



# Combined search for the Standard Model Higgs boson using up to $4.9 \text{ fb}^{-1}$ of $pp$ collision data at $\sqrt{s} = 7 \text{ TeV}$ with the ATLAS detector at the LHC<sup>☆</sup>

ATLAS Collaboration<sup>\*</sup>

## ARTICLE INFO

### Article history:

Received 7 February 2012

Received in revised form 16 February 2012

Accepted 17 February 2012

Available online 21 February 2012

Editor: W.-D. Schlatter

## ABSTRACT

A combined search for the Standard Model Higgs boson with the ATLAS experiment at the LHC using datasets corresponding to integrated luminosities from  $1.04 \text{ fb}^{-1}$  to  $4.9 \text{ fb}^{-1}$  of  $pp$  collisions collected at  $\sqrt{s} = 7 \text{ TeV}$  is presented. The Higgs boson mass ranges 112.9–115.5 GeV, 131–238 GeV and 251–466 GeV are excluded at the 95% confidence level (CL), while the range 124–519 GeV is expected to be excluded in the absence of a signal. An excess of events is observed around  $m_H \sim 126 \text{ GeV}$  with a local significance of 3.5 standard deviations ( $\sigma$ ). The local significances of  $H \rightarrow \gamma\gamma$ ,  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+\ell^-\ell'^+\ell'^-$  and  $H \rightarrow WW^{(*)} \rightarrow \ell^+\nu\ell'^-\bar{\nu}$ , the three most sensitive channels in this mass range, are  $2.8\sigma$ ,  $2.1\sigma$  and  $1.4\sigma$ , respectively. The global probability for the background to produce such a fluctuation anywhere in the explored Higgs boson mass range 110–600 GeV is estimated to be  $\sim 1.4\%$  or, equivalently,  $2.2\sigma$ .

© 2012 CERN. Published by Elsevier B.V. All rights reserved.

## 1. Introduction

The discovery of the mechanism for electroweak symmetry breaking (EWSB) is a major goal of the physics programme at the Large Hadron Collider (LHC). In the Standard Model (SM), EWSB is achieved by invoking the Higgs mechanism, which requires the existence of the Higgs boson [1–6]. In the SM, the Higgs boson mass,  $m_H$ , is a priori unknown. However, for a given  $m_H$  hypothesis, the production cross sections and branching fractions of each decay mode are predicted, which enables a combined search with data from several decay channels.

Direct searches at the CERN LEP  $e^+e^-$  collider excluded the production of a SM Higgs boson with mass below 114.4 GeV at the 95% CL [7]. The combined searches at the Fermilab Tevatron  $p\bar{p}$  collider have excluded the production of a Higgs boson with mass between 156 GeV and 177 GeV at the 95% CL [8].

In 2011, the LHC delivered to ATLAS an integrated luminosity of  $5.6 \text{ fb}^{-1}$  of  $pp$  collisions at 7 TeV centre-of-mass energy. The ATLAS experiment collected and analysed an integrated luminosity corresponding to up to  $4.9 \text{ fb}^{-1}$  of data fulfilling all the data quality requirements to search for the SM Higgs boson. In this Letter a combined search using six distinct channels, covering the mass range 110 GeV to 600 GeV, is presented. The Higgs boson is produced primarily through the gluon fusion process and the following decay modes are considered:  $H \rightarrow \gamma\gamma$ ,  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+\ell^-\ell'^+\ell'^-$ ,  $H \rightarrow ZZ \rightarrow \ell^+\ell^-q\bar{q}$ ,  $H \rightarrow ZZ \rightarrow \ell^+\ell^-\nu\bar{\nu}$ ,  $H \rightarrow WW^{(*)} \rightarrow \ell^+\nu\ell'^-\bar{\nu}$ , and  $H \rightarrow WW \rightarrow \ell\nu q\bar{q}'$ , where  $\ell$  denotes an electron or a muon.

New limits on SM Higgs boson production are established and the significance of an excess of events observed in the low mass region around  $m_H = 126 \text{ GeV}$  is quantified.

## 2. Search channels

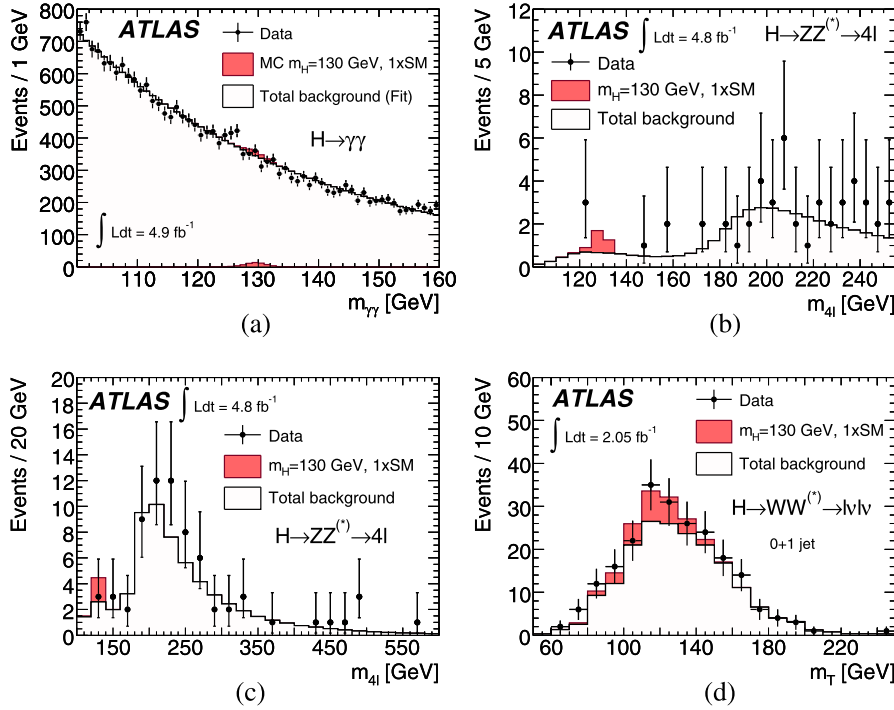
All search analyses are described in their respective references [9–14] and therefore only the main features relevant to the statistical combination of the various channels are summarised here. Two channels, the  $H \rightarrow ZZ \rightarrow \ell^+\ell^-q\bar{q}$  and  $H \rightarrow ZZ \rightarrow \ell^+\ell^-\nu\bar{\nu}$ , have been updated to a data sample corresponding to an integrated luminosity larger than that used in the previously published results and are described in more detail.

The  $H \rightarrow \gamma\gamma$  search is carried out for  $m_H$  hypotheses between 110 GeV and 150 GeV and uses an integrated luminosity of  $4.9 \text{ fb}^{-1}$  [9]. The analysis in this channel separates events into nine independent categories of varying sensitivity. The categorisation is based on the direction of each photon and whether it was reconstructed as a converted or unconverted photon, together with the momentum component of the diphoton system transverse to the thrust axis. The diphoton invariant mass  $m_{\gamma\gamma}$  is used as a discriminating variable to distinguish signal and background, to take advantage of the mass resolution of approximately 1.4% for  $m_H \sim 120 \text{ GeV}$ . The distribution of  $m_{\gamma\gamma}$  in the data is fit to a smooth function to estimate the background. The inclusive invariant mass distribution of the observed candidates, summing over all categories, is shown in Fig. 1(a).

The search in the  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+\ell^-\ell'^+\ell'^-$  channel is performed for  $m_H$  hypotheses in the full 110 GeV to 600 GeV mass range using data corresponding to an integrated luminosity of  $4.8 \text{ fb}^{-1}$  [10]. The main irreducible  $ZZ^{(*)}$  background is estimated

<sup>☆</sup> © CERN for the benefit of the ATLAS Collaboration.

<sup>\*</sup> E-mail address: atlas.publications@cern.ch.



**Fig. 1.** Distributions of the reconstructed invariant or transverse mass for the selected candidate events and for the total background and signal ( $m_H = 130$  GeV) expected in the  $H \rightarrow \gamma\gamma$  (a), the  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+ \ell^- \ell'^+ \ell'^-$  in the low mass region (b) and the entire mass range (c), and the  $H \rightarrow WW^{(*)} \rightarrow \ell^+ \nu \ell'^- \bar{\nu}$  (d) channels.

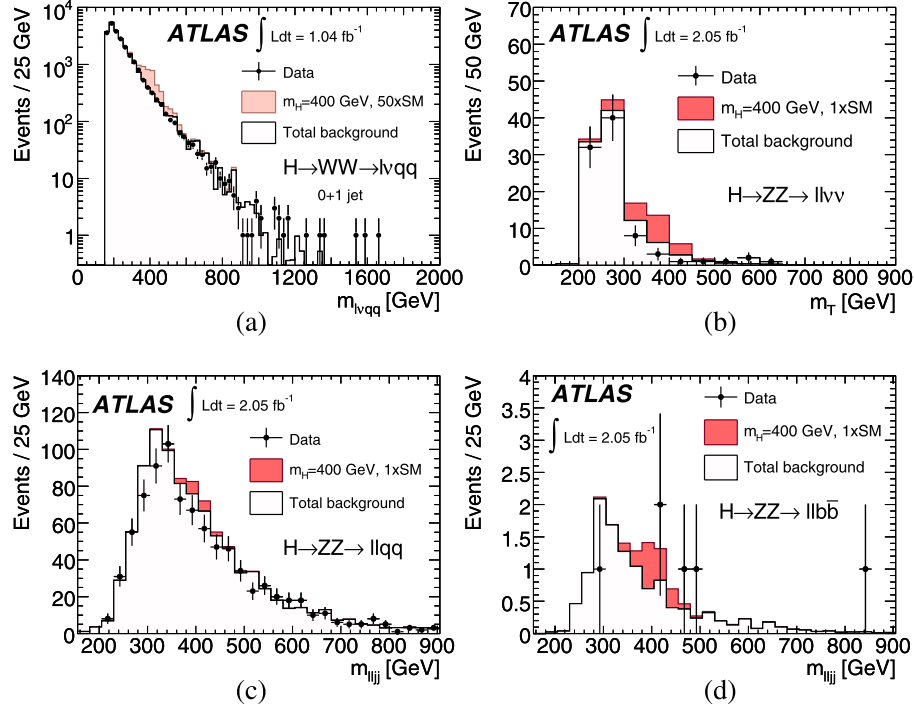
using Monte Carlo simulation. The reducible  $Z + \text{jets}$  background, which has an impact mostly for low four-lepton invariant masses, is estimated from control regions in the data. The top-quark background normalisation is validated in a control sample of events with an opposite sign electron–muon pair with an invariant mass consistent with that of the  $Z$  boson and two leptons of the same flavour. The events are categorised according to the lepton flavour combinations. The mass resolutions are approximately 1.5% in the four-muon channel and 2% in the four-electron channel for  $m_H \sim 120$  GeV. The four-lepton invariant mass is used as a discriminating variable. Its distribution for events selected after all cuts is displayed in Fig. 1(b) for the low mass range and Fig. 1(c) for the full mass range.

The  $H \rightarrow WW^{(*)} \rightarrow \ell^+ \nu \ell'^- \bar{\nu}$  search is performed as an event counting analysis for  $m_H$  hypotheses between 110 GeV and 300 GeV, using an integrated luminosity of  $2.05 \text{ fb}^{-1}$  [11]. The main background contribution, from non-resonant  $WW$  production, is estimated from the data using control regions based on the dilepton invariant mass  $m_{\ell\ell}$ . The analysis is separated into 0-jet and 1-jet categories as well as according to lepton flavour. In the 1-jet category, a  $b$ -jet veto is applied to reject events from top-quark production. The relative fractions of the background contributions expected in the signal and control regions are taken from Monte Carlo simulation. The transverse mass distribution of events for both jet categories is displayed in Fig. 1(d).

The  $H \rightarrow WW \rightarrow \ell\nu q\bar{q}'$  analysis covers  $m_H$  hypotheses in the 240 GeV to 600 GeV range and is carried out using data corresponding to an integrated luminosity of  $1.04 \text{ fb}^{-1}$  [12]. This channel is also separated according to lepton flavour and into 0-jet and 1-jet categories, where the number of jets refers to those in addition to the jets selected as originating from the  $W$ -boson decay. Events with at least one  $b$ -tagged jet are rejected to reduce backgrounds from top-quark production. The  $\ell\nu q\bar{q}'$  mass is reconstructed using a constraint to the  $\ell\nu$  system to  $W$ -boson mass. It is used as a discriminating variable and its distribution is illustrated in Fig. 2(a).

The search in the  $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \nu \bar{\nu}$  channel is performed in the 200 GeV to 600 GeV range of  $m_H$ . The analysis described in Ref. [13] is based on data corresponding to an integrated luminosity of  $1.04 \text{ fb}^{-1}$ . It has been updated using a dataset corresponding to an integrated luminosity of  $2.05 \text{ fb}^{-1}$ . The main change in the event selection is the use of an improved  $b$ -tagging algorithm [15] to veto events with jets likely to have originated from  $b$ -quarks. The analysis is tuned for two search regions with  $m_H$  hypotheses above and below 280 GeV and separated into lepton flavour categories. The  $\ell^+ \ell^-$  pair invariant mass is required to be within 15 GeV of the  $Z$ -boson mass. The reverse requirement is applied to same flavor leptons in the  $H \rightarrow WW^{(*)} \rightarrow \ell^+ \nu \ell'^- \bar{\nu}$  channel to avoid overlaps. The transverse mass is used as a discriminating variable. Its distribution is shown in Fig. 2(b) for the high  $m_H$  search. In total 175 events are selected in the low  $m_H$  search and  $192 \pm 23$  are expected from the background. Similarly, the high-mass search selects 89 events, while  $100 \pm 11$  are expected from the background. The expected number of signal events in the low mass search for  $m_H = 200$  GeV is  $9.9 \pm 1.8$  and  $19.6 \pm 3.4$  for the high-mass selection for  $m_H = 400$  GeV.

The analysis of the  $H \rightarrow ZZ \rightarrow \ell^+ \ell^- q\bar{q}$  channel, carried out in the  $m_H$  range from 200 GeV to 600 GeV using data corresponding to an integrated luminosity of  $1.04 \text{ fb}^{-1}$ , is described in Ref. [14]. It has been updated using a dataset corresponding to an integrated luminosity of  $2.05 \text{ fb}^{-1}$ , taking advantage of the improved  $b$ -tagging algorithm and of the larger sample of data to better constrain systematic uncertainties on the background yield. The analysis is separated into search regions above and below  $m_H = 300$  GeV, where the event selections are independently optimised. The dominant background arises from  $Z + \text{jets}$  production, which is normalised from data using the sidebands of the dilepton invariant mass distribution. To profit from the sizable branching fraction of the  $Z$  decaying into a pair of  $b$ -quarks in the signal, the analysis is divided into two categories, the first containing events where the two jets are  $b$ -tagged and the second with events with fewer than two  $b$ -tags. Using the  $Z$ -boson



**Fig. 2.** Distributions of the reconstructed invariant or transverse mass, in analyses relevant for the search of the Higgs boson at high mass, for selected candidate events, the total background and the signal ( $m_H = 400$  GeV) expected for the given value of  $m_H$  in the  $H \rightarrow WW \rightarrow \ell\nu q\bar{q}'$  channel (a), the  $H \rightarrow ZZ \rightarrow \ell^+\ell^-\nu\bar{\nu}$  channel (b) and the  $H \rightarrow ZZ \rightarrow \ell^+\ell^-\bar{q}q'$  channel for events selected in the  $b$ -jet untagged (c) and the tagged (d) categories. The signal distribution is displayed in a lighter red colour in the  $H \rightarrow WW \rightarrow \ell\nu q\bar{q}'$  channel where it has been scaled up by a factor 50. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this Letter.)

mass constraint improves the mass resolution of the  $\ell\ell q\bar{q}$  system by approximately 10%. The number of events selected in the data with the low  $m_H$  (high  $m_H$ ) untagged search is 21 000 (851) where  $21\,370 \pm 310$  ( $920 \pm 100$ ) are expected from the background, and  $67 \pm 11$  ( $21.1 \pm 0.8$ ) from a signal with  $m_H = 200$  GeV ( $m_H = 400$  GeV). For the tagged search, the number of observed events in the data with the low  $m_H$  (high  $m_H$ ) selection is 145 (6), in reasonable agreement with the  $165 \pm 22$  ( $11.6 \pm 1.9$ ) expected from the background, while  $4.4 \pm 1.2$  ( $2.1 \pm 3.4$ ) are expected from a signal with  $m_H = 200$  GeV ( $m_H = 400$  GeV). The invariant mass is used as the discriminating variable and its distribution is shown in Figs. 2(c) and 2(d) for the two categories.

### 3. Systematic uncertainties

The sources of systematic uncertainties, and their effects on the signal and background yields and shapes in each individual channel, are described in detail in Refs. [9–14]. In the combination, systematic uncertainties are considered either as fully correlated or uncorrelated. Partial correlations are treated by separating a given source into correlated and uncorrelated components. The effect of each uncertainty is estimated independently for each channel. The dominant correlated systematic uncertainties are those on the measurement of the integrated luminosity and on the theoretical predictions of the signal production cross sections and decay branching fractions, as well as those related to detector response that impact the analyses through the reconstruction of electrons, photons, muon, jets, magnitude of the missing transverse momentum ( $E_T^{\text{miss}}$ ) and  $b$ -tagging.

The uncertainty on the integrated luminosity is considered as fully correlated among channels and ranges from 3.7% to 3.9% depending on the data-taking period of the samples used in each specific channel [16,17]. The uncertainty is larger for the last part

of the 2011 data due to an increase in the average number of proton–proton interactions occurring in the same bunch crossing (pileup events).

The Higgs boson production cross sections are computed up to Next-to-Next-to-Leading Order (NNLO) [18–23] in QCD for the gluon fusion ( $gg \rightarrow H$ ) process, including soft-gluon resummations up to Next-to-Next-to-Leading Log (NNLL) [24,25] and Next-to-Leading Order (NLO) electroweak (EW) corrections [26,27]. These results are compiled in Refs. [28–30]. The cross section for the vector-boson fusion ( $qq' \rightarrow qq'H$ ) process is estimated at NLO [31–33] and approximate NNLO QCD [34]. The associated  $WH/ZH$  production processes ( $q\bar{q} \rightarrow WH/ZH$ ) are computed at NLO [35, 36] and NNLO [37]. The associated production with a  $t\bar{t}$  pair ( $q\bar{q}/gg \rightarrow t\bar{t}H$ ) is estimated at NLO [38–41]. The Higgs boson production cross sections, decay branching ratios [42–45] and their related uncertainties are compiled in Ref. [46]. The QCD scale uncertainties for  $m_H = 120$  GeV amount to  $^{+12}_{-8}\%$  for the  $gg \rightarrow H$  process,  $\pm 1\%$  for the  $qq' \rightarrow qq'H$  and associated  $WH/ZH$  processes, and  $^{+3}_{-3}\%$  for the  $q\bar{q}/gg \rightarrow t\bar{t}H$  process. The uncertainties related to the parton distribution functions (PDF) for low  $m_H$  hypotheses typically amount to  $\pm 8\%$  for the predominantly gluon-initiated processes  $gg \rightarrow H$  and  $q\bar{q}/gg \rightarrow t\bar{t}H$ , and  $\pm 4\%$  for the predominantly quark-initiated  $qq' \rightarrow qq'H$  and  $WH/ZH$  processes [47–50]. The theoretical uncertainty associated with the exclusive Higgs boson production process with one additional jet in the  $H \rightarrow WW^{(*)} \rightarrow \ell^+\nu\ell'^-\bar{\nu}$  channel amounts to  $\pm 20\%$  and is treated according to the prescription of Refs. [51–53]. Additional theoretical uncertainty on the signal normalisation, to account for effects related to off-shell Higgs boson production and interference with other SM processes, is assigned at high Higgs boson masses ( $m_H \gtrsim 300$  GeV) as  $150\% \times (m_H/\text{TeV})^3$  [53–56].

The detector-related sources of systematic uncertainty are modelled using the following classification: trigger and identification

efficiencies, energy scale and energy resolution for electrons, photons and for muons; jet energy scale (JES) and jet energy resolution, which include a specific treatment for  $b$ -jets; contributions to the  $E_T^{\text{miss}}$  uncertainties uncorrelated with the JES;  $b$ -tagging and  $b$ -veto. The effect of these systematic uncertainties depends on the topology of each final state, but is typically small compared to that from the theoretical prediction of the production cross section. The only exception is the jet energy scale uncertainty which can reach  $\sim 20\%$  on the signal yield in channels such as  $H \rightarrow WW \rightarrow \ell\nu q\bar{q}'$  and  $H \rightarrow ZZ \rightarrow \ell^+\ell^-q\bar{q}$ . The electron and muon energy scales are directly constrained by  $Z \rightarrow e^+e^-$  and  $Z \rightarrow \mu^+\mu^-$  events; the impact of the resulting systematic uncertainty on the four-lepton invariant mass is of the order of  $\sim 0.5\%$  for electrons and negligible for muons. The impact of the photon energy scale systematic uncertainty on the diphoton invariant mass is approximately  $0.6\%$ .

#### 4. Exclusion limits

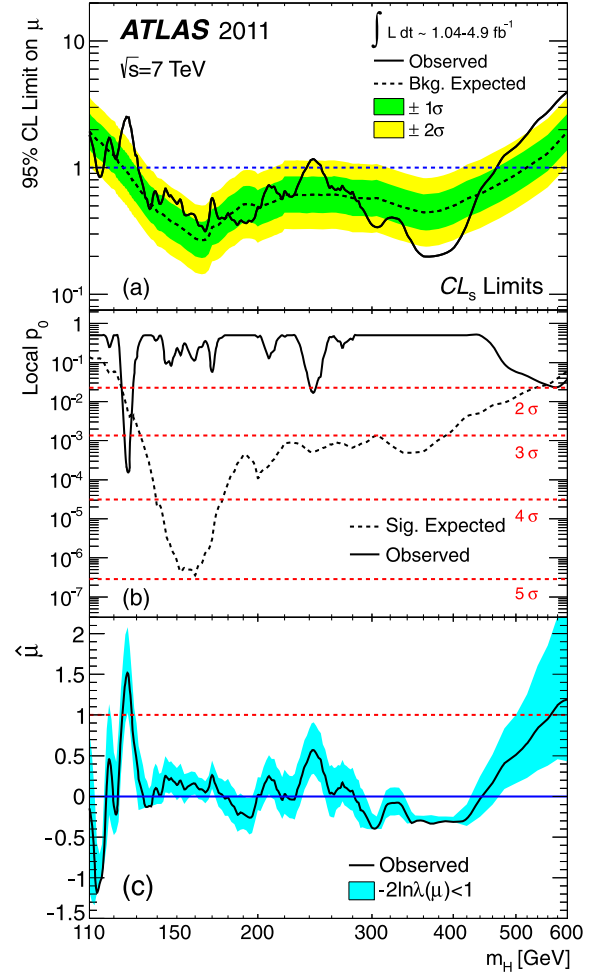
The signal strength,  $\mu$ , is defined as  $\mu = \sigma/\sigma_{\text{SM}}$ , where  $\sigma$  is the Higgs boson production cross section being tested and  $\sigma_{\text{SM}}$  its SM value; it is a single factor used to scale all signal production processes for a given  $m_H$  hypothesis. The combination procedure of Refs. [52,57,58] is based on the profile likelihood ratio test statistic  $\lambda(\mu)$  [59], which extracts the information on the signal strength from the full likelihood including all the parameters describing the systematic uncertainties and their correlations. Exclusion limits are based on the  $CL_s$  method [60] and a value of  $\mu$  is regarded as excluded at the 95% (99%) CL when  $CL_s$  takes on the corresponding value.

