

# Recast of LHC searches: MadAnalysis 5 PAD

Daniele Barducci

**First meeting of the LHC Dark Matter WG**  
CERN 11th December 2015

DB, Bein, Belanger, Chalons, Conte, Delaunay, Dumont,  
Fuks, Kraml, Kulkarni, Pandey, Sengupta, Sharma, Wymant

# Outline

## The WG

- brings together theorists and experimentalists to define guidelines and recommendations for the benchmark models, interpretation, and characterisation necessary for broad and systematic searches for dark matter at the LHC.
- develops and promotes well-defined signal models, specifying the assumptions behind them and describing the conditions under which they should be used.
- works to improve the set of tools available to the experiments, such as higher-precision calculations of the backgrounds.
- assists theorists with understanding and making use of LHC results.
- develops and maintains close connections with theorists and other experimental particle DM searches (e.g. Direct and Indirect Detection experiments) in order to help verify and constrain particle physics models of astrophysical excesses, to understand how collider searches and non-collider experiments complement one another, and to help build a comprehensive understanding of viable dark matter models.

- Introduction and motivations for LHC [analyses recast](#)
- The [MadAnalysis 5](#) framework and the PAD
- Wrap up and conclusions

# Why recast LHC searches?

The discovery of a scalar boson has been the major outcome of the 7 and 8 TeV run of the LHC

It has however also been the "only" new discovery made at the LHC so far

No clear direct signs of new physics have emerged from 7+8 TeV collisions (yet some little excess...)

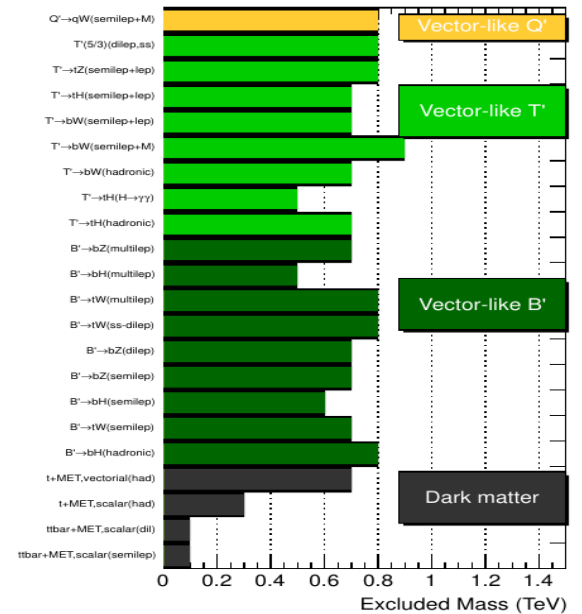
ATLAS and CMS has therefore set limits on common BSM scenarios (SUSY, CHMs, ED...)

