Standard Model and Higgs boson physics with the ATLAS experiment at the Large Hadron Collider

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on behalf of ATLAS Canada

Carleton UNIVERSITY

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Outline

- The Large Hadron Collider (LHC) and the ATLAS Detector
- The Standard Model and the W Boson Mass
- Higgs Boson Production at the LHC and Higgs Boson Mass
- $H \rightarrow \gamma\gamma$
- $H \rightarrow ZZ^* \rightarrow 4\,\ell$
- $H \rightarrow WW^* \rightarrow \ell\nu\,\ell\nu$
- $H \rightarrow \mu\,\mu$

Fiducial and Differential Cross Sections

Event Categories

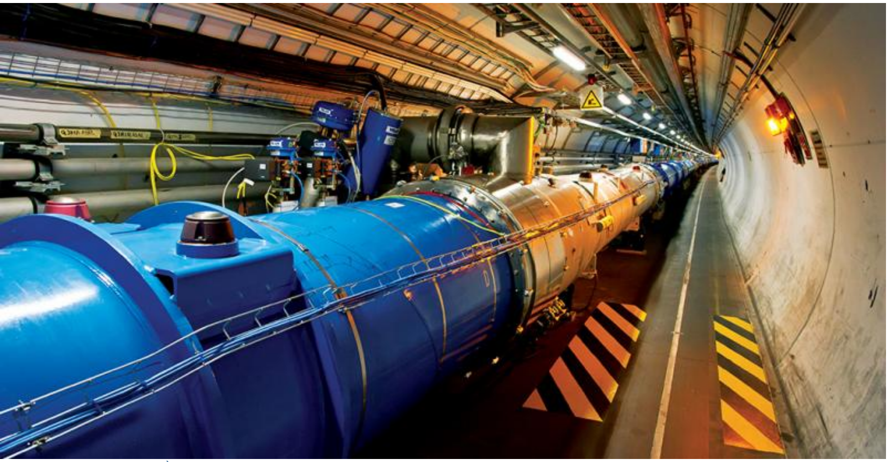
Total Production Cross Section & Signal Strength

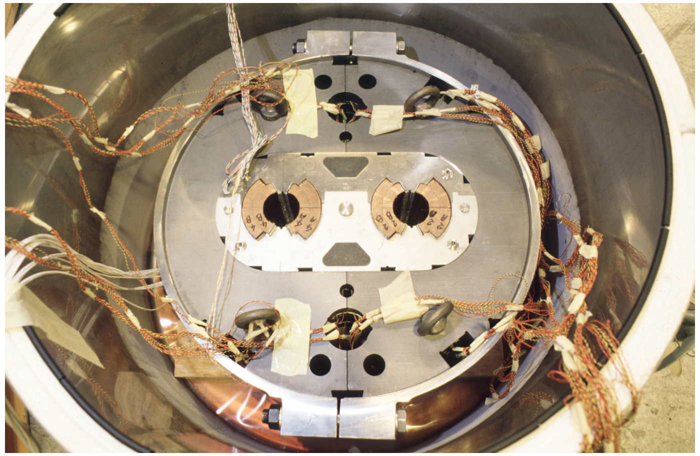
- Summary

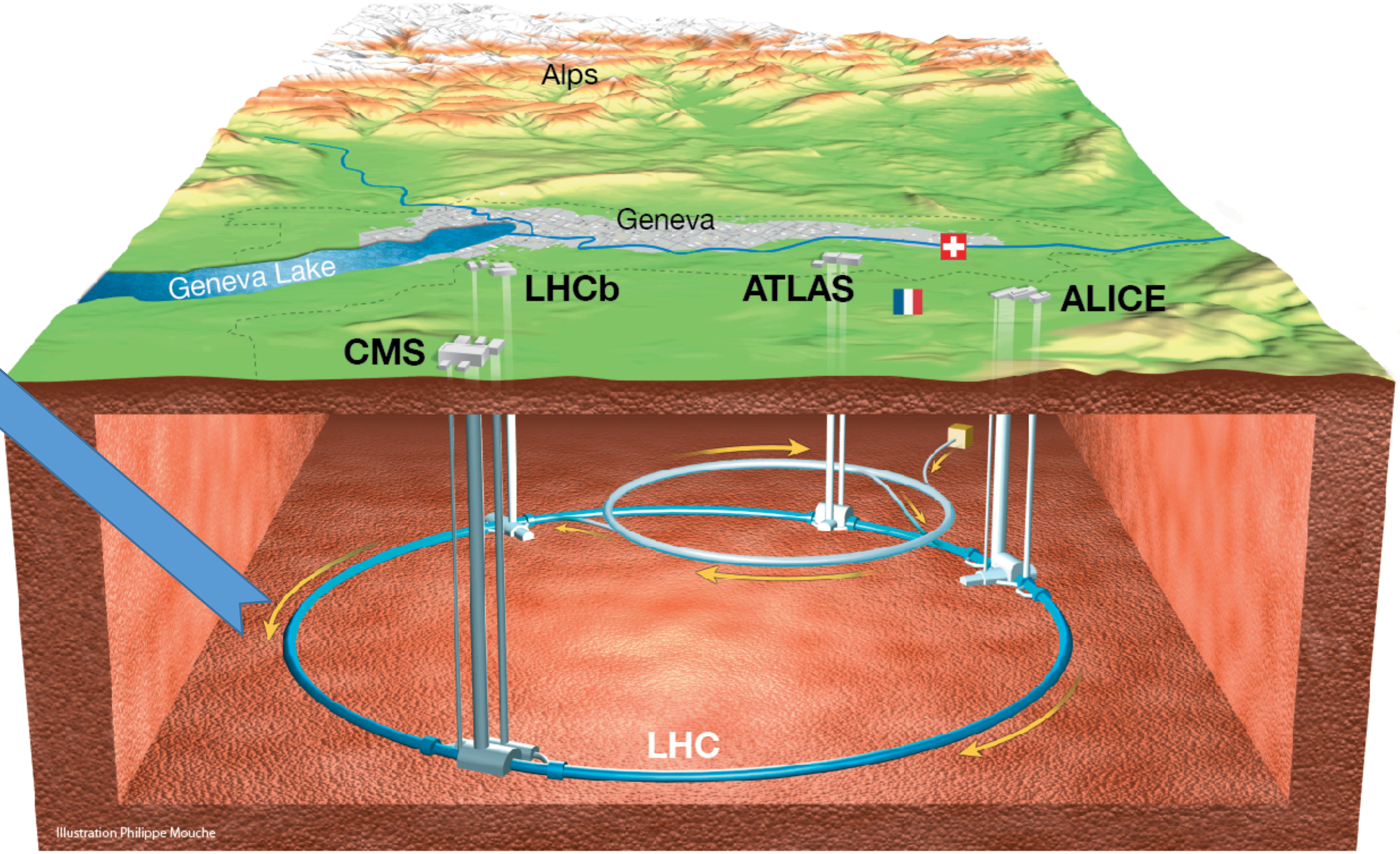
LHC and ATLAS

The Large Hadron Collider (LHC) at CERN

The **LHC** is the world's largest and most powerful particle accelerator. The LHC consists of a **27-kilometer** ring of superconducting **magnets** with a number of accelerating structures to boost the energy of the particles along the way. It collides protons at a center-of-mass energy of **13 TeV** (designed for 14 TeV).





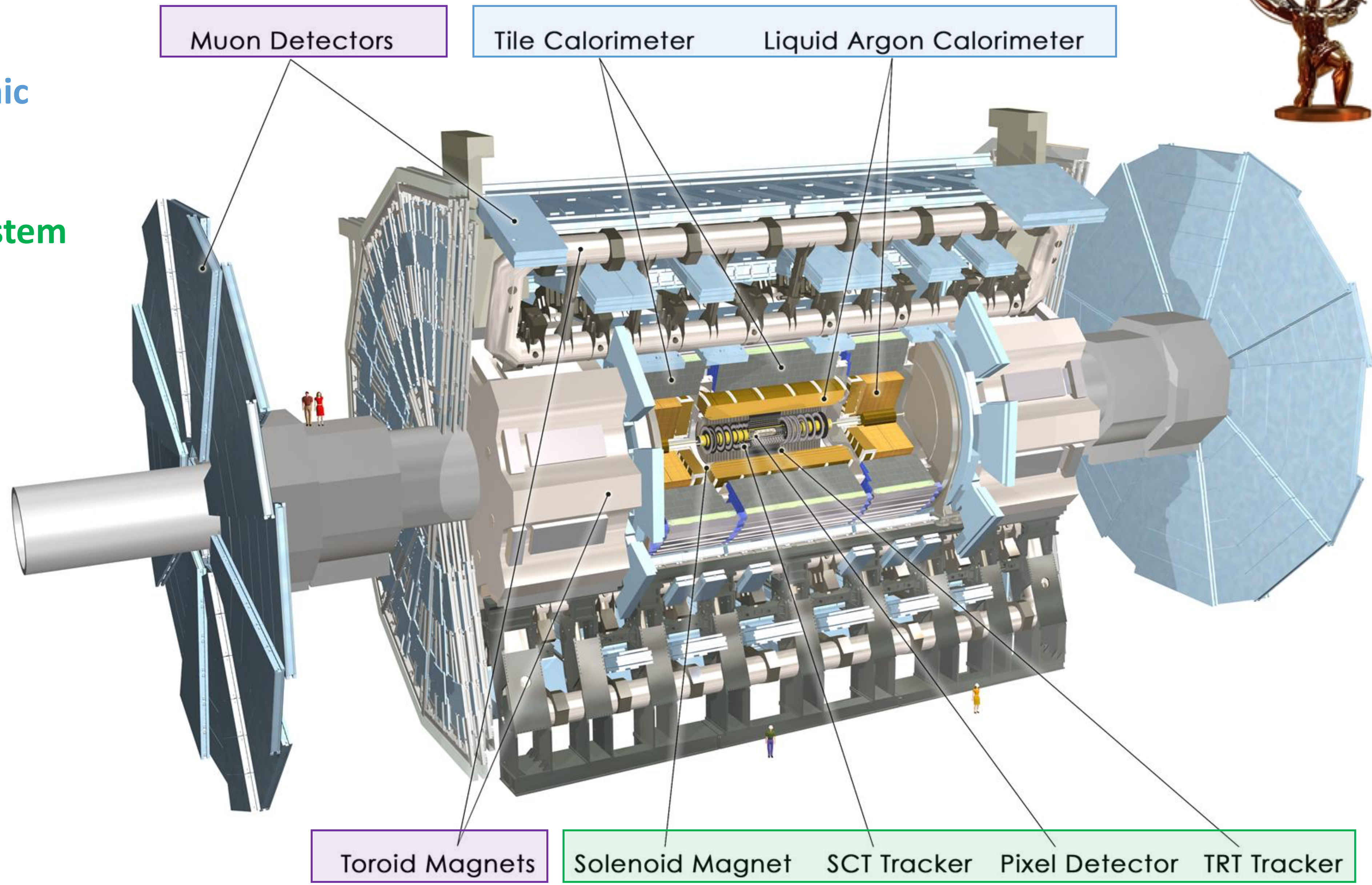


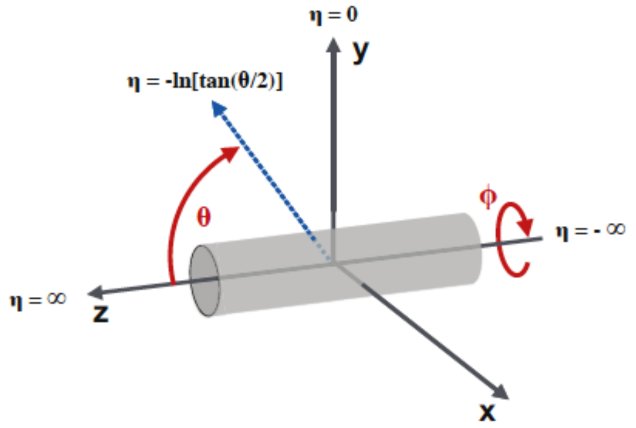
The ATLAS Detector

Electromagnetic and Hadronic Calorimeters

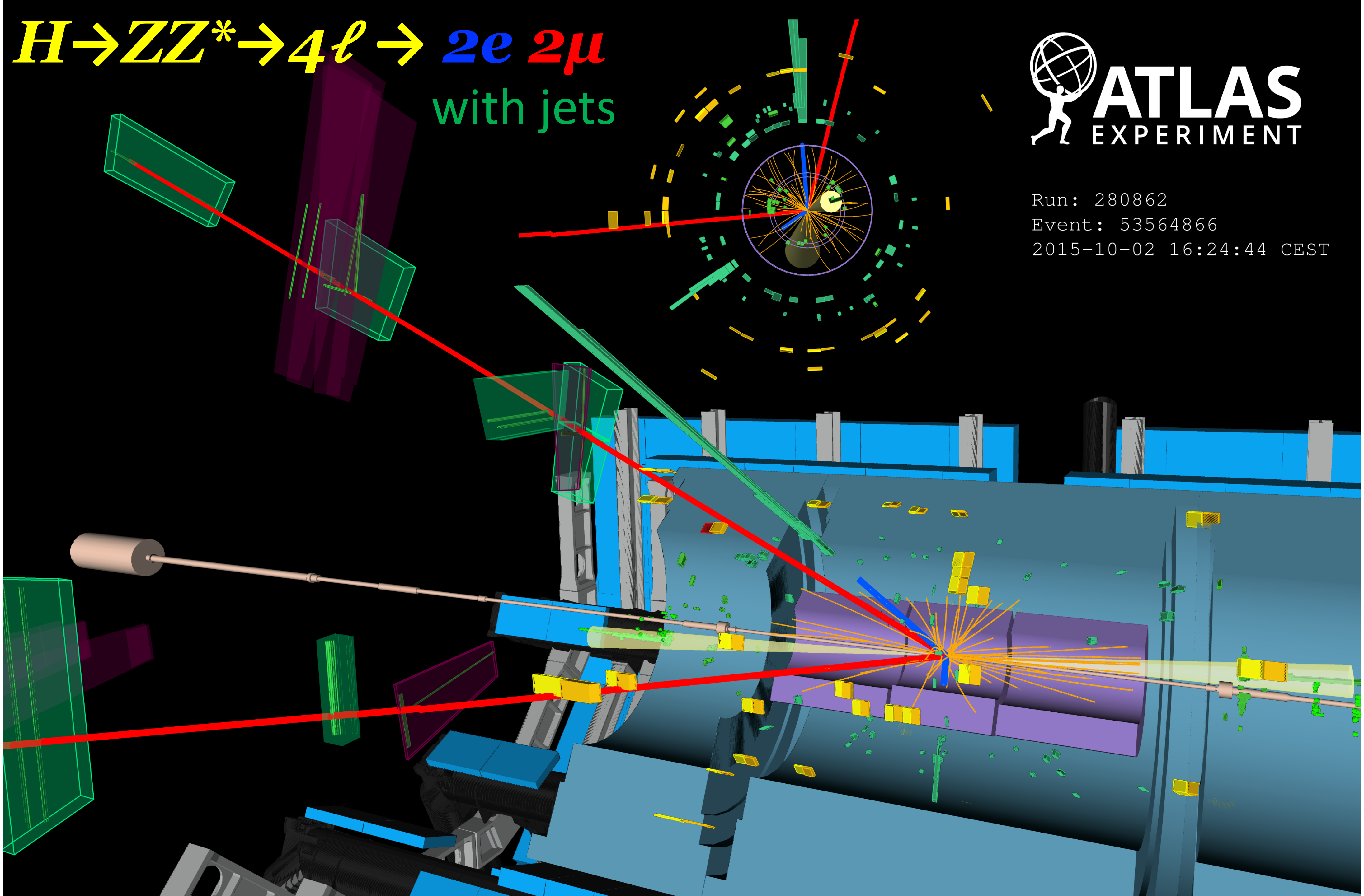
Charged particle tracking system

Muon spectrometer

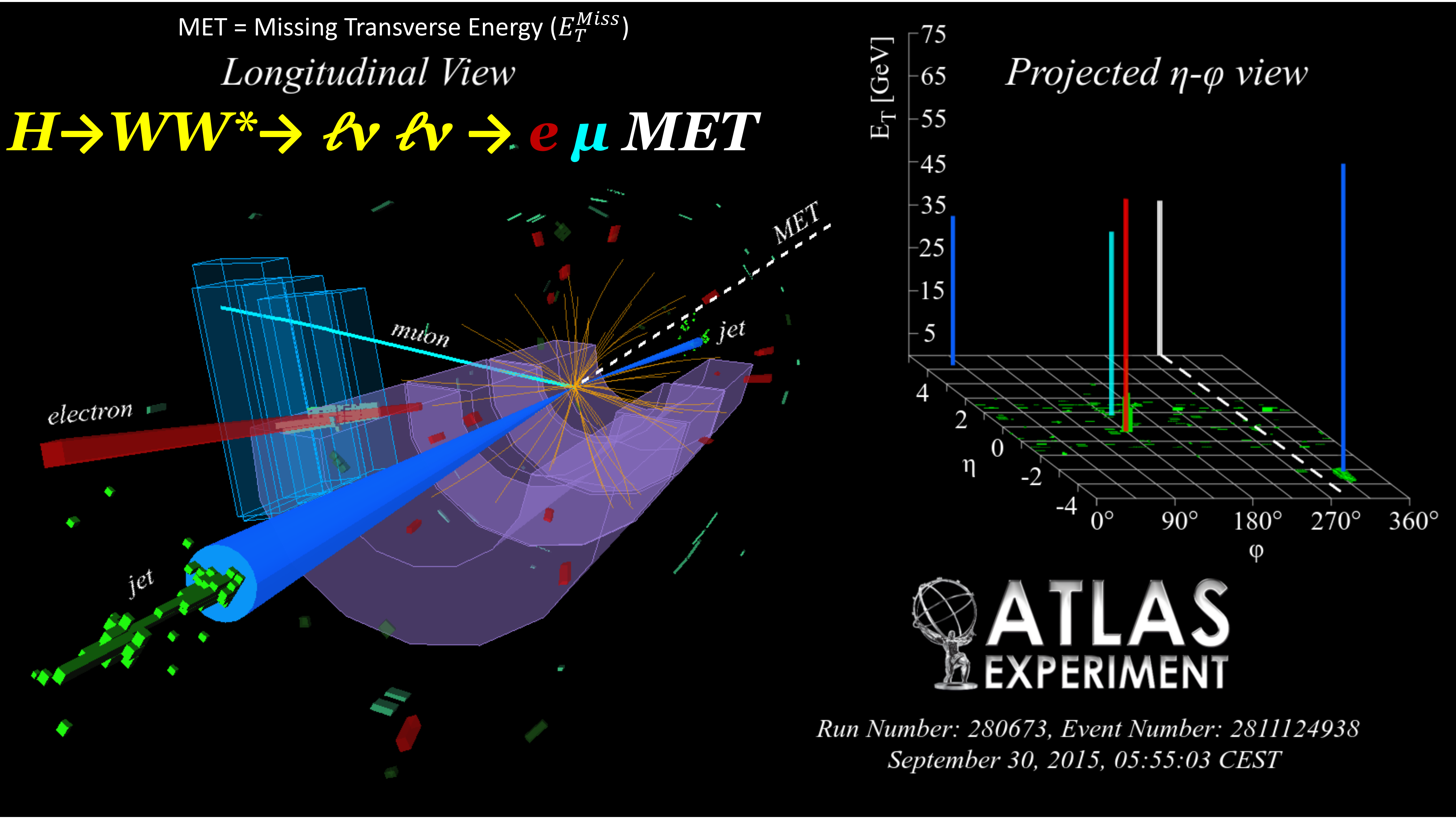




H→γγ
ATLAS EXPERIMENT
Run Number: 191426, Event Number: 86694500
Date: 2011-10-22 15:30:29 UTC
with jets
35 ET (GeV)
25
15
5
η
0
90
180
270
360
Φ



H→ZZ*→4ℓ→ 2e 2μ
with jets
ATLAS
EXPERIMENT
Run: 280862
Event: 53564866
2015-10-02 16:24:44 CEST



MET = Missing Transverse Energy (E_T^{Miss})
Longitudinal View
H→WW*→ ℓν ℓν → e μ MET
MET
muon
jet
electron
jet
Projected η-φ view
E_T [GeV]
75
65
55
45
35
25
15
5
4
2
0
-2
-4
η
0°
90°
180°
270°
360°
φ
ATLAS
EXPERIMENT
Run Number: 280673, Event Number: 2811124938
September 30, 2015, 05:55:03 CEST

Dataset

Run 1:

$\sqrt{s}$ = 7 TeV

2011: 4.5 fb^{-1}

$\sqrt{s}$ = 8 TeV

2012: 20.3 fb^{-1}

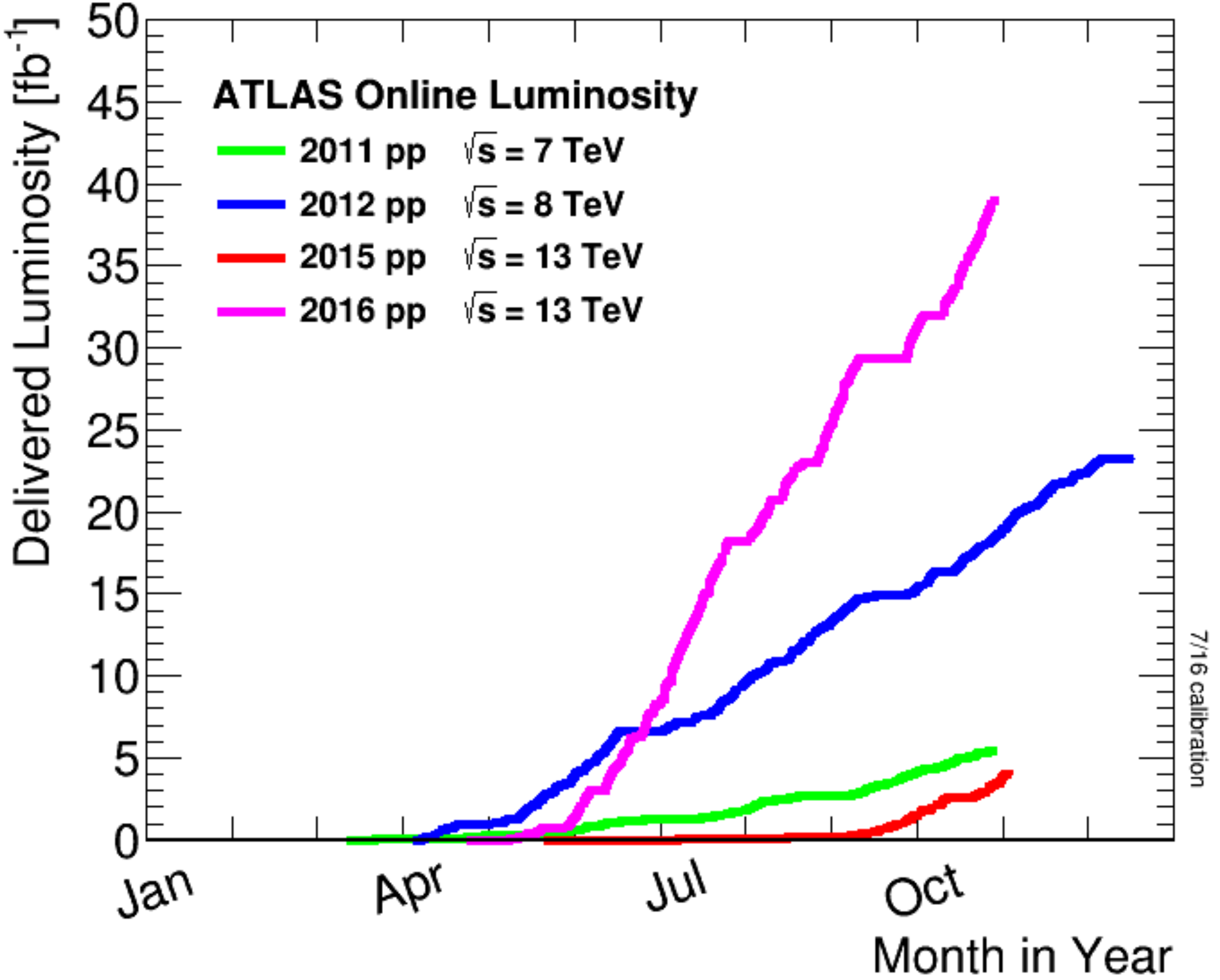
Run 2:

