

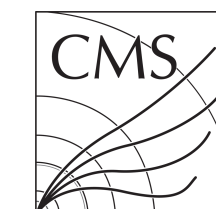


VBS WH Analysis

Towards correcting the discontinuous 2D exclusion plot

August 25th, 2023

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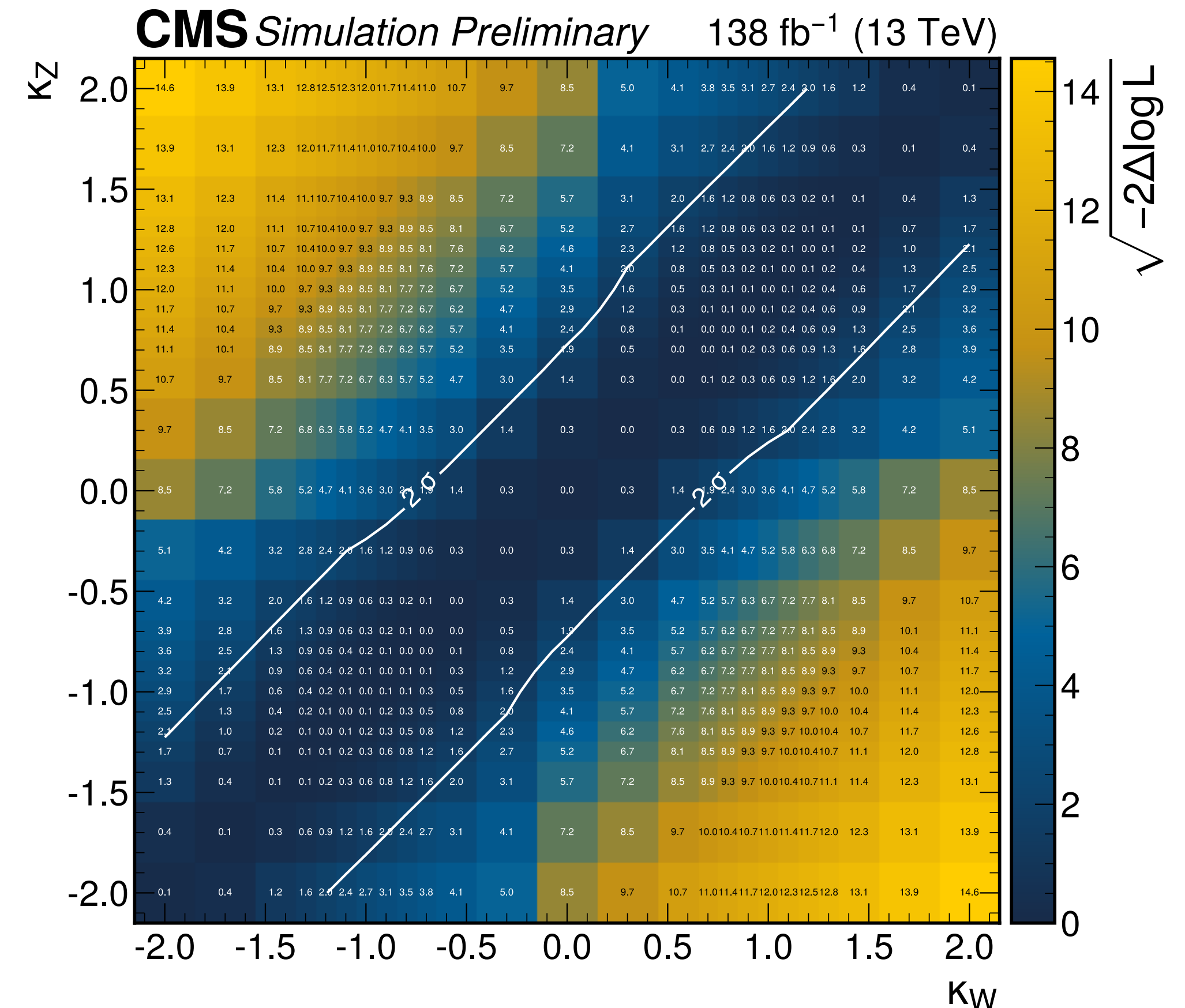


UC San Diego



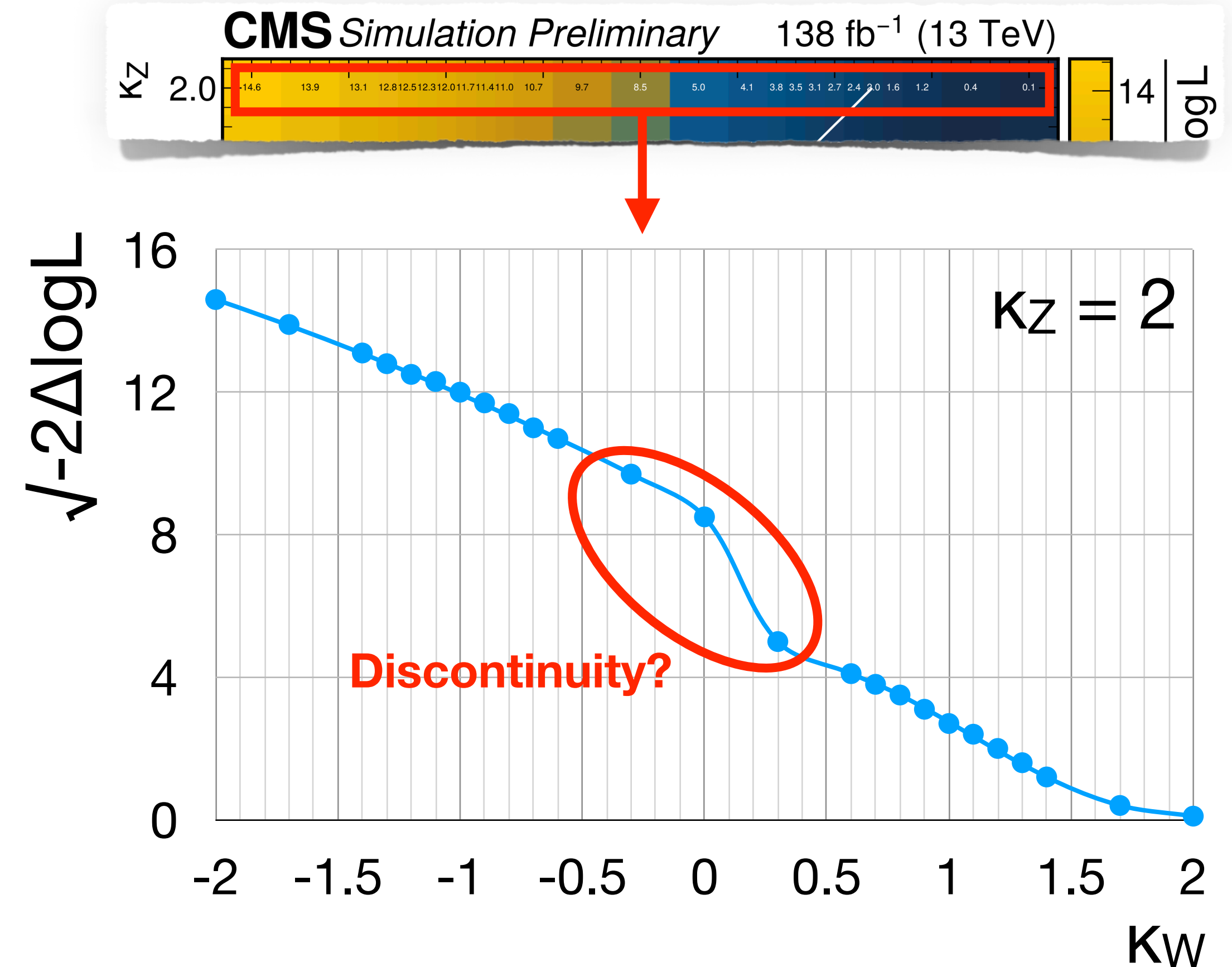
Exclusion Discontinuity

- Cross section changes smoothly as a function of κ_V
- Exclusion shown in AN seems to have a “discontinuity” between κ_W , κ_Z quadrants
 - e.g. figure on the right
- Acceptance of SR does change as a function of λ_{WZ} (i.e. lose boost near SM), but does not explain this discontinuity
- **What is going on?**



