EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

FERMILAB-PUB-15-112-CMS

CERN-PH-EP/2015-075
2015/03/27

CMS-HIG-14-042
ATLAS-HIGG-2014-14

arXiv:1503.07589v1 [hep-ex] 26 Mar 2015

Combined Measurement of the Higgs Boson Mass in pp Collisions at $\sqrt{s} = 7$ and 8 TeV with the ATLAS and CMS Experiments

The ATLAS and CMS Collaborations*

Abstract

A measurement of the Higgs boson mass is presented based on the combined data samples of the ATLAS and CMS experiments at the CERN LHC in the $H \to \gamma\gamma$ and $H \to ZZ \to 4\ell$ decay channels. The results are obtained from a simultaneous fit to the reconstructed invariant mass peaks in the two channels and for the two experiments. The measured masses from the individual channels and the two experiments are found to be consistent among themselves. The combined measured mass of the Higgs boson is $m_H = 125.09 \pm 0.21\,(\text{stat.}) \pm 0.11\,(\text{syst.})$ GeV.

Submitted to Physical Review Letters

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*See appendices A and B for lists of collaboration members.

The study of the mechanism of electroweak symmetry breaking is one of the principal goals of the CERN LHC program. In the Standard Model (SM), this symmetry breaking is achieved through the introduction of a complex doublet scalar field, leading to the prediction of the Higgs boson H [1–6], whose mass m_H is, however, not predicted by the theory. In 2012, the ATLAS and CMS Collaborations at the LHC announced the discovery of a particle with Higgs boson-like properties and a mass of about 125 GeV [7–9]. The discovery was based primarily on mass peaks observed in the $\gamma\gamma$ and $ZZ \to \ell^+\ell^-\ell'^+\ell'^-$ (denoted $H \to ZZ \to 4\ell$ for simplicity) decay channels, where one or both of the Z bosons can be off-shell and where ℓ and ℓ' denote an electron or muon. With m_H known, all properties of the SM Higgs boson, such as its production cross section and partial decay widths, can be predicted. Increasingly precise measurements [10–13] have established that all observed properties of the new particle, including its spin, parity, and coupling strengths to SM particles are consistent within the uncertainties with those expected for the SM Higgs boson.

The ATLAS and CMS Collaborations have independently measured m_H using the samples of proton-proton collision data collected in 2011 and 2012, commonly referred to as LHC Run 1. The analyzed samples correspond to approximately 5 fb^{-1} of integrated luminosity at $\sqrt{s} =$ 7 TeV, and 20 fb^{-1} at $\sqrt{s} = 8$ TeV, for each experiment. Combined results in the context of the separate experiments, as well as those in the individual channels, are presented in Refs. [12, 14–16].

This Letter describes a combination of the Run 1 data from the two experiments, leading to improved precision for m_H. Besides its intrinsic importance as a fundamental parameter, improved knowledge of m_H yields more precise predictions for the other Higgs boson properties. Furthermore, the combined mass measurement provides a first step towards combinations of other quantities, such as the couplings. In the SM, m_H is related to the values of the masses of the W boson and top quark through loop-induced effects. Taking into account other measured SM quantities, the comparison of the measurements of the Higgs boson, W boson, and top quark masses can be used to directly test the consistency of the SM [17] and thus to search for evidence of physics beyond the SM.

The combination is performed using only the $H \to \gamma\gamma$ and $H \to ZZ \to 4\ell$ decay channels, because these two channels offer the best mass resolution. Interference between the Higgs boson signal and the continuum background is expected to produce a downward shift of the signal peak relative to the true value of m_H. The overall effect in the $H \to \gamma\gamma$ channel [18–20] is expected to be a few tens of MeV for a Higgs boson with a width near the SM value, which is small compared to the current precision. The effect in the $H \to ZZ \to 4\ell$ channel is expected to be much smaller [21]. The effects of the interference on the mass spectra are neglected in this Letter.

The ATLAS and CMS detectors [22, 23] are designed to precisely reconstruct charged leptons, photons, hadronic jets, and the imbalance of momentum transverse to the direction of the beams. The two detectors are based on different technologies requiring different reconstruction and calibration methods. Consequently they are subject to different sources of systematic uncertainty.

The $H \to \gamma\gamma$ channel is characterized by a narrow resonant signal peak containing several hundred events per experiment above a large falling continuum background. The overall signal-to-background ratio is a few percent. Both experiments divide the $H \to \gamma\gamma$ events into different categories depending on the signal purity and mass resolution, as a means to improve sensitivity. While CMS uses the same analysis procedure for the measurement of the Higgs boson mass and couplings [15], ATLAS implements separate analyses for the couplings [24] and for

the mass [14]; the latter analysis classifies events in a manner that reduces the expected systematic uncertainties in m_H.

The $H \to ZZ \to 4\ell$ channel yields only a few tens of signal events per experiment, but has very little background, resulting in a signal-to-background ratio larger than 1. The events are analyzed separately depending on the flavor of the lepton pairs. To extract m_H, ATLAS employs a two-dimensional (2D) fit to the distribution of the four-lepton mass and a kinematic discriminant introduced to reject the main background, which arises from ZZ continuum production. The CMS procedure is based on a three-dimensional fit, utilizing the four-lepton mass distribution, a kinematic discriminant, and the estimated event-by-event uncertainty in the four-lepton mass. Both analyses are optimized for the mass measurement and neither attempts to distinguish between different Higgs boson production mechanisms.

There are only minor differences in the parameterizations used for the present combination compared to those used for the combination of the two channels by the individual experiments. These differences have almost no effect on the results.

The measurement of m_H, along with its uncertainty, is based on the maximization of profile-likelihood ratios $\Lambda(\boldsymbol{\alpha})$ in the asymptotic regime [25, 26]:

$$\Lambda(\boldsymbol{\alpha}) = \frac{L\big(\boldsymbol{\alpha}\,,\,\hat{\hat{\boldsymbol{\theta}}}(\boldsymbol{\alpha})\big)}{L(\hat{\boldsymbol{\alpha}},\hat{\boldsymbol{\theta}})}, \tag{1}$$

where L represents the likelihood function, $\boldsymbol{\alpha}$ the parameters of interest, and $\boldsymbol{\theta}$ the nuisance parameters. There are three types of nuisance parameters: those corresponding to systematic uncertainties, the fitted parameters of the background models, and any unconstrained signal model parameters not relevant to the particular hypothesis under test. Systematic uncertainties are discussed below. The other two types of nuisance parameters are incorporated into the statistical uncertainty. The $\boldsymbol{\theta}$ terms are profiled, i.e., for each possible value of a parameter of interest (e.g., m_H), all nuisance parameters are refitted to maximize L. The $\hat{\boldsymbol{\alpha}}$ and $\hat{\boldsymbol{\theta}}$ terms denote the unconditional maximum likelihood estimates of the best-fit values for the parameters, while $\hat{\hat{\boldsymbol{\theta}}}(\boldsymbol{\alpha})$ is the conditional maximum likelihood estimate for given parameter values $\boldsymbol{\alpha}$.

The likelihood functions L are constructed using signal and background probability density functions (PDFs) that depend on the discriminating variables: for the $H \to \gamma\gamma$ channel, the diphoton mass and, for the $H \to ZZ \to 4\ell$ channel, the four-lepton mass (for CMS, also its uncertainty) and the kinematic discriminant. The signal PDFs are derived from samples of Monte Carlo (MC) simulated events. For the $H \to ZZ \to 4\ell$ channel, the background PDFs are determined using a combination of simulation and data control regions. For the $H \to \gamma\gamma$ channel, the background PDFs are obtained directly from the fit to the data. The profile-likelihood fits to the data are performed as a function of m_H and the signal-strength scale factors defined below. The fitting framework is implemented independently by ATLAS and CMS, using the ROOFIT [27], ROOSTATS [28], and HISTFACTORY [29] data modeling and handling packages.

Despite the current agreement between the measured Higgs boson properties and the SM predictions, it is pertinent to perform a mass measurement that is as independent as possible of SM assumptions. For this purpose, three signal-strength scale factors are introduced and profiled in the fit, thus reducing the dependence of the results on assumptions about the Higgs boson couplings and about the variation of the production cross section times branching fraction with the mass. The signal strengths are defined as $\mu = (\sigma_{\text{expt}} \times \text{BF}_{\text{expt}})/(\sigma_{\text{SM}} \times \text{BF}_{\text{SM}})$, representing the ratio of the cross section times branching fraction in the experiment to the correspond-

ing SM expectation for the different production and decay modes. Two factors, $\mu^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H}$ and $\mu^{\gamma\gamma}_{\mathrm{VBF}+VH}$, are used to scale the signal strength in the $H \to \gamma\gamma$ channel. The production processes involving Higgs boson couplings to fermions, namely gluon fusion (ggF) and associated production with a top quark-antiquark pair ($t\bar{t}H$), are scaled with the $\mu^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H}$ factor. The production processes involving couplings to vector bosons, namely vector boson fusion (VBF) and associated production with a vector boson (VH), are scaled with the $\mu^{\gamma\gamma}_{\mathrm{VBF}+VH}$ factor. The third factor, $\mu^{4\ell}$, is used to scale the signal strength in the $H \to ZZ \to 4\ell$ channel. Only a single signal-strength parameter is used for $H \to ZZ \to 4\ell$ events because the m_H measurement in this case is found to exhibit almost no sensitivity to the different production mechanisms.

The procedure based on the two scale factors $\mu^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H}$ and $\mu^{\gamma\gamma}_{\mathrm{VBF}+VH}$ for the $H \to \gamma\gamma$ channel was previously employed by CMS [15] but not by ATLAS. Instead, ATLAS relied on a single $H \to \gamma\gamma$ signal-strength scale factor. The additional degree-of-freedom introduced by ATLAS for the present study results in a shift of about 40 MeV in the ATLAS $H \to \gamma\gamma$ result, leading to a shift of 20 MeV in the ATLAS combined mass measurement.

The individual signal strengths $\mu^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H}$, $\mu^{\gamma\gamma}_{\mathrm{VBF}+VH}$, and $\mu^{4\ell}$ are assumed to be the same for ATLAS and CMS, and are profiled in the combined fit for m_H. The corresponding profile-likelihood ratio is

$$\Lambda(m_H) = \frac{L\big(m_H\,,\,\hat{\hat{\mu}}^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H}(m_H)\,,\hat{\hat{\mu}}^{\gamma\gamma}_{\mathrm{VBF}+VH}(m_H)\,,\,\hat{\hat{\mu}}^{4\ell}(m_H)\,,\,\hat{\hat{\boldsymbol{\theta}}}(m_H)\big)}{L(\hat{m}_H, \hat{\mu}^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H}\,, \hat{\mu}^{\gamma\gamma}_{\mathrm{VBF}+VH}, \hat{\mu}^{4\ell}, \hat{\boldsymbol{\theta}})}\,. \tag{2}$$

Slightly more complex fit models are used, as described below, to perform additional compatibility tests between the different decay channels and between the results from ATLAS and CMS.

Combining the ATLAS and CMS data for the $H \to \gamma\gamma$ and $H \to ZZ \to 4\ell$ channels according to the above procedure, the mass of the Higgs boson is determined to be

$$\begin{aligned} m_H &= 125.09 \pm 0.24 \text{ GeV} \\ &= 125.09 \pm 0.21\,(\text{stat.}) \pm 0.11\,(\text{syst.}) \text{ GeV}, \end{aligned} \tag{3}$$

where the total uncertainty is obtained from the width of a negative log-likelihood ratio scan with all parameters profiled. The statistical uncertainty is determined by fixing all nuisance parameters to their best-fit values, except for the three signal-strength scale factors and the $H \to \gamma\gamma$ background function parameters, which are profiled. The systematic uncertainty is determined by subtracting in quadrature the statistical uncertainty from the total uncertainty. Equation (3) shows that the uncertainties in the m_H measurement are dominated by the statistical term, even when the Run 1 data sets of ATLAS and CMS are combined. Figure 1 shows the negative log-likelihood ratio scans as a function of m_H, with all nuisance parameters profiled (solid curves), and with the nuisance parameters fixed to their best-fit values (dashed curves).

The signal strengths at the measured value of m_H are found to be $\mu^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H} = 1.15^{+0.28}_{-0.25}$, $\mu^{\gamma\gamma}_{\mathrm{VBF}+VH} = 1.17^{+0.58}_{-0.53}$, and $\mu^{4\ell} = 1.40^{+0.30}_{-0.25}$. The combined overall signal strength μ (with $\mu^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H} = \mu^{\gamma\gamma}_{\mathrm{VBF}+VH} = \mu^{4\ell} \equiv \mu$) is $\mu = 1.24^{+0.18}_{-0.16}$. The results reported here for the signal strengths are not expected to have the same sensitivity, nor exactly the same values, as those that would be extracted from a combined analysis optimized for the coupling measurements.

The combined ATLAS and CMS results for m_H in the separate $H \to \gamma\gamma$ and $H \to ZZ \to 4\ell$ channels are

$$\begin{aligned} m_H^{\gamma\gamma} &= 125.07 \pm 0.29 \text{ GeV} \\ &= 125.07 \pm 0.25\,(\text{stat.}) \pm 0.14\,(\text{syst.}) \text{ GeV} \end{aligned} \tag{4}$$

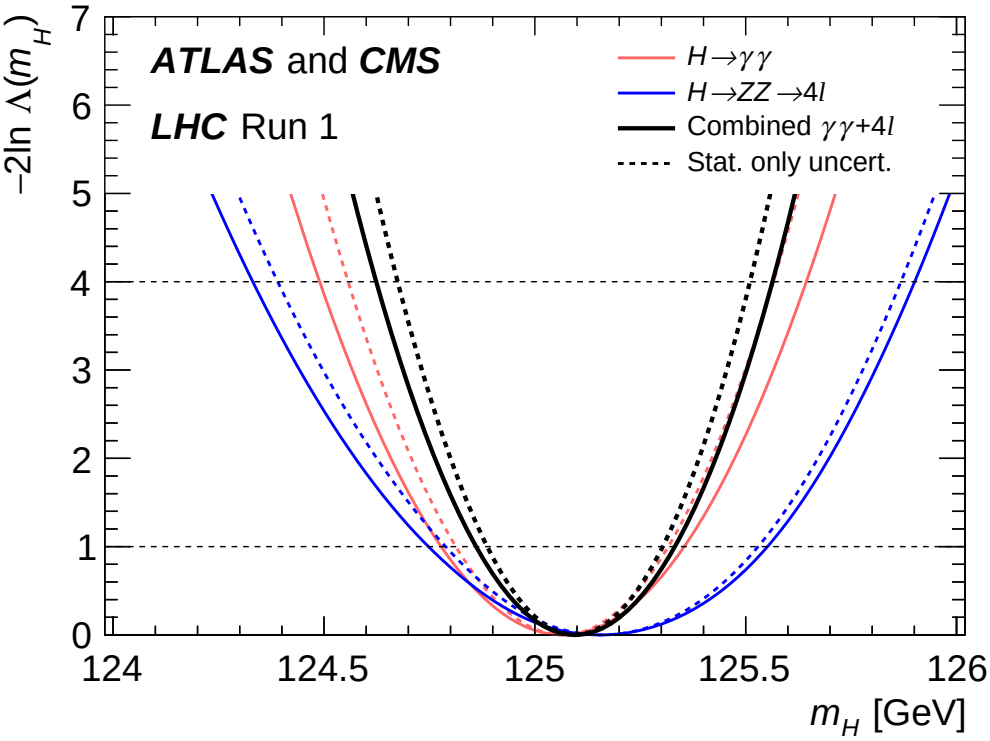

Figure 1: Scans of twice the negative log-likelihood ratio $-2\ln\Lambda(m_H)$ as functions of the Higgs boson mass m_H for the ATLAS and CMS combination of the $H \to \gamma\gamma$ (red), $H \to ZZ \to 4\ell$ (blue), and combined (black) channels. The dashed curves show the results accounting for statistical uncertainties only, with all nuisance parameters associated with systematic uncertainties fixed to their best-fit values. The 1 and 2 standard deviation limits are indicated by the intersections of the horizontal lines at 1 and 4, respectively, with the log-likelihood scan curves.

and

$$\begin{aligned} m_H^{4\ell} &= 125.15 \pm 0.40 \text{ GeV} \\ &= 125.15 \pm 0.37\,(\text{stat.}) \pm 0.15\,(\text{syst.}) \text{ GeV}. \end{aligned} \tag{5}$$

The corresponding likelihood ratio scans are shown in Fig. 1.

A summary of the results from the individual analyses and their combination is presented in Fig. 2.

