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Observation of the γγ→ττ process in Pb+Pb collisions and constraints on the τ-lepton anomalous magnetic moment with the ATLAS detector. Physical Review Letters, 131. 151802. ISSN 0031-9007

https://doi.org/10.1103/physrevlett.131.151802

Editors' Suggestion

Observation of the $\gamma\gamma \to \tau\tau$ Process in Pb + Pb Collisions and Constraints on the τ-Lepton Anomalous Magnetic Moment with the ATLAS Detector

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(Received 3 May 2022; accepted 7 July 2022; published 12 October 2023)

This Letter reports the observation of τ-lepton-pair production in ultraperipheral lead-lead collisions $\mathrm{Pb+Pb} \to \mathrm{Pb}(\gamma\gamma \to \tau\tau)\mathrm{Pb}$ and constraints on the τ-lepton anomalous magnetic moment a_τ. The dataset corresponds to an integrated luminosity of 1.44 nb^{-1} of LHC Pb + Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV recorded by the ATLAS experiment in 2018. Selected events contain one muon from a τ-lepton decay, an electron or charged-particle track(s) from the other τ-lepton decay, little additional central-detector activity, and no forward neutrons. The $\gamma\gamma \to \tau\tau$ process is observed in Pb + Pb collisions with a significance exceeding 5 standard deviations and a signal strength of $\mu_{\tau\tau} = 1.03^{+0.06}_{-0.05}$ assuming the standard model value for a_τ. To measure a_τ, a template fit to the muon transverse-momentum distribution from τ-lepton candidates is performed, using a dimuon ($\gamma\gamma \to \mu\mu$) control sample to constrain systematic uncertainties. The observed 95% confidence-level interval for a_τ is $-0.057 < a_\tau < 0.024$.

DOI: 10.1103/PhysRevLett.131.151802

Measurements of the anomalous magnetic moment, $a_\ell = \frac{1}{2}(g_\ell - 2)$, of charged leptons ℓ (electrons, muons, and τ leptons) are cornerstone tests of the standard model (SM) with unique sensitivity to beyond-the-SM (BSM) phenomena. The leading contribution to a_ℓ in the SM is the one-loop Schwinger term $\alpha_{\mathrm{EM}}/2\pi \simeq 0.00116$ [1,2], where α_{EM} is the electromagnetic (EM) fine-structure constant. For the electron (muon), a_e (a_μ) is tested to parts per 10^{10} [3–8] (10^7 [9–11]) precision. Measurements of a_μ report tensions with the SM expectation [12–16], which may suggest BSM dynamics. Specific BSM scenarios such as supersymmetry [17] predict enhancements that scale quadratically with lepton mass m_ℓ, i.e., $\delta a_\ell \propto m_\ell^2$, resulting in a $(m_\tau/m_\mu)^2 \simeq 280$ times larger effect for τ leptons. However, the short τ-lepton lifetime precludes precise spin-precession measurements of a_τ to test the SM prediction of $a_\tau^{\mathrm{SM}} = 0.001\,177\,21(5)$ [18] and potential BSM contributions.

Photon-induced events arise from interactions between the EM fields surrounding the beam particles at colliders. Observing photon-induced τ-lepton pairs ($\gamma\gamma \to \tau\tau$) predicted to occur at the Large Hadron Collider (LHC) [19–26] would open the way to hadron-collider probes of a_τ. Currently, the most precise single-experiment measurement is $a_\tau = -0.018(17)$ by the DELPHI Collaboration [27,28] using $\gamma\gamma \to \tau\tau$ events at the Large Electron Positron (LEP) collider. The OPAL [29] and L3 [30] Collaborations also set constraints using radiative τ-lepton decays [31]. At the LHC, photon-induced dilepton production has only been measured in the dielectron (ee) and dimuon ($\mu\mu$) channels, using proton-proton (pp) [32–37] and lead-lead (Pb + Pb) collisions [38–43]. The $\tau\tau$ channel is challenging due to hadronic backgrounds and neutrinos in τ-lepton decays diluting visible final-state kinematics. This renders triggering and reconstruction more difficult, especially in high-luminosity pp collisions. Strategies to overcome these experimental obstacles using heavy-ion collisions were proposed in Refs. [44–46].

