**THE EUROPEAN
PHYSICAL JOURNAL C**

Letter

Search for pair-produced massive coloured scalars in four-jet final states with the ATLAS detector in proton–proton collisions at $\sqrt{s} = 7$ TeV

The ATLAS Collaboration[*]

CERN, 1211 Geneva 23, Switzerland

Abstract A search for pair-produced massive coloured scalar particles decaying to a four-jet final state is performed by the ATLAS experiment at the LHC in proton–proton collisions at $\sqrt{s} = 7$ TeV. The analysed data sample corresponds to an integrated luminosity of 4.6 fb^{-1}. No deviation from the Standard Model is observed in the invariant mass spectrum of the two-jet pairs. A limit on the scalar gluon pair production cross section of 70 pb (10 pb) is obtained at the 95 % confidence level for a scalar gluon mass of 150 GeV (350 GeV). Interpreting these results as mass limits on scalar gluons, masses ranging from 150 GeV to 287 GeV are excluded at the 95 % confidence level.

Massive coloured scalar particles that decay into gluons are predicted in several extensions of the Standard Model (SM). The most prominent examples are the scalar partners of a Dirac gluino called scalar gluons ('sgluons') in extended supersymmetric models like the $\mathcal{N} = 1/\mathcal{N} = 2$ hybrid model [1, 2] or the R-symmetric MSSM [3, 4]. These particles are also present in compositeness models [5–9] where they are called hyperpions. While single production of sgluons is possible, the production cross section depends strongly on the masses of the supersymmetric particles and, in typical supersymmetric scenarios, is of the same order as the pair production cross section. On the contrary the pair production cross section does not, at leading order, depend on supersymmetric parameters except for the sgluon mass. Since the sgluon has positive R-parity [10] and since the sgluon coupling to quark–antiquark pairs is suppressed by the quark mass, light sgluons, i.e. sgluons with masses of the order of 100 GeV, are expected to decay to two gluons with a branching ratio close to one [2, 4]. Pair production of sgluons each decaying to two gluons, leading to a four-jet

final state, is therefore used as a benchmark process. ATLAS has previously searched for signatures of these particles in the dataset of 34 pb^{-1} recorded in 2010 [11], excluding at the 95 % confidence level (CL) sgluons with masses of 100 GeV to 180 GeV, with the exception of a mass window of 5 GeV around 140 GeV. The search described in this paper, using data recorded in 2011, explores the mass region from 150 GeV up to about 300 GeV.

The strategy of the analysis is to first reconstruct the two sgluon candidates. The relative mass difference and the ΔR between the two jets associated to a reconstructed sgluon are used to select well reconstructed sgluons with a small mass difference, where $\Delta R = \sqrt{(\Delta\phi)^2 + (\Delta\eta)^2}$ with $\Delta\phi$ and $\Delta\eta$ being the difference in azimuth and pseudorapidity of the two jets. The distribution of the reconstructed average mass of the two sgluon candidates is then analysed for evidence of a signal with a fit to the background plus a signal template of variable strength. The background for this search is the SM multijet background, due to its large cross section.

ATLAS is a multipurpose detector [12, 13] with nearly 4π coverage in solid angle. The inner detector, consisting of silicon pixel and microstrip detectors as well as a transition radiation tracker, is immersed in a 2 T axial magnetic field. In the pseudorapidity[1] region $|\eta| < 3.2$, high-granularity lead/liquid-argon (LAr) electromagnetic (EM) sampling calorimeters are used. An iron/scintillator-tile calorimeter provides hadronic coverage for $|\eta| < 1.7$. The end-cap and forward regions, spanning $1.5 < |\eta| < 4.9$, are instrumented with LAr calorimeters for both EM and hadronic measurements. The calorimeters are surrounded

---

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

[1] ATLAS uses a right-handed coordinate system with its origin at the nominal interaction point (IP) in the centre of the detector and the z-axis along the beam pipe. The x-axis points from the IP to the centre of the LHC ring, and the y-axis points upward. Cylindrical coordinates (r, ϕ) are used in the transverse $(x-y)$ plane, ϕ being the azimuthal angle around the beam axis. The pseudorapidity is defined in terms of the polar angle θ as $\eta = -\ln\tan(\theta/2)$.

by a muon spectrometer which consists of three large super-conducting toroids, a system of precision tracking chambers, and fast detectors for triggering. ATLAS uses a three-level trigger system. The first-level trigger is implemented in custom hardware, the other two trigger levels are implemented in software running on commercially available PC farms.

A data-driven method is used for the background estimation. The method is developed and validated on SM multijet Monte Carlo (MC) samples. The samples are also used to determine a systematic error on the background determination. To incorporate detector effects, these events are passed through a detailed simulation of the ATLAS detector [14] based on GEANT4 [15]. ALPGEN [16] SM multijet samples are generated with the MLM matching scheme [17] and interfaced to HERWIG [18] for the parton shower and fragmentation processes and to JIMMY [19] for the simulation of the underlying event. The ALPGEN samples are generated with the CTEQ6L1 parton distribution functions (PDFs) [20] (underlying event tune AUET2-CTEQ6L1 [21]). PYTHIA [22] SM multijet samples are generated with the LO* MRST PDFs [23] (underlying event tune AUET2B LO** [21]). The sgluon pair production differential cross section [2] is implemented as an external process interfaced to PYTHIA. The decay of the sgluons as well as fragmentation and hadronisation are performed by PYTHIA. For the normalisation of the signal a next-to-leading-order (NLO) cross section is used [24].

Signal samples of 40k to 120k events each were generated with sgluon masses of 150, 200, 250, 300 and 350 GeV and passed through the fast simulation of the ATLAS detector. Additionally the fast simulation was verified by passing some samples through the detailed simulation which leads to results with good agreement.

Jets are reconstructed using the anti-k_t jet clustering algorithm [25] with a radius parameter of 0.4. The inputs to the jet algorithm are three-dimensional clusters [26] formed from energy deposits in the calorimeters. The jets are calibrated using transverse momentum (p_T) and η-dependent correction factors based on MC simulations and validated by test beam and collision data studies [27]. Quality criteria are applied to reject jets produced by non-collision backgrounds [28]. Such jets are typically produced by hardware problems in the calorimeters, LHC beam-gas interactions or cosmic-ray induced showers. The jet energy resolution for a jet with a p_T of 80 GeV is about 11 % [29].

The analysis uses collision data collected in the year 2011 at a centre-of-mass energy of $\sqrt{s} = 7$ TeV and corresponding to an integrated luminosity of 4.6 fb^{-1}. The data were recorded with a multijet trigger requiring at least four jets. Reflecting the threshold of the third level trigger of 45 GeV, the trigger efficiency does not depend strongly on the p_T of the four highest-p_T jets for $p_T > 80$ GeV. To ensure full trigger efficiency for the analysis, the four highest-p_T jets in
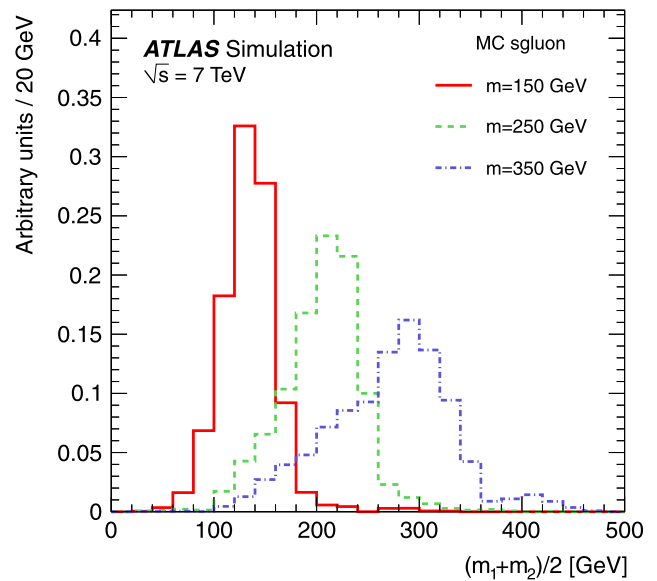

Fig. 1 The reconstructed average mass distribution after all analysis cuts for the signal samples with $m_{sgluon} = 150, 250$ and 350 GeV. The curves are normalised to unit area

a selected event are required to be separated from each other by $\Delta R > 0.6$. The resulting trigger efficiency of at least 99 % obtained with simulated events was verified in data with the use of a single-electron trigger. The average number of proton–proton interactions in the same event (pile-up) has increased to about 12 events over the course of the run. Simulated minimum-bias events are overlayed onto the simulated samples of the hard-scattering processes. The resulting events are reweighted to reproduce the luminosity profile of the data. The requirement on the p_T of the jets makes the analysis robust with respect to the increase of pile-up.

A selected event must contain at least one reconstructed primary vertex with five or more associated tracks each having $p_T > 400$ MeV. At least four jets with $p_T > 80$ GeV and $|\eta| < 1.4$ are required, since the signal is produced centrally, in contrast to the SM multijet background. These selection criteria together with the trigger requirements are referred to as preselection in the following. To improve the sensitivity of the analysis, the jet p_T threshold is defined as a function of the probed sgluon mass. The p_T of the fourth highest-p_T jet is required to be greater than the maximum between 80 GeV and 0.3 times the sgluon mass plus 30 GeV (p_T (4th jet) $> \max(0.3 \times m_{sgluon} + 30, 80)$ GeV). The stringent p_T requirements select sgluons produced with a boost and hence lead to an accumulation of jet pairs from sgluon decays with $\Delta R \approx 1$. Taking advantage of this property to reconstruct the two sgluon candidates, the four highest-p_T jets in a preselected event are paired by minimising the quantity $|\Delta R_{pair1} - 1| + |\Delta R_{pair2} - 1|$. The event is rejected if, for the chosen combination, a jet pair has $\Delta R > 1.6$. The reconstructed masses of the sgluons are denoted m_1 and m_2.

The reconstructed average mass is $(m_1 + m_2)/2$. The scattering angle is defined as the angle between the direction of motion of the reconstructed sgluons in the rest frame of the four highest-p_T jets and the boost direction between the lab frame and the rest frame of the four highest-p_T jets. The magnitude of the cosine of the scattering angle $|\cos(\theta^*)|$ is required to be less than 0.5. In fact the SM multijet background is peaked in the forward region, reflecting t-channel gluon exchange, while the signal is produced centrally due to the (mainly) s-channel production and scalar nature of the sgluon. Finally, to further improve the rejection of the SM multijet background, the relative difference between the two reconstructed masses $|m_1 - m_2|/(m_1 + m_2)$ is required to be less than 0.15. The requirement on the relative mass difference selects well reconstructed events increasing the bulk of the signal distribution with respect to the tails. Loosening the requirement, i.e., accepting events with larger mass differences, leads to an increase of signal events but also an increase of background events. The selection that increases the number of events in the control regions without decreasing the sensitivity is chosen. As the requirement on the 4th jet is mass dependent, a selection efficiency of 0.6 % is achieved for all simulated samples of the different sgluon masses.

The reconstructed average mass distribution after all cuts is shown for sgluon signals with varying masses in Fig. 1. The natural width of the sgluon in this mass range is negligible and the width of the observable is entirely dominated by the instrumental mass resolution. As the mass of the sgluon increases, the requirement on the transverse momentum of the jets becomes relatively less stringent. An increase of 100 GeV in the sgluon mass leads to an increase of only 30 GeV in the requirement on the jet transverse momenta. As a consequence the radiative tails to lower masses are more evident for higher masses in the figure, as they are less sculpted by the p_T cut.

After applying preselection and jet pairing, the primary variables used in the analysis are compared to the ALPGEN and PYTHIA multijet simulation. Backgrounds other than SM multijet events are estimated to be smaller than 1 % of the total background sample and are thus neglected. Since the analysis requires at least four jets, ALPGEN is expected to give a better description than PYTHIA, which generates the third and fourth jets via a parton shower.

The MC samples are normalised to the data after the preselection described above. The normalisation factor of 1.25 obtained for ALPGEN is compatible with the one (1.26) obtained in Ref. [11]. For PYTHIA the normalisation factor is 0.75, close to the value of 0.65 [30] obtained with the 2010 data using a different tune (AMBT1). After this normalisation, for the transverse momentum of the 4th jet (Fig. 2(a)), the separation of the two jets of the sgluon candidate with the highest transverse momentum (Fig. 2(b)), the relative mass difference (Fig. 2(c)) and the cosine of the scattering

Table 1 Definition of the four regions for the background determination. Region A is the signal region

Region	$|\cos(\theta^*)|$	$|m_1 - m_2|/(m_1 + m_2)$
A	<0.5	<0.15
B	>0.5	<0.15
C	<0.5	>0.15
D	>0.5	>0.15

angle (Fig. 2(d)), the agreement between the data and the MC simulations is, in general, at the 20 % level. To reduce the dependence on simulation, the background is estimated from data, taking advantage of the kinematic properties of the sgluon signal. Only the systematic error on the method is taken from the Monte Carlo studies.

The main discriminating variable for the analysis is the reconstructed average mass. To determine the background normalisation as well as the shape of the background in the signal region, an ABCD method is used. The data sample is divided into one signal region (A) and three background-dominated regions (B, C and D). The variables used to define the four regions are $|\cos(\theta^*)|$ and $|m_1 - m_2|/(m_1 + m_2)$. The regions defined in Table 1 are chosen as a compromise between the statistical significance of the signal in region A and the statistical uncertainty in the regions B, C and D which feeds into the uncertainty on the background prediction.

The correlation between the two variables is less than 0.1 % in the four regions in the data and less than 1 % in the PYTHIA samples, so the normalisation of the background in the region A is derived from the ratio of events in the control samples using $N'_A = N_B \cdot N_C/N_D$. A closure test is performed with the PYTHIA and ALPGEN MC samples and shows that N'_A reproduces the actual number of events in region A, N_A, within 2 %. The difference is assigned as a systematic uncertainty on the background prediction.

Table 2 summarises the results obtained in data, for the five sgluon mass hypotheses and corresponding signal regions, A, together with the corresponding background predictions. Good agreement is observed. The assumption of the ABCD method that the shapes of the reconstructed average mass distributions in regions A and B are the same was verified on the Monte Carlo samples. The last column gives the p-value obtained from a Kolmogorov–Smirnov test between the shapes of the reconstructed average mass distributions for data in regions A and B. Satisfactory p-values are found in this test on the data, which considers statistical uncertainties only.

