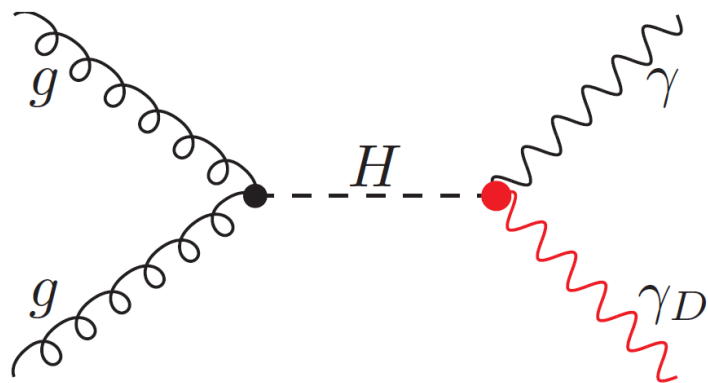
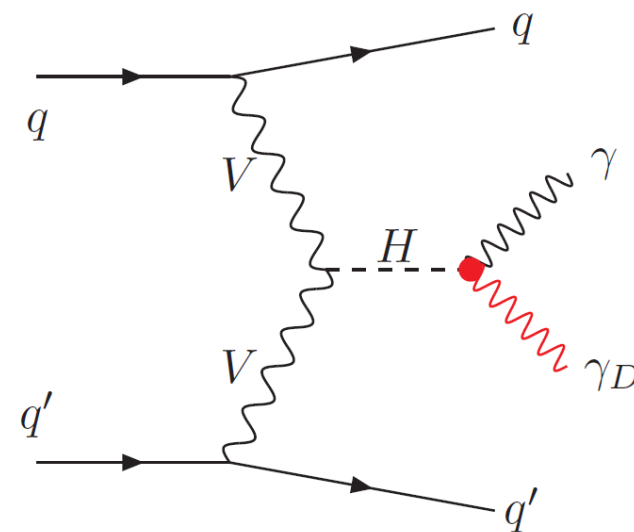


