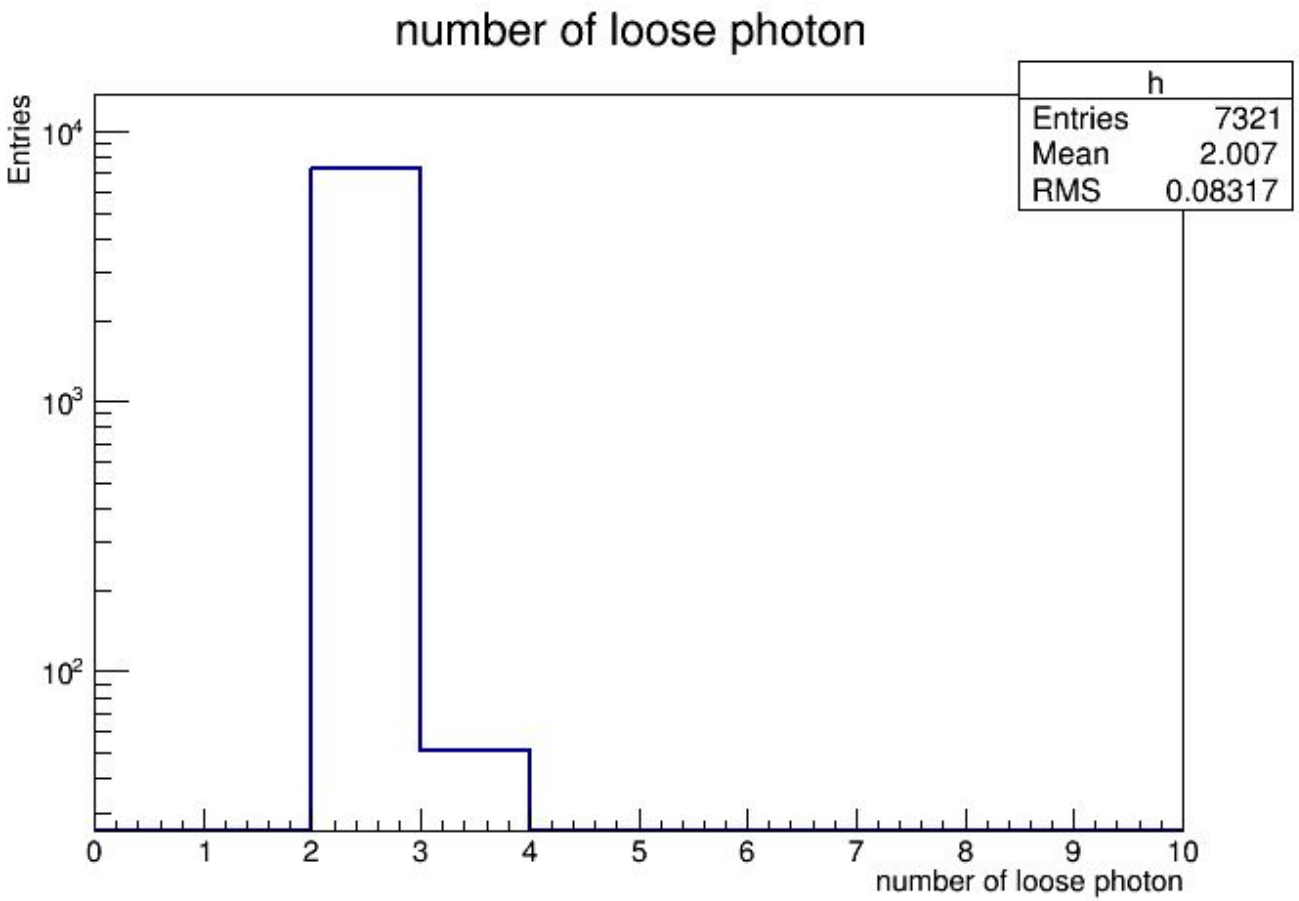
High Mass Diphoton Resonance

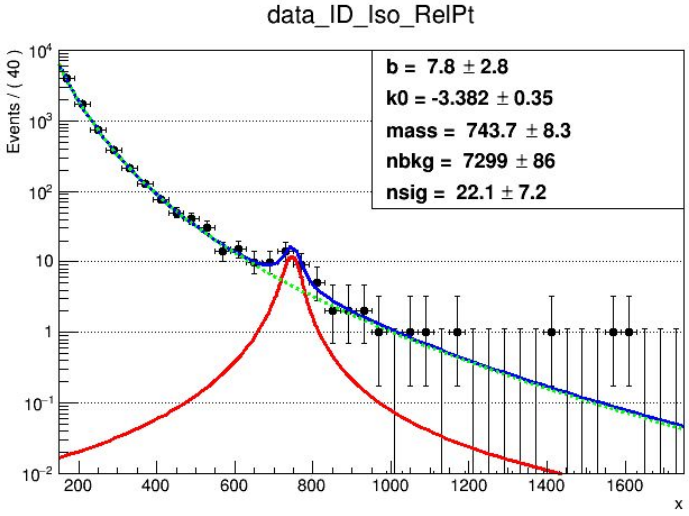
Yu Zhang

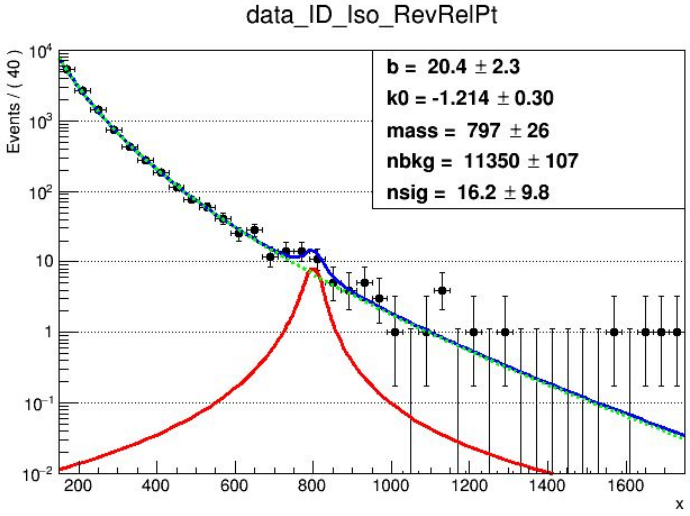
01.04

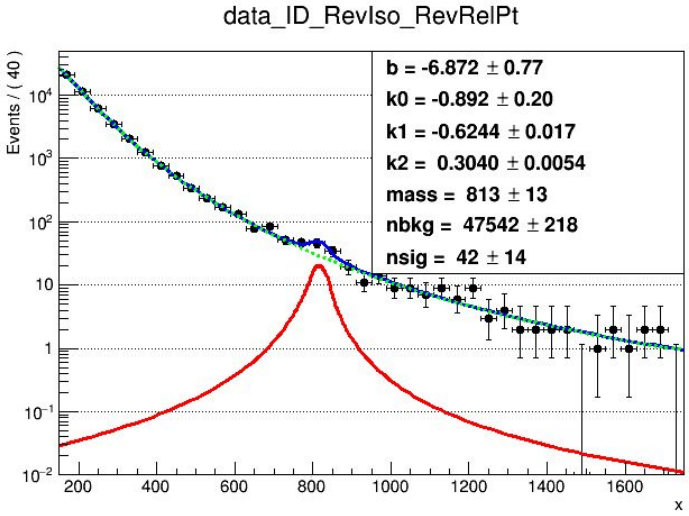
number of loose photon



Significance

