



First Measurement of $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$

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We present the first measurement of $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$. We use the low P_T track multiplicity in lepton+jet channel to separate out gg initial states. We show that the average number of low P_T tracks scales with the gluon content of the sample. We take advantage of the fact that the gluon composition of the gluon rich fraction of the Standard Model $t\bar{t}$ processes is close to that of the gluon-rich fraction of dijet samples with relatively high leading jet E_T values, and that the W+0 jet sample is dominated by $q\bar{q}$ initial states. We extract the gluon rich fraction and measure $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$. We find a value of $0.07 \pm 0.14(\text{stat}) \pm 0.07(\text{syst})$ for $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$ using 0.95 fb^{-1} of data.

Preliminary Results for Winter 2007 Conferences

According to the standard model (SM) in $p\bar{p}$ collisions of center-of-momentum of about 2 TeV, top quark pairs are expected to be produced through gluon gluon fusion (15%) and quark-antiquark annihilation (85%) [1]. In this study, we make a measurement of the $t\bar{t}$ cross section fraction through gg fusion. This can provide a test of the perturbative quantum chromodynamics (pQCD). Also, it may reveal the existence of unknown $t\bar{t}$ production and top quark decay mechanisms, where the new decay mechanism hides the excess due to a new production mechanism [2]. Thus, there is an interest in studying the $t\bar{t}$ production mechanisms independent of the $t\bar{t}$ final state channels.

In order to make this measurement, one needs to discriminate between the two production channels. In this study, we take advantage of the fact that gluons are more likely to radiate a gluon with a low fraction of their momentum than quarks, as such we expect to see a larger number of low energy particles in gg than in $q\bar{q}$ production. To be able to observe this difference, we use the low P_T charged particle multiplicity. The CDF II detector is described in detail in [4]. As there are large uncertainties associated with the Monte Carlo (MC) prediction for soft gluon radiation, we cannot rely on MC for this analysis and so define a number of calibration samples that are similar to the gg and $q\bar{q}$ processes.

II. DATA SAMPLE & EVENT SELECTION

This analysis is based on an integrated luminosity of 0.95 fb^{-1} collected with the CDF II detector between March 2002 and February 2006. We use both data and MC samples for dijet and W+n jet processes as explained in the following subsections. These samples have different gluon contents based on their leading jet E_T range or jet multiplicity, respectively. The MC samples are used to find the average number of gluons present in each sample while data samples are used to find the average number of charged particles in a sample.

A. W+n Jet Samples

The W+n jet data are collected with an inclusive lepton trigger that requires an electron or muon with $E_T > 18$ GeV ($P_T > 18$ GeV/c for the muon). From this inclusive lepton dataset we select events offline with a reconstructed isolated electron E_T (muon P_T) greater than 20 GeV and missing $E_T > 20$ GeV. Jets have $E_T > 15$ GeV and $|\eta| < 2$. W+n jet samples where n = 0, 1, 2, or 3 constitute part of our calibration sample. We remove any event that is a $t\bar{t}$ dilepton or a Z boson candidate and veto any event where the electron is consistent with coming from a conversion. The MC sample used for the W+n jet is ALPGEN+PYTHIA for $W(\rightarrow e/\mu\nu) + 0, 1, 2, 3$ and 4 partons, where each sample is added with the appropriate weight based on their cross sections. The same event selection criteria is applied to both data and MC. Jets are defined using a cone algorithm with a cone of 0.4 and are corrected for energy calibration, calorimeter η dependence and multiple interactions.

B. Dijet Samples

The dijet data are collected using two inclusive jet triggers that require a jet with E_T of 50 and 100 GeV. The MC samples are generated using PYTHIA [5] with minimum parton P_T of 40 and 90 GeV tuned to reproduce the underlying events. For both data and MC, the following event selection criteria is used:

- To avoid any trigger bias, we require a minimum uncorrected leading jet E_T of 75 and 130 GeV for Jet50 data (Jet40 MC) and Jet100 data (Jet90 MC), respectively.
- We remove any event that has any electron or muon with $E_T > 18$ GeV ($P_T > 18$ GeV/c for the muon).
- We require 2 and only 2 jets within $|\eta| \leq 2$ with a minimum corrected E_T of 20 GeV in the event.
- The two jets should be back-to-back in ϕ within 35° .

