NNLOPS– a comparison

Marek Schönherr

Universität Zürich

Zürich, 12/03/2015

FONDS NATIONAL SUISSE
SCHWEIZERISCHER NATIONALFONDS
FONDO NAZIONALE SVIZZERO
SWISS NATIONAL SCIENCE FOUNDATION

NNLOPs comparison

Two approaches

- POWHEG/MiNLO + reweighting
  $pp \to h$ Hamilton, Nason, Re, Zanderighi arXiv:1309.0017
  $pp \to \ell^+\ell^-$ Karlberg, Re, Zanderighi arXiv:1407.2940

- S-MC@NLO + UNLOPS + $q_\perp$-slicing
  $pp \to \ell^+\ell^-$ Höche, Li, Prestel arXiv:1405.3607
  $pp \to h$ Höche, Li, Prestel arXiv:1407.3773

both only work for singlet production where NNLO contrib only lives at $p_\perp = 0$

⇒ reflects my understanding of these papers, no guarantee that correct in all respects

Resummation properties of parton showers

$$\langle O\rangle^{\text{PS}}=\int \mathrm{d}\Phi_n\,\mathrm{B}_n(\Phi_n)\left[\Delta_n^{(\mathcal{K})}(t_c,\mu_Q^2)\,O(\Phi_n)+\int_{t_c}^{\mu_Q^2}\mathrm{d}\Phi_1\,\mathcal{K}_n(\Phi_1)\,\Delta_n^{(\mathcal{K})}(t,\mu_Q^2)\,O(\Phi_{n+1})\right]$$

- splitting kernel $\mathcal{K}_n=\sum\mathcal{K}_i$ and $\mathcal{K}_i(\Phi_1)\propto\frac{\alpha_s}{t}P_i(z)$, $\Phi_1=\{t,z,\phi\}$
- Sudakov form factor

$$L=\log\frac{t}{t'}$$

$$\Delta^{(\mathcal{K})}(t,t')\;=\;\exp\left[-\int_t^{t'}\mathrm{d}\Phi_1\,\mathcal{K}(\Phi_1)\right]\;=\;\exp\left[\,c_1\,\alpha_s L^2+c_2\,\alpha_s L+\ldots\right]$$

- parton shower starting scale μ_Q plays role of resummation scale, at LO commonly identified with μ_F to recover PDF evolution
- resummation in evolution variable t, soft limit at most in $N_c\to\infty$ c_1 correct, c_2 at most in $N_c\to\infty$ approximation
- 1-loop running $\alpha_s(k_\perp)$ catches dominant terms of higher log. order

$\Rightarrow$ **crucial in defining "parton shower accuracy"**

Resummation properties of parton showers

$$\langle O\rangle^{\text{PS}} = \int \mathrm{d}\Phi_n\,\mathrm{B}_n(\Phi_n)\,\mathcal{F}_n(\mu_Q^2,O)$$

$$\mathcal{F}_n(t,O) = \Delta_n(t_c,t)\,O(\Phi_n) + \int_{t_c}^{t} \mathrm{d}\hat{\Phi}_1\,\mathcal{K}_n(\hat{\Phi}_1)\,\Delta_n(\hat{t},t)\,\mathcal{F}_{n+1}(\hat{t},O)$$

- generating functional $\mathcal{F}_n(t,O)$ on n-parton state with starting scale t
- unitary higher order approximation with
  - $R_n(\Phi_{n+1}) \approx \mathrm{B}_n(\Phi_n)\cdot\mathcal{K}_n(\hat{\Phi}_1)\,\Theta(\mu_Q^2-\hat{t}) = \mathrm{D}_n(\Phi_{n+1})$
  - $V_n(\Phi_n) \approx -\mathrm{B}_n(\Phi_n)\cdot\int \mathrm{d}\hat{\Phi}_1\,\mathcal{K}_n(\hat{\Phi}_1)\,\Theta(\mu_Q^2-\hat{t}) = -\int \mathrm{d}\hat{\Phi}_1\,\mathrm{D}_n(\Phi_n,\hat{\Phi}_1)$
- can improve through (soft limit)
  - matrix element correction $\mathrm{D}_n(\Phi_{n+1}) = \mathrm{R}_n(\Phi_{n+1})\,\Theta(\mu_Q^2-\hat{t})$
  - $N_c = 3$ splitting functions $\mathrm{D}_n(\Phi_{n+1}) = \mathrm{B}_n(\Phi_n)\otimes\mathcal{K}_n(\hat{\Phi}_1)\,\Theta(\mu_Q^2-\hat{t})$

