STAR-SMFNS
2019

# STUDY OF DRELL-YAN Z-BOSON PRODUCTION IN pPb and PbPb COLLISIONS


Darío A. Ramírez Zaldívar[1]

Fernando Guzmán Martínez[1]

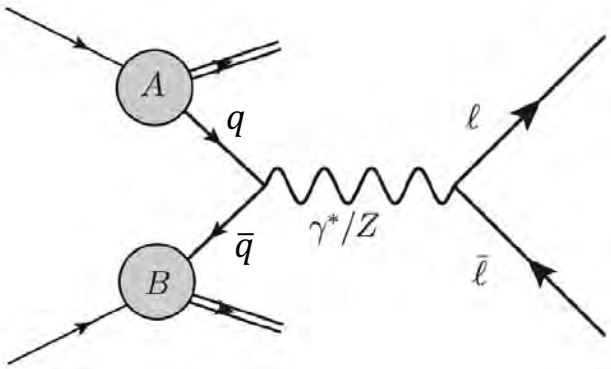
Hannes Jung[2]

[1] Higher Institute of Technologies and Applied Sciences (InSTEC, UH)

[2] Deutches Elektron Syncrotron (DESY)

# OUTLINE

- Simulation's details
- Pythia8 & POWHEG: LO&NLO calculation
- CASCADE&POWHEG: NLO calculation
- Cross section dependence with "pT cut" parameter
- PbPb NLO & $R_{AA}$




CERN-PH-EP/2015-302
2016/05/27
CMS-HIN-15-002

Study of Z boson production in pPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV

CERN-PH-EP/2011-003
2018/06/25
CMS-HIN-10-003

Study of Z boson production in PbPb collisions at $\sqrt{s_{NN}} = 2.76$ TeV

91,1876(21)GeV

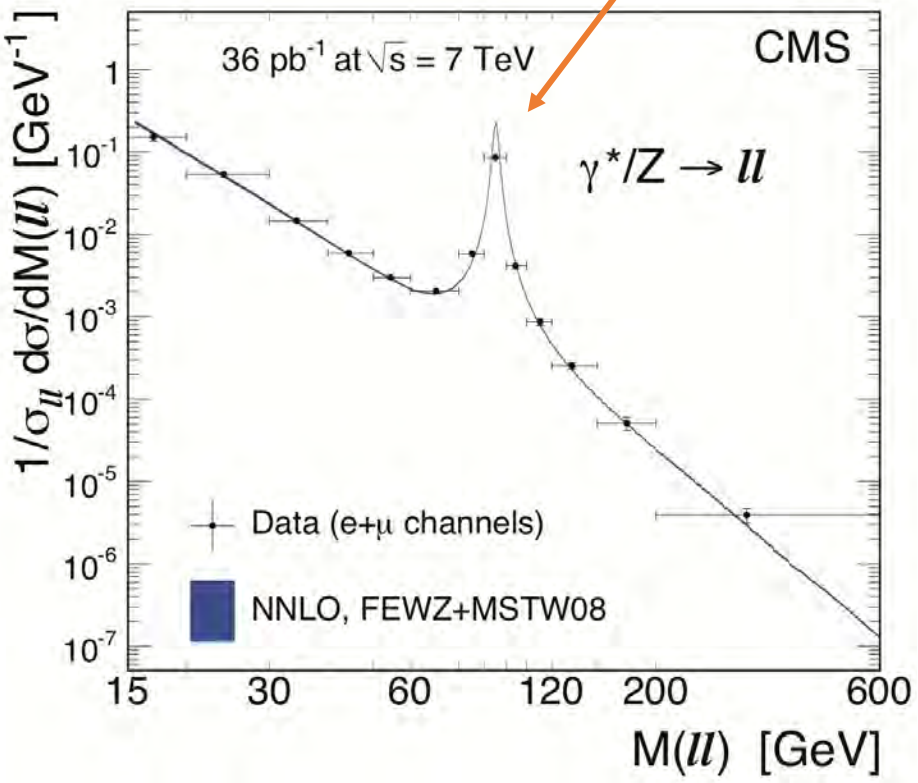
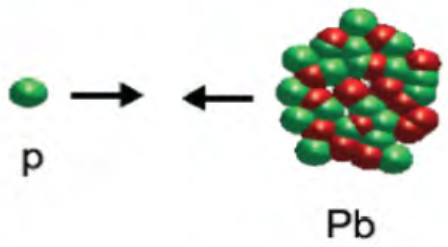