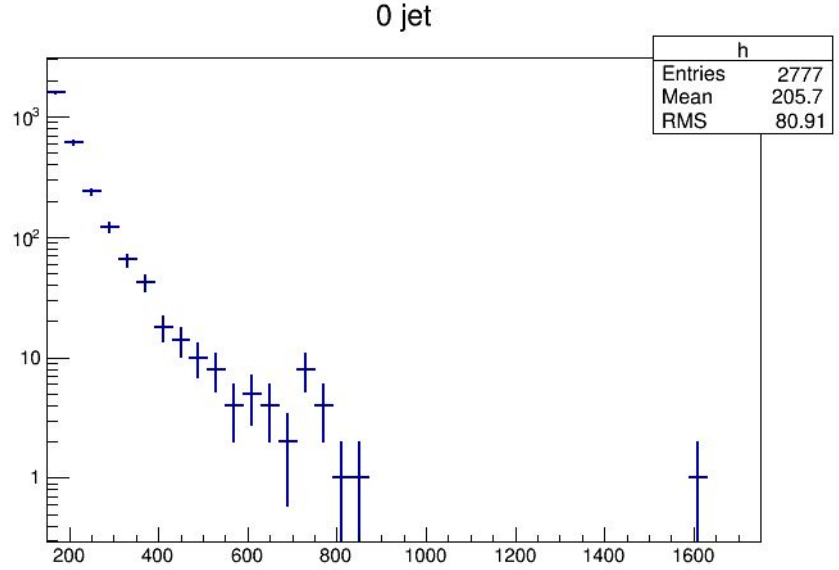


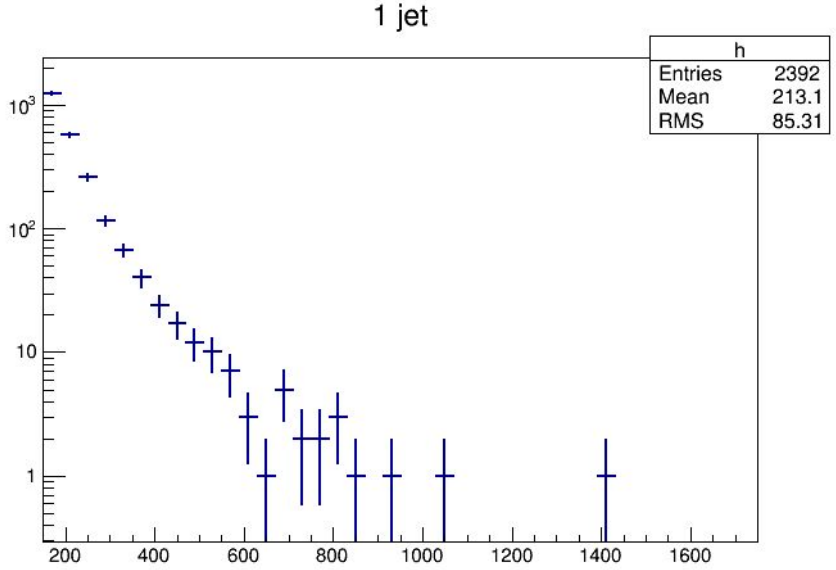


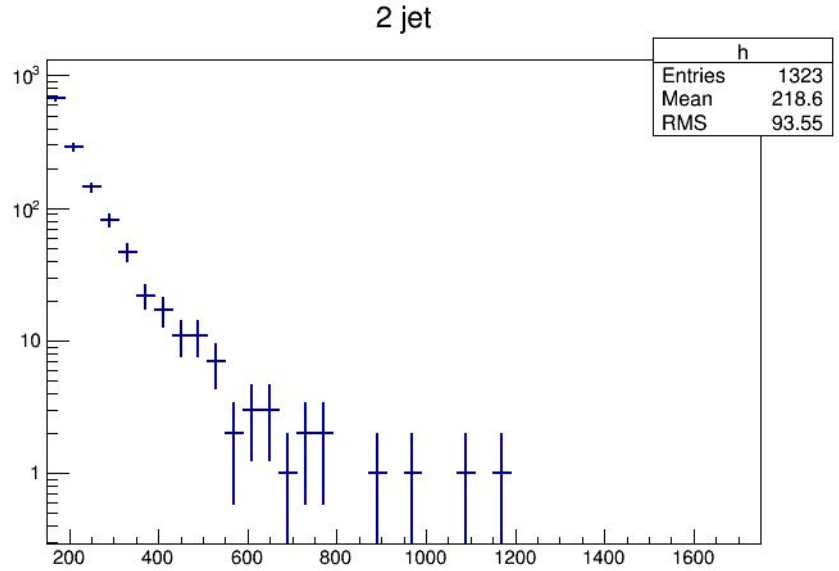


	public note	Iso_RelPt	Iso_RevRelPt	RevIso_RevRelPt
signal	18.5	17.71	13.96	36
background	24.2	17.63	26.81	173.16
significance	3.95	3.71	2.17	2.65

