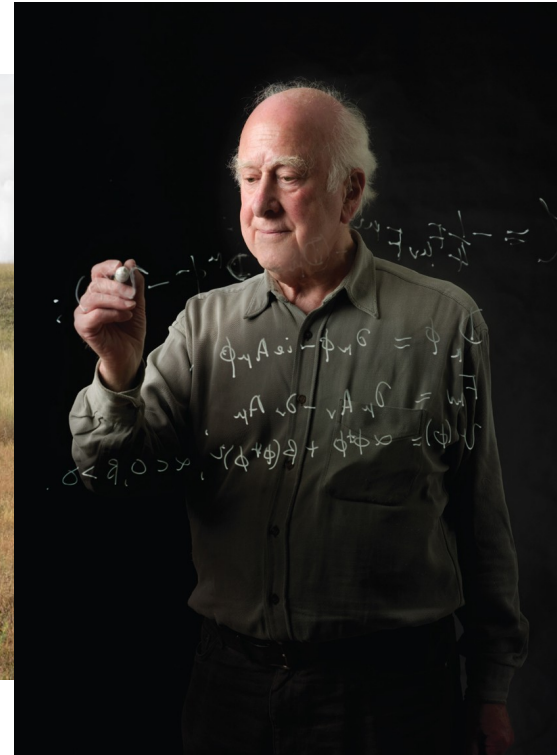


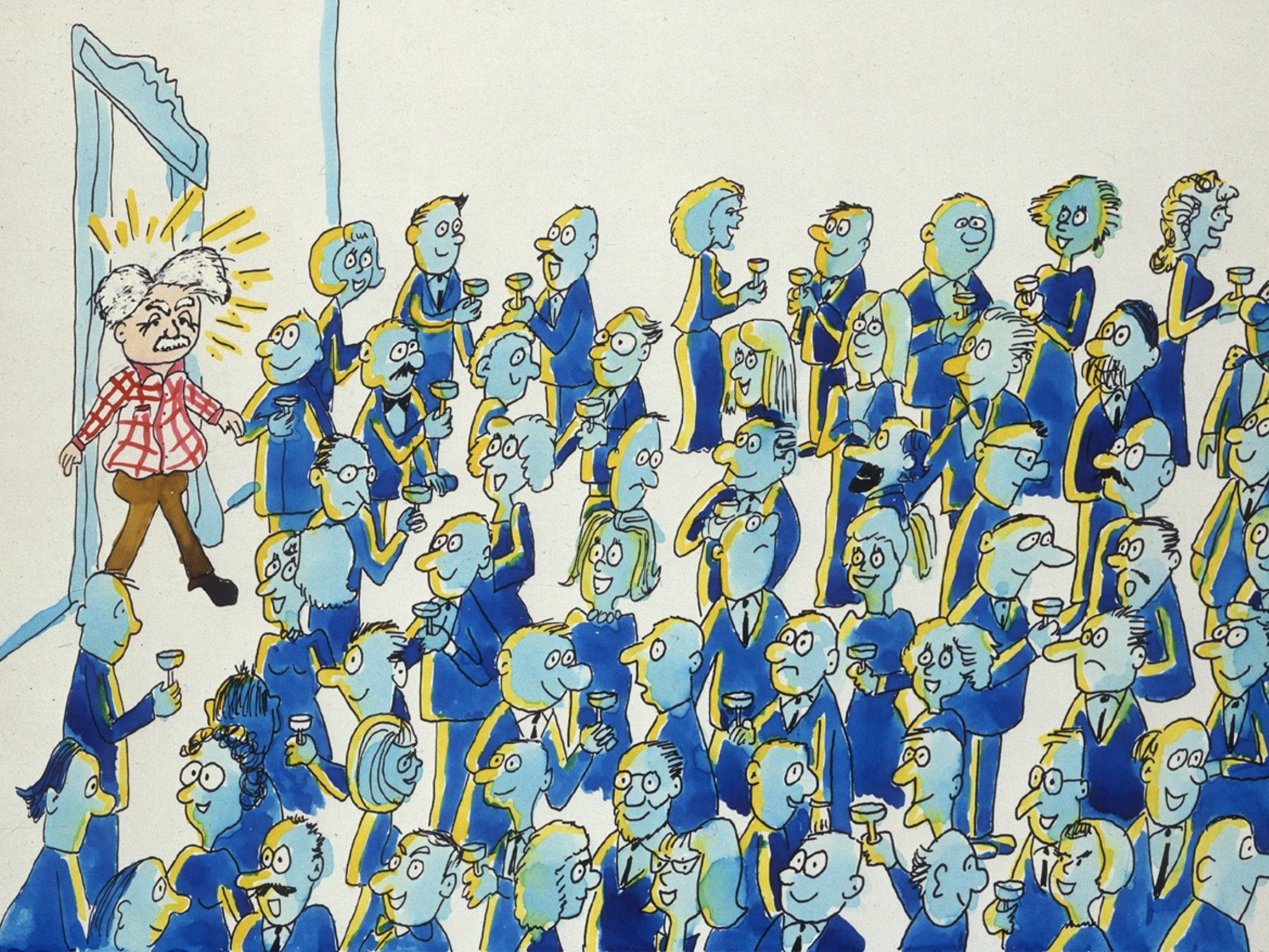
Higgs Hunting*

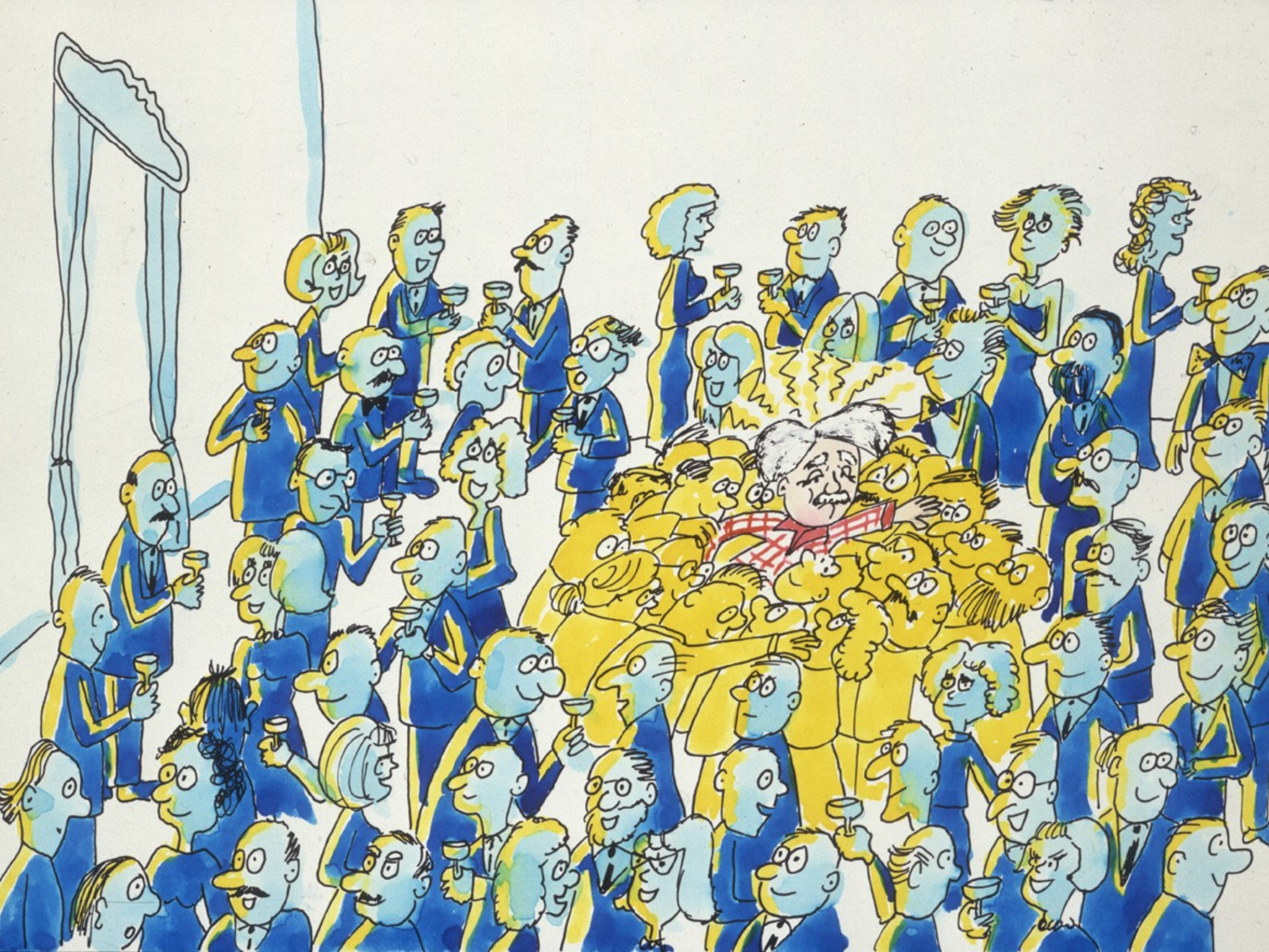
15.4.2019
Vojtěch Pleskot



*Noone will be killed







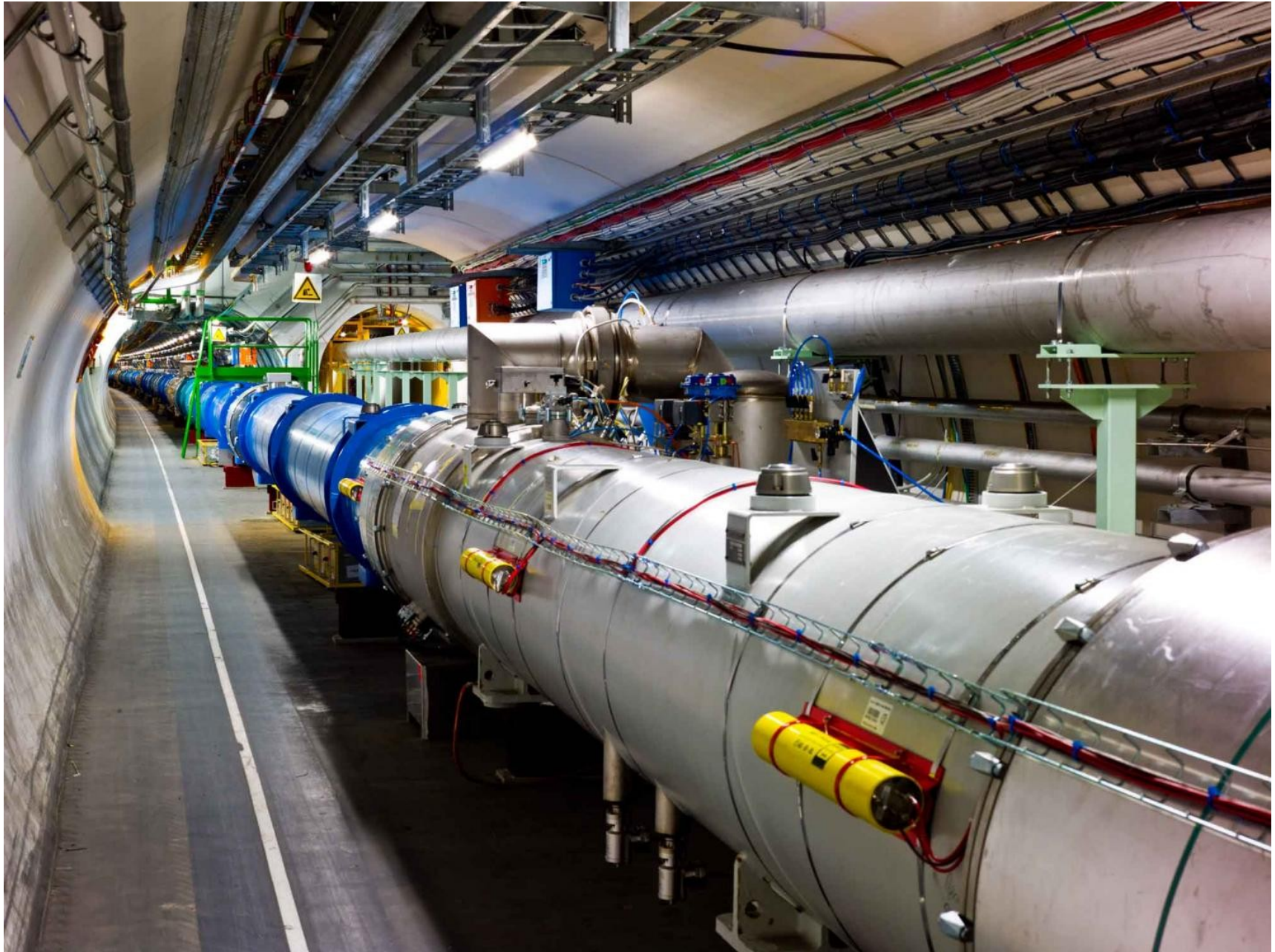




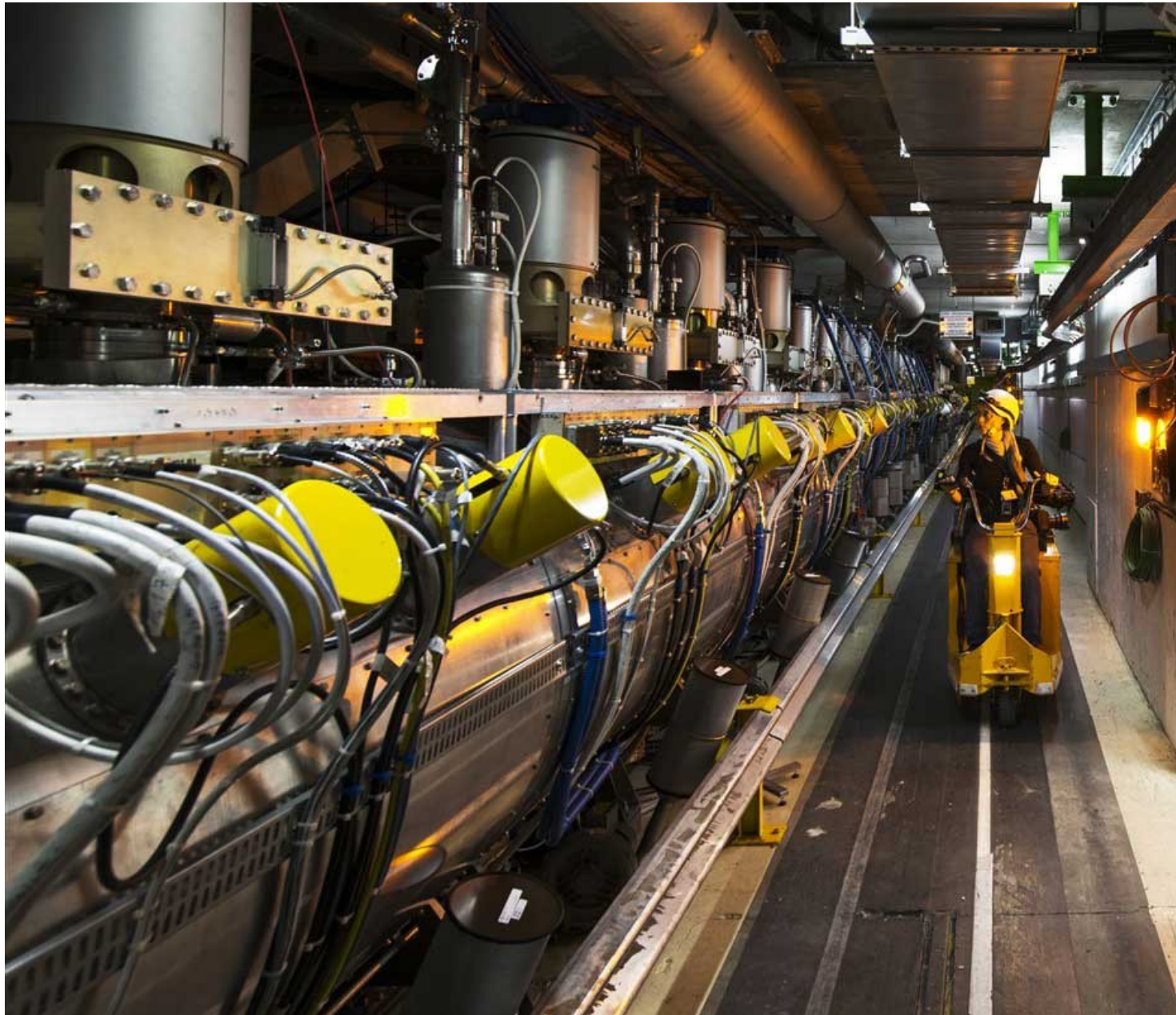
Large Hadron Collider



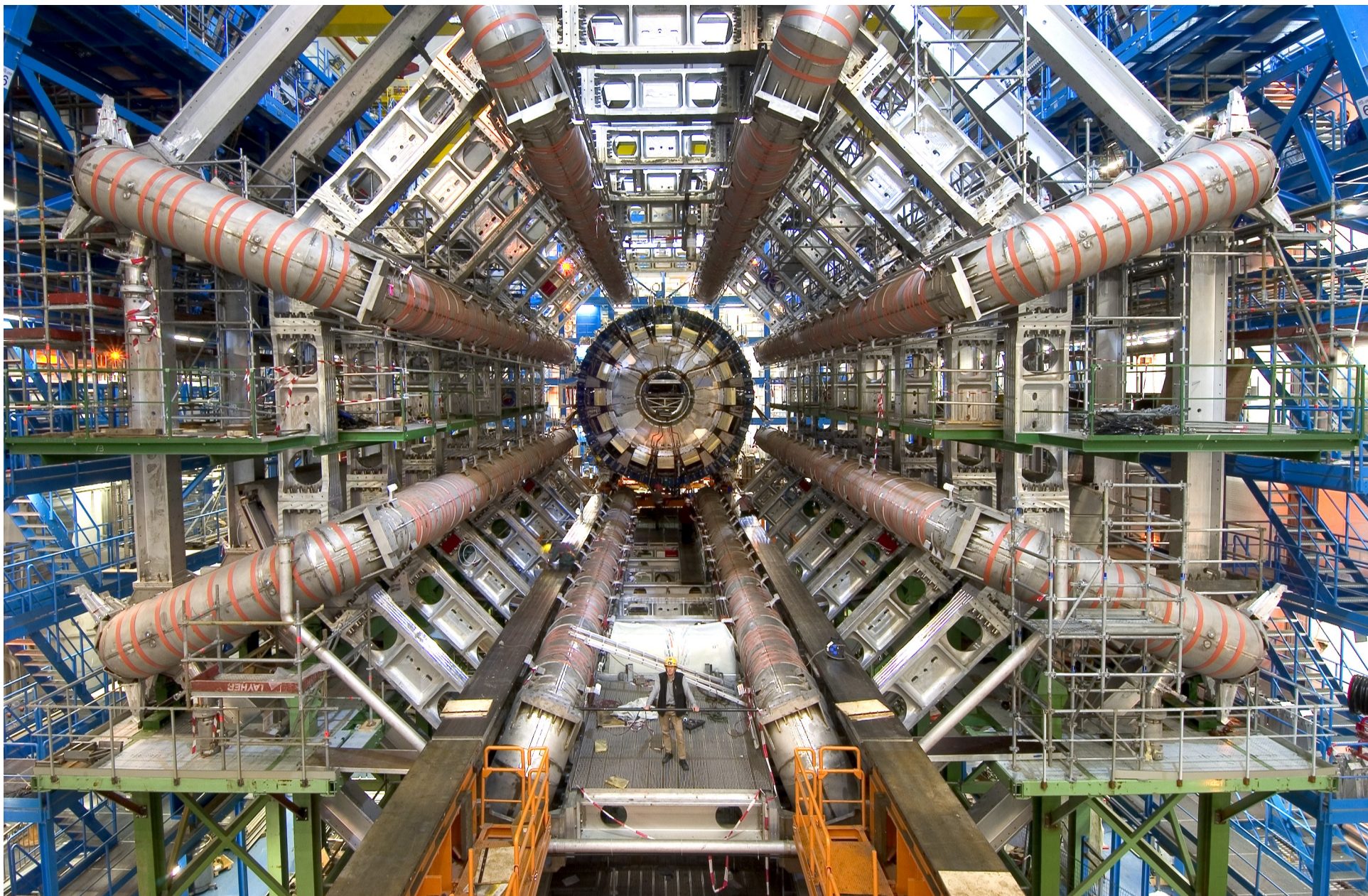
Large Hadron Collider



