Proton Inelastic Cross-section analysis: Low Energy Reconstruction Study

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Hadron Analysis Meeting

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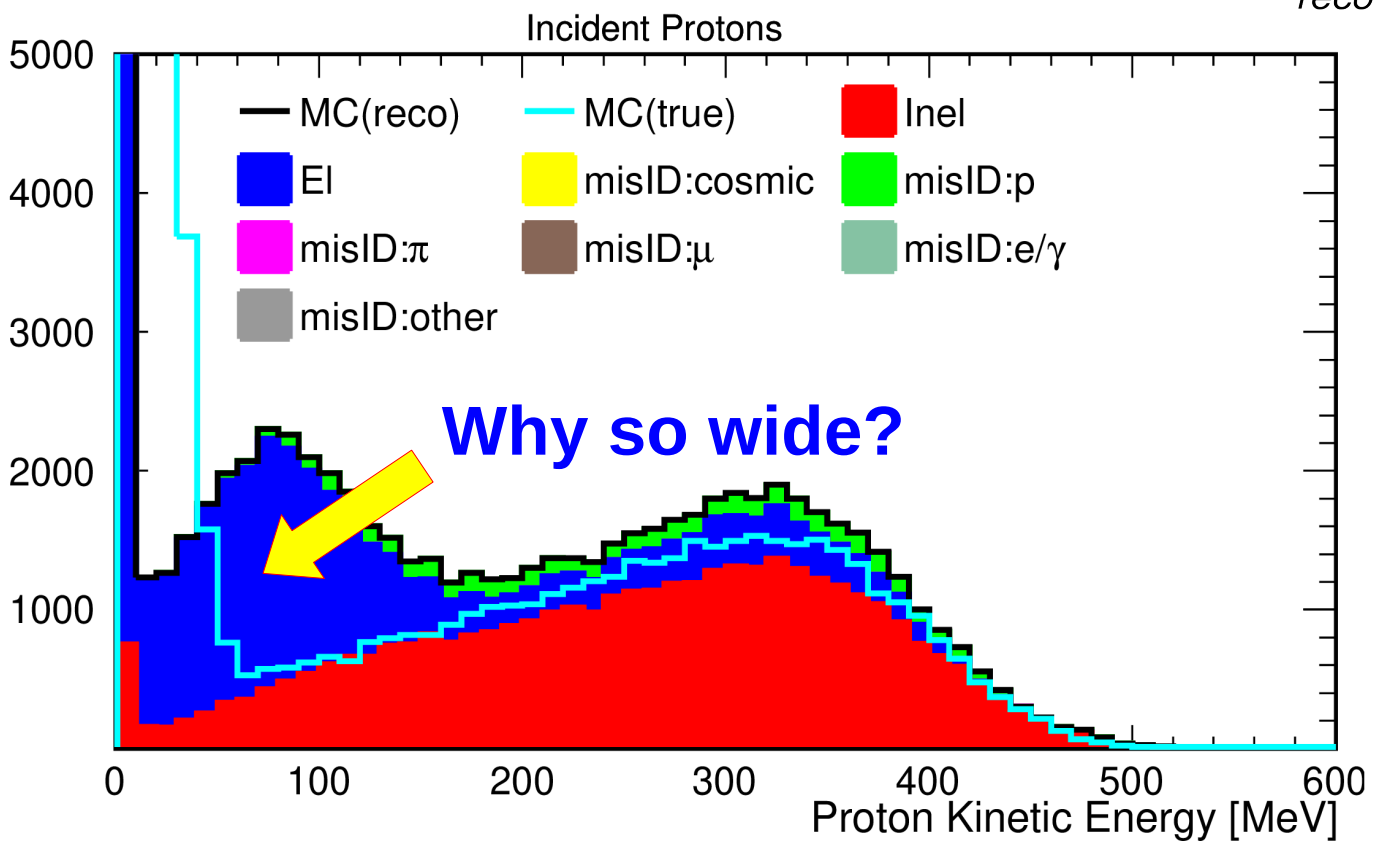
KANSAS STATE UNIVERSITY Fermilab

DUNE

Outline

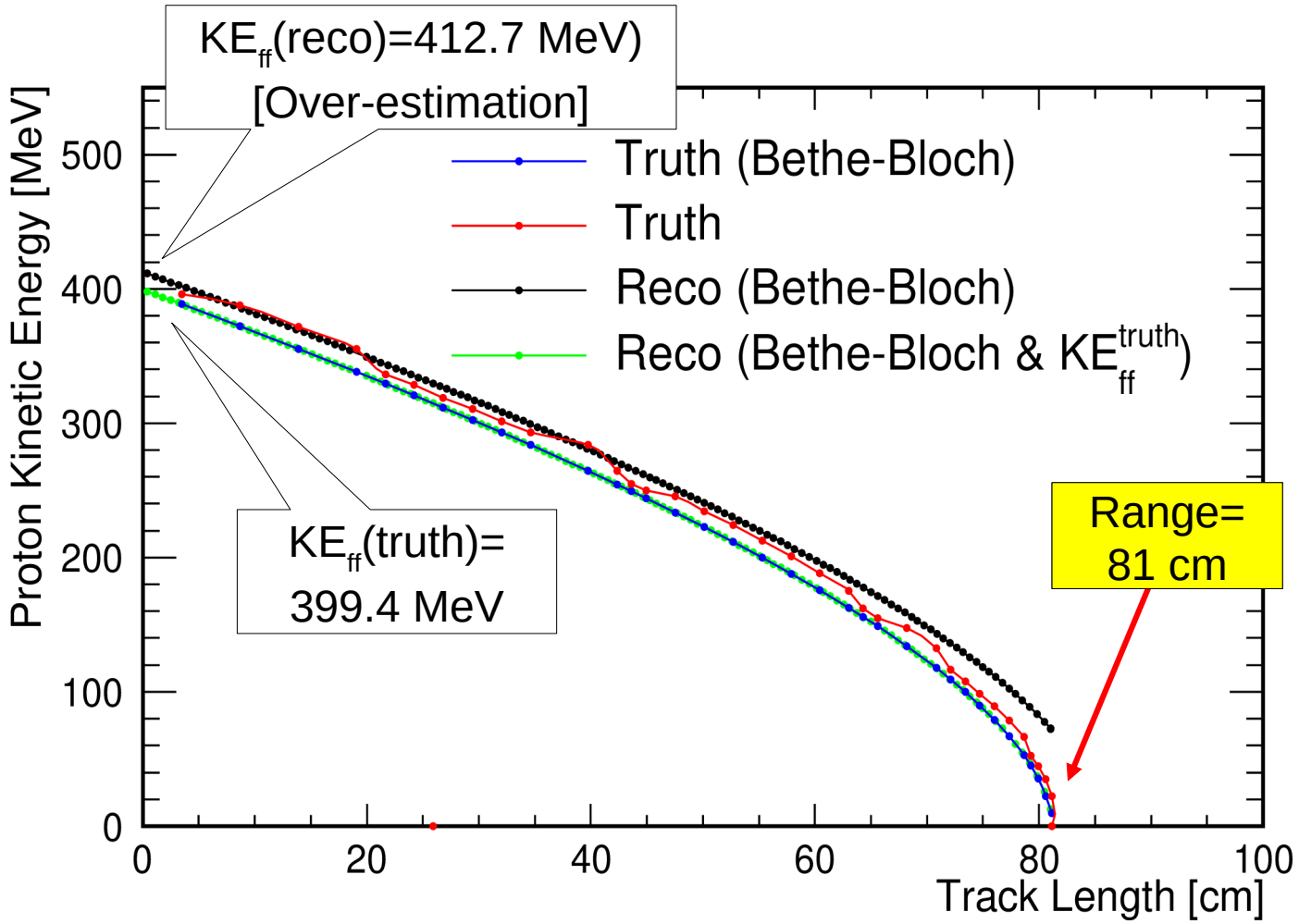
- Investigation on bad KE reco in low energy

