weekly report

Introduction

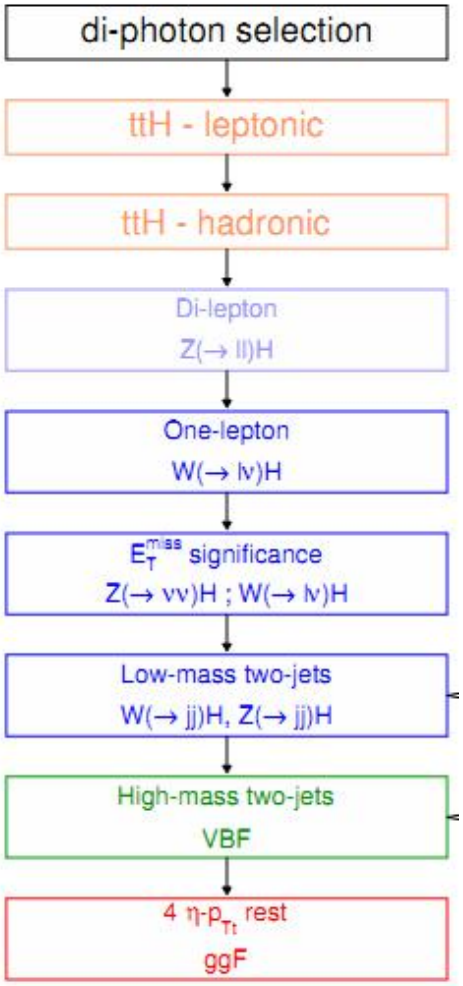
- Analysis towars ICHEP
  - HGam Coupling
    - 3.2(2015) + 10.06(2016 toroid on)
  - High Mass Diphoton
    - 3.2(2015) + 10.9(2016 toroid off)

HGam Coupling

- aim to measure signal strength : $\mu=\sigma_{obs}/\sigma_{SM}$ in each ProdMode
- a combined CONF note with Cross Section Group
- My Contribution
  - VBF optimization
- ATLAS Approval this Wednesday

Index	Category	Selection
13	ttH lep	$N_{lep} \geq 1$, $N_{jets} \geq 2$, $N_{tags} \geq 1$ ($\|\eta\| < 2.5$, $p_T > 25$ GeV) $\|m_{e\gamma} - 89$ GeV$\| > 10$ GeV, $\|m_{\ell\ell} - 91$ GeV$\| > 10$ GeV, $E_T^{miss} > 20$ GeV or $N_{tags} \geq 2$
12	ttH had	$N_{lep} = 0$, $N_{jets} \geq 5$, $N_{tags} \geq 1$ ($\|\eta\| < 2.5$, $p_T > 30$ GeV)
11	VH dilep	$N_{lep} \geq 2$, 70 GeV $\leq m_{\ell\ell} \leq 110$ GeV, $N_{tags} = 0$
10	VH lep	$N_{lep} = 1$, $N_{jets} < 5$, $N_{tags} = 0$, E_T^{miss} significance > 4.5
9	VH MET	$p_{T\gamma\gamma} > 90$ GeV, E_T^{miss} significance > 7
8	VH had tight	50 GeV $< m_{jj} < 150$ GeV, BDT > 0.56
7	VH had loose	50 GeV $< m_{jj} < 150$ GeV, $0.2 <$ BDT < 0.56
6	VBF tight	$\Delta\eta_{jj} > 2$, $\eta^{Zeppenfeld} < 5$, BDT > 0.88
5	VBF loose	$\Delta\eta_{jj} > 2$, $\eta^{Zeppenfeld} < 5$, $0.61 <$ BDT < 0.88
4	ggH forward high p_{Tt}	remaining events, one photon w/ $\|\eta\| > 0.95$, $p_{Tt} > 70$ GeV
3	ggH forward low p_{Tt}	remaining events, one photon w/ $\|\eta\| > 0.95$, $p_{Tt} \leq 70$ GeV
2	ggH central high p_{Tt}	remaining events, two photons w/ $\|\eta\| \leq 0.95$, $p_{Tt} > 70$ GeV
1	ggH central low p_{Tt}	remaining events, two photons w/ $\|\eta\| \leq 0.95$, $p_{Tt} \leq 70$ GeV

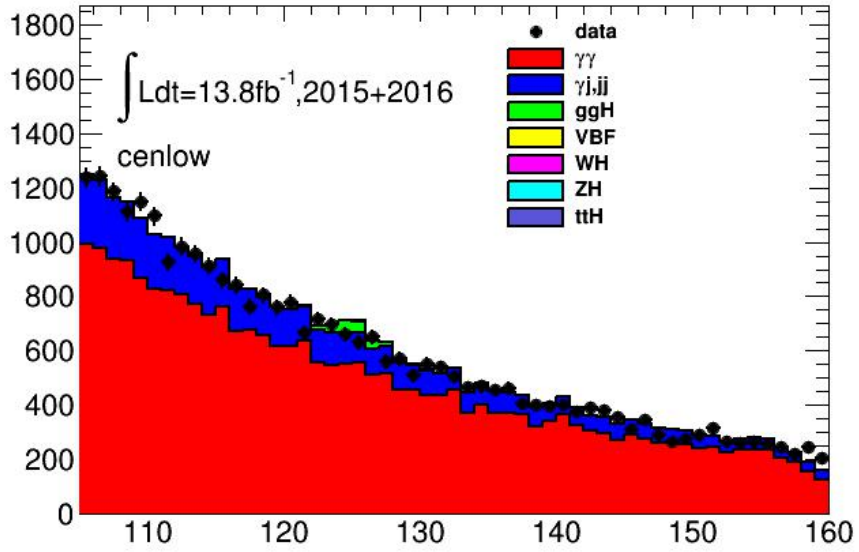
Table 23: Table detailing index and event selection defining each category.

