



ttHyy Analysis Status

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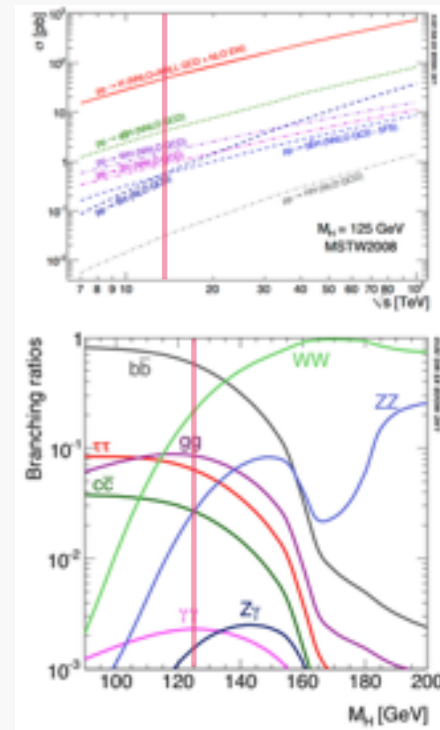
Introduction for ttH(yy) Analysis

- Low cross section channel

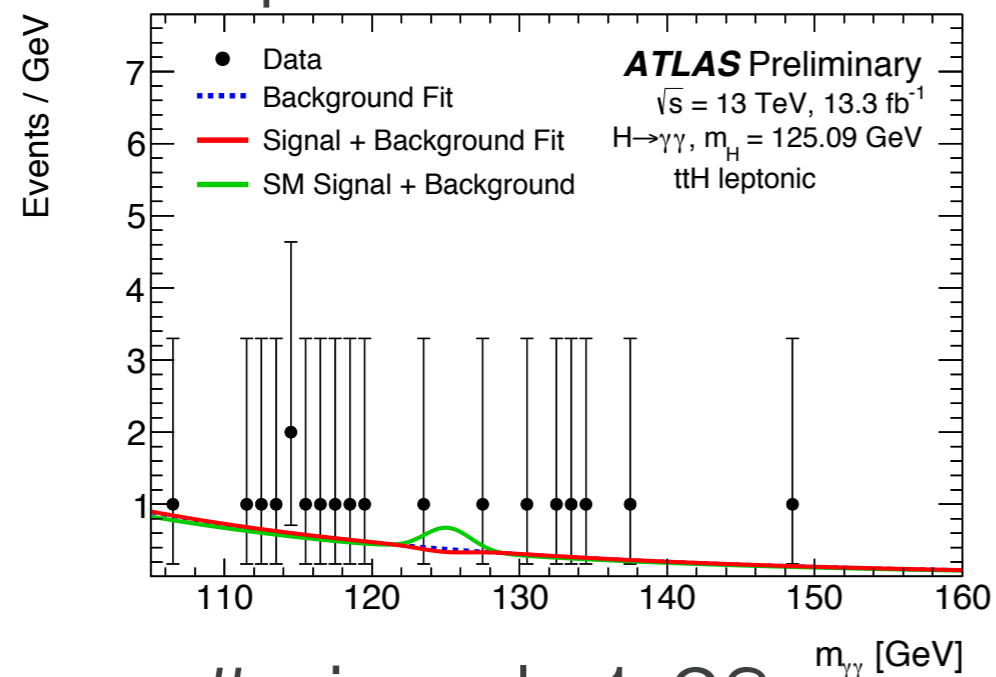
➔ O(10) signals in 35 fb^{-1}

▶ if not considering detector acceptance ($N = L \times \sigma_{\text{ttHyy}}$)

