Axigluon Sample Generations for Top Quark Forward Backward Asymmetry Studies

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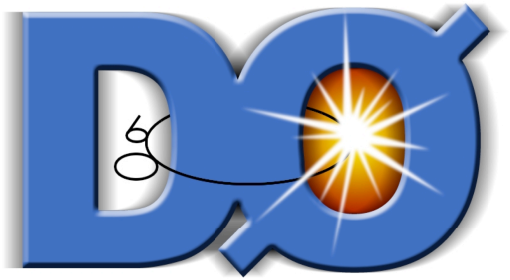
19 September 2012

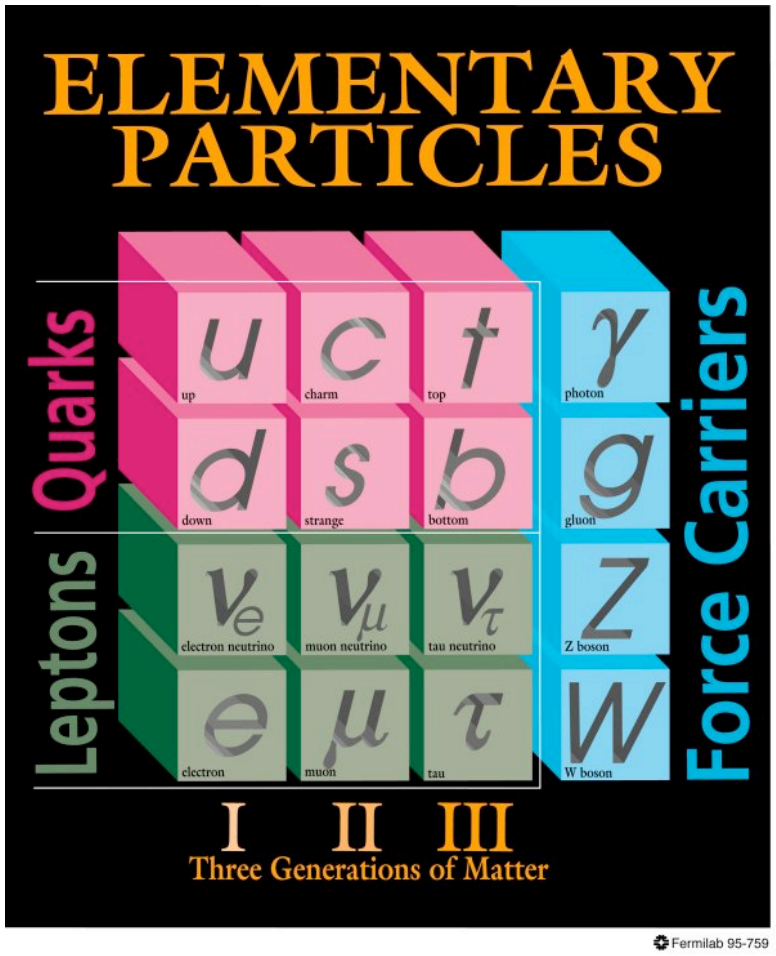


Outline

- Motivation.
- Explanation of terms.
- What I did in the analysis.
- My results.

The Standard Model (SM)

- The SM, to the best of our knowledge, describes how our universe works.
- Organization of the building blocks of matter.
- But wait, does this explain everything?
  - No.



