

Measurements of $Z(\nu\nu)\gamma$

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Projects I am currently involved on

- ▶ Fast Tracker Upgrade (FTK)
 - performance on electron isolation
- ▶ Boosted top quark decays
- ▶ Higgs to $Z(l\bar{l})\gamma$ search (advising summer student from Duke)
 - Giving a poster presentation at ANL
 - US Atlas Meeting at Ann Arbor
- ▶ SUSY sensitivity study with diphotons and missing transverse energy
- ▶ $Z(\nu\nu)\gamma$
 - Cross-section Measurement
 - Anomalous triple gauge coupling (ATGC) limits



How did I get started on $Z(\nu\nu)\gamma$?

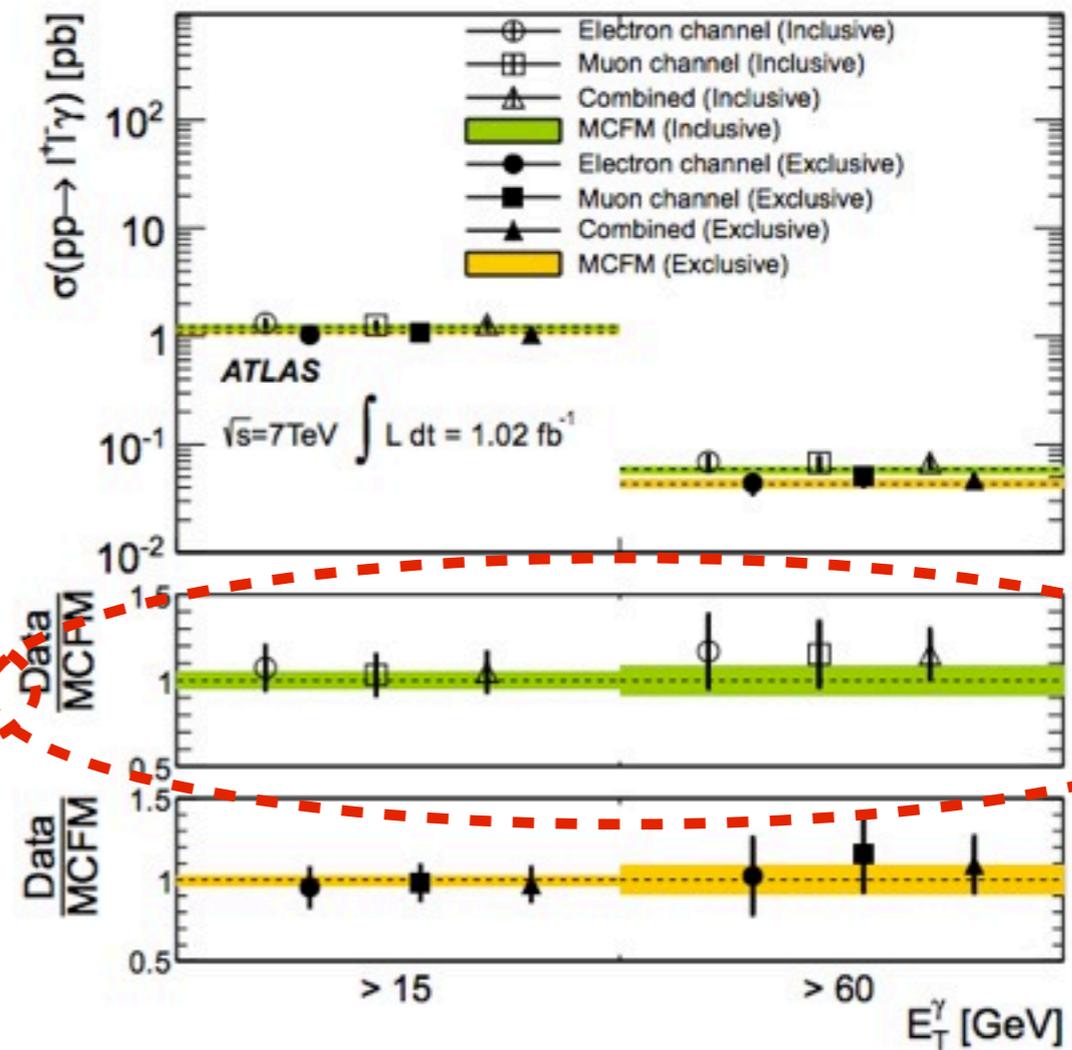
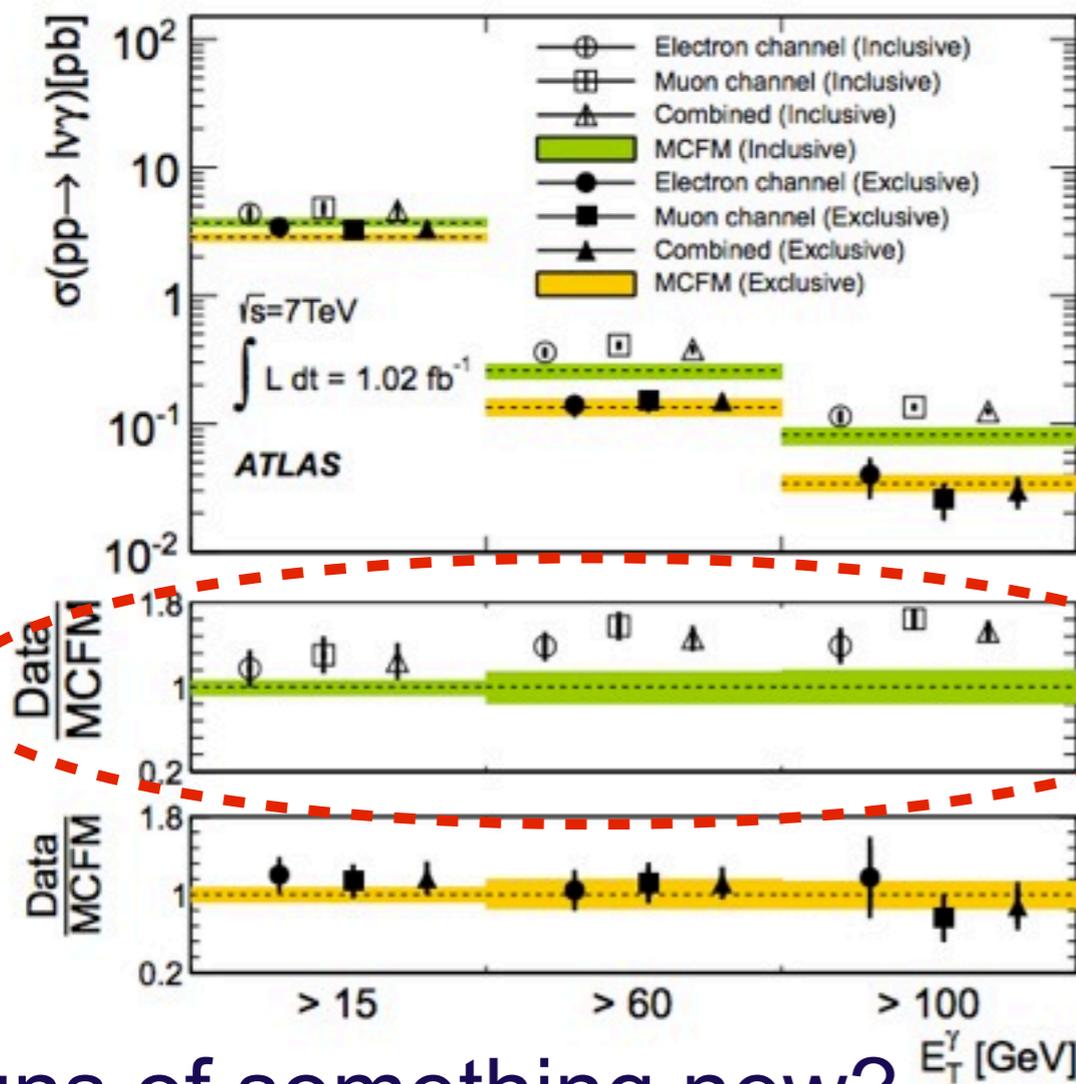
- ▶ Became a PostDoc at ANL (Oct. 2011)
- ▶ Began Collaborating with Al Goshaw (Duke) and started looking at Higgs
→ $Z(ee)\gamma$ (Oct. 2011)
- ▶ But there were groups working on $Z(ee)\gamma$ for the EWK group (Nov. 2011)
- ▶ **No one** was working on $Z(\nu\nu)\gamma$ (Dec. 2011) and they were looking for volunteers
- ▶ I volunteered because I was (still am!) interested in this channel and ANL has a strong association with Jets, MET, and Photons
- ▶ Gained a lot through working with A. Kruse, S. Norberg (grad. students) at the ASC
 - They are the ones who know how to set up current ATLAS packages
 - They are right around the corner! Just like at CDF

How and why do we measure $Z(\nu\nu)\gamma$?

