Study for Higgs $\longrightarrow Z\gamma$

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Datasets & MC samples

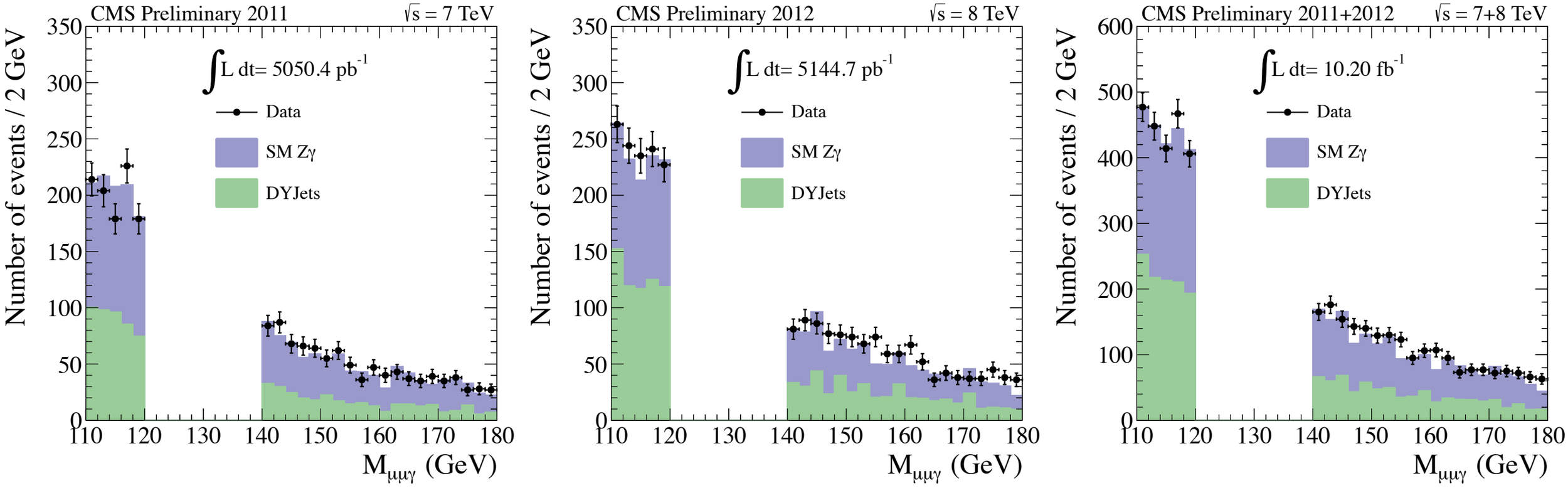
- Datasets:
  - 7 TeV: 16Jan ReReco DoubleMu
    - Luminosity = 5050.43 pb^{-1}
  - 8 TeV: 29Jun ReReco DoubleMu (up to run195398)
    - Luminosity = 5144.685 pb^{-1}
- MC samples:
  - Signal:
    - 7 TeV: Powheg HToZG (ggH, TTH, VBFH, WH and ZH)
    - 8 TeV: normalize 7 TeV sample to 8 TeV cross section
  - Background:
    - ZG and DYJetsToLL

Event Selection

- Good vertex requirement: at least one good vertex
- HLT requirement:
  - Data:
    - 160431 <= run <= 163869: HLT_DoubleMu7
    - 165088 <= run <= 178380: HLT_Mu13_Mu8
    - 178420 <= run <= 195398: HLT_Mu17_Mu8
  - MC:
    - Mu17_Mu8
- Muon selection:
  - $P_T^{leading} > 18$ GeV, $P_T^{trailing} > 9$ GeV, $|\eta| < 2.4$
  - Pass tight ID and tight PF isolation cuts
- Photon selection:
  - $E_T^{\gamma} > (M_{\mu\mu\gamma} \times 15/110)$ GeV and $|\eta^{sc}| < 2.5$ ($1.4442 < |\eta^{sc}| < 1.566$ is excluded)
  - Removal of noisy crystal (2012 only)
    - -1.78 < PhoSCEta < -1.75 && 1.36 < PhoSCPhi < 1.39
  - Pass loose cut-based selection
  - min $\Delta R(\mu,\gamma) > 0.4$
- $M_{\mu\mu} > 50$ GeV and 110 GeV $< M_{\mu\mu\gamma} <$ 180 GeV

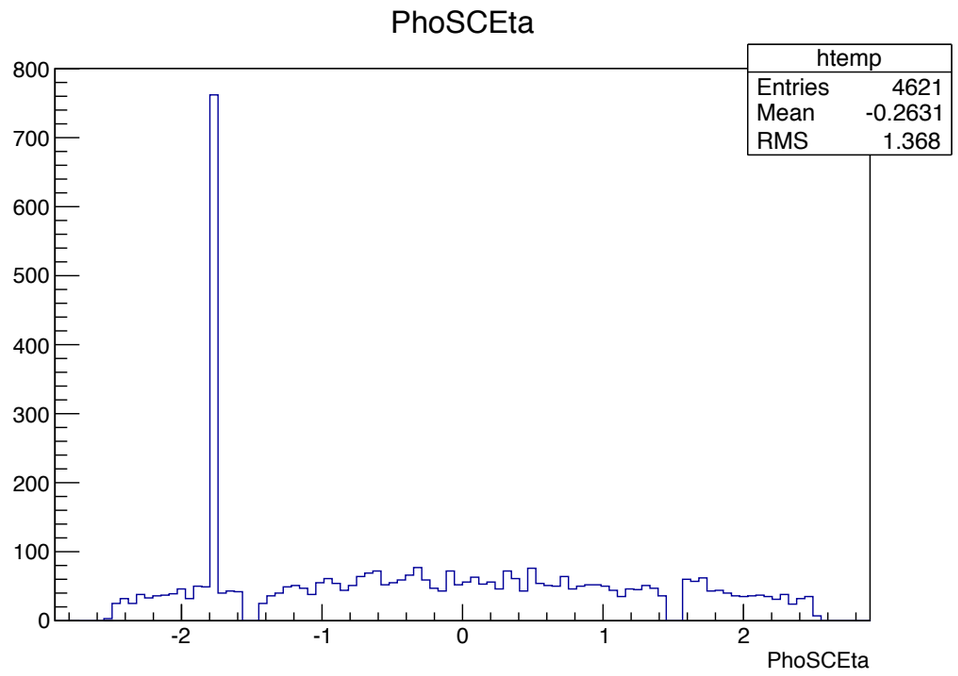
Mass Spectrum

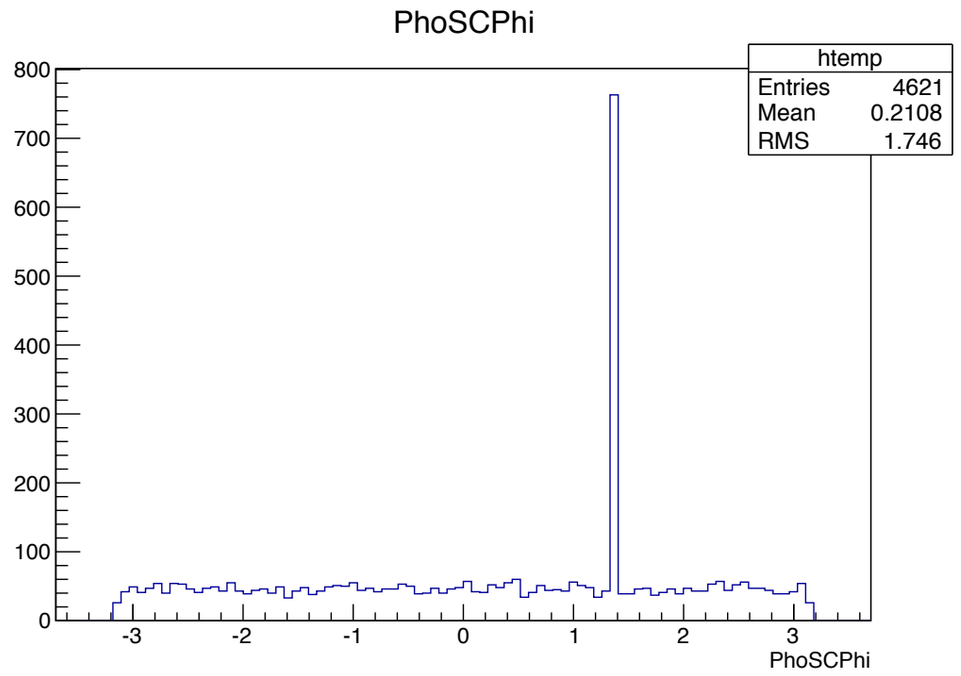
- For 7 TeV (5.05 fb^{-1}):
  - Data yield = 3263; MC yield = 3215.2 (SM Zγ + DYJetToLL)
  - MCFM NLO XS of SM Zγ is 135.6 pb
  - MC signal yield (M_H = 125 GeV) = 1.6
- For 8 TeV (5.14 fb^{-1}):
  - Data yield = 3903; MC yield = 3694.6 (SM Zγ + DYJetToLL)
  - MCFM NLO XS of SM Zγ is 156.2 pb
  - MC signal yield (M_H = 125 GeV) = 1.76

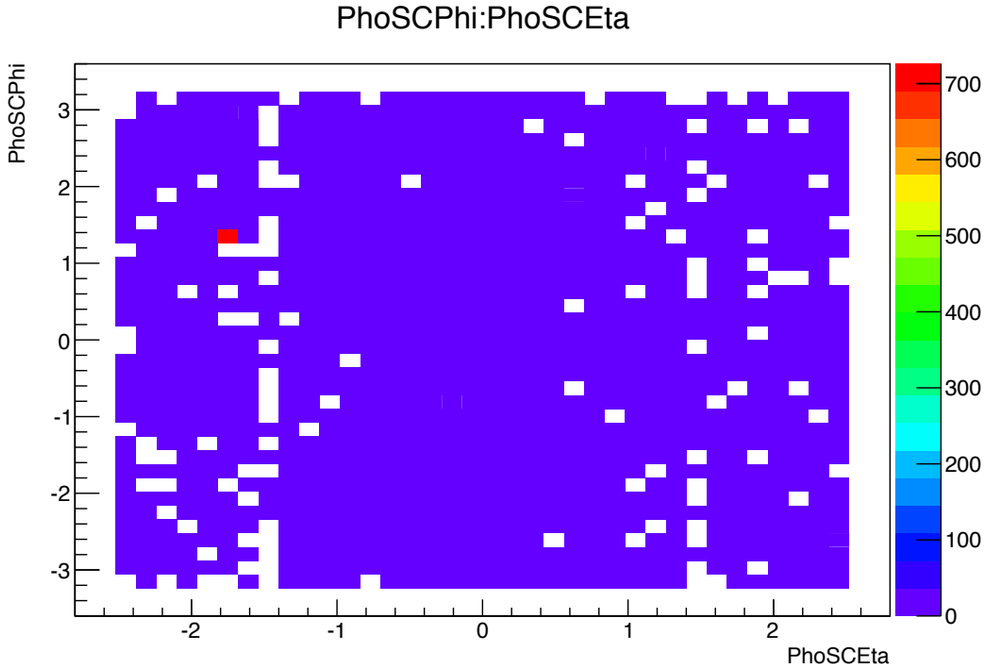


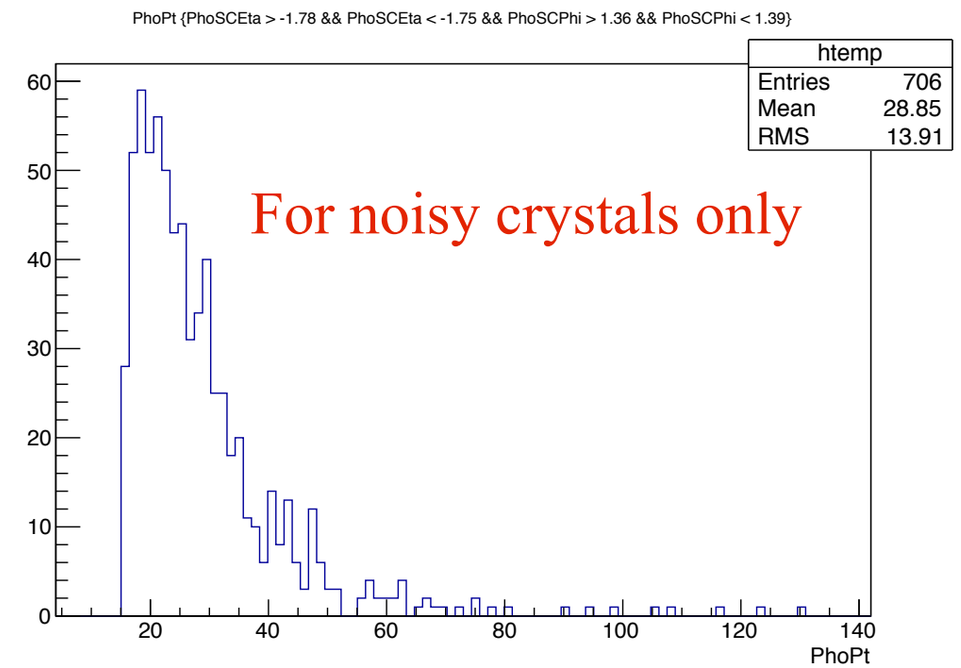
Photon η & ϕ Distributions (1)

- Strange η and ϕ distributions in 2012
  https://hypernews.cern.ch/HyperNews/CMS/get/physics-validation/1837.html





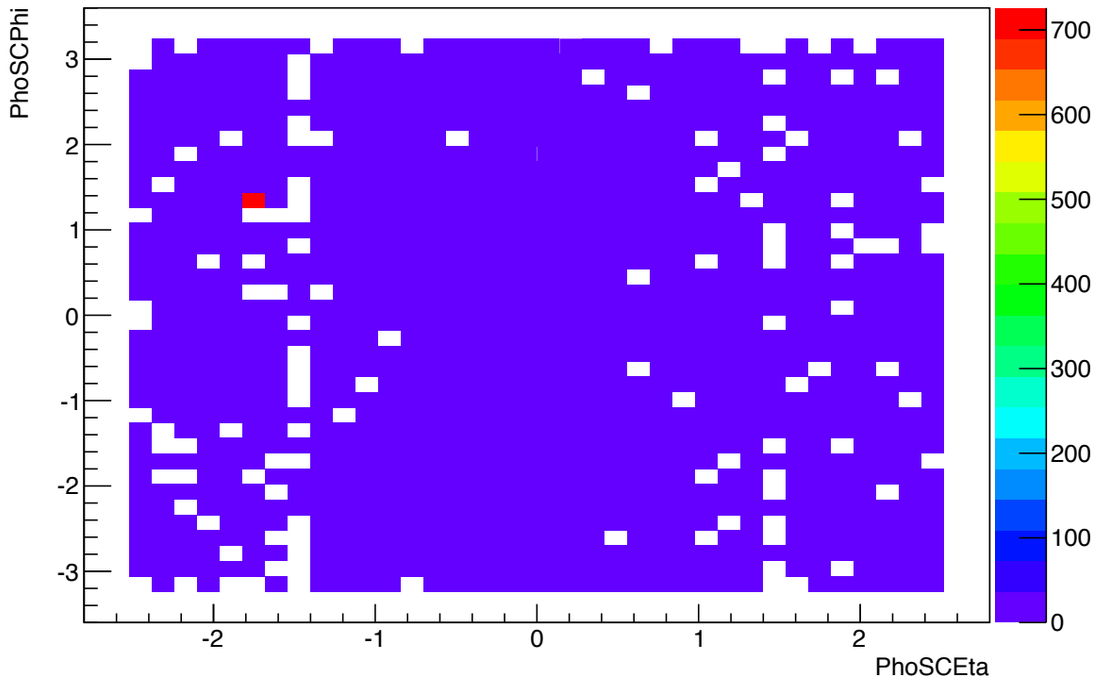




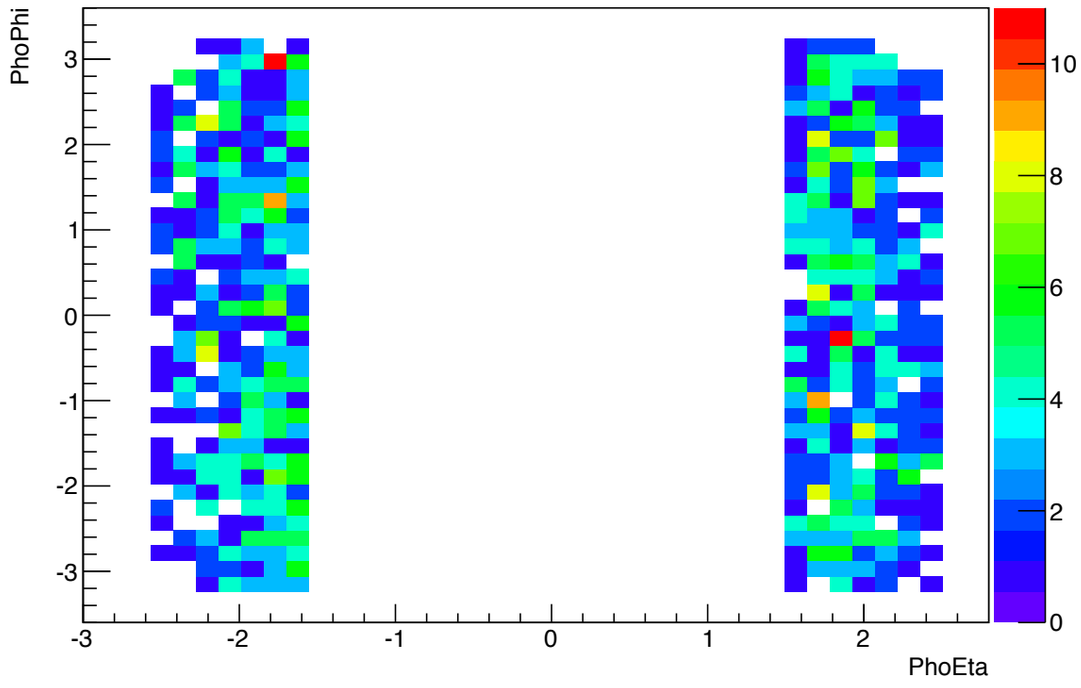
Photon η & ϕ Distributions (2)

- The strange η and ϕ distributions are not significant in FSR μμγ events

110 GeV < $M_{\mu\mu\gamma}$ < 180 GeV



70 GeV < $M_{\mu\mu\gamma}$ < 110 GeV

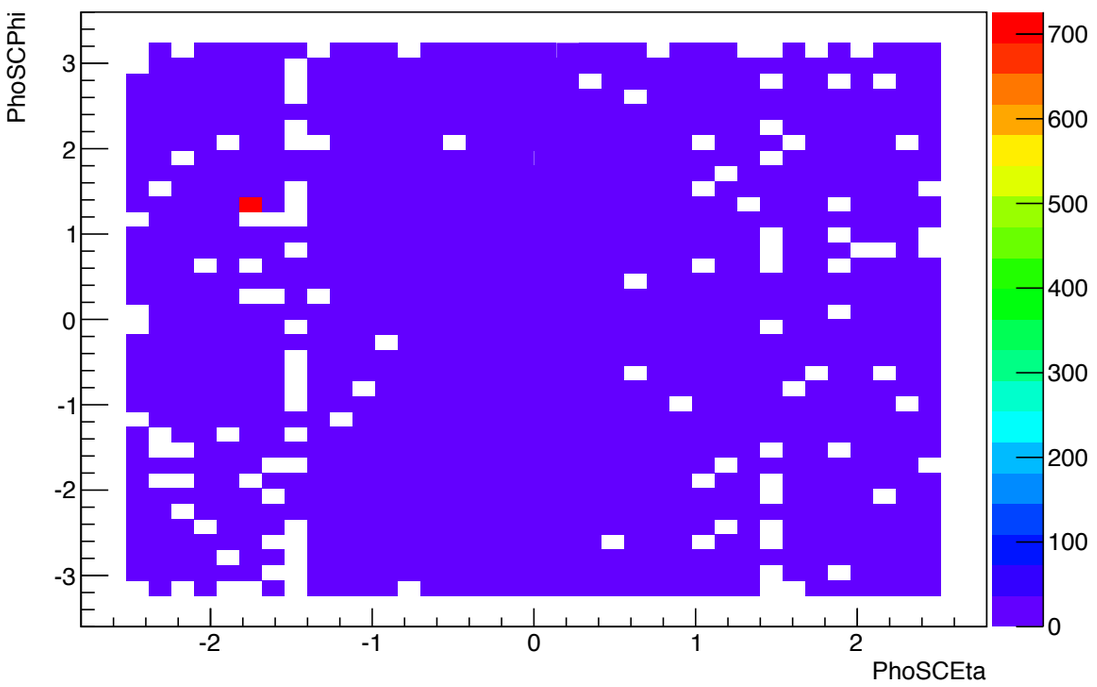


Photon η & ϕ Distributions (3)

- The result for muon channel is using 29Jun ReReco DoubleMu dataset and the same event selection is on slide3
- The result for electron channel is using Prompt Reco DoubleElectron dataset
  - HLT: HLT_Ele17_CaloIdT_CaloIsoVL_TrkIdVL_TrkIsoVL_Ele8_CaloIdT_CaloIsoVL_TrkIdVL_TrkIsoVL
  - Electron $P_T > 20$ GeV and pass 2012 loose selection
  - The rest of selections are the same as muon channel

- The strange η and ϕ distributions only exist in 29Jun ReReco dataset

29Jun ReReco DoubleMu



Prompt Reco DoubleEle