



Session 2: Tools & MC

BSM modelling and interpretation

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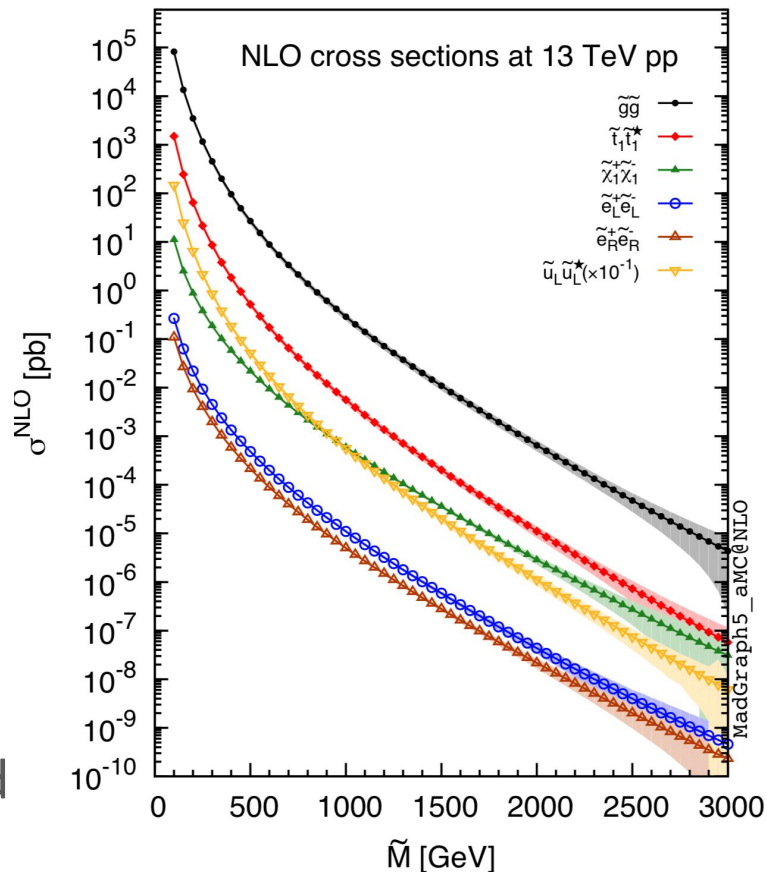
MC for BSM in 2019

BSM signal toolchain

- ❖ FeynRules \leadsto UFO \leadsto MG5 \leadsto shower...
- ❖ **Works** at LO & NLO QCD [now]

Bottlenecks for BSM

- ❖ Plethora of models
 - \leadsto where to go?
 - \leadsto Technically: everything is available
- ✓ Not directly dealing with SM background



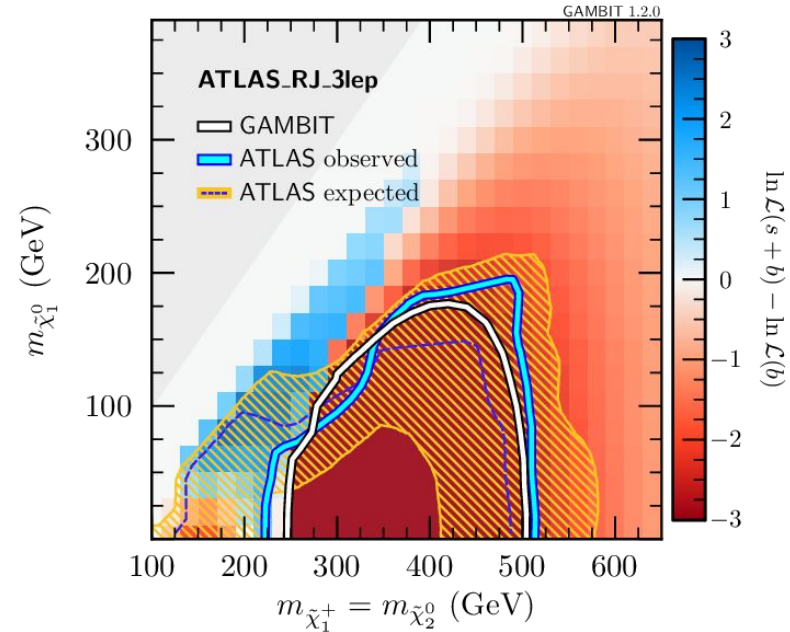
Reinterpretation landscape

Several reinterpretation codes:

