Towards a Measurement of $\sigma(gg \to t\bar{t}) / \sigma(q\bar{q} \to t\bar{t})$ in $p\bar{p}$ Collisions at E_{CM} of 1.96 TeV

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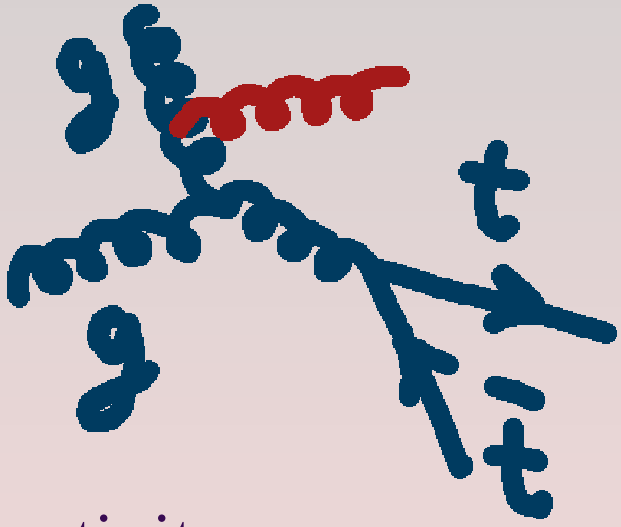
Introduction

- According to SM, in $p\bar{p}$ collisions at $\sqrt{s} \sim 2$ TeV
  - $gg \rightarrow t\bar{t}$ ~ 15%
  - $q\bar{q} \rightarrow t\bar{t}$ ~ 85%
- Measure $\sigma_{(gg\rightarrow t\bar{t})} / \sigma_{(q\bar{q}\rightarrow t\bar{t})}$
  - Test of pQCD calculations
  - Non-SM mechanisms

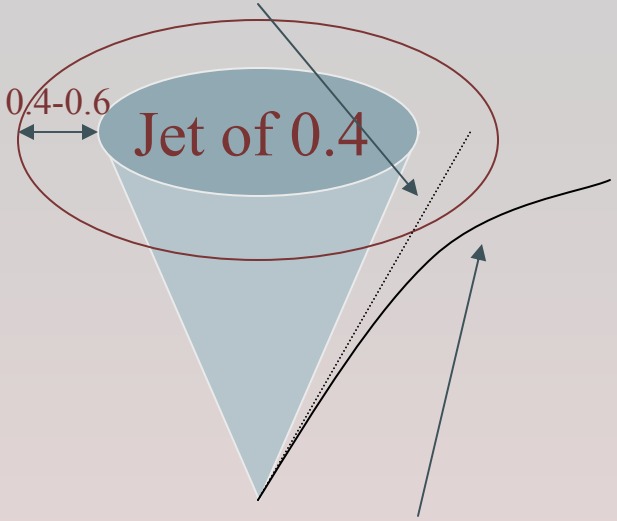


- Processes differ in underlying activity
  - The difference comes from ISR

The Difference

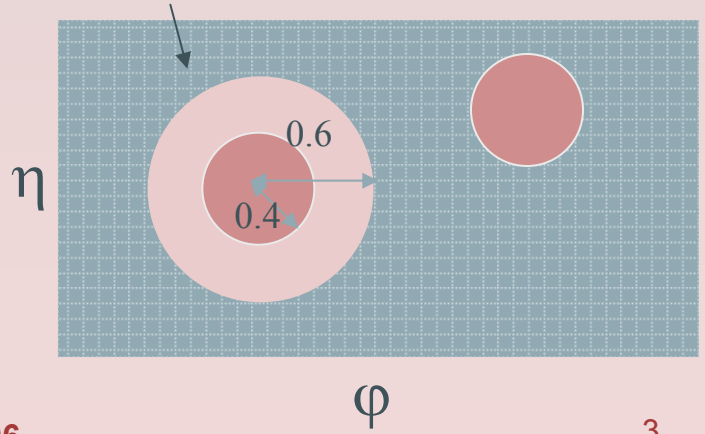
- Gluons radiate more gluons than quarks do
  - More charged particles in gg channel
- Track Multiplicity
  - Low p_T
  - $|\eta| \leq 1.1$
  - Matched to the event vertex
  - Away from jets
  - Correct for area differences