Jets are defined the same way as in the W+n jet samples except that they are also corrected for any non-linearity and energy loss in the un-instrumented regions of the calorimeter.

To define $t\bar{t}$ candidates, we consider $W+\geq 4$ jet candidates. This sample has a noticeable background coming from the W boson production in association with jets. To reduce this background, we require at least one of the jets in the event to be identified as coming from a b-quark (b-tagged) jet using the SecVtx algorithm [3]. Our selection criteria for $t\bar{t}$ candidates is similar to the standard $t\bar{t}$ cross section measurements. Jets are defined in the same way as they are in the $W+n$ jet samples.

III. TRACK MULTIPLICITY

We show that there is a correlation between the number of high-energy gluons and number of low P_T tracks in a given sample. We find the average number of low P_T tracks, $\langle N_{trk} \rangle$, using data and the average number of high-energy gluons in the sample, $\langle N_g \rangle$, using MC as explained in the following subsections.

A. Track Selection

In this section, we describe the selection criteria for including a track in our definition of track multiplicity. The goal is to have a measure that best correlates with the presence of the soft gluons radiated from the “matrix element” partons in the event. Therefore, it should be independent of the number of extra interactions and number of jets present in the event. One also likes to reduce the contribution from the final state partons in order that the measure be topology independent. We use the following criteria:

- We use tracks with P_T in the range 0.3-2.9 GeV/ c and $|\eta| \leq 1.1$, where we expect to have good tracking coverage.
- The tracks should not be part of the jets present in the event. We therefore require the tracks not to fall within $\Delta R = 0.6$ of the high E_T jets (15 GeV or more) and within $\Delta R = 0.4$ of the low E_T (6-15 GeV) jets in the event. These cuts are set as such due to the fact that we expect higher E_T jets to generate larger number of wide-angle, low P_T particles than low E_T jets do.
- The track should match the primary vertex of the event within ± 3 cm. This requirement reduces the contribution from other interactions. We also check that the track will not match a second vertex better than it does match the primary vertex. Such tracks are rejected.
- The fact that we exclude regions around the jets provides different tracking area available for different events and samples. To have a comparable measure of track multiplicity, we find the track density for each event by dividing the track multiplicity by the available tracking area. Then, we multiply this density with the total central area, 4.4π , to get our tracking multiplicity.
- The track multiplicity, even though tracks from jets are excluded, still has a modest dependency on the number of high E_T jets in the event. We therefore make a further correction due to contribution from each high E_T jet present in the central ($|\eta| \leq 1.1$) region.

For the track selection, in all samples, the jets are defined using a cone algorithm with a cone of 0.4 and are corrected for energy calibration, calorimeter η dependence, multiple interactions and any non-linearity and energy loss in the un-instrumented regions of the calorimeter.

B. Counting Gluons

We apply the same event selection cuts to data and to MC samples. Using the generator-level information, we count the number of gluons in each event, taking into consideration the 2 incoming and all the outgoing partons. We define the outgoing partons as the immediate daughters of the 2 incoming partons. For all dijet samples, we have 2 incoming and 2 outgoing partons. In the W samples, depending on the type of generated event, we have 2 incoming and 0, 1, 2, 3 or 4 (excluding the W boson) outgoing partons corresponding to the $W+0$, 1, 2, 3 or 4 parton samples used to create the $W+n$ jet MC sample. To get the average number of gluons in a sample, we sum over the number of gluons in each event of our MC sample and divide the sum by the total number of events in the sample.

The correlation between $\langle N_{trk} \rangle$ (measured from data) and $\langle N_g \rangle$ (MC calculations) as well as the linear χ^2 fit to W+0, 1 and 2 jet samples along with the dijet samples with leading jet E_T range 80-100, 100-120 and 120-140 GeV are shown in Fig. 1. This correlation can be used to measure $\langle N_g \rangle$ in a given data sample. The comparisons of the measured and the expected $\langle N_g \rangle$ are shown in Table I.

