BSM gg → H → hh → WWyy Search with jjjjyy final state

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A first look at sideband region

Njets>=4

- Sideband region:
  - mass(yy) within [100,160] GeV
  - mass(yy) is excluded from $|m_h - \Delta m_h - m_{\gamma\gamma}| < 2\sigma_{\gamma\gamma}$
  - where mh=125.6, deltamh=0.15, sigma=1.6

sideband	# of evt
ggH	0.467175
VBF	0.123474
WH	0.0638113
ZH	0.0405459
ttH	0.138622
Continuum	?
In data	1170

Continuum?

There are large components in backgrounds not yet clear
Need to at least introduce pp→jjjjyy and pp→jjyy

Bkg samples, use bbyy continuum samples?

A first look at signal region

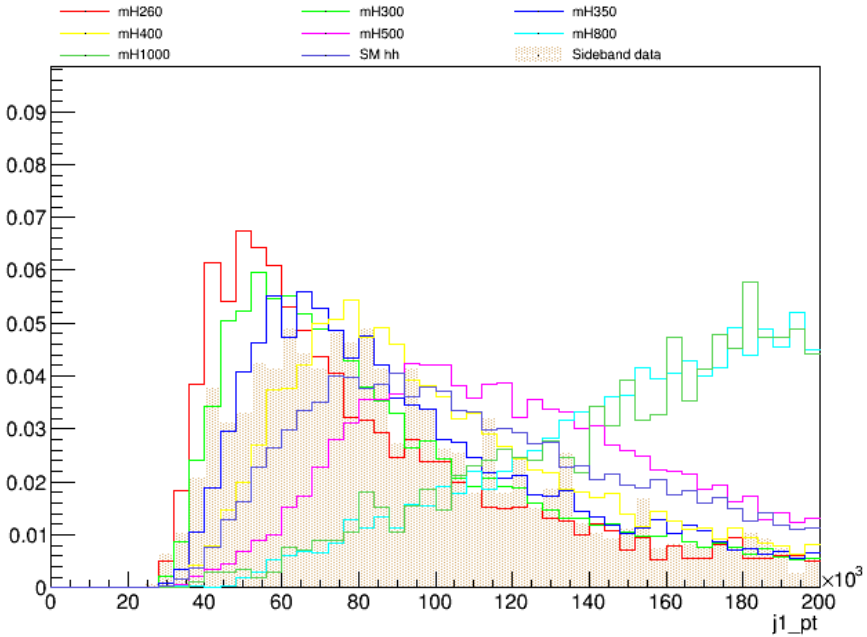
Njets>=4

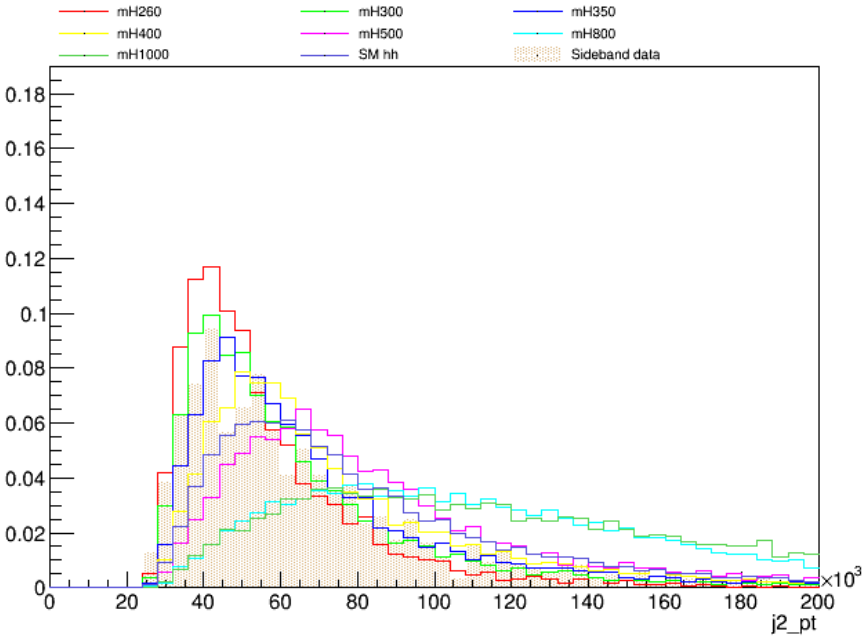
- Signal region:
  - mass(yy) is required by $|m_h - \Delta m_h - m_{\gamma\gamma}| < 2\sigma_{\gamma\gamma}$
  - where mh=125.6, deltamh=0.15, sigma=1.6