➔ Need to increase signal acceptance

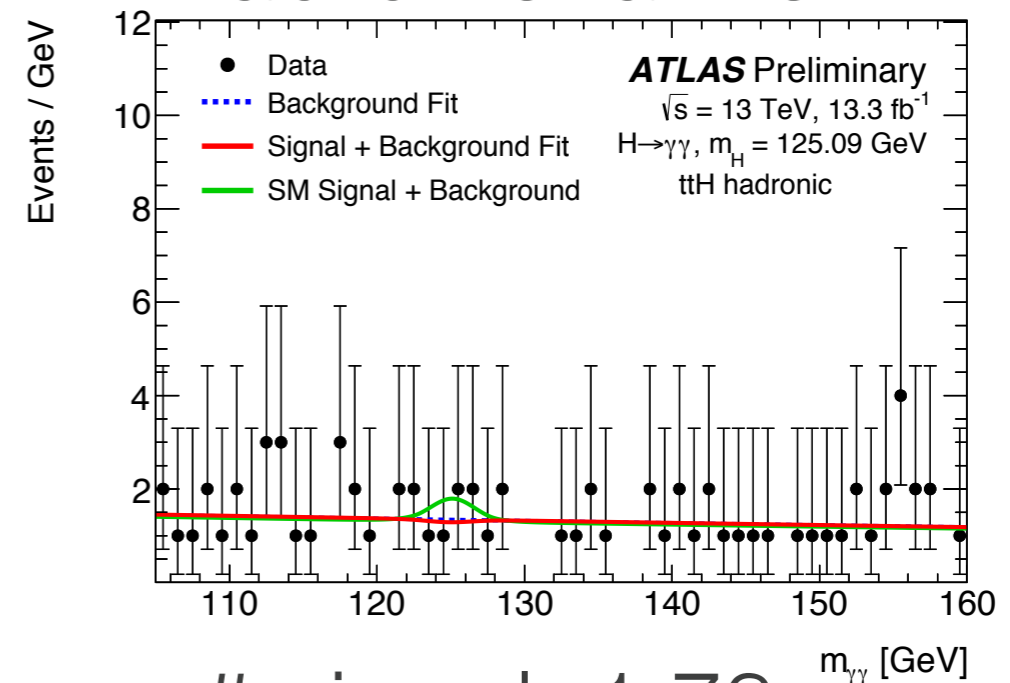


lepton channel



signal: 1.28
 # BG: 2.30 (in ICHEP)

hadron channel



signal: 1.78
 # BG: 8.07 (in ICHEP)

Significance Improvement Strategy

- Checking which selections decrease ttHyy signal acceptance

- using signal MC

- Considering if these selections can be relaxed

- estimating significance improvement

- ▶ very preliminary...

- MC sample

- mc15_13TeV.

- 343436.aMcAtNloPythia8EvtGen_A14_NNPDF23_NNPDF30ME_ttH125_gamgam.merge.DAOD_HIGG1D1.e4704_s2726_r7772_r7676_p2669

- ▶ no-skim option

Cut by Cut Efficiency in Photon Object Selection (1)