This Letter presents the observation of the $\mathrm{Pb+Pb} \to \mathrm{Pb}(\gamma\gamma \to \tau\tau)\mathrm{Pb}$ process and measurement of a_τ using 1.44 nb^{-1} of Pb + Pb data recorded by ATLAS in 2018 at a nucleon-nucleon (NN) center-of-mass energy of $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV. The EM fields accompanying the ions coherently create photons that interact to produce τ-lepton pairs. The cross section is enhanced by Z^4 relative to pp collisions, where Z is the atomic number ($Z = 82$ for lead). The ions can remain intact, enabling selection of low-multiplicity events with one muon originating from one of the τ leptons, while the other τ-lepton decay is reconstructed as either an electron or one or three charged-particle tracks with low transverse momentum.

The ATLAS experiment [47–49] is a multipurpose particle detector with cylindrical geometry [50], comprising an inner-detector (ID) tracker, EM and hadronic calorimeters, and a muon spectrometer (MS). The zero-degree calorimeters (ZDCs) [51] are located at $z = \pm 140$ m from

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the interaction point and detect neutral particles such as neutrons emitted from interacting nuclei. A two-level trigger system [52,53] was used to select events containing one muon with $p_T > 4$ GeV and, at most, 50 GeV (3 GeV) of transverse energy deposited in the whole (forward $3.2 < |\eta| < 4.9$) calorimeter [54]. An extensive software suite [55] is used in the reconstruction and analysis of real and simulated data, in detector operations and in the trigger and data acquisition systems. Standard data-quality requirements are imposed [56]. The average number of hadronic interactions per bunch crossing was 0.003.

Samples of simulated $\gamma\gamma \to \tau\tau$ signal events were produced at leading order in QED using the STARLIGHT2.0 [57] Monte Carlo (MC) generator, interfaced with TAUOLA [58,59] for τ-lepton decays. Final-state radiation (FSR) from the τ leptons and charged decay products of τ leptons was simulated using PYTHIA8.245 [60] and PHOTOS3.61 [61], respectively. One of the dominant background sources is the $\gamma\gamma \to \mu\mu$ process, and its contribution is estimated with the aid of MC samples generated using STARLIGHT; PYTHIA8 was used to model EM FSR from the muons. The photon-flux distribution in simulated $\gamma\gamma \to \tau\tau$ and $\gamma\gamma \to \mu\mu$ events was reweighted to that of SUPERCHIC3.05 [62], differentially in dilepton invariant mass and dilepton rapidity. In the STARLIGHT and SUPERCHIC simulations, no restriction on the Coulomb breakup of either nucleus was imposed. Dijet samples from photon-induced diquark production, $\gamma\gamma \to q\bar{q}$, were generated using PYTHIA8. Nondiffractive photonuclear events ($\gamma A \to X$) were simulated with STARLIGHT interfaced with DPMJET-III [63]. All MC samples were passed through a detailed detector simulation based on GEANT4 [64,65].

Charged-particle tracks reconstructed in the ID must satisfy $p_T > 100$ MeV, $|\eta| < 2.5$, transverse impact parameter $|d_0| < 1.5$ mm, and the "loose primary" track selection criterion [66–68]. Electrons must satisfy $p_T > 4$ GeV, $|\eta| < 2.47$ (excluding the calorimeter transition region, i.e., $|\eta| \notin [1.37, 1.52]$), $|d_0| < 0.5$ mm, and "loose" [69] likelihood-based identification criteria. Muons must satisfy $p_T > 4$ GeV, $|\eta| < 2.4$, $|d_0| < 0.3$ mm, and "low p_T" [70] identification criteria. Small corrections, derived using tag-and-probe methods similar to those in Refs. [40,71,72], are applied to simulated reconstruction and trigger efficiencies of electrons and muons. Clusters of topologically connected calorimeter cells called topoclusters [73] must satisfy $|\eta| < 4.9$, $p_T > 0.1$ GeV ($p_T > 1$ GeV) for $2.5 < |\eta| < 4.9$ ($|\eta| < 2.5$), and the cell significance criteria for measured energies outlined in Ref. [74]. Topoclusters from calorimeter regions with an abnormal noise distribution are removed using a data-driven procedure based on analyzing η-ϕ distributions of topocluster activity for each calorimeter layer. Reconstructed photons must satisfy $E_T > 1.5$ GeV, $|\eta| < 2.37 \notin [1.37, 1.52]$, and dedicated identification criteria defined in Ref. [72].

