Search for an excess of events with an identical flavour lepton pair and significant missing transverse momentum in √s = 7 TeV proton-proton collisions with the ATLAS detector

Aad, G.; et al., [Unknown]; Bentvelsen, S.; Colijn, A.P.; de Jong, P.; de Nooij, L.; Doxiadis, A.D.; Ferrari, P.; Garitaonandia, H.; Geerts, D.A.A.; Gosselink, M.; Kayl, M.S.; Koffeman, E.; Lee, H.; Linde, F.; Mechnich, J.; Mussche, I.; Ottersbach, J.P.; Tsiakiris, M.; van der Kraaij, E.; van der Leeuw, R.; van Kesteren, Z.; van Vulpen, I.; Vermeulen, J.C.; Vreeswijk, M.

DOI
10.1140/epjc/s10052-011-1647-9

Publication date
2011

Document Version
Final published version

Published in
European Physical Journal C

Eur. Phys. J. C (2011) 71:1647
DOI 10.1140/epjc/s10052-011-1647-9

THE EUROPEAN PHYSICAL JOURNAL C

Letter

Search for an excess of events with an identical flavour lepton pair and significant missing transverse momentum in $\sqrt{s} = 7$ TeV proton–proton collisions with the ATLAS detector

The ATLAS Collaboration[*]
CERN, 1211 Geneva 23, Switzerland

Received: 1 April 2011 / Revised: 28 April 2011 / Published online: 9 July 2011

Abstract Results are presented of a search for particles decaying into final states with significant missing transverse momentum and exactly two identical flavour leptons (e, μ) of opposite charge in $\sqrt{s} = 7$ TeV collisions at the Large Hadron Collider. This channel is particularly sensitive to supersymmetric particle cascade decays producing flavour correlated lepton pairs. Flavour uncorrelated backgrounds are subtracted using a sample of opposite flavour lepton pair events. Observation of an excess beyond Standard Model expectations following this subtraction procedure would offer one of the best routes to measuring the masses of supersymmetric particles. In a data sample corresponding to an integrated luminosity of 35 pb^{-1} no such excess is observed. Model-independent limits are set on the contribution to these final states from supersymmetry and are used to exclude regions of a phenomenological supersymmetric parameter space.

In this letter the first results are reported of a search for the production of particles at ATLAS in events with exactly two leptons of identical flavour (e or μ) and opposite charge, and significant missing transverse momentum ($E_{\mathrm{T}}^{\mathrm{miss}}$). This signature can be generated in supersymmetry (SUSY) [1–9] events by the correlated production of leptons, for instance via the decay chains $\tilde{\chi}_2^0 \to \tilde{\ell}\ell^{\pm} \to \tilde{\chi}_1^0 \ell^+\ell^-$ or $\tilde{\chi}_2^0 \to \tilde{\chi}_1^0 \ell^+\ell^-$. Such events offer one of the best routes to model-independent measurements of the masses of SUSY particles via end-points in the lepton pair invariant mass distribution [10–12]. The dominant sources of Standard Model (SM) background generally possess equal branching fractions for the production of lepton pairs of identical and different flavour, and can therefore be removed with a 'flavour subtraction' procedure [10] in which the observation in the $e\mu$ channel is subtracted from that in the ee and $\mu\mu$ channels. The subtraction reduces the impact on the analysis of various experimental uncertainties, common to both the identical- and different-flavour channels. This method is applicable to a variety of different kinds of new physics. As a benchmark, this letter presents the results in terms of a search for SUSY. The results reported here are complementary to those of inclusive SUSY particle searches using lepton pairs [13], and also to those of inclusive searches requiring jets, $E_{\mathrm{T}}^{\mathrm{miss}}$ and zero leptons [14] or one lepton [15]. A search by CMS for SUSY in events with lepton pairs is reported in [16].

The ATLAS detector [17] is a multipurpose particle physics apparatus with a forward-backward symmetric cylindrical geometry and near 4π coverage in solid angle.[1] The inner tracking detector (ID) consists of a silicon pixel detector, a silicon microstrip detector (SCT), and a transition radiation tracker (TRT) which also provides particle identification capability. The ID is surrounded by a thin superconducting solenoid providing a 2 T magnetic field, and by high-granularity liquid-argon (LAr) sampling electromagnetic calorimeters. Hadronic coverage is provided by an iron-scintillator tile calorimeter in the central rapidity range. The end-cap and forward regions are instrumented with LAr calorimetry for both electromagnetic and hadronic measurements. The muon spectrometer (MS) surrounds the calorimeters and consists of three large superconducting toroids, a system of precision tracking chambers, and detectors for triggering.

[*] 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 coinciding with the axis of 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 plane, ϕ being the azimuthal angle around the beam pipe. The pseudorapidity is defined in terms of the polar angle θ as $\eta = -\ln\tan(\theta/2)$.

The pp-collision data used in this analysis were collected between March and November 2010 at the LHC operating at a centre-of-mass energy of 7 TeV. Application of basic beam, detector and data-quality requirements results in a total integrated luminosity of 35 pb^{-1}. The uncertainty on the luminosity is estimated to be 11% [18]. The data have been collected with a single lepton (e or μ) trigger. The detailed trigger requirements vary throughout the data-taking period due to the rapidly increasing LHC luminosity and the commissioning of the trigger system, but always have a threshold that ensures a trigger efficiency for leptons with transverse momentum $p_{\text{T}} > 20$ GeV at the plateau. The efficiency of the triggers is studied with data, and agrees well with expectations.

Monte Carlo (MC) simulated event samples are used to develop and validate the analysis procedure and to estimate the residual SM backgrounds following flavour subtraction. Samples of QCD jet events are generated with PYTHIA [19], using the MRST2007LO* modified leading-order parton distribution functions (PDF) [20], which are used with all leading-order (LO) MC codes. Production of top quark pairs is simulated with MC@NLO [21, 22] (with a top quark mass of 172.5 GeV) and the next-to-leading order (NLO) PDF set CTEQ6.6 [23], which is used with all NLO MC codes. Samples of W and Z/γ^* production with accompanying jets are produced with ALPGEN [24]. Diboson (WW, WZ, ZZ) production is simulated with HERWIG [25, 26], single top production with MC@NLO [27, 28], and Drell–Yan production with PYTHIA. Fragmentation and hadronization for the ALPGEN and MC@NLO samples are performed with HERWIG, using JIMMY [29] for the underlying event. The MC samples are produced using the ATLAS MC09 parameter tune [30] and a GEANT4 [31] based detector simulation [32].

Criteria for electron and muon identification closely follow those described in Ref. [33]. Candidate electrons are required to pass "tight" electron selection criteria and isolation requirements, and have $p_{\text{T}} > 20$ GeV and $|\eta| < 2.47$. Identified electrons are used to select events for both the signal region of the analysis and control regions used to estimate backgrounds. "Medium" electron selection criteria are mainly based on lateral shower shape requirements in the calorimeter, while E/p (where E is the shower energy in the calorimeter and p the track momentum in the ID) and TRT cuts are applied for the tight electron selection, which provides additional rejection against conversions and fakes from hadrons. The electron isolation criteria require that the total transverse energy within a cone size $\Delta R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2} = 0.2$ around the electron, is less than 0.15 of the electron p_T. Events are always vetoed if a medium electron is found in the transition region between the barrel and end-cap electromagnetic calorimeter, $1.37 < |\eta| < 1.52$. Muons are required to be identified either in both the ID and MS systems (combined muons) or as a match between an extrapolated ID track and one or more track segments in the MS. The ID track is required to have at least one pixel hit, more than five SCT hits, and a number of TRT hits that varies with η. For combined muons, a good match between ID and MS tracks is required, and the p_{T} values measured by these two systems must be compatible within the resolution. Isolation requirements are imposed, whereby the summed p_{T} of other ID tracks above 500 MeV within a distance $\Delta R < 0.2$ around the muon track is required to be less than 1.8 GeV. Only muons with $p_{\text{T}} > 20$ GeV and $|\eta| < 2.4$ are considered. For the final selection, the distance between the z coordinate of the primary vertex and that of the extrapolated muon track at the point of closest approach to the primary vertex must be less than 10 mm. Jets are reconstructed using the anti-k_t jet clustering algorithm [34] with a distance parameter $D = 0.4$. The inputs to this algorithm are clusters of calorimeter cells seeded by cells with energy significantly above the measured noise. Jets are constructed by performing a four-vector sum over these clusters, treating each cluster as an $(E, \boldsymbol{p})$ four-vector with zero mass. Jets are corrected for calorimeter non-compensation, material and other effects using p_{T}- and η-dependent calibration factors obtained from Monte Carlo and validated with test-beam and collision-data studies [35]. Only jets with $p_{\text{T}} > 20$ GeV and $|\eta| < 2.5$ are considered. If a jet and a medium electron are both identified within a distance $\Delta R < 0.2$ of each other, the jet is discarded. Furthermore, identified medium electrons or muons are only considered if they satisfy $\Delta R > 0.4$ with respect to the closest remaining jet. Events are discarded if they contain any jet failing basic quality selection criteria, which rejects detector noise and non-collision backgrounds [36]. The calculation of the missing transverse momentum, $E_{\text{T}}^{\text{miss}}$, is based on the modulus of the vector sum of the p_{T} of the reconstructed objects (jets with $p_{\text{T}} > 20$ GeV, but over the full calorimeter coverage $|\eta| < 4.9$, and selected leptons), any additional non-isolated muons, and the calorimeter clusters not belonging to reconstructed objects.

"Signal region" events that contain lepton pairs of identical flavour (e^+e^- and $\mu^+\mu^-$) and different flavour ($e^\pm\mu^\mp$) are selected, with the two populations subsequently used to calculate the excess of identical-flavour events. Selected events must contain exactly two opposite sign leptons (e or μ), with invariant mass ($m_{\ell\ell}$) greater than 5 GeV. The $E_{\text{T}}^{\text{miss}}$ must exceed 100 GeV in order to reject SM Z+jets events whilst maintaining efficiency for a range of SUSY models. Events must also possess at least one reconstructed primary vertex with at least five associated tracks. A flavour subtraction is performed through the use of the quantity $\mathcal{S}$

defined as

$$\mathcal{S} = \frac{N(e^{\pm}e^{\mp})}{\beta(1-(1-\tau_e)^2)} - \frac{N(e^{\pm}\mu^{\mp})}{1-(1-\tau_e)(1-\tau_\mu)} + \frac{\beta N(\mu^{\pm}\mu^{\mp})}{(1-(1-\tau_\mu)^2)}, \quad (1)$$

which measures the excess of identical-flavour events (first and third terms) over different-flavour events (second term), taking into account the electron and muon plateau trigger efficiencies (τ_e and τ_μ) and the ratio of electron to muon efficiency times acceptance (β). The trigger efficiencies for offline reconstructed objects are $\tau_e = (98.5\pm1.1)\%$ and $\tau_\mu = (83.7\pm1.9)\%$, respectively, while β is determined from data to be 0.69 ± 0.03, with the quoted errors including both systematic and statistical uncertainties.

The value of $\mathcal{S}$ obtained from selected identical-flavour and different-flavour lepton SM events is expected to be small but non-zero, due primarily to Z/γ^* boson production. The contributions to $\mathcal{S}$ expected from SM processes are estimated using a combination of Monte Carlo simulation and data-driven techniques. Contributions from single top and diboson events are estimated using the MC samples described above, scaled to the luminosity of the data sample. Contributions from Z/γ^*+jets, $t\bar{t}$ and events containing fake leptons (from QCD jets and W+jets events) are estimated using MC samples normalised to data in an appropriate control region. The Z/γ^* control region contains lepton pair events satisfying the same selection criteria as the signal region but with $E_{\mathrm{T}}^{\mathrm{miss}} < 20$ GeV and an additional $81 < m_{\ell\ell} < 101$ GeV requirement. The $t\bar{t}$ control region [13] contains "top-tagged" lepton pair events again satisfying the same selection criteria as signal candidates but with $60 < E_{\mathrm{T}}^{\mathrm{miss}} < 80$ GeV and an additional requirement of ≥ 2 jets with $p_{\mathrm{T}} > 20$ GeV. The top-tagging requirement is imposed through the use of the variable m_{CT} [37], which can be calculated from the four-vectors of the selected jets and leptons:

$$m_{\mathrm{CT}}^2(v_1, v_2) = \left[E_{\mathrm{T}}(v_1) + E_{\mathrm{T}}(v_2)\right]^2 - \left[\mathbf{p}_{\mathrm{T}}(v_1) - \mathbf{p}_{\mathrm{T}}(v_2)\right]^2, \quad (2)$$

where v_i can be a lepton, a jet, or a lepton-jet combination, transverse momentum vectors are denoted by $\mathbf{p}_{\mathrm{T}}$ and transverse energies E_T are defined as $E_T = \sqrt{p_{\mathrm{T}}^2 + m^2}$. This quantity is bounded from above by analytical functions of the top quark and W masses as described in [38]. Top-tagged events are required to possess m_{CT} values calculated from combinations of jets and leptons consistent with the expected bounds from $t\bar{t}$ events, as well as lepton-jet invariant mass values consistent with top quark decays. An electron control region for fake lepton events requires events to possess $E_{\mathrm{T}}^{\mathrm{miss}} < 60$ GeV, $\Delta\phi$ between the $E_{\mathrm{T}}^{\mathrm{miss}}$ vector and a jet < 0.1 and an electron with $p_{\mathrm{T}} > 30$ GeV. A single muon control region for fake lepton events requires events to possess $E_{\mathrm{T}}^{\mathrm{miss}} < 30$ GeV, a muon with $p_{\mathrm{T}} < 40$ GeV and a transverse mass $m_T(\mu, E_{\mathrm{T}}^{\mathrm{miss}}) < 30$ GeV. The electron and muon identification criteria are relaxed, to obtain a 'looser' sample dominated by fakes. A loose-tight matrix method is then used to estimate the number of events with fake leptons in the signal region after final selection criteria. This method, which uses the probabilities derived from data for loosely selected leptons and hadrons to satisfy the tight selection criteria to predict the mixture of real and fake leptons in the final sample, is similar to that described in [39]. The dominant uncertainties in the data-normalised background estimates arise from limited numbers of events in the control regions, theoretical uncertainties (including choice of generator, initial and final state radiation), an approximate $\sim \pm 7\%$ jet energy scale uncertainty [40] and an approximate $\sim 14\%$ jet energy resolution uncertainty [41]. The latter uncertainties affect the shapes of the MC $E_{\mathrm{T}}^{\mathrm{miss}}$ distributions. Uncertainties on backgrounds estimated solely with MC are dominated by the jet energy scale and resolution.