- At least 2 loose photons ... **59 %**

→ $pT > 25 \text{ GeV}$, $|\eta| < 2.37$ (excluding cluck region), loose ID

▶ then requiring at least 2 photon

- Tight ID ... **82 %**

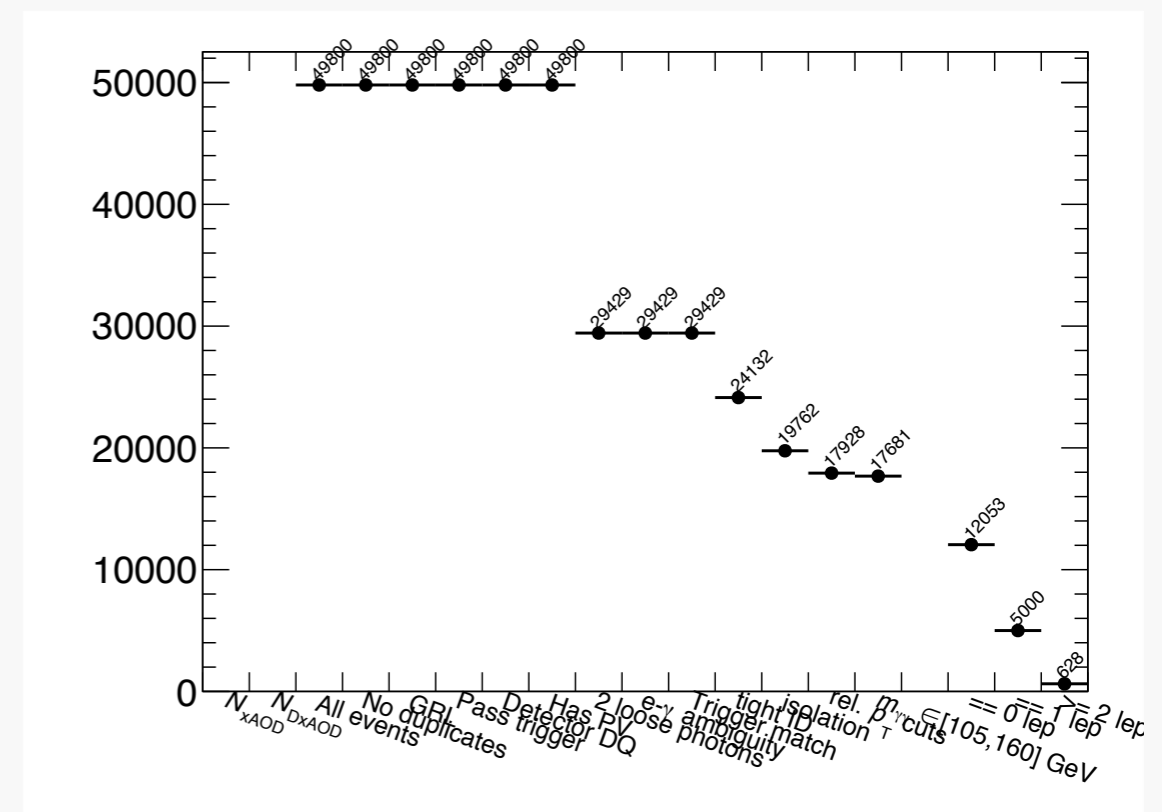
- Isolation (Loose) ... **82 %**

- Relative pT cut ... **91 %**

→ $pT_{\gamma 1} / m_{\gamma\gamma} > 0.35$, $pT_{\gamma 2} / m_{\gamma\gamma} > 0.25$

- Diphoton mass window ... **99 %**

→ $105 \text{ GeV} < m_{\gamma\gamma} < 160 \text{ GeV}$



Cut by Cut Efficiency in Photon Object Selection (2)

- At least 2 loose photons ... **59 %**

→ $pT > 25 \text{ GeV}$, $|\eta| < 2.37$ (excluding e^+e^-)