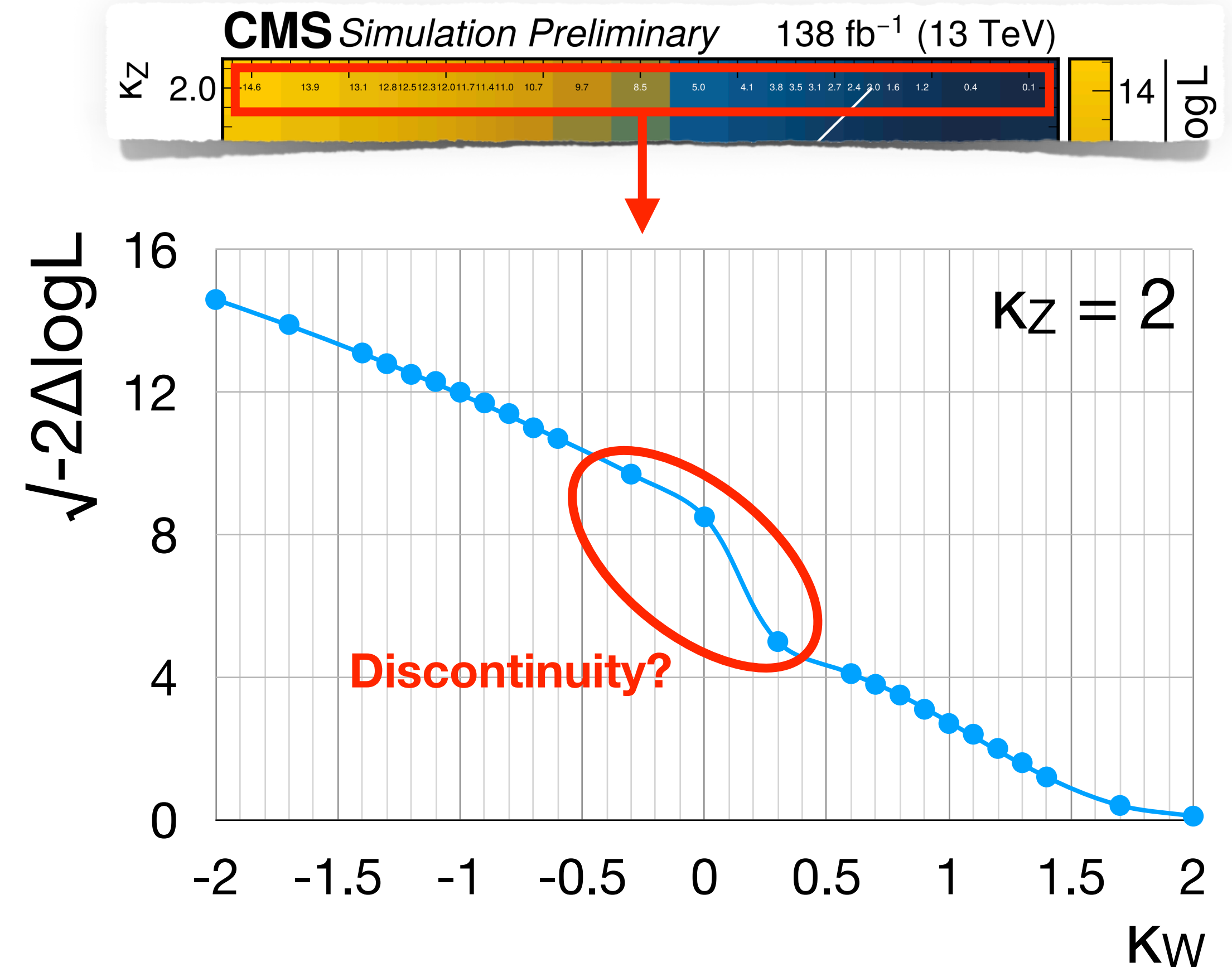
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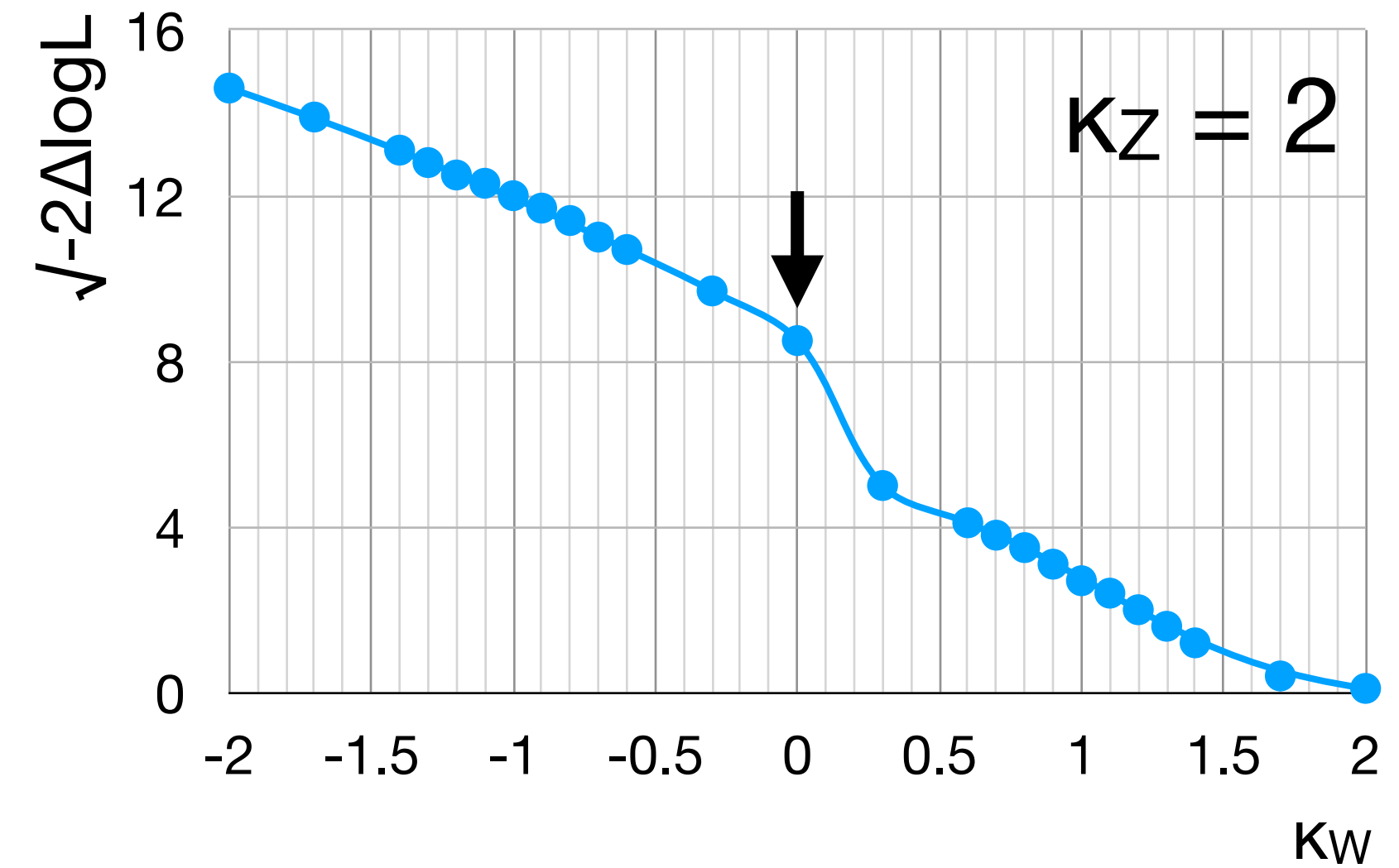
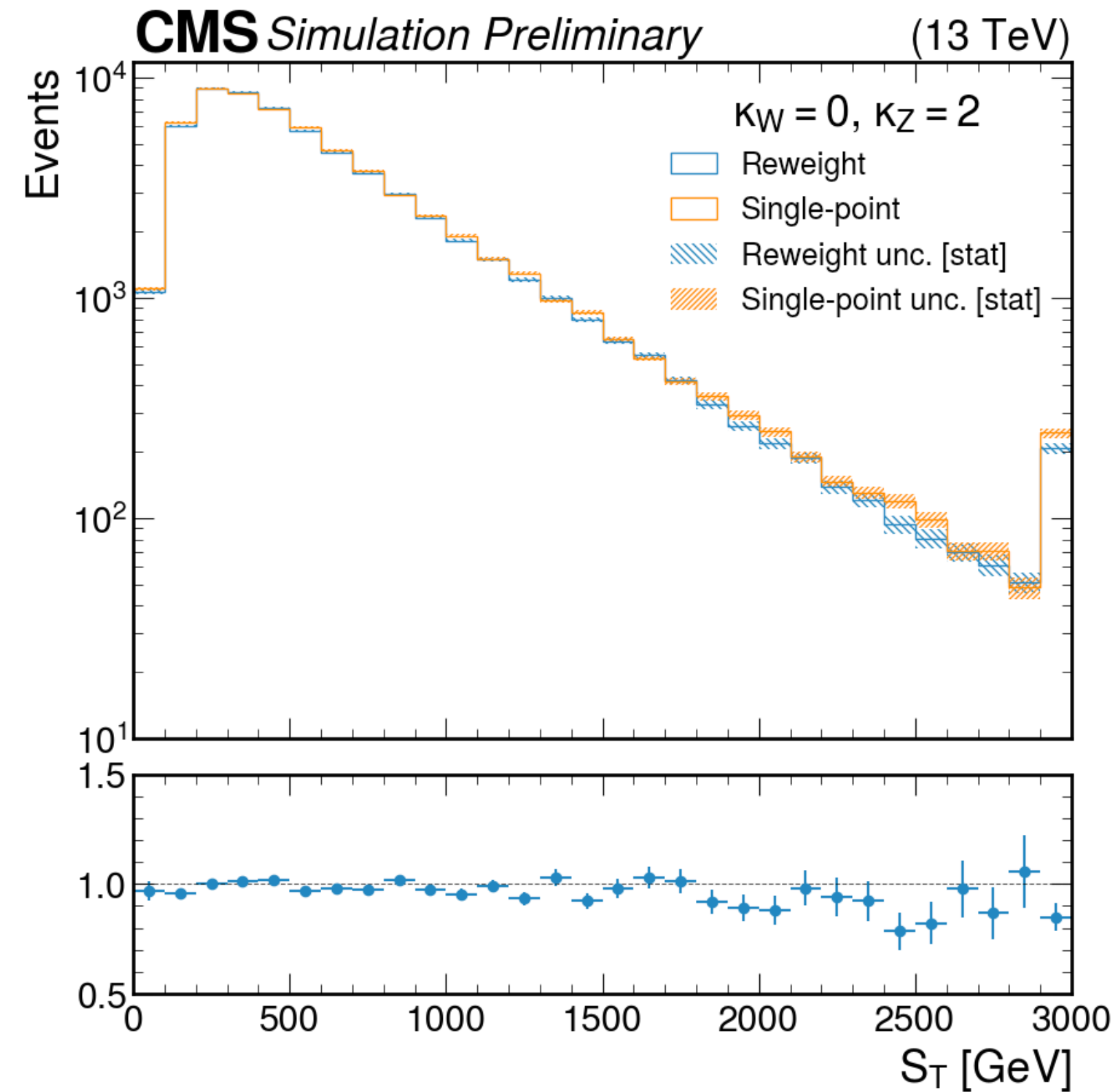
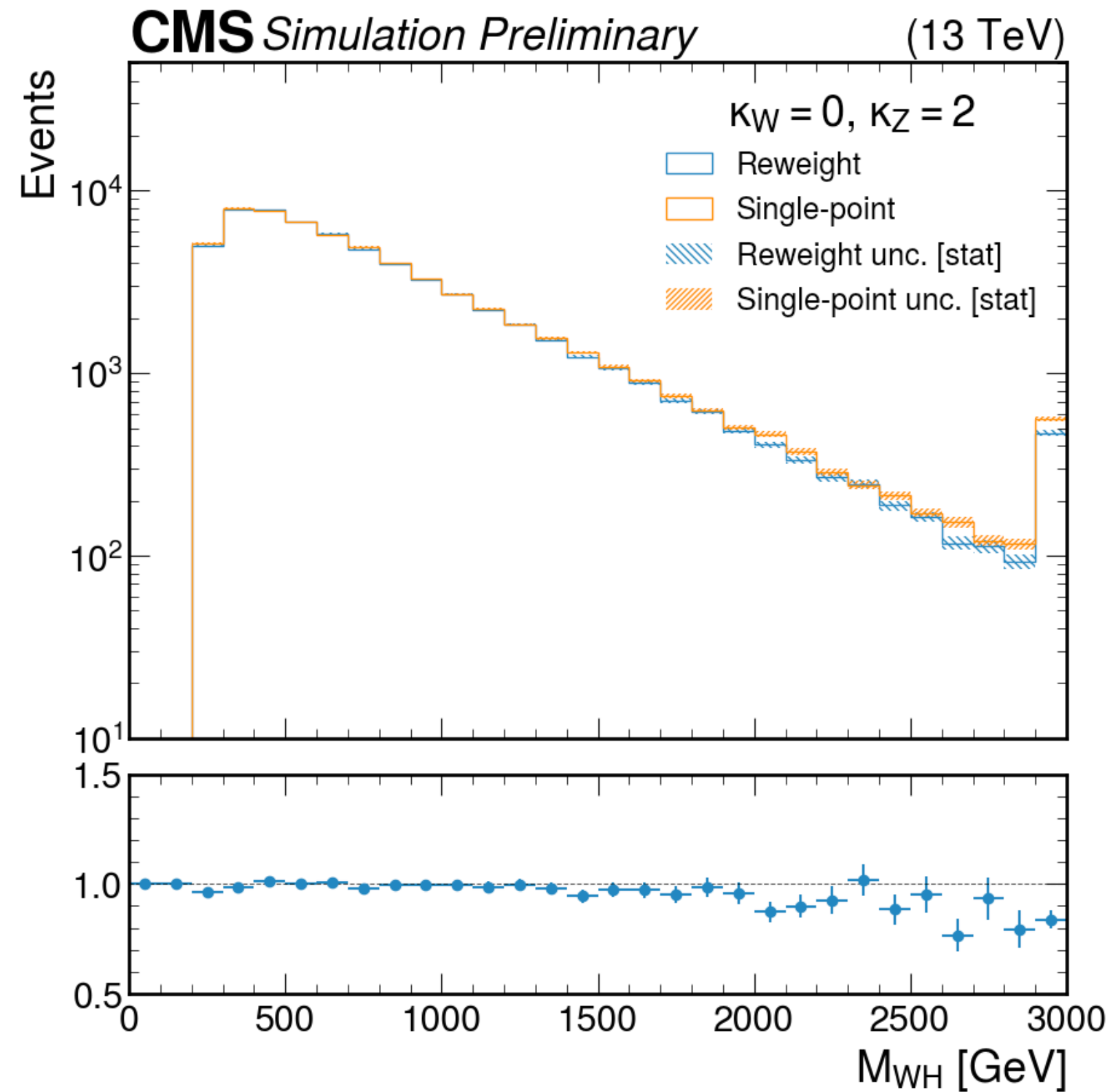


