DY background subtraction

- The easy way:
  1. Compute e→γ fake rate from Z→ee events reconstructed as eγ in Z mass window

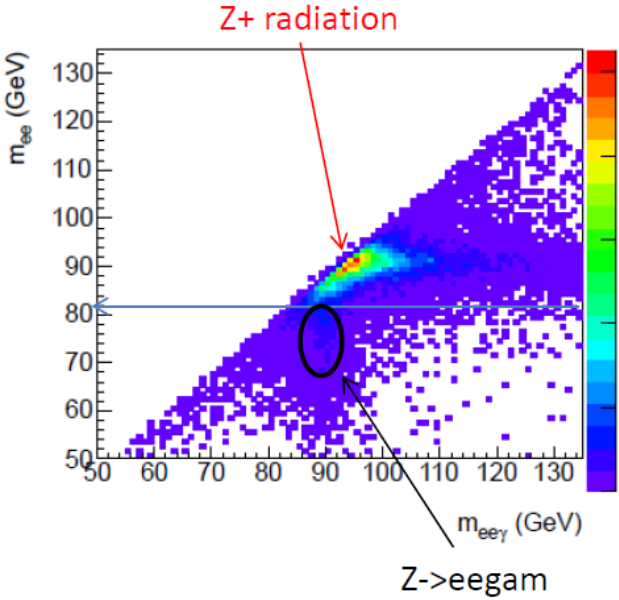
$$\begin{aligned} N_{ee} &= m_{ee} \\ N_{\gamma e} &= m_{ee} \cdot 2 f_{e\to\gamma} \end{aligned} \quad \Rightarrow \quad f_{e\to\gamma} = \frac{N_{\gamma e}}{2N_{ee}}$$

  2. Measure ee distribution to get γγ DY component, $N_{\gamma\gamma}^{DY} = \alpha f_{e\to\gamma}^{2} N_{ee}$ with α evaluated from MC

- One step further:
  1. Take into account γ→e fake rate measured from Z→eeγ events

$$f_{\gamma\to e} = N_{eee}/N_{ee\gamma}$$

  2. $$\Rightarrow \begin{pmatrix} N_{\gamma\gamma} \\ N_{\gamma e} \\ N_{ee} \end{pmatrix} = \begin{pmatrix} 1 & f_{e\to\gamma} & (f_{e\to\gamma})^2 \\ 2f_{\gamma\to e} & (1 + f_{e\to\gamma} f_{\gamma\to e}) & 2f_{e\to\gamma} \\ (f_{\gamma\to e})^2 & f_{\gamma\to e} & 1 \end{pmatrix} \times \begin{pmatrix} N_{\gamma\gamma}^{sig} \\ N_{\gamma e}^{sig} \\ N_{ee}^{sig} \end{pmatrix}$$



- Everything can be extracted from data
  - Cross check with Zee MC

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A few notes:

1. Should we use tight electrons or medium++ (not tight++) and isolated or not?
2. For Z+radiation background use m_{ee}<80 GeV cut + maybe $\Delta R(e,\gamma)>0.3$
3. Is overlap removal necessary? Keep γ, Ignore e if $\Delta R(e,\gamma)<0.01$ (or 0.05 as it was in 2011)
4. How to get the background under the Z peak? Sidebands? Crystal ball + gaussian?
5. Different fake rates for leading/subleading?
6. Effect of asymmetric p^T cut?
7. Categorize events according to γ conversion status
8. Fake rates dependence on the invariant mass, p^T