BSM Searches & MC

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ATLAS-CMS Monte Carlo Generators Workshop
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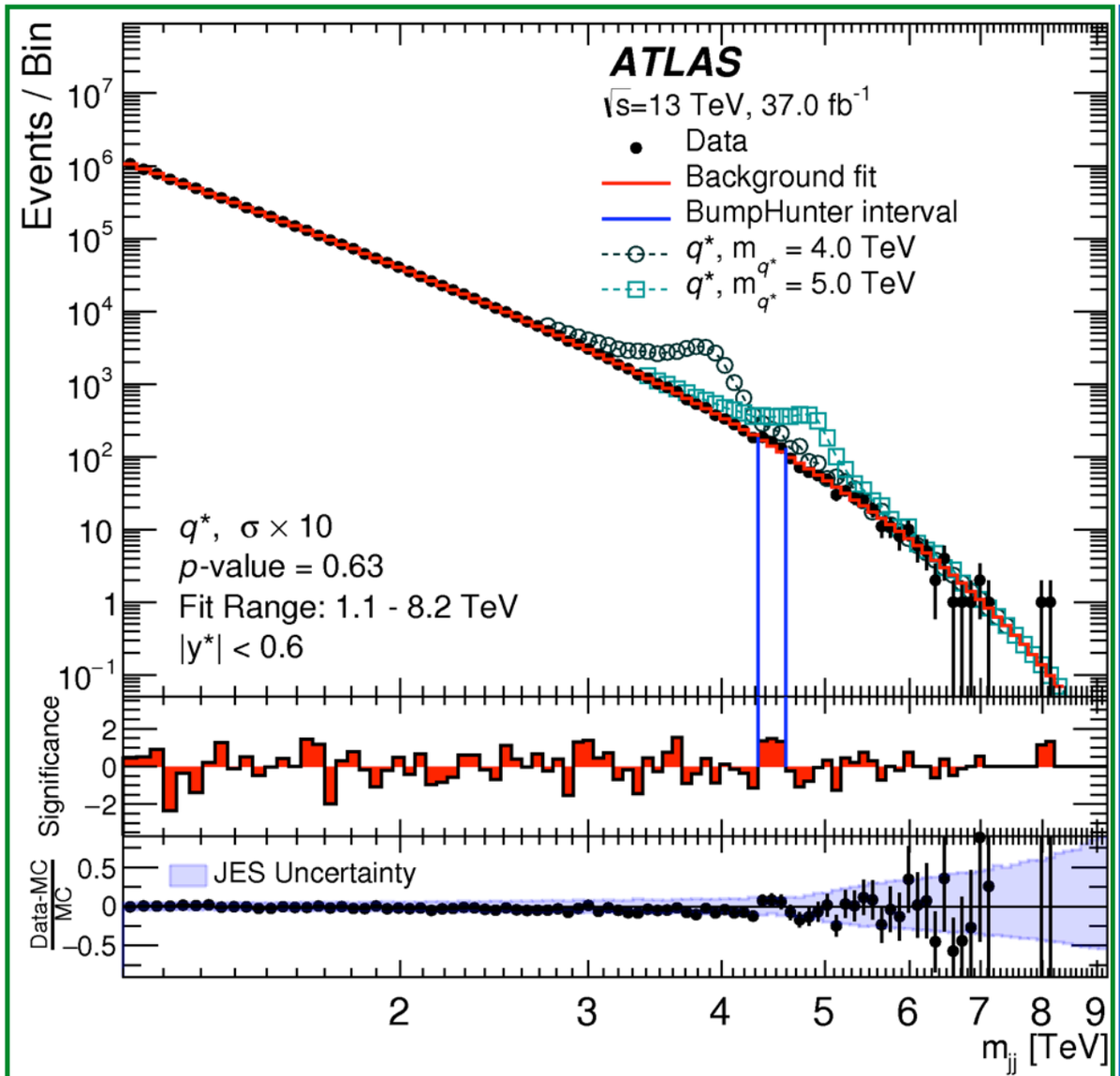
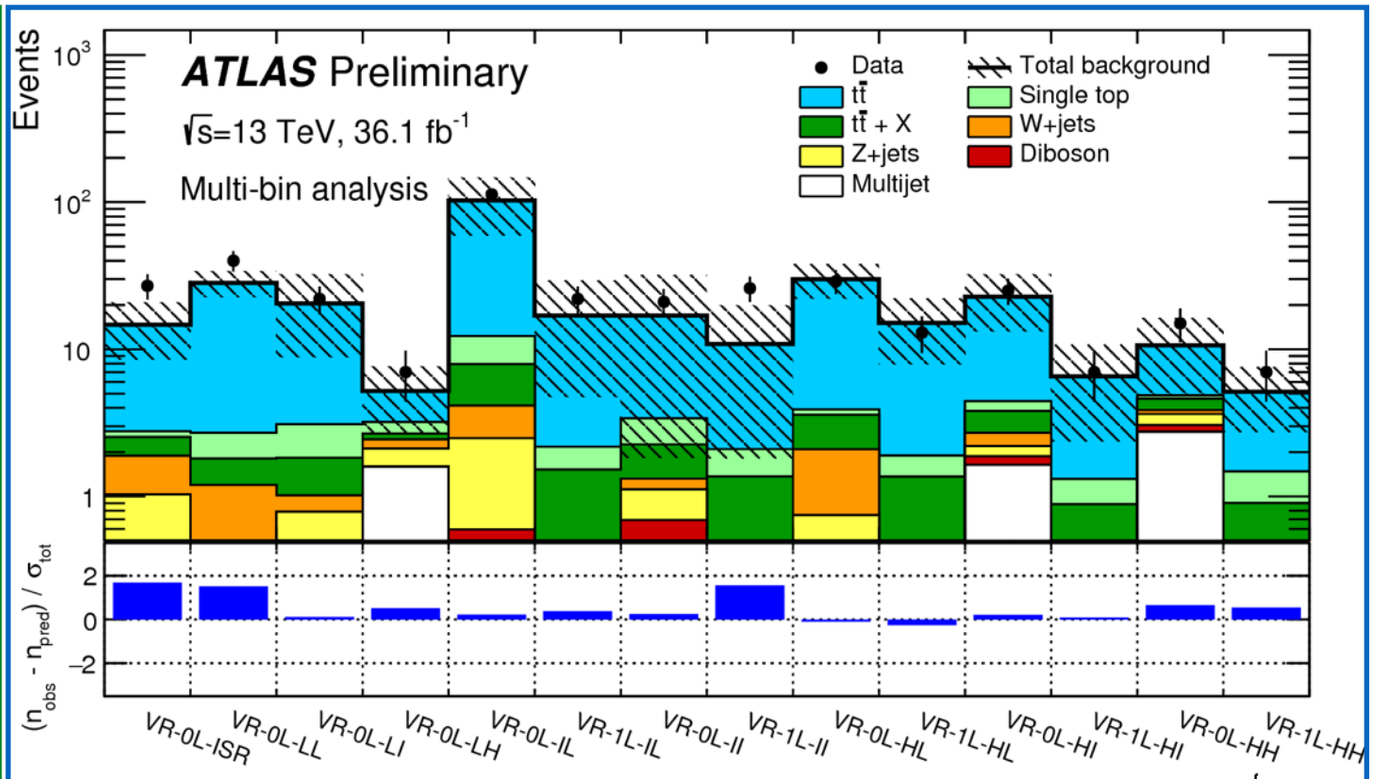
Science & Technology
Facilities Council

