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Photon Reconstruction Efficiencies in Higgs→γγ Events

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Motivation For Study

- Default ATLFAST does not account for particle reconstruction efficiencies.
- Standard solution: apply a flat 80% reconstruction efficiency to ATLFAST photons.
- However, lower efficiencies in crack and higher η regions not accounted for.
- For multi-photon final states, these effects add up.
- Tool available in CVS - ATLFAST C.

  Applies parameterised (P_T & η) particle reconstruction efficiencies and mis-id's to ATLFAST e, μ, γ and jets.

  Efficiencies obtained from full simulation studies.

  Developed by *Sarah Allwood-Spiers, Chris Collins-Tooth, Tony Doyle, Samir Ferrag and Catherine Wright* from Glasgow.

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Introduction

- Study (in full sim) the impact on γ reconstruction efficiencies in a "quiet" and a "noisy" environment ⇨ ATLFAST.
- Full Simulation (gg+VBF)H → γγ :
  trig1_misal1_mc12.006384.PythiaH120gamgam.recon.AOD.v12000604
- Full Simulation ttH → γγ :
  trig1_misal1_mc12.006369.PythiattH120gamgam.recon.AOD.v12000604
- Hgg Analysis Tools used to create ntuples – HggAnalysisUtils-00-03-17

	Dataset	
Information	**H→γγ**	**ttH→γγ**
Version	12.0.6.4	12.0.6.4
Gen γ Eta Filter	±2.7	±3
Gen γ Pt Filter	20 GeV	0 GeV
# Of Events	9,750	14,500
Average γ Reco Efficiency	80.39%	82.21%

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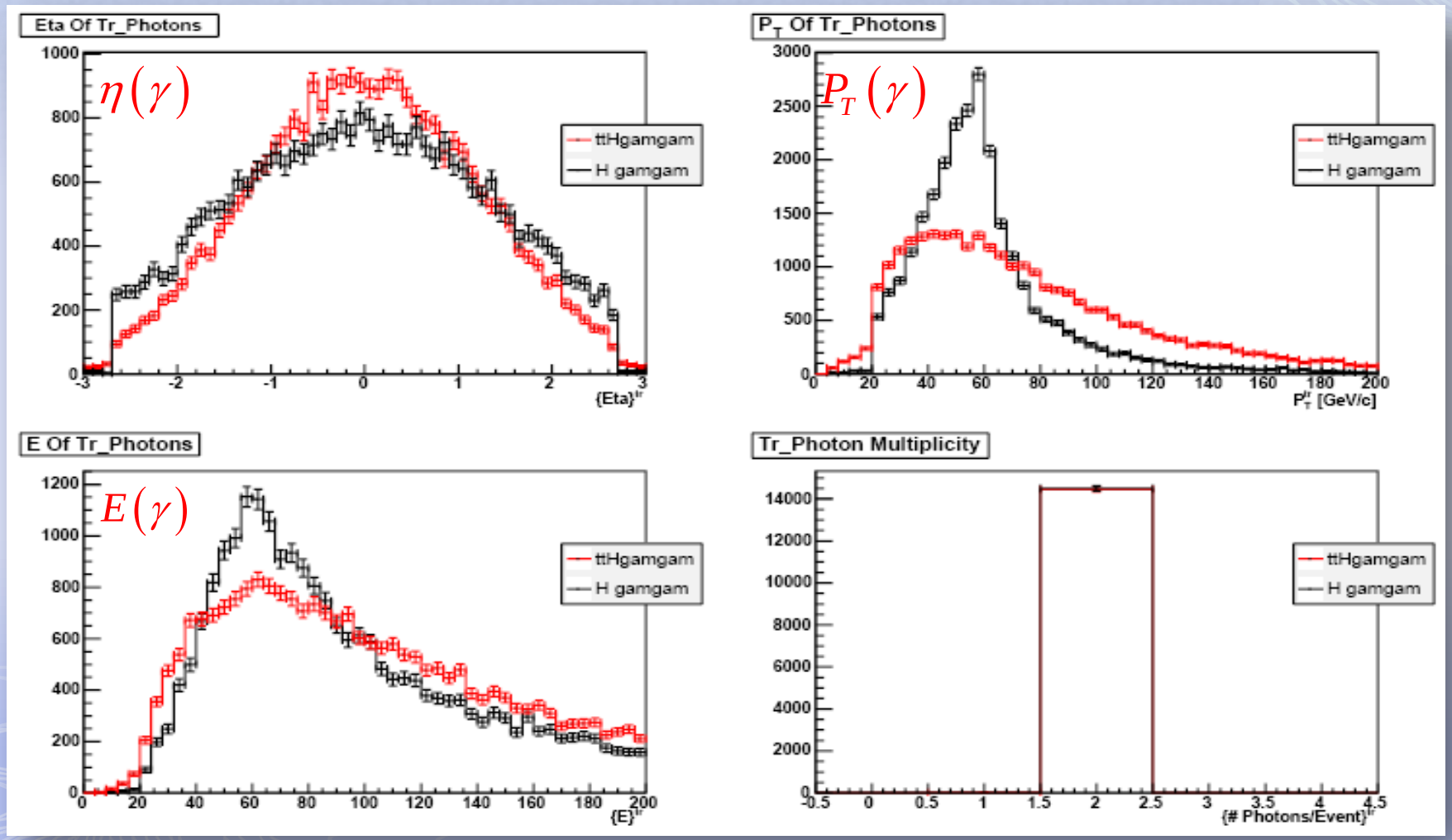
Truth H decay γs