The result of the background estimation is shown in Fig. 3 for sgluon masses of 150, 250, 300 and 350 GeV. The data in region A are compared to the data in the control region B normalised using the ABCD method. The expected sgluon signal in region A is also shown. The ratio of
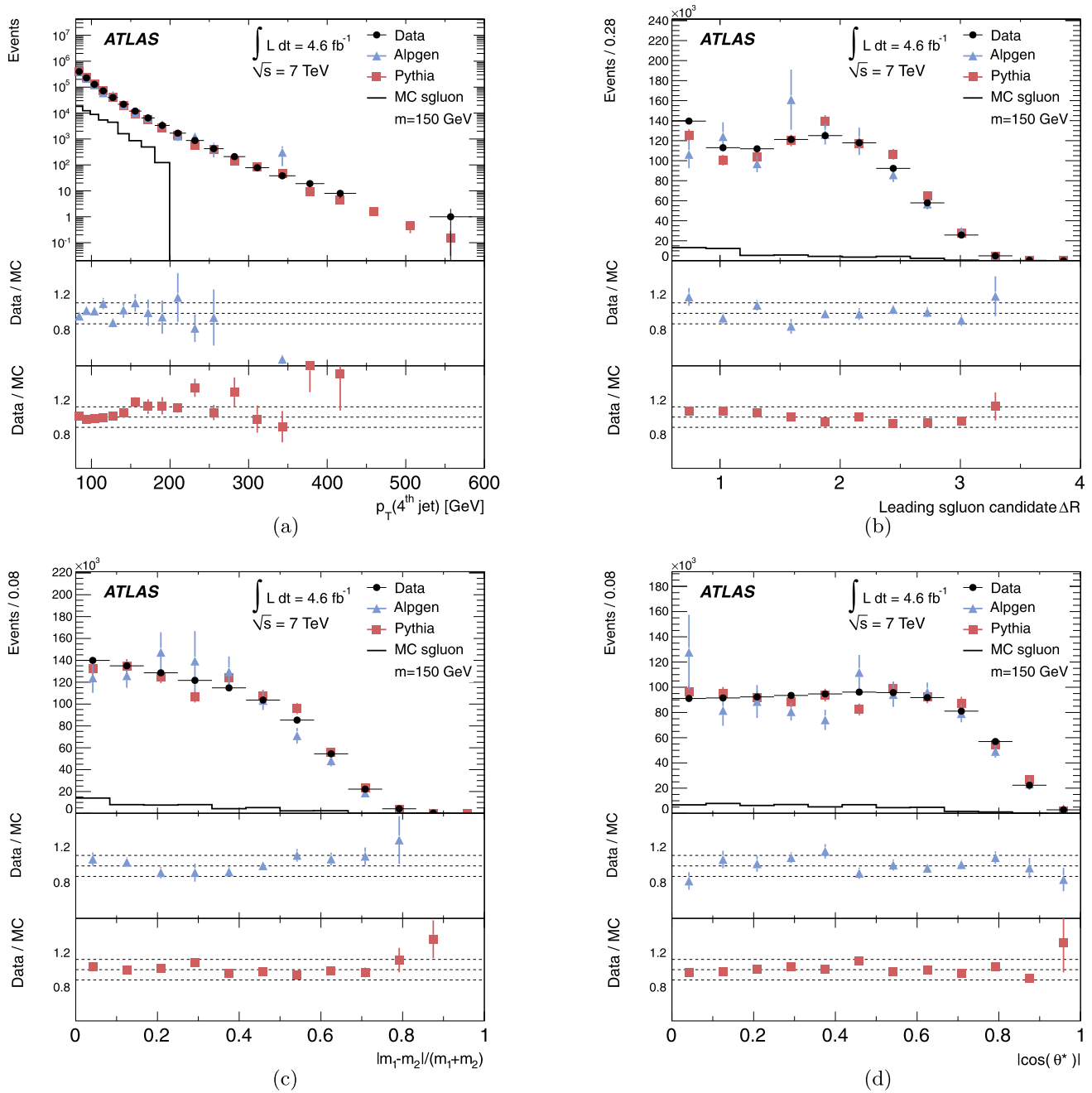
Fig. 2 The kinematic variables of the analysis are shown after applying the preselection and pairing the four highest-p_T jets: (**a**) is the transverse momentum of the fourth highest-p_T jet; (**b**) is the ΔR between the two jets of the reconstructed sgluon candidate with the highest transverse momentum jet; (**c**) is the relative mass difference; (**d**) is the cosine of the scattering angle in the four-jet centre-of-mass frame.

The black histogram is the signal for a sgluon mass of 150 GeV normalised to the NLO cross section. Data (*dots*) are compared to the ALPGEN (*triangles*) and PYTHIA (*rectangles*) SM multijet samples where the MC samples are normalised to the data. The ratio data/MC is also shown separately for ALPGEN and PYTHIA with its statistical uncertainty

background to data as well as the significance, in standard deviations, of the difference between the data and the prediction are shown as a function of the reconstructed average mass. The significance takes into account only statistical uncertainties.

The average mass distribution of the data in region A is compared to the background-only prediction and to the background-plus-signal prediction using a binned likelihood test, which incorporates the signal contamination in the control regions and systematic uncertainties via nuisance pa-
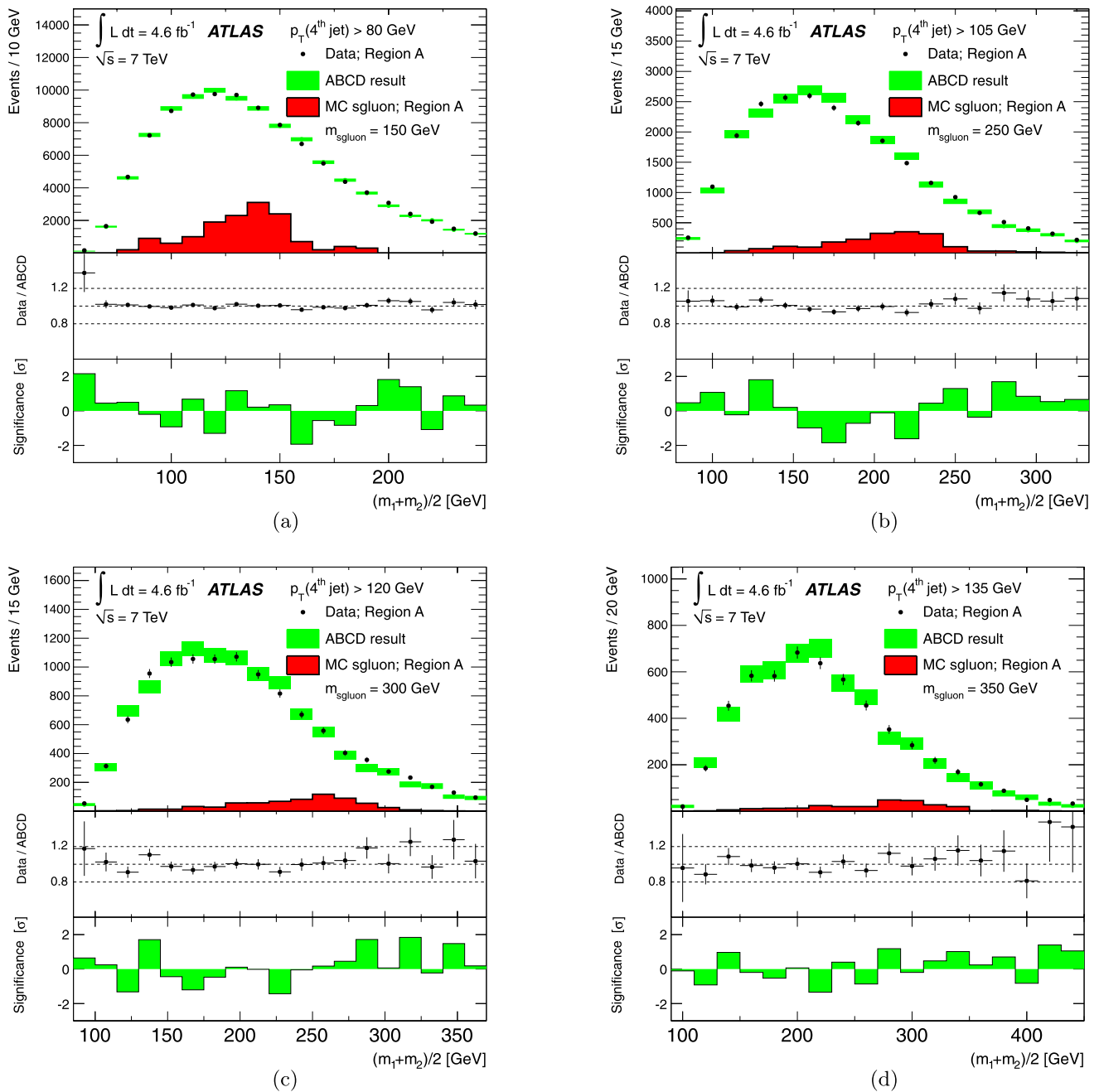
(a)

(b)

(c)

(d)

Fig. 3 The comparison of the data in the signal region with the background prediction is shown for: (**a**) $m_{sgluon} = 150$ GeV, (**b**) $m_{sgluon} = 250$ GeV, (**c**) $m_{sgluon} = 300$ GeV and (**d**) $m_{sgluon} = 350$ GeV. The *points* are the data in the signal region (region A). The plain histogram (*red*) is the expected signal in region A normalised to the NLO cross section. The prediction of background in region A based upon the data in region B normalised using the ABCD method is shown as the *rectangles* which include the statistical uncertainty. The data/background ratio and the statistical significance of its difference from one, in standard deviations, are also shown in the *lower panels*

rameters. Systematic uncertainties affecting the simulated sgluon signal shapes are incorporated in the fit by varying signal templates, taking into account the migration of events between the regions.

The systematic uncertainties on the acceptance, and the correlation assumed for each uncertainty source between the four regions, are listed in Table 3 for a sgluon mass of 300 GeV. The uncertainty on the jet energy scale as well as the uncertainty on the jet energy resolution impacts both the signal shape and the acceptance. These uncertainties were measured with the complete 2010 dataset [31] to which an extra uncertainty for the higher pile-up in the 2011 run was

Table 2 Comparison of the data in the signal region with the background prediction. The first column is the sgluon mass hypothesis, the second column is the corresponding minimum p_T requirement on the four jets, followed by the number of observed data events in the signal region A (third column) and the number of predicted events using the ABCD method (fourth column), where the first uncertainty given is statistical and the second systematic. The last column gives the p-value obtained from a Kolmogorov–Smirnov test between the shapes of the reconstructed average mass distributions in regions A and B. Only statistical uncertainties are considered in this test

Sgluon mass [GeV]	$p_T^{\min}$ [GeV]	Data	ABCD prediction	Shape p-value(A,B)
150	80	102162	$101100 \pm 800 \pm 2000$	0.22
200	90	55194	$54500 \pm 600 \pm 1100$	0.10
250	105	23404	$22500 \pm 340 \pm 500$	0.28
300	120	11082	$10640 \pm 230 \pm 210$	0.24
350	135	5571	$5330 \pm 180 \pm 110$	0.70

Table 3 The systematic uncertainties on the signal due to the jet energy scale (JES), jet energy resolution (JER), initial and final state radiation (ISR/FSR), the trigger efficiency (Trigger), the Monte Carlo signal statistics (MC Statistics), the choice of parton distribution functions (PDFs) and the integrated luminosity (Luminosity). The relative uncertainty of the signal acceptance is given for the four regions and for a sgluon mass of 300 GeV. The JES uncertainty is treated as asymmetric, corresponding to upward and downward fluctuations of the JES. For the JER uncertainty, only an upward fluctuation of the JER is considered, i.e. only a degradation of the JER, with respect to the nominal MC JER. The last column shows the expected correlation among the four regions

Systematic	A	B	C	D	Correlation ABCD
JES	$+10\,\%, -10\,\%$	$+11\,\%, -11\,\%$	$+11\,\%, -13\,\%$	$+15\,\%, -10\,\%$	100 %
JER	$+0\,\%, -2\,\%$	$+0\,\%, -7\,\%$	$+0\,\%, -1\,\%$	$+0\,\%, -2\,\%$	100 %
ISR/FSR	$+3.5\,\%, -3.5\,\%$	$+3.5\,\%, -3.5\,\%$	$+3.5\,\%, -3.5\,\%$	$+3.5\,\%, -3.5\,\%$	100 %
Trigger	$\pm1\,\%$	$\pm1\,\%$	$\pm1\,\%$	$\pm1\,\%$	100 %
MC Statistics	$\pm4\,\%$	$\pm11\,\%$	$\pm5\,\%$	$\pm8\,\%$	0 %
PDFs	$\pm3\,\%$	$\pm3\,\%$	$\pm3\,\%$	$\pm2\,\%$	0 %
Luminosity	$\pm3.9\,\%$	$\pm3.9\,\%$	$\pm3.9\,\%$	$\pm3.9\,\%$	100 %

added. The variation of the PYTHIA parameters controlling initial state and final state radiation in a range consistent with experimental data [32] produces only a small effect on the reconstructed average mass distribution. Therefore, this systematic uncertainty is taken into account for the signal acceptance. An uncertainty of 1 % is assigned to the trigger efficiency for sgluon signals. The uncertainty on the signal acceptance due to the signal MC statistical uncertainty is uncorrelated among the four regions. The acceptance uncertainty due to the PDFs is estimated using the independent CT10 [20] error sets. The uncertainty on the luminosity is taken to be 3.9 % [33, 34].

To probe for the presence of a signal, a fit with a freely varying signal strength parameter is performed for each mass hypothesis. No significant deviation from zero is found, and limits on sgluon production are derived.

The profile likelihood ratio $\tilde{q}_\mu$ [35] is used as test statistic, and exclusions are determined using the CL$_s$ approach [36]. Exclusion limits are computed using samples of pseudo-experiments generated taking into account all uncertainties and also contamination of the control regions by signal events. The normalisation and shape of the event distribution in region B are used, whereas for regions C and D only the normalisation is used. MC templates are used to generate the shape of the signal in each pseudo-experiment. In each pseudo-experiment the statistical and systematic uncertainties are randomised, using Poisson and Gaussian distributions.

Figure 4 shows the expected and observed 95 % CL upper bounds on the product of the scalar pair production cross section and the branching ratio to gluons as a function of the scalar mass. For a mass of 150 GeV (350 GeV), a limit of 70 pb (10 pb) on the scalar gluon pair production cross section at the 95 % CL is obtained. The solid line corresponds to the prediction of the sgluon pair production cross section at NLO [24], which is larger than the leading order cross section by a factor of about 1.6. The hatched band indicates the systematic uncertainty due to the choices of renormalisation and factorisation scales. Due to this recent NLO calculation, the previously unexcluded mass region around 140 GeV [11] is now excluded by reinterpreting the limits obtained with the data recorded in 2010. For the analysis of the data recorded in 2011, sgluons with a mass from 150 GeV to 287 GeV are excluded. The endpoint of the mass limit is defined as the intersection of the cross-section limit
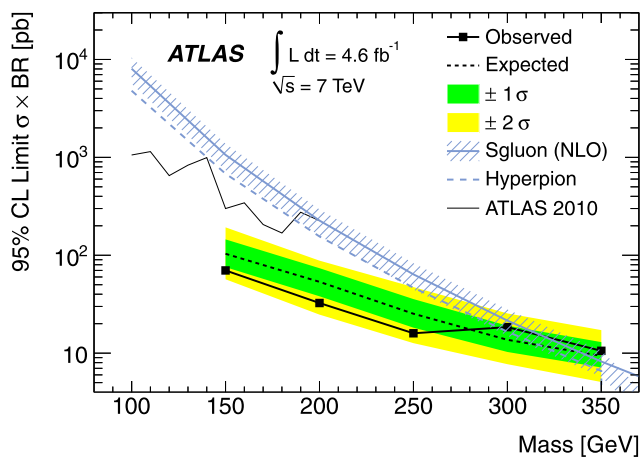
Fig. 4 Expected and observed 95 % CL upper bounds on the product of the scalar pair production cross section and the branching ratio to gluons as a function of the scalar mass using the profile likelihood ratio as the test statistic. The predictions of the sgluon and hyperpion pair production cross section are also shown as well as the observed limit from a previous ATLAS search [11]. The sgluon cross section is at NLO [24]

with the NLO cross section minus one standard deviation of the theory uncertainty.

The dashed line is the prediction for the hyperpion cross section of a compositeness model, obtained by rescaling the sgluon cross section according to the ratios from Ref. [7]. Since the ratios were calculated at leading order, this line should only be considered as an approximate indication of the excluded mass region.

In summary, using 4.6 fb^{-1} of $\sqrt{s} = 7$ TeV proton–proton collision data, collected by the ATLAS detector, four-jet events have been analysed to search for the pair production of a new scalar particle decaying into two gluons. The data in the signal region are in good agreement with the data-driven background estimation. No evidence for new phenomena is found. Cross section times branching ratio limits as a function of the mass of the scalar particle are derived. Interpreting the cross-section limit with the NLO cross-section calculation, sgluons with masses from 150 GeV to 287 GeV are excluded at 95 % CL using the data recorded in 2011 while the range 150 GeV to 306 GeV is expected to be excluded in the absence of a signal. Combining the exclusions obtained with the analyses of 2010 and 2011 data, sgluons with masses from 100 GeV to 287 GeV are excluded at the 95 % CL.