Testing the Discontinuity

- We can examine whether this discontinuity is truly an issue by
 - Generating a single-point sample at a given K_W , K_Z point
 - Comparing the reweighted sample at that point with the single-point sample
- This will tell us if the reweighting procedure is indeed failing somehow

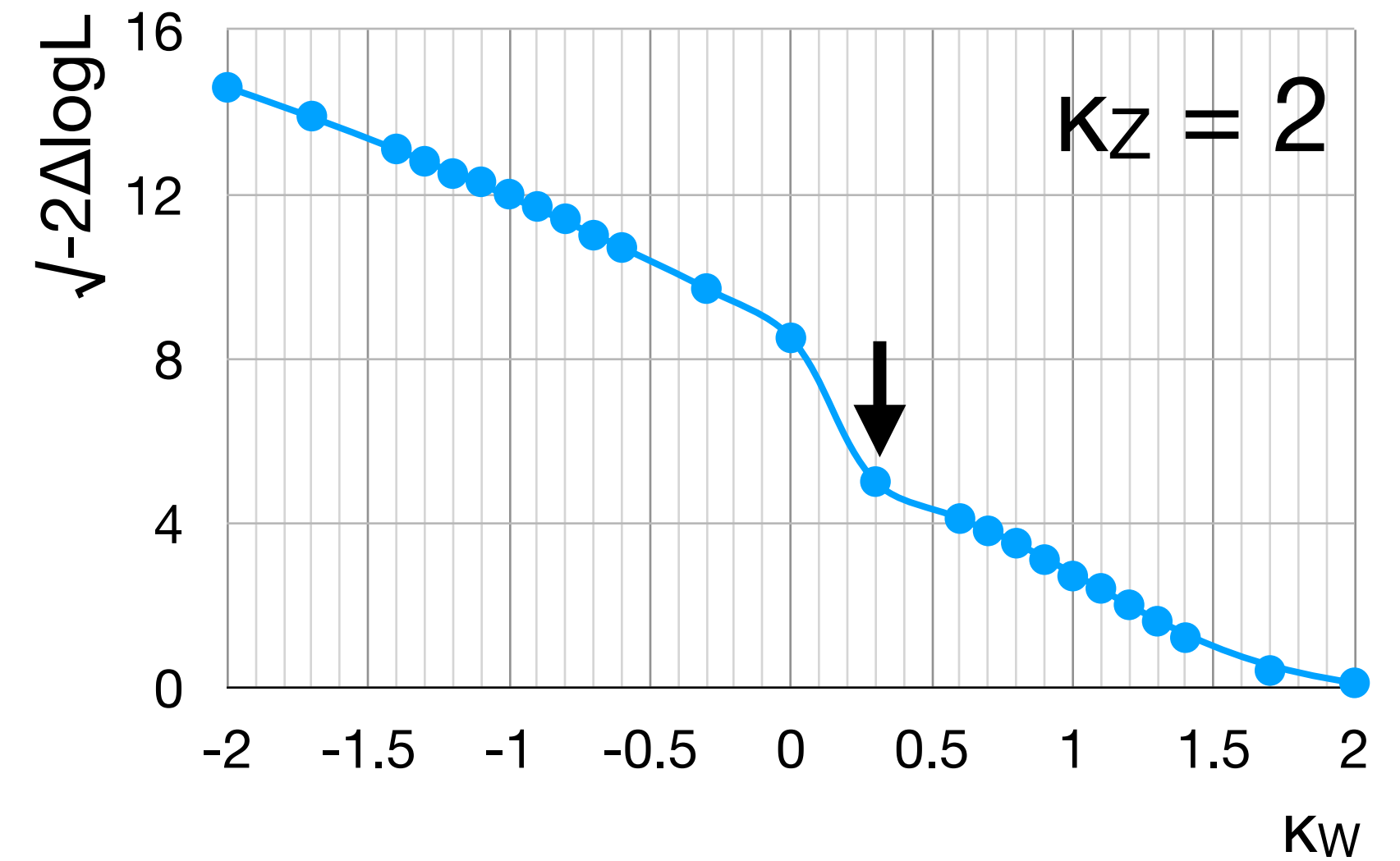
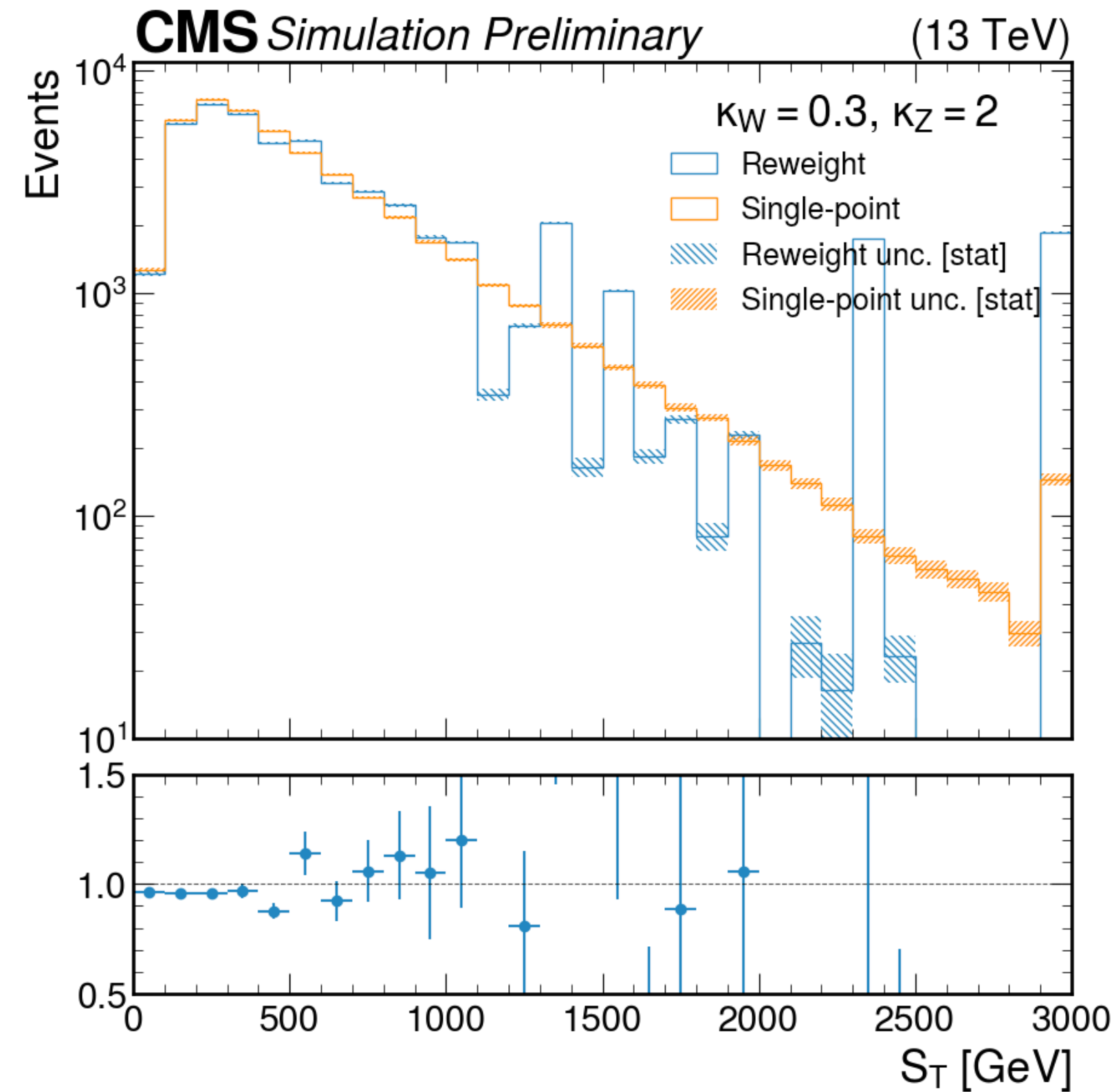
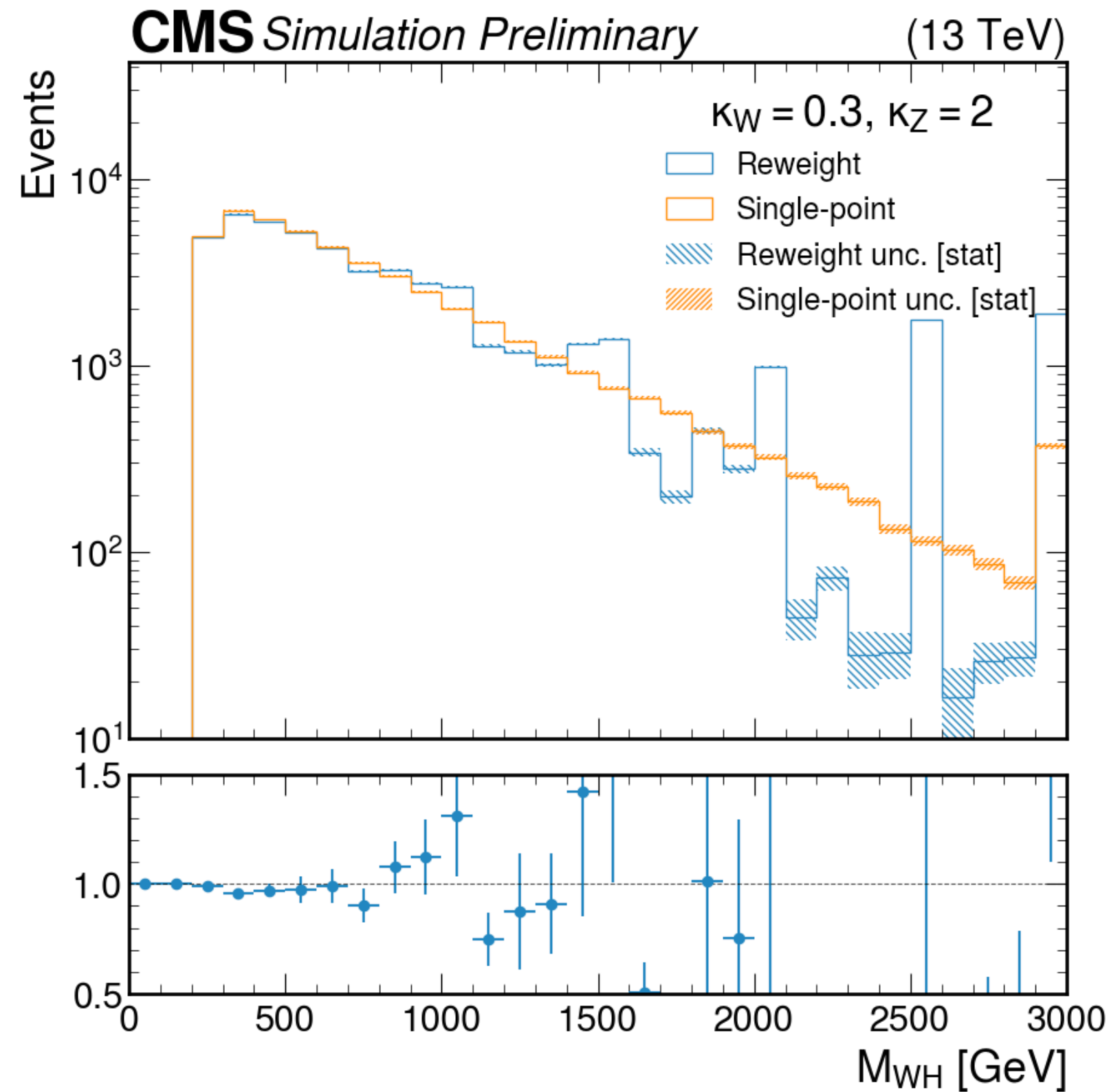


Rewweighted vs. Single-point



Rewweighting slightly under-predicts yield in SR-like high S_T , high M_{WH} tail
 Not a significant issue \Rightarrow what about the next point?