ATLAS SUSY Searches\* - 95% CL Lower Limits  
Status: July 2015

ATLAS Preliminary  
 $\sqrt{s} = 7, 8 \text{ TeV}$

| Model   | $\epsilon, \mu, \tau, \gamma$   | Jets                        | $E_{miss}$   | $L_{int} [fb^{-1}]$ | Mass limit | $\sqrt{s} = 7 \text{ TeV}$  | $\sqrt{s} = 8 \text{ TeV}$   | Reference            |
|---|---|-----------------------------|--------------|---------------------|------------|---|--|----------------------|
| MSUGRA/CMSSM  | $0 < \mu < 1/2, \tau > 10 \text{ jets} > 0$   | 2                           | Yes          | 20.3                | 1.8 TeV    | 850 GeV   | $m(\tilde{t}_1) = m(\tilde{b}_1)$  | 1507.0525            |
| Inclusive Searches                                  | $gg \rightarrow \gamma\gamma$   | 0                           | 2-6 jets     | Yes                 | 20.3       | 100-440 GeV   | $m(\tilde{t}_1) = 0 \text{ GeV}, m(\tilde{t}_2) = 10 \text{ GeV}$  | 1405.7875            |
|   | $gg \rightarrow \gamma\gamma$ (compressed)  | monojet                     | 1-2 jets     | Yes                 | 20.3       | 760 GeV   | $m(\tilde{t}_1) = m(\tilde{b}_1) = 110 \text{ GeV}$  | 1507.0525            |
|   | $gg \rightarrow \gamma\gamma$ (with $\tilde{t}_1$ )   | $2 < \mu < 2$               | 2 jets       | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}$   | 1503.0590            |
|   | $gg \rightarrow \gamma\gamma$   | 0                           | 2-6 jets     | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}$   | 1405.7875            |
|   | $gg \rightarrow \gamma\gamma$ (with $\tilde{t}_1$ )   | $0 < \mu < 2$               | 2 jets       | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 300 \text{ GeV}, m(\tilde{t}_2) = 0.5 m(\tilde{t}_1), m(\tilde{b}_1) = 0$                    | 1507.0525            |
|   | $gg \rightarrow \gamma\gamma$ (with $\tilde{t}_1$ )   | $2 < \mu < 2$               | 0-3 jets     | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}$   | 1501.0555            |
|   | CMSSM (w/ NLSP)   | $1 < \mu < 1, 0 < \tau < 2$ | 0-2 jets     | Yes                 | 20.3       |   | long $\tilde{t}_1$   | 1407.0003            |
|   | GGIM (w/ NLSP)  | 2                           | 0            | Yes                 | 20.3       |   | $r(NLSP) > 0.1 \text{ mm}$   | 1507.05493           |
|   | GGIM (higgsino bino NLSP)   | 7                           | 1-8          | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 300 \text{ GeV}, m(NLSP) = 0.1 \text{ mm}, \mu = 0$  | 1507.05493           |
|   | GGIM (higgsino bino NLSP)   | 7                           | 2 jets       | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 800 \text{ GeV}, m(NLSP) = 0.1 \text{ mm}, \mu = 0$  | 1503.05290           |
| GGIM (higgsino NLSP)                                | $2 < \mu < 2$   | 2 jets                      | Yes          | 20.3                |            | $m(NLSP) = 430 \text{ GeV}$   | 1503.05290   |                      |
| Gravitino LSP                                       | 0   | monojet                     | Yes          | 20.3                |            | $m(\tilde{g}) = 1.8 \text{ TeV}, m(\tilde{u}_L) = m(\tilde{d}_L) = 1.5 \text{ TeV}$ | 1502.01518   |                      |
| 3 $\gamma$ dim. $\tilde{g}$ prod.                   | $gg \rightarrow \tilde{g}\tilde{g}$   | 0                           | 3-6          | Yes                 | 20.1       |   | $m(\tilde{t}_1) = 400 \text{ GeV}$   | 1407.0000            |
|   | $gg \rightarrow \tilde{g}\tilde{g}$   | 0                           | 7-10 jets    | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 350 \text{ GeV}$   | 1308.1841            |
|   | $gg \rightarrow \tilde{g}\tilde{g}$   | $0 < \mu < 3$               | 3-6          | Yes                 | 20.1       |   | $m(\tilde{t}_1) = 400 \text{ GeV}$   | 1407.0000            |
|   | $gg \rightarrow \tilde{g}\tilde{g}$   | $0 < \mu < 3$               | 3-6          | Yes                 | 20.1       |   | $m(\tilde{t}_1) = 300 \text{ GeV}$   | 1407.0000            |
| 3 $\gamma$ dim. $\tilde{g}$ prod.                   | $b\bar{b}, b_s \rightarrow \tilde{g}\tilde{g}$  | 0                           | 2-6          | Yes                 | 20.1       |   | $m(\tilde{t}_1) = 90 \text{ GeV}$  | 1308.2031            |
|   | $b\bar{b}, b_s \rightarrow \tilde{g}\tilde{g}$  | $2 < \mu < 2$               | 0-3-6        | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 2m(\tilde{t}_2), m(\tilde{t}_2) = 50 \text{ GeV}$  | 1404.2500            |
|   | $b\bar{b}, b_s \rightarrow \tilde{g}\tilde{g}$  | $1 < \mu < 1, 2 < \tau < 2$ | 1-2-6        | Yes                 | 4.720.3    |   | $m(\tilde{t}_1) = 2m(\tilde{t}_2), m(\tilde{t}_2) = 50 \text{ GeV}$  | 1209.2102, 1407.0563 |
|   | $b\bar{b}, b_s \rightarrow \tilde{g}\tilde{g}$ or $\tilde{t}_1\tilde{t}_1$  | $0 < \mu < 2, 0 < \tau < 2$ | 0-2-6        | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}$   | 1306.0616            |
| 3 $\gamma$ dim. $\tilde{g}$ prod.                   | $b\bar{b}, b_s \rightarrow \tilde{g}\tilde{g}$  | 0                           | monojet+tag  | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 185 \text{ GeV}$   | 1407.0008            |
|   | $b\bar{b}, b_s \rightarrow \tilde{g}\tilde{g}$  | $2 < \mu < 2$               | 1-6          | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 150 \text{ GeV}$   | 1403.3222            |
|   | $b\bar{b}, b_s \rightarrow \tilde{g}\tilde{g}$  | $3 < \mu < 2$               | 1-6          | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 200 \text{ GeV}$   | 1403.3222            |
|   | $b\bar{b}, b_s \rightarrow \tilde{g}\tilde{g}$  | $3 < \mu < 2$               | 1-6          | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 200 \text{ GeV}$   | 1403.3222            |