Track if no magnetic field exists



Track in magnetic field

Jet of 0.4 and its annuli



Calibration Samples

- Can not rely on the modeling of gluon radiation
- Should calibrate using data
  - W + n jet events
    - W with no jet is mainly $q\bar{q}'$
    - As jet multiplicity increases, the gluon-content increases
  - Dijet events
    - Gluon-content decreases as the leading jet E_T increases

Jet in W+ n jet categories:

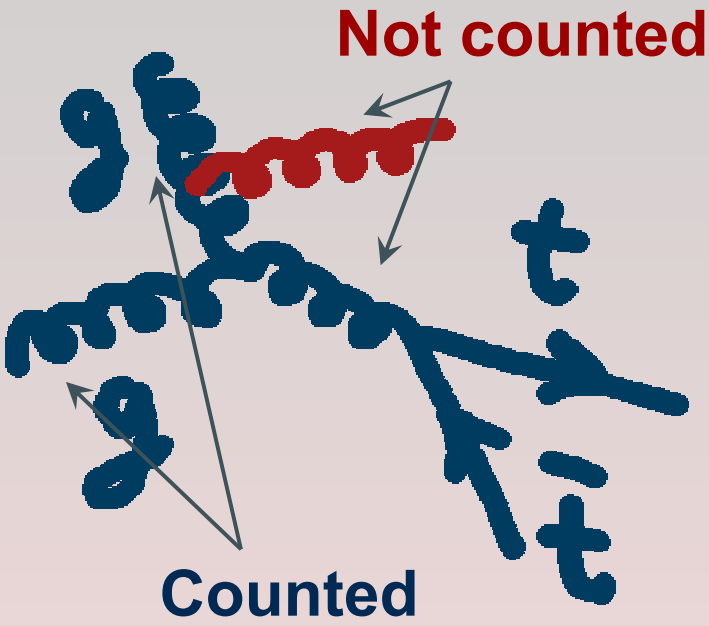
- $E_T \geq 20$
- $|\eta| \leq 2$

Leading jet in dijet categories:

- starting from 80 GeV
- bins of 20 GeV
- up to 220 GeV or more

Correlation of $<N_{trk}>$ and $<N_g>$ ...