- ▶ Signature based analysis:
 - Large MET, and High Energy Photon, no reconstructed electrons, and no reconstructed muons
 - Two search regions:
 - Inclusive number of jets, and exclusive 0 reconstructed jets
- ▶ Motivation
 - Important background to possible dark matter events
 - Cross section of this decay not yet been measured by ATLAS
 - Cross section is ~ 6 times larger than charged lepton $Z\gamma$ search
 - greatly improve ATGC limits
 - improves search for new production mechanisms

What might be out there?

- ▶ At 1 fb^{-1} the $W\gamma$ and $Z\gamma$ group saw an odd behavior
- ▶ The cross sections appeared **larger** than expected



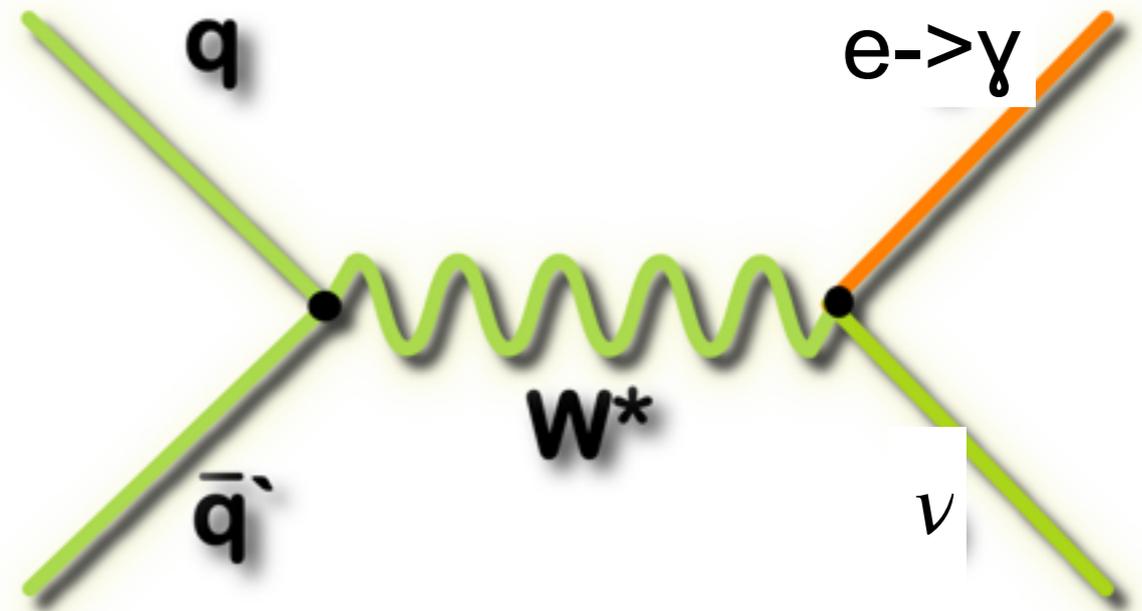
Signs of something new?