NLOPS

Two types:

- MC@NLO/POWHEG

$$\langle O \rangle^{\text{NLOPS}} = \int \mathrm{d}\Phi_0\, \bar{\mathrm{B}}_0(\Phi_0)\, \bar{\mathcal{F}}_0(\mu_Q^2, O) \; + \int \mathrm{d}\Phi_1\, \mathbb{H}_0(\Phi_1)\, \mathcal{F}_1(t_1, O)$$

  NLO correction smeared through resummation phase space

- UNLOPS

$$\langle O \rangle^{\text{UNLOPS}} = \int \mathrm{d}\Phi_0\, \mathrm{B}_0(\Phi_0)\, \bar{\mathcal{F}}_0(\mu_Q^2, O) \; + \int \mathrm{d}\Phi_1\, \mathbb{H}_0(\Phi_1)\, \mathcal{F}_1(t_1, O) + \int \mathrm{d}\Phi_0\, \left[\bar{\mathrm{B}}_0 - \mathrm{B}_0\right](\Phi_0)\; O(\Phi_0)$$

  NLO correction localised in Born phase space, not showered

⇒ **same logarithmic accuracy, differ at $\mathcal{O}(\alpha_s^2)$**
⇒ **resum logarithms wrt. Φ_0**

NLOPS

$$\bar{\mathrm{B}} = \mathrm{B} + \mathrm{V} + \int \mathrm{d}\hat{\Phi}_1 \mathrm{D}_0 \Theta(\mu_Q^2 - t)$$

$$\mathbb{H} = \mathrm{R} - \mathrm{D}_0 \Theta(t - \mu_Q^2)$$

$$\bar{\mathcal{F}}_n(t, O) = \bar{\Delta}_n(t_c, t)\, O(\Phi_n) + \int \mathrm{d}\hat{\Phi}_1 \frac{\mathrm{D}_n}{\mathrm{B}_n} \bar{\Delta}_n(t_c, \hat{t})\, \mathcal{F}_{n+1}(\hat{t}, O)$$

Two types:

- MC@NLO/POWHEG

$$\langle O \rangle^{\text{NLOPS}} = \int \mathrm{d}\Phi_0\, \bar{\mathrm{B}}_0(\Phi_0)\, \bar{\mathcal{F}}_0(\mu_Q^2, O) + \int \mathrm{d}\Phi_1\, \mathbb{H}_0(\Phi_1)\, \mathcal{F}_1(t_1, O)$$

  NLO correction smeared through resummation phase space

- UNLOPS

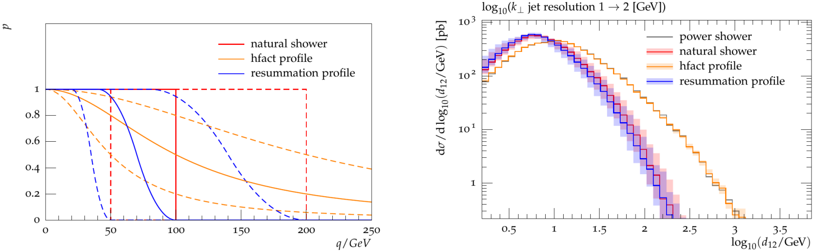
$$\langle O \rangle^{\text{UNLOPS}} = \int \mathrm{d}\Phi_0\, \mathrm{B}_0(\Phi_0)\, \bar{\mathcal{F}}_0(\mu_Q^2, O) + \int \mathrm{d}\Phi_1\, \mathbb{H}_0(\Phi_1)\, \mathcal{F}_1(t_1, O) + \int \mathrm{d}\Phi_0 \left[\bar{\mathrm{B}}_0 - \mathrm{B}_0\right](\Phi_0)\, O(\Phi_0)$$