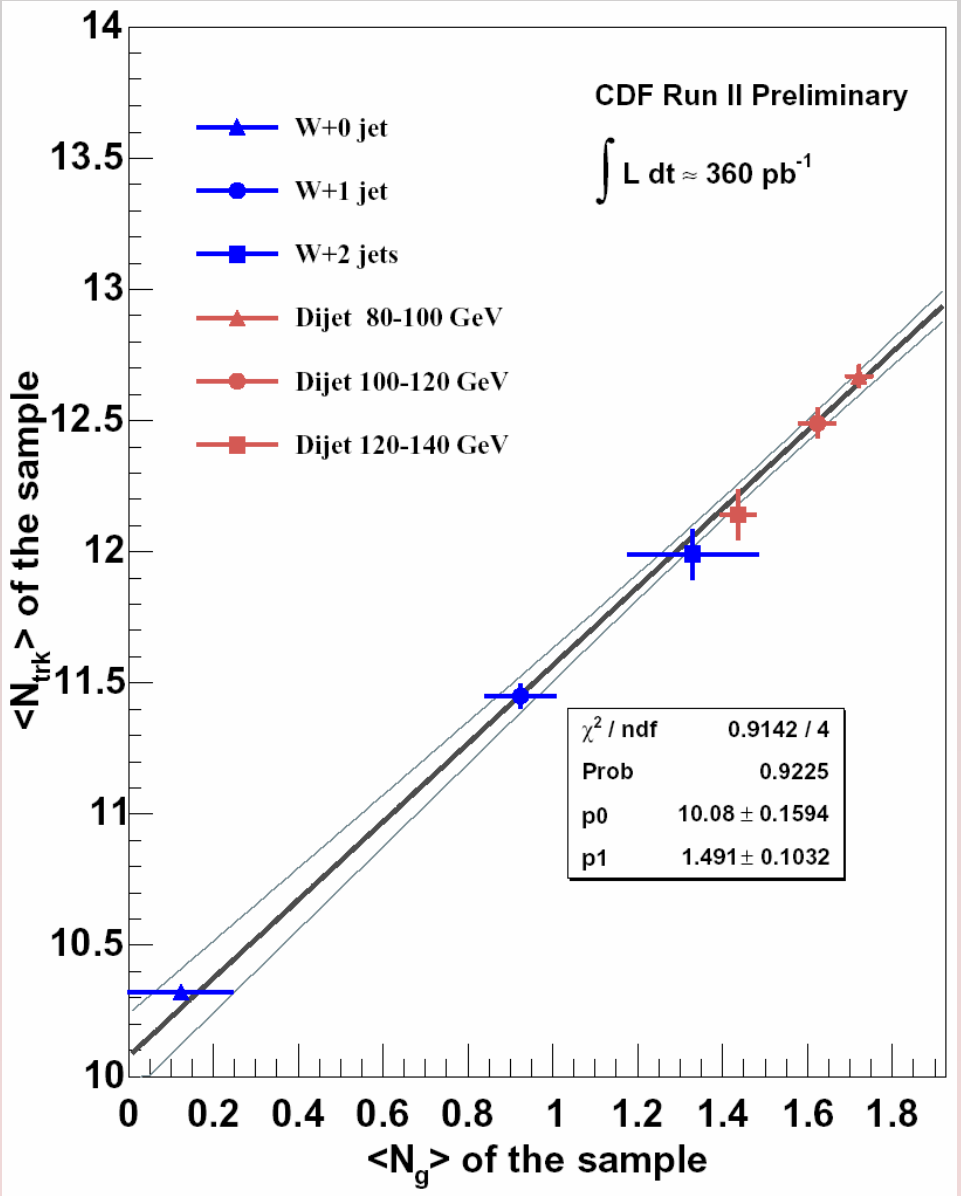
- Count the number of gluons which are part of the Martix Element
- Add the number for all the MC events
- Divide by the total number of MC events



$$\frac{\sum_{\text{events}} \text{number of gluons in the initial and final state of the process}}{\text{Total number of events}}$$

...Correlation of $<N_{trk}>$ and $<N_g>$...

Sample	MC $<N_g>$	Data $<N_{trk}>$
W+0 jet	0.12 ±0.12	10.32±0.01
W+1 jet	0.92 ±0.08	11.45 ±0.04
W+2 jets	1.33 ±0.15	11.99 ±0.09
80-100 GeV	1.72 ±0.03	12.67 ±0.04
100-120 GeV	1.62 ±0.04	12.49 ±0.05
120-140 GeV	1.44 ±0.04	12.14 ±0.09



Using the fit to find $\langle N_g \rangle$ for $\langle N_{trk} \rangle$ of other calibration samples

Sample	MC prediction	Fit result
140-160 GeV	1.26 ±0.04	1.22 ±0.04
160-180 GeV	1.13 ±0.04	1.10 ±0.04
180-200 GeV	0.99 ±0.07	0.98 ±0.05
200-220 GeV	0.92 ±0.10	0.81 ±0.06
220+ GeV	0.67 ±0.10	0.67 ±0.07