$\sqrt{s}$ = 13 TeV

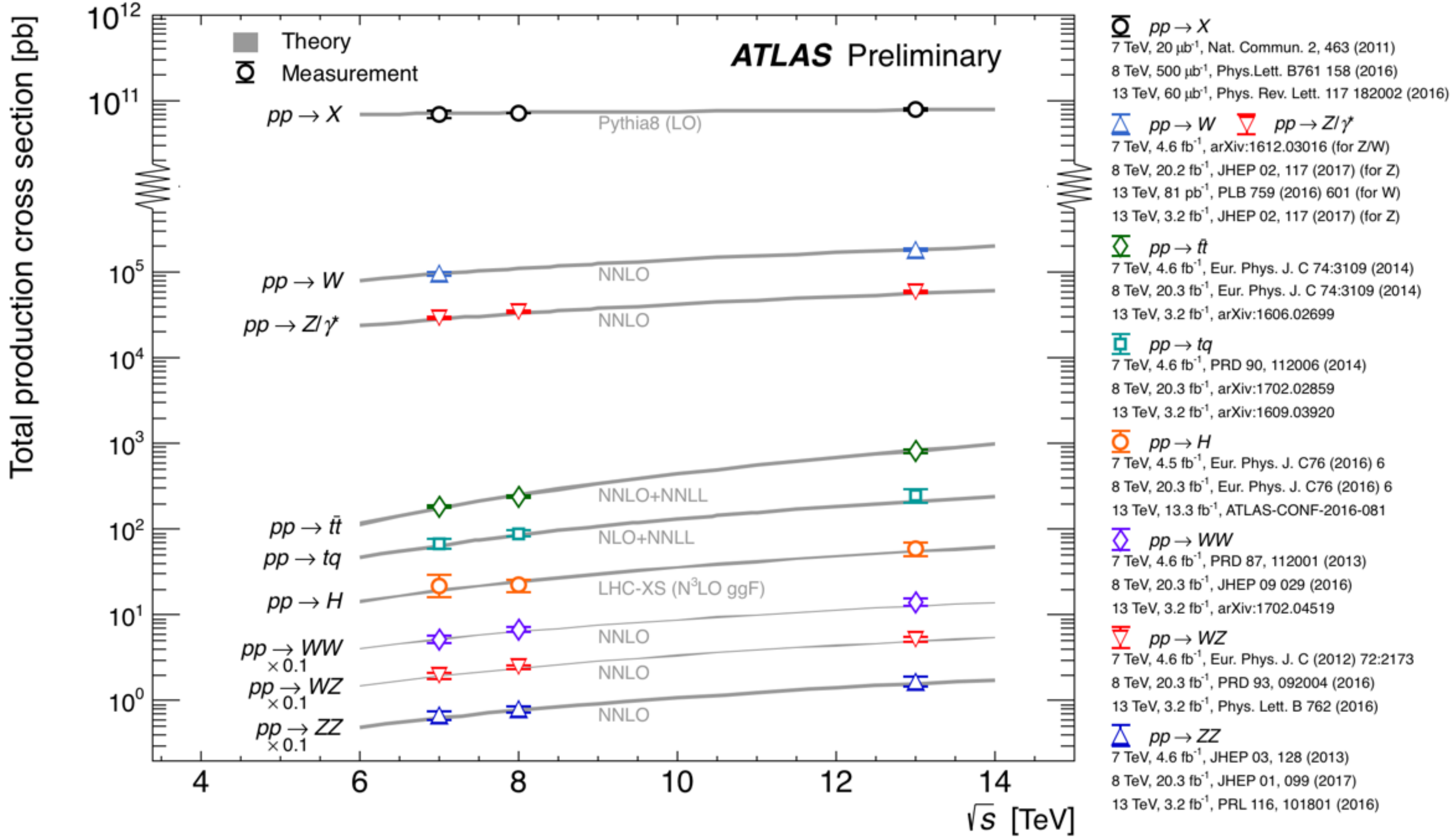
2015: 3.2 fb^{-1}

2016: 32.9 fb^{-1}

2017: *starting*



The Standard Model and Production Cross-Section



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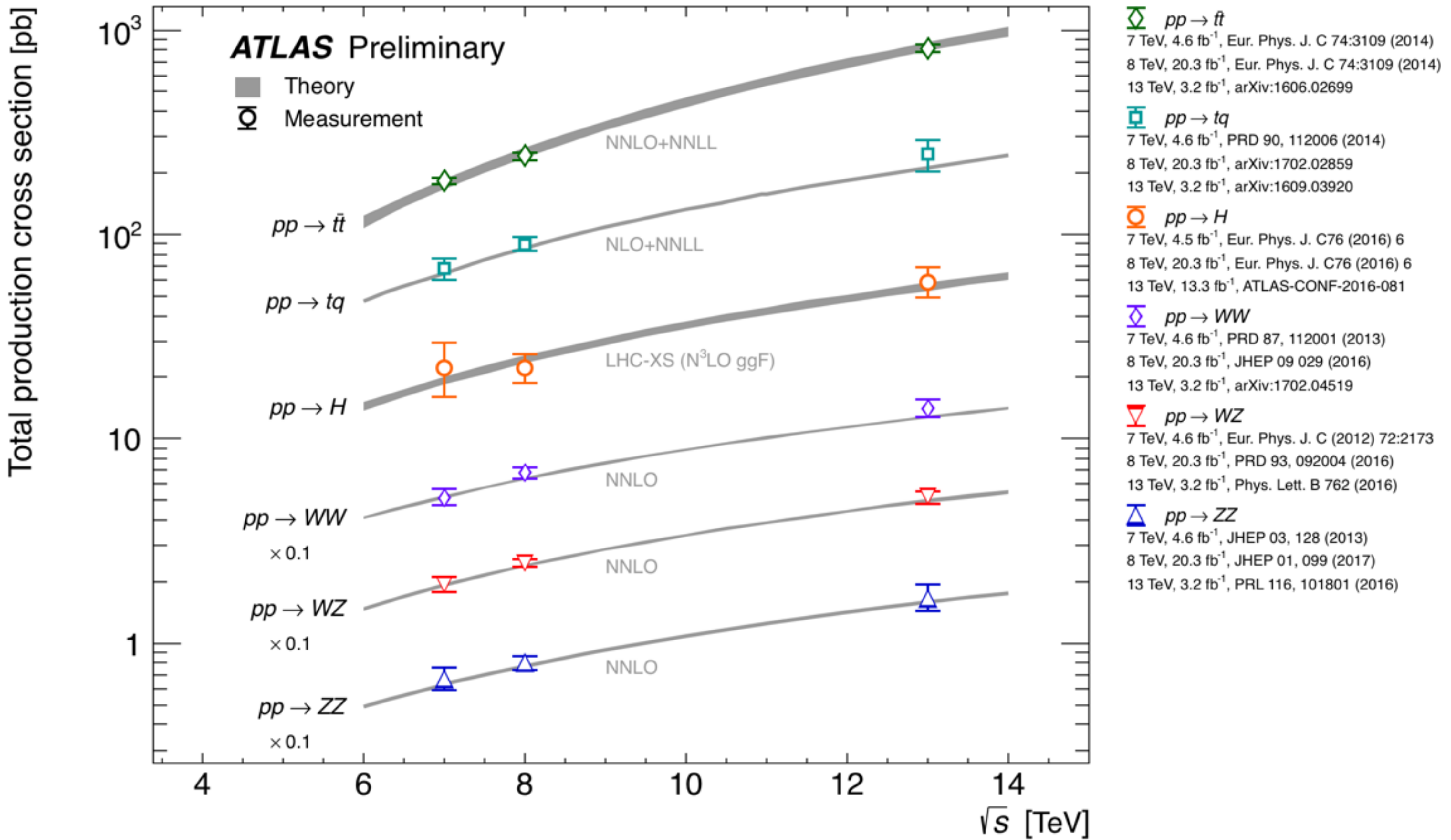
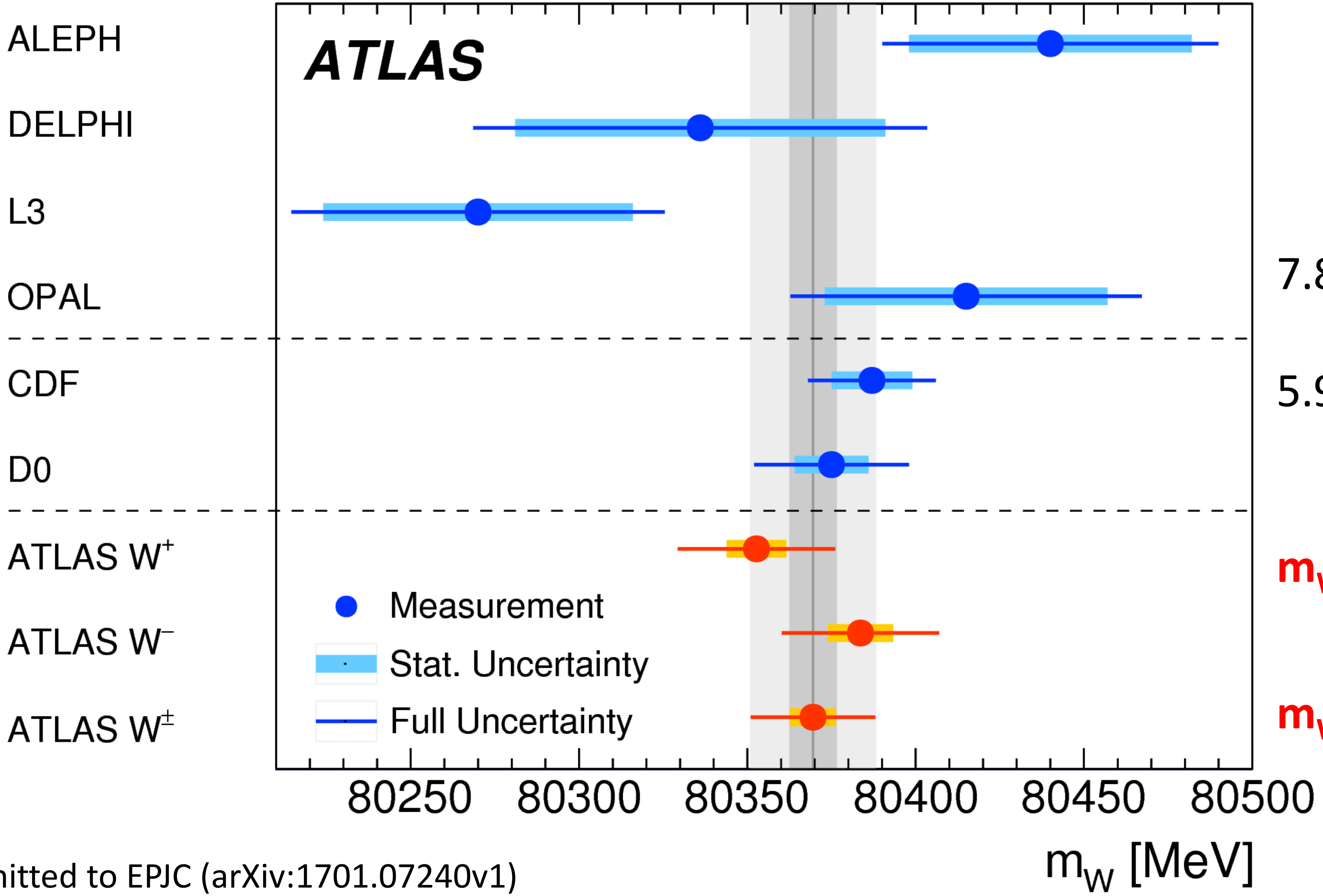


W-boson Mass Measurement (Run1 result at 7 TeV)

m_W= 80370 MeV ± 7(stat.) ± 11(exp. syst.) ± 14(mod. syst.) MeV



7.8×10^6 $W\rightarrow\mu\nu$ candidates

5.9×10^6 $W\rightarrow e\nu$ candidates

$m_{W+} - m_{W-} = -29 \pm 28$ MeV

$m_W = 80370 \pm 19$ MeV

Submitted to EPJC (arXiv:1701.07240v1)

The Standard Model and Higgs Boson Production

The highlight of the first run of the LHC was undoubtedly the discovery by the ATLAS and CMS Collaborations of a new elementary particle of a type never seen before. All the properties of this particle measured so far are consistent with those predicted for the **Brout-Englert-Higgs (BEH)** of the Standard Model of particle physics.

The Standard Model and the Higgs Boson

Couplings to the **BEH scalar field** determine the **masses** of all elementary particles

$$\Phi = \frac{1}{\sqrt{2}}\begin{pmatrix}\phi^+\\ \phi^0\end{pmatrix}, \langle 0|\Phi|0\rangle = \frac{1}{\sqrt{2}}\begin{pmatrix}0\\ v\end{pmatrix}$$

$$\mathcal{L}_{\text{BEH}} = \left|\left(\partial_\mu - \frac{i}{2}g' B_\mu - \frac{i}{2} g\tau^a W_\mu^a\right)\Phi\right|^2 + \mu^2\Phi^+\Phi - \frac{\lambda}{2}(\Phi^+\Phi)^2$$

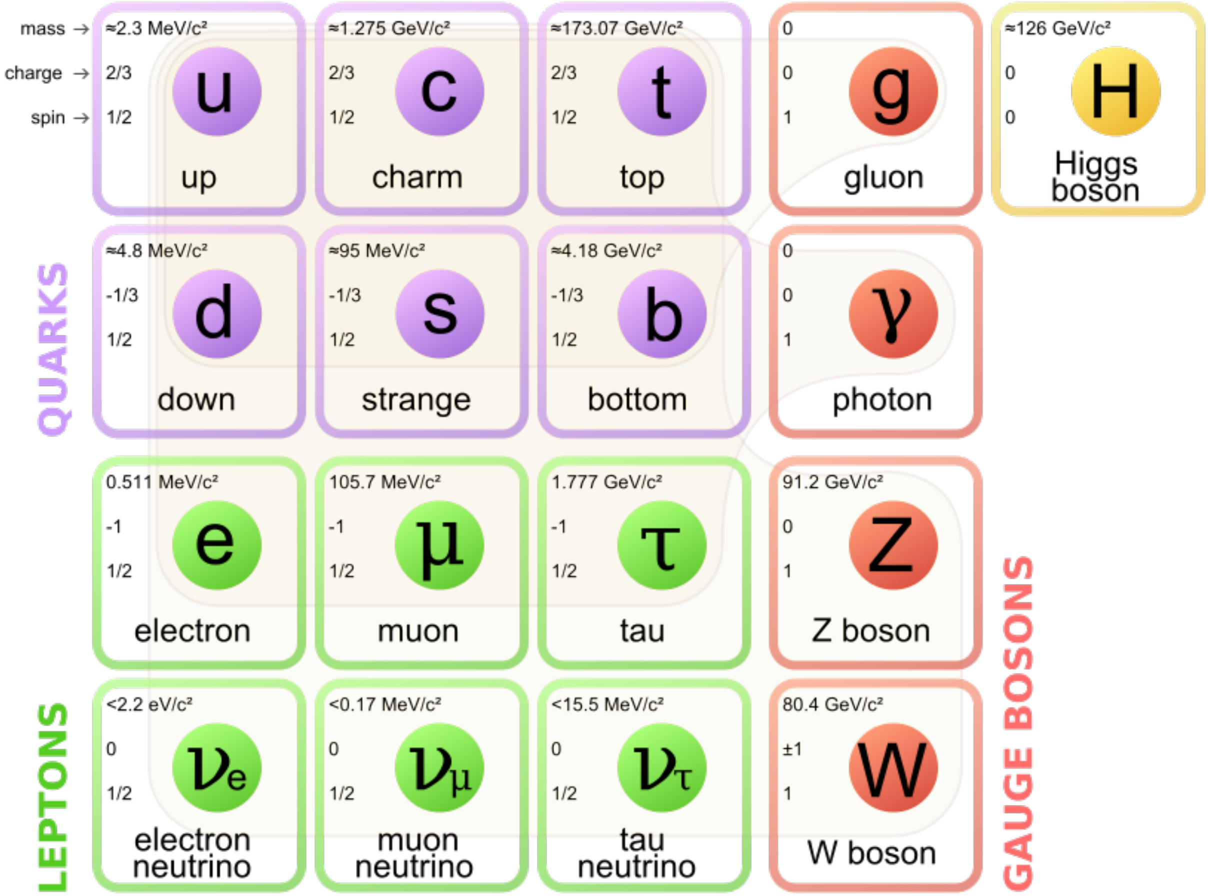
$$m_W = \frac{gv}{2}, m_Z = \frac{\sqrt{g^2+g'^2}v}{2}, m_H = \sqrt{\lambda}v, v = \sqrt{\frac{2\mu^2}{\lambda}}$$

$$\mathcal{L}_{\text{lepton}}^{\text{mass}} = \sum_{j=e,\mu,\tau}(-f_j)[(\bar{L}_j\Phi)R_j + \bar{R}_j(\Phi^+ L_j)]$$

$$m_j = \frac{f_j v}{\sqrt{2}}$$

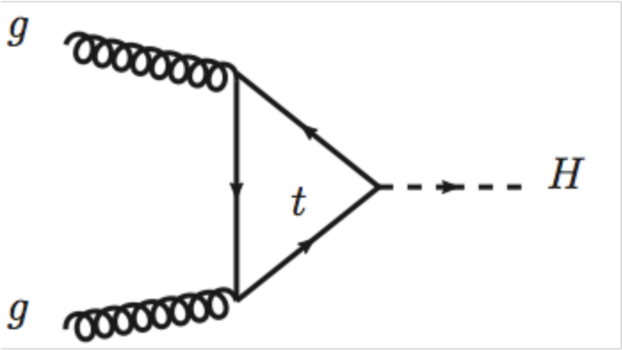
$$\mathcal{L}_{\text{quark}}^{\text{mass}} = \sum_{f=d,s,b}(-f_f)[(\bar{L}_f\Phi)R_f + \bar{R}_f(\Phi^+ L_f)] + \sum_{F=u,c,t}(-f_F)[(\bar{L}_F\tilde{\Phi})R_F + \bar{R}_F(\tilde{\Phi}^+ L_F)]$$

$$m_f = \frac{f_f v}{\sqrt{2}}, m_F = \frac{f_F v}{\sqrt{2}}$$

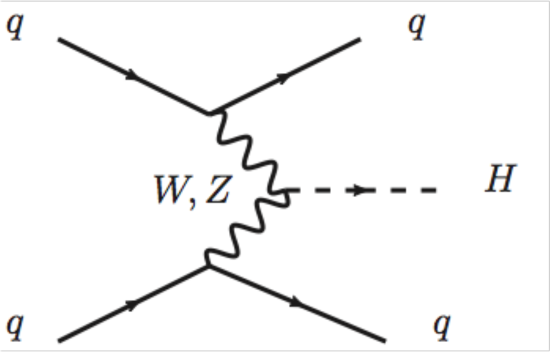


Higgs boson production & decay at the LHC

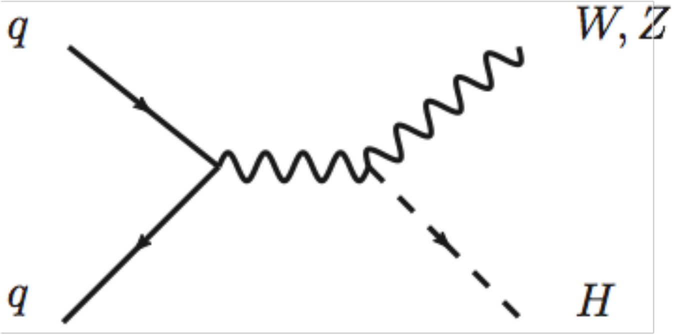
Production ($\sqrt{s} = 13$ TeV):



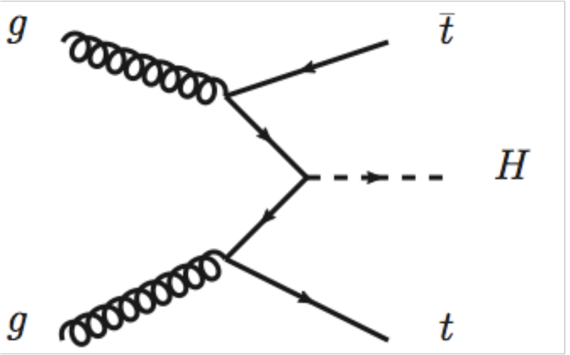
ggF: ~ 88%



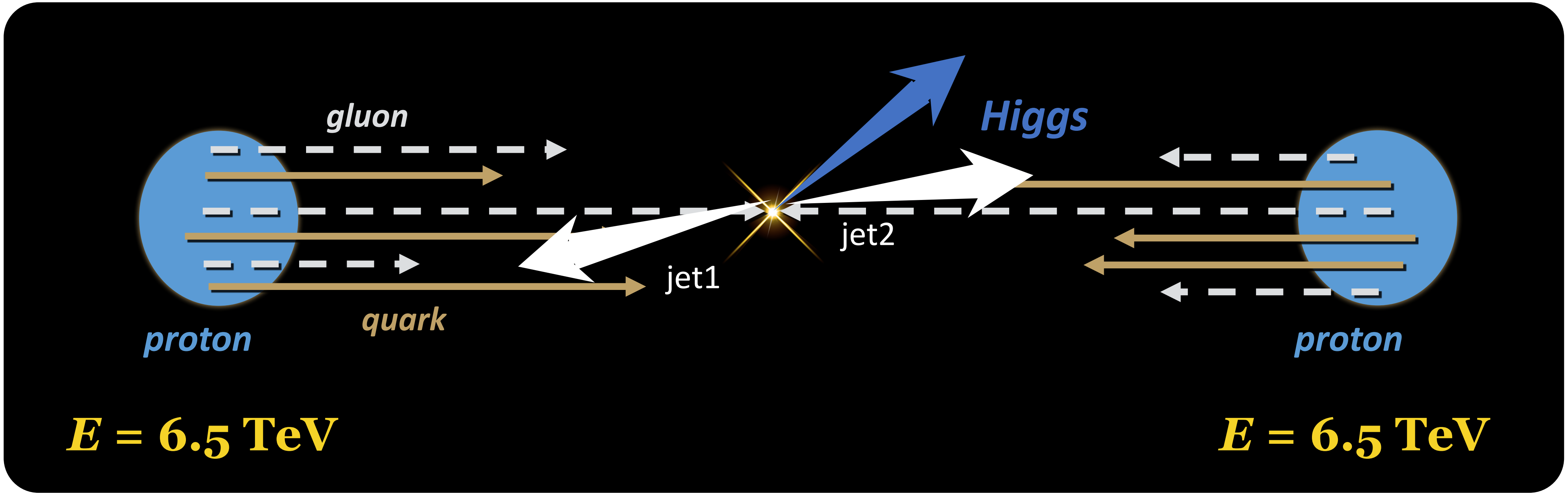
VBF: ~ 7.0%



VH ≡ WH or ZH: ~ 4.1%



ttH: ~ 0.9%



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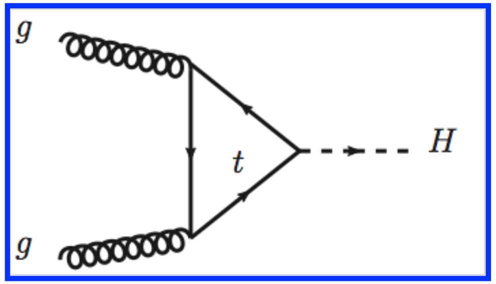
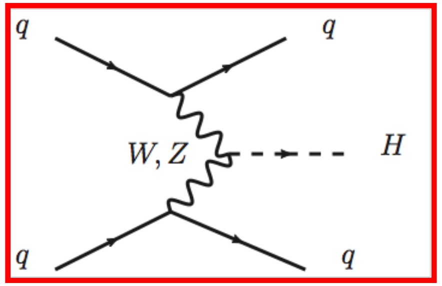
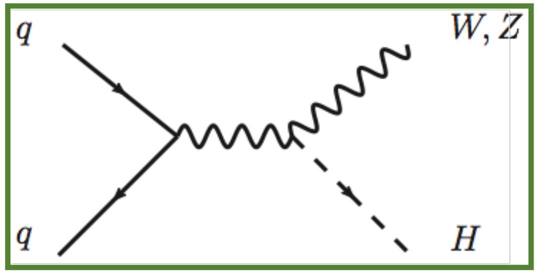
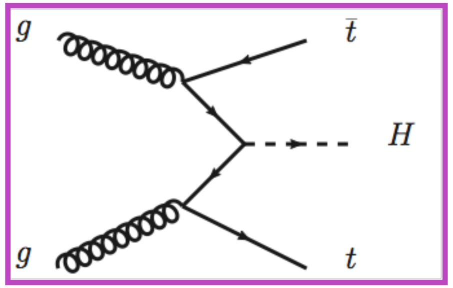
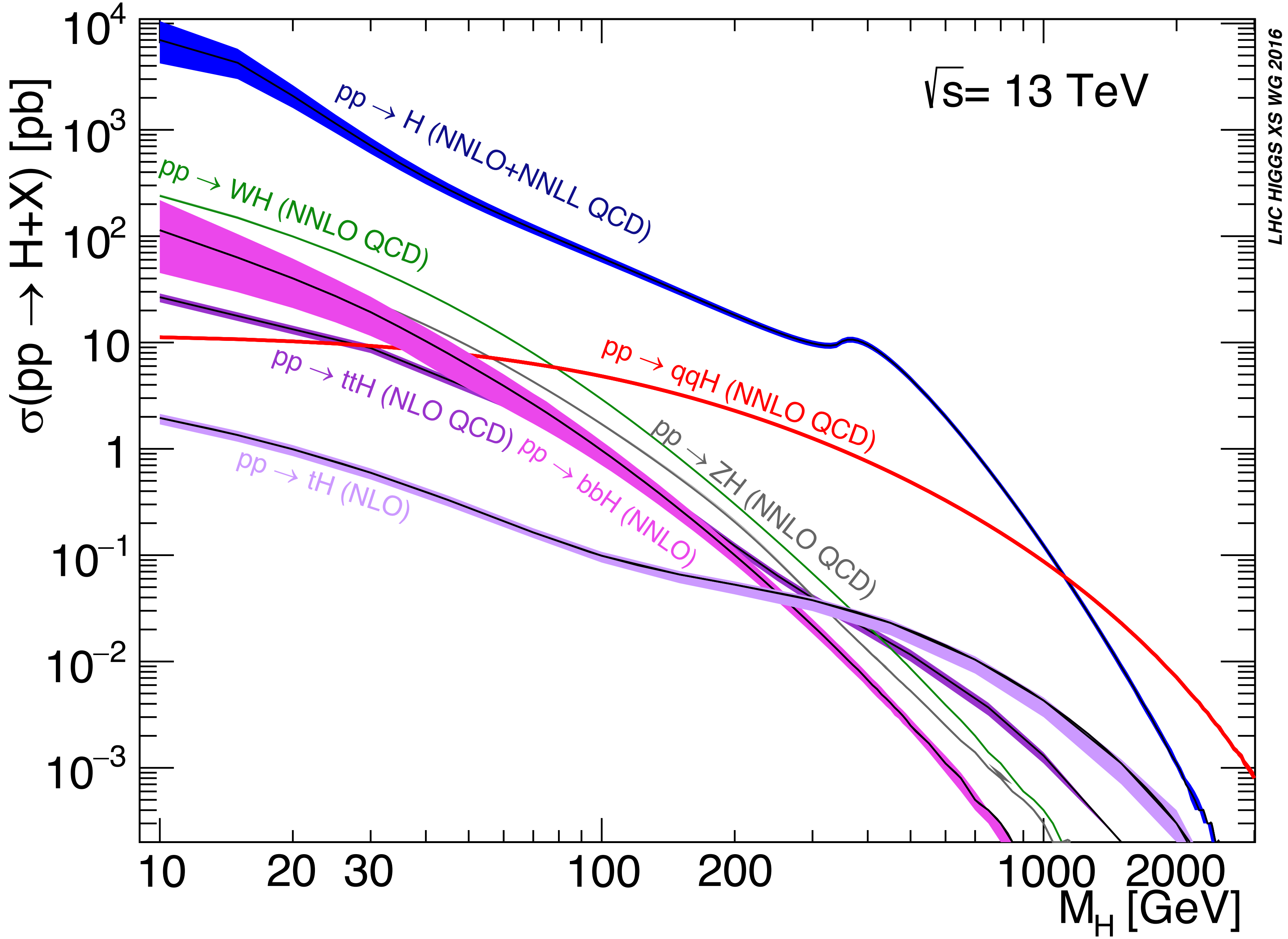


