1 Supplementary material for LHCB-PAPER-2022-039

1.1 Nominal fit

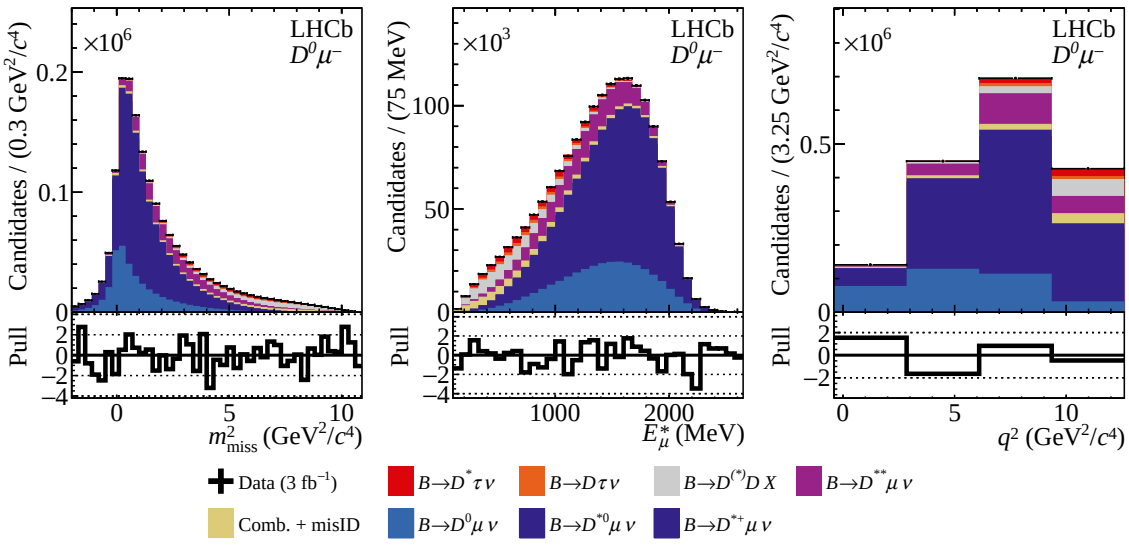

Figure 1: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ signal region.

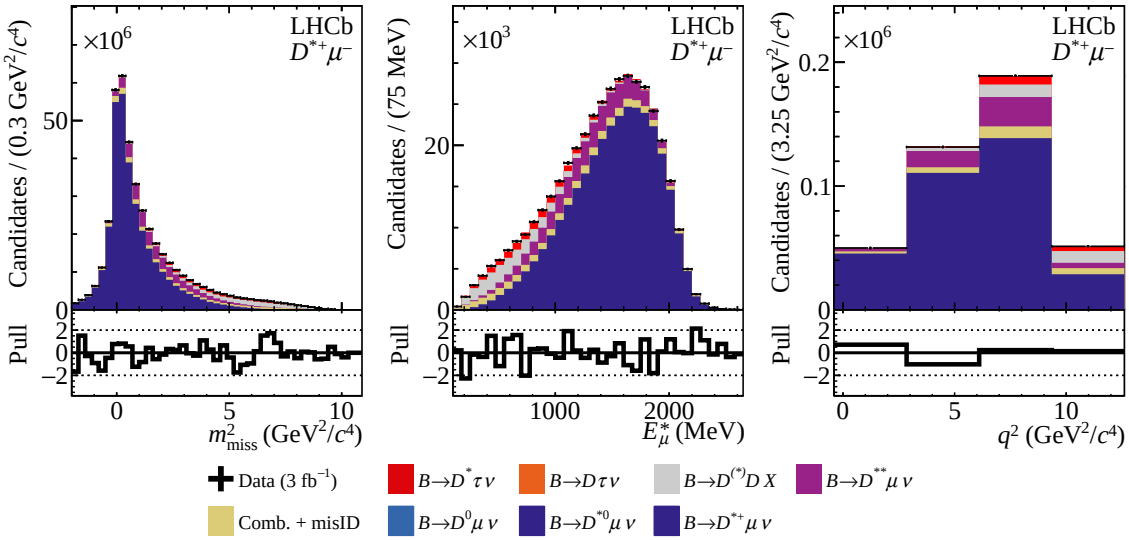

Figure 2: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^*\mu^-$ signal region.

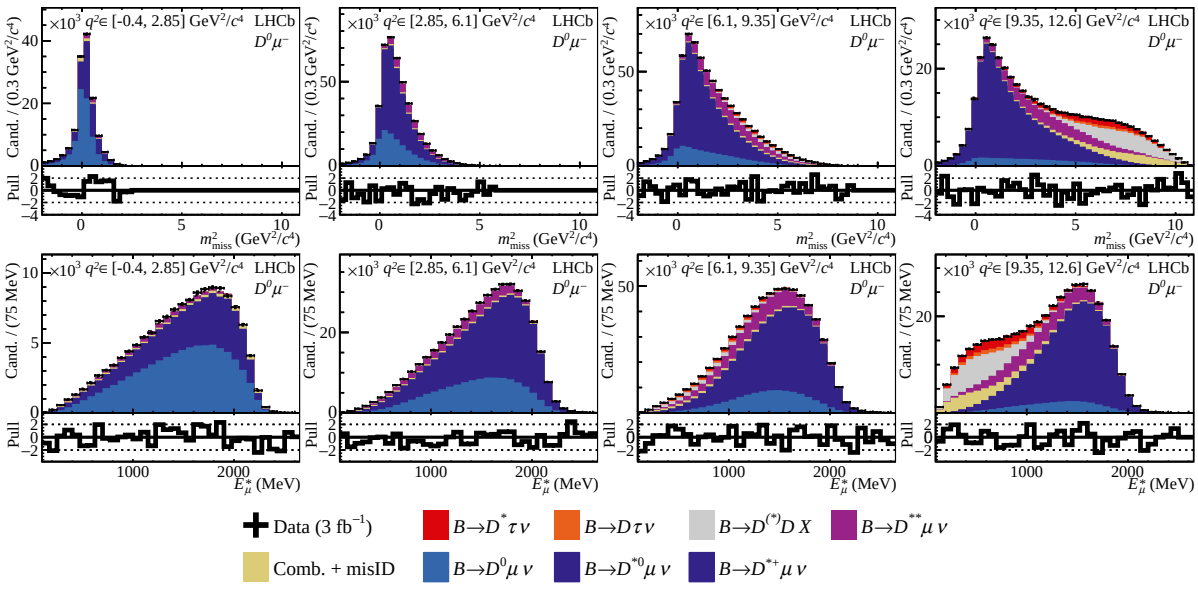

Figure 3: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ signal region, in the four bins of q^2.

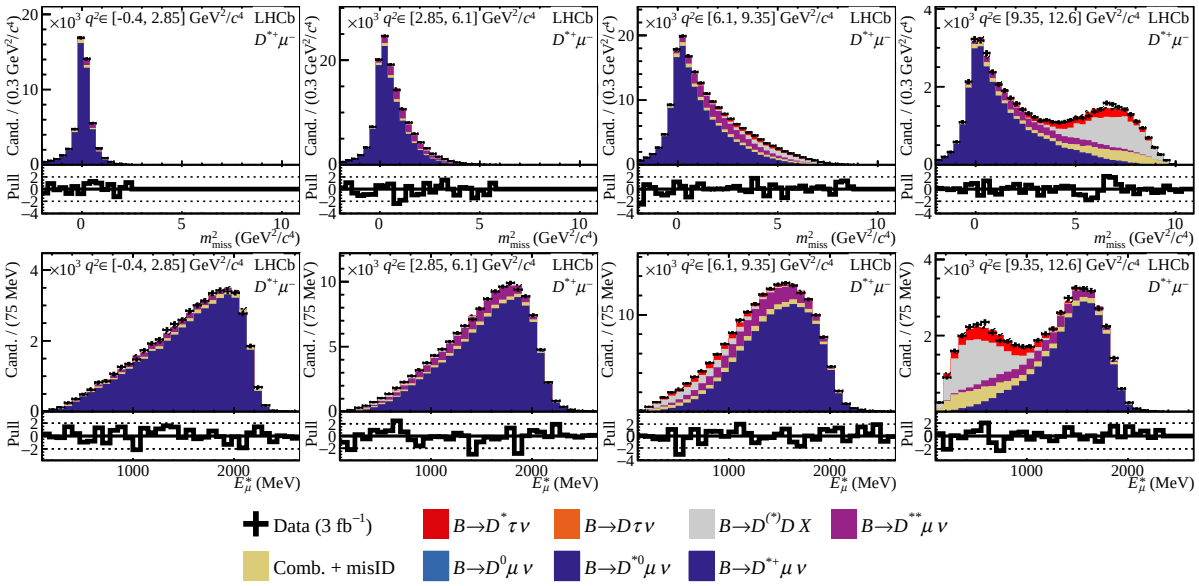

Figure 4: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^{*+}\mu^-$ signal region, in the four bins of q^2.

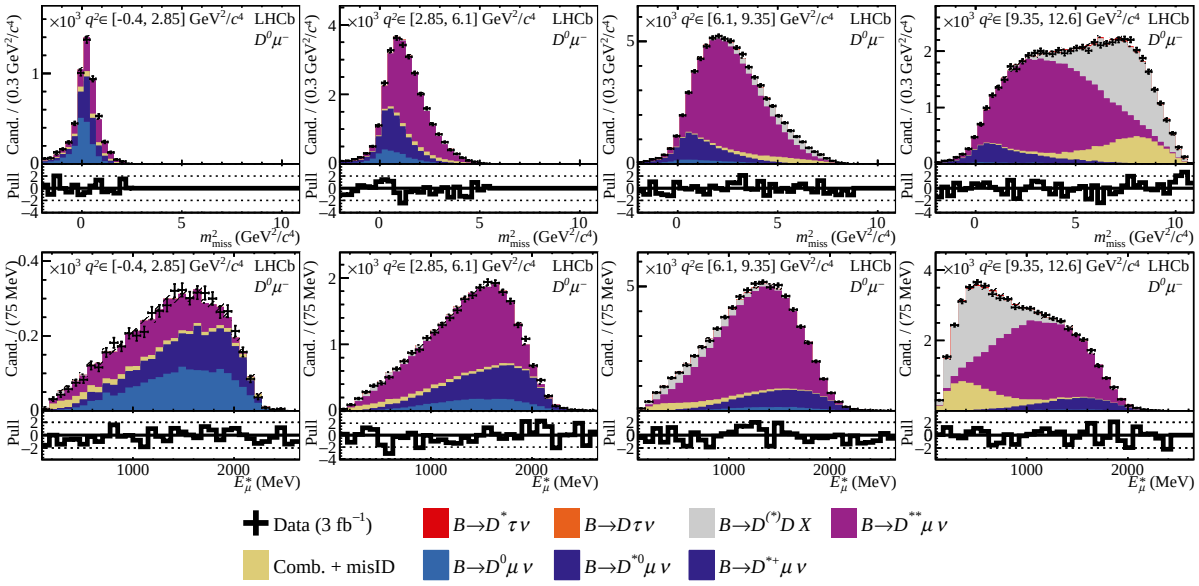

Figure 5: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ with exactly one extra pion consistent with the B vertex, in the four bins of q^2.

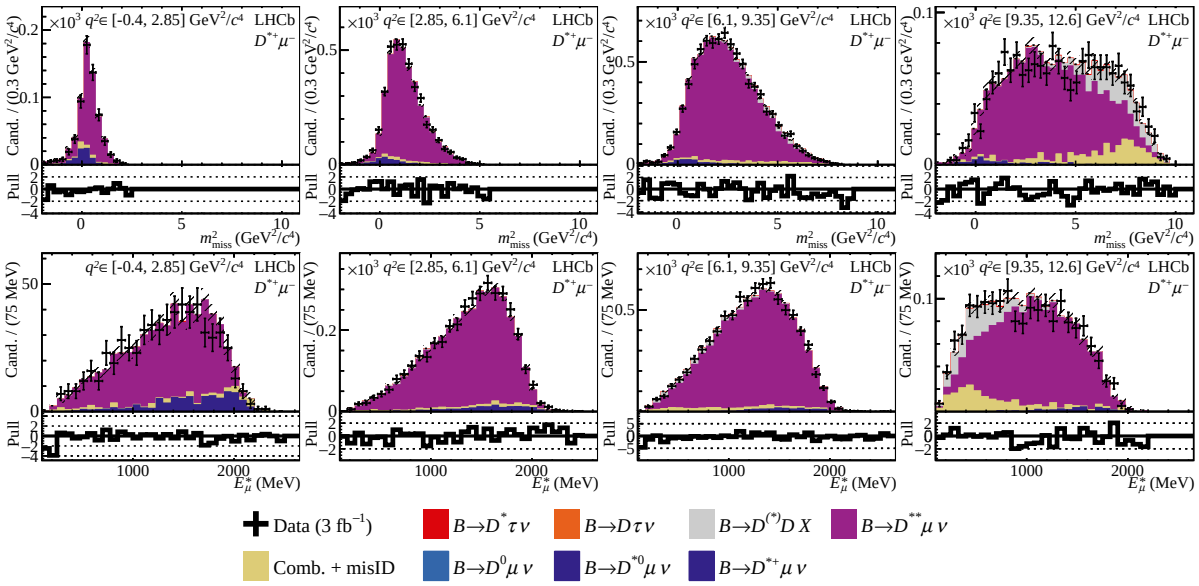

Figure 6: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^{*+}\mu^-$ with exactly one extra pion consistent with the B vertex, in the four bins of q^2.

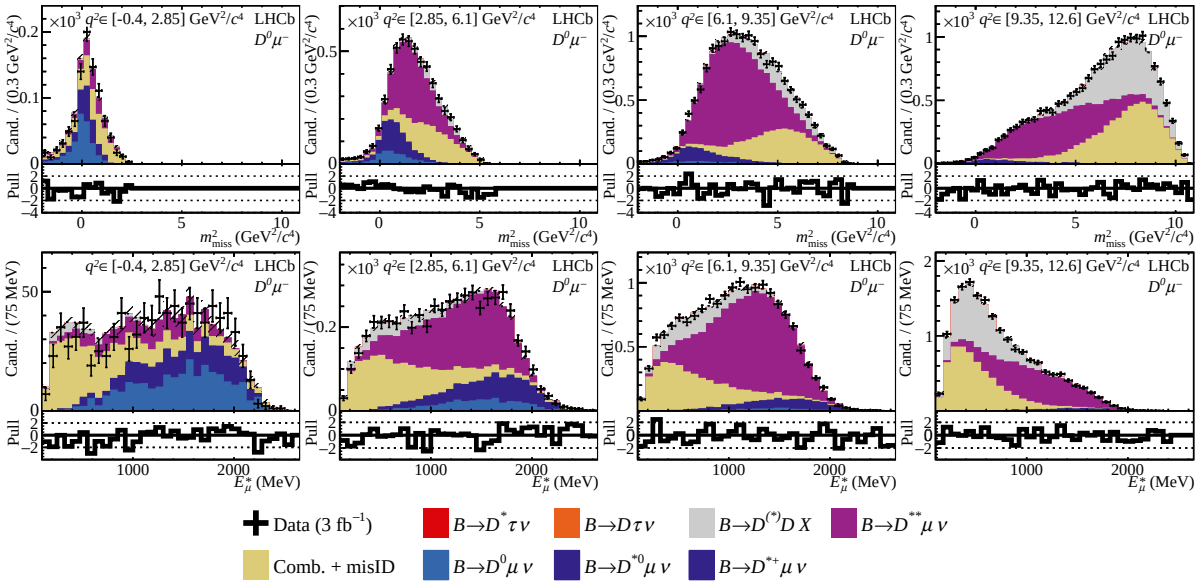

Figure 7: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with exactly two extra opposite-sign pions consistent with the B vertex, in the four bins of q^2.

