# Search for squarks and gluinos using final states with jets and missing transverse momentum with the ATLAS detector in √s=7 TeV proton-proton collisions

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.B.; Vermeulen, J.C.; Vreeswijk, M.

**DOI**
10.1016/j.physletb.2011.05.061

**Publication date**
2011

**Document Version**
Final published version

**Published in**
Physics Letters B

Physics Letters B 701 (2011) 186–203

Contents lists available at ScienceDirect

Physics Letters B

www.elsevier.com/locate/physletb

# Search for squarks and gluinos using final states with jets and missing transverse momentum with the ATLAS detector in $\sqrt{s} = 7$ TeV proton–proton collisions ☆

ATLAS Collaboration *

ARTICLE INFO

*Article history:*
Received 25 February 2011
Received in revised form 10 May 2011
Accepted 13 May 2011
Available online 1 June 2011
Editor: H. Weerts

*Keywords:*
Supersymmetry
Squark
Gluino
Search
LHC
ATLAS

ABSTRACT

A search for squarks and gluinos in final states containing jets, missing transverse momentum and no electrons or muons is presented. The data were recorded by the ATLAS experiment in $\sqrt{s} = 7$ TeV proton–proton collisions at the Large Hadron Collider. No excess above the Standard Model background expectation was observed in 35 $\text{pb}^{-1}$ of analysed data. Gluino masses below 500 GeV are excluded at the 95% confidence level in simplified models containing only squarks of the first two generations, a gluino octet and a massless neutralino. The exclusion increases to 870 GeV for equal mass squarks and gluinos. In MSUGRA/CMSSM models with $\tan\beta = 3$, $A_0 = 0$ and $\mu > 0$, squarks and gluinos of equal mass are excluded below 775 GeV. These are the most stringent limits to date.



## 1. Introduction

Many extensions of the Standard Model (SM) include heavy coloured particles, some of which could be accessible at the LHC. The squarks and gluinos of supersymmetric theories [1] are one example of such particles. This Letter presents the first ATLAS search for squarks and gluinos in final states containing only jets and large missing transverse momentum. Interest in this final state is motivated by the large number of $R$-parity conserving models [2] in which squarks, $\tilde{q}$, and gluinos, $\tilde{g}$, can be produced in pairs $\{\tilde{g}\tilde{g}, \tilde{q}\tilde{q}, \tilde{q}\tilde{g}\}$ and can generate that final state in their decays $\tilde{q} \to q\tilde{\chi}_1^0$ and $\tilde{g} \to qq\tilde{\chi}_1^0$ to weakly interacting neutralinos, $\tilde{\chi}_1^0$, which escape the detector unseen. The analysis presented here is based on a study of purely hadronic final states; events with reconstructed electrons and muons are vetoed to avoid overlap with a related ATLAS search [3] which requires them. The search strategy was optimised for maximum exclusion in the $(m_{\tilde{g}}, m_{\tilde{q}})$-plane for a set of simplified models in which all other supersymmetric particles (except for the lightest neutralino) were given masses beyond the reach of the LHC. Though interpreted in terms of supersymmetric models, the main results of this analysis (the data and expected background event counts in the signal regions) are relevant for excluding any model of new physics that predicts jets in association with missing transverse momentum. Currently, the most stringent limits on squark and gluino masses are obtained at the LHC [4] and at the Tevatron [5–9].

## 2. The ATLAS detector and data samples

The ATLAS detector [10] is a multipurpose particle physics apparatus with a forward–backward symmetric cylindrical geometry and nearly $4\pi$ coverage in solid angle.[1] The layout of the detector is dominated by four superconducting magnet systems, which comprise a thin solenoid surrounding inner tracking detectors and three large toroids supporting a large muon tracker. The calorimeters are of particular importance to this analysis. In the pseudorapidity region $|\eta| < 3.2$, high-granularity liquid-argon (LAr) electromagnetic (EM) sampling calorimeters are used. An iron-scintillator tile calorimeter provides hadronic coverage over $|\eta| < 1.7$. The end-cap and forward regions, spanning $1.5 < |\eta| < 4.9$, are instrumented with LAr calorimetry for both EM and hadronic measurements.

The data sample used in this analysis was taken in 2010 with the LHC operating at a centre-of-mass energy of 7 TeV. Application of beam, detector and data-quality requirements resulted in a total integrated luminosity of 35 $\text{pb}^{-1}$. The detailed trigger specification varied throughout the data-taking period, partly as a consequence of the rapidly increasing LHC luminosity, but always guaranteed a trigger efficiency above 97% for events with a reconstructed jet with transverse momentum ($p_\text{T}$) exceeding 120 GeV and more than 100 GeV of missing $p_\text{T}$.

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



* *E-mail address:* atlas.publications@cern.ch.

0370-2693/ © 2011 CERN. Published by Elsevier B.V. All rights reserved.
doi:10.1016/j.physletb.2011.05.061

## 3. Object reconstruction

Jet candidates are reconstructed using the anti-$k_t$ jet clustering algorithm [11,12] with a distance parameter of 0.4. The inputs to this algorithm are clusters of calorimeter cells seeded by those with energy significantly above the measured noise. Jet momenta are constructed by performing a four-vector sum over these cell clusters, treating each as an $(E, \vec{p})$ four-vector with zero mass. These jets are corrected for the effects of calorimeter non-compensation and inhomogeneities by using $p_T$- and $\eta$-dependent calibration factors based on Monte Carlo (MC) corrections validated with extensive test-beam and collision-data studies [13]. Only jet candidates with $p_T > 20$ GeV and $|\eta| < 4.9$ are subsequently retained.

Electron candidates are required to have $p_T > 10$ GeV, to have $|\eta| < 2.47$, to pass the 'medium' electron shower shape and track selection criteria of Ref. [14], and to be outside problematic regions of the calorimeter. Muon candidates are required to have $p_T > 10$ GeV and $|\eta| < 2.4$. The sum of the transverse momenta of charged particle tracks within a cone of radius $\Delta R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2} = 0.2$ around the muon trajectory is required to be less than 1.8 GeV.