**Figure A: Dilepton mass cross section of a collision pp at $\sqrt{S} = 7\ TeV$**

# Motivation




**Nuclear effects on proton-ion collision.**

**Asymmetric collision**

**Drell-Yan process**

**Primary vertex dependence**

## Goals

- Write the Rivet's plugin CMS_2016_I1410832
- Match TMDs with NLO

**Simulation**

**pp collision**


**Experiment**

**pPb collision**

**pPb COLISSION AT $\sqrt{S_{NN}} = 5.02$ TeV**

Beam symmetry

Laboratory Frame

**Using Asymmetric beams**

Center of Mass Frame

**Using a shift on rapidity distribution**

$\Delta y = 0.465$

Scale factor

$$\sigma_{pA}^{hard} = A\sigma_{NN}^{hard}$$

# Pythia8 & POWHEG: LO&NLO calculation

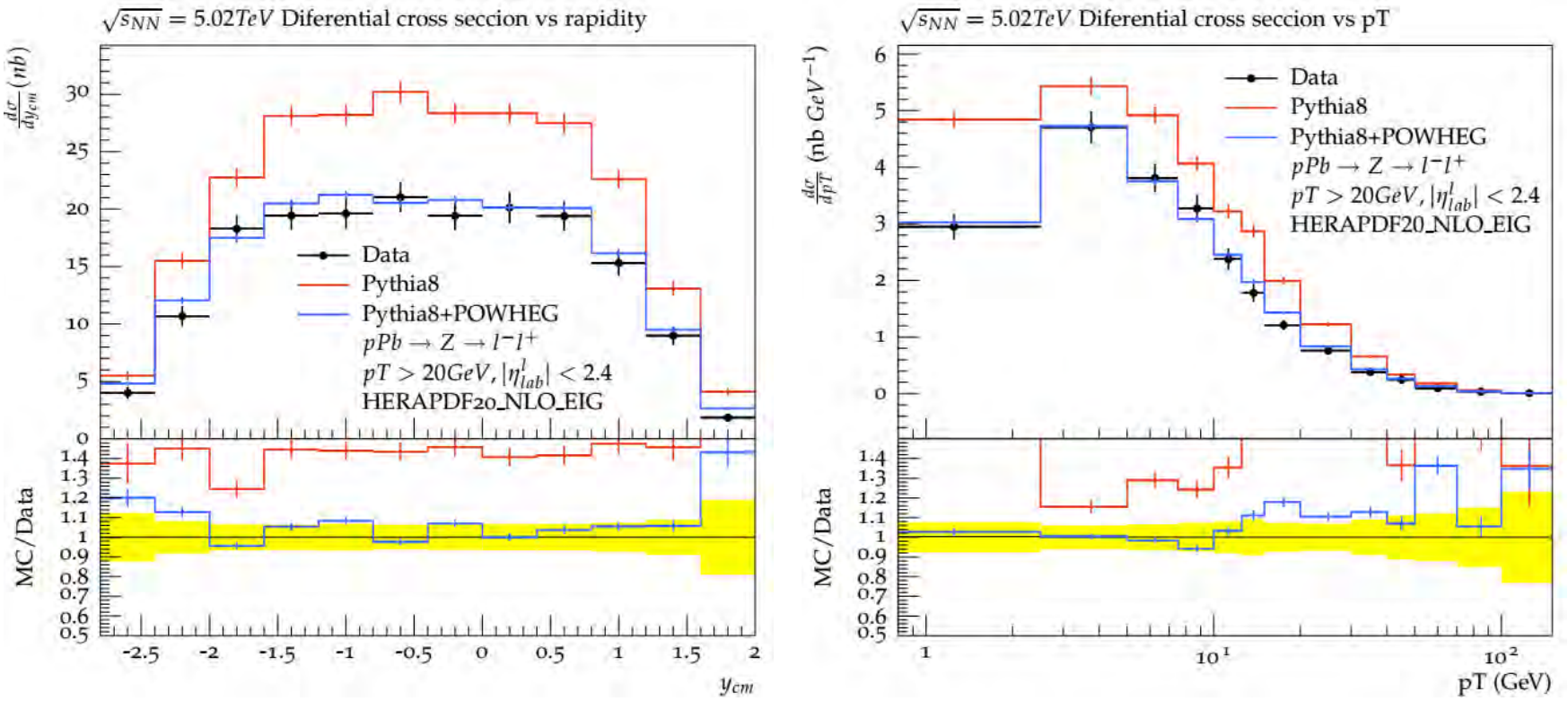
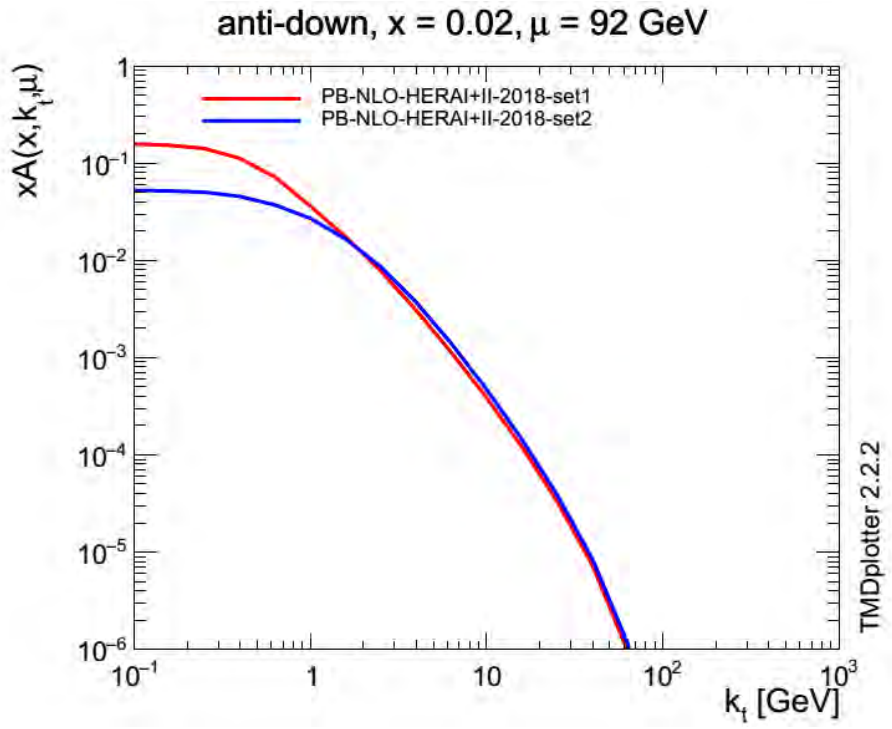



