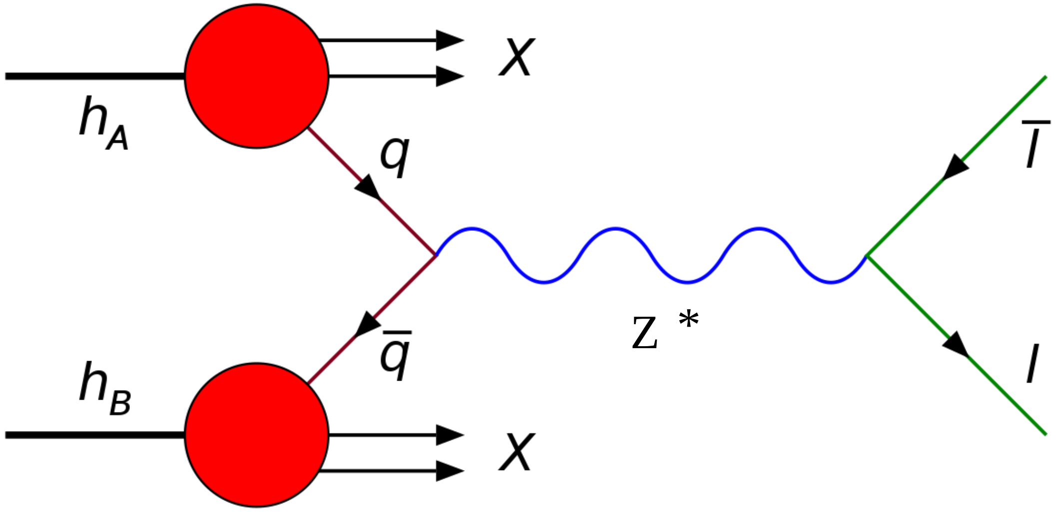
Studies on p-p and p-Pb DY production

2019 Summer Student Program



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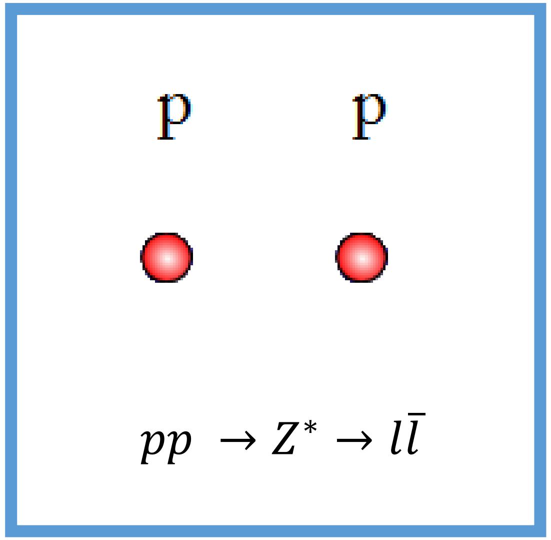
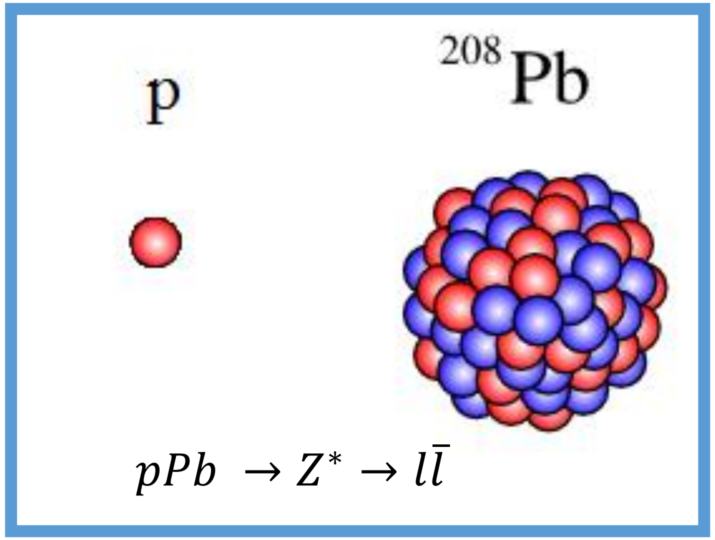
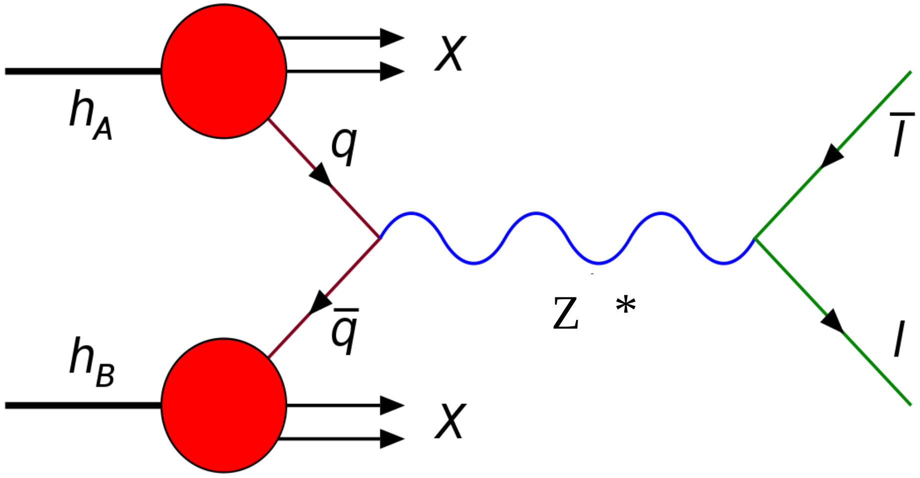
Armando Martínez Bermúdes