Following the steps above, overlaps between candidate jets with $|\eta| < 2.5$ and leptons are resolved using the method of Ref. [15] as follows. First, any such jet candidate lying within a distance $\Delta R < 0.2$ of an electron is discarded. Then the whole event is rejected if any electron candidate remains in the calorimeter transition region $1.37 < |\eta| < 1.52$ between barrel and end-cap. Finally, any lepton candidate remaining within a distance $\Delta R = 0.4$ of such a jet candidate is discarded.

The measurement of the missing transverse momentum two-vector $\vec{P}_T^{\text{miss}}$ (and its magnitude $E_T^{\text{miss}}$) is then based on the transverse momenta of all remaining jet and lepton candidates and all calorimeter clusters not associated to such objects. Following this, all jet candidates with $|\eta| > 2.5$ are discarded. Thereafter, the remaining lepton and jet candidates are considered "reconstructed", and the term "candidate" is dropped.

## 4. Event selection

Following the object reconstruction described above, events are discarded if any electrons or muons remain, or if they have any jets failing quality selection criteria designed to suppress detector noise and non-collision backgrounds [16], or if they lack a reconstructed primary vertex associated with five or more tracks.

In order to achieve maximal reach over the $(m_{\tilde{g}}, m_{\tilde{q}})$-plane, several signal regions are defined. When production of squark pairs $\tilde{q}\tilde{q}$ is dominant, only a small number of jets (one per squark from $\tilde{q} \to q\tilde{\chi}_1^0$) is expected. The optimal strategy for the $\tilde{q}\tilde{q}$ region therefore makes requirements on two jets only. When production involves gluinos ($\tilde{g}\tilde{g}$ and $\tilde{q}\tilde{g}$), extra jets are expected from $\tilde{g} \to qq\tilde{\chi}_1^0$. In these regions, requiring at least three jets yields better sensitivity. The higher total cross section in the associated $\tilde{q}\tilde{g}$ region where both species are accessible permits the use of tighter criteria than in the $\tilde{g}\tilde{g}$ region. Four signal regions A, B, C and D are therefore defined (targeting light-$\tilde{q}\tilde{q}$, heavy-$\tilde{q}\tilde{q}$, $\tilde{g}\tilde{g}$ and $\tilde{g}\tilde{q}$ production, respectively) as shown in Table 1. In this table, $\Delta\phi(\text{jet}, \vec{P}_T^{\text{miss}})_{\text{min}}$ is the smallest of the azimuthal separations between $\vec{P}_T^{\text{miss}}$ and jets with $p_T > 40$ GeV (up to a maximum of three, in descending order of $p_T$, whether pre-selected or not). The variable $m_{T2}$ [17–19] is defined to be the maximal lower bound on the mass of a pair produced particle which decays into one of the pre-selected jets and a massless undetected particle, assuming the two undetected particles are the only source of the event $\vec{P}_T^{\text{miss}}$. The effective mass, $m_{\text{eff}}$, is defined as the sum of $E_T^{\text{miss}}$ and the magnitudes of the transverse momenta of the two highest $p_T$ jets (in signal region A) or three highest $p_T$ jets (in signal regions C and D). The $\tilde{q}\tilde{q}$ channel has two signal regions, A and B, because the $m_{T2}$ distribution has the best expected reach in $m_{\tilde{q}}$, but $m_{\text{eff}}$ offers better coverage for lighter squarks.

## 5. Backgrounds, simulation and normalisation

Standard Model background processes contribute to the event counts in the signal regions. The dominant sources are: $W$ + jets, $Z$ + jets, top pair, multi-jet and single top production. Non-collision backgrounds are negligible. The majority of the $W$ + jets background is composed of $W \to \tau\nu$ events, or $W \to l\nu$ events in which no electron or muon candidate is reconstructed. The largest part of the $Z$ + jets background comes from the irreducible component in which $Z \to \nu\bar{\nu}$ generates large $E_T^{\text{miss}}$. Hadronic $\tau$ decays in $t\bar{t} \to b\bar{b}\tau\nu qq$ can generate large $E_T^{\text{miss}}$ and pass the jet and lepton requirements at a non-negligible rate. The multi-jet background in the signal regions is predominantly caused by poor reconstruction of jet energies in calorimeters leading to 'fake' missing transverse momentum. There is also a contribution from neutrinos when events contain semileptonic decays of heavy quarks. Extensive validation of MC against data has been performed for each of these background sources and for a wide variety of control regions. The excellent agreement found motivates an approach in which the systematic uncertainties on the $W$ + jets, $Z$ + jets and top background estimates are derived from the validation against data, while the central values for those estimates are taken from MC simulation to reduce sensitivity to correlations between data-driven estimates for different backgrounds. In contrast, the multi-jet background is normalised to data in control regions as described below.

Production of $W$ and $Z$ bosons, in association with jets, was simulated with ALPGEN [20] v2.13 at leading order (LO) and up to $2 \to 5$ partons using CTEQ6L1 PDFs [21]. Both were separately normalised to the next-to-next-to-leading-order inclusive $W$ and $Z$ cross sections from FEWZ [22,23] v2.0. Both resulting samples were found to be consistent with a variety of data-derived estimates, including methods based on: re-simulation of reconstructed leptons as hadronically decaying taus; removal of leptons from $W(l\nu)$ + jet and $Z(ll)$ + jet events; and by comparing MC predictions to data in control regions enriched with background events.

Production of top quarks (both singly and in pairs, assuming $m_{\text{top}} = 172.5$ GeV) was simulated with MC@NLO [24,25] v3.41 using CTEQ6.6 next-to-leading-order (NLO) PDFs [26]. This estimate was found to be consistent with a data-driven cross-check based on replacement of reconstructed muons in the corresponding single lepton channels with simulated hadronic $\tau$ decays. Agreement was also found after reweighting the $t\bar{t}$ MC according to experimentally measured $b$-tag weights.

