

Measurement of the Low Mass Drell-Yan Process at ATLAS

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High Energy and Astro Particle Physics
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Motivation and Outline

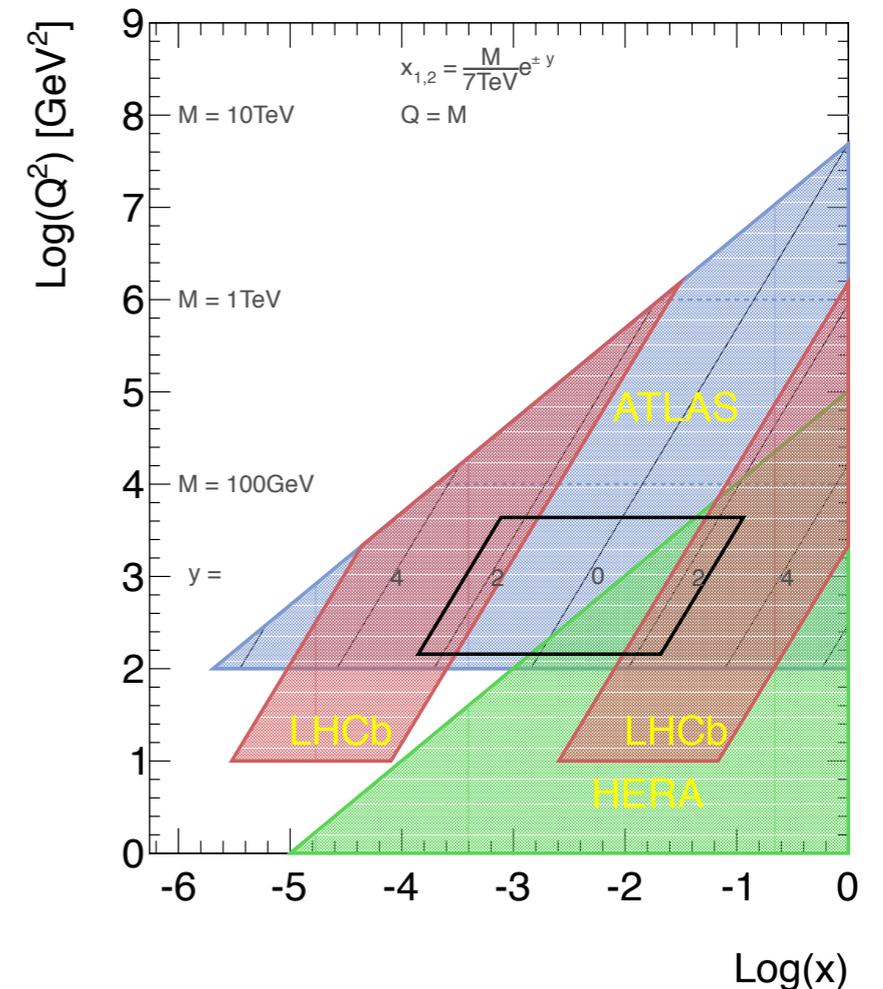
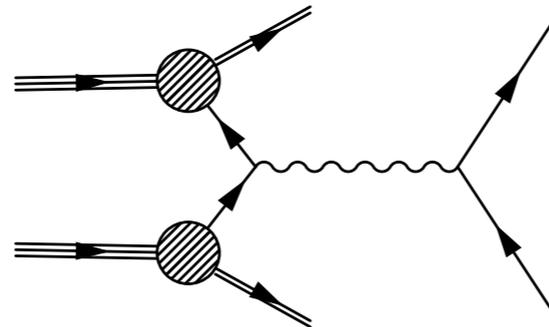
- Measurement of the Drell-Yan $d\sigma/dM_{ll}$ in a mass window of $12 < M_{ll} < 66$ GeV.
- Complement to cross-section measurements made at the Z peak and above.
- Will help to constrain the PDF errors.
- Have split the analysis into two streams:

- Nominal Analysis (2011 data):

- $26 \text{ GeV} < M_{ll} < 66 \text{ GeV}$
- Electron Channel
- Muon Channel

- Extended Analysis (2010 data):

- $12 \text{ GeV} < M_{ll} < 66 \text{ GeV}$
- Muon Channel Only



Fiducial Cross-Section Definitions:

Nominal Analysis

$p_T > 12 \text{ \& } 15 \text{ GeV}$
 $|\eta| < 2.4$

Extended Analysis

$p_T > 6 \text{ \& } 9 \text{ GeV}$
 $|\eta| < 2.4$

As the analysis is still to be approved, this talk will concentrate on the 2011 muon analysis and comparisons to theory.

2011 Muon Event Selection

$26 \text{ GeV} < M_{\mu\mu} < 66 \text{ GeV}$

DiMuon Trigger requiring
muon $p_T > 10 \text{ GeV}$

Primary Vertex with ≥ 3
tracks

Require certain
number of hits in
the inner
tracking
detectors

Track Quality Cuts

Oppositely charged
muons

Ensures muons are well
within the acceptance of the
inner detector ($|\eta| < 2.5$)