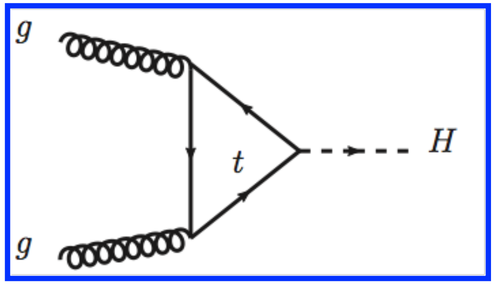


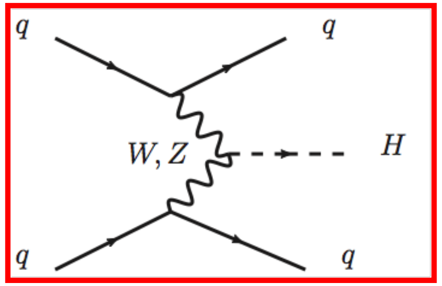


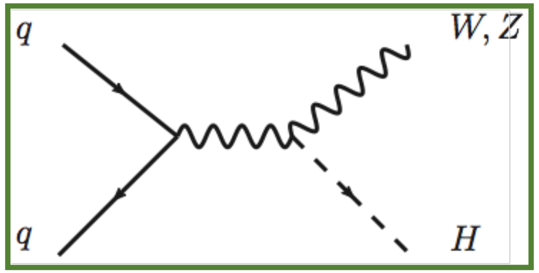


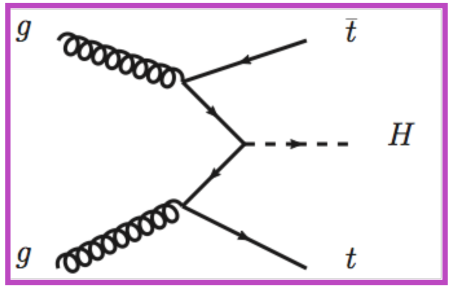


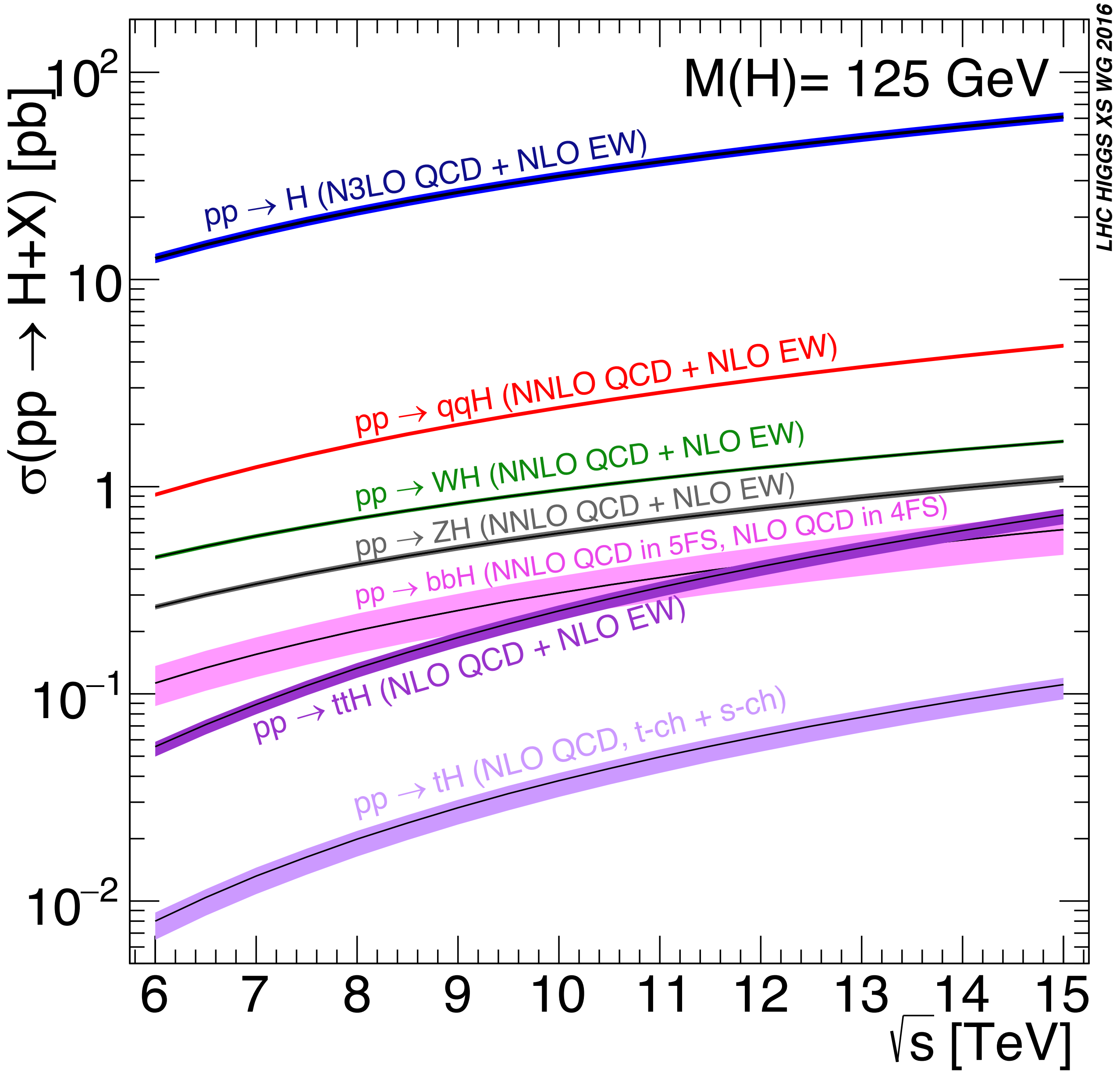
Higgs boson production & decay at the LHC





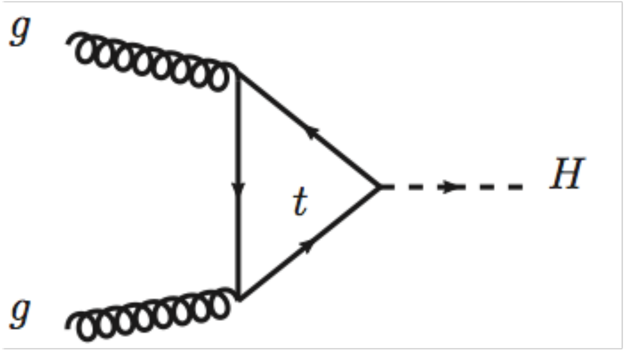




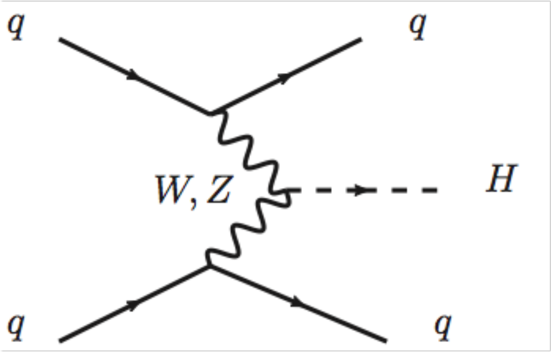


Higgs boson production & decay at the LHC

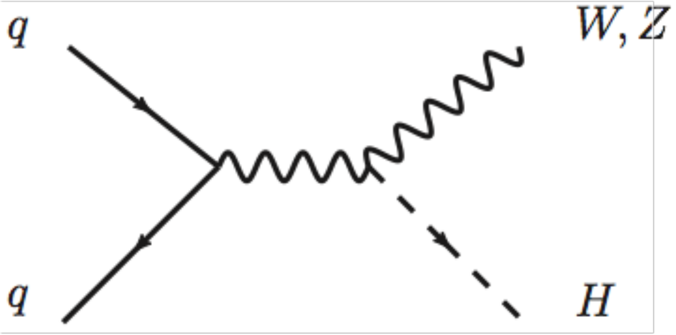
Production ($\sqrt{s} = 13$ TeV):



ggF: ~ 88%



VBF: ~ 7.0%



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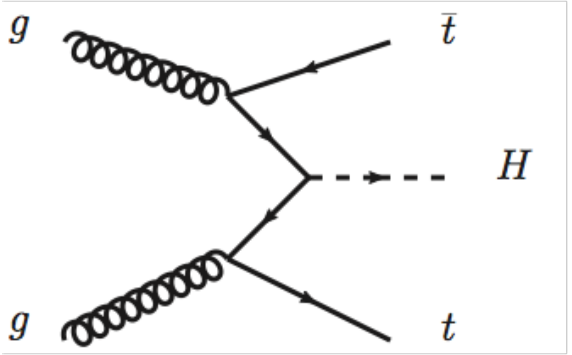
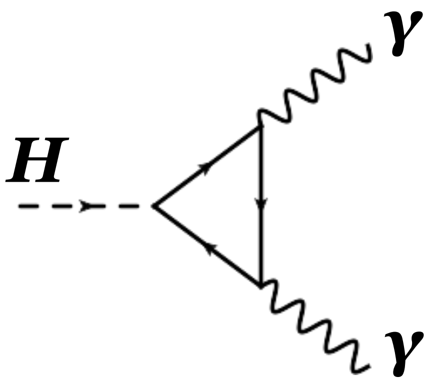


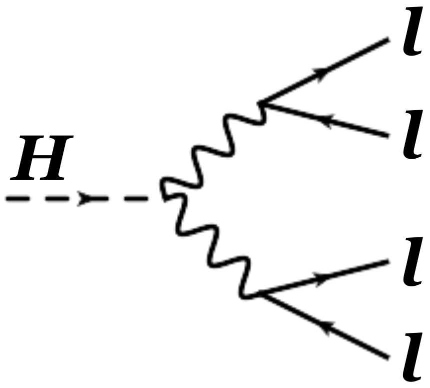
ttH: ~ 0.9%

Decay ($m_H = 125$ GeV):

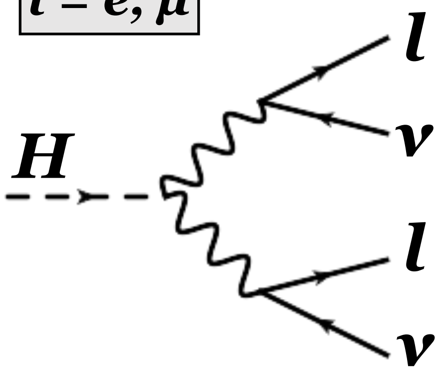
$l = e, \mu$



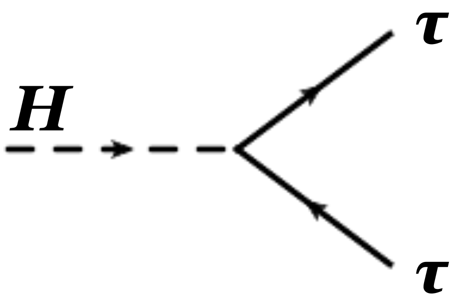
0.228%
$H \to \gamma\gamma$



0.013%
$H \to ZZ^* \to 4l$



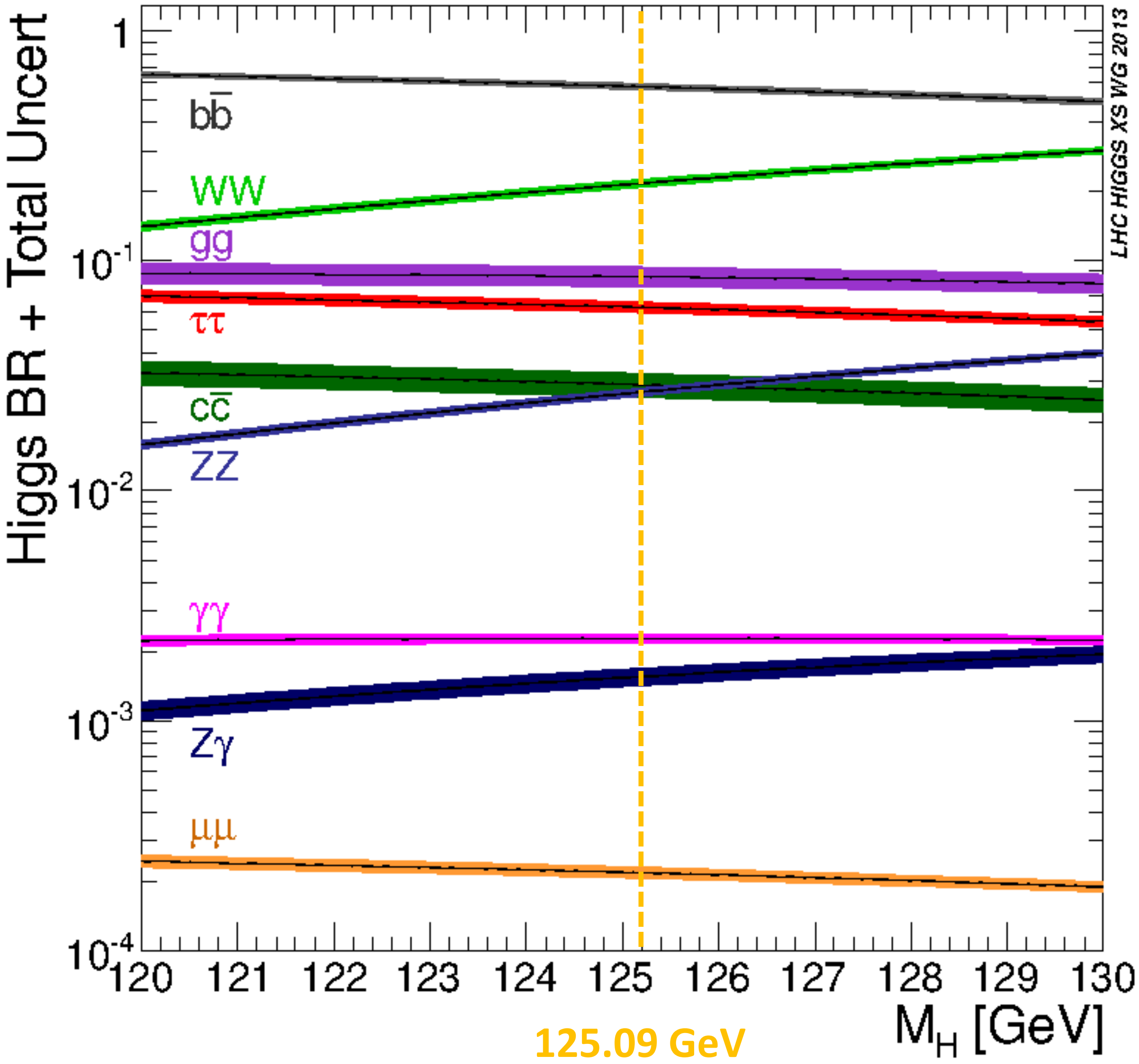
1.09%
$H \to WW \to l\nu l\nu$



6.25%
$H \to \tau\tau$

$H \to bb$	58%
$H \to WW^*$	22%
$H \to gg$	8.5%
$H \to cc$	2.9%
$H \to ZZ^*$	2.6%
…	
$H \to Z\gamma$	0.15%
$H \to \mu\mu$	0.02%

Higgs boson production & decay at the LHC

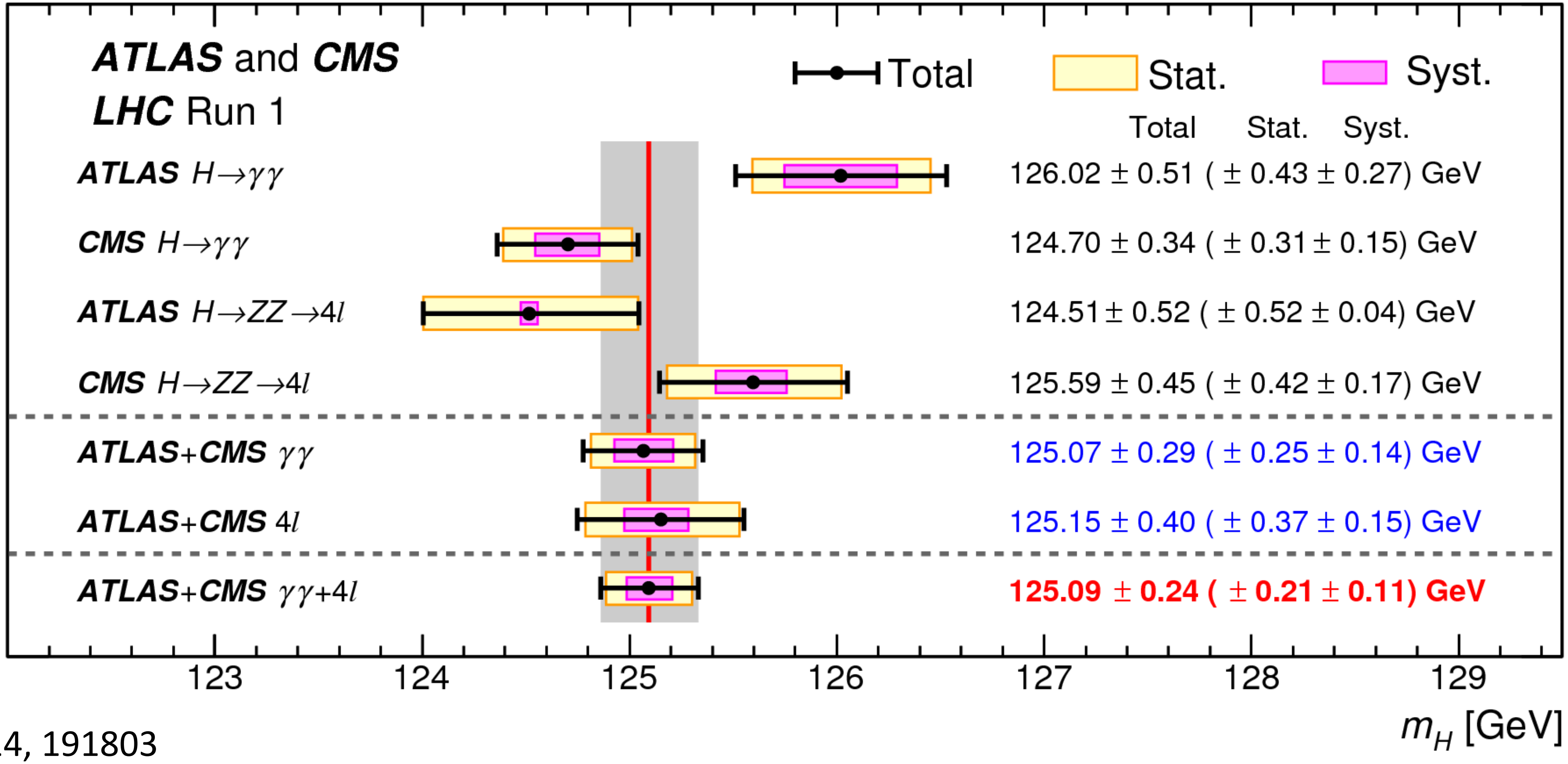


Higgs boson mass (Run1 mass results at 7 & 8 TeV)

- Determination of the Higgs potential, which is not predicted by the Standard Model ($m_H = \sqrt{2}\,|\mu|$)
- Constrained by EW precision fit, but very difficult to measure precisely without direct Higgs mass measurements

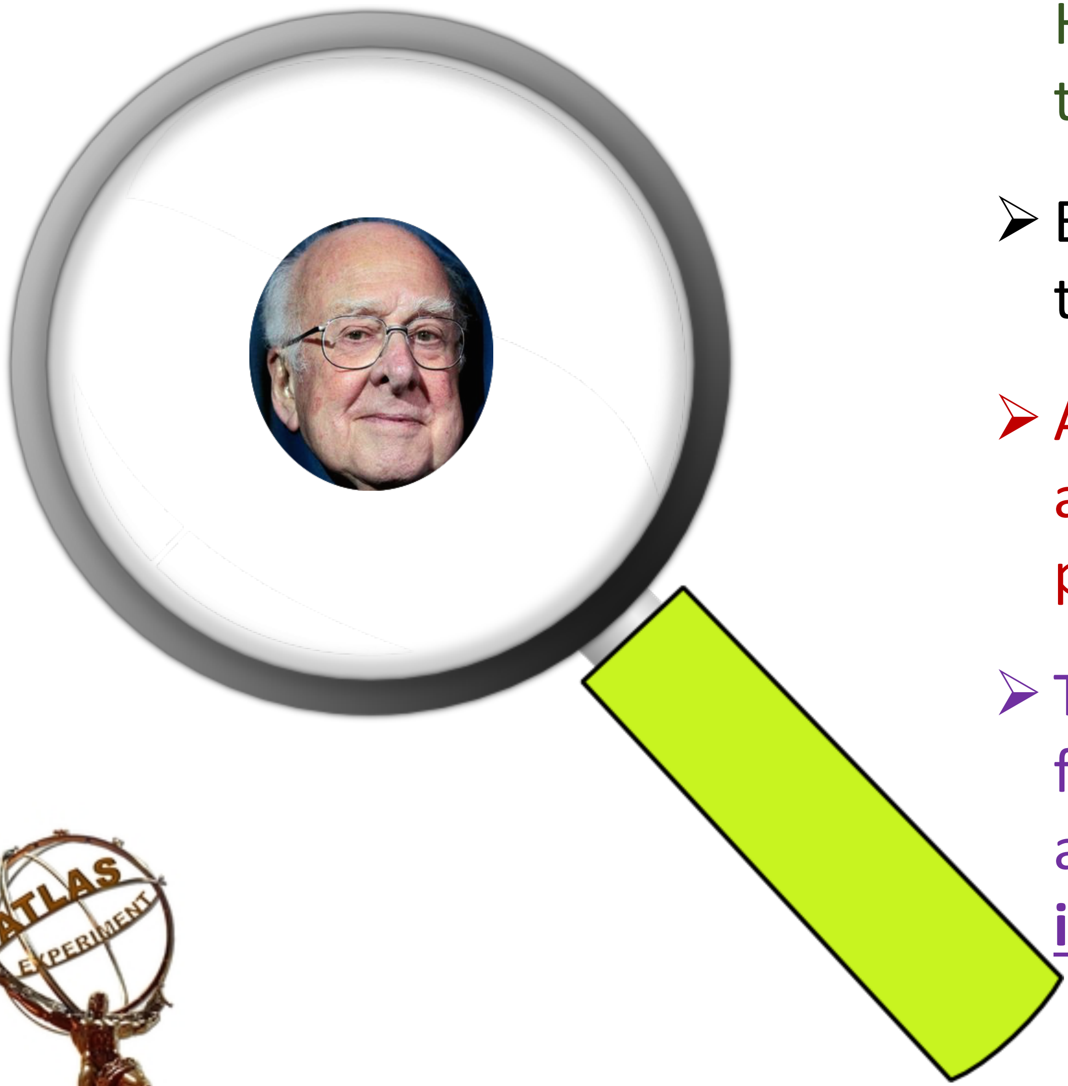
Combination of the ATLAS and CMS results

m_H = 125.09 ± 0.21 (stat.) ± 0.11(syst.) GeV



Phys. Rev. Lett. 114, 191803

Objectives pp→ Higgs at the LHC (for this talk)



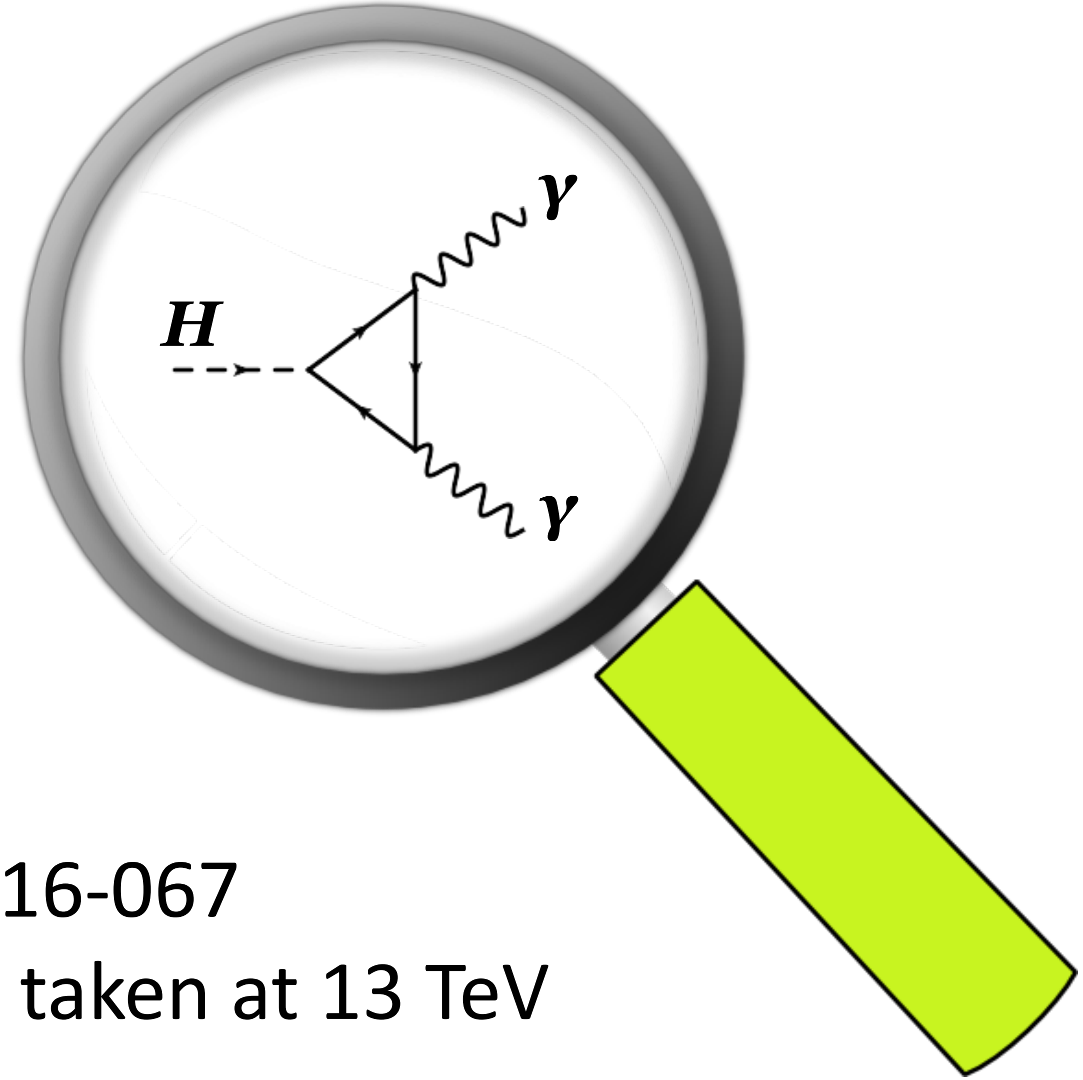
- After discovery, want to measure the properties of the Higgs boson and test the consistency of the SM with the **new** 13 TeV data

