

Signal Study of the Pair Production of Z' Bosons Decaying to Dark Matter and Boosted Jets at CMS

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This study aims to develop a search for dark matter (DM) in a signature of missing transverse energy and jets in the CMS detector at the Large Hadron Collider at CERN. We study the generation of a simplified model for the pair production of spin-1 Z' bosons, with one of them decaying into a pair of DM particles. The signal events are generated via MadGraph, in the LHE (Les Houches Event) file format, and their kinematics are studied.

Introduction

If non-gravitational interactions occur between DM and SM particles, the DM particles could be produced in the high-energy proton-proton collisions of the Large Hadron Collider (LHC).

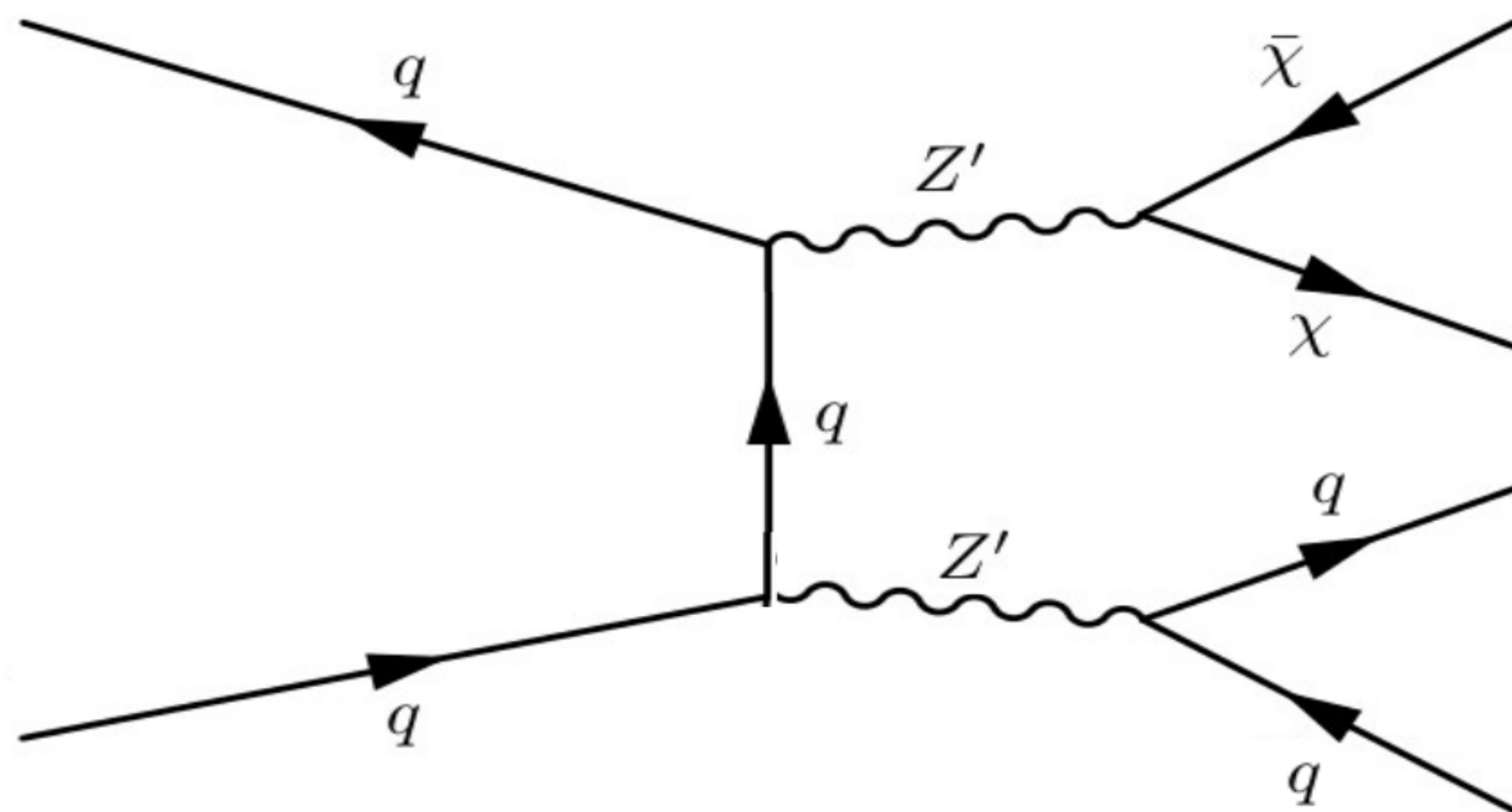


Figure 1: Feynman diagram of Mono- Z' model.

