PDF Uncertainties for LQ1 (EXO-12-041)

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Introduction

- Slides show how to find PDF uncertainty on LQ signal
- Method follows from LQ3 analysis:
  - EXO-12-030
- LQ3 analysis method taken from prescription on arXiv:
  - arXiv:hep-ph/0605240
  - arXiv:1101.0538

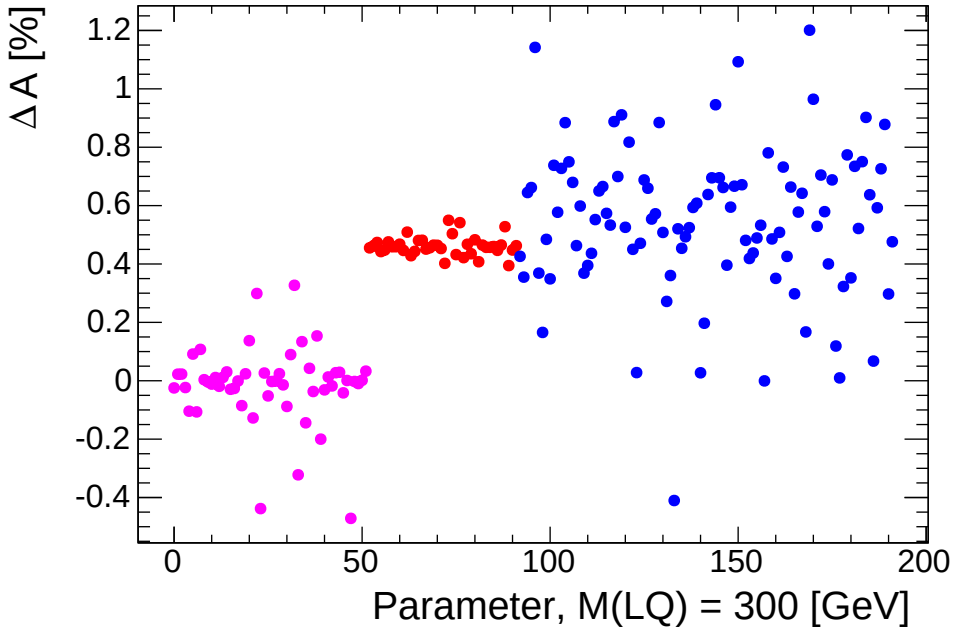
Variables stored in ntuples

- Three vectors:
  - `PDFCTEQWeights` (53 elements per event, `CTEQ`)
  - `PDFMSTWWeights` (41 elements per event, `MSTW`)
  - `PDFNNPDFWeights` (101 elements per event, `NNPDF`)
- First element of vector: mean weight (`mean`)
- Other elements of vector: varied weight (`varied`)
  - Each represents a weight from varying a parameter
- For each vector element, $i \neq 0$ of each PDF:
  - PDF weight = `varied` / `mean`

