MiNLO

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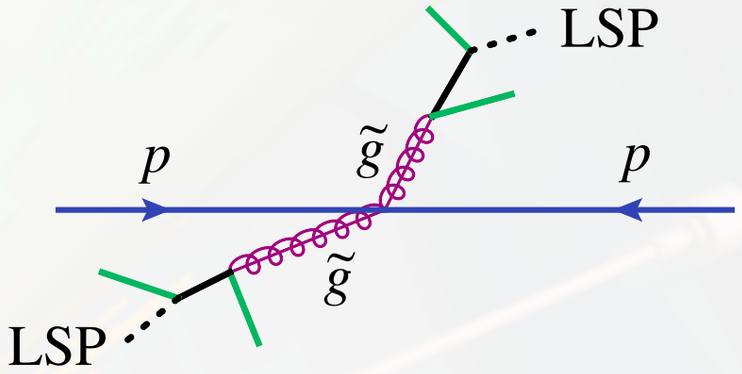
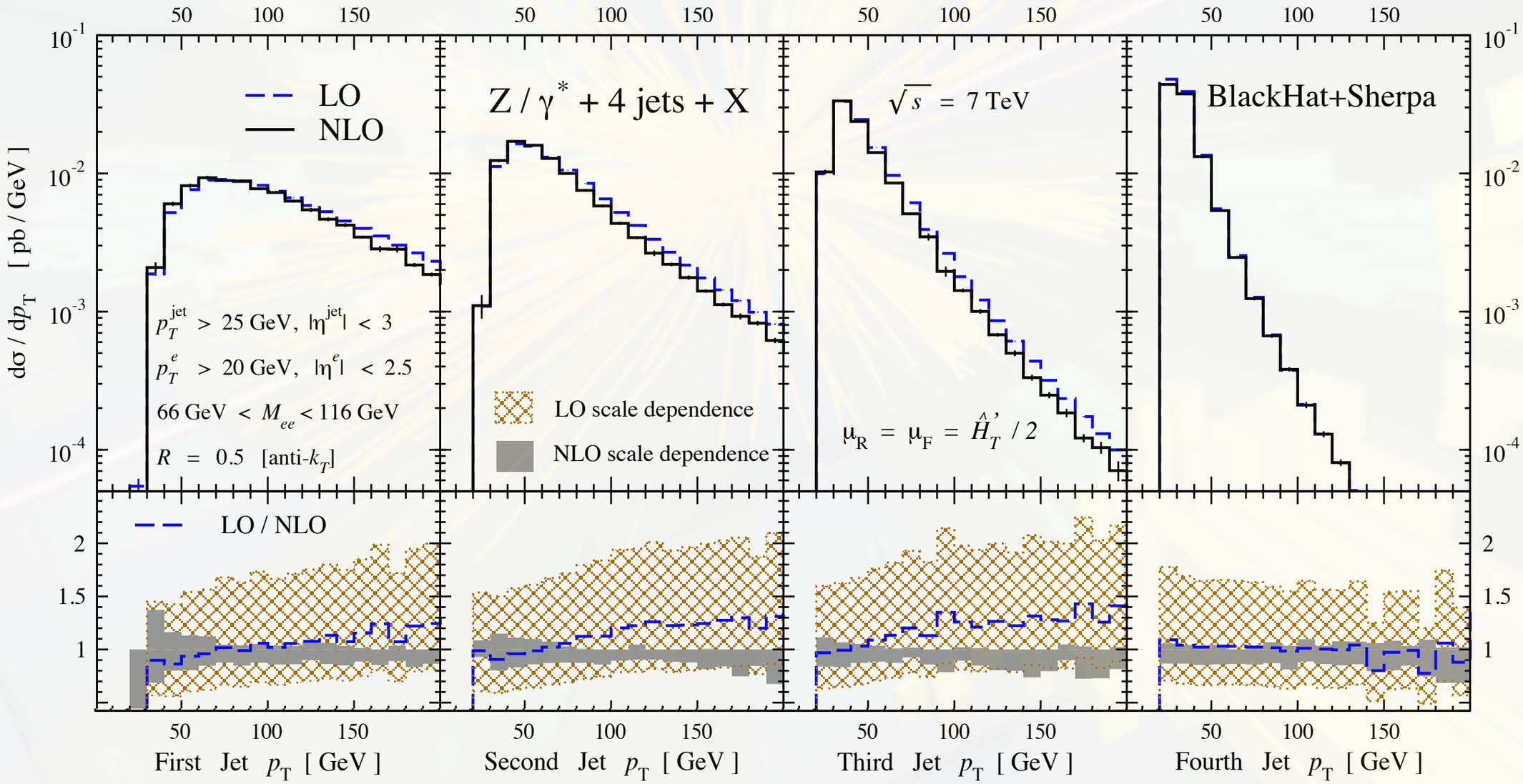
Outline

- MiNLO
  - Motivations for NLO
  - Renormalization and factorization scales
  - Motivations for MiNLO
  - MiNLO scale setting sketched with an example
  - Applications

Case for next-to-leading order calculations

- Help looking for / setting limits on SUSY
- Take $\tilde{g}\tilde{g}$ product^{n} → 4 jets + MET
- Main bkg Z+4 jets [4 jet = 4 α_s's]