Introduction

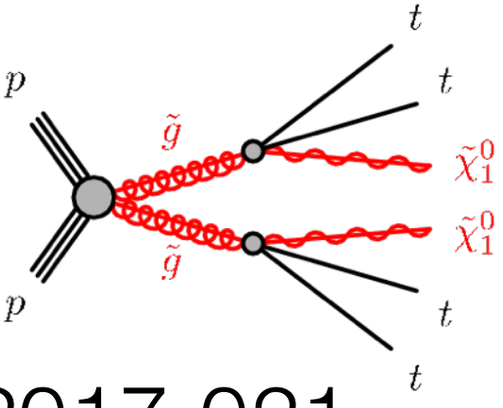
- Some searches are *nearly* independent of the quality of Monte Carlo, while many are **not**



arXiv:1703.09127



highly dependent on tt modeling



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Extremes

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

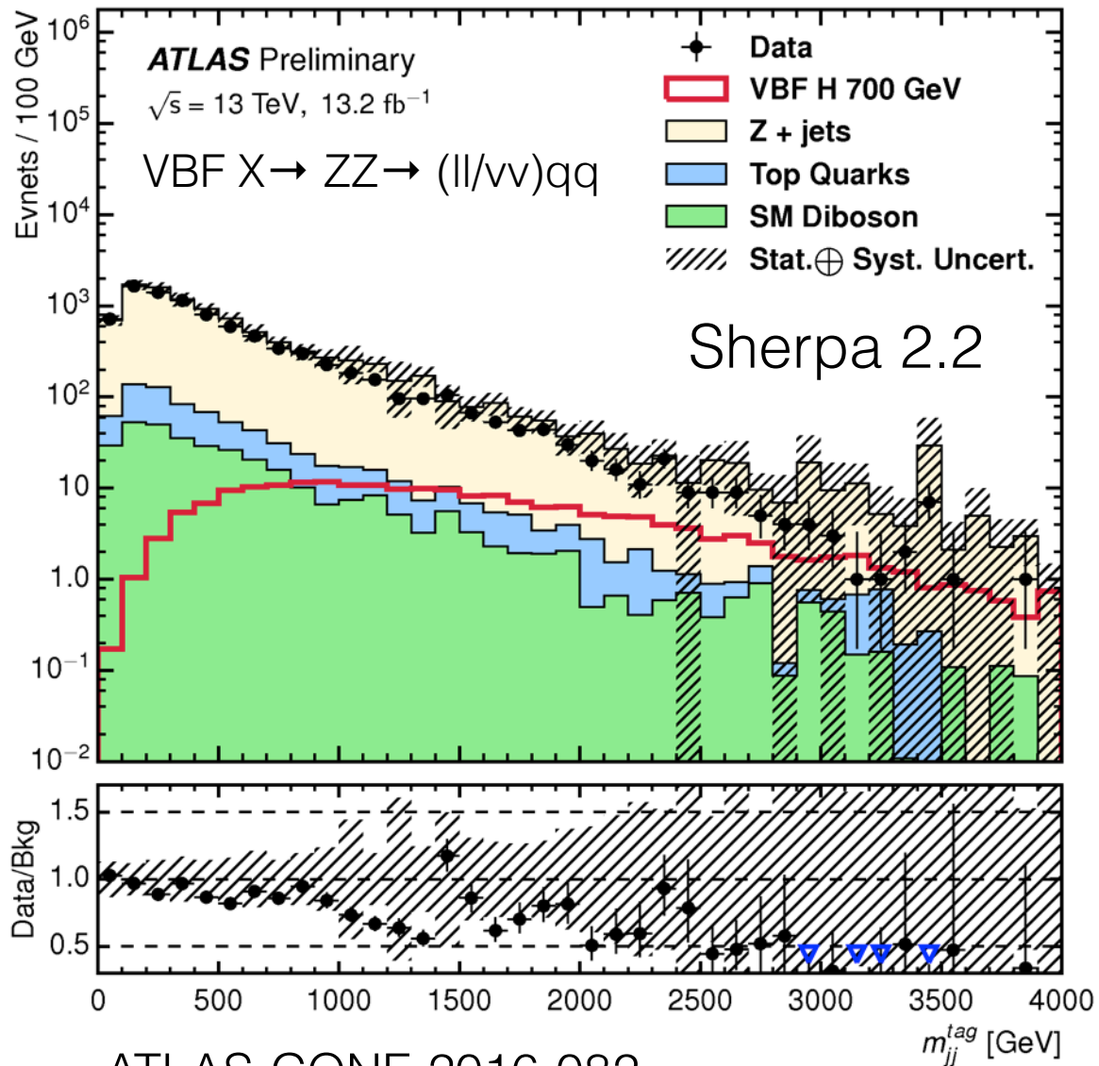
- Dependence on:

  - **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



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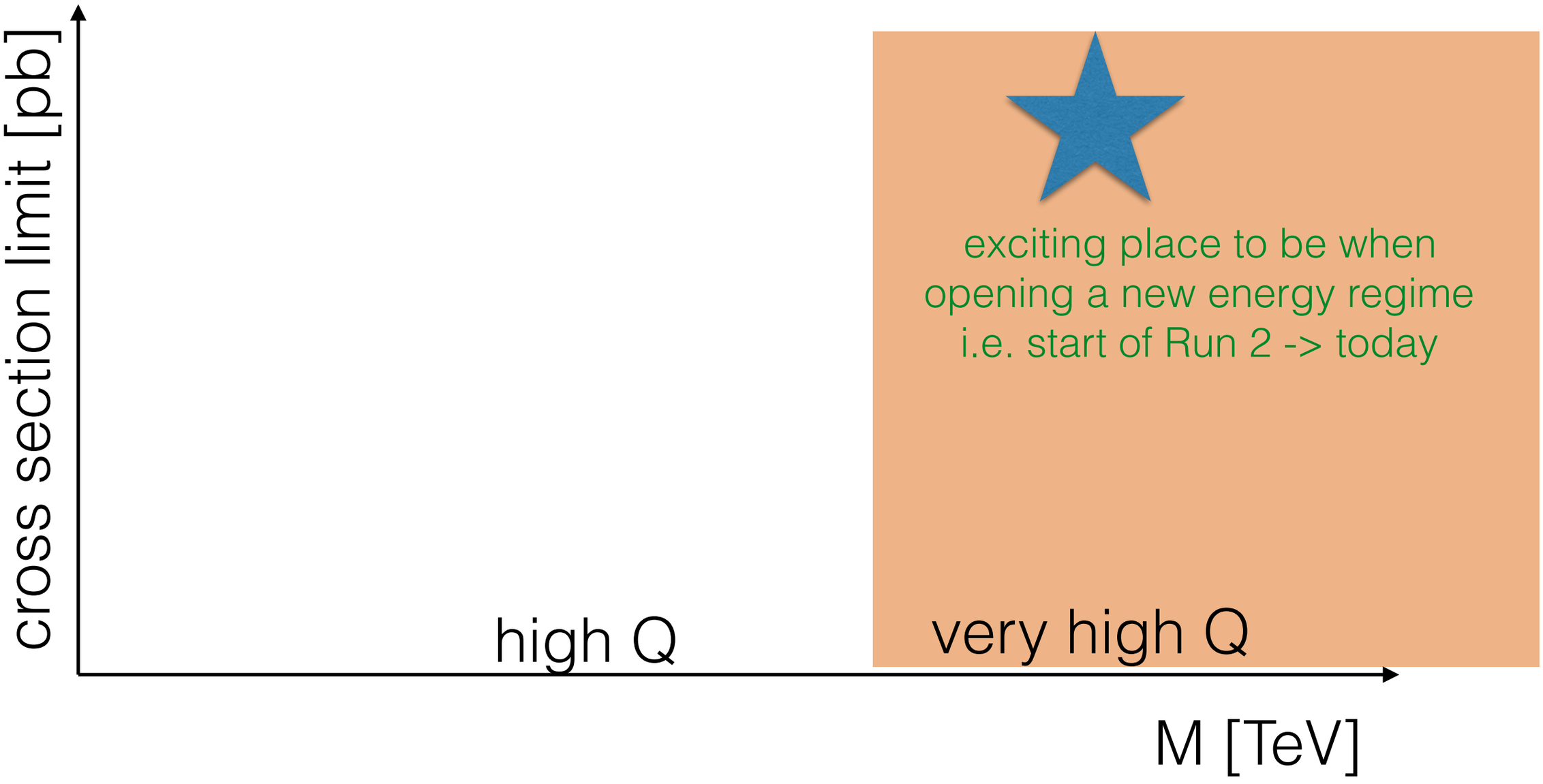
- Many topics already discussed in this workshop so will not go into much detail on these points

