

University of Groningen

Erratum to: Differential branching fraction and angular analysis of $\Lambda b 0 \rightarrow \Lambda\mu+\mu^-$ decays

Onderwater, C. J. G.; LHCb Collaboration

Published in:
Journal of High Energy Physics

DOI:
[10.1007/JHEP09\(2018\)145](https://doi.org/10.1007/JHEP09(2018)145)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2018

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):
Onderwater, C. J. G., & LHCb Collaboration (2018). Erratum to: Differential branching fraction and angular analysis of $\Lambda b 0 \rightarrow \Lambda\mu+\mu^-$ decays. *Journal of High Energy Physics*, 2018(9), Article 145.
[https://doi.org/10.1007/JHEP09\(2018\)145](https://doi.org/10.1007/JHEP09(2018)145)

Copyright

Other than for strictly personal use, 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), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Erratum: Differential branching fraction and angular analysis of $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$ decays



The LHCb collaboration

E-mail: luca.pescatore@cern.ch

ERRATUM TO: [JHEP06\(2015\)115](#)

ARXIV EPRINT: [1503.07138](#)

The angular distribution of the dimuon system of the decays $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$ and $\bar{\Lambda}_b^0 \rightarrow \bar{\Lambda} \mu^+ \mu^-$ can be described by

$$\frac{d\Gamma}{d \cos \theta_\ell} = \frac{3}{8}(1 + \cos^2 \theta_\ell)(1 - f_L) + A_{\text{FB}}^\ell \cos \theta_\ell + \frac{3}{4}f_L \sin^2 \theta_\ell, \quad (1)$$

where A_{FB}^ℓ is the forward-backward asymmetry of the dimuon system and f_L is its longitudinal polarisation fraction. For the Λ_b^0 decay, the angle θ_ℓ is calculated as the angle between the direction of the μ^+ lepton, in the rest frame of the dimuon pair, and the direction of the dimuon pair, in the rest frame of the Λ_b^0 decay. The forward-backward asymmetry of the lepton pair, A_{FB}^ℓ , is “odd” under CP conjugation and changes in sign between the Λ_b^0 and $\bar{\Lambda}_b^0$ decays. To compensate for this sign, the angle θ_ℓ is usually calculated from the μ^- lepton rather than the μ^+ lepton such that A_{FB}^ℓ can be calculated from the combined sample. This was the intended approach of this paper. Unfortunately, A_{FB}^ℓ was determined using the μ^+ lepton when determining θ_ℓ for both the Λ_b^0 and the $\bar{\Lambda}_b^0$ decays. Consequently, the value of A_{FB}^ℓ in this paper corresponds to a difference $A(A_{\text{FB}}^\ell)$ in asymmetries between the Λ_b^0 and $\bar{\Lambda}_b^0$ decays rather than a proper average and is expected to be zero if CP is conserved. The result quoted as A_{FB}^ℓ in this paper should therefore be interpreted as

$$A(A_{\text{FB}}^\ell) = -0.05 \pm 0.09 \text{ (stat)} \pm 0.03 \text{ (syst)}, \quad (2)$$

and is indeed consistent with the Standard Model expectation that CP violating effects should be small in the decay $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$. This is in itself a useful result. A measurement of A_{FB}^ℓ has since been presented in ref. [1]. The results in ref. [1] supersede the corresponding results in this paper. Note, the mistake in the angular definition only affects the value of A_{FB}^ℓ presented in the paper. The values of f_L , A_{FB}^h and the differential branching fraction are unchanged, due to the symmetry of the efficiency model in $\cos \theta_\ell$.

Open Access. This article is distributed under the terms of the Creative Commons Attribution License ([CC-BY 4.0](https://creativecommons.org/licenses/by/4.0/)), which permits any use, distribution and reproduction in any medium, provided the original author(s) and source are credited.

References

- [1] LHCb collaboration, *Angular moments of the decay $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$ at low hadronic recoil*, *JHEP* **09** (2018) 146 [[arXiv:1808.00264](https://arxiv.org/abs/1808.00264)] [[INSPIRE](https://inspirehep.net/literature/1808002)].

