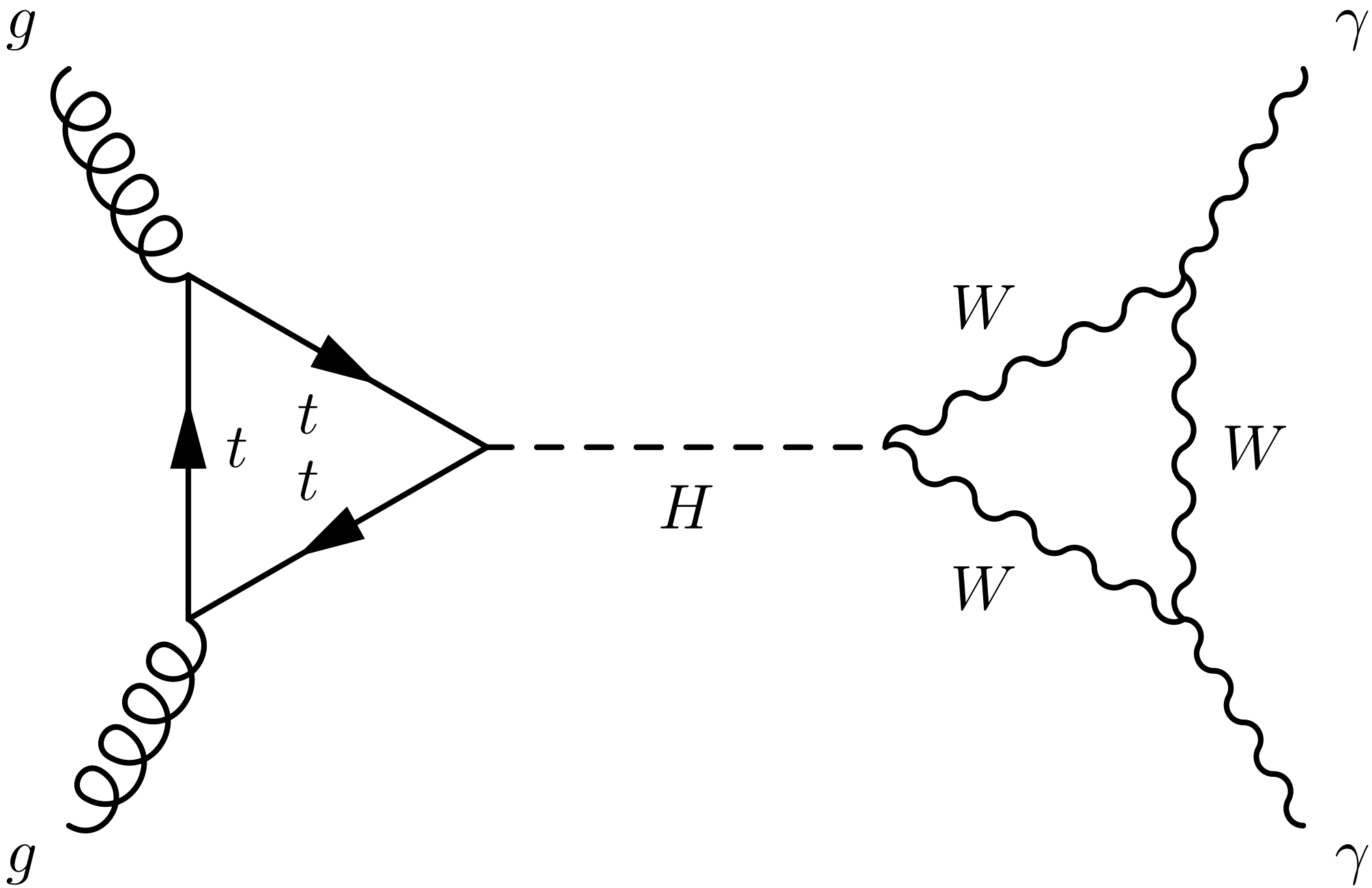
Experimental particle physics

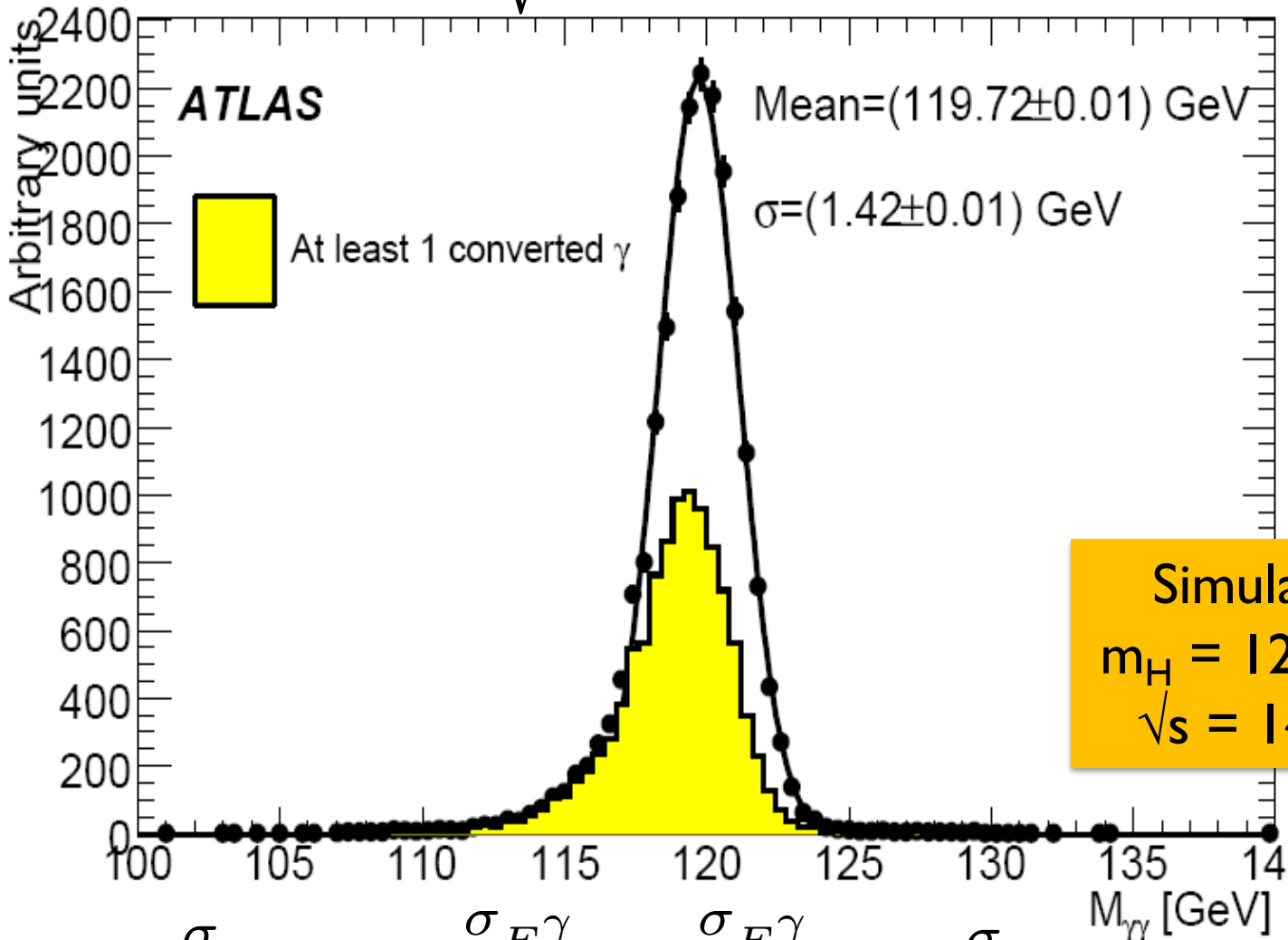
esipap
European School of Instrumentation in Particle & Astroparticle Physics