  NLO correction localised in Born phase space, not showered

⇒ **same logarithmic accuracy, differ at $\mathcal{O}(\alpha_s^2)$**

⇒ **resum logarithms wrt. Φ_0**

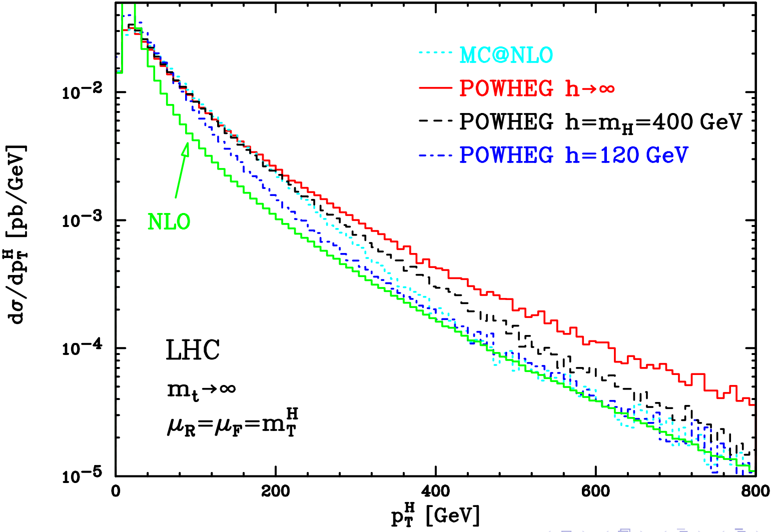
NLOPs – resummation region



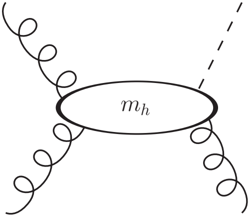
- MC@NLO choice: resummation region $\propto \Theta(\mu_Q^2 - t)$
- POWHEG choice: resummation region $\propto \frac{h^\gamma}{p_\perp^\gamma + h^\gamma}$

graphics by S. Plätzer

NLOPs – resummation region



CKKW/MiNLO



$$\alpha_s^3(\mu_R) = \alpha_s^3(m_h)$$

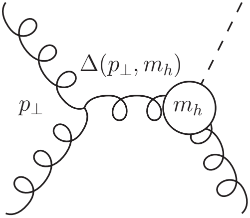
standard NLO

$$\langle O \rangle = \int \mathrm{d}\Phi_B \; \alpha_s^2(\mu_R) \Big[\mathrm{B} + \alpha_s(\mu_R)\mathrm{V} \Big] \; O(\Phi_B) + \int \mathrm{d}\Phi_R \; \alpha_s^3(\mu_R) \mathrm{R}(\Phi_R) \; O(\Phi_R)$$

Sudakov resums leading jet $p_\perp$ in $pp \to hj$ wrt. $pp \to h$
$\Delta(p_\perp > m_h, m_h) = 1$
$\to$ underlying every multijet merging method

- with NLL Sudakov result is finite as $p_\perp \to 0$
- include proc. dep. B_2 to be NLO also in $pp \to h$

CKKW/MiNLO



$$\alpha_s^3(\tilde{\mu}_R) = \alpha_s^2(m_h)\alpha_s(p_\perp)$$

Sudakov resums leading jet $p_\perp$ in $pp \to hj$ wrt. $pp \to h$

$\Delta(p_\perp > m_h, m_h) = 1$

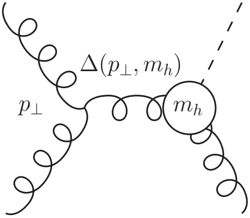
$\to$ underlying every multijet merging method