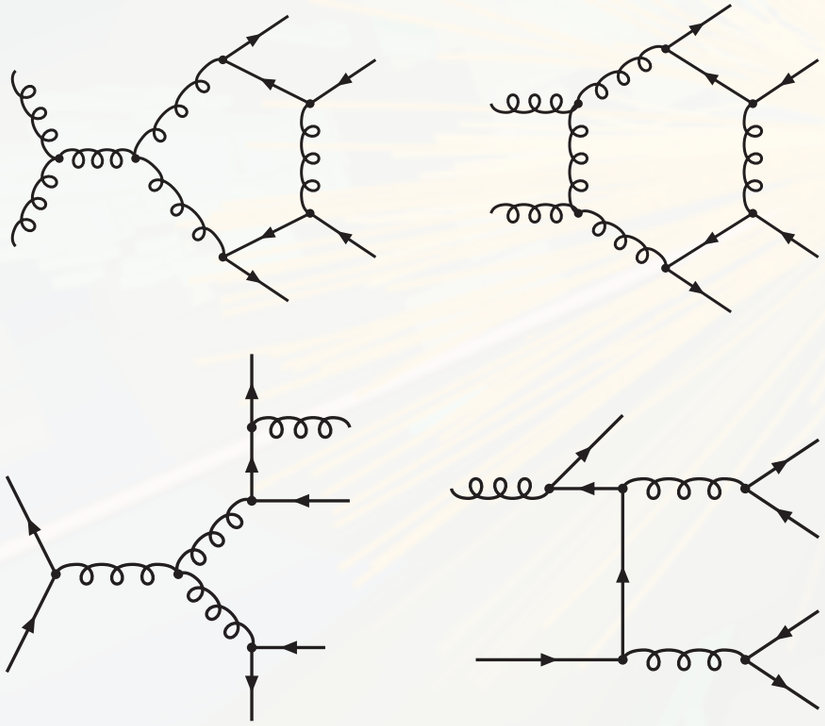


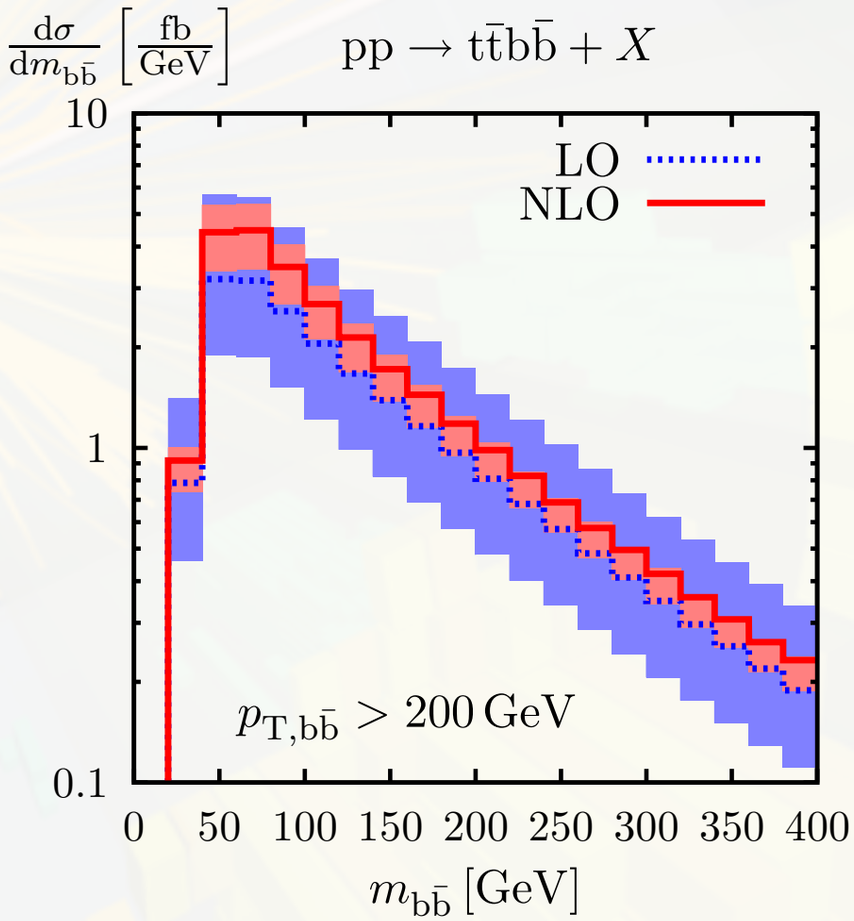
[BlackHat coll. PRD 85 (2012)] [Fernando, Harald & friends]

- You would rather know this bkg at NLO ...

Case for next-to-leading order calculations

- Is it the SM Higgs? Observe+measure product^{n} + decay modes
- pp → $t\bar{t}H$ probes top Yukawa at tree level
- Has significant irreducible background from pp → $t\bar{t}b\bar{b}$