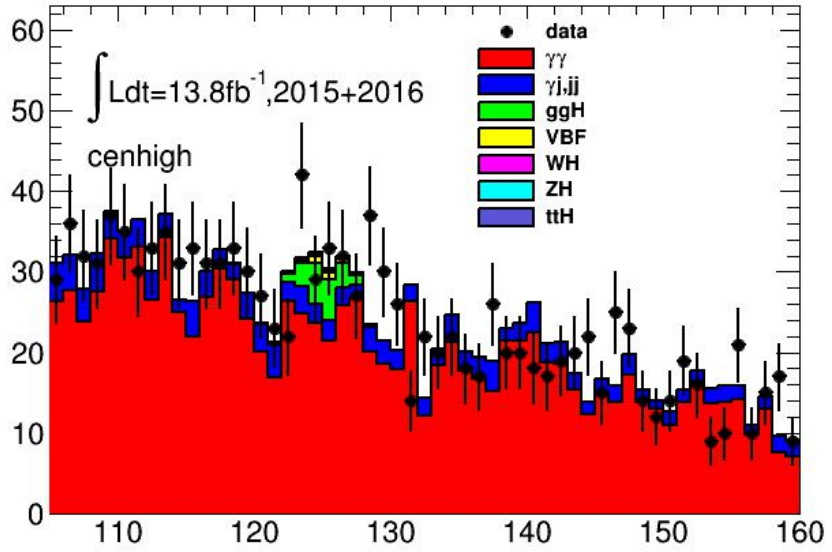


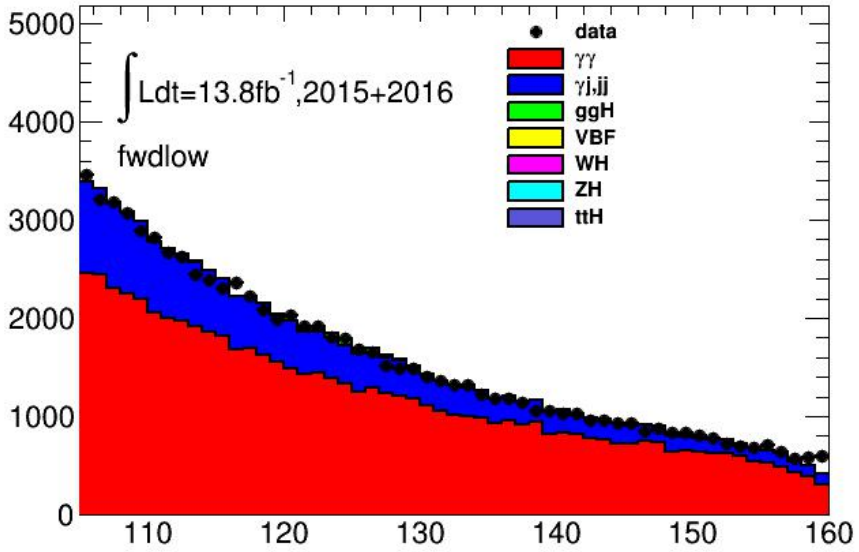
Signal and Bkg modelling

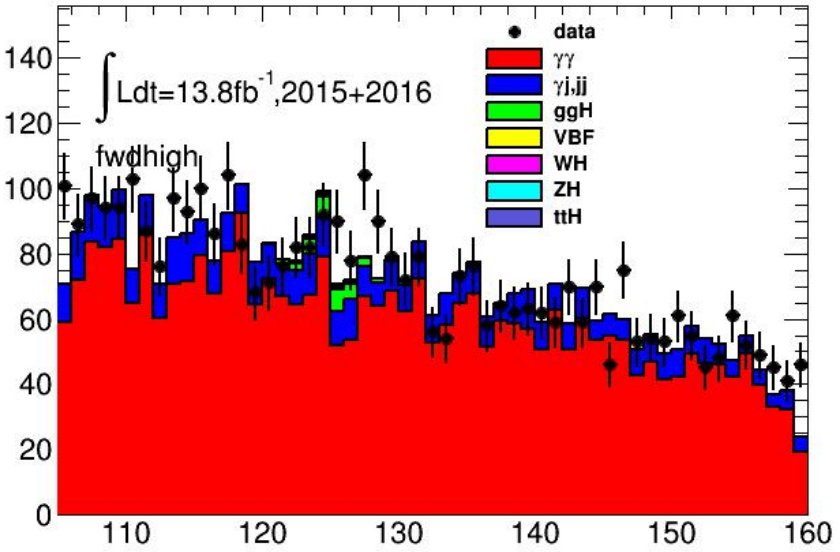
- Signal
  - Double Side Crystal Ball
  - fix mh=125.09GeV
- Bkg
  - bkg decomposition : data driven
  - diphoton MC plus CR(γj,jj)
  - spurious signal used to validate the bkg function
- Statistic interpretation
  - plan to take part in , μ uncertainty, upper limit, significance
  - post-ICHEP
- Many contributions from Chinese group
  - Yanping Huang and Cong Peng (VH had, IHEP)
  - Zirui Wang (VH non-had, SJTU)
  - Huijun Zhang (Pdf uncerntainty, SS, NJU)

