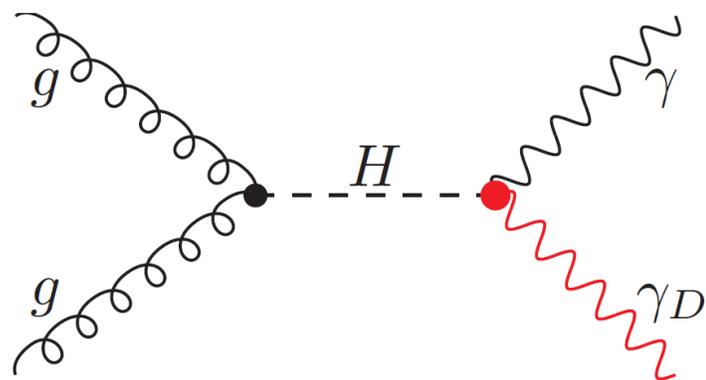
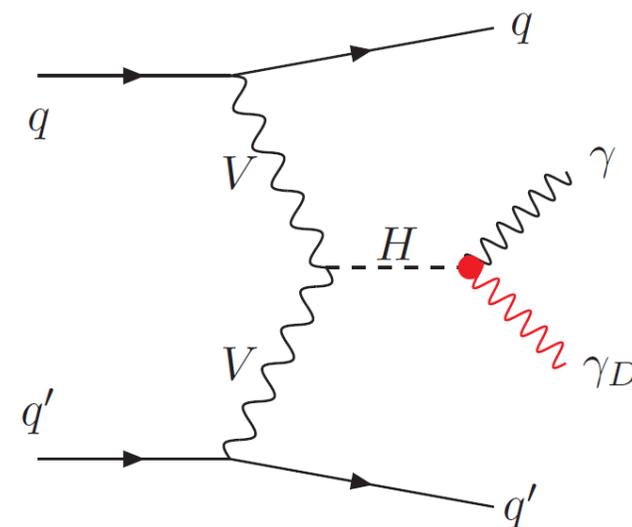


