

Analysis and presentation of data using simplified models

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Reasons for using models in searches and analyses

- Guidance for designing searches and analyses
- Benchmark to compare searches
- Presentation of results:
 - Exclusion limits
 - Characterization of excesses

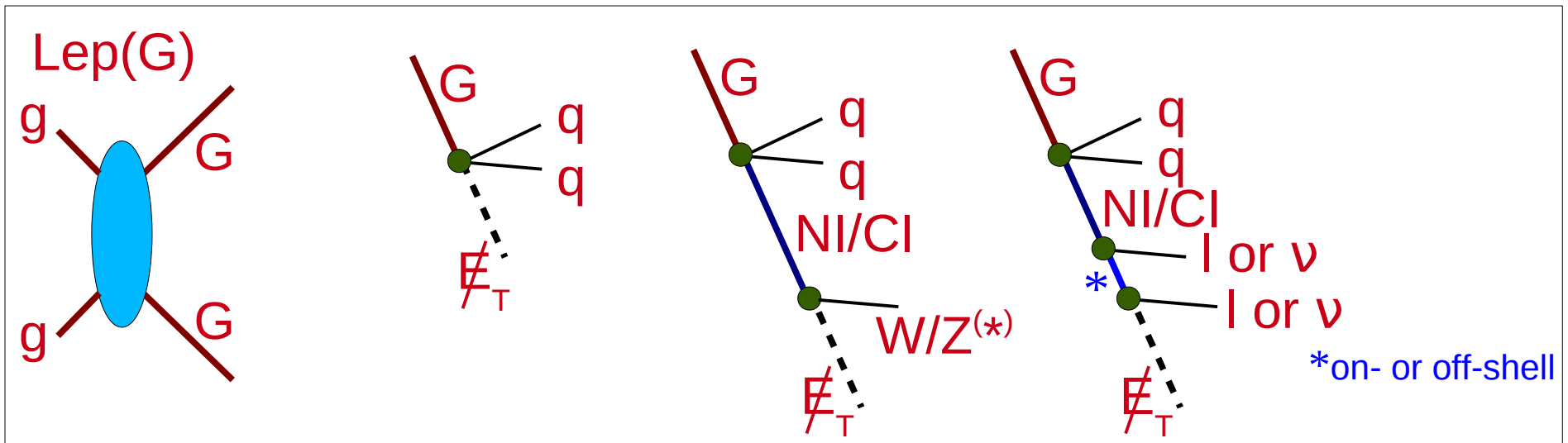
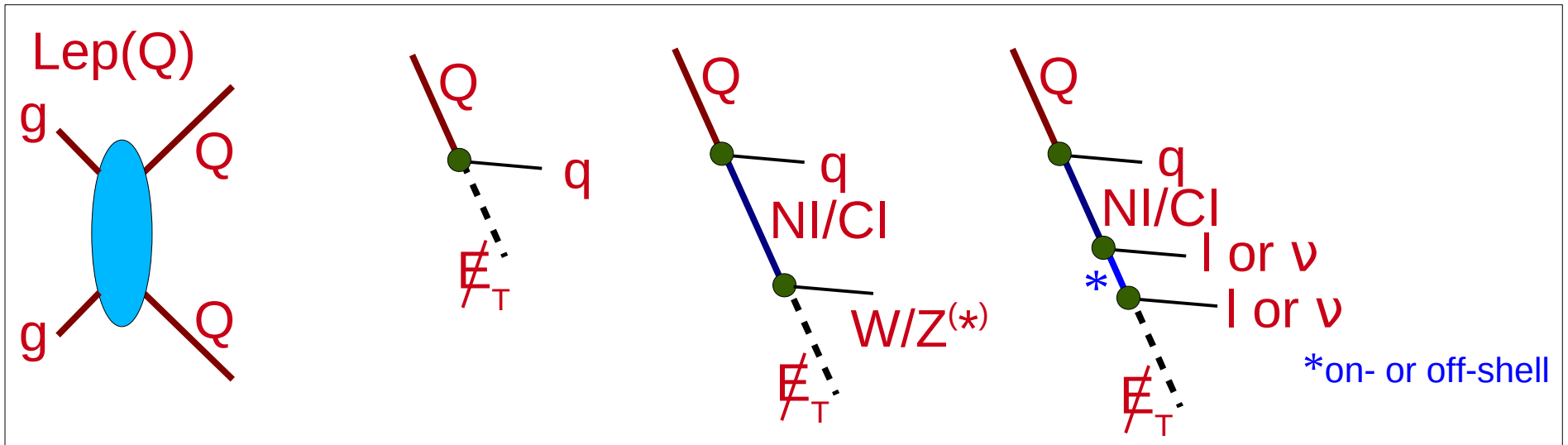
Model-dependent searches

