Inclusive Jet Cross Section Measurement from 8TeV (SMP-12-012)

Sanmay Ganguly
Tata Institute Of Fundamental Research
On Behalf Of Inclusive Jet Team

September 6, 2013

DataSet And Software Used

•The data set used for the current analysis is
/Jet/Run2012A-22Jan2013-v1/AOD
/JetMon/Run2012B-22Jan2013-v1/AOD /JetHT/Run2012B-22Jan2013-v1/AOD
/JetMon/Run2012C-22Jan2013-v1/AOD /JetHT/Run2012C-22Jan2013-v1/AOD
/JetMon/Run2012D-22Jan2013-v1/AOD /JetHT/Run2012D-22Jan2013-v1/AOD

•The MC sample used is
/QCD_Pt-15to3000_TuneZ2star_Flat_8TeV_pythia6/Summer12-DR53X_S10_START53_V7A-v1/AODSIM

•The golden JSON file used is
Cert_190456-208686_8TeV_22Jan2013ReReco_Collisions12_JSON.txt

•The software version used is CMSSW_5_3_7_patch6.

Datasets	Run Range	Luminosity(pb^{-1})	GT
/Jet/Run2012A	190456-193686	815	FT_53_V21_AN6
/JetMon/Run2012B	193752-197044	4429	FT_53_V21_AN6
/JetMon/Run2012C	198934-203755	7151	FT_53_V21_AN6
/JetMon/Run2012D	203777-208686	7317	FT_53_V21_AN6
Pythia6	-	-	START53_V26

Datasets used along with the corresponding run numbers and luminosity

Trigger Thresholds

- In order to obtain the lower threshold with maximum efficiency of the jet triggers we produce trigger turn on curves for each HLT trigger paths. The trigger efficiency, for HLT_PFJetY is defined as:

$$\mathrm{Jet_{eff}Y} = \frac{\mathrm{RecoJet\_p_T(JetX{+}L1Obj\_p_T{>}Z{+}HLTObj\_p_T{>}Y)}}{\mathrm{RecoJet\_p_T(JetX)}}$$

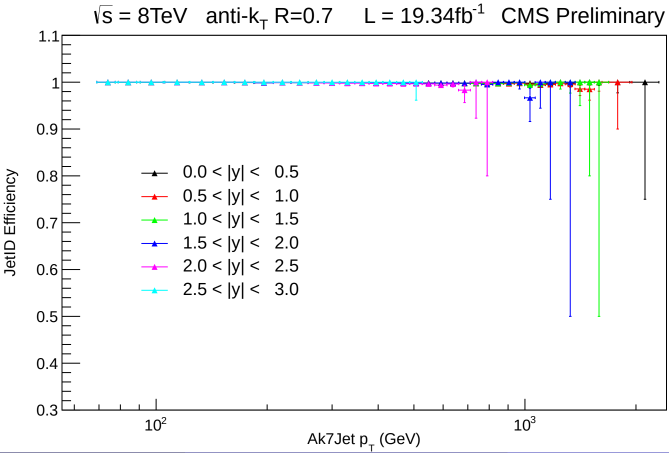
HLTPath	Jet40	Jet80	Jet140	Jet200	Jet260	Jet320
New PtCut	74	133	220	300	395	507

Table: p_T threshold(GeV) for each HLT Path. The new trigger thresholds ensure 100% trigger efficiency.

Jet ID Efficiency

The Jet Identification efficiency is estimated by tag and probe method.

•If N1 be the number of events where tag jet passes tight JetID criteria, and out of them N2 be the number of events where the probe jet also passes the tight JetID criteria, then the JetID efficiency is defined as $ID_{eff} = \frac{N2}{N1}$



Jet Energy Resoluion

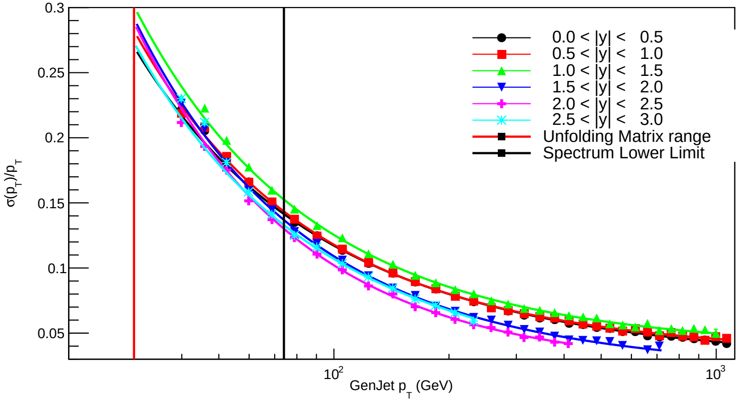


Figure: Jet energy resoluion as a function of jet p_T

Jet Energy Resoluion Parametrization

The JER is taken from MC simulation and further corrected by the factors (C_{Data}) derived from data.