The LHCb collaboration

R. Aaij⁴¹, B. Adeva³⁷, M. Adinolfi⁴⁶, A. Affolder⁵², Z. Ajaltouni⁵, S. Akar⁶, J. Albrecht⁹, F. Alessio³⁸, M. Alexander⁵¹, S. Ali⁴¹, G. Alkhazov³⁰, P. Alvarez Cartelle⁵³, A.A. Alves Jr⁵⁷, S. Amato², S. Amerio²², Y. Amhis⁷, L. An³, L. Anderlini^{17,g}, J. Anderson⁴⁰, M. Andreotti^{16,f}, J.E. Andrews⁵⁸, R.B. Appleby⁵⁴, O. Aquines Gutierrez¹⁰, F. Archilli³⁸, A. Artamonov³⁵, M. Artuso⁵⁹, E. Aslanides⁶, G. Auriemma^{25,n}, M. Baalouch⁵, S. Bachmann¹¹, J.J. Back⁴⁸, A. Badalov³⁶, C. Baesso⁶⁰, W. Baldini^{16,38}, R.J. Barlow⁵⁴, C. Barschel³⁸, S. Barsuk⁷, W. Barter³⁸, V. Batozskaya²⁸, V. Battista³⁹, A. Bay³⁹, L. Beaucourt⁴, J. Beddow⁵¹, F. Bedeschi²³, I. Bediaga¹, L.J. Bel⁴¹, I. Belyaev³¹, E. Ben-Haim⁸, G. Bencivenni¹⁸, S. Benson³⁸, J. Benton⁴⁶, A. Berezhnoy³², R. Bernet⁴⁰, A. Bertolin²², M.-O. Bettler³⁸, M. van Beuzekom⁴¹, A. Bien¹¹, S. Bifani⁴⁵, T. Bird⁵⁴, A. Bizzeti^{17,i}, T. Blake⁴⁸, F. Blanc³⁹, J. Blouw¹⁰, S. Blusk⁵⁹, V. Bocci²⁵, A. Bondar³⁴, N. Bondar^{30,38}, W. Bonivento¹⁵, S. Borghi⁵⁴, M. Borsato⁷, T.J.V. Bowcock⁵², E. Bowen⁴⁰, C. Bozzi¹⁶, S. Braun¹¹, D. Brett⁵⁴, M. Britsch¹⁰, T. Britton⁵⁹, J. Brodzicka⁵⁴, N.H. Brook⁴⁶, A. Bursche⁴⁰, J. Buytaert³⁸, S. Cadeddu¹⁵, R. Calabrese^{16,f}, M. Calvi^{20,k}, M. Calvo Gomez^{36,p}, P. Campana¹⁸, D. Campora Perez³⁸, L. Capriotti⁵⁴, A. Carbone^{14,d}, G. Carboni^{24,l}, R. Cardinale^{19,j}, A. Cardini¹⁵, P. Carniti²⁰, L. Carson⁵⁰, K. Carvalho Akiba^{2,38}, R. Casanova Mohr³⁶, G. Casse⁵², L. Cassina^{20,k}, L. Castillo Garcia³⁸, M. Cattaneo³⁸, Ch. Cauet⁹, G. Cavallero¹⁹, R. Cenci^{23,t}, M. Charles⁸, Ph. Charpentier³⁸, M. Chefdeville⁴, S. Chen⁵⁴, S.-F. Cheung⁵⁵, N. Chiapolini⁴⁰, M. Chrzaszcz^{40,26}, X. Cid Vidal³⁸, G. Ciezarek⁴¹, P.E.L. Clarke⁵⁰, M. Clemencic³⁸, H.V. Cliff⁴⁷, J. Closier³⁸, V. Coco³⁸, J. Cogan⁶, E. Cogneras⁵, V. Cogoni^{15,e}, L. Cojocariu²⁹, G. Collazuol²², P. Collins³⁸, A. Comerma-Montells¹¹, A. Contu^{15,38}, A. Cook⁴⁶, M. Coombes⁴⁶, S. Coquereau⁸, G. Corti³⁸, M. Corvo^{16,f}, I. Counts⁵⁶, B. Couturier³⁸, G.A. Cowan⁵⁰, D.C. Craik⁴⁸, A.C. Crocombe⁴⁸, M. Cruz Torres⁶⁰, S. Cunliffe⁵³, R. Currie⁵³, C. D'Ambrosio³⁸, J. Dalseno⁴⁶, P.N.Y. David⁴¹, A. Davis⁵⁷, K. De Bruyn⁴¹, S. De Capua⁵⁴, M. De Cian¹¹, J.M. De Miranda¹, L. De Paula², W. De Silva⁵⁷, P. De Simone¹⁸, C.