# weekly report

# method description

- 2X2D Sideband method
  - code : https://svnweb.cern.ch/trac/atlasoff/browser/PhysicsAnalysis/HiggsPhys/Run2/HGamma/xAOD/Purity2x2DSB/trunk
  - only add the SM Higgs selection, various MET category and MET slice
- two independent variable
  - Isolation          :          Fail vs Pass
  - ID                    :          tight
                            :          Pass loose prime 4 but Fail tight
- Loose prime 4
  - to decrease the correlation with isolation
  - pass loose and omit 4 shower shape variables in tight ID

# method description

- 2x2 sideband
  - both leading/subleading photon can be splitted into 4 regions
  - totally we have 16 regions AA,AB......
- Parameters
- tight efficiency
- Iso efficiency
- tight fake rate
- Iso fake rate
- yield of yy,yj,jy,jj
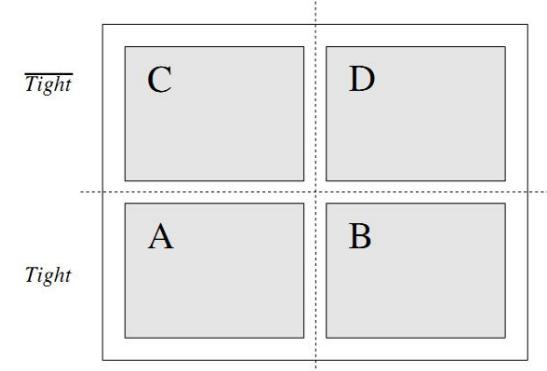
$$\overline{Tight} \quad \begin{array}{|c|c|} \hline C & D \\ \hline A & B \\ \hline \end{array}$$

$$
\begin{aligned}
N_{\mathrm{TITI}} = & \, W_{\gamma\gamma}^{L'L'} \epsilon_{I1}\epsilon_{T1}\epsilon_{I2}\epsilon_{T2} \\
& + W_{\gamma j}^{L'L'} \epsilon_{I1}\epsilon_{T1}f_{I2}f_{T2} \\
& + W_{j\gamma}^{L'L'} f_{I1}f_{T1}\epsilon_{I2}\epsilon_{T2} \\
& + W_{jj}^{L'L'} f'_{I1}f'_{T1}f'_{I2}f'_{T2}\xi_{Ijj} \,,
\end{aligned}
\tag{2}
$$

where

- $\epsilon_{I1}$ and $\epsilon_{I2}$ are the efficiencies of the isolation criteria of one of the six analysis under study for the leading and subleading photons respectively. They are determined from the di-photon simulation;
- $\epsilon_{T1}$ and $\epsilon_{T2}$ are the Tight identification efficiencies for the leading and subleading photons respectively, also determined from the di-photon simulation;
- $f_{I1}$ and $f_{I2}$ are the isolation fake rates for the $\gamma j$ and $j\gamma$ events, fitted directly on data;
- $f_{T1}$ and $f_{T2}$ are the Tight identification fake rates for the $\gamma j$ and $j\gamma$ events, fitted directly on data;
- $f'_{I1}$ and $f'_{I2}$ are the isolation fake rates for the $jj$ events, fitted directly on data;
- $f'_{T1}$ and $f'_{T2}$ are the Tight identification fake rates for the $jj$ events, fitted directly on data;
- $\xi_{Ijj}$ is the isolation correlation factor between the jets in the $jj$ events, fitted directly on data.

# method description

- 16 equations
- 4 known parameters
  - tight ID effciency
  - Iso effciency
  - from yy MC
- 13 free parameters
  - yield of yy,yj,jy,jj in LL region
  - 8 fake rate
  - isolation correlation factor in jj event
- constrain by data

$$N_{\mathrm{TITI}} = W_{\gamma\gamma}^{L'L'} \epsilon_{I1}\epsilon_{T1}\epsilon_{I2}\epsilon_{T2}$$
$$+ W_{\gamma j}^{L'L'} \epsilon_{I1}\epsilon_{T1} f_{I2}f_{T2}$$
$$+ W_{j\gamma}^{L'L'} f_{I1}f_{T1}\epsilon_{I2}\epsilon_{T2}$$
$$+ W_{jj}^{L'L'} f'_{I1}f'_{T1}f'_{I2}f'_{T2}\xi_{Ijj},$$

