APPENDIX D

CONTROL REGION PLOTS

This section includes the CR plots for the five CRs studied in this analysis. The selection criteria for the CRs are described below, and plots for each of the CRs for all of the UL years are shown in Figures D.1 through D.20.

- 2lss CR: For the 2lss CR, we require two same signed tight leptons, exactly 1 medium b tag, and exactly 1 or 2 jets. Note that for the jet multiplicity plots in this CR, the contribution from 3j is also included (as this makes any trends in the jet multiplicity easier to see). However, the signal samples contribute more significantly to the 3j bin than to the lower jet multiplicity bins; we would like to minimize the signal contamination in this CR, so we do not include the 3j contributions in the kinematic distributions for this CR.
- 3l CR: For the 3l CR, we require exactly three tight leptons, and exactly 0 medium b tagged jets. We do not apply a jet requirement.
- 2l os Z CR: For the 2l os Z CR, we require exactly two tight leptons of opposite sign and same flavor. We also require the invariant mass of the lepton pair to be within 10 GeV of the Z mass. Exactly 0 medium b tagged jets are required. No requirement on N_{jets} is specified.
- 2l os $t\bar{t}$ CR: For the 2l os $t\bar{t}$ CR, we require exactly two opposite sign, opposite flavor leptons. We require exactly 2 medium b tags, and exactly two jets. Note that we do not apply top p_T reweighting, so we do not expect exact agreement in the p_T distributions.
- 2l ss flip CR: For the 2lss charge flip CR, we require exactly two tight electrons with an invariant mass within 30 GeV of the Z peak. We place no requirement on b jets, but require fewer than 4 total jets.

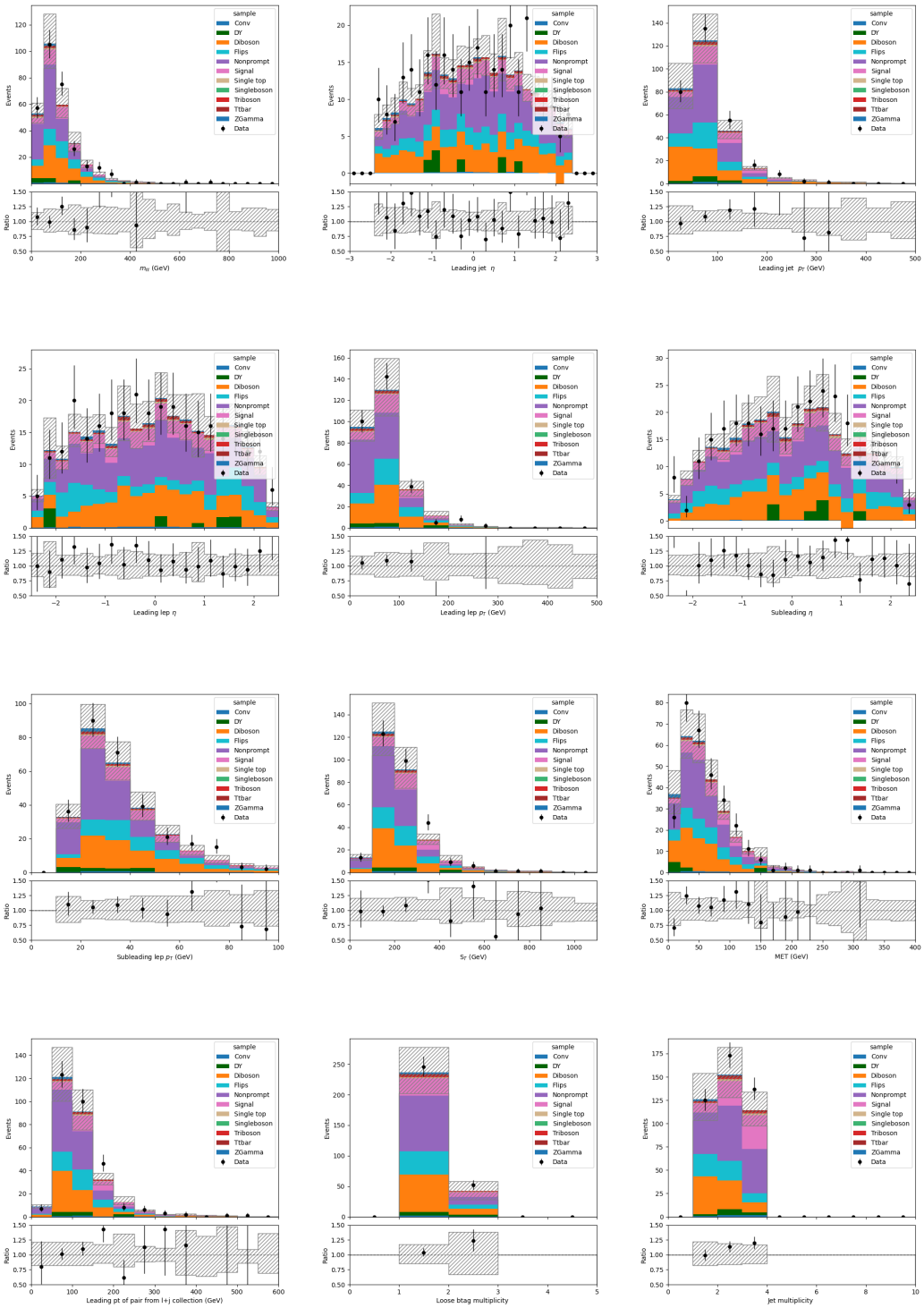

Figure D.1. Control region plots for the 2lss CR (for UL16 samples). The shaded gray band indicates the systematic uncertainty.

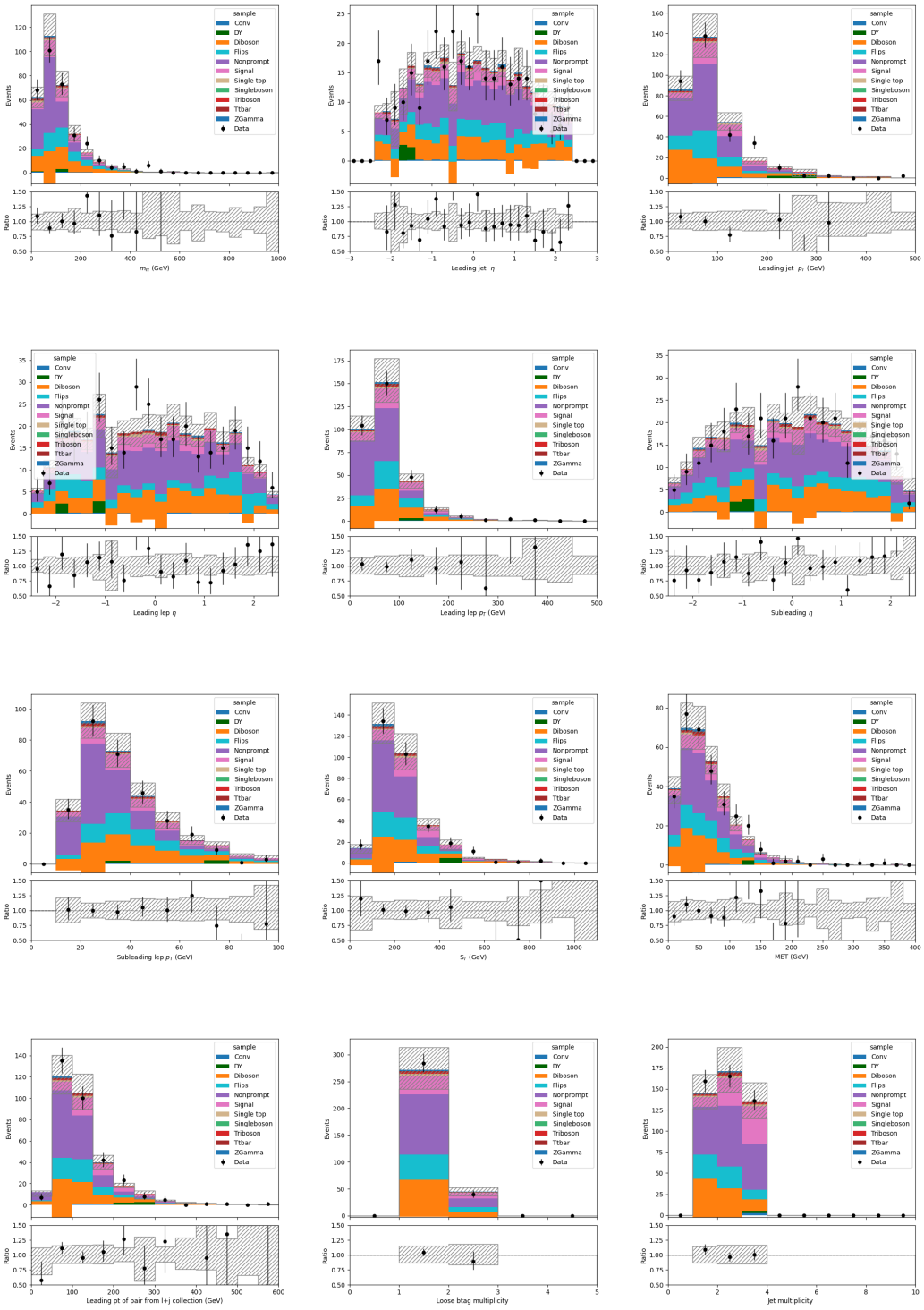

Figure D.2. Control region plots for the 2lss CR (for UL16APV samples). The shaded gray band indicates the systematic uncertainty.

