

Observation of the $\gamma\gamma \rightarrow \tau^+\tau^-$ production in PbPb collisions with the CMS experiment

Matthew Nickel on behalf of the CMS Collaboration

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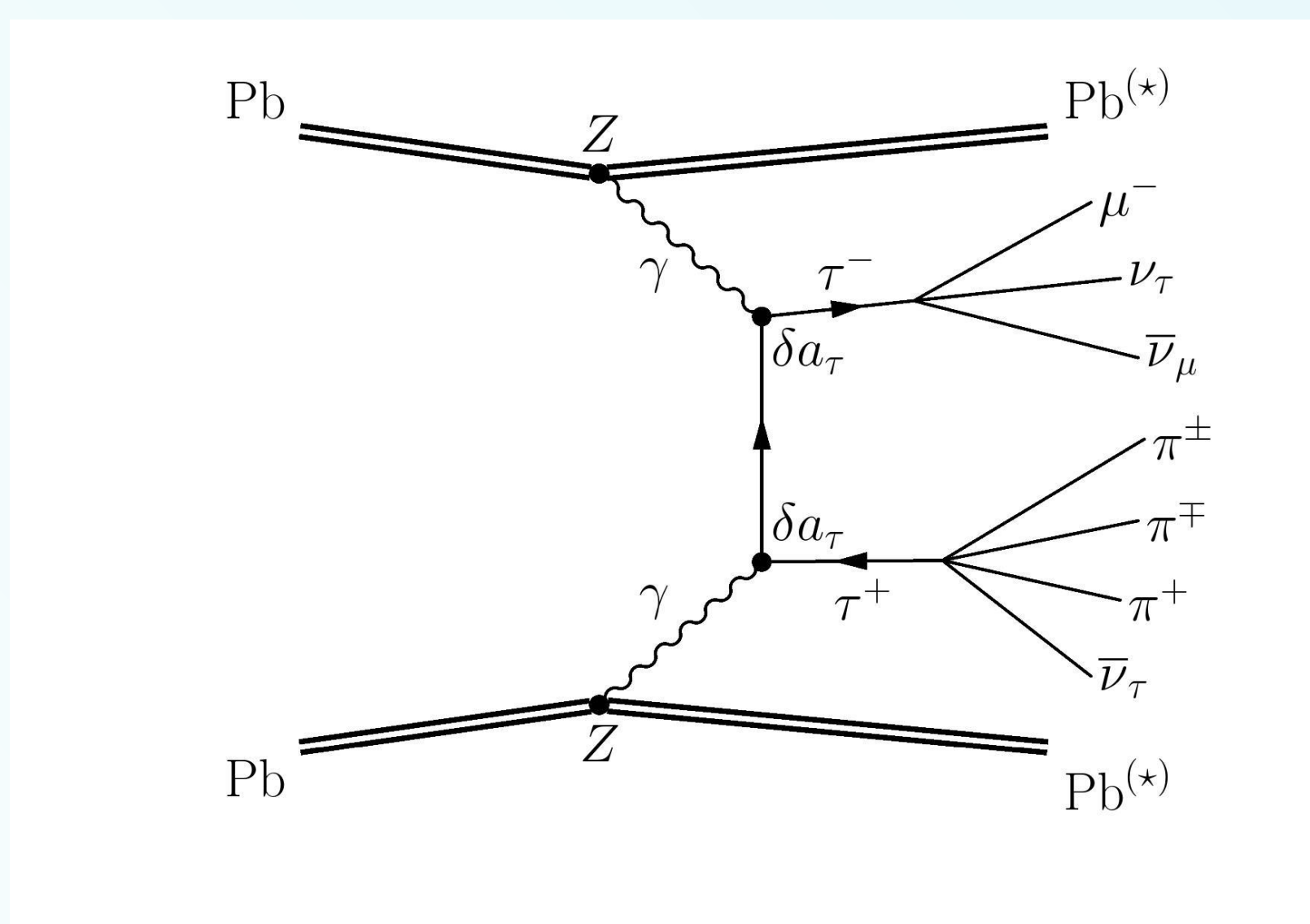
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Abstract

