EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH (CERN)

Submitted to: Physical Review Letters

CERN-EP-2024-173
9th July 2024

Disentangling sources of momentum fluctuations in Xe+Xe and Pb+Pb collisions with the ATLAS detector

The ATLAS Collaboration

High-energy nuclear collisions create a quark-gluon plasma, whose initial condition and subsequent expansion vary from event to event, impacting the distribution of the event-wise average transverse momentum ($P([p_{\mathrm{T}}])$). Distinguishing between contributions from fluctuations in the size of the nuclear overlap area (geometrical component) and other sources at fixed size (intrinsic component) presents a challenge. Here, these two components are distinguished by measuring the mean, variance, and skewness of $P([p_{\mathrm{T}}])$ in ^{208}Pb+^{208}Pb and ^{129}Xe+^{129}Xe collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 and 5.44 TeV, respectively, using the ATLAS detector at the LHC. All observables show distinct changes in behavior in ultra-central collisions, where the geometrical variations are suppressed as the overlap area reaches its maximum. These results demonstrate a new technique to disentangle geometrical and intrinsic fluctuations, enabling constraints on initial condition and properties of the quark-gluon plasma, such as the speed of sound.

High energy nuclear collisions at the Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC) create a strongly-interacting state of matter known as quark-gluon plasma (QGP) [1]. The hydrodynamic expansion of the QGP induces a significant boost to the transverse momentum (p_{T}) of the final-state particles. This boost transforms the shape anisotropies and size variations in QGP's initial state into final state anisotropies known as anisotropic flow [2–4] and variations in the average p_{T} in each event, $[p_{\mathrm{T}}]$ [5]. Comparisons of data with theoretical models of anisotropic flow have provided crucial insights about the QGP's initial condition such as the overlap area, nucleon/subnucleonic fluctuations, as well as QGP's transport properties such as shear and bulk viscosities [1, 6]. However, quantitative extractions of these properties remain subject to large uncertainty due to a lack of detailed knowledge about the initial conditions of the QGP [7, 8].

Naturally, progress in this area can be made by studying the $[p_{\mathrm{T}}]$ and its distribution $P([p_{\mathrm{T}}])$ for events with similar impact parameters between the centers of the two colliding nuclei. Since the $[p_{\mathrm{T}}]$ in each event is sensitive to the radial flow of the QGP, $P([p_{\mathrm{T}}])$ offers a sensitive probe of the initial-state variations and properties of the plasma, such as the equation of state (EOS) and the associated speed-of-sound squared (c_s^2) in the QGP [9–15]. $P([p_{\mathrm{T}}])$ can be characterized through moments, such as the mean, $\langle [p_{\mathrm{T}}] \rangle$, variance, $\left\langle (\delta p_{\mathrm{T}})^2 \right\rangle$, and skewness, $\left\langle (\delta p_{\mathrm{T}})^3 \right\rangle$, where $\delta p_{\mathrm{T}} = [p_{\mathrm{T}}] - \langle [p_{\mathrm{T}}] \rangle$. The notation "$\langle\rangle$" indicates an average over an ensemble of events.

Most sources of $P([p_{\mathrm{T}}])$ appear stochastic, encompassing fluctuations in transverse size, R, of the overlap region, nucleon and parton positions in the initial state, energy deposition, and temperature of the QGP fluid in its local rest frame. These sources can be categorized into "geometrical fluctuations" that capture the hydrodynamic response to event-by-event variations in R, following $\delta p_{\mathrm{T}} / \langle [p_{\mathrm{T}}] \rangle \approx -\delta R / \langle R \rangle$ [5], and "intrinsic fluctuations" that include other sources of δp_{T} at fixed R [11]. If nuclear collisions are considered as a superposition of independent particle production from participating nucleons, followed by final state interactions, both geometrical and intrinsic fluctuations are expected to scale with the number of participating nucleons (N_{part}), or approximately with charged particle multiplicity: $\left\langle (\delta p_{\mathrm{T}})^2 \right\rangle \propto 1/N_{\mathrm{part}}$ and $\left\langle (\delta p_{\mathrm{T}})^3 \right\rangle \propto 1/N_{\mathrm{part}}^2$. This scaling expectation is referred to as the independent superposition scenario [16, 17].

It was proposed to separate geometric and intrinsic fluctuations using moments of $P([p_{\mathrm{T}}])$ in ultra-central collisions (UCC) [11, 12]. As the impact parameter approaches zero in UCC, N_{part} and R reach their maximum values. Subsequently, geometrical fluctuations are suppressed, leading to a deviation from the anticipated $1/N_{\mathrm{part}}$ scaling. In contrast, intrinsic fluctuations still follow the expected scaling behavior. The interplay between the reduced geometrical and residual intrinsic fluctuations gives rise to complex behaviors in the moments of $P([p_{\mathrm{T}}])$. Therefore, measurements in UCC can constrain the properties of the intrinsic fluctuations, which were shown to be sensitive to c_s^2 [9] in the QGP, as implemented in hydrodynamic model simulations.

The multiplicity dependence of the mean and variance of $P([p_{\mathrm{T}}])$ has been measured across various system sizes and collision energies [18–27]. These studies reveal an increase of $\langle [p_{\mathrm{T}}] \rangle$ towards more central collisions, while the variance follows the anticipated power-law scaling. Recently, ALICE reported measurements of skewness and kurtosis in Xe+Xe and Pb+Pb collisions [28] but only in broad multiplicity ranges. CMS performed a detailed study of the behavior of $\langle [p_{\mathrm{T}}] \rangle$ in Pb+Pb UCC and claimed to extract the c_s^2 [29] but with caveats [13–15]. These measurements were not able to disentangle the geometrical and intrinsic components of $P([p_{\mathrm{T}}])$. A precise measurement of higher-order moments in UCC is necessary to achieve this goal and connect more precisely to the initial condition of the QGP and its properties.

This Letter reports the measurement of the mean, variance, and skewness of $P([p_T])$ as a function of charged particle multiplicity in ^{208}Pb+^{208}Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV and ^{129}Xe+^{129}Xe collisions at $\sqrt{s_{NN}}$ = 5.44 TeV. A smaller multiplicity range and transverse size in Xe+Xe than Pb+Pb provide a unique lever arm to test the impact of system size on the scaling behavior of $[p_T]$-moments. The much-improved precision of variance and skewness over previous measurements [28] enables a detailed investigation of their behavior.

The measurements are performed using the ATLAS inner detector (ID), forward calorimeter (FCal), and zero-degree calorimeters (ZDCs) along with the trigger and data acquisition systems [30–32]. The ID detects charged particles within $|\eta| < 2.5$[1] using a combination of silicon pixel detectors, silicon microstrip detectors, and a straw-tube transition-radiation tracker, all immersed in a 2T axial magnetic field [31]. The FCal consists of three sampling layers, covering $3.2 < |\eta| < 4.9$. The ZDCs are positioned at ±140 m from the interaction point (IP), and detect neutrons with $|\eta| > 8.3$. The ATLAS trigger system [32] consists of a hardware-based level-1 (L1) trigger and a software-based high-level trigger (HLT). A software suite [33] is used in data simulation, in the reconstruction and analysis of real and simulated data, in detector operations, and in the trigger and data acquisition systems of the experiment.

This analysis uses 470 μb^{-1} of Pb+Pb data collected in 2015 and 3 μb^{-1} of Xe+Xe data collected in 2017. The Pb+Pb events are selected by requiring the total transverse energy deposited in the calorimeters over $|\eta|$ < 4.9 at L1 (E_T^{L1}) to be greater than 50 GeV. Additionally, dedicated central collision triggers are included to improve event statistics for the largest values of FCal transverse energy [34]. The Xe+Xe events are selected by requiring $E_T^{L1} > 4$ GeV.

Charged-particle tracks are reconstructed from hits in the ID using a reconstruction and selection procedure optimized for heavy-ion collisions [35]. Tracks used in this analysis must have $p_T > 0.5$ GeV and $|\eta| < 2.5$, and the total number of such tracks in each event is denoted by N_{ch}^{rec}. Events containing multiple inelastic collisions (pileup) are suppressed by exploiting the correlation between N_{ch}^{rec} and the transverse energy measured in the FCal, ΣE_T. The pileup probability is 0.17% in Pb+Pb collisions and a factor of ten smaller in Xe+Xe collisions. In the Pb+Pb dataset, pileup is further suppressed by exploiting the correlation between the energy deposited in the ZDCs and ΣE_T [36]. The residual pileup fraction is less than 0.01% in central collisions (see Appendix).

Events are categorized into centrality intervals using a Glauber model [37] parameterization of the ΣE_T distribution [34]. Each interval represents a range in ΣE_T, starting at 0% for the most central collisions with the highest ΣE_T value and ending at 80%. In this analysis, events within the top 5% centrality, where observables display strong deviations from power-law scaling, are denoted as UCC. These events correspond to $\Sigma E_T > 3.62$ TeV and 2.27 TeV in Pb+Pb and Xe+Xe collisions, respectively.

Unless specified, the results are presented for charged particles with $0.5 < p_T < 5$ GeV. The track reconstruction efficiency, $\epsilon(p_T, \eta, N_{ch}^{rec})$, is assessed using Monte Carlo (MC) simulated events from Pb+Pb and Xe+Xe collisions generated with HIJING [38]. The detector response is simulated with GEANT4 [39, 40], and events are reconstructed using the same algorithms as applied to the data. For charged particles with $p_T > 0.8$ GeV, where the efficiency varies very slowly, the efficiency in UCC Pb+Pb collisions ranges from 71% at $\eta \approx 0$ to about 40% for $|\eta| > 2$. The efficiency decreases by 12% from 0.8 GeV to 0.5 GeV, when averaged over the full η range. In peripheral collisions, the efficiency is less dependent on η and is up

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

to 4% higher. The rate of falsely reconstructed ("fake") tracks, $f(p_{\mathrm{T}}, \eta, N_{\mathrm{ch}}^{\mathrm{rec}})$, is found to be significant for $p_{\mathrm{T}} < 1$ GeV in UCC collisions, where it ranges from 2% for $|\eta| < 1$ to 8% at larger $|\eta|$. The fake-track rate drops rapidly for higher p_{T} and more peripheral collisions. Within the $N_{\mathrm{ch}}^{\mathrm{rec}}$ range spanned by UCC events, the efficiency drops by 1% with increasing $N_{\mathrm{ch}}^{\mathrm{rec}}$, while the fake rate increases by 4%. The behavior of efficiency and fake rate in Xe+Xe collisions have similar p_{T}, η, and $N_{\mathrm{ch}}^{\mathrm{rec}}$ dependence as Pb+Pb. At the same $N_{\mathrm{ch}}^{\mathrm{rec}}$, the Xe+Xe efficiency is about 2% lower than the Pb+Pb efficiency, and fake rates agree within 1%.

The moments of $P([p_{\mathrm{T}}])$ are calculated by taking advantage of computational methods developed for the study of anisotropic flow [41, 42]. The $[p_{\mathrm{T}}]$ and n-particle correlators in a single event are computed as $[p_{\mathrm{T}}] = \sum_i w_i p_i / \sum_i w_i$, $c_2 = \sum_{i \neq j} w_i w_j \delta p_i \delta p_j / \sum_{i \neq j} w_i w_j$ and $c_3 = \sum_{i \neq j \neq k} w_i w_j w_k \delta p_i \delta p_j \delta p_k / \sum_{i \neq j \neq k} w_i w_j w_k$. Here, $\delta p_i \equiv p_{\mathrm{T},i} - \langle [p_{\mathrm{T}}] \rangle$, and w_i represent weights applied to track i to correct for reconstruction efficiency ϵ_i and fake track rate f_i: $w_i \equiv (1 - f_i)/\epsilon_i$ [43]. The n^{th} central moment of the corresponding $P([p_{\mathrm{T}}])$ is obtained by averaging c_n over a given event ensemble in unit $N_{\mathrm{ch}}^{\mathrm{rec}}$ intervals, denoted as $\langle c_n \rangle = \langle (\delta p_{\mathrm{T}})^n \rangle$. We also calculate the charged particle multiplicity, corrected for detector effects, in $0.5 < p_{\mathrm{T}} < 5$ GeV and $|\eta| < 2.5$ as $N_{\mathrm{ch}} = \sum_i w_i$. The results are presented as a function of N_{ch}.

This analysis focuses on the mean, $\langle [p_{\mathrm{T}}] \rangle$, variance, $\langle c_2 \rangle$, and skewness, $\langle c_3 \rangle$. The variance and skewness are normalized into dimensionless quantities [44]:

$$k_2 = \frac{\langle c_2 \rangle}{\langle [p_{\mathrm{T}}] \rangle^2}, \quad k_3 = \frac{\langle c_3 \rangle}{\langle [p_{\mathrm{T}}] \rangle^3}, \quad \gamma = \frac{\langle c_3 \rangle}{\langle c_2 \rangle^{3/2}}, \quad \Gamma = \frac{\langle c_3 \rangle \langle [p_{\mathrm{T}}] \rangle}{\langle c_2 \rangle^2}. \tag{1}$$

These quantities have reduced sensitivity to efficiency and fake rates. The "standard skewness", γ, is equivalent to the skewness for a distribution with unit variance, whereas Γ is referred to as the "intensive skewness". Statistical uncertainties for these observables are computed using a standard Poisson bootstrap method [45]. Since N_{ch} is approximately proportional to N_{part}, in the independent superposition scenario, it is expected that $k_2 \propto 1/N_{\mathrm{ch}}$, $k_3 \propto 1/(N_{\mathrm{ch}})^2$, $\gamma \propto 1/\sqrt{N_{\mathrm{ch}}}$, whereas Γ should be roughly independent of N_{ch}.

Systematic uncertainties stem from track selection, reconstruction efficiency, residual pileup, centrality definition, and MC consistency check. Their values in the 0–60% centrality range are summarized as follows. Uncertainties related to track selection are assessed by comparing nominal results against those obtained with stricter criteria, resulting in deviations of < 0.5% for $\langle [p_{\mathrm{T}}] \rangle$, 0.5–3% for k_2, 0–1.5% for k_3, 0.5–4% for γ, and 0.5–1.5% for Γ. Due to potentially inaccurate modeling of the detector material in Geant4, the reconstruction efficiency has up to 4% uncertainty [43]. The impact on the analysis is evaluated by varying the efficiency within its uncertainty range, resulting in changes of around 1% for $\langle [p_{\mathrm{T}}] \rangle$, 0.5% for k_2, 2–2.5% for k_3, 1–1.5% for γ, and 1.5–2.5% for Γ. The effect of residual pileup is estimated by varying the pileup rejection criteria, leading to uncertainties less than 0.5% for all observables. Uncertainties for the centrality definition are estimated by varying the Glauber model parameters. These uncertainties are applicable only when results are presented in centrality intervals, and are less than 0.5% in UCC for all observables. The Hijing MC samples are used to evaluate the consistency of the $P([p_{\mathrm{T}}])$ moments, obtained using truth particles or the reconstructed tracks with the same correction procedures for the real data applied [34, 46]. The differences are less than 0.25% for $\langle [p_{\mathrm{T}}] \rangle$ and k_2, and are around 1.2% for k_3, γ and Γ.

Total systematic uncertainties for each observable are obtained by adding the individual sources in quadrature. Among these sources, the track selection dominates the total systematic uncertainties in mid-central and central collisions. The uncertainties are less than 1% for $\langle [p_{\mathrm{T}}] \rangle$, 2–4% for k_2, 2–5% for k_3, and 2–4% for γ and Γ in both systems; they are smaller than the statistical uncertainties except for

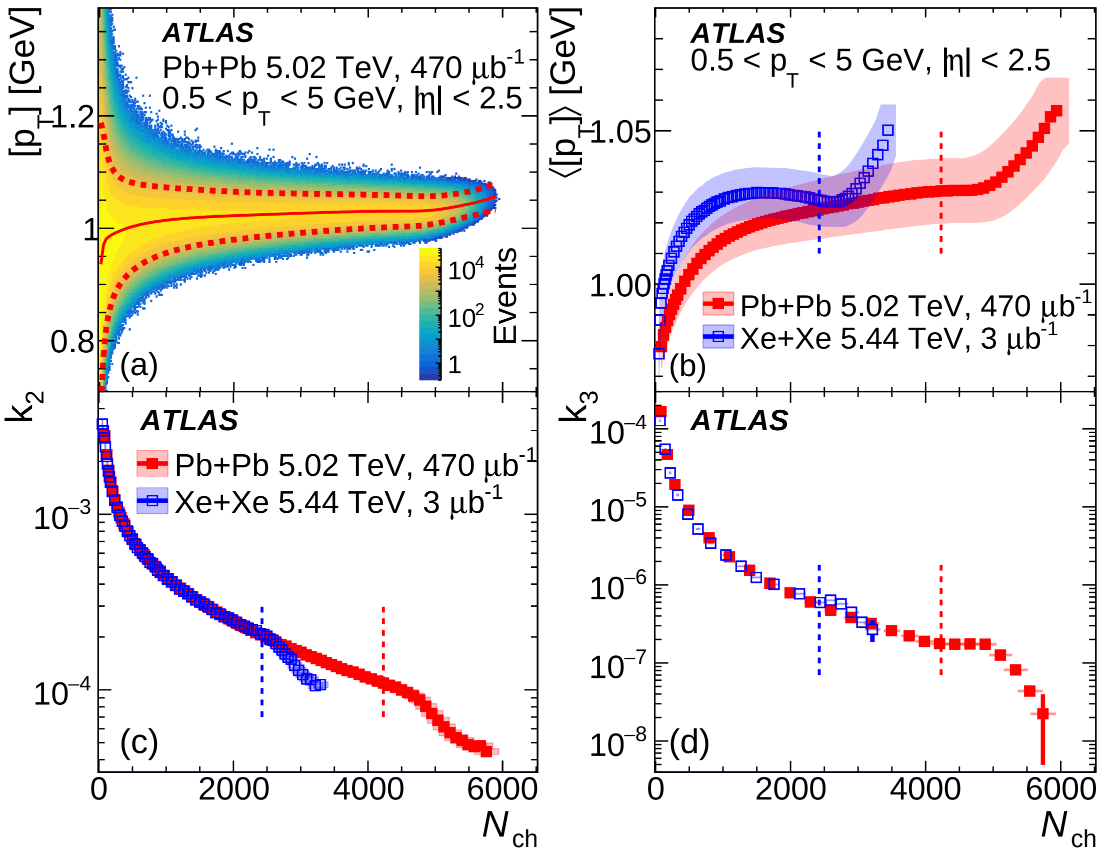

Figure 1: Panel (a) depicts the 2D distribution of $[p_\mathrm{T}]$ versus N_ch in Pb+Pb collisions, where the solid and dashed lines indicate the mean and two standard deviations, respectively. Panels (b), (c), and (d) show the N_ch dependence of $\langle[p_\mathrm{T}]\rangle$, k_2, and k_3, respectively. The error bars represent statistical uncertainties of the measurement, whereas the shaded boxes represent the systematic uncertainties in both x- and y-axes. The vertical dashed lines mark the N_ch values 4230 and 2425, corresponding to 5% centrality in Pb+Pb and Xe+Xe collisions, respectively.

$\langle[p_\mathrm{T}]\rangle$. The uncertainty for N_ch is dominated by the correction for tracking efficiency and fake tracks, and is about 3% in Pb+Pb UCC.

The two-dimensional (2D) distribution of $[p_\mathrm{T}]$ versus N_ch is illustrated in Figure 1(a) for Pb+Pb collisions, whose mean and widths at fixed N_ch are indicated by the solid and dashed lines, respectively. The data shows a mild increase of the means and a narrowing of the widths with increasing N_ch.

The measured moments for both systems are shown in Figure 1(b)-(d) for $\langle[p_\mathrm{T}]\rangle$, k_2, and k_3, respectively. An increase of $\langle[p_\mathrm{T}]\rangle$ with N_ch, consistent with the onset of radial flow, is observed in peripheral collisions, which weakens in mid-central collisions. The values of k_2 and k_3 show a power-law-like decrease with increasing N_ch. In UCC, all three observables show sudden deviations from their mid-central behaviors. Specifically, $\langle[p_\mathrm{T}]\rangle$ increases while k_2 and k_3 decrease towards higher N_ch values.