- Unconstrained models: Too many parameters
- Constrained models with few parameters (mSUGRA, mGSMB, etc)
 - Correlations between masses (not valid in general) (ex. $m_{\tilde{g}}:m_{\tilde{W}}:m_{\tilde{B}} \sim 6:2:1$, $m_{\tilde{q}} \gtrsim m_{\tilde{g}}$)
 - Branching ratios and masses fixed simultaneously (ex. squark \rightarrow q LSP / q V LSP / q l^+l^- LSP)
- Muddles dependences on different aspects of model
- Prejudices for ranges of masses/couplings
- Complicates comparisons with other models

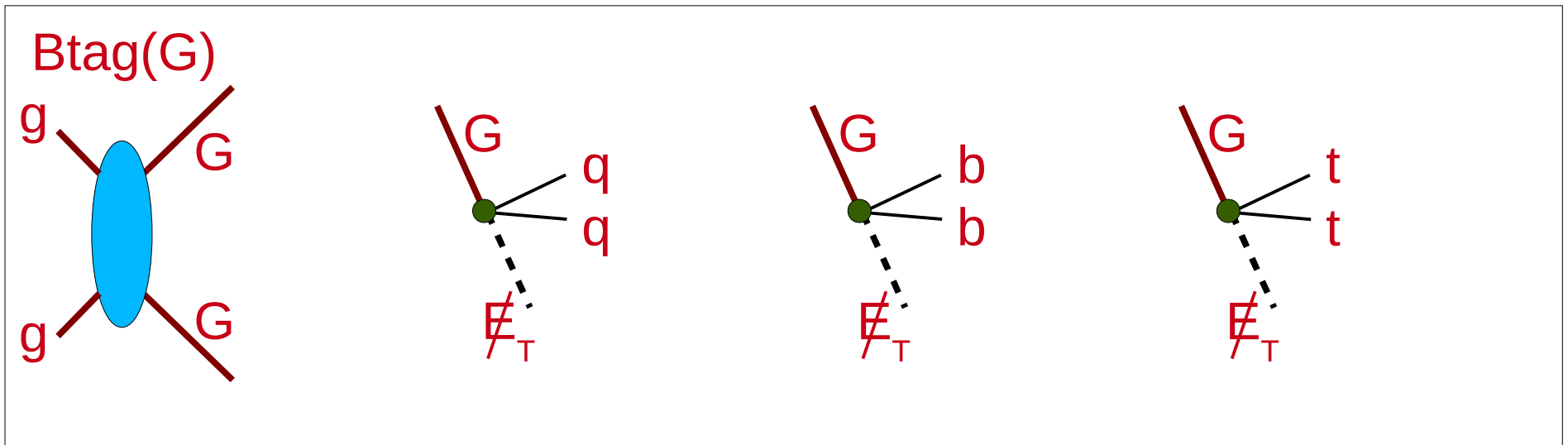
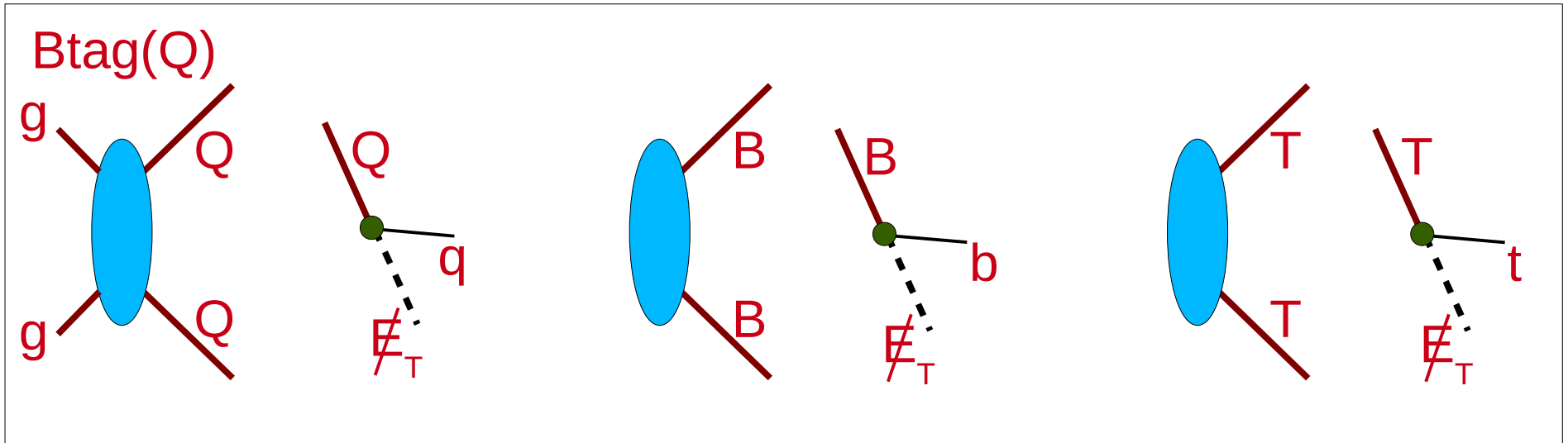
Alternative to models

