Les Houches Recommendations for the Presentation of LHC Results

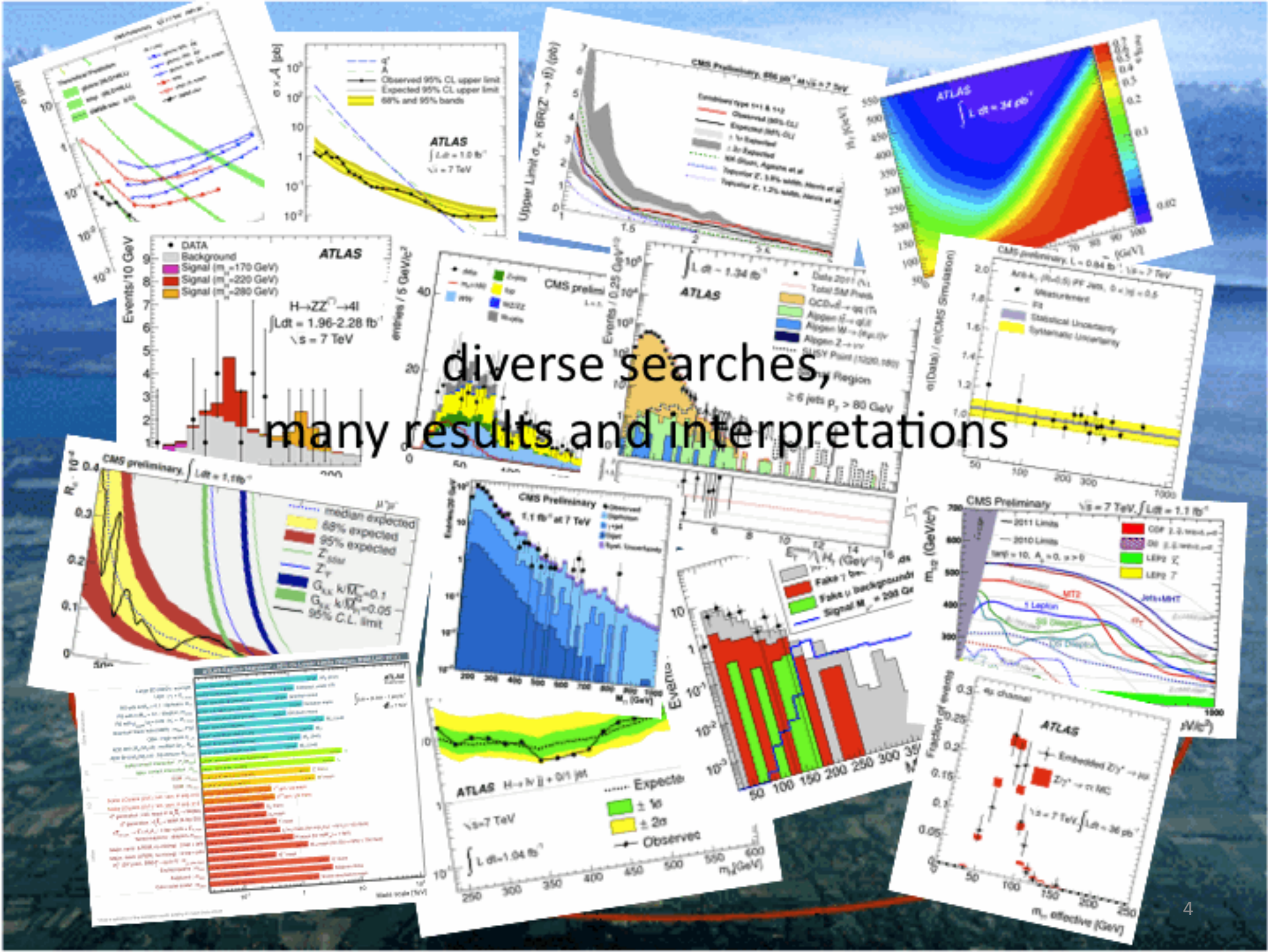**Implications of LHC results for TeV-scale physics workshop**

CERN, Geneva, 27 March 2012

…only a few days before the LHC 8 TeV pp collisions…
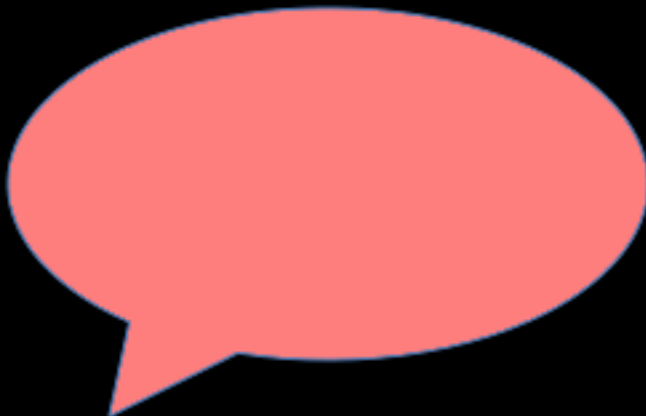
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"Data are coming! Data are coming!"

diverse searches,
many results and interpretations

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and diverse ideas,
diverse models
to be tested

We'd like to make the most of the LHC results !