To test the expected power-law scaling behavior, the values of $(N_\mathrm{ch})^{n-1}k_n$ and Γ are shown as a function of N_ch in Figure 2. The $N_\mathrm{ch}k_2$ rises sharply until up to $N_\mathrm{ch} \approx 1500$ in both systems. This growth saturates gradually over $2000 \lesssim N_\mathrm{ch} \lesssim 4000$ in Pb+Pb collisions. The rapid increase at low N_ch has been associated with the onset of radial flow [47] and thermalization [16, 48]. The $(N_\mathrm{ch})^2k_3$ also displays a rapid increase in both systems followed by saturation in mid-central Pb+Pb collisions, driven by the same mechanisms

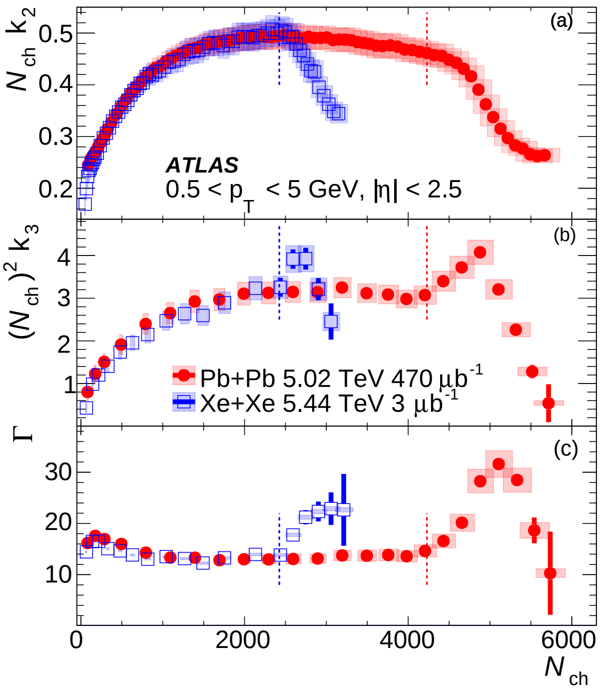

Figure 2: The values of (a) $N_{\text{ch}}k_2$, (b) $(N_{\text{ch}})^2k_3$, and (c) Γ, as a function of N_{ch} in Pb+Pb and Xe+Xe collisions. The error bars represent the statistical uncertainties of the measurement, whereas the shaded boxes represent the systematic uncertainties of the data along the x- and y-axes. The vertical dashed lines mark the N_{ch} values corresponding to 5% centrality in Pb+Pb and Xe+Xe collisions respectively.

responsible for the increase in $N_{\text{ch}}k_2$. Γ decreases slightly from peripheral to mid-central collisions, after which it is flat until the UCC region.

In UCC, $N_{\text{ch}}k_2$ displays a notable decrease as a function of N_{ch}. The values of $(N_{\text{ch}})^2k_3$ and Γ show an abrupt increase followed by a sharp decrease as a function of N_{ch}. These shape variations are consistent with the expected suppression of the distribution of R, $P(R)$, from the larger R side [11]. This suppression first leads to a positive skew which then vanishes as the variance for $P(R)$ approaches zero.

To better visualize these non-monotonic behaviors in UCC, Figure 3 presents $\langle[p_{\text{T}}]\rangle$ and the normalized observables from Eq. (1), scaled by their values at 5% centrality. Such scaling highlights their behavior in UCC and partially cancels systematic uncertainties. The observables are plotted as a function of N_{ch} normalized by its value at 5% centrality, $N_{\text{ch}}/N_{\text{ch}}^{5\%}$, which enables comparing the two systems at a similar scale along the x-axis.

Qualitatively similar behavior is observed in the two collision systems for all observables. However, the variations in Xe+Xe collisions are generally weaker as a function of $N_{\text{ch}}/N_{\text{ch}}^{5\%}$. This is expected due to the smaller mass number of Xe compared to Pb, which leads to a larger spread in $N_{\text{ch}}/N_{\text{ch}}^{5\%}$ for the same centrality range in Xe+Xe collisions, resulting in a weaker suppression of the geometrical component expected in smaller systems. This argument demonstrates the importance of comparing data using nuclei of different sizes.

Recently, Refs. [11, 12] studied the fluctuations of $[p_{\text{T}}]$ by modeling $P([p_{\text{T}}])$ as a 2D Gaussian function of N_{ch} and impact parameter, where the fluctuations of $[p_{\text{T}}]$ at a given N_{ch} are driven solely by the variations in the impact parameter and R. The increase of $\langle[p_{\text{T}}]\rangle$ arises from enhanced intrinsic fluctuations at fixed

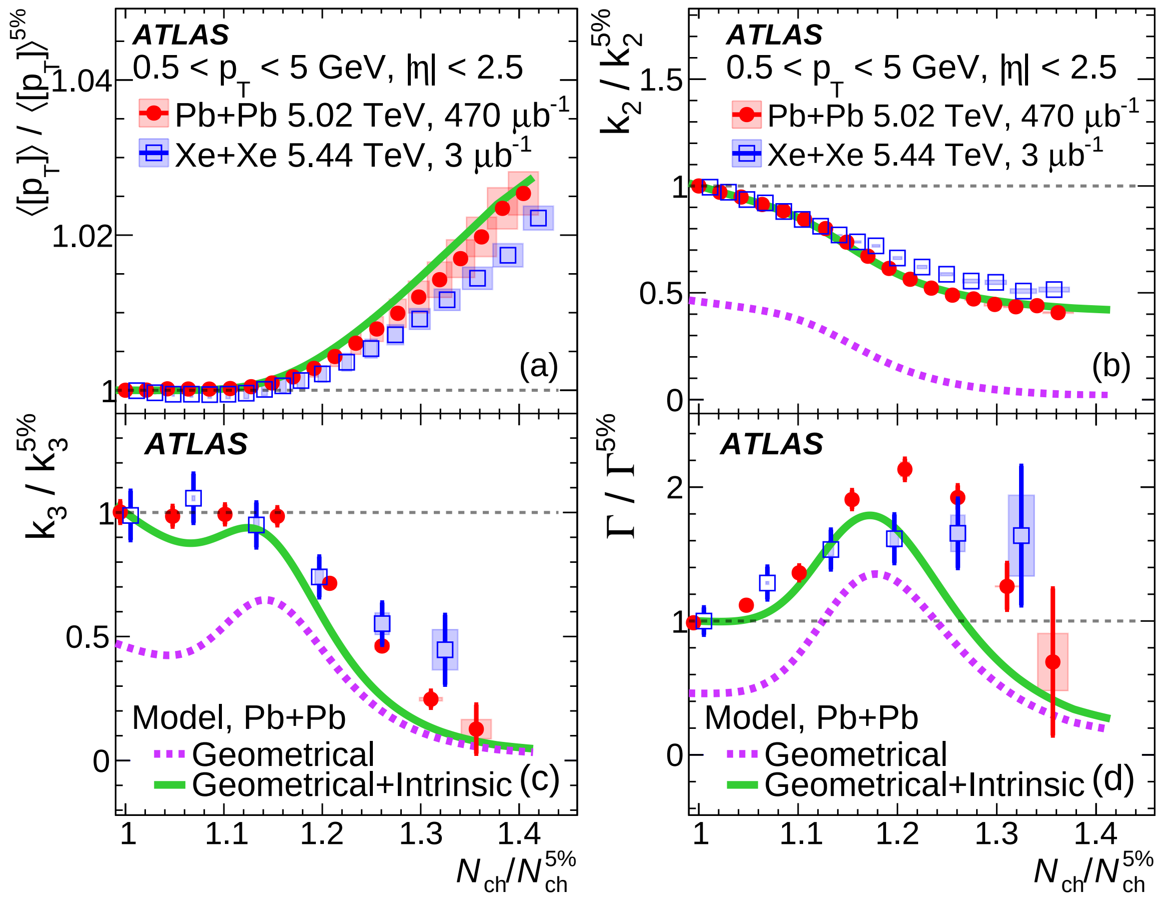

Figure 3: The (a) $\langle[p_\mathrm{T}]\rangle$, (b) k_2, (c) k_3 and (d) Γ, scaled by their values at 5% centrality as a function of $N_\mathrm{ch}/N_\mathrm{ch}^{5\%}$ in Pb+Pb and Xe+Xe collisions. The error bars represent statistical uncertainties of the measurement, whereas the shaded boxes represent the systematic uncertainties of the data along the x- and y-axes. The data are compared to predictions from Ref. [12], where the estimated geometrical component is also shown.

R, whereas the k_2 in the model arises from geometrical and intrinsic contributions. The k_3 in the model originates from a geometrical contribution and a cross-term between geometrical and intrinsic components, but has no contribution from the pure intrinsic component [12].

Figure 3 compares the model predictions previously described to the Pb+Pb data. The model describes reasonably the increase of $\langle[p_\mathrm{T}]\rangle$ and the decrease of k_2. The predicted k_3 values exhibit a steeper decrease with $N_\mathrm{ch}/N_\mathrm{ch}^{5\%}$, a trend also observed for Γ. The larger k_3 and Γ values in the data require the model to include additional sources of skewness in $P([p_\mathrm{T}])$ [44]. Most variations in k_2, k_3 and Γ can be largely attributed to the geometrical component as indicated by the dashed lines.

For a more direct study of the correlation between $[p_\mathrm{T}]$ and N_ch in UCC, a detailed analysis of the 0–1% most central events is performed. The $[p_\mathrm{T}]$ and N_ch values averaged over these events are denoted by $\langle[p_\mathrm{T}]\rangle_{0-1\%}$ and $\langle N_\mathrm{ch}\rangle_{0-1\%}$. Then, $\langle[p_\mathrm{T}]\rangle$ is calculated by averaging $[p_\mathrm{T}]$ over events in narrow N_ch slices to obtain $\Delta p_\mathrm{T}/\langle[p_\mathrm{T}]\rangle_{0-1\%}$ as a function of $\Delta N_\mathrm{ch}/\langle N_\mathrm{ch}\rangle_{0-1\%}$, where $\Delta p_\mathrm{T} = \langle[p_\mathrm{T}]\rangle - \langle[p_\mathrm{T}]\rangle_{0-1\%}$ and $\Delta N_\mathrm{ch} = N_\mathrm{ch} - \langle N_\mathrm{ch}\rangle_{0-1\%}$. Figure 4 shows the correlation between $\Delta p_\mathrm{T}/\langle[p_\mathrm{T}]\rangle_{0-1\%}$ and $\Delta N_\mathrm{ch}/\langle N_\mathrm{ch}\rangle_{0-1\%}$ for Pb+Pb and Xe+Xe collisions in two p_T ranges. The correlation is observed to be positive and nearly linear, and with similar slopes in both systems. The slope, however, varies with the p_T range selection,

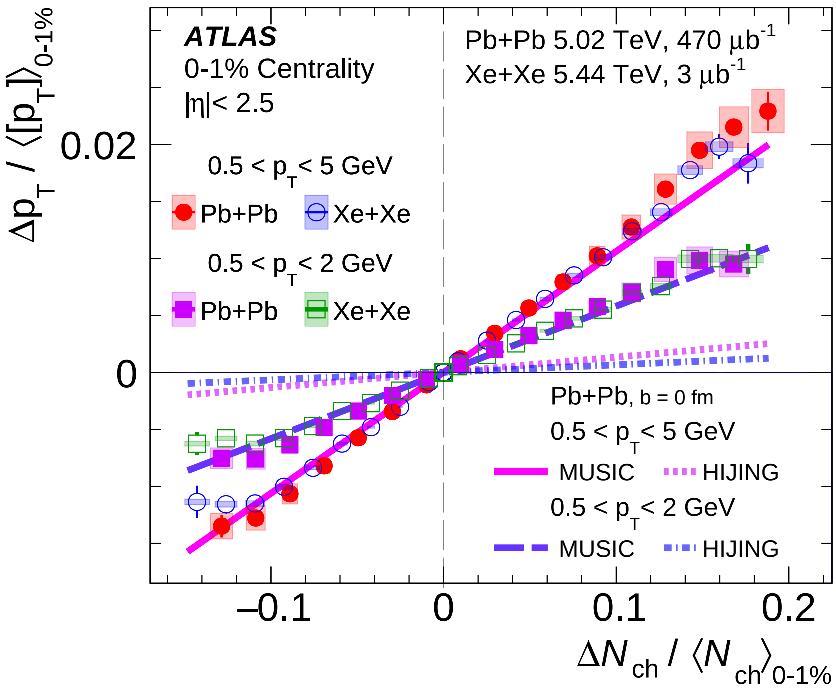

Figure 4: Correlation between $\Delta p_{\mathrm{T}}/\langle[p_{\mathrm{T}}]\rangle_{0-1\%}$ and $\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle_{0-1\%}$ in the 0–1% most central Pb+Pb and Xe+Xe collisions for two p_{T} ranges. The error bars represent the statistical uncertainties of the measurement, whereas the shaded boxes represent the systematic uncertainties of the data along the x- and y-axes. The data are compared to calculations from the MUSIC hydrodynamic model and the Hijing model at zero impact parameter (b = 0 fm) [11].

reflecting the kinematic sensitivity to the radial flow.

The Pb+Pb data are compared to the Hijing model [38], which has no final-state interactions, and the state-of-the-art MUSIC model [49], which includes the full hydrodynamic response of the QGP to its initial-state geometry. The Hijing model grossly underpredicts the slope of the data while the MUSIC model quantitatively captures the slopes in both p_{T} ranges. This behavior suggests that the slopes characterized the hydrodynamic response of the QGP in UCC, where its initial transverse size is fixed and its energy density varies strongly.

A recent model study [10] related the increase of $[p_{\mathrm{T}}]$ in UCC to the speed of sound of the QGP [9], calculated as $c_s^2(T) = d\ln T/d\ln s$ where T and s are the medium temperature and entropy density, respectively. Although T evolves over the lifetime of the QGP, c_s^2 was estimated at an effective temperature T_{eff}, corresponding to approximately 1/3 of the average p_{T} calculated for all particles [9, 10]:

$$c_s^2(T_{\mathrm{eff}}) \propto \frac{d\ln(\langle[p_{\mathrm{T}}]\rangle)}{d\ln(N_{\mathrm{ch}})} \approx \frac{\Delta p_{\mathrm{T}}/\langle[p_{\mathrm{T}}]\rangle}{\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle}\,.$$

According to this model, the measured slope in Figure 4 can be used to estimate $c_s^2(T_{\mathrm{eff}})$. A reasonable agreement of the MUSIC model with the Pb+Pb data, including its p_{T} dependence, is achieved by using $c_s^2 \approx 0.23$ with $T_{\mathrm{eff}} \approx 222$ MeV [9], values consistent with those reported by the CMS Collaboration [29]. However, the extraction of the c_s^2 was shown to be sensitive to several aspects of analyses, including the kinematic selection of the particles used to define the centrality and $\langle[p_{\mathrm{T}}]\rangle$ [13, 15].

Understanding the initial-state geometry of the QGP and how it drives the hydrodynamic response is a key objective in high-energy nuclear physics. This aim can be pursued by analyzing the moments of event-by-event transverse momentum distribution $P([p_{\mathrm{T}}])$. This Letter presents the first experimental differentiation between geometrical and intrinsic fluctuations using the mean, variance, and skewness of $P([p_{\mathrm{T}}])$ in ^{208}Pb+^{208}Pb and ^{129}Xe+^{129}Xe collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV and 5.44 TeV, respectively. Across a wide N_{ch} range, the variance and skewness exhibit an approximate power-law scaling with N_{ch}, consistent with expectations from an independent superposition scenario. However, in ultra-central collisions , as a result of suppressed geometrical fluctuations and unhindered intrinsic fluctuations, all observables depart from such scaling. Notably, there is a distinctive rise in the mean, a sharp decline in the variance, and a pattern of increase followed by a sharp decrease in the skewness. Moreover, the linear rise in $\langle [p_{\mathrm{T}}] \rangle$ with increasing N_{ch} is reproduced by a hydrodynamic model using $c_s^2 \approx 0.23$ at an effective temperature $T_{\mathrm{eff}} \approx 222$ MeV. The centrality dependence of these observables in ultra-central collisions is slightly weaker in the smaller Xe+Xe collisions, and colliding even smaller nuclear species could probe this effect further. The study of $[p_{\mathrm{T}}]$ fluctuations offers an effective tool for constraining the initial-state fluctuations and the final-state hydrodynamic response in heavy-ion collisions.

Acknowledgements

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

The crucial computing support from all WLCG partners is acknowledged gratefully, in particular from CERN, the ATLAS Tier-1 facilities at TRIUMF/SFU (Canada), NDGF (Denmark, Norway, Sweden), CC-IN2P3 (France), KIT/GridKA (Germany), INFN-CNAF (Italy), NL-T1 (Netherlands), PIC (Spain), RAL (UK) and BNL (USA), the Tier-2 facilities worldwide and large non-WLCG resource providers. Major contributors of computing resources are listed in Ref. [50].

We gratefully acknowledge the support of ANPCyT, Argentina; YerPhI, Armenia; ARC, Australia; BMWFW and FWF, Austria; ANAS, Azerbaijan; CNPq and FAPESP, Brazil; NSERC, NRC and CFI, Canada; CERN; ANID, Chile; CAS, MOST and NSFC, China; Minciencias, Colombia; MEYS CR, Czech Republic; DNRF and DNSRC, Denmark; IN2P3-CNRS and CEA-DRF/IRFU, France; SRNSFG, Georgia; BMBF, HGF and MPG, Germany; GSRI, Greece; RGC and Hong Kong SAR, China; ISF and Benoziyo Center, Israel; INFN, Italy; MEXT and JSPS, Japan; CNRST, Morocco; NWO, Netherlands; RCN, Norway; MNiSW, Poland; FCT, Portugal; MNE/IFA, Romania; MESTD, Serbia; MSSR, Slovakia; ARRS and MIZŠ, Slovenia; DSI/NRF, South Africa; MICINN, Spain; SRC and Wallenberg Foundation, Sweden; SERI, SNSF and Cantons of Bern and Geneva, Switzerland; MOST, Taipei; TENMAK, Türkiye; STFC, United Kingdom; DOE and NSF, United States of America.

Individual groups and members have received support from BCKDF, CANARIE, CRC and DRAC, Canada; CERN-CZ, FORTE and PRIMUS, Czech Republic; COST, ERC, ERDF, Horizon 2020, ICSC-NextGenerationEU and Marie Skłodowska-Curie Actions, European Union; Investissements d'Avenir Labex, Investissements d'Avenir Idex and ANR, France; DFG and AvH Foundation, Germany; Herakleitos, Thales and Aristeia programmes co-financed by EU-ESF and the Greek NSRF, Greece; BSF-NSF and MINERVA, Israel; NCN and NAWA, Poland; La Caixa Banking Foundation, CERCA Programme Generalitat de Catalunya and PROMETEO and GenT Programmes Generalitat Valenciana, Spain; Göran Gustafssons Stiftelse, Sweden; The Royal Society and Leverhulme Trust, United Kingdom.