Muon $|\eta| < 2.4$

Different cuts for
leading and sub-
leading muons

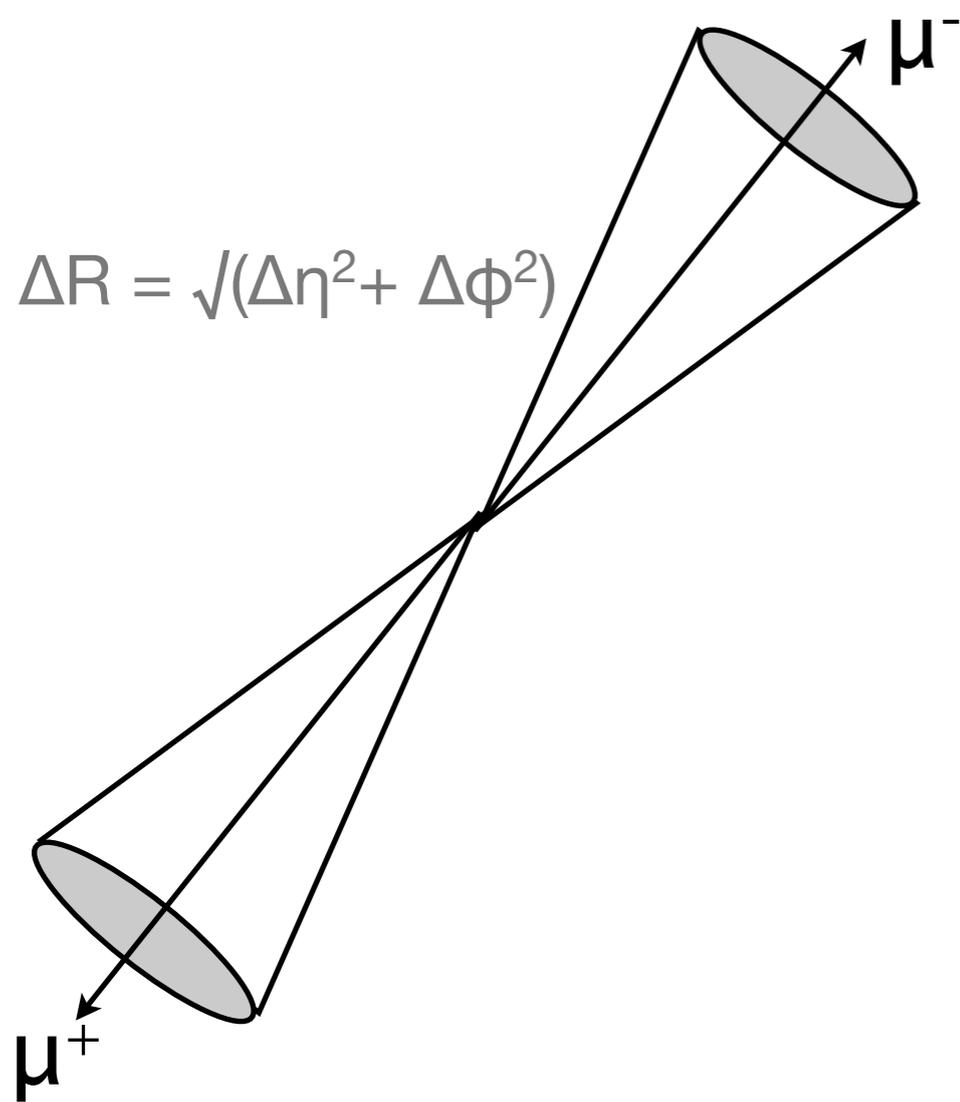
Muon $p_T > 12 \text{ \& } 15 \text{ GeV}$

Muons required to be
isolated

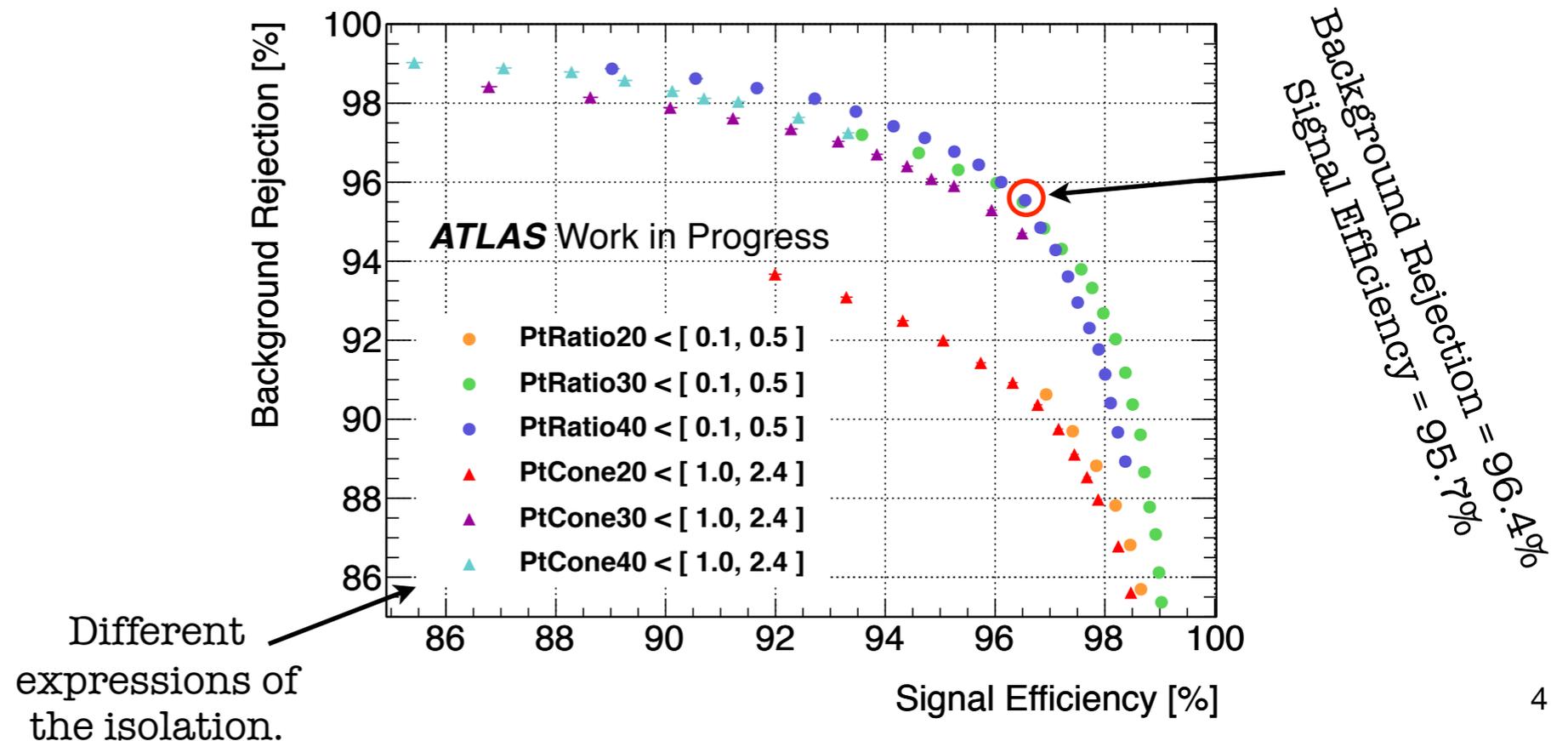
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Isolation

- At low muon p_T and di-muon invariant mass, it is particularly important to suppress and understand the background from multijet events.