Search Lifetime



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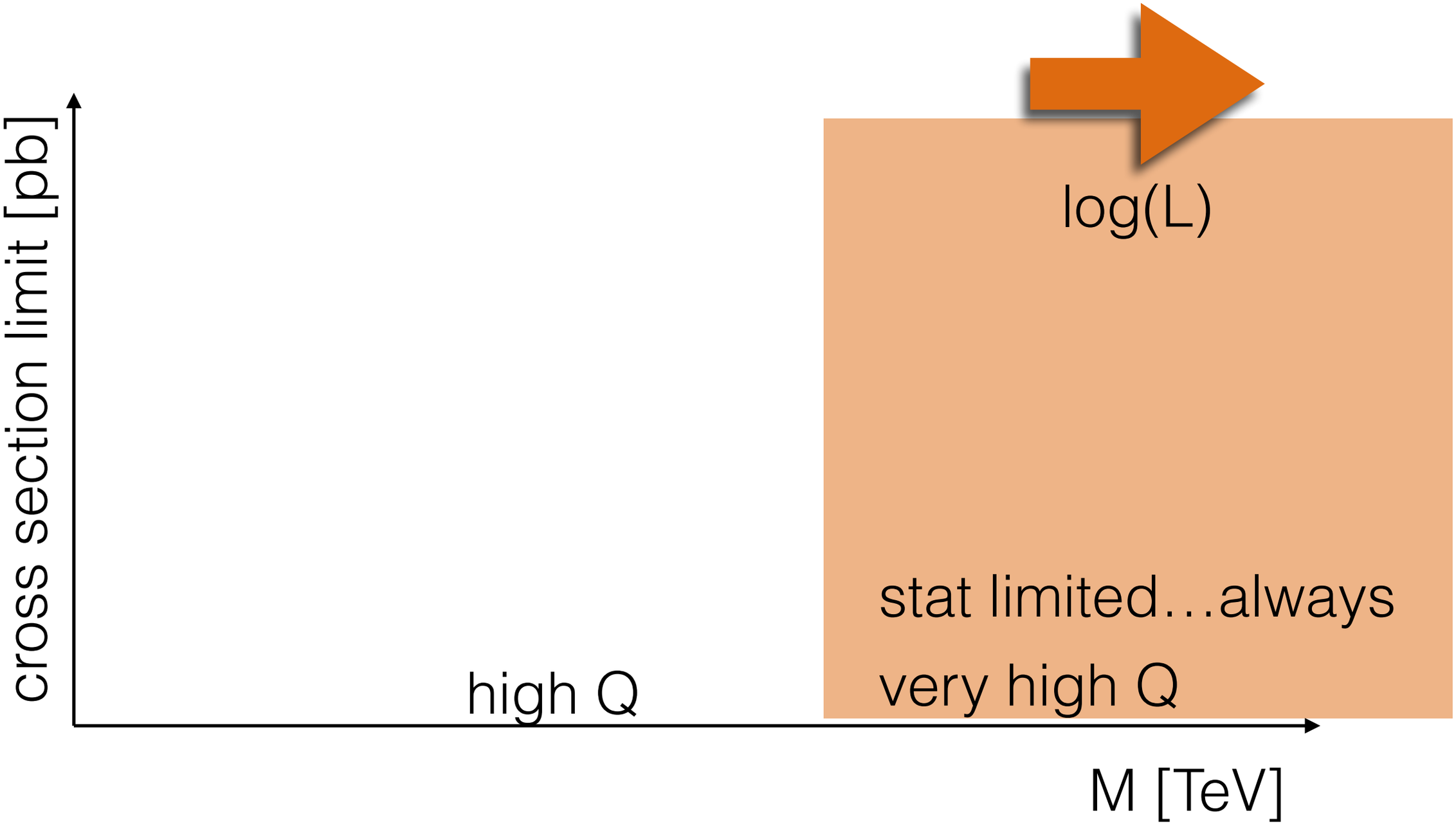

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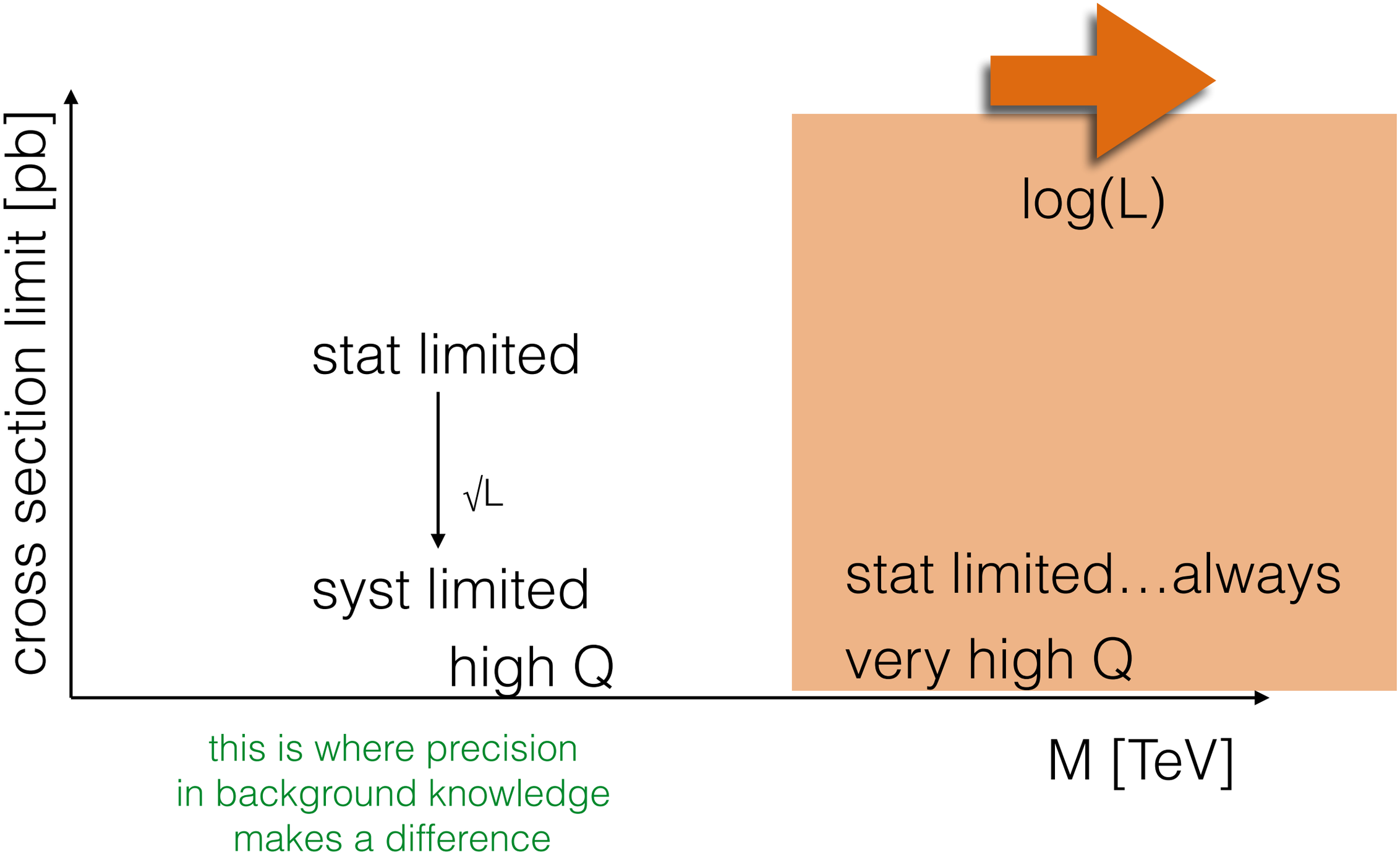


psychology - how low can you go??