Introduction

Drell Yan Process

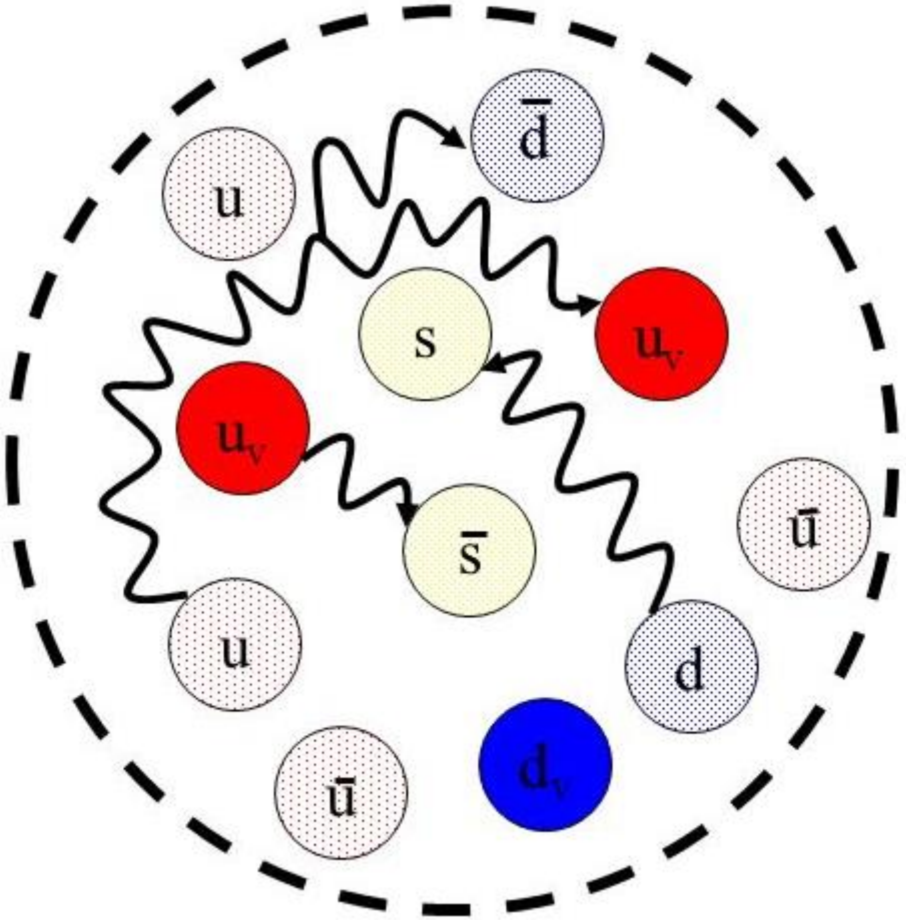






Introduction

The proton inner structure



- Three valence quarks
- Sea of quark-antiquark pairs and gluons
- Quark and gluons are partons
- Proton momentum P and each parton carries momentum xP

  → Pdf (parton distribuition function)

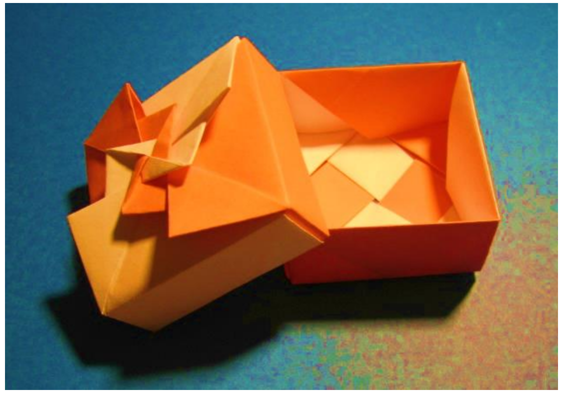
  → Collinear

  → TMD

Introduction

The software

POWHEG BOX



NLO calculation

$< f|S|i >$

$p_{T_{min}}$

$Pdf\ set$

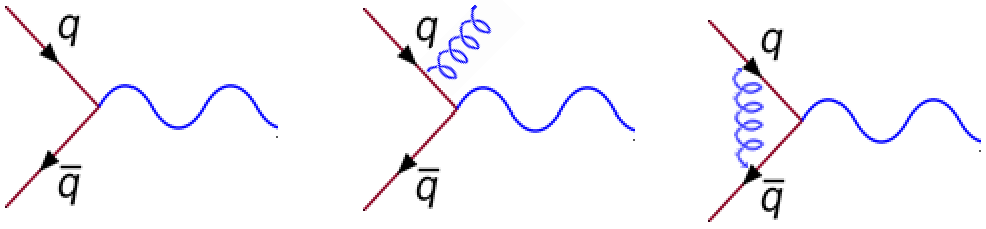
h_{damp}

+

SHOWER MC PROGRAMS

CASCADE (TMD)

