Forum on the Interpretation of the LHC Results for BSM studies

The quest for new physics beyond the Standard Model is arguably the driving topic for Run 2 of the LHC. Indeed, the LHC collaborations are pursuing searches for new physics in a vast variety of channels. While the collaborations typically provide themselves interpretations of their results, for instance in terms of simplified models, the full understanding of the implications of these searches requires the interpretation of the experimental results in the context of all kinds of theoretical models. This is a very active field, with close theory-experiment interaction and with several public tools being developed.

With this forum, we want to provide a platform for continued discussion of topics related to the BSM (re)interpretation of LHC data, including the development of the necessary public RecastingTools and related infrastructure.

If you have questions or want to contribute, contact Sabine Kraml, sabine.kraml@gmail.com, or any of the topical contacts given below.

Meetings

Meetings of this forum

- **6th workshop**, 15-19 Feb 2020 on Zoom (online only)
- **5th workshop**, 2-4 April 2019 at Imperial College (registration via the IOP workshop webpage)
- **4th workshop**, 14-16 May 2018 at CERN
- **3rd workshop**, 16-18 Oct 2017 at Fermilab
- **2nd workshop**, 12-14 Dec 2016 at CERN
  - Agenda | introduction | final discussion | WorkshopSummaryNotes
- **Kick-off workshop**: (Re)interpreting the results of new physics searches at the LHC, 15-17 June 2016 at CERN
  - Agenda | general discussion | KickoffSummaryNotes

Other workshops, potentially interesting for our forum

- Long Lived Particles Community Workshop 16-19 Nov (virtual)
- Analysis Description Languages Workshop 6-8 May 2019, LPC Fermilab
- Searches for Long Lived particles 2nd workshop, 17-20 Oct 2017, ICTP Trieste
- The Les Houches PhysTeV2017 workshop will have a strong activity on interpreting LHC results; the BSM session in LH is taking place 14-23 June 2017.
- LHC Long-Lived Particle workshop, CERN, 24-26 April 2017, "to address the status and future of beyond-the-Standard Model LLP searches at the ATLAS, CMS, and LHCb experiments, as well as auxiliary LHC detectors and projects".
- 6th edition of the workshop "Implications of LHCb measurements and future prospects", CERN, 12-14 October 2016. NB participation is restricted to the members of the LHCb Collaboration, and of interested theorists.

Mailing list

- CERN e-group: info-LHC-interpretation@cern.ch
- To subscribe, go to
Steering group

The steering group comprises a representative of each of the public recasting tools as well as a couple of individual LHC physicists. Current members are:


Mailing list: info-LHC-interpretation-organisers@cernNOSPAMPLEASE.ch

Many thanks to previous members: Suchita Kulkarni, Jamie Tattersall

News

[2020-10-22] The (virtual) LLP Workshop 16-19 Nov will have a hands-on Reinterpretations WG session on Wednesday Nov 18th between 13:00-15:00 CERN time.


[2019-10-25] The Les Houches Recommendations 3(b) and 3(c) have been achieved for the first time as of this week. In ATL-PHYS-PUB-2019-029, ATLAS described the "statistical reproduction" of the SUSY sbottom multi-b analysis using a plain-text serialization of the likelihood. As of this week, the plain-text serialization has been made available on HEPdata (click "Resources" -> "Common Resources"). See also the CERN seminar by Lukas Heinrich in this context.

[2018-12-19] Created a Zenodo community on (Re)interpretation of LHC results for BSM studies; it is ready to receive your recast data and codes, basically "Everything that has to do with the (re)interpretation of LHC results for beyond-the-Standard Model (BSM) physics".


[2018-04-06] Matthias Danninger (ATLAS) and Nick Wardle (CMS) join the steering group.

Topics, ongoing and proposed efforts

• Review of tools for the BSM (re)interpretation of LHC data: see RecastingTools

• Implications of SM (incl. top and Higgs) measurements: See talks by Florian Bernlochner on Higgs fiducial cross sections and Jon Butterworth on using SM measurements at the kick-off meeting as well as ATLAS & CMS reviews of Standard Model/top measurements and re-use for constraining BSM at 2nd workshop (Monday afternoon). Useful: publish SM theory predictions in HepData.

♦ Contacts: Jon Butterworth
**Digitized information:** Lots of useful 'data' still has to be read off from tiny paper plots (and/or is difficult to be found at all) --> Encourage as much as possible the systematic use of the new HEPData; this concerns the publication of results but also auxiliary material and -very important-performance plots. HEPData itself makes an effort to become better searchable and more user-friendly.

♦ Contacts: Frank Krauss, Graeme Watt
♦ see also: PhenoData database

**Validation material:** continue and improve interaction with experimental groups on providing (auxiliary) material necessary for a rigorous validation of recast codes: well defined benchmark points, detailed MC settings (run cards!), detailed cutflows for preselection and all signal regions. NEW: A discussion / Q&A forum should be set up to give feedback on the quality of the documentation and show how well different results can be used and how much they are being used. We should review the importance of various elements, to help the time-constrained experimental analysis teams prioritise. See final discussion of the Dec 12-14, 2016 workshop.

**Correlation matrices:** an example of an experiment producing a correlation matrix for systematics between bins in a single analysis, and a corresponding pheno recast making use of it in a likelihood function. Some work has started on this in GAMBIT together with people from CMS. It will be useful to have example recasts showing the usefulness of this extra info. Could an extensible approach with decomposition into correlated and fully correlated errors from identified standard error sources be agreed?