CKKW/MiNLO

$$\begin{aligned}\langle O \rangle = & \int \mathrm{d}\Phi_B\, \alpha_s^2(\tilde{\mu}_R)\, \Delta(p_\perp, m_h) \\ & \times \left[\mathrm{B} + \alpha_s(\tilde{\mu}_R)\mathrm{V} + \mathrm{B}\Delta^{(1)}\right] O(\Phi_B) \\ & + \int \mathrm{d}\Phi_R\, \alpha_s^3(\tilde{\mu}_R)\, \Delta(p_\perp, m_h)\, \mathrm{R}(\Phi_R)\, O(\Phi_R)\end{aligned}$$

- with NLL Sudakov result is finite as $p_\perp \to 0$
- include proc. dep. B_2 to be NLO also in $pp \to h$

CKKW/MiNLO



$\alpha_s^3(\tilde{\mu}_R) = \alpha_s^2(m_h)\alpha_s(p_\perp)$

Sudakov resums leading jet $p_\perp$ in $pp \to hj$ wrt. $pp \to h$
$\Delta(p_\perp > m_h, m_h) = 1$
$\to$ underlying every multijet merging method

CKKW/MiNLO

$$\langle O \rangle = \int \mathrm{d}\Phi_B \, \alpha_s^2(\tilde{\mu}_R) \, \Delta(p_\perp, m_h) \times \left[\mathrm{B} + \alpha_s(\tilde{\mu}_R)\mathrm{V} + \mathrm{B}\Delta^{(1)}\right] O(\Phi_B) + \int \mathrm{d}\Phi_R \, \alpha_s^3(\tilde{\mu}_R) \, \Delta(p_\perp, m_h) \, \mathrm{R}(\Phi_R) \, O(\Phi_R)$$

- with NLL Sudakov result is finite as $p_\perp \to 0$
- include proc. dep. B_2 to be NLO also in $pp \to h$

NNLOPS with POWHEG/MiNLO + reweighting

Hamilton, Nason, Re, Zanderighi arXiv:1309.0017, Karlberg, Re, Zanderighi arXiv:1407.2940

A simulation that is accurate to NLO in both Φ_0 and Φ_1 can be reweighted differentially in Φ_0 by

$$K(\Phi_0) = \frac{\mathrm{d}\sigma^{\text{NNLO}}}{\mathrm{d}\Phi_0} \Big/ \frac{\mathrm{d}\sigma^{\text{MiNLO}}}{\mathrm{d}\Phi_0}$$

to give a NNLO correct result. The resummation accuracy remains untouched.

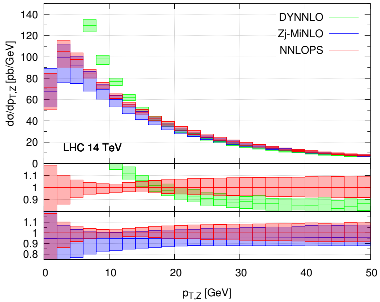
- generate MiNLO $pp \to hj$, reweight in y_h to HNNLO
- generate MiNLO $pp \to \ell\ell j$, reweight in $y_{\ell\ell}$, θ^*_ℓ, $a_{m\ell\ell}$ to DYNNLO

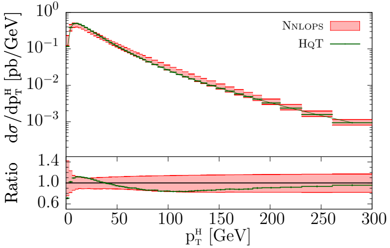
problem: cannot use same scales in POWHEG/MiNLO and HNNLO/DYNNLO

- residual effect on observables in Φ_1 beyond accuracy

NNLOPS with POWHEG/MiNLO + reweighting

Hamilton, Nason, Re, Zanderighi arXiv:1309.0017, Karlberg, Re, Zanderighi arXiv:1407.2940





NNLOPS with S-MC@NLO + UNLOPS + $q_\perp$-slicing

Höche, Li, Prestel arXiv:1405.3607, arXiv:1407.3773

For $q_\perp > q_{\perp,\text{cut}}$ ($q_{\perp,\text{cut}} < t_c$) a S-MC@NLO calculation in Φ_1 can be used to complement an exclusive NNLO calculation at zero $q_\perp$. Same as in NLO multijet merging, overlap of the Sudakov form factor and the NNLO calculation have to be subtracted.