- ❖ CheckMATE, Contur, Gambit, MadAnalysis 5, SModelS
[represented at Les Houches & public]
- ❖ ATOM, MasterCode
[not at Les Houches and not public]

Main advantages of such a diversity

- ❖ Complementarities
- ❖ Cross validations
- ❖ Some codes have more specific features



Searches vs measurements

“SM” measurements as probes to BSM

- ❖ Easy comparison: Contur
- ❖ Complementary to searches

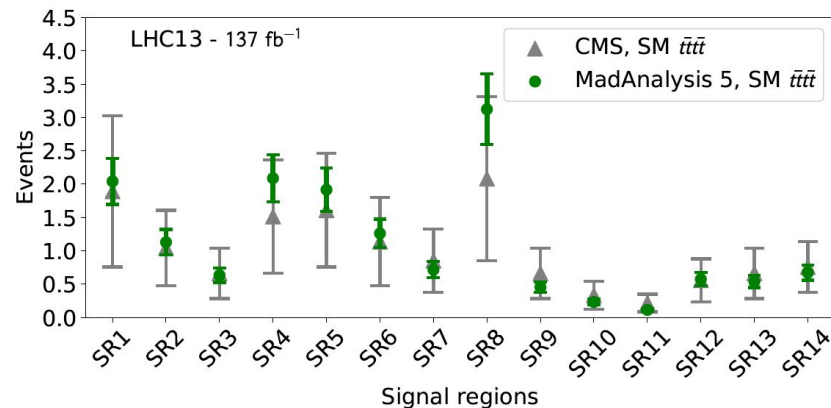
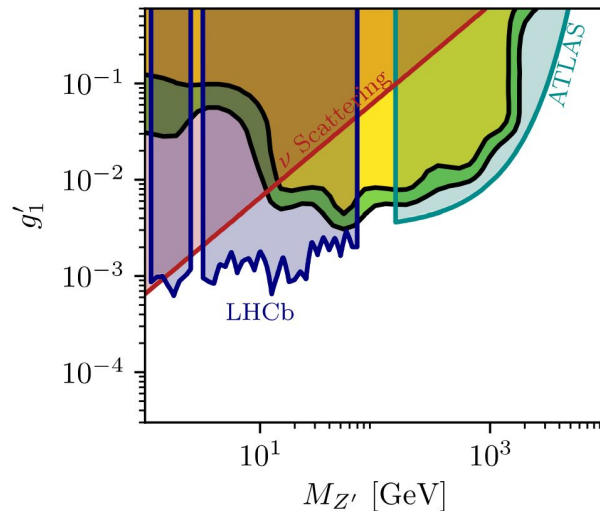
No explicit *combination* so far

- ❖ **First attempts here?**
- ❖ Any significant correlations?

Also new: MadAnalysis 5 *tttt*

“Extreme measurements”

↪ control regions, ...?



Reinterpretation potential projects

Public collider interpretation/preservation codes:

- ❖ CheckMATE, ColliderBit, MadAnalysis5, Rivet, SModelS

Duplication

- ❖ Useful cross-checks (same physics from different methods)
- ❖ Issues: **finish LH2017 comparison project** (?)