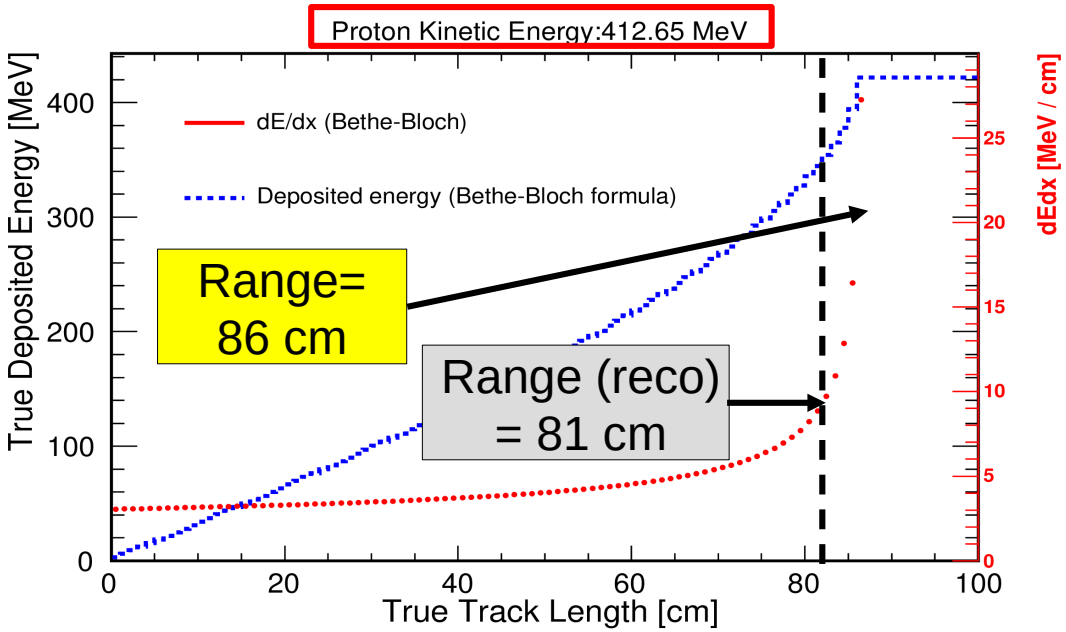
$$KE_{reco} = (KE_{beam} - \langle \Delta E \rangle) - \int \frac{dE}{dx} dx_{reco}$$