$$\langle O\rangle^{\text{S-MC@NLO}}_{>q_{\perp,\text{cut}}} = \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_1\, \bar{\mathrm{B}}_1(\Phi_1)\, \tilde{\mathcal{F}}_1(O) + \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_2\, \mathbb{H}_1(\Phi_2)\, \mathcal{F}_2(O)$$

add Δ_0 for resummation wrt. Φ_0, subtract $\mathcal{O}(\alpha_s)$ expansion

$\Rightarrow$ **match NLO Φ_1 with S-MC@NLO**
match NNLO Φ_0 UNLOPS-style

NNLOPS with S-MC@NLO + UNLOPS + $q_\perp$-slicing

Höche, Li, Prestel arXiv:1405.3607, arXiv:1407.3773

$$
\begin{aligned}
\langle O\rangle^{\mathrm{UN^2LOPS}}
&= \int \mathrm{d}\Phi_0\; \bar{\bar{\mathrm{B}}}_0^{q_\perp,\mathrm{cut}}(\Phi_0)\; \mathrm{O}(\Phi_0) \\
&\quad + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_1 \left[1-\Delta_0(1+\Delta_0^{(1)})\right] \mathrm{B}_1(\Phi_1)\; O(\Phi_1) + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_1\; \Delta_0(1+\Delta_0^{(1)})\,\mathrm{B}_1(\Phi_1)\; \bar{\mathcal{F}}_1(O) \\
&\quad + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_1\,[1-\Delta_0]\,\bar{\mathrm{B}}_1^R(\Phi_1)\; O(\Phi_1) + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_1\; \Delta_0\,\bar{\mathrm{B}}_1^R(\Phi_1)\; \bar{\mathcal{F}}_1(O) \\
&\quad + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_2\,[1-\Delta_0]\,\mathbb{H}_1^R(\Phi_2)\; O(\Phi_2) + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_2\; \Delta_0\,\mathbb{H}_1^R(\Phi_2)\; \mathcal{F}_2(O) \\
&\quad + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_2\; \mathbb{H}_1^E(\Phi_2)\; \mathcal{F}_2(O)
\end{aligned}
$$

$$
\begin{aligned}
\bar{\mathrm{B}}^R &= \bar{\mathrm{B}} - \mathrm{B} \\
\bar{\mathbb{H}}^R &= \mathbb{H}\;\Theta(t_2-t_1)\,\Theta(t_1-t_c) \\
\bar{\mathbb{H}}^E &= \bar{\mathbb{H}} - \bar{\mathbb{H}}^R
\end{aligned}
$$

NNLOPS with S-MC@NLO + UNLOPS + $q_\perp$-slicing

Höche, Li, Prestel arXiv:1405.3607, arXiv:1407.3773

$\langle O\rangle^{\text{UN}^2\text{LOPS}}$

$$= \int \mathrm{d}\Phi_0\, \bar{\bar{\mathrm{B}}}_0^{q_{\perp,\mathrm{cut}}}(\Phi_0)\, \mathrm{O}(\Phi_0)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_1 \left[1-\Delta_0(1+\Delta_0^{(1)})\right] \mathrm{B}_1(\Phi_1)\, O(\Phi_1) + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_1\, \Delta_0(1+\Delta_0^{(1)})\, \mathrm{B}_1(\Phi_1)\, \bar{\mathcal{F}}_1(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_1 \left[1-\Delta_0\right] \bar{\mathrm{B}}_1^R(\Phi_1)\, O(\Phi_1) + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_1\, \Delta_0\, \bar{\mathrm{B}}_1^R(\Phi_1)\, \bar{\mathcal{F}}_1(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_2 \left[1-\Delta_0\right] \mathbb{H}_1^R(\Phi_2)\, O(\Phi_2) + \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_2\, \Delta_0\, \mathbb{H}_1^R(\Phi_2)\, \mathcal{F}_2(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} \mathrm{d}\Phi_2\, \mathbb{H}_1^E(\Phi_2)\, \mathcal{F}_2(O)$$