Variables to be defined

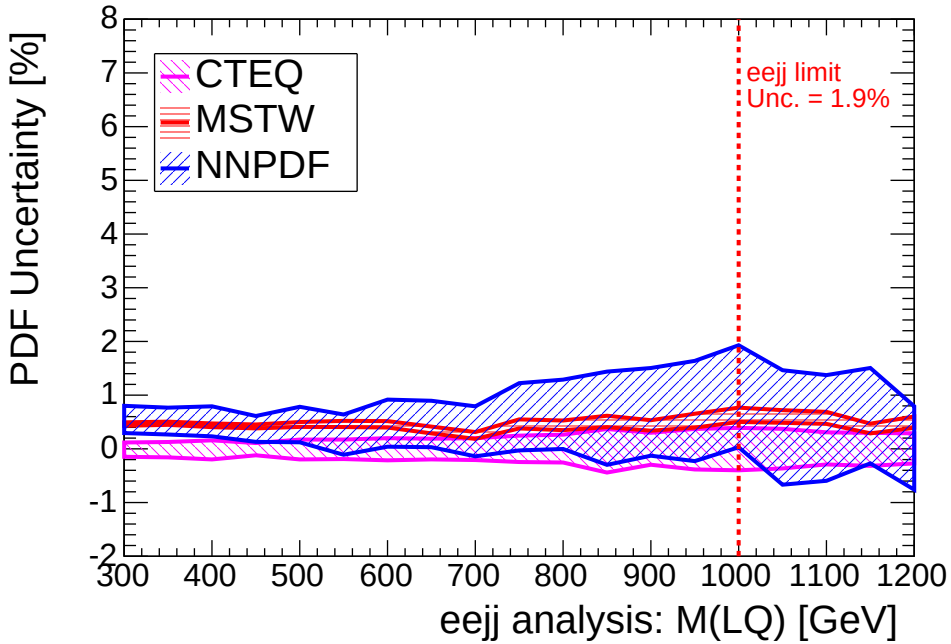
- for LQ of mass m, define four N(event) quantities:
  - U_m^0: N(unweighted MC events) in sample initially
  - U_m^f: N(unweighted MC events) passing final selection
  - W_m^0: N(PDF weighted MC events) in sample initially
  - W_m^f: N(PDF weighted MC events) passing final selection
- Now define acceptance for LQ of mass m:
  - $AU_m = \frac{U_m^f}{U_m^0}$
  - $AW_m = \frac{W_m^f}{W_m^0}$
- We are interested in the % change in acceptance:
  - $\Delta A = 100 \cdot \left[\left(\frac{AW_m}{AU_m} \right) - 1 \right] = 100 \cdot \left[\left(\frac{W_m^f}{W_m^0} \cdot \frac{U_m^0}{U_m^f} \right) - 1 \right]$

Example values of ΔA for M(LQ) = 300, eejj



- Pink: `CTEQ`, Red: `MSTW`, Blue: `NNPDF`
- x-axis: PDF parameter number
- y-axis: ΔA (defined last slide)

PDF uncertainty: eejj signal



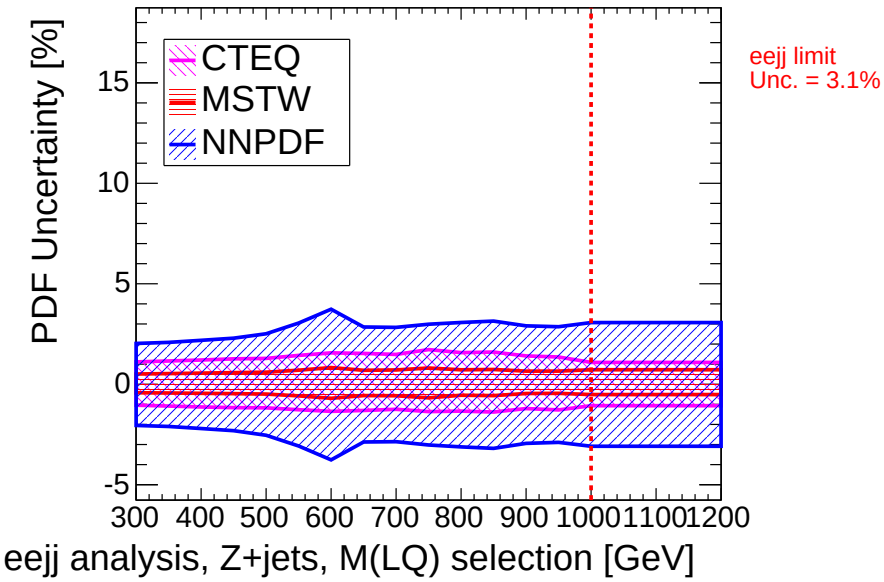
- *x*-axis: LQ mass
- *y*-axis mean: mean from plots similar to slide 5
- *y*-axis width: RMS from plots similar to slide 5