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

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"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."

arXiv:1203.2489

Photo courtesy J. Hewett

First, some thanks

• We thank the ATLAS and CMS collaborations for supporting the recommendations. Physics coordinators, new physics conveners and various other colleagues from ATLAS and CMS kindly reviewed the document and provided valuable feedback.

• We had a dedicated miniworkshop at CERN to discuss the recommendations on 13 February 2012. Thanks to all participants for their contributions.

On the recommendations

• These recommendations are from the HEP community to the HEP community.

• Our wish is to stimulate discussions among the whole community and work towards an agreement on a common standard for the presentation of the LHC results. The goal is to help the community make the most of an extraordinary scientific opportunity.

• Implementing the recommendations would be a further step towards a more comprehensive approach to the storage, persistence and future use of LHC results.

• Many of these recommendations are already implemented in experimental analyses and publications. Recommendations intend to encourage and enhance such good practice.

On the recommendations

- What has been observed, and how it has been observed in an experiment should be clear to a non-collaboration colleague, such that she/he should be able to use and (re-)interpret results without the need to take up the time of collaboration insiders.

- The above principle implies that all ingredients (e.g., data, experimental systematics, cuts, procedures and so forth) in the analysis should be completely and unambiguously specified.

- The recommendations are intended to respect the intellectual property rights of the collaborations and be concrete, practical and clear, as well as not being burdensome for the scientists performing the experimental analyses.

Results versus interpretation

We think it useful to distinguish between experimental results and their interpretation and suggest to use the following definitions for these terms:

- An experimental result is the empirical outcome, such as an event count or the measurement of some physical quantity. The experimental results themselves should be independent of any hypothesized new physics model.

- Interpretation is the act of comparing the experimental results to model predictions.

While an analysis may have been guided by a specific physics model, the experimental results are ideally independent from the physics model.

Recommendations

Our recommendations fall into four broad categories

- Analysis description
- Detector modeling
- Analysis dissemination
- Analysis design

Analysis description

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Explicit description of the analysis

Recommendation 1a: *Provide a clear, explicit description of the analysis in publications. In particular, the most crucial information such as basic object definitions and event selection should be clearly displayed in the publications, preferably in tabular form, and kinematic variables utilized should be unambiguously defined. Further information necessary to reproduce the analysis should be provided, as soon as it becomes available for release, on a suitable common platform.*

Analysis database

Recommendation 1b: *The community should identify, develop and adopt a common platform to store analysis databases, collecting object definitions, cuts, and all other information, including well-encapsulated functions, necessary to reproduce or use the results of the analyses, and as required by other recommendations*

Analysis database

Recommendation 1b: *The community should identify, develop and adopt a common platform to store analysis databases, collecting object definitions, cuts, and all other information, including well-encapsulated functions, necessary to reproduce or use the results of the analyses, and as required by other recommendations*
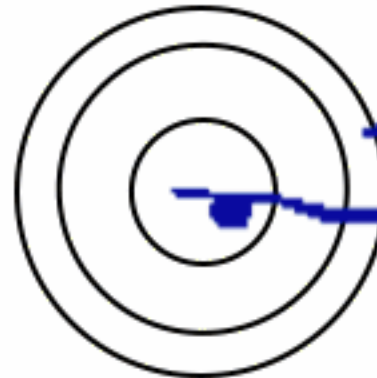
STARTED

