Implementationn of LHC Run 2 Electroweak SUSY Searches within GAMBIT

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Abstract

The implementation of six LHC run 2 SUSY electroweak searches within GAMBIT is presented. GAMBIT is a global-fitting framework which attempts to remedy the absence of proper statistical statements about BSM theories of interest. The analyses probe single to multi-lepton channels and different kinematic regimes. Each search was validated thoroughly using of kinematic distributions and cutflow tables comparing GAMBIT's simulations to CMS or ATLAS reconstructed data. Through this process, certain elements of the GAMBIT code were changed to improve GAMBIT's results.

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I. INTRODUCTION

Since its inception, the Standard Model (SM) of particle physics has been greatly successful at predicting the elementary interactions of particles. However, it has fallen short of explaining certain physical phenomena. Of note, the SM does not explain the presence of dark matter, which would dominate over ordinary matter within the Universe. This leads scientists to suggest extensions to the Standard Model, called Beyond the Standard Model (BSM) theories, in order to properly model these observed behaviours.

The search for BSM physics is necessarily multi-disciplinary as observations indicative of currently unknown particle phenomena could appear in any field, whether it be particle, astro-particle or nuclear physics. Therefore, scientists must be capable of comparing results from searches within these various fields and, ultimately, combine them to determine which theories are allowed and which are not. However, providing rigorous statements about the viability of models over others is far from trivial. One needs the simultaneous predictions of the different theory observables which the different searches in question are sensitive to and full likelihood functions for all the searches [1]. One also needs to be capable of testing complete parameter spaces, not single model points, and of comparing models against each other. Global fits accomplish this and are thus one of the main scientific tools for BSM physics.

Due to the inherent difficulty of producing global fits, current BSM global fits are hardcoded to only focus on a few theories, to deal with a limited number of theory calculators datasets and observables, and use usually only one scanning algorithm. The current BSM global fit frameworks are thus inflexible and usually quite time-consuming to implement. Consequently, searches usually concentrate on individual parameter combinations for statistical analysis, such as the production of exclusion limits on the space of two particles' masses within a simplified model. In the end, there is a lack of proper statistical statements for most BSM theories of interest.

The Global and Modular Beyond-the-Standard- Model Inference Tool, GAMBIT for short, is an open-source global fitting package which attempts to fill this absence. As it names suggests, GAMBIT is made up of various physics modules, and a sampling and statistics module, ScannerBit, which interact together to provide global fits. A module of note for this report is ColliderBit, which deals with the computation of particle collider observables and likelihoods, using Monte Carlo and detector simulations.

This project will concentrate on the BSM theory of supersymmetry within the GAMBIT framework, although the work done can be used to analyze any BSM theory due to the flexility of GAMBIT. Supersymmetry, or SUSY, is one of the most heavily studied BSM theory. It predicts a bosonic partner for each SM fermion and a fermionic partner to each SM boson, as well as an additional Higgs doublet. SUSY provides a solution to many current issues within the Standard Model, like the hierarchy problem. It also naturally produces a candidate for dark matter, the lightest supersymmetric partner (LSP), which is stable and could evade detection. Generally, the LSP is believed to be the lightest of the neutralinos, $\tilde{\chi}_1^0$. Neutralinos, $\tilde{\chi}_i^0$ and, for that matter, charginos, $\tilde{\chi}_j^\pm$, are the mass eigenstates of the linear combination of the spartners of the Higgs, H^0, and electroweak bosons.

As the for-most tool for the study of particle interactions, searches for BSM physics within the Large Hadron Collider (LHC) must be taken into account by ColliderBit. The LHC is well within its second run at a centre of energy of $\sqrt{s} = 13\ TeV$. SUSY predicts that the cross-section for coloured interactions involving squarks and gluinos, would be the largest production mechanisms for SUSY processes at the LHC. However, run 1 results suggest that the SUSY coloured sector lives at TeV energies currently inaccessible. Therefore, probing the electroweak sector, by searching for the pair production of charginos and neutralinos through their decays to SM particles and the stable LSP, may be the only possibility of observing SUSY at the LHC. It is important to include the recent LHC SUSY electroweak searches within the GAMBIT code for its global fit limits to continue to be representative of current particle physics observations.

II. ANALYSIS IMPLEMENTATION

In order for ColliderBit to compute likelihood functions across searches, it needs, for each signal region, the number of observed events and the expected number of background events, with its uncertainty, both given by the LHC analysis, as well as the number of expected signal events, which ColliderBit produces. The latter is computed as described below.

Pythia, the Monte Carlo generator used by ColliderBit, generates events according to the BSM model and signal topology given. It equally computes the cross-section σ for the included processes up to LO+LL, due to computing power restrictions, such that the correct number of events is generated [2]. It is important to note that the σ_{GAMBIT} is ordinarily lower than the one provided by the LHC analysis, which is usually computed up to NLO. The events are then passed through a custom detector simulator, BuckFast, which applies detector effects to the kinematics of the event. Each event is then fed into an analysis loop, which mimics the selection criteria applied within the LHC analysis to select signal and reject background. The number of expected signal events is then incremented appropriately.

III. ATLAS 8 TEV 1 LEPTON, 2 B-JETS ANALYSIS VALIDATION

The first search implemented and validated within the context of this project was an ATLAS 8 TeV SUSY analysis [3]. While this was a run 1 search and thus not representative of the

LHC's current results, the ATLAS reconstructed data was available for this analysis. This allowed for a more detailed validation of its implementation, through the use of kinematic distributions. With a greater understanding of GAMBIT's simulation capabilities through this validation, it was easier to correctly implement the run 2 analyses of interest.

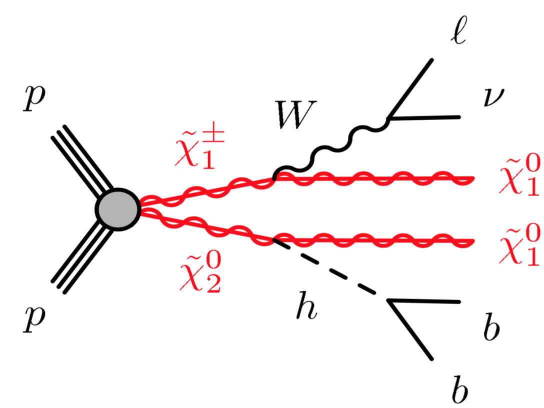
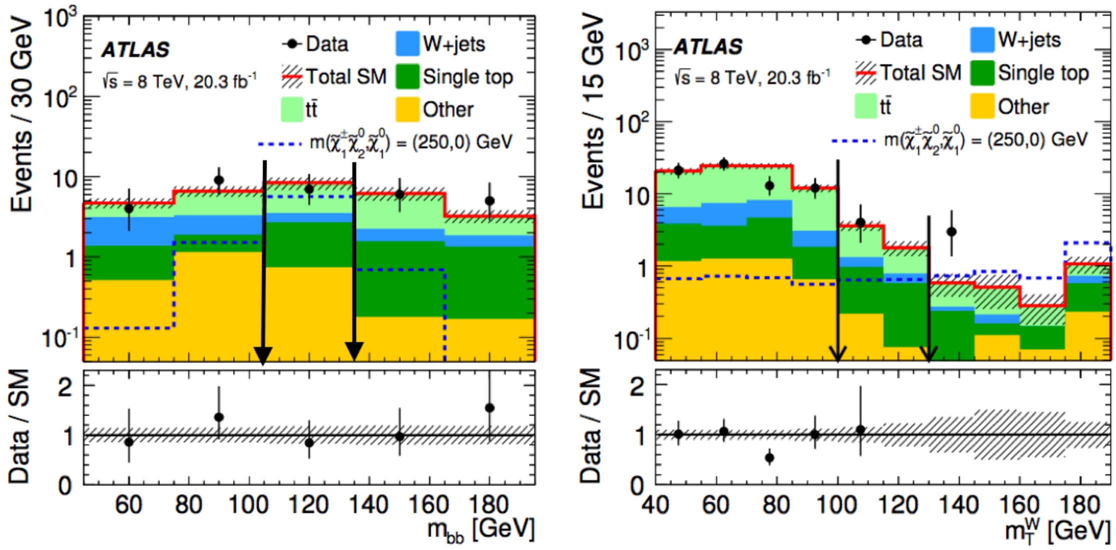


FIG. 1: Signal topology for ATLAS 8 TeV 1 lepton, 2 b-jets analysis. Adapted from [3].

