Mid-Rapidity Di-Jet Cross Section and A_{LL} Flash Talk

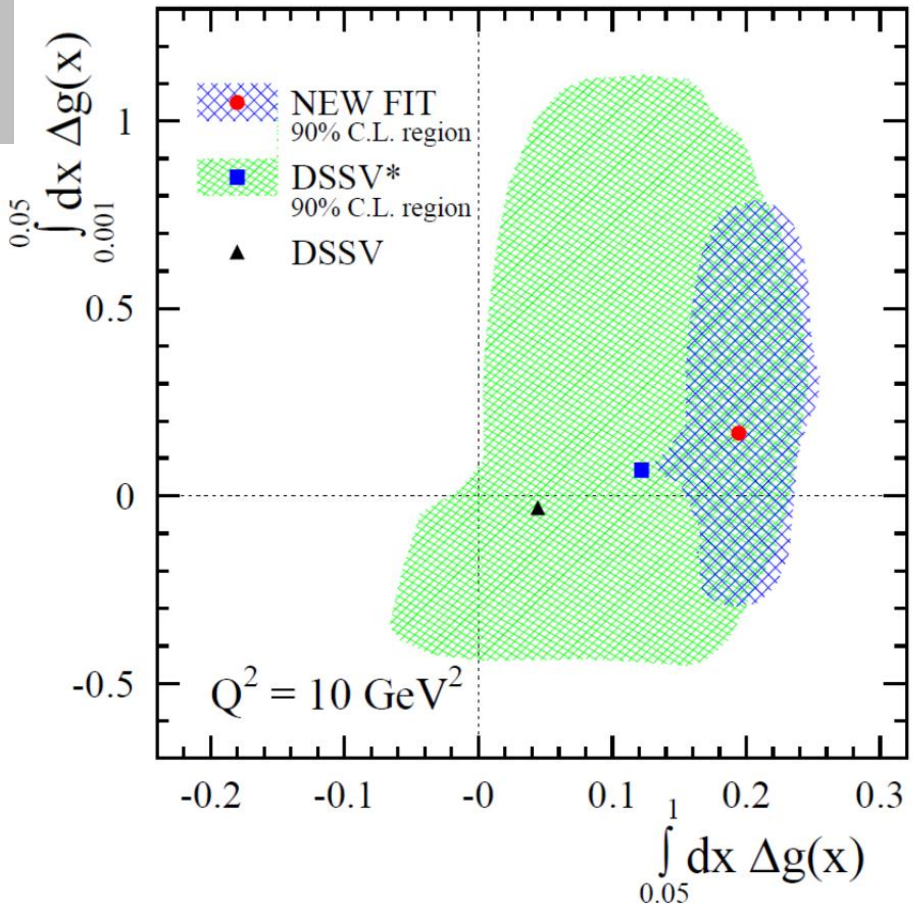
B. S. Page

Goal: Constrain ΔG Using Di-Jets

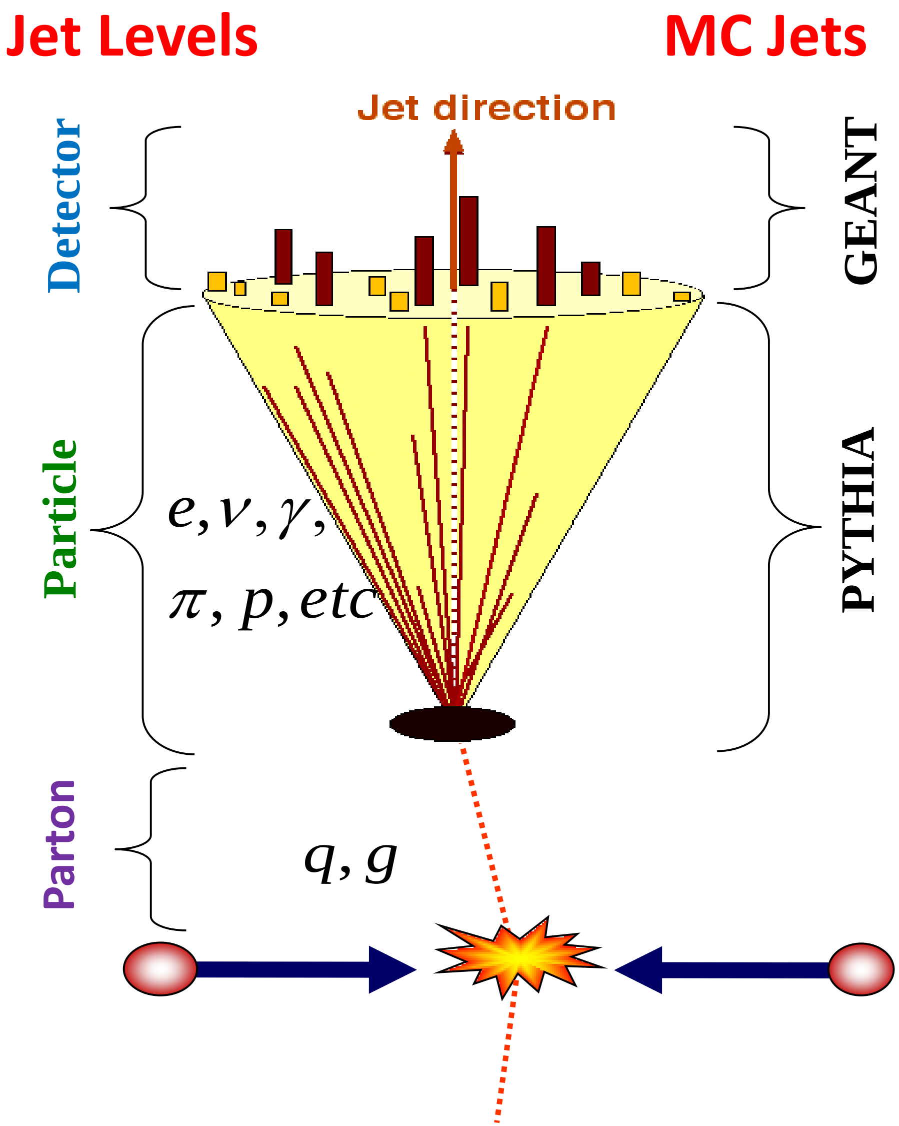
$$S = \frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta G + L$$