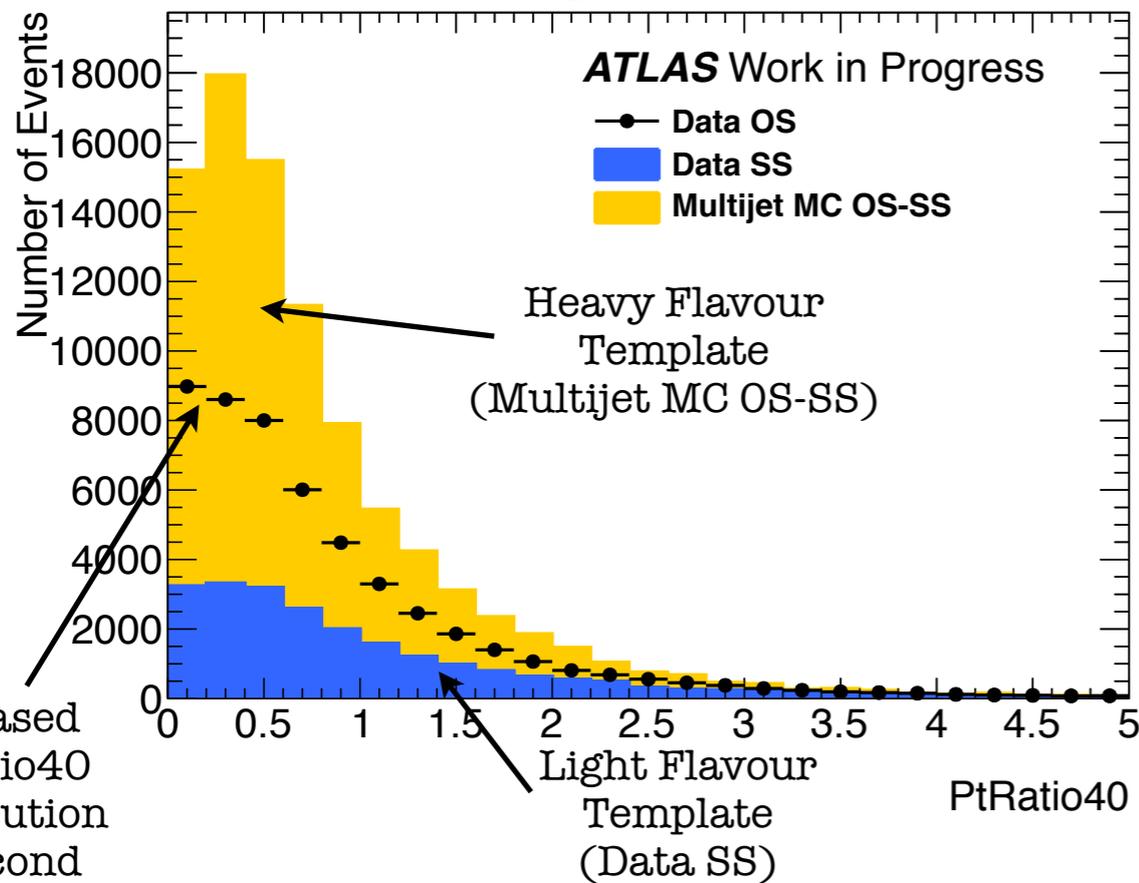
- Drell-Yan muons will be isolated, as they are the only decay products of the process.
- Muons in jets however will typically be accompanied by many other nearby tracks in the inner detector.
- We settled on $PtRatio40 = \sum p_T^{(\Delta R=0.4)}/p_T < 0.18$
- Often $\sum p_T^{(\Delta R=0.4)}/p_T$ is referred to as PtRatio40



