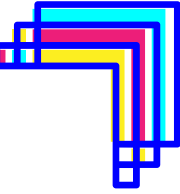


Search for dark photons in decays of Higgs bosons

Longsheng Tan

2025.06.16

Expect limit study



- **Samples**

- **# signal**
 - "DarkPhoton_ggF": "darkPhoton_ggf",
- **# QCD**
 - "QCD_Gjet": "qcdgjets",
 - "QCD_Zjet": "qcdzll",
 - "QCD_Wjet": "qcdwjets",
 - "QCD_Znunu": "qcdzjets",
- **# EWK**
 - "EWK_Gjet": "ewkgjets",
 - "EWK_Zjet": "ewkzll",
 - "EWK_Znunu": "ewkzjets",
 - "EWK_Wjet": "ewkwjets",
- **# V+gamma**
 - "Zgamma": "zgamma",
 - "Wgamma": "wgamma",
- **# minor**
 - "TTbar": "top",
 - "Diboson": "diboson",

- Rootfiles got after plotting, so that everything **is normalized to the correct lumi and cross section**.
- Build pseudo-data: sum of all MC background histograms.

- **Systematic**

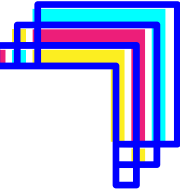
- ("JEC", {"sources": {"jec_Total": "jec_Nominal"}, "isShape": True}),

- **Variable**

- MT

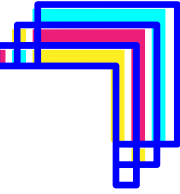
[XS of darkphoton - Google 表格](#)

Expect limit study

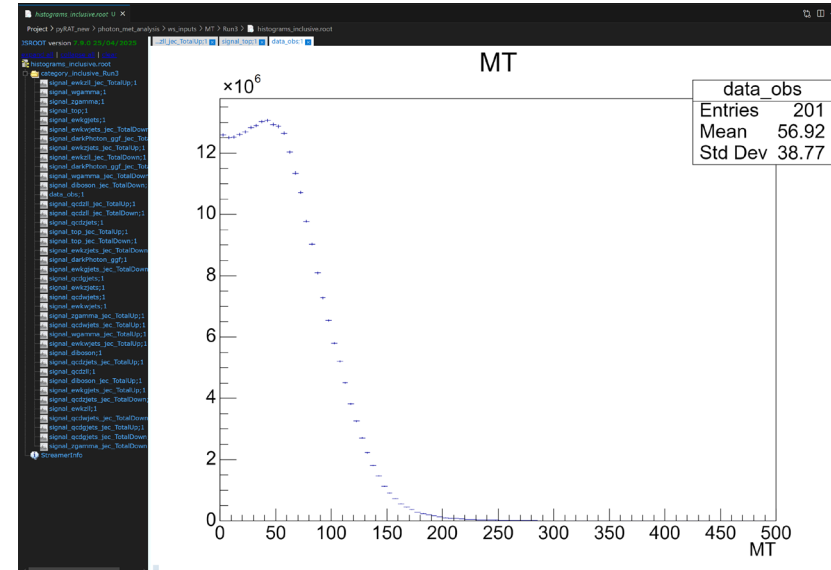


- Steps
 1. Extract shape from plotting rootfiles
 - `python3 create_workspace_inputs.py` (Inherit invisible code)
 2. Prepare a datacard (built by script)
 3. Running combine

