Tools for Drell-Yan at NNLO in QCD

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Z & W's at Hadron Colliders

- EW gauge boson production has large σ and clear collider signature - leptonic final state

- provide good analyses on early data - L_{int} of nb^{-1}'s to pb^{-1}'s

- Z/W properties are well known (M_V, Γ_V, σ_V)
  - reliable predictions

- LHC 'Standard Candles'
  - detector calibration
  - luminosity monitoring
  - EW parameter measurements,
  - PDF constraints

- BSM constraints

Need for Higher Order?

- LHC will produce large amount of data
  - → small statistical error
  - → measurements limited by systematics & theoretical error

- Can expect percent level physics

- Measurements require theory input → need higher order calculations
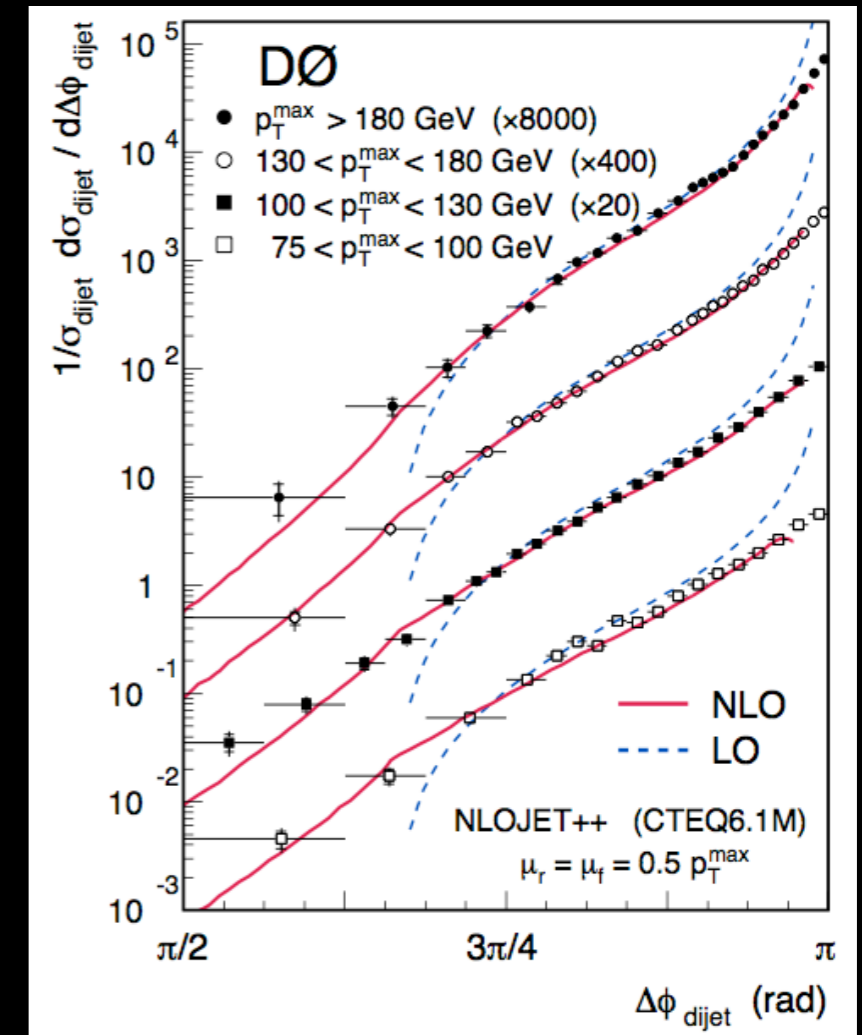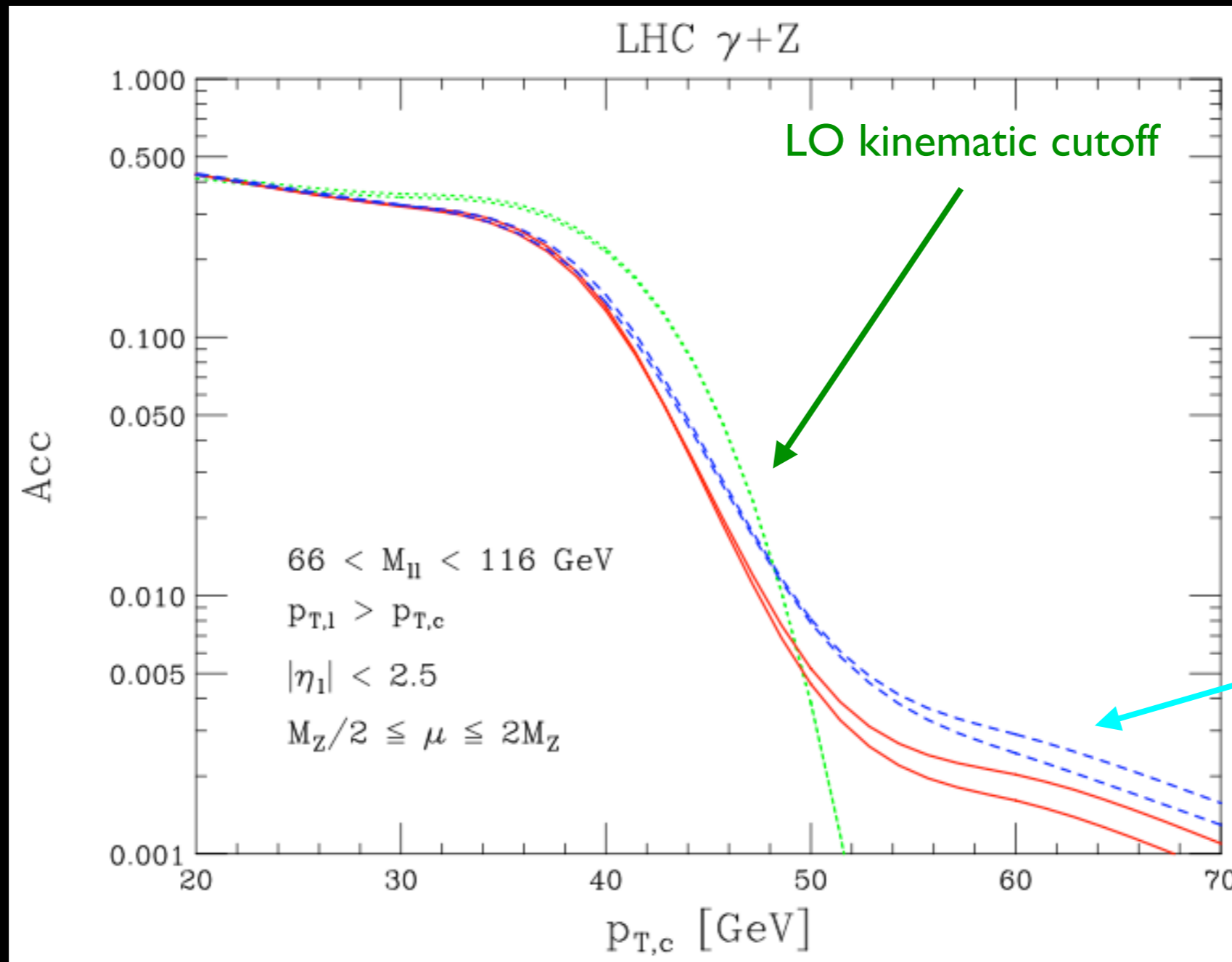