The observed uncertainties in the combined measurement can be compared with expectations. The latter are evaluated by generating two Asimov data sets [26], where an Asimov data set is a representative event sample that provides both the median expectation for an experimental result and its expected statistical variation, in the asymptotic approximation, without the need for an extensive MC-based calculation. The first Asimov data set is a "prefit" sample, generated using $m_H = 125.0$ GeV and the SM predictions for the couplings, with all nuisance parameters fixed to their nominal values. The second Asimov data set is a "postfit" sample, in which m_H, the three signal strengths $\mu^{\gamma\gamma}_{gg\mathrm{F}+t\bar{t}H}$, $\mu^{\gamma\gamma}_{\mathrm{VBF}+VH}$, and $\mu^{4\ell}$, and all nuisance parameters are fixed to their best-fit estimates from the data. The expected uncertainties for the combined mass are

$$\delta m_{H\mathrm{prefit}} = \pm 0.24 \text{ GeV} = \pm 0.22\,(\text{stat.}) \pm 0.10\,(\text{syst.}) \text{ GeV} \tag{6}$$

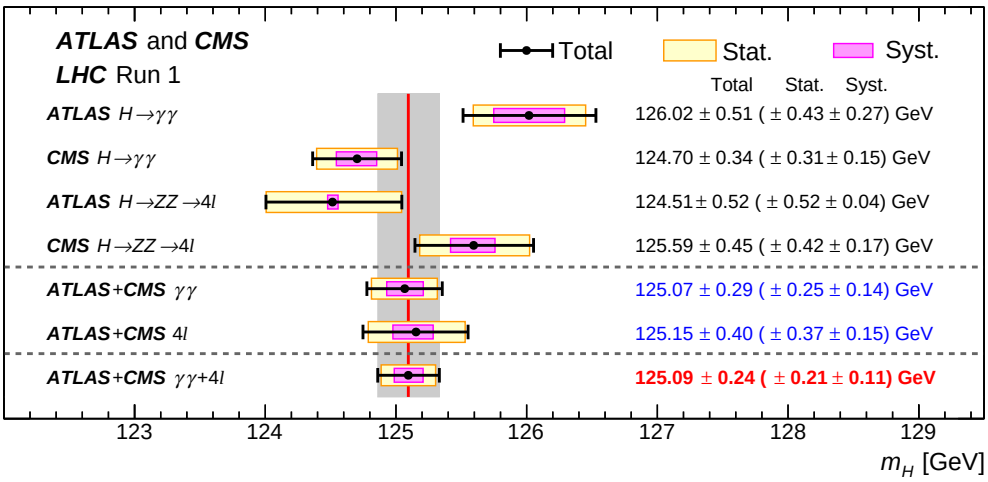

Figure 2: Summary of Higgs boson mass measurements from the individual analyses of ATLAS and CMS and from the combined analysis presented here. The systematic (narrower, magenta-shaded bands), statistical (wider, yellow-shaded bands), and total (black error bars) uncertainties are indicated. The (red) vertical line and corresponding (gray) shaded column indicate the central value and the total uncertainty of the combined measurement, respectively.

for the prefit case and

$$\delta m_{H_{\text{postfit}}} = \pm 0.22\ \text{GeV} = \pm 0.19\ (\text{stat.})\ \pm 0.10(\text{syst.})\ \text{GeV} \tag{7}$$

for the postfit case, which are both very similar to the observed uncertainties reported in Eq. (3).

Constraining all signal yields to their SM predictions results in an m_H value that is about 70 MeV larger than the nominal result with a comparable uncertainty. The increase in the central value reflects the combined effect of the higher-than-expected $H \to ZZ \to 4\ell$ measured signal strength and the increase of the $H \to ZZ$ branching fraction with m_H. Thus, the fit assuming SM couplings forces the mass to a higher value in order to accommodate the value $\mu = 1$ expected in the SM.

Since the discovery, both experiments have improved their understanding of the electron, photon, and muon measurements [16, 30–34], leading to a significant reduction of the systematic uncertainties in the mass measurement. Nevertheless, the treatment and understanding of systematic uncertainties is an important aspect of the individual measurements and their combination. The combined analysis incorporates approximately 300 nuisance parameters. Among these, approximately 100 are fitted parameters describing the shapes and normalizations of the background models in the $H \to \gamma\gamma$ channel, including a number of discrete parameters that allow the functional form in each of the CMS $H \to \gamma\gamma$ analysis categories to be changed [35]. Of the remaining almost 200 nuisance parameters, most correspond to experimental or theoretical systematic uncertainties.

Based on the results from the individual experiments, the dominant systematic uncertainties for the combined m_H result are expected to be those associated with the energy or momentum scale and its resolution: for the photons in the $H \to \gamma\gamma$ channel and for the electrons and muons in the $H \to ZZ \to 4\ell$ channel [14–16]. These uncertainties are assumed to be uncorrelated between the two experiments since they are related to the specific characteristics of the detectors as well as to the calibration procedures, which are fully independent except for negligible effects due to the use of the common Z boson mass [36] to specify the absolute energy and

Table 1: Systematic uncertainties δm_H (see text) associated with the indicated effects for each of the four input channels, and the corresponding contributions of ATLAS and CMS to the systematic uncertainties of the combined result. "ECAL" refers to the electromagnetic calorimeters. The numbers in parentheses indicate expected values obtained from the prefit Asimov data set discussed in the text. The uncertainties for the combined result are related to the values of the individual channels through the relative weight of the individual channel in the combination, which is proportional to the inverse of the respective uncertainty squared. The top section of the table divides the sources of systematic uncertainty into three classes, which are discussed in the text. The bottom section of the table shows the total systematic uncertainties estimated by adding the individual contributions in quadrature, the total systematic uncertainties evaluated using the nominal method discussed in the text, the statistical uncertainties, the total uncertainties, and the analysis weights, illustrative of the relative weight of each channel in the combined m_H measurement.

	Uncertainty in ATLAS results [GeV]: observed (expected)		Uncertainty in CMS results [GeV]: observed (expected)		Uncertainty in combined result [GeV]: observed (expected)	
	$H \to \gamma\gamma$	$H \to ZZ \to 4\ell$	$H \to \gamma\gamma$	$H \to ZZ \to 4\ell$	ATLAS	CMS
Scale uncertainties:						
ATLAS ECAL non-linearity / CMS photon non-linearity	0.14 (0.16)	–	0.10 (0.13)	–	0.02 (0.04)	0.05 (0.06)
Material in front of ECAL	0.15 (0.13)	–	0.07 (0.07)	–	0.03 (0.03)	0.04 (0.03)
ECAL longitudinal response	0.12 (0.13)	–	0.02 (0.01)	–	0.02 (0.03)	0.01 (0.01)
ECAL lateral shower shape	0.09 (0.08)	–	0.06 (0.06)	–	0.02 (0.02)	0.03 (0.03)
Photon energy resolution	0.03 (0.01)	–	0.01 (<0.01)	–	0.02 (<0.01)	<0.01 (<0.01)
ATLAS $H \to \gamma\gamma$ vertex & conversion reconstruction	0.05 (0.05)	–	–	–	0.01 (0.01)	–
$Z \to ee$ calibration	0.05 (0.04)	0.03 (0.02)	0.05 (0.05)	–	0.02 (0.01)	0.02 (0.02)
CMS electron energy scale & resolution	–	–	–	0.12 (0.09)	–	0.03 (0.02)
Muon momentum scale & resolution	–	0.03 (0.04)	–	0.11 (0.10)	<0.01 (0.01)	0.05 (0.02)
Other uncertainties:						
ATLAS $H \to \gamma\gamma$ background modeling	0.04 (0.03)	–	–	–	0.01 (0.01)	–
Integrated luminosity	0.01 (<0.01)	<0.01 (<0.01)	0.01 (<0.01)	<0.01 (<0.01)	0.01 (<0.01)	
Additional experimental systematic uncertainties	0.03 (<0.01)	<0.01 (<0.01)	0.02 (<0.01)	0.01 (<0.01)	0.01 (<0.01)	0.01 (<0.01)
Theory uncertainties	<0.01 (<0.01)	<0.01 (<0.01)	0.02 (<0.01)	<0.01 (<0.01)	0.01 (<0.01)	
Systematic uncertainty (sum in quadrature)	0.27 (0.27)	0.04 (0.04)	0.15 (0.17)	0.16 (0.13)	0.11 (0.10)	
Systematic uncertainty (nominal)	0.27 (0.27)	0.04 (0.05)	0.15 (0.17)	0.17 (0.14)	0.11 (0.10)	
Statistical uncertainty	0.43 (0.45)	0.52 (0.66)	0.31 (0.32)	0.42 (0.57)	0.21 (0.22)	
Total uncertainty	0.51 (0.52)	0.52 (0.66)	0.34 (0.36)	0.45 (0.59)	0.24 (0.24)	
Analysis weights	19% (22%)	18% (14%)	40% (46%)	23% (17%)	–	

momentum scales. Other experimental systematic uncertainties [14–16] are similarly assumed to be uncorrelated between the two experiments. Uncertainties in the theoretical predictions and in the measured integrated luminosities are treated as fully and partially correlated, respectively.

To evaluate the relative importance of the different sources of systematic uncertainty, the nuisance parameters are grouped according to their correspondence to three broad classes of systematic uncertainty:

- uncertainties in the energy or momentum scale and resolution for photons, electrons, and muons ("scale"),
- theoretical uncertainties, e.g., uncertainties in the Higgs boson cross section and branching fractions, and in the normalization of SM background processes ("theory"),
- other experimental uncertainties ("other").

First, the total uncertainty is obtained from the full profile-likelihood scan, as explained above. Next, parameters associated with the "scale" terms are fixed and a new scan is performed.

Then, in addition to the scale terms, the parameters associated with the "theory" terms are fixed and a scan performed. Finally, in addition, the "other" parameters are fixed and a scan performed. Thus the fits are performed iteratively, with the different classes of nuisance parameters cumulatively held fixed to their best-fit values. The uncertainties associated with the different classes of nuisance parameters are defined by the difference in quadrature between the uncertainties resulting from consecutive scans. The statistical uncertainty is determined from the final scan, with all nuisance parameters associated with systematic terms held fixed, as explained above. The result is

$$m_H = 125.09 \pm 0.21\,(\text{stat.}) \pm 0.11\,(\text{scale}) \pm 0.02\,(\text{other}) \pm 0.01\,(\text{theory})\ \text{GeV}, \tag{8}$$

from which it is seen that the systematic uncertainty is indeed dominated by the energy and momentum scale terms.

The relative importance of the various sources of systematic uncertainty is further investigated by dividing the nuisance parameters into yet-finer groups, with each group associated with a specific underlying effect, and evaluating the impact of each group on the overall mass uncertainty. The matching of nuisance parameters to an effect is not strictly rigorous because nuisance parameters in the two experiments do not always represent exactly the same effect and in some cases multiple effects are related to the same nuisance parameter. Nevertheless the relative impact of the different effects can be explored. A few experiment-specific groups of nuisance parameters are defined. For example, ATLAS includes a group of nuisance parameters to account for the inaccuracy of the background modeling for the $H \to \gamma\gamma$ channel. To model this background, ATLAS uses specific analytic functions in each category [14] while CMS simultaneously considers different background parameterizations [35]. The systematic uncertainty in m_H related to the background modeling in CMS is estimated to be negligible [15].

The impact of groups of nuisance parameters is evaluated starting from the contribution of each individual nuisance parameter to the total uncertainty. This contribution is defined as the mass shift δm_H observed when re-evaluating the profile-likelihood ratio after fixing the nuisance parameter in question to its best-fit value increased or decreased by 1 standard deviation (σ) in its distribution. For a nuisance parameter whose PDF is a Gaussian distribution, this shift corresponds to the contribution of that particular nuisance parameter to the final uncertainty. The impact of a group of nuisance parameters is estimated by summing in quadrature the contributions from the individual parameters.

The impacts δm_H due to each of the considered effects are listed in Table 1. The results are reported for the four individual channels, both for the data and (in parentheses) the prefit Asimov data set. The row labeled "Systematic uncertainty (sum in quadrature)" shows the total sums in quadrature of the individual terms in the table. The row labeled "Systematic uncertainty (nominal)" shows the corresponding total systematic uncertainties derived using the subtraction in quadrature method discussed in connection with Eq. (3). The two methods to evaluate the total systematic uncertainty are seen to agree within 10 MeV, which is comparable with the precision of the estimates. The two rightmost columns of Table 1 list the contribution of each group of nuisance parameters to the uncertainties in the combined mass measurement, for ATLAS and CMS separately.

The statistical and total uncertainties are summarized in the bottom section of Table 1. Since the weight of a channel in the final combination is determined by the inverse of the squared uncertainty, the approximate relative weights for the combined result are 19% ($H \to \gamma\gamma$) and 18% ($H \to ZZ \to 4\ell$) for ATLAS, and 40% ($H \to \gamma\gamma$) and 23% ($H \to ZZ \to 4\ell$) for CMS. These weights are reported in the last row of Table 1, along with the expected values.

Figure 3 presents the impact of each group of nuisance parameters on the total systematic uncertainty in the mass measurement of ATLAS, CMS, and the combination. For the individual ATLAS and CMS measurements, the results in Fig. 3 are approximately equivalent to the sum in quadrature of the respective δm_H terms in Table 1 multiplied by their analysis weights, after normalizing these weights to correspond to either ATLAS only or CMS only. The ATLAS and CMS combined results in Fig. 3 are the sum in quadrature of the combined results in Table 1.

The results in Table 1 and Fig. 3 establish that the largest systematic effects for the mass uncertainty are those related to the determination of the energy scale of the photons, followed by those associated with the determination of the electron and muon momentum scales. Since the CMS $H \to \gamma\gamma$ channel has the largest weight in the combination, its impact on the systematic uncertainty of the combined result is largest.

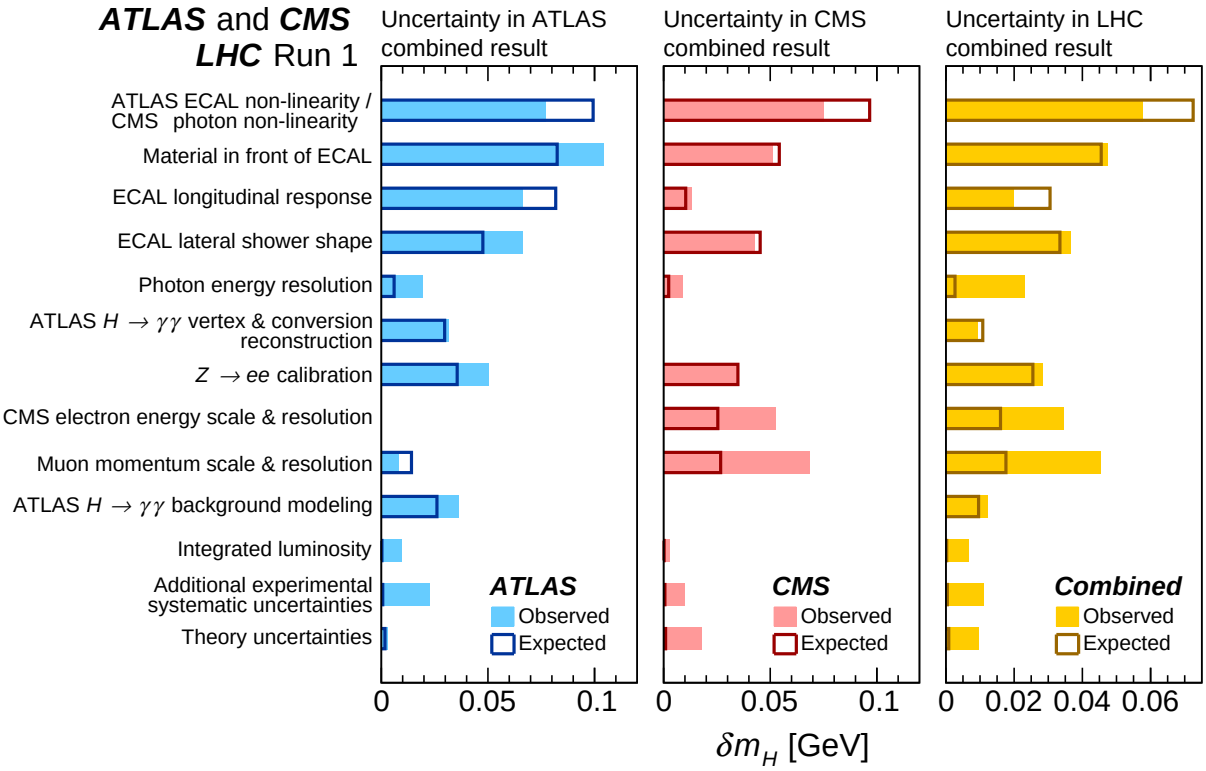

Figure 3: The impacts δm_H (see text) of the nuisance parameter groups in Table 1 on the ATLAS (left), CMS (center), and combined (right) mass measurement uncertainty. The observed (expected) results are shown by the solid (empty) bars.

The mutual compatibility of the m_H results from the four individual channels is tested using a likelihood ratio with four masses in the numerator and a common mass in the denominator, and thus three degrees of freedom. The three signal strengths are profiled in both the numerator and denominator as in Eq. (1). The resulting compatibility, defined as the asymptotic p-value of the fit, is 10%. Allowing the ATLAS and CMS signal strengths to vary independently yields a compatibility of 7%. This latter fit results in an m_H value that is 40 MeV larger than the nominal result.

The compatibility of the combined ATLAS and CMS mass measurement in the $H \to \gamma\gamma$ channel with the combined measurement in the $H \to ZZ \to 4\ell$ channel is evaluated using the variable $\Delta m_{\gamma Z} \equiv m_H^{\gamma\gamma} - m_H^{4\ell}$ as the parameter of interest, with all other parameters, includ-

ing m_H, profiled. Similarly, the compatibility of the ATLAS combined mass measurement in the two channels with the CMS combined measurement in the two channels is evaluated using the variable $\Delta m^{\text{expt}} \equiv m_H^{\text{ATLAS}} - m_H^{\text{CMS}}$. The observed results, $\Delta m_{\gamma Z} = -0.1 \pm 0.5$ GeV and $\Delta m^{\text{expt}} = 0.4 \pm 0.5$ GeV, are both consistent with zero within $1\,\sigma$. The difference between the mass values in the two experiments is $\Delta m_{\gamma\gamma}^{\text{expt}} = 1.3 \pm 0.6$ GeV ($2.1\,\sigma$) for the $H \to \gamma\gamma$ channel and $\Delta m_{4\ell}^{\text{expt}} = -0.9 \pm 0.7$ GeV ($1.3\,\sigma$) for the $H \to ZZ \to 4\ell$ channel. The combined results exhibit a greater degree of compatibility than the results from the individual decay channels because the Δm^{expt} value has opposite signs in the two channels.

