avolio³⁰, G. Azuelos^{94,d}, Y. Azuma¹⁵⁶, M. A. Baak³⁰, A. Baas^{58a}, C. Bacci^{135a,135b}, H. Bachacou¹³⁷, K. Bachas¹⁵⁵, M. Backes³⁰, M. Backhaus³⁰, J. Backus Mayes¹⁴⁴, E. Badescu^{26a}, P. Bagiacchi^{133a,133b}, P. Bagnaia^{133a,133b}, Y. Bai^{33a}, T. Bain³⁵, J. T. Baines¹³⁰, O. K. Baker¹⁷⁷, P. Balek¹²⁸, F. Balli¹³⁷, E. Banas³⁹, Sw. Banerjee¹⁷⁴, A. A. E. Bannoura¹⁷⁶, V. Bansal¹⁷⁰, H. S. Bansil¹⁸, L. Barak¹⁷³, S. P. Baranov⁹⁵, E. L. Barberio⁸⁷, D. Barberis^{50a,50b}, M. Barbero⁸⁴, T. Barillari¹⁰⁰, M. Barisonzi¹⁷⁶, T. Barklow¹⁴⁴, N. Barlow²⁸, B. M. Barnett¹³⁰, R. M. Barnett¹⁵, Z. Barnovska⁵, A. Baroncelli^{135a}, G. Barone⁴⁹, A. J. Barr¹¹⁹, F. Barreiro⁸¹, J. Barreiro Guimarães da Costa⁵⁷, R. Bartoldus¹⁴⁴, A. E. Barton⁷¹, P. Bartos^{145a}, V. Bartsch¹⁵⁰, A. Bassalat¹¹⁶, A. Basye¹⁶⁶, R. L. Bates⁵³, J. R. Batley²⁸, M. Battaglia¹³⁸, M. Battistin³⁰, F. Bauer¹³⁷, H. S. Bawa^{144,e}, M. D. Beattie⁷¹, T. Beau⁷⁹, P. H. Beauchemin¹⁶², R. Beccherle^{123a,123b}, P. Bechtel²¹, H. P. Beck¹⁷, K. Becker¹⁷⁶, S. Becker⁹⁹, M. Beckingham¹⁷¹, C. Becot¹¹⁶, A. J. Beddall^{19c}, A. Beddall^{19c}, S. Bedikian¹⁷⁷, V. A. Bednyakov⁶⁴, C. P. Bee¹⁴⁹, L. J. Beemster¹⁰⁶, T. A. Beermann¹⁷⁶, M. Begel²⁵, K. Behr¹¹⁹, C. Belanger-Champagne⁸⁶, P. J. Bell⁴⁹, W. H. Bell⁴⁹, G. Bella¹⁵⁴, L. Bellagamba^{20a}, A. Bellerive²⁹, M. Bellomo⁸⁵, K. Belotskiy⁹⁷, O. Beltramello³⁰, O. Benary¹⁵⁴, D. Bencheikroun^{136a}, K. Bendtz^{147a,147b}, N. Benekos¹⁶⁶, Y. Benhammou¹⁵⁴, E. Benhar Noccioli⁴⁹, J. A. Benitez Garcia^{160b}, D. P. Benjamin⁴⁵, J. R. Bensinger²³, K. Benslama¹³¹, S. Bentvelsen¹⁰⁶, D. Berge¹⁰⁶, E. Bergeaas Kuutmann¹⁶, N. Berger⁵, F. Berghaus¹⁷⁰, J. Beringer¹⁵, C. Bernard²², P. Bernat⁷⁷, C. Bernius⁷⁸, F. U. Bernlochner¹⁷⁰, T. Berry⁷⁶, P. Berta¹²⁸, C. Bertella⁸⁴, G. Bertoli^{147a,147b}, F. Bertolucci^{123a,123b}, C. Bertsche¹¹², D. Bertsche¹¹², M. I. Besana^{90a}, G. J. Besjes¹⁰⁵, O. Bessidskaia^{147a,147b}, M. F. Bessner⁴², N. Besson¹³⁷, C. Betancourt⁴⁸, S. Bethke¹⁰⁰, W. Bhimji⁴⁶, R. M. Bianchi¹²⁴, L. Bianchini²³, M. Bianco³⁰, O. Biebel⁹⁹, S. P. Bieniek⁷⁷, K. Bierwagen⁵⁴, J. Biesiada¹⁵, M. Biglietti^{135a}, J. Bilbao De Mendizabal⁴⁹, H. Bilokon⁴⁷, M. Bindi⁵⁴, S. Binet¹¹⁶, A. Bingul^{19c}, C. Bini^{133a,133b}, C. W. Black¹⁵¹, J. E. Black¹⁴⁴, K. M. Black²², D. Blackburn¹³⁹, R. E. Blair⁶, J.-B. Blanchard¹³⁷, T. Blazek^{145a}, I. Bloch⁴², C. Blocker²³, W. Blum^{82,*}, U. Blumenschein⁵⁴, G. J. Bobbink¹⁰⁶, V. S. Bobrovnikov¹⁰⁸, S. S. Bocchetta⁸⁰, A. Bocci⁴⁵, C. Bock⁹⁹, C. R. Boddy¹¹⁹, M. Boehler⁴⁸, T. T. Boek¹⁷⁶, J. A. Bogaerts³⁰, A. G. Bogdanchikov¹⁰⁸, A. Bogouch^{91,*}, C. Bohm^{147a}, J. Bohm¹²⁶, V. Boisvert⁷⁶, T. Bold^{38a}, V. Boldea^{26a},

A. S. Boldyrev⁹⁸, M. Bomben⁷⁹, M. Bona⁷⁵, M. Boonekamp¹³⁷, A. Borisov¹²⁹, G. Borisso⁷¹, M. Borri⁸³, S. Borroni⁴², J. Bortfeldt⁹⁹, V. Bortolotto^{135a,135b}, K. Bos¹⁰⁶, D. Boscherini^{20a}, M. Bosman¹², H. Boterenbrood¹⁰⁶, J. Boudreau¹²⁴, J. Bouffard², E. V. Bouhova-Thacker⁷¹, D. Boumediene³⁴, C. Bourdarios¹¹⁶, N. Bousson¹¹³, S. Boutouil^{136d}, A. Boveia³¹, J. Boyd³⁰, I. R. Boyko⁶⁴, J. Bracinik¹⁸, A. Brandt⁸, G. Brandt¹⁵, O. Brandt^{58a}, U. Bratzler¹⁵⁷, B. Brau⁸⁵, J. E. Brau¹¹⁵, H. M. Braun^{176,*}, S. F. Brazzale^{165a,165c}, B. Brelief¹⁵⁹, K. Brendlinger¹²¹, A. J. Brennan⁸⁷, R. Brenner¹⁶⁷, S. Bressler¹⁷³, K. Bristow^{146c}, T. M. Bristow⁴⁶, D. Britton⁵³, F. M. Brochu²⁸, I. Brock²¹, R. Brock⁸⁹, C. Bromberg⁸⁹, J. Bronner¹⁰⁰, G. Brooijmans³⁵, T. Brooks⁷⁶, W. K. Brooks^{32b}, J. Brosamer¹⁵, E. Brost¹¹⁵, J. Brown⁵⁵, P. A. Bruckman de Renstrom³⁹, D. Bruncko^{145b}, R. Bruneliere⁴⁸, S. Brunet⁶⁰, A. Bruni^{20a}, G. Bruni^{20a}, M. Bruschi^{20a}, L. Bryngemark⁸⁰, T. Buanes¹⁴, Q. Buat¹⁴³, F. Bucci⁴⁹, P. Buchholz¹⁴², R. M. Buckingham¹¹⁹, A. G. Buckley⁵³, S. I. Buda^{26a}, I. A. Budagov⁶⁴, F. Buehrer⁴⁸, L. Bugge¹¹⁸, M. K. Bugge¹¹⁸, O. Bulekov⁹⁷, A. C. Bundock⁷³, H. Burckhart³⁰, S. Burdin⁷³, B. Burghgrave¹⁰⁷, S. Burke¹³⁰, I. Burmeister⁴³, E. Busato³⁴, D. Büscher⁴⁸, V. Büscher⁸², P. Bussey⁵³, C. P. Buszello¹⁶⁷, B. Butler⁵⁷, J. M. Butler²², A. I. Butt³, C. M. Buttar⁵³, J. M. Butterworth⁷⁷, P. Butti¹⁰⁶, W. Buttinger²⁸, A. Buzatu⁵³, M. Byszewski¹⁰, S. Cabrera Urbán¹⁶⁸, D. Caforio^{20a,20b}, O. Cakir^{4a}, P. Calafiura¹⁵, A. Calandri¹³⁷, G. Calderini⁷⁹, P. Calfayan⁹⁹, R. Calkins¹⁰⁷, L. P. Caloba^{24a}, D. Calvet³⁴, S. Calvet³⁴, R. Camacho Toro⁴⁹, S. Camarda⁴², D. Cameron¹¹⁸, L. M. Caminada¹⁵, R. Caminal Armadans¹², S. Campana³⁰, M. Campanelli⁷⁷, A. Campoverde¹⁴⁹, V. Canale^{103a,103b}, A. Canepa^{160a}, M. Cano Bret⁷⁵, J. Cantero⁸¹, R. Cantrill^{125a}, T. Cao⁴⁰, M. D. M. Capeans Garrido³⁰, I. Caprini^{26a}, M. Caprini^{26a}, M. Capua^{37a,37b}, R. Caputo⁸², R. Cardarelli^{134a}, T. Carli³⁰, G. Carlino^{103a}, L. Carminati^{90a,90b}, S. Caron¹⁰⁵, E. Carquin^{32a}, G. D. Carrillo-Montoya^{146c}, J. R. Carter²⁸, J. Carvalho^{125a,125c}, D. Casadei⁷⁷, M. P. Casado¹², M. Casolino¹², E. Castaneda-Miranda^{146b}, A. Castelli¹⁰⁶, V. Castillo Gimenez¹⁶⁸, N. F. Castro^{125a}, P. Catastini⁵⁷, A. Catinaccio³⁰, J. R. Catmore¹¹⁸, A. Cattai³⁰, G. Cattani^{134a,134b}, S. Caughron⁸⁹, V. Cavaliere¹⁶⁶, D. Cavalli^{90a}, M. Cavalli-Sforza¹², V. Cavasinni^{123a,123b}, F. Ceradini^{135a,135b}, B. Cerio⁴⁵, K. Cerny¹²⁸, A. S. Cerqueira^{24b}, A. Cerri¹⁵⁰, L. Cerrito⁷⁵, F. Cerutti¹⁵, M. Cerv³⁰, A. Cervelli¹⁷, S. A. Cetin^{19b}, A. Chafaq^{136a}, D. Chakraborty¹⁰⁷, I. Chalupkova¹²⁸, P. Chang¹⁶⁶, B. Chapleau⁸⁶, J. D. Chapman²⁸, D. Charfeddine¹¹⁶, D. G. Charlton¹⁸, C. C. Chau¹⁵⁹, C. A. Chavez Barajas¹⁵⁰, S. Cheatham⁸⁶, A. Chegwidan⁸⁹, S. Chekanov⁶, S. V. Chekulaev^{160a}, G. A. Chelkov^{64,f}, M. A. Chelstowska⁸⁸, C. Chen⁶³, H. Chen²⁵, K. Chen¹⁴⁹, L. Chen^{33d,g}, S. Chen^{33c}, X. Chen^{146c}, Y. Chen⁶⁶, Y. Chen³⁵, H. C. Cheng⁸⁸, Y. Cheng³¹, A. Cheplakov⁶⁴, R. Cherkaoui El Moursli^{136e}, V. Chernyatin^{25,*}, E. Cheu⁷, L. Chevalier¹³⁷, V. Chiarella⁴⁷, G. Chiefari^{103a,103b}, J. T. Childers⁶, A. Chilingarov⁷¹, G. Chiodini^{72a}, A. S. Chisholm¹⁸, R. T. Chislett⁷⁷, A. Chitan^{26a}, M. V. Chizhov⁶⁴, S. Chouridou⁹, B. K. B. Chow⁹⁹, D. Chromek-Burckhart³⁰, M. L. Chu¹⁵², J. Chudoba¹²⁶, J. J. Chwastowski³⁹, L. Chytka¹¹⁴, G. Ciapetti^{133a,133b}, A. K. Ciftci^{4a}, R. Ciftci^{4a}, D. Cinca⁵³, V. Cindro⁷⁴, A. Ciocio¹⁵, P. Cirkovic^{13b}, Z. H. Citron¹⁷³, M. Citterio^{90a}, M. Ciubancan^{26a}, A. Clark⁴⁹, P. J. Clark⁴⁶, R. N. Clarke¹⁵, W. Cleland¹²⁴, J. C. Clemens⁸⁴, C. Clement^{147a,147b}, Y. Coadou⁸⁴, M. Cobal^{165a,165c}, A. Coccaro¹³⁹, J. Cochran⁶³, L. Coffey²³, J. G. Cogan¹⁴⁴, J. Coggeshall¹⁶⁶, B. Cole³⁵, S. Cole¹⁰⁷, A. P. Colijn¹⁰⁶, J. Collot⁵⁵, T. Colombo^{58c}, G. Colon⁸⁵, G. Compostella¹⁰⁰, P. Conde Muiño^{125a,125b}, E. Coniavitis⁴⁸, M. C. Conidi¹², S. H. Connell^{146b}, I. A. Connelly⁷⁶, S. M. Consonni^{90a,90b}, V. Consorti⁴⁸, S. Constantinescu^{26a}, C. Conta^{120a,120b}, G. Conti⁵⁷, F. Conventi^{103a,h}, M. Cooke¹⁵, B. D. Cooper⁷⁷, A. M. Cooper-Sarkar¹¹⁹, N. J. Cooper-Smith⁷⁶, K. Copic¹⁵, T. Cornelissen¹⁷⁶, M. Corradi^{20a}, F. Corriveau^{86,i}, A. Corso-Radu¹⁶⁴, A. Cortes-Gonzalez¹², G. Cortiana¹⁰⁰, G. Costa^{90a}, M. J. Costa¹⁶⁸, D. Costanzo¹⁴⁰, D. Côté⁸, G. Cottin²⁸, G. Cowan⁷⁶, B. E. Cox⁸³, K. Cranmer¹⁰⁹, G. Cree²⁹, S. Crépe-Renaudin⁵⁵, F. Crescioli⁷⁹, W. A. Cribbs^{147a,147b}, M. Crispin Ortuzar¹¹⁹, M. Cristinziani²¹, V. Croft¹⁰⁵, G. Crosetti^{37a,37b}, C. -M. Cuciuc^{26a}, T. Cuhadar Donszelmann¹⁴⁰, J. Cummings¹⁷⁷, M. Curatolo⁴⁷, C. Cuthbert¹⁵¹, H. Czirr¹⁴², P. Czodrowski³, Z. Czyczula¹⁷⁷, S. D'Auria⁵³, M. D'Onofrio⁷³, M. J. Da Cunha Sargedas De Sousa^{125a,125b}, C. Da Via⁸³, W. Dabrowski^{38a}, A. Dafinca¹¹⁹, T. Dai⁸⁸, O. Dale¹⁴, F. Dallaire⁹⁴, C. Dallapiccola⁸⁵, M. Dam³⁶, A. C. Daniells¹⁸, M. Dano Hoffmann¹³⁷, V. Dao⁴⁸, G. Darbo^{50a}, S. Darmora⁸, J. A. Dassoulas⁴², A. Dattagupta⁶⁰, W. Davey²¹, C. David¹⁷⁰, T. Davidek¹²⁸, E. Davies^{119,c}, M. Davies¹⁵⁴, O. Davignon⁷⁹, A. R. Davison⁷⁷, P. Davison⁷⁷, Y. Davygora^{58a}, E. Dawe¹⁴³, I. Dawson¹⁴⁰, R. K. Daya-Ishmukhametova⁸⁵, K. De⁸, R. de Asmundis^{103a}, S. De Castro^{20a,20b}, S. De Cecco⁷⁹, N. De Groot¹⁰⁵, P. de Jong¹⁰⁶, H. De la Torre⁸¹, F. De Lorenzi⁶³, L. De Nooij¹⁰⁶, D. De Pedis^{133a}, A. De Salvo^{133a}, U. De Sanctis^{165a,165b}, A. De Santo¹⁵⁰, J. B. De Vivie De Regie¹¹⁶, W. J. Dearnaley⁷¹, R. Debebe²⁵, C. Debenedetti¹³⁸, B. Dechenaux⁵⁵, D. V. Dedovich⁶⁴, I. Deigaard¹⁰⁶, J. Del Peso⁸¹, T. Del Prete^{123a,123b}, F. Deliot¹³⁷, C. M. Delitzsch⁴⁹, M. Deliyergiyev⁷⁴, A. Dell'Acqua³⁰, L. Dell'Asta²², M. Dell'Orso^{123a,123b}, M. Della Pietra^{103a,h}, D. della Volpe⁴⁹, M. Delmastro⁵, P. A. Delsart⁵⁵, C. Deluca¹⁰⁶, S. Demers¹⁷⁷, M. Demichev⁶⁴, A. Demilly⁷⁹, S. P. Denisov¹²⁹, D. Derendarz³⁹, J. E. Derkaoui^{136d}, F. Derue⁷⁹, P. Dervan⁷³, K. Desch²¹, C. Deterre⁴², P. O. Deviveiros¹⁰⁶, A. Dewhurst¹³⁰, S. Dhaliwal¹⁰⁶, A. Di Ciaccio^{134a,134b}, L. Di Ciaccio⁵, A. Di Domenico^{133a,133b}, C. Di Donato^{103a,103b}, A. Di Girolamo³⁰, B. Di Girolamo³⁰, A. Di Mattia¹⁵³, B. Di Micco^{135a,135b}, R. Di Nardo⁴⁷, A. Di Simone⁴⁸, R. Di Sipio^{20a,20b}, D. Di Valentino²⁹, F. A. Dias⁴⁶, M. A. Diaz^{32a}, E. B. Diehl⁸⁸, J. Dietrich⁴², T. A. Dietzsch^{58a}, S. Diglio⁸⁴, A. Dimitrievska^{13a}, J. Dingfelder²¹, C. Dionisi^{133a,133b},

