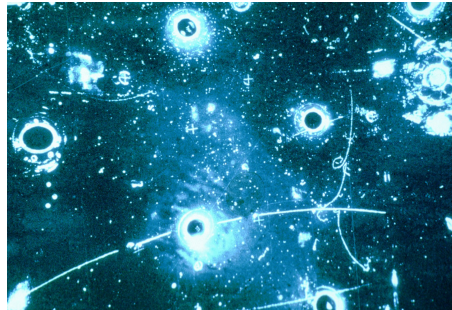


# EW corrections to Drell-Yan processes (W-Bosons in the electron channel)

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- Reminder: Importance of EW corrections
- Differences in the electron channel
- Tagging the photons?
- Outlook



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in collaboration with

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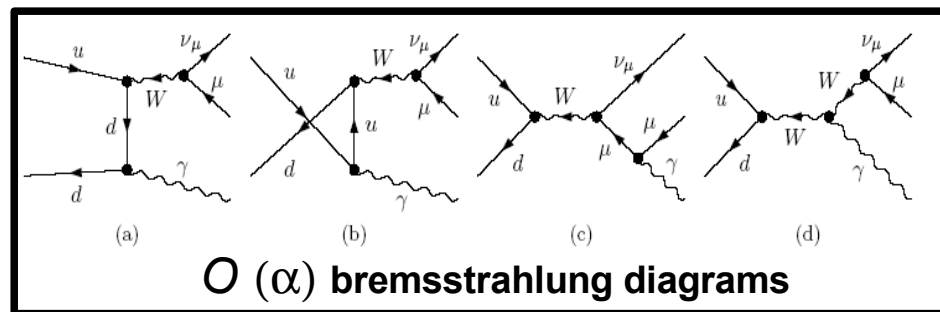


**DAAD** Deutscher Akademischer Austausch Dienst  
German Academic Exchange Service



# Impact of EW corrections

- EW precision measurements crucial for the LHC:
  - Luminosity measurement**
  - PDF constraints**
  - Test on the SM**
- N(N....)LO QCD corrections more precise and smaller in size with each iteration
- EW corrections become more and more important in comparison



- corrections on the cross-section of up to 10% (SM region)
- shift in distributions ( $W$  transverse mass, ...)
  - depending on input scheme , i.e.  $\alpha(0)$  ( $\alpha$ ,  $M_Z$ ,  $M_W$ ) or  $G_\mu$  ( $G_\mu$ ,  $M_Z$ ,  $M_W$ )

**NEED to check impact on our measurements!!!**

# Generators used and datasets analysed

## PHOTOS

- standard in Athena
- multi-photon emission implemented as QED Parton Shower (leading-log approx.)
- at low  $P_T$  in agreement with HORACE

## HORACE

- matching fixed EW  $O(\alpha)$  calculation with higher order QED PS (leading log)

Datasamples:

		12.0.6.1 Generation/Atfast	12.0.5 full sim	* LeptonEff (12.0.6)
Herwig/Jimmy/Tauola	with PHOTOS	~ 1 Mio.	8780	0.640243
	Born level	~ 1 Mio.	8547	0.648613

\*

- LeptonFilter applied on generator level
- events with PHOTOS being run are rejected, because after modification by QED PS electrons no longer fulfill cuts
- otherwise samples have exactly the same random seeds

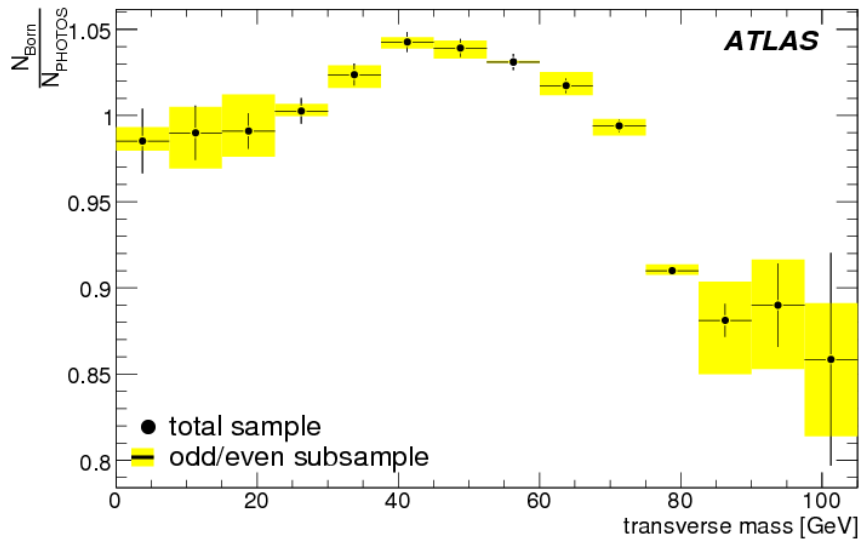
in the following studies PHOTOS is used to study the effects of EW corrections on

- **shapes of the distributions**
- **explore possibilities to tag EW prompt photons**

**CAVEAT:** No cross-section determination, change in normalization can't be estimated  
So far only TRUTH-Level studies, **no** look in full sim+reco yet