- Used truth H decay γs.
- (gg+VBF)H→γγ plots normalised to area ttH→γγ ones.



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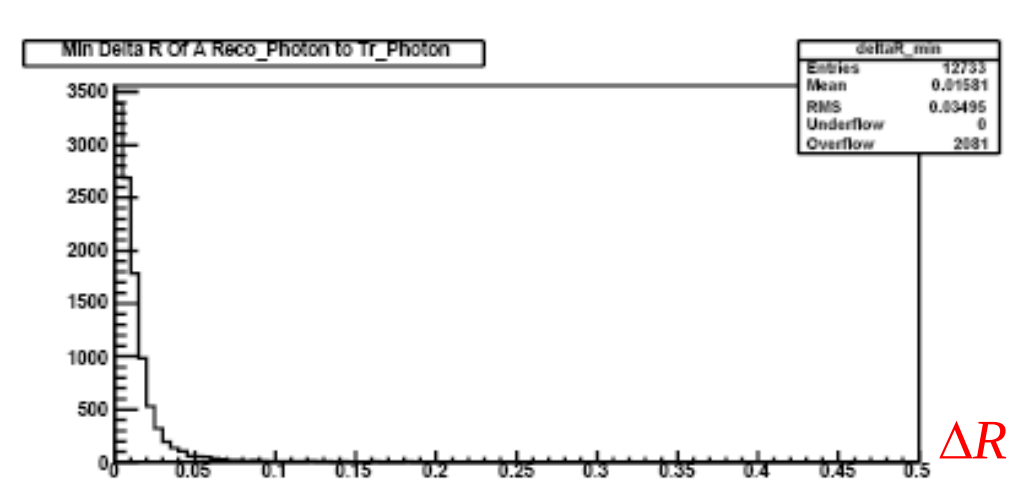
Truth to Reconstructed Matching

- Look at the ΔR_{min} between a truth γ and a full simulation reconstructed γ:



- Match accepted if closest reconstructed γ is inside a cone of $\Delta R = 0.1$ centered around the truth γ.

- However important to define reconstructed γs.

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Reconstructed γ Definition

- Many definitions of reconstructed γs used in ATLAS, e.g.

  EgammaPID γ definition with isEM==0.

  ElectronPhotonID definition with isEM==0.

  Hgg WG photonID: cuts on γ shower shapes (ingredients of isEM) derived by G.Unal for 12.0.X

- Important to state definition used when extracting reconstruction efficiencies for use elsewhere.

- Hgg definition most appropriate for this study so is used throughout.