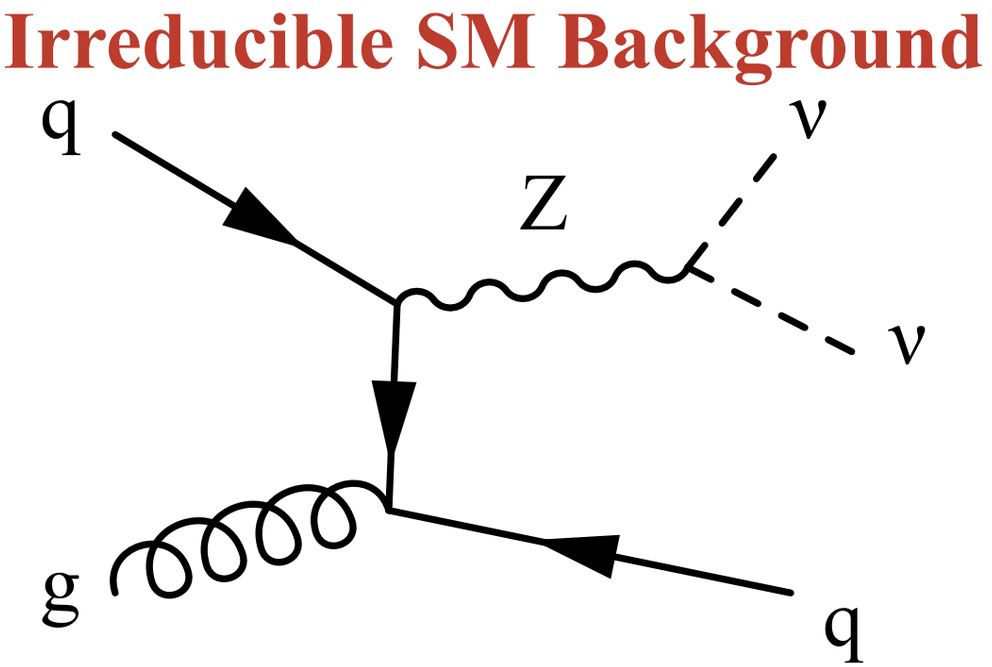
Minor Items Wishlist

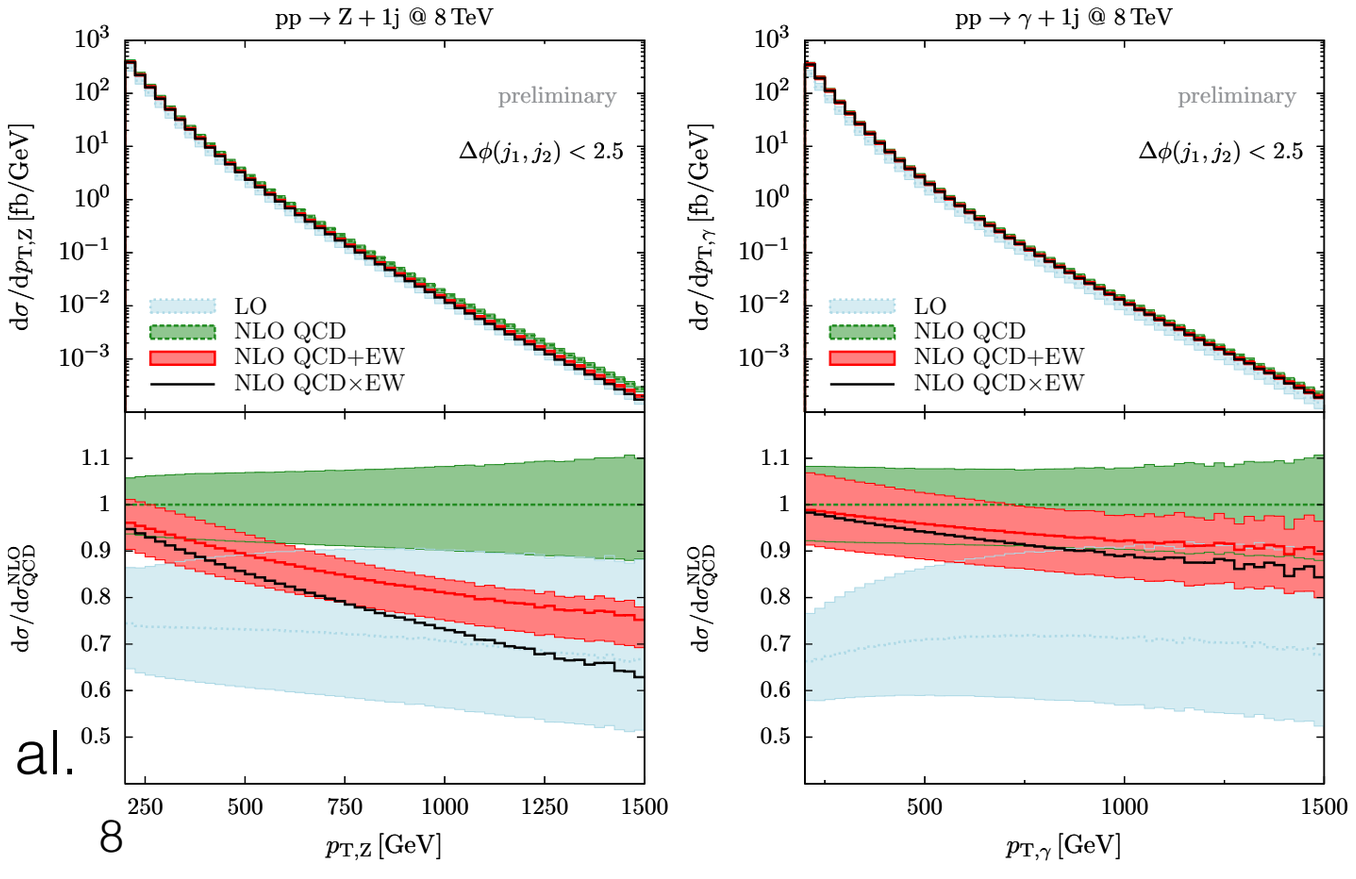
- NLO Signal Generation
  - NLO modeling of SM processes can differ between generators
    - MG5_aMC have NLO signal models available and getting easier to use.
- Comprehensive list of small backgrounds - are we forgetting a small background that is O(signal yield)