# Transverse mass of the W-Boson

$N_{\text{born}}/N_{\text{PHOTOS}}$



LeptonFilter cuts:

$P_T$  (electron) > 10 GeV

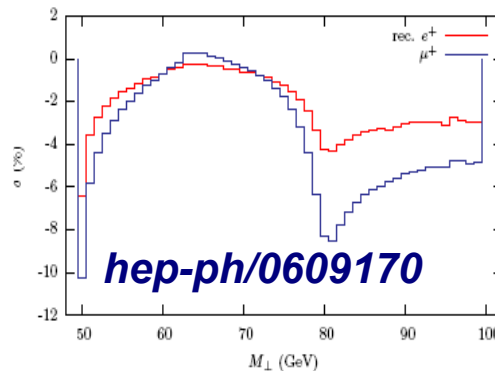
$|\eta|$  (electron) > 2.7

events not passing the LeptonFilter Cuts  
(red, scaled to events with PHOTOS)

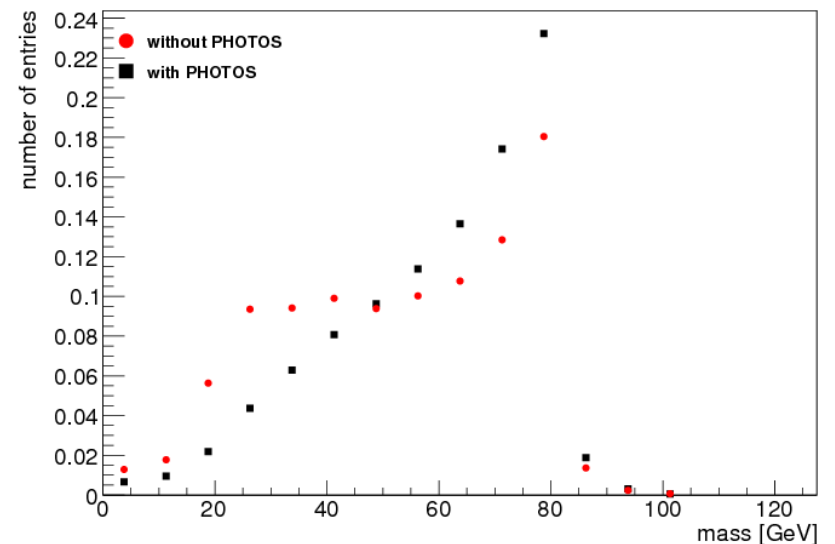
estimate uncertainty by

- statistical errors on total sample (black bars)

- fluctuations in subsamples (yellow band)