We already started a discussion with the INSPIRE developers on the role INSPIRE can play in building a coherent information system for hosting the LHC results with detailed searchable and citable entries.
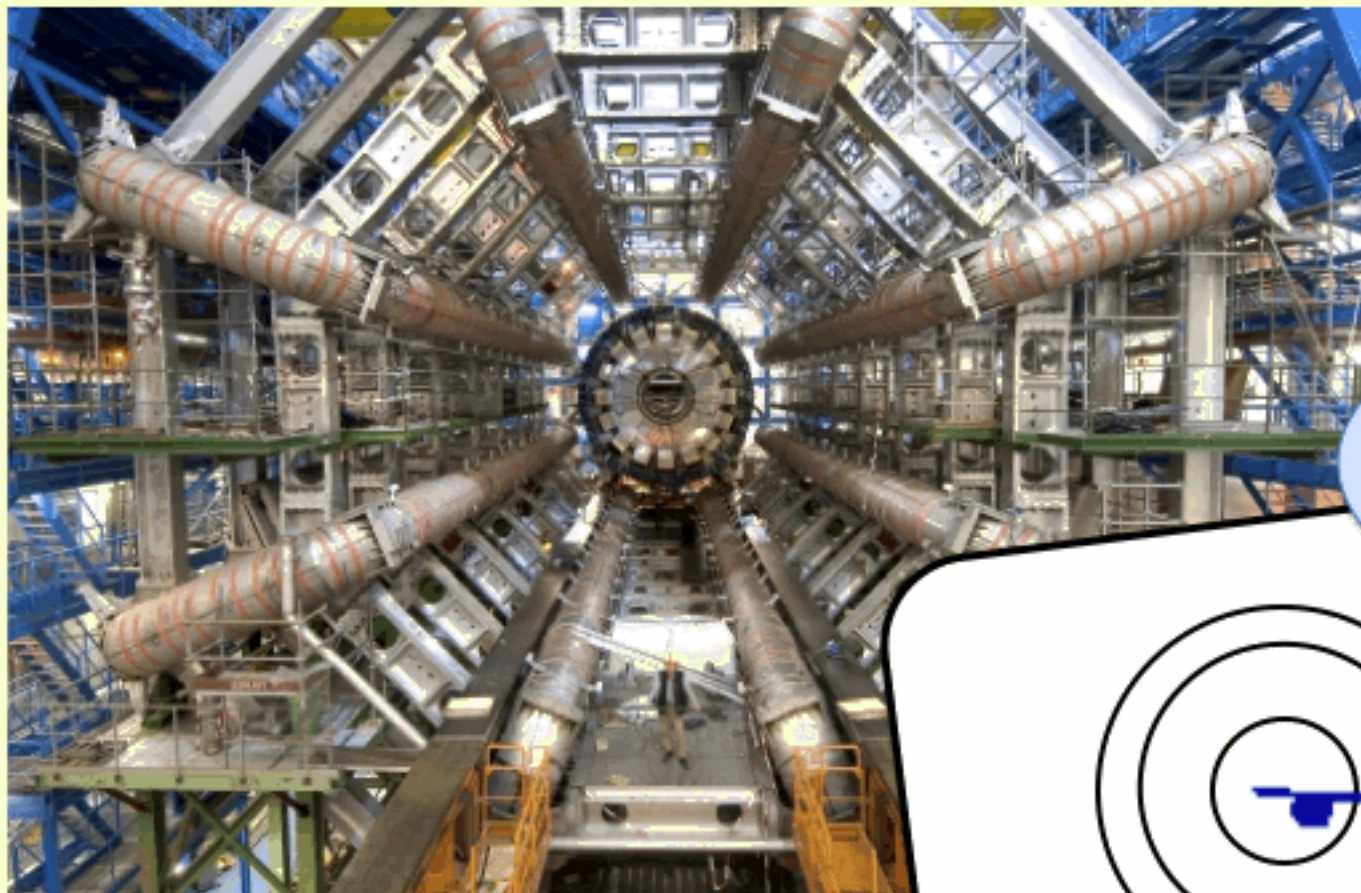
Detector modeling

Efficiency maps

Recommendation 2a: *Provide histograms or functional forms of efficiency maps wherever possible in the auxiliary information, along with precise definitions of the efficiencies, and preferably provide them in standard electronic forms that can easily be interfaced with simulation or analysis software.*

Public fast detector simulation

Recommendation 2b: *The community should take responsibility for providing, validating and maintaining a simplified simulation code for public use, reproducing the basic response of the LHC detectors. The validation and tuning of this tool should be based on comparisons with actual performance plots, and/or other inputs, made available by the experiments along the lines of Recommendation 2a. Limits of validity should be investigated and clearly documented.*