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

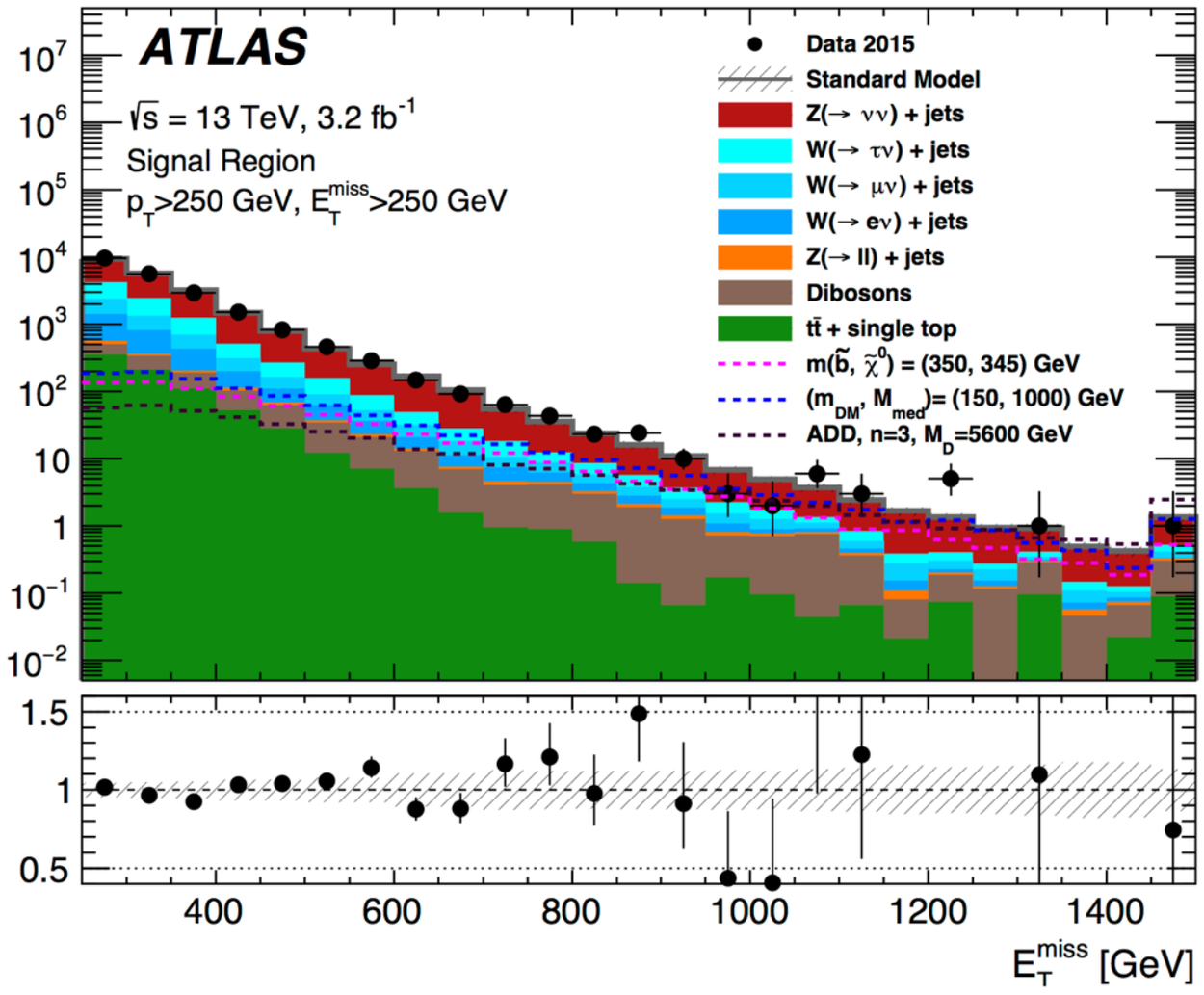




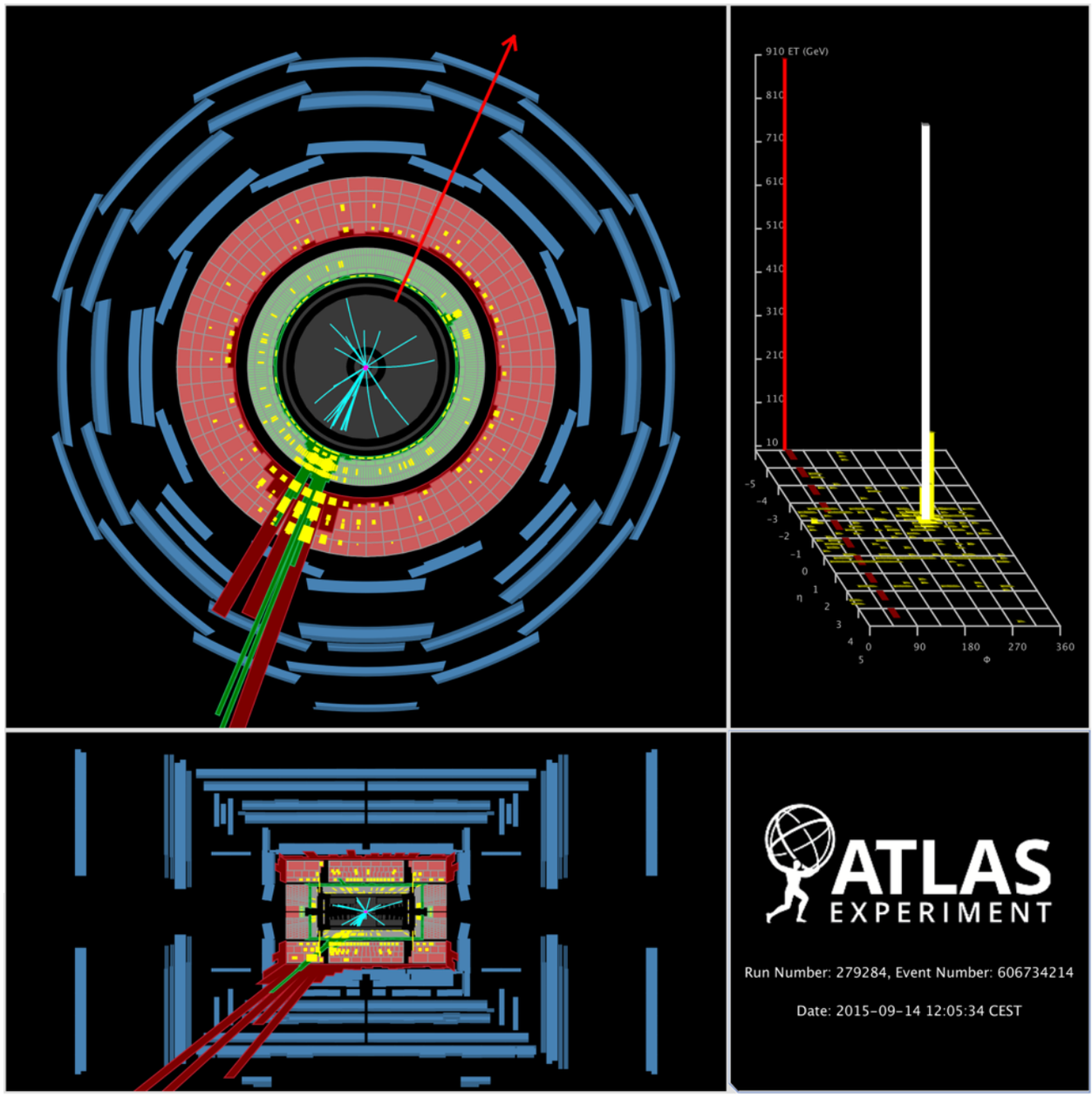
J. Lindert et. al.

Dark Matter

Strategy and sensitivity of MET+X analysis are dependent on the knowledge of the Z pT of the Z->vv SM process

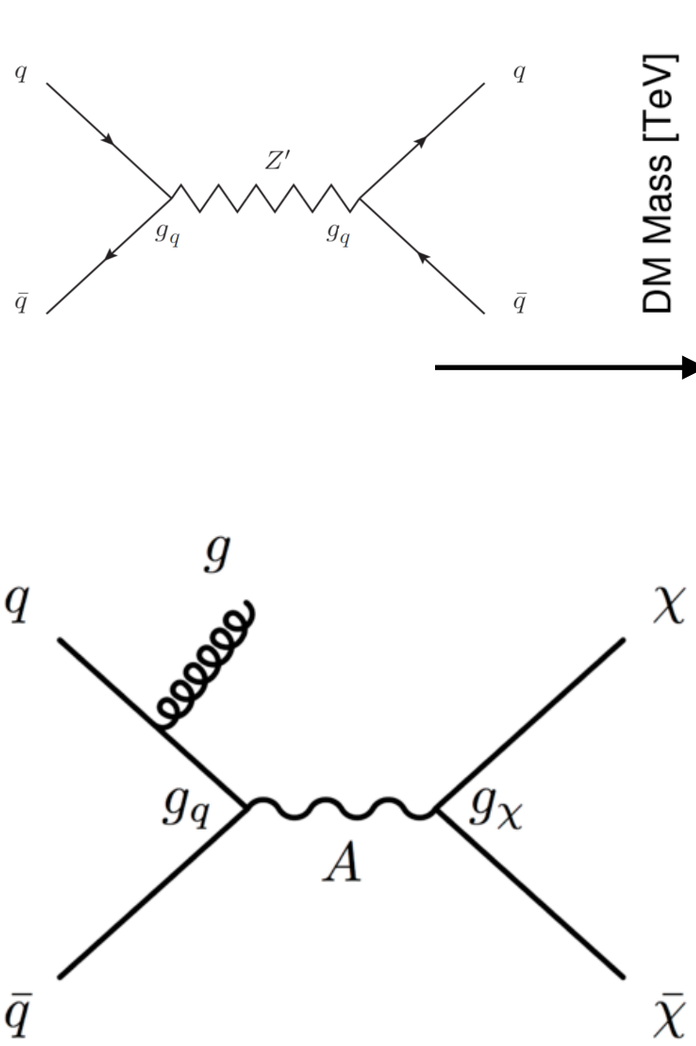


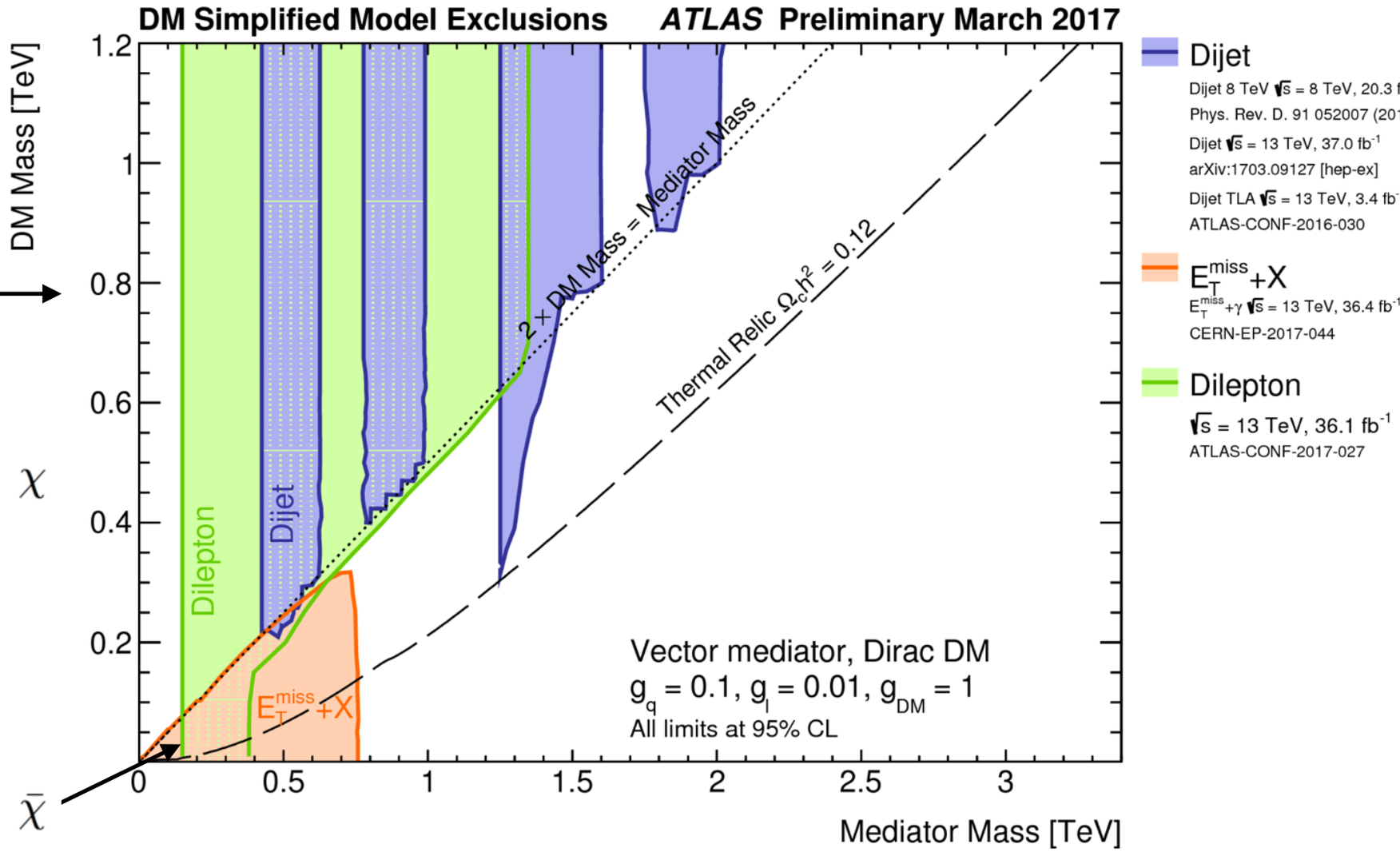
Transfer knowledge from Z->ll, W->lv, or g+j CR