**Figure 1: Cross section dependency with rapidity and transversal momentum.**



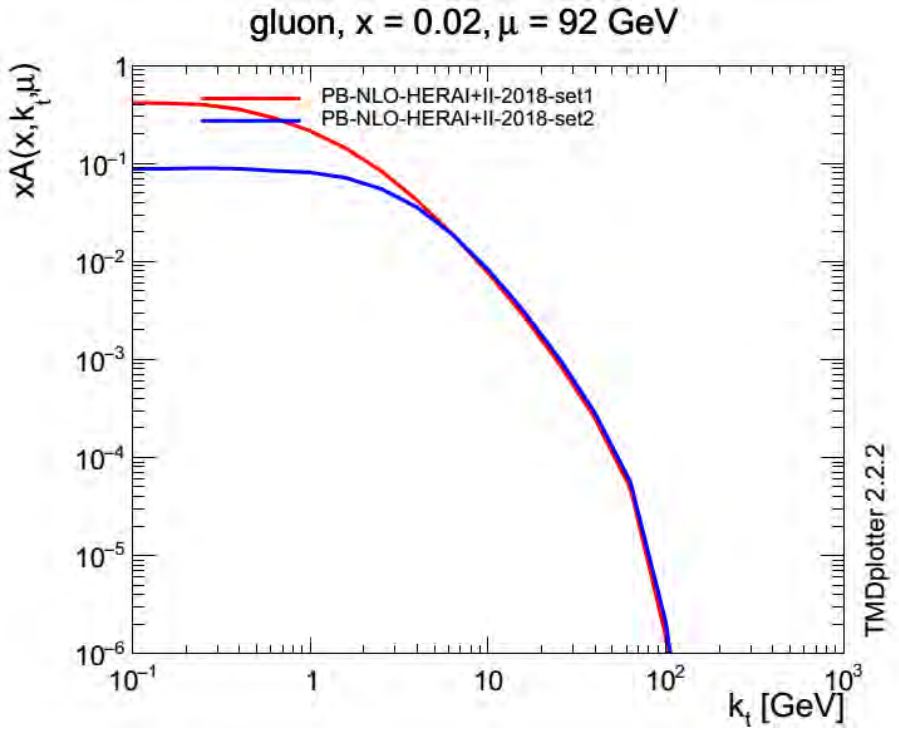
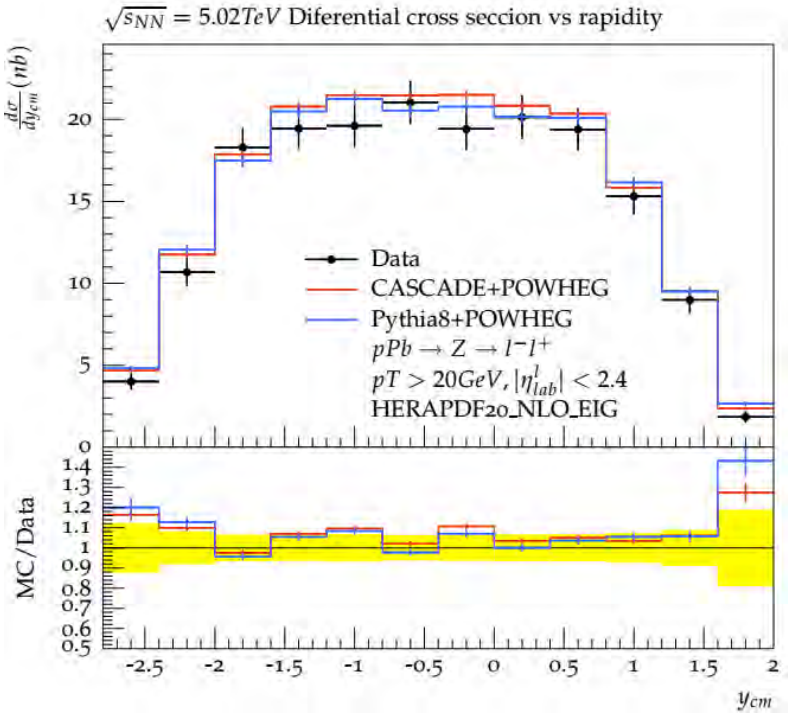




