



The Resonance Aware POWHEG Method

YTF - 2024



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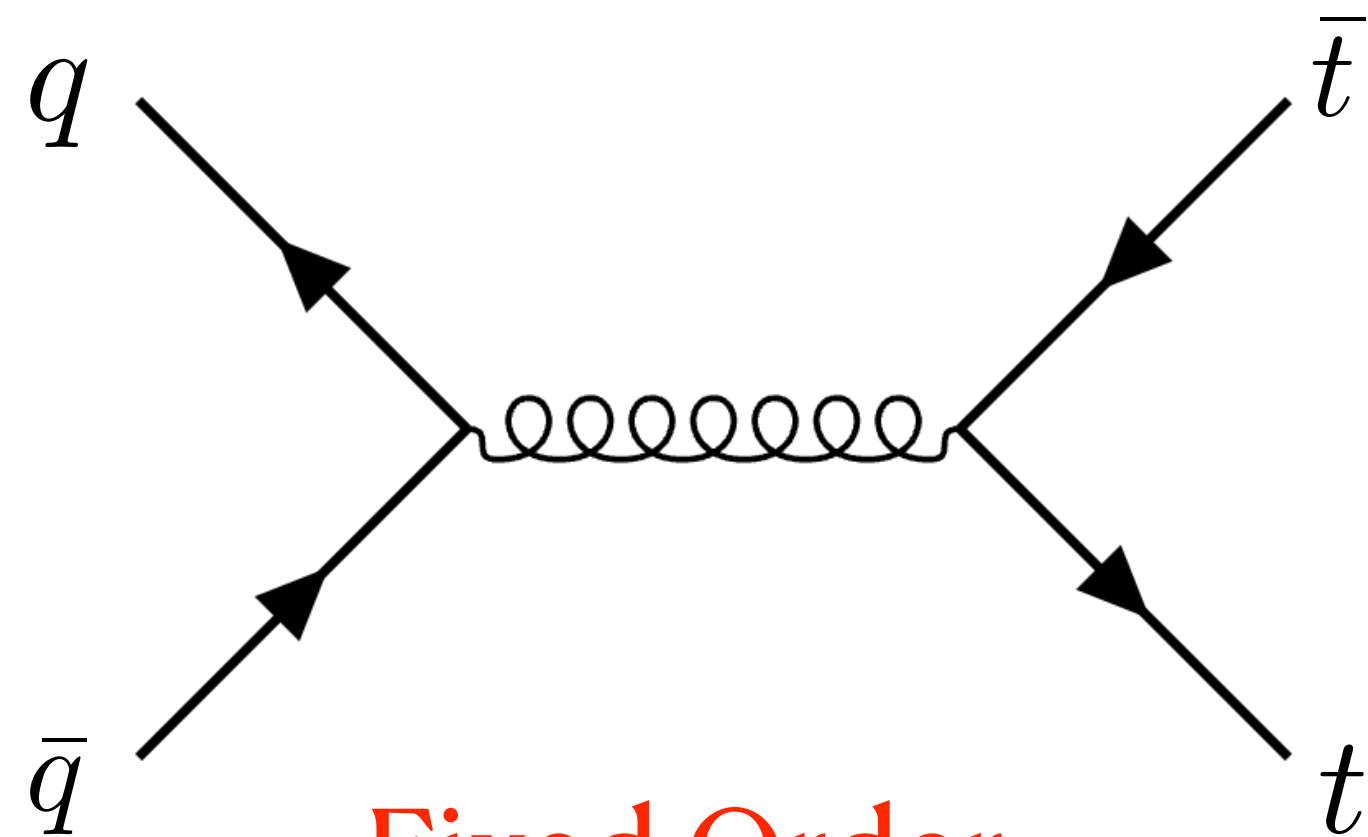


The Need for Precision Top Physics

- Top physics important for many open questions in high energy physics
- Short lifetime and large decay width leads to large off-shell effects
- Top quarks mass important understand the EW scale
- Higgs production dominated by top loop process
- Most top quark parameters testable at HL-LHC
- Setting bench mark for future colliders (FCC-ee, FCC-hh etc)

The POWHEG Method

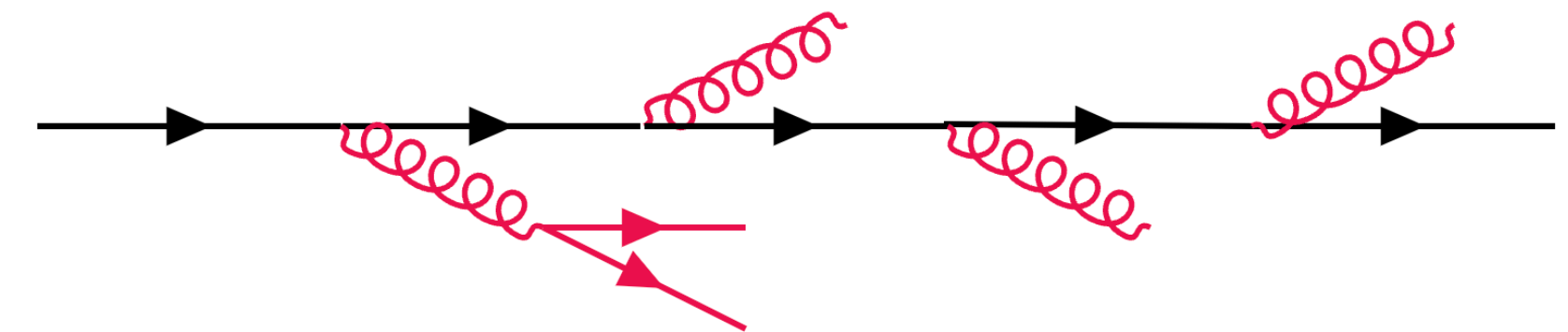
POpositive **W**eight **H**ardest **E**mission **G**enerator