Dark Matter

- An example - for parts of parameter space are only accessible with MET+X searches





Diboson, ttbar, dijets: EW corrections also interesting
Alternative: Z->ll only

Biasing

- *Generating enough MC for the expected dataset is a tremendous challenge!* *(+more for systematics)*

- critical for the future to have better generator filters to keep up with the larger and larger dataset.
  - "**better**" means **faster** (applied earlier on) and more **flexible** (include various observables)

- Slicing vs biasing all @ NLO - which will give more stable results

- NB: *negative weights* or *large event weights* **are killer** when limited MC stats are available

Meaningful & Harmonized

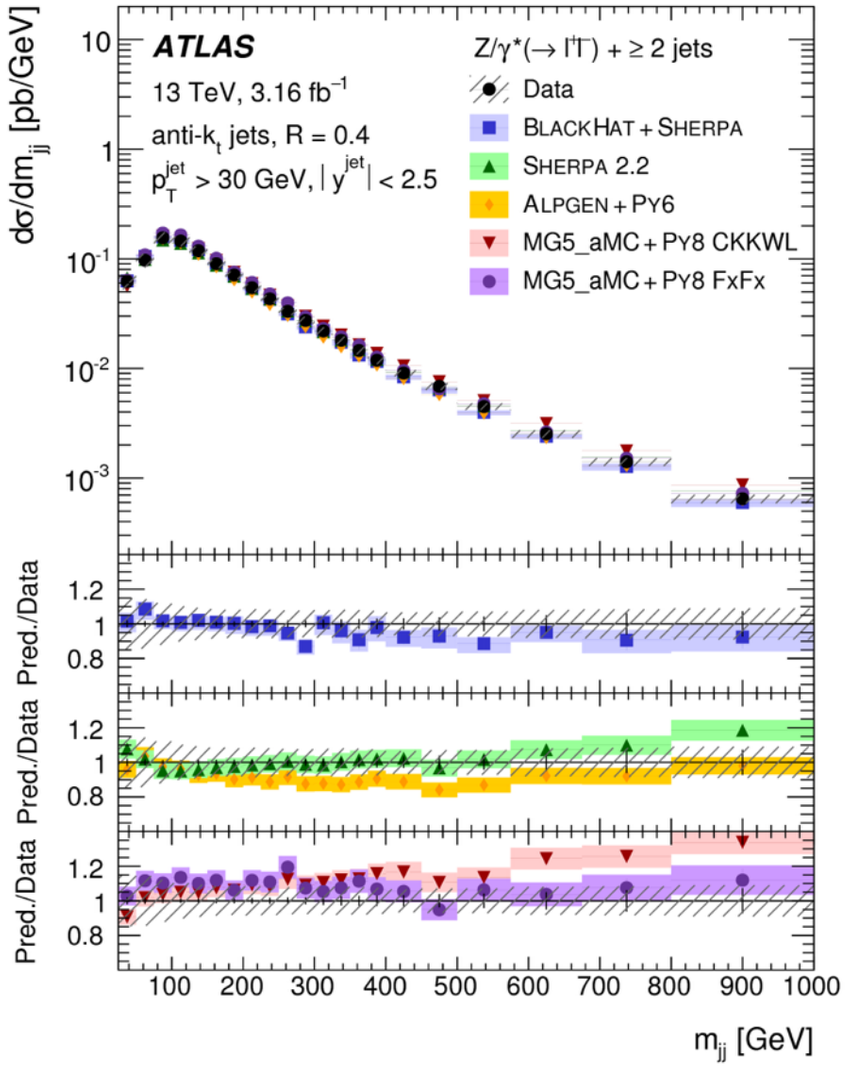
- **Modeling systematics are quite tricky business i.e. top p_T**

- An analysis might:
  - compare 1 generator in 2 settings
  - compare 2 generators

- This is *~arbitrary* and tricky especially when used in modern statistical tools in which these comparisons represent 1 sigma systematics and can be profiled

- Procedures are **not uniform** at ATLAS & CMS.
  - i.e. ttbar/single top interference

- Are recipes "**correct**" or "**complete**"? Items missing, double counted, etc?



More Than Limits

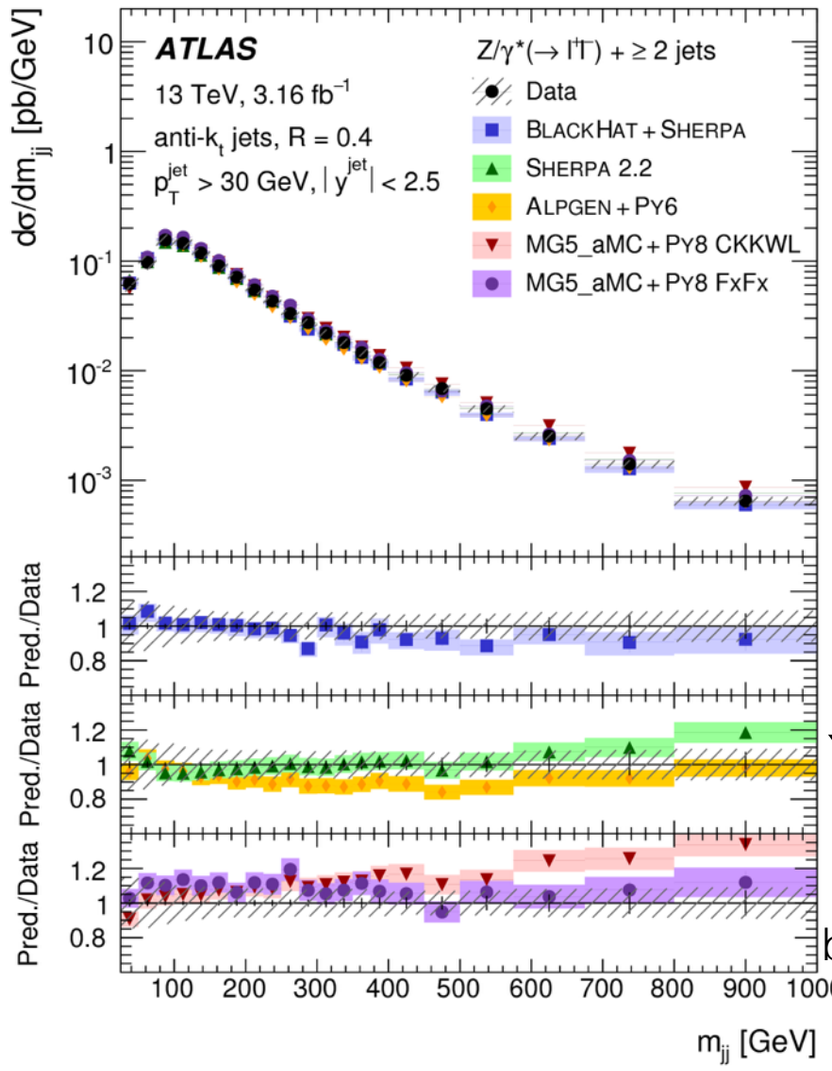
- Search groups burn through the data much faster than measurement groups

(Think search control regions not signal regions)

(Not discussing re-interpretation)