**Figure 2: kT distribution of $\bar{d}$ and gluon for a typical x value of 0.02 at a scale of the z-mass.**

**CASCADE** — TMD

**PYTHIA** — PS



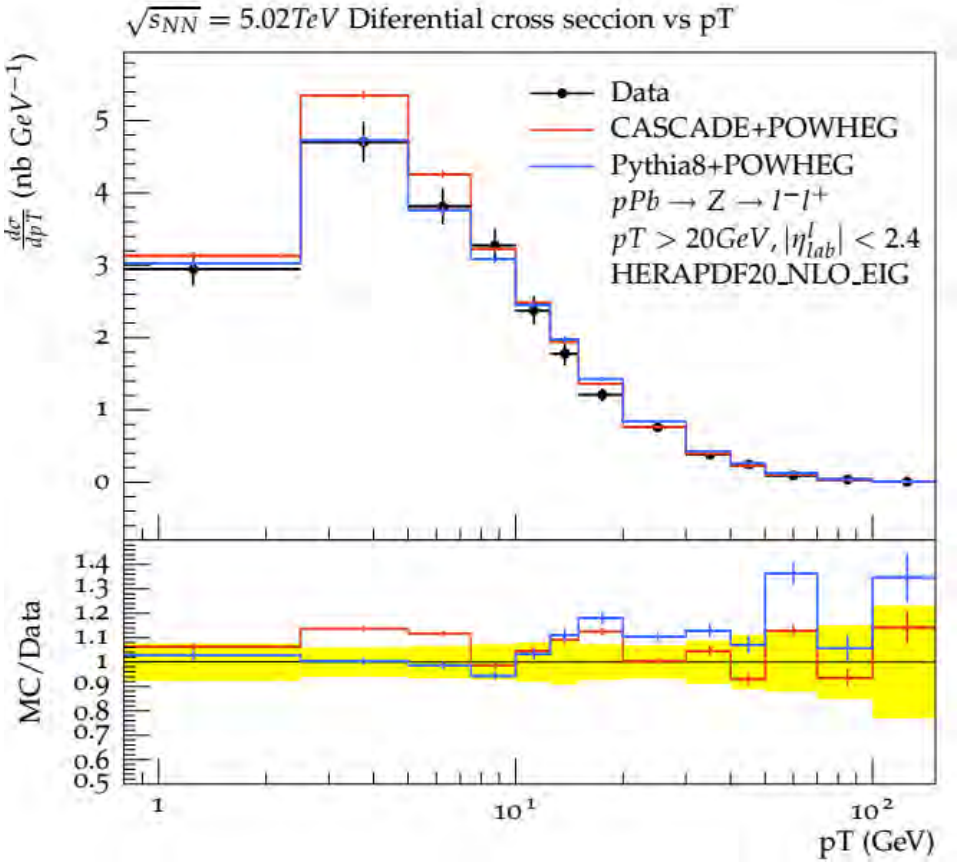




**Figure 3: Cross section decency with transversal momentum. CASCADE+POWHEG NLO calculation**

"pT cut" → pTsqmin → Minimum value of $pT^2$ to produce shower

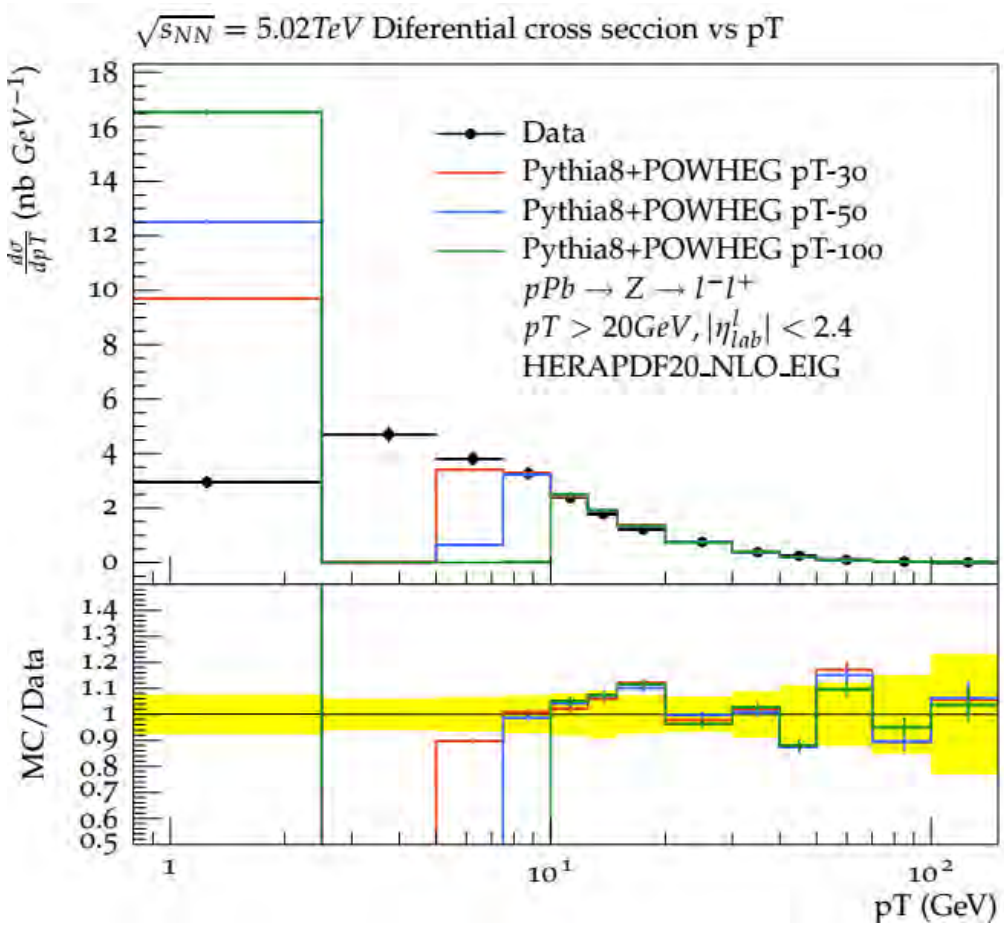



**Figure 4: Cross section dependency with transversal momentum using different "pt cut" values. Parton shower – OFF.**

# Cross section dependence with “pT cut” parameter

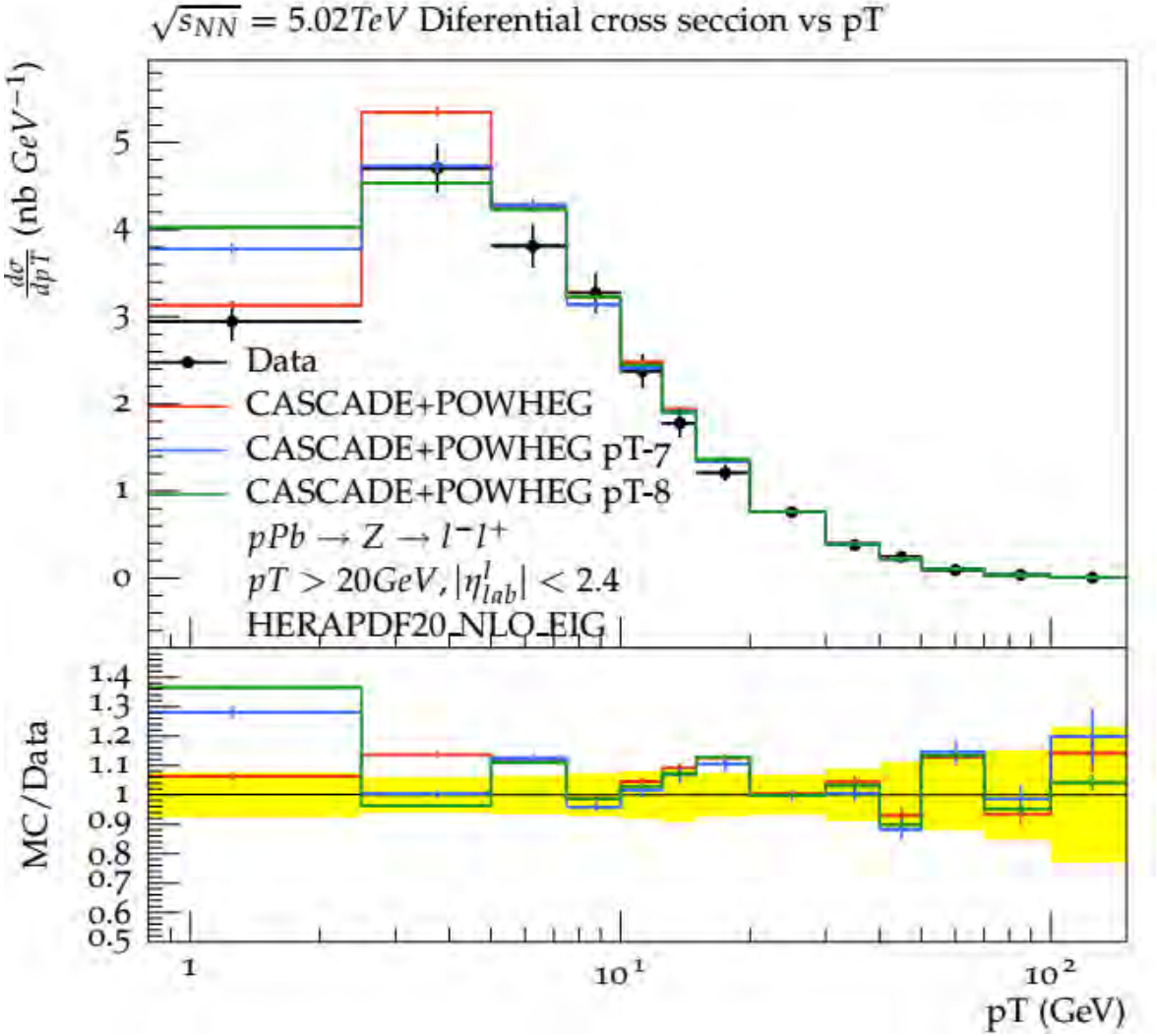