inclusive cross section for W + n jets (pb)

number of jets	CDF	LO	NLO
1	53.5 ± 5.6	$41.40(0.02)^{+7.59}_{-5.94}$	$57.83(0.12)^{+4.36}_{-4.00}$
2	6.8 ± 1.1	$6.159(0.004)^{+2.41}_{-1.58}$	$7.62(0.04)^{+0.62}_{-0.86}$
3	0.84 ± 0.24	$0.796(0.001)^{+0.488}_{-0.276}$	$0.882(0.005)^{+0.057}_{-0.138}$

Higher Orders

- Even at NNLO...

DY at NNLO

- DY at NNLO calculated, but inclusive
  (Hamberg, Matsuura, van Neerven)

- differential distributions needed

  - PDF extraction Z rapidity dependent

  - simulate distributions in detector-like scenarios

    - cuts on p_T, rapidity, isolation

- Tools on the market

  - FEWZ (Melnikov, Petriello, arXiv:hep-ph/0603182, hep-ph/0609070)

  - DYNNLO (Catani, Cieri, Ferrera, de Florian, Grazzini, arXiv:0903.2120)

FEWZ

- Fortran numerical code, computes W/Z DY cross sections in hadron colliders

  - Fully Exclusive at LO, NLO, & NNLO in QCD

  - Leptonic decays of W & Z contain full spin correlations

  - User can choose

    - collider type, perturbative order, integration parameters (Vegas), PDF sets, cuts on leptons

- FEWZ has it's problems, goal is to ease use of FEWZz (Z production)

Improved FEWZz

- New features to FEWZz:

  - PDF error propagation

  - revised input file (set cuts, PDF, jet algorithm, isolation)

