Predicting ZZ from observing Z
[for discussion]

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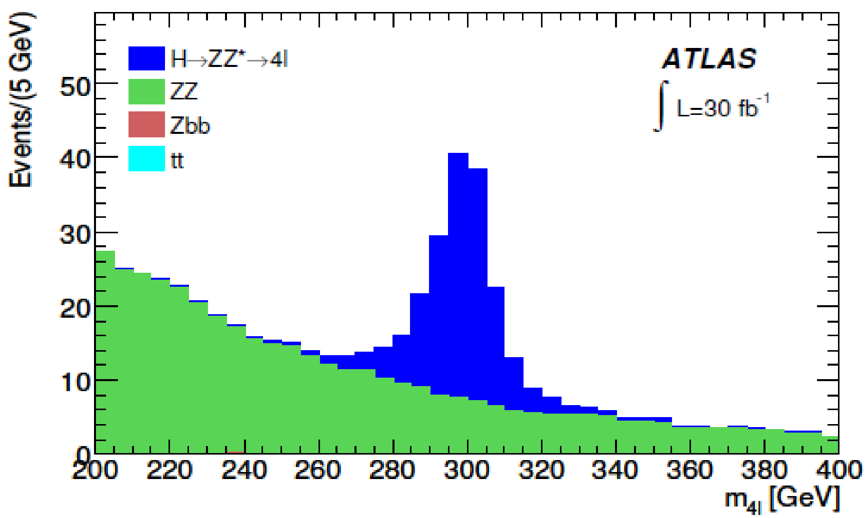
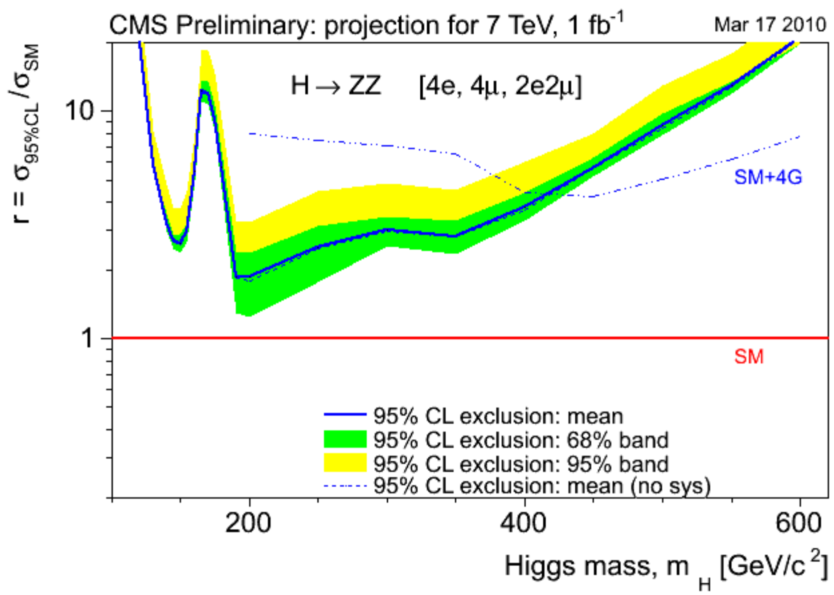
Why do we want it?

- **pp→ZZ→4l is the main background for pp→H→ZZ→4l**
  Look for a peak over the continuum---easy, right? Why bother with predicting ZZ?

- **Signal/bkgd ratio is relatively high:** We will be discovering or excluding Higgs when there are too few events in the sidebands (~10 events per 1 fb^{-1} at 7 TeV) for a direct **measurement** of the ZZ bkgd rate and shape





Can we predict ZZ from Z?