The jet energy resolution $\sigma(p_T)$ is parametrized as a function of jet p_T as,

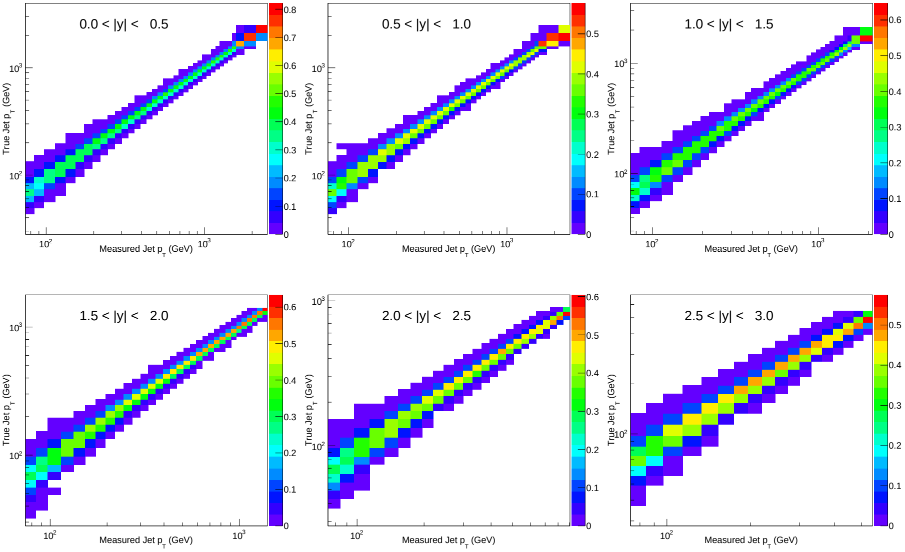
$$\frac{\sigma(p_T)}{p_T} = C_{Data}.\sqrt{\frac{N^2}{p_T^2} + \frac{S^2}{p_T} + C^2}. \tag{1}$$

The parameters N, S, C used in the above equation are shown in Table 2.

Table: The values of the JER parameters N, S and C used in equation 1.

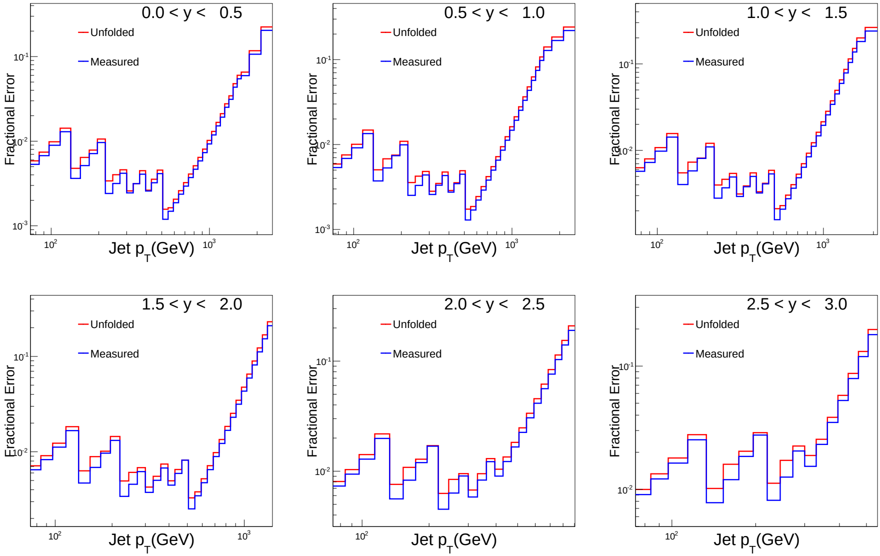
$\|y\|$ Bin	$0.0 - 0.5$	$0.5 - 1.0$	$1.0 - 1.5$	$1.5 - 2.0$	$2.0 - 2.5$	$2.5 - 3.0$
C_{Data}	1.12	1.11	1.11	1.22	1.23	1.1
N	6.130	6.815	5.695	7.321	7.312	6.847
S	0.949	0.896	0.939	0.736	0.589	0.821
C	0.031	0.035	0.039	0.021	0.023	0.036