- ***Can searches provide more useful information for MC generator tuning?***

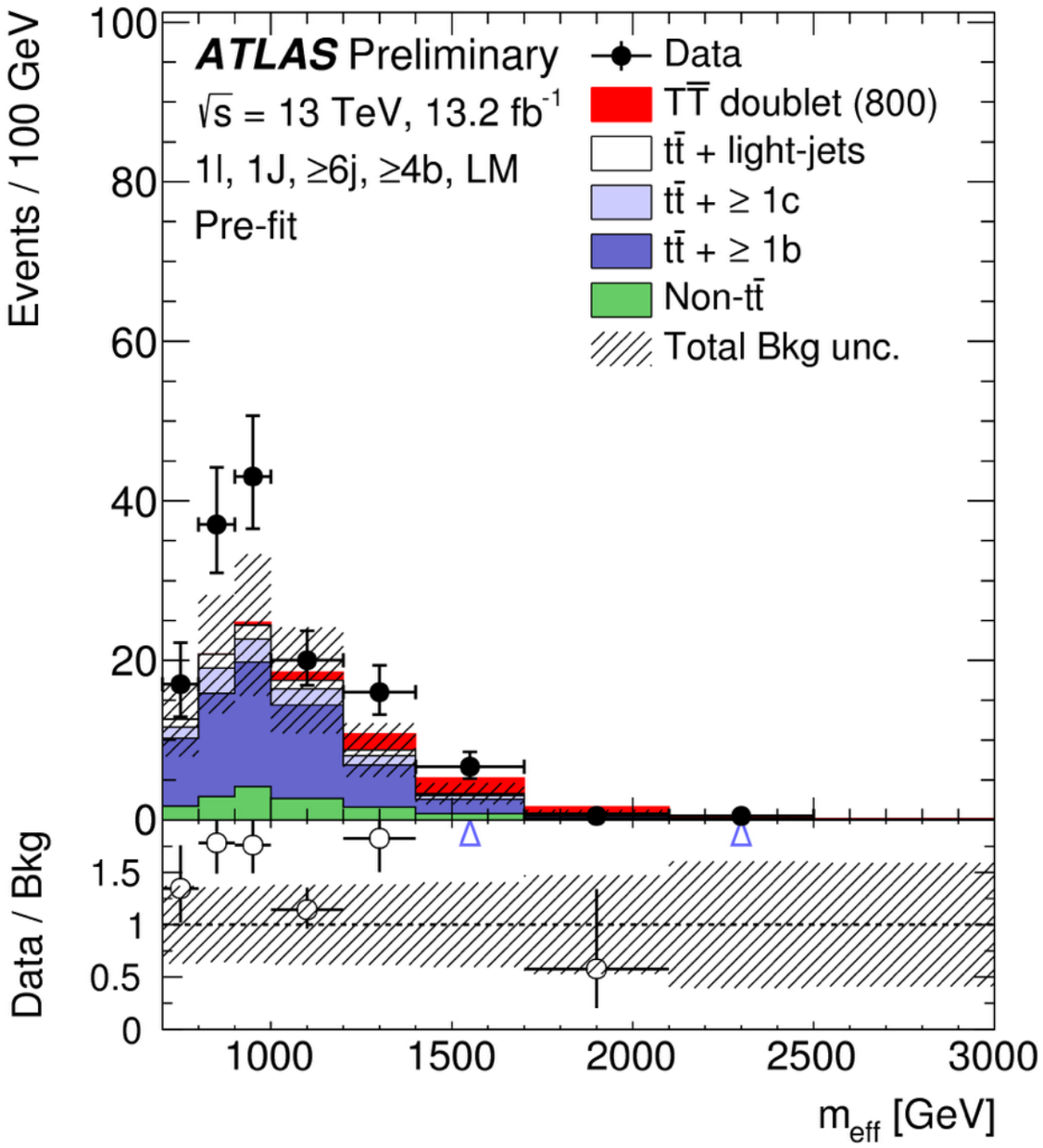
  - Living in the *extremes of phase* space where measurements are less likely to be.
  - What is the **minimal** amount of information?
  - Will you *use it*? Don't just say "yes"!

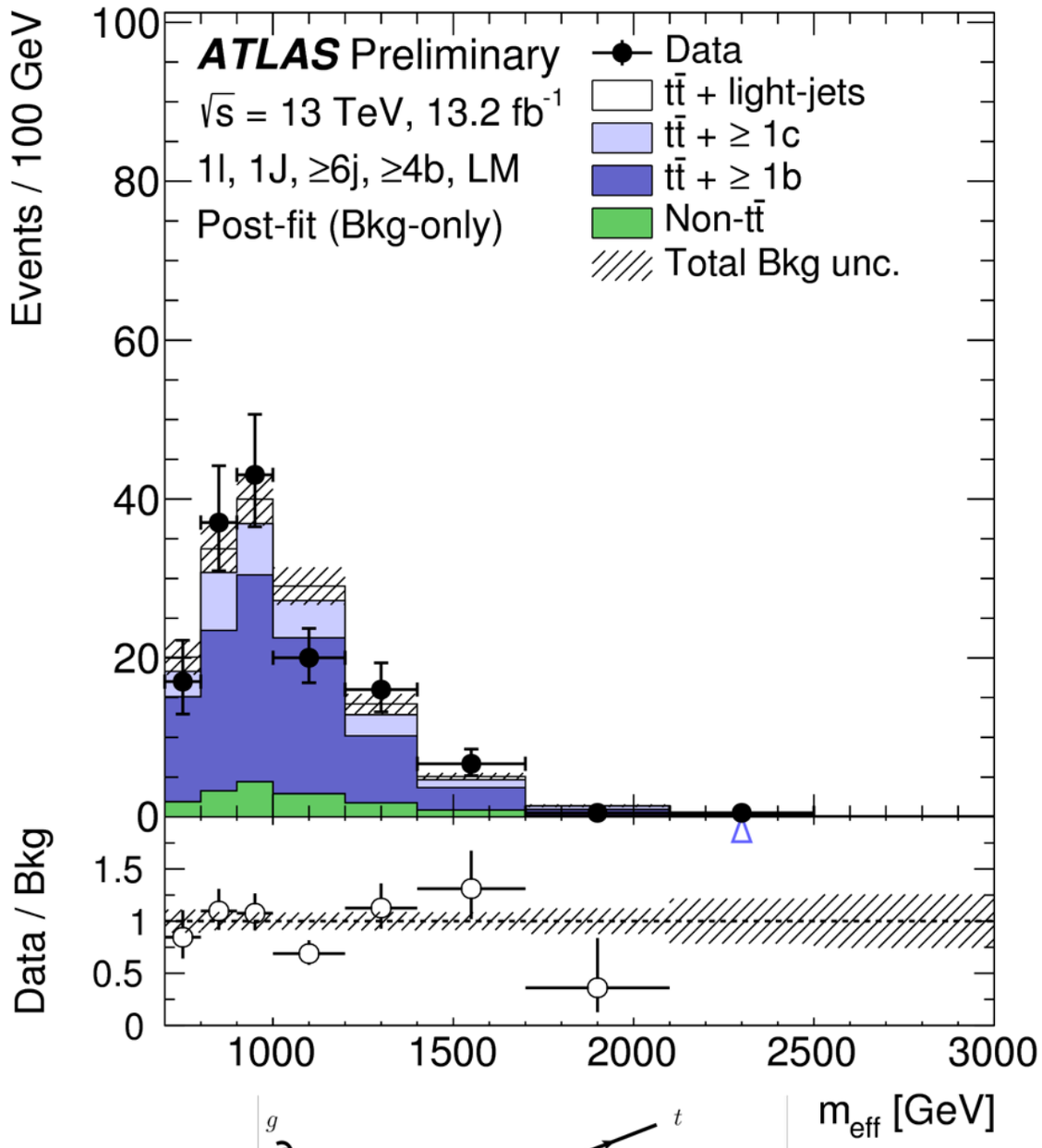


guess what happens beyond 1 TeV!

arXiv:1702.05725

More Than Limits





At all useful?

tt: Powheg v2 + Pythia 6, CT10 PDF set

MET (W), MET+m_T^W, 1 leptons, 5+ jets, 2+ b-jets

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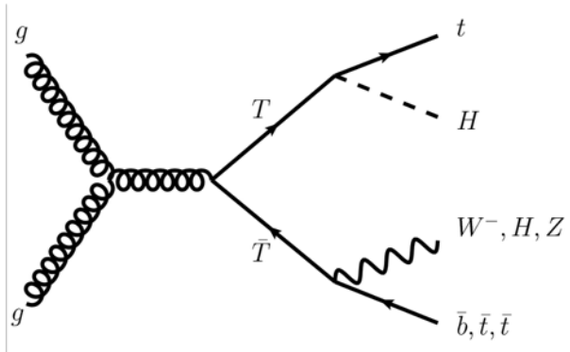
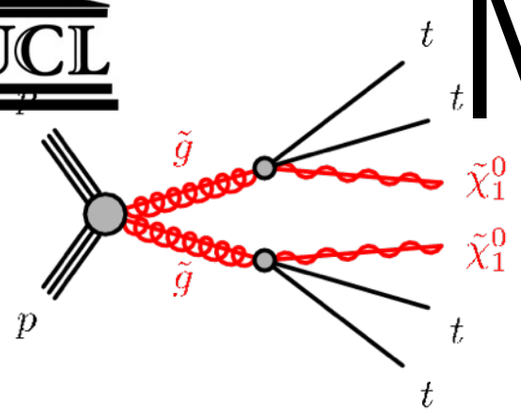