# Selection

- **SM Higgs selection**
- **Category**
  - **1 : highMET hight pTyy:**          **met_TST>100,pT_yy>100**
  - **2 : else highMET low pTyy:**      **met_TST>100,pT_yy<100**
  - **3 : else mediumMET high pT_hard:met_TST>50,pT_hard>40**
  - **the vector sum of hard photon and jets**
  - **4 : else high pTyy:**              **pT_yy>15**
- **MET slice**
  - **[0, 20, 40, 60, 100, 200]**
  - **It seems a bug when calculate the purity in MET slice, will fix it**
- **Sample**
  - **mc15c.Sherpa_gamgam_2DP20_100-160.MxAOD.p2613.h012.root**
  - **data15_13TeV.periodAllYear_3245ipb.physics_Main.MxAOD.p2614.h012.root**
  - **data16_13TeV.periodAll25ns_2688ipb.physics_Main.MxAOD.p2667.h012.root**

# result

- 2015

| category | data | WGG | WGJ | WJG | WJJ | purity |
|---|---|---|---|---|---|---|
| inclusive | 30869 | 24134 | 3943 | 2008 | 791 | 0.782 |
| 1 | 16 | not converg | | | | |
| 2 | 39 | 18 | 12 | 7 | 0 | 0.486 |
| 3 | 942 | 649 | 146 | 113 | 30 | 0.692 |
| 4 | 20984 | 16462 | 2683 | 1350 | 493 | 0.784 |

- 2016 2688ipb

| category | data | WGG | WGJ | WJG | WJJ | purity |
|---|---|---|---|---|---|---|
| inclusive | 24218 | 18445 | 3444 | 1667 | 698 | 0.760 |
| 1 | 16 | not converge | | | | |
| 2 | 83 | 67 | 8 | 4 | 1 | 0.838 |
| 3 | 1204 | 860 | 198 | 100 | 44 | 0.715 |
| 4 | 16155 | 12306 | 2345 | 1128 | 407 | 0.760 |

# Summary

- 2015 inclusive result is comparable with the supporting note
- don't understand the difference between 2015 and 2016
  - the fraction of each category is quite different, any ideas?
- numbers with systematic are attached in backup
- to do
  - calculate the purity in MET slice
  - fix the bug in high MET high pTyy category
  - may try another Matrix method to cross check
  - understand more about the systematic estimation

# myy

- 3568/pb

# yy+ at least 3jets

m_yy/1000 {isPassed&&N_j>=3}

| h1 | |
|---|---|
| Entries | 3388 |
| Mean | 125.8 |
| RMS | 15.14 |

m_yy/1000 {isPassedPID&&isPassedIsolation&&isPassedRelPtCuts&&m_yy/1000>105&&m_yy/1000<160&&N_j>=3}