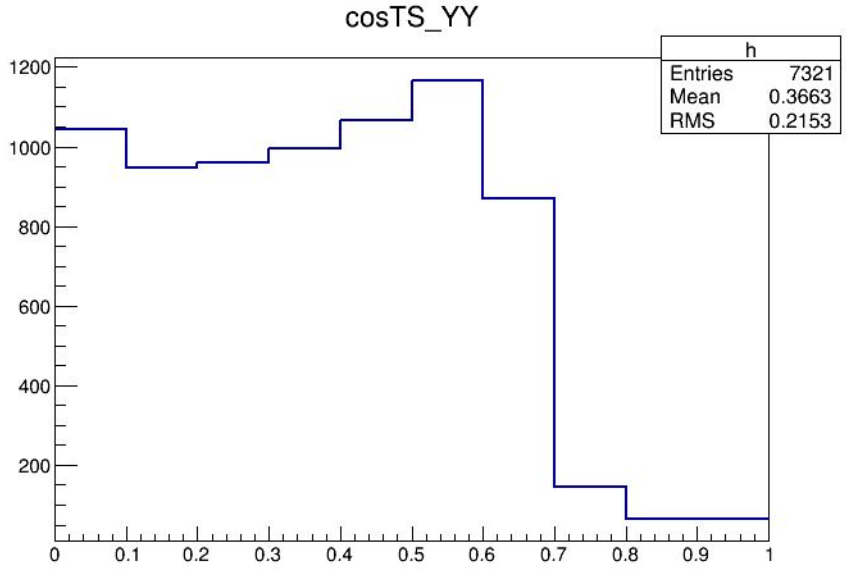
spectrum in different jet multipicity

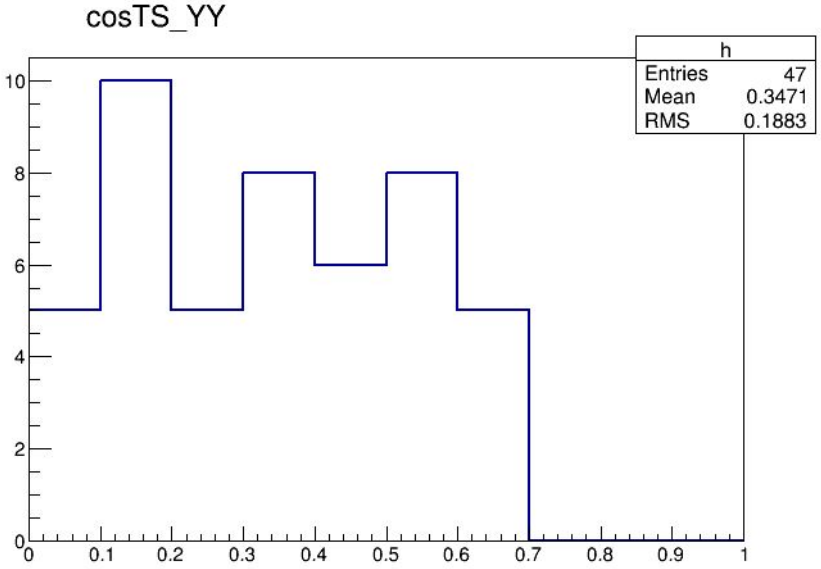




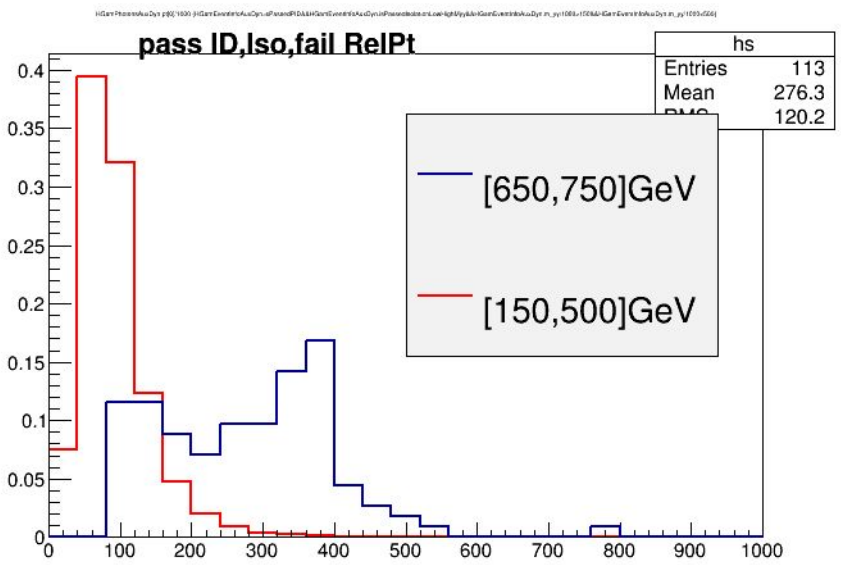


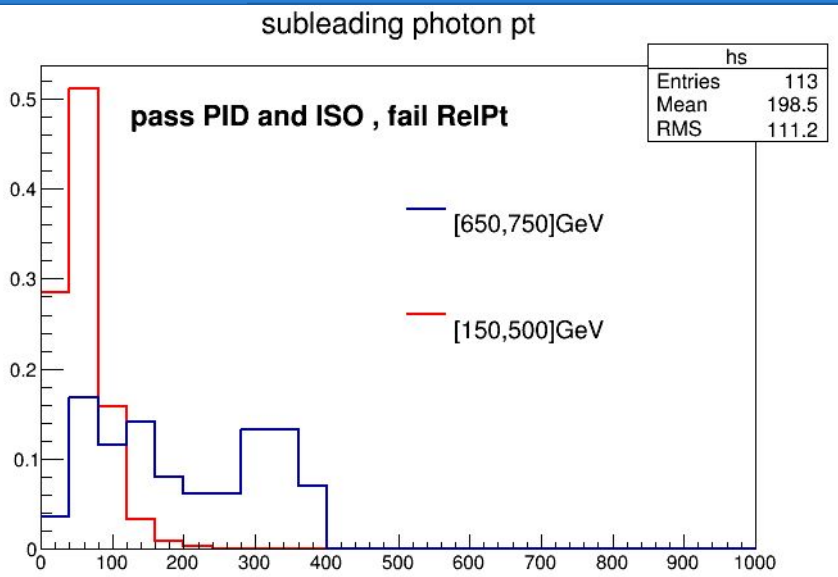
costheta*


cosTS_YY
h
Entries 7321
Mean 0.3663
RMS 0.2153
1200
1000
800
600
400
200
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


cosTS_YY
h
Entries 47
Mean 0.3471
RMS 0.1883
10
8
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

kinematic


pass ID,Iso,fail RelPt
hs
Entries 113
Mean 276.3
120.2
[650,750]GeV
[150,500]GeV


subleading photon pt
pass PID and ISO , fail RelPt
hs
Entries 113
Mean 198.5
RMS 111.2
[650,750]GeV
[150,500]GeV

backup

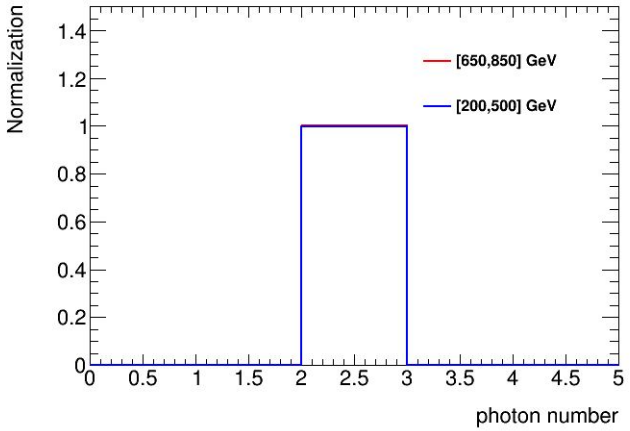
Sample

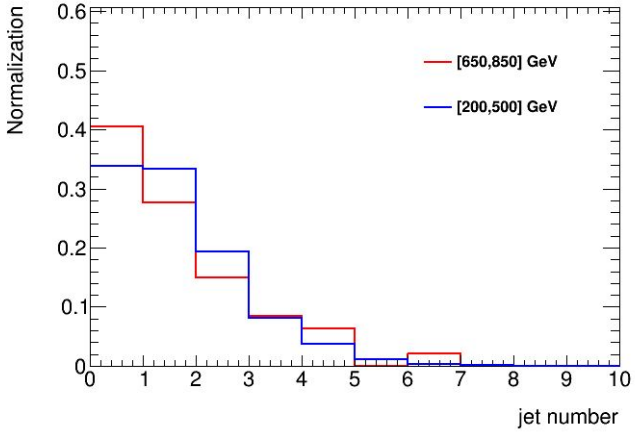
- h009 MxAOD
  - /eos/atlas/atlascerngroupdisk/phys-higgs/HSG1/MxAOD/h009/data15_13TeV.periodAll25ns_3317invpb.MxAOD.p2425.h009.root
  - contains :LowHighMyy selection
  - Thanks to Liron