Extract shape from plotting rootfiles



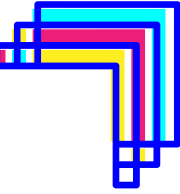
```
[lotan@m9 Run3]$ root -l histograms_inclusive.root
root [0]
Attaching file histograms_inclusive.root as _file0...
(TFile *) 0x32070a0
root [1] .ls
TFile**      histograms_inclusive.root
TFile*       histograms_inclusive.root
KEY: TDirectoryFile  category_inclusive_Run3;1    category_inclusive_Run3
root [2] category_inclusive_Run3->cd()
(bool) true
root [3] .ls
TDirectoryFile*      category_inclusive_Run3 category_inclusive_Run3
KEY: TH1F            signal_ewkzll_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_wgamma;1 MT
KEY: TH1F            signal_zgamma;1 MT
KEY: TH1F            signal_top;1    MT
KEY: TH1F            signal_ewkgjets;1    MT
KEY: TH1F            signal_ewkwjets_jec_TotalDown;1 MT_jec_Total_down
KEY: TH1F            signal_darkPhoton_ggf_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_ewkzjets_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_ewkzll_jec_TotalDown;1    MT_jec_Total_down
KEY: TH1F            signal_darkPhoton_ggf_jec_TotalDown;1 MT_jec_Total_down
KEY: TH1F            signal_wgamma_jec_TotalDown;1    MT_jec_Total_down
KEY: TH1F            signal_diboson_jec_TotalDown;1    MT_jec_Total_down
KEY: TH1F            data_obs;1    MT
KEY: TH1F            signal_qcdzll_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_qcdzll_jec_TotalDown;1    MT_jec_Total_down
KEY: TH1F            signal_qcdzjets;1    MT
KEY: TH1F            signal_top_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_top_jec_TotalDown;1    MT_jec_Total_down
KEY: TH1F            signal_ewkzjets_jec_TotalDown;1 MT_jec_Total_down
KEY: TH1F            signal_darkPhoton_ggf;1 MT
KEY: TH1F            signal_ewkgjets_jec_TotalDown;1 MT_jec_Total_down
KEY: TH1F            signal_qcdgjets;1    MT
KEY: TH1F            signal_ewkzjets;1    MT
KEY: TH1F            signal_qcdwjets;1    MT
KEY: TH1F            signal_ewkwjets;1    MT
KEY: TH1F            signal_zgamma_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_qcdwjets_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_wgamma_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_ewkwjets_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_diboson;1    MT
KEY: TH1F            signal_qcdzjets_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_qcdzll;1 MT
KEY: TH1F            signal_diboson_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_ewkgjets_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_qcdzjets_jec_TotalDown;1 MT_jec_Total_down
KEY: TH1F            signal_ewkzll;1 MT
KEY: TH1F            signal_qcdwjets_jec_TotalDown;1 MT_jec_Total_down
KEY: TH1F            signal_qcdgjets_jec_TotalUp;1    MT_jec_Total_up
KEY: TH1F            signal_qcdgjets_jec_TotalDown;1 MT_jec_Total_down
KEY: TH1F            signal_zgamma_jec_TotalDown;1    MT_jec_Total_down
```



Histogram Name	Integral
=====	=====
signal_wgamma	196351.350300
signal_zgamma	53677.257448
signal_top	79520.500239
signal_ewkgjets	487278.366131
data_obs	264744411.446182
signal_qcdzjets	18097.420324
signal_darkPhoton_ggf	11787.575485
signal_qcdgjets	262753912.161942
signal_ewkzjets	445.507589
signal_qcdwjets	917642.229953
signal_ewkwjets	5607.540305
signal_diboson	9193.047783
signal_qcdzll	222054.461525
signal_ewkzll	628.140243

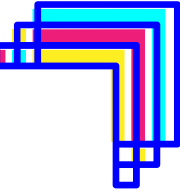
XS of darkphoton_ggf_M125 is 1 in yaml file!

Prepare a datacard (built by script)



```
1 imax 1
2  jmax 12
3  kmax *
4
5  -----
6  shapes * * histograms_inclusive.root category_inclusive_Run3/signal_$PROCESS category_inclusive_Run3/signal_$PROCESS_$SYSTEMATIC
7  shapes data_obs * histograms_inclusive.root category_inclusive_Run3/data_obs
8
9  -----
10 bin                category_inclusive_Run3
11 observation         -1
12
13  -----
14 bin                category_inclusive_Run3    category_inclusive_Run3    category_inclusive_Run3    category_inclusive_Run3
15 process            darkPhoton_ggf             diboson                    ewkgjets                    ewkwjets
16 process            0                          1                          2                          3
17 rate               -1                         -1                         -1                         -1
18  -----
19 jec_Total          shape    1                1                1                1
20
```

Running combine



- **Steps**

1. Build the workspace
 - `text2workspace.py datacard_inclusive.txt -o workspace.root -m 125`
2. Calculate the upper limit of expectation
 - `combine -M AsymptoticLimits workspace.root -t -1 --expectSignal 0 -m 125`