The SM of Particle Physics [1]

An Incomplete Model

- an example: Hierarchy problem. Why is gravity so much weaker than the other forces?
- Another example: top quark forward backward asymmetry.
  - At leading order in quantum chromodynamics (QCD) there is no asymmetry present. [2]
  - Basically the SM predicts there not to be a forward backward asymmetry.
  - Problem: There is an asymmetry, specifically in the top quark of about 6% [3]

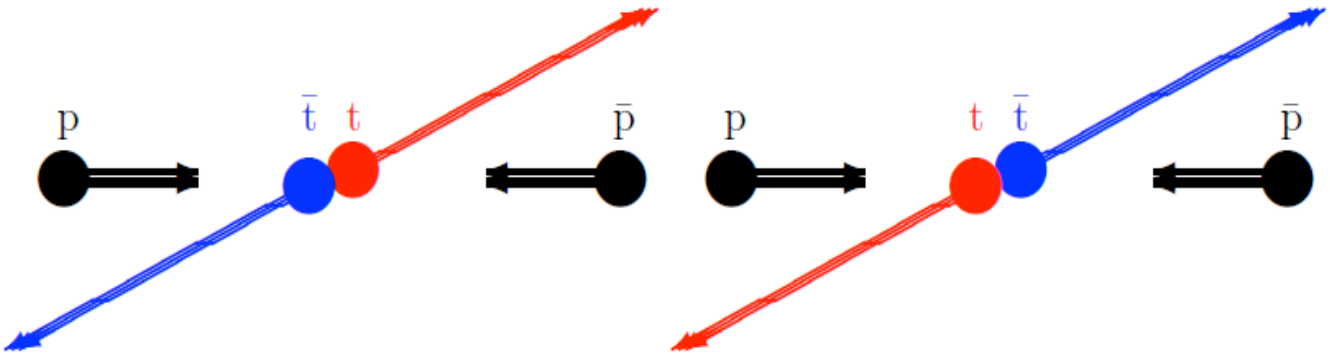
Axigluon

- A possible beyond the standard model (BSM) solution to the asymmetry problem.
- What are axigluon colored octets?
  - “Like hell should I know, the theorists worry about the details.” - my advisor.
- Has to do with “chiral color” in QCD. [4]
- Important part: it's a theorized particle that is a nice candidate for breaking the forward backward asymmetry.

What is forward backward asymmetry?

- Asymmetry in the number of forward and backward events:

$$A_{FB} = (N_F - N_B)/(N_F + N_B)$$



Forward Event

Backward Event

Some Observables

- Rapidity (y) – a quantity that is related to the angle of a value (such as momentum) with respect to the beam line.

$$rapidity = 0.5 * \log((energy + p_z)/(energy - p_z))$$

- Charged Lepton Rapidity ($q_l y_l$) – This rapidity takes into account the value of the lepton's charge when the top quark decays leptonically.
- Forward:
- Backward:

$$\Delta y > 0 \text{ or } q_l y_l > 0$$

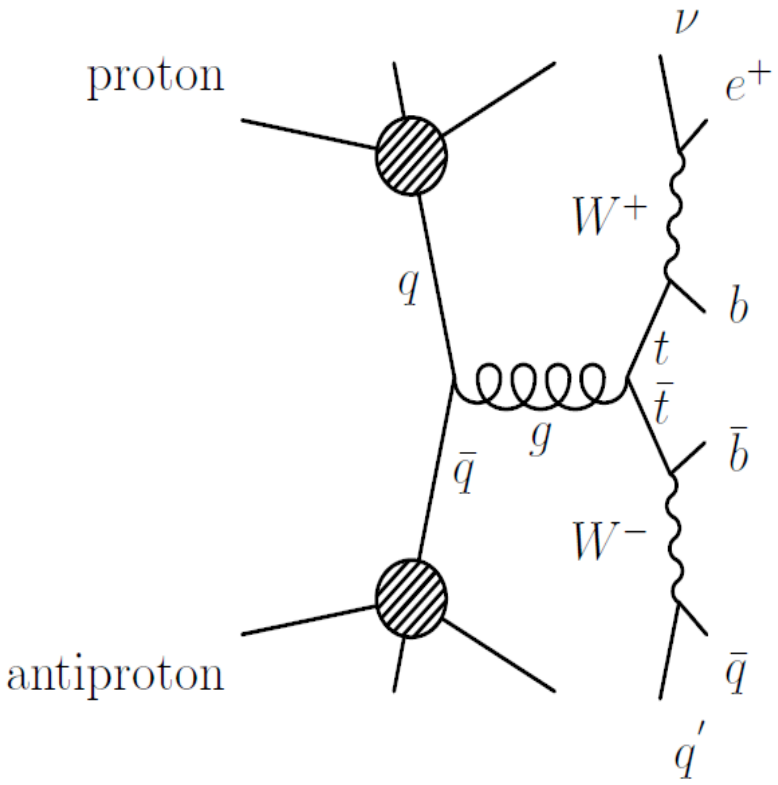
$$\Delta y < 0 \text{ or } q_l y_l < 0$$