This analysis searched for $\tilde{\chi}_2^0\tilde{\chi}_1^\pm$ pair production yielding a signal topology of one lepton from the W decay, two b-jets from the H^0 and a lot of E_T^{miss} from the ν and the two $\tilde{\chi}_1^0$ (Fig. 1). The search defines two signal regions SRA and SRB. Both regions live within the H^0 sensitive window of the invariant mass of the b-jets: $105 < m_{bb} < 135\ GeV$ (Fig. 2a). They differ in their cut on transverse mass calculated with the lepton and the E_T^{miss}: $100 < m_T < 130\ GeV$ for SRA and $m_T > 130\ GeV$ for SRB (Fig. 2b). This variable has a kinematic endpoint at the mass of the leptonically decaying particle, W in this case, if no other sources of E_T^{miss} are present. Thus, cutting high above the mass of the W rejects the W+jets background.

After introducing this search within ColliderBit's code, a cutflow table comparing ATLAS and GAMBIT was created in order to determine if each cut was correctly implemented (Table I). It is clear from the last two columns that GAMBIT systematically over-estimates



(a) (b)

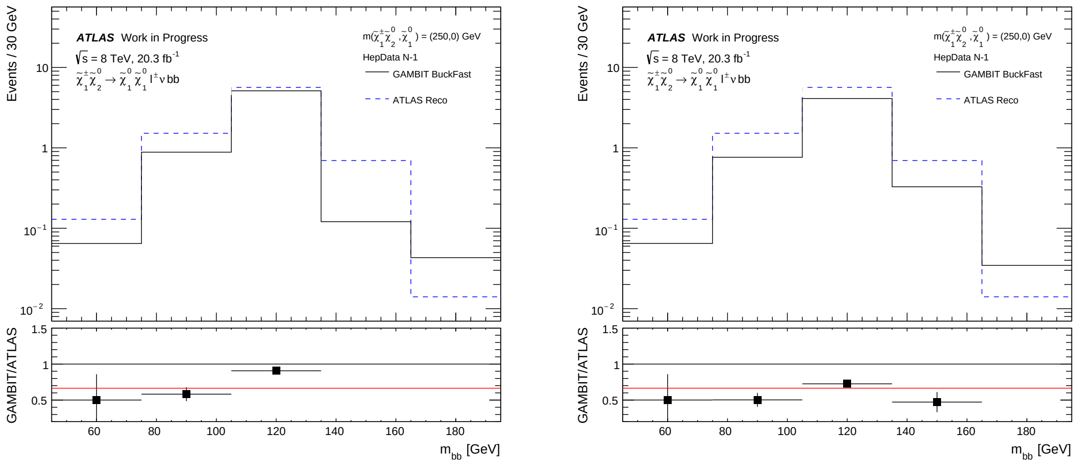
FIG. 2: Signal region distributions of (a) m_{bb} and (b) m_T where the signal region cuts for these variables are indicated by arrows. Adapted from [3].

the number of expected events at a given cut level, when taking into account the difference in cross-section value between ATLAS and GAMBIT. Two aspects of this over-estimation were investigated in more depth. Firstly, the over-estimation is largest at the first cut level, meaning GAMBIT largely over-simulates events with one lepton and two b-jets. Secondly, while the over-estimation decreases with each additional cut, it increases once again for the signal regions, with respect to the $45 < m_{bb} < 195$ GeV cut level. The first behaviour was resolved by introducing lepton trigger, b-tagging and ID selection efficiencies in the code to better mimic the ATLAS detector's capabilities. The second behaviour was eliminated by looking at the GAMBIT and ATLAS kinematic distributions for m_{bb} (Fig. 3a). The m_{bb} distribution produced by GAMBIT is more peaked about the H^0 mass than the one provided by ATLAS, causing an over-estimation of events in the signal regions as they are within the H^0 sensitive window. Thus, a jet p_T smearing function was introduced to better model m_{bb}.

TABLE I: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/h, $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0] : [250, 0][GeV]$ (no jet p_T smearing)

	ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	320 fb	213 fb	0.67	1
Generated Events	99000	1000000	-	-
Expected events at 20.3 fb^{-1}				
Lepton + 2 b-jets	71.3	72.4	1.01	1.51
$E_T^{miss} > 100GeV$	45.2	39.8	0.88	1.31
$m_{CT} > 160GeV$	15.0	12.8	0.85	1.27
$m_T > 100GeV$	8.1	6.4	0.79	1.18
$45GeV < m_{bb} < 195GeV$	8.0	6.3	0.79	1.18
SRA	1.3	1.1	0.85	1.27
SRB	4.4	4.0	0.91	1.36
Percentage (%)				
Lepton + 2 b-jets	100	100	-	-
$E_T^{miss} > 100GeV$	63.4	55.0	-	-
$m_{CT} > 160GeV$	21.0	17.7	-	-
$m_T > 100GeV$	11.4	8.8	-	-
$45GeV < m_{bb} < 195GeV$	11.2	8.7	-	-
SRA	1.8	1.5	-	-
SRB	6.2	5.5	-	-

A new cutflow table was produced with these modifications included. GAMBIT's behaviour greatly improved, with its over-estimation being at most 15% (Table 2). Furthermore, the GAMBIT m_{bb} distribution better matched the ATLAS data (Fig. 3b). The remaining differences can be attributed to statistical fluctuations and the lack of certain detector level variables within ColliderBit. With this analysis well validated, the jet smearing function was applied to all other analyses and there was a careful and rigorous implementation of relevant efficiencies across all searches.



(a) (b)

FIG. 3: GAMBIT and ATLAS N-1 distributions of m_{bb} (a) before and (b) after the jet p_T smearing function is implemented within ColliderBit. Made using public data from [4].

TABLE II: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/h, $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0] : [250, 0][GeV]$ (jet p_T smearing)

	ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	320 fb	212.6fb	0.66	1
Generated Events	99000	1000000	-	-
Expected events at 20.3 fb^{-1}				
Lepton + 2 b-jets	71.3	54.5	0.76	1.15
$E_T^{miss} > 100GeV$	45.2	30.6	0.68	1.02
$m_{CT} > 160GeV$	15	11.0	0.73	1.10
$m_T > 100GeV$	8.1	5.4	0.67	1.01
$45GeV < m_{bb} < 195GeV$	8	5.3	0.67	1.00
SRA	1.3	1.0	0.76	1.15
SRB	4.4	3.1	0.71	1.07
Percentage (%)				
Lepton + 2 b-jets	100	100	-	-
$E_T^{miss} > 100GeV$	63.4	56.1	-	-
$m_{CT} > 160GeV$	21.0	20.1	-	-
$m_T > 100GeV$	11.4	9.5	-	-
$45GeV < m_{bb} < 195GeV$	11.2	9.8	-	-
SRA	1.8	1.8	-	-
SRB	6.2	5.7	-	-

IV. REMAINING ATLAS AND CMS ANALYSIS VALIDATIONS

To avoid needless repetition, this section will quickly describe the other analyses implemented within the context of this project. The validation data, in other words the cutflows and kinematic distributions, not included in the above section and for the following analyses are in this document's appendices.

