ZZ PRODUCTION: EARLY MEASUREMENT AT 13 TEV WITH THE ATLAS DETECTOR

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In short

- Measure fiducial inclusive cross section for ZZ at $\sqrt{s} = 13$ TeV in the four-lepton channel, using 3.2 fb^{-1} of data collected in 2015
- Z means Z/γ^* with mass between 66–116 GeV
- Lepton means electron or muon
- Four-lepton channel has small cross section, but good dilepton mass resolution and almost no background
- Also extrapolate to total phase space and all Z boson decays
- Results agree with NNLO QCD (α_s^2) standard model predictions
- Statistical uncertainty dominates (~15% for combined cross section)

ZZ production at the 13-TeV LHC

- Mainly $q\bar{q}$-initiated
- $O(10\%)$ loop-induced gluon-initiated contribution. Theoretical predictions have large (QCD scale) uncertainty → interesting to study!

Why measure ZZ?

- Standard model test: need solid, model-independent measurement
- Appears in background and/or sidebands in Higgs boson analyses and new-physics searches

Limits on anomalous gauge couplings

Towards vector boson scattering

Fiducial region definition

- Prompt dressed electrons and muons, with $p_\perp > 20$ GeV and $|\eta| < 2.7$
- Leptons separated by $\Delta R_{\ell\ell} > 0.2$
- Four selected leptons forming 2 same-flavour opposite-charge pairs (if ambiguous, choose pairing that minimises $|m_{\ell\ell,1} - m_Z| + |m_{\ell\ell,2} - m_Z|$)
- Dileptons have mass 66 GeV $< m_{\ell\ell,1}, m_{\ell\ell,2} <$ 116 GeV

Methods and systematic uncertainties

Background is estimated using simulation as well as a data-driven method (for backgrounds with 1–2 misidentified or nonprompt leptons). The total estimated background is only ~1%

Unfolding of the fiducial cross sections is performed by applying a correction factor, which is derived using simulation

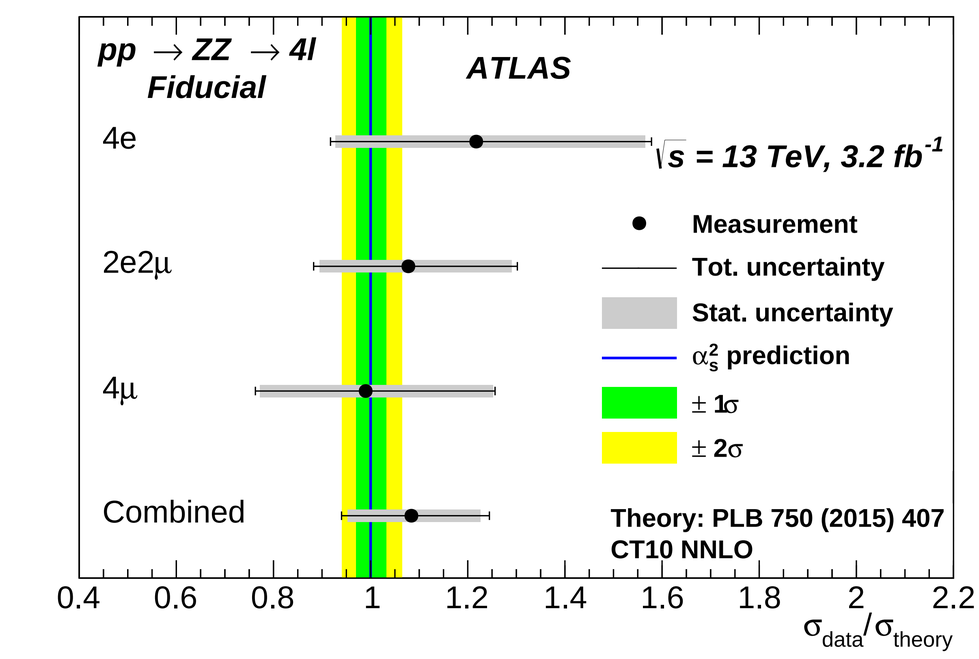
Cross section estimation is done with maximum-likelihood fits. Event yields are treated as Poissonian parameters, systematic uncertainties as Gaussian nuissance parameters