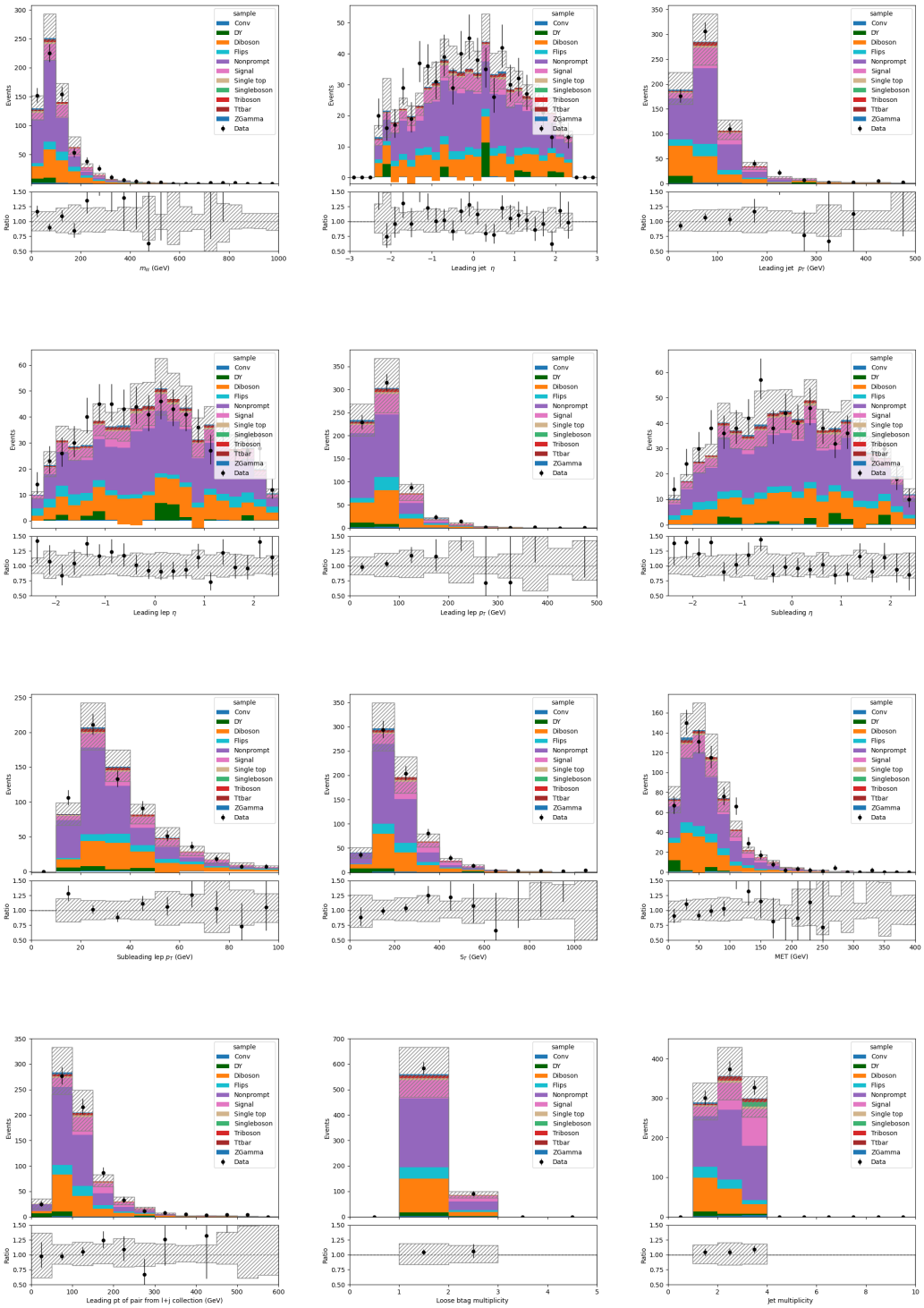

Figure D.3. Control region plots for the 2lss CR (for UL17 samples). The shaded gray band indicates the systematic uncertainty.

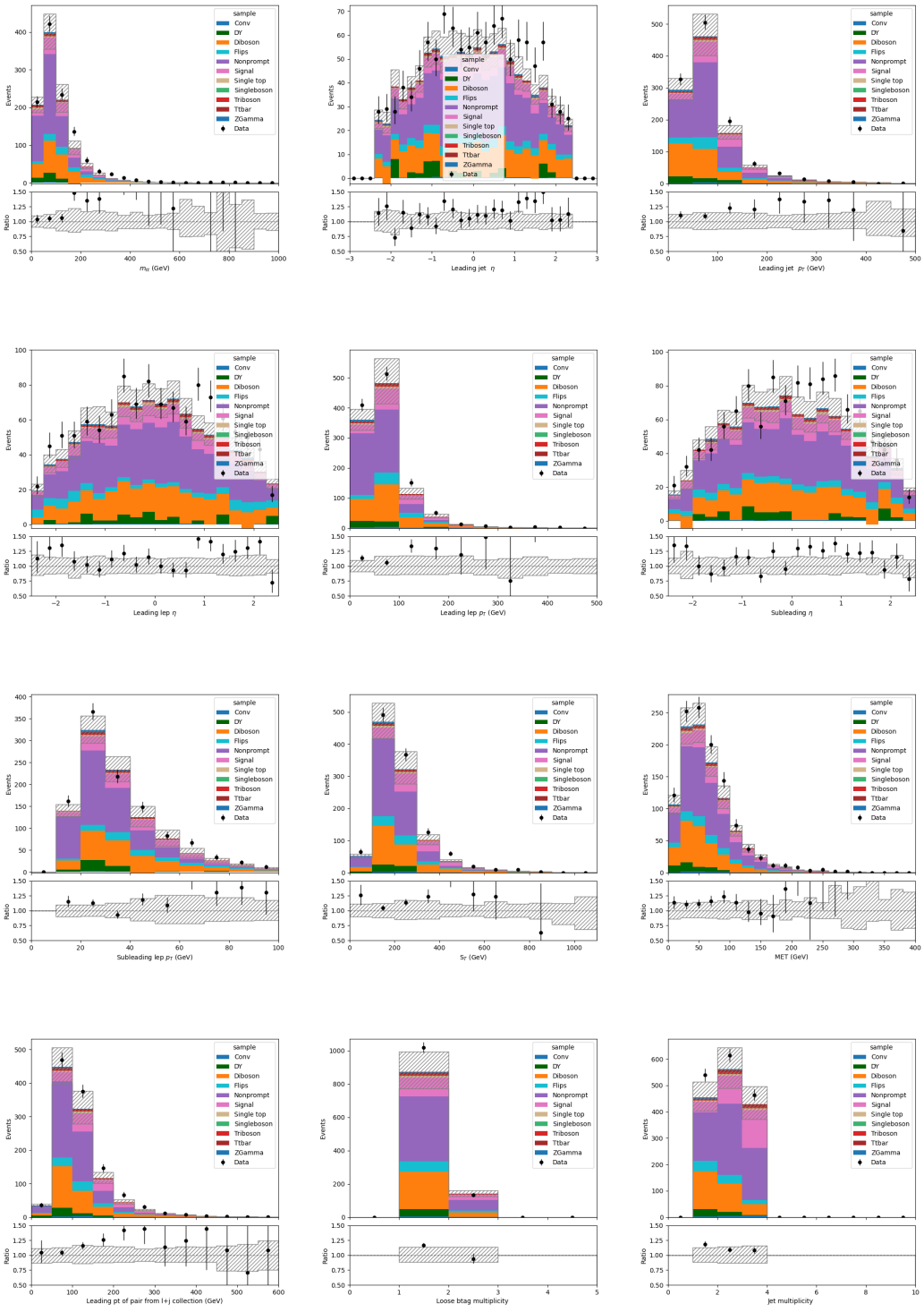

Figure D.4. Control region plots for the 2lss CR (for UL18 samples). The shaded gray band indicates the systematic uncertainty.

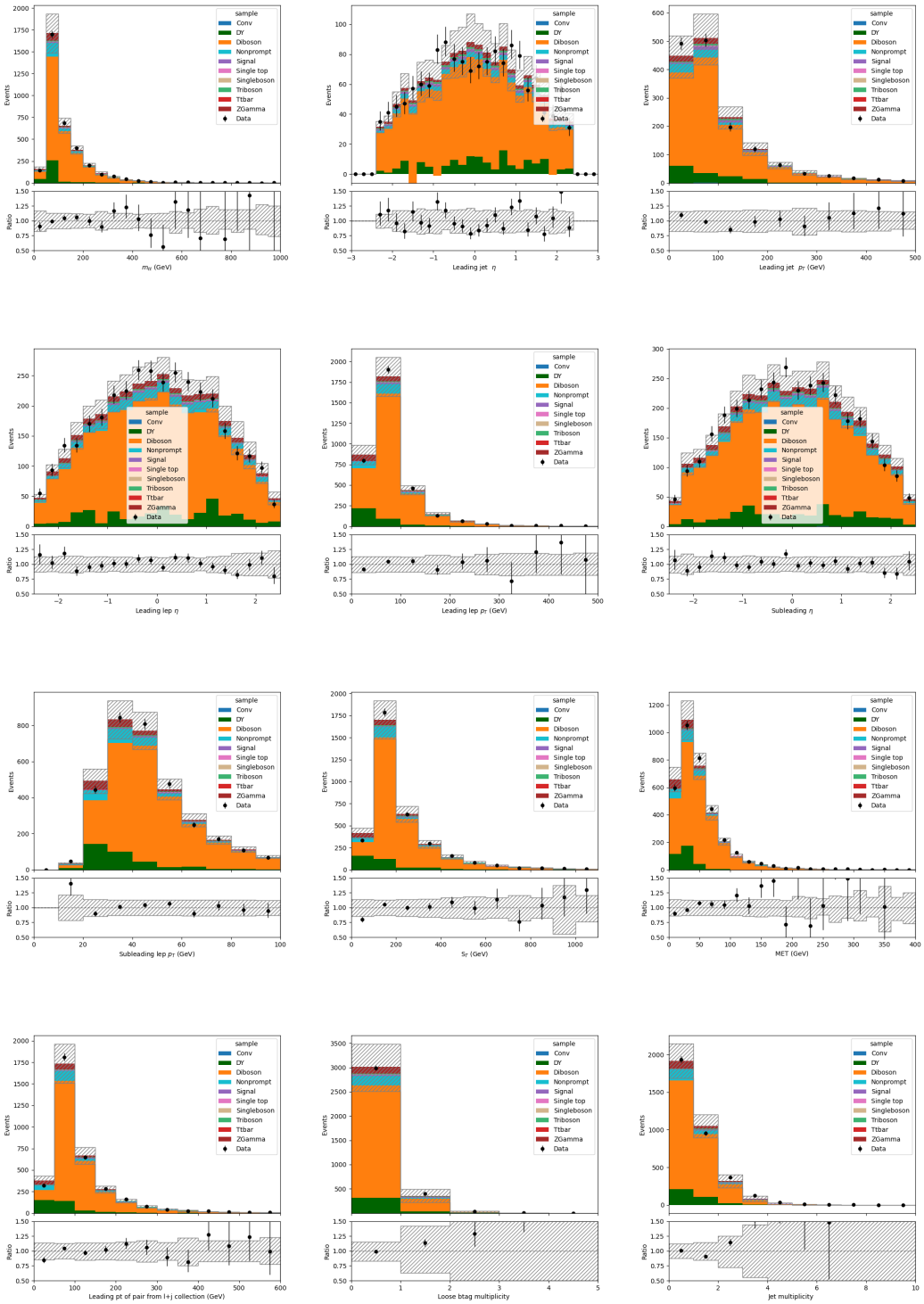

Figure D.5. Control region plots for the 3l CR (for UL16 samples). The shaded gray band indicates the systematic uncertainty.