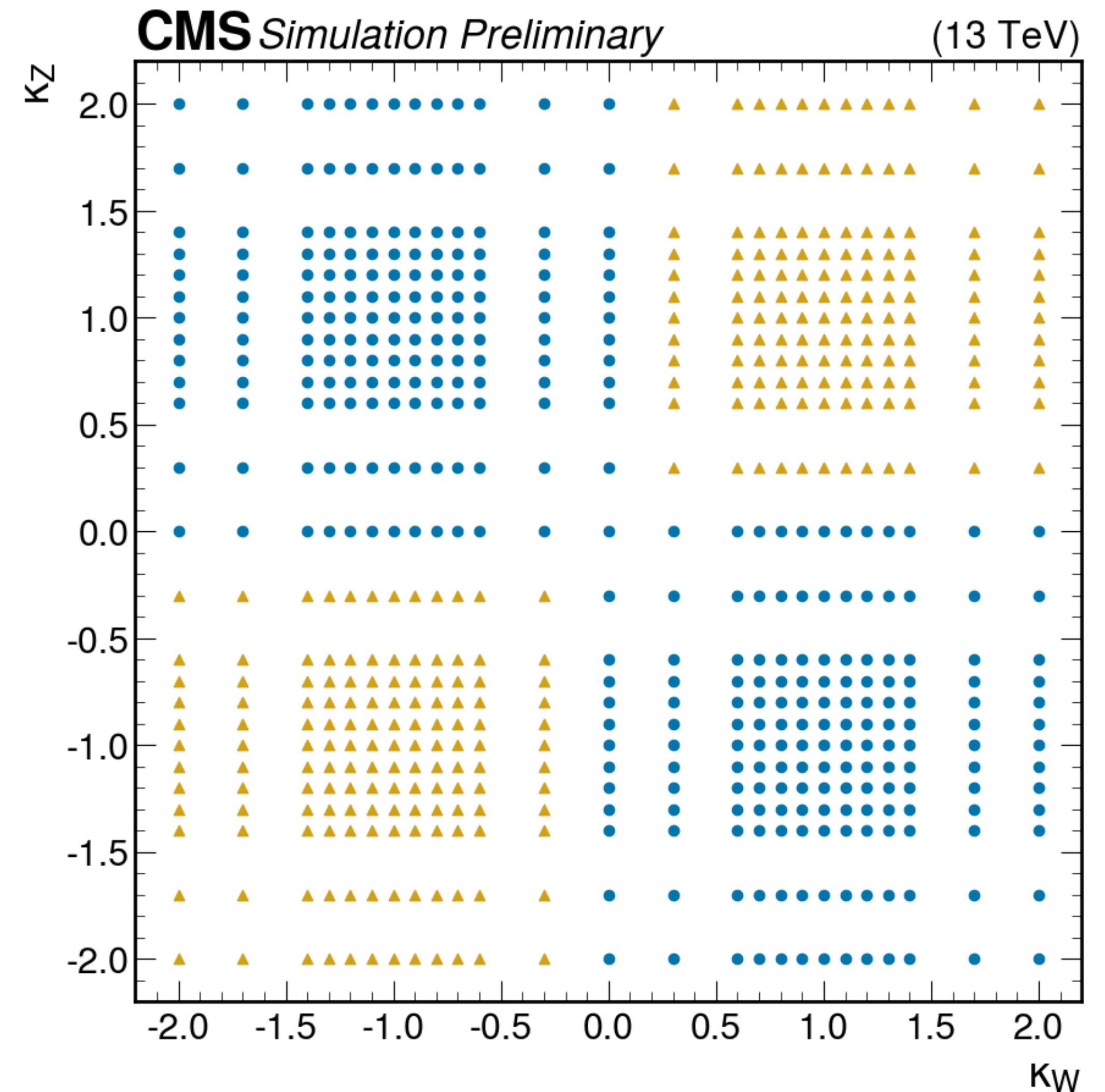
Rewweighted vs. Single-point



Rewweighting from SM gives poor statistics in SR-like high S_T , high M_{WH} tail
This might explain the issue: bad reweighting!

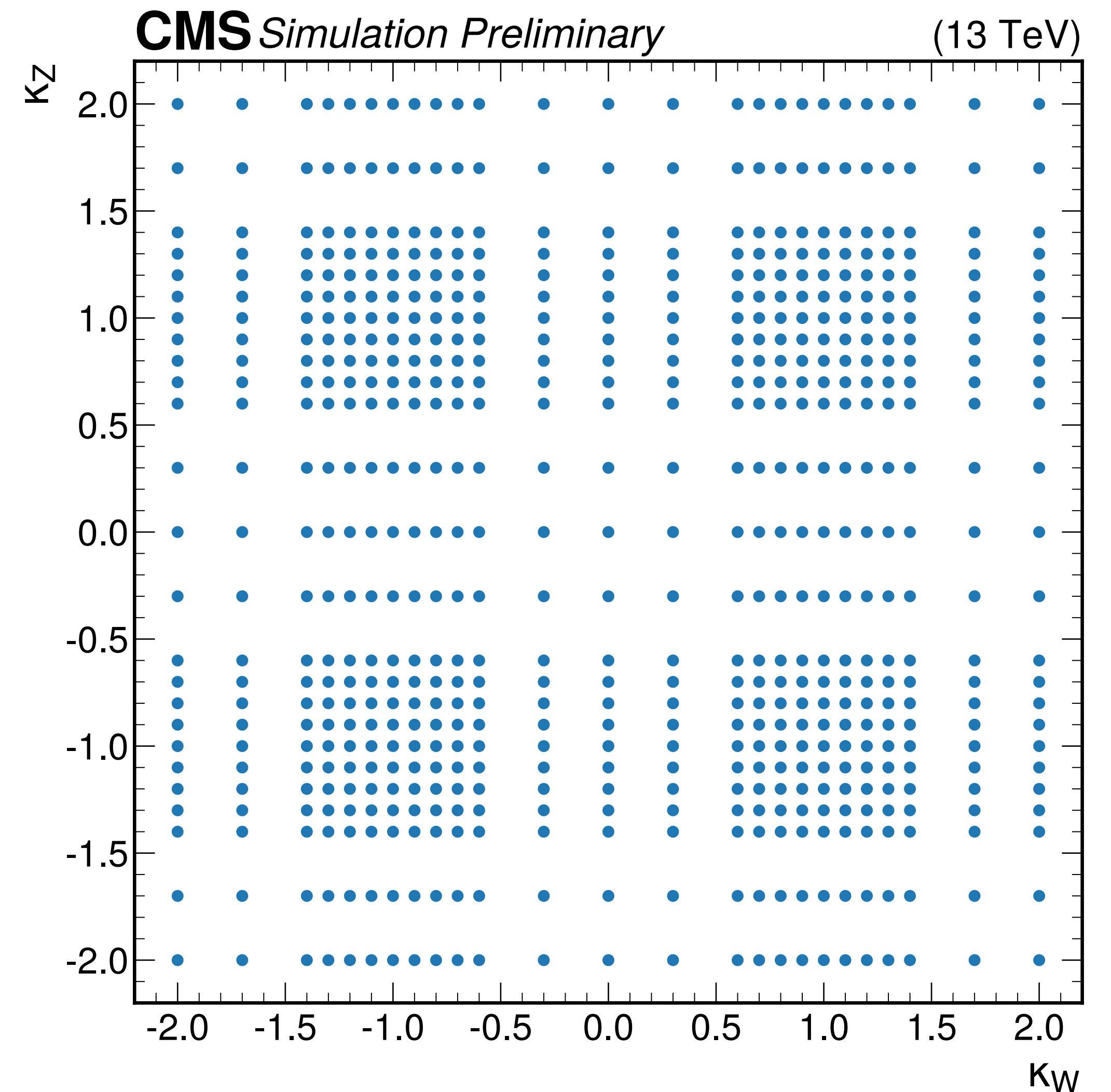
Issue with Reweighting

- Recall: reweighted result is given by two samples
 - $\lambda_{WZ} \leq 0$ reweighted from $\kappa_W = -1, \kappa_Z = +1$
 - $\lambda_{WZ} > 0$ reweighted from $\kappa_W = +1, \kappa_Z = +1$
- We know **high ST tail disappears for SM**
- SM stats in the tail are likely **insufficient for reweighting to slightly boosted topologies**