myy distribution --- ggH Cat, ratio plot needed

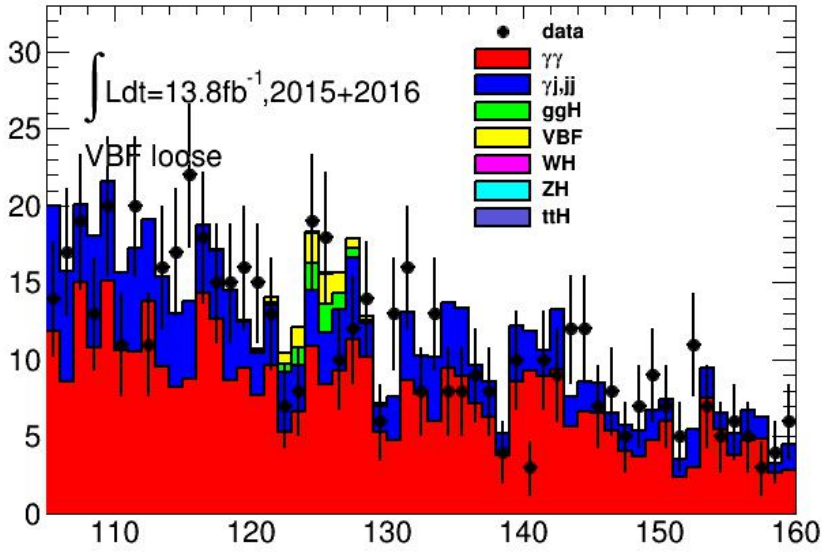


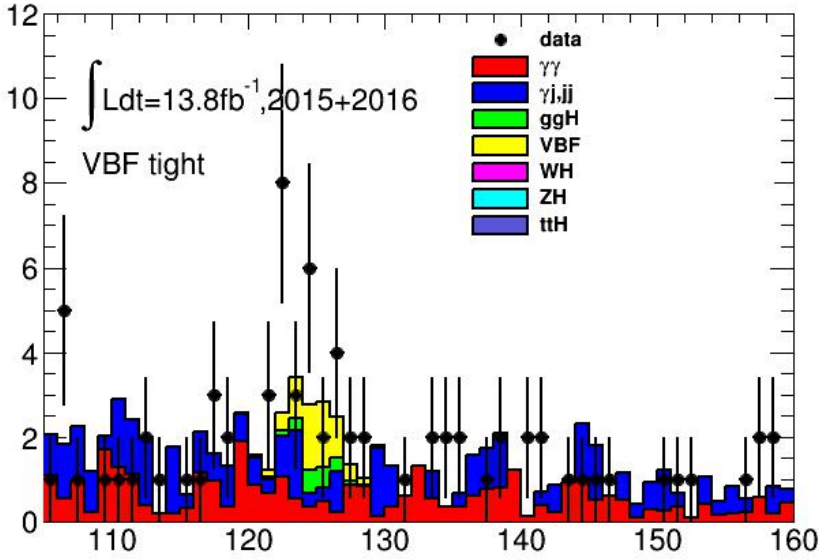


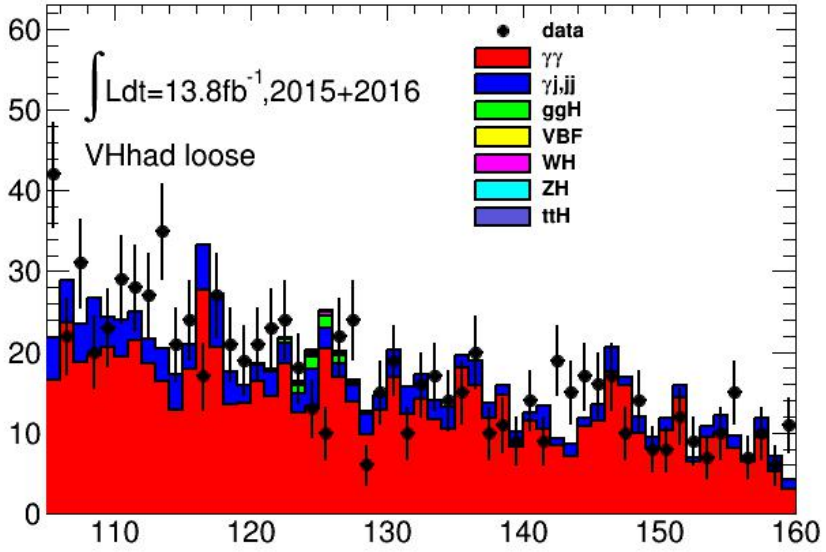


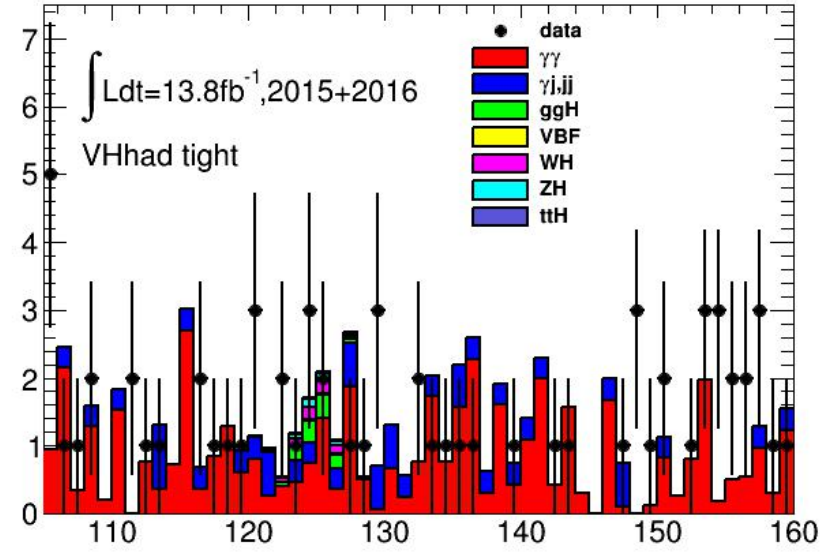


VBF and VH had Cat

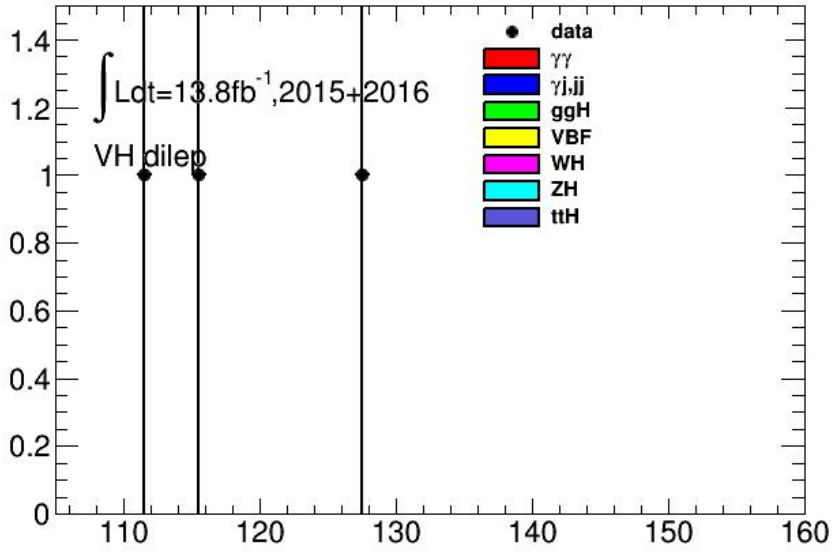


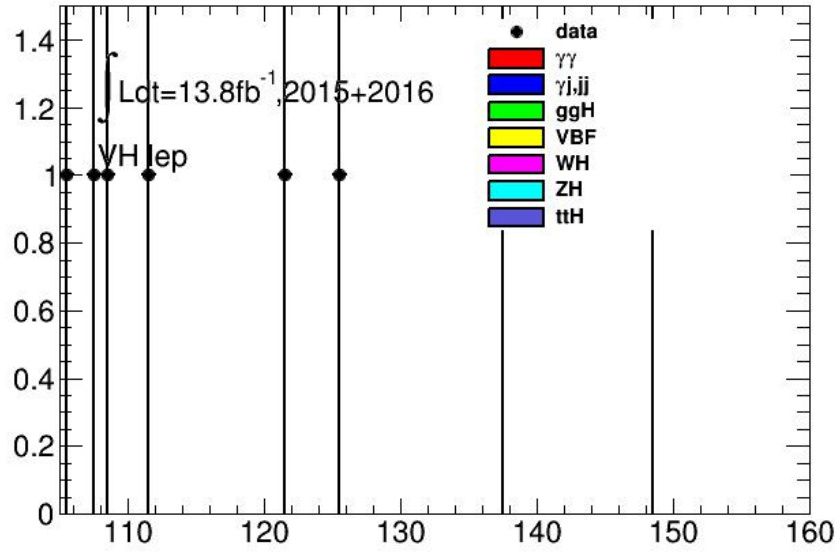


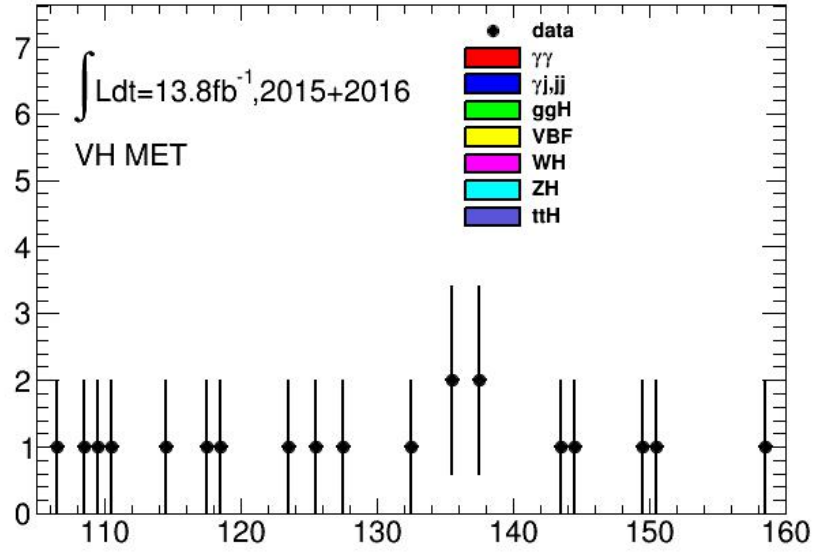




VH non-had

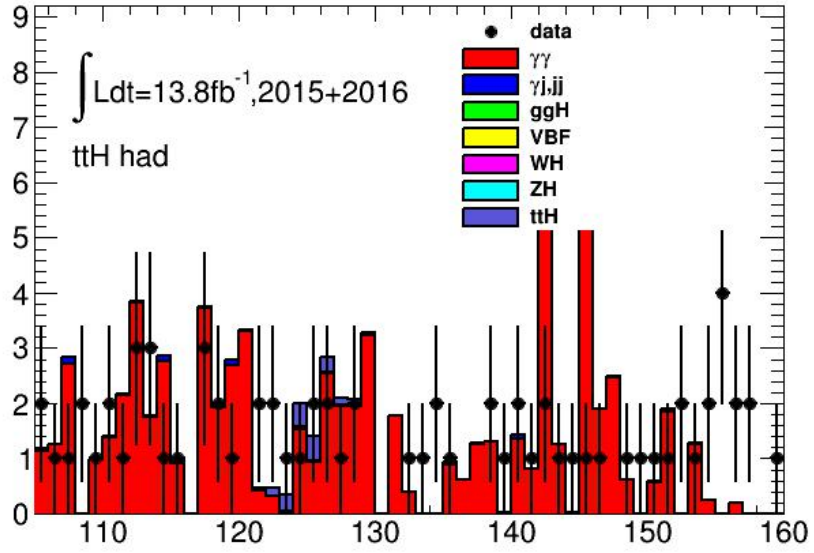


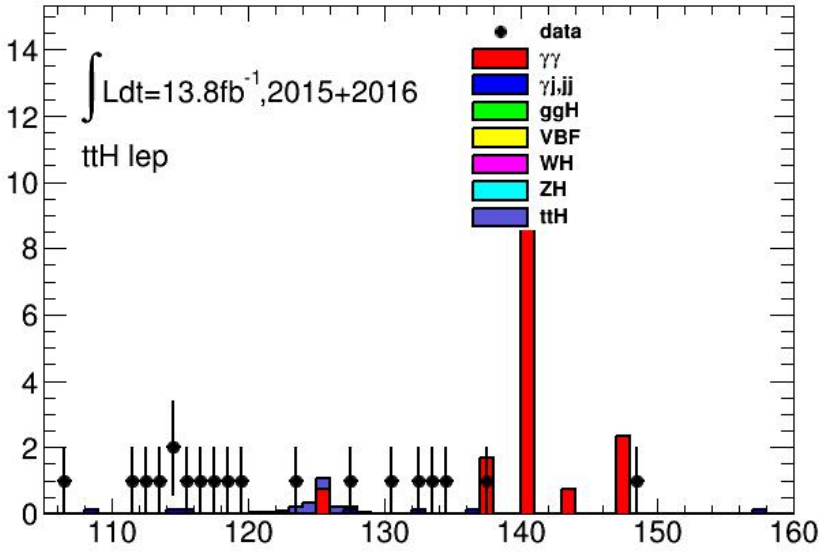




- low statistic in both data and MC
- bkg decompostion is not well described
  - Vγ and Vγγ are not included

ttH lep and had





- MC statistic is low in ttH Cat

result with 3.2+8.5=11.7fb-1

$$\mu = 0.85\ ^{+0.24}_{-0.22} = 0.85\ ^{+0.21}_{-0.21}\,(\text{stat.})\ ^{+0.14}_{-0.09}\,(\text{syst.})\ ^{+0.06}_{-0.03}\,(\text{theory})$$

$$\mu_{ggH} = 0.53\ ^{+0.33}_{-0.31} = 0.53\ ^{+0.31}_{-0.31}\,(\text{stat.})\ ^{+0.12}_{-0.07}\,(\text{syst.})\ ^{+0.06}_{-0.01}\,(\text{theory})$$

$$\mu_{\text{VBF}} = 2.10\ ^{+0.89}_{-0.79} = 2.10\ ^{+0.84}_{-0.76}\,(\text{stat.})\ ^{+0.29}_{-0.22}\,(\text{syst.})\ ^{+0.08}_{-0.04}\,(\text{theory})$$

$$\mu_{\text{VH}} = 1.07\ ^{+1.76}_{-1.21} = 1.07\ ^{+1.69}_{-1.20}\,(\text{stat.})\ ^{+0.52}_{-0.13}\,(\text{syst.})\ ^{+0.09}_{-0.01}\,(\text{theory})$$

$$\mu_{t\bar{t}H} = -0.24\ ^{+1.70}_{-1.30} = -0.24\ ^{+1.65}_{-1.28}\,(\text{stat.})\ ^{+0.43}_{-0.27}\,(\text{syst.})\ ^{+0.11}_{-0.14}\,(\text{theory})$$

$$\mu = 0.85\ ^{+0.24}_{-0.22} = 0.85\ ^{+0.21}_{-0.21}\,(\text{stat.})\ ^{+0.14}_{-0.09}\,(\text{syst.})\ ^{+0.06}_{-0.03}\,(\text{theory})$$

$$m_H = 125.06\ ^{+0.80}_{-0.79}\,\text{GeV} = (125.06\ ^{+0.58}_{-0.58}\,(\text{stat.})\ ^{+0.54}_{-0.54}\,(\text{syst.}))\,\text{GeV}$$

$$\mu_{ggH} = 0.51\ ^{+0.33}_{-0.32} = 0.51\ ^{+0.32}_{-0.31}\,(\text{stat.})\ ^{+0.12}_{-0.07}\,(\text{syst.})\ ^{+0.06}_{-0.01}\,(\text{theory})$$

$$\mu_{\text{VBF}} = 2.14\ ^{+0.89}_{-0.79} = 2.14\ ^{+0.84}_{-0.77}\,(\text{stat.})\ ^{+0.28}_{-0.19}\,(\text{syst.})\ ^{+0.08}_{-0.04}\,(\text{theory})$$

$$\mu_{\text{VH}} = 1.11\ ^{+1.89}_{-1.28} = 1.11\ ^{+1.84}_{-1.27}\,(\text{stat.})\ ^{+0.48}_{-0.12}\,(\text{syst.})\ ^{+0.11}_{-0.02}\,(\text{theory})$$

$$\mu_{t\bar{t}H} = -0.33\ ^{+1.67}_{-1.24} = -0.31\ ^{+1.64}_{-1.22}\,(\text{stat.})\ ^{+0.22}_{-0.25}\,(\text{syst.})\ ^{+0.11}_{-0.14}\,(\text{theory})$$

$$m_H = 124.74\ ^{+0.76}_{-0.75}\,\text{GeV} = (124.74\ ^{+0.54}_{-0.52}\,(\text{stat.})\ ^{+0.54}_{-0.54}\,(\text{syst.}))\,\text{GeV}$$