In addition, individual members wish to acknowledge support from Armenia: Yerevan Physics Institute (FAPERJ); CERN: European Organization for Nuclear Research (CERN PJAS); Chile: Agencia Nacional de Investigación y Desarrollo (FONDECYT 1230812, FONDECYT 1230987, FONDECYT 1240864); China: Chinese Ministry of Science and Technology (MOST-2023YFA1605700), National Natural Science Foundation of China (NSFC - 12175119, NSFC 12275265, NSFC-12075060); Czech Republic: Czech Science Foundation (GACR - 24-11373S), Ministry of Education Youth and Sports (FORTE CZ.02.01.01/00/22_008/0004632), PRIMUS Research Programme (PRIMUS/21/SCI/017); EU: H2020 European Research Council (ERC - 101002463); European Union: European Research Council (ERC - 948254, ERC 101089007), Horizon 2020 Framework Programme (MUCCA - CHIST-ERA-19-XAI-00), European Union, Future Artificial Intelligence Research (FAIR-NextGenerationEU PE00000013), Italian Center for High Performance Computing, Big Data and Quantum Computing (ICSC, NextGenerationEU); France: Agence Nationale de la Recherche (ANR-20-CE31-0013, ANR-21-CE31-0013, ANR-21-CE31-0022), Investissements d'Avenir Labex (ANR-11-LABX-0012); Germany: Baden-Württemberg Stiftung (BW Stiftung-Postdoc Eliteprogramme), Deutsche Forschungsgemeinschaft (DFG - 469666862, DFG - CR 312/5-2); Italy: Istituto Nazionale di Fisica Nucleare (ICSC, NextGenerationEU); Japan: Japan Society for the Promotion of Science (JSPS KAKENHI JP22H01227, JSPS KAKENHI JP22H04944, JSPS KAKENHI JP22KK0227, JSPS KAKENHI JP23KK0245); Netherlands: Netherlands Organisation for Scientific Research (NWO Veni 2020 - VI.Veni.202.179); Norway: Research Council of Norway (RCN-314472); Poland: Polish National Agency for Academic Exchange (PPN/PPO/2020/1/00002/U/00001), Polish National Science Centre (NCN 2021/42/E/ST2/00350, NCN OPUS nr 2022/47/B/ST2/03059, NCN UMO-2019/34/E/ST2/00393, UMO-2020/37/B/ST2/01043, UMO-2021/40/C/ST2/00187, UMO-2022/47/O/ST2/00148, UMO-2023/49/B/ST2/04085); Slovenia: Slovenian Research Agency (ARIS grant J1-3010); Spain: Generalitat Valenciana (Artemisa, FEDER, IDIFEDER/2018/048), Ministry of Science and Innovation (MCIN & NextGenEU PCI2022-135018-2, MICIN & FEDER PID2021-125273NB, RYC2019-028510-I, RYC2020-030254-I, RYC2021-031273-I, RYC2022-038164-I), PROMETEO and GenT Programmes Generalitat Valenciana (CIDEGENT/2019/027); Sweden: Swedish Research Council (Swedish Research Council 2023-04654, VR 2018-00482, VR 2022-03845, VR 2022-04683, VR 2023-03403, VR grant 2021-03651), Knut and Alice Wallenberg Foundation (KAW 2018.0157, KAW 2018.0458, KAW 2019.0447, KAW 2022.0358); Switzerland: Swiss National Science Foundation (SNSF - PCEFP2_194658); United Kingdom: Leverhulme Trust (Leverhulme Trust RPG-2020-004), Royal Society (NIF-R1-231091); United States of America: U.S. Department of Energy (ECA DE-AC02-76SF00515), Neubauer Family Foundation.

1 Appendix

The pileup probability is $\langle\mu\rangle = 0.0017$ in Pb+Pb collisions and 0.00019 in Xe+Xe collisions. The pileup events have a non-uniform distribution in N_{ch} and tend to have a larger contribution in UCC. The impact of pileup events can be estimated and rejected based on the anti-correlation between ZDC energy (E_{ZDC}) and FCal ΣE_{T} as shown in Figure 5(a). A typical pileup event in the UCC region consists of a genuine central event with small E_{ZDC} and large ΣE_{T} and a peripheral or mid-central event with large E_{ZDC} and small ΣE_{T}, contributing to the satellite band. The good events are selected within a six standard deviation from the peak value of E_{ZDC} at a given ΣE_{T}, as indicated by the red line. A convolution of the distribution of good events according to the pileup probability then yields an estimate of the distribution for pileup events in Figure 5(b).

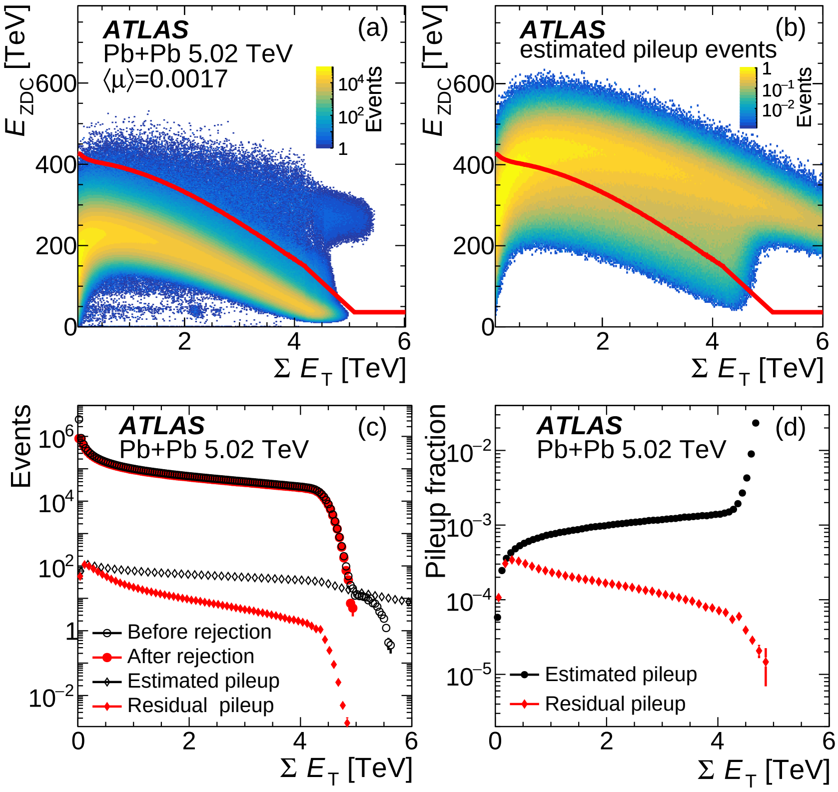

Figure 5: Top: The distributions of energy deposited in the ZDCs vs FCal for (a) all events, and (b) estimated pileup events, the red line represents the line used for selection of good events. Bottom: As a function ΣE_{T}, (c) the distributions of all events, pileup events, good events, and residual pileup events and (d) the fraction of pileup events before and after pileup rejection. The results are obtained for 5.02 TeV Pb+Pb collisions.

Figure 5(c) shows the distributions of all events and estimated pileup events as a function of ΣE_{T}, as well as the good events and residual pileup events after applying the selection criteria. The pileup events are greatly reduced and its fraction is $\lesssim 0.01\%$ in UCC, as shown in Figure 5(d). The pileup rejection criteria have been relaxed to vary the residual fraction of the pileup events, the results are insensitive to this variation.

Figure 6(a) shows the correlation between ΣE_{T} and N_{ch}. The correlation is smeared, implying that the 0–1% most central events selected on ΣE_{T} would span a large range of N_{ch} as indicated by the shaded box. Correspondingly, the $[p_{\mathrm{T}}]$ for these events span a large range $\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle_{0-1\%}$ as shown by the x-axis in Figure 4.

Figure 7 displays the multiplicity dependence of γ and scaled-γ in the two systems. They can be derived from Figures 1 and 3, but are shown here for completeness.

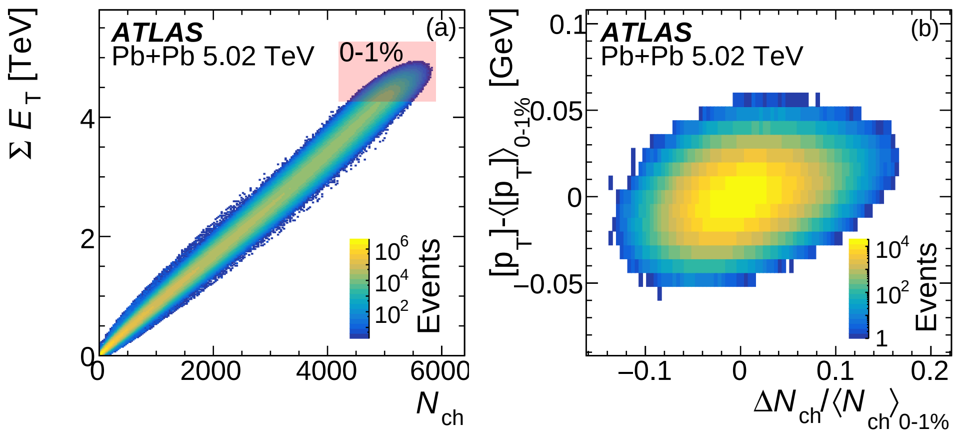

Figure 6: (a) Correlation between FCal ΣE_{T} and N_{ch} in Pb+Pb collisions, where the shaded region covers 0–1% most central events, and (b) correlation between $[p_{\mathrm{T}}]$ and $\Delta N_{\mathrm{ch}}/\langle N_{\mathrm{ch}}\rangle_{0-1\%}$.

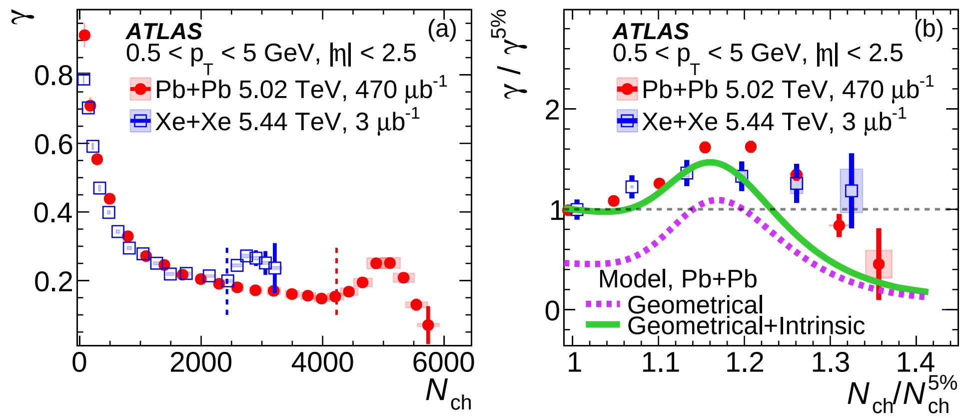

Figure 7: (a) γ as a function of N_{ch} and (b) scaled-γ as a function of $N_{\mathrm{ch}}/N_{\mathrm{ch}}^{5\%}$ in Pb+Pb and Xe+Xe collisions compared to predictions from Ref. [12]. The error bars and shaded area represent statistical and systematic uncertainties, respectively. The vertical dashed lines in (a) mark the N_{ch} values corresponding to 5% centrality in Pb+Pb and Xe+Xe collisions.

References

[1] W. Busza, K. Rajagopal and W. van der Schee, *Heavy Ion Collisions: The Big Picture, and the Big Questions*, Ann. Rev. Nucl. Part. Sci. **68** (2018) 339, arXiv: 1802.04801 [hep-ph].

[2] D. Teaney and L. Yan, *Triangularity and dipole asymmetry in relativistic heavy ion collisions*, Phys. Rev. C **83** (2011) 064904, arXiv: 1010.1876 [nucl-th].

[3] F. G. Gardim, F. Grassi, M. Luzum and J.-Y. Ollitrault, *Mapping the hydrodynamic response to the initial geometry in heavy-ion collisions*, Phys. Rev. C **85** (2012) 024908, arXiv: 1111.6538 [nucl-th].

[4] H. Niemi, G. S. Denicol, H. Holopainen and P. Huovinen, *Event-by-event distributions of azimuthal asymmetries in ultrarelativistic heavy-ion collisions*, Phys. Rev. C **87** (2013) 054901, arXiv: 1212.1008 [nucl-th].

[5] P. Bożek and W. Broniowski, *Transverse-momentum fluctuations in relativistic heavy-ion collisions from event-by-event viscous hydrodynamics*, Phys. Rev. C **85** (2012) 044910, arXiv: 1203.1810 [nucl-th].

[6] P. Romatschke and U. Romatschke, *Relativistic Fluid Dynamics In and Out of Equilibrium*, Cambridge Monographs on Mathematical Physics, Cambridge University Press, 2019, arXiv: 1712.05815 [nucl-th].

[7] J. E. Bernhard, J. S. Moreland and S. A. Bass, *Bayesian estimation of the specific shear and bulk viscosity of quark–gluon plasma*, Nature Phys. **15** (2019) 1113.

[8] G. Nijs, W. van der Schee, U. Gürsoy and R. Snellings, *Bayesian analysis of heavy ion collisions with the heavy ion computational framework Trajectum*, Phys. Rev. C **103** (2021) 054909, arXiv: 2010.15134 [nucl-th].

[9] F. G. Gardim, G. Giacalone, M. Luzum and J.-Y. Ollitrault, *Thermodynamics of hot strong-interaction matter from ultrarelativistic nuclear collisions*, Nature Phys. **16** (2020) 615, arXiv: 1908.09728 [nucl-th].

[10] F. G. Gardim, G. Giacalone and J.-Y. Ollitrault, *The mean transverse momentum of ultracentral heavy-ion collisions: A new probe of hydrodynamics*, Phys. Lett. B **809** (2020) 135749, arXiv: 1909.11609 [nucl-th].

[11] R. Samanta, S. Bhatta, J. Jia, M. Luzum and J.-Y. Ollitrault, *Thermalization at the femtoscale seen in high-energy Pb+Pb collisions*, Phys. Rev. C **109** (2024) L051902, arXiv: 2303.15323 [nucl-th].

[12] R. Samanta, J. P. Picchetti, M. Luzum and J.-Y. Ollitrault, *Non-Gaussian transverse momentum fluctuations from impact parameter fluctuations*, Phys. Rev. C **108** (2023) 024908, arXiv: 2306.09294 [nucl-th].

[13] G. Nijs and W. van der Schee, *Ultracentral heavy ion collisions, transverse momentum and the equation of state*, Phys. Lett. B **853** (2024) 138636, arXiv: 2312.04623 [nucl-th].

[14] F. G. Gardim, A. V. Giannini and J.-Y. Ollitrault, *Accessing the speed of sound in relativistic ultracentral nucleus-nucleus collisions using the mean transverse momentum*, (2024), arXiv: 2403.06052 [nucl-th].

[15] G. Soares Rocha, L. Gavassino, M. Singh and J.-F. Paquet, *Analytical insights into the interplay of momentum, multiplicity and the speed of sound in heavy-ion collisions*, (2024), arXiv: 2405.10401 [hep-ph].

[16] S. Gavin and G. Moschelli, *Fluctuation Probes of Early-Time Correlations in Nuclear Collisions*, Phys. Rev. C **85** (2012) 014905, arXiv: 1107.3317 [nucl-th].

[17] M. Cody et al., *Complementary two-particle correlation observables for relativistic nuclear collisions*, Phys. Rev. C **107** (2023) 014909, arXiv: 2110.04884 [nucl-th].

[18] NA49 Collaboration, *Event-by-event fluctuations of average transverse momentum in central Pb + Pb collisions at 158 GeV per nucleon*, Phys. Lett. B **459** (1999) 679, arXiv: hep-ex/9904014.

[19] PHENIX Collaboration, *Event-by-event fluctuations in mean p_T and mean E_T in $\sqrt{s_{\mathrm{NN}}}$ = 130 GeV Au+Au collisions*, Phys. Rev. C **66** (2002) 024901, arXiv: nucl-ex/0203015.

[20] PHENIX Collaboration, *Measurement of non-random event-by-event fluctuations of average transverse momentum in $\sqrt{s_{\mathrm{NN}}}$= 200 GeV Au+Au and p+p collisions*, Phys. Rev. Lett. **93** (2004) 092301, arXiv: nucl-ex/0310005.

[21] STAR Collaboration, *Event-wise $\langle p_T \rangle$ fluctuations in Au - Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 130 GeV*, Phys. Rev. C **71** (2005) 064906, arXiv: nucl-ex/0308033.

[22] NA49 Collaboration, *Transverse momentum fluctuations in nuclear collisions at 158 A GeV*, Phys. Rev. C **70** (2004) 034902, arXiv: hep-ex/0311009.

[23] CERES Collaboration, *Event-by-event fluctuations of the mean transverse momentum in 40, 80 and 158 A GeV Pb - Au collisions*, Nucl. Phys. A **727** (2003) 97, arXiv: nucl-ex/0305002.

[24] STAR Collaboration, *Incident energy dependence of p_t correlations at RHIC*, Phys. Rev. C **72** (2005) 044902, arXiv: nucl-ex/0504031.

[25] STAR Collaboration, *System-size dependence of transverse momentum correlations at* $\sqrt{s_{\mathrm{NN}}} = 62.4$ *and 200 GeV at the BNL Relativistic Heavy Ion Collider*, Phys. Rev. C **87** (2013) 064902, arXiv: 1301.6633 [nucl-ex].

[26] ALICE Collaboration, *Event-by-event mean p_{T} fluctuations in pp and Pb-Pb collisions at the LHC*, Eur. Phys. J. C **74** (2014) 3077, arXiv: 1407.5530 [nucl-ex].

[27] STAR Collaboration, *Collision-energy dependence of p_T correlations in Au + Au collisions at energies available at the BNL Relativistic Heavy Ion Collider*, Phys. Rev. C **99** (2019) 044918, arXiv: 1901.00837 [nucl-ex].

[28] ALICE Collaboration, *Skewness and kurtosis of mean transverse momentum fluctuations at the LHC energies*, Phys. Lett. B **850** (2024) 138541, arXiv: 2308.16217 [nucl-ex].

[29] CMS Collaboration, *Extracting the speed of sound in quark–gluon plasma with ultrarelativistic lead–lead collisions at the LHC*, Rept. Prog. Phys. **87** (2024) 077801, arXiv: 2401.06896 [nucl-ex].

[30] ATLAS Collaboration, *The ATLAS Experiment at the CERN Large Hadron Collider*, JINST **3** (2008) S08003.

[31] ATLAS Collaboration, *The ATLAS Inner Detector commissioning and calibration*, Eur. Phys. J. C **70** (2010) 787, arXiv: 1004.5293 [physics.ins-det].

[32] ATLAS Collaboration, *Performance of the ATLAS trigger system in 2015*, Eur. Phys. J. C **77** (2017) 317, arXiv: 1611.09661 [hep-ex].

[33] ATLAS Collaboration, *Software and computing for Run 3 of the ATLAS experiment at the LHC*, (2024), arXiv: 2404.06335 [hep-ex].

[34] ATLAS Collaboration, *Fluctuations of anisotropic flow in Pb+Pb collisions at $\sqrt{s_{\text{NN}}}$ = 5.02 TeV with the ATLAS detector*, JHEP **01** (2020) 051, arXiv: 1904.04808 [nucl-ex].

[35] ATLAS Collaboration, *Measurement of charged-particle spectra in Pb+Pb collisions at $\sqrt{s_{\text{NN}}} = 2.76$ TeV with the ATLAS detector at the LHC*, JHEP **09** (2015) 050, arXiv: 1504.04337 [hep-ex].

[36] ATLAS Collaboration, *Charged-hadron production in pp, p+Pb, Pb+Pb, and Xe+Xe collisions at $\sqrt{s_{NN}} = 5$ TeV with the ATLAS detector at the LHC*, JHEP **07** (2023) 074, arXiv: 2211.15257 [hep-ex].

[37] M. L. Miller, K. Reygers, S. J. Sanders and P. Steinberg, *Glauber Modeling in High-Energy Nuclear Collisions*, Ann. Rev. Nucl. Part. Sci. **57** (2007) 205, arXiv: nucl-ex/0701025.

[38] M. Gyulassy and X.-N. Wang, *HIJING 1.0: A Monte Carlo program for parton and particle production in high-energy hadronic and nuclear collisions*, Comput. Phys. Commun. **83** (1994) 307, arXiv: nucl-th/9502021.

[39] S. Agostinelli et al., *GEANT4 – a simulation toolkit*, Nucl. Instrum. Meth. A **506** (2003) 250.

[40] ATLAS Collaboration, *The ATLAS Simulation Infrastructure*, Eur. Phys. J. C **70** (2010) 823, arXiv: 1005.4568 [physics.ins-det].

[41] A. Bilandzic, R. Snellings and S. Voloshin, *Flow analysis with cumulants: Direct calculations*, Phys. Rev. C **83** (2011) 044913, arXiv: 1010.0233 [nucl-ex].

[42] S. Bhatta, C. Zhang and J. Jia, *Higher-order transverse momentum fluctuations in heavy-ion collisions*, Phys. Rev. C **105** (2022) 024904, arXiv: 2112.03397 [nucl-th].

[43] ATLAS Collaboration, *Measurement of flow harmonics correlations with mean transverse momentum in lead-lead and proton-lead collisions at $\sqrt{s_{\text{NN}}} = 5.02$ TeV with the ATLAS detector*, Eur. Phys. J. C **79** (2019) 985, arXiv: 1907.05176 [nucl-ex].

