# Validation note for the supersymmetry ATLAS search in the multijet + missing energy channel (ATLAS-SUSY-2013-04)

Monika Blanke

*Institut fur Theoretische Teilchenphysik, Karlsruhe Institute of Technology, Engesserstraße 7, D-76128 Karlsruhe, Germany and Institut fur Kernphysik, Karlsruhe Institute of Technology, Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen, Germany*

Benjamin Fuks

*Sorbonne Universités, UPMC Univ. Paris 06, UMR 7589, LPTHE, F-75005, Paris, France and CNRS, UMR 7589, LPTHE, F-75005, Paris, France*

Iftah Galon

*Department of Physics and Astronomy, University of California, Irvine, CA 92697, USA*

(Dated: December 16, 2015)

The recast of the ATLAS-SUSY-2013-04 search makes use of the MadAnalysis 5 framework [1, 2], together with the MA5tune version of Delphes described in Ref. [3]. Our implementation therefore relies on the interfacing of Delphes [4] as implemented in the version 1.1.12 of MadAnalysis 5. The necessary configuration file of Delphes can be found on the public analysis database webpage,

http://madanalysis.irmp.ucl.ac.be/wiki/PublicAnalysisDatabase .

The validation of the analysis implementation has been achieved by relying on a set of benchmark scenarios belonging to the gluino-stop (off-shell) model introduced in the ATLAS publication [5]. In this case, the SM is supplemented by a gluino and a neutralino, and the gluino is enforced to decay into a top-antitop final state via an off-shell top squark. For validation purposes, we generate events following the procedure of the ATLAS collaboration, using the Herwig++ program [6] for the simulation of the hard process, the parton showering and the hadronization. The supersymmetric spectrum file has been provided by the ATLAS collaboration *via* HepData and the Herwig++ configuration that we have used can be obtained from the MadAnalysis 5 webpage.

In Table I, we compare the ATLAS results for the cut-flow counts to those obtained with our reimplementation of the ATLAS-SUSY-2013-04 analysis in MadAnalysis 5. We present the surviving number of events after each step of the selection strategy for the 13 signal regions under consideration and for a scenario in which the gluino mass is set to 1100 GeV and the neutralino mass

| Selection step | Events counts | | Relative change | |
| --- | --- | --- | --- | --- |
| | MADANALYSIS 5 | ATLAS | MADANALYSIS 5 | ATLAS |
| Initial number of events | 206.3 | 206.3 | | |
| 6 jets with $E_T > 45$ GeV | 157.0 | 168 | -23.9% | -18.6% |
| lepton veto | 88.1 | 78 | -43.9% | -53.6% |
| 8 jets ($p_T > 50$ GeV) | 18.3 | 16.3 | -79.2% | -79.1% |
| $\not{E}_T/\sqrt{H_T} > 4$ GeV$^{1/2}$ | 15.4 | 14.1 | -15.8% | -13.5% |
| $\to$ without $b$-tags | 0.97 | 0.85 | -93.7% | -94.0% |
| $\to$ with 1 $b$-tag | 3.80 | 3 | -75.3% | -78.7% |
| $\to$ with 2 $b$-tags | 10.7 | 11 | -30.5% | -22.0% |
| 9 jets ($p_T > 50$ GeV) | 11.6 | 9.6 | -86.8% | -87.7% |
| $\not{E}_T/\sqrt{H_T} > 4$ GeV$^{1/2}$ | 9.32 | 8.0 | -19.7% | -16.7% |
| $\to$ without $b$-tags | 0.70 | 0.33 | -92.5% | -95.9% |
| $\to$ with 1 $b$-tag | 1.93 | 1.7 | -79.3% | -78.8% |
| $\to$ with 2 $b$-tags | 6.68 | 6.5 | -28.3% | -18.8% |
| $\geq 10$ jets ($p_T > 50$ GeV) | 6.99 | 5.7 | -92.1% | -92.7% |
| $\not{E}_T/\sqrt{H_T} > 4$ GeV$^{1/2}$ | 5.34 | 4.7 | -23.6% | -17.5% |
| 7 jets ($p_T > 80$ GeV) | 9.72 | 7.53 | -88.1% | -87.7% |
| $\not{E}_T/\sqrt{H_T} > 4$ GeV$^{1/2}$ | 8.07 | 6.25 | -17.0% | -17.0% |
| $\to$ without $b$-tags | 0.47 | 0.31 | -94.2% | -95.0% |
| $\to$ with 1 $b$-tag | 1.73 | 1.3 | -78.6% | -79.2% |
| $\to$ with 2 $b$-tags | 5.86 | 5.1 | -27.4% | -18.4% |
| $\geq 8$ jets ($p_T > 80$ GeV) | 4.72 | 3.2 | -94.6% | -95.9% |
| $\not{E}_T/\sqrt{H_T} > 4$ GeV$^{1/2}$ | 3.65 | 2.6 | -22.7% | -18.8% |
| $\to$ without $b$-tags | 0.06 | 0.13 | -98.4% | -95.0% |
| $\to$ with 1 $b$-tag | 0.72 | 0.55 | -80.3% | -78.8% |
| $\to$ with 2 $b$-tags | 2.87 | 2.1 | -21.4% | -19.2% |