C. Significance of H→γγ signal


g
g
t
t
t
H
W
W
W
γ
γ

A narrow mass peak…

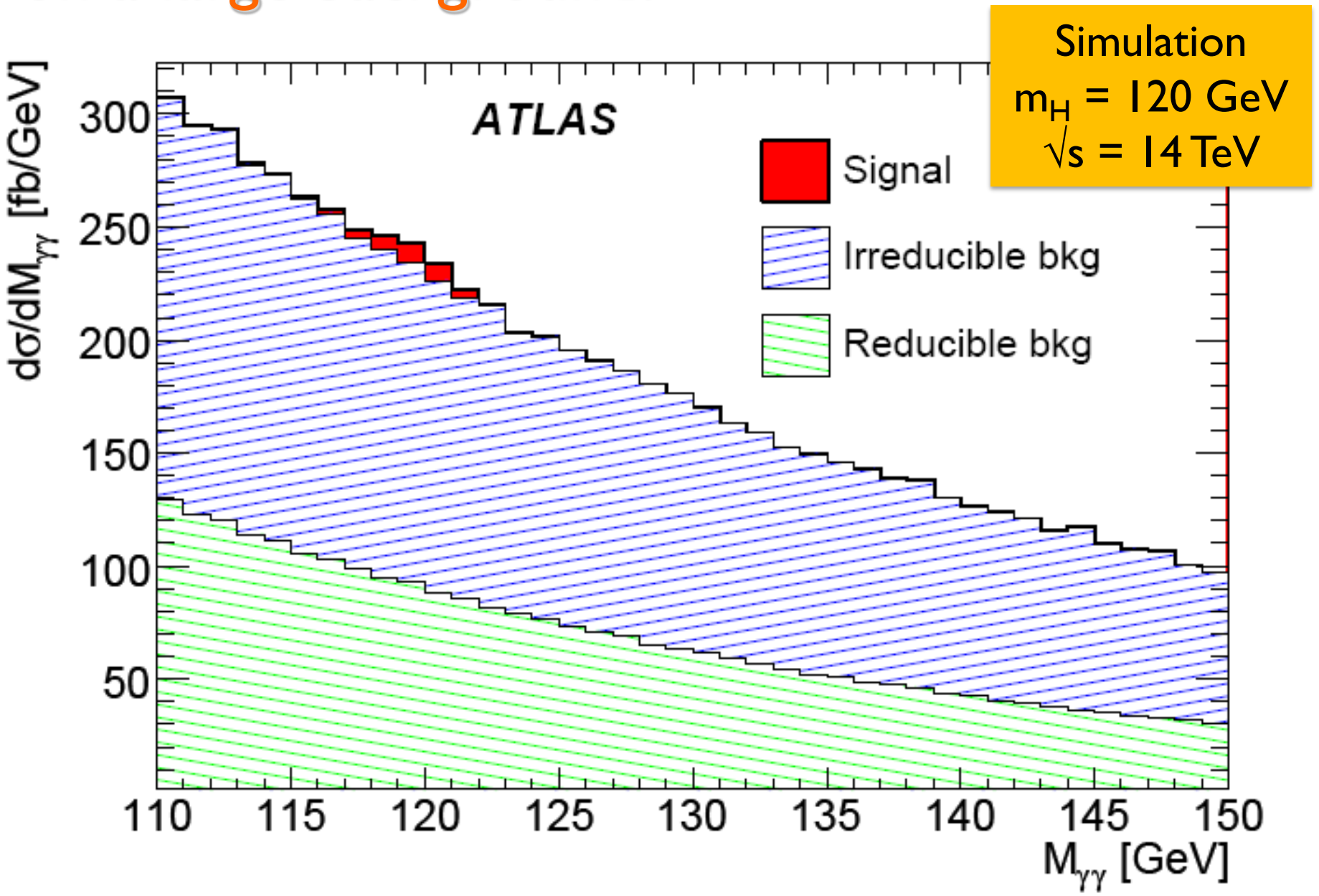
$$m_{\gamma\gamma} = \sqrt{2E_1^\gamma E_2^\gamma (1 - \cos\alpha_{12})}$$



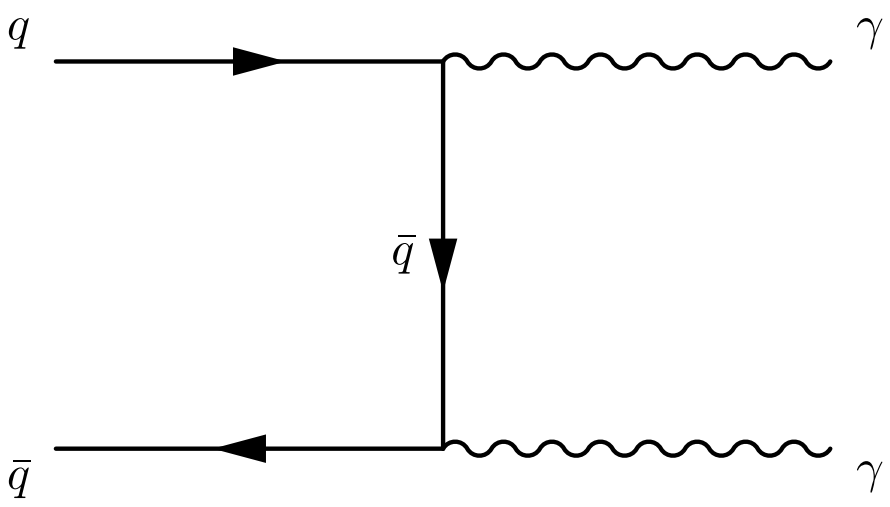
Simulation
m_H = 120 GeV
$\sqrt{s}$ = 14 TeV