Fixed Order

Perturbative
Low Multiplicity
Hard Scale

Multiplicative matching algorithm



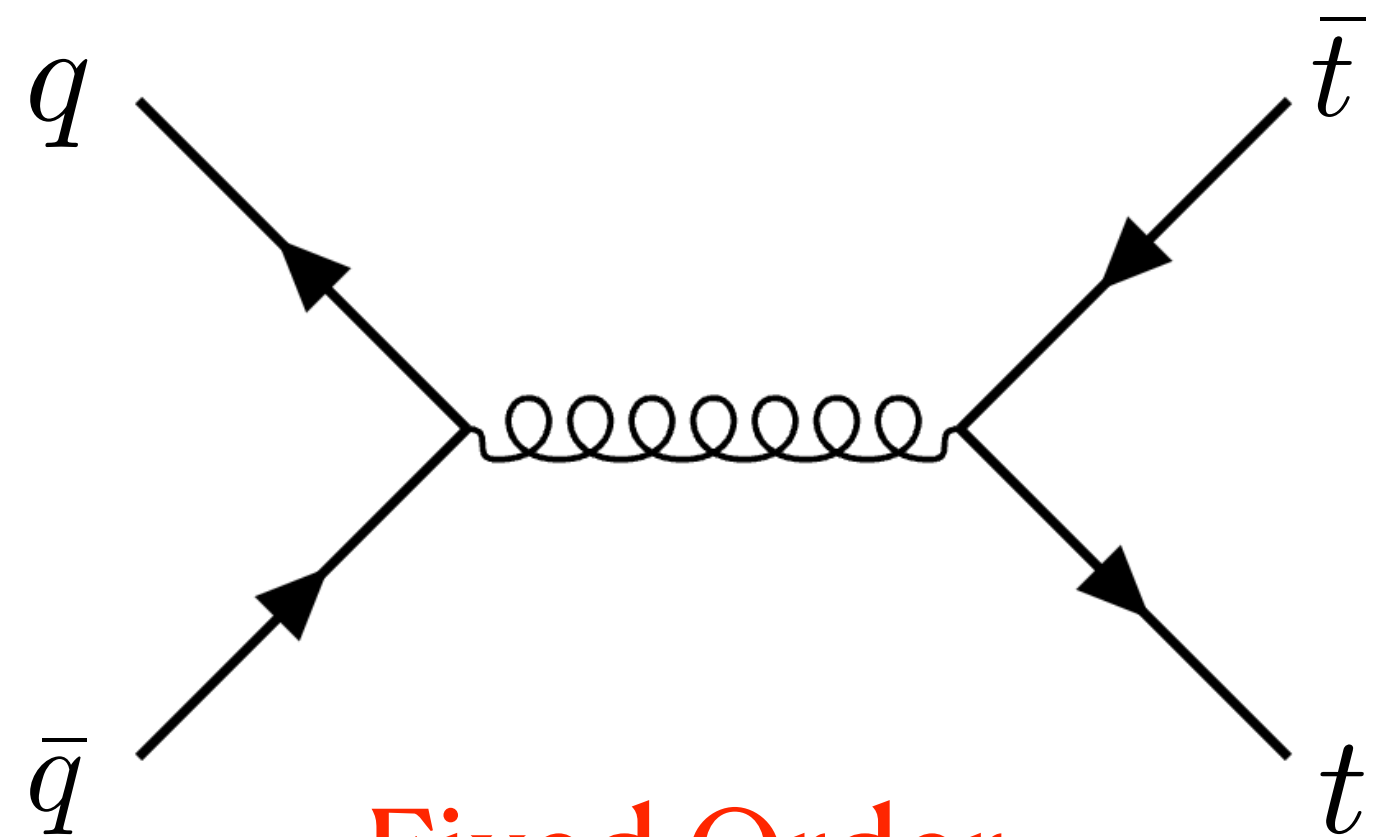
Parton Shower

Eikonal Approximation
High Multiplicity
Soft Scale

$$d\sigma_{POWHEG} = d\phi_B \left[B + V + \int d\phi_1 R \right] \times \left[\tilde{\Delta}(Q^2, Q_0^2) + \tilde{\Delta}(Q^2, t) d\phi_1 \frac{R}{B} \right]$$

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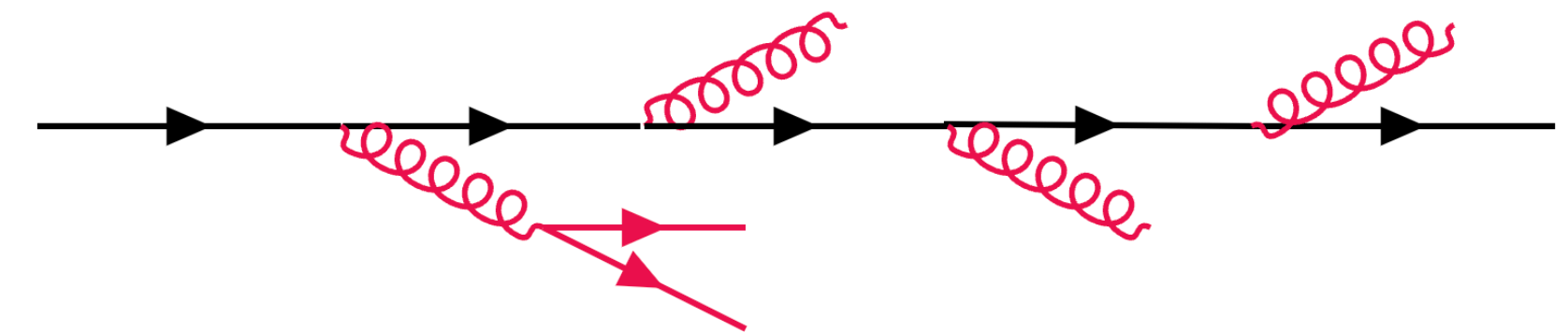
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Energy Scale, $Q^2 \rightarrow t$



