

Studying Jet Cross Section Measurements of ATLAS Experiment

Michelle Marrero García

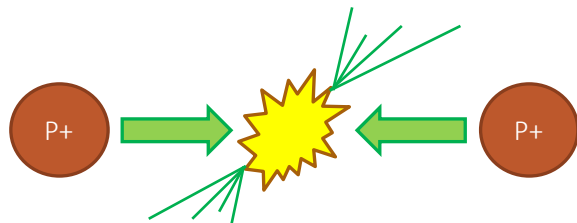
University of Puerto Rico, Mayagüez Campus

Mentor: Tancredi Carli (EP Department)

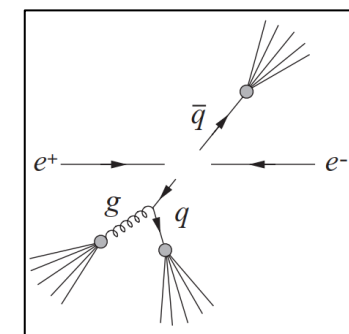
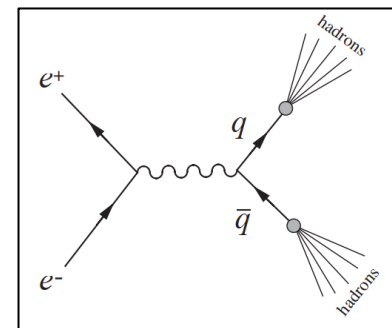
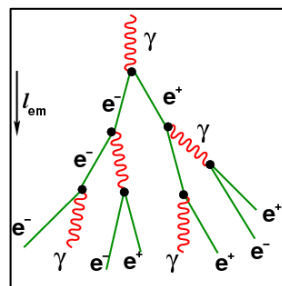
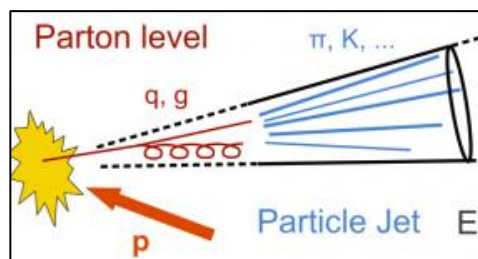
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Introduction

- $p^+ - p^+$ collisions with CM energy of 13 TeV.



- Jets are sprays of hadrons and their interaction is governed by the strong force and described by QCD.
- Initiated by a parton (quarks and gluons) that radiates other partons and produces a quark and gluon shower that then turns into hadrons observed in detectors.



- Focus on jet production
 - Study QCD predictions
 - Search for new physics
 - Study partonic structure of proton
- Frequently produced and complex
 - Secondary parton interactions (Underlying event)
 - Multiple proton interactions (Pileup)
 - Top quark, W/Z/H bosons produced (EW resonances)

Introduction

- Cross section is probability that an interaction occurs.
Measured experimentally
Calculated theoretically

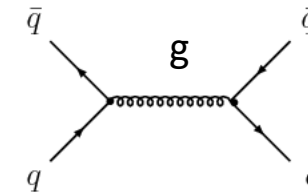
- Calculation in perturbative QCD:

$$\sigma = \sum \alpha_s(Q^2) \int dx_1 dx_2 dQ^2 \text{ME}(x_1, x_2, Q^2) f_{q/p}(x_1, Q^2) f_{q/p}(x_2, Q^2)$$

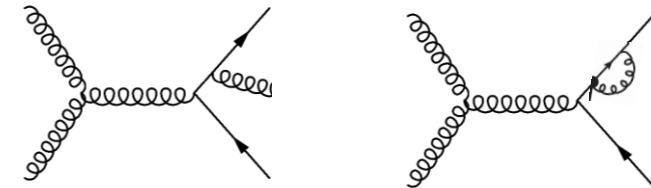
- α_s is the strong coupling constant
- x_1 and x_2 are momentum fractions of each p+
- Q^2 is the transverse momentum transfer squared
- $f_{q/p}(x_1, Q^2)$ and $f_{q/p}(x_2, Q^2)$ is the probability to find a parton in each p+ (PDF)
- $\text{ME}(x_1, x_2, Q^2)$ is the matrix element which describes the hard scattering process