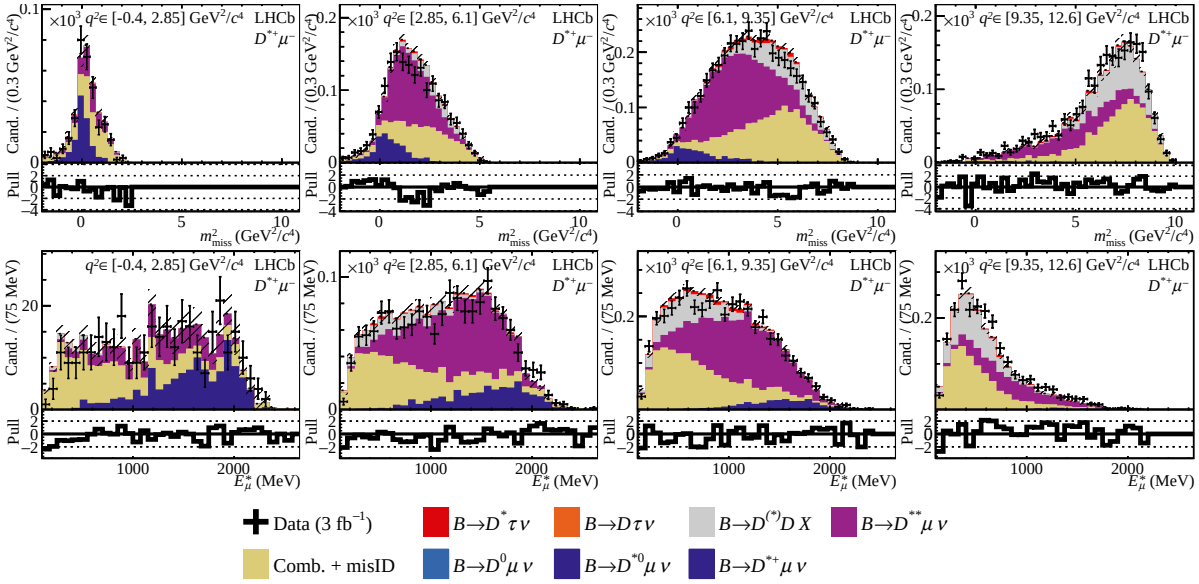

Figure 8: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^{*+}\mu^-$ region with exactly two extra opposite-sign pions consistent with the B vertex, in the four bins of q^2.

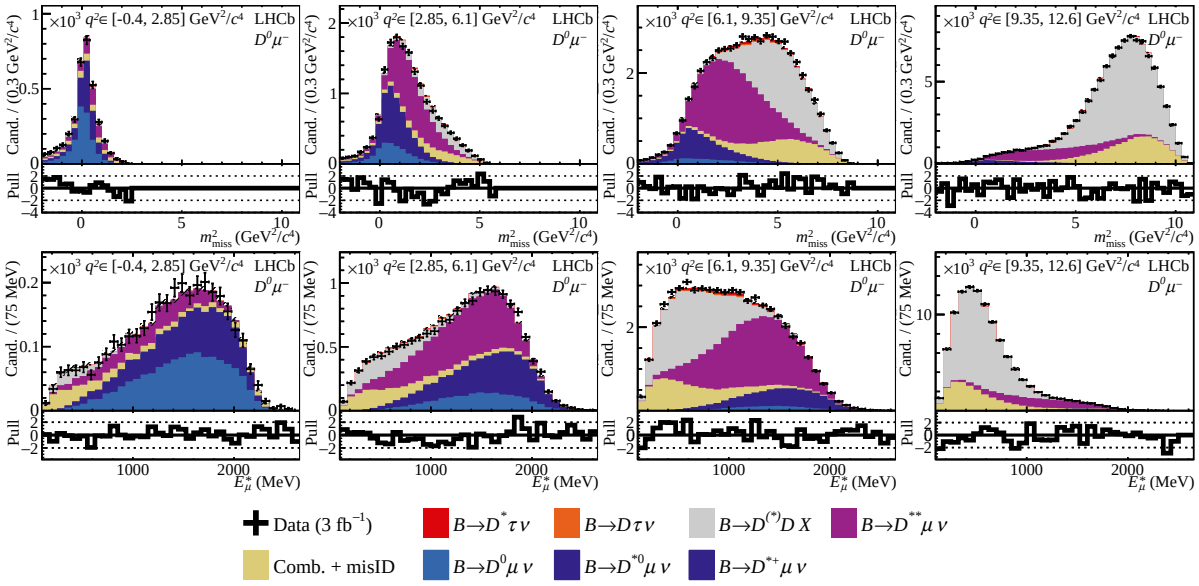

Figure 9: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with at least one kaon of either sign and no restrictions on the number of additional tracks consistent with the B vertex, in the four bins of q^2.

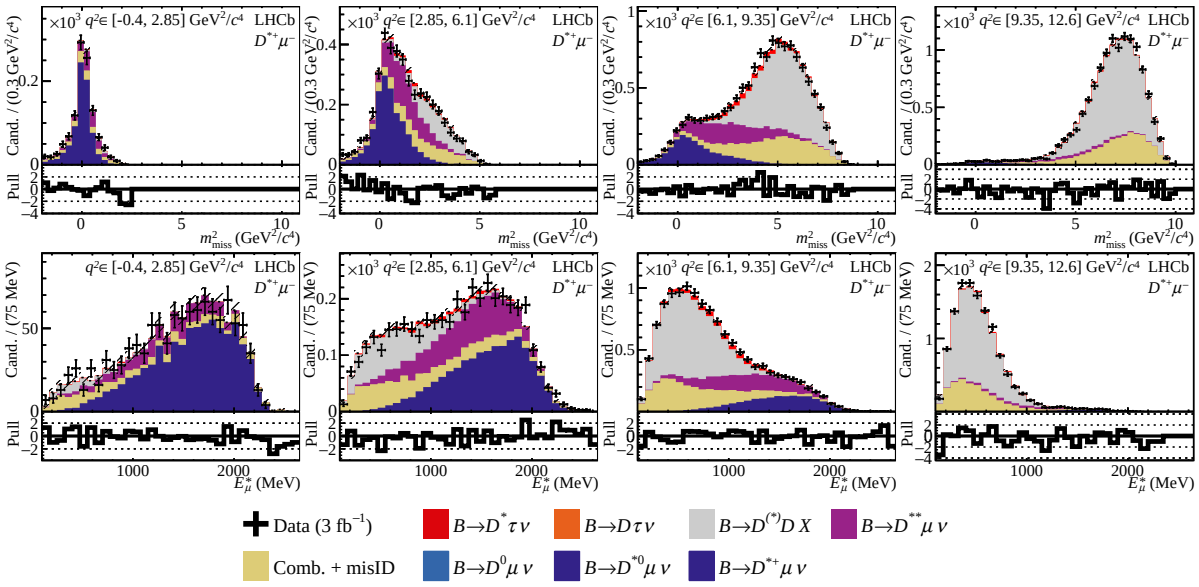

Figure 10: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^{*+}\mu^-$ region with at least one kaon of either sign and no restrictions on the number of additional tracks consistent with the B vertex, in the four bins of q^2.

1.2 Additional fit validation regions

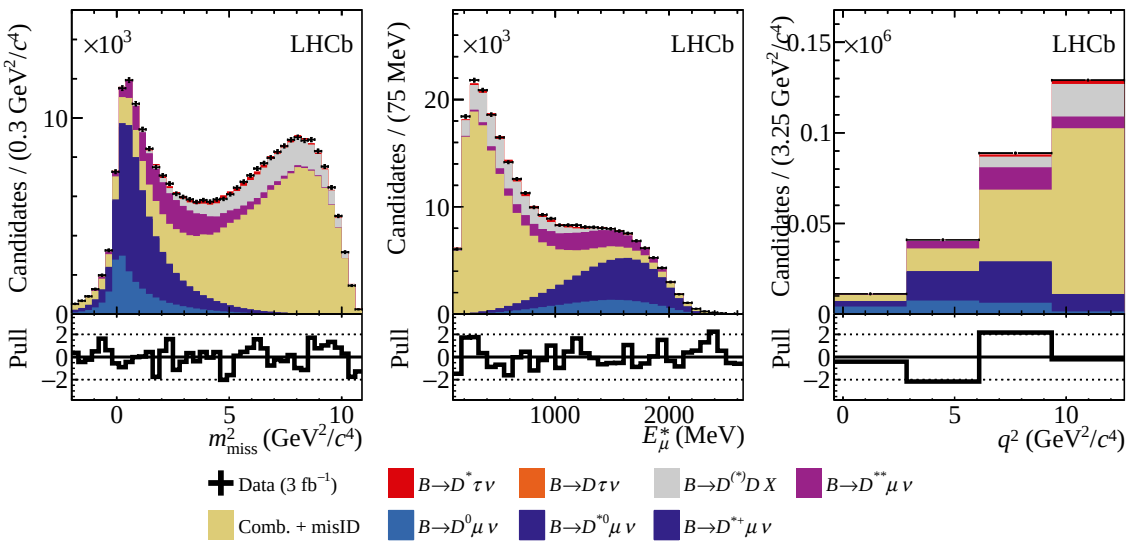

Figure 11: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region which fails the custom muon ID requirement.

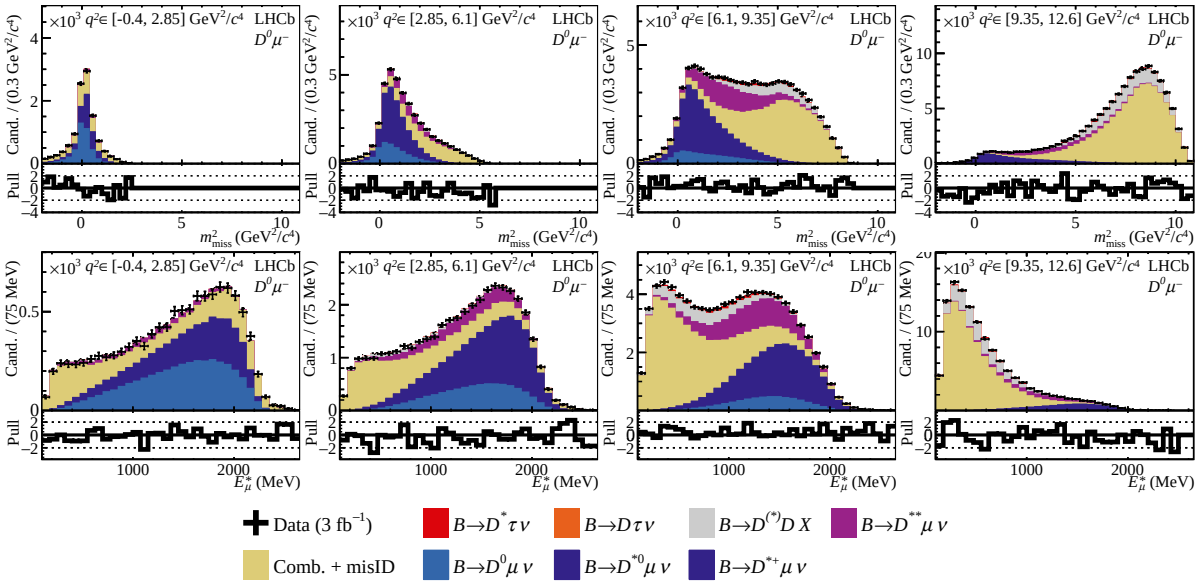

Figure 12: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region which fails the custom muon ID requirement, in the four bins of q^2.

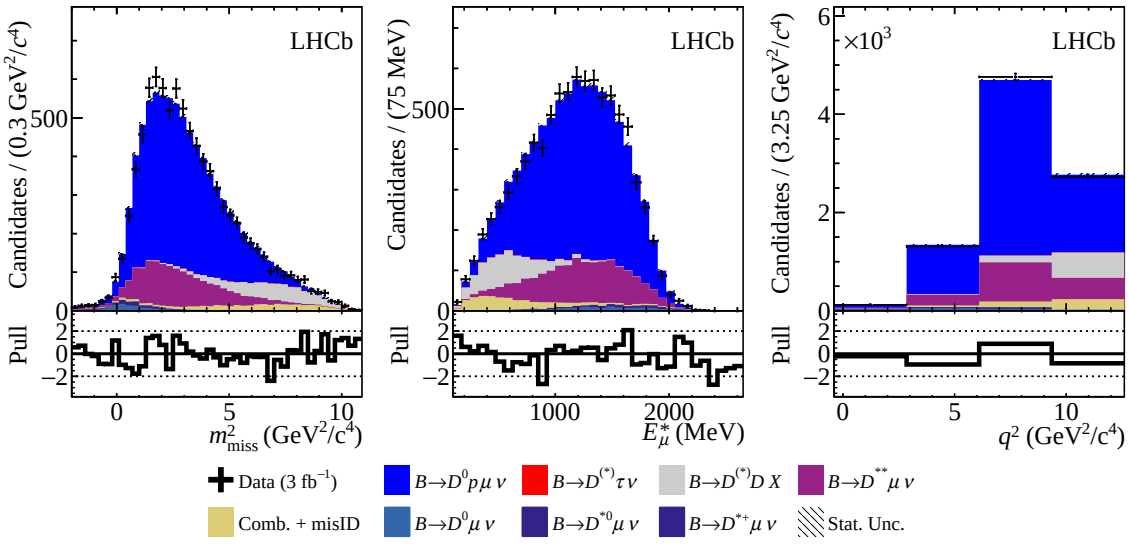

Figure 13: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with exactly one proton consistent with the B vertex. This fit includes the duplicated D^{**} components, collectively labelled as $B \to D^0 p\mu\nu$. The label stat. unc. refers to the statistical uncertainty on the fitted sum of templates.