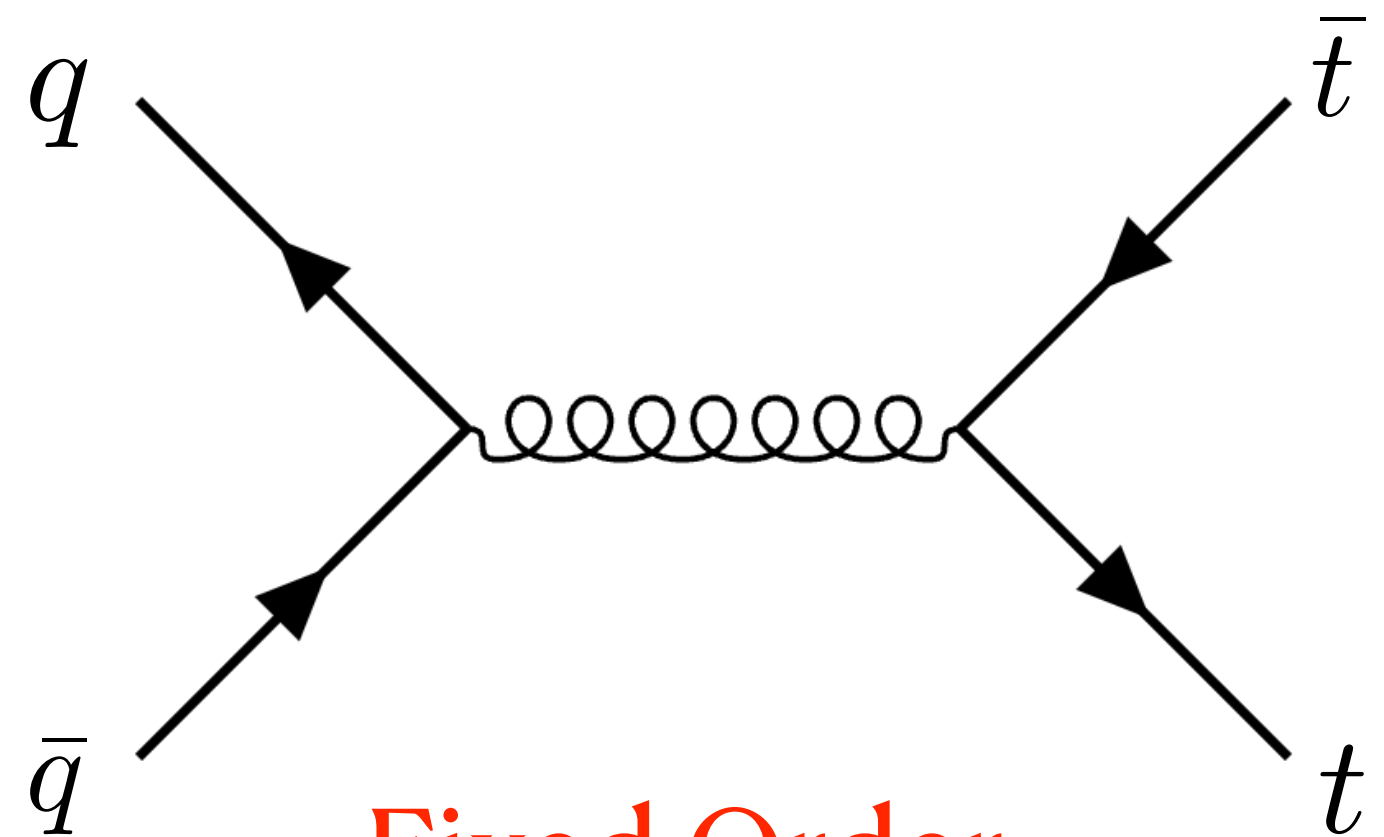
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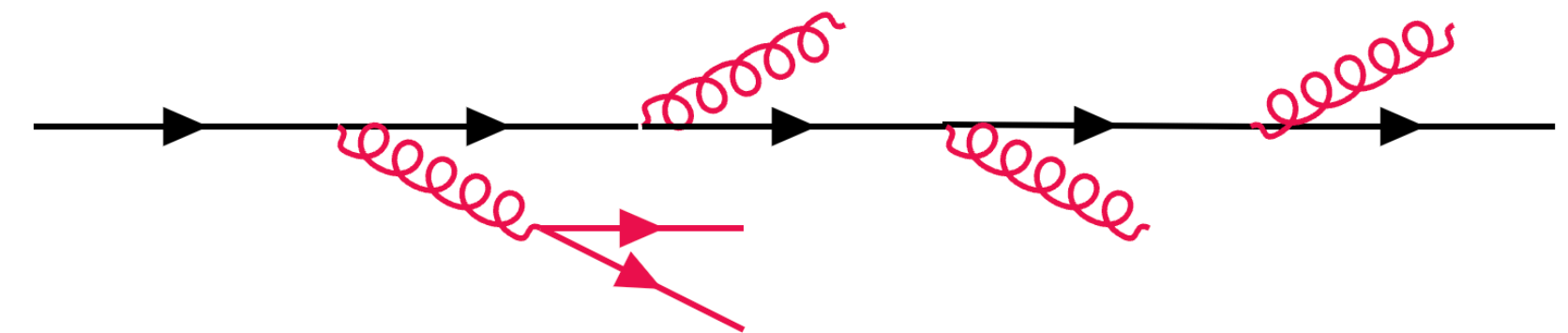


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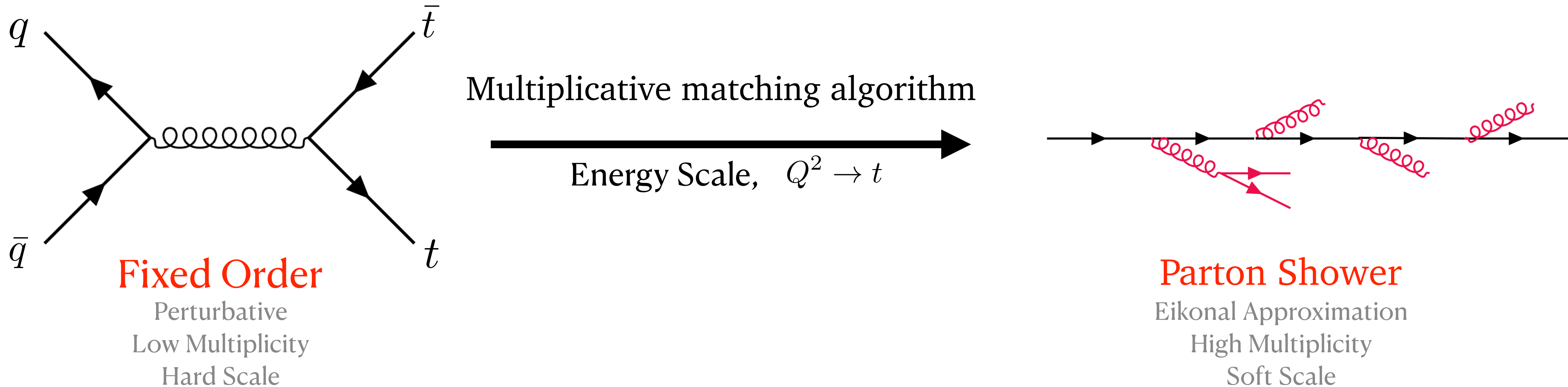
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Exact NLO Cross Section