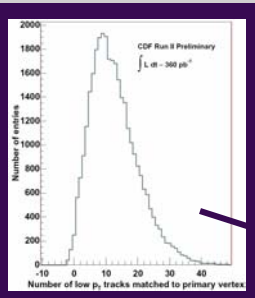
Measuring <Ng> in Calibration Samples

- Define and parameterize two distributions representing no-gluon and gluon-rich samples
  - F_q, W+0 jet which is almost purely qq→W
  - F_g, dijet sample with leading jet E_T of 80-100 GeV after we subtract the qq component from it, here we use PYTHIA dijet Monte Carlo calculations, an average of 2.37 gluons
- Use the normalized parameterization of the two distributions in a fit to the low p_T track multiplicity distribution in any other sample

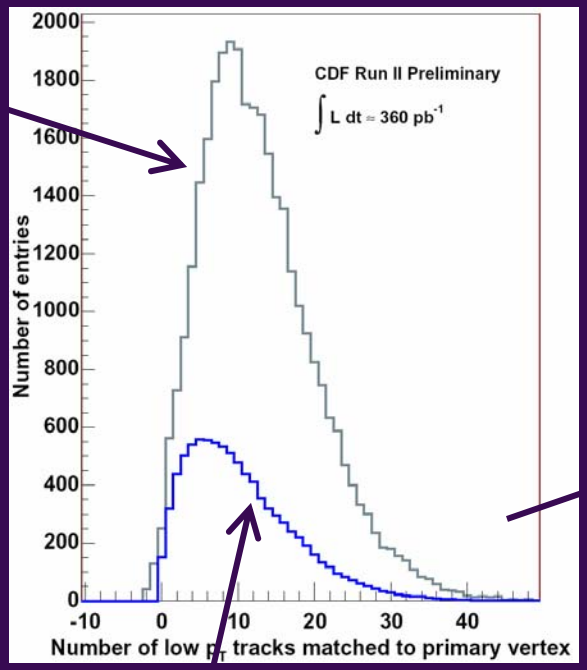
$$N[f_{glu-rich}F_g^{norm} + (1-f_{glu-rich})F_q^{norm}]$$

- $\langle N_g \rangle^{measured} = 2.37 * f_{glu\text{-}rich}$

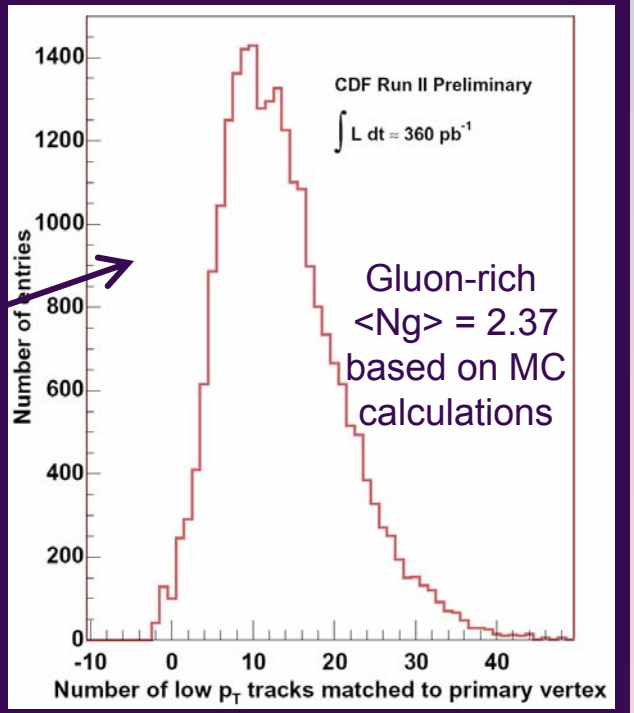
Gluon-Rich Distribution



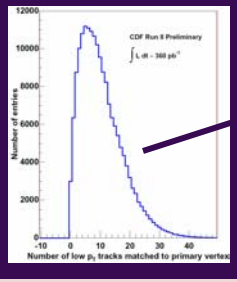
DATA
dijet 80-100 GeV
Based on MC
27% $qq \rightarrow qq$
<Ng> = 2.37
for the rest