  - simultaneous generation of predefined histograms

    - histogram parameters set in a histogram input file

  - reduced run time for NNLO calculations

  - complete control of EW parameters
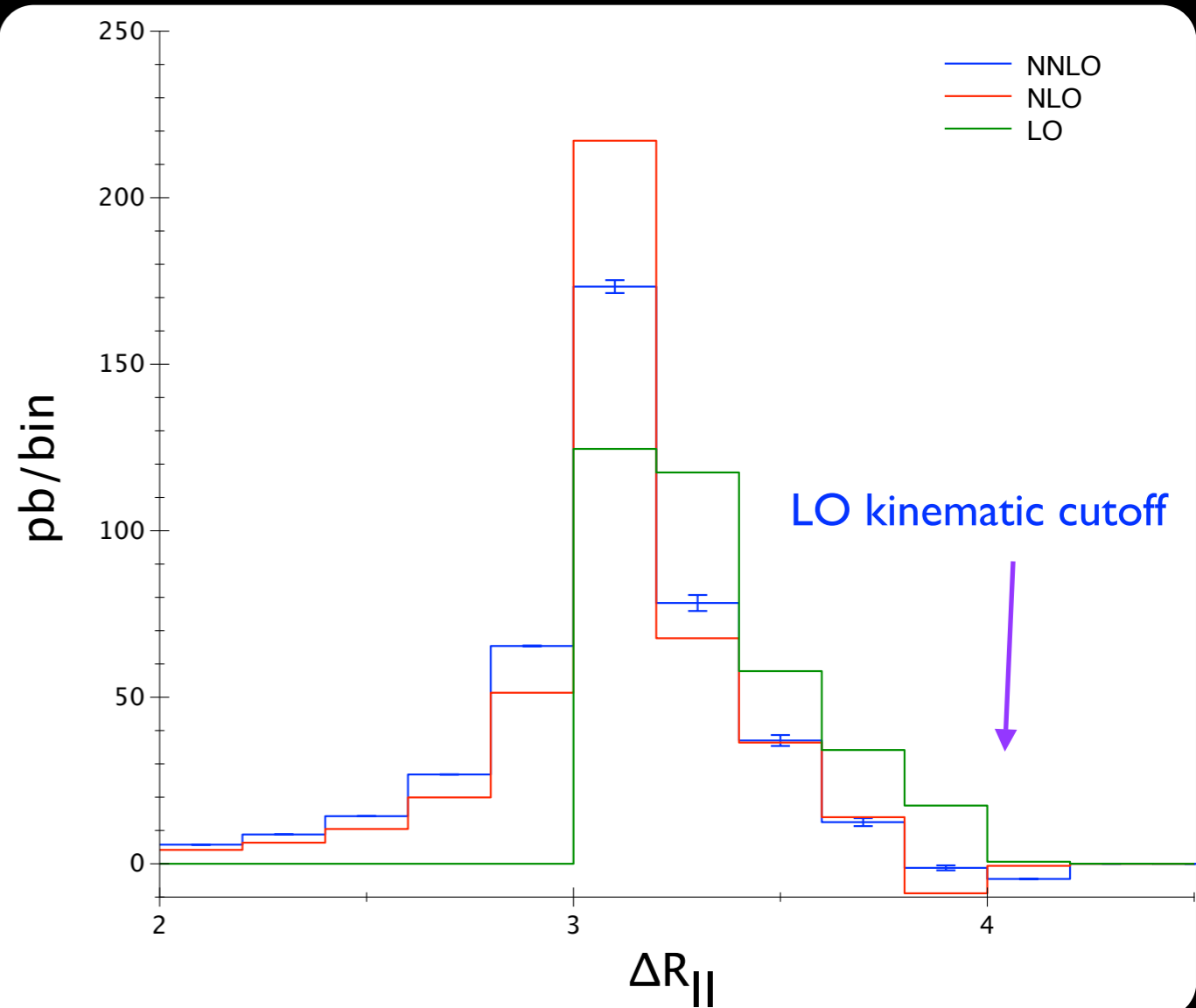