P. Dita^{26a}, S. Dita^{26a}, F. Dittus³⁰, F. Djama⁸⁴, T. Djobava^{51b}, M. A. B. do Vale^{24c}, A. Do Valle Wemans^{125a,125g}, T. K. O. Doan⁵, D. Dobos³⁰, C. Doglioni⁴⁹, T. Doherty⁵³, T. Dohmae¹⁵⁶, J. Dolejsi¹²⁸, Z. Dolezal¹²⁸, B. A. Dolgoshein^{97,*}, M. Donadelli^{24d}, S. Donati^{123a,123b}, P. Dondero^{120a,120b}, J. Donini³⁴, J. Dopke¹³⁰, A. Doria^{103a}, M. T. Dova⁷⁰, A. T. Doyle⁵³, M. Dris¹⁰, J. Dubbert⁸⁸, S. Dube¹⁵, E. Dubreuil³⁴, E. Duchovni¹⁷³, G. Duckeck⁹⁹, O. A. Ducu^{26a}, D. Duda¹⁷⁶, A. Dudarev³⁰, F. Dudziak⁶³, L. Duflot¹¹⁶, L. Duguid⁷⁶, M. Dührssen³⁰, M. Dunford^{58a}, H. Duran Yildiz^{4a}, M. Düren⁵², A. Durglishvili^{51b}, M. Dwuznik^{38a}, M. Dyndal^{38a}, J. Ebke⁹⁹, W. Edson², N. C. Edwards⁴⁶, W. Ehrenfeld²¹, T. Eifert¹⁴⁴, G. Eigen¹⁴, K. Einsweiler¹⁵, T. Ekelof¹⁶⁷, M. El Kacimi^{136c}, M. Ellert¹⁶⁷, S. Elles⁵, F. Ellinghaus⁸², N. Ellis³⁰, J. Elmsheuser⁹⁹, M. Elsing³⁰, D. Emelianov¹³⁰, Y. Enari¹⁵⁶, O. C. Endner⁸², M. Endo¹¹⁷, R. Engelmann¹⁴⁹, J. Erdmann¹⁷⁷, A. Ereditato¹⁷, D. Eriksson^{147a}, G. Ernis¹⁷⁶, J. Ernst², M. Ernst²⁵, J. Ernwein¹³⁷, D. Errede¹⁶⁶, S. Errede¹⁶⁶, E. Ertel⁸², M. Escalier¹¹⁶, H. Esch⁴³, C. Escobar¹²⁴, B. Esposito⁴⁷, A. I. Etienvre¹³⁷, E. Etzion¹⁵⁴, H. Evans⁶⁰, A. Ezhilov¹²², L. Fabbri^{20a,20b}, G. Facini³¹, R. M. Fakhruddinov¹²⁹, S. Falciano^{133a}, R. J. Falla⁷⁷, J. Faltova¹²⁸, Y. Fang^{33a}, M. Fanti^{90a,90b}, A. Farbin⁸, A. Farilla^{135a}, T. Faroouque¹², S. Farrell¹⁵, S. M. Farrington¹⁷¹, P. Farthouat³⁰, F. Fassi^{136e}, P. Fassnacht³⁰, D. Fassouliotis⁹, A. Favareto^{50a,50b}, L. Fayard¹¹⁶, P. Federic^{145a}, O. L. Fedin^{122,j}, W. Fedorko¹⁶⁹, M. Fehling-Kaschek⁴⁸, S. Feigl³⁰, L. Felgioni⁸⁴, C. Feng^{33d}, E. J. Feng⁶, H. Feng⁸⁸, A. B. Fenyuk¹²⁹, S. Fernandez Perez³⁰, S. Ferrag⁵³, J. Ferrando⁵³, A. Ferrari¹⁶⁷, P. Ferrari¹⁰⁶, R. Ferrari^{120a}, D. E. Ferreira de Lima⁵³, A. Ferrer¹⁶⁸, D. Ferrere⁴⁹, C. Ferretti⁸⁸, A. Ferretto Parodi^{50a,50b}, M. Fiascaris³¹, F. Fiedler⁸², A. Filipčić⁷⁴, M. Filipuzzi⁴², F. Filthaut¹⁰⁵, M. Fincke-Keeler¹⁷⁰, K. D. Finelli¹⁵¹, M. C. N. Fiolhais^{125a,125c}, L. Fiorini¹⁶⁸, A. Firan⁴⁰, A. Fischer², J. Fischer¹⁷⁶, W. C. Fisher⁸⁹, E. A. Fitzgerald²³, M. Flechl⁴⁸, I. Fleck¹⁴², P. Fleischmann⁸⁸, S. Fleischmann¹⁷⁶, G. T. Fletcher¹⁴⁰, G. Fletcher⁷⁵, T. Flick¹⁷⁶, A. Floderus⁸⁰, L. R. Flores Castillo^{174,k}, A. C. Florez Bustos^{160b}, M. J. Flowerdew¹⁰⁰, A. Formica¹³⁷, A. Forti⁸³, D. Fortin^{160a}, D. Fournier¹¹⁶, H. Fox⁷¹, S. Fracchia¹², P. Francavilla⁷⁹, M. Franchini^{20a,20b}, S. Franchino³⁰, D. Francis³⁰, L. Franconi¹¹⁸, M. Franklin⁵⁷, S. Franz⁶¹, M. Fraternali^{120a,120b}, S. T. French²⁸, C. Friedrich⁴², F. Friedrich⁴⁴, D. Froidevaux³⁰, J. A. Frost²⁸, C. Fukunaga¹⁵⁷, E. Fullana Torregrosa⁸², B. G. Fulsom¹⁴⁴, J. Fuster¹⁶⁸, C. Gabaldon⁵⁵, O. Gabizon¹⁷³, A. Gabrielli^{20a,20b}, A. Gabrielli^{133a,133b}, S. Gadatsch¹⁰⁶, S. Gadomski⁴⁹, G. Gagliardi^{50a,50b}, P. Gagnon⁶⁰, C. Galea¹⁰⁵, B. Galhardo^{125a,125c}, E. J. Gallas¹¹⁹, V. Gallo¹⁷, B. J. Gallop¹³⁰, P. Gallus¹²⁷, G. Galster³⁶, K. K. Gan¹¹⁰, J. Gao^{33b,g}, Y. S. Gao^{144,e}, F. M. Garay Walls⁴⁶, F. Garbersson¹⁷⁷, C. García¹⁶⁸, J. E. García Navarro¹⁶⁸, M. Garcia-Sciveres¹⁵, R. W. Gardner³¹, N. Garelli¹⁴⁴, V. Garonne³⁰, C. Gatti⁴⁷, G. Gaudio^{120a}, B. Gaur¹⁴², L. Gauthier⁹⁴, P. Gauzzi^{133a,133b}, I. L. Gavrilenko⁹⁵, C. Gay¹⁶⁹, G. Gaycken²¹, E. N. Gazis¹⁰, P. Ge^{33d}, Z. Gece¹⁶⁹, C. N. P. Gee¹³⁰, D. A. A. Geerts¹⁰⁶, Ch. Geich-Gimbel²¹, K. Gellerstedt^{147a,147b}, C. Gemme^{50a}, A. Gemmell⁵³, M. H. Genest⁵⁵, S. Gentile^{133a,133b}, M. George⁵⁴, S. George⁷⁶, D. Gerbaudo¹⁶⁴, A. Gershon¹⁵⁴, H. Ghazlane^{136b}, N. Ghodbane³⁴, B. Giacobbe^{20a}, S. Giagu^{133a,133b}, V. Giangiobbe¹², P. Giannetti^{123a,123b}, F. Gianotti³⁰, B. Gibbard²⁵, S. M. Gibson⁷⁶, M. Gilchriese¹⁵, T. P. S. Gillam²⁸, D. Gillberg³⁰, G. Gilles³⁴, D. M. Gingrich^{3,d}, N. Giokaris⁹, M. P. Giordani^{165a,165c}, R. Giordano^{103a,103b}, F. M. Giorgi^{20a}, F. M. Giorgi¹⁶, P. F. Giraud¹³⁷, D. Giugni^{90a}, C. Giuliani⁴⁸, M. Giulini^{58b}, B. K. Gjelsten¹¹⁸, S. Gkaitatzis¹⁵⁵, I. Gkialas^{155,1}, L. K. Gladilin⁹⁸, C. Glasman⁸¹, J. Glatzer³⁰, P. C. F. Glaysher⁴⁶, A. Glazov⁴², G. L. Glonti⁶⁴, M. Goblirsch-Kolb¹⁰⁰, J. R. Goddard⁷⁵, J. Godfrey¹⁴³, J. Godlewski³⁰, C. Goeringer⁸², S. Goldfarb⁸⁸, T. Golling¹⁷⁷, D. Golubkov¹²⁹, A. Gomes^{125a,125b,125d}, L. S. Gomez Fajardo⁴², R. Gonçalo^{125a}, J. Goncalves Pinto Firmino Da Costa¹³⁷, L. Gonella²¹, S. González de la Hoz¹⁶⁸, G. Gonzalez Parra¹², S. Gonzalez-Sevilla⁴⁹, L. Goossens³⁰, P. A. Gorbounov⁹⁶, H. A. Gordon²⁵, I. Gorelov¹⁰⁴, B. Gorini³⁰, E. Gorini^{72a,72b}, A. Gorišek⁷⁴, E. Gornicki³⁹, A. T. Goshaw⁶, C. Gössling⁴³, M. I. Gostkin⁶⁴, M. Gouighri^{136a}, D. Goujdami^{136c}, M. P. Goulette⁴⁹, A. G. Goussiou¹³⁹, C. Goy⁵, S. Gozpinar²³, H. M. X. Grabas¹³⁷, L. Graber⁵⁴, I. Grabowska-Bold^{38a}, P. Grafström^{20a,20b}, K.-J. Grahn⁴², J. Gramling⁴⁹, E. Gramstad¹¹⁸, S. Grancagnolo¹⁶, V. Grassi¹⁴⁹, V. Gratchev¹²², H. M. Gray³⁰, E. Graziani^{135a}, O. G. Grebenyuk¹²², Z. D. Greenwood^{78,m}, K. Gregersen⁷⁷, I. M. Gregor⁴², P. Grenier¹⁴⁴, J. Griffiths⁸, A. A. Grillo¹³⁸, K. Grimm⁷¹, S. Grinstein^{12,n}, Ph. Gris³⁴, Y. V. Grishkevich⁹⁸, J. -F. Grivaz¹¹⁶, J. P. Grohs⁴⁴, A. Grohsjean⁴², E. Gross¹⁷³, J. Grosse-Knetter⁵⁴, G. C. Grossi^{134a,134b}, J. Groth-Jensen¹⁷³, Z. J. Grout¹⁵⁰, L. Guan^{33b}, F. Guescini⁴⁹, D. Guest¹⁷⁷, O. Gueta¹⁵⁴, C. Guicheney³⁴, E. Guido^{50a,50b}, T. Guillemin¹¹⁶, S. Guindon², U. Gul⁵³, C. Gumpert⁴⁴, J. Gunther¹²⁷, J. Guo³⁵, S. Gupta¹¹⁹, P. Gutierrez¹¹², N. G. Gutierrez Ortiz⁵³, C. Gutsche⁷⁷, N. Guttman¹⁵⁴, C. Guyot¹³⁷, C. Gwenlan¹¹⁹, C. B. Gwilliam⁷³, A. Haas¹⁰⁹, C. Haber¹⁵, H. K. Hadavand⁸, N. Haddad^{136e}, P. Haefner²¹, S. Hageböck²¹, Z. Hajduk³⁹, H. Hakobyan¹⁷⁸, M. Haleem⁴², D. Hall¹¹⁹, G. Halladjian⁸⁹, K. Hamacher¹⁷⁶, P. Hamal¹¹⁴, K. Hamano¹⁷⁰, M. Hamer⁵⁴, A. Hamilton^{146a}, S. Hamilton¹⁶², G. N. Hamity^{146c}, P. G. Hamnett⁴², L. Han^{33b}, K. Hanagaki¹¹⁷, K. Hanawa¹⁵⁶, M. Hance¹⁵, P. Hanke^{58a}, R. Hanna¹³⁷, J. B. Hansen³⁶, J. D. Hansen³⁶, P. H. Hansen³⁶, K. Hara¹⁶¹, A. S. Hard¹⁷⁴, T. Harenberg¹⁷⁶, F. Hariri¹¹⁶, S. Harkusha⁹¹, D. Harper⁸⁸, R. D. Harrington⁴⁶, O. M. Harris¹³⁹, P. F. Harrison¹⁷¹, F. Hartjes¹⁰⁶, M. Hasegawa⁶⁶, S. Hasegawa¹⁰², Y. Hasegawa¹⁴¹, A. Hasib¹¹², S. Hassani¹³⁷, S. Haug¹⁷, M. Hauschild³⁰, R. Hauser⁸⁹, M. Havranek¹²⁶, C. M. Hawkes¹⁸, R. J. Hawkings³⁰, A. D. Hawkins⁸⁰, T. Hayashi¹⁶¹, D. Hayden⁸⁹, C. P. Hays¹¹⁹, H. S. Hayward⁷³, S. J. Haywood¹³⁰, S. J. Head¹⁸, T. Heck⁸², V. Hedberg⁸⁰, L. Heelan⁸,