Mass fixed

- **Run1 result**

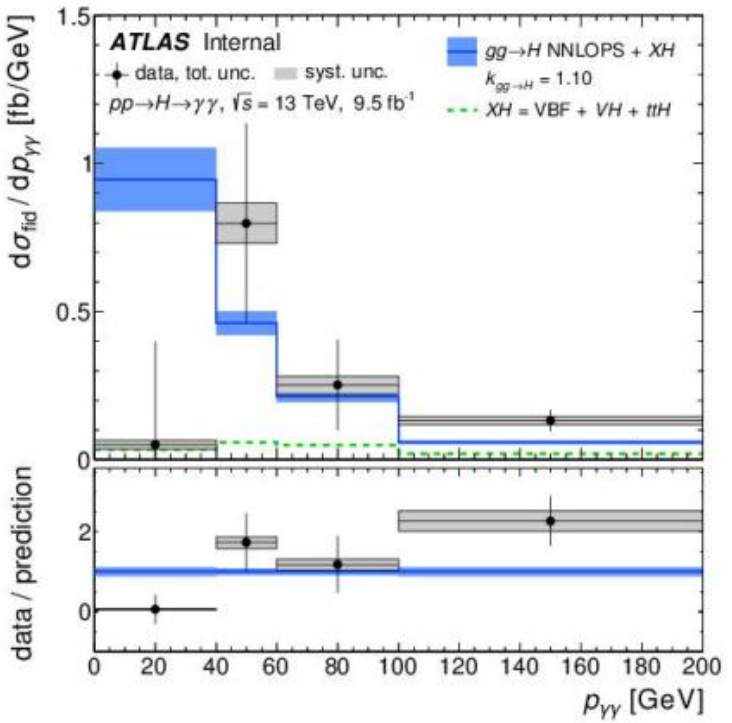
$$\mu_{ggH} = 1.32^{+0.32}_{-0.32}(stat.)\ ^{+0.23}_{-0.15}(syst.)$$

$$\mu_{VBF} = 0.78^{+0.72}_{-0.63}(stat.)\ ^{+0.30}_{-0.29}(syst.)$$

$$\mu_{WH} = 0.97^{+1.64}_{-1.46}(stat.)\ ^{+0.36}_{-0.17}(syst.)$$

$$\mu_{ZH} = 0.13^{+3.62}_{-0.13}(stat.)\ ^{+0.64}_{-0.00}(syst.)$$

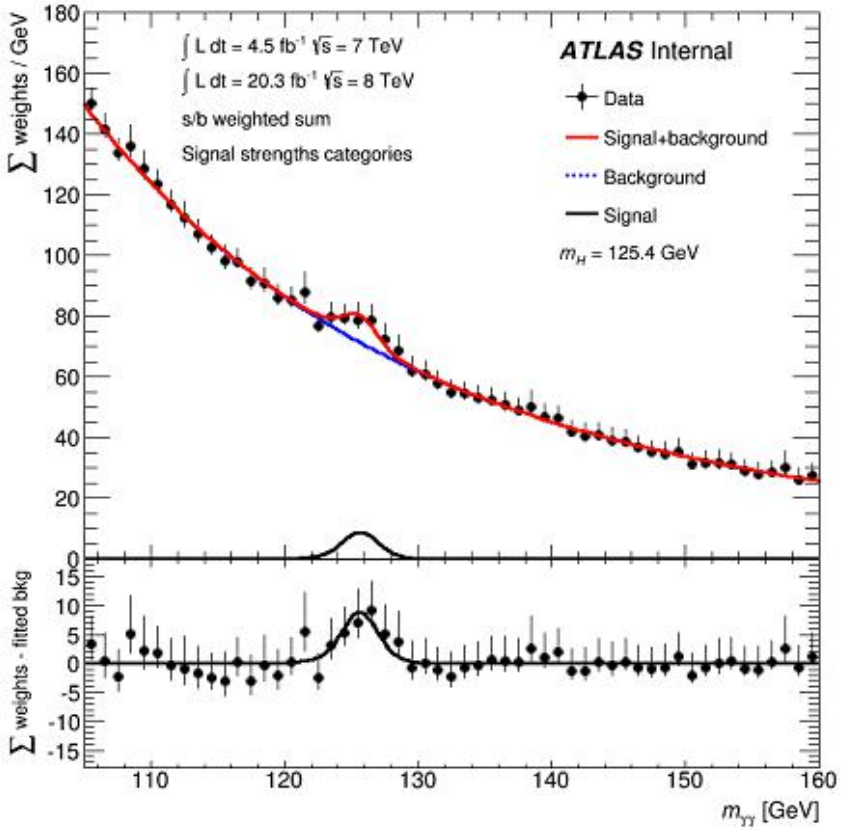
$$\mu_{ttH} = 1.55^{+2.62}_{-1.75}(stat.)\ ^{+0.79}_{-0.36}(syst.)$$



Run1 result, 20.3fb-1

- weighted by signal-bkg ratio
- Compatible with Run2?

$$\mu_{ggH} = 1.32^{+0.32}_{-0.32}(stat.)\ ^{+0.23}_{-0.15}(syst.)$$
$$\mu_{VBF} = 0.78^{+0.72}_{-0.63}(stat.)\ ^{+0.30}_{-0.29}(syst.)$$
$$\mu_{WH} = 0.97^{+1.64}_{-1.46}(stat.)\ ^{+0.36}_{-0.17}(syst.)$$
$$\mu_{ZH} = 0.13^{+3.62}_{-0.13}(stat.)\ ^{+0.64}_{-0.00}(syst.)$$
$$\mu_{ttH} = 1.55^{+2.62}_{-1.75}(stat.)\ ^{+0.79}_{-0.36}(syst.)$$



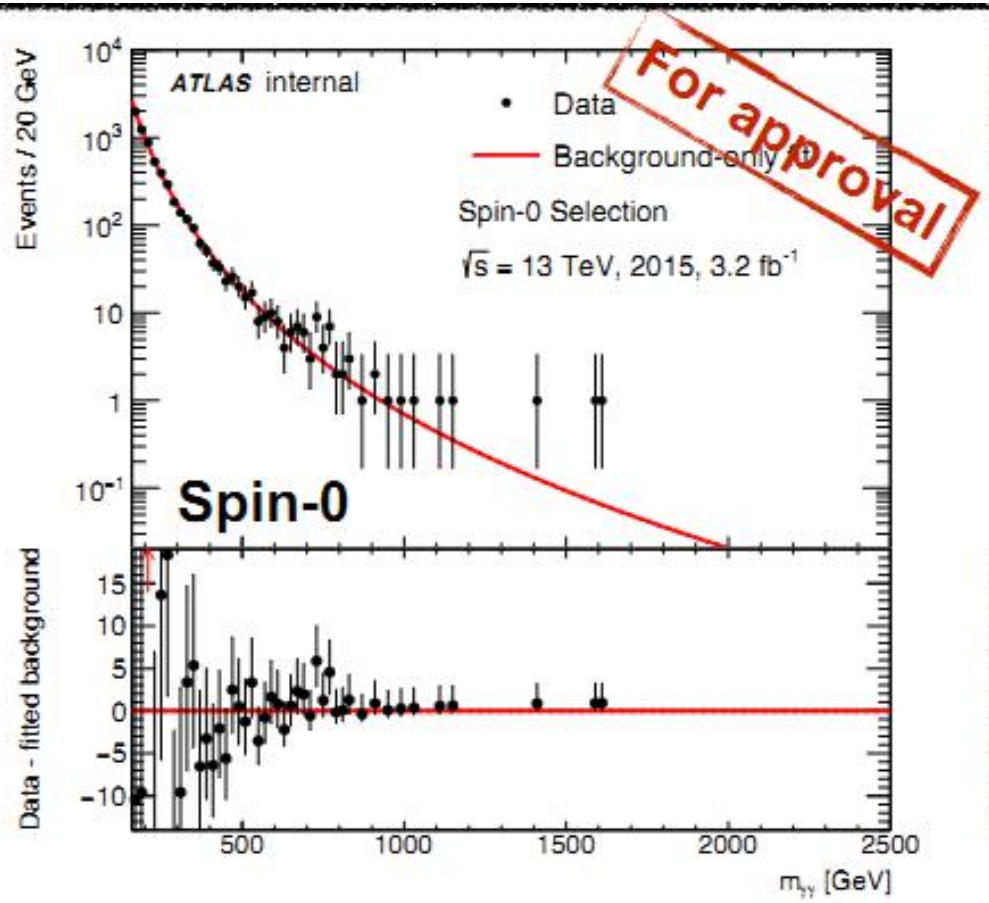
The results of 2011+2012 global signal strength measurement fit to $m_H = 125.4$ GeV is:

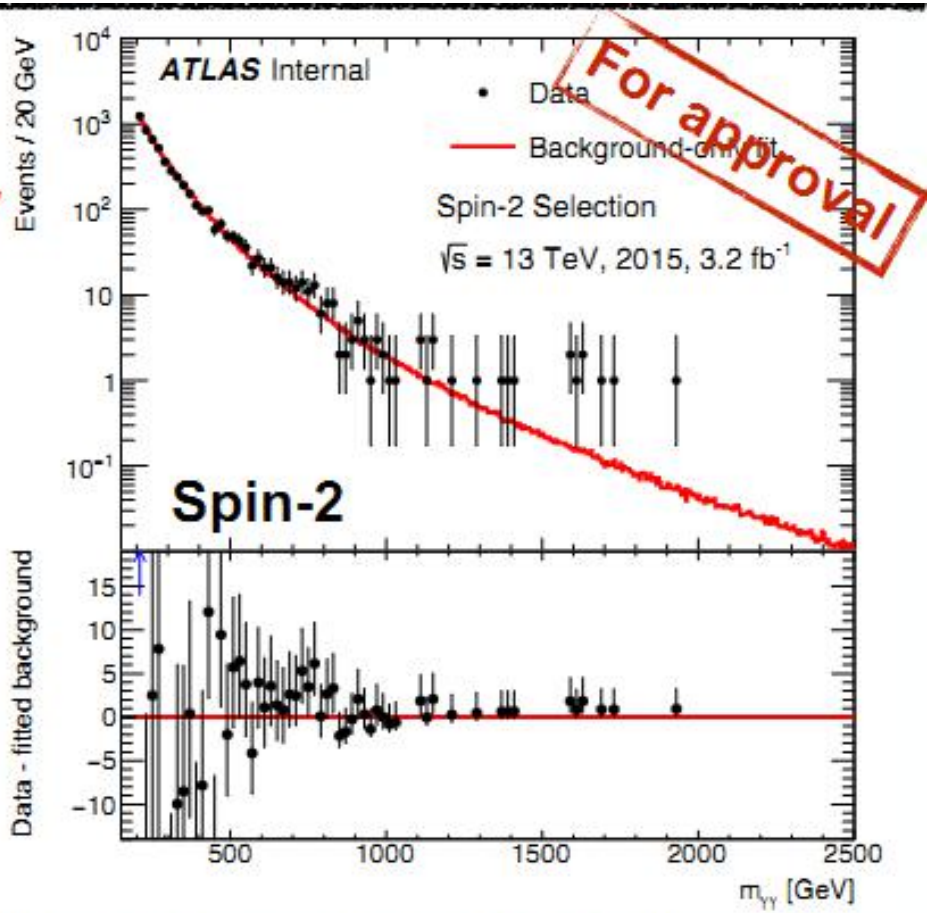
$$\mu = 1.17^{+0.28}_{-0.26} = 1.17^{+0.23}_{-0.23}(stat.)^{+0.10}_{-0.08}(syst.)^{+0.12}_{-0.08}(theory)$$

High Mass diphoton (750GeV)

- ATLAS approval last Friday
  - spin0 is approved
- another discussion this Friday
  - focus on spin2, especially EEos and low pT, show later
- tomorrow a talk on bkg estimationi in high mass diphton
  - interpretation in SM model
- Ooutline
  - Isolation and Purity
  - Analysis : Signal and Bkg model
  - Result
- Copy from Hongtao's approval talk!

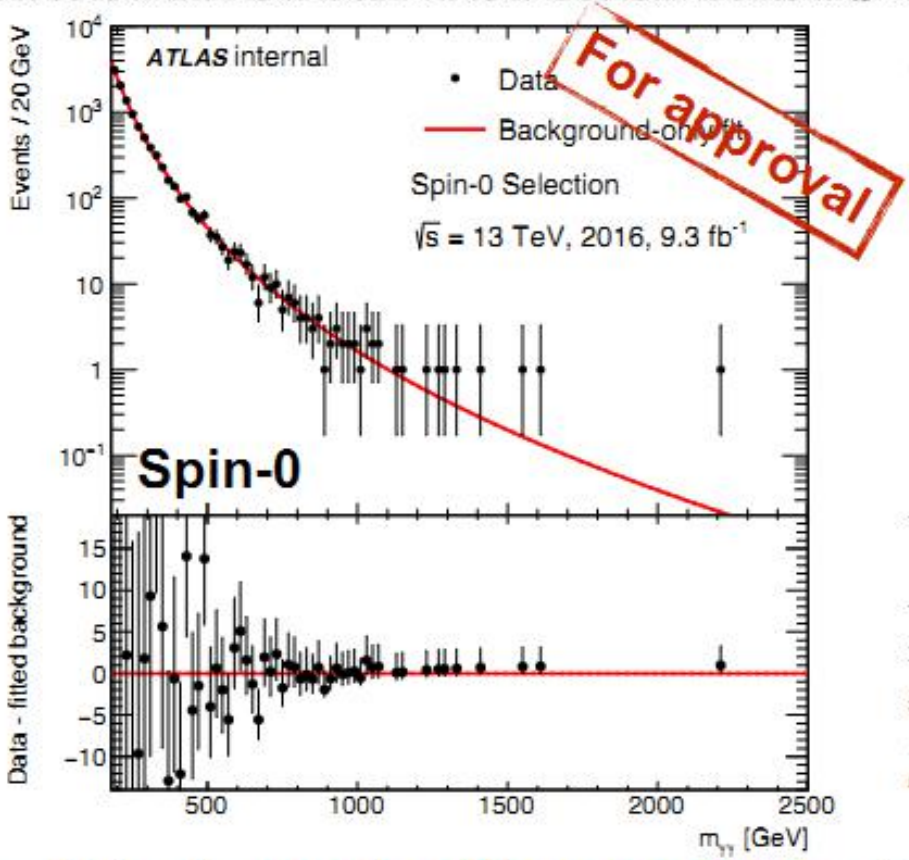
2015 re-analysis, update

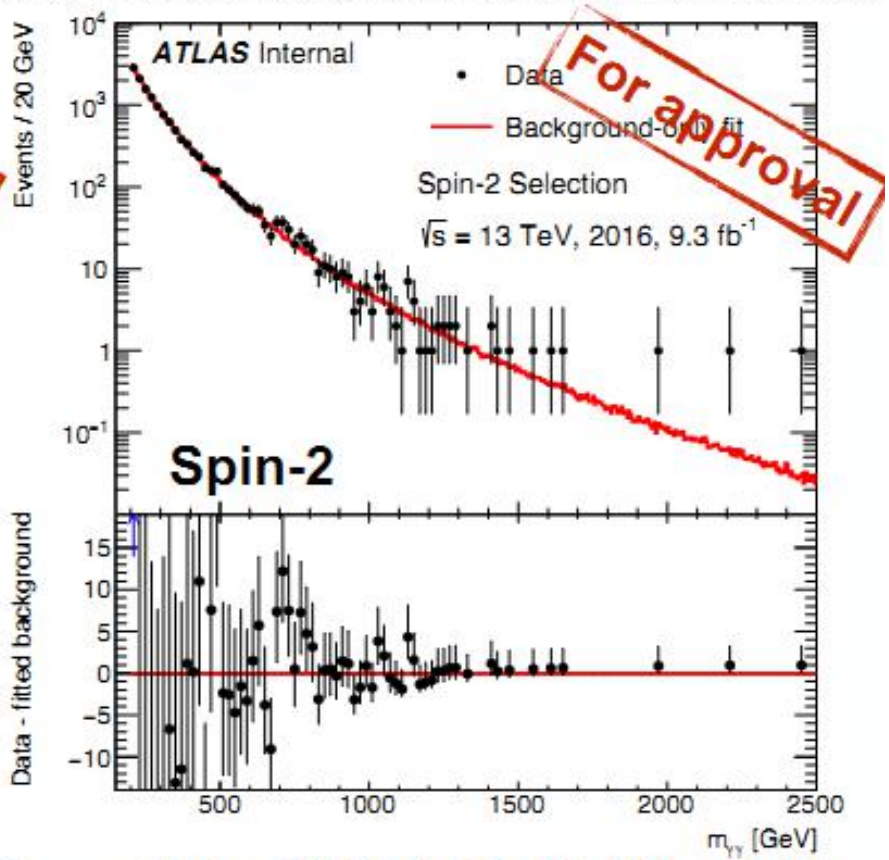




- Spin-0: 3.9σ @750 GeV, Γ_X/m_X=6%→**3.4σ** @734 GeV, Γ_X/m_X=8%
- Spin-2: 3.8σ @750 GeV, k/M_{Pl}=0.23→**3.3σ** @740 GeV, k/M_{Pl}=0.30
- Changes from Rel. 20.1 to Rel. 20.7 understood (see analysis internal note). No obvious tension between two set of results

