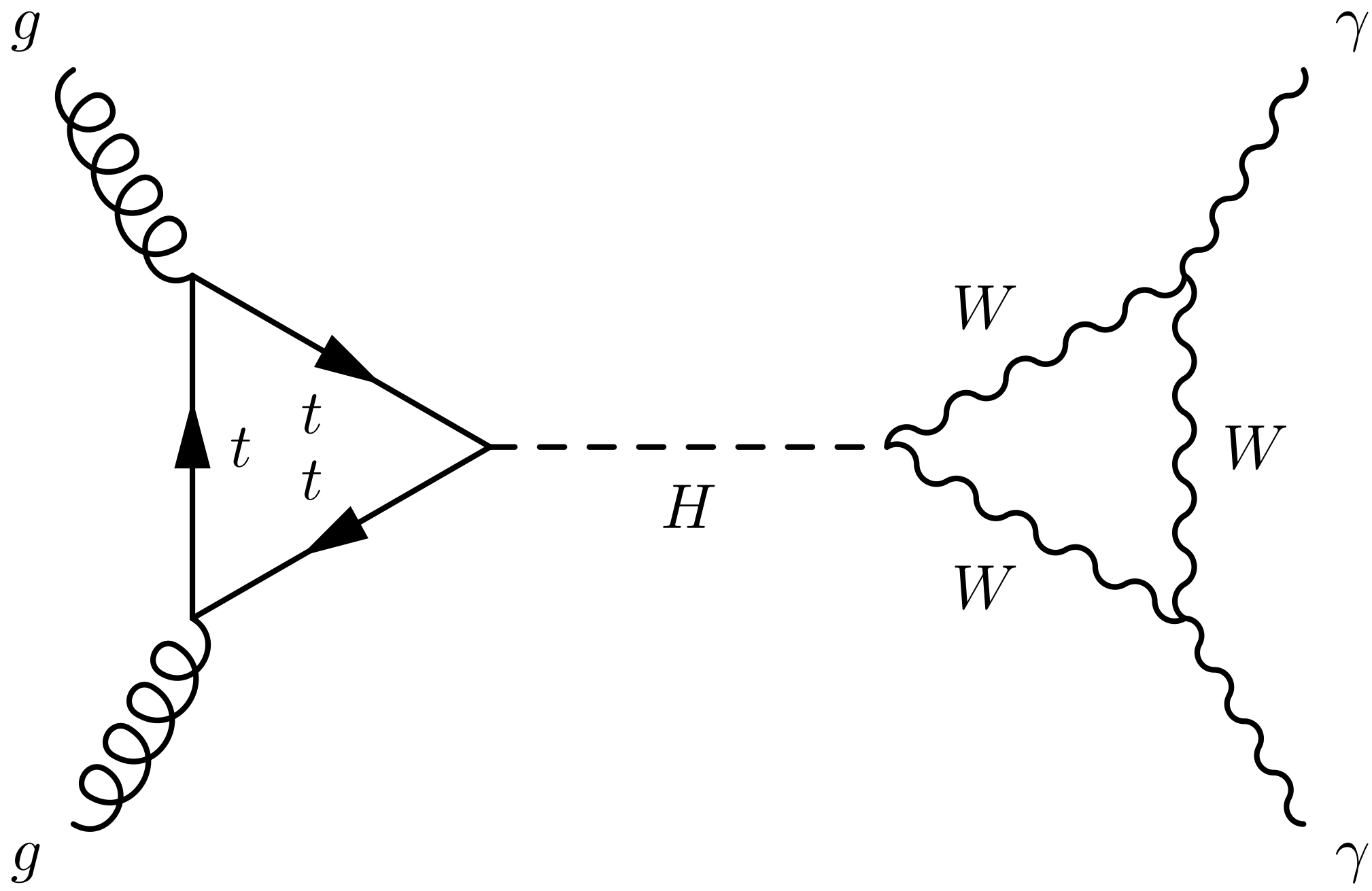


Experimental particle. physics

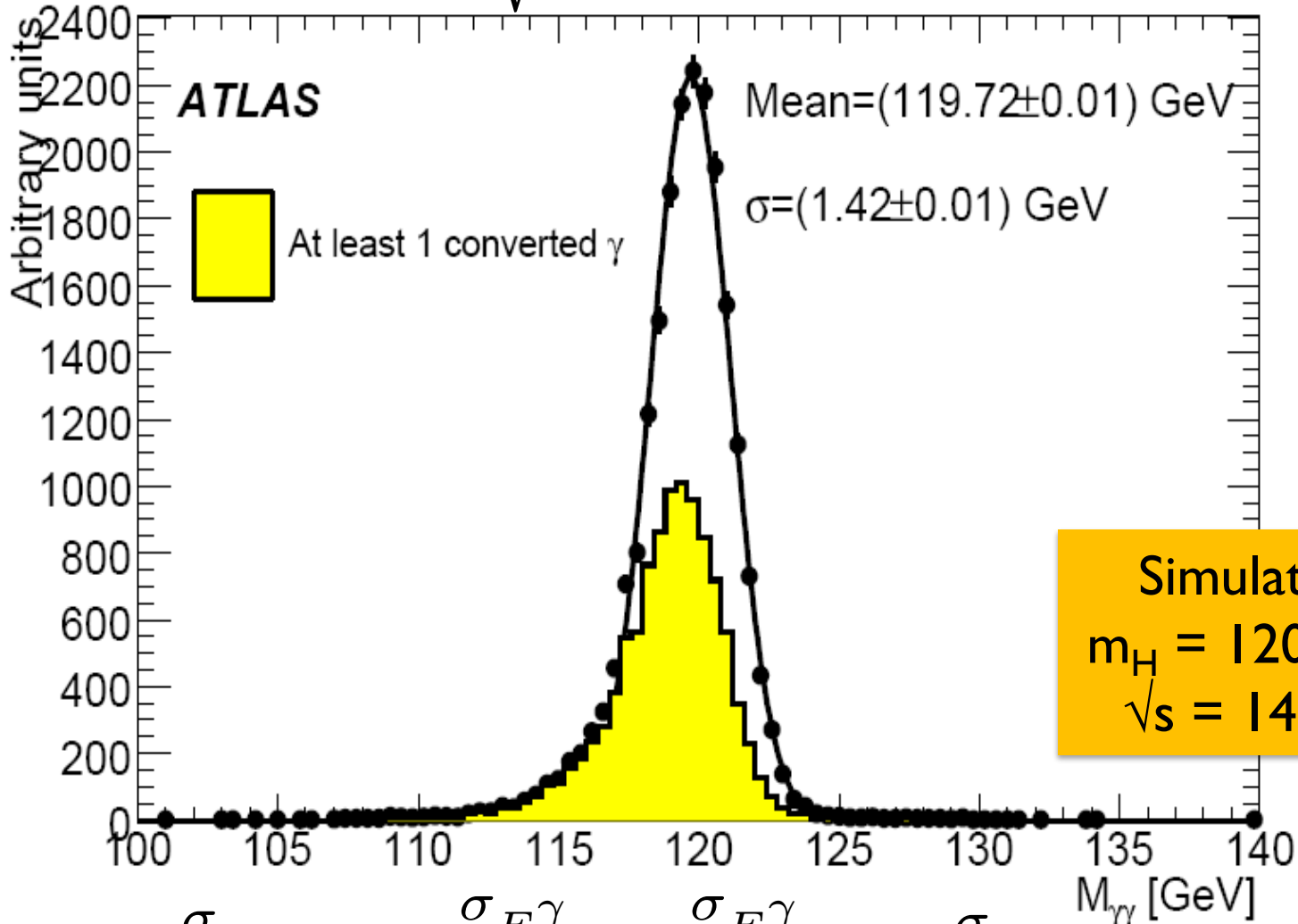
esipap...
European School of Instrumentation
in Particle & Astroparticle Physics