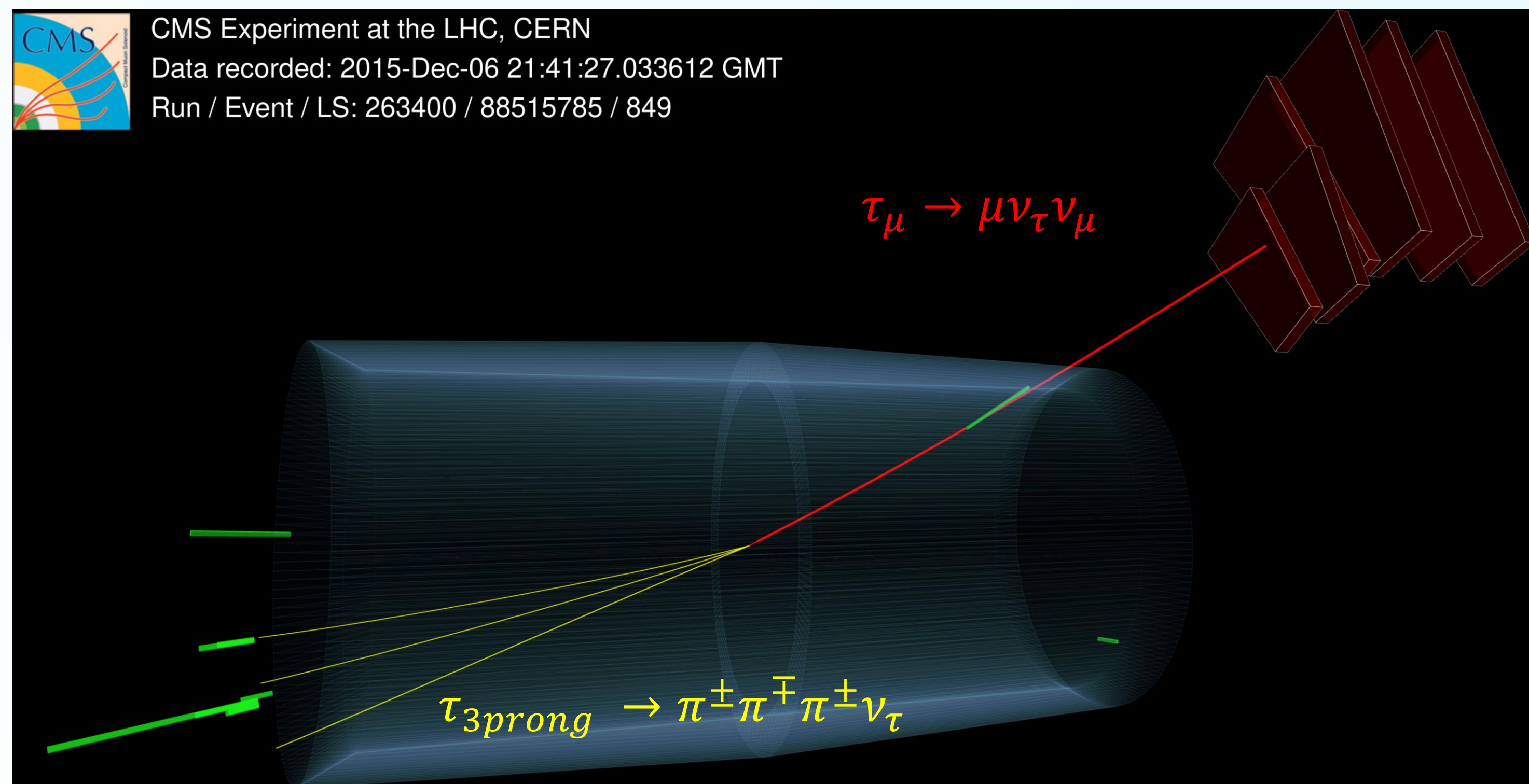
We present an observation of photon-photon production of τ lepton pairs in ultra-peripheral lead-lead collisions. The measurement is based on a data sample with an integrated luminosity of $404 \mu\text{b}^{-1}$ collected by the CMS experiment at the nucleon nucleon center-of-mass energy of 5.02 TeV. The $\gamma\gamma \rightarrow \tau^+\tau^-$ process is observed for $\tau^+\tau^-$ events with a muon and three charged hadrons in the final state. The measured fiducial cross section is $\sigma(\gamma\gamma \rightarrow \tau^+\tau^-) = 4.8 \pm 0.6(\text{stat}) \pm 0.5(\text{syst}) \mu\text{b}$, in agreement with leading-order QED predictions. Using $\sigma(\gamma\gamma \rightarrow \tau^+\tau^-)$, we estimated a model-dependent value of the anomalous magnetic moment of the τ lepton of $a_\tau = 0.001_{-0.089}^{+0.055}$ at a 68% confidence level.