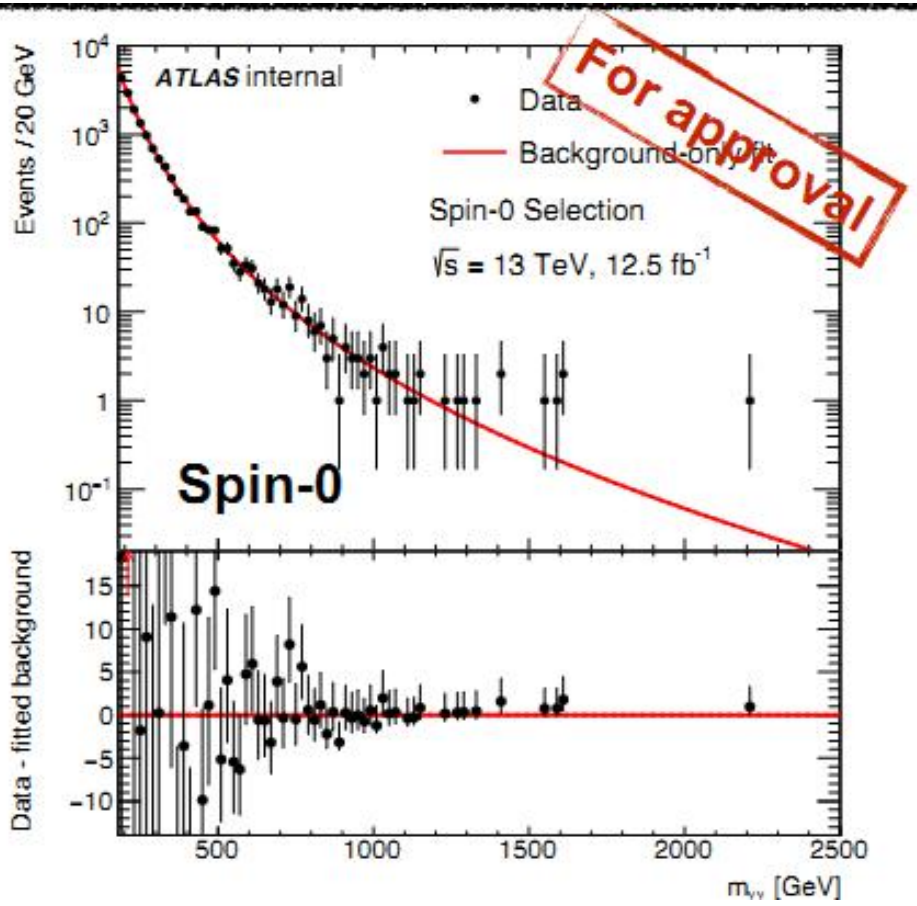
2016 9.3fb-1

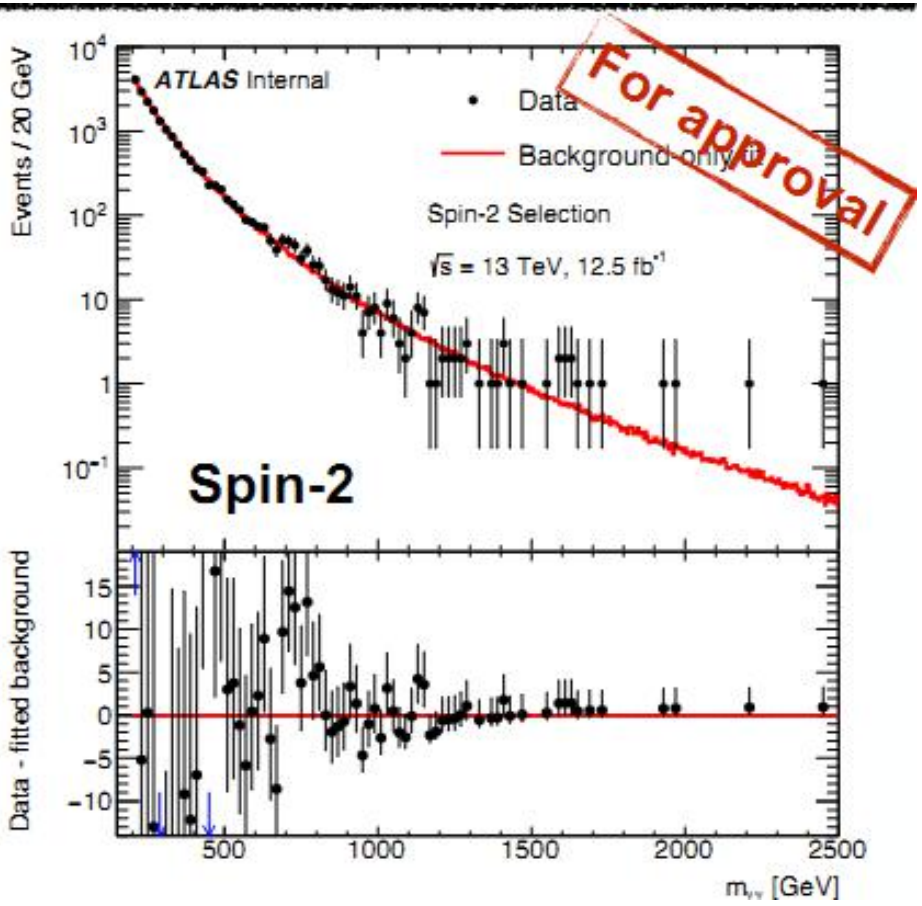




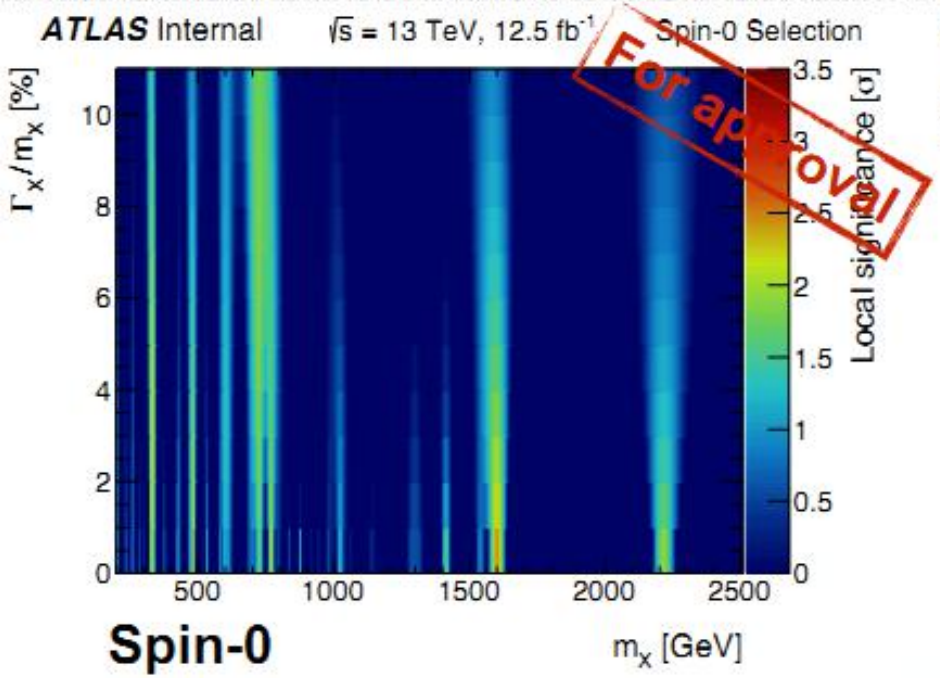
- Spin-0: **no significant excess**. $Z_{max.}$=2.5σ @334 GeV, 2% width
  - Between 700 and 800 GeV: $Z_{max.}$=1.5σ @776 GeV with NWA
- Spin-2: $Z_{max.}$=**3.0σ** @700 GeV with k/M_{Pl}=0.04
  - Excess has been increasing with luminosity in 2016

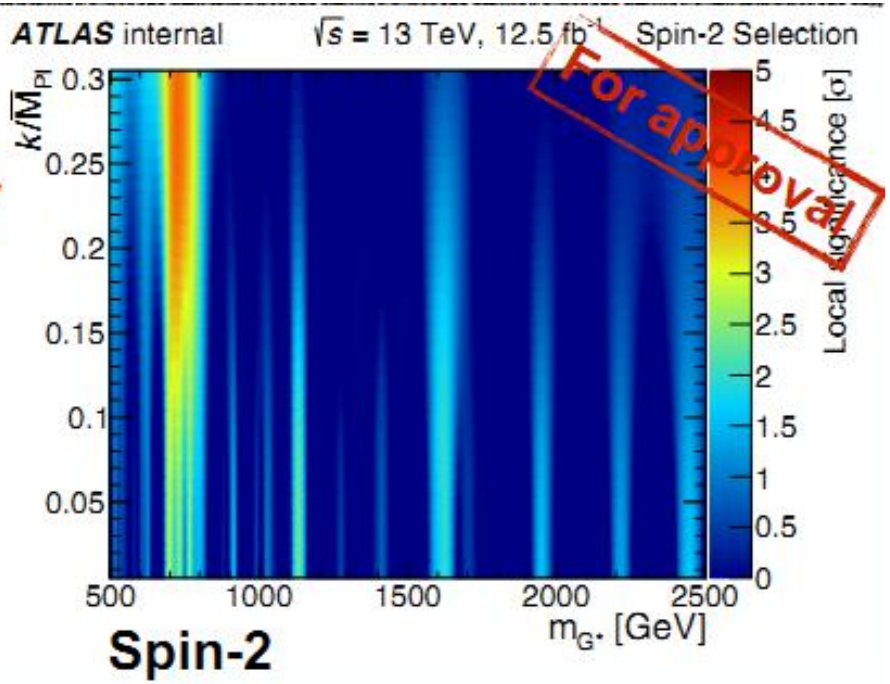
2015+2016


ATLAS internal
Data
Background-only fit
Spin-0 Selection
√s = 13 TeV, 12.5 fb-1
Spin-0
For approval
Events / 20 GeV
Data - fitted background
mγγ [GeV]