excl. NNLO contribution

$$\bar{\mathrm{B}}^R = \bar{\mathrm{B}} - \mathrm{B}$$

$$\bar{\mathbb{H}}^R = \mathbb{H}\, \Theta(t_2 - t_1)\, \Theta(t_1 - t_c)$$

$$\bar{\mathbb{H}}^E = \bar{\mathbb{H}} - \bar{\mathbb{H}}^R$$

NNLOPS with S-MC@NLO + UNLOPS + $q_\perp$-slicing

Höche, Li, Prestel arXiv:1405.3607, arXiv:1407.3773

$$\langle O\rangle^{\mathrm{UN^2LOPS}}$$

$$= \int d\Phi_0\, \bar{\bar{\mathrm{B}}}_0^{q_\perp,\mathrm{cut}}(\Phi_0)\, \mathrm{O}(\Phi_0)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} d\Phi_1 \left[1-\Delta_0(1+\Delta_0^{(1)})\right] \mathrm{B}_1(\Phi_1)\, O(\Phi_1) + \int_{q_{\perp,\mathrm{cut}}} d\Phi_1\, \Delta_0(1+\Delta_0^{(1)})\,\mathrm{B}_1(\Phi_1)\, \bar{\mathcal{F}}_1(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} d\Phi_1 \left[1-\Delta_0\right] \bar{\mathrm{B}}_1^R(\Phi_1)\, O(\Phi_1) + \int_{q_{\perp,\mathrm{cut}}} d\Phi_1\, \Delta_0\, \bar{\mathrm{B}}_1^R(\Phi_1)\, \bar{\mathcal{F}}_1(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} d\Phi_2 \left[1-\Delta_0\right] \mathbb{H}_1^R(\Phi_2)\, O(\Phi_2) + \int_{q_{\perp,\mathrm{cut}}} d\Phi_2\, \Delta_0\, \mathbb{H}_1^R(\Phi_2)\, \mathcal{F}_2(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} d\Phi_2\, \mathbb{H}_1^E(\Phi_2)\, \mathcal{F}_2(O)$$

$$\bar{\mathrm{B}}^R = \bar{\mathrm{B}} - \mathrm{B}$$

$$\bar{\mathbb{H}}^R = \mathbb{H}\,\Theta(t_2-t_1)\,\Theta(t_1-t_c)$$

$$\bar{\mathbb{H}}^E = \bar{\mathbb{H}} - \bar{\mathbb{H}}^R$$

S-MC@NLO in Φ_1, with Δ_0 resummation

NNLOPs with S-MC@NLO + UNLOPs + $q_\perp$-slicing

Höche, Li, Prestel arXiv:1405.3607, arXiv:1407.3773

$$\langle O\rangle^{\text{UN}^2\text{LOPs}}$$

$$= \int \mathrm{d}\Phi_0\, \bar{\bar{\mathrm{B}}}_0^{q_\perp,\text{cut}}(\Phi_0)\, \mathrm{O}(\Phi_0)$$

$$+ \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_1 \left[1-\Delta_0(1+\Delta_0^{(1)})\right] \mathrm{B}_1(\Phi_1)\, O(\Phi_1) + \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_1\, \Delta_0(1+\Delta_0^{(1)})\, \mathrm{B}_1(\Phi_1)\, \bar{\mathcal{F}}_1(O)$$

$$+ \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_1 \left[1-\Delta_0\right] \bar{\mathrm{B}}_1^R(\Phi_1)\, O(\Phi_1) + \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_1\, \Delta_0\, \bar{\mathrm{B}}_1^R(\Phi_1)\, \bar{\mathcal{F}}_1(O)$$

$$+ \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_2 \left[1-\Delta_0\right] \bar{\mathbb{H}}_1^R(\Phi_2)\, O(\Phi_2) + \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_2\, \Delta_0\, \bar{\mathbb{H}}_1^R(\Phi_2)\, \mathcal{F}_2(O)$$

$$+ \int\limits_{q_{\perp,\text{cut}}} \mathrm{d}\Phi_2\, \bar{\mathbb{H}}_1^E(\Phi_2)\, \mathcal{F}_2(O)$$