References

1. P. Fayet, Nucl. Phys. B **113**, 135 (1976)
2. S.Y. Choi, M. Drees, J. Kalinowski, J.M. Kim, E. Popenda, P.M. Zerwas, Phys. Lett. B **672**, 246 (2009). . arXiv:0812.3586 [hep-ph]
3. G.D. Kribs, E. Poppitz, N. Weiner, Phys. Rev. D **78**, 055010 (2008). arXiv:0712.2039 [hep-ph]
4. T. Plehn, T.M.P. Tait, J. Phys. G **36**, 075001 (2009). arXiv:0810.3919 [hep-ph]
5. C. Kilic, T. Okui, R. Sundrum, J. High Energy Phys. **0807**, 038 (2008). arXiv:0802.2568 [hep-ph]
6. C. Kilic, S. Schumann, M. Son, J. High Energy Phys. **0904**, 128 (2009). arXiv:0810.5542 [hep-ph]
7. S. Schumann, A. Renaud, D. Zerwas, J. High Energy Phys. **1109**, 074 (2011). arXiv:1108.2957 [hep-ph]
8. C. Kilic, T. Okui, R. Sundrum, J. High Energy Phys. **1002**, 018 (2010). arXiv:0906.0577 [hep-ph]
9. Y. Bai, J. Shelton, J. High Energy Phys. **1207**, 067 (2012). arXiv:1107.3563 [hep-ph]
10. G.R. Farrar, P. Fayet, Phys. Lett. B **76**, 575 (1978)
11. ATLAS Collaboration, Eur. Phys. J. C **71**, 1828 (2011). arXiv:1110.2693 [hep-ex]
12. ATLAS Collaboration, J. Instrum. **3**, S08003 (2008)
13. ATLAS Collaboration, CERN-OPEN-2008-020. arXiv:0901.0512 [hep-ex]
14. ATLAS Collaboration, Eur. Phys. J. C **70**, 823 (2010). arXiv:1005.4568 [physics.ins-det]
15. S. Agostinelli et al. (GEANT4 Collaboration), Nucl. Instrum. Methods A **506**, 250 (2003)
16. M.L. Mangano, M. Moretti, F. Piccinini, R. Pittau, A.D. Polosa, J. High Energy Phys. **0307**, 001 (2003). arXiv:hep-ph/0206293
17. S. Hoeche, F. Krauss, N. Lavesson, L. Lonnblad, M. Mangano, A. Schalicke, S. Schumann, arXiv:hep-ph/0602031
18. G. Corcella, I.G. Knowles, G. Marchesini, S. Moretti, K. Odagiri, P. Richardson, M.H. Seymour, B.R. Webber, arXiv:hep-ph/0210213
19. J.M. Butterworth, J.R. Forshaw, M.H. Seymour, Z. Phys. C **72**, 637 (1996). hep-ph/9601371

20. H.-L. Lai, M. Guzzi, J. Huston, Z. Li, P.M. Nadolsky, J. Pumplin, C.-P. Yuan, Phys. Rev. D **82**, 074024 (2010). arXiv:1007.2241 [hep-ph]

21. ATLAS Collaboration, ATL-PHYS-PUB-2011-009. http://cdsweb.cern.ch/record/1363300

22. T. Sjostrand, S. Mrenna, P.Z. Skands, J. High Energy Phys. **0605**, 026 (2006). hep-ph/0603175

23. A. Sherstnev, R.S. Thorne, Eur. Phys. J. C **55**, 553 (2008). arXiv:0711.2473 [hep-ph]

24. D. Goncalves-Netto, D. Lopez-Val, K. Mawatari, T. Plehn, I. Wigmore, arXiv:1203.6358 [hep-ph]

25. M. Cacciari, G.P. Salam, G. Soyez, J. High Energy Phys. **0804**, 063 (2008). arXiv:0802.1189 [hep-ph]

26. W. Lampl, S. Laplace, D. Lelas, P. Loch, H. Ma, S. Menke, S. Rajagopalan, D. Rousseau et al. ATL-LARG-PUB-2008-002

27. ATLAS Collaboration, submitted to Eur. Phys. J. C. arXiv:1203.1302 [hep-ex]

28. ATLAS Collaboration, ATLAS-CONF-2012-020. http://cdsweb.cern.ch/record/1430034

29. ATLAS Collaboration, submitted to Eur. Phys. J. C. arXiv:1210.6210 [hep-ex]

30. ATLAS Collaboration, Eur. Phys. J. C **71**, 1763 (2011). arXiv:1107.2092 [hep-ex]

31. ATLAS Collaboration, submitted to Eur. Phys. J. C, arXiv:1112.6426 [hep-ex]

32. ATLAS Collaboration, Eur. Phys. J. C **72**, 1926 (2012). arXiv:1201.2808 [hep-ex]

33. ATLAS Collaboration, ATLAS-CONF-2011-116. http://cdsweb.cern.ch/record/1376384

34. ATLAS Collaboration, Eur. Phys. J. C **71**, 1630 (2011). arXiv:1101.2185 [hep-ex]

35. G. Cowan, K. Cranmer, E. Gross, O. Vitells, Eur. Phys. J. C **71**, 1554 (2011). arXiv:1007.1727 [physics.data-an]

36. A.L. Read, J. Phys. G **28**, 2693 (2002)

The ATLAS Collaboration

G. Aad[48], T. Abajyan[21], B. Abbott[111], J. Abdallah[12], S. Abdel Khalek[115], A.A. Abdelalim[49], O. Abdinov[11], R. Aben[105], B. Abi[112], M. Abolins[88], O.S. AbouZeid[158], H. Abramowicz[153], H. Abreu[136], B.S. Acharya[164a,164b], L. Adamczyk[38], D.L. Adams[25], T.N. Addy[56], J. Adelman[176], S. Adomeit[98], P. Adragna[75], T. Adye[129], S. Aefsky[23], J.A. Aguilar-Saavedra[124b,a], M. Agustoni[17], M. Aharrouche[81], S.P. Ahlen[22], F. Ahles[48], A. Ahmad[148], M. Ahsan[41], G. Aielli[133a,133b], T. Akdogan[19a], T.P.A. Åkesson[79], G. Akimoto[155], A.V. Akimov[94], M.S. Alam[2], M.A. Alam[76], J. Albert[169], S. Albrand[55], M. Aleksa[30], I.N. Aleksandrov[64], F. Alessandria[89a], C. Alexa[26a], G. Alexander[153], G. Alexandre[49], T. Alexopoulos[10], M. Alhroob[164a,164c], M. Aliev[16], G. Alimonti[89a], J. Alison[120], B.M.M. Allbrooke[18], P.P. Allport[73], S.E. Allwood-Spiers[53], J. Almond[82], A. Aloisio[102a,102b], R. Alon[172], A. Alonso[79], F. Alonso[70], A. Altheimer[35], B. Alvarez Gonzalez[88], M.G. Alviggi[102a,102b], K. Amako[65], C. Amelung[23], V.V. Ammosov[128,*], S.P. Amor Dos Santos[124a], A. Amorim[124a,b], N. Amram[153], C. Anastopoulos[30], L.S. Ancu[17], N. Andari[115], T. Andeen[35], C.F. Anders[58b], G. Anders[58a], K.J. Anderson[31], A. Andreazza[89a,89b], V. Andrei[58a], M-L. Andrieux[55], X.S. Anduaga[70], S. Angelidakis[9], P. Anger[44], A. Angerami[35], F. Anghinolfi[30], A. Anisenkov[107], N. Anjos[124a], A. Annovi[47], A. Antonaki[9], M. Antonelli[47], A. Antonov[96], J. Antos[144b], F. Anulli[132a], M. Aoki[101], S. Aoun[83], L. Aperio Bella[5], R. Apolle[118,c], G. Arabidze[88], I. Aracena[143], Y. Arai[65], A.T.H. Arce[45], S. Arfaoui[148], J-F. Arguin[93], E. Arik[19a,*], M. Arik[19a], A.J. Armbruster[87], O. Arnaez[81], V. Arnal[80], C. Arnault[115], A. Artamonov[95], G. Artoni[132a,132b], D. Arutinov[21], S. Asai[155], S. Ask[28], B. Åsman[146a,146b], L. Asquith[6], K. Assamagan[25], A. Astbury[169], M. Atkinson[165], B. Aubert[5], E. Auge[115], K. Augsten[127], M. Aurousseau[145a], G. Avolio[30], R. Avramidou[10], D. Axen[168], G. Azuelos[93,d], Y. Azuma[155], M.A. Baak[30], G. Baccaglioni[89a], C. Bacci[134a,134b], A.M. Bach[15], H. Bachacou[136], K. Bachas[30], M. Backes[49], M. Backhaus[21], J. Backus Mayes[143], E. Badescu[26a], P. Bagnaia[132a,132b], S. Bahinipati[3], Y. Bai[33a], D.C. Bailey[158], T. Bain[158], J.T. Baines[129], O.K. Baker[176], M.D. Baker[25], S. Baker[77], P. Balek[126], E. Banas[39], P. Banerjee[93], Sw. Banerjee[173], D. Banfi[30], A. Bangert[150], V. Bansal[169], H.S. Bansil[18], L. Barak[172], S.P. Baranov[94], A. Barbaro Galtieri[15], T. Barber[48], E.L. Barberio[86], D. Barberis[50a,50b], M. Barbero[21], D.Y. Bardin[64], T. Barillari[99], M. Barisonzi[175], T. Barklow[143], N. Barlow[28], B.M. Barnett[129], R.M. Barnett[15], A. Baroncelli[134a], G. Barone[49], A.J. Barr[118], F. Barreiro[80], J. Barreiro Guimarães da Costa[57], P. Barrillon[115], R. Bartoldus[143], A.E. Barton[71], V. Bartsch[149], A. Basye[165], R.L. Bates[53], L. Batkova[144a], J.R. Batley[28], A. Battaglia[17], M. Battistin[30], F. Bauer[136], H.S. Bawa[143,e], S. Beale[98], T. Beau[78], P.H. Beauchemin[161], R. Beccherle[50a], P. Bechtle[21], H.P. Beck[17], A.K. Becker[175], S. Becker[98], M. Beckingham[138], K.H. Becks[175], A.J. Beddall[19c], A. Beddall[19c], S. Bedikian[176], V.A. Bednyakov[64], C.P. Bee[83], L.J. Beemster[105], M. Begel[25], S. Behar Harpaz[152], P.K. Behera[62], M. Beimforde[99], C. Belanger-Champagne[85], P.J. Bell[49], W.H. Bell[49], G. Bella[153], L. Bellagamba[20a], M. Bellomo[30], A. Belloni[57], O. Beloborodova[107,f], K. Belotskiy[96], O. Beltramello[30], O. Benary[153], D. Benchekroun[135a], K. Bendtz[146a,146b], N. Benekos[165], Y. Benhammou[153], E. Benhar Noccioli[49], J.A. Benitez Garcia[159b], D.P. Benjamin[45], M. Benoit[115], J.R. Bensinger[23], K. Benslama[130], S. Bentvelsen[105], D. Berge[30], E. Bergeaas Kuutmann[42], N. Berger[5], F. Berghaus[169], E. Berglund[105], J. Beringer[15], P. Bernat[77], R. Bernhard[48], C. Bernius[25], T. Berry[76], C. Bertella[83], A. Bertin[20a,20b], F. Bertolucci[122a,122b], M.I. Besana[89a,89b], G.J. Besjes[104], N. Besson[136], S. Bethke[99], W. Bhimji[46],

R.M. Bianchi[30], L. Bianchini[23], M. Bianco[72a,72b], O. Biebel[98], S.P. Bieniek[77], K. Bierwagen[54], J. Biesiada[15], M. Biglietti[134a], H. Bilokon[47], M. Bindi[20a,20b], S. Binet[115], A. Bingul[19c], C. Bini[132a,132b], C. Biscarat[178], B. Bittner[99], K.M. Black[22], R.E. Blair[6], J.-B. Blanchard[136], G. Blanchot[30], T. Blazek[144a], I. Bloch[42], C. Blocker[23], J. Blocki[39], A. Blondel[49], W. Blum[81], U. Blumenschein[54], G.J. Bobbink[105], V.B. Bobrovnikov[107], S.S. Bocchetta[79], A. Bocci[45], C.R. Boddy[118], M. Boehler[48], J. Boek[175], N. Boelaert[36], J.A. Bogaerts[30], A. Bogdanchikov[107], A. Bogouch[90,*], C. Bohm[146a], J. Bohm[125], V. Boisvert[76], T. Bold[38], V. Boldea[26a], N.M. Bolnet[136], M. Bomben[78], M. Bona[75], M. Boonekamp[136], S. Bordoni[78], C. Borer[17], A. Borisov[128], G. Borissov[71], I. Borjanovic[13a], M. Borri[82], S. Borroni[87], J. Bortfeldt[98], V. Bortolotto[134a,134b], K. Bos[105], D. Boscherini[20a], M. Bosman[12], H. Boterenbrood[105], J. Bouchami[93], J. Boudreau[123], E.V. Bouhova-Thacker[71], D. Boumediene[34], C. Bourdarios[115], N. Bousson[83], A. Boveia[31], J. Boyd[30], I.R. Boyko[64], I. Bozovic-Jelisavcic[13b], J. Bracinik[18], P. Branchini[134a], A. Brandt[8], G. Brandt[118], O. Brandt[54], U. Bratzler[156], B. Brau[84], J.E. Brau[114], H.M. Braun[175,*], S.F. Brazzale[164a,164c], B. Brelier[158], J. Bremer[30], K. Brendlinger[120], R. Brenner[166], S. Bressler[172], D. Britton[53], F.M. Brochu[28], I. Brock[21], R. Brock[88], F. Broggi[89a], C. Bromberg[88], J. Bronner[99], G. Brooijmans[35], T. Brooks[76], W.K. Brooks[32b], G. Brown[82], H. Brown[8], P.A. Bruckman de Renstrom[39], D. Bruncko[144b], R. Bruneliere[48], S. Brunet[60], A. Bruni[20a], G. Bruni[20a], M. Bruschi[20a], T. Buanes[14], Q. Buat[55], F. Bucci[49], J. Buchanan[118], P. Buchholz[141], R.M. Buckingham[118], A.G. Buckley[46], S.I. Buda[26a], I.A. Budagov[64], B. Budick[108], V. Büscher[81], L. Bugge[117], O. Bulekov[96], A.C. Bundock[73], M. Bunse[43], T. Buran[117], H. Burckhart[30], S. Burdin[73], T. Burgess[14], S. Burke[129], E. Busato[34], P. Bussey[53], C.P. Buszello[166], B. Butler[143], J.M. Butler[22], C.M. Buttar[53], J.M. Butterworth[77], W. Buttinger[28], M. Byszewski[30], S. Cabrera Urbán[167], D. Caforio[20a,20b], O. Cakir[4a], P. Calafiura[15], G. Calderini[78], P. Calfayan[98], R. Calkins[106], L.P. Caloba[24a], R. Caloi[132a,132b], D. Calvet[34], S. Calvet[34], R. Camacho Toro[34], P. Camarri[133a,133b], D. Cameron[117], L.M. Caminada[15], R. Caminal Armadans[12], S. Campana[30], M. Campanelli[77], V. Canale[102a,102b], F. Canelli[31], A. Canepa[159a], J. Cantero[80], R. Cantrill[76], L. Capasso[102a,102b], M.D.M. Capeans Garrido[30], I. Caprini[26a], M. Caprini[26a], D. Capriotti[99], M. Capua[37a,37b], R. Caputo[81], R. Cardarelli[133a], T. Carli[30], G. Carlino[102a], L. Carminati[89a,89b], B. Caron[85], S. Caron[104], E. Carquin[32b], G.D. Carrillo-Montoya[173], A.A. Carter[75], J.R. Carter[28], J. Carvalho[124a,g], D. Casadei[108], M.P. Casado[12], M. Cascella[122a,122b], C. Caso[50a,50b,*], A.M. Castaneda Hernandez[173,h], E. Castaneda-Miranda[173], V. Castillo Gimenez[167], N.F. Castro[124a], G. Cataldi[72a], P. Catastini[57], A. Catinaccio[30], J.R. Catmore[30], A. Cattai[30], G. Cattani[133a,133b], S. Caughron[88], V. Cavaliere[165], P. Cavalleri[78], D. Cavalli[89a], M. Cavalli-Sforza[12], V. Cavasinni[122a,122b], F. Ceradini[134a,134b], A.S. Cerqueira[24b], A. Cerri[30], L. Cerrito[75], F. Cerutti[47], S.A. Cetin[19b], A. Chafaq[135a], D. Chakraborty[106], I. Chalupkova[126], K. Chan[3], P. Chang[165], B. Chapleau[85], J.D. Chapman[28], J.W. Chapman[87], E. Chareyre[78], D.G. Charlton[18], V. Chavda[82], C.A. Chavez Barajas[30], S. Cheatham[85], S. Chekanov[6], S.V. Chekulaev[159a], G.A. Chelkov[64], M.A. Chelstowska[104], C. Chen[63], H. Chen[25], S. Chen[33c], X. Chen[173], Y. Chen[35], Y. Cheng[31], A. Cheplakov[64], R. Cherkaoui El Moursli[135e], V. Chernyatin[25], E. Cheu[7], S.L. Cheung[158], L. Chevalier[136], G. Chiefari[102a,102b], L. Chikovani[51a,*], J.T. Childers[30], A. Chilingarov[71], G. Chiodini[72a], A.S. Chisholm[18], R.T. Chislett[77], A. Chitan[26a], M.V. Chizhov[64], G. Choudalakis[31], S. Chouridou[137], I.A. Christidi[77], A. Christov[48], D. Chromek-Burckhart[30], M.L. Chu[151], J. Chudoba[125], G. Ciapetti[132a,132b], A.K. Ciftci[4a], R. Ciftci[4a], D. Cinca[34], V. Cindro[74], C. Ciocca[20a,20b], A. Ciocio[15], M. Cirilli[87], P. Cirkovic[13b], Z.H. Citron[172], M. Citterio[89a], M. Ciubancan[26a], A. Clark[49], P.J. Clark[46], R.N. Clarke[15], W. Cleland[123], J.C. Clemens[83], B. Clement[55], C. Clement[146a,146b], Y. Coadou[83], M. Cobal[164a,164c], A. Coccaro[138], J. Cochran[63], L. Coffey[23], J.G. Cogan[143], J. Coggeshall[165], E. Cogneras[178], J. Colas[5], S. Cole[106], A.P. Colijn[105], N.J. Collins[18], C. Collins-Tooth[53], J. Collot[55], T. Colombo[119a,119b], G. Colon[84], G. Compostella[99], P. Conde Muiño[124a], E. Coniavitis[166], M.C. Conidi[12], S.M. Consonni[89a,89b], V. Consorti[48], S. Constantinescu[26a], C. Conta[119a,119b], G. Conti[57], F. Conventi[102a,i], M. Cooke[15], B.D. Cooper[77], A.M. Cooper-Sarkar[118], K. Copic[15], T. Cornelissen[175], M. Corradi[20a], F. Corriveau[85,j], A. Cortes-Gonzalez[165], G. Cortiana[99], G. Costa[89a], M.J. Costa[167], D. Costanzo[139], D. Côté[30], L. Courneyea[169], G. Cowan[76], C. Cowden[28], B.E. Cox[82], K. Cranmer[108], F. Crescioli[122a,122b], M. Cristinziani[21], G. Crosetti[37a,37b], S. Crépé-Renaudin[55], C.-M. Cuciuc[26a], C. Cuenca Almenar[176], T. Cuhadar Donszelmann[139], M. Curatolo[47], C.J. Curtis[18], C. Cuthbert[150], P. Cwetanski[60], H. Czirr[141], P. Czodrowski[44], Z. Czyczula[176], S. D'Auria[53], M. D'Onofrio[73], A. D'Orazio[132a,132b], M.J. Da Cunha Sargedas De Sousa[124a], C. Da Via[82], W. Dabrowski[38], A. Dafinca[118], T. Dai[87], C. Dallapiccola[84], M. Dam[36], M. Dameri[50a,50b], D.S. Damiani[137], H.O. Danielsson[30], V. Dao[49], G. Darbo[50a], G.L. Darlea[26b], J.A. Dassoulas[42], W. Davey[21], T. Davidek[126], N. Davidson[86], R. Davidson[71], E. Davies[118,c], M. Davies[93], O. Davignon[78], A.R. Davison[77], Y. Davygora[58a], E. Dawe[142], I. Dawson[139], R.K. Daya-Ishmukhametova[23], K. De[8], R. de Asmundis[102a], S. De Castro[20a,20b], S. De Cecco[78], J. de Graat[98], N. De Groot[104], P. de Jong[105], C. De La Taille[115], H. De la Torre[80], F. De Lorenzi[63], L. de Mora[71], L. De Nooij[105], D. De Pedis[132a], A. De Salvo[132a], U. De Sanctis[164a,164c], A. De Santo[149], J.B. De Vivie De Regie[115], G. De Zorzi[132a,132b], W.J. Dearnaley[71], R. Debbe[25], C. Debenedetti[46], B. Dechenaux[55], D.V. Dedovich[64], J. Degenhardt[120], C. Del Papa[164a,164c], J. Del Peso[80], T. Del Prete[122a,122b], T. Delemontex[55], M. Deliyergiyev[74], A. Dell'Acqua[30], L. Dell'Asta[22], M. Della Pietra[102a,i], D. della Volpe[102a,102b], M. Delmastro[5], P.A. Delsart[55], C. Deluca[105], S. Demers[176], M. Demichev[64], B. Demirkoz[12,k], J. Deng[163], S.P. Denisov[128], D. Derendarz[39],