$(gg+VBF)H \rightarrow \gamma\gamma$

Quality Of Matching

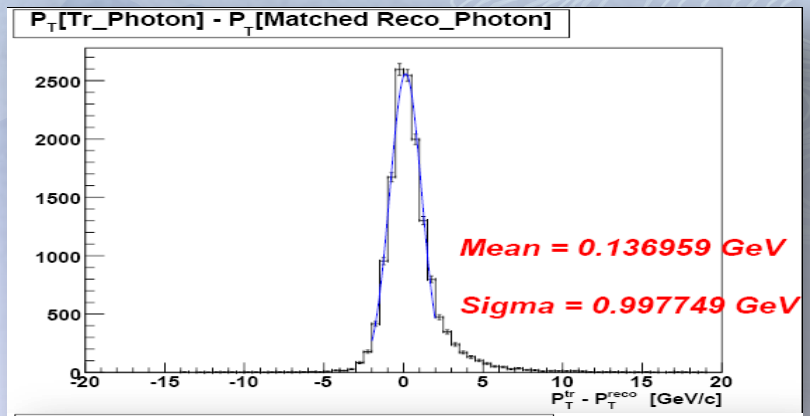
- P_T *(truth)* – P_T *(reco).*

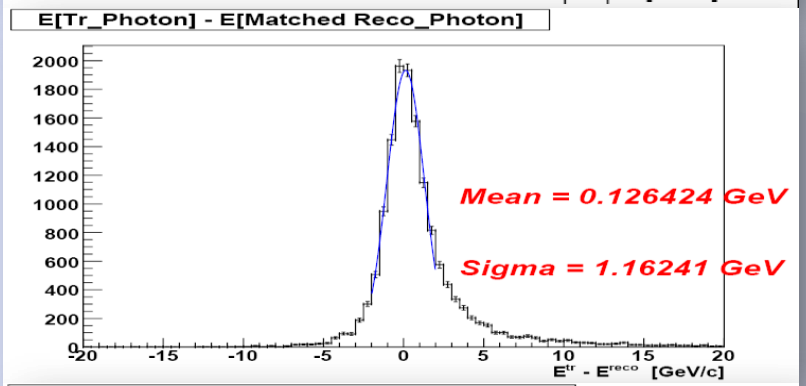
  Gaussian fitted to give Offsets and Resolutions.