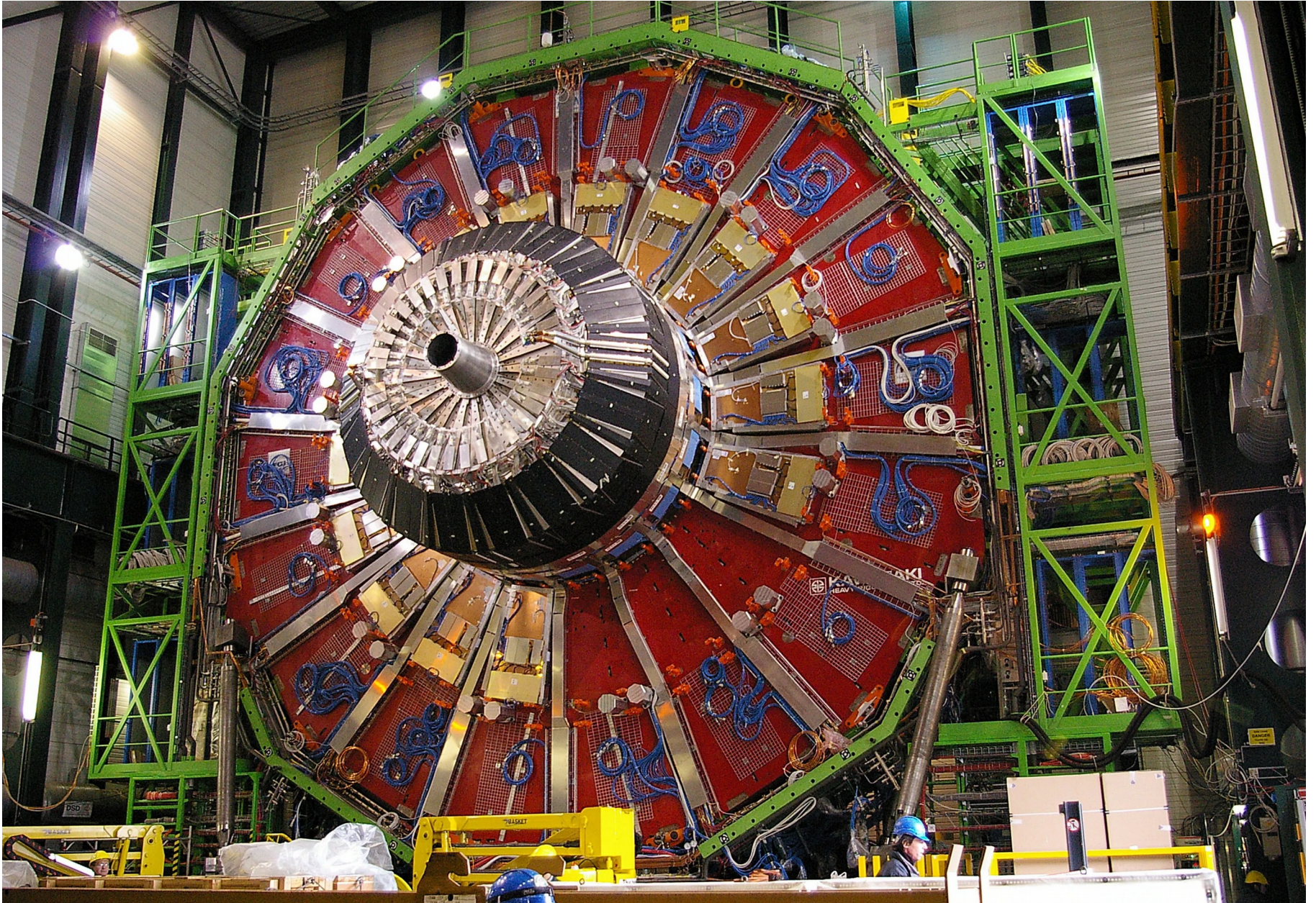
Large Hadron Collider



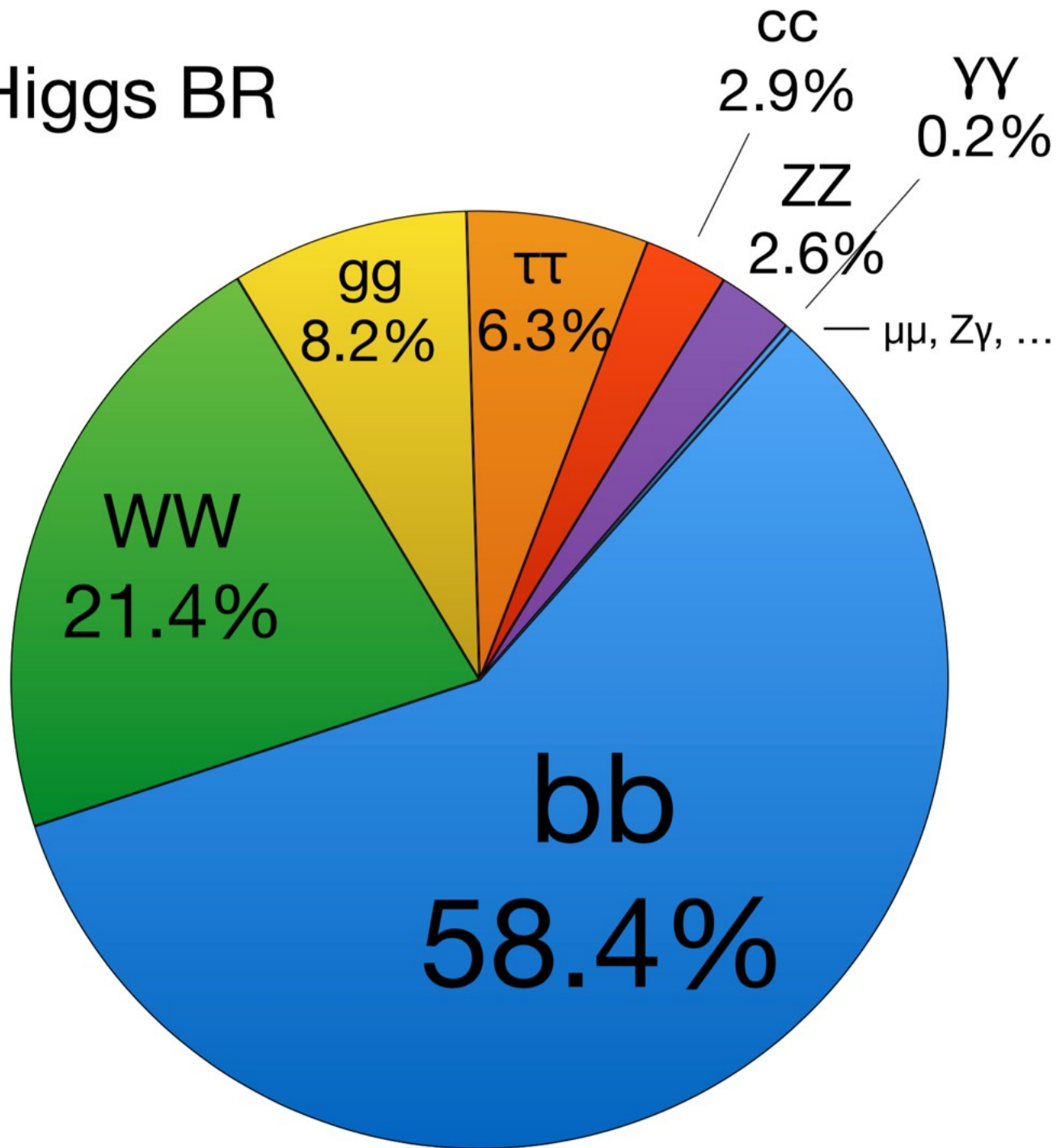
ATLAS Detector



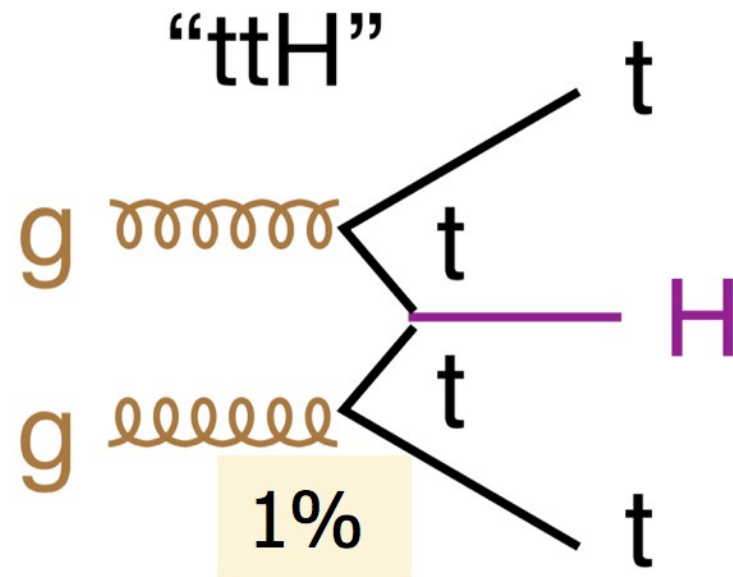
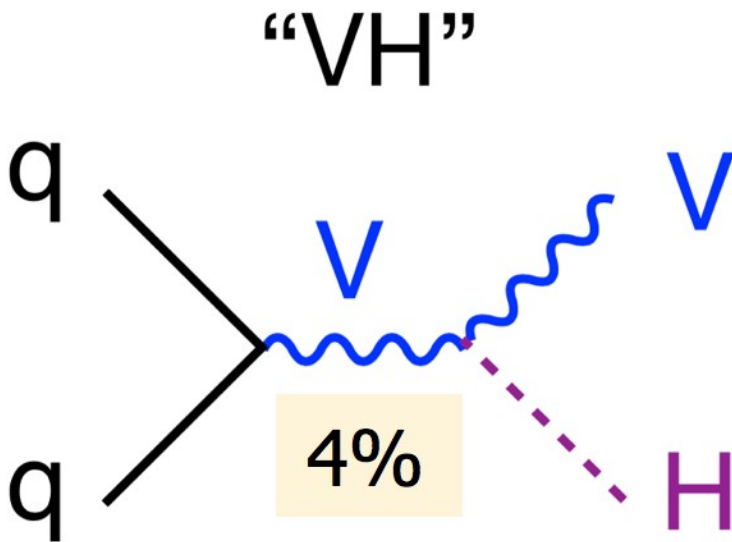
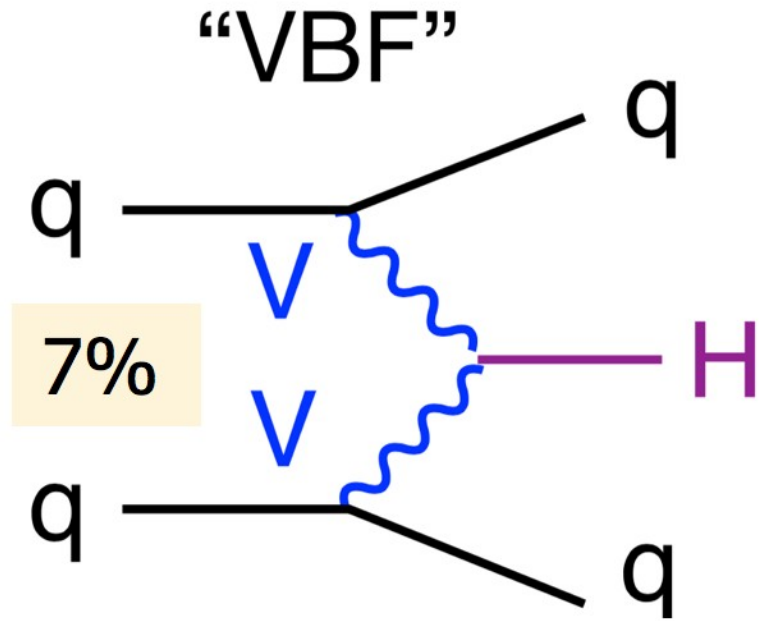
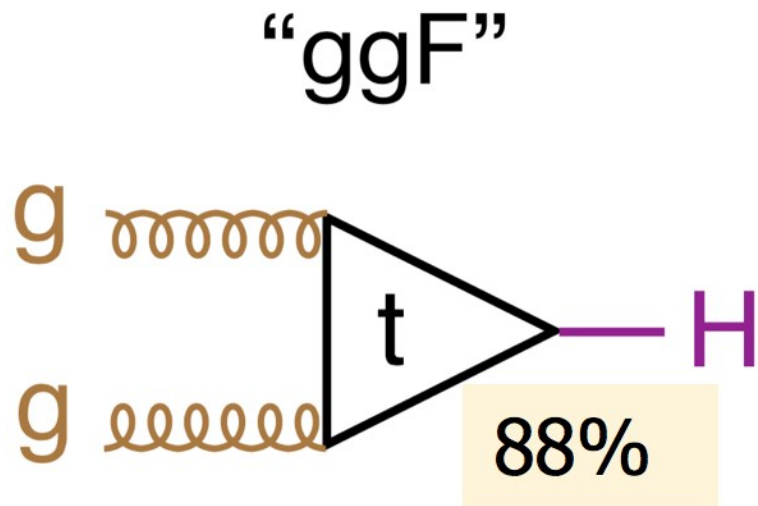
CMS Detector



Higgs BR



Higgs production at the LHC



CAUTION

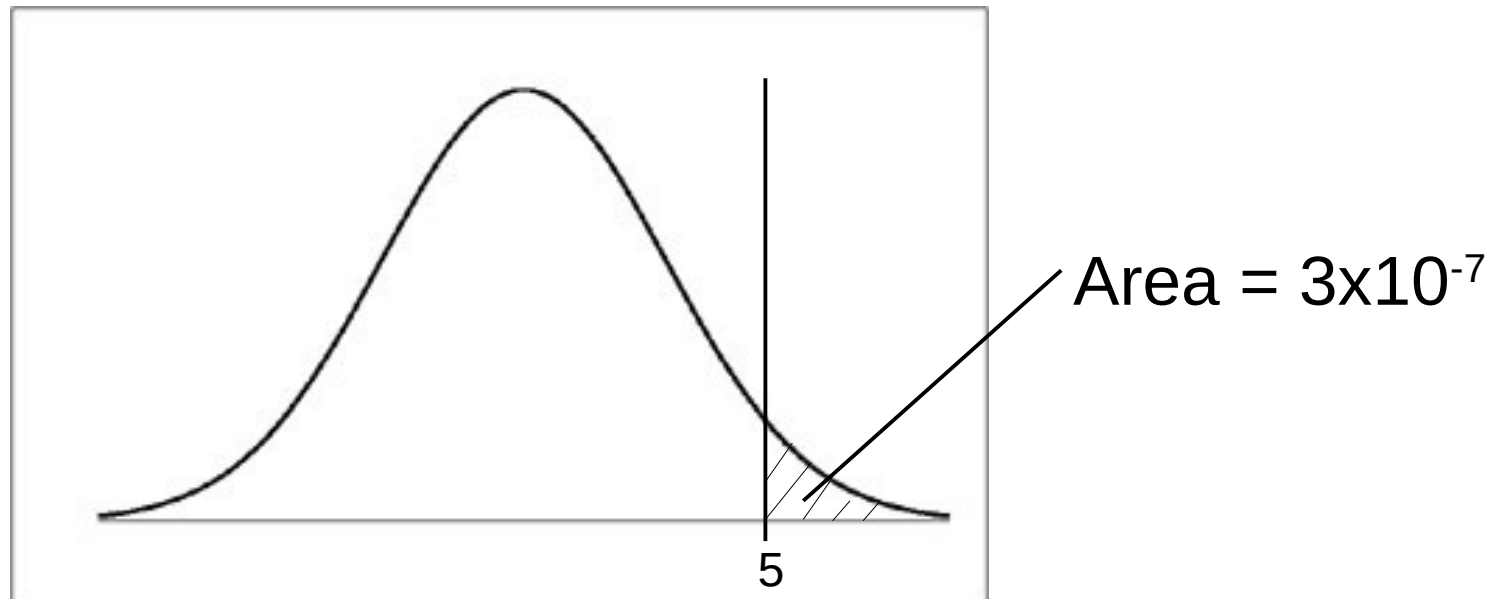