- Want to better constrain x dependence of ΔG by measuring di-jet A_{LL}
- Correlation measurements such as di-jets give access to partonic kinematics at leading order
- Agreement between measured di-jet cross section and NLO pQCD predictions would give confidence that di-jets can be used in asymmetry measurements

arXiv:1404.4293



Jet Reconstruction



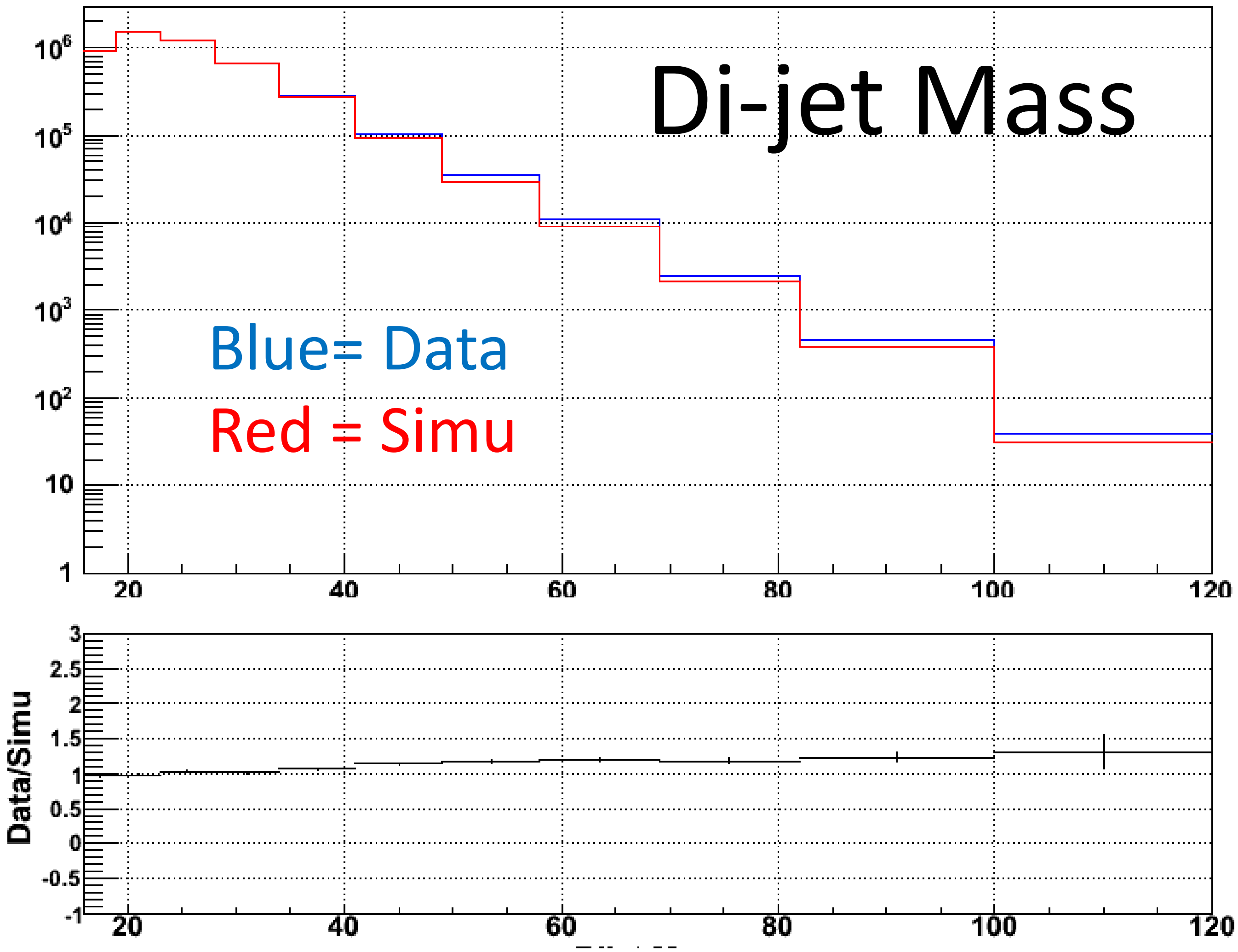
Anti-K_T Algorithm:

- Radius = 0.6
- Less sensitive to underlying event and pile-up effects
- Implemented using FastJet
- Used in both data and simulation

Three Simulation Jet Levels:

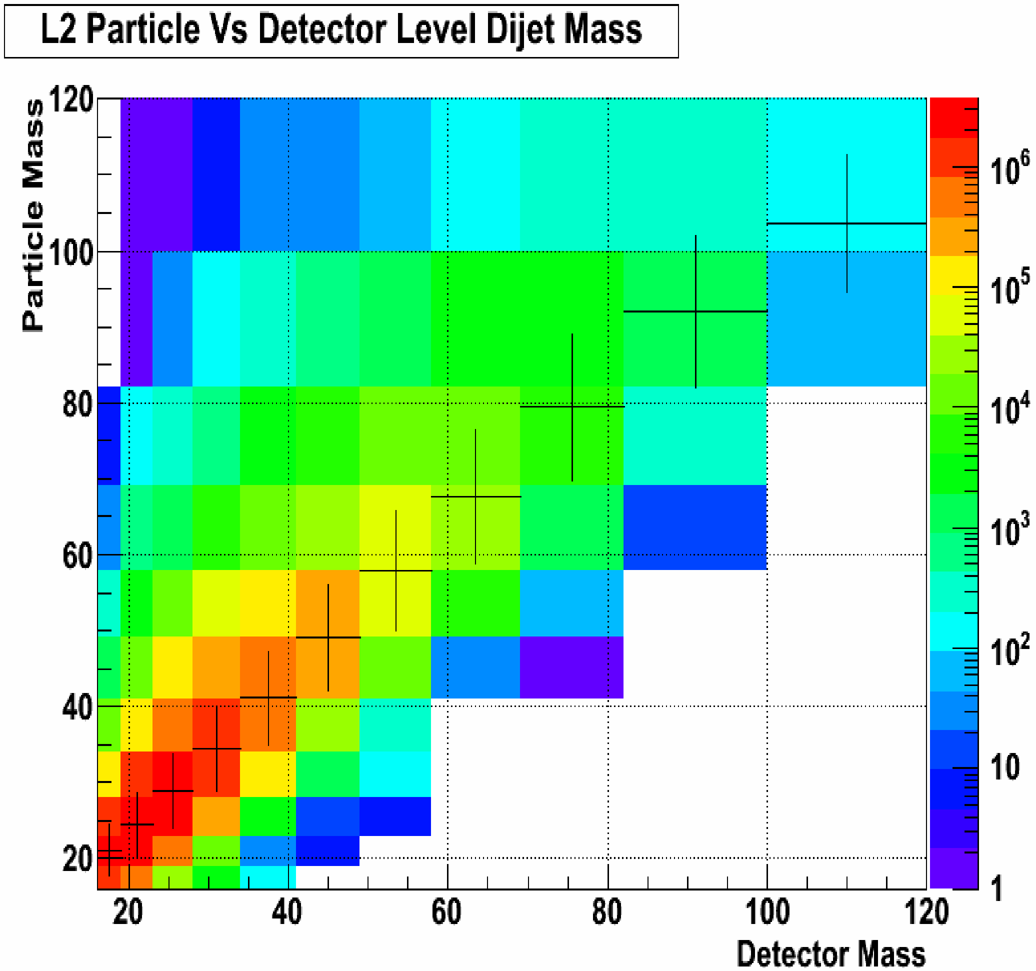
- Parton – Jets produced from hard scattered partons as well as ISR and FSR
- Particle – Jets produced from stable particles arising from fragmenting partons including beam remnants
- Detector – Jets produced from simulated detector response to final state particles

Data – Simulation Comparison



Di-jet Mass [GeV/c^2]