S. Heim¹²¹, T. Heim¹⁷⁶, B. Heinemann¹⁵, L. Heinrich¹⁰⁹, J. Hejbal¹²⁶, L. Helary²², C. Heller⁹⁹, M. Heller³⁰, S. Hellman^{147a,147b}, D. Hellmich²¹, C. Helsens³⁰, J. Henderson¹¹⁹, R. C. W. Henderson⁷¹, Y. Heng¹⁷⁴, C. Hengler⁴², A. Henrichs¹⁷⁷, A. M. Henriques Correia³⁰, S. Henrot-Versille¹¹⁶, C. Hensel⁵⁴, G. H. Herbert¹⁶, Y. Hernández Jiménez¹⁶⁸, R. Herrberg-Schubert¹⁶, G. Herten⁴⁸, R. Hertenberger⁹⁹, L. Hervas³⁰, G. G. Hesketh⁷⁷, N. P. Hessey¹⁰⁶, R. Hickling⁷⁵, E. Higón-Rodríguez¹⁶⁸, E. Hill¹⁷⁰, J. C. Hill²⁸, K. H. Hiller⁴², S. Hillert²¹, S. J. Hillier¹⁸, I. Hinchliffe¹⁵, E. Hines¹²¹, M. Hirose¹⁵⁸, D. Hirschbuehl¹⁷⁶, J. Hobbs¹⁴⁹, N. Hod¹⁰⁶, M. C. Hodgkinson¹⁴⁰, P. Hodgson¹⁴⁰, A. Hoecker³⁰, M. R. Hoferkamp¹⁰⁴, F. Hoenig⁹⁹, J. Hoffman⁴⁰, D. Hoffmann⁸⁴, J. I. Hofmann^{58a}, M. Hohlfeld⁸², T. R. Holmes¹⁵, T. M. Hong¹²¹, L. Hooft van Huysduynen¹⁰⁹, Y. Horii¹⁰², J.-Y. Hostachy⁵⁵, S. Hou¹⁵², A. Hoummada^{136a}, J. Howard¹¹⁹, J. Howarth⁴², M. Hrabovsky¹¹⁴, I. Hristova¹⁶, J. Hrivnac¹¹⁶, T. Hryn'ova⁵, C. Hsu^{146c}, P. J. Hsu⁸², S. -C. Hsu¹³⁹, D. Hu³⁵, X. Hu²⁵, Y. Huang⁴², Z. Hubacek³⁰, F. Hubaut⁸⁴, F. Huegging²¹, T. B. Huffman¹¹⁹, E. W. Hughes³⁵, G. Hughes⁷¹, M. Huhtinen³⁰, T. A. Hülsing⁸², M. Hurwitz¹⁵, N. Huseynov^{64,b}, J. Huston⁸⁹, J. Huth⁵⁷, G. Iacobucci⁴⁹, G. Iakovidis¹⁰, I. Ibragimov¹⁴², L. Iconomidou-Fayard¹¹⁶, E. Ideal¹⁷⁷, P. Iengo^{103a}, O. Igonkina¹⁰⁶, T. Iizawa¹⁷², Y. Ikegami⁶⁵, K. Ikematsu¹⁴², M. Ikeno⁶⁵, Y. Ilchenko^{31,o}, D. Iliadis¹⁵⁵, N. Ilic¹⁵⁹, Y. Inamaru⁶⁶, T. Ince¹⁰⁰, P. Ioannou⁹, M. Iodice^{135a}, K. Iordanidou⁹, V. Ippolito⁵⁷, A. Irlles Quiles¹⁶⁸, C. Isaksson¹⁶⁷, M. Ishino⁶⁷, M. Ishitsuka¹⁵⁸, R. Ishmukhametov¹¹⁰, C. Issever¹¹⁹, S. Istin^{19a}, J. M. Iturbe Ponce⁸³, R. Iuppa^{134a,134b}, J. Ivarsson⁸⁰, W. Iwanski³⁹, H. Iwasaki⁶⁵, J. M. Izen⁴¹, V. Izzo^{103a}, B. Jackson¹²¹, M. Jackson⁷³, P. Jackson¹, M. R. Jaekel³⁰, V. Jain², K. Jakobs⁴⁸, S. Jakobsen³⁰, T. Jakoubek¹²⁶, J. Jakubek¹²⁷, D. O. Jamin¹⁵², D. K. Jana⁷⁸, E. Jansen⁷⁷, H. Jansen³⁰, J. Janssen²¹, M. Janus¹⁷¹, G. Jarlskog⁸⁰, N. Javadov^{64,b}, T. Javůrek⁴⁸, L. Jeanty¹⁵, J. Jejelava^{51a,p}, G. -Y. Jeng¹⁵¹, D. Jennens⁸⁷, P. Jenni^{48,q}, J. Jentsch⁴³, C. Jeske¹⁷¹, S. Jézéquel⁵, H. Ji¹⁷⁴, J. Jia¹⁴⁹, Y. Jiang^{33b}, M. Jimenez Belenguer⁴², S. Jin^{33a}, A. Jinaru^{26a}, O. Jinnouchi¹⁵⁸, M. D. Joergensen³⁶, K. E. Johansson^{147a,147b}, P. Johansson¹⁴⁰, K. A. Johns⁷, K. Jon-And^{147a,147b}, G. Jones¹⁷¹, R. W. L. Jones⁷¹, T. J. Jones⁷³, J. Jongmanns^{58a}, P. M. Jorge^{125a,125b}, K. D. Joshi⁸³, J. Jovicevic¹⁴⁸, X. Ju¹⁷⁴, C. A. Jung⁴³, R. M. Jungst³⁰, P. Jussel⁶¹, A. Juste Rozas^{12,n}, M. Kaci¹⁶⁸, A. Kaczmarska³⁹, M. Kado¹¹⁶, H. Kagan¹¹⁰, M. Kagan¹⁴⁴, E. Kajomovitz⁴⁵, C. W. Kalderon¹¹⁹, S. Kama⁴⁰, A. Kamenshchikov¹²⁹, N. Kanaya¹⁵⁶, M. Kaneda³⁰, S. Kaneti²⁸, V. A. Kantserov⁹⁷, J. Kanzaki⁶⁵, B. Kaplan¹⁰⁹, A. Kapliy³¹, D. Kar⁵³, K. Karakostas¹⁰, N. Karastathis¹⁰, M. Karnevskiy⁸², S. N. Karpov⁶⁴, Z. M. Karpova⁶⁴, K. Karthik¹⁰⁹, V. Kartvelishvili⁷¹, A. N. Karyukhin¹²⁹, L. Kashif¹⁷⁴, G. Kasieczka^{58b}, R. D. Kass¹¹⁰, A. Kastanas¹⁴, Y. Kataoka¹⁵⁶, A. Katre⁴⁹, J. Katzy⁴², V. Kaushik⁷, K. Kawagoe⁶⁹, T. Kawamoto¹⁵⁶, G. Kawamura⁵⁴, S. Kazama¹⁵⁶, V. F. Kazanin¹⁰⁸, M. Y. Kazarinov⁶⁴, R. Keeler¹⁷⁰, R. Kehoe⁴⁰, M. Keil⁵⁴, J. S. Keller⁴², J. J. Kempster⁷⁶, H. Keoshkerian⁵, O. Kepka¹²⁶, B. P. Kerševan⁷⁴, S. Kersten¹⁷⁶, K. Kessoku¹⁵⁶, J. Keung¹⁵⁹, F. Khalil-zada¹¹, H. Khandanyan^{147a,147b}, A. Khanov¹¹³, A. Khodinov⁹⁷, A. Khomich^{58a}, T. J. Khoo²⁸, G. Khoraiuli²¹, A. Khoroshilov¹⁷⁶, V. Khovanskiy⁹⁶, E. Khramov⁶⁴, J. Khubua^{51b}, H. Y. Kim⁸, H. Kim^{147a,147b}, S. H. Kim¹⁶¹, N. Kimura¹⁷², O. Kind¹⁶, B. T. King⁷³, M. King¹⁶⁸, R. S. B. King¹¹⁹, S. B. King¹⁶⁹, J. Kirk¹³⁰, A. E. Kiryunin¹⁰⁰, T. Kishimoto⁶⁶, D. Kisielewska^{38a}, F. Kiss⁴⁸, T. Kittelmann¹²⁴, K. Kiuchi¹⁶¹, E. Kladiva^{145b}, M. Klein⁷³, U. Klein⁷³, K. Kleinknecht⁸², P. Klimek^{147a,147b}, A. Klimentov²⁵, R. Klingenberg⁴³, J. A. Klinger⁸³, T. Klioutchnikova³⁰, P. F. Klok¹⁰⁵, E. -E. Kluge^{58a}, P. Kluit¹⁰⁶, S. Kluth¹⁰⁰, E. Kneringer⁶¹, E. B. F. G. Knoops⁸⁴, A. Knue⁵³, D. Kobayashi¹⁵⁸, T. Kobayashi¹⁵⁶, M. Kobel⁴⁴, M. Kocian¹⁴⁴, P. Kodys¹²⁸, P. Koesesarko²¹, T. Koffas²⁹, E. Koffeman¹⁰⁶, L. A. Kogan¹¹⁹, S. Kohlmann¹⁷⁶, Z. Kohout¹²⁷, T. Kohriki⁶⁵, T. Koi¹⁴⁴, H. Kolanoski¹⁶, I. Koletsou⁵, J. Koll⁸⁹, A. A. Komar^{95,*}, Y. Komori¹⁵⁶, T. Kondo⁶⁵, N. Kondrashova⁴², K. Köneke⁴⁸, A. C. König¹⁰⁵, S. König⁸², T. Kono^{65,r}, R. Konoplich^{109,s}, N. Konstantinidis⁷⁷, R. Kopeliainsky¹⁵³, S. Koperny^{38a}, L. Köpke⁸², A. K. Kopp⁴⁸, K. Korcyl³⁹, K. Kordas¹⁵⁵, A. Korn⁷⁷, A. A. Korol^{108,t}, I. Korolkov¹², E. V. Korolkova¹⁴⁰, V. A. Korotkov¹²⁹, O. Kortner¹⁰⁰, S. Kortner¹⁰⁰, V. V. Kostyukhin²¹, V. M. Kotov⁶⁴, A. Kotwal⁴⁵, C. Kourkoumelis⁹, V. Kouskoura¹⁵⁵, A. Koutsman^{160a}, R. Kowalewski¹⁷⁰, T. Z. Kowalski^{38a}, W. Kozanecki¹³⁷, A. S. Kozhin¹²⁹, V. Kral¹²⁷, V. A. Kramarenko⁹⁸, G. Kramberger⁷⁴, D. Krasnopevtsev⁹⁷, M. W. Krasny⁷⁹, A. Krasznahorkay³⁰, J. K. Kraus²¹, A. Kravchenko²⁵, S. Kreiss¹⁰⁹, M. Kretz^{58c}, J. Kretschmar⁷³, K. Kreuzfeldt⁵², P. Krieger¹⁵⁹, K. Kroeninger⁵⁴, H. Kroha¹⁰⁰, J. Kroll¹²¹, J. Kroseberg²¹, J. Krstic^{13a}, U. Kruchonak⁶⁴, H. Krüger²¹, T. Kruker¹⁷, N. Krumnack⁶³, Z. V. Krumshteyn⁶⁴, A. Kruse¹⁷⁴, M. C. Kruse⁴⁵, M. Kruskal²², T. Kubota⁸⁷, S. Kuday^{4a}, S. Kuehn⁴⁸, A. Kugel^{58c}, A. Kuhl¹³⁸, T. Kuhl⁴², V. Kukhtin⁶⁴, Y. Kulchitsky⁹¹, S. Kuleshov^{32b}, M. Kuna^{133a,133b}, J. Kunkle¹²¹, A. Kupco¹²⁶, H. Kurashige⁶⁶, Y. A. Kurochkin⁹¹, R. Kurumida⁶⁶, V. Kus¹²⁶, E. S. Kuwertz¹⁴⁸, M. Kuze¹⁵⁸, J. Kvita¹¹⁴, A. La Rosa⁴⁹, L. La Rotonda^{37a,37b}, C. Lacasta¹⁶⁸, F. Lacava^{133a,133b}, J. Lacey²⁹, H. Lacker¹⁶, D. Lacour⁷⁹, V. R. Lacuesta¹⁶⁸, E. Ladygin⁶⁴, R. Lafaye⁵, B. Laforge⁷⁹, T. Lagouri¹⁷⁷, S. Lai⁴⁸, H. Laier^{58a}, L. Lambourne⁷⁷, S. Lammers⁶⁰, C. L. Lampen⁷, W. Lampl⁷, E. Lançon¹³⁷, U. Landgraf⁴⁸, M. P. J. Landon⁷⁵, V. S. Lang^{58a}, A. J. Lankford¹⁶⁴, F. Lanni²⁵, K. Lantzsch³⁰, S. Laplace⁷⁹, C. Lapoire²¹, J. F. Laporte¹³⁷, T. Lari^{90a}, M. Lassnig³⁰, P. Laurelli⁴⁷, W. Lavrijsen¹⁵, A. T. Law¹³⁸, P. Laycock⁷³, O. Le Dortz⁷⁹, E. Le Guirriec⁸⁴, E. Le Menedeu¹², T. LeCompte⁶, F. Ledroit-Guillon⁵⁵, C. A. Lee¹⁵², H. Lee¹⁰⁶, J. S. H. Lee¹¹⁷, S. C. Lee¹⁵², L. Lee¹⁷⁷, G. Lefebvre⁷⁹, M. Lefebvre¹⁷⁰, F. Legger⁹⁹, C. Leggett¹⁵, A. Lehan⁷³, M. Lehmacher²¹, G. Lehmann Miotto³⁰,