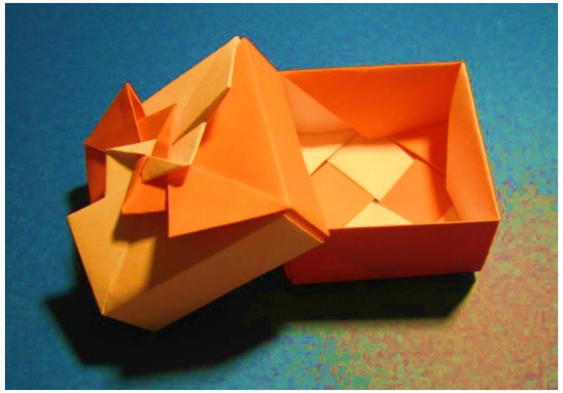
PYTHIA 6



Introduction

The software

POWHEG BOX



NLO calculation

$$< f|S|i >$$

SHOWER MC PROGRAMS

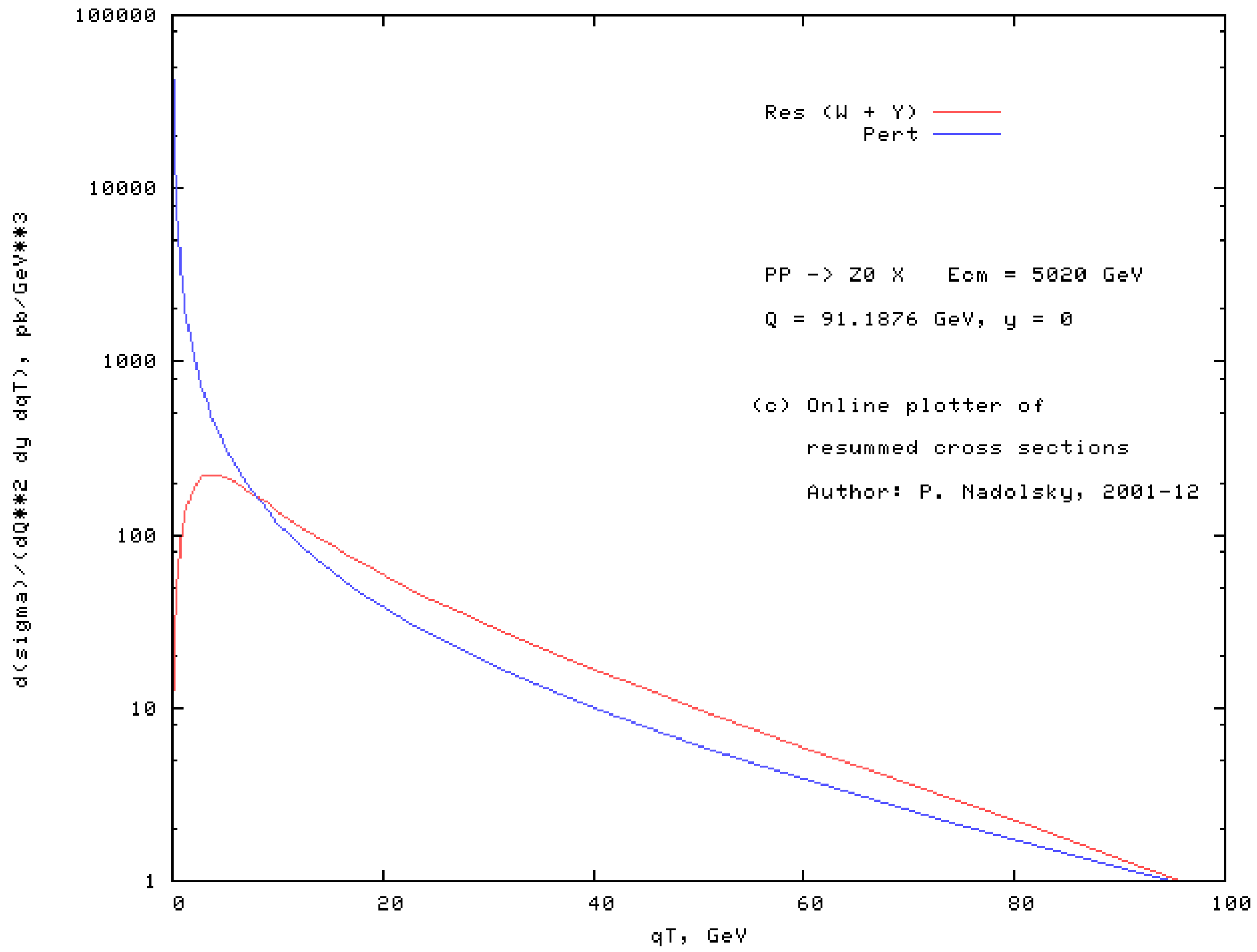
CASCADE (TMD)

PYTHIA 6

TASK

- Validation of a rivet plugin for p-Pb DY production
- NLO + TMD calculations
- Compare results to other NLO calculations