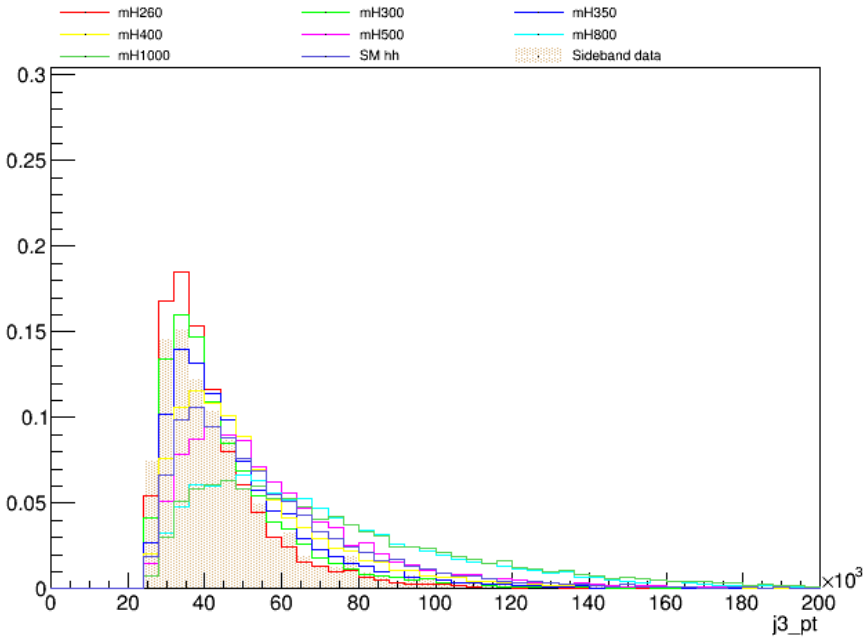
sideband	# of evt
ggH	4.91724
VBF	1.0963
WH	0.570564
ZH	0.374228
ttH	1.34295
Continuum	?
est bkg*	143

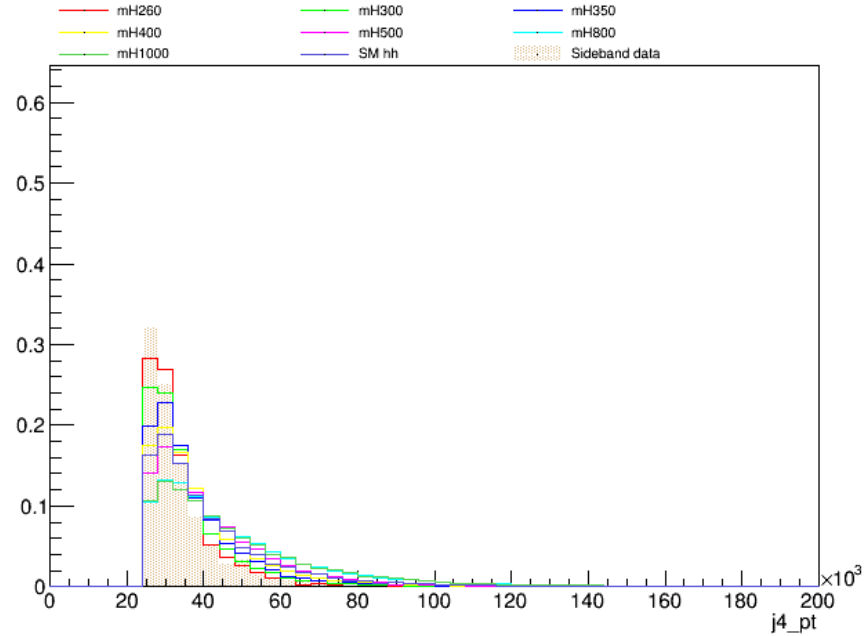
* bkg in signal region estimated by fitting to exponential with sideband data

Central production (inclusive samples)









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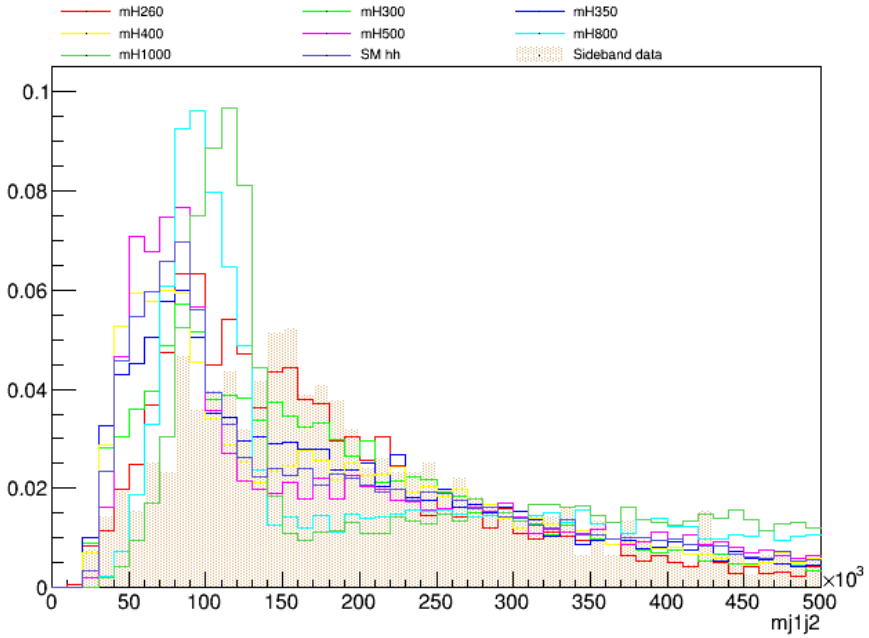