- Extract information about the Higgs boson's couplings to other particles (while assuming m_H = 125.09 GeV)

- A fiducial region, or a bin of a differential distribution, is a **specific area of phase space** to probe the Higgs properties

- Through unfolding, the measurements are corrected for experimental effects such as detector acceptance and resolution. Thus, designed to be as **model-independent** as possible to:
  - Allow direct comparison with theory predictions
  - Probe physics beyond the SM

$H \rightarrow \gamma\gamma$

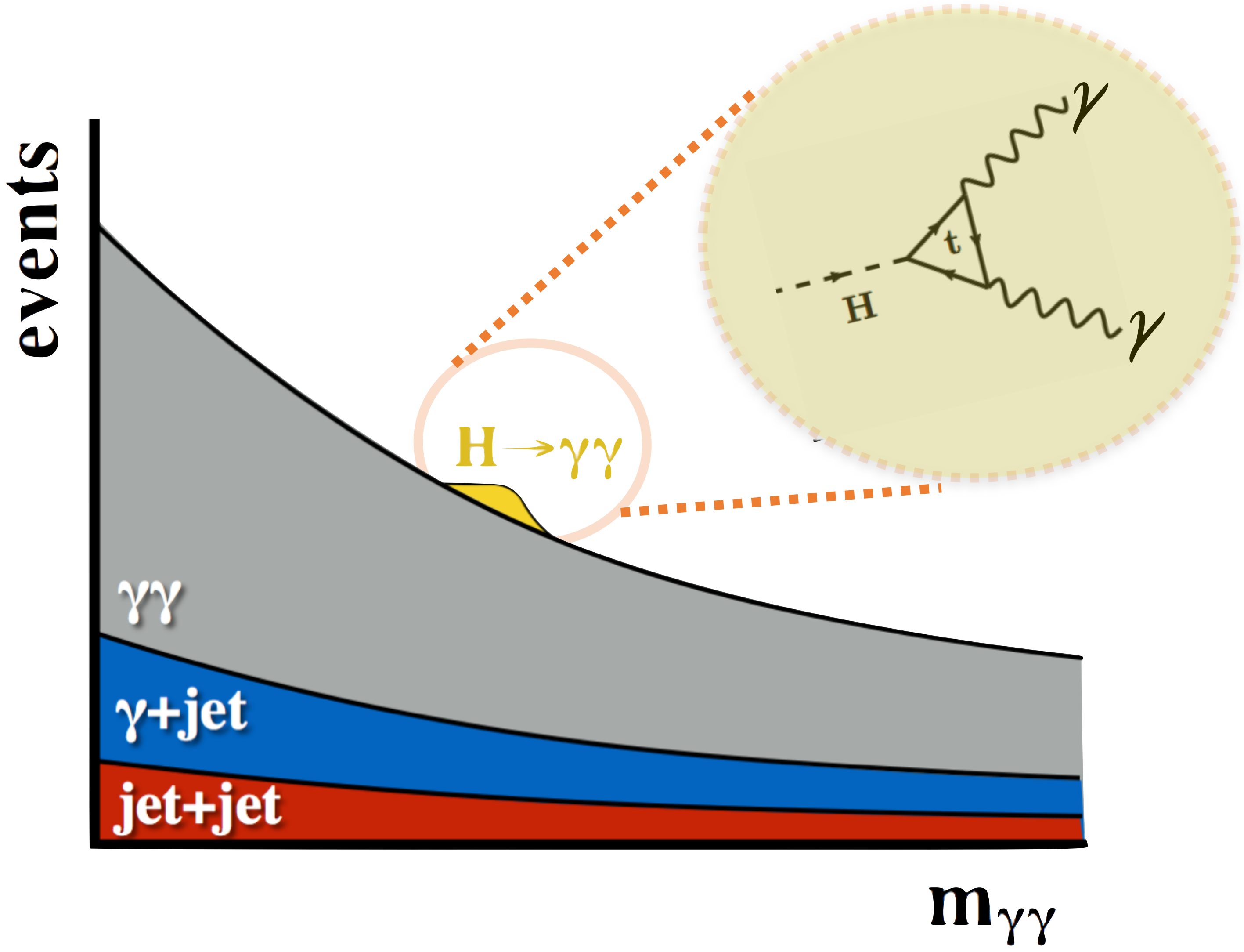


ATLAS-CONF-2016-067

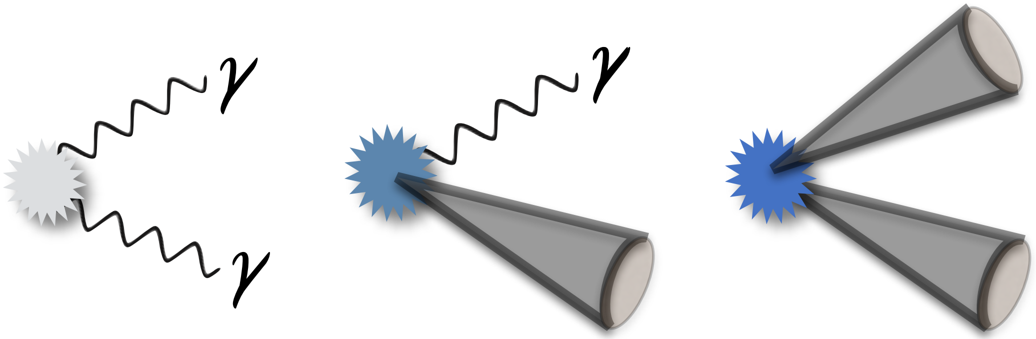
13.3 fb^{-1} of data taken at 13 TeV

H→γγ signature

- Higgs signal and SM background processes look identical, but background produces no peak!
- Background must be well modelled in order to minimize potential measurement biases



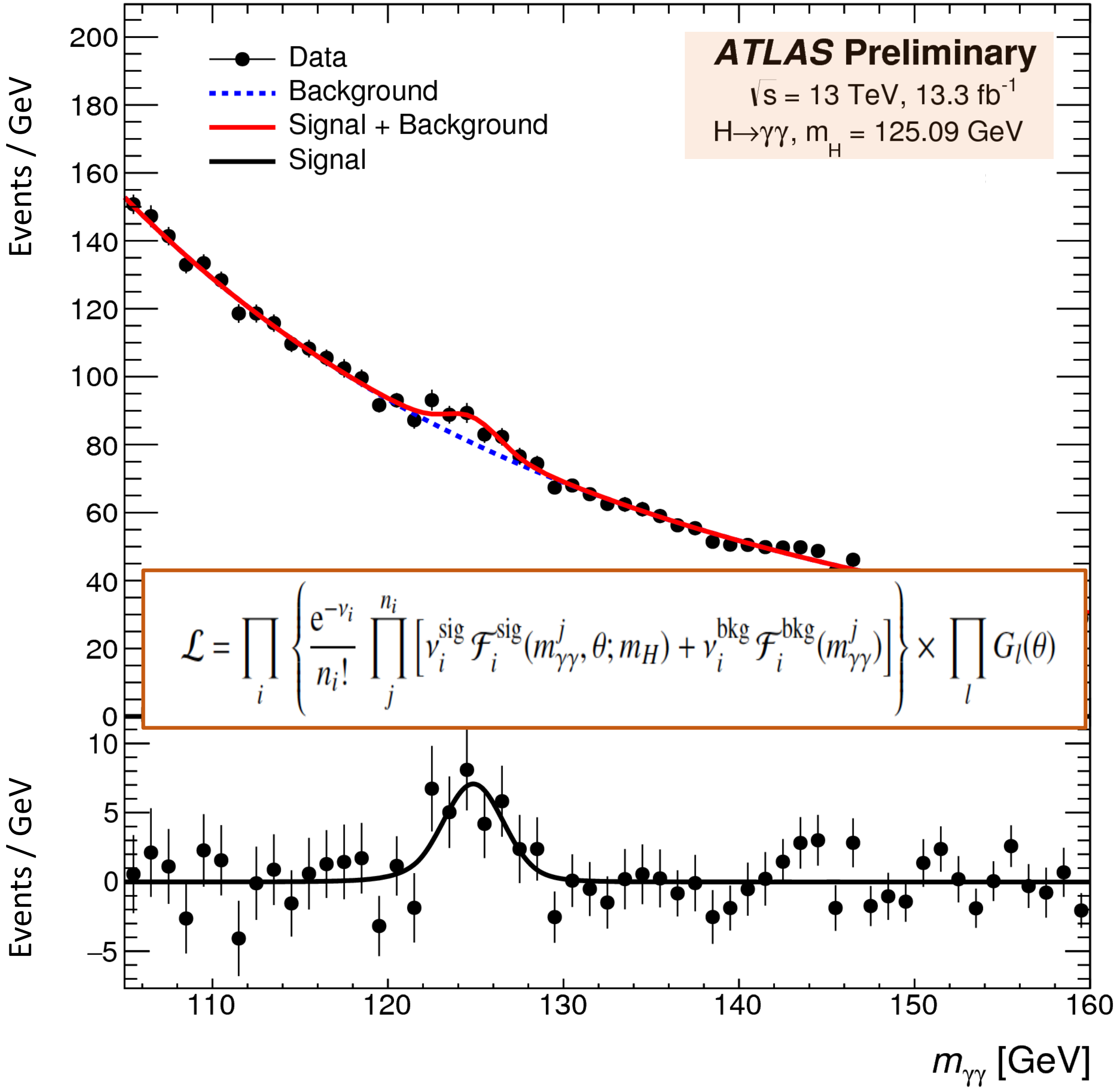
main backgrounds



$$m_{\gamma\gamma} = \sqrt{2E_1E_2[1-\cos(\alpha)]}$$

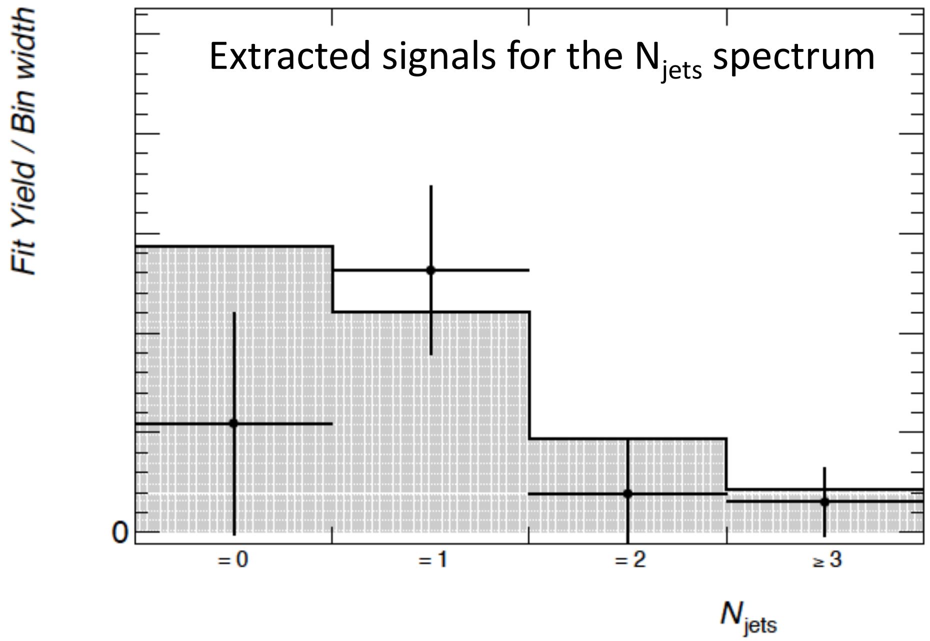
Event Yields per bin or region

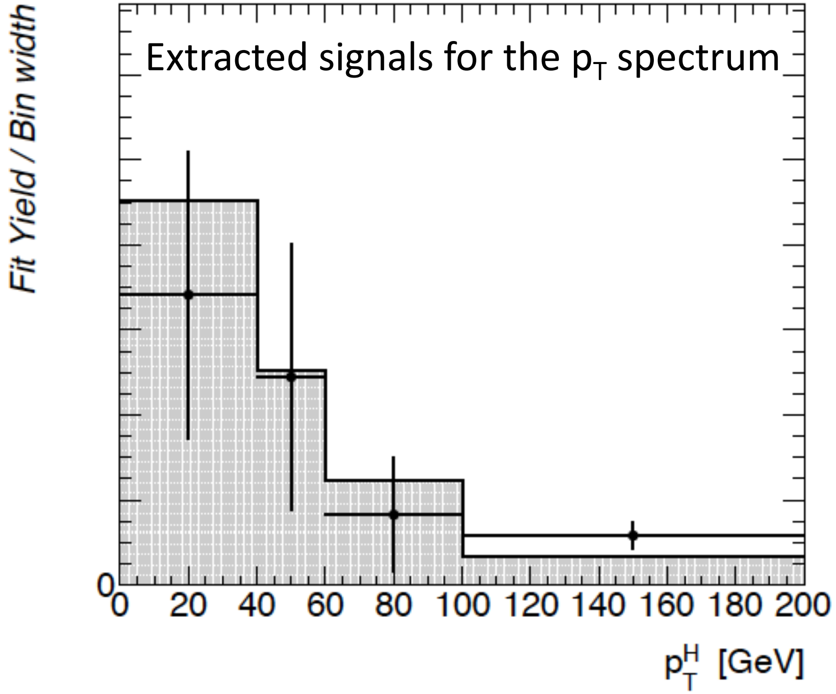
Use the ATLAS + CMS $\sqrt{s}$ = 7 & 8 TeV combined measurement of m_H = 125.09 GeV



$$\mathcal{L} = \prod_i \left\{ \frac{e^{-\nu_i}}{n_i!} \prod_j^{n_i} \left[\nu_i^{\mathrm{sig}} \mathcal{F}_i^{\mathrm{sig}}(m_{\gamma\gamma}^j, \theta; m_H) + \nu_i^{\mathrm{bkg}} \mathcal{F}_i^{\mathrm{bkg}}(m_{\gamma\gamma}^j) \right] \right\} \times \prod_l G_l(\theta)$$

Unbinned maximum likelihood fit to the $m_{\gamma\gamma}$ spectrum in each fiducial region or bin of a differential distribution





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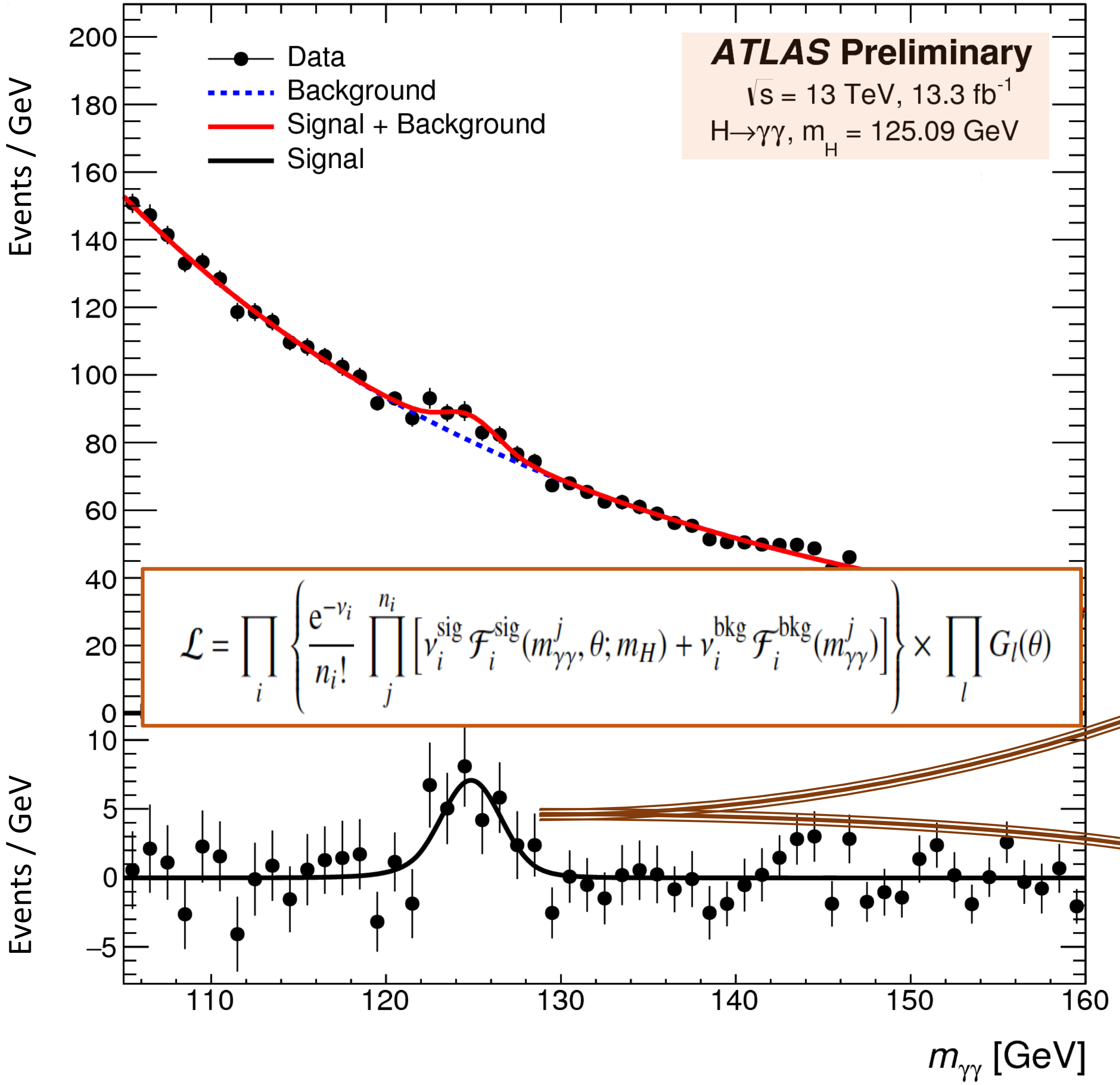
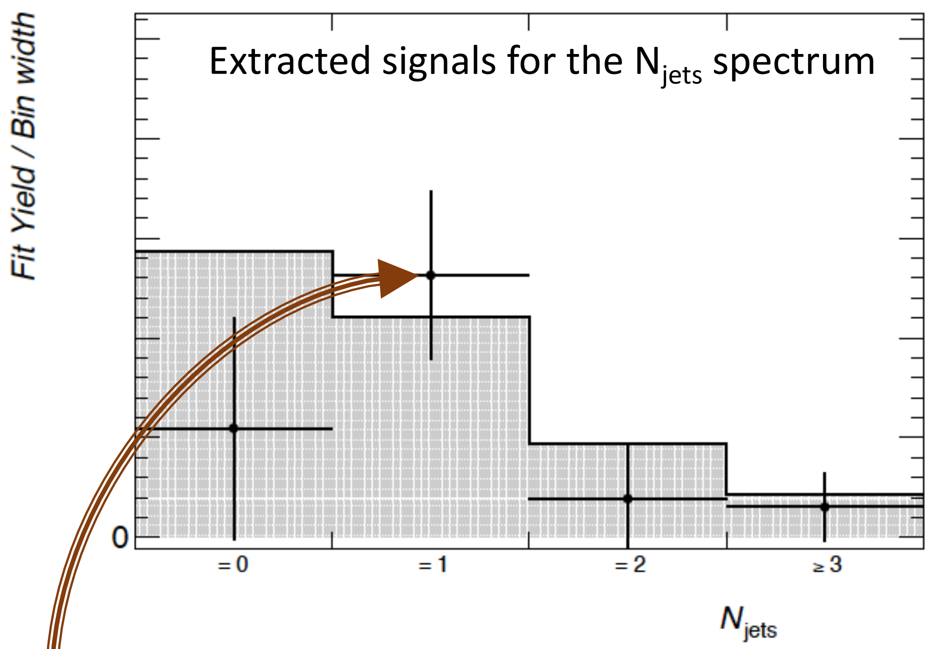
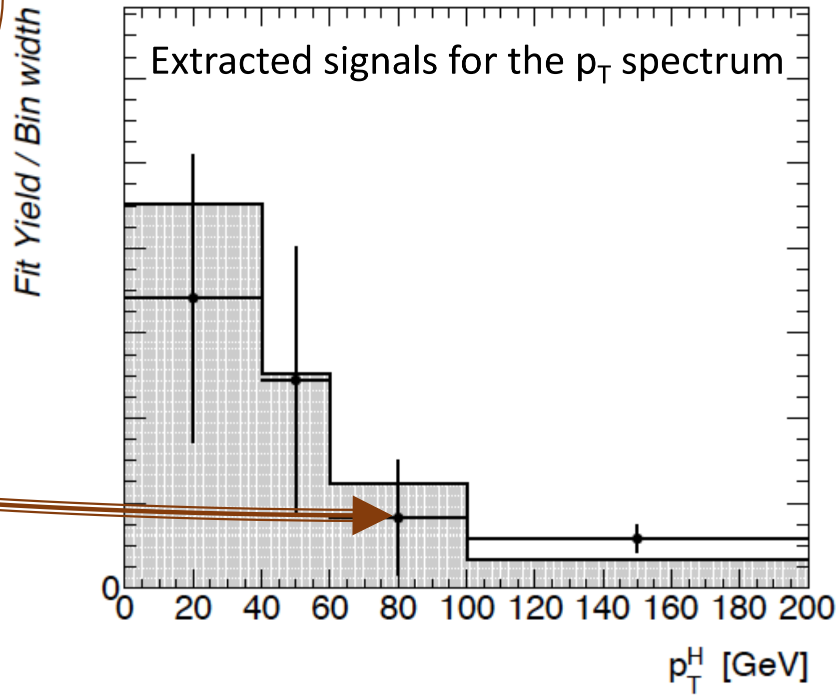


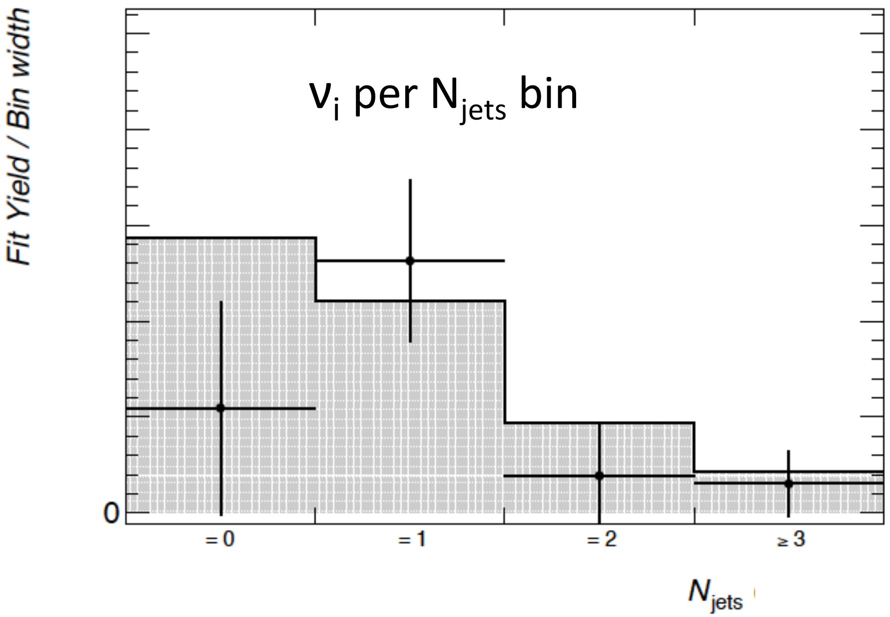
$$\mathcal{L} = \prod_i \left\{ \frac{e^{-\nu_i}}{n_i!} \prod_j^{n_i} \left[\nu_i^{\mathrm{sig}} \mathcal{F}_i^{\mathrm{sig}}(m_{\gamma\gamma}^j, \theta; m_H) + \nu_i^{\mathrm{bkg}} \mathcal{F}_i^{\mathrm{bkg}}(m_{\gamma\gamma}^j) \right] \right\} \times \prod_l G_l(\theta)$$

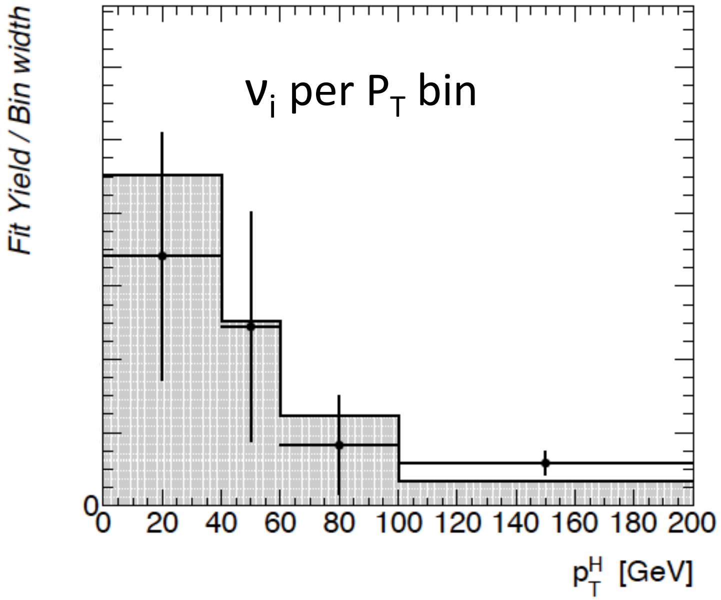
Unbinned maximum likelihood fit to the $m_{\gamma\gamma}$ spectrum in each fiducial region or bin of a differential distribution