-T. Dean⁵¹, D. Decamp⁴, M. Deckenhoff⁹, L. Del Buono⁸, N. Déléage⁴, D. Derkach⁵⁵, O. Deschamps⁵, F. Dettori³⁸, B. Dey⁴⁰, A. Di Canto³⁸, F. Di Ruscio²⁴, H. Dijkstra³⁸, S. Donleavy⁵², F. Dordei¹¹, M. Dorigo³⁹, A. Dosil Suárez³⁷, D. Dossett⁴⁸, A. Dovbnya⁴³, K. Dreimanic⁵², G. Dujany⁵⁴, F. Dupertuis³⁹, P. Durante³⁸, R. Dzhelyadin³⁵, A. Dziurda²⁶, A. Dzyuba³⁰, S. Easo^{49,38}, U. Egede⁵³, V. Egorychev³¹, S. Eidelman³⁴, S. Eisenhardt⁵⁰, U. Eitschberger⁹, R. Ekelhof⁹, L. Eklund⁵¹, I. El Rifai⁵, Ch. Elsasser⁴⁰, S. Ely⁵⁹, S. Esen¹¹, H.M. Evans⁴⁷, T. Evans⁵⁵, A. Falabella¹⁴, C. Färber¹¹, C. Farinelli⁴¹, N. Farley⁴⁵, S. Farry⁵², R. Fay⁵², D. Ferguson⁵⁰, V. Fernandez Albor³⁷, F. Ferrari¹⁴, F. Ferreira Rodrigues¹, M. Ferro-Luzzi³⁸, S. Filippov³³, M. Fiore^{16,38,f}, M. Fiorini^{16,f}, M. Firlej²⁷, C. Fitzpatrick³⁹, T. Fiutowski²⁷, P. Fol⁵³, M. Fontana¹⁰, F. Fontanelli^{19,j}, R. Forty³⁸, O. Francisco², M. Frank³⁸, C. Frei³⁸, M. Frosini¹⁷, J. Fu^{21,38}, E. Furfaro^{24,l}, A. Gallas Torreira³⁷, D. Galli^{14,d}, S. Gallorini^{22,38}, S. Gambetta^{19,j}, M. Gandelman², P. Gandini⁵⁵, Y. Gao³, J. García Pardiñas³⁷, J. Garofoli⁵⁹, J. Garra Tico⁴⁷, L. Garrido³⁶, D. Gascon³⁶, C. Gaspar³⁸, U. Gastaldi¹⁶, R. Gauld⁵⁵, L. Gavardi⁹, G. Gazzoni⁵, A. Geraci^{21,v}, D. Gerick¹¹, E. Gersabeck¹¹, M. Gersabeck⁵⁴, T. Gershon⁴⁸, Ph. Ghez⁴, A. Gianelle²², S. Giani³⁹, V. Gibson⁴⁷, L. Giubega²⁹, V.V. Gligorov³⁸, C. Göbel⁶⁰, D. Golubkov³¹, A. Golutvin^{53,31,38}, A. Gomes^{1,a}, C. Gotti^{20,k}, M. Grabalosa Gándara⁵, R. Graciani Diaz³⁶, L.A. Granado Cardoso³⁸, E. Graugés³⁶, E. Graverini⁴⁰, G. Graziani¹⁷, A. Grecu²⁹, E. Greening⁵⁵, S. Gregson⁴⁷, P. Griffith⁴⁵, L. Grillo¹¹, O. Grünberg⁶³, B. Gui⁵⁹, E. Gushchin³³, Yu. Guz^{35,38}, T. Gys³⁸, C. Hadjivasiliou⁵⁹, G. Haefeli³⁹, C. Haen³⁸, S.C. Haines⁴⁷, S. Hall⁵³, B. Hamilton⁵⁸, T. Hampson⁴⁶, X. Han¹¹, S. Hansmann-Menzemer¹¹, N. Harnew⁵⁵, S.T. Harnew⁴⁶, J. Harrison⁵⁴, J. He³⁸, T. Head³⁹, V. Heijne⁴¹, K. Hennessy⁵², P. Henrard⁵, L. Henry⁸, J.A. Hernando Morata³⁷, E. van Herwijnen³⁸,