[44] G. Giacalone, F. G. Gardim, J. Noronha-Hostler and J.-Y. Ollitrault, *Skewness of mean transverse momentum fluctuations in heavy-ion collisions*, Phys. Rev. C **103** (2021) 024910, arXiv: 2004.09799 [nucl-th].

[45] ATLAS Collaboration, *Evaluating statistical uncertainties and correlations using the bootstrap method*, ATL-PHYS-PUB-2021-011 (2021), URL: https://cds.cern.ch/record/2759945.

[46] ATLAS Collaboration, *Measurement of the azimuthal anisotropy of charged-particle production in $Xe + Xe$ collisions at $\sqrt{s_{\text{NN}}} = 5.44$ TeV with the ATLAS detector*, Phys. Rev. C **101** (2020) 024906, arXiv: 1911.04812 [nucl-ex].

[47] S. A. Voloshin, *Transverse radial expansion in nuclear collisions and two particle correlations*, Phys. Lett. B **632** (2006) 490, arXiv: nucl-th/0312065.

[48] S. Gavin, *Traces of thermalization from transverse momentum fluctuations in nuclear collisions*, Phys. Rev. Lett. **92** (2004) 162301, arXiv: nucl-th/0308067.

[49] B. Schenke, S. Jeon and C. Gale, *(3+1)D hydrodynamic simulation of relativistic heavy-ion collisions*, Phys. Rev. C **82** (2010) 014903, arXiv: 1004.1408 [hep-ph].

[50] ATLAS Collaboration, *ATLAS Computing Acknowledgements*, ATL-SOFT-PUB-2023-001, 2023, URL: https://cds.cern.ch/record/2869272.

The ATLAS Collaboration

G. Aad[104], E. Aakvaag[17], B. Abbott[123], S. Abdelhameed[119a], K. Abeling[56], N.J. Abicht[50], S.H. Abidi[30], M. Aboelela[45], A. Aboulhorma[36e], H. Abramowicz[154], H. Abreu[153], Y. Abulaiti[120], B.S. Acharya[70a,70b,l], A. Ackermann[64a], C. Adam Bourdarios[4], L. Adamczyk[87a], S.V. Addepalli[27], M.J. Addison[103], J. Adelman[118], A. Adiguzel[22c], T. Adye[137], A.A. Affolder[139], Y. Afik[40], M.N. Agaras[13], J. Agarwala[74a,74b], A. Aggarwal[102], C. Agheorghiesei[28c], F. Ahmadov[39,y], W.S. Ahmed[106], S. Ahuja[97], X. Ai[63e], G. Aielli[77a,77b], A. Aikot[166], M. Ait Tamlihat[36e], B. Aitbenchikh[36a], M. Akbiyik[102], T.P.A. Åkesson[100], A.V. Akimov[38], D. Akiyama[171], N.N. Akolkar[25], S. Aktas[22a], K. Al Khoury[42], G.L. Alberghi[24b], J. Albert[168], P. Albicocco[54], G.L. Albouy[61], S. Alderweireldt[53], Z.L. Alegria[124], M. Aleksa[37], I.N. Aleksandrov[39], C. Alexa[28b], T. Alexopoulos[10], F. Alfonsi[24b], M. Algren[57], M. Alhroob[170], B. Ali[135], H.M.J. Ali[93], S. Ali[32], S.W. Alibocus[94], M. Aliev[34c], G. Alimonti[72a], W. Alkakhi[56], C. Allaire[67], B.M.M. Allbrooke[149], J.F. Allen[53], C.A. Allendes Flores[140f], P.P. Allport[21], A. Aloisio[73a,73b], F. Alonso[92], C. Alpigiani[141], Z.M.K. Alsolami[93], M. Alvarez Estevez[101], A. Alvarez Fernandez[102], M. Alves Cardoso[57], M.G. Alviggi[73a,73b], M. Aly[103], Y. Amaral Coutinho[84b], A. Ambler[106], C. Amelung[37], M. Amerl[103], C.G. Ames[111], D. Amidei[108], B. Amini[55], K.J. Amirie[158], S.P. Amor Dos Santos[133a], K.R. Amos[166], S. An[85], V. Ananiev[128], C. Anastopoulos[142], T. Andeen[11], J.K. Anders[37], A.C. Anderson[60], S.Y. Andrean[48a,48b], A. Andreazza[72a,72b], S. Angelidakis[9], A. Angerami[42], A.V. Anisenkov[38], A. Annovi[75a], C. Antel[57], E. Antipov[148], M. Antonelli[54], F. Anulli[76a], M. Aoki[85], T. Aoki[156], M.A. Aparo[149], L. Aperio Bella[49], C. Appelt[19], A. Apyan[27], S.J. Arbiol Val[88], C. Arcangeletti[54], A.T.H. Arce[52], J-F. Arguin[110], S. Argyropoulos[55], J.-H. Arling[49], O. Arnaez[4], H. Arnold[148], G. Artoni[76a,76b], H. Asada[113], K. Asai[121], S. Asai[156], N.A. Asbah[37], R.A. Ashby Pickering[170], K. Assamagan[30], R. Astalos[29a], K.S.V. Astrand[100], S. Atashi[162], R.J. Atkin[34a], M. Atkinson[165], H. Atmani[36f], P.A. Atmasiddha[131], K. Augsten[135], S. Auricchio[73a,73b], A.D. Auriol[21], V.A. Austrup[103], G. Avolio[37], K. Axiotis[57], G. Azuelos[110,ad], D. Babal[29b], H. Bachacou[138], K. Bachas[155,p], A. Bachiu[35], F. Backman[48a,48b], A. Badea[40], T.M. Baer[108], P. Bagnaia[76a,76b], M. Bahmani[19], D. Bahner[55], K. Bai[126], J.T. Baines[137], L. Baines[96], O.K. Baker[175], E. Bakos[16], D. Bakshi Gupta[8], L.E. Balabram Filho[84b], V. Balakrishnan[123], R. Balasubramanian[117], E.M. Baldin[38], P. Balek[87a], E. Ballabene[24b,24a], F. Balli[138], L.M. Baltes[64a], W.K. Balunas[33], J. Balz[102], I. Bamwidhi[119b], E. Banas[88], M. Bandieramonte[132], A. Bandyopadhyay[25], S. Bansal[25], L. Barak[154], M. Barakat[49], E.L. Barberio[107], D. Barberis[58b,58a], M. Barbero[104], M.Z. Barel[117], T. Barillari[112], M-S. Barisits[37], T. Barklow[146], P. Baron[125], D.A. Baron Moreno[103], A. Baroncelli[63a], A.J. Barr[129], J.D. Barr[98], F. Barreiro[101], J. Barreiro Guimarães da Costa[14], U. Barron[154], M.G. Barros Teixeira[133a], S. Barsov[38], F. Bartels[64a], R. Bartoldus[146], A.E. Barton[93], P. Bartos[29a], A. Basan[102], M. Baselga[50], A. Bassalat[67,b], M.J. Basso[159a], S. Bataju[45], R. Bate[167], R.L. Bates[60], S. Batlamous[101], B. Batool[144], M. Battaglia[139], D. Battulga[19], M. Bauce[76a,76b], M. Bauer[80], P. Bauer[25], L.T. Bazzano Hurrell[31], J.B. Beacham[52], T. Beau[130], J.Y. Beaucamp[92], P.H. Beauchemin[161], P. Bechtle[25], H.P. Beck[20,o], K. Becker[170], A.J. Beddall[83], V.A. Bednyakov[39], C.P. Bee[148], L.J. Beemster[16], T.A. Beermann[37], M. Begalli[84d], M. Begel[30], A. Behera[148], J.K. Behr[49], J.F. Beirer[37], F. Beisiegel[25], M. Belfkir[119b], G. Bella[154], L. Bellagamba[24b], A. Bellerive[35], P. Bellos[21], K. Beloborodov[38], D. Benchekroun[36a], F. Bendebba[36a], Y. Benhammou[154], K.C. Benkendorfer[62], L. Beresford[49], M. Beretta[54], E. Bergeaas Kuutmann[164], N. Berger[4], B. Bergmann[135], J. Beringer[18a], G. Bernardi[5], C. Bernius[146], F.U. Bernlochner[25], F. Bernon[37,104], A. Berrocal Guardia[13], T. Berry[97], P. Berta[136], A. Berthold[51], S. Bethke[112], A. Betti[76a,76b], A.J. Bevan[96], N.K. Bhalla[55], S. Bhatta[148], D.S. Bhattacharya[169], P. Bhattarai[146], K.D. Bhide[55], V.S. Bhopatkar[124], R.M. Bianchi[132], G. Bianco[24b,24a], O. Biebel[111], R. Bielski[126], M. Biglietti[78a], C.S. Billingsley[45], Y. Bimgdi[36f], M. Bindi[56], A. Bingul[22b], C. Bini[76a,76b], G.A. Bird[33], M. Birman[172], M. Biros[136], S. Biryukov[149], T. Bisanz[50], E. Bisceglie[44b,44a], J.P. Biswal[137], D. Biswas[144], I. Bloch[49], A. Blue[60], U. Blumenschein[96], J. Blumenthal[102], V.S. Bobrovnikov[38], M. Boehler[55], B. Boehm[169], D. Bogavac[37], A.G. Bogdanchikov[38], C. Bohm[48a], V. Boisvert[97], P. Bokan[37], T. Bold[87a], M. Bomben[5], M. Bona[96], M. Boonekamp[138], C.D. Booth[97], A.G. Borbély[60], I.S. Bordulev[38], G. Borissov[93], D. Bortoletto[129], D. Boscherini[24b], M. Bosman[13], J.D. Bossio Sola[37], K. Bouaouda[36a], N. Bouchhar[166], L. Boudet[4], J. Boudreau[132], E.V. Bouhova-Thacker[93], D. Boumediene[41], R. Bouquet[58b,58a], A. Boveia[122], J. Boyd[37], D. Boye[30], I.R. Boyko[39], L. Bozianu[57], J. Bracinik[21], N. Brahimi[4], G. Brandt[174], O. Brandt[33], F. Braren[49], B. Brau[105], J.E. Brau[126], R. Brener[172], L. Brenner[117], R. Brenner[164], S. Bressler[172], G. Brianti[79a,79b], D. Britton[60], D. Britzger[112], I. Brock[25], G. Brooijmans[42], E.M. Brooks[159b], E. Brost[30], L.M. Brown[168], L.E. Bruce[62], T.L. Bruckler[129], P.A. Bruckman de Renstrom[88], B. Brüers[49], A. Bruni[24b], G. Bruni[24b], M. Bruschi[24b], N. Bruscino[76a,76b], T. Buanes[17], Q. Buat[141], D. Buchin[112], A.G. Buckley[60], O. Bulekov[38], B.A. Bullard[146], S. Burdin[94], C.D. Burgard[50], A.M. Burger[37], B. Burghgrave[8], O. Burlayenko[55], J. Burleson[165], J.T.P. Burr[33], J.C. Burzynski[145], E.L. Busch[42], V. Büscher[102], P.J. Bussey[60], J.M. Butler[26], C.M. Buttar[60], J.M. Butterworth[98], W. Buttinger[137], C.J. Buxo Vazquez[109], A.R. Buzykaev[38], S. Cabrera Urbán[166], L. Cadamuro[67], D. Caforio[59], H. Cai[132], Y. Cai[14,114c], Y. Cai[114a], V.M.M. Cairo[37], O. Cakir[3a], N. Calace[37], P. Calafiura[18a], G. Calderini[130], P. Calfayan[69], G. Callea[60], L.P. Caloba[84b], D. Calvet[41], S. Calvet[41], M. Calvetti[75a,75b], R. Camacho Toro[130], S. Camarda[37], D. Camarero Munoz[27], P. Camarri[77a,77b], M.T. Camerlingo[73a,73b], D. Cameron[37], C. Camincher[168], M. Campanelli[98], A. Camplani[43], V. Canale[73a,73b], A.C. Canbay[3a], E. Canonero[97], J. Cantero[166], Y. Cao[165], F. Capocasa[27], M. Capua[44b,44a], A. Carbone[72a,72b], R. Cardarelli[77a], J.C.J. Cardenas[8], G. Carducci[44b,44a], T. Carli[37], G. Carlino[73a], J.I. Carlotto[13], B.T. Carlson[132,q], E.M. Carlson[168,159a], J. Carmignani[94], L. Carminati[72a,72b], A. Carnelli[138], M. Carnesale[76a,76b], S. Caron[116], E. Carquin[140f], S. Carrá[72a], G. Carratta[24b,24a], A.M. Carroll[126], T.M. Carter[53], M.P. Casado[13,i], M. Caspar[49], F.L. Castillo[4], L. Castillo Garcia[13], V. Castillo Gimenez[166], N.F. Castro[133a,133e], A. Catinaccio[37], J.R. Catmore[128], T. Cavaliere[4], V. Cavaliere[30], N. Cavalli[24b,24a], L.J. Caviedes Betancourt[23b], Y.C. Cekmecelioglu[49], E. Celebi[83], S. Cella[37], F. Celli[129], M.S. Centonze[71a,71b], V. Cepaitis[57], K. Cerny[125], A.S. Cerqueira[84a], A. Cerri[149], L. Cerrito[77a,77b], F. Cerutti[18a], B. Cervato[144], A. Cervelli[24b], G. Cesarini[54], S.A. Cetin[83], D. Chakraborty[118], J. Chan[18a], W.Y. Chan[156], J.D. Chapman[33], E. Chapon[138], B. Chargeishvili[152b], D.G. Charlton[21], M. Chatterjee[20], C. Chauhan[136], Y. Che[114a], S. Chekanov[6], S.V. Chekulaev[159a], G.A. Chelkov[39,a], A. Chen[108], B. Chen[154], B. Chen[168], H. Chen[114a], H. Chen[30], J. Chen[63c], J. Chen[145], M. Chen[129], S. Chen[156], S.J. Chen[114a], X. Chen[63c], X. Chen[15,ac], Y. Chen[63a], C.L. Cheng[173], H.C. Cheng[65a], S. Cheong[146], A. Cheplakov[39], E. Cheremushkina[49], E. Cherepanova[117], R. Cherkaoui El Moursli[36e], E. Cheu[7], K. Cheung[66], L. Chevalier[138], V. Chiarella[54], G. Chiarelli[75a], N. Chiedde[104], G. Chiodini[71a], A.S. Chisholm[21], A. Chitan[28b], M. Chitishvili[166], M.V. Chizhov[39],

K. Choi [11], Y. Chou [141], E.Y.S. Chow [116], K.L. Chu [172], M.C. Chu [65a], X. Chu [14,114c], Z. Chubinidze [54], J. Chudoba [134], J.J. Chwastowski [88], D. Cieri [112], K.M. Ciesla [87a], V. Cindro [95], A. Ciocio [18a], F. Cirotto [73a,73b], Z.H. Citron [172], M. Citterio [72a], D.A. Ciubotaru [28b], A. Clark [57], P.J. Clark [53], N. Clarke Hall [98], C. Clarry [158], J.M. Clavijo Columbie [49], S.E. Clawson [49], C. Clement [48a,48b], Y. Coadou [104], M. Cobal [70a,70c], A. Coccaro [58b], R.F. Coelho Barrue [133a], R. Coelho Lopes De Sa [105], S. Coelli [72a], B. Cole [42], J. Collot [61], P. Conde Muiño [133a,133g], M.P. Connell [34c], S.H. Connell [34c], E.I. Conroy [129], F. Conventi [73a,ae], H.G. Cooke [21], A.M. Cooper-Sarkar [129], F.A. Corchia [24b,24a], A. Cordeiro Oudot Choi [130], L.D. Corpe [41], M. Corradi [76a,76b], F. Corriveau [106,w], A. Cortes-Gonzalez [19], M.J. Costa [166], F. Costanza [4], D. Costanzo [142], B.M. Cote [122], J. Couthures [4], G. Cowan [97], K. Cranmer [173], D. Cremonini [24b,24a], S. Crépé-Renaudin [61], F. Crescioli [130], M. Cristinziani [144], M. Cristoforetti [79a,79b], V. Croft [117], J.E. Crosby [124], G. Crosetti [44b,44a], A. Cueto [101], H. Cui [98], Z. Cui [7], W.R. Cunningham [60], F. Curcio [166], J.R. Curran [53], P. Czodrowski [37], M.J. Da Cunha Sargedas De Sousa [58b,58a], J.V. Da Fonseca Pinto [84b], C. Da Via [103], W. Dabrowski [87a], T. Dado [37], S. Dahbi [151], T. Dai [108], D. Dal Santo [20], C. Dallapiccola [105], M. Dam [43], G. D'amen [30], V. D'Amico [111], J. Damp [102], J.R. Dandoy [35], D. Dannheim [37], M. Danninger [145], V. Dao [148], G. Darbo [58b], S.J. Das [30,af], F. Dattola [49], S. D'Auria [72a,72b], A. D'avanzo [73a,73b], C. David [34a], T. Davidek [136], I. Dawson [96], H.A. Day-hall [135], K. De [8], R. De Asmundis [73a], N. De Biase [49], S. De Castro [24b,24a], N. De Groot [116], P. de Jong [117], H. De la Torre [118], A. De Maria [114a], A. De Salvo [76a], U. De Sanctis [77a,77b], F. De Santis [71a,71b], A. De Santo [149], J.B. De Vivie De Regie [61], D.V. Dedovich[39], J. Degens [94], A.M. Deiana [45], F. Del Corso [24b,24a], J. Del Peso [101], F. Del Rio [64a], L. Delagrange [130], F. Deliot [138], C.M. Delitzsch [50], M. Della Pietra [73a,73b], D. Della Volpe [57], A. Dell'Acqua [37], L. Dell'Asta [72a,72b], M. Delmastro [4], P.A. Delsart [61], S. Demers [175], M. Demichev [39], S.P. Denisov [38], L. D'Eramo [41], D. Derendarz [88], F. Derue [130], P. Dervan [94], K. Desch [25], C. Deutsch [25], F.A. Di Bello [58b,58a], A. Di Ciaccio [77a,77b], L. Di Ciaccio [4], A. Di Domenico [76a,76b], C. Di Donato [73a,73b], A. Di Girolamo [37], G. Di Gregorio [37], A. Di Luca [79a,79b], B. Di Micco [78a,78b], R. Di Nardo [78a,78b], K.F. Di Petrillo [40], M. Diamantopoulou [35], F.A. Dias [117], T. Dias Do Vale [145], M.A. Diaz [140a,140b], F.G. Diaz Capriles [25], A.R. Didenko[39], M. Didenko [166], E.B. Diehl [108], S. Díez Cornell [49], C. Diez Pardos [144], C. Dimitriadi [164], A. Dimitrievska [21], J. Dingfelder [25], T. Dingley [129], I-M. Dinu [28b], S.J. Dittmeier [64b], F. Dittus [37], M. Divisek [136], F. Djama [104], T. Djobava [152b], C. Doglioni [103,100], A. Dohnalova [29a], J. Dolejsi [136], Z. Dolezal [136], K. Domijan [87a], K.M. Dona [40], M. Donadelli [84d], B. Dong [109], J. Donini [41], A. D'Onofrio [73a,73b], M. D'Onofrio [94], J. Dopke [137], A. Doria [73a], N. Dos Santos Fernandes [133a], P. Dougan [103], M.T. Dova [92], A.T. Doyle [60], M.A. Draguet [129], E. Dreyer [172], I. Drivas-koulouris [10], M. Drnevich [120], M. Drozdova [57], D. Du [63a], T.A. du Pree [117], F. Dubinin [38], M. Dubovsky [29a], E. Duchovni [172], G. Duckeck [111], O.A. Ducu [28b], D. Duda [53], A. Dudarev [37], E.R. Duden [27], M. D'uffizi [103], L. Duflot [67], M. Dührssen [37], I. Duminica [28g], A.E. Dumitriu [28b], M. Dunford [64a], S. Dungs [50], K. Dunne [48a,48b], A. Duperrin [104], H. Duran Yildiz [3a], M. Düren [59], A. Durglishvili [152b], B.L. Dwyer [118], G.I. Dyckes [18a], M. Dyndal [87a], B.S. Dziedzic [37], Z.O. Earnshaw [149], G.H. Eberwein [129], B. Eckerova [29a], S. Eggebrecht [56], E. Egidio Purcino De Souza [84e], L.F. Ehrke [57], G. Eigen [17], K. Einsweiler [18a], T. Ekelof [164], P.A. Ekman [100], S. El Farkh [36b], Y. El Ghazali [63a], H. El Jarrari [37], A. El Moussaouy [36a], V. Ellajosyula [164], M. Ellert [164], F. Ellinghaus [174], N. Ellis [37], J. Elmsheuser [30], M. Elsawy [119a], M. Elsing [37], D. Emeliyanov [137], Y. Enari [85], I. Ene [18a], S. Epari [13], P.A. Erland [88], D. Ernani Martins Neto [88], M. Errenst [174], M. Escalier [67], C. Escobar [166], E. Etzion [154],