X. Lei⁷, W. A. Leight²⁹, A. Leisos¹⁵⁵, A. G. Leister¹⁷⁷, M. A. L. Leite^{24d}, R. Leitner¹²⁸, D. Lellouch¹⁷³, B. Lemmer⁵⁴, K. J. C. Leney⁷⁷, T. Lenz²¹, G. Lenzen¹⁷⁶, B. Lenzi³⁰, R. Leone⁷, S. Leone^{123a,123b}, K. Leonhardt⁴⁴, C. Leonidopoulos⁴⁶, S. Leontsinis¹⁰, C. Leroy⁹⁴, C. G. Lester²⁸, C. M. Lester¹²¹, M. Levchenko¹²², J. Levêque⁵, D. Levin⁸⁸, L. J. Levinson¹⁷³, M. Levy¹⁸, A. Lewis¹¹⁹, G. H. Lewis¹⁰⁹, A. M. Leyko²¹, M. Leyton⁴¹, B. Li^{33b,u}, B. Li⁸⁴, H. Li¹⁴⁹, H. L. Li³¹, L. Li⁴⁵, L. Li^{33e}, S. Li⁴⁵, Y. Li^{33c,v}, Z. Liang¹³⁸, H. Liao³⁴, B. Liberti^{134a}, P. Lichard³⁰, K. Lie¹⁶⁶, J. Liebal²¹, W. Liebig¹⁴, C. Limbach²¹, A. Limosani⁸⁷, S. C. Lin^{152,w}, T. H. Lin⁸², F. Linde¹⁰⁶, B. E. Lindquist¹⁴⁹, J. T. Linnemann⁸⁹, E. Lipeles¹²¹, A. Lipniacka¹⁴, M. Lisovsky⁴², T. M. Liss¹⁶⁶, D. Lissauer²⁵, A. Lister¹⁶⁹, A. M. Litke¹³⁸, B. Liu¹⁵², D. Liu¹⁵², J. B. Liu^{33b}, K. Liu^{33b,x}, L. Liu⁸⁸, M. Liu⁴⁵, M. Liu^{33b}, Y. Liu^{33b}, M. Livan^{120a,120b}, S. S. A. Livermore¹¹⁹, A. Lleres⁵⁵, J. Llorente Merino⁸¹, S. L. Lloyd⁷⁵, F. Lo Sterzo¹⁵², E. Lobodzinska⁴², P. Loch⁷, W. S. Lockman¹³⁸, T. Loddenkoetter²¹, F. K. Loebinger⁸³, A. E. Loevschall-Jensen³⁶, A. Loginov¹⁷⁷, T. Lohse¹⁶, K. Lohwasser⁴², M. Lokajicek¹²⁶, V. P. Lombardo⁵, B. A. Long²², J. D. Long⁸⁸, R. E. Long⁷¹, L. Lopes^{125a}, D. Lopez Mateos⁵⁷, B. Lopez Paredes¹⁴⁰, I. Lopez Paz¹², J. Lorenz⁹⁹, N. Lorenzo Martinez⁶⁰, M. Losada¹⁶³, P. Loscutoff¹⁵, X. Lou⁴¹, A. Lounis¹¹⁶, J. Love⁶, P. A. Love⁷¹, A. J. Lowe^{144,e}, F. Lu^{33a}, N. Lu⁸⁸, H. J. Lubatti¹³⁹, C. Luci^{133a,133b}, A. Lucotte⁵⁵, F. Luehring⁶⁰, W. Lukas⁶¹, L. Luminari^{133a}, O. Lundberg^{147a,147b}, B. Lund-Jensen¹⁴⁸, M. Lungwitz⁸², D. Lynn²⁵, R. Lysak¹²⁶, E. Lytken⁸⁰, H. Ma²⁵, L. L. Ma^{33d}, G. Maccarrone⁴⁷, A. Macchiolo¹⁰⁰, J. Machado Miguens^{125a,125b}, D. Macina³⁰, D. Madaffari⁸⁴, R. Madar⁴⁸, H. J. Maddocks⁷¹, W. F. Mader⁴⁴, A. Madsen¹⁶⁷, M. Maeno⁸, T. Maeno²⁵, E. Magradze⁵⁴, K. Mahboubi⁴⁸, J. Mahlstedt¹⁰⁶, S. Mahmoud⁷³, C. Maiani¹³⁷, C. Maidantchik^{24a}, A. A. Maier¹⁰⁰, A. Maio^{125a,125b,125d}, S. Majewski¹¹⁵, Y. Makida⁶⁵, N. Makovec¹¹⁶, P. Mal^{137,y}, B. Malaescu⁷⁹, Pa. Malecki³⁹, V. P. Maleev¹²², F. Malek⁵⁵, U. Mallik⁶², D. Malon⁶, C. Malone¹⁴⁴, S. Maltezos¹⁰, V. M. Malyshev¹⁰⁸, S. Malyukov³⁰, J. Mamuzic^{13b}, B. Mandelli³⁰, L. Mandelli^{90a}, I. Mandic⁷⁴, R. Mandrysch⁶², J. Maneira^{125a,125b}, A. Manfredini¹⁰⁰, L. Manhaes de Andrade Filho^{24b}, J. A. Manjarres Ramos^{160b}, A. Mann⁹⁹, P. M. Manning¹³⁸, A. Manousakis-Katsikakis⁹, B. Mansoulie¹³⁷, R. Mantifel⁸⁶, L. Mapelli³⁰, L. March¹⁶⁸, J. F. Marchand²⁹, G. Marchiori⁷⁹, M. Marcisovsky¹²⁶, C. P. Marino¹⁷⁰, M. Marjanovic^{13a}, C. N. Marques^{125a}, F. Marroquim^{24a}, S. P. Marsden⁸³, Z. Marshall¹⁵, L. F. Marti¹⁷, S. Marti-Garcia¹⁶⁸, B. Martin³⁰, B. Martin⁸⁹, T. A. Martin¹⁷¹, V. J. Martin⁴⁶, B. Martin dit Latour¹⁴, H. Martinez¹³⁷, M. Martinez^{12,n}, S. Martin-Haugh¹³⁰, A. C. Martyniuk⁷⁷, M. Marx¹³⁹, F. Marzano^{133a}, A. Marzin³⁰, L. Masetti⁸², T. Mashimo¹⁵⁶, R. Mashinistov⁹⁵, J. Masik⁸³, A. L. Maslennikov¹⁰⁸, I. Massa^{20a,20b}, L. Massa^{20a,20b}, N. Massol⁵, P. Mastrandrea¹⁴⁹, A. Mastroberardino^{37a,37b}, T. Masubuchi¹⁵⁶, P. Mättig¹⁷⁶, J. Mattmann⁸², J. Maurer^{26a}, S. J. Maxfield⁷³, D. A. Maximov^{108,t}, R. Mazini¹⁵², L. Mazzaferro^{134a,134b}, G. Mc Goldrick¹⁵⁹, S. P. Mc Kee⁸⁸, A. McCann⁸⁸, R. L. McCarthy¹⁴⁹, T. G. McCarthy²⁹, N. A. McCubbin¹³⁰, K. W. McFarlane^{56,*}, J. A. McFayden⁷⁷, G. Mchedlidze⁵⁴, S. J. McMahon¹³⁰, R. A. McPherson^{170,i}, A. Meade⁸⁵, J. Mechnich¹⁰⁶, M. Medinnis⁴², S. Meehan³¹, S. Mehlhase⁹⁹, A. Mehta⁷³, K. Meier^{58a}, C. Meineck⁹⁹, B. Meirose⁸⁰, C. Melachrinou³¹, B. R. Mellado Garcia^{146c}, F. Meloni¹⁷, A. Mengarelli^{20a,20b}, S. Menke¹⁰⁰, E. Meoni¹⁶², K. M. Mercurio⁵⁷, S. Mergelmeyer²¹, N. Meric¹³⁷, P. Mermoud⁴⁹, L. Merola^{103a,103b}, C. Meroni^{90a}, F. S. Merritt³¹, H. Merritt¹¹⁰, A. Messina^{30,z}, J. Metcalfe²⁵, A. S. Mete¹⁶⁴, C. Meyer⁸², C. Meyer¹²¹, J-P. Meyer¹³⁷, J. Meyer³⁰, R. P. Middleton¹³⁰, S. Migas⁷³, L. Mijovic²¹, G. Mikenberg¹⁷³, M. Mikesikova¹²⁶, M. Mikuš⁷⁴, A. Milic³⁰, D. W. Miller³¹, C. Mills⁴⁶, A. Milov¹⁷³, D. A. Milstead^{147a,147b}, D. Milstein¹⁷³, A. A. Minaenko¹²⁹, I. A. Minashvili⁶⁴, A. I. Mincer¹⁰⁹, B. Mindur^{38a}, M. Mineev⁶⁴, Y. Ming¹⁷⁴, L. M. Mir¹², G. Mirabelli^{133a}, T. Mitani¹⁷², J. Mitrevski⁹⁹, V. A. Mitsou¹⁶⁸, S. Mitsui⁶⁵, A. Miucci⁴⁹, P. S. Miyagawa¹⁴⁰, J. U. Mjörnmark⁸⁰, T. Moa^{147a,147b}, K. Mochizuki⁸⁴, S. Mohapatra³⁵, W. Mohr⁴⁸, S. Molander^{147a,147b}, R. Moles-Valls¹⁶⁸, K. Mönig⁴², C. Monini⁵⁵, J. Monk³⁶, E. Monnier⁸⁴, J. Montejo Berlingen¹², F. Monticelli⁷⁰, S. Monzani^{133a,133b}, R. W. Moore³, A. Moraes⁵³, N. Morange⁶², D. Moreno⁸², M. Moreno Llácer⁵⁴, P. Morettini^{50a}, M. Morgenstern⁴⁴, M. Morii⁵⁷, S. Moritz⁸², A. K. Morley¹⁴⁸, G. Mornacchi³⁰, J. D. Morris⁷⁵, L. Morvaj¹⁰², H. G. Moser¹⁰⁰, M. Mosidze^{51b}, J. Moss¹¹⁰, K. Motohashi¹⁵⁸, R. Mount¹⁴⁴, E. Mountricha²⁵, S. V. Mouraviev^{95,*}, E. J. W. Moyses⁸⁵, S. Muanza⁸⁴, R. D. Mudd¹⁸, F. Mueller^{58a}, J. Mueller¹²⁴, K. Mueller²¹, T. Mueller²⁸, T. Mueller⁸², D. Muenstermann⁴⁹, Y. Munwes¹⁵⁴, J. A. Murillo Quijada¹⁸, W. J. Murray^{171,130}, H. Musheghyan⁵⁴, E. Musto¹⁵³, A. G. Myagkov^{129,aa}, M. Myska¹²⁷, O. Nackenhorst⁵⁴, J. Nadal⁵⁴, K. Nagai⁶¹, R. Nagai¹⁵⁸, Y. Nagai⁸⁴, K. Nagano⁶⁵, A. Nagarkar¹¹⁰, Y. Nagasaka⁵⁹, M. Nagel¹⁰⁰, A. M. Nairz³⁰, Y. Nakahama³⁰, K. Nakamura⁶⁵, T. Nakamura¹⁵⁶, I. Nakano¹¹¹, H. Namasivayam⁴¹, G. Nanava²¹, R. Narayan^{58b}, T. Nattermann²¹, T. Naumann⁴², G. Navarro¹⁶³, R. Nayyar⁷, H. A. Neal⁸⁸, P. Yu. Nechaeva⁹⁵, T. J. Neep⁸³, P. D. Nef¹⁴⁴, A. Negri^{120a,120b}, G. Negri³⁰, M. Negrini^{20a}, S. Nektarijevic⁴⁹, A. Nelson¹⁶⁴, T. K. Nelson¹⁴⁴, S. Nemecek¹²⁶, P. Nemethy¹⁰⁹, A. A. Nepomuceno^{24a}, M. Nessi^{30,ab}, M. S. Neubauer¹⁶⁶, M. Neumann¹⁷⁶, R. M. Neves¹⁰⁹, P. Nevski²⁵, P. R. Newman¹⁸, D. H. Nguyen⁶, R. B. Nickerson¹¹⁹, R. Nicolaidou¹³⁷, B. Nicquevert³⁰, J. Nielsen¹³⁸, N. Nikiforou³⁵, A. Nikiforov¹⁶, V. Nikolaenko^{129,aa}, I. Nikolic-Audit⁷⁹, K. Nikolic⁴⁹, K. Nikolopoulos¹⁸, P. Nilsson⁸, Y. Ninomiya¹⁵⁶, A. Nisati^{133a}, R. Nisius¹⁰⁰, T. Nobe¹⁵⁸, L. Nodulman⁶, M. Nomachi¹¹⁷, I. Nomidis²⁹, S. Norberg¹¹², M. Nordberg³⁰, O. Novgorodova⁴⁴, S. Nowak¹⁰⁰, M. Nozaki⁶⁵, L. Nozka¹¹⁴, K. Ntekas¹⁰, G. Nunes Hanninger⁸⁷, T. Nunnemann⁹⁹, E. Nurse⁷⁷, F. Nuti⁸⁷, B. J. O'Brien⁴⁶, F. O'grady⁷, D. C. O'Neil¹⁴³, V. O'Shea⁵³