- These problems can be overcome by picking only *relevant subset of model* and using only *directly relevant parameters*
- Relevant subset: Produced particles + decay chains relevant for the search
- Relevant parameters:
 - masses
 - cross sections x branching ratios
 - Note: spin, interference etc. mainly affects cross section
- All the benefits of regular models, without the disadvantages

Examples (simplified models)

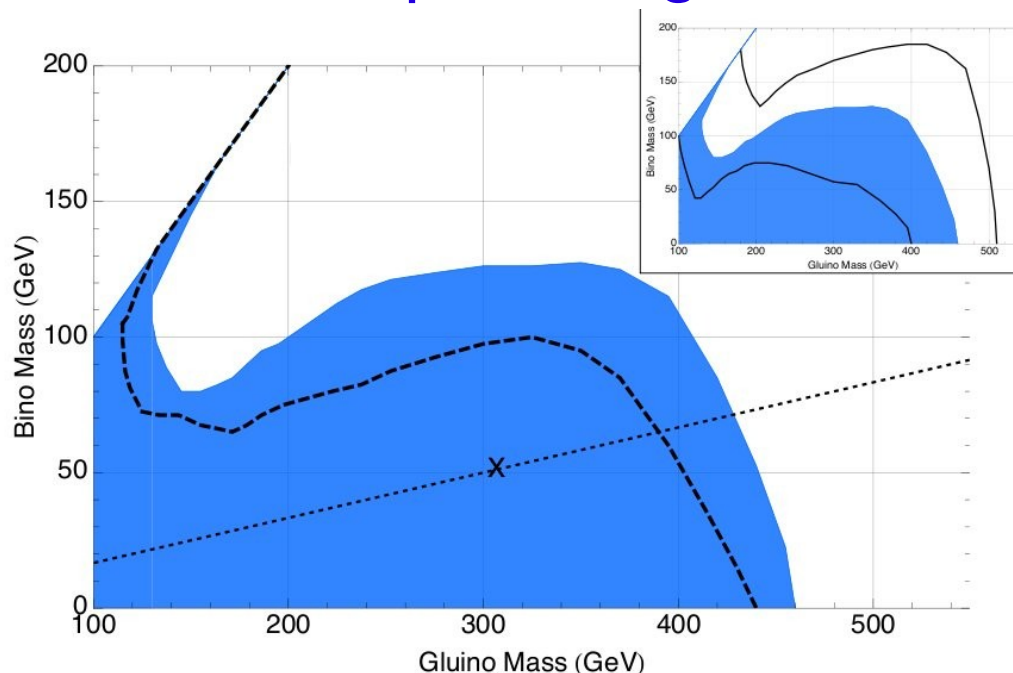


Examples (simplified models)



Searches with simplified models

- Multijet + missing ET search:
 - Use $G \rightarrow qqX$ and $Q \rightarrow qX$
 - 2 mass parameters + $1 \sigma \times \text{BR}$ (each)
 - Can choose spin assignment as most convenient



Exclusion assuming
fermion color octet
cross section,
100% BR $G \rightarrow qqX$

[arXiv:0803.0019]

Searches with simplified models

- In general:
 - Report cross section \times BR limits in grid of masses for individual topologies
 - For visualization: Exclusion plots assuming given spin states and pure QCD cross sections
 - Distributions showing data, background and signal for example masses / cross sections

Characterization with simplified models

- In case of single excess:
Use (e.g.) best-fit topology/masses/cross section to characterize excess
- In case of multiple excesses across different channels ([arXiv:0810.3921](https://arxiv.org/abs/0810.3921)):
 - Simultaneous characterization using well-motivated set of simplified models, see slides 5/6
 - Present relevant plots with best-fit model as comparison curves, to act as detector-independent comparison for other models

