Update on muon Signed Distance

Aug. 9, 2024

TMS

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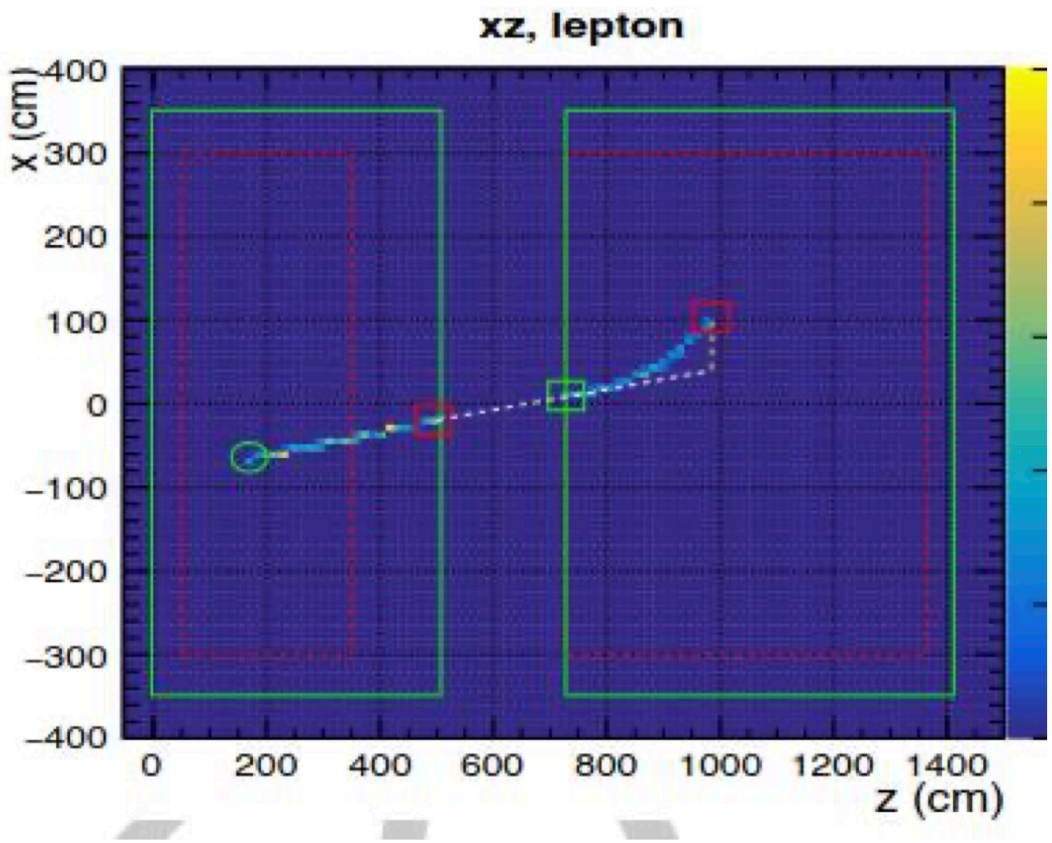
TMS muon signed distance

- Sushil did great work relating to the sign distance.
- Begun looking into Sushil's code to continue it and obtain some useful metrics about muon reco capabilities.
- Seems there is some interested in:
  - low-KE muons?
  - high-KE muons?



$$S.D = (x3 - x1) - (x2 - x1)(z3 - z1)/z2 - z1$$

[x1,z1] = **ND LAr exit**
[x2, z2] = **TMS start**
[x3, z3] = **TMS end**

Inputs

- I am working off of a new branch `sign_dist_mu_mom`, off of `main` branch from ~ few days ago.
- Using an FHC and RHC `tmsreco` file (below).
  - FHC is 1 T magnetic field.
  - Unsure of the RHC file B field.

```
/exp/dune/data/users/kleykamp/tmsreco_combined_files/2024-04-19_bfield_1p0T.tmsreco.root
/exp/dune/data/users/kleykamp/tmsreco_combined_files/2024-04-18_rhc_test_larger.tmsreco.root
```

Signed distance

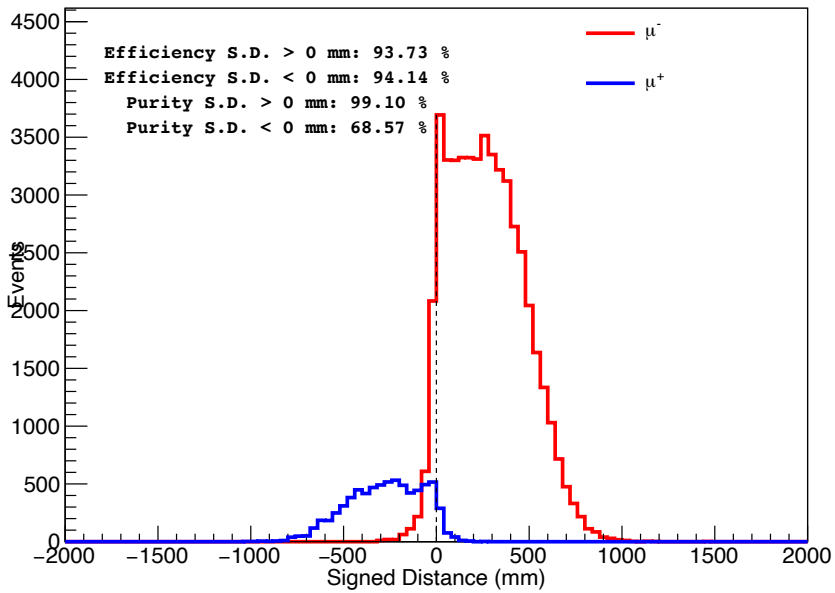
efficiency $_{\mu}$ = events of SD > 0 / all μ events

purity $_{\mu}$ = μ events of SD > 0 / all events of SD > 0

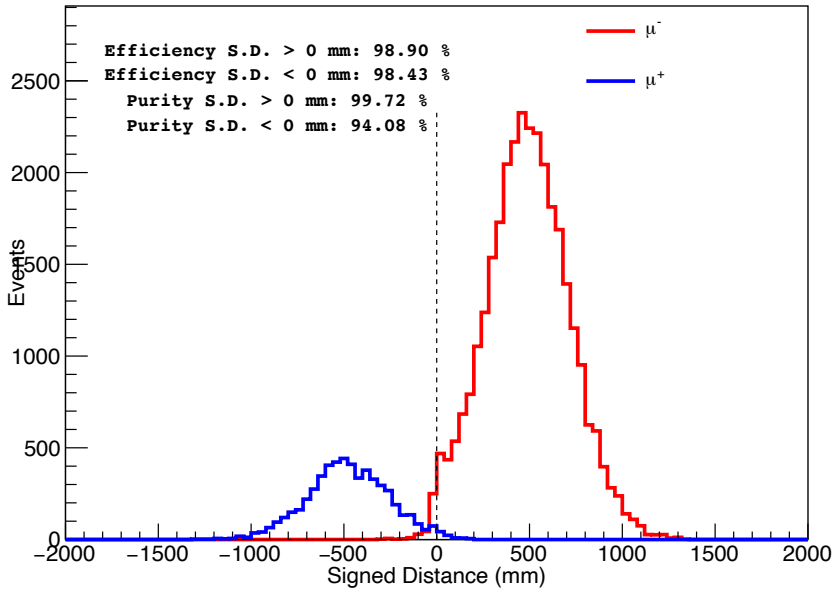
- Took Sushil's code slightly further:
  - made an attempt at an efficiency and purity metric.

$$S.D = (x3 - x1) - (x2 - x1)(z3 - z1)/z2 - z1$$