M. Heß⁶³, A. Hicheur², D. Hill⁵⁵, M. Hoballah⁵, C. Hombach⁵⁴, W. Hulsbergen⁴¹, T. Humair⁵³, N. Hussain⁵⁵, D. Hutchcroft⁵², D. Hynds⁵¹, M. Idzik²⁷, P. Ilten⁵⁶, R. Jacobsson³⁸, A. Jaeger¹¹, J. Jalocha⁵⁵, E. Jans⁴¹, A. Jawahery⁵⁸, F. Jing³, M. John⁵⁵, D. Johnson³⁸, C.R. Jones⁴⁷, C. Joram³⁸, B. Jost³⁸, N. Jurik⁵⁹, S. Kandybei⁴³, W. Kanso⁶, M. Karacson³⁸, T.M. Karbach³⁸, S. Karodia⁵¹, M. Kelsey⁵⁹, I.R. Kenyon⁴⁵, M. Kenzie³⁸, T. Ketel⁴², B. Khanji^{20,38,k}, C. Khurewathanakul³⁹, S. Klaver⁵⁴, K. Klimaszewski²⁸, O. Kochebina⁷, M. Kolpin¹¹, I. Komarov³⁹, R.F. Koopman⁴², P. Koppenburg^{41,38}, M. Korolev³², L. Kravchuk³³, K. Kreplin¹¹, M. Kreps⁴⁸, G. Krocker¹¹, P. Krokovny³⁴, F. Kruse⁹, W. Kucewicz^{26,o}, M. Kucharczyk²⁶, V. Kudryavtsev³⁴, K. Kurek²⁸, T. Kvaratskheliya³¹, V.N. La Thi³⁹, D. Lacarrere³⁸, G. Lafferty⁵⁴, A. Lai¹⁵, D. Lambert⁵⁰, R.W. Lambert⁴², G. Lanfranchi¹⁸, C. Langenbruch⁴⁸, B. Langhans³⁸, T. Latham⁴⁸, C. Lazzeroni⁴⁵, R. Le Gac⁶, J. van Leerdam⁴¹, J.-P. Lees⁴, R. Lefèvre⁵, A. Leflat³², J. Lefrançois⁷, O. Leroy⁶, T. Lesiak²⁶, B. Leverington¹¹, Y. Li⁷, T. Likhomanenko⁶⁴, M. Liles⁵², R. Lindner³⁸, C. Linn³⁸, F. Lionetto⁴⁰, B. Liu¹⁵, S. Lohn³⁸, I. Longstaff⁵¹, J.H. Lopes², P. Lowdon⁴⁰, D. Lucchesi^{22,r}, H. Luo⁵⁰, A. Lupato²², E. Luppi^{16,f}, O. Lupton⁵⁵, F. Machefert⁷, F. Maciuc²⁹, O. Maev³⁰, S. Malde⁵⁵, A. Malinin⁶⁴, G. Manca^{15,e}, G. Mancinelli⁶, P. Manning⁵⁹, A. Mapelli³⁸, J. Maratas⁵, J.F. Marchand⁴, U. Marconi¹⁴, C. Marin Benito³⁶, P. Marino^{23,38,t}, R. Märki³⁹, J. Marks¹¹, G. Martellotti²⁵, M. Martinelli³⁹, D. Martinez Santos⁴², F. Martinez Vidal⁶⁶, D. Martins Tostes², A. Massafferri¹, R. Matev³⁸, A. Mathad⁴⁸, Z. Mathe³⁸, C. Matteuzzi²⁰, A. Mauri⁴⁰, B. Maurin³⁹, A. Mazurov⁴⁵, M. McCann⁵³, J. McCarthy⁴⁵, A. McNab⁵⁴, R. McNulty¹², B. Meadows⁵⁷, F. Meier⁹, M. Meissner¹¹, M. Merk⁴¹, D.A. Milanes⁶², M.-N. Minard⁴, D.S. Mitzel¹¹, J. Molina Rodriguez⁶⁰, S. Monteil⁵, M. Morandin²², P. Morawski²⁷, A. Mordà⁶, M.J. Morello^{23,t}, J. Moron²⁷, A.