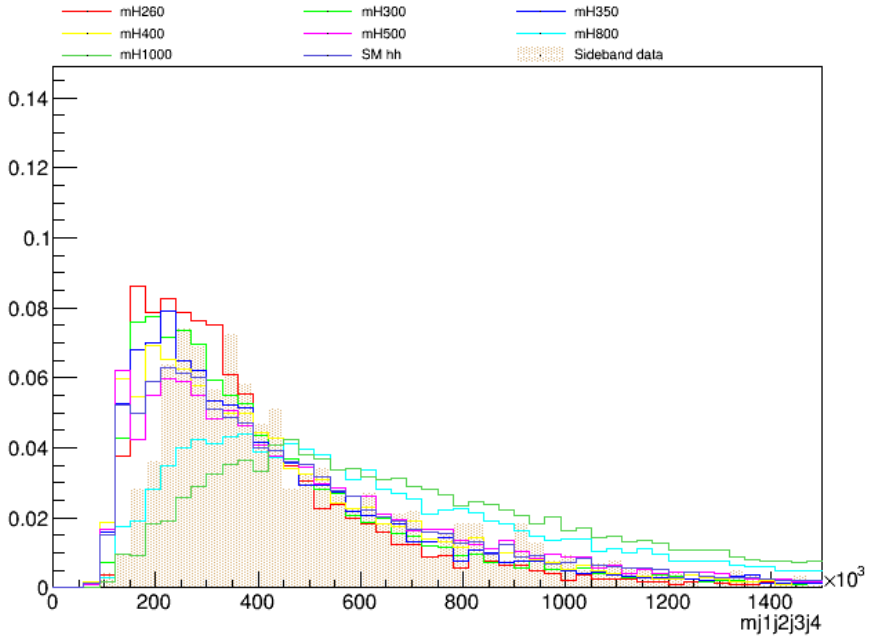

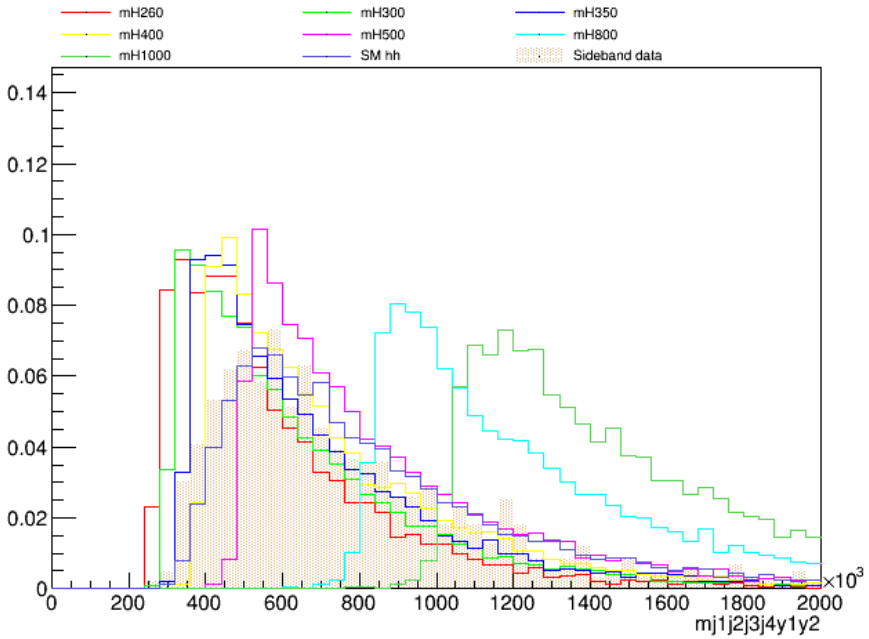

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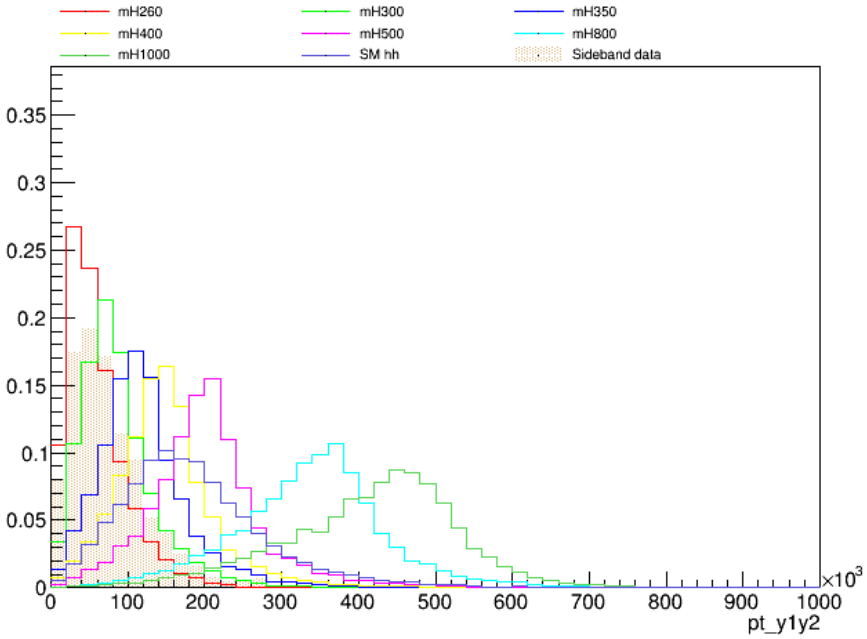

