HF noise study Run3

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Introduction

- **Origin:**
  - It occurs when a muon or charged particle from a shower hits a PMT in the HF (Hadronic Forward) detector, causing spurious (fake) signals.
  - It can also arise from bremsstrahlung of high-energy muons in the HF detector.
  - So, HF detector suffers from a significant noise.
- **Effect:**
  - It leads to fake energy deposits which are usually have spread in η and narrow in ϕ.
  - Produces fake jets with $|\eta| > 2.99$, often with unusual shower shapes.
  - Results in fake p_t-miss in the opposite ϕ direction.

Estimation

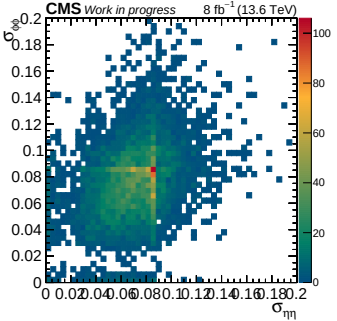
- **HF shower shape variables:**
  - Jets resulting form the noise have distinct shape w.r.t. the physics jets i.e. they are spread in η and narrow in ϕ.
  - New shower shape variables ($\sigma_{i\eta i\eta}$, $\sigma_{i\phi i\phi}$, HF central strip size) were introduced in NanoAOD's to help reject noise.
- **Purpose of these variables:**
  - Cuts on these variables reject noise while keeping high efficiency on physics jets.
  - Efficiencies measured in data and simulation; ratio (SF) used to correct simulation.

Regions & Selections

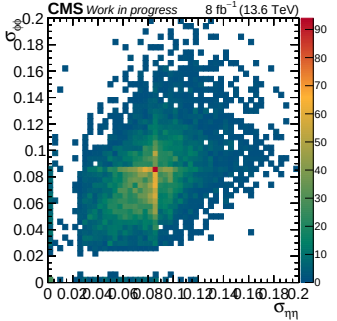
- In order to study the discriminating power of these variables directly in data, two regions enriched in "physics jets" and "noise jets" are defined:
- **Physics-enriched region:**
  - Events where a HF jet recoils against a Z boson (decaying into two muons), or a photon. They are required to pass the following selection:
    - Exactly one well identified Z decaying to two muons or a photon.
    - Events passing the isolated dimuon trigger or single photon trigger.
    - $\Delta\phi$(Z, jet) > 2.7
    - $0.5 < p_t(V)/p_t(j) < 1.5$
    - p_t-miss < 50 GeV
- **Noise-enriched region:**
  - Events with exactly one high pT HF jet and high pT-miss. The complete requirements are:
    - Trigger based on MET/MHT.
    - p_t-miss > 100 GeV
    - Exactly one HF jet with $p_t > 100$ GeV
    - No extra jets with $p_t > 30$ GeV
    - No leptons with $p_t > 10$ GeV

Physics-enriched region: 2022

- Data: EGamma.
- Trigger: HLT_Photon110EB_TightID_TightIso.



$|\eta|$: 2.99 - 3.25



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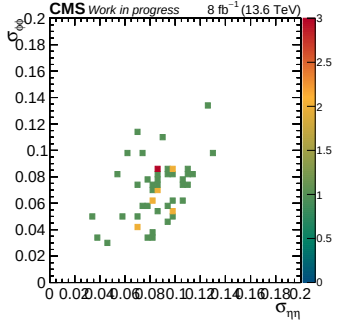
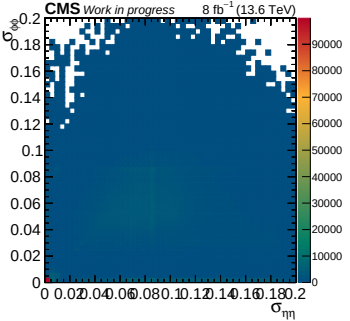


$|\eta|$: 4.00 - 5.20

Noise-enriched region: 2022

- Data: JetMET.
- Trigger: HLT_PFMETNoMu120_PFMHTNoMu120_IDTight.