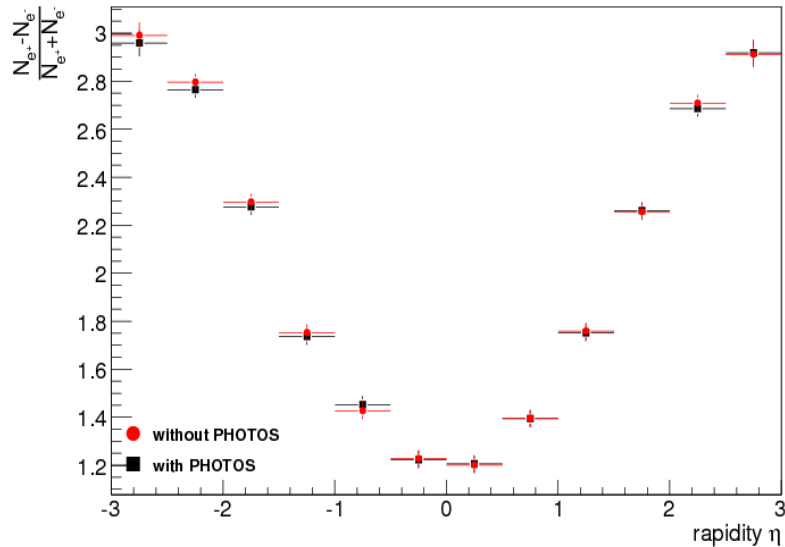


for muons

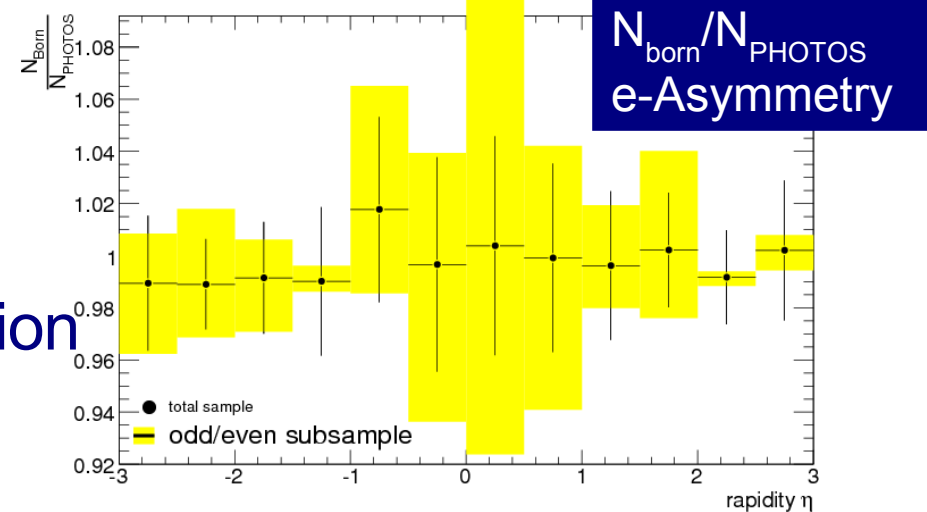


# Electron asymmetry and rapidity

electron asymmetry for both samples

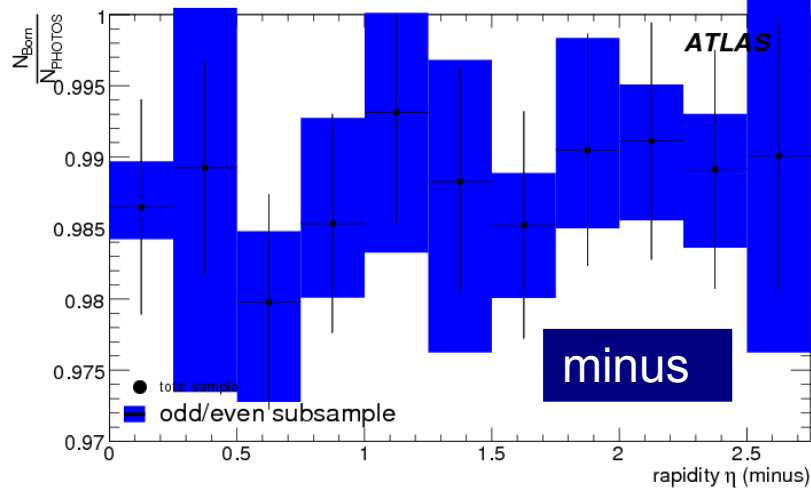


difference =  $0.997 \pm 0.008$  (RMS)



no distortion  
in shape

difference =  $0.988 \pm 0.003$  (RMS)

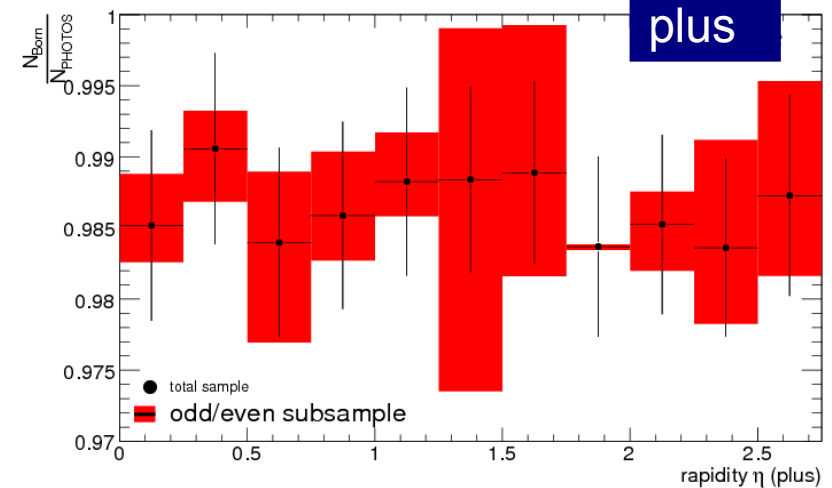


comparable with  
1.6 %-point loss  
due to  
LeptonFilter Cuts  
(non-scaled  
comparison)