The other ATLAS search added within ColliderBit was the 13 TeV SUSY multi-lepton analysis [5]. It probed multiple signal topologies, considering $\tilde{\chi}_2^0\tilde{\chi}_1^\pm$, $\tilde{\chi}_2^\pm\tilde{\chi}_1^\pm$ and $\tilde{l}\tilde{l}$ pair productions, with final states of two or three leptons from W, Z and $\tilde{l}$ decays, zero to five jets from W decays and large values of E_T^{miss} from the presence of $\tilde{\chi}_1^0$ and ν. Seven cutflows were produced using each signal topology at least once, as different cuts are optimized for different signal models. Overall, the cutflows were satisfactory as the last cutlevels usually had small over-estimation or under-estimation by GAMBIT compared to ATLAS. However, TABLE IX contains a GAMBIT over-estimation close to 100%, which is problematic as GAMBIT simulates more events in the signal regions than ATLAS, regardless of cross-section differences. This would lead to more stringent limits set by GAMBIT for this particular model. Although, the over-estimation is fairly constant and the cutlevel percentages are quite similar. Thus, it is fairly possible that this is simply due to not having been capable of correctly reproducing the signal model within ColliderBit and not due to a wrong implementation of the search.

The CMS 13 TeV one lepton, two b-jets analysis, the run 2 version of the ATLAS analysis presented in the previous section, was added to the ColliderBit framework and validated [6]. This CMS analysis greatly resembled the ATLAS analysis in its use of kinematic variables and cuts. It also used the same signal topology for $\tilde{\chi}_2^0\tilde{\chi}_1^\pm$ pair production and decay (Fig. 1). To validate the code, five cutflow tables were produced, all with the above signal topology but different masses assumptions for the degenerate $\tilde{\chi}_2^0\tilde{\chi}_1^\pm$ and the LSP. Generally, at the "2 bjets" cutlevel, GAMBIT over-estimates compared to CMS by 30% and decreases to an acceptable amount of under 20% for the last cutlevel. The lepton trigger efficiency is only implemented for cutlevels "2 bjets" and below, which explains why the over-estimation is much better for these cutlevels.

Another CMS 13 TeV search implemented considered the two same-flavor opposite-sign (SFOS) leptons channel [7]. The signal topology probed was $\tilde{\chi}_2^0\tilde{\chi}_1^\pm$ pair production, yielding a leptonically decaying W and hadronically decaying Z and two $\tilde{\chi}_2^0$. A single cutflow was created for validation. It was unclear whether the Z was forced to decay leptonically when CMS produced the cutflow. It seems to be the case, although GAMBIT consistently over-simulated the expected number of events when this is applied to the signal model within ColliderBit. However, since the percentages are quite similar and the GAMBIT over-estimation is so stable, it is probable that the cuts were well-implemented and the over-estimations are due to unknown differences in the signal models.

The CMS 13 TeV two SFOS soft leptons analysis was implemented and validated [8]. This analysis probed the same signal topology as above, but the W and Z were considered to be virtual due to small differences between the masses of the $\tilde{\chi}_2^0\tilde{\chi}_1^\pm$ and the $\tilde{\chi}_1^0$, causing the leptons to have very low in p_T. This analysis attempted to access a different kinematic regime and thus employed very different cuts. The difficulty with the validation of this analysis lied within the fact that the kinematics of this signal topology, especially the value for E_T^{miss}, are highly dependent on the modelling of initial-state radiation (ISR) jets, which requires cross-section computations up to NLO. Therefore, ColliderBit was unable to properly simulate this signal, explaining the drop at cut levels "ISR jets" and "$125 < E_T^{miss} < 200\ GeV$" in the two produced cutflows. However, the GAMBIT to CMS ratio is fairly stable after the sharp decrease and the cuts above it seem to behave properly as well.

Finally, the last CMS 13 TeV analysis added considered multi-lepton final states [9]. This search was similar to the ATLAS multi-lepton one, but CMS uniquely considered $\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}$ pair production. Furthermore, this search considered states with two or more leptons and many variations of $\tilde{l}$-mediated decay, from "τ-dominated" to "flavor-democratic". Four cutflow tables were produced in order to probe most of the considered signal topologies. The first two, considering decay via W and Z bosons, yielded low values for the GAMBIT to CMS ratio. However, this ratio is extremely stable and the percentages at each cut level for GAMBIT and CMS agree tremendously well. It is certain that the discrepancies observed are simply due to the differences in the signal model, like the branching ratio values. The table which investigated decay via $\tilde{\tau}$ has a large values for the ratio, but, once again, the ratio stays fairly stable and the percentages are sensible, indicating discrepancies within the signal model. While there are certain issues with the cutflows, it is fairly certain that the analysis is well implemented and the differences come from not having access to the original signal model files used by CMS.

V. CONCLUSION

The search for BSM physics, especially for the popular SUSY theory, has become a staple of modern experimental concerns as many important observations are still un-accounted by the SM. This effort is necessarily multi-disciplinary as BSM phenomena could be observed at very different physical scales and within many different fields. To properly inform theorists about the validity of models over others with respect to measurements and observations, there is a need for a rigorous statistical combination of these different search results, in other words, global fits. The open-source global fitting package GAMBIT strives to provide a flexible and complete tool for BSM global fits..

With LHC run 2 results beginning to be published in large number and LHC run 1 analyses suggesting the SUSY coloured sector is at TeV energies, there was a need for the implementation of LHC run 2 SUSY electroweak searches within the GAMBIT framework, such that their limits remain representative of current results. In total, six different ATLAS and CMS analyses were added and validated, probing different channels and kinematic regimes.

[1] P. Athron *et al.* (GAMBIT), (2017), arXiv:1705.07908 [hep-ph].

[2] C. Balzs *et al.* (GAMBIT), (2017), arXiv:1705.07919 [hep-ph].

[3] G. Aad *et al.* (ATLAS), Eur. Phys. J. **C75**, 208 (2015), arXiv:1501.07110 [hep-ex].

[4] 1526796, 10.17182/hepdata.68405.v1/t6.

[5] *Search for electroweak production of supersymmetric particles in the two and three lepton final state at* $\sqrt{s} = 13$ *TeV with the ATLAS detector*, Tech. Rep. ATLAS-CONF-2017-039 (CERN, Geneva, 2017).

[6] *Search for electroweak production of charginos and neutralinos in WH events in proton-proton collisions at* $\sqrt{s}$ = *13 TeV*, Tech. Rep. CMS-SUS-16-043. CMS-SUS-16-043-003 (CERN, Geneva, 2017) submitted to JHEP. All figures and tables can be found at http://cms-results.web.cern.ch/cms-results/public-results/publications/SUS-16-043.

[7] *Search for new physics in final states with two opposite-sign, same-flavor leptons, jets, and missing transverse momentum in pp collisions at* $\sqrt{s} = 13$ TeV, Tech. Rep. CMS-PAS-SUS-16-034 (CERN, Geneva, 2017).

[8] *Search for new physics in events with two low momentum opposite-sign leptons and missing transverse energy at* $\sqrt{s} = 13$ TeV, Tech. Rep. CMS-PAS-SUS-16-048 (CERN, Geneva, 2017).

[9] *Search for electroweak production of charginos and neutralinos in multilepton final states in pp collision data at* $\sqrt{s} = 13$ TeV, Tech. Rep. CMS-PAS-SUS-16-039 (CERN, Geneva, 2017).

[10] 1526792, 10.17182/hepdata.68405.v1/t2.

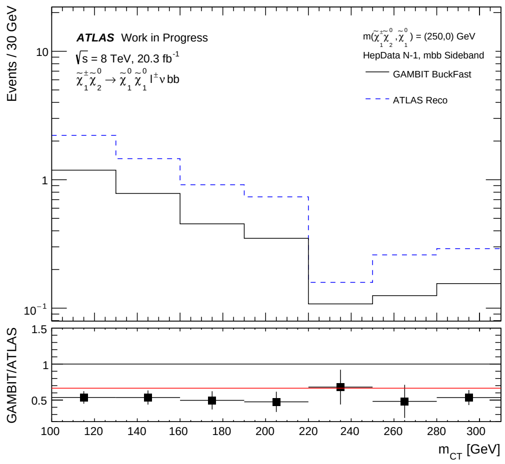
[11] 1526794, 10.17182/hepdata.68405.v1/t4.