H \rightarrow Photon + MET

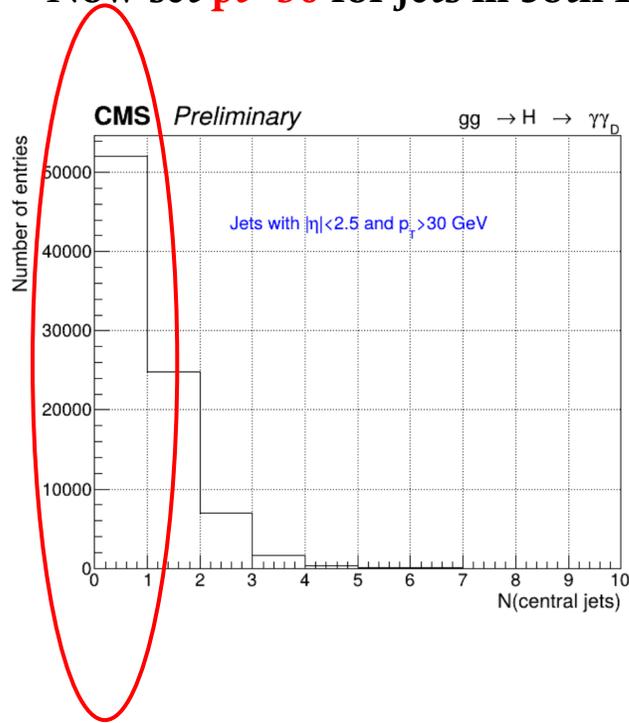


Longsheng Tan

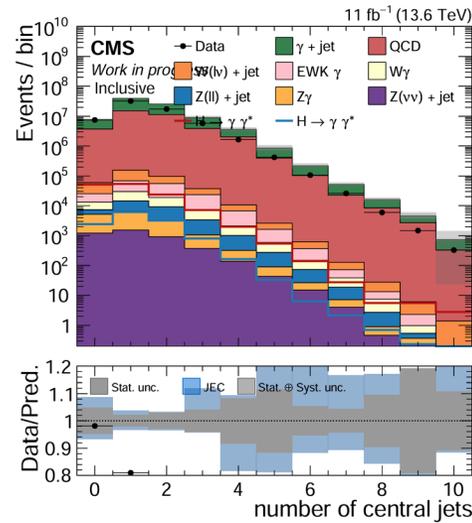
2026.1.12



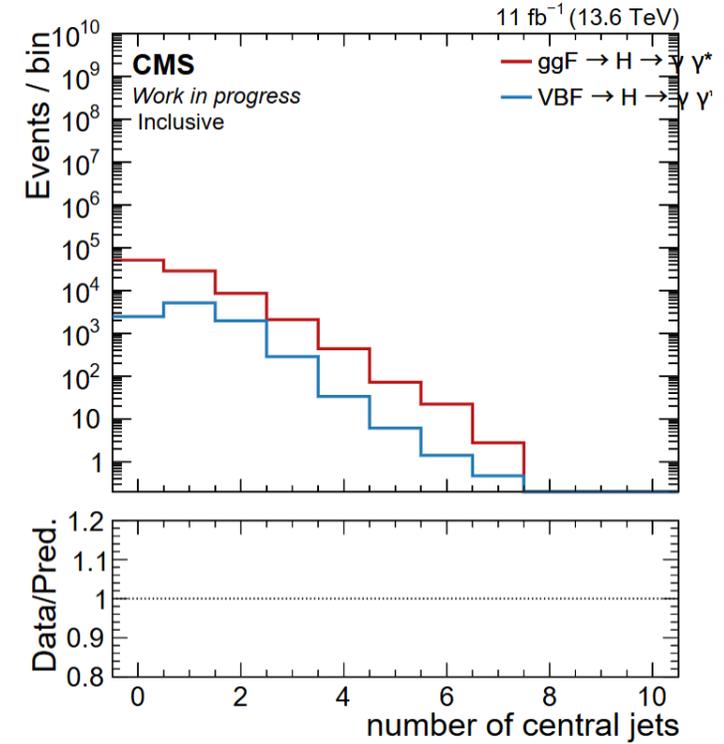
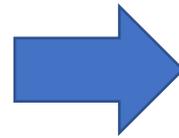
- Fixed bugs mentioned about 0 central jets peak missing in **Inclusive jets category**
 - Default jet pt **setting (pt>20)** for **jet clean** which pt>30 for central jets should be supplemented
 - Wrote a new model for Inclusive jets category
- Now set **pt>30** for jets in both Inclusive and VBF category



Checked by colleague
Original nanoaod

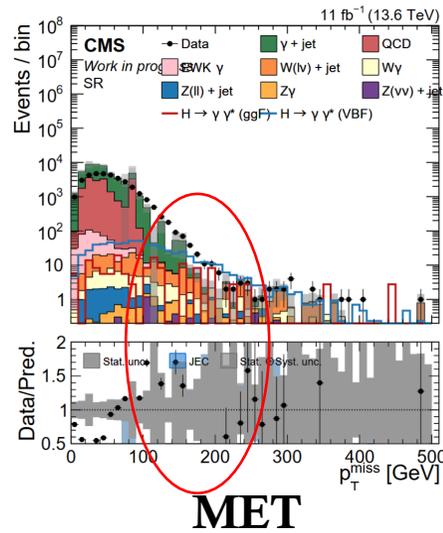
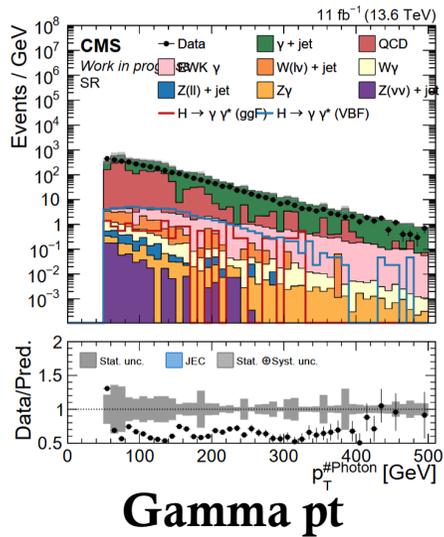