**Figure 5: Cross section decency with transversal momentum. CASCADE+POWHEG NLO calculation. Dependency with “pt cut”**

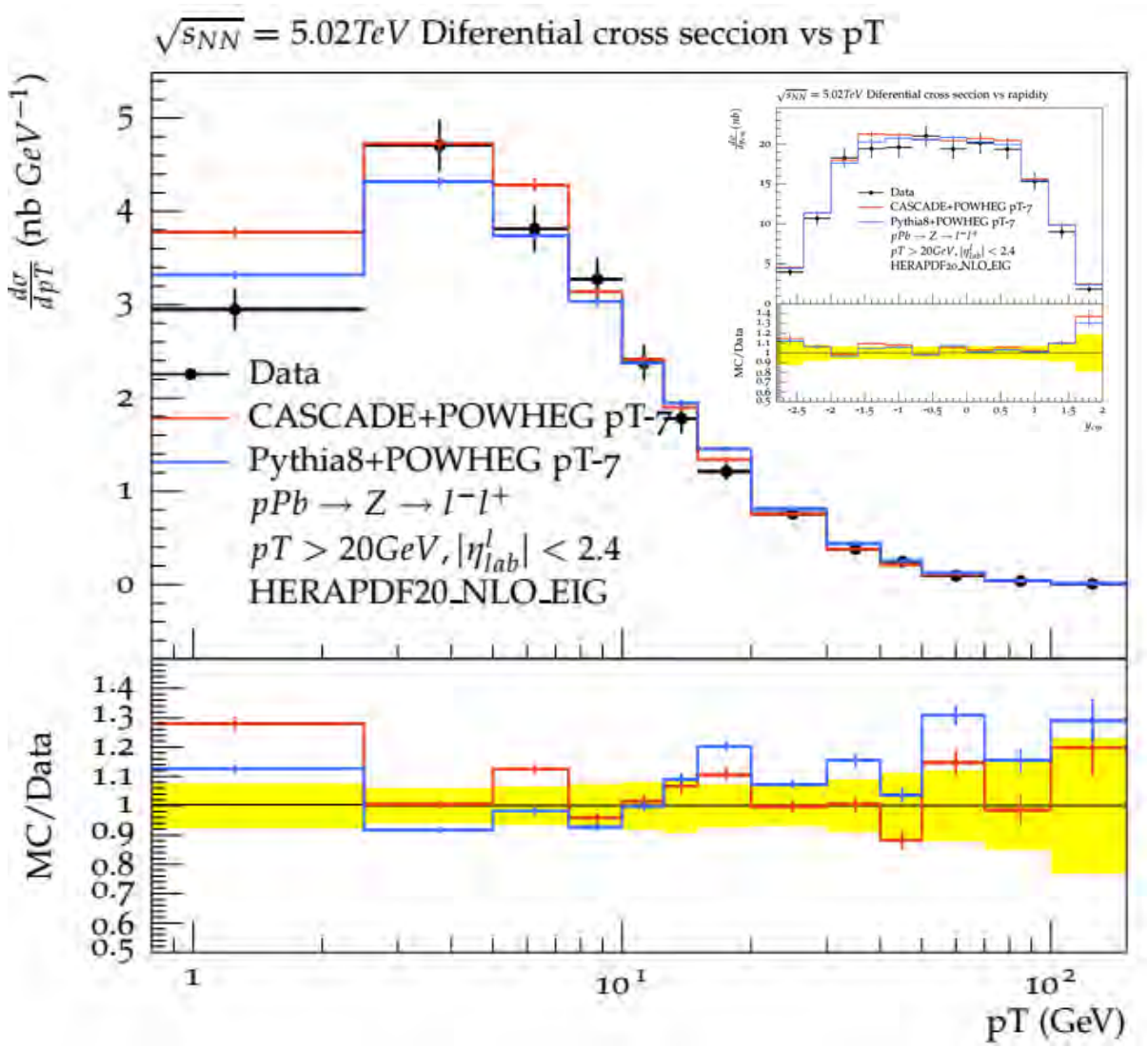



**Figure 6: Comparison between Pythia8+POWHEG and CASCADE +POWHEG at "pT cut" = 7 GeV**

## Goals

- Write the Rivet's plugin CMS_2015_I1322726
- Explore nuclear modifications

**Simulation** → **Experiment**

**pp collision** → ? → **PbPb collision**

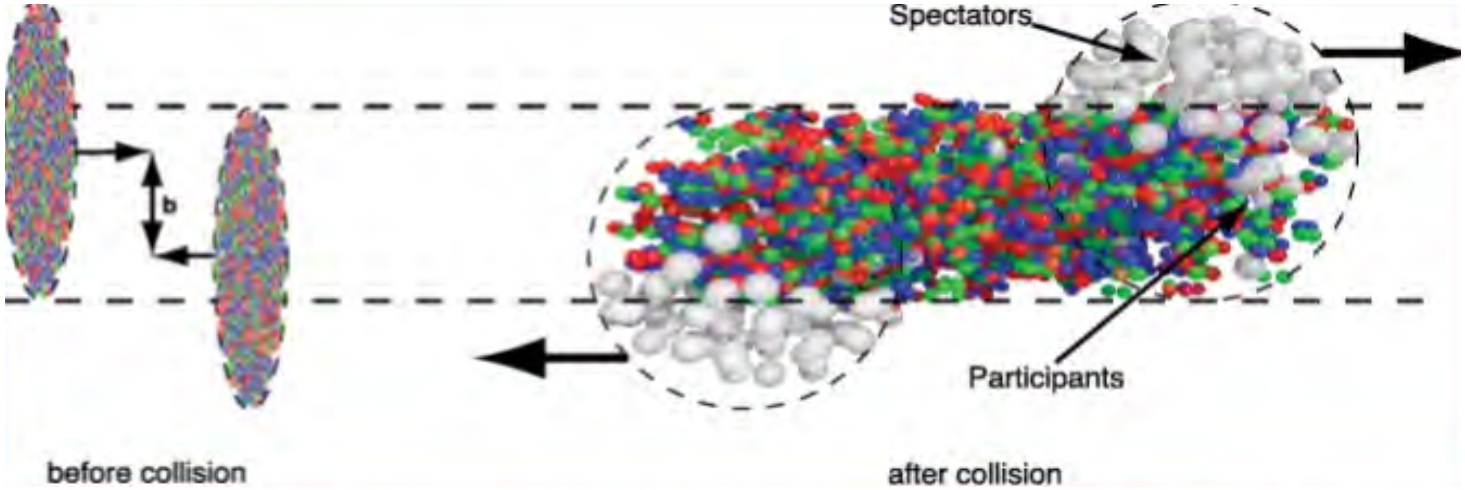
**PbPb COLISSION AT $\sqrt{S_{NN}} = 2.76\ \mathrm{TeV}$**