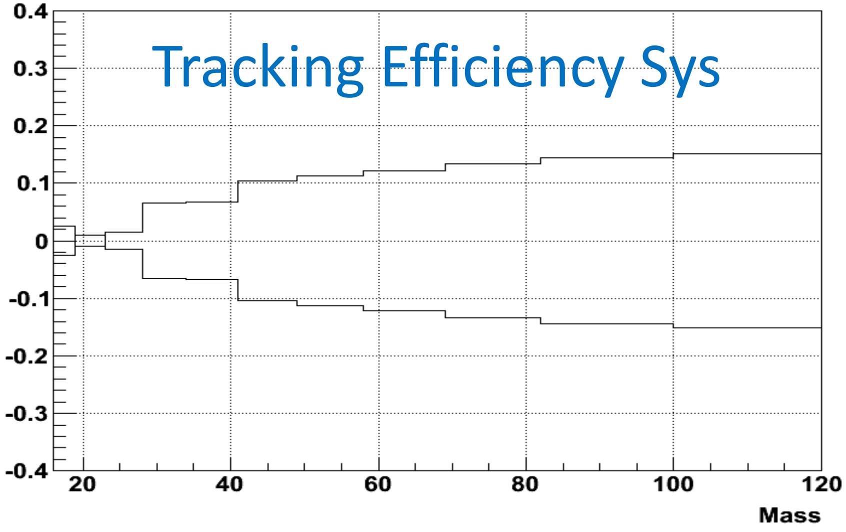
Unfolding Raw Yields

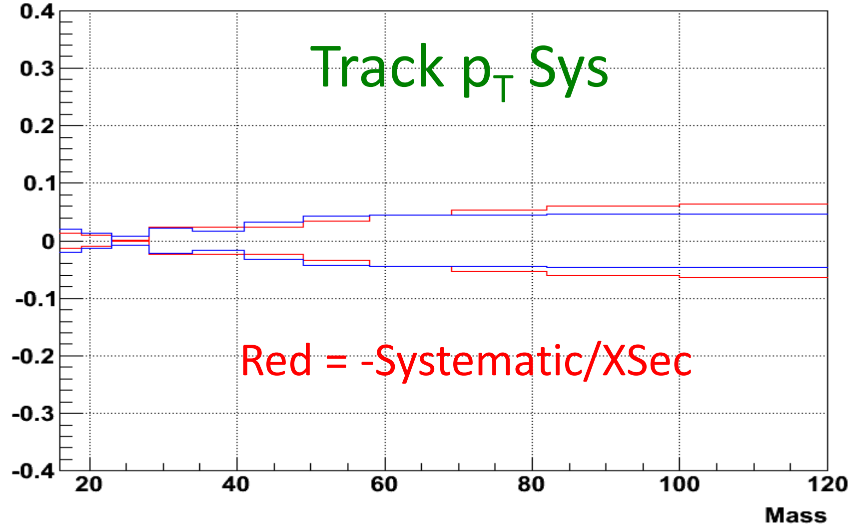


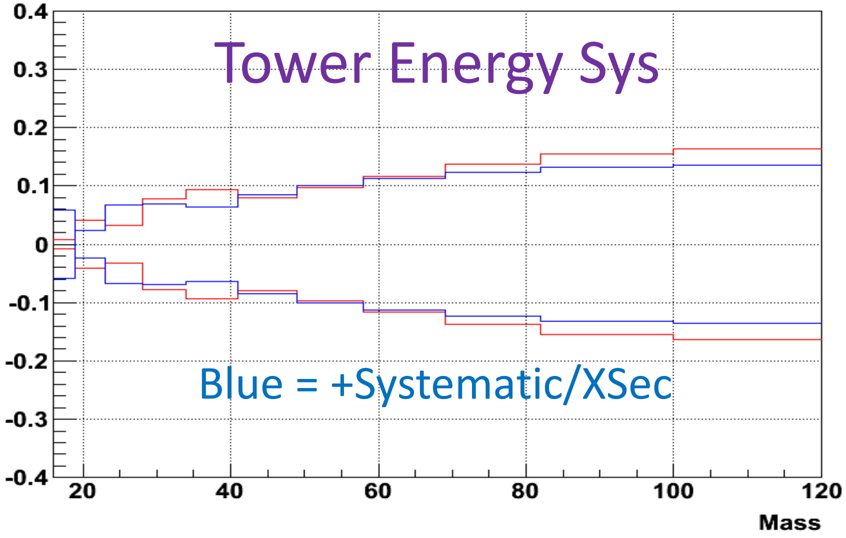
http://hepunx.rl.ac.uk/~adye/software/unfold/RooUnfold.html

- Raw di-jet yield must be corrected for detector resolution and acceptance effects – Unfolding
- Utilize the Singular Value Decomposition (SVD) method ito unfold raw yield [arXiv:hep-ph/9509307]
- Use 'Response Matrix' to relate detector response to thrown particles
- SVD a way of solving the linear system in a regularized way
- SVD method implemented in RooUnfold package