Given by framework
All basic selections applied

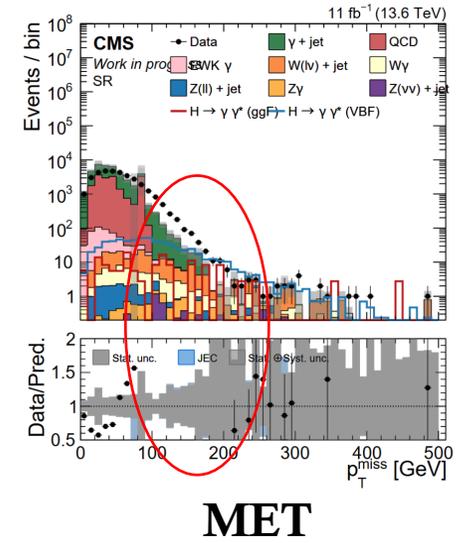
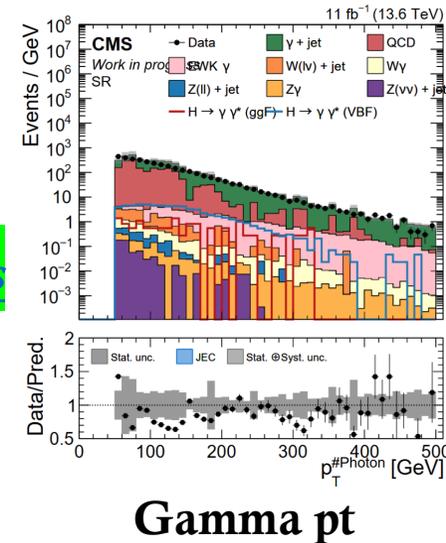


Given by framework
All basic selections applied

Integral		MT	Nevents
signal	ggF	138.75766	138.75766
	VBF	656.38236	656.38641
background	QCD_23Gjet	31484.367	31484.428
	QCD_24Gjet	21878.434	21878.426
	QCD_Zjet	13.863205	13.863209
	QCD_Wjet	151.83769	151.83765
	QCDJets	17228.552	17228.551
	QCD_Znunu	6.0990074	6.1130838
	EWK_Gjet	404.90241	404.90137
	Zgamma	9.9396641	10.230591
	Wgamma	51.214951	51.427971



23 Gjets VS 24Gjets



• **Most background : Gjets**

- 24 Gjets better than 23 Gjets in whole gamma pt region
 - However
 - 23 Gjets better than 24 Gjets in **Mid-high MET** region
 - **k-factor** can be applied to **23 Gjets** to achieve the same **gamma pt** matching as that of the 24Gjets
- Gjets has overlap with QCD, remove Gjets from QCD contribution maybe will improve data/MC agreement?