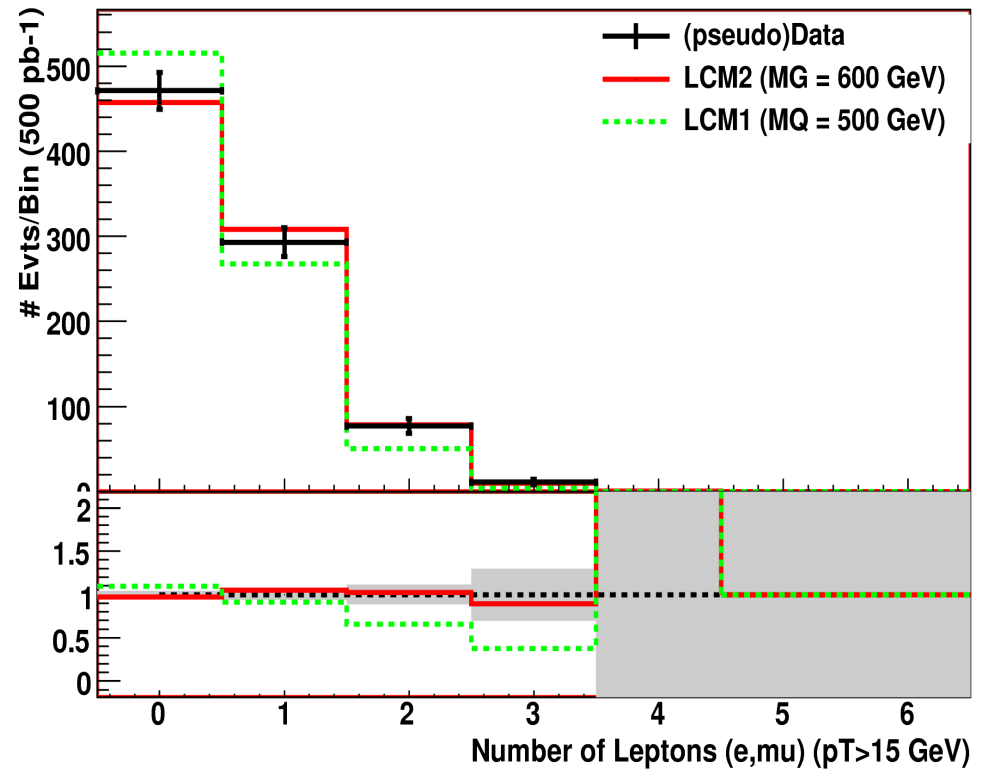
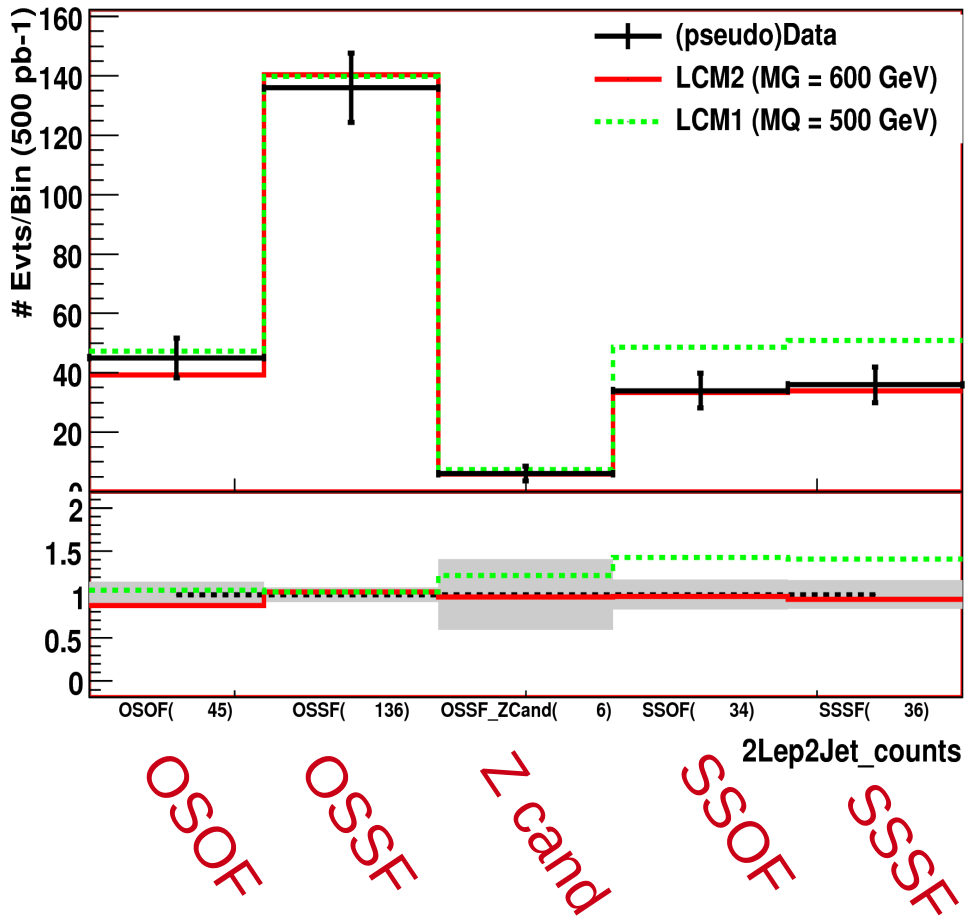
Summary