J.E. Derkaoui[135d], F. Derue[78], P. Dervan[73], K. Desch[21], E. Devetak[148], P.O. Deviveiros[105], A. Dewhurst[129], B. DeWilde[148], S. Dhaliwal[158], R. Dhullipudi[25,l], A. Di Ciaccio[133a,133b], L. Di Ciaccio[5], C. Di Donato[102a,102b], A. Di Girolamo[30], B. Di Girolamo[30], S. Di Luise[134a,134b], A. Di Mattia[173], B. Di Micco[30], R. Di Nardo[47], A. Di Simone[133a,133b], R. Di Sipio[20a,20b], M.A. Diaz[32a], E.B. Diehl[87], J. Dietrich[42], T.A. Dietzsch[58a], S. Diglio[86], K. Dindar Yagci[40], J. Dingfelder[21], F. Dinut[26a], C. Dionisi[132a,132b], P. Dita[26a], S. Dita[26a], F. Dittus[30], F. Djama[83], T. Djobava[51b], M.A.B. do Vale[24c], A. Do Valle Wemans[124a,m], T.K.O. Doan[5], M. Dobbs[85], D. Dobos[30], E. Dobson[30,n], J. Dodd[35], C. Doglioni[49], T. Doherty[53], Y. Doi[65,*], J. Dolejsi[126], I. Dolenc[74], Z. Dolezal[126], B.A. Dolgoshein[96,*], T. Dohmae[155], M. Donadelli[24d], J. Donini[34], J. Dopke[30], A. Doria[102a], A. Dos Anjos[173], A. Dotti[122a,122b], M.T. Dova[70], A.D. Doxiadis[105], A.T. Doyle[53], N. Dressnandt[120], M. Dris[10], J. Dubbert[99], S. Dube[15], E. Duchovni[172], G. Duckeck[98], D. Duda[175], A. Dudarev[30], F. Dudziak[63], M. Dührssen[30], I.P. Duerdoth[82], L. Duflot[115], M-A. Dufour[85], L. Duguid[76], M. Dunford[58a], H. Duran Yildiz[4a], R. Duxfield[139], M. Dwuznik[38], F. Dydak[30], M. Düren[52], W.L. Ebenstein[45], J. Ebke[98], S. Eckweiler[81], K. Edmonds[81], W. Edson[2], C.A. Edwards[76], N.C. Edwards[53], W. Ehrenfeld[42], T. Eifert[143], G. Eigen[14], K. Einsweiler[15], E. Eisenhandler[75], T. Ekelof[166], M. El Kacimi[135c], M. Ellert[166], S. Elles[5], F. Ellinghaus[81], K. Ellis[75], N. Ellis[30], J. Elmsheuser[98], M. Elsing[30], D. Emeliyanov[129], R. Engelmann[148], A. Engl[98], B. Epp[61], J. Erdmann[54], A. Ereditato[17], D. Eriksson[146a], J. Ernst[2], M. Ernst[25], J. Ernwein[136], D. Errede[165], S. Errede[165], E. Ertel[81], M. Escalier[115], H. Esch[43], C. Escobar[123], X. Espinal Curull[12], B. Esposito[47], F. Etienne[83], A.I. Etienvre[136], E. Etzion[153], D. Evangelakou[54], H. Evans[60], L. Fabbri[20a,20b], C. Fabre[30], R.M. Fakhrutdinov[128], S. Falciano[132a], Y. Fang[173], M. Fanti[89a,89b], A. Farbin[8], A. Farilla[134a], J. Farley[148], T. Farooque[158], S. Farrell[163], S.M. Farrington[170], P. Farthouat[30], F. Fassi[167], P. Fassnacht[30], D. Fassouliotis[9], B. Fatholahzadeh[158], A. Favareto[89a,89b], L. Fayard[115], S. Fazio[37a,37b], R. Febbraro[34], P. Federic[144a], O.L. Fedin[121], W. Fedorko[88], M. Fehling-Kaschek[48], L. Feligioni[83], D. Fellmann[6], C. Feng[33d], E.J. Feng[6], A.B. Fenyuk[128], J. Ferencei[144b], W. Fernando[6], S. Ferrag[53], J. Ferrando[53], V. Ferrara[42], A. Ferrari[166], P. Ferrari[105], R. Ferrari[119a], D.E. Ferreira de Lima[53], A. Ferrer[167], D. Ferrere[49], C. Ferretti[87], A. Ferretto Parodi[50a,50b], M. Fiascaris[31], F. Fiedler[81], A. Filipčič[74], M. Filthaut[104], M. Fincke-Keeler[169], M.C.N. Fiolhais[124a,g], L. Fiorini[167], A. Firan[40], G. Fischer[42], M.J. Fisher[109], M. Flechl[48], I. Fleck[141], J. Fleckner[81], P. Fleischmann[174], S. Fleischmann[175], T. Flick[175], A. Floderus[79], L.R. Flores Castillo[173], M.J. Flowerdew[99], T. Fonseca Martin[17], A. Formica[136], A. Forti[82], D. Fortin[159a], D. Fournier[115], A.J. Fowler[45], H. Fox[71], P. Francavilla[12], M. Franchini[20a,20b], S. Franchino[119a,119b], D. Francis[30], T. Frank[172], M. Franklin[57], S. Franz[30], M. Fraternali[119a,119b], S. Fratina[120], S.T. French[28], C. Friedrich[42], F. Friedrich[44], R. Froeschl[30], D. Froidevaux[30], J.A. Frost[28], C. Fukunaga[156], E. Fullana Torregrosa[30], B.G. Fulsom[143], J. Fuster[167], C. Gabaldon[30], O. Gabizon[172], T. Gadfort[25], S. Gadomski[49], G. Gagliardi[50a,50b], P. Gagnon[60], C. Galea[98], B. Galhardo[124a], E.J. Gallas[118], V. Gallo[17], B.J. Gallop[129], P. Gallus[125], K.K. Gan[109], Y.S. Gao[143,e], A. Gaponenko[15], F. Garberson[176], M. Garcia-Sciveres[15], C. García[167], J.E. García Navarro[167], R.W. Gardner[31], N. Garelli[30], H. Garitaonandia[105], V. Garonne[30], C. Gatti[47], G. Gaudio[119a], B. Gaur[141], L. Gauthier[136], P. Gauzzi[132a,132b], I.L. Gavrilenko[94], C. Gay[168], G. Gaycken[21], E.N. Gazis[10], P. Ge[33d], Z. Gecse[168], C.N.P. Gee[129], D.A.A. Geerts[105], Ch. Geich-Gimbel[21], K. Gellerstedt[146a,146b], C. Gemme[50a], A. Gemmell[53], M.H. Genest[55], S. Gentile[132a,132b], M. George[54], S. George[76], P. Gerlach[175], A. Gershon[153], C. Geweniger[58a], H. Ghazlane[135b], N. Ghodbane[34], B. Giacobbe[20a], S. Giagu[132a,132b], V. Giakoumopoulou[9], V. Giangiobbe[12], F. Gianotti[30], B. Gibbard[25], A. Gibson[158], S.M. Gibson[30], M. Gilchriese[15], D. Gillberg[29], A.R. Gillman[129], D.M. Gingrich[3,d], J. Ginzburg[153], N. Giokaris[9], M.P. Giordani[164c], R. Giordano[102a,102b], F.M. Giorgi[16], P. Giovannini[99], P.F. Giraud[136], D. Giugni[89a], M. Giunta[93], P. Giusti[20a], B.K. Gjelsten[117], L.K. Gladilin[97], C. Glasman[80], J. Glatzer[21], A. Glazov[42], K.W. Glitza[175], G.L. Glonti[64], J.R. Goddard[75], J. Godfrey[142], J. Godlewski[30], M. Goebel[42], T. Göpfert[44], C. Goeringer[81], C. Gössling[43], S. Goldfarb[87], T. Golling[176], A. Gomes[124a,b], L.S. Gomez Fajardo[42], R. Gonçalo[76], J. Goncalves Pinto Firmino Da Costa[42], L. Gonella[21], S. González de la Hoz[167], G. Gonzalez Parra[12], M.L. Gonzalez Silva[27], S. Gonzalez-Sevilla[49], J.J. Goodson[148], L. Goossens[30], P.A. Gorbounov[95], H.A. Gordon[25], I. Gorelov[103], G. Gorfine[175], B. Gorini[30], E. Gorini[72a,72b], A. Gorišek[74], E. Gornicki[39], B. Gosdzik[42], A.T. Goshaw[6], M. Gosselink[105], M.I. Gostkin[64], I. Gough Eschrich[163], M. Gouighri[135a], D. Goujdami[135c], M.P. Goulette[49], A.G. Goussiou[138], C. Goy[5], S. Gozpinar[23], I. Grabowska-Bold[38], P. Grafström[20a,20b], K-J. Grahn[42], E. Gramstad[117], F. Grancagnolo[72a], S. Grancagnolo[16], V. Grassi[148], V. Gratchev[121], N. Grau[35], H.M. Gray[30], J.A. Gray[148], E. Graziani[134a], O.G. Grebenyuk[121], T. Greenshaw[73], Z.D. Greenwood[25,l], K. Gregersen[36], I.M. Gregor[42], P. Grenier[143], J. Griffiths[8], N. Grigalashvili[64], A.A. Grillo[137], S. Grinstein[12], Ph. Gris[34], Y.V. Grishkevich[97], J.-F. Grivaz[115], E. Gross[172], J. Grosse-Knetter[54], J. Groth-Jensen[172], K. Grybel[141], D. Guest[176], C. Guicheney[34], S. Guindon[54], U. Gul[53], J. Gunther[125], B. Guo[158], J. Guo[35], P. Gutierrez[111], N. Guttman[153], O. Gutzwiller[173], C. Guyot[136], C. Gwenlan[118], C.B. Gwilliam[73], A. Haas[108], S. Haas[30], C. Haber[15], H.K. Hadavand[8], D.R. Hadley[18], P. Haefner[21], F. Hahn[30], S. Haider[30], Z. Hajduk[39], H. Hakobyan[177], D. Hall[118], K. Hamacher[175], P. Hamal[113], K. Hamano[86], M. Hamer[54], A. Hamilton[145b,o], S. Hamilton[161], L. Han[33b], K. Hanagaki[116], K. Hanawa[160], M. Hance[15], C. Handel[81], P. Hanke[58a], J.R. Hansen[36], J.B. Hansen[36], J.D. Hansen[36], P.H. Hansen[36], P. Hansson[143], K. Hara[160], G.A. Hare[137], T. Harenberg[175], S. Harkusha[90], D. Harper[87], R.D. Harrington[46], O.M. Harris[138], J. Hartert[48], F. Hartjes[105], T. Haruyama[65], A. Harvey[56], S. Hasegawa[101], Y. Hasegawa[140], S. Hassani[136], S. Haug[17],