The compatibility of the signal strengths from ATLAS and CMS is evaluated through the ratios $\lambda^{\text{expt}} = \mu^{\text{ATLAS}}/\mu^{\text{CMS}}$, $\lambda_F^{\text{expt}} = \mu_{gg\text{F}+t\bar{t}H}^{\gamma\gamma\ \text{ATLAS}}/\mu_{gg\text{F}+t\bar{t}H}^{\gamma\gamma\ \text{CMS}}$, and $\lambda_{4\ell}^{\text{expt}} = \mu^{4\ell\ \text{ATLAS}}/\mu^{4\ell\ \text{CMS}}$. For this purpose, each ratio is individually taken to be the parameter of interest, with all other nuisance parameters profiled, including the remaining two ratios for the first two tests. We find $\lambda^{\text{expt}} = 1.21^{+0.30}_{-0.24}$, $\lambda_F^{\text{expt}} = 1.3^{+0.8}_{-0.5}$, and $\lambda_{4\ell}^{\text{expt}} = 1.3^{+0.5}_{-0.4}$, all of which are consistent with unity within $1\,\sigma$. The ratio $\lambda_V^{\text{expt}} = \mu_{\text{VBF}+VH}^{\gamma\gamma\ \text{ATLAS}}/\mu_{\text{VBF}+VH}^{\gamma\gamma\ \text{CMS}}$ is omitted because the ATLAS mass measurement in the $H \to \gamma\gamma$ channel is not sensitive to $\mu_{\text{VBF}+VH}^{\gamma\gamma}/\mu_{gg\text{F}+t\bar{t}H}^{\gamma\gamma}$.

The correlation between the signal strength and the measured mass is explored with 2D likelihood scans as functions of μ and m_H. The three signal strengths are assumed to be the same: $\mu_{gg\text{F}+t\bar{t}H}^{\gamma\gamma} = \mu_{\text{VBF}+VH}^{\gamma\gamma} = \mu^{4\ell} \equiv \mu$, and thus the ratios of the production cross sections times branching fractions are constrained to the SM predictions. Assuming that the negative log-likelihood ratio $-2\ln\Lambda(\mu, m_H)$ is distributed as a χ^2 variable with two degrees of freedom, the 68% confidence level (CL) confidence regions are shown in Fig. 4 for each individual measurement, as well as for the combined result.

In summary, a combined measurement of the Higgs boson mass is performed in the $H \to \gamma\gamma$ and $H \to ZZ \to 4\ell$ channels using the LHC Run 1 data sets of the ATLAS and CMS experiments, with minimal reliance on the assumption that the Higgs boson behaves as predicted by the SM.

The result is

$$\begin{aligned} m_H &= 125.09 \pm 0.24\ \text{GeV} \\ &= 125.09 \pm 0.21\ (\text{stat.}) \pm 0.11\ (\text{syst.})\ \text{GeV}, \end{aligned} \tag{9}$$

where the total uncertainty is dominated by the statistical term, with the systematic uncertainty dominated by effects related to the photon, electron, and muon energy or momentum scales and resolutions. Compatibility tests are performed to ascertain whether the measurements are consistent with each other, both between the different decay channels and between the two experiments. All tests on the combined results indicate consistency of the different measurements within $1\,\sigma$, while the four Higgs boson mass measurements in the two channels of the two experiments agree within $2\,\sigma$. The combined measurement of the Higgs boson mass improves upon the results from the individual experiments and is the most precise measurement to date of this fundamental parameter of the newly discovered particle.

Acknowledgments

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

We acknowledge the support of ANPCyT (Argentina); YerPhI (Armenia); ARC (Australia); BMWFW and FWF (Austria); ANAS (Azerbaijan); SSTC (Belarus); FNRS and FWO (Belgium);

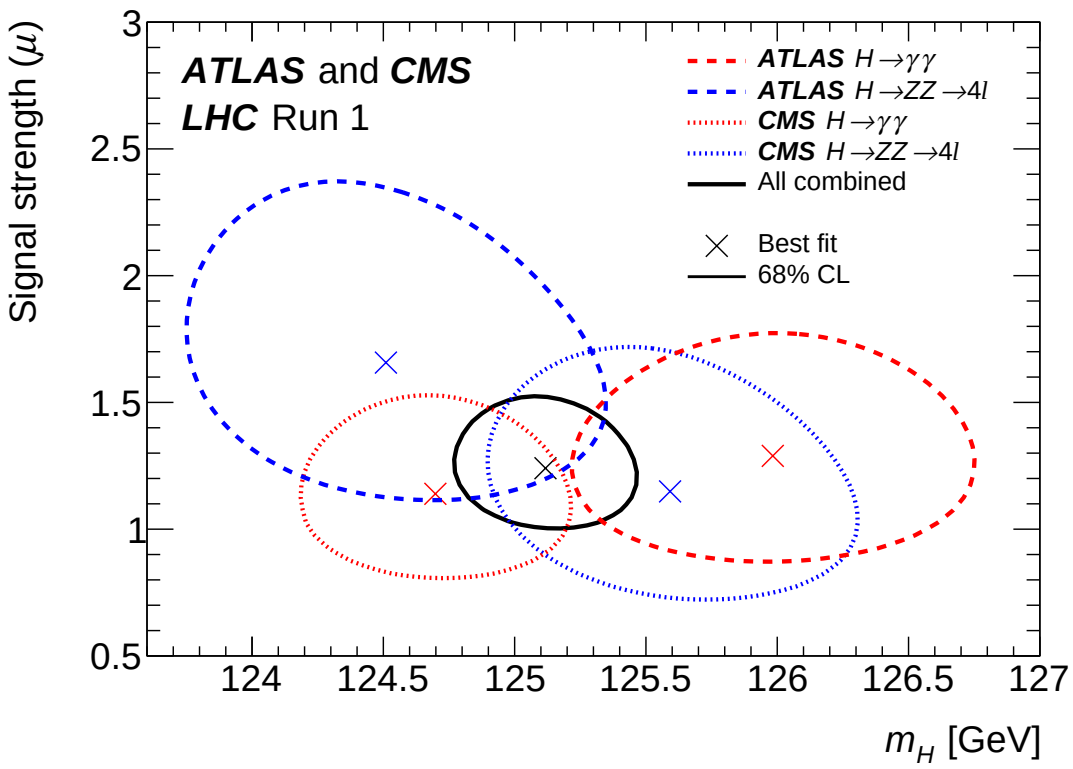

Figure 4: Summary of likelihood scans in the 2D plane of signal strength μ versus Higgs boson mass m_H for the ATLAS and CMS experiments. The 68% CL confidence regions of the individual measurements are shown by the dashed curves and of the overall combination by the solid curve. The markers indicate the respective best-fit values.

CNPq, CAPES, FAPERJ, and FAPESP (Brazil); MES (Bulgaria); NSERC, NRC, and CFI (Canada); CERN; CONICYT (Chile); CAS, MoST, and NSFC (China); COLCIENCIAS (Colombia); MSES and CSF (Croatia); RPF (Cyprus); MSMT CR, MPO CR and VSC CR (Czech Republic); DNRF, DNSRC and Lundbeck Foundation (Denmark); MoER, ERC IUT and ERDF (Estonia); EPLANET, ERC and NSRF (European Union); Academy of Finland, MEC, and HIP (Finland); CEA, CNRS/IN2P3 (France); GNSF (Georgia); BMBF , DFG, HGF, MPG, and AvH Foundation (Germany); GSRT and NSRF (Greece); RGC (Hong Kong SAR, China); OTKA and NIH (Hungary); DAE and DST (India); IPM (Iran); SFI (Ireland); ISF, MINERVA, GIF, I-CORE and Benoziyo Center (Israel); INFN (Italy); MEXT and JSPS (Japan); JINR; MSIP and NRF (Republic of Korea); LAS (Lithuania); MOE and UM (Malaysia); CINVESTAV, CONACYT, SEP, and UASLP-FAI (Mexico); CNRST (Morocco); FOM and NWO (Netherlands); MBIE (New Zealand); BRF and RCN (Norway); PAEC (Pakistan); MNiSW, MSHE, NCN, and NSC (Poland); GRICES and FCT (Portugal); MNE/IFA (Romania); MES of Russia, MON, RosAtom, RAS, and RFBR (Russian Federation); MSTD and MESTD (Serbia); MSSR (Slovakia); ARRS and MIZŠ (Slovenia); DST/NRF (South Africa); MINECO, SEIDI and CPAN (Spain); SRC and Wallenberg Foundation (Sweden); ETH Board, ETH Zurich, PSI, SER, SNSF, UniZH, and Cantons of Bern, Genève and Zurich (Switzerland); NSC (Taipei); MST (Taiwan); ThEPCenter, IPST, STAR and NSTDA (Thailand); TUBITAK and TAEK (Turkey); NASU and SFFR (Ukraine); STFC and the Royal Society and Leverhulme Trust (United Kingdom); DOE and NSF (United States of America).

In addition, we gratefully acknowledge the crucial computing support from all WLCG partners, in particular from CERN and the Tier-1 and Tier-2 facilities worldwide.

References

[1] F. Englert and R. Brout, "Broken symmetry and the mass of gauge vector mesons", *Phys. Rev. Lett.* **13** (1964) 321, doi:10.1103/PhysRevLett.13.321.

[2] P. W. Higgs, "Broken symmetries, massless particles and gauge fields", *Phys. Lett.* **12** (1964) 132, doi:10.1016/0031-9163(64)91136-9.

[3] P. W. Higgs, "Broken symmetries and the masses of gauge bosons", *Phys. Rev. Lett.* **13** (1964) 508, doi:10.1103/PhysRevLett.13.508.

[4] G. S. Guralnik, C. R. Hagen, and T. W. B. Kibble, "Global conservation laws and massless particles", *Phys. Rev. Lett.* **13** (1964) 585, doi:10.1103/PhysRevLett.13.585.

[5] P. W. Higgs, "Spontaneous symmetry breakdown without massless bosons", *Phys. Rev.* **145** (1966) 1156, doi:10.1103/PhysRev.145.1156.

[6] T. W. B. Kibble, "Symmetry breaking in non-Abelian gauge theories", *Phys. Rev.* **155** (1967) 1554, doi:10.1103/PhysRev.155.1554.

[7] ATLAS Collaboration, "Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC", *Phys. Lett. B* **716** (2012) 1, doi:10.1016/j.physletb.2012.08.020, arXiv:1207.7214.

[8] CMS Collaboration, "Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC", *Phys. Lett. B* **716** (2012) 30, doi:10.1016/j.physletb.2012.08.021, arXiv:1207.7235.

[9] CMS Collaboration, "Observation of a new boson with mass near 125 GeV in pp collisions at $\sqrt{s}$ = 7 and 8 TeV", *JHEP* **06** (2013) 081, doi:10.1007/JHEP06(2013)081, arXiv:1303.4571.

[10] ATLAS Collaboration, "Measurements of Higgs boson production and couplings in diboson final states with the ATLAS detector at the LHC", *Phys. Lett. B* **726** (2013) 88, doi:10.1016/j.physletb.2013.08.010, arXiv:1307.1427.

[11] ATLAS Collaboration, "Evidence for the spin-0 nature of the Higgs boson using ATLAS data", *Phys. Lett. B* **726** (2013) 120, doi:10.1016/j.physletb.2013.08.026, arXiv:1307.1432.

[12] CMS Collaboration, "Precise determination of the mass of the Higgs boson and tests of compatibility of its couplings with the standard model predictions using proton collisions at 7 and 8 TeV", (2014). arXiv:1412.8662. Accepted for publication in *Eur. Phys. J. C*.

[13] CMS Collaboration, "Constraints on the spin-parity and anomalous HVV couplings of the Higgs boson in proton collisions at 7 and 8 TeV", (2014). arXiv:1411.3441. Submitted for publication in *Phys. Rev. D*.

[14] ATLAS Collaboration, "Measurement of the Higgs boson mass from the $H \to \gamma\gamma$ and $H \to ZZ^* \to 4\ell$ channels in pp collisions at center-of-mass energies of 7 and 8 TeV with the ATLAS detector", *Phys. Rev. D* **90** (2014) 052004, doi:10.1103/PhysRevD.90.052004, arXiv:1406.3827.

[15] CMS Collaboration, "Observation of the diphoton decay of the 125 GeV Higgs boson and measurement of its properties", *Eur. Phys. J. C* **74** (2014) 3076, doi:10.1140/epjc/s10052-014-3076-z, arXiv:1407.0558.

[16] CMS Collaboration, "Measurement of the properties of a Higgs boson in the four-lepton final state", *Phys. Rev. D* **89** (2014) 092007, doi:10.1103/PhysRevD.89.092007, arXiv:1312.5353.

[17] Gfitter Group, M. Baak et al., "The global electroweak fit at NNLO and prospects for the LHC and ILC", *Eur. Phys. J. C* **74** (2014) 3046, doi:10.1140/epjc/s10052-014-3046-5, arXiv:1407.3792.

[18] L. J. Dixon and M. S. Siu, "Resonance-Continuum Interference in the Diphoton Higgs Signal at the LHC", *Phys. Rev. Lett.* **90** (2003) 252001, doi:10.1103/PhysRevLett.90.252001, arXiv:hep-ph/0302233.

[19] S. P. Martin, "Shift in the LHC Higgs diphoton mass peak from interference with background", *Phys. Rev. D* **86** (2012) 073016, doi:10.1103/PhysRevD.86.073016, arXiv:1208.1533.

[20] L. J. Dixon and Y. Li, "Bounding the Higgs Boson Width Through Interferometry", *Phys. Rev. Lett.* **111** (2013) 111802, doi:10.1103/PhysRevLett.111.111802, arXiv:1305.3854.

[21] N. Kauer and G. Passarino, "Inadequacy of zero-width approximation for a light Higgs boson signal", *JHEP* **08** (2012) 116, doi:10.1007/JHEP08(2012)116, arXiv:1206.4803.

[22] ATLAS Collaboration, "The ATLAS experiment at the CERN Large Hadron Collider", *JINST* **3** (2008) S08003, doi:10.1088/1748-0221/3/08/S08003.

[23] CMS Collaboration, "The CMS experiment at the CERN LHC", *JINST* **3** (2008) S08004, doi:10.1088/1748-0221/3/08/S08004.

[24] ATLAS Collaboration, "Measurement of Higgs boson production in the diphoton decay channel in pp collisions at center-of-mass energies of 7 and 8 TeV with the ATLAS detector", *Phys. Rev. D* **90** (2014) 112015, doi:10.1103/PhysRevD.90.112015, arXiv:1408.7084.

[25] ATLAS and CMS Collaborations, "Procedure for the LHC Higgs boson search combination in Summer 2011", Technical Report ATL-PHYS-PUB 2011-11, CMS NOTE 2011/005, 2011.

[26] G. Cowan, K. Cranmer, E. Gross, and O. Vitells, "Asymptotic formulae for likelihood-based tests of new physics", *Eur. Phys. J. C* **71** (2011) 1554, doi:10.1140/epjc/s10052-011-1554-0, arXiv:1007.1727.

[27] W. Verkerke and D. P. Kirkby, "The RooFit toolkit for data modeling", in *13th International Conference for Computing in High-Energy and Nuclear Physics (CHEP03)*. 2003. arXiv:physics/0306116. CHEP-2003-MOLT007.

[28] L. Moneta et al., "The RooStats Project", in *13th International Workshop on Advanced Computing and Analysis Techniques in Physics Research (ACAT2010)*. SISSA, 2010. arXiv:1009.1003. PoS(ACAT2010)057.

[29] ROOT Collaboration, "HistFactory: A tool for creating statistical models for use with RooFit and RooStats", Technical Report CERN-OPEN-2012-016, 2012.

[30] ATLAS Collaboration, "Electron and photon energy calibration with the ATLAS detector using LHC Run 1 data", *Eur. Phys. J. C* **74** (2014) 3071, doi:10.1140/epjc/s10052-014-3071-4, arXiv:1407.5063.

[31] ATLAS Collaboration, "Measurement of the muon reconstruction performance of the ATLAS detector using 2011 and 2012 LHC proton-proton collision data", *Eur. Phys. J. C* **74** (2014) 3130, doi:10.1140/epjc/s10052-014-3130-x, arXiv:1407.3935.

[32] CMS Collaboration, "Performance of CMS muon reconstruction in pp collision events at $\sqrt{s} = 7$ TeV", *JINST* **7** (2012) P10002, doi:10.1088/1748-0221/7/10/P10002, arXiv:1206.4071.

[33] CMS Collaboration, "Performance of electron reconstruction and selection with the CMS detector in proton-proton collisions at $\sqrt{s} = 8$ TeV", (2015). arXiv:1502.02701. Submitted for publication in *JINST*.

[34] CMS Collaboration, "Performance of photon reconstruction and identification with the CMS detector in proton-proton collisions at $\sqrt{s} = 8$ TeV", (2015). arXiv:1502.02702. Submitted for publication in *JINST*.