▶ then requiring at least 2 photon

- Tight ID ... **82 %**

- Isolation (Loose) ... **82 %**

- Relative pT cut ... **91 %**

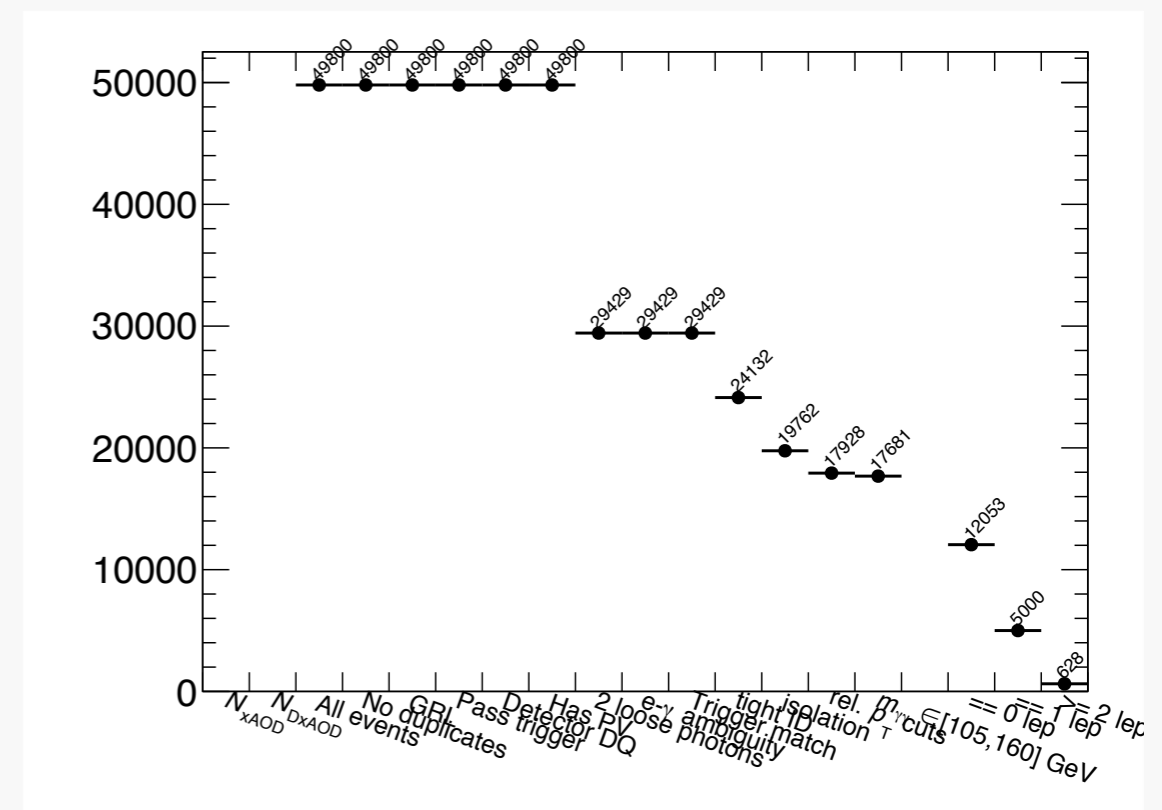
→ $pT_{\gamma 1} / m_{\gamma\gamma} > 