Design of a new common analysis language

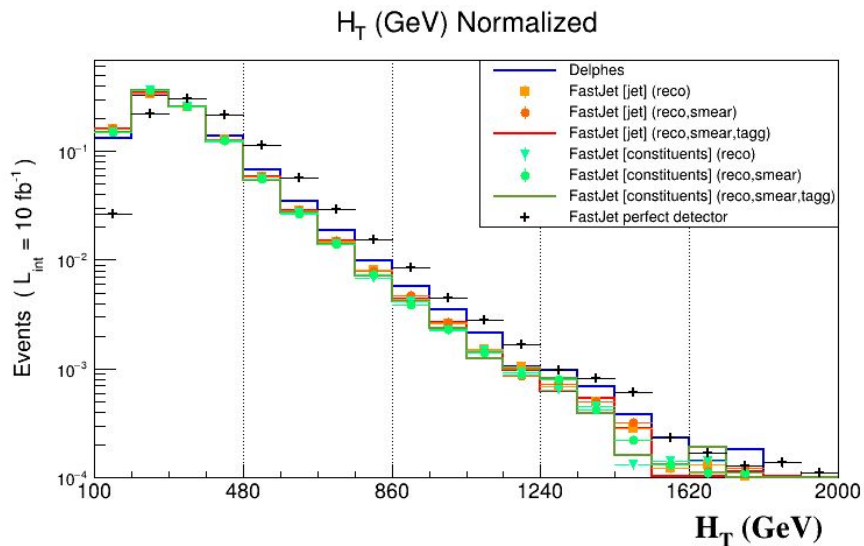
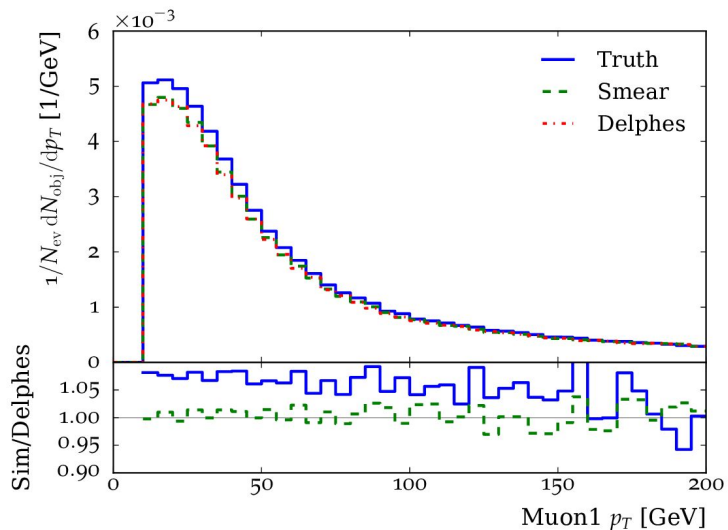
- ❖ Replacing all other (code-specific) formats
- ❖ Too ambitious and progress slow

↪ **Easier ways towards interoperability?**

Maybe **common steering**, maybe a simple subset of searches...

Detector effects

Most BSM results not corrected for detector bias → **fast emulation**
Implementations: Delphes, Rivet, Gambit, MadAnalysis 5. **Scaling?**



Delphes vs smearing

Monolithic fastsim working too hard?

Scaling vs MadAnalysis5 smearing:

Sample size	Output file size			Event reconstruction time		
	Delphes (.root)	FastJet (.lhe) [jet]	FastJet (.lhe) [constituents]	Delphes	FastJet [jet]	FastJet [constituents]
1k	83.1 Mb	3.3 Mb	3.5 Mb	39.64(± 0.5) seconds	33.76 seconds	33.90 seconds
10k	816.0 Mb	33.0 Mb	35.1 Mb	4 minutes 53.5 (± 0.5) seconds	3 minutes 18 seconds	3 minutes 12 seconds
25k	2.0 Gb	82.6 Mb	87.8 Mb	11 minutes 45.5(± 0.5) seconds	7 minutes 43 seconds	8 minutes 17 seconds
50k	4.1 Gb	165.1 Mb	175.7 Mb	23 minutes 23.5 (± 0.5) seconds	14 minutes 30 seconds	15 minutes 27 seconds
75k	6.1 Gb	247.4 Mb	263.2 Mb	36 minutes 50.5 (± 0.5) seconds	21 minutes 42 seconds	22 minutes 53 seconds
100k	8.2 Gb	330.1 Mb	351.4 Mb	45 minutes 37.5 (± 0.5) seconds	32 minutes 17 seconds	29 minutes 50 seconds

Published search info - preservation (1/2)

Experimental efforts towards **SR combinations** (vs. single-SR usage)

- ❖ CMS releases covariance matrices \leadsto simplified likelihoods
- ❖ ATLAS: does nothing... (**yet?**) \leadsto Python HistFactory (pyhf) soon?

Usage & extension of Simplified Likelihoods started at last LH

- ❖ Useful? **How to move on?** Should we?
- ❖ Convergence of scans with large numbers of SRs: strategies?
 - Explore use of generation biasing for distribution tails
- ❖ Or... preservation of full likelihoods (*e.g.* via pyhf files)?