The combined 95% CL exclusion limits on  $\mu$  are shown in Fig. 3(a) as a function of  $m_H$ . These results are based on the asymptotic approximation [59]. The observed and expected limits using this procedure have been validated using ensemble tests and a Bayesian calculation of the exclusion limits with a uniform prior on the signal cross section. These approaches agree with the asymptotic median results to within a few percent. The expected 95% CL exclusion region covers the  $m_H$  range from 124 GeV to 519 GeV. The observed 95% CL exclusion regions are from 131 GeV to 238 GeV and from 251 GeV to 466 GeV. The regions between 133 GeV and 230 GeV and between 260 GeV and 437 GeV are excluded at the 99% CL. A deficit of events is observed in two  $m_H$  regions. At very low masses a local deficit in the diphoton channel allows an additional small mass range between 112.9 GeV and 115.5 GeV to be excluded at the 95% CL. Small deficits in various high-mass channels lead to observed limits for masses between 300 GeV and 400 GeV that are stronger than expected. The local probability of such a downward fluctuation of a background-only experiment corresponds to a significance of approximately  $2.5\sigma$ . The probability to observe such a downward fluctuation over the full inspected mass range in the absence of a signal, using the method described in Section 5 [61], is estimated to be approximately 30%.

The observed exclusion covers a large part of the expected exclusion range, with the exception of the low and high  $m_H$  regions where excesses of events above the expected background are observed in various channels, and in a small mass interval around 245 GeV, which is not excluded due to an excess mostly in the  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+\ell^-\ell'^+\ell'^-$  channel.

#### 5. Significance of the excess

An excess of events is observed near  $m_H \sim 126$  GeV in the  $H \rightarrow \gamma\gamma$  and  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+\ell^-\ell'^+\ell'^-$  channels, both of which provide a high-resolution invariant mass for fully reconstructed



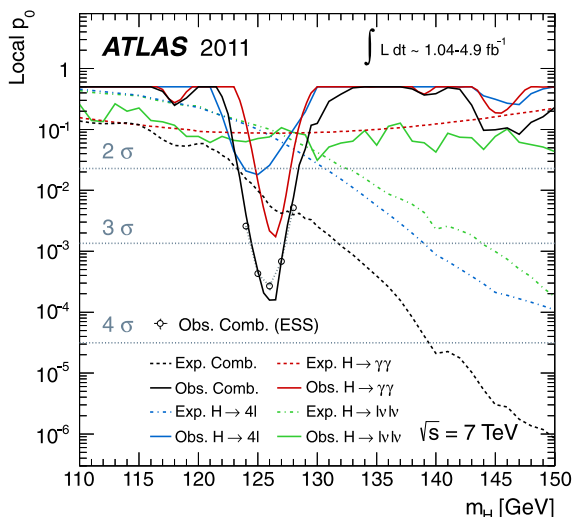
**Fig. 3.** (a) The combined 95% CL upper limits on the signal strength as a function of  $m_H$ ; the solid curve indicates the observed limit and the dotted curve illustrates the median expected limit in the absence of a signal together with the  $\pm 1\sigma$  (dark) and  $\pm 2\sigma$  (light) bands. (b) The local  $p_0$  as a function of the  $m_H$  hypothesis. The dashed curve indicates the median expected value for the hypothesis of a SM Higgs boson signal at that mass. The four horizontal dashed lines indicate the  $p_0$  values corresponding to significances of  $2\sigma$ ,  $3\sigma$ ,  $4\sigma$  and  $5\sigma$ . (c) The best-fit signal strength as a function of the  $m_H$  hypothesis. The band shows the interval around  $\hat{\mu}$  corresponding to region where  $-2\ln\lambda(\mu) < 1$ .

candidates. The  $H \rightarrow WW^{(*)} \rightarrow \ell^+\nu\ell'^-\bar{\nu}$  channel as well has a broad excess of events in the transverse mass distribution as seen in Fig. 1(d).

The significance of an excess is quantified by the probability ( $p_0$ ) that a background-only experiment is more signal-like than that observed. The profile likelihood ratio test statistic is defined such that  $p_0$  cannot exceed 50% [52,58,59].

The local  $p_0$  probability is assessed for a fixed  $m_H$  hypothesis and the equivalent formulation in terms of number of standard deviations is referred to as the local significance. The probability for a background-only experiment to produce a local significance of this size or larger anywhere in a given mass region is referred to as the global  $p_0$ . The corresponding reduction in the significance is referred to as the look-elsewhere effect and is estimated using the prescription described in Refs. [52,61].

The observed local  $p_0$  values, calculated using the asymptotic approximation [59], as a function of  $m_H$  and the expected value in the presence of a SM Higgs boson signal at that mass, are shown in Fig. 3(b) in the entire search mass range and in Fig. 4 for the individual channels and their combination in the low mass range. Numerically consistent results are obtained using ensemble tests.



**Fig. 4.** The local probability  $p_0$  for a background-only experiment to be more signal-like than the observation. The solid curves give the individual and combined observed  $p_0$ , estimated using the asymptotic approximation. The dashed curves show the median expected value for the hypothesis of a SM Higgs boson signal at that mass. The three horizontal dashed lines indicate the  $p_0$  corresponding to significances of  $2\sigma$ ,  $3\sigma$ , and  $4\sigma$ . The points indicate the observed local  $p_0$  estimated using ensemble tests and taking into account energy scale systematic uncertainties (ESS).

The largest local significance for the combination is achieved for  $m_H = 126$  GeV, where it reaches  $3.6\sigma$  with an expected value of  $2.5\sigma$  for a SM signal. The observed (expected) local significance for  $m_H = 126$  GeV is  $2.8\sigma$  ( $1.4\sigma$ ) in the  $H \rightarrow \gamma\gamma$  channel,  $2.1\sigma$  ( $1.4\sigma$ ) in the  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+\ell^-\ell'^+\ell'^-$  channel, and  $1.4\sigma$  ( $1.4\sigma$ ) in the  $H \rightarrow WW^{(*)} \rightarrow \ell^+\nu\ell'^-\bar{\nu}$  channel.

The significance of the excess is mildly sensitive to systematic uncertainties on the energy scale (herein referred to as ESS) and resolution for photons and electrons. The muon energy scale systematic uncertainties are smaller and therefore neglected. The presence of these uncertainties, which affect the shape and position of the signal distributions, lead to a small deviation from the asymptotic approximation. The observed  $p_0$  including these effects is therefore computed using ensemble tests. The results are displayed in Fig. 4 as a function of  $m_H$ . The observed effect of the ESS uncertainty is small and reduces the maximum local significance from  $3.6\sigma$  to  $3.5\sigma$ .

The global  $p_0$  of a local excess depends on the range of  $m_H$  and the channels considered. The global  $p_0$  associated with a  $2.8\sigma$  excess anywhere in the  $H \rightarrow \gamma\gamma$  search domain 110–150 GeV is approximately 7%. A  $2.1\sigma$  excess anywhere in the  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+\ell^-\ell'^+\ell'^-$  search range 110–600 GeV corresponds to a global  $p_0$  of approximately 30%. The global  $p_0$  for a combined  $3.5\sigma$  excess to be found anywhere in the range from 114 GeV to 146 GeV is 0.6% ( $2.5\sigma$ ). This mass interval corresponds to the region not excluded at 99% CL by the combination of Higgs boson searches at LEP [7] and the first LHC combined search [54]. For the full mass range from 110 GeV to 600 GeV, the global  $p_0$  is 1.4% ( $2.2\sigma$ ).

The best-fit value of  $\mu$ , denoted  $\hat{\mu}$ , is displayed in Fig. 3(c) as a function of the  $m_H$  hypothesis. The bands around  $\hat{\mu}$  illustrate the  $\mu$  interval corresponding to  $-2\ln\lambda(\mu) < 1$  and represent an approximate  $\pm 1\sigma$  variation. When evaluating exclusion limits and significance,  $\mu$  is not allowed to be negative; however, this restriction is not applied in Fig. 3(c), in order to illustrate the presence and extent of downward fluctuations. Nevertheless, the  $\mu$  parameter is still bounded to prevent negative values of the probability density functions in the individual channels, and for negative  $\hat{\mu}$  values close to the boundary, the  $-2\ln\lambda(\mu) < 1$  region does not

always reflect a 68% confidence interval. The excess observed for  $m_H = 126$  GeV corresponds to  $\hat{\mu}$  of approximately  $1.5_{-0.5}^{+0.6}$ , which is compatible with the signal expected from a SM Higgs boson at that mass ( $\mu = 1$ ).

## 6. Conclusions

A dataset of up to  $4.9 \text{ fb}^{-1}$  recorded in 2011 has been used to search for the SM Higgs boson with the ATLAS experiment at the LHC. Higgs boson masses between 124 GeV and 519 GeV are expected to be excluded at the 95% CL. The observed exclusion at the 95% CL ranges from 112.9 GeV to 115.5 GeV, 131 GeV to 238 GeV and 251 GeV to 466 GeV. An exclusion of the SM Higgs boson production at the 99% CL is achieved in the regions between 133 GeV and 230 GeV and between 260 GeV and 437 GeV.

An excess of events is observed in the  $H \rightarrow \gamma\gamma$  and  $H \rightarrow ZZ^{(*)} \rightarrow \ell^+\ell^-\ell'^+\ell'^-$  channels, for  $m_H$  close to 126 GeV, which is also supported by a broad excess in the  $H \rightarrow WW^{(*)} \rightarrow \ell^+\nu\ell'^-\bar{\nu}$  channel. The observed local significances of the individual excesses are  $2.8\sigma$ ,  $2.0\sigma$  and  $1.4\sigma$ , respectively. The expected local significances of these channels, for a 126 GeV SM Higgs boson are, coincidentally, all  $\sim 1.4\sigma$ . The combined local significance of these excesses is  $3.6\sigma$ . When the energy scale uncertainties are taken into account, the combined local significance is reduced to  $3.5\sigma$ . The expected combined local significance in the presence of a SM Higgs boson signal at that mass is  $2.5\sigma$ . The global probability for such an excess to be found in the full search range, in the absence of a signal, is approximately 1.4%, corresponding to  $2.2\sigma$ .

## Acknowledgements

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

We acknowledge the support of ANPCyT, Argentina; YerPhI, Armenia; ARC, Australia; BMWF, Austria; ANAS, Azerbaijan; SSTC, Belarus; CNPq and FAPESP, Brazil; NSERC, NRC and CFI, Canada; CERN; CONICYT, Chile; CAS, MOST and NSFC, China; COLCIENCIAS, Colombia; MSMT CR, MPO CR and VSC CR, Czech Republic; DNRF, DNSRC and Lundbeck Foundation, Denmark; ARTEMIS and ERC, 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; MERYV (MECTS), Romania; MES of Russia and ROSATOM, Russian Federation; JINR; MSTP, Serbia; MSSR, Slovakia; ARRS and MVZT, Slovenia; DST/NRF, South Africa; MICINN, Spain; SRC and Wallenberg Foundation, Sweden; SER, SNSF and Cantons of Bern and Geneva, Switzerland; NSC, Taiwan; TAEK, Turkey; STFC, the Royal Society and Leverhulme Trust, United Kingdom; DOE and NSF, United States of America.

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

## Open access

This article is published Open Access at [sciencedirect.com](http://sciencedirect.com). It is distributed under the terms of the Creative Commons Attribution License 3.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original authors and source are credited.

## References

- [1] F. Englert, R. Brout, *Phys. Rev. Lett.* **13** (1964) 321.  
 [2] P.W. Higgs, *Phys. Lett.* **12** (1964) 132.  
 [3] P.W. Higgs, *Phys. Rev. Lett.* **13** (1964) 508.  
 [4] G.S. Guralnik, C.R. Hagen, T.W.B. Kibble, *Phys. Rev. Lett.* **13** (1964) 585.  
 [5] P.W. Higgs, *Phys. Rev.* **145** (1966) 1156.  
 [6] T.W.B. Kibble, *Phys. Rev.* **155** (1967) 1554.  
 [7] ALEPH Collaboration, DELPHI Collaboration, L3 Collaboration, OPAL Collaboration, LEP Working Group for Higgs Boson Searches, *Phys. Lett. B* **565** (2003) 61.  
 [8] TEVNP (Tevatron New Phenomena and Higgs Working Group), Combined CDF and D0 upper limits on Standard Model Higgs boson production with up to  $8.6 \text{ fb}^{-1}$  of data, arXiv:1107.5518, 2011.  
 [9] ATLAS Collaboration, Search for the Standard Model Higgs boson in the diphoton decay channel with  $4.9 \text{ fb}^{-1}$  of ATLAS data at  $\sqrt{s} = 7 \text{ TeV}$ , CERN-PH-EP-2012-013, arXiv:1202.1414 [hep-ex], 2012.  
 [10] ATLAS Collaboration, Search for the Standard Model Higgs boson in the decay channel  $H \rightarrow ZZ^{(*)} \rightarrow 4\ell$  with  $4.8 \text{ fb}^{-1}$  of  $pp$  collisions at  $\sqrt{s} = 7 \text{ TeV}$ , CERN-PH-EP-2012-014, arXiv:1202.1415 [hep-ex], 2012.  
 [11] ATLAS Collaboration, Search for the Higgs boson in the  $H \rightarrow WW^{(*)} \rightarrow \ell\nu\ell\nu$  decay channel in  $pp$  collisions at  $\sqrt{s} = 7 \text{ TeV}$  with the ATLAS detector, CERN-PH-EP-2011-190, 2011, *Phys. Rev. Lett.*, arXiv:1112.2577 [hep-ex], submitted for publication.  
 [12] ATLAS Collaboration, *Phys. Rev. Lett.* **107** (2011) 231801.  
 [13] ATLAS Collaboration, *Phys. Rev. Lett.* **107** (2011) 221802.  
 [14] ATLAS Collaboration, *Phys. Lett. B* **707** (2012) 27.  
 [15] ATLAS Collaboration, Commissioning of the ATLAS high-performance b-tagging algorithms in the 7 TeV collision data, ATLAS-CONF-2011-102, 2011.  
 [16] ATLAS Collaboration, *Eur. Phys. J. C* **71** (2011) 1630.  
 [17] ATLAS Collaboration, Luminosity determination in  $pp$  collisions at  $\sqrt{s} = 7 \text{ TeV}$  using the ATLAS detector, ATLAS-CONF-2011-116, 2011, <https://cdsweb.cern.ch/record/1376384/files/ATLAS-CONF-2011-116.pdf>.  
 [18] A. Djouadi, M. Spira, P. Zerwas, *Phys. Lett. B* **264** (1991) 440.  
 [19] S. Dawson, *Nucl. Phys. B* **359** (1991) 283.  
 [20] M. Spira, A. Djouadi, D. Graudenz, P.M. Zerwas, *Nucl. Phys. B* **453** (1995) 17.  
 [21] R.V. Harlander, W.B. Kilgore, *Phys. Rev. Lett.* **88** (2002) 201801.  
 [22] C. Anastasiou, K. Melnikov, *Nucl. Phys. B* **646** (2002) 220.  
 [23] V. Ravindran, J. Smith, W.L. van Neerven, *Nucl. Phys. B* **665** (2003) 325.  
 [24] S. Catani, D. de Florian, M. Grazzini, P. Nason, *JHEP* **0307** (2003) 028.  
 [25] D. de Florian, G. Ferrera, M. Grazzini, D. Tommasini, *JHEP* **1111** (2011) 064.  
 [26] U. Aglietti, R. Bonciani, G. Degrossi, A. Vicini, *Phys. Lett. B* **595** (2004) 432.  
 [27] S. Actis, G. Passarino, C. Sturm, S. Uccirati, *Phys. Lett. B* **670** (2008) 12.  
 [28] C. Anastasiou, R. Boughezal, F. Petriello, *JHEP* **0904** (2009) 003.  
 [29] D. de Florian, M. Grazzini, *Phys. Lett. B* **674** (2009) 291.  
 [30] J. Baglio, A. Djouadi, *JHEP* **1103** (2011) 055.  
 [31] M. Ciccolini, A. Denner, S. Dittmaier, *Phys. Rev. Lett.* **99** (2007) 161803.  
 [32] M. Ciccolini, A. Denner, S. Dittmaier, *Phys. Rev. D* **77** (2008) 013002.  
 [33] K. Arnold, et al., *Comput. Phys. Commun.* **180** (2009) 1661.  
 [34] P. Bolzoni, F. Maltoni, S.-O. Moch, M. Zaro, *Phys. Rev. Lett.* **105** (2010) 011801.  
 [35] T. Han, S. Willenbrock, *Phys. Lett. B* **273** (1991) 167.  
 [36] M.L. Ciccolini, S. Dittmaier, M. Krämer, *Phys. Rev. D* **68** (2003) 073003.  
 [37] O. Brein, A. Djouadi, R. Harlander, *Phys. Lett. B* **579** (2004) 149.  
 [38] W. Beenakker, et al., *Phys. Rev. Lett.* **87** (2001) 201805.  
 [39] W. Beenakker, et al., *Nucl. Phys. B* **653** (2003) 151.  
 [40] S. Dawson, L.H. Orr, L. Reina, D. Wackerroth, *Phys. Rev. D* **67** (2003) 071503.  
 [41] S. Dawson, C. Jackson, L. Orr, L. Reina, D. Wackerroth, *Phys. Rev. D* **68** (2003) 034022.  
 [42] A. Djouadi, J. Kalinowski, M. Spira, *Comput. Phys. Commun.* **108** (1998) 56.  
 [43] A. Bredenstein, A. Denner, S. Dittmaier, M.M. Weber, *Phys. Rev. D* **74** (2006) 013004.  
 [44] A. Bredenstein, A. Denner, S. Dittmaier, M. Weber, *JHEP* **0702** (2007) 080.  
 [45] S. Actis, G. Passarino, C. Sturm, S. Uccirati, *Nucl. Phys. B* **811** (2009) 182.  
 [46] LHC Higgs Cross Section Working Group, S. Dittmaier, C. Mariotti, G. Passarino, R. Tanaka (Eds.), Handbook of LHC Higgs Cross Sections: 1. Inclusive Observables, CERN-2011-002, arXiv:1101.0593, 2011.  
 [47] M. Botje, et al., The PDF4LHC Working Group interim recommendations, arXiv:1101.0538, 2011.  
 [48] H.-L. Lai, M. Guzzi, J. Huston, Z. Li, P.M. Nadolsky, et al., *Phys. Rev. D* **82** (2010) 074024.  
 [49] A.D. Martin, W.J. Stirling, R.S. Thorne, G. Watt, *Eur. Phys. J. C* **63** (2009) 189.  
 [50] R.D. Ball, V. Bertone, F. Cerutti, L. Del Debbio, S. Forte, et al., Impact of heavy quark masses on parton distributions and LHC phenomenology, arXiv:1101.1300, 2011.  
 [51] I.W. Stewart, F.J. Tackmann, *Phys. Rev. D* **85** (2012) 034011.  
 [52] ATLAS Collaboration, CMS Collaboration, LHC Higgs combination working group report, ATL-PHYS-PUB-2011-011, CERN-CMS-NOTE-2011-005, 2011.  
 [53] LHC Higgs Cross Section Working Group, S. Dittmaier, C. Mariotti, G. Passarino, R. Tanaka (Eds.), Handbook of LHC Higgs Cross Sections: 2. Differential Distributions, arXiv:1201.3084, 2012.  
 [54] ATLAS Collaboration, CMS Collaboration, Combined Standard Model Higgs boson searches with up to  $2.3 \text{ fb}^{-1}$  of  $pp$  collisions at  $\sqrt{s} = 7 \text{ TeV}$  at the LHC, ATLAS-CONF-2011-157, CMS-PAS-HIG-11-023, 2011.  
 [55] G. Passarino, C. Sturm, S. Uccirati, *Nucl. Phys. B* **834** (2010) 77.  
 [56] C. Anastasiou, S. Buehler, F. Herzog, A. Lazopoulos, *JHEP* **1112** (2011) 058.  
 [57] ATLAS Collaboration, *Eur. Phys. J. C* **71** (2010) 1728.  
 [58] L. Moneta, K. Belasco, K.S. Cranmer, S. Kreiss, A. Lazzaro, et al., PoS ACAT2010 (2010) 057.  
 [59] G. Cowan, K. Cranmer, E. Gross, O. Vitells, *Eur. Phys. J. C* **71** (2011) 1554.  
 [60] A.L. Read, *J. Phys. G* **28** (2002) 2693.  
 [61] E. Gross, O. Vitells, *Eur. Phys. J. C* **70** (2010) 525.

## ATLAS Collaboration

G. Aad<sup>48</sup>, B. Abbott<sup>111</sup>, J. Abdallah<sup>11</sup>, S. Abdel Khalek<sup>115</sup>, A.A. Abdelalim<sup>49</sup>, A. Abdesselam<sup>118</sup>, O. Abidinov<sup>10</sup>, B. Abi<sup>112</sup>, M. Abolins<sup>88</sup>, O.S. AbouZeid<sup>158</sup>, H. Abramowicz<sup>153</sup>, H. Abreu<sup>115</sup>, E. Acerbi<sup>89a,89b</sup>, B.S. Acharya<sup>164a,164b</sup>, L. Adamczyk<sup>37</sup>, D.L. Adams<sup>24</sup>, T.N. Addy<sup>56</sup>, J. Adelman<sup>175</sup>, M. Aderholz<sup>99</sup>, S. Adomeit<sup>98</sup>, P. Adragna<sup>75</sup>, T. Adye<sup>129</sup>, S. Aefsky<sup>22</sup>, J.A. Aguilar-Saavedra<sup>124b,a</sup>, M. Aharrouche<sup>81</sup>, S.P. Ahlen<sup>21</sup>, F. Ahles<sup>48</sup>, A. Ahmad<sup>148</sup>, M. Ahsan<sup>40</sup>, G. Aielli<sup>133a,133b</sup>, T. Akdogan<sup>18a</sup>, T.P.A. Åkesson<sup>79</sup>, G. Akimoto<sup>155</sup>, A.V. Akimov<sup>94</sup>, A. Akiyama<sup>67</sup>, M.S. Alam<sup>1</sup>, M.A. Alam<sup>76</sup>, J. Albert<sup>169</sup>, S. Albrand<sup>55</sup>, M. Aleksa<sup>29</sup>, I.N. Aleksandrov<sup>65</sup>, F. Alessandria<sup>89a</sup>, C. Alexa<sup>25a</sup>, G. Alexander<sup>153</sup>, G. Alexandre<sup>49</sup>, T. Alexopoulos<sup>9</sup>, M. Alhroob<sup>20</sup>, M. Aliev<sup>15</sup>, G. Alimonti<sup>89a</sup>, J. Alison<sup>120</sup>, M. Aliyev<sup>10</sup>, B.M.M. Allbrooke<sup>17</sup>, P.P. Allport<sup>73</sup>, S.E. Allwood-Spiers<sup>53</sup>, J. Almond<sup>82</sup>, A. Aloisio<sup>102a,102b</sup>, R. Alon<sup>171</sup>, A. Alonso<sup>79</sup>, B. Alvarez Gonzalez<sup>88</sup>, M.G. Alviggi<sup>102a,102b</sup>, K. Amako<sup>66</sup>, P. Amaral<sup>29</sup>, C. Amelung<sup>22</sup>, V.V. Ammosov<sup>128</sup>, A. Amorim<sup>124a,b</sup>, G. Amorós<sup>167</sup>, N. Amram<sup>153</sup>, C. Anastopoulos<sup>29</sup>, L.S. Ancu<sup>16</sup>, N. Andari<sup>115</sup>, T. Andeen<sup>34</sup>, C.F. Anders<sup>20</sup>, G. Anders<sup>58a</sup>, K.J. Anderson<sup>30</sup>, A. Andreazza<sup>89a,89b</sup>, V. Andrei<sup>58a</sup>, M.-L. Andrieux<sup>55</sup>, X.S. Anduaga<sup>70</sup>, A. Angerami<sup>34</sup>, F. Anghinolfi<sup>29</sup>, A. Anisenkov<sup>107</sup>, N. Anjos<sup>124a</sup>, A. Annovi<sup>47</sup>, A. Antonaki<sup>8</sup>, M. Antonelli<sup>47</sup>, A. Antonov<sup>96</sup>, J. Antos<sup>144b</sup>, F. Anulli<sup>132a</sup>, S. Aoun<sup>83</sup>, L. Aperio Bella<sup>4</sup>, R. Apolle<sup>118,c</sup>, G. Arabidze<sup>88</sup>, I. Aracena<sup>143</sup>, Y. Arai<sup>66</sup>, A.T.H. Arce<sup>44</sup>, S. Arfaoui<sup>148</sup>, J.-F. Arguin<sup>14</sup>, E. Arik<sup>18a,\*</sup>, M. Arik<sup>18a</sup>, A.J. Armbruster<sup>87</sup>, O. Arnaez<sup>81</sup>, V. Arnal<sup>80</sup>, C. Arnault<sup>115</sup>, A. Artamonov<sup>95</sup>, G. Artoni<sup>132a,132b</sup>, D. Arutinov<sup>20</sup>, S. Asai<sup>155</sup>, R. Asfandiyarov<sup>172</sup>, S. Ask<sup>27</sup>, B. Åsman<sup>146a,146b</sup>, L. Asquith<sup>5</sup>, K. Assamagan<sup>24</sup>, A. Astbury<sup>169</sup>, A. Astvatsatourov<sup>52</sup>, B. Aubert<sup>4</sup>, E. Auge<sup>115</sup>, K. Augsten<sup>127</sup>, M. Aurousseau<sup>145a</sup>, G. Avolio<sup>163</sup>, R. Avramidou<sup>9</sup>, D. Axen<sup>168</sup>,

