

# Validation of the **MadAnalysis 5** implementation of CMS-EXO-16-052

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December 8, 2017

## 1 INTRODUCTION

## 2 SIMULATION DETAILS

Selections	MG5	Offical
cut1	0.9	0.9
cut2	0.9	0.9
cut3	0.9	0.9
cut4	0.9	0.9

Table 1: Cut flows, expressed in terms of efficiencies, for three signal samples in signal region SR2jl

## 3 RESULTS

### 3.1 Cut-flow

### 3.2 Various Samples

Theory  $\sigma$  is the cross-section output from MadGraph.

The efficiency is determined from the fraction of events reconstructed by Delphes and passing the analysis cuts into the signal region.

$N_{exp}$  is the number of events resulting from the expected cross-section and efficiency for the CMS analysis using  $34 \text{ fb}^{-1}$ .

The exclusion limit is determined by taking the 95% C.L. upper limit based on the number of expected events and the results of CMS

Sample	$\sigma$ Cross Section (pb)	Efficiency	$N_{Expected}$
./Samples/DMSimp_s_spin1-axial_0j.txt	0.021318904968	0.1272	97.3523531583
./Samples/DMSimp_s_spin1-axial_ee_0j.txt	0.010659482475	0.0978	37.4256561594
./Samples/DMSimp_s_spin1-axial_mm_0j.txt	0.010659482475	0.1481	56.6742298283
./Samples/DMSimp_s_spin1-vector_0j.txt	0.0393553945622	0.1227	173.357758169
./Samples/DMSimp_s_spin1-vector_0j_qcd.txt	0.06788	0.1251	304.8551892
./Samples/DMSimp_s_spin1-vector_1j.txt	0.0666819164253	0.0752	180.037839919
./Samples/DMSimp_s_spin1-vector_1j_qcd.txt	0.1251	0.1125	505.082719261
./Samples/DMSimp_s_spin1-vector_ee_0j.txt	0.0196775973111	0.1003	70.8545020699
./Samples/DMSimp_s_spin1-vector_mm_0j.txt	0.0196775973111	0.1572	111.050126873

Figure 1: Samples of spin-1 axial and vector DM models. 0j is for events generated without extra partons generated by MAdGraph, 1j for is for 1 extra parton generated by MadGraph, and QCD is including QCD NLO calculations in the MadGraph calculation. ee is for Z to electrons only, mm for muons, otherwise both the electron and muon channels are generated.

## 4 CONCLUSION

Sample	Cross Section (pb)	Eff.	Expected	Exclusion (sigma/sigma <sub>0</sub> )
Run 30/10/2017				
./Samples/DMsimp.s.spin0P_0j_1000_1.txt	5.28328517293 (-06)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0P_0j_100_1.txt	5.29581021579 (-05)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0P_0j_10_1.txt	9.81497810099 (-05)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0P_0j_500_1.txt	2.10019490453 (-05)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0P_0j_50_1.txt	8.02167613779 (-05)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_1000_1.txt	6.46834888936 (-06)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_100_1.txt	9.65746285084 (-05)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_10_1.txt	0.00028727155715	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_500_1.txt	2.66324370678 (-05)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_50_1.txt	0.000177391817776	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0_default.txt	6.50211256127 (-06)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin1-axial_0j.txt	0.021318904968	0.1272	97.3523531583	0.864208980016
./Samples/DMsimp.s.spin1-axial_ee_0j.txt	0.010659482475	0.0978	37.4256561594	2.24554648455
./Samples/DMsimp.s.spin1-axial_mm_0j.txt	0.010659482475	0.1481	56.6742298283	1.48558733966
./Samples/DMsimp.s.spin1-vector_0j.txt	0.0393553945622	0.1227	173.357758169	0.484974465556
./Samples/DMsimp.s.spin1-vector_0j_10_1.txt	0.299915034487	0.0076	81.8288180094	1.02663162079
./Samples/DMsimp.s.spin1-vector_0j_50_1.txt	0.217641714014	0.0263	205.490777121	0.410468667038
./Samples/DMsimp.s.spin1-vector_0j_100_1.txt	0.168503454019	0.0490	296.414425965	0.283063751571
./Samples/DMsimp.s.spin1-vector_0j_500_1.txt	0.0419776079768	0.1291	194.553199914	0.430585232638
./Samples/DMsimp.s.spin1-vector_0j_1000_1.txt	0.0112635212815	0.1509	61.0179864735	1.37606381584
./Samples/DMsimp.s.spin1-vector_0j_qcd.txt	0.06788	0.1251	304.8551892	0.275613171719
./Samples/DMsimp.s.spin1-vector_1j.txt	0.0666819164253	0.0752	180.037839919	0.469328247868
./Samples/DMsimp.s.spin1-vector_1j_qcd.txt	0.1251	0.1125	505.082719261	0.166834705882
./Samples/DMsimp.s.spin1-vector_1j_qcd.Qcut10.txt	0.1251	-1.0000	-4491.09	ERR
./Samples/DMsimp.s.spin1-vector_1j_qcd.Qcut100.txt	0.1251	-1.0000	-4491.09	ERR
./Samples/DMsimp.s.spin1-vector_ee_0j.txt	0.0196775973111	0.1003	70.8545020699	1.1868190876
./Samples/DMsimp.s.spin1-vector_mm_0j.txt	0.0196775973111	0.1572	111.050126873	0.759155804105
Run 30/11/2017				
./Samples/DMsimp.s.spin0P_0j_1000_1.txt	5.28486997514 (-06)	0.0064	0.00121425172549	69140.5077591
./Samples/DMsimp.s.spin0P_0j_100_1.txt	5.29739882874 (-05)	0.0181	0.0344219678493	2447.54969572
./Samples/DMsimp.s.spin0P_0j_100_1_QCD.txt	0	-1.0000	-0.0	99999.9996275
./Samples/DMsimp.s.spin0P_0j_10_1.txt	9.8179223129 (-05)	0.0024	0.00845912186479	9942.6415468
./Samples/DMsimp.s.spin0P_0j_10_1_QCD.txt	0.0001969	-1.0000	-7.06871	ERR
./Samples/DMsimp.s.spin0P_0j_500_1.txt	2.10082494163 (-05)	0.0126	0.00950287154097	8841.97930621
./Samples/DMsimp.s.spin0P_0j_50_1.txt	8.0240824427 (-05)	0.0077	0.0221809710964	3788.30687204
./Samples/DMsimp.s.spin0P_0j_50_1_QCD.txt	0.0001702	-1.0000	-6.11018	ERR
./Samples/DMsimp.s.spin0S_0j_1000_1.txt	6.47028916275 (-06)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_100_1.txt	9.660359773 (-05)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_10_1.txt	0.0002873577256	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_500_1.txt	2.66404256188 (-05)	0.0000	0.0	99999.9996275
./Samples/DMsimp.s.spin0S_0j_50_1.txt	0.000177445033	0.0000	0.0	99999.9996275

Figure 2: As before, with 0P and 0S being for pseudo-scalar and scalar DM models respectively.