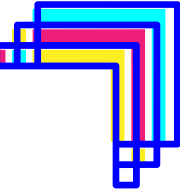
```
[lotan@m9 Run3]$ combine -M AsymptoticLimits workspace.root -t -1 --expectSignal 0 -m 125
<<< Combine >>>
<<< v10.2.1 >>>
>>> Random number generator seed is 123456
>>> Method used is AsymptoticLimits

-- AsymptoticLimits ( CLs ) --
Observed Limit: r < 1.3230
Expected  2.5%: r < 0.7169
Expected 16.0%: r < 0.9526
Expected 50.0%: r < 1.3203
Expected 84.0%: r < 1.8361
Expected 97.5%: r < 2.4403

Done in 0.00 min (cpu), 0.00 min (real)
```

Calculation shows that results are consistent with the null hypothesis.

Running combine



- Impacts

1. initial fit

- `combineTool.py -M Impacts -d workspace.root -m 125 --doInitialFit --robustFit 1 --expectSignal 0`

```
[lotan@m9 Run3]$ combineTool.py -M Impacts -d workspace.root -m 125 --doInitialFit --robustFit 1 --expectSignal 0
Have POIs: ['r']
>> combine -M MultiDimFit -n _initialFit_Test --algo singles --redefineSignalPOIs r --robustFit 1 --expectSignal 0 -m 125 -d workspace.root
<<< Combine >>>
<<< v10.2.1 >>>
>>> Random number generator seed is 123456
>>> Method used is MultiDimFit
Doing initial fit:
[ERROR] Closed range without finding crossing!

--- MultiDimFit ---
best fit parameter values and profile-likelihood uncertainties:
Warning - No valid low-error found, will report difference to minimum of range for : r
r :    +0.025    -0.025/+0.645 (68%)
Done in 0.00 min (cpu), 0.00 min (real)
```

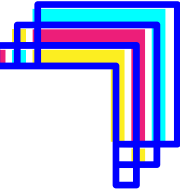
2. Perform an impact scan for each nuisance

- `combineTool.py -M Impacts -d workspace.root -m 125 --doInitialFit --robustFit 1 --expectSignal 0`

```
[lotan@m9 Run3]$ combineTool.py -M Impacts -d workspace.root -m 125 --doFits --robustFit 1 --expectSignal 0
Have POIs: ['r']
Have parameters: 1
>> combine -M MultiDimFit -n _paramFit_Test_jec_Total --algo impact --redefineSignalPOIs r -P jec_Total --floatOtherPOIs 1 --saveInactivePOI 1 --robustFit 1
--expectSignal 0 -m 125 -d workspace.root
<<< Combine >>>
<<< v10.2.1 >>>
>>> Random number generator seed is 123456
>>> Method used is MultiDimFit
Doing initial fit:
[ERROR] Closed range without finding crossing!

--- MultiDimFit ---
Parameter impacts:
Parameter : Best-fit      r
jec_Total : -0.000    -0.002/+0.000  +0.200/+0.000
Done in 0.00 min (cpu), 0.00 min (real)
```

Running combine



- Impacts

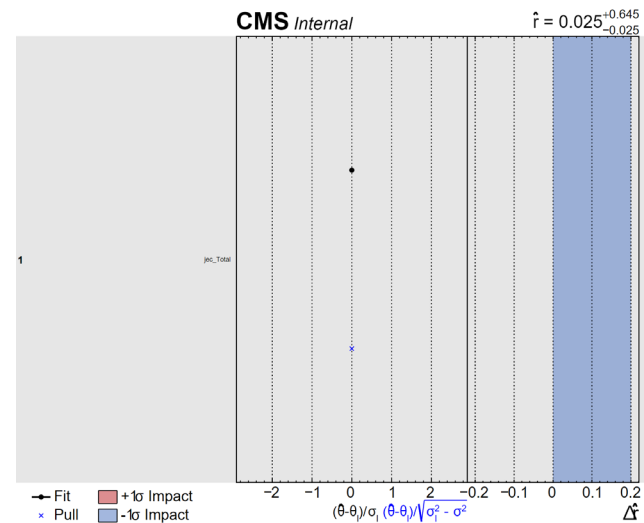
- 3. Collect the results and generate JSON