C. Ay<sup>54</sup>, G. Azuelos<sup>93,d</sup>, Y. Azuma<sup>155</sup>, M.A. Baak<sup>29</sup>, G. Baccaglioni<sup>89a</sup>, C. Bacci<sup>134a,134b</sup>, A.M. Bach<sup>14</sup>,  
 H. Bachacou<sup>136</sup>, K. Bachas<sup>29</sup>, M. Backes<sup>49</sup>, M. Backhaus<sup>20</sup>, E. Badescu<sup>25a</sup>, P. Bagnaia<sup>132a,132b</sup>,  
 S. Bahinipati<sup>2</sup>, Y. Bai<sup>32a</sup>, D.C. Bailey<sup>158</sup>, T. Bain<sup>158</sup>, J.T. Baines<sup>129</sup>, O.K. Baker<sup>175</sup>, M.D. Baker<sup>24</sup>,  
 S. Baker<sup>77</sup>, E. Banas<sup>38</sup>, P. Banerjee<sup>93</sup>, Sw. Banerjee<sup>172</sup>, D. Banfi<sup>29</sup>, A. Bangert<sup>150</sup>, V. Bansal<sup>169</sup>,  
 H.S. Bansil<sup>17</sup>, L. Barak<sup>171</sup>, S.P. Baranov<sup>94</sup>, A. Barashkou<sup>65</sup>, A. Barbaro Galtieri<sup>14</sup>, T. Barber<sup>48</sup>,  
 E.L. Barberio<sup>86</sup>, D. Barberis<sup>50a,50b</sup>, M. Barbero<sup>20</sup>, D.Y. Bardin<sup>65</sup>, T. Barillari<sup>99</sup>, M. Barisonzi<sup>174</sup>,  
 T. Barklow<sup>143</sup>, N. Barlow<sup>27</sup>, B.M. Barnett<sup>129</sup>, R.M. Barnett<sup>14</sup>, A. Baroncelli<sup>134a</sup>, G. Barone<sup>49</sup>, A.J. Barr<sup>118</sup>,  
 F. Barreiro<sup>80</sup>, J. Barreiro Guimarães da Costa<sup>57</sup>, P. Barrillon<sup>115</sup>, R. Bartoldus<sup>143</sup>, A.E. Barton<sup>71</sup>,  
 V. Bartsch<sup>149</sup>, R.L. Bates<sup>53</sup>, L. Batkova<sup>144a</sup>, J.R. Batley<sup>27</sup>, A. Battaglia<sup>16</sup>, M. Battistin<sup>29</sup>, F. Bauer<sup>136</sup>,  
 H.S. Bawa<sup>143,e</sup>, S. Beale<sup>98</sup>, T. Beau<sup>78</sup>, P.H. Beauchemin<sup>161</sup>, R. Beccherle<sup>50a</sup>, P. Bechtle<sup>20</sup>, H.P. Beck<sup>16</sup>,  
 S. Becker<sup>98</sup>, M. Beckingham<sup>138</sup>, K.H. Becks<sup>174</sup>, A.J. Beddall<sup>18c</sup>, A. Beddall<sup>18c</sup>, S. Bedikian<sup>175</sup>,  
 V.A. Bednyakov<sup>65</sup>, C.P. Bee<sup>83</sup>, M. Begel<sup>24</sup>, S. Behar Harpaz<sup>152</sup>, P.K. Behera<sup>63</sup>, M. Beimforde<sup>99</sup>,  
 C. Belanger-Champagne<sup>85</sup>, P.J. Bell<sup>49</sup>, W.H. Bell<sup>49</sup>, G. Bella<sup>153</sup>, L. Bellagamba<sup>19a</sup>, F. Bellina<sup>29</sup>,  
 M. Bellomo<sup>29</sup>, A. Belloni<sup>57</sup>, O. Beloborodova<sup>107,f</sup>, K. Belotskiy<sup>96</sup>, O. Beltramello<sup>29</sup>, O. Benary<sup>153</sup>,  
 D. Benchekroun<sup>135a</sup>, M. Bendel<sup>81</sup>, N. Benekos<sup>165</sup>, Y. Benhammou<sup>153</sup>, E. Benhar Nocchioli<sup>49</sup>,  
 J.A. Benitez Garcia<sup>159b</sup>, D.P. Benjamin<sup>44</sup>, M. Benoit<sup>115</sup>, J.R. Bensinger<sup>22</sup>, K. Benslama<sup>130</sup>,  
 S. Bentvelsen<sup>105</sup>, D. Berge<sup>29</sup>, E. Bergeaas Kuutmann<sup>41</sup>, N. Berger<sup>4</sup>, F. Berghaus<sup>169</sup>, E. Berglund<sup>105</sup>,  
 J. Beringer<sup>14</sup>, P. Bernat<sup>77</sup>, R. Bernhard<sup>48</sup>, C. Bernius<sup>24</sup>, T. Berry<sup>76</sup>, C. Bertella<sup>83</sup>, A. Bertin<sup>19a,19b</sup>,  
 F. Bertinelli<sup>29</sup>, F. Bertolucci<sup>122a,122b</sup>, M.I. Besana<sup>89a,89b</sup>, N. Besson<sup>136</sup>, S. Bethke<sup>99</sup>, W. Bhimji<sup>45</sup>,  
 R.M. Bianchi<sup>29</sup>, M. Bianco<sup>72a,72b</sup>, O. Biebel<sup>98</sup>, S.P. Bieniek<sup>77</sup>, K. Bierwagen<sup>54</sup>, J. Biesiada<sup>14</sup>,  
 M. Biglietti<sup>134a</sup>, H. Bilokon<sup>47</sup>, M. Bindi<sup>19a,19b</sup>, S. Binet<sup>115</sup>, A. Bingul<sup>18c</sup>, C. Bini<sup>132a,132b</sup>, C. Biscarat<sup>177</sup>,  
 U. Bitenc<sup>48</sup>, K.M. Black<sup>21</sup>, R.E. Blair<sup>5</sup>, J.-B. Blanchard<sup>136</sup>, G. Blanchot<sup>29</sup>, T. Blazek<sup>144a</sup>, C. Blocker<sup>22</sup>,  
 J. Blocki<sup>38</sup>, A. Blondel<sup>49</sup>, W. Blum<sup>81</sup>, U. Blumenschein<sup>54</sup>, G.J. Bobbink<sup>105</sup>, V.B. Bobrovnikov<sup>107</sup>,  
 S.S. Bocchetta<sup>79</sup>, A. Bocci<sup>44</sup>, C.R. Boddy<sup>118</sup>, M. Boehler<sup>41</sup>, J. Boek<sup>174</sup>, N. Boelaert<sup>35</sup>, J.A. Bogaerts<sup>29</sup>,  
 A. Bogdanchikov<sup>107</sup>, A. Bogouch<sup>90,\*</sup>, C. Bohm<sup>146a</sup>, J. Bohm<sup>125</sup>, V. Boisvert<sup>76</sup>, T. Bold<sup>37</sup>, V. Boldea<sup>25a</sup>,  
 N.M. Bolnet<sup>136</sup>, M. Bomben<sup>78</sup>, M. Bona<sup>75</sup>, V.G. Bondarenko<sup>96</sup>, M. Bondioli<sup>163</sup>, M. Boonekamp<sup>136</sup>,  
 C.N. Booth<sup>139</sup>, S. Bordononi<sup>78</sup>, C. Borer<sup>16</sup>, A. Borisov<sup>128</sup>, G. Borissov<sup>71</sup>, I. Borjanovic<sup>12a</sup>, M. Borri<sup>82</sup>,  
 S. Borroni<sup>87</sup>, V. Bortolotto<sup>134a,134b</sup>, K. Bos<sup>105</sup>, D. Boscherini<sup>19a</sup>, M. Bosman<sup>11</sup>, H. Boterenbrood<sup>105</sup>,  
 D. Botterill<sup>129</sup>, J. Bouchami<sup>93</sup>, J. Boudreau<sup>123</sup>, E.V. Bouhova-Thacker<sup>71</sup>, D. Boumediene<sup>33</sup>,  
 C. Bourdarios<sup>115</sup>, N. Bousson<sup>83</sup>, A. Boveia<sup>30</sup>, J. Boyd<sup>29</sup>, I.R. Boyko<sup>65</sup>, N.I. Bozhko<sup>128</sup>,  
 I. Bozovic-Jelisavcic<sup>12b</sup>, J. Bracinik<sup>17</sup>, A. Braem<sup>29</sup>, P. Branchini<sup>134a</sup>, G.W. Brandenburg<sup>57</sup>, A. Brandt<sup>7</sup>,  
 G. Brandt<sup>118</sup>, O. Brandt<sup>54</sup>, U. Bratzler<sup>156</sup>, B. Brau<sup>84</sup>, J.E. Brau<sup>114</sup>, H.M. Braun<sup>174</sup>, B. Brelier<sup>158</sup>,  
 J. Bremer<sup>29</sup>, R. Brenner<sup>166</sup>, S. Bressler<sup>171</sup>, D. Britton<sup>53</sup>, F.M. Brochu<sup>27</sup>, I. Brock<sup>20</sup>, R. Brock<sup>88</sup>,  
 T.J. Brodbeck<sup>71</sup>, E. Brodet<sup>153</sup>, F. Broggi<sup>89a</sup>, C. Bromberg<sup>88</sup>, J. Bronner<sup>99</sup>, G. Brooijmans<sup>34</sup>,  
 W.K. Brooks<sup>31b</sup>, G. Brown<sup>82</sup>, H. Brown<sup>7</sup>, P.A. Bruckman de Renstrom<sup>38</sup>, D. Bruncko<sup>144b</sup>, R. Bruneliere<sup>48</sup>,  
 S. Brunet<sup>61</sup>, A. Bruni<sup>19a</sup>, G. Bruni<sup>19a</sup>, M. Bruschi<sup>19a</sup>, T. Buanes<sup>13</sup>, Q. Buat<sup>55</sup>, F. Bucci<sup>49</sup>, J. Buchanan<sup>118</sup>,  
 N.J. Buchanan<sup>2</sup>, P. Buchholz<sup>141</sup>, R.M. Buckingham<sup>118</sup>, A.G. Buckley<sup>45</sup>, S.I. Buda<sup>25a</sup>, I.A. Budagov<sup>65</sup>,  
 B. Budick<sup>108</sup>, V. Büscher<sup>81</sup>, L. Bugge<sup>117</sup>, O. Bulekov<sup>96</sup>, M. Bunse<sup>42</sup>, T. Buran<sup>117</sup>, H. Burckhart<sup>29</sup>,  
 S. Burdin<sup>73</sup>, T. Burgess<sup>13</sup>, S. Burke<sup>129</sup>, E. Busato<sup>33</sup>, P. Bussey<sup>53</sup>, C.P. Buszello<sup>166</sup>, F. Butin<sup>29</sup>, B. Butler<sup>143</sup>,  
 J.M. Butler<sup>21</sup>, C.M. Buttar<sup>53</sup>, J.M. Butterworth<sup>77</sup>, W. Buttinger<sup>27</sup>, S. Cabrera Urbán<sup>167</sup>, D. Caforio<sup>19a,19b</sup>,  
 O. Cakir<sup>3a</sup>, P. Calafiura<sup>14</sup>, G. Calderini<sup>78</sup>, P. Calfayan<sup>98</sup>, R. Calkins<sup>106</sup>, L.P. Caloba<sup>23a</sup>, R. Caloi<sup>132a,132b</sup>,  
 D. Calvet<sup>33</sup>, S. Calvet<sup>33</sup>, R. Camacho Toro<sup>33</sup>, P. Camarri<sup>133a,133b</sup>, M. Cambiaghi<sup>119a,119b</sup>, D. Cameron<sup>117</sup>,  
 L.M. Caminada<sup>14</sup>, S. Campana<sup>29</sup>, M. Campanelli<sup>77</sup>, V. Canale<sup>102a,102b</sup>, F. Canelli<sup>30,g</sup>, A. Canepa<sup>159a</sup>,  
 J. Cantero<sup>80</sup>, L. Capasso<sup>102a,102b</sup>, M.D.M. Capeans Garrido<sup>29</sup>, I. Caprini<sup>25a</sup>, M. Caprini<sup>25a</sup>, D. Capriotti<sup>99</sup>,  
 M. Capua<sup>36a,36b</sup>, R. Caputo<sup>81</sup>, R. Cardarelli<sup>133a</sup>, T. Carli<sup>29</sup>, G. Carlino<sup>102a</sup>, L. Carminati<sup>89a,89b</sup>, B. Caron<sup>85</sup>,  
 S. Caron<sup>104</sup>, E. Carquin<sup>31b</sup>, G.D. Carrillo Montoya<sup>172</sup>, A.A. Carter<sup>75</sup>, J.R. Carter<sup>27</sup>, J. Carvalho<sup>124a,h</sup>,  
 D. Casadei<sup>108</sup>, M.P. Casado<sup>11</sup>, M. Cascella<sup>122a,122b</sup>, C. Caso<sup>50a,50b,\*</sup>, A.M. Castaneda Hernandez<sup>172</sup>,  
 E. Castaneda-Miranda<sup>172</sup>, V. Castillo Gimenez<sup>167</sup>, N.F. Castro<sup>124a</sup>, G. Cataldi<sup>72a</sup>, A. Catinaccio<sup>29</sup>,  
 J.R. Catmore<sup>71</sup>, A. Cattai<sup>29</sup>, G. Cattani<sup>133a,133b</sup>, S. Caughron<sup>88</sup>, D. Cauz<sup>164a,164c</sup>, P. Cavalleri<sup>78</sup>,  
 D. Cavalli<sup>89a</sup>, M. Cavalli-Sforza<sup>11</sup>, V. Cavasinni<sup>122a,122b</sup>, F. Ceradini<sup>134a,134b</sup>, A.S. Cerqueira<sup>23b</sup>, A. Cerri<sup>29</sup>,  
 L. Cerrito<sup>75</sup>, F. Cerutti<sup>47</sup>, S.A. Cetin<sup>18b</sup>, F. Cevenini<sup>102a,102b</sup>, A. Chafaq<sup>135a</sup>, D. Chakraborty<sup>106</sup>, K. Chan<sup>2</sup>,  
 B. Chapleau<sup>85</sup>, J.D. Chapman<sup>27</sup>, J.W. Chapman<sup>87</sup>, E. Chareyre<sup>78</sup>, D.G. Charlton<sup>17</sup>, V. Chavda<sup>82</sup>,

C.A. Chavez Barajas<sup>29</sup>, S. Cheatham<sup>85</sup>, S. Chekanov<sup>5</sup>, S.V. Chekulaev<sup>159a</sup>, G.A. Chelkov<sup>65</sup>, M.A. Chelstowska<sup>104</sup>, C. Chen<sup>64</sup>, H. Chen<sup>24</sup>, S. Chen<sup>32c</sup>, T. Chen<sup>32c</sup>, X. Chen<sup>172</sup>, S. Cheng<sup>32a</sup>, A. Cheplakov<sup>65</sup>, V.F. Chepurinov<sup>65</sup>, R. Cherkaoui El Moursli<sup>135e</sup>, V. Chernyatin<sup>24</sup>, E. Cheu<sup>6</sup>, S.L. Cheung<sup>158</sup>, L. Chevalier<sup>136</sup>, G. Chiefari<sup>102a,102b</sup>, L. Chikovani<sup>51a</sup>, J.T. Childers<sup>58a</sup>, A. Chilingarov<sup>71</sup>, G. Chiodini<sup>72a</sup>, A.S. Chisholm<sup>17</sup>, R.T. Chislett<sup>77</sup>, M.V. Chizhov<sup>65</sup>, G. Choudalakis<sup>30</sup>, S. Chouridou<sup>137</sup>, I.A. Christidi<sup>77</sup>, A. Christov<sup>48</sup>, D. Chromek-Burckhart<sup>29</sup>, M.L. Chu<sup>151</sup>, J. Chudoba<sup>125</sup>, G. Ciapetti<sup>132a,132b</sup>, A.K. Ciftci<sup>3a</sup>, R. Ciftci<sup>3a</sup>, D. Cinca<sup>33</sup>, V. Cindro<sup>74</sup>, M.D. Ciobotaru<sup>163</sup>, C. Ciocca<sup>19a</sup>, A. Ciocio<sup>14</sup>, M. Cirilli<sup>87</sup>, M. Citterio<sup>89a</sup>, M. Ciubancan<sup>25a</sup>, A. Clark<sup>49</sup>, P.J. Clark<sup>45</sup>, W. Cleland<sup>123</sup>, J.C. Clemens<sup>83</sup>, B. Clement<sup>55</sup>, C. Clement<sup>146a,146b</sup>, R.W. Clift<sup>129</sup>, Y. Coadou<sup>83</sup>, M. Cobal<sup>164a,164c</sup>, A. Coccaro<sup>172</sup>, J. Cochran<sup>64</sup>, P. Coe<sup>118</sup>, J.G. Cogan<sup>143</sup>, J. Coggeshall<sup>165</sup>, E. Cogneras<sup>177</sup>, J. Colas<sup>4</sup>, A.P. Colijn<sup>105</sup>, C. Collard<sup>115</sup>, N.J. Collins<sup>17</sup>, C. Collins-Tooth<sup>53</sup>, J. Collot<sup>55</sup>, G. Colon<sup>84</sup>, P. Conde Muiño<sup>124a</sup>, E. Coniavitis<sup>118</sup>, M.C. Conidi<sup>11</sup>, M. Consonni<sup>104</sup>, S.M. Consonni<sup>89a,89b</sup>, V. Consorti<sup>48</sup>, S. Constantinescu<sup>25a</sup>, C. Conta<sup>119a,119b</sup>, G. Conti<sup>57</sup>, F. Conventi<sup>102a,i</sup>, J. Cook<sup>29</sup>, M. Cooke<sup>14</sup>, B.D. Cooper<sup>77</sup>, A.M. Cooper-Sarkar<sup>118</sup>, K. Copic<sup>14</sup>, T. Cornelissen<sup>174</sup>, M. Corradi<sup>19a</sup>, F. Corriveau<sup>85,j</sup>, A. Cortes-Gonzalez<sup>165</sup>, G. Cortiana<sup>99</sup>, G. Costa<sup>89a</sup>, M.J. Costa<sup>167</sup>, D. Costanzo<sup>139</sup>, T. Costin<sup>30</sup>, D. Côté<sup>29</sup>, R. Coura Torres<sup>23a</sup>, L. Courneyea<sup>169</sup>, G. Cowan<sup>76</sup>, C. Cowden<sup>27</sup>, B.E. Cox<sup>82</sup>, K. Cranmer<sup>108</sup>, F. Crescioli<sup>122a,122b</sup>, M. Cristinziani<sup>20</sup>, G. Crosetti<sup>36a,36b</sup>, R. Crupi<sup>72a,72b</sup>, S. Crépe-Renaudin<sup>55</sup>, C.-M. Cuciuc<sup>25a</sup>, C. Cuenca Almenar<sup>175</sup>, T. Cuhadar Donszelmann<sup>139</sup>, M. Curatolo<sup>47</sup>, C.J. Curtis<sup>17</sup>, C. Cuthbert<sup>150</sup>, P. Cwetanski<sup>61</sup>, H. Czirr<sup>141</sup>, P. Czodrowski<sup>43</sup>, Z. Czyczula<sup>175</sup>, S. D'Auria<sup>53</sup>, M. D'Onofrio<sup>73</sup>, A. D'Orazio<sup>132a,132b</sup>, P.V.M. Da Silva<sup>23a</sup>, C. Da Via<sup>82</sup>, W. Dabrowski<sup>37</sup>, T. Dai<sup>87</sup>, C. Dallapiccola<sup>84</sup>, M. Dam<sup>35</sup>, M. Dameri<sup>50a,50b</sup>, D.S. Damiani<sup>137</sup>, H.O. Danielsson<sup>29</sup>, D. Dannheim<sup>99</sup>, V. Dao<sup>49</sup>, G. Darbo<sup>50a</sup>, G.L. Darlea<sup>25b</sup>, W. Davey<sup>20</sup>, T. Davidek<sup>126</sup>, N. Davidson<sup>86</sup>, R. Davidson<sup>71</sup>, E. Davies<sup>118,c</sup>, M. Davies<sup>93</sup>, A.R. Davison<sup>77</sup>, Y. Davygora<sup>58a</sup>, E. Dawe<sup>142</sup>, I. Dawson<sup>139</sup>, J.W. Dawson<sup>5,\*</sup>, R.K. Daya<sup>22</sup>, K. De<sup>7</sup>, R. de Asmundis<sup>102a</sup>, S. De Castro<sup>19a,19b</sup>, P.E. De Castro Faria Salgado<sup>24</sup>, S. De Cecco<sup>78</sup>, J. de Graat<sup>98</sup>, N. De Groot<sup>104</sup>, P. de Jong<sup>105</sup>, C. De La Taille<sup>115</sup>, H. De la Torre<sup>80</sup>, B. De Lotto<sup>164a,164c</sup>, L. de Mora<sup>71</sup>, L. De Nooij<sup>105</sup>, D. De Pedis<sup>132a</sup>, A. De Salvo<sup>132a</sup>, U. De Sanctis<sup>164a,164c</sup>, A. De Santo<sup>149</sup>, J.B. De Vivie De Regie<sup>115</sup>, G. De Zorzi<sup>132a,132b</sup>, S. Dean<sup>77</sup>, W.J. Dearnaley<sup>71</sup>, R. Debbe<sup>24</sup>, C. Debenedetti<sup>45</sup>, B. Dechenaux<sup>55</sup>, D.V. Dedovich<sup>65</sup>, J. Degenhardt<sup>120</sup>, M. Dehchar<sup>118</sup>, C. Del Papa<sup>164a,164c</sup>, J. Del Peso<sup>80</sup>, T. Del Prete<sup>122a,122b</sup>, T. Delemontex<sup>55</sup>, M. Deliyergiyev<sup>74</sup>, A. Dell'Acqua<sup>29</sup>, L. Dell'Asta<sup>21</sup>, M. Della Pietra<sup>102a,i</sup>, D. della Volpe<sup>102a,102b</sup>, M. Delmastro<sup>4</sup>, N. Delruelle<sup>29</sup>, P.A. Delsart<sup>55</sup>, C. Deluca<sup>148</sup>, S. Demers<sup>175</sup>, M. Demichev<sup>65</sup>, B. Demirköz<sup>11,k</sup>, J. Deng<sup>163</sup>, S.P. Denisov<sup>128</sup>, D. Derendarz<sup>38</sup>, J.E. Derkaoui<sup>135d</sup>, F. Derue<sup>78</sup>, P. Dervan<sup>73</sup>, K. Desch<sup>20</sup>, E. Devetak<sup>148</sup>, P.O. Deviveiros<sup>105</sup>, A. Dewhurst<sup>129</sup>, B. DeWilde<sup>148</sup>, S. Dhaliwal<sup>158</sup>, R. Dhullipudi<sup>24,l</sup>, A. Di Ciaccio<sup>133a,133b</sup>, L. Di Ciaccio<sup>4</sup>, A. Di Girolamo<sup>29</sup>, B. Di Girolamo<sup>29</sup>, S. Di Luise<sup>134a,134b</sup>, A. Di Mattia<sup>172</sup>, B. Di Micco<sup>29</sup>, R. Di Nardo<sup>47</sup>, A. Di Simone<sup>133a,133b</sup>, R. Di Sipio<sup>19a,19b</sup>, M.A. Diaz<sup>31a</sup>, F. Diblen<sup>18c</sup>, E.B. Diehl<sup>87</sup>, J. Dietrich<sup>41</sup>, T.A. Dietzsch<sup>58a</sup>, S. Diglio<sup>86</sup>, K. Dindar Yagci<sup>39</sup>, J. Dingfelder<sup>20</sup>, C. Dionisi<sup>132a,132b</sup>, P. Dita<sup>25a</sup>, S. Dita<sup>25a</sup>, F. Dittus<sup>29</sup>, F. Djama<sup>83</sup>, T. Djobava<sup>51b</sup>, M.A.B. do Vale<sup>23c</sup>, A. Do Valle Wemans<sup>124a</sup>, T.K.O. Doan<sup>4</sup>, M. Dobbs<sup>85</sup>, R. Dobinson<sup>29,\*</sup>, D. Dobos<sup>29</sup>, E. Dobson<sup>29,m</sup>, M. Dobson<sup>163</sup>, J. Dodd<sup>34</sup>, C. Doglioni<sup>49</sup>, T. Doherty<sup>53</sup>, Y. Doi<sup>66,\*</sup>, J. Dolejsi<sup>126</sup>, I. Dolenc<sup>74</sup>, Z. Dolezal<sup>126</sup>, B.A. Dolgoshein<sup>96,\*</sup>, T. Dohmae<sup>155</sup>, M. Donadelli<sup>23d</sup>, M. Donega<sup>120</sup>, J. Donini<sup>33</sup>, J. Dopke<sup>29</sup>, A. Doria<sup>102a</sup>, A. Dos Anjos<sup>172</sup>, M. Dosil<sup>11</sup>, A. Dotti<sup>122a,122b</sup>, M.T. Dova<sup>70</sup>, A.D. Doxiadis<sup>105</sup>, A.T. Doyle<sup>53</sup>, Z. Drasal<sup>126</sup>, J. Drees<sup>174</sup>, N. Dressnandt<sup>120</sup>, H. Drevermann<sup>29</sup>, C. Driouichi<sup>35</sup>, M. Dris<sup>9</sup>, J. Dubbert<sup>99</sup>, S. Dube<sup>14</sup>, E. Duchovni<sup>171</sup>, G. Duckeck<sup>98</sup>, A. Dudarev<sup>29</sup>, F. Dudziak<sup>64</sup>, M. Dührssen<sup>29</sup>, I.P. Duerdoth<sup>82</sup>, L. Duflot<sup>115</sup>, M.-A. Dufour<sup>85</sup>, M. Dunford<sup>29</sup>, H. Duran Yildiz<sup>3b</sup>, R. Duxfield<sup>139</sup>, M. Dwuznik<sup>37</sup>, F. Dydak<sup>29</sup>, M. Düren<sup>52</sup>, W.L. Ebenstein<sup>44</sup>, J. Ebke<sup>98</sup>, S. Eckweiler<sup>81</sup>, K. Edmonds<sup>81</sup>, C.A. Edwards<sup>76</sup>, N.C. Edwards<sup>53</sup>, W. Ehrenfeld<sup>41</sup>, T. Ehrich<sup>99</sup>, T. Eifert<sup>143</sup>, G. Eigen<sup>13</sup>, K. Einsweiler<sup>14</sup>, E. Eisenhandler<sup>75</sup>, T. Ekelof<sup>166</sup>, M. El Kacimi<sup>135c</sup>, M. Ellert<sup>166</sup>, S. Elles<sup>4</sup>, F. Ellinghaus<sup>81</sup>, K. Ellis<sup>75</sup>, N. Ellis<sup>29</sup>, J. Elmsheuser<sup>98</sup>, M. Elsing<sup>29</sup>, D. Emeliyanov<sup>129</sup>, R. Engelmann<sup>148</sup>, A. Engl<sup>98</sup>, B. Epp<sup>62</sup>, A. Eppig<sup>87</sup>, J. Erdmann<sup>54</sup>, A. Ereditato<sup>16</sup>, D. Eriksson<sup>146a</sup>, J. Ernst<sup>1</sup>, M. Ernst<sup>24</sup>, J. Ernwein<sup>136</sup>, D. Errede<sup>165</sup>, S. Errede<sup>165</sup>, E. Ertel<sup>81</sup>, M. Escalier<sup>115</sup>, C. Escobar<sup>123</sup>, X. Espinal Curull<sup>11</sup>, B. Esposito<sup>47</sup>, F. Etienne<sup>83</sup>, A.I. Etievre<sup>136</sup>, E. Etzion<sup>153</sup>, D. Evangelakou<sup>54</sup>, H. Evans<sup>61</sup>, L. Fabbri<sup>19a,19b</sup>, C. Fabre<sup>29</sup>, R.M. Fakhruddinov<sup>128</sup>, S. Falciano<sup>132a</sup>, Y. Fang<sup>172</sup>, M. Fanti<sup>89a,89b</sup>, A. Farbin<sup>7</sup>, A. Farilla<sup>134a</sup>,