How do you make a top quark?

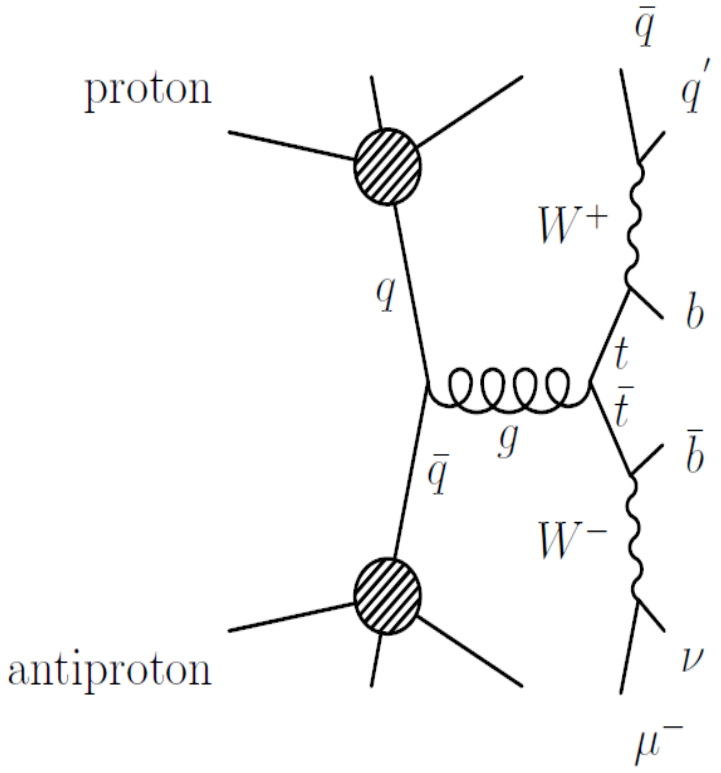
- Collide protons and antiprotons!
- 99.999954% speed of light. [5]
- All begins with a tank of hydrogen and then some nickel.

Diagram of the Tevatron in Batavia, IL. [5]

Top Quark Decays (that I cared about)



"electron plus jets"
Feynman Diagram [2]