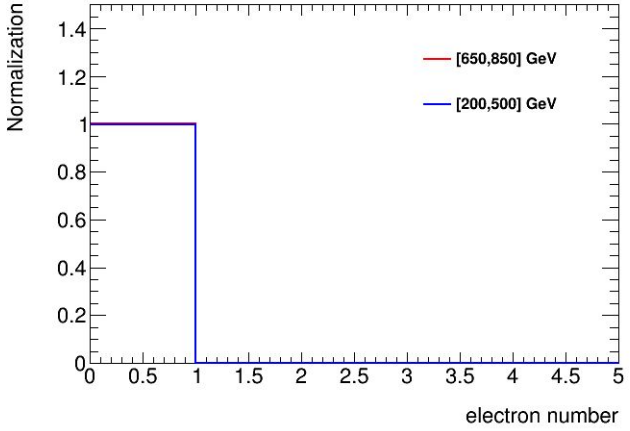
Selection(copy)

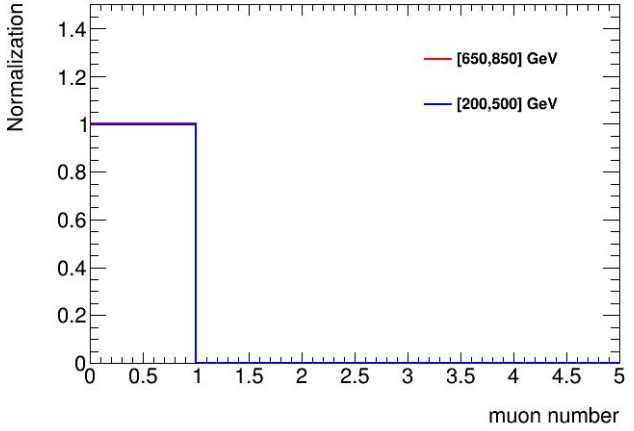
- Preselection
  - GRL, Trigger, Detector Quality, Vertex
  - two loose photons, PtEta cuts
- ID
- Isolation
  - calo isolation $\Delta R=0.4$: isolation $Et<0.022*Et+2.45GeV$ (Higgs $\Delta R=0.2$: $0.065*pT$)
  - track isolation $\Delta R=0.2$: isolation $pT<0.05*Et$ (Higgs $\Delta R=0.2$: $0.05*pT$)
- Relative Pt

object numbers









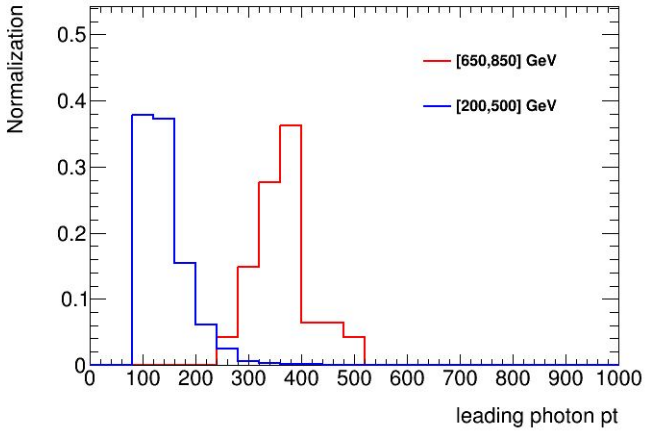
Signal Region [650,850]GeV

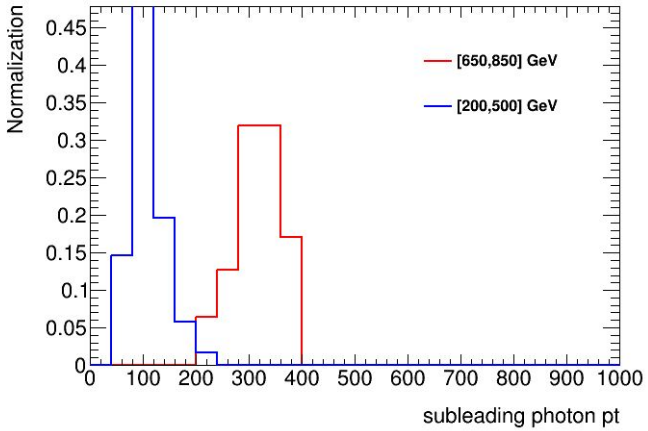
	0	1	2
jet	19	13	7
el	47	0	0
mu	47	0	0

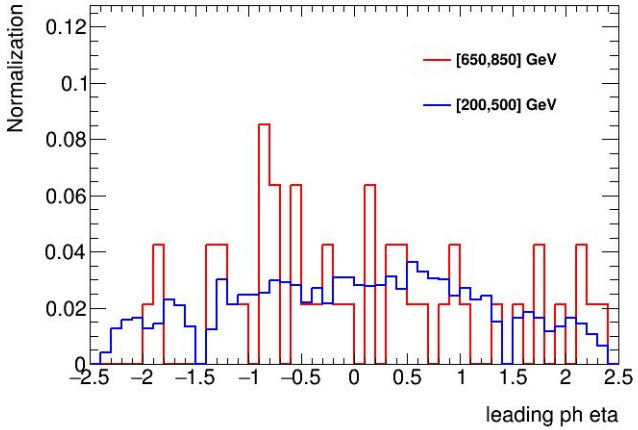
Control Region [200,500]GeV

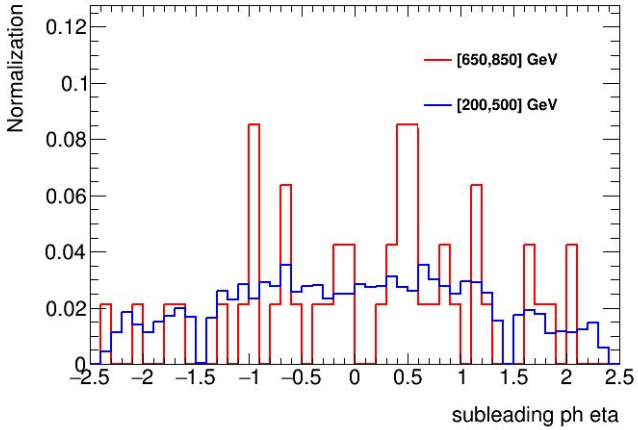
	0	1	2
jet	922	908	526
el	2725	5	0
mu	2728	2	0