Method for determining final uncertainty

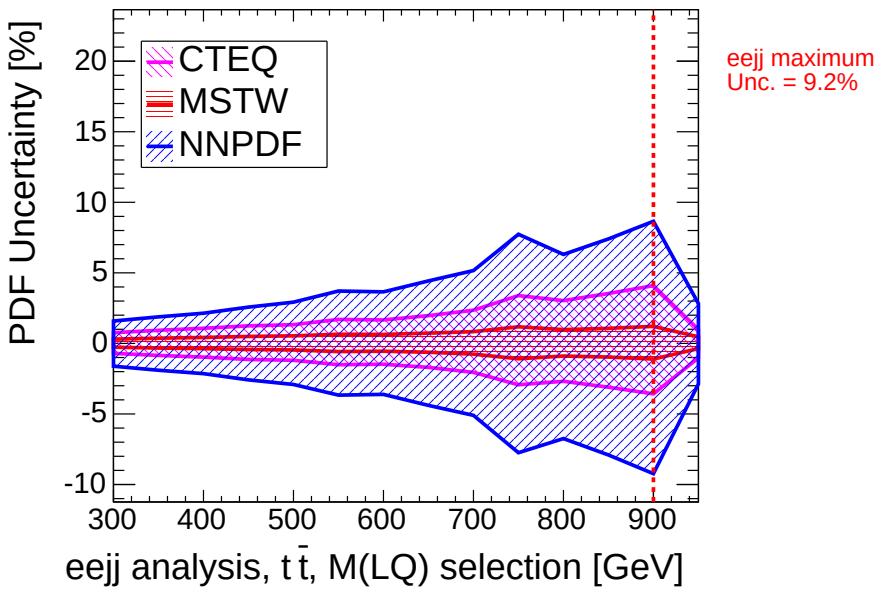
- Quote one uncertainty for all LQ mass selections
- If there are no MC events passing a given selection, we can't evaluate PDF uncertainty at that selection level
- If there are MC events passing the selection at the LQ limit (1050 GeV for eejj, 850 GeV for evjj):
  - Use the uncertainty evaluated at the LQ limit
- Otherwise:
  - Use the maximum evaluated uncertainty

PDF uncertainty: eejj background

$Z + \text{jets}$ MC



$t\bar{t}$ MC (not used)



- x-axis: LQ mass
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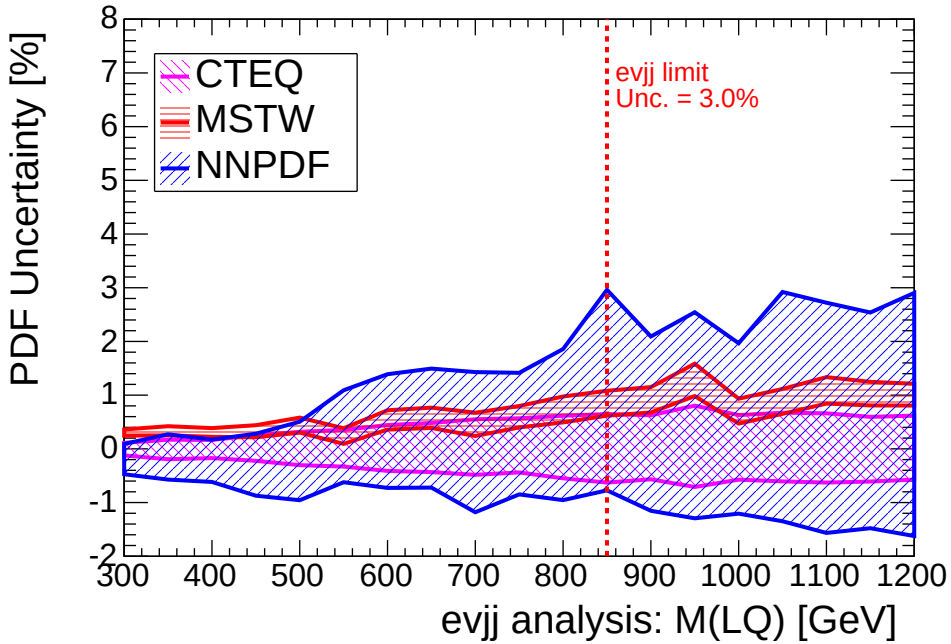
- y-axis width: RMS from plots similar to slide 5

