


BMS Tools and MC during LH17: naïve (SM) experimentalist's view

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together with Peter Richardson and Fabio Maltoni

Les Houches Session 2
June 15th 2017

Where to start

From the twiki, obviously



The screenshot shows a web browser window with the address bar containing the URL <https://phystev.cnrs.fr/wiki/2017:topics>. The page content is as follows:

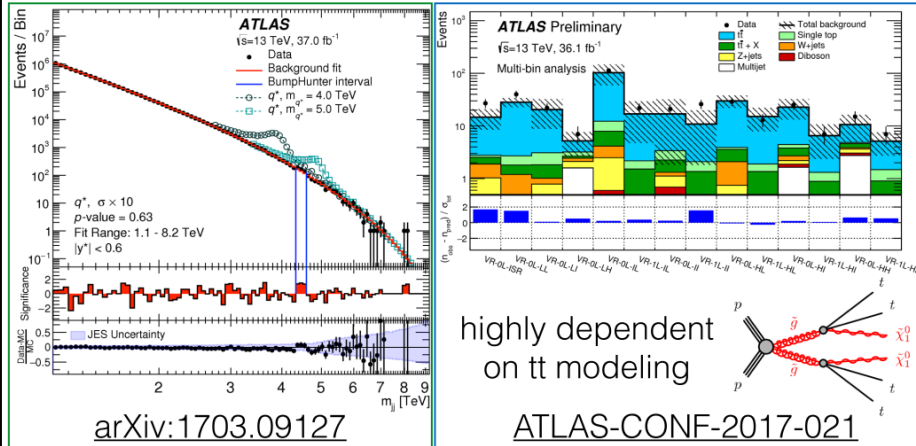
BMS tools and MC (from LP, FM,PR)

- EFT top/Higgs : basis, NLO corrections, applications...
- Dark Matter specific tools: current challenges for s-channel/t-channel simplified models. NLO?
- Recasting/presenting experimental results
- Simplified Models
- MC comparisons in BMS phase spaces (in overlap with SM session)
- Boosted SM objects as probes for BSM searches (in overlap with SM session)

1

Introduction

- Some searches are *nearly* independent of the quality of Monte Carlo, **while many are not**



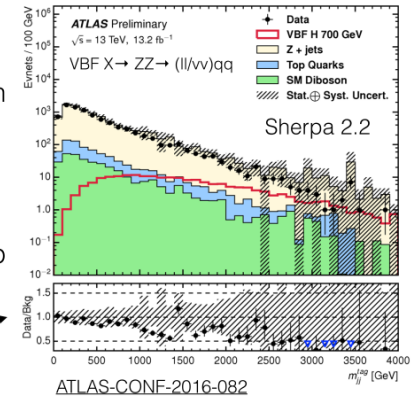
2

Extremes

Many BSM searches live in the **extremes** of phase space

Dependence on:

- top p_T** in top pair production events
 - V p_T** in V+Jets events
 - high jet multiplicities** in top and V+jets events
 - VBF** phase-space
- Many topics already discussed in this workshop so will not go into much detail on these points



3

UCL

More Than Limits

- How to compare currently **non-unfolded distributions** to new MC version outside of ATLAS?
- We often reweigh or only show "post-fit" MC.
If given MC before this, would it be useful?
- Is **folding i.e. via Rivet routines** a viable option?
- What *regions of phase space near where searches are being done* are interesting to measure in order to understand MC better?
- If you had **one wish**, it would be to see a plot of...
- To what *extent is it important to unfold distributions* in order for generator authors to improve MC?

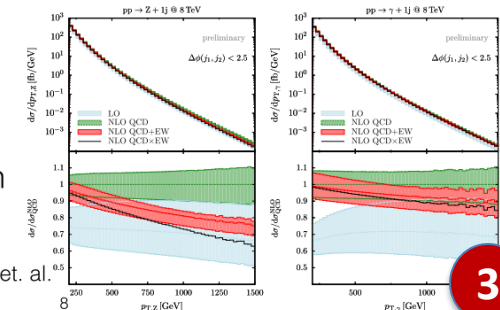
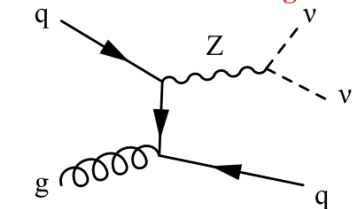