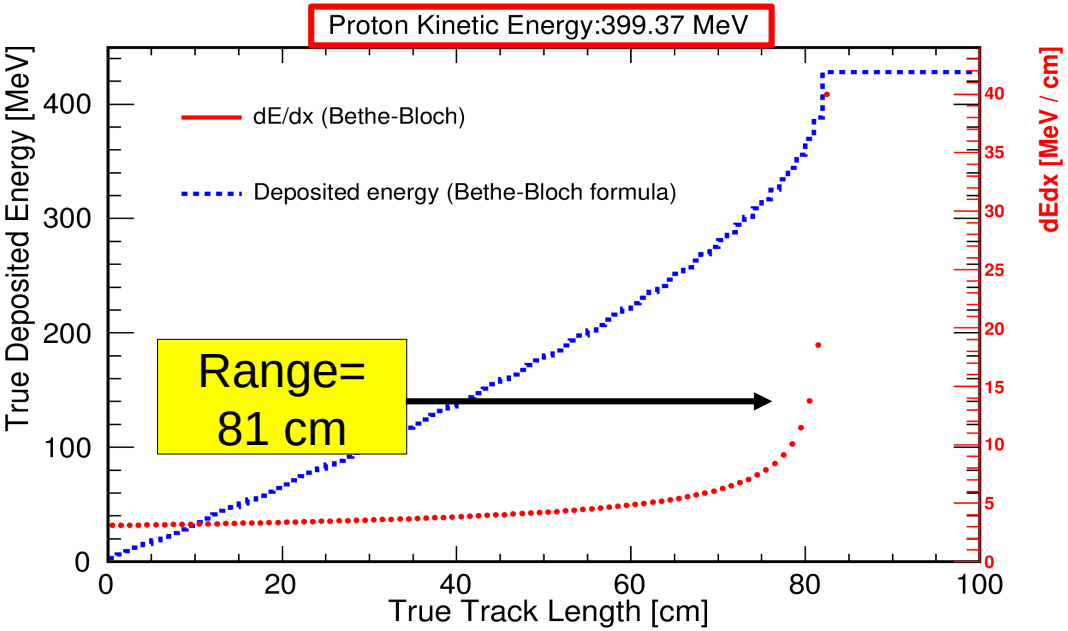


Using Bethe-Bloch, KE_{ff} is Critical

Run: 21644123	Subrun: 406	Event: 1286	ID: 34







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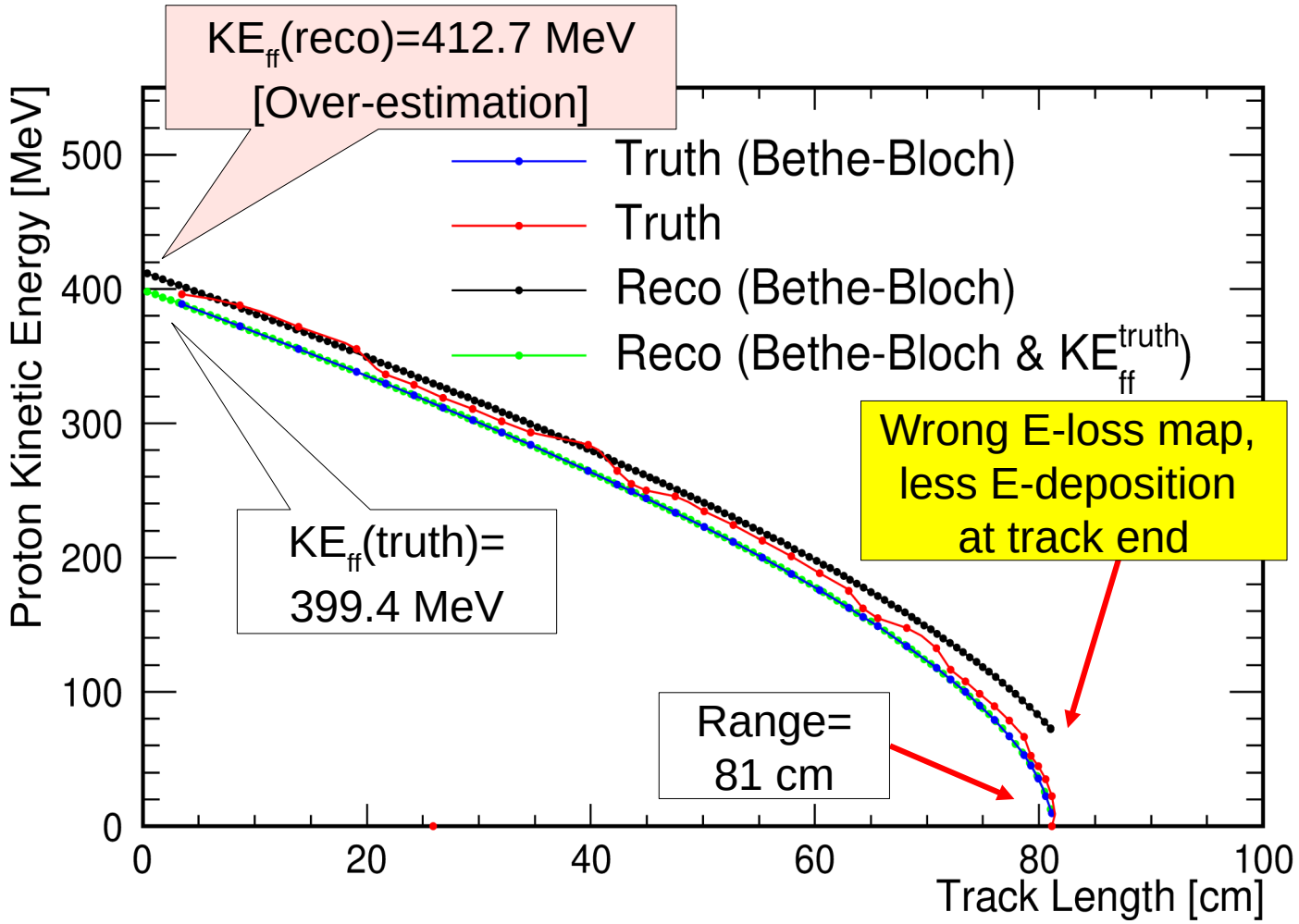
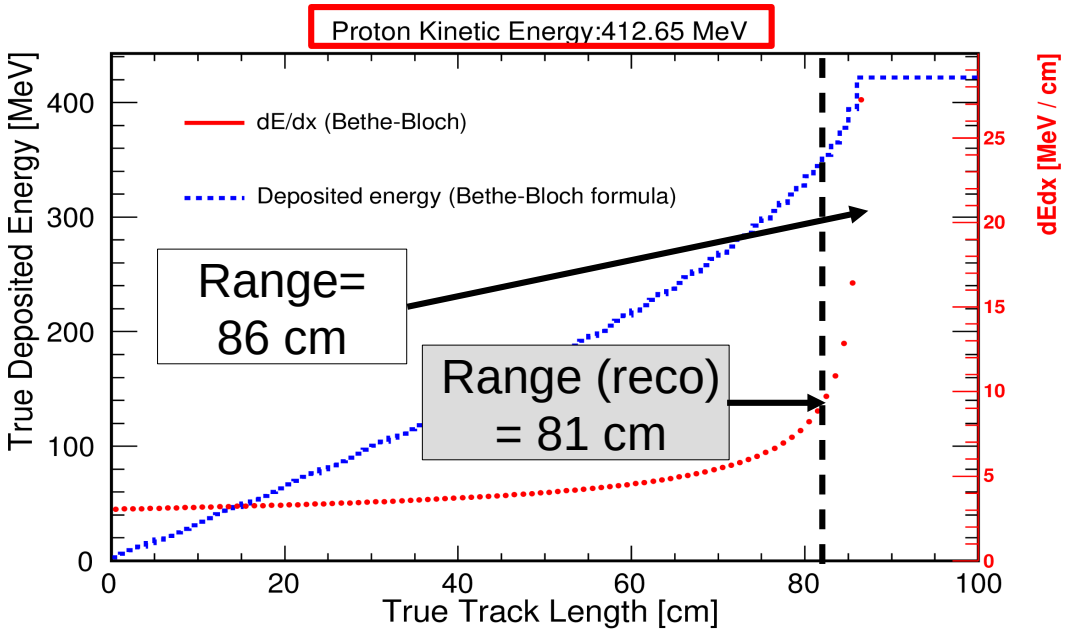
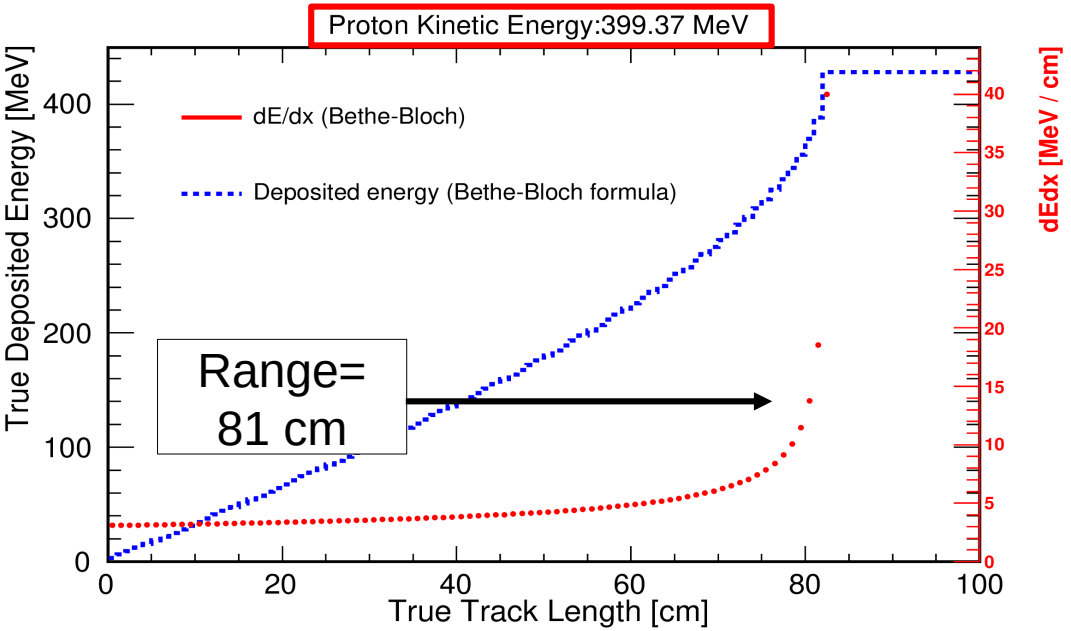
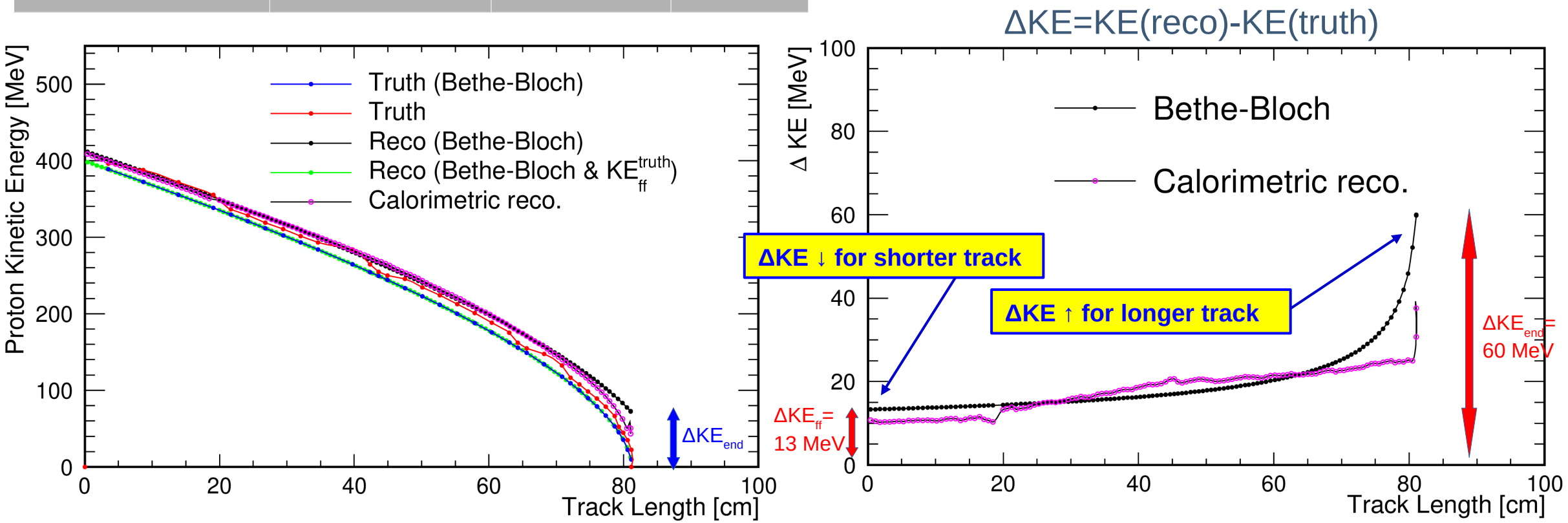