Symmetric Collision

Scale factor

$$\frac{d\sigma_{pA}}{dx_i} \sim T_{AA} \frac{d\sigma_{pp}}{dx_i}$$

**0-100% Centrality Interval**



# Pythia8 & POWHEG: NLO calculation

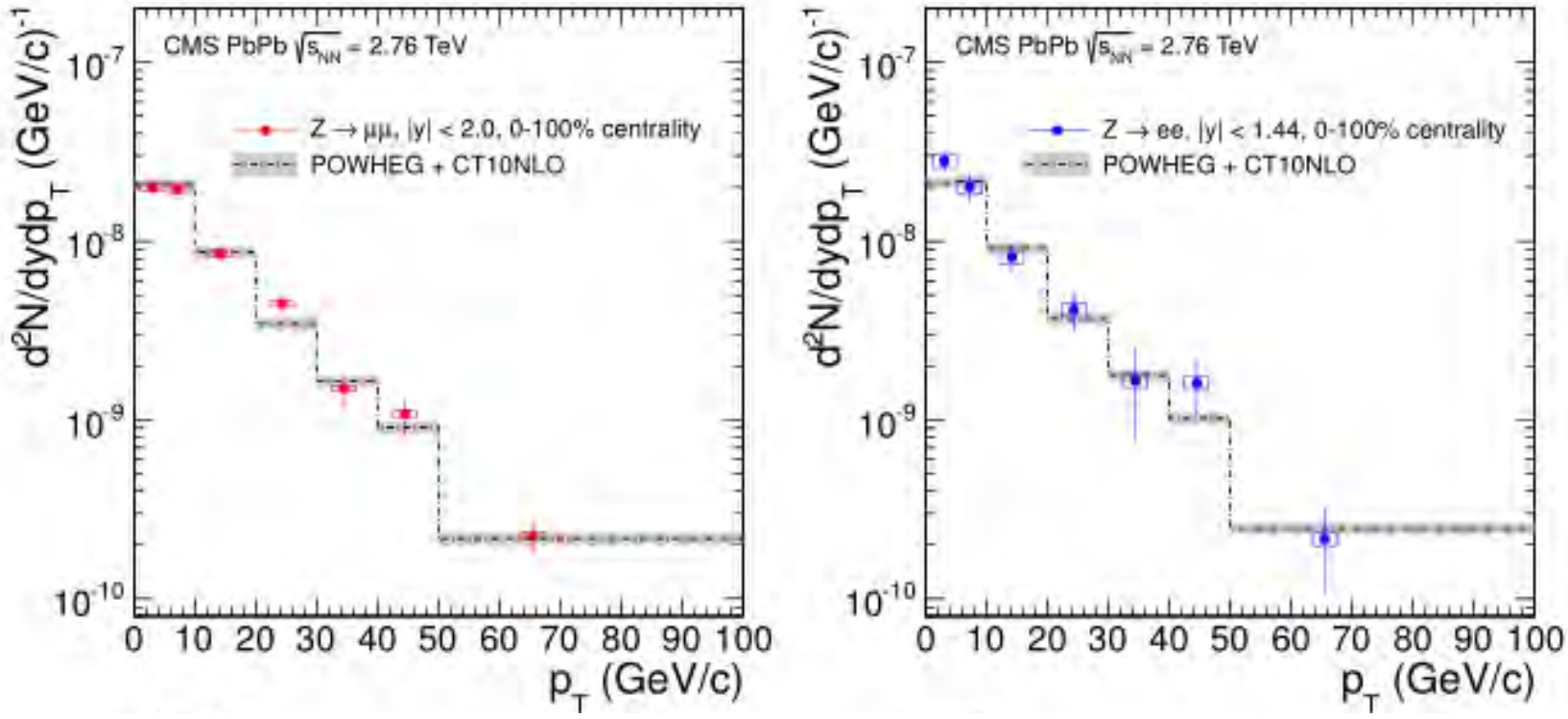



**Figure 9: Invariant yield dependency with transversal momentum.**

$$R_{AA} = \frac{N^{Z}_{PbPb}}{T_{AA} \times \sigma^{Z}_{pp}}$$

$$\equiv \frac{N^{Z}_{PbPb}}{N_{coll} \times N^{Z}_{pp}}$$

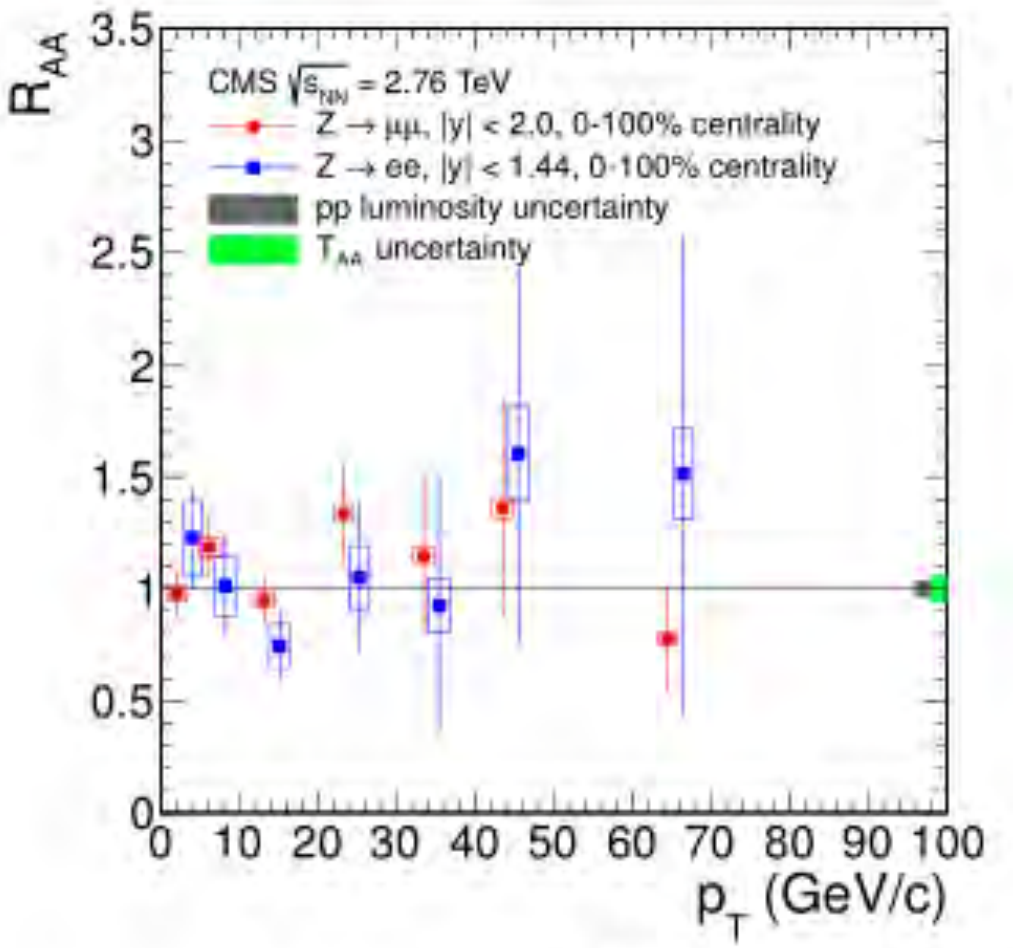



**Figure 10: Experimental estimation of nuclear modification factor distribution.**

# Summary

- ✓ Write the Rivet's plugin CMS_2016_I1410832 and CMS_2015_I1322726. Ready to use!!!