Selected events must contain exactly one muon, which targets a muonic decay of one of the τ leptons while reducing backgrounds from $\gamma\gamma \to \mu\mu$ and $\gamma\gamma \to q\bar{q}$. Three signal regions (SRs) then categorize events by the decay signature of the other τ lepton. The μe-SR category additionally requires one electron and no additional tracks separated from the muon (electron) by $\Delta R_{\mu(e),\mathrm{trk}} > 0.1$, which targets fully leptonic decays of both τ leptons. The different-flavor (μe) requirement suppresses same-flavor backgrounds dominated by $\gamma\gamma \to \mu\mu/ee$. The μ1T-SR (μ3T-SR) category requires exactly one track (three tracks) separated from the muon by $\Delta R_{\mu,\mathrm{trk}} > 0.1$, which targets τ-lepton decays to one or three charged hadrons. The one-track requirement also captures leptonic τ-lepton decays that fail electron or muon reconstruction. The electric charges of the muon, electron, and tracks must sum to zero.

For both μ1T-SR and μ3T-SR, events must contain no additional muons satisfying looser criteria and no electrons to reject $\gamma\gamma \to \mu\mu/ee$ backgrounds. The looser requirements on muons comprise matched tracks in the ID and MS satisfying $p_T > 2$ GeV and $|\eta| < 2.5$. To suppress hadronic backgrounds such as photonuclear processes, there must be no topoclusters separated from the muon (track or three-track system [75]) by $\Delta R_{\mathrm{clust},\mu} > 0.3$ ($\Delta R_{\mathrm{clust,trk(s)}} > 1.0$); this requirement is referred to as the topocluster veto. To further reduce photonuclear backgrounds, the acoplanarity between the muon and the track (three-track system) must satisfy $A_\phi^{\mu,\mathrm{trk(s)}} \equiv 1 - |\Delta\phi_{\mu,\mathrm{trk(s)}}|/\pi < 0.4(0.2)$. The signal has a narrower $A_\phi^{\mu,\mathrm{trk(s)}}$ distribution in μ3T-SR than μ1T-SR, motivating the tighter requirement.

For μ1T-SR, the p_T of the muon-track pair must satisfy $p_T^{\mu,\mathrm{trk}} > 1$ GeV to reject p_T-balanced backgrounds, such as $\gamma\gamma \to \mu\mu$. To further reduce the $\gamma\gamma \to \mu\mu\gamma$ background, the p_T of the muon, track, and photon (topocluster) system must fulfill $p_T^{\mu,\mathrm{trk},\gamma(\mathrm{clust})} > 1$ GeV for events containing a photon (topocluster) within $\Delta R_{\gamma(\mathrm{clust}),\mathrm{trk}} = 1$ of the track. If there are multiple nearby photons (topoclusters), the highest-p_T photon (topocluster) is used. The topoclusters considered here must have $p_T > 2$ GeV and not be track matched; these criteria avoid track-induced topoclusters from, e.g., charged-pion energy deposits. Topoclusters within $\Delta R_{\mathrm{clust,trk}} = 0.1$ of a track with $p_T > 0.7$ GeV extrapolated to the calorimeter are considered track matched. Low-multiplicity events in minimum-bias data are used to correct for the bending due to the magnetic field, such that the $\Delta R_{\mathrm{clust,trk}}$ distribution of topoclusters associated with a track peaks at zero. Tracks with $p_T < 0.7$ GeV are not considered in the track-cluster matching, as they typically do not deposit significant energy in the calorimeter.