Slides presented for the DOE review of ANL



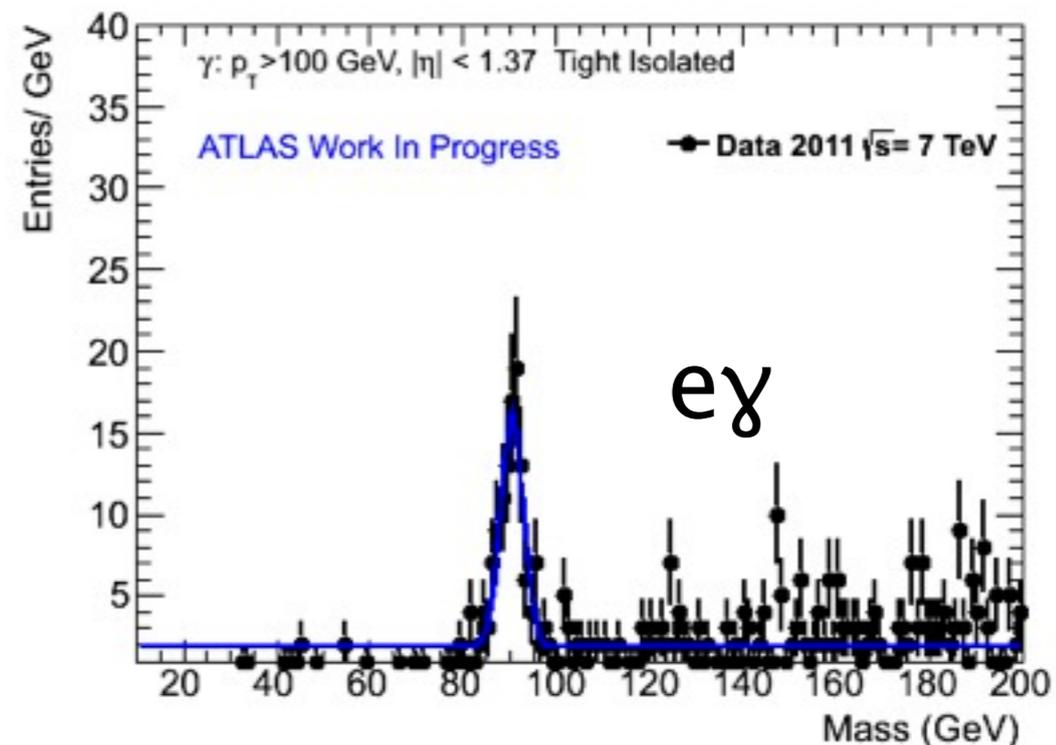
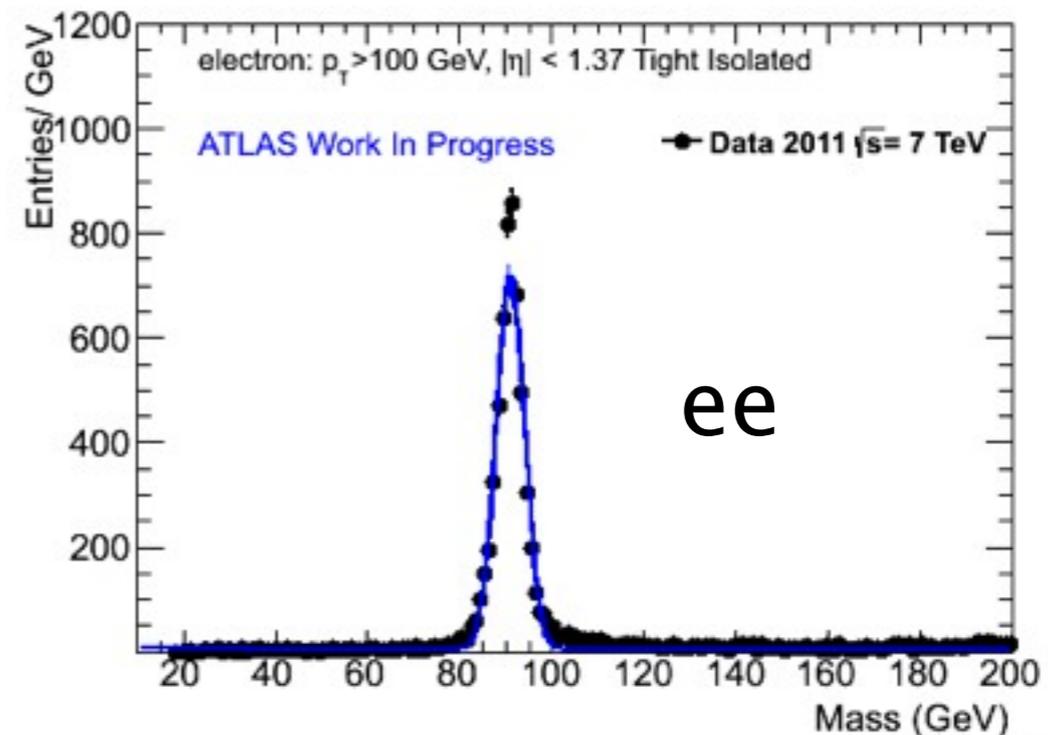
Backgrounds to the Signature

- ▶ Challenging signature
 - Experiment has numerous systematic uncertainties that need to be understood
- ▶ Monte Carlo based Backgrounds
 - Photon+Jet
 - Photon is detected, but the jet is not reconstructed resulting in MET
 - $W\gamma$
 - W decays leptonically, but l^\pm is not reconstructed, MET and a photon detected
- ▶ Data-Driven Backgrounds
 - $W \rightarrow e\nu$, e misidentified as photon
 - MET+jets, jet misidentified as photon