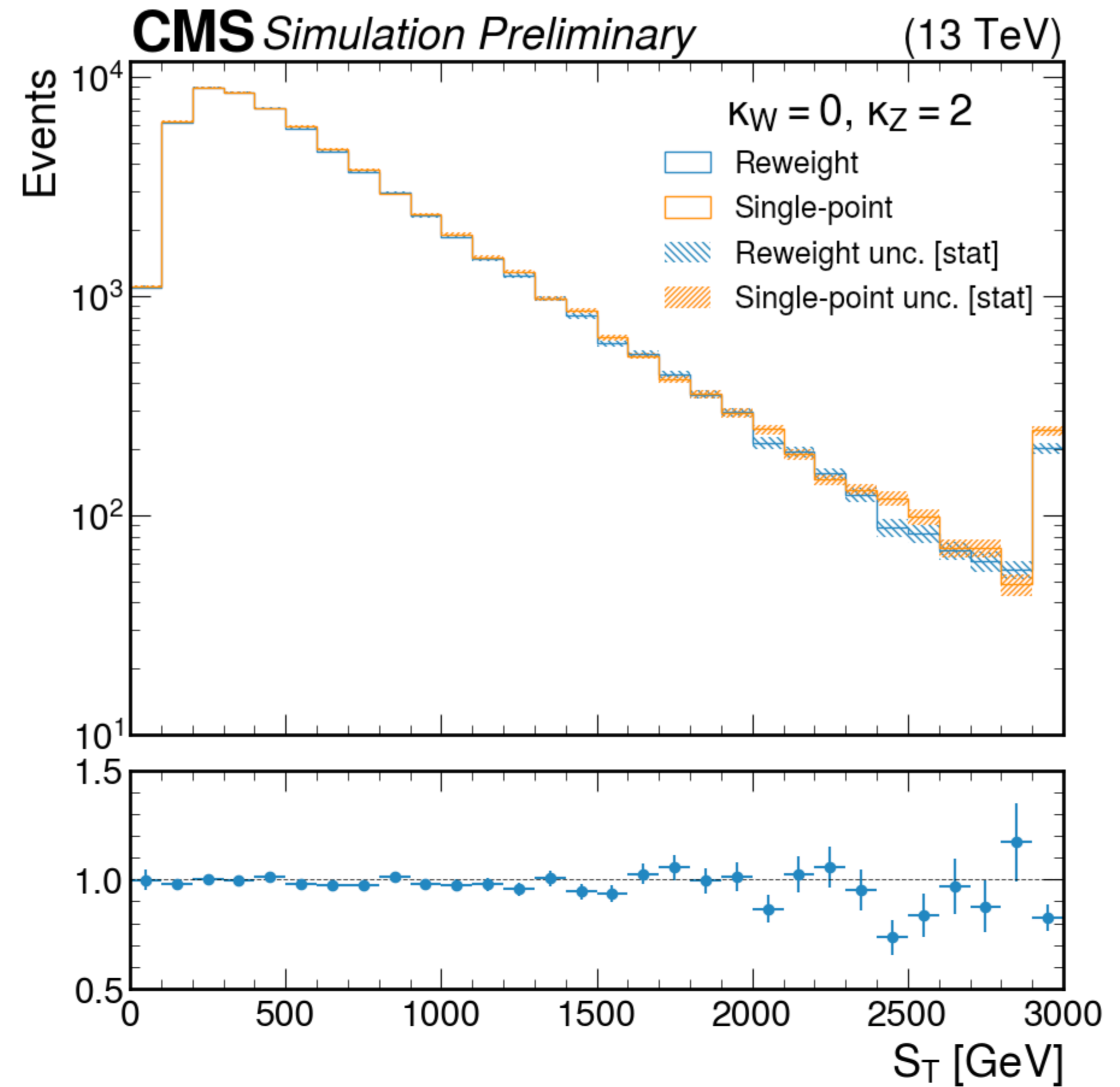
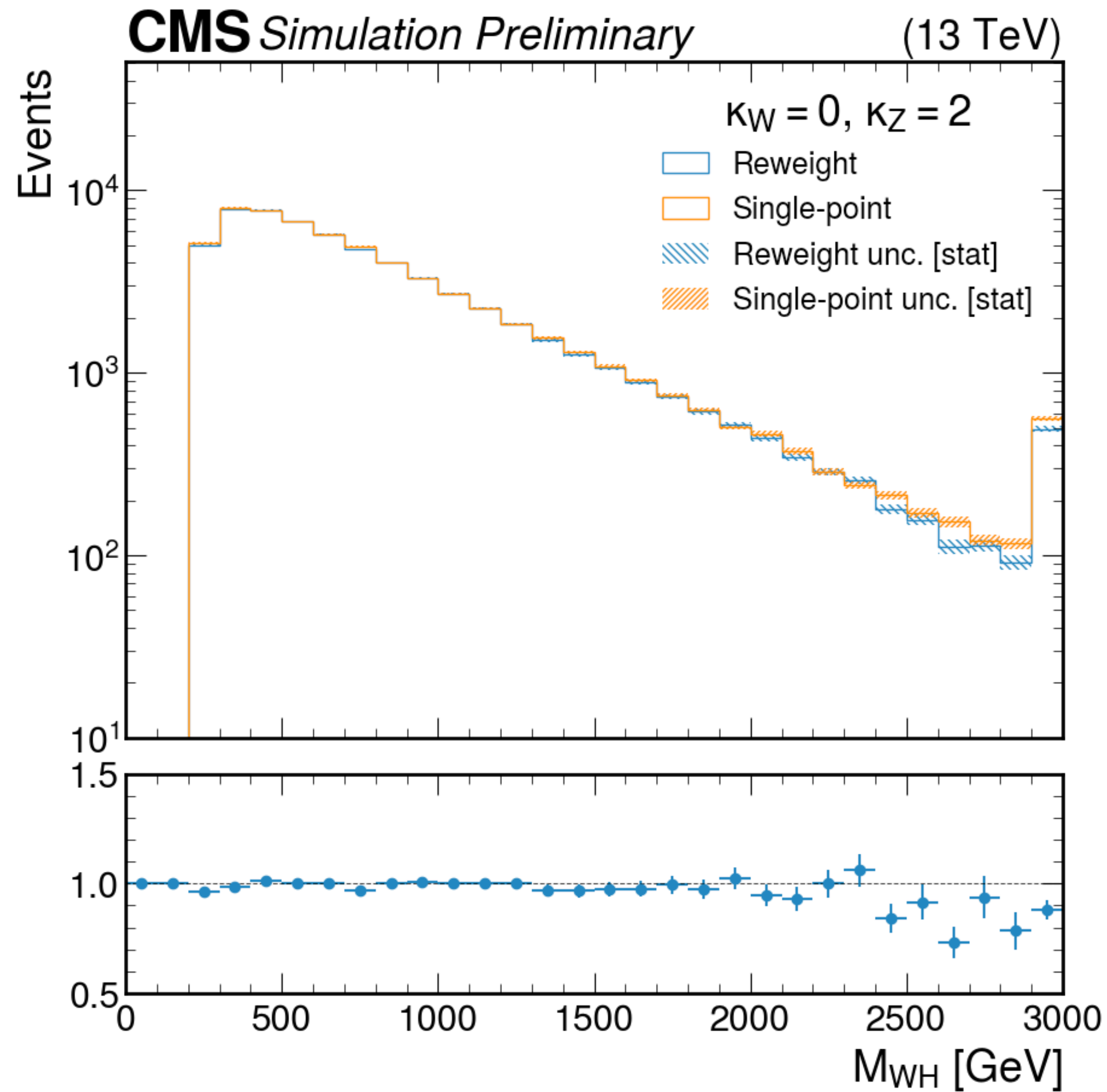


Issue with Reweighting

- Recall: reweighted result is given by two samples
 - $\lambda_{WZ} \leq 0$ reweighted from $\kappa_W = -1, \kappa_Z = +1$
 - $\lambda_{WZ} > 0$ reweighted from $\kappa_W = +1, \kappa_Z = +1$