-B. Morris⁵⁰, R. Mountain⁵⁹, F. Muheim⁵⁰, K. Müller⁴⁰, M. Mussini¹⁴, B. Muster³⁹, P. Naik⁴⁶, T. Nakada³⁹, R. Nandakumar⁴⁹, I. Nasteva², M. Needham⁵⁰, N. Neri²¹, S. Neubert¹¹, N. Neufeld³⁸, M. Neuner¹¹, A.D. Nguyen³⁹, T.D. Nguyen³⁹, C. Nguyen-Mau^{39,q}, V. Niess⁵, R. Niet⁹, N. Nikitin³², T. Nikodem¹¹, A. Novoselov³⁵, D.P. O'Hanlon⁴⁸, A. Oblakowska-Mucha²⁷, V. Obraztsov³⁵, S. Ogilvy⁵¹, O. Okhrimenko⁴⁴, R. Oldeman^{15,e}, C.J.G. Onderwater⁶⁷, B. Osorio Rodrigues¹, J.M. Otalora Goicochea², A. Otto³⁸, P. Owen⁵³, A. Oyanguren⁶⁶, A. Palano^{13,c}, F. Palombo^{21,u}, M. Palutan¹⁸, J. Panman³⁸, A. Papanestis⁴⁹, M. Pappagallo⁵¹, L.L. Pappalardo^{16,f}, C. Parkes⁵⁴, G. Passaleva¹⁷, G.D. Patel⁵², M. Patel⁵³, C. Patrignani^{19,j}, A. Pearce^{54,49}, A. Pellegrino⁴¹, G. Penso^{25,m}, M. Pepe Altarelli³⁸, S. Perazzini^{14,d}, P. Perret⁵, L. Pescatore⁴⁵, K. Petridis⁴⁶, A. Petrolini^{19,j}, E. Picatoste Olloqui³⁶, B. Pietrzyk⁴, T. Pilar⁴⁸, D. Pinci²⁵, A. Pistone¹⁹, S. Playfer⁵⁰, M. Plo Casasus³⁷, T. Poikela³⁸, F. Polci⁸, A. Poluektov^{48,34}, I. Polyakov³¹, E. Polycarpou², A. Popov³⁵, D. Popov¹⁰, B. Popovici²⁹, C. Potterat², E. Price⁴⁶, J.D. Price⁵², J. Prisciandaro³⁹, A. Pritchard⁵², C. Prouve⁴⁶, V. Pugatch⁴⁴, A. Puig Navarro³⁹, G. Punzi^{23,s}, W. Qian⁴, R. Quagliani^{7,46}, B. Rachwal²⁶, J.H. Rademacker⁴⁶, B. Rakotomiamanana³⁹, M. Rama²³, M.S. Rangel², I. Raniuk⁴³, N. Rauschmayr³⁸, G. Raven⁴², F. Redi⁵³, S. Reichert⁵⁴, M.M. Reid⁴⁸, A.C. dos Reis¹, S. Ricciardi⁴⁹, S. Richards⁴⁶, M. Rihl³⁸, K. Rinnert⁵², V. Rives Molina³⁶, P. Robbe^{7,38}, A.B. Rodrigues¹, E. Rodrigues⁵⁴, J.A. Rodriguez Lopez⁶², P. Rodriguez Perez⁵⁴, S. Roiser³⁸, V. Romanovsky³⁵, A. Romero Vidal³⁷, M. Rotondo²², J. Rouvinet³⁹, T. Ruf³⁸, H. Ruiz³⁶, P. Ruiz Valls⁶⁶, J.J. Saborido Silva³⁷, N. Sagidova³⁰, P. Sail⁵¹, B. Saitta^{15,e}, V. Salustino Guimaraes², C. Sanchez Mayordomo⁶⁶, B. Sanmartin Sedes³⁷, R. Santacesaria²⁵, C. Santamarina Rios³⁷, E. Santovetti^{24,l}, A. Sarti^{18,m}, C. Satriano^{25,n}, A. Satta²⁴, D.M. Saunders⁴⁶, D. Savrina^{31,32}, M. Schiller³⁸, H. Schindler³⁸, M. Schlupp⁹, M. Schmelling¹⁰, B. Schmidt³⁸, O. Schneider³⁹, A. Schopper³⁸, M.-H. Schune⁷, R. Schwemmer³⁸, B. Sciascia¹⁸, A. Sciubba^{25,m}, A. Semennikov³¹, I. Sepp⁵³, N. Serra⁴⁰, J. Serrano⁶, L. Sestini²², P. Seyfert¹¹, M. Shapkin³⁵, I. Shapoval^{16,43,f}, Y. Shcheglov³⁰, T. Shears⁵², L. Shekhtman³⁴, V. Shevchenko⁶⁴, A. Shires⁹, R. Silva Coutinho⁴⁸, G. Simi²², M. Sirendi⁴⁷, N. Skidmore⁴⁶,