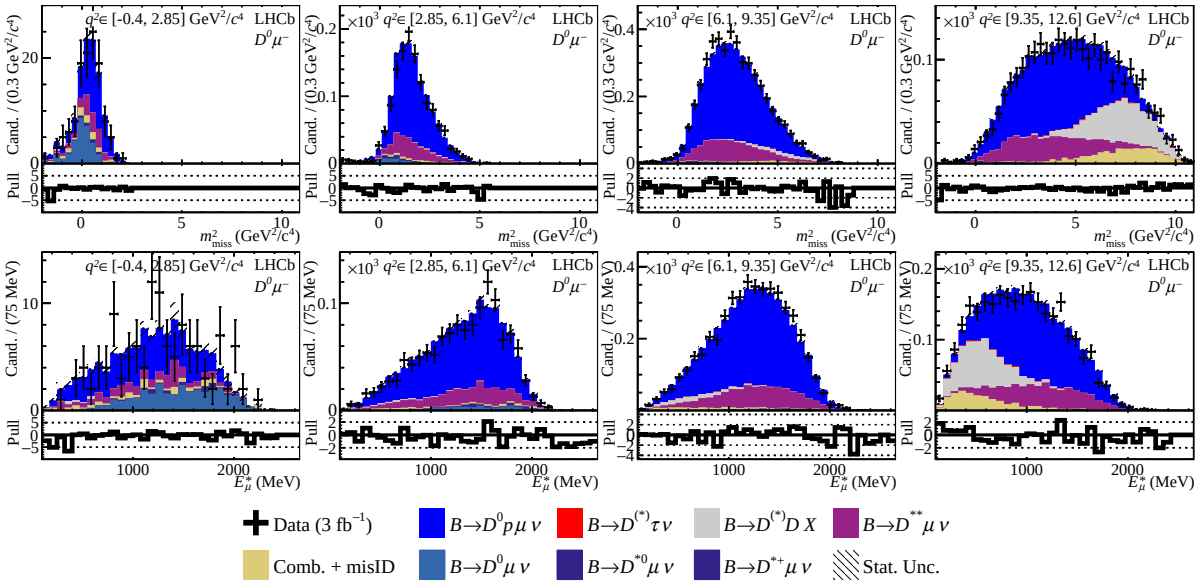

Figure 14: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with exactly one proton consistent with the B vertex, in the four bins of q^2. This fit includes the duplicated D^{**} components, collectively labelled as $B \to D^0 p\mu\nu$. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

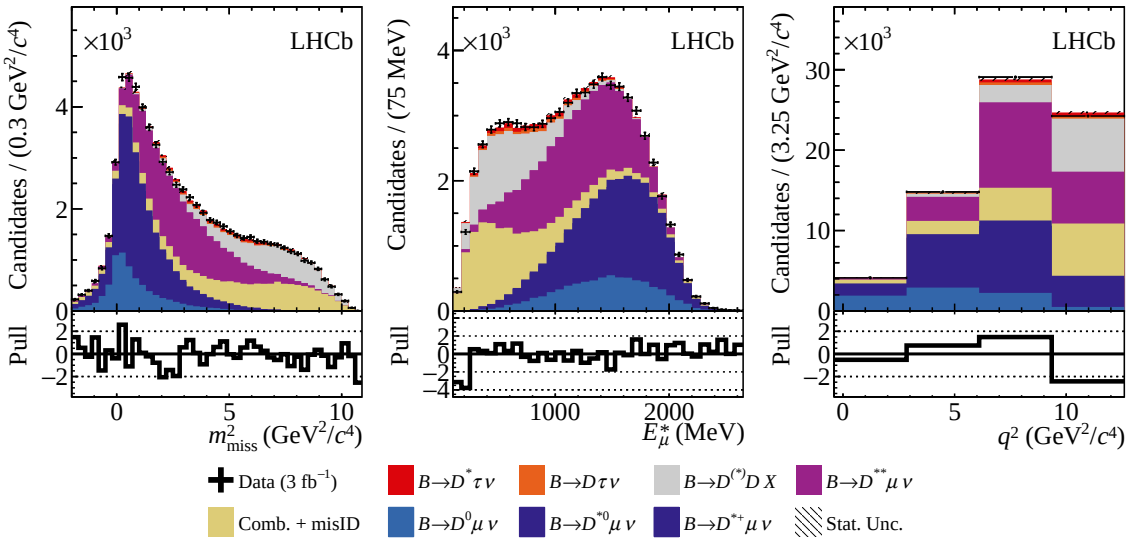

Figure 15: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with one extra pion with identical charge to the muon consistent with the B vertex. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

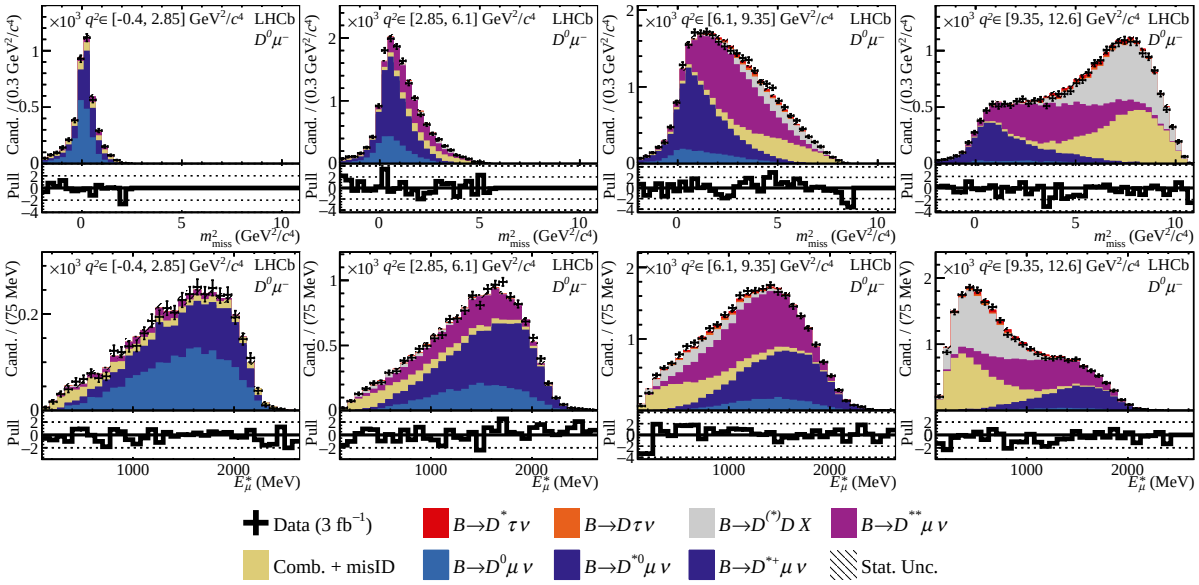

Figure 16: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with one extra pion with identical charge to the muon consistent with the B vertex, in the four bins of q^2. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

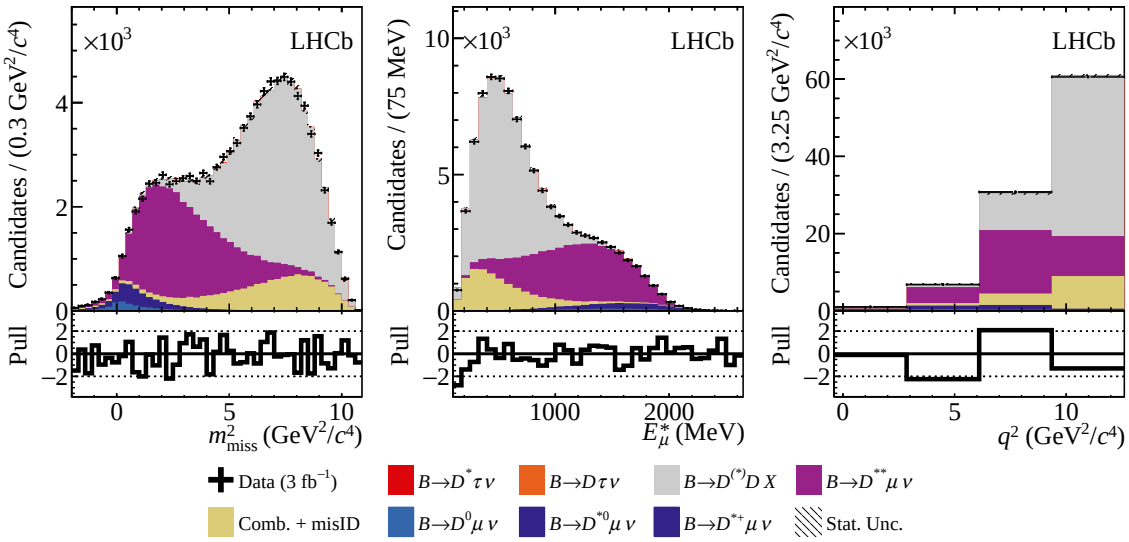

Figure 17: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with at least one kaon of opposite charge to the muon, and no restrictions on the number of additional tracks consistent with the B vertex. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

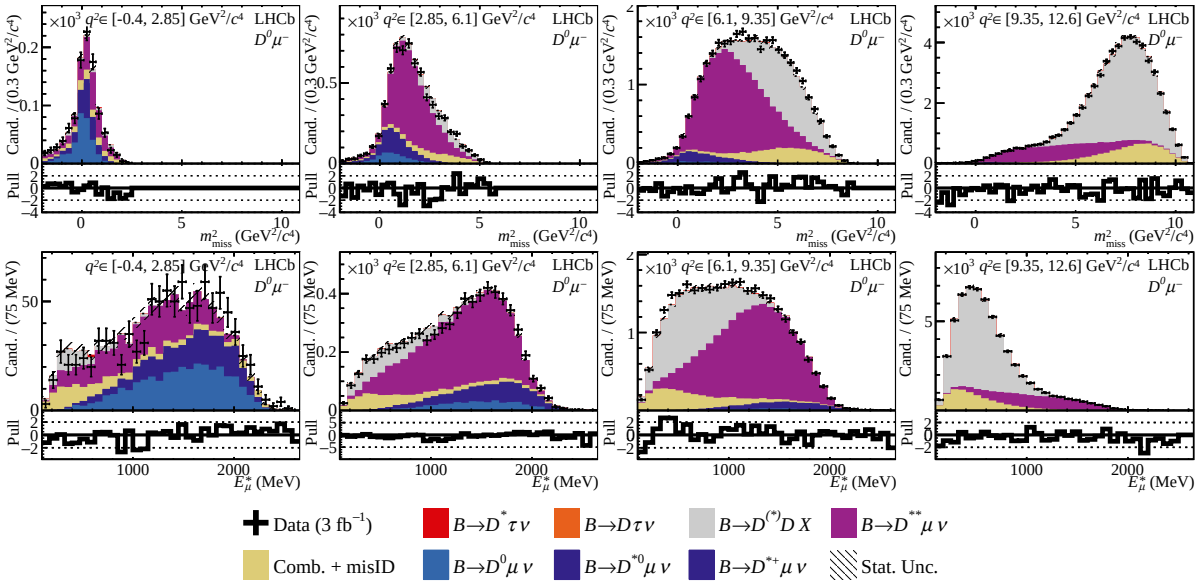

Figure 18: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with at least one kaon of opposite charge to the muon, and no restrictions on the number of additional tracks consistent with the B vertex, in the four bins of q^2. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

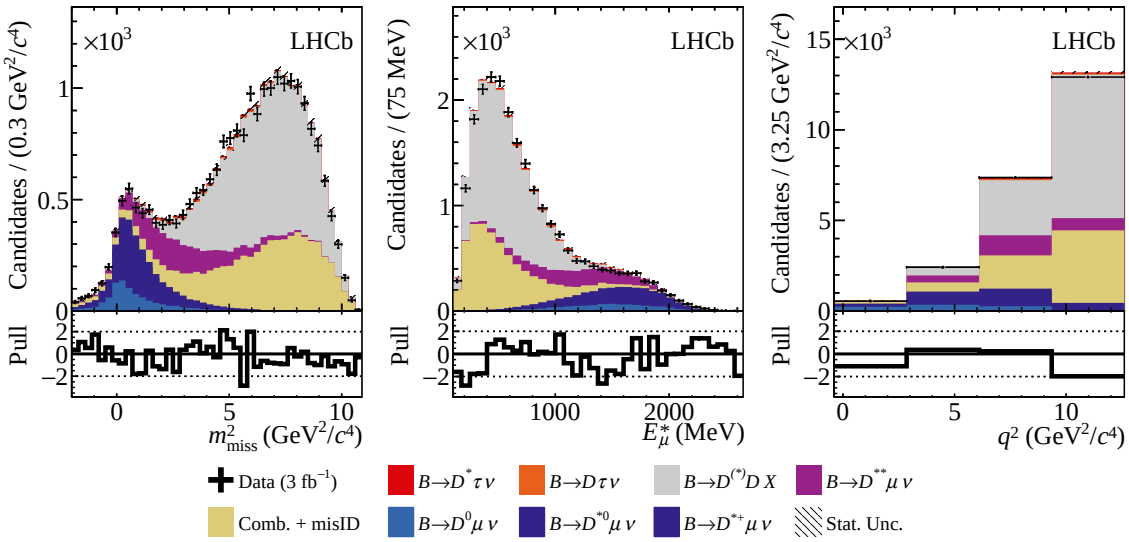

Figure 19: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with at least one kaon of identical charge to the muon, and no restrictions on the number of additional tracks consistent with the B vertex DD_WSK" category.