D. Significance of
 $H \rightarrow \gamma\gamma$ signal



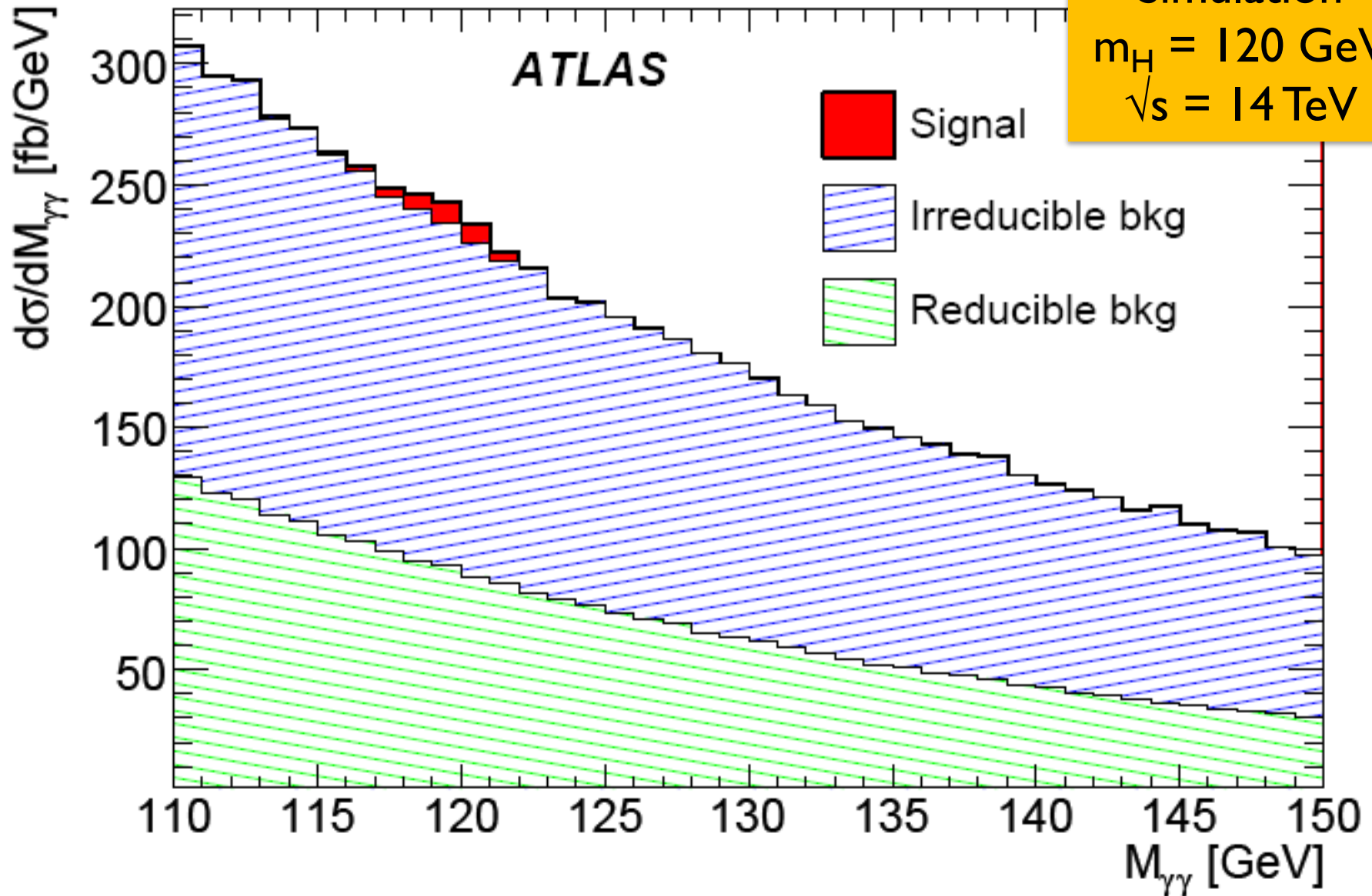
A narrow mass peak...