The NLO and the corrected cross sections



https://hep.pa.msu.edu/cgi-bin/wwwlegacy/level1.cgi

Validation of CMS plugin for p-Pb collision

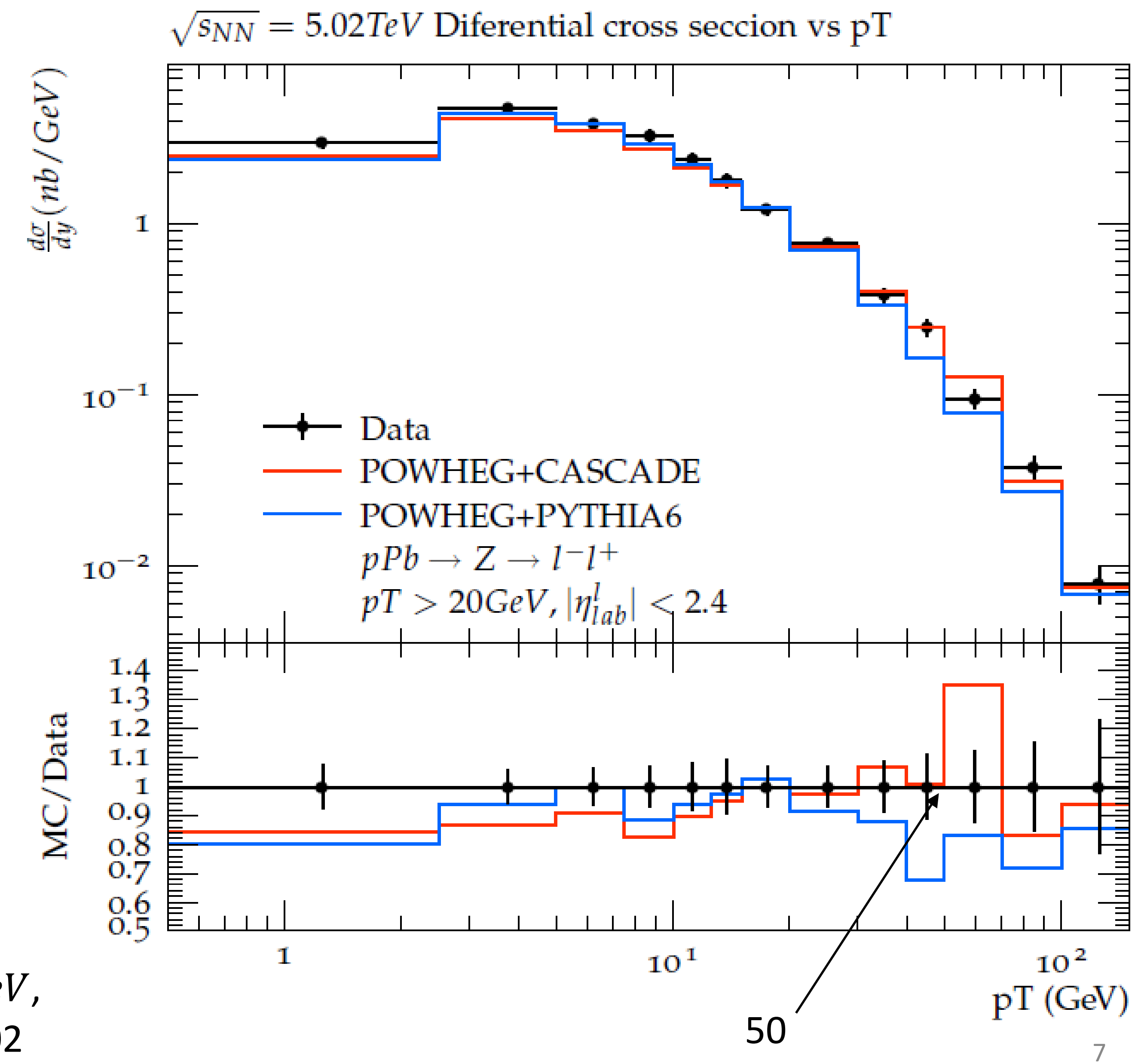
The plugin

→ σ scaled to # nucleons in ^{208}Pb

The simulation

POWHEG
→ hdamp 0.5, $p_{T_{min}}$ 50
→ $\sqrt{s_{NN}}$ = 5.02 TeV
→ Z → e-e+
→ pdf Set 2 for CASCADE
→ pdf CT10 for PYTHIA 6

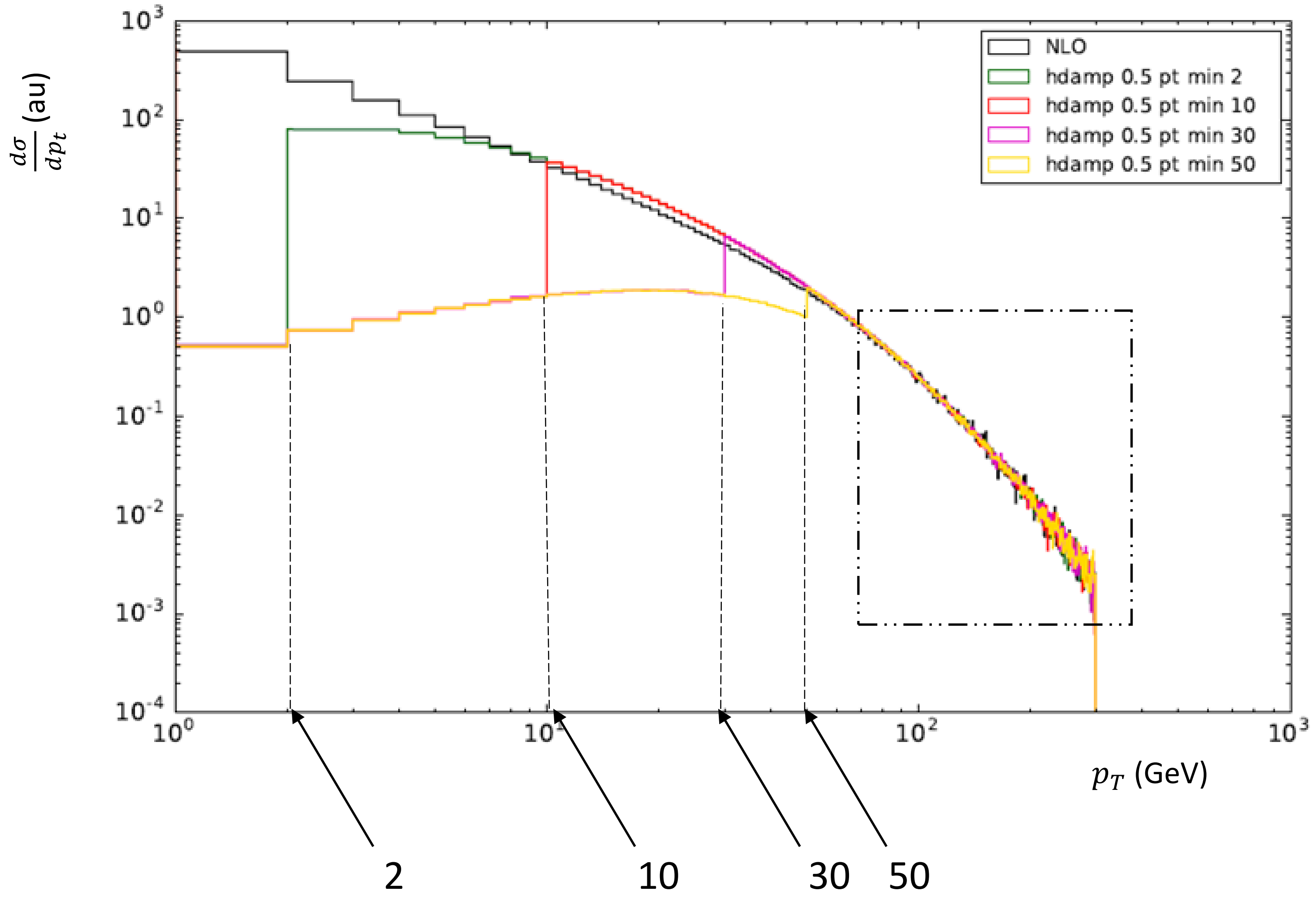
CASCADE
→ TMD Set 2 for CASCADE



The CMS collaboration, Study of Z boson production in pPb collisions at $\sqrt{s_{NN}} = 5,02\ TeV$, (2016). Phys.Lett. B759 36-57, CMS-HIN-15-002

