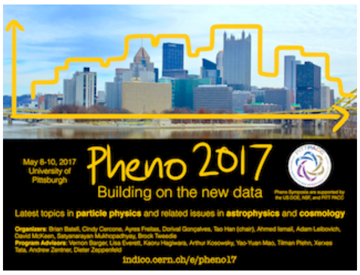

Contribution ID: **436** Type: **parallel talk**

Using the (Modified) Matrix Element Method to constrain L_mu - L_tau Interactions

Monday 8 May 2017 18:30 (15 minutes)

In this paper, we explore the discriminatory power of the matrix element method in constraining the $L_\mu - L_\tau$ model at the LHC. The Z' boson associated with the spontaneously broken $U(1)_{L_\mu - L_\tau}$ symmetry only interacts with the second and third generation of leptons, and is thus difficult to produce at the LHC. We argue that the best channels for discovering this Z' are in $Z \to 4\mu$ and 2μ+MET. Both these channels have a large number of independent observables, which strongly motivates the usage of a multivariate technique. The matrix element method (MEM) is a multivariate analysis that uses the squared matrix element $|\mathcal{M}|^2$ to quantify the likelihood of the testing hypotheses. As the computation of the $|\mathcal{M}|^2$ requires knowing the initial and final state momenta and the model parameters, it is not commonly used in new physics searches. While conventionally new parameters are estimated by maximizing the likelihood of the signal with respect to the background, we outline scenarios in which this process is (in)effective. We illustrate that the new parameters can be determined by studying the $|\mathcal{M}|^2$ distributions, and even if our estimation is off, we may gain better sensitivity than cut-and-count methods. Additionally, unlike conventional MEM techniques that integrate over unknown momenta in processes with MET, we may estimate these momenta, depending on the process topology. This procedure, which we refer to as the "modified squared matrix element", is computationally much faster than the canonical matrix element method, but also possibly less effective in the signal-background discrimination. Using MEM, we can improve our sensitivity by about an order of magnitude compared with the cut-and-count method for the same amount of data.

Summary

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Session Classification: BSM II