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

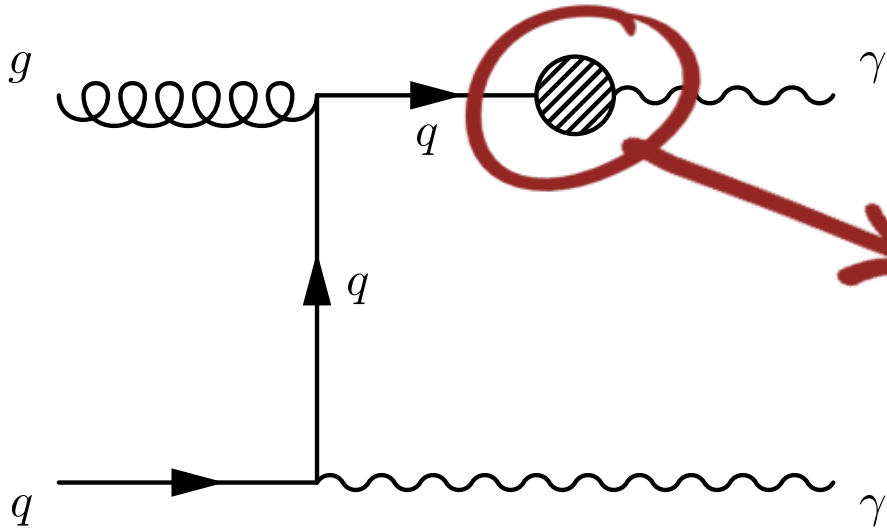
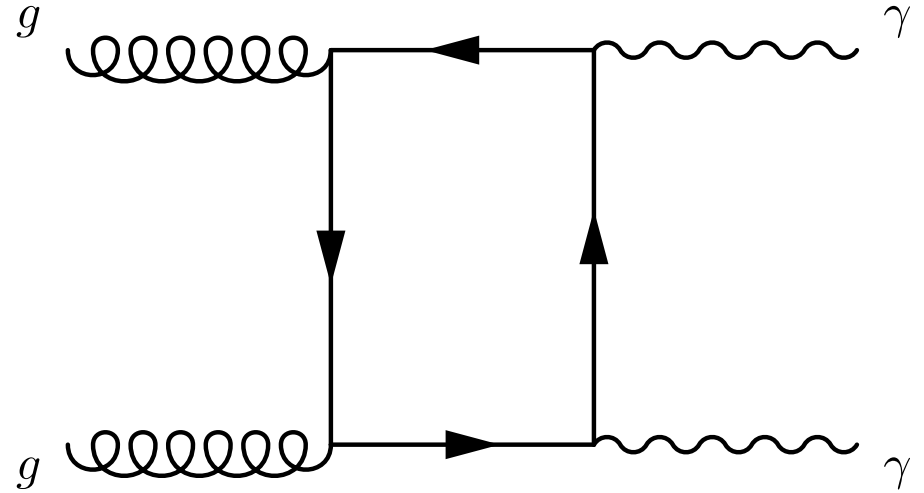
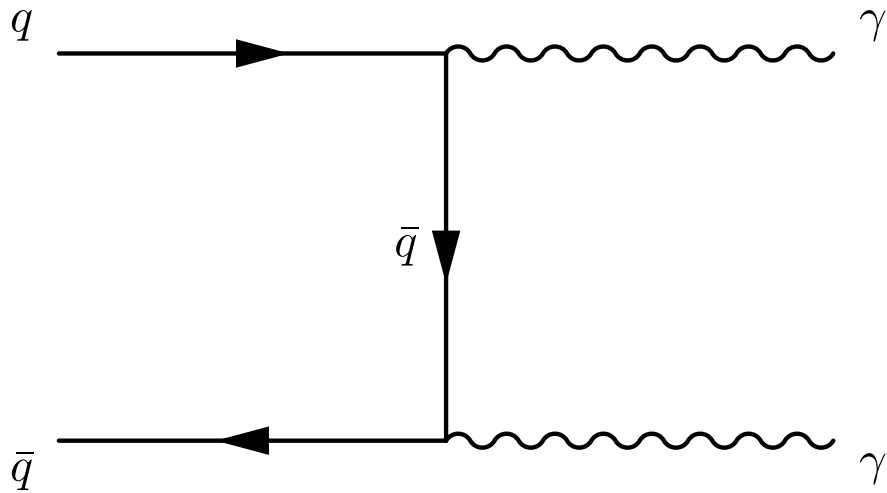


$$\frac{\sigma_{m_{\gamma\gamma}}}{m_{\gamma\gamma}} = \frac{\sigma_{E_1^\gamma}}{E_1^\gamma} \oplus \frac{\sigma_{E_2^\gamma}}{E_2^\gamma} \oplus \frac{\sigma_{\alpha_{12}}}{\tan \alpha_{12}}$$

... on a large background!