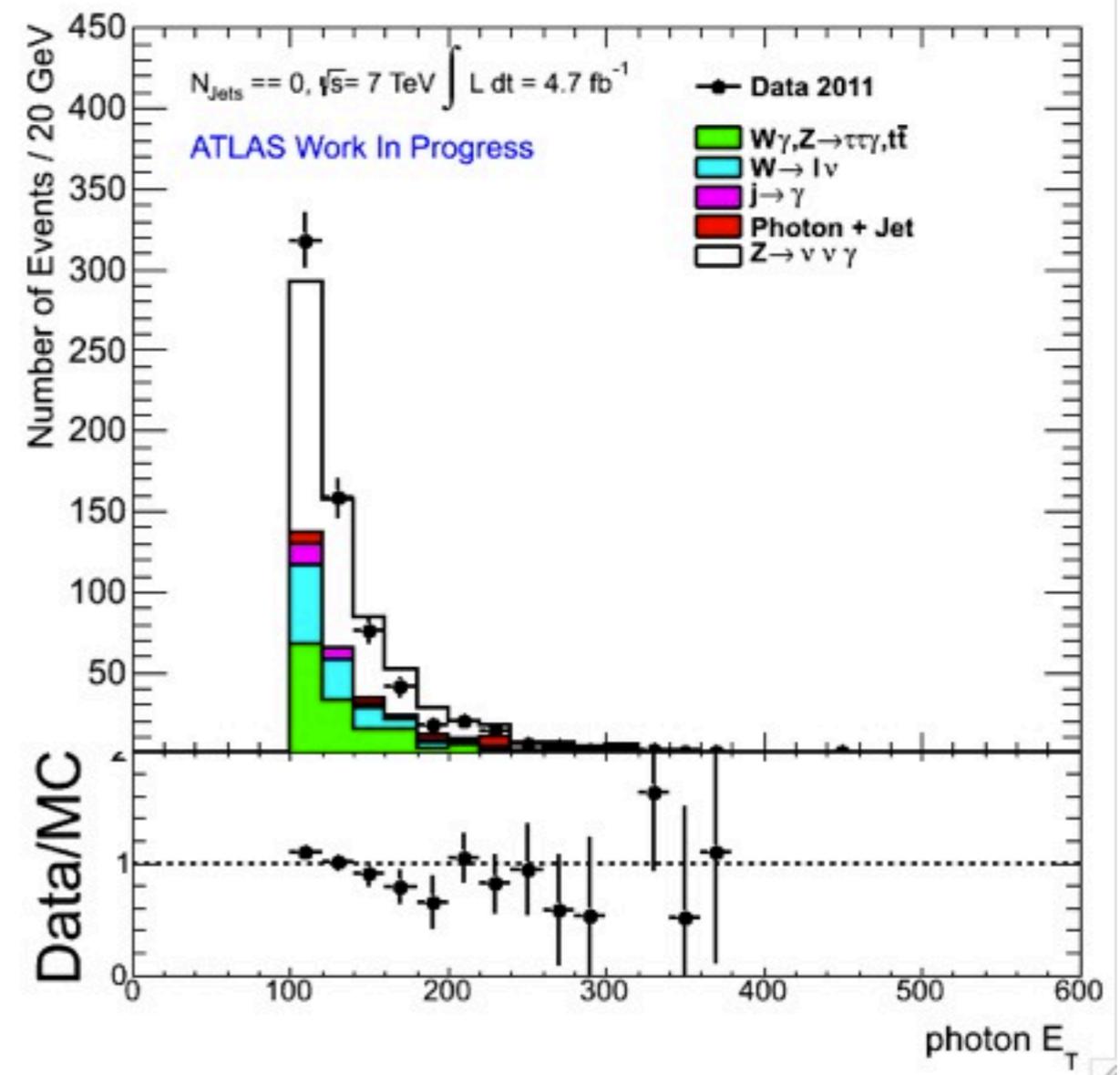
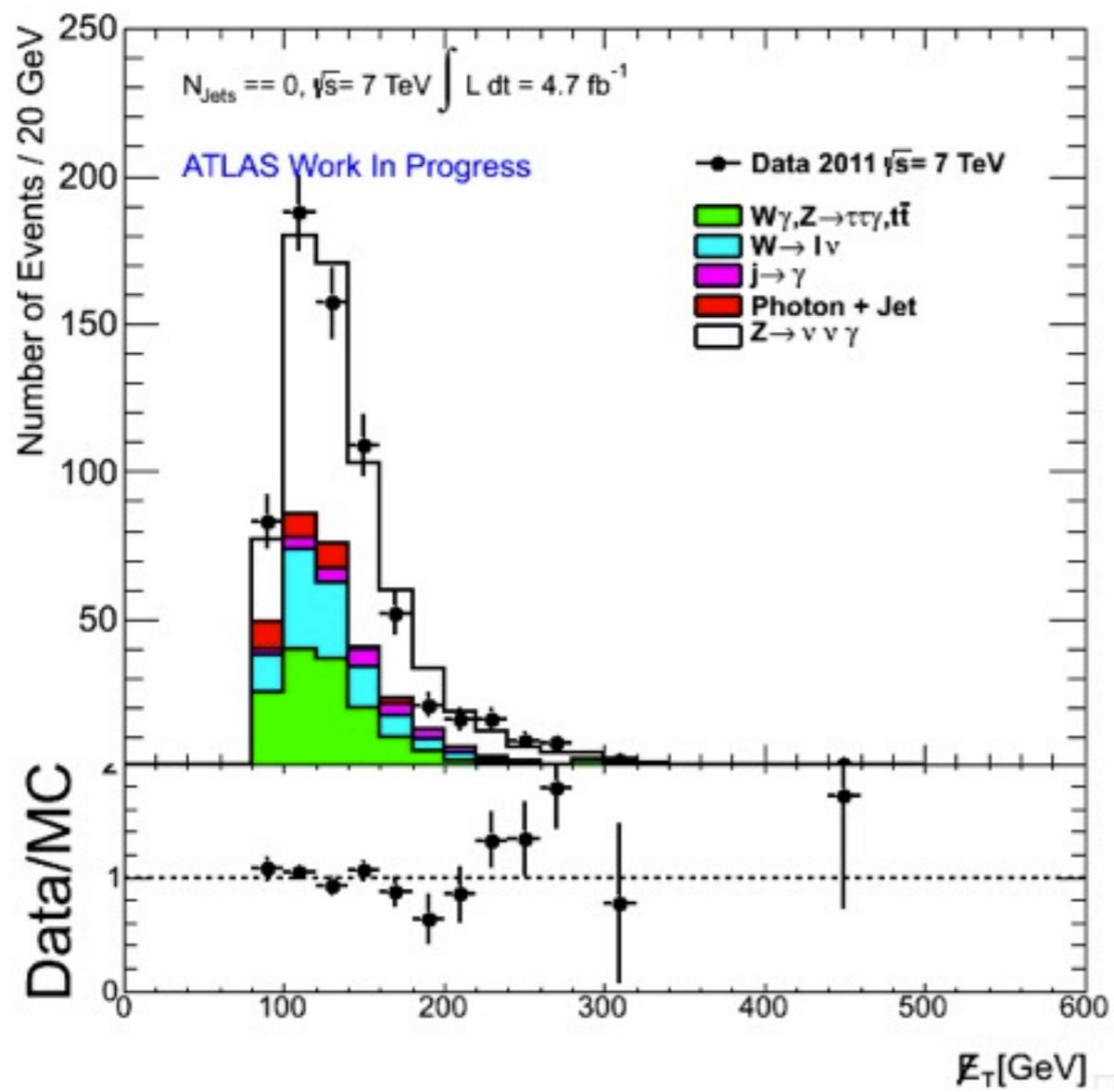
Electrons Misidentified as Photons