Response Matrix



Response Matrix for each Rapidity Bin

Relative Uncertainties Before and After Unfolding

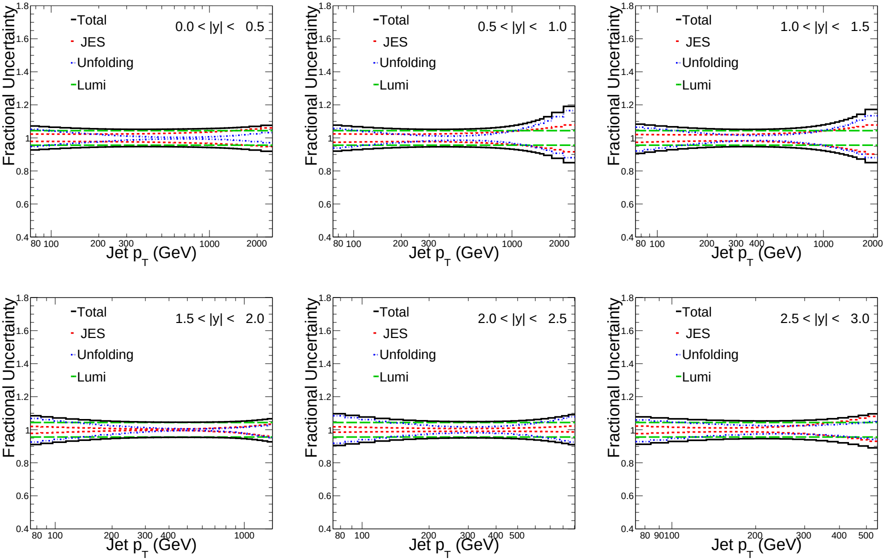


Experimental Uncertainty

The Jet energy scale uncertainty has several independent components. They are as following

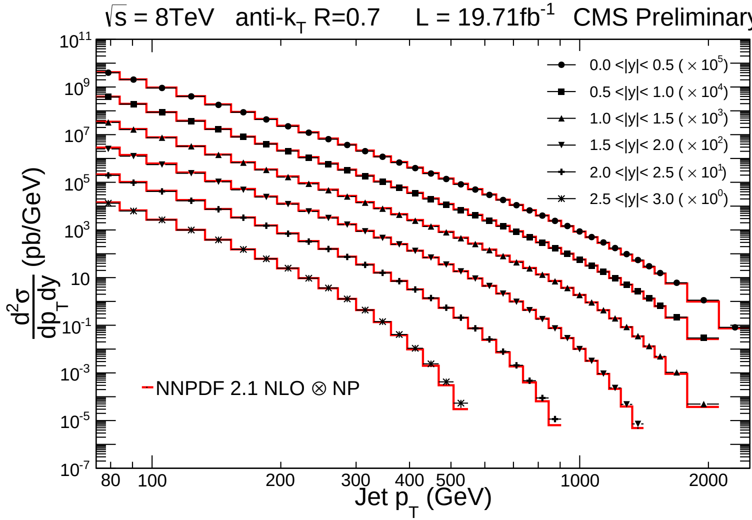
- Absolute, HighPtExtra, SinglePion(ECAL,HCAL), Flavor, Time, RelativeJER(EC1,EC2,HF), RelativePt(BB,EC1,EC2,HF), RelativeFSR, RelativeStat(EC2,HF), PileUpDataMC, PileUpPt(BB,EC,HF), PileUpBias, FlavorZJet, FlavorPhotonJet, FlavorPureGluon, FlavorPureQuark, FlavorPureCharm, FlavorPureBottom.
- The total Jet Energy Scale uncertainty is obtained by summing the independent components in quadrature.