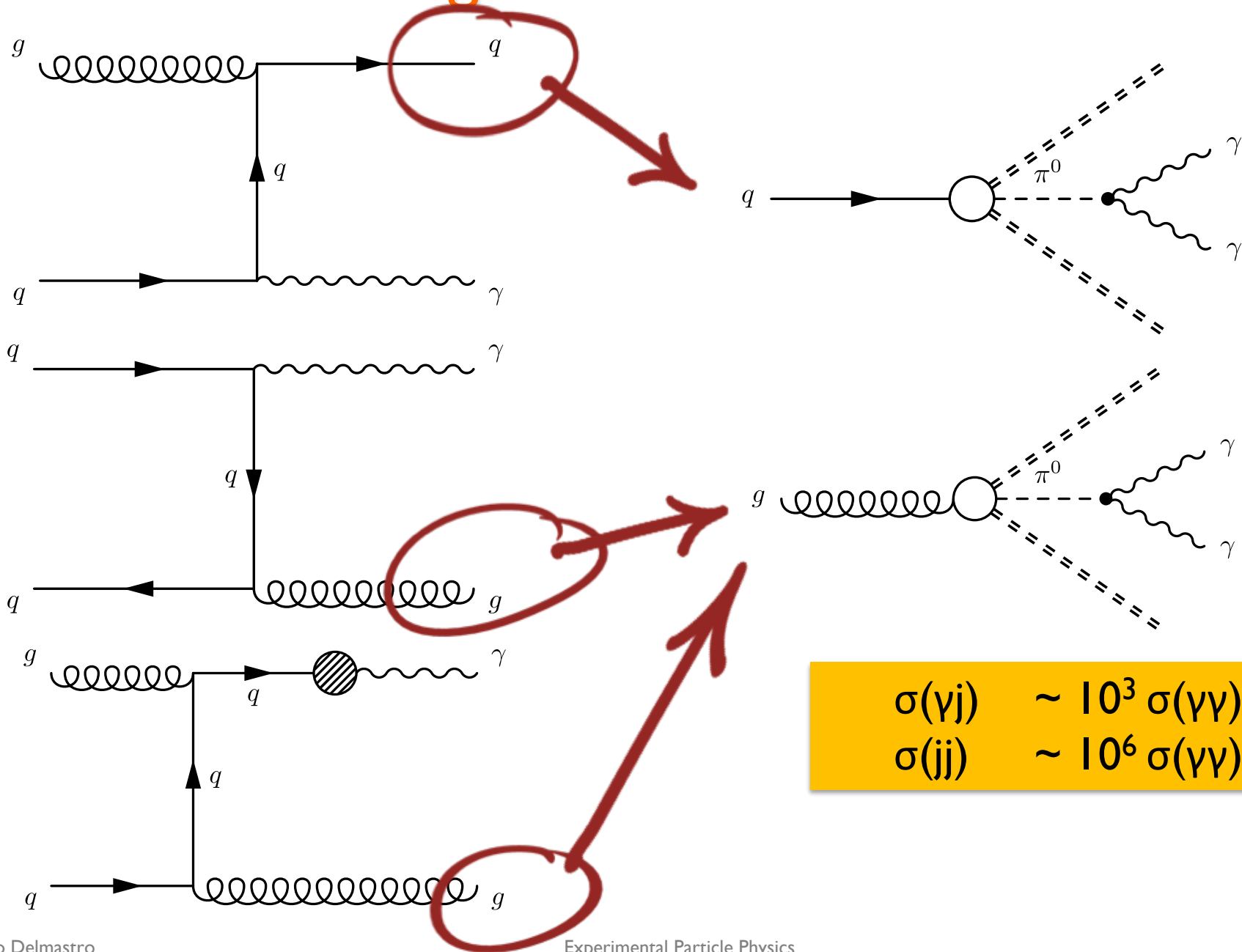


“Irreducible” background



parton fragmentation

“Reducible” background

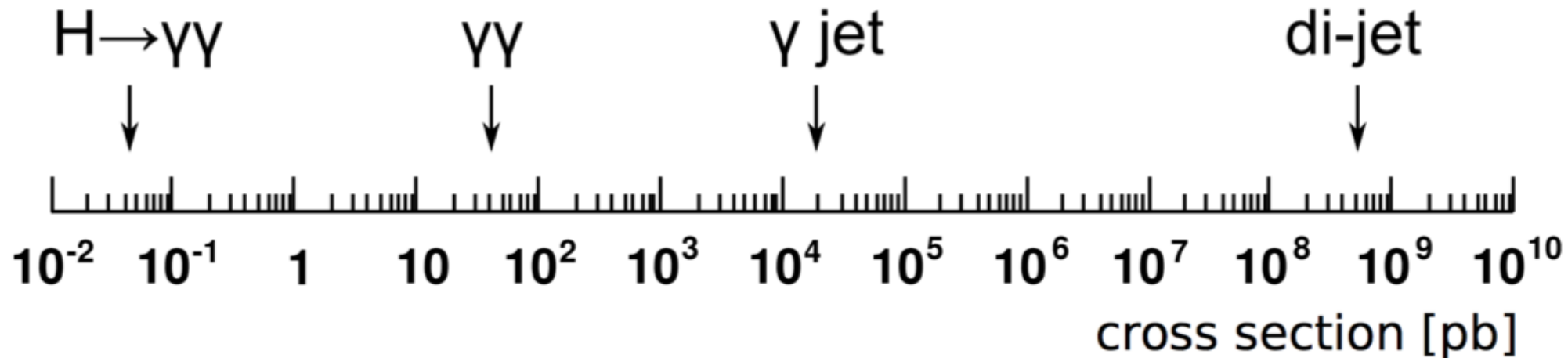
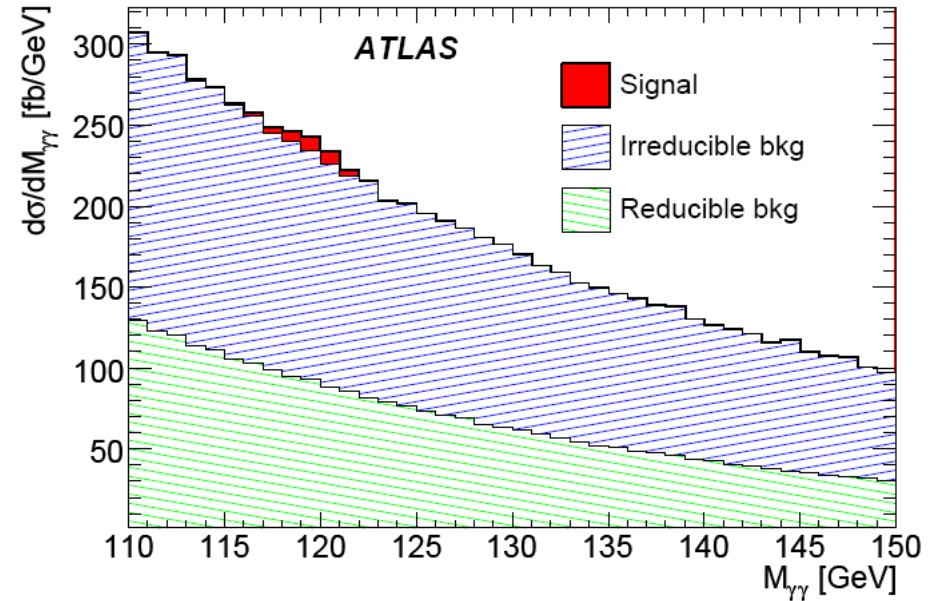


$$\sigma(\gamma j) \sim 10^3 \sigma(\gamma\gamma)$$

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

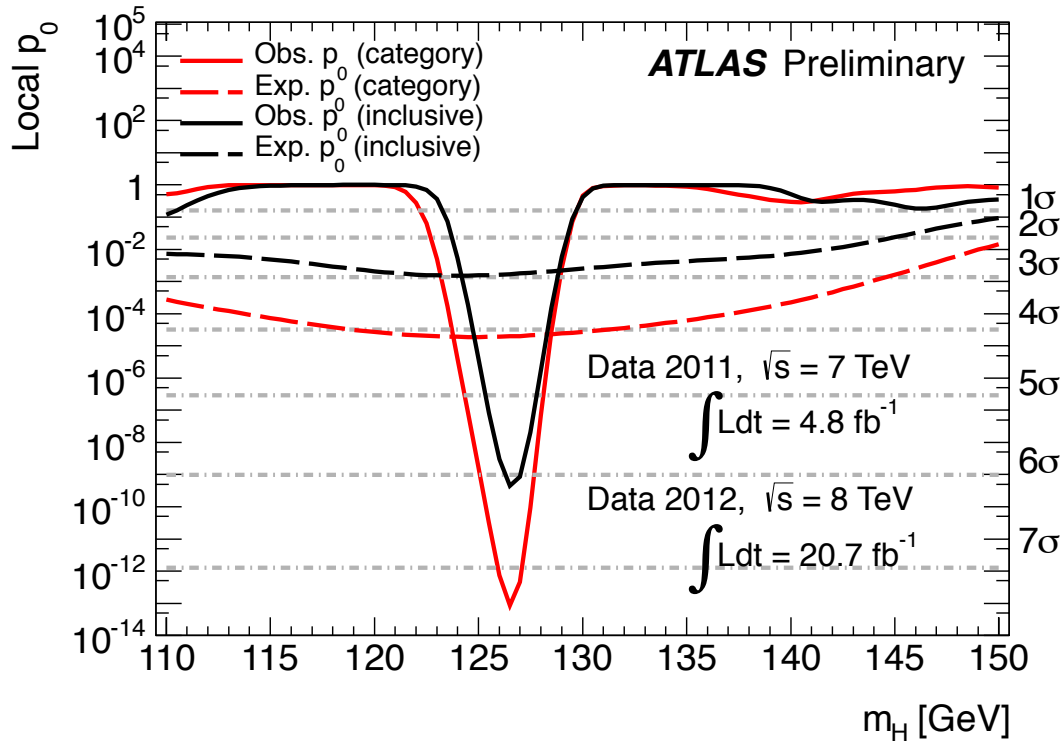
Signal vs. background

- small branching ratio ($\sim 10^{-3}$)
- huge background
 - ✓ $\gamma\gamma$, γj , jj , Drell-Yan
- S/B $\sim 3\%$