Fiducial & Differential Cross-Sections

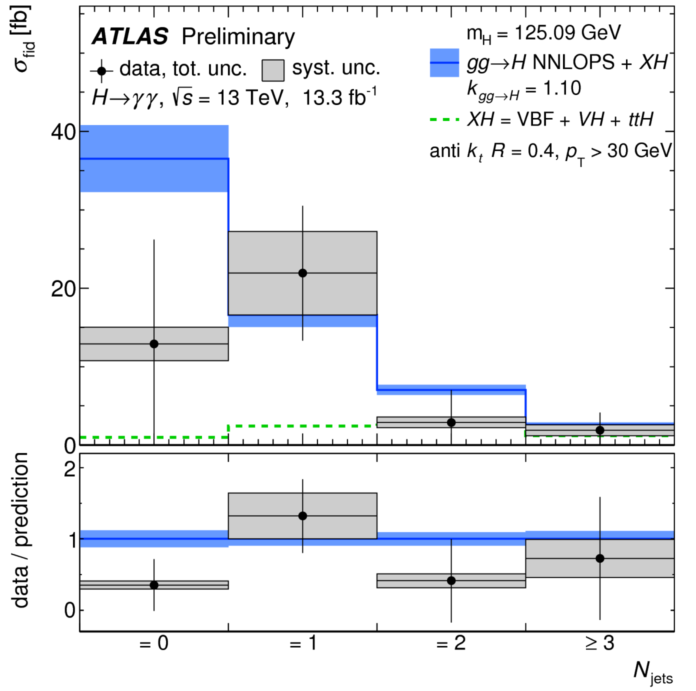


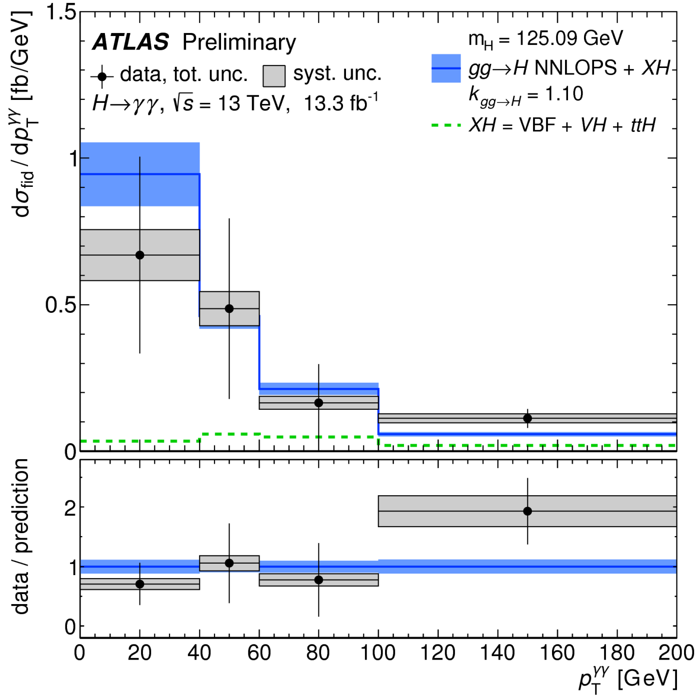


$$\sigma_{\text{fid}} = \frac{\nu_i^{\text{sig}}}{C_i \ \mathcal{L}_{\text{int}}}$$

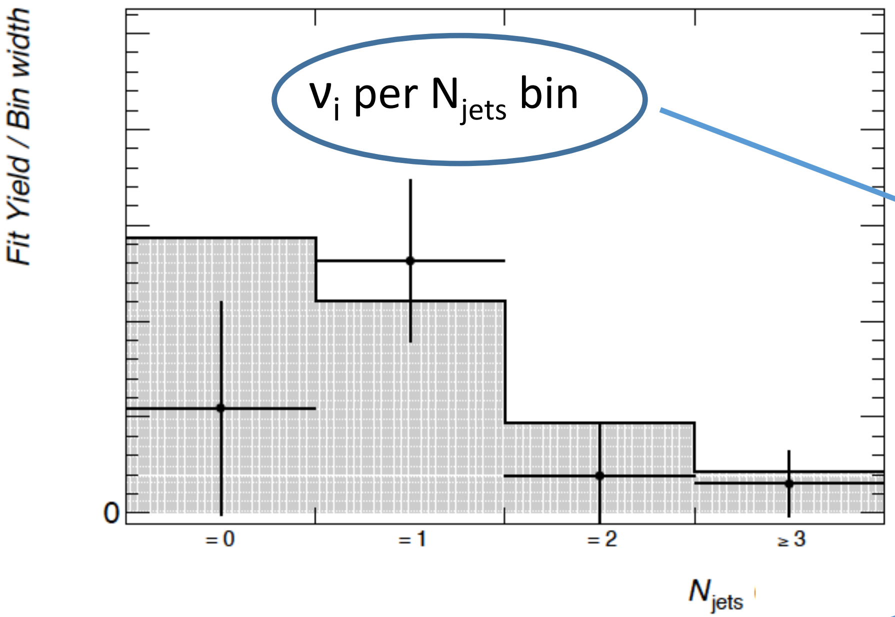
correction factor for detector effects

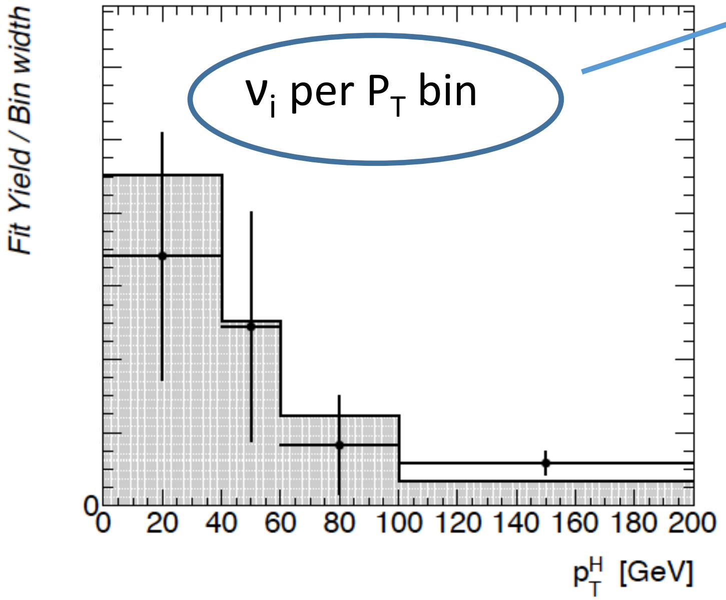
integrated luminosity





Fiducial & Differential Cross-Sections

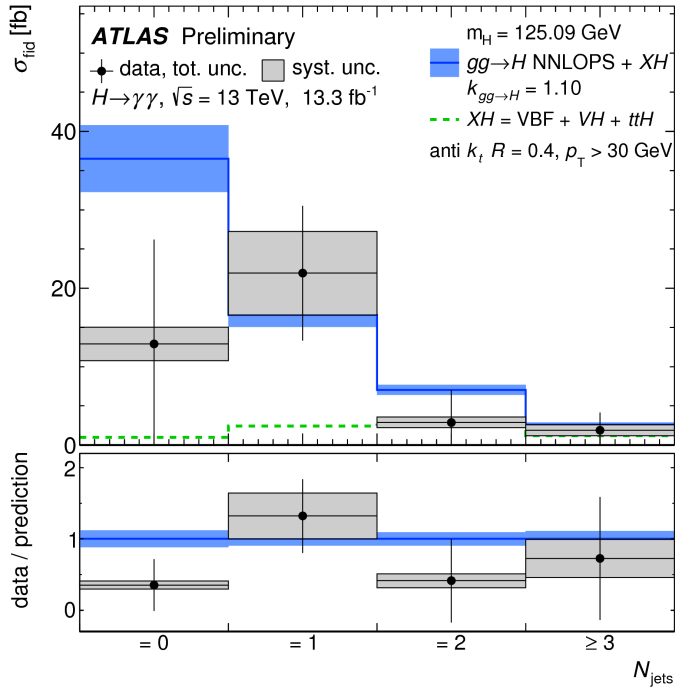


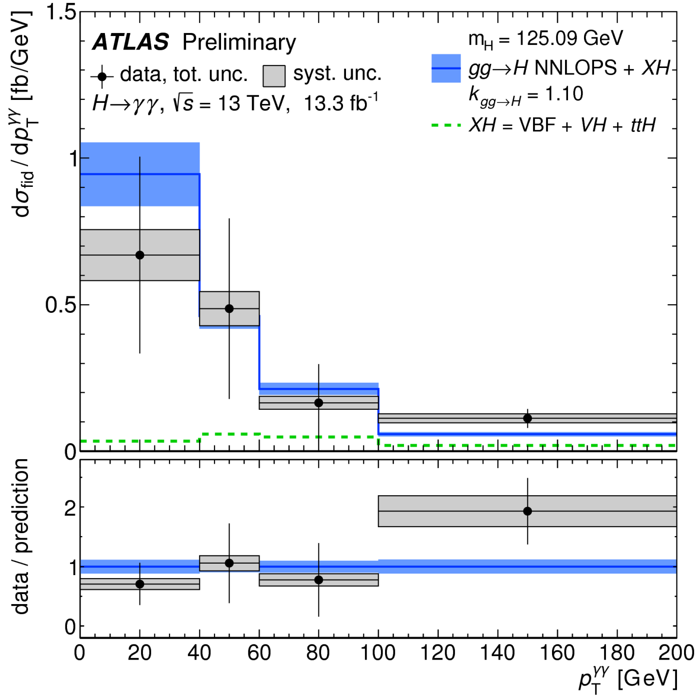


$$\sigma_{\text{fid}} = \frac{\nu_i^{\text{sig}}}{C_i \; \mathcal{L}_{\text{int}}}$$

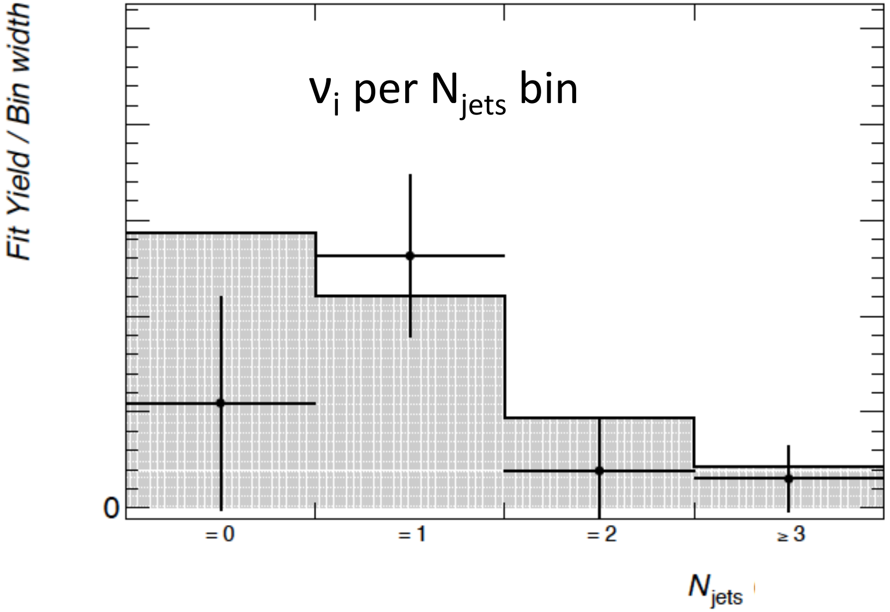
correction factor for detector effects

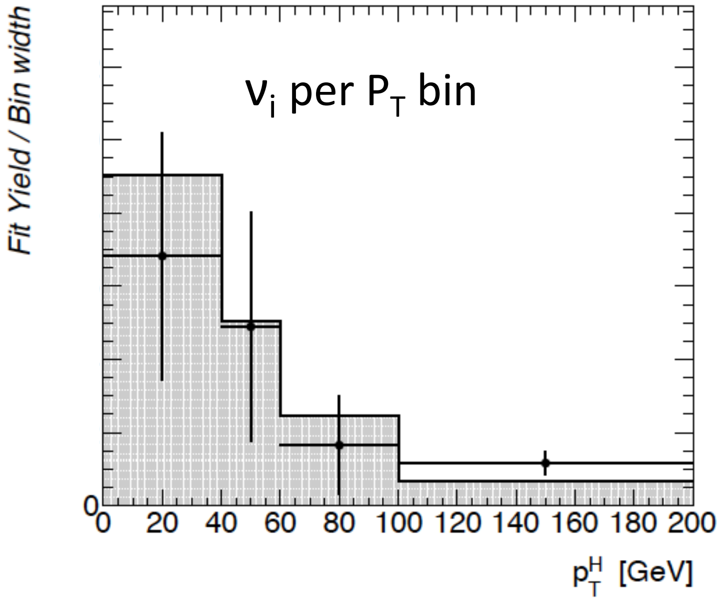
integrated luminosity





Fiducial & Differential Cross-Sections



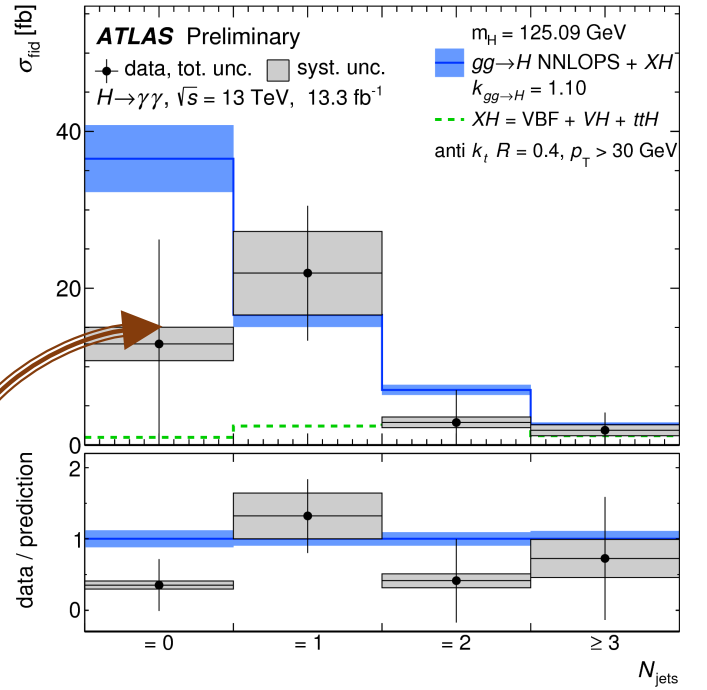


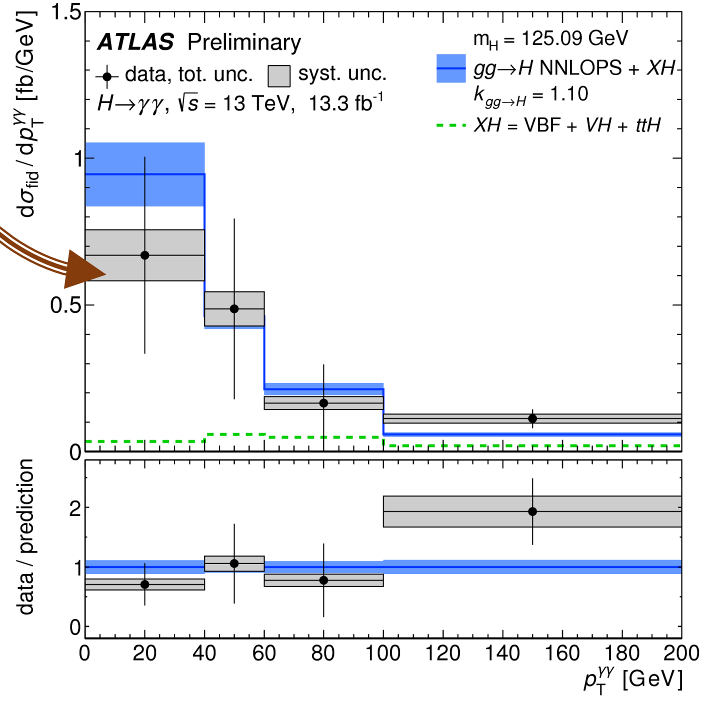
Particle-level cross-section measurements

$$\sigma_{\text{fid}} = \frac{\nu_i^{\text{sig}}}{C_i \; \mathcal{L}_{\text{int}}}$$

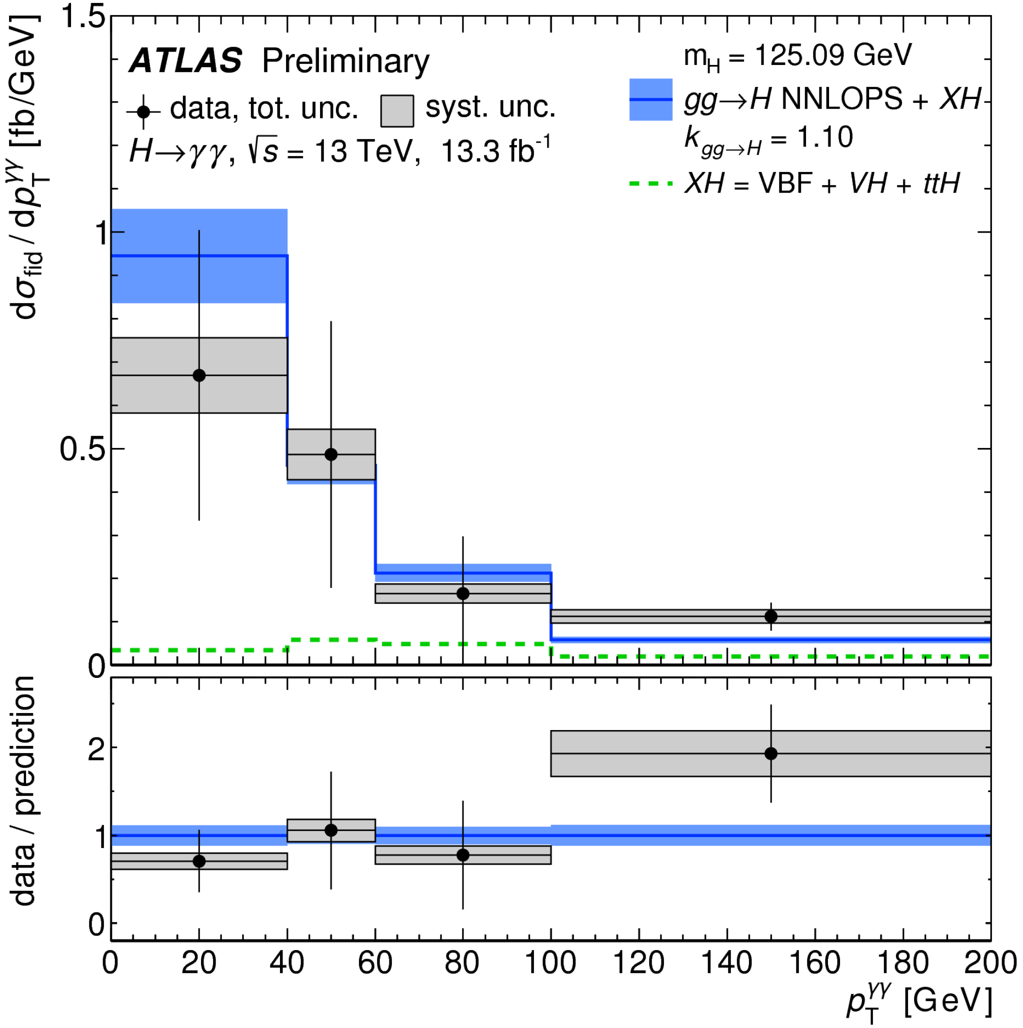
correction factor for detector effects

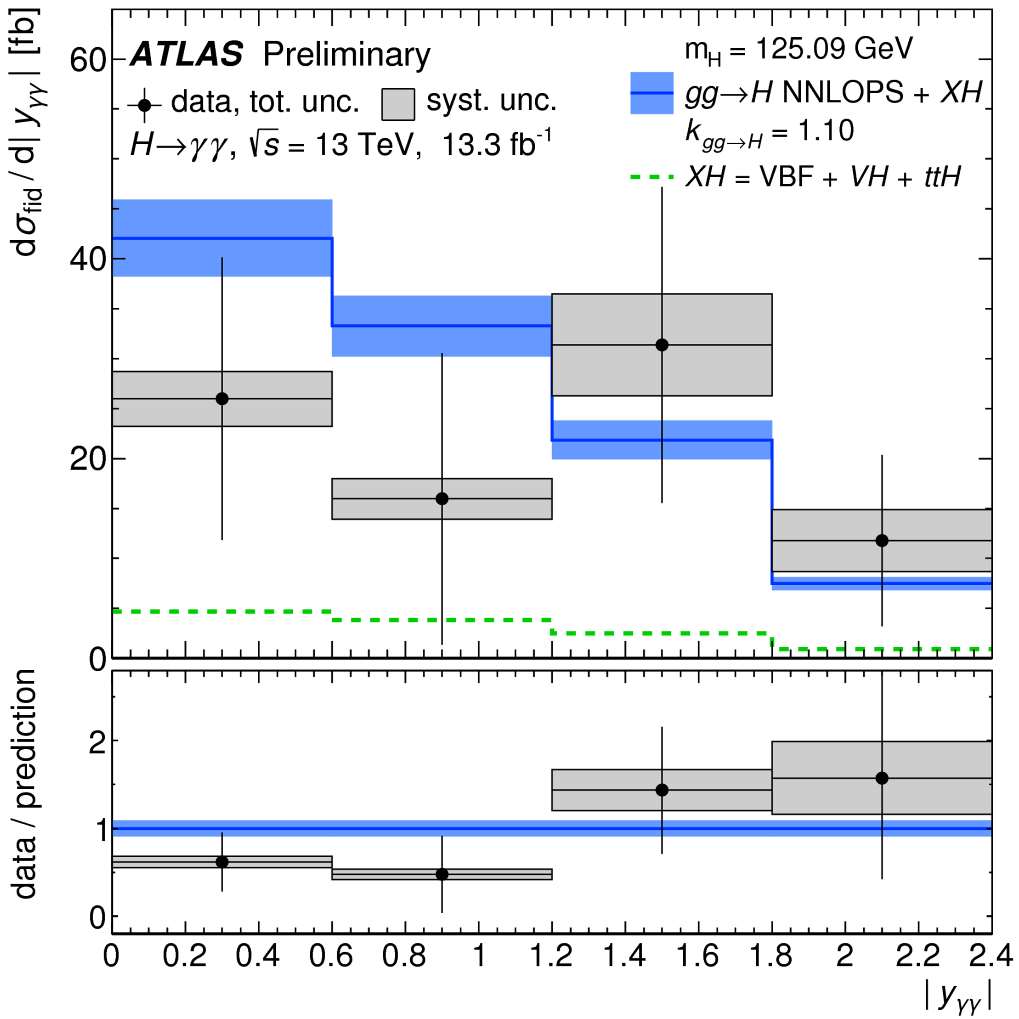
integrated luminosity





Higgs boson kinematics pp→ H → $\gamma\gamma$:



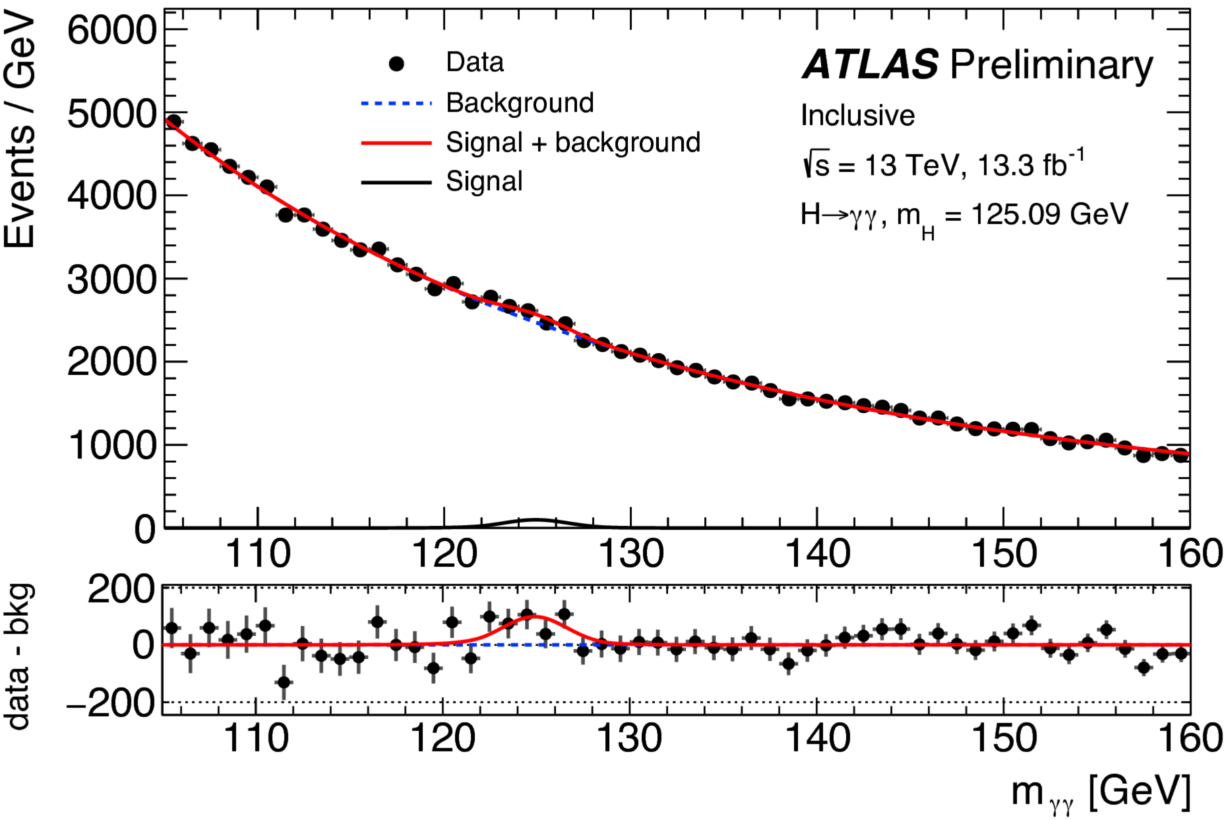


Good agreement data & SM prediction

Diphoton invariant mass spectrum ($H \rightarrow \gamma\gamma$)