J. Farley<sup>148</sup>, T. Farooque<sup>158</sup>, S. Farrell<sup>163</sup>, S.M. Farrington<sup>118</sup>, P. Farthouat<sup>29</sup>, P. Fassnacht<sup>29</sup>,  
 D. Fassouliotis<sup>8</sup>, B. Fatholahzadeh<sup>158</sup>, A. Favareto<sup>89a,89b</sup>, L. Fayard<sup>115</sup>, S. Fazio<sup>36a,36b</sup>, R. Febbraro<sup>33</sup>,  
 P. Federic<sup>144a</sup>, O.L. Fedin<sup>121</sup>, W. Fedorko<sup>88</sup>, M. Fehling-Kaschek<sup>48</sup>, L. Feligioni<sup>83</sup>, D. Fellmann<sup>5</sup>,  
 C. Feng<sup>32d</sup>, E.J. Feng<sup>30</sup>, A.B. Fenyuk<sup>128</sup>, J. Ferencei<sup>144b</sup>, J. Ferland<sup>93</sup>, W. Fernando<sup>109</sup>, S. Ferrag<sup>53</sup>,  
 J. Ferrando<sup>53</sup>, V. Ferrara<sup>41</sup>, A. Ferrari<sup>166</sup>, P. Ferrari<sup>105</sup>, R. Ferrari<sup>119a</sup>, D.E. Ferreira de Lima<sup>53</sup>,  
 A. Ferrer<sup>167</sup>, M.L. Ferrer<sup>47</sup>, D. Ferrere<sup>49</sup>, C. Ferretti<sup>87</sup>, A. Ferretto Parodi<sup>50a,50b</sup>, M. Fiascaris<sup>30</sup>,  
 F. Fiedler<sup>81</sup>, A. Filipčič<sup>74</sup>, A. Filippas<sup>9</sup>, F. Filthaut<sup>104</sup>, M. Fincke-Keeler<sup>169</sup>, M.C.N. Fiolhais<sup>124a,h</sup>,  
 L. Fiorini<sup>167</sup>, A. Firan<sup>39</sup>, G. Fischer<sup>41</sup>, P. Fischer<sup>20</sup>, M.J. Fisher<sup>109</sup>, M. Flechl<sup>48</sup>, I. Fleck<sup>141</sup>, J. Fleckner<sup>81</sup>,  
 P. Fleischmann<sup>173</sup>, S. Fleischmann<sup>174</sup>, T. Flick<sup>174</sup>, A. Floderus<sup>79</sup>, L.R. Flores Castillo<sup>172</sup>,  
 M.J. Flowerdew<sup>99</sup>, M. Fokitis<sup>9</sup>, T. Fonseca Martin<sup>16</sup>, D.A. Forbush<sup>138</sup>, A. Formica<sup>136</sup>, A. Forti<sup>82</sup>,  
 D. Fortin<sup>159a</sup>, J.M. Foster<sup>82</sup>, D. Fournier<sup>115</sup>, A. Foussat<sup>29</sup>, A.J. Fowler<sup>44</sup>, K. Fowler<sup>137</sup>, H. Fox<sup>71</sup>,  
 P. Francavilla<sup>11</sup>, S. Franchino<sup>119a,119b</sup>, D. Francis<sup>29</sup>, T. Frank<sup>171</sup>, M. Franklin<sup>57</sup>, S. Franz<sup>29</sup>,  
 M. Fraternali<sup>119a,119b</sup>, S. Fratina<sup>120</sup>, S.T. French<sup>27</sup>, F. Friedrich<sup>43</sup>, R. Froeschl<sup>29</sup>, D. Froidevaux<sup>29</sup>,  
 J.A. Frost<sup>27</sup>, C. Fukunaga<sup>156</sup>, E. Fullana Torregrosa<sup>29</sup>, J. Fuster<sup>167</sup>, C. Gabaldon<sup>29</sup>, O. Gabizon<sup>171</sup>,  
 T. Gadfort<sup>24</sup>, S. Gadomski<sup>49</sup>, G. Gagliardi<sup>50a,50b</sup>, P. Gagnon<sup>61</sup>, C. Galea<sup>98</sup>, E.J. Gallas<sup>118</sup>, V. Gallo<sup>16</sup>,  
 B.J. Gallop<sup>129</sup>, P. Gallus<sup>125</sup>, K.K. Gan<sup>109</sup>, Y.S. Gao<sup>143,e</sup>, V.A. Gapienko<sup>128</sup>, A. Gaponenko<sup>14</sup>,  
 F. Garberon<sup>175</sup>, M. Garcia-Sciveres<sup>14</sup>, C. García<sup>167</sup>, J.E. García Navarro<sup>167</sup>, R.W. Gardner<sup>30</sup>, N. Garelli<sup>29</sup>,  
 H. Garitaonandia<sup>105</sup>, V. Garonne<sup>29</sup>, J. Garvey<sup>17</sup>, C. Gatti<sup>47</sup>, G. Gaudio<sup>119a</sup>, B. Gaur<sup>141</sup>, L. Gauthier<sup>136</sup>,  
 P. Gauzzi<sup>132a,132b</sup>, I.L. Gavrilenko<sup>94</sup>, C. Gay<sup>168</sup>, G. Gaycken<sup>20</sup>, J.-C. Gayde<sup>29</sup>, E.N. Gazis<sup>9</sup>, P. Ge<sup>32d</sup>,  
 C.N.P. Gee<sup>129</sup>, D.A.A. Geerts<sup>105</sup>, Ch. Geich-Gimbel<sup>20</sup>, K. Gellerstedt<sup>146a,146b</sup>, C. Gemme<sup>50a</sup>,  
 A. Gemmell<sup>53</sup>, M.H. Genest<sup>55</sup>, S. Gentile<sup>132a,132b</sup>, M. George<sup>54</sup>, S. George<sup>76</sup>, P. Gerlach<sup>174</sup>,  
 A. Gershon<sup>153</sup>, C. Geweniger<sup>58a</sup>, H. Ghazlane<sup>135b</sup>, N. Ghodbane<sup>33</sup>, B. Giacobbe<sup>19a</sup>, S. Giagu<sup>132a,132b</sup>,  
 V. Giakoumopoulou<sup>8</sup>, V. Giangiobbe<sup>11</sup>, F. Gianotti<sup>29</sup>, B. Gibbard<sup>24</sup>, A. Gibson<sup>158</sup>, S.M. Gibson<sup>29</sup>,  
 L.M. Gilbert<sup>118</sup>, V. Gilewsky<sup>91</sup>, D. Gillberg<sup>28</sup>, A.R. Gillman<sup>129</sup>, D.M. Gingrich<sup>2,d</sup>, J. Ginzburg<sup>153</sup>,  
 N. Giokaris<sup>8</sup>, M.P. Giordani<sup>164c</sup>, R. Giordano<sup>102a,102b</sup>, F.M. Giorgi<sup>15</sup>, P. Giovannini<sup>99</sup>, P.F. Giraud<sup>136</sup>,  
 D. Giugni<sup>89a</sup>, M. Giunta<sup>93</sup>, P. Giusti<sup>19a</sup>, B.K. Gjelsten<sup>117</sup>, L.K. Gladilin<sup>97</sup>, C. Glasman<sup>80</sup>, J. Glatzer<sup>48</sup>,  
 A. Glazov<sup>41</sup>, K.W. Glitza<sup>174</sup>, G.L. Glonti<sup>65</sup>, J.R. Goddard<sup>75</sup>, J. Godfrey<sup>142</sup>, J. Godlewski<sup>29</sup>, M. Goebel<sup>41</sup>,  
 T. Göpfert<sup>43</sup>, C. Goeringer<sup>81</sup>, C. Gössling<sup>42</sup>, T. Göttert<sup>99</sup>, S. Goldfarb<sup>87</sup>, T. Golling<sup>175</sup>, A. Gomes<sup>124a,b</sup>,  
 L.S. Gomez Fajardo<sup>41</sup>, R. Gonçalo<sup>76</sup>, J. Goncalves Pinto Firmino Da Costa<sup>41</sup>, L. Gonella<sup>20</sup>, A. Gonidec<sup>29</sup>,  
 S. Gonzalez<sup>172</sup>, S. González de la Hoz<sup>167</sup>, G. Gonzalez Parra<sup>11</sup>, M.L. Gonzalez Silva<sup>26</sup>,  
 S. Gonzalez-Sevilla<sup>49</sup>, J.J. Goodson<sup>148</sup>, L. Goossens<sup>29</sup>, P.A. Gorbounov<sup>95</sup>, H.A. Gordon<sup>24</sup>, I. Gorelov<sup>103</sup>,  
 G. Gorfine<sup>174</sup>, B. Gorini<sup>29</sup>, E. Gorini<sup>72a,72b</sup>, A. Gorišek<sup>74</sup>, E. Gornicki<sup>38</sup>, V.N. Goryachev<sup>128</sup>, B. Godzik<sup>41</sup>,  
 M. Gosselink<sup>105</sup>, M.I. Gostkin<sup>65</sup>, I. Gough Eschrich<sup>163</sup>, M. Gouighri<sup>135a</sup>, D. Goujdami<sup>135c</sup>,  
 M.P. Goulette<sup>49</sup>, A.G. Goussiou<sup>138</sup>, C. Goy<sup>4</sup>, S. Gozpinar<sup>22</sup>, I. Grabowska-Bold<sup>37</sup>, P. Grafström<sup>29</sup>,  
 K.-J. Grahm<sup>41</sup>, F. Grancagnolo<sup>72a</sup>, S. Grancagnolo<sup>15</sup>, V. Grassi<sup>148</sup>, V. Gratchev<sup>121</sup>, N. Grau<sup>34</sup>, H.M. Gray<sup>29</sup>,  
 J.A. Gray<sup>148</sup>, E. Graziani<sup>134a</sup>, O.G. Grebenyuk<sup>121</sup>, T. Greenshaw<sup>73</sup>, Z.D. Greenwood<sup>24,l</sup>, K. Gregersen<sup>35</sup>,  
 I.M. Gregor<sup>41</sup>, P. Grenier<sup>143</sup>, J. Griffiths<sup>138</sup>, N. Grigalashvili<sup>65</sup>, A.A. Grillo<sup>137</sup>, S. Grinstein<sup>11</sup>,  
 Y.V. Grishkevich<sup>97</sup>, J.-F. Grivaz<sup>115</sup>, M. Groh<sup>99</sup>, E. Gross<sup>171</sup>, J. Grosse-Knetter<sup>54</sup>, J. Groth-Jensen<sup>171</sup>,  
 K. Grybel<sup>141</sup>, V.J. Guarino<sup>5</sup>, D. Guest<sup>175</sup>, C. Guicheney<sup>33</sup>, A. Guida<sup>72a,72b</sup>, S. Guindon<sup>54</sup>, H. Guler<sup>85,n</sup>,  
 J. Gunther<sup>125</sup>, B. Guo<sup>158</sup>, J. Guo<sup>34</sup>, A. Gupta<sup>30</sup>, Y. Gusakov<sup>65</sup>, V.N. Gushchin<sup>128</sup>, P. Gutierrez<sup>111</sup>,  
 N. Guttman<sup>153</sup>, O. Gutzwiller<sup>172</sup>, C. Guyot<sup>136</sup>, C. Gwenlan<sup>118</sup>, C.B. Gwilliam<sup>73</sup>, A. Haas<sup>143</sup>, S. Haas<sup>29</sup>,  
 C. Haber<sup>14</sup>, R. Hackenburg<sup>24</sup>, H.K. Hadavand<sup>39</sup>, D.R. Hadley<sup>17</sup>, P. Haefner<sup>99</sup>, F. Hahn<sup>29</sup>, S. Haider<sup>29</sup>,  
 Z. Hajduk<sup>38</sup>, H. Hakobyan<sup>176</sup>, D. Hall<sup>118</sup>, J. Haller<sup>54</sup>, K. Hamacher<sup>174</sup>, P. Hamal<sup>113</sup>, M. Hamer<sup>54</sup>,  
 A. Hamilton<sup>145b</sup>, S. Hamilton<sup>161</sup>, H. Han<sup>32a</sup>, L. Han<sup>32b</sup>, K. Hanagaki<sup>116</sup>, K. Hanawa<sup>160</sup>, M. Hance<sup>14</sup>,  
 C. Handel<sup>81</sup>, P. Hanke<sup>58a</sup>, J.R. Hansen<sup>35</sup>, J.B. Hansen<sup>35</sup>, J.D. Hansen<sup>35</sup>, P.H. Hansen<sup>35</sup>, P. Hansson<sup>143</sup>,  
 K. Hara<sup>160</sup>, G.A. Hare<sup>137</sup>, T. Harenberg<sup>174</sup>, S. Harkusha<sup>90</sup>, D. Harper<sup>87</sup>, R.D. Harrington<sup>45</sup>,  
 O.M. Harris<sup>138</sup>, K. Harrison<sup>17</sup>, J. Hartert<sup>48</sup>, F. Hartjes<sup>105</sup>, T. Haruyama<sup>66</sup>, A. Harvey<sup>56</sup>, S. Hasegawa<sup>101</sup>,  
 Y. Hasegawa<sup>140</sup>, S. Hassani<sup>136</sup>, M. Hatch<sup>29</sup>, D. Hauff<sup>99</sup>, S. Haug<sup>16</sup>, M. Hauschild<sup>29</sup>, R. Hauser<sup>88</sup>,  
 M. Havranek<sup>20</sup>, B.M. Hawes<sup>118</sup>, C.M. Hawkes<sup>17</sup>, R.J. Hawkins<sup>29</sup>, A.D. Hawkins<sup>79</sup>, D. Hawkins<sup>163</sup>,  
 T. Hayakawa<sup>67</sup>, T. Hayashi<sup>160</sup>, D. Hayden<sup>76</sup>, H.S. Hayward<sup>73</sup>, S.J. Haywood<sup>129</sup>, E. Hazen<sup>21</sup>, M. He<sup>32d</sup>,  
 S.J. Head<sup>17</sup>, V. Hedberg<sup>79</sup>, L. Heelan<sup>7</sup>, S. Heim<sup>88</sup>, B. Heinemann<sup>14</sup>, S. Heisterkamp<sup>35</sup>, L. Helary<sup>4</sup>,  
 C. Heller<sup>98</sup>, M. Heller<sup>29</sup>, S. Hellman<sup>146a,146b</sup>, D. Hellmich<sup>20</sup>, C. Helsens<sup>11</sup>, R.C.W. Henderson<sup>71</sup>,