For μ3T-SR, the three-track system mass must fulfill $m_{3\mathrm{trk}} < 1.7$ GeV, assuming each track has the charged-pion mass of 140 MeV. This requirement retains three-prong hadronic τ-lepton decays and suppresses background from exclusive ρ^0 mesons ($\gamma A \to \rho^0 \to \pi\pi$) produced simultaneously with $\gamma\gamma \to \mu\mu$ events. In this background process, neither muon is correlated with the $\pi\pi$ system and $m_{\pi\pi\mu}$ typically exceeds 1.7 GeV for a muon with p_T of several GeV.

To constrain the $\gamma\gamma \to \mu\mu$ background, a control region (CR) of dimuon events called 2μ-CR is defined. It requires exactly two muons with invariant mass above 11 GeV to suppress quarkonia $[\Upsilon(nS) \to \mu\mu]$ backgrounds and no additional tracks separated from the muons by $\Delta R_{\mu,\mathrm{trk}} > 0.1$.

Events must additionally not have ZDC energies satisfying $E_{\mathrm{ZDC}} > 1$ TeV on each side, mainly to suppress photonuclear backgrounds where ion dissociation typically occurs. This class of events with no forward neutrons detected ($0n0n$) corresponds to the absence of Coulomb breakup of either nucleus. Such breakup typically proceeds through the giant dipole resonance and induces the emission of one or more neutrons [40]. This requirement also fully suppresses lepton-pair production in which the initial photon emission results in the dissociation of one or both nuclei [40]. The SRs and 2μ-CR are all statistically independent. Since the extra forward neutron emissions are not simulated, the $\gamma\gamma \to \ell\ell$ MC samples are corrected using data-driven probabilities for the $0n0n$ event topology, which are found to be between 0.4 and 0.7. These are extracted from 2μ-CR without the E_{ZDC} requirement, differentially in dilepton invariant mass and dilepton rapidity.

The dominant sources of background after event selection are radiative dimuon ($\gamma\gamma \to \mu\mu\gamma$) and photonuclear events with low central-detector activity.

The $\gamma\gamma \to \mu\mu\gamma$ background is estimated with the aid of MC samples. This process enters μ1T-SR when FSR photons substantially modify the dimuon kinematics so as to mimic the signal kinematics and enters μ3T-SR and μe-SR primarily when photons convert to e^+e^- in detector material. To improve the modeling of high-p_T ($p_T^\gamma \gtrsim p_T^\mu$) photon emissions for t- and u-channel $\gamma\gamma \to \mu\mu$ processes, an additional $\gamma\gamma \to \mu\mu\gamma$ MC sample generated using MADGRAPH5_AMC@NLO [76] with the photon flux reweighted to SUPERCHIC is used instead of STARLIGHT+PYTHIA8 if a leading photon has $p_T^\gamma > 2$ GeV. Comparing the $\gamma\gamma \to \mu\mu(\gamma)$ simulated events with data in 2μ-CR shows reasonable data-to-MC agreement in differential distributions and normalization to within 5%. The simulated $\gamma\gamma \to \mu\mu(\gamma)$ event yield in 2μ-CR is 15% lower than data if STARLIGHT photon-flux calculations are used due to known limitations of STARLIGHT [40,77]. Before the fit to data, this method estimates 70, 6.5, and 2.8 $\gamma\gamma \to \mu\mu(\gamma)$ events enter μ1T-SR, μ3T-SR, and μe-SR, respectively.