[35] P. D. Dauncey, M. Kenzie, N. Wardle, and G. Davies, "Handling uncertainties in background shapes: the discrete profiling method", (2014). arXiv:1408.6865. Accepted for publication in *JINST*.

[36] The ALEPH, DELPHI, L3, OPAL, SLD Collaborations, the LEP Electroweak Working Group, the SLD Electroweak and Heavy Flavour Groups, "Precision Electroweak Measurements on the Z Resonance", *Phys. Rept.* **427** (2006) 257, doi:10.1016/j.physrep.2005.12.006, arXiv:hep-ex/0509008.

A The ATLAS Collaboration

G. Aad[85], B. Abbott[113], J. Abdallah[151], O. Abdinov[11], R. Aben[107], M. Abolins[90], O.S. AbouZeid[158], H. Abramowicz[153], H. Abreu[152], R. Abreu[30], Y. Abulaiti[146a,146b], B.S. Acharya[164a,164b,a], L. Adamczyk[38a], D.L. Adams[25], J. Adelman[108], S. Adomeit[100], T. Adye[131], A.A. Affolder[74], T. Agatonovic-Jovin[13], J.A. Aguilar-Saavedra[126a,126f], S.P. Ahlen[22], F. Ahmadov[65,b], G. Aielli[133a,133b], H. Akerstedt[146a,146b], T.P.A. Åkesson[81], G. Akimoto[155], A.V. Akimov[96], G.L. Alberghi[20a,20b], J. Albert[169], S. Albrand[55], M.J. Alconada Verzini[71], M. Aleksa[30], I.N. Aleksandrov[65], C. Alexa[26a], G. Alexander[153], T. Alexopoulos[10], M. Alhroob[113], G. Alimonti[91a], L. Alio[85], J. Alison[31], S.P. Alkire[35], B.M.M. Allbrooke[18], P.P. Allport[74], A. Aloisio[104a,104b], A. Alonso[36], F. Alonso[71], C. Alpigiani[76], A. Altheimer[35], B. Alvarez Gonzalez[30], D. Álvarez Piqueras[167], M.G. Alviggi[104a,104b], B.T. Amadio[15], K. Amako[66], Y. Amaral Coutinho[24a], C. Amelung[23], D. Amidei[89], S.P. Amor Dos Santos[126a,126c], A. Amorim[126a,126b], S. Amoroso[48], N. Amram[153], G. Amundsen[23], C. Anastopoulos[139], L.S. Ancu[49], N. Andari[30], T. Andeen[35], C.F. Anders[58b], G. Anders[30], J.K. Anders[74], K.J. Anderson[31], A. Andreazza[91a,91b], V. Andrei[58a], S. Angelidakis[9], I. Angelozzi[107], P. Anger[44], A. Angerami[35], F. Anghinolfi[30], A.V. Anisenkov[109,c], N. Anjos[12], A. Annovi[124a,124b], M. Antonelli[47], A. Antonov[98], J. Antos[144b], F. Anulli[132a], M. Aoki[66], L. Aperio Bella[18], G. Arabidze[90], Y. Arai[66], J.P. Araque[126a], A.T.H. Arce[45], F.A. Arduh[71], J-F. Arguin[95], S. Argyropoulos[42], M. Arik[19a], A.J. Armbruster[30], O. Arnaez[30], V. Arnal[82], H. Arnold[48], M. Arratia[28], O. Arslan[21], A. Artamonov[97], G. Artoni[23], S. Asai[155], N. Asbah[42], A. Ashkenazi[153], B. Åsman[146a,146b], L. Asquith[149], K. Assamagan[25], R. Astalos[144a], M. Atkinson[165], N.B. Atlay[141], B. Auerbach[6], K. Augsten[128], M. Aurousseau[145b], G. Avolio[30], B. Axen[15], M.K. Ayoub[117], G. Azuelos[95,d], M.A. Baak[30], A.E. Baas[58a], C. Bacci[134a,134b], H. Bachacou[136], K. Bachas[154], M. Backes[30], M. Backhaus[30], E. Badescu[26a], P. Bagiacchi[132a,132b], P. Bagnaia[132a,132b], Y. Bai[33a], T. Bain[35], J.T. Baines[131], O.K. Baker[176], P. Balek[129], T. Balestri[148], F. Balli[84], E. Banas[39], Sw. Banerjee[173], A.A.E. Bannoura[175], H.S. Bansil[18], L. Barak[30], S.P. Baranov[96], E.L. Barberio[88], D. Barberis[50a,50b], M. Barbero[85], T. Barillari[101], M. Barisonzi[164a,164b], T. Barklow[143], N. Barlow[28], S.L. Barnes[84], B.M. Barnett[131], R.M. Barnett[15], Z. Barnovska[5], A. Baroncelli[134a], G. Barone[49], A.J. Barr[120], F. Barreiro[82], J. Barreiro Guimarães da Costa[57], R. Bartoldus[143], A.E. Barton[72], P. Bartos[144a], A. Bassalat[117], A. Basye[165], R.L. Bates[53], S.J. Batista[158], J.R. Batley[28], M. Battaglia[137], M. Bauce[132a,132b], F. Bauer[136], H.S. Bawa[143,e], J.B. Beacham[111], M.D. Beattie[72], T. Beau[80], P.H. Beauchemin[161], R. Beccherle[124a,124b], P. Bechtle[21], H.P. Beck[17,f], K. Becker[120], M. Becker[83], S. Becker[100], M. Beckingham[170], C. Becot[117], A.J. Beddall[19c], A. Beddall[19c], V.A. Bednyakov[65], C.P. Bee[148], L.J. Beemster[107], T.A. Beermann[175], M. Begel[25], J.K. Behr[120], C. Belanger-Champagne[87], W.H. Bell[49], G. Bella[153], L. Bellagamba[20a], A. Bellerive[29], M. Bellomo[86], K. Belotskiy[98], O. Beltramello[30], O. Benary[153], D. Benchekroun[135a], M. Bender[100], K. Bendtz[146a,146b], N. Benekos[10], Y. Benhammou[153], E. Benhar Noccioli[49], J.A. Benitez Garcia[159b], D.P. Benjamin[45], J.R. Bensinger[23], S. Bentvelsen[107], L. Beresford[120], M. Beretta[47], D. Berge[107], E. Bergeaas Kuutmann[166], N. Berger[5], F. Berghaus[169], J. Beringer[15], C. Bernard[22], N.R. Bernard[86], C. Bernius[110], F.U. Bernlochner[21], T. Berry[77], P. Berta[129], C. Bertella[83], G. Bertoli[146a,146b], F. Bertolucci[124a,124b], C. Bertsche[113], D. Bertsche[113], M.I. Besana[91a], G.J. Besjes[106], O. Bessidskaia Bylund[146a,146b], M. Bessner[42], N. Besson[136], C. Betancourt[48], S. Bethke[101], A.J. Bevan[76], W. Bhimji[46], R.M. Bianchi[125], L. Bianchini[23], M. Bianco[30], O. Biebel[100], S.P. Bieniek[78], M. Biglietti[134a], J. Bilbao De Mendizabal[49], H. Bilokon[47], M. Bindi[54], S. Binet[117], A. Bingul[19c], C. Bini[132a,132b], C.W. Black[150], J.E. Black[143], K.M. Black[22], D. Blackburn[138], R.E. Blair[6], J.-B. Blanchard[136], J.E. Blanco[77], T. Blazek[144a], I. Bloch[42], C. Blocker[23], W. Blum[83,*], U. Blumenschein[54], G.J. Bobbink[107], V.S. Bobrovnikov[109,c], S.S. Bocchetta[81], A. Bocci[45], C. Bock[100], M. Boehler[48], J.A. Bogaerts[30], A.G. Bogdanchikov[109], C. Bohm[146a], V. Boisvert[77], T. Bold[38a], V. Boldea[26a], A.S. Boldyrev[99],

M. Bomben[80], M. Bona[76], M. Boonekamp[136], A. Borisov[130], G. Borissov[72], S. Borroni[42], J. Bortfeldt[100], V. Bortolotto[60a,60b,60c], K. Bos[107], D. Boscherini[20a], M. Bosman[12], J. Boudreau[125], J. Bouffard[2], E.V. Bouhova-Thacker[72], D. Boumediene[34], C. Bourdarios[117], N. Bousson[114], A. Boveia[30], J. Boyd[30], I.R. Boyko[65], I. Bozic[13], J. Bracinik[18], A. Brandt[8], G. Brandt[54], O. Brandt[58a], U. Bratzler[156], B. Brau[86], J.E. Brau[116], H.M. Braun[175,*], S.F. Brazzale[164a,164c], K. Brendlinger[122], A.J. Brennan[88], L. Brenner[107], R. Brenner[166], S. Bressler[172], K. Bristow[145c], T.M. Bristow[46], D. Britton[53], D. Britzger[42], F.M. Brochu[28], I. Brock[21], R. Brock[90], J. Bronner[101], G. Brooijmans[35], T. Brooks[77], W.K. Brooks[32b], J. Brosamer[15], E. Brost[116], J. Brown[55], P.A. Bruckman de Renstrom[39], D. Bruncko[144b], R. Bruneliere[48], A. Bruni[20a], G. Bruni[20a], M. Bruschi[20a], L. Bryngemark[81], T. Buanes[14], Q. Buat[142], P. Buchholz[141], A.G. Buckley[53], S.I. Buda[26a], I.A. Budagov[65], F. Buehrer[48], L. Bugge[119], M.K. Bugge[119], O. Bulekov[98], D. Bullock[8], H. Burckhart[30], S. Burdin[74], B. Burghgrave[108], S. Burke[131], I. Burmeister[43], E. Busato[34], D. Büscher[48], V. Büscher[83], P. Bussey[53], C.P. Buszello[166], J.M. Butler[22], A.I. Butt[3], C.M. Buttar[53], J.M. Butterworth[78], P. Butti[107], W. Buttinger[25], A. Buzatu[53], R. Buzykaev[109,c], S. Cabrera Urbán[167], D. Caforio[128], V.M. Cairo[37a,37b], O. Cakir[4a], P. Calafiura[15], A. Calandri[136], G. Calderini[80], P. Calfayan[100], L.P. Caloba[24a], D. Calvet[34], S. Calvet[34], R. Camacho Toro[31], S. Camarda[42], P. Camarri[133a,133b], D. Cameron[119], L.M. Caminada[15], R. Caminal Armadans[12], S. Campana[30], M. Campanelli[78], A. Campoverde[148], V. Canale[104a,104b], A. Canepa[159a], M. Cano Bret[76], J. Cantero[82], R. Cantrill[126a], T. Cao[40], M.D.M. Capeans Garrido[30], I. Caprini[26a], M. 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Sbrizzi[20a,20b], T. Scanlon[78], D.A. Scannicchio[163], M. Scarcella[150], V. Scarfone[37a,37b], J. Schaarschmidt[172], P. Schacht[101], D. Schaefer[30], R. Schaefer[42], J. Schaeffer[83], S. Schaepe[21], S. Schaetzel[58b], U. Schäfer[83], A.C. Schaffer[117], D. Schaile[100], R.D. Schamberger[148], V. Scharf[58a], V.A. Schegelsky[123], D. Scheirich[129], M. Schernau[163], C. Schiavi[50a,50b], C. Schillo[48], M. Schioppa[37a,37b], S. Schlenker[30], E. Schmidt[48], K. Schmieden[30], C. Schmitt[83], S. Schmitt[58b], S. Schmitt[42], B. Schneider[159a], Y.J. Schnellbach[74], U. Schnoor[44], L. Schoeffel[136], A. Schoening[58b], B.D. Schoenrock[90], E. Schopf[21], A.L.S. Schorlemmer[54], M. Schott[83], D. Schouten[159a], J. Schovancova[8], S. Schramm[158], M. Schreyer[174], C. Schroeder[83], N. Schuh[83], M.J. Schultens[21], H.-C. Schultz-Coulon[58a], H. Schulz[16], M. Schumacher[48], B.A. Schumm[137], Ph. Schune[136], C. Schwanenberger[84], A. Schwartzman[143], T.A. Schwarz[89], Ph. Schwegler[101], Ph. Schwemling[136], R. Schwienhorst[90], J. Schwindling[136], T. Schwindt[21], M. Schwoerer[5], F.G. Sciacca[17], E. Scifo[117], G. Sciolla[23], F. Scuri[124a,124b], F. Scutti[21], J. Searcy[89], G. Sedov[42], E. Sedykh[123], P. Seema[21], S.C. Seidel[105], A. Seiden[137], F. Seifert[128], J.M. Seixas[24a], G. Sekhniaidze[104a], K. Sekhon[89], S.J. Sekula[40], K.E. Selbach[46], D.M. Seliverstov[123,*], N. Semprini-Cesari[20a,20b], C. Serfon[30], L. Serin[117], L. Serkin[164a,164b], T. Serre[85], M. Sessa[134a,134b], R. Seuster[159a], H. Severini[113], T. Sfiligoj[75], F. Sforza[101], A. Sfyrla[30], E. Shabalina[54], M. Shamim[116], L.Y. Shan[33a], R. Shang[165], J.T. Shank[22], M. Shapiro[15], P.B. Shatalov[97], K. Shaw[164a,164b], S.M. Shaw[84], A. Shcherbakova[146a,146b], C.Y. Shehu[149], P. Sherwood[78], L. Shi[151,ae], S. Shimizu[67], C.O. Shimmin[163], M. Shimojima[102], M. Shiyakova[65], A. Shmeleva[96], D. Shoaleh Saadi[95], M.J. Shochet[31], S. Shojaii[91a,91b], S. Shrestha[111], E. Shulga[98], M.A. Shupe[7], S. Shushkevich[42],

P. Sicho[127], O. Sidiropoulou[174], D. Sidorov[114], A. Sidoti[20a,20b], F. Siegert[44], Dj. Sijacki[13], J. Silva[126a,126d], Y. Silver[153], S.B. Silverstein[146a], V. Simak[128], O. Simard[5], Lj. Simic[13], S. Simion[117], E. Simioni[83], B. Simmons[78], D. Simon[34], R. Simoniello[91a,91b], P. Sinervo[158], N.B. Sinev[116], G. Siragusa[174], A.N. Sisakyan[65,*], S.Yu. Sivoklokov[99], J. Sjölin[146a,146b], T.B. Sjursen[14], M.B. Skinner[72], H.P. Skottowe[57], P. Skubic[113], M. Slater[18], T. Slavicek[128], M. Slawinska[107], K. Sliwa[161], V. Smakhtin[172], B.H. Smart[46], L. Smestad[14], S.Yu. Smirnov[98], Y. Smirnov[98], L.N. Smirnova[99,af], O. Smirnova[81], M.N.K. Smith[35], R.W. Smith[35], M. Smizanska[72], K. Smolek[128], A.A. Snesarev[96], G. Snidero[76], S. Snyder[25], R. Sobie[169,k], F. Socher[44], A. Soffer[153], D.A. Soh[151,ae], C.A. Solans[30], M. Solar[128], J. Solc[128], E.Yu. Soldatov[98], U. Soldevila[167], A.A. Solodkov[130], A. Soloshenko[65], O.V. Solovyanov[130], V. Solovyev[123], P. Sommer[48], H.Y. Song[33b], N. Soni[1], A. Sood[15], A. Sopczak[128], B. Sopko[128], V. Sopko[128], V. Sorin[12], D. Sosa[58b], M. Sosebee[8], C.L. Sotiropoulou[124a,124b], R. Soualah[164a,164c], P. Soueid[95], A.M. Soukharev[109,c], D. South[42], B.C. Sowden[77], S. Spagnolo[73a,73b], M. Spalla[124a,124b], F. Spanò[77], W.R. Spearman[57], F. Spettel[101], R. Spighi[20a], G. Spigo[30], L.A. Spiller[88], M. Spousta[129], T. Spreitzer[158], R.D. St. Denis[53,*], S. Staerz[44], J. Stahlman[122], R. Stamen[58a], S. Stamm[16], E. Stanecka[39], C. Stanescu[134a], M. Stanescu-Bellu[42], M.M. Stanitzki[42], S. Stapnes[119], E.A. Starchenko[130], J. Stark[55], P. Staroba[127], P. Starovoitov[42], R. Staszewski[39], P. Stavina[144a,*], P. Steinberg[25], B. Stelzer[142], H.J. Stelzer[30], O. Stelzer-Chilton[159a], H. Stenzel[52], S. Stern[101], G.A. Stewart[53], J.A. Stillings[21], M.C. Stockton[87], M. Stoebe[87], G. Stoicea[26a], P. Stolte[54], S. Stonjek[101], A.R. Stradling[8], A. Straessner[44], M.E. Stramaglia[17], J. Strandberg[147], S. Strandberg[146a,146b], A. Strandlie[119], E. Strauss[143], M. Strauss[113], P. Strizenec[144b], R. Ströhmer[174], D.M. Strom[116], R. Stroynowski[40], A. Strubig[106], S.A. Stucci[17], B. Stugu[14], N.A. Styles[42], D. Su[143], J. Su[125], R. Subramaniam[79], A. Succurro[12], Y. Sugaya[118], C. Suhr[108], M. Suk[128], V.V. Sulin[96], S. Sultansoy[4d], T. Sumida[68], S. Sun[57], X. Sun[33a], J.E. Sundermann[48], K. Suruliz[149], G. Susinno[37a,37b], M.R. Sutton[149], S. Suzuki[66], Y. Suzuki[66], M. Svatos[127], S. Swedish[168], M. Swiatlowski[143], I. Sykora[144a], T. Sykora[129], D. Ta[90], C. Taccini[134a,134b], K. Tackmann[42], J. Taenzer[158], A. Taffard[163], R. Tafirout[159a], N. Taiblum[153], H. Takai[25], R. Takashima[69], H. Takeda[67], T. Takeshita[140], Y. Takubo[66], M. Talby[85], A.A. Talyshev[109,c], J.Y.C. Tam[174], K.G. Tan[88], J. Tanaka[155], R. Tanaka[117], S. 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[1] Department of Physics, University of Adelaide, Adelaide, Australia
[2] Physics Department, SUNY Albany, Albany NY, United States of America
[3] Department of Physics, University of Alberta, Edmonton AB, Canada

