Shining Light on Dark Matter, One Photon at a Time

by

Brandon Leigh Allen

Submitted to the Department of Physics
in partial fulfillment of the requirements for the degree of

Doctorate of Science in Physics

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2019

Author . . . .
Department of Physics
May 18, 2019

Certified by . . . .
Christoph E.M. Paus
Professor
Thesis Supervisor

Accepted by . . . .
Arthur C. Smith
Chairman, Department Committee on Graduate Theses

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Abstract

A search is conducted for new physics in final states containing a photon and missing transverse momentum in proton-proton collisions at $\sqrt{s} = 13$ TeV. The data collected by the CMS experiment at the CERN LHC correspond to an integrated luminosity of 35.9 inverse femtobarns. No deviations from the predictions of the standard model are observed. The results are interpreted in the context of dark matter production and limits on new physics parameters are calculated at 95% confidence level. For the two simplified dark matter production models considered, the observed (expected) lower limits on the mediator masses are both $950\,(1150)\,GeV$ for $1\,GeV$ dark matter mass.

Thesis Supervisor: Christoph E.M. Paus
Title: Professor

Acknowledgments

This is the acknowledgements section. You should replace this with your own acknowledgements.

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Using the transfer factor $R^{Z}_{\ell\ell}$, the total estimated event yield $T_{\ell\ell}$ in each dilepton control region in the i^{th} bin of the E_{T} distribution can be expressed as

$$T_{\ell\ell,i} = \frac{N^{Z}_{i}}{R^{Z}_{\ell\ell,i}} + b_{\ell\ell,i}, \tag{5.1}$$

where N^{Z} is the number of $Z(\rightarrow)+$ events in the combined signal regions and $b_{\ell\ell}$ is the predicted contribution from other background sources in the dilepton control region, namely $t\bar{t}$ VV, and misidentified hadrons. The subscript i indicates that the quantities are evaluated in bin i of the E_{T}distribution.

Using R^{W}_{ℓ} and f^{Z}_{W}, the total estimated event yield T_{ℓ} in each single-lepton control region in the ith bin of the E_{T} distribution can be expressed as

$$T_{\ell,i} = \frac{N^{Z}_{i}}{R^{W}_{\ell,i} f^{Z}_{W,i}} + b_{\ell,i}, \tag{5.2}$$