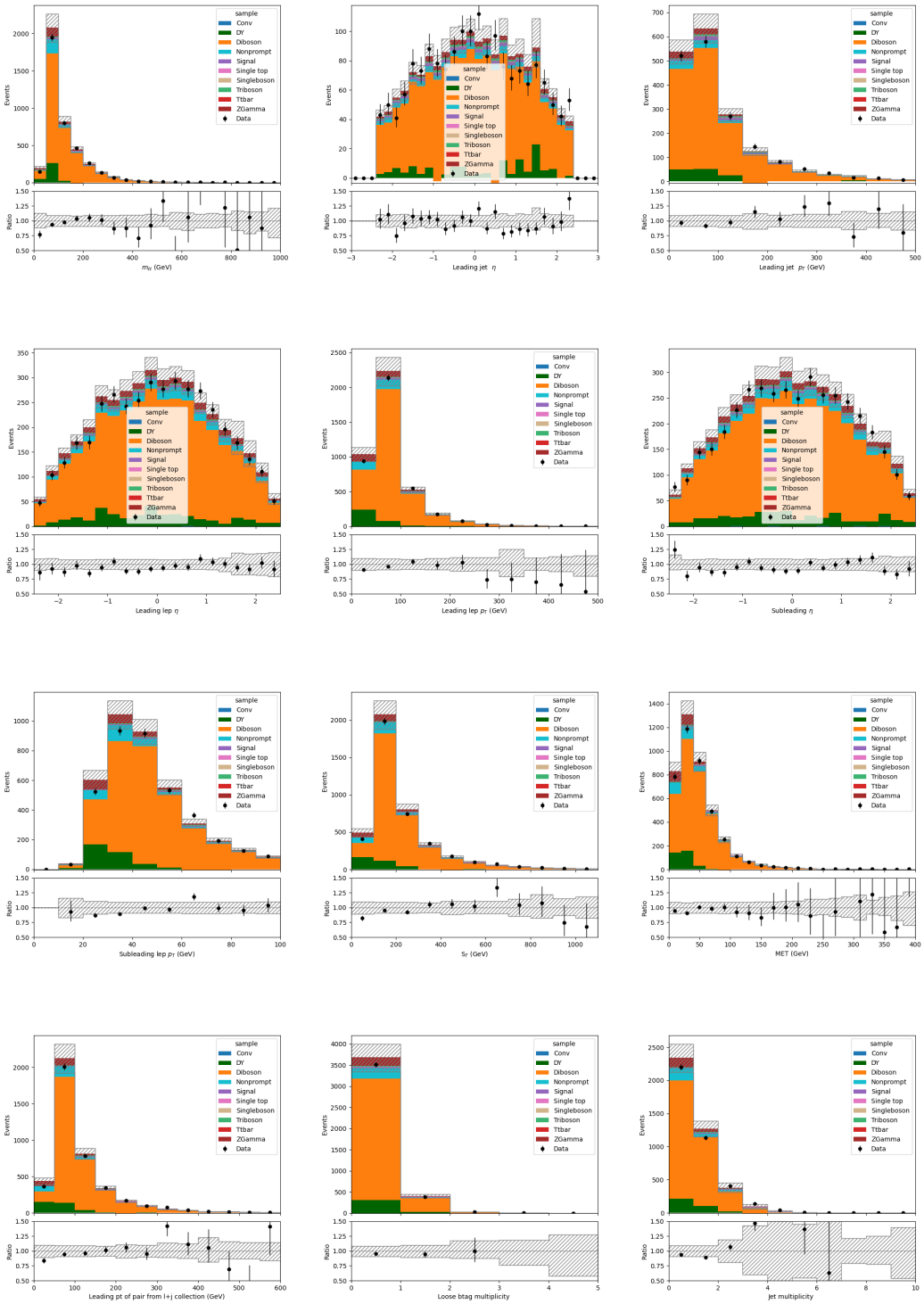

Figure D.6. Control region plots for the 3l CR (for UL16APV samples). The shaded gray band indicates the systematic uncertainty.

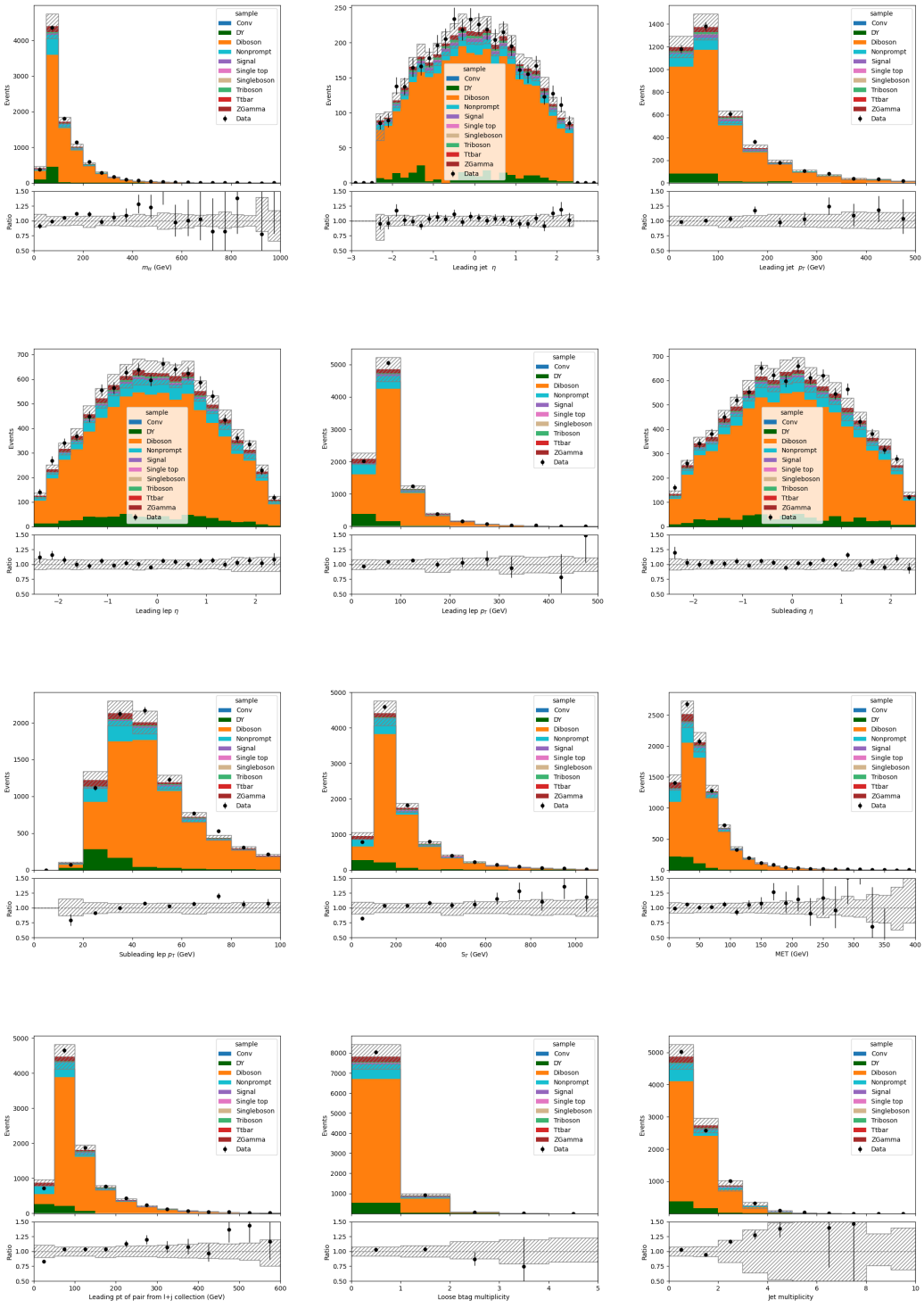

Figure D.7. Control region plots for the 3l CR (for UL17 samples). The shaded gray band indicates the systematic uncertainty.