- `combineTool.py -M Impacts -d workspace.root -m 125 -o impacts.json`

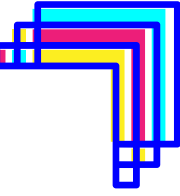
```
[lotan@m9 Run3]$ combineTool.py -M Impacts -d workspace.root -m 125 -o impacts.json
Have POIs: ['r']
Have parameters: 1
```

- 4. Plotting

- `plotImpacts.py -i impacts.json -o impacts_plot`

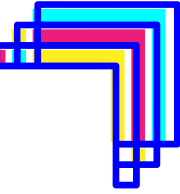


"jec_Total" is sources of uncertainty what we are currently considering, and its main contribution lies in the "+1σ" direction.



Thanks!

Error

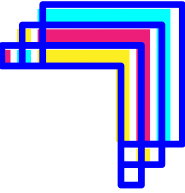


```
(lzanhen) [lotan@m9 pyRAT_new]$ ./photon_met_analysis/macros/steer.py
INFO | steer::main: Starting main...
--> ModuleRunner info:
analysis      dark_photon
module        FullAnalysis
campaigns
  Run3Summer23 NanoAODv12
ncorpus       50
log_level     INFO
pretend       False
generic_commands
  analysis    dark_photon
  module      FullAnalysis
  log_level   INFO
batch         htcondor_ulb
--> ModuleRunner info: end.
INFO | module_runner::run_analyser: Setting up 54 commands...
INFO | submission_manager::submit_jobs: Found 39 jobs to run.
INFO | submission_manager::submit_jobs: Submitting batch jobs:
--> Submitting 39 jobs to HTCondor...
INFO | submission_manager::submit_jobs: Found 43 jobs to run.
INFO | submission_manager::submit_jobs: Submitting batch jobs:
--> Submitting 43 jobs to HTCondor...
INFO | submission_manager::submit_jobs: Found 74 jobs to run.
INFO | submission_manager::submit_jobs: Submitting batch jobs:
--> Submitting 74 jobs to HTCondor...
INFO | submission_manager::submit_jobs: Found 6 jobs to run.
INFO | submission_manager::submit_jobs: Submitting batch jobs:
--> Submitting 6 jobs to HTCondor...
INFO | submission_manager::submit_jobs: Found 5 jobs to run.
INFO | submission_manager::submit_jobs: Submitting batch jobs:
--> Submitting 5 jobs to HTCondor...
ERROR | utils_runners::validate_input_file: Input file '/pnfs/iihe/cms/ph/sc4/store/mc/Run3Summer23NanoAODv12/DYto2L-2Jets_MLL-50_0J_TuneCP5_13p6TeV_amcatnlOfFXFX-pythia8/NANOADSIM/130X_mcRun3_2023_realistic_v14-v3/2810000/065eb842-5fd3-4678-bf83-4f546654b7ad.root' does not exist.
CRITICAL | utils_runner::handle_missing_file: ERROR :: Missing input file: /pnfs/iihe/cms/ph/sc4/store/mc/Run3Summer23NanoAODv12/DYto2L-2Jets_MLL-50_0J_TuneCP5_13p6TeV_amcatnlOfFXFX-pythia8/NA
NADSIM/130X_mcRun3_2023_realistic_v14-v3/2810000/065eb842-5fd3-4678-bf83-4f546654b7ad.root
Traceback (most recent call last):
  File "/ada_mnt/ada/user/lotan/Project/pyRAT_new/executables/main/pyrat_batch.py", line 64, in <module>
    main()
  File "/ada_mnt/ada/user/lotan/Project/pyRAT_new/executables/main/pyrat_batch.py", line 59, in main
    submitter = PyratSubmitter()
  File "/ada_mnt/ada/user/lotan/Project/pyRAT_new/executables/main/pyrat_batch.py", line 19, in __init__
    self.input_files = get_input_files_from_list(args=self.args)
  File "/ada_mnt/ada/user/lotan/Project/pyRAT_new/utils/pyrat/utils_runner.py", line 250, in get_input_files_from_list
    handle_missing_file(file_path=input_file, force=args.force, message="input file")
  File "/ada_mnt/ada/user/lotan/Project/pyRAT_new/utils/pyrat/utils_runner.py", line 229, in handle_missing_file
    logger.critical(f"ERROR :: Missing {message}: {file_path}", exception_cls=ValueError)
  File "/ada_mnt/ada/user/lotan/Project/pyRAT_new/utils/generic/logger.py", line 86, in critical
    raise exception_cls(message)
```

```
[lotan@m9 Run3]$ combineTool.py -M Impacts -d workspace.root -m 125 --doInitialFit --robustFit 1 --expectSignal 0 --setParameterRanges r=0,3
Have POIs: ['r']
>> combine -M MultiDimFit -n _initialFit_Test --algo singles --redefineSignalPOIs r --robustFit 1 --expectSignal 0 --setParameterRanges r=0,3 -m 125 -d workspace.root
<<< Combine >>>
<<< v10.2.1 >>>
>>> Random number generator seed is 123456
>>> Method used is MultiDimFit
Set Range of Parameter r To : (0,3)
Doing initial fit:
[ERROR] Closed range without finding crossing!

--- MultiDimFit ---
best fit parameter values and profile-likelihood uncertainties:
Warning - No valid low-error found, will report difference to minimum of range for : r
r : +0.004 -0.004/+0.666 (68%)
Done in 0.00 min (cpu), 0.00 min (real)
```