Subtract

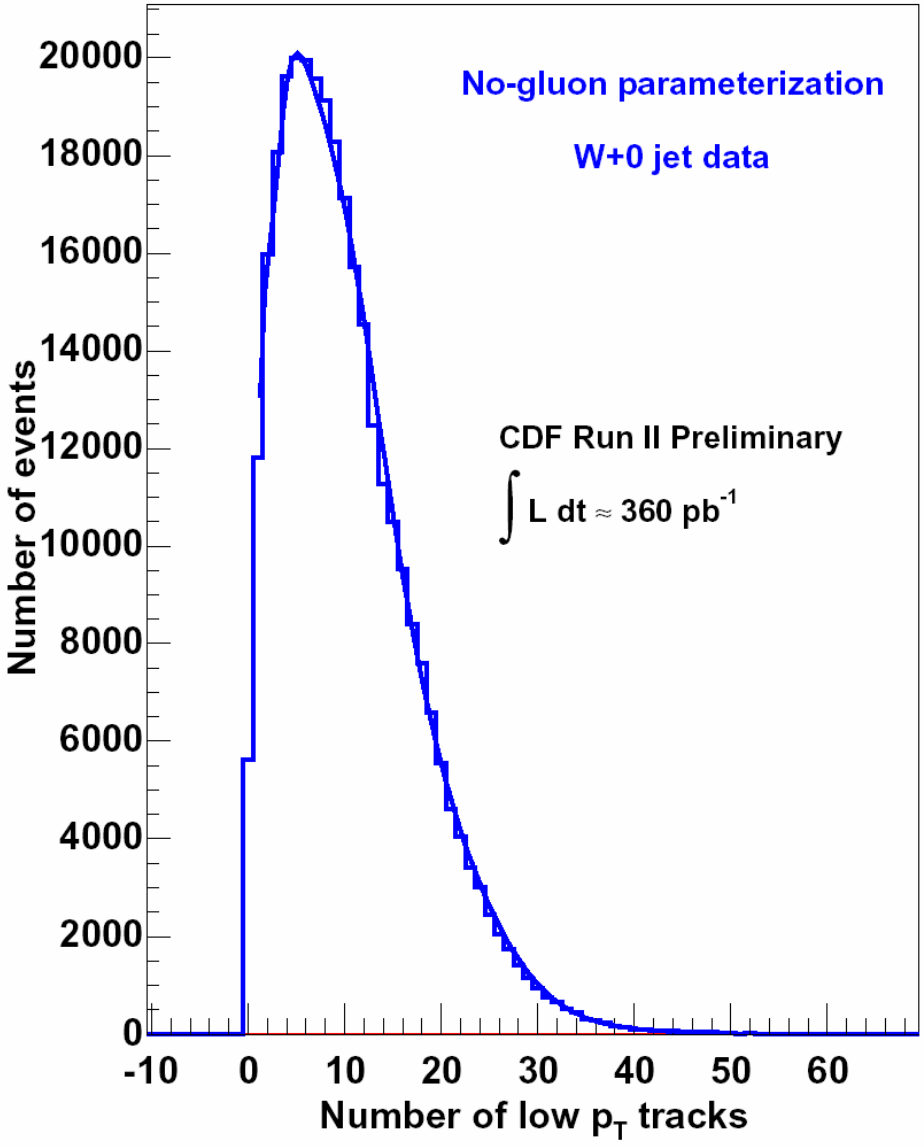