The new signal process in this study is the pair production of Z' bosons, where one of them decays to DM particles while the other decays to SM quarks.

If the Z' boson is sufficiently energetic, quarks coming from its decay will get reconstructed into a single jet.

Methodology

We generate the Z' assuming a minimal decay width, a coupling to quarks $g = 0.25$, and a coupling to DM $g_{\text{chi}}^P = 1.0$.

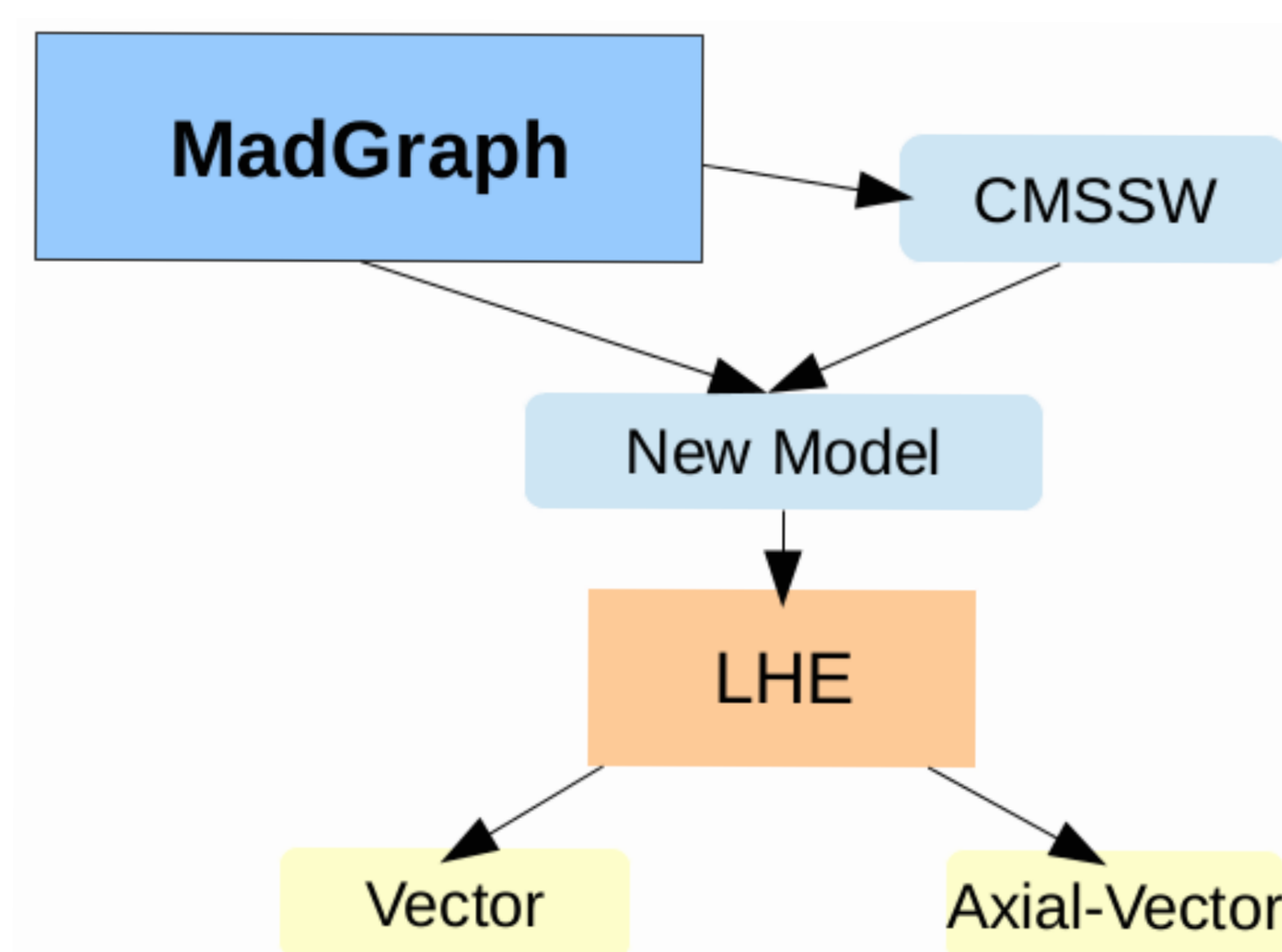


Figure 2: Graphic representation of the methodology process.



Figure 3: Graphic representation of data process.

χ	Mediator (Z')										
