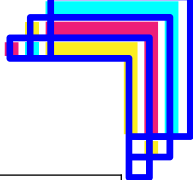


Search for dark photons in decays of Higgs bosons

Longsheng Tan

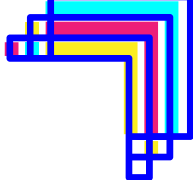
2025.10.20

Strategies



Data-taking year	2016	2017/2018		2024 SR	2024 gamma_jets_CR	2024 W_CR	comment
Trigger	VBF+ γ	single photon	pt miss	single photon			W_CR selections are applied for electron
Number of photons	≥ 1			1			
pt γ	$> 80\text{GeV}$	$> 230\text{ GeV}$	$> 80\text{GeV}$	100GeV			
$\eta\ \gamma$	< 1.47			< 1.4442			
Number of leptons	0 (veto loose electron or muon)					0 (veto loose photon)	
pt j	$> 30\text{GeV}$						
pt j1,j2	$> 50\text{GeV}$			$j1>80\text{GeV}, j2>40\text{GeV}$			
pt miss	$> 100\text{GeV}$	$> 140\text{GeV}$					
jet countinng	2 to 5			none			
mjj	$> 500\text{ GeV}$						
$\eta\ j$	< 4.7						
$ \Delta\eta_{jj} $	> 3.0						
$\eta_1\eta_2$	< 0						
jets and ptmiss dphi	> 1.0				< 0.5	> 1.0	
Zeppendfeld	< 0.6						
total pt	$< 150\text{GeV}$						
dijet dphi	none			$\Delta\phi < 1.5$			

Run3 yield Of SR



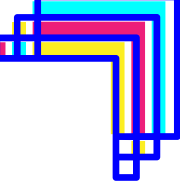
SR

Medium photon ID						
Type	Name	Run2(EW+QCD)	2024 12pb-1	2024 scaled	Ratio	Comment
signal	ggF	30.6	33.956937	19.33491014	1.582629543	sig: factor = yield(12pb-1)*11.3879*0.05 bkg: factor = yield(12pb-1)*11.3879
	VBF	50.5	90.850873	51.73003283	0.976222075	
background	Gjet	230	44.18324036	503.1543229	0.457116216	only QCD for 2014
	Wjet	250	19.12608	217.8058864	1.147811035	
	Znunu jet	41	1.3727313	15.63252677	2.622736593	
	Zgamma	98	2.703972	30.79256274	3.182586679	
	Wgamma	98	6.5680236	74.79599595	1.310230564	

/eos/home-i00/l/lotan/www/pyRATOUTPUT/SR_VBF_PT_100_MET_140/SR_VBF

		MT	Nevents
signal	ggF	33.956937	33.95694
	VBF	90.850873	90.85088
background	QCD_Gjet	43.488163	43.52609
	QCD_Zjet	0.3135359	0.313536
	QCD_Wjet	19.12608	19.12608
	QCDJets	0.1073494	0.107349
	QCD_Znunu	1.3727313	1.423806
	EWK_Gjet	0.6950774	0.695077
	Zgamma	2.703972	3.250441
	Wgamma	6.5680236	6.876912

Run3 yield Of CR



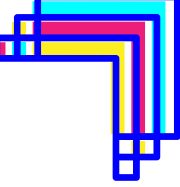
gamma+jets region

Medium photon ID						
Type	Name	Run2(EW+QCD)	2024 12pb-1	2024 scaled	Ratio	Comment
signal	ggF	4.5	39.462089	22.46951617	0.200271335	sig: factor = yield(12pb-1)*11.3879*0.05 bkg: factor = yield(12pb-1)*11.3879
	VBF	6.9	94.67332	53.90651504	0.127999371	
background	Gjet	1400	73.3516558	835.3213211	1.676001755	only QCD for 2014
	Wjet	180	21.04327	239.6386544	0.751130908	
	Znunu jet	26	1.7392802	19.80674899	1.312683874	
	Zgamma	46	3.3938414	38.64872648	1.190207393	
	Wgamma	76	9.0610527	103.186362	0.736531442	