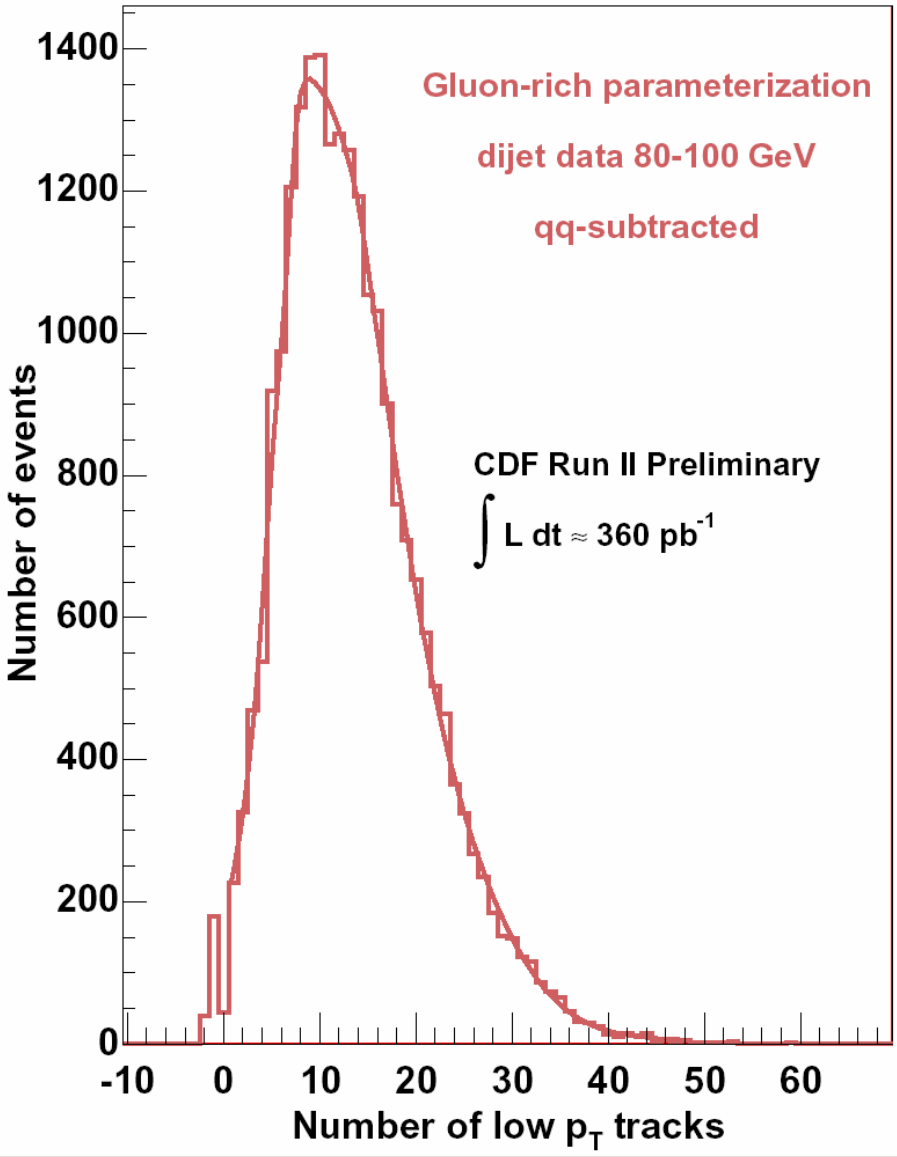
DATA
W+0 jet
Similar to
$qq \rightarrow qq$