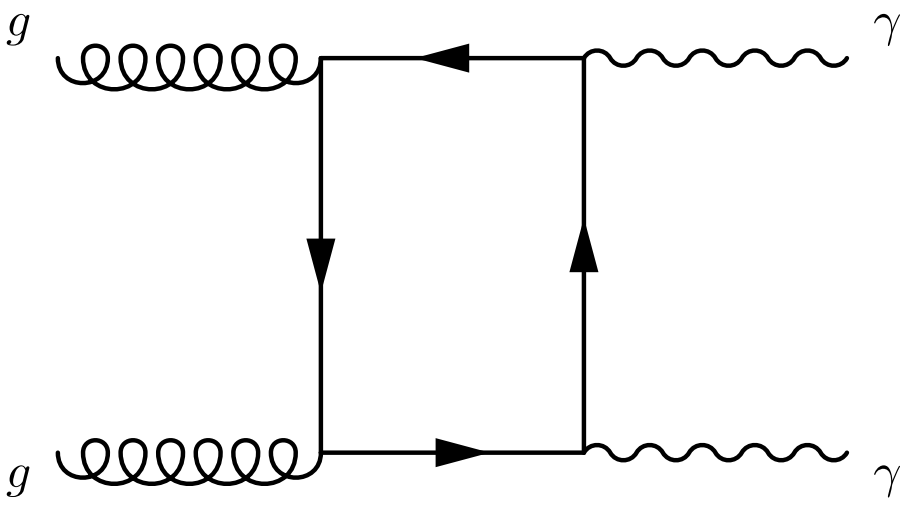
$$\frac{\sigma_{m_{\gamma\gamma}}}{m_{\gamma\gamma}} = \frac{\sigma_{E_1^\gamma}}{E_1^\gamma} \oplus \frac{\sigma_{E_2^\gamma}}{E_2^\gamma} \oplus \frac{\sigma_{\alpha_{12}}}{\tan\alpha_{12}}$$

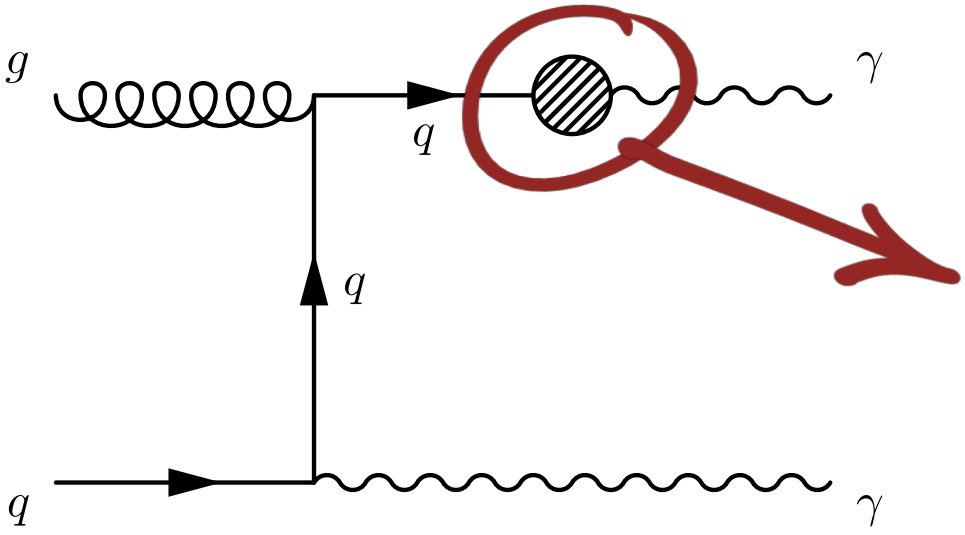
… on a large background!