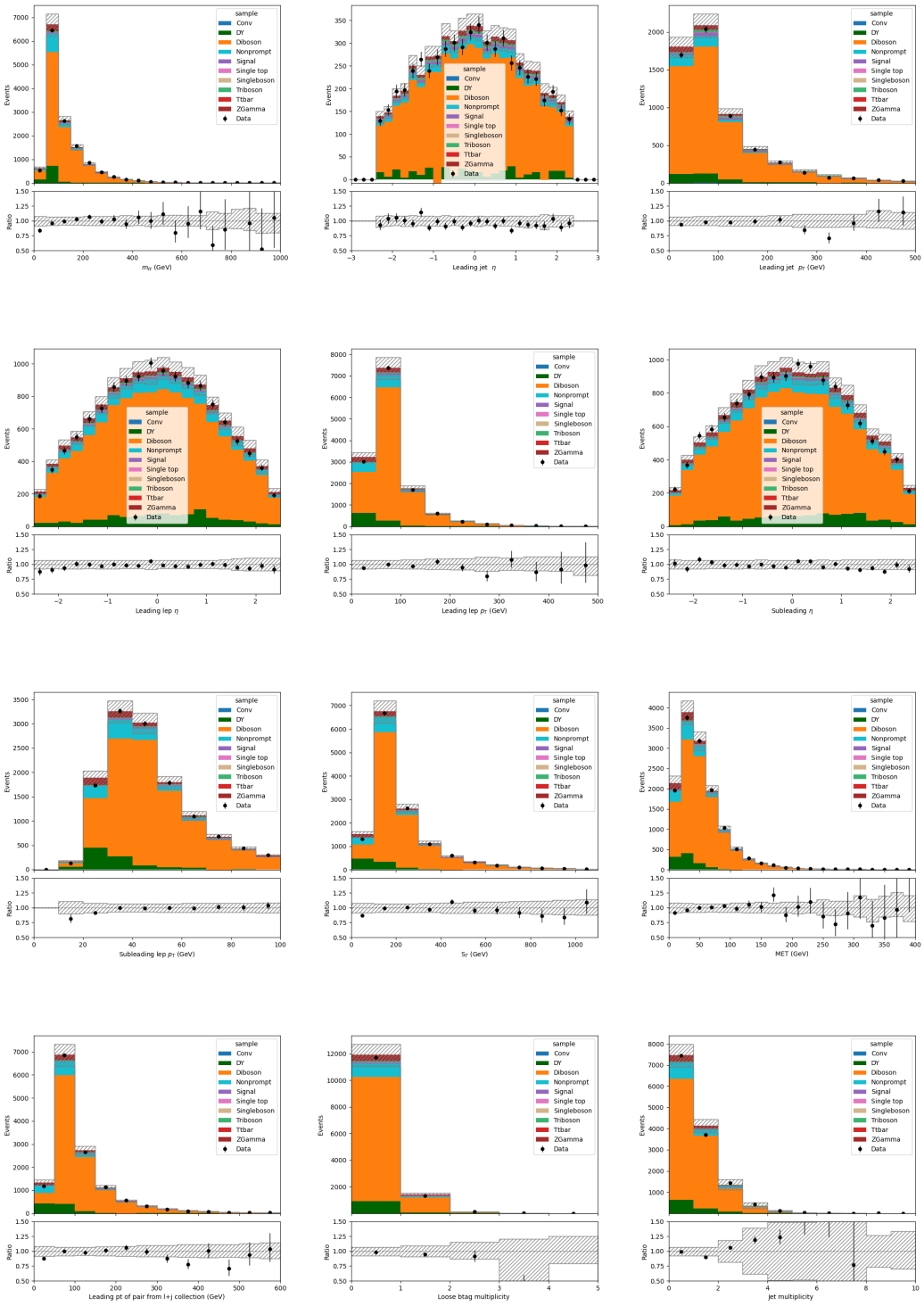

Figure D.8. Control region plots for the 3l CR (for UL18 samples). The shaded gray band indicates the systematic uncertainty.

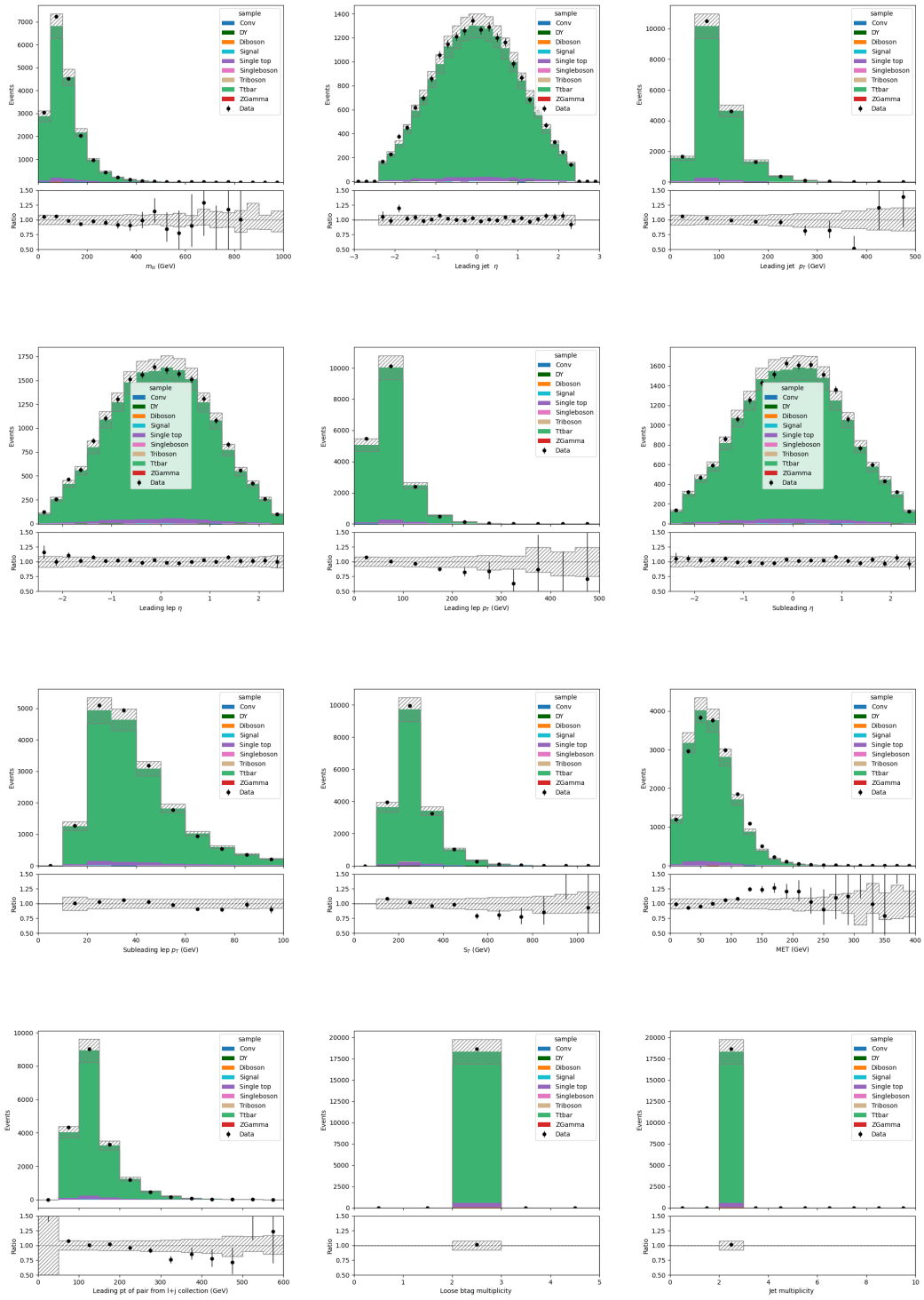

Figure D.9. Control region plots for the 2los $t\bar{t}$ CR (for UL16 samples). The shaded gray band indicates the systematic uncertainty.

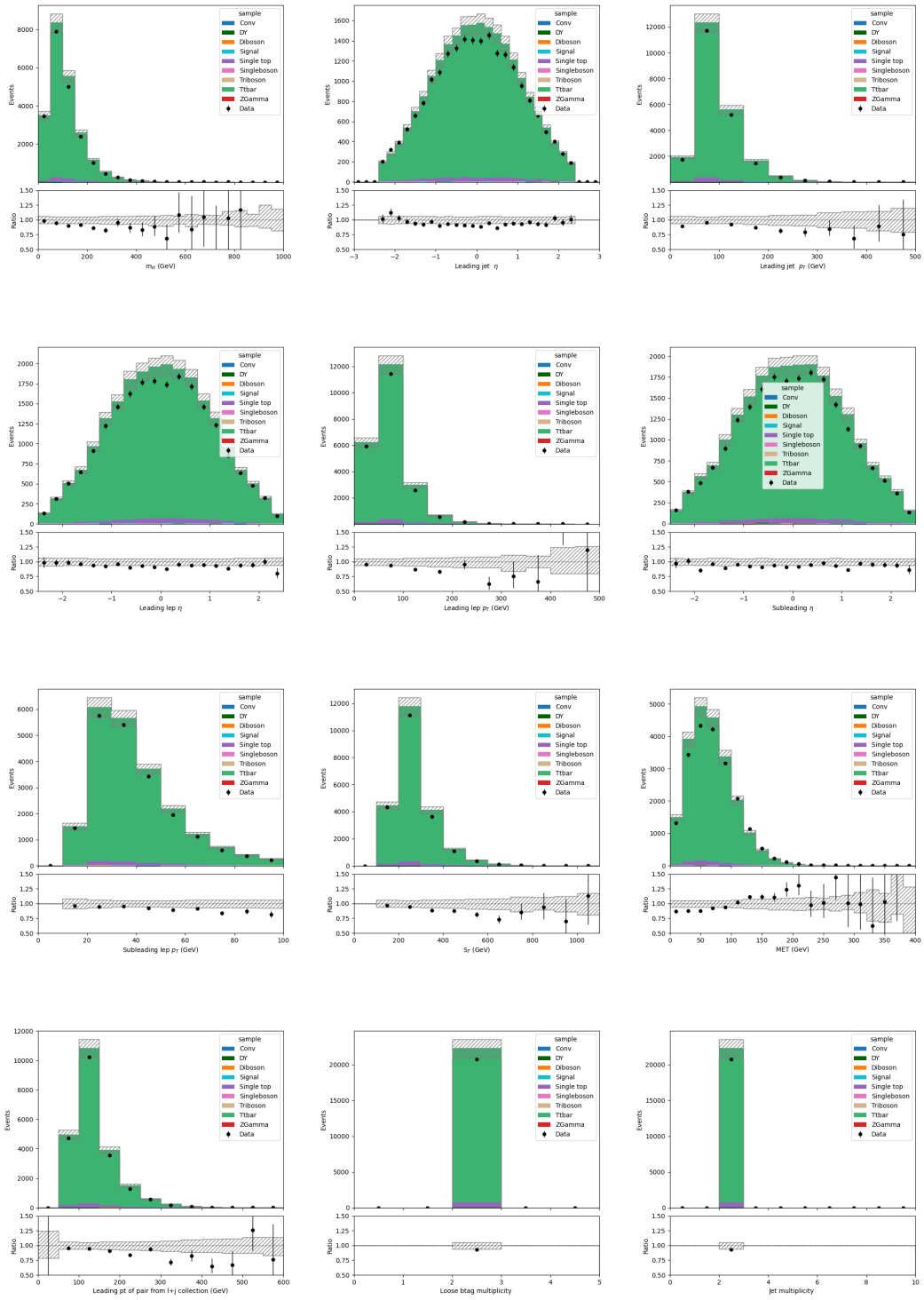

Figure D.10. Control region plots for the 2los $t\bar{t}$ CR (for UL16APV samples). The shaded gray band indicates the systematic uncertainty.