**TESTING
IN PROGRESS
DO NOT DISTURB**

LHC: 7.6 M Higgs bosons



Presentation of a probability

- With the use of the normal distribution, $\text{Gaus}(\mu=0, \sigma=1)$



Higgs to fermions

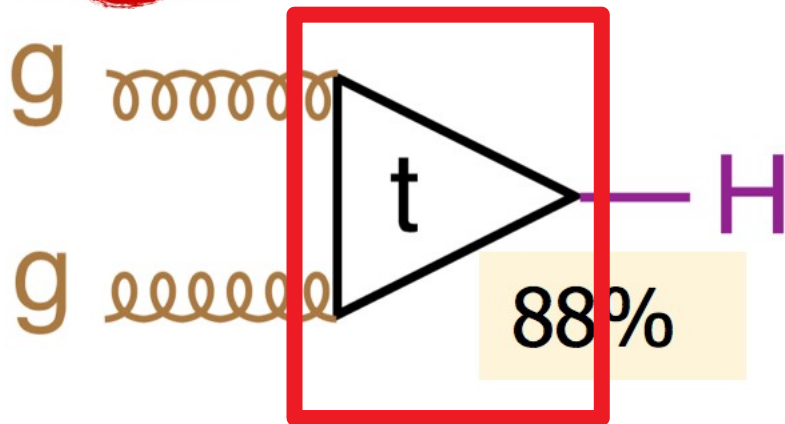
Hot News!

Higgs and top

- No decay $H \rightarrow t\bar{t}$!
- Must study production



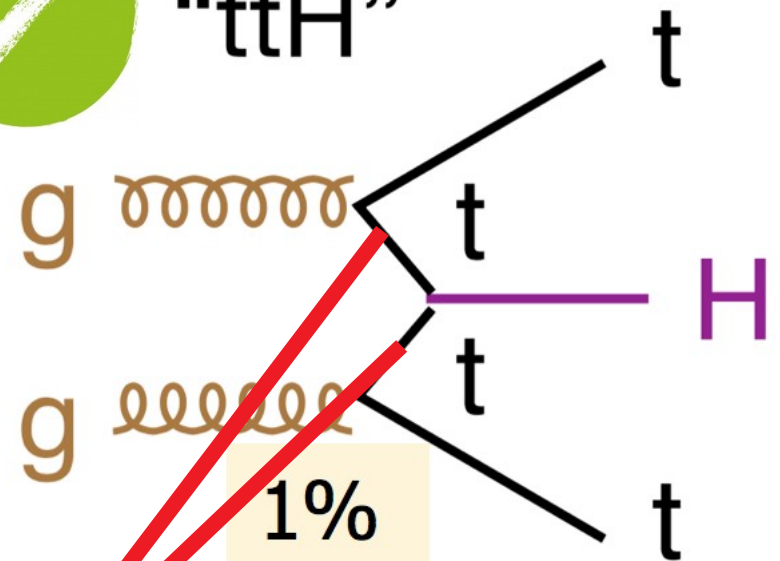
“ggF”



Here can be “anything”