| EW direct   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$   | $2 < \mu < 2$               | 0            | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}$   | 1403.3294            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$   | $2 < \mu < 2$               | 0            | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}, m(\tilde{t}_2) = 0.5 m(\tilde{t}_1), m(\tilde{b}_1) = 0$                      | 1403.3294            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$   | $2 < \mu < 2$               | 0            | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}, m(\tilde{t}_2) = 0.5 m(\tilde{t}_1), m(\tilde{b}_1) = 0$                      | 1407.2280            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$   | $2 < \mu < 2$               | 0-2 jets     | Yes                 | 20.3       |   | $m(\tilde{t}_1) = m(\tilde{b}_1), m(\tilde{t}_2) = 0, m(\tilde{b}_2) = 0, m(\tilde{t}_1) = 0.5 m(\tilde{t}_2)$ | 1403.3294, 1402.7029 |
| EW direct   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$   | $2 < \mu < 2$               | 0-2 jets     | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}, m(\tilde{t}_2) = 0, m(\tilde{b}_1) = 0, m(\tilde{b}_2) = 0$                   | 1501.0710            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$   | $2 < \mu < 2$               | 0-2 jets     | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}, m(\tilde{t}_2) = 0, m(\tilde{b}_1) = 0, m(\tilde{b}_2) = 0$                   | 1405.0096            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$   | $2 < \mu < 2$               | 0-2 jets     | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}, m(\tilde{t}_2) = 0, m(\tilde{b}_1) = 0, m(\tilde{b}_2) = 0$                   | 1507.05493           |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$   | $2 < \mu < 2$               | 0-2 jets     | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0 \text{ GeV}, m(\tilde{t}_2) = 0, m(\tilde{b}_1) = 0, m(\tilde{b}_2) = 0$                   | 1507.05493           |
| Long-lived particle                                 | Direct $\tilde{t}_1\tilde{t}_1$ prod. long-lived $\tilde{t}_1$  | Discapp. thk.               | 1 jet        | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 160 \text{ MeV}, m(\tilde{t}_2) = 0.2 \text{ ns}$  | 1310.3075            |
|   | Direct $\tilde{t}_1\tilde{t}_1$ prod. long-lived $\tilde{t}_1$  | discapp. thk.               | 0            | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 160 \text{ MeV}, m(\tilde{t}_2) = 15 \text{ ns}$   | 1508.0330            |
|   | Stable, stopped $\beta$ R-hadron  | 0                           | 1-5 jets     | Yes                 | 27.9       |   | $m(\tilde{t}_1) = 100 \text{ GeV}, 10 \mu\text{s} < \tau < 1000 \text{ s}$                                     | 1316.6584            |
|   | Stable $\beta$ R-hadron   | thk.                        | 0            | Yes                 | 18.1       |   |  | 1411.6795            |
| RPV   | CMSSM, stable $\tilde{t}_1, \tilde{t}_1 \rightarrow 10, \beta, \tau, \mu, e, \nu_\tau$  | $1 < \mu < 1$               | 0            | Yes                 | 20.3       |   | $10^{-4} \text{ tag} < 50$   | 1411.6795            |
|   | CMSSM, $\tilde{t}_1 \rightarrow \nu, \tilde{t}_1 \rightarrow 10, \beta, \tau, \mu, e, \nu_\tau$   | $2 < \mu < 2$               | 0            | Yes                 | 20.3       |   | $2 < \tau < 3 \text{ ns}, \text{SPS8 model}$   | 1409.0542            |
|   | GGIM, $\tilde{t}_1 \rightarrow \nu, \tilde{t}_1 \rightarrow 10, \beta, \tau, \mu, e, \nu_\tau$  | discapp. thk./mu            | 0            | Yes                 | 20.3       |   | $7 < \tau < 100 \text{ mm}, m(\tilde{t}_1) < 3 \text{ TeV}$  | 1504.0162            |
|   | GGIM, $\tilde{t}_1 \rightarrow \nu, \tilde{t}_1 \rightarrow 10, \beta, \tau, \mu, e, \nu_\tau$  | discapp. thk./mu            | 0            | Yes                 | 20.3       |   | $6 < \tau < 10^4 < 480 \text{ mm}, m(\tilde{t}_1) < 1.5 \text{ TeV}$   | 1504.0162            |
| Other   | LFV $\tilde{g}\tilde{g} \rightarrow \tilde{g}\tilde{g}, \tilde{g}\tilde{g} \rightarrow \tilde{g}\tilde{g}, \tilde{g}\tilde{g} \rightarrow \tilde{g}\tilde{g}$                     | $0 < \mu < 2$               | 0-3-6        | Yes                 | 20.3       |   | $A_{\tilde{g}\tilde{g}\tilde{g}} = 11, A_{\tilde{g}\tilde{g}\tilde{g}} = 0.07$                                 | 1503.0440            |
|   | Bilinear RPV CMSSM  | $2 < \mu < 2$               | 0-3-6        | Yes                 | 20.3       |   | $m(\tilde{g}) = 0, \tau < 1 \text{ mm}$  | 1404.2500            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$ | $4 < \mu < 4$               | 0            | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0.2 m(\tilde{t}_2), L_{\tilde{t}_1} = 0$   | 1405.5088            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$ | 0                           | 0-7 jets     | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 0.2 m(\tilde{t}_2), L_{\tilde{t}_1} = 0$   | 1502.0588            |
| Other   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$ | $2 < \mu < 2$               | 0-3-6        | Yes                 | 20.3       |   | $m(\tilde{t}_1) = 600 \text{ GeV}$   | 1502.0588            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$ | 0                           | 0-7 jets     | Yes                 | 20.3       |   |  | 1404.2500            |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$ | $2 < \mu < 2$               | 2 jets + 2 b | Yes                 | 20.3       |   |  | ATLAS CONF-2015-026  |
|   | $\tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1, \tilde{t}_1\tilde{t}_1 \rightarrow \tilde{t}_1\tilde{t}_1$ | $0 < \mu < 2$               | 2-6          | Yes                 | 20.3       |   |  | ATLAS CONF-2015-015  |
| Scalar charm, $\tilde{t}_1 \rightarrow \tilde{t}_1$ | 0   | 2 c                         | Yes          | 20.3                |            |   | 1501.0125  |                      |