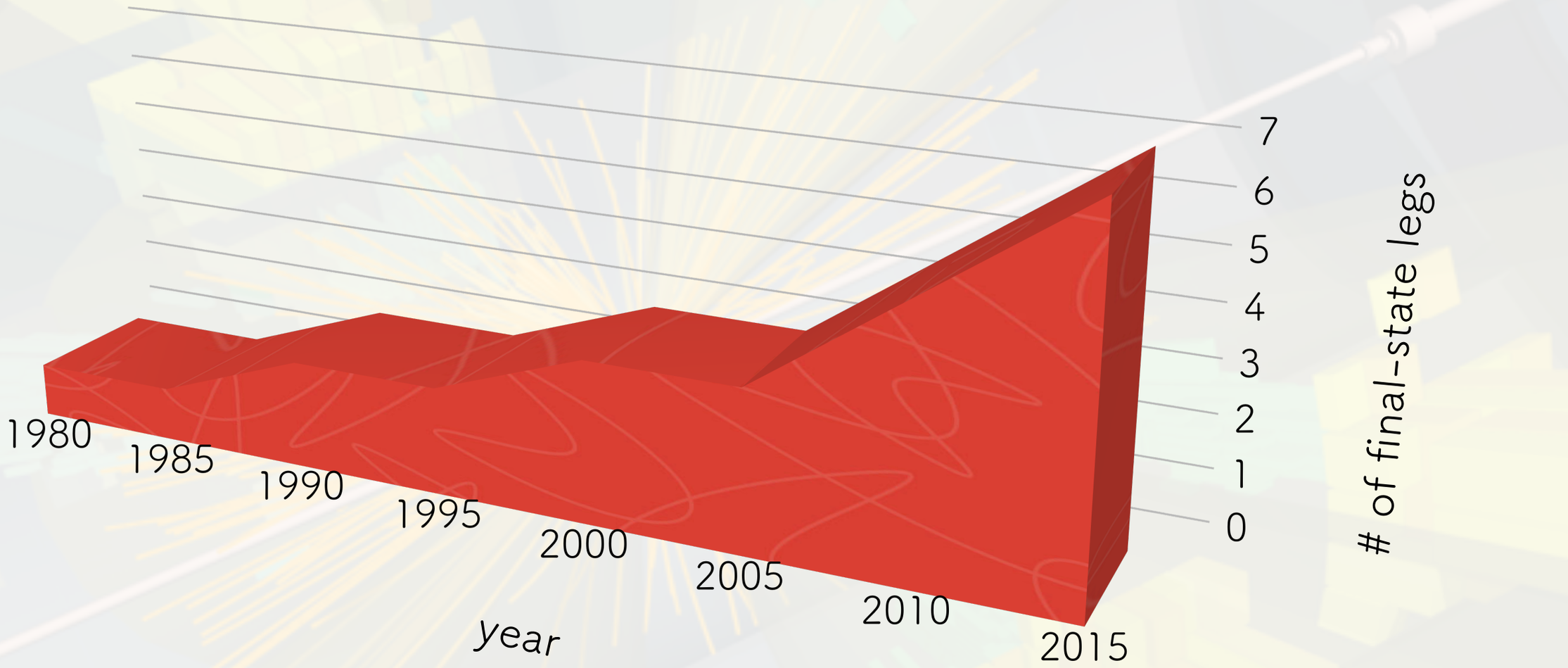
- You would rather know this bkg at NLO ...

[Bredenstein, Denner, Dittmaier, Pozzorini PRL 103 (2009)]

[Bevilacqua, Czakon, Papadopoulos, Pittau, Worek JHEP 0909 (2009)]

Case for next-to-leading order calculations

- Recent years have seen amazing progress in NLO calculatⁿs:



- Besides lots of work & ingenuity, increasing complexity brings increasing powers of $\alpha_s(\mu)$
- More emphasis on choosing renormalization/factorization μ's carefully

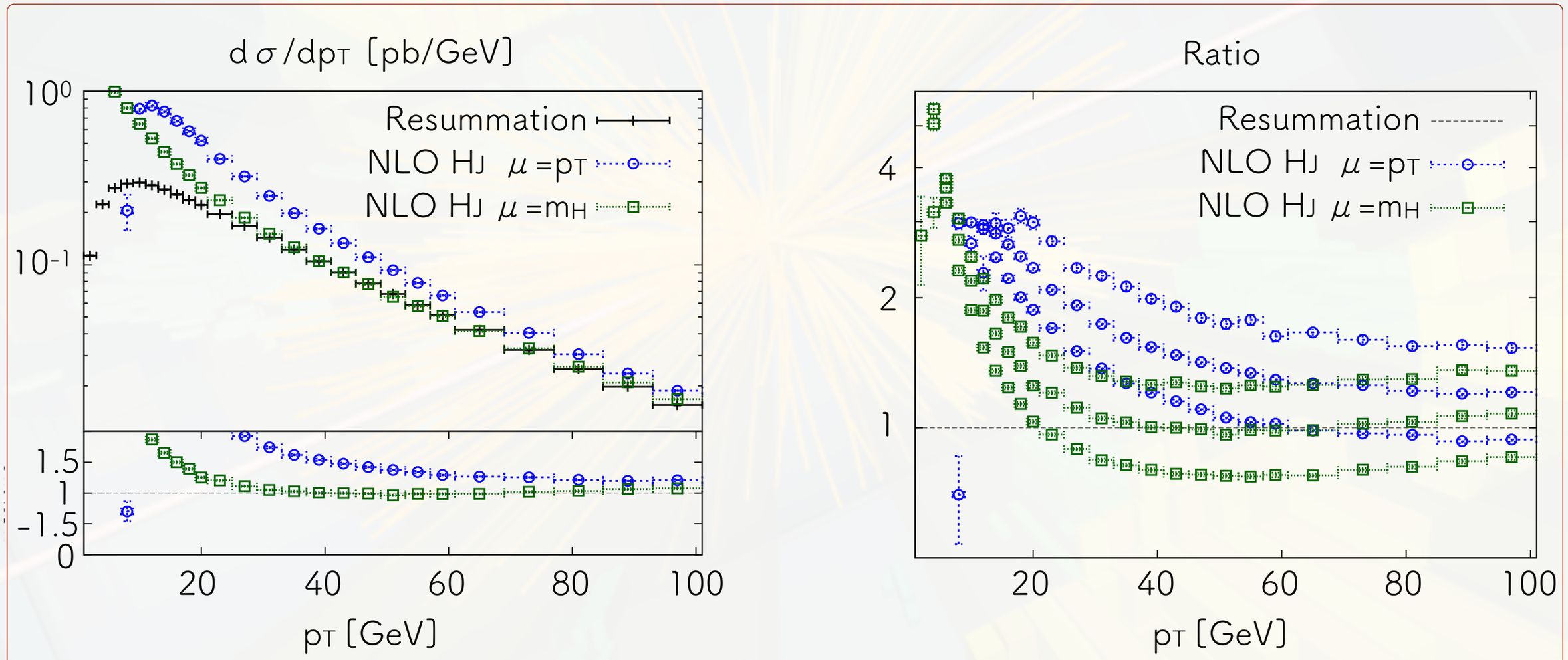
Renormalization and factorization scales

- ‘Good scales’ commonly considered to be so retrospectively on seeing that the NLO corr^{n}s and the scale sensitivity are small

- ‘Bad scales’ commonly declared as such on finding large NLO corr^{n}s & scale sensitivity : typically diagnosed as large unphysical scale logs

Q1: are large NLO corrⁿs all down to large $\mu_{R/F}$ logs?