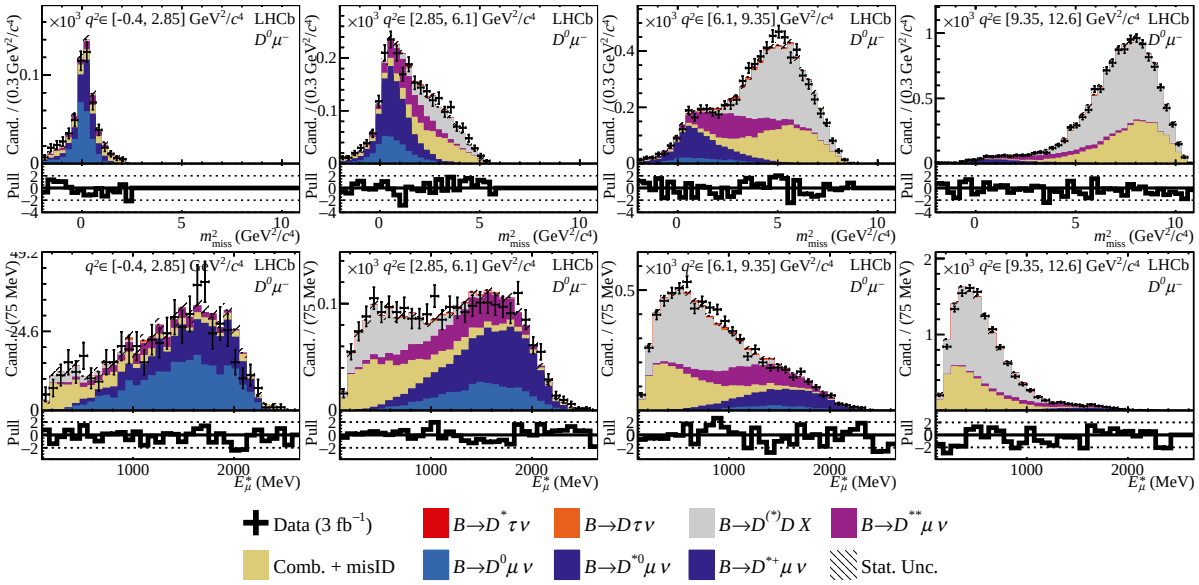

Figure 20: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with at least one kaon of identical charge to the muon, and no restrictions on the number of additional tracks consistent with the B vertex, in the four bins of q^2. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

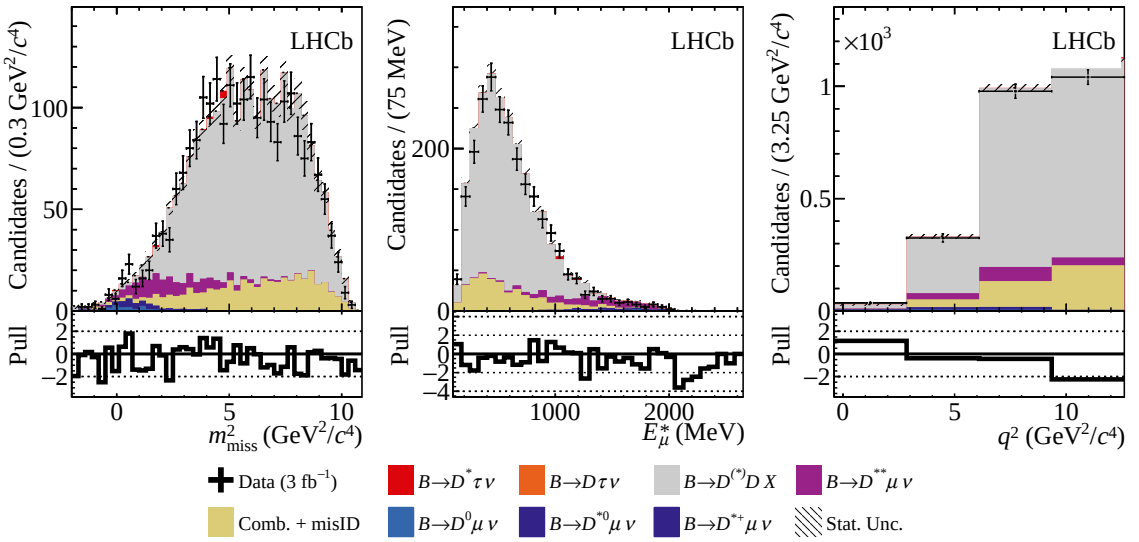

Figure 21: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with two opposite-sign kaons consistent with the B vertex, with a mass close to the nominal ϕ mass. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

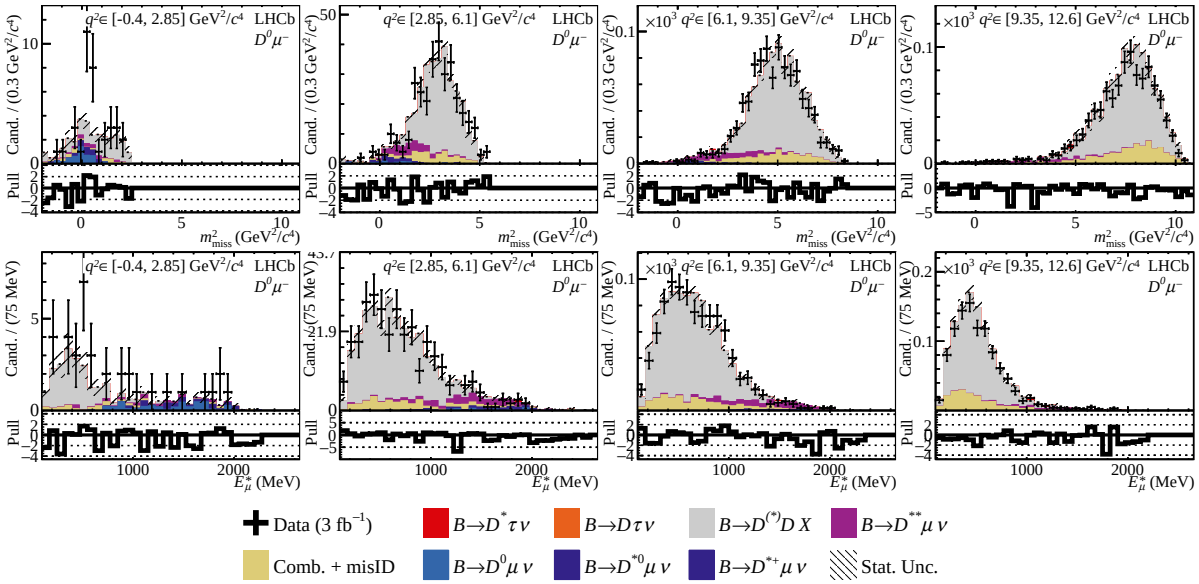

Figure 22: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with two opposite-sign kaons consistent with the B vertex, with a mass close to the nominal ϕ mass, in the four bins of q^2. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

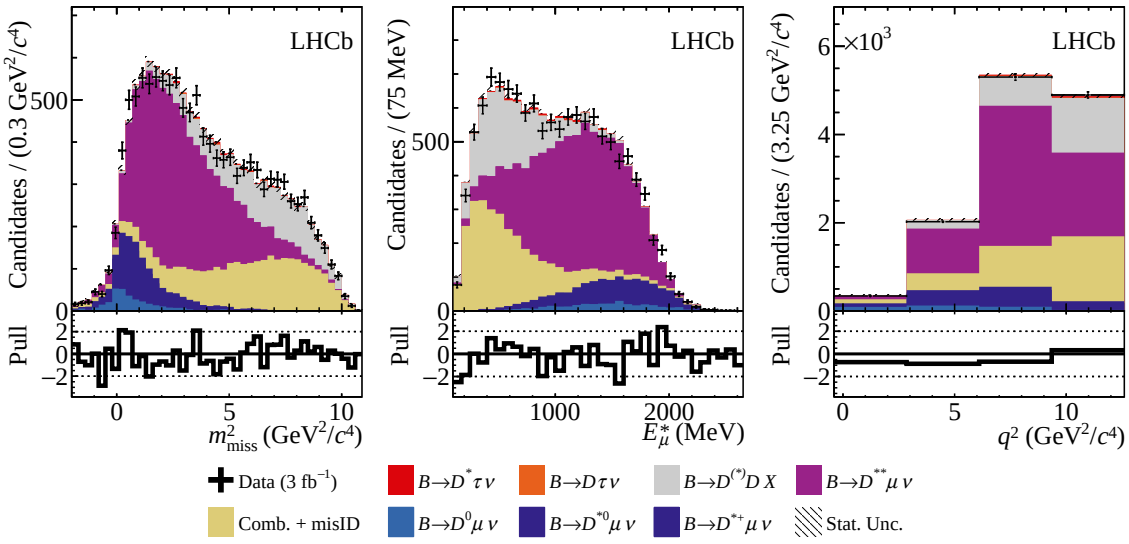

Figure 23: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with exactly two opposite-sign pions consistent with the B vertex, with a mass consistent with $\eta\to\pi^+\pi^-\pi^0$ decays. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

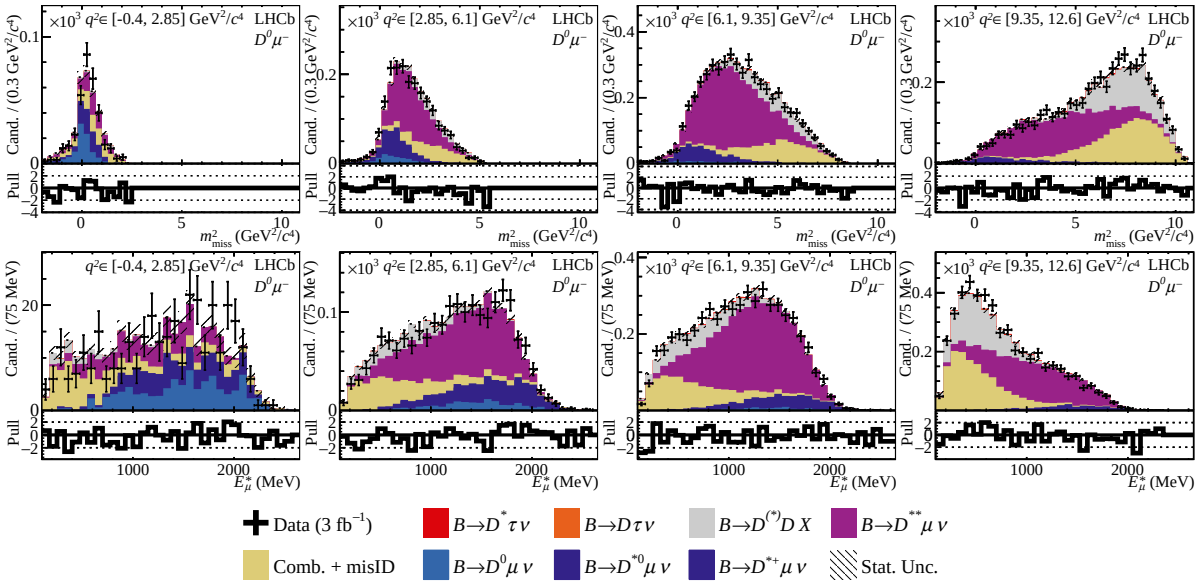

Figure 24: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with exactly two opposite-sign pions consistent with the B vertex, with a mass consistent with $\eta \to \pi^+\pi^-\pi^0$ decays, in the four bins of q^2. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

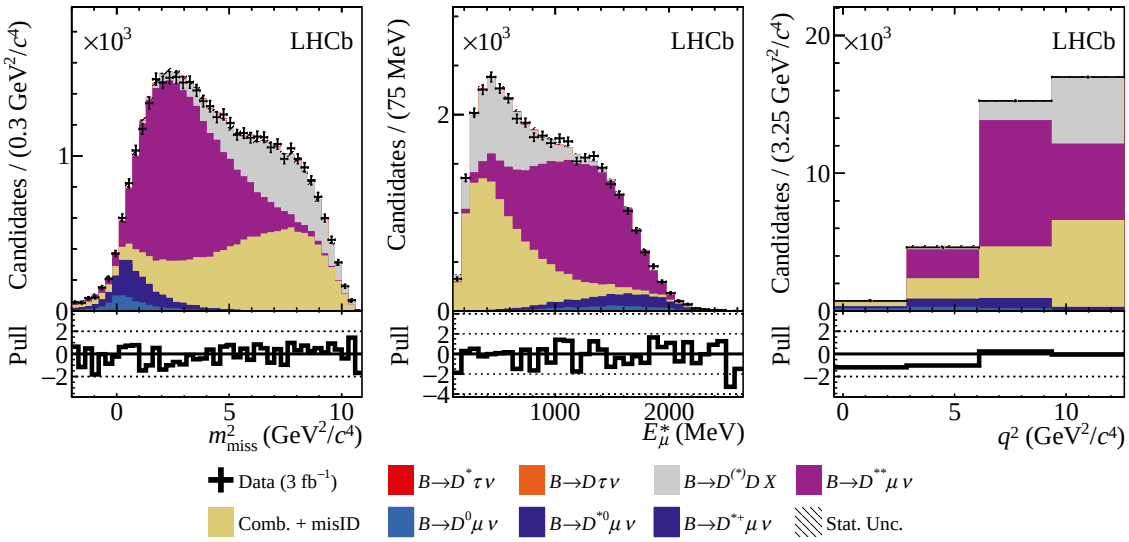

Figure 25: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with exactly two opposite-sign pions consistent with the B vertex, with a mass not consistent with $\eta \to \pi^+\pi^-\pi^0$ decays. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

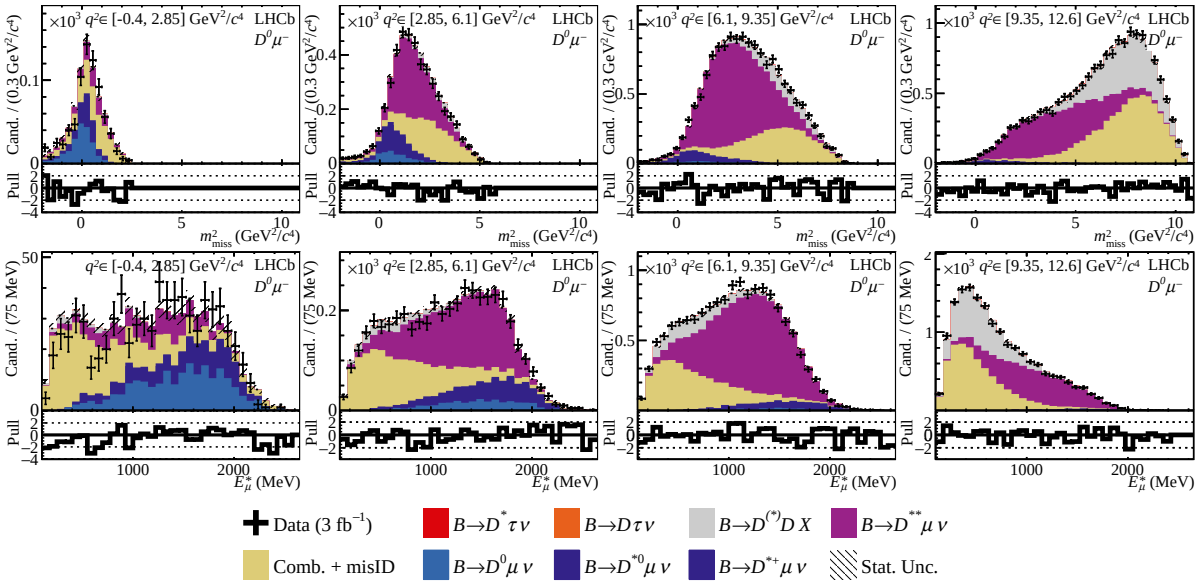

Figure 26: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with exactly two opposite-sign pions consistent with the B vertex, with a mass not consistent with $\eta \to \pi^+\pi^-\pi^0$ decays, in the four bins of q^2. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