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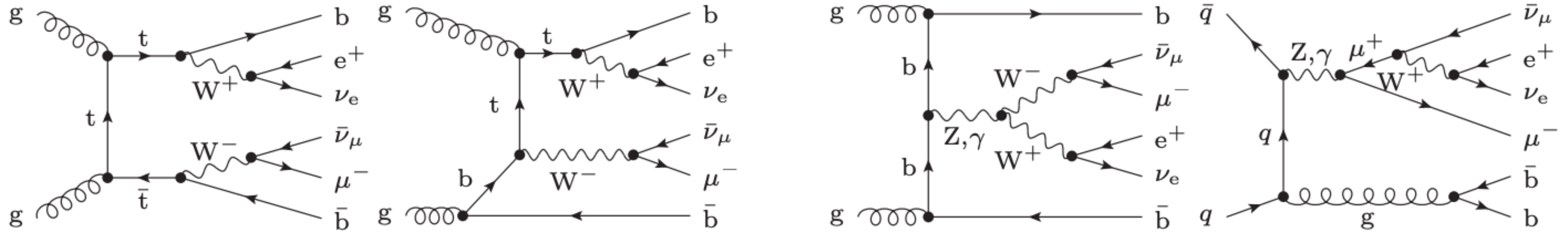
Exact NLO Cross Section

Modified Sudakov Factors

$$d\sigma_{POWHEG} = d\phi_B \left[B + V + \int d\phi_1 R \right] \times \left[\tilde{\Delta}(Q^2, Q_0^2) + \tilde{\Delta}(Q^2, t) d\phi_1 \frac{R}{B} \right]$$