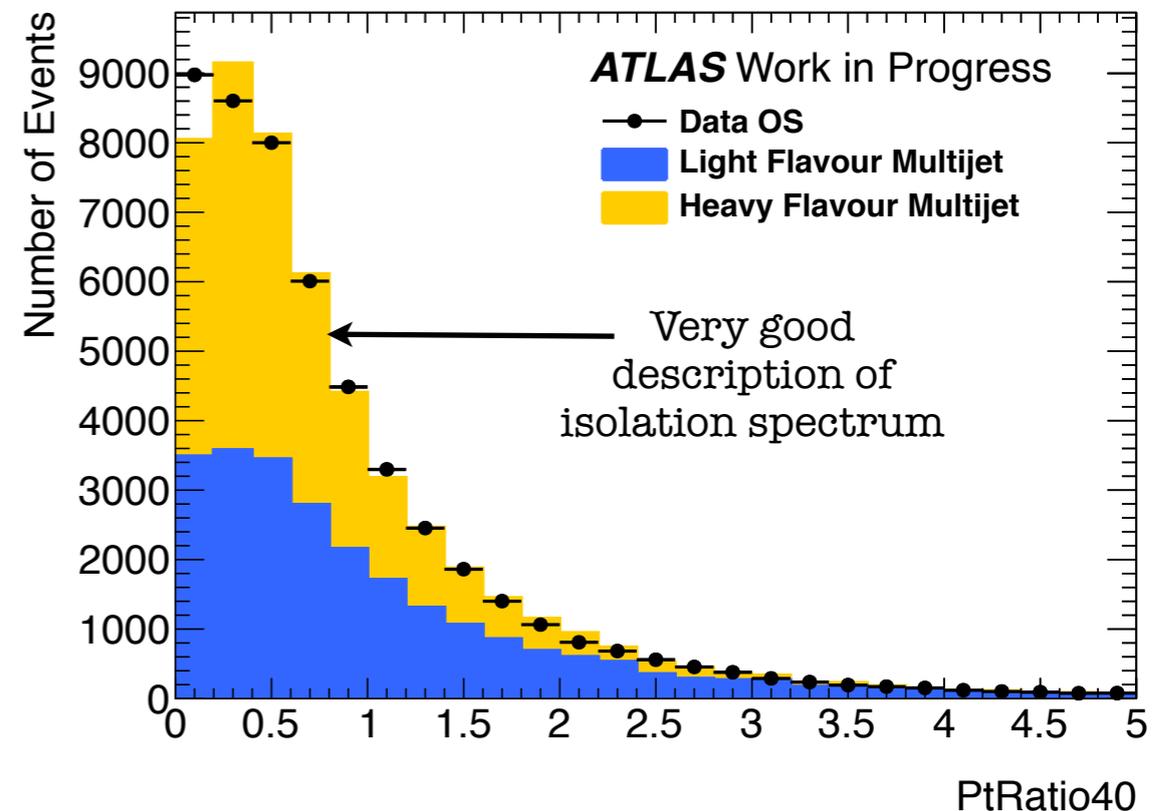
Multijet Background Estimate

- The shape of the multijet background is not well modelled by the Monte Carlo, so we want to use data to help correct the shape and normalisation of the Monte Carlo.
- A Multijet background dominated sample was selected by applying a harsh anti-isolation cut on one of the muons.
 - $PtRatio40 > 0.38$ allows only $\sim 1\%$ signal past the cut.
- We get normalisation factors from a template fit to apply to our Multijet MC OS-SS and data SS samples, to give a good description of the data OS.
 - These are determined by TFractionFitter using a likelihood fit.