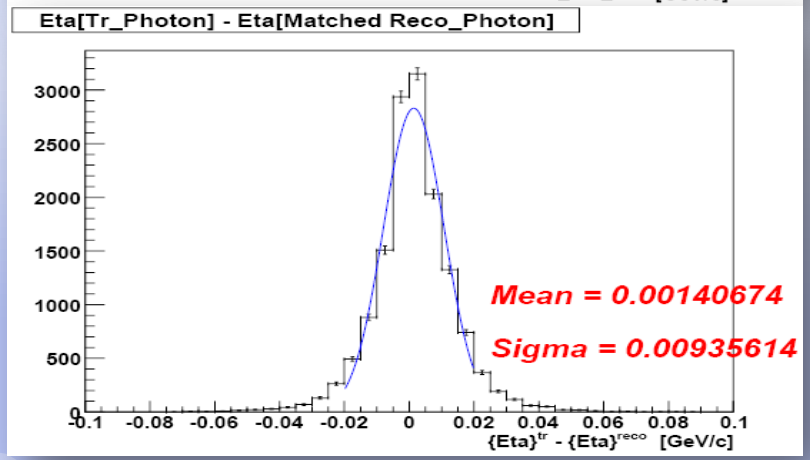
  Peak Only Fitted

- *Energy (truth) – Energy (reco).*

- η *(truth)* – η *(reco).*



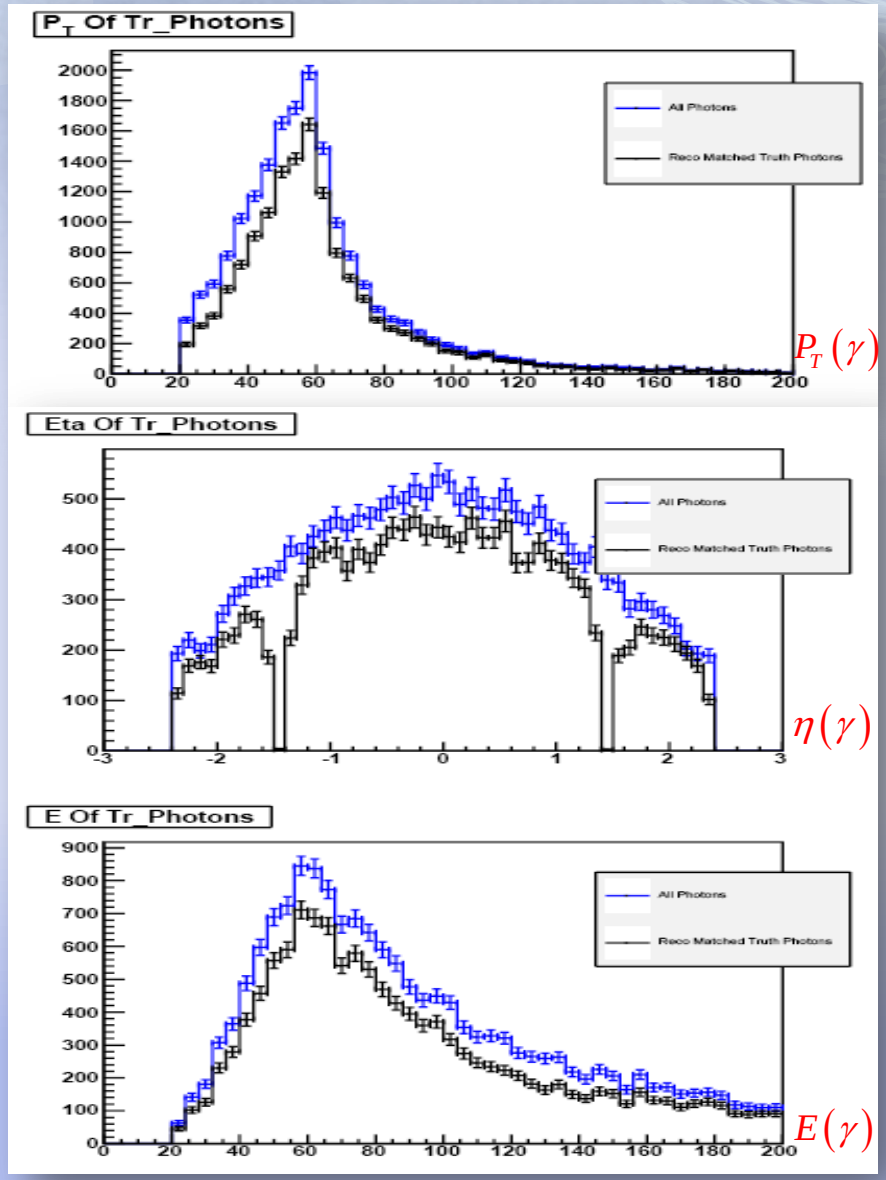




$(gg+VBF)H \rightarrow \gamma\gamma$

Matched Truth

- Black: truth H decay γs which have a matched reco γ.
- Blue: all truth H decay γs.
- Shows a detector slant on the truth.



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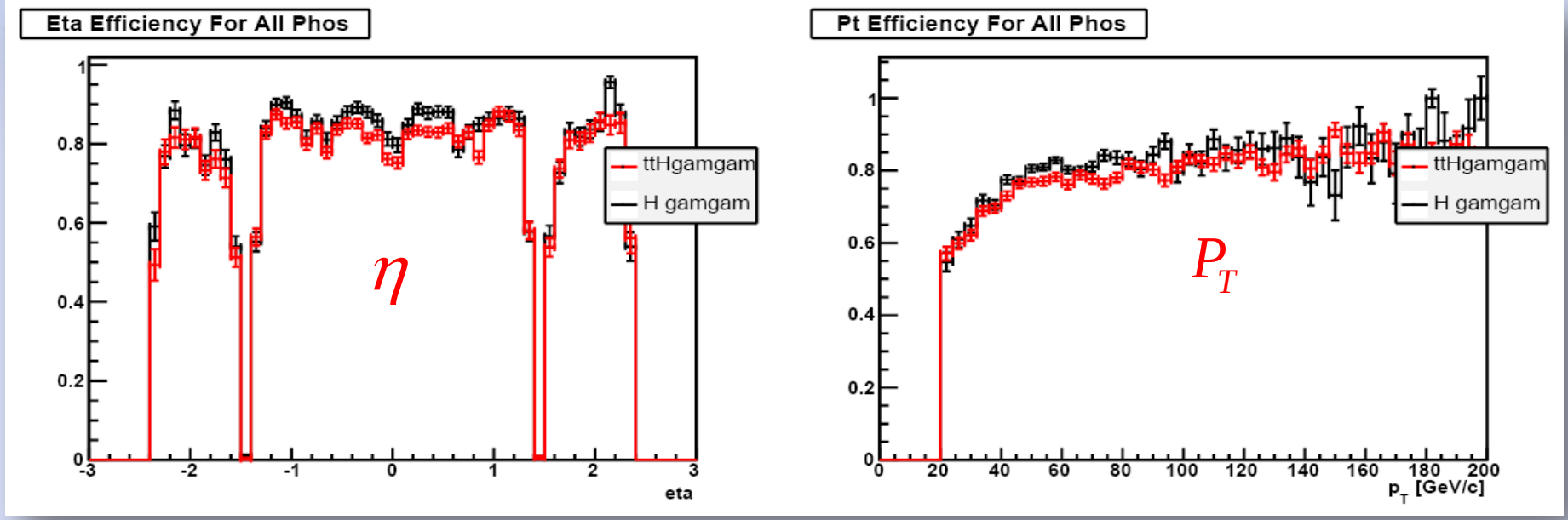
Reconstruction Efficiencies