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EW Corrections

- larger datasets require more precision in the SM description
- calculations of EW corrections not readily available in public codes and can quickly become complicated for high multiplicities

Irreducible SM Background

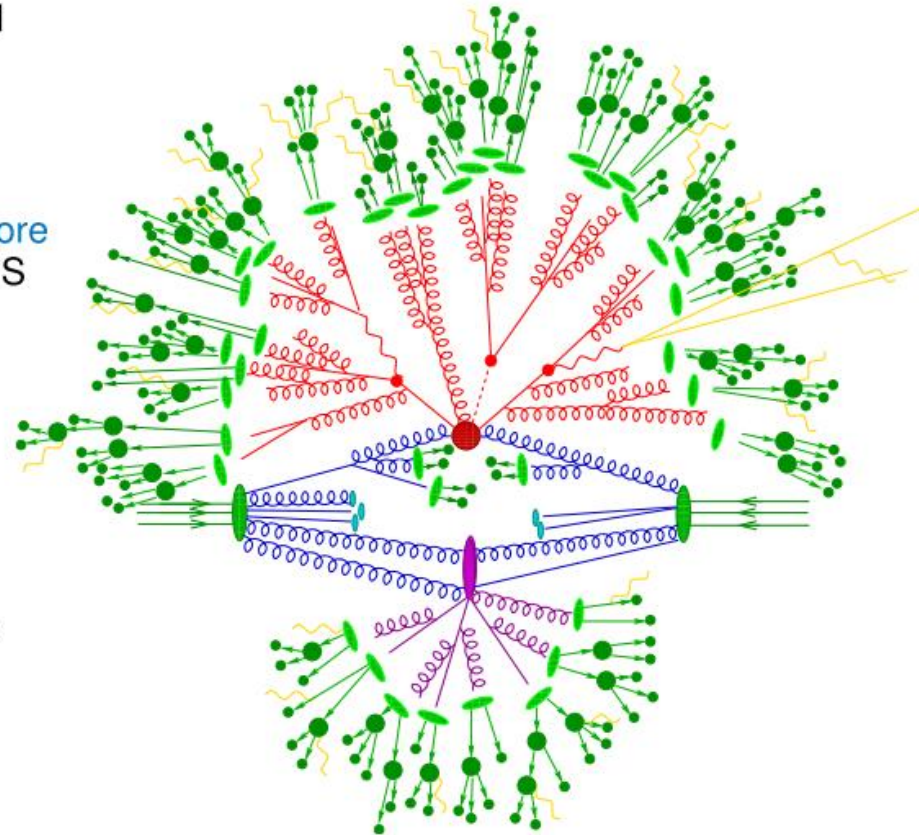


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From LH17 SM Tools and MC summary

- ▶ **precision measurements**: estimate uncertainties induced by our limited understanding of some aspects of fully-differential event generation
- ▶ identify where **better modeling is more urgent**, or where matching ME vs PS needs be improved
- ▶ **comparison** among different **state-of-the-art tools** and, where possible, higher logarithmic resummed (and matched) result:
 - ⇒ ultimate goal: move towards a better assessment of “**theory uncertainties**” for event generators
- ▶ studies involving MCs also in other subgroups...

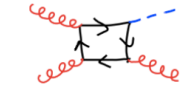
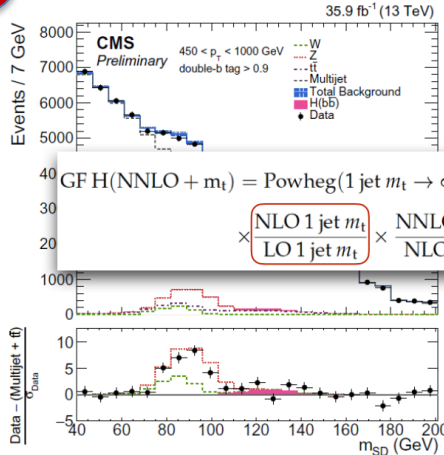


BSM and SM: different languages, different priorities?

Why bother with SM ?!?

SM measurement

1 Higgs @ large p_T :



only known to LO!