| h | |
|---|---|
| Entries | 5221 |
| Mean | 125.3 |
| RMS | 15.06 |
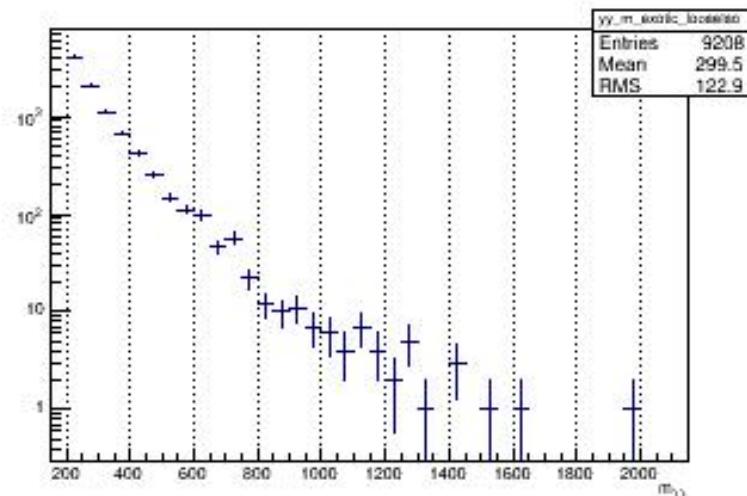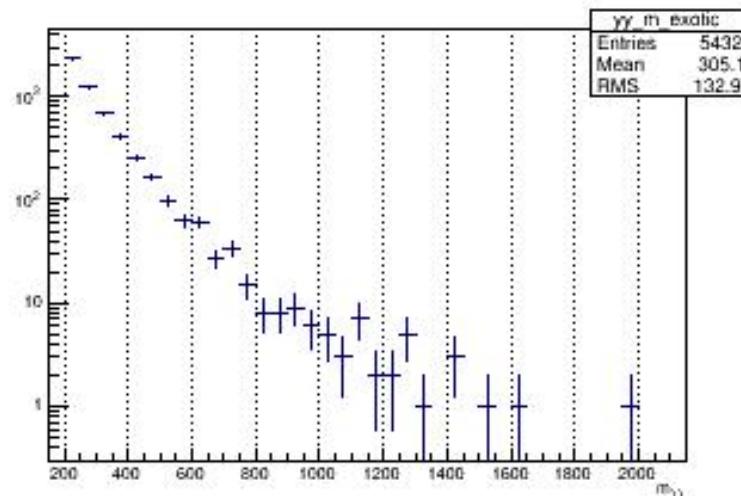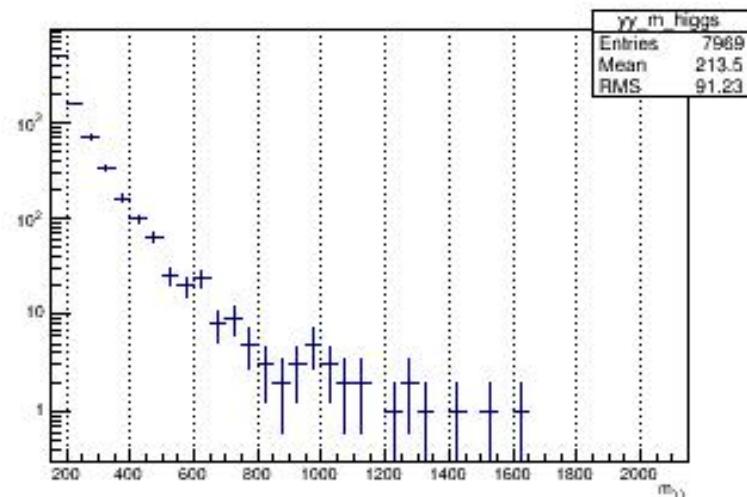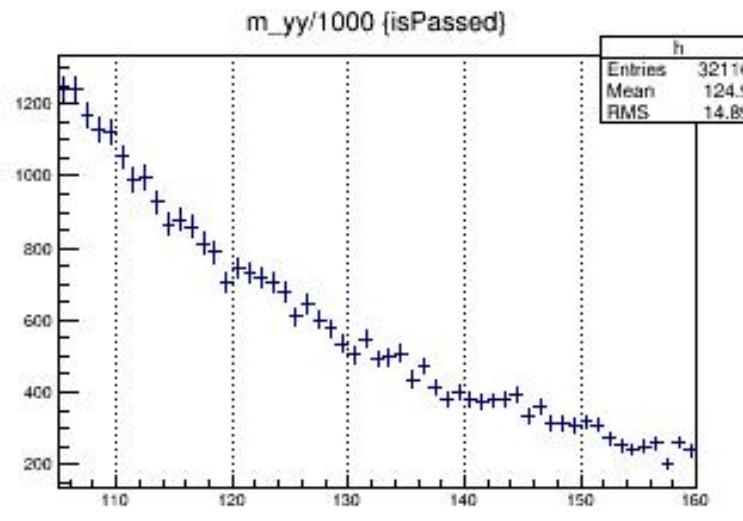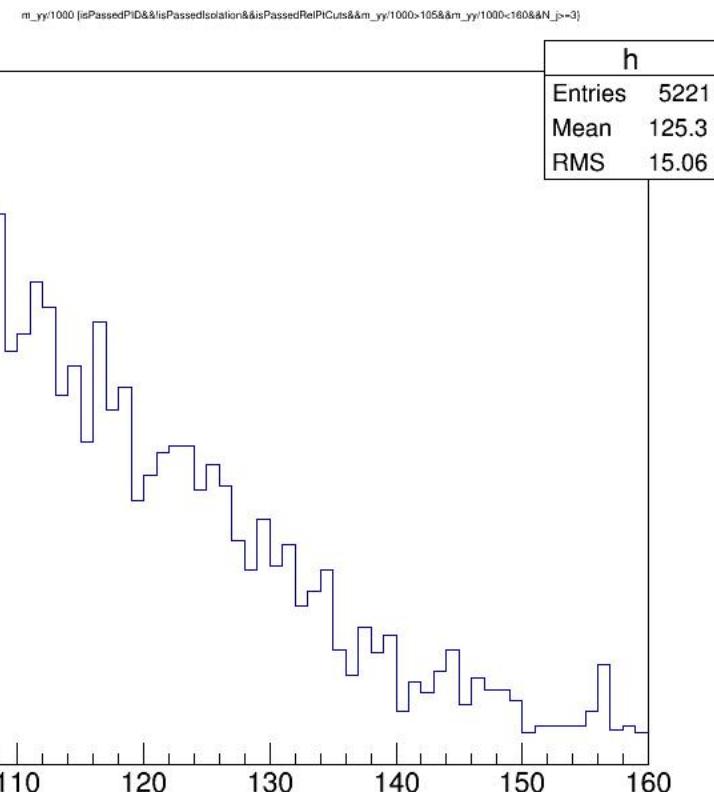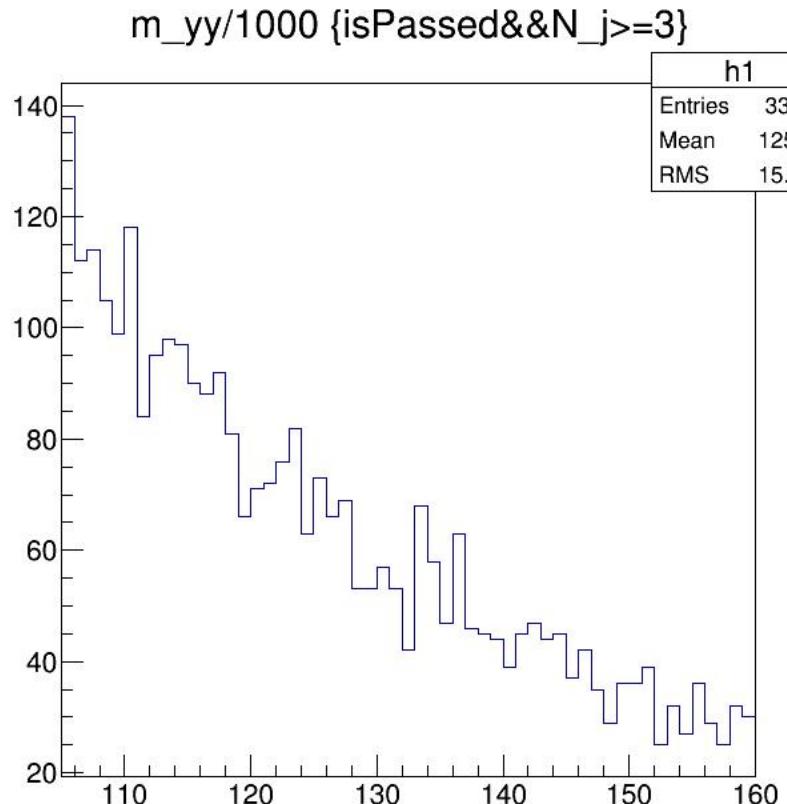
# 2015 inclusive