- We know **high ST tail disappears for SM**
- SM stats in the tail are likely **insufficient for reweighting to slightly boosted topologies**
- Instead: **reweight all from $\kappa_W = -1, \kappa_Z = +1$**

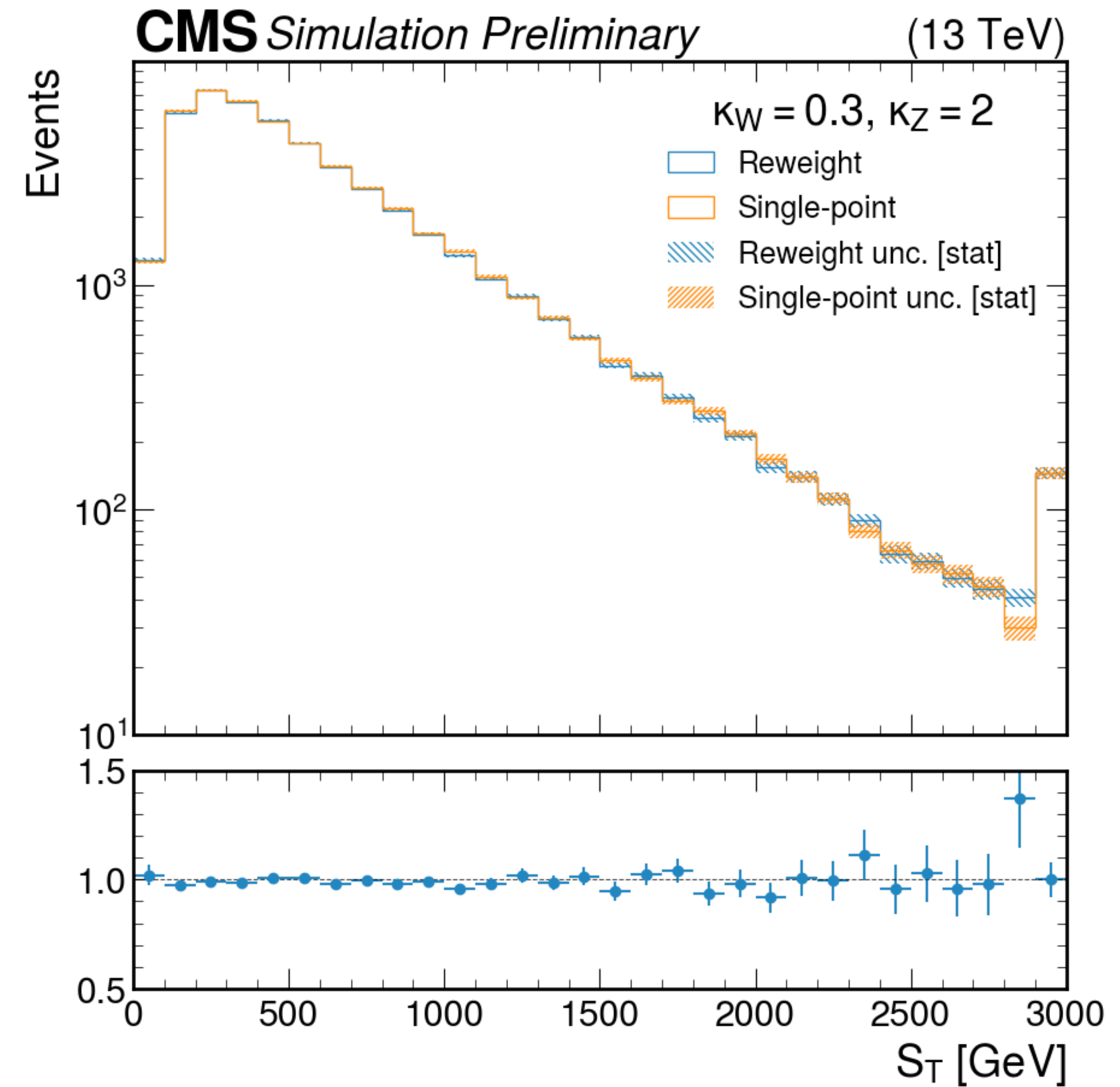
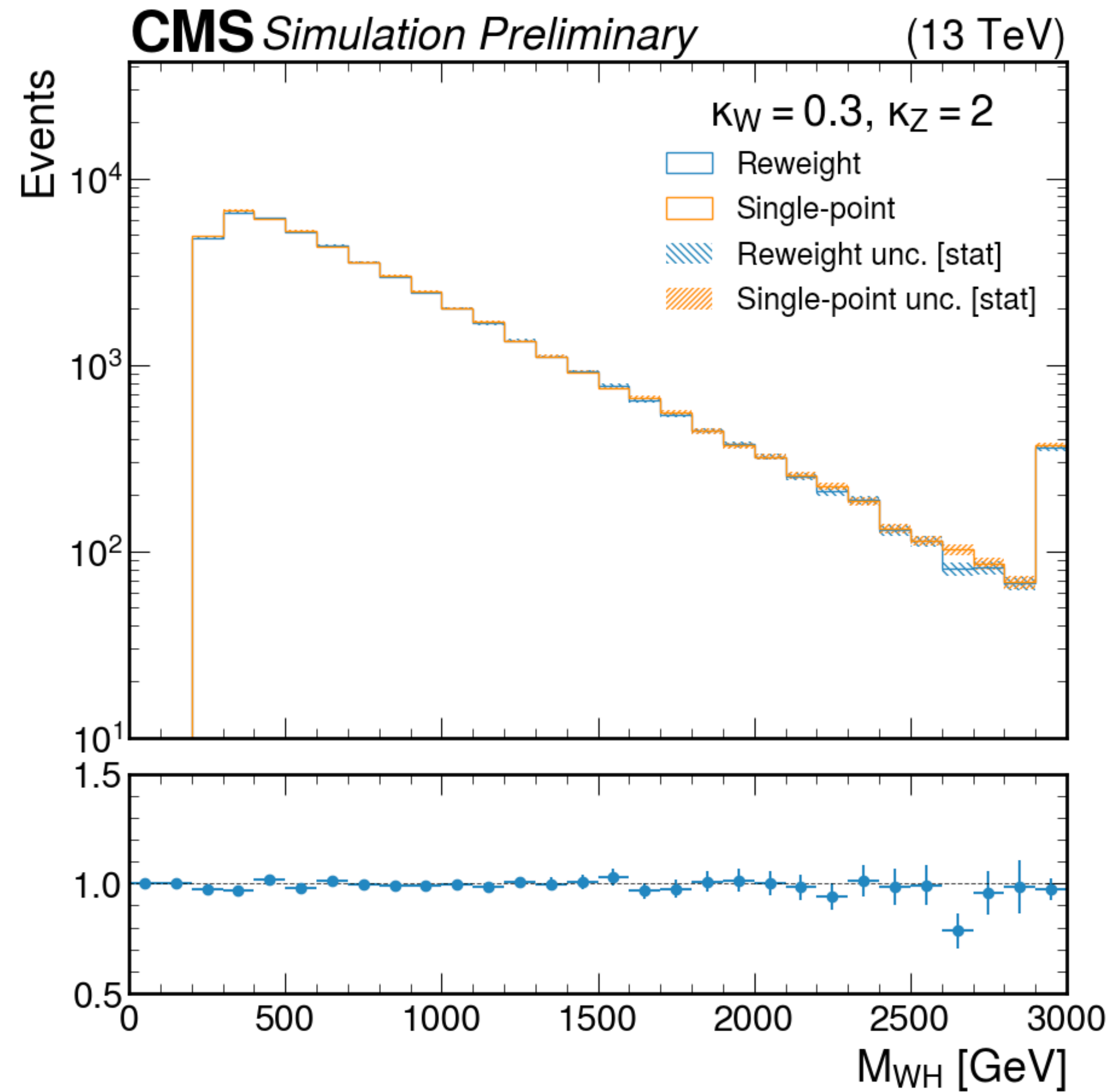


