

# PYTHIA8 predictions to the Underlying event measurements using different PDF sets

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## Introduction

PYTHIA is highly successful and well established Monte Carlo event generator and developed over the past decades with the experimental discoveries. In this work, new tunings of the PYTHIA8 Monte Carlo event generator using Underlying event (UE) data published by the ATLAS are presented. Altogether four parameters are varied: three parameters of the Multiple Parton Interaction (MPI) model and one Color Reconnection Model parameter. It is shown that LO PDFs behave almost in similar manner as compared to LO\*\*. For the tuning we have made use of Professor Tuning Software. All the data Monte Carlo comparison plots are created using the Rivet Analysis tool.

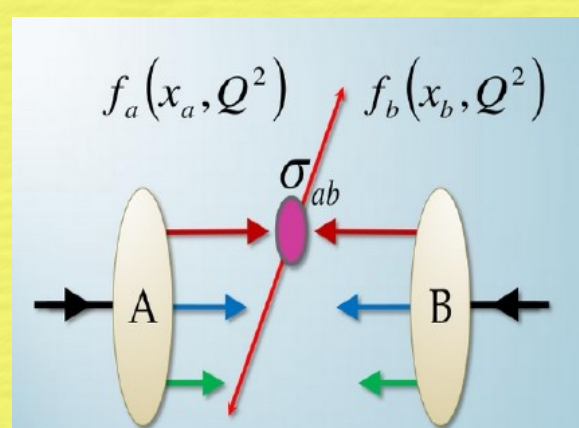
## Event Structure (PYTHIA8)

To describe a typical high energy physics process Monte Carlo event generator simulate several sub processes like:

- **Hard Process:**  
One parton from each colliding hadron undergo a hard collision (large momentum transfer)
- **Initial /Final State Radiation:**  
Radiation that are associated with the two incoming/out going partons.
- **Multiple Parton Interactions:**  
More than one parton pair from each hadron may collide within one single hadronic collision.
- **Beam Remnant:**  
Incoming beam particles, which do not take active part in the ISR or hard scattering process.
- **Hadronization:**  
Transition of colored objects into colorless hadrons To describe above processes PYTHIA8 implemented several phenomenological models which have free parameters need to be tweaked to describe the data well. Four parameters are selected for tuning based on their sensitivity to the selected data.

## PARTON DENSITY FUNCTION

Parton Density Functions are parameterizations of the partonic content of the proton at Hadron Colliders cross-section calculation is a convolution of the cross-section at parton level and PDFs:



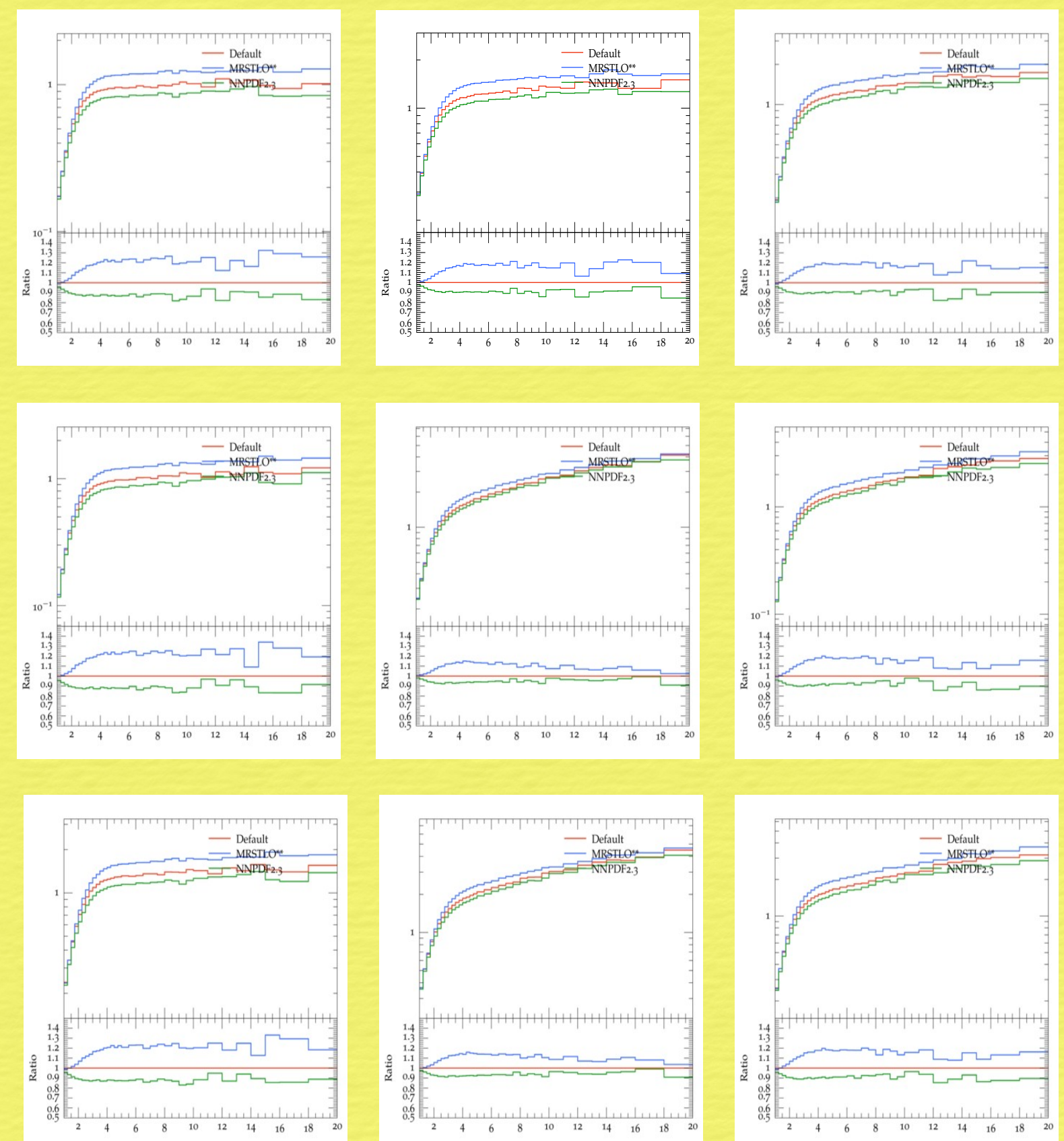
## PDF Sets Used

PDF Type	PDF Set
Leading Order (LO)	NNPDF2.3
Modified Leading Order (LO**)	MRSTLO**
Next-to-Leading-Order (NLO)	CTEQ6L

## Tuned Parameters

Parameter	NNPDF2.3	MRSTLO**	NNPDF
Multiparton Interactions:coreFraction	0.156	0.106	0.50
Multiparton Interactions:coreRadius	0.419	0.107	0.40
Multiparton Interactions:pT0Ref	2.461	2.790	2.28
Colour Reconnection:range	2.461	1.018	1.80

## Data Monte Carlo Comparison



<https://arxiv.org/abs/1608.04954v1>  
<https://arxiv.org/abs/1912.05451>  
<https://arxiv.org/abs/0907.2973>  
<https://arxiv.org/abs/2203.11601>  
<https://arxiv.org/abs/1404.5630>