- Model guidance needed for optimal searches
- Model-dependent searches, analyses and characterization of excesses has disadvantages
 - Correlations between masses/cross sections/BRs
 - Prejudice for allowed regions
 - Difficult to compare results to general models
- Solution: topology-based searches (defining only produced particle and decay chain)
 - Parameters: Masses and cross section \times BR
 - Small set of topologies cover large range of models

Backup slides

Fitting examples

Examples of plots used for lepton BR fitting:



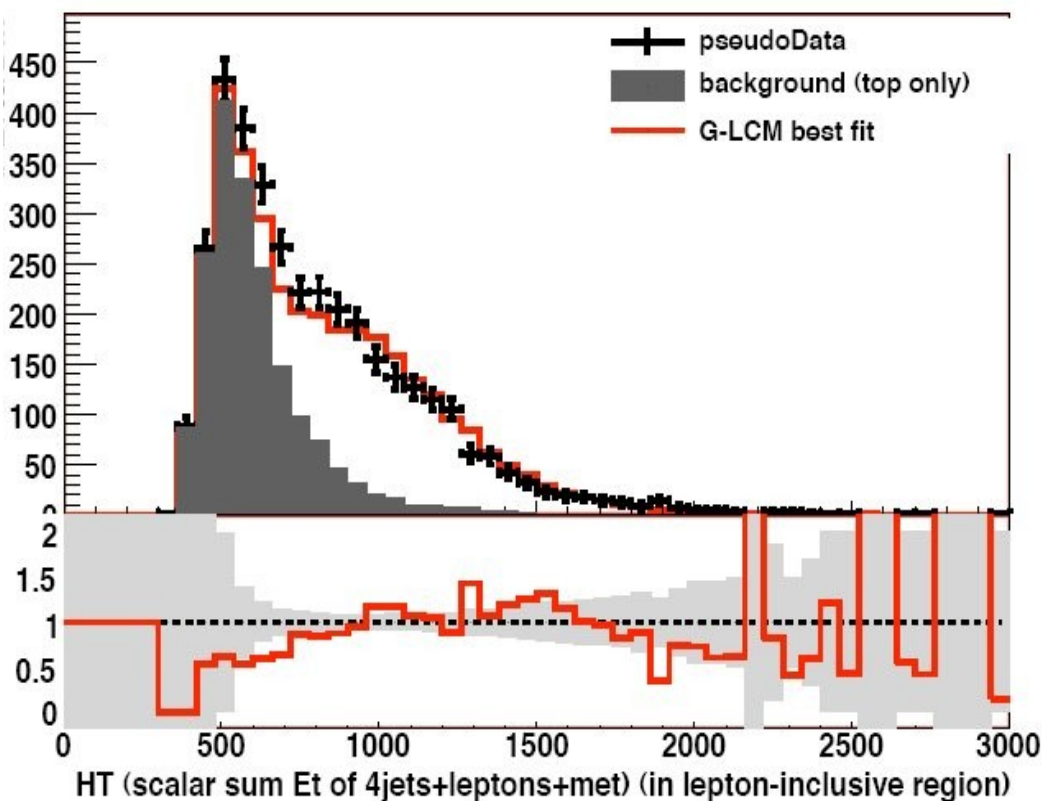
Number of leptons in lepton-incl. signal region

How to use the simplified models?

- Fit parameters give direct information
 - Mass scales and mass differences
 - Presence of weak bosons or lepton partners
 - Over- or underrepresentation of heavy flavor
- Inspiration / starting point for model building
 - Deviations from data indicates missing features of the simplified models – additions for second iteration
- Allows direct comparison with theory using tools available to theorists

How to use the simplified models?

Experimental fit of
Simplified model
over SM background



Theoretical comparison
Simplified model
vs. three SUSY models