M. Hauschild[30], R. Hauser[88], M. Havranek[21], C.M. Hawkes[18], R.J. Hawkings[30], A.D. Hawkins[79], T. Hayakawa[66], T. Hayashi[160], D. Hayden[76], C.P. Hays[118], H.S. Hayward[73], S.J. Haywood[129], S.J. Head[18], V. Hedberg[79], L. Heelan[8], S. Heim[120], B. Heinemann[15], S. Heisterkamp[36], L. Helary[22], C. Heller[98], M. Heller[30], S. Hellman[146a,146b], D. Hellmich[21], C. Helsens[12], R.C.W. Henderson[71], M. Henke[58a], A. Henrichs[176], A.M. Henriques Correia[30], S. Henrot-Versille[115], C. Hensel[54], T. Henß[175], C.M. Hernandez[8], Y. Hernández Jiménez[167], R. Herrberg[16], G. Herten[48], R. Hertenberger[98], L. Hervas[30], G.G. Hesketh[77], N.P. Hessey[105], E. Higón-Rodriguez[167], J.C. Hill[28], K.H. Hiller[42], S. Hillert[21], S.J. Hillier[18], I. Hinchliffe[15], E. Hines[120], M. Hirose[116], F. Hirsch[43], D. Hirschbuehl[175], J. Hobbs[148], N. Hod[153], M.C. Hodgkinson[139], P. Hodgson[139], A. Hoecker[30], M.R. Hoeferkamp[103], J. Hoffman[40], D. Hoffmann[83], M. Hohlfeld[81], M. Holder[141], S.O. Holmgren[146a], T. Holy[127], J.L. Holzbauer[88], T.M. Hong[120], L. Hooft van Huysduynen[108], S. Horner[48], J-Y. Hostachy[55], S. Hou[151], A. Hoummada[135a], J. Howard[118], J. Howarth[82], I. Hristova[16], J. Hrivnac[115], T. Hryn'ova[5], P.J. Hsu[81], S.-C. Hsu[15], D. Hu[35], Z. Hubacek[127], F. Hubaut[83], F. Huegging[21], T.B. Huffman[118], E.W. Hughes[35], G. Hughes[71], M. Huhtinen[30], M. Hurwitz[15], N. Huseynov[64,p], J. Huston[88], J. Huth[57], G. Iacobucci[49], G. Iakovidis[10], M. Ibbotson[82], I. Ibragimov[141], L. Iconomidou-Fayard[115], J. Idarraga[115], P. Iengo[102a], O. Igonkina[105], Y. Ikegami[65], M. Ikeno[65], D. Iliadis[154], N. Ilic[158], T. Ince[99], J. Inigo-Golfin[30], P. Ioannou[9], M. Iodice[134a], K. Iordanidou[9], V. Ippolito[132a,132b], A. Irles Quiles[167], C. Isaksson[166], M. Ishino[67], M. Ishitsuka[157], R. Ishmukhametov[109], C. Issever[118], S. Istin[19a], A.V. Ivashin[128], W. Iwanski[39], H. Iwasaki[65], J.M. Izen[41], V. Izzo[102a], B. Jackson[120], J.N. Jackson[73], P. Jackson[1], M.R. Jaekel[30], V. Jain[60], K. Jakobs[48], S. Jakobsen[36], T. Jakoubek[125], J. Jakubek[127], D.O. Jamin[151], D.K. Jana[111], E. Jansen[77], H. Jansen[30], A. Jantsch[99], M. Janus[48], G. Jarlskog[79], L. Jeanty[57], I. Jen-La Plante[31], D. Jennens[86], P. Jenni[30], A.E. Loevschall-Jensen[36], P. Jež[36], S. Jézéquel[5], M.K. Jha[20a], H. Ji[173], W. Ji[81], J. Jia[148], Y. Jiang[33b], M. Jimenez Belenguer[42], S. Jin[33a], O. Jinnouchi[157], M.D. Joergensen[36], D. Joffe[40], M. Johansen[146a,146b], K.E. Johansson[146a], P. Johansson[139], S. Johnert[42], K.A. Johns[7], K. Jon-And[146a,146b], G. Jones[170], R.W.L. Jones[71], T.J. Jones[73], C. Joram[30], P.M. Jorge[124a], K.D. Joshi[82], J. Jovicevic[147], T. Jovin[13b], X. Ju[173], C.A. Jung[43], R.M. Jungst[30], V. Juranek[125], P. Jussel[61], A. Juste Rozas[12], S. Kabana[17], M. Kaci[167], A. Kaczmarska[39], P. Kadlecik[36], M. Kado[115], H. Kagan[109], M. Kagan[57], E. Kajomovitz[152], S. Kalinin[175], L.V. Kalinovskaya[64], S. Kama[40], N. Kanaya[155], M. Kaneda[30], S. Kaneti[28], T. Kanno[157], V.A. Kantserov[96], J. Kanzaki[65], B. Kaplan[108], A. Kapliy[31], J. Kaplon[30], D. Kar[53], M. Karagounis[21], K. Karakostas[10], M. Karnevskiy[42], V. Kartvelishvili[71], A.N. Karyukhin[128], L. Kashif[173], G. Kasieczka[58b], R.D. Kass[109], A. Kastanas[14], M. Kataoka[5], Y. Kataoka[155], E. Katsoufis[10], J. Katzy[42], V. Kaushik[7], K. Kawagoe[69], T. Kawamoto[155], G. Kawamura[81], M.S. Kayl[105], S. Kazama[155], V.A. Kazanin[107], M.Y. Kazarinov[64], R. Keeler[169], P.T. Keener[120], R. Kehoe[40], M. Keil[54], G.D. Kekelidze[64], J.S. Keller[138], M. Kenyon[53], O. Kepka[125], N. Kerschen[30], B.P. Kerševan[74], S. Kersten[175], K. Kessoku[155], J. Keung[158], F. Khalil-zada[11], H. Khandanyan[146a,146b], A. Khanov[112], D. Kharchenko[64], A. Khodinov[96], A. Khomich[58a], T.J. Khoo[28], G. Khoriauli[21], A. Khoroshilov[175], V. Khovanskiy[95], E. Khramov[64], J. Khubua[51b], H. Kim[146a,146b], S.H. Kim[160], N. Kimura[171], O. Kind[16], B.T. King[73], M. King[66], R.S.B. King[118], J. Kirk[129], A.E. Kiryunin[99], T. Kishimoto[66], D. Kisielewska[38], T. Kitamura[66], T. Kittelmann[123], K. Kiuchi[160], E. Kladiva[144b], M. Klein[73], U. Klein[73], K. Kleinknecht[81], M. Klemetti[85], A. Klier[172], P. Klimek[146a,146b], A. Klimentov[25], R. Klingenberg[43], J.A. Klinger[82], E.B. Klinkby[36], T. Klioutchnikova[30], P.F. Klok[104], S. Klous[105], E.-E. Kluge[58a], T. Kluge[73], P. Kluit[105], S. Kluth[99], E. Kneringer[61], E.B.F.G. Knoops[83], A. Knue[54], B.R. Ko[45], T. Kobayashi[155], M. Kobel[44], M. Kocian[143], P. Kodys[126], K. Köneke[30], A.C. König[104], S. Koenig[81], L. Köpke[81], F. Koetsveld[104], P. Koevesarki[21], T. Koffas[29], E. Koffeman[105], L.A. Kogan[118], S. Kohlmann[175], F. Kohn[54], Z. Kohout[127], T. Kohriki[65], T. Koi[143], G.M. Kolachev[107,*], H. Kolanoski[16], V. Kolesnikov[64], I. Koletsou[89a], J. Koll[88], A.A. Komar[94], Y. Komori[155], T. Kondo[65], T. Kono[42,q], A.I. Kononov[48], R. Konoplich[108,r], N. Konstantinidis[77], R. Kopeliansky[152], S. Koperny[38], K. Korcyl[39], K. Kordas[154], A. Korn[118], A. Korol[107], I. Korolkov[12], E.V. Korolkova[139], V.A. Korotkov[128], O. Kortner[99], S. Kortner[99], V.V. Kostyukhin[21], S. Kotov[99], V.M. Kotov[64], A. Kotwal[45], C. Kourkoumelis[9], V. Kouskoura[154], A. Koutsman[159a], R. Kowalewski[169], T.Z. Kowalski[38], W. Kozanecki[136], A.S. Kozhin[128], V. Kral[127], V.A. Kramarenko[97], G. Kramberger[74], M.W. Krasny[78], A. Krasznahorkay[108], J.K. Kraus[21], S. Kreiss[108], F. Krejci[127], J. Kretzschmar[73], N. Krieger[54], P. Krieger[158], K. Kroeninger[54], H. Kroha[99], J. Kroll[120], J. Kroseberg[21], J. Krstic[13a], U. Kruchonak[64], H. Krüger[21], T. Kruker[17], N. Krumnack[63], Z.V. Krumshteyn[64], T. Kubota[86], S. Kuday[4a], S. Kuehn[48], A. Kugel[58c], T. Kuhl[42], D. Kuhn[61], V. Kukhtin[64], Y. Kulchitsky[90], S. Kuleshov[32b], C. Kummer[98], M. Kuna[78], J. Kunkle[120], A. Kupco[125], H. Kurashige[66], M. Kurata[160], Y.A. Kurochkin[90], V. Kus[125], E.S. Kuwertz[147], M. Kuze[157], J. Kvita[142], R. Kwee[16], A. La Rosa[49], L. La Rotonda[37a,37b], L. Labarga[80], J. Labbe[5], S. Lablak[135a], C. Lacasta[167], F. Lacava[132a,132b], J. Lacey[29], H. Lacker[16], D. Lacour[78], V.R. Lacuesta[167], E. Ladygin[64], R. Lafaye[5], B. Laforge[78], T. Lagouri[176], S. Lai[48], E. Laisne[55], M. Lamanna[30], L. Lambourne[77], C.L. Lampen[7], W. Lampl[7], E. Lancon[136], U. Landgraf[48], M.P.J. Landon[75], V.S. Lang[58a], C. Lange[42], A.J. Lankford[163], F. Lanni[25], K. Lantzsch[175], S. Laplace[78], C. Lapoire[21], J.F. Laporte[136], T. Lari[89a], A. Larner[118], M. Lassnig[30], P. Laurelli[47], V. Lavorini[37a,37b], W. Lavrijsen[15], P. Laycock[73], O. Le Dortz[78], E. Le Guirriec[83], E. Le Menedeu[12], T. LeCompte[6], F. Ledroit-Guillon[55], H. Lee[105], J.S.H. Lee[116], S.C. Lee[151], L. Lee[176],

M. Lefebvre[169], M. Legendre[136], F. Legger[98], C. Leggett[15], M. Lehmacher[21], G. Lehmann Miotto[30], M.A.L. Leite[24d], R. Leitner[126], D. Lellouch[172], B. Lemmer[54], V. Lendermann[58a], K.J.C. Leney[145b], T. Lenz[105], G. Lenzen[175], B. Lenzi[30], K. Leonhardt[44], S. Leontsinis[10], F. Lepold[58a], C. Leroy[93], J-R. Lessard[169], C.G. Lester[28], C.M. Lester[120], J. Levêque[5], D. Levin[87], L.J. Levinson[172], A. Lewis[118], G.H. Lewis[108], A.M. Leyko[21], M. Leyton[16], B. Li[83], H. Li[148], H.L. Li[31], S. Li[33b,s], X. Li[87], Z. Liang[118,t], H. Liao[34], B. Liberti[133a], P. Lichard[30], M. Lichtnecker[98], K. Lie[165], W. Liebig[14], C. Limbach[21], A. Limosani[86], M. Limper[62], S.C. Lin[151,u], F. Linde[105], J.T. Linnemann[88], E. Lipeles[120], A. Lipniacka[14], T.M. Liss[165], D. Lissauer[25], A. Lister[49], A.M. Litke[137], C. Liu[29], D. Liu[151], H. Liu[87], J.B. Liu[87], L. Liu[87], M. Liu[33b], Y. Liu[33b], M. Livan[119a,119b], S.S.A. Livermore[118], A. Lleres[55], J. Llorente Merino[80], S.L. Lloyd[75], E. Lobodzinska[42], P. Loch[7], W.S. Lockman[137], T. Loddenkoetter[21], F.K. Loebinger[82], A. Loginov[176], C.W. Loh[168], T. Lohse[16], K. Lohwasser[48], M. Lokajicek[125], V.P. Lombardo[5], R.E. Long[71], L. Lopes[124a], D. Lopez Mateos[57], J. Lorenz[98], N. Lorenzo Martinez[115], M. Losada[162], P. Loscutoff[15], F. Lo Sterzo[132a,132b], M.J. Losty[159a,*], X. Lou[41], A. Lounis[115], K.F. Loureiro[162], J. Love[6], P.A. Love[71], A.J. Lowe[143,e], F. Lu[33a], H.J. Lubatti[138], C. Luci[132a,132b], A. Lucotte[55], A. Ludwig[44], D. Ludwig[42], I. Ludwig[48], J. Ludwig[48], F. Luehring[60], G. Luijckx[105], W. Lukas[61], L. Luminari[132a], E. Lund[117], B. Lund-Jensen[147], B. Lundberg[79], J. Lundberg[146a,146b], O. Lundberg[146a,146b], J. Lundquist[36], M. Lungwitz[81], D. Lynn[25], E. Lytken[79], H. Ma[25], L.L. Ma[173], G. Maccarrone[47], A. Macchiolo[99], B. Maček[74], J. Machado Miguens[124a], R. Mackeprang[36], R.J. Madaras[15], H.J. Maddocks[71], W.F. Mader[44], R. Maenner[58c], T. Maeno[25], P. Mättig[175], S. Mättig[81], L. Magnoni[163], E. Magradze[54], K. Mahboubi[48], J. Mahlstedt[105], S. Mahmoud[73], G. Mahout[18], C. Maiani[136], C. Maidantchik[24a], A. Maio[124a,b], S. Majewski[25], Y. Makida[65], N. Makovec[115], P. Mal[136], B. Malaescu[30], Pa. Malecki[39], P. Malecki[39], V.P. Maleev[121], F. Malek[55], U. Mallik[62], D. Malon[6], C. Malone[143], S. Maltezos[10], V. Malyshev[107], S. Malyukov[30], R. Mameghani[98], J. Mamuzic[13b], A. Manabe[65], L. Mandelli[89a], I. Mandić[74], R. Mandrysch[16], J. Maneira[124a], A. Manfredini[99], P.S. Mangeard[88], L. Manhaes de Andrade Filho[24b], J.A. Manjarres Ramos[136], A. Mann[54], P.M. Manning[137], A. Manousakis-Katsikakis[9], B. Mansoulie[136], A. Mapelli[30], L. Mapelli[30], L. March[167], J.F. Marchand[29], F. Marchese[133a,133b], G. Marchiori[78], M. Marcisovsky[125], C.P. Marino[169], F. Marroquim[24a], Z. Marshall[30], F.K. Martens[158], L.F. Marti[17], S. Marti-Garcia[167], B. Martin[30], B. Martin[88], J.P. Martin[93], T.A. Martin[18], V.J. Martin[46], B. Martin dit Latour[49], S. Martin-Haugh[149], M. Martinez[12], V. Martinez Outschoorn[57], A.C. Martyniuk[169], M. Marx[82], F. Marzano[132a], A. Marzin[111], L. Masetti[81], T. Mashimo[155], R. Mashinistov[94], J. Masik[82], A.L. Maslennikov[107], I. Massa[20a,20b], G. Massaro[105], N. Massol[5], P. Mastrandrea[148], A. Mastroberardino[37a,37b], T. Masubuchi[155], P. Matricon[115], H. Matsunaga[155], T. Matsushita[66], C. Mattravers[118,c], J. Maurer[83], S.J. Maxfield[73], D.A. Maximov[107,f], A. Mayne[139], R. Mazini[151], M. Mazur[21], L. Mazzaferro[133a,133b], M. Mazzanti[89a], J. Mc Donald[85], S.P. Mc Kee[87], A. McCarn[165], R.L. McCarthy[148], T.G. McCarthy[29], N.A. McCubbin[129], K.W. McFarlane[56,*], J.A. Mcfayden[139], G. Mchedlidze[51b], T. Mclaughlan[18], S.J. McMahon[129], R.A. McPherson[169,j], A. Meade[84], J. Mechnich[105], M. Mechtel[175], M. Medinnis[42], R. Meera-Lebbai[111], T. Meguro[116], S. Mehlhase[36], A. Mehta[73], K. Meier[58a], B. Meirose[79], C. Melachrinos[31], B.R. Mellado Garcia[173], F. Meloni[89a,89b], L. Mendoza Navas[162], Z. Meng[151,v], A. Mengarelli[20a,20b], S. Menke[99], E. Meoni[161], K.M. Mercurio[57], P. Mermod[49], L. Merola[102a,102b], C. Meroni[89a], F.S. Merritt[31], H. Merritt[109], A. Messina[30,w], J. Metcalfe[25], A.S. Mete[163], C. Meyer[81], C. Meyer[31], J-P. Meyer[136], J. Meyer[174], J. Meyer[54], T.C. Meyer[30], S. Michal[30], L. Micu[26a], R.P. Middleton[129], S. Migas[73], L. Mijović[136], G. Mikenberg[172], M. Mikestikova[125], M. Mikuž[74], D.W. Miller[31], R.J. Miller[88], W.J. Mills[168], C. Mills[57], A. Milov[172], D.A. Milstead[146a,146b], D. Milstein[172], A.A. Minaenko[128], M. Miñano Moya[167], I.A. Minashvili[64], A.I. Mincer[108], B. Mindur[38], M. Mineev[64], Y. Ming[173], L.M. Mir[12], G. Mirabelli[132a], J. Mitrevski[137], V.A. Mitsou[167], S. Mitsui[65], P.S. Miyagawa[139], J.U. Mjörnmark[79], T. Moa[146a,146b], V. Moeller[28], K. Mönig[42], N. Möser[21], S. Mohapatra[148], W. Mohr[48], R. Moles-Valls[167], A. Molfetas[30], J. Monk[77], E. Monnier[83], J. Montejo Berlingen[12], F. Monticelli[70], S. Monzani[20a,20b], R.W. Moore[3], G.F. Moorhead[86], C. Mora Herrera[49], A. Moraes[53], N. Morange[136], J. Morel[54], G. Morello[37a,37b], D. Moreno[81], M. Moreno Llácer[167], P. Morettini[50a], M. Morgenstern[44], M. Morii[57], A.K. Morley[30], G. Mornacchi[30], J.D. Morris[75], L. Morvaj[101], H.G. Moser[99], M. Mosidze[51b], J. Moss[109], R. Mount[143], E. Mountricha[10,x], S.V. Mouraviev[94,*], E.J.W. Moyse[84], F. Mueller[58a], J. Mueller[123], K. Mueller[21], T.A. Müller[98], T. Mueller[81], D. Muenstermann[30], Y. Munwes[153], W.J. Murray[129], I. Mussche[105], E. Musto[102a,102b], A.G. Myagkov[128], M. Myska[125], O. Nackenhorst[54], J. Nadal[12], K. Nagai[160], R. Nagai[157], K. Nagano[65], A. Nagarkar[109], Y. Nagasaka[59], M. Nagel[99], A.M. Nairz[30], Y. Nakahama[30], K. Nakamura[155], T. Nakamura[155], I. Nakano[110], G. Nanava[21], A. Napier[161], R. Narayan[58b], M. Nash[77,c], T. Nattermann[21], T. Naumann[42], G. Navarro[162], H.A. Neal[87], P.Yu. Nechaeva[94], T.J. Neep[82], A. Negri[119a,119b], G. Negri[30], M. Negrini[20a], S. Nektarijevic[49], A. Nelson[163], T.K. Nelson[143], S. Nemecek[125], P. Nemethy[108], A.A. Nepomuceno[24a], M. Nessi[30,y], M.S. Neubauer[165], M. Neumann[175], A. Neusiedl[81], R.M. Neves[108], P. Nevski[25], F.M. Newcomer[120], P.R. Newman[18], V. Nguyen Thi Hong[136], R.B. Nickerson[118], R. Nicolaidou[136], B. Nicquevert[30], F. Niedercorn[115], J. Nielsen[137], N. Nikiforou[35], A. Nikiforov[16], V. Nikolaenko[128], I. Nikolic-Audit[78], K. Nikolics[49], K. Nikolopoulos[18], H. Nilsen[48], P. Nilsson[8], Y. Ninomiya[155], A. Nisati[132a], R. Nisius[99], T. Nobe[157], L. Nodulman[6], M. Nomachi[116], I. Nomidis[154], S. Norberg[111], M. Nordberg[30], P.R. Norton[129], J. Novakova[126], M. Nozaki[65], L. Nozka[113], I.M. Nugent[159a], A.-E. Nuncio-Quiroz[21], G. Nunes Hanninger[86], T. Nunnemann[98], E. Nurse[77], B.J. O'Brien[46], D.C. O'Neil[142],