Input to Fit

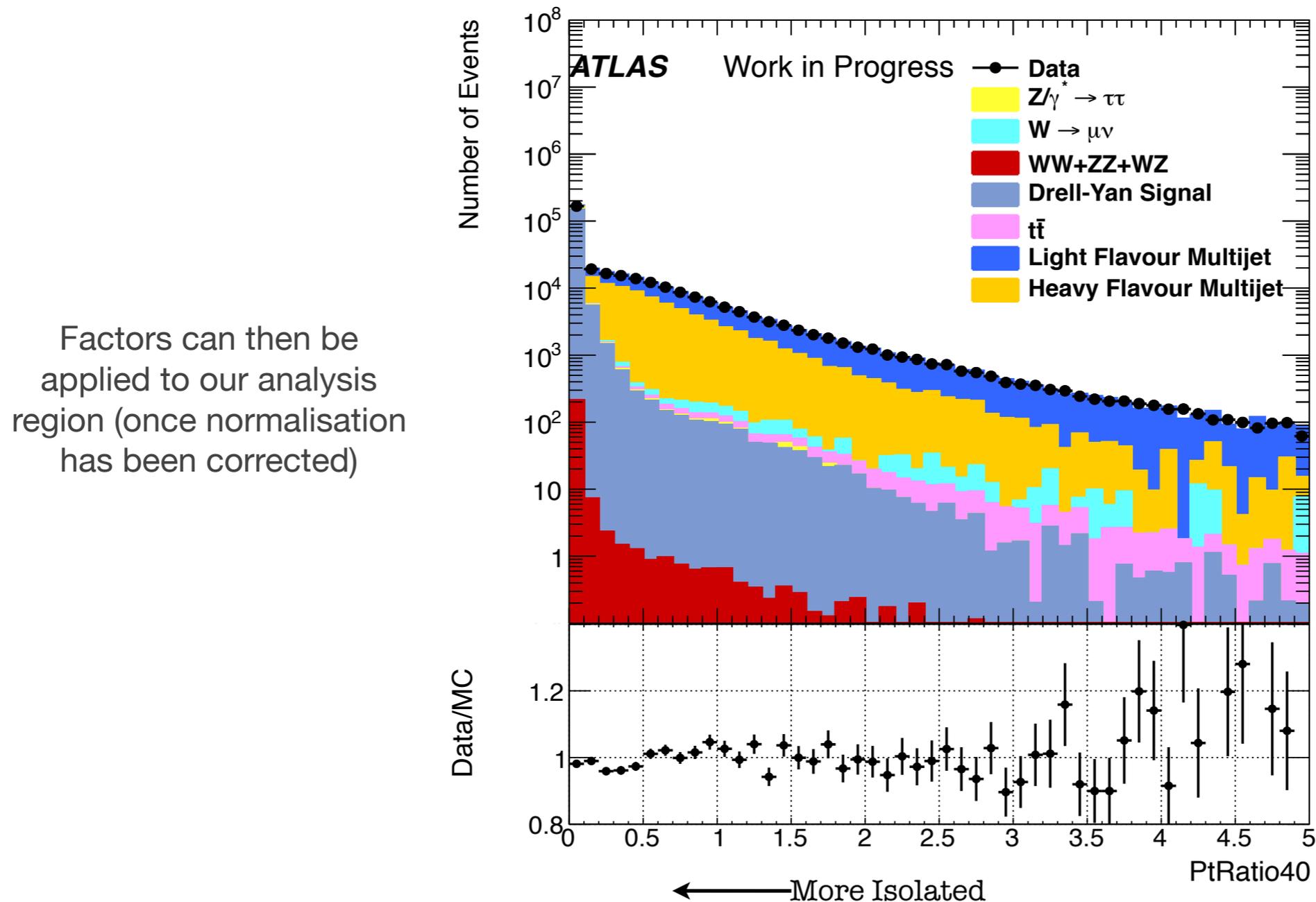


Output of Fit



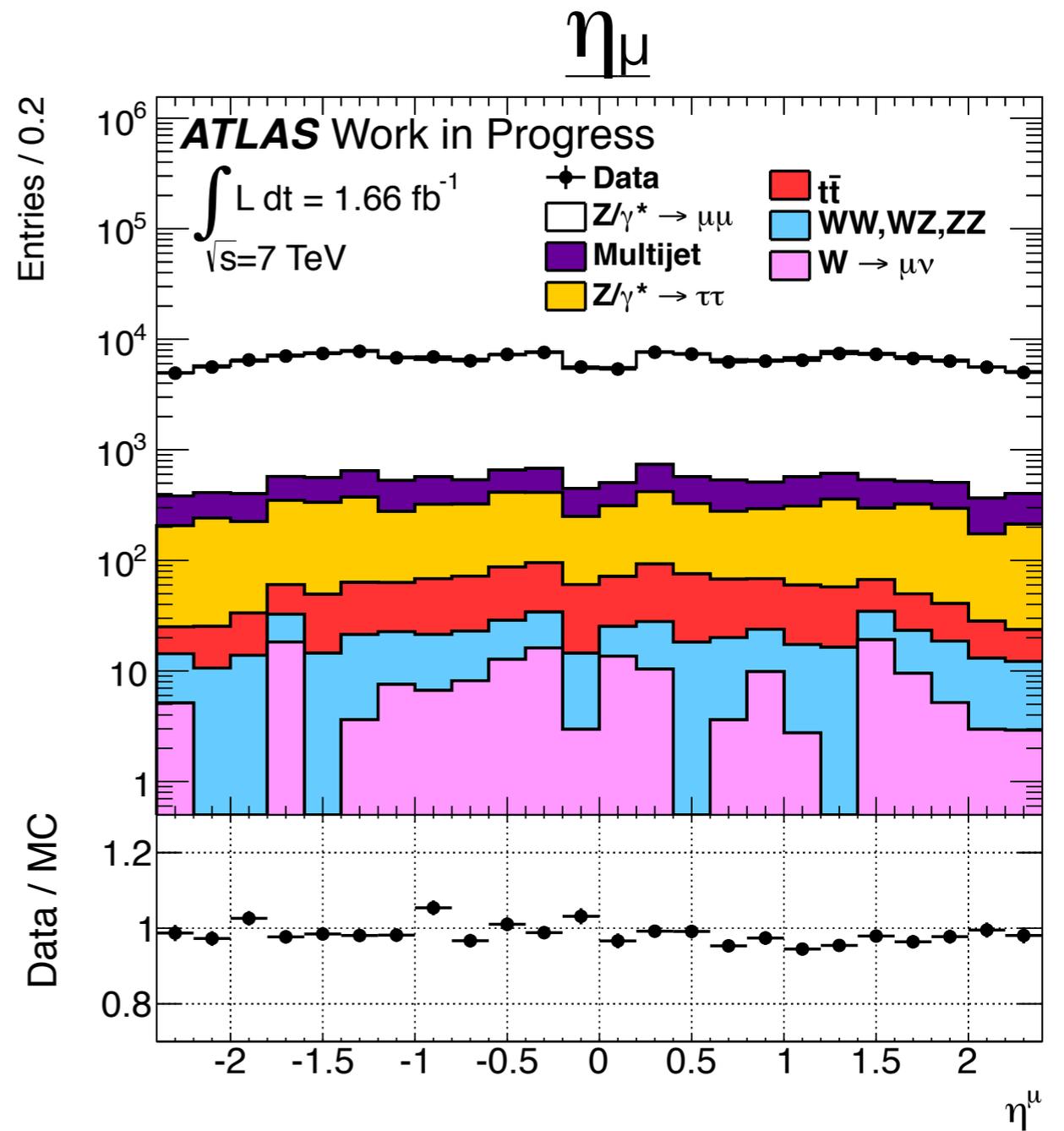
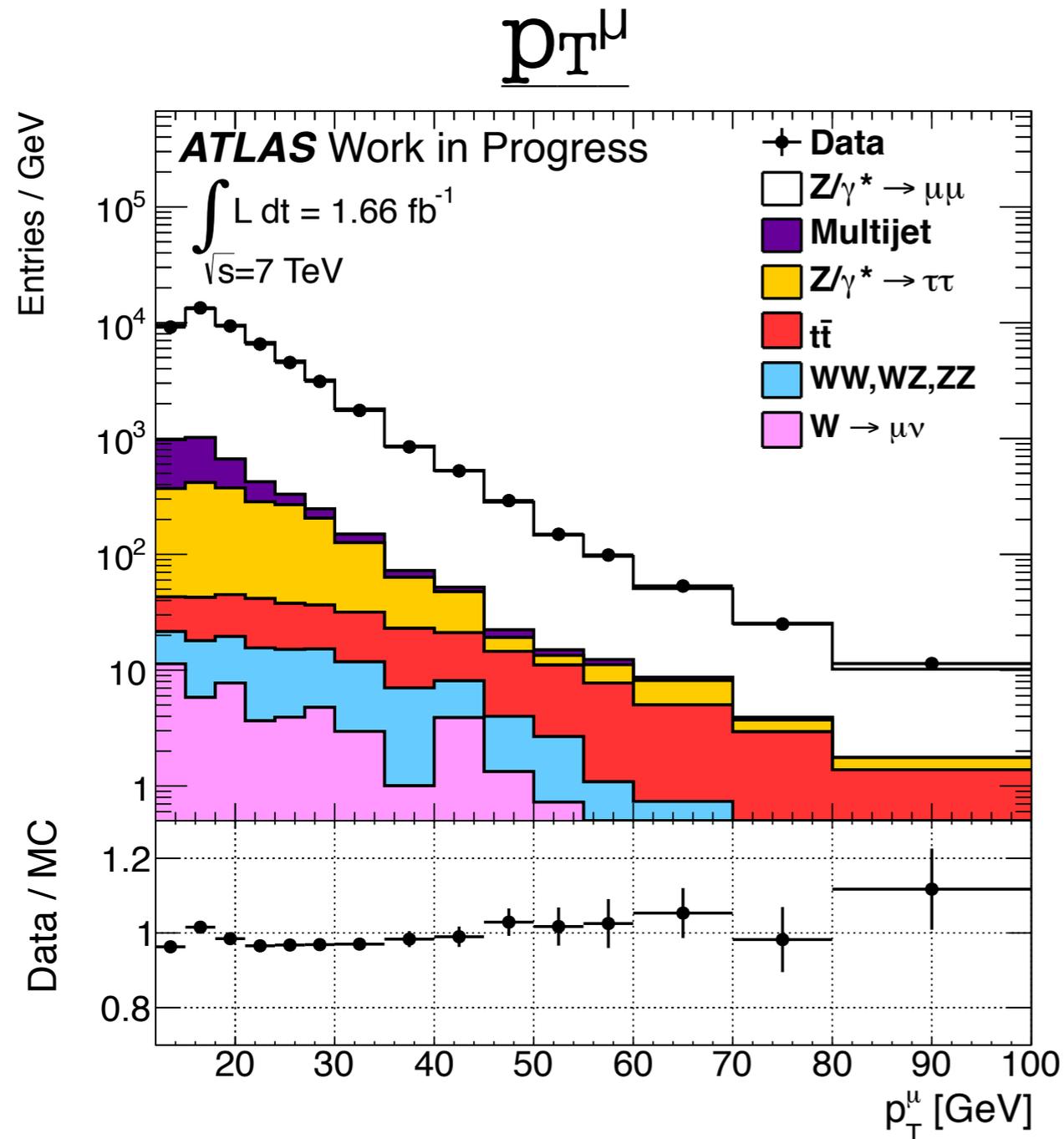
Multijet Background Estimate

The full set of analysis cuts has been applied apart from the isolation.