CMS-PAS-HIG-17-010

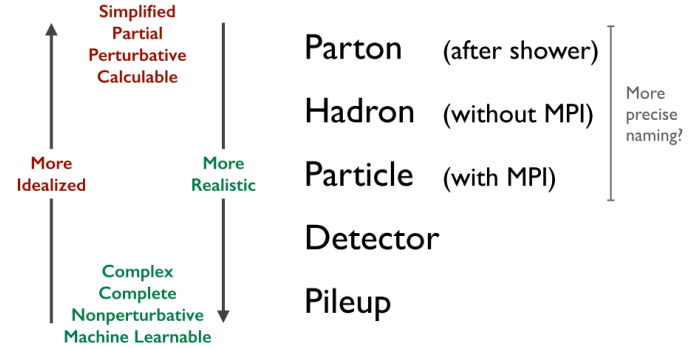
R. Harlander, Higgs Summary (TH), Les Houches 2017



Understand tools

Levels of Jet Understanding

Late night in the QCD room (and jet room)

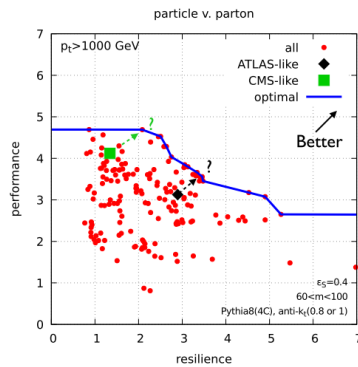


Resilient jet strategies exhibit similar behavior at all levels

Jose Thaler — Report of the Les Houches Jet Physics Subgroup(s)

Improve performance

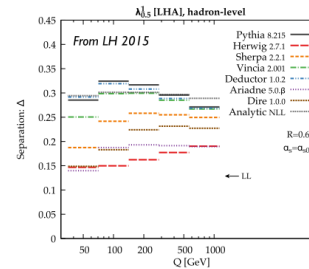
The Resilience Frontier



Looking forward to finding optimality contour for full parton \Rightarrow hadron \Rightarrow particle \Rightarrow detector \Rightarrow pileup chain

Reduce TH dependence

New Opportunities for 1-Prong Tagging



Assuming progress parton shower models by LH 2019...

...what physics analyses might benefit from quark/gluon tagging?

Eg.: dark matter mono-tagged-jet plus MET, quark-rich gluino cascade decays, pileup jet mitigation, double subject tagging in boosted hadronic W/Z, constrain parton showers using LEP data, resolving combinatorics in tt + jet, forward jet tagging in VBF/VBS, constraining PDFs with (N)NLO interplay, disentangle box/triangle graphs in high p_T Higgs, initial-state tagging using jet vetoes, ...

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Jose Thaler — Report of the Les Houches Jet Physics Subgroup(s)

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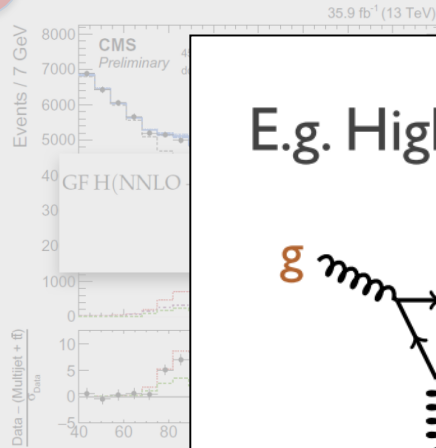
Jose Thaler — Report of the Les Houches Jet Physics Subgroup(s)

Why bother with SM ?!?

SM measurement

Understand tools

1 Higgs @ large p_T :



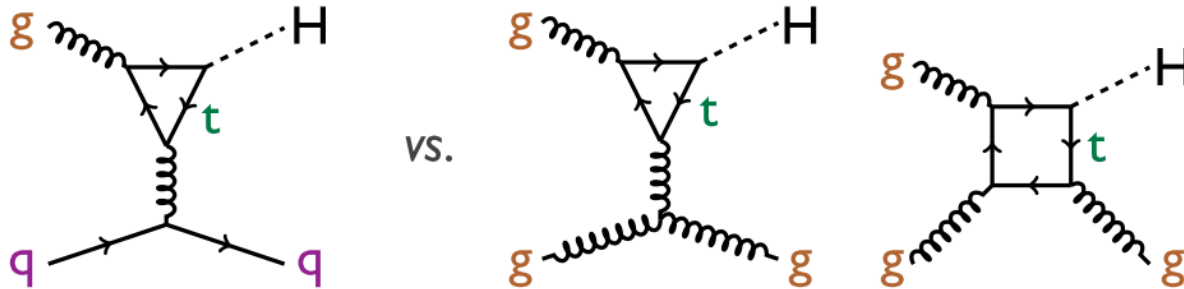
Levels of Jet Understanding

Late night in the QCD room (and jet room)