/eos/home-i00/l/lotan/www/pyRATOUTPUT/SR_VBF_PT_100_MET_140/gamma_jets_CR_VBF

		MT	Nevents
signal	ggF	39.462089	39.46209
	VBF	94.67332	94.67333
background	QCD_Gjet	71.929441	76.45229
	QCD_Zjet	0.6950601	0.69506
	QCD_Wjet	21.04327	19.77354
	QCDJets	4.668065	4.703787
	QCD_Znunu	1.7392802	1.792411
	EWK_Gjet	1.4222148	1.8151
	Zgamma	3.3938414	4.2349
	Wgamma	9.0610527	9.800763

Run3 yield Of CR



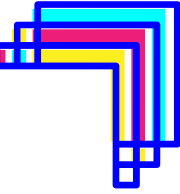
W+jets region

Medium photon ID						
Type	Name	Run2(EW+QCD)	2024 12pb-1	2024 scaled	Ratio	Comment
signal	ggF	1.2	0	0	-	sig: factor = yield(12pb-1)*11.3879*0.05 bkg: factor = yield(12pb-1)*11.3879
	VBF	1.7	3.3569462	1.911428382	0.889387233	
background	Gjet	12	1.328016013	15.12331355	0.793476903	only QCD for 2014
	Wjet	10500	546.82249	6227.159834	1.686161955	
	Znunu jet	100	-0.15608024	-1.777426165	-56.26112745	
	Zgamma	6.8	0.068269457	0.777445749	8.746591007	
	Wgamma	240	13.286657	151.3071213	1.586177822	

/eos/home-i00/l/lotan/www/pyRATOUTPUT/SR_VBF_PT_100_MET_140/W_CR_VBF

		MT	Nevents
signal	ggF	0	0
	VBF	3.3569462	3.356946
background	QCD_Gjet	1.3141141	1.52605
	QCD_Zjet	13.150731	13.35536
	QCD_Wjet	546.82249	550.0385
	QCDJets	1.1620712	1.497363
	QCD_Znunu	-0.1560802	-0.15608
	EWK_Gjet	0.0139019	0.013902
	Zgamma	0.0682695	0.099791
	Wgamma	13.286657	13.4502

Back up



- Steps

```
text2workspace.py datacard_VBF.txt -o workspace.root -m 125  
combine -M AsymptoticLimits workspace.root -t -1 -m 125 --run blind
```

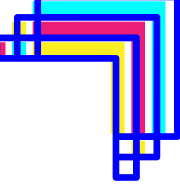
```
text2workspace.py datacard_VBF_mjj500_1500.txt -o workspace_mjj500_1500.root -m 125  
combine -M AsymptoticLimits workspace_mjj500_1500.root -t -1 -m 125 --run blind -n _mjj500_1500
```

```
text2workspace.py datacard_VBF_mjj1500_6000.txt -o workspace_mjj1500_6000.root -m 125  
combine -M AsymptoticLimits workspace_mjj1500_6000.root -t -1 -m 125 --run blind -n  
_mjj1500_6000
```

```
combineCards.py \  
  mjj500_1500=datacard_VBF_mjj500_1500.txt\  
  mjj1500_6000=datacard_VBF_mjj1500_6000.txt \  
> datacard_VBF_mjj.txt
```

```
text2workspace.py datacard_VBF_mjj.txt -o workspace_mjj.root -m 125  
combine -M AsymptoticLimits workspace_mjj.root -t -1 -m 125 --run blind -n _mjj
```

Run2 Samples



Type	Name	Process	Discription
signal	ggF		
	VBF		
background QCD	Gjet	Υ from q	with a mismeasured MET.
	QCD multi jets		which can contribute to the SR when a jet is misidentified as a photon.
	Wjet	q qbarprime	photon candidate is a misidentified electron.
	Znunu	Zto2Nu-2Jets	which can contribute to the SR when a jet is misidentified as a photon.
background V+gamma	Zgamma	ZGto2NuG-1Jets	1. For these processes, a VBF-like two-jet signature can be produced by initial-state QCD radiation.
	Wgamma	WGtoLNUG-1Jets	2. TheWgamma process becomes an irreducible background if the charged lepton falls outside of the detector acceptance.
background EWK	Wjet	VBFtoLNU	purely electroweak interactions, becomes more relevant at higher m _{jj} .
	Znunu	VBFto2Nu	
	Zgamma		
	Wgamma		
Others	VV		1. involving a photon and neutrinos or out-of-acceptance leptons. 2. minor background processes are very small after the final selection, so they are estimated directly from MC simulation.
	VVV		
	TTbar gamma		
	Tgamma		