[4] [(a)] Department of Physics, Ankara University, Ankara; [(c)] Istanbul Aydin University, Istanbul; [(d)] Division of Physics, TOBB University of Economics and Technology, Ankara, Turkey
[5] LAPP, CNRS/IN2P3 and Université Savoie Mont Blanc, Annecy-le-Vieux, France
[6] High Energy Physics Division, Argonne National Laboratory, Argonne IL, United States of America
[7] Department of Physics, University of Arizona, Tucson AZ, United States of America
[8] Department of Physics, The University of Texas at Arlington, Arlington TX, United States of America
[9] Physics Department, University of Athens, Athens, Greece
[10] Physics Department, National Technical University of Athens, Zografou, Greece
[11] Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan
[12] Institut de Física d'Altes Energies and Departament de Física de la Universitat Autònoma de Barcelona, Barcelona, Spain
[13] Institute of Physics, University of Belgrade, Belgrade, Serbia
[14] Department for Physics and Technology, University of Bergen, Bergen, Norway
[15] Physics Division, Lawrence Berkeley National Laboratory and University of California, Berkeley CA, United States of America
[16] Department of Physics, Humboldt University, Berlin, Germany
[17] Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern, Switzerland
[18] School of Physics and Astronomy, University of Birmingham, Birmingham, United Kingdom
[19] [(a)] Department of Physics, Bogazici University, Istanbul; [(b)] Department of Physics, Dogus University, Istanbul; [(c)] Department of Physics Engineering, Gaziantep University, Gaziantep, Turkey
[20] [(a)] INFN Sezione di Bologna; [(b)] Dipartimento di Fisica e Astronomia, Università di Bologna, Bologna, Italy
[21] Physikalisches Institut, University of Bonn, Bonn, Germany
[22] Department of Physics, Boston University, Boston MA, United States of America
[23] Department of Physics, Brandeis University, Waltham MA, United States of America
[24] [(a)] Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro; [(b)] Electrical Circuits Department, Federal University of Juiz de Fora (UFJF), Juiz de Fora; [(c)] Federal University of Sao Joao del Rei (UFSJ), Sao Joao del Rei; [(d)] Instituto de Fisica, Universidade de Sao Paulo, Sao Paulo, Brazil
[25] Physics Department, Brookhaven National Laboratory, Upton NY, United States of America
[26] [(a)] National Institute of Physics and Nuclear Engineering, Bucharest; [(b)] National Institute for Research and Development of Isotopic and Molecular Technologies, Physics Department, Cluj Napoca; [(c)] University Politehnica Bucharest, Bucharest; [(d)] West University in Timisoara, Timisoara, Romania
[27] Departamento de Física, Universidad de Buenos Aires, Buenos Aires, Argentina
[28] Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom
[29] Department of Physics, Carleton University, Ottawa ON, Canada
[30] CERN, Geneva, Switzerland
[31] Enrico Fermi Institute, University of Chicago, Chicago IL, United States of America
[32] [(a)] Departamento de Física, Pontificia Universidad Católica de Chile, Santiago; [(b)] Departamento de Física, Universidad Técnica Federico Santa María, Valparaíso, Chile
[33] [(a)] Institute of High Energy Physics, Chinese Academy of Sciences, Beijing; [(b)] Department of Modern Physics, University of Science and Technology of China, Anhui; [(c)] Department of Physics, Nanjing University, Jiangsu; [(d)] School of Physics, Shandong University, Shandong; [(e)] Department of Physics and Astronomy, Shanghai Key Laboratory for Particle Physics

and Cosmology, Shanghai Jiao Tong University, Shanghai; [(f)] Physics Department, Tsinghua University, Beijing 100084, China
[34] Laboratoire de Physique Corpusculaire, Clermont Université and Université Blaise Pascal and CNRS/IN2P3, Clermont-Ferrand, France
[35] Nevis Laboratory, Columbia University, Irvington NY, United States of America
[36] Niels Bohr Institute, University of Copenhagen, Kobenhavn, Denmark
[37] [(a)] INFN Gruppo Collegato di Cosenza, Laboratori Nazionali di Frascati; [(b)] Dipartimento di Fisica, Università della Calabria, Rende, Italy
[38] [(a)] AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow; [(b)] Marian Smoluchowski Institute of Physics, Jagiellonian University, Krakow, Poland
[39] Institute of Nuclear Physics Polish Academy of Sciences, Krakow, Poland
[40] Physics Department, Southern Methodist University, Dallas TX, United States of America
[41] Physics Department, University of Texas at Dallas, Richardson TX, United States of America
[42] DESY, Hamburg and Zeuthen, Germany
[43] Institut für Experimentelle Physik IV, Technische Universität Dortmund, Dortmund, Germany
[44] Institut für Kern- und Teilchenphysik, Technische Universität Dresden, Dresden, Germany
[45] Department of Physics, Duke University, Durham NC, United States of America
[46] SUPA - School of Physics and Astronomy, University of Edinburgh, Edinburgh, United Kingdom
[47] INFN Laboratori Nazionali di Frascati, Frascati, Italy
[48] Fakultät für Mathematik und Physik, Albert-Ludwigs-Universität, Freiburg, Germany
[49] Section de Physique, Université de Genève, Geneva, Switzerland
[50] [(a)] INFN Sezione di Genova; [(b)] Dipartimento di Fisica, Università di Genova, Genova, Italy
[51] [(a)] E. Andronikashvili Institute of Physics, Iv. Javakhishvili Tbilisi State University, Tbilisi; [(b)] High Energy Physics Institute, Tbilisi State University, Tbilisi, Georgia
[52] II Physikalisches Institut, Justus-Liebig-Universität Giessen, Giessen, Germany
[53] SUPA - School of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom
[54] II Physikalisches Institut, Georg-August-Universität, Göttingen, Germany
[55] Laboratoire de Physique Subatomique et de Cosmologie, Université Grenoble-Alpes, CNRS/IN2P3, Grenoble, France
[56] Department of Physics, Hampton University, Hampton VA, United States of America
[57] Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge MA, United States of America
[58] [(a)] Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg; [(b)] Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg; [(c)] ZITI Institut für technische Informatik, Ruprecht-Karls-Universität Heidelberg, Mannheim, Germany
[59] Faculty of Applied Information Science, Hiroshima Institute of Technology, Hiroshima, Japan
[60] [(a)] Department of Physics, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong; [(b)] Department of Physics, The University of Hong Kong, Hong Kong; [(c)] Department of Physics, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China
[61] Department of Physics, Indiana University, Bloomington IN, United States of America
[62] Institut für Astro- und Teilchenphysik, Leopold-Franzens-Universität, Innsbruck, Austria
[63] University of Iowa, Iowa City IA, United States of America
[64] Department of Physics and Astronomy, Iowa State University, Ames IA, United States of America

[65] Joint Institute for Nuclear Research, JINR Dubna, Dubna, Russia
[66] KEK, High Energy Accelerator Research Organization, Tsukuba, Japan
[67] Graduate School of Science, Kobe University, Kobe, Japan
[68] Faculty of Science, Kyoto University, Kyoto, Japan
[69] Kyoto University of Education, Kyoto, Japan
[70] Department of Physics, Kyushu University, Fukuoka, Japan
[71] Instituto de Física La Plata, Universidad Nacional de La Plata and CONICET, La Plata, Argentina
[72] Physics Department, Lancaster University, Lancaster, United Kingdom
[73] [(a)] INFN Sezione di Lecce; [(b)] Dipartimento di Matematica e Fisica, Università del Salento, Lecce, Italy
[74] Oliver Lodge Laboratory, University of Liverpool, Liverpool, United Kingdom
[75] Department of Physics, Jožef Stefan Institute and University of Ljubljana, Ljubljana, Slovenia
[76] School of Physics and Astronomy, Queen Mary University of London, London, United Kingdom
[77] Department of Physics, Royal Holloway University of London, Surrey, United Kingdom
[78] Department of Physics and Astronomy, University College London, London, United Kingdom
[79] Louisiana Tech University, Ruston LA, United States of America
[80] Laboratoire de Physique Nucléaire et de Hautes Energies, UPMC and Université Paris-Diderot and CNRS/IN2P3, Paris, France
[81] Fysiska institutionen, Lunds universitet, Lund, Sweden
[82] Departamento de Fisica Teorica C-15, Universidad Autonoma de Madrid, Madrid, Spain
[83] Institut für Physik, Universität Mainz, Mainz, Germany
[84] School of Physics and Astronomy, University of Manchester, Manchester, United Kingdom
[85] CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France
[86] Department of Physics, University of Massachusetts, Amherst MA, United States of America
[87] Department of Physics, McGill University, Montreal QC, Canada
[88] School of Physics, University of Melbourne, Victoria, Australia
[89] Department of Physics, The University of Michigan, Ann Arbor MI, United States of America
[90] Department of Physics and Astronomy, Michigan State University, East Lansing MI, United States of America
[91] [(a)] INFN Sezione di Milano; [(b)] Dipartimento di Fisica, Università di Milano, Milano, Italy
[92] B.I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Minsk, Republic of Belarus
[93] National Scientific and Educational Centre for Particle and High Energy Physics, Minsk, Republic of Belarus
[94] Department of Physics, Massachusetts Institute of Technology, Cambridge MA, United States of America
[95] Group of Particle Physics, University of Montreal, Montreal QC, Canada
[96] P.N. Lebedev Institute of Physics, Academy of Sciences, Moscow, Russia
[97] Institute for Theoretical and Experimental Physics (ITEP), Moscow, Russia
[98] National Research Nuclear University MEPhI, Moscow, Russia
[99] D.V. Skobeltsyn Institute of Nuclear Physics, M.V. Lomonosov Moscow State University, Moscow, Russia
[100] Fakultät für Physik, Ludwig-Maximilians-Universität München, München, Germany
[101] Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München, Germany
[102] Nagasaki Institute of Applied Science, Nagasaki, Japan

[103] Graduate School of Science and Kobayashi-Maskawa Institute, Nagoya University, Nagoya, Japan
[104] [(a)] INFN Sezione di Napoli; [(b)] Dipartimento di Fisica, Università di Napoli, Napoli, Italy
[105] Department of Physics and Astronomy, University of New Mexico, Albuquerque NM, United States of America
[106] Institute for Mathematics, Astrophysics and Particle Physics, Radboud University Nijmegen/Nikhef, Nijmegen, Netherlands
[107] Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam, Netherlands
[108] Department of Physics, Northern Illinois University, DeKalb IL, United States of America
[109] Budker Institute of Nuclear Physics, SB RAS, Novosibirsk, Russia
[110] Department of Physics, New York University, New York NY, United States of America
[111] Ohio State University, Columbus OH, United States of America
[112] Faculty of Science, Okayama University, Okayama, Japan
[113] Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman OK, United States of America
[114] Department of Physics, Oklahoma State University, Stillwater OK, United States of America
[115] Palacký University, RCPTM, Olomouc, Czech Republic
[116] Center for High Energy Physics, University of Oregon, Eugene OR, United States of America
[117] LAL, Université Paris-Sud and CNRS/IN2P3, Orsay, France
[118] Graduate School of Science, Osaka University, Osaka, Japan
[119] Department of Physics, University of Oslo, Oslo, Norway
[120] Department of Physics, Oxford University, Oxford, United Kingdom
[121] [(a)] INFN Sezione di Pavia; [(b)] Dipartimento di Fisica, Università di Pavia, Pavia, Italy
[122] Department of Physics, University of Pennsylvania, Philadelphia PA, United States of America
[123] National Research Centre "Kurchatov Institute" B.P.Konstantinov Petersburg Nuclear Physics Institute, St. Petersburg, Russia
[124] [(a)] INFN Sezione di Pisa; [(b)] Dipartimento di Fisica E. Fermi, Università di Pisa, Pisa, Italy
[125] Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh PA, United States of America
[126] [(a)] Laboratorio de Instrumentacao e Fisica Experimental de Particulas - LIP, Lisboa; [(b)] Faculdade de Ciências, Universidade de Lisboa, Lisboa; [(c)] Department of Physics, University of Coimbra, Coimbra; [(d)] Centro de Física Nuclear da Universidade de Lisboa, Lisboa; [(e)] Departamento de Fisica, Universidade do Minho, Braga; [(f)] Departamento de Fisica Teorica y del Cosmos and CAFPE, Universidad de Granada, Granada (Spain); [(g)] Dep Fisica and CEFITEC of Faculdade de Ciencias e Tecnologia, Universidade Nova de Lisboa, Caparica, Portugal
[127] Institute of Physics, Academy of Sciences of the Czech Republic, Praha, Czech Republic
[128] Czech Technical University in Prague, Praha, Czech Republic
[129] Faculty of Mathematics and Physics, Charles University in Prague, Praha, Czech Republic
[130] State Research Center Institute for High Energy Physics, Protvino, Russia
[131] Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom
[132] [(a)] INFN Sezione di Roma; [(b)] Dipartimento di Fisica, Sapienza Università di Roma, Roma, Italy
[133] [(a)] INFN Sezione di Roma Tor Vergata; [(b)] Dipartimento di Fisica, Università di Roma Tor Vergata, Roma, Italy
[134] [(a)] INFN Sezione di Roma Tre; [(b)] Dipartimento di Matematica e Fisica, Università Roma

Tre, Roma, Italy
[135] [(a)] Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies - Université Hassan II, Casablanca; [(b)] Centre National de l'Energie des Sciences Techniques Nucleaires, Rabat; [(c)] Faculté des Sciences Semlalia, Université Cadi Ayyad, LPHEA-Marrakech; [(d)] Faculté des Sciences, Université Mohamed Premier and LPTPM, Oujda; [(e)] Faculté des sciences, Université Mohammed V-Agdal, Rabat, Morocco
[136] DSM/IRFU (Institut de Recherches sur les Lois Fondamentales de l'Univers), CEA Saclay (Commissariat à l'Energie Atomique et aux Energies Alternatives), Gif-sur-Yvette, France
[137] Santa Cruz Institute for Particle Physics, University of California Santa Cruz, Santa Cruz CA, United States of America
[138] Department of Physics, University of Washington, Seattle WA, United States of America
[139] Department of Physics and Astronomy, University of Sheffield, Sheffield, United Kingdom
[140] Department of Physics, Shinshu University, Nagano, Japan
[141] Fachbereich Physik, Universität Siegen, Siegen, Germany
[142] Department of Physics, Simon Fraser University, Burnaby BC, Canada
[143] SLAC National Accelerator Laboratory, Stanford CA, United States of America
[144] [(a)] Faculty of Mathematics, Physics & Informatics, Comenius University, Bratislava; [(b)] Department of Subnuclear Physics, Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice, Slovak Republic
[145] [(a)] Department of Physics, University of Cape Town, Cape Town; [(b)] Department of Physics, University of Johannesburg, Johannesburg; [(c)] School of Physics, University of the Witwatersrand, Johannesburg, South Africa
[146] [(a)] Department of Physics, Stockholm University; [(b)] The Oskar Klein Centre, Stockholm, Sweden
[147] Physics Department, Royal Institute of Technology, Stockholm, Sweden
[148] Departments of Physics & Astronomy and Chemistry, Stony Brook University, Stony Brook NY, United States of America
[149] Department of Physics and Astronomy, University of Sussex, Brighton, United Kingdom
[150] School of Physics, University of Sydney, Sydney, Australia
[151] Institute of Physics, Academia Sinica, Taipei, Taiwan
[152] Department of Physics, Technion: Israel Institute of Technology, Haifa, Israel
[153] Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel
[154] Department of Physics, Aristotle University of Thessaloniki, Thessaloniki, Greece
[155] International Center for Elementary Particle Physics and Department of Physics, The University of Tokyo, Tokyo, Japan
[156] Graduate School of Science and Technology, Tokyo Metropolitan University, Tokyo, Japan
[157] Department of Physics, Tokyo Institute of Technology, Tokyo, Japan
[158] Department of Physics, University of Toronto, Toronto ON, Canada
[159] [(a)] TRIUMF, Vancouver BC; [(b)] Department of Physics and Astronomy, York University, Toronto ON, Canada
[160] Faculty of Pure and Applied Sciences, University of Tsukuba, Tsukuba, Japan
[161] Department of Physics and Astronomy, Tufts University, Medford MA, United States of America
[162] Centro de Investigaciones, Universidad Antonio Narino, Bogota, Colombia
[163] Department of Physics and Astronomy, University of California Irvine, Irvine CA, United States of America
[164] [(a)] INFN Gruppo Collegato di Udine, Sezione di Trieste, Udine; [(b)] ICTP, Trieste; [(c)] Dipartimento di Chimica, Fisica e Ambiente, Università di Udine, Udine, Italy