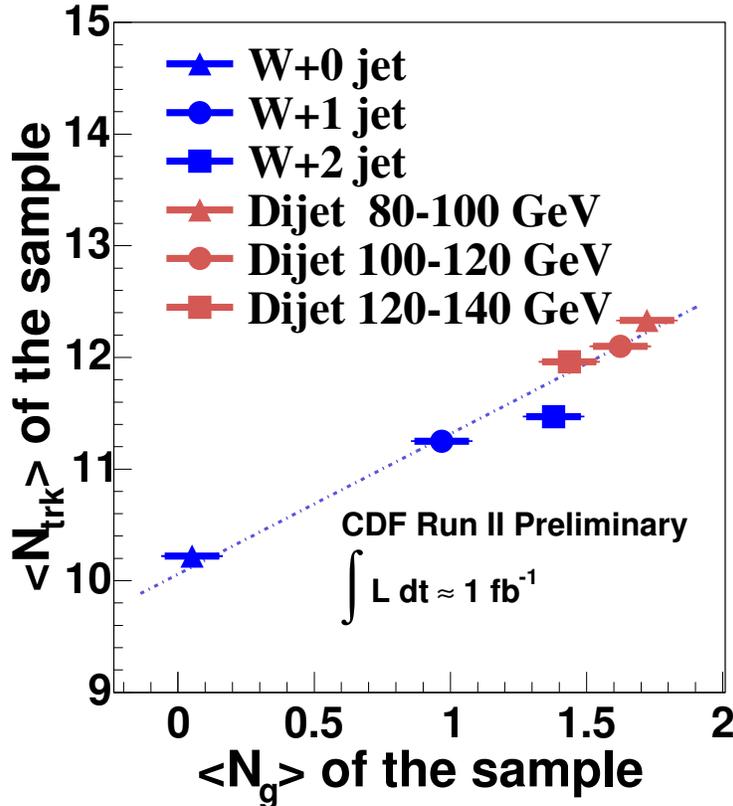


FIG. 1: Using three W and three dijet samples, we find the correlation between the average low P_T track multiplicity and the average number of gluons. $\langle N_g \rangle$ is predicted using MC for each sample and $\langle N_{trk} \rangle$ is measured using data. Different samples are shown with different markers and colors. The lighter grey(red) corresponds to dijet samples and the darker grey(blue) represents W samples. Solid circles, squares and triangles are used to distinguish different subsamples as specified in the legend.

IV. MEASUREMENT METHOD

The $\langle N_{trk} \rangle$ and $\langle N_g \rangle$ correlation enables us to define low P_T track multiplicity distributions representing specific average number of gluons. Most importantly, we can define gluon rich distributions and distributions with no gluon content. The latter can be defined using the W+0 jet data sample. This sample is almost purely a quark-quark process with a small QCD background of order 1%. It also includes some gluon content coming from W production in association with other partons when we fail to observe these final-state partons in form of jets, (we call this the “feed-down background”). We use MC calculations to predict the composition of this background and its contribution to the average number of gluons present in the W+0 jet sample. To define the gluon rich distribution, we use our dijet sample with the lowest jet E_T range, 80-100 GeV. In order to have as pure as possible no-gluon distribution and a gluon rich distribution with a comparable gluon content to that of the $t\bar{t}$, we iteratively subtract the gluon component from W+0 jet sample and $qq \rightarrow qq$ contribution from the dijet sample with a leading jet E_T of 80-100 GeV. The $qq \rightarrow qq$ process is estimated to be about 27% in the 80-100 GeV dijet sample using PYTHIA MC calculations. We

Sample	MC expectation from fit to data	
dijet 140-160 GeV	1.26 ± 0.04	$1.39_{-0.05}^{+0.06}$
dijet 160-180 GeV	1.13 ± 0.04	1.23 ± 0.05
dijet 180-200 GeV	0.99 ± 0.07	$1.08_{-0.06}^{+0.05}$
dijet 200-220 GeV	0.92 ± 0.10	$0.88_{-0.07}^{+0.04}$
dijet 220+ GeV	0.67 ± 0.10	$0.65_{-0.10}^{+0.05}$