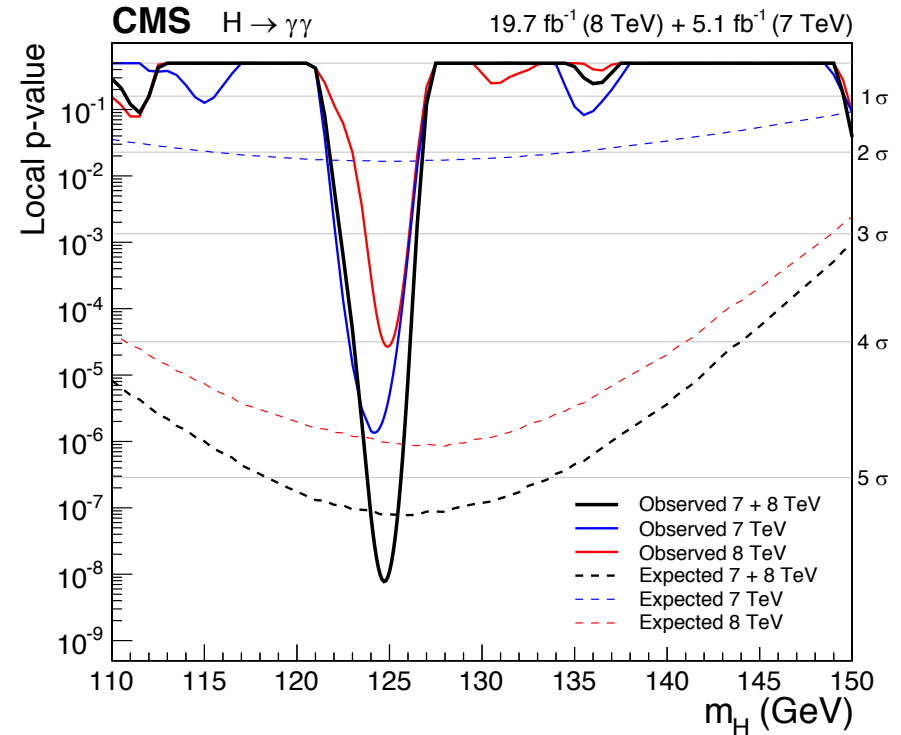
H → γγ significance

ATLAS



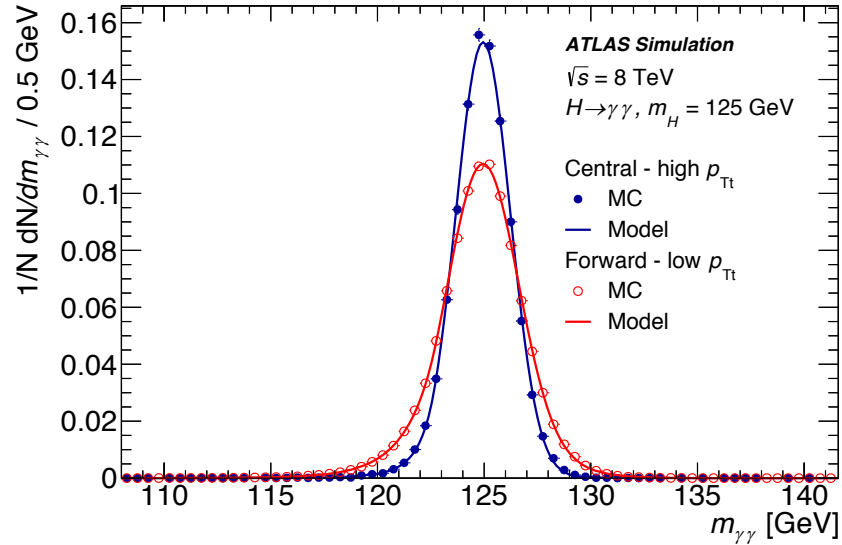
[ATLAS-CONF-2013-012](#)

CMS



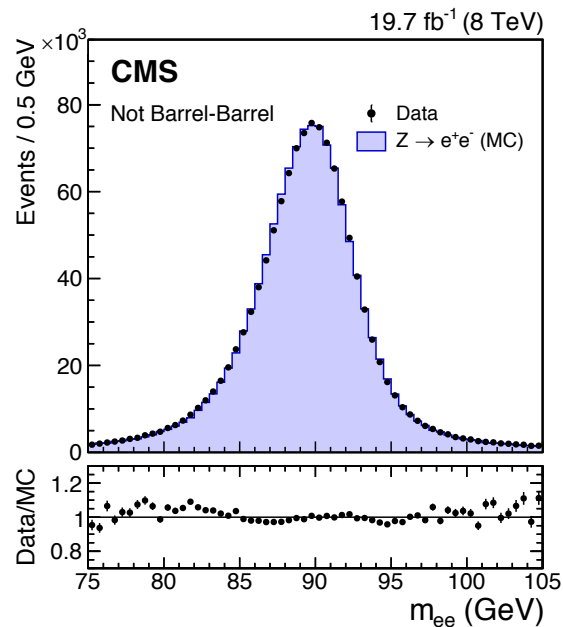
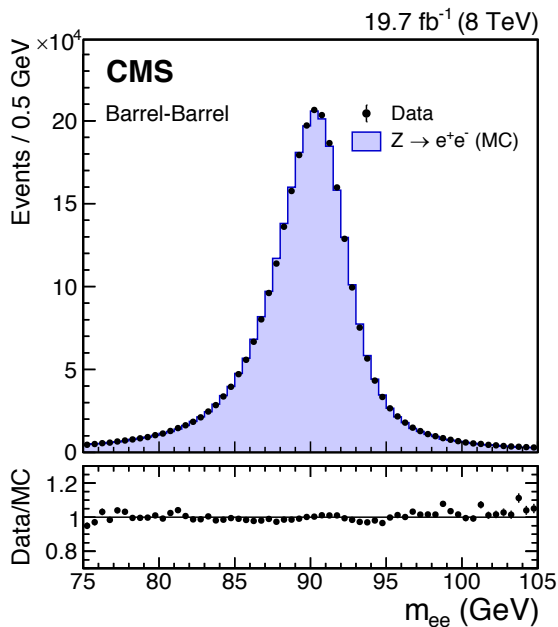
[Eur. Phys. J. C 74 \(2014\) 3076](#)