kinematics

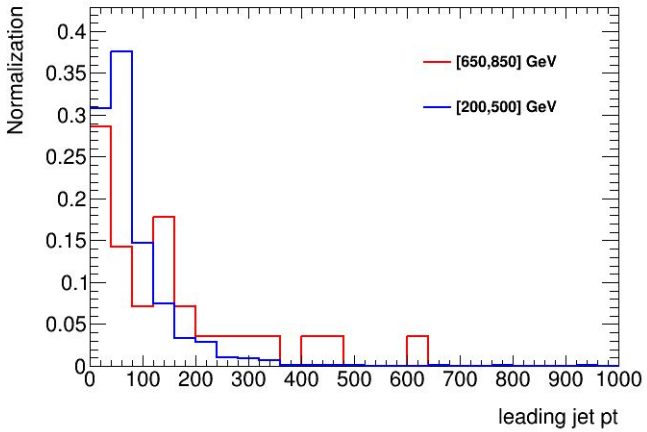

Normalization
[650,850] GeV
[200,500] GeV
leading photon pt

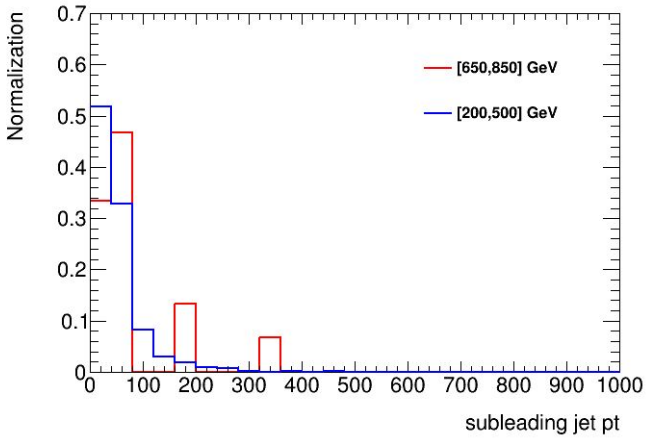

Normalization
[650,850] GeV
[200,500] GeV
subleading photon pt

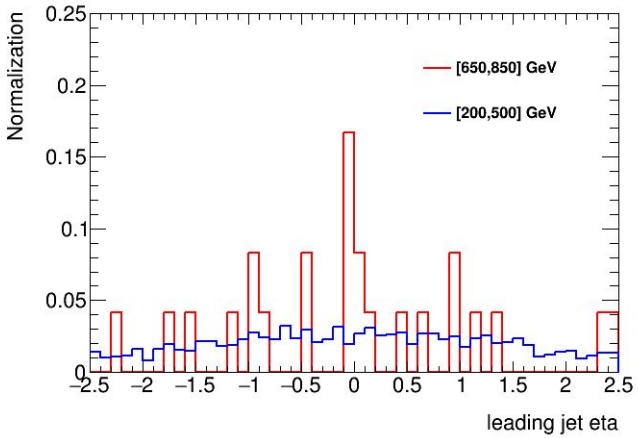

Normalization
[650,850] GeV
[200,500] GeV
leading ph eta

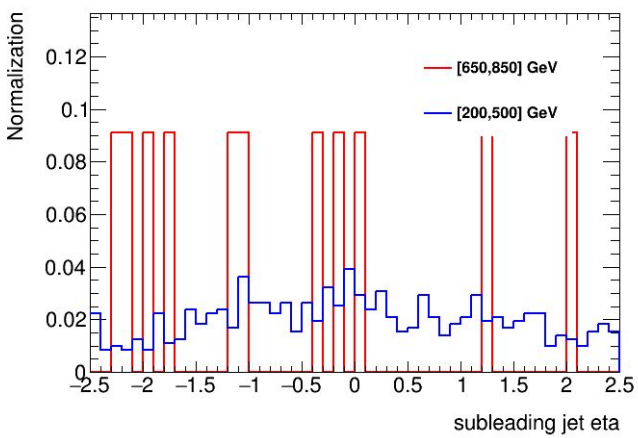

Normalization
[650,850] GeV
[200,500] GeV
subleading ph eta

kinematics


Normalization
[650,850] GeV
[200,500] GeV
leading jet pt


Normalization
[650,850] GeV
[200,500] GeV
subleading jet pt

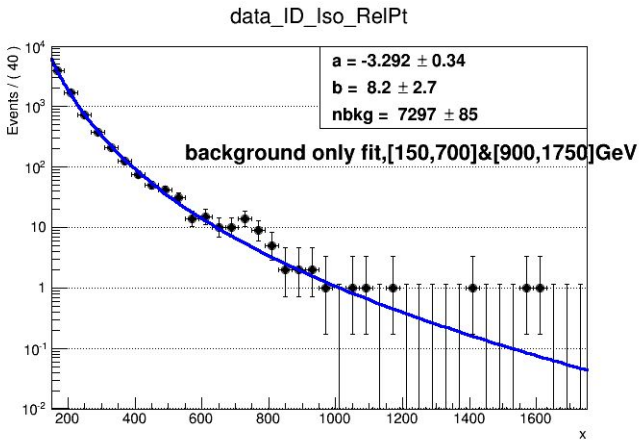

Normalization
[650,850] GeV
[200,500] GeV
leading jet eta

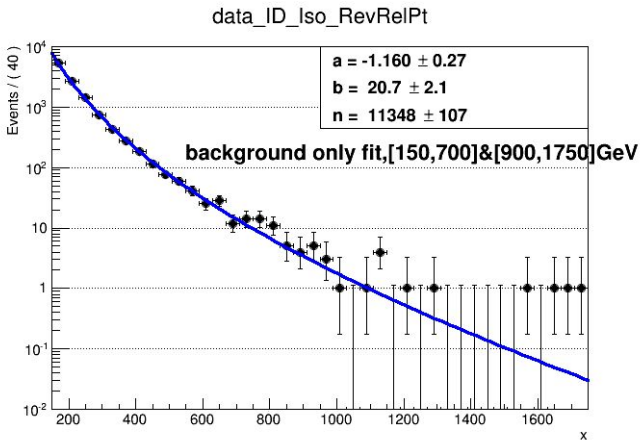

Normalization
[650,850] GeV
[200,500] GeV
subleading jet eta

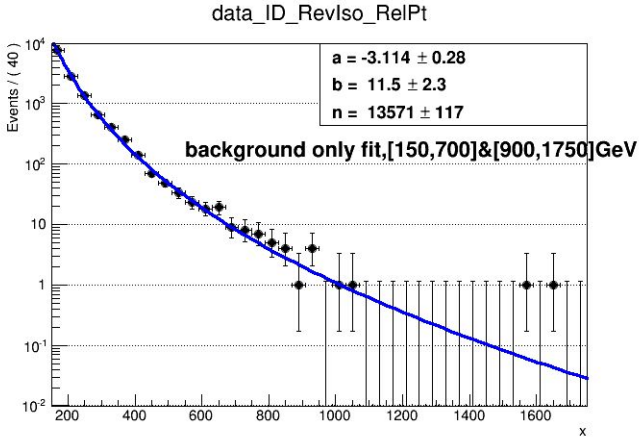
control region

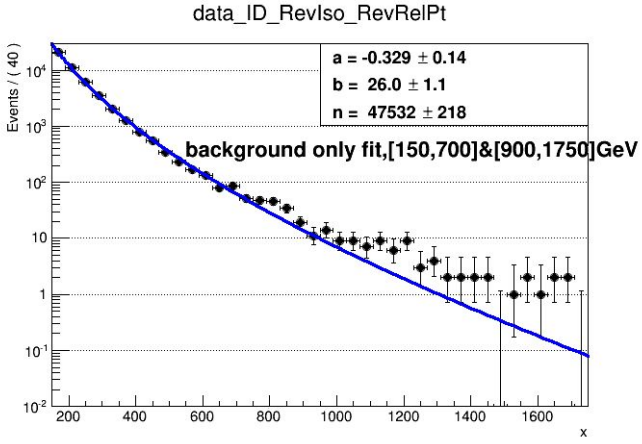
- ID: both photons pass tight ID
- RevID: at least one photon fails tight ID
- Iso: both photons pass Isolation
- RevIso: at least one photon fails Isolation
- RelPt: both photons pass RelPt
- RevRelPt: at least one photon fails RelPt
- 1 Signal region, 8 control regions
- In principle, background is dominant in control region .