Calorimetric Reco

Run: 21644123	Subrun: 406	Event: 1286	ID: 34

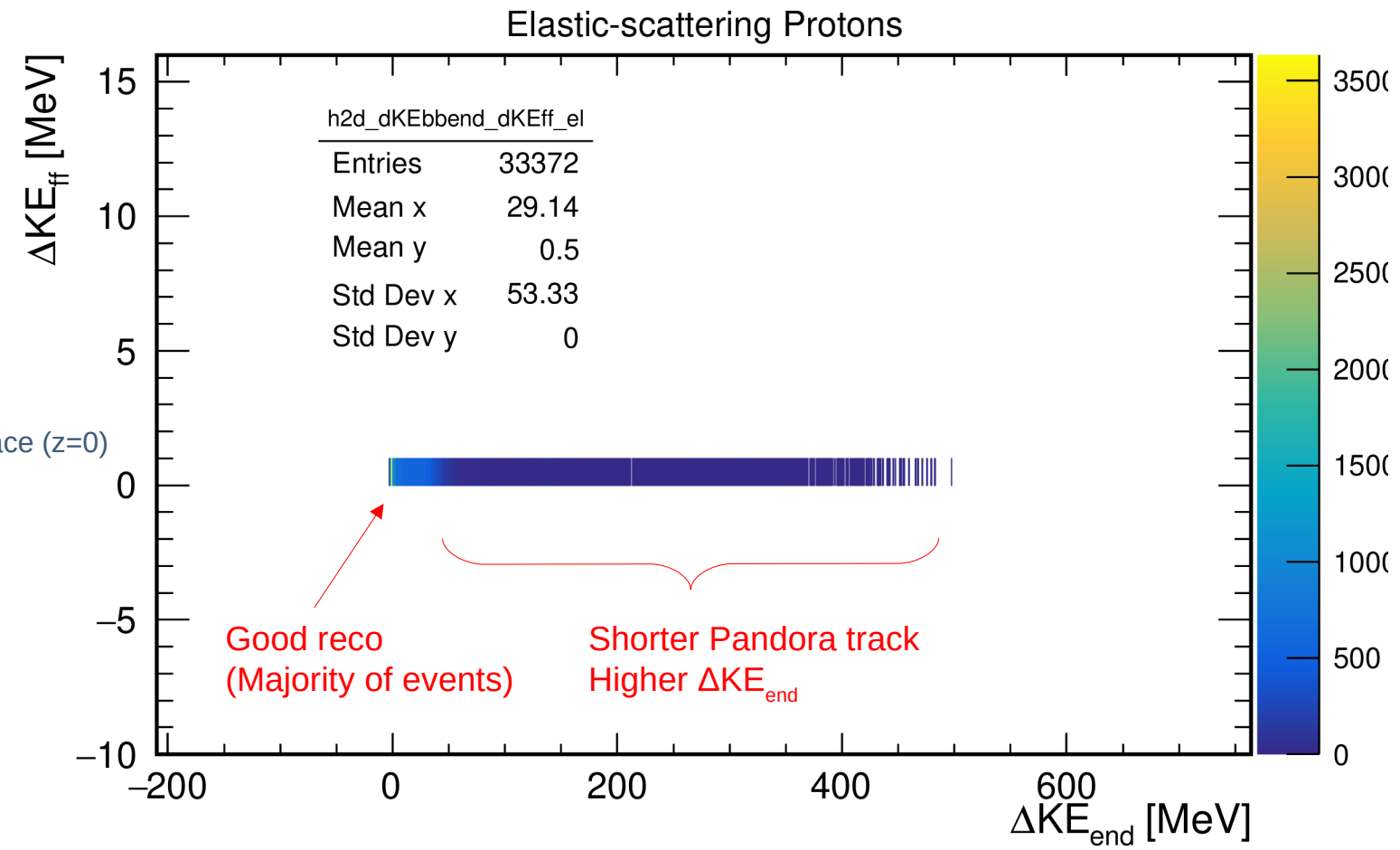


- ΔKE_{end} is amplified due to over-estimation of KE_{ff}
- ΔKE(calo) at track end is less affected by the estimation of KE_{ff}

  → KE_{end} (calo) also depends on KE_{ff} but with right E-loss “map” (“linear” ΔKE distribution)
- Better energy estimation for KE(calo) at low KE is expected

ΔKE_{ff} vs ΔKE_{end}: KE_{ff}(reco)=KE_{ff}(truth)

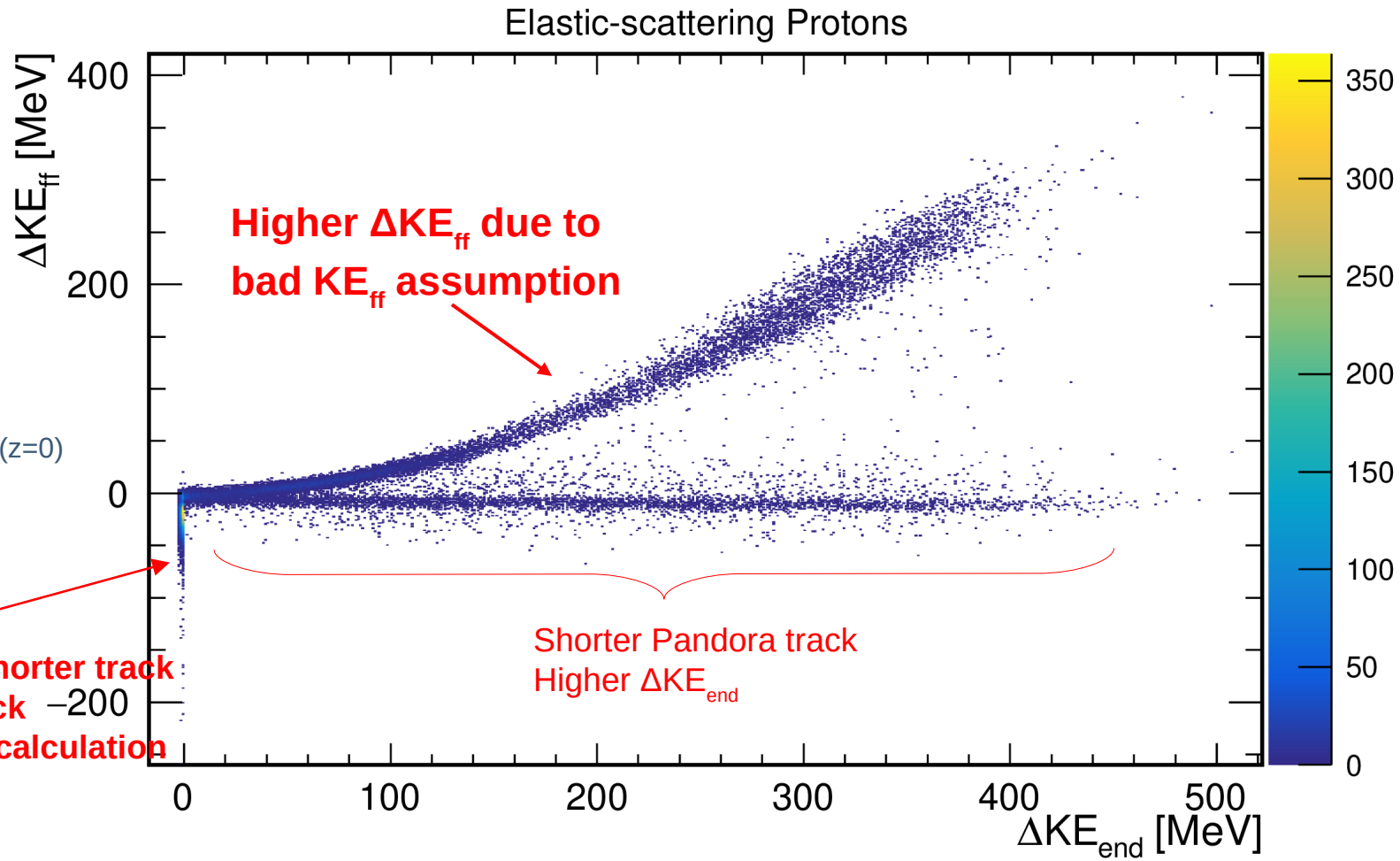
ΔKE_{ff}=KE_{ff}(reco)-KE_{ff}(truth)
KE_{ff}(truth):=KE at TPC front face (z=0)