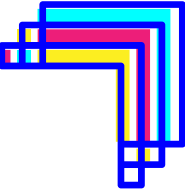
Error



```
(kraken) [lotan@m9 pyRAT_new]$ ./photon_met_analysis/macros/steer.py
INFO      | steer::main: Starting main...
--> ModuleRunner info:

analysis      dark_photon
module         FullAnalysis
campaigns
  Run3Summer24      NanoAODv14
ncores         50
log_level      INFO
pretend        False
generic_commands
  analysis      dark_photon
  module         FullAnalysis
  log_level      INFO
batch          htcondor_ulb
--> ModuleRunner info: end.
INFO      | module_runner::plot: Generating plots for selection: SR_VBF
INFO      | plotter::main: Starting the plotter
Traceback (most recent call last):
  File "/ada_mnt/ada/user/lotan/Project/pyRAT_new/executables/main/plotter.py", line 152, in <module>
    main()
  File "/ada_mnt/ada/user/lotan/Project/pyRAT_new/executables/main/plotter.py", line 39, in main
    plots = plotting_module.get_plots(campaign=args.campaign, region=plotting_module.get_region())
TypeError: get_plots() got an unexpected keyword argument 'campaign'
```

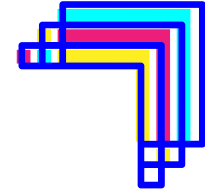
Preliminary Selection for Inclusive Region-In progress



Strategies	Description
Basic selections	lumiMask_selection
	Noise_filter_selection
	DetectorMitigation_selection
Trigger_selections	SinglePhoton_trigger_selection
Vetos	tight_Muon_veto_selection
	tight_Electron_veto_selection
Channel-specific	jec_Nominal_TypeIPuppiMET_selection (0 for now)
	singlePhoton_tight_id_selection
	jec_Nominal_tight_mt_selection (0 for now)

- MET and MT are both 0 -> fake photon + fake MET included.

Samples



1.Data:

EGamma(run I)

2.MC:

DarkPhoton_ggF

QCD_Gjet

EWK_Gjet

EWK_Wjet

EWK_Zjet

EWK_Znu

QCD_Zjet

QCD_Wjet

QCD_Znu

Zgamma

Wgamma

TTbar

Diboson

QCDJets (scale to 0)

```
##### QCD_Gjet #####
/GJ_PTG-20to100_ETAG-2p0_TuneCP5_13p6TeV_amcatnlo-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v15-v2/NANOAODSIM
/GJ_PTG-100to200_TuneCP5_13p6TeV_amcatnlo-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/GJ_PTG-200to400_TuneCP5_13p6TeV_amcatnlo-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/GJ_PTG-400to600_TuneCP5_13p6TeV_amcatnlo-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/GJ_PTG-600_TuneCP5_13p6TeV_amcatnlo-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
```

```
##### EWK_Gjet #####
/VBFtoG_PTG-10to100_TuneCP5_13p6TeV_madgraph-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v15_ext1-v3/NANOAODSIM
/VBFtoG_PTG-100to200_TuneCP5_13p6TeV_madgraph-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v15_ext1-v3/NANOAODSIM
/VBFtoG_PTG-200_TuneCP5_13p6TeV_madgraph-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v15_ext1-v3/NANOAODSIM
```