1	10	100	300	500	750	1000	1500	1750	2000	2250	2500
10								1750	2000	2250	
50		100									
100			300					1750	2000	2250	
150				500				1750	2000	2250	
200		100		500				1750	2000	2250	
300			300	500	750	1000	1500	1750	2000	2250	
400			300			1000		1750	2000	2250	2500
500				500				1750	2000	2250	
600					750	1000	1500				2500
700											2500

Figure 4: Hypotheses masses for mediator and DM particles.

Results

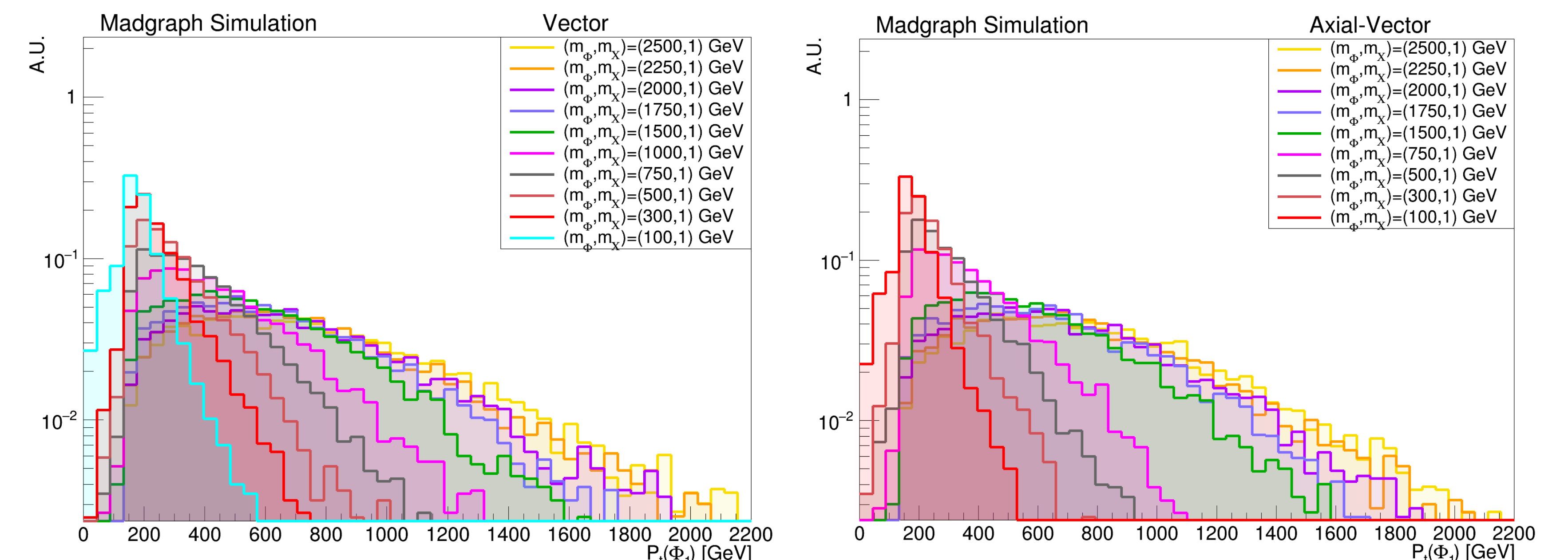


Figure 6: Distribution for the signal model $p p \rightarrow x d x d^{\sim} y_1$ for Vector and Axial-Vector with 1GeV DM.