- Definition Of Efficiency:

$$\varepsilon(P_t,\eta) = \frac{\text{No. Of Reco Match Truth } \gamma\text{s}}{\text{Total No. Of Truth } \gamma\text{s}}$$



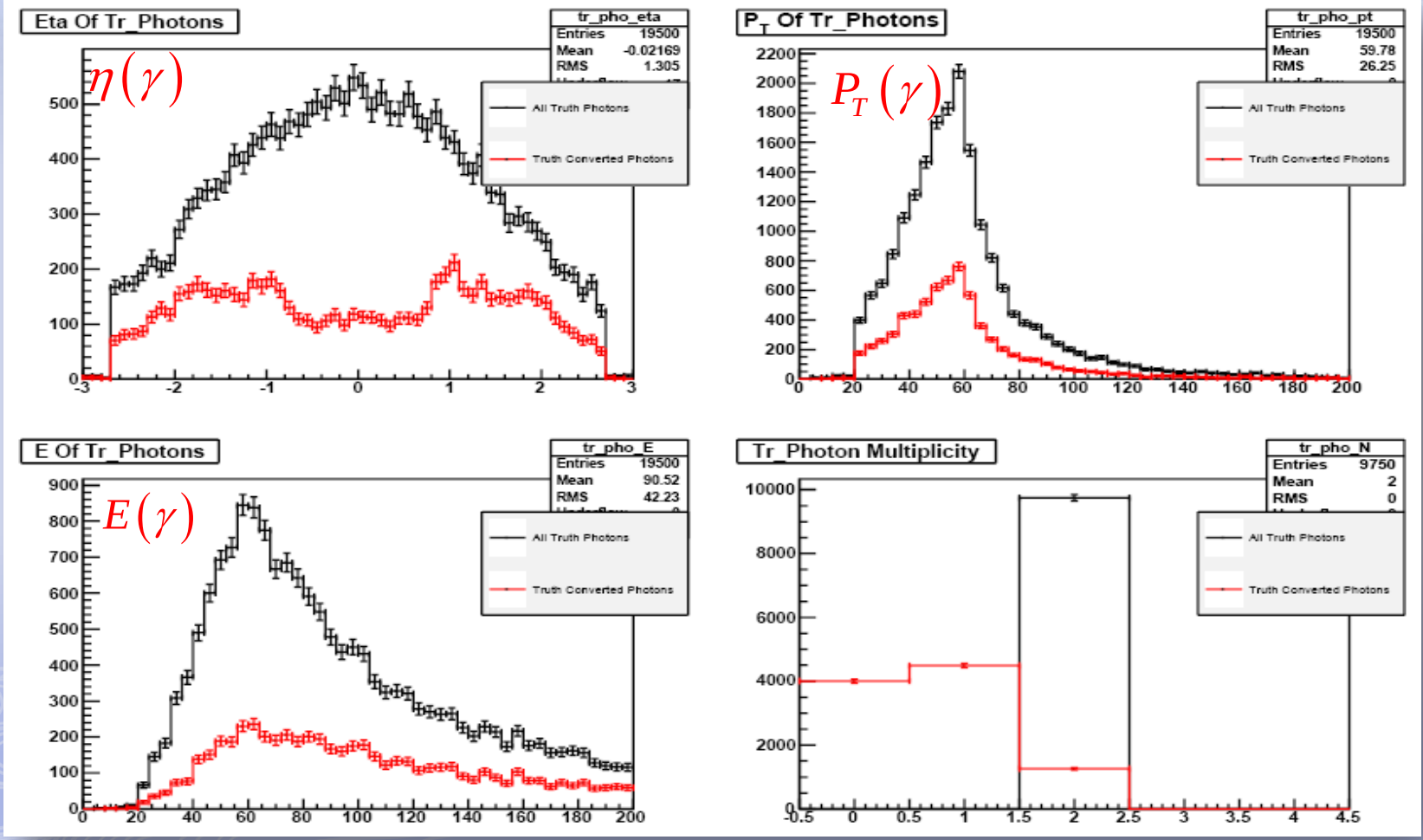
- Efficiency across η and P_T is physics independent for these samples ⇨ Justifiable to parameterise the reconstruction efficiency with just these two variables.

