L1 Trigger Algorithms at CMS for the HL-LHC[1]

e/γ, Jets, E_T^{miss} and τ_h

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On behalf of the CMS collaboration

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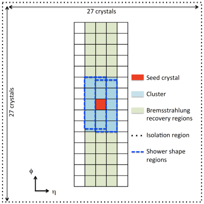
[1]Based on CMS-TDR-021

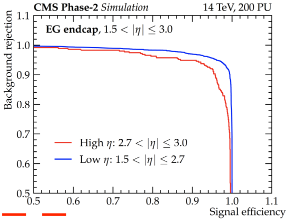
Electrons and Photons

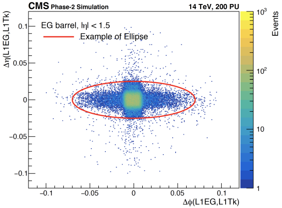
- Calorimeter upgrades
  - Crystal granularity in barrel
  - New high-granularity calorimeter (HGCAL) in endcap

- e/γ reconstruction in barrel
  - Seeding+clustering+ ID&isolation



- e/γ reconstruction in endcap
  - 3D shower information provided by HGCAL
  - BDT is implemented
    - High background rejection & signal efficiency





- L1 tracks
  - Matched with calorimeter objects
  - Track isolation

Efficiency	calorimeter only	track-matched
30GeV	97.5%	84.5%
40GeV	98.7%	88.0%

Table 1: Single electron efficiency in the barrel

Rate	calorimeter only	track-matched
30GeV	78.2 kHz	19.0 kHz
40GeV	25.5 kHz	8.3 kHz

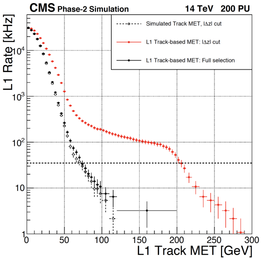
Table 2: Trigger rate of the barrel L1 objects

Summary

- Improved efficiency and resolution due to higher granularity
- Reduced trigger rate due to L1 tracks

Jets and Energy Sums

- Track-only jet and MET
  - Relies on track purity
  - Reduces the threshold significantly (below)

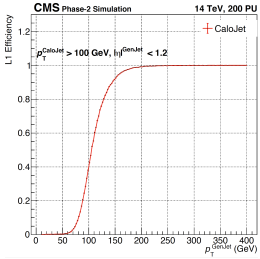


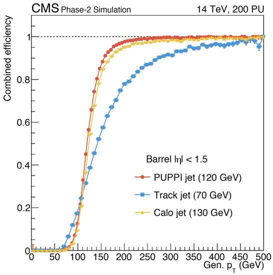
- Particle-flow (PF) based
  - Jets
    - The performance is close to that of the offline AK4 algorihtm when using PUPPI inputs
  - MET
    - Takes PUPPI inputs

- Calorimeter-only jets (right)

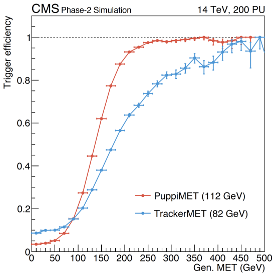
Summary

- Improved resolution and efficiency for PF-based algorithm
- Standalone algorithms add robustness





Jets

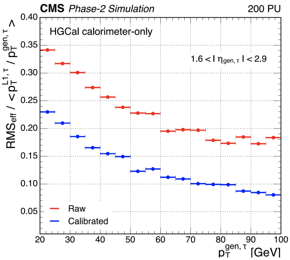


MET

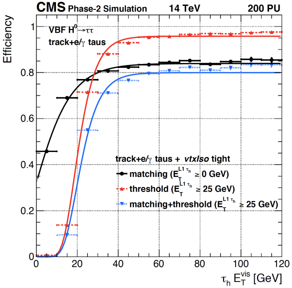
Hadronic τ

- Calorimeter-only τ_h
  - Similar to calorimeter based jet finding
  - Possible improvements in the HGCAL with BDT
- Track+e/γ τ_h
  - Associates e/γ clusters with tracks
  - Simple yet efficient
- PF-based τ_h
  - Neural network + PUPPI inputs
  - More complicated firmware
  - Capable of identifying a τ_h every 25 ns

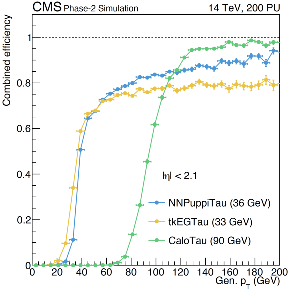
- Energy calibration with BDT regression (Calo-only)



- Track+e/γ



- Comparison of different algorithms (right)



Summary

- Different algorithms are complementary to each other