[165] Department of Physics, University of Illinois, Urbana IL, United States of America
[166] Department of Physics and Astronomy, University of Uppsala, Uppsala, Sweden
[167] Instituto de Física Corpuscular (IFIC) and Departamento de Física Atómica, Molecular y Nuclear and Departamento de Ingeniería Electrónica and Instituto de Microelectrónica de Barcelona (IMB-CNM), University of Valencia and CSIC, Valencia, Spain
[168] Department of Physics, University of British Columbia, Vancouver BC, Canada
[169] Department of Physics and Astronomy, University of Victoria, Victoria BC, Canada
[170] Department of Physics, University of Warwick, Coventry, United Kingdom
[171] Waseda University, Tokyo, Japan
[172] Department of Particle Physics, The Weizmann Institute of Science, Rehovot, Israel
[173] Department of Physics, University of Wisconsin, Madison WI, United States of America
[174] Fakultät für Physik und Astronomie, Julius-Maximilians-Universität, Würzburg, Germany
[175] Fachbereich C Physik, Bergische Universität Wuppertal, Wuppertal, Germany
[176] Department of Physics, Yale University, New Haven CT, United States of America
[177] Yerevan Physics Institute, Yerevan, Armenia
[178] Centre de Calcul de l'Institut National de Physique Nucléaire et de Physique des Particules (IN2P3), Villeurbanne, France
[a] Also at Department of Physics, King's College London, London, United Kingdom
[b] Also at Institute of Physics, Azerbaijan Academy of Sciences, Baku, Azerbaijan
[c] Also at Novosibirsk State University, Novosibirsk, Russia
[d] Also at TRIUMF, Vancouver BC, Canada
[e] Also at Department of Physics, California State University, Fresno CA, United States of America
[f] Also at Department of Physics, University of Fribourg, Fribourg, Switzerland
[g] Also at Departamento de Fisica e Astronomia, Faculdade de Ciencias, Universidade do Porto, Portugal
[h] Also at Tomsk State University, Tomsk, Russia
[i] Also at CPPM, Aix-Marseille Université and CNRS/IN2P3, Marseille, France
[j] Also at Università di Napoli Parthenope, Napoli, Italy
[k] Also at Institute of Particle Physics (IPP), Canada
[l] Also at Particle Physics Department, Rutherford Appleton Laboratory, Didcot, United Kingdom
[m] Also at Department of Physics, St. Petersburg State Polytechnical University, St. Petersburg, Russia
[n] Also at Louisiana Tech University, Ruston LA, United States of America
[o] Also at Institucio Catalana de Recerca i Estudis Avancats, ICREA, Barcelona, Spain
[p] Also at Department of Physics, National Tsing Hua University, Taiwan
[q] Also at Department of Physics, The University of Texas at Austin, Austin TX, United States of America
[r] Also at Institute of Theoretical Physics, Ilia State University, Tbilisi, Georgia
[s] Also at CERN, Geneva, Switzerland
[t] Also at Georgian Technical University (GTU),Tbilisi, Georgia
[u] Also at Ochadai Academic Production, Ochanomizu University, Tokyo, Japan
[v] Also at Manhattan College, New York NY, United States of America
[w] Also at Institute of Physics, Academia Sinica, Taipei, Taiwan
[x] Also at LAL, Université Paris-Sud and CNRS/IN2P3, Orsay, France
[y] Also at Academia Sinica Grid Computing, Institute of Physics, Academia Sinica, Taipei, Taiwan
[z] Also at School of Physics, Shandong University, Shandong, China

[aa] Also at Moscow Institute of Physics and Technology State University, Dolgoprudny, Russia
[ab] Also at Section de Physique, Université de Genève, Geneva, Switzerland
[ac] Also at International School for Advanced Studies (SISSA), Trieste, Italy
[ad] Also at Department of Physics and Astronomy, University of South Carolina, Columbia SC, United States of America
[ae] Also at School of Physics and Engineering, Sun Yat-sen University, Guangzhou, China
[af] Also at Faculty of Physics, M.V.Lomonosov Moscow State University, Moscow, Russia
[ag] Also at National Research Nuclear University MEPhI, Moscow, Russia
[ah] Also at Department of Physics, Stanford University, Stanford CA, United States of America
[ai] Also at Institute for Particle and Nuclear Physics, Wigner Research Centre for Physics, Budapest, Hungary
[aj] Also at Department of Physics, The University of Michigan, Ann Arbor MI, United States of America
[ak] Also at Discipline of Physics, University of KwaZulu-Natal, Durban, South Africa
[al] Also at University of Malaya, Department of Physics, Kuala Lumpur, Malaysia
* Deceased

B The CMS Collaboration

V. Khachatryan[1], A.M. Sirunyan[1], A. Tumasyan[1], W. Adam[2], E. Asilar[2], T. Bergauer[2], J. Brandstetter[2], E. Brondolin[2], M. Dragicevic[2], J. Erö[2], M. Flechl[2], M. Friedl[2], R. Frühwirth[2,b], V.M. Ghete[2], C. Hartl[2], N. Hörmann[2], J. Hrubec[2], M. Jeitler[2,b], V. Knünz[2], A. König[2], M. Krammer[2,b], I. Krätschmer[2], D. Liko[2], T. Matsushita[2], I. Mikulec[2], D. Rabady[2,c], B. Rahbaran[2], H. Rohringer[2], J. Schieck[2,b], R. Schöfbeck[2], J. Strauss[2], W. Treberer-Treberspurg[2], W. Waltenberger[2], C.-E. Wulz[2,b], V. Mossolov[3], N. Shumeiko[3], J. Suarez Gonzalez[3], S. Alderweireldt[4], T. Cornelis[4], E.A. De Wolf[4], X. Janssen[4], A. Knutsson[4], J. Lauwers[4], S. Luyckx[4], S. Ochesanu[4], R. Rougny[4], M. Van De Klundert[4], H. Van Haevermaet[4], P. Van Mechelen[4], N. Van Remortel[4], A. Van Spilbeeck[4], S. Abu Zeid[5], F. Blekman[5], J. D'Hondt[5], N. Daci[5], I. De Bruyn[5], K. Deroover[5], N. Heracleous[5], J. Keaveney[5], S. Lowette[5], L. Moreels[5], A. Olbrechts[5], Q. Python[5], D. Strom[5], S. Tavernier[5], W. Van Doninck[5], P. Van Mulders[5], G.P. Van Onsem[5], I. Van Parijs[5], P. Barria[6], C. Caillol[6], B. Clerbaux[6], G. De Lentdecker[6], H. Delannoy[6], D. Dobur[6], G. Fasanella[6], L. Favart[6], A.P.R. Gay[6], A. Grebenyuk[6], T. Lenzi[6], A. Léonard[6], T. Maerschalk[6], A. Mohammadi[6], L. Perniè[6], A. Randle-conde[6], T. Reis[6], T. Seva[6], L. Thomas[6], C. Vander Velde[6], P. Vanlaer[6], J. Wang[6], R. Yonamine[6], F. Zenoni[6], F. Zhang[6,d], K. Beernaert[7], L. Benucci[7], A. Cimmino[7], S. Crucy[7], A. Fagot[7], G. Garcia[7], M. Gul[7], J. Mccartin[7], A.A. Ocampo Rios[7], D. Poyraz[7], D. Ryckbosch[7], S. Salva Diblen[7], M. Sigamani[7], N. Strobbe[7], M. Tytgat[7], W. Van Driessche[7], E. Yazgan[7], N. Zaganidis[7], S. Basegmez[8], C. Beluffi[8,e], O. Bondu[8], G. Bruno[8], R. Castello[8], A. Caudron[8], L. Ceard[8], G.G. Da Silveira[8], C. Delaere[8], D. Favart[8], L. Forthomme[8], A. Giammanco[8,f], J. Hollar[8], A. Jafari[8], P. Jez[8], M. Komm[8], V. Lemaitre[8], A. Mertens[8], C. Nuttens[8], L. Perrini[8], A. Pin[8], K. Piotrzkowski[8], A. Popov[8,g], L. Quertenmont[8], M. Selvaggi[8], M. Vidal Marono[8], N. Beliy[9], T. Caebergs[9], G.H. Hammad[9], W.L. Aldá Júnior[10], G.A. Alves[10], L. Brito[10], M. Correa Martins Junior[10], T. Dos Reis Martins[10], C. Hensel[10], C. Mora Herrera[10], A. Moraes[10], M.E. Pol[10], P. Rebello Teles[10], E. Belchior Batista Das Chagas[11], W. Carvalho[11], J. Chinellato[11,h], A. Custódio[11], E.M. Da Costa[11], D. De Jesus Damiao[11], C. De Oliveira Martins[11], S. Fonseca De Souza[11], L.M. Huertas Guativa[11], H. Malbouisson[11], D. Matos Figueiredo[11], L. Mundim[11], H. Nogima[11], W.L. Prado Da Silva[11], A. Santoro[11], A. Sznajder[11], E.J. Tonelli Manganote[11,h], A. Vilela Pereira[11], S. Ahuja[12a], C.A. Bernardes[12b], A. De Souza Santos[12b], S. Dogra[12a], T.R. Fernandez Perez Tomei[12a], E.M. Gregores[12b], P.G. Mercadante[12b], C.S. Moon[12a,i], S.F. Novaes[12a], Sandra S. Padula[12a], D. Romero Abad[12a], J.C. Ruiz Vargas[12a], A. Aleksandrov[13], V. Genchev[13,c], R. Hadjiiska[13], P. Iaydjiev[13], A. Marinov[13], S. Piperov[13], M. Rodozov[13], S. Stoykova[13], G. Sultanov[13], M. Vutova[13], A. Dimitrov[14], I. Glushkov[14], L. Litov[14], B. Pavlov[14], P. Petkov[14], M. Ahmad[15], J.G. Bian[15], G.M. Chen[15], H.S. Chen[15], M. Chen[15], T. Cheng[15], R. Du[15], C.H. Jiang[15], R. Plestina[15,j], F. Romeo[15], S.M. Shaheen[15], J. Tao[15], C. Wang[15], Z. Wang[15], H. Zhang[15], C. Asawatangtrakuldee[16], Y. Ban[16], G. Chen[16], Q. Li[16], S. Liu[16], Y. Mao[16], S.J. Qian[16], D. Wang[16], M. Wang[16], Q. Wang[16], Z. Xu[16], D. Yang[16], Z. Zhang[16], W. Zou[16], C. Avila[17], A. Cabrera[17], L.F. Chaparro Sierra[17], C. Florez[17], J.P. Gomez[17], B. Gomez Moreno[17], J.C. Sanabria[17], N. Godinovic[18], D. Lelas[18], D. Polic[18], I. Puljak[18], Z. Antunovic[19], M. Kovac[19], V. Brigljevic[20], K. Kadija[20], J. Luetic[20], L. Sudic[20], A. Attikis[21], G. Mavromanolakis[21], J. Mousa[21], C. Nicolaou[21], F. Ptochos[21], P.A. Razis[21], H. Rykaczewski[21], M. Bodlak[22], M. Finger[22,k], M. Finger Jr.[22,k], A. Ali[23,l,m], R. Aly[23,n], S. Aly[23,n], Y. Assran[23,o], A. Ellithi Kamel[23,p], A. Lotfy[23,q], M.A. Mahmoud[23,r], R. Masod[23,s], A. Radi[23,t,s], B. Calpas[24], M. Kadastik[24], M. Murumaa[24], M. Raidal[24], A. Tiko[24], C. Veelken[24], P. Eerola[25], J. Pekkanen[25], M. Voutilainen[25], J. Härkönen[26], V. Karimäki[26], R. Kinnunen[26], T. Lampén[26], K. Lassila-Perini[26], S. Lehti[26], T. Lindén[26], P. Luukka[26], T. Mäenpää[26], T. Peltola[26], E. Tuominen[26], J. Tuominiemi[26], E. Tuovinen[26], L. Wendland[26], J. Talvitie[27], T. Tuuva[27], M. Besancon[28], F. Couderc[28], M. Dejardin[28],

D. Denegri[28], B. Fabbro[28], J.L. Faure[28], C. Favaro[28], F. Ferri[28], S. Ganjour[28], A. Givernaud[28], P. Gras[28], G. Hamel de Monchenault[28], P. Jarry[28], E. Locci[28], M. Machet[28], J. Malcles[28], J. Rander[28], A. Rosowsky[28], M. Titov[28], A. Zghiche[28], S. Baffioni[29], F. Beaudette[29], P. Busson[29], L. Cadamuro[29], E. Chapon[29], C. Charlot[29], T. Dahms[29], O. Davignon[29], N. Filipovic[29], A. Florent[29], R. Granier de Cassagnac[29], S. Lisniak[29], L. Mastrolorenzo[29], P. Miné[29], I.N. Naranjo[29], M. Nguyen[29], C. Ochando[29], G. Ortona[29], P. Paganini[29], S. Regnard[29], R. Salerno[29], J.B. Sauvan[29], Y. Sirois[29], T. Strebler[29], Y. Yilmaz[29], A. Zabi[29], J.-L. Agram[30,u], J. Andrea[30], A. Aubin[30], D. Bloch[30], J.-M. Brom[30], M. Buttignol[30], E.C. Chabert[30], N. Chanon[30], C. Collard[30], E. Conte[30,u], J.-C. Fontaine[30,u], D. Gelé[30], U. Goerlach[30], C. Goetzmann[30], A.-C. Le Bihan[30], J.A. Merlin[30,c], K. Skovpen[30], P. Van Hove[30], S. Gadrat[31], S. Beauceron[32], C. Bernet[32], G. Boudoul[32], E. Bouvier[32], S. Brochet[32], C.A. Carrillo Montoya[32], J. Chasserat[32], R. Chierici[32], D. Contardo[32], B. Courbon[32], P. Depasse[32], H. El Mamouni[32], J. Fan[32], J. Fay[32], S. Gascon[32], M. Gouzevitch[32], B. Ille[32], I.B. Laktineh[32], M. Lethuillier[32], L. Mirabito[32], A.L. Pequegnot[32], S. Perries[32], J.D. Ruiz Alvarez[32], D. Sabes[32], L. Sgandurra[32], V. Sordini[32], M. Vander Donckt[32], P. Verdier[32], S. Viret[32], H. Xiao[32], Z. Tsamalaidze[33,k], C. Autermann[34], S. Beranek[34], M. Bontenackels[34], M. Edelhoff[34], L. Feld[34], A. Heister[34], M.K. Kiesel[34], K. Klein[34], M. Lipinski[34], A. Ostapchuk[34], M. Preuten[34], F. Raupach[34], J. Sammet[34], S. Schael[34], J.F. Schulte[34], T. Verlage[34], H. Weber[34], B. Wittmer[34], V. Zhukov[34,g], M. Ata[35], M. Brodski[35], E. Dietz-Laursonn[35], D. Duchardt[35], M. Endres[35], M. Erdmann[35], S. Erdweg[35], T. Esch[35], R. Fischer[35], A. Güth[35], T. Hebbeker[35], C. Heidemann[35], K. Hoepfner[35], D. Klingebiel[35], S. Knutzen[35], P. Kreuzer[35], M. Merschmeyer[35], A. Meyer[35], P. Millet[35], M. Olschewski[35], K. Padeken[35], P. Papacz[35], T. Pook[35], M. Radziej[35], H. Reithler[35], M. Rieger[35], F. Scheuch[35], L. Sonnenschein[35], D. Teyssier[35], S. Thüer[35], V. Cherepanov[36], Y. Erdogan[36], G. Flügge[36], H. Geenen[36], M. Geisler[36], W. Haj Ahmad[36], F. Hoehle[36], B. Kargoll[36], T. Kress[36], Y. Kuessel[36], A. Künsken[36], J. Lingemann[36,c], A. Nehrkorn[36], A. Nowack[36], I.M. Nugent[36], C. Pistone[36], O. Pooth[36], A. Stahl[36], M. Aldaya Martin[37], I. Asin[37], N. Bartosik[37], O. Behnke[37], U. Behrens[37], A.J. Bell[37], K. Borras[37], A. Burgmeier[37], A. Cakir[37], L. Calligaris[37], A. Campbell[37], S. Choudhury[37], F. Costanza[37], C. Diez Pardos[37], G. Dolinska[37], S. Dooling[37], T. Dorland[37], G. Eckerlin[37], D. Eckstein[37], T. Eichhorn[37], G. Flucke[37], E. Gallo[37], J. Garay Garcia[37], A. Geiser[37], A. Gizhko[37], P. Gunnellini[37], J. Hauk[37], M. Hempel[37,v], H. Jung[37], A. Kalogeropoulos[37], O. Karacheban[37,v], M. Kasemann[37], P. Katsas[37], J. Kieseler[37], C. Kleinwort[37], I. Korol[37], W. Lange[37], J. Leonard[37], K. Lipka[37], A. Lobanov[37], W. Lohmann[37,v], R. Mankel[37], I. Marfin[37,v], I.-A. Melzer-Pellmann[37], A.B. Meyer[37], G. Mittag[37], J. Mnich[37], A. Mussgiller[37], S. Naumann-Emme[37], A. Nayak[37], E. Ntomari[37], H. Perrey[37], D. Pitzl[37], R. Placakyte[37], A. Raspereza[37], P.M. Ribeiro Cipriano[37], B. Roland[37], M.Ö. Sahin[37], J. Salfeld-Nebgen[37], P. Saxena[37], T. Schoerner-Sadenius[37], M. Schröder[37], C. Seitz[37], S. Spannagel[37], K.D. Trippkewitz[37], C. Wissing[37], V. Blobel[38], M. Centis Vignali[38], A.R. Draeger[38], J. Erfle[38], E. Garutti[38], K. Goebel[38], D. Gonzalez[38], M. Görner[38], J. Haller[38], M. Hoffmann[38], R.S. Höing[38], A. Junkes[38], R. Klanner[38], R. Kogler[38], T. Lapsien[38], T. Lenz[38], I. Marchesini[38], D. Marconi[38], D. Nowatschin[38], J. Ott[38], F. Pantaleo[38,c], T. Peiffer[38], A. Perieanu[38], N. Pietsch[38], J. Poehlsen[38], D. Rathjens[38], C. Sander[38], H. Schettler[38], P. Schleper[38], E. Schlieckau[38], A. Schmidt[38], J. Schwandt[38], M. Seidel[38], V. Sola[38], H. Stadie[38], G. Steinbrück[38], H. Tholen[38], D. Troendle[38], E. Usai[38], L. Vanelderen[38], A. Vanhoefer[38], M. Akbiyik[39], C. Amstutz[39], C. Barth[39], C. Baus[39], J. Berger[39], C. Beskidt[39], C. Böser[39], E. Butz[39], R. Caspart[39], T. Chwalek[39], F. Colombo[39], W. De Boer[39], A. Descroix[39], A. Dierlamm[39], R. Eber[39], M. Feindt[39], S. Fink[39], M. Fischer[39], F. Frensch[39], B. Freund[39], R. Friese[39], D. Funke[39], M. Giffels[39], A. Gilbert[39], D. Haitz[39], T. Harbaum[39], M.A. Harrendorf[39], F. Hartmann[39,c], U. Husemann[39], F. Kassel[39,c], I. Katkov[39,g], A. Kornmayer[39,c], S. Kudella[39], P. Lobelle Pardo[39], B. Maier[39], H. Mildner[39], M.U. Mozer[39], T. Müller[39], Th. Müller[39], M. Plagge[39], M. Printz[39], G. Quast[39], K. Rabbertz[39], S. Röcker[39], F. Roscher[39], I. Shvetsov[39],