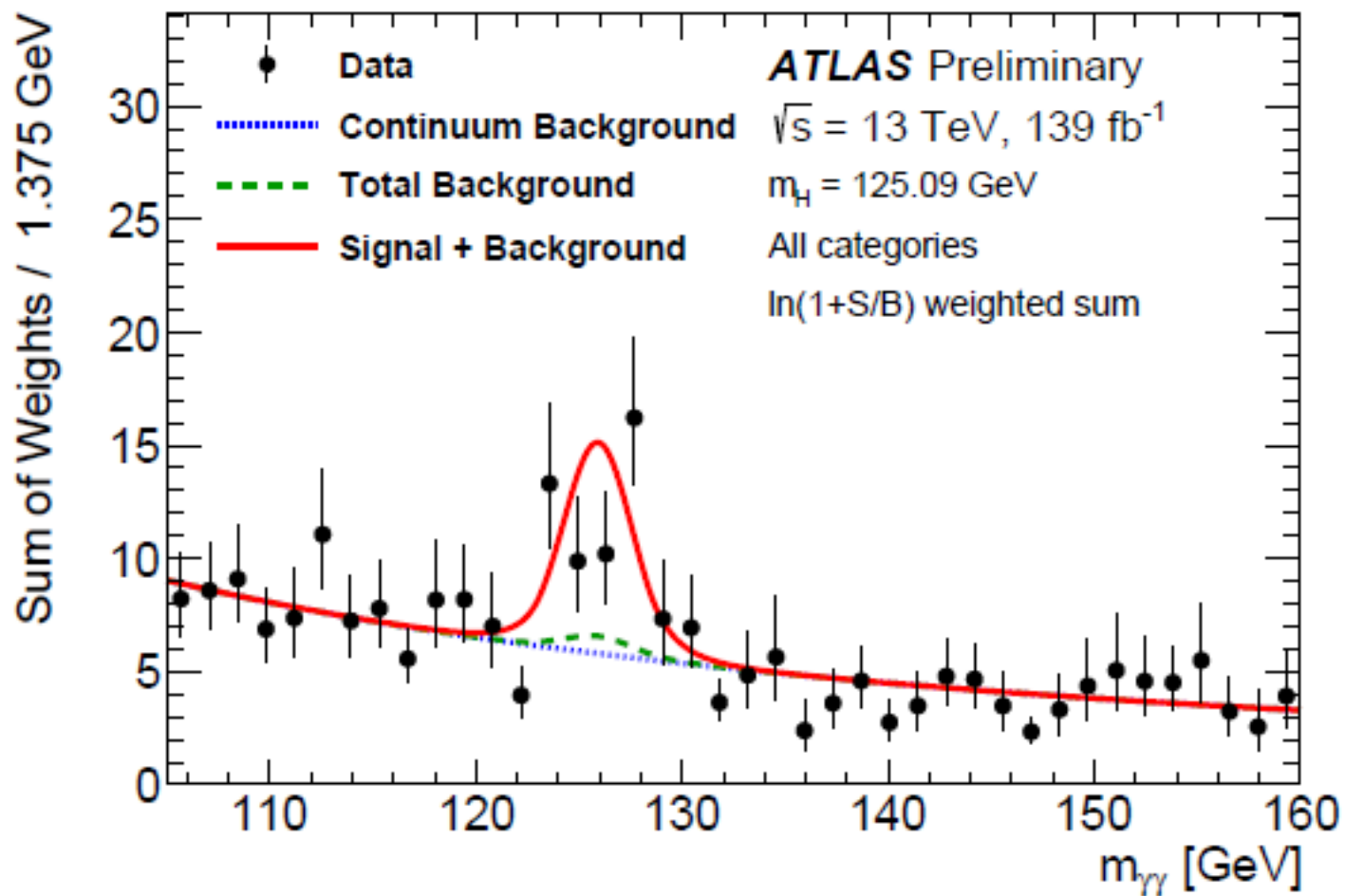


“ttH”



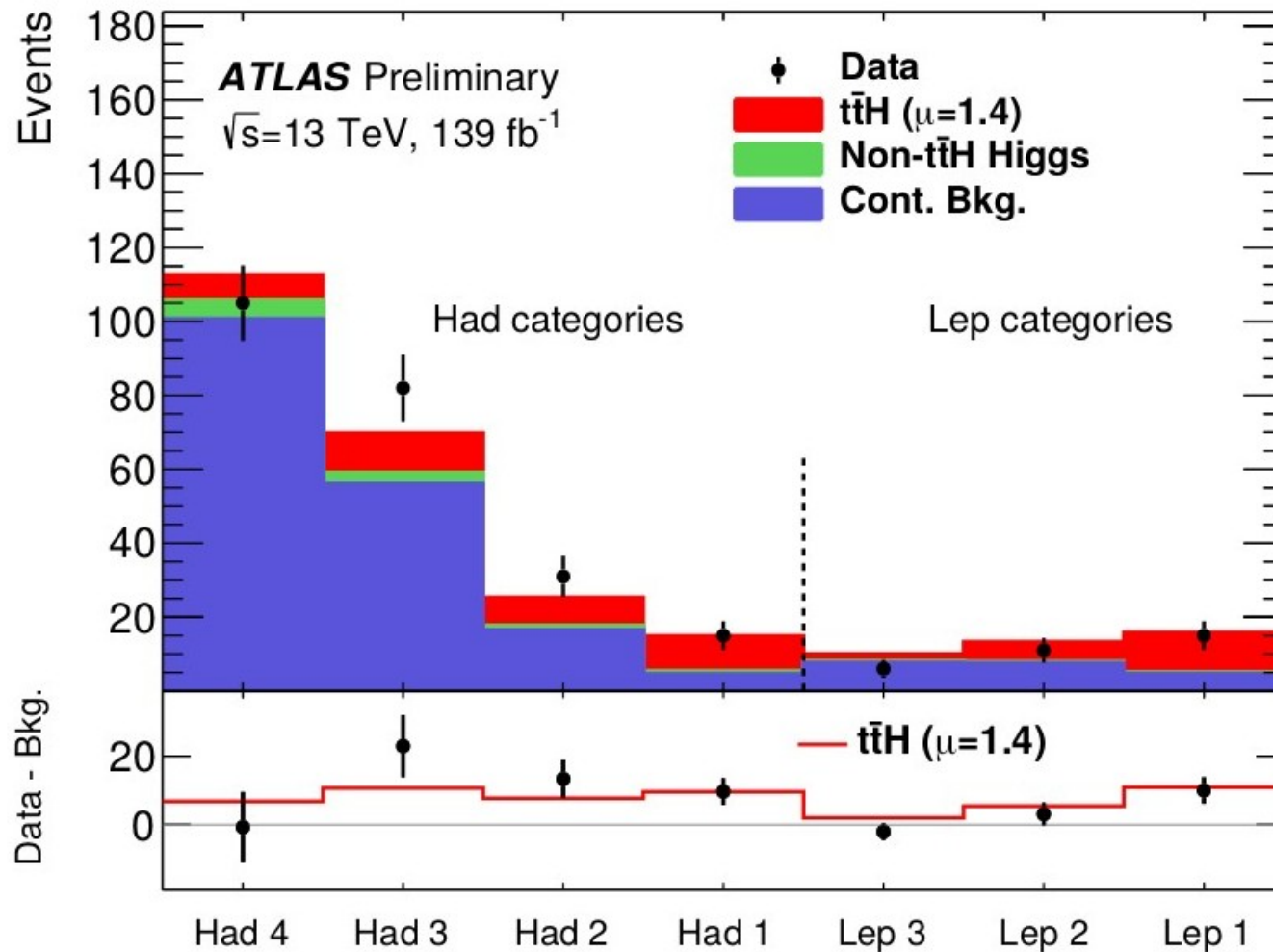
Here can be just top!
Events easy to tag

$ttH(\gamma\gamma)$

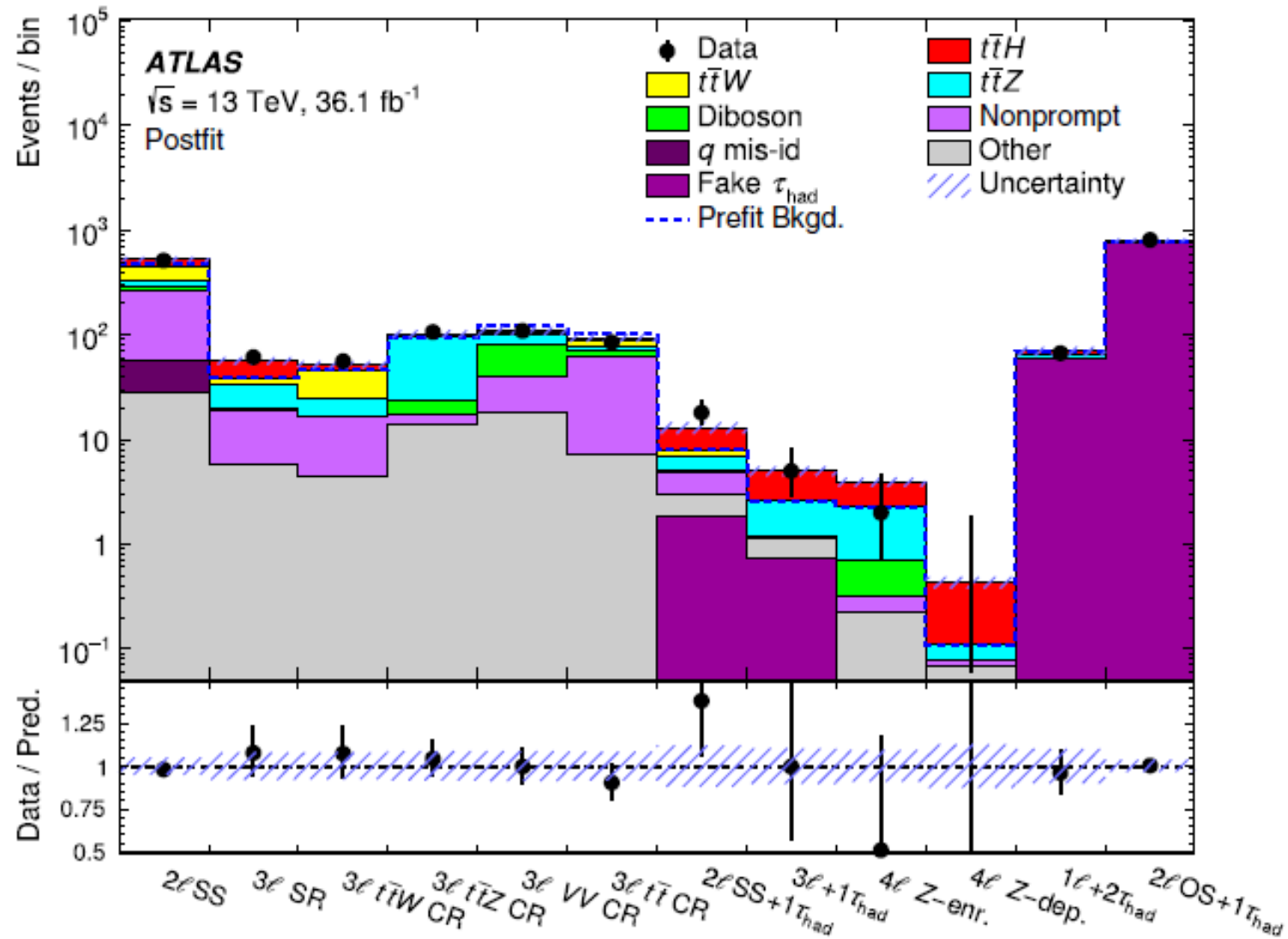


$t\bar{t}H(\gamma\gamma)$

Every category corresponds to an equivalent of
~one PhD thesis!!!



ttH multilepton



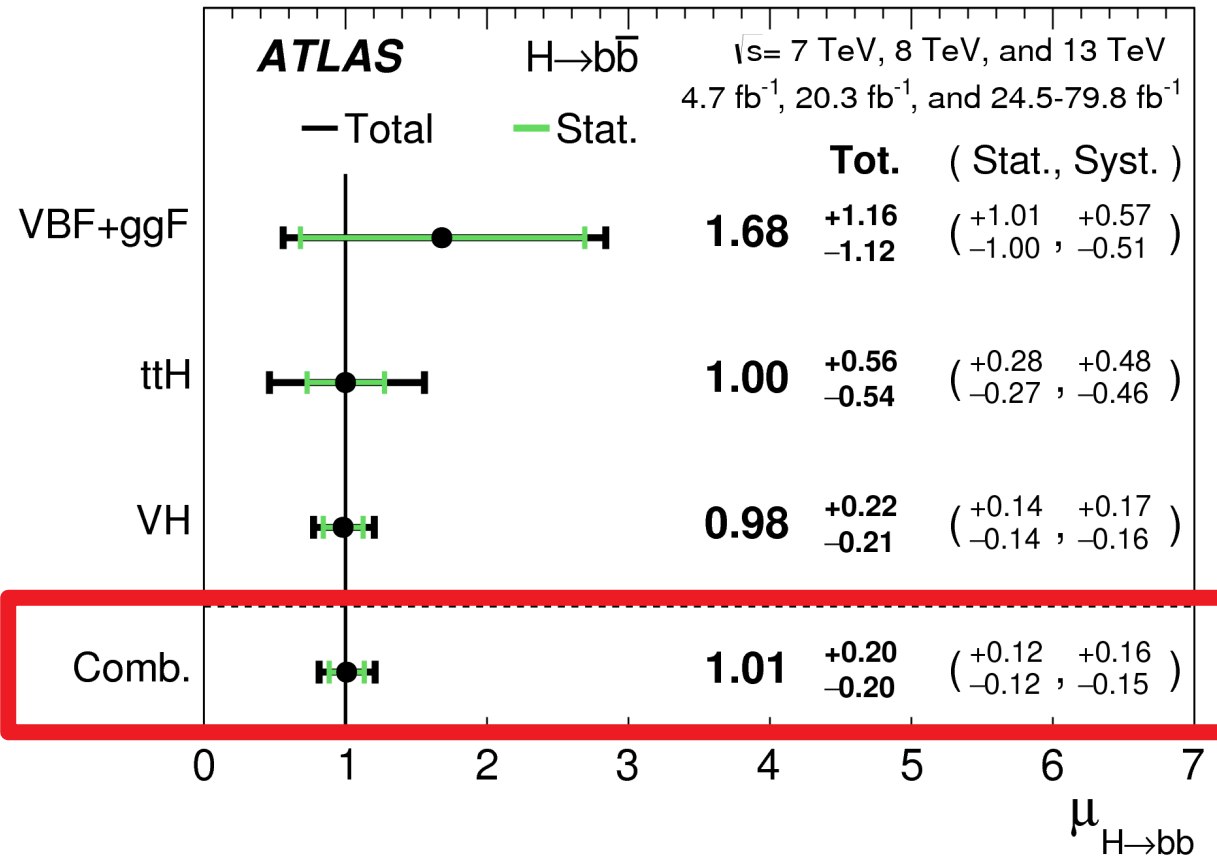
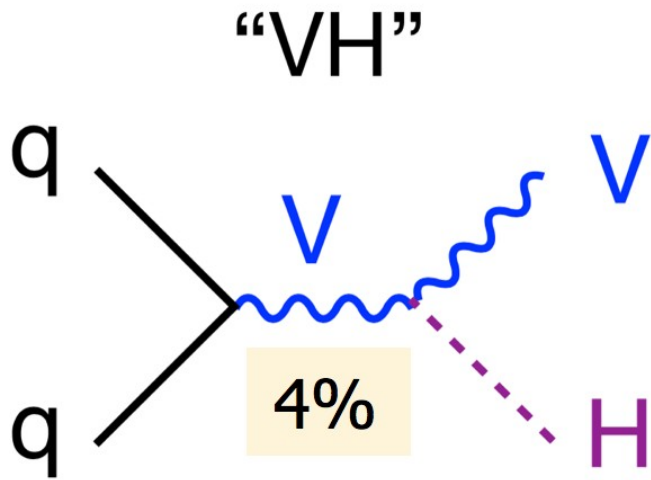
ttH summary