Table 1 Expected numbers of SM background events in the signal region for each of the three lepton flavour combinations. The estimates are obtained using the procedures described in the text. The quoted error includes systematic and statistical uncertainties, taking into account correlations. The negative number of fakes predicted in the $e^{\pm}\mu^{\mp}$ channel is an artifact of the matrix method used to estimate this contribution. In the 'Total SM', the number of fakes in this channel is taken to be zero. The probabilities for the SM to fluctuate to the respective observation are $e^{\pm}e^{\mp}$ 48%, $e^{\pm}\mu^{\mp}$ 14% and $\mu^{\pm}\mu^{\mp}$ 6%

	$e^{\pm}e^{\mp}$	$e^{\pm}\mu^{\mp}$	$\mu^{\pm}\mu^{\mp}$
Data	4	13	13
Z/γ^*+jets	0.40 ± 0.46	0.36 ± 0.20	0.91 ± 0.67
Dibosons	0.30 ± 0.11	0.36 ± 0.10	0.61 ± 0.10
$t\bar{t}$	2.50 ± 1.02	6.61 ± 2.68	4.71 ± 1.91
Single top	0.13 ± 0.09	0.76 ± 0.25	0.67 ± 0.33
Fakes	0.31 ± 0.21	-0.15 ± 0.08	0.01 ± 0.01
Total SM	3.64 ± 1.24	8.08 ± 2.78	6.91 ± 2.20

The invariant mass distributions of lepton pairs in selected data events, prior to applying the $E_{\mathrm{T}}^{\mathrm{miss}}$ requirement, are presented in Fig. 1, weighted by the multiplicative factors in (1) to yield the identical-flavour and different-flavour contributions to $\mathcal{S}$. After applying the $E_{\mathrm{T}}^{\mathrm{miss}} > 100$ GeV requirement 4, 13 and 13 events are observed in the $e^{\pm}e^{\mp}$, $e^{\pm}\mu^{\mp}$ and $\mu^{\pm}\mu^{\mp}$ channels, respectively. The expected numbers of events in these channels, determined using the techniques described above, are listed in Table 1 and are in reasonable agreement for the given luminosity as suggested by the probabilities for the SM to fluctuate at least to the level of observed events. The dominant contribution to each channel arises from $t\bar{t}$ production. Using the observed numbers of

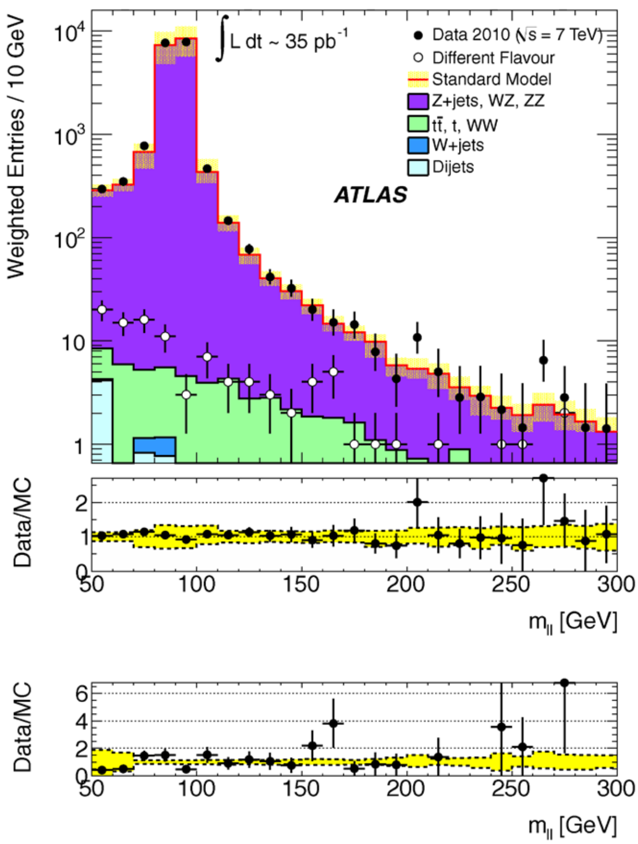

Fig. 1 Invariant mass distribution of identical-flavour lepton pairs prior to applying the $E_{\mathrm{T}}^{\mathrm{miss}}$ requirement, weighted by the acceptance and efficiency factors as in (1). The stacked histograms show the expected distributions from MC samples normalised to the luminosity of the data. The band indicates the uncertainty on the expectation from finite statistics, cross section, luminosity, jet and lepton energy scales and resolutions. Also shown is the observed distribution for different-flavour pairs, weighted according to (1). In the region with $m_{ll} < 100$ GeV, the dominant contributions to the different-flavour data events are expected to come from $t\bar{t}$, QCD and Z/γ^*+jets events. The lower of the two Data/MC ratios is the comparison between data and MC normalised to the luminosity of the data for different-flavour events

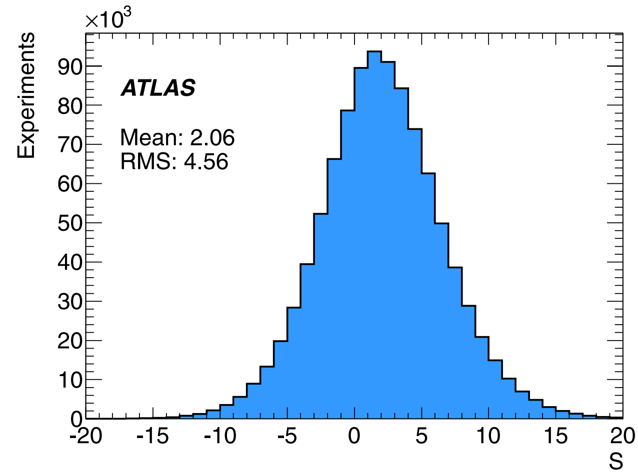

Fig. 2 Distribution of observed $\mathcal{S}$ values from one million hypothetical signal-free experiments. The shape is driven by statistical Poisson fluctuations in the expected rates of identical-flavour and different-flavour events, dominated by $t\bar{t}$ events

events in each channel together with the measured values of τ_e, τ_μ and β, the observed value of $\mathcal{S}$ is found to be $\mathcal{S}_{\mathrm{obs}} = 1.98 \pm 0.15(\beta) \pm 0.02(\tau_e) \pm 0.06(\tau_\mu)$, where the uncertainties are those from the respective efficiency parameters. The expected mean value of $\mathcal{S}$ from SM background events alone is $\bar{\mathcal{S}}_b = 2.06 \pm 0.79(stat.) \pm 0.78(sys.)$. The observation agrees very well with the SM background which is, however, expected to fluctuate considerably (see Fig. 2). The dominant contributions to $\bar{\mathcal{S}}_b$ are from Z/γ^*+jets and diboson processes. The dominant contributions from $t\bar{t}$ events to the individual channels largely cancel when calculating $\mathcal{S}$, as expected. The $t\bar{t}$ population nevertheless has a significant impact on this analysis because the range of observed $\mathcal{S}$ values expected from a large number of hypothetical signal-free experiments is dominated by statistical fluctuations in the numbers of selected $t\bar{t}$ events in each channel.

To quantify the consistency between the observed $\mathcal{S}$ value and the SM prediction the expected distribution of $\mathcal{S}_b$ in the absence of SUSY must be determined. This distribution possesses a mean given by $\bar{\mathcal{S}}_b$ and a width dominated by statistical fluctuations in the numbers of events observed in each channel. The distribution can be determined by generating pseudo-experiments using the estimated mean numbers of background events from Table 1 as input. For each pseudo-experiment the mean number of background events in each channel and from each source are sampled, taking appropriate account of correlations between the uncertainties in the estimates of these means. The resulting total mean number of background events in each channel is then used to construct a Poisson distribution from which the observed number of events in that channel is drawn. The resulting sampled event counts in each channel are then used with (1), taking care also to sample values of τ_e, τ_μ and β according to their means and uncertainties, to determine a value of $\mathcal{S}_b$. The distribution of $\mathcal{S}_b$ values obtained in this way is used to estimate the probability of observing a value of $\mathcal{S}$ at least as large as $\mathcal{S}_{\mathrm{obs}}$.

The distribution of $\mathcal{S}$ values obtained from one million signal-free experiments using this procedure is shown in Fig. 2. The shape of the distribution is dominated by statistical fluctuations in the numbers of events in each channel, with the uncertainty on $\bar{\mathcal{S}}_b$ being negligible by comparison. The probability of observing a value of $\mathcal{S}$ at least as large as $\mathcal{S}_{\mathrm{obs}}$ is 49.7% and hence no evidence of an excess of identical-flavour events beyond SM expectations is observed.

Limits are set on $\bar{\mathcal{S}}_s$, the mean contribution to $\mathcal{S}$ from SUSY. The statistical procedure employed follows that used to determine the consistency of the observed value of $\mathcal{S}$ with the background expectation. The pseudo-experiments are modified by adding signal event contributions to the input mean numbers of background events in each channel. An assumption must be made regarding the relative branching ratio of SUSY events into identical-flavour and different-flavour channels, as adding flavour uncorrelated SUSY contributions to the identical-flavour and different-flavour channels increases the width of the $\mathcal{S}$ distribution. Given such an assumption, a model-independent limit can be set on $\bar{\mathcal{S}}_s$ by comparing $\mathcal{S}_{\text{obs}}$ with the distribution of $\mathcal{S}$ values obtained from the new set of signal-plus-background pseudo-experiments.

If the assumption is made that the branching fractions for $e^{\pm}e^{\mp}$ and $\mu^{\pm}\mu^{\mp}$ final states in SUSY events are identical, and the branching fraction for $e^{\pm}\mu^{\mp}$ final states is zero, a limit $\bar{\mathcal{S}}_s < 8.8$ is set at 95% confidence level. Alternatively, if SUSY events are assumed to possess a different-flavour branching fraction of one half that for identical-flavour events, then the limit becomes $\bar{\mathcal{S}}_s < 12.6$ at 95% confidence. The limits are driven by the statistical fluctuations in $\mathcal{S}$, rather than systematic and statistical uncertainties in $\bar{\mathcal{S}}_b$ and in the variance of the $\mathcal{S}_b$ distribution.

A similar procedure can be used to set limits within a specific SUSY parameter space. In this case the mean numbers of signal events added to each channel are sampled according to the expectations from each point in the parameter space of the model together with the uncertainties in these expectations. The fraction of resulting pseudo-experiments with $\mathcal{S} < \mathcal{S}_{\text{obs}}$ gives the probability of the signal-plus-background hypothesis being falsely rejected. If the probability of being falsely rejected is <5%, the point is excluded at 95% confidence.

As an example, two-dimensional grids in the parameter space of a 24-parameter MSSM model [42] are considered (to be referred to as 'MSSM PhenoGrid2'). The 24-parameter MSSM is a generic MSSM on which flavour and CP violation have been imposed. For these grids the following parameters are fixed: $m_A = 1000$ GeV, $\mu = 1.5\min(m_{\tilde{g}}, m_{\tilde{q}})$, $\tan\beta = 4$, $A_t = \mu/\tan\beta$, $A_b = \mu\tan\beta$, and $A_l = \mu\tan\beta$. The masses of the 3rd generation sfermions are set to 2 TeV, and common squark mass and slepton mass parameters are assumed for the first two generations. Two grids in the $m_{\tilde{g}} - m_{\tilde{q}}$ plane are studied: one with a compressed spectrum yielding a soft final state kinematics, defined by $m_{\tilde{\chi}_2^0} = M - 50$ GeV, $m_{\tilde{\chi}_1^0} = M - 150$ GeV and $m_{\tilde{l}_L} = M - 100$ GeV, where M is the minimum of the gluino and squark mass ('compressed spectrum'); and one with a very light LSP, yielding a harder spectrum of leptons, jets and $E_{\mathrm{T}}^{\mathrm{miss}}$, with $m_{\tilde{\chi}_2^0} = M - 100$ GeV, $m_{\tilde{\chi}_1^0} = 100$ GeV and $m_{\tilde{l}_L} = M/2$ GeV ('light neutralino'). Signal events are generated with HERWIG for the MSSM grids. The cross sections are calculated at NLO with PROSPINO [43]. Theoretical and experimental uncertainties are determined for each model and used when sampling the mean numbers of signal events in each channel. Theoretical uncertainties are evaluated by varying the factorisation and renormalisation scales and the CTEQ6.6 PDF sets [23] used for the cross section calculation. Experimental uncertainties are dominated by the uncertainty on the jet energy scale and resolution. An 11% luminosity uncertainty is included. The results are shown in the $m_{\tilde{g}} - m_{\tilde{q}}$ plane in Fig. 3. For 'compressed spectrum' ('light neutralino') models and $m_{\tilde{g}} = m_{\tilde{q}} + 10$ GeV, the 95% confidence lower limit on $m_{\tilde{q}}$ is 503 (558) GeV.

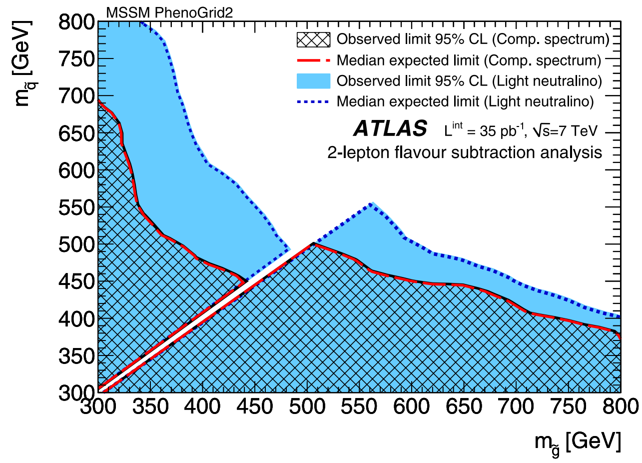

Fig. 3 Observed and expected 95% C.L. exclusion limits in the $m_{\tilde{g}} - m_{\tilde{q}}$ plane for two 24-parameter MSSM models

In summary, a flavour subtraction technique has been used to search for an excess beyond SM expectations of high missing transverse momentum events containing opposite charge identical-flavour lepton pairs. No significant excess has been observed, allowing limits to be set on the model-independent quantity $\bar{\mathcal{S}}_s$, which measures the mean excess from SUSY taking into account flavour-dependent acceptances and efficiencies. This search and limit is of course applicable to other new physics scenarios, not just the SUSY scenario described here.

Acknowledgements We thank CERN for the very successful operation of the LHC, as well as the support staff from our institutions without whom ATLAS could not be operated efficiently.

We acknowledge the support of ANPCyT, Argentina; YerPhI, Armenia; ARC, Australia; BMWF, Austria; ANAS, Azerbaijan; SSTC, Belarus; CNPq and FAPESP, Brazil; NSERC, NRC and CFI, Canada; CERN; CONICYT, Chile; CAS, MOST and NSFC, China; COLCIENCIAS, Colombia; MSMT CR, MPO CR and VSC CR, Czech Republic; DNRF, DNSRC and Lundbeck Foundation, Denmark; ARTEMIS, European Union; IN2P3-CNRS, CEA-DSM/IRFU, France; GNAS, Georgia; BMBF, DFG, HGF, MPG and AvH Foundation, Germany; GSRT, Greece; ISF, MINERVA, GIF, DIP and Benoziyo Center, Israel; INFN, Italy; MEXT and JSPS, Japan; CNRST, Morocco; FOM and NWO, The Netherlands; RCN, Norway; MNiSW, Poland; GRICES and FCT, Portugal; MERYS (MECTS), Romania; MES of Russia and ROSATOM, Russian Federation; JINR; MSTD, Serbia; MSSR, Slovakia; ARRS and MVZT, Slovenia; DST/NRF, South Africa; MICINN, Spain; SRC and Wallenberg Foundation, Sweden; SER, SNSF and Cantons of Bern and Geneva, Switzerland; NSC, Taiwan; TAEK, Turkey; STFC, the Royal Society and Leverhulme Trust, United Kingdom; DOE and NSF, United States of America.