- Kolmogorv test statistic of 0.94 for efficiencies vs. η, and 0.99 for the P_T.

$(gg+VBF)H \rightarrow \gamma\gamma$

Truth Converted H Decay γs

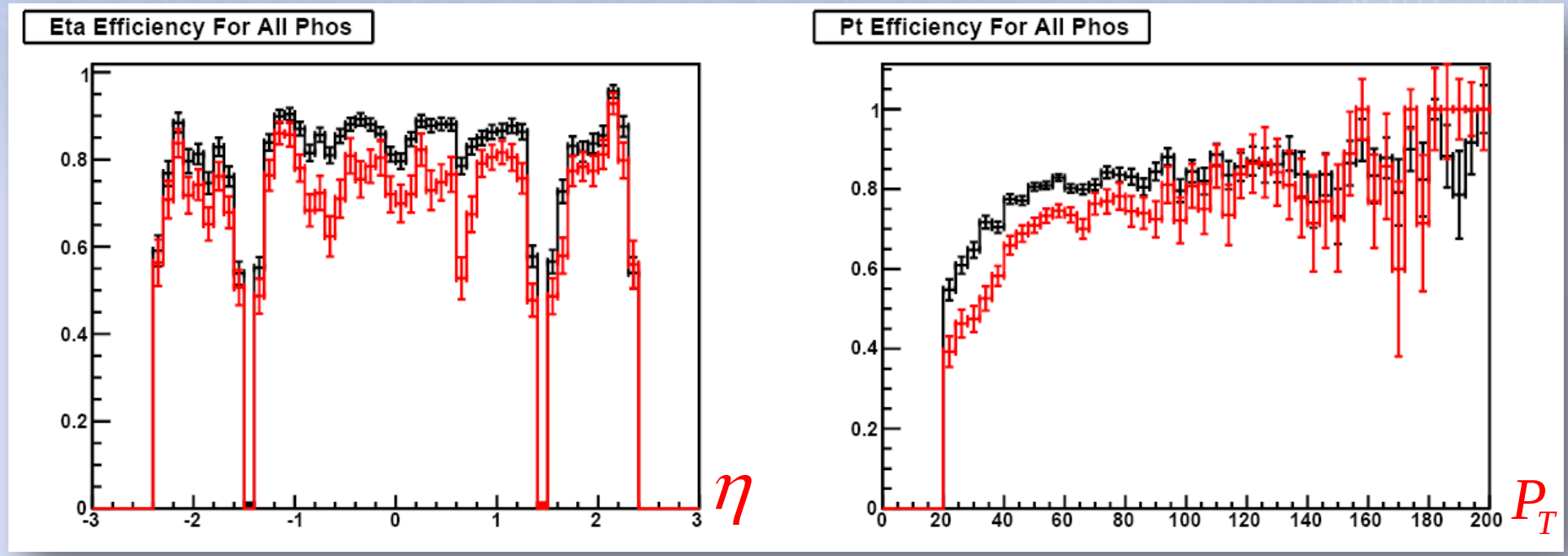
- Used truth γs from Higgs decay.
- Converted γs in red and for reference all truth H decay γs in black.