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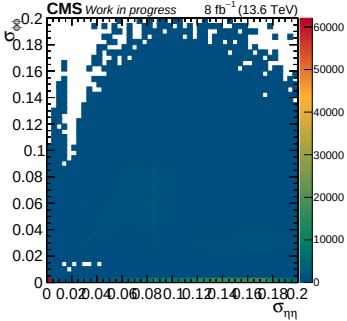

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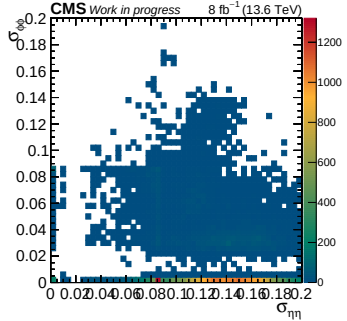
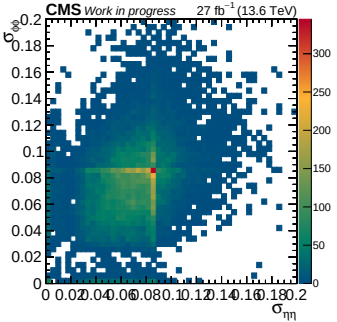


$|\eta|$: 4.00 - 5.20

Physics-enriched region: 2022EE

- Data: EGamma.
- Trigger: HLT_Photon110EB_TightID_TightIso.



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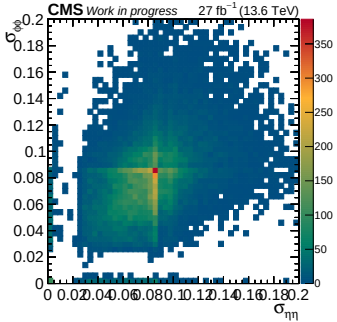

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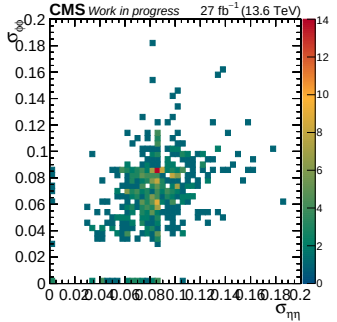

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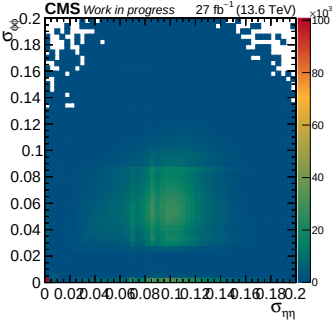
Noise-enriched region: 2022EE

- Data: JetMET.
- Trigger: HLT_PFMETNoMu120_PFMHTNoMu120_IDTight.



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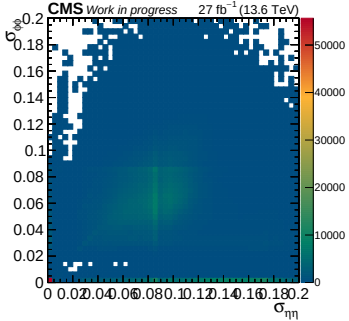

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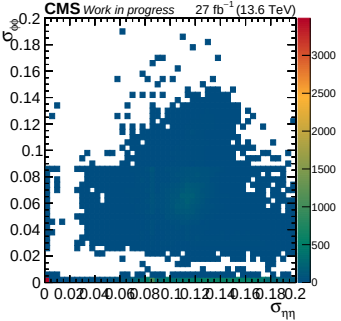

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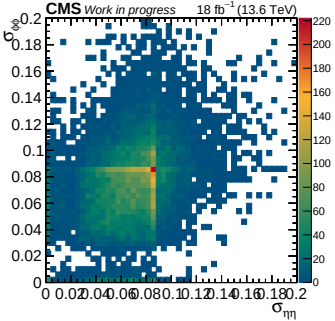
Physics-enriched region: 2023

- Data: EGamma.
- Trigger: HLT_Photon110EB_TightID_TightIso.



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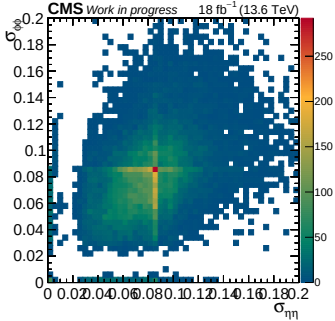

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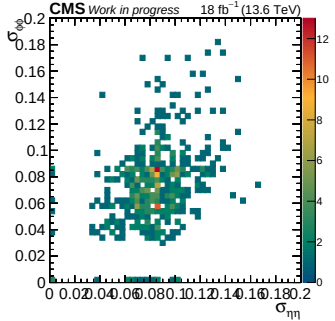

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Noise-enriched region: 2023

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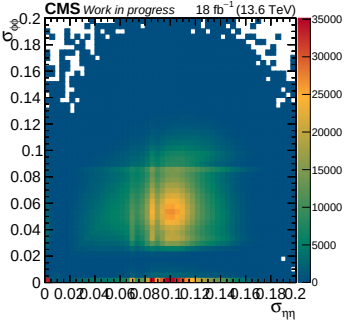
- Trigger: HLT_PFMETNoMu120_PFMHTNoMu120_IDTight.



