A few studies

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Outline

- Photon overlap removal between MC samples
- Lepton momentum corrections
- Second lepton veto
- Three photon events

Photon overlap between MC samples

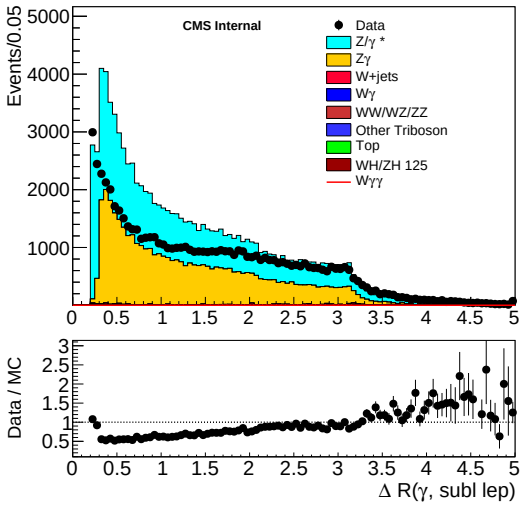
The phase space of photon emission overlaps between MC samples

- Wjets
- Wγ
- W$\gamma\gamma$
- Zjets
- Zγ

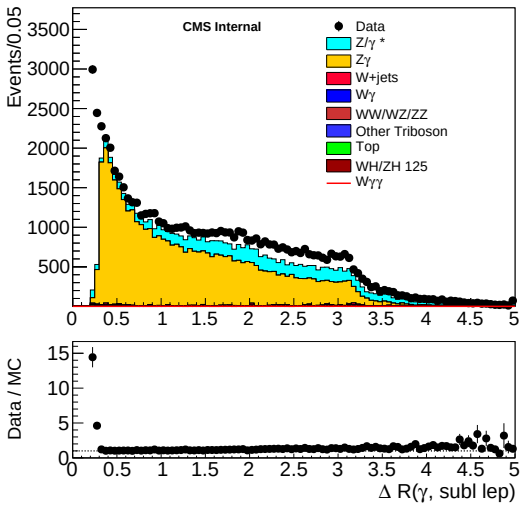
- The samples that add a photon require the emission of at least one additional hard photon
- Therefore we must veto events in the samples without the filter that have a hard photon
- Use mcParentage to determine if parent is lepton or QCD
  if(mcParentage & 0x12) == 0x12) n_hard_photons++
- In Wjets,Zjets require 0 hard photons, in Wγ require 1 hard photon