V. O'Shea[53], L.B. Oakes[98], F.G. Oakham[29,d], H. Oberlack[99], J. Ocariz[78], A. Ochi[66], S. Oda[69], S. Odaka[65], J. Odier[83], H. Ogren[60], A. Oh[82], S.H. Oh[45], C.C. Ohm[30], T. Ohshima[101], W. Okamura[116], H. Okawa[25], Y. Okumura[31], T. Okuyama[155], A. Olariu[26a], A.G. Olchevski[64], S.A. Olivares Pino[32a], M. Oliveira[124a,g], D. Oliveira Damazio[25], E. Oliver Garcia[167], D. Olivito[120], A. Olszewski[39], J. Olszowska[39], A. Onofre[124a,z], P.U.E. Onyisi[31], C.J. Oram[159a], M.J. Oreglia[31], Y. Oren[153], D. Orestano[134a,134b], N. Orlando[72a,72b], I. Orlov[107], C. Oropeza Barrera[53], R.S. Orr[158], B. Osculati[50a,50b], R. Ospanov[120], C. Osuna[12], G. Otero y Garzon[27], J.P. Ottersbach[105], M. Ouchrif[135d], E.A. Ouellette[169], F. Ould-Saada[117], A. Ouraou[136], Q. Ouyang[33a], A. Ovcharova[15], M. Owen[82], S. Owen[139], V.E. Ozcan[19a], N. Ozturk[8], A. Pacheco Pages[12], C. Padilla Aranda[12], S. Pagan Griso[15], E. Paganis[139], C. Pahl[99], F. Paige[25], P. Pais[84], K. Pajchel[117], G. Palacino[159b], C.P. Paleari[7], S. Palestini[30], D. Pallin[34], A. Palma[124a], J.D. Palmer[18], Y.B. Pan[173], E. Panagiotopoulou[10], J.G. Panduro Vazquez[76], P. Pani[105], N. Panikashvili[87], S. Panitkin[25], D. Pantea[26a], A. Papadelis[146a], Th.D. Papadopoulou[10], A. Paramonov[6], D. Paredes Hernandez[34], W. Park[25,aa], M.A. Parker[28], F. Parodi[50a,50b], J.A. Parsons[35], U. Parzefall[48], S. Pashapour[54], E. Pasqualucci[132a], S. Passaggio[50a], A. Passeri[134a], F. Pastore[134a,134b,*], Fr. Pastore[76], G. Pásztor[49,ab], S. Pataraia[175], N. Patel[150], J.R. Pater[82], S. Patricelli[102a,102b], T. Pauly[30], M. Pecsy[144a], S. Pedraza Lopez[167], M.I. Pedraza Morales[173], S.V. Peleganchuk[107], D. Pelikan[166], H. Peng[33b], B. Penning[31], A. Penson[35], J. Penwell[60], M. Perantoni[24a], K. Perez[35,ac], T. Perez Cavalcanti[42], E. Perez Codina[159a], M.T. Pérez García-Estañ[167], V. Perez Reale[35], L. Perini[89a,89b], H. Pernegger[30], R. Perrino[72a], P. Perrodo[5], V.D. Peshekhonov[64], K. Peters[30], B.A. Petersen[30], J. Petersen[30], T.C. Petersen[36], E. Petit[5], A. Petridis[154], C. Petridou[154], E. Petrolo[132a], F. Petrucci[134a,134b], D. Petschull[42], M. Petteni[142], R. Pezoa[32b], A. Phan[86], P.W. Phillips[129], G. Piacquadio[30], A. Picazio[49], E. Piccaro[75], M. Piccinini[20a,20b], S.M. Piec[42], R. Piegaia[27], D.T. Pignotti[109], J.E. Pilcher[31], A.D. Pilkington[82], J. Pina[124a,b], M. Pinamonti[164a,164c], A. Pinder[118], J.L. Pinfold[3], B. Pinto[124a], C. Pizio[89a,89b], M. Plamondon[169], M.-A. Pleier[25], E. Plotnikova[64], A. Poblaguev[25], S. Poddar[58a], F. Podlyski[34], L. Poggioli[115], D. Pohl[21], M. Pohl[49], G. Polesello[119a], A. Policicchio[37a,37b], A. Polini[20a], J. Poll[75], V. Polychronakos[25], D. Pomeroy[23], K. Pommès[30], L. Pontecorvo[132a], B.G. Pope[88], G.A. Popeneciu[26a], D.S. Popovic[13a], A. Poppleton[30], X. Portell Bueso[30], G.E. Pospelov[99], S. Pospisil[127], I.N. Potrap[99], C.J. Potter[149], C.T. Potter[114], G. Poulard[30], J. Poveda[60], V. Pozdnyakov[64], R. Prabhu[77], P. Pralavorio[83], A. Pranko[15], S. Prasad[30], R. Pravahan[25], S. Prell[63], K. Pretzl[17], D. Price[60], J. Price[73], L.E. Price[6], D. Prieur[123], M. Primavera[72a], K. Prokofiev[108], F. Prokoshin[32b], S. Protopopescu[25], J. Proudfoot[6], X. Prudent[44], M. Przybycien[38], H. Przysiezniak[5], S. Psoroulas[21], E. Ptacek[114], E. Pueschel[84], J. Purdham[87], M. Purohit[25,aa], P. Puzo[115], Y. Pylypchenko[62], J. Qian[87], A. Quadt[54], D.R. Quarrie[15], W.B. Quayle[173], F. Quinonez[32a], M. Raas[104], V. Radeka[25], V. Radescu[42], P. Radloff[114], T. Rador[19a], F. Ragusa[89a,89b], G. Rahal[178], A.M. Rahimi[109], D. Rahm[25], S. Rajagopalan[25], M. Rammensee[48], M. Rammes[141], A.S. Randle-Conde[40], K. Randrianarivony[29], F. Rauscher[98], T.C. Rave[48], M. Raymond[30], A.L. Read[117], D.M. Rebuzzi[119a,119b], A. Redelbach[174], G. Redlinger[25], R. Reece[120], K. Reeves[41], E. Reinherz-Aronis[153], A. Reinsch[114], I. Reisinger[43], C. Rembser[30], Z.L. Ren[151], A. Renaud[115], M. Rescigno[132a], S. Resconi[89a], B. Resende[136], P. Reznicek[98], R. Rezvani[158], R. Richter[99], E. Richter-Was[5,ad], M. Ridel[78], M. Rijpstra[105], M. Rijssenbeek[148], A. Rimoldi[119a,119b], L. Rinaldi[20a], R.R. Rios[40], I. Riu[12], G. Rivoltella[89a,89b], F. Rizatdinova[112], E. Rizvi[75], S.H. Robertson[85,j], A. Robichaud-Veronneau[118], D. Robinson[28], J.E.M. Robinson[82], A. Robson[53], J.G. Rocha de Lima[106], C. Roda[122a,122b], D. Roda Dos Santos[30], A. Roe[54], S. Roe[30], O. Røhne[117], S. Rolli[161], A. Romaniouk[96], M. Romano[20a,20b], G. Romeo[27], E. Romero Adam[167], N. Rompotis[138], L. Roos[78], E. Ros[167], S. Rosati[132a], K. Rosbach[49], A. Rose[149], M. Rose[76], G.A. Rosenbaum[158], E.I. Rosenberg[63], P.L. Rosendahl[14], O. Rosenthal[141], L. Rosselet[49], V. Rossetti[12], E. Rossi[132a,132b], L.P. Rossi[50a], M. Rotaru[26a], I. Roth[172], J. Rothberg[138], D. Rousseau[115], C.R. Royon[136], A. Rozanov[83], Y. Rozen[152], X. Ruan[33a,ae], F. Rubbo[12], I. Rubinskiy[42], N. Ruckstuhl[105], V.I. Rud[97], C. Rudolph[44], G. Rudolph[61], F. Rühr[7], A. Ruiz-Martinez[63], L. Rumyantsev[64], Z. Rurikova[48], N.A. Rusakovich[64], A. Ruschke[98], J.P. Rutherfoord[7], P. Ruzicka[125], Y.F. Ryabov[121], M. Rybar[126], G. Rybkin[115], N.C. Ryder[118], A.F. Saavedra[150], I. Sadeh[153], H.F-W. Sadrozinski[137], R. Sadykov[64], F. Safai Tehrani[132a], H. Sakamoto[155], G. Salamanna[75], A. Salamon[133a], M. Saleem[111], D. Salek[30], D. Salihagic[99], A. Salnikov[143], J. Salt[167], B.M. Salvachua Ferrando[6], D. Salvatore[37a,37b], F. Salvatore[149], A. Salvucci[104], A. Salzburger[30], D. Sampsonidis[154], B.H. Samset[117], A. Sanchez[102a,102b], V. Sanchez Martinez[167], H. Sandaker[14], H.G. Sander[81], M.P. Sanders[98], M. Sandhoff[175], T. Sandoval[28], C. Sandoval[162], R. Sandstroem[99], D.P.C. Sankey[129], A. Sansoni[47], C. Santamarina Rios[85], C. Santoni[34], R. Santonico[133a,133b], H. Santos[124a], J.G. Saraiva[124a], T. Sarangi[173], E. Sarkisyan-Grinbaum[8], F. Sarri[122a,122b], G. Sartisohn[175], O. Sasaki[65], Y. Sasaki[155], N. Sasao[67], I. Satsounkevitch[90], G. Sauvage[5,*], E. Sauvan[5], J.B. Sauvan[115], P. Savard[158,d], V. Savinov[123], D.O. Savu[30], L. Sawyer[25,l], D.H. Saxon[53], J. Saxon[120], C. Sbarra[20a], A. Sbrizzi[20a,20b], D.A. Scannicchio[163], M. Scarcella[150], J. Schaarschmidt[115], P. Schacht[99], D. Schaefer[120], U. Schäfer[81], A. Schaelicke[46], S. Schaepe[21], S. Schaetzel[58b], A.C. Schaffer[115], D. Schaile[98], R.D. Schamberger[148], A.G. Schamov[107], V. Scharf[58a], V.A. Schegelsky[121], D. Scheirich[87], M. Schernau[163], M.I. Scherzer[35], C. Schiavi[50a,50b], J. Schieck[98], M. Schioppa[37a,37b], S. Schlenker[30], E. Schmidt[48], K. Schmieden[21], C. Schmitt[81], S. Schmitt[58b], M. Schmitz[21], B. Schneider[17], U. Schnoor[44], L. Schoeffel[136], A. Schoening[58b], A.L.S. Schorlemmer[54], M. Schott[30], D. Schouten[159a], J. Schovancova[125], M. Schram[85],