The crucial computing support from all WLCG partners is acknowledged gratefully, in particular from CERN and the ATLAS Tier-1 facilities at TRIUMF (Canada), NDGF (Denmark, Norway, Sweden), CC-IN2P3 (France), KIT/GridKA (Germany), INFN-CNAF (Italy), NL-T1 (The Netherlands), PIC (Spain), ASGC (Taiwan), RAL (UK) and BNL (USA) and in the Tier-2 facilities worldwide.

References

1. Yu.A. Golfand, E.P. Likhtman, JETP Lett. **13**, 323–326 (1971)
2. A. Neveu, J.H. Schwartz, Nucl. Phys. B **31**, 86–112 (1971)
3. A. Neveu, J.H. Schwartz, Phys. Rev. D **4**, 1109–1111 (1971)
4. P. Ramond, Phys. Rev. D **3**, 2415–2418 (1971)
5. D.V. Volkov, V.P. Akulov, Phys. Lett. B **46**, 109–130 (1973)
6. J. Wess, B. Zumino, Phys. Lett. B **49**, 52–60 (1974)
7. J. Wess, B. Zumino, Nucl. Phys. B **70**, 39–50 (1974)
8. P. Fayet, Phys. Lett. B **69**, 489 (1977)
9. G.R. Farrar, P. Fayet, Phys. Lett. B **76**, 575 (1978)
10. I. Hinchliffe, F.E. Paige, M.D. Shapiro, J. Soderqvist, W. Yao, Phys. Rev. D **55**, 5520–5540 (1997)
11. B.C. Allanach, C.G. Lester, M.A. Parker, B.R. Webber, J. High Energy Phys. **09**, 004 (2000)
12. D. Costanzo, D.R. Tovey, J. High Energy Phys. **04**, 084 (2009)
13. ATLAS Collaboration, Submitted to EPJC (2011). arXiv:1103.6214 [hep-ex]
14. ATLAS Collaboration, Submitted to Phys. Lett. B (2011). arXiv:1102.5290 [hep-ex]
15. ATLAS Collaboration, Submitted to Phys. Rev. Lett. (2011). arXiv:1102.2357 [hep-ex]
16. CMS Collaboration, Submitted to JHEP (2011). arXiv:1103.1348 [hep-ex]
17. ATLAS Collaboration, JINST **3**, S08003 (2008)
18. ATLAS Collaboration, Accepted for publication in EPJC (2011). arXiv:1101.2185 [hep-ex]
19. T. Sjöstrand, S. Mrenna, P.Z. Skands, J. High Energy Phys. **05**, 026 (2006)
20. A. Sherstnev, R. Thorne, Eur. Phys. J. C **55**, 553–575 (2008)
21. S. Frixione, B.R. Webber, J. High Energy Phys. **06**, 029 (2002)
22. S. Frixione, P. Nason, B.R. Webber, J. High Energy Phys. **08**, 007 (2003)
23. P.M. Nadolsky et al., Phys. Rev. D **78**, 013004 (2008)
24. M.L. Mangano, M. Moretti, F. Piccinini, R. Pittau, A.D. Polosa, J. High Energy Phys. **07**, 001 (2003)
25. G. Corcella et al., J. High Energy Phys. **01**, 010 (2001)
26. G. Corcella et al., arXiv:hep-ph/0210213
27. S. Frixione, E. Laenen, P. Motylinski, B.R. Webber, J. High Energy Phys. **0603**, 092 (2006)
28. S. Frixione, E. Laenen, P. Motylinski, B.R. Webber, C.D. White, J. High Energy Phys. **0807**, 029 (2008)
29. J.M. Butterworth, J.R. Forshaw, M.H. Seymour, Z. Phys. C **72**, 637–646 (1996)
30. ATLAS Collaboration, Eur. Phys. J. C **70**, 823–874 (2010)
31. The GEANT4 Collaboration, Nucl. Instrum. Methods A **506**, 250–303 (2003)
32. ATLAS Collaboration, Eur. Phys. J. C **70**, 823–874 (2010). arXiv:1005.4568 [physics.ins-det]
33. ATLAS Collaboration, J. High Energy Phys. **12**, 060 (2010)
34. M. Cacciari, G.P. Salam, G. Soyez, J. High Energy Phys. **04**, 063 (2008)
35. E. Abat et al. (ATLAS Collaboration), Nucl. Instrum. Methods A **621**, 134 (2010)
36. ATLAS Collaboration, ATLAS-CONF-2010-038, cds:1277678
37. D.R. Tovey, J. High Energy Phys. **04**, 034 (2008)
38. G. Polesello, D.R. Tovey, J. High Energy Phys. **03**, 030 (2010)
39. ATLAS Collaboration, Submitted to EPJC (2010). arXiv:1012.1792 [hep-ex]
40. ATLAS Collaboration, Submitted to EPJC (2010). arXiv:1009.5908v2
41. ATLAS Collaboration, ATLAS-CONF-2010-054, cds:1281311
42. F.E. Paige, S.D. Protopopescu, H. Baer, X. Tata, arXiv:hep-ph/0312045
43. W. Beenakker et al., Nucl. Phys. B **492**, 51–103 (1997)

The ATLAS Collaboration

G. Aad[48], B. Abbott[111], J. Abdallah[11], A.A. Abdelalim[49], A. Abdesselam[118], O. Abdinov[10], B. Abi[112], M. Abolins[88], H. Abramowicz[153], H. Abreu[115], E. Acerbi[89a,89b], B.S. Acharya[164a,164b], D.L. Adams[24], T.N. Addy[56], J. Adelman[175], M. Aderholz[99], S. Adomeit[98], P. Adragna[75], T. Adye[129], S. Aefsky[22], J.A. Aguilar-Saavedra[124b,a], M. Aharrouche[81], S.P. Ahlen[21], F. Ahles[48], A. Ahmad[148], M. Ahsan[40], G. Aielli[133a,133b], T. Akdogan[18a], T.P.A. Åkesson[79], G. Akimoto[155], A.V. Akimov[94], A. Akiyama[67], M.S. Alam[1], M.A. Alam[76], S. Albrand[55], M. Aleksa[29], I.N. Aleksandrov[65], F. Alessandria[89a], C. Alexa[25a], G. Alexander[153], G. Alexandre[49], T. Alexopoulos[9], M. Alhroob[20], M. Aliev[15], G. Alimonti[89a], J. Alison[120], M. Aliyev[10], P.P. Allport[73], S.E. Allwood-Spiers[53], J. Almond[82], A. Aloisio[102a,102b], R. Alon[171], A. Alonso[79], M.G. Alviggi[102a,102b], K. Amako[66], P. Amaral[29], C. Amelung[22], V.V. Ammosov[128], A. Amorim[124a,b],

G. Amorós[167], N. Amram[153], C. Anastopoulos[139], T. Andeen[34], C.F. Anders[20], K.J. Anderson[30], A. Andreazza[89a,89b], V. Andrei[58a], M.-L. Andrieux[55], X.S. Anduaga[70], A. Angerami[34], F. Anghinolfi[29], N. Anjos[124a], A. Annovi[47], A. Antonaki[8], M. Antonelli[47], S. Antonelli[19a,19b], A. Antonov[96], J. Antos[144b], F. Anulli[132a], S. Aoun[83], L. Aperio Bella[4], R. Apolle[118], G. Arabidze[88], I. Aracena[143], Y. Arai[66], A.T.H. Arce[44], J.P. Archambault[28], S. Arfaoui[29,c], J.-F. Arguin[14], E. Arik[18a,*], M. Arik[18a], A.J. Armbruster[87], O. Arnaez[81], C. Arnault[115], A. Artamonov[95], G. Artoni[132a,132b], D. Arutinov[20], S. Asai[155], R. Asfandiyarov[172], S. Ask[27], B. Åsman[146a,146b], L. Asquith[5], K. Assamagan[24], A. Astbury[169], A. Astvatsatourov[52], G. Atoian[175], B. Aubert[4], B. Auerbach[175], E. Auge[115], K. Augsten[127], M. Aurousseau[145a], N. Austin[73], R. Avramidou[9], D. Axen[168], C. Ay[54], G. Azuelos[93,d], Y. Azuma[155], M.A. Baak[29], G. Baccaglioni[89a], C. Bacci[134a,134b], A.M. Bach[14], H. Bachacou[136], K. Bachas[29], G. Bachy[29], M. Backes[49], M. Backhaus[20], E. Badescu[25a], P. Bagnaia[132a,132b], S. Bahinipati[2], Y. Bai[32a], D.C. Bailey[158], T. Bain[158], J.T. Baines[129], O.K. Baker[175], M.D. Baker[24], S. Baker[77], F. Baltasar Dos Santos Pedrosa[29], E. Banas[38], P. Banerjee[93], Sw. Banerjee[169], D. Banfi[29], A. Bangert[137], V. Bansal[169], H.S. Bansil[17], L. Barak[171], S.P. Baranov[94], A. Barashkou[65], A. Barbaro Galtieri[14], T. Barber[27], E.L. Barberio[86], D. Barberis[50a,50b], M. Barbero[20], D.Y. Bardin[65], T. Barillari[99], M. Barisonzi[174], T. Barklow[143], N. Barlow[27], B.M. Barnett[129], R.M. Barnett[14], A. Baroncelli[134a], A.J. Barr[118], F. Barreiro[80], J. Barreiro Guimarães da Costa[57], P. Barrillon[115], R. Bartoldus[143], A.E. Barton[71], D. Bartsch[20], V. Bartsch[149], R.L. Bates[53], L. Batkova[144a], J.R. Batley[27], A. Battaglia[16], M. Battistin[29], G. Battistoni[89a], F. Bauer[136], H.S. Bawa[143,e], B. Beare[158], T. Beau[78], P.H. Beauchemin[118], R. Beccherle[50a], P. Bechtle[41], H.P. Beck[16], M. Beckingham[48], K.H. Becks[174], A.J. Beddall[18c], A. Beddall[18c], S. Bedikian[175], V.A. Bednyakov[65], C.P. Bee[83], M. Begel[24], S. Behar Harpaz[152], P.K. Behera[63], M. Beimforde[99], C. Belanger-Champagne[166], P.J. Bell[49], W.H. Bell[49], G. Bella[153], L. Bellagamba[19a], F. Bellina[29], M. Bellomo[119a], A. Belloni[57], O. Beloborodova[107], K. Belotskiy[96], O. Beltramello[29], S. Ben Ami[152], O. Benary[153], D. Benchekroun[135a], C. Benchouk[83], M. Bendel[81], B.H. Benedict[163], N. Benekos[165], Y. Benhammou[153], D.P. Benjamin[44], M. Benoit[115], J.R. Bensinger[22], K. Benslama[130], S. Bentvelsen[105], D. Berge[29], E. Bergeaas Kuutmann[41], N. Berger[4], F. Berghaus[169], E. Berglund[49], J. Beringer[14], K. Bernardet[83], P. Bernat[77], R. Bernhard[48], C. Bernius[24], T. Berry[76], A. Bertin[19a,19b], F. Bertinelli[29], F. Bertolucci[122a,122b], M.I. Besana[89a,89b], N. Besson[136], S. Bethke[99], W. Bhimji[45], R.M. Bianchi[29], M. Bianco[72a,72b], O. Biebel[98], S.P. Bieniek[77], J. Biesiada[14], M. Biglietti[134a,134b], H. Bilokon[47], M. Bindi[19a,19b], S. Binet[115], A. Bingul[18c], C. Bini[132a,132b], C. Biscarat[177], U. Bitenc[48], K.M. Black[21], R.E. Blair[5], J.-B. Blanchard[115], G. Blanchot[29], C. Blocker[22], J. Blocki[38], A. Blondel[49], W. Blum[81], U. Blumenschein[54], G.J. Bobbink[105], V.B. Bobrovnikov[107], S.S. Bocchetta[79], A. Bocci[44], C.R. Boddy[118], M. Boehler[41], J. Boek[174], N. Boelaert[35], S. Böser[77], J.A. Bogaerts[29], A. Bogdanchikov[107], A. Bogouch[90,*], C. Bohm[146a], V. Boisvert[76], T. Bold[163,f], V. Boldea[25a], M. Bona[75], V.G. Bondarenko[96], M. Boonekamp[136], G. Boorman[76], C.N. Booth[139], P. Booth[139], S. Bordoni[78], C. Borer[16], A. Borisov[128], G. Borissov[71], I. Borjanovic[12a], S. Borroni[132a,132b], K. Bos[105], D. Boscherini[19a], M. Bosman[11], H. Boterenbrood[105], D. Botterill[129], J. Bouchami[93], J. Boudreau[123], E.V. Bouhova-Thacker[71], C. Boulahouache[123], C. Bourdarios[115], N. Bousson[83], A. Boveia[30], J. Boyd[29], I.R. Boyko[65], N.I. Bozhko[128], I. Bozovic-Jelisavcic[12b], J. Bracinik[17], A. Braem[29], P. Branchini[134a], G.W. Brandenburg[57], A. Brandt[7], G. Brandt[15], O. Brandt[54], U. Bratzler[156], B. Brau[84], J.E. Brau[114], H.M. Braun[174], B. Brelier[158], J. Bremer[29], R. Brenner[166], S. Bressler[152], D. Breton[115], N.D. Brett[118], D. Britton[53], F.M. Brochu[27], I. Brock[20], R. Brock[88], T.J. Brodbeck[71], E. Brodet[153], F. Broggi[89a], C. Bromberg[88], G. Brooijmans[34], W.K. Brooks[31b], G. Brown[82], E. Brubaker[30], P.A. Bruckman de Renstrom[38], D. Bruncko[144b], R. Bruneliere[48], S. Brunet[61], A. Bruni[19a], G. Bruni[19a], M. Bruschi[19a], T. Buanes[13], F. Bucci[49], J. Buchanan[118], N.J. Buchanan[2], P. Buchholz[141], R.M. Buckingham[118], A.G. Buckley[45], S.I. Buda[25a], I.A. Budagov[65], B. Budick[108], V. Büscher[81], L. Bugge[117], D. Buira-Clark[118], E.J. Buis[105], O. Bulekov[96], M. Bunse[42], T. Buran[117], H. Burckhart[29], S. Burdin[73], T. Burgess[13], S. Burke[129], E. Busato[33], P. Bussey[53], C.P. Buszello[166], F. Butin[29], B. Butler[143], J.M. Butler[21], C.M. Buttar[53], J.M. Butterworth[77], W. Buttinger[27], T. Byatt[77], S. Cabrera Urbán[167], D. Caforio[19a,19b], O. Cakir[3a], P. Calafiura[14], G. Calderini[78], P. Calfayan[98], R. Calkins[106], L.P. Caloba[23a], R. Caloi[132a,132b], D. Calvet[33], S. Calvet[33], R. Camacho Toro[33], A. Camard[78], P. Camarri[133a,133b], M. Cambiaghi[119a,119b], D. Cameron[117], J. Cammin[20], S. Campana[29], M. Campanelli[77], V. Canale[102a,102b], F. Canelli[30], A. Canepa[159a], J. Cantero[80], L. Capasso[102a,102b], M.D.M. Capeans Garrido[29], I. Caprini[25a], M. Caprini[25a], D. Capriotti[99], M. Capua[36a,36b], R. Caputo[148], C. Caramarcu[25a], R. Cardarelli[133a], T. Carli[29], G. Carlino[102a], L. Carminati[89a,89b], B. Caron[159a], S. Caron[48], C. Carpentieri[48], G.D. Carrillo Montoya[172], A.A. Carter[75], J.R. Carter[27], J. Carvalho[124a,g], D. Casadei[108], M.P. Casado[11], M. Cascella[122a,122b], C. Caso[50a,50b,*], A.M. Castaneda Hernandez[172], E. Castaneda-Miranda[172], V. Castillo Gimenez[167], N.F. Castro[124a], G. Cataldi[72a], F. Cataneo[29], A. Catinaccio[29], J.R. Catmore[71], A. Cattai[29], G. Cattani[133a,133b], S. Caughron[88], D. Cauz[164a,164c], A. Cavallari[132a,132b], P. Cavalleri[78], D. Cavalli[89a], M. Cavalli-Sforza[11], V. Cavasinni[122a,122b], A. Cazzato[72a,72b], F. Ceradini[134a,134b], A.S. Cerqueira[23a], A. Cerri[29], L. Cerrito[75], F. Cerutti[47], S.A. Cetin[18b], F. Cevenini[102a,102b], A. Chafaq[135a], D. Chakraborty[106], K. Chan[2], B. Chapleau[85], J.D. Chapman[27], J.W. Chapman[87], E. Chareyre[78], D.G. Charlton[17], V. Chavda[82], S. Cheatham[71], S. Chekanov[5], S.V. Chekulaev[159a], G.A. Chelkov[65], M.A. Chelstowska[104], C. Chen[64], H. Chen[24], L. Chen[2], S. Chen[32c], T. Chen[32c],