- $\gamma\gamma$ 4.9 σ
- multilepton 4.1 σ
- bb 1.4 σ
- **Combination** 6.3 σ

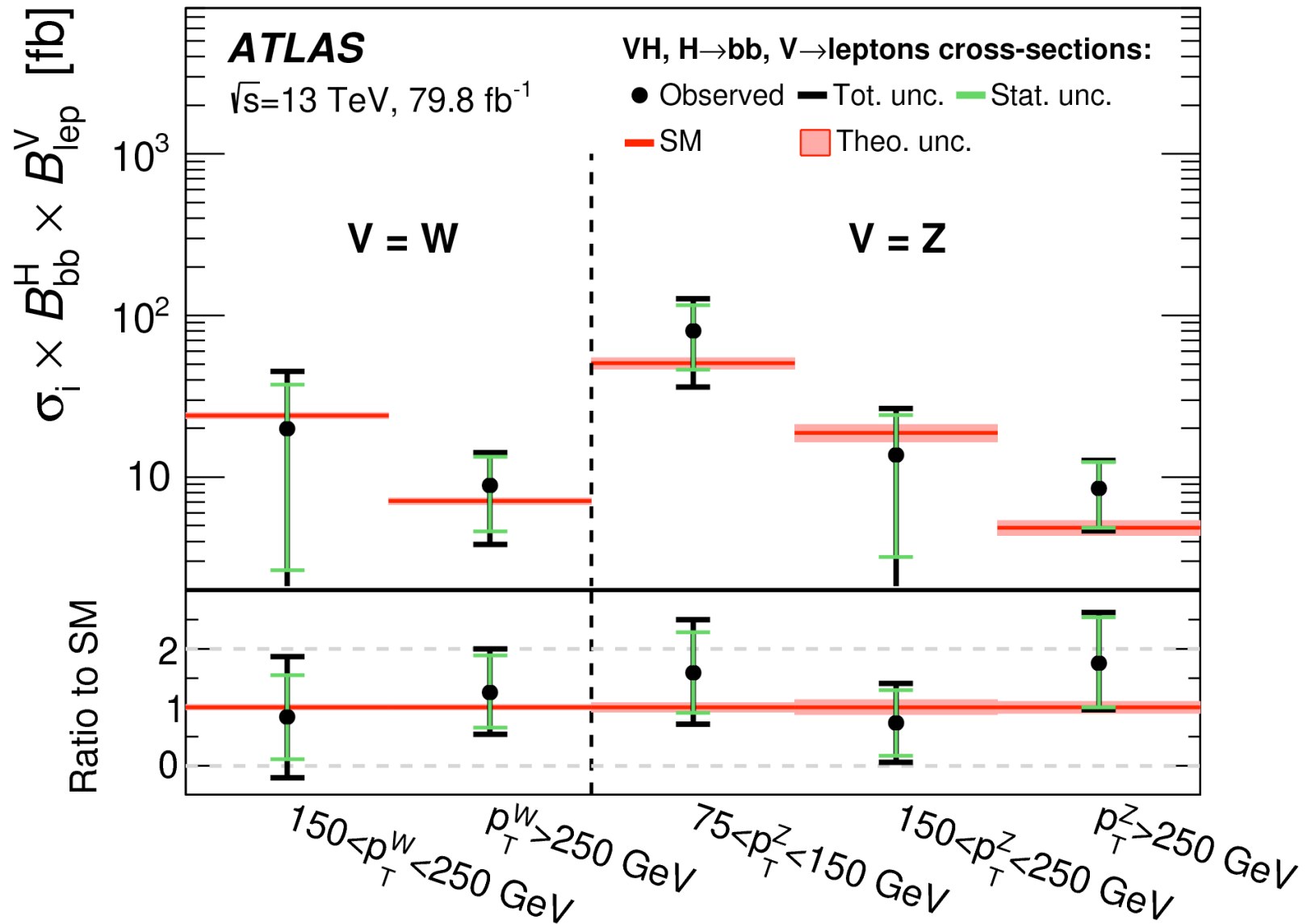


Tension-Type Headache

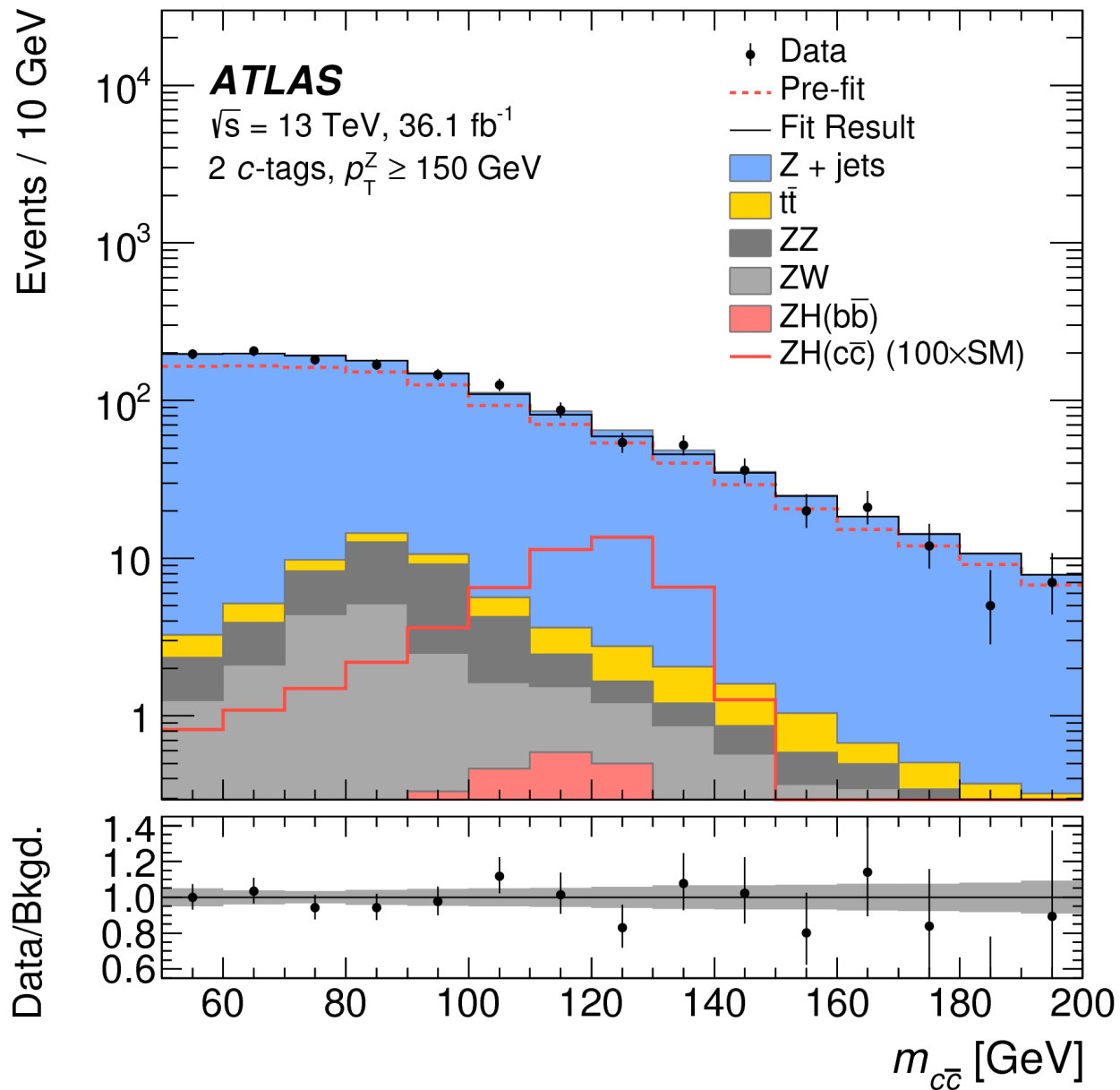
$$H \rightarrow b\bar{b}$$



H \rightarrow $b\bar{b}$, even differential!