[12] 1526795, 10.17182/hepdata.68405.v1/t5.

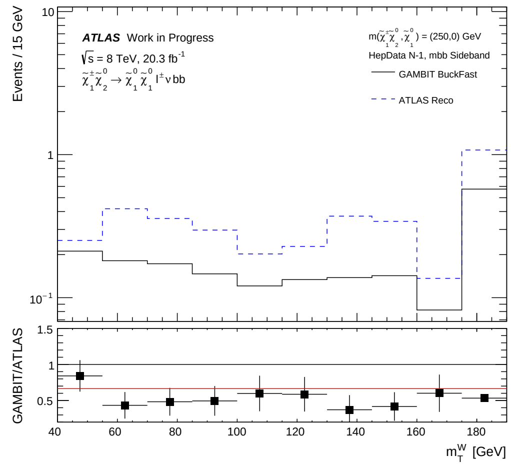
Appendix A: ATLAS 8 TeV 1 Lepton, 2 B-jets Analysis

TABLE III: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/h, $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0] : [130, 0][GeV]$

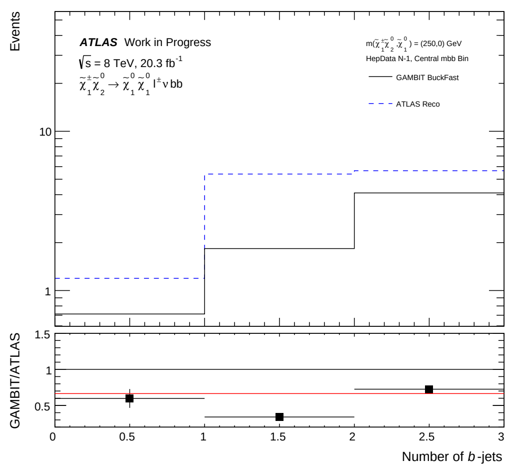
	ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	4240 fb	2801fb	0.6605	1
Generated Events	1e+05	1000000	-	-
Expected events at 20.3 fb^{-1}				
Lepton + 2 b-jets	531.1	563.1	1.06	1.605
$E_T^{miss} > 100GeV$	163.7	109.8	0.671	1.016
$m_{CT} > 160GeV$	70.4	55.89	0.7939	1.202
$m_T > 100GeV$	9.7	8.016	0.8264	1.251
$45GeV < m_{bb} < 195GeV$	9.6	8.016	0.835	1.264
SRA	7.2	6.368	0.8844	1.339
SRB	0.3	0.1706	0.5685	0.8607
Percentage (%)				
Lepton + 2 b-jets	100	100	-	-
$E_T^{miss} > 100GeV$	30.82	19.51	-	-
$m_{CT} > 160GeV$	13.26	9.925	-	-
$m_T > 100GeV$	1.826	1.424	-	-
$45GeV < m_{bb} < 195GeV$	1.808	1.424	-	-
SRA	1.356	1.131	-	-
SRB	0.05649	0.03029	-	-



(a)



(b)



(c)

FIG. 4: GAMBIT and ATLAS N-1 distributions of (a) m_{CT} in the m_{bb} sidebands (b) m_T in the m_{bb} sidebands (c) number of b-jets in the central m_{bb} bin. Made using public data from [10–12].

Appendix B: ATLAS 13 TeV Multi-lepton Analysis

TABLE IV: $\tilde{l}^{\pm}\tilde{l}^{\mp}$ decay into leptons and $\tilde{\chi}_1^0$, $[\tilde{l}^{\pm}, \tilde{\chi}_1^0]$: $[400.5, 1][GeV]$

	ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
$\sigma(pp \to \tilde{l}^{\pm}\tilde{l}^{\mp})$	5.43 fb	4.36fb	0.803	1
Generated Events	1e+04	100000	-	-
Expected events at 36.1 fb^{-1}				
2 signal leptons & OS	89.7	74.9	0.835	1.04
$p_T^{l0} > 25GeV$	89.7	74.85	0.8344	1.039
Jet veto	89.5	50.63	0.5657	0.7045
$m_{ll} > 40GeV$	55.7	50.23	0.9018	1.123
Same flavour	55.7	49.11	0.8818	1.098
$m_{ll} > 111GeV$	53.7	46.78	0.8711	1.085
$m_{T2} > 100GeV$	40.4	34.1	0.8441	1.051
Percentage (%)				
2 signal leptons & OS	100	100.1	-	-
$p_T^{l0} > 25GeV$	100	100	-	-
Jet veto	99.78	67.65	-	-
$m_{ll} > 40GeV$	62.1	67.11	-	-
Same flavour	62.1	65.62	-	-
$m_{ll} > 111GeV$	59.87	62.49	-	-
$m_{T2} > 100GeV$	45.04	45.56	-	-

TABLE V: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/Z (on-shell), $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0] : [200, 100][GeV]$

		ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
	$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	1807 fb	$1213fb$	0.6712	1
	Generated Events	1.768e+04	100000	-	-
Expected events at 36.1 fb^{-1}					
Event selection	$\geq$ 2 signal leptons & SFOS	425.6	1533	3.602	5.367
	3 signal leptons & extra lepton veto	424.6	242.2	0.5704	0.8498
	B-jet veto	414.4	242.2	0.5844	0.8706
	$p_T^{l0} > 25GeV$	414	241.7	0.5839	0.87
	$p_T^{l2} > 20GeV$	306.9	187.9	0.6122	0.912
	$m_{lll} > 20GeV$	301.7	187.9	0.6227	0.9278
	$\|m_{ll} - m_Z\| < 10GeV$	227.2	145	0.6382	0.9508
0 jets	-	110.3	63.5	0.5755	0.8573
	$60 < E_T^{miss} < 120GeV$	43.24	24.09	0.557	0.8299
	$m_T^{min} > 110GeV$	8.91	6.131	0.6881	1.025
	$120 < E_T^{miss} < 170GeV$	6.02	1.752	0.291	0.4335
	$m_T^{min} > 110GeV$	1.1	0.4379	0.3981	0.5932
	$E_T^{miss} > 170GeV$	3.15	1.314	0.4171	0.6214
	$m_T^{min} > 110GeV$	0.49	0	0	0
$\geq$ 1 jet	-	116.8	81.46	0.6973	1.039
	$120 < E_T^{miss} < 200GeV$	18.86	12.26	0.6502	0.9687
	$m_T^{min} > 110GeV$	5.8	3.066	0.5285	0.7875
	$p_T^{lll} < 120GeV$	4.63	1.314	0.2838	0.4228
	$p_T^{j0} > 70GeV$	3.18	0.8759	0.2754	0.4104
	$E_T^{miss} > 200GeV$	7.32	6.569	0.8974	1.337
	$110 < m_T^{min} < 160GeV$	1.85	0.8759	0.4734	0.7054
Percentage (%)					
Event selection	$\geq$ 2 signal leptons & SFOS	100.2	633.1	-	-
	3 signal leptons & extra lepton veto	100	100	-	-
	B-jet veto	97.61	100	-	-
	$p_T^{l0} > 25GeV$	97.5	99.82	-	-
	$p_T^{l2} > 20GeV$	72.28	77.58	-	-
	$m_{lll} > 20GeV$	71.06	77.58	-	-
	$\|m_{ll} - m_Z\| < 10GeV$	53.5	59.86	-	-
0 jets	-	25.99	26.22	-	-
	$60 < E_T^{miss} < 120GeV$	10.18	9.946	-	-
	$m_T^{min} > 110GeV$	2.098	2.532	-	-
	$120 < E_T^{miss} < 170GeV$	1.418	0.7233	-	-
	$m_T^{min} > 110GeV$	0.2591	0.1808	-	-
	$E_T^{miss} > 170GeV$	0.7419	0.5425	-	-
	$m_T^{min} > 110GeV$	0.1154	0	-	-
$\geq$ 1 jet	-	27.51	33.63	-	-
	$120 < E_T^{miss} < 200GeV$	4.442	5.063	-	-
	$m_T^{min} > 110GeV$	1.366	1.266	-	-
	$p_T^{lll} < 120GeV$	1.09	0.5425	-	-
	$p_T^{j0} > 70GeV$	0.749	0.3617	-	-
	$E_T^{miss} > 200GeV$	1.724	2.712	-	-
	$110 < m_T^{min} < 160GeV$	0.4357	0.3617	-	-