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STARTED

We are planning a workshop at CERN in late spring on public fast simulators – we will discuss the current status and necessary developments.
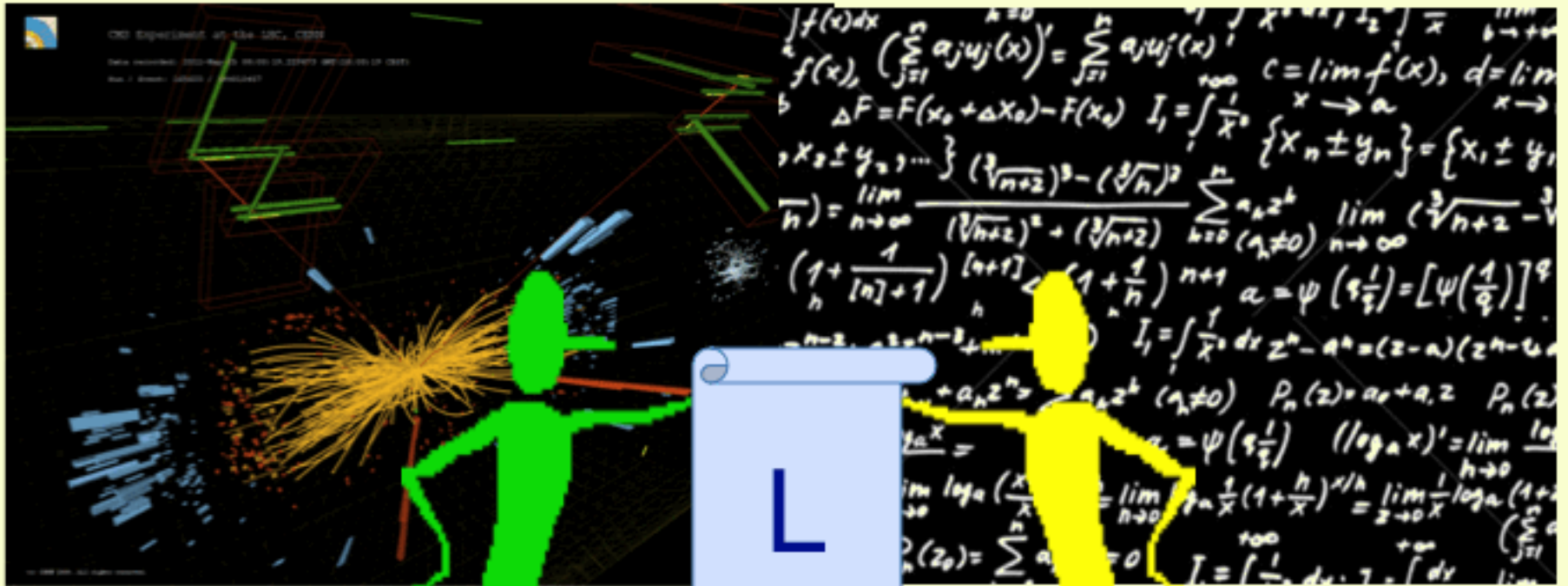
Analysis dissemination

Recommendation 3a: *Provide all crucial numbers regarding the results of the analysis, preferably in tabulated form in the publication itself. Further relevant information, like fit functions or distributions, should be provided as auxiliary material.*

Addendum to 3a: *For multi-bin results, provide an ensemble of sets of the numbers B, δB, L, δL, Q, k, etc in the auxiliary information. These would be created by sampling from the various experiment-specific systematic effects, such as the jet energy scale, jet energy resolution, etc. Results should be quoted without inclusion of systematic/theoretical uncertainties external to the experiment.*

B: BG estimate, L: Luminosity estimate, Q: Observed number of events in the control region, k: expected BG in control region / expected BG in signal region

The full likelihood

Recommendation 3b: *When feasible, provide a mathematical description of the final likelihood function in which experimental data and parameters are clearly distinguished, either in the publication or the auxiliary information. Limits of validity should always be clearly specified.*

Recommendation 3c: *Additionally provide a digitized implementation of the likelihood that is consistent with the mathematical description.*

The full likelihood

Recommendation 3b: *When feasible, provide a mathematical description of the final likelihood function in which experimental data and parameters are clearly distinguished, either in the publication or the auxiliary information. Limits of validity should always be clearly specified.*

Recommendation 3c: *Additionally provide a digitized implementation of the likelihood that is consistent with the mathematical description.*

STARTED

We are planning a (mostly pedagogical) workshop at CERN in late autumn on likelihoods, to familiarize ourselves more with their construction and explicit use cases.