ΔKE_{end}=KE_{end}(reco)-KE_{end}(truth)
KE_{end}(truth):=KE of the 2nd last true trajectory point (last one KE=0)

$$KE_{reco} = (KE_{beam} - \langle \Delta E \rangle) - \int \frac{dE}{dx} dx_{reco}$$

ΔKE_{ff} vs ΔKE_{end}: KE_{ff}(reco)=const. E-loss



$\Delta KE_{ff}=KE_{ff}(reco)-KE_{ff}(truth)$

$KE_{ff}(truth)$:=KE at TPC front face (z=0)

If KE_{ff} under-estimated

→ Bethe-Bloch expects shorter track but reco has longer track

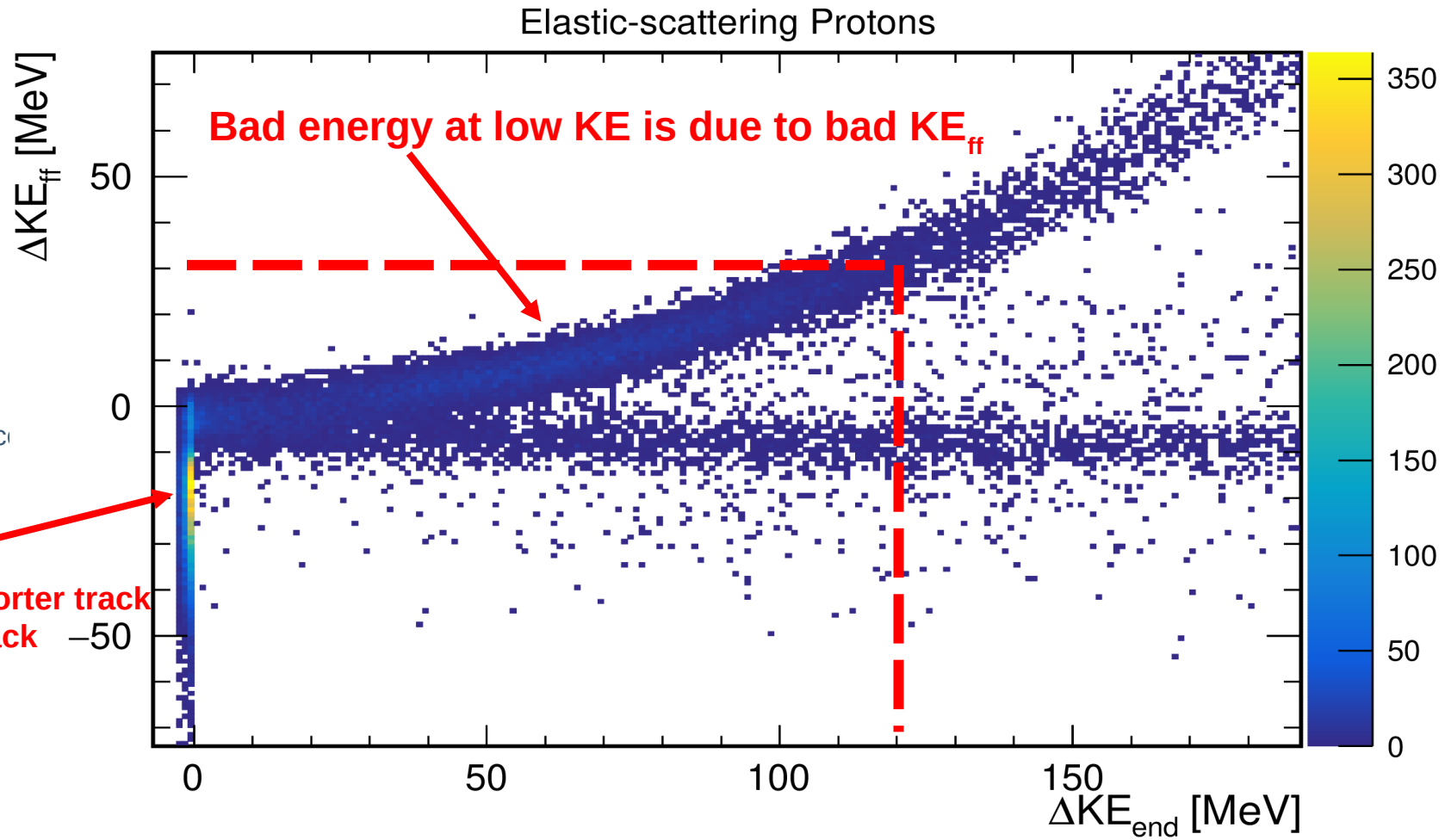
→ Negative ΔE occurs in calculation

→ Set KE=0

$\Delta KE_{end}=KE_{end}(reco)-KE_{end}(truth)$

$KE_{end}(truth)$:=KE of the 2nd last true trajectory point (last one KE=0)

ΔKE_{ff} vs ΔKE_{end}: KE_{ff}(reco)=const. E-loss



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If KE_{ff} under-estimated
→ Bethe-Bloch expect shorter track
But reco has longer track
→ Negative ΔE occurs
→ Set KE=0