M. Henke<sup>58a</sup>, A. Henrichs<sup>54</sup>, A.M. Henriques Correia<sup>29</sup>, S. Henrot-Versille<sup>115</sup>, F. Henry-Couannier<sup>83</sup>,  
 C. Hensel<sup>54</sup>, T. Henß<sup>174</sup>, C.M. Hernandez<sup>7</sup>, Y. Hernández Jiménez<sup>167</sup>, R. Herrberg<sup>15</sup>,  
 A.D. Hershenhorn<sup>152</sup>, G. Herten<sup>48</sup>, R. Hertenberger<sup>98</sup>, L. Hervas<sup>29</sup>, G.G. Hesketh<sup>77</sup>, N.P. Hessey<sup>105</sup>,  
 E. Higón-Rodríguez<sup>167</sup>, D. Hill<sup>5,\*</sup>, J.C. Hill<sup>27</sup>, N. Hill<sup>5</sup>, K.H. Hiller<sup>41</sup>, S. Hillert<sup>20</sup>, S.J. Hillier<sup>17</sup>,  
 I. Hinchliffe<sup>14</sup>, E. Hines<sup>120</sup>, M. Hirose<sup>116</sup>, F. Hirsch<sup>42</sup>, D. Hirschbuehl<sup>174</sup>, J. Hobbs<sup>148</sup>, N. Hod<sup>153</sup>,  
 M.C. Hodgkinson<sup>139</sup>, P. Hodgson<sup>139</sup>, A. Hoecker<sup>29</sup>, M.R. Hoferkamp<sup>103</sup>, J. Hoffman<sup>39</sup>, D. Hoffmann<sup>83</sup>,  
 M. Hohlfeld<sup>81</sup>, M. Holder<sup>141</sup>, S.O. Holmgren<sup>146a</sup>, T. Holy<sup>127</sup>, J.L. Holzbauer<sup>88</sup>, Y. Homma<sup>67</sup>,  
 T.M. Hong<sup>120</sup>, L. Hooft van Huysduynen<sup>108</sup>, T. Horazdovsky<sup>127</sup>, C. Horn<sup>143</sup>, S. Horner<sup>48</sup>,  
 J.-Y. Hostachy<sup>55</sup>, S. Hou<sup>151</sup>, M.A. Houlden<sup>73</sup>, A. Hoummada<sup>135a</sup>, J. Howarth<sup>82</sup>, D.F. Howell<sup>118</sup>,  
 I. Hristova<sup>15</sup>, J. Hrivnac<sup>115</sup>, I. Hruska<sup>125</sup>, T. Hryn'ova<sup>4</sup>, P.J. Hsu<sup>81</sup>, S.-C. Hsu<sup>14</sup>, G.S. Huang<sup>111</sup>,  
 Z. Hubacek<sup>127</sup>, F. Hubaut<sup>83</sup>, F. Huegging<sup>20</sup>, A. Huettmann<sup>41</sup>, T.B. Huffman<sup>118</sup>, E.W. Hughes<sup>34</sup>,  
 G. Hughes<sup>71</sup>, R.E. Hughes-Jones<sup>82</sup>, M. Huhtinen<sup>29</sup>, P. Hurst<sup>57</sup>, M. Hurwitz<sup>14</sup>, U. Husemann<sup>41</sup>,  
 N. Huseynov<sup>65,o</sup>, J. Huston<sup>88</sup>, J. Huth<sup>57</sup>, G. Iacobucci<sup>49</sup>, G. Iakovidis<sup>9</sup>, M. Ibbotson<sup>82</sup>, I. Ibragimov<sup>141</sup>,  
 R. Ichimiya<sup>67</sup>, L. Iconomidou-Fayard<sup>115</sup>, J. Idarraga<sup>115</sup>, P. Iengo<sup>102a</sup>, O. Igonkina<sup>105</sup>, Y. Ikegami<sup>66</sup>,  
 M. Ikeno<sup>66</sup>, Y. Ilchenko<sup>39</sup>, D. Iliadis<sup>154</sup>, N. Ilic<sup>158</sup>, M. Imori<sup>155</sup>, T. Ince<sup>20</sup>, J. Inigo-Golfin<sup>29</sup>, P. Ioannou<sup>8</sup>,  
 M. Iodice<sup>134a</sup>, V. Ippolito<sup>132a,132b</sup>, A. Irlles Quiles<sup>167</sup>, C. Isaksson<sup>166</sup>, A. Ishikawa<sup>67</sup>, M. Ishino<sup>68</sup>,  
 R. Ishmukhametov<sup>39</sup>, C. Issever<sup>118</sup>, S. Istin<sup>18a</sup>, A.V. Ivashin<sup>128</sup>, W. Iwanski<sup>38</sup>, H. Iwasaki<sup>66</sup>, J.M. Izen<sup>40</sup>,  
 V. Izzo<sup>102a</sup>, B. Jackson<sup>120</sup>, J.N. Jackson<sup>73</sup>, P. Jackson<sup>143</sup>, M.R. Jaekel<sup>29</sup>, V. Jain<sup>61</sup>, K. Jakobs<sup>48</sup>,  
 S. Jakobsen<sup>35</sup>, J. Jakubek<sup>127</sup>, D.K. Jana<sup>111</sup>, E. Jansen<sup>77</sup>, H. Jansen<sup>29</sup>, A. Jantsch<sup>99</sup>, M. Janus<sup>20</sup>,  
 G. Jarlskog<sup>79</sup>, L. Jeanty<sup>57</sup>, K. Jelen<sup>37</sup>, I. Jen-La Plante<sup>30</sup>, P. Jenni<sup>29</sup>, A. Jeremie<sup>4</sup>, P. Jež<sup>35</sup>, S. Jézéquel<sup>4</sup>,  
 M.K. Jha<sup>19a</sup>, H. Ji<sup>172</sup>, W. Ji<sup>81</sup>, J. Jia<sup>148</sup>, Y. Jiang<sup>32b</sup>, M. Jimenez Belenguer<sup>41</sup>, G. Jin<sup>32b</sup>, S. Jin<sup>32a</sup>,  
 O. Jinnouchi<sup>157</sup>, M.D. Joergensen<sup>35</sup>, D. Joffe<sup>39</sup>, L.G. Johansen<sup>13</sup>, M. Johansen<sup>146a,146b</sup>, K.E. Johansson<sup>146a</sup>,  
 P. Johansson<sup>139</sup>, S. Johnert<sup>41</sup>, K.A. Johns<sup>6</sup>, K. Jon-And<sup>146a,146b</sup>, G. Jones<sup>118</sup>, R.W.L. Jones<sup>71</sup>, T.W. Jones<sup>77</sup>,  
 T.J. Jones<sup>73</sup>, O. Jonsson<sup>29</sup>, C. Joram<sup>29</sup>, P.M. Jorge<sup>124a</sup>, J. Joseph<sup>14</sup>, K.D. Joshi<sup>82</sup>, J. Jovicevic<sup>147</sup>, T. Jovin<sup>12b</sup>,  
 X. Ju<sup>172</sup>, C.A. Jung<sup>42</sup>, R.M. Jungst<sup>29</sup>, V. Juranek<sup>125</sup>, P. Jussel<sup>62</sup>, A. Juste Rozas<sup>11</sup>, V.V. Kabachenko<sup>128</sup>,  
 S. Kabana<sup>16</sup>, M. Kaci<sup>167</sup>, A. Kaczmarska<sup>38</sup>, P. Kadlecik<sup>35</sup>, M. Kado<sup>115</sup>, H. Kagan<sup>109</sup>, M. Kagan<sup>57</sup>,  
 S. Kaiser<sup>99</sup>, E. Kajomovitz<sup>152</sup>, S. Kalinin<sup>174</sup>, L.V. Kalinovskaya<sup>65</sup>, S. Kama<sup>39</sup>, N. Kanaya<sup>155</sup>, M. Kaneda<sup>29</sup>,  
 S. Kaneti<sup>27</sup>, T. Kanno<sup>157</sup>, V.A. Kantserov<sup>96</sup>, J. Kanzaki<sup>66</sup>, B. Kaplan<sup>175</sup>, A. Kapliy<sup>30</sup>, J. Kaplon<sup>29</sup>, D. Kar<sup>43</sup>,  
 M. Karagöz<sup>118</sup>, M. Karnevskiy<sup>41</sup>, V. Kartvelishvili<sup>71</sup>, A.N. Karyukhin<sup>128</sup>, L. Kashif<sup>172</sup>, G. Kasieczka<sup>58b</sup>,  
 A. Kasmi<sup>39</sup>, R.D. Kass<sup>109</sup>, A. Kastanas<sup>13</sup>, M. Kataoka<sup>4</sup>, Y. Kataoka<sup>155</sup>, E. Katsoufis<sup>9</sup>, J. Katzy<sup>41</sup>,  
 V. Kaushik<sup>6</sup>, K. Kawagoe<sup>67</sup>, T. Kawamoto<sup>155</sup>, G. Kawamura<sup>81</sup>, M.S. Kayl<sup>105</sup>, V.A. Kazanin<sup>107</sup>,  
 M.Y. Kazarinov<sup>65</sup>, R. Keeler<sup>169</sup>, R. Kehoe<sup>39</sup>, M. Keil<sup>54</sup>, G.D. Kekelidze<sup>65</sup>, J.S. Keller<sup>138</sup>, J. Kennedy<sup>98</sup>,  
 M. Kenyon<sup>53</sup>, O. Kepka<sup>125</sup>, N. Kerschen<sup>29</sup>, B.P. Kerševan<sup>74</sup>, S. Kersten<sup>174</sup>, K. Kessoku<sup>155</sup>, J. Keung<sup>158</sup>,  
 M. Khakzad<sup>28</sup>, F. Khalil-zada<sup>10</sup>, H. Khandanyan<sup>165</sup>, A. Khanov<sup>112</sup>, D. Kharchenko<sup>65</sup>, A. Khodinov<sup>96</sup>,  
 A.G. Kholodenko<sup>128</sup>, A. Khomich<sup>58a</sup>, T.J. Khoo<sup>27</sup>, G. Khoriauli<sup>20</sup>, A. Khoroshilov<sup>174</sup>, N. Khovanskiy<sup>65</sup>,  
 V. Khovanskiy<sup>95</sup>, E. Khramov<sup>65</sup>, J. Khubua<sup>51b</sup>, H. Kim<sup>146a,146b</sup>, M.S. Kim<sup>2</sup>, S.H. Kim<sup>160</sup>, N. Kimura<sup>170</sup>,  
 O. Kind<sup>15</sup>, B.T. King<sup>73</sup>, M. King<sup>67</sup>, R.S.B. King<sup>118</sup>, J. Kirk<sup>129</sup>, L.E. Kirsch<sup>22</sup>, A.E. Kiryunin<sup>99</sup>,  
 T. Kishimoto<sup>67</sup>, D. Kisielewska<sup>37</sup>, T. Kittelmann<sup>123</sup>, A.M. Kiver<sup>128</sup>, E. Kladiva<sup>144b</sup>, M. Klein<sup>73</sup>, U. Klein<sup>73</sup>,  
 K. Kleinknecht<sup>81</sup>, M. Klemetti<sup>85</sup>, A. Klier<sup>171</sup>, P. Klimek<sup>146a,146b</sup>, A. Klimentov<sup>24</sup>, R. Klingenberg<sup>42</sup>,  
 J.A. Klinger<sup>82</sup>, E.B. Klinkby<sup>35</sup>, T. Klioutchnikova<sup>29</sup>, P.F. Klok<sup>104</sup>, S. Klous<sup>105</sup>, E.-E. Kluge<sup>58a</sup>, T. Kluge<sup>73</sup>,  
 P. Kluit<sup>105</sup>, S. Kluth<sup>99</sup>, N.S. Knecht<sup>158</sup>, E. Kneringer<sup>62</sup>, J. Knobloch<sup>29</sup>, E.B.F.G. Knoops<sup>83</sup>, A. Knue<sup>54</sup>,  
 B.R. Ko<sup>44</sup>, T. Kobayashi<sup>155</sup>, M. Kobel<sup>43</sup>, M. Kocian<sup>143</sup>, P. Kodys<sup>126</sup>, K. Köneke<sup>29</sup>, A.C. König<sup>104</sup>,  
 S. Koenig<sup>81</sup>, L. Köpke<sup>81</sup>, F. Koetsveld<sup>104</sup>, P. Koevesarki<sup>20</sup>, T. Koffas<sup>28</sup>, E. Koffeman<sup>105</sup>, L.A. Kogan<sup>118</sup>,  
 F. Kohn<sup>54</sup>, Z. Kohout<sup>127</sup>, T. Kohriki<sup>66</sup>, T. Koi<sup>143</sup>, T. Kokott<sup>20</sup>, G.M. Kolachev<sup>107</sup>, H. Kolanoski<sup>15</sup>,  
 V. Kolesnikov<sup>65</sup>, I. Koletsou<sup>89a</sup>, J. Koll<sup>88</sup>, M. Kollefrath<sup>48</sup>, S.D. Kolya<sup>82</sup>, A.A. Komar<sup>94</sup>, Y. Komori<sup>155</sup>,  
 T. Kondo<sup>66</sup>, T. Kono<sup>41,p</sup>, A.I. Kononov<sup>48</sup>, R. Konoplich<sup>108,q</sup>, N. Konstantinidis<sup>77</sup>, A. Kootz<sup>174</sup>,  
 S. Koperny<sup>37</sup>, K. Korcyl<sup>38</sup>, K. Kordas<sup>154</sup>, V. Koreshev<sup>128</sup>, A. Korn<sup>118</sup>, A. Korol<sup>107</sup>, I. Korolkov<sup>11</sup>,  
 E.V. Korolkova<sup>139</sup>, V.A. Korotkov<sup>128</sup>, O. Kortner<sup>99</sup>, S. Kortner<sup>99</sup>, V.V. Kostyukhin<sup>20</sup>, M.J. Kotamäki<sup>29</sup>,  
 S. Kotov<sup>99</sup>, V.M. Kotov<sup>65</sup>, A. Kotwal<sup>44</sup>, C. Kourkoumelis<sup>8</sup>, V. Kouskoura<sup>154</sup>, A. Koutsman<sup>159a</sup>,  
 R. Kowalewski<sup>169</sup>, T.Z. Kowalski<sup>37</sup>, W. Kozanecki<sup>136</sup>, A.S. Kozhin<sup>128</sup>, V. Kral<sup>127</sup>, V.A. Kramarenko<sup>97</sup>,  
 G. Kramberger<sup>74</sup>, M.W. Krasny<sup>78</sup>, A. Krasznahorkay<sup>108</sup>, J. Kraus<sup>88</sup>, J.K. Kraus<sup>20</sup>, A. Kreisel<sup>153</sup>,  
 S. Kreiss<sup>108</sup>, F. Krejci<sup>127</sup>, J. Kretzschmar<sup>73</sup>, N. Krieger<sup>54</sup>, P. Krieger<sup>158</sup>, K. Kroeninger<sup>54</sup>, H. Kroha<sup>99</sup>,

J. Kroll<sup>120</sup>, J. Kroseberg<sup>20</sup>, J. Krstic<sup>12a</sup>, U. Kruchonak<sup>65</sup>, H. Krüger<sup>20</sup>, T. Kruker<sup>16</sup>, N. Krumnack<sup>64</sup>, Z.V. Krumshteyn<sup>65</sup>, A. Kruth<sup>20</sup>, T. Kubota<sup>86</sup>, S. Kuday<sup>3a</sup>, S. Kuehn<sup>48</sup>, A. Kugel<sup>58c</sup>, T. Kuhl<sup>41</sup>, D. Kuhn<sup>62</sup>, V. Kukhtin<sup>65</sup>, Y. Kulchitsky<sup>90</sup>, S. Kuleshov<sup>31b</sup>, C. Kummer<sup>98</sup>, M. Kuna<sup>78</sup>, N. Kundu<sup>118</sup>, J. Kunkle<sup>120</sup>, A. Kupco<sup>125</sup>, H. Kurashige<sup>67</sup>, M. Kurata<sup>160</sup>, Y.A. Kurochkin<sup>90</sup>, V. Kus<sup>125</sup>, E.S. Kuwertz<sup>147</sup>, M. Kuze<sup>157</sup>, J. Kvita<sup>142</sup>, R. Kwee<sup>15</sup>, A. La Rosa<sup>49</sup>, L. La Rotonda<sup>36a,36b</sup>, L. Labarga<sup>80</sup>, J. Labbe<sup>4</sup>, S. Lablak<sup>135a</sup>, C. Lacasta<sup>167</sup>, F. Lacava<sup>132a,132b</sup>, H. Lacker<sup>15</sup>, D. Lacour<sup>78</sup>, V.R. Lacuesta<sup>167</sup>, E. Ladygin<sup>65</sup>, R. Lafaye<sup>4</sup>, B. Laforge<sup>78</sup>, T. Lagouri<sup>80</sup>, S. Lai<sup>48</sup>, E. Laisne<sup>55</sup>, M. Lamanna<sup>29</sup>, L. Lambourne<sup>77</sup>, C.L. Lampen<sup>6</sup>, W. Lampl<sup>6</sup>, E. Lancon<sup>136</sup>, U. Landgraf<sup>48</sup>, M.P.J. Landon<sup>75</sup>, J.L. Lane<sup>82</sup>, C. Lange<sup>41</sup>, A.J. Lankford<sup>163</sup>, F. Lanni<sup>24</sup>, K. Lantzsich<sup>174</sup>, S. Laplace<sup>78</sup>, C. Lapoire<sup>20</sup>, J.F. Laporte<sup>136</sup>, T. Lari<sup>89a</sup>, A.V. Larionov<sup>128</sup>, A. Larnier<sup>118</sup>, C. Lasseur<sup>29</sup>, M. Lassnig<sup>29</sup>, P. Laurelli<sup>47</sup>, V. Lavorini<sup>36a,36b</sup>, W. Lavrijsen<sup>14</sup>, P. Laycock<sup>73</sup>, A.B. Lazarev<sup>65</sup>, O. Le Dortz<sup>78</sup>, E. Le Guirriec<sup>83</sup>, C. Le Maner<sup>158</sup>, E. Le Menedeu<sup>9</sup>, C. Lebel<sup>93</sup>, T. LeCompte<sup>5</sup>, F. Ledroit-Guillon<sup>55</sup>, H. Lee<sup>105</sup>, J.S.H. Lee<sup>116</sup>, S.C. Lee<sup>151</sup>, L. Lee<sup>175</sup>, M. Lefebvre<sup>169</sup>, M. Legendre<sup>136</sup>, A. Leger<sup>49</sup>, B.C. LeGeyt<sup>120</sup>, F. Legger<sup>98</sup>, C. Leggett<sup>14</sup>, M. Lehmacher<sup>20</sup>, G. Lehmann Miotto<sup>29</sup>, X. Lei<sup>6</sup>, M.A.L. Leite<sup>23d</sup>, R. Leitner<sup>126</sup>, D. Lellouch<sup>171</sup>, M. Leltchouk<sup>34</sup>, B. Lemmer<sup>54</sup>, V. Lendermann<sup>58a</sup>, K.J.C. Leney<sup>145b</sup>, T. Lenz<sup>105</sup>, G. Lenzen<sup>174</sup>, B. Lenzi<sup>29</sup>, K. Leonhardt<sup>43</sup>, S. Leontsinis<sup>9</sup>, C. Leroy<sup>93</sup>, J.-R. Lessard<sup>169</sup>, J. Lesser<sup>146a</sup>, C.G. Lester<sup>27</sup>, A. Leung Fook Cheong<sup>172</sup>, J. Levêque<sup>4</sup>, D. Levin<sup>87</sup>, L.J. Levinson<sup>171</sup>, M.S. Levitski<sup>128</sup>, A. Lewis<sup>118</sup>, G.H. Lewis<sup>108</sup>, A.M. Leyko<sup>20</sup>, M. Leyton<sup>15</sup>, B. Li<sup>83</sup>, H. Li<sup>172,r</sup>, S. Li<sup>32b,s</sup>, X. Li<sup>87</sup>, Z. Liang<sup>118,t</sup>, H. Liao<sup>33</sup>, B. Liberti<sup>133a</sup>, P. Lichard<sup>29</sup>, M. Lichtnecker<sup>98</sup>, K. Lie<sup>165</sup>, W. Liebig<sup>13</sup>, J.N. Lilley<sup>17</sup>, C. Limbach<sup>20</sup>, A. Limosani<sup>86</sup>, M. Limper<sup>63</sup>, S.C. Lin<sup>151,u</sup>, F. Linde<sup>105</sup>, J.T. Linnemann<sup>88</sup>, E. Lipeles<sup>120</sup>, L. Lipinsky<sup>125</sup>, A. Lipniacka<sup>13</sup>, T.M. Liss<sup>165</sup>, D. Lissauer<sup>24</sup>, A. Lister<sup>49</sup>, A.M. Litke<sup>137</sup>, C. Liu<sup>28</sup>, D. Liu<sup>151</sup>, H. Liu<sup>87</sup>, J.B. Liu<sup>87</sup>, M. Liu<sup>32b</sup>, Y. Liu<sup>32b</sup>, M. Livan<sup>119a,119b</sup>, S.S.A. Livermore<sup>118</sup>, A. Lleres<sup>55</sup>, J. Llorente Merino<sup>80</sup>, S.L. Lloyd<sup>75</sup>, E. Lobodzinska<sup>41</sup>, P. Loch<sup>6</sup>, W.S. Lockman<sup>137</sup>, T. Loddenkoetter<sup>20</sup>, F.K. Loebinger<sup>82</sup>, A. Loginov<sup>175</sup>, C.W. Loh<sup>168</sup>, T. Lohse<sup>15</sup>, K. Lohwasser<sup>48</sup>, M. Lokajicek<sup>125</sup>, J. Loken<sup>118</sup>, V.P. Lombardo<sup>4</sup>, R.E. Long<sup>71</sup>, L. Lopes<sup>124a</sup>, D. Lopez Mateos<sup>57</sup>, J. Lorenz<sup>98</sup>, N. Lorenzo Martinez<sup>115</sup>, M. Losada<sup>162</sup>, P. Loscutoff<sup>14</sup>, F. Lo Sterzo<sup>132a,132b</sup>, M.J. Losty<sup>159a</sup>, X. Lou<sup>40</sup>, A. Lounis<sup>115</sup>, K.F. Loureiro<sup>162</sup>, J. Love<sup>21</sup>, P.A. Love<sup>71</sup>, A.J. Lowe<sup>143,e</sup>, F. Lu<sup>32a</sup>, H.J. Lubatti<sup>138</sup>, C. Luci<sup>132a,132b</sup>, A. Lucotte<sup>55</sup>, A. Ludwig<sup>43</sup>, D. Ludwig<sup>41</sup>, I. Ludwig<sup>48</sup>, J. Ludwig<sup>48</sup>, F. Luehring<sup>61</sup>, G. Luijckx<sup>105</sup>, W. Lukas<sup>62</sup>, D. Lumb<sup>48</sup>, L. Luminari<sup>132a</sup>, E. Lund<sup>117</sup>, B. Lund-Jensen<sup>147</sup>, B. Lundberg<sup>79</sup>, J. Lundberg<sup>146a,146b</sup>, J. Lundquist<sup>35</sup>, M. Lungwitz<sup>81</sup>, G. Lutz<sup>99</sup>, D. Lynn<sup>24</sup>, J. Lys<sup>14</sup>, E. Lytken<sup>79</sup>, H. Ma<sup>24</sup>, L.L. Ma<sup>172</sup>, J.A. Macana Goia<sup>93</sup>, G. Maccarrone<sup>47</sup>, A. Macchiolo<sup>99</sup>, B. Maček<sup>74</sup>, J. Machado Miguens<sup>124a</sup>, R. Mackeprang<sup>35</sup>, R.J. Madaras<sup>14</sup>, W.F. Mader<sup>43</sup>, R. Maenner<sup>58c</sup>, T. Maeno<sup>24</sup>, P. Mättig<sup>174</sup>, S. Mättig<sup>41</sup>, L. Magnoni<sup>29</sup>, E. Magradze<sup>54</sup>, Y. Mahalalel<sup>153</sup>, K. Mahboubi<sup>48</sup>, S. Mahmoud<sup>73</sup>, G. Mahout<sup>17</sup>, C. Maiani<sup>132a,132b</sup>, C. Maidantchik<sup>23a</sup>, A. Maio<sup>124a,b</sup>, S. Majewski<sup>24</sup>, Y. Makida<sup>66</sup>, N. Makovec<sup>115</sup>, P. Mal<sup>136</sup>, B. Malaescu<sup>29</sup>, Pa. Malecki<sup>38</sup>, P. Malecki<sup>38</sup>, V.P. Maleev<sup>121</sup>, F. Malek<sup>55</sup>, U. Mallik<sup>63</sup>, D. Malon<sup>5</sup>, C. Malone<sup>143</sup>, S. Maltezos<sup>9</sup>, V. Malyshev<sup>107</sup>, S. Malyukov<sup>29</sup>, R. Mameghani<sup>98</sup>, J. Mamuzic<sup>12b</sup>, A. Manabe<sup>66</sup>, L. Mandelli<sup>89a</sup>, I. Mandić<sup>74</sup>, R. Mandrysch<sup>15</sup>, J. Maneira<sup>124a</sup>, P.S. Mangedard<sup>88</sup>, L. Manhaes de Andrade Filho<sup>23a</sup>, I.D. Manjavidze<sup>65</sup>, A. Mann<sup>54</sup>, P.M. Manning<sup>137</sup>, A. Manousakis-Katsikakis<sup>8</sup>, B. Mansoulie<sup>136</sup>, A. Manz<sup>99</sup>, A. Mapelli<sup>29</sup>, L. Mapelli<sup>29</sup>, L. March<sup>80</sup>, J.F. Marchand<sup>28</sup>, F. Marchese<sup>133a,133b</sup>, G. Marchiori<sup>78</sup>, M. Marcisovsky<sup>125</sup>, C.P. Marino<sup>169</sup>, F. Marroquim<sup>23a</sup>, R. Marshall<sup>82</sup>, Z. Marshall<sup>29</sup>, F.K. Martens<sup>158</sup>, S. Marti-Garcia<sup>167</sup>, A.J. Martin<sup>175</sup>, B. Martin<sup>29</sup>, B. Martin<sup>88</sup>, F.F. Martin<sup>120</sup>, J.P. Martin<sup>93</sup>, Ph. Martin<sup>55</sup>, T.A. Martin<sup>17</sup>, V.J. Martin<sup>45</sup>, B. Martin dit Latour<sup>49</sup>, S. Martin-Haugh<sup>149</sup>, M. Martinez<sup>11</sup>, V. Martinez Outschoorn<sup>57</sup>, A.C. Martyniuk<sup>169</sup>, M. Marx<sup>82</sup>, F. Marzano<sup>132a</sup>, A. Marzin<sup>111</sup>, L. Masetti<sup>81</sup>, T. Mashimo<sup>155</sup>, R. Mashinistov<sup>94</sup>, J. Masik<sup>82</sup>, A.L. Maslennikov<sup>107</sup>, I. Massa<sup>19a,19b</sup>, G. Massaro<sup>105</sup>, N. Massol<sup>4</sup>, P. Mastrandrea<sup>132a,132b</sup>, A. Mastroberardino<sup>36a,36b</sup>, T. Masubuchi<sup>155</sup>, P. Matricon<sup>115</sup>, H. Matsumoto<sup>155</sup>, H. Matsunaga<sup>155</sup>, T. Matsushita<sup>67</sup>, C. Mattravers<sup>118,c</sup>, J.M. Maugain<sup>29</sup>, J. Maurer<sup>83</sup>, S.J. Maxfield<sup>73</sup>, D.A. Maximov<sup>107,f</sup>, E.N. May<sup>5</sup>, A. Mayne<sup>139</sup>, R. Mazini<sup>151</sup>, M. Mazur<sup>20</sup>, M. Mazzanti<sup>89a</sup>, S.P. Mc Kee<sup>87</sup>, A. McCarn<sup>165</sup>, R.L. McCarthy<sup>148</sup>, T.G. McCarthy<sup>28</sup>, N.A. McCubbin<sup>129</sup>, K.W. McFarlane<sup>56</sup>, J.A. McFayden<sup>139</sup>, H. McGlone<sup>53</sup>, G. Mchedlidze<sup>51b</sup>, R.A. McLaren<sup>29</sup>, T. McLaughlan<sup>17</sup>, S.J. McMahon<sup>129</sup>, R.A. McPherson<sup>169,j</sup>, A. Meade<sup>84</sup>, J. Mechnich<sup>105</sup>, M. Mechtel<sup>174</sup>, M. Medinnis<sup>41</sup>, R. Meera-Lebbai<sup>111</sup>, T. Meguro<sup>116</sup>, R. Mehdiyev<sup>93</sup>, S. Mehlhase<sup>35</sup>, A. Mehta<sup>73</sup>, K. Meier<sup>58a</sup>, B. Meirose<sup>79</sup>, C. Melachrinos<sup>30</sup>, B.R. Mellado Garcia<sup>172</sup>, L. Mendoza Navas<sup>162</sup>, Z. Meng<sup>151,r</sup>, A. Mengarelli<sup>19a,19b</sup>, S. Menke<sup>99</sup>,