2

Make a meaningful BSM measurement

E.g. High- p_T Higgs Physics



Possible Strategy:

Target:

Tag Final State with Jet Substructure

Tag Initial State with Jet Vetoes

Explore non-trivial interplay

Disentangle (anomalous) Higgs couplings to top quarks and gluons

[see e.g. Ebert, Liebler, Moul, Stewart, F.Tackmann, K. Tackmann, Zeune, 1605.06114]

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Looking for Jesse Thaler — Report of the Les Houches Jet Physics Subgroup(s)

parton \Rightarrow hadron \Rightarrow particle \Rightarrow detector \Rightarrow pileup chain

4

Jesse Thaler — Report of the Les Houches Jet Physics Subgroup(s)

25

Jesse Thaler — Report of the Les Houches Jet Physics Subgroup(s)

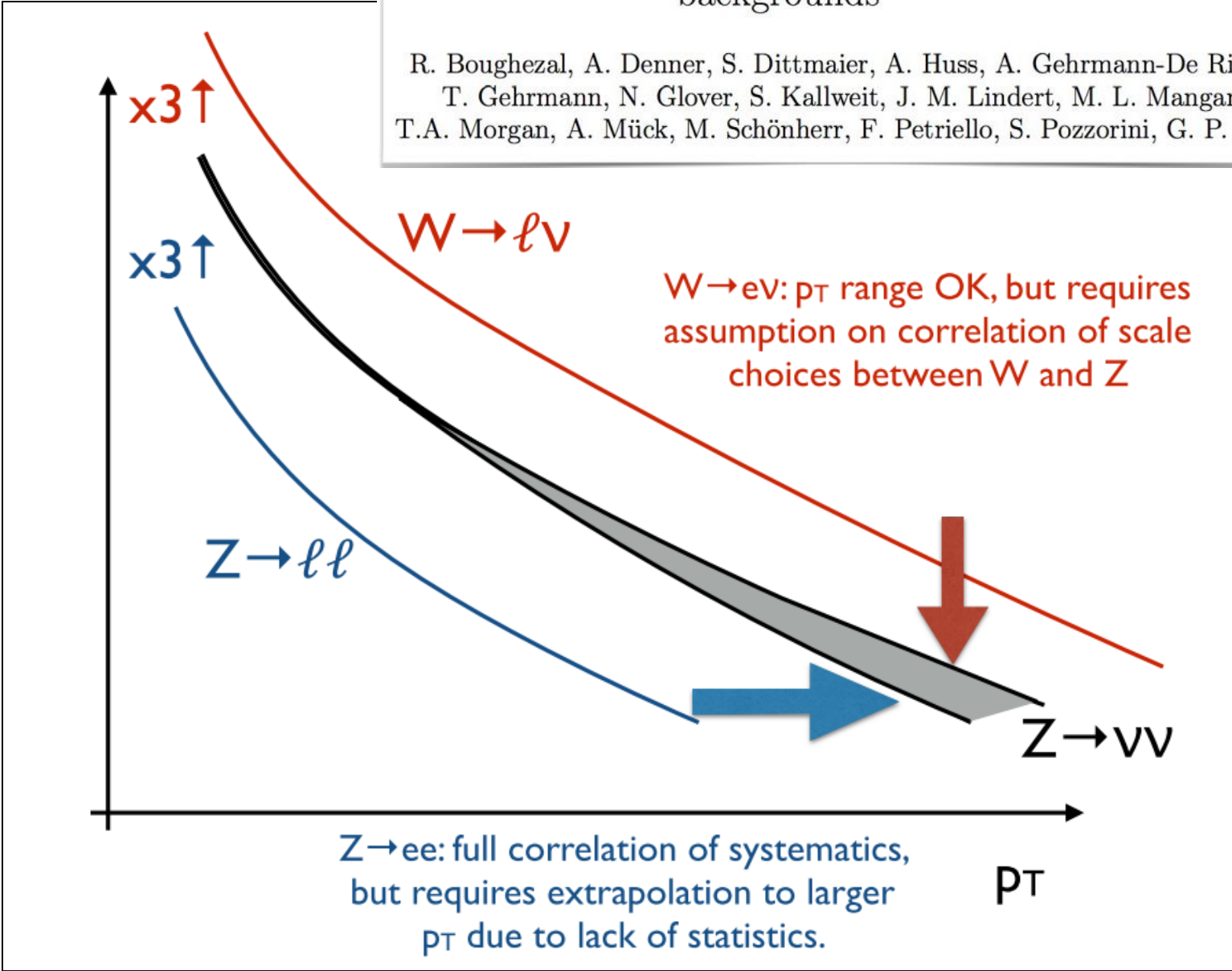
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the decays, WIZ, tt + jet, interplay, jet vetoes, ...