$H \rightarrow \text{Photon} + \text{MET}$



Longsheng Tan

2026.4.27

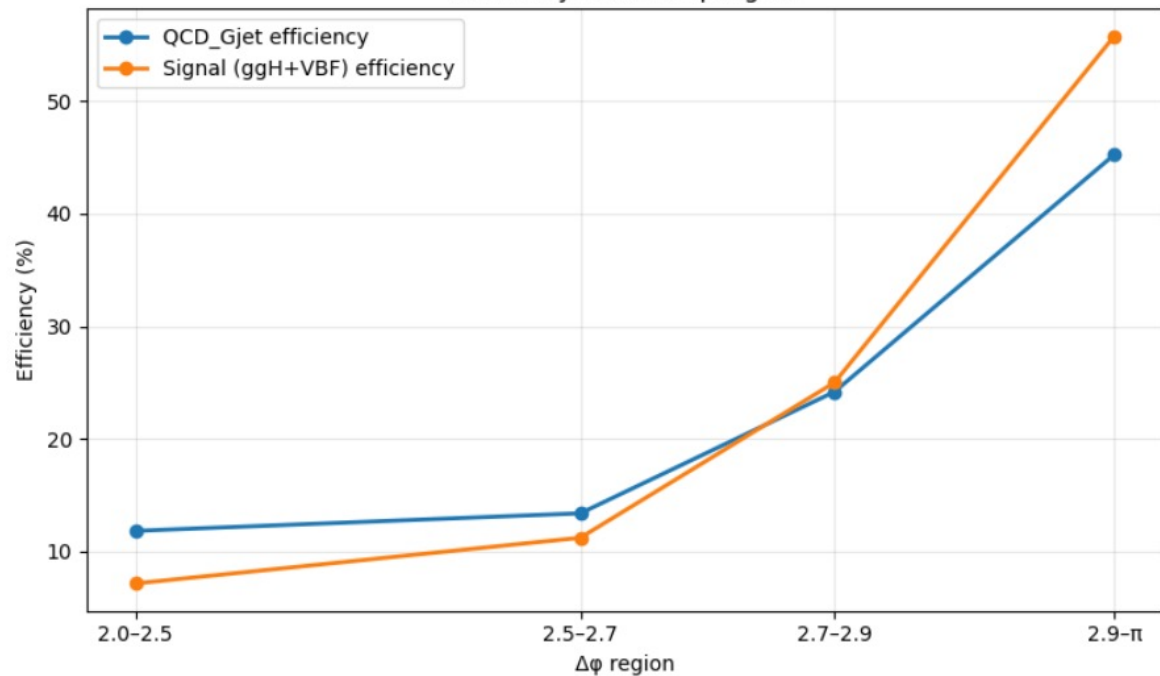


- Signal and background efficiencies were evaluated in different $\Delta\phi(\gamma, \text{MET})$ regions

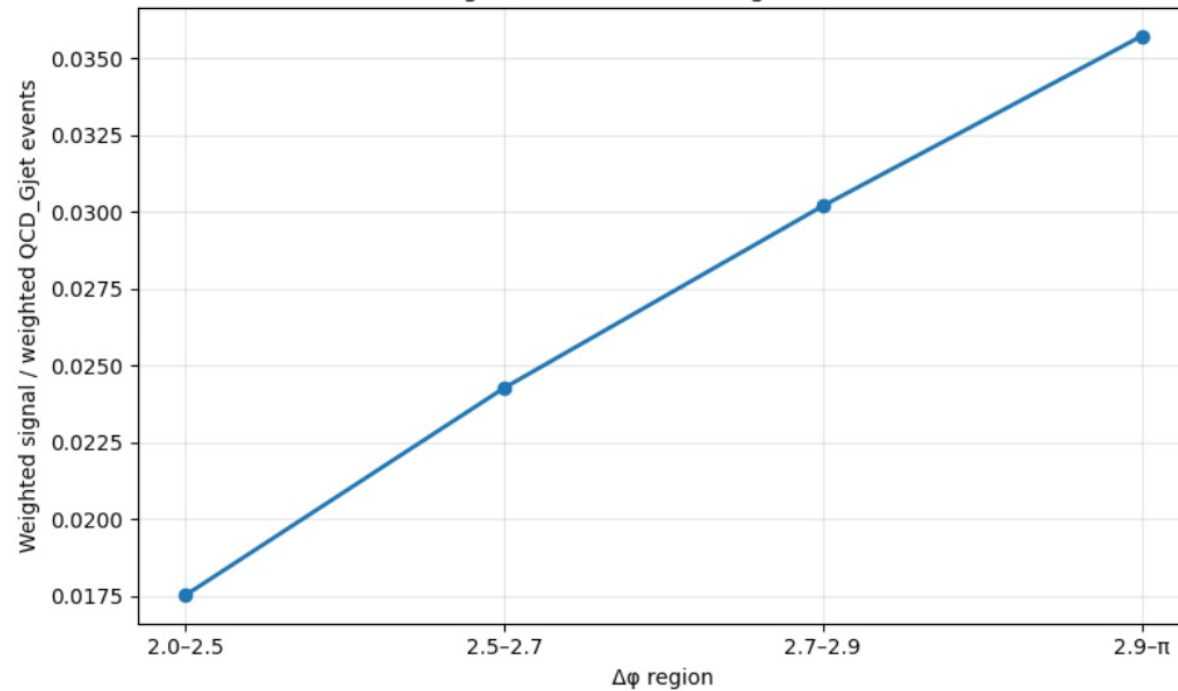
$$\text{efficiency} = \frac{\text{signal in region}}{\text{signal without dphi cut}}$$