X. Chen[172], S. Cheng[32a], A. Cheplakov[65], V.F. Chepurnov[65], R. Cherkaoui El Moursli[135e], V. Chernyatin[24], E. Cheu[6], S.L. Cheung[158], L. Chevalier[136], G. Chiefari[102a,102b], L. Chikovani[51], J.T. Childers[58a], A. Chilingarov[71], G. Chiodini[72a], M.V. Chizhov[65], G. Choudalakis[30], S. Chouridou[137], I.A. Christidi[77], A. Christov[48], D. Chromek-Burckhart[29], M.L. Chu[151], J. Chudoba[125], G. Ciapetti[132a,132b], K. Ciba[37], A.K. Ciftci[3a], R. Ciftci[3a], D. Cinca[33], V. Cindro[74], M.D. Ciobotaru[163], C. Ciocca[19a,19b], A. Ciocio[14], M. Cirilli[87], M. Ciubancan[25a], A. Clark[49], P.J. Clark[45], W. Cleland[123], J.C. Clemens[83], B. Clement[55], C. Clement[146a,146b], R.W. Clifft[129], Y. Coadou[83], M. Cobal[164a,164c], A. Coccaro[50a,50b], J. Cochran[64], P. Coe[118], J.G. Cogan[143], J. Coggeshall[165], E. Cogneras[177], C.D. Cojocaru[28], J. Colas[4], A.P. Colijn[105], C. Collard[115], N.J. Collins[17], C. Collins-Tooth[53], J. Collot[55], G. Colon[84], G. Comune[88], P. Conde Muiño[124a], E. Coniavitis[118], M.C. Conidi[11], M. Consonni[104], S. Constantinescu[25a], C. Conta[119a,119b], F. Conventi[102a,h], J. Cook[29], M. Cooke[14], B.D. Cooper[77], A.M. Cooper-Sarkar[118], N.J. Cooper-Smith[76], K. Copic[34], T. Cornelissen[50a,50b], M. Corradi[19a], F. Corriveau[85,i], A. Cortes-Gonzalez[165], G. Cortiana[99], G. Costa[89a], M.J. Costa[167], D. Costanzo[139], T. Costin[30], D. Côté[29], R. Coura Torres[23a], L. Courneyea[169], G. Cowan[76], C. Cowden[27], B.E. Cox[82], K. Cranmer[108], F. Crescioli[122a,122b], M. Cristinziani[20], G. Crosetti[36a,36b], R. Crupi[72a,72b], S. Crépé-Renaudin[55], C. Cuenca Almenar[175], T. Cuhadar Donszelmann[139], S. Cuneo[50a,50b], M. Curatolo[47], C.J. Curtis[17], P. Cwetanski[61], H. Czirr[141], Z. Czyczula[117], S. D'Auria[53], M. D'Onofrio[73], A. D'Orazio[132a,132b], A. Da Rocha Gesualdi Mello[23a], P.V.M. Da Silva[23a], C. Da Via[82], W. Dabrowski[37], A. Dahlhoff[48], T. Dai[87], C. Dallapiccola[84], S.J. Dallison[129,*], M. Dam[35], M. Dameri[50a,50b], D.S. Damiani[137], H.O. Danielsson[29], R. Dankers[105], D. Dannheim[99], V. Dao[49], G. Darbo[50a], G.L. Darlea[25b], C. Daum[105], J.P. Dauvergne[29], W. Davey[86], T. Davidek[126], N. Davidson[86], R. Davidson[71], M. Davies[93], A.R. Davison[77], E. Dawe[142], I. Dawson[139], J.W. Dawson[5,*], R.K. Daya[39], K. De[7], R. de Asmundis[102a], S. De Castro[19a,19b], P.E. De Castro Faria Salgado[24], 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], B. De Lotto[164a,164c], L. De Mora[71], L. De Nooij[105], M. De Oliveira Branco[29], D. De Pedis[132a], P. de Saintignon[55], A. De Salvo[132a], U. De Sanctis[164a,164c], A. De Santo[149], J.B. De Vivie De Regie[115], S. Dean[77], D.V. Dedovich[65], J. Degenhardt[120], M. Dehchar[118], M. Deile[98], C. Del Papa[164a,164c], J. Del Peso[80], T. Del Prete[122a,122b], A. Dell'Acqua[29], L. Dell'Asta[89a,89b], M. Della Pietra[102a,h], D. della Volpe[102a,102b], M. Delmastro[29], P. Delpierre[83], N. Delruelle[29], P.A. Delsart[55], C. Deluca[148], S. Demers[175], M. Demichev[65], B. Demirkoz[11], J. Deng[163], S.P. Denisov[128], D. Derendarz[38], J.E. Derkaoui[135d], F. Derue[78], P. Dervan[73], K. Desch[20], E. Devetak[148], P.O. Deviveiros[158], A. Dewhurst[129], B. DeWilde[148], S. Dhaliwal[158], R. Dhullipudi[24,j], A. Di Ciaccio[133a,133b], L. Di Ciaccio[4], A. Di Girolamo[29], B. Di Girolamo[29], S. Di Luise[134a,134b], A. Di Mattia[88], B. Di Micco[29], R. Di Nardo[133a,133b], A. Di Simone[133a,133b], R. Di Sipio[19a,19b], M.A. Diaz[31a], F. Diblen[18c], E.B. Diehl[87], H. Dietl[99], J. Dietrich[48], T.A. Dietzsch[58a], S. Diglio[115], K. Dindar Yagci[39], J. Dingfelder[20], C. Dionisi[132a,132b], P. Dita[25a], S. Dita[25a], F. Dittus[29], F. Djama[83], R. Djilkibaev[108], T. Djobava[51], M.A.B. do Vale[23a], A. Do Valle Wemans[124a], T.K.O. Doan[4], M. Dobbs[85], R. Dobinson[29,*], D. Dobos[42], E. Dobson[29], M. Dobson[163], J. Dodd[34], O.B. Dogan[18a,*], C. Doglioni[118], T. Doherty[53], Y. Doi[66,*], J. Dolejsi[126], I. Dolenc[74], Z. Dolezal[126], B.A. Dolgoshein[96,*], T. Dohmae[155], M. Donadelli[23b], M. Donega[120], J. Donini[55], J. Dopke[29], A. Doria[102a], A. Dos Anjos[172], M. Dosil[11], A. Dotti[122a,122b], M.T. Dova[70], J.D. Dowell[17], A.D. Doxiadis[105], A.T. Doyle[53], Z. Drasal[126], J. Drees[174], N. Dressnandt[120], H. Drevermann[29], C. Driouichi[35], M. Dris[9], J.G. Drohan[77], J. Dubbert[99], T. Dubbs[137], S. Dube[14], E. Duchovni[171], G. Duckeck[98], A. Dudarev[29], F. Dudziak[64], M. Dührssen[29], I.P. Duerdoth[82], L. Duflot[115], M.-A. Dufour[85], M. Dunford[29], H. Duran Yildiz[3b], R. Duxfield[139], M. Dwuznik[37], F. Dydak[29], D. Dzahini[55], M. Düren[52], W.L. Ebenstein[44], J. Ebke[98], S. Eckert[48], S. Eckweiler[81], K. Edmonds[81], C.A. Edwards[76], W. Ehrenfeld[41], T. Ehrich[99], T. Eifert[29], G. Eigen[13], K. Einsweiler[14], E. Eisenhandler[75], T. Ekelof[166], M. El Kacimi[135c], M. Ellert[166], S. Elles[4], F. Ellinghaus[81], K. Ellis[75], N. Ellis[29], J. Elmsheuser[98], M. Elsing[29], R. Ely[14], D. Emeliyanov[129], R. Engelmann[148], A. Engl[98], B. Epp[62], A. Eppig[87], J. Erdmann[54], A. Ereditato[16], D. Eriksson[146a], J. Ernst[1], M. Ernst[24], J. Ernwein[136], D. Errede[165], S. Errede[165], E. Ertel[81], M. Escalier[115], C. Escobar[167], X. Espinal Curull[11], B. Esposito[47], F. Etienne[83], A.I. Etienvre[136], E. Etzion[153], D. Evangelakou[54], H. Evans[61], L. Fabbri[19a,19b], C. Fabre[29], K. Facius[35], R.M. Fakhrutdinov[128], S. Falciano[132a], A.C. Falou[115], Y. Fang[172], M. Fanti[89a,89b], A. Farbin[7], A. Farilla[134a], J. Farley[148], T. Farooque[158], S.M. Farrington[118], P. Farthouat[29], D. Fasching[172], P. Fassnacht[29], D. Fassouliotis[8], B. Fatholahzadeh[158], A. Favareto[89a,89b], L. Fayard[115], S. Fazio[36a,36b], R. Febbraro[33], P. Federic[144a], O.L. Fedin[121], I. Fedorko[29], W. Fedorko[88], M. Fehling-Kaschek[48], L. Feligioni[83], D. Fellmann[5], C.U. Felzmann[86], C. Feng[32d], E.J. Feng[30], A.B. Fenyuk[128], J. Ferencei[144b], J. Ferland[93], B. Fernandes[124a,b], W. Fernando[109], S. Ferrag[53], J. Ferrando[118], V. Ferrara[41], A. Ferrari[166], P. Ferrari[105], R. Ferrari[119a], A. Ferrer[167], M.L. Ferrer[47], D. Ferrere[49], C. Ferretti[87], A. Ferretto Parodi[50a,50b], M. Fiascaris[30], F. Fiedler[81], A. Filipčič[74], A. Filippas[9], F. Filthaut[104], M. Fincke-Keeler[169], M.C.N. Fiolhais[124a,g], L. Fiorini[11], A. Firan[39], G. Fischer[41], P. Fischer[20], M.J. Fisher[109], S.M. Fisher[129], J. Flammer[29], M. Flechl[48], I. Fleck[141], J. Fleckner[81], P. Fleischmann[173], S. Fleischmann[174], T. Flick[174], L.R. Flores Castillo[172], M.J. Flowerdew[99], F. Föhlisch[58a], M. Fokitis[9], T. Fonseca Martin[16], D.A. Forbush[138], A. Formica[136], A. Forti[82], D. Fortin[159a], J.M. Foster[82], D. Fournier[115], A. Foussat[29], A.J. Fowler[44], K. Fowler[137], H. Fox[71], P. Francavilla[122a,122b], S. Franchino[119a,119b], D. Francis[29], T. Frank[171], M. Franklin[57], S. Franz[29], M. Fraternali[119a,119b], S. Fratina[120], S.T. French[27],