TABLE I: The average number of gluons in each sample as predicted by MC calculations and the average number of gluons as found using the correlation fit for data. All uncertainties are statistical.

first normalize the W+0 jet sample to our dijet sample and then subtract it from the dijet sample by a factor of 0.27. This will give us the first gluon rich sample. We then use this subtracted, gluon rich sample to subtract the gluon content contribution to the W+0 jet distribution. We have an $\langle N_g \rangle$ estimate of 0.15 for the W+0 jet sample, where about 0.05 is the feiddown background contribution and about 0.1 is the QCD background contribution, as we have $(4.9 \pm 0.4)\%$ QCD background and we assume it has a similar gluon content as that of the gluon rich sample. Using the estimated gluon composition of the dijet sample, from PYTHIA MC calculations, we then subtract the gluon content of the W+0 jet. This subtracted version of the W+0 jet sample is what we consider as our no gluon distribution. Finally, we subtract the $qq \rightarrow qq$ contribution from dijet 80-100 GeV track multiplicity distribution using our no gluon distribution, normalized and scaled to the appropriate fraction of $(27 \pm 3)\%$. The remaining distribution is what we consider our gluon rich sample. Changes to the distributions due to subsequent iterations are indistinguishable. We use the normalized parameterizations of these distributions in a simple binned likelihood fit with two free parameters to find the fraction of gluon rich components in a given sample. Figure 2 shows the parameterizations of the no gluon and gluon rich distributions. The gluon rich fraction of a given low P_T track multiplicity distribution can be found using a fit of the N_{trk} distribution to the form

$$N[f_g \mathcal{F}_g + (1 - f_g) \mathcal{F}_q], \quad (1)$$

where N is the normalization factor and one of the free parameters, f_g is the fraction of gluon rich components of the sample and the second free parameter, and \mathcal{F}_g and \mathcal{F}_q are the normalized gluon-rich and 0-gluon parameterizations, respectively.

The fraction f_g can be used as the fraction of gluon-rich components for samples with similar gluon composition or can be used to find the $\langle N_g \rangle$ in a given sample by multiplying it with the estimated $\langle N_g \rangle$ in the gluon-rich distribution, ~ 2.36 , based on its gluon composition. Table II summarizes the f_g measured using the fit to the dijet data calibration sample distributions and estimated f_g from MC calculations. The good agreement between the fit values shows that our decomposition works and allows us to move to the next step, the extraction of the gluon-rich fraction of the $t\bar{t}$ sample and measurement of $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$.

Sample	MC expectation f_g from fit to data	
dijet 80-100 GeV	0.73 ± 0.03	0.73 ± 0.01
dijet 100-120 GeV	0.69 ± 0.03	0.69 ± 0.01
dijet 120-140 GeV	0.63 ± 0.04	0.66 ± 0.01
dijet 140-160 GeV	0.57 ± 0.04	0.63 ± 0.01
dijet 160-180 GeV	0.52 ± 0.04	0.57 ± 0.01
dijet 180+ GeV	0.42 ± 0.05	0.49 ± 0.01

TABLE II: The fraction of gluon-rich events in each sample as predicted by MC calculations and the fraction of gluon-rich events as found using the likelihood fit to track multiplicity distributions. All data and fitted uncertainties are statistical. Uncertainties for the MC fractions are statistical and systematical.