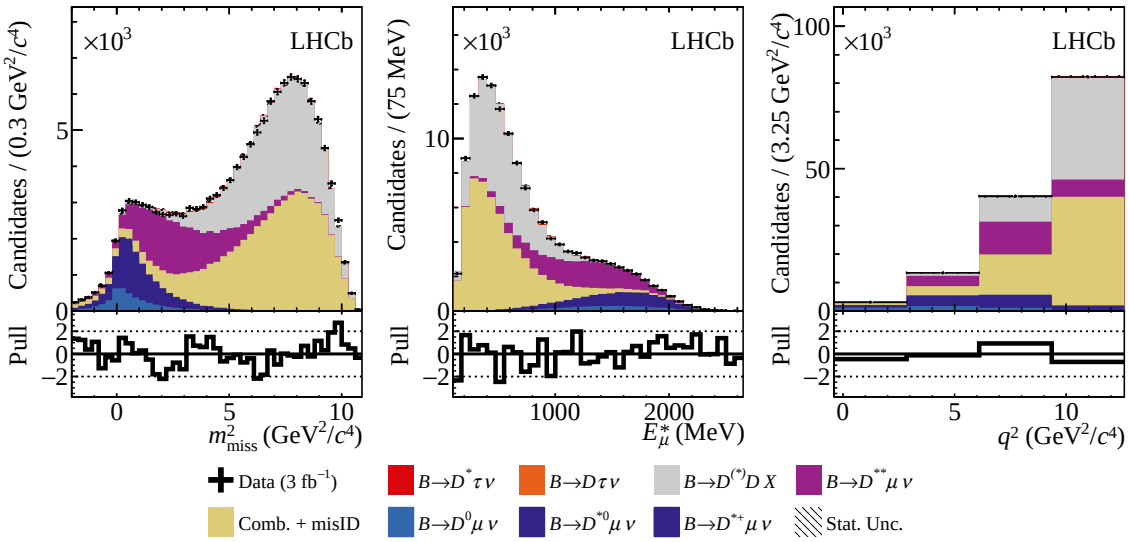

Figure 27: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with three pions consistent with the B vertex. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

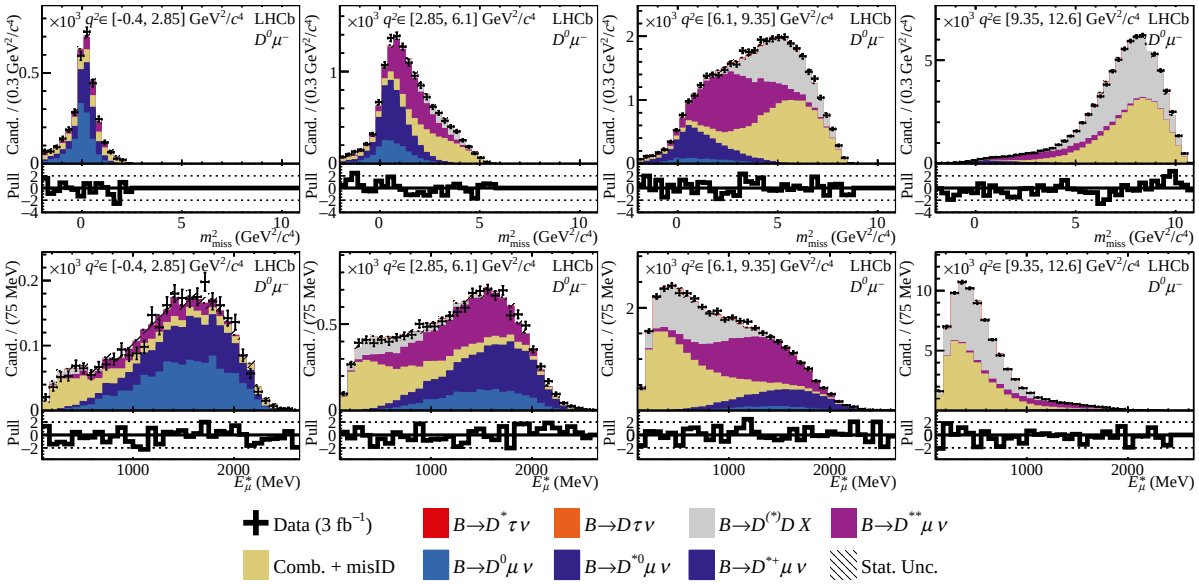

Figure 28: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with three pions consistent with the B vertex, in the four bins of q^2. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

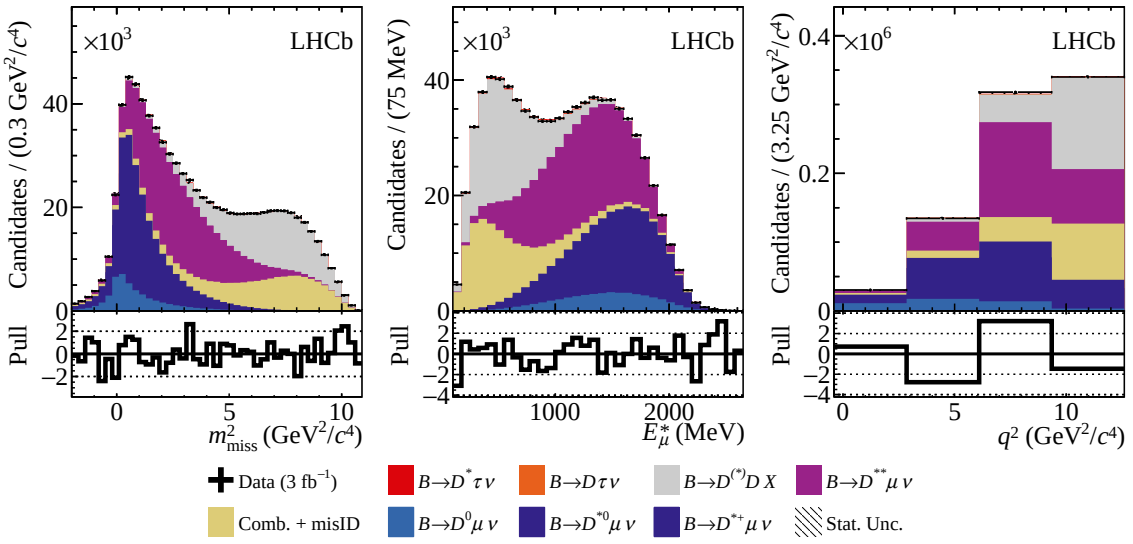

Figure 29: Distributions of (left) missing mass squared, (middle) lepton energy, and (right) q^2, overlaid with the projections of the fit model in the $D^0\mu^-$ region with any extra particle consistent with the B vertex. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

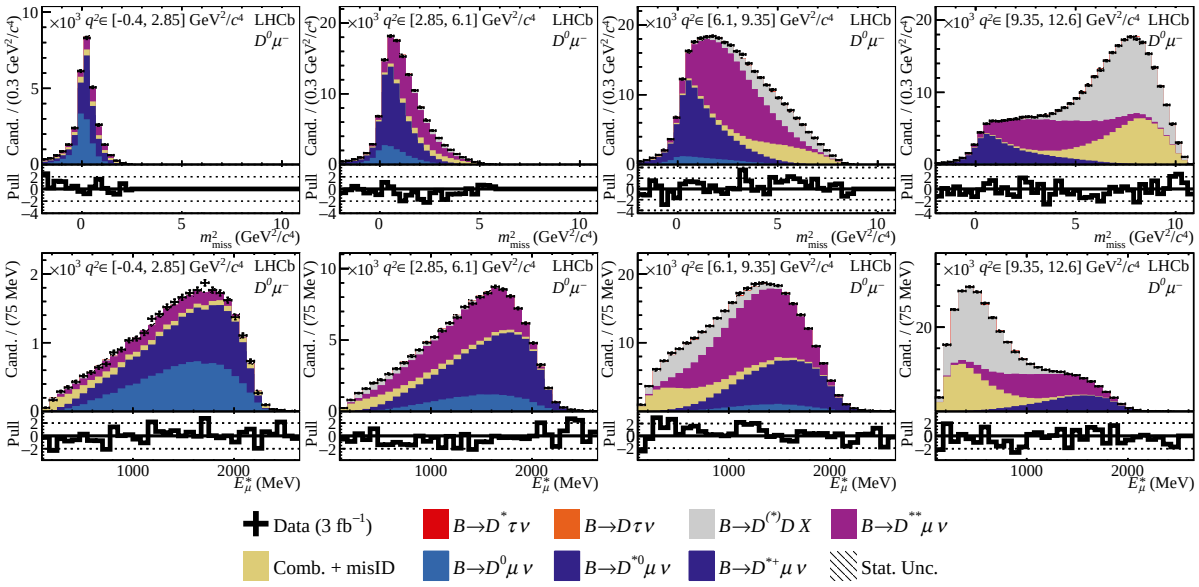

Figure 30: Distributions of (top row) missing mass squared and (bottom row) lepton energy overlaid with the projections of the fit model in the $D^0\mu^-$ region with any extra particle consistent with the B vertex, in the four bins of q^2. The label "stat. unc." refers to the statistical uncertainty on the fitted sum of templates.

1.3 Data - simulation comparison plots

In this section distributions are show for the following quantities: IP is defined as the distance of closest approach between a given particle trajectory and any primary vertex in the event; $\chi^2_{\rm IP}$ is defined as the difference in χ^2/ndof for the primary vertex reconstructed with and without this particle trajectory included; DIRA is defined as the angle between the particle momentum direction and the line connecting the primary and decay vertices.

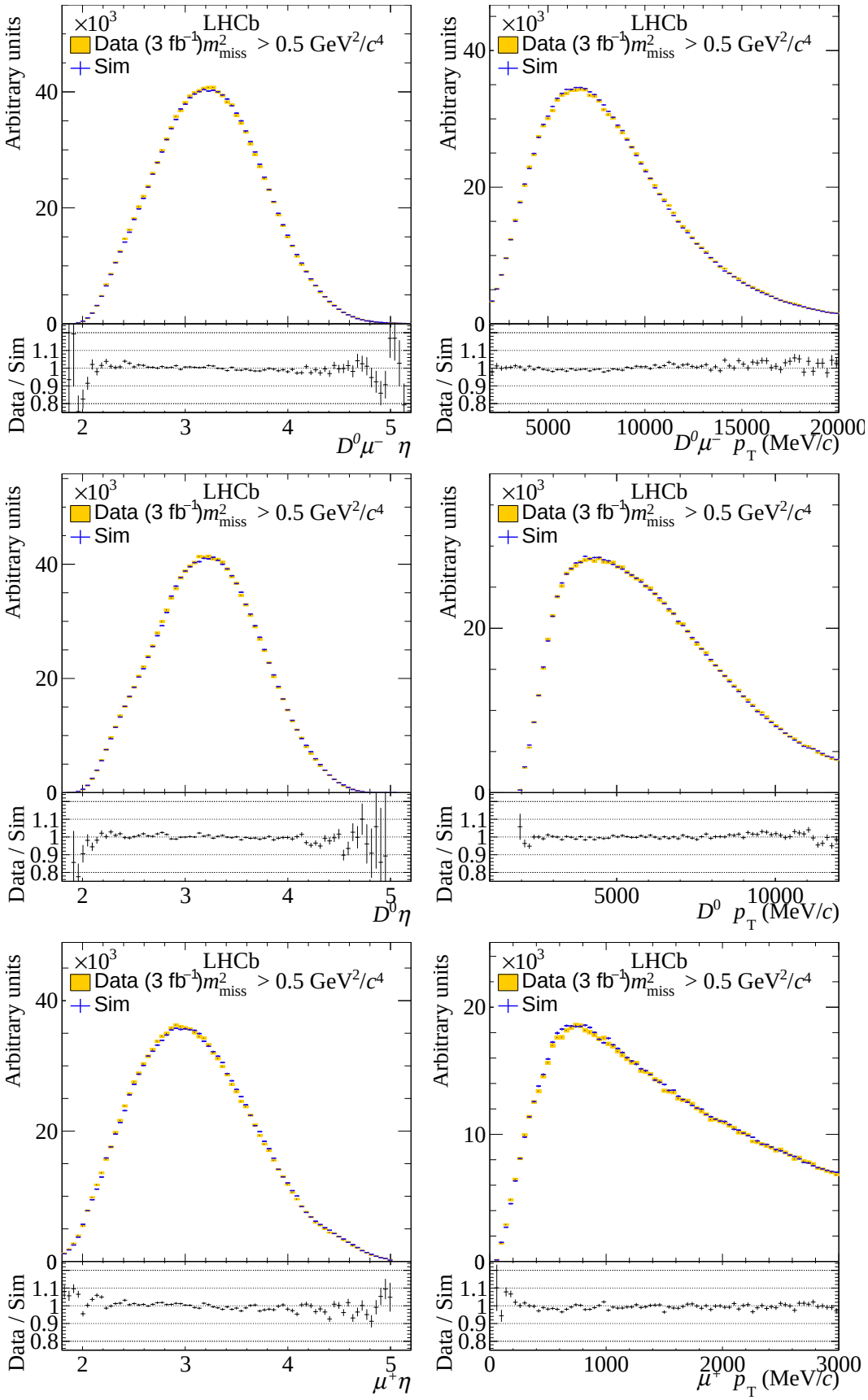

Figure 31: Distributions of kinematic variables in simulation and $D^0\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\text{miss}} > 0.5\,\text{GeV}^2/c^4$, which is not used to generate corrections.

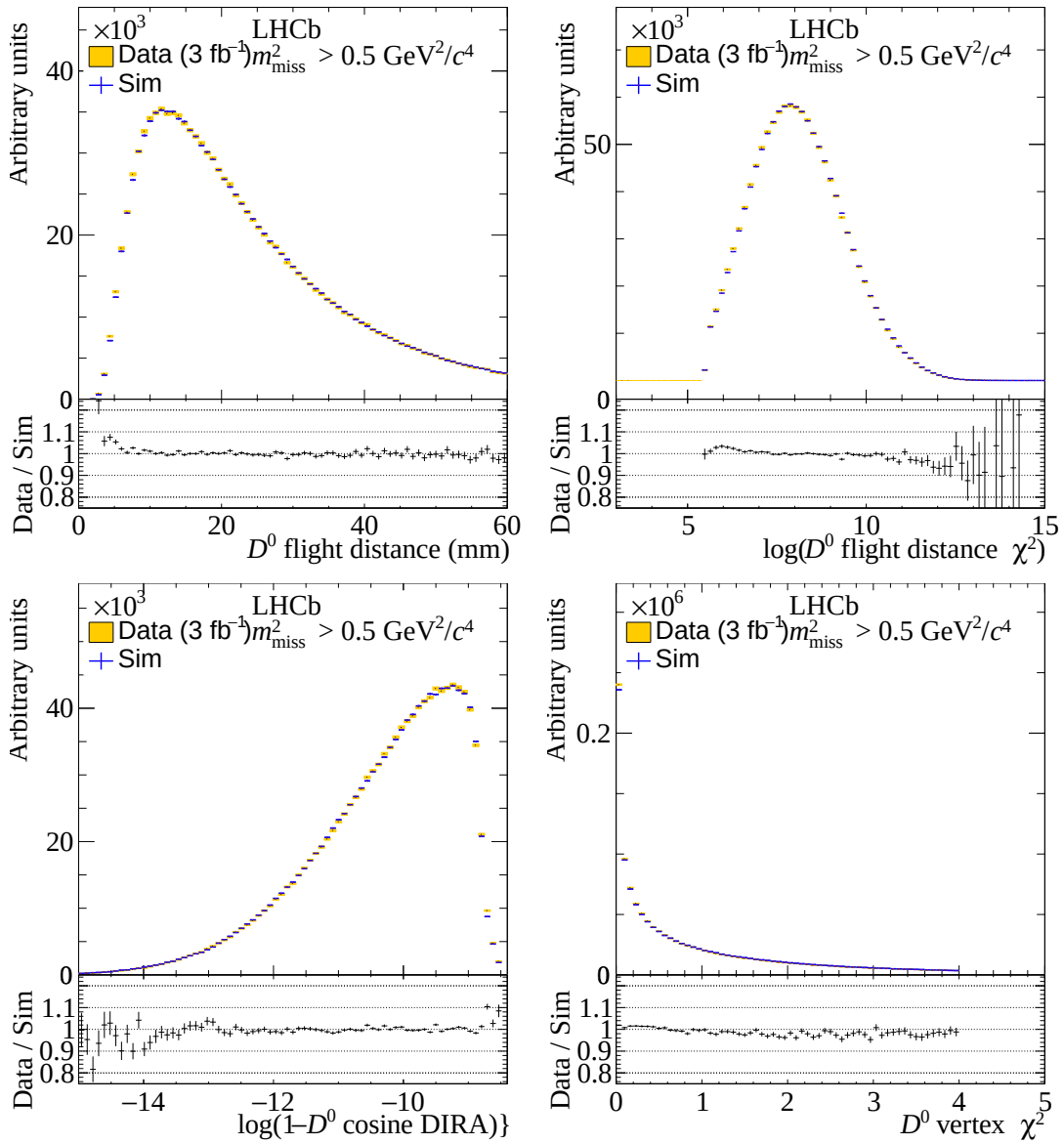

Figure 32: Distributions of geometric variables for D^0 mesons in simulation and $D^0\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