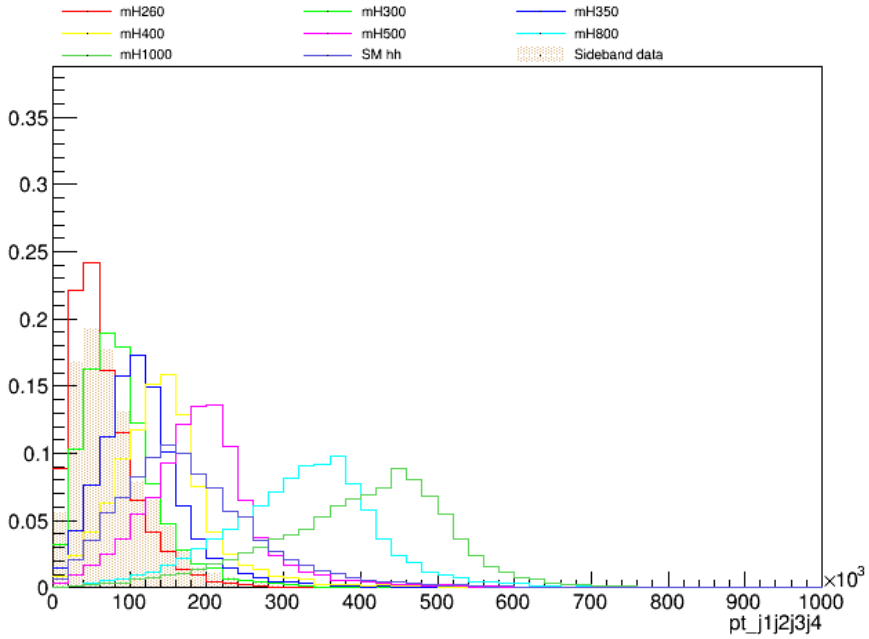

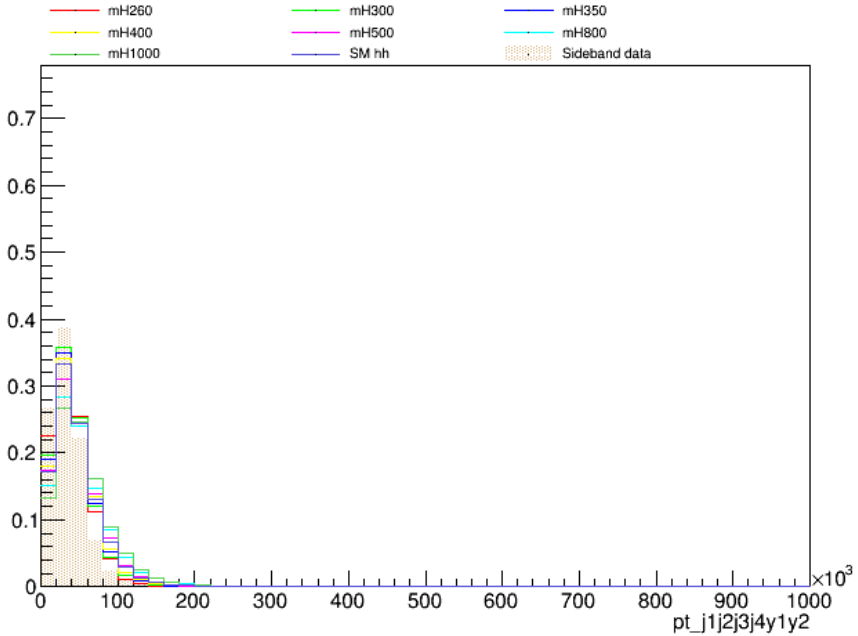

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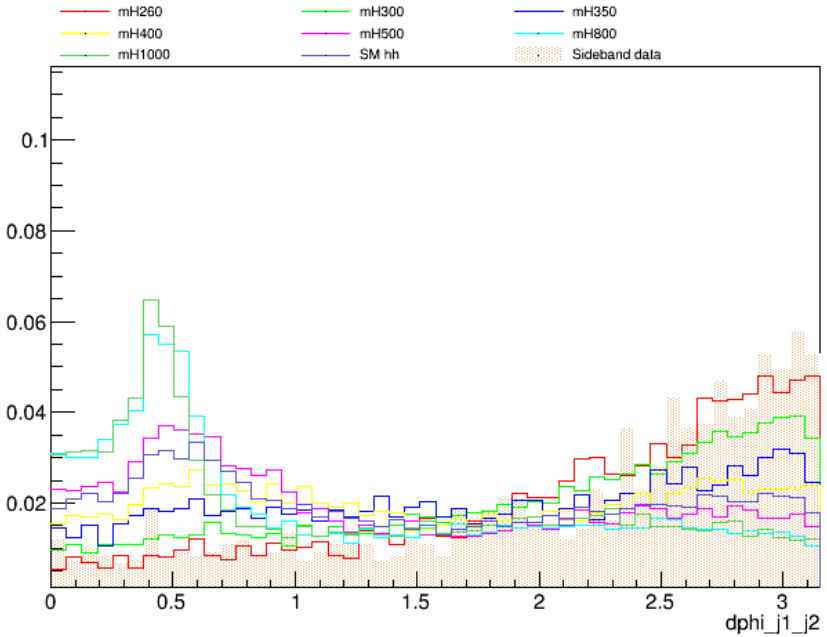