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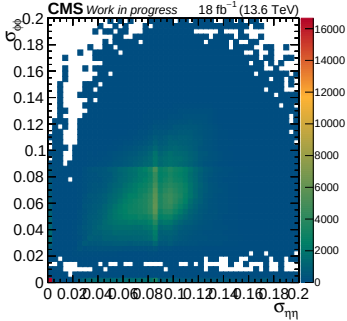

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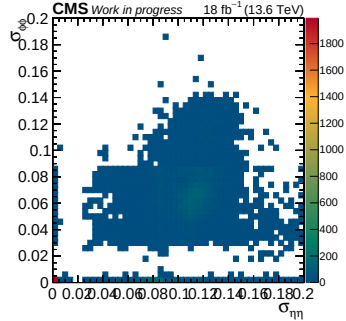

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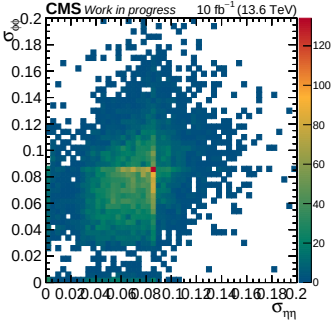
Physics-enriched region: 2023 BPix

- Data: EGamma.
- Trigger: HLT_Photon110EB_TightID_TightIso.



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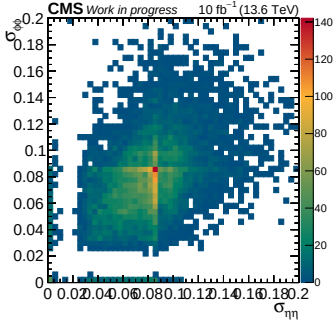

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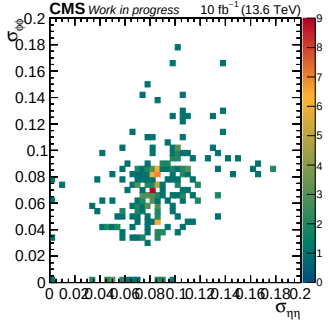

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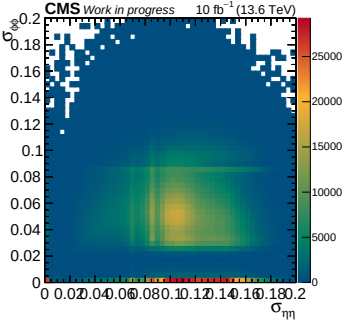
Noise-enriched region: 2023BPix

- Data: JetMET.
- Trigger: HLT_PFMETNoMu120_PFMHTNoMu120_IDTight.



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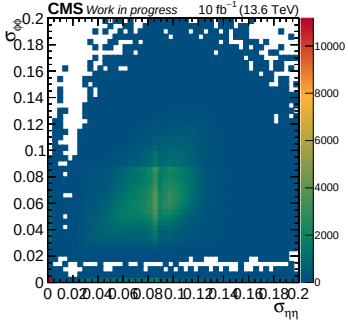

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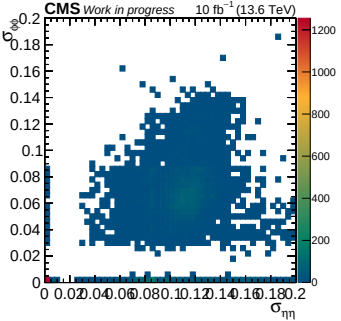
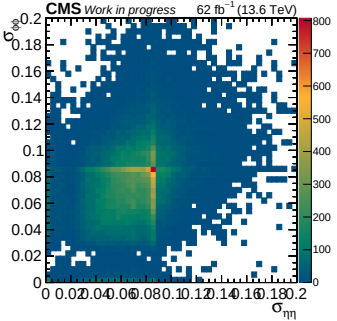


$|\eta|$: 4.00 - 5.20

Physics-enriched region: Run3

- Data: EGamma.
- Trigger: HLT_Photon110EB_TightID_TightIso.