$$\bar{\mathrm{B}}^R = \bar{\mathrm{B}} - \mathrm{B}$$

$$\bar{\mathbb{H}}^R = \mathbb{H}\, \Theta(t_2 - t_1)\, \Theta(t_1 - t_c)$$

$$\bar{\mathbb{H}}^E = \bar{\mathbb{H}} - \bar{\mathbb{H}}^R$$

UNLOPs subtraction

NNLOPs with S-MC@NLO + UNLOPs + $q_\perp$-slicing

Höche, Li, Prestel arXiv:1405.3607, arXiv:1407.3773

$\langle O \rangle^{\text{UN}^2\text{LOPs}}$

$$= \int d\Phi_0 \, \bar{\bar{\mathrm{B}}}_0^{q_\perp,\mathrm{cut}}(\Phi_0)\, \mathrm{O}(\Phi_0)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} d\Phi_1 \left[1 - \Delta_0(1 + \Delta_0^{(1)})\right] \mathrm{B}_1(\Phi_1)\, O(\Phi_1) + \int_{q_{\perp,\mathrm{cut}}} d\Phi_1 \, \Delta_0(1 + \Delta_0^{(1)})\, \mathrm{B}_1(\Phi_1)\, \bar{\mathcal{F}}_1(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} d\Phi_1 \left[1 - \Delta_0(1 + \Delta_0^{(1)})\right] \tilde{\mathrm{B}}_1^R(\Phi_1)\, O(\Phi_1) + \int_{q_{\perp,\mathrm{cut}}} d\Phi_1 \, \Delta_0(1 + \Delta_0^{(1)})\, \tilde{\mathrm{B}}_1^R(\Phi_1)\, \bar{\mathcal{F}}_1(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} d\Phi_2 \left[1 - \Delta_0(1 + \Delta_0^{(1)})\right] \mathbb{H}_1^R(\Phi_2)\, O(\Phi_2) + \int_{q_{\perp,\mathrm{cut}}} d\Phi_2 \, \Delta_0(1 + \Delta_0^{(1)})\, \mathbb{H}_1^R(\Phi_2)\, \mathcal{F}_2(O)$$

$$+ \int_{q_{\perp,\mathrm{cut}}} d\Phi_2 \, \mathbb{H}_1^E(\Phi_2)\, \mathcal{F}_2(O)$$

$$\bar{\mathrm{B}}^R = \bar{\mathrm{B}} - \mathrm{B}$$

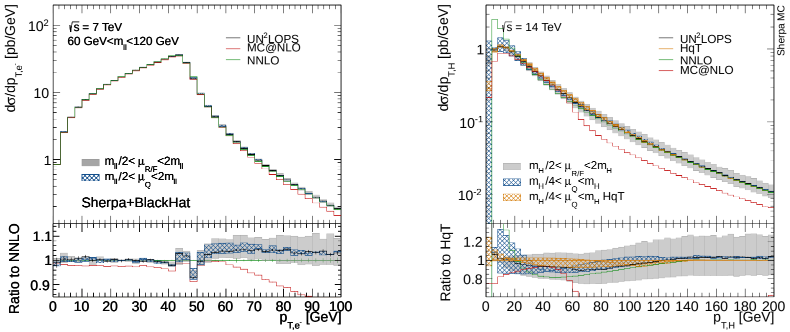
$$\bar{\mathbb{H}}^R = \mathbb{H}\, \Theta(t_2 - t_1)\, \Theta(t_1 - t_c)$$

$$\bar{\mathbb{H}}^E = \bar{\mathbb{H}} - \bar{\mathbb{H}}^R$$

differs in higher order terms
possibly smoother for large NNLO corr.

NNLOPS with S-MC@NLO + UNLOPS + $q_\perp$-slicing

Höche, Li, Prestel arXiv:1405.3607, arXiv:1407.3773



Conclusions

- both ansatzes differ by terms beyond NNLOPS accuracy
  $\rightarrow$ different matching conditions lead to different uncontrolled terms of relative $\mathcal{O}(\alpha_s^3)$, no impact on resummation accuracy
- if NNLO corrections are large, difference between schemes is large

Thank you for your attention!

Backup