F. G. Oakham^{29,d}, H. Oberlack¹⁰⁰, T. Obermann²¹, J. Ocariz⁷⁹, A. Ochi⁶⁶, M. I. Ochoa⁷⁷, S. Oda⁶⁹, S. Odaka⁶⁵, H. Ogren⁶⁰, A. Oh⁸³, S. H. Oh⁴⁵, C. C. Ohm¹⁵, H. Ohman¹⁶⁷, W. Okamura¹¹⁷, H. Okawa²⁵, Y. Okumura³¹, T. Okuyama¹⁵⁶, A. Olariu^{26a}, A. G. Olchevski⁶⁴, S. A. Olivares Pino⁴⁶, D. Oliveira Damazio²⁵, E. Oliver Garcia¹⁶⁸, A. Olszewski³⁹, J. Olszowska³⁹, A. Onofre^{125a,125e}, P. U. E. Onyisi^{31,o}, C. J. Oram^{160a}, M. J. Oreglia³¹, Y. Oren¹⁵⁴, D. Orestano^{135a,135b}, N. Orlando^{72a,72b}, C. Oropeza Barrera⁵³, R. S. Ori¹⁵⁹, B. Osculati^{50a,50b}, R. Ospanov¹²¹, G. Otero y Garzon²⁷, H. Otono⁶⁹, M. Ouchrif^{136d}, E. A. Ouellette¹⁷⁰, F. Ould-Saada¹¹⁸, A. Ouraou¹³⁷, K. P. Oussoren¹⁰⁶, Q. Ouyang^{33a}, A. Ovcharova¹⁵, M. Owen⁸³, V. E. Ozcan^{19a}, N. Ozturk⁸, K. Pachal¹¹⁹, A. Pacheco Pages¹², C. Padilla Aranda¹², M. Pagáčová⁴⁸, S. Pagan Griso¹⁵, E. Paganis¹⁴⁰, C. Pahl¹⁰⁰, F. Paige²⁵, P. Pais⁸⁵, K. Pajchel¹¹⁸, G. Palacino^{160b}, S. Palestini³⁰, M. Palka^{38b}, D. Pallin³⁴, A. Palma^{125a,125b}, J. D. Palmer¹⁸, Y. B. Pan¹⁷⁴, E. Panagiotopoulou¹⁰, J. G. Panduro Vazquez⁷⁶, P. Pani¹⁰⁶, N. Panikashvili⁸⁸, S. Panitkin²⁵, D. Pantea^{26a}, L. Paolozzi^{134a,134b}, Th. D. Papadopoulou¹⁰, K. Papageorgiou^{155.1}, A. Paramonov⁶, D. Paredes Hernandez³⁴, M. A. Parker²⁸, F. Parodi^{50a,50b}, J. A. Parsons³⁵, U. Parzefall⁴⁸, E. Pasqualucci^{133a}, S. Passaggio^{50a}, A. Passeri^{135a}, F. Pastore^{135a,135b,*}, Fr. Pastore⁷⁶, G. Pásztor²⁹, S. Patariaia¹⁷⁶, N. D. Patel¹⁵¹, J. R. Pater⁸³, S. Patricelli^{103a,103b}, T. Pauly³⁰, J. Pearce¹⁷⁰, M. Pedersen¹¹⁸, S. Pedraza Lopez¹⁶⁸, R. Pedro^{125a,125b}, S. V. Peleganchuk¹⁰⁸, D. Pelikan¹⁶⁷, H. Peng^{33b}, B. Penning³¹, J. Penwell⁶⁰, D. V. Perepelitsa²⁵, E. Perez Codina^{160a}, M. T. Pérez García-Estañ¹⁶⁸, V. Perez Reale³⁵, L. Perini^{90a,90b}, H. Pernegger³⁰, R. Perrino^{72a}, R. Peschke⁴², V. D. Peshekhonov⁶⁴, K. Peters³⁰, R. F. Y. Peters⁸³, B. A. Petersen³⁰, T. C. Petersen³⁶, E. Petit⁴², A. Petridis^{147a,147b}, C. Petridou¹⁵⁵, E. Petrolo^{133a}, F. Petrucci^{135a,135b}, N. E. Pettersson¹⁵⁸, R. Pezosa^{32b}, P. W. Phillips¹³⁰, G. Piacquadio¹⁴⁴, E. Pianori¹⁷¹, A. Picazio⁴⁹, E. Piccaro⁷⁵, M. Piccinini^{20a,20b}, R. Piegaia²⁷, D. T. Pignotti¹¹⁰, J. E. Pilcher³¹, A. D. Pilkington⁷⁷, J. Pina^{125a,125b,125d}, M. Pinamonti^{165a,165c,ac}, A. Pinder¹¹⁹, J. L. Pinfold³, A. Pingel³⁶, B. Pinto^{125a}, S. Pires⁷⁹, M. Pitt¹⁷³, C. Pizio^{90a,90b}, L. Plazak^{145a}, M.-A. Pleier²⁵, V. Pleskot¹²⁸, E. Plotnikova⁶⁴, P. Plucinski^{147a,147b}, S. Poddar^{58a}, F. Podlyski³⁴, R. Poettgen⁸², L. Poggioli¹¹⁶, D. Pohl²¹, M. Pohl⁴⁹, G. Polesello^{120a}, A. Policicchio^{37a,37b}, R. Polifka¹⁵⁹, A. Polini^{20a}, C. S. Pollard⁴⁵, V. Polychronakos²⁵, K. Pommès³⁰, L. Pontecorvo^{133a}, B. G. Pope⁸⁹, G. A. Popeneciu^{26b}, D. S. Popovic^{13a}, A. Poppleton³⁰, X. Portell Bueso¹², S. Pospisil¹²⁷, K. Potamianos¹⁵, I. N. Potrap⁶⁴, C. J. Potter¹⁵⁰, C. T. Potter¹¹⁵, G. Poulard³⁰, J. Poveda⁶⁰, V. Pozdnyakov⁶⁴, P. Pralavorio⁸⁴, A. Pranko¹⁵, S. Prasad³⁰, R. Pravahan⁸, S. Prell⁶³, D. Price⁸³, J. Price⁷³, L. E. Price⁶, D. Prieur¹²⁴, M. Primavera^{72a}, M. Proissl⁴⁶, K. Prokofiev⁴⁷, F. Prokoshin^{32b}, E. Protopapadaki¹³⁷, S. Protopopescu²⁵, J. Proudfoot⁶, M. Przybycien^{38a}, H. Przysieznik⁵, E. Ptacek¹¹⁵, D. Puddu^{135a,135b}, E. Pueschel⁸⁵, D. Poldon¹⁴⁹, M. Purohit^{25,ad}, P. Puzo¹¹⁶, J. Qian⁸⁸, G. Qin⁵³, Y. Qin⁸³, A. Quadt⁵⁴, D. R. Quarrie¹⁵, W. B. Quayle^{165a,165b}, M. Queitsch-Maitland⁸³, D. Quilty⁵³, A. Qureshi^{160b}, V. Radeka²⁵, V. Radescu⁴², S. K. Radhakrishnan¹⁴⁹, P. Radloff¹¹⁵, P. Rados⁸⁷, F. Ragusa^{90a,90b}, G. Rahal¹⁷⁹, S. Rajagopalan²⁵, M. Rammensee³⁰, A. S. Randle-Conde⁴⁰, C. Rangel-Smith¹⁶⁷, K. Rao¹⁶⁴, F. Rauscher⁹⁹, T. C. Rave⁴⁸, T. Ravenscroft⁵³, M. Raymond³⁰, A. L. Read¹¹⁸, N. P. Readioff⁷³, D. M. Rebuffi^{120a,120b}, A. Redelbach¹⁷⁵, G. Redlinger²⁵, R. Reece¹³⁸, K. Reeves⁴¹, L. Rehnisch¹⁶, H. Reisin²⁷, M. Relich¹⁶⁴, C. Rembser³⁰, H. Ren^{33a}, Z. L. Ren¹⁵², A. Renaud¹¹⁶, M. Rescigno^{133a}, S. Resconi^{90a}, O. L. Rezanova^{108,t}, P. Reznicek¹²⁸, R. Rezvani⁹⁴, R. Richter¹⁰⁰, M. Ridel⁷⁹, P. Rieck¹⁶, J. Rieger⁵⁴, M. Rijssenbeek¹⁴⁹, A. Rimoldi^{120a,120b}, L. Rinaldi^{20a}, E. Ritsch⁶¹, I. Riu¹², F. Rizatdinova¹¹³, E. Rizvi⁷⁵, S. H. Robertson^{86,i}, A. Robichaud-Veronneau⁸⁶, D. Robinson²⁸, J. E. M. Robinson⁸³, A. Robson⁵³, C. Roda^{123a,123b}, L. Rodrigues³⁰, S. Roe³⁰, O. Røhne¹¹⁸, S. Rolli¹⁶², A. Romaniouk⁹⁷, M. Romano^{20a,20b}, E. Romero Adam¹⁶⁸, N. Rompotis¹³⁹, M. Ronzani⁴⁸, L. Roos⁷⁹, E. Ros¹⁶⁸, S. Rosati^{133a}, K. Rosbach⁴⁹, M. Rose⁷⁶, P. Rose¹³⁸, P. L. Rosendahl¹⁴, O. Rosenthal¹⁴², V. Rossetti^{147a,147b}, E. Rossi^{103a,103b}, L. P. Rossi^{50a}, R. Rosten¹³⁹, M. Rotaru^{26a}, I. Roth¹⁷³, J. Rothberg¹³⁹, D. Rousseau¹¹⁶, C. R. Royon¹³⁷, A. Rozanov⁸⁴, Y. Rozen¹⁵³, X. Ruan^{146c}, F. Rubbo¹², I. Rubinskiy⁴², V. I. Rud⁹⁸, C. Rudolph⁴⁴, M. S. Rudolph¹⁵⁹, F. Rühr⁴⁸, A. Ruiz-Martinez³⁰, Z. Rurikova⁴⁸, N. A. Rusakovich⁶⁴, A. Ruschke⁹⁹, J. P. Rutherford⁷, N. Ruthmann⁴⁸, Y. F. Ryabov¹²², M. Rybar¹²⁸, G. Rybkin¹¹⁶, N. C. Ryder¹¹⁹, A. F. Saavedra¹⁵¹, S. Sacerdoti²⁷, A. Saddique³, I. Sadeh¹⁵⁴, H. F.-W. Sadrozinski¹³⁸, R. Sadykov⁶⁴, F. Safai Tehrani^{133a}, H. Sakamoto¹⁵⁶, Y. Sakurai¹⁷², G. Salamanna^{135a,135b}, A. Salamon^{134a}, M. Saleem¹¹², D. Salek¹⁰⁶, P. H. Sales De Bruin¹³⁹, D. Salihagic¹⁰⁰, A. Salnikov¹⁴⁴, J. Salt¹⁶⁸, D. Salvatore^{37a,37b}, F. Salvatore¹⁵⁰, A. Salvucci¹⁰⁵, A. Salzburger³⁰, D. Sampsonidis¹⁵⁵, A. Sanchez^{103a,103b}, J. Sánchez¹⁶⁸, V. Sanchez Martinez¹⁶⁸, H. Sandaker¹⁴, R. L. Sandbach⁷⁵, H. G. Sander⁸², M. P. Sanders⁹⁹, M. Sandhoff¹⁷⁶, T. Sandoval²⁸, C. Sandoval¹⁶³, R. Sandstroem¹⁰⁰, D. P. C. Sankey¹³⁰, A. Sansoni⁴⁷, C. Santoni³⁴, R. Santonico^{134a,134b}, H. Santos^{125a}, I. Santoyo Castillo¹⁵⁰, K. Sapp¹²⁴, A. Sapronov⁶⁴, J. G. Saraiva^{125a,125d}, B. Sarrazin²¹, G. Sartisohn¹⁷⁶, O. Sasaki⁶⁵, Y. Sasaki¹⁵⁶, G. Sauvage^{5,*}, E. Sauvan⁵, P. Savard^{159,d}, D. O. Savu³⁰, C. Sawyer¹¹⁹, L. Sawyer^{78,m}, D. H. Saxon⁵³, J. Saxon¹²¹, C. Sbarra^{20a}, A. Sbrizzi³, T. Scanlon⁷⁷, D. A. Scannicchio¹⁶⁴, M. Scarcella¹⁵¹, V. Scarfone^{37a,37b}, J. Schaarschmidt¹⁷³, P. Schacht¹⁰⁰, D. Schaefer³⁰, R. Schaefer⁴², S. Schaepe²¹, S. Schaezel^{58b}, U. Schäfer⁸², A. C. Schaffer¹¹⁶, D. Schaile⁹⁹, R. D. Schamberger¹⁴⁹, V. Scharf^{58a}, V. A. Schegelsky¹²², D. Scheirich¹²⁸, M. Schernau¹⁶⁴, M. I. Scherzer³⁵, C. Schiavi^{50a,50b}, J. Schieck⁹⁹, C. Schillo⁴⁸, M. Schioppa^{37a,37b}, S. Schlenker³⁰, E. Schmidt⁴⁸, K. Schmieden³⁰, C. Schmitt⁸², C. Schmitt⁹⁹