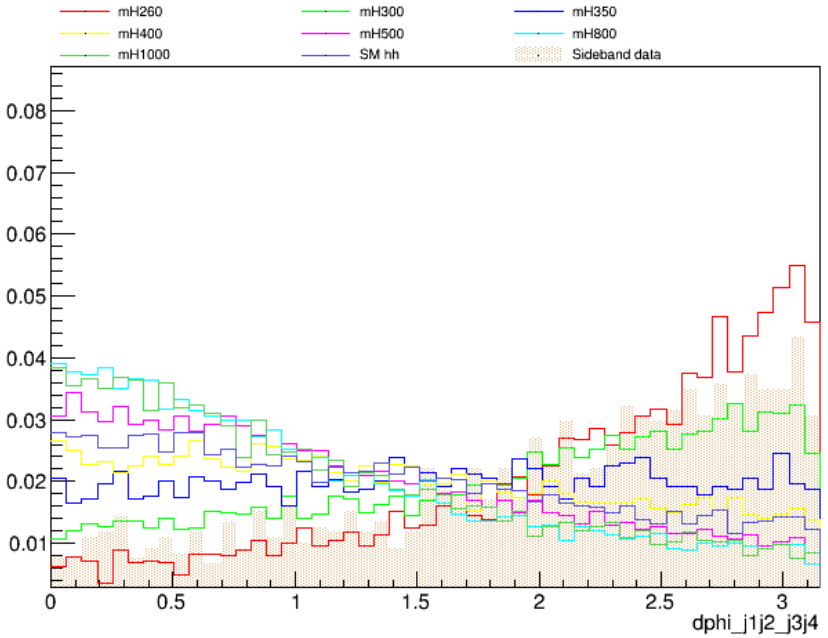

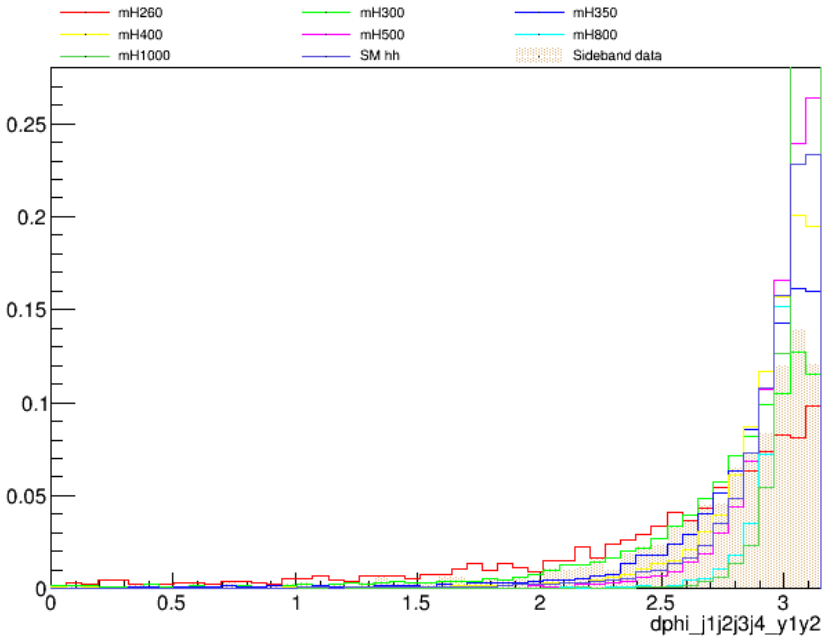

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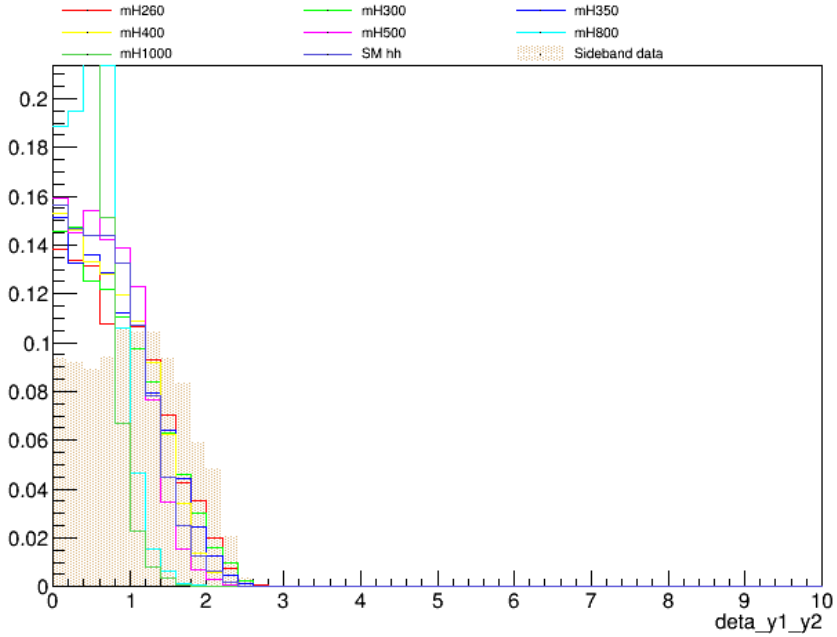