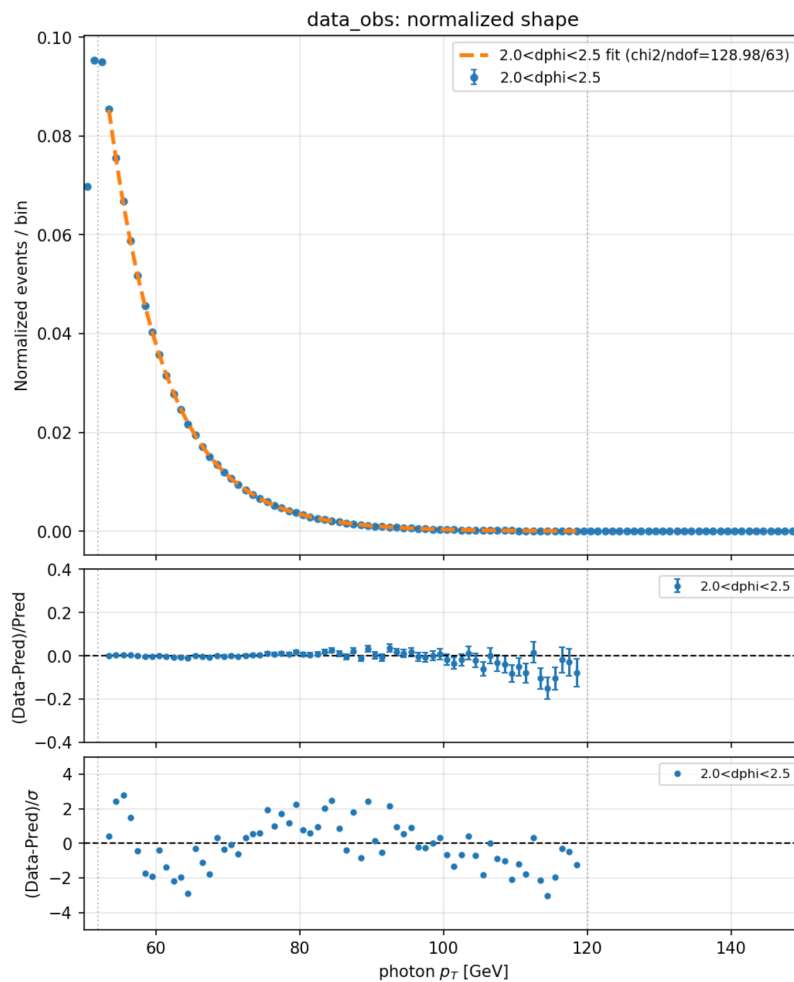
- Performed background-shape fitting in the CR, $2.0 < \Delta\phi < 2.5$, using **full 2024** data, 108.79fb^{-1}
- Trigger efficiency study
- *Enable systematics for signal sample
 - trigger (in progress)
 - luminosity
 - pileup ✓
 - jet ✓
 - photon ID ✓
- Questions