$$H \rightarrow c\bar{c}$$



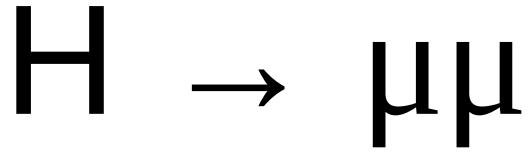
$$\sigma / \sigma_{\text{SM}} < 110$$

H \rightarrow $d\bar{d}$, $u\bar{u}$, $s\bar{s}$



$H \rightarrow \pi$

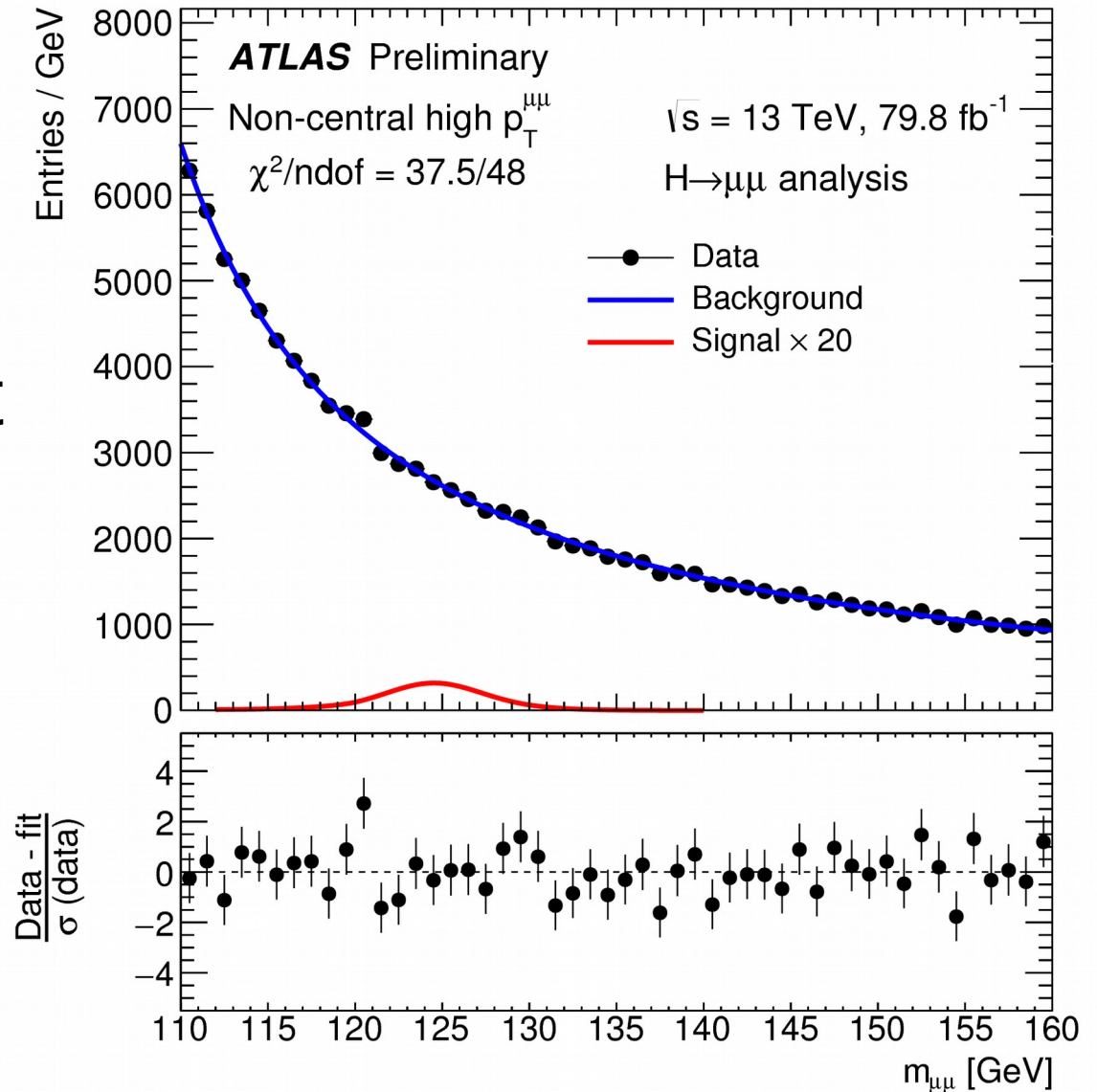




$$\sigma / \sigma_{\text{SM}} < 2.1$$

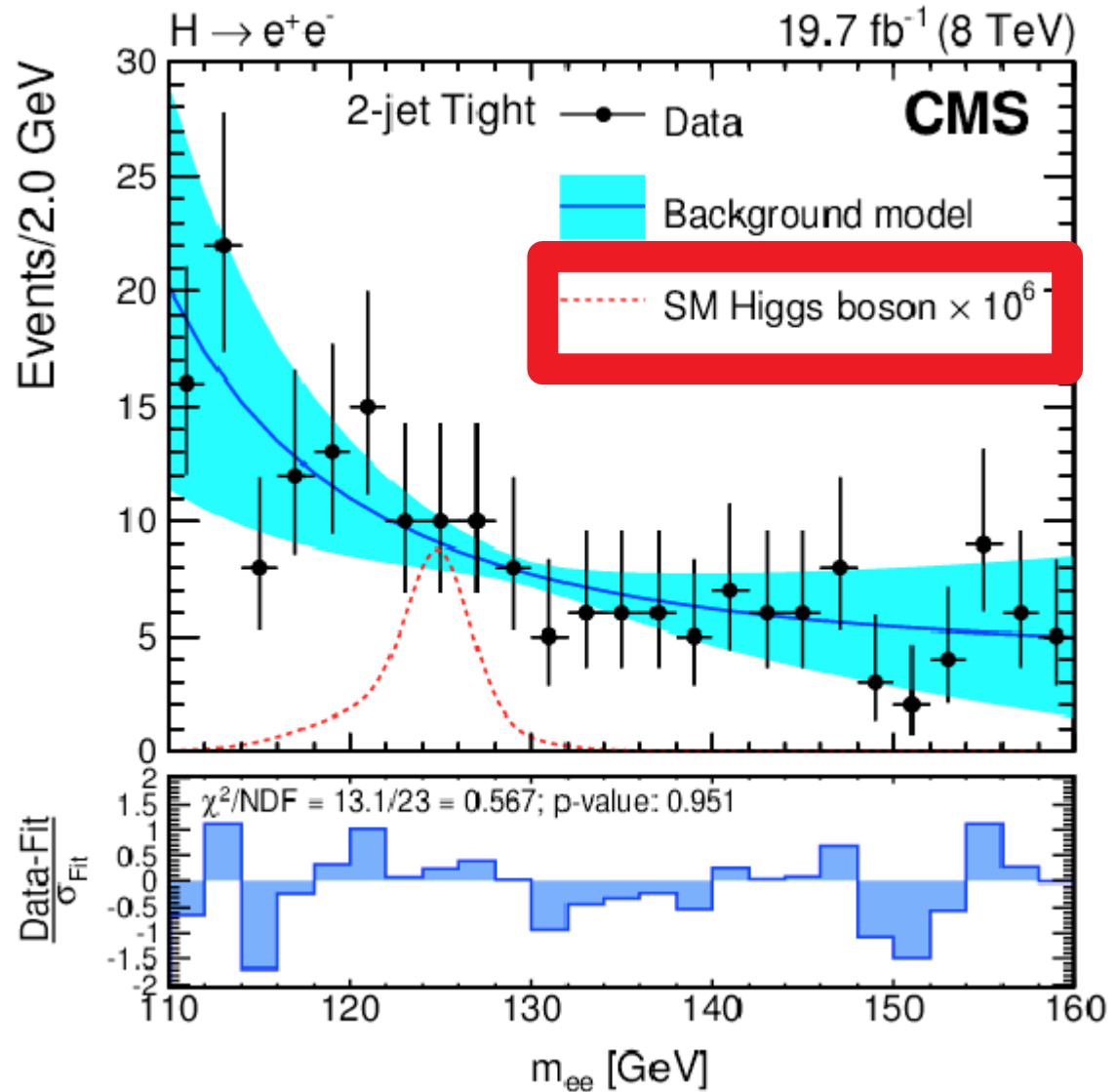
Incredible but almost there!

Evidence expected at HL LHC!



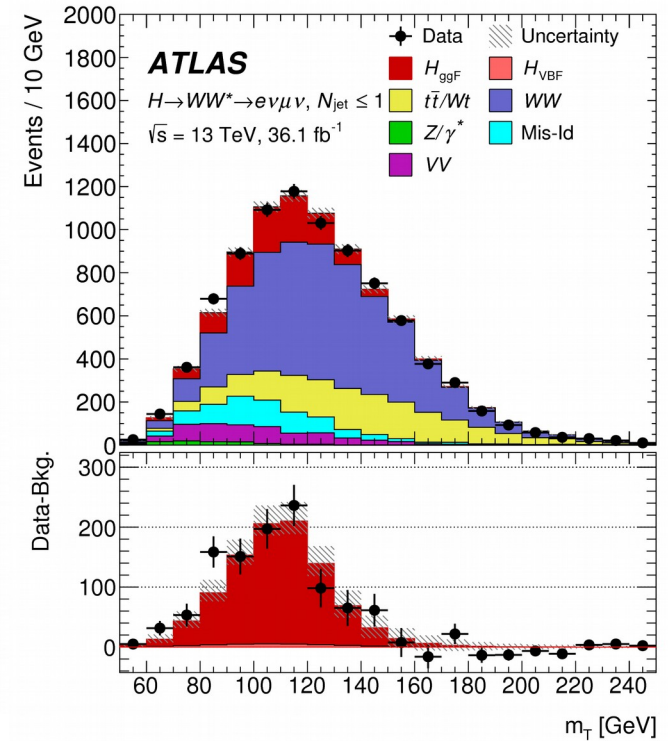
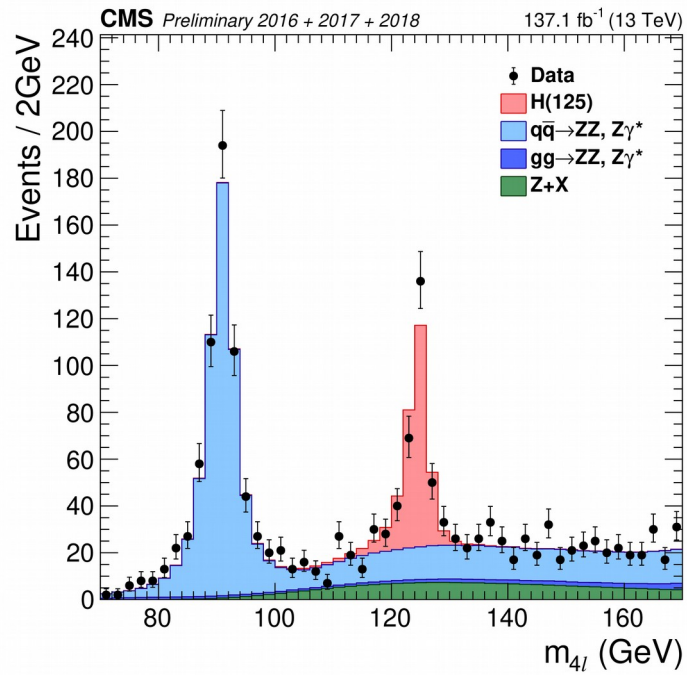
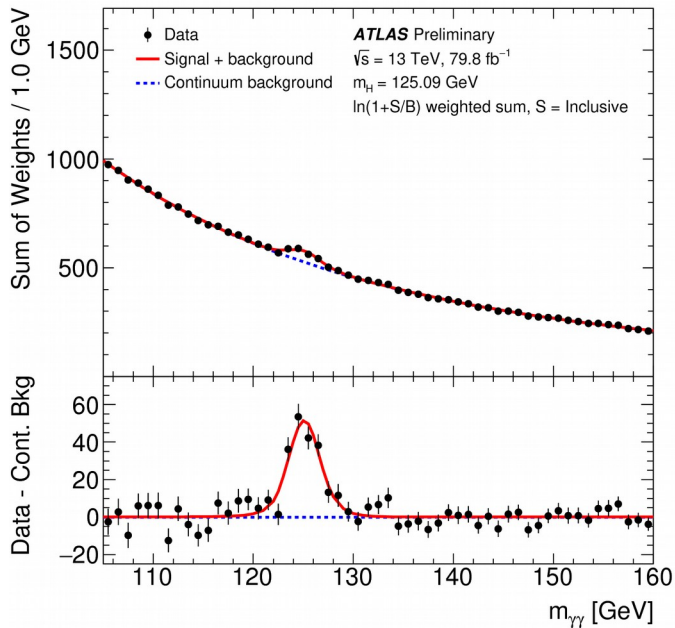
H \rightarrow ee

$$\sigma / \sigma_{SM} < 3.7 \times 10^5$$



Higgs to bosons

Run 2



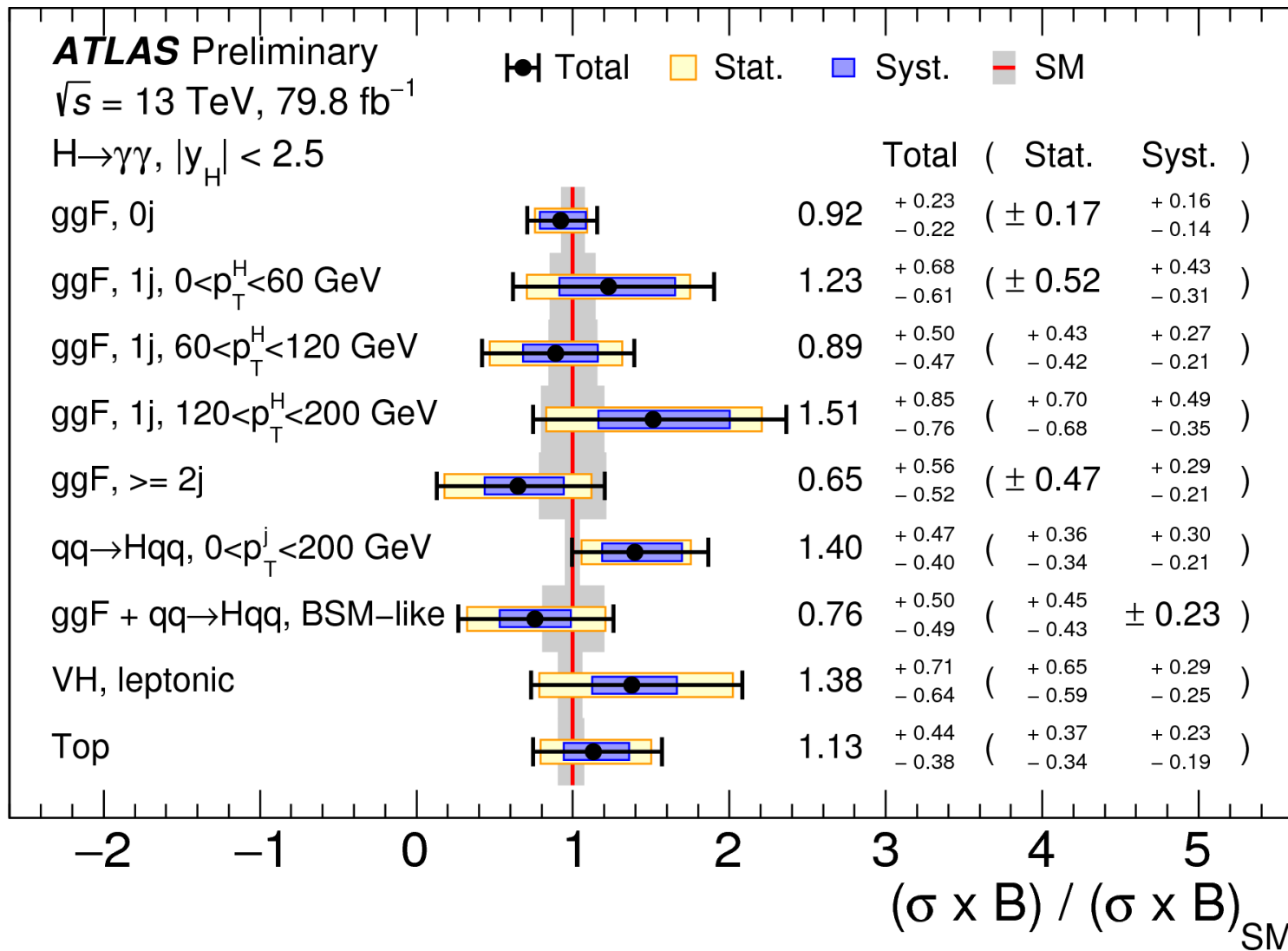
Wonderful peaks! Allow for advanced stuff

Higgs mass and width

($H \rightarrow 4l$)

- $m_H = 125.26 \pm 0.20$ (stat.) ± 0.08 (syst.) GeV
- $\Gamma_H < 9.16$ MeV at 95% CL
 - Comparison of on- and off-shell rates
 - Direct measurement: $\Gamma_H < 1.1$ GeV at 95% CL

Production modes, differential cross-sections



Searches with Higgs

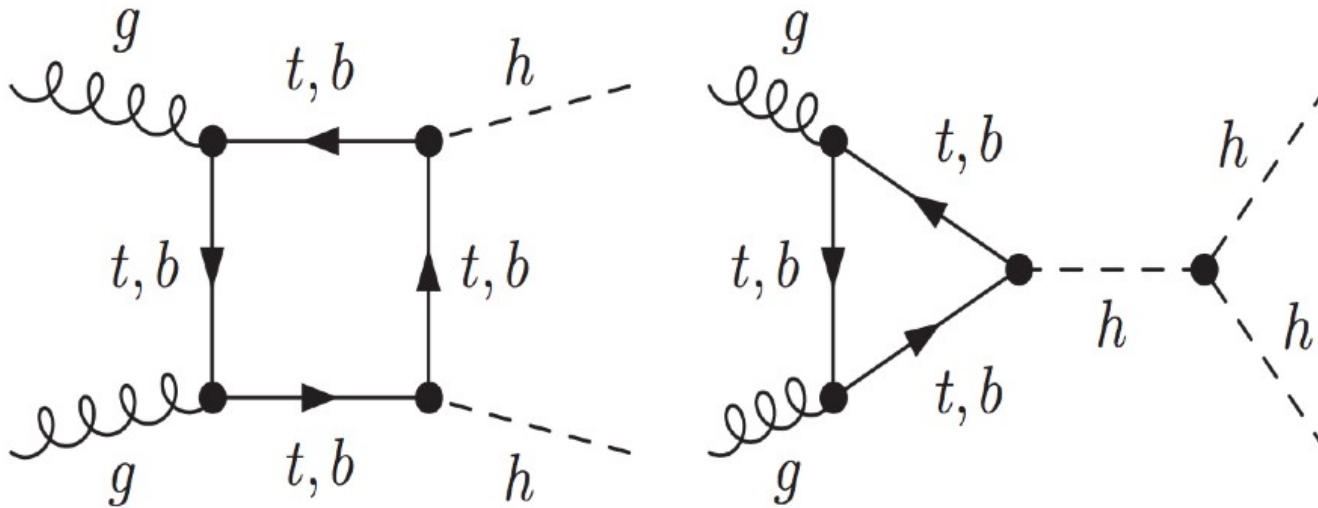


- Anomalous couplings
- $H \rightarrow$ invisible
- $H \rightarrow$ light bosons
- CP-odd Higgs, charged Higgses
- Resonances decaying to HH
- LFV decays
- Mono-Higgs search