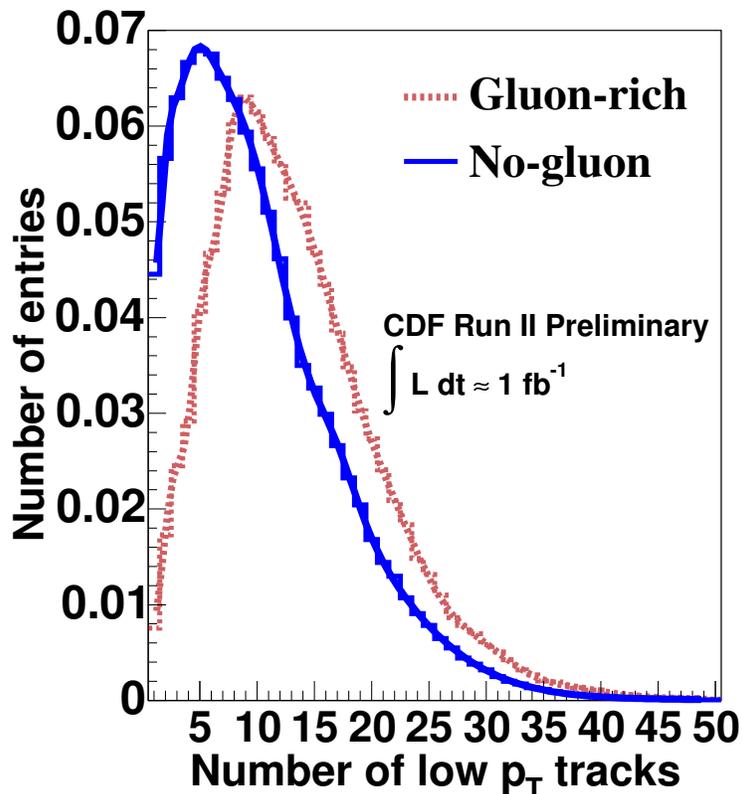


FIG. 2: Comparison between no-gluon and gluon-rich parameterizations.

A. $t\bar{t}$ Gluon Rich Fraction

The measured gluon rich fraction in the tagged $W+\geq 4$ or more jet sample consists of two components, the $t\bar{t}$ gluon-rich fraction and the background gluon-rich fraction. Therefore, knowing the background fraction in our sample and the measured f_g from the fit, we can write

$$f_g = f_b f_g^{bkg} + (1 - f_b) f_g^{t\bar{t}}, \quad (2)$$

where, f_b is the background fraction and f_g^{bkg} and $f_g^{t\bar{t}}$ are the gluon rich fraction of the background and $t\bar{t}$ signal, respectively. The latter is what we want to measure, while f_b can be estimated for the 4 or more jets tagged sample as done in $t\bar{t}$ cross section measurements. Figure 3 shows the fit to the tagged $W+\geq 4$ or more jets sample. In order to find the fraction of gluon-rich components in the background, we measure f_g in $W+1$, $W+2$ and $W+3$ jet data samples with no positive SecVtx tag and with at least one tight SecVtx b-tag using the fit to the N_{trk} distribution for each sample. We then extrapolate the f_g values from $W+1$, 2 and 3 jet to $W+4$ or more jet bins for both tagged, $f_g^{bkg^{Tagged}}$, and no-tag, $f_g^{bkg^{Notag}}$, samples. We consider the tagged sample as the representative of the single top and heavy flavour backgrounds (HF), and the no-tag sample as representative of the light flavour background (LF). As the background coming from QCD processes (nonW) consists of both HF and LF events, we consider half of this background to contribute to HF and half to the LF background. Therefore, one can get an estimate of f_g^{bkg} by adding $f_g^{bkg^{Tagged}}$ and $f_g^{bkg^{Notag}}$ weighted by the corresponding background fractions, f_{bkg}^{HF} and f_{bkg}^{LF} . This results in

$$f_g^{bkg} = f_g^{bkg^{Notag}} f_{bkg}^{LF} + f_g^{bkg^{Tagged}} f_{bkg}^{HF}. \quad (3)$$

We determine the f_g^{bkg} uncertainty assuming Gaussian distributions for the four variables used to define f_g^{bkg} and then numerically calculating a distribution for f_g^{bkg} . Using this distribution, we find a value of 0.53 ± 0.09 for the

gluon-rich fraction of the background. The gluon fractions found by the fit to the W+1, 2 and 3 jet samples in both tagged and no-tag samples as well as the extrapolated values are shown in Table III. The gluon-rich fraction in the no-tag sample increases with increasing jet multiplicity. The tagged sample has contributions from $t\bar{t}$ in the 2 and 3 jet bin and as such, assuming SM prediction for $t\bar{t}$, one would expect the actual gluon-rich fraction to be different from what we observe if we take into account the contribution from $t\bar{t}$. To correct for this, one needs to know $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$. As this is the variable we measure and given the small contribution of tagged f_g to the calculation of $f_g^{t\bar{t}}$, we use the observed fractions with no correction.