0.35$, $pT_{\gamma 2} / m_{\gamma\gamma} > 0.25$

- Diphoton mass window ... **99 %**

→ $105 \text{ GeV} < m_{\gamma\gamma} < 160 \text{ GeV}$

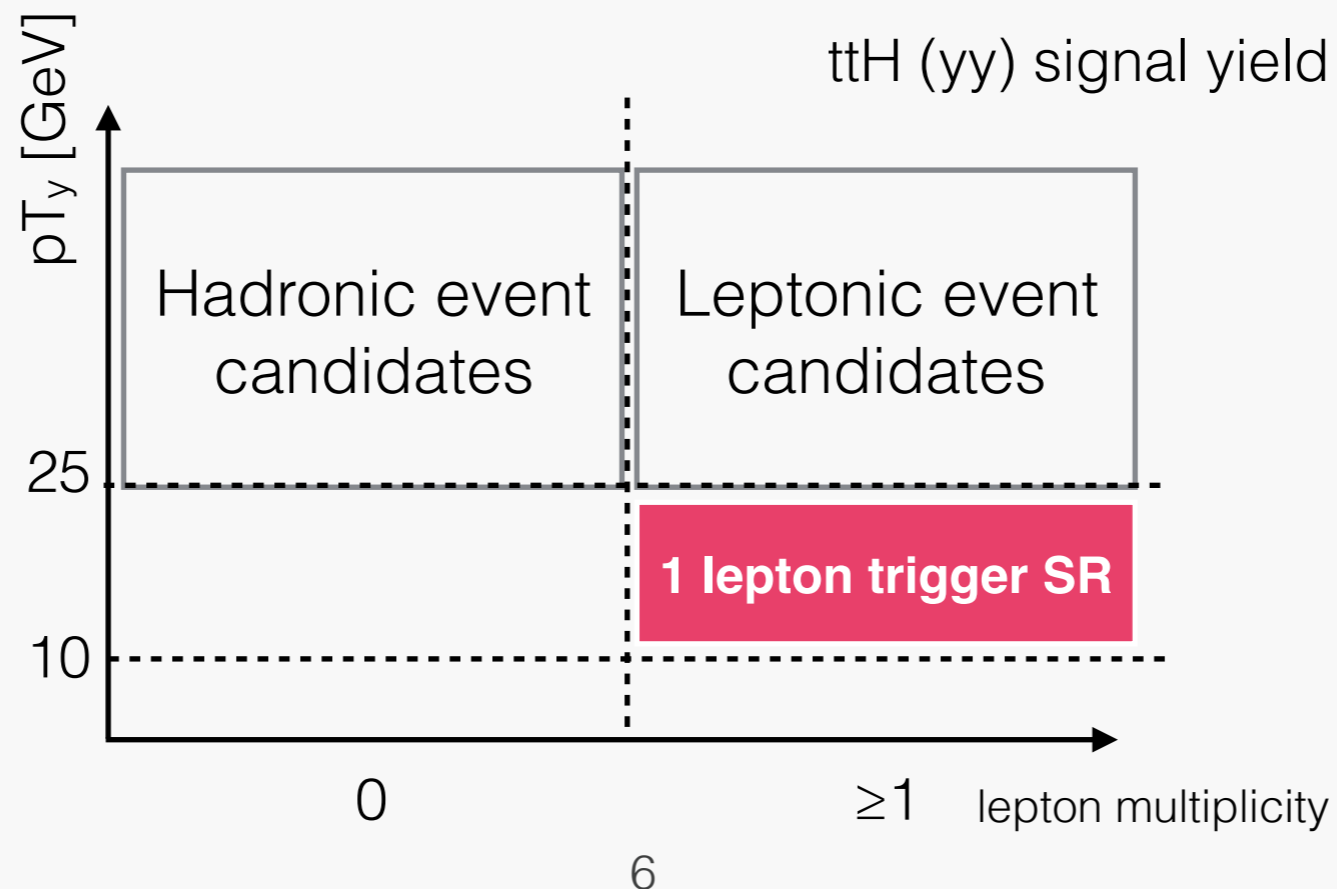
Possible candidates to be relaxed:

1. Decreasing pT threshold
(rel pT cut should also be relaxed)
2. Loosen photon ID
(only requiring "Loose" photon ID)
3. Loosen photon isolation
(already chosen "Loose" selection)



Idea for adding “1 Lepton Trigger” category

- $pT_y \leq 25$ GeV event cannot be picked up due to di-photon trigger
 - ➔ requiring $pT_{y1} \geq 35$ GeV, $pT_{y2} \geq 25$ GeV
- Adding single lepton trigger category as new SR
 - ➔ can extend acceptance to low photon pT region



Requirement for 1 Lepton Trigger SR

- Fail nominal ttH selection
- At least 1 lepton
- Relaxed photon selection:
 - $pT_y > 10$ GeV for all photon
 - ($pT_y > 25$ GeV in di-photon triggered events)
 - loose photon ID
 - (tight photon ID in di-photon triggered events)
 - $pT / myy > 0.1$ for leading & sub-leading photons
 - ($pT / myy > 0.35$ for leading photon and 0.25 for sub-leading photon in di-photon triggered events)
- Additional selection is required for leading lepton (next page)

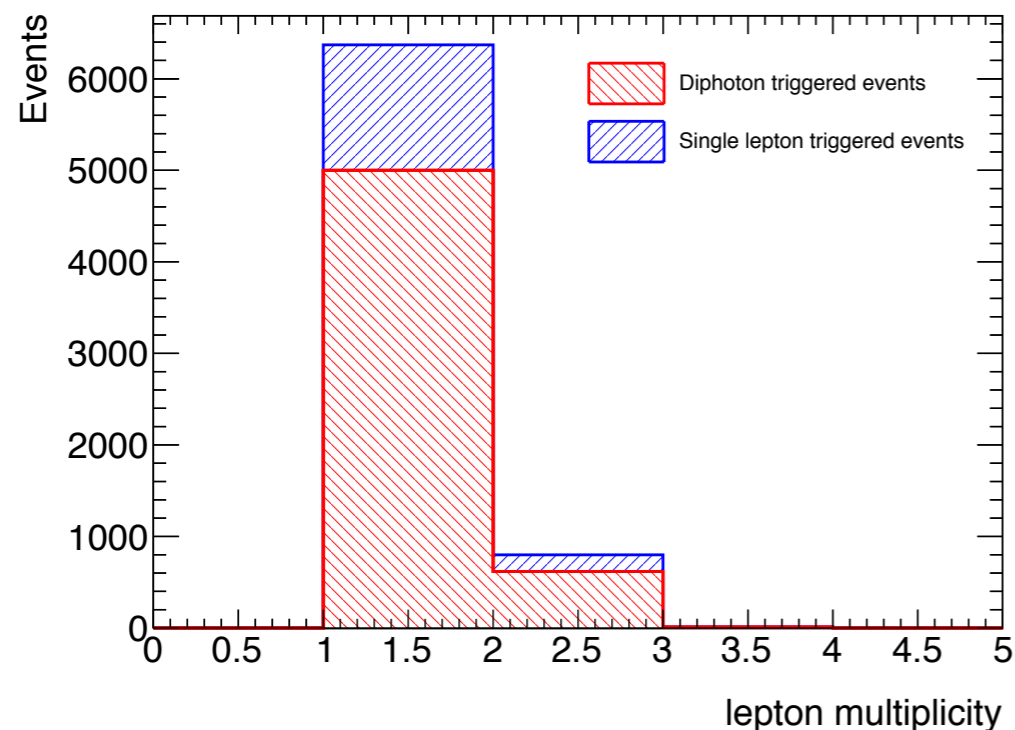
Leading Lepton Selection for 1 Lepton Trigger SR

- Applying single lepton trigger selection

→ using offline cut to emulate online cut

object	variable	di-photon trigger	single lepton trigger*
electron	pT	> 10 GeV	> 26 GeV
	PID	Medium	Tight
	Isolation	Loose	ivarloose
muon	pT	> 10 GeV	> 26 GeV
	PID	Medium	Medium
	Isolation	Gradient Loose	ivarmedium