Experimental Uncertainty Total



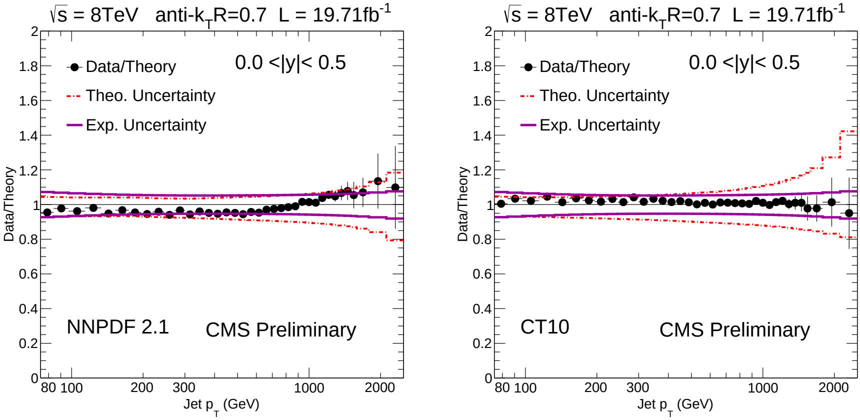
Experimental Uncertainty Limit On Measured Cross Section

Data-Theory Comparison



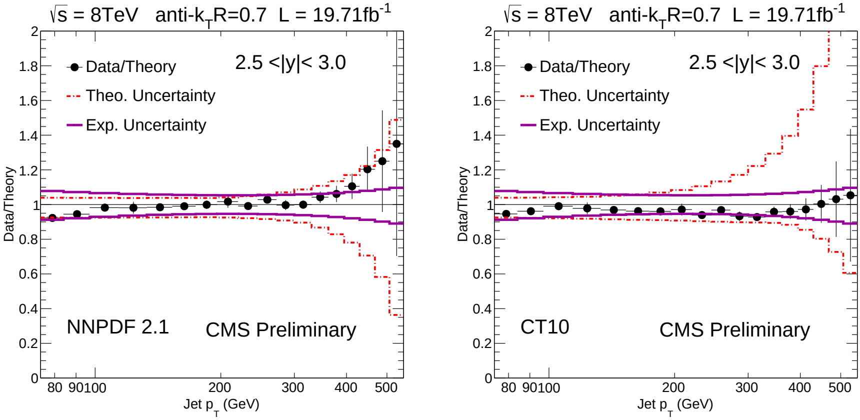
Double differential measured spectrum compared to NNPDF NLO Prediction

Data Over Theory



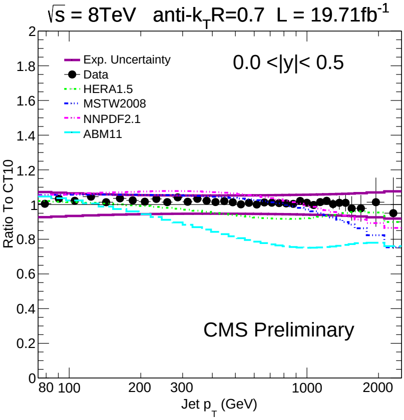
Data Over Theory for two different PDF sets for central y bin.

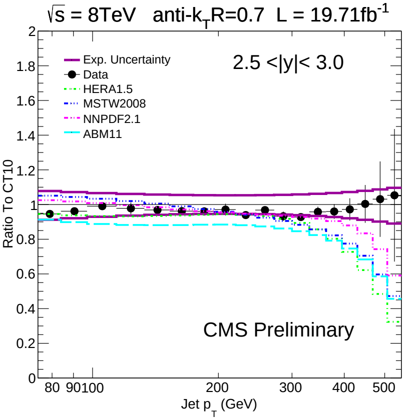
Data Over Theory



Data Over Theory for two different PDF sets for outer y bin.