I. Skillicorn⁵¹, T. Skwarnicki⁵⁹, N.A. Smith⁵², E. Smith^{55,49}, E. Smith⁵³, J. Smith⁴⁷, M. Smith⁵⁴, H. Snoek⁴¹, M.D. Sokoloff^{57,38}, F.J.P. Soler⁵¹, F. Soomro³⁹, D. Souza⁴⁶, B. Souza De Paula², B. Spaan⁹, P. Spradlin⁵¹, S. Sridharan³⁸, F. Stagni³⁸, M. Stahl¹¹, S. Stahl³⁸, O. Steinkamp⁴⁰, O. Stenyakin³⁵, F. Sterpka⁵⁹, S. Stevenson⁵⁵, S. Stoica²⁹, S. Stone⁵⁹, B. Storaci⁴⁰, S. Stracka^{23,t}, M. Straticiu²⁹, U. Straumann⁴⁰, R. Stroili²², L. Sun⁵⁷, W. Sutcliffe⁵³, K. Swientek²⁷, S. Swientek⁹, V. Syropoulos⁴², M. Szczekowski²⁸, P. Szczypka^{39,38}, T. Szumlak²⁷, S. T’Jampens⁴, M. Teklishyn⁷, G. Tellarini^{16,f}, F. Teubert³⁸, C. Thomas⁵⁵, E. Thomas³⁸, J. van Tilburg⁴¹, V. Tisserand⁴, M. Tobin³⁹, J. Todd⁵⁷, S. Tolk⁴², L. Tomassetti^{16,f}, D. Tonelli³⁸, S. Topp-Joergensen⁵⁵, N. Torr⁵⁵, E. Tournefier⁴, S. Tourneur³⁹, K. Trabelsi³⁹, M.T. Tran³⁹, M. Tresch⁴⁰, A. Trisovic³⁸, A. Tsaregorodtsev⁶, P. Tsopelas⁴¹, N. Tuning^{41,38}, A. Ukleja²⁸, A. Ustyuzhanin⁶⁵, U. Uwer¹¹, C. Vacca^{15,e}, V. Vagnoni¹⁴, G. Valenti¹⁴, A. Vallier⁷, R. Vazquez Gomez¹⁸, P. Vazquez Regueiro³⁷, C. Vázquez Sierra³⁷, S. Vecchi¹⁶, J.J. Velthuis⁴⁶, M. Veltri^{17,h}, G. Veneziano³⁹, M. Vesterinen¹¹, J.V. Viana Barbosa³⁸, B. Viaud⁷, D. Vieira², M. Vieites Diaz³⁷, X. Vilasis-Cardona^{36,p}, A. Vollhardt⁴⁰, D. Volyansky¹⁰, D. Voong⁴⁶, A. Vorobyev³⁰, V. Vorobyev³⁴, C. Voß⁶³, J.A. de Vries⁴¹, R. Waldi⁶³, C. Wallace⁴⁸, R. Wallace¹², J. Walsh²³, S. Wandernoth¹¹, J. Wang⁵⁹, D.R. Ward⁴⁷, N.K. Watson⁴⁵, D. Websdale⁵³, A. Weiden⁴⁰, M. Whitehead⁴⁸, D. Wiedner¹¹, G. Wilkinson^{55,38}, M. Wilkinson⁵⁹, M. Williams³⁸, M.P. Williams⁴⁵, M. Williams⁵⁶, F.F. Wilson⁴⁹, J. Wimberley⁵⁸, J. Wishahi⁹, W. Wislicki²⁸, M. Witek²⁶, G. Wormser⁷, S.A. Wotton⁴⁷, S. Wright⁴⁷, K. Wyllie³⁸, Y. Xie⁶¹, Z. Xu³⁹, Z. Yang³, X. Yuan³⁴, O. Yushchenko³⁵, M. Zangoli¹⁴, M. Zavertyaev^{10,b}, L. Zhang³, Y. Zhang³, A. Zhelezov¹¹, A. Zhokhov³¹ and L. Zhong³