$H \rightarrow \gamma\gamma$ invariant mass resolution



ATLAS

[Phys. Rev. D. 90, 112015 \(2014\)](#)

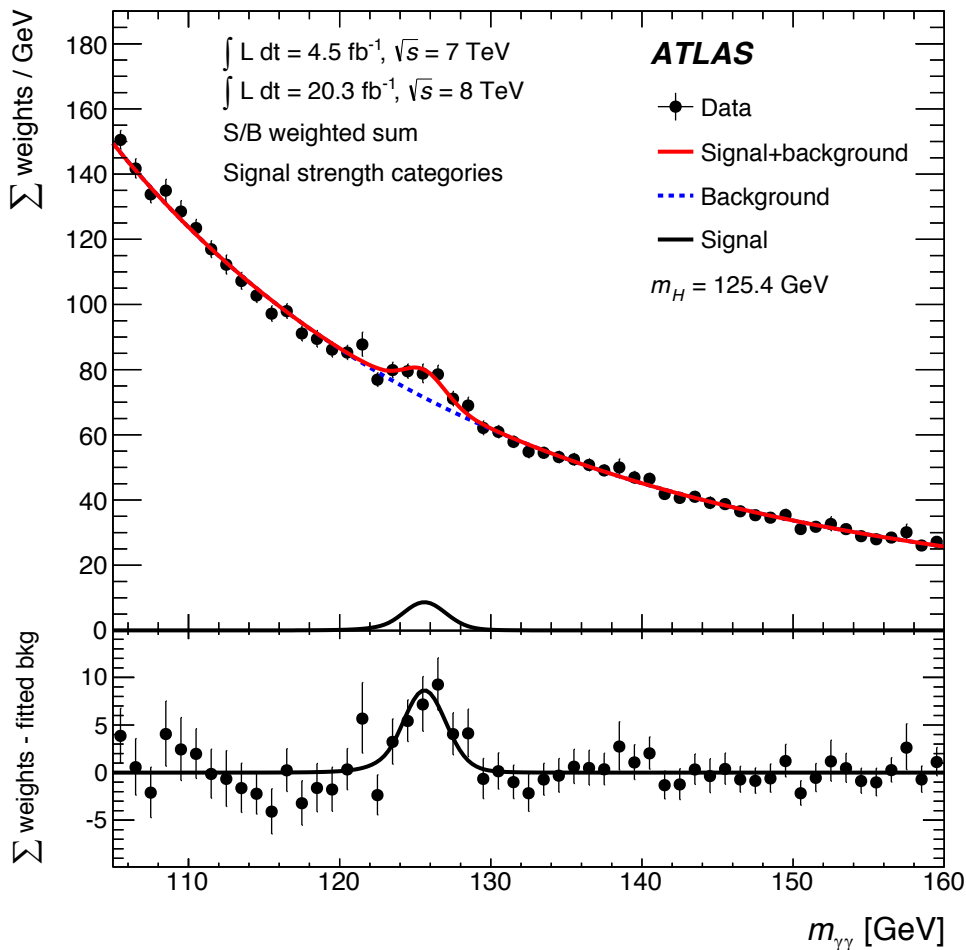


CMS

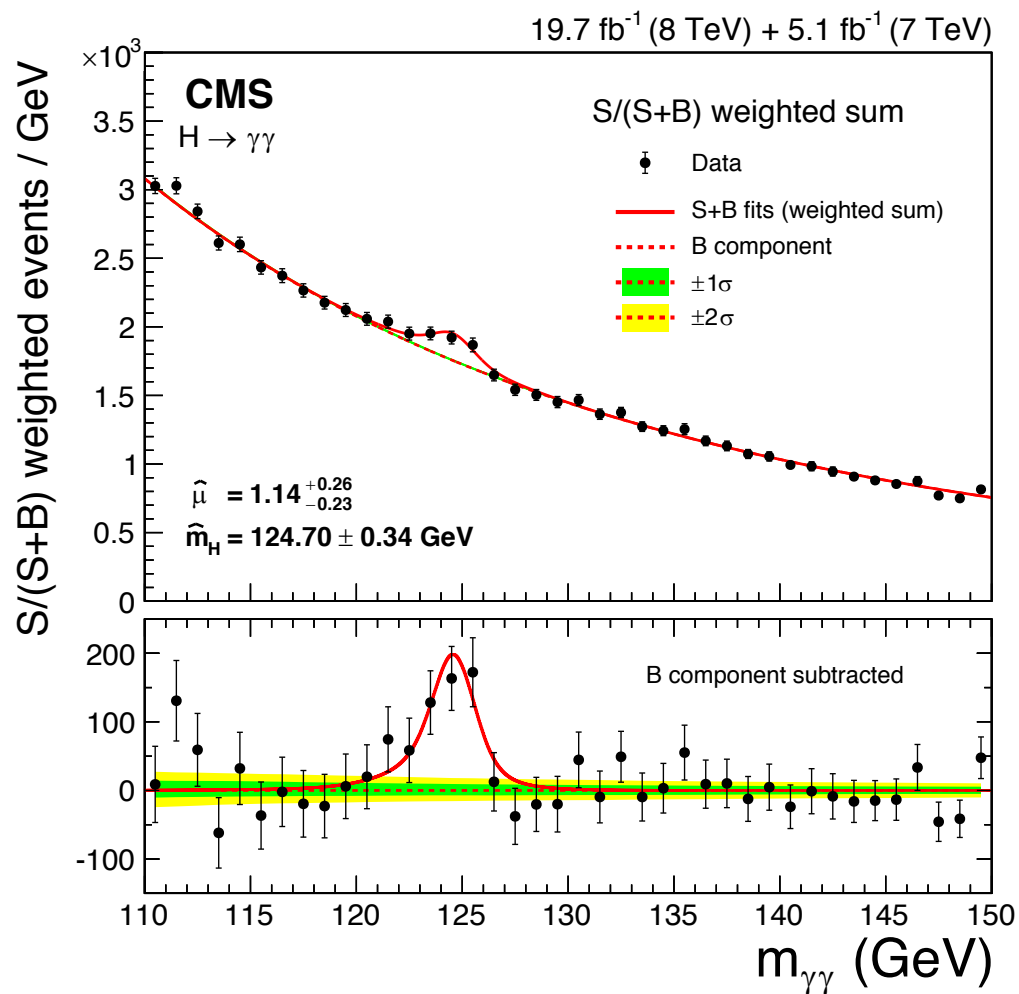
[Eur. Phys. J. C 74 \(2014\) 3076](#)