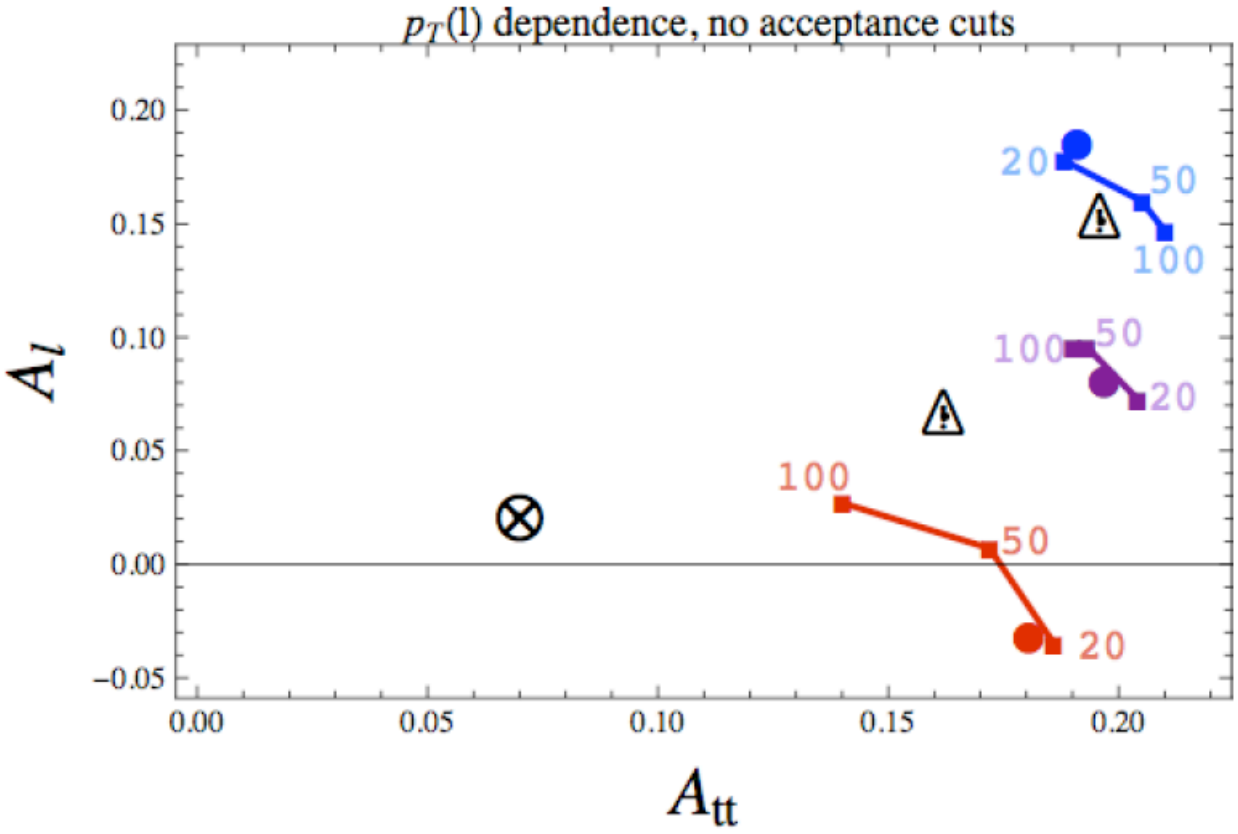


"muon plus jets"
Feynman Diagram [2]

MadGraph!