♦ See more details on simplified likelihoods which use such correlation matrices here
♦ More discussion at the LHC Chapter II workshop in Natal, Nov 2017
♦ Contact: Nick Wardle
♦ Mailing list for ongoing discussion: info-LHC-interpretation-correlations@cern

**Interpretation of resonance searches:** depending on the signal assumptions, using directly the cross section / branching ratio limits from the experimental paper can be quite misleading. So far, we have no dedicated discussion of this in our Forum. See e.g. arXiv:1801.08129 for a recent relevant paper.

**BSM analysis implemented in Rivet:** as from v2.5.0 efficiencies and smearing can be used in Rivet to deal with results which are not unfolded (the typical BSM case). Efficiencies are particularly relevant for leptonic analyses and/or analyses involving b-jets. The Rivet implementation allows the efficiency and smearing functions to be completely specific to each analysis. Some LHC Run 2 analyses are implemented already but need further validation and comparison to recast tools using Delphes3.

♦ Contacts: Andy Buckley

**Multi-variant or BDT analyses:** how to publish the MVA or BDT 'function' for use in public tools? Try to come up with a working example; again to be done in collaboration with a sympathetic analysis group from ATLAS or CMS (best both).

♦ See the CMS razor example in this talk by J.M. Duarte at the 2013 Likelihoods for the LHC searches workshop.

**LHCb likelihoods:** do an example recast using the new LHCb B->K*mumu public extended likelihood in multiple q^2 bins. See talks by Christoph Langenbruch on data and likelihood release in LHCb at the kick-off meeting and by Marcin/Nazila on Reinterpretation of Flavour Constraints at 2nd workshop.

♦ Contacts: Marcin Chrzaszcz, Nazila Mahmoudi

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Topics, ongoing and proposed efforts
• **Publishing full likelihoods:** Publication of full likelihoods of LHC experiment analyses to HEPData using a plain-text serialization. See "Reproducing searches for new physics with the ATLAS experiment through publication of full statistical likelihoods" (ATL-PHYS-PUB-2019-029) and the HEPData entry for the corresponding ATLAS SUSY analysis as an example, which uses the JSON schema developed by pyhf for HistFactory models.

  ◆ Contact: Giordon Stark (ATLAS), Lukas Heinrich (ATLAS), Matthew Feickert (ATLAS)

• **Usability of SMS results:** SMS results are very useful for quickly checking LHC constraints without the need of event simulation. However, there exist severe limitations in the usability of the SMS interpretations provided by the collaborations, for example when only 1 mass plane is given for a 2-step topology. See these slides from the kick-off meeting for more details. Another issue is the limited coverage by the currently published SMS results (see e.g. 1707.09036). We'd like to improve on these issues.

  ◆ Contacts: Suchita Kulkarni, Wolfgang Waltenberger

• **Long-lived particles** develop public recast codes for LLP searches ... several contributions at kick-off meeting and 2nd workshop but no public code yet. Lots of discussions on simplified models and presentation of results at LHC Long-Lived Particle and Les Houches PhysTeV2017 workshops. See also the LH wiki on simplified models for LLP. Actions: joint sessions with LLP community workshops, github code repository.

  ◆ Contact: Nishita Desai, Andre Lessa

• **Delphes developments:** several of the public recast codes and generally many pheno analyses rely on Delphes for the emulation of detector effects. Related with the point above, a generic treatment of long-lived particles (HSCP, displaced signatures, ...) within Delphes would be highly needed.

  ◆ Contact: Michele Selvaggi

• **ADL - Analysis Description Language**

  ◆ Latest status, discussion notes and future steps linked in the agenda of the Analysis Description Languages Workshop 6-8 May 2019, LPC Fermilab.


  ◆ Gitter forum for community-wide discussions involving experimentalists, phenomenologists and computer scientists

  ◆ Parsing/interpreting tools for ADLs:


  ◆ Contact: Sezen Sekmen

• **Open Data:** Learn how to use it, make a physics case. (The released data is not yet that interesting for BSM, but none the less interesting to get experience and give feedback). See also presentation by Kati Lassila-Perini at the kick-off meeting.

  ◆ Contact: Achim Geiser (CMS)

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**Examples of recast studies**

• This list of recent RecastingStudies may serve as a feedback to the experiments about the use of their results and the information they provide.
• 'Best practice' guide: we remind all colleagues doing recasts that they, too, should provide their codes and supplementary info to the community/experiments (via HEPData where appropriate), to make it easier for others to repeat and/or re-use their results.

Documents

• Wish list from phenomenologists: material needed for implementing and validating LHC new physics searches in fast simulation tools, recast-wishlist-2014.pdf (30 Sep 2014)

Links

Other initiatives or working groups

• LHCPhysics Web (hosts twiki pages of several groups)
• Dark Matter Working Group
• LHC Long Lived Particle Miniworkshop, 12 May 2016

Related previous workshops

• Mini-workshop on recasting ATLAS and CMS new physics searches, 8-12 September 2014
• Coordinating a simplified models effort, 29-30 October 2013
• Likelihoods for the LHC Searches, 21-23 January 2013
• Searches for new physics: recommendations for the presentation of LHC results, 13 February 2012
• Global BSM fits and LHC data, 10-11 February 2011

-- SabineKraml - 2020-12-08