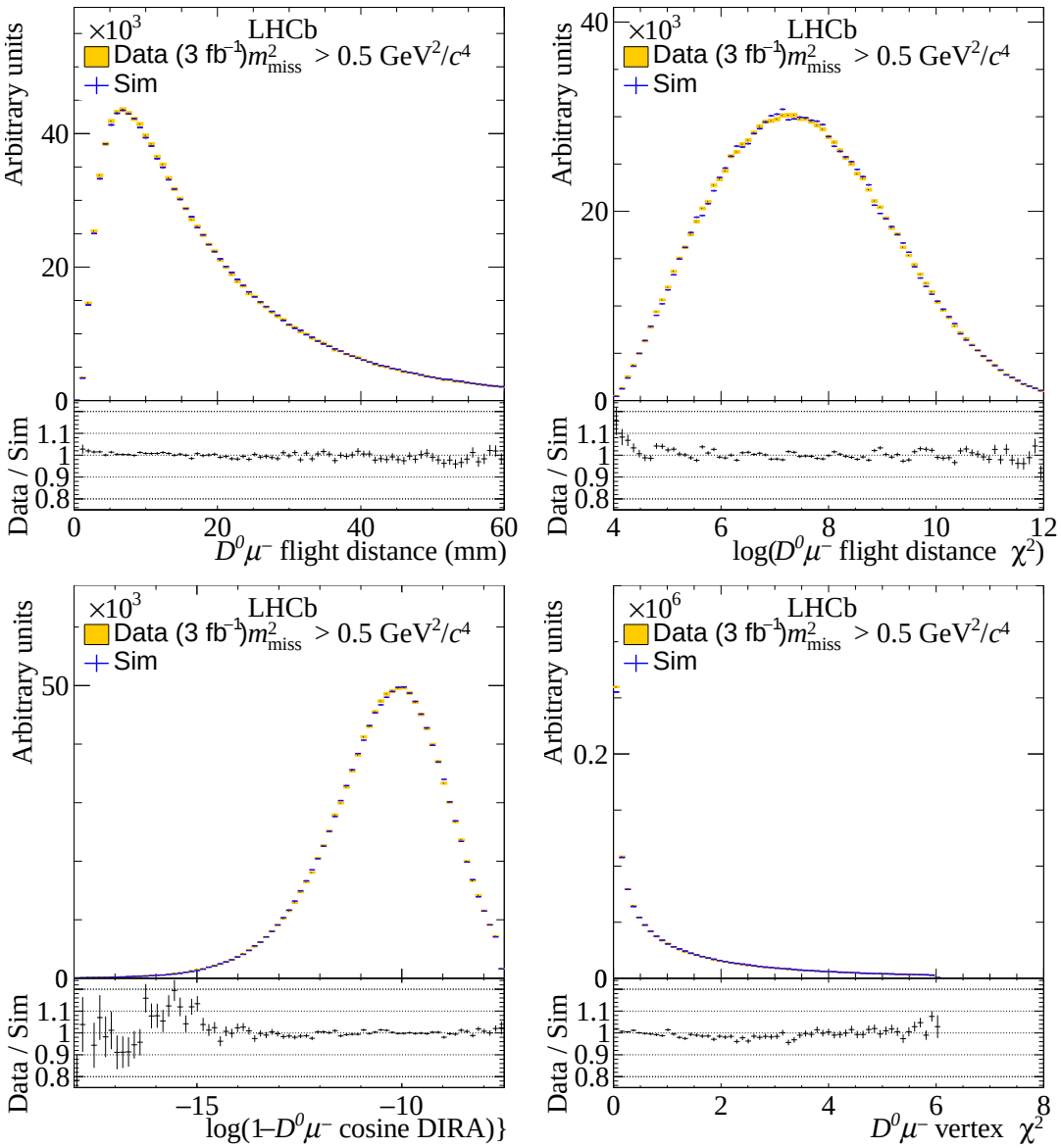

Figure 33: Distributions of geometric variables in simulation and $D^0\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

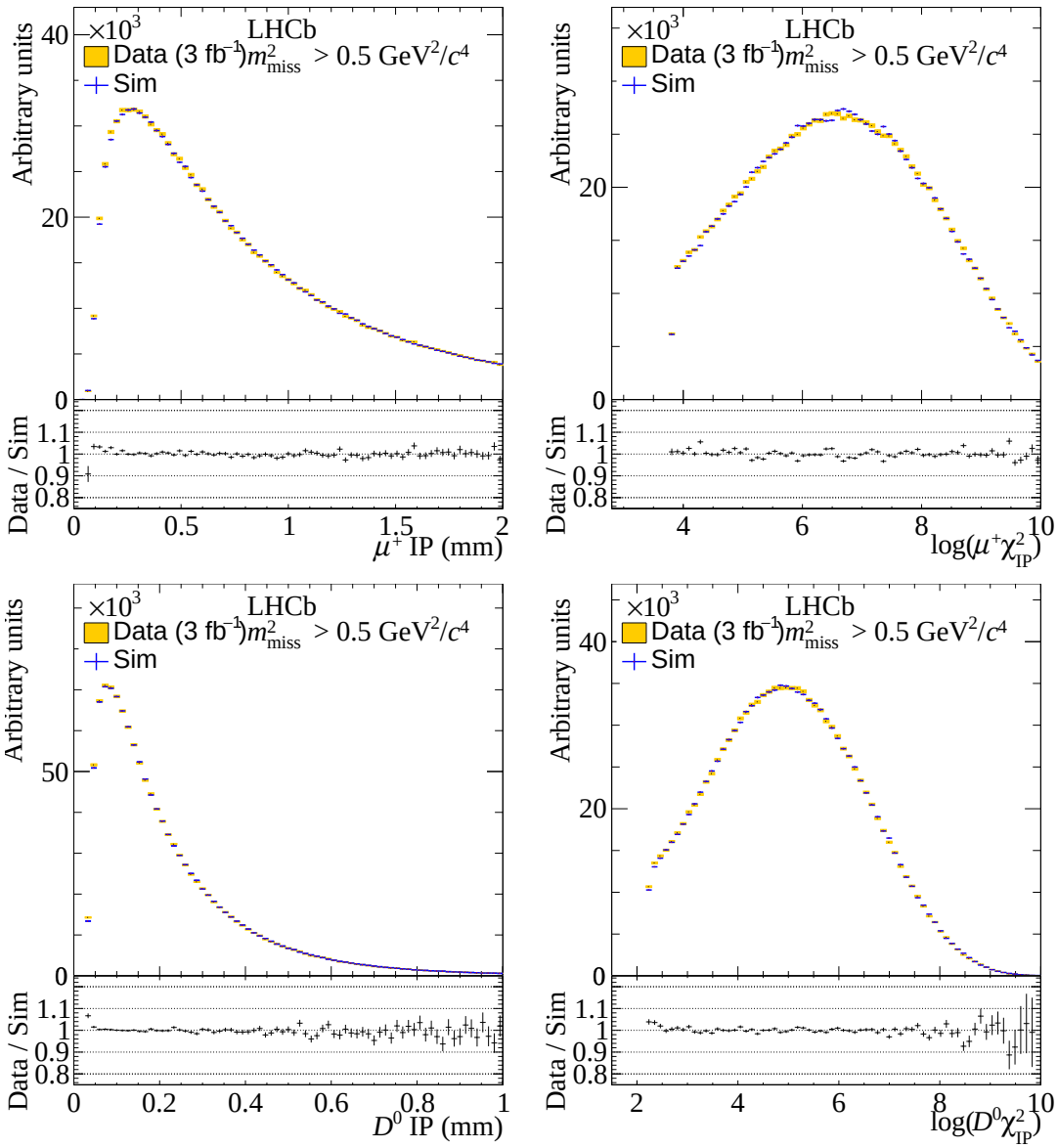

Figure 34: Distributions of impact parameter and the quantity $\chi^2_{\rm IP}$ in simulation and $D^0\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

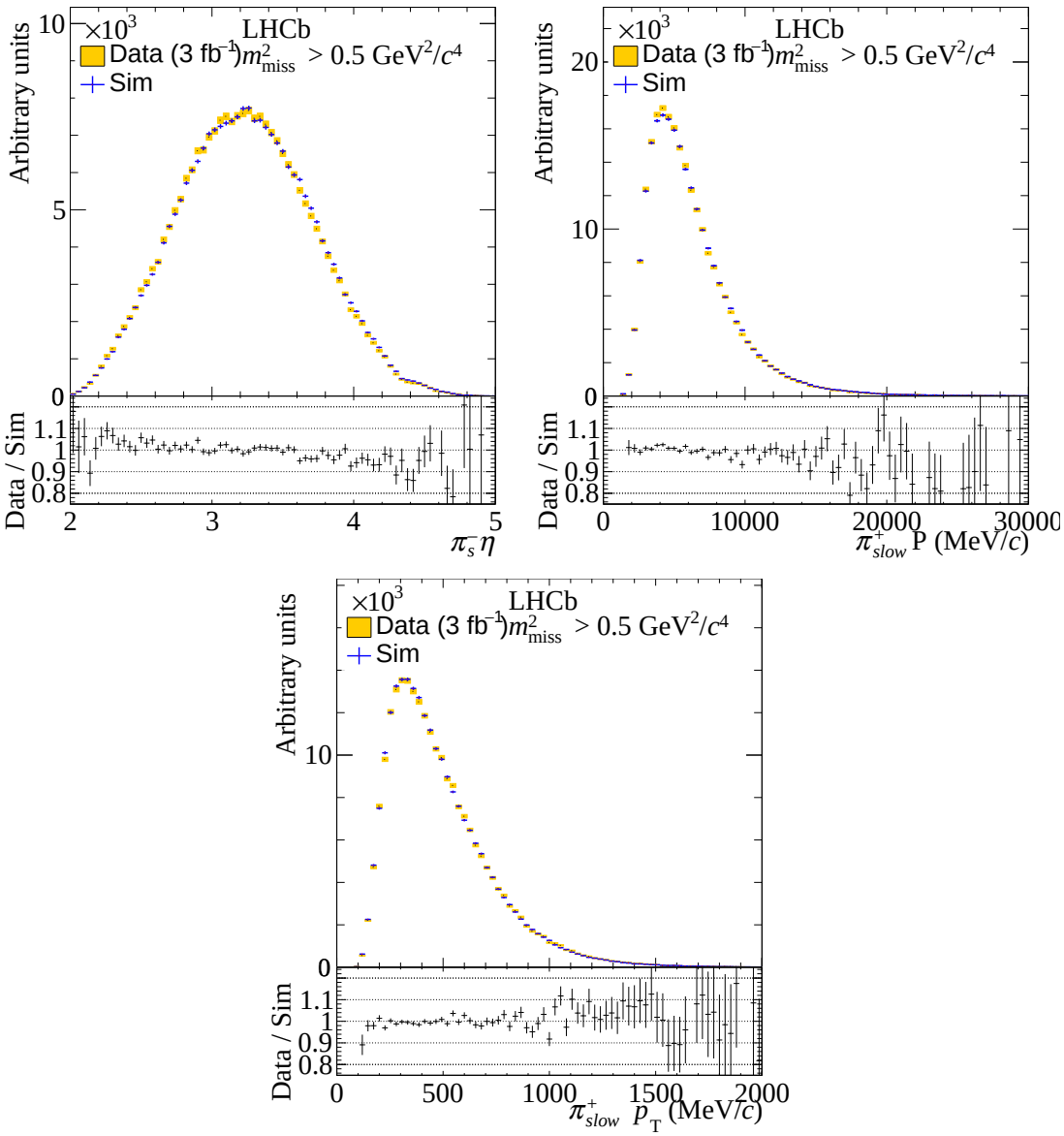

Figure 35: Distributions of kinematic variables in simulation and $D^{*+}\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