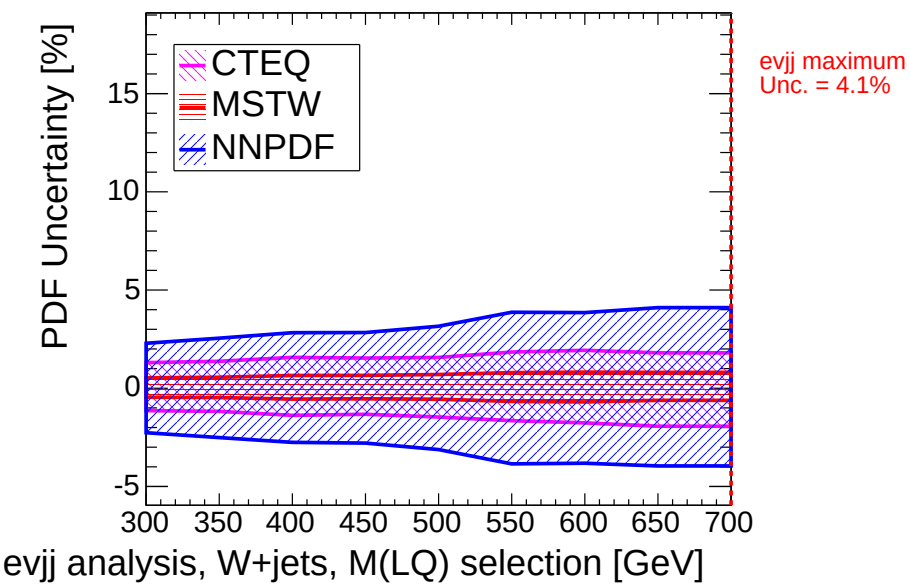
PDF uncertainty: evjj signal



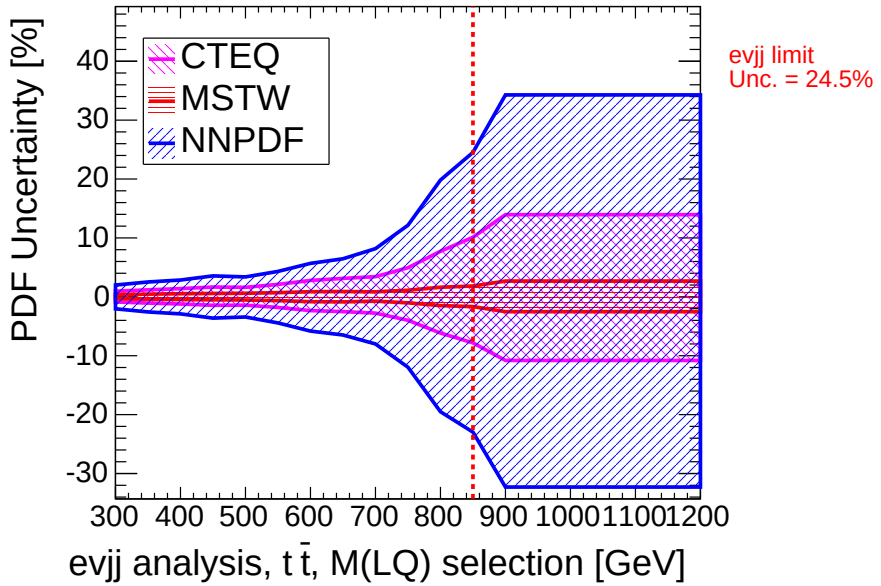
- x-axis: LQ mass
- y-axis mean: mean from plots similar to slide 5
- y-axis width: RMS from plots similar to slide 5

PDF uncertainty: evjj background

W + jets MC



$t\bar{t}$ MC



- *x*-axis: LQ mass
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- *y*-axis width: RMS from plots similar to slide 5

Conclusion

- Signal PDF uncertainties:
  - eejj: 2%
  - evjj: 3%
- Background PDF uncertainties:
  - eejj $Z + \text{jets}$: 3%
  - evjj $W + \text{jets}$: 4%
  - evjj $t\bar{t}$: 25%
- Why is the evjj $t\bar{t}$ uncertainty so high? Possible answer:
  - Final acceptance is very low (but not zero) for $t\bar{t}$ MC
  - Only 8 events pass M(LQ) = 850 selection (evjj limit)
  - Extremely hard cuts imply larger PDF uncertainties