Simulated multi-jet events were generated both with PYTHIA [27] v6.4.21, which uses $2 \to 2$ LO matrix elements (ME) with the MRST2007 LO* PDF set [28], and with ALPGEN implementing the exact LO ME for up to $2 \to 5$ partons. The normalisation of these samples was fixed by a scaling designed to achieve a match to data in control regions obtained by reversing the $\Delta\phi$ requirements. After this scaling, both sets of simulations were in agreement within the experimental uncertainties, and therefore only PYTHIA multi-jet simulations are used further in this analysis. The resulting simulation was found to be consistent with a data-driven estimate in which high $E_T^{\text{miss}}$ events were generated from data by smearing low $E_T^{\text{miss}}$ events on a jet-by-jet basis with measured jet energy resolution functions. This latter technique has

**Table 1**
Criteria for admission to each of the four overlapping signal regions A–D. All variables are defined in Section 4.

| | | A | B | C | D |
|---|---|---|---|---|---|
| Pre-selection | Number of required jets | $\geqslant 2$ | $\geqslant 2$ | $\geqslant 3$ | $\geqslant 3$ |
| | Leading jet $p_T$ [GeV] | $> 120$ | $> 120$ | $> 120$ | $> 120$ |
| | Other jet(s) $p_T$ [GeV] | $> 40$ | $> 40$ | $> 40$ | $> 40$ |
| | $E_T^{miss}$ [GeV] | $> 100$ | $> 100$ | $> 100$ | $> 100$ |
| Final selection | $\Delta\phi(\text{jet}, \vec{P}_T^{miss})_{min}$ | $> 0.4$ | $> 0.4$ | $> 0.4$ | $> 0.4$ |
| | $E_T^{miss}/m_{eff}$ | $> 0.3$ | – | $> 0.25$ | $> 0.25$ |
| | $m_{eff}$ [GeV] | $> 500$ | – | $> 500$ | $> 1000$ |
| | $m_{T2}$ [GeV] | – | $> 300$ | – | – |

no MC dependencies; it provides a completely independent determination of the multi-jet background using only quantities measured from the data. Additional control regions having reversed $E_T^{miss}/m_{eff}$ requirements were used as further checks on the normalisation.

Supersymmetric events were generated with HERWIG++ [29] v2.4.2. These samples were normalised using NLO cross sections determined by PROSPINO [30] v2.1.

All non-PYTHIA samples used HERWIG++ or HERWIG-6.510 [31] to simulate parton showering and fragmentation, while JIMMY [32] v4.31 was used to generate the underlying event. All samples were produced using an ATLAS 'tune' [33] and a full detector simulation [34].

## 6. Systematic uncertainties

The primary sources of systematic uncertainties in the background estimates are: the luminosity determination, the jet energy scale (JES), the jet energy resolution (JER), the MC modelling, the lepton efficiencies, the extrapolation from control regions into signal regions, and the finite statistics of the MC samples and control regions. The uncertainty on the luminosity determination is estimated to be 11% [35]. The JES uncertainty has been measured from the complete 2010 data set using the techniques described in Ref. [13] and, though $p_T$ and $\eta$ dependent, is around 7%. The JER measured in data [36] was applied to all MC simulated jets and was propagated to $\vec{P}_T^{miss}$. The difference between the re-calibrated and nominal MC is taken as the systematic uncertainty on the JER. The uncertainty on the estimated top background is dominated by the JES uncertainty. Systematic uncertainties associated with mis-identification of leptons, jet energy scale inter-calibration, the rate of leptonic $b$-decays and the non-Gaussian tail of the jet response function have also been incorporated where appropriate.

Systematic uncertainties on the SUSY signal were estimated by variation of the factorisation and renormalisation scales in PROSPINO between half and twice their default values and by considering the PDF uncertainties provided by CTEQ6. Uncertainties were calculated for individual production processes (e.g. $\tilde{q}\tilde{q}$, $\tilde{g}\tilde{g}$, etc.).

## 7. Results, interpretation and limits

The number of observed data events and the number of SM events expected to enter each of the signal regions are shown in Table 2. The background model is found to be in good agreement with the data, and the distributions of $m_{eff}$, $m_{T2}$ and $E_T^{miss}$ are shown in Fig. 1.

An interpretation of the results is presented in Fig. 2 as a 95% confidence exclusion region in the $(m_{\tilde{g}}, m_{\tilde{q}})$-plane for the simplified set of models with $m_{\tilde{\chi}_1^0} = 0$ for which the analysis was optimised. In these models the gluino mass and the masses of the squarks of the first two generations are set to the values shown in the figure. All other supersymmetric particles, including the squarks of the third generation, are decoupled by being given masses of 5 TeV. ISASUSY from ISAJET [37] v7.80 was used to calculate the decay tables, and to guarantee consistent electroweak symmetry breaking. The SUSY Les Houches Accord files for the models used may be found online [38]. The results are also interpreted in the $\tan\beta = 3$, $A_0 = 0$, $\mu > 0$ slice of MSUGRA/CMSSM[2] [39–44] in Fig. 3.