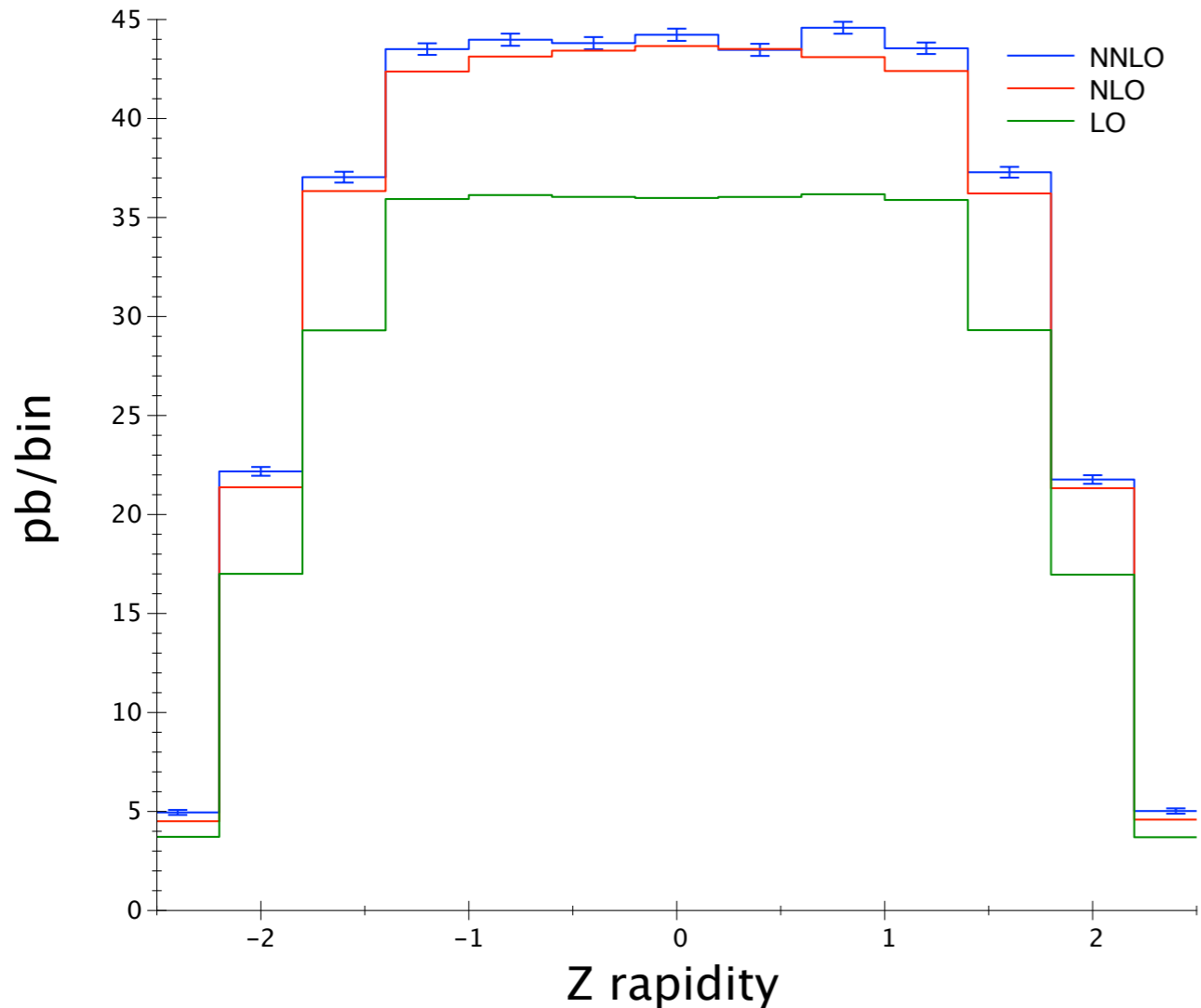
Inclusive Z Production at 7 TeV
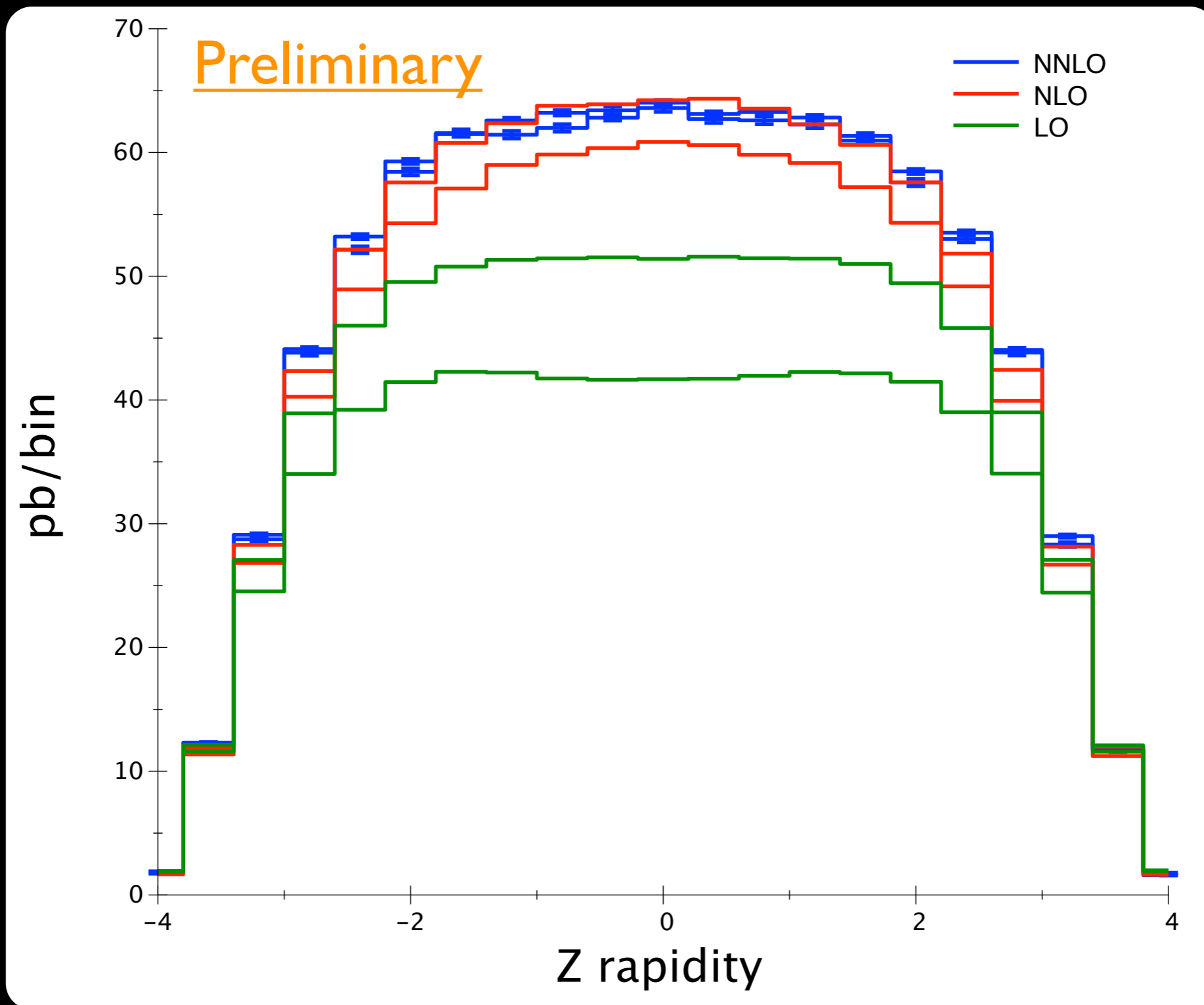
Distributions with Cuts

- 66 GeV < M_{ll} < 116 GeV

- lepton $|\eta|$ < 2.5

- lepton p_T > 25 GeV

- lepton $\Delta R_{isolation}$ = 0.5

- PDFs: MSTW2008 at NNLO

LHC at 7 TeV

Preliminary

LO kinematic cutoff

On the Web

- http://www.hep.wisc.edu/~frankjp/FEWZ.html

- Updated version to be released soon

- EW correction to come in the near future