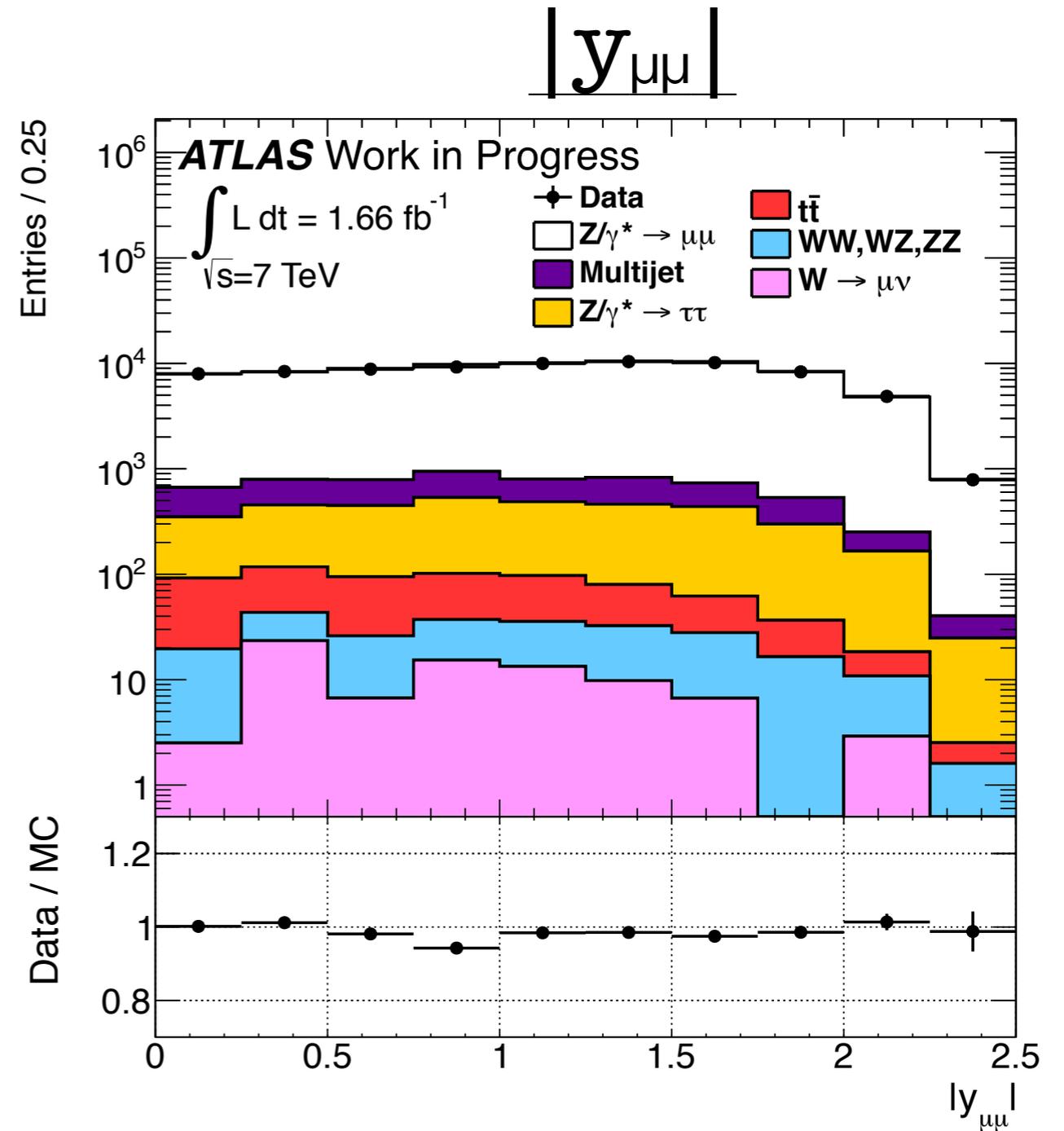
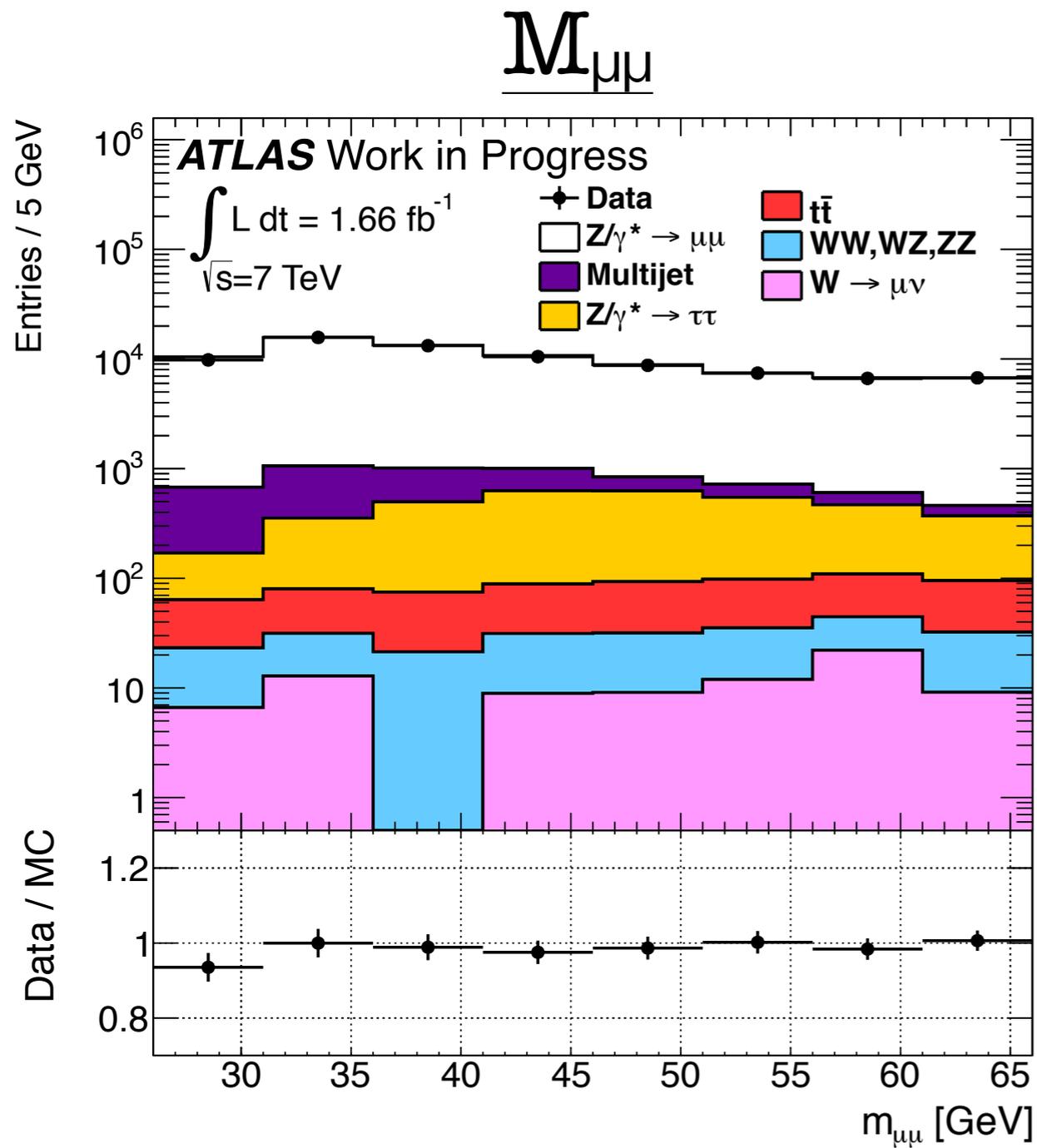