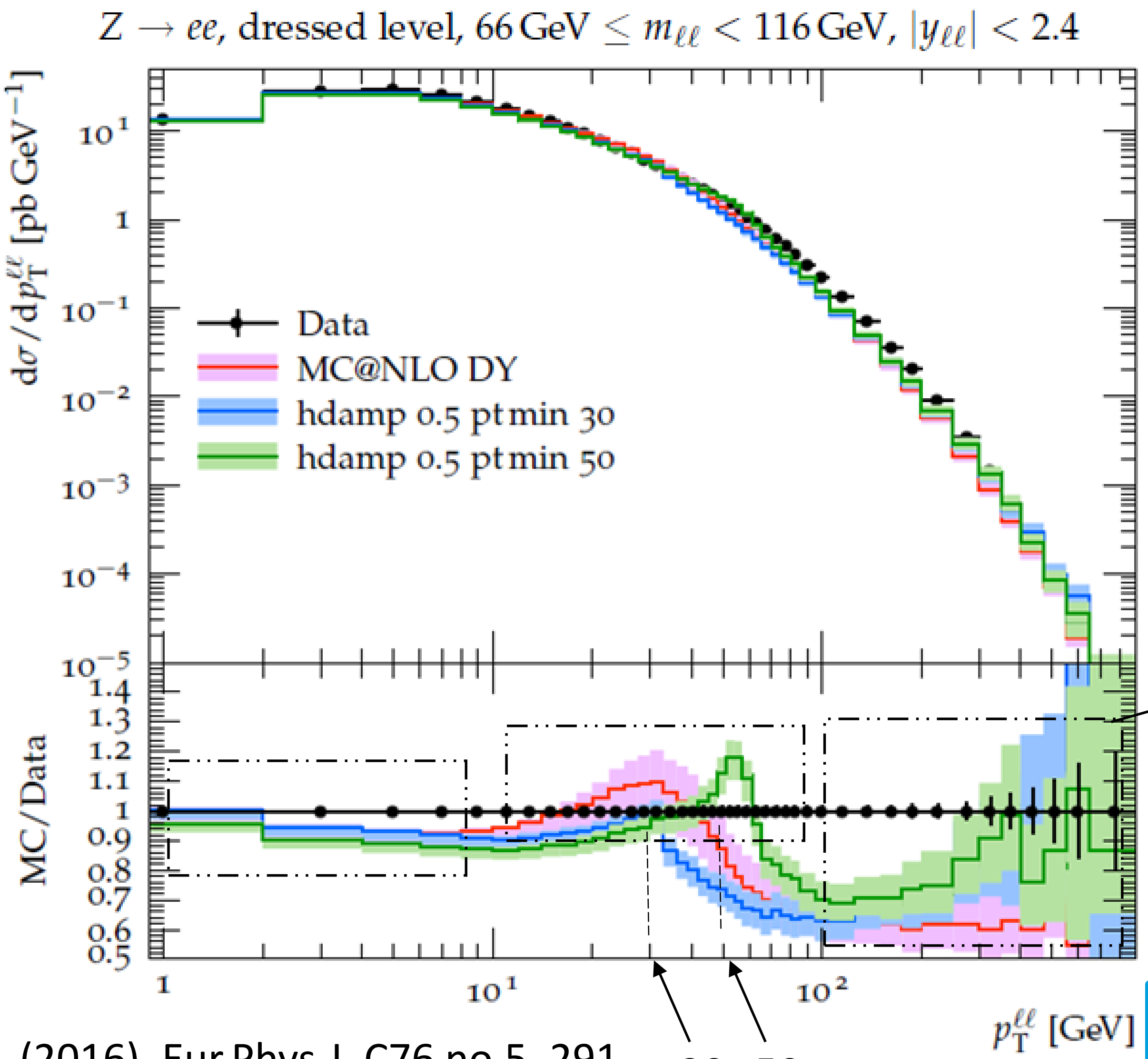
Comparing POWHEG with NLO $d\sigma/dp_T$

p-p DY production, $\sqrt{s_{NN}} = 8\ TeV$



Comparing to data from p-p ATLAS analysis $\sqrt{s_{NN}} = 8\,TeV$

POWHEG + TMD and MC@NLO



30 50

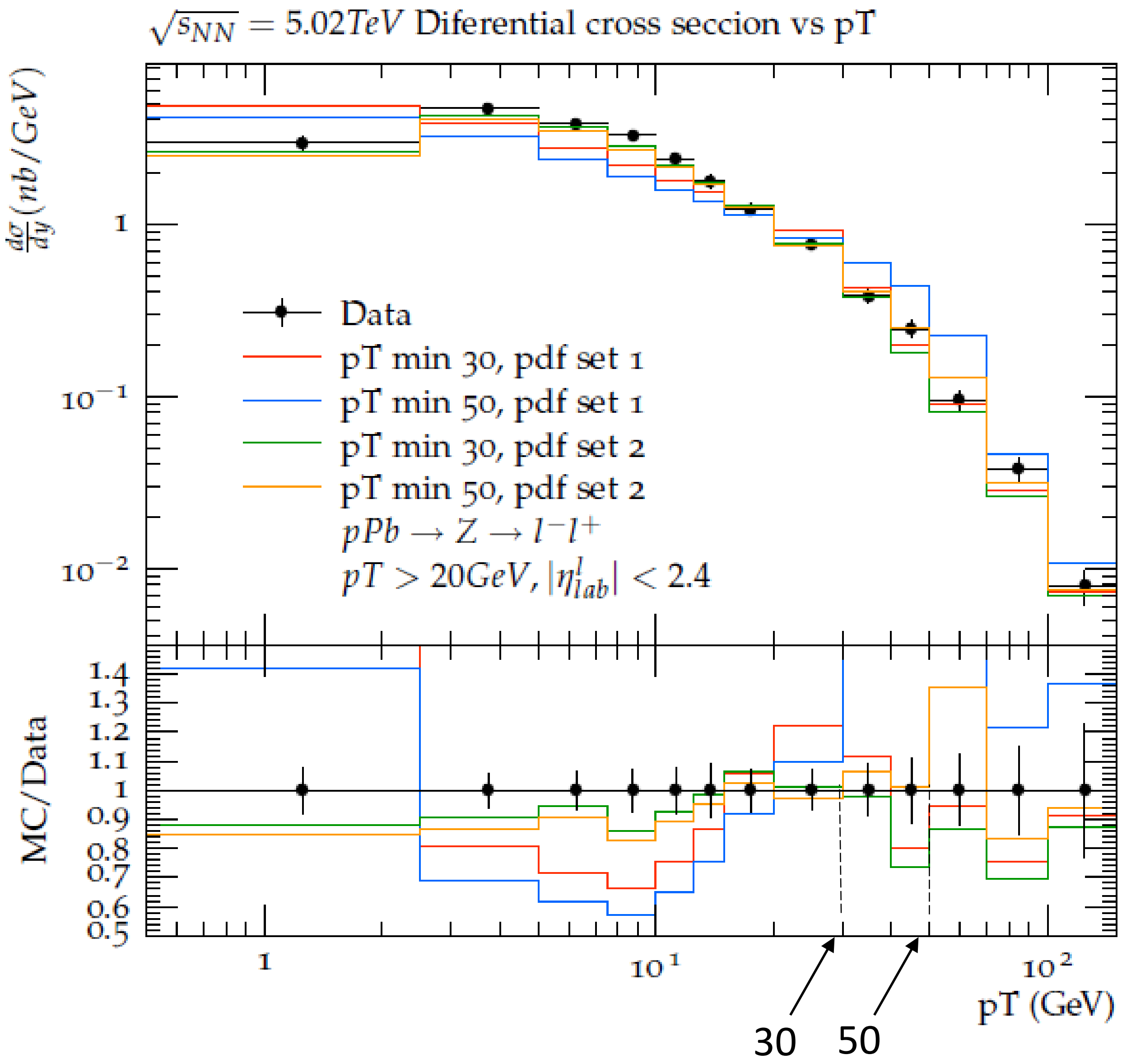
Effect of the scale of the process:
MC@NLO employs a higher μ^2
α_s decreases when μ^2 increases
$\sigma \sim \alpha_s$

