The EW Sudakov Approximation

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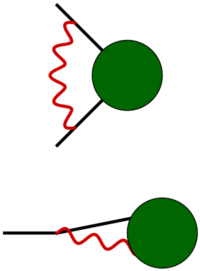
Contributing Diagrams - Mass Singularities

Relevant diagrams as shown in J. Math. Phys. 3, 650 (1962)



- Bosons can become soft and/or collinear $\rightarrow$ logarithms.
- Diverge for vanishing mass.
- Real contribution for $V = W^{\pm}, Z$ emission distinguishable.
- Leaves large logarithms of $\log s/M_V^2$. M_V is boson mass, $\sqrt{s}$ is COM energy.
- Valid for all kinematic invariants $\gg \sqrt{s}$.
- Outside of this regime, a full NLO EW calculation is necessary.

Size of Sudakov Logarithms

- NLO EW/EW Sudakov corrections have similar size to NNLO.
- EW Sudakov logarithms dominate at high energy.
- At centre of mass energy $\sqrt{s} = 1$ TeV:
  - Double logarithms are typically of the order 5%.

Double logs

$$\frac{\alpha}{4\pi} \log^2 \left(\frac{s}{M_W^2} \right)$$

  - Single logarithms are typically of the order 1%.

Single log

$$\frac{\alpha}{4\pi} \log \left(\frac{s}{M_W^2} \right)$$

Implementation

- My implementation follows hep-ph/0010201v3 (A. Denner and S. Pozzorini)
- Not yet publically available.
- Ignore subleading logarithms $\sim \log\left(\frac{M_W^2}{M_Z^2}\right)$
- Largely factorises: Implement as a K-factor: KFACTOR EW
- Parameter renormalisation logs need running EW scales
- Validated so far for W/Z+jets

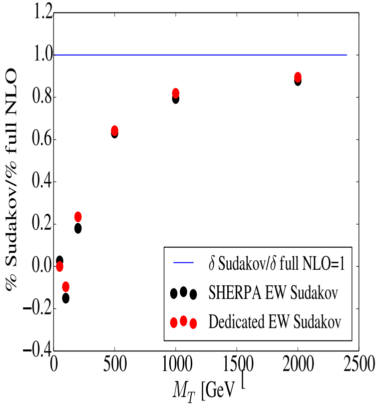
Factorisation of correction

$$\mathcal{M}_{EW} = \sum_{ij} \sum_{\text{helicities}} \sum_{\text{weak bosons}} \mathcal{M}'_{LO\ ij} \delta_{EW\ ij}$$

Current Limitations

- Cannot currently treat heavy fermions
- On-shell production of unstable particles - spin correlations not preserved
- Requires COMIX as ME generator

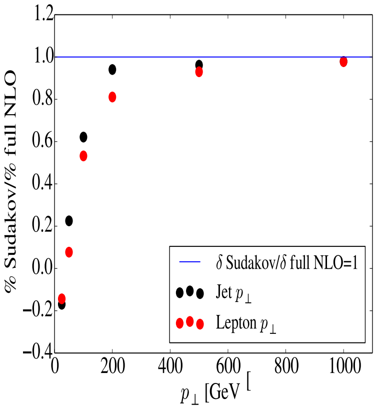
Results - $pp \to \mu\nu$ at 14 TeV LHC



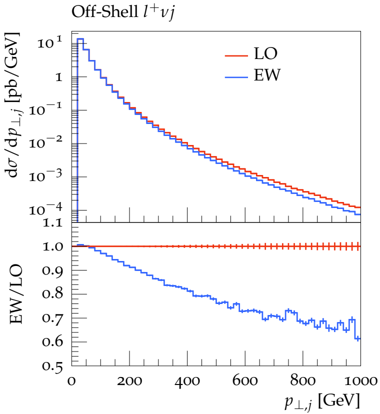
- SHERPA EW Sudakov logarithms (purple)
- Dedicated EW Sudakov calculation (red)
- Approximation approaches full result in high M_T region

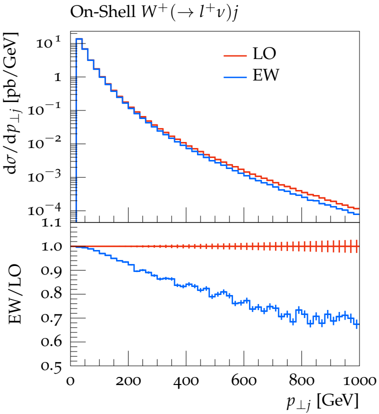
Results - $pp \to l\nu j$ at 14 TeV LHC

- Similar behaviour
- Sudakov approximation good in high $p_\perp$ regime
- For this process, $p_\perp$ jet approaches full result faster



Results - $pp \to Wj$ at 14 TeV LHC





Off-shell production

On-shell production

Conclusions

- EW Corrections are of a similar size to NNLO QCD Corrections.
- EW Sudakov logarithms are a good approximation in the high-energy limit
- The SHERPA implementation will be public soon.
- More accurate predictions require NLO EW + NLO QCD corrections.