\*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1 $\sigma$  theoretical signal cross section uncertainty.



**Caveat** : These limits are **strongly dependent** upon the underlying (simplified) model assumptions!

# Why recast LHC searches?

$$\frac{N_{\text{theo. models}}}{N_{\text{exp. analyses}}} \rightarrow \infty$$

Various groups have investigated the problem and developed tools based on two different approaches

## SMS approach

Decompose a model signal in terms of simplified models (SMS) topologies

Through efficiency maps or comparing with cross sections upper limits determine if a given model is allowed or excluded

**Fastlim** [Papucci et al. 1402.0492]  
**SModelS** [Kraml et al. 1312.4175]  
**XQCAT** [DB et al. 1409.3116]

## Recast approach

Implement analysis selections in a computer code that allows to test MC events for any given model

For the same models interpreted by ATLAS and CMS, the code should give consistent results: **validation**

**ATOM** (not public) [Papucci et al]  
**Checkmate** [Drees et al. 1312.2591]  
**MadAnalysis 5** [Conte et al. 1206.1599]  
**+ MA5 PAD** [Conte et al. 1405.3982, Dumont et al. 1407.3278]

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No need to generate MC events ✓  
Simplified model do not cover all possibilities ✗

Fast method, but with limitation

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Need to generate MC events ✗  
Can cover **any BSM model** ✓  
Analyses can be **shared** ✓✓✓

Maybe slower, but huge potential !!!