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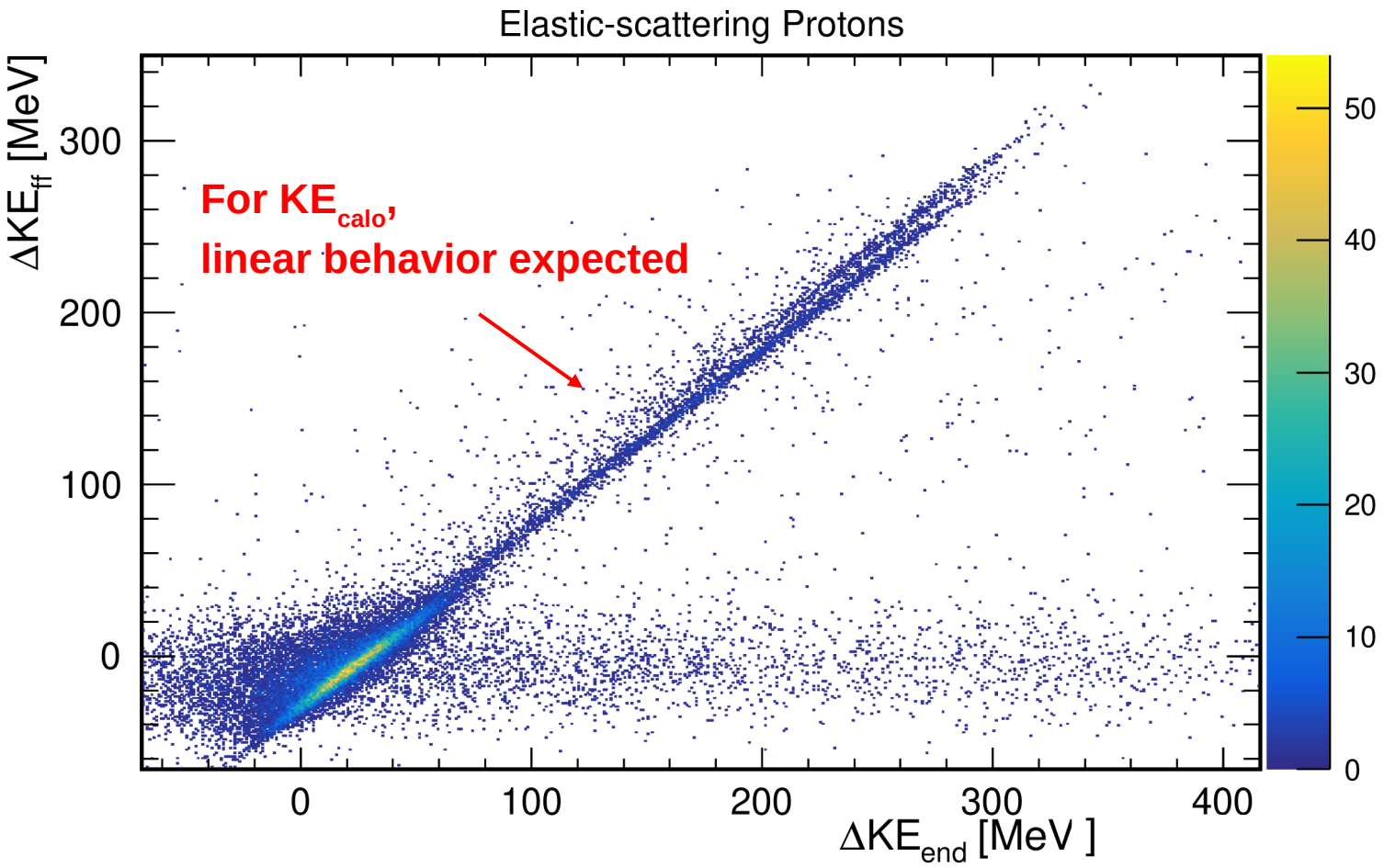
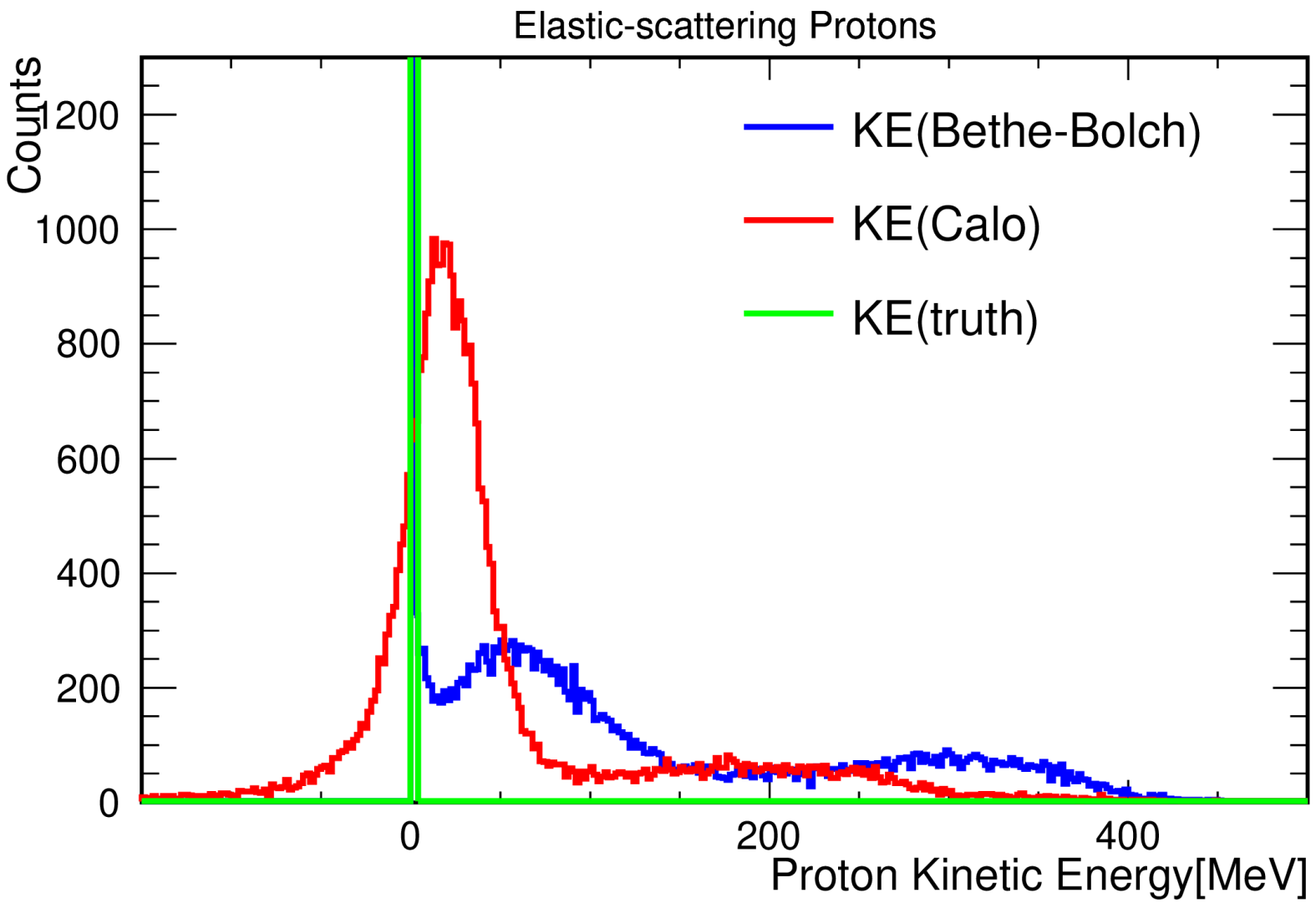


ΔKE_{end}=KE_{end}(reco)-KE_{end}(truth)
KE_{end}(reco)=Σ(dE/dx*dx)
KE_{end}(truth):=KE of the 2nd last true trajectory point (last one KE=0)

KE Comparison (with const. E-loss assumption)