- Up to NLO, ZZ→4l and Z→2l look rather similar

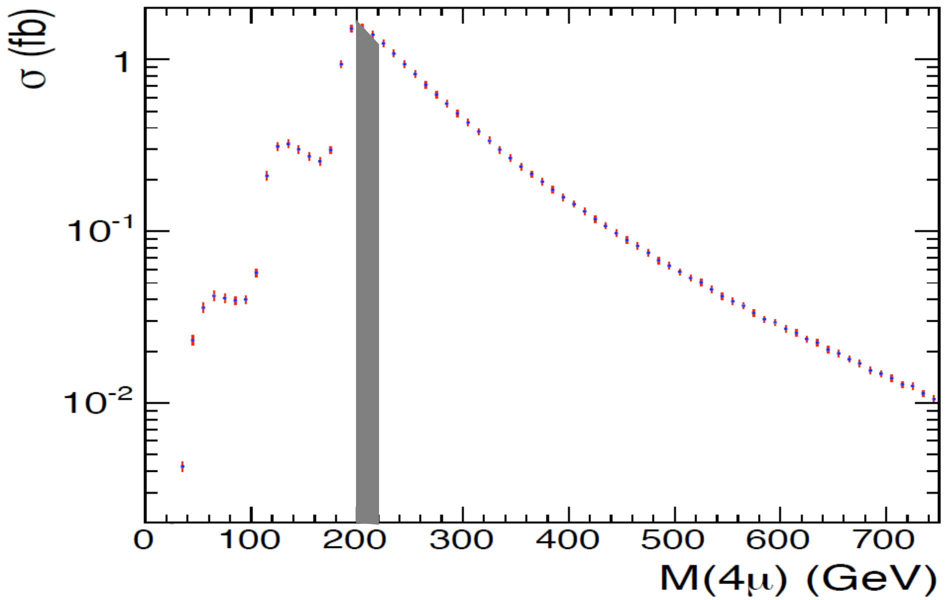
- If we use Z→2l or Z*→2l as a control region (CR), one may expect
  - partial cancellation of PDF uncertainties…
  - partial cancellation of QCD scale uncertainties…
  - and partial or complete cancellation of many experimental uncertainties

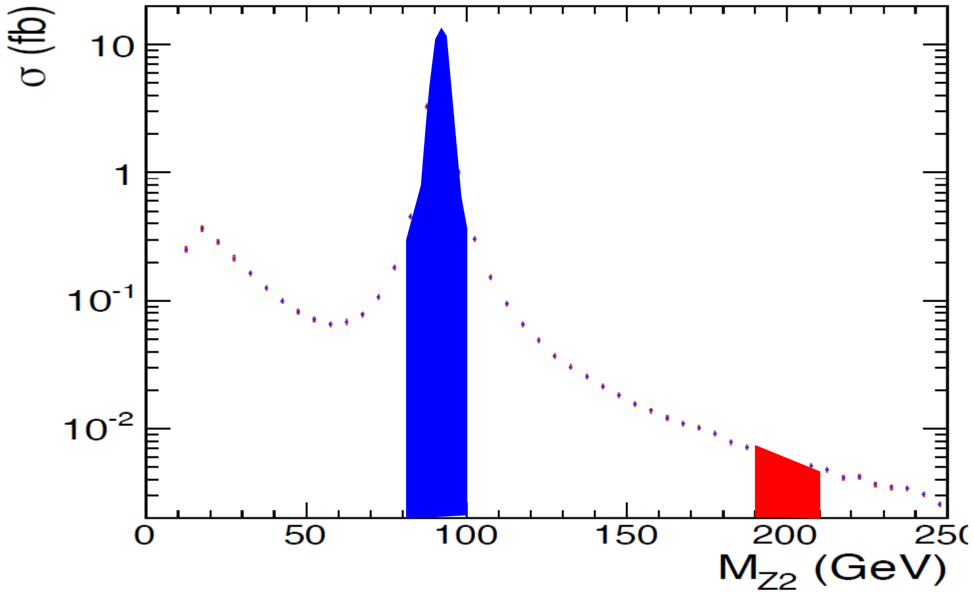
$$N_{ZZ}^{\text{predicted}}(\Delta m) = \rho(m_{\text{H}}) \cdot N_{CR}^{\text{measured}}$$

$$\rho(m_{\text{H}}) = \frac{N_{ZZ}^{\text{theory}}(\Delta m) \cdot \epsilon_{ZZ}}{N_{CR}^{\text{theory}} \cdot \epsilon_{CR}}$$

- NNLO gg→ZZ is O(20%) has very little connection to Z→2l and probably should be treated as an "independent" add-on piece