These figures also show the variation of the expected limit in response to $\pm 1\sigma$ fluctuations of the SM expectation including the stated systematic uncertainties. The character of the statistic which is used to construct the exclusion regions in the $(m_{\tilde{g}}, m_{\tilde{q}})$ and CMSSM planes varies as a function of position. Specifically, at each point in those planes, only the data from a single signal region (A, B, C or D) is used to form that statistic, where the region was chosen based on the best expected sensitivity. For a given signal region, the statistic is defined to be the log of the profile likelihood ratio [45,46] for the observed event count in that region, assuming a non-negative signal contribution. A detailed description of how this is done and how the correlated and uncorrelated nuisance parameters representing systematic uncertainties are incorporated may be found in the Higgs chapter of Ref. [15]. Plots showing where each signal region is dominant may be found in [38]. All signal regions contribute to the exclusion and to its boundary in the $(m_{\tilde{g}}, m_{\tilde{q}})$-plane. Region D is dominant near the CMSSM boundary. Pseudo-experiments are used to compute one-sided upper limits on the signal contribution and guarantee exact coverage. In the simplified model, changing the $\tilde{\chi}_1^0$ mass from 0 to 100 GeV reduces the number of selected events by only $\lesssim 20\%$ near the exclusion curve so only slightly modifies the excluded region in the $(m_{\tilde{g}}, m_{\tilde{q}})$-plane. In the CMSSM, varying $A_0$ to 300 GeV, $\tan\beta$ to 30 or $\mu$ to $-\mu$ leads to significant ($\sim 5\%$) changes, among the strongly interacting particles, only in the stop and sbottom masses. Accordingly, the exclusion limits are not strongly sensitive to these parameters.

## 8. Summary

This Letter reports a search for new physics in final states containing high-$p_T$ jets, missing transverse momentum and no electrons or muons. Good agreement is seen between the numbers of events observed in the four signal regions and the numbers of events expected from SM sources. Signal regions A, B, C and D exclude non-SM cross sections within acceptance of 1.3, 0.35, 1.1 and 0.11 pb respectively at 95% confidence.

[2] There are five parameters which are needed to specify a particular MSUGRA/CMSSM model. They are the universal scalar mass, $m_0$, the universal gaugino mass $m_{1/2}$, the universal trilinear scalar coupling, $A_0$, the ratio of the vacuum expectation values of the two Higgs fields, $\tan\beta$, and the sign of the higgsino mass parameter, $\mu = \pm$.

**Table 2**
Expected and observed numbers of events in the four signal regions. Uncertainties shown are due to "MC statistics, statistics in control regions, other sources of uncorrelated systematic uncertainty, and also the jet energy resolution and lepton efficiencies" [u], the jet energy scale [j], and the luminosity [$\mathcal{L}$]. Totals are correct within rounding errors.

| | Signal region A | Signal region B | Signal region C | Signal region D |
|---|---|---|---|---|
| Multi-jet | $7^{+8}_{-7}[\mathrm{u}+\mathrm{j}]$ | $0.6^{+0.7}_{-0.6}[\mathrm{u}+\mathrm{j}]$ | $9^{+10}_{-9}[\mathrm{u}+\mathrm{j}]$ | $0.2^{+0.4}_{-0.2}[\mathrm{u}+\mathrm{j}]$ |
| $W$+jets | $50 \pm 11[\mathrm{u}]^{+14}_{-10}[\mathrm{j}] \pm 5[\mathcal{L}]$ | $4.4 \pm 3.2[\mathrm{u}]^{+1.5}_{-0.8}[\mathrm{j}] \pm 0.5[\mathcal{L}]$ | $35 \pm 9[\mathrm{u}]^{+10}_{-8}[\mathrm{j}] \pm 4[\mathcal{L}]$ | $1.1 \pm 0.7[\mathrm{u}]^{+0.2}_{-0.3}[\mathrm{j}] \pm 0.1[\mathcal{L}]$ |
| $Z$+jets | $52 \pm 21[\mathrm{u}]^{+15}_{-11}[\mathrm{j}] \pm 6[\mathcal{L}]$ | $4.1 \pm 2.9[\mathrm{u}]^{+2.1}_{-0.8}[\mathrm{j}] \pm 0.5[\mathcal{L}]$ | $27 \pm 12[\mathrm{u}]^{+10}_{-6}[\mathrm{j}] \pm 3[\mathcal{L}]$ | $0.8 \pm 0.7[\mathrm{u}]^{+0.6}_{-0.0}[\mathrm{j}] \pm 0.1[\mathcal{L}]$ |
| $t\bar{t}$ and $t$ | $10 \pm 0[\mathrm{u}]^{+3}_{-2}[\mathrm{j}] \pm 1[\mathcal{L}]$ | $0.9 \pm 0.1[\mathrm{u}]^{+0.4}_{-0.3}[\mathrm{j}] \pm 0.1[\mathcal{L}]$ | $17 \pm 1[\mathrm{u}]^{+6}_{-4}[\mathrm{j}] \pm 2[\mathcal{L}]$ | $0.3 \pm 0.1[\mathrm{u}]^{+0.2}_{-0.1}[\mathrm{j}] \pm 0.0[\mathcal{L}]$ |
| Total SM | $118 \pm 25[\mathrm{u}]^{+32}_{-23}[\mathrm{j}] \pm 12[\mathcal{L}]$ | $10.0 \pm 4.3[\mathrm{u}]^{+4.0}_{-1.9}[\mathrm{j}] \pm 1.0[\mathcal{L}]$ | $88 \pm 18[\mathrm{u}]^{+26}_{-18}[\mathrm{j}] \pm 9[\mathcal{L}]$ | $2.5 \pm 1.0[\mathrm{u}]^{+1.0}_{-0.4}[\mathrm{j}] \pm 0.2[\mathcal{L}]$ |
| Data | 87 | 11 | 66 | 2 |