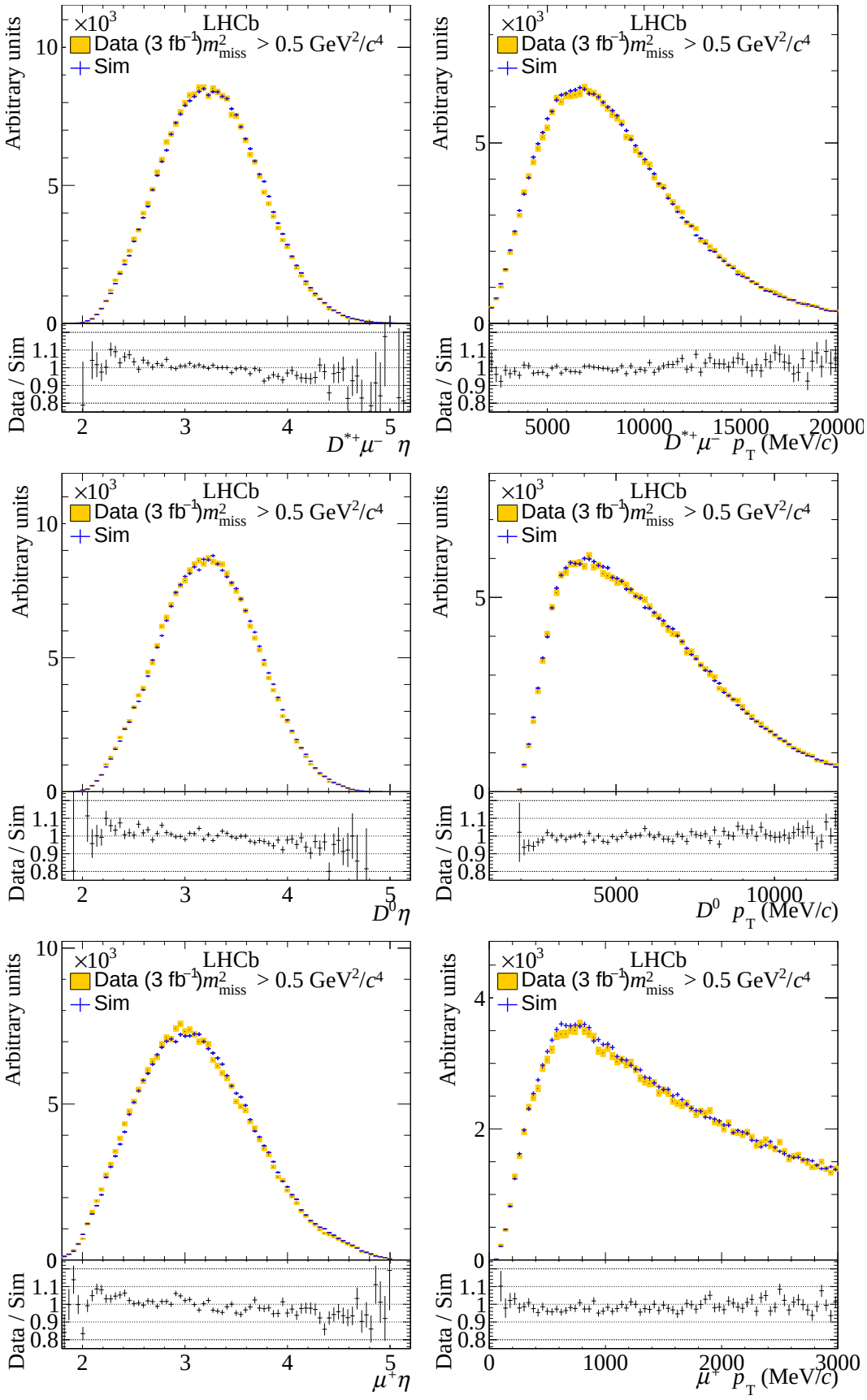

Figure 36: Distributions of kinematic variables in simulation and $D^{*+}\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

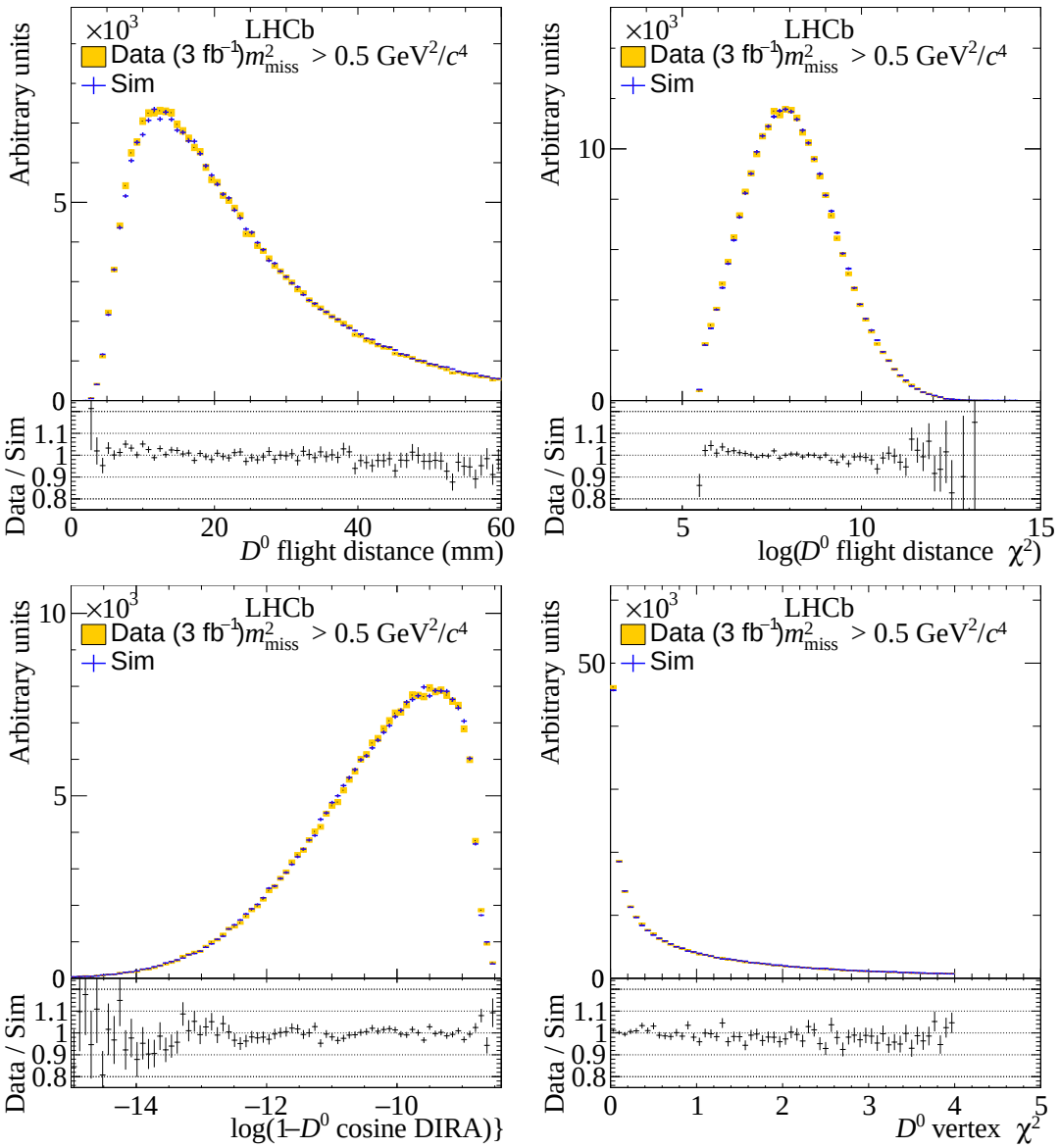

Figure 37: Distributions of geometric variables for D^0 mesons in simulation and $D^{*+}\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

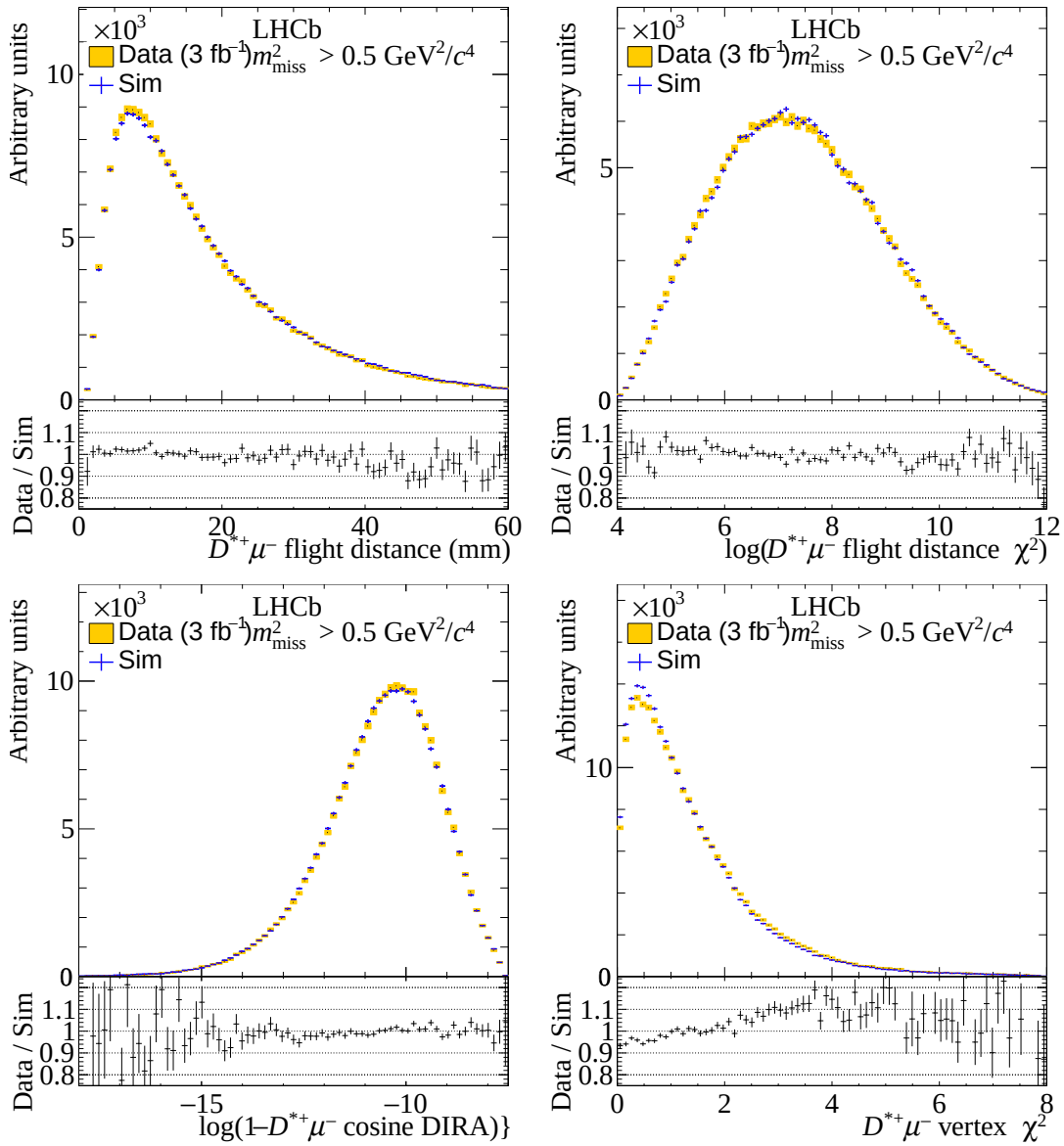

Figure 38: Distributions of geometric variables in simulation and $D^{*+}\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\text{miss}} > 0.5\,\text{GeV}^2/c^4$, which is not used to generate corrections.

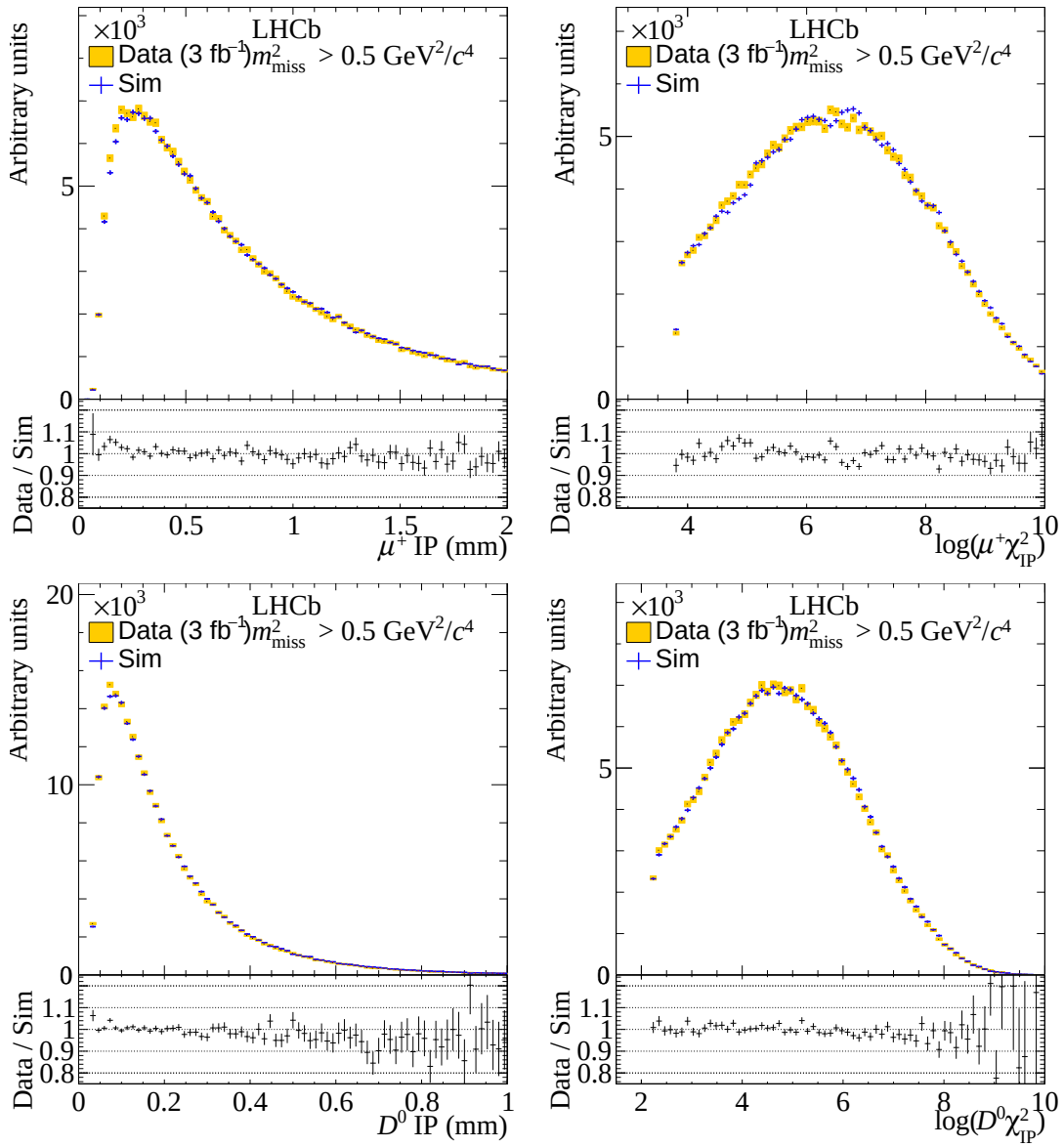

Figure 39: Distributions of impact parameter and the quantity $\chi^2_{\rm IP}$ in simulation and $D^{*+}\mu^-$ data, with the nominal corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