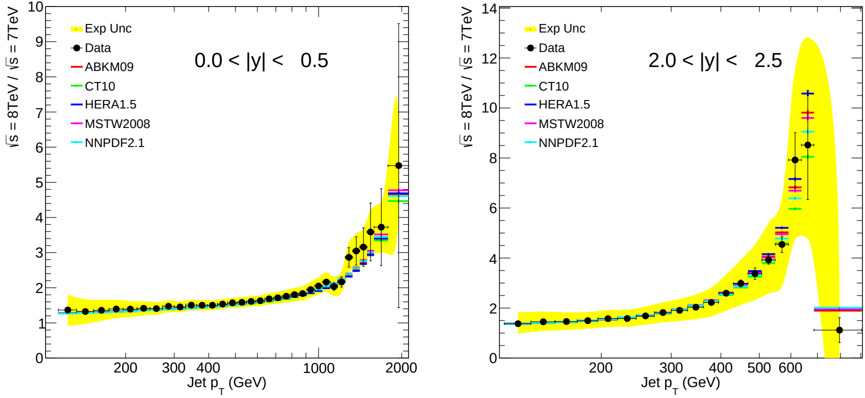
Data Over Theory





Data Over Theory compared to ratio with other PDF sets for CT10

8TeV Over 7TeV



$\sqrt{s} = 8\,TeV/\sqrt{s} = 7\,TeV$ spectrum ratio. The correlation among experimental uncertainties for two run era are taken into account.

$\alpha_s(M_z)$ Determination

From the obtained double differential crosss section, we aim to extract the strong coupling contact at $\alpha_s(M_z)$.
The $\alpha_s(M_z)$ is extracted from the minimum of $\chi^2(\alpha_s(M_z))$ which is defined as

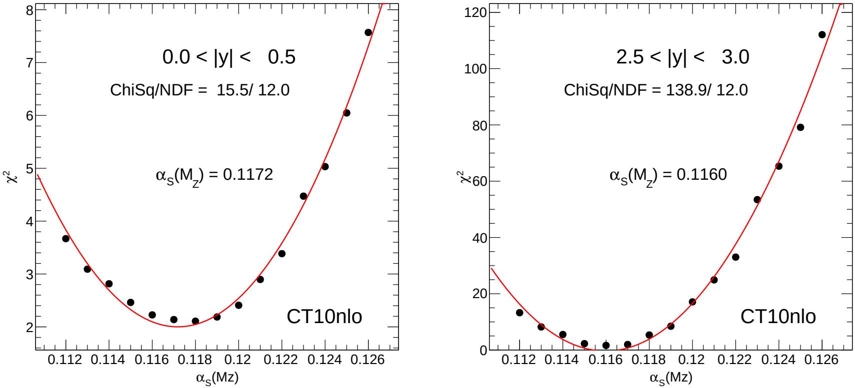
$$\chi^2 = \sum_{i,j=1}^{N_{BIN}} (\mathcal{O}^i_{Th} - \mathcal{O}^i_{Data}) C^{-1}_{ij} (\mathcal{O}^j_{Th} - \mathcal{O}^j_{Data})$$

where $\mathcal{O} = \frac{d^2\sigma}{dp_T dy}$ and C is the covariance matrix which includes statistical and JES systematics.

$$C = Cov^{Unfolding} + \sum Cov^{JES} + Cov^{LUMI} + Cov^{Theo}$$

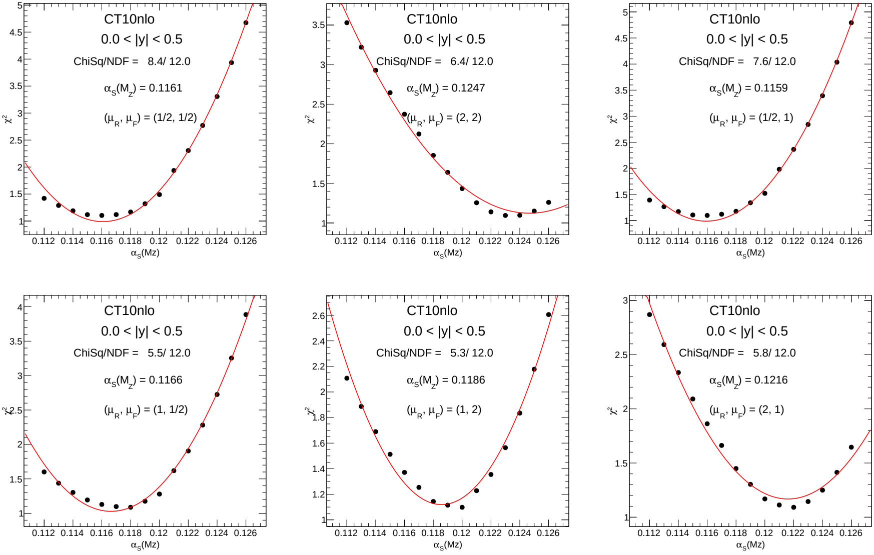
The obtained χ^2 distribution as a function of $\alpha_s(M_Z)$ is fitted with a 2nd order polynomial.