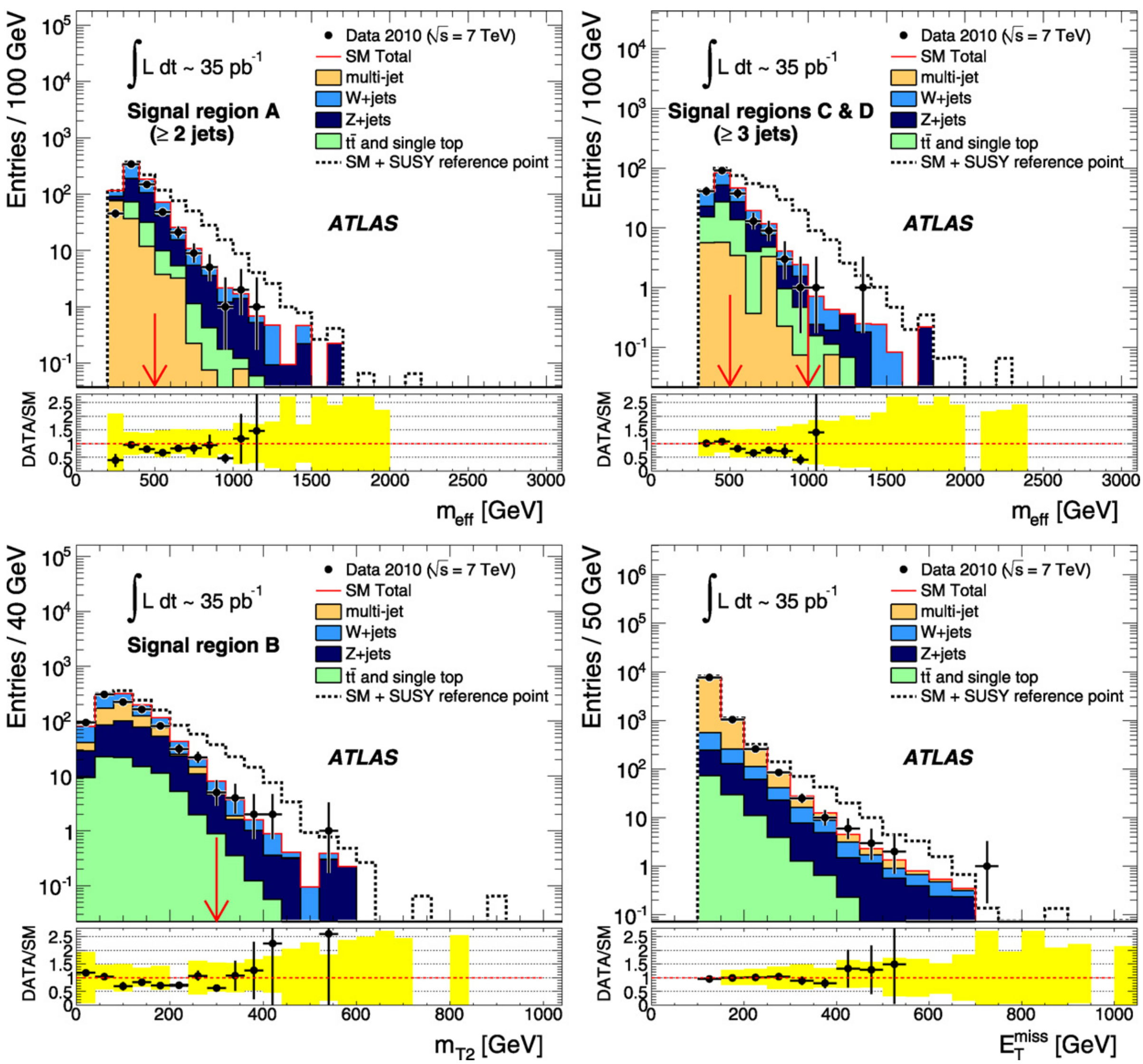


**Fig. 1.** The distributions of $m_{\mathrm{eff}}$ (separately for the $\geqslant 2$ and $\geqslant 3$ jet regions) and $m_{\mathrm{T2}}$ are shown for data and for the expected SM contributions after application of all selection criteria — cuts on the variables themselves are indicated by the red arrows. Also shown is the $E_{\mathrm{T}}^{\mathrm{miss}}$ distribution after the $\geqslant 2$ jet preselection cuts only. For comparison, each plot includes a curve showing the expectation for an MSUGRA/CMSSM reference point with $m_0 = 200$ GeV, $m_{1/2} = 190$ GeV, $A_0 = 0$, $\tan\beta = 3$ and $\mu > 0$. This reference point is also indicated by the star on Fig. 3. Below each plot the ratio of the data to the SM expectation is provided. Black vertical bars show the statistical uncertainty from the data, while the yellow band shows the size of the Standard Model MC uncertainty. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this Letter.)

The results are interpreted in both a simplified model containing only squarks of the first two generations, a gluino octet and a massless neutralino, as well as in MSUGRA/CMSSM models with $\tan\beta = 3$, $A_0 = 0$ and $\mu > 0$. In the simplified model, gluino masses below 500 GeV are excluded at the 95% confidence level with the limit increasing to 870 GeV for equal mass squarks and gluinos. In the MSUGRA/CMSSM models equal mass squarks and gluinos below 775 GeV are excluded.

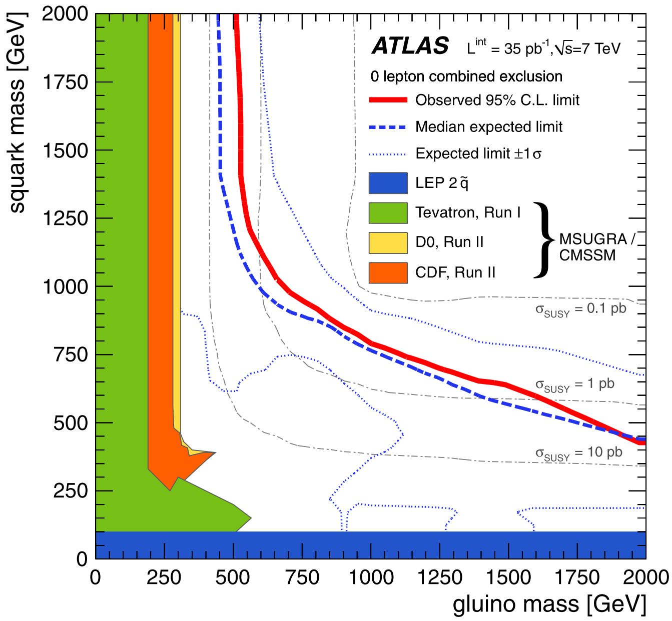


**Fig. 2.** 95% C.L. exclusion limits in the $(m_{\tilde{g}}, m_{\tilde{q}})$ plane together with existing limits [5–9] and contours showing the total supersymmetric cross section, for the simplified squark–gluino model with massless $\tilde{\chi}_1^0$. Comparison with existing limits is illustrative only as some are derived in the context of MSUGRA/CMSSM or may not assume $m_{\tilde{\chi}_1^0} = 0$.