# MadAnalysis 5 PAD

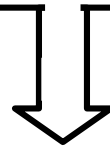
MA5 is a **public framework** for **phenomenological** analyses

Analyse MC events at different particle level: parton, hadronic or detector reconstructed

Analyse MC events in a **normal** or **expert** mode

**Normal mode:** simple commands in a python interface  
output of analysis in a human-readable output (HTML and LaTeX)  
built in function for basic kinematic variables  
ideal for preliminary/simple event analysis

**Expert mode:** Code an analysis in a C++ format within the SampleAnalyzer framework  
Possibility to implement (almost) all the selections adopted in LHC searches  
Ideal for high level phenomenological analysis



This leads to the idea of a Public Analyses Database (PAD)

# MadAnalysis 5 PAD

Choose an experimental analysis that, e.g., might have potentiality to **cover not yet explored scenarios**

Understand the selections cuts that the analysis enforces to select signal regions (SRs)

Test the code with MC samples of the **same model points** adopted by the experimental collaborations

**Implement the selection cuts** in a C++ code with the help of built in functions (for example to compute particle isolations)

**Get the same final number of events** as the exp. analysis (easy to say, hard to obtain...)

Get the same exclusion CL  
 $CLs(\text{signal}, \text{bg}, \Delta \text{bg}, \text{data})$



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**Share the code** with the hep community for other pheno studies

Apply it to your model and obtain your results (easy/hard task... depends...)

Create a **public database of analyses** MA5 PAD [Dumont et al. 1407.3278]

This might show some **blind spots** of present analyses to certain models  
Possibility to **propose different selections** more sensitive to a particular scenario

# MadAnalysis 5 PAD

The construction of a PAD is well under way <https://madanalysis.irmp.ucl.ac.be/wiki/PublicAnalysisDatabase>

| Analysis                                       | Short Description                         | Implemented by          | Code                    | Validation note                                    | Version |
|--|---|-------------------------|-------------------------|--|---------|
| <a href="#">ATLAS-SUSY-2013-05</a> (published) | stop/sbottom search: 0 leptons + 2 b-jets | G. Chalons              | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">figures</a>        | MA5tune |
| <a href="#">ATLAS-SUSY-2013-11</a> (published) | EWK-inos, 2 leptons + MET                 | B. Dumont               | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">source</a>         | MA5tune |
| <a href="#">ATLAS-HIGG-2013-03</a> (published) | ZH->ll+invisible                          | B. Dumont               | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">source</a>         | MA5tune |
| <a href="#">ATLAS-EXOT-2014-06</a> (published) | mono-photons + MET                        | D. Barducci             | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">MadGraph cards</a> | MA5tune |
| <a href="#">ATLAS-SUSY-2014-10</a> (published) | 2 leptons + jets + MET                    | B. Dumont               | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">source</a>         | MA5tune |
| <a href="#">ATLAS-SUSY-2013-21</a> (published) | 0 leptons + mono-jet/c-jets + MET         | G. Chalons, D. Sengupta | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">source</a>         | MA5tune |
| <a href="#">ATLAS-SUSY-2013-02</a> (published) | 0 leptons + 2-6 jets + MET                | G. Chalons, D. Sengupta | <a href="#">Inspire</a> | <a href="#">PDF</a>                                | MA5tune |

| Analysis                                   | Short Description   | Implemented by                | Code                        | Validation note  | Version       |
|--|---|-------------------------------|-----------------------------|--|---------------|
| <a href="#">CMS-SUS-13-011</a> (published) | stop search in the single lepton mode   | B. Dumont, B. Fuks, C. Wymant | <a href="#">Inspire</a> [1] | <a href="#">PDF</a> <a href="#">source</a>                         | MA5tune       |
| <a href="#">CMS-SUS-13-012</a> (published) | gluino/squark search in jet multiplicity and missing energy                             | S. Bein, D. Sengupta          | <a href="#">Inspire</a>     | <a href="#">PDF</a> <a href="#">source</a>                         | MA5tune       |
| <a href="#">CMS-SUS-13-016</a> (PAS)       | search for gluinos using OS dileptons and b-jets  | D. Sengupta, S. Kulkarni      | <a href="#">Inspire</a>     | <a href="#">PDF</a> <a href="#">source</a>                         | MA5tune       |
| <a href="#">CMS-SUS-14-001</a> (published) | Searches for third-generation squarks in fully hadronic final states (monojet analysis) | S. Sharma, S. Pandey          | <a href="#">Inspire</a>     | <a href="#">PDF</a>  | MA5tune       |
| <a href="#">CMS-B2G-12-012</a> (published) | T5/3 top partners in same-sign dilepton channel   | D. Barducci, C. Delaunay      | <a href="#">Inspire</a>     | <a href="#">PDF</a> <a href="#">source</a> , <a href="#">cards</a> | v1.2/Delphes3 |