QCD and EW corrections for V+jets DM backgrounds

*

R. Boughezal, A. Denner, S. Dittmaier, A. Huss, A. Gehrmann-De Ridder, T. Gehrmann, N. Glover, S. Kallweit, J. M. Lindert, M. L. Mangano, T.A. Morgan, A. Mück, M. Schönherr, F. Petriello, S. Pozzorini, G. P. Salam



NEVER forget extrapolation systematics

1

Systematic uncertainties

CMS Prescriptions

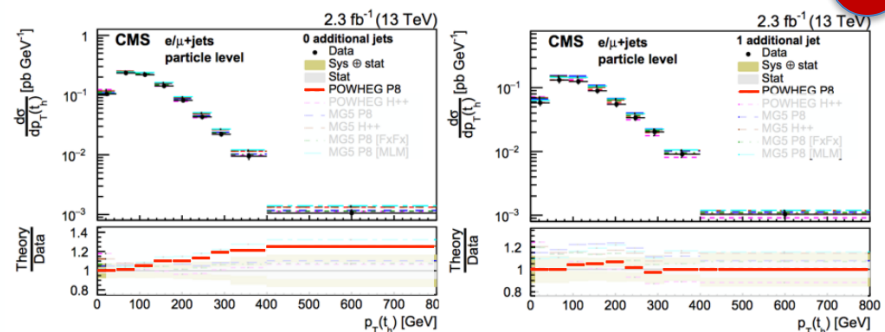
- Tricky to make definitive list, prescriptions vary with \sqrt{s} , time, and analyses.

	RUN 1	RUN 2
Scale	MG5 Q ² variations	POWHEG μ_R, μ_F variations
Matrix Element	POWHEG -vs- MG5	POWHEG -vs- FxFx
ME - PS	Threshold variations.	hdamp variations
Hadronisation	b-frag., semi-leptonic B decays, HW6 vs PY6 JER	HERWIG++ -vs- PYTHIA8
Non-perturbative	Tune variations	CUET2P8M4
PDF	CT10 variations	CT14/NNPDF30 variations
Other	Mass variations and pT(t) reweighting	

ATLAS+CMS MC workshop <https://indico.cern.ch/event/588781/timetable/>

Top p_T modelling (Particle Level):

2



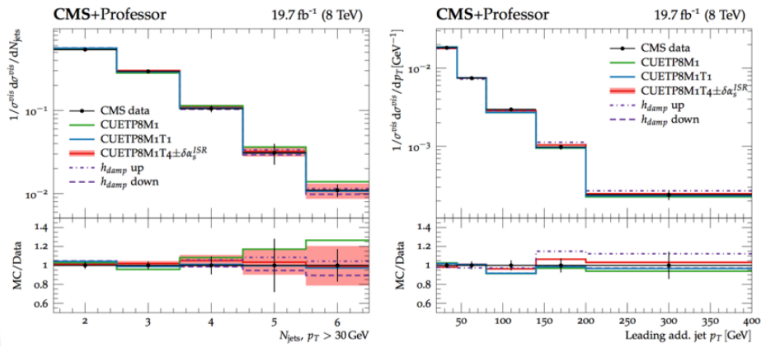
- Measured with 0,1,2,3+ additional jets
- Some interesting shape changes as N_{jets} is probed (e.g. POWHEG P8 in 0 jets vs 1 additional jets).

Example:

- What is the uncertainty extrapolated to a signal region, given info/constraints in the control region?
- How are things correlated?
- ...

POWHEG Tuning

New Tune results: $h_{damp} = 1.581^{+0.658}_{-0.585} \times m_t$, $\alpha_s^{ISR} = 0.1108^{+0.0145}_{-0.0142}$



Data prefers lower setting of α_s^{ISR} and higher setting of h_{damp} .