$(gg+VBF)H \rightarrow \gamma\gamma$

Converted γ Reconstruction Efficiencies 1

- Comparison of efficiency curves for converted and all H decay γs,



- Converted γs have a lower reconstruction efficiency in central η and lower P_T region – to be investigated.

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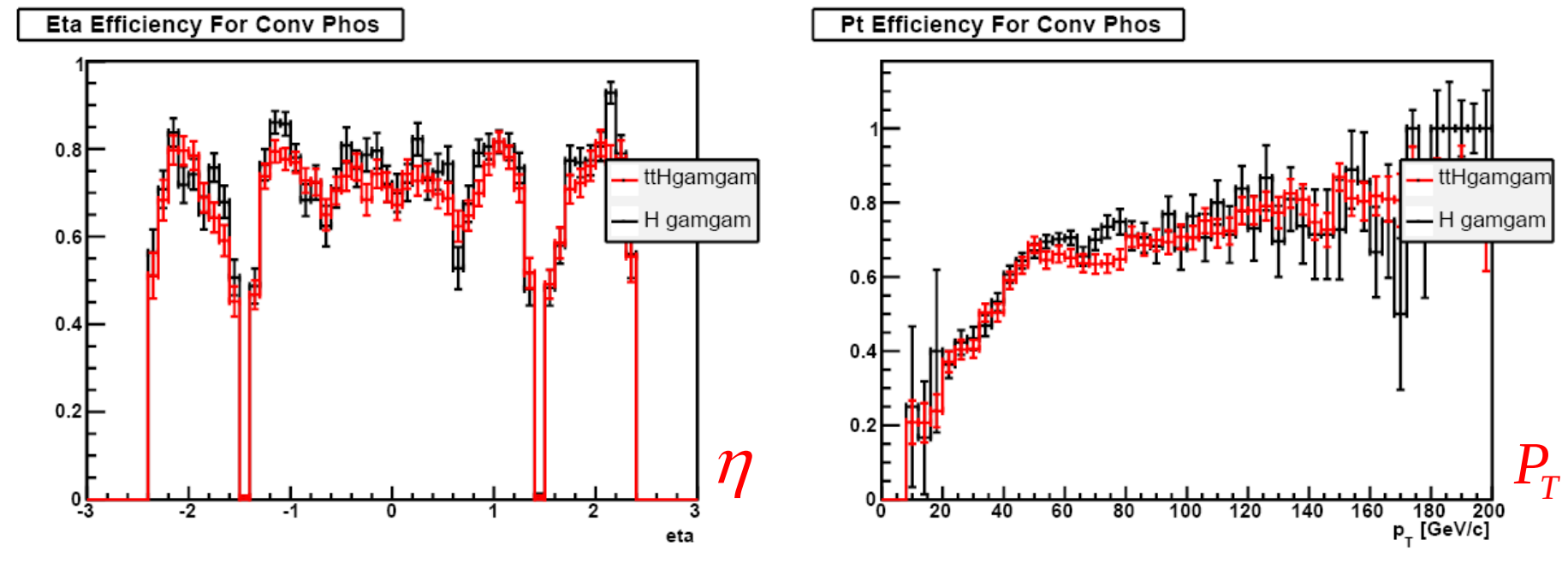
Converted γ Reconstruction Efficiencies 2

- Comparison of converted γ efficiencies between the ttH and (gg+VBF)H samples.



- Again γ reconstruction efficiencies from the two samples compare well.

- Physics independence shown – No need to create channel specific parameterisations for converted γs from Higgs decays.

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Summary

- Two $H \rightarrow \gamma\gamma$ samples investigated.
- Full simulation γ - reconstruction efficiencies have been found to be:
  - dependant on only P_T, η.
  - physics independent (for the two samples).
- Converted γs:
  - lower reconstruction efficiencies at low P_Ts and central ηs – to be understood.
  - account for a third of all Higgs decay γ (for the two samples).
  - physics independent (for the two samples).
- Further Work:
  - Repeat work on other high P_T γ samples.
  - incorporate γ parameterisations presented here into ATLFASTC for use by others.