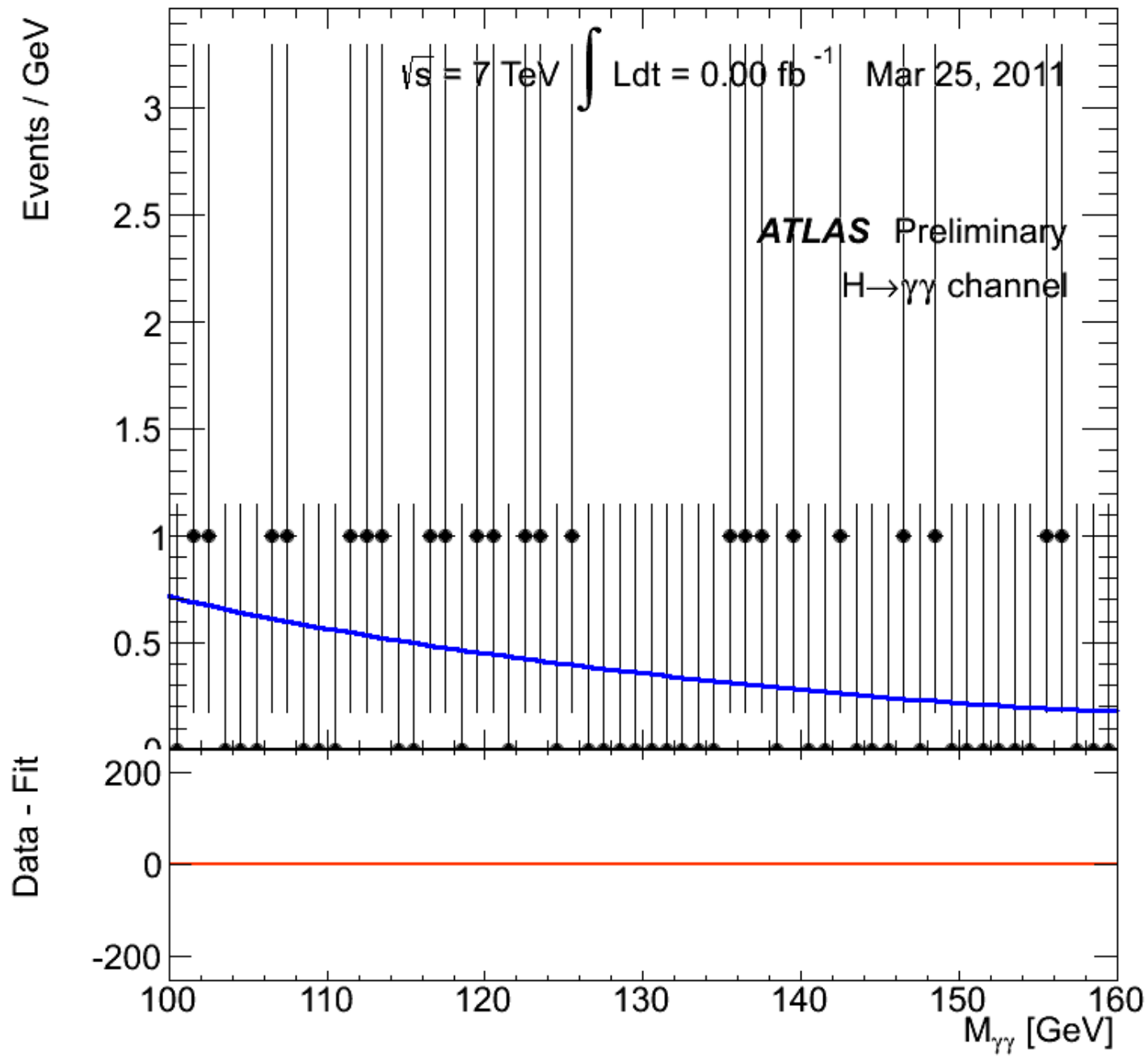
H → $\gamma\gamma$ (weighted) mass spectra

ATLAS



CMS





$H \rightarrow \gamma\gamma$ signal and background “toy” models

- $\gamma\gamma$ background approximated model

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

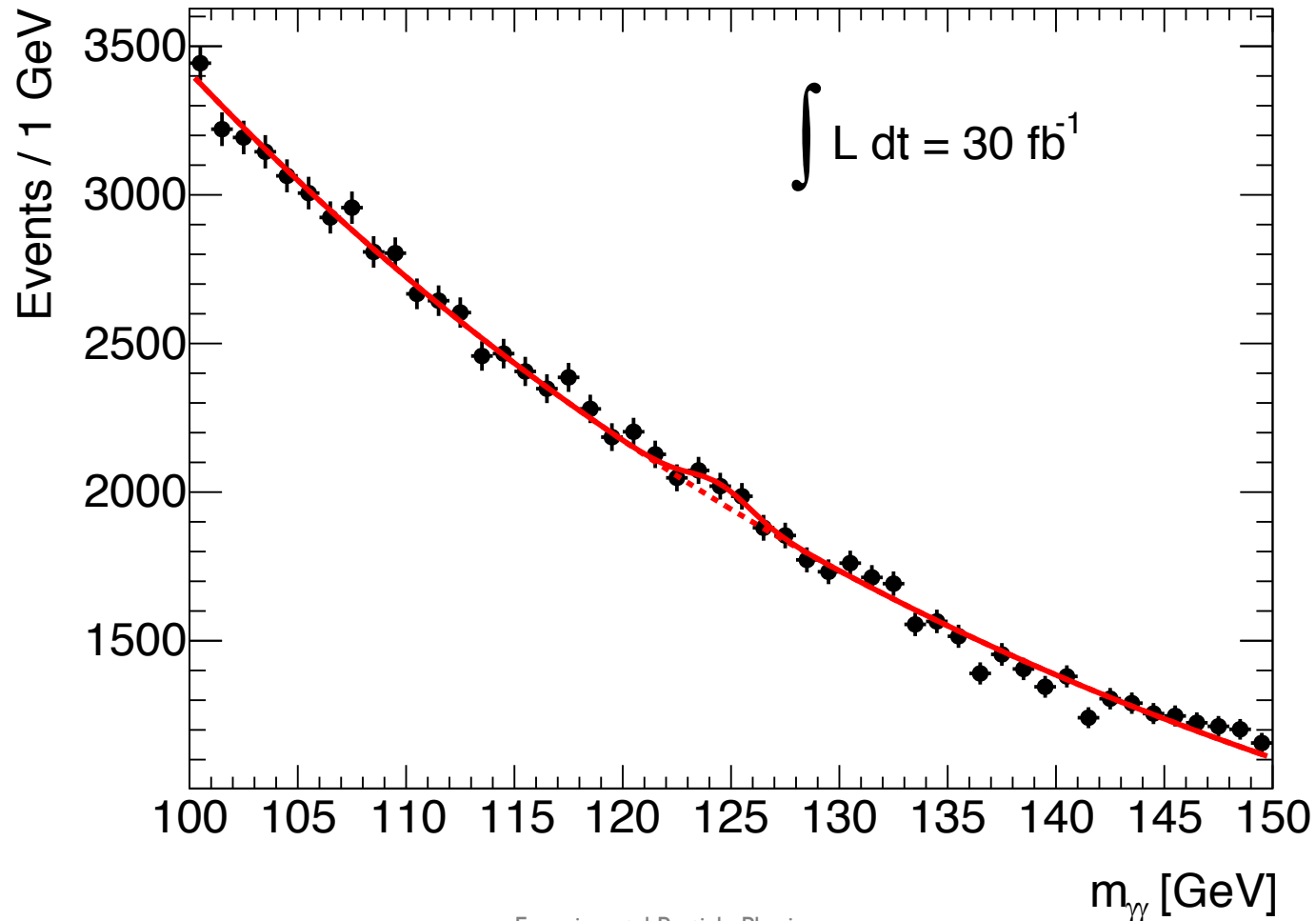
- $H \rightarrow \gamma\gamma$ approximated model