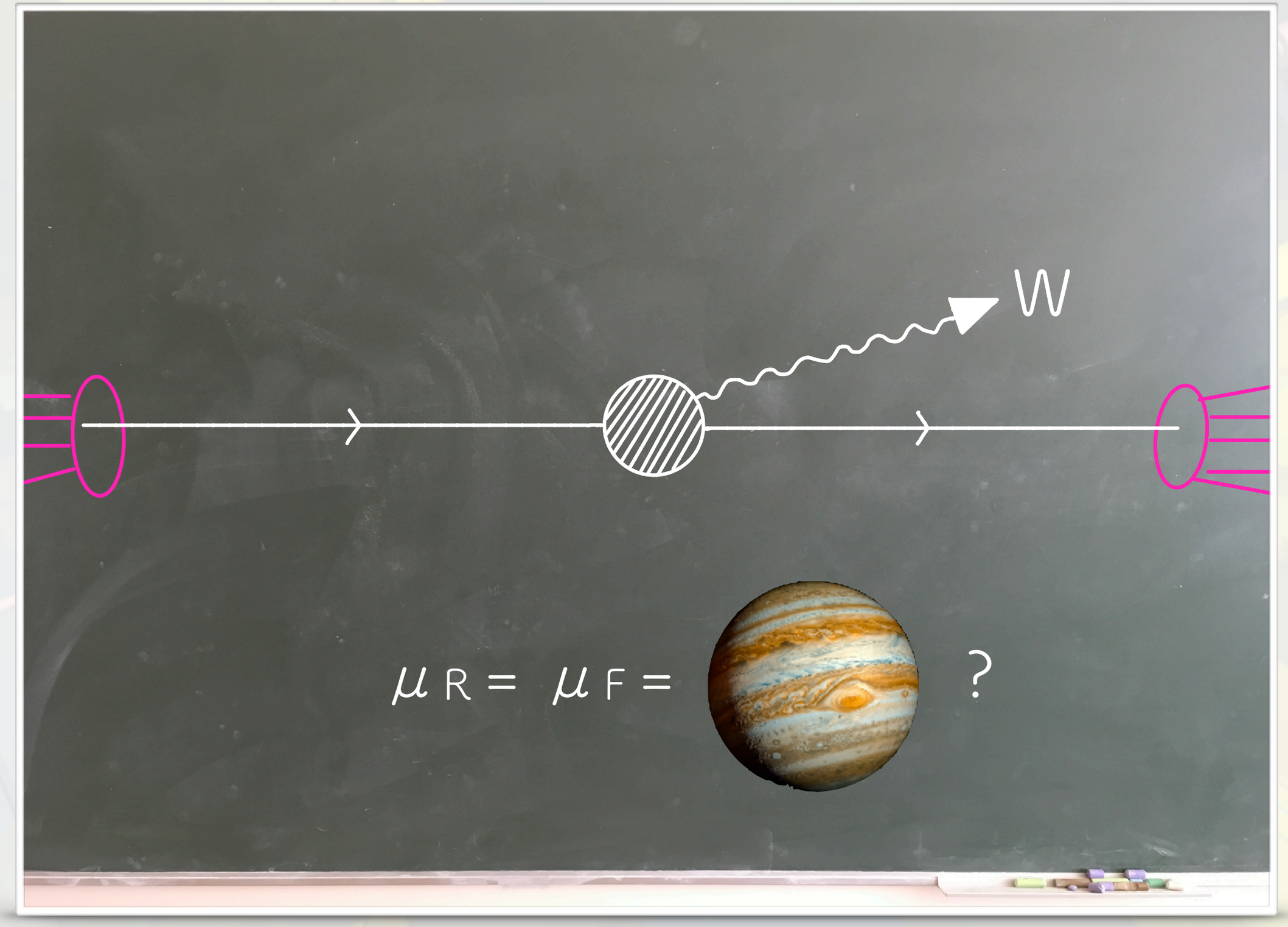
- Big corrⁿs can have real physical origins: new prodⁿ channels, big colour factors, large gluon flux, I.R. logs ...



- Adjusting scale to make corrⁿs / sensitivity small can effectively 'eat' unrelated physics in scale choice

Q2: what if there are many scales to choose from?