Efficiency in each $\Delta\phi$ region



Relative signal-richness from weighted event counts



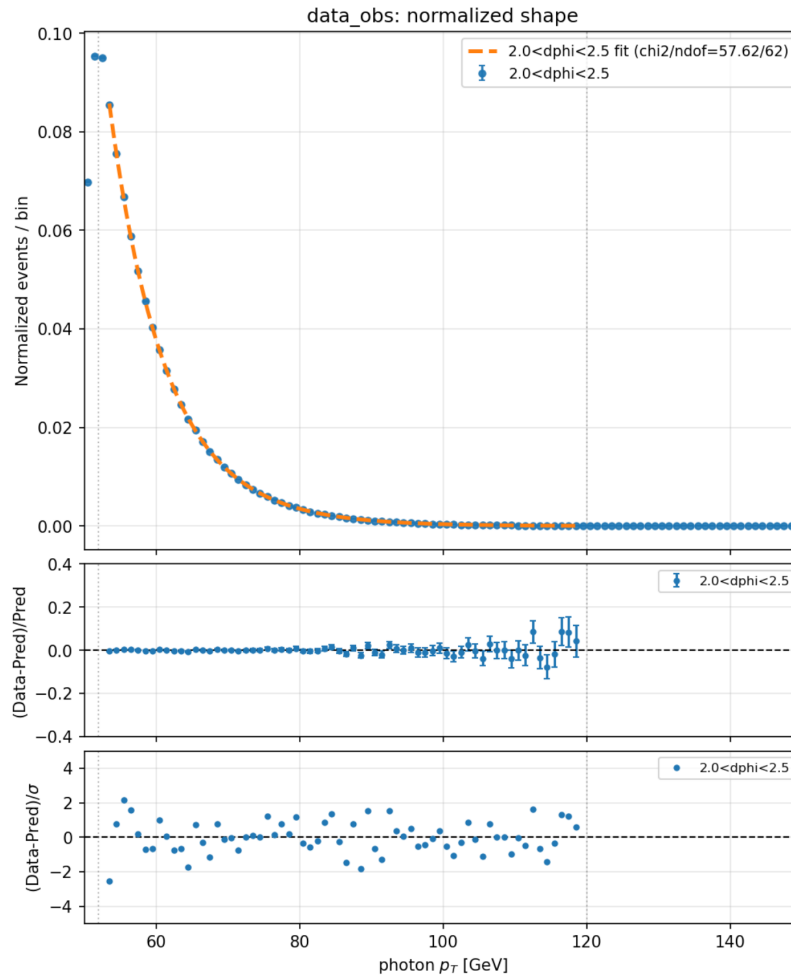


$$f(x) = \exp(a + bx + cx^2)$$

```
=====
data_obs
```

```
2.0<dphi<2.5: integral = 4.44701e+06
```

```
[Separate fit] 2.0<dphi<2.5: a = 4.753 ± 0.035, b = -0.144 ± 0.001, c = 1.756e-04 ± 7.312e-06, chi2/ndof = 128.98/63
```



$$f(x) = \exp(a + bx + cx^2 + dx^3)$$

```
=====
data_obs
=====
2.0<dphi<2.5: integral = 4.44701e+06
[Separate fit] 2.0<dphi<2.5: a = 5.591 ± 0.101, b = -0.179 ± 0.004, c = 6.551e-04 ± 5.862e-05, d = -2.119e-06 ± 2.645e-07, chi2/ndof = 57.62/62
=====
```

- Trigger efficiency measurement
 - HLT_Photon50EB_TightID_TightIso
- Sample
 - 24 data + $Z \rightarrow ee$ MC
 - $Z \rightarrow ee$ events are used to construct $e+\gamma$ candidates
- Tag
 - Offline tight electron
 - Endcap $|\eta| > 1.5$
 - Match with fired independent single-electron trigger (HLTel132)
 - Event is required to be selected by an independent single-electron trigger
- Probe
 - Offline tight photon
 - EB
 - Using the same photon ID and selection as in the analysis
 - Efficiency evaluated in bins of photon P_t

Key feature

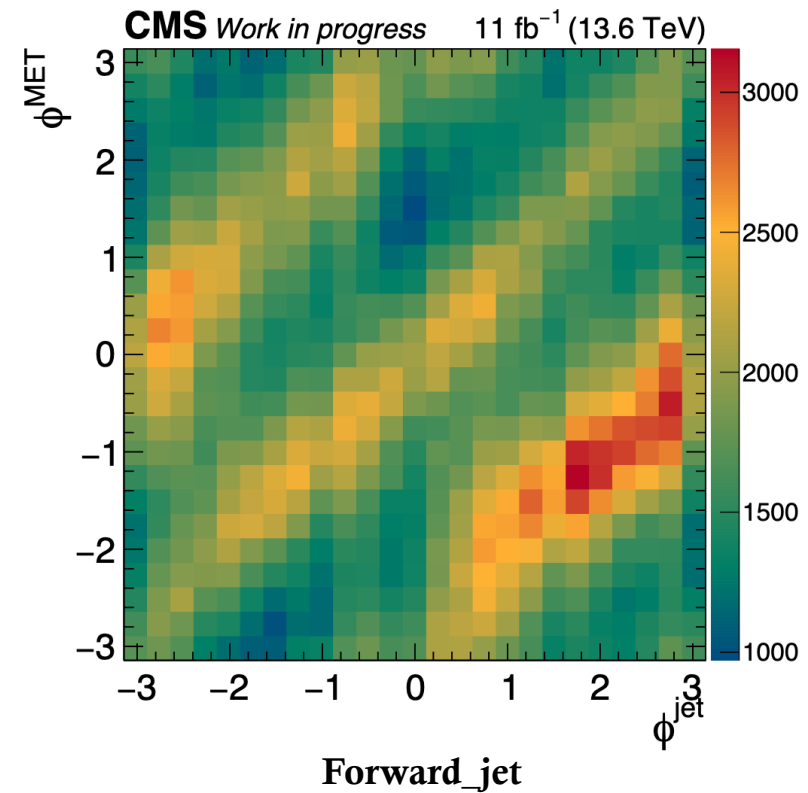
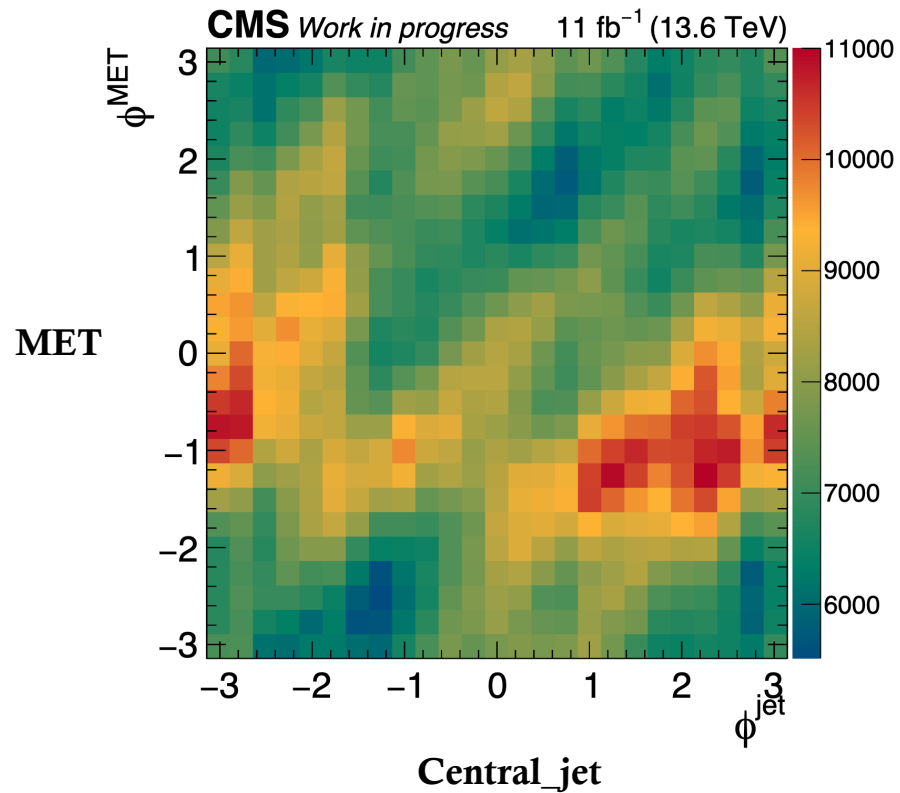
- The tag is in the endcap while the photon trigger only selects barrel photons
- Therefore, the trigger can be uniquely attributed to the probe photon
- No trigger object matching is required

- Selection
 - $80 < m(e, \gamma) < 100$ GeV

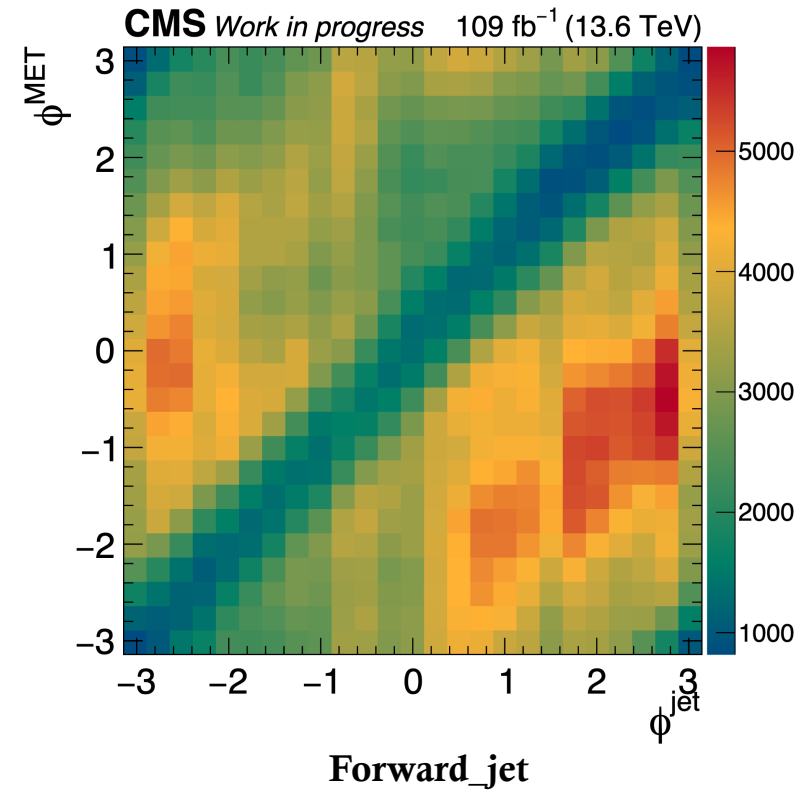
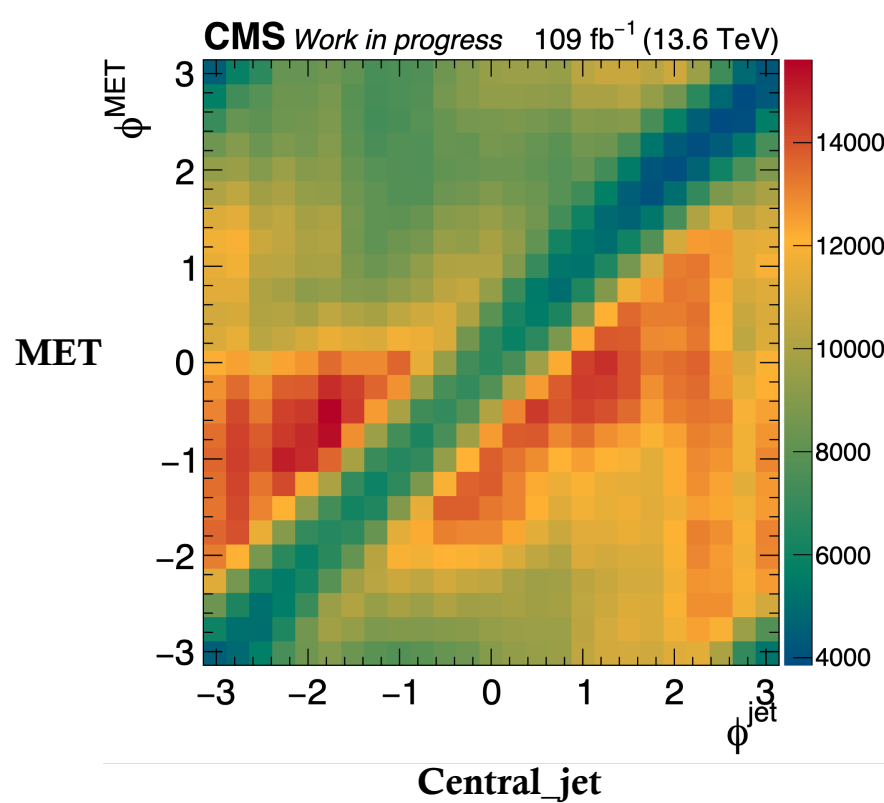
$$\epsilon(p_T) = \frac{N(\text{events passing trigger and tag-probe selection})}{N(\text{events passing tag-probe selection})}$$

- Efficiency definition
 - Where the selection defines the probe photon phase space

- Veto jet pt 30
 - 2d $\phi(\text{MET}, \text{jet}_{\text{pt}>15})$ of data
 - RunI, 11.42fb^{-1}



- Veto jet pt 30
 - 2d $\phi(\text{MET}, \text{jet}_{\text{pt}>15})$ of data
 - Full 24, 108.79fb^{-1}



Back up

Table 8: Loose photon identification criteria.

Variable	Selection Barrel (Endcap)
Full 5x5 $\sigma_{i\eta i\eta}$	<0.0114521 (<0.0276744)
H/E	<0.129991 (<0.153428)
charged hadron isolation	<1.88518 (<1.65396)
neutral hadron isolation	$<6.34397(1.85881) + 0.0100547(0.0116989) \times p_T + 5.78332(7.47603) \times 10^{-5} \times p_T^2$
photon isolation	$<0.703789(6.61585) + 0.000652035(0.000195486) \times p_T$
Conversion safe electron veto	Yes (Yes)

Table 9: Tight photon identification criteria. The criteria is only given for the barrel region since endcap photons are not taken into account.

Variable	Selection Barrel
Full 5x5 $\sigma_{i\eta i\eta}$	<0.00999299
H/E	<0.0417588
charged hadron isolation	<0.316306
neutral hadron isolation	$<0.39057 + 0.0100547 \times p_T + 5.78332 \times 10^{-5} \times p_T^2$
photon isolation	$<0.14189 + 0.000652035 \times p_T$
Conversion safe electron veto	Yes

VBF category

- **Object selections**
 - Photon
 - **Tight ID**
 - **Pt>50** |eta|<1.4442
 - Overlap removal
 - Medium Electron
 - Tight Muon
 - Jet
 - **Pt>30** |eta|<4.7
 - Overlap removal
 - Medium Electron
 - Tight Muon
 - Medium Photon
 - MET
 - **Pt>40**
 - TypeIPuppiMET
- **Event selections**
 - Photon
 - **Single** tight ID photon
 - Leptons
 - Veto loose electrons and muons
 - Jet
 - Jet1>80, Jet2>40
 - Mjj>500
 - $|\Delta\eta_{jj}|>3.0$, $\eta_{j1}\eta_{j2}<0$
 - $d\phi(j1,j2) < 1.5$
 - $d\phi(\text{jets}, \text{met}) < 0.5$
 - Zeppendfield < 0.5
 - Total pt < 150
 - Trigger
 - HLT_Photon**50**EB_**TightID**_TightIso

0 jet category

- **Object selections**
 - Photon
 - **Tight ID**
 - **Pt>50** | eta | <1.4442
 - Overlap removal
 - Medium Electron
 - Tight Muon
 - Jet
 - **Pt>30** | eta | <4.7
 - Overlap removal
 - Medium Electron
 - Tight Muon
 - Medium Photon
- MET
 - **Pt>40**
 - TypeIPuppiMET
- **Event selections**
 - Photon
 - **Single** tight ID photon
 - Leptons
 - Veto loose electrons, muons and **taus**
 - Jets
 - Veto **b jets, fake jets**
 - Trigger
 - HLT_Photon50EB_**TightID_TightIso**

• Update most samples into 24 version

• Signal

- Run3Summer23BPix
 - ggF VBF

• Background

- Run3Summer23
 - QCD_Zjet
 - DYto2L-2Jets_MLL-50_{}_J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8 0 1 2
 - QCD_Wjet
 - WtoLNU-2Jets_{}_J_TuneCP5_13p6TeV_amcatnloFXFX-pythia8 0 1 2
 - Zgamma
 - ZGto2NuG-1Jets_PTG-{}_TuneCP5_13p6TeV_amcatnloFXFX-pythia8 ["10to100", "100to200", "200to400", "400to600", "600"]
 - Wgamma
 - WGtoLNUG-1Jets_PTG-{}_TuneCP5_13p6TeV_amcatnloFXFX-pythia8 ["10to100", "100to200", "200to400", "400to600", "600"]
- RunIII2024Summer24
 - QCD_Gjet
 - GJ-4Jets-2NLO2LO_Bin-PTG-25_Par-BiasedPTG_TuneSherpaDef_13p6TeV_sherpaMEPS
 - QCDJets
 - QCD_Bin-PT-{}_TuneCP5_13p6TeV_pythia8
 - QCD_Znu
 - Zto2Nu-2Jets_Bin-{}_J-PTNuNu-{}_TuneCP5_13p6TeV_amcatnloFXFX-pythia8 1 2
 - EWK_Gjet
 - VBFtoG_Bin-PTG-{}_TuneCP5_13p6TeV_madgraph-pythia8
 - TTbar
 - {}_TuneCP5_13p6TeV_powheg-pythia8 TTto2L2Nu TTto4Q TTtoLNU2Q
 - DYIIIG
 - DYGto2LG-1Jets_Bin-MLL-50-PTG-100_TuneCP5_13p6TeV_amcatnloFXFX-pythia8