- WGGTITI = 24134.8 +/- 215.637 (stat)  + 157.091 - 1109.18 (syst)
- WGJTITI = 3943.57 +/- 89.6305 (stat)  + 647.405 - 165.465 (syst)
- WJGTITI = 2008.69 +/- 70.4828 (stat)  + 175.26 - 27.9001 (syst)
- WJJTITI = 791.396 +/- 29.6137 (stat)  + 285.441 - 41.135 (syst)
- WGJJGTITI = 5952.26 +/- 138.992 (stat)  + 822.666 - 101.738 (syst)
- PURITYTITI = 0.781607 +/- 0.00512232 (stat)  + 0.00472533 - 0.0358949 (syst)

- not converge

- WGGTITI = 18.4992 +/- 8.29294 (stat)  + 3.01373 - 0.475485 (syst)

- WGJTITI = 12.6231 +/- 3.70333 (stat)  + 4.93444 - 2.44684 (syst)

- WJGTITI = 7.54852 +/- 3.39856 (stat)  + 0 - 5.94913 (syst)

- WJJTITI = 0.000483823 +/- 0.000463932 (stat)  + 2.9446 - 0 (syst)

- WGJJGTITI = 20.1716 +/- 6.15231 (stat)  + 0 - 4.07961 (syst)

- PURITYTITI = 0.478371 +/- 0.187967 (stat)  + 0.0807998 - 0.0134714 (syst)