- In single/few scale processes it's harder to make a bad scale choice



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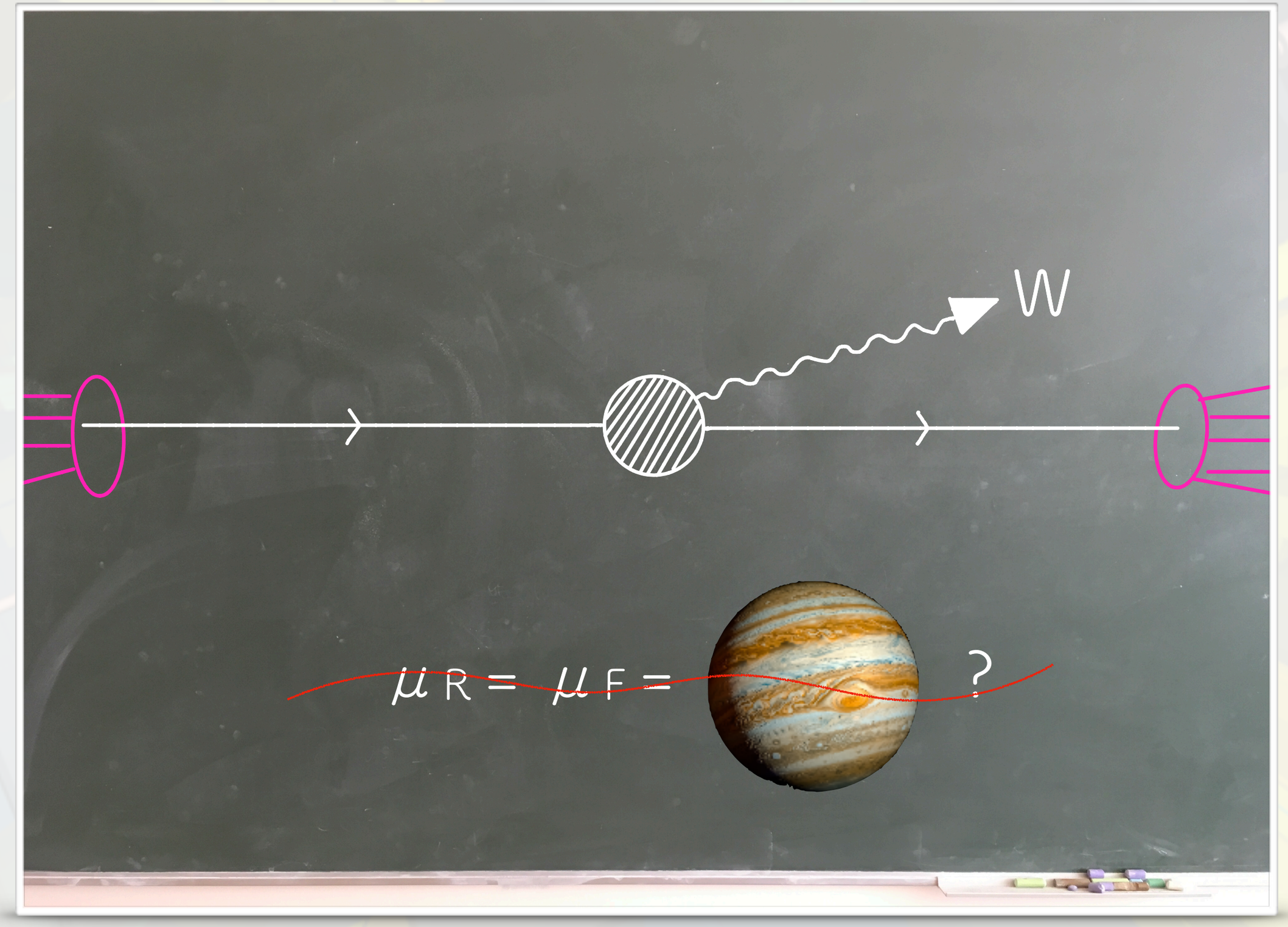