ZZ/Z-ratio



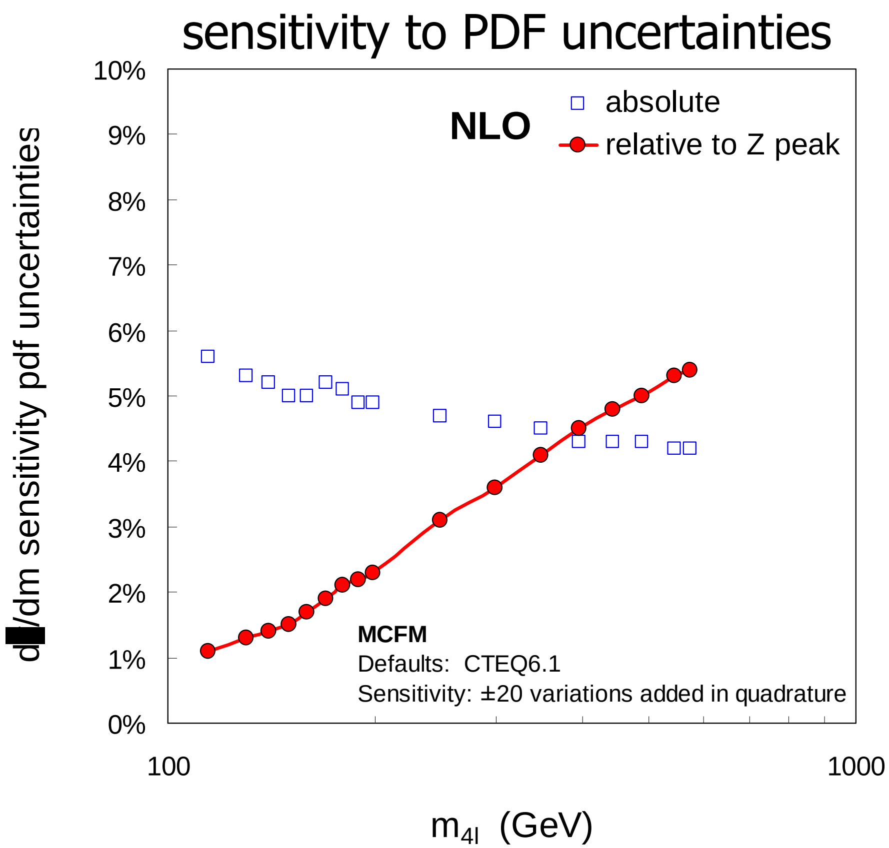


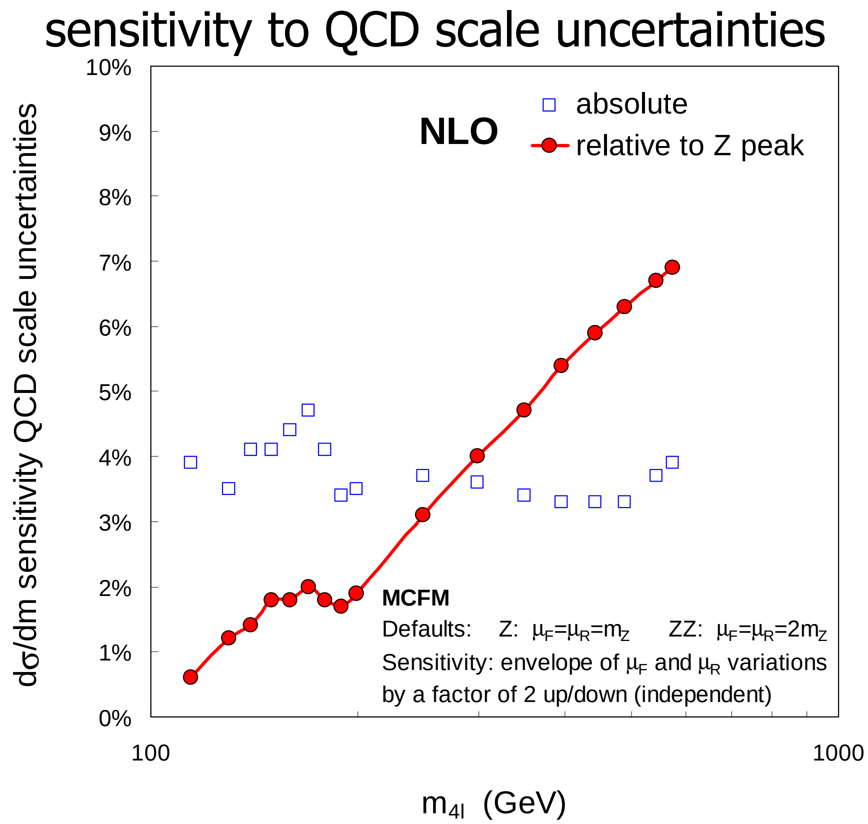
Two choices:

- **$M_{ll} = m_Z$ (independent of m_{4l})** **CMS NOTE 2006/068 (2006)**
  - plenty of statistics and very clean
  - but we will be losing the correlation between ZZ and Z as m_{4l} slides away from m_Z
- **$M_{ll} = m_{4l}$ (follow m_{4l})** **Phys. Rev. D80, 054023 (2009)**
  - penalty in the statistics in the control sample
  - keep much tighter correlation between ZZ and Z at large m_{4l}

So, what are the uncertainties?