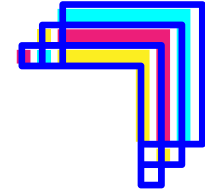
```
##### EWK_Vjet #####
/VBFto2L_MLL-50_TuneCP5_13p6TeV_madgraph-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v15_ext1-v2/NANOAODSIM
/VBFtoLNU_TuneCP5_13p6TeV_madgraph-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v15_ext1-v2/NANOAODSIM
/VBFto2NU_TuneCP5_13p6TeV_madgraph-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v15_ext1-v2/NANOAODSIM
```

```
##### QCD_Zjet #####
/DYto2L-2Jets_MLL-50_0J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/DYto2L-2Jets_MLL-50_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/DYto2L-2Jets_MLL-50_2J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
```

```
##### QCD_Wjet #####
/WtoLNU-2Jets_0J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/WtoLNU-2Jets_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/WtoLNU-2Jets_2J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
```

```
##### QCD_Znu #####
/Zto2Nu-2Jets_PTNuNu-40to100_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/Zto2Nu-2Jets_PTNuNu-100to200_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/Zto2Nu-2Jets_PTNuNu-200to400_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/Zto2Nu-2Jets_PTNuNu-400to600_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/Zto2Nu-2Jets_PTNuNu-600_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