“Irreducible” background

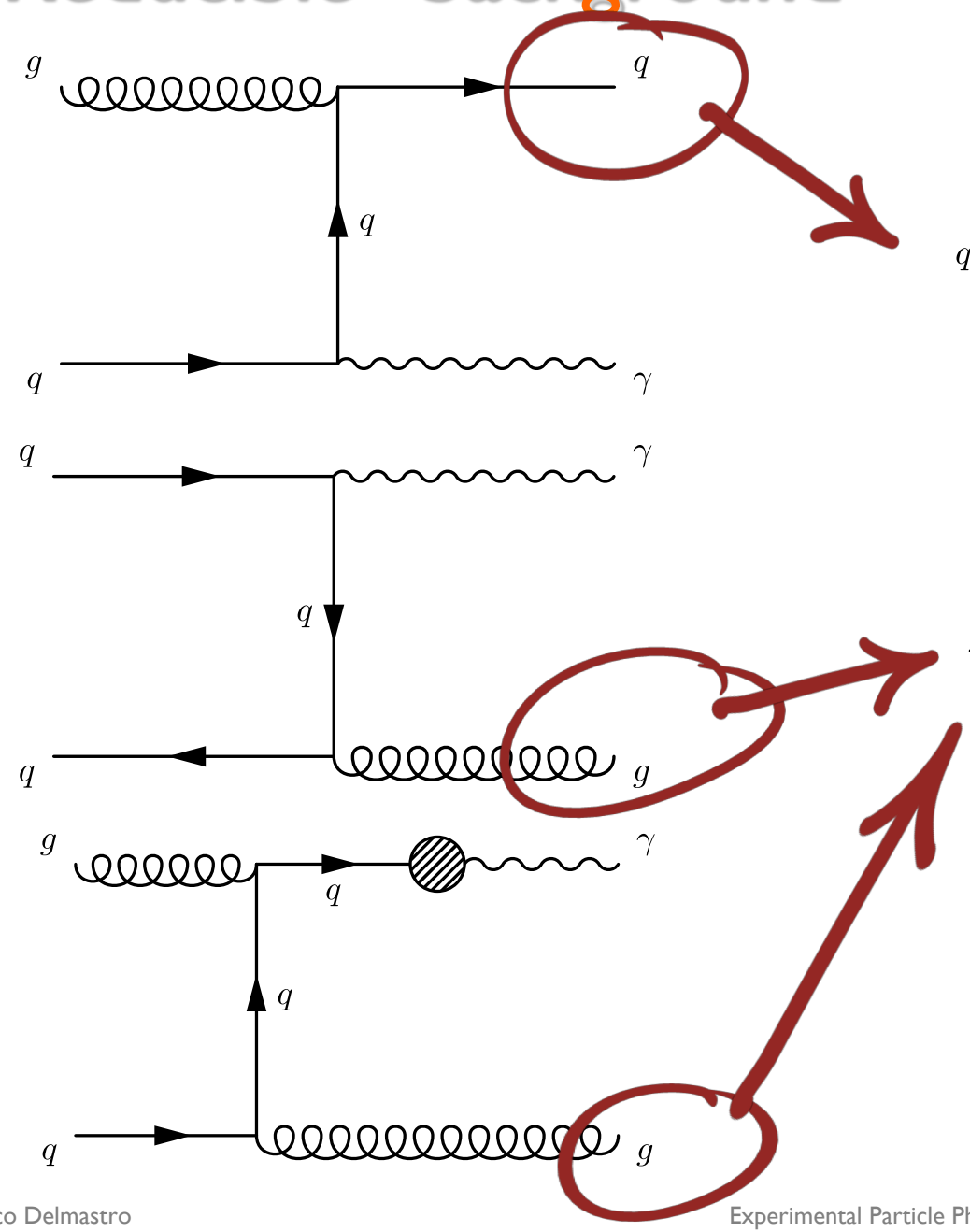


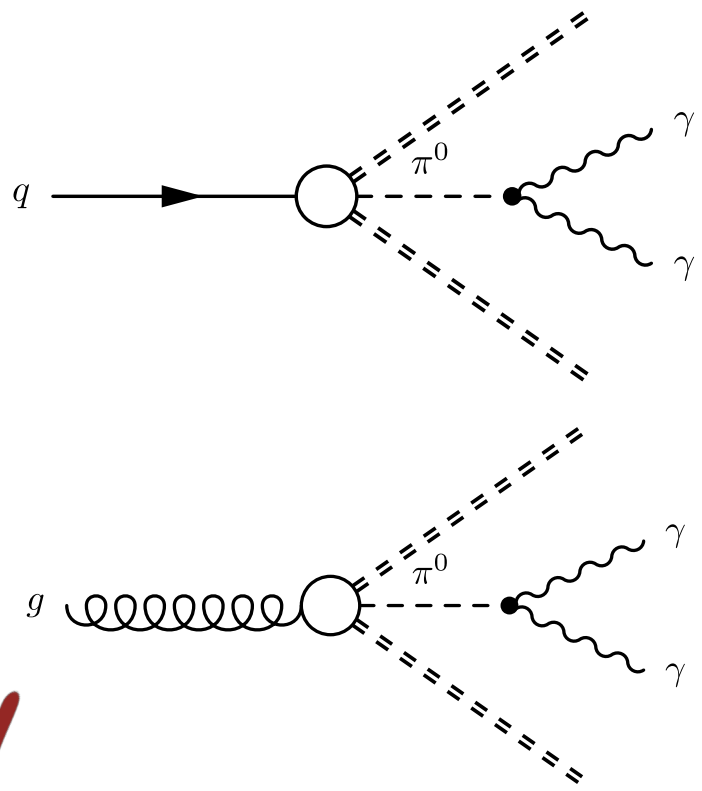




parton fragmentation

"Reducible" background



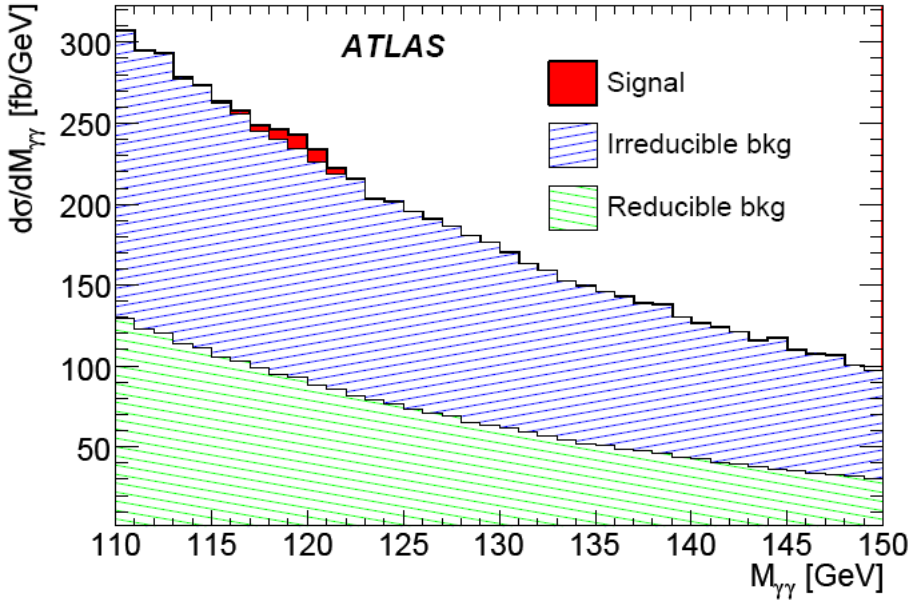


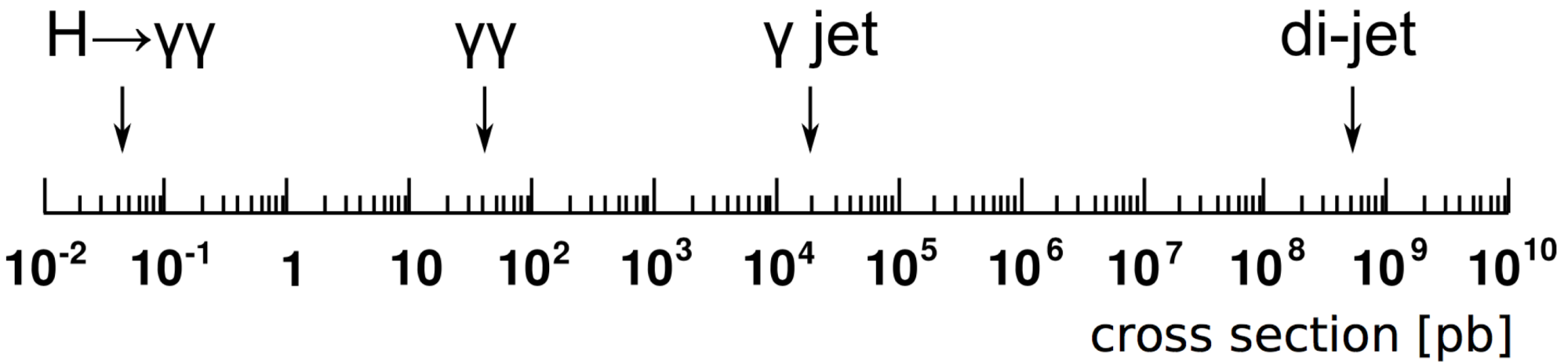
$\sigma(\gamma j) \sim 10^3\, \sigma(\gamma\gamma)$