CMS NOTE 2006/068
acceptance cuts applied
$|\eta|<2.4$, $p_T>7$, $m_{ll}>12$





Errors partially cancel out up to m_{4l}~300 GeV

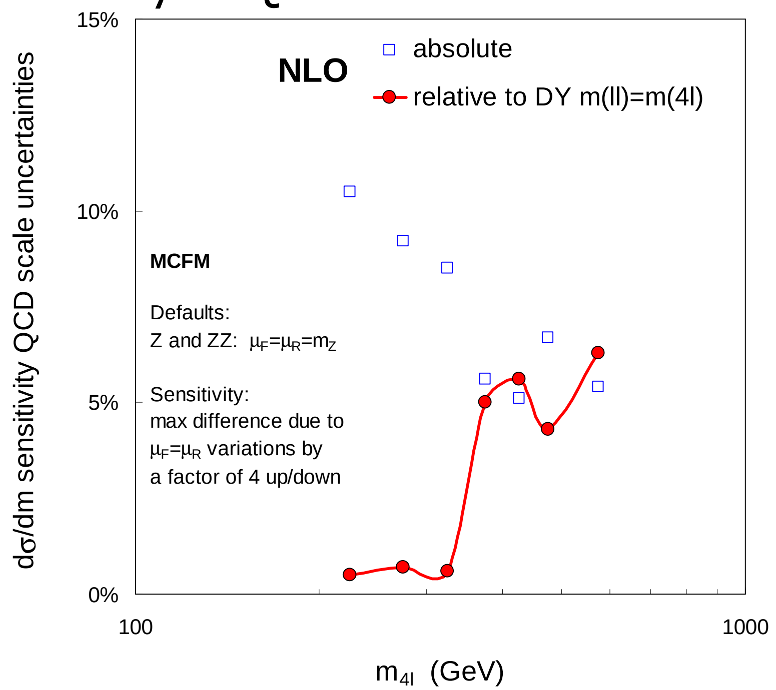
Beyond m_{4l}~300 GeV, we seem to lose the correlation,
but we still cancel out many experimental errors!

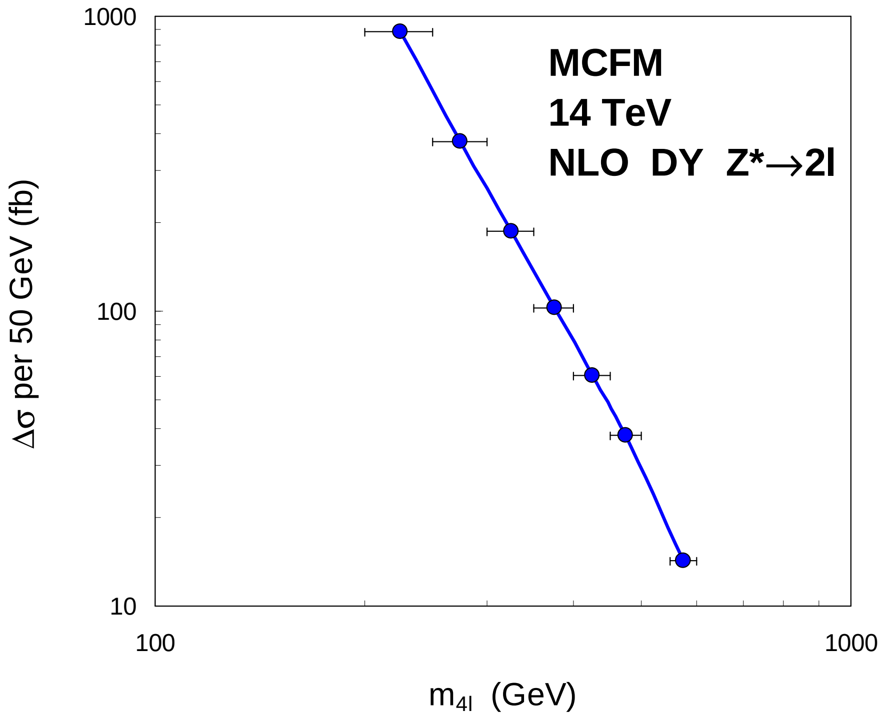
So, what are the uncertainties?

Phys. Rev. D80, 054023 (2009)
acceptance cuts applied
$|\eta|<2.5$, $p_T>20$

sensitivity to PDF uncertainties is very small (0.5%)

sensitivity to QCD scale uncertainties





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Note: we quickly run out of DY events: beyond 300 GeV at 1 fb^{-1}, stat errors dominate

Discussion

Does it all make sense?