# 2015 mediumMET_highPTHARD

- WGGTITI = 649.984 +/- 38.1922 (stat) + 25.2265 - 47.0863 (syst)
- WGJTITI = 146.15 +/- 15.6033 (stat) + 30.3034 - 9.09786 (syst)
- WJGTITI = 113.646 +/- 13.9623 (stat) + 15.1347 - 7.7098 (syst)
- WJJTITI = 30.8396 +/- 5.39037 (stat) + 4.13444 - 6.79253 (syst)
- WGJJGTITI = 259.796 +/- 25.6177 (stat) + 45.438 - 16.8077 (syst)
- PURITYTITI = 0.691017 +/- 0.0317776 (stat) + 0.0255801 - 0.0517485 (syst)

# 2015 highPTGG

- WGGTITI = 16462.8 +/- 177.84 (stat)  + 139.872 - 795.287 (syst)

- WGJTITI = 2683.61 +/- 74.5041 (stat)  + 529.096 - 129.363 (syst)

- WJGTITI = 1350.63 +/- 56.8951 (stat)  + 47.3375 - 40.1653 (syst)

- WJJTITI = 493.747 +/- 23.584 (stat)  + 227.27 - 45.3513 (syst)

- WGJJGTITI = 4034.24 +/- 114.135 (stat)  + 563.654 - 82.025 (syst)

- PURITYTITI = 0.784287 +/- 0.00618214 (stat)  + 0.00619291 - 0.0377322 (syst)

# 2016 inclusive

- WGGTITI = 18445.6 +/- 192.748 (stat)  + 138.504 - 934.402 (syst)
- WGJTITI = 3444.54 +/- 82.3664 (stat)  + 689.519 - 135.874 (syst)
- WJGTITI = 1667.3 +/- 64.1316 (stat)  + 63.1937 - 100.625 (syst)
- WJJTITI = 698.452 +/- 28.2077 (stat)  + 160.329 - 44.751 (syst)
- WGJJGTITI = 5111.84 +/- 127.198 (stat)  + 750.555 - 72.6801 (syst)
- PURITYTITI = 0.760459 +/- 0.00598823 (stat)  + 0.00504506 - 0.037822 (syst)

- not converge

# 2016 highMET lowPTGG

- WGGTITI = 67.8094 +/- 11.055 (stat)  + 1.23822 - 8.72672 (syst)

- WGJTITI = 8.03918 +/- 3.88835 (stat)  + 13.6917 - 2.59014 (syst)

- WJGTITI = 4.27651 +/- 3.85922 (stat)  + 0.843758 - 3.74113 (syst)

- WJJTITI = 1.8058 +/- 1.30064 (stat)  + 0.137459 - 1.75533 (syst)

- WGJJGTITI = 12.3157 +/- 6.70961 (stat)  + 9.95052 - 1.74638 (syst)

- PURITYTITI = 0.827641 +/- 0.0922968 (stat)  + 0.0189434 - 0.114425 (syst)

# 2016 mediumMET highPTHARD

- WGGTITI = 860.326 +/- 43.3995 (stat) + 60.2932 - 0 (syst)
- WGJTITI = 198.256 +/- 18.8681 (stat) + 0 - 63.7535 (syst)
- WJGTITI = 100.874 +/- 14.7717 (stat) + 30.0498 - 0.0252457 (syst)
- WJJTITI = 44.7031 +/- 6.52667 (stat) + 9.70344 - 8.06897 (syst)
- WGJJGTITI = 299.13 +/- 29.2048 (stat) + 6.38643 - 63.7788 (syst)
- PURITYTITI = 0.714462 +/- 0.0280467 (stat) + 0.0505056 - 0 (syst)

# 2016 highPTGG

- WGGTITI = 12306.3 +/- 157.571 (stat)  + 136.807 - 749.535 (syst)
- WGJTITI = 2345.78 +/- 67.7446 (stat)  + 506.496 - 116.556 (syst)
- WJGTITI = 1128.07 +/- 51.2851 (stat)  + 58.1798 - 0 (syst)
- WJJTITI = 407.302 +/- 21.8633 (stat)  + 162.08 - 14.2062 (syst)
- WGJJGTITI = 3473.85 +/- 103.411 (stat)  + 564.676 - 104.679 (syst)
- PURITYTITI = 0.760238 +/- 0.00729787 (stat)  + 0.00760131 - 0.0452973 (syst)