David Ruiter
PHYS 324
February 9, 2026

Selections for Higgs Re-discovery Project

1. 2 electron + 2 muon selection

- Particle count: Exactly 2 electrons and exactly 2 muons
- Eta: Each electron has $|\eta| < 2.5$ and each muon has $|\eta| < 2.4$
- Pt: Each electron and each muon has $p_T > 10$ GeV
- Isolation: Each electron and each muon has isolation < 0.4, as contained in the relevant "pfRelIso" column.
- Primary vertex: Each electron and muon has $|\text{dxy}| < 0.5$ and $|\text{dz}| < 1.0$.
- Impact parameters: Each particle has an impact parameter defined by $\text{ip3d} \equiv \sqrt{\text{dxy}^2 + \text{dz}^2}$, and an associated error defined by $\text{sip3d} \equiv \frac{\text{ip3d}}{\sqrt{\text{dxyErr}^2 + \text{dzErr}^2}}$. Each electron and muon should have $\text{sip3d} < 4$.
- Charge: The charges of the two electrons should sum to zero, and the charges of the two muons should sum to zero.
- Bonus cut if we get to it: for any two particles with $\eta_1, \eta_2, \varphi_1, \varphi_2$, one can define $\Delta r \equiv \sqrt{(\eta_1 - \eta_2)^2 + (\varphi_1 - \varphi_2)^2)}$. The 2 electrons should have $\Delta r_{e_1 e_2} < 0.02$ and the 2 muons should have $\Delta r_{\mu_1 \mu_2} < 0.02$.

2. 4 muon or 4 electron selection

- Particle count: Exactly four muons or electrons
- Eta: As 2e2mu
- Pt: Each particle has $p_T > 5$ GeV
- Isolation: As 2e2mu
- Primary vertex: As 2e2mu
- Impact parameters: As 2e2mu
- Charge: There should be exactly two positively charged particles and exactly two negatively charged particles
- Bonus cut if we get to it: Δr as 2e2mu