Higgs self-coupling



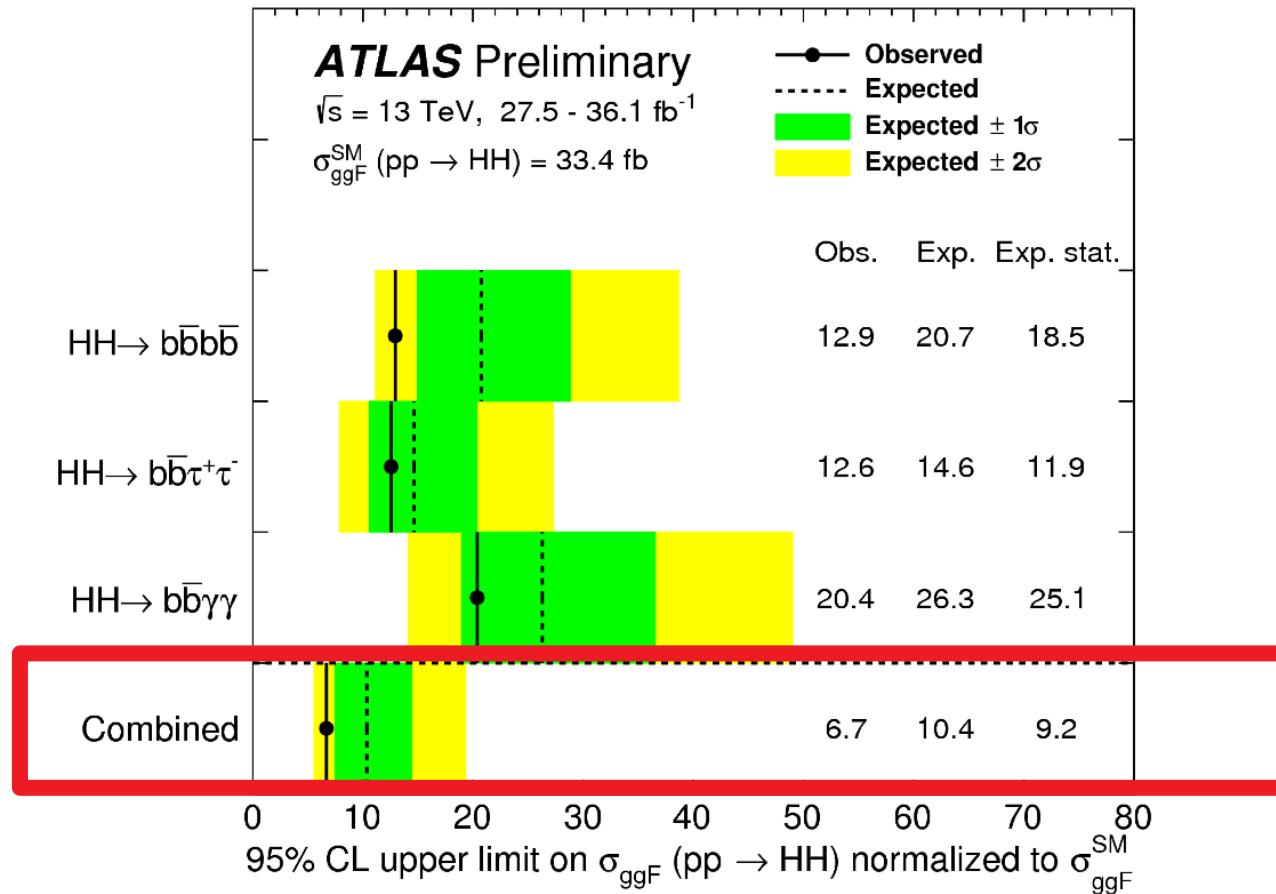
Higgs self-coupling



Destructive interference

=> very low cross-section: $\sigma = 33 \text{ fb}$

Higgs self-coupling



Expecting 3σ at HL LHC

HUH?

WHO?

HIGGS?

HIGGS BOSON

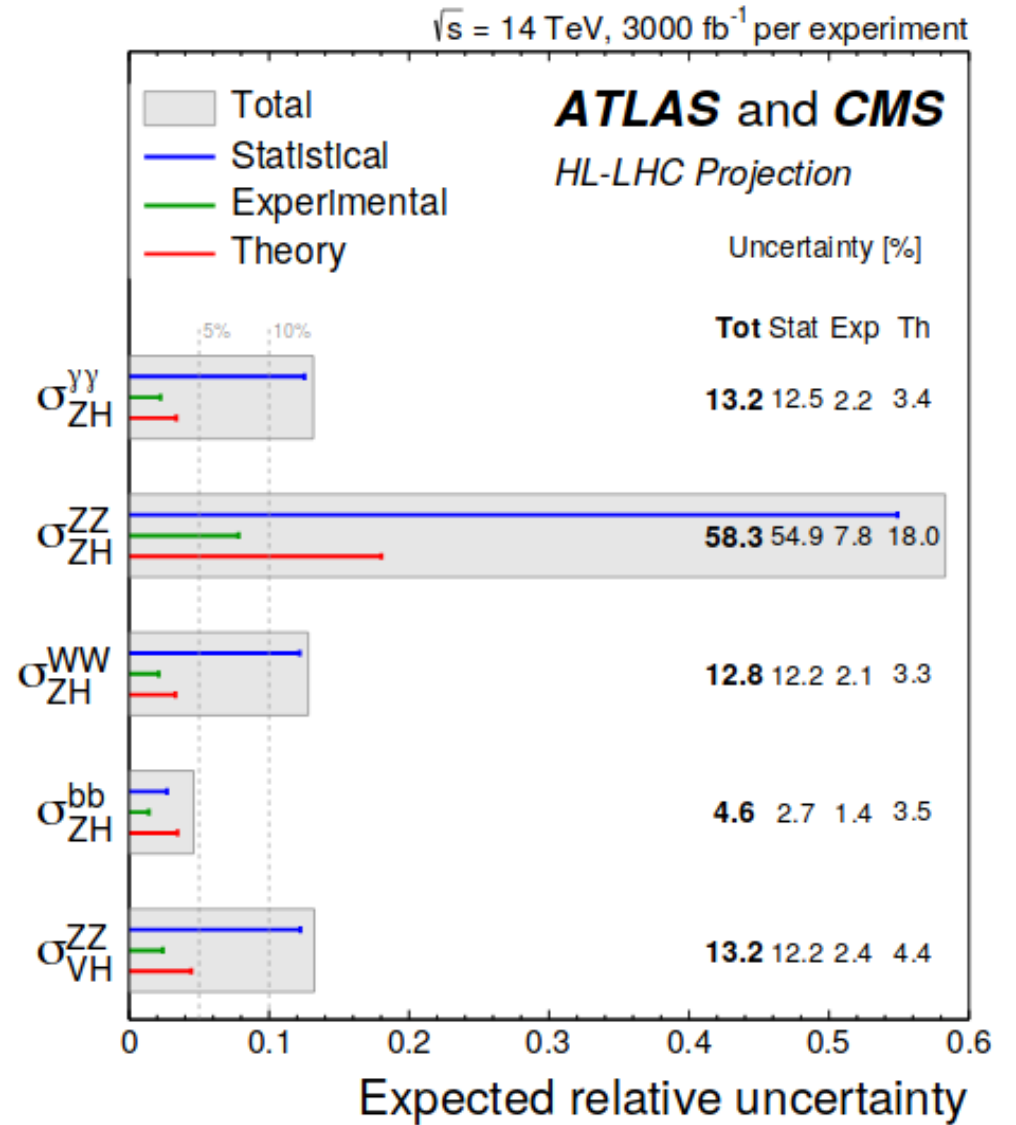
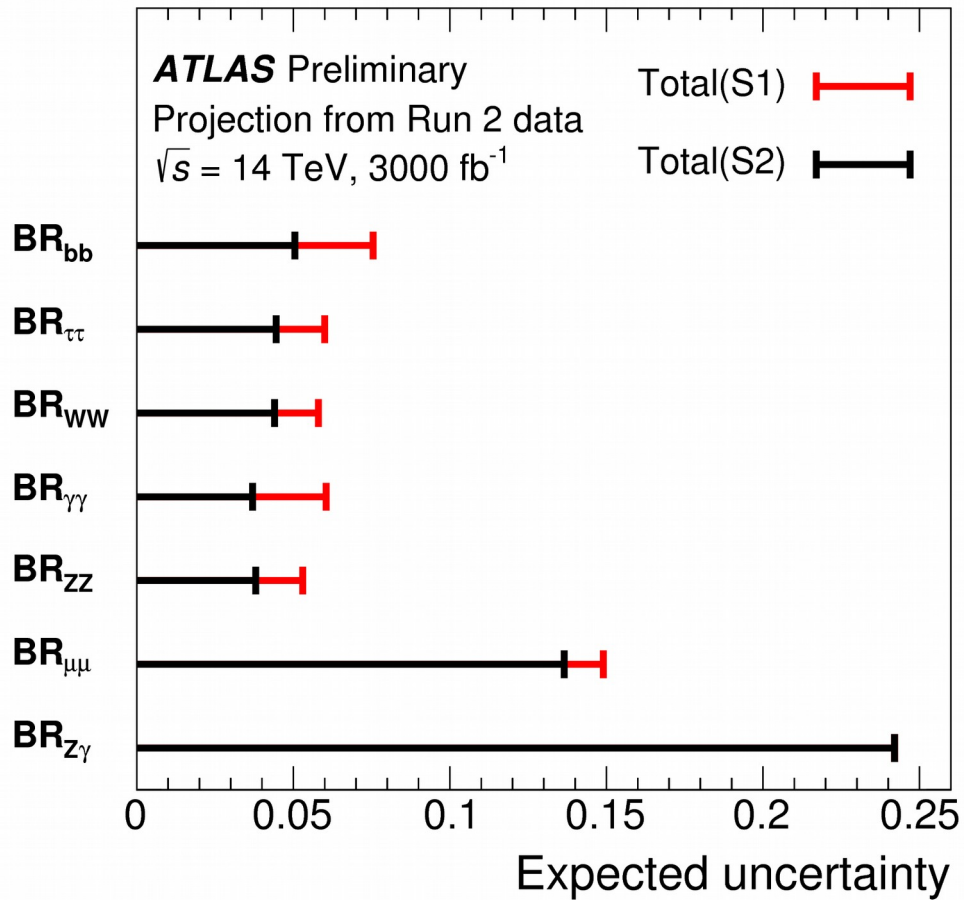
WHAT?

BOSON?

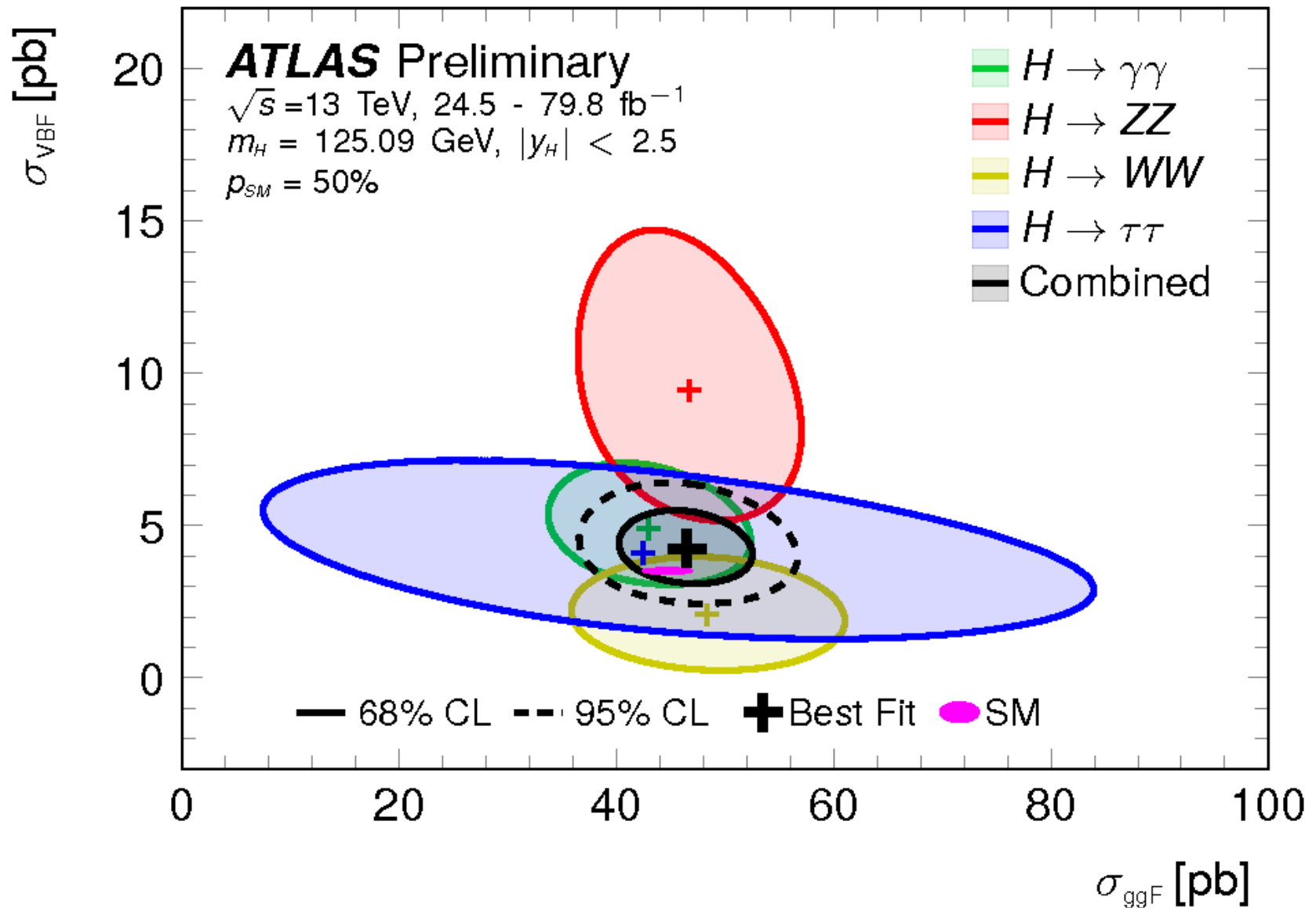
WHY?