Diffractive photonuclear backgrounds with low particle activity are estimated using fully data-driven methods. Dedicated CRs are introduced, called μ2T-CR (μ4T-CR), which apply the same selection as μ1T-SR (μ3T-SR), but require an additional track satisfying $p_T < 0.5$ GeV. Furthermore, the $E_{\mathrm{ZDC}} < 1$ TeV requirement is removed on either side to enrich the sample with events from photonuclear processes. To suppress the $\gamma\gamma \to \tau\tau$ signal contamination in μ2T-CR, the two-track system mass must fulfill $m_{2\mathrm{trk}} > 1$ GeV; if $m_{2\mathrm{trk}} < 1$ GeV, the acoplanarity of the muon and highest-p_T track is required to exceed 0.2. The event yields in CRs are extrapolated to SRs by loosening the veto on topoclusters not matched to the muon or tracks from $n_{\mathrm{TC}}^{\mathrm{unmatch}} = 0$ to $n_{\mathrm{TC}}^{\mathrm{unmatch}} \leq 8$, both in CRs and SRs. The μ2T-CR (μ4T-CR) templates for $n_{\mathrm{TC}}^{\mathrm{unmatch}}$ distributions are normalized to the event yield in μ1T-SR (μ3T-SR) in the region $4 \leq n_{\mathrm{TC}}^{\mathrm{unmatch}} \leq 8$. In this region, the signal and dimuon background contributions are found to be negligible, and events exhibit properties that suggest nonexclusive diffractive production, such as a small or no rapidity gap [78]. As the additional track in μ2T-CR and μ4T-CR is soft ($p_T < 0.5$ GeV), its possible correlation with topocluster activity is very small. This method estimates that 13 (2.8) photonuclear events enter μ1T-SR (μ3T-SR); photonuclear events are expected to be negligible in μe-SR.

Other sources of background are predicted to be negligible in the SRs. Nondiffractive photonuclear interactions are estimated using the STARLIGHT+DPMJET-III sample and are found to be negligible in all three SRs. The PYTHIA8 simulation of $\gamma\gamma \to q\bar{q}$ estimates dijet backgrounds contribute less than 0.3 events in both μ1T-SR and μ3T-SR. Similarly, the contribution from resolved $\gamma\gamma$ interactions, as estimated with PYTHIA8 [79], is found to be negligible. Exclusive ρ^0-meson production with simultaneous $\gamma\gamma \to \mu\mu$ production in μ3T-SR is studied using a data-driven method. Template distributions for this process are built from events with two muons and two additional charged-particle tracks. The acoplanarities of both the muon pair and the track pair must be below 0.05. All events in these templates are found to have $m_{3\mathrm{trk}} > 1.7$ GeV, so this background is expected to be negligible in μ3T-SR.

Systematic uncertainties affecting the measurement arise from the reconstruction of leptons, photons, charged-particle tracks and topoclusters, the signal and background modeling, and integrated luminosity.

Uncertainties in the muon momentum scale and resolution follow those in Ref. [80]. The analysis includes uncertainties in the data-to-MC correction factors applied to simulated samples for the muon trigger and reconstruction efficiencies. Uncertainties in the reconstruction, identification, and energy calibration of electrons and photons are evaluated in accord with Ref. [72]. The uncertainty in the inclusive track reconstruction efficiency is dominated by the uncertainty in the amount of ID material [67]. This uncertainty is applied in the simulation by randomly removing tracks with a p_T- and η-dependent probability corresponding to the material uncertainty. Uncertainties in the topocluster reconstruction efficiency and energy calibration are