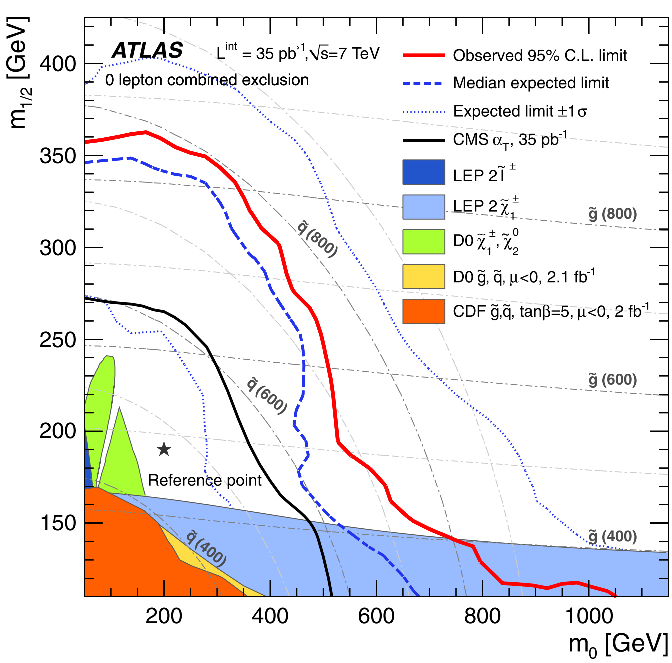


**Fig. 3.** 95% C.L. exclusion limits in the $(m_0, m_{1/2})$ plane of MSUGRA/CMSSM for which $\tan\beta = 3$, $A_0 = 0$ and $\mu > 0$. Also shown are existing limits [7–9,4] having the different model assumptions given in the legend. Contours of constant gluino and squark mass are displayed at 100 GeV intervals.

## Acknowledgements

We wish to thank CERN for the efficient commissioning and operation of the LHC during this initial high-energy data-taking period 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, 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.

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 (Netherlands), PIC (Spain), ASGC (Taiwan), RAL (UK) and BNL (USA) and in the Tier-2 facilities worldwide.

## Open access



## References


[1] Yu.A. Golfand, E.P. Likhtman, JETP Lett. 13 (1971) 323;
A. Neveu, J.H. Schwartz, Nucl. Phys. B 31 (1971) 86;
A. Neveu, J.H. Schwartz, Phys. Rev. D 4 (1971) 1109;
P. Ramond, Phys. Rev. D 3 (1971) 2415;
D.V. Volkov, V.P. Akulov, Phys. Lett. B 46 (1973) 109;
J. Wess, B. Zumino, Phys. Lett. B 49 (1974) 52;
J. Wess, B. Zumino, Nucl. Phys. B 70 (1974) 39.
[2] P. Fayet, Phys. Lett. B 69 (1977) 489;
G.R. Farrar, P. Fayet, Phys. Lett. B 76 (1978) 575.
[3] ATLAS Collaboration, Phys. Rev. Lett. 102 (2011) 131802, arXiv:1102.2357 [hep-ex].
[4] CMS Collaboration, Phys. Lett. B 698 (2011) 196, arXiv:1101.1628 [hep-ex].
[5] D0 Collaboration, Phys. Rev. Lett. 75 (1995) 618.
[6] CDF Collaboration, Phys. Rev. Lett. 88 (2002) 041801, arXiv:hep-ex/0106001.
[7] CDF Collaboration, Phys. Rev. Lett. 102 (2009) 121801, arXiv:0811.2512 [hep-ex].
[8] D0 Collaboration, Phys. Lett. B 660 (2008) 449, arXiv:0712.3805 [hep-ex].
[9] D0 Collaboration, Phys. Lett. B 680 (2009) 34, arXiv:0901.0646 [hep-ex].
[10] ATLAS Collaboration, JINST 3 (2008) S08003.
[11] M. Cacciari, G.P. Salam, G. Soyez, JHEP 0804 (2008) 063, arXiv:0802.1189 [hep-ph].
[12] M. Cacciari, G.P. Salam, Phys. Lett. B 641 (2006) 57, arXiv:hep-ph/0512210.
[13] ATLAS Collaboration, Jet energy scale and its systematic uncertainty in ATLAS for jets produced in proton–proton collisions at $\sqrt{s} = 7$ TeV, ATLAS-CONF-2010-056.
[14] ATLAS Collaboration, JHEP 1012 (2010) 060, arXiv:1010.2130 [hep-ex].
[15] ATLAS Collaboration, Expected performance of the ATLAS experiment — detector, trigger and physics, CERN-OPEN-2008-020, arXiv:0901.0512 [hep-ex].
[16] ATLAS Collaboration, Data-quality requirements and event cleaning for jets and missing transverse energy reconstruction with the ATLAS detector in proton–proton collisions at a center-of-mass energy of 7 TeV, ATLAS-CONF-2010-038.
[17] C.G. Lester, D.J. Summers, Phys. Lett. B 463 (1999) 99, arXiv:hep-ph/9906349.
[18] A. Barr, C. Lester, P. Stephens, J. Phys. G 29 (2003) 2343, arXiv:hep-ph/0304226.
[19] H.-C. Cheng, Z. Han, JHEP 0812 (2008) 063, arXiv:0810.5178 [hep-ph].
[20] M.L. Mangano, M. Moretti, F. Piccinini, R. Pittau, A.D. Polosa, JHEP 0307 (2003) 001, arXiv:hep-ph/0206293.
[21] J. Pumplin, et al., JHEP 0207 (2002) 012, arXiv:hep-ph/0201195.
[22] K. Melnikov, F. Petriello, Phys. Rev. D 74 (2006) 114017, arXiv:hep-ph/0609070.