/Zto2Nu-2Jets_PTNuNu-40to100_2J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v3/NANOAODSIM
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Samples



1.Data:

EGamma(run I)

2.MC:

DarkPhoton_ggF

QCD_Gjet

EWK_Gjet

EWK_Wjet

EWK_Zjet

EWK_Znu

QCD_Zjet

QCD_Wjet

QCD_Znu

Zgamma

Wgamma

TTbar

Diboson

QCDJets (scale to 0)

Vgamma

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TTbar

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/TTtoLNU2Q_TuneCP5_13p6TeV_powheg-pythia8/Run3Summer23NanoAODv12-130X_mcRun3_2023_realistic_v14-v2/NANOAODSIM
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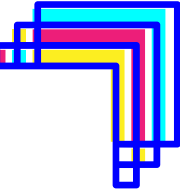
Diboson

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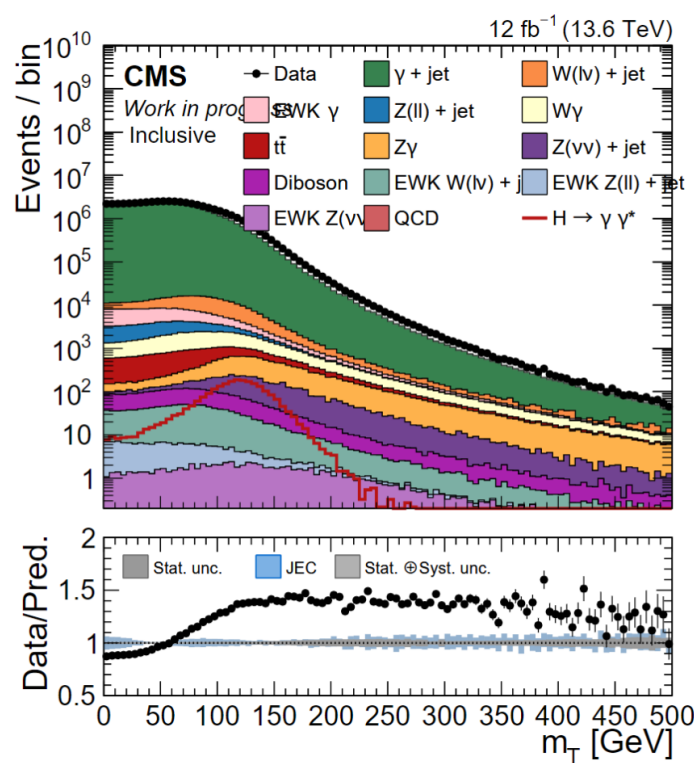
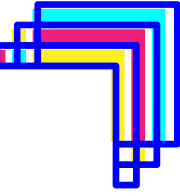
QCD_multijet

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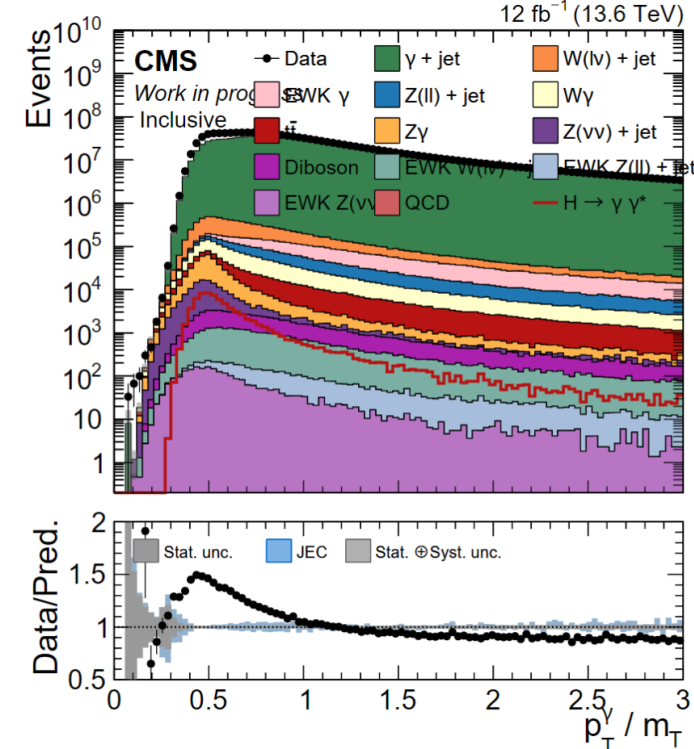
Samples-XS



EWK_Gjet	VBFToG_PTG-10to100_TuneCP5_13p6TeV_madgraph-pythia8		6.23E+02	100.00%
	VBFToG_PTG-100to200_TuneCP5_13p6TeV_madgraph-pythia8	8.557	7.56E+00	13.23%