¹ *Centro Brasileiro de Pesquisas Físicas (CBPF), Rio de Janeiro, Brazil*

² *Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil*

³ *Center for High Energy Physics, Tsinghua University, Beijing, China*

⁴ *LAPP, Université Savoie Mont-Blanc, CNRS/IN2P3, Annecy-Le-Vieux, France*

⁵ *Clermont Université, Université Blaise Pascal, CNRS/IN2P3, LPC, Clermont-Ferrand, France*

⁶ *CPPM, Aix-Marseille Université, CNRS/IN2P3, Marseille, France*

⁷ *LAL, Université Paris-Sud, CNRS/IN2P3, Orsay, France*

⁸ *LPNHE, Université Pierre et Marie Curie, Université Paris Diderot, CNRS/IN2P3, Paris, France*

⁹ *Fakultät Physik, Technische Universität Dortmund, Dortmund, Germany*

¹⁰ *Max-Planck-Institut für Kernphysik (MPIK), Heidelberg, Germany*

¹¹ *Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany*

¹² *School of Physics, University College Dublin, Dublin, Ireland*

¹³ *Sezione INFN di Bari, Bari, Italy*

¹⁴ *Sezione INFN di Bologna, Bologna, Italy*

¹⁵ *Sezione INFN di Cagliari, Cagliari, Italy*

¹⁶ *Sezione INFN di Ferrara, Ferrara, Italy*

¹⁷ *Sezione INFN di Firenze, Firenze, Italy*

¹⁸ *Laboratori Nazionali dell’INFN di Frascati, Frascati, Italy*

¹⁹ *Sezione INFN di Genova, Genova, Italy*

²⁰ *Sezione INFN di Milano Bicocca, Milano, Italy*

²¹ *Sezione INFN di Milano, Milano, Italy*

²² *Sezione INFN di Padova, Padova, Italy*

²³ *Sezione INFN di Pisa, Pisa, Italy*

²⁴ *Sezione INFN di Roma Tor Vergata, Roma, Italy*

²⁵ *Sezione INFN di Roma La Sapienza, Roma, Italy*

²⁶ *Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Sciences, Kraków, Poland*

²⁷ *AGH — University of Science and Technology, Faculty of Physics and Applied Computer Science, Kraków, Poland*