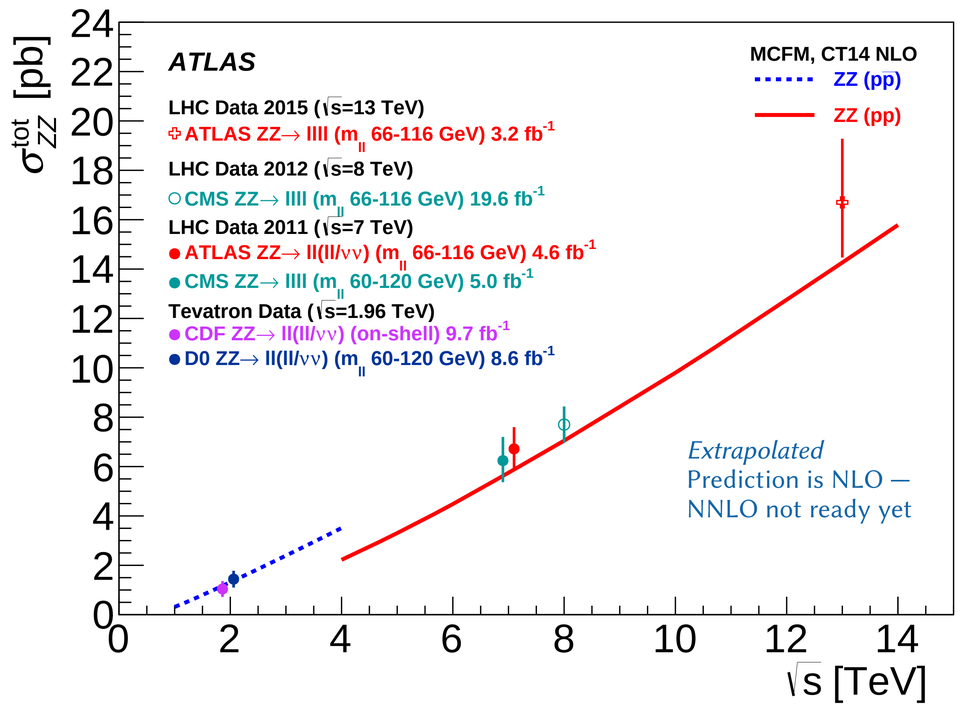
Important systematic uncertainties are shown in the table. They enter the denominator of the cross section estimator.

Integrated luminosity	5.0%
Correction for detector effects	
Statistical	0.5–0.7%
Theoretical (generator, PDFs)	2.5%
Experimental efficiencies	2.0–2.3%
Momentum scales and resolutions	0.1–0.4%
Extrapolation factor	3.7%