G. Evans[133a], H. Evans[69], L.S. Evans[97], A. Ezhilov[38], S. Ezzarqtouni[36a], F. Fabbri[24b,24a], L. Fabbri[24b,24a], G. Facini[98], V. Fadeyev[139], R.M. Fakhrutdinov[38], D. Fakoudis[102], S. Falciano[76a], L.F. Falda Ulhoa Coelho[37], F. Fallavollita[112], G. Falsetti[44b,44a], J. Faltova[136], C. Fan[165], Y. Fan[14], Y. Fang[14,114c], M. Fanti[72a,72b], M. Faraj[70a,70b], Z. Farazpay[99], A. Farbin[8], A. Farilla[78a], T. Farooque[109], S.M. Farrington[53], F. Fassi[36e], D. Fassouliotis[9], M. Faucci Giannelli[77a,77b], W.J. Fawcett[33], L. Fayard[67], P. Federic[136], P. Federicova[134], O.L. Fedin[38,a], M. Feickert[173], L. Feligioni[104], D.E. Fellers[126], C. Feng[63b], Z. Feng[117], M.J. Fenton[162], L. Ferencz[49], R.A.M. Ferguson[93], S.I. Fernandez Luengo[140f], P. Fernandez Martinez[13], M.J.V. Fernoux[104], J. Ferrando[93], A. Ferrari[164], P. Ferrari[117,116], R. Ferrari[74a], D. Ferrere[57], C. Ferretti[108], D. Fiacco[76a,76b], F. Fiedler[102], P. Fiedler[135], A. Filipčič[95], E.K. Filmer[1], F. Filthaut[116], M.C.N. Fiolhais[133a,133c,c], L. Fiorini[166], W.C. Fisher[109], T. Fitschen[103], P.M. Fitzhugh[138], I. Fleck[144], P. Fleischmann[108], T. Flick[174], M. Flores[34d,aa], L.R. Flores Castillo[65a], L. Flores Sanz De Acedo[37], F.M. Follega[79a,79b], N. Fomin[33], J.H. Foo[158], A. Formica[138], A.C. Forti[103], E. Fortin[37], A.W. Fortman[18a], M.G. Foti[18a], L. Fountas[9,j], D. Fournier[67], H. Fox[93], P. Francavilla[75a,75b], S. Francescato[62], S. Franchellucci[57], M. Franchini[24b,24a], S. Franchino[64a], D. Francis[37], L. Franco[116], V. Franco Lima[37], L. Franconi[49], M. Franklin[62], G. Frattari[27], Y.Y. Frid[154], J. Friend[60], N. Fritzsche[37], A. Froch[55], D. Froidevaux[37], J.A. Frost[129], Y. Fu[63a], S. Fuenzalida Garrido[140f], M. Fujimoto[104], K.Y. Fung[65a], E. Furtado De Simas Filho[84e], M. Furukawa[156], J. Fuster[166], A. Gaa[56], A. Gabrielli[24b,24a], A. Gabrielli[158], P. Gadow[37], G. Gagliardi[58b,58a], L.G. Gagnon[18a], S. Gaid[163], S. Galantzan[154], E.J. Gallas[129], B.J. Gallop[137], K.K. Gan[122], S. Ganguly[156], Y. Gao[53], F.M. Garay Walls[140a,140b], B. Garcia[30], C. García[166], A. Garcia Alonso[117], A.G. Garcia Caffaro[175], J.E. García Navarro[166], M. Garcia-Sciveres[18a], G.L. Gardner[131], R.W. Gardner[40], N. Garelli[161], D. Garg[81], R.B. Garg[146], J.M. Gargan[53], C.A. Garner[158], C.M. Garvey[34a], V.K. Gassmann[161], G. Gaudio[74a], V. Gautam[13], P. Gauzzi[76a,76b], J. Gavranovic[95], I.L. Gavrilenko[38], A. Gavrilyuk[38], C. Gay[167], G. Gaycken[126], E.N. Gazis[10], A.A. Geanta[28b], C.M. Gee[139], A. Gekow[122], C. Gemme[58b], M.H. Genest[61], A.D. Gentry[115], S. George[97], W.F. George[21], T. Geralis[47], P. Gessinger-Befurt[37], M.E. Geyik[174], M. Ghani[170], K. Ghorbanian[96], A. Ghosal[144], A. Ghosh[162], A. Ghosh[7], B. Giacobbe[24b], S. Giagu[76a,76b], T. Giani[117], A. Giannini[63a], S.M. Gibson[97], M. Gignac[139], D.T. Gil[87b], A.K. Gilbert[87a], B.J. Gilbert[42], D. Gillberg[35], G. Gilles[117], L. Ginabat[130], D.M. Gingrich[2,ad], M.P. Giordani[70a,70c], P.F. Giraud[138], G. Giugliarelli[70a,70c], D. Giugni[72a], F. Giuli[37], I. Gkialas[9,j], L.K. Gladilin[38], C. Glasman[101], G.R. Gledhill[126], G. Glemža[49], M. Glisic[126], I. Gnesi[44b,e], Y. Go[30], M. Goblirsch-Kolb[37], B. Gocke[50], D. Godin[110], B. Gokturk[22a], S. Goldfarb[107], T. Golling[57], M.G.D. Gololo[34g], D. Golubkov[38], J.P. Gombas[109], A. Gomes[133a,133b], G. Gomes Da Silva[144], A.J. Gomez Delegido[166], R. Gonçalo[133a], L. Gonella[21], A. Gongadze[152c], F. Gonnella[21], J.L. Gonski[146], R.Y. González Andana[53], S. González de la Hoz[166], R. Gonzalez Lopez[94], C. Gonzalez Renteria[18a], M.V. Gonzalez Rodrigues[49], R. Gonzalez Suarez[164], S. Gonzalez-Sevilla[57], L. Goossens[37], B. Gorini[37], E. Gorini[71a,71b], A. Gorišek[95], T.C. Gosart[131], A.T. Goshaw[52], M.I. Gostkin[39], S. Goswami[124], C.A. Gottardo[37], S.A. Gotz[111], M. Gouighri[36b], V. Goumarre[49], A.G. Goussiou[141], N. Govender[34c], R.P. Grabarczyk[129], I. Grabowska-Bold[87a], K. Graham[35], E. Gramstad[128], S. Grancagnolo[71a,71b], C.M. Grant[1,138], P.M. Gravila[28f], F.G. Gravili[71a,71b], H.M. Gray[18a], M. Greco[71a,71b], M.J. Green[1], C. Grefe[25], A.S. Grefsrud[17], I.M. Gregor[49], K.T. Greif[162], P. Grenier[146], S.G. Grewe[112], A.A. Grillo[139], K. Grimm[32], S. Grinstein[13,s], J.-F. Grivaz[67], E. Gross[172], J. Grosse-Knetter[56], J.C. Grundy[129], L. Guan[108], J.G.R. Guerrero Rojas[166],

G. Guerrieri [37], R. Gugel [102], J.A.M. Guhit [108], A. Guida [19], E. Guilloton [170], S. Guindon [37], F. Guo [14,114c], J. Guo [63c], L. Guo [49], Y. Guo [108], R. Gupta [132], S. Gurbuz [25], S.S. Gurdasani [55], G. Gustavino [76a,76b], P. Gutierrez [123], L.F. Gutierrez Zagazeta [131], M. Gutsche [51], C. Gutschow [98], C. Gwenlan [129], C.B. Gwilliam [94], E.S. Haaland [128], A. Haas [120], M. Habedank [49], C. Haber [18a], H.K. Hadavand [8], A. Hadef [51], S. Hadzic [112], A.I. Hagan [93], J.J. Hahn [144], E.H. Haines [98], M. Haleem [169], J. Haley [124], J.J. Hall [142], G.D. Hallewell [104], L. Halser [20], K. Hamano [168], M. Hamer [25], G.N. Hamity [53], E.J. Hampshire [97], J. Han [63b], K. Han [63a], L. Han [114a], L. Han [63a], S. Han [18a], Y.F. Han [158], K. Hanagaki [85], M. Hance [139], D.A. Hangal [42], H. Hanif [145], M.D. Hank [131], J.B. Hansen [43], P.H. Hansen [43], D. Harada [57], T. Harenberg [174], S. Harkusha [38], M.L. Harris [105], Y.T. Harris [129], J. Harrison [13], N.M. Harrison [122], P.F. Harrison[170], N.M. Hartman [112], N.M. Hartmann [111], R.Z. Hasan [97,137], Y. Hasegawa [143], F. Haslbeck [129], S. Hassan [17], R. Hauser [109], C.M. Hawkes [21], R.J. Hawkings [37], Y. Hayashi [156], D. Hayden [109], C. Hayes [108], R.L. Hayes [117], C.P. Hays [129], J.M. Hays [96], H.S. Hayward [94], F. He [63a], M. He [14,114c], Y. He [49], Y. He [98], N.B. Heatley [96], V. Hedberg [100], A.L. Heggelund [128], N.D. Hehir [96,*], C. Heidegger [55], K.K. Heidegger [55], J. Heilman [35], S. Heim [49], T. Heim [18a], J.G. Heinlein [131], J.J. Heinrich [126], L. Heinrich [112,ab], J. Hejbal [134], A. Held [173], S. Hellesund [17], C.M. Helling [167], S. Hellman [48a,48b], R.C.W. Henderson[93], L. Henkelmann [33], A.M. Henriques Correia[37], H. Herde [100], Y. Hernández Jiménez [148], L.M. Herrmann [25], T. Herrmann [51], G. Herten [55], R. Hertenberger [111], L. Hervas [37], M.E. Hesping [102], N.P. Hessey [159a], M. Hidaoui [36b], N. Hidic [136], E. Hill [158], S.J. Hillier [21], J.R. Hinds [109], F. Hinterkeuser [25], M. Hirose [127], S. Hirose [160], D. Hirschbuehl [174], T.G. Hitchings [103], B. Hiti [95], J. Hobbs [148], R. Hobincu [28e], N. Hod [172], M.C. Hodgkinson [142], B.H. Hodkinson [129], A. Hoecker [37], D.D. Hofer [108], J. Hofer [49], T. Holm [25], M. Holzbock [37], L.B.A.H. Hommels [33], B.P. Honan [103], J.J. Hong [69], J. Hong [63c], T.M. Hong [132], B.H. Hooberman [165], W.H. Hopkins [6], M.C. Hoppesch [165], Y. Horii [113], S. Hou [151], A.S. Howard [95], J. Howarth [60], J. Hoya [6], M. Hrabovsky [125], A. Hrynevich [49], T. Hryn'ova [4], P.J. Hsu [66], S.-C. Hsu [141], T. Hsu [67], M. Hu [18a], Q. Hu [63a], S. Huang [65b], X. Huang [14,114c], Y. Huang [142], Y. Huang [102], Y. Huang [14], Z. Huang [103], Z. Hubacek [135], M. Huebner [25], F. Huegging [25], T.B. Huffman [129], C.A. Hugli [49], M. Huhtinen [37], S.K. Huiberts [17], R. Hulsken [106], N. Huseynov [12,g], J. Huston [109], J. Huth [62], R. Hyneman [146], G. Iacobucci [57], G. Iakovidis [30], L. Iconomidou-Fayard [67], J.P. Iddon [37], P. Iengo [73a,73b], R. Iguchi [156], Y. Iiyama [156], T. Iizawa [129], Y. Ikegami [85], N. Ilic [158], H. Imam [84c], M. Ince Lezki [57], T. Ingebretsen Carlson [48a,48b], J.M. Inglis [96], G. Introzzi [74a,74b], M. Iodice [78a], V. Ippolito [76a,76b], R.K. Irwin [94], M. Ishino [156], W. Islam [173], C. Issever [19,49], S. Istin [22a,ah], H. Ito [171], R. Iuppa [79a,79b], A. Ivina [172], J.M. Izen [46], V. Izzo [73a], P. Jacka [134], P. Jackson [1], C.S. Jagfeld [111], G. Jain [159a], P. Jain [49], K. Jakobs [55], T. Jakoubek [172], J. Jamieson [60], W. Jang [156], M. Javurkova [105], P. Jawahar [103], L. Jeanty [126], J. Jejelava [152a,z], P. Jenni [55,f], C.E. Jessiman [35], C. Jia[63b], J. Jia [148], X. Jia [62], X. Jia [14,114c], Z. Jia [114a], C. Jiang [53], S. Jiggins [49], J. Jimenez Pena [13], S. Jin [114a], A. Jinaru [28b], O. Jinnouchi [157], P. Johansson [142], K.A. Johns [7], J.W. Johnson [139], F.A. Jolly [49], D.M. Jones [149], E. Jones [49], K.S. Jones[8], P. Jones [33], R.W.L. Jones [93], T.J. Jones [94], H.L. Joos [56,37], R. Joshi [122], J. Jovicevic [16], X. Ju [18a], J.J. Junggeburth [105], T. Junkermann [64a], A. Juste Rozas [13,s], M.K. Juzek [88], S. Kabana [140e], A. Kaczmarska [88], M. Kado [112], H. Kagan [122], M. Kagan [146], A. Kahn [131], C. Kahra [102], T. Kaji [156], E. Kajomovitz [153], N. Kakati [172], I. Kalaitzidou [55], C.W. Kalderon [30], N.J. Kang [139], D. Kar [34g], K. Karava [129], M.J. Kareem [159b], E. Karentzos [55], O. Karkout [117], S.N. Karpov [39], Z.M. Karpova [39], V. Kartvelishvili [93], A.N. Karyukhin [38], E. Kasimi [155],

J. Katzy[49], S. Kaur[35], K. Kawade[143], M.P. Kawale[123], C. Kawamoto[89], T. Kawamoto[63a], E.F. Kay[37], F.I. Kaya[161], S. Kazakos[109], V.F. Kazanin[38], Y. Ke[148], J.M. Keaveney[34a], R. Keeler[168], G.V. Kehris[62], J.S. Keller[35], A.S. Kelly[98], J.J. Kempster[149], P.D. Kennedy[102], O. Kepka[134], B.P. Kerridge[137], S. Kersten[174], B.P. Kerševan[95], L. Keszeghova[29a], S. Ketabchi Haghighat[158], R.A. Khan[132], A. Khanov[124], A.G. Kharlamov[38], T. Kharlamova[38], E.E. Khoda[141], M. Kholodenko[133a], T.J. Khoo[19], G. Khoriauli[169], J. Khubua[152b,*], Y.A.R. Khwaira[130], B. Kibirige[34g], D. Kim[6], D.W. Kim[48a,48b], Y.K. Kim[40], N. Kimura[98], M.K. Kingston[56], A. Kirchhoff[56], C. Kirfel[25], F. Kirfel[25], J. Kirk[137], A.E. Kiryunin[112], C. Kitsaki[10], O. Kivernyk[25], M. Klassen[161], C. Klein[35], L. Klein[169], M.H. Klein[45], S.B. Klein[57], U. Klein[94], P. Klimek[37], A. Klimentov[30], T. Klioutchnikova[37], P. Kluit[117], S. Kluth[112], E. Kneringer[80], T.M. Knight[158], A. Knue[50], D. Kobylianskii[172], S.F. Koch[129], M. Kocian[146], P. Kodyš[136], D.M. Koeck[126], P.T. Koenig[25], T. Koffas[35], O. Kolay[51], I. Koletsou[4], T. Komarek[88], K. Köneke[55], A.X.Y. Kong[1], T. Kono[121], N. Konstantinidis[98], P. Kontaxakis[57], B. Konya[100], R. Kopeliansky[42], S. Koperny[87a], K. Korcyl[88], K. Kordas[155,d], A. Korn[98], S. Korn[56], I. Korolkov[13], N. Korotkova[38], B. Kortman[117], O. Kortner[112], S. Kortner[112], W.H. Kostecka[118], V.V. Kostyukhin[144], A. Kotsokechagia[37], A. Kotwal[52], A. Koulouris[37], A. Kourkoumeli-Charalampidi[74a,74b], C. Kourkoumelis[9], E. Kourlitis[112,ab], O. Kovanda[126], R. Kowalewski[168], W. Kozanecki[138], A.S. Kozhin[38], V.A. Kramarenko[38], G. Kramberger[95], P. Kramer[102], M.W. Krasny[130], A. Krasznahorkay[37], A.C. Kraus[118], J.W. Kraus[174], J.A. Kremer[49], T. Kresse[51], L. Kretschmann[174], J. Kretzschmar[94], K. Kreul[19], P. Krieger[158], M. Krivos[136], K. Krizka[21], K. Kroeninger[50], H. Kroha[112], J. Kroll[134], J. Kroll[131], K.S. Krowpman[109], U. Kruchonak[39], H. Krüger[25], N. Krumnack[82], M.C. Kruse[52], O. Kuchinskaia[38], S. Kuday[3a], S. Kuehn[37], R. Kuesters[55], T. Kuhl[49], V. Kukhtin[39], Y. Kulchitsky[38,a], S. Kuleshov[140d,140b], M. Kumar[34g], N. Kumari[49], P. Kumari[159b], A. Kupco[134], T. Kupfer[50], A. Kupich[38], O. Kuprash[55], H. Kurashige[86], L.L. Kurchaninov[159a], O. Kurdysh[67], Y.A. Kurochkin[38], A. Kurova[38], M. Kuze[157], A.K. Kvam[105], J. Kvita[125], T. Kwan[106], N.G. Kyriacou[108], L.A.O. Laatu[104], C. Lacasta[166], F. Lacava[76a,76b], H. Lacker[19], D. Lacour[130], N.N. Lad[98], E. Ladygin[39], A. Lafarge[41], B. Laforge[130], T. Lagouri[175], F.Z. Lahbabi[36a], S. Lai[56], J.E. Lambert[168], S. Lammers[69], W. Lampl[7], C. Lampoudis[155,d], G. Lamprinoudis[102], A.N. Lancaster[118], E. Lançon[30], U. Landgraf[55], M.P.J. Landon[96], V.S. Lang[55], O.K.B. Langrekken[128], A.J. Lankford[162], F. Lanni[37], K. Lantzsch[25], A. Lanza[74a], J.F. Laporte[138], T. Lari[72a], F. Lasagni Manghi[24b], M. Lassnig[37], V. Latonova[134], A. Laurier[153], S.D. Lawlor[142], Z. Lawrence[103], R. Lazaridou[170], M. Lazzaroni[72a,72b], B. Le[103], E.M. Le Boulicaut[52], L.T. Le Pottier[18a], B. Leban[24b,24a], A. Lebedev[82], M. LeBlanc[103], F. Ledroit-Guillon[61], S.C. Lee[151], S. Lee[48a,48b], T.F. Lee[94], L.L. Leeuw[34c], H.P. Lefebvre[97], M. Lefebvre[168], C. Leggett[18a], G. Lehmann Miotto[37], M. Leigh[57], W.A. Leight[105], W. Leinonen[116], A. Leisos[155,r], M.A.L. Leite[84c], C.E. Leitgeb[19], R. Leitner[136], K.J.C. Leney[45], T. Lenz[25], S. Leone[75a], C. Leonidopoulos[53], A. Leopold[147], R. Les[109], C.G. Lester[33], M. Levchenko[38], J. Levêque[4], L.J. Levinson[172], G. Levrini[24b,24a], M.P. Lewicki[88], C. Lewis[141], D.J. Lewis[4], A. Li[5], B. Li[63b], C. Li[63a], C-Q. Li[112], H. Li[63a], H. Li[63b], H. Li[114a], H. Li[15], H. Li[63b], J. Li[63c], K. Li[141], L. Li[63c], M. Li[14,114c], S. Li[14,114c], S. Li[63d,63c], T. Li[5], X. Li[106], Z. Li[129], Z. Li[156], Z. Li[14,114c], Z. Li[63a], S. Liang[14,114c], Z. Liang[14], M. Liberatore[138], B. Liberti[77a], K. Lie[65c], J. Lieber Marin[84e], H. Lien[69], H. Lin[108], K. Lin[109], R.E. Lindley[7], J.H. Lindon[2], J. Ling[62], E. Lipeles[131], A. Lipniacka[17], A. Lister[167], J.D. Little[69], B. Liu[14], B.X. Liu[114b], D. Liu[63d,63c], E.H.L. Liu[21], J.B. Liu[63a], J.K.K. Liu[33], K. Liu[63d], K. Liu[63d,63c], M. Liu[63a], M.Y. Liu[63a],