# MadAnalysis 5 PAD

The construction of a PAD is well under way <https://madanalysis.irmp.ucl.ac.be/wiki/PublicAnalysisDatabase>

| Analysis                                       | Short Description                         | Implemented by          | Code                    | Validation note                                    | Version |
|--|---|-------------------------|-------------------------|--|---------|
| <a href="#">ATLAS-SUSY-2013-05</a> (published) | stop/sbottom search: 0 leptons + 2 b-jets | G. Chalons              | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">(figures)</a>      | MA5tune |
| <a href="#">ATLAS-SUSY-2013-11</a> (published) | EWK-inos, 2 leptons + MET                 | B. Dumont               | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">(source)</a>       | MA5tune |
| <a href="#">ATLAS-HIGG-2013-03</a> (published) | ZH->ll+invisible                          | B. Dumont               | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">(source)</a>       | MA5tune |
| <a href="#">ATLAS-EXOT-2014-06</a> (published) | mono-photons + MET                        | D. Barducci             | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">MadGraph cards</a> | MA5tune |
| <a href="#">ATLAS-SUSY-2014-10</a> (published) | 2 leptons + jets + MET                    | B. Dumont               | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">(source)</a>       | MA5tune |
| <a href="#">ATLAS-SUSY-2013-21</a> (published) | 0 leptons + mono-jet/c-jets + MET         | G. Chalons, D. Sengupta | <a href="#">Inspire</a> | <a href="#">PDF</a> <a href="#">(source)</a>       | MA5tune |
| <a href="#">ATLAS-SUSY-2013-02</a> (published) | 0 leptons + 2-6 jets + MET                | G. Chalons, D. Sengupta | <a href="#">Inspire</a> | <a href="#">PDF</a>                                | MA5tune |

| Analysis                                   | Short Description   | Implemented by                | Code                        | Validation note  | Version       |
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| <a href="#">CMS-SUS-13-011</a> (published) | stop search in the single lepton mode   | B. Dumont, B. Fuks, C. Wymant | <a href="#">Inspire</a> [1] | <a href="#">PDF</a> <a href="#">(source)</a>                         | MA5tune       |
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Information **Citations (1)** Files Data

## MadAnalysis 5 implementation of ATLAS-EXOT-2014-06

Daniele Barducci (LAPTH, Annecy-le-Vieux)

**Description:** This is the MadAnalysis 5 implementation of the ATLAS mono-photon search with 20.3/fb at 8 TeV, to be used for re-interpretation studies.

Note: Information how to use this code as well as a detailed validation summary are available at <http://madanalysis.irmp.ucl.ac.be/wiki/PhysicsAnalysisDatabase>

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Record added 2015-03-22, last modified 2015-11-13

Information Citations (0) Files Data

[MadAnalysis 5 implementation of ATLAS-EXOT-2014-06 - Daniele Barducci](#)

ATLAS\_EXOT\_2014\_06

- [ATLAS\\_EXOT\\_2014\\_06.cpd](#) [10.38 KB] 23 Mar 2015, 14:53
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Record added 2015-03-22, last modified 2015-11-13

Details of the validation are **public** and provided in the **validation notes!!!**

Information Citations (0) Files Data

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# MadAnalysis 5 PAD

## Dark Matter searches in the PAD

### Monojet searches

- [ATLAS-SUSY-2013-021](#): compressed SUSY
- [CMS-SUS-14-001](#): compressed SUSY
- [CMS-EXO-12-048](#): non SUSY (soon)

### Monophoton searches

- [ATLAS-EXOT-2014-006](#): non SUSY
- [CMS-EXO-12-047](#): non SUSY (soon)

**Validation:** Reproducing (with [some degree of accuracy](#)) the exp. results is not always a trivial task

**Problem 1.** [Fast detector simulation](#) tools (e.g. Delphes) can not reproduce the degree of accuracy of full experimental simulations.