Systematic Errors for X-Section

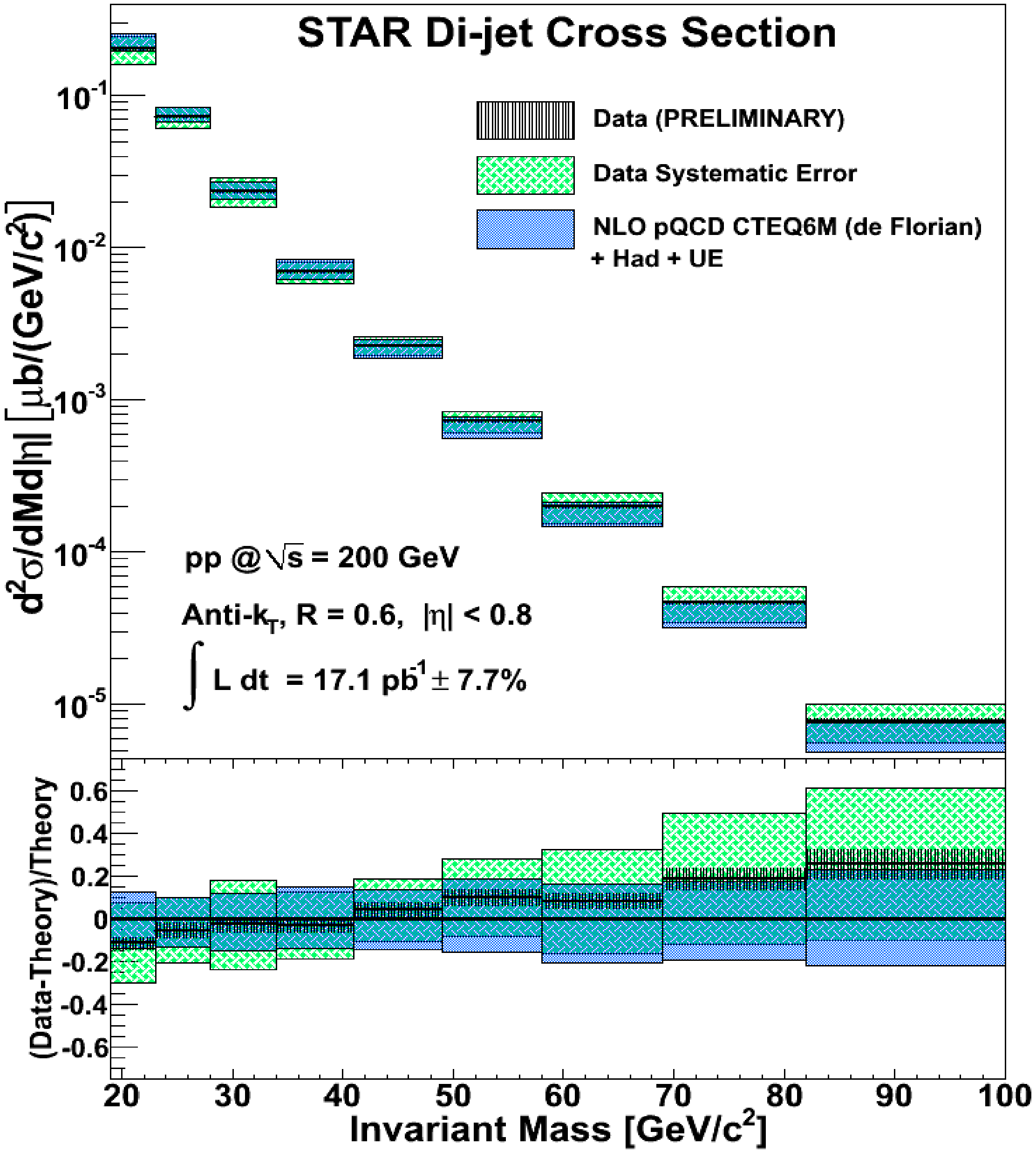






- Evaluated three 'Detector' Systematics
  - Tracking Efficiency: 4%
  - Track p_T Uncertainty: ± 1%
  - Tower Energy Scale Uncertainty: ± 3.7%
- Systematic in each bin is the average between + and – systematic
- Additional systematics for unfolding and integrated luminosity determination were also evaluated