The template method shows excellent agreement between the data and MC.
The isolation spectrum is well described to $\pm 5\%$.

Control Plots



Control Plots



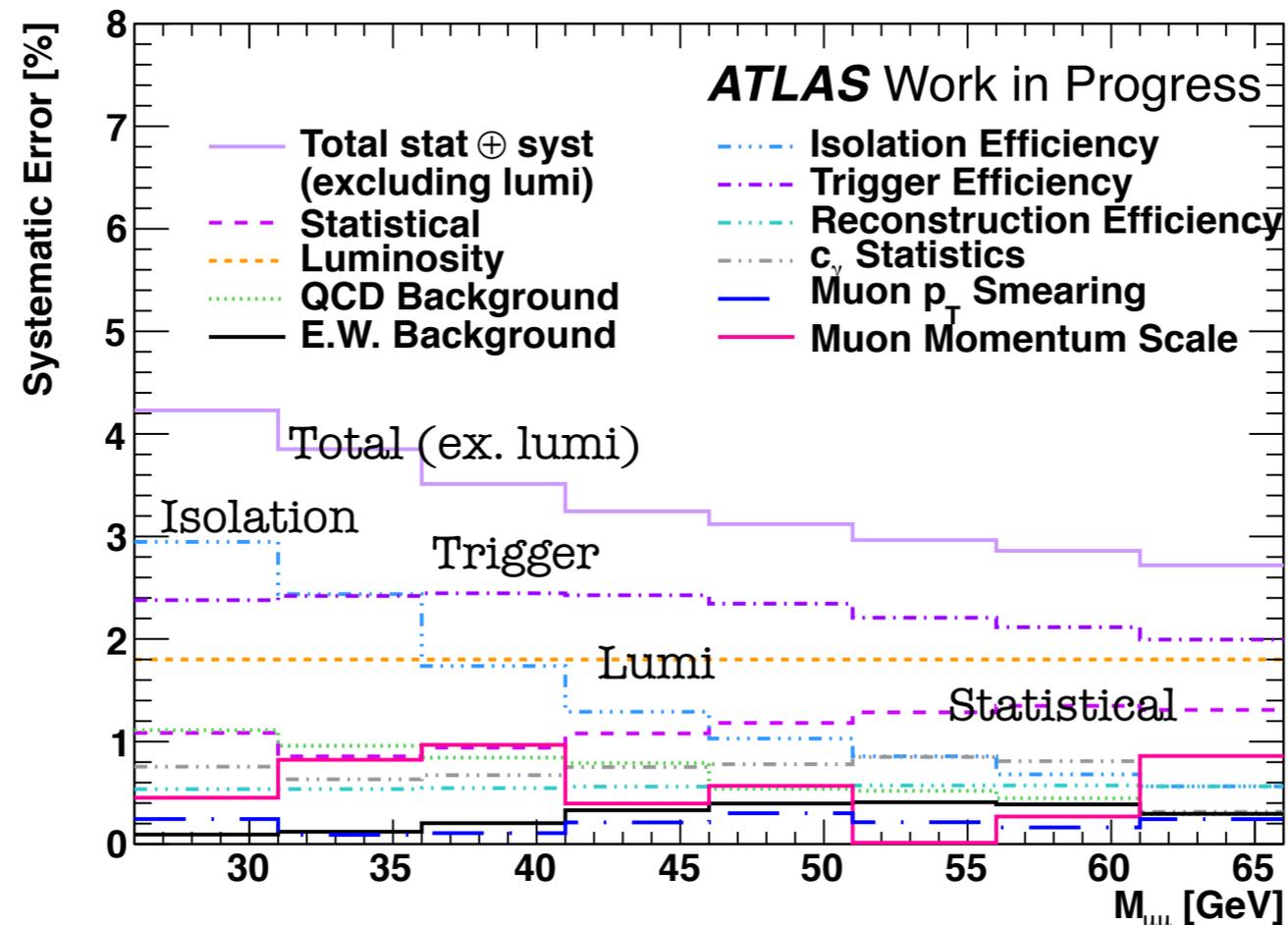
Fiducial Differential Cross-Section

- The fiducial differential cross-section is calculated in the normal way.