$N_{\text{born}} / N_{\text{PHOTOS}}$   
 $\eta$ -distribution

minus

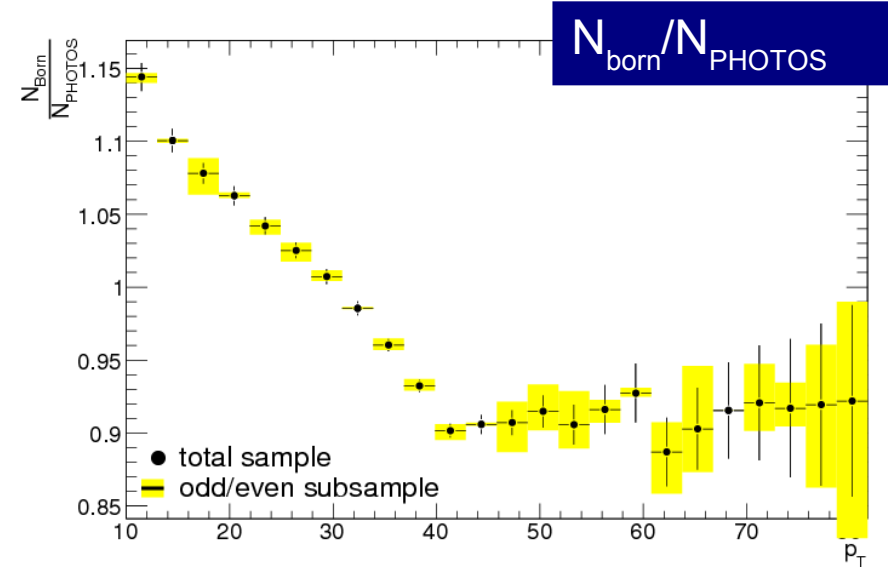
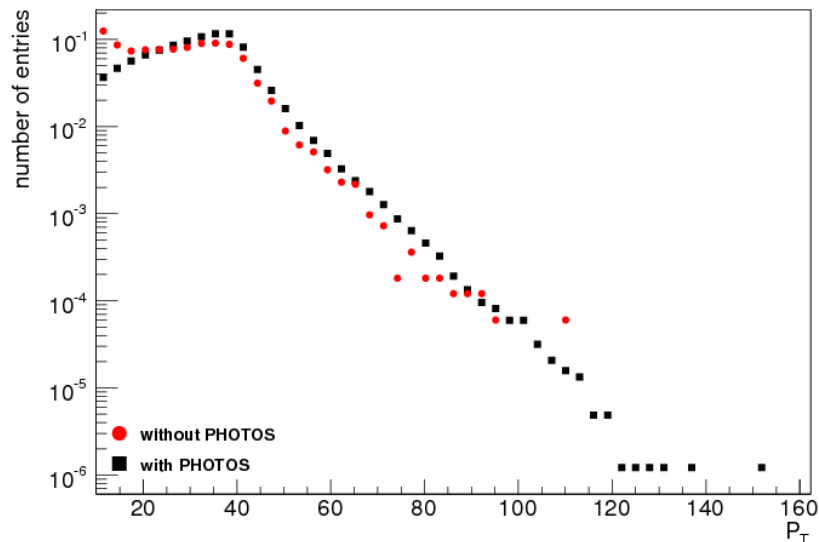
difference =  $0.986 \pm 0.002$  (RMS)



plus

# Electron transverse momentum

evens not passing the LeptonFilter Cuts  
(red, scaled to events with PHOTOS)

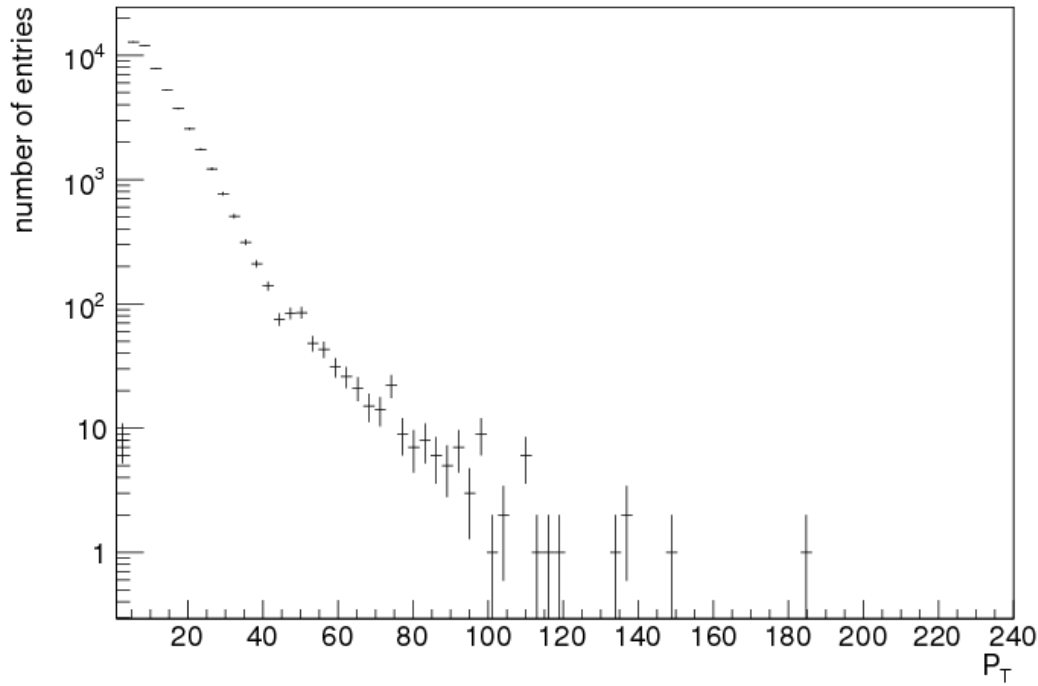


- Transverse momentum shifted towards lower values
- $P_T$  cuts (trigger, electron ID, analysis cuts) crucial parameter
- can change number of final events significantly
- **and thus normalization shift due to EW corrections!**