- Types of interactions

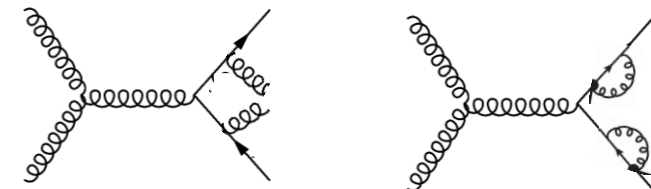
Leading Order (LO): 2 – 2



Next to Leading Order (NLO): 2 – 3



Next to Next to Leading Order (NNLO): 2 - 4

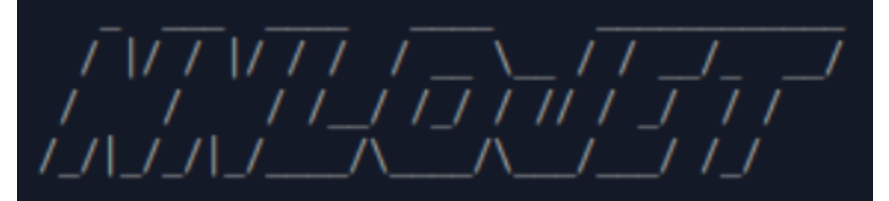


Project Details

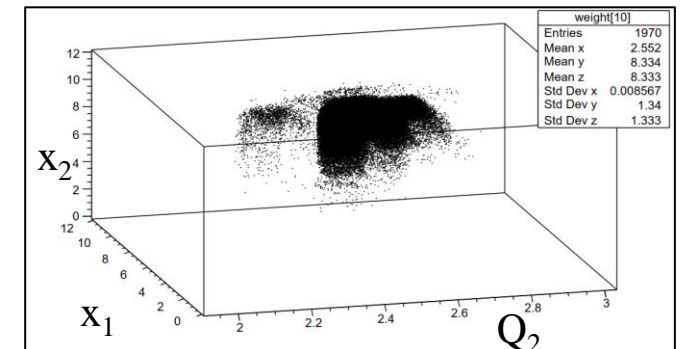
- We want to use a program to calculate ME and store the values in a lookup table for the scientific community.
- Compare theoretical cross section with experimental cross section values.
- Fix ME values so that only the PDFs values $((f_{q/p}(x_1, Q^2) f_{q/p}(x_2, Q^2)))$ and the α_s are altered to agree with theory.
- Check if this approach works by comparing (for the same α_s and $(f_{q/p}(x_1, Q^2) f_{q/p}(x_2, Q^2))$) cross section results when using the lookup table and without using it.

Project Details

- NLO QCD calculation: 1992
NLOJET program: 2002
- NNLO QCD calculation: 2018
NNLOJET program: Not available for public
- NNLOJET generates events and calculates cross section.
 - Warmup: Generates boundaries
 - Grid: Creates a grid for each p_T bin defined and generates random events.
 - Production: Optimizes the boundaries depending on the events generated to give non-empty grids.
- Variables: Interaction type (LO, NLO, NNLO), Number of events, Seed number and dijets/inclusive jets, among others.
- Calculations are different for dijets (fill grids per events) and inclusive jets (fill grids per jet).
- Takes a long time
 - 8 hours for dijets (NLO): 700,000 events
 - 8 hours for inclusive jets (NLO): 1,600,000 events



Dijet Grid Example



Project Details

- Set up NNLOJET with the help of Mark Sutton and learned to run the program, change runcards and plot results.
- Ran NNLOJET for all interactions (dijet) with little statistics.
- Adapted runcards to run NNLOJET for inclusive jets.
- Learned about bash programming and Python and am writing a program to run NNLOJET without manually changing runcards.
- Tasks:
 - Run NNLOJET for dijets with more statistics
 - Run NNLOJET for inclusive jets with more statistics
 - Compare NNLOJET results with lookup table calculations
 - Compare NNLOJET and NLOJET
 - Use CIJET to calculate NLO CI contributions
- Final goal: produce NNLO lookup table for published jet cross section for scientific community.

Other Activities



- Joined CERN's Boxing Club
- Gym
- Geneva's Natural History Museum
- Geneva's Art History Museum
- Old Geneva (saw light show)
- Jet d'Eau
- Barcelona
- UN





Thank you!