mγγ spectrum in each control region

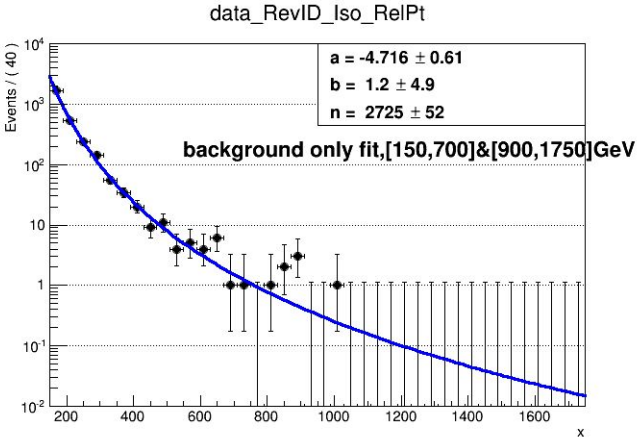


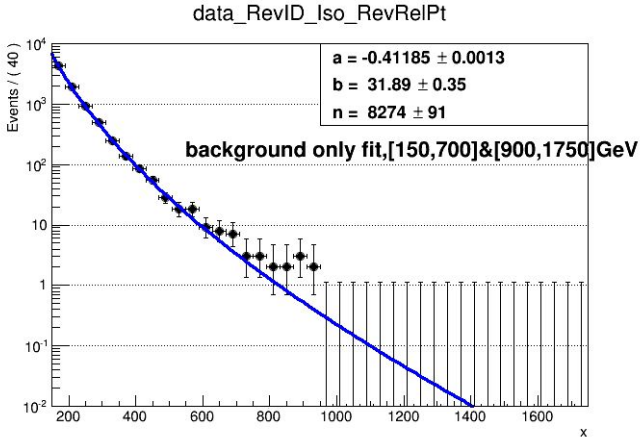


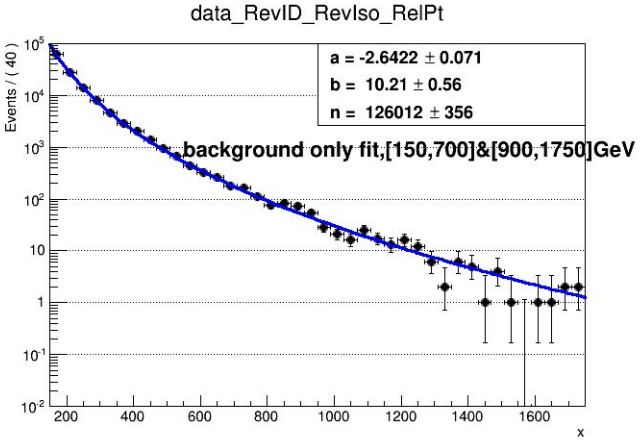


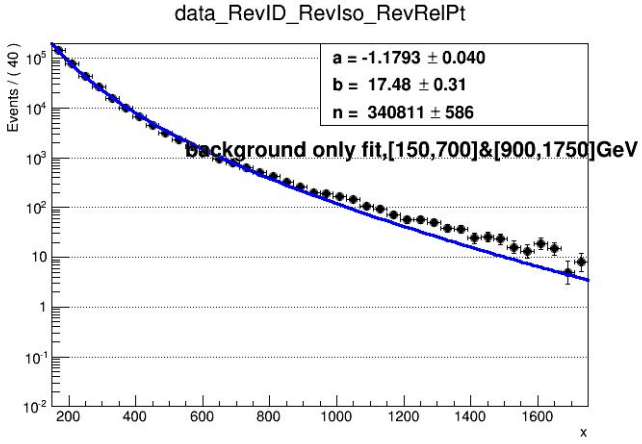


mγγ spectrum in control region

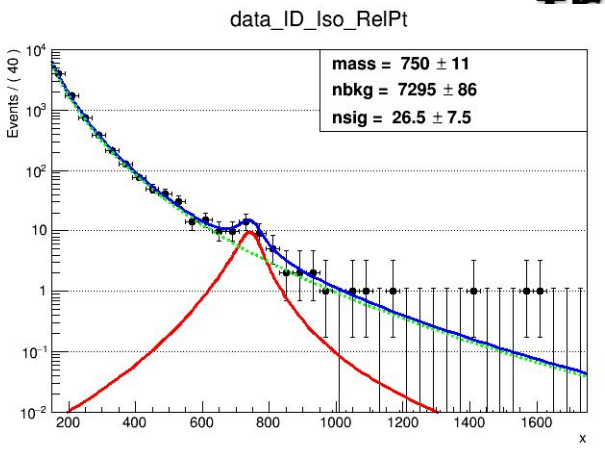


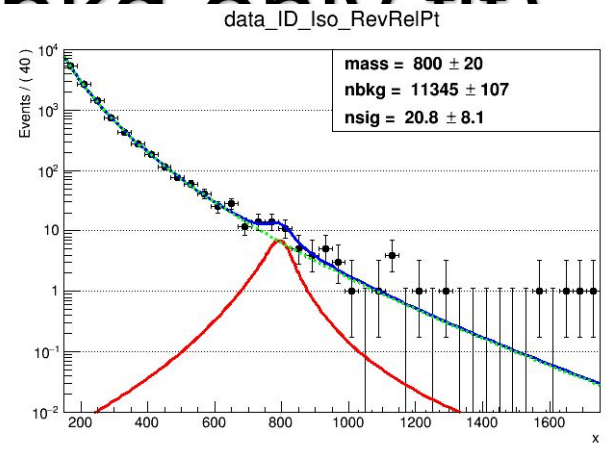


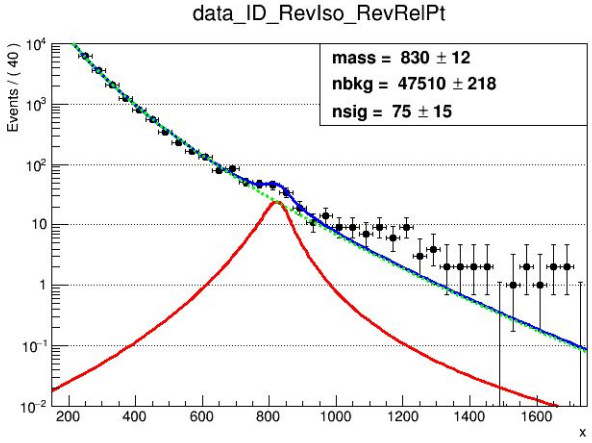




S+B fit ---Large Width (bkg shape from bkg only fit)