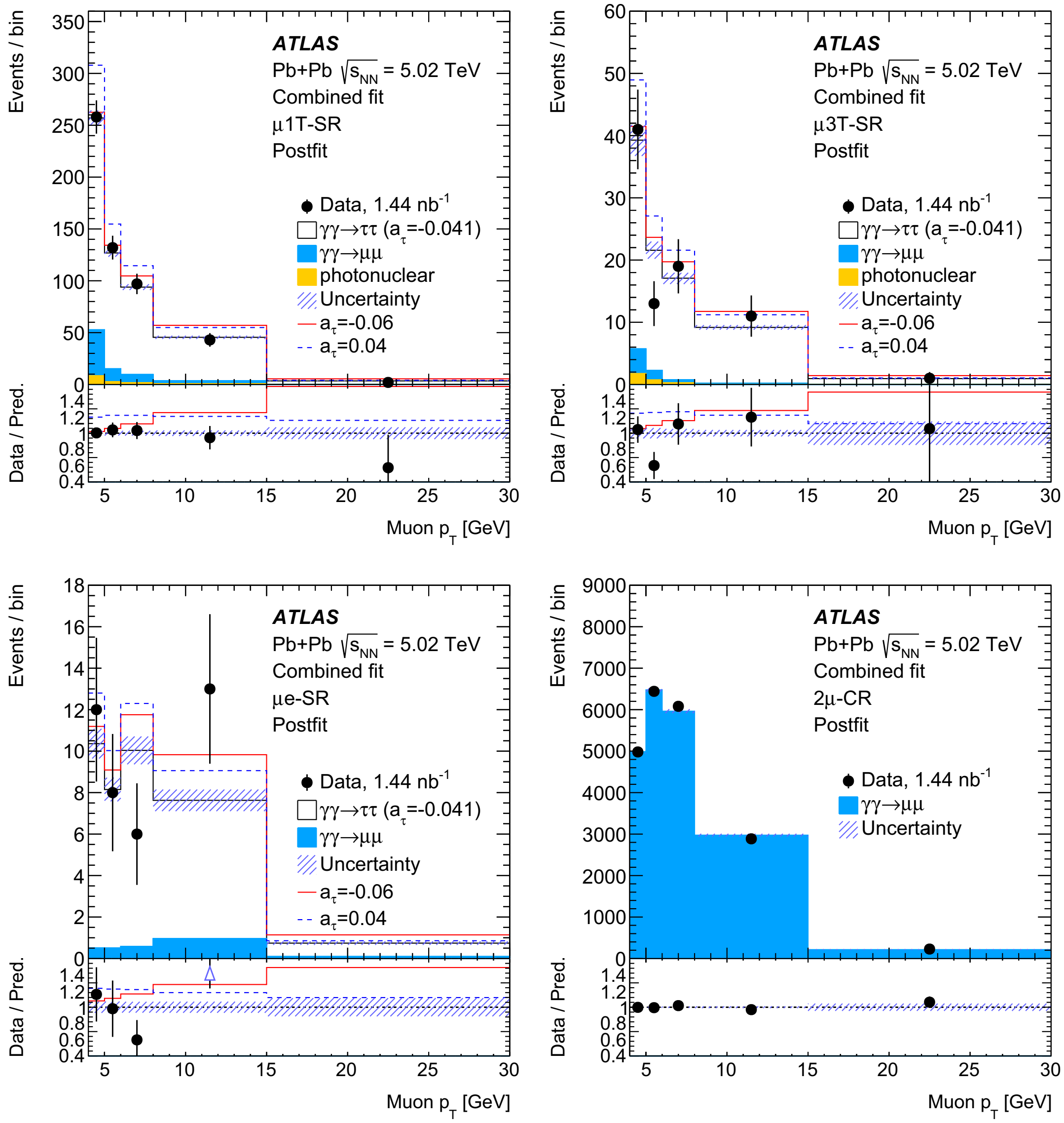

FIG. 1. Muon transverse-momentum distributions in the (top left) μ1T-SR, (top right) μ3T-SR, (bottom left) μe-SR, and (bottom right) 2μ-CR categories. Black markers denote data and stacked histograms indicate the different components contributing to the regions. Postfit distributions are shown with the signal contribution corresponding to the best-fit a_τ value ($a_\tau = -0.041$). For comparison, signal contributions with alternative a_τ values are shown as solid red ($a_\tau = -0.06$) or dashed blue ($a_\tau = 0.04$) lines. The bottom panel shows the ratio of the data to postfit predictions. Vertical bars denote uncertainties from the finite number of data events. Hatched bands represent $\pm 1\sigma$ systematic uncertainties of the prediction with the constraints from the fit applied.

estimated using $\gamma\gamma \to ee$ events where one of the electrons emits a hard bremsstrahlung photon due to its interaction with detector material [72].

Uncertainties in the photonuclear background evaluation are estimated by repeating the procedure with alternative requirements for CRs. These resemble the μ1T-SR (μ3T-SR) selection except that the track (three-track system) has the same electric charge as the muon candidate. The difference between the photonuclear background contribution evaluated with alternative and nominal CRs defines the uncertainties, affecting both the normalization and differential distributions. Uncertainties in modeling the photon flux are estimated by using the STARLIGHT MC samples without reweighting to SUPERCHIC. This affects the normalization and differential distributions of the signal and $\gamma\gamma \to \mu\mu$ background. Uncertainties in modeling τ-lepton decays are estimated using PYTHIA8 [81] as an alternative MC simulation to TAUOLA. The effect of τ-lepton spin correlations in TAUOLA is implemented using helicity amplitudes from the $\gamma^* \to \tau\tau$ process. This modeling is therefore cross-checked by comparing signal events simulated using two versions of PYTHIA8: v8.245 uses helicity amplitudes from the $\gamma^* \to \tau\tau$ process, whereas v8.305 uses the $\gamma\gamma \to \tau\tau$ elementary process. The difference between the