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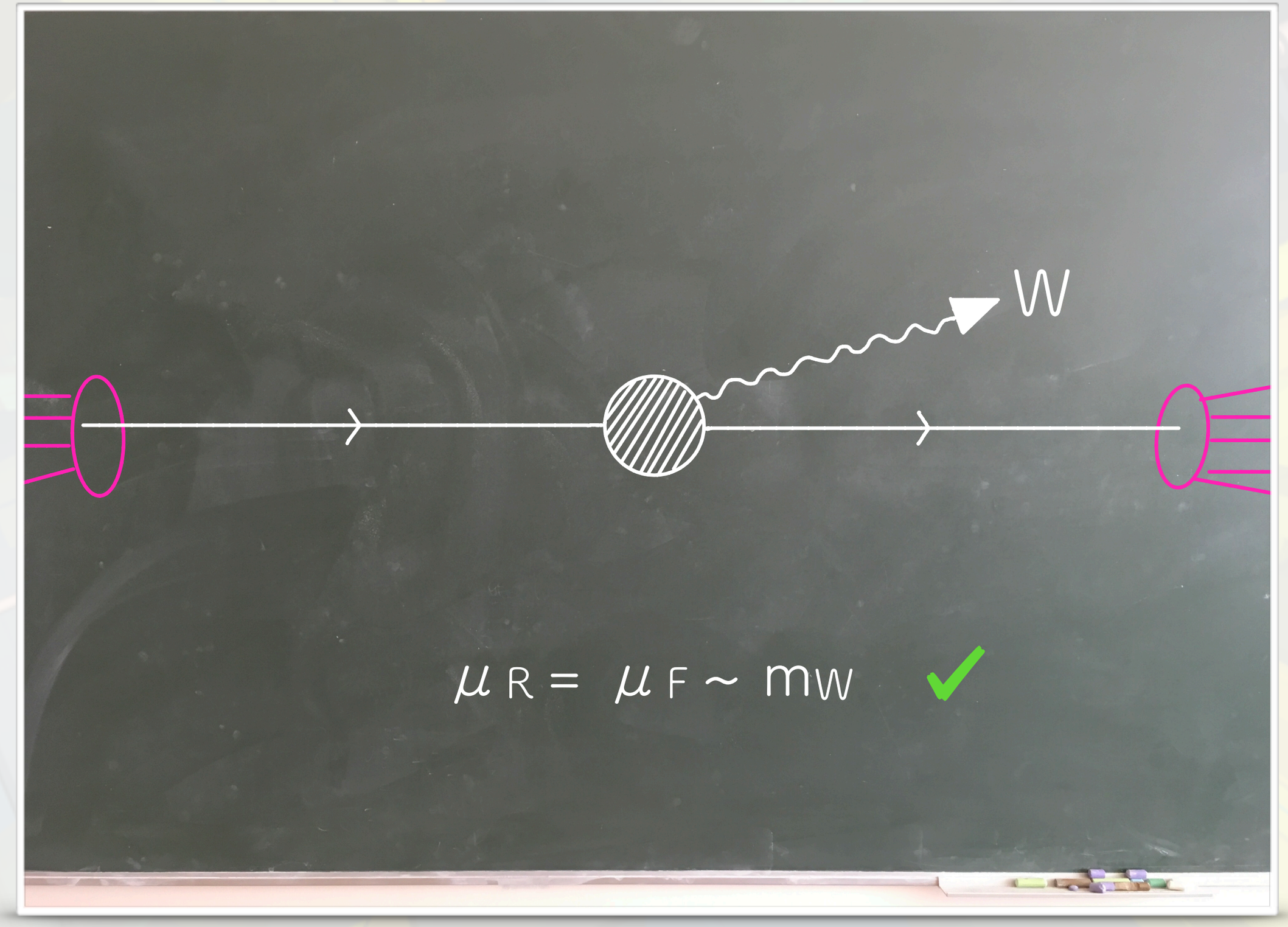
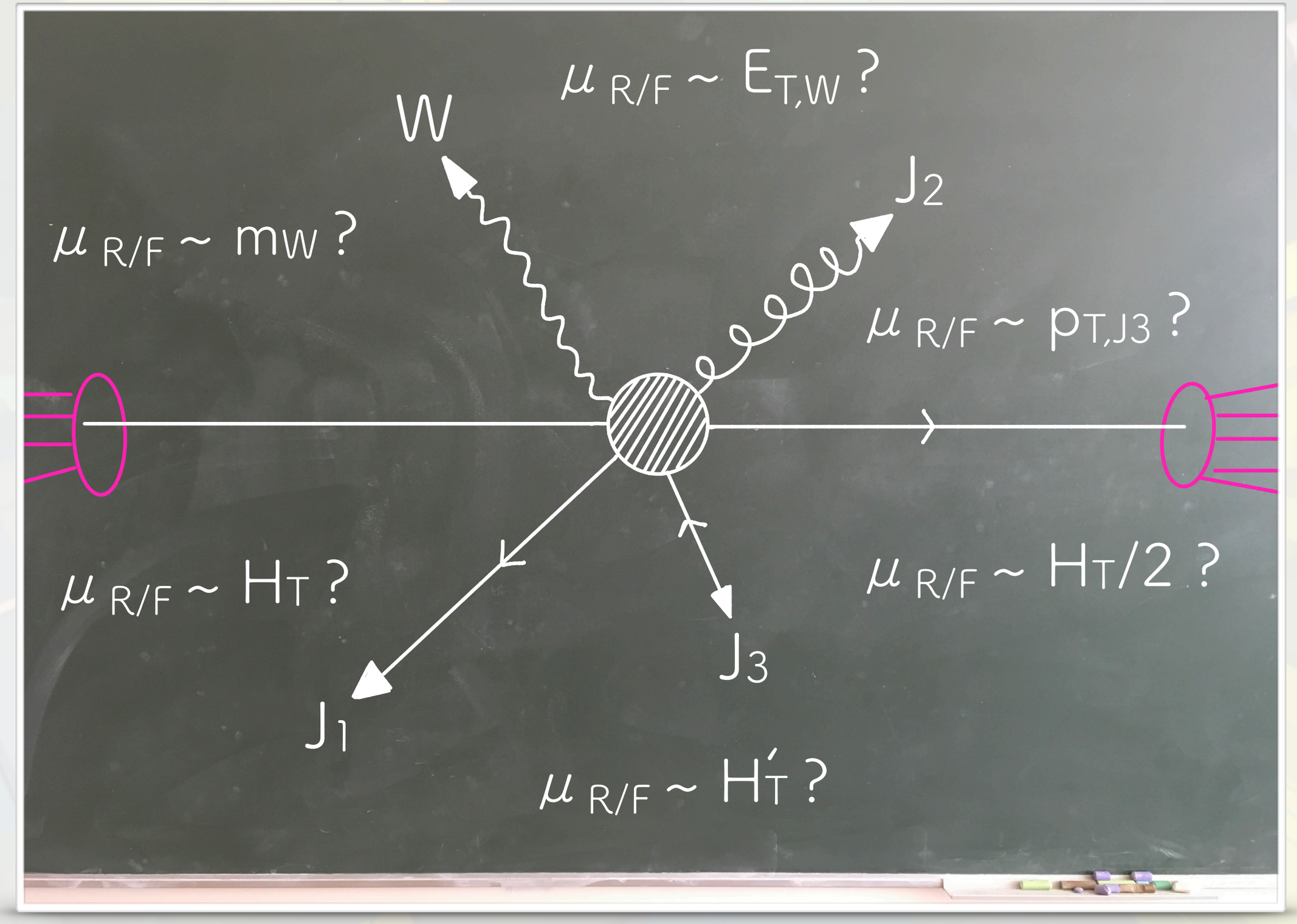