New Reweighted vs. Single-point



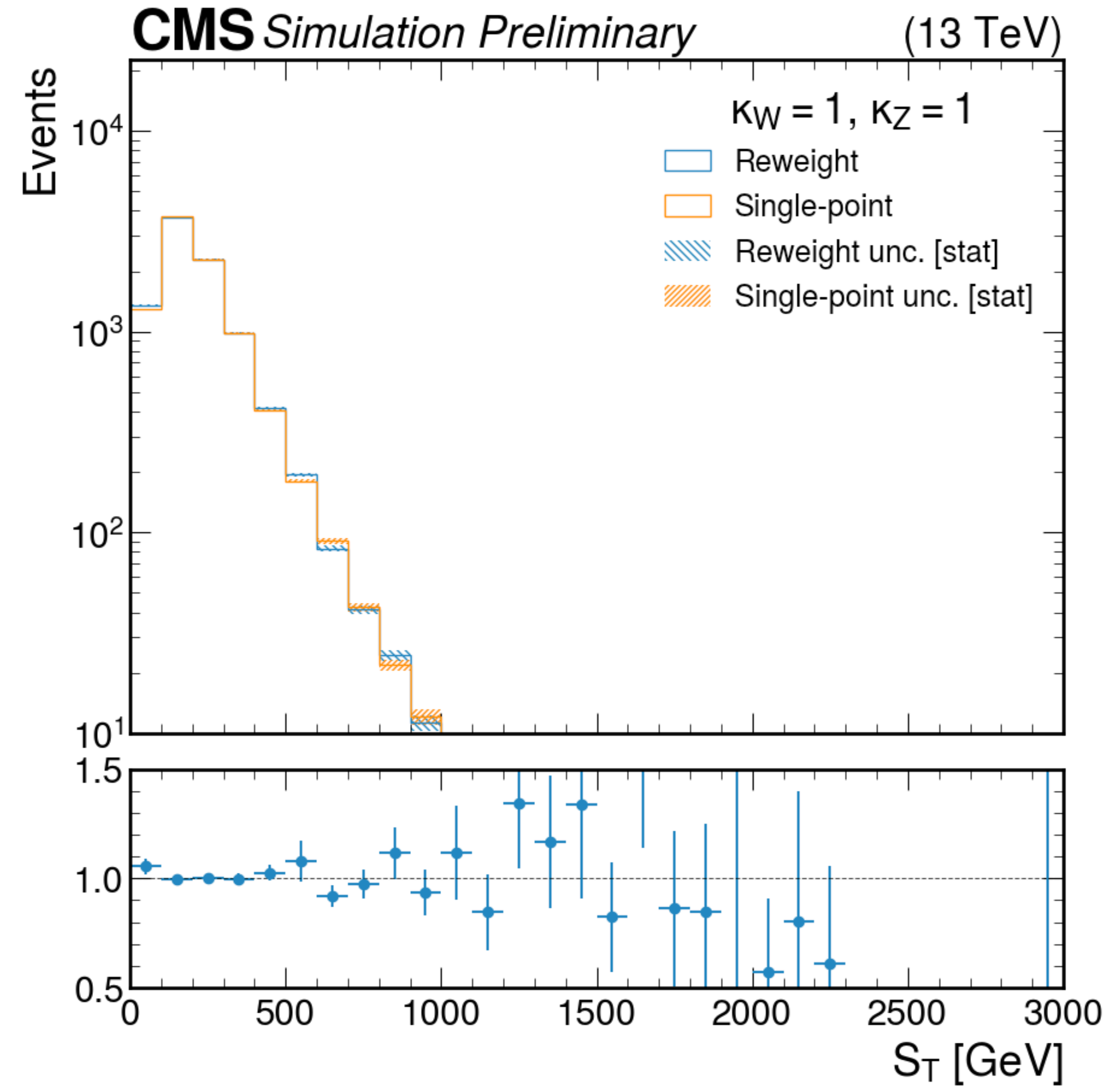
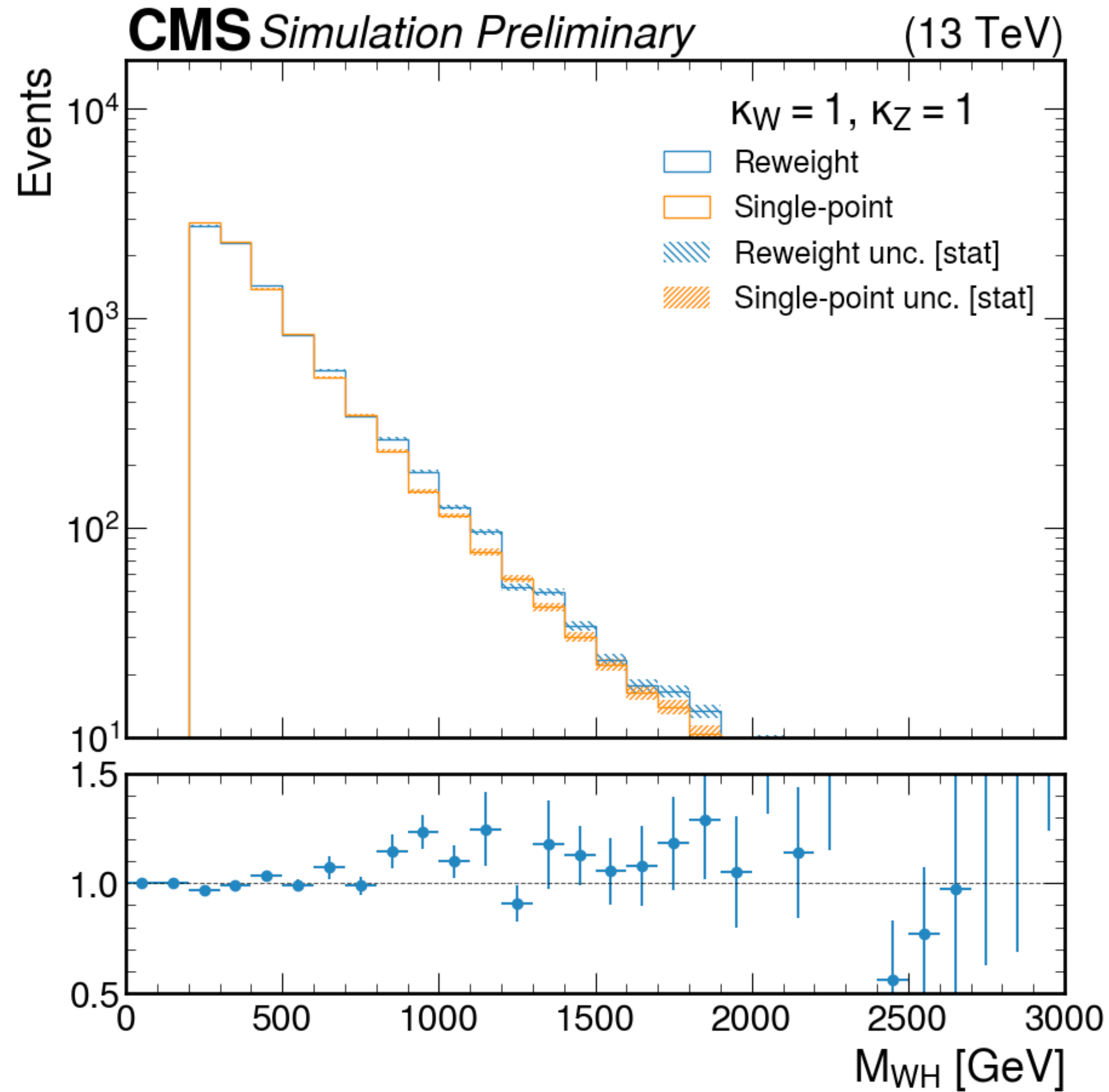
**New reweighting still slightly under-predicts yield in SR-like tails
for $\kappa_W = 0, \kappa_Z = 2$**