NLO χ^2 Plots



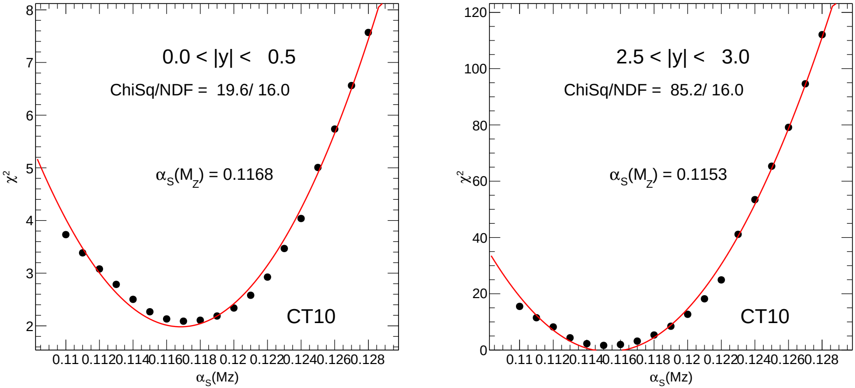
Basic χ^2 plots for two extreme rapidity bins using NLO CT10 PDF.

Scale Variation



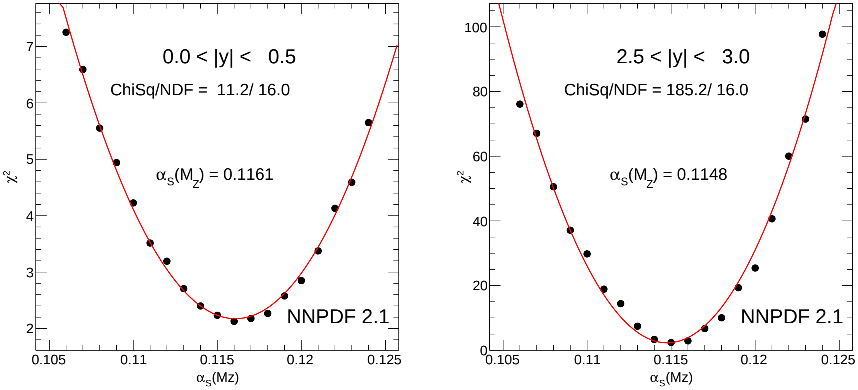
Basic χ^2 plots with varying (μ_R, μ_F) using NLO CT10 PDF.

NNLO χ^2 Plots



Basic χ^2 plots for two extreme rapidity bins using NNLO CT10 PDF.

NNLO χ^2 Plots



Basic χ^2 plots for two extreme rapidity bins using NNLO NNPDF2.1 PDF.

Remarks

Summary

- A short update on inclusive jet analysis has been presented with full $\sqrt{s} = 8\,TeV$ re-reco data has been presented.
- The unfolded spectrum is obtained with new JER parameters.
- A study of $\sqrt{s} = 8\,TeV/\sqrt{s} = 7\,TeV$ spectrum ratio is done and compared with different NLO theory prediction. Within experimental uncertainty limits and statistical fluctuation data agrees with theory.
  Correlations among different uncerainties are taken into account.
- A first study of $\alpha_s(M_z)$ fitting has been presented.

Future Plans:

• The correlation of new flavor components of uncertainty has to be evaluated.

• The experimental and theoretical uncertainties on $\alpha_s(M_z)$ has to be evaluated. PDF uncertainty for each individual PDF set has to be evaluated.

• We will proceed to study the $\alpha_s(Q)$ evolution with scale.