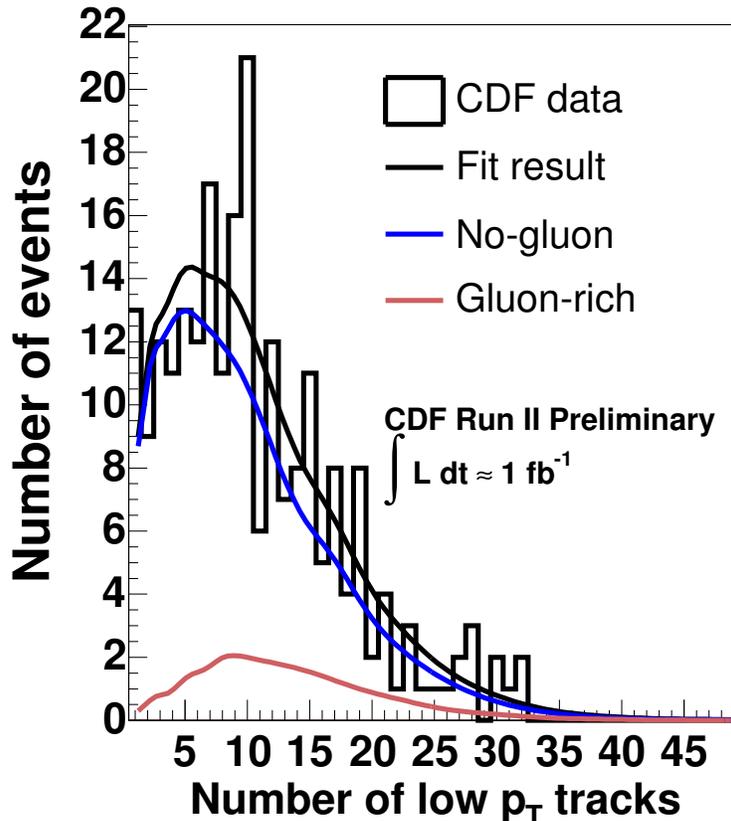


FIG. 3: The fit result for the tagged W+4 or more jet sample. The two components of the fit (gluon-rich and no-gluon) contributions are also shown.

Jet multiplicity	No b-tag	At least 1 b-tag
W+1 jet	0.41 ± 0.01	0.56 ± 0.05
W+2 jet	0.51 ± 0.02	0.42 ± 0.08
W+3 jet	0.56 ± 0.04	0.44 ± 0.12
Extrapolated W+4 or more jets	0.72 ± 0.05	0.27 ± 0.19

TABLE III: Gluon-rich fraction values from the likelihood fit to the low P_T track multiplicity distributions for W+0, 1 and 2 jet samples with no positive b-tag and with at least one positive b-tag, as well as the extrapolated gluon-rich fractions for both tagged and no-tag sets.

We use the $t\bar{t}$ cross section measurement [6] estimates to get the background event fraction as well as the HF and LF fractions. The background fractions used in the analysis, f_b , f_{bkg}^{HF} and f_{bkg}^{LF} in the tagged sample, are summarized in Table IV. Using $f_b = 0.13 \pm 0.02$, $f_g^{bkg} = 0.53 \pm 0.09$ and measured $f_g = 0.15 \pm 0.14$, we get $f_g^{t\bar{t}} = 0.09 \pm 0.16$. The systematic uncertainties will be discussed in a subsequent section.