*only for leading lepton



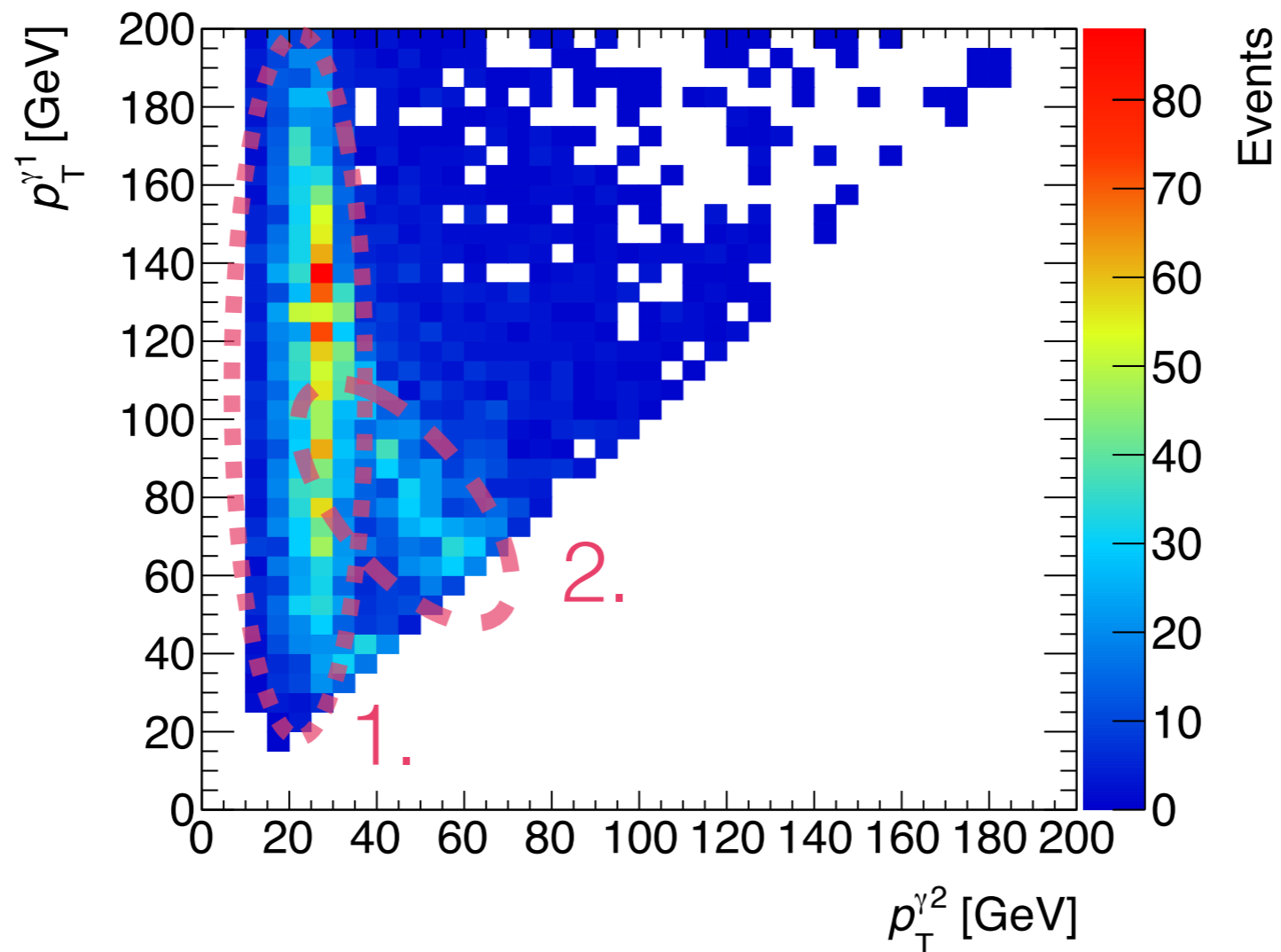
Current leptonic SR: 5628 events

1 lepton trigger SR: **1551 events**

27.6 % gain in leptonic decay mode!!

1 Lepton Trigger SR Events

- Consisted in 2 components of 27.6 % gain
 - ➔ 1. low p_T photons (13.8 %)
 - ➔ 2. not tight but loose photons (13.8 %)