Choosing $p_{T_{min}}$ the bump can be more or less pronounced

ATLAS measurement, (2016). Eur.Phys.J. C76 no.5, 291

Comparing results using different PDF/TMD Sets

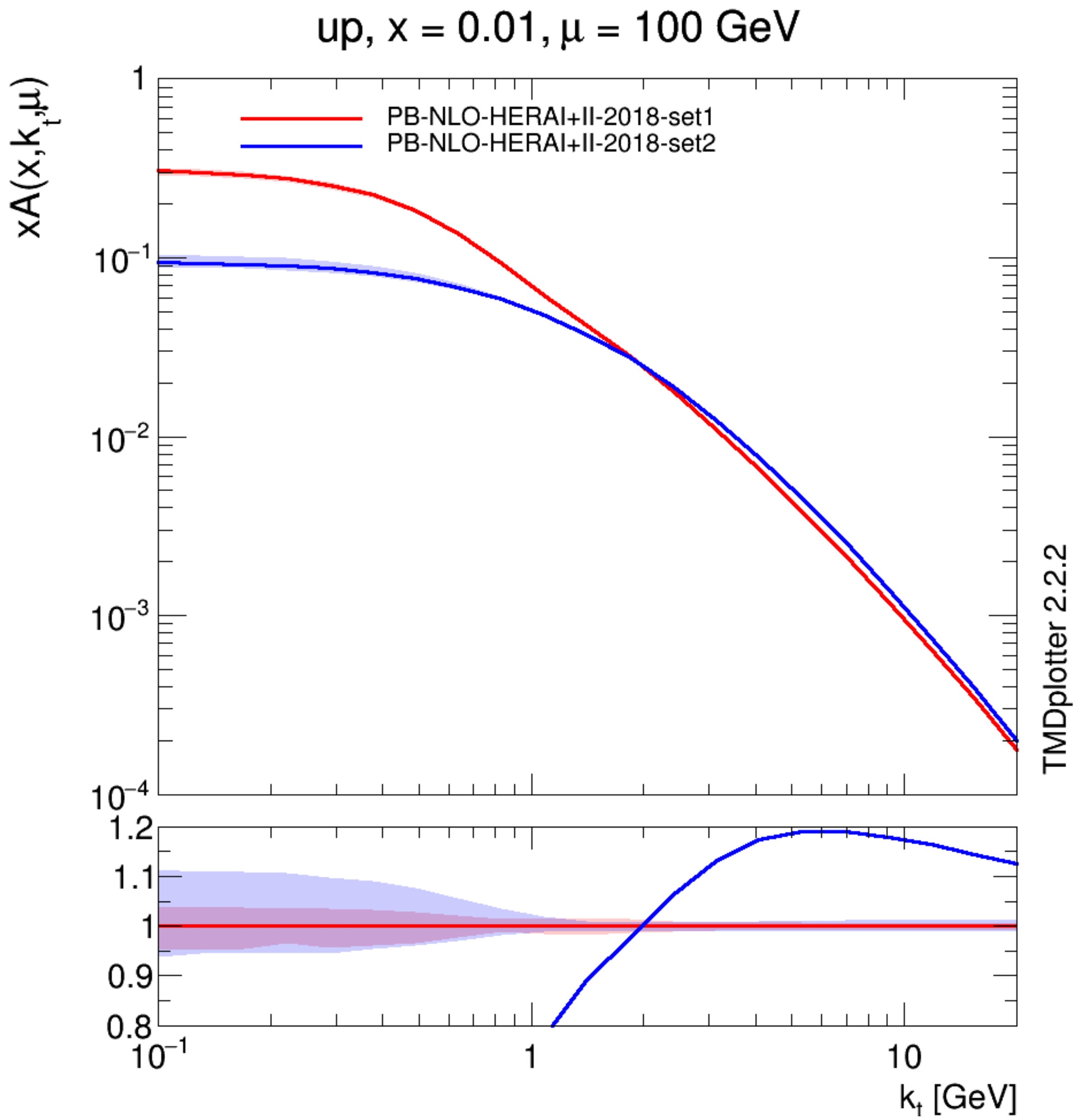
pPb collision Set 1 and Set 2



- Comparing the pdf Sets, Set 2 results are more accurate
- The effects of matching TMD-NLO can be seen, but much less, due the binning used