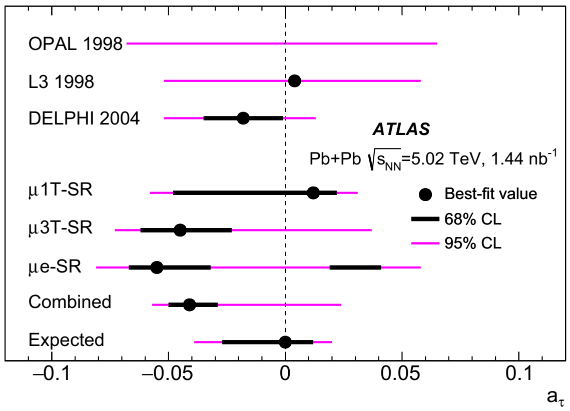

FIG. 2. Measurements of a_τ from fits to individual signal regions (including the dimuon control region) and from the combined fit. These are compared with existing measurements from the OPAL [29], L3 [30], and DELPHI [27] experiments at LEP. A point denotes the best-fit a_τ value for each measurement if available, while thick black (thin magenta) lines show 68% CL (95% CL) intervals. The expected interval from the ATLAS combined fit is also shown.

two implementations is found to be negligible, and no further systematic uncertainty is assigned.

The uncertainty in the integrated luminosity is 1.9%, obtained with the LUCID-2 detector [82] using methods similar to Ref. [83] for the primary luminosity measurements.

After applying the event selection, a total of 532, 85, and 39 data events are observed, compared with 84 ± 19, 9 ± 3, and 2.8 ± 0.7 expected background events in μ1T-SR, μ3T-SR, and μe-SR, respectively. The background-only hypothesis is rejected with significance exceeding 5σ, establishing the observation of the $\gamma\gamma \to \tau\tau$ process at ATLAS. The signal significance is highest in μ1T-SR, while μe-SR has the largest signal-to-background ratio. The prefit signal-plus-background hypothesis predicts 543 ± 111, 93 ± 20, and 35 ± 8 events in μ1T-SR, μ3T-SR, and μe-SR, respectively, which is compatible with the observed data. The signal strength $\mu_{\tau\tau}$, defined as the ratio of the observed signal yield to the SM expectation assuming the SM value for a_τ, is measured using a profile-likelihood fit [84,85] to be $\mu_{\tau\tau} = 1.03^{+0.06}_{-0.05}(\mathrm{tot}) = 1.03^{+0.05}_{-0.05}(\mathrm{stat})\,^{+0.03}_{-0.03}(\mathrm{syst})$. The fit uses the p_T^μ distribution in the three SRs and 2μ-CR with $\mu_{\tau\tau}$ being the only parameter of interest.

Approximately 80 nuisance parameters representing the systematic uncertainties are included in the fit. Many systematic uncertainties are correlated between the SRs and 2μ-CR, so their impact on the measurement precision is minimized since they are constrained by 2μ-CR. The dominant prefit contribution is the photon-flux uncertainty, which mainly affects the signal yield (by approximately 20%), with a significantly smaller impact on the signal shape found upon decorrelation from the normalization component. After the fit, the photon-flux uncertainty becomes subdominant and luminosity uncertainty becomes negligible relative to other sources. The leading contributions to the total systematic uncertainty are the estimation of the muon trigger efficiency, τ-lepton decay modeling, and track reconstruction efficiency.