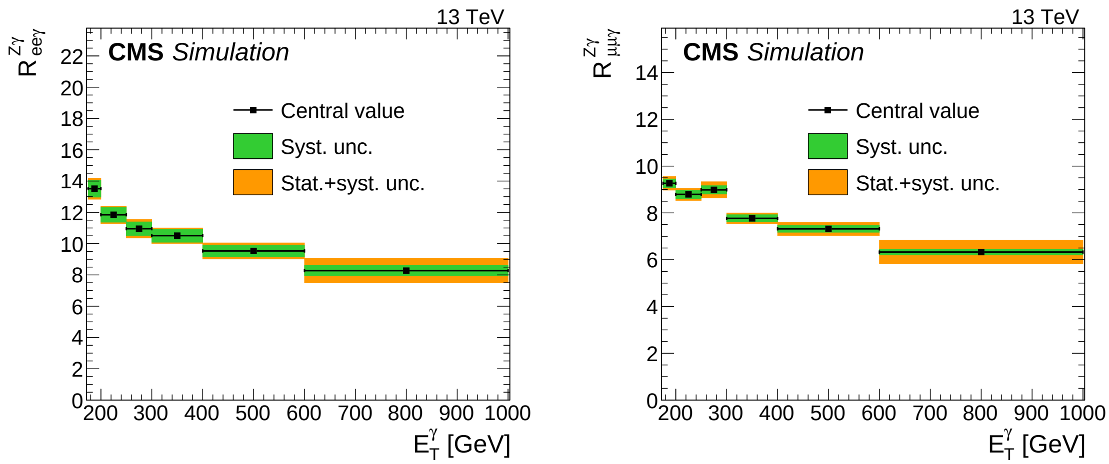

Figure 5-1: Transfer factors R^Z_{ee} (left) and $R^Z_{\mu\mu}$ (right). The uncertainty bands in green (inner) and orange (outer) show the systematic uncertainty, and the combination of systematic and statistical uncertainty arising from limited MC sample size, respectively. The systematic uncertainties considered are the uncertainties in the data-to-simulation correction factors ρ for the lepton identification efficiencies. Simulated $Z(\rightarrow \ell\bar{\ell})+$ events are generated in two samples, one with generated E_T required to be greater than 300 GeV, and one with a looser restriction. The E_T bin centred at 270 GeV is close to the boundary between the two samples, where there are fewer generated events. The relatively large statistical fluctuation visible in the third bin of the right-hand figure results from this.

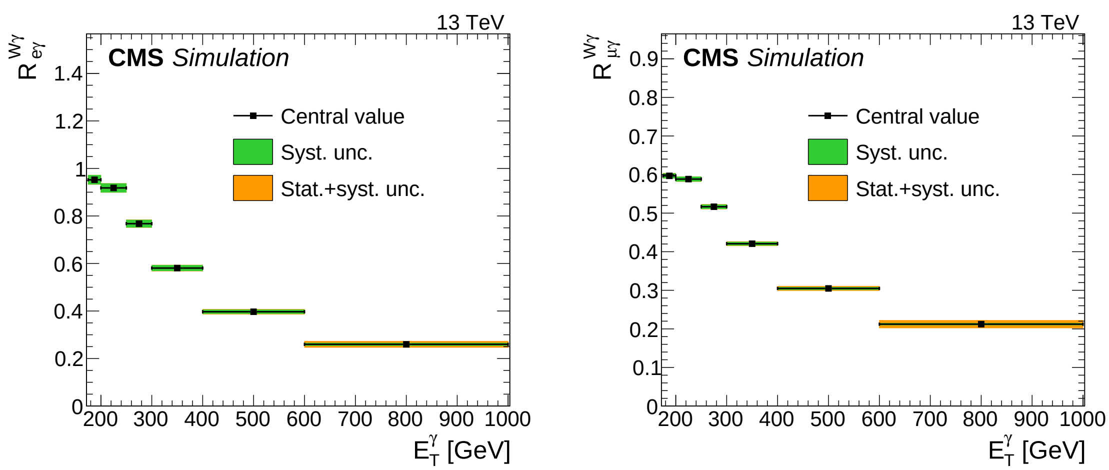

Figure 5-2: Transfer factors R^W_e (left) and R^W_μ (right). The uncertainty bands in green (inner) and orange (outer) show the systematic uncertainty, and the combination of systematic and statistical uncertainty arising from limited MC sample size, respectively. The systematic uncertainties considered are the uncertainties in the data-to-simulation correction factors ρ for the lepton identification efficiencies.

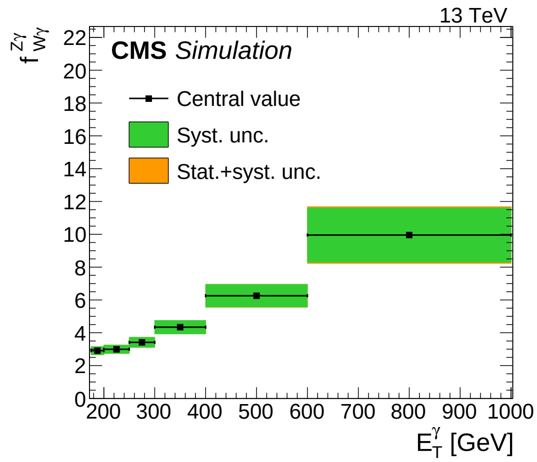

Figure 5-3: Transfer factor f_W^Z. The uncertainty bands in green (inner) and orange (outer) show the systematic uncertainty, and the combination of systematic and statistical uncertainty arising from limited MC sample size, respectively. The systematic uncertainties considered are the uncertainties from higher-order theoretical corrections.

where b_ℓ is the predicted contribution from other background sources in the single-lepton regions, namely misidentified electrons and hadrons and other minor SM processes.

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