[23] R. Gavin, Y. Li, F. Petriello, S. Quackenbush, FEWZ 2.0: A code for hadronic Z production at next-to-next-to-leading order, arXiv:1011.3540 [hep-ph].
[24] S. Frixione, B.R. Webber, JHEP 0206 (2002) 029, arXiv:hep-ph/0204244.
[25] S. Frixione, P. Nason, B.R. Webber, JHEP 0308 (2003) 007, arXiv:hep-ph/0305252.
[26] P.M. Nadolsky, et al., Phys. Rev. D 78 (2008) 013004, arXiv:0802.0007 [hep-ph].
[27] T. Sjöstrand, S. Mrenna, P.Z. Skands, JHEP 0605 (2006) 026, arXiv:hep-ph/0603175.
[28] A. Sherstnev, R. Thorne, Eur. Phys. J. C 55 (2008) 553, arXiv:0711.2473 [hep-ph].
[29] M. Bahr, et al., Eur. Phys. J. C 58 (2008) 639, arXiv:0803.0883 [hep-ph].
[30] W. Beenakker, R. Hopker, M. Spira, P.M. Zerwas, Nucl. Phys. B 492 (1997) 51, arXiv:hep-ph/9610490.
[31] G. Corcella, et al., JHEP 0101 (2001) 010, arXiv:hep-ph/0011363.
[32] J.M. Butterworth, J.R. Forshaw, M.H. Seymour, Z. Phys. C 72 (1996) 637, arXiv:hep-ph/9601371.
[33] ATLAS Collaboration, ATLAS Monte Carlo tunes for MC09, ATL-PHYS-PUB-2010-002.
[34] ATLAS Collaboration, Eur. Phys. J. C 70 (2010) 823, arXiv:1005.4568 [physics.ins-det].
[35] ATLAS Collaboration, G. Aad, et al., Eur. Phys. J. C 71 (2011) 1630, arXiv:1101.2185 [hep-ex].
[36] ATLAS Collaboration, Jet energy resolution and selection efficiency relative to track jets from in-situ techniques with the ATLAS detector using proton–proton collisions at a center of mass energy $\sqrt{s} = 7$ TeV, ATLAS-CONF-2010-054.
[37] F.E. Paige, S.D. Protopopescu, H. Baer, X. Tata, ISAJET 7.69: A Monte Carlo event generator for $pp$, anti-$pp$, and $e^+e^-$ reactions, arXiv:hep-ph/0312045.
[38] http://hepdata.cedar.ac.uk/resource/atlas/.
[39] A.H. Chamseddine, R.L. Arnowitt, P. Nath, Phys. Rev. Lett. 49 (1982) 970.
[40] R. Barbieri, S. Ferrara, C.A. Savoy, Phys. Lett. B 119 (1982) 343.
[41] L.E. Ibanez, Phys. Lett. B 118 (1982) 73.
[42] L.J. Hall, J.D. Lykken, S. Weinberg, Phys. Rev. D 27 (1983) 2359.
[43] N. Ohta, Prog. Theor. Phys. 70 (1983) 542.
[44] G.L. Kane, C.F. Kolda, L. Roszkowski, J.D. Wells, Phys. Rev. D 49 (1994) 6173, arXiv:hep-ph/9312272.
[45] A. Stuart, K. Ord, S. Arnold, Kendall's Advanced Theory of Statistics, 6th ed., Oxford Univ. Press, 1999.
[46] G. Cowan, K. Cranmer, E. Gross, O. Vitells, Eur. Phys. J. C 71 (2011) 1554, arXiv:1007.1727.