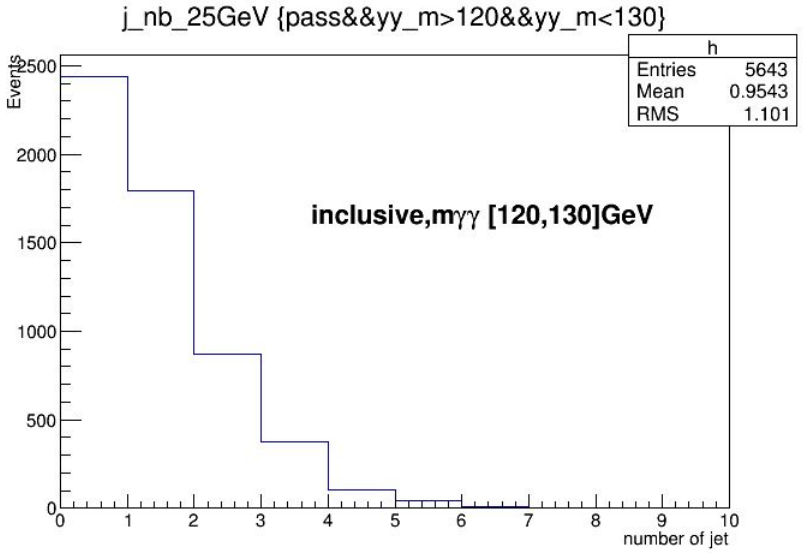


- Large Width result in note
  - Background events: 7299±86
  - Signal events: 22.4±7.4

summary

- Due to low statistic , it is hard to check the property of this resonance
- associated with some jets
- some excess events in control region

back up


j_nb_25GeV {pass&&yy_m>120&&yy_m<130}
h
Entries 5643
Mean 0.9543
RMS 1.101
inclusive,mγγ [120,130]GeV
Events
number of jet
0
500
1000
1500
2000
2500
0 1 2 3 4 5 6 7 8 9 10

isolation efficiency(copy)

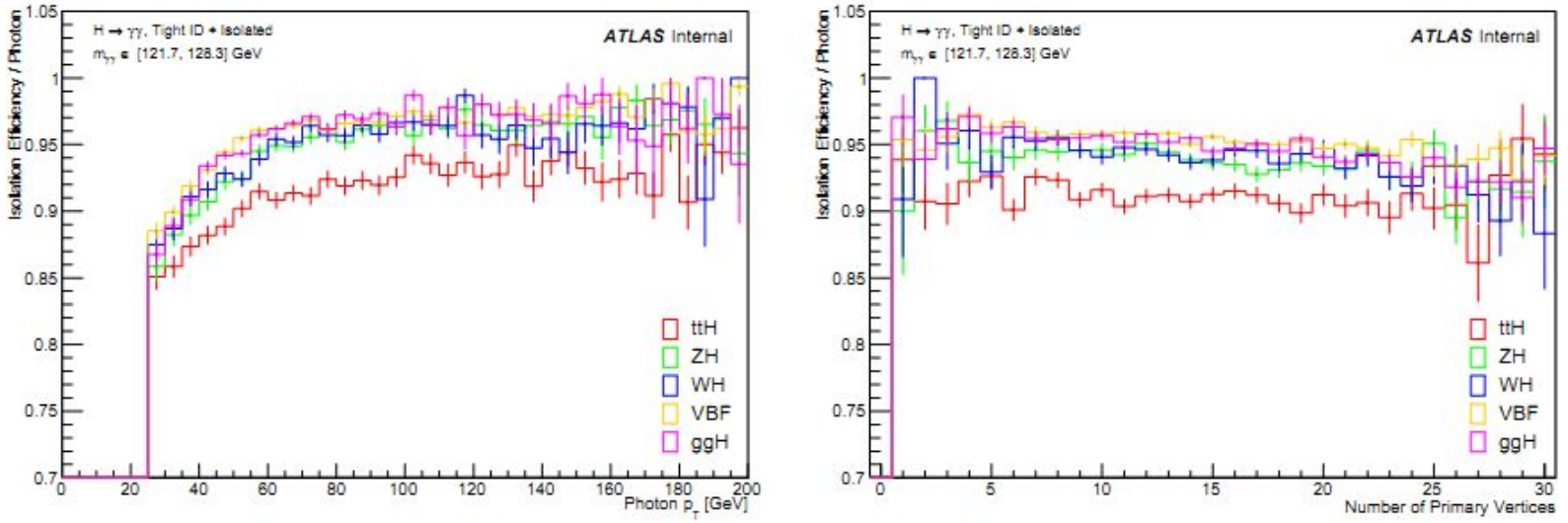
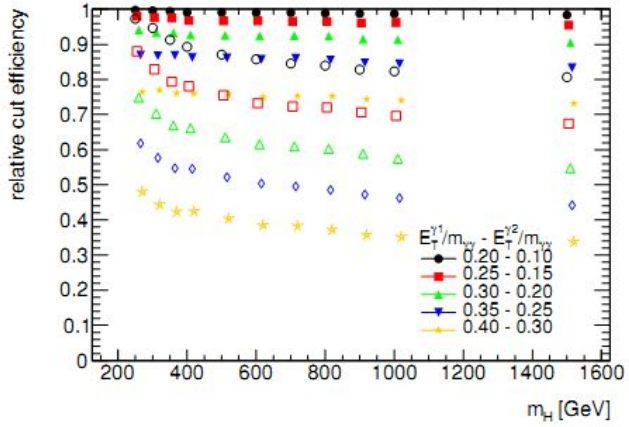
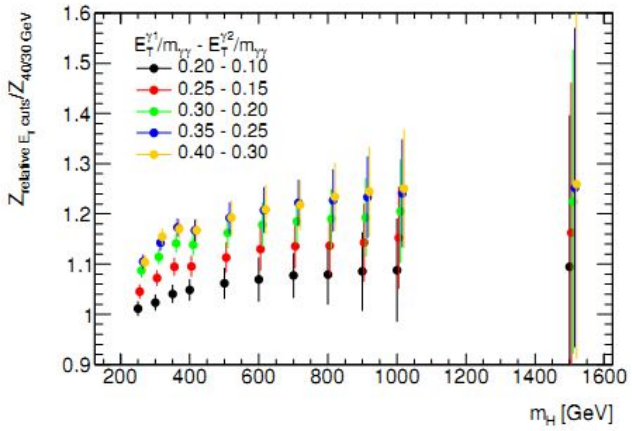
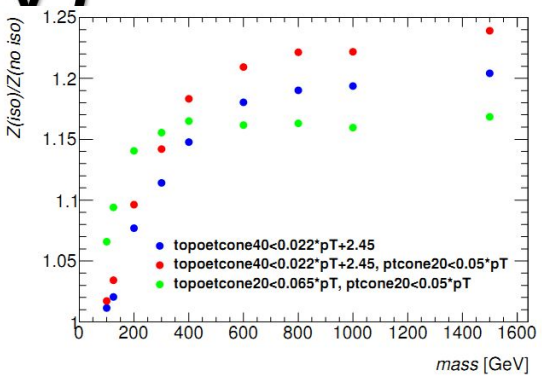


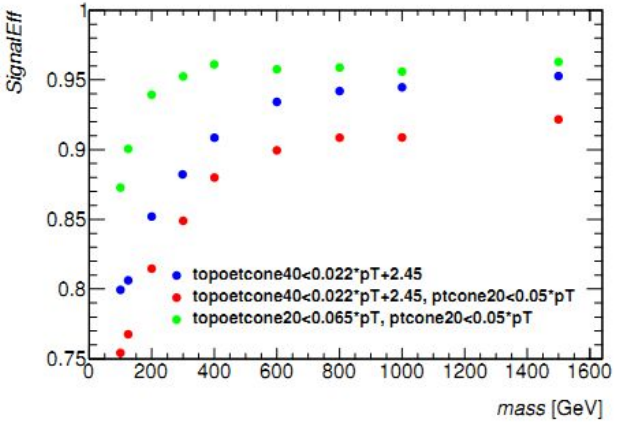
Figure 22: This figure shows the per photon isolation efficiency vs. Photon p_T and the number of primary vertices. Photons are selected to satisfy a tight ID, and fall in the mass range of 125 ± 3.3 GeV.