Summary

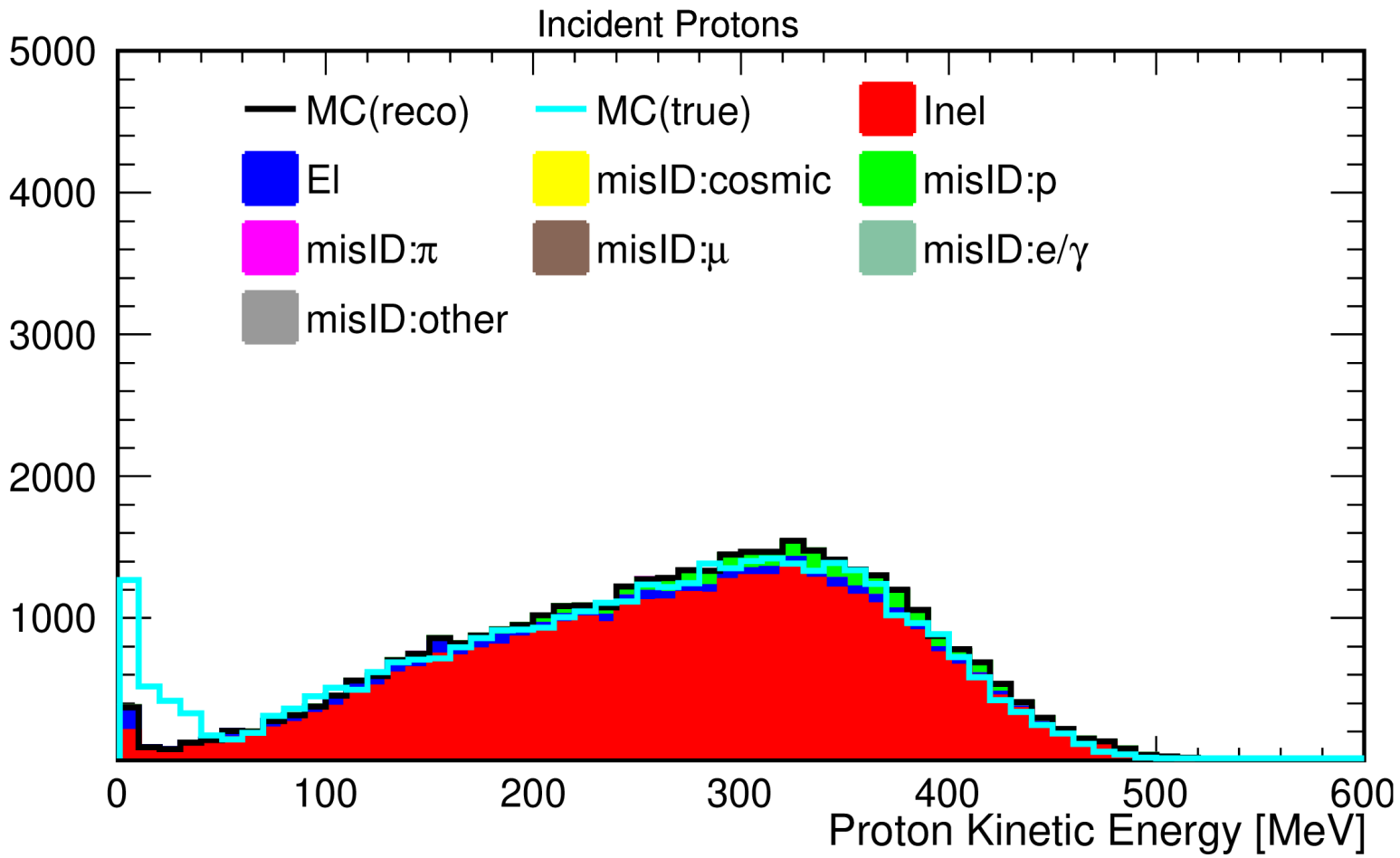
- Kinetic energy at TPC front face is critical for Bethe-Bloch-based energy estimation
  - Constant E-loss assumption worsen the performance at low KE

- Better energy estimation using calorimetric reconstruction

- Near-term goals
  - data/MC comparison using KE_{calo}+ potential improvement on $KE_{ff}(E)$
  - XS unblinding

Backup

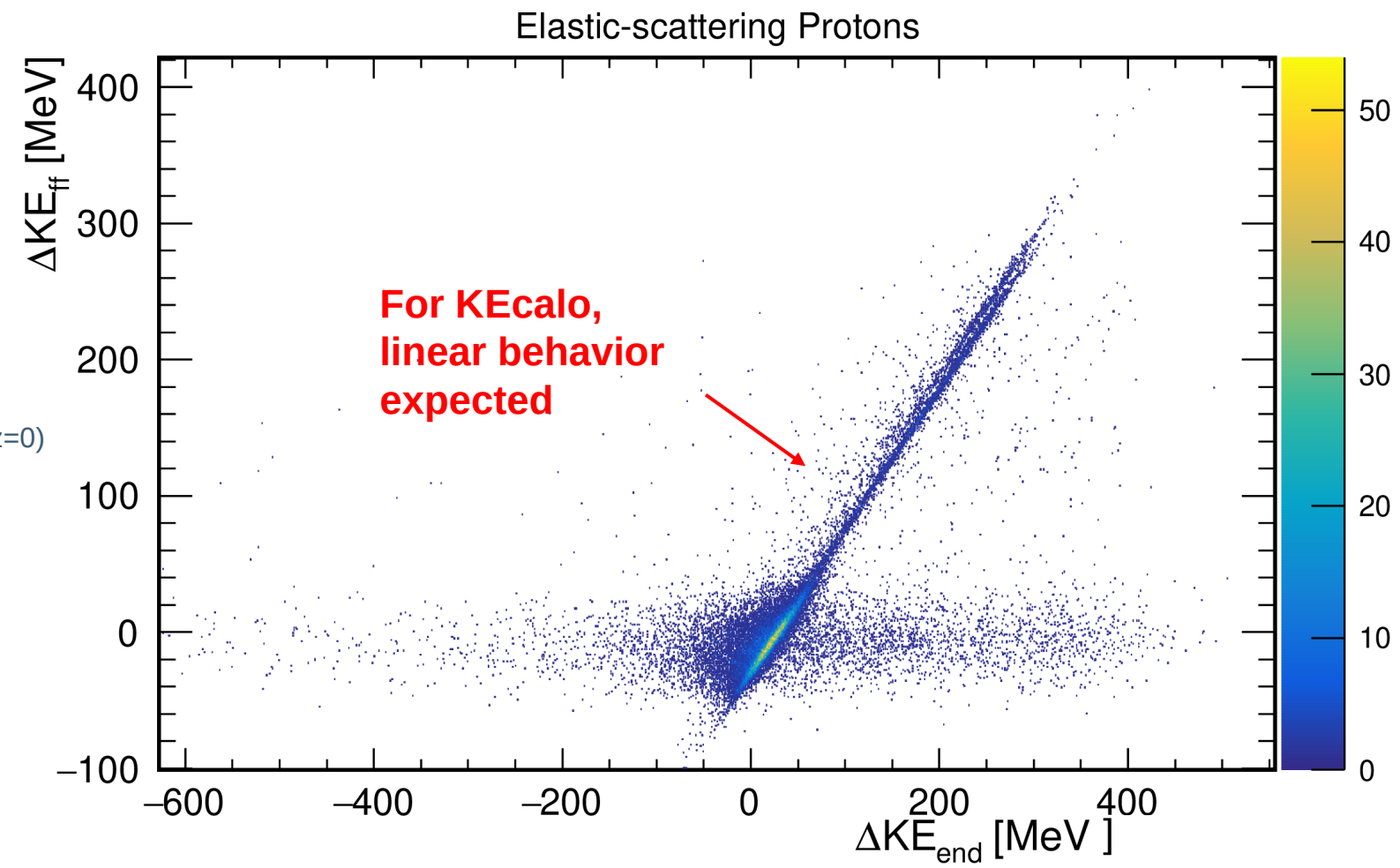
KE of Inelastic-scattering Protons



ΔKE_{ff} vs ΔKE_{end}: KE_{ff}(reco)=const. E-loss

$\Delta KE_{ff}=KE_{ff}(reco)-KE_{ff}(truth)$

$KE_{ff}(truth)$:=KE at TPC front face (z=0)