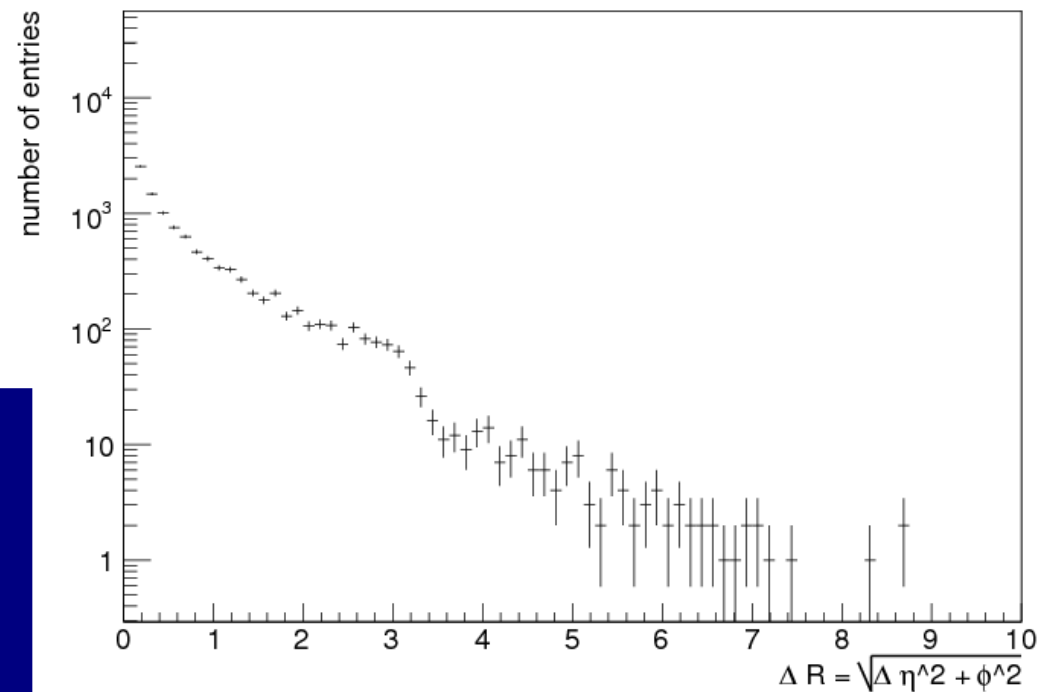
(need to study that with HORACE, where normalization can be estimated)

# Photon distributions

prompt photon transverse momentum



separation of prompt photon and electron



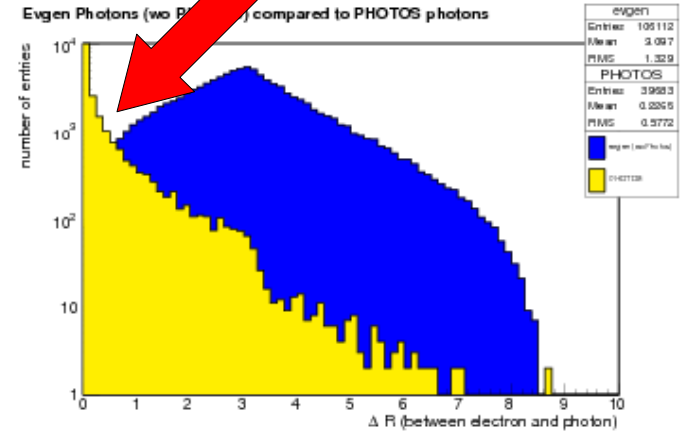
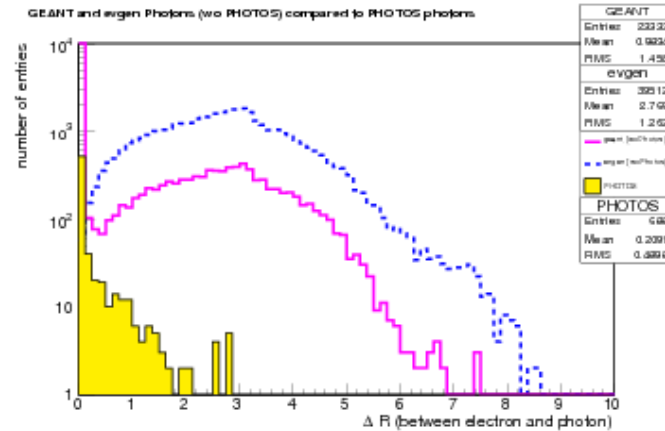
- spectrum of EW photons hard  
→ **detection feasible**
- separation with electron big enough  
→ **distinguish between the two**