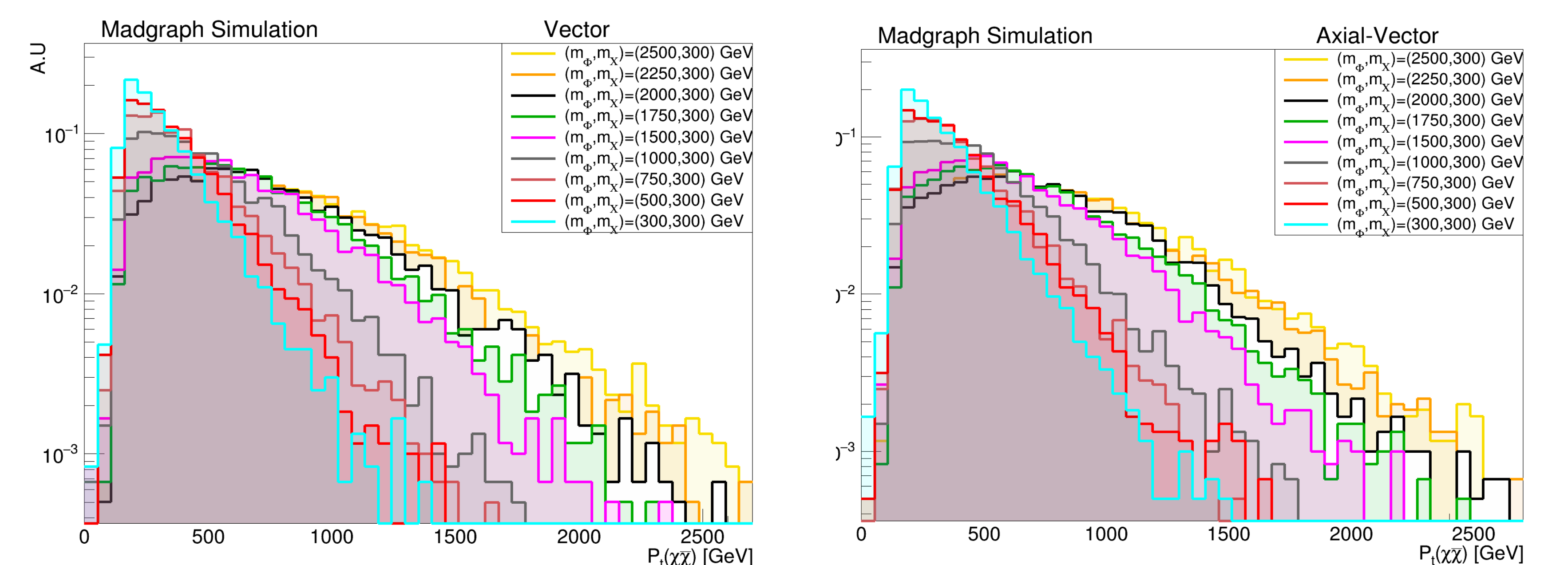


Figure 7: Distribution for the signal model $p p \rightarrow x d x d^{\sim} y_1$ for Vector and Axial-Vector with 300GeV DM.