Di-jet Cross Section Result



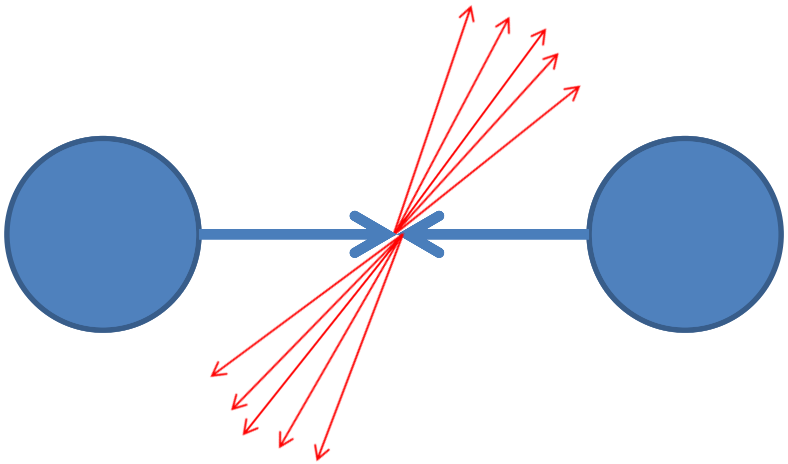
Thickness of vertical black hashing represents size of statistical error on the measurement

Green hatched box is symmetric about data point and is the quadrature sum of all systematic errors

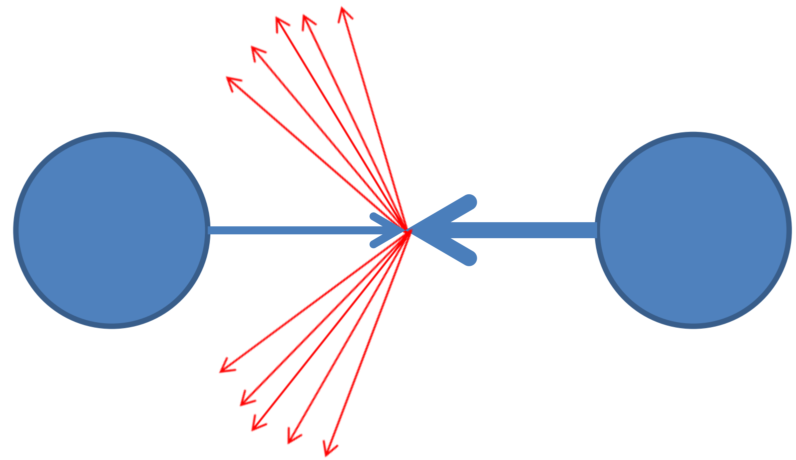
Thickness of blue box represents error on theory determined by changing factorization and renormalization scales by factor of 0.5 and 2