	Tagged W+4 or more jet sample
HF/bkg	0.45 ± 0.11
LF/bkg	0.55 ± 0.13
bkg/S+bkg	0.13 ± 0.02

TABLE IV: The background fractions used in the analysis, f_b , f_{bkg}^{HF} and f_{bkg}^{LF} in the tagged sample

B. $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$

The last step to measure $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$ is to estimate the relative acceptance of $gg \rightarrow t\bar{t}$ and $p\bar{p} \rightarrow t\bar{t}$. To do so, we use HERWIG MC calculations. We use about 4M $t\bar{t}$ events, of which about 50K arise from gg fusion and about 800K come from $q\bar{q}$ annihilation. The fraction of $gg \rightarrow t\bar{t}$ events that falls in 4 or more jet bins is higher than that of the $q\bar{q} \rightarrow t\bar{t}$, as expected due to the higher gluon radiation probability for gluons. Using the MC calculations, we find $(14.1 \pm 0.5(stat + syst))\%$ of $gg \rightarrow t\bar{t}$ and $(11.5 \pm 0.4(stat + syst))\%$ of $q\bar{q} \rightarrow t\bar{t}$ events passing our tagged sample criteria. These numbers do not have the data-MC b-tag scale factor incorporated in them. As we are interested in the relative acceptance, the effects of this factor cancel out. We find

$$\frac{\sigma(gg \rightarrow t\bar{t})}{\sigma(p\bar{p} \rightarrow t\bar{t})} = \frac{1}{1 - (\mathcal{A}_{gg \rightarrow t\bar{t}}/\mathcal{A}_{q\bar{q} \rightarrow t\bar{t}}) + (\mathcal{A}_{gg \rightarrow t\bar{t}}/\mathcal{A}_{q\bar{q} \rightarrow t\bar{t}})(1/f_g^{t\bar{t}})} = 0.07 \pm 0.14(stat), \quad (4)$$

where $\mathcal{A}_{gg \rightarrow t\bar{t}}$ and $\mathcal{A}_{q\bar{q} \rightarrow t\bar{t}}$ are the acceptance for $gg \rightarrow t\bar{t}$ and $q\bar{q} \rightarrow t\bar{t}$, respectively.

V. SYSTEMATIC UNCERTAINTIES

The systematic uncertainties of this measurement are estimated in a few steps. First, we identify and find the uncertainties affecting the track multiplicity distributions. The estimates, in principle, are done by changing the central values and observing the changes in the relevant variables. Second, we find the uncertainties for the measured gluon-rich fraction and the background gluon-rich fraction estimates. We then use these uncertainties and the background fraction uncertainties to find the uncertainty in the $t\bar{t}$ gluon-rich fraction and propagate these into the systematic uncertainty in $\frac{\sigma(gg \rightarrow t\bar{t})}{\sigma(p\bar{p} \rightarrow t\bar{t})}$.

A. Sources of Uncertainty in Track Multiplicity Distribution

- The process composition of W+0 jet and dijets with E_T of 80-100 GeV

We have used ALPGEN+PYTHIA and PYTHIA jet40 MC calculations for the process composition of W+0 jet and dijet events with E_T of 80-100 GeV samples, respectively. We also had the Gen5 MADGRAPH+PYTHIA (with $K_T = 15$) estimates for the W+0 jet sample. We have used a central value of 0.27 ± 0.03 for the $q\bar{q} \rightarrow q\bar{q}$ process in dijet 80-100 GeV and 0.15 ± 0.10 for $\langle N_g \rangle$ of W+0 jet sample. To find the systematic uncertainties due to the quark-gluon compositions used in the definition of gluon-rich and no-gluon distributions, we fluctuated the central values by one standard deviation.

- The choice of jet E_T threshold

One expects higher numbers of jets coming from initial or final state gluon radiation in events with higher gluon content. As we exclude the low P_T tracks that fall within a radius of 0.4 from the centroid of low E_T jets (6-15 GeV), our low P_T track multiplicity distribution might change differently for the gluon-rich and no-gluon events. To estimate the effect of this cut, we measure f_g and estimate f_g^{bkg} using a low E_T cut of 8 GeV instead of 6 GeV.