Motivations

- Muon g-2 measurements had new results in the past few years that challenge the standard model predictions potentially leading to new physics.
- If the new physics is due to a massive new particle, then the tau lepton would be over 200 times more sensitive to new physics than the muon.
- Tau g-2 can be deduced using $\gamma\gamma \rightarrow \tau^+\tau^-$ cross section using ultra-peripheral heavy ion collisions.



Event Selection

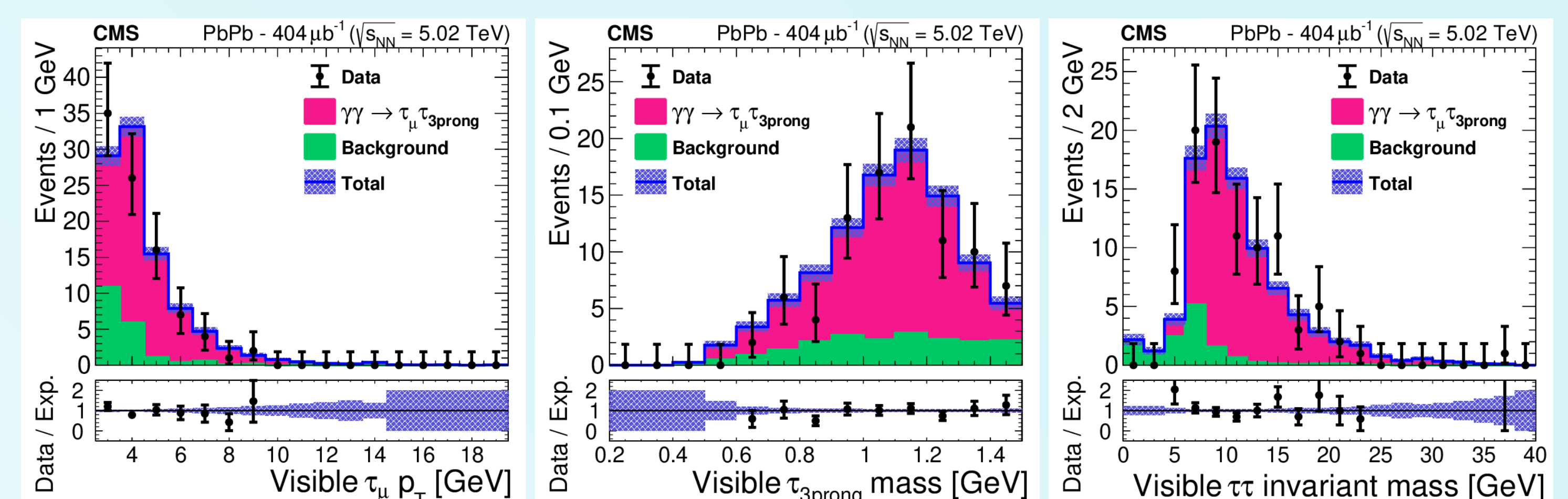


- Using the 2015 Pb-Pb Ion Data with a trigger requiring 1 muon, at least 1 track in the pixel detector and no HF activity in at least one side.
- The signal region consists of 1 muon and 3 charged hadrons.
- Selections are shown in the table.
- The background was estimated with the ABCD method with background regions with more charged hadrons and higher HF activity.