C. Schroeder[81], N. Schroer[58c], M.J. Schultens[21], J. Schultes[175], H.-C. Schultz-Coulon[58a], H. Schulz[16], M. Schumacher[48], B.A. Schumm[137], Ph. Schune[136], C. Schwanenberger[82], A. Schwartzman[143], Ph. Schwegler[99], Ph. Schwemling[78], R. Schwienhorst[88], R. Schwierz[44], J. Schwindling[136], T. Schwindt[21], M. Schwoerer[5], G. Sciolla[23], W.G. Scott[129], J. Searcy[114], G. Sedov[42], E. Sedykh[121], S.C. Seidel[103], A. Seiden[137], F. Seifert[44], J.M. Seixas[24a], G. Sekhniaidze[102a], S.J. Sekula[40], K.E. Selbach[46], D.M. Seliverstov[121], B. Sellden[146a], G. Sellers[73], M. Seman[144b], N. Semprini-Cesari[20a,20b], C. Serfon[98], L. Serin[115], L. Serkin[54], R. Seuster[159a], H. Severini[111], A. Sfyrla[30], E. Shabalina[54], M. Shamim[114], L.Y. Shan[33a], J.T. Shank[22], Q.T. Shao[86], M. Shapiro[15], P.B. Shatalov[95], K. Shaw[164a,164c], D. Sherman[176], P. Sherwood[77], S. Shimizu[101], M. Shimojima[100], T. Shin[56], M. Shiyakova[64], A. Shmeleva[94], M.J. Shochet[31], D. Short[118], S. Shrestha[63], E. Shulga[96], M.A. Shupe[7], P. Sicho[125], A. Sidoti[132a], F. Siegert[48], Dj. Sijacki[13a], O. Silbert[172], J. Silva[124a], Y. Silver[153], D. Silverstein[143], S.B. Silverstein[146a], V. Simak[127], O. Simard[136], Lj. Simic[13a], S. Simion[115], E. Simioni[81], B. Simmons[77], R. Simoniello[89a,89b], M. Simonyan[36], P. Sinervo[158], N.B. Sinev[114], V. Sipica[141], G. Siragusa[174], A. Sircar[25], A.N. Sisakyan[64,*], S.Yu. Sivoklokov[97], J. Sjölin[146a,146b], T.B. Sjursen[14], L.A. Skinnari[15], H.P. Skottowe[57], K. Skovpen[107], P. Skubic[111], M. Slater[18], T. Slavicek[127], K. Sliwa[161], V. Smakhtin[172], B.H. Smart[46], L. Smestad[117], S.Yu. Smirnov[96], Y. Smirnov[96], L.N. Smirnova[97], O. Smirnova[79], B.C. Smith[57], D. Smith[143], K.M. Smith[53], M. Smizanska[71], K. Smolek[127], A.A. Snesarev[94], S.W. Snow[82], J. Snow[111], S. Snyder[25], R. Sobie[169,j], J. Sodomka[127], A. Soffer[153], C.A. Solans[167], M. Solar[127], J. Solc[127], E.Yu. Soldatov[96], U. Soldevila[167], E. Solfaroli Camillocci[132a,132b], A.A. Solodkov[128], O.V. Solovyanov[128], V. Solovyev[121], N. Soni[1], V. Sopko[127], B. Sopko[127], M. Sosebee[8], R. Soualah[164a,164c], A. Soukharev[107], S. Spagnolo[72a,72b], F. Spanò[76], R. Spighi[20a], G. Spigo[30], R. Spiwoks[30], M. Spousta[126,af], T. Spreitzer[158], B. Spurlock[8], R.D. St. Denis[53], J. Stahlman[120], R. Stamen[58a], E. Stanecka[39], R.W. Stanek[6], C. Stanescu[134a], M. Stanescu-Bellu[42], M.M. Stanitzki[42], S. Stapnes[117], E.A. Starchenko[128], J. Stark[55], P. Staroba[125], P. Starovoitov[42], R. Staszewski[39], A. Staude[98], P. Stavina[144a,*], G. Steele[53], P. Steinbach[44], P. Steinberg[25], I. Stekl[127], B. Stelzer[142], H.J. Stelzer[88], O. Stelzer-Chilton[159a], H. Stenzel[52], S. Stern[99], G.A. Stewart[30], J.A. Stillings[21], M.C. Stockton[85], K. Stoerig[48], G. Stoicea[26a], S. Stonjek[99], P. Strachota[126], A.R. Stradling[8], A. Straessner[44], J. Strandberg[147], S. Strandberg[146a,146b], A. Strandlie[117], M. Strang[109], E. Strauss[143], M. Strauss[111], P. Strizenec[144b], R. Ströhmer[174], D.M. Strom[114], J.A. Strong[76,*], R. Stroynowski[40], B. Stugu[14], I. Stumer[25,*], J. Stupak[148], P. Sturm[175], N.A. Styles[42], D.A. Soh[151,t], D. Su[143], HS. Subramania[3], R. Subramaniam[25], A. Succurro[12], Y. Sugaya[116], C. Suhr[106], M. Suk[126], V.V. Sulin[94], S. Sultansoy[4d], T. Sumida[67], X. Sun[55], J.E. Sundermann[48], K. Suruliz[139], G. Susinno[37a,37b], M.R. Sutton[149], Y. Suzuki[65], Y. Suzuki[66], M. Svatos[125], S. Swedish[168], I. Sykora[144a], T. Sykora[126], J. Sánchez[167], D. Ta[105], K. Tackmann[42], A. Taffard[163], R. Tafirout[159a], N. Taiblum[153], Y. Takahashi[101], H. Takai[25], R. Takashima[68], H. Takeda[66], T. Takeshita[140], Y. Takubo[65], M. Talby[83], A. Talyshev[107,f], M.C. Tamsett[25], K.G. Tan[86], J. Tanaka[155], R. Tanaka[115], S. Tanaka[131], S. Tanaka[65], A.J. Tanasijczuk[142], K. Tani[66], N. Tannoury[83], S. Tapprogge[81], D. Tardif[158], S. Tarem[152], F. Tarrade[29], G.F. Tartarelli[89a], P. Tas[126], M. Tasevsky[125], E. Tassi[37a,37b], M. Tatarkhanov[15], Y. Tayalati[135d], C. Taylor[77], F.E. Taylor[92], G.N. Taylor[86], W. Taylor[159b], M. Teinturier[115], F.A. Teischinger[30], M. Teixeira Dias Castanheira[75], P. Teixeira-Dias[76], K.K. Temming[48], H. Ten Kate[30], P.K. Teng[151], S. Terada[65], K. Terashi[155], J. Terron[80], M. Testa[47], R.J. Teuscher[158,j], J. Therhaag[21], T. Theveneaux-Pelzer[78], S. Thoma[48], J.P. Thomas[18], E.N. Thompson[35], P.D. Thompson[18], P.D. Thompson[158], A.S. Thompson[53], L.A. Thomsen[36], E. Thomson[120], M. Thomson[28], W.M. Thong[86], R.P. Thun[87], F. Tian[35], M.J. Tibbetts[15], T. Tic[125], V.O. Tikhomirov[94], Y.A. Tikhonov[107,f], S. Timoshenko[96], E. Tiouchichine[83], P. Tipton[176], S. Tisserant[83], T. Todorov[5], S. Todorova-Nova[161], B. Toggerson[163], J. Tojo[69], S. Tokár[144a], K. Tokushuku[65], K. Tollefson[88], M. Tomoto[101], L. Tompkins[31], K. Toms[103], A. Tonoyan[14], C. Topfel[17], N.D. Topilin[64], I. Torchiani[30], E. Torrence[114], H. Torres[78], E. Torró Pastor[167], J. Toth[83,ab], F. Touchard[83], D.R. Tovey[139], T. Trefzger[174], L. Tremblet[30], A. Tricoli[30], I.M. Trigger[159a], S. Trincaz-Duvoid[78], M.F. Tripiana[70], N. Triplett[25], W. Trischuk[158], B. Trocmé[55], C. Troncon[89a], M. Trottier-McDonald[142], M. Trzebinski[39], A. Trzupek[39], C. Tsarouchas[30], J.C-L. Tseng[118], M. Tsiakiris[105], P.V. Tsiareshka[90], D. Tsionou[5,ag], G. Tsipolitis[10], S. Tsiskaridze[12], V. Tsiskaridze[48], E.G. Tskhadadze[51a], I.I. Tsukerman[95], V. Tsulaia[15], J.-W. Tsung[21], S. Tsuno[65], D. Tsybychev[148], A. Tua[139], A. Tudorache[26a], V. Tudorache[26a], J.M. Tuggle[31], M. Turala[39], D. Turecek[127], I. Turk Cakir[4e], E. Turlay[105], R. Turra[89a,89b], P.M. Tuts[35], A. Tykhonov[74], M. Tylmad[146a,146b], M. Tyndel[129], G. Tzanakos[9], K. Uchida[21], I. Ueda[155], R. Ueno[29], M. Ugland[14], M. Uhlenbrock[21], M. Uhrmacher[54], F. Ukegawa[160], G. Unal[30], A. Undrus[25], G. Unel[163], Y. Unno[65], D. Urbaniec[35], P. Urquijo[21], G. Usai[8], M. Uslenghi[119a,119b], L. Vacavant[83], V. Vacek[127], B. Vachon[85], S. Vahsen[15], J. Valenta[125], S. Valentinetti[20a,20b], A. Valero[167], S. Valkar[126], E. Valladolid Gallego[167], S. Vallecorsa[152], J.A. Valls Ferrer[167], R. Van Berg[120], P.C. Van Der Deijl[105], R. van der Geer[105], H. van der Graaf[105], R. Van Der Leeuw[105], E. van der Poel[105], D. van der Ster[30], N. van Eldik[30], P. van Gemmeren[6], I. van Vulpen[105], M. Vanadia[99], W. Vandelli[30], A. Vaniachine[6], P. Vankov[42], F. Vannucci[78], R. Vari[132a], E.W. Varnes[7], T. Varol[84], D. Varouchas[15], A. Vartapetian[8], K.E. Varvell[150], V.I. Vassilakopoulos[56], F. Vazeille[34], T. Vazquez Schroeder[54], G. Vegni[89a,89b], J.J. Veillet[115], F. Veloso[124a], R. Veness[30], S. Veneziano[132a], A. Ventura[72a,72b], D. Ventura[84], M. Venturi[48], N. Venturi[158], V. Vercesi[119a], M. Verducci[138], W. Verkerke[105], J.C. Vermeulen[105], A. Vest[44],

M.C. Vetterli[142,d], I. Vichou[165], T. Vickey[145b,ah], O.E. Vickey Boeriu[145b], G.H.A. Viehhauser[118], S. Viel[168], M. Villa[20a,20b], M. Villaplana Perez[167], E. Vilucchi[47], M.G. Vincter[29], E. Vinek[30], V.B. Vinogradov[64], M. Virchaux[136,*], J. Virzi[15], O. Vitells[172], M. Viti[42], I. Vivarelli[48], F. Vives Vaque[3], S. Vlachos[10], D. Vladoiu[98], M. Vlasak[127], A. Vogel[21], P. Vokac[127], G. Volpi[47], M. Volpi[86], G. Volpini[89a], H. von der Schmitt[99], H. von Radziewski[48], E. von Toerne[21], V. Vorobel[126], V. Vorwerk[12], M. Vos[167], R. Voss[30], T.T. Voss[175], J.H. Vossebeld[73], N. Vranjes[136], M. Vranjes Milosavljevic[105], V. Vrba[125], M. Vreeswijk[105], T. Vu Anh[48], R. Vuillermet[30], I. Vukotic[31], W. Wagner[175], P. Wagner[120], H. Wahlen[175], S. Wahrmund[44], J. Wakabayashi[101], S. Walch[87], J. Walder[71], R. Walker[98], W. Walkowiak[141], R. Wall[176], P. Waller[73], B. Walsh[176], C. Wang[45], H. Wang[173], H. Wang[33b,ai], J. Wang[151], J. Wang[55], R. Wang[103], S.M. Wang[151], T. Wang[21], A. Warburton[85], C.P. Ward[28], D.R. Wardrope[77], M. Warsinsky[48], A. Washbrook[46], C. Wasicki[42], I. Watanabe[66], P.M. Watkins[18], A.T. Watson[18], I.J. Watson[150], M.F. Watson[18], G. Watts[138], S. Watts[82], A.T. Waugh[150], B.M. Waugh[77], M.S. Weber[17], P. Weber[54], J.S. Webster[31], A.R. Weidberg[118], P. Weigell[99], J. Weingarten[54], C. Weiser[48], P.S. Wells[30], T. Wenaus[25], D. Wendland[16], Z. Weng[151,t], T. Wengler[30], S. Wenig[30], N. Wermes[21], M. Werner[48], P. Werner[30], M. Werth[163], M. Wessels[58a], J. Wetter[161], C. Weydert[55], K. Whalen[29], A. White[8], M.J. White[86], S. White[122a,122b], S.R. Whitehead[118], D. Whiteson[163], D. Whittington[60], F. Wicek[115], D. Wicke[175], F.J. Wickens[129], W. Wiedenmann[173], M. Wielers[129], P. Wienemann[21], C. Wiglesworth[75], L.A.M. Wiik-Fuchs[21], P.A. Wijeratne[77], A. Wildauer[99], M.A. Wildt[42,q], I. Wilhelm[126], H.G. Wilkens[30], J.Z. Will[98], E. Williams[35], H.H. Williams[120], W. Willis[35], S. Willocq[84], J.A. Wilson[18], M.G. Wilson[143], A. Wilson[87], I. Wingerter-Seez[5], S. Winkelmann[48], F. Winklmeier[30], M. Wittgen[143], S.J. Wollstadt[81], M.W. Wolter[39], H. Wolters[124a,g], W.C. Wong[41], G. Wooden[87], B.K. Wosiek[39], J. Wotschack[30], M.J. Woudstra[82], K.W. Wozniak[39], K. Wraight[53], M. Wright[53], B. Wrona[73], S.L. Wu[173], X. Wu[49], Y. Wu[33b,aj], E. Wulf[35], B.M. Wynne[46], S. Xella[36], M. Xiao[136], S. Xie[48], C. Xu[33b,x], D. Xu[139], B. Yabsley[150], S. Yacoob[145a,ak], M. Yamada[65], H. Yamaguchi[155], A. Yamamoto[65], K. Yamamoto[63], S. Yamamoto[155], T. Yamamura[155], T. Yamanaka[155], T. Yamazaki[155], Y. Yamazaki[66], Z. Yan[22], H. Yang[87], U.K. Yang[82], Y. Yang[109], Z. Yang[146a,146b], S. Yanush[91], L. Yao[33a], Y. Yao[15], Y. Yasu[65], G.V. Ybeles Smit[130], J. Ye[40], S. Ye[25], M. Yilmaz[4c], R. Yoosoofmiya[123], K. Yorita[171], R. Yoshida[6], K. Yoshihara[155], C. Young[143], C.J. Young[118], S. Youssef[22], D. Yu[25], J. Yu[8], J. Yu[112], L. Yuan[66], A. Yurkewicz[106], B. Zabinski[39], R. Zaidan[62], A.M. Zaitsev[128], Z. Zajacova[30], L. Zanello[132a,132b], D. Zanzi[99], A. Zaytsev[25], C. Zeitnitz[175], M. Zeman[125], A. Zemla[39], C. Zendler[21], O. Zenin[128], T. Ženiš[144a], Z. Zinonos[122a,122b], S. Zenz[15], D. Zerwas[115], G. Zevi della Porta[57], D. Zhang[33b,ai], H. Zhang[88], J. Zhang[6], X. Zhang[33d], Z. Zhang[115], L. Zhao[108], Z. Zhao[33b], A. Zhemchugov[64], J. Zhong[118], B. Zhou[87], N. Zhou[163], Y. Zhou[151], C.G. Zhu[33d], H. Zhu[42], J. Zhu[87], Y. Zhu[33b], X. Zhuang[98], V. Zhuravlov[99], A. Zibell[98], D. Zieminska[60], N.I. Zimin[64], R. Zimmermann[21], S. Zimmermann[21], S. Zimmermann[48], M. Ziolkowski[141], R. Zitoun[5], L. Živković[35], V.V. Zmouchko[128,*], G. Zobernig[173], A. Zoccoli[20a,20b], M. zur Nedden[16], V. Zutshi[106], L. Zwalinski[30]

[1]School of Chemistry and Physics, University of Adelaide, Adelaide, Australia

[2]Physics Department, SUNY Albany, Albany NY, United States of America

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

[4](a) Department of Physics, Ankara University, Ankara; (b) Department of Physics, Dumlupinar University, Kutahya; (c) Department of Physics, Gazi University, Ankara; (d) Division of Physics, TOBB University of Economics and Technology, Ankara; (e) 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, United States of America

[7]Department of Physics, University of Arizona, Tucson AZ, United States of America

[8]Department of Physics, The University of Texas at Arlington, Arlington TX, United States of America

[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 and ICREA, Barcelona, Spain

[13](a) Institute of Physics, University of Belgrade, Belgrade; (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, United States of America