New Reweighted vs. Single-point



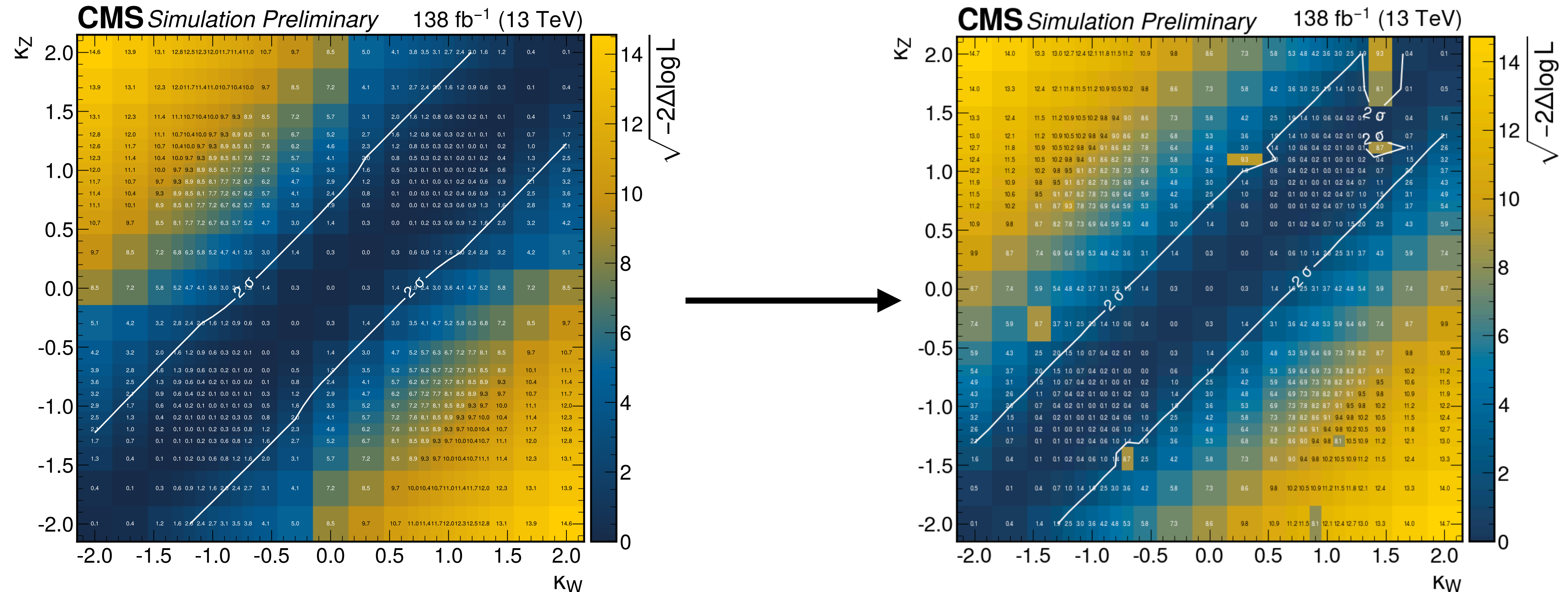
**New reweighting is almost perfect
for $\kappa_W = 0.3, \kappa_Z = 2$**

New Reweighted vs. Single-point



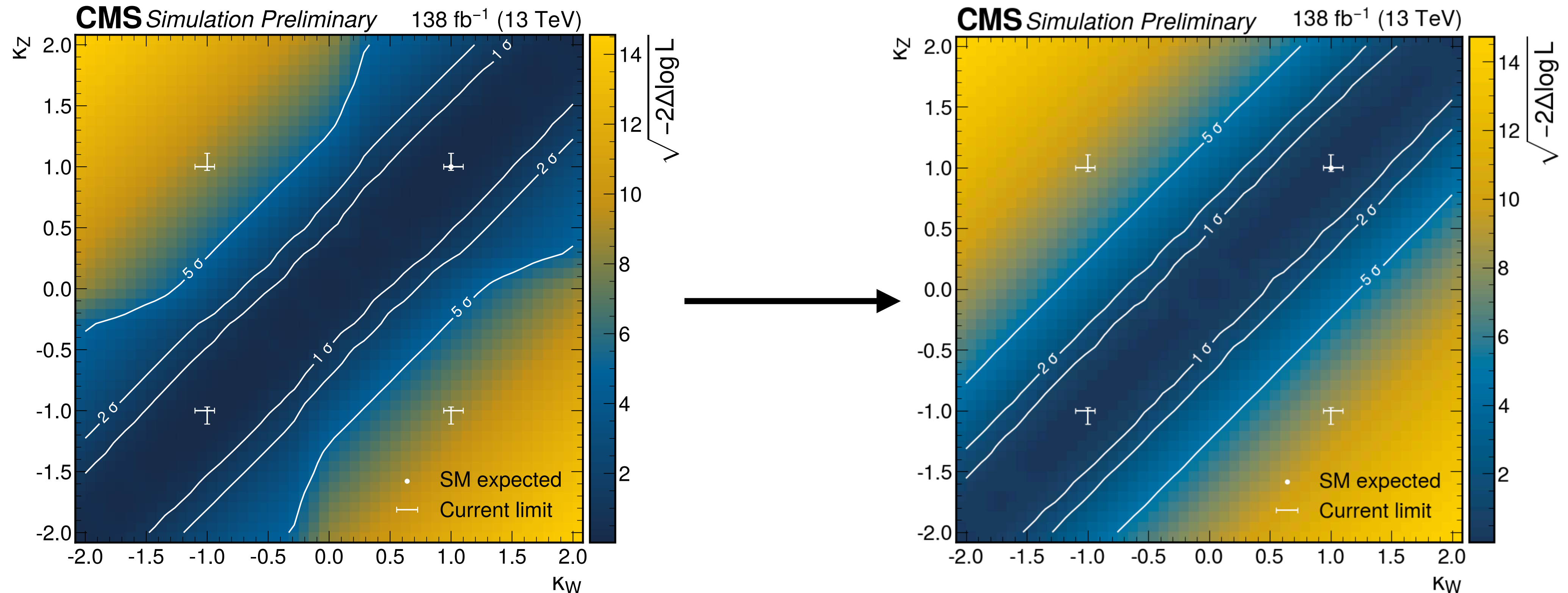
New reweighting also gets SM shape right
 \Rightarrow reweighing all from $\kappa_W = -1, \kappa_Z = +1$ seems valid

Old vs. New Exclusion



- Discontinuity seems to have been resolved
- New reweighting was done in a single sample (625 points) and some points seem to have failed, but we can simply exclude these from the interpolation (next slide)

Old vs. New Exclusion



- Again, we see discontinuity has been corrected: clear 5 σ boundary around $\lambda_{WZ} < 0$ quadrants is gone
- Handful of failed reweights do not affect final result

Summary

- We originally reweighed $\lambda_{WZ} \leq 0$ from $\kappa_W = -1, \kappa_Z = +1$ and $\lambda_{WZ} > 0$ from SM
- SM has insufficient statistics in the tail to properly reweight to e.g. $\kappa_W = 0.3, \kappa_Z = 2$
- We now instead reweight everything from $\kappa_W = -1, \kappa_Z = +1$
 - Fixes issues we saw with original reweighting scheme
 - Correctly reweighs to e.g. SM
- Reweighting now in a single sample (625 points), so some points failed
- **We can exclude the failed points (only a handful) and get a sensible final result**

Backup

LHE Selection (Run Card)

- In addition to the standard phase space cuts:
 - $M(\text{jet}+\text{jet}) > 100$
 - $|\eta(\text{jet})| < 6.5$
- The additional cuts were approved/requested by GEN contacts
- Identical run card to central sample:
https://github.com/cms-sw/genproductions/blob/master/bin/MadGraph5_aMCatNLO/cards/production/13TeV/VBSWH_mkW_Inclusive_4f_LO/VBSWH_mkW_Inclusive_4f_LO_run_card.dat