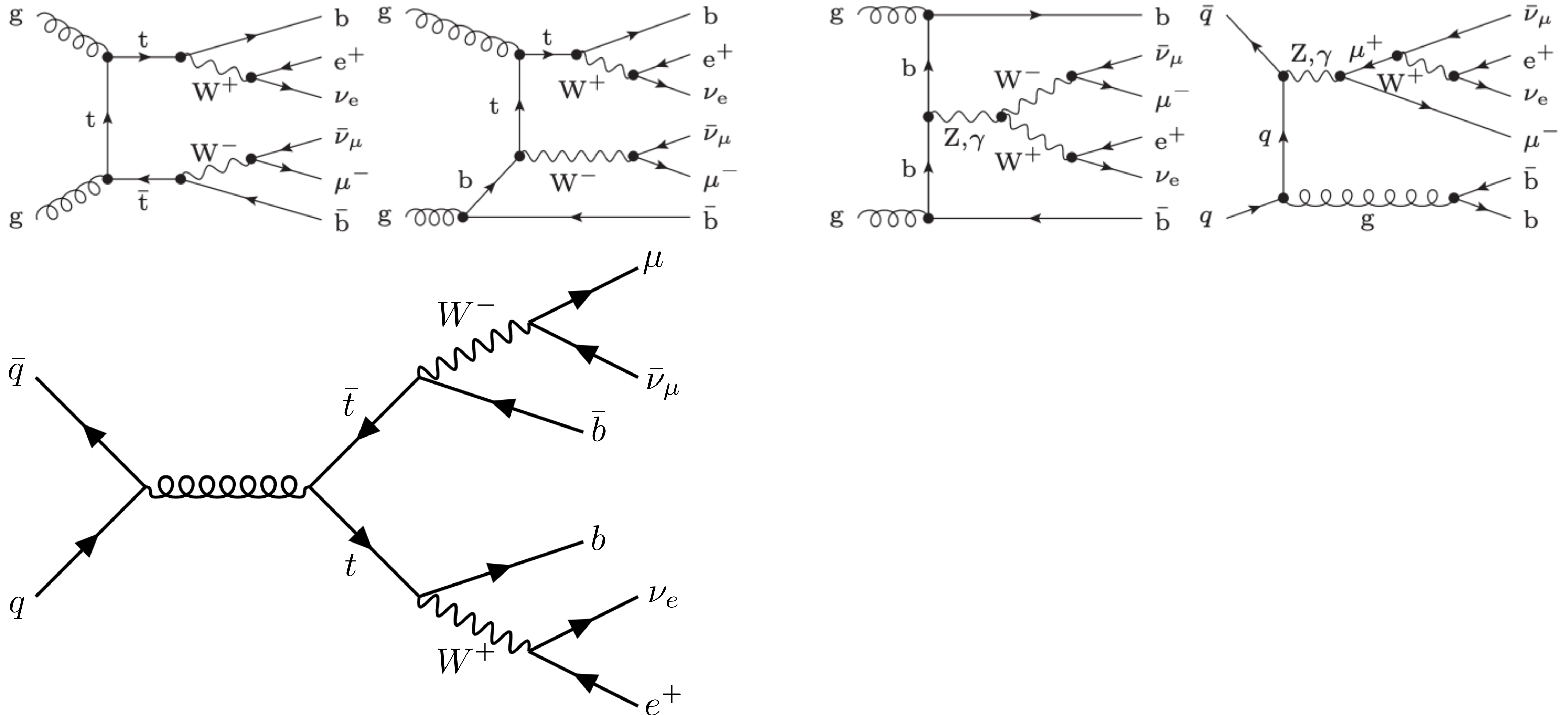
Resonance Aware POWHEG

LO contributions to cross section for bb4l final state



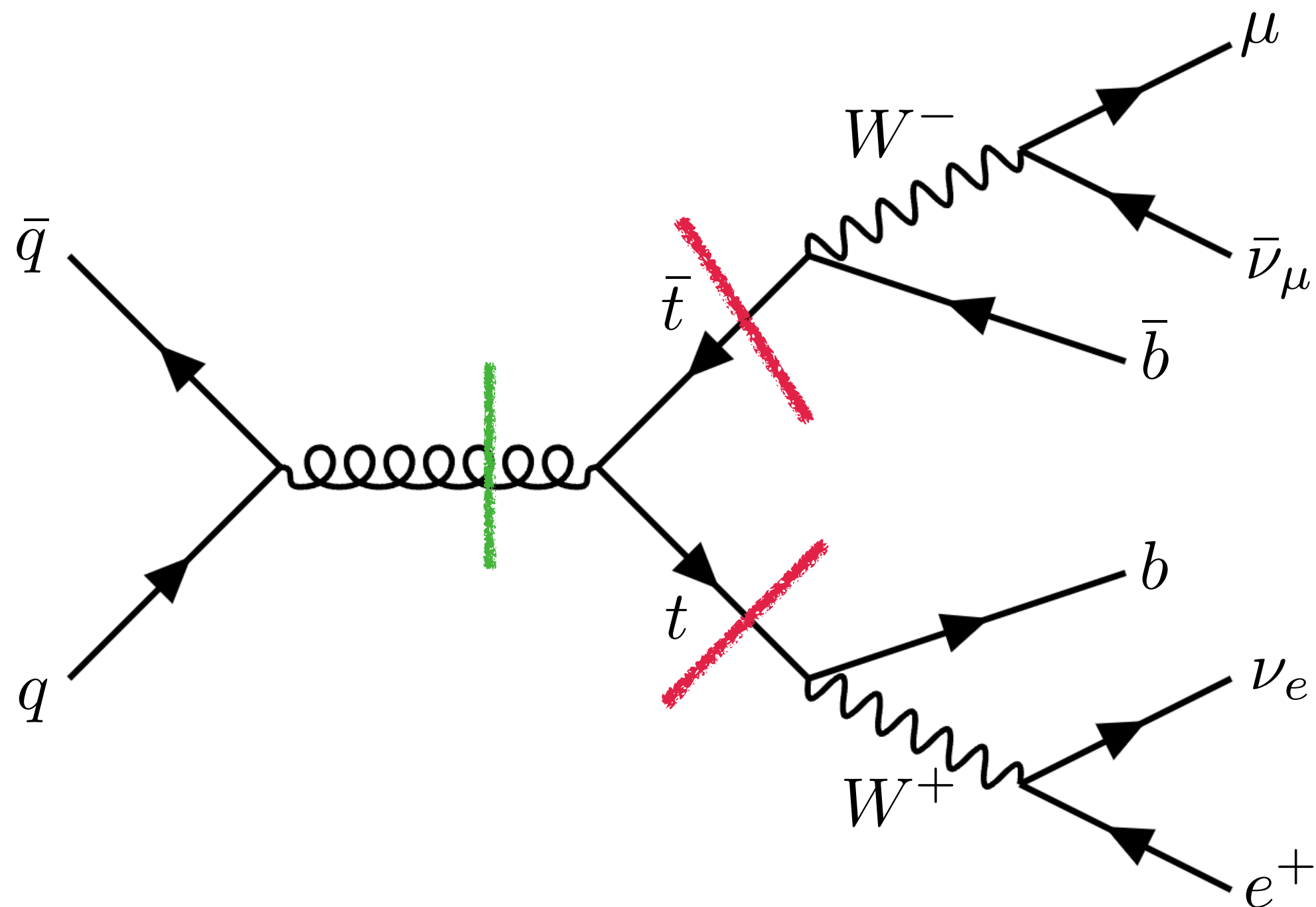
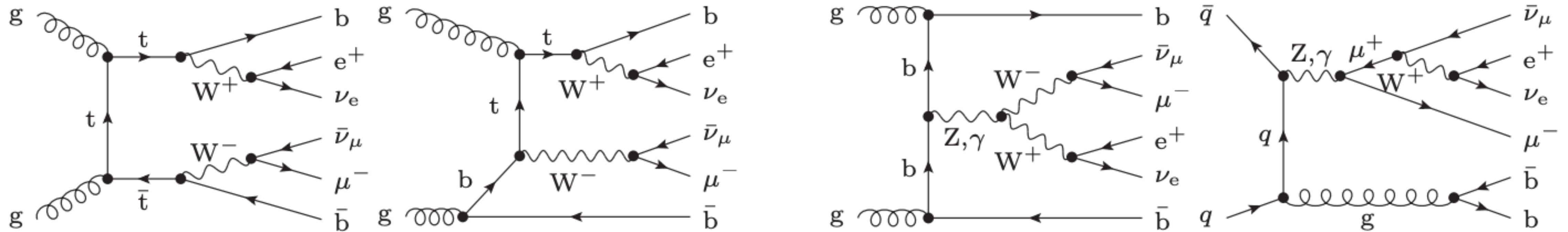
Resonance Aware POWHEG