P. Liu[14], Q. Liu[63d,141,63c], X. Liu[63a], X. Liu[63b], Y. Liu[114b,114c], Y.L. Liu[63b], Y.W. Liu[63a], S.L. Lloyd[96], E.M. Lobodzinska[49], P. Loch[7], T. Lohse[19], K. Lohwasser[142], E. Loiacono[49], M. Lokajicek[134,*], J.D. Lomas[21], J.D. Long[165], I. Longarini[162], R. Longo[165], I. Lopez Paz[68], A. Lopez Solis[49], N.A. Lopez-canelas[7], N. Lorenzo Martinez[4], A.M. Lory[111], M. Losada[119a], G. Löschcke Centeno[149], O. Loseva[38], X. Lou[48a,48b], X. Lou[14,114c], A. Lounis[67], P.A. Love[93], G. Lu[14,114c], M. Lu[67], S. Lu[131], Y.J. Lu[66], H.J. Lubatti[141], C. Luci[76a,76b], F.L. Lucio Alves[114a], F. Luehring[69], I. Luise[148], O. Lukianchuk[67], O. Lundberg[147], B. Lund-Jensen[147,*], N.A. Luongo[6], M.S. Lutz[37], A.B. Lux[26], D. Lynn[30], R. Lysak[134], E. Lytken[100], V. Lyubushkin[39], T. Lyubushkina[39], M.M. Lyukova[148], M.Firdaus M. Soberi[53], H. Ma[30], K. Ma[63a], L.L. Ma[63b], W. Ma[63a], Y. Ma[124], J.C. MacDonald[102], P.C. Machado De Abreu Farias[84e], R. Madar[41], T. Madula[98], J. Maeda[86], T. Maeno[30], H. Maguire[142], V. Maiboroda[138], A. Maio[133a,133b,133d], K. Maj[87a], O. Majersky[49], S. Majewski[126], N. Makovec[67], V. Maksimovic[16], B. Malaescu[130], Pa. Malecki[88], V.P. Maleev[38], F. Malek[61,n], M. Mali[95], D. Malito[97], U. Mallik[81], S. Maltezos[10], S. Malyukov[39], J. Mamuzic[13], G. Mancini[54], M.N. Mancini[27], G. Manco[74a,74b], J.P. Mandalia[96], S.S. Mandarry[149], I. Mandić[95], L. Manhaes de Andrade Filho[84a], I.M. Maniatis[172], J. Manjarres Ramos[91], D.C. Mankad[172], A. Mann[111], S. Manzoni[37], L. Mao[63c], X. Mapekula[34c], A. Marantis[155,r], G. Marchiori[5], M. Marcisovsky[134], C. Marcon[72a], M. Marinescu[21], S. Marium[49], M. Marjanovic[123], A. Markhoos[55], M. Markovitch[67], E.J. Marshall[93], Z. Marshall[18a], S. Marti-Garcia[166], J. Martin[98], T.A. Martin[137], V.J. Martin[53], B. Martin dit Latour[17], L. Martinelli[76a,76b], M. Martinez[13,s], P. Martinez Agullo[166], V.I. Martinez Outschoorn[105], P. Martinez Suarez[13], S. Martin-Haugh[137], G. Martinovicova[136], V.S. Martoiu[28b], A.C. Martyniuk[98], A. Marzin[37], D. Mascione[79a,79b], L. Masetti[102], J. Masik[103], A.L. Maslennikov[38], P. Massarotti[73a,73b], P. Mastrandrea[75a,75b], A. Mastroberardino[44b,44a], T. Masubuchi[127], T. Mathisen[164], J. Matousek[136], J. Maurer[28b], A.J. Maury[67], B. Maček[95], D.A. Maximov[38], A.E. May[103], R. Mazini[151], I. Maznas[118], M. Mazza[109], S.M. Mazza[139], E. Mazzeo[72a,72b], C. Mc Ginn[30], J.P. Mc Gowan[168], S.P. Mc Kee[108], C.C. McCracken[167], E.F. McDonald[107], A.E. McDougall[117], J.A. Mcfayden[149], R.P. McGovern[131], R.P. Mckenzie[34g], T.C. Mclachlan[49], D.J. Mclaughlin[98], S.J. McMahon[137], C.M. Mcpartland[94], R.A. McPherson[168,w], S. Mehlhase[111], A. Mehta[94], D. Melini[166], B.R. Mellado Garcia[34g], A.H. Melo[56], F. Meloni[49], A.M. Mendes Jacques Da Costa[103], H.Y. Meng[158], L. Meng[93], S. Menke[112], M. Mentink[37], E. Meoni[44b,44a], G. Mercado[118], S. Merianos[155], C. Merlassino[70a,70c], L. Merola[73a,73b], C. Meroni[72a,72b], J. Metcalfe[6], A.S. Mete[6], E. Meuser[102], C. Meyer[69], J-P. Meyer[138], R.P. Middleton[137], L. Mijović[53], G. Mikenberg[172], M. Mikestikova[134], M. Mikuž[95], H. Mildner[102], A. Milic[37], D.W. Miller[40], E.H. Miller[146], L.S. Miller[35], A. Milov[172], D.A. Milstead[48a,48b], T. Min[114a], A.A. Minaenko[38], I.A. Minashvili[152b], L. Mince[60], A.I. Mincer[120], B. Mindur[87a], M. Mineev[39], Y. Mino[89], L.M. Mir[13], M. Miralles Lopez[60], M. Mironova[18a], M.C. Missio[116], A. Mitra[170], V.A. Mitsou[166], Y. Mitsumori[113], O. Miu[158], P.S. Miyagawa[96], T. Mkrtchyan[64a], M. Mlinarevic[98], T. Mlinarevic[98], M. Mlynarikova[37], S. Mobius[20], P. Mogg[111], M.H. Mohamed Farook[115], A.F. Mohammed[14,114c], S. Mohapatra[42], G. Mokgatitswane[34g], L. Moleri[172], B. Mondal[144], S. Mondal[135], K. Mönig[49], E. Monnier[104], L. Monsonis Romero[166], J. Montejo Berlingen[13], A. Montella[48a,48b], M. Montella[122], F. Montereali[78a,78b], F. Monticelli[92], S. Monzani[70a,70c], A. Morancho Tarda[43], N. Morange[67], A.L. Moreira De Carvalho[49], M. Moreno Llácer[166], C. Moreno Martinez[57], P. Morettini[58b], S. Morgenstern[37], M. Morii[62], M. Morinaga[156], F. Morodei[76a,76b], L. Morvaj[37], P. Moschovakos[37], B. Moser[129], M. Mosidze[152b], T. Moskalets[45],

P. Moskvitina[116], J. Moss[32,k], P. Moszkowicz[87a], A. Moussa[36d], E.J.W. Moyse[105], O. Mtintsilana[34g], S. Muanza[104], J. Mueller[132], D. Muenstermann[93], R. Müller[37], G.A. Mullier[164], A.J. Mullin[33], J.J. Mullin[131], D.P. Mungo[158], D. Munoz Perez[166], F.J. Munoz Sanchez[103], M. Murin[103], W.J. Murray[170,137], M. Muškinja[95], C. Mwewa[30], A.G. Myagkov[38,a], A.J. Myers[8], G. Myers[108], M. Myska[135], B.P. Nachman[18a], O. Nackenhorst[50], K. Nagai[129], K. Nagano[85], J.L. Nagle[30,af], E. Nagy[104], A.M. Nairz[37], Y. Nakahama[85], K. Nakamura[85], K. Nakkalil[5], H. Nanjo[127], E.A. Narayanan[115], I. Naryshkin[38], L. Nasella[72a,72b], M. Naseri[35], S. Nasri[119b], C. Nass[25], G. Navarro[23a], J. Navarro-Gonzalez[166], R. Nayak[154], A. Nayaz[19], P.Y. Nechaeva[38], S. Nechaeva[24b,24a], F. Nechansky[49], L. Nedic[129], T.J. Neep[21], A. Negri[74a,74b], M. Negrini[24b], C. Nellist[117], C. Nelson[106], K. Nelson[108], S. Nemecek[134], M. Nessi[37,h], M.S. Neubauer[165], F. Neuhaus[102], J. Neundorf[49], P.R. Newman[21], C.W. Ng[132], Y.W.Y. Ng[49], B. Ngair[119a], H.D.N. Nguyen[110], R.B. Nickerson[129], R. Nicolaidou[138], J. Nielsen[139], M. Niemeyer[56], J. Niermann[56], N. Nikiforou[37], V. Nikolaenko[38,a], I. Nikolic-Audit[130], K. Nikolopoulos[21], P. Nilsson[30], I. Ninca[49], G. Ninio[154], A. Nisati[76a], N. Nishu[2], R. Nisius[112], J-E. Nitschke[51], E.K. Nkadimeng[34g], T. Nobe[156], T. Nommensen[150], M.B. Norfolk[142], B.J. Norman[35], M. Noury[36a], J. Novak[95], T. Novak[95], L. Novotny[135], R. Novotny[115], L. Nozka[125], K. Ntekas[162], N.M.J. Nunes De Moura Junior[84b], J. Ocariz[130], A. Ochi[86], I. Ochoa[133a], S. Oerdek[49,t], J.T. Offermann[40], A. Ogrodnik[136], A. Oh[103], C.C. Ohm[147], H. Oide[85], R. Oishi[156], M.L. Ojeda[49], Y. Okumura[156], L.F. Oleiro Seabra[133a], I. Oleksiyuk[57], S.A. Olivares Pino[140d], G. Oliveira Correa[13], D. Oliveira Damazio[30], J.L. Oliver[162], Ö.O. Öncel[55], A.P. O'Neill[20], A. Onofre[133a,133e], P.U.E. Onyisi[11], M.J. Oreglia[40], G.E. Orellana[92], D. Orestano[78a,78b], N. Orlando[13], R.S. Orr[158], L.M. Osojnak[131], R. Ospanov[63a], G. Otero y Garzon[31], H. Otono[90], P.S. Ott[64a], G.J. Ottino[18a], M. Ouchrif[36d], F. Ould-Saada[128], T. Ovsiannikova[141], M. Owen[60], R.E. Owen[137], V.E. Ozcan[22a], F. Ozturk[88], N. Ozturk[8], S. Ozturk[83], H.A. Pacey[129], A. Pacheco Pages[13], C. Padilla Aranda[13], G. Padovano[76a,76b], S. Pagan Griso[18a], G. Palacino[69], A. Palazzo[71a,71b], J. Pampel[25], J. Pan[175], T. Pan[65a], D.K. Panchal[11], C.E. Pandini[117], J.G. Panduro Vazquez[137], H.D. Pandya[1], H. Pang[15], P. Pani[49], G. Panizzo[70a,70c], L. Panwar[130], L. Paolozzi[57], S. Parajuli[165], A. Paramonov[6], C. Paraskevopoulos[54], D. Paredes Hernandez[65b], A. Pareti[74a,74b], K.R. Park[42], T.H. Park[158], M.A. Parker[33], F. Parodi[58b,58a], E.W. Parrish[118], V.A. Parrish[53], J.A. Parsons[42], U. Parzefall[55], B. Pascual Dias[110], L. Pascual Dominguez[101], E. Pasqualucci[76a], S. Passaggio[58b], F. Pastore[97], P. Patel[88], U.M. Patel[52], J.R. Pater[103], T. Pauly[37], C.I. Pazos[161], J. Pearkes[146], M. Pedersen[128], R. Pedro[133a], S.V. Peleganchuk[38], O. Penc[37], E.A. Pender[53], S. Peng[15], G.D. Penn[175], K.E. Penski[111], M. Penzin[38], B.S. Peralva[84d], A.P. Pereira Peixoto[141], L. Pereira Sanchez[146], D.V. Perepelitsa[30,af], G. Perera[105], E. Perez Codina[159a], M. Perganti[10], H. Pernegger[37], S. Perrella[76a,76b], O. Perrin[41], K. Peters[49], R.F.Y. Peters[103], B.A. Petersen[37], T.C. Petersen[43], E. Petit[104], V. Petousis[135], C. Petridou[155,d], T. Petru[136], A. Petrukhin[144], M. Pettee[18a], A. Petukhov[38], K. Petukhova[37], R. Pezoa[140f], L. Pezzotti[37], G. Pezzullo[175], T.M. Pham[173], T. Pham[107], P.W. Phillips[137], G. Piacquadio[148], E. Pianori[18a], F. Piazza[126], R. Piegaia[31], D. Pietreanu[28b], A.D. Pilkington[103], M. Pinamonti[70a,70c], J.L. Pinfold[2], B.C. Pinheiro Pereira[133a], A.E. Pinto Pinoargote[138,138], L. Pintucci[70a,70c], K.M. Piper[149], A. Pirttikoski[57], D.A. Pizzi[35], L. Pizzimento[65b], A. Pizzini[117], M.-A. Pleier[30], V. Pleskot[136], E. Plotnikova[39], G. Poddar[96], R. Poettgen[100], L. Poggioli[130], I. Pokharel[56], S. Polacek[136], G. Polesello[74a], A. Poley[145,159a], A. Polini[24b], C.S. Pollard[170], Z.B. Pollock[122], E. Pompa Pacchi[76a,76b], N.I. Pond[98], D. Ponomarenko[116], L. Pontecorvo[37], S. Popa[28a], G.A. Popeneciu[28d],

A. Poreba [37], D.M. Portillo Quintero [159a], S. Pospisil [135], M.A. Postill [142], P. Postolache [28c], K. Potamianos [170], P.A. Potepa [87a], I.N. Potrap [39], C.J. Potter [33], H. Potti [150], J. Poveda [166], M.E. Pozo Astigarraga [37], A. Prades Ibanez [77a,77b], J. Pretel [168], D. Price [103], M. Primavera [71a], L. Primomo [70a,70c], M.A. Principe Martin [101], R. Privara [125], T. Procter [60], M.L. Proffitt [141], N. Proklova [131], K. Prokofiev [65c], G. Proto [112], J. Proudfoot [6], M. Przybycien [87a], W.W. Przygoda [87b], A. Psallidas [47], J.E. Puddefoot [142], D. Pudzha [55], D. Pyatiizbyantseva [38], J. Qian [108], D. Qichen [103], Y. Qin [13], T. Qiu [53], A. Quadt [56], M. Queitsch-Maitland [103], G. Quetant [57], R.P. Quinn [167], G. Rabanal Bolanos [62], D. Rafanoharana [55], F. Raffaeli [77a,77b], F. Ragusa [72a,72b], J.L. Rainbolt [40], J.A. Raine [57], S. Rajagopalan [30], E. Ramakoti [38], L. Rambelli [58b,58a], I.A. Ramirez-Berend [35], K. Ran [49,114c], D.S. Rankin [131], N.P. Rapheeha [34g], H. Rasheed [28b], V. Raskina [130], D.F. Rassloff [64a], A. Rastogi [18a], S. Rave [102], S. Ravera [58b,58a], B. Ravina [56], I. Ravinovich [172], M. Raymond [37], A.L. Read [128], N.P. Readioff [142], D.M. Rebuzzi [74a,74b], G. Redlinger [30], A.S. Reed [112], K. Reeves [27], J.A. Reidelsturz [174], D. Reikher [126], A. Rej [50], C. Rembser [37], M. Renda [28b], F. Renner [49], A.G. Rennie [162], A.L. Rescia [49], S. Resconi [72a], M. Ressegotti [58b,58a], S. Rettie [37], J.G. Reyes Rivera [109], E. Reynolds [18a], O.L. Rezanova [38], P. Reznicek [136], H. Riani [36d], N. Ribaric [93], E. Ricci [79a,79b], R. Richter [112], S. Richter [48a,48b], E. Richter-Was [87b], M. Ridel [130], S. Ridouani [36d], P. Rieck [120], P. Riedler [37], E.M. Riefel [48a,48b], J.O. Rieger [117], M. Rijssenbeek [148], M. Rimoldi [37], L. Rinaldi [24b,24a], P. Rincke [56,164], T.T. Rinn [30], M.P. Rinnagel [111], G. Ripellino [164], I. Riu [13], J.C. Rivera Vergara [168], F. Rizatdinova [124], E. Rizvi [96], B.R. Roberts [18a], S.S. Roberts [139], S.H. Robertson [106,w], D. Robinson [33], M. Robles Manzano [102], A. Robson [60], A. Rocchi [77a,77b], C. Roda [75a,75b], S. Rodriguez Bosca [37], Y. Rodriguez Garcia [23a], A. Rodriguez Rodriguez [55], A.M. Rodríguez Vera [118], S. Roe[37], J.T. Roemer [37], A.R. Roepe-Gier [139], O. Røhne [128], R.A. Rojas [105], C.P.A. Roland [130], J. Roloff [30], A. Romaniouk [38], E. Romano [74a,74b], M. Romano [24b], A.C. Romero Hernandez [165], N. Rompotis [94], L. Roos [130], S. Rosati [76a], B.J. Rosser [40], E. Rossi [129], E. Rossi [73a,73b], L.P. Rossi [62], L. Rossini [55], R. Rosten [122], M. Rotaru [28b], B. Rottler [55], C. Rougier [91], D. Rousseau [67], D. Rousso [49], A. Roy [165], S. Roy-Garand [158], A. Rozanov [104], Z.M.A. Rozario [60], Y. Rozen [153], A. Rubio Jimenez [166], A.J. Ruby [94], V.H. Ruelas Rivera [19], T.A. Ruggeri [1], A. Ruggiero [129], A. Ruiz-Martinez [166], A. Rummler [37], Z. Rurikova [55], N.A. Rusakovich [39], H.L. Russell [168], G. Russo [76a,76b], J.P. Rutherfoord [7], S. Rutherford Colmenares [33], M. Rybar [136], E.B. Rye [128], A. Ryzhov [45], J.A. Sabater Iglesias [57], H.F-W. Sadrozinski [139], F. Safai Tehrani [76a], B. Safarzadeh Samani [137], S. Saha [1], M. Sahinsoy [83], A. Saibel [166], M. Saimpert [138], M. Saito [156], T. Saito [156], A. Sala [72a,72b], D. Salamani [37], A. Salnikov [146], J. Salt [166], A. Salvador Salas [154], D. Salvatore [44b,44a], F. Salvatore [149], A. Salzburger [37], D. Sammel [55], E. Sampson [93], D. Sampsonidis [155,d], D. Sampsonidou [126], J. Sánchez [166], V. Sanchez Sebastian [166], H. Sandaker [128], C.O. Sander [49], J.A. Sandesara [105], M. Sandhoff [174], C. Sandoval [23b], L. Sanfilippo [64a], D.P.C. Sankey [137], T. Sano [89], A. Sansoni [54], L. Santi [37,76b], C. Santoni [41], H. Santos [133a,133b], A. Santra [172], E. Sanzani [24b,24a], K.A. Saoucha [163], J.G. Saraiva [133a,133d], J. Sardain [7], O. Sasaki [85], K. Sato [160], C. Sauer[64b], E. Sauvan [4], P. Savard [158,ad], R. Sawada [156], C. Sawyer [137], L. Sawyer [99], C. Sbarra [24b], A. Sbrizzi [24b,24a], T. Scanlon [98], J. Schaarschmidt [141], U. Schäfer [102], A.C. Schaffer [67,45], D. Schaile [111], R.D. Schamberger [148], C. Scharf [19], M.M. Schefer [20], V.A. Schegelsky [38], D. Scheirich [136], M. Schernau [162], C. Scheulen [56], C. Schiavi [58b,58a], M. Schioppa [44b,44a], B. Schlag [146,m], K.E. Schleicher [55], S. Schlenker [37], J. Schmeing [174], M.A. Schmidt [174], K. Schmieden [102], C. Schmitt [102], N. Schmitt [102], S. Schmitt [49], L. Schoeffel [138], A. Schoening [64b], P.G. Scholer [35], E. Schopf [129], M. Schott [25], J. Schovancova [37], S. Schramm [57], T. Schroer [57], H-C. Schultz-Coulon [64a],