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

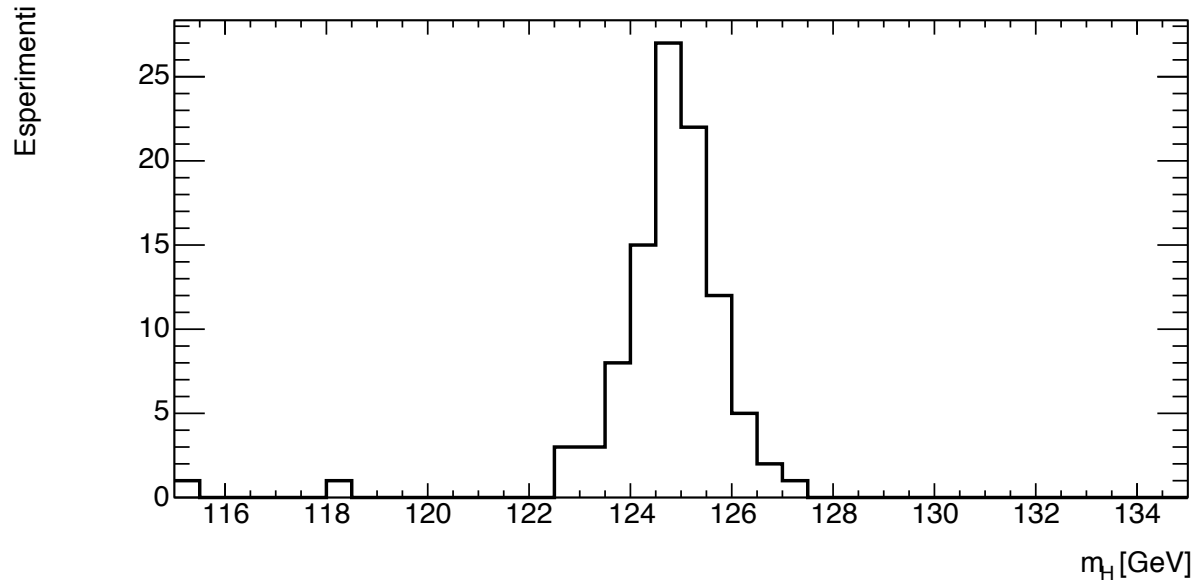
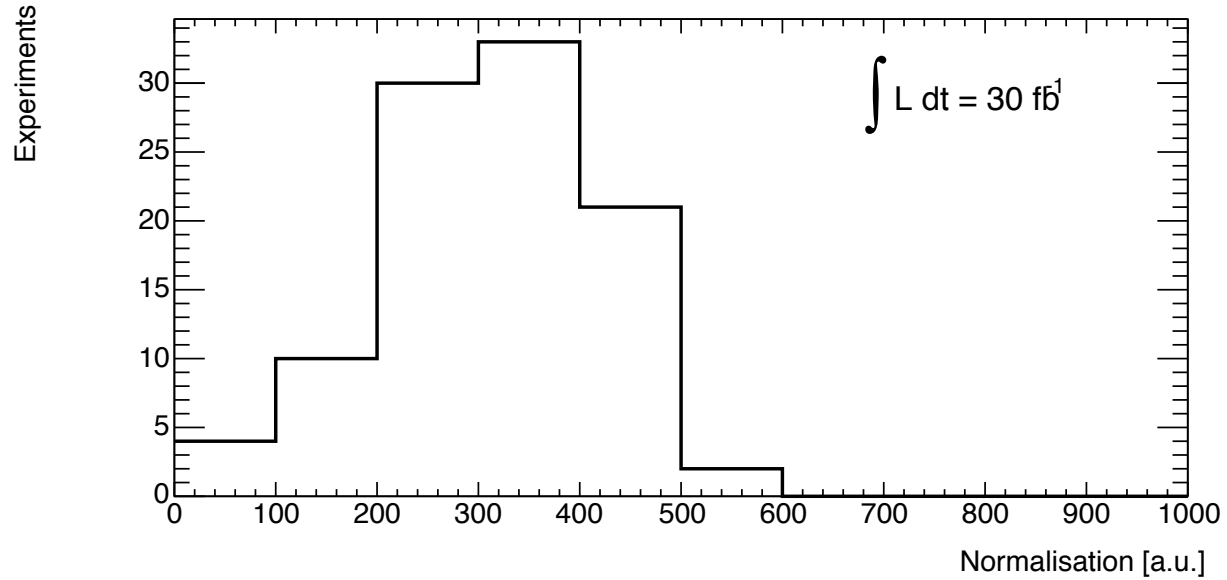
- Width dominated by invariant mass resolution $\sigma_{\gamma\gamma}$

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