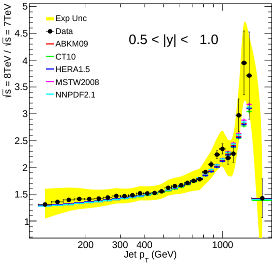
BackUp Slide

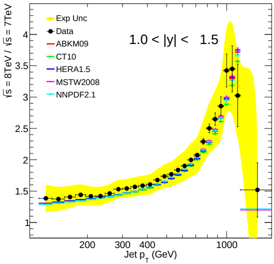
BACK UP

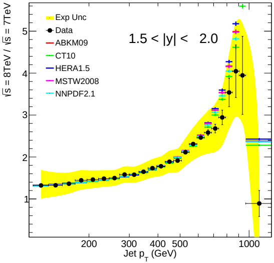
Uncertainty Sources

- The correlated uncertainty sources between 7TeV and 8TeV are
  •HighPTExtra
  •Single Pion
  •Flavor
  •Relative JEREC1, Relative JEREC2
  •Relative FSR
  •PileUP DataMC
  •PileUP Bias
- The uncorrelated uncertainty sources between 7TeV and 8TeV are
  •Absolute
  •Time
  •Relative StatEC2
  •PileUP OOT
  •PileUP Jate Rate
  •PileUp Pt

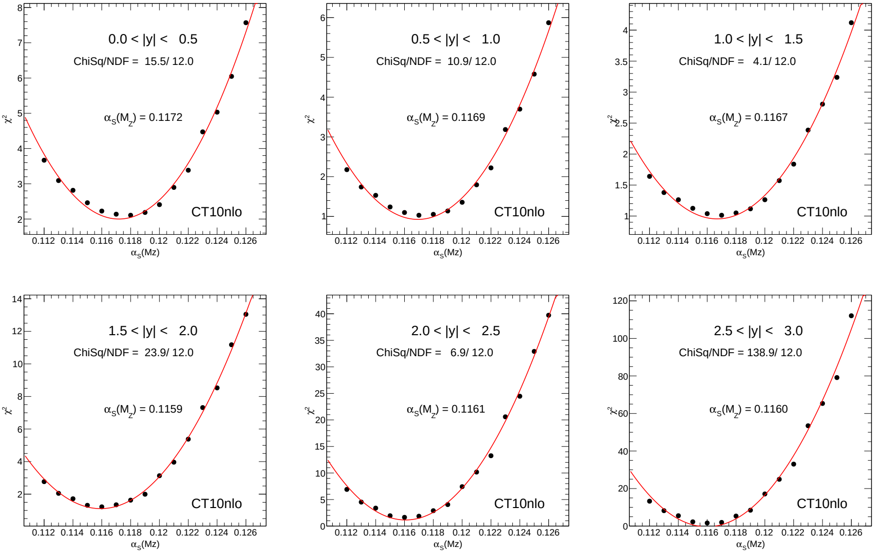
8TeV Over 7TeV





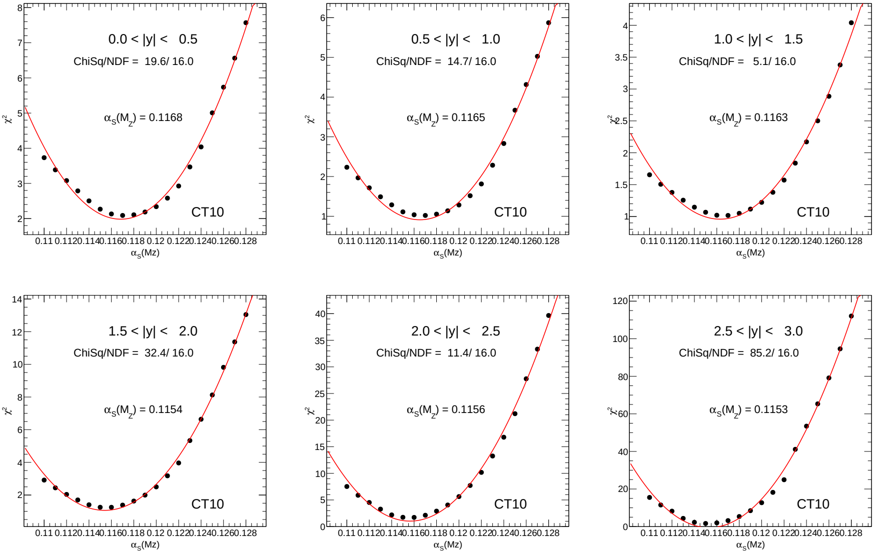


NLO χ^2 Plots



Basic χ^2 plots for all rapidity bins using NLO CT10 PDF.

NNLO χ^2 Plots



Basic χ^2 plots for all rapidity bins using NNLO CT10 PDF.