Next-to-simplified likelihoods

Work started at LH 2017

↪ continued at Natal in Nov 2017

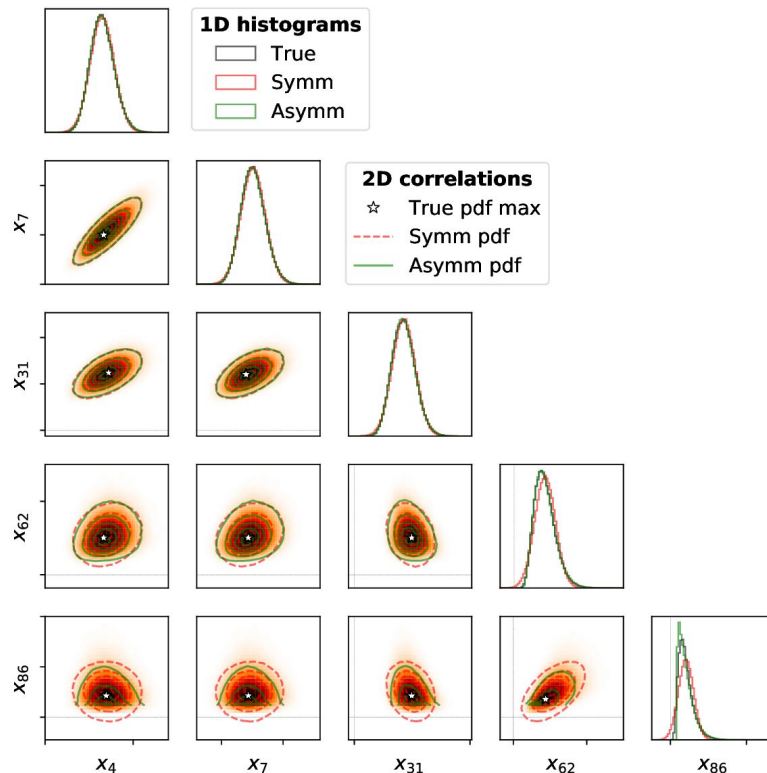
↪ **NSL, with non-linear Δ -rate**

Leading correction to Gaussian rate

↪ solves low-rate problems

↪ **just N_{SR} extra number**

[Paper](#), [reference code](#)



Published search info - preservation (2/2)

Extra needs (**validation** of the recasting codes)

- ❖ Cut flows for well defined scenarios (SLHAs)
- ❖ Exact generator steering (generation bias)
- ❖ Sharing codes!

Searches for New Physics: Les Houches Recommendations for the Presentation of LHC Results

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Community statements

- ❖ A first try in LH 2011
 - ↪ [Eur. Phys. J. C 72 \(2012\) 1976](#)
- ❖ **2019 extension underway**
 - ↪ [Overleaf link](#)

Abstract

We present a set of recommendations for the presentation of LHC results on searches for new physics, which are aimed at providing a more efficient flow of scientific information between the experimental collaborations and the rest of the high energy physics community, and at facilitating the interpretation of the results in a wide class of models. Implementing these recommendations would aid the full exploitation of the physics potential of the LHC.

Long-lived particle searches

- ❖ Long-lived leptons in MadAnalysis 5
 - ↪ via Delphes 3.4.2
 - ↪ extra dependence on d_0 , dz
- ❖ Recasting with displaced jets
 - open problem...

Region	$c\tau_{\tilde{t}}$ [cm]	MA5	CMS	Difference [%]
SR-I	0.1	3.89	3.8	2.30
	1	4.44	5.2	14.51
	10	0.697	0.8	12.84
	100	0.0610	0.009	> 100%
SR-II	0.1	0.924	0.94	1.71
	1	3.87	4.1	5.61
	10	0.854	1.0	14.58
	100	0.0662	0.03	~ 100%
SR-III	0.1	0.139	0.16	12.84
	1	6.19	7.0	11.59
	10	4.45	5.8	23.56
	100	0.497	0.27	~ 100%

Summary: many potential tools projects

- ❖ Recasting comparisons, tool interactions
- ❖ SM vs BSM complementarities and model studies
- ❖ Preservation: likelihoods, convergence, MC strategies
- ❖ LLP fastsim & recasting (focus on displaced jets)