Dijet Topologies for A_{LL}

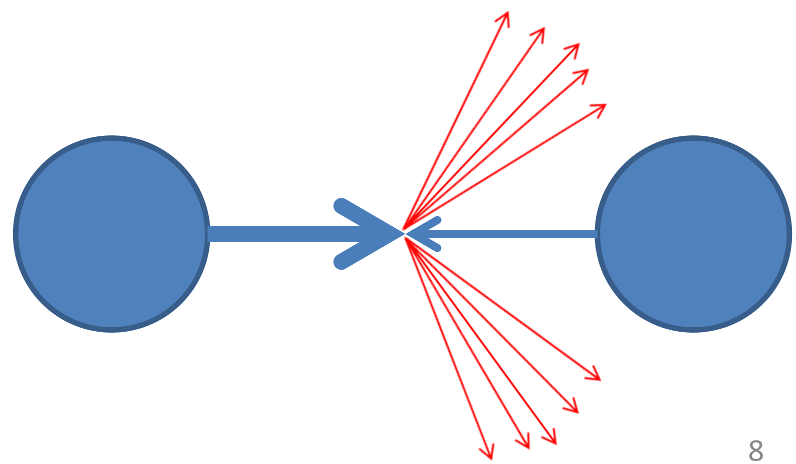
East-West



East-East



West-West

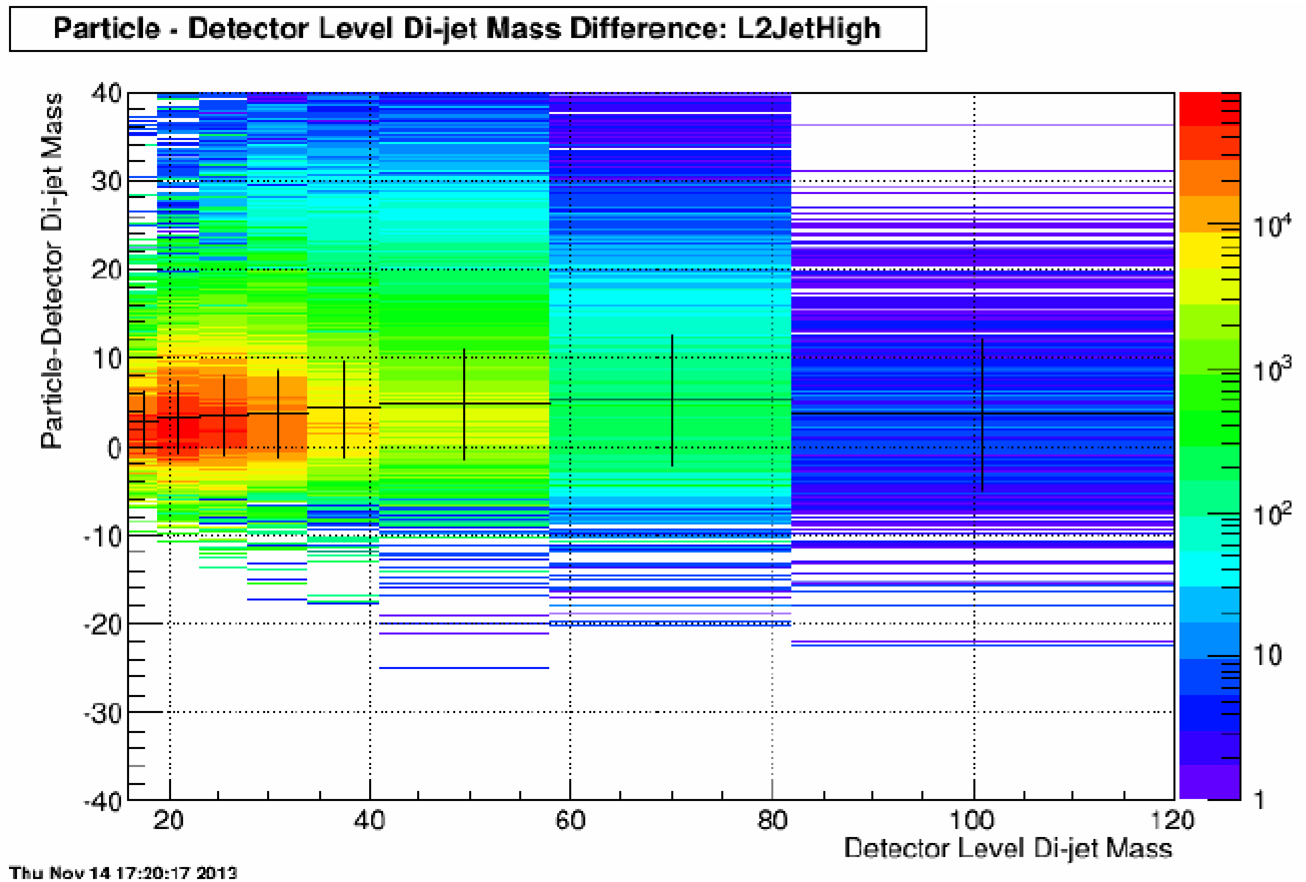


$$\eta_3 + \eta_4 = \ln \frac{x_1}{x_2}$$

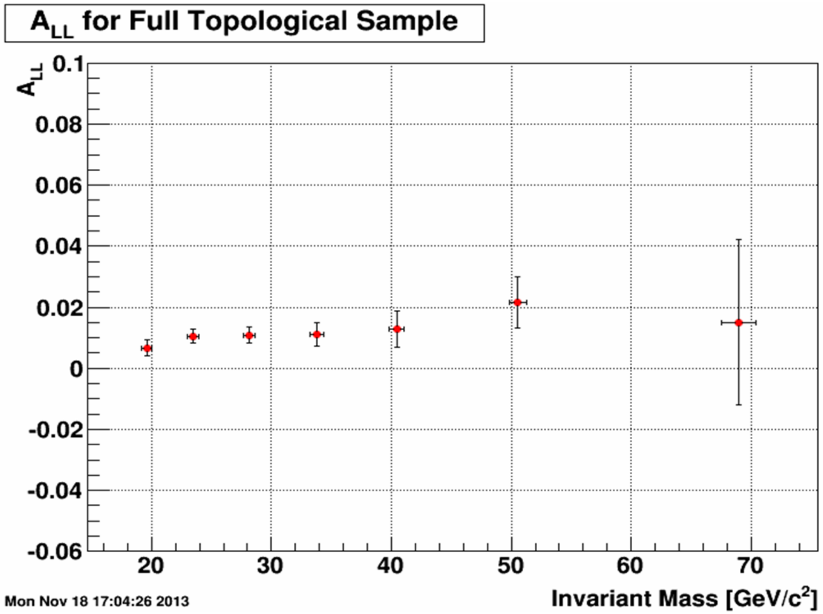
Invariant Mass Shifts

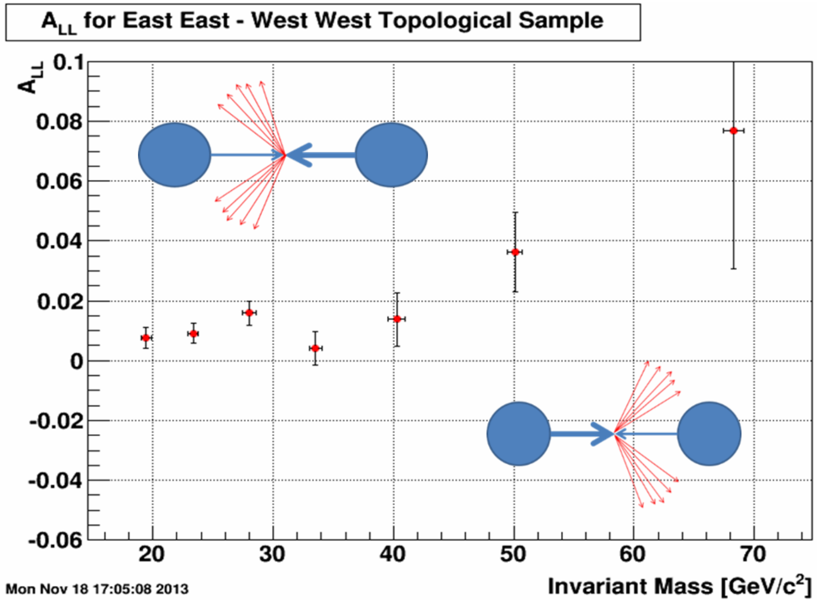
- In Simulation: For each detector level mass bin find particle level – detector level mass difference
- Mass Shift is the mean of the distribution in each bin

- Shifts calculated for particle / parton levels, topologies, triggers, and track loss percentages

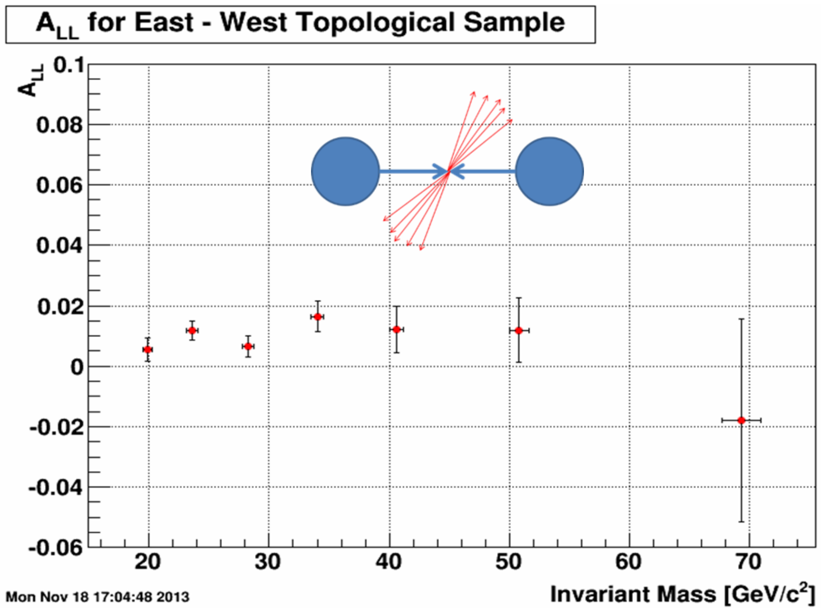


Di-Jet A_{LL}





$$A_{LL} = \frac{1}{P_Y P_B}\left[\frac{(N^{++}+N^{--}) - R_3\,(N^{+-}+N^{-+})}{(N^{++}+N^{--}) + R_3\,(N^{+-}+N^{-+})}\right]$$



- Di-jet A_{LL} is shown for two unique topologies and the combination
- Results have been updated since thesis was submitted and are currently under review