Check overlap removal in 2lepton + photon CR

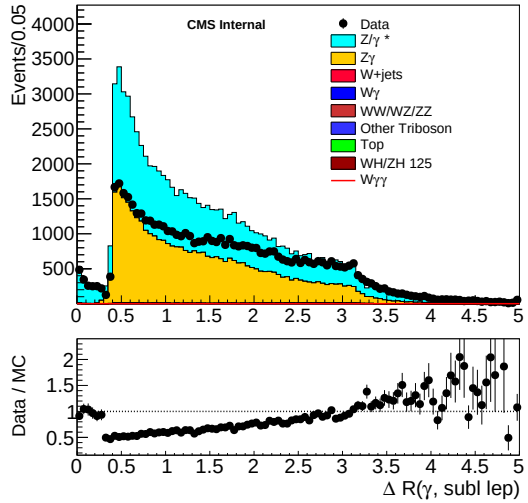
$ee\gamma$
before



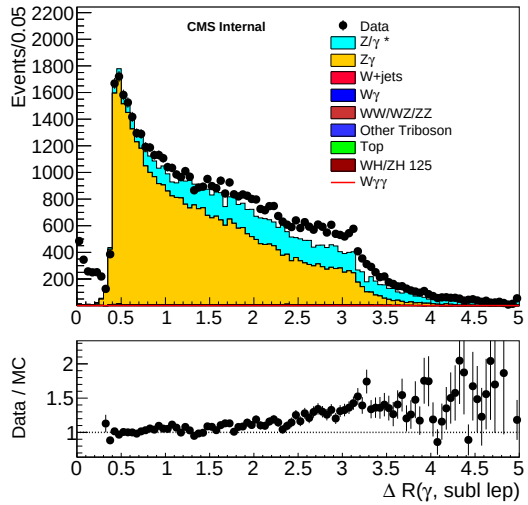
after



$\mu\mu\gamma$
before

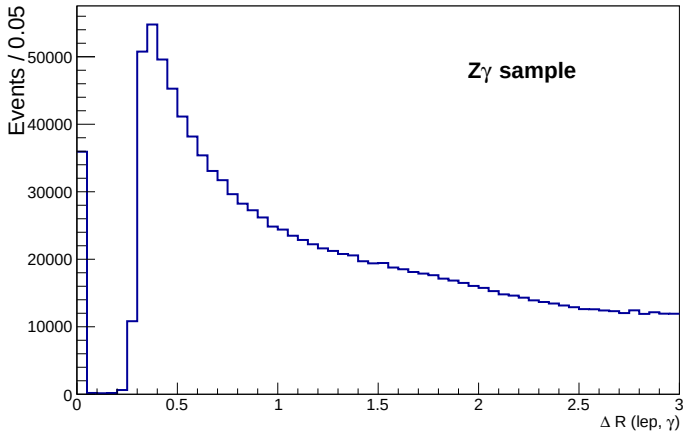


after



Modification of hard photon requirement

- From the previous slide, its clear that we should add a ΔR cut to the hard photon requirement
- In the Zg sample, the generator level ΔR cut is 0.3

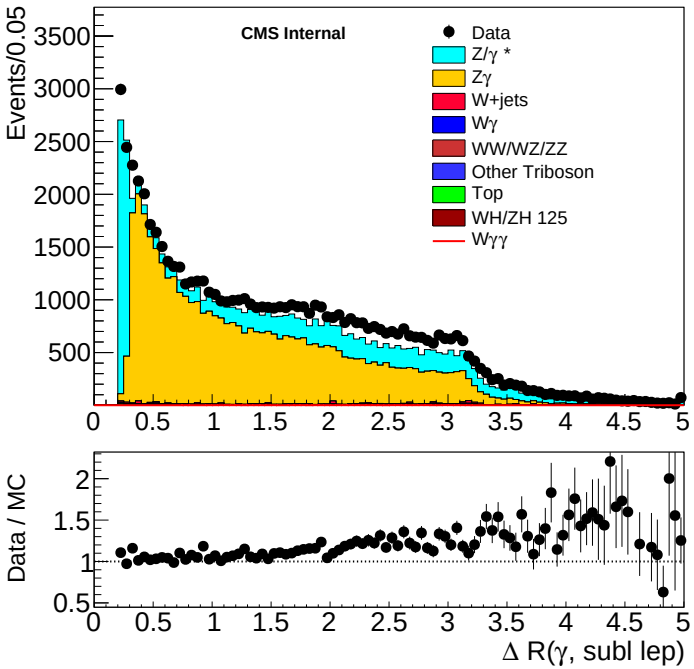


- Procedure :
  - Identify a photon using mcParentage as before
  - Find the parent particle (usually a lepton, sometimes a pion) by PID
  - A direct index link is not available in the ntuples, so a particle with matching PID may not be the mother
  - Calculate the ΔR with all potential mothers. If none are less than 0.3, this is a hard photon

