artemide at level 2

LHC EW precision sub-group meeting (pT W/Z benchmarking)

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Level 2
same as level 1 but with **default evolution settings**

Default evolution settings in `artemide`

- Fixed μ evolution
- RAD: Resummed + NP tale

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```
*3   :
*p1  : initialize TMDR module
 T

*A   : ---- Main definitions ----
*p1  : Order of evolution
 NNNLO
*p2  : Type of evolution solution (1 =
 1
*B   : ---- Parameters of NP model ----
```

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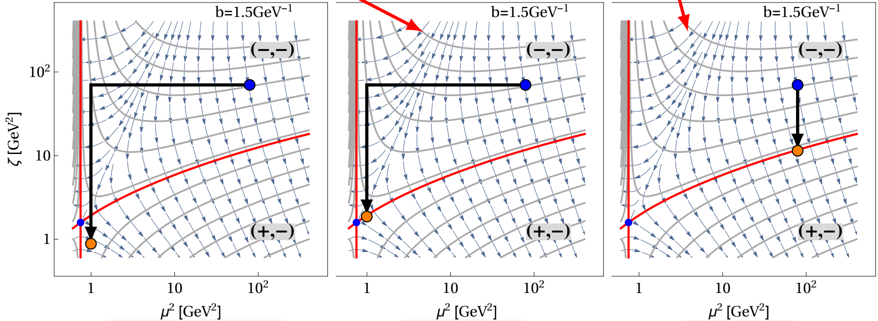
 3
*B   : ---- Parameters of NP model ----
```

canonic CSS
`NangaParbat`

`artemide`
CSS-like

`artemide`
default



$$\mu_{\rm f}^2 = \zeta_f \simeq \frac{C_0}{b^*(b)}$$

$$\mu_{\rm f}^2 \simeq \frac{C_0}{b^*(b)} \qquad \zeta = \zeta_{\mu_f}(b)$$

$$\mu_{\rm f}^2 = Q \qquad \zeta = \zeta_Q(b)$$

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Evolution exponent is an algebraic function of $\mathcal{D}$

$$R(\mu,\zeta) = \left(\frac{\zeta}{\zeta_\mu[\mathcal{D}(\mathbf{b})]}\right)^{-\mathcal{D}(\mu,\mathbf{b})}. \tag{1}$$

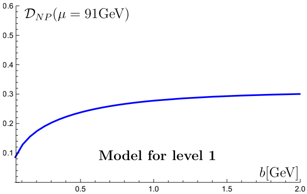
- Equal to CSS (at the ζ-line) **in the limit of exact perturbation theory.**

Level 1 Model

```
b0=1.1229189671337703_dp
bSTAR=b/SQRT(1_dp+b**2/b0**2)
DNP=Dpert(mu,bSTAR,1)
```

$$\mathcal{D} = \mathcal{D}_{\text{pert}}(\mu, b^*)$$

$$B_{NP} = 2e^{-\gamma_E}$$



Level 2 Model

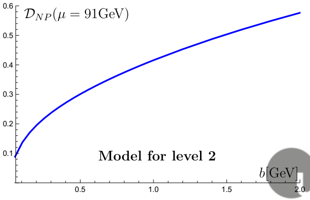
```
bSTAR=b/SQRT(1+b**2/NPparam(1)**2)
DNP=Dresum(mu,bSTAR,1)+NPparam(2)*bSTAR*b
```

+ in code

```
call artemide_SetNPparameters_TMDR((/1.86d0, 0.0296d0/))
```

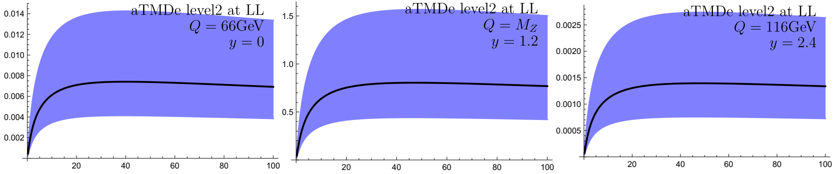
$$\mathcal{D} = \mathcal{D}_{\text{resum}}(\mu, b^*) + c_0 b b^*$$

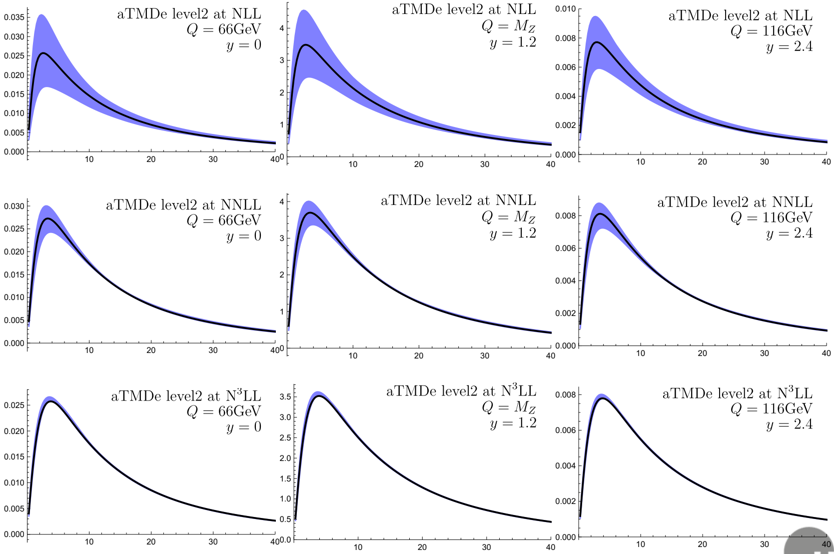
$$B_{NP} = 1.86, \qquad c_0 = 0.0296$$



LL order is broken...