M. Schumacher[55], B.A. Schumm[139], Ph. Schune[138], A.J. Schuy[141], H.R. Schwartz[139], A. Schwartzman[146], T.A. Schwarz[108], Ph. Schwemling[138], R. Schwienhorst[109], F.G. Sciacca[20], A. Sciandra[30], G. Sciolla[27], F. Scuri[75a], C.D. Sebastiani[94], K. Sedlaczek[118], S.C. Seidel[115], A. Seiden[139], B.D. Seidlitz[42], C. Seitz[49], J.M. Seixas[84b], G. Sekhniaidze[73a], L. Selem[61], N. Semprini-Cesari[24b,24a], D. Sengupta[57], V. Senthilkumar[166], L. Serin[67], M. Sessa[77a,77b], H. Severini[123], F. Sforza[58b,58a], A. Sfyrla[57], Q. Sha[14], E. Shabalina[56], A.H. Shah[33], R. Shaheen[147], J.D. Shahinian[131], D. Shaked Renous[172], L.Y. Shan[14], M. Shapiro[18a], A. Sharma[37], A.S. Sharma[167], P. Sharma[81], P.B. Shatalov[38], K. Shaw[149], S.M. Shaw[103], Q. Shen[63c], D.J. Sheppard[145], P. Sherwood[98], L. Shi[98], X. Shi[14], S. Shimizu[85], C.O. Shimmin[175], J.D. Shinner[97], I.P.J. Shipsey[129], S. Shirabe[90], M. Shiyakova[39,u], M.J. Shochet[40], D.R. Shope[128], B. Shrestha[123], S. Shrestha[122,ag], M.J. Shroff[168], P. Sicho[134], A.M. Sickles[165], E. Sideras Haddad[34g], A.C. Sidley[117], A. Sidoti[24b], F. Siegert[51], Dj. Sijacki[16], F. Sili[92], J.M. Silva[53], I. Silva Ferreira[84b], M.V. Silva Oliveira[30], S.B. Silverstein[48a], S. Simion[67], R. Simoniello[37], E.L. Simpson[103], H. Simpson[149], L.R. Simpson[108], N.D. Simpson[100], S. Simsek[83], S. Sindhu[56], P. Sinervo[158], S. Singh[158], S. Sinha[49], S. Sinha[103], M. Sioli[24b,24a], I. Siral[37], E. Sitnikova[49], J. Sjölin[48a,48b], A. Skaf[56], E. Skorda[21], P. Skubic[123], M. Slawinska[88], V. Smakhtin[172], B.H. Smart[137], S.Yu. Smirnov[38], Y. Smirnov[38], L.N. Smirnova[38,a], O. Smirnova[100], A.C. Smith[42], D.R. Smith[162], E.A. Smith[40], H.A. Smith[129], J.L. Smith[103], R. Smith[146], M. Smizanska[93], K. Smolek[135], A.A. Snesarev[38], S.R. Snider[158], H.L. Snoek[117], S. Snyder[30], R. Sobie[168,w], A. Soffer[154], C.A. Solans Sanchez[37], E.Yu. Soldatov[38], U. Soldevila[166], A.A. Solodkov[38], S. Solomon[27], A. Soloshenko[39], K. Solovieva[55], O.V. Solovyanov[41], P. Sommer[51], A. Sonay[13], W.Y. Song[159b], A. Sopczak[135], A.L. Sopio[98], F. Sopkova[29b], J.D. Sorenson[115], I.R. Sotarriva Alvarez[157], V. Sothilingam[64a], O.J. Soto Sandoval[140c,140b], S. Sottocornola[69], R. Soualah[163], Z. Soumaimi[36e], D. South[49], N. Soybelman[172], S. Spagnolo[71a,71b], M. Spalla[112], D. Sperlich[55], G. Spigo[37], B. Spisso[73a,73b], D.P. Spiteri[60], M. Spousta[136], E.J. Staats[35], R. Stamen[64a], A. Stampekis[21], M. Standke[25], E. Stanecka[88], W. Stanek-Maslouska[49], M.V. Stange[51], B. Stanislaus[18a], M.M. Stanitzki[49], B. Stapf[49], E.A. Starchenko[38], G.H. Stark[139], J. Stark[91], P. Staroba[134], P. Starovoitov[64a], S. Stärz[106], R. Staszewski[88], G. Stavropoulos[47], P. Steinberg[30], B. Stelzer[145,159a], H.J. Stelzer[132], O. Stelzer-Chilton[159a], H. Stenzel[59], T.J. Stevenson[149], G.A. Stewart[37], J.R. Stewart[124], M.C. Stockton[37], G. Stoicea[28b], M. Stolarski[133a], S. Stonjek[112], A. Straessner[51], J. Strandberg[147], S. Strandberg[48a,48b], M. Stratmann[174], M. Strauss[123], T. Strebler[104], P. Strizenec[29b], R. Ströhmer[169], D.M. Strom[126], R. Stroynowski[45], A. Strubig[48a,48b], S.A. Stucci[30], B. Stugu[17], J. Stupak[123], N.A. Styles[49], D. Su[146], S. Su[63a], W. Su[63d], X. Su[63a], D. Suchy[29a], K. Sugizaki[156], V.V. Sulin[38], M.J. Sullivan[94], D.M.S. Sultan[129], L. Sultanaliyeva[38], S. Sultansoy[3b], T. Sumida[89], S. Sun[173], O. Sunneborn Gudnadottir[164], N. Sur[104], M.R. Sutton[149], H. Suzuki[160], M. Svatos[134], M. Swiatlowski[159a], T. Swirski[169], I. Sykora[29a], M. Sykora[136], T. Sykora[136], D. Ta[102], K. Tackmann[49,t], A. Taffard[162], R. Tafirout[159a], J.S. Tafoya Vargas[67], Y. Takubo[85], M. Talby[104], A.A. Talyshev[38], K.C. Tam[65b], N.M. Tamir[154], A. Tanaka[156], J. Tanaka[156], R. Tanaka[67], M. Tanasini[148], Z. Tao[167], S. Tapia Araya[140f], S. Tapprogge[102], A. Tarek Abouelfadl Mohamed[109], S. Tarem[153], K. Tariq[14], G. Tarna[28b], G.F. Tartarelli[72a], M.J. Tartarin[91], P. Tas[136], M. Tasevsky[134], E. Tassi[44b,44a], A.C. Tate[165], G. Tateno[156], Y. Tayalati[36e,v], G.N. Taylor[107], W. Taylor[159b], R. Teixeira De Lima[146], P. Teixeira-Dias[97], J.J. Teoh[158], K. Terashi[156], J. Terron[101], S. Terzo[13], M. Testa[54], R.J. Teuscher[158,w], A. Thaler[80], O. Theiner[57], N. Themistokleous[53], T. Theveneaux-Pelzer[104], O. Thielmann[174], D.W. Thomas[97], J.P. Thomas[21], E.A. Thompson[18a], P.D. Thompson[21], E. Thomson[131], R.E. Thornberry[45], C. Tian[63a], Y. Tian[56], V. Tikhomirov[38,a], Yu.A. Tikhonov[38], S. Timoshenko[38], D. Timoshyn[136], E.X.L. Ting[1], P. Tipton[175], A. Tishelman-Charny[30], S.H. Tlou[34g], K. Todome[157], S. Todorova-Nova[136], S. Todt[51], L. Toffolin[70a,70c], M. Togawa[85], J. Tojo[90], S. Tokár[29a], K. Tokushuku[85], O. Toldaiev[69], M. Tomoto[85,113], L. Tompkins[146,m], K.W. Topolnicki[87b], E. Torrence[126], H. Torres[91], E. Torró Pastor[166], M. Toscani[31], C. Tosciri[40], M. Tost[11], D.R. Tovey[142], I.S. Trandafir[28b], T. Trefzger[169], A. Tricoli[30], I.M. Trigger[159a], S. Trincaz-Duvoid[130], D.A. Trischuk[27], B. Trocmé[61], A. Tropina[39], L. Truong[34c], M. Trzebinski[88], A. Trzupek[88], F. Tsai[148], M. Tsai[108], A. Tsiamis[155,d], P.V. Tsiareshka[38], S. Tsigaridas[159a], A. Tsirigotis[155,r], V. Tsiskaridze[158], E.G. Tskhadadze[152a], M. Tsopoulou[155], Y. Tsujikawa[89], I.I. Tsukerman[38], V. Tsulaia[18a], S. Tsuno[85], K. Tsuri[121], D. Tsybychev[148], Y. Tu[65b], A. Tudorache[28b], V. Tudorache[28b], A.N. Tuna[62], S. Turchikhin[58b,58a], I. Turk Cakir[3a], R. Turra[72a], T. Turtuvshin[39,x], P.M. Tuts[42], S. Tzamarias[155,d], E. Tzovara[102], F. Ukegawa[160], P.A. Ulloa Poblete[140c,140b], E.N. Umaka[30], G. Unal[37], A. Undrus[30], G. Unel[162], J. Urban[29b], P. Urrejola[140a], G. Usai[8], R. Ushioda[157], M. Usman[110], Z. Uysal[83], V. Vacek[135], B. Vachon[106], T. Vafeiadis[37], A. Vaitkus[98], C. Valderanis[111], E. Valdes Santurio[48a,48b], M. Valente[159a], S. Valentinetti[24b,24a], A. Valero[166], E. Valiente Moreno[166], A. Vallier[91], J.A. Valls Ferrer[166], D.R. Van Arneman[117], T.R. Van Daalen[141], A. Van Der Graaf[50], P. Van Gemmeren[6], M. Van Rijnbach[37], S. Van Stroud[98], I. Van Vulpen[117], P. Vana[136], M. Vanadia[77a,77b], W. Vandelli[37], E.R. Vandewall[124], D. Vannicola[154], L. Vannoli[54], R. Vari[76a], E.W. Varnes[7], C. Varni[18b], T. Varol[151], D. Varouchas[67], L. Varriale[166], K.E. Varvell[150], M.E. Vasile[28b], L. Vaslin[85], G.A. Vasquez[168], A. Vasyukov[39], L.M. Vaughan[124], R. Vavricka[102], T. Vazquez Schroeder[37], J. Veatch[32], V. Vecchio[103], M.J. Veen[105], I. Veliscek[30], L.M. Veloce[158], F. Veloso[133a,133c], S. Veneziano[76a], A. Ventura[71a,71b], S. Ventura Gonzalez[138], A. Verbytskyi[112], M. Verducci[75a,75b], C. Vergis[96], M. Verissimo De Araujo[84b], W. Verkerke[117], J.C. Vermeulen[117], C. Vernieri[146], M. Vessella[105], M.C. Vetterli[145,ad], A. Vgenopoulos[102], N. Viaux Maira[140f], T. Vickey[142], O.E. Vickey Boeriu[142], G.H.A. Viehhauser[129], L. Vigani[64b], M. Vigl[112], M. Villa[24b,24a], M. Villaplana Perez[166], E.M. Villhauer[53], E. Vilucchi[54], M.G. Vincter[35], A. Visibile[117], C. Vittori[37], I. Vivarelli[24b,24a], E. Voevodina[112], F. Vogel[111], J.C. Voigt[51], P. Vokac[135], Yu. Volkotrub[87b], J. Von Ahnen[49], E. Von Toerne[25], B. Vormwald[37], V. Vorobel[136], K. Vorobev[38], M. Vos[166], K. Voss[144], M. Vozak[117], L. Vozdecky[123], N. Vranjes[16], M. Vranjes Milosavljevic[16], M. Vreeswijk[117], N.K. Vu[63d,63c], R. Vuillermet[37], O. Vujinovic[102], I. Vukotic[40], S. Wada[160], C. Wagner[105], J.M. Wagner[18a], W. Wagner[174], S. Wahdan[174], H. Wahlberg[92], J. Walder[137], R. Walker[111], W. Walkowiak[144], A. Wall[131], E.J. Wallin[100], T. Wamorkar[6], A.Z. Wang[139], C. Wang[102], C. Wang[11], H. Wang[18a], J. Wang[65c], P. Wang[98], R. Wang[62], R. Wang[6], S.M. Wang[151], S. Wang[63b], S. Wang[14], T. Wang[63a], W.T. Wang[81], W. Wang[14], X. Wang[114a], X. Wang[165], X. Wang[63c], Y. Wang[63d], Y. Wang[114a], Y. Wang[63a], Z. Wang[108], Z. Wang[63d,52,63c], Z. Wang[108], A. Warburton[106], R.J. Ward[21], N. Warrack[60], S. Waterhouse[97], A.T. Watson[21], H. Watson[60], M.F. Watson[21], E. Watton[60,137], G. Watts[141], B.M. Waugh[98], J.M. Webb[55], C. Weber[30], H.A. Weber[19], M.S. Weber[20], S.M. Weber[64a], C. Wei[63a], Y. Wei[55], A.R. Weidberg[129], E.J. Weik[120], J. Weingarten[50], C. Weiser[55], C.J. Wells[49], T. Wenaus[30], B. Wendland[50], T. Wengler[37], N.S. Wenke[112], N. Wermes[25], M. Wessels[64a], A.M. Wharton[93], A.S. White[62], A. White[8], M.J. White[1], D. Whiteson[162], L. Wickremasinghe[127], W. Wiedenmann[173], M. Wielers[137], C. Wiglesworth[43], D.J. Wilbern[123], H.G. Wilkens[37], J.J.H. Wilkinson[33], D.M. Williams[42], H.H. Williams[131], S. Williams[33], S. Willocq[105], B.J. Wilson [103], P.J. Windischhofer [40], F.I. Winkel [31], F. Winklmeier [126], B.T. Winter [55], J.K. Winter [103], M. Wittgen[146], M. Wobisch [99], T. Wojtkowski[61], Z. Wolffs [117], J. Wollrath[162], M.W. Wolter [88], H. Wolters [133a,133c], M.C. Wong[139], E.L. Woodward [42], S.D. Worm [49], B.K. Wosiek [88], K.W. Woźniak [88], S. Wozniewski [56], K. Wraight [60], C. Wu [21], M. Wu [114b], M. Wu [116], S.L. Wu [173], X. Wu [57], Y. Wu [63a], Z. Wu [4], J. Wuerzinger [112,ab], T.R. Wyatt [103], B.M. Wynne [53], S. Xella [43], L. Xia [114a], M. Xia [15], M. Xie [63a], S. Xin [14,114c], A. Xiong [126], J. Xiong [18a], D. Xu [14], H. Xu [63a], L. Xu [63a], R. Xu [131], T. Xu [108], Y. Xu [15], Z. Xu [53], Z. Xu[114a], B. Yabsley [150], S. Yacoob [34a], Y. Yamaguchi [85], E. Yamashita [156], H. Yamauchi [160], T. Yamazaki [18a], Y. Yamazaki [86], J. Yan[63c], S. Yan [60], Z. Yan [105], H.J. Yang [63c,63d], H.T. Yang [63a], S. Yang [63a], T. Yang [65c], X. Yang [37], X. Yang [14], Y. Yang [45], Y. Yang[63a], Z. Yang [63a], W-M. Yao [18a], H. Ye [114a], H. Ye [56], J. Ye [14], S. Ye [30], X. Ye [63a], Y. Yeh [98], I. Yeletskikh [39], B.K. Yeo [18b], M.R. Yexley [98], T.P. Yildirim [129], P. Yin [42], K. Yorita [171], S. Younas [28b], C.J.S. Young [37], C. Young [146], C. Yu [14,114c], Y. Yu [63a], J. Yuan [14,114c], M. Yuan [108], R. Yuan [63d,63c], L. Yue [98], M. Zaazoua [63a], B. Zabinski [88], E. Zaid[53], Z.K. Zak [88], T. Zakareishvili [166], S. Zambito [57], J.A. Zamora Saa [140d,140b], J. Zang [156], D. Zanzi [55], O. Zaplatilek [135], C. Zeitnitz [174], H. Zeng [14], J.C. Zeng [165], D.T. Zenger Jr [27], O. Zenin [38], T. Ženiš [29a], S. Zenz [96], S. Zerradi [36a], D. Zerwas [67], M. Zhai [14,114c], D.F. Zhang [142], J. Zhang [63b], J. Zhang [6], K. Zhang [14,114c], L. Zhang [63a], L. Zhang [114a], P. Zhang [14,114c], R. Zhang [173], S. Zhang [108], S. Zhang [91], T. Zhang [156], X. Zhang [63c], X. Zhang [63b], Y. Zhang [63c], Y. Zhang [98], Y. Zhang [114a], Z. Zhang [18a], Z. Zhang [63b], Z. Zhang [67], H. Zhao [141], T. Zhao [63b], Y. Zhao [139], Z. Zhao [63a], Z. Zhao [63a], A. Zhemchugov [39], J. Zheng [114a], K. Zheng [165], X. Zheng [63a], Z. Zheng [146], D. Zhong [165], B. Zhou [108], H. Zhou [7], N. Zhou [63c], Y. Zhou[15], Y. Zhou [114a], Y. Zhou[7], C.G. Zhu [63b], J. Zhu [108], X. Zhu[63d], Y. Zhu [63c], Y. Zhu [63a], X. Zhuang [14], K. Zhukov [69], N.I. Zimine [39], J. Zinsser [64b], M. Ziolkowski [144], L. Živković [16], A. Zoccoli [24b,24a], K. Zoch [62], T.G. Zorbas [142], O. Zormpa [47], W. Zou [42], L. Zwalinski [37].