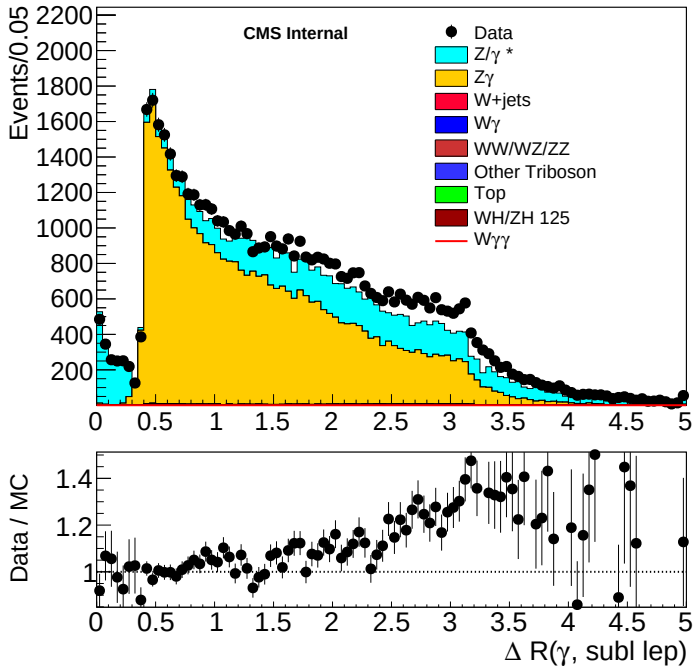
After modification

MC agrees better wit data at low ΔR

$ee\gamma$



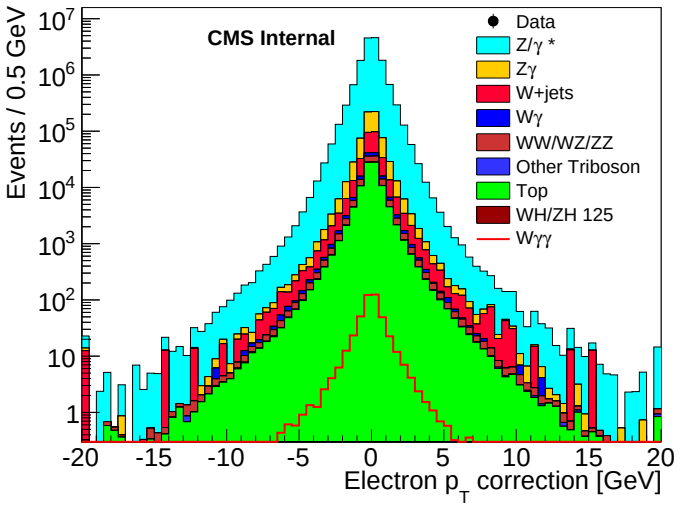
$\mu\mu\gamma$



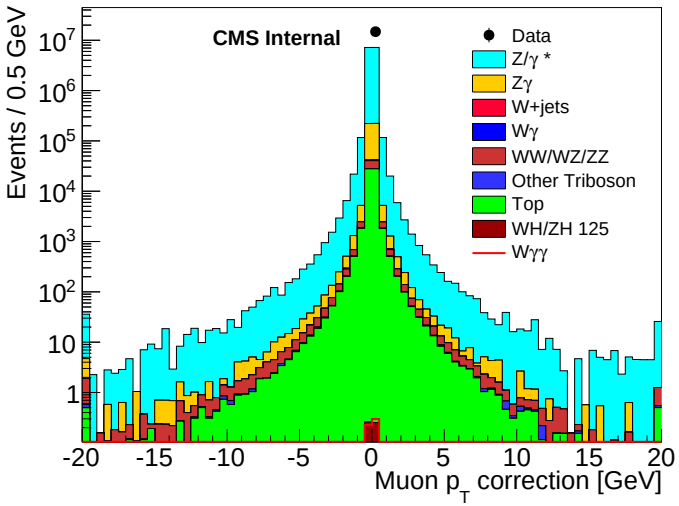
Check corrected lepton momentum in 2 lepton CR

- Applying corrections to electron and muon momenta in MC
- Following procedures linked on twiki

Electrons



Muons

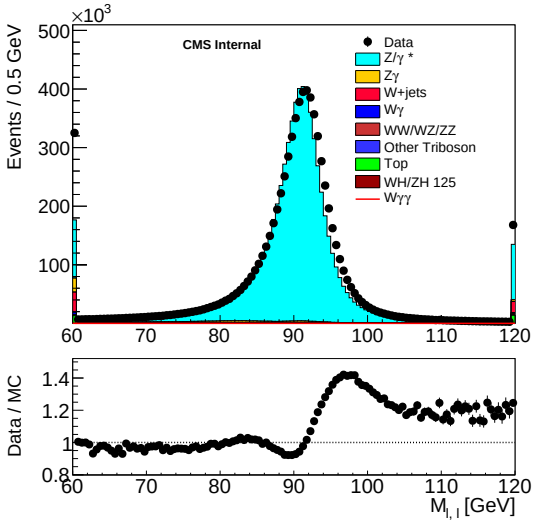


Check shape of Z peak between Data and MC

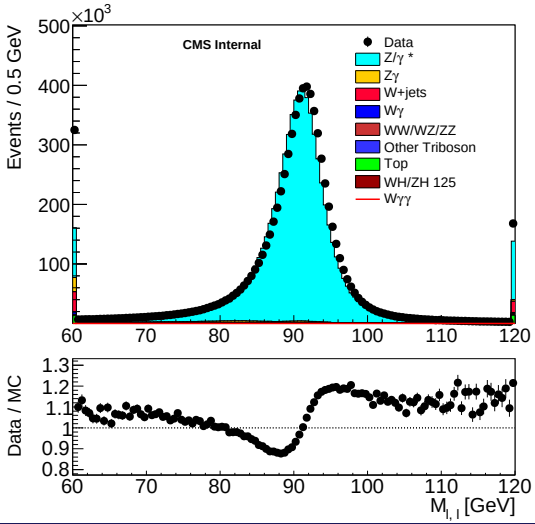
The momentum correction improves the agreement, but its not great