S. Schmitt^{58b}, B. Schneider¹⁷, Y. J. Schnellbach⁷³, U. Schnoor⁴⁴, L. Schoeffel¹³⁷, A. Schoening^{58b}, B. D. Schoenrock⁸⁹, A. L. S. Schorlemmer⁵⁴, M. Schott⁸², D. Schouten^{160a}, J. Schovancova²⁵, S. Schramm¹⁵⁹, M. Schreyer¹⁷⁵, C. Schroeder⁸², N. Schuh⁸², M. J. Schultens²¹, H. -C. Schultz-Coulon^{58a}, H. Schulz¹⁶, M. Schumacher⁴⁸, B. A. Schumm¹³⁸, Ph. Schune¹³⁷, C. Schwanenberger⁸³, A. Schwartzman¹⁴⁴, Ph. Schwegler¹⁰⁰, Ph. Schwemling¹³⁷, R. Schwienhorst⁸⁹, J. Schwindling¹³⁷, T. Schwindt²¹, M. Schwoerer⁵, F. G. Sciacca¹⁷, E. Scifo¹¹⁶, G. Sciolla²³, W. G. Scott¹³⁰, F. Scuri^{123a,123b}, F. Scutti²¹, J. Searcy⁸⁸, G. Sedov⁴², E. Sedykh¹²², S. C. Seidel¹⁰⁴, A. Seiden¹³⁸, F. Seifert¹²⁷, J. M. Seixas^{24a}, G. Sekhniaidze^{103a}, S. J. Sekula⁴⁰, K. E. Selbach⁴⁶, D. M. Seliverstov^{122,*}, G. Sellers⁷³, N. Semprini-Cesari^{20a,20b}, C. Serfon³⁰, L. Serin¹¹⁶, L. Serkin⁵⁴, T. Serre⁸⁴, R. Seuster^{160a}, H. Severini¹¹², T. Sfiligoj⁷⁴, F. Sforza¹⁰⁰, A. Sfyrla³⁰, E. Shabalina⁵⁴, M. Shamim¹¹⁵, L. Y. Shan^{33a}, R. Shang¹⁶⁶, J. T. Shank²², M. Shapiro¹⁵, P. B. Shatalov⁹⁶, K. Shaw^{165a,165b}, C. Y. Shehu¹⁵⁰, P. Sherwood⁷⁷, L. Shi^{152,ae}, S. Shimizu⁶⁶, C. O. Shimmin¹⁶⁴, M. Shimojima¹⁰¹, M. Shiyakova⁶⁴, A. Shmeleva⁹⁵, M. J. Shochet³¹, D. Short¹¹⁹, S. Shrestha⁶³, E. Shulga⁹⁷, M. A. Shupe⁷, S. Shushkevich⁴², P. Sicho¹²⁶, O. Sidiropoulou¹⁵⁵, D. Sidorov¹¹³, A. Sidoti^{133a}, F. Siegert⁴⁴, Dj. Sijacki^{13a}, J. Silva^{125a,125d}, Y. Silver¹⁵⁴, D. Silverstein¹⁴⁴, S. B. Silverstein^{147a}, V. Simak¹²⁷, O. Simard⁵, Lj. Simic^{13a}, S. Simion¹¹⁶, E. Simioni⁸², B. Simmons⁷⁷, R. Simoniello^{90a,90b}, M. Simonyan³⁶, P. Sinervo¹⁵⁹, N. B. Sinev¹¹⁵, V. Sipica¹⁴², G. Siragusa¹⁷⁵, A. Sircar⁷⁸, A. N. Sisakyan^{64,*}, S. Yu. Sivoklov⁹⁸, J. Sjolin^{147a,147b}, T. B. Sjrnsen¹⁴, H. P. Skottowe⁵⁷, K. Yu. Skovpen¹⁰⁸, P. Skubic¹¹², M. Slater¹⁸, T. Slavicek¹²⁷, K. Sliwa¹⁶², V. Smakhtin¹⁷³, B. H. Smart⁴⁶, L. Smestad¹⁴, S. Yu. Smirnov⁹⁷, Y. Smirnov⁹⁷, L. N. Smirnova^{98,af}, O. Smirnova⁸⁰, K. M. Smith⁵³, M. Smizanska⁷¹, K. Smolek¹²⁷, A. A. Snesarev⁹⁵, G. Snidero⁷⁵, S. Snyder²⁵, R. Sobie^{170,i}, F. Socher⁴⁴, A. Soffer¹⁵⁴, D. A. Soh^{152,ae}, C. A. Solans³⁰, M. Solar¹²⁷, J. Solc¹²⁷, E. Yu. Soldatov⁹⁷, U. Soldevila¹⁶⁸, A. A. Solodkov¹²⁹, A. Soloshenko⁶⁴, O. V. Solovyanov¹²⁹, V. Solovyev¹²², P. Sommer⁴⁸, H. Y. Song^{33b}, N. Soni¹, A. Sood¹⁵, A. Sopczak¹²⁷, B. Sopko¹²⁷, V. Sopko¹²⁷, V. Sorin¹², M. Sosebee⁸, R. Soualah^{165a,165c}, P. Soueid⁹⁴, A. M. Soukharev¹⁰⁸, D. South⁴², S. Spagnolo^{72a,72b}, F. Spanò⁷⁶, W. R. Spearman⁵⁷, F. Spettel¹⁰⁰, R. Spighi^{20a}, G. Spigo³⁰, M. Spousta¹²⁸, T. Spreitzer¹⁵⁹, B. Spurlock⁸, R. D. St. Denis^{53,*}, S. Staerz⁴⁴, J. Stahlman¹²¹, R. Stamen^{58a}, E. Stanecka³⁹, R. W. Stanek⁶, C. Stanescu^{135a}, M. Stanescu-Bellu⁴², M. M. Stanitzki⁴², S. Stapnes¹¹⁸, E. A. Starchenko¹²⁹, J. Stark⁵⁵, P. Staroba¹²⁶, P. Starovoitov⁴², R. Staszewski³⁹, P. Stavina^{145a,*}, P. Steinberg²⁵, B. Stelzer¹⁴³, H. J. Stelzer³⁰, O. Stelzer-Chilton^{160a}, H. Stenzel⁵², S. Stern¹⁰⁰, G. A. Stewart⁵³, J. A. Stillings²¹, M. C. Stockton⁸⁶, M. Stoebe⁸⁶, G. Stoicea^{26a}, P. Stolte⁵⁴, S. Stonjek¹⁰⁰, A. R. Stradling⁸, A. Straessner⁴⁴, M. E. Stramaglia¹⁷, J. Strandberg¹⁴⁸, S. Strandberg^{147a,147b}, A. Strandlie¹¹⁸, E. Strauss¹⁴⁴, M. Strauss¹¹², P. Strizenc^{145b}, R. Ströhmer¹⁷⁵, D. M. Strom¹¹⁵, R. Stroynowski⁴⁰, S. A. Stucci¹⁷, B. Stugu¹⁴, N. A. Styles⁴², D. Su¹⁴⁴, J. Su¹²⁴, R. Subramaniam⁷⁸, A. Succurro¹², Y. Sugaya¹¹⁷, C. Suhr¹⁰⁷, M. Suk¹²⁷, V. V. Sulin⁹⁵, S. Sultansoy^{4c}, T. Sumida⁶⁷, S. Sun⁵⁷, X. Sun^{33a}, J. E. Sundermann⁴⁸, K. Suruliz¹⁴⁰, G. Susinno^{37a,37b}, M. R. Sutton¹⁵⁰, Y. Suzuki⁶⁵, M. Svatos¹²⁶, S. Swedish¹⁶⁹, M. Swiatlowski¹⁴⁴, I. Sykora^{145a}, T. Sykora¹²⁸, D. Ta⁸⁹, C. Taccini^{135a,135b}, K. Tackmann⁴², J. Taenzer¹⁵⁹, A. Taffard¹⁶⁴, R. Tafirout^{160a}, N. Taiblum¹⁵⁴, H. Takai²⁵, R. Takashima⁶⁸, H. Takeda⁶⁶, T. Takeshita¹⁴¹, Y. Takubo⁶⁵, M. Talby⁸⁴, A. A. Talyshev^{108,t}, J. Y. C. Tam¹⁷⁵, K. G. Tan⁸⁷, J. Tanaka¹⁵⁶, R. Tanaka¹¹⁶, S. Tanaka¹³², S. Tanaka⁶⁵, A. J. Tanasijczuk¹⁴³, B. B. Tannenwald¹¹⁰, N. Tannoury²¹, S. Tapprogge⁸², S. Tarem¹⁵³, F. Tarrade²⁹, G. F. Tartarelli^{90a}, P. Tas¹²⁸, M. Tasevsky¹²⁶, T. Tashiro⁶⁷, E. Tassi^{37a,37b}, A. Tavares Delgado^{125a,125b}, Y. Tayalati^{136d}, F. E. Taylor⁹³, G. N. Taylor⁸⁷, W. Taylor^{160b}, F. A. Teischinger³⁰, M. Teixeira Dias Castanheira⁷⁵, P. Teixeira-Dias⁷⁶, K. K. Temming⁴⁸, H. Ten Kate³⁰, P. K. Teng¹⁵², J. J. Teoh¹¹⁷, S. Terada⁶⁵, K. Terashi¹⁵⁶, J. Terron⁸¹, S. Terzo¹⁰⁰, M. Testa⁴⁷, R. J. Teuscher^{159,i}, J. Therhaag²¹, T. Theveneaux-Pelzer³⁴, J. P. Thomas¹⁸, J. Thomas-Wilsker⁷⁶, E. N. Thompson³⁵, P. D. Thompson¹⁸, P. D. Thompson¹⁵⁹, A. S. Thompson⁵³, L. A. Thomsen³⁶, E. Thomson¹²¹, M. Thomson²⁸, W. M. Thong⁸⁷, R. P. Thun^{88,*}, F. Tian³⁵, M. J. Tibbetts¹⁵, V. O. Tikhomirov^{95,ag}, Yu. A. Tikhonov^{108,t}, S. Timoshenko⁹⁷, E. Tiouchichine⁸⁴, P. Tipton¹⁷⁷, S. Tisserant⁸⁴, T. Todorov⁵, S. Todorova-Nova¹²⁸, B. Toggerson⁷, J. Tojo⁶⁹, S. Tokár^{145a}, K. Tokushuku⁶⁵, K. Tollefson⁸⁹, L. Tomlinson⁸³, M. Tomoto¹⁰², L. Tompkins³¹, K. Toms¹⁰⁴, N. D. Topilin⁶⁴, E. Torrence¹¹⁵, H. Torres¹⁴³, E. Torró Pastor¹⁶⁸, J. Toth^{84,ah}, F. Touchard⁸⁴, D. R. Tovey¹⁴⁰, H. L. Tran¹¹⁶, T. Trefzger¹⁷⁵, L. Tremblet³⁰, A. Tricoli³⁰, I. M. Trigger^{160a}, S. Trincaz-Duvoid⁷⁹, M. F. Tripiana¹², W. Trischuk¹⁵⁹, B. Trocme⁵⁵, C. Troncon^{90a}, M. Trotter-McDonald¹⁴³, M. Trovatelli^{135a,135b}, P. True⁸⁹, M. Trzebinski³⁹, A. Trzupek³⁹, C. Tsarouchas³⁰, J. C.-L. Tseng¹¹⁹, P. V. Tsiareshka⁹¹, D. Tsiounou¹³⁷, G. Tsipolitis¹⁰, N. Tsirintanis⁹, S. Tsiskaridze¹², V. Tsiskaridze⁴⁸, E. G. Tskhadadze^{51a}, I. I. Tsukerman⁹⁶, V. Tsulaia¹⁵, S. Tsuno⁶⁵, D. Tsybychev¹⁴⁹, A. Tudorache^{26a}, V. Tudorache^{26a}, A. N. Tuna¹²¹, S. A. Tuppiti^{20a,20b}, S. Turchikhin^{98,af}, D. Turecek¹²⁷, I. Turk Cakir^{4d}, R. Turra^{90a,90b}, P. M. Tuts³⁵, A. Tykhonov⁴⁹, M. Tylmad^{147a,147b}, M. Tyndel¹³⁰, K. Uchida²¹, I. Ueda¹⁵⁶, R. Ueno²⁹, M. Ughetto⁸⁴, M. Uglan¹⁴, M. Uhlenbrock²¹, F. Ukegawa¹⁶¹, G. Unal³⁰, A. Undrus²⁵, G. Unel¹⁶⁴, F. C. Ungaro⁴⁸, Y. Unno⁶⁵, D. Urbaniec³⁵, P. Urquijo⁸⁷, G. Usai⁸, A. Usanova⁶¹, L. Vacavant⁸⁴, V. Vacek¹²⁷, B. Vachon⁸⁶, N. Valencic¹⁰⁶, S. Valentini^{20a,20b}, A. Valero¹⁶⁸, L. Valery³⁴, S. Valkar¹²⁸, E. Valladolid Gallego¹⁶⁸, S. Vallecorsa⁴⁹, J. A. Valls Ferrer¹⁶⁸, W. Van Den Wollenberg¹⁰⁶, P. C. Van Der Deijl¹⁰⁶, R. van der Geer¹⁰⁶, H. van der Graaf¹⁰⁶, R. Van Der Leeuw¹⁰⁶, D. van der Ster³⁰, N. van Eldik³⁰, P. van Gemmeren⁶, J. Van Nieuwkoop¹⁴³, I. van Vulpen¹⁰⁶, M. C. van Woerden³⁰