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From LH2015 BSM proceedings...

arxiv:1605.02684

Tools and Methods	134
15 Falcon: towards an ultra fast non-parametric detector simulator	135
<i>S. Gleyzer, R. D. Orlando, H. B. Prosper, S. Sekmen and O. A. Zapata</i>	
16 Towards an analysis description accord for the LHC	140
<i>D. Barducci, A. Buckley, G. Chalons, E. Conte, N. Desai, N. de Filippis, B. Fuks, P. Gras, S. Kraml, S. Kulkarni, U. Laa, M. Papucci, C. Pollard, H. B. Prosper, K. Sakurai, D. Schmeier, S. Sekmen, D. Sengupta, J. Sonneveld, J. Tattersall, G. Unel, W. Waltenberger and A. Weiler</i>	

A discussion was started in the Les Houches PhysTeV workshop in 2011, and continued thereafter within a wider group of LHC physicists, in order to determine what information is crucial for describing an analysis. The outcome of this discussion was reported in the “Recommendations for Presentation of LHC Results” [524, 525], and has been embraced by many LHC physicists.

[524] G. Brooijmans *et al.*, in *Proceedings, 7th Les Houches Workshop on Physics at TeV Colliders*, pp. 221–463, 2012. [1203.1488](#). 140

[525] S. Kraml *et al.*, *Eur. Phys. J. C* **72** (2012) 1976, [[1203.2489](#)]. 140

From LH2015 BSM proceedings...

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Tools and Methods


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- 17 **A proposal for a Les Houches Analysis Description Accord** 147
D. Barducci, G. Chalons, N. Desai, N. de Filippis, P. Gras, S. Kraml, S. Kulkarni, U. Laa, M. Papucci, H. B. Prosper, K. Sakurai, D. Schmeier, S. Sekmen, D. Sengupta, J. Sonneveld, J. Tattersall, G. Unel, W. Waltenberger and A. Weiler
- 18 **Basis-independent constraints on Standard Model Effective Field Theories with ROSETTA** 158
J. Bernon, A. Carvalho, A. Falkowski, B. Fuks, F. Goertz, K. Mawatari, K. Mimasu and T. You

Les Houches disaccord?!?



©daniel tojson

A man with dark hair, wearing a dark tuxedo jacket, a white shirt, and a dark bow tie, stands in a room with wood-paneled walls. He is looking slightly to the right of the camera with a serious expression. The lighting is dramatic, with strong highlights and deep shadows. The text "I'm Winston Wolfe. I solve problems" is overlaid in white at the bottom of the image.

I'm Winston Wolfe. I solve problems

Why a Les Houches Accord on Analysis Description?

◆ Picking up an experimental publication

- ❖ Reading
- ❖ Understanding

✓ Relatively easy

◆ Writing the analysis code in the tool internal language

✓ Relatively easy

◆ Getting the information missing from the publication for a proper validation

- ❖ **Efficiencies** (trigger, electrons, muons, b-tagging, JES, etc.)
 - ★ Including p_T and/or η dependence
 - ★ Accurate information
- ❖ Detailed **cutflows** for some well-defined **benchmark** scenarios
 - ★ Exact definition of the benchmarks (SLHA spectra)
 - ★ Event generation information (cards, tunes, LHE files if possible)
- ❖ Expected **number of events** in each region and **cross sections**
- ❖ **Digitized histograms** (e.g., on HEPDATA)

⚠ **Essential**
✗ **Often difficult!**

◆ Comparing tools and real life

LHAAD: Les Houches Accord on Analysis Description

[The session 2 tools working group]

- ◆ **Development of a way to provide the information on the analysis in a readily form**
 - ❖ The analysis is described following a text format
 - ★ Two similar options so far (to be merged in one for the proceedings)
 - ★ Blocks for object definitions, functions and methods, selections, region definitions
 - ★ Regions are defined from a combination of cut blocks
 - ❖ Validation: detailed cutflows for specific benchmarks must be provided in the description
 - ❖ **Must be endorsed by the experimental collaborations**
 - ★ Small amount of work to make the analysis useable by the TH community
 - ❖ **Finalization of the recommendations to be achieved for the proceedings**

- ◆ **Presentation of results for specific new physics scenario**
 - ❖ Structure for the cutflows, the errors, etc.
 - ❖ Information on how to (or not to) combine signal regions / analyses

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Maybe this assumption
is the cause of the disaccord...

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