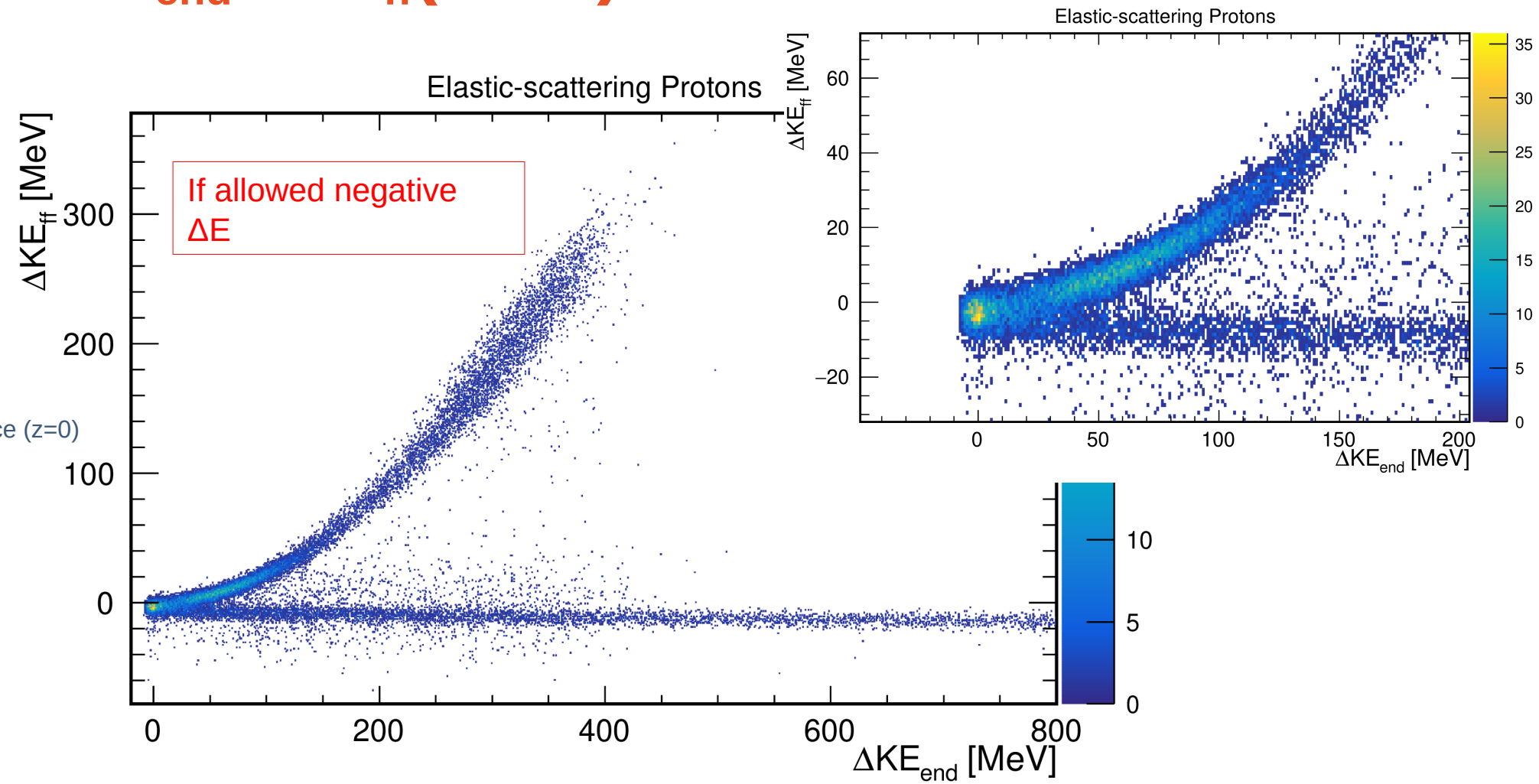


$\Delta KE_{end}=KE_{end}(reco)-KE_{end}(truth)$

$KE_{end}(reco)=sum(dE/dx*dx)$

$KE_{end}(truth)$:=KE of the 2nd last true trajectory point (last one KE=0)

ΔKE_{ff} vs ΔKE_{end}: KE_{ff}(reco)=const. E-loss



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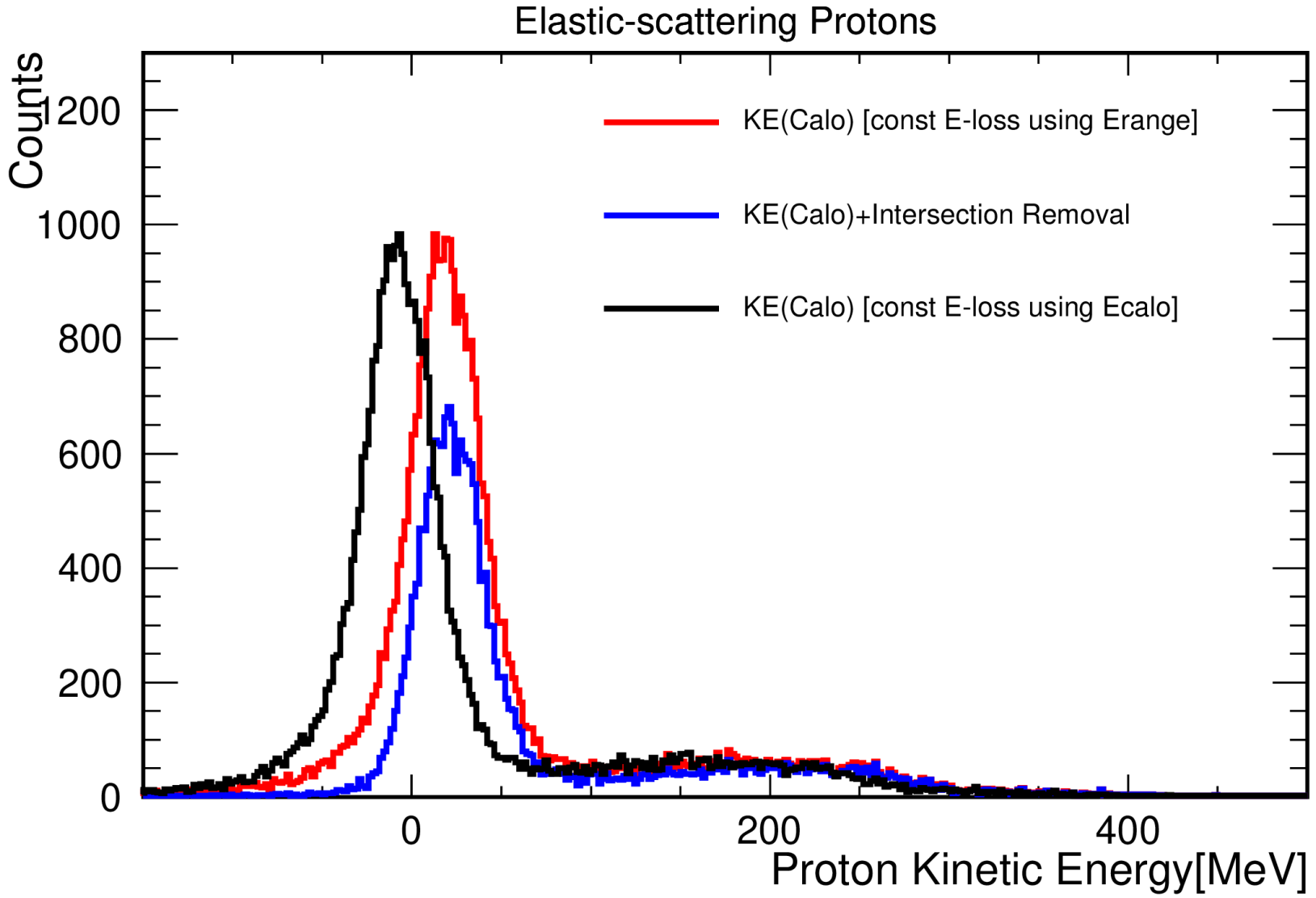
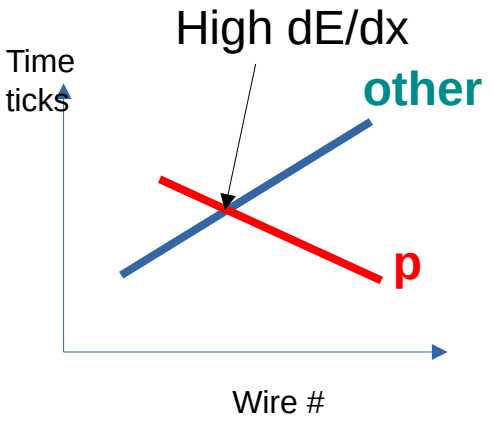
$\Delta KE_{end}=KE_{end}$(reco)-KE_{end}(truth)

KE_{end}(truth):=KE of the 2nd last true trajectory point (last one KE=0)

KEcalo Comparison



Intersection Removal



Energy loss [Stopping Protons]