LO contributions to cross section for bb4l final state



Resonance Aware POWHEG

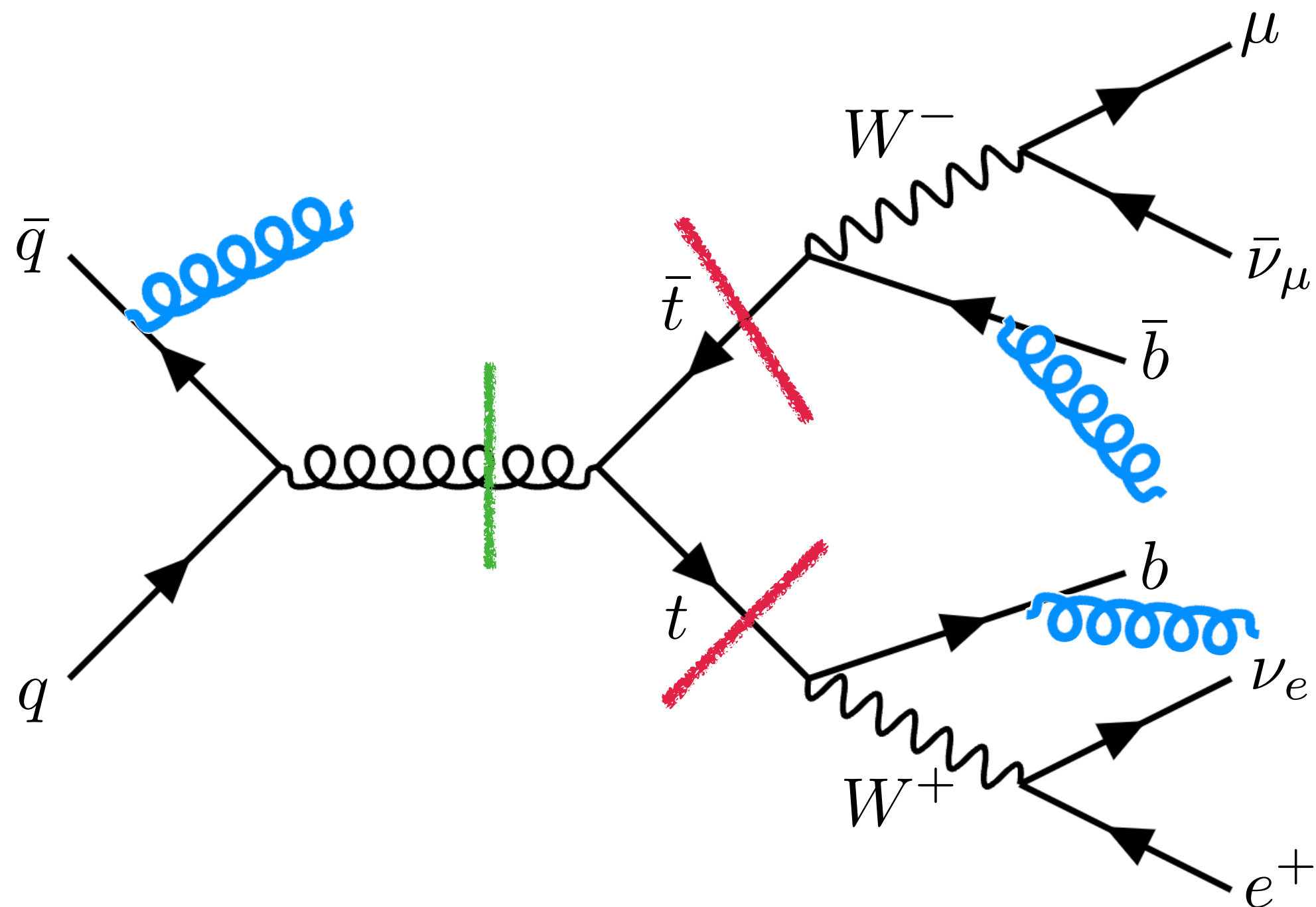
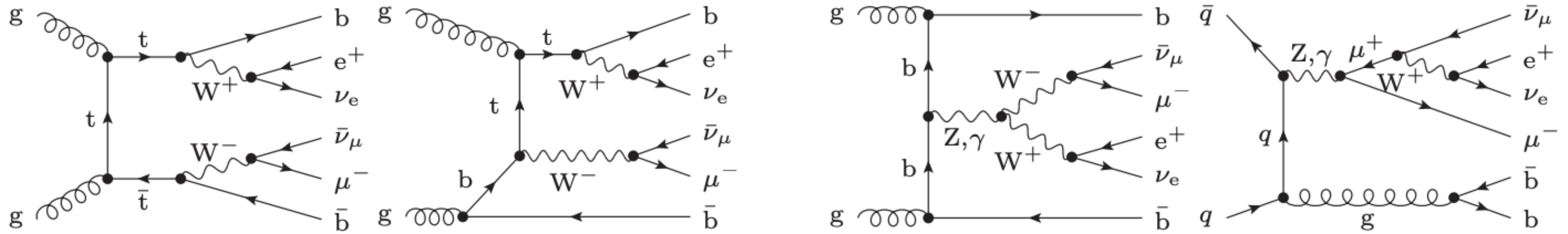
LO contributions to cross section for bb4l final state



POWHEG - RES separates **production** and **final state** partons into resonance histories