This is an intrinsic difference between a theory/pheno and an experimental study  
We accept this and we aim to reproduce exp. results within a certain accuracy

**Problem 2.** Sometimes not enough details of exp. analyses are provided

This is a problem that can be overcome by working close with exp. colleagues

# Validation of a search

Example: ATLAS-EXOT-2014-06 Monophoton search

[Phys. Rev. D 91, 012008 \(2015\)](#)

[Erratum](#)

3 November 2014

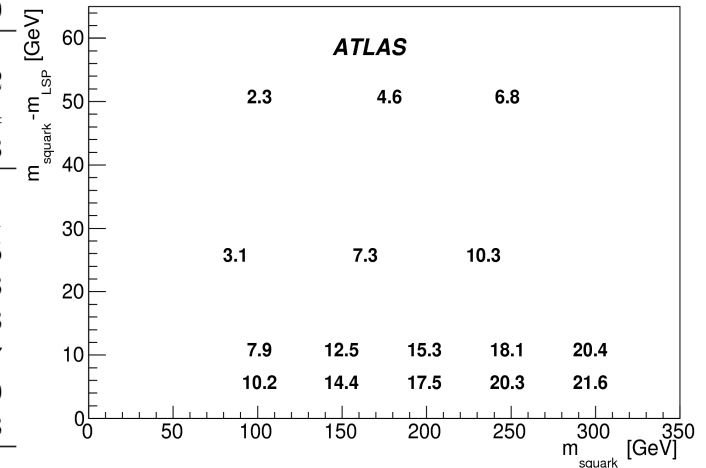
e-print [arXiv:1411.1559](#)

[Inspire record](#)

[Data points](#)

[Figures, Tables and Auxiliary Material](#)

|   |      |
|---|------|
| Nominal   | 9989 |
| <b>Pre-selected:</b>  |      |
| 1. Trigger  | 8582 |
| 2. Good vertex  | 8574 |
| 3. Cleaning cuts  | 8213 |
| <b>SR Cuts:</b>   |      |
| 1. $E_T^{\text{miss}} > 150$ GeV  | 4131 |
| 2. At least one loose photon with $p_T > 125$ GeV ( $ \eta  < 2.37$ )                               | 2645 |
| 3. The leading photon is tight with $ \eta  < 1.37$   | 2068 |
| 4. The leading photon is isolated   | 1898 |
| 5. $\Delta\phi(\gamma^{\text{leading}}, \mathbf{E}_T^{\text{miss}}) > 0.4$                          | 1887 |
| 6. Jet veto: $N_{\text{jet}} \leq 1$ and $\Delta\phi(\text{jet}, \mathbf{E}_T^{\text{miss}}) > 0.4$ | 1219 |
| 7. Lepton veto  | 1188 |



## Extremely well documented search:

- SLHA cards for signal points on HEPdata ✓
- HelpPlots of A x Eff. [all the signal points](#) ✓
- No histograms for signal distributions x
- Cutflow for a signal point on the Twiki ✓
- ATLAS provided us with MG cards ✓✓

Easy comparison of our simulation with the available information: [efficiencies and exclusion plots...](#)