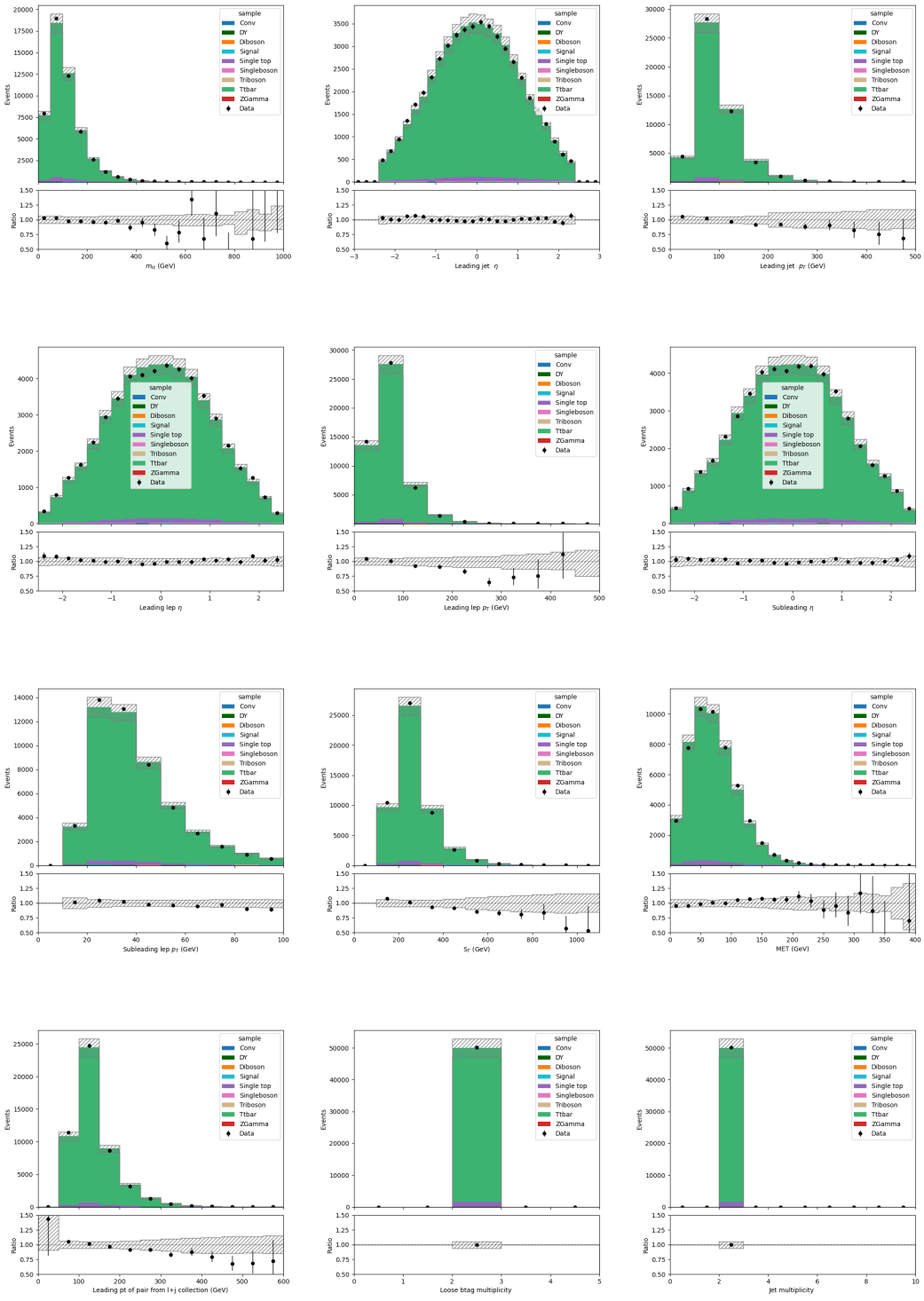

Figure D.11. Control region plots for the 2los $t\bar{t}$ CR (for UL17 samples). The shaded gray band indicates the systematic uncertainty.

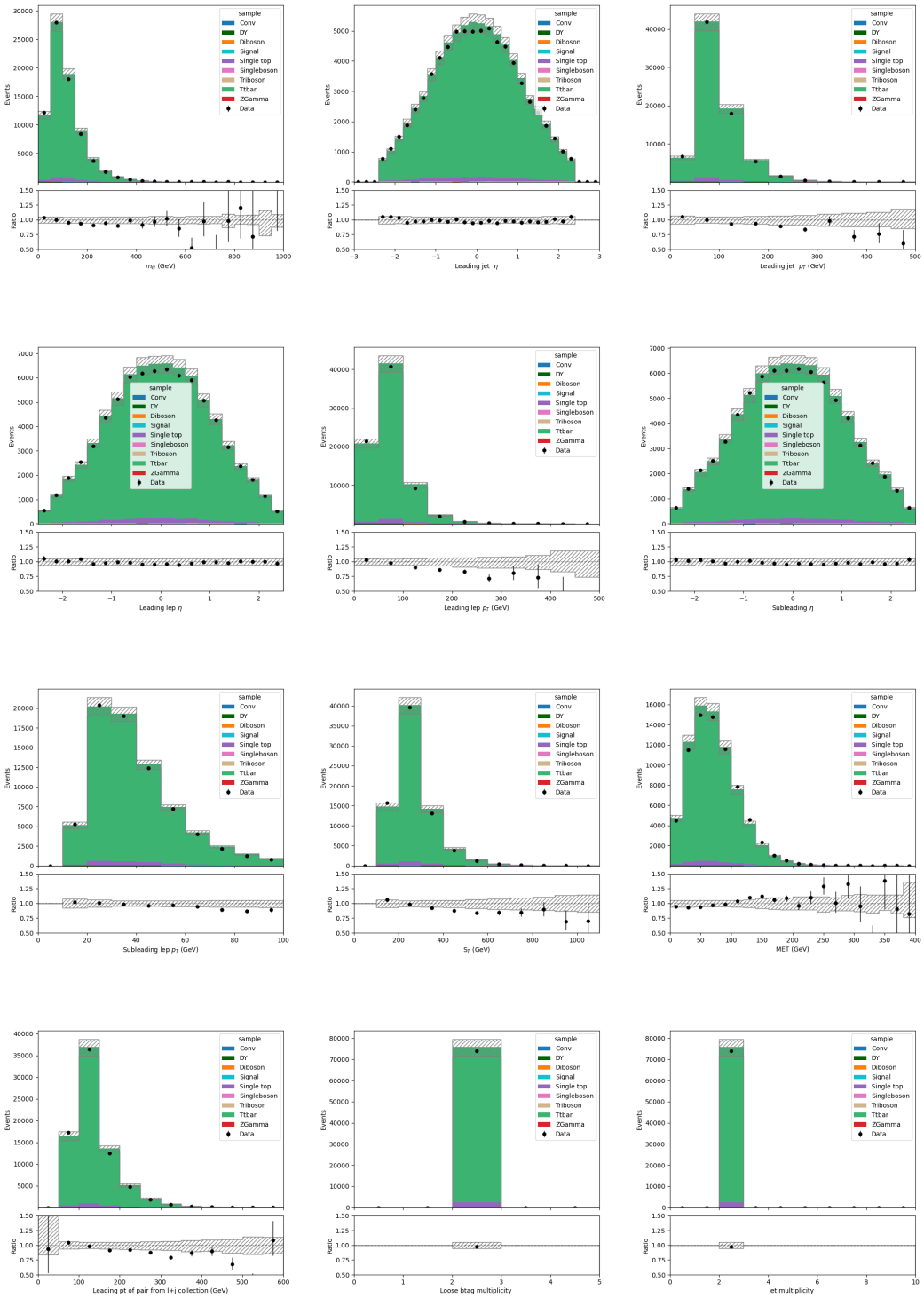

Figure D.12. Control region plots for the 2los $t\bar{t}$ CR (for UL18 samples). The shaded gray band indicates the systematic uncertainty.