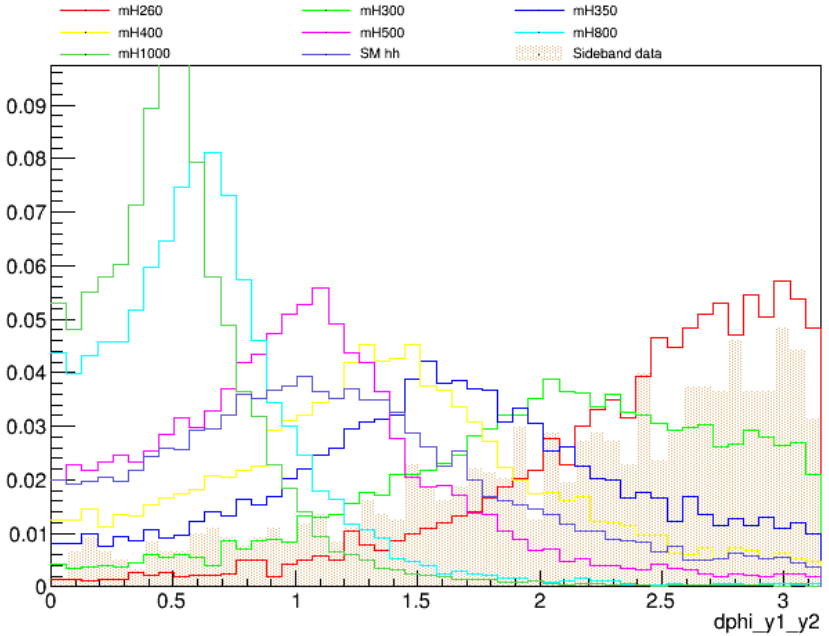

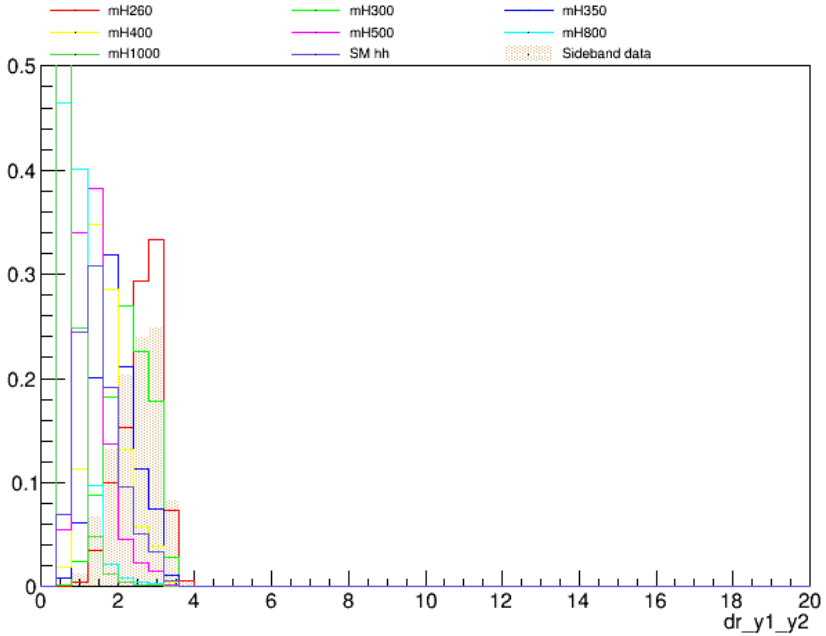

Reconstructed jets

- By matching with truth information of jets, one find calculate the correctness of the well-reconstructed jet pairs

specific	#evts	%
none (all cuts form yy side)	2914	-
any pairs from W	1887	65%
1 pair from W	1704	**58%**
2 pairs from W	183	**6%**
the pair from 1st W	1243	43%
the pair from 2nd W	827	28%

*all numbers except the case of 'none' are calculated by asking njets>=4
pT > 25 GeV when |eta| < 2.4
pT > 30 GeV when |eta| > 2.4

So, instead of asking for >=4 jets and trying to reconstruct both Ws,
one may keep higher statistics and obtain better sensitivities by
Looking also 2,3,>=4 jets and reconstruct only one of the Ws from 2 jets

Jet bin

- Look at different events with different jet multiplicities separately
  - Njets = 2
  - Njets = 3
  - Njets >= 4

specific	2jets	3jets	>=4jets
evts	2702	2702	2908
0pair of jets from real W	75%	51%	35%
1pair of jets from real W	**25%**	**49%**	**59%**
2pair of jets from real W	0%	0%	6%