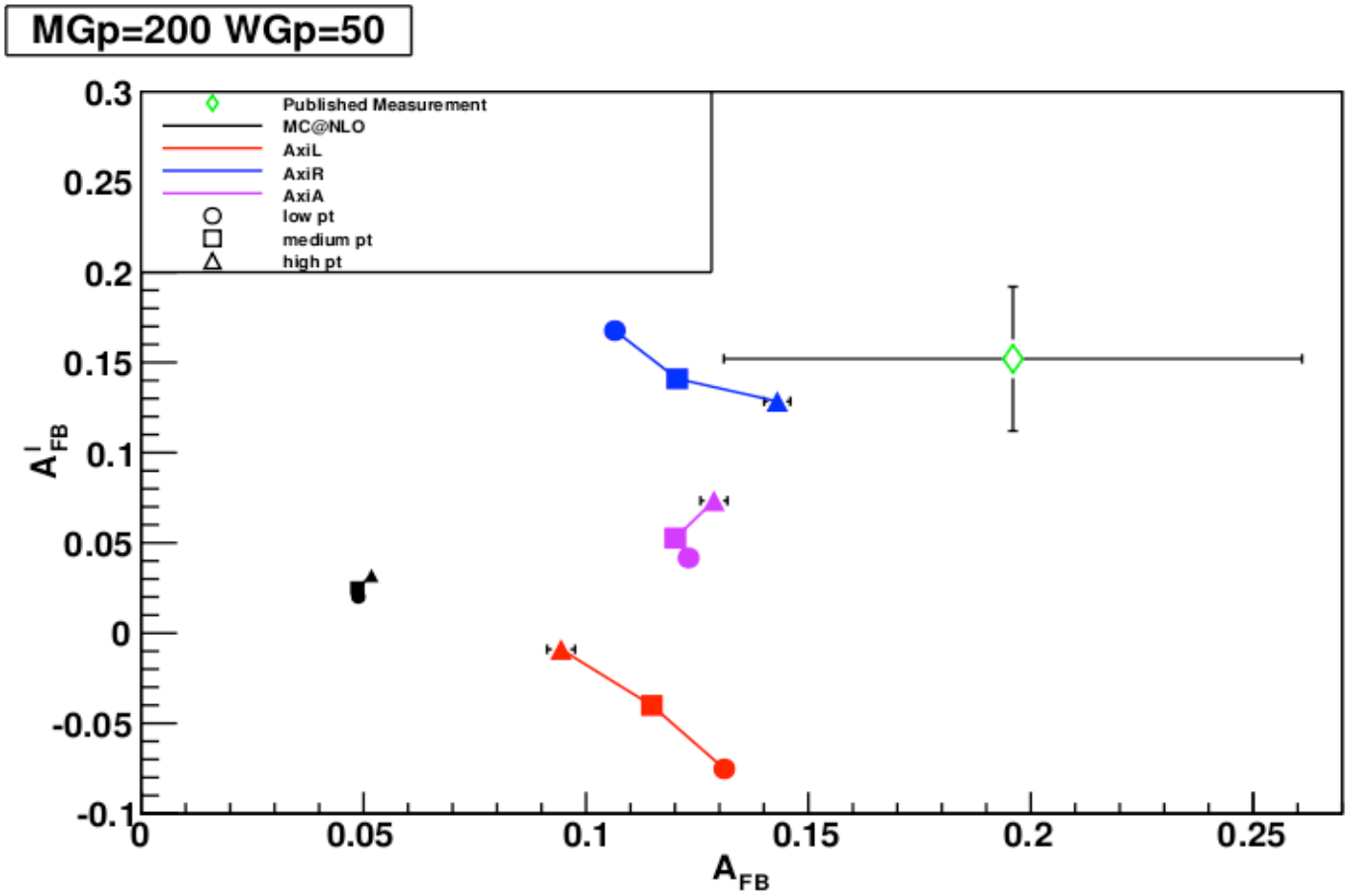
- Matrix element generator. i.e. it is a program which generates random events based on the parameters you indicate.
- Analyzed these events by making a graphs of $q_l y_l$ based asymmetry vs $\mathbf{D}y$ based asymmetry.
- My summer goal was to replicate a graph presented at a talk given by Dr. Adam Falkowski (Warsaw Univ).

Goal



Asymmetry comparison plot by Adam Falkowski [6]
Axigluon Mass = 200 GeV, Axigluon Width = 50 GeV.

My Resulting Graph



Axigluon Mass = 200 GeV, Axigluon Width = 50 GeV

Conclusion

- My analysis was a step in the analysis. The events I generated need to be reconstructed before truly being compared to data.
- Decide which mass/width to use in the analysis.
- The graphs I made look nice, and will help get money to aid in continuing the forward backward asymmetry study.

That's all Folks!

Works Cited

- [1] http://www.fnal.gov/pub/inquiring/matter/madeof/index.html
- [5] http://www.fnal.gov/pub/science/accelerator/
- [2] Thesis of Doug Orabaker, University of Rochester, can be provided upon request.
- [3] http://www.fnal.gov/pub/today/archive_2011/today11-01-07.html
- [4] http://en.wikipedia.org/wiki/Chiral_color
- [6] Adam Falowski Presentation: http://indico.cern.ch/getFile.py/access?contribId=22&sessionId=3&resId=0&materialId=slides&confId=175916