[16]Department of Physics, Humboldt University, Berlin, Germany

[17]Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland

[18] School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom

[19] (a) Department of Physics, Bogazici University, Istanbul; (b) Division of Physics, Dogus University, Istanbul; (c) Department of Physics Engineering, Gaziantep University, Gaziantep; (d) Department of Physics, Istanbul Technical University, Istanbul, Turkey

[20] (a) INFN Sezione di Bologna; (b) Dipartimento di Fisica, Università di Bologna, Bologna, Italy

[21] Physikalisches Institut, University of Bonn, Bonn, Germany

[22] Department of Physics, Boston University, Boston MA, United States of America

[23] Department of Physics, Brandeis University, Waltham MA, United States of America

[24] (a) Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro; (b) Federal University of Juiz de Fora (UFJF), Juiz de Fora; (c) Federal University of Sao Joao del Rei (UFSJ), Sao Joao del Rei; (d) Instituto de Fisica, Universidade de Sao Paulo, Sao Paulo, Brazil

[25] Physics Department, Brookhaven National Laboratory, Upton NY, United States of America

[26] (a) National Institute of Physics and Nuclear Engineering, Bucharest; (b) University Politehnica Bucharest, Bucharest; (c) West University in Timisoara, Timisoara, Romania

[27] Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina

[28] Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom

[29] Department of Physics, Carleton University, Ottawa ON, Canada

[30] CERN, Geneva, Switzerland

[31] Enrico Fermi Institute, University of Chicago, Chicago IL, United States of America

[32] (a) Departamento de Física, Pontificia Universidad Católica de Chile, Santiago; (b) Departamento de Física, Universidad Técnica Federico Santa María, Valparaíso, Chile

[33] (a) Institute of High Energy Physics, Chinese Academy of Sciences, Beijing; (b) Department of Modern Physics, University of Science and Technology of China, Anhui; (c) Department of Physics, Nanjing University, Jiangsu; (d) School of Physics, Shandong University, Shandong, 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, United States of America

[36] Niels Bohr Institute, University of Copenhagen, Kobenhavn, Denmark

[37] (a) INFN Gruppo Collegato di Cosenza; (b) Dipartimento di Fisica, Università della Calabria, Arcavata di Rende, Italy

[38] AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland

[39] The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland

[40] Physics Department, Southern Methodist University, Dallas TX, United States of America

[41] Physics Department, University of Texas at Dallas, Richardson TX, United States of America

[42] DESY, Hamburg and Zeuthen, Germany

[43] Institut für Experimentelle Physik IV, Technische Universität Dortmund, Dortmund, Germany

[44] Institut für Kern- und Teilchenphysik, Technical University Dresden, Dresden, Germany

[45] Department of Physics, Duke University, Durham NC, United States of America

[46] SUPA - School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom

[47] INFN Laboratori Nazionali di Frascati, Frascati, Italy

[48] Fakultät für Mathematik und Physik, Albert-Ludwigs-Universität, Freiburg, Germany

[49] Section de Physique, Université de Genève, Geneva, Switzerland

[50] (a) INFN Sezione di Genova; (b) Dipartimento di Fisica, Università di Genova, Genova, Italy

[51] (a) E. Andronikashvili Institute of Physics, Iv. Javakhishvili Tbilisi State University, Tbilisi; (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, United Kingdom

[54] II Physikalisches Institut, Georg-August-Universität, Göttingen, Germany

[55] Laboratoire de Physique Subatomique et de Cosmologie, Université Joseph Fourier and CNRS/IN2P3 and Institut National Polytechnique de Grenoble, Grenoble, France

[56] Department of Physics, Hampton University, Hampton VA, United States of America

[57] Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge MA, United States of America

[58] (a) Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg; (b) Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg; (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, United States of America

[61]Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria

[62]University of Iowa, Iowa City IA, United States of America

[63]Department of Physics and Astronomy, Iowa State University, Ames IA, United States of America

[64]Joint Institute for Nuclear Research, JINR Dubna, Dubna, Russia

[65]KEK, High Energy Accelerator Research Organization, Tsukuba, Japan

[66]Graduate School of Science, Kobe University, Kobe, Japan

[67]Faculty of Science, Kyoto University, Kyoto, Japan

[68]Kyoto University of Education, Kyoto, Japan

[69]Department of Physics, Kyushu University, Fukuoka, Japan

[70]Instituto de Física La Plata, Universidad Nacional de La Plata and CONICET, La Plata, Argentina

[71]Physics Department, Lancaster University, Lancaster, United Kingdom

[72](a) INFN Sezione di Lecce; (b) Dipartimento di Matematica e Fisica, Università del Salento, Lecce, Italy

[73]Oliver Lodge Laboratory, University of Liverpool, Liverpool, United Kingdom

[74]Department of Physics, Jožef Stefan Institute and University of Ljubljana, Ljubljana, Slovenia

[75]School of Physics and Astronomy, Queen Mary University of London, London, United Kingdom

[76]Department of Physics, Royal Holloway University of London, Surrey, United Kingdom

[77]Department of Physics and Astronomy, University College London, London, United Kingdom

[78]Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France

[79]Fysiska institutionen, Lunds universitet, Lund, Sweden

[80]Departamento de Fisica Teorica C-15, Universidad Autonoma de Madrid, Madrid, Spain

[81]Institut für Physik, Universität Mainz, Mainz, Germany

[82]School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom

[83]CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France

[84]Department of Physics, University of Massachusetts, Amherst MA, United States of America

[85]Department of Physics, McGill University, Montreal QC, Canada

[86]School of Physics, University of Melbourne, Victoria, Australia

[87]Department of Physics, The University of Michigan, Ann Arbor MI, United States of America

[88]Department of Physics and Astronomy, Michigan State University, East Lansing MI, United States of America

[89](a) INFN Sezione di Milano; (b) Dipartimento di Fisica, Università di Milano, Milano, Italy

[90]B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Republic of Belarus

[91]National Scientific and Educational Centre for Particle and High Energy Physics, Minsk, Republic of Belarus

[92]Department of Physics, Massachusetts Institute of Technology, Cambridge MA, United States of America

[93]Group of Particle Physics, University of Montreal, Montreal QC, Canada

[94]P.N. Lebedev Institute of Physics, Academy of Sciences, Moscow, Russia

[95]Institute for Theoretical and Experimental Physics (ITEP), Moscow, Russia

[96]Moscow Engineering and Physics Institute (MEPhI), Moscow, Russia

[97]Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow, Russia

[98]Fakultät für Physik, Ludwig-Maximilians-Universität München, München, Germany

[99]Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München, Germany

[100]Nagasaki Institute of Applied Science, Nagasaki, Japan

[101]Graduate School of Science and Kobayashi-Maskawa Institute, Nagoya University, Nagoya, Japan

[102](a) INFN Sezione di Napoli; (b) Dipartimento di Scienze Fisiche, Università di Napoli, Napoli, Italy

[103]Department of Physics and Astronomy, University of New Mexico, Albuquerque NM, United States of America

[104]Institute for Mathematics, Astrophysics and Particle Physics, Radboud University Nijmegen/Nikhef, Nijmegen, Netherlands

[105]Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam, Netherlands

[106]Department of Physics, Northern Illinois University, DeKalb IL, United States of America

[107]Budker Institute of Nuclear Physics, SB RAS, Novosibirsk, Russia

[108]Department of Physics, New York University, New York NY, United States of America

[109]Ohio State University, Columbus OH, United States of America

[110]Faculty of Science, Okayama University, Okayama, Japan

[111]Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman OK, United States of America

[112]Department of Physics, Oklahoma State University, Stillwater OK, United States of America

[113]Palacký University, RCPTM, Olomouc, Czech Republic

[114]Center for High Energy Physics, University of Oregon, Eugene OR, United States of America

[115]LAL, Université Paris-Sud and CNRS/IN2P3, Orsay, France

[116]Graduate School of Science, Osaka University, Osaka, Japan

[117]Department of Physics, University of Oslo, Oslo, Norway

[118]Department of Physics, Oxford University, Oxford, United Kingdom

[119](a) INFN Sezione di Pavia; (b) Dipartimento di Fisica, Università di Pavia, Pavia, Italy

[120]Department of Physics, University of Pennsylvania, Philadelphia PA, United States of America

[121]Petersburg Nuclear Physics Institute, Gatchina, Russia

[122](a) INFN Sezione di Pisa; (b) Dipartimento di Fisica E. Fermi, Università di Pisa, Pisa, Italy

[123]Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh PA, United States of America

[124](a) Laboratorio de Instrumentacao e Fisica Experimental de Particulas - LIP, Lisboa, Portugal; (b) Departamento de Fisica Teorica y del Cosmos and CAFPE, Universidad de Granada, Granada, Spain

[125]Institute of Physics, Academy of Sciences of the Czech Republic, Praha, Czech Republic

[126]Faculty of Mathematics and Physics, Charles University in Prague, Praha, Czech Republic

[127]Czech Technical University in Prague, Praha, Czech Republic

[128]State Research Center Institute for High Energy Physics, Protvino, Russia

[129]Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom

[130]Physics Department, University of Regina, Regina SK, Canada

[131]Ritsumeikan University, Kusatsu, Shiga, Japan

[132](a) INFN Sezione di Roma I; (b) Dipartimento di Fisica, Università La Sapienza, Roma, Italy

[133](a) INFN Sezione di Roma Tor Vergata; (b) Dipartimento di Fisica, Università di Roma Tor Vergata, Roma, Italy

[134](a) INFN Sezione di Roma Tre; (b) Dipartimento di Fisica, Università Roma Tre, Roma, Italy

[135](a) Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies - Université Hassan II, Casablanca; (b) Centre National de l'Energie des Sciences Techniques Nucleaires, Rabat; (c) Faculté des Sciences Semlalia, Université Cadi Ayyad, LPHEA-Marrakech; (d) Faculté des Sciences, Université Mohamed Premier and LPTPM, Oujda; (e) Faculté des sciences, Université Mohammed V-Agdal, Rabat, Morocco

[136]DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l'Univers), CEA Saclay (Commissariat a l'Energie Atomique), Gif-sur-Yvette, France

[137]Santa Cruz Institute for Particle Physics, University of California Santa Cruz, Santa Cruz CA, United States of America

[138]Department of Physics, University of Washington, Seattle WA, United States of America

[139]Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom

[140]Department of Physics, Shinshu University, Nagano, Japan

[141]Fachbereich Physik, Universität Siegen, Siegen, Germany

[142]Department of Physics, Simon Fraser University, Burnaby BC, Canada

[143]SLAC National Accelerator Laboratory, Stanford CA, United States of America

[144](a) Faculty of Mathematics, Physics & Informatics, Comenius University, Bratislava; (b) Department of Subnuclear Physics, Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice, Slovak Republic

[145](a) Department of Physics, University of Johannesburg, Johannesburg; (b) School of Physics, University of the Witwatersrand, Johannesburg, South Africa

[146](a) Department of Physics, Stockholm University; (b) The Oskar Klein Centre, Stockholm, Sweden

[147]Physics Department, Royal Institute of Technology, Stockholm, Sweden

[148]Departments of Physics & Astronomy and Chemistry, Stony Brook University, Stony Brook NY, United States of America

[149]Department of Physics and Astronomy, University of Sussex, Brighton, United Kingdom

[150]School of Physics, University of Sydney, Sydney, Australia

[151]Institute of Physics, Academia Sinica, Taipei, Taiwan

[152]Department of Physics, Technion: Israel Institute of Technology, Haifa, Israel

[153]Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel

[154]Department of Physics, Aristotle University of Thessaloniki, Thessaloniki, Greece

[155]International Center for Elementary Particle Physics and Department of Physics, The University of Tokyo, Tokyo, Japan

[156]Graduate School of Science and Technology, Tokyo Metropolitan University, Tokyo, Japan

[157]Department of Physics, Tokyo Institute of Technology, Tokyo, Japan

[158]Department of Physics, University of Toronto, Toronto ON, Canada

[159](a) TRIUMF, Vancouver BC; (b) Department of Physics and Astronomy, York University, Toronto ON, Canada

[160]Faculty of Pure and Applied Sciences, University of Tsukuba, Tsukuba, Japan

[161]Department of Physics and Astronomy, Tufts University, Medford MA, United States of America

[162]Centro de Investigaciones, Universidad Antonio Narino, Bogota, Colombia

[163]Department of Physics and Astronomy, University of California Irvine, Irvine CA, United States of America

[164](a) INFN Gruppo Collegato di Udine, Udine; (b) ICTP, Trieste; (c) Dipartimento di Chimica, Fisica e Ambiente, Università di Udine, Udine, Italy

[165]Department of Physics, University of Illinois, Urbana IL, United States of America

[166]Department of Physics and Astronomy, University of Uppsala, Uppsala, Sweden

[167]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

[168]Department of Physics, University of British Columbia, Vancouver BC, Canada

[169]Department of Physics and Astronomy, University of Victoria, Victoria BC, Canada

[170]Department of Physics, University of Warwick, Coventry, United Kingdom

[171]Waseda University, Tokyo, Japan

[172]Department of Particle Physics, The Weizmann Institute of Science, Rehovot, Israel

[173]Department of Physics, University of Wisconsin, Madison WI, United States of America

[174]Fakultät für Physik und Astronomie, Julius-Maximilians-Universität, Würzburg, Germany

[175]Fachbereich C Physik, Bergische Universität Wuppertal, Wuppertal, Germany

[176]Department of Physics, Yale University, New Haven CT, United States of America

[177]Yerevan Physics Institute, Yerevan, Armenia

[178]Centre de Calcul de l'Institut National de Physique Nucléaire et de Physique des Particules (IN2P3), Villeurbanne, France

[a]Also at Laboratorio de Instrumentacao e Fisica Experimental de Particulas - LIP, Lisboa, Portugal

[b]Also at Faculdade de Ciencias and CFNUL, Universidade de Lisboa, Lisboa, Portugal

[c]Also at Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom

[d]Also at TRIUMF, Vancouver BC, Canada

[e]Also at Department of Physics, California State University, Fresno CA, United States of America

[f]Also at Novosibirsk State University, Novosibirsk, Russia

[g]Also at Department of Physics, University of Coimbra, Coimbra, Portugal

[h]Also at Department of Physics, UASLP, San Luis Potosi, Mexico

[i]Also at Università di Napoli Parthenope, Napoli, Italy

[j]Also at Institute of Particle Physics (IPP), Canada

[k]Also at Department of Physics, Middle East Technical University, Ankara, Turkey

[l]Also at Louisiana Tech University, Ruston LA, United States of America

[m]Also at Dep Fisica and CEFITEC of Faculdade de Ciencias e Tecnologia, Universidade Nova de Lisboa, Caparica, Portugal

[n]Also at Department of Physics and Astronomy, University College London, London, United Kingdom

[o]Also at Department of Physics, University of Cape Town, Cape Town, South Africa

[p]Also at Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan

[q]Also at Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany

[r]Also at Manhattan College, New York NY, United States of America

[s]Also at CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France

[t]Also at School of Physics and Engineering, Sun Yat-sen University, Guanzhou, China

[u]Also at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan

[v]Also at School of Physics, Shandong University, Shandong, China

[w]Also at Dipartimento di Fisica, Università La Sapienza, Roma, Italy

[x] Also at DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l'Univers), CEA Saclay (Commissariat a l'Energie Atomique), Gif-sur-Yvette, France

[y] Also at Section de Physique, Université de Genève, Geneva, Switzerland

[z] Also at Departamento de Fisica, Universidade de Minho, Braga, Portugal

[aa] Also at Department of Physics and Astronomy, University of South Carolina, Columbia SC, United States of America

[ab] Also at Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Budapest, Hungary

[ac] Also at California Institute of Technology, Pasadena CA, United States of America

[ad] Also at Institute of Physics, Jagiellonian University, Krakow, Poland

[ae] Also at LAL, Université Paris-Sud and CNRS/IN2P3, Orsay, France

[af] Also at Nevis Laboratory, Columbia University, Irvington NY, United States of America

[ag] Also at Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom

[ah] Also at Department of Physics, Oxford University, Oxford, United Kingdom

[ai] Also at Institute of Physics, Academia Sinica, Taipei, Taiwan

[aj] Also at Department of Physics, The University of Michigan, Ann Arbor MI, United States of America

[ak] Also at Discipline of Physics, University of KwaZulu-Natal, Durban, South Africa

[*] Deceased