M. Vanadia^{133a,133b}, W. Vandelli³⁰, R. Vanguri¹²¹, A. Vaniachine⁶, P. Vankov⁴², F. Vannucci⁷⁹, G. Vardanyan¹⁷⁸, R. Vari^{133a}, E. W. Varnes⁷, T. Varol⁸⁵, D. Varouchas⁷⁹, A. Vartapetian⁸, K. E. Varvell¹⁵¹, F. Vazeille³⁴, T. Vazquez Schroeder⁵⁴, J. Veatch⁷, F. Veloso^{125a,125c}, S. Veneziano^{133a}, A. Ventura^{72a,72b}, D. Ventura⁸⁵, M. Venturi¹⁷⁰, N. Venturi¹⁵⁹, A. Venturini²³, V. Vercesi^{120a}, M. Verducci^{133a,133b}, W. Verkerke¹⁰⁶, J. C. Vermeulen¹⁰⁶, A. Vest⁴⁴, M. C. Vetterli^{143,d}, O. Viazlo⁸⁰, I. Vichou¹⁶⁶, T. Vickey^{146c,ai}, O. E. Vickey Boeriu^{146c}, G. H. A. Viehhauser¹¹⁹, S. Viel¹⁶⁹, R. Vigne³⁰, M. Villa^{20a,20b}, M. Villaplana Perez^{90a,90b}, E. Vilucchi⁴⁷, M. G. Vincter²⁹, V. B. Vinogradov⁶⁴, J. Virzi¹⁵, I. Vivarelli¹⁵⁰, F. Vives Vaque³, S. Vlachos¹⁰, D. Vladoiu⁹⁹, M. Vlasak¹²⁷, A. Vogel²¹, M. Vogel^{32a}, P. Vokac¹²⁷, G. Volpi^{123a,123b}, M. Volpi⁸⁷, H. von der Schmitt¹⁰⁰, H. von Radziewski⁴⁸, E. von Toerne²¹, V. Vorobel¹²⁸, K. Vorobev⁹⁷, M. Vos¹⁶⁸, R. Voss³⁰, J. H. Vossebeld⁷³, N. Vranjes¹³⁷, M. Vranjes Milosavljevic¹⁰⁶, V. Vrba¹²⁶, M. Vreeswijk¹⁰⁶, T. Vu Anh⁴⁸, R. Vuillermet³⁰, I. Vukotic³¹, Z. Vykydal¹²⁷, P. Wagner²¹, W. Wagner¹⁷⁶, H. Wahlberg⁷⁰, S. Wahrmund⁴⁴, J. Wakabayashi¹⁰², J. Walder⁷¹, R. Walker⁹⁹, W. Walkowiak¹⁴², R. Wall¹⁷⁷, P. Waller⁷³, B. Walsh¹⁷⁷, C. Wang^{152,aj}, C. Wang⁴⁵, F. Wang¹⁷⁴, H. Wang¹⁵, H. Wang⁴⁰, J. Wang⁴², J. Wang^{33a}, K. Wang⁸⁶, R. Wang¹⁰⁴, S. M. Wang¹⁵², T. Wang²¹, X. Wang¹⁷⁷, C. Wanotayaroj¹¹⁵, A. Warburton⁸⁶, C. P. Ward²⁸, D. R. Wardrope⁷⁷, M. Warsinsky⁴⁸, A. Washbrook⁴⁶, C. Wasicki⁴², P. M. Watkins¹⁸, A. T. Watson¹⁸, I. J. Watson¹⁵¹, M. F. Watson¹⁸, G. Watts¹³⁹, S. Watts⁸³, B. M. Waugh⁷⁷, S. Webb⁸³, M. S. Weber¹⁷, S. W. Weber¹⁷⁵, J. S. Webster³¹, A. R. Weidberg¹¹⁹, P. Weigell¹⁰⁰, B. Weinert⁶⁰, J. Weingarten⁵⁴, C. Weiser⁴⁸, H. Weits¹⁰⁶, P. S. Wells³⁰, T. Wenaus²⁵, D. Wendland¹⁶, Z. Weng^{152,ac}, T. Wengler³⁰, S. Wenig³⁰, N. Worme²¹, M. Werner⁴⁸, P. Werner³⁰, M. Wessels^{58a}, J. Wetter¹⁶², K. Whalen²⁹, A. White⁸, M. J. White¹, R. White^{32b}, S. White^{123a,123b}, D. Whiteson¹⁶⁴, D. Wicke¹⁷⁶, F. J. Wickens¹³⁰, W. Wiedenmann¹⁷⁴, M. Wielers¹³⁰, P. Wienemann²¹, C. Wiglesworth³⁶, L. A. M. Wiik-Fuchs²¹, P. A. Wijeratne⁷⁷, A. Wildauer¹⁰⁰, M. A. Wildt^{42,ak}, H. G. Wilkens³⁰, J. Z. Will⁹⁹, H. H. Williams¹²¹, S. Williams²⁸, C. Willis⁸⁹, S. Willocq⁸⁵, A. Wilson⁸⁸, J. A. Wilson¹⁸, I. Wingerter-Seez⁵, F. Winklmeier¹¹⁵, B. T. Winter²¹, M. Wittgen¹⁴⁴, T. Wittig⁴³, J. Wittkowski⁹⁹, S. J. Wollstadt⁸², M. W. Wolter³⁹, H. Wolters^{125a,125c}, B. K. Wosiek³⁹, J. Wotschack³⁰, M. J. Woudstra⁸³, K. W. Wozniak³⁹, M. Wright⁵³, M. Wu⁵⁵, S. L. Wu¹⁷⁴, X. Wu⁴⁹, Y. Wu⁸⁸, E. Wulf³⁵, T. R. Wyatt⁸³, B. M. Wynne⁴⁶, S. Xella³⁶, M. Xiao¹³⁷, D. Xu^{33a}, L. Xu^{33b,al}, B. Yabsley¹⁵¹, S. Yacoub^{146b,am}, R. Yakabe⁶⁶, M. Yamada⁶⁵, H. Yamaguchi¹⁵⁶, Y. Yamaguchi¹¹⁷, A. Yamamoto⁶⁵, K. Yamamoto⁶³, S. Yamamoto¹⁵⁶, T. Yamamura¹⁵⁶, T. Yamanaka¹⁵⁶, K. Yamauchi¹⁰², Y. Yamazaki⁶⁶, Z. Yan²², H. Yang^{33e}, H. Yang¹⁷⁴, U. K. Yang⁸³, Y. Yang¹¹⁰, S. Yanush⁹², L. Yao^{33a}, W.-M. Yao¹⁵, Y. Yasu⁶⁵, E. Yatsenko⁴², K. H. Yau Wong²¹, J. Ye⁴⁰, S. Ye²⁵, A. L. Yen⁵⁷, E. Yildirim⁴², M. Yilmaz^{4b}, R. Yoosoofmiya¹²⁴, K. Yorita¹⁷², R. Yoshida⁶, K. Yoshihara¹⁵⁶, C. Young¹⁴⁴, C. J. S. Young³⁰, S. Youssef²², D. R. Yu¹⁵, J. Yu⁸, J. M. Yu⁸⁸, J. Yu¹¹³, L. Yuan⁶⁶, A. Yurkewicz¹⁰⁷, I. Yusuff^{28,an}, B. Zabinski³⁹, R. Zaidan⁶², A. M. Zaitsev^{129,aa}, A. Zaman¹⁴⁹, S. Zambito²³, L. Zanello^{133a,133b}, D. Zanzi¹⁰⁰, C. Zeitnitz¹⁷⁶, M. Zeman¹²⁷, A. Zemla^{38a}, K. Zengel²³, O. Zenin¹²⁹, T. Ženiš^{145a}, D. Zerwas¹¹⁶, G. Zevi della Porta⁵⁷, D. Zhang⁸⁸, F. Zhang¹⁷⁴, H. Zhang⁸⁹, J. Zhang⁶, L. Zhang¹⁵², X. Zhang^{33d}, Z. Zhang¹¹⁶, Z. Zhao^{33b}, A. Zhemchugov⁶⁴, J. Zhong¹¹⁹, B. Zhou⁸⁸, L. Zhou³⁵, N. Zhou¹⁶⁴, C. G. Zhu^{33d}, H. Zhu^{33a}, J. Zhu⁸⁸, Y. Zhu^{33b}, X. Zhuang^{33a}, K. Zhukov⁹⁵, A. Zibell¹⁷⁵, D. Zieminska⁶⁰, N. I. Zimine⁶⁴, C. Zimmermann⁸², R. Zimmermann²¹, S. Zimmermann²¹, S. Zimmermann⁴⁸, Z. Zinonos⁵⁴, M. Ziolkowski¹⁴², G. Zobernig¹⁷⁴, A. Zoccoli^{20a,20b}, M. zur Nedden¹⁶, G. Zurzolo^{103a,103b}, V. Zutshi¹⁰⁷, L. Zwalinski³⁰

¹ Department of Physics, University of Adelaide, Adelaide, SA, Australia

² Physics Department, SUNY Albany, Albany, NY, USA

³ Department of Physics, University of Alberta, Edmonton, AB, Canada

⁴ (a) Department of Physics, Ankara University, Ankara, Turkey; (b) Department of Physics, Gazi University, Ankara, Turkey; (c) Division of Physics, TOBB University of Economics and Technology, Ankara, Turkey; (d) 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, IL, USA

⁷ Department of Physics, University of Arizona, Tucson, AZ, USA

⁸ Department of Physics, The University of Texas at Arlington, Arlington, TX, 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