$\sigma(jj) \sim 10^6\, \sigma(\gamma\gamma)$

Signal vs. background

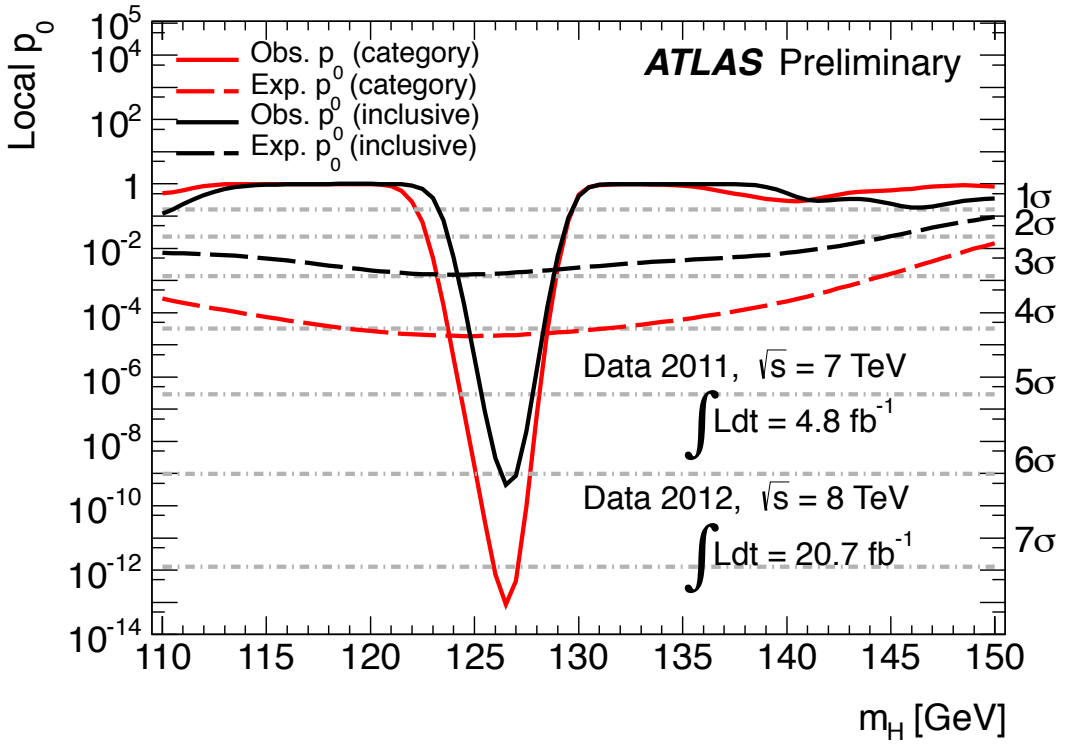
- small branching ratio (~10^{-3})
- huge background
  - ✓ γγ, γj, jj, Drell-Yan
- S/B ~ 3%





H→γγ significance

ATLAS



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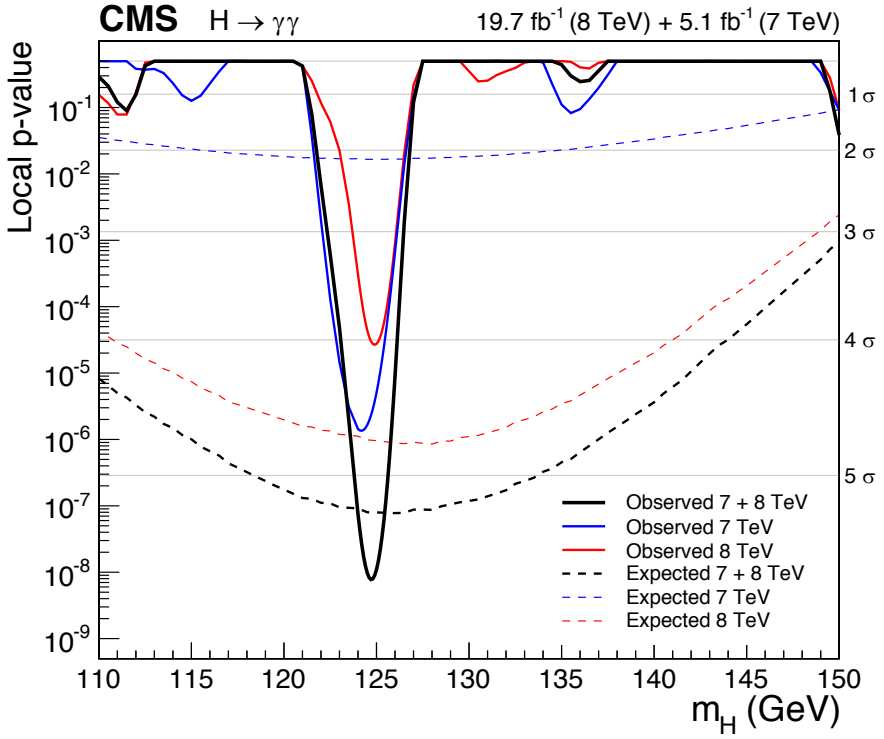
CMS



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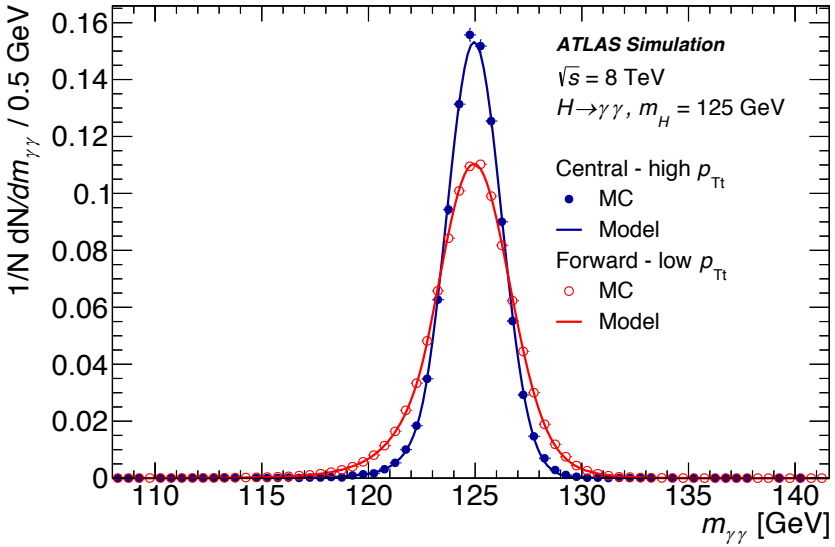
H→γγ invariant mass resolution



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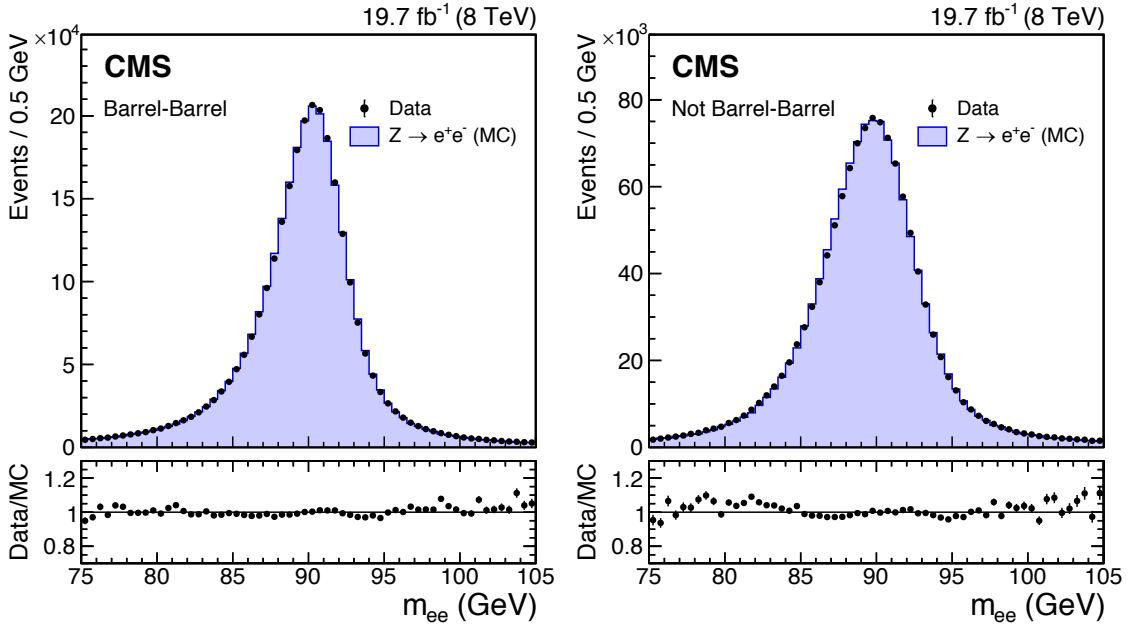