BACKUP

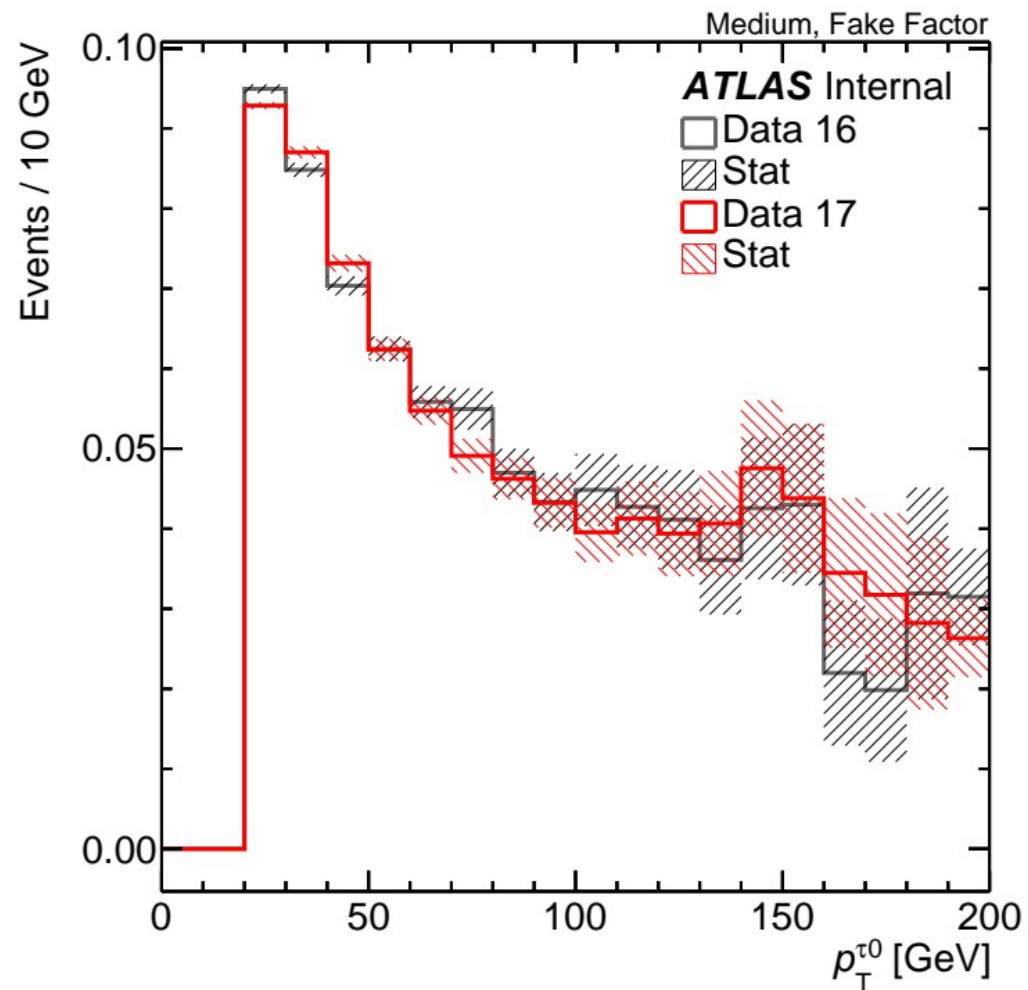
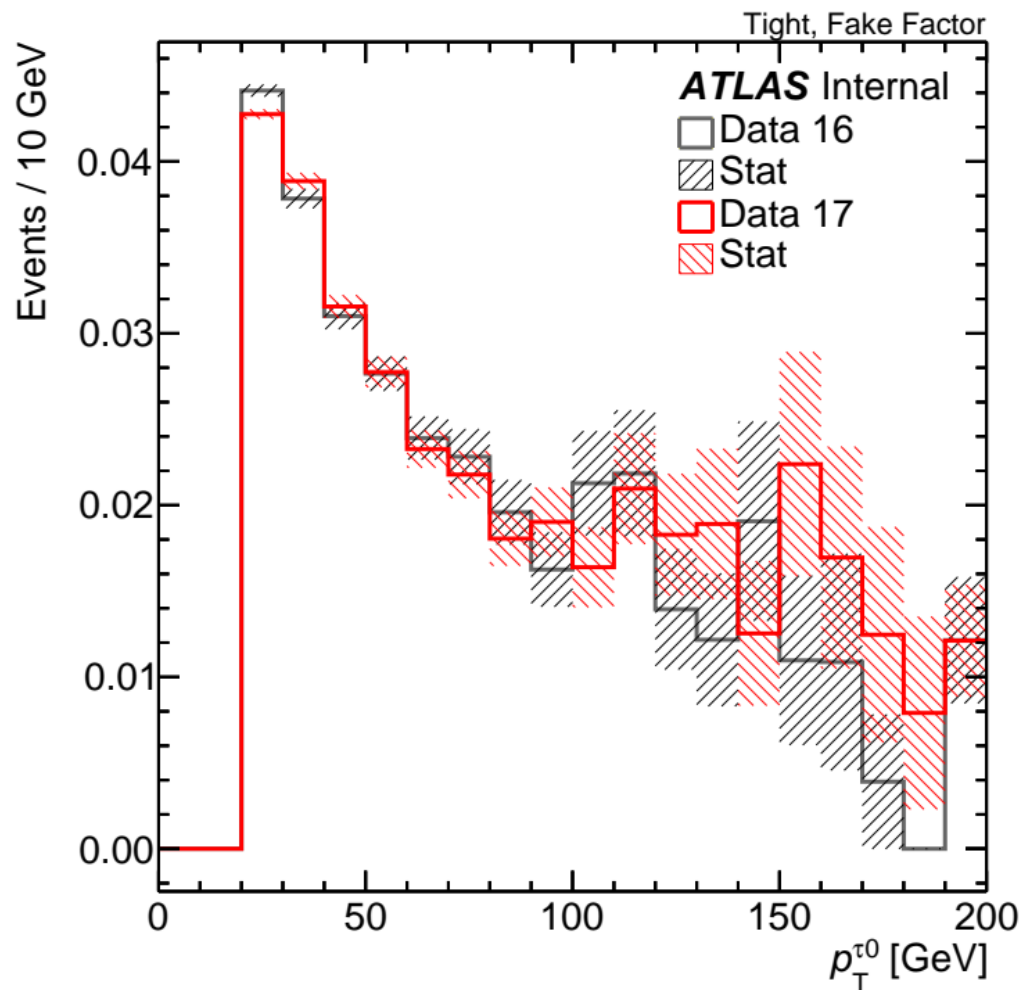
Outlook



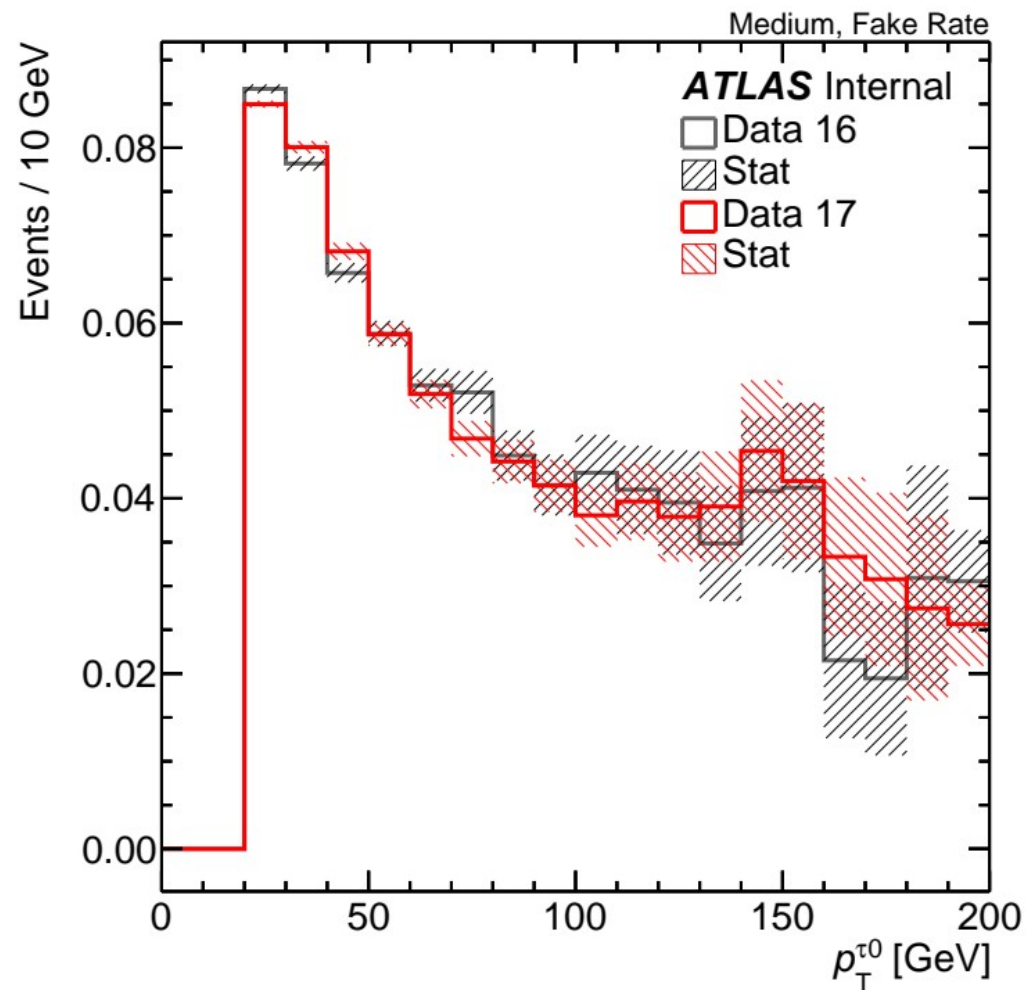
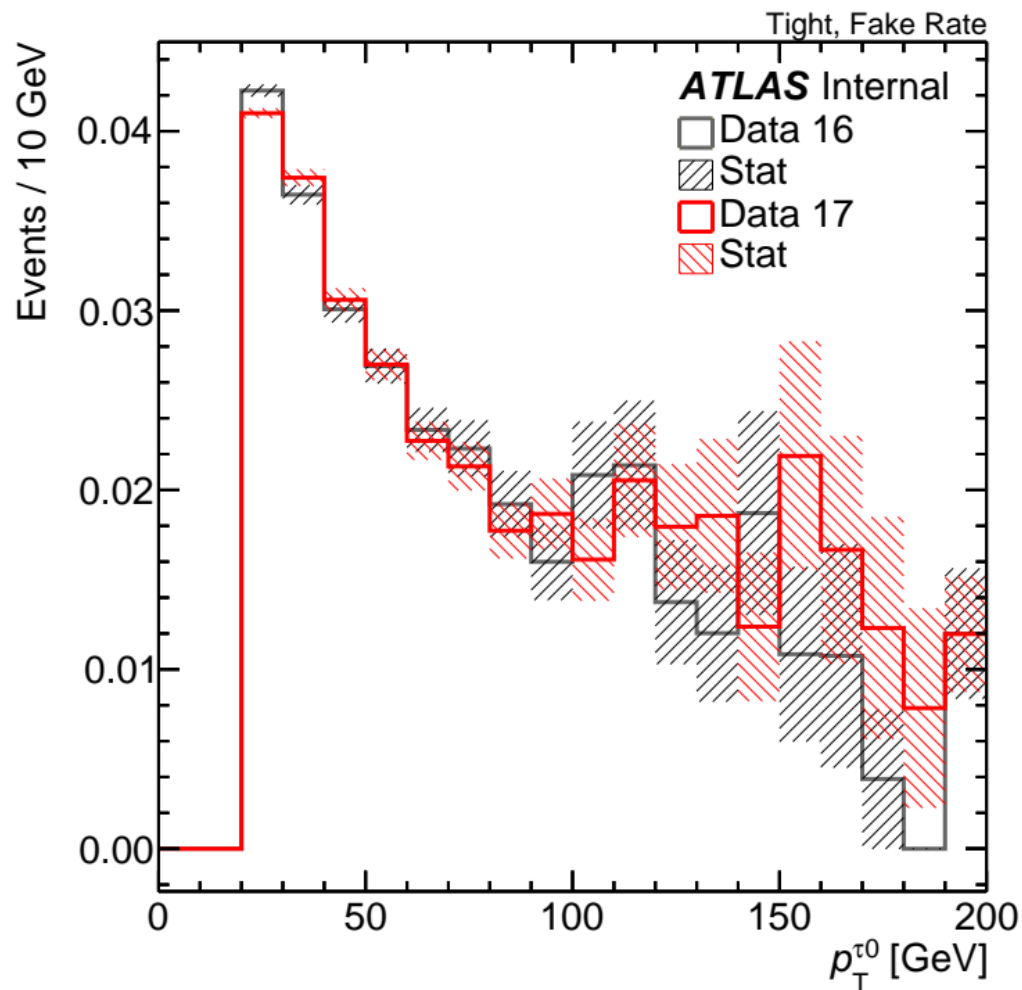
Production: compatibility with SM



Fake tau background



Fake tau background



Fake tau background