Results: fiducial and extrapolated cross sections

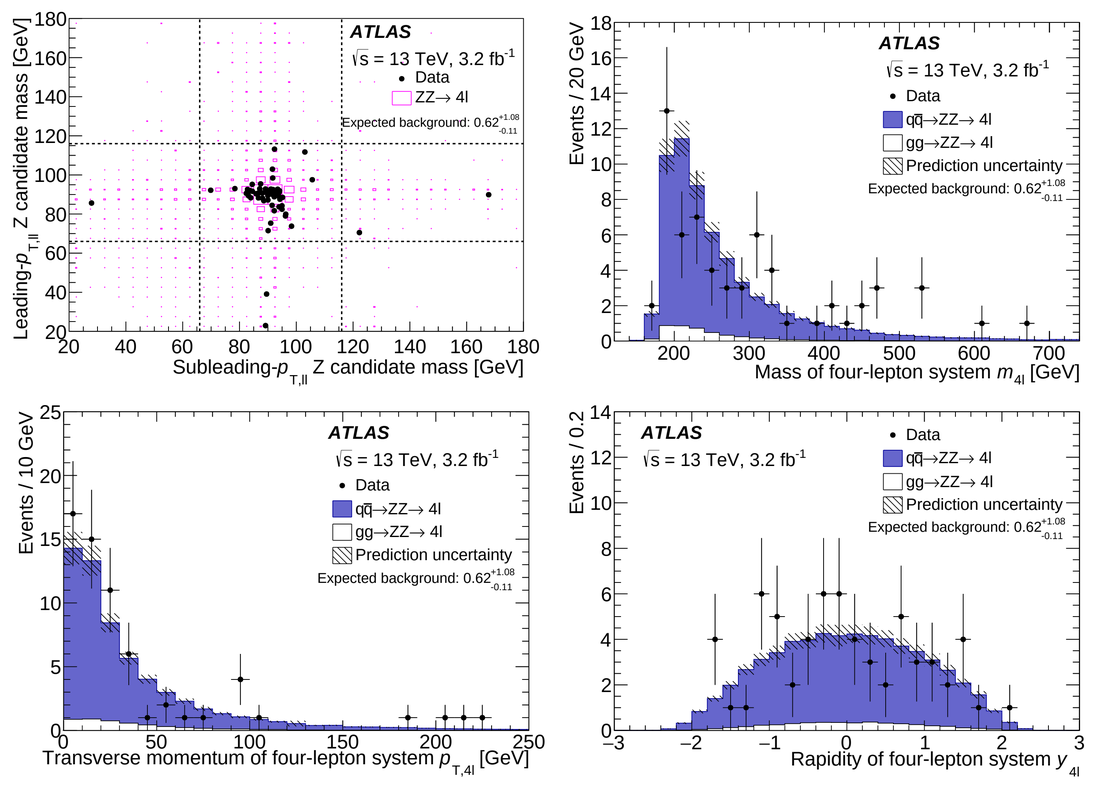
	Measurement	NNLO prediction [1507.06257]
$\sigma^{\text{fiducial}}_{ZZ\to e^+e^-e^+e^-}$	$8.4\ ^{+2.4}_{-2.0}(\text{stat.})\ ^{+0.4}_{-0.2}(\text{syst.})\ ^{+0.5}_{-0.3}(\text{lumi.})$ fb	$6.9^{+0.2}_{-0.2}$ fb
$\sigma^{\text{fiducial}}_{ZZ\to e^+e^-\mu^+\mu^-}$	$14.7\ ^{+2.9}_{-2.5}(\text{stat.})\ ^{+0.6}_{-0.4}(\text{syst.})\ ^{+0.9}_{-0.6}(\text{lumi.})$ fb	$13.6^{+0.4}_{-0.4}$ fb
$\sigma^{\text{fiducial}}_{ZZ\to \mu^+\mu^-\mu^+\mu^-}$	$6.8\ ^{+1.8}_{-1.5}(\text{stat.})\ ^{+0.3}_{-0.3}(\text{syst.})\ ^{+0.4}_{-0.3}(\text{lumi.})$ fb	$6.9^{+0.2}_{-0.2}$ fb
$\sigma^{\text{fiducial}}_{ZZ\to \ell^+\ell^-\ell'^+\ell'^-}$	$29.7\ ^{+3.9}_{-3.6}(\text{stat.})\ ^{+1.0}_{-0.8}(\text{syst.})\ ^{+1.7}_{-1.3}(\text{lumi.})$ fb	$27.4^{+0.9}_{-0.8}$ fb
$\sigma^{\text{extrapolated}}_{ZZ}$	$16.7\ ^{+2.2}_{-2.0}(\text{stat.})\ ^{+0.9}_{-0.7}(\text{syst.})\ ^{+1.0}_{-0.7}(\text{lumi.})$ pb	$15.6^{+0.4}_{-0.4}$ pb





Find us on HepData: http://hepdata.cedar.ac.uk/view/ins1409923

Signal kinematics



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