[1]Department of Physics, University of Adelaide, Adelaide; Australia.
[2]Department of Physics, University of Alberta, Edmonton AB; Canada.
[3] [(a)]Department of Physics, Ankara University, Ankara; [(b)]Division of Physics, TOBB University of Economics and Technology, Ankara; Türkiye.
[4]LAPP, Université Savoie Mont Blanc, CNRS/IN2P3, Annecy; France.
[5]APC, Université Paris Cité, CNRS/IN2P3, Paris; 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, University of Texas at Arlington, Arlington TX; United States of America.
[9]Physics Department, National and Kapodistrian University of Athens, Athens; Greece.
[10]Physics Department, National Technical University of Athens, Zografou; Greece.
[11]Department of Physics, University of Texas at Austin, Austin TX; United States of America.
[12]Institute of Physics, Azerbaijan Academy of Sciences, Baku; Azerbaijan.
[13]Institut de Física d'Altes Energies (IFAE), Barcelona Institute of Science and Technology, Barcelona; Spain.
[14]Institute of High Energy Physics, Chinese Academy of Sciences, Beijing; China.
[15]Physics Department, Tsinghua University, Beijing; China.
[16]Institute of Physics, University of Belgrade, Belgrade; Serbia.
[17]Department for Physics and Technology, University of Bergen, Bergen; Norway.
[18] [(a)]Physics Division, Lawrence Berkeley National Laboratory, Berkeley CA; [(b)]University of California,

Berkeley CA; United States of America.
[19]Institut für Physik, Humboldt Universität zu Berlin, Berlin; Germany.
[20]Albert Einstein Center for Fundamental Physics and Laboratory for High Energy Physics, University of Bern, Bern; Switzerland.
[21]School of Physics and Astronomy, University of Birmingham, Birmingham; United Kingdom.
[22(a)]Department of Physics, Bogazici University, Istanbul;[(b)]Department of Physics Engineering, Gaziantep University, Gaziantep;[(c)]Department of Physics, Istanbul University, Istanbul; Türkiye.
[23(a)]Facultad de Ciencias y Centro de Investigaciónes, Universidad Antonio Nariño, Bogotá;[(b)]Departamento de Física, Universidad Nacional de Colombia, Bogotá; Colombia.
[24(a)]Dipartimento di Fisica e Astronomia A. Righi, Università di Bologna, Bologna;[(b)]INFN Sezione di Bologna; Italy.
[25]Physikalisches Institut, Universität Bonn, Bonn; Germany.
[26]Department of Physics, Boston University, Boston MA; United States of America.
[27]Department of Physics, Brandeis University, Waltham MA; United States of America.
[28(a)]Transilvania University of Brasov, Brasov;[(b)]Horia Hulubei National Institute of Physics and Nuclear Engineering, Bucharest;[(c)]Department of Physics, Alexandru Ioan Cuza University of Iasi, Iasi;[(d)]National Institute for Research and Development of Isotopic and Molecular Technologies, Physics Department, Cluj-Napoca;[(e)]National University of Science and Technology Politechnica, Bucharest;[(f)]West University in Timisoara, Timisoara;[(g)]Faculty of Physics, University of Bucharest, Bucharest; Romania.
[29(a)]Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava;[(b)]Department of Subnuclear Physics, Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice; Slovak Republic.
[30]Physics Department, Brookhaven National Laboratory, Upton NY; United States of America.
[31]Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales, Departamento de Física, y CONICET, Instituto de Física de Buenos Aires (IFIBA), Buenos Aires; Argentina.
[32]California State University, CA; United States of America.
[33]Cavendish Laboratory, University of Cambridge, Cambridge; United Kingdom.
[34(a)]Department of Physics, University of Cape Town, Cape Town;[(b)]iThemba Labs, Western Cape;[(c)]Department of Mechanical Engineering Science, University of Johannesburg, Johannesburg;[(d)]National Institute of Physics, University of the Philippines Diliman (Philippines);[(e)]University of South Africa, Department of Physics, Pretoria;[(f)]University of Zululand, KwaDlangezwa;[(g)]School of Physics, University of the Witwatersrand, Johannesburg; South Africa.
[35]Department of Physics, Carleton University, Ottawa ON; Canada.
[36(a)]Faculté des Sciences Ain Chock, Réseau Universitaire de Physique des Hautes Energies - Université Hassan II, Casablanca;[(b)]Faculté des Sciences, Université Ibn-Tofail, Kénitra;[(c)]Faculté des Sciences Semlalia, Université Cadi Ayyad, LPHEA-Marrakech;[(d)]LPMR, Faculté des Sciences, Université Mohamed Premier, Oujda;[(e)]Faculté des sciences, Université Mohammed V, Rabat;[(f)]Institute of Applied Physics, Mohammed VI Polytechnic University, Ben Guerir; Morocco.
[37]CERN, Geneva; Switzerland.
[38]Affiliated with an institute covered by a cooperation agreement with CERN.
[39]Affiliated with an international laboratory covered by a cooperation agreement with CERN.
[40]Enrico Fermi Institute, University of Chicago, Chicago IL; United States of America.
[41]LPC, Université Clermont Auvergne, CNRS/IN2P3, Clermont-Ferrand; France.
[42]Nevis Laboratory, Columbia University, Irvington NY; United States of America.
[43]Niels Bohr Institute, University of Copenhagen, Copenhagen; Denmark.
[44(a)]Dipartimento di Fisica, Università della Calabria, Rende;[(b)]INFN Gruppo Collegato di Cosenza, Laboratori Nazionali di Frascati; Italy.

[45]Physics Department, Southern Methodist University, Dallas TX; United States of America.
[46]Physics Department, University of Texas at Dallas, Richardson TX; United States of America.
[47]National Centre for Scientific Research "Demokritos", Agia Paraskevi; Greece.
[48(a)]Department of Physics, Stockholm University;[(b)]Oskar Klein Centre, Stockholm; Sweden.
[49]Deutsches Elektronen-Synchrotron DESY, Hamburg and Zeuthen; Germany.
[50]Fakultät Physik , Technische Universität Dortmund, Dortmund; Germany.
[51]Institut für Kern- und Teilchenphysik, Technische Universität Dresden, Dresden; Germany.
[52]Department of Physics, Duke University, Durham NC; United States of America.
[53]SUPA - School of Physics and Astronomy, University of Edinburgh, Edinburgh; United Kingdom.
[54]INFN e Laboratori Nazionali di Frascati, Frascati; Italy.
[55]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Freiburg; Germany.
[56]II. Physikalisches Institut, Georg-August-Universität Göttingen, Göttingen; Germany.
[57]Département de Physique Nucléaire et Corpusculaire, Université de Genève, Genève; Switzerland.
[58(a)]Dipartimento di Fisica, Università di Genova, Genova;[(b)]INFN Sezione di Genova; Italy.
[59]II. Physikalisches Institut, Justus-Liebig-Universität Giessen, Giessen; Germany.
[60]SUPA - School of Physics and Astronomy, University of Glasgow, Glasgow; United Kingdom.
[61]LPSC, Université Grenoble Alpes, CNRS/IN2P3, Grenoble INP, Grenoble; France.
[62]Laboratory for Particle Physics and Cosmology, Harvard University, Cambridge MA; United States of America.
[63(a)]Department of Modern Physics and State Key Laboratory of Particle Detection and Electronics, University of Science and Technology of China, Hefei;[(b)]Institute of Frontier and Interdisciplinary Science and Key Laboratory of Particle Physics and Particle Irradiation (MOE), Shandong University, Qingdao;[(c)]School of Physics and Astronomy, Shanghai Jiao Tong University, Key Laboratory for Particle Astrophysics and Cosmology (MOE), SKLPPC, Shanghai;[(d)]Tsung-Dao Lee Institute, Shanghai;[(e)]School of Physics and Microelectronics, Zhengzhou University; China.
[64(a)]Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität Heidelberg, Heidelberg;[(b)]Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg; Germany.
[65(a)]Department of Physics, Chinese University of Hong Kong, Shatin, N.T., Hong Kong;[(b)]Department of Physics, University of Hong Kong, Hong Kong;[(c)]Department of Physics and Institute for Advanced Study, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong; China.
[66]Department of Physics, National Tsing Hua University, Hsinchu; Taiwan.
[67]IJCLab, Université Paris-Saclay, CNRS/IN2P3, 91405, Orsay; France.
[68]Centro Nacional de Microelectrónica (IMB-CNM-CSIC), Barcelona; Spain.
[69]Department of Physics, Indiana University, Bloomington IN; United States of America.
[70(a)]INFN Gruppo Collegato di Udine, Sezione di Trieste, Udine;[(b)]ICTP, Trieste;[(c)]Dipartimento Politecnico di Ingegneria e Architettura, Università di Udine, Udine; Italy.
[71(a)]INFN Sezione di Lecce;[(b)]Dipartimento di Matematica e Fisica, Università del Salento, Lecce; Italy.
[72(a)]INFN Sezione di Milano;[(b)]Dipartimento di Fisica, Università di Milano, Milano; Italy.
[73(a)]INFN Sezione di Napoli;[(b)]Dipartimento di Fisica, Università di Napoli, Napoli; Italy.
[74(a)]INFN Sezione di Pavia;[(b)]Dipartimento di Fisica, Università di Pavia, Pavia; Italy.
[75(a)]INFN Sezione di Pisa;[(b)]Dipartimento di Fisica E. Fermi, Università di Pisa, Pisa; Italy.
[76(a)]INFN Sezione di Roma;[(b)]Dipartimento di Fisica, Sapienza Università di Roma, Roma; Italy.
[77(a)]INFN Sezione di Roma Tor Vergata;[(b)]Dipartimento di Fisica, Università di Roma Tor Vergata, Roma; Italy.
[78(a)]INFN Sezione di Roma Tre;[(b)]Dipartimento di Matematica e Fisica, Università Roma Tre, Roma; Italy.
[79(a)]INFN-TIFPA;[(b)]Università degli Studi di Trento, Trento; Italy.

[80]Universität Innsbruck, Department of Astro and Particle Physics, Innsbruck; Austria.
[81]University of Iowa, Iowa City IA; United States of America.
[82]Department of Physics and Astronomy, Iowa State University, Ames IA; United States of America.
[83]Istinye University, Sariyer, Istanbul; Türkiye.
[84(a)]Departamento de Engenharia Elétrica, Universidade Federal de Juiz de Fora (UFJF), Juiz de Fora;[(b)]Universidade Federal do Rio De Janeiro COPPE/EE/IF, Rio de Janeiro;[(c)]Instituto de Física, Universidade de São Paulo, São Paulo;[(d)]Rio de Janeiro State University, Rio de Janeiro;[(e)]Federal University of Bahia, Bahia; Brazil.
[85]KEK, High Energy Accelerator Research Organization, Tsukuba; Japan.
[86]Graduate School of Science, Kobe University, Kobe; Japan.
[87(a)]AGH University of Krakow, Faculty of Physics and Applied Computer Science, Krakow;[(b)]Marian Smoluchowski Institute of Physics, Jagiellonian University, Krakow; Poland.
[88]Institute of Nuclear Physics Polish Academy of Sciences, Krakow; Poland.
[89]Faculty of Science, Kyoto University, Kyoto; Japan.
[90]Research Center for Advanced Particle Physics and Department of Physics, Kyushu University, Fukuoka ; Japan.
[91]L2IT, Université de Toulouse, CNRS/IN2P3, UPS, Toulouse; France.
[92]Instituto de Física La Plata, Universidad Nacional de La Plata and CONICET, La Plata; Argentina.
[93]Physics Department, Lancaster University, Lancaster; United Kingdom.
[94]Oliver Lodge Laboratory, University of Liverpool, Liverpool; United Kingdom.
[95]Department of Experimental Particle Physics, Jožef Stefan Institute and Department of Physics, University of Ljubljana, Ljubljana; Slovenia.
[96]School of Physics and Astronomy, Queen Mary University of London, London; United Kingdom.
[97]Department of Physics, Royal Holloway University of London, Egham; United Kingdom.
[98]Department of Physics and Astronomy, University College London, London; United Kingdom.
[99]Louisiana Tech University, Ruston LA; United States of America.
[100]Fysiska institutionen, Lunds universitet, Lund; Sweden.
[101]Departamento de Física Teorica C-15 and CIAFF, Universidad Autónoma de Madrid, Madrid; Spain.
[102]Institut für Physik, Universität Mainz, Mainz; Germany.
[103]School of Physics and Astronomy, University of Manchester, Manchester; United Kingdom.
[104]CPPM, Aix-Marseille Université, CNRS/IN2P3, Marseille; France.
[105]Department of Physics, University of Massachusetts, Amherst MA; United States of America.
[106]Department of Physics, McGill University, Montreal QC; Canada.
[107]School of Physics, University of Melbourne, Victoria; Australia.
[108]Department of Physics, University of Michigan, Ann Arbor MI; United States of America.
[109]Department of Physics and Astronomy, Michigan State University, East Lansing MI; United States of America.
[110]Group of Particle Physics, University of Montreal, Montreal QC; Canada.
[111]Fakultät für Physik, Ludwig-Maximilians-Universität München, München; Germany.
[112]Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München; Germany.
[113]Graduate School of Science and Kobayashi-Maskawa Institute, Nagoya University, Nagoya; Japan.
[114(a)]Department of Physics, Nanjing University, Nanjing;[(b)]School of Science, Shenzhen Campus of Sun Yat-sen University;[(c)]University of Chinese Academy of Science (UCAS), Beijing; China.
[115]Department of Physics and Astronomy, University of New Mexico, Albuquerque NM; United States of America.
[116]Institute for Mathematics, Astrophysics and Particle Physics, Radboud University/Nikhef, Nijmegen; Netherlands.

[117]Nikhef National Institute for Subatomic Physics and University of Amsterdam, Amsterdam; Netherlands.
[118]Department of Physics, Northern Illinois University, DeKalb IL; United States of America.
[119][(a)]New York University Abu Dhabi, Abu Dhabi;[(b)]United Arab Emirates University, Al Ain; United Arab Emirates.
[120]Department of Physics, New York University, New York NY; United States of America.
[121]Ochanomizu University, Otsuka, Bunkyo-ku, Tokyo; Japan.
[122]Ohio State University, Columbus OH; United States of America.
[123]Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman OK; United States of America.
[124]Department of Physics, Oklahoma State University, Stillwater OK; United States of America.
[125]Palacký University, Joint Laboratory of Optics, Olomouc; Czech Republic.
[126]Institute for Fundamental Science, University of Oregon, Eugene, OR; United States of America.
[127]Graduate School of Science, Osaka University, Osaka; Japan.
[128]Department of Physics, University of Oslo, Oslo; Norway.
[129]Department of Physics, Oxford University, Oxford; United Kingdom.
[130]LPNHE, Sorbonne Université, Université Paris Cité, CNRS/IN2P3, Paris; France.
[131]Department of Physics, University of Pennsylvania, Philadelphia PA; United States of America.
[132]Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh PA; United States of America.
[133][(a)]Laboratório de Instrumentação e Física Experimental de Partículas - LIP, Lisboa;[(b)]Departamento de Física, Faculdade de Ciências, Universidade de Lisboa, Lisboa;[(c)]Departamento de Física, Universidade de Coimbra, Coimbra;[(d)]Centro de Física Nuclear da Universidade de Lisboa, Lisboa;[(e)]Departamento de Física, Universidade do Minho, Braga;[(f)]Departamento de Física Teórica y del Cosmos, Universidad de Granada, Granada (Spain);[(g)]Departamento de Física, Instituto Superior Técnico, Universidade de Lisboa, Lisboa; Portugal.
[134]Institute of Physics of the Czech Academy of Sciences, Prague; Czech Republic.
[135]Czech Technical University in Prague, Prague; Czech Republic.
[136]Charles University, Faculty of Mathematics and Physics, Prague; Czech Republic.
[137]Particle Physics Department, Rutherford Appleton Laboratory, Didcot; United Kingdom.
[138]IRFU, CEA, Université Paris-Saclay, Gif-sur-Yvette; France.
[139]Santa Cruz Institute for Particle Physics, University of California Santa Cruz, Santa Cruz CA; United States of America.
[140][(a)]Departamento de Física, Pontificia Universidad Católica de Chile, Santiago;[(b)]Millennium Institute for Subatomic physics at high energy frontier (SAPHIR), Santiago;[(c)]Instituto de Investigación Multidisciplinario en Ciencia y Tecnología, y Departamento de Física, Universidad de La Serena;[(d)]Universidad Andres Bello, Department of Physics, Santiago;[(e)]Instituto de Alta Investigación, Universidad de Tarapacá, Arica;[(f)]Departamento de Física, Universidad Técnica Federico Santa María, Valparaíso; Chile.
[141]Department of Physics, University of Washington, Seattle WA; United States of America.
[142]Department of Physics and Astronomy, University of Sheffield, Sheffield; United Kingdom.
[143]Department of Physics, Shinshu University, Nagano; Japan.
[144]Department Physik, Universität Siegen, Siegen; Germany.
[145]Department of Physics, Simon Fraser University, Burnaby BC; Canada.
[146]SLAC National Accelerator Laboratory, Stanford CA; United States of America.
[147]Department of Physics, Royal Institute of Technology, Stockholm; Sweden.
[148]Departments of Physics and Astronomy, Stony Brook University, Stony Brook NY; United States of

America.
[149]Department of Physics and Astronomy, University of Sussex, Brighton; United Kingdom.
[150]School of Physics, University of Sydney, Sydney; Australia.
[151]Institute of Physics, Academia Sinica, Taipei; Taiwan.
[152](a)E. Andronikashvili Institute of Physics, Iv. Javakhishvili Tbilisi State University, Tbilisi;(b)High Energy Physics Institute, Tbilisi State University, Tbilisi;(c)University of Georgia, Tbilisi; Georgia.
[153]Department of Physics, Technion, Israel Institute of Technology, Haifa; Israel.
[154]Raymond and Beverly Sackler School of Physics and Astronomy, Tel Aviv University, Tel Aviv; Israel.
[155]Department of Physics, Aristotle University of Thessaloniki, Thessaloniki; Greece.
[156]International Center for Elementary Particle Physics and Department of Physics, University of Tokyo, 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]Division of Physics and Tomonaga Center for the History of the Universe, 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]Department of Physics and Astronomy, University of California Irvine, Irvine CA; United States of America.
[163]University of Sharjah, Sharjah; United Arab Emirates.
[164]Department of Physics and Astronomy, University of Uppsala, Uppsala; Sweden.
[165]Department of Physics, University of Illinois, Urbana IL; United States of America.
[166]Instituto de Física Corpuscular (IFIC), Centro Mixto Universidad de Valencia - CSIC, Valencia; Spain.
[167]Department of Physics, University of British Columbia, Vancouver BC; Canada.
[168]Department of Physics and Astronomy, University of Victoria, Victoria BC; Canada.
[169]Fakultät für Physik und Astronomie, Julius-Maximilians-Universität Würzburg, Würzburg; Germany.
[170]Department of Physics, University of Warwick, Coventry; United Kingdom.
[171]Waseda University, Tokyo; Japan.
[172]Department of Particle Physics and Astrophysics, Weizmann Institute of Science, Rehovot; Israel.
[173]Department of Physics, University of Wisconsin, Madison WI; United States of America.
[174]Fakultät für Mathematik und Naturwissenschaften, Fachgruppe Physik, Bergische Universität Wuppertal, Wuppertal; Germany.
[175]Department of Physics, Yale University, New Haven CT; United States of America.
[a] Also Affiliated with an institute covered by a cooperation agreement with CERN.
[b] Also at An-Najah National University, Nablus; Palestine.
[c] Also at Borough of Manhattan Community College, City University of New York, New York NY; United States of America.
[d] Also at Center for Interdisciplinary Research and Innovation (CIRI-AUTH), Thessaloniki; Greece.
[e] Also at Centro Studi e Ricerche Enrico Fermi; Italy.
[f] Also at CERN, Geneva; Switzerland.
[g] Also at CMD-AC UNEC Research Center, Azerbaijan State University of Economics (UNEC); Azerbaijan.
[h] Also at Département de Physique Nucléaire et Corpusculaire, Université de Genève, Genève; Switzerland.
[i] Also at Departament de Fisica de la Universitat Autonoma de Barcelona, Barcelona; Spain.
[j] Also at Department of Financial and Management Engineering, University of the Aegean, Chios; Greece.

[k] Also at Department of Physics, California State University, Sacramento; United States of America.
[l] Also at Department of Physics, King's College London, London; United Kingdom.
[m] Also at Department of Physics, Stanford University, Stanford CA; United States of America.
[n] Also at Department of Physics, Stellenbosch University; South Africa.
[o] Also at Department of Physics, University of Fribourg, Fribourg; Switzerland.
[p] Also at Department of Physics, University of Thessaly; Greece.
[q] Also at Department of Physics, Westmont College, Santa Barbara; United States of America.
[r] Also at Hellenic Open University, Patras; Greece.
[s] Also at Institucio Catalana de Recerca i Estudis Avancats, ICREA, Barcelona; Spain.
[t] Also at Institut für Experimentalphysik, Universität Hamburg, Hamburg; Germany.
[u] Also at Institute for Nuclear Research and Nuclear Energy (INRNE) of the Bulgarian Academy of Sciences, Sofia; Bulgaria.
[v] Also at Institute of Applied Physics, Mohammed VI Polytechnic University, Ben Guerir; Morocco.
[w] Also at Institute of Particle Physics (IPP); Canada.
[x] Also at Institute of Physics and Technology, Mongolian Academy of Sciences, Ulaanbaatar; Mongolia.
[y] Also at Institute of Physics, Azerbaijan Academy of Sciences, Baku; Azerbaijan.
[z] Also at Institute of Theoretical Physics, Ilia State University, Tbilisi; Georgia.
[aa] Also at National Institute of Physics, University of the Philippines Diliman (Philippines); Philippines.
[ab] Also at Technical University of Munich, Munich; Germany.
[ac] Also at The Collaborative Innovation Center of Quantum Matter (CICQM), Beijing; China.
[ad] Also at TRIUMF, Vancouver BC; Canada.
[ae] Also at Università di Napoli Parthenope, Napoli; Italy.
[af] Also at University of Colorado Boulder, Department of Physics, Colorado; United States of America.
[ag] Also at Washington College, Chestertown, MD; United States of America.
[ah] Also at Yeditepe University, Physics Department, Istanbul; Türkiye.
[*] Deceased