# Can we tag the EW photon?

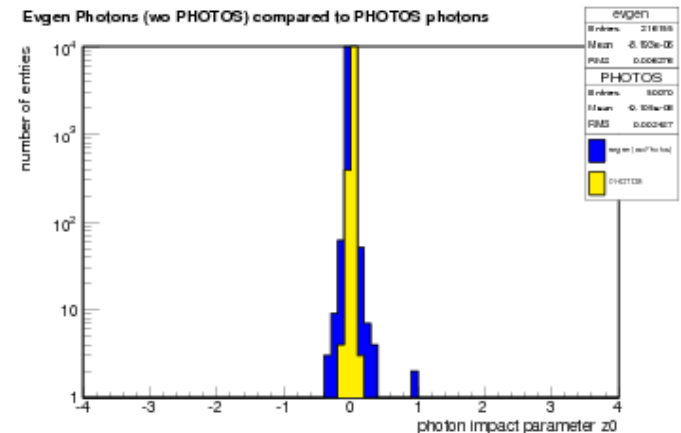
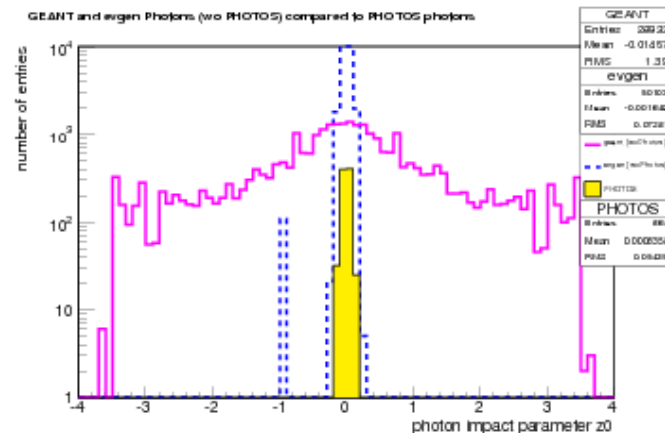
- Need to **determine exact cross-section** and compare to MC, if we want to use Drell-Yan production of EW Bosons for **luminosity measurements**.

- To be sure about **real size of EW corrections**, need to find way to measure them

- Is there possibility to **tag (EW) Brems photon** and reject them?



$\Delta R$  between electron and photon

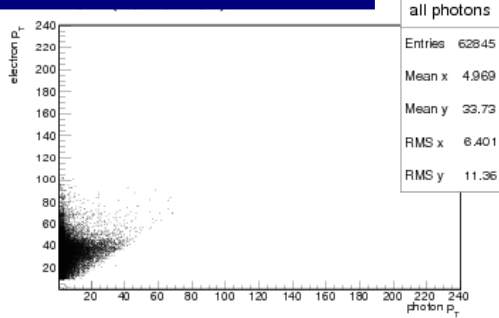


impact parameter  $z_0$  (observable for photons?)

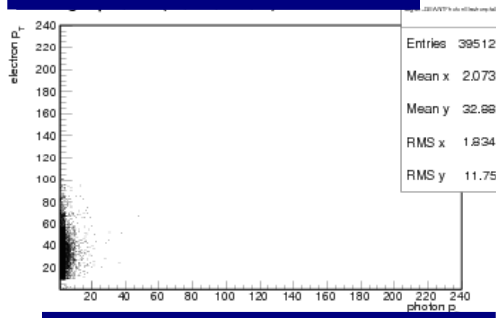


# $P_T$ correlations for electron and photons

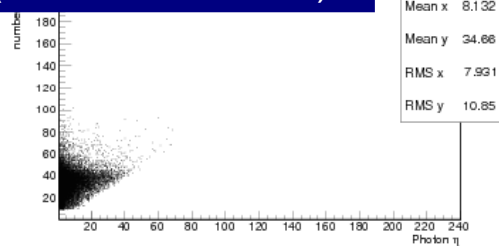
all Photons  
(wo EW corrections)



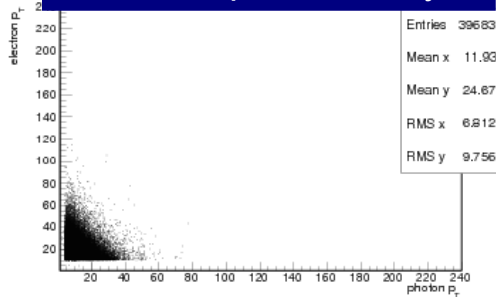
Generator Photons  
(wo EW corrections)



GEANT Photons  
(wo EW corrections)



PHOTOS photons only



$P_T$  correlations between  
electron and photon

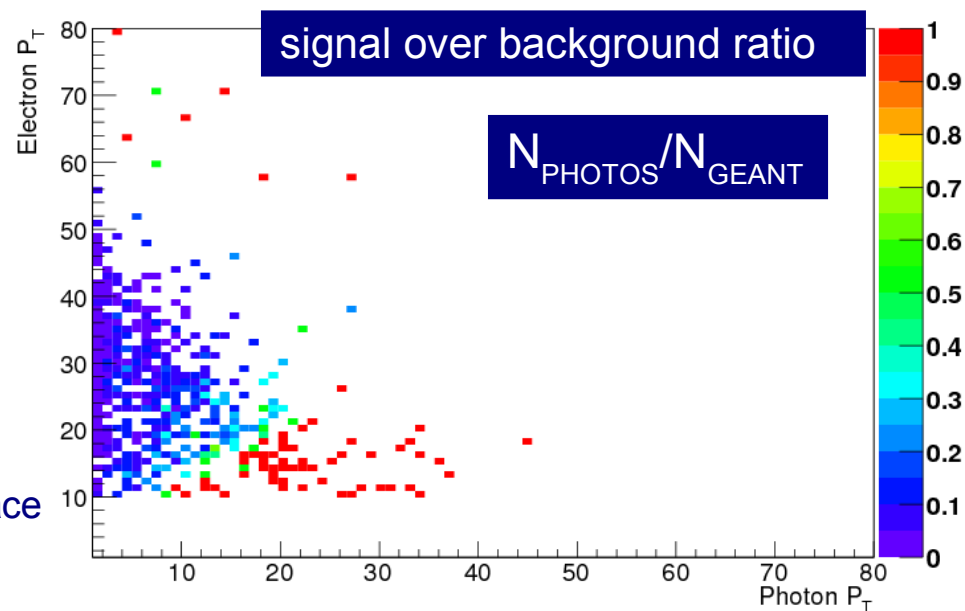
take PHOTOS-distribution  
and divide by GEANT  
to find region in phase space  
populated by EW photons