ATLAS Internal
Data
Background-only fit
Spin-2 Selection
√s = 13 TeV, 12.5 fb-1
Spin-2
For approval
Events / 20 GeV
Data - fitted background
mγγ [GeV]

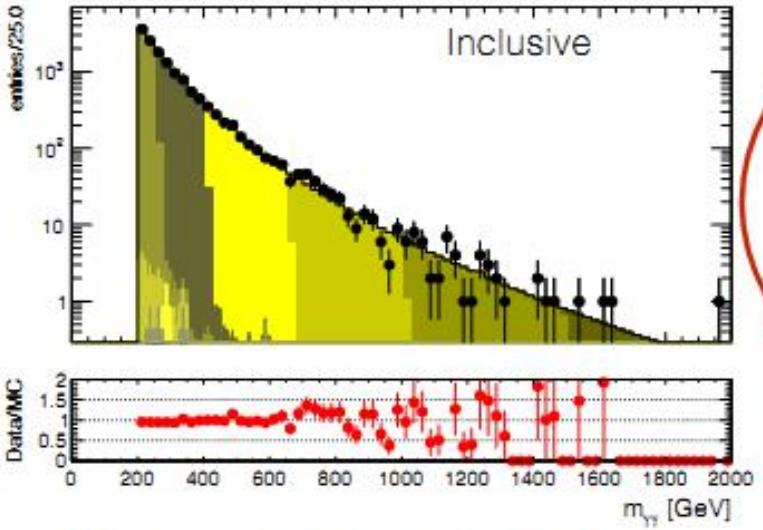
2015+2016 2D p0

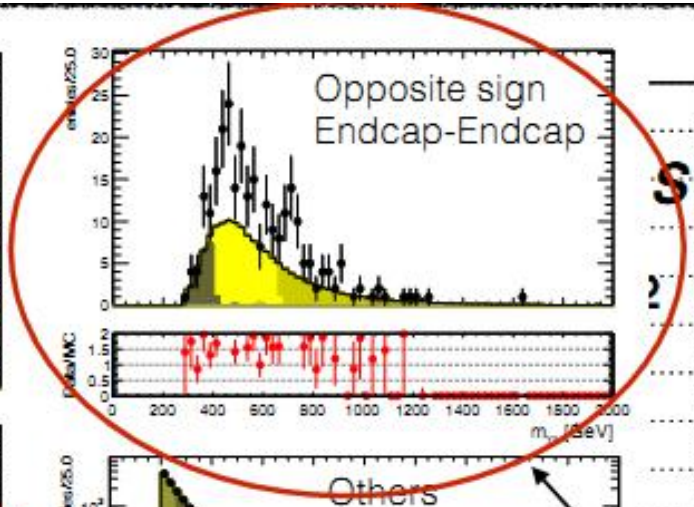


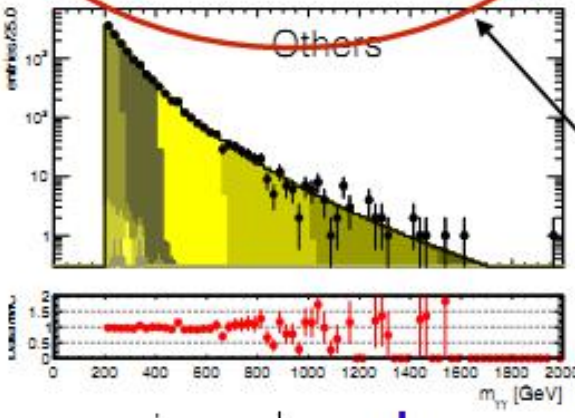


- Spin-0: $Z_{max.}$=2.5σ @486 GeV with NWA
  - Between 700 and 800 GeV: 2.2σ @772 GeV with NWA
- Spin-2: $Z_{max.}$=**3.9σ** @720 GeV with k/M_{Pl}=0.28. Global significance **2.2σ**
  - Cross checks on the excess will be discussed later

excess region, EEos







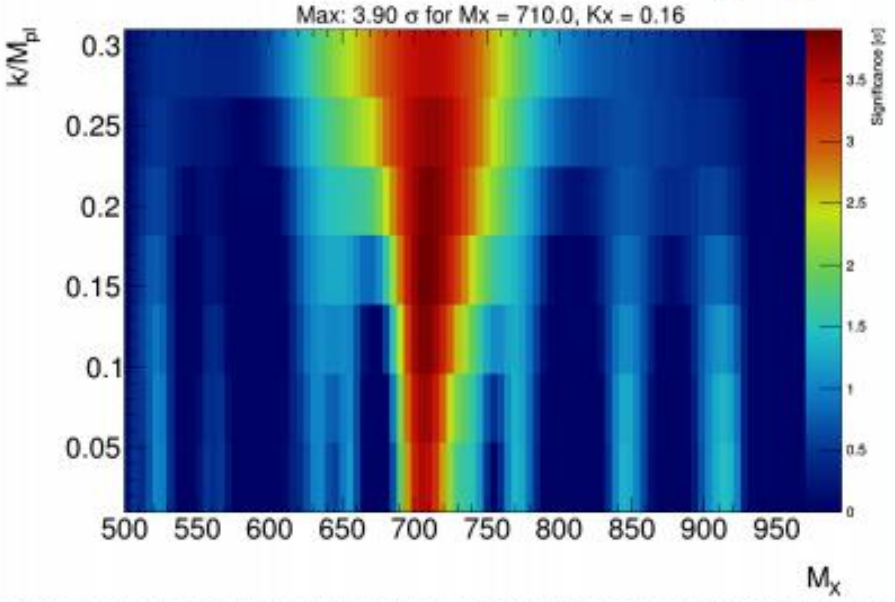
- MC cannot handle relative normalization correctly (?)
- NLO tends to match data better by 10~20%

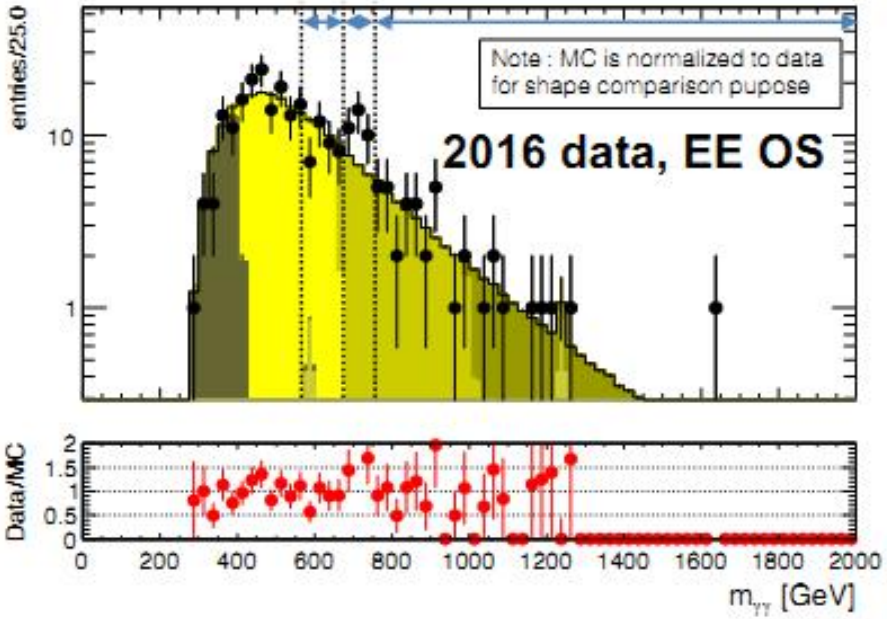
Will normalize MC to data in the category in the following discussion