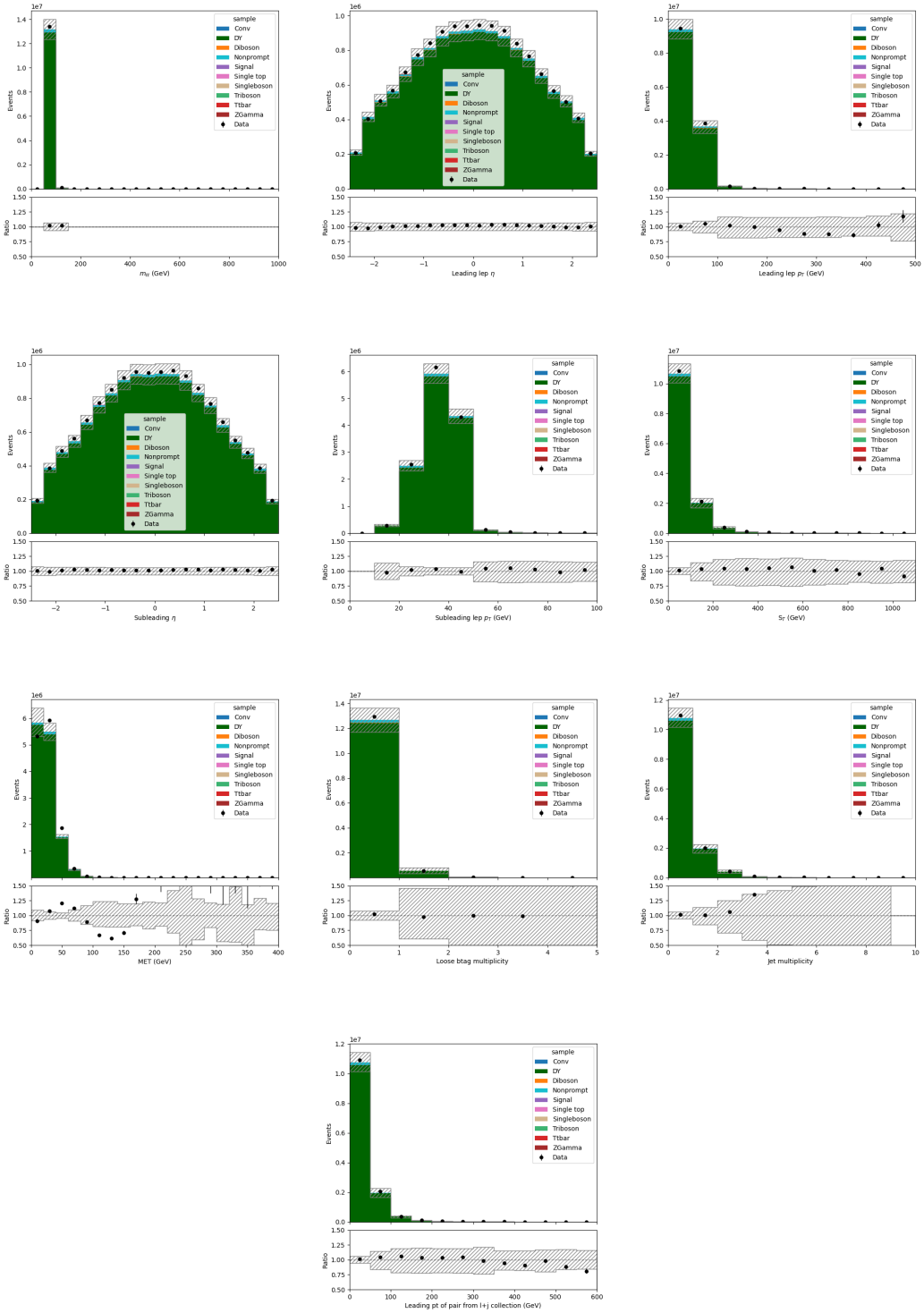

Figure D.13. Control region plots for the 2los Z CR (for UL16 smaples). The shaded gray band indicates the systematic uncertainty.

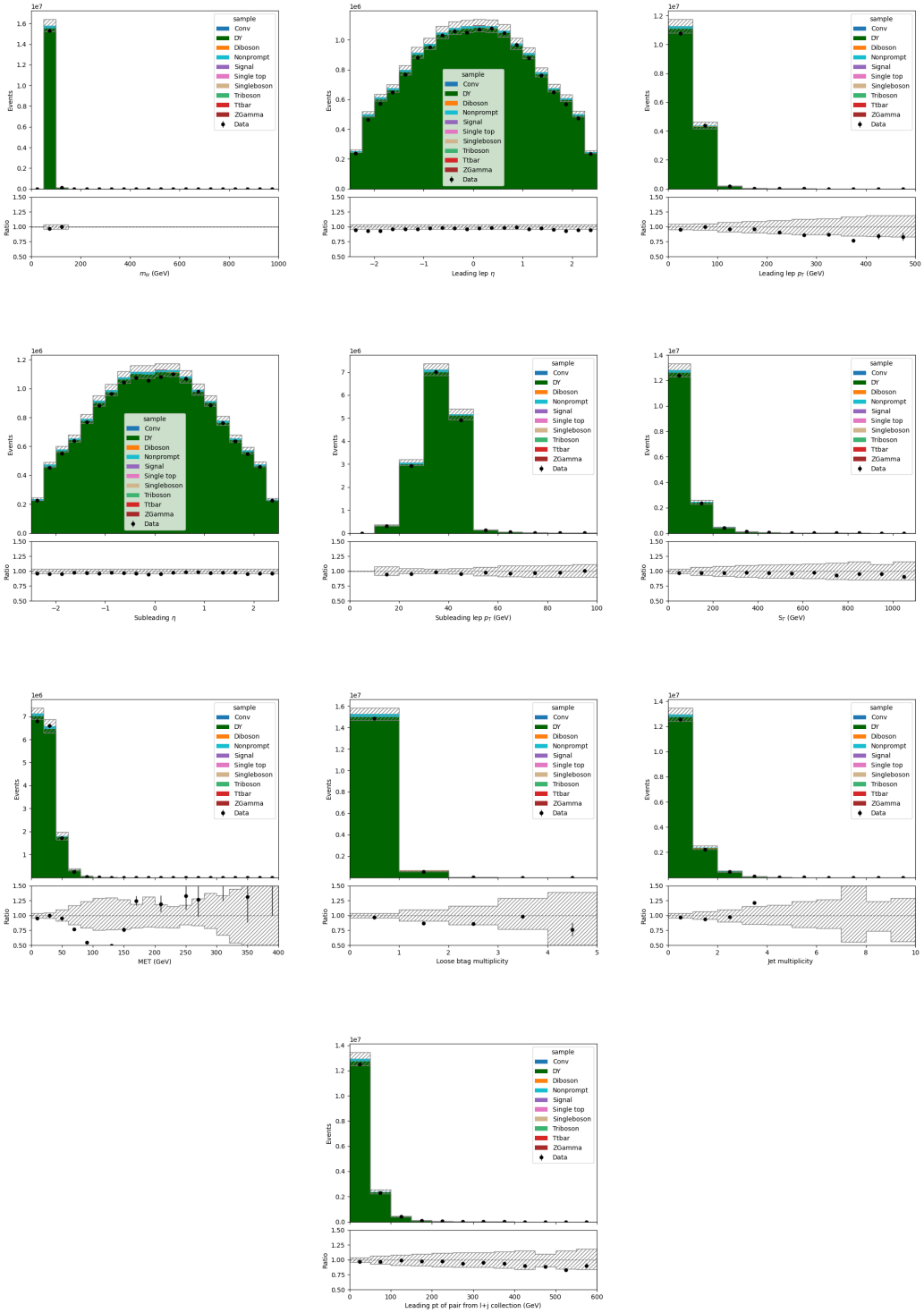

Figure D.14. Control region plots for the 2los Z CR (for UL16APV smaples). The shaded gray band indicates the systematic uncertainty.

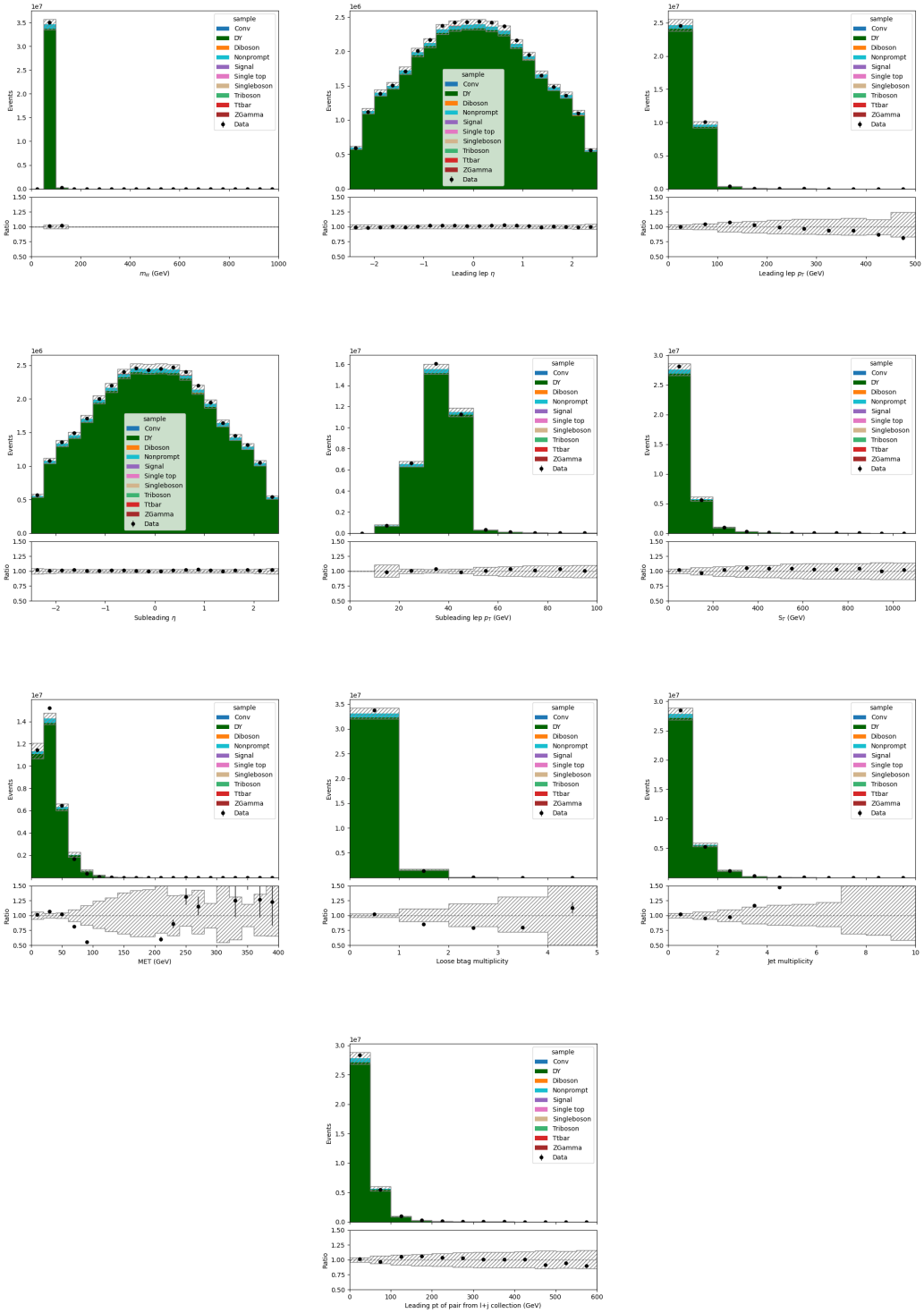

Figure D.15. Control region plots for the 2los Z CR (for UL17 smaples). The shaded gray band indicates the systematic uncertainty.