¹³ (a) Institute of Physics, University of Belgrade, Belgrade, Serbia; (b) 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, CA, 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, UK
- ¹⁹ ^(a)Department of Physics, Bogazici University, Istanbul, Turkey; ^(b)Department of Physics, Dogus University, Istanbul, Turkey; ^(c)Department of Physics Engineering, Gaziantep University, Gaziantep, Turkey
- ²⁰ ^(a)INFN Sezione di Bologna, Bologna, Italy; ^(b)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, MA, USA
- ²³ Department of Physics, Brandeis University, Waltham, MA, USA
- ²⁴ ^(a)Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro, Brazil; ^(b)Federal University of Juiz de Fora (UFJF), Juiz de Fora, Brazil; ^(c)Federal University of Sao Joao del Rei (UFSJ), Sao Joao del Rei, Brazil; ^(d)Instituto de Fisica, Universidade de Sao Paulo, São Paulo, Brazil
- ²⁵ Physics Department, Brookhaven National Laboratory, Upton, NY, USA
- ²⁶ ^(a)National Institute of Physics and Nuclear Engineering, Bucharest, Romania; ^(b)Physics Department, National Institute for Research and Development of Isotopic and Molecular Technologies, Cluj Napoca, Romania; ^(c)University Politehnica Bucharest, Bucharest, Romania; ^(d)West University in Timisoara, Timisoara, Romania
- ²⁷ Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina
- ²⁸ Cavendish Laboratory, University of Cambridge, Cambridge, UK
- ²⁹ Department of Physics, Carleton University, Ottawa, ON, Canada
- ³⁰ CERN, Geneva, Switzerland
- ³¹ Enrico Fermi Institute, University of Chicago, Chicago, IL, USA
- ³² ^(a)Departamento de Física, Pontificia Universidad Católica de Chile, Santiago, Chile; ^(b)Departamento de Física, Universidad Técnica Federico Santa María, Valparaiso, Chile
- ³³ ^(a)Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China; ^(b)Department of Modern Physics, University of Science and Technology of China, Hefei, Anhui, China; ^(c)Department of Physics, Nanjing University, Nanjing, Jiangsu, China; ^(d)School of Physics, Shandong University, Jinan, Shandong, China; ^(e)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, NY, USA
- ³⁶ Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark
- ³⁷ ^(a)INFN Gruppo Collegato di Cosenza, Laboratori Nazionali di Frascati, Frascati, Italy; ^(b)Dipartimento di Fisica, Università della Calabria, Rende, Italy
- ³⁸ ^(a)AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Kraków, Poland; ^(b)Marian Smoluchowski Institute of Physics, Jagiellonian University, Kraków, Poland
- ³⁹ The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Kraków, Poland
- ⁴⁰ Physics Department, Southern Methodist University, Dallas, TX, USA
- ⁴¹ Physics Department, University of Texas at Dallas, Richardson, TX, USA
- ⁴² DESY, Hamburg, 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, NC, USA
- ⁴⁶ SUPA-School of Physics and Astronomy, University of Edinburgh, Edinburgh, UK
- 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
- ⁵⁰ ^(a)INFN Sezione di Genova, Genoa, Italy; ^(b)Dipartimento di Fisica, Università di Genova, Genoa, Italy
- ⁵¹ ^(a)E. Andronikashvili Institute of Physics, Iv. Javakhishvili Tbilisi State University, Tbilisi, Georgia; ^(b)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, UK
- 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, VA, USA
- 57 Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge, MA, USA
- 58 ^(a)Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany; ^(b)Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany; ^(c)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, IN, USA
- 61 Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria
- 62 University of Iowa, Iowa City, IA, USA
- 63 Department of Physics and Astronomy, Iowa State University, Ames, IA, 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, UK
- 72 ^(a)INFN Sezione di Lecce, Lecce, Italy; ^(b)Dipartimento di Matematica e Fisica, Università del Salento, Lecce, Italy
- 73 Oliver Lodge Laboratory, University of Liverpool, Liverpool, UK
- 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, UK
- 76 Department of Physics, Royal Holloway University of London, Surrey, UK
- 77 Department of Physics and Astronomy, University College London, London, UK
- 78 Louisiana Tech University, Ruston, LA, 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, UK
- 84 CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France
- 85 Department of Physics, University of Massachusetts, Amherst, MA, USA
- 86 Department of Physics, McGill University, Montreal, QC, Canada
- 87 School of Physics, University of Melbourne, Melbourne, VIC, Australia
- 88 Department of Physics, The University of Michigan, Ann Arbor, MI, USA
- 89 Department of Physics and Astronomy, Michigan State University, East Lansing, MI, USA
- 90 ^(a)INFN Sezione di Milano, Milan, Italy; ^(b)Dipartimento di Fisica, Università di Milano, Milan, 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, MA, USA
- 94 Group of Particle Physics, University of Montreal, Montreal, QC, Canada
- 95 P.N. Lebedev Institute of Physical, 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. Skobel'syn Institute of Nuclear Physics, M.V. Lomonosov Moscow State University, Moscow, Russia
- 99 Fakultät für Physik, Ludwig-Maximilians-Universität München, Munich, Germany
- 100 Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), Munich, Germany
- 101 Nagasaki Institute of Applied Science, Nagasaki, Japan
- 102 Graduate School of Science and Kobayashi-Maskawa Institute, Nagoya University, Nagoya, Japan

- 103 (a)INFN Sezione di Napoli, Naples, Italy; (b)Dipartimento di Fisica, Università di Napoli, Naples, Italy
 104 Department of Physics and Astronomy, University of New Mexico, Albuquerque, NM, USA
 105 Institute for Mathematics, Astrophysics and Particle Physics, Radboud University Nijmegen/Nikhef, Nijmegen, The Netherlands
 106 Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam, The Netherlands
 107 Department of Physics, Northern Illinois University, DeKalb, IL, USA
 108 Budker Institute of Nuclear Physics, SB RAS, Novosibirsk, Russia
 109 Department of Physics, New York University, New York, NY, USA
 110 Ohio State University, Columbus, OH, USA
 111 Faculty of Science, Okayama University, Okayama, Japan
 112 Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman, OK, USA
 113 Department of Physics, Oklahoma State University, Stillwater, OK, USA
 114 Palacký University, RCPTM, Olomouc, Czech Republic
 115 Center for High Energy Physics, University of Oregon, Eugene, OR, 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, UK
 120 (a)INFN Sezione di Pavia, Pavia, Italy; (b)Dipartimento di Fisica, Università di Pavia, Pavia, Italy
 121 Department of Physics, University of Pennsylvania, Philadelphia, PA, USA
 122 Petersburg Nuclear Physics Institute, Gatchina, Russia
 123 (a)INFN Sezione di Pisa, Pisa, Italy; (b)Dipartimento di Fisica E. Fermi, Università di Pisa, Pisa, Italy
 124 Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA, USA
 125 (a)Laboratorio de Instrumentacao e Fisica Experimental de Particulas-LIP, Lisbon, Portugal; (b)Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal; (c)Department of Physics, University of Coimbra, Coimbra, Portugal; (d)Centro de Física Nuclear da Universidade de Lisboa, Lisbon, Portugal; (e)Departamento de Fisica, Universidade do Minho, Braga, Portugal; (f)Departamento de Fisica Teorica y del Cosmos and CAFPE, Universidad de Granada, Granada, Spain; (g)Dep Fisica and CEFITEC of Faculdade de Ciencias e Tecnologia, Universidade Nova de Lisboa, Caparica, Portugal
 126 Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic
 127 Czech Technical University in Prague, Prague, Czech Republic
 128 Faculty of Mathematics and Physics, Charles University in Prague, Prague, Czech Republic
 129 State Research Center Institute for High Energy Physics, Protvino, Russia
 130 Particle Physics Department, Rutherford Appleton Laboratory, Didcot, UK
 131 Physics Department, University of Regina, Regina, SK, Canada
 132 Ritsumeikan University, Kusatsu, Shiga, Japan
 133 (a)INFN Sezione di Roma, Rome, Italy; (b)Dipartimento di Fisica, Sapienza Università di Roma, Rome, Italy
 134 (a)INFN Sezione di Roma Tor Vergata, Rome, Italy; (b)Dipartimento di Fisica, Università di Roma Tor Vergata, Rome, Italy
 135 (a)INFN Sezione di Roma Tre, Rome, Italy; (b)Dipartimento di Matematica e Fisica, Università Roma Tre, Rome, Italy
 136 (a)Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies-Université Hassan II, Casablanca, Morocco; (b)Centre National de l'Energie des Sciences Techniques Nucleaires, Rabat, Morocco; (c)Faculté des Sciences Semlalia, Université Cadi Ayyad, LPHEA-Marrakech, Marrakech, Morocco; (d)Faculté des Sciences, Université Mohamed Premier and LTPM, Oujda, Morocco; (e)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, CA, USA
 139 Department of Physics, University of Washington, Seattle, WA, USA
 140 Department of Physics and Astronomy, University of Sheffield, Sheffield, UK
 141 Department of Physics, Shinshu University, Nagano, Japan
 142 Fachbereich Physik, Universität Siegen, Siegen, Germany
 143 Department of Physics, Simon Fraser University, Burnaby, BC, Canada

- 144 SLAC National Accelerator Laboratory, Stanford, CA, USA
- 145 ^(a)Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava, Slovak Republic; ^(b)Department of Subnuclear Physics, Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice, Slovak Republic
- 146 ^(a)Department of Physics, University of Cape Town, Cape Town, South Africa; ^(b)Department of Physics, University of Johannesburg, Johannesburg, South Africa; ^(c)School of Physics, University of the Witwatersrand, Johannesburg, South Africa
- 147 ^(a)Department of Physics, Stockholm University, Stockholm, Sweden; ^(b)The Oskar Klein Centre, Stockholm, Sweden
- 148 Physics Department, Royal Institute of Technology, Stockholm, Sweden
- 149 Departments of Physics and Astronomy and Chemistry, Stony Brook University, Stony Brook, NY, USA
- 150 Department of Physics and Astronomy, University of Sussex, Brighton, UK
- 151 School of Physics, University of Sydney, Sydney, NSW, 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, ON, Canada
- 160 ^(a)TRIUMF, Vancouver, BC, Canada; ^(b)Department of Physics and Astronomy, York University, Toronto, ON, Canada
- 161 Faculty of Pure and Applied Sciences, University of Tsukuba, Tsukuba, Japan
- 162 Department of Physics and Astronomy, Tufts University, Medford, MA, USA
- 163 Centro de Investigaciones, Universidad Antonio Narino, Bogota, Colombia
- 164 Department of Physics and Astronomy, University of California Irvine, Irvine, CA, USA
- 165 ^(a)INFN Gruppo Collegato di Udine, Sezione di Trieste, Udine, Italy; ^(b)ICTP, Trieste, Italy; ^(c)Dipartimento di Chimica Fisica e Ambiente, Università di Udine, Udine, Italy
- 166 Department of Physics, University of Illinois, Urbana, IL, 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, BC, Canada
- 170 Department of Physics and Astronomy, University of Victoria, Victoria, BC, Canada
- 171 Department of Physics, University of Warwick, Coventry, UK
- 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, WI, 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, CT, 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
- ^a Also at Department of Physics, King's College London, London, UK
- ^b Also at Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan
- ^c Also at Particle Physics Department, Rutherford Appleton Laboratory, Didcot, UK
- ^d Also at TRIUMF, Vancouver BC, Canada
- ^e Also at Department of Physics, California State University, Fresno CA, USA
- ^f Also at Tomsk State University, Tomsk, Russia
- ^g Also at CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France
- ^h Also at Università di Napoli Parthenope, Napoli, Italy
- ⁱ Also at Institute of Particle Physics (IPP), Victoria BC, Canada
- ^j Also at Department of Physics, St. Petersburg State Polytechnical University, St. Petersburg, Russia

- ^k Also at Chinese University of Hong Kong, Hong Kong, China
- ^l Also at Department of Financial and Management Engineering, University of the Aegean, Chios, Greece
- ^m Also at Louisiana Tech University, Ruston LA, USA
- ⁿ Also at Institucio Catalana de Recerca i Estudis Avancats, ICREA, Barcelona, Spain
- ^o Also at Department of Physics, The University of Texas at Austin, Austin TX, USA
- ^p Also at Institute of Theoretical Physics, Ilia State University, Tbilisi, Georgia
- ^q Also at CERN, Geneva, Switzerland
- ^r Also at O Chadai Academic Production, Ochanomizu University, Tokyo, Japan
- ^s Also at Manhattan College, New York NY, USA
- ^t Also at Novosibirsk State University, Novosibirsk, Russia
- ^u Also at Institute of Physics, Academia Sinica, Taipei, Taiwan
- ^v Also at LAL, Université Paris-Sud and CNRS/IN2P3, Orsay, France
- ^w Also at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan
- ^x Also at Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France
- ^y Also at School of Physical Sciences, National Institute of Science Education and Research, Bhubaneswar, India
- ^z Also at Dipartimento di Fisica, Sapienza Università di Roma, Roma, Italy
- ^{aa} Also at Moscow Institute of Physics and Technology State University, Dolgoprudny, Russia
- ^{ab} Also at Section de Physique, Université de Genève, Geneva, Switzerland
- ^{ac} Also at International School for Advanced Studies (SISSA), Trieste, Italy
- ^{ad} Also at Department of Physics and Astronomy, University of South Carolina, Columbia SC, USA
- ^{ae} Also at School of Physics and Engineering, Sun Yat-sen University, Guangzhou, China
- ^{af} Also at Faculty of Physics, M.V.Lomonosov Moscow State University, Moscow, Russia
- ^{ag} Also at Moscow Engineering and Physics Institute (MEPhI), Moscow, Russia
- ^{ah} Also at Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Budapest, Hungary
- ^{ai} Also at Department of Physics, Oxford University, Oxford, UK
- ^{aj} Also at Department of Physics, Nanjing University, Jiangsu, China
- ^{ak} Also at Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany
- ^{al} Also at Department of Physics, The University of Michigan, Ann Arbor MI, USA
- ^{am} Also at Discipline of Physics, University of KwaZulu-Natal, Durban, South Africa
- ^{an} Also at University of Malaya, Department of Physics, Kuala Lumpur, Malaysia
- * Deceased