- ▶ Prescription for measuring the misidentification rate
 - Look for a pair of ee or $e\gamma$ objects near the Z pole mass
 - The Z boson cannot decay to an electron and a photon
 - Compare the rate of events with a pair of electrons and the rate of $e\gamma$ events near the Z pole
 - Ratio is the probability that an electron is misidentified as a photon
- ▶ Using the rate
 - Make a sample of electrons + MET
 - Apply the misidentification rate to the electrons
- ▶ Validate using $W(\rightarrow e\nu)$ MC



In the Zero Jets case

- ▶ The yields look very consistent with Standard Model production



Conclusions from $Z(\nu\nu)\gamma$ analysis

- ▶ $Z(\nu\nu)\gamma$ cross section extracted from data
- ▶ Does not appear to be anomalous production
- ▶ Both 0 Jets and N Jets cross sections consistent within uncertainty
- ▶ Will set strong limits on two ATGC parameters in the Standard Model
- ▶ **Measurement of $W\gamma$ and $Z\gamma$ Productions and Searches for Technicolor in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS Detector** currently being read by editorial board and it will be published by end of August

Thank you very much



Jets misidentified as photons

- ▶ Select events with MET > 90 GeV, and photon candidates > 100 GeV
 - Photon candidates can be tight, or anti-tight and any value of isolation
- ▶ Signal Photons are Tight and Isolated
 - Form a 2D region by having Tight and Anti-Tight, and Isolated and Not Isolated