Muon selection	$p_T > 3.5 \text{ GeV}$ for $ \eta < 1.2$ $p_T > 2.5 \text{ GeV}$ for $1.2 < \eta < 2.4$
Pion selection	$p_T > 0.5 \text{ GeV}$ for the leading $p_T > 0.3 \text{ GeV}$ for the (sub-)subleading $ \eta < 2.5$
$\tau_{3\text{prong}}$ selection	$p_T^{\text{vis}} > 2 \text{ GeV}$ and $0.2 < m_\tau^{\text{vis}} < 1.5 \text{ GeV}$

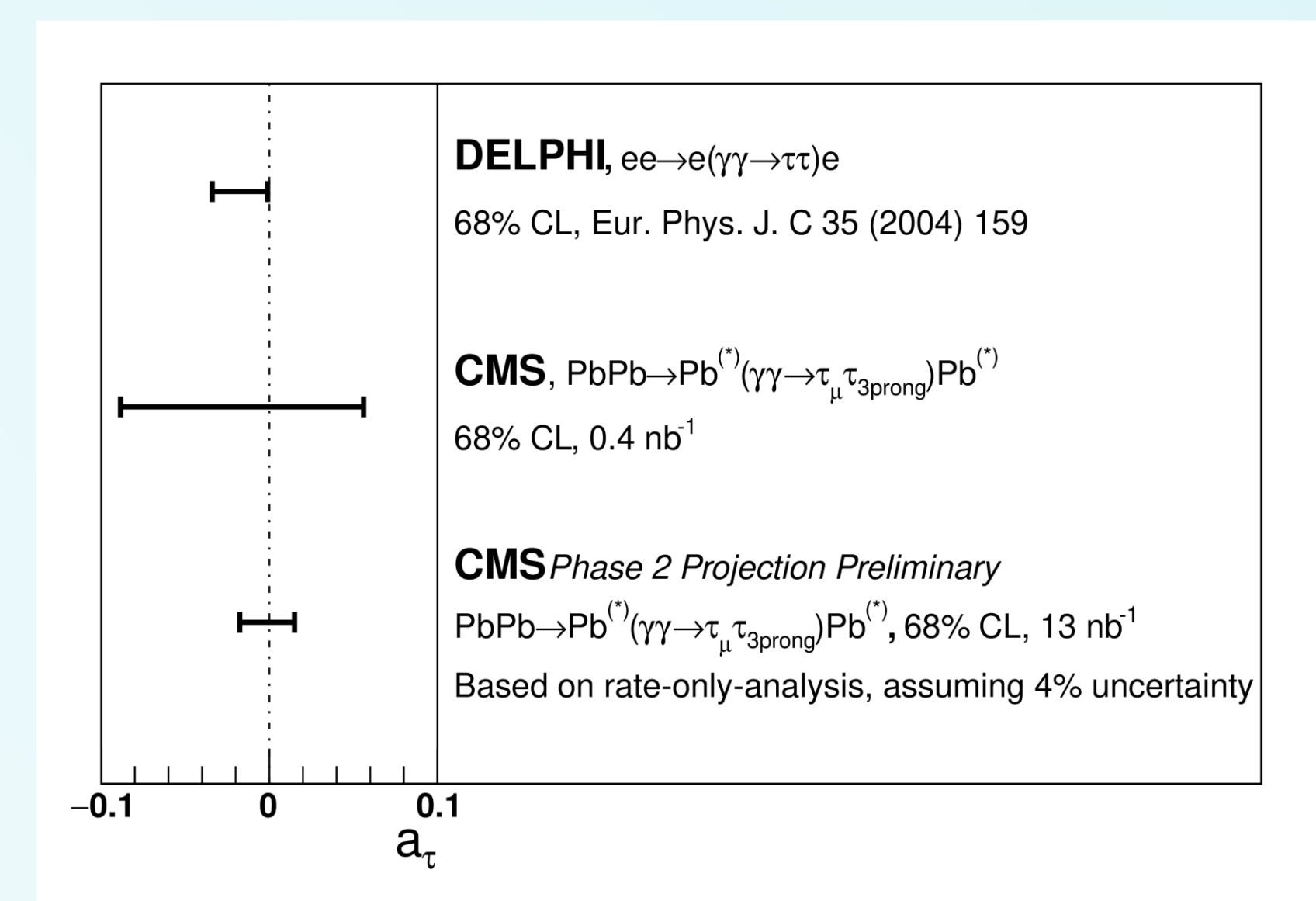
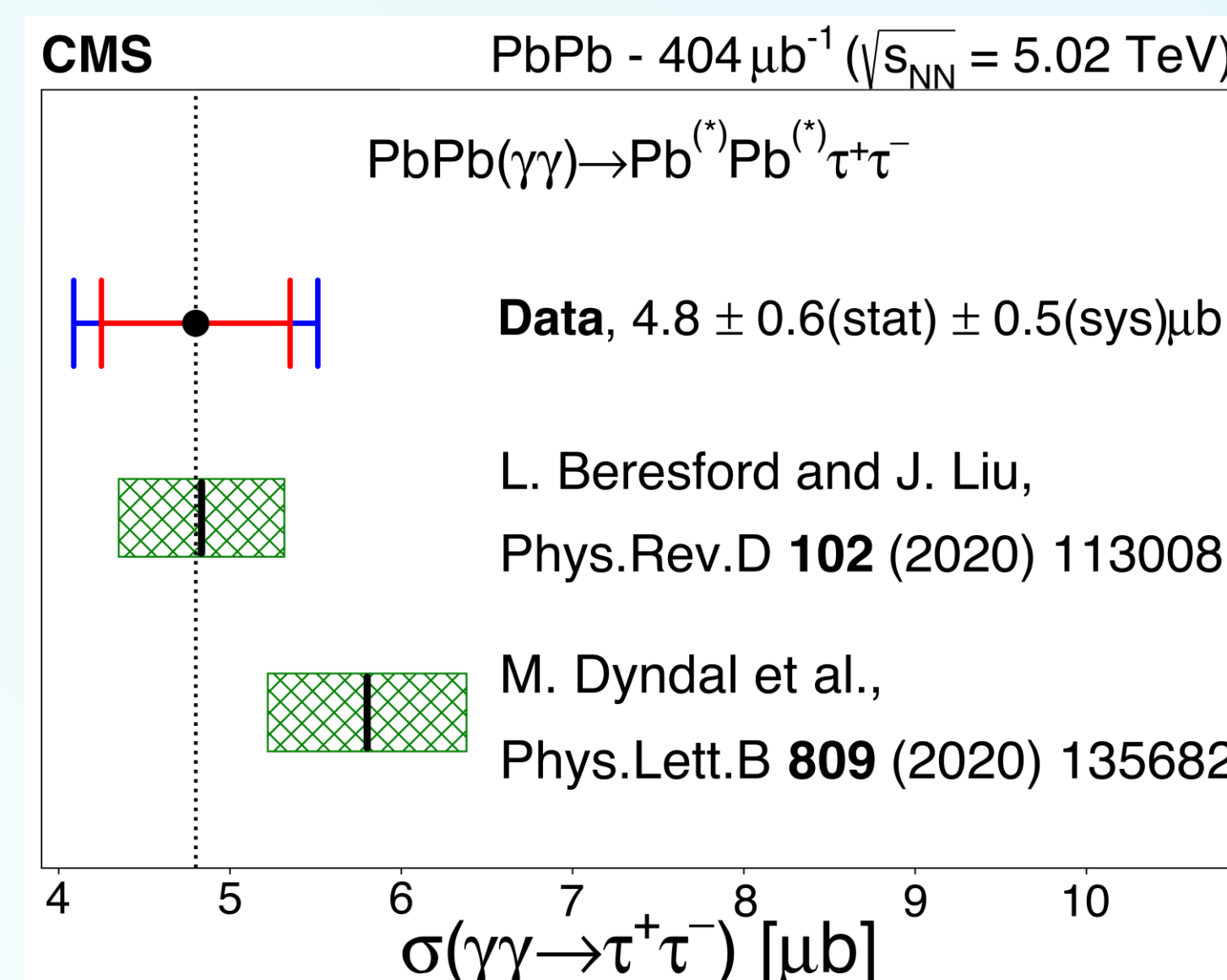
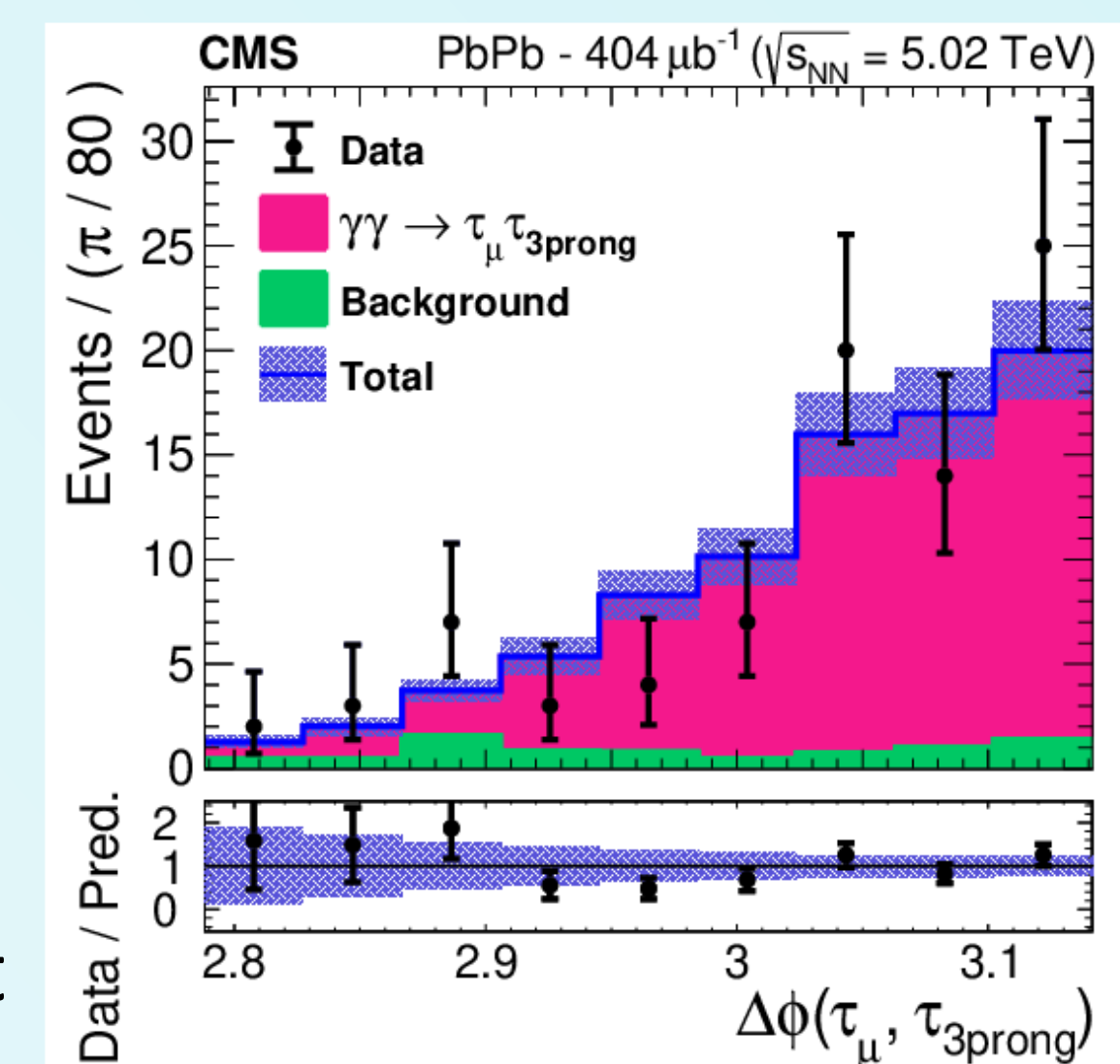
Signal and Background Events