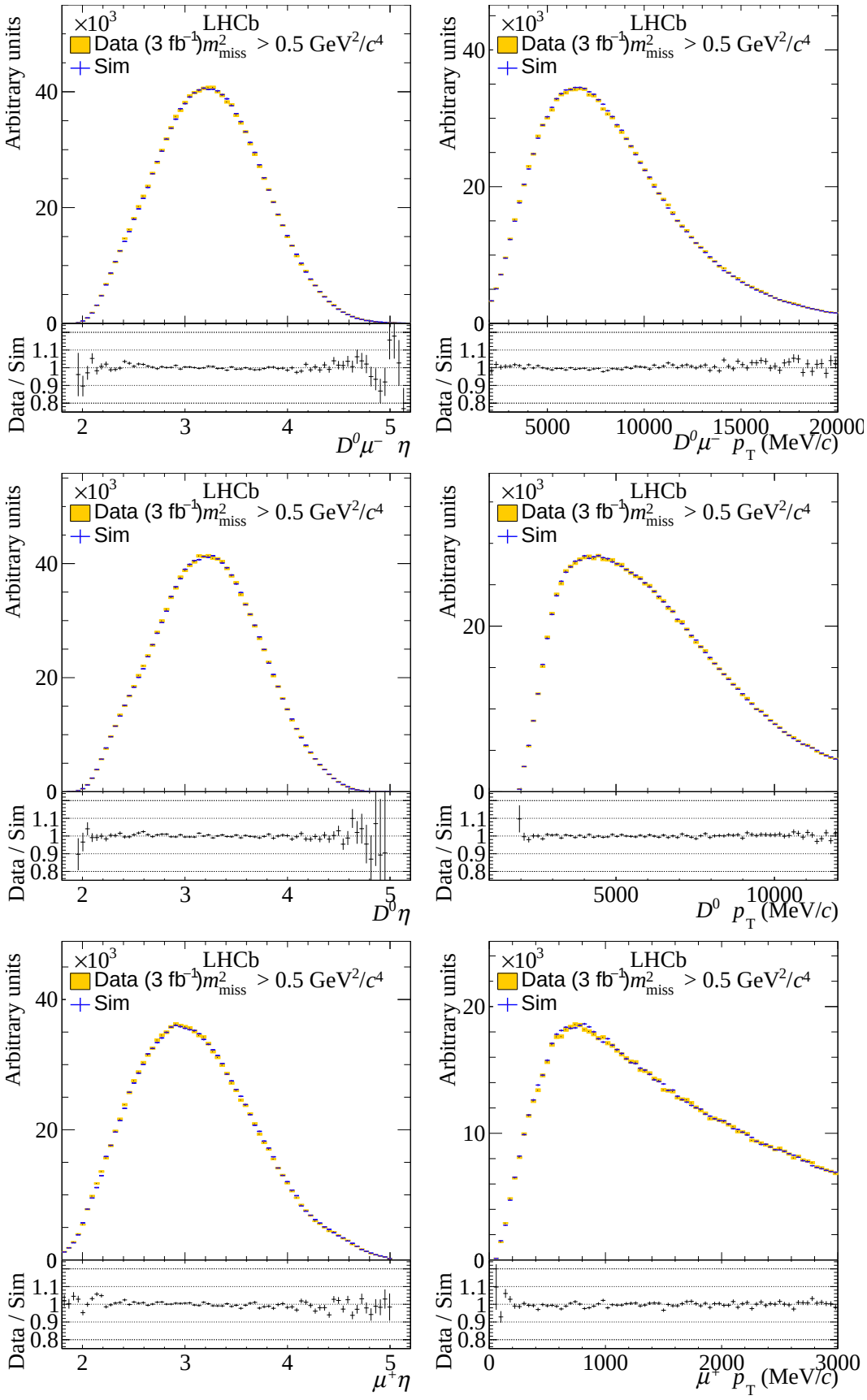

Figure 40: Distributions of kinematic variables in simulation and $D^0\mu^-$ data, with the second iteration of the corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

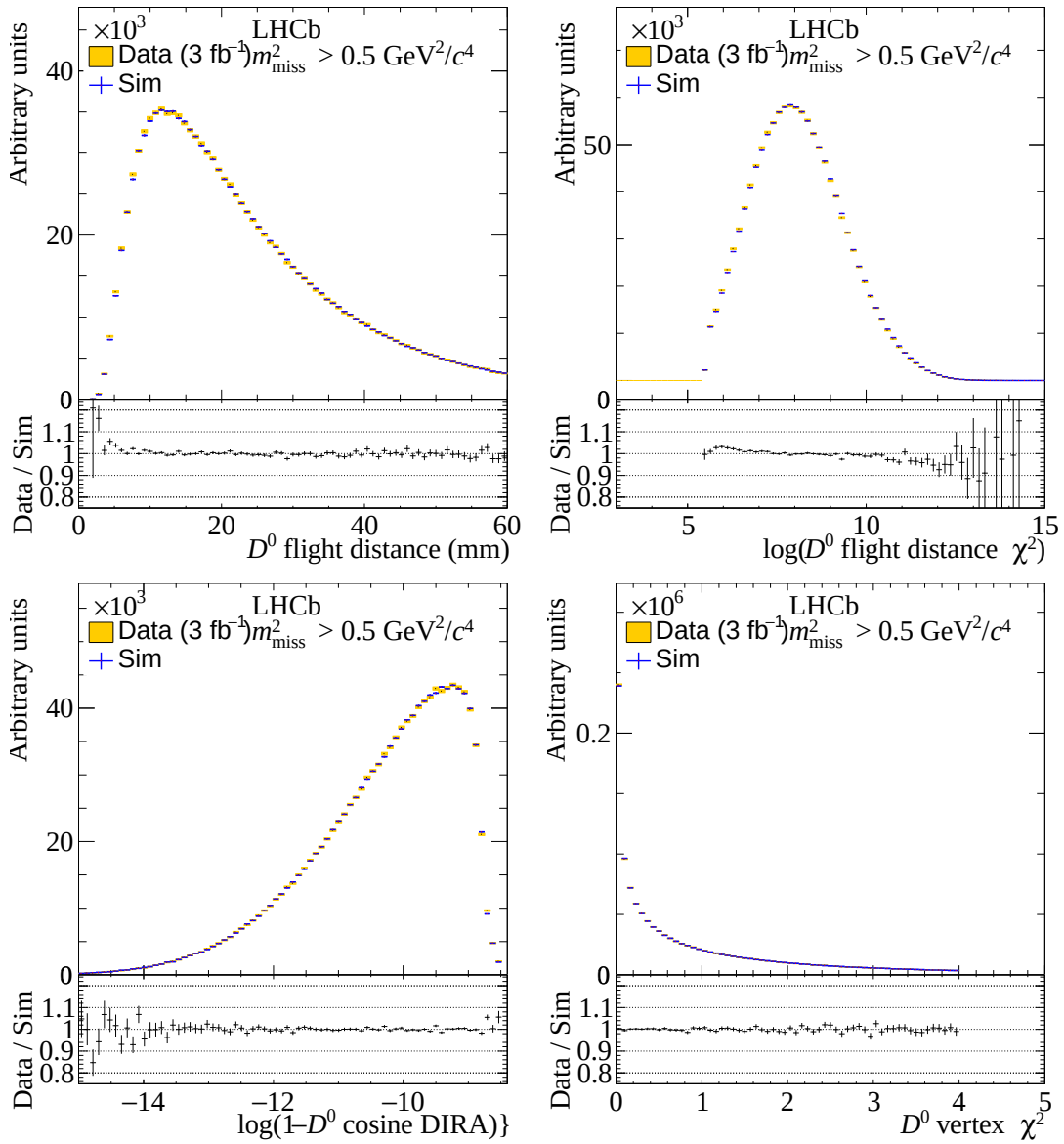

Figure 41: Distributions of geometric variables for D^0 mesons in simulation and $D^0\mu^-$ data, with the second iteration of the corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

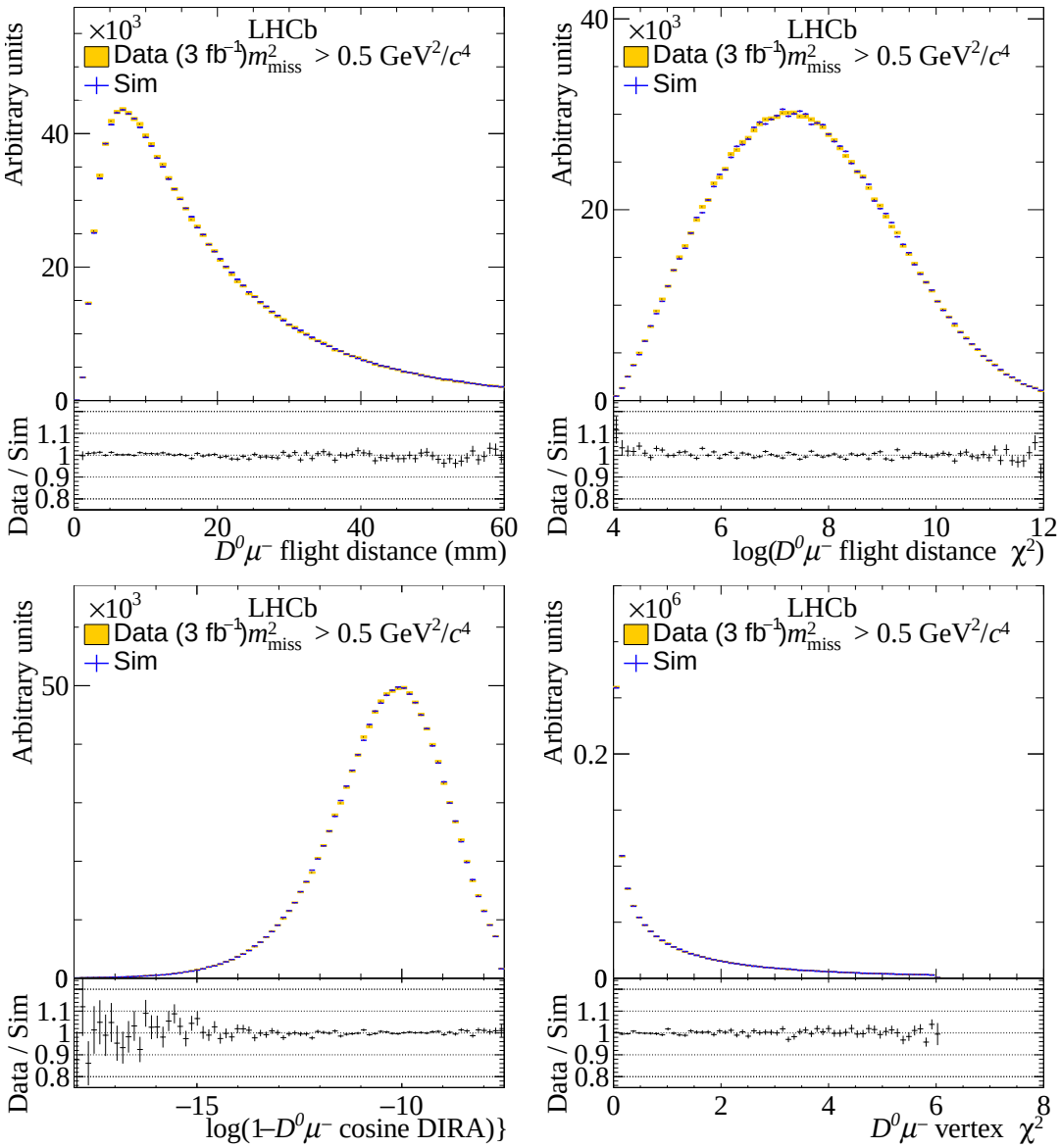

Figure 42: Distributions of geometric variables in simulation and $D^0\mu^-$ data, with the second iteration of the corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.

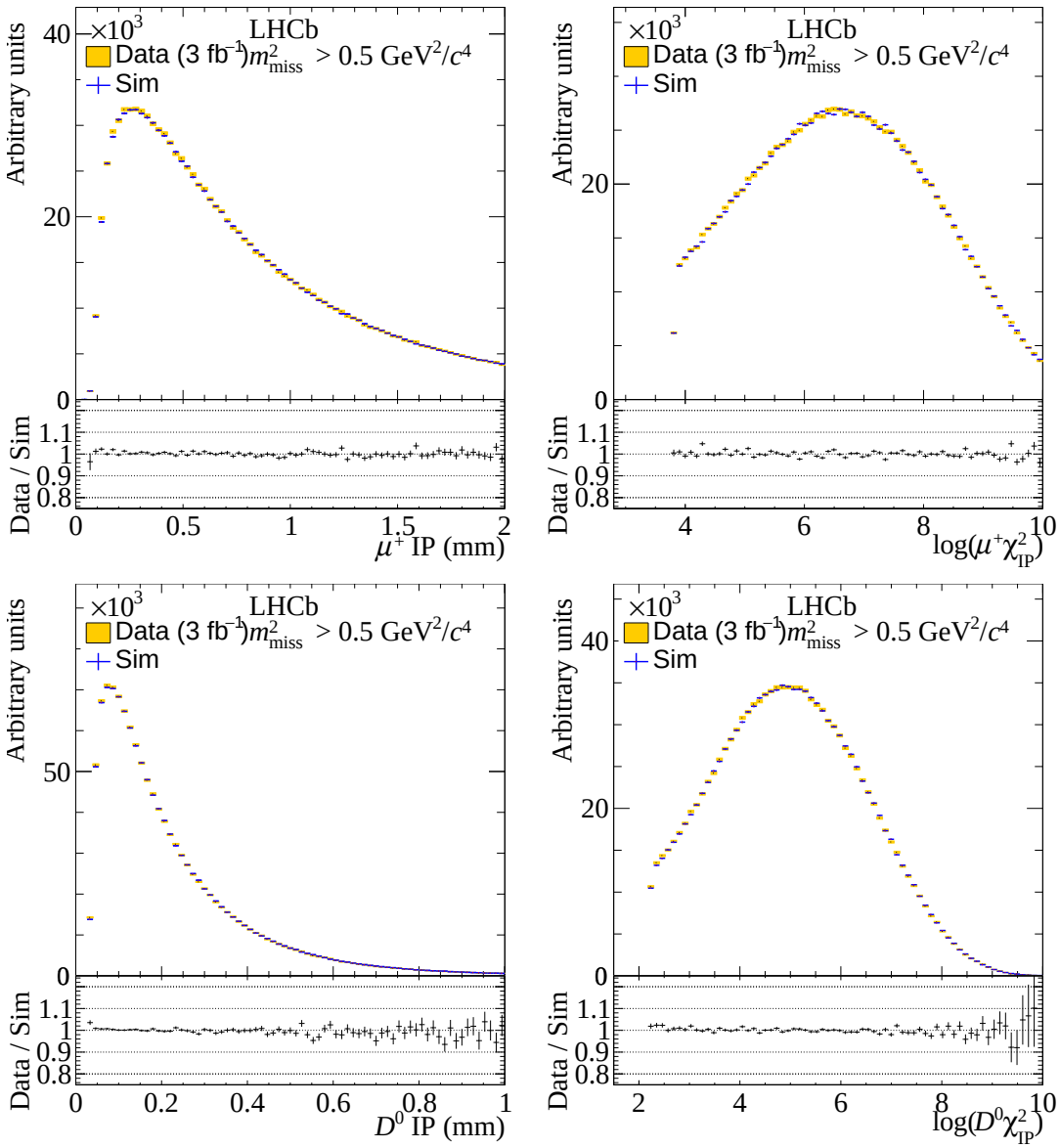

Figure 43: Distributions of impact parameter and the quantity $\chi^2_{\rm IP}$ in simulation and $D^0\mu^-$ data, with the second iteration of the corrections applied. The data correspond to the region with $m^2_{\rm miss} > 0.5\,{\rm GeV}^2/c^4$, which is not used to generate corrections.