C. Menot<sup>29</sup>, E. Meoni<sup>11</sup>, K.M. Mercurio<sup>57</sup>, P. Mermoud<sup>49</sup>, L. Merola<sup>102a,102b</sup>, C. Meroni<sup>89a</sup>, F.S. Merritt<sup>30</sup>,  
 H. Merritt<sup>109</sup>, A. Messina<sup>29</sup>, J. Metcalfe<sup>103</sup>, A.S. Mete<sup>64</sup>, C. Meyer<sup>81</sup>, C. Meyer<sup>30</sup>, J.-P. Meyer<sup>136</sup>,  
 J. Meyer<sup>173</sup>, J. Meyer<sup>54</sup>, T.C. Meyer<sup>29</sup>, W.T. Meyer<sup>64</sup>, J. Miao<sup>32d</sup>, S. Michal<sup>29</sup>, L. Micu<sup>25a</sup>,  
 R.P. Middleton<sup>129</sup>, S. Migas<sup>73</sup>, L. Mijović<sup>41</sup>, G. Mikenberg<sup>171</sup>, M. Mikestikova<sup>125</sup>, M. Mikuž<sup>74</sup>,  
 D.W. Miller<sup>30</sup>, R.J. Miller<sup>88</sup>, W.J. Mills<sup>168</sup>, C. Mills<sup>57</sup>, A. Milov<sup>171</sup>, D.A. Milstead<sup>146a,146b</sup>, D. Milstein<sup>171</sup>,  
 A.A. Minaenko<sup>128</sup>, M. Miñano Moya<sup>167</sup>, I.A. Minashvili<sup>65</sup>, A.I. Mincer<sup>108</sup>, B. Mindur<sup>37</sup>, M. Mineev<sup>65</sup>,  
 Y. Ming<sup>172</sup>, L.M. Mir<sup>11</sup>, G. Mirabelli<sup>132a</sup>, L. Miralles Verge<sup>11</sup>, A. Misiejuk<sup>76</sup>, J. Mitrevski<sup>137</sup>,  
 G.Y. Mitrofanov<sup>128</sup>, V.A. Mitsou<sup>167</sup>, S. Mitsui<sup>66</sup>, P.S. Miyagawa<sup>139</sup>, K. Miyazaki<sup>67</sup>, J.U. Mjörnmark<sup>79</sup>,  
 T. Moa<sup>146a,146b</sup>, P. Mockett<sup>138</sup>, S. Moed<sup>57</sup>, V. Moeller<sup>27</sup>, K. Mönig<sup>41</sup>, N. Möser<sup>20</sup>, S. Mohapatra<sup>148</sup>,  
 W. Mohr<sup>48</sup>, S. Mohrdieck-Möck<sup>99</sup>, A.M. Moisseev<sup>128,\*</sup>, R. Moles-Valls<sup>167</sup>, J. Molina-Perez<sup>29</sup>, J. Monk<sup>77</sup>,  
 E. Monnier<sup>83</sup>, S. Montesano<sup>89a,89b</sup>, F. Monticelli<sup>70</sup>, S. Monzani<sup>19a,19b</sup>, R.W. Moore<sup>2</sup>, G.F. Moorhead<sup>86</sup>,  
 C. Mora Herrera<sup>49</sup>, A. Moraes<sup>53</sup>, N. Morange<sup>136</sup>, J. Morel<sup>54</sup>, G. Morello<sup>36a,36b</sup>, D. Moreno<sup>81</sup>,  
 M. Moreno Llácer<sup>167</sup>, P. Morettini<sup>50a</sup>, M. Morgenstern<sup>43</sup>, M. Morii<sup>57</sup>, J. Morin<sup>75</sup>, A.K. Morley<sup>29</sup>,  
 G. Mornacchi<sup>29</sup>, S.V. Morozov<sup>96</sup>, J.D. Morris<sup>75</sup>, L. Morvaj<sup>101</sup>, H.G. Moser<sup>99</sup>, M. Mosidze<sup>51b</sup>, J. Moss<sup>109</sup>,  
 R. Mount<sup>143</sup>, E. Mountricha<sup>9</sup>, S.V. Mouraviev<sup>94</sup>, E.J.W. Moyse<sup>84</sup>, M. Mudrinic<sup>12b</sup>, F. Mueller<sup>58a</sup>,  
 J. Mueller<sup>123</sup>, K. Mueller<sup>20</sup>, T.A. Müller<sup>98</sup>, T. Mueller<sup>81</sup>, D. Muenstermann<sup>29</sup>, A. Muir<sup>168</sup>, Y. Munwes<sup>153</sup>,  
 W.J. Murray<sup>129</sup>, I. Mussche<sup>105</sup>, E. Musto<sup>102a,102b</sup>, A.G. Myagkov<sup>128</sup>, J. Nadal<sup>11</sup>, K. Nagai<sup>160</sup>, K. Nagano<sup>66</sup>,  
 A. Nagarkar<sup>109</sup>, Y. Nagasaka<sup>60</sup>, M. Nagel<sup>99</sup>, A.M. Nairz<sup>29</sup>, Y. Nakahama<sup>29</sup>, K. Nakamura<sup>155</sup>,  
 T. Nakamura<sup>155</sup>, I. Nakano<sup>110</sup>, G. Nanava<sup>20</sup>, A. Napier<sup>161</sup>, R. Narayan<sup>58b</sup>, M. Nash<sup>77,c</sup>, N.R. Nation<sup>21</sup>,  
 T. Nattermann<sup>20</sup>, T. Naumann<sup>41</sup>, G. Navarro<sup>162</sup>, H.A. Neal<sup>87</sup>, E. Nebot<sup>80</sup>, P.Yu. Nechaeva<sup>94</sup>, T.J. Neep<sup>82</sup>,  
 A. Negri<sup>119a,119b</sup>, G. Negri<sup>29</sup>, S. Nektarijevic<sup>49</sup>, A. Nelson<sup>163</sup>, T.K. Nelson<sup>143</sup>, S. Nemecek<sup>125</sup>,  
 P. Nemethy<sup>108</sup>, A.A. Nepomuceno<sup>23a</sup>, M. Nessi<sup>29,v</sup>, M.S. Neubauer<sup>165</sup>, A. Neusiedl<sup>81</sup>, R.M. Neves<sup>108</sup>,  
 P. Nevski<sup>24</sup>, P.R. Newman<sup>17</sup>, V. Nguyen Thi Hong<sup>136</sup>, R.B. Nickerson<sup>118</sup>, R. Nicolaidou<sup>136</sup>, L. Nicolas<sup>139</sup>,  
 B. Nicquevert<sup>29</sup>, F. Niedercorn<sup>115</sup>, J. Nielsen<sup>137</sup>, T. Niinikoski<sup>29</sup>, N. Nikiforou<sup>34</sup>, A. Nikiforov<sup>15</sup>,  
 V. Nikolaenko<sup>128</sup>, K. Nikolaev<sup>65</sup>, I. Nikolic-Audit<sup>78</sup>, K. Nikolics<sup>49</sup>, K. Nikolopoulos<sup>24</sup>, H. Nilsen<sup>48</sup>,  
 P. Nilsson<sup>7</sup>, Y. Ninomiya<sup>155</sup>, A. Nisati<sup>132a</sup>, T. Nishiyama<sup>67</sup>, R. Nisius<sup>99</sup>, L. Nodulman<sup>5</sup>, M. Nomachi<sup>116</sup>,  
 I. Nomidis<sup>154</sup>, M. Nordberg<sup>29</sup>, B. Nordkvist<sup>146a,146b</sup>, P.R. Norton<sup>129</sup>, J. Novakova<sup>126</sup>, M. Nozaki<sup>66</sup>,  
 L. Nozka<sup>113</sup>, I.M. Nugent<sup>159a</sup>, A.-E. Nuncio-Quiroz<sup>20</sup>, G. Nunes Hanninger<sup>86</sup>, T. Nunnemann<sup>98</sup>,  
 E. Nurse<sup>77</sup>, B.J. O'Brien<sup>45</sup>, S.W. O'Neale<sup>17,\*</sup>, D.C. O'Neil<sup>142</sup>, V. O'Shea<sup>53</sup>, L.B. Oakes<sup>98</sup>, F.G. Oakham<sup>28,d</sup>,  
 H. Oberlack<sup>99</sup>, J. Ocariz<sup>78</sup>, A. Ochi<sup>67</sup>, S. Oda<sup>155</sup>, S. Odaka<sup>66</sup>, J. Odier<sup>83</sup>, H. Ogren<sup>61</sup>, A. Oh<sup>82</sup>, S.H. Oh<sup>44</sup>,  
 C.C. Ohm<sup>146a,146b</sup>, T. Ohshima<sup>101</sup>, H. Ohshita<sup>140</sup>, S. Okada<sup>67</sup>, H. Okawa<sup>163</sup>, Y. Okumura<sup>101</sup>,  
 T. Okuyama<sup>155</sup>, A. Olariu<sup>25a</sup>, M. Olcese<sup>50a</sup>, A.G. Olchevski<sup>65</sup>, S.A. Olivares Pino<sup>31a</sup>, M. Oliveira<sup>124a,h</sup>,  
 D. Oliveira Damazio<sup>24</sup>, E. Oliver Garcia<sup>167</sup>, D. Olivito<sup>120</sup>, A. Olszewski<sup>38</sup>, J. Olszowska<sup>38</sup>, C. Omachi<sup>67</sup>,  
 A. Onofre<sup>124a,w</sup>, P.U.E. Onyisi<sup>30</sup>, C.J. Oram<sup>159a</sup>, M.J. Oreglia<sup>30</sup>, Y. Oren<sup>153</sup>, D. Orestano<sup>134a,134b</sup>,  
 N. Orlando<sup>72a,72b</sup>, I. Orlov<sup>107</sup>, C. Oropeza Barrera<sup>53</sup>, R.S. Orr<sup>158</sup>, B. Osculati<sup>50a,50b</sup>, R. Ospanov<sup>120</sup>,  
 C. Osuna<sup>11</sup>, G. Otero y Garzon<sup>26</sup>, J.P. Ottersbach<sup>105</sup>, M. Ouchrif<sup>135d</sup>, E.A. Ouellette<sup>169</sup>, F. Ould-Saada<sup>117</sup>,  
 A. Ouraou<sup>136</sup>, Q. Ouyang<sup>32a</sup>, A. Ovcharova<sup>14</sup>, M. Owen<sup>82</sup>, S. Owen<sup>139</sup>, V.E. Ozcan<sup>18a</sup>, N. Ozturk<sup>7</sup>,  
 A. Pacheco Pages<sup>11</sup>, C. Padilla Aranda<sup>11</sup>, S. Pagan Griso<sup>14</sup>, E. Paganis<sup>139</sup>, F. Paige<sup>24</sup>, P. Pais<sup>84</sup>,  
 K. Pajchel<sup>117</sup>, G. Palacino<sup>159b</sup>, C.P. Paleari<sup>6</sup>, S. Palestini<sup>29</sup>, D. Pallin<sup>33</sup>, A. Palma<sup>124a</sup>, J.D. Palmer<sup>17</sup>,  
 Y.B. Pan<sup>172</sup>, E. Panagiotopoulou<sup>9</sup>, B. Panes<sup>31a</sup>, N. Panikashvili<sup>87</sup>, S. Panitkin<sup>24</sup>, D. Pantea<sup>25a</sup>,  
 M. Panuskova<sup>125</sup>, V. Paolone<sup>123</sup>, A. Papadelis<sup>146a</sup>, Th.D. Papadopoulou<sup>9</sup>, A. Paramonov<sup>5</sup>, W. Park<sup>24,x</sup>,  
 M.A. Parker<sup>27</sup>, F. Parodi<sup>50a,50b</sup>, J.A. Parsons<sup>34</sup>, U. Parzefall<sup>48</sup>, S. Pashapour<sup>54</sup>, E. Pasqualucci<sup>132a</sup>,  
 S. Passaggio<sup>50a</sup>, A. Passeri<sup>134a</sup>, F. Pastore<sup>134a,134b</sup>, Fr. Pastore<sup>76</sup>, G. Pásztor<sup>49,y</sup>, S. Patariaia<sup>174</sup>,  
 N. Patel<sup>150</sup>, J.R. Pater<sup>82</sup>, S. Patricelli<sup>102a,102b</sup>, T. Pauly<sup>29</sup>, M. Pecsny<sup>144a</sup>, M.I. Pedraza Morales<sup>172</sup>,  
 S.V. Peleganchuk<sup>107</sup>, H. Peng<sup>32b</sup>, B. Penning<sup>30</sup>, A. Penson<sup>34</sup>, J. Penwell<sup>61</sup>, M. Perantoni<sup>23a</sup>, K. Perez<sup>34,z</sup>,  
 T. Perez Cavalcanti<sup>41</sup>, E. Perez Codina<sup>11</sup>, M.T. Pérez García-Estañ<sup>167</sup>, V. Perez Reale<sup>34</sup>, L. Perini<sup>89a,89b</sup>,  
 H. Pernegger<sup>29</sup>, R. Perrino<sup>72a</sup>, P. Perrodo<sup>4</sup>, S. Persebe<sup>3a</sup>, V.D. Peshekhonov<sup>65</sup>, K. Peters<sup>29</sup>,  
 B.A. Petersen<sup>29</sup>, J. Petersen<sup>29</sup>, T.C. Petersen<sup>35</sup>, E. Petit<sup>4</sup>, A. Petridis<sup>154</sup>, C. Petridou<sup>154</sup>, E. Petrolo<sup>132a</sup>,  
 F. Petrucci<sup>134a,134b</sup>, D. Petschull<sup>41</sup>, M. Petteni<sup>142</sup>, R. Pezoa<sup>31b</sup>, A. Phan<sup>86</sup>, P.W. Phillips<sup>129</sup>,  
 G. Piacquadio<sup>29</sup>, A. Picazio<sup>49</sup>, E. Piccaro<sup>75</sup>, M. Piccinini<sup>19a,19b</sup>, S.M. Piec<sup>41</sup>, R. Piegai<sup>26</sup>, D.T. Pignotti<sup>109</sup>,  
 J.E. Pilcher<sup>30</sup>, A.D. Pilkington<sup>82</sup>, J. Pina<sup>124a,b</sup>, M. Pinamonti<sup>164a,164c</sup>, A. Pinder<sup>118</sup>, J.L. Pinfold<sup>2</sup>,  
 J. Ping<sup>32c</sup>, B. Pinto<sup>124a</sup>, O. Pirotte<sup>29</sup>, C. Pizio<sup>89a,89b</sup>, R. Placakyte<sup>41</sup>, M. Plamondon<sup>169</sup>, M.-A. Pleier<sup>24</sup>,

A.V. Pleskach<sup>128</sup>, E. Plotnikova<sup>65</sup>, A. Poblaguev<sup>24</sup>, S. Poddar<sup>58a</sup>, F. Podlyski<sup>33</sup>, L. Poggioli<sup>115</sup>,  
 T. Poghosyan<sup>20</sup>, M. Pohl<sup>49</sup>, F. Polci<sup>55</sup>, G. Polesello<sup>119a</sup>, A. Policicchio<sup>138</sup>, A. Polini<sup>19a</sup>, J. Poll<sup>75</sup>,  
 V. Polychronakos<sup>24</sup>, D.M. Pomarede<sup>136</sup>, D. Pomeroy<sup>22</sup>, K. Pommès<sup>29</sup>, L. Pontecorvo<sup>132a</sup>, B.G. Pope<sup>88</sup>,  
 G.A. Popeneciu<sup>25a</sup>, D.S. Popovic<sup>12a</sup>, A. Poppleton<sup>29</sup>, X. Portell Bueso<sup>29</sup>, C. Posch<sup>21</sup>, G.E. Pospelov<sup>99</sup>,  
 S. Pospisil<sup>127</sup>, I.N. Potrap<sup>99</sup>, C.J. Potter<sup>149</sup>, C.T. Potter<sup>114</sup>, G. Poulard<sup>29</sup>, J. Poveda<sup>172</sup>, V. Pozdnyakov<sup>65</sup>,  
 R. Prabhu<sup>77</sup>, P. Pralavorio<sup>83</sup>, A. Pranko<sup>14</sup>, S. Prasad<sup>29</sup>, R. Pravahan<sup>7</sup>, S. Prell<sup>64</sup>, K. Pretzl<sup>16</sup>, L. Pribyl<sup>29</sup>,  
 D. Price<sup>61</sup>, J. Price<sup>73</sup>, L.E. Price<sup>5</sup>, M.J. Price<sup>29</sup>, D. Prieur<sup>123</sup>, M. Primavera<sup>72a</sup>, K. Prokofiev<sup>108</sup>,  
 F. Prokoshin<sup>31b</sup>, S. Protopopescu<sup>24</sup>, J. Proudfoot<sup>5</sup>, X. Prudent<sup>43</sup>, M. Przybycien<sup>37</sup>, H. Przysiezniak<sup>4</sup>,  
 S. Psoroulas<sup>20</sup>, E. Ptacek<sup>114</sup>, E. Pueschel<sup>84</sup>, J. Purdham<sup>87</sup>, M. Purohit<sup>24,x</sup>, P. Puzo<sup>115</sup>, Y. Pylypchenko<sup>63</sup>,  
 J. Qian<sup>87</sup>, Z. Qian<sup>83</sup>, Z. Qin<sup>41</sup>, A. Quadt<sup>54</sup>, D.R. Quarrie<sup>14</sup>, W.B. Quayle<sup>172</sup>, F. Quinonez<sup>31a</sup>, M. Raas<sup>104</sup>,  
 V. Radescu<sup>41</sup>, B. Radics<sup>20</sup>, P. Radloff<sup>114</sup>, T. Rador<sup>18a</sup>, F. Ragusa<sup>89a,89b</sup>, G. Rahal<sup>177</sup>, A.M. Rahimi<sup>109</sup>,  
 D. Rahm<sup>24</sup>, S. Rajagopalan<sup>24</sup>, M. Rammensee<sup>48</sup>, M. Rammes<sup>141</sup>, A.S. Randle-Conde<sup>39</sup>,  
 K. Randrianarivony<sup>28</sup>, P.N. Ratoff<sup>71</sup>, F. Rauscher<sup>98</sup>, T.C. Rave<sup>48</sup>, M. Raymond<sup>29</sup>, A.L. Read<sup>117</sup>,  
 D.M. Rebuzzi<sup>119a,119b</sup>, A. Redelbach<sup>173</sup>, G. Redlinger<sup>24</sup>, R. Reece<sup>120</sup>, K. Reeves<sup>40</sup>, A. Reichold<sup>105</sup>,  
 E. Reinherz-Aronis<sup>153</sup>, A. Reinsch<sup>114</sup>, I. Reisinger<sup>42</sup>, C. Rembser<sup>29</sup>, Z.L. Ren<sup>151</sup>, A. Renaud<sup>115</sup>,  
 M. Rescigno<sup>132a</sup>, S. Resconi<sup>89a</sup>, B. Resende<sup>136</sup>, P. Reznicek<sup>98</sup>, R. Rezvani<sup>158</sup>, A. Richards<sup>77</sup>, R. Richter<sup>99</sup>,  
 E. Richter-Was<sup>4,aa</sup>, M. Ridel<sup>78</sup>, M. Rijpstra<sup>105</sup>, M. Rijssenbeek<sup>148</sup>, A. Rimoldi<sup>119a,119b</sup>, L. Rinaldi<sup>19a</sup>,  
 R.R. Rios<sup>39</sup>, I. Riu<sup>11</sup>, G. Rivoltella<sup>89a,89b</sup>, F. Rizatdinova<sup>112</sup>, E. Rizvi<sup>75</sup>, S.H. Robertson<sup>85,j</sup>,  
 A. Robichaud-Veronneau<sup>118</sup>, D. Robinson<sup>27</sup>, J.E.M. Robinson<sup>77</sup>, A. Robson<sup>53</sup>, J.G. Rocha de Lima<sup>106</sup>,  
 C. Roda<sup>122a,122b</sup>, D. Roda Dos Santos<sup>29</sup>, D. Rodriguez<sup>162</sup>, A. Roe<sup>54</sup>, S. Roe<sup>29</sup>, O. Røhne<sup>117</sup>, V. Rojo<sup>1</sup>,  
 S. Rolli<sup>161</sup>, A. Romaniouk<sup>96</sup>, M. Romano<sup>19a,19b</sup>, V.M. Romanov<sup>65</sup>, G. Romeo<sup>26</sup>, E. Romero Adam<sup>167</sup>,  
 L. Roos<sup>78</sup>, E. Ros<sup>167</sup>, S. Rosati<sup>132a</sup>, K. Rosbach<sup>49</sup>, A. Rose<sup>149</sup>, M. Rose<sup>76</sup>, G.A. Rosenbaum<sup>158</sup>,  
 E.I. Rosenberg<sup>64</sup>, P.L. Rosendahl<sup>13</sup>, O. Rosenthal<sup>141</sup>, L. Rossetlet<sup>49</sup>, V. Rossetti<sup>11</sup>, E. Rossi<sup>132a,132b</sup>,  
 L.P. Rossi<sup>50a</sup>, M. Rotaru<sup>25a</sup>, I. Roth<sup>171</sup>, J. Rothberg<sup>138</sup>, D. Rousseau<sup>115</sup>, C.R. Royon<sup>136</sup>, A. Rozanov<sup>83</sup>,  
 Y. Rozen<sup>152</sup>, X. Ruan<sup>32a,ab</sup>, I. Rubinskiy<sup>41</sup>, B. Ruckert<sup>98</sup>, N. Ruckstuhl<sup>105</sup>, V.I. Rud<sup>97</sup>, C. Rudolph<sup>43</sup>,  
 G. Rudolph<sup>62</sup>, F. Rühr<sup>6</sup>, F. Ruggieri<sup>134a,134b</sup>, A. Ruiz-Martinez<sup>64</sup>, V. Rumiantsev<sup>91,\*</sup>, L. Romyantsev<sup>65</sup>,  
 K. Runge<sup>48</sup>, Z. Rurikova<sup>48</sup>, N.A. Rusakovich<sup>65</sup>, J.P. Rutherford<sup>6</sup>, C. Ruwiedel<sup>14</sup>, P. Ruzicka<sup>125</sup>,  
 Y.F. Ryabov<sup>121</sup>, V. Ryadovikov<sup>128</sup>, P. Ryan<sup>88</sup>, M. Rybar<sup>126</sup>, G. Rybkin<sup>115</sup>, N.C. Ryder<sup>118</sup>, S. Rzaeva<sup>10</sup>,  
 A.F. Saavedra<sup>150</sup>, I. Sadeh<sup>153</sup>, H.F.-W. Sadrozinski<sup>137</sup>, R. Sadykov<sup>65</sup>, F. Safai Tehrani<sup>132a</sup>, H. Sakamoto<sup>155</sup>,  
 G. Salamanna<sup>75</sup>, A. Salamon<sup>133a</sup>, M. Saleem<sup>111</sup>, D. Salihagic<sup>99</sup>, A. Salnikov<sup>143</sup>, J. Salt<sup>167</sup>,  
 B.M. Salvachua Ferrando<sup>5</sup>, D. Salvatore<sup>36a,36b</sup>, F. Salvatore<sup>149</sup>, A. Salvucci<sup>104</sup>, A. Salzburger<sup>29</sup>,  
 D. Sampsonidis<sup>154</sup>, B.H. Samset<sup>117</sup>, A. Sanchez<sup>102a,102b</sup>, V. Sanchez Martinez<sup>167</sup>, H. Sandaker<sup>13</sup>,  
 H.G. Sander<sup>81</sup>, M.P. Sanders<sup>98</sup>, M. Sandhoff<sup>174</sup>, T. Sandoval<sup>27</sup>, C. Sandoval<sup>162</sup>, R. Sandstroem<sup>99</sup>,  
 S. Sandvoss<sup>174</sup>, D.P.C. Sankey<sup>129</sup>, A. Sansoni<sup>47</sup>, C. Santamarina Rios<sup>85</sup>, C. Santoni<sup>33</sup>,  
 R. Santonico<sup>133a,133b</sup>, H. Santos<sup>124a</sup>, J.G. Saraiva<sup>124a</sup>, T. Sarangi<sup>172</sup>, E. Sarkisyan-Grinbaum<sup>7</sup>,  
 F. Sarri<sup>122a,122b</sup>, G. Sartisohn<sup>174</sup>, O. Sasaki<sup>66</sup>, T. Sasaki<sup>66</sup>, N. Sasao<sup>68</sup>, I. Satsounkevitch<sup>90</sup>, G. Sauvage<sup>4</sup>,  
 E. Sauvan<sup>4</sup>, J.B. Sauvan<sup>115</sup>, P. Savard<sup>158,d</sup>, V. Savinov<sup>123</sup>, D.O. Savu<sup>29</sup>, L. Sawyer<sup>24,l</sup>, D.H. Saxon<sup>53</sup>,  
 J. Saxon<sup>120</sup>, L.P. SAYS<sup>33</sup>, C. Sbarra<sup>19a</sup>, A. Sbrizzi<sup>19a,19b</sup>, O. Scallon<sup>93</sup>, D.A. Scannicchio<sup>163</sup>, M. Scarcella<sup>150</sup>,  
 J. Schaarschmidt<sup>115</sup>, P. Schacht<sup>99</sup>, D. Schaefer<sup>120</sup>, U. Schäfer<sup>81</sup>, S. Schaepe<sup>20</sup>, S. Schaezel<sup>58b</sup>,  
 A.C. Schaffer<sup>115</sup>, D. Schaile<sup>98</sup>, R.D. Schamberger<sup>148</sup>, A.G. Schamov<sup>107</sup>, V. Scharf<sup>58a</sup>, V.A. Schegelsky<sup>121</sup>,  
 D. Scheirich<sup>87</sup>, M. Schernau<sup>163</sup>, M.I. Scherzer<sup>34</sup>, C. Schiavi<sup>50a,50b</sup>, J. Schieck<sup>98</sup>, M. Schioppa<sup>36a,36b</sup>,  
 S. Schlenker<sup>29</sup>, J.L. Schlereth<sup>5</sup>, E. Schmidt<sup>48</sup>, K. Schmieden<sup>20</sup>, C. Schmitt<sup>81</sup>, S. Schmitt<sup>58b</sup>, M. Schmitz<sup>20</sup>,  
 A. Schöning<sup>58b</sup>, M. Schott<sup>29</sup>, D. Schouten<sup>159a</sup>, J. Schovancova<sup>125</sup>, M. Schram<sup>85</sup>, C. Schroeder<sup>81</sup>,  
 N. Schroer<sup>58c</sup>, G. Schuler<sup>29</sup>, M.J. Schultens<sup>20</sup>, J. Schultes<sup>174</sup>, H.-C. Schultz-Coulon<sup>58a</sup>, H. Schulz<sup>15</sup>,  
 J.W. Schumacher<sup>20</sup>, M. Schumacher<sup>48</sup>, B.A. Schumm<sup>137</sup>, Ph. Schune<sup>136</sup>, A. Schwartzman<sup>143</sup>,  
 Ph. Schwemling<sup>78</sup>, R. Schwienhorst<sup>88</sup>, R. Schwierz<sup>43</sup>, J. Schwindling<sup>136</sup>, T. Schwindt<sup>20</sup>, M. Schwoerer<sup>4</sup>,  
 G. Sciolla<sup>22</sup>, W.G. Scott<sup>129</sup>, J. Searcy<sup>114</sup>, G. Sedov<sup>41</sup>, E. Sedykh<sup>121</sup>, E. Segura<sup>11</sup>, S.C. Seidel<sup>103</sup>,  
 A. Seiden<sup>137</sup>, F. Seifert<sup>43</sup>, J.M. Seixas<sup>23a</sup>, G. Sekhniaidze<sup>102a</sup>, S.J. Sekula<sup>39</sup>, K.E. Selbach<sup>45</sup>,  
 D.M. Seliverstov<sup>121</sup>, B. Sellden<sup>146a</sup>, G. Sellers<sup>73</sup>, M. Seman<sup>144b</sup>, N. Semprini-Cesari<sup>19a,19b</sup>, C. Serfon<sup>98</sup>,  
 L. Serin<sup>115</sup>, L. Serkin<sup>54</sup>, R. Seuster<sup>99</sup>, H. Severini<sup>111</sup>, M.E. Sevir<sup>86</sup>, A. Sfyrla<sup>29</sup>, E. Shabalina<sup>54,ac</sup>,  
 M. Shamim<sup>114</sup>, L.Y. Shan<sup>32a</sup>, J.T. Shank<sup>21</sup>, Q.T. Shao<sup>86</sup>, M. Shapiro<sup>14</sup>, P.B. Shatalov<sup>95</sup>, L. Shaver<sup>6</sup>,  
 K. Shaw<sup>164a,164c</sup>, D. Sherman<sup>175</sup>, P. Sherwood<sup>77</sup>, A. Shibata<sup>108</sup>, H. Shichi<sup>101</sup>, S. Shimizu<sup>29</sup>,