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H→γγ (weighted) mass spectra

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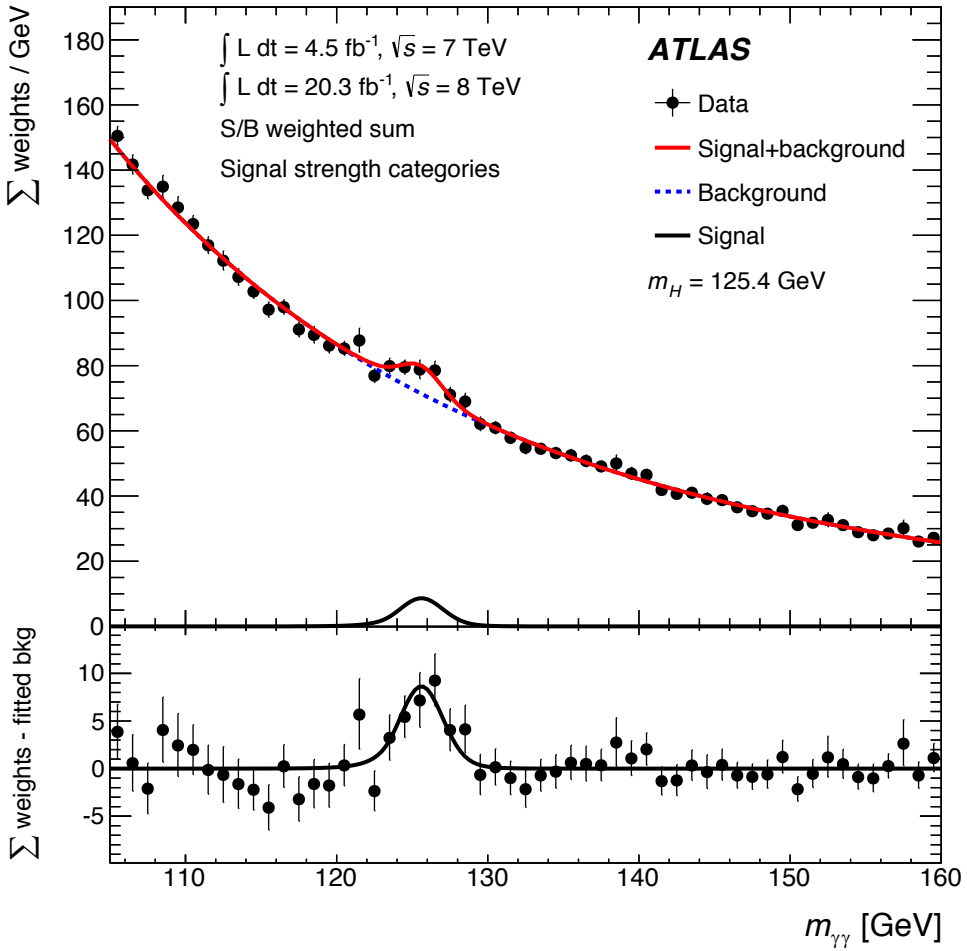
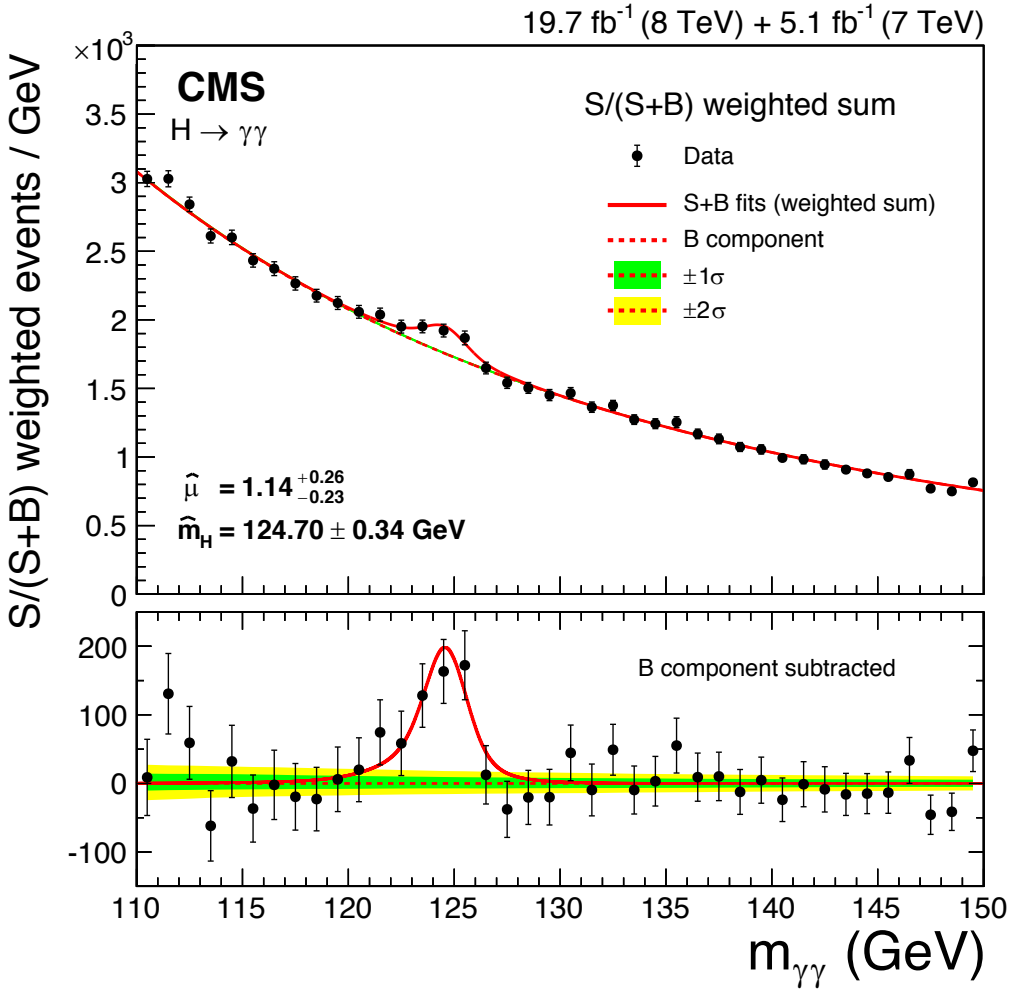
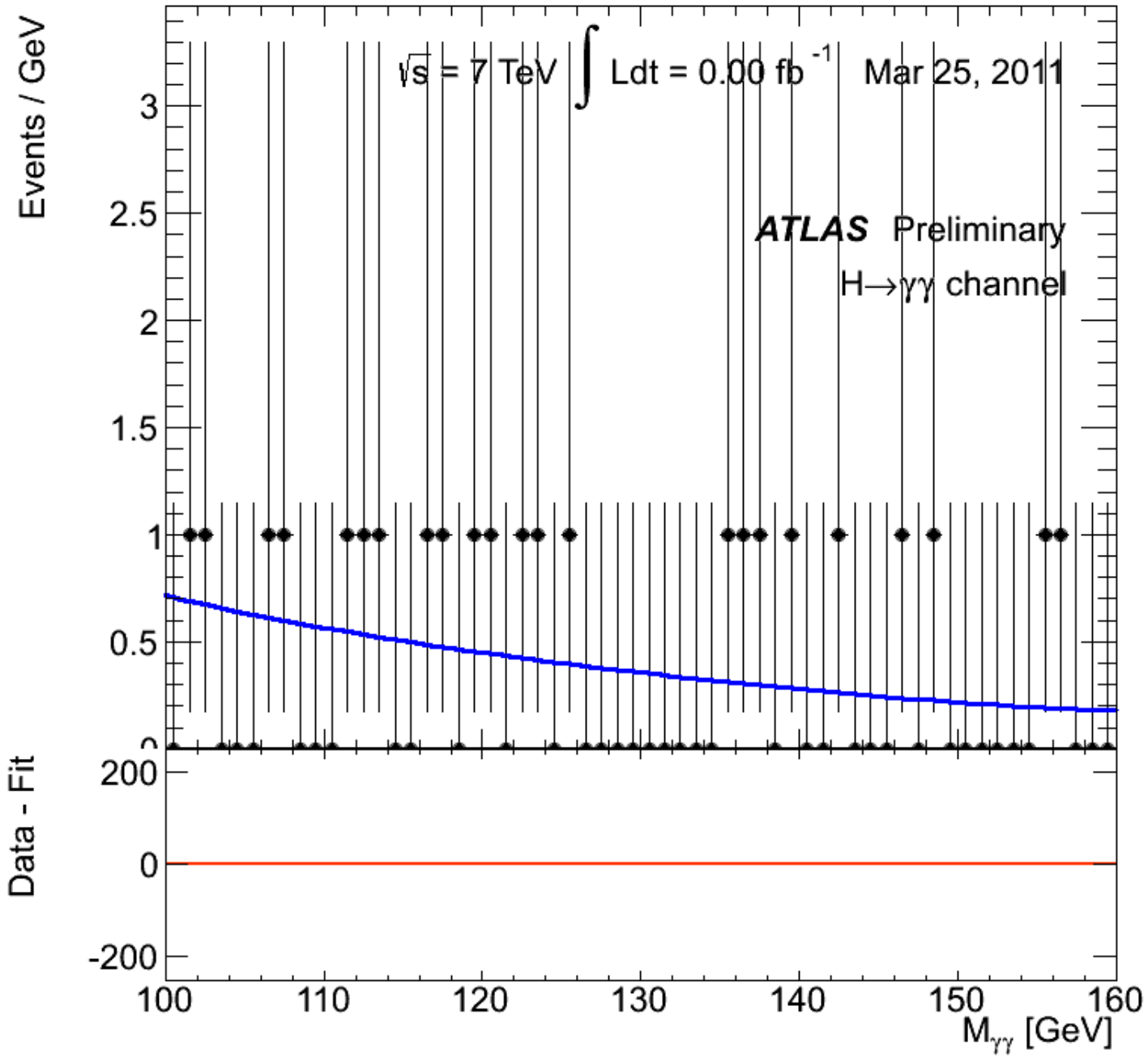