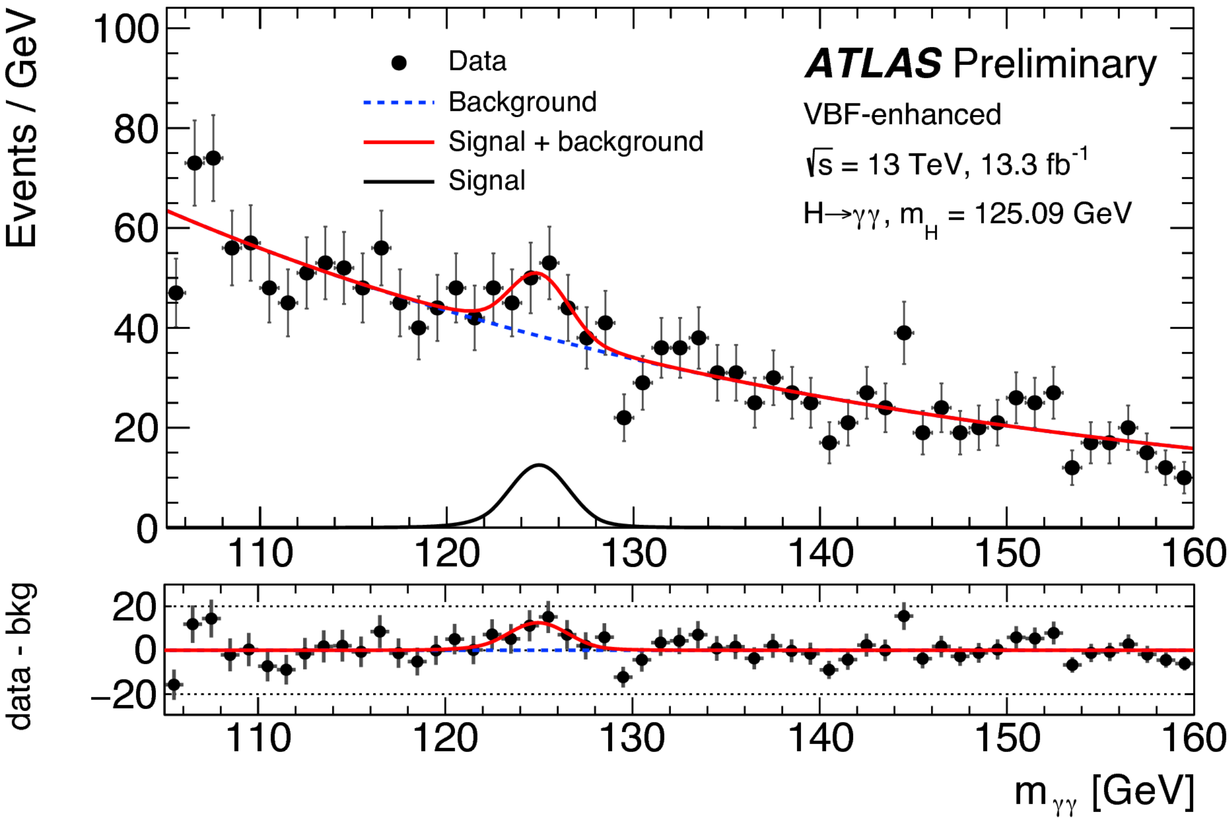
Baseline

$p_T(\gamma_1)/m_{\gamma\gamma} > 0.35$ and $p_T(\gamma_2)/m_{\gamma\gamma} > 0.25$
$|\eta| < 2.37$ (excluding crack-region $1.37 \leq |\eta| < 1.52$)



VBF-enhanced

$p_T(\text{jet}) > 30$ GeV, $|y(\text{jet})| < 4.4$ and $m_{jj} > 400$ GeV
$|\Delta y_{jj}| > 2.8$ and $|\Delta\Phi_{\gamma\gamma,jj}| > 2.6$



Cross Sections in Fiducial Phase Space Regions

$H \to \gamma\gamma$

	diphoton baseline	VBF enhanced	single lepton
Photons	$\lvert\eta\rvert < 1.37$ or $1.52 < \lvert\eta\rvert < 2.37$ $p_T^{\gamma_1} > 0.35\, m_{\gamma\gamma}$ and $p_T^{\gamma_2} > 0.25\, m_{\gamma\gamma}$		
Jets	- - -	$p_T > 30\,\text{GeV}$, $\lvert y\rvert < 4.4$ $m_{jj} > 400\,\text{GeV}$, $\lvert\Delta y_{jj}\rvert > 2.8$ $\lvert\Delta\phi_{\gamma\gamma,jj}\rvert > 2.6$	- - -
Leptons	-	-	$p_T > 15\,\text{GeV}$ $\lvert\eta\rvert < 2.47$

Fiducial region	Measured cross section (fb)	SM prediction (fb)	
Baseline	$43.2 \pm 14.9\,(\text{stat.}) \pm 4.9\,(\text{syst.})$	$62.8\,^{+3.4}_{-4.4}$	$[\text{N}^3\text{LO} + \text{XH}]$
VBF-enhanced	$4.0 \pm 1.4\,(\text{stat.}) \pm 0.7\,(\text{syst.})$	2.04 ± 0.13	[NNLOPS + XH]
single lepton	$1.5 \pm 0.8\,(\text{stat.}) \pm 0.2\,(\text{syst.})$	0.56 ± 0.03	[NNLOPS + XH]

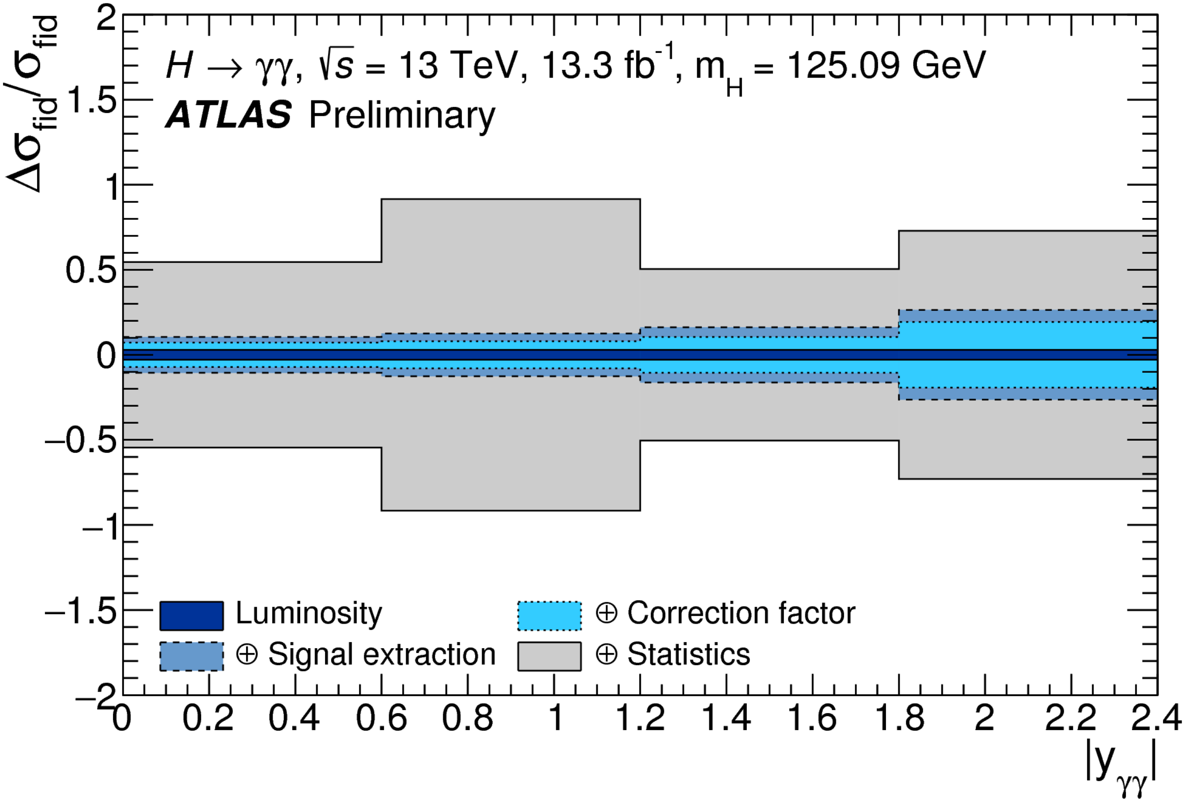
$H \to \gamma\gamma$ Systematics Uncertainties and Their Impacts

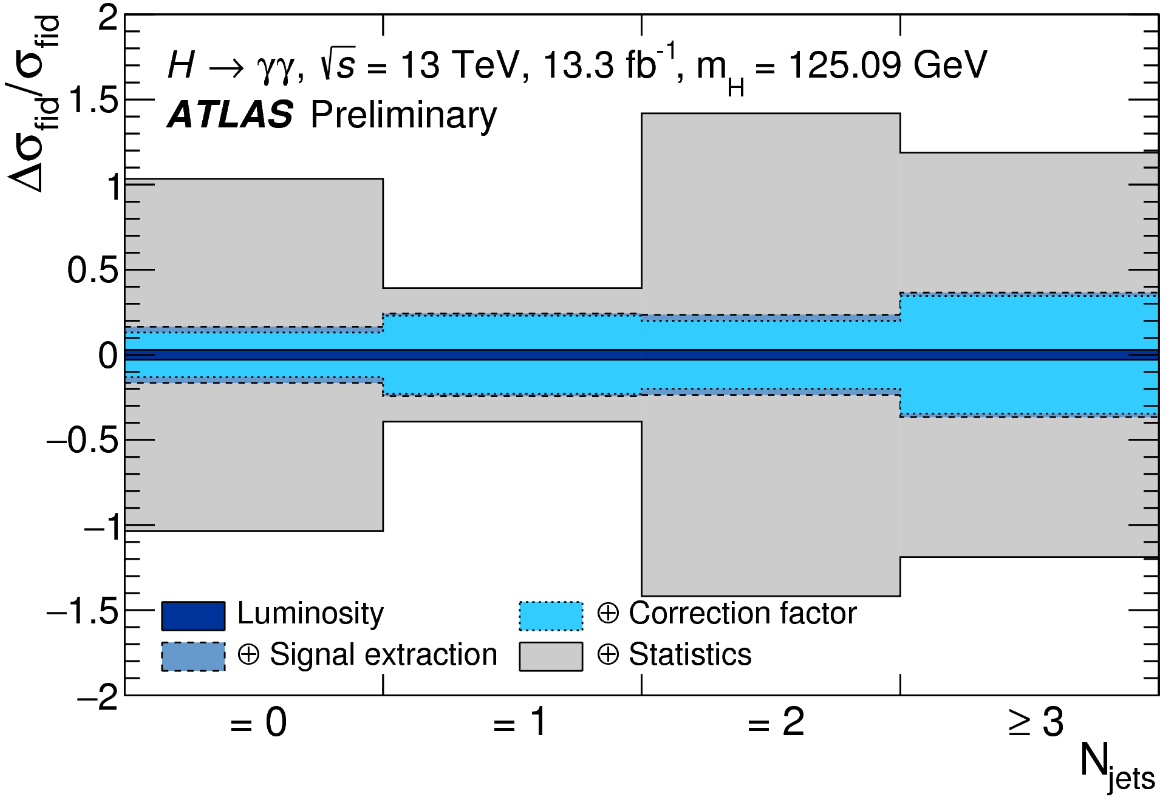
Photon energy resolution and **background modeling** are typically the main uncertainties

Jet energy calibration uncertainties important when jet activity

Source	Uncertainty on fiducial cross section (%)		
	Baseline	VBF-enhanced	single-lepton
Fit (stat.)	34.5	35.0	52.9
Fit (syst.)	9.0	11.1	9.3
Photon efficiency	4.4	4.4	4.4
Jet energy scale/resolution	-	9.4	-
Lepton selection	-	-	0.8
Pileup	1.1	2.0	1.4
Theoretical modelling	4.3	9.4	8.4
Luminosity	2.9	2.9	2.9

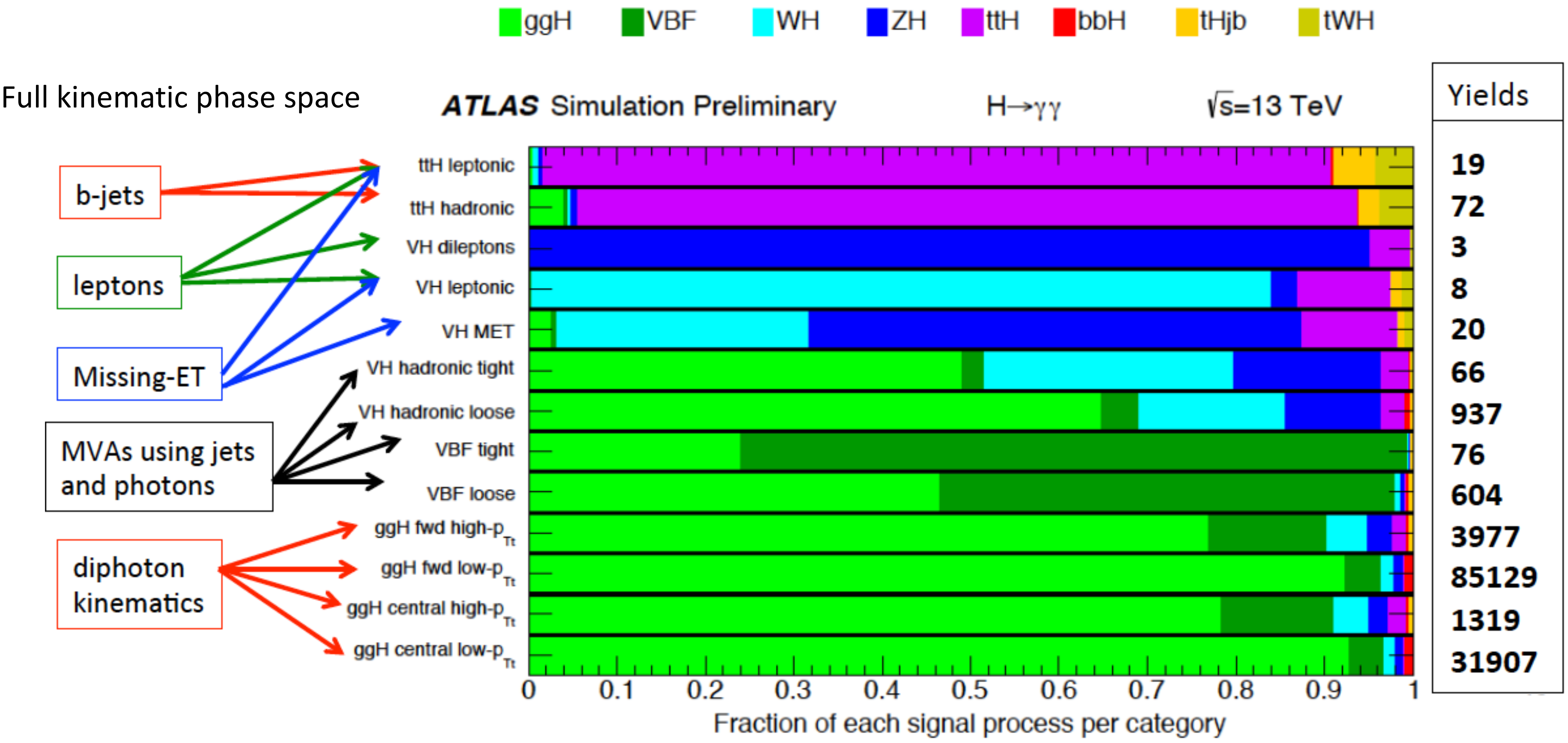
Dominated by statistical error !!!





H → γγ Simplified Template Cross Sections

Events are split into 13 orthogonal categories that exploit topological differences between production mechanisms



H → $\gamma\gamma$ Procedure to get Signal Yields per category

Production cross section extracted by a combined fit to $m_{\gamma\gamma}$ specta

$$N_k^{\text{sig}} = \sum_i \sigma_i \cdot \mathcal{B}(H \to \gamma\gamma) \cdot \epsilon_{ik} \cdot A_{ik} \cdot \int L\,\mathrm{d}t$$

Signal yield in specified category

Production cross section times branching ratio for given process

Acceptance predicted by SM for given process in specified category

Dominant uncertainty again from photon energy scale/resolution in fit

Large uncertainty from theoretical modelling of acceptances, especially for gluon fusion in VBF-enriched categories

H → $\gamma\gamma$ Production mode Cross Section

Total Higgs production cross section

$$\sigma_{ggH} \times \mathcal{B}(H \to \gamma\gamma) = 65\ ^{+32}_{-31}\ \text{fb}$$

$$\sigma_{\text{VBF}} \times \mathcal{B}(H \to \gamma\gamma) = 19.2\ ^{+6.8}_{-6.1}\ \text{fb}$$

$$\sigma_{\text{VH}} \times \mathcal{B}(H \to \gamma\gamma) = 1.2\ ^{+6.5}_{-5.4}\ \text{fb}$$

$$\sigma_{t\bar{t}H} \times \mathcal{B}(H \to \gamma\gamma) = -0.28\ ^{+1.44}_{-1.12}\ \text{fb}$$

Higgs production cross section ($|y_H|<2.5$)

$$\sigma_{ggH} \times \mathcal{B}(H \to \gamma\gamma) = 63\ ^{+30}_{-29}\ \text{fb}$$

$$\sigma_{\text{VBF}} \times \mathcal{B}(H \to \gamma\gamma) = 17.8\ ^{+6.3}_{-5.7}\ \text{fb}$$

$$\sigma_{\text{VHlep}} \times \mathcal{B}(H \to \gamma\gamma) = 0.96\ ^{+2.52}_{-1.90}\ \text{fb}$$

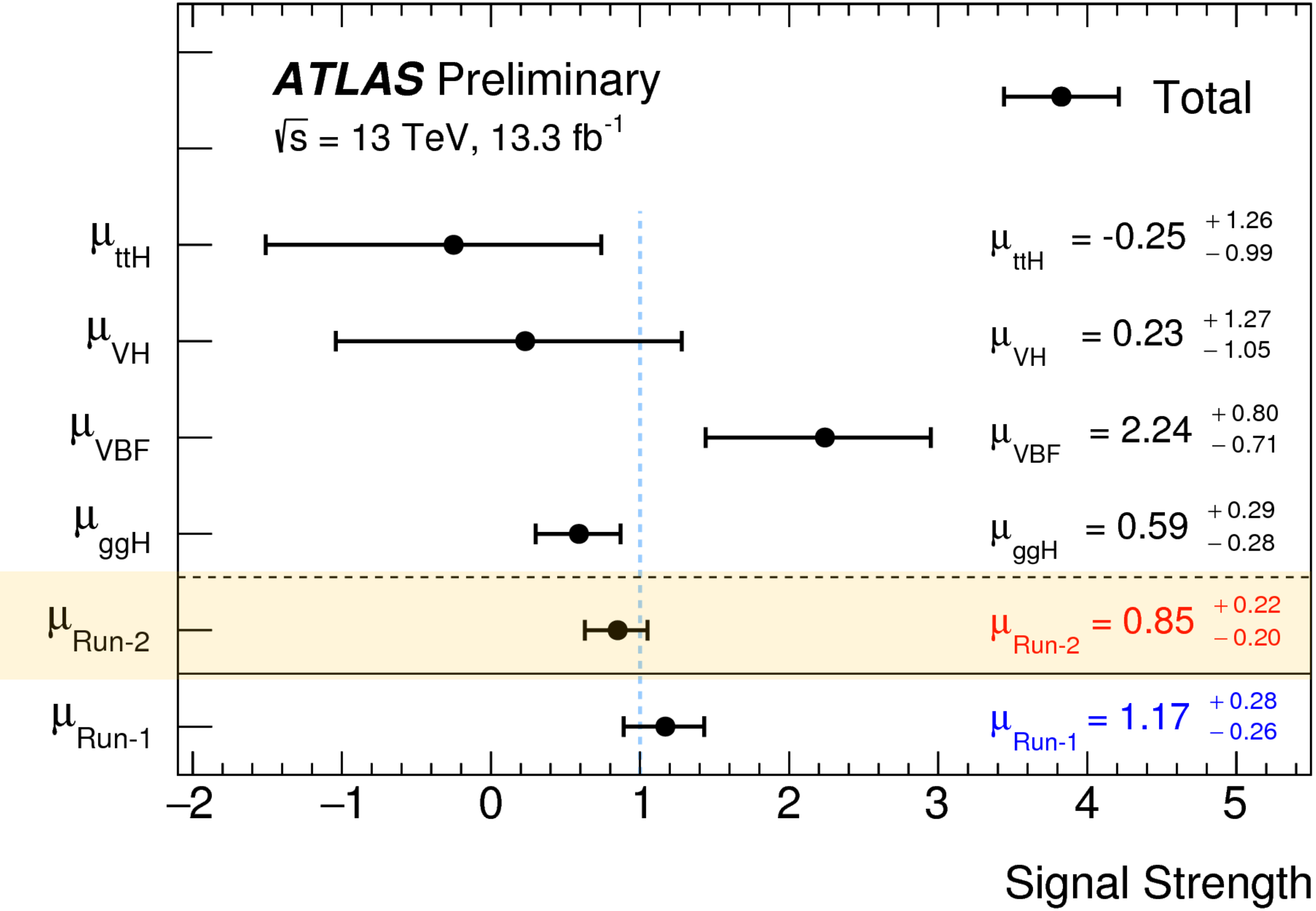
$$\sigma_{\text{VHhad}} \times \mathcal{B}(H \to \gamma\gamma) = -2.3\ ^{+6.8}_{-5.8}\ \text{fb}$$

$$\sigma_{t\bar{t}H} \times \mathcal{B}(H \to \gamma\gamma) = -0.28\ ^{+1.43}_{-1.12}\ \text{fb}$$

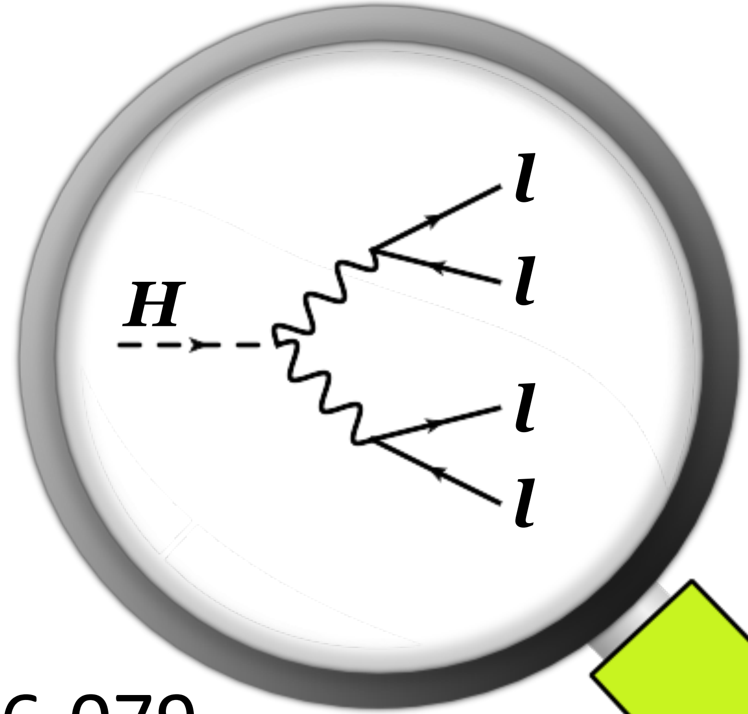
Observed significance of H→$\gamma\gamma$ signal is 4.7σ (SM expectation of 5.4σ)