M. Shimojima<sup>100</sup>, T. Shin<sup>56</sup>, M. Shiyakova<sup>65</sup>, A. Shmeleva<sup>94</sup>, M.J. Shochet<sup>30</sup>, D. Short<sup>118</sup>, S. Shrestha<sup>64</sup>,  
 E. Shulga<sup>96</sup>, M.A. Shupe<sup>6</sup>, P. Sicho<sup>125</sup>, A. Sidoti<sup>132a</sup>, F. Siegert<sup>48</sup>, Dj. Sijacki<sup>12a</sup>, O. Silbert<sup>171</sup>, J. Silva<sup>124a</sup>,  
 Y. Silver<sup>153</sup>, D. Silverstein<sup>143</sup>, S.B. Silverstein<sup>146a</sup>, V. Simak<sup>127</sup>, O. Simard<sup>136</sup>, Lj. Simic<sup>12a</sup>, S. Simion<sup>115</sup>,  
 B. Simmons<sup>77</sup>, R. Simoniello<sup>89a,89b</sup>, M. Simonyan<sup>35</sup>, P. Sinervo<sup>158</sup>, N.B. Sinev<sup>114</sup>, V. Sipica<sup>141</sup>,  
 G. Siragusa<sup>173</sup>, A. Sircar<sup>24</sup>, A.N. Sisakyan<sup>65</sup>, S.Yu. Sivoklov<sup>97</sup>, J. Sjölin<sup>146a,146b</sup>, T.B. Sjørnsen<sup>13</sup>,  
 L.A. Skinnari<sup>14</sup>, H.P. Skottowe<sup>57</sup>, K. Skovpen<sup>107</sup>, P. Skubic<sup>111</sup>, N. Skvorodnev<sup>22</sup>, M. Slater<sup>17</sup>,  
 T. Slavicek<sup>127</sup>, K. Sliwa<sup>161</sup>, J. Sloper<sup>29</sup>, V. Smakhtin<sup>171</sup>, B.H. Smart<sup>45</sup>, S.Yu. Smirnov<sup>96</sup>, Y. Smirnov<sup>96</sup>,  
 L.N. Smirnova<sup>97</sup>, O. Smirnova<sup>79</sup>, B.C. Smith<sup>57</sup>, D. Smith<sup>143</sup>, K.M. Smith<sup>53</sup>, M. Smizanska<sup>71</sup>,  
 K. Smolek<sup>127</sup>, A.A. Snesarev<sup>94</sup>, S.W. Snow<sup>82</sup>, J. Snow<sup>111</sup>, J. Snuverink<sup>105</sup>, S. Snyder<sup>24</sup>, M. Soares<sup>124a</sup>,  
 R. Sobie<sup>169,j</sup>, J. Sodomka<sup>127</sup>, A. Soffer<sup>153</sup>, C.A. Solans<sup>167</sup>, M. Solar<sup>127</sup>, J. Solc<sup>127</sup>, E. Soldatov<sup>96</sup>,  
 U. Soldevila<sup>167</sup>, E. Solfaroli Camillocci<sup>132a,132b</sup>, A.A. Solodkov<sup>128</sup>, O.V. Solovyanov<sup>128</sup>, N. Soni<sup>2</sup>,  
 V. Sopko<sup>127</sup>, B. Sopko<sup>127</sup>, M. Sosebee<sup>7</sup>, R. Soualah<sup>164a,164c</sup>, A. Soukharev<sup>107</sup>, S. Spagnolo<sup>72a,72b</sup>,  
 F. Spanò<sup>76</sup>, R. Spighi<sup>19a</sup>, G. Spigo<sup>29</sup>, F. Spila<sup>132a,132b</sup>, R. Spiwoks<sup>29</sup>, M. Spousta<sup>126</sup>, T. Spreitzer<sup>158</sup>,  
 B. Spurlock<sup>7</sup>, R.D. St. Denis<sup>53</sup>, J. Stahlman<sup>120</sup>, R. Stamen<sup>58a</sup>, E. Stanecka<sup>38</sup>, R.W. Stanek<sup>5</sup>,  
 C. Stanescu<sup>134a</sup>, M. Stanescu-Bellu<sup>41</sup>, S. Stapnes<sup>117</sup>, E.A. Starchenko<sup>128</sup>, J. Stark<sup>55</sup>, P. Staroba<sup>125</sup>,  
 P. Starovoitov<sup>91</sup>, A. Staude<sup>98</sup>, P. Stavina<sup>144a</sup>, G. Steele<sup>53</sup>, P. Steinbach<sup>43</sup>, P. Steinberg<sup>24</sup>, I. Stekl<sup>127</sup>,  
 B. Stelzer<sup>142</sup>, H.J. Stelzer<sup>88</sup>, O. Stelzer-Chilton<sup>159a</sup>, H. Stenzel<sup>52</sup>, S. Stern<sup>99</sup>, K. Stevenson<sup>75</sup>,  
 G.A. Stewart<sup>29</sup>, J.A. Stillings<sup>20</sup>, M.C. Stockton<sup>85</sup>, K. Stoerig<sup>48</sup>, G. Stoicea<sup>25a</sup>, S. Stonjek<sup>99</sup>, P. Strachota<sup>126</sup>,  
 A.R. Stradling<sup>7</sup>, A. Straessner<sup>43</sup>, J. Strandberg<sup>147</sup>, S. Strandberg<sup>146a,146b</sup>, A. Strandlie<sup>117</sup>, M. Strang<sup>109</sup>,  
 E. Strauss<sup>143</sup>, M. Strauss<sup>111</sup>, P. Strizenec<sup>144b</sup>, R. Ströhmer<sup>173</sup>, D.M. Strom<sup>114</sup>, J.A. Strong<sup>76,\*</sup>,  
 R. Stroynowski<sup>39</sup>, J. Strube<sup>129</sup>, B. Stugu<sup>13</sup>, I. Stumer<sup>24,\*</sup>, J. Stupak<sup>148</sup>, P. Sturm<sup>174</sup>, N.A. Styles<sup>41</sup>,  
 D.A. Soh<sup>151,t</sup>, D. Su<sup>143</sup>, H.S. Subramania<sup>2</sup>, A. Succurro<sup>11</sup>, Y. Sugaya<sup>116</sup>, T. Sugimoto<sup>101</sup>, C. Suhr<sup>106</sup>,  
 K. Suita<sup>67</sup>, M. Suk<sup>126</sup>, V.V. Sulin<sup>94</sup>, S. Sultansoy<sup>3d</sup>, T. Sumida<sup>68</sup>, X. Sun<sup>55</sup>, J.E. Sundermann<sup>48</sup>,  
 K. Suruliz<sup>139</sup>, S. Sushkov<sup>11</sup>, G. Susinno<sup>36a,36b</sup>, M.R. Sutton<sup>149</sup>, Y. Suzuki<sup>66</sup>, Y. Suzuki<sup>67</sup>, M. Svatos<sup>125</sup>,  
 Yu.M. Sviridov<sup>128</sup>, S. Swedish<sup>168</sup>, I. Sykora<sup>144a</sup>, T. Sykora<sup>126</sup>, B. Szeless<sup>29</sup>, J. Sánchez<sup>167</sup>, D. Ta<sup>105</sup>,  
 K. Tackmann<sup>41</sup>, A. Taffard<sup>163</sup>, R. Tafirout<sup>159a</sup>, N. Taiblum<sup>153</sup>, Y. Takahashi<sup>101</sup>, H. Takai<sup>24</sup>,  
 R. Takashima<sup>69</sup>, H. Takeda<sup>67</sup>, T. Takeshita<sup>140</sup>, Y. Takubo<sup>66</sup>, M. Talby<sup>83</sup>, A. Talyshev<sup>107,f</sup>, M.C. Tamsett<sup>24</sup>,  
 J. Tanaka<sup>155</sup>, R. Tanaka<sup>115</sup>, S. Tanaka<sup>131</sup>, S. Tanaka<sup>66</sup>, Y. Tanaka<sup>100</sup>, A.J. Tanasijczuk<sup>142</sup>, K. Tani<sup>67</sup>,  
 N. Tannoury<sup>83</sup>, G.P. Tappern<sup>29</sup>, S. Tapprogge<sup>81</sup>, D. Tardif<sup>158</sup>, S. Tarem<sup>152</sup>, F. Tarrade<sup>28</sup>, G.F. Tartarelli<sup>89a</sup>,  
 P. Tas<sup>126</sup>, M. Tasevsky<sup>125</sup>, E. Tassi<sup>36a,36b</sup>, M. Tatarkhanov<sup>14</sup>, Y. Tayalati<sup>135d</sup>, C. Taylor<sup>77</sup>, F.E. Taylor<sup>92</sup>,  
 G.N. Taylor<sup>86</sup>, W. Taylor<sup>159b</sup>, M. Teinturier<sup>115</sup>, M. Teixeira Dias Castanheira<sup>75</sup>, P. Teixeira-Dias<sup>76</sup>,  
 K.K. Temming<sup>48</sup>, H. Ten Kate<sup>29</sup>, P.K. Teng<sup>151</sup>, S. Terada<sup>66</sup>, K. Terashi<sup>155</sup>, J. Terron<sup>80</sup>, M. Testa<sup>47</sup>,  
 R.J. Teuscher<sup>158,j</sup>, J. Thadome<sup>174</sup>, J. Therhaag<sup>20</sup>, T. Theveneaux-Pelzer<sup>78</sup>, M. Thioye<sup>175</sup>, S. Thoma<sup>48</sup>,  
 J.P. Thomas<sup>17</sup>, E.N. Thompson<sup>34</sup>, P.D. Thompson<sup>17</sup>, P.D. Thompson<sup>158</sup>, A.S. Thompson<sup>53</sup>,  
 L.A. Thomsen<sup>35</sup>, E. Thomson<sup>120</sup>, M. Thomson<sup>27</sup>, R.P. Thun<sup>87</sup>, F. Tian<sup>34</sup>, M.J. Tibbetts<sup>14</sup>, T. Tic<sup>125</sup>,  
 V.O. Tikhomirov<sup>94</sup>, Y.A. Tikhonov<sup>107,f</sup>, S. Timoshenko<sup>96</sup>, P. Tipton<sup>175</sup>, F.J. Tique Aires Viegas<sup>29</sup>,  
 S. Tisserant<sup>83</sup>, J. Tobias<sup>48</sup>, B. Toczek<sup>37</sup>, T. Todorov<sup>4</sup>, S. Todorova-Nova<sup>161</sup>, B. Toggerson<sup>163</sup>, J. Tojo<sup>66</sup>,  
 S. Tokár<sup>144a</sup>, K. Tokunaga<sup>67</sup>, K. Tokushuku<sup>66</sup>, K. Tollefson<sup>88</sup>, M. Tomoto<sup>101</sup>, L. Tompkins<sup>30</sup>, K. Toms<sup>103</sup>,  
 G. Tong<sup>32a</sup>, A. Tonoyan<sup>13</sup>, C. Topfel<sup>16</sup>, N.D. Topilin<sup>65</sup>, I. Torchiani<sup>29</sup>, E. Torrence<sup>114</sup>, H. Torres<sup>78</sup>,  
 E. Torrò Pastor<sup>167</sup>, J. Toth<sup>83,y</sup>, F. Touchard<sup>83</sup>, D.R. Tovey<sup>139</sup>, T. Trefzger<sup>173</sup>, L. Tremblet<sup>29</sup>, A. Tricoli<sup>29</sup>,  
 I.M. Trigger<sup>159a</sup>, S. Trincaz-Duvoid<sup>78</sup>, T.N. Trinh<sup>78</sup>, M.F. Tripania<sup>70</sup>, W. Trischuk<sup>158</sup>, A. Trivedi<sup>24,x</sup>,  
 B. Trocmé<sup>55</sup>, C. Troncon<sup>89a</sup>, M. Trottier-McDonald<sup>142</sup>, M. Trzebinski<sup>38</sup>, A. Trzupek<sup>38</sup>, C. Tsarouchas<sup>29</sup>,  
 J.C.-L. Tseng<sup>118</sup>, M. Tsiakiris<sup>105</sup>, P.V. Tsiarehka<sup>90</sup>, D. Tsionou<sup>4,ad</sup>, G. Tsipolitis<sup>9</sup>, V. Tsiskaridze<sup>48</sup>,  
 E.G. Tskhadadze<sup>51a</sup>, I.I. Tsukerman<sup>95</sup>, V. Tsulaia<sup>14</sup>, J.-W. Tsung<sup>20</sup>, S. Tsuno<sup>66</sup>, D. Tsybychev<sup>148</sup>,  
 A. Tua<sup>139</sup>, A. Tudorache<sup>25a</sup>, V. Tudorache<sup>25a</sup>, J.M. Tuggle<sup>30</sup>, M. Turala<sup>38</sup>, D. Turecek<sup>127</sup>, I. Turk Cakir<sup>3e</sup>,  
 E. Turlay<sup>105</sup>, R. Turra<sup>89a,89b</sup>, P.M. Tuts<sup>34</sup>, A. Tykhonov<sup>74</sup>, M. Tylmad<sup>146a,146b</sup>, M. Tyndel<sup>129</sup>,  
 G. Tzanakos<sup>8</sup>, K. Uchida<sup>20</sup>, I. Ueda<sup>155</sup>, R. Ueno<sup>28</sup>, M. Uglund<sup>13</sup>, M. Uhlenbrock<sup>20</sup>, M. Uhrmacher<sup>54</sup>,  
 F. Ukegawa<sup>160</sup>, G. Unal<sup>29</sup>, D.G. Underwood<sup>5</sup>, A. Undrus<sup>24</sup>, G. Unel<sup>163</sup>, Y. Unno<sup>66</sup>, D. Urbaniec<sup>34</sup>,  
 G. Usai<sup>7</sup>, M. Uslenghi<sup>119a,119b</sup>, L. Vacavant<sup>83</sup>, V. Vacek<sup>127</sup>, B. Vachon<sup>85</sup>, S. Vahsen<sup>14</sup>, J. Valenta<sup>125</sup>,  
 P. Valente<sup>132a</sup>, S. Valentini<sup>19a,19b</sup>, S. Valkar<sup>126</sup>, E. Valladolid Gallego<sup>167</sup>, S. Vallecorsa<sup>152</sup>,  
 J.A. Valls Ferrer<sup>167</sup>, H. van der Graaf<sup>105</sup>, E. van der Kraaij<sup>105</sup>, R. Van Der Leeuw<sup>105</sup>, E. van der Poel<sup>105</sup>,  
 D. van der Ster<sup>29</sup>, N. van Eldik<sup>84</sup>, P. van Gemmeren<sup>5</sup>, Z. van Kesteren<sup>105</sup>, I. van Vulpen<sup>105</sup>,