Resonance Aware POWHEG

LO contributions to cross section for bb4l final state

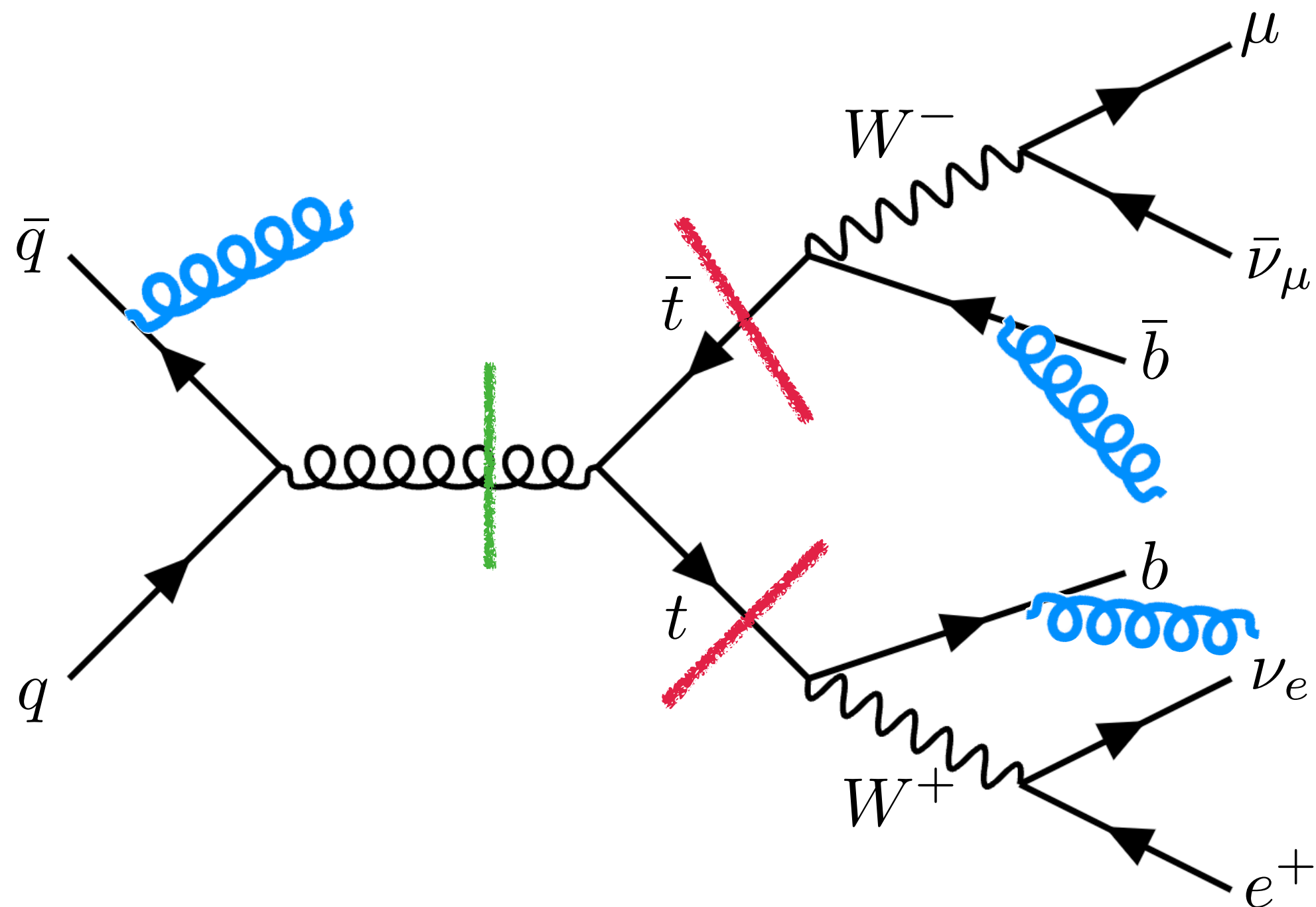
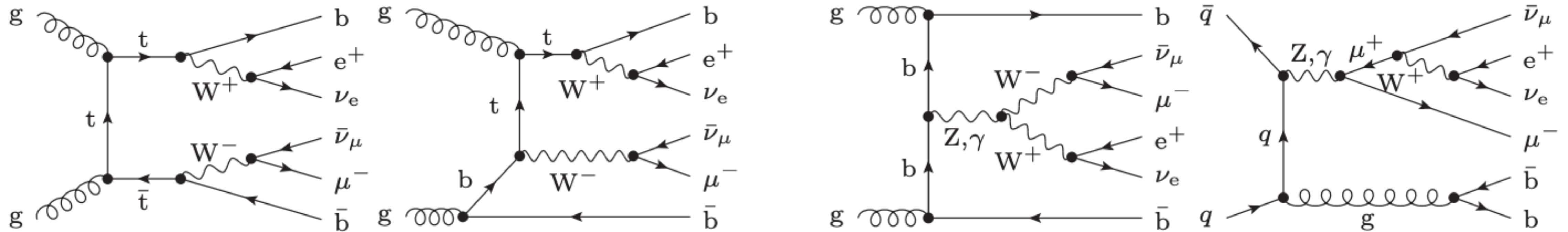


POWHEG - RES separates **production** and **final state** partons into resonance histories

POWHEG emission generated for each resonance history

Resonance Aware POWHEG

LO contributions to cross section for bb4l final state



POWHEG - RES separates **production** and **final state** partons into resonance histories

POWHEG emission generated for each resonance history

Resonance aware approach preserves NLO differential cross section shapes

Initial Results

$$\sigma_{on-shell} = \frac{\sigma_{off-shell}(\Gamma_t) \Gamma_t^2}{BR^2 \Gamma_{t,phys}^2}$$