TABLE VI: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/Z (on-shell), $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0]:[200,100][GeV]$

	ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	1807 fb	1216fb	0.6728	1
Generated Events	2e+04	100000	-	-
Expected events at 36.1 fb^{-1}				
2 signal leptons & SFOS	957	901.7	0.9422	1.4
B-jet veto	880.6	901.3	1.023	1.521
$E_T^{miss} > 100GeV$	120.8	124.7	1.032	1.534
2 signal jets	30.2	36.44	1.207	1.793
$p_T^{j0}, p_T^{j1} > 30GeV$	20.6	27.22	1.321	1.964
$81 < m_Z < 101GeV$	18.8	23.71	1.261	1.874
$70 < m_W < 90GeV$	6.2	4.829	0.7789	1.158
$p_T^Z > 60GeV$	5.1	4.829	0.9469	1.407
$\Delta\phi(E_T^{miss}, Z) < 0.8$	2.7	1.756	0.6504	0.9666
$\Delta\phi(E_T^{miss}, W) > 1.5$	2.7	1.756	0.6504	0.9666
$E_T^{miss}/p_T^W < 0.8$	2.6	1.756	0.6754	1.004
$0.6 < E_T^{miss}/p_T^Z < 1.6$	2.2	1.756	0.7982	1.186
3-5 signal jets	71.7	64.97	0.9062	1.347
$p_T^{j0}, p_T^{j1}, p_T^{j2} > 30GeV$	47.9	49.61	1.036	1.539
$81 < m_Z < 101GeV$	37.1	47.41	1.278	1.899
$70 < m_W < 90GeV$	9.3	18.88	2.03	3.017
$\|\|\eta(Z)\|\| < 1.6$	7.1	13.17	1.855	2.757
$p_T^Z > 40GeV$	6.9	12.73	1.845	2.742
$\Delta\phi(E_T^{miss}, ISR) > 2.4$	6.3	8.341	1.324	1.968
$\Delta\phi(E_T^{miss}, j1) > 2.6$	5.3	5.707	1.077	1.6
$\Delta\phi(E_T^{miss}, W) < 2.2$	4.8	5.707	1.189	1.767
$0.4 < E_T^{miss}/ISR < 0.8$	4	3.951	0.9877	1.468
$\Delta R(W \to 2j) < 2.2$	3.6	3.073	0.8536	1.269
Percentage (%)				
2 signal leptons & SFOS	108.7	100	-	-
B-jet veto	100	100	-	-
$E_T^{miss} > 100GeV$	13.72	13.83	-	-
2 signal jets	3.429	4.043	-	-
$p_T^{j0}, p_T^{j1} > 30GeV$	2.339	3.02	-	-
$81 < m_Z < 101GeV$	2.135	2.63	-	-
$70 < m_W < 90GeV$	0.7041	0.5358	-	-
$p_T^Z > 60GeV$	0.5792	0.5358	-	-
$\Delta\phi(E_T^{miss}, Z) < 0.8$	0.3066	0.1948	-	-
$\Delta\phi(E_T^{miss}, W) > 1.5$	0.3066	0.1948	-	-
$E_T^{miss}/p_T^W < 0.8$	0.2953	0.1948	-	-
$0.6 < E_T^{miss}/p_T^Z < 1.6$	0.2498	0.1948	-	-
3-5 signal jets	8.142	7.209	-	-
$p_T^{j0}, p_T^{j1}, p_T^{j2} > 30GeV$	5.439	5.504	-	-
$81 < m_Z < 101GeV$	4.213	5.261	-	-
$70 < m_W < 90GeV$	1.056	2.094	-	-
$\|\|\eta(Z)\|\| < 1.6$	0.8063	1.461	-	-
$p_T^Z > 40GeV$	0.7836	1.413	-	-
$\Delta\phi(E_T^{miss}, ISR) > 2.4$	0.7154	0.9255	-	-
$\Delta\phi(E_T^{miss}, j1) > 2.6$	0.6019	0.6332	-	-
$\Delta\phi(E_T^{miss}, W) < 2.2$	0.5451	0.6332	-	-
$0.4 < E_T^{miss}/ISR < 0.8$	0.4542	0.4384	-	-
$\Delta R(W \to 2j) < 2.2$	0.4088	0.341	-	-

TABLE VII: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/Z (on-shell), $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0] : [400, 200][GeV]$

	ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	121 fb	82.56fb	0.6822	1
Generated Events	1e+04	100000	-	-
Expected events at 36.1 fb^{-1}				
2 signal leptons & SFOS	83.1	85.21	1.025	1.503
B-jet veto	75.8	85.18	1.124	1.647
$\geq$ 2 signal jets	64.7	69.41	1.073	1.573
$p_T^{j0}, p_T^{j1} > 30GeV$	53.3	59.55	1.117	1.638
$E_T^{miss} > 150GeV$	29.8	33.5	1.124	1.648
$p_T^Z > 80GeV$	25	27.36	1.094	1.604
$p_T^W > 100GeV$	20.3	16.18	0.7972	1.169
$81 < m_Z < 101GeV$	18.4	14.96	0.8131	1.192
$70 < m_W < 100GeV$	7.7	7.511	0.9754	1.43
$m_{T2} > 100GeV$	5.8	5.365	0.925	1.356
$0.5 < \Delta\phi(E_T^{miss}, W) < 3.0$	5.5	4.918	0.8941	1.311
$\Delta R(W \to jj) < 1.5$	5.4	4.798	0.8886	1.303
$\Delta R(Z \to ll) < 1.8$	5.2	4.59	0.8827	1.294
Percentage (%)				
2 signal leptons & SFOS	109.6	100	-	-
B-jet veto	100	100	-	-
$\geq$ 2 signal jets	85.36	81.49	-	-
$p_T^{j0}, p_T^{j1} > 30GeV$	70.32	69.91	-	-
$E_T^{miss} > 150GeV$	39.31	39.33	-	-
$p_T^Z > 80GeV$	32.98	32.12	-	-
$p_T^W > 100GeV$	26.78	19	-	-
$81 < m_Z < 101GeV$	24.27	17.56	-	-
$70 < m_W < 100GeV$	10.16	8.817	-	-
$m_{T2} > 100GeV$	7.652	6.298	-	-
$0.5 < \Delta\phi(E_T^{miss}, W) < 3.0$	7.256	5.773	-	-
$\Delta R(W \to jj) < 1.5$	7.124	5.633	-	-
$\Delta R(Z \to ll) < 1.8$	6.86	5.388	-	-

TABLE VIII: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/Z (on-shell), $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0] : [500, 100][GeV]$

	ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	46.36 fb	31.72fb	0.6841	1
Generated Events	5000	100000	-	-
Expected events at 36.1 fb^{-1}				
2 signal leptons & SFOS	37.9	35.58	0.9389	1.372
B-jet veto	33.7	35.58	1.056	1.543
$\geq$ 2 signal jets	28.9	29.04	1.005	1.469
$p_T^{j0}, p_T^{j1} > 30GeV$	25.3	25.81	1.02	1.491
$E_T^{miss} > 150GeV$	20.5	20.46	0.998	1.459
$p_T^Z > 80GeV$	19.4	19.3	0.995	1.454
$p_T^W > 100GeV$	17.5	13.64	0.7792	1.139
$81 < m_Z < 101GeV$	15.6	12.23	0.7838	1.146
$70 < m_W < 100GeV$	7.4	6.08	0.8216	1.201
$m_{T2} > 100GeV$	6.7	5.312	0.7929	1.159
$0.5 < \Delta\phi(E_T^{miss}, W) < 3.0$	5.9	4.877	0.8267	1.208
$\Delta R(W \to jj) < 1.5$	5.9	4.729	0.8014	1.171
$\Delta R(Z \to ll) < 1.8$	5.9	4.694	0.7956	1.163
Percentage (%)				
2 signal leptons & SFOS	112.5	100	-	-
B-jet veto	100	100	-	-
$\geq$ 2 signal jets	85.76	81.6	-	-
$p_T^{j0}, p_T^{j1} > 30GeV$	75.07	72.52	-	-
$E_T^{miss} > 150GeV$	60.83	57.5	-	-
$p_T^Z > 80GeV$	57.57	54.25	-	-
$p_T^W > 100GeV$	51.93	38.32	-	-
$81 < m_Z < 101GeV$	46.29	34.36	-	-
$70 < m_W < 100GeV$	21.96	17.08	-	-
$m_{T2} > 100GeV$	19.88	14.93	-	-
$0.5 < \Delta\phi(E_T^{miss}, W) < 3.0$	17.51	13.71	-	-
$\Delta R(W \to jj) < 1.5$	17.51	13.29	-	-
$\Delta R(Z \to ll) < 1.8$	17.51	13.19	-	-

TABLE IX: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via $\tilde{l}$, $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0]$: $[800, 600][GeV]$

		ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
	$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	3.803 fb	3.085fb	0.8112	1
	Generated Events	9291	100000	-	-
	Expected events at 36.1 fb^{-1}				
	3 signal leptons & SFOS	25.13	31.16	1.24	1.529
	Pass event cleaning	23.54	31.15	1.323	1.631
	$m_T^{min} > 110GeV$	14.43	20.28	1.405	1.732
	$E_T^{miss} > 130GeV$	10.22	14.79	1.447	1.784
$m_{SFOS}^{min} < 81.2GeV$	-	2.1	3.1	1.476	1.82
	$20 < p_T^{l2} < 30GeV$	0.11	0.1392	1.265	1.56
	$p_T^{l2} > 30GeV$	1.99	2.918	1.466	1.808
$m_{SFOS}^{min} > 101.2GeV$	-	6.8	10.21	1.501	1.851
	$20 < p_T^{l2} < 50GeV$	2.53	3.44	1.36	1.676
	$50 < p_T^{l2} < 80GeV$	3.01	4.636	1.54	1.899
	$p_T^{l2} > 80GeV$	1.25	1.978	1.582	1.951
	Percentage (%)				
	3 signal leptons & SFOS	106.8	100	-	-
	Pass event cleaning	100	100	-	-
	$m_T^{min} > 110GeV$	61.3	65.09	-	-
	$E_T^{miss} > 130GeV$	43.42	47.47	-	-
$m_{SFOS}^{min} < 81.2GeV$	-	8.921	9.953	-	-
	$20 < p_T^{l2} < 30GeV$	0.4673	0.4469	-	-
	$p_T^{l2} > 30GeV$	8.454	9.367	-	-
$m_{SFOS}^{min} > 101.2GeV$	-	28.89	32.77	-	-
	$20 < p_T^{l2} < 50GeV$	10.75	11.04	-	-
	$50 < p_T^{l2} < 80GeV$	12.79	14.88	-	-
	$p_T^{l2} > 80GeV$	5.31	6.349	-	-

TABLE X: $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ decay via $\tilde{l}$, $[\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [300, 150][GeV]$

	ATLAS	GAMBIT	GAMBIT/ATLAS	σ-corrected GAMBIT/ATLAS
$\sigma(pp \to \tilde{l}^{\pm}\tilde{l}^{\mp})$	190.2 fb	146.7fb	0.7714	1
Generated Events	2.5e+04	100000	-	-
Expected events at 36.1 fb^{-1}				
2 signal leptons & OS	1797	1666	0.9269	1.202
$p_T^{l0} > 25GeV$	1795	1652	0.9204	1.193
Jet veto	1692	1200	0.7091	0.9192
$m_{ll} > 40GeV$	1262	1107	0.877	1.137
Same flavour	667.4	556.2	0.8334	1.08
$m_{ll} > 111GeV$	405	309.8	0.7649	0.9916
$m_{T2} > 100GeV$	46.9	35.8	0.7633	0.9895
Different flavour	594.5	550.5	0.926	1.2
$m_{ll} > 111GeV$	363.8	309.3	0.8501	1.102
$m_{T2} > 100GeV$	45.7	35.53	0.7776	1.008
Percentage (%)				
2 signal leptons & OS	100.1	100.8	-	-
$p_T^{l0} > 25GeV$	100	100	-	-
Jet veto	94.25	72.62	-	-
$m_{ll} > 40GeV$	70.29	66.98	-	-
Same flavour	37.17	33.66	-	-
$m_{ll} > 111GeV$	22.56	18.75	-	-
$m_{T2} > 100GeV$	2.612	2.167	-	-
Different flavour	33.11	33.32	-	-
$m_{ll} > 111GeV$	20.26	18.72	-	-
$m_{T2} > 100GeV$	2.546	2.151	-	-

Appendix C: CMS 13 TeV 1 Lepton, 2 B-jets Analysis

TABLE XI: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via $W/h, [\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [225, 75][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	1165 fb	884.3fb	0.759	1
Expected events at 35.9 fb^{-1}				
All events	7298	3.174e+04	4.35	5.731
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	1320	2406	1.822	2.401
2nd lepton veto	1265	2406	1.902	2.506
Tau veto	1259	2304	1.83	2.411
2 jets	680.8	848.4	1.246	1.642
2 bjets	299	293.9	0.983	1.295
$90 < m_{bb} < 150GeV$	258.4	256.2	0.9917	1.306
$m_{CT} > 170GeV$	50.9	42.57	0.8363	1.102
$E_T^{miss} > 125GeV$	38.4	31.14	0.811	1.068
$m_T > 150GeV$	4.7	3.905	0.8308	1.095
Percentage (%)				
All events	552.6	1319	-	-
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	100	100	-	-
2nd lepton veto	95.82	100	-	-
Tau veto	95.34	95.76	-	-
2 jets	51.56	35.26	-	-
2 bjets	22.64	12.21	-	-
$90 < m_{bb} < 150GeV$	19.57	10.65	-	-
$m_{CT} > 170GeV$	3.855	1.769	-	-
$E_T^{miss} > 125GeV$	2.908	1.294	-	-
$m_T > 150GeV$	0.3559	0.1623	-	-

TABLE XII: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/h, $[\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [250, 1][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	782.5 fb	595.4fb	0.7609	1
Expected events at 35.9 fb^{-1}				
All events	4901	2.137e+04	4.361	5.732
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	1035	1932	1.866	2.453
2nd lepton veto	994.3	1932	1.943	2.554
Tau veto	989.6	1847	1.867	2.453
2 jets	542.3	684.3	1.262	1.658
2 bjets	242.6	241.3	0.9946	1.307
$90 < m_{bb} < 150GeV$	214.4	209	0.9749	1.281
$m_{CT} > 170GeV$	67.2	51	0.7589	0.9974
$E_T^{miss} > 125GeV$	54.8	40.78	0.7442	0.9781
$m_T > 150GeV$	17.6	12.97	0.7372	0.9688
Percentage (%)				
All events	473.5	1106	-	-
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	100	100	-	-
2nd lepton veto	96.06	100	-	-
Tau veto	95.6	95.62	-	-
2 jets	52.39	35.42	-	-
2 bjets	23.44	12.49	-	-
$90 < m_{bb} < 150GeV$	20.71	10.82	-	-
$m_{CT} > 170GeV$	6.492	2.64	-	-
$E_T^{miss} > 125GeV$	5.294	2.111	-	-
$m_T > 150GeV$	1.7	0.6715	-	-