R. Froeschl[29], D. Froidevaux[29], J.A. Frost[27], C. Fukunaga[156], E. Fullana Torregrosa[29], J. Fuster[167], C. Gabaldon[29], O. Gabizon[171], T. Gadfort[24], S. Gadomski[49], G. Gagliardi[50a,50b], P. Gagnon[61], C. Galea[98], E.J. Gallas[118], M.V. Gallas[29], V. Gallo[16], B.J. Gallop[129], P. Gallus[125], E. Galyaev[40], K.K. Gan[109], Y.S. Gao[143,e], V.A. Gapienko[128], A. Gaponenko[14], F. Garberson[175], M. Garcia-Sciveres[14], C. García[167], J.E. García Navarro[49], R.W. Gardner[30], N. Garelli[29], H. Garitaonandia[105], V. Garonne[29], J. Garvey[17], C. Gatti[47], G. Gaudio[119a], O. Gaumer[49], B. Gaur[141], L. Gauthier[136], I.L. Gavrilenko[94], C. Gay[168], G. Gaycken[20], J.-C. Gayde[29], E.N. Gazis[9], P. Ge[32d], C.N.P. Gee[129], D.A.A. Geerts[105], Ch. Geich-Gimbel[20], K. Gellerstedt[146a,146b], C. Gemme[50a], A. Gemmell[53], M.H. Genest[98], S. Gentile[132a,132b], M. George[54], S. George[76], P. Gerlach[174], A. Gershon[153], C. Geweniger[58a], H. Ghazlane[135b], P. Ghez[4], N. Ghodbane[33], B. Giacobbe[19a], S. Giagu[132a,132b], V. Giakoumopoulou[8], V. Giangiobbe[122a,122b], F. Gianotti[29], B. Gibbard[24], A. Gibson[158], S.M. Gibson[29], G.F. Gieraltowski[5], L.M. Gilbert[118], M. Gilchriese[14], V. Gilewsky[91], D. Gillberg[28], A.R. Gillman[129], D.M. Gingrich[2,d], J. Ginzburg[153], N. Giokaris[8], R. Giordano[102a,102b], F.M. Giorgi[15], P. Giovannini[99], P.F. Giraud[136], D. Giugni[89a], P. Giusti[19a], B.K. Gjelsten[117], L.K. Gladilin[97], C. Glasman[80], J. Glatzer[48], A. Glazov[41], K.W. Glitza[174], G.L. Glonti[65], J. Godfrey[142], J. Godlewski[29], M. Goebel[41], T. Göpfert[43], C. Goeringer[81], C. Gössling[42], T. Göttfert[99], S. Goldfarb[87], D. Goldin[39], T. Golling[175], S.N. Golovnia[128], A. Gomes[124a,b], L.S. Gomez Fajardo[41], R. Gonçalo[76], J. Goncalves Pinto Firmino Da Costa[41], L. Gonella[20], A. Gonidec[29], S. Gonzalez[172], S. González de la Hoz[167], M.L. Gonzalez Silva[26], S. Gonzalez-Sevilla[49], J.J. Goodson[148], L. Goossens[29], P.A. Gorbounov[95], H.A. Gordon[24], I. Gorelov[103], G. Gorfine[174], B. Gorini[29], E. Gorini[72a,72b], A. Gorišek[74], E. Gornicki[38], S.A. Gorokhov[128], V.N. Goryachev[128], B. Gosdzik[41], M. Gosselink[105], M.I. Gostkin[65], M. Gouanère[4], I. Gough Eschrich[163], M. Gouighri[135a], D. Goujdami[135c], M.P. Goulette[49], A.G. Goussiou[138], C. Goy[4], I. Grabowska-Bold[163,f], V. Grabski[176], P. Grafström[29], C. Grah[174], K.-J. Grahn[147], F. Grancagnolo[72a], S. Grancagnolo[15], V. Grassi[148], V. Gratchev[121], N. Grau[34], H.M. Gray[29], J.A. Gray[148], E. Graziani[134a], O.G. Grebenyuk[121], D. Greenfield[129], T. Greenshaw[73], Z.D. Greenwood[24,j], I.M. Gregor[41], P. Grenier[143], E. Griesmayer[46], J. Griffiths[138], N. Grigalashvili[65], A.A. Grillo[137], S. Grinstein[11], P.L.Y. Gris[33], Y.V. Grishkevich[97], J.-F. Grivaz[115], J. Grognuz[29], M. Groh[99], E. Gross[171], J. Grosse-Knetter[54], J. Groth-Jensen[79], M. Gruwe[29], K. Grybel[141], V.J. Guarino[5], D. Guest[175], C. Guicheney[33], A. Guida[72a,72b], T. Guillemin[4], S. Guindon[54], H. Guler[85,k], J. Gunther[125], B. Guo[158], J. Guo[34], A. Gupta[30], Y. Gusakov[65], V.N. Gushchin[128], A. Gutierrez[93], P. Gutierrez[111], N. Guttman[153], O. Gutzwiller[172], C. Guyot[136], C. Gwenlan[118], C.B. Gwilliam[73], A. Haas[143], S. Haas[29], C. Haber[14], R. Hackenburg[24], H.K. Hadavand[39], D.R. Hadley[17], P. Haefner[99], F. Hahn[29], S. Haider[29], Z. Hajduk[38], H. Hakobyan[176], J. Haller[54], K. Hamacher[174], P. Hamal[113], A. Hamilton[49], S. Hamilton[161], H. Han[32a], L. Han[32b], K. Hanagaki[116], M. Hance[120], C. Handel[81], P. Hanke[58a], C.J. Hansen[166], J.R. Hansen[35], J.B. Hansen[35], J.D. Hansen[35], P.H. Hansen[35], P. Hansson[143], K. Hara[160], G.A. Hare[137], T. Harenberg[174], D. Harper[87], R.D. Harrington[21], O.M. Harris[138], K. Harrison[17], J. Hartert[48], F. Hartjes[105], T. Haruyama[66], A. Harvey[56], S. Hasegawa[101], Y. Hasegawa[140], S. Hassani[136], M. Hatch[29], D. Hauff[99], S. Haug[16], M. Hauschild[29], R. Hauser[88], M. Havranek[20], B.M. Hawes[118], C.M. Hawkes[17], R.J. Hawkings[29], D. Hawkins[163], T. Hayakawa[67], D. Hayden[76], H.S. Hayward[73], S.J. Haywood[129], E. Hazen[21], M. He[32d], S.J. Head[17], V. Hedberg[79], L. Heelan[7], S. Heim[88], B. Heinemann[14], S. Heisterkamp[35], L. Helary[4], M. Heldmann[48], M. Heller[115], S. Hellman[146a,146b], C. Helsens[11], R.C.W. Henderson[71], M. Henke[58a], A. Henrichs[54], A.M. Henriques Correia[29], S. Henrot-Versille[115], F. Henry-Couannier[83], C. Hensel[54], T. Henß[174], Y. Hernández Jiménez[167], R. Herrberg[15], A.D. Hershenhorn[152], G. Herten[48], R. Hertenberger[98], L. Hervas[29], N.P. Hessey[105], A. Hidvegi[146a], E. Higón-Rodriguez[167], D. Hill[5,*], J.C. Hill[27], N. Hill[5], K.H. Hiller[41], S. Hillert[20], S.J. Hillier[17], I. Hinchliffe[14], E. Hines[120], M. Hirose[116], F. Hirsch[42], D. Hirschbuehl[174], J. Hobbs[148], N. Hod[153], M.C. Hodgkinson[139], P. Hodgson[139], A. Hoecker[29], M.R. Hoeferkamp[103], J. Hoffman[39], D. Hoffmann[83], M. Hohlfeld[81], M. Holder[141], A. Holmes[118], S.O. Holmgren[146a], T. Holy[127], J.L. Holzbauer[88], Y. Homma[67], L. Hooft van Huysduynen[108], T. Horazdovsky[127], C. Horn[143], S. Horner[48], K. Horton[118], J.-Y. Hostachy[55], S. Hou[151], M.A. Houlden[73], A. Hoummada[135a], J. Howarth[82], D.F. Howell[118], I. Hristova[41], J. Hrivnac[115], I. Hruska[125], T. Hryn'ova[4], P.J. Hsu[175], S.-C. Hsu[14], G.S. Huang[111], Z. Hubacek[127], F. Hubaut[83], F. Huegging[20], T.B. Huffman[118], E.W. Hughes[34], G. Hughes[71], R.E. Hughes-Jones[82], M. Huhtinen[29], P. Hurst[57], M. Hurwitz[14], U. Husemann[41], N. Huseynov[65,l], J. Huston[88], J. Huth[57], G. Iacobucci[102a], G. Iakovidis[9], M. Ibbotson[82], I. Ibragimov[141], R. Ichimiya[67], L. Iconomidou-Fayard[115], J. Idarraga[115], M. Idzik[37], P. Iengo[102a,102b], O. Igonkina[105], Y. Ikegami[66], M. Ikeno[66], Y. Ilchenko[39], D. Iliadis[154], D. Imbault[78], M. Imhaeuser[174], M. Imori[155], T. Ince[20], J. Inigo-Golfin[29], P. Ioannou[8], M. Iodice[134a], G. Ionescu[4], A. Irles Quiles[167], K. Ishii[66], A. Ishikawa[67], M. Ishino[66], R. Ishmukhametov[39], C. Issever[118], S. Istin[18a], Y. Itoh[101], A.V. Ivashin[128], W. Iwanski[38], H. Iwasaki[66], J.M. Izen[40], V. Izzo[102a], B. Jackson[120], J.N. Jackson[73], P. Jackson[143], M.R. Jaekel[29], V. Jain[61], K. Jakobs[48], S. Jakobsen[35], J. Jakubek[127], D.K. Jana[111], E. Jankowski[158], E. Jansen[77], A. Jantsch[99], M. Janus[20], G. Jarlskog[79], L. Jeanty[57], K. Jelen[37], I. Jen-La Plante[30], P. Jenni[29], A. Jeremie[4], P. Jež[35], S. Jézéquel[4], M.K. Jha[19a], H. Ji[172], W. Ji[81], J. Jia[148], Y. Jiang[32b], M. Jimenez Belenguer[41], G. Jin[32b], S. Jin[32a], O. Jinnouchi[157], M.D. Joergensen[35], D. Joffe[39], L.G. Johansen[13], M. Johansen[146a,146b], K.E. Johansson[146a], P. Johansson[139], S. Johnert[41], K.A. Johns[6], K. Jon-And[146a,146b], G. Jones[82], R.W.L. Jones[71], T.W. Jones[77], T.J. Jones[73],

O. Jonsson[29], C. Joram[29], P.M. Jorge[124a,b], J. Joseph[14], X. Ju[130], V. Juranek[125], P. Jussel[62], V.V. Kabachenko[128], S. Kabana[16], M. Kaci[167], A. Kaczmarska[38], P. Kadlecik[35], M. Kado[115], H. Kagan[109], M. Kagan[57], S. Kaiser[99], E. Kajomovitz[152], S. Kalinin[174], L.V. Kalinovskaya[65], S. Kama[39], N. Kanaya[155], M. Kaneda[155], T. Kanno[157], V.A. Kantserov[96], J. Kanzaki[66], B. Kaplan[175], A. Kapliy[30], J. Kaplon[29], D. Kar[43], M. Karagoz[118], M. Karnevskiy[41], K. Karr[5], V. Kartvelishvili[71], A.N. Karyukhin[128], L. Kashif[172], A. Kasmi[39], R.D. Kass[109], A. Kastanas[13], M. Kataoka[4], Y. Kataoka[155], E. Katsoufis[9], J. Katzy[41], V. Kaushik[6], K. Kawagoe[67], T. Kawamoto[155], G. Kawamura[81], M.S. Kayl[105], V.A. Kazanin[107], M.Y. Kazarinov[65], S.I. Kazi[86], J.R. Keates[82], R. Keeler[169], R. Kehoe[39], M. Keil[54], G.D. Kekelidze[65], M. Kelly[82], J. Kennedy[98], C.J. Kenney[143], M. Kenyon[53], O. Kepka[125], N. Kerschen[29], B.P. Kerševan[74], S. Kersten[174], K. Kessoku[155], C. Ketterer[48], M. Khakzad[28], F. Khalil-zada[10], H. Khandanyan[165], A. Khanov[112], D. Kharchenko[65], A. Khodinov[148], A.G. Kholodenko[128], A. Khomich[58a], T.J. Khoo[27], G. Khoriauli[20], N. Khovanskiy[65], V. Khovanskiy[95], E. Khramov[65], J. Khubua[51], G. Kilvington[76], H. Kim[7], M.S. Kim[2], P.C. Kim[143], S.H. Kim[160], N. Kimura[170], O. Kind[15], B.T. King[73], M. King[67], R.S.B. King[118], J. Kirk[129], G.P. Kirsch[118], L.E. Kirsch[22], A.E. Kiryunin[99], D. Kisielewska[37], T. Kittelmann[123], A.M. Kiver[128], H. Kiyamura[67], E. Kladiva[144b], J. Klaiber-Lodewigs[42], M. Klein[73], U. Klein[73], K. Kleinknecht[81], M. Klemetti[85], A. Klier[171], A. Klimentov[24], R. Klingenberg[42], E.B. Klinkby[35], T. Klioutchnikova[29], P.F. Klok[104], S. Klous[105], E.-E. Kluge[58a], T. Kluge[73], P. Kluit[105], S. Kluth[99], E. Kneringer[62], J. Knobloch[29], E.B.F.G. Knoops[83], A. Knue[54], B.R. Ko[44], T. Kobayashi[155], M. Kobel[43], B. Koblitz[29], M. Kocian[143], A. Kocnar[113], P. Kodys[126], K. Köneke[29], A.C. König[104], S. Koenig[81], L. Köpke[81], F. Koetsveld[104], P. Koevesarki[20], T. Koffas[29], E. Koffeman[105], F. Kohn[54], Z. Kohout[127], T. Kohriki[66], T. Koi[143], T. Kokott[20], G.M. Kolachev[107], H. Kolanoski[15], V. Kolesnikov[65], I. Koletsou[89a], J. Koll[88], D. Kollar[29], M. Kollefrath[48], S.D. Kolya[82], A.A. Komar[94], J.R. Komaragiri[142], T. Kondo[66], T. Kono[41,m], A.I. Kononov[48], R. Konoplich[108,n], N. Konstantinidis[77], A. Kootz[174], S. Koperny[37], S.V. Kopikov[128], K. Korcyl[38], K. Kordas[154], V. Koreshev[128], A. Korn[14], A. Korol[107], I. Korolkov[11], E.V. Korolkova[139], V.A. Korotkov[128], O. Kortner[99], S. Kortner[99], V.V. Kostyukhin[20], M.J. Kotamäki[29], S. Kotov[99], V.M. Kotov[65], C. Kourkoumelis[8], V. Kouskoura[154], A. Koutsman[105], R. Kowalewski[169], H. Kowalski[41], T.Z. Kowalski[37], W. Kozanecki[136], A.S. Kozhin[128], V. Kral[127], V.A. Kramarenko[97], G. Kramberger[74], O. Krasel[42], M.W. Krasny[78], A. Krasznahorkay[108], J. Kraus[88], A. Kreisel[153], F. Krejci[127], J. Kretzschmar[73], N. Krieger[54], P. Krieger[158], K. Kroeninger[54], H. Kroha[99], J. Kroll[120], J. Kroseberg[20], J. Krstic[12a], U. Kruchonak[65], H. Krüger[20], Z.V. Krumshteyn[65], A. Kruth[20], T. Kubota[155], S. Kuehn[48], A. Kugel[58c], T. Kuhl[174], D. Kuhn[62], V. Kukhtin[65], Y. Kulchitsky[90], S. Kuleshov[31b], C. Kummer[98], M. Kuna[78], N. Kundu[118], J. Kunkle[120], A. Kupco[125], H. Kurashige[67], M. Kurata[160], Y.A. Kurochkin[90], V. Kus[125], W. Kuykendall[138], M. Kuze[157], P. Kuzhir[91], O. Kvasnicka[125], J. Kvita[29], R. Kwee[15], A. La Rosa[29], L. La Rotonda[36a,36b], L. Labarga[80], J. Labbe[4], S. Lablak[135a], C. Lacasta[167], F. Lacava[132a,132b], H. Lacker[15], D. Lacour[78], V.R. Lacuesta[167], E. Ladygin[65], R. Lafaye[4], B. Laforge[78], T. Lagouri[80], S. Lai[48], E. Laisne[55], M. Lamanna[29], C.L. Lampen[6], W. Lampl[6], E. Lancon[136], U. Landgraf[48], M.P.J. Landon[75], H. Landsman[152], J.L. Lane[82], C. Lange[41], A.J. Lankford[163], F. Lanni[24], K. Lantzsch[29], V.V. Lapin[128,*], S. Laplace[78], C. Lapoire[20], J.F. Laporte[136], T. Lari[89a], A.V. Larionov[128], A. Larner[118], C. Lasseur[29], M. Lassnig[29], W. Lau[118], P. Laurelli[47], A. Lavorato[118], W. Lavrijsen[14], P. Laycock[73], A.B. Lazarev[65], A. Lazzaro[89a,89b], O. Le Dortz[78], E. Le Guirriec[83], C. Le Maner[158], E. Le Menedeu[136], A. Lebedev[64], C. Lebel[93], T. LeCompte[5], F. Ledroit-Guillon[55], H. Lee[105], J.S.H. Lee[150], S.C. Lee[151], L. Lee[175], M. Lefebvre[169], M. Legendre[136], A. Leger[49], B.C. LeGeyt[120], F. Legger[98], C. Leggett[14], M. Lehmacher[20], G. Lehmann Miotto[29], X. Lei[6], M.A.L. Leite[23b], R. Leitner[126], D. Lellouch[171], J. Lellouch[78], M. Leltchouk[34], V. Lendermann[58a], K.J.C. Leney[145b], T. Lenz[174], G. Lenzen[174], B. Lenzi[136], K. Leonhardt[43], S. Leontsinis[9], C. Leroy[93], J.-R. Lessard[169], J. Lesser[146a], C.G. Lester[27], A. Leung Fook Cheong[172], J. Levêque[4], D. Levin[87], L.J. Levinson[171], M.S. Levitski[128], M. Lewandowska[21], G.H. Lewis[108], M. Leyton[15], B. Li[83], H. Li[172], S. Li[32b], X. Li[87], Z. Liang[39], Z. Liang[118,o], B. Liberti[133a], P. Lichard[29], M. Lichtnecker[98], K. Lie[165], W. Liebig[13], R. Lifshitz[152], J.N. Lilley[17], C. Limbach[20], A. Limosani[86], M. Limper[63], S.C. Lin[151,p], F. Linde[105], J.T. Linnemann[88], E. Lipeles[120], L. Lipinsky[125], A. Lipniacka[13], T.M. Liss[165], D. Lissauer[24], A. Lister[49], A.M. Litke[137], C. Liu[28], D. Liu[151,q], H. Liu[87], J.B. Liu[87], M. Liu[32b], S. Liu[2], Y. Liu[32b], M. Livan[119a,119b], S.S.A. Livermore[118], A. Lleres[55], S.L. Lloyd[75], E. Lobodzinska[41], P. Loch[6], W.S. Lockman[137], S. Lockwitz[175], T. Loddenkoetter[20], F.K. Loebinger[82], A. Loginov[175], C.W. Loh[168], T. Lohse[15], K. Lohwasser[48], M. Lokajicek[125], J. Loken[118], V.P. Lombardo[89a], R.E. Long[71], L. Lopes[124a,b], D. Lopez Mateos[34,r], M. Losada[162], P. Loscutoff[14], F. Lo Sterzo[132a,132b], M.J. Losty[159a], X. Lou[40], A. Lounis[115], K.F. Loureiro[162], J. Love[21], P.A. Love[71], A.J. Lowe[143,e], F. Lu[32a], L. Lu[39], H.J. Lubatti[138], C. Luci[132a,132b], A. Lucotte[55], A. Ludwig[43], D. Ludwig[41], I. Ludwig[48], J. Ludwig[48], F. Luehring[61], G. Luijckx[105], D. Lumb[48], L. Luminari[132a], E. Lund[117], B. Lund-Jensen[147], B. Lundberg[79], J. Lundberg[146a,146b], J. Lundquist[35], M. Lungwitz[81], A. Lupi[122a,122b], G. Lutz[99], D. Lynn[24], J. Lys[14], E. Lytken[79], H. Ma[24], L.L. Ma[172], J.A. Macana Goia[93], G. Maccarrone[47], A. Macchiolo[99], B. Maček[74], J. Machado Miguens[124a], D. Macina[49], R. Mackeprang[35], R.J. Madaras[14], W.F. Mader[43], R. Maenner[58c], T. Maeno[24], P. Mättig[174], S. Mättig[41], P.J. Magalhaes Martins[124a,g], L. Magnoni[29], E. Magradze[51], Y. Mahalalel[153], K. Mahboubi[48], G. Mahout[17], C. Maiani[132a,132b], C. Maidantchik[23a], A. Maio[124a,b], S. Majewski[24], Y. Makida[66], N. Makovec[115],