- Figures below show the control plots for the leptonic τ , hadronic τ and $\tau^+\tau^-$ system.
- Control plots show great agreement between MC and Data.



Results and Conclusion

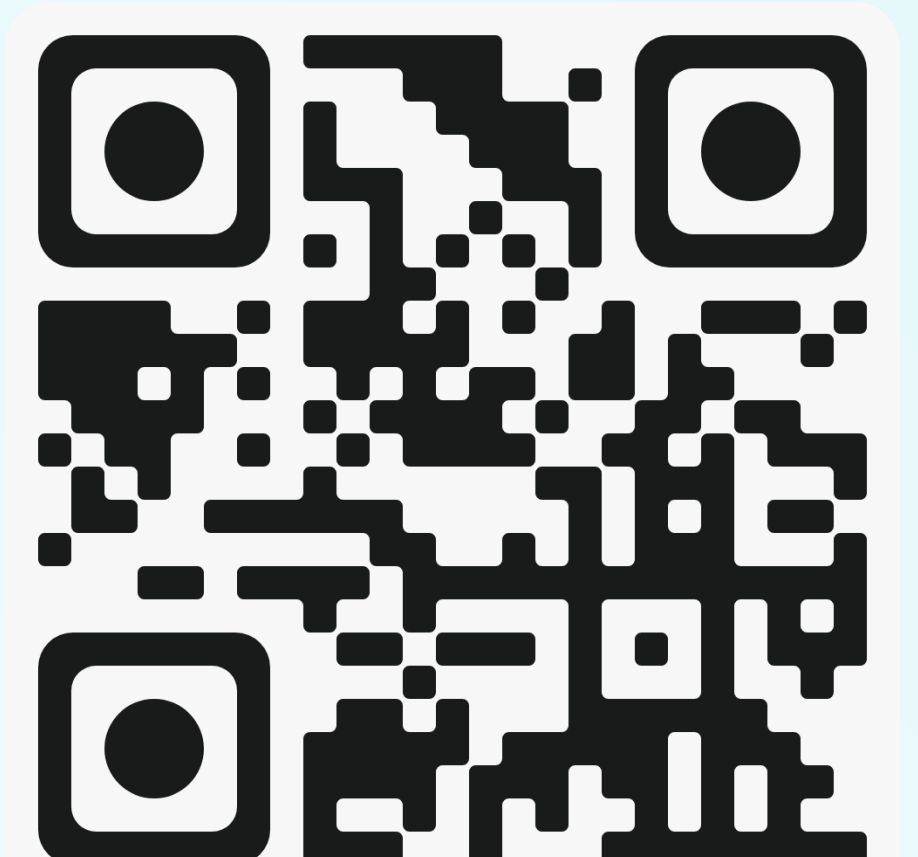
- Signal yield calculated by binned likelihood fit of $\Delta\phi$ (angular separation in transverse plane).
- Post Fit signal events: 77 ± 12
- $\sigma(\gamma\gamma \rightarrow \tau^+\tau^-) = \frac{N_{\text{sig}}}{2\epsilon L_{\text{int}} B_{\tau_\mu} B_{\tau_{3\text{prong}}}}$
- $L = 404 \mu\text{b}$, $B_{\tau_\mu} = 17.89\%$, $B_{\tau_{3\text{prong}}} = 14.55\%$, $\epsilon = 78.5\%$
- $\sigma(\gamma\gamma \rightarrow \tau^+\tau^-) = 4.8 \pm 0.6(\text{stat}) \pm 0.5(\text{syst}) \mu\text{b}$
- With the HL-LHC, the cross-section measurement should be able to discriminate between models the tau anomalous magnetic moment.



Acknowledgements

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For More Details



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