Signal Strength from H → $\gamma\gamma$

$$\mu = \frac{\sigma \times BR}{(\sigma \times BR)_{SM}}$$



$H \rightarrow ZZ^* \rightarrow 4\ell$



ATLAS-CONF-2016-079

14.8 fb^{-1} of data taken at 13 TeV

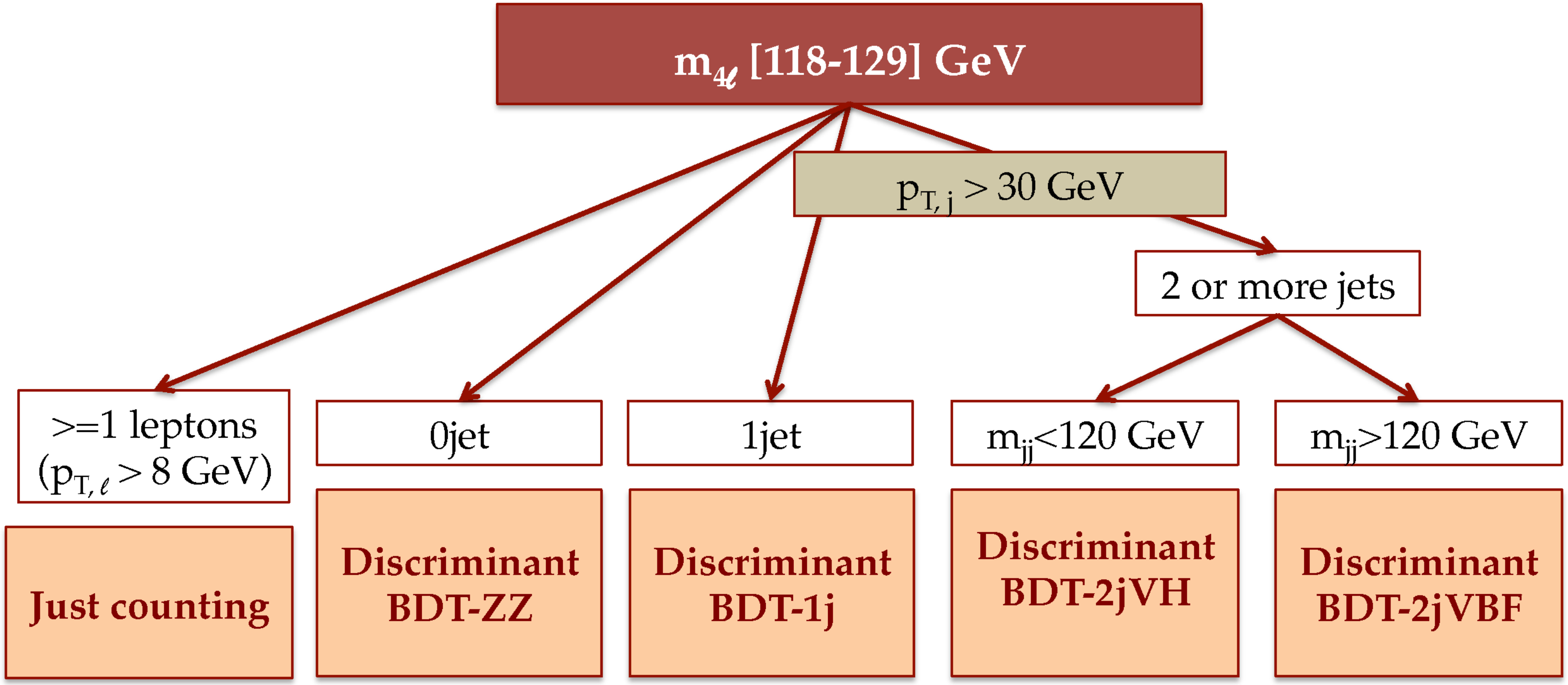
ATLAS-CONF-2017-032

36.1 fb^{-1} of data taken at 13 TeV

new

$H \rightarrow 4\ell$ Event Categorization with BDT

➢ Signals extracted through a likelihood fit to the shape of BDT discriminants in each category



BDT_ZZ:
- $p_{T4\ell}$
- $\eta_{4\ell}$
- KD = $\log(ME_{HZZ}/ME_{ZZ})$

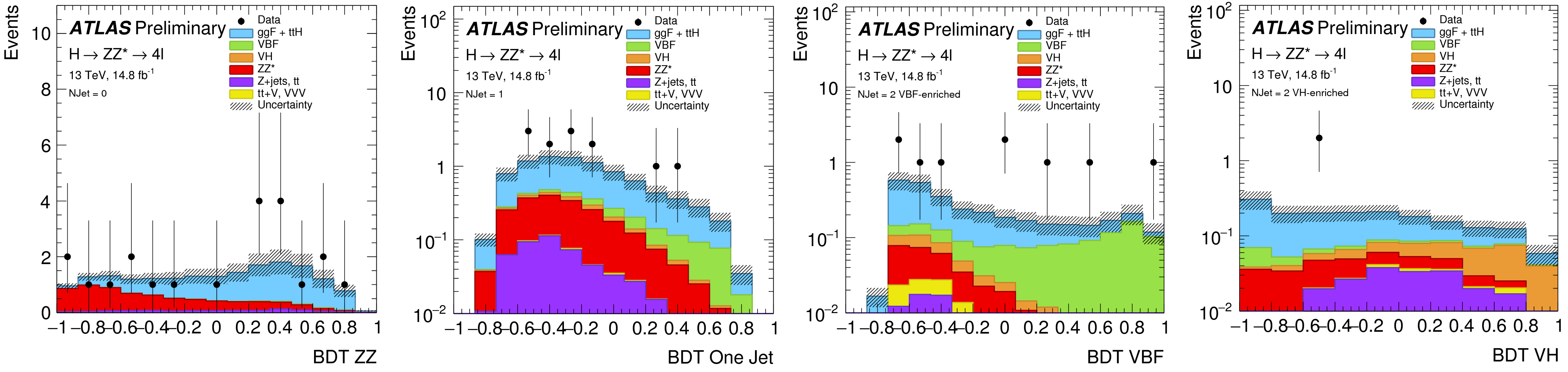
BDT_1jet:
- $p_{T,j}$
- η_j
- $\Delta R_{4\ell j}$

BDT_2jet_VH:
- $p_{T,j1}$
- $p_{T,j2}$
- η_{j1}
- $\Delta\eta_{jj}$
- $\Delta\eta_{4\ell jj}$
- m_{jj}
- $\min(\Delta R_{Zj})$

BDT_2jet_VBF:
- $p_{T,j1}$
- $p_{T,j2}$
- $p_{T,4\ell jj}$
- $\Delta\eta_{jj}$
- $\Delta\eta_{4\ell jj}$
- m_{jj}
- $\min(\Delta R_{Zj})$

BTD = Boosted Decision Tree (machine learning technique)

H → 4ℓ Likelihood Fit Shape of BDT in Each Category



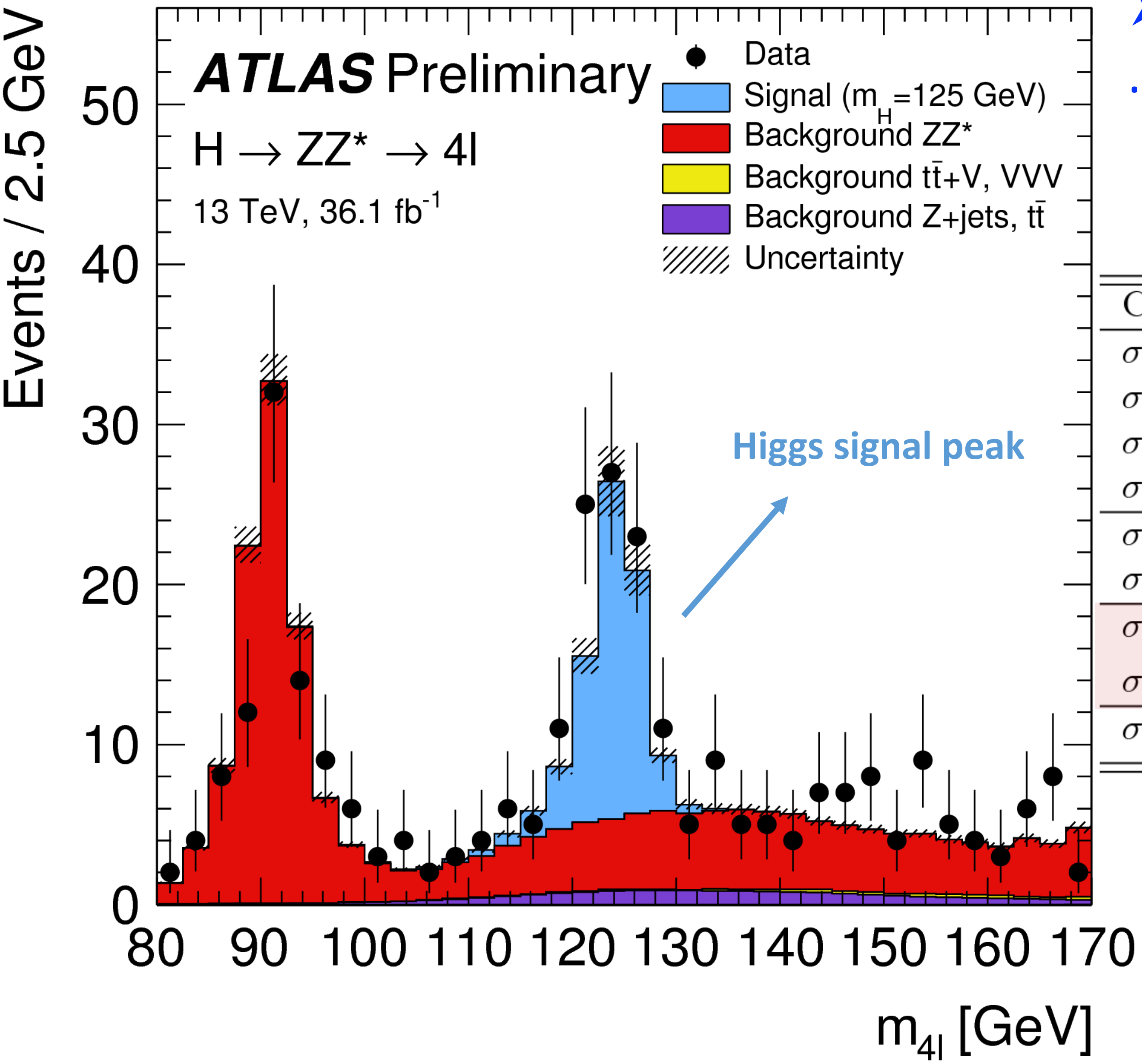
$$\sigma_{\mathrm{ggF}+b\bar{b}H+t\bar{t}H} \cdot \mathcal{B}(H \to ZZ^*) = 1.80^{+0.49}_{-0.44}\ \mathrm{pb} \qquad \sigma_{\mathrm{SM,ggF}+b\bar{b}H+t\bar{t}H} \cdot \mathcal{B}(H \to ZZ^*) = 1.31 \pm 0.07\ \mathrm{pb}$$

$$\sigma_{\mathrm{VBF}} \cdot \mathcal{B}(H \to ZZ^*) = 0.37^{+0.28}_{-0.21}\ \mathrm{pb} \qquad \sigma_{\mathrm{SM,VBF}} \cdot \mathcal{B}(H \to ZZ^*) = 0.100 \pm 0.003\ \mathrm{pb}$$

$$\sigma_{\mathrm{VH}} \cdot \mathcal{B}(H \to ZZ^*) = 0^{+0.15}\ \mathrm{pb} \qquad \sigma_{\mathrm{SM,VH}} \cdot \mathcal{B}(H \to ZZ^*) = 0.059 \pm 0.002\ \mathrm{pb}$$

The compatibility between the measured $\sigma_{\mathrm{ggF}+b\bar{b}H+t\bar{t}H} \cdot \mathcal{B}(H \to ZZ^*)$ and the SM prediction is at the level of 1.1 standard deviations, while for the $\sigma_{\mathrm{VBF}} \cdot \mathcal{B}(H \to ZZ^*)$ the compatibility with the SM prediction is at the level of 1.4 standard deviations.

H → 4ℓ Mass Distribution & Fiducial Cross Sections

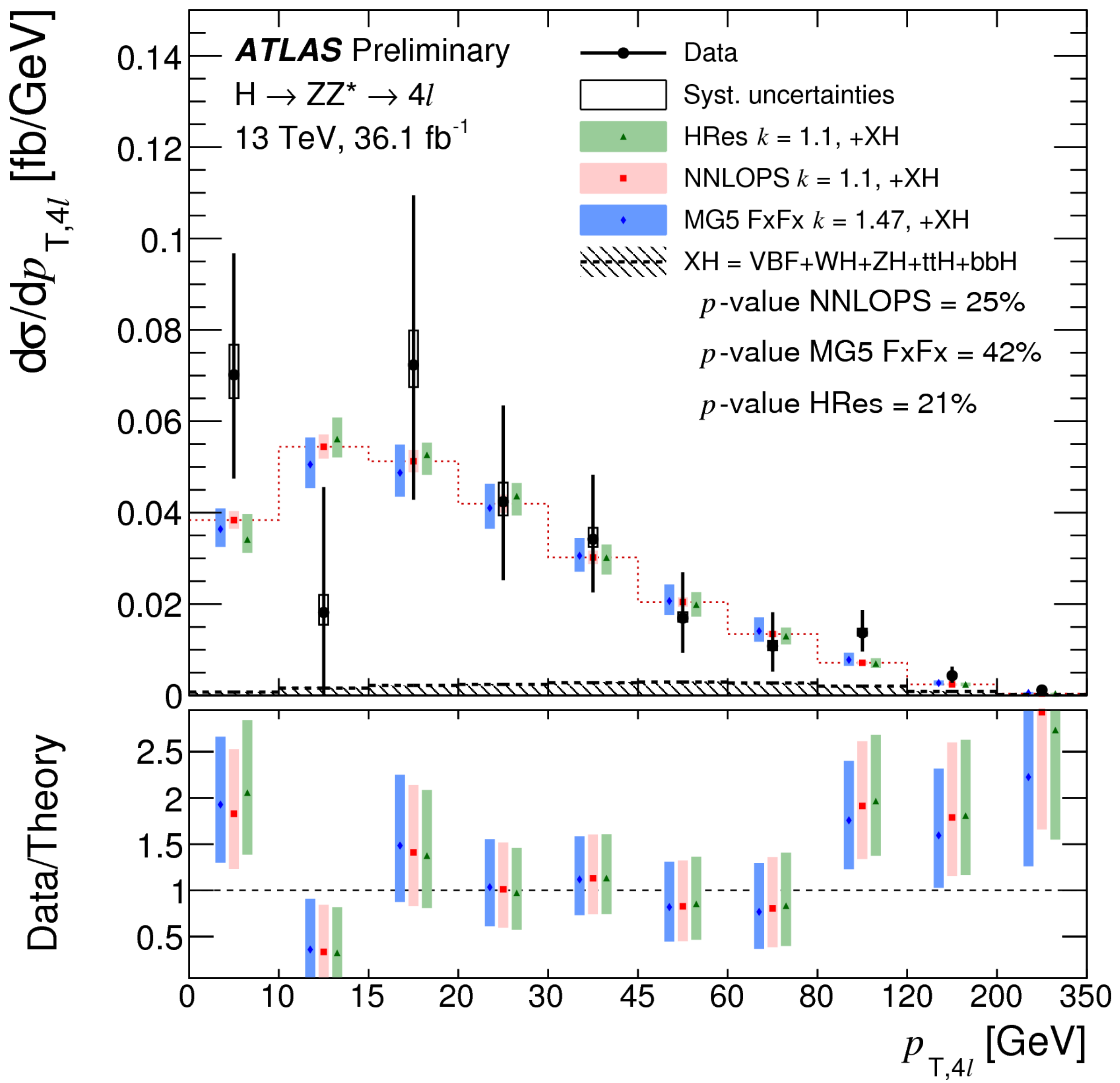


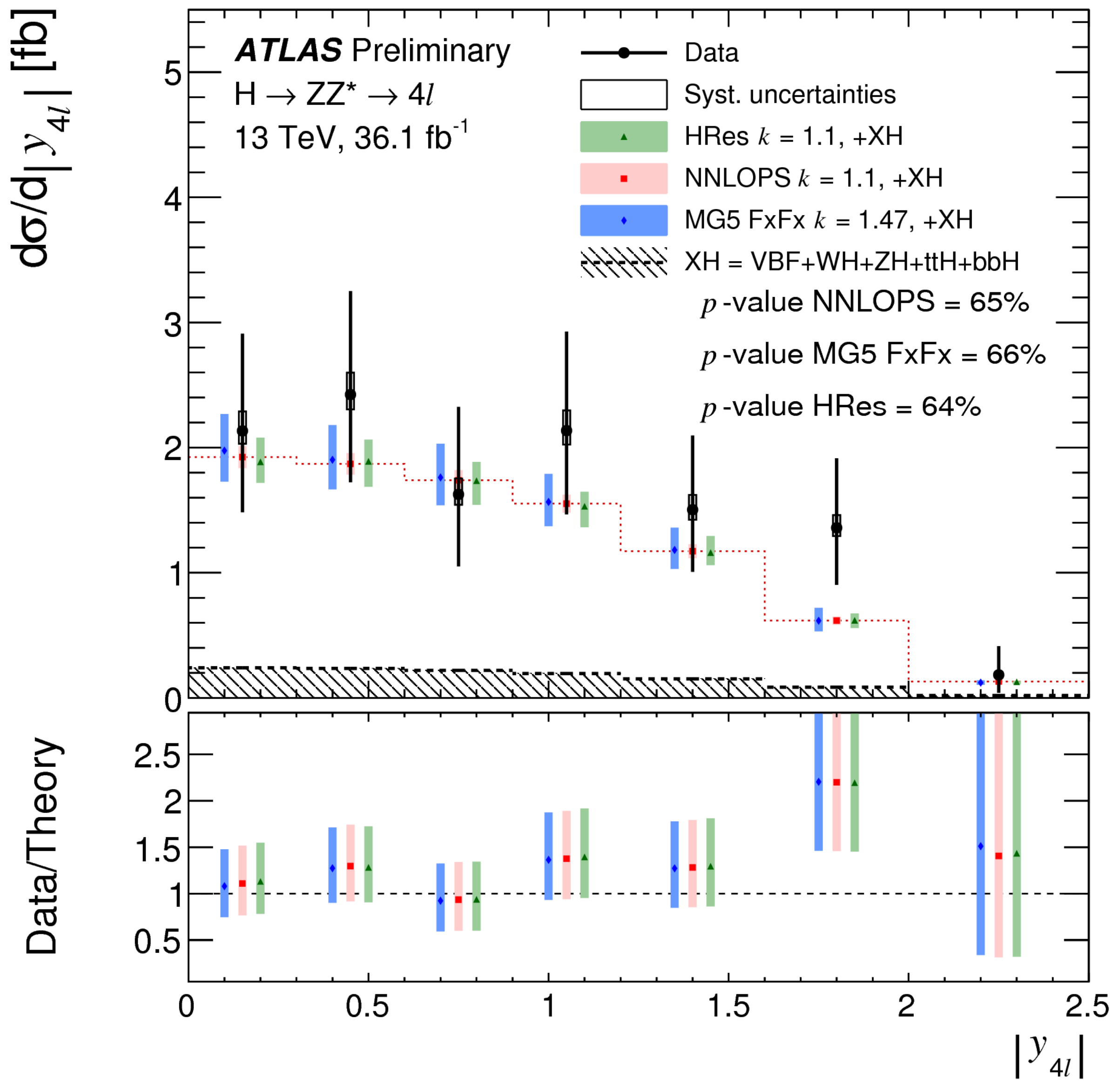
- Small number of events after event selection
… but very clean signature [115–130 GeV]

$N_{expected}$ = 87.0 ± 6 with $N_{observed}$ = 102

Cross section	Data (± (stat) ± (sys))	LHCXSWG prediction
$\sigma_{4\mu}$ [fb]	$0.92\ ^{+0.25}_{-0.23}\ ^{+0.07}_{-0.05}$	0.880 ± 0.039
σ_{4e} [fb]	$0.67\ ^{+0.28}_{-0.23}\ ^{+0.08}_{-0.06}$	0.688 ± 0.031
$\sigma_{2\mu2e}$ [fb]	$0.84\ ^{+0.28}_{-0.24}\ ^{+0.09}_{-0.06}$	0.625 ± 0.028
$\sigma_{2e2\mu}$ [fb]	$1.18\ ^{+0.30}_{-0.26}\ ^{+0.07}_{-0.05}$	0.717 ± 0.032
$\sigma_{4\mu+4e}$ [fb]	$1.59\ ^{+0.37}_{-0.33}\ ^{+0.12}_{-0.10}$	1.57 ± 0.07
$\sigma_{2\mu2e+2e2\mu}$ [fb]	$2.02\ ^{+0.40}_{-0.36}\ ^{+0.14}_{-0.11}$	1.34 ± 0.06
σ_{sum} [fb]	$3.61\ ^{+0.54}_{-0.50}\ ^{+0.26}_{-0.21}$	2.91 ± 0.13
σ_{comb} [fb]	$3.62\ ^{+0.53}_{-0.50}\ ^{+0.25}_{-0.20}$	2.91 ± 0.13
σ_{tot} [pb]	$69\ ^{+10}_{-9}\ \pm 5$	55.6 ± 2.5

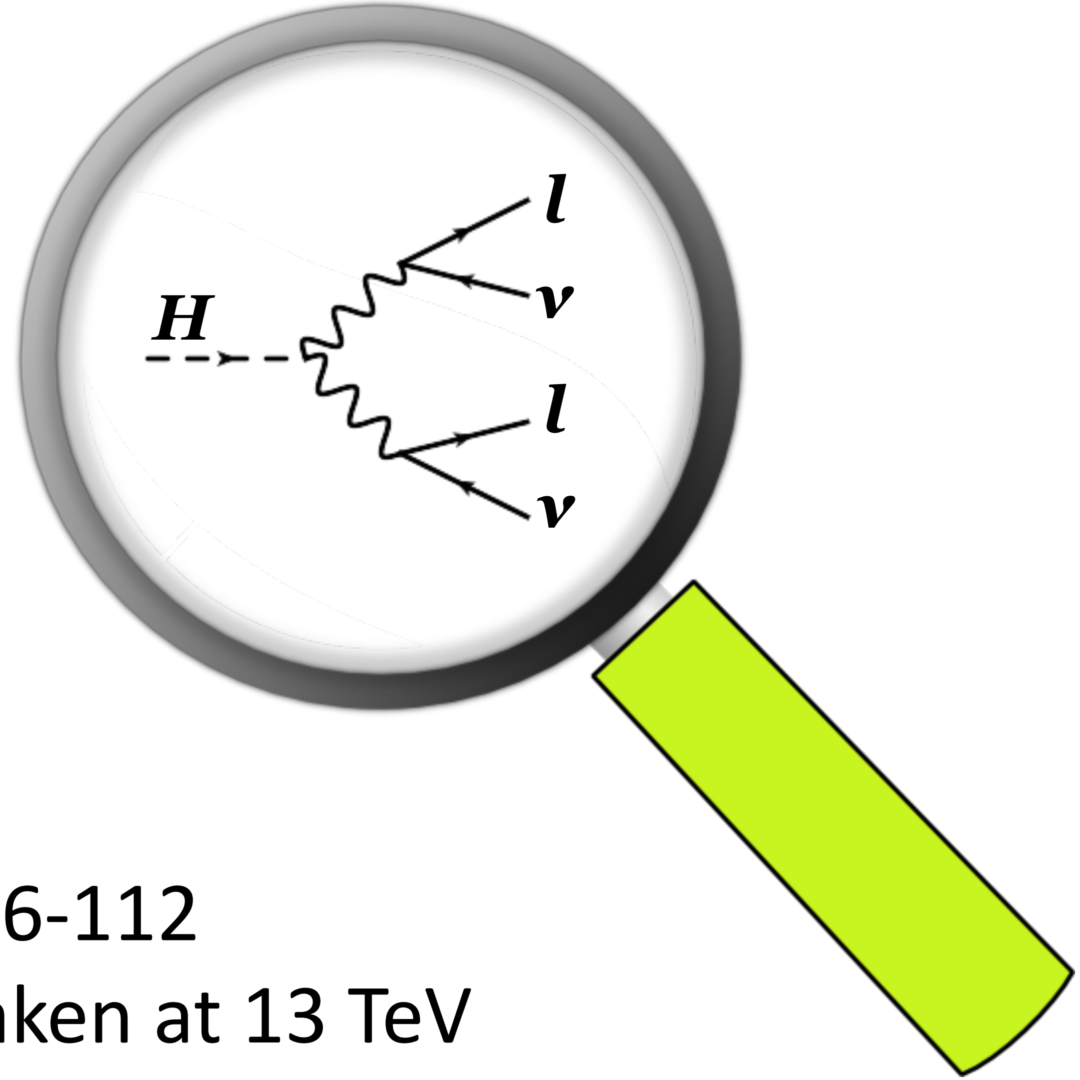
Higgs boson kinematics pp→ H → 4ℓ:





Good agreement data & SM prediction

$H \rightarrow WW^* \rightarrow \ell\nu\, \ell\nu$



ATLAS-CONF-2016-112

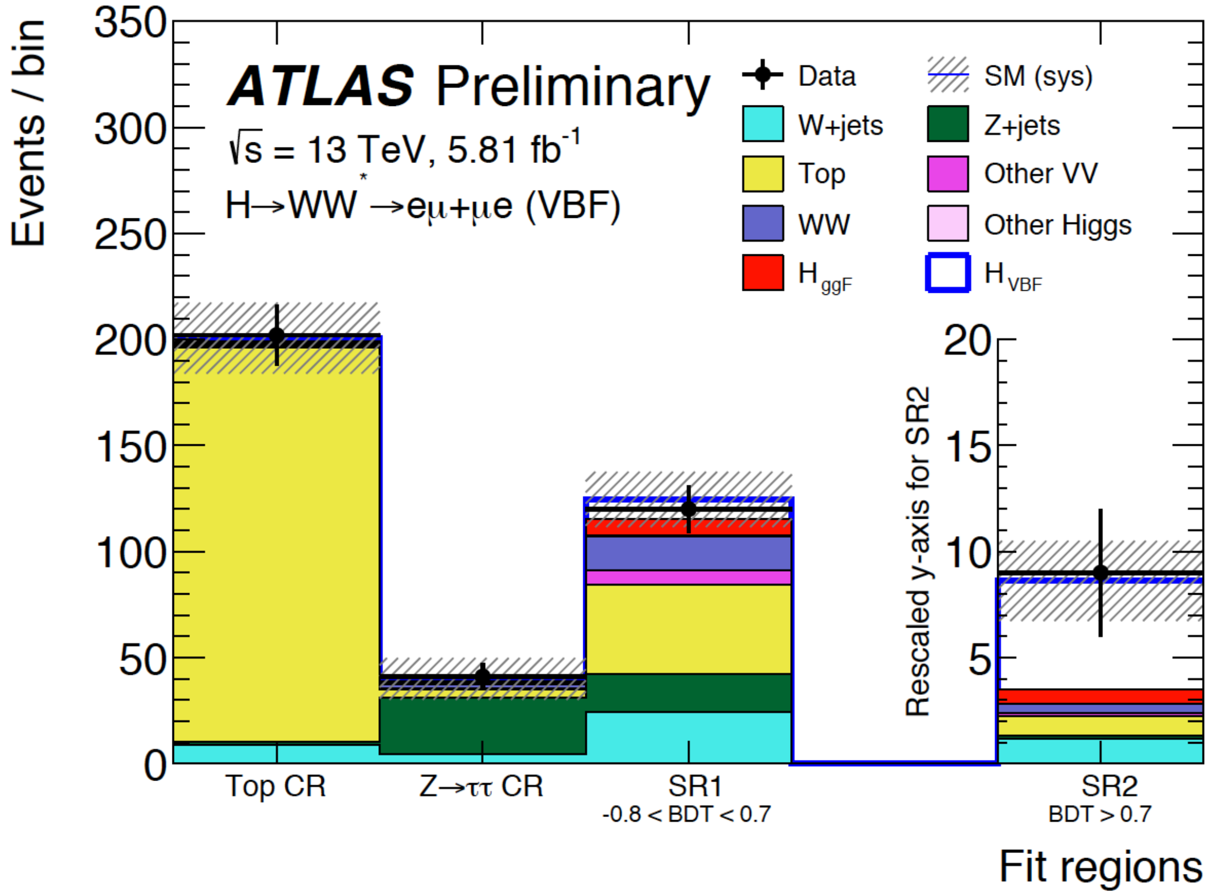
5.8 fb^{-1} of data taken at 13 TeV

H→WW*→ ℓν ℓν Signal Strength and Cross Sections

Consistent with the Standard Model

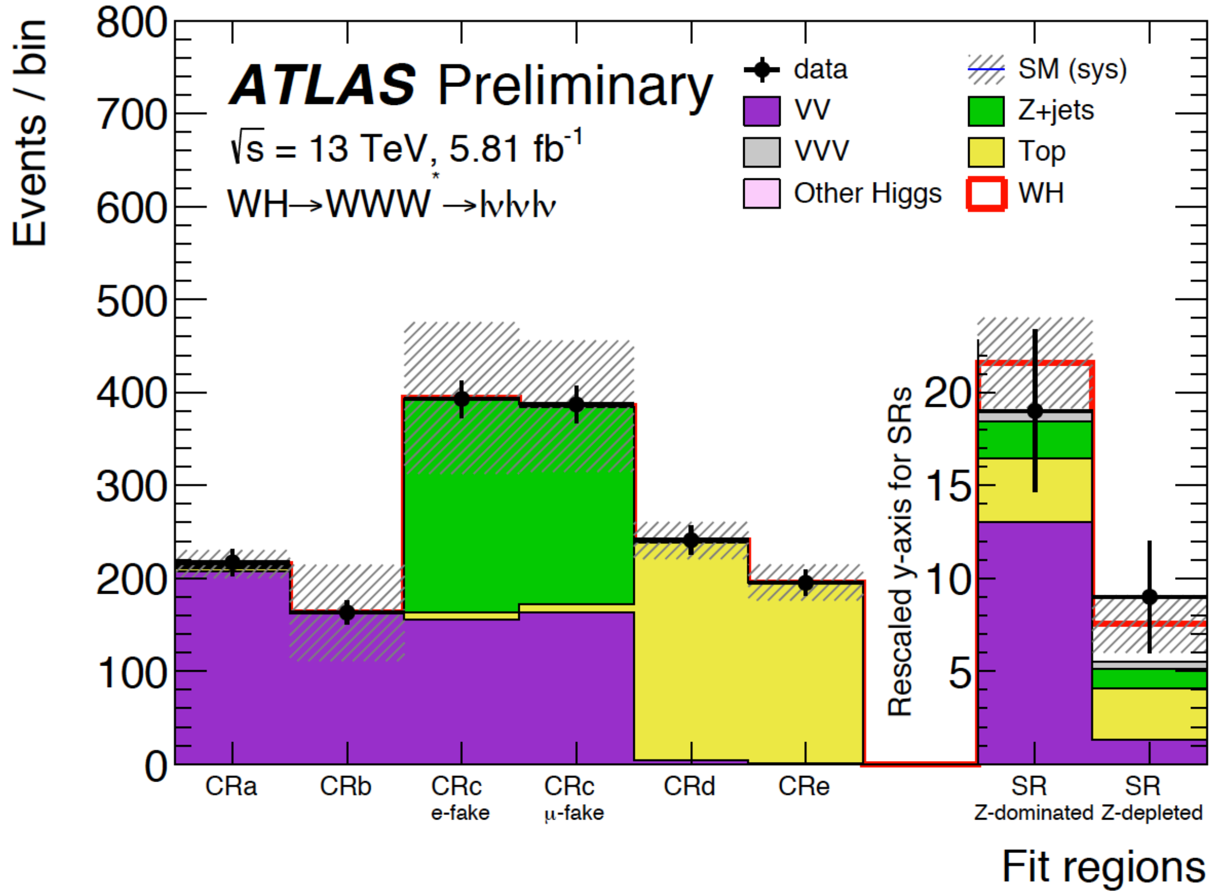
$$\mu_{\mathrm{VBF}} = 1.7^{+1.0}_{-0.8}(\mathrm{stat})^{+0.6}_{-0.4}(\mathrm{sys})$$

$$\sigma_{\mathrm{VBF}} \cdot \mathcal{B}_{H\to WW^*} = 1.4^{+0.8}_{-0.6}(\mathrm{stat})^{+0.5}_{-0.4}(\mathrm{sys})\ \mathrm{pb}$$



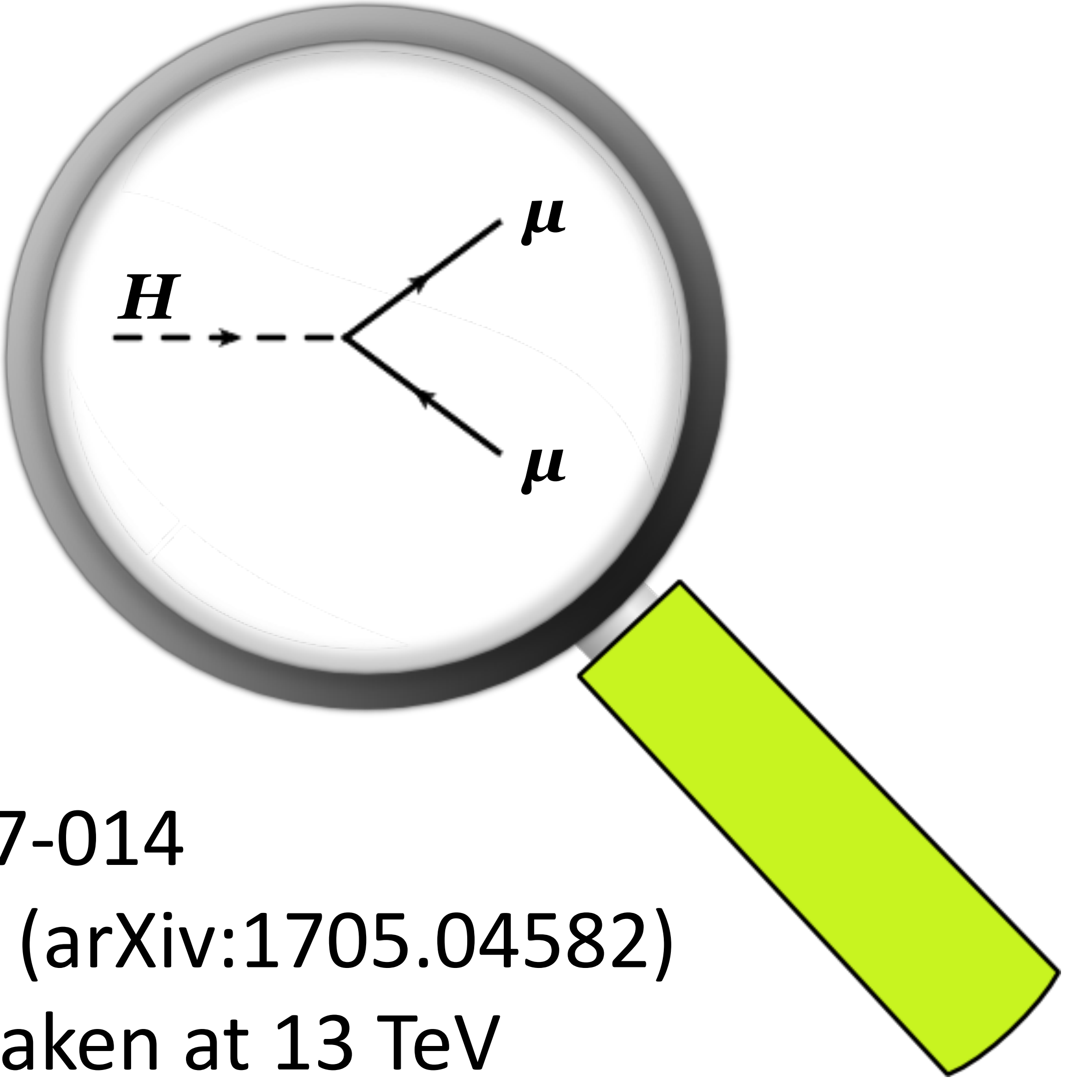
$$\mu_{WH} = 3.2^{+3.7}_{-3.2}(\mathrm{stat})^{+2.3}_{-2.7}(\mathrm{sys})$$

$$\sigma_{WH} \cdot \mathcal{B}_{H\to WW^*} = 0.9^{+1.1}_{-0.9}(\mathrm{stat})^{+0.7}_{-0.8}(\mathrm{sys})\ \mathrm{pb}$$



H→μμ

new



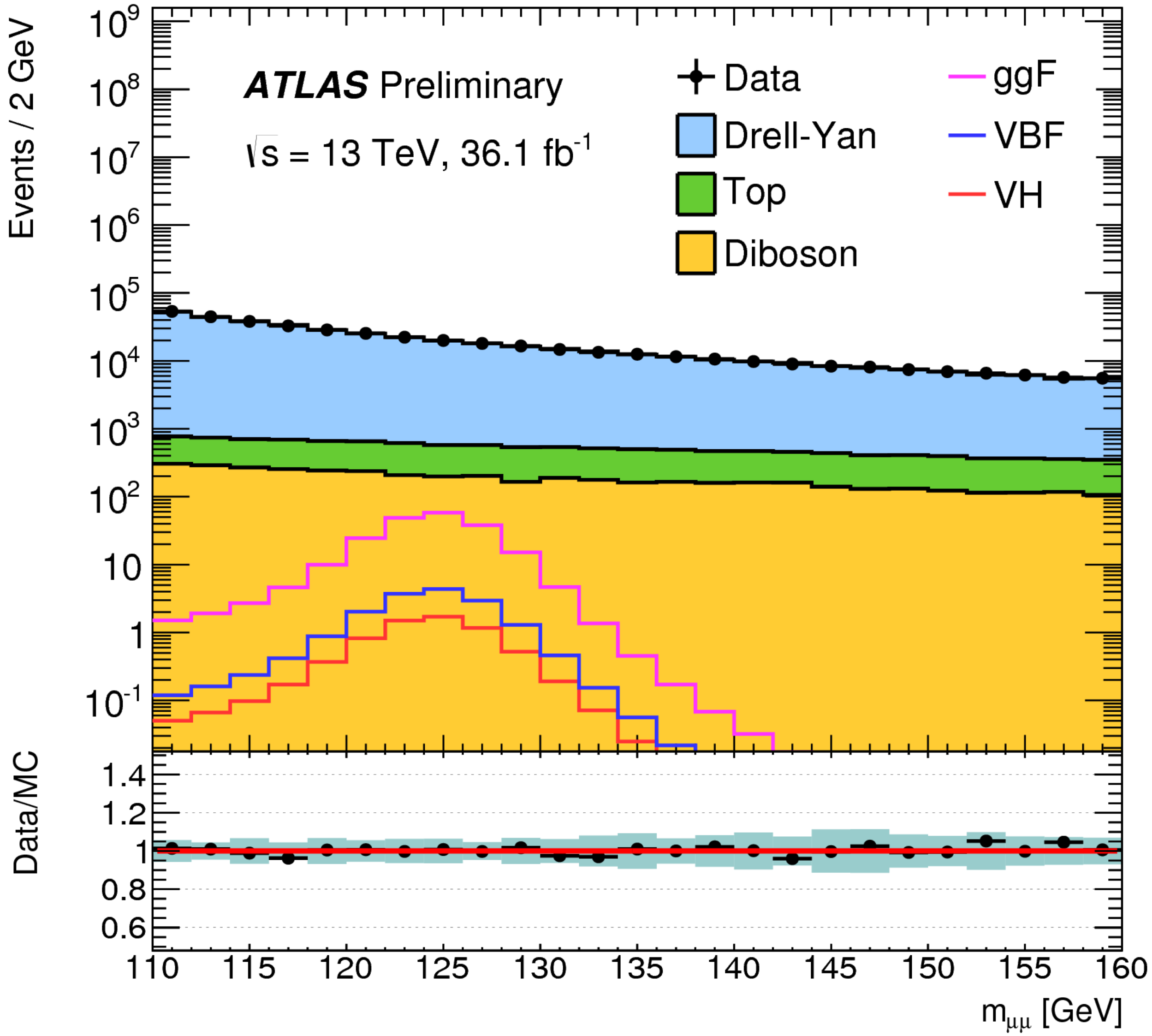
ATLAS-CONF-2017-014

Submitted to PRL (arXiv:1705.04582)

36.1 fb^{-1} of data taken at 13 TeV

H→ μμ Decays

- Event classification in orthogonal categories for ggF and VBF production
- Fit dimuon spectra: very good signal resolution, smooth $m_{\mu\mu}$ around m_H
- Simultaneous fit to the observed $m_{\mu\mu}$ in all categories (110 GeV<$m_{\mu\mu}$<160 GeV) to extract signal strength and determine background normalization and shapes



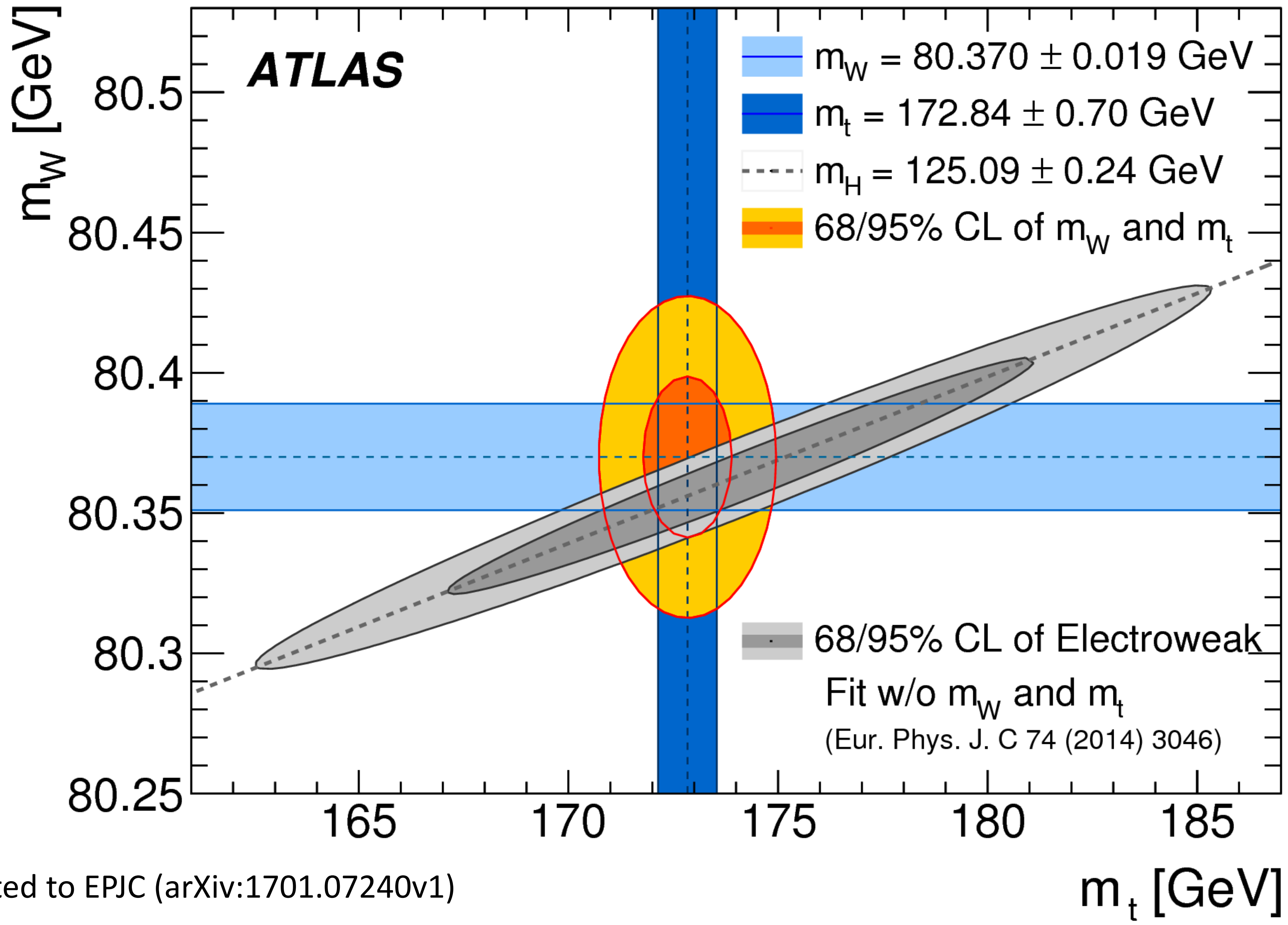
No significant excess is observed above the background expectation for a Higgs boson mass of 125 GeV.

Data set	Upper Limit @95 C L Observed (expected)		Signal Strength μ_s
Run2 (13 TeV)	3.0	(3.1)	-0.07 ± 1.5

Wrapping Up

Since the 2012 discovery of the Higgs boson, focus has shifted to measuring its properties and testing the consistency of the Standard Model with **new** data

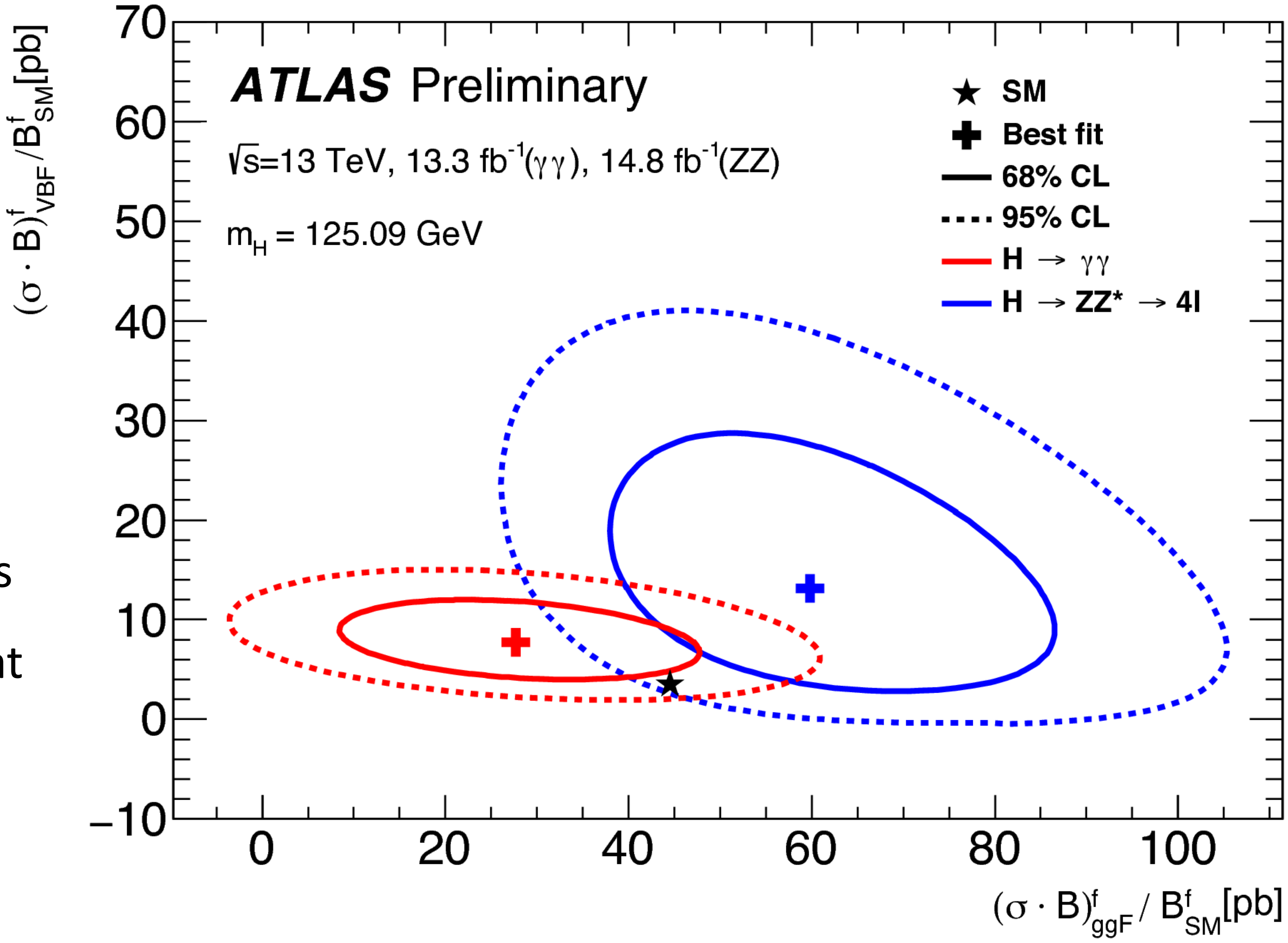
Standard Model Measurements at ATLAS



Submitted to EPJC (arXiv:1701.07240v1)

Summary

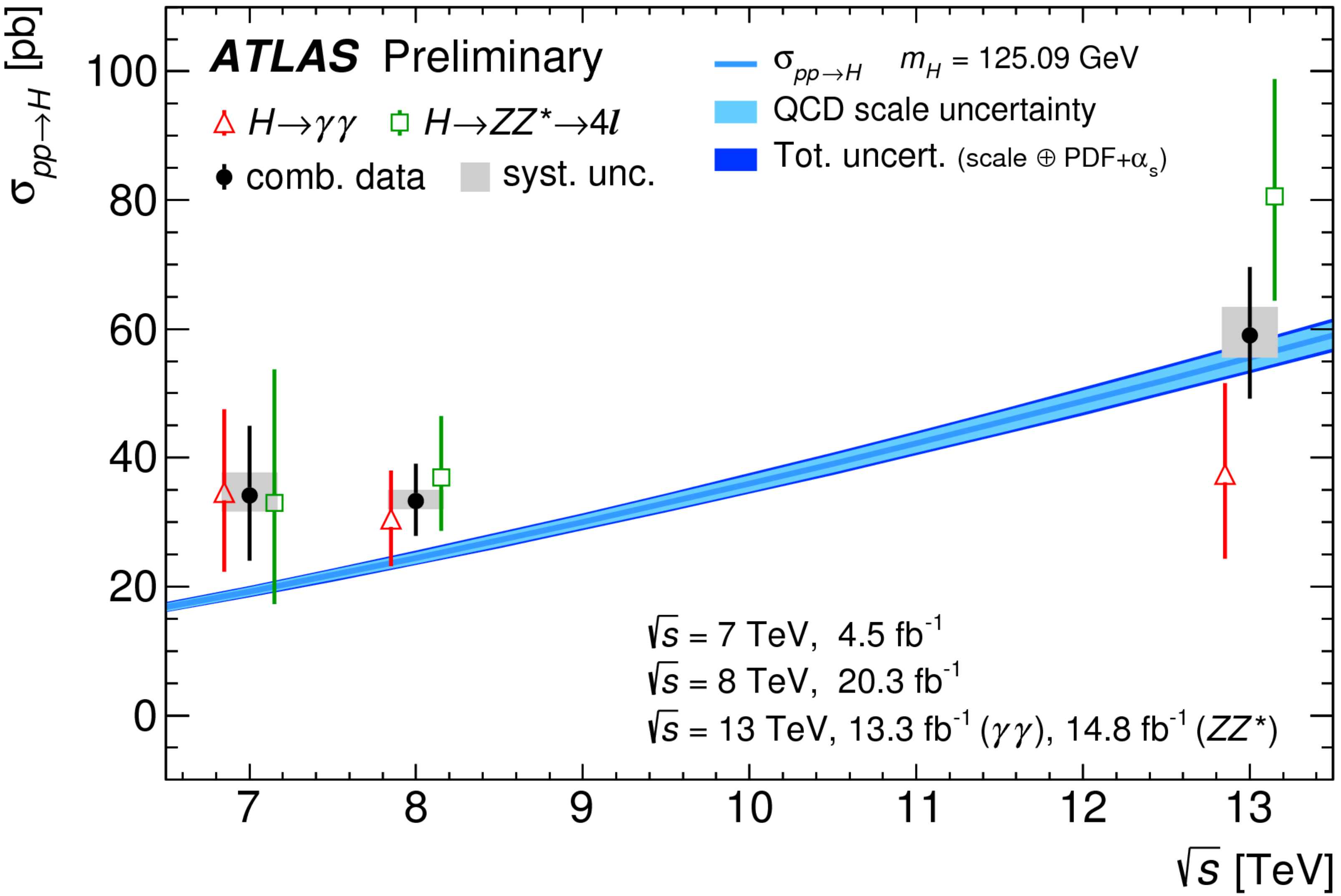
- Combine H→γγ & H → ZZ* → 4l inclusive samples, with no categorization
- Higgs production is observed with 10σ local significance (8.6σ expected) with 13 TeV data in agreement with SM expectations
- Measurement & SM prediction at 13 TeV leads to $\mu = 1.13^{+0.18}_{-0.17}$



ATLAS-CONF-2016-081

Summary

- Combine H→γγ & H → ZZ* → 4l inclusive samples, with no categorization
- Higgs production is observed with 10σ local significance (8.6σ expected) with 13 TeV data in agreement with SM expectations
- Measurement & SM prediction at 13 TeV leads to $\mu = 1.13^{+0.18}_{-0.17}$



ATLAS-CONF-2016-081

Conclusion

Standard Model (SM): Very precise W-boson and top masses measurements; as well as production cross-sections

First fiducial, differential and production cross section measurements of Higgs boson production in $H \rightarrow \gamma\gamma$ & $H \rightarrow ZZ^* \rightarrow 4l$ at **13 TeV** with data collected in 2015 and summer 2016

pp → H:

- Analysis goal is to minimize the dependence on theoretical modelling
- Results statistically limited at the moment
- Comparison to theory predictions

All results consistent with the SM within statistical errors
The LHC has started its 2017 data production… stay tune!