TABLE I: Summary of yields for a gluino-stop off-shell scenario in which the gluino and neutralino masses have been fixed to 1100 and 400 GeV, respectively. The results obtained with MADANALYSIS 5 are compared to the official ATLAS results, both in terms of event counts and efficiencies computed from the number of events before and after each of the selection steps.

to 400 GeV. We have found that all selection steps are properly described by the MADANALYSIS 5 implementation, the agreement reaching the level of about 10%. On Figure 1, we move away from the chosen benchmark scenario and vary the gluino and neutralino masses freely, enforcing however that the gluino decay channel into a top-antitop pair and a neutralino stays open. We observe that our machinery allows us to reproduce the ATLAS official bounds (obtained from HEPDATA) at the 50 GeV level, which is acceptable on the basis of the limitations of our procedure. The
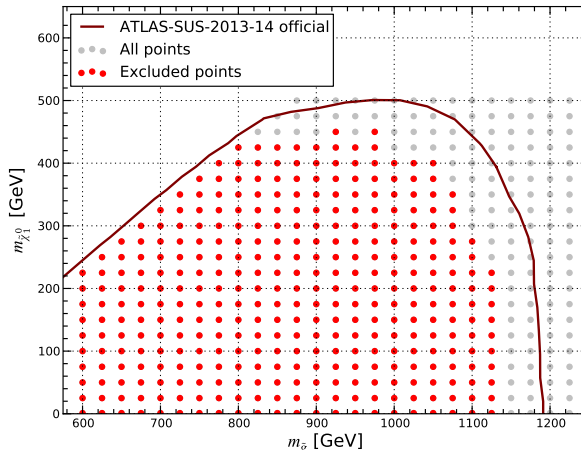
FIG. 1: 95% CL exclusion limit for gluino-stop off-shell scenarios presented as contours in the gluino-neutralino mass plane. We compare results obtained with MadAnalysis 5 (dots) to the official ATLAS results (solid line).

MadAnalysis 5 implementation of the analysis can be obtained from Inspire [7].

_____

[1] E. Conte, B. Fuks, and G. Serret, "MadAnalysis 5, A User-Friendly Framework for Collider Phenomenology," *Comput. Phys. Commun.* **184** (2013) 222–256, arXiv:1206.1599 [hep-ph].

[2] E. Conte, B. Dumont, B. Fuks, and C. Wymant, "Designing and recasting LHC analyses with MadAnalysis 5," *Eur. Phys. J.* **C74** (2014) no. 10, 3103, arXiv:1405.3982 [hep-ph].

[3] B. Dumont, B. Fuks, S. Kraml, S. Bein, G. Chalons, E. Conte, S. Kulkarni, D. Sengupta, and C. Wymant, "Toward a public analysis database for LHC new physics searches using MADANALYSIS 5," *Eur. Phys. J.* **C75** (2015) no. 2, 56, arXiv:1407.3278 [hep-ph].

[4] **DELPHES 3** Collaboration, J. de Favereau *et al.*, "DELPHES 3, A modular framework for fast simulation of a generic collider experiment," *JHEP* **1402** (2014) 057, arXiv:1307.6346 [hep-ex].

[5] **ATLAS** Collaboration, G. Aad *et al.*, "Search for new phenomena in final states with large jet multiplicities and missing transverse momentum at $\sqrt{s}$=8 TeV proton-proton collisions using the ATLAS experiment," *JHEP* **1310** (2013) 130, arXiv:1308.1841 [hep-ex].

[6] M. Bahr *et al.*, "Herwig++ Physics and Manual," *Eur. Phys. J.* **C58** (2008) 639–707, arXiv:0803.0883 [hep-ph].

[7] B. Fuks, M. Blanke, and I. Galon, "MadAnalysis5 implementation of ATLAS-SUSY-2013-04," 10.7484/INSPIREHEP.DATA.STLS.SAMT.