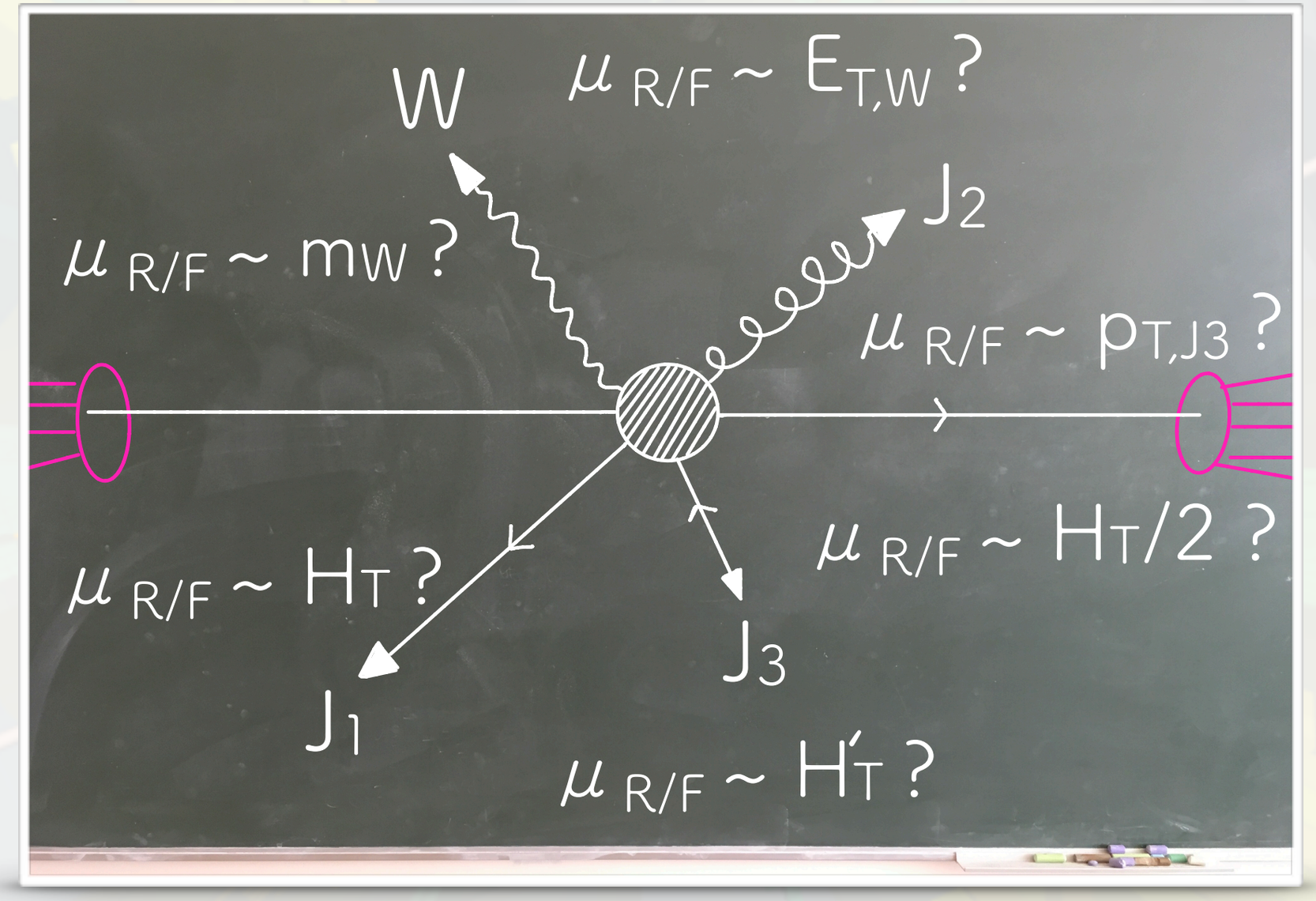
Q2: what if there are many scales to choose from?

- In procs with more jets, i.e. more scales, it's harder to know what to do



Q2: what if there are many scales to choose from?

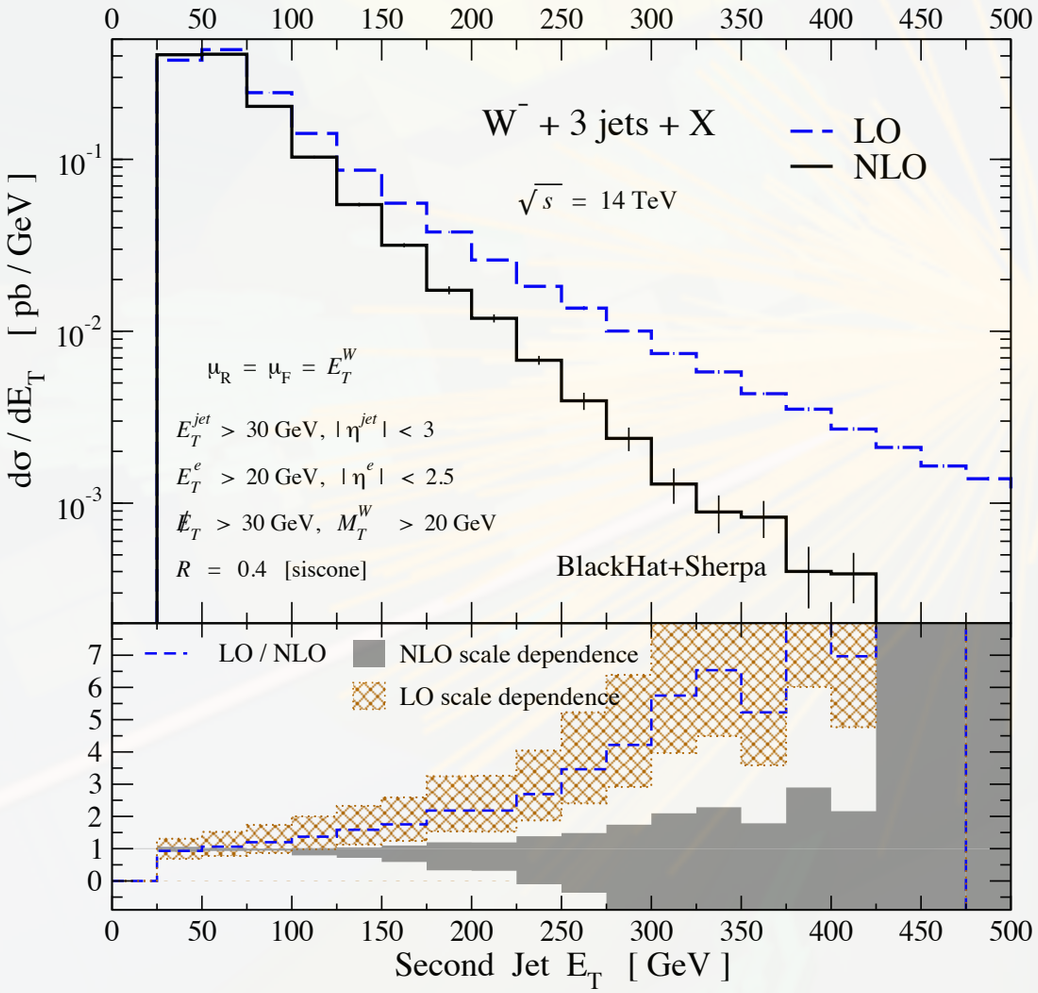
- It's also common for these scales to be VERY different to each other