The integrability condition is violated as $\sim \alpha_s$, thus there is a huge effect:




aTMDe level2 at NLL
$Q = 66$GeV
$y = 0$
aTMDe level2 at NLL
$Q = M_Z$
$y = 1.2$
aTMDe level2 at NLL
$Q = 116$GeV
$y = 2.4$
aTMDe level2 at NNLL
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aTMDe level2 at N^{3}LL
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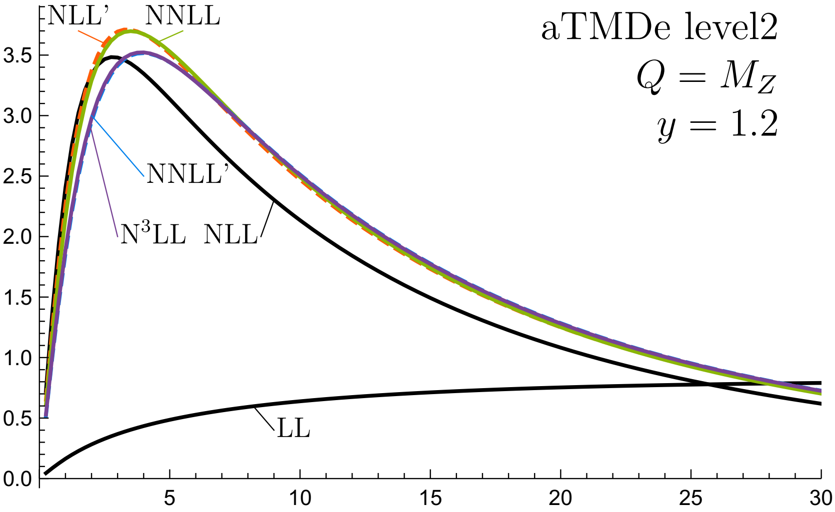


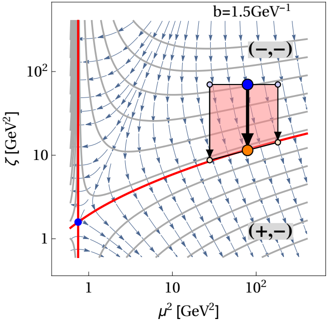
NLL'
NNLL
aTMDe level2
$Q = M_Z$
$y = 1.2$
NNLL'
N^3LL
NLL
LL
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5
10
15
20
25
30

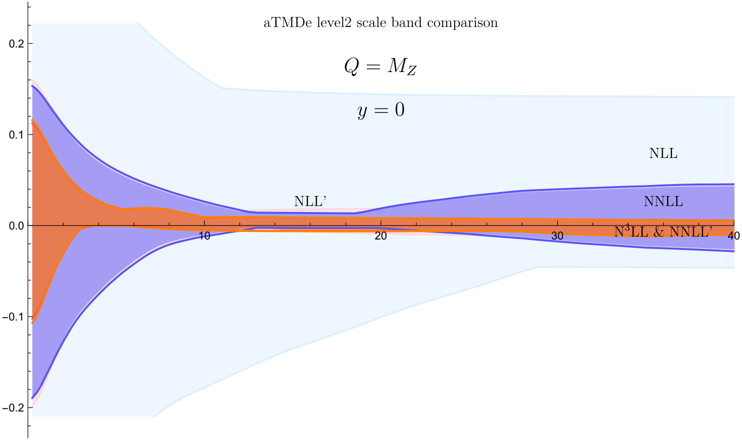
Scale variations:

$$\frac{d\sigma}{dq^4} \sim \int d^2 b e^{ibq_T} |C_V(Q, Qc_2)|^2 \left(\frac{Q^2}{\zeta_{c_2 Q}[\mathcal{D}]}\right)^{-\mathcal{D}(c_2 Q, b)} F_1(x_1, b) F_2(x_2, b) \tag{2}$$

$$F_1(x,b) = \int_x^1 \frac{dy}{y} C\left(y, c_4 \mu_{\text{OPE}}\right) f\left(\frac{x}{y}, c_4 \mu_{\text{OPE}}\right) \tag{3}$$

The band is the maximum deviation for $c_{2,4} \in [0.5, 2]$





Starting from NNLL the scale error is dominated by c_4 error. (thus there is very tiny difference between N^{3}LL and NNLL' bands).

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Since ζ-line is unique, and $\mu = Q$ the evolution series converge very fast
Difference between N^3LL and NLL' is almost negligible.