²⁸ *National Center for Nuclear Research (NCBJ), Warsaw, Poland*

- ²⁹ *Horia Hulubei National Institute of Physics and Nuclear Engineering, Bucharest-Magurele, Romania*
- ³⁰ *Petersburg Nuclear Physics Institute (PNPI), Gatchina, Russia*
- ³¹ *Institute of Theoretical and Experimental Physics (ITEP), Moscow, Russia*
- ³² *Institute of Nuclear Physics, Moscow State University (SINP MSU), Moscow, Russia*
- ³³ *Institute for Nuclear Research of the Russian Academy of Sciences (INR RAN), Moscow, Russia*
- ³⁴ *Budker Institute of Nuclear Physics (SB RAS) and Novosibirsk State University, Novosibirsk, Russia*
- ³⁵ *Institute for High Energy Physics (IHEP), Protvino, Russia*
- ³⁶ *Universitat de Barcelona, Barcelona, Spain*
- ³⁷ *Universidad de Santiago de Compostela, Santiago de Compostela, Spain*
- ³⁸ *European Organization for Nuclear Research (CERN), Geneva, Switzerland*
- ³⁹ *Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland*
- ⁴⁰ *Physik-Institut, Universität Zürich, Zürich, Switzerland*
- ⁴¹ *Nikhef National Institute for Subatomic Physics, Amsterdam, The Netherlands*
- ⁴² *Nikhef National Institute for Subatomic Physics and VU University Amsterdam, Amsterdam, The Netherlands*
- ⁴³ *NSC Kharkiv Institute of Physics and Technology (NSC KIPT), Kharkiv, Ukraine*
- ⁴⁴ *Institute for Nuclear Research of the National Academy of Sciences (KINR), Kyiv, Ukraine*
- ⁴⁵ *University of Birmingham, Birmingham, United Kingdom*
- ⁴⁶ *H.H. Wills Physics Laboratory, University of Bristol, Bristol, United Kingdom*
- ⁴⁷ *Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom*
- ⁴⁸ *Department of Physics, University of Warwick, Coventry, United Kingdom*
- ⁴⁹ *STFC Rutherford Appleton Laboratory, Didcot, United Kingdom*
- ⁵⁰ *School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom*
- ⁵¹ *School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom*
- ⁵² *Oliver Lodge Laboratory, University of Liverpool, Liverpool, United Kingdom*
- ⁵³ *Imperial College London, London, United Kingdom*
- ⁵⁴ *School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom*
- ⁵⁵ *Department of Physics, University of Oxford, Oxford, United Kingdom*
- ⁵⁶ *Massachusetts Institute of Technology, Cambridge, MA, United States*
- ⁵⁷ *University of Cincinnati, Cincinnati, OH, United States*
- ⁵⁸ *University of Maryland, College Park, MD, United States*
- ⁵⁹ *Syracuse University, Syracuse, NY, United States*
- ⁶⁰ *Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), Rio de Janeiro, Brazil, associated to ²*
- ⁶¹ *Institute of Particle Physics, Central China Normal University, Wuhan, Hubei, China, associated to ³*
- ⁶² *Departamento de Física, Universidad Nacional de Colombia, Bogota, Colombia, associated to ⁸*
- ⁶³ *Institut für Physik, Universität Rostock, Rostock, Germany, associated to ¹¹*
- ⁶⁴ *National Research Centre Kurchatov Institute, Moscow, Russia, associated to ³¹*
- ⁶⁵ *Yandex School of Data Analysis, Moscow, Russia, associated to ³¹*
- ⁶⁶ *Instituto de Física Corpuscular (IFIC), Universitat de Valencia-CSIC, Valencia, Spain, associated to ³⁶*
- ⁶⁷ *Van Swinderen Institute, University of Groningen, Groningen, The Netherlands, associated to ⁴¹*
- ^a *Universidade Federal do Triângulo Mineiro (UFTM), Uberaba-MG, Brazil*
- ^b *P.N. Lebedev Physical Institute, Russian Academy of Science (LPI RAS), Moscow, Russia*
- ^c *Università di Bari, Bari, Italy*
- ^d *Università di Bologna, Bologna, Italy*
- ^e *Università di Cagliari, Cagliari, Italy*
- ^f *Università di Ferrara, Ferrara, Italy*

- ^g *Università di Firenze, Firenze, Italy*
- ^h *Università di Urbino, Urbino, Italy*
- ⁱ *Università di Modena e Reggio Emilia, Modena, Italy*
- ^j *Università di Genova, Genova, Italy*
- ^k *Università di Milano Bicocca, Milano, Italy*
- ^l *Università di Roma Tor Vergata, Roma, Italy*
- ^m *Università di Roma La Sapienza, Roma, Italy*
- ⁿ *Università della Basilicata, Potenza, Italy*
- ^o *AGH — University of Science and Technology, Faculty of Computer Science, Electronics and Telecommunications, Kraków, Poland*
- ^p *LIFAELS, La Salle, Universitat Ramon Llull, Barcelona, Spain*
- ^q *Hanoi University of Science, Hanoi, Viet Nam*
- ^r *Università di Padova, Padova, Italy*
- ^s *Università di Pisa, Pisa, Italy*
- ^t *Scuola Normale Superiore, Pisa, Italy*
- ^u *Università degli Studi di Milano, Milano, Italy*
- ^v *Politecnico di Milano, Milano, Italy*