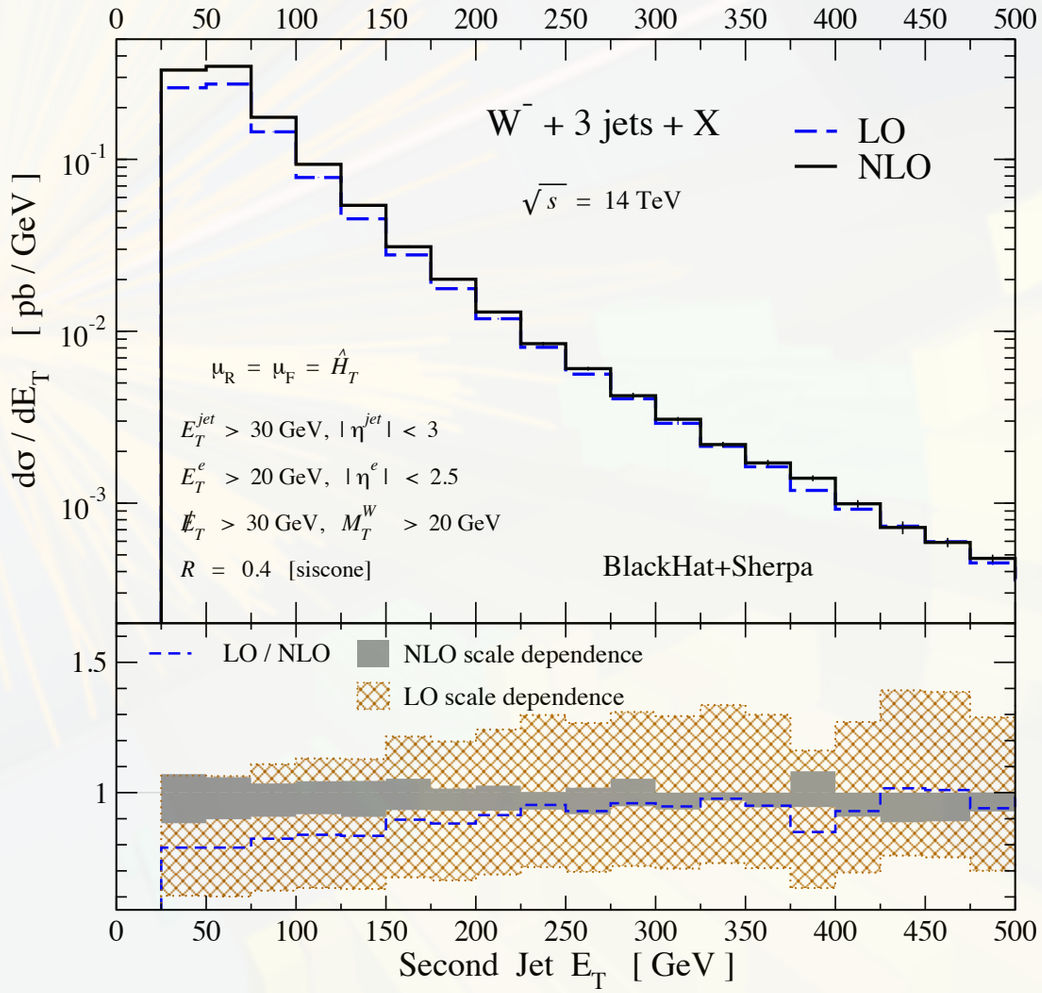
- The problem is that complicated processes such as W + 2, 3-jet production have many intrinsic scales, and it is not clear we can distill them into a single number. For any given point in the fully-differential cross section, there is a range of scales one could plausibly choose —— BlackHat collaboration

Q2: what if there are many scales to choose from?

- BSM background: W+3 jets [3 jets = 3 α_s's]
- BlackHat paper points out physical distⁿs can go -ve for $\mu_R = \mu_F = E_{T,W}$



$\mu_R = \mu_F = E_{T,W}$



$\mu_R = \mu_F = \hat{H}_T$

- For sufficiently poor choices [of scales] large logs can appear in some distributions, invalidating even an NLO prediction —— BlackHat collaboration