To measure a_τ, an alternative fit is performed where a_τ is the only free parameter using the p_T^μ distribution in the three SRs and 2μ-CR; p_T^μ is chosen because of its high sensitivity to a_τ [46]. Simulated signal samples with various a_τ values are employed. In the nominal sample, a_τ is set to its SM value. Signal templates for alternative a_τ hypotheses are obtained by reweighting the nominal sample in three dimensions, differentially in $\tau\tau$ invariant mass, $\tau\tau$ rapidity, and rapidity difference between the two τ leptons, according to calculations from Ref. [46]. These calculations parametrize the $\tau\tau\gamma$ coupling by $F_1(q^2)\gamma^\mu + F_2(q^2)(i/2m_\tau)\sigma^{\mu\nu}q_\nu$, where q_ν is the photon four-momentum, $\sigma^{\mu\nu} = i[\gamma^\mu, \gamma^\nu]/2$ the spin tensor, and the form factors satisfy $F_1(q^2 \to 0) = 1$ and $F_2(q^2 \to 0) = a_\tau$. A similar parametrization was used in previous LEP measurements [27,29,30], which exploits the near-zero virtuality of initial-state photons. A total of 14 templates for different a_τ values are created to model the dependence of the p_T^μ distribution on a_τ in the three SRs.

Figure 1 shows the p_T^μ distributions of the four analysis regions for the data and postfit expectation. The fit describes the data well.

The best-fit value of a_τ is $a_\tau = -0.041$, with the corresponding 68% and 95% confidence level (CL) intervals being $(-0.050, -0.029)$ and $(-0.057, 0.024)$, respectively. The higher-than-expected observed yields lead to the highly asymmetric 95% CL interval. This arises from the nearly quadratic signal cross section dependence on a_τ, caused by the interference of the SM and BSM amplitudes [29,30,46]. The expected 95% CL interval is $-0.039 < a_\tau < 0.020$. The impact of systematic uncertainties on the final results is small relative to statistical uncertainties. Figure 2 shows the a_τ measurement alongside previous results obtained at LEP. The precision of this measurement is similar to the most precise single-experiment measurement by the DELPHI Collaboration.

In summary, τ-lepton-pair production in ultraperipheral heavy-ion collisions, $\mathrm{Pb+Pb} \to \mathrm{Pb}(\gamma\gamma \to \tau\tau)\mathrm{Pb}$, is observed by ATLAS with a significance exceeding 5σ in 1.44 nb^{-1} of $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV data at the LHC. The observed event yield is compatible with that expected from the SM prediction within uncertainties. The events are used to set constraints on the τ-lepton anomalous magnetic moment, corresponding to $-0.057 < a_\tau < 0.024$ at 95% CL. The measurement precision is limited by statistical uncertainties. This result introduces the use of hadron-collider data to test electromagnetic properties of the τ lepton, and the results are competitive with existing lepton-collider constraints.

We thank CERN for the very successful operation of the LHC, as well as the support staff from our institutions without whom ATLAS could not be operated efficiently. We acknowledge the support of ANPCyT, Argentina; YerPhI, Armenia; ARC, Australia; 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; MEiN, 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, Taiwan; TENMAK, Turkey; STFC, United Kingdom; DOE and NSF, U.S. In addition, individual groups and members have received support from BCKDF, CANARIE, Compute Canada, and CRC, Canada; PRIMUS 21/SCI/017 and UNCE SCI/013, Czech Republic; COST, ERC, ERDF, Horizon 2020 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 programs cofinanced by EU-ESF and the Greek NSRF, Greece; BSF-NSF and MINERVA, Israel; Norwegian Financial Mechanism 2014-2021, Norway; NCN and NAWA, Poland; La Caixa Banking Foundation, CERCA Programme Generalitat de Catalunya, and PROMETEO and GenT Programs Generalitat Valenciana, Spain; Göran Gustafssons Stiftelse, Sweden; The Royal Society and Leverhulme Trust, United Kingdom. The crucial computing support from all WLCG partners is acknowledged gratefully, in particular from CERN, the ATLAS Tier-1 facilities at TRIUMF (Canada), NDGF (Denmark, Norway, Sweden), CC-IN2P3 (France), KIT/GridKA (Germany), INFN-CNAF (Italy), NL-T1 (Netherlands), PIC (Spain), ASGC (Taiwan), RAL (UK), and BNL (U.S.), the Tier-2 facilities worldwide, and large non-WLCG resource providers. Major contributors of computing resources are listed in Ref. [86].

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