More Than Limits



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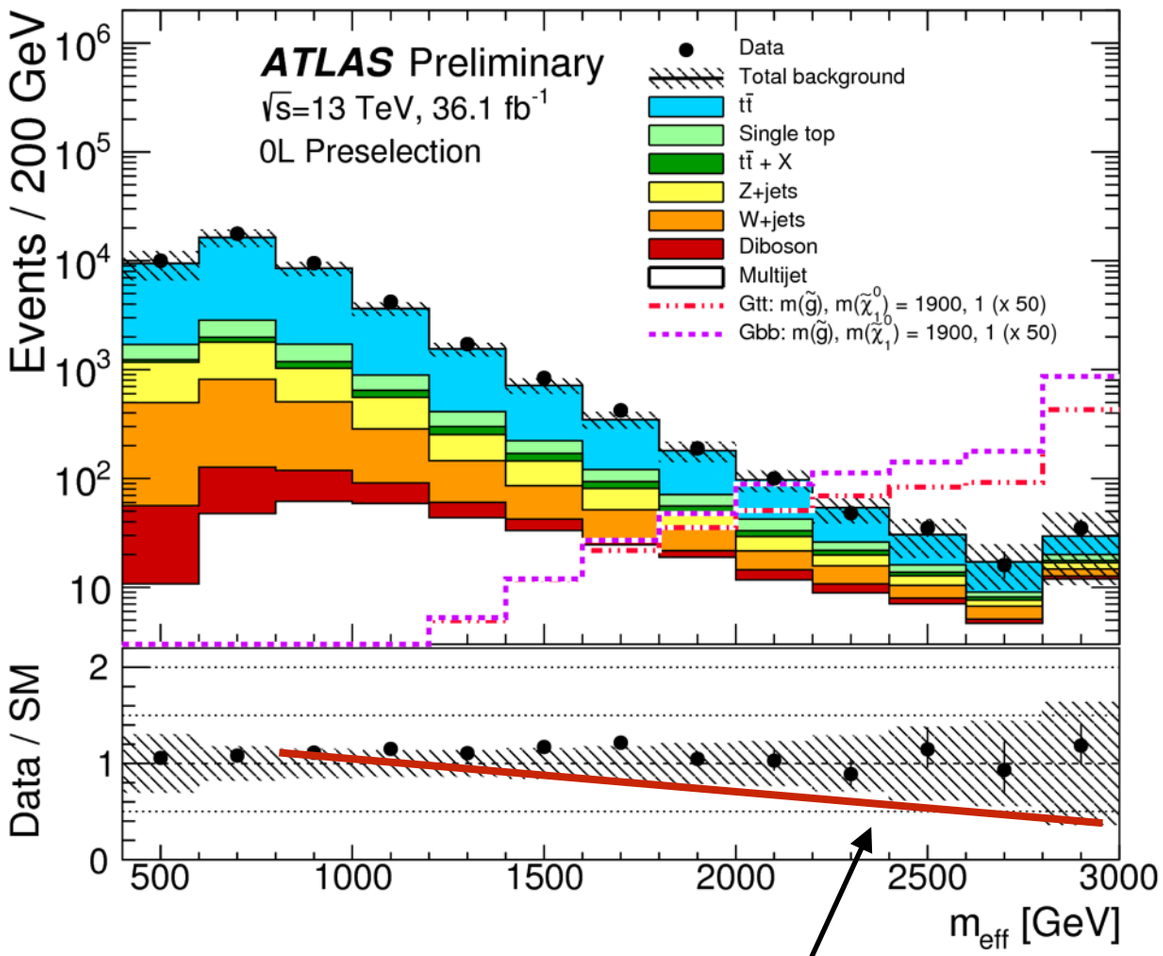
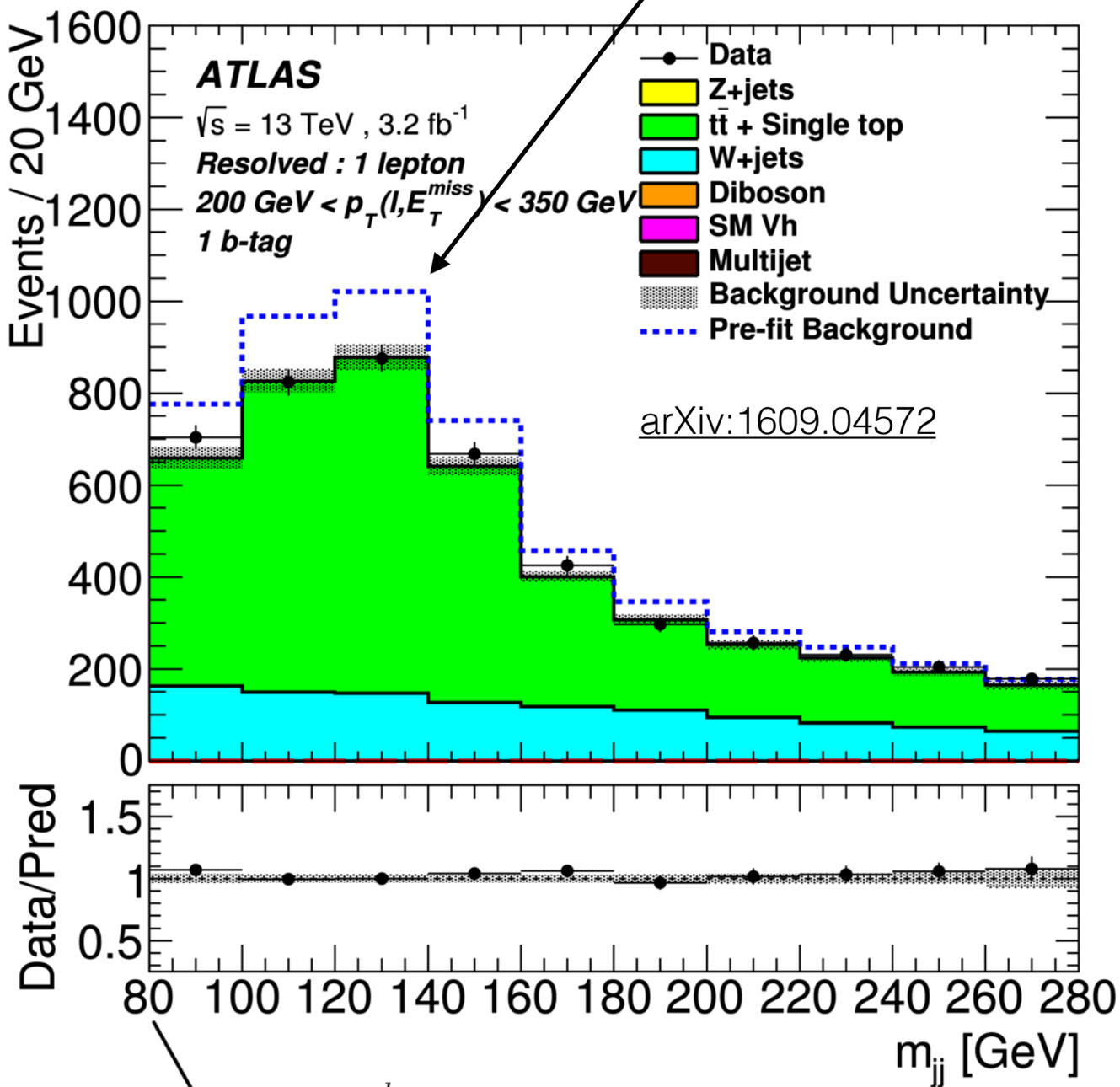


what if we showed you this?

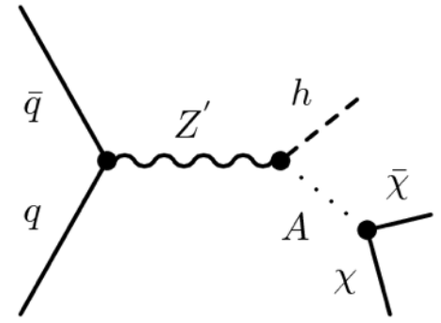
tt: Powheg v2 + Pythia 6, CT10 PDF set

MET, 0 leptons, 4+ jets, 2+ b-jets, ΔΦ(jets)>0.4

At all useful?



arXiv:1609.04572



W pT cut, 1 lepton, 2 jets, 1 b-jets, anti-QCD cuts, H_T

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?

Conclusions

- Searches go out to the ***most extreme regions of phase-space*** where the MC is not tuned nor many measurements are done (yet/ever)
  - *Understanding of SM might be limiting factor in near future*
- List of minor item wish lists shown
- EW Corrections - important for the ultimate **precision**
- Slicing/Biasing MC - **critical** - faster, more flexible
- In these regions, ad hoc procedures are needed for systematics i.e. generator comparisons. ***Can we harmonize or discuss to make this more robust/meaningful?***
- **More than limits** - *what is the minimal amount of information from searches that can be useful for MC studies? What is next-to-minimal? Dream plots?*