- Now ABCD method is planned to apply to QCD samples
 - Photon purity study
 - The leading source of **fake photons** is from **QCD multijet events**, where jets are misidentified as a photon
 - Fake photons exhibit **a less pronounced peak** (from photons inside jets) and **a broader tail** at larger $\sigma_{\eta\eta}$ values (from hadrons interacting in the ECAL)
 - Investigating 2d distribution of Photon_pfChargedIso and Photon_sieie (**uncorrelated variables**)
 - Photon_pfChargedIso: PF absolute isolation $dR=0.3$, charged component with dxy,dz match to PV
 - Photon_sieie: $\sigma_{\eta\eta}$ of the supercluster, calculated with full 5x5 region
 - Write new model **photon_purity_for_darkphoton** and implement it in channel_selections as invisible did
 - **Configs.update(create_module_config(name="PhotonPurityForDarkphoton", photons="Photon"))**
 - **Only for leading photon**

```

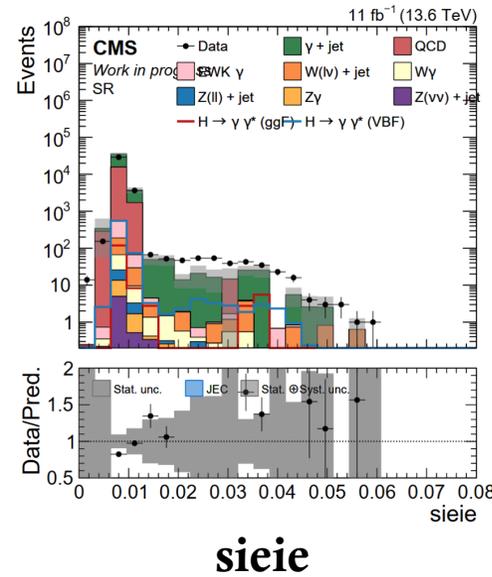
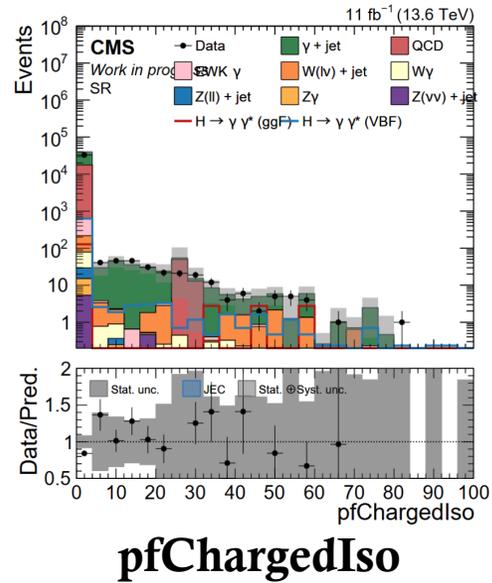
Project > pyRAT > modules > photon_purity_for_darkphoton.py > ...
1 from typing import Any, Optional
2 import awkward as ak # type: ignore
3
4 from framework.module import Module
5 from framework.events import Events
6 from modules.helpers.objects_utils import get_object
7
8
9 class PhotonPurityForDarkphoton(Module):
10     """Store leading-photon raw variables from NanoAOD: sieie, pfChargedIso."""
11
12     def __init__(self, cfg: dict[str, Any], events: Optional[Events] = None):
13         super().__init__(cfg, events=events)
14         self.collection: str = self.cfg.get("collection", "")
15         self.validate_parameters()
16