Sig vs bkg (sideband data)

- Using only side band data as bkg for the time-being by rejecting yy invariant mass window
- S is absolute evt Nbrs from MC, B is absolute evt Nbrs from data in side band, so S/sqrt(B) is calculated as a relative value, their absolute values are meaningless

specific	2jets	3jets	>=4jets
Sig evts	2702	2702	2908
Bkg evts	9121	3014	1168
Rel. S/sqrt(B)	28	49	85

Run II

- A new page of searching for heavy Higgs resonance
- Continue to look at gg → H → hh → WWyy → jjjjyy
- Start to look at gg → H → hh → Wwyy → lvjjyy and lvlvyy, which become possible with high statistics under higher center of mass energy
- Manpower:
  - 1 researcher (permanent)
  - 1 postdoc till the end of 2015
  - 2 PhD student till 2017/2018
  - + ?

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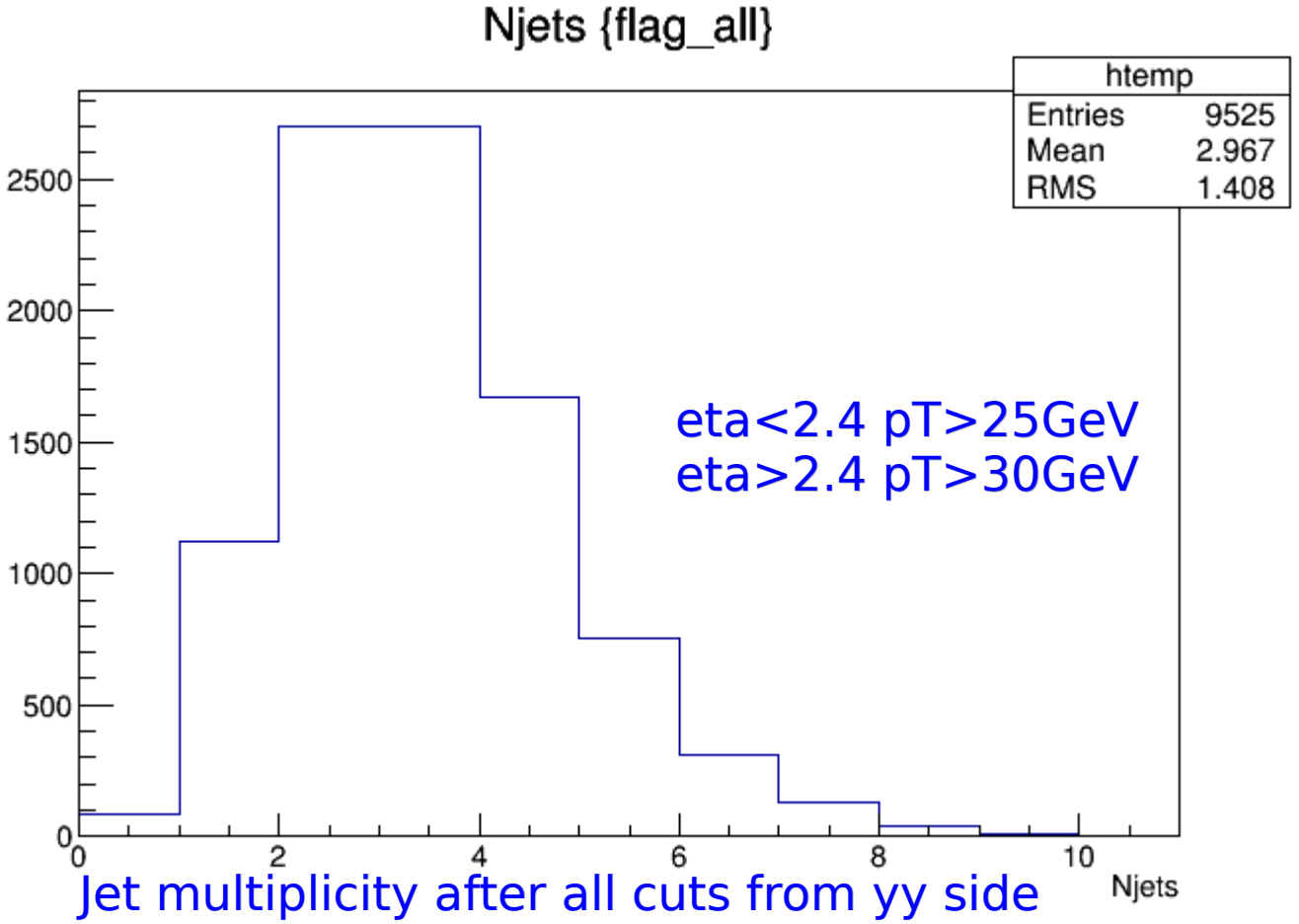
Backup

Introduction

- A

Additional cuts

- Additionally, we will cut on kinematics of the children from the other Higgs boson
  - To do some studies on cuts: deltaPhi(j,j) deltaEta(j,j)
  - To find the more correct combinations of jets originating from the same W boson