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Recommendation 4: *In the interpretation of experimental results, preferably provide the final likelihood function (following Recommendations 3b/3c). When this is not possible or desirable, provide a grid of confidence levels over the parameter space. The expected constraints should be given in addition to the observed ones, and whatever sensitivity measure is applied must be precisely defined. Modeling of the acceptance needs to be precisely described.*
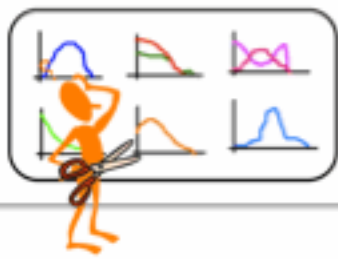
Higgs searches

Recommendation 5: *For Higgs searches, provide all relevant information on a channel-by-channel basis for both production and decay processes.*
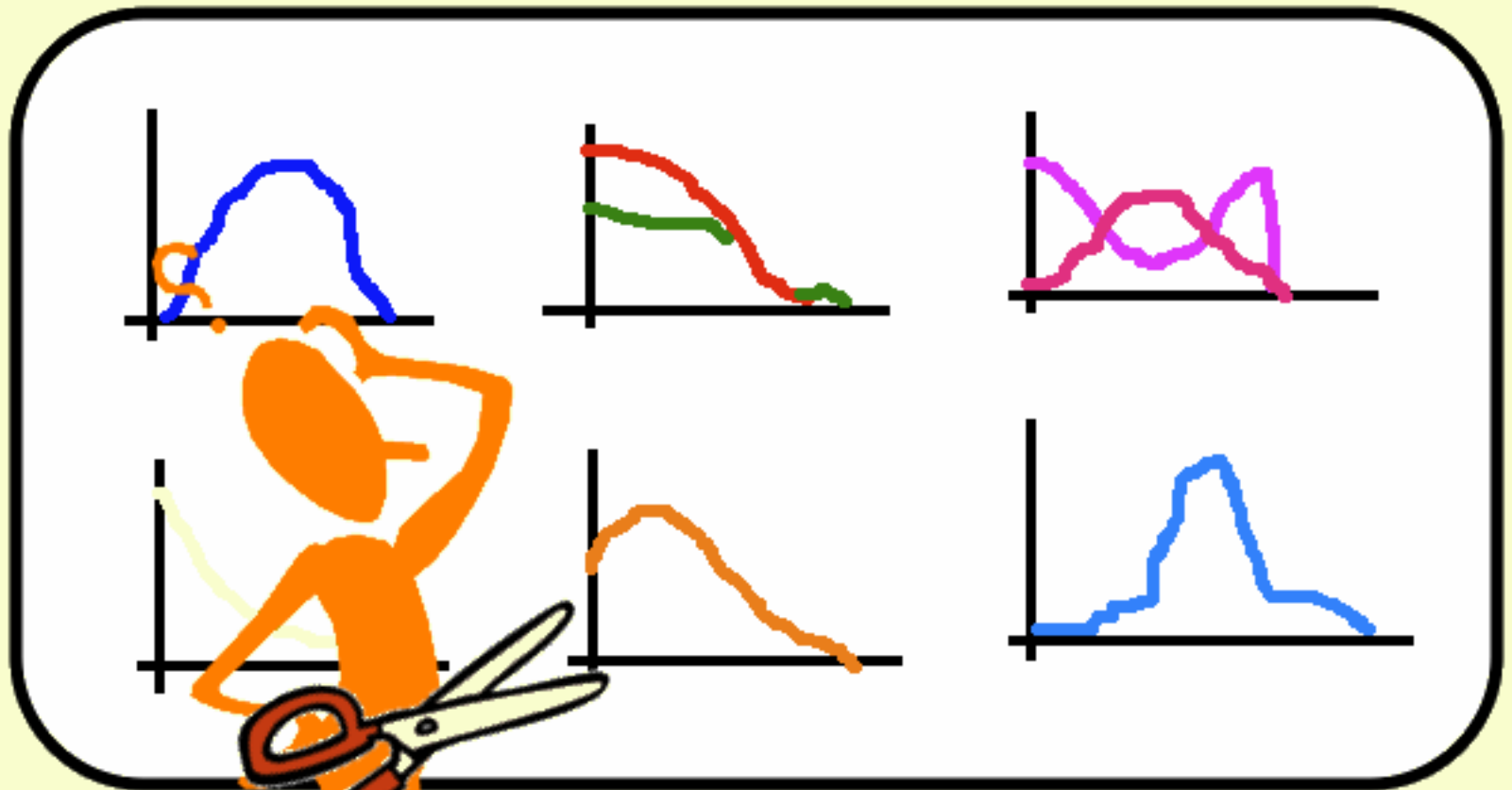
Analysis design

Recommendation 6: *When relevant, design analyses and signal regions that are based on disjoint sets of events.*

Conclusions

• We proposed a set of recommendations for the presentation of LHC results.

• Now it is the time to start working together on the implementation of these recommendations through dedicated studies.

• Started discussing with INSPIRE experts on an analysis database.

• Please remember the two upcoming workshops at CERN on "Fast Simulation" (late spring) and "Likelihoods" (late fall). We will announce the dates soon!