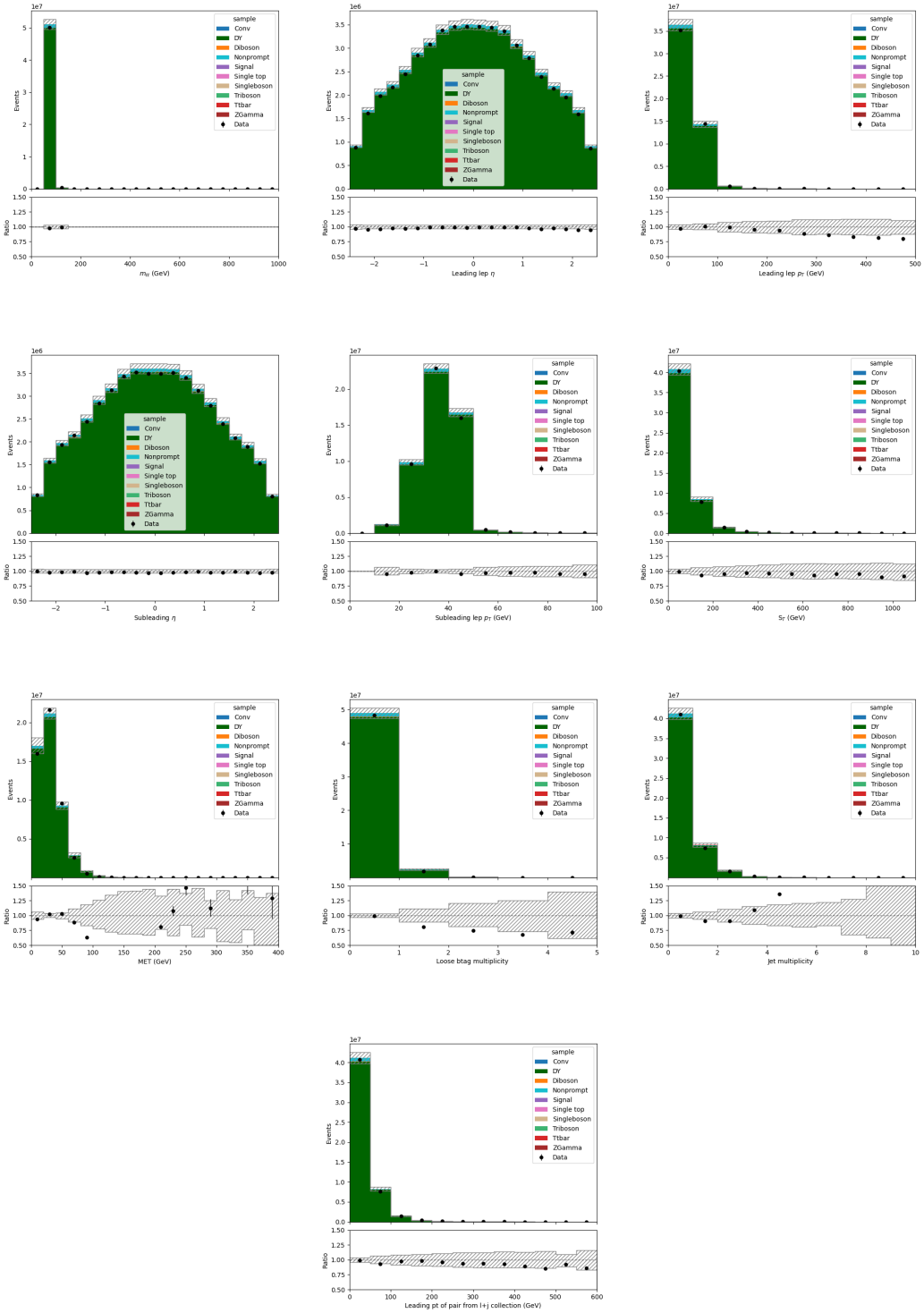

Figure D.16. Control region plots for the 2los Z CR (for UL18 smaples). The shaded gray band indicates the systematic uncertainty.

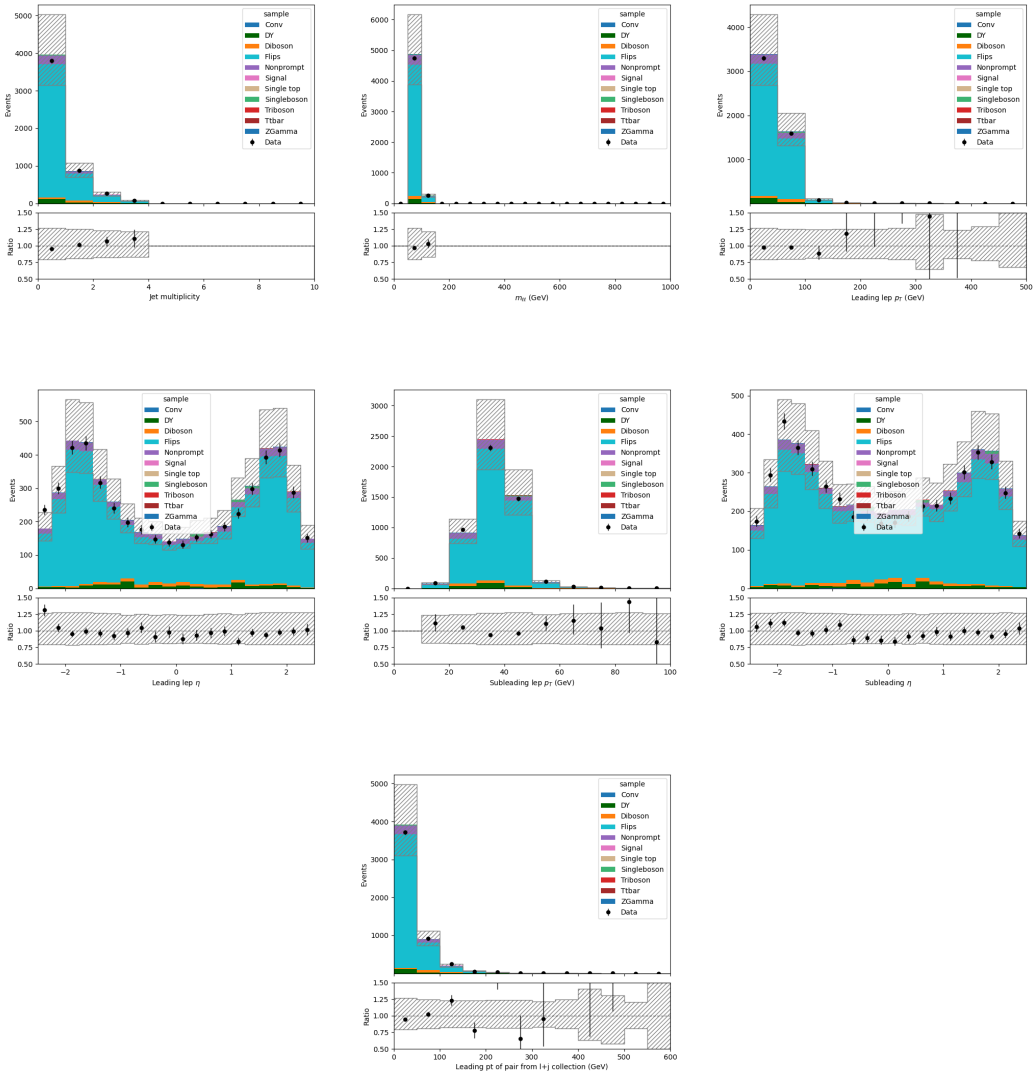

Figure D.17. Charge flip control regions for the UL16 samples after applying the scaling factors listed in 8.1. The shaded gray band indicates the systematic uncertainty.