- ✓ Match TMDs with NLO.
- ✓ The mismatching on pT distribution have the same behavior in PbPb, pPb and pp collision.

It's mainly Influence by the simulations tune!!!

- ✓ Due to experimental uncertainties not significant nuclear modification have been found.

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MUCHAS GRACIAS
THANK YOU
VIELEN DANK
MUITO OBRIGADO
どうもありがとう

# QUESTIONS TIME!!!
# DO NOT BE SHY

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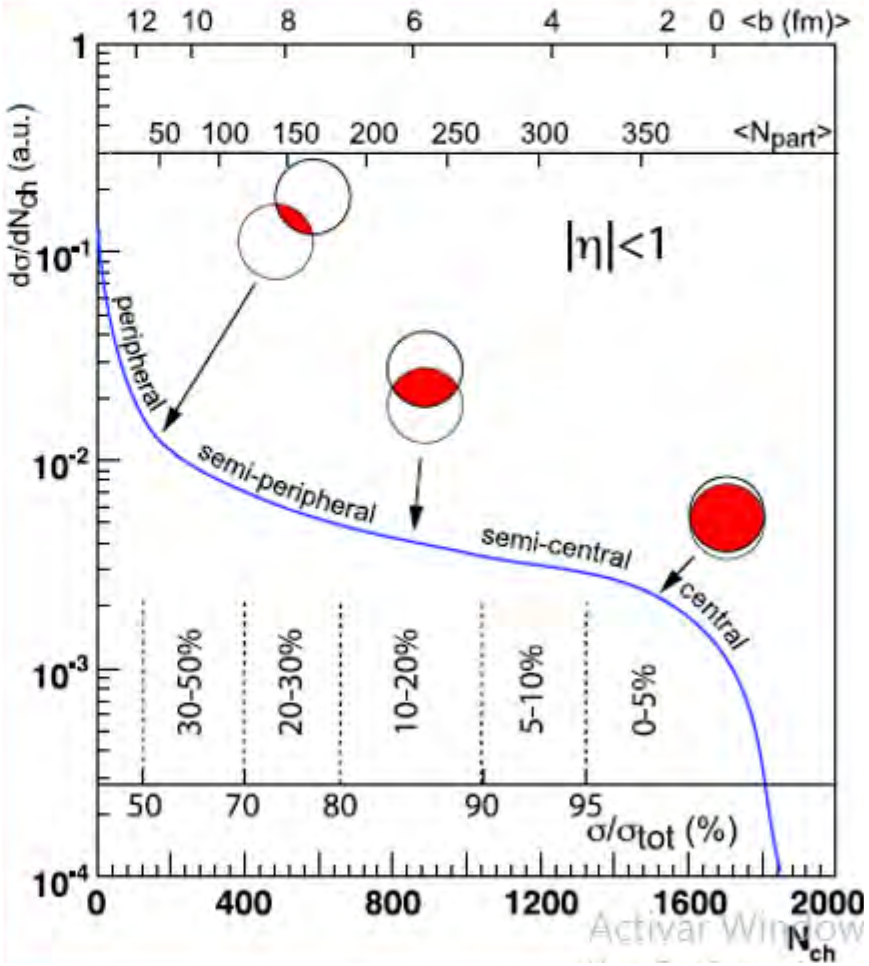
$$T_A(b) = \int dz\ \rho_A(b,z)$$