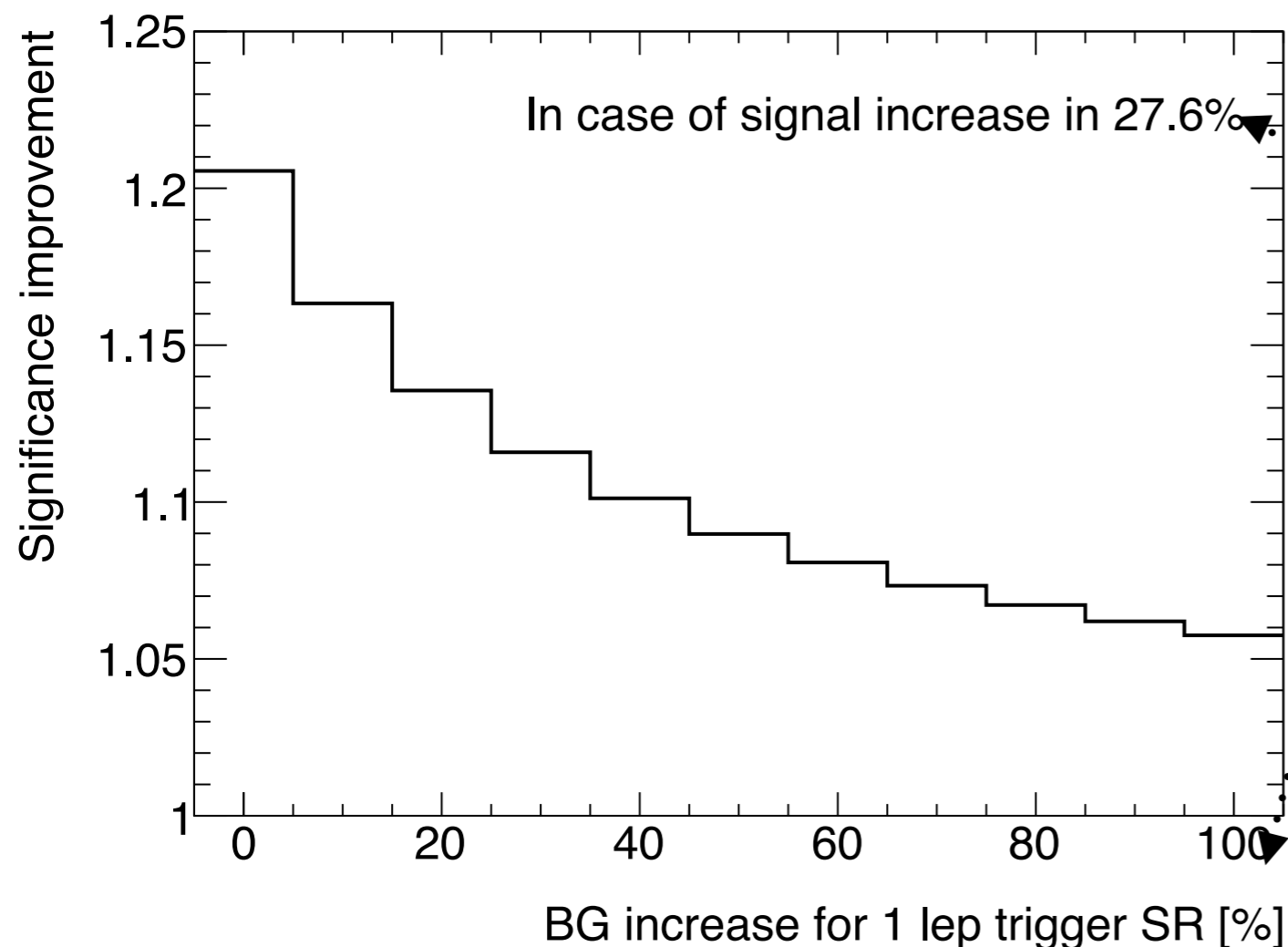


Significance Improvement

- Significance estimation as a function of BG increase in 1 lepton trigger

- ▶ $Z = S / \sqrt{(S+B)}$

- ▶ Z improvement:
$$\frac{\sqrt{Z(\text{current SR})^2 + Z(1 \text{ lep trigger SR})^2}}{Z(\text{current SR})}$$



... comparing to lepton channel (diphoton trigger)

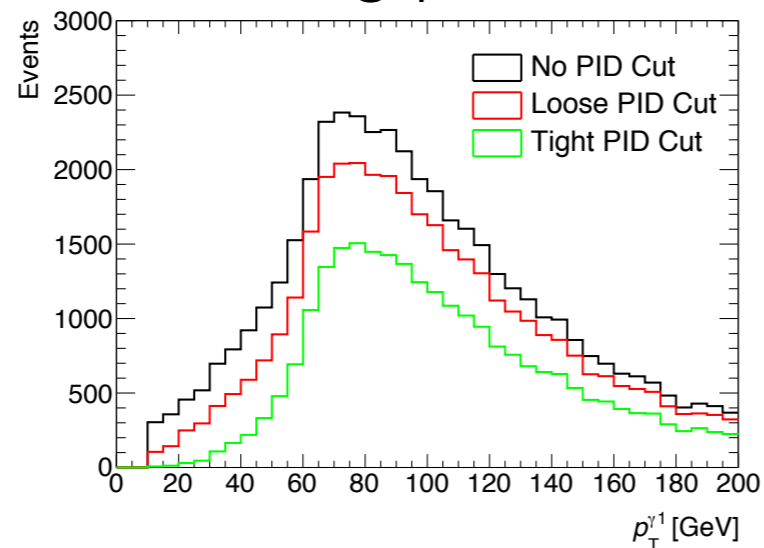
e.g. In case of 40 % BG increase :
10 % improvement!

Backup

Loose Photon ID Selection

- If removing tight ID selection for ttH nominal selection, ...
 - ➔ 13.8 % signal signal increase

Leading photon



Sub-leading photon