- promising for tagging is the  $P_T$  distribution

- generator photons mainly from fragmentation and  $\pi^0$

- GEANT photons are Brems photons off electron, hard

- BUT coupled to the  $P_T$  of the electron



# Conclusions and outlook

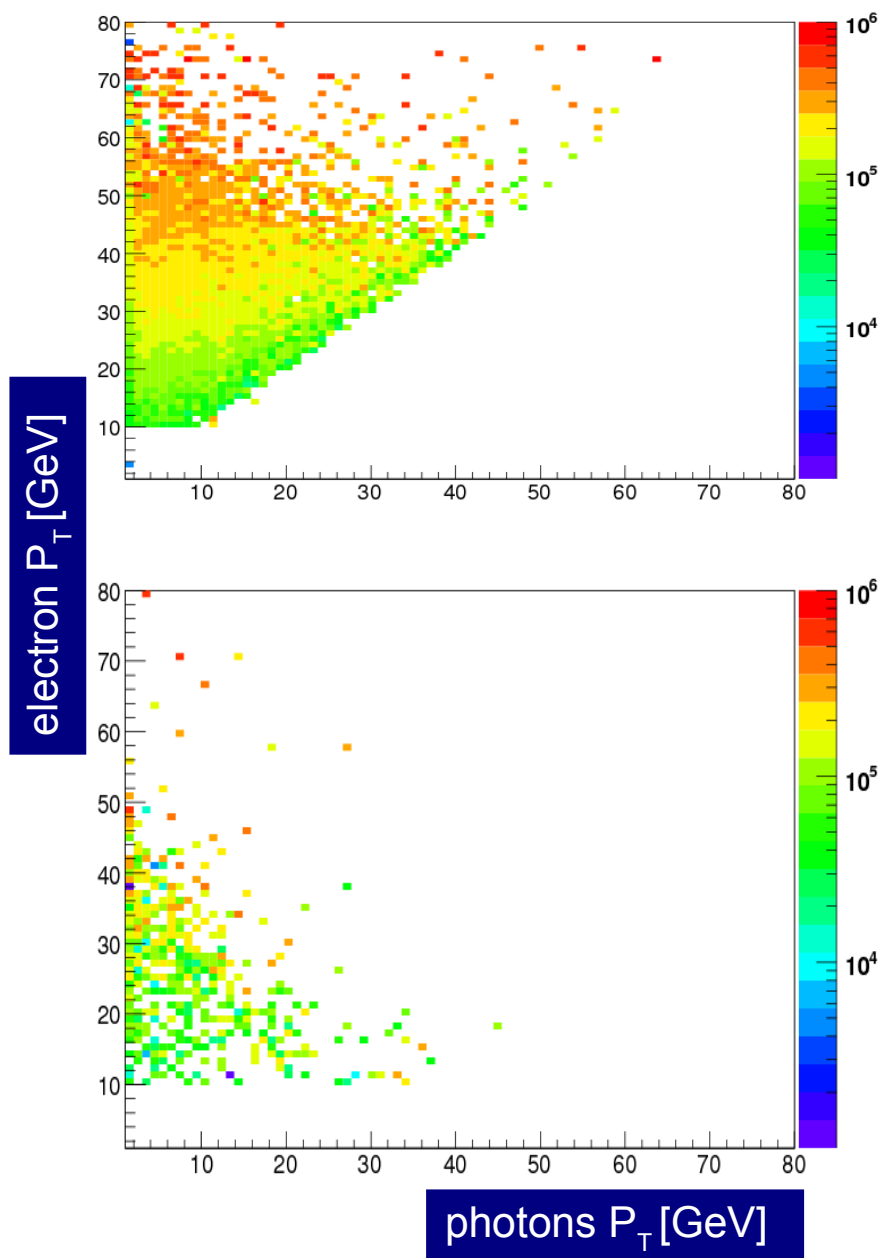
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- different shapes of  $P_T$  and  $W$  transverse mass distribution
- NO difference for asymmetry and rapidity
- About 2 percentage point difference for normalization due to electron  $P_T$  cuts
- Need to use HORACE for difference due to cross section normalisation (for muon channel  $\sim 3\%$ )
- Might be able to tag EW Brems photons ( $P_T$  correlation, impact parameter,  $\Delta R$ )
- Need to study these effects on full simulated and reconstructed sample (so far only Truth-Level studies)
  - electron efficiency, trigger cuts, acceptance
  - photon reconstruction efficiency and tagging possibilities