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Chawla[47], R. Gupta[47], U.Bhawandeep[47], A.K. Kalsi[47], A. Kaur[47], M. Kaur[47], R. Kumar[47], A. Mehta[47], M. Mittal[47], N. Nishu[47], J.B. Singh[47], G. Walia[47], Ashok Kumar[48], Arun Kumar[48], A. Bhardwaj[48], B.C. Choudhary[48], R.B. Garg[48], A. Kumar[48], S. Malhotra[48], M. Naimuddin[48], K. Ranjan[48], R. Sharma[48], V. Sharma[48], S. Banerjee[49], S. Bhattacharya[49], K. Chatterjee[49], S. Dey[49], S. Dutta[49], Sa. Jain[49], Sh. Jain[49], R. Khurana[49], N. Majumdar[49], A. Modak[49], K. Mondal[49], S. Mukherjee[49], S. Mukhopadhyay[49], A. Roy[49], D. Roy[49], S. Roy Chowdhury[49], S. Sarkar[49], M. Sharan[49], A. Abdulsalam[50], R. Chudasama[50], D. Dutta[50], V. Jha[50], V. Kumar[50], A.K. Mohanty[50,c], L.M. Pant[50], P. Shukla[50], A. Topkar[50], T. Aziz[51], S. Banerjee[51], S. Bhowmik[51,aa], R.M. Chatterjee[51], R.K. Dewanjee[51], S. Dugad[51], S. Ganguly[51], S. Ghosh[51], M. Guchait[51], A. Gurtu[51,bb], G. Kole[51], S. Kumar[51], B. Mahakud[51], M. Maity[51,aa], G. Majumder[51], K. Mazumdar[51], S. Mitra[51], G.B. Mohanty[51], B. Parida[51], T. Sarkar[51,aa], K. Sudhakar[51], N. Sur[51], B. Sutar[51], N. Wickramage[51,cc], S. Sharma[52], H. Bakhshiansohi[53], H. Behnamian[53], S.M. Etesami[53,dd], A. Fahim[53,ee], R. Goldouzian[53], M. Khakzad[53], M. Mohammadi Najafabadi[53], M. Naseri[53], S. Paktinat Mehdiabadi[53], F. Rezaei Hosseinabadi[53], B. Safarzadeh[53,ff], M. Zeinali[53], M. Felcini[54], M. Grunewald[54], M. Abbrescia[55a,55b], C. Calabria[55a,55b], C. Caputo[55a,55b], S.S. Chhibra[55a,55b], A. Colaleo[55a], D. Creanza[55a,55c], L. Cristella[55a,55b], N. De Filippis[55a,55c], M. De Palma[55a,55b], L. Fiore[55a], G. Iaselli[55a,55c], G. Maggi[55a,55c], M. Maggi[55a], G. Miniello[55a,55b], S. My[55a,55c], S. Nuzzo[55a,55b], A. Pompili[55a,55b], G. Pugliese[55a,55c], R. Radogna[55a,55b], A. Ranieri[55a], G. Selvaggi[55a,55b], L. Silvestris[55a,c], R. Venditti[55a,55b], P. Verwilligen[55a], G. Abbiendi[56a], C. 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Gutsche[132], J. Hanlon[132], D. Hare[132], R.M. Harris[132], J. Hirschauer[132], B. Hooberman[132], Z. Hu[132], S. Jindariani[132], M. Johnson[132], U. Joshi[132], A.W. Jung[132], B. Klima[132], B. Kreis[132], S. Kwan[a,132], S. Lammel[132], J. Linacre[132], D. Lincoln[132], R. Lipton[132], T. Liu[132], R. Lopes De Sá[132], J. Lykken[132], K. Maeshima[132], J.M. Marraffino[132], V.I. Martinez Outschoorn[132], S. Maruyama[132], D. Mason[132], P. McBride[132], P. Merkel[132], K. Mishra[132], S. Mrenna[132], S. Nahn[132], C. Newman-Holmes[132], V. O'Dell[132], O. Prokofyev[132], E. Sexton-Kennedy[132], A. Soha[132], W.J. Spalding[132], L. Spiegel[132], L. Taylor[132], S. Tkaczyk[132], N.V. Tran[132], L. Uplegger[132], E.W. Vaandering[132], C. Vernieri[132], M. Verzocchi[132], R. Vidal[132], A. Whitbeck[132], F. Yang[132], H. Yin[132], D. Acosta[133], P. Avery[133], P. Bortignon[133], D. Bourilkov[133], A. Carnes[133], M. Carver[133], D. Curry[133], S. Das[133], G.P. Di Giovanni[133], R.D. Field[133], M. Fisher[133], I.K. Furic[133], J. Hugon[133], J. Konigsberg[133], A. Korytov[133], J.F. Low[133], P. Ma[133], K. Matchev[133], H. Mei[133], P. Milenovic[133,nnn], G. Mitselmakher[133], L. Muniz[133], D. Rank[133], L. Shchutska[133], M. Snowball[133], D. Sperka[133], S.j. Wang[133], J. Yelton[133], S. Hewamanage[134], S. Linn[134], P. Markowitz[134], G. Martinez[134], J.L. Rodriguez[134], A. Ackert[135], J.R. Adams[135], T. Adams[135], A. Askew[135], J. Bochenek[135], B. Diamond[135], J. Haas[135], S. Hagopian[135], V. Hagopian[135], K.F. Johnson[135], A. Khatiwada[135], H. Prosper[135], V. Veeraraghavan[135], M. Weinberg[135], V. Bhopatkar[136], M. Hohlmann[136], H. Kalakhety[136], D. Mareskas-palcek[136], T. Roy[136], F. Yumiceva[136], M.R. Adams[137], L. Apanasevich[137], D. Berry[137], R.R. Betts[137], I. Bucinskaite[137], R. Cavanaugh[137], O. Evdokimov[137], L. Gauthier[137], C.E. Gerber[137], D.J. Hofman[137], P. Kurt[137], C. O'Brien[137], I.D. Sandoval Gonzalez[137], C. Silkworth[137], P. Turner[137], N. Varelas[137], Z. Wu[137], M. Zakaria[137], B. Bilki[138,ooo], W. Clarida[138], K. Dilsiz[138], S. Durgut[138], R.P. Gandrajula[138], M. Haytmyradov[138], V. Khristenko[138], J.-P. Merlo[138], H. Mermerkaya[138,ppp], A. Mestvirishvili[138], A. Moeller[138], J. Nachtman[138], H. Ogul[138], Y. Onel[138], F. Ozok[138,eee], A. Penzo[138], C. Snyder[138], P. Tan[138], E. Tiras[138], J. Wetzel[138], K. Yi[138], I. Anderson[139], B.A. Barnett[139], B. Blumenfeld[139], D. Fehling[139], L. Feng[139], A.V. Gritsan[139], P. Maksimovic[139], C. Martin[139], K. Nash[139], M. Osherson[139], M. Swartz[139], M. Xiao[139], Y. Xin[139], P. Baringer[140], A. Bean[140], G. Benelli[140], C. Bruner[140], J. Gray[140], R.P. Kenny III[140], D. Majumder[140], M. Malek[140], M. Murray[140], D. Noonan[140], S. Sanders[140], R. Stringer[140], Q. Wang[140], J.S. Wood[140], I. Chakaberia[141], A. Ivanov[141], K. Kaadze[141], S. Khalil[141], M. Makouski[141], Y. Maravin[141], L.K. Saini[141], N. Skhirtladze[141], I. Svintradze[141], S. Toda[141], D. Lange[142], F. Rebassoo[142], D. Wright[142], C. Anelli[143], A. Baden[143], O. Baron[143], A. Belloni[143], B. Calvert[143], S.C. Eno[143], C. Ferraioli[143], J.A. Gomez[143], N.J. Hadley[143], S. Jabeen[143], R.G. Kellogg[143], T. Kolberg[143], J. Kunkle[143], Y. Lu[143], A.C. Mignerey[143], K. Pedro[143], Y.H. Shin[143], A. Skuja[143], M.B. Tonjes[143], S.C. Tonwar[143], A. Apyan[144], R. Barbieri[144], A. Baty[144], K. Bierwagen[144], S. Brandt[144], W. Busza[144], I.A. Cali[144], L. Di Matteo[144], G. Gomez Ceballos[144], M. Goncharov[144], D. Gulhan[144], G.M. Innocenti[144], M. Klute[144], D. Kovalskyi[144], Y.S. Lai[144], Y.-J. Lee[144], A. Levin[144], P.D. Luckey[144], C. Mcginn[144], X. Niu[144], C. Paus[144], D. Ralph[144], C. Roland[144], G. Roland[144], G.S.F. Stephans[144], K. Sumorok[144], M. Varma[144], D. Velicanu[144], J. Veverka[144], J. Wang[144], T.W. Wang[144], B. Wyslouch[144], M. Yang[144], V. Zhukova[144], B. Dahmes[145], A. Finkel[145], A. Gude[145], P. Hansen[145], S. Kalafut[145], S.C. Kao[145], K. Klapoetke[145],

Y. Kubota[145], Z. Lesko[145], J. Mans[145], S. Nourbakhsh[145], N. Ruckstuhl[145], R. Rusack[145], N. Tambe[145], J. Turkewitz[145], J.G. Acosta[146], S. Oliveros[146], E. Avdeeva[147], K. Bloom[147], S. Bose[147], D.R. Claes[147], A. Dominguez[147], C. Fangmeier[147], R. Gonzalez Suarez[147], R. Kamalieddin[147], J. Keller[147], D. Knowlton[147], I. Kravchenko[147], J. Lazo-Flores[147], F. Meier[147], J. Monroy[147], F. Ratnikov[147], J.E. Siado[147], G.R. Snow[147], M. Alyari[148], J. Dolen[148], J. George[148], A. Godshalk[148], I. Iashvili[148], J. Kaisen[148], A. Kharchilava[148], A. Kumar[148], S. Rappoccio[148], G. Alverson[149], E. Barberis[149], D. Baumgartel[149], M. Chasco[149], A. Hortiangtham[149], A. Massironi[149], D.M. Morse[149], D. Nash[149], T. Orimoto[149], R. Teixeira De Lima[149], D. Trocino[149], R.-J. Wang[149], D. Wood[149], J. Zhang[149], K.A. Hahn[150], A. Kubik[150], N. Mucia[150], N. Odell[150], B. Pollack[150], A. Pozdnyakov[150], M. Schmitt[150], S. Stoynev[150], K. Sung[150], M. Trovato[150], M. Velasco[150], S. Won[150], A. Brinkerhoff[151], N. Dev[151], M. Hildreth[151], C. Jessop[151], D.J. Karmgard[151], N. Kellams[151], K. Lannon[151], S. Lynch[151], N. Marinelli[151], F. Meng[151], C. Mueller[151], Y. Musienko[151,kk], T. Pearson[151], M. Planer[151], R. Ruchti[151], G. Smith[151], N. Valls[151], M. Wayne[151], M. Wolf[151], A. Woodard[151], L. Antonelli[152], J. Brinson[152], B. Bylsma[152], L.S. Durkin[152], S. Flowers[152], A. Hart[152], C. Hill[152], R. Hughes[152], K. Kotov[152], T.Y. Ling[152], B. Liu[152], W. Luo[152], D. Puigh[152], M. Rodenburg[152], B.L. Winer[152], H.W. Wulsin[152], O. Driga[153], P. Elmer[153], J. Hardenbrook[153], P. Hebda[153], S.A. Koay[153], P. Lujan[153], D. Marlow[153], T. Medvedeva[153], M. Mooney[153], J. Olsen[153], C. Palmer[153], P. Piroué[153], X. Quan[153], H. Saka[153], D. Stickland[153], C. Tully[153], J.S. Werner[153], A. Zuranski[153], V.E. Barnes[154], D. Benedetti[154], D. Bortoletto[154], L. Gutay[154], M.K. Jha[154], M. Jones[154], K. Jung[154], M. Kress[154], N. Leonardo[154], D.H. Miller[154], N. Neumeister[154], F. Primavera[154], B.C. Radburn-Smith[154], X. Shi[154], I. Shipsey[154], D. Silvers[154], J. Sun[154], A. Svyatkovskiy[154], F. Wang[154], W. Xie[154], L. Xu[154], J. Zablocki[154], N. Parashar[155], J. Stupak[155], A. Adair[156], B. Akgun[156], Z. Chen[156], K.M. Ecklund[156], F.J.M. Geurts[156], M. Guilbaud[156], W. Li[156], B. Michlin[156], M. Northup[156], B.P. Padley[156], R. Redjimi[156], J. Roberts[156], J. Rorie[156], Z. Tu[156], J. Zabel[156], B. Betchart[157], A. Bodek[157], P. de Barbaro[157], R. Demina[157], Y. Eshaq[157], T. Ferbel[157], M. Galanti[157], A. Garcia-Bellido[157], P. Goldenzweig[157], J. Han[157], A. Harel[157], O. Hindrichs[157], A. Khukhunaishvili[157], G. Petrillo[157], M. Verzetti[157], L. Demortier[158], S. Arora[159], A. Barker[159], J.P. Chou[159], C. Contreras-Campana[159], E. Contreras-Campana[159], D. Duggan[159], D. Ferencek[159], Y. Gershtein[159], R. Gray[159], E. Halkiadakis[159], D. Hidas[159], E. Hughes[159], S. Kaplan[159], R. Kunnawalkam Elayavalli[159], A. Lath[159], S. Panwalkar[159], M. Park[159], S. Salur[159], S. Schnetzer[159], D. Sheffield[159], S. Somalwar[159], R. Stone[159], S. Thomas[159], P. Thomassen[159], M. Walker[159], M. Foerster[160], G. Riley[160], K. Rose[160], S. Spanier[160], A. York[160], O. Bouhali[161,qqq], A. Castaneda Hernandez[161], M. Dalchenko[161], M. De Mattia[161], A. Delgado[161], S. Dildick[161], R. Eusebi[161], W. Flanagan[161], J. Gilmore[161], T. Kamon[161,rrr], V. Krutelyov[161], R. Montalvo[161], R. Mueller[161], I. Osipenkov[161], Y. Pakhotin[161], R. Patel[161], A. Perloff[161], J. Roe[161], A. Rose[161], A. Safonov[161], A. Tatarinov[161], K.A. Ulmer[161,c], N. Akchurin[162], C. Cowden[162], J. Damgov[162], C. Dragoiu[162], P.R. Dudero[162], J. Faulkner[162], S. Kunori[162], K. Lamichhane[162], S.W. Lee[162], T. Libeiro[162], S. Undleeb[162], I. Volobouev[162], E. Appelt[163], A.G. Delannoy[163], S. Greene[163], A. Gurrola[163], R. Janjam[163], W. Johns[163], C. Maguire[163], Y. Mao[163], A. Melo[163], P. Sheldon[163], B. Snook[163], S. Tuo[163], J. Velkovska[163], Q. Xu[163], M.W. Arenton[164], S. Boutle[164], B. Cox[164], B. Francis[164], J. Goodell[164], R. Hirosky[164], A. Ledovskoy[164], H. Li[164], C. Lin[164], C. Neu[164], E. Wolfe[164], J. Wood[164], F. Xia[164], C. Clarke[165], R. Harr[165], P.E. Karchin[165], C. Kottachchi Kankanamge Don[165], P. Lamichhane[165], J. Sturdy[165], D.A. Belknap[166], D. Carlsmith[166], M. Cepeda[166], A. Christian[166], S. Dasu[166], L. Dodd[166], S. Duric[166], E. Friis[166], B. Gomber[166], R. Hall-Wilton[166], M. Herndon[166], A. Hervé[166], P. Klabbers[166], A. Lanaro[166], A. Levine[166], K. Long[166], R. Loveless[166], A. Mohapatra[166], I. Ojalvo[166], T. Perry[166], G.A. Pierro[166], G. Polese[166], I. Ross[166], T. Ruggles[166], T. Sarangi[166], A. Savin[166], A. Sharma[166], N. Smith[166], W.H. Smith[166], D. Taylor[166], N. Woods[166]