M. Vanadia<sup>99</sup>, W. Vandelli<sup>29</sup>, G. Vandoni<sup>29</sup>, A. Vaniachine<sup>5</sup>, P. Vankov<sup>41</sup>, F. Vannucci<sup>78</sup>,  
 F. Varela Rodriguez<sup>29</sup>, R. Vari<sup>132a</sup>, E.W. Varnes<sup>6</sup>, T. Varol<sup>84</sup>, D. Varouchas<sup>14</sup>, A. Vartapetian<sup>7</sup>,  
 K.E. Varvell<sup>150</sup>, V.I. Vassilakopoulos<sup>56</sup>, F. Vazeille<sup>33</sup>, T. Vazquez Schroeder<sup>54</sup>, G. Vegni<sup>89a,89b</sup>,  
 J.J. Veillet<sup>115</sup>, C. Vellidis<sup>8</sup>, F. Veloso<sup>124a</sup>, R. Veness<sup>29</sup>, S. Veneziano<sup>132a</sup>, A. Ventura<sup>72a,72b</sup>, D. Ventura<sup>138</sup>,  
 M. Venturi<sup>48</sup>, N. Venturi<sup>158</sup>, V. Vercesi<sup>119a</sup>, M. Verducci<sup>138</sup>, W. Verkerke<sup>105</sup>, J.C. Vermeulen<sup>105</sup>,  
 A. Vest<sup>43</sup>, M.C. Vetterli<sup>142,d</sup>, I. Vichou<sup>165</sup>, T. Vickey<sup>145b,ae</sup>, O.E. Vickey Boeriu<sup>145b</sup>, G.H.A. Viehhauser<sup>118</sup>,  
 S. Viel<sup>168</sup>, M. Villa<sup>19a,19b</sup>, M. Villaplana Perez<sup>167</sup>, E. Vilucchi<sup>47</sup>, M.G. Vincter<sup>28</sup>, E. Vinek<sup>29</sup>,  
 V.B. Vinogradov<sup>65</sup>, M. Virchaux<sup>136,\*</sup>, J. Virzi<sup>14</sup>, O. Vitells<sup>171</sup>, M. Viti<sup>41</sup>, I. Vivarelli<sup>48</sup>, F. Vives Vaque<sup>2</sup>,  
 S. Vlachos<sup>9</sup>, D. Vladoiu<sup>98</sup>, M. Vlasak<sup>127</sup>, N. Vlasov<sup>20</sup>, A. Vogel<sup>20</sup>, P. Vokac<sup>127</sup>, G. Volpi<sup>47</sup>, M. Volpi<sup>86</sup>,  
 G. Volpini<sup>89a</sup>, H. von der Schmitt<sup>99</sup>, J. von Loeben<sup>99</sup>, H. von Radziewski<sup>48</sup>, E. von Toerne<sup>20</sup>,  
 V. Vorobel<sup>126</sup>, A.P. Vorobiev<sup>128</sup>, V. Vorwerk<sup>11</sup>, M. Vos<sup>167</sup>, R. Voss<sup>29</sup>, T.T. Voss<sup>174</sup>, J.H. Vosseveld<sup>73</sup>,  
 N. Vranjes<sup>136</sup>, M. Vranjes Milosavljevic<sup>105</sup>, V. Vrba<sup>125</sup>, M. Vreeswijk<sup>105</sup>, T. Vu Anh<sup>48</sup>, R. Vuillermet<sup>29</sup>,  
 I. Vukotic<sup>115</sup>, W. Wagner<sup>174</sup>, P. Wagner<sup>120</sup>, H. Wahlen<sup>174</sup>, J. Wakabayashi<sup>101</sup>, S. Walch<sup>87</sup>, J. Walder<sup>71</sup>,  
 R. Walker<sup>98</sup>, W. Walkowiak<sup>141</sup>, R. Wall<sup>175</sup>, P. Waller<sup>73</sup>, C. Wang<sup>44</sup>, H. Wang<sup>172</sup>, H. Wang<sup>32b,af</sup>,  
 J. Wang<sup>151</sup>, J. Wang<sup>55</sup>, J.C. Wang<sup>138</sup>, R. Wang<sup>103</sup>, S.M. Wang<sup>151</sup>, A. Warburton<sup>85</sup>, C.P. Ward<sup>27</sup>,  
 M. Warsinsky<sup>48</sup>, C. Wasicki<sup>41</sup>, P.M. Watkins<sup>17</sup>, A.T. Watson<sup>17</sup>, I.J. Watson<sup>150</sup>, M.F. Watson<sup>17</sup>,  
 G. Watts<sup>138</sup>, S. Watts<sup>82</sup>, A.T. Waugh<sup>150</sup>, B.M. Waugh<sup>77</sup>, M. Weber<sup>129</sup>, M.S. Weber<sup>16</sup>, P. Weber<sup>54</sup>,  
 A.R. Weidberg<sup>118</sup>, P. Weigell<sup>99</sup>, J. Weingarten<sup>54</sup>, C. Weiser<sup>48</sup>, H. Wellenstein<sup>22</sup>, P.S. Wells<sup>29</sup>,  
 T. Wenaus<sup>24</sup>, D. Wendland<sup>15</sup>, S. Wendler<sup>123</sup>, Z. Weng<sup>151,t</sup>, T. Wengler<sup>29</sup>, S. Wenig<sup>29</sup>, N. Wermes<sup>20</sup>,  
 M. Werner<sup>48</sup>, P. Werner<sup>29</sup>, M. Werth<sup>163</sup>, M. Wessels<sup>58a</sup>, J. Wetter<sup>161</sup>, C. Weydert<sup>55</sup>, K. Whalen<sup>28</sup>,  
 S.J. Wheeler-Ellis<sup>163</sup>, S.P. Whitaker<sup>21</sup>, A. White<sup>7</sup>, M.J. White<sup>86</sup>, S.R. Whitehead<sup>118</sup>, D. Whiteson<sup>163</sup>,  
 D. Whittington<sup>61</sup>, F. Wicek<sup>115</sup>, D. Wicke<sup>174</sup>, F.J. Wickens<sup>129</sup>, W. Wiedenmann<sup>172</sup>, M. Wielers<sup>129</sup>,  
 P. Wienemann<sup>20</sup>, C. Wiglesworth<sup>75</sup>, L.A.M. Wiik<sup>48</sup>, P.A. Wijeratne<sup>77</sup>, A. Wildauer<sup>167</sup>, M.A. Wildt<sup>41,p</sup>,  
 I. Wilhelm<sup>126</sup>, H.G. Wilkens<sup>29</sup>, J.Z. Will<sup>98</sup>, E. Williams<sup>34</sup>, H.H. Williams<sup>120</sup>, W. Willis<sup>34</sup>, S. Willocq<sup>84</sup>,  
 J.A. Wilson<sup>17</sup>, M.G. Wilson<sup>143</sup>, A. Wilson<sup>87</sup>, I. Wingerter-Seez<sup>4</sup>, S. Winkelmann<sup>48</sup>, F. Winklmeier<sup>29</sup>,  
 M. Wittgen<sup>143</sup>, M.W. Wolter<sup>38</sup>, H. Wolters<sup>124a,h</sup>, W.C. Wong<sup>40</sup>, G. Wooden<sup>87</sup>, B.K. Wosiek<sup>38</sup>,  
 J. Wotschack<sup>29</sup>, M.J. Woudstra<sup>84</sup>, K.W. Wozniak<sup>38</sup>, K. Wraight<sup>53</sup>, C. Wright<sup>53</sup>, M. Wright<sup>53</sup>, B. Wrona<sup>73</sup>,  
 S.L. Wu<sup>172</sup>, X. Wu<sup>49</sup>, Y. Wu<sup>32b,ag</sup>, E. Wulf<sup>34</sup>, R. Wunstorf<sup>42</sup>, B.M. Wynne<sup>45</sup>, S. Xella<sup>35</sup>, M. Xiao<sup>136</sup>,  
 S. Xie<sup>48</sup>, Y. Xie<sup>32a</sup>, C. Xu<sup>32b,ah</sup>, D. Xu<sup>139</sup>, G. Xu<sup>32a</sup>, B. Yabsley<sup>150</sup>, S. Yacoob<sup>145b</sup>, M. Yamada<sup>66</sup>,  
 H. Yamaguchi<sup>155</sup>, A. Yamamoto<sup>66</sup>, K. Yamamoto<sup>64</sup>, S. Yamamoto<sup>155</sup>, T. Yamamura<sup>155</sup>, T. Yamanaka<sup>155</sup>,  
 J. Yamaoka<sup>44</sup>, T. Yamazaki<sup>155</sup>, Y. Yamazaki<sup>67</sup>, Z. Yan<sup>21</sup>, H. Yang<sup>87</sup>, U.K. Yang<sup>82</sup>, Y. Yang<sup>61</sup>, Y. Yang<sup>32a</sup>,  
 Z. Yang<sup>146a,146b</sup>, S. Yanush<sup>91</sup>, Y. Yao<sup>14</sup>, Y. Yasu<sup>66</sup>, G.V. Ybeles Smit<sup>130</sup>, J. Ye<sup>39</sup>, S. Ye<sup>24</sup>, M. Yilmaz<sup>3c</sup>,  
 R. Yoosoofmiya<sup>123</sup>, K. Yorita<sup>170</sup>, R. Yoshida<sup>5</sup>, C. Young<sup>143</sup>, S. Youssef<sup>21</sup>, D. Yu<sup>24</sup>, J. Yu<sup>7</sup>, J. Yu<sup>112</sup>,  
 L. Yuan<sup>32a,ai</sup>, A. Yurkewicz<sup>106</sup>, B. Zabinski<sup>38</sup>, V.G. Zaets<sup>128</sup>, R. Zaidan<sup>63</sup>, A.M. Zaitsev<sup>128</sup>, Z. Zajacova<sup>29</sup>,  
 L. Zanello<sup>132a,132b</sup>, A. Zaytsev<sup>107</sup>, C. Zeitnitz<sup>174</sup>, M. Zeller<sup>175</sup>, M. Zeman<sup>125</sup>, A. Zemla<sup>38</sup>, C. Zender<sup>20</sup>,  
 O. Zenin<sup>128</sup>, T. Ženiš<sup>144a</sup>, Z. Zenonos<sup>122a,122b</sup>, S. Zenz<sup>14</sup>, D. Zerwas<sup>115</sup>, G. Zevi della Porta<sup>57</sup>, Z. Zhan<sup>32d</sup>,  
 D. Zhang<sup>32b,af</sup>, H. Zhang<sup>88</sup>, J. Zhang<sup>5</sup>, X. Zhang<sup>32d</sup>, Z. Zhang<sup>115</sup>, L. Zhao<sup>108</sup>, T. Zhao<sup>138</sup>, Z. Zhao<sup>32b</sup>,  
 A. Zhemchugov<sup>65</sup>, S. Zheng<sup>32a</sup>, J. Zhong<sup>118</sup>, B. Zhou<sup>87</sup>, N. Zhou<sup>163</sup>, Y. Zhou<sup>151</sup>, C.G. Zhu<sup>32d</sup>, H. Zhu<sup>41</sup>,  
 J. Zhu<sup>87</sup>, Y. Zhu<sup>32b</sup>, X. Zhuang<sup>98</sup>, V. Zhuravlov<sup>99</sup>, D. Zieminska<sup>61</sup>, R. Zimmermann<sup>20</sup>, S. Zimmermann<sup>20</sup>,  
 S. Zimmermann<sup>48</sup>, M. Ziolkowski<sup>141</sup>, R. Zitoun<sup>4</sup>, L. Živković<sup>34</sup>, V.V. Zmouchko<sup>128,\*</sup>, G. Zobernig<sup>172</sup>,  
 A. Zoccoli<sup>19a,19b</sup>, A. Zsenei<sup>29</sup>, M. zur Nedden<sup>15</sup>, V. Zutshi<sup>106</sup>, L. Zwalinski<sup>29</sup>

<sup>1</sup> University at Albany, Albany, NY, United States

<sup>2</sup> Department of Physics, University of Alberta, Edmonton, AB, Canada

<sup>3</sup> (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

<sup>4</sup> LAPP, CNRS/IN2P3 and Université de Savoie, Annecy-le-Vieux, France

<sup>5</sup> High Energy Physics Division, Argonne National Laboratory, Argonne, IL, United States

<sup>6</sup> Department of Physics, University of Arizona, Tucson, AZ, United States

<sup>7</sup> Department of Physics, The University of Texas at Arlington, Arlington, TX, United States

<sup>8</sup> Physics Department, University of Athens, Athens, Greece

<sup>9</sup> Physics Department, National Technical University of Athens, Zografou, Greece

<sup>10</sup> Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan

<sup>11</sup> Institut de Física d'Altes Energies and Departament de Física de la Universitat Autònoma de Barcelona and ICREA, Barcelona, Spain

<sup>12</sup> (a) Institute of Physics, University of Belgrade, Belgrade; (b) Vinca Institute of Nuclear Sciences, Belgrade, Serbia

<sup>13</sup> Department for Physics and Technology, University of Bergen, Bergen, Norway

<sup>14</sup> Physics Division, Lawrence Berkeley National Laboratory and University of California, Berkeley, CA, United States

<sup>15</sup> Department of Physics, Humboldt University, Berlin, Germany

- <sup>16</sup> Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland
- <sup>17</sup> School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom
- <sup>18</sup> <sup>(a)</sup> Department of Physics, Bogazici University, Istanbul; <sup>(b)</sup> Division of Physics, Dogus University, Istanbul; <sup>(c)</sup> Department of Physics Engineering, Gaziantep University, Gaziantep;
- <sup>(d)</sup> Department of Physics, Istanbul Technical University, Istanbul, Turkey
- <sup>19</sup> <sup>(a)</sup> INFN Sezione di Bologna; <sup>(b)</sup> Dipartimento di Fisica, Università di Bologna, Bologna, Italy
- <sup>20</sup> Physikalisches Institut, University of Bonn, Bonn, Germany
- <sup>21</sup> Department of Physics, Boston University, Boston, MA, United States
- <sup>22</sup> Department of Physics, Brandeis University, Waltham, MA, United States
- <sup>23</sup> <sup>(a)</sup> Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro; <sup>(b)</sup> Federal University of Juiz de Fora (UFJF), Juiz de Fora; <sup>(c)</sup> Federal University of Sao Joao del Rei (UFSJ), Sao Joao del Rei; <sup>(d)</sup> Instituto de Fisica, Universidade de Sao Paulo, Sao Paulo, Brazil
- <sup>24</sup> Physics Department, Brookhaven National Laboratory, Upton, NY, United States
- <sup>25</sup> <sup>(a)</sup> National Institute of Physics and Nuclear Engineering, Bucharest; <sup>(b)</sup> University Politehnica Bucharest, Bucharest; <sup>(c)</sup> West University in Timisoara, Timisoara, Romania
- <sup>26</sup> Departamento de Fisica, Universidad de Buenos Aires, Buenos Aires, Argentina
- <sup>27</sup> Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom
- <sup>28</sup> Department of Physics, Carleton University, Ottawa, ON, Canada
- <sup>29</sup> CERN, Geneva, Switzerland
- <sup>30</sup> Enrico Fermi Institute, University of Chicago, Chicago, IL, United States
- <sup>31</sup> <sup>(a)</sup> Departamento de Fisica, Pontificia Universidad Católica de Chile, Santiago; <sup>(b)</sup> Departamento de Fisica, Universidad Técnica Federico Santa María, Valparaíso, Chile
- <sup>32</sup> <sup>(a)</sup> Institute of High Energy Physics, Chinese Academy of Sciences, Beijing; <sup>(b)</sup> Department of Modern Physics, University of Science and Technology of China, Anhui; <sup>(c)</sup> Department of Physics, Nanjing University, Jiangsu; <sup>(d)</sup> School of Physics, Shandong University, Shandong, China
- <sup>33</sup> Laboratoire de Physique Corpusculaire, Clermont Université and Université Blaise Pascal and CNRS/IN2P3, Aubiere Cedex, France
- <sup>34</sup> Nevis Laboratory, Columbia University, Irvington, NY, United States
- <sup>35</sup> Niels Bohr Institute, University of Copenhagen, Kobenhavn, Denmark
- <sup>36</sup> <sup>(a)</sup> INFN Gruppo Collegato di Cosenza; <sup>(b)</sup> Dipartimento di Fisica, Università della Calabria, Arcavata di Rende, Italy
- <sup>37</sup> AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland
- <sup>38</sup> The Henryk Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland
- <sup>39</sup> Physics Department, Southern Methodist University, Dallas, TX, United States
- <sup>40</sup> Physics Department, University of Texas at Dallas, Richardson, TX, United States
- <sup>41</sup> DESY, Hamburg and Zeuthen, Germany
- <sup>42</sup> Institut für Experimentelle Physik IV, Technische Universität Dortmund, Dortmund, Germany
- <sup>43</sup> Institut für Kern- und Teilchenphysik, Technical University Dresden, Dresden, Germany
- <sup>44</sup> Department of Physics, Duke University, Durham, NC, United States
- <sup>45</sup> SUPA – School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom
- <sup>46</sup> Fachhochschule Wiener Neustadt, Johannes Gutenbergstrasse 3, 2700 Wiener Neustadt, Austria
- <sup>47</sup> INFN Laboratori Nazionali di Frascati, Frascati, Italy
- <sup>48</sup> Fakultät für Mathematik und Physik, Albert-Ludwigs-Universität, Freiburg i.Br., Germany
- <sup>49</sup> Section de Physique, Université de Genève, Geneva, Switzerland
- <sup>50</sup> <sup>(a)</sup> INFN Sezione di Genova; <sup>(b)</sup> Dipartimento di Fisica, Università di Genova, Genova, Italy
- <sup>51</sup> <sup>(a)</sup> E. Andronikashvili Institute of Physics, Georgian Academy of Sciences, Tbilisi; <sup>(b)</sup> High Energy Physics Institute, Tbilisi State University, Tbilisi, Georgia
- <sup>52</sup> II Physikalisches Institut, Justus-Liebig-Universität Giessen, Giessen, Germany
- <sup>53</sup> SUPA – School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom
- <sup>54</sup> II Physikalisches Institut, Georg-August-Universität, Göttingen, Germany
- <sup>55</sup> Laboratoire de Physique Subatomique et de Cosmologie, Université Joseph Fourier and CNRS/IN2P3 and Institut National Polytechnique de Grenoble, Grenoble, France
- <sup>56</sup> Department of Physics, Hampton University, Hampton, VA, United States
- <sup>57</sup> Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge, MA, United States
- <sup>58</sup> <sup>(a)</sup> Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg; <sup>(b)</sup> Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg;
- <sup>(c)</sup> ZITI Institut für Technische Informatik, Ruprecht-Karls-Universität Heidelberg, Mannheim, Germany
- <sup>59</sup> Faculty of Science, Hiroshima University, Hiroshima, Japan
- <sup>60</sup> Faculty of Applied Information Science, Hiroshima Institute of Technology, Hiroshima, Japan
- <sup>61</sup> Department of Physics, Indiana University, Bloomington, IN, United States
- <sup>62</sup> Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria
- <sup>63</sup> University of Iowa, Iowa City, IA, United States
- <sup>64</sup> Department of Physics and Astronomy, Iowa State University, Ames, IA, United States
- <sup>65</sup> Joint Institute for Nuclear Research, JINR Dubna, Dubna, Russia
- <sup>66</sup> KEK, High Energy Accelerator Research Organization, Tsukuba, Japan
- <sup>67</sup> Graduate School of Science, Kobe University, Kobe, Japan
- <sup>68</sup> Faculty of Science, Kyoto University, Kyoto, Japan
- <sup>69</sup> Kyoto University of Education, Kyoto, Japan
- <sup>70</sup> Instituto de Fisica La Plata, Universidad Nacional de La Plata and CONICET, La Plata, Argentina
- <sup>71</sup> Physics Department, Lancaster University, Lancaster, United Kingdom
- <sup>72</sup> <sup>(a)</sup> INFN Sezione di Lecce; <sup>(b)</sup> Dipartimento di Fisica, Università del Salento, Lecce, Italy
- <sup>73</sup> Oliver Lodge Laboratory, University of Liverpool, Liverpool, United Kingdom
- <sup>74</sup> Department of Physics, Jožef Stefan Institute and University of Ljubljana, Ljubljana, Slovenia
- <sup>75</sup> School of Physics and Astronomy, Queen Mary University of London, London, United Kingdom
- <sup>76</sup> Department of Physics, Royal Holloway University of London, Surrey, United Kingdom
- <sup>77</sup> Department of Physics and Astronomy, University College London, London, United Kingdom
- <sup>78</sup> Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France
- <sup>79</sup> Fysiska Institutionen, Lunds Universitet, Lund, Sweden
- <sup>80</sup> Departamento de Fisica Teorica C-15, Universidad Autonoma de Madrid, Madrid, Spain
- <sup>81</sup> Institut für Physik, Universität Mainz, Mainz, Germany
- <sup>82</sup> School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom
- <sup>83</sup> CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France
- <sup>84</sup> Department of Physics, University of Massachusetts, Amherst, MA, United States
- <sup>85</sup> Department of Physics, McGill University, Montreal, QC, Canada
- <sup>86</sup> School of Physics, University of Melbourne, Victoria, Australia
- <sup>87</sup> Department of Physics, The University of Michigan, Ann Arbor, MI, United States
- <sup>88</sup> Department of Physics and Astronomy, Michigan State University, East Lansing, MI, United States
- <sup>89</sup> <sup>(a)</sup> INFN Sezione di Milano; <sup>(b)</sup> Dipartimento di Fisica, Università di Milano, Milano, Italy
- <sup>90</sup> B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Belarus



- 91 National Scientific and Educational Centre for Particle and High Energy Physics, Minsk, 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 <sup>(a)</sup> INFN Sezione di Napoli; <sup>(b)</sup> 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, SB RAS, 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, RPTM, 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 <sup>(a)</sup> INFN Sezione di Pavia; <sup>(b)</sup> 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 <sup>(a)</sup> INFN Sezione di Pisa; <sup>(b)</sup> Dipartimento di Fisica E. Fermi, Università di Pisa, Pisa, Italy  
 123 Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA, United States  
 124 <sup>(a)</sup> Laboratório de Instrumentação e Física Experimental de Partículas – LIP, Lisboa, Portugal; <sup>(b)</sup> Departamento de Física Teórica 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 <sup>(a)</sup> INFN Sezione di Roma I; <sup>(b)</sup> Dipartimento di Fisica, Università La Sapienza, Roma, Italy  
 133 <sup>(a)</sup> INFN Sezione di Roma Tor Vergata; <sup>(b)</sup> Dipartimento di Fisica, Università di Roma Tor Vergata, Roma, Italy  
 134 <sup>(a)</sup> INFN Sezione di Roma Tre; <sup>(b)</sup> Dipartimento di Fisica, Università Roma Tre, Roma, Italy  
 135 <sup>(a)</sup> Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies – Université Hassan II, Casablanca; <sup>(b)</sup> Centre National de l'Energie des Sciences Techniques Nucleaires, Rabat; <sup>(c)</sup> Faculté des Sciences Semlalia, Université Cadi Ayyad, LPHEA-Marrakech; <sup>(d)</sup> Faculté des Sciences, Université Mohamed Premier and LPTPM, Oujda; <sup>(e)</sup> 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 <sup>(a)</sup> Faculty of Mathematics, Physics & Informatics, Comenius University, Bratislava; <sup>(b)</sup> Department of Subnuclear Physics, Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice, Slovak Republic  
 145 <sup>(a)</sup> Department of Physics, University of Johannesburg, Johannesburg; <sup>(b)</sup> School of Physics, University of the Witwatersrand, Johannesburg, South Africa  
 146 <sup>(a)</sup> Department of Physics, Stockholm University; <sup>(b)</sup> The Oskar Klein Centre, Stockholm, Sweden  
 147 Physics Department, Royal Institute of Technology, Stockholm, Sweden  
 148 Departments of Physics & Astronomy and Chemistry, Stony Brook University, Stony Brook, NY, United States  
 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 <sup>(a)</sup> TRIUMF, Vancouver, BC; <sup>(b)</sup> Department of Physics and Astronomy, York University, Toronto, ON, Canada  
 160 Institute of Pure and Applied Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8571, 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 <sup>(a)</sup> INFN Gruppo Collegato di Udine; <sup>(b)</sup> ICTP, Trieste; <sup>(c)</sup> Dipartimento di Chimica, Fisica e Ambiente, Università di Udine, Udine, Italy  
 165 Department of Physics, University of Illinois, Urbana, IL, United States

- <sup>166</sup> Department of Physics and Astronomy, University of Uppsala, Uppsala, Sweden  
<sup>167</sup> Instituto de Física Corpuscular (IFIC) and Departamento de Física Atómica, Molecular y Nuclear and Departamento de Ingeniería Electrónica and Instituto de Microelectrónica de Barcelona (IMB-CNM), University of Valencia and CSIC, Valencia, Spain  
<sup>168</sup> Department of Physics, University of British Columbia, Vancouver, BC, Canada  
<sup>169</sup> Department of Physics and Astronomy, University of Victoria, Victoria, BC, Canada  
<sup>170</sup> Waseda University, Tokyo, Japan  
<sup>171</sup> Department of Particle Physics, The Weizmann Institute of Science, Rehovot, Israel  
<sup>172</sup> Department of Physics, University of Wisconsin, Madison, WI, United States  
<sup>173</sup> Fakultät für Physik und Astronomie, Julius-Maximilians-Universität, Würzburg, Germany  
<sup>174</sup> Fachbereich C Physik, Bergische Universität Wuppertal, Wuppertal, Germany  
<sup>175</sup> Department of Physics, Yale University, New Haven, CT, United States  
<sup>176</sup> Yerevan Physics Institute, Yerevan, Armenia  
<sup>177</sup> Domaine scientifique de la Doua, Centre de Calcul CNRS/IN2P3, Villeurbanne Cedex, France

- <sup>a</sup> Also at Laboratório de Instrumentação e Física Experimental de Partículas – LIP, Lisboa, Portugal.  
<sup>b</sup> Also at Faculdade de Ciências and CFNUL, Universidade de Lisboa, Lisboa, Portugal.  
<sup>c</sup> Also at Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom.  
<sup>d</sup> Also at TRIUMF, Vancouver, BC, Canada.  
<sup>e</sup> Also at Department of Physics, California State University, Fresno, CA, United States.  
<sup>f</sup> Also at Novosibirsk State University, Novosibirsk, Russia.  
<sup>g</sup> Also at Fermilab, Batavia, IL, United States.  
<sup>h</sup> Also at Department of Physics, University of Coimbra, Coimbra, Portugal.  
<sup>i</sup> Also at Università di Napoli Parthenope, Napoli, Italy.  
<sup>j</sup> Also at Institute of Particle Physics (IPP), Canada.  
<sup>k</sup> Also at Department of Physics, Middle East Technical University, Ankara, Turkey.  
<sup>l</sup> Also at Louisiana Tech University, Ruston, LA, United States.  
<sup>m</sup> Also at Department of Physics and Astronomy, University College London, London, United Kingdom.  
<sup>n</sup> Also at Group of Particle Physics, University of Montreal, Montreal, QC, Canada.  
<sup>o</sup> Also at Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan.  
<sup>p</sup> Also at Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany.  
<sup>q</sup> Also at Manhattan College, New York, NY, United States.  
<sup>r</sup> Also at School of Physics, Shandong University, Shandong, China.  
<sup>s</sup> Also at CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France.  
<sup>t</sup> Also at School of Physics and Engineering, Sun Yat-sen University, Guanzhou, China.  
<sup>u</sup> Also at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan.  
<sup>v</sup> Also at Section de Physique, Université de Genève, Geneva, Switzerland.  
<sup>w</sup> Also at Departamento de Física, Universidade de Minho, Braga, Portugal.  
<sup>x</sup> Also at Department of Physics and Astronomy, University of South Carolina, Columbia, SC, United States.  
<sup>y</sup> Also at Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Budapest, Hungary.  
<sup>z</sup> Also at California Institute of Technology, Pasadena, CA, United States.  
<sup>aa</sup> Also at Institute of Physics, Jagiellonian University, Krakow, Poland.  
<sup>ab</sup> Also at LAL, Univ. Paris-Sud and CNRS/IN2P3, Orsay, France.  
<sup>ac</sup> Also at High Energy Physics Group, Shandong University, Shandong, China.  
<sup>ad</sup> Also at Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom.  
<sup>ae</sup> Also at Department of Physics, Oxford University, Oxford, United Kingdom.  
<sup>af</sup> Also at Institute of Physics, Academia Sinica, Taipei, Taiwan.  
<sup>ag</sup> Also at Department of Physics, The University of Michigan, Ann Arbor, MI, United States.  
<sup>ah</sup> Also at DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l'Univers), CEA Saclay (Commissariat à l'Energie Atomique), Gif-sur-Yvette, France.  
<sup>ai</sup> Also at Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France.  
<sup>\*</sup> Deceased.