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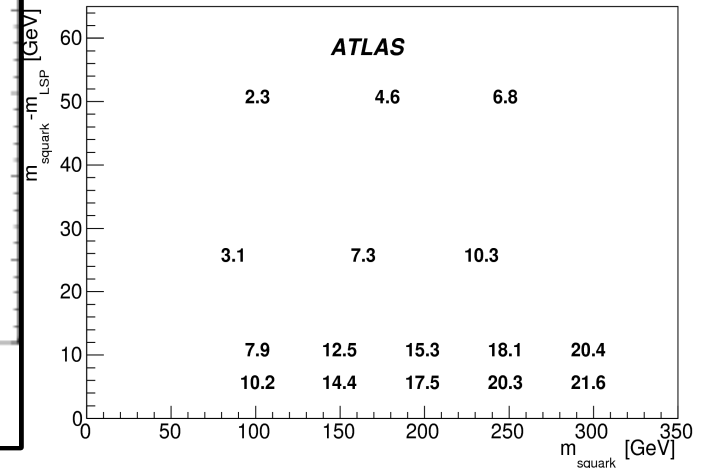
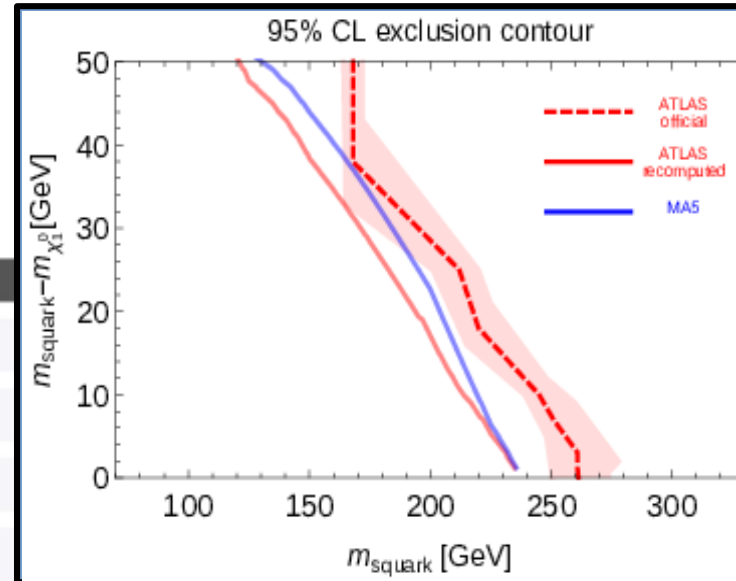
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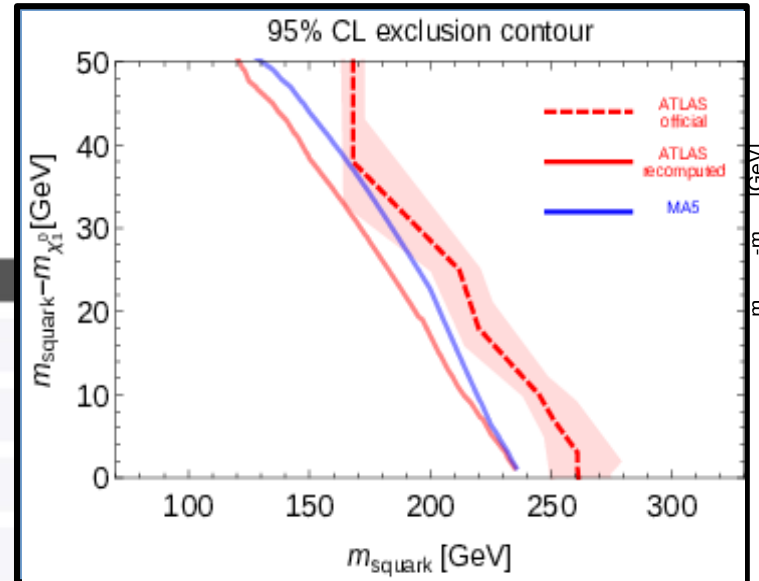
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# Recaster wishlist

## Implementation

- Clear description of all the cuts, including their sequence
- Efficiencies for reconstructing physics objects: electrons, muons, taus, b/c tagging...
- Efficiencies for triggers, event cleaning, i.e anything that can not be reproduced within a fast detector simulation

## Validation

- Exact configuration of MonteCarlo tools (MadGraph, CalcHEP, PYTHIA)  
version, input card and settings...
- Clear description of the generated process  
Number of extra partons generated, cross section order...
- Clear definition of benchmark points for all SRs (masses, couplings, widths...)  
SLHA or other input cards, LHE parton level events...
- Detailed cutflows for (at least) one benchmark point  
Including (pre)selection requirements...
- Plots of kinematic distributions for (at least) one benchmark points  
After different cut selection...
- Acceptance and efficiencies for simulated signal points

# Conclusions

- Reinterpreting the LHC analyses is crucial to fully exploit the data that the LHC has delivered
- Two complementary approaches are possible: **simplified models** and **analyses recast**
- Through the recast approach we can aim at the creation of a database of recast analyses
- These analyses are available for **all the hep community** for pheno studies

- The MadAnalysis 5 framework is an **active project**
- MadAnalysis 5 PAD is a project that requires **manpower** to expand: we encourage colleagues to **validate** their search and **share** the results on the PAD database

- ATLAS and CMS analyses are generally very well documented
- Always need a complete set of basic information to allow recast the analyses
- HEPdata, twiki... are powerful platforms to share this information
- Also goes in the direction of preserving analyses in time

Looking forward for first 13 TeV analyses

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Thank you!!!