TABLE XIII: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via $W/h, [\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [350, 100][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	209.4 fb	160.2fb	0.7648	1
Expected events at 35.9 fb^{-1}				
All events	1309	5750	4.392	5.742
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	328.1	604.6	1.843	2.409
2nd lepton veto	316.6	604.6	1.91	2.497
Tau veto	315.3	577.2	1.831	2.394
2 jets	162.9	208	1.277	1.669
2 bjets	74.9	75.21	1.004	1.313
$90 < m_{bb} < 150GeV$	65.6	64.49	0.9831	1.285
$m_{CT} > 170GeV$	26.7	21.87	0.819	1.071
$E_T^{miss} > 125GeV$	22.9	18.55	0.8102	1.059
$m_T > 150GeV$	10.7	8.182	0.7647	0.9998
Percentage (%)				
All events	399	951	-	-
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	100	100	-	-
2nd lepton veto	96.49	100	-	-
Tau veto	96.1	95.47	-	-
2 jets	49.65	34.4	-	-
2 bjets	22.83	12.44	-	-
$90 < m_{bb} < 150GeV$	19.99	10.67	-	-
$m_{CT} > 170GeV$	8.138	3.617	-	-
$E_T^{miss} > 125GeV$	6.98	3.069	-	-
$m_T > 150GeV$	3.261	1.353	-	-

TABLE XIV: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via $W/h, [\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [500, 1][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	46.35 fb	35.52fb	0.7664	1
Expected events at 35.9 fb^{-1}				
All events	290.2	1275	4.394	5.734
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	89	157.1	1.765	2.303
2nd lepton veto	85.8	157.1	1.831	2.389
Tau veto	85.5	149.6	1.75	2.284
2 jets	42.3	51.26	1.212	1.581
2 bjets	19.7	19.73	1.001	1.307
$90 < m_{bb} < 150GeV$	17.5	16.53	0.9443	1.232
$m_{CT} > 170GeV$	11.9	10.38	0.8723	1.138
$E_T^{miss} > 125GeV$	10.9	9.61	0.8817	1.15
$m_T > 150GeV$	7.1	6.37	0.8972	1.171
Percentage (%)				
All events	326.1	811.7	-	-
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	100	100	-	-
2nd lepton veto	96.4	100	-	-
Tau veto	96.07	95.24	-	-
2 jets	47.53	32.63	-	-
2 bjets	22.13	12.56	-	-
$90 < m_{bb} < 150GeV$	19.66	10.52	-	-
$m_{CT} > 170GeV$	13.37	6.607	-	-
$E_T^{miss} > 125GeV$	12.25	6.117	-	-
$m_T > 150GeV$	7.978	4.054	-	-

TABLE XV: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via $W/h, [\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [500, 125][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	46.35 fb	35.52fb	0.7664	1
Expected events at 35.9 fb^{-1}				
All events	290.3	1275	4.393	5.732
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	86.9	154.1	1.774	2.315
2nd lepton veto	84.1	154.1	1.833	2.392
Tau veto	83.9	146.9	1.751	2.285
2 jets	41.1	50.53	1.23	1.604
2 bjets	19.5	19.43	0.9963	1.3
$90 < m_{bb} < 150GeV$	17.6	16.22	0.9218	1.203
$m_{CT} > 170GeV$	10.9	9.38	0.8606	1.123
$E_T^{miss} > 125GeV$	9.9	8.602	0.8689	1.134
$m_T > 150GeV$	6.5	5.523	0.8497	1.109
Percentage (%)				
All events	334.1	827.3	-	-
$\geq$ 1 signal lepton; $E_T^{miss} > 50GeV$	100	100	-	-
2nd lepton veto	96.78	100	-	-
Tau veto	96.55	95.33	-	-
2 jets	47.3	32.78	-	-
2 bjets	22.44	12.6	-	-
$90 < m_{bb} < 150GeV$	20.25	10.53	-	-
$m_{CT} > 170GeV$	12.54	6.085	-	-
$E_T^{miss} > 125GeV$	11.39	5.581	-	-
$m_T > 150GeV$	7.48	3.583	-	-

Appendix D: CMS 13 TeV 2 Opposite-sign, Same-flavor Leptons Analysis

TABLE XVI: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via $W/Z, [\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [550, 200][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	30.2 fb	23.14fb	0.7661	1
Expected events at 35.9 fb^{-1}				
All events	109.3	830.6	7.596	9.915
$\geq$ 2 SFOS leptons with $p_T > 25(20)GeV$	24.21	32.11	1.326	1.731
Extra lepton vetos	18.37	24.6	1.339	1.748
$86 < m_{ll} < 96GeV$	14.13	18.43	1.304	1.702
2-3 Jets	11.98	10.84	0.9047	1.181
$\Delta\Phi(E_T^{miss}, j_0), \Delta\Phi(E_T^{miss}, j_1) > 0.4$	10.95	10.1	0.9225	1.204
Btag veto	9.92	10.1	1.018	1.329
$M_{T2}(ll) > 80GeV$	8.04	7.751	0.964	1.258
M_{jj} for min $\Delta\Phi$ jets $< 150GeV$	5.62	5.619	0.9999	1.305
$E_T^{miss} > 100GeV$	5.41	5.404	0.9989	1.304
$E_T^{miss} > 150GeV$	4.96	4.97	1.002	1.308
$E_T^{miss} > 250GeV$	3.59	3.514	0.979	1.278
$E_T^{miss} > 350GeV$	1.94	1.755	0.9047	1.181
Percentage (%)				
All events	451.7	2587	-	-
$\geq$ 2 SFOS leptons with $p_T > 25(20)GeV$	100	100	-	-
Extra lepton vetos	75.88	76.63	-	-
$86 < m_{ll} < 96GeV$	58.36	57.39	-	-
2-3 Jets	49.48	33.76	-	-
$\Delta\Phi(E_T^{miss}, j_0), \Delta\Phi(E_T^{miss}, j_1) > 0.4$	45.23	31.46	-	-
Btag veto	40.97	31.46	-	-
$M_{T2}(ll) > 80GeV$	33.21	24.14	-	-
M_{jj} for min $\Delta\Phi$ jets $< 150GeV$	23.21	17.5	-	-
$E_T^{miss} > 100GeV$	22.35	16.83	-	-
$E_T^{miss} > 150GeV$	20.49	15.48	-	-
$E_T^{miss} > 250GeV$	14.83	10.95	-	-
$E_T^{miss} > 350GeV$	8.013	5.466	-	-

Appendix E: CMS 13 TeV 2 Soft Leptons Analysis

TABLE XVII: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W^*/Z^*, $[\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [150, 130][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	5180 fb	3619fb	0.6986	1
Expected events at 35.9 fb^{-1}				
All events	645.9	1.299e+05	201.1	287.9
2 μ in acceptance	171.8	245	1.426	2.041
Opposite-sign	163.5	217.2	1.329	1.902
$p_T(\mu\mu) > 3GeV$	161.4	215.7	1.336	1.913
$M(\mu\mu) > 4GeV$	150.1	215.7	1.437	2.057
$M(\mu\mu)$ veto [9,10.5] GeV	134.7	205.1	1.523	2.18
ISR jet	112.4	111.1	0.9882	1.415
$125 < E_T^{miss} < 200GeV$	32.2	12.21	0.3792	0.5429
$0.6 < E_T^{miss}/H_T < 1.4$ and $H_T > 100GeV$	30.9	9.354	0.3027	0.4333
B-tag veto	17.6	9.354	0.5315	0.7608
$M(\tau\tau)$	14.8	9.354	0.632	0.9047
$M_T(\mu_x, E_T^{miss}), x = 1, 2 < 70GeV$	11.4	6.626	0.5812	0.8319
Percentage (%)				
2 μ in acceptance	100	100	-	-
Opposite-sign	95.17	88.65	-	-
$p_T(\mu\mu) > 3GeV$	93.95	88.02	-	-
$M(\mu\mu) > 4GeV$	87.37	88.02	-	-
$M(\mu\mu)$ veto [9,10.5] GeV	78.41	83.72	-	-
ISR jet	65.42	45.33	-	-
$125 < E_T^{miss} < 200GeV$	18.74	4.984	-	-
$0.6 < E_T^{miss}/H_T < 1.4$ and $H_T > 100GeV$	17.99	3.818	-	-
B-tag veto	10.24	3.818	-	-
$M(\tau\tau)$	8.615	3.818	-	-
$M_T(\mu_x, E_T^{miss}), x = 1, 2 < 70GeV$	6.636	2.704	-	-