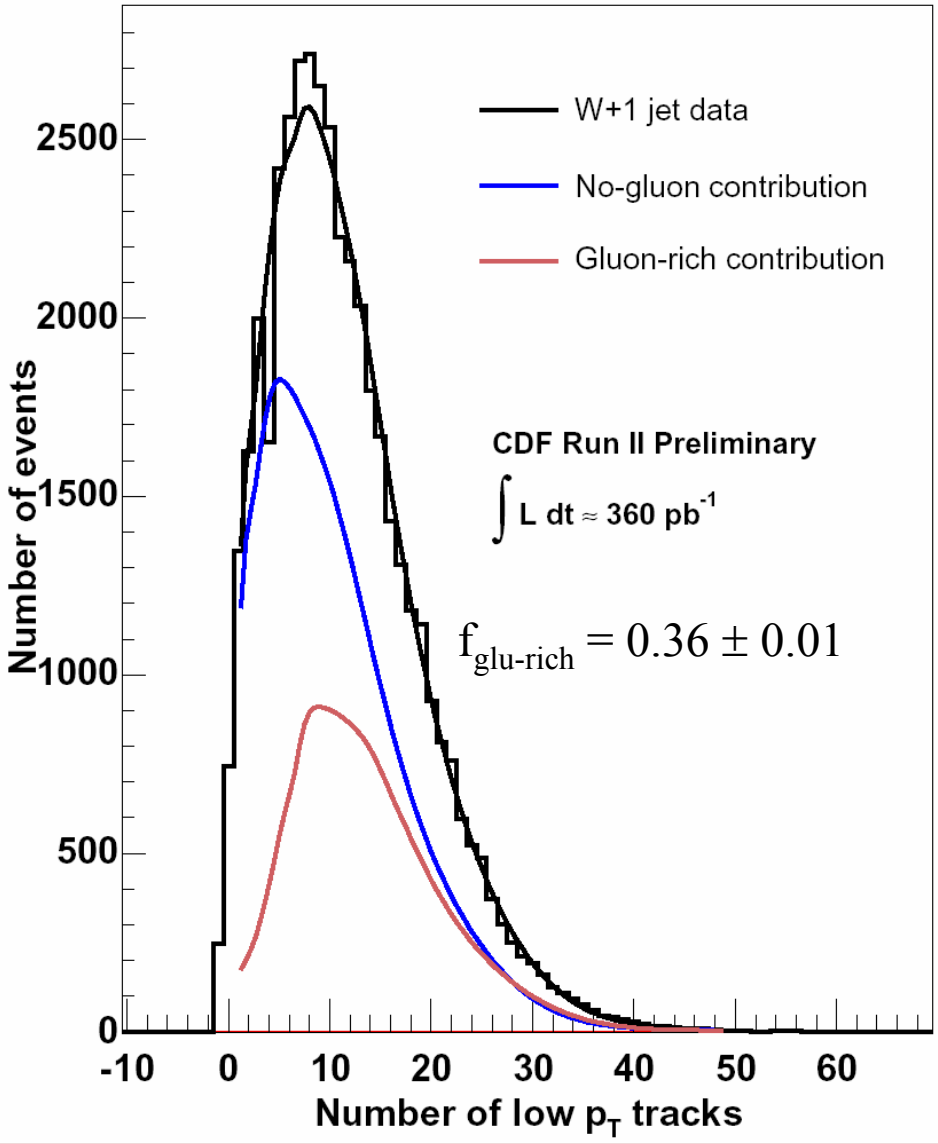
Normalized to dijet
80-100 GeV
Scaled by 0.27 to
represent $qq \rightarrow qq$