17     def call(self, events: Events) -> dict[str, Any]:
18         # Read raw NanoAOD branches (per-photon arrays)
19         pt = get_object(events=events, obj_name="Photon_pt")
20         sieie = get_object(events=events, obj_name="Photon_sieie")
21         pf_ch_iso = get_object(events=events, obj_name="Photon_pfChargedIso")
22
23         # Sort photons by pt (descending) and take leading
24         order = ak.argsort(pt, axis=1, ascending=False)
25
26         sieie_sorted = sieie[order]
27         pf_ch_iso_sorted = pf_ch_iso[order]
28
29         sieie_lead = ak.fill_none(ak.firsts(sieie_sorted), -999.0)
30         pf_ch_iso_lead = ak.fill_none(ak.firsts(pf_ch_iso_sorted), -999.0)
31
32         return {
33             f"PhotonVars_{self.collection}sieie_lead": sieie_lead,
34             f"PhotonVars_{self.collection}pfChargedIso_lead": pf_ch_iso_lead,
35         }
36
37     def validate_parameters(self) -> None:
38         if self.collection:
39             self.collection = f"{self.collection}_"
40
    
```

```

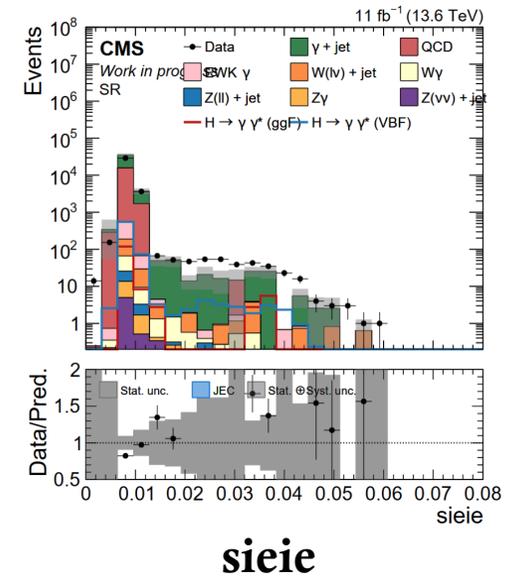
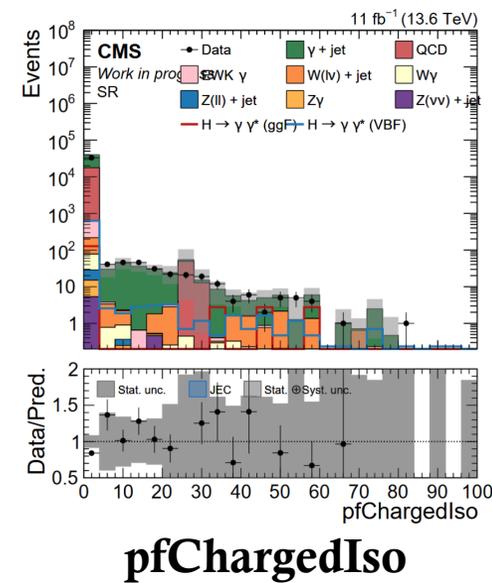
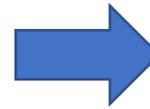
def add_channel_selections(configs: Config, campaign: str) -> None:
    """Add configurations for channel selections."""
    years = CampaignInfoMap().get_allowed_years()
    channel_selections = {}
    njets_conditions = {
        "0": {"exact_count": 0},
        "1": {"exact_count": 1},
        "2": {"exact_count": 2},
        "atleast2": {"min_count": 2},
        "atleast3": {"min_count": 3},
    }
    jec_variations = get_jec_variations(campaign=campaign)
    jet_collections_map = {
        f"jet_{coll}": {f"jet_collection": f"cleaned_{coll}_{jet_collection}_jet" for coll in ["inclusive", "central"] for jet_collection in jec_variations}
    }
    for sel_name, jet_collection in jet_collections_map.items():
        # for working_point in ["loose", "tight"]:
        for obj in ["Photon", "Electron"]:
            channel_selections[f"VBF_{sel_name}_{obj}"] = {}
            module: "VBFSelectionForDarkphoton",
            jets: jet_collection,
            obj: f"cleaned_{medium}_{obj}",
            met: "jec_nominal_typePuppiMET",
            min_ej1: 500,
            min_pt_jet1: 80,
            min_pt_jet2: 40,
            }
            for njets_conditions in njets_conditions.items():
                channel_selections[f"{obj}_{sel_name}"] = {
                    "module": "ObjectCountFilter",
                    "objects": jet_collection,
                    **conditions,
                }
    configs.update(create_module_config(name="PhotonPurityForDarkphoton", photons="Photon"))

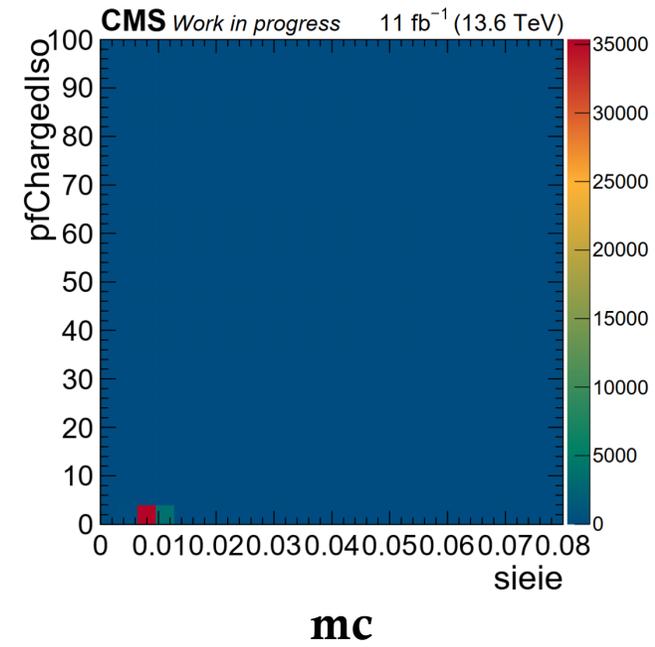
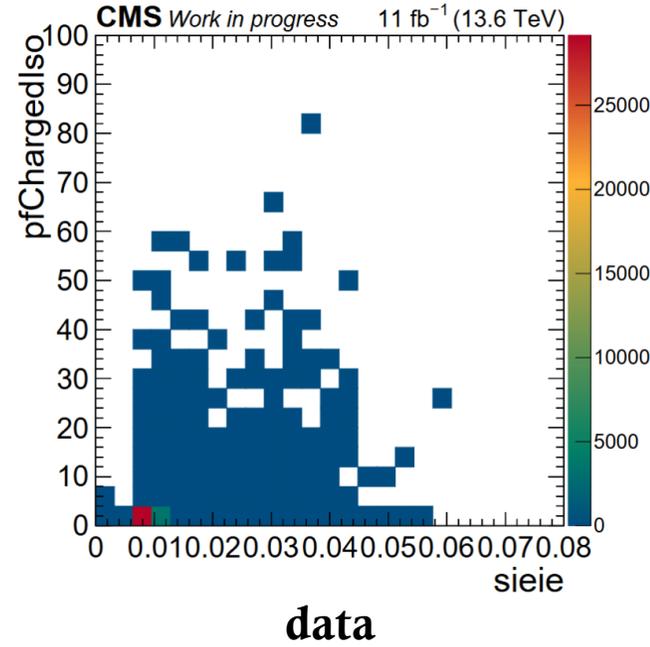
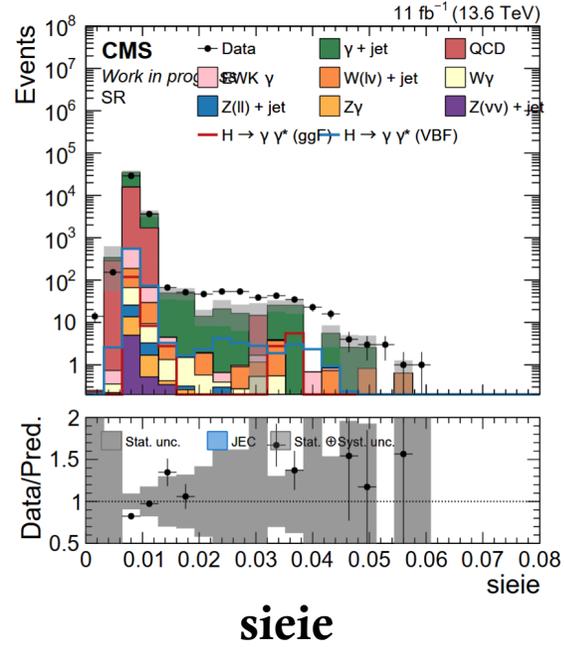
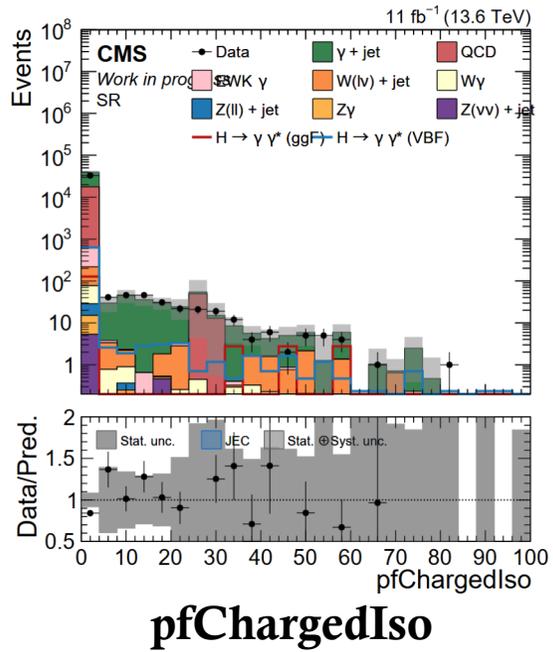
    for mode, config in channel_selections.items():
        configs.update(create_module_config(name=mode, collection=mode, **config))
    analysis_channels = list(channel_selections.keys())
    configs.update(
        create_module_config(
            name="FilterChannel",
            module="TriggerSelection",
            selection_name="FilterChannel",
            trigger_selections={year: [f"{mode}_selection" for mode in analysis_channels] for year in years,
        }
    )
    
```

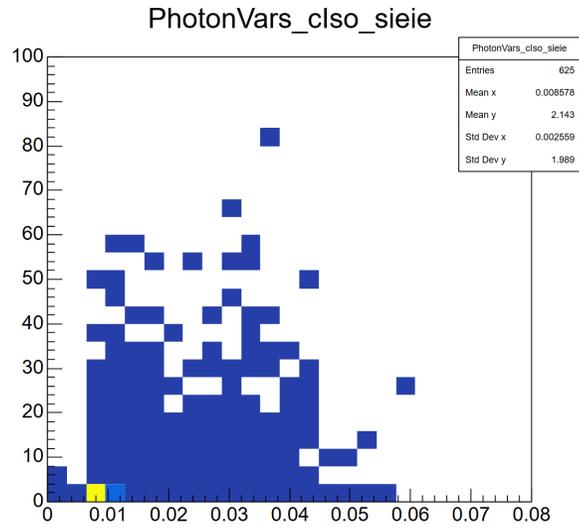
- Remove singlePhoton_medium_id_selection now
 - Only few number of events changed



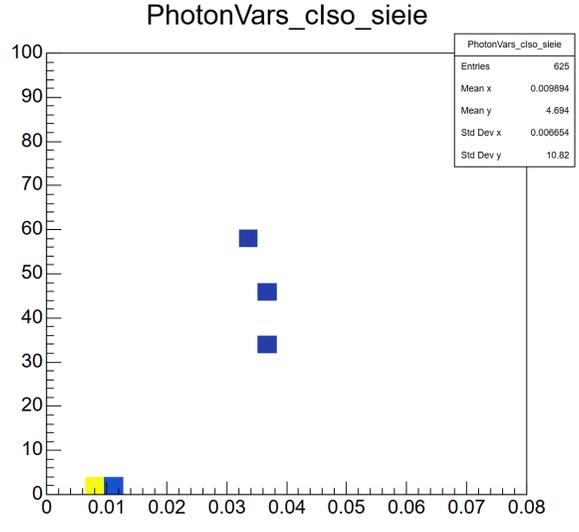
Add ID selection



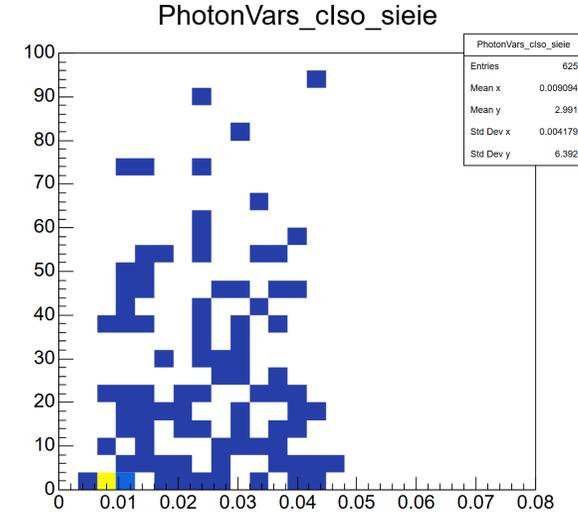




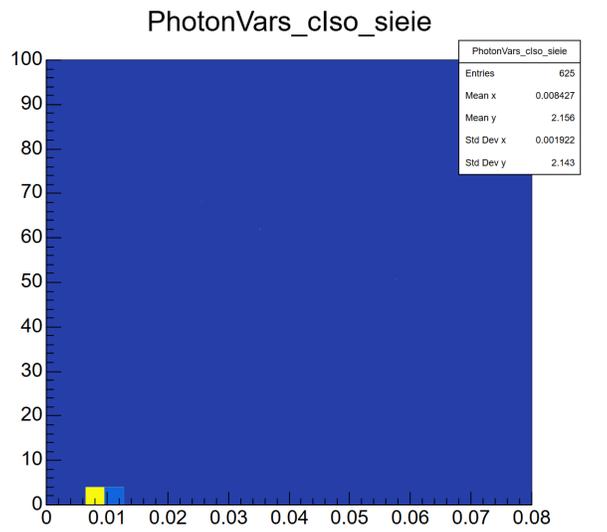
data



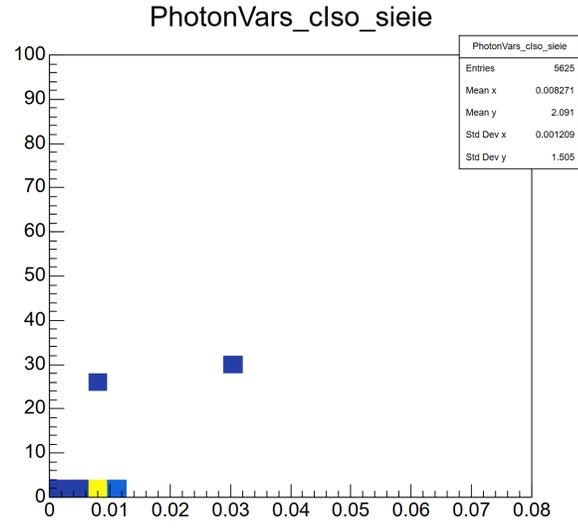
ggf



vbf



Gjets



QCD

- **Uncorrelated variables**
- **Data wide distribution is suitable for use in ABCD**
- **Most of the ggF/VBF are in the region of low pfChargedIso and low sieie (~0.01)**
- **QCD samples make significant contributions in the signal region with low isolation and low $\sigma_{\eta\eta}$ and have a tail around 0.03**