Comparing two PDF/TMD Sets for $\sqrt{s_{NN}} = 5,02\ TeV$

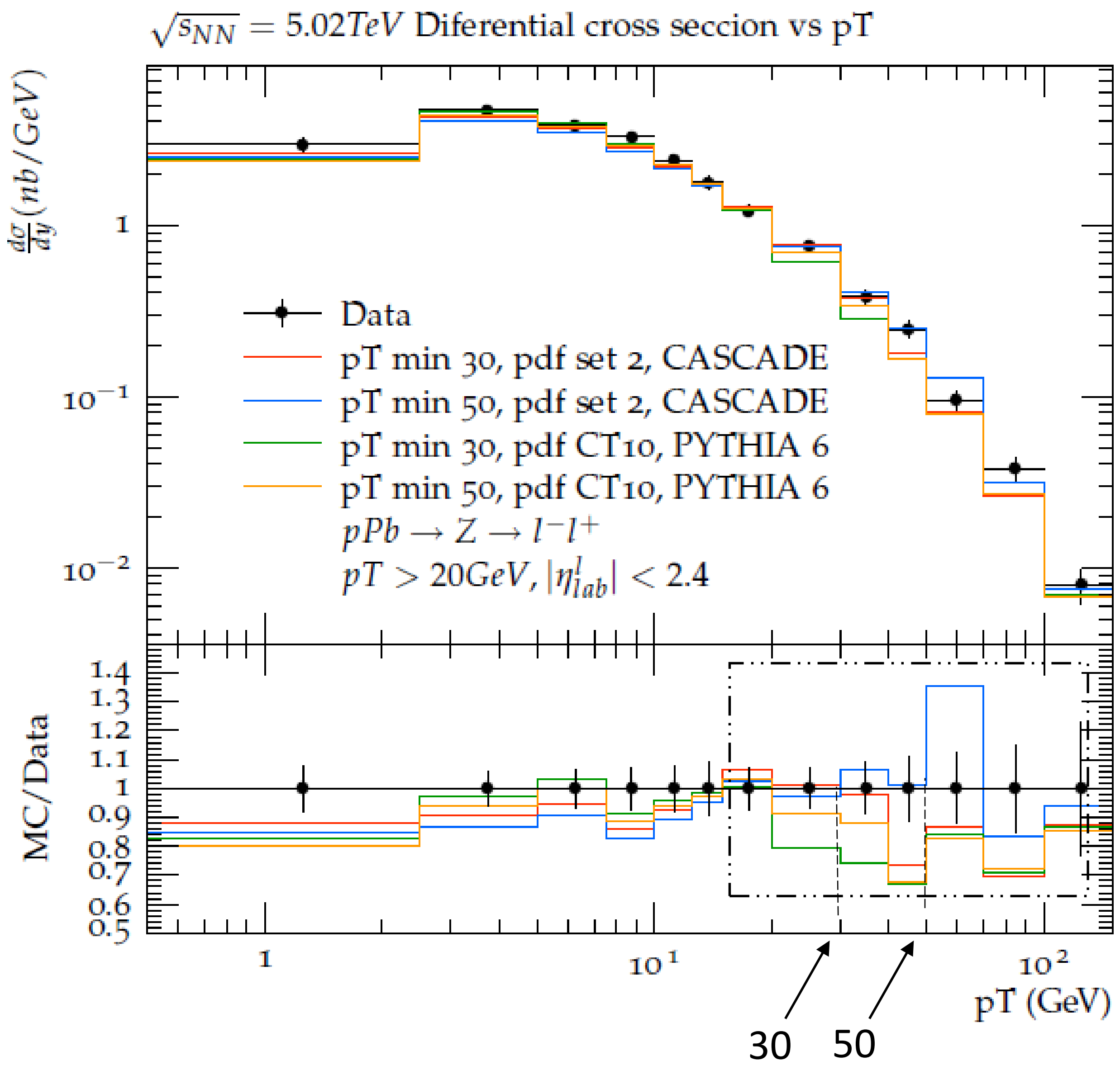
Set 1 and Set 2



http://tmdplotter.desy.de/

Comparing two PDF/TMD Sets in p-Pb collisions

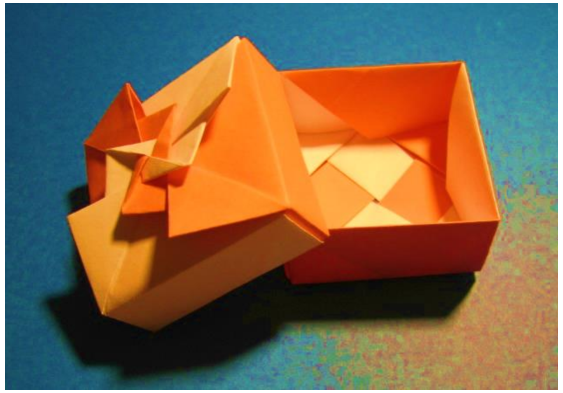
pPb collision Set 2 + CASCADE and Set CT10 + PYTHIA 6



- At low pT using PYTHIA 6 and CASCADE shows the same behavior.
- For pT 20 - 50, better results using CASCADE