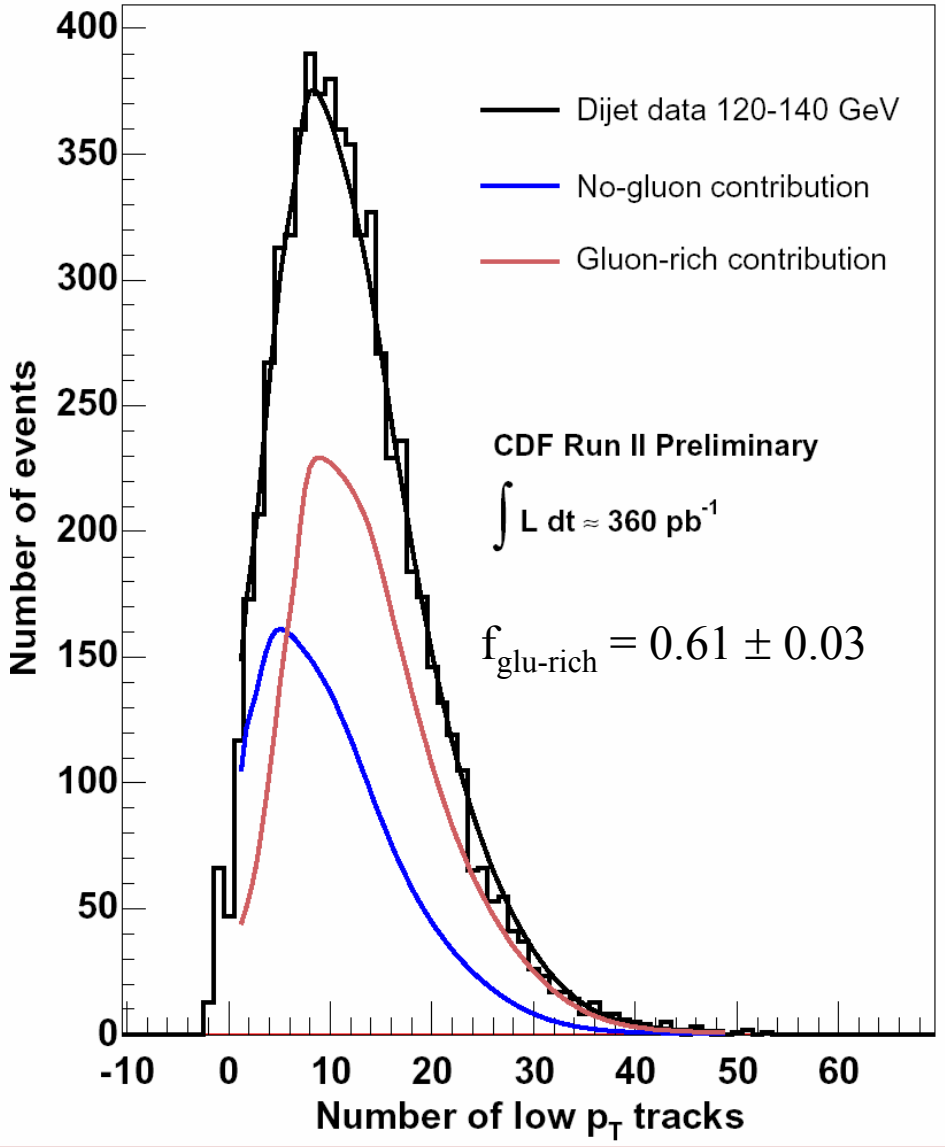
Parameterizations





Two sample fits





Sample	$\langle N_g \rangle$ from fit $2.37\ F_{glu\text{-}rich}$	MC $\langle N_g \rangle$
W+1 jet	0.84 ±0.03	0.92 ± 0.08
W+2 jet	1.12 ±0.05	1.33 ±0.15
100-120 Gev	1.59 ±0.03	1.62 ±0.02
120-140 GeV	1.45 ± 0.06	1.44 ±0.04
140-160 Gev	1.26 ±0.03	1.26 ±0.04
160-180 GeV	1.14 ±0.04	1.14 ±0.04
180-200 GeV	1.00 ±0.05	0.99 ±0.07
200-220 GeV	0.89 ±0.08	0.92 ±0.10
220+ GeV	0.70 ±0.08	0.67 ±0.10

Summary

- Using about 380 pb^{-1} data collected at CDF, we show
  - There exists a clear correlation between the $<N_g>$ and $<N_{trk}>$
  - $<N_g>$ in a sample can be determined using low p_T track multiplicity distribution of the sample, using only one input value from Monte Carlo
  - The fit results are in good agreement with MC predictions

Outlook

- Use the measurement of the $<N_g>$ in W+4 jets sample to get the fraction of $gg \rightarrow t\bar{t}$
- Looking forward to seeing the result? Don't miss Canadian Association of Physicists Congress…