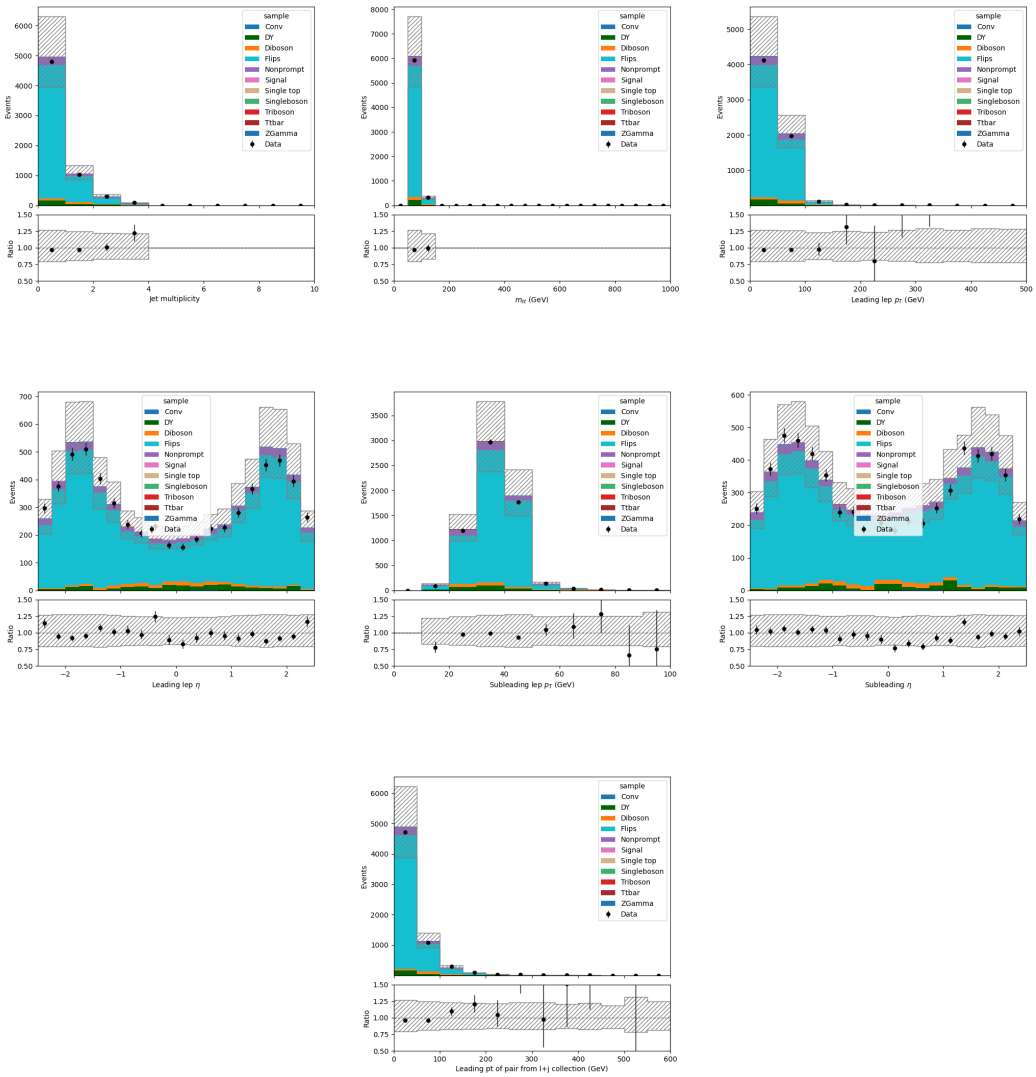

Figure D.18. Charge flip control regions for the UL16APV samples after applying the scaling factors listed in 8.1. The shaded gray band indicates the systematic uncertainty.

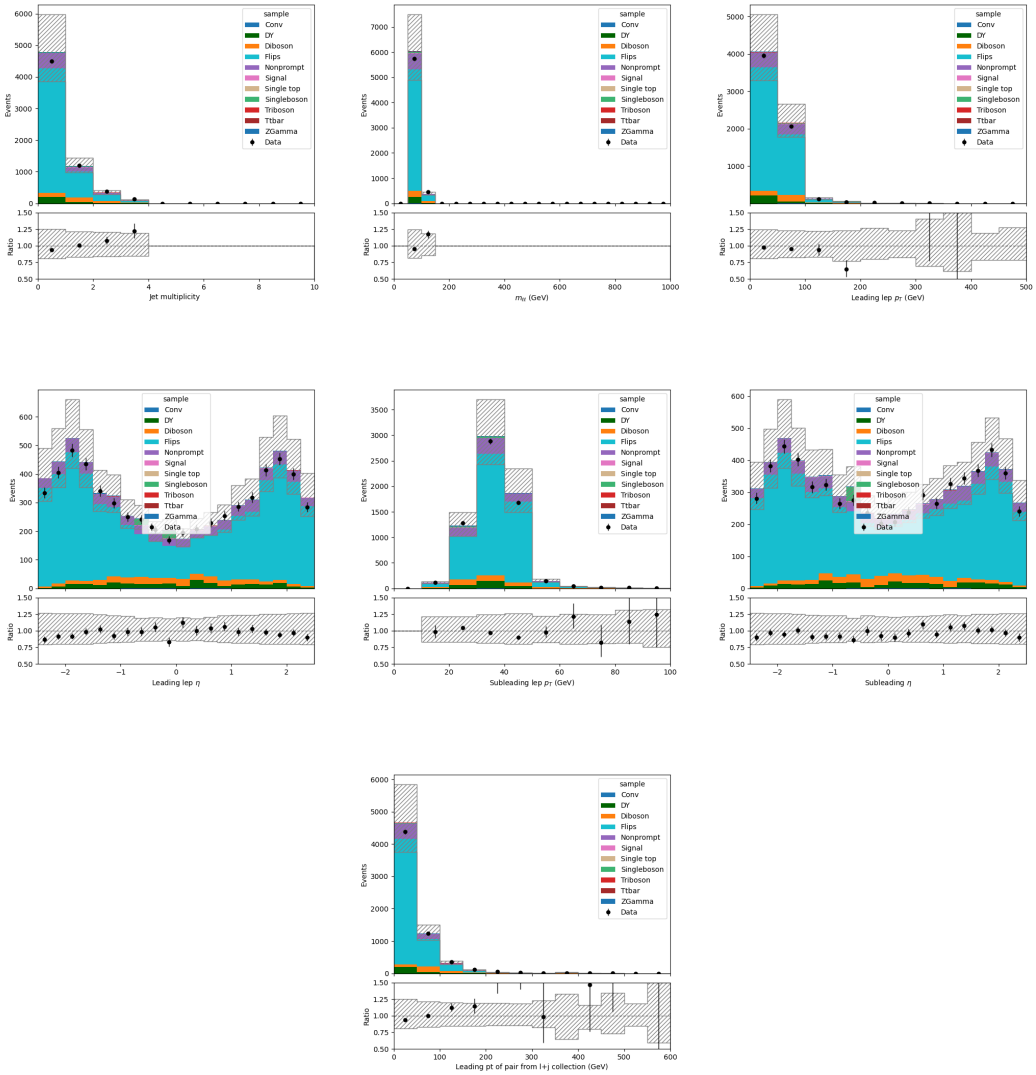

Figure D.19. Charge flip control regions for the UL17 samples after applying the scaling factors listed in 8.1. The shaded gray band indicates the systematic uncertainty.

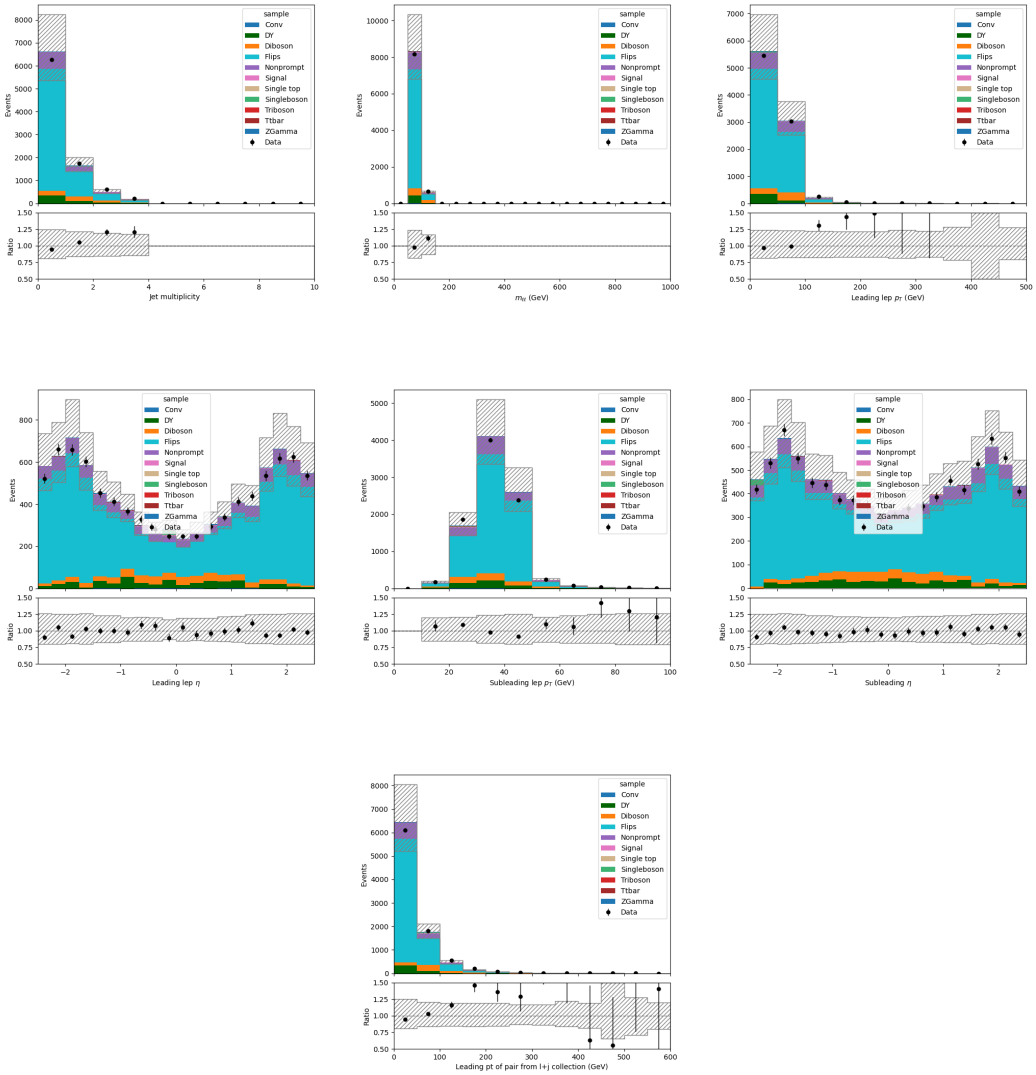

Figure D.20. Charge flip control regions for the UL18 samples after applying the scaling factors listed in 8.1. The shaded gray band indicates the systematic uncertainty.