Conclusions

- The mid-rapidity di-jet cross section has been measured at $\sqrt{s}$ = 200 GeV using the Anti-k_T algorithm and is in good agreement with NLO pQCD theoretical predictions

- The good agreement between data and theory shows that di-jets are well understood at STAR

- The di-jet A_{LL} has been measured for two unique topological configurations which sample different partonic kinematics

Backup

False Asymmetries

$$A_L^Y = \frac{1}{P_Y}\left[\frac{(N^{--}+N^{-+}) - R_1\,(N^{++}+N^{+-})}{(N^{--}+N^{-+}) + R_1\,(N^{++}+N^{+-})}\right]$$

$$A_L^B = \frac{1}{P_B}\left[\frac{(N^{--}+N^{+-}) - R_2\,(N^{++}+N^{-+})}{(N^{--}+N^{+-}) + R_2\,(N^{++}+N^{-+})}\right]$$

$$A_{LL}^{ls} = \frac{1}{P_Y P_B}\left[\frac{N^{--} - R_4 N^{++}}{N^{--} + R_4 N^{++}}\right]$$

$$A_{LL}^{us} = \frac{1}{P_Y P_B}\left[\frac{R_6 N^{-+} - R_5 N^{+-}}{R_6 N^{-+} + R_5 N^{+-}}\right]$$

False Asymmetries