[1] Yerevan Physics Institute, Yerevan, Armenia
[2] Institut für Hochenergiephysik der OeAW, Wien, Austria
[3] National Centre for Particle and High Energy Physics, Minsk, Belarus
[4] Universiteit Antwerpen, Antwerpen, Belgium
[5] Vrije Universiteit Brussel, Brussel, Belgium
[6] Université Libre de Bruxelles, Bruxelles, Belgium
[7] Ghent University, Ghent, Belgium
[8] Université Catholique de Louvain, Louvain-la-Neuve, Belgium
[9] Université de Mons, Mons, Belgium
[10] Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil
[11] Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil
[12] Universidade Estadual Paulista, Universidade Federal do ABC, São Paulo, Brazil
[12a] Universidade Estadual Paulista
[12b] Universidade Federal do ABC
[13] Institute for Nuclear Research and Nuclear Energy, Sofia, Bulgaria
[14] University of Sofia, Sofia, Bulgaria
[15] Institute of High Energy Physics, Beijing, China
[16] State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing, China
[17] Universidad de Los Andes, Bogota, Colombia
[18] University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, Split, Croatia
[19] University of Split, Faculty of Science, Split, Croatia
[20] Institute Rudjer Boskovic, Zagreb, Croatia
[21] University of Cyprus, Nicosia, Cyprus
[22] Charles University, Prague, Czech Republic
[23] Academy of Scientific Research and Technology of the Arab Republic of Egypt, Egyptian Network of High Energy Physics, Cairo, Egypt
[24] National Institute of Chemical Physics and Biophysics, Tallinn, Estonia
[25] Department of Physics, University of Helsinki, Helsinki, Finland
[26] Helsinki Institute of Physics, Helsinki, Finland
[27] Lappeenranta University of Technology, Lappeenranta, Finland
[28] DSM/IRFU, CEA/Saclay, Gif-sur-Yvette, France
[29] Laboratoire Leprince-Ringuet, Ecole Polytechnique, IN2P3-CNRS, Palaiseau, France
[30] Institut Pluridisciplinaire Hubert Curien, Université de Strasbourg, Université de Haute Alsace Mulhouse, CNRS/IN2P3, Strasbourg, France
[31] Centre de Calcul de l'Institut National de Physique Nucleaire et de Physique des Particules, CNRS/IN2P3, Villeurbanne, France
[32] Université de Lyon, Université Claude Bernard Lyon 1, CNRS-IN2P3, Institut de Physique Nucléaire de Lyon, Villeurbanne, France
[33] Institute of High Energy Physics and Informatization, Tbilisi State University, Tbilisi, Georgia
[34] RWTH Aachen University, I. Physikalisches Institut, Aachen, Germany
[35] RWTH Aachen University, III. Physikalisches Institut A, Aachen, Germany
[36] RWTH Aachen University, III. Physikalisches Institut B, Aachen, Germany
[37] Deutsches Elektronen-Synchrotron, Hamburg, Germany
[38] University of Hamburg, Hamburg, Germany
[39] Institut für Experimentelle Kernphysik, Karlsruhe, Germany
[40] Institute of Nuclear and Particle Physics (INPP), NCSR Demokritos, Aghia Paraskevi, Greece

[41] University of Athens, Athens, Greece
[42] University of Ioánnina, Ioánnina, Greece
[43] Wigner Research Centre for Physics, Budapest, Hungary
[44] Institute of Nuclear Research ATOMKI, Debrecen, Hungary
[45] University of Debrecen, Debrecen, Hungary
[46] National Institute of Science Education and Research, Bhubaneswar, India
[47] Panjab University, Chandigarh, India
[48] University of Delhi, Delhi, India
[49] Saha Institute of Nuclear Physics, Kolkata, India
[50] Bhabha Atomic Research Centre, Mumbai, India
[51] Tata Institute of Fundamental Research, Mumbai, India
[52] Indian Institute of Science Education and Research (IISER), Pune, India
[53] Institute for Research in Fundamental Sciences (IPM), Tehran, Iran
[54] University College Dublin, Dublin, Ireland
[55] INFN Sezione di Bari, Università di Bari, Politecnico di Bari, Bari, Italy
[55a] INFN Sezione di Bari
[55b] Università di Bari
[55c] Politecnico di Bari
[56] INFN Sezione di Bologna, Università di Bologna, Bologna, Italy
[56a] INFN Sezione di Bologna
[56b] Università di Bologna
[57] INFN Sezione di Catania, Università di Catania, CSFNSM, Catania, Italy
[57a] INFN Sezione di Catania
[57b] Università di Catania
[57c] CSFNSM
[58] INFN Sezione di Firenze, Università di Firenze, Firenze, Italy
[58a] INFN Sezione di Firenze
[58b] Università di Firenze
[59] INFN Laboratori Nazionali di Frascati, Frascati, Italy
[60] INFN Sezione di Genova, Università di Genova, Genova, Italy
[60a] INFN Sezione di Genova
[60b] Università di Genova
[61] INFN Sezione di Milano-Bicocca, Università di Milano-Bicocca, Milano, Italy
[61a] INFN Sezione di Milano-Bicocca
[61b] Università di Milano-Bicocca
[62] INFN Sezione di Napoli, Università di Napoli 'Federico II', Napoli, Italy, Università della Basilicata, Potenza, Italy, Università G. Marconi, Roma, Italy
[62a] INFN Sezione di Napoli
[62b] Università di Napoli 'Federico II'
[62c] Università della Basilicata
[62d] Università G. Marconi
[63] INFN Sezione di Padova, Università di Padova, Padova, Italy, Università di Trento, Trento, Italy
[63a] INFN Sezione di Padova
[63b] Università di Padova
[63c] Università di Trento
[64] INFN Sezione di Pavia, Università di Pavia, Pavia, Italy
[64a] INFN Sezione di Pavia
[64b] Università di Pavia

[65] INFN Sezione di Perugia, Università di Perugia, Perugia, Italy
[65a] INFN Sezione di Perugia
[65b] Università di Perugia
[66] INFN Sezione di Pisa, Università di Pisa, Scuola Normale Superiore di Pisa, Pisa, Italy
[66a] INFN Sezione di Pisa
[66b] Università di Pisa
[66c] Scuola Normale Superiore di Pisa
[67] INFN Sezione di Roma, Università di Roma, Roma, Italy
[67a] INFN Sezione di Roma
[67b] Università di Roma
[68] INFN Sezione di Torino, Università di Torino, Torino, Italy, Università del Piemonte Orientale, Novara, Italy
[68a] INFN Sezione di Torino
[68b] Università di Torino
[68c] Università del Piemonte Orientale
[69] INFN Sezione di Trieste, Università di Trieste, Trieste, Italy
[69a] INFN Sezione di Trieste
[69b] Università di Trieste
[70] Kangwon National University, Chunchon, Korea
[71] Kyungpook National University, Daegu, Korea
[72] Chonbuk National University, Jeonju, Korea
[73] Chonnam National University, Institute for Universe and Elementary Particles, Kwangju, Korea
[74] Korea University, Seoul, Korea
[75] Seoul National University, Seoul, Korea
[76] University of Seoul, Seoul, Korea
[77] Sungkyunkwan University, Suwon, Korea
[78] Vilnius University, Vilnius, Lithuania
[79] National Centre for Particle Physics, Universiti Malaya, Kuala Lumpur, Malaysia
[80] Centro de Investigacion y de Estudios Avanzados del IPN, Mexico City, Mexico
[81] Universidad Iberoamericana, Mexico City, Mexico
[82] Benemerita Universidad Autonoma de Puebla, Puebla, Mexico
[83] Universidad Autónoma de San Luis Potosí, San Luis Potosí, Mexico
[84] University of Auckland, Auckland, New Zealand
[85] University of Canterbury, Christchurch, New Zealand
[86] National Centre for Physics, Quaid-I-Azam University, Islamabad, Pakistan
[87] National Centre for Nuclear Research, Swierk, Poland
[88] Institute of Experimental Physics, Faculty of Physics, University of Warsaw, Warsaw, Poland
[89] Laboratório de Instrumentação e Física Experimental de Partículas, Lisboa, Portugal
[90] Joint Institute for Nuclear Research, Dubna, Russia
[91] Petersburg Nuclear Physics Institute, Gatchina (St. Petersburg), Russia
[92] Institute for Nuclear Research, Moscow, Russia
[93] Institute for Theoretical and Experimental Physics, Moscow, Russia
[94] P.N. Lebedev Physical Institute, Moscow, Russia
[95] Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow, Russia
[96] State Research Center of Russian Federation, Institute for High Energy Physics, Protvino, Russia
[97] University of Belgrade, Faculty of Physics and Vinca Institute of Nuclear Sciences, Belgrade,

Serbia
[98] Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (CIEMAT), Madrid, Spain
[99] Universidad Autónoma de Madrid, Madrid, Spain
[100] Universidad de Oviedo, Oviedo, Spain
[101] Instituto de Física de Cantabria (IFCA), CSIC-Universidad de Cantabria, Santander, Spain
[102] CERN, European Organization for Nuclear Research, Geneva, Switzerland
[103] Paul Scherrer Institut, Villigen, Switzerland
[104] Institute for Particle Physics, ETH Zurich, Zurich, Switzerland
[105] Universität Zürich, Zurich, Switzerland
[106] National Central University, Chung-Li, Taiwan
[107] National Taiwan University (NTU), Taipei, Taiwan
[108] Chulalongkorn University, Faculty of Science, Department of Physics, Bangkok, Thailand
[109] Cukurova University, Adana, Turkey
[110] Middle East Technical University, Physics Department, Ankara, Turkey
[111] Bogazici University, Istanbul, Turkey
[112] Istanbul Technical University, Istanbul, Turkey
[113] Institute for Scintillation Materials of National Academy of Science of Ukraine, Kharkov, Ukraine
[114] National Scientific Center, Kharkov Institute of Physics and Technology, Kharkov, Ukraine
[115] University of Bristol, Bristol, United Kingdom
[116] Rutherford Appleton Laboratory, Didcot, United Kingdom
[117] Imperial College, London, United Kingdom
[118] Brunel University, Uxbridge, United Kingdom
[119] Baylor University, Waco, USA
[120] The University of Alabama, Tuscaloosa, USA
[121] Boston University, Boston, USA
[122] Brown University, Providence, USA
[123] University of California, Davis, Davis, USA
[124] University of California, Los Angeles, USA
[125] University of California, Riverside, Riverside, USA
[126] University of California, San Diego, La Jolla, USA
[127] University of California, Santa Barbara, Santa Barbara, USA
[128] California Institute of Technology, Pasadena, USA
[129] Carnegie Mellon University, Pittsburgh, USA
[130] University of Colorado at Boulder, Boulder, USA
[131] Cornell University, Ithaca, USA
[132] Fermi National Accelerator Laboratory, Batavia, USA
[133] University of Florida, Gainesville, USA
[134] Florida International University, Miami, USA
[135] Florida State University, Tallahassee, USA
[136] Florida Institute of Technology, Melbourne, USA
[137] University of Illinois at Chicago (UIC), Chicago, USA
[138] The University of Iowa, Iowa City, USA
[139] Johns Hopkins University, Baltimore, USA
[140] The University of Kansas, Lawrence, USA
[141] Kansas State University, Manhattan, USA
[142] Lawrence Livermore National Laboratory, Livermore, USA
[143] University of Maryland, College Park, USA

[144] Massachusetts Institute of Technology, Cambridge, USA
[145] University of Minnesota, Minneapolis, USA
[146] University of Mississippi, Oxford, USA
[147] University of Nebraska-Lincoln, Lincoln, USA
[148] State University of New York at Buffalo, Buffalo, USA
[149] Northeastern University, Boston, USA
[150] Northwestern University, Evanston, USA
[151] University of Notre Dame, Notre Dame, USA
[152] The Ohio State University, Columbus, USA
[153] Princeton University, Princeton, USA
[154] Purdue University, West Lafayette, USA
[155] Purdue University Calumet, Hammond, USA
[156] Rice University, Houston, USA
[157] University of Rochester, Rochester, USA
[158] The Rockefeller University, New York, USA
[159] Rutgers, The State University of New Jersey, Piscataway, USA
[160] University of Tennessee, Knoxville, USA
[161] Texas A&M University, College Station, USA
[162] Texas Tech University, Lubbock, USA
[163] Vanderbilt University, Nashville, USA
[164] University of Virginia, Charlottesville, USA
[165] Wayne State University, Detroit, USA
[166] University of Wisconsin, Madison, USA

a Deceased
b Also at Vienna University of Technology, Vienna, Austria
c Also at CERN, European Organization for Nuclear Research, Geneva, Switzerland
d Also at State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing, China
e Also at Institut Pluridisciplinaire Hubert Curien, Université de Strasbourg, Université de Haute Alsace Mulhouse, CNRS/IN2P3, Strasbourg, France
f Also at National Institute of Chemical Physics and Biophysics, Tallinn, Estonia
g Also at Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow, Russia
h Also at Universidade Estadual de Campinas, Campinas, Brazil
i Also at Centre National de la Recherche Scientifique (CNRS) - IN2P3, Paris, France
j Also at Laboratoire Leprince-Ringuet, Ecole Polytechnique, IN2P3-CNRS, Palaiseau, France
k Also at Joint Institute for Nuclear Research, Dubna, Russia
m Now at British University in Egypt, Cairo, Egypt
n Now at Helwan University, Cairo, Egypt
o Also at Suez University, Suez, Egypt
p Also at Cairo University, Cairo, Egypt
q Now at Fayoum University, El-Fayoum, Egypt
s Now at Ain Shams University, Cairo, Egypt
u Also at Université de Haute Alsace, Mulhouse, France
v Also at Brandenburg University of Technology, Cottbus, Germany
w Also at Institute of Nuclear Research ATOMKI, Debrecen, Hungary
x Also at Eötvös Loránd University, Budapest, Hungary
y Also at University of Debrecen, Debrecen, Hungary
z Also at Wigner Research Centre for Physics, Budapest, Hungary
aa Also at University of Visva-Bharati, Santiniketan, India

bb Now at King Abdulaziz University, Jeddah, Saudi Arabia
cc Also at University of Ruhuna, Matara, Sri Lanka
dd Also at Isfahan University of Technology, Isfahan, Iran
ee Also at University of Tehran, Department of Engineering Science, Tehran, Iran
ff Also at Plasma Physics Research Center, Science and Research Branch, Islamic Azad University, Tehran, Iran
gg Also at Università degli Studi di Siena, Siena, Italy
hh Also at Purdue University, West Lafayette, USA
ii Also at International Islamic University of Malaysia, Kuala Lumpur, Malaysia
jj Also at CONSEJO NATIONAL DE CIENCIA Y TECNOLOGIA, MEXICO, Mexico
kk Also at Institute for Nuclear Research, Moscow, Russia
ll Also at Institute of High Energy Physics and Informatization, Tbilisi State University, Tbilisi, Georgia
mm Also at St. Petersburg State Polytechnical University, St. Petersburg, Russia
nn Also at National Research Nuclear University 'Moscow Engineering Physics Institute' (MEPhI), Moscow, Russia
oo Also at California Institute of Technology, Pasadena, USA
pp Also at Faculty of Physics, University of Belgrade, Belgrade, Serbia
qq Also at Facoltà Ingegneria, Università di Roma, Roma, Italy
rr Also at National Technical University of Athens, Athens, Greece
ss Also at Scuola Normale e Sezione dell'INFN, Pisa, Italy
tt Also at University of Athens, Athens, Greece
uu Also at Warsaw University of Technology, Institute of Electronic Systems, Warsaw, Poland
vv Also at Institute for Theoretical and Experimental Physics, Moscow, Russia
ww Also at Albert Einstein Center for Fundamental Physics, Bern, Switzerland
xx Also at Adiyaman University, Adiyaman, Turkey
yy Also at Mersin University, Mersin, Turkey
zz Also at Cag University, Mersin, Turkey
aaa Also at Piri Reis University, Istanbul, Turkey
bbb Also at Gaziosmanpasa University, Tokat, Turkey
ccc Also at Ozyegin University, Istanbul, Turkey
ddd Also at Izmir Institute of Technology, Izmir, Turkey
eee Also at Mimar Sinan University, Istanbul, Istanbul, Turkey
fff Also at Marmara University, Istanbul, Turkey
ggg Also at Kafkas University, Kars, Turkey
hhh Also at Yildiz Technical University, Istanbul, Turkey
iii Also at Hacettepe University, Ankara, Turkey
jjj Also at Rutherford Appleton Laboratory, Didcot, United Kingdom
kkk Also at School of Physics and Astronomy, University of Southampton, Southampton, United Kingdom
lll Also at Instituto de Astrofísica de Canarias, La Laguna, Spain
mmm Also at Utah Valley University, Orem, USA
nnn Also at University of Belgrade, Faculty of Physics and Vinca Institute of Nuclear Sciences, Belgrade, Serbia
ooo Also at Argonne National Laboratory, Argonne, USA
ppp Also at Erzincan University, Erzincan, Turkey
qqq Also at Texas A&M University at Qatar, Doha, Qatar
rrr Also at Kyungpook National University, Daegu, Korea