Angular coefficients in W + j production at the LHC with high precision

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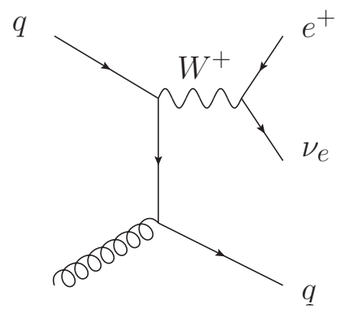
[arXiv:2204.12394]

1. Introduction

- Angular coefficients are used in the W-boson mass measurement[1], which are unfolded from the Z-boson coefficients measurement

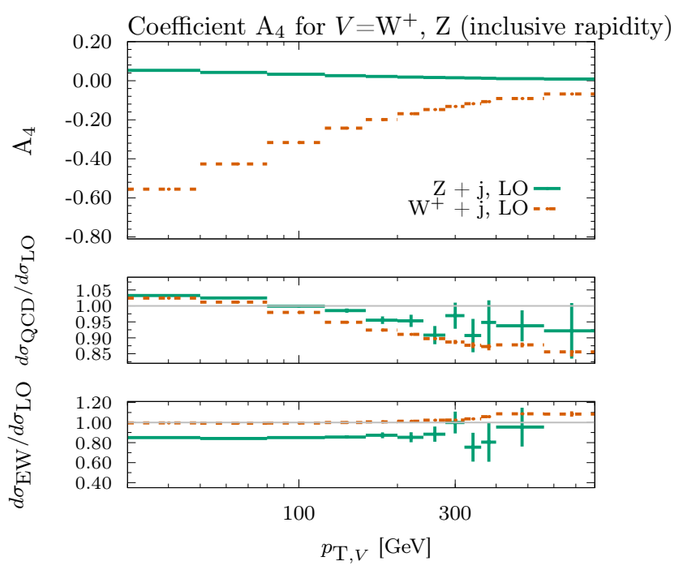


- Differential cross section for finite boson-p_{T} (↑) Drell-Yan process is parametrized by **angular coefficients** :

$$\frac{3}{16\pi}\frac{\mathrm{d}\sigma^{\mathrm{U}}}{\mathrm{d}p_{\mathrm{T},W}\,\mathrm{d}y_W\,\mathrm{d}m_{\ell\nu}}\Big((1+\cos^2\theta)+\mathrm{A}_0\frac{1}{2}(1-3\cos^2\theta)+\mathrm{A}_1\sin 2\theta\cos\phi+\mathrm{A}_2\frac{1}{2}\sin^2\theta\cos 2\phi+\mathrm{A}_3\sin\theta\cos\phi+\mathrm{A}_4\cos\theta+\mathrm{A}_5\sin^2\theta\sin 2\phi+\mathrm{A}_6\sin 2\theta\sin\phi+\mathrm{A}_7\sin\theta\sin\phi\Big)$$

- **Our goal: obtain NNLO QCD + NLO EW accurate predictions for A_j**

2. Comparison with Z-boson coefficients



- Small deviation in QCD corrections for W- and Z-boson[2]
- Large overall NLO EW corrections due to missing higher-order corrections in input parameters for the parity-odd A_3, A_4

3. Mixed QCD+EW expansion of the coefficients

- Coefficients are ratios of weighted moments of spherical harmonics

$$\mathrm{A}_j^{\mathrm{def}} = \frac{\sigma_{\mathrm{num}}}{\sigma_{\mathrm{den}}}$$

- Expanded in the strong coupling α_s up to NNLO:

$$\mathrm{A}_j^{\mathrm{exp}} = A + \alpha_s B + \alpha_s^2 C$$

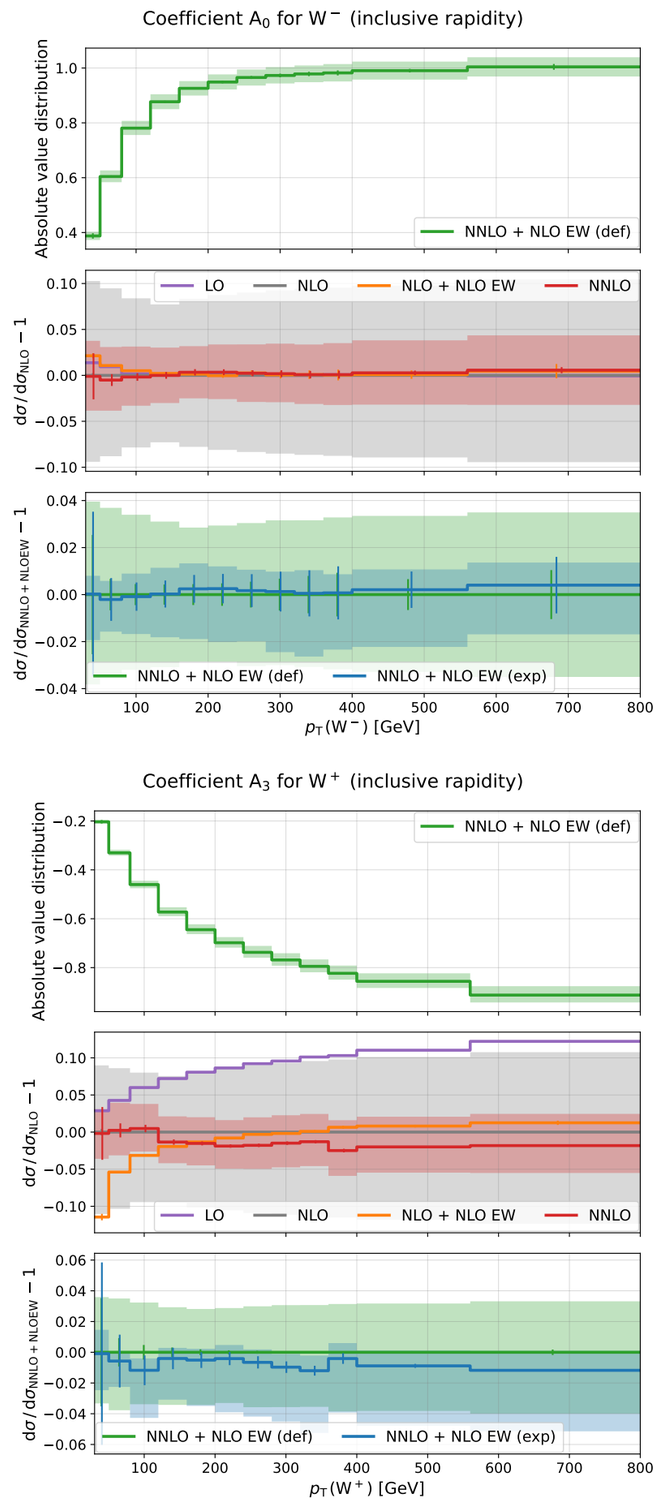
- Including NLO electroweak corrections:

$$\mathrm{A}_{j,\mathrm{QCD+EW}}^{\mathrm{def/exp}} = K_{\mathsf{EW}} \times \mathrm{A}_j^{\mathrm{def/exp}}$$

4. Input and tools

- QCD: using NWA (off-shell effects validated to be negligible at NLO)
- Electroweak sector: complex-mass-scheme and the $\bar{G}_\mu$ scheme
- Scale choice: transverse energy $\mu_R^0 = \mu_F^0 = E_{\mathrm{T},l\nu_l}$
- Computation of NNLO QCD: STRIPPER framework[3]
- Computation of NLO EW: MADGRAPH5_AMC@NLO[4]

5. Results: $\mathrm{W}^{\pm}$ distributions



- Scale band decrease by factor 2-3 for NLO QCD → NNLO QCD
- Scale bands smaller by factor 2 for expanded version of most coefficients
- NNLO QCD and NLO EW corrections similar for W^+ signature (flipped sign for A_3, A_4)
- Distributions of A_0, A_2, A_3 independent of rapidity
- Coefficients A_1, A_4 show large dependence on rapidity: vanishing in central regions

References

[1] **ATLAS** Collaboration, Eur. Phys. J. C 78 (2018)
[2] R. Frederix, T. Vitos, Eur. Phys. J. C 80 (2020)
[3] M. Czakon, Phys. Lett. B 693 (2010)
[4] R. Frederix, et al, JHEP 07 (2018)