√s = 7 TeV ∫ Ldt = 0.00 fb -1 Mar 25, 2011
ATLAS Preliminary
H→γγ channel
Events / GeV
3
2.5
2
1.5
1
0.5
Data - Fit
200
0
-200
100
110
120
130
140
150
160
Mγγ [GeV]

H→γγ signal and background "toy"models

- γγ background approximated model

$$\frac{d\sigma_{\text{background}}}{dm_{\gamma\gamma}} = 1145[\text{fb/GeV}]e^{-0.023[\text{GeV}^{-1}]m_{\gamma\gamma}}$$

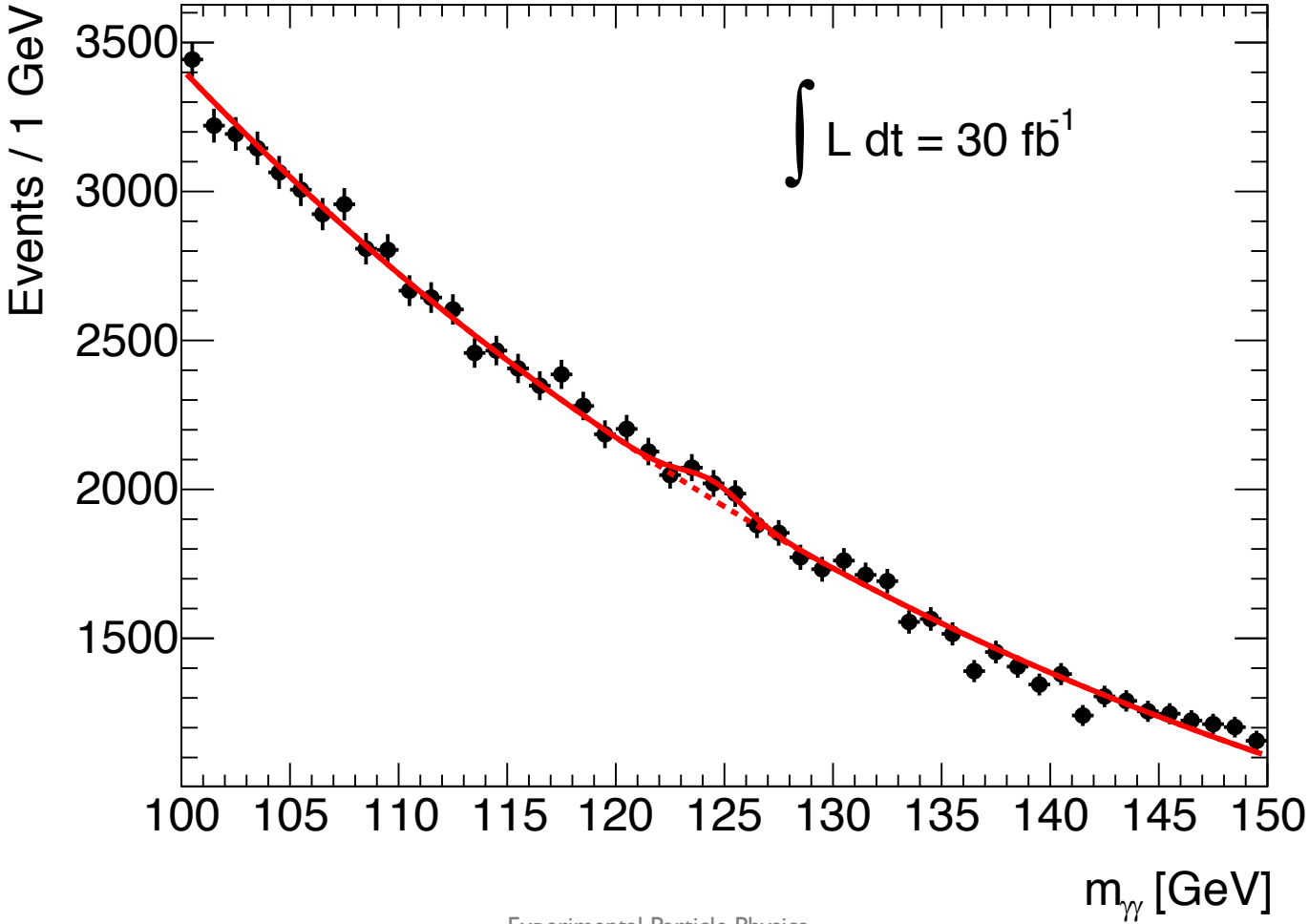
- H→γγ approximated model

$$\sigma(m_H = 125GeV) \times BR \times \varepsilon_{\text{experiment}} \simeq 10fb$$

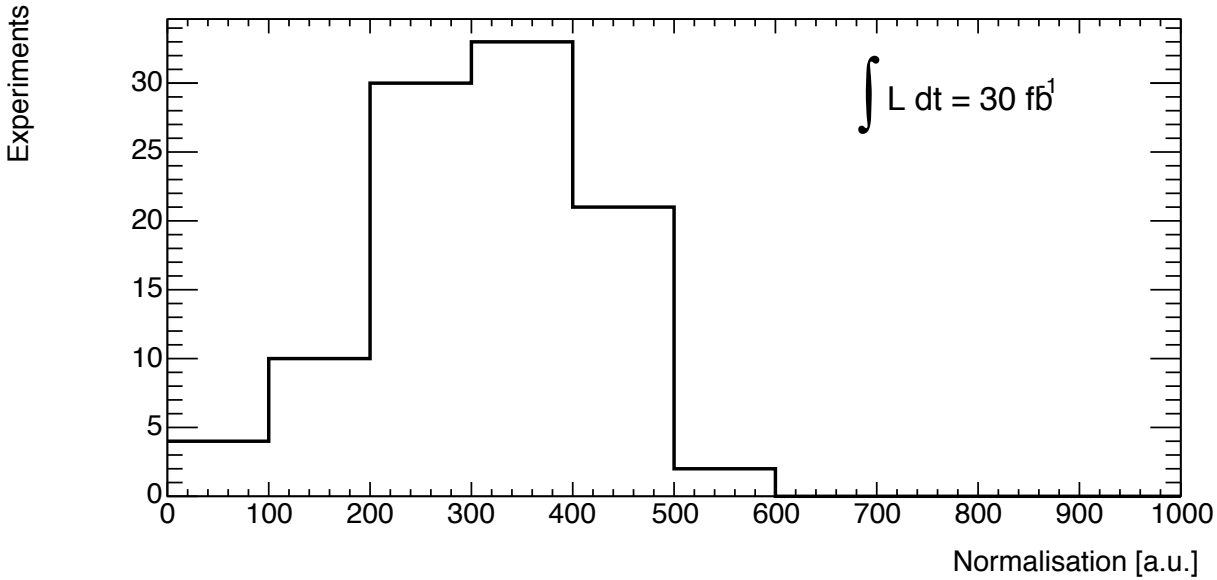
- Width dominated by invariant mass resolution $\sigma_{\gamma\gamma}$

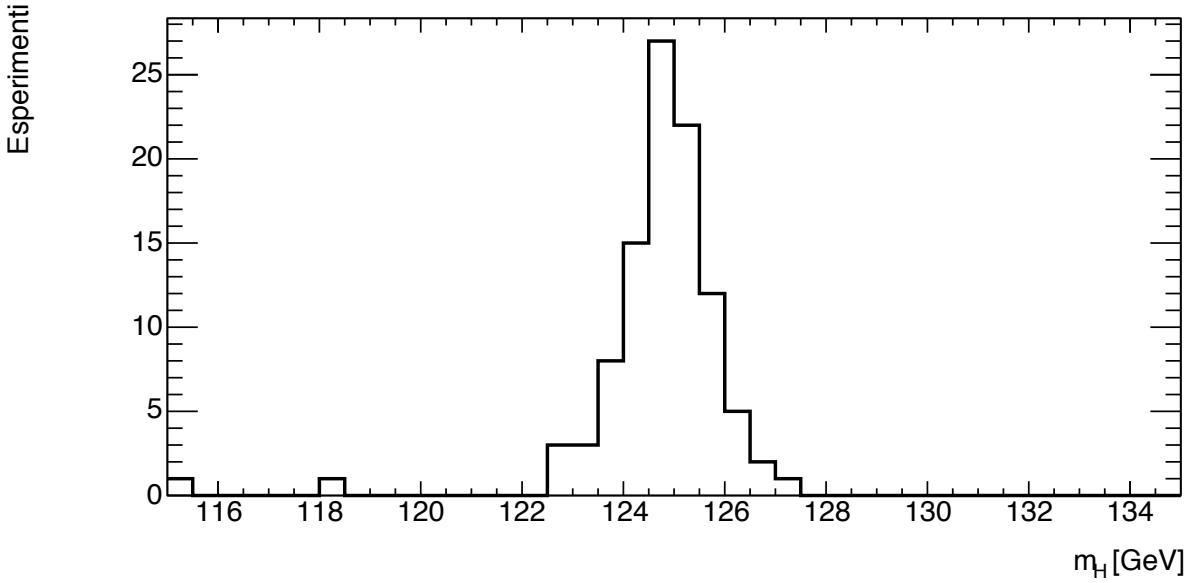
H→γγ fit "toy" example

$$p_0 e^{-p_1 m} + p_2 \frac{1}{\sqrt{2\pi} p_4} e^{-\frac{1}{2}\frac{(m-p_3)^2}{p_4^2}}$$



Toy experiments (fluctuation can change the results!)





Significance evolution