	Isolated (< 6GeV)		Not Isolated (> 7GeV)
Tight	A		B
Not -Tight	C		D

6 7 GeV

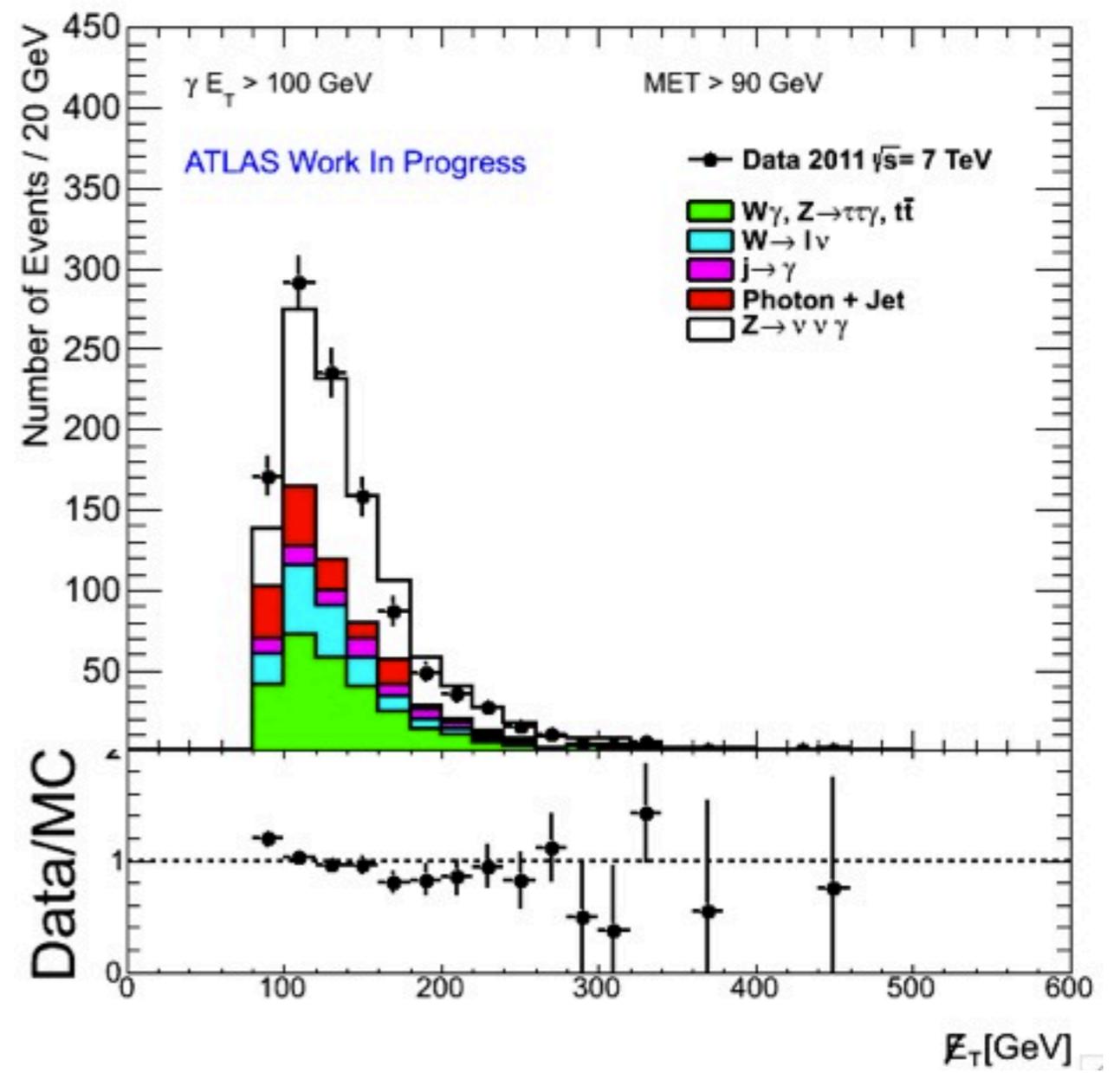
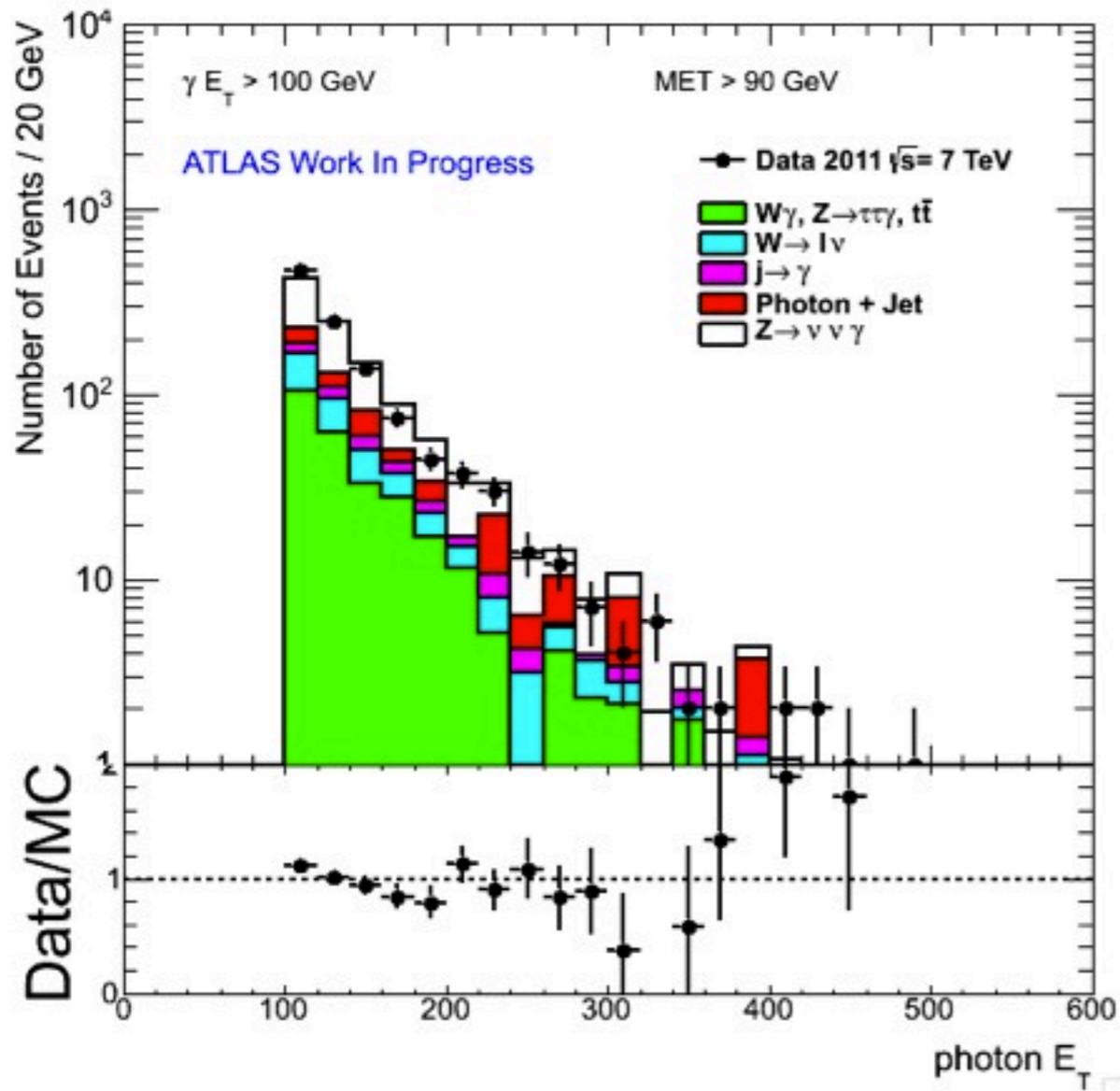
- Amount of misidentified photons is then $A_{\text{mis-id}} = B \times C / D$

▶ Validation

- use Z(vv)+Jets (should only be misidentified photons)

Putting it all together...

- ▶ The yields look very consistent with Standard Model production



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- ▶ The yields look very consistent with Standard Model production