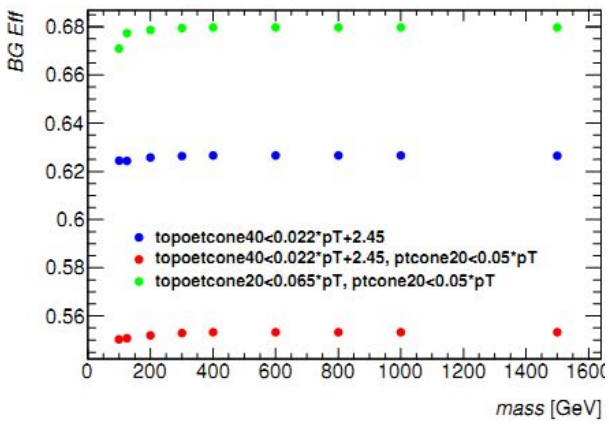
cut efficiency and significance improvements(copy)

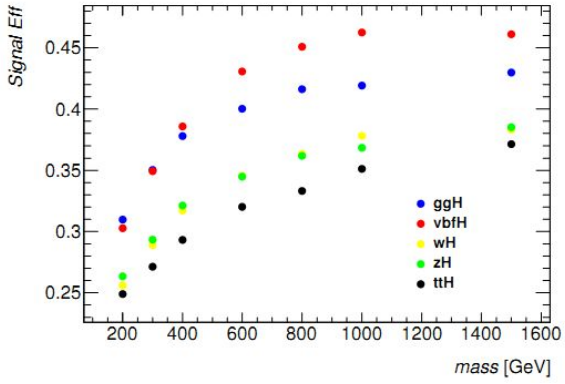












background modeling(copy)

- from dijet analysis

$$f_{k;d}(x;b,\{a_k\}) = (1-x^d)^b x^{\sum_{j=0}^{k} a_j \log(x)^j}$$

- spurious sinal, fit goodness
  - use S+B function to fit background sample
  - uncertainty of fitted background number of events

$$f_{k=0;d=1/3}(x;b,d,\{a_k\}) = (1-x^{1/3})^b x^{a_0}$$

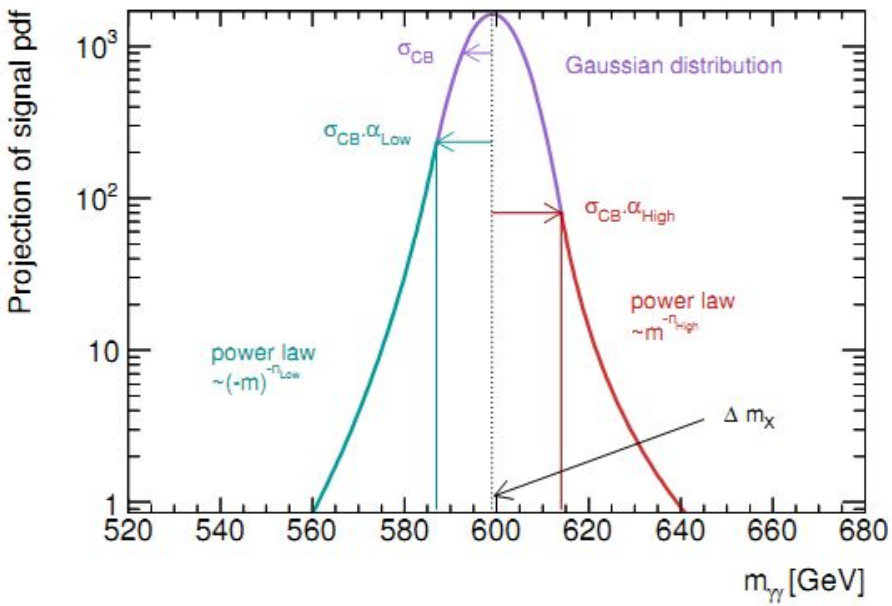
  - fitted signal strength
  - user B only function to fit background sample , Chi2/ndf
  - final choice

signal modeling(copy)

- Double-Sided Crystal Ball (DSCB)
  - asymmetric and non-Gaussian low and high mass tails
  - six parameters:μ_{CB},σ_{CB}, α_{Low}, α_{High}, N_{Low}, N_{High}

$$N \cdot \begin{cases} e^{-t^2/2} & \text{if } -\alpha_{Low} \geq t \geq \alpha_{High} \\ \dfrac{e^{-0.5\alpha_{Low}^2}}{\left[\frac{\alpha_{Low}}{n_{Low}}\left(\frac{n_{Low}}{\alpha_{Low}} - \alpha_{Low} - t\right)\right]^{n_{Low}}} & \text{if } t < -\alpha_{Low} \\ \dfrac{e^{-0.5\alpha_{High}^2}}{\left[\frac{\alpha_{High}}{n_{High}}\left(\frac{n_{High}}{\alpha_{High}} - \alpha_{High} + t\right)\right]^{n_{High}}} & \text{if } t > \alpha_{High}, \end{cases}$$

$$t = \Delta m_X / \sigma_{CB},\ \Delta m_X = m_X - \mu_{CB}$$



signal modeling(copy)

- parameter dependence on mass,
- Narrow Width Approxi $m_{nX} = \frac{m_X - 100}{100}$ (NWA)

Parameter	Parameterization	a	b	c
Δm_X	$a + bm_{nX} + cm_{nX}^2$	-0.014 ± 0.011	-0.042 ± 0.003	0.0008 ± 0.0003
σ_{CB}	$a + bm_{nX}$	1.528 ± 0.010	0.605 ± 0.002	
α_{Low}	$a + b/(m_{nX} + c)$	1.372 ± 0.013	5.466 ± 1.167	16.431 ± 4.587
n_{Low}	a	5.95		
α_{High}	$a + b/(m_{nX} + c)$	2.305 ± 0.015	-0.451 ± 0.112	2.0652 ± 0.527
n_{High}	a	3.15		

$$\Delta m_X = a + bm_{nX} + cm_{nX}^2$$

$$\sigma_{CB} = a + bm_{nX}$$

$$\alpha_{Low,High} = a + b/(m_{nX} + c)$$

$$N_{Low,High} = const$$

- Large Width App

Crystal Ball parameter	Mass-dependence parameter	Value at $\alpha_X = 0.06$	Value at $\alpha_X = 0.10$
Δm_X	a	-0.00637	0.901
	b	-0.222	-1.19
	c	-0.0200	0.0146
σ_{CB}	a	3.64	4.19
	b	2.73	4.12
α_{Low}	a	-0.0220	-3.04
	b	30.6	673
	c	24.8	173
n_{Low}		2.5	6
α_{Hi}	a	1.26	1.09
	b	-0.0141	-0.160
	c	-0.803	-0.479
n_{Hi}		2.1	3.39