Jet multiplicity after all cuts from yy side

Cutflow

- Use h → yy trigger and get the gamma pair
- Follow the same preselection in HSG1, check on cutflow (private MC production 28k):

	Unweighted evt	Cut eff (%)
generated	28000	100%
trigger	19953	71%
GRL	19953	71%
detector errors	19953	71%
vertex tracks	19953	71%
pre-selection	15547	56%
photon pT	13996	50%
photon ID	12041	43%
photon isolation	9525	34%
diphoton mass	9516	34%

Additionally

Njets>=4	2913	10%

And

XXX	-	5%

Descriptions of cuts

	descriptions
generated	Generated events
trigger	EF g35 loose g25 loose (8TeV)
GRL	Good Run List
detector errors	LAr error, TileError, BadJet
vertex tracks	Primary vertex track requirements
pre-selection	At least two loose photons
photon pT	1^{st} > 40 GeV, 2^{nd} > 30 GeV
photon ID	IsEM & 0x45fc01 == 0
photon isolation	Calo (etcone40) < 6GeV && track < 2.6GeV
diphoton mass	[100GeV, 160GeV]

BSM gg → H → hh → bbyy

	SM	Resonant NWA				
	Benchmark	260 GeV	300 GeV	350 GeV	500 GeV	1000 GeV
Generated	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Trigger	73.1%	72.5%	71.6%	71.8%	73.6%	81.0%
Preselection	57.3%	56.7%	56.1%	56.2%	57.7%	65.1%
Photon p_T	51.6%	51.6%	49.8%	49.2%	52.5%	62.4%
Photon Identification	45.3%	44.2%	42.8%	42.6%	46.4%	56.2%
Isolation	39.1%	33.1%	33.8%	35.9%	40.6%	47.4%
$105 < m_{\gamma\gamma} < 160$ GeV	39.0%	33.0%	33.8%	35.9%	40.5%	47.4%
2 Central Jets	33.9%	25.5%	26.9%	29.8%	36.2%	45.1%
Tagging	12.5%	8.4%	8.9%	10.0%	14.1%	19.1%
b p_T Cuts	10.1%	4.8%	5.6%	7.2%	12.0%	18.1%
$95 < m_{b\bar{b}} < 135$ GeV	7.4%	4.0%	4.3%	5.3%	8.6%	14.2%

Reconstructed jets >=2

- Redo the cutflow and the correctness tables

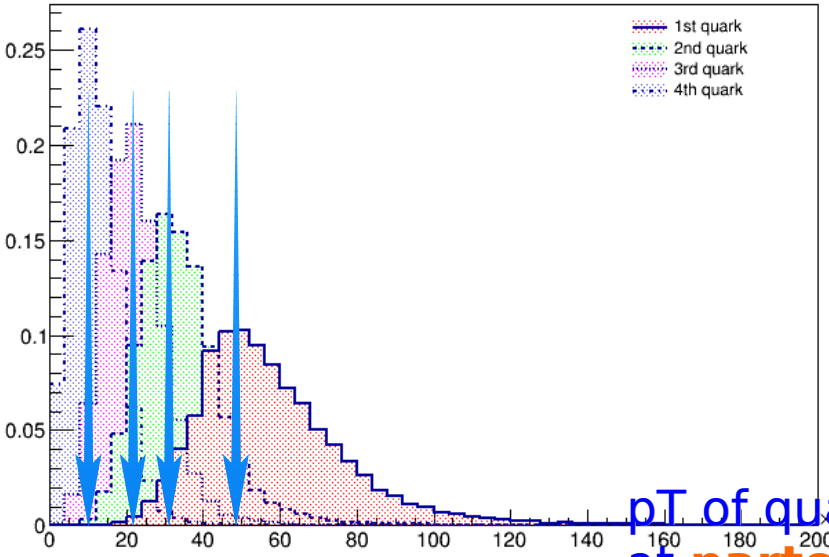
	Unweighted evt	Cut eff (%)
generated	28000	100%
trigger	19953	71%
GRL	19953	71%
detector errors	19953	71%
vertex tracks	19953	71%
pre-selection	15547	56%
photon pT	13996	50%
photon ID	12041	43%
photon iso	9525	34%
diphoton mass	9516	34%

Njets>=2	**8312**	**30%**

specific	#evts	%
none (all cuts form yy side)	8312	-
any pairs from W	3909	47%
1 pair from W	3726	**45%**
2 pairs from W	183	**2%**
the pair from 1st W	2631	32%
the pair from 2nd W	1461	18%

BSM gg → H → hh → WWyy → jjjjyy

- Triggered by the recent results on H → hh → bbyy search
  - There is a significance of 3.0 standard deviations at mH=300GeV
- We look at second largest decay: H → hh → WWyy → jjjjyy
- Look at the pT of jets in parton level, find it quite difficult to reconstruct all four jets



pT of quarks at **parton** lvl

pT threshold	evts(parton lvl)	efficiencies
non	19430	100%
5 GeV	17168	88%
10 GeV	11389	59%
15 GeV	5437	28%
20 GeV	1963	10%
25 GeV	**594**	**3%**