excess region

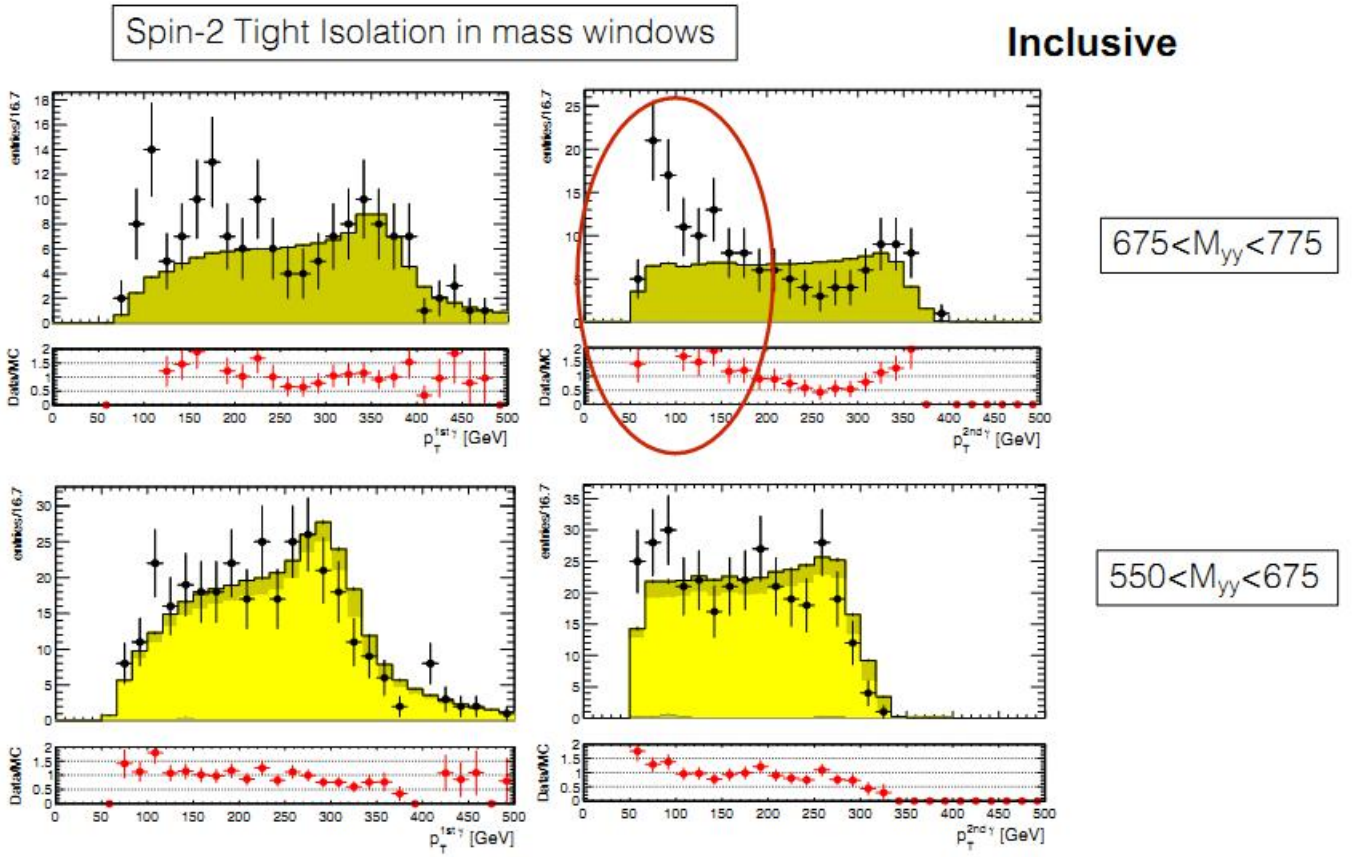
- **Excess in 2016 data keeps increasing with luminosity so far**
- Excess largely from **ECal Endcap-Endcap (EE)**
- **No strong evidence that excess region is affected by fake photon**: shower shapes and isolation variables more close to real photon
- Excess seems to be enhanced at **high pileup**
- Excess region seems having softer (subleading) photon E_T

2016 data EE OS category





excess region

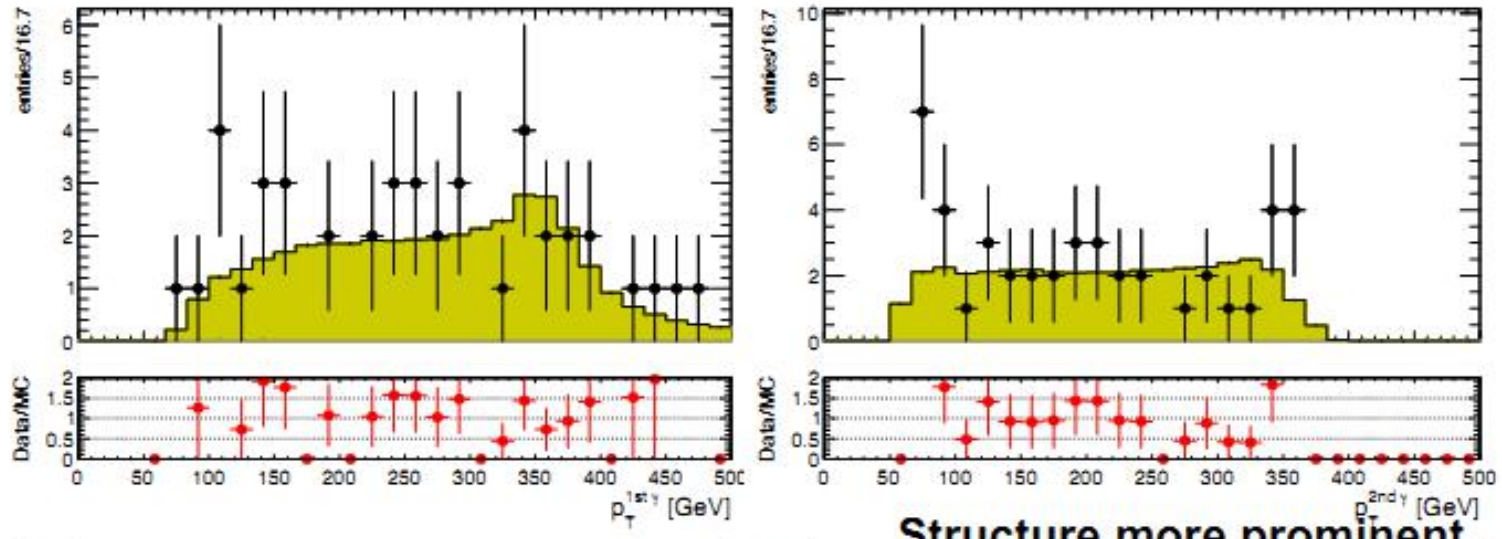


- obviously, low pT and EEos is correlated
- people feel this region is dangerous in this low pT EEos region, due to large pile up

pile up dependence---no conlusion

Spin-2 Tight Isolation, excess region (675<Myy<775 GeV)

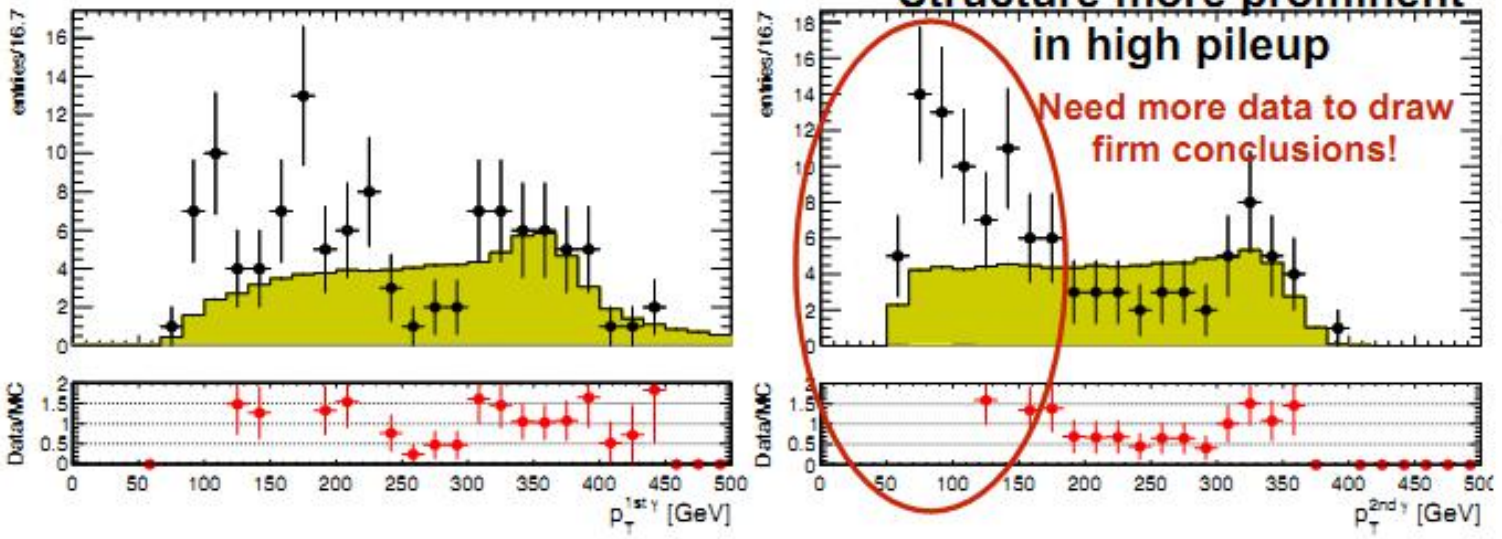
Inclusive



<μ> in (0, 20]

Structure more prominent in high pileup

Need more data to draw firm conclusions!



<μ> in (20, inf]

Summary

- SM Higgs
  - work on statistic
  - spin/parity?
- X(750)->$\gamma\gamma$
  - devote more time?
- WW(jjjj)$\gamma\gamma$
  - yy+>=3jets