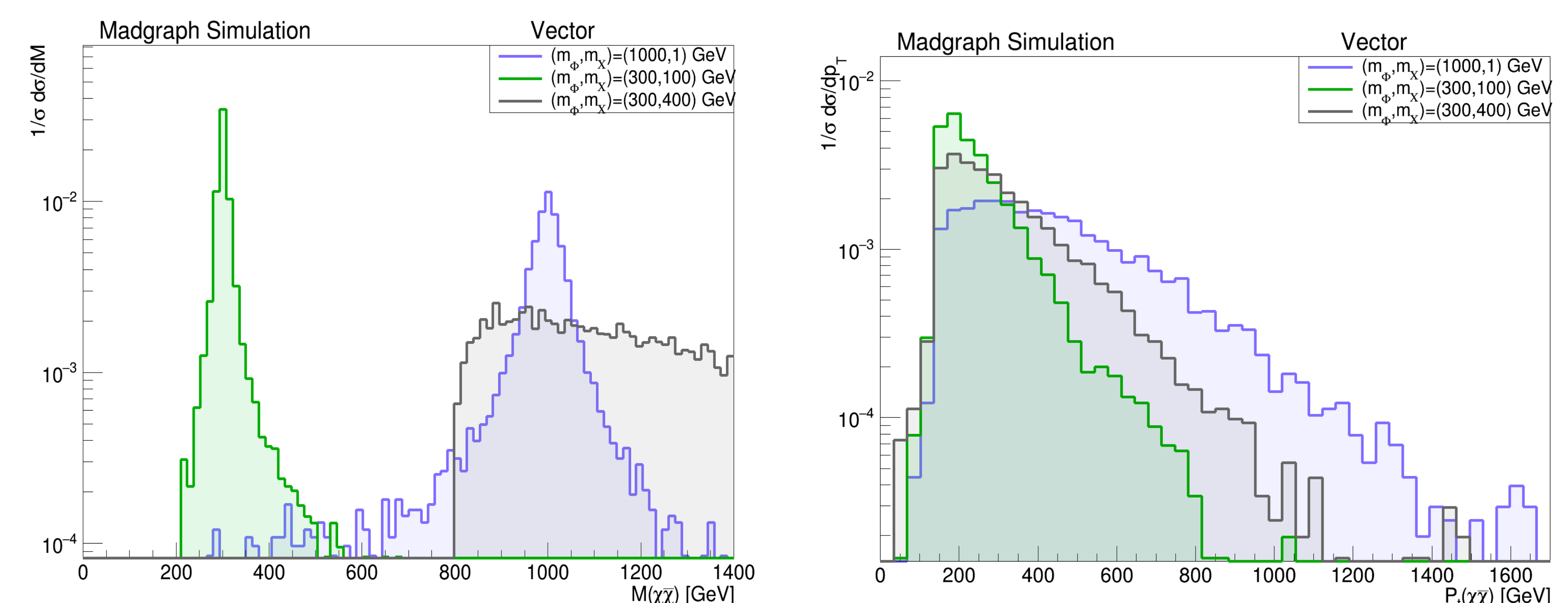


Figure 8: Distribution for the signal model $p p \rightarrow x d x d^{\sim} y_1$ for kinematic distributions.

Next Steps

To use the new generated samples in a search with CMS data, the LHE events will be hadronized with Pythia 8 and will be passed through the CMS detector simulation.

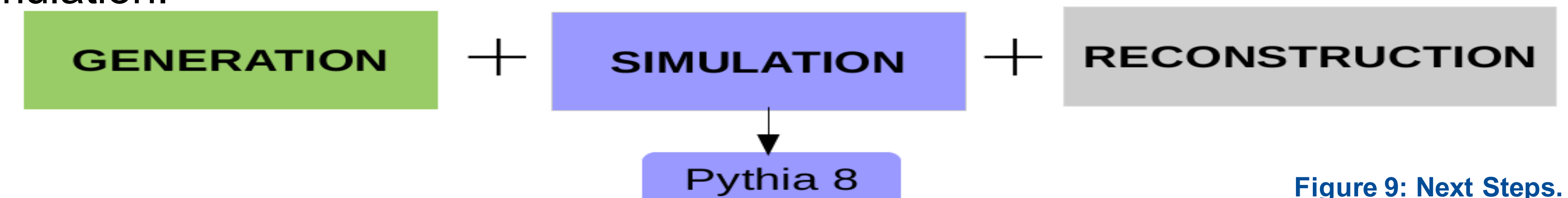


Figure 9: Next Steps.

Conclusion

We generated a model for Z' pair production and considered the case where one Z' decays to DM and the other to SM quarks. The principal kinematic variables were analyzed and validated, which allows us to move forward to a full search for this process in LHC collision data collected by the CMS detector.