BR = Branching Ratio

$\Gamma_{t,phys}$ = physical top width

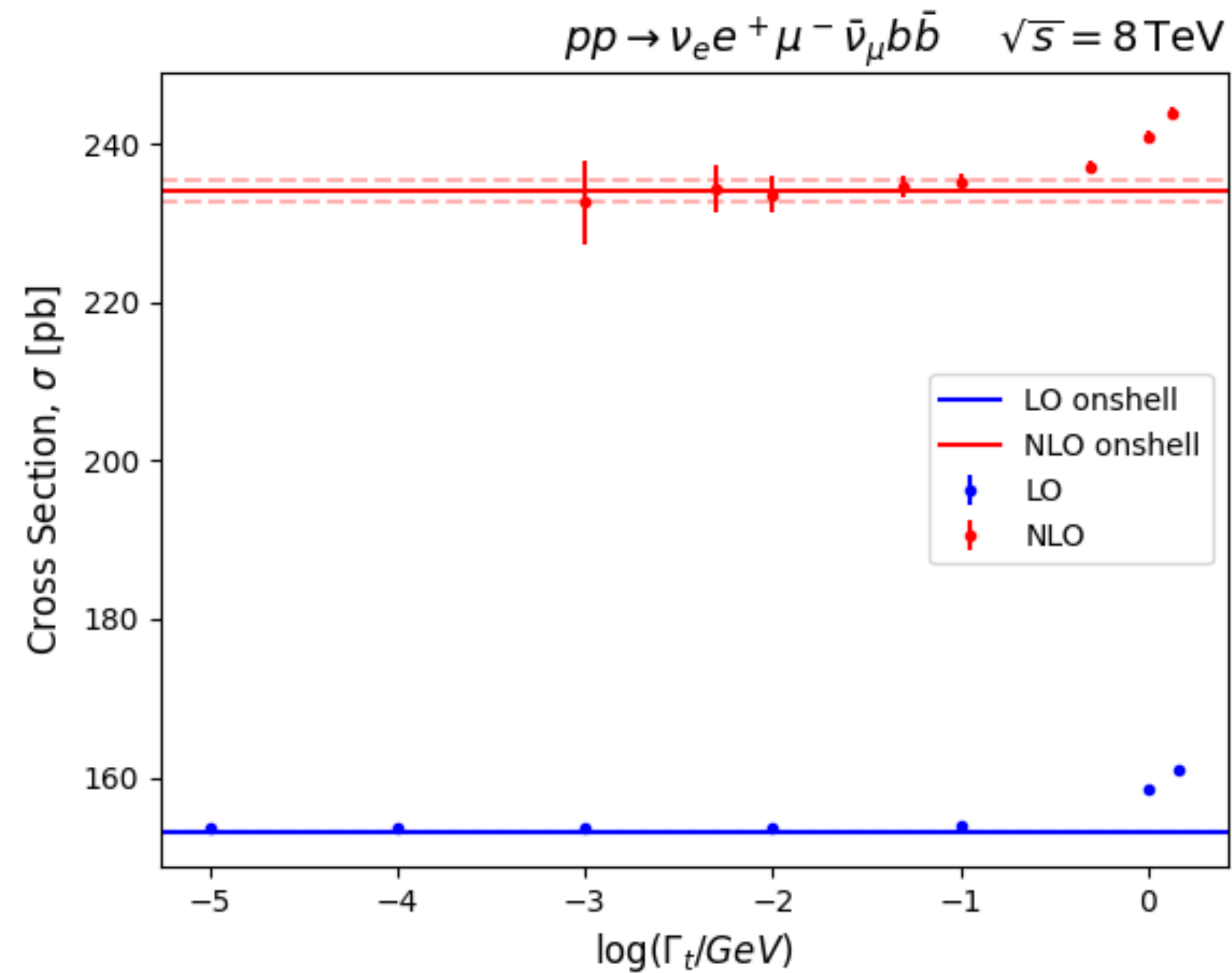


Fig 1. Validation of bb4l POWHEG-RES generator (points) at LO and NLO with decreasing top width, Γ_t , compared with on shell, $\Gamma_t = 0$, cross section computed using Sherpa.

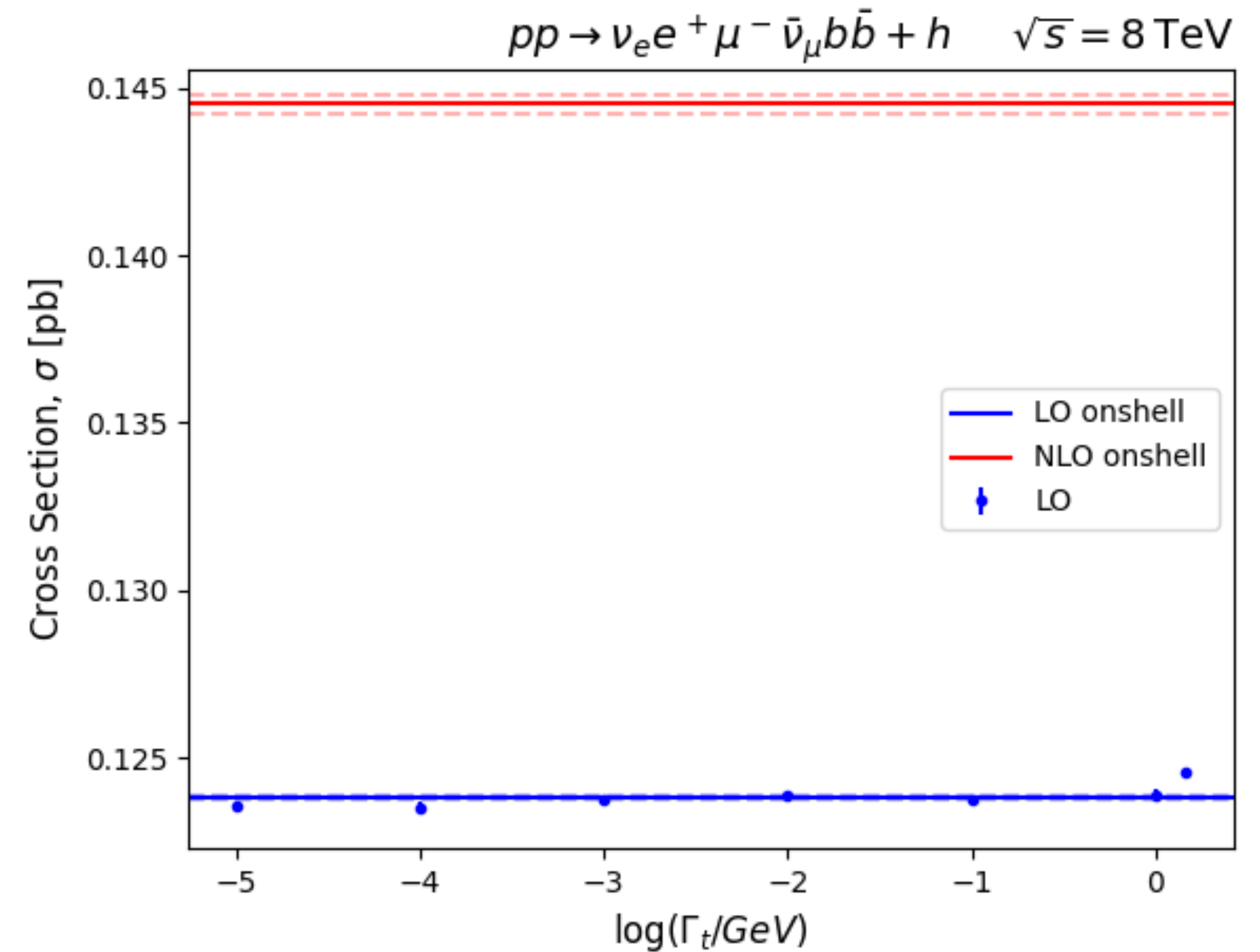


Fig 2. Validation of new bb4lh POWHEG-RES generator at LO for decreasing top width, Γ_t , compared with on shell, $\Gamma_t = 0$, cross section computed using Sherpa.

Thank you for Listening