$$\left(\frac{d\sigma}{dm_{\mu\mu}} \right)_i = \frac{N_i - B_i}{\mathcal{L} C_{\gamma^* i} (\Delta m)_i}$$

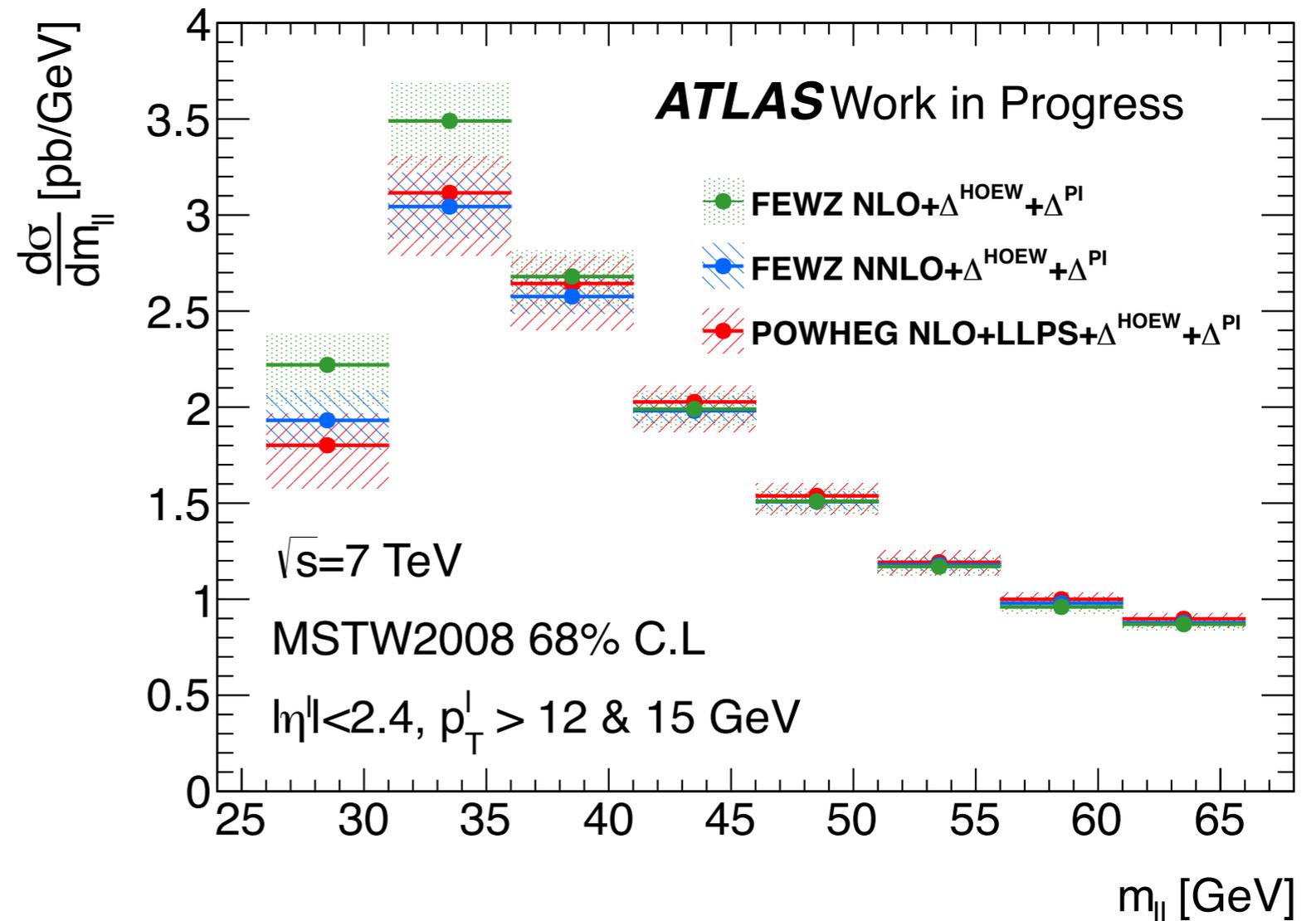
N_i = Selected Data Events
 B_i = Selected Monte Carlo Background Events
 \mathcal{L} = Integrated Luminosity of Data
 $C_{\gamma^* i}$ = Unfolding Factor
 $(\Delta m)_i$ = Bin Width

- The C_{γ^*} is produced by bin-by-bin unfolding.
- Uncertainties from a number of sources have been considered



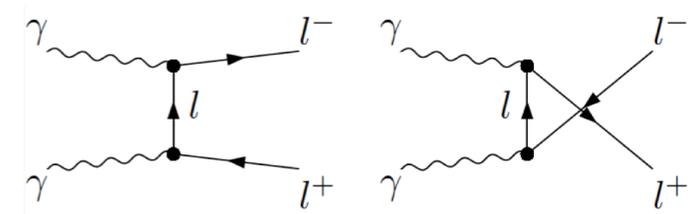
Comparisons To Theory

- Three comparisons to theory will be made:
 - NLO FEWZ (using MSTW2008NLO PDF)
 - NLO+LLPS POWHEG (using MSTW2008NLO PDF)
 - NNLO FEWZ (using MSTW2008NNLO PDF)
- All three have had NLO electroweak corrections applied:
 - Using the G_μ scheme
 - To correct for EW loop effects, initial state QED radiation and initial/final state QED interference effects



- All three have also had the non-resonant photon induced di-lepton cross-sections included:

- Calculated partonic cross-section for fiducial region
- Calculated at LO with MRST2004QED PDF and added to theory prediction



- ATLAS is the first LHC experiment to include PI production into the theory comparisons

Conclusions

- An overview of the low mass Drell-Yan measurement has been shown
 - concentrating on the 2011 muon measurement.
- Demonstrate a good understanding and control of our multijet background.
- Paper in production, combining all three strands of the analysis.
 - Hope to be able to comment if the addition of leading-log parton showers to NLO or moving to NNLO improves the agreement with data.