**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], M.S. Alam [1], M.A. Alam [76], S. Albrand [55], M. Aleksa [29], I.N. Aleksandrov [65], M. Aleppo [89a,89b], 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], 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 [4], 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], 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], V.A. Bednyakov [65], C. 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], G. Bellomo [89a,89b], 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 [132a,132b], 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], 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], E. Brambilla [72a,72b], 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], P.G. Bright-Thomas [17], 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], M. Caccia [89a,89b], 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], 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 [135d], V. Chernyatin [24], E. Cheu [6], S.L. Cheung [158], L. Chevalier [136], F. Chevallier [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], R. Coluccia [72a,72b], 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], 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 [135c], 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 [134a,134b], 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 [174], 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], I. Efthymiopoulos [49], W. Ehrenfeld [41], T. Ehrich [99], T. Eifert [29], G. Eigen [13], K. Einsweiler [14], E. Eisenhandler [75], T. Ekelof [166], M. El Kacimi [4], 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], 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 [135a], 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 [34,k], 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,l], 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 [28], 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], T. Hott [99], 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,m], 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 [4], 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], T. Isobe [155], 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], 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], S. König [48], 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,n], A.I. Kononov [48], R. Konoplich [108,o], 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], 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 [83], 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], 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], M. Leahu [29], 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 [83], 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,p], B. Liberti [133a], P. Lichard [29], M. Lichtnecker [98], K. Lie [165], W. Liebig [13], R. Lifshitz [152], J.N. Lilley [17], A. Limosani [86], M. Limper [63], S.C. Lin [151,q], 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,r], 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,k], 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], J. Lu [2], 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], C.A. Magrath [104], 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], M. Marchesotti [29], G. Marchiori [78], M. Marcisovsky [125], A. Marin [21,*], C.P. Marino [61], F. Marroquim [23a], R. Marshall [82], Z. Marshall [34,k], 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. McKee [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,r], A. Mengarelli [19a,19b], S. Menke [99], C. Menot [29], E. Meoni [11], 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], J. Morel [54], 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 [42], 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], 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], G. Ordonez [104], 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 [135c], F. Ould-Saada [117], A. Ouraou [136], Q. Ouyang [32a], M. Owen [82], S. Owen [139], A. Oyarzun [31b], O.K. Øye [13], V.E. Ozcan [18a], N. Ozturk [7], A. Pacheco Pages [11], C. Padilla Aranda [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,k], 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 [85], 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], C. Rahm [24], S. Rajagopalan [24], S. Rajek [42], M. Rammensee [48], M. Rammes [141], M. Ramstedt [146a,146b], K. Randrianarivony [28], P.N. Ratoff [71], F. Rauscher [98], E. Rauter [99], T.C. Rave [48], 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 [138], 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], I. Rottländer [20], 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. 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 [15], 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], 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,p], D. Su [143], S. Subramania [2], 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], Y.D. Tennenbaum-Katan [152], S. Terada [66], K. Terashi [155], J. Terron [80], M. Terwort [41,n], 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], A. Tonazzo [134a,134b], 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], P.M. Tuts [34], A. Tykhonov [74], M. Tylmad [146a,146b], M. Tyndel [129], D. Typaldos [17], 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. Urquijo [49], 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], 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], 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,p], 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,n], 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], J. Ye [39], S. Ye [24], M. Yilmaz [3c], R. Yoosoofmiya [123], K. Yorita [170], R. Yoshida [5], C. Young [143], C.J. Young [118], 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], B. Zilka [144a], 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*
[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*
[6] *Department of Physics, University of Arizona, Tucson AZ, United States*
[7] *Department of Physics, The University of Texas at Arlington, Arlington TX, United States*
[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*
[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*
[22] *Department of Physics, Brandeis University, Waltham MA, United States*
[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*
[25] [(a)] *National Institute of Physics and Nuclear Engineering, Bucharest;* [(b)] *University Politehnica Bucharest, Bucharest; 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*
[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*
[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
[40] University of Texas at Dallas, Richardson TX, United States
[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
[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
[57] Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge MA, United States
[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
[62] Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria
[63] University of Iowa, Iowa City IA, United States
[64] Department of Physics and Astronomy, Iowa State University, Ames IA, United States
[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
[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
[88] Department of Physics and Astronomy, Michigan State University, East Lansing MI, United States
[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
[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
[104] Institute for Mathematics, Astrophysics and Particle Physics, Radboud University Nijmegen/Nikhef, Nijmegen, Netherlands
[105] Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam, Netherlands
[106] Department of Physics, Northern Illinois University, DeKalb IL, United States
[107] Budker Institute of Nuclear Physics (BINP), Novosibirsk, Russia
[108] Department of Physics, New York University, New York NY, United States
[109] Ohio State University, Columbus OH, United States
[110] Faculty of Science, Okayama University, Okayama, Japan
[111] Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman OK, United States
[112] Department of Physics, Oklahoma State University, Stillwater OK, United States
[113] Palacký University, RCPTM, Olomouc, Czech Republic
[114] Center for High Energy Physics, University of Oregon, Eugene OR, United States
[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*
[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*
[124] [(a)] *Laboratorio de Instrumentacao e Fisica Experimental de Particulas - LIP, Lisboa, Portugal;* [(b)] *Departamento de Fisica Teorica y del Cosmos and CAFPE, Universidad de Granada, Granada, Spain*
[125] *Institute of Physics, Academy of Sciences of the Czech Republic, Praha, Czech Republic*
[126] *Faculty of Mathematics and Physics, Charles University in Prague, Praha, Czech Republic*
[127] *Czech Technical University in Prague, Praha, Czech Republic*
[128] *State Research Center Institute for High Energy Physics, Protvino, Russia*
[129] *Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom*
[130] *Physics Department, University of Regina, Regina SK, Canada*
[131] *Ritsumeikan University, Kusatsu, Shiga, Japan*
[132] [(a)] *INFN Sezione di Roma I;* [(b)] *Dipartimento di Fisica, Università La Sapienza, Roma, Italy*
[133] [(a)] *INFN Sezione di Roma Tor Vergata;* [(b)] *Dipartimento di Fisica, Università di Roma Tor Vergata, Roma, Italy*
[134] [(a)] *INFN Sezione di Roma Tre;* [(b)] *Dipartimento di Fisica, Università Roma Tre, Roma, Italy*
[135] [(a)] *Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies - Université Hassan II, Casablanca;* [(b)] *Centre National de l'Energie des Sciences Techniques Nucleaires, Rabat;* [(c)] *Faculté des Sciences, Université Mohamed Premier and LPTPM, Oujda;* [(d)] *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*
[138] *Department of Physics, University of Washington, Seattle WA, United States*
[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*
[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*
[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*
[162] *Centro de Investigaciones, Universidad Antonio Narino, Bogota, Colombia*
[163] *Department of Physics and Astronomy, University of California Irvine, Irvine CA, United States*
[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*
[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*
[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*
[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 Universite 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.
[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.

[k] Also at California Institute of Technology, Pasadena CA, United States.
[l] Also at Group of Particle Physics, University of Montreal, Montreal QC, Canada.
[m] Also at Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan.
[n] Also at Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany.
[o] Also at Manhattan College, New York NY, United States.
[p] Also at School of Physics and Engineering, Sun Yat-sen University, Guangzhou, China.
[q] Also at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan.
[r] Also at High Energy Physics Group, Shandong University, Shandong, China.
[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.
[w] Also at KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary.
[x] Also at Institute of Physics, Jagiellonian University, Kracow, Poland.
[y] Also at Department of Physics, Oxford University, Oxford, United Kingdom.
[z] Also at DSM/IRFU, CEA Saclay, 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.