Conclusions

POWHEG BOX



+ TMD = Good description of DY spectra

Appropriate for p-p and p-Pb collisions

Works at different $\sqrt{s_{NN}}$

Description similar to other NLO calculations

Thank you

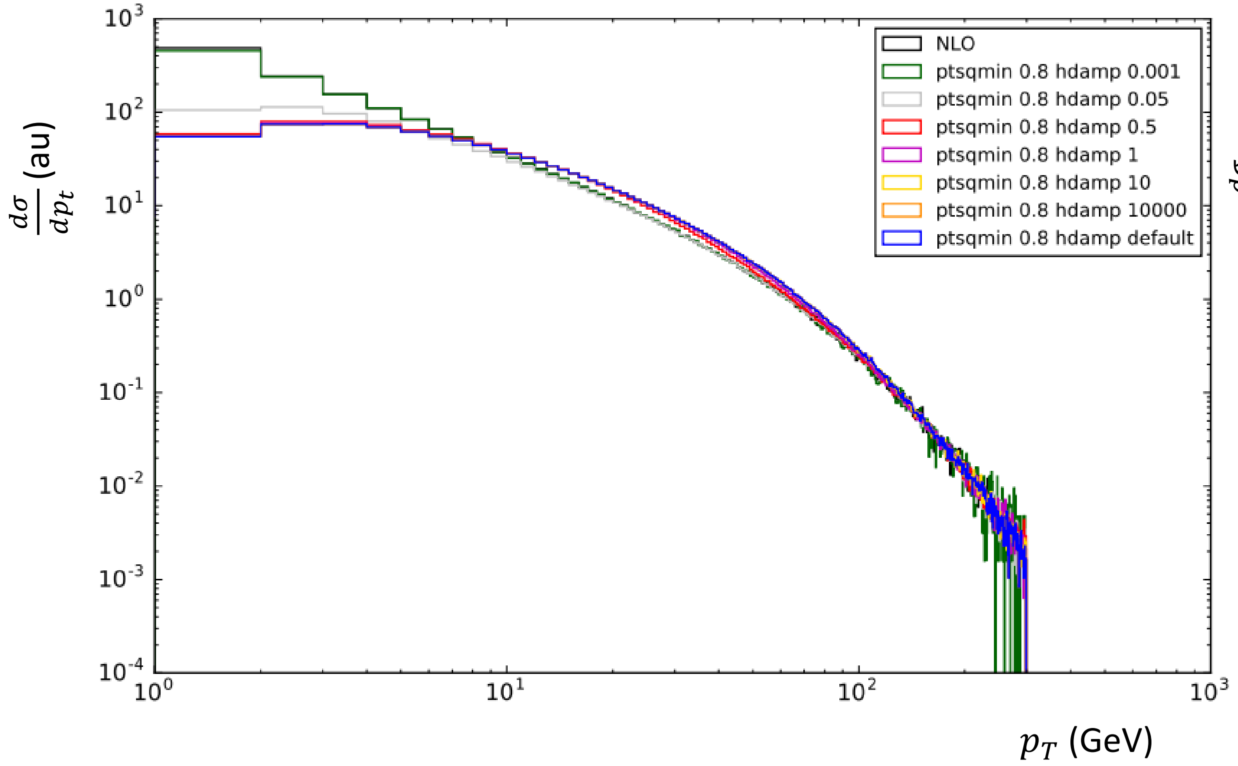
Back up slides

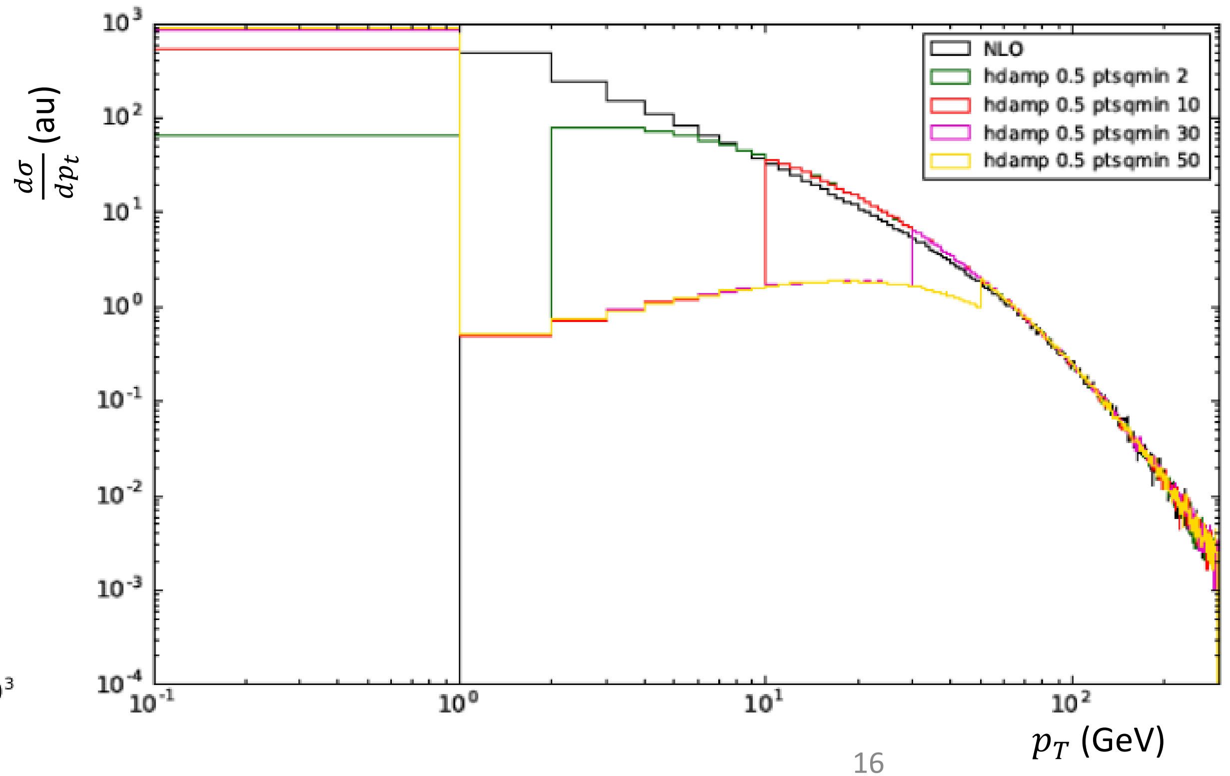
The role of h_{damp} in POWHEG

hdamp

$$D = \frac{h^2 M_Z^2}{p_T^2 + h^2 M_Z^2}$$

$$\frac{d\sigma^{PH}}{dp_t} = DR\, e^{-\int D\frac{R}{B} dp_T} + (1-D)R$$





Glauber formalism

Glauber multiple collision model

The inelastic σ_{pA} can be derived from the corresponding σ_{NN}

$$\sigma_{pA} = \int d^2b \left[1 - e^{-\sigma_{NN}(s)T_A(b)}\right]$$

Nuclear thickness function

$$T_A(b) = \int dz\, \rho_A(b,z)$$

Number of nucleons in nucleus A per unit area along direction z, separated from the center of the nucleus by b.

$$\int d^2b\, T_A(b) = A$$

1st approximation

$$\sigma_{pA} \approx \int d^2b\, \sigma_{NN}(s)\, T_A(b)$$

$$\sigma_{pA} \approx \sigma_{NN}(s) \int d^2b\;\; T_A(b)$$

$$\sigma_{pA} \approx \sigma_{NN}(s) A$$

d'Enterria, D. (2003). Hard scattering cross sections at LHC in the Glauber approach: from pp to pA and AA collisions. *arXiv preprint nucl-ex/0302016*