$$T_{AB}(b) = \int d^2\vec{s}\, T_A(\vec{s})\, T_B(|\vec{b}-\vec{s}|)$$

$$\sigma_{AB}^{hard} \approx \int d^2b\, \sigma_{NN}^{hard}\, T_{AB}(b)$$



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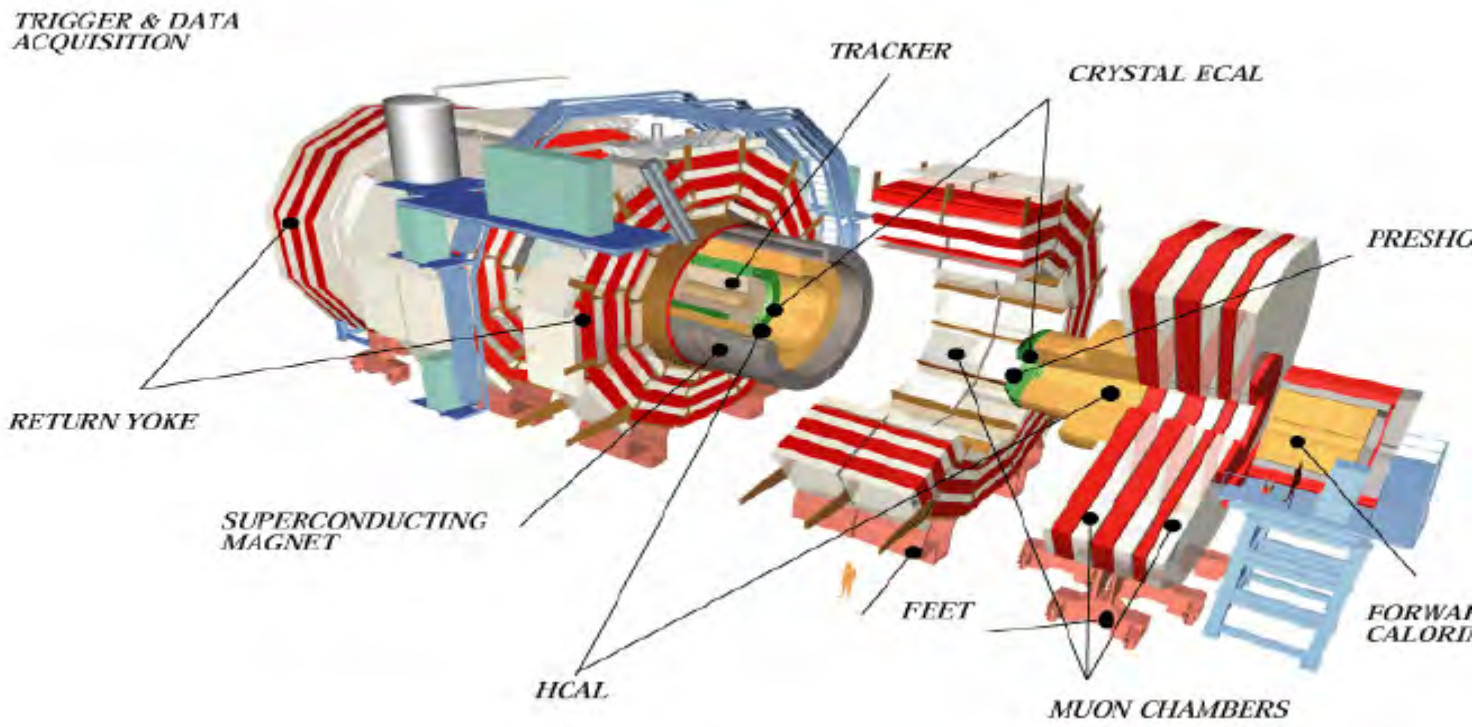
$$\langle N_{coll} \rangle (b) = \sigma_{NN} \cdot T_{AB}(b)$$



# Cross section dependence with “pT cut” parameter

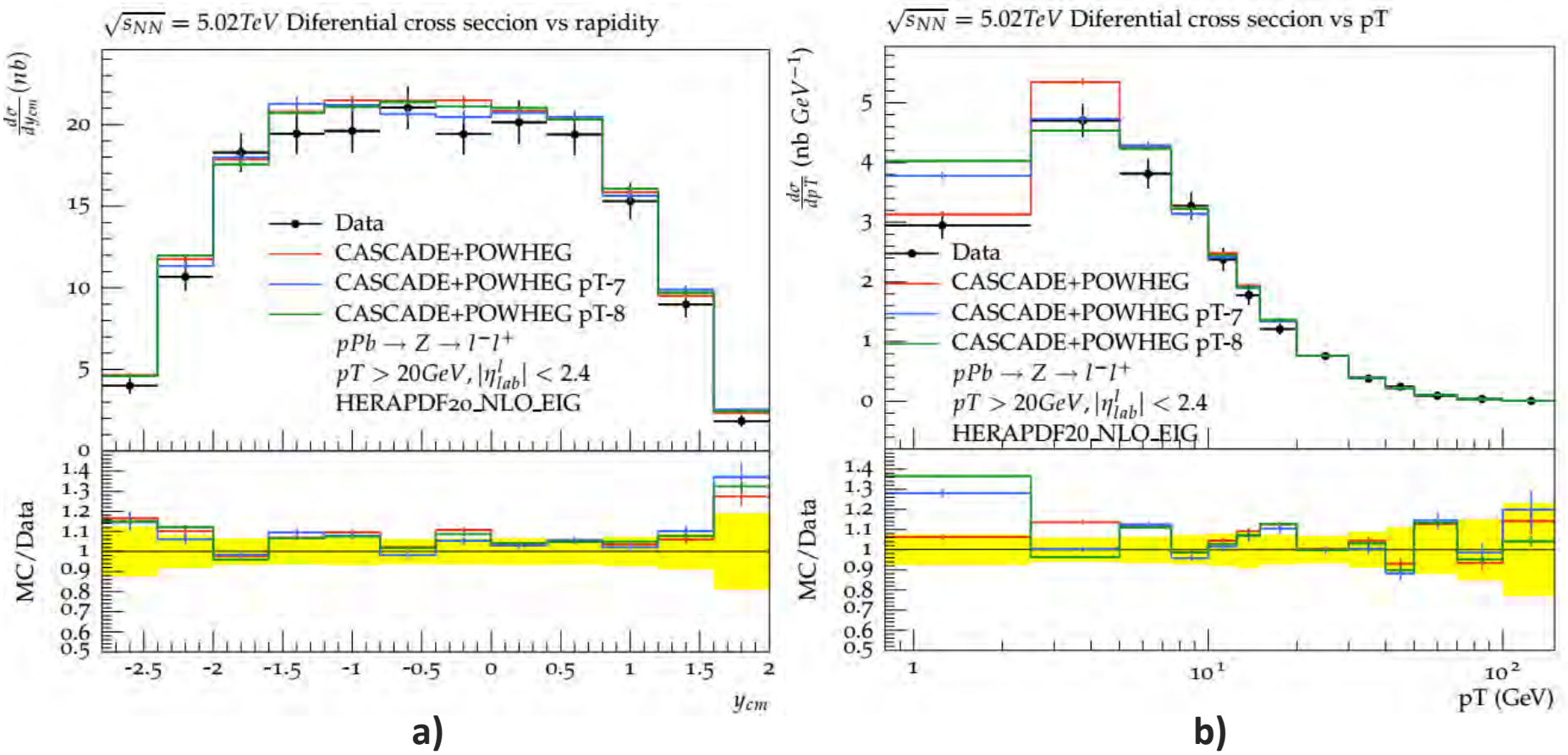



**Figure 5: Cross section decency with a) rapidity and b) transversal momentum. CASCADE+POWHEG NLO calculation. Dependency with “pt cut”**