TABLE XVIII: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W^*/Z^*, $[\tilde{\chi}_2^0\tilde{\chi}_1^{\pm}, \tilde{\chi}_1^0] : [150, 143][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	5180 fb	3859fb	0.745	1
Expected events at 35.9 fb^{-1}				
All events	220.3	1.385e+05	628.8	844.1
2 μ in acceptance	53.3	41.42	0.7771	1.043
Opposite-sign	49.4	35.05	0.7095	0.9524
$p_T(\mu\mu) > 3GeV$	48.9	34.22	0.6998	0.9393
$M(\mu\mu) > 4GeV$	23.5	18.42	0.784	1.052
$M(\mu\mu)$ veto [9,10.5] GeV	23.3	18.42	0.7908	1.061
ISR jet	21.5	11.91	0.5541	0.7438
$125 < E_T^{miss} < 200GeV$	5.8	1.108	0.1911	0.2565
$0.6 < E_T^{miss}/H_T < 1.4$ and $H_T > 100GeV$	3.8	0.9697	0.2552	0.3426
B-tag veto	3.2	0.9697	0.303	0.4068
$M(\tau\tau)$	2.8	0.9697	0.3463	0.4649
$M_T(\mu_x, E_T^{miss}), x = 1, 2 < 70GeV$	2.4	0.8312	0.3463	0.4649
Percentage (%)				
2 μ in acceptance	100	100	-	-
Opposite-sign	92.68	84.62	-	-
$p_T(\mu\mu) > 3GeV$	91.74	82.61	-	-
$M(\mu\mu) > 4GeV$	44.09	44.48	-	-
$M(\mu\mu)$ veto [9,10.5] GeV	43.71	44.48	-	-
ISR jet	40.34	28.76	-	-
$125 < E_T^{miss} < 200GeV$	10.88	2.676	-	-
$0.6 < E_T^{miss}/H_T < 1.4$ and $H_T > 100GeV$	7.129	2.341	-	-
B-tag veto	6.004	2.341	-	-
$M(\tau\tau)$	5.253	2.341	-	-
$M_T(\mu_x, E_T^{miss}), x = 1, 2 < 70GeV$	4.503	2.007	-	-

Appendix F: CMS 13 TeV Multi-lepton Analysis

TABLE XIX: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/Z, $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0]$: $[200, 100][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	1800 fb	1365fb	0.7585	1
Expected events at 35.9 fb^{-1}				
All events	3630	4.902e+04	13.5	17.8
3 leptons	481.5	233.9	0.4858	0.6404
Low mass & conversions veto	463.7	226.2	0.4877	0.643
Bjet veto	456.7	226.1	0.495	0.6526
$E_T^{miss} > 50GeV$	317	142.3	0.449	0.592
$m_T > 100GeV$	112	47.55	0.4246	0.5598
$m_{ll} > 75GeV$	103.5	44.56	0.4305	0.5676
Percentage (%)				
All events	753.9	2.096e+04	-	-
3 leptons	100	100	-	-
Low mass & conversions veto	96.31	96.69	-	-
Bjet veto	94.85	96.65	-	-
$E_T^{miss} > 50GeV$	65.84	60.85	-	-
$m_T > 100GeV$	23.25	20.33	-	-
$m_{ll} > 75GeV$	21.49	19.05	-	-

TABLE XX: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via W/Z, $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0] : [500, 150][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	46 fb	35.53fb	0.7723	1
Expected events at 35.9 fb^{-1}				
All events	115.8	1275	11.02	14.26
3 leptons	18.03	4.997	0.2772	0.3589
Low mass & conversions veto	17.79	4.923	0.2767	0.3583
Bjet veto	17.47	4.923	0.2818	0.3649
$E_T^{miss} > 50GeV$	16.98	4.724	0.2782	0.3602
$m_T > 100GeV$	12.74	3.51	0.2755	0.3567
$m_{ll} > 75GeV$	11.71	3.203	0.2735	0.3541
Percentage (%)				
All events	642.2	2.552e+04	-	-
3 leptons	100	100	-	-
Low mass & conversions veto	98.67	98.52	-	-
Bjet veto	96.89	98.52	-	-
$E_T^{miss} > 50GeV$	94.18	94.54	-	-
$m_T > 100GeV$	70.66	70.24	-	-
$m_{ll} > 75GeV$	64.95	64.09	-	-

TABLE XXI: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via $\tilde{\tau}$, $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0] : [250, 150][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	780 fb	595fb	0.7628	1
Expected events at 35.9 fb^{-1}				
All events	5304	2.136e+04	4.027	5.279
3 leptons	188.6	530.8	2.815	3.69
Low mass & conversion veto	168.2	505.8	3.007	3.942
Bjet veto	166.3	505.8	3.042	3.988
$E_T^{miss} > 50GeV$	117.1	318.4	2.719	3.565
$m_{T2} < 100GeV$	112.3	306.2	2.727	3.575
$m_{ll} < 75GeV$	93.07	283.2	3.043	3.989
Percentage (%)				
All events	2813	4024	-	-
3 leptons	100	100	-	-
Low mass & conversion veto	89.19	95.29	-	-
Bjet veto	88.16	95.28	-	-
$E_T^{miss} > 50GeV$	62.09	59.99	-	-
$m_{T2} < 100GeV$	59.53	57.68	-	-
$m_{ll} < 75GeV$	49.35	53.35	-	-

TABLE XXII: $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ decay via $\tilde{l}/\tilde{\nu}$ (flavor-democratic), $[\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0, \tilde{\chi}_1^0, \tilde{l}] : [500, 350, 357.5][GeV]$

	CMS	GAMBIT	GAMBIT/CMS	σ-corrected GAMBIT/CMS
$\sigma(pp \to \tilde{\chi}_1^{\pm}, \tilde{\chi}_2^0)$	46 fb	35.52fb	0.7721	1
Expected events at 35.9 fb^{-1}				
All events	485.4	1275	2.627	3.402
2 light leptons	214.2	107.5	0.502	0.6502
Same-sign	91.09	56.61	0.6215	0.8049
3^{rd} lepton veto	75.82	56.47	0.7448	0.9647
Low mass veto	73.61	56.47	0.7672	0.9936
Bjet veto	71.27	56.46	0.7922	1.026
$E_T^{miss} > 60GeV$	62.79	49.15	0.7828	1.014
0 or 1 ISR jet	54.85	43.96	0.8014	1.038
$m_T < 100GeV$	18.3	14.66	0.8008	1.037
$p_T^{ll} > 100GeV$	10.01	6.804	0.6797	0.8803
Percentage (%)				
All events	226.5	1186	-	-
2 light leptons	100	100	-	-
Same-sign	42.52	52.64	-	-
3^{rd} lepton veto	35.39	52.51	-	-
Low mass veto	34.36	52.51	-	-
Bjet veto	33.27	52.5	-	-
$E_T^{miss} > 60GeV$	29.31	45.7	-	-
0 or 1 ISR jet	25.6	40.87	-	-
$m_T < 100GeV$	8.542	13.63	-	-
$p_T^{ll} > 100GeV$	4.672	6.326	-	-