# back-up

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# Isolation energy



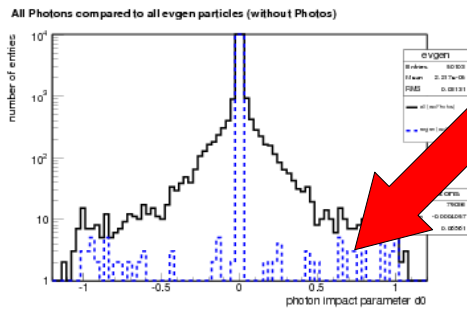
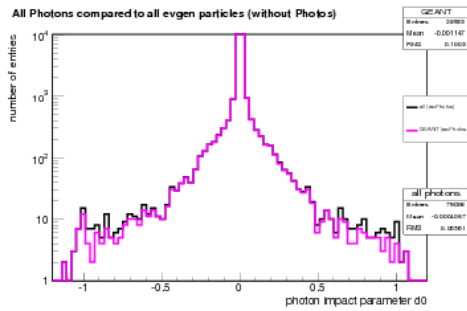
energy in cone (R=0.2)  
[MeV]

mean energy in cone around photons  
plotted against the pt of the photon (x-  
axis) and the pt of the electron (y-axis)

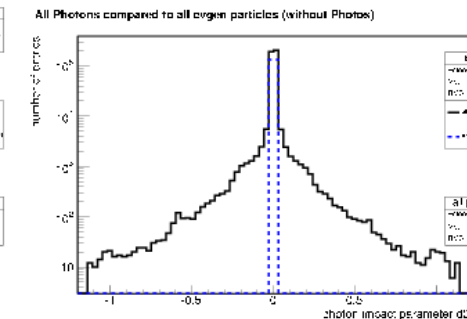
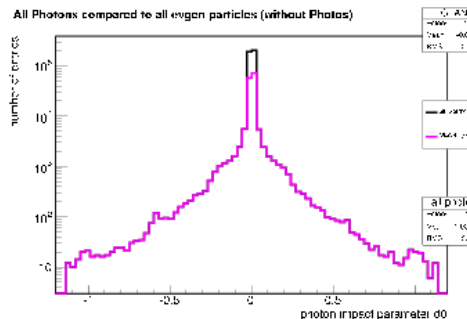
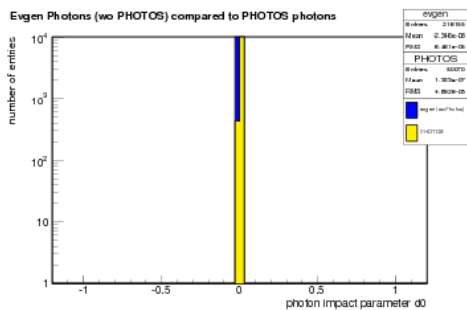
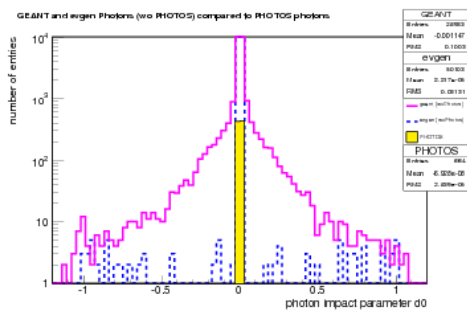
maybe slightly less energy for PHOTOS  
photons?

Need to study in full reconstruction (here  
only iso-energy of GEANT particles  
summed up)

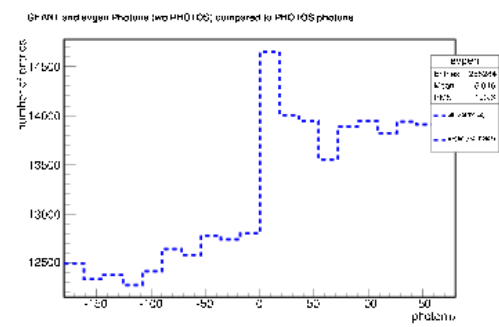
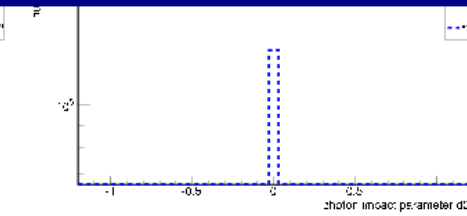
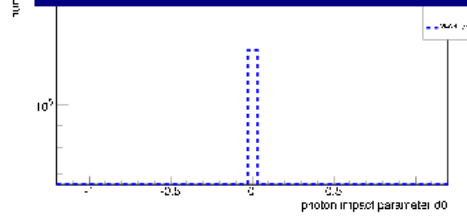
# Phi / Impact parameter puzzle



where does the outliers in d0 come from?  
 Not appearing in purely generated sample, nor in official samples  
 trig1\_misal1\_csc11.005100.JimmyWenu.recon.  
 NTUP.v12000601\_tid006031.\_00xxx.root



both plots are done on the official ntuple sample, the upper one with the GEANT sample loop, the lower one with the generator sample loop -> the outliers come not from loop differences!!!



these however show strange phi dependence  
 (problem of releases / misal?)