Electrons

Before

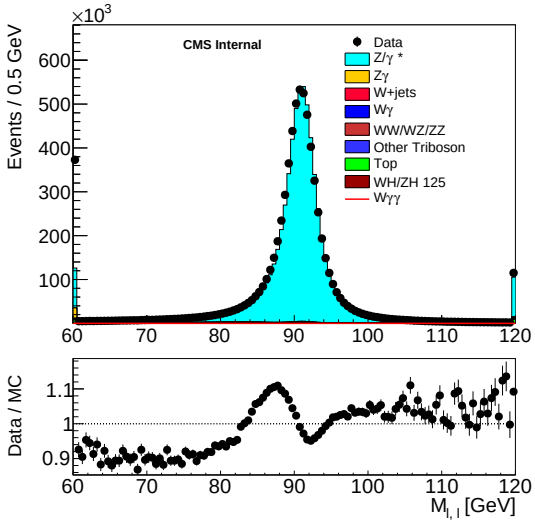


After

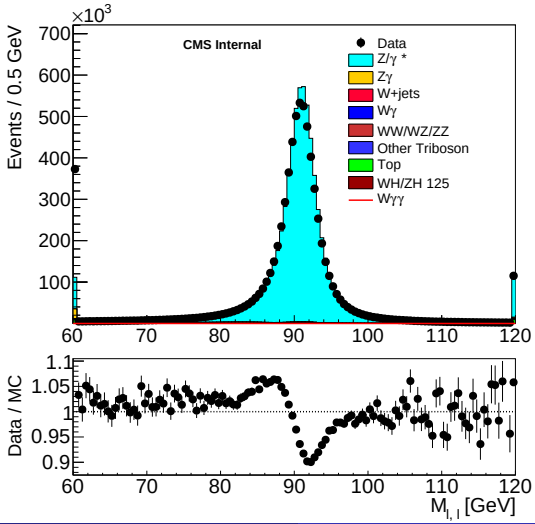


Muons

Before



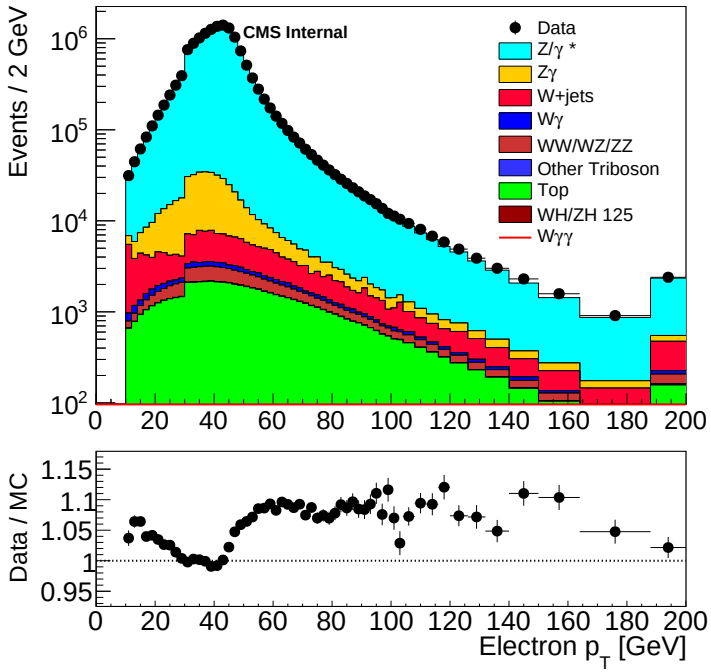
After



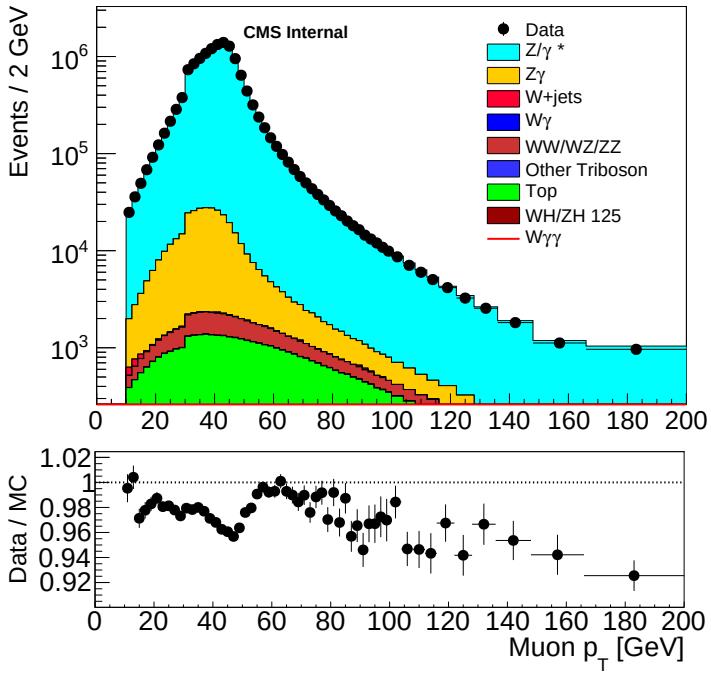
Check corrected lepton momentum spectra

Still about 10% variation over the p_T spectrum

Electrons



Muons



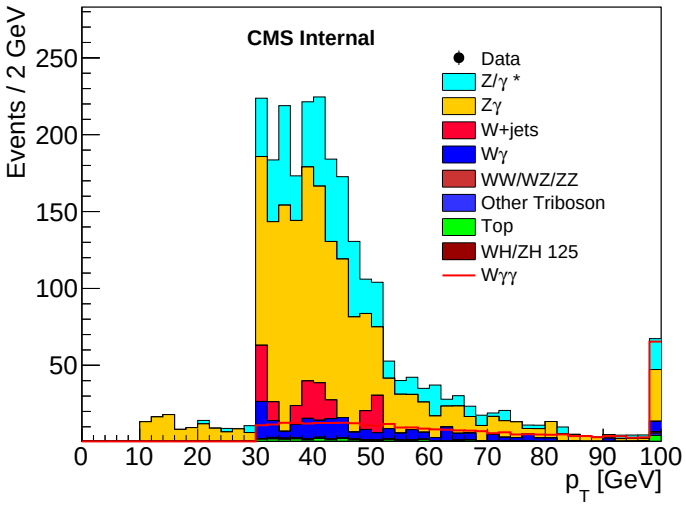
Second lepton veto

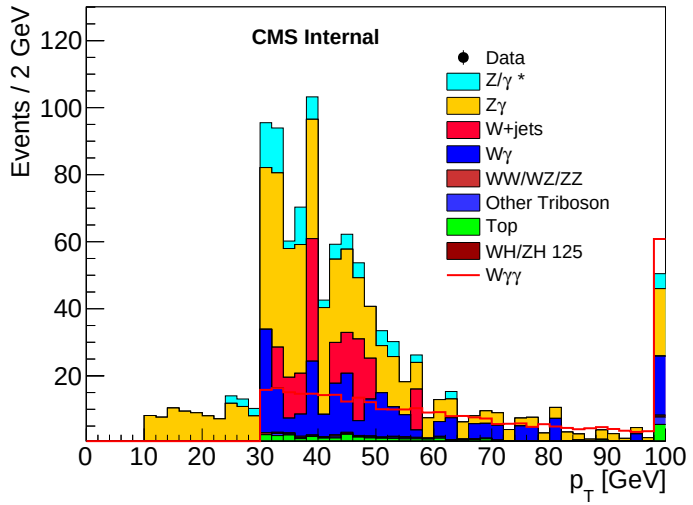
Check efficiency of veto on additional leptons having $p_T > 10$ GeV

Electron channel

	Total MC	Signal	Signal / bkg
Before	2563	338	0.13
After	2213	334	0.15

	Total MC	Signal	Signal / bkg
Before	1059	357	0.34
After	752	357	0.47





Three photon events

- While our signal prefers to produce 2 photons, it is possible to emit an additional photon
- The number of events is small, but the requirement of a third photon further reduces background
- Could provide additional TGC/QGC sensitivity
- Unclear if we should include it in the cross section "what cross section are we measuring?"
- May present some challenges to background estimation

Muon channel

	Total MC	Signal	Signal / bkg
2 photons	752	357	0.15
3 photons	0.6	1.2	2
3 photons, 3rd photon $p_T > 10$ GeV	3.1	4.2	1.35

Electron channel

	Total MC	Signal	Signal / bkg
2 photons	2213	334	0.47
3 photons	3.5	1.8	0.51
3 photons, 3rd photon $p_T > 10$ GeV	16.2	4.0	0.25