P. Mal[6], Pa. Malecki[38], P. Malecki[38], V.P. Maleev[121], F. Malek[55], U. Mallik[63], D. Malon[5], S. Maltezos[9], V. Malyshev[107], S. Malyukov[65], R. Mameghani[98], J. Mamuzic[12b], A. Manabe[66], L. Mandelli[89a], I. Mandić[74], R. Mandrysch[15], J. Maneira[124a], P.S. Mangeard[88], I.D. Manjavidze[65], A. Mann[54], P.M. Manning[137], A. Manousakis-Katsikakis[8], B. Mansoulie[136], A. Manz[99], A. Mapelli[29], L. Mapelli[29], L. March[80], J.F. Marchand[29], F. Marchese[133a,133b], G. Marchiori[78], M. Marcisovsky[125], A. Marin[21,*], C.P. Marino[61], F. Marroquim[23a], R. Marshall[82], Z. Marshall[34,r], F.K. Martens[158], S. Marti-Garcia[167], A.J. Martin[175], B. Martin[29], B. Martin[88], F.F. Martin[120], J.P. Martin[93], Ph. Martin[55], T.A. Martin[17], B. Martin dit Latour[49], M. Martinez[11], V. Martinez Outschoorn[57], A.C. Martyniuk[82], 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], M. Maß[42], I. Massa[19a,19b], G. Massaro[105], N. Massol[4], A. Mastroberardino[36a,36b], T. Masubuchi[155], M. Mathes[20], P. Matricon[115], H. Matsumoto[155], H. Matsunaga[155], T. Matsushita[67], C. Mattravers[118,s], J.M. Maugain[29], S.J. Maxfield[73], D.A. Maximov[107], E.N. May[5], A. Mayne[139], R. Mazini[151], M. Mazur[20], M. Mazzanti[89a], E. Mazzoni[122a,122b], S.P. Mc Kee[87], A. McCarn[165], R.L. McCarthy[148], T.G. McCarthy[28], N.A. McCubbin[129], K.W. McFarlane[56], J.A. Mcfayden[139], H. McGlone[53], G. Mchedlidze[51], R.A. McLaren[29], T. Mclaughlan[17], S.J. McMahon[129], R.A. McPherson[169,i], A. Meade[84], J. Mechnich[105], M. Mechtel[174], M. Medinnis[41], R. Meera-Lebbai[111], T. Meguro[116], R. Mehdiyev[93], S. Mehlhase[35], A. Mehta[73], K. Meier[58a], J. Meinhardt[48], B. Meirose[79], C. Melachrinos[30], B.R. Mellado Garcia[172], L. Mendoza Navas[162], Z. Meng[151,q], A. Mengarelli[19a,19b], S. Menke[99], C. Menot[29], E. Meoni[11], K.M. Mercurio[57], P. Mermod[118], L. Merola[102a,102b], C. Meroni[89a], F.S. Merritt[30], A. Messina[29], J. Metcalfe[103], A.S. Mete[64], S. Meuser[20], C. Meyer[81], J.-P. Meyer[136], J. Meyer[173], J. Meyer[54], T.C. Meyer[29], W.T. Meyer[64], J. Miao[32d], S. Michal[29], L. Micu[25a], R.P. Middleton[129], P. Miele[29], S. Migas[73], L. Mijović[41], G. Mikenberg[171], M. Mikestikova[125], B. Mikulec[49], M. Mikuž[74], D.W. Miller[143], R.J. Miller[88], W.J. Mills[168], C. Mills[57], A. Milov[171], D.A. Milstead[146a,146b], D. Milstein[171], A.A. Minaenko[128], M. Miñano[167], I.A. Minashvili[65], A.I. Mincer[108], B. Mindur[37], M. Mineev[65], Y. Ming[130], L.M. Mir[11], G. Mirabelli[132a], L. Miralles Verge[11], A. Misiejuk[76], J. Mitrevski[137], G.Y. Mitrofanov[128], V.A. Mitsou[167], S. Mitsui[66], P.S. Miyagawa[82], K. Miyazaki[67], J.U. Mjörnmark[79], T. Moa[146a,146b], P. Mockett[138], S. Moed[57], V. Moeller[27], K. Mönig[41], N. Möser[20], S. Mohapatra[148], B. Mohn[13], W. Mohr[48], S. Mohrdieck-Möck[99], A.M. Moisseev[128,*], R. Moles-Valls[167], J. Molina-Perez[29], L. Moneta[49], J. Monk[77], E. Monnier[83], S. Montesano[89a,89b], F. Monticelli[70], S. Monzani[19a,19b], R.W. Moore[2], G.F. Moorhead[86], C. Mora Herrera[49], A. Moraes[53], A. Morais[124a,b], N. Morange[136], G. Morello[36a,36b], D. Moreno[81], M. Moreno Llácer[167], P. Morettini[50a], M. Morii[57], J. Morin[75], Y. Morita[66], A.K. Morley[29], G. Mornacchi[29], M.-C. Morone[49], S.V. Morozov[96], J.D. Morris[75], H.G. Moser[99], M. Mosidze[51], J. Moss[109], R. Mount[143], E. Mountricha[9], S.V. Mouraviev[94], E.J.W. Moyse[84], M. Mudrinic[12b], F. Mueller[58a], J. Mueller[123], K. Mueller[20], T.A. Müller[98], D. Muenstermann[29], A. Muijs[105], A. Muir[168], Y. Munwes[153], K. Murakami[66], W.J. Murray[129], I. Mussche[105], E. Musto[102a,102b], A.G. Myagkov[128], M. Myska[125], J. Nadal[11], K. Nagai[160], K. Nagano[66], Y. Nagasaka[60], A.M. Nairz[29], Y. Nakahama[115], K. Nakamura[155], I. Nakano[110], G. Nanava[20], A. Napier[161], M. Nash[77,s], N.R. Nation[21], T. Nattermann[20], T. Naumann[41], G. Navarro[162], H.A. Neal[87], E. Nebot[80], P.Yu. Nechaeva[94], A. Negri[119a,119b], G. Negri[29], S. Nektarijevic[49], A. Nelson[64], S. Nelson[143], T.K. Nelson[143], S. Nemecek[125], P. Nemethy[108], A.A. Nepomuceno[23a], M. Nessi[29,t], S.Y. Nesterov[121], M.S. Neubauer[165], A. Neusiedl[81], R.M. Neves[108], P. Nevski[24], P.R. Newman[17], R.B. Nickerson[118], R. Nicolaidou[136], L. Nicolas[139], B. Nicquevert[29], F. Niedercorn[115], J. Nielsen[137], T. Niinikoski[29], A. Nikiforov[15], V. Nikolaenko[128], K. Nikolaev[65], I. Nikolic-Audit[78], K. Nikolopoulos[24], H. Nilsen[48], P. Nilsson[7], Y. Ninomiya[155], A. Nisati[132a], T. Nishiyama[67], R. Nisius[99], L. Nodulman[5], M. Nomachi[116], I. Nomidis[154], H. Nomoto[155], M. Nordberg[29], B. Nordkvist[146a,146b], P.R. Norton[129], J. Novakova[126], M. Nozaki[66], M. Nožička[41], L. Nozka[113], I.M. Nugent[159a], A.-E. Nuncio-Quiroz[20], G. Nunes Hanninger[20], T. Nunnemann[98], E. Nurse[77], T. Nyman[29], B.J. O'Brien[45], S.W. O'Neale[17,*], D.C. O'Neil[142], V. O'Shea[53], F.G. Oakham[28,d], H. Oberlack[99], J. Ocariz[78], A. Ochi[67], S. Oda[155], S. Odaka[66], J. Odier[83], H. Ogren[61], A. Oh[82], S.H. Oh[44], C.C. Ohm[146a,146b], T. Ohshima[101], H. Ohshita[140], T.K. Ohska[66], T. Ohsugi[59], S. Okada[67], H. Okawa[163], Y. Okumura[101], T. Okuyama[155], M. Olcese[50a], A.G. Olchevski[65], M. Oliveira[124a,g], D. Oliveira Damazio[24], E. Oliver Garcia[167], D. Olivito[120], A. Olszewski[38], J. Olszowska[38], C. Omachi[67], A. Onofre[124a,u], P.U.E. Onyisi[30], C.J. Oram[159a], M.J. Oreglia[30], F. Orellana[49], Y. Oren[153], D. Orestano[134a,134b], I. Orlov[107], C. Oropeza Barrera[53], R.S. Orr[158], E.O. Ortega[130], B. Osculati[50a,50b], R. Ospanov[120], C. Osuna[11], G. Otero y Garzon[26], J. P Ottersbach[105], M. Ouchrif[135d], F. Ould-Saada[117], A. Ouraou[136], Q. Ouyang[32a], M. Owen[82], S. Owen[139], O.K. Øye[13], V.E. Ozcan[18a], A. Pacheco Pages[11], E. Paganis[139], F. Paige[24], K. Pajchel[117], S. Palestini[29], D. Pallin[33], A. Palma[124a,b], J.D. Palmer[17], Y.B. Pan[172], E. Panagiotopoulou[9], B. Panes[31a], N. Panikashvili[87], S. Panitkin[24], D. Pantea[25a], M. Panuskova[125], V. Paolone[123], A. Paoloni[133a,133b], A. Papadelis[146a], Th.D. Papadopoulou[9], A. Paramonov[5], W. Park[24,v], M.A. Parker[27], F. Parodi[50a,50b], J.A. Parsons[34], U. Parzefall[48], E. Pasqualucci[132a], A. Passeri[134a], F. Pastore[134a,134b], Fr. Pastore[29], G. Pásztor[49,w], S. Pataraia[172], N. Patel[150], J.R. Pater[82], S. Patricelli[102a,102b], T. Pauly[29], M. Pecsy[144a], M.I. Pedraza Morales[172], S.V. Peleganchuk[107], H. Peng[172], R. Pengo[29], A. Penson[34], J. Penwell[61], M. Perantoni[23a], K. Perez[34,r], T. Perez Cavalcanti[41], E. Perez Codina[11], M.T. Pérez García-Estañ[167], V. Perez Reale[34], I. Peric[20],