	VBFToG_PTG-200_TuneCP5_13p6TeV_madgraph-pythia8	1.212	1.08E+00	12.74%
QCD_Znunu	Zto2Nu-2Jets_PTNU-40to100_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8	917.3	9.25E+02	0.86%
	Zto2Nu-2Jets_PTNU-100to200_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8	87.89	8.72E+01	0.76%
	Zto2Nu-2Jets_PTNU-200to400_1J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8	6.319		#DIV/0!
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	Zto2Nu-2Jets_PTNU-40to100_2J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8	328.9	3.36E+02	1.97%
	Zto2Nu-2Jets_PTNU-100to200_2J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8	101.4	1.01E+02	0.40%
	Zto2Nu-2Jets_PTNU-200to400_2J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8	13.81	1.37E+01	0.95%
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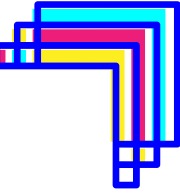
MT



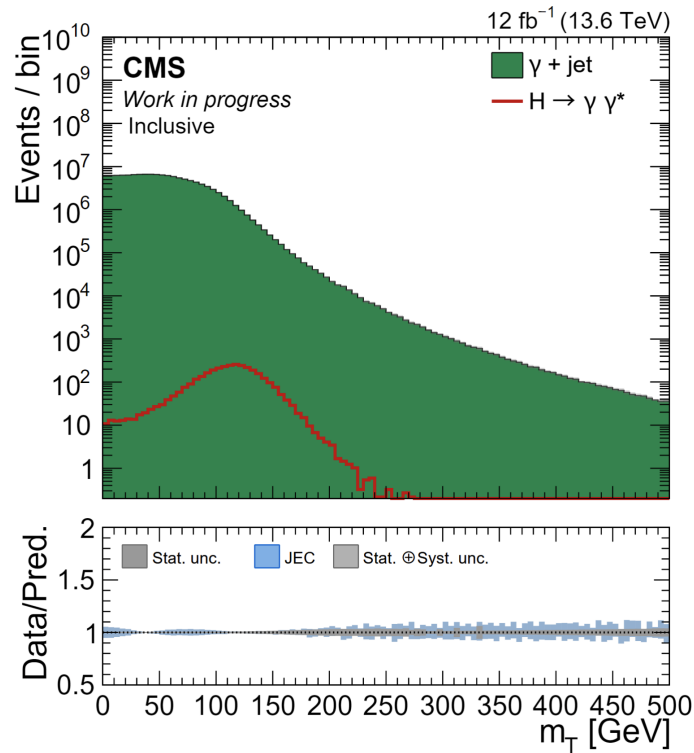
PT_gamma/MT

- Fake MET + True Photon $\rightarrow$ This will increase m_T and lower the PT_gamma/MT ratio.
- Fake photon not properly modeled in MC.
- Photon SF are not applied?

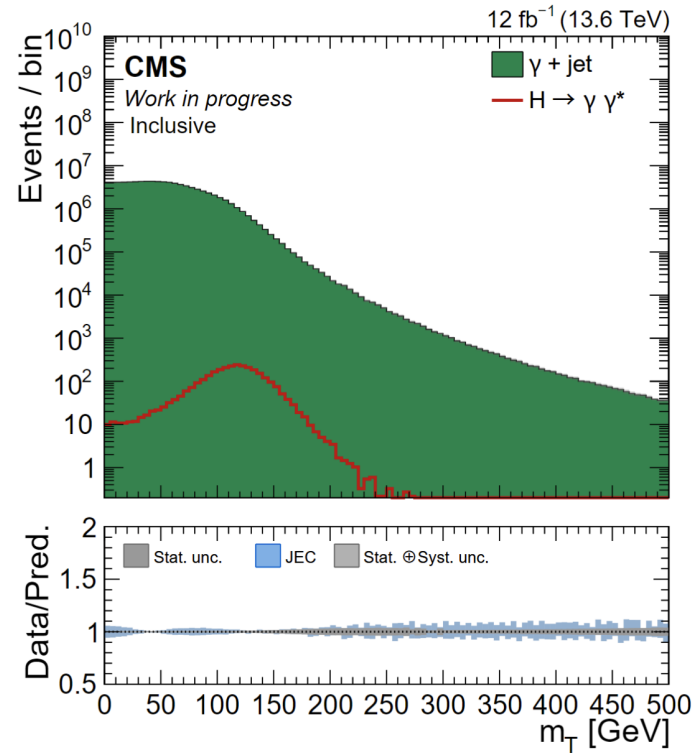
Gjet + signal without any trigger requirements



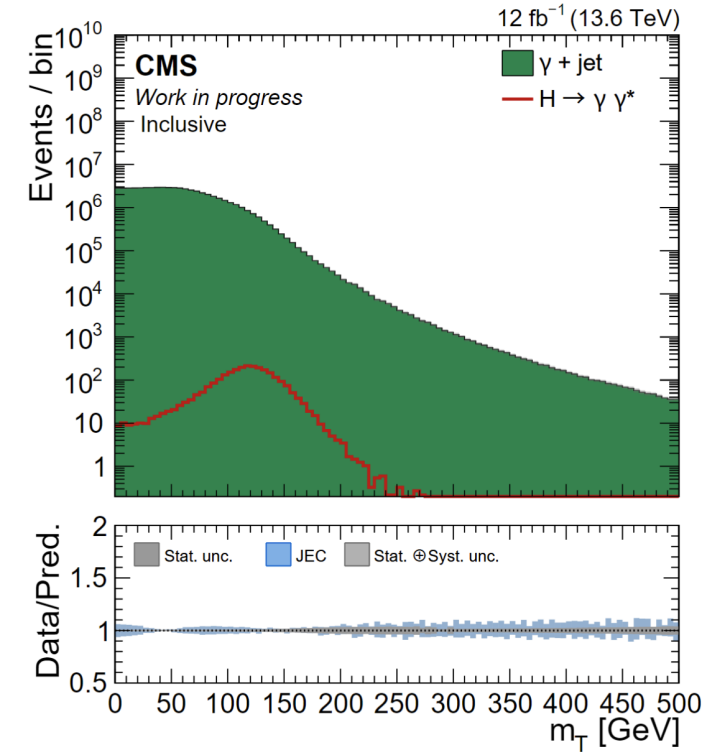
MT



pt gamma >40



pt gamma >45



pt gamma >50