- The track multiplicity correction per high E_T jet

To reduce contributions to $\langle N_{trk} \rangle$ from the high E_T jets present in the event, we make additional corrections of 0.90 ± 0.03 , 0.97 ± 0.04 and 0.96 ± 0.04 tracks to the track multiplicity of the event for each central high E_T jet in the three subsets of data, differing primarily in their average instantaneous luminosity.

	f_g	f_g^{bkg}
trk/jet	± 0.051	± 0.001
jet E_T cut	± 0.021	± 0.035
dijet $qq \rightarrow qq$	± 0.002	± 0.019
W+0 jet $\langle N_g \rangle$	± 0.039	± 0.007
nonW variation	-	± 0.06
Modeling the distribution	-	± 0.09
Total	± 0.07	± 0.11
	$f_g^{t\bar{t}}$	
f_g	± 0.08	
f_g^{bkg}	± 0.02	
f_b	± 0.01	
Total	± 0.08	
	$\frac{\sigma(gg \rightarrow t\bar{t})}{\sigma(p\bar{p} \rightarrow t\bar{t})}$	
$f_g^{t\bar{t}}$	± 0.07	
$\frac{\mathcal{A}_{gg \rightarrow t\bar{t}}}{\mathcal{A}_{q\bar{q} \rightarrow t\bar{t}}}$	± 0.004	
Total	± 0.07	

TABLE V: Sources of systematics effects and their effects on different variables

We estimate the systematics associated with this correction by making the correction of $\pm 1\sigma$ of the central value for each dataset before combining them.

B. Other Uncertainties

- The estimation of f_g^{bkg}

As mentioned in Section 3, we estimate this value by extrapolation in the no-tag and tagged samples weighted by the HF and LF background fractions. Therefore, the sources mentioned above change the estimate of f_g^{bkg} . The systematic uncertainty associated with this variable is the root-square sum of uncertainty in the central value, half of the difference in the values we get if we assign all nonW background to LF or to HF backgrounds and half of the difference of the low and high values of each of the above uncertainties, except for the low jet E_T cut. In the latter, we take the difference instead of half of the difference.

- The acceptance for $t\bar{t}$ events

We associate a systematic uncertainty of 3% for the acceptance due to the parton distribution function (PDF) and MC generator differences. This value is based on the uncertainties due to PDF (2%) and choice of MC generator (2%) in $t\bar{t}$ production cross section measurement reported in [7].

These systematic uncertainties are summarized in Table V.

Taking into account these systematics effects, we find

- $f_g = 0.15 \pm 0.14(stat) \pm 0.07(syst)$,
- $f_g^{bkg} = 0.53 \pm 0.11(stat + syst)$,
- $f_g^{t\bar{t}} = 0.09 \pm 0.16(stat) \pm 0.08(syst)$,
- $\frac{\mathcal{A}_{gg \rightarrow t\bar{t}}}{\mathcal{A}_{q\bar{q} \rightarrow t\bar{t}}} = 1.23 \pm 0.06(stat + syst)$

and then determine

$$\frac{\sigma(gg \rightarrow t\bar{t})}{\sigma(p\bar{p} \rightarrow t\bar{t})} = \frac{1}{1 - (\mathcal{A}_{gg \rightarrow t\bar{t}}/\mathcal{A}_{q\bar{q} \rightarrow t\bar{t}}) + (\mathcal{A}_{gg \rightarrow t\bar{t}}/\mathcal{A}_{q\bar{q} \rightarrow t\bar{t}})(1/f_g^{t\bar{t}})} = 0.07 \pm 0.14(stat) \pm 0.07(syst). \quad (5)$$

The first measurement of $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$ is presented. Using a dataset with an integrated luminosity of 0.95 fb^{-1} . We have shown that the low P_T track multiplicity distribution in a given sample can be used to find the gluon composition of the sample. As there is no reliable MC calculations to predict the low P_T track multiplicity of a sample, we employ a data-driven method and define the shape of the low P_T track multiplicity distributions for 0-gluon process and gluon-rich process. These parameterizations are used to find the fraction of $gg \rightarrow t\bar{t}$. Using this fraction we find a value of $0.07 \pm 0.14(\text{stat}) \pm 0.07(\text{syst})$ for $\sigma(gg \rightarrow t\bar{t})/\sigma(p\bar{p} \rightarrow t\bar{t})$. MC calculations are used to predict the composition of a given process. Sources of systematic effects are explained and their estimated uncertainties are given.

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