L. Perini[89a,89b], H. Pernegger[29], R. Perrino[72a], P. Perrodo[4], S. Persembe[3a], V.D. Peshekhonov[65], O. Peters[105], B.A. Petersen[29], J. Petersen[29], T.C. Petersen[35], E. Petit[83], A. Petridis[154], C. Petridou[154], E. Petrolo[132a], F. Petrucci[134a,134b], D. Petschull[41], M. Petteni[142], R. Pezoa[31b], A. Phan[86], A.W. Phillips[27], P.W. Phillips[129], G. Piacquadio[29], E. Piccaro[75], M. Piccinini[19a,19b], A. Pickford[53], S.M. Piec[41], R. Piegaia[26], J.E. Pilcher[30], A.D. Pilkington[82], J. Pina[124a,b], M. Pinamonti[164a,164c], A. Pinder[118], J.L. Pinfold[2], J. Ping[32c], B. Pinto[124a,b], O. Pirotte[29], C. Pizio[89a,89b], R. Placakyte[41], M. Plamondon[169], W.G. Plano[82], M.-A. Pleier[24], A.V. Pleskach[128], A. Poblaguev[24], S. Poddar[58a], F. Podlyski[33], L. Poggioli[115], T. Poghosyan[20], M. Pohl[49], F. Polci[55], G. Polesello[119a], A. Policicchio[138], A. Polini[19a], J. Poll[75], V. Polychronakos[24], D.M. Pomarede[136], D. Pomeroy[22], K. Pommès[29], L. Pontecorvo[132a], B.G. Pope[88], G.A. Popeneciu[25a], D.S. Popovic[12a], A. Poppleton[29], X. Portell Bueso[48], R. Porter[163], C. Posch[21], G.E. Pospelov[99], S. Pospisil[127], I.N. Potrap[99], C.J. Potter[149], C.T. Potter[114], G. Poulard[29], J. Poveda[172], R. Prabhu[77], P. Pralavorio[83], S. Prasad[57], R. Pravahan[7], S. Prell[64], K. Pretzl[16], L. Pribyl[29], D. Price[61], L.E. Price[5], M.J. Price[29], P.M. Prichard[73], D. Prieur[123], M. Primavera[72a], K. Prokofiev[108], F. Prokoshin[31b], S. Protopopescu[24], J. Proudfoot[5], X. Prudent[43], H. Przysiezniak[4], S. Psoroulas[20], E. Ptacek[114], J. Purdham[87], M. Purohit[24,v], P. Puzo[115], Y. Pylypchenko[117], J. Qian[87], Z. Qian[83], Z. Qin[41], A. Quadt[54], D.R. Quarrie[14], W.B. Quayle[172], F. Quinonez[31a], M. Raas[104], V. Radescu[58b], B. Radics[20], T. Rador[18a], F. Ragusa[89a,89b], G. Rahal[177], A.M. Rahimi[109], D. Rahm[24], S. Rajagopalan[24], M. Rammensee[48], M. Rammes[141], M. Ramstedt[146a,146b], K. Randrianarivony[28], P.N. Ratoff[71], F. Rauscher[98], E. Rauter[99], M. Raymond[29], A.L. Read[117], D.M. Rebuzzi[119a,119b], A. Redelbach[173], G. Redlinger[24], R. Reece[120], K. Reeves[40], A. Reichold[105], E. Reinherz-Aronis[153], A. Reinsch[114], I. Reisinger[42], D. Reljic[12a], C. Rembser[29], Z.L. Ren[151], A. Renaud[115], P. Renkel[39], B. Rensch[35], M. Rescigno[132a], S. Resconi[89a], B. Resende[136], P. Reznicek[98], R. Rezvani[158], A. Richards[77], R. Richter[99], E. Richter-Was[38,x], M. Ridel[78], S. Rieke[81], M. Rijpstra[105], M. Rijssenbeek[148], A. Rimoldi[119a,119b], L. Rinaldi[19a], R.R. Rios[39], I. Riu[11], G. Rivoltella[89a,89b], F. Rizatdinova[112], E. Rizvi[75], S.H. Robertson[85,i], A. Robichaud-Veronneau[49], D. Robinson[27], J.E.M. Robinson[77], M. Robinson[114], A. Robson[53], J.G. Rocha de Lima[106], C. Roda[122a,122b], D. Roda Dos Santos[29], S. Rodier[80], D. Rodriguez[162], Y. Rodriguez Garcia[15], A. Roe[54], S. Roe[29], O. Røhne[117], V. Rojo[1], S. Rolli[161], A. Romaniouk[96], V.M. Romanov[65], G. Romeo[26], D. Romero Maltrana[31a], L. Roos[78], E. Ros[167], S. Rosati[132a,132b], M. Rose[76], G.A. Rosenbaum[158], E.I. Rosenberg[64], P.L. Rosendahl[13], L. Rosselet[49], V. Rossetti[11], E. Rossi[102a,102b], L.P. Rossi[50a], L. Rossi[89a,89b], M. Rotaru[25a], I. Roth[171], J. Rothberg[138], D. Rousseau[115], C.R. Royon[136], A. Rozanov[83], Y. Rozen[152], X. Ruan[115], I. Rubinskiy[41], B. Ruckert[98], N. Ruckstuhl[105], V.I. Rud[97], G. Rudolph[62], F. Rühr[6], F. Ruggieri[134a,134b], A. Ruiz-Martinez[64], E. Rulikowska-Zarebska[37], V. Rumiantsev[91,*], L. Rumyantsev[65], K. Runge[48], O. Runolfsson[20], Z. Rurikova[48], N.A. Rusakovich[65], D.R. Rust[61], J.P. Rutherfoord[6], C. Ruwiedel[14], P. Ruzicka[125], Y.F. Ryabov[121], V. Ryadovikov[128], P. Ryan[88], M. Rybar[126], G. Rybkin[115], N.C. Ryder[118], S. Rzaeva[10], A.F. Saavedra[150], I. Sadeh[153], H.F.-W. Sadrozinski[137], R. Sadykov[65], F. Safai Tehrani[132a,132b], H. Sakamoto[155], G. Salamanna[105], A. Salamon[133a], M. Saleem[111], D. Salihagic[99], A. Salnikov[143], J. Salt[167], B.M. Salvachua Ferrando[5], D. Salvatore[36a,36b], F. Salvatore[149], A. Salzburger[29], D. Sampsonidis[154], B.H. Samset[117], H. Sandaker[13], H.G. Sander[81], M.P. Sanders[98], M. Sandhoff[174], P. Sandhu[158], T. Sandoval[27], R. Sandstroem[105], S. Sandvoss[174], D.P.C. Sankey[129], A. Sansoni[47], C. Santamarina Rios[85], C. Santoni[33], R. Santonico[133a,133b], H. Santos[124a], J.G. Saraiva[124a,b], T. Sarangi[172], E. Sarkisyan-Grinbaum[7], F. Sarri[122a,122b], G. Sartisohn[174], O. Sasaki[66], T. Sasaki[66], N. Sasao[68], I. Satsounkevitch[90], G. Sauvage[4], J.B. Sauvan[115], P. Savard[158,d], V. Savinov[123], D.O. Savu[29], P. Savva[9], L. Sawyer[24,j], D.H. Saxon[53], L.P. Says[33], C. Sbarra[19a,19b], A. Sbrizzi[19a,19b], O. Scallon[93], D.A. Scannicchio[163], J. Schaarschmidt[115], P. Schacht[99], U. Schäfer[81], S. Schaepe[20], 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.I. Scherzer[14], C. Schiavi[50a,50b], J. Schieck[98], M. Schioppa[36a,36b], S. Schlenker[29], J.L. Schlereth[5], E. Schmidt[48], M.P. Schmidt[175,*], K. Schmieden[20], C. Schmitt[81], M. Schmitz[20], A. Schöning[58b], M. Schott[29], D. Schouten[142], J. Schovancova[125], M. Schram[85], C. Schroeder[81], N. Schroer[58c], S. Schuh[29], G. Schuler[29], J. Schultes[174], H.-C. Schultz-Coulon[58a], H. Schulz[15], J.W. Schumacher[20], M. Schumacher[48], B.A. Schumm[137], Ph. Schune[136], C. Schwanenberger[82], A. Schwartzman[143], Ph. Schwemling[78], R. Schwienhorst[88], R. Schwierz[43], J. Schwindling[136], W.G. Scott[129], J. Searcy[114], E. Sedykh[121], E. Segura[11], S.C. Seidel[103], A. Seiden[137], F. Seifert[43], J.M. Seixas[23a], G. Sekhniaidze[102a], D.M. Seliverstov[121], B. Sellden[146a], G. Sellers[73], M. Seman[144b], N. Semprini-Cesari[19a,19b], C. Serfon[98], L. Serin[115], R. Seuster[99], H. Severini[111], M.E. Sevior[86], A. Sfyrla[29], E. Shabalina[54], M. Shamim[114], L.Y. Shan[32a], J.T. Shank[21], Q.T. Shao[86], M. Shapiro[14], P.B. Shatalov[95], L. Shaver[6], C. Shaw[53], K. Shaw[164a,164c], D. Sherman[175], P. Sherwood[77], A. Shibata[108], S. Shimizu[29], M. Shimojima[100], T. Shin[56], A. Shmeleva[94], M.J. Shochet[30], D. Short[118], M.A. Shupe[6], P. Sicho[125], A. Sidoti[132a,132b], A. Siebel[174], F. Siegert[48], J. Siegrist[14], Dj. Sijacki[12a], O. Silbert[171], J. Silva[124a,b], Y. Silver[153], D. Silverstein[143], S.B. Silverstein[146a], V. Simak[127], O. Simard[136], Lj. Simic[12a], S. Simion[115], B. Simmons[77], M. Simonyan[35], P. Sinervo[158], N.B. Sinev[114], V. Sipica[141], G. Siragusa[81], A.N. Sisakyan[65], S.Yu. Sivoklokov[97], J. Sjölin[146a,146b], T.B. Sjursen[13], L.A. Skinnari[14], K. Skovpen[107], P. Skubic[111], N. Skvorodnev[22], M. Slater[17], T. Slavicek[127], K. Sliwa[161], T.J. Sloan[71], J. Sloper[29], V. Smakhtin[171], S.Yu. 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], J. Snuverink[105], S. Snyder[24], M. Soares[124a], R. Sobie[169,i], J. Sodomka[127], A. Soffer[153], C.A. Solans[167], M. Solar[127], J. Solc[127], E. Soldatov[96], U. Soldevila[167], E. Solfaroli Camillocci[132a,132b], A.A. Solodkov[128], O.V. Solovyanov[128], J. Sondericker[24], N. Soni[2], V. Sopko[127], B. Sopko[127], M. Sorbi[89a,89b], M. Sosebee[7], A. Soukharev[107], S. Spagnolo[72a,72b], F. Spanò[34], R. Spighi[19a], G. Spigo[29], F. Spila[132a,132b], E. Spiriti[134a], R. Spiwoks[29], M. Spousta[126], T. Spreitzer[158], B. Spurlock[7], R.D.St. Denis[53], T. Stahl[141], J. Stahlman[120], R. Stamen[58a], E. Stanecka[29], R.W. Stanek[5], C. Stanescu[134a], S. Stapnes[117], E.A. Starchenko[128], J. Stark[55], P. Staroba[125], P. Starovoitov[91], A. Staude[98], P. Stavina[144a], G. Stavropoulos[14], G. Steele[53], P. Steinbach[43], P. Steinberg[24], I. Stekl[127], B. Stelzer[142], H.J. Stelzer[41], O. Stelzer-Chilton[159a], H. Stenzel[52], K. Stevenson[75], G.A. Stewart[53], J.A. Stillings[20], T. Stockmanns[20], M.C. Stockton[29], K. Stoerig[48], G. Stoicea[25a], S. Stonjek[99], P. Strachota[126], A.R. Stradling[7], A. Straessner[43], J. Strandberg[87], S. Strandberg[146a,146b], A. Strandlie[117], M. Strang[109], E. Strauss[143], M. Strauss[111], P. Strizenec[144b], R. Ströhmer[173], D.M. Strom[114], J.A. Strong[76,*], R. Stroynowski[39], J. Strube[129], B. Stugu[13], I. Stumer[24,*], J. Stupak[148], P. Sturm[174], D.A. Soh[151,o], D. Su[143], H.S. Subramania[2], A. Succurro[11], Y. Sugaya[116], T. Sugimoto[101], C. Suhr[106], K. Suita[67], M. Suk[126], V.V. Sulin[94], S. Sultansoy[3d], T. Sumida[29], X. Sun[55], J.E. Sundermann[48], K. Suruliz[164a,164b], S. Sushkov[11], G. Susinno[36a,36b], M.R. Sutton[139], Y. Suzuki[66], Yu.M. Sviridov[128], S. Swedish[168], I. Sykora[144a], T. Sykora[126], B. Szeless[29], J. Sánchez[167], D. Ta[105], K. Tackmann[29], A. Taffard[163], R. Tafirout[159a], A. Taga[117], N. Taiblum[153], Y. Takahashi[101], H. Takai[24], R. Takashima[69], H. Takeda[67], T. Takeshita[140], M. Talby[83], A. Talyshev[107], M.C. Tamsett[24], J. Tanaka[155], R. Tanaka[115], S. Tanaka[131], S. Tanaka[66], Y. Tanaka[100], K. Tani[67], N. Tannoury[83], G.P. Tappern[29], S. Tapprogge[81], D. Tardif[158], S. Tarem[152], F. Tarrade[24], G.F. Tartarelli[89a], P. Tas[126], M. Tasevsky[125], E. Tassi[36a,36b], M. Tatarkhanov[14], C. Taylor[77], F.E. Taylor[92], G.N. Taylor[86], W. Taylor[159b], M. Teixeira Dias Castanheira[75], P. Teixeira-Dias[76], K.K. Temming[48], H. Ten Kate[29], P.K. Teng[151], S. Terada[66], K. Terashi[155], J. Terron[80], M. Terwort[41,m], M. Testa[47], R.J. Teuscher[158,i], C.M. Tevlin[82], J. Thadome[174], J. Therhaag[20], T. Theveneaux-Pelzer[78], M. Thioye[175], S. Thoma[48], J.P. Thomas[17], E.N. Thompson[84], P.D. Thompson[17], P.D. Thompson[158], A.S. Thompson[53], E. Thomson[120], M. Thomson[27], R.P. Thun[87], T. Tic[125], V.O. Tikhomirov[94], Y.A. Tikhonov[107], C.J.W.P. Timmermans[104], P. Tipton[175], F.J. Tique Aires Viegas[29], S. Tisserant[83], J. Tobias[48], B. Toczek[37], T. Todorov[4], S. Todorova-Nova[161], B. Toggerson[163], J. Tojo[66], S. Tokár[144a], K. Tokunaga[67], K. Tokushuku[66], K. Tollefson[88], M. Tomoto[101], L. Tompkins[14], K. Toms[103], G. Tong[32a], A. Tonoyan[13], C. Topfel[16], N.D. Topilin[65], I. Torchiani[29], E. Torrence[114], E. Torró Pastor[167], J. Toth[83,w], F. Touchard[83], D.R. Tovey[139], D. Traynor[75], T. Trefzger[173], J. Treis[20], L. Tremblet[29], A. Tricoli[29], I.M. Trigger[159a], S. Trincaz-Duvoid[78], T.N. Trinh[78], M.F. Tripiana[70], N. Triplett[64], W. Trischuk[158], A. Trivedi[24,v], B. Trocmé[55], C. Troncon[89a], M. Trottier-McDonald[142], A. Trzupek[38], C. Tsarouchas[29], J.C.-L. Tseng[118], M. Tsiakiris[105], P.V. Tsiareshka[90], D. Tsionou[4], G. Tsipolitis[9], V. Tsiskaridze[48], E.G. Tskhadadze[51], I.I. Tsukerman[95], V. Tsulaia[123], J.-W. Tsung[20], S. Tsuno[66], D. Tsybychev[148], A. Tua[139], J.M. Tuggle[30], M. Turala[38], D. Turecek[127], I. Turk Cakir[3e], E. Turlay[105], R. Turra[89a,89b], P.M. Tuts[34], A. Tykhonov[74], M. Tylmad[146a,146b], M. Tyndel[129], H. Tyrvainen[29], G. Tzanakos[8], K. Uchida[20], I. Ueda[155], R. Ueno[28], M. Ugland[13], M. Uhlenbrock[20], M. Uhrmacher[54], F. Ukegawa[160], G. Unal[29], D.G. Underwood[5], A. Undrus[24], G. Unel[163], Y. Unno[66], D. Urbaniec[34], E. Urkovsky[153], P. Urrejola[31a], G. Usai[7], M. Uslenghi[119a,119b], L. Vacavant[83], V. Vacek[127], B. Vachon[85], S. Vahsen[14], C. Valderanis[99], J. Valenta[125], P. Valente[132a], S. Valentinetti[19a,19b], S. Valkar[126], E. Valladolid Gallego[167], S. Vallecorsa[152], J.A. Valls Ferrer[167], H. van der Graaf[105], E. van der Kraaij[105], R. Van Der Leeuw[105], E. van der Poel[105], D. van der Ster[29], B. Van Eijk[105], N. van Eldik[84], P. van Gemmeren[5], Z. van Kesteren[105], I. van Vulpen[105], W. Vandelli[29], G. Vandoni[29], A. Vaniachine[5], P. Vankov[41], F. Vannucci[78], F. Varela Rodriguez[29], R. Vari[132a], E.W. Varnes[6], D. Varouchas[14], A. Vartapetian[7], K.E. Varvell[150], V.I. Vassilakopoulos[56], F. Vazeille[33], G. Vegni[89a,89b], J.J. Veillet[115], C. Vellidis[8], F. Veloso[124a], R. Veness[29], S. Veneziano[132a], A. Ventura[72a,72b], D. Ventura[138], M. Venturi[48], N. Venturi[16], V. Vercesi[119a], M. Verducci[138], W. Verkerke[105], J.C. Vermeulen[105], A. Vest[43], M.C. Vetterli[142,d], I. Vichou[165], T. Vickey[145b,y], G.H.A. Viehhauser[118], S. Viel[168], M. Villa[19a,19b], M. Villaplana Perez[167], E. Vilucchi[47], M.G. Vincter[28], E. Vinek[29], V.B. Vinogradov[65], M. Virchaux[136,*], S. Viret[33], J. Virzi[14], A. Vitale[19a,19b], O. Vitells[171], M. Viti[41], I. Vivarelli[48], F. Vives Vaque[11], S. Vlachos[9], M. Vlasak[127], N. Vlasov[20], A. Vogel[20], P. Vokac[127], G. Volpi[47], M. Volpi[11], G. Volpini[89a], H. von der Schmitt[99], J. von Loeben[99], H. von Radziewski[48], E. von Toerne[20], V. Vorobel[126], A.P. Vorobiev[128], V. Vorwerk[11], M. Vos[167], R. Voss[29], T.T. Voss[174], J.H. Vossebeld[73], A.S. Vovenko[128], N. Vranjes[12a], M. Vranjes Milosavljevic[12a], V. Vrba[125], M. Vreeswijk[105], T. Vu Anh[81], R. Vuillermet[29], I. Vukotic[115], W. Wagner[174], P. Wagner[120], H. Wahlen[174], J. Wakabayashi[101], J. Walbersloh[42], S. Walch[87], J. Walder[71], R. Walker[98], W. Walkowiak[141], R. Wall[175], P. Waller[73], C. Wang[44], H. Wang[172], H. Wang[32b], J. Wang[151], J. Wang[32d], J.C. Wang[138], R. Wang[103], S.M. Wang[151], A. Warburton[85], C.P. Ward[27], M. Warsinsky[48], P.M. Watkins[17], A.T. Watson[17], M.F. Watson[17], G. Watts[138], S. Watts[82], A.T. Waugh[150], B.M. Waugh[77], J. Weber[42], M. Weber[129], M.S. Weber[16], P. Weber[54], A.R. Weidberg[118], P. Weigell[99], J. Weingarten[54], C. Weiser[48], H. Wellenstein[22], P.S. Wells[29], M. Wen[47], T. Wenaus[24], S. Wendler[123], Z. Weng[151,o], T. Wengler[29], S. Wenig[29], N. Wermes[20], M. Werner[48], P. Werner[29], M. Werth[163], M. Wessels[58a], K. Whalen[28], S.J. Wheeler-Ellis[163], S.P. Whitaker[21], A. White[7], M.J. White[86], S. White[24], S.R. Whitehead[118], D. Whiteson[163], D. Whittington[61], F. Wicek[115], D. Wicke[174], F.J. Wickens[129], W. Wiedenmann[172], M. Wielers[129],

P. Wienemann[20], C. Wiglesworth[73], L.A.M. Wiik[48], P.A. Wijeratne[77], A. Wildauer[167], M.A. Wildt[41,m], I. Wilhelm[126], H.G. Wilkens[29], J.Z. Will[98], E. Williams[34], H.H. Williams[120], W. Willis[34], S. Willocq[84], J.A. Wilson[17], M.G. Wilson[143], A. Wilson[87], I. Wingerter-Seez[4], S. Winkelmann[48], F. Winklmeier[29], M. Wittgen[143], M.W. Wolter[38], H. Wolters[124a,g], G. Wooden[118], B.K. Wosiek[38], J. Wotschack[29], M.J. Woudstra[84], K. Wraight[53], C. Wright[53], B. Wrona[73], S.L. Wu[172], X. Wu[49], Y. Wu[32b], E. Wulf[34], R. Wunstorf[42], B.M. Wynne[45], L. Xaplanteris[9], S. Xella[35], S. Xie[48], Y. Xie[32a], C. Xu[32b], D. Xu[139], G. Xu[32a], B. Yabsley[150], M. Yamada[66], A. Yamamoto[66], K. Yamamoto[64], S. Yamamoto[155], T. Yamamura[155], J. Yamaoka[44], T. Yamazaki[155], Y. Yamazaki[67], Z. Yan[21], H. Yang[87], U.K. Yang[82], Y. Yang[61], Y. Yang[32a], Z. Yang[146a,146b], S. Yanush[91], W.-M. Yao[14], Y. Yao[14], Y. Yasu[66], G.V. Ybeles Smit[130], J. Ye[39], S. Ye[24], M. Yilmaz[3c], R. Yoosoofmiya[123], K. Yorita[170], R. Yoshida[5], C. Young[143], S. Youssef[21], D. Yu[24], J. Yu[7], J. Yu[32c,z], L. Yuan[32a,aa], A. Yurkewicz[148], V.G. Zaets[128], R. Zaidan[63], A.M. Zaitsev[128], Z. Zajacova[29], Yo.K. Zalite[121], L. Zanello[132a,132b], P. Zarzhitsky[39], A. Zaytsev[107], C. Zeitnitz[174], M. Zeller[175], P.F. Zema[29], A. Zemla[38], C. Zendler[20], A.V. Zenin[128], O. Zenin[128], T. Ženiš[144a], Z. Zenonos[122a,122b], S. Zenz[14], D. Zerwas[115], G. Zevi della Porta[57], Z. Zhan[32d], D. Zhang[32b], H. Zhang[88], J. Zhang[5], X. Zhang[32d], Z. Zhang[115], L. Zhao[108], T. Zhao[138], Z. Zhao[32b], A. Zhemchugov[65], S. Zheng[32a], J. Zhong[151,ab], B. Zhou[87], N. Zhou[163], Y. Zhou[151], C.G. Zhu[32d], H. Zhu[41], Y. Zhu[172], X. Zhuang[98], V. Zhuravlov[99], D. Zieminska[61], R. Zimmermann[20], S. Zimmermann[20], S. Zimmermann[48], M. Ziolkowski[141], R. Zitoun[4], L. Živković[34], V.V. Zmouchko[128,*], G. Zobernig[172], A. Zoccoli[19a,19b], Y. Zolnierowski[4], A. Zsenei[29], M. zur Nedden[15], V. Zutshi[106], L. Zwalinski[29]

[1]University at Albany, Albany NY, United States of America
[2]Department of Physics, University of Alberta, Edmonton AB, Canada
[3(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
[4]LAPP, CNRS/IN2P3 and Université de Savoie, Annecy-le-Vieux, France
[5]High Energy Physics Division, Argonne National Laboratory, Argonne IL, United States of America
[6]Department of Physics, University of Arizona, Tucson AZ, United States of America
[7]Department of Physics, The University of Texas at Arlington, Arlington TX, United States of America
[8]Physics Department, University of Athens, Athens, Greece
[9]Physics Department, National Technical University of Athens, Zografou, Greece
[10]Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan
[11]Institut de Física d'Altes Energies and Universitat Autònoma de Barcelona and ICREA, Barcelona, Spain
[12(a)]Institute of Physics, University of Belgrade, Belgrade; [(b)]Vinca Institute of Nuclear Sciences, Belgrade, Serbia
[13]Department for Physics and Technology, University of Bergen, Bergen, Norway
[14]Physics Division, Lawrence Berkeley National Laboratory and University of California, Berkeley CA, United States of America
[15]Department of Physics, Humboldt University, Berlin, Germany
[16]Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland
[17]School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom
[18(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
[19(a)]INFN Sezione di Bologna; [(b)]Dipartimento di Fisica, Università di Bologna, Bologna, Italy
[20]Physikalisches Institut, University of Bonn, Bonn, Germany
[21]Department of Physics, Boston University, Boston MA, United States of America
[22]Department of Physics, Brandeis University, Waltham MA, United States of America
[23(a)]Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro; [(b)]Instituto de Fisica, Universidade de Sao Paulo, Sao Paulo, Brazil
[24]Physics Department, Brookhaven National Laboratory, Upton NY, United States of America
[25(a)]National Institute of Physics and Nuclear Engineering, Bucharest; [(b)]University Politehnica Bucharest, Bucharest; [(c)]West University in Timisoara, Timisoara, Romania
[26]Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina
[27]Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom
[28]Department of Physics, Carleton University, Ottawa ON, Canada
[29]CERN, Geneva, Switzerland

[30]Enrico Fermi Institute, University of Chicago, Chicago IL, United States of America
[31(a)]Departamento de Fisica, Pontificia Universidad Católica de Chile, Santiago; [(b)]Departamento de Física, Universidad Técnica Federico Santa María, Valparaíso, Chile
[32(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)]High Energy Physics Group, Shandong University, Shandong, China
[33]Laboratoire de Physique Corpusculaire, Clermont Université and Université Blaise Pascal and CNRS/IN2P3, Aubiere Cedex, France
[34]Nevis Laboratory, Columbia University, Irvington NY, United States of America
[35]Niels Bohr Institute, University of Copenhagen, Kobenhavn, Denmark
[36(a)]INFN Gruppo Collegato di Cosenza; [(b)]Dipartimento di Fisica, Università della Calabria, Arcavata di Rende, Italy
[37]Faculty of Physics and Applied Computer Science, AGH-University of Science and Technology, Krakow, Poland
[38]The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland
[39]Physics Department, Southern Methodist University, Dallas TX, United States of America
[40]Physics Department, University of Texas at Dallas, Richardson TX, United States of America
[41]DESY, Hamburg and Zeuthen, Germany
[42]Institut für Experimentelle Physik IV, Technische Universität Dortmund, Dortmund, Germany
[43]Institut für Kern- und Teilchenphysik, Technical University Dresden, Dresden, Germany
[44]Department of Physics, Duke University, Durham NC, United States of America
[45]SUPA-School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom
[46]Fachhochschule Wiener Neustadt, Wiener Neustadt, Austria
[47]INFN Laboratori Nazionali di Frascati, Frascati, Italy
[48]Fakultät für Mathematik und Physik, Albert-Ludwigs-Universität, Freiburg i.Br., 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]Institute of Physics and HEP Institute, Georgian Academy of Sciences and 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 Science, Hiroshima University, Hiroshima, Japan
[60]Faculty of Applied Information Science, Hiroshima Institute of Technology, Hiroshima, Japan
[61]Department of Physics, Indiana University, Bloomington IN, United States of America
[62]Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria
[63]University of Iowa, Iowa City IA, United States of America
[64]Department of Physics and Astronomy, Iowa State University, Ames IA, United States of America
[65]Joint Institute for Nuclear Research, JINR Dubna, Dubna, Russia
[66]KEK, High Energy Accelerator Research Organization, Tsukuba, Japan
[67]Graduate School of Science, Kobe University, Kobe, Japan
[68]Faculty of Science, Kyoto University, Kyoto, Japan
[69]Kyoto University of Education, Kyoto, 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 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]Department of Physics, 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, 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, The Netherlands
[105]Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam, The Netherlands
[106]Department of Physics, Northern Illinois University, DeKalb IL, United States of America
[107]Budker Institute of Nuclear Physics (BINP), 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, Univ. 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 Nucleare e Teorica, 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)]Université Cadi Ayyad, Faculté des sciences Semlalia Département de Physique, B.P. 2390 Marrakech 40000; [(d)]Faculté des Sciences, Université Mohamed Premier and LPTPM, Oujda; [(e)]Faculté des Sciences, Université Mohammed V, 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]Department of Physics and Astronomy, 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 Inst. 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]Institute of Pure and Applied Sciences, University of Tsukuba, Ibaraki, Japan
[161]Science and Technology Center, 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; [(b)]ICTP, Trieste; [(c)]Dipartimento di Fisica, 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 Ingenierá 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]Waseda University, Tokyo, Japan
[171]Department of Particle Physics, The Weizmann Institute of Science, Rehovot, Israel
[172]Department of Physics, University of Wisconsin, Madison WI, United States of America
[173]Fakultät für Physik und Astronomie, Julius-Maximilians-Universität, Würzburg, Germany
[174]Fachbereich C Physik, Bergische Universität Wuppertal, Wuppertal, Germany
[175]Department of Physics, Yale University, New Haven CT, United States of America
[176]Yerevan Physics Institute, Yerevan, Armenia
[177]Domaine scientifique de la Doua, Centre de Calcul CNRS/IN2P3, Villeurbanne Cedex, 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 CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France
[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 Faculty of Physics and Applied Computer Science, AGH-University of Science and Technology, Krakow, Poland
[g]Also at Department of Physics, University of Coimbra, Coimbra, Portugal
[h]Also at Università di Napoli Parthenope, Napoli, Italy
[i]Also at Institute of Particle Physics (IPP), Canada
[j]Also at Louisiana Tech University, Ruston LA, United States of America
[k]Also at Group of Particle Physics, University of Montreal, Montreal QC, Canada
[l]Also at Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan
[m]Also at Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany
[n]lso at Manhattan College, New York NY, United States of America
[o]Also at School of Physics and Engineering, Sun Yat-sen University, Guanzhou, China
[p]Also at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan
[q]Also at High Energy Physics Group, Shandong University, Shandong, China
[r]Also at California Institute of Technology, Pasadena CA, United States of America
[s]Also at Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom
[t]Also at Section de Physique, Université de Genève, Geneva, Switzerland
[u]Also at Departamento de Fisica, Universidade de Minho, Braga, Portugal
[v]Also at Department of Physics and Astronomy, University of South Carolina, Columbia SC, United States of America
[w]Also at KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary
[x]Also at Institute of Physics, Jagiellonian University, Krakow, Poland
[y]Also at Department of Physics, Oxford University, Oxford, United Kingdom
[z]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
[aa]Also at Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France
[ab]Also at Department of Physics, Nanjing University, Jiangsu, China
[*]Deceased