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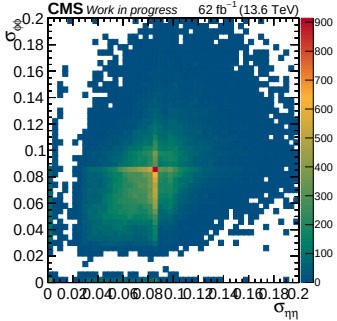

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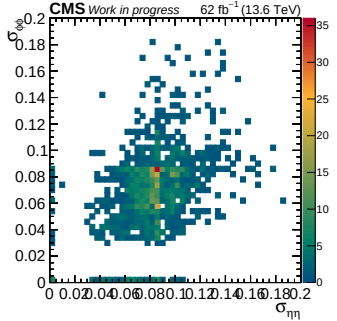
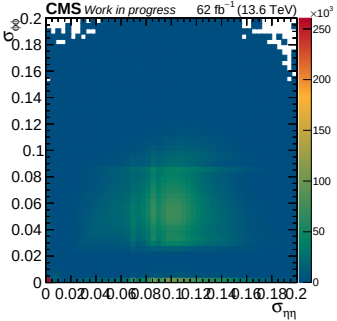


$|\eta|$: 4.00 - 5.20

Noise-enriched region: Run3

- Data: JetMET.
- Trigger: HLT_PFMETNoMu120_PFMHTNoMu120_IDTight.



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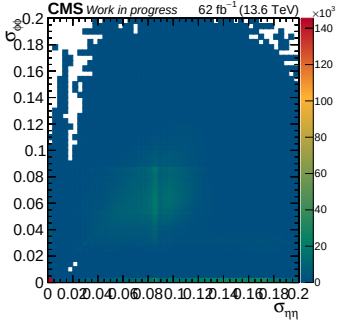

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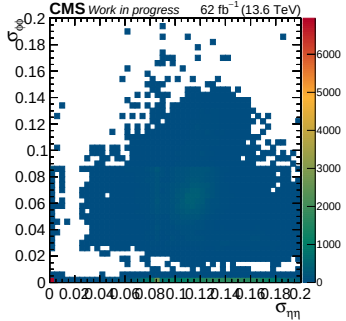

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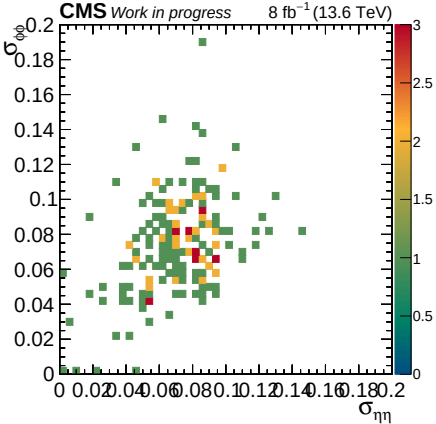
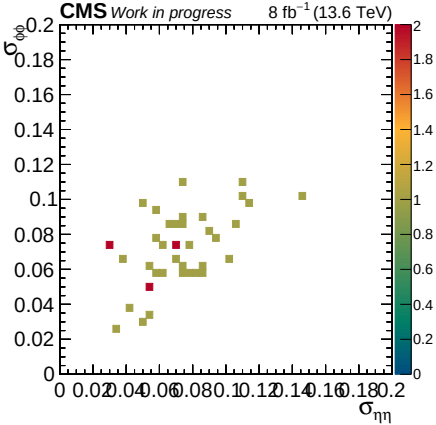
Backup

Physics-enriched region: Comparison (2022)

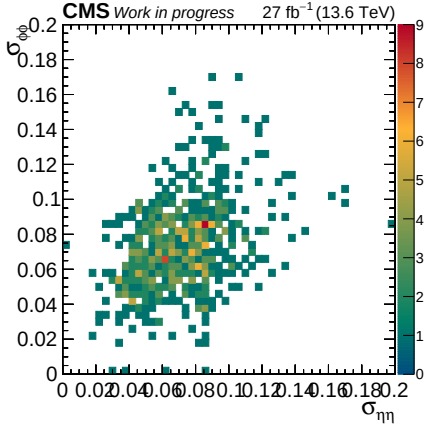


Data: EGamma, HLT_Photon200

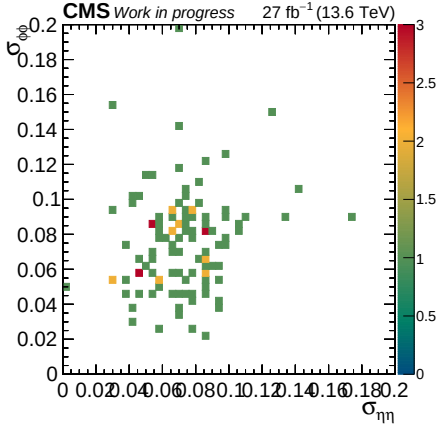


Data: Muon, HLT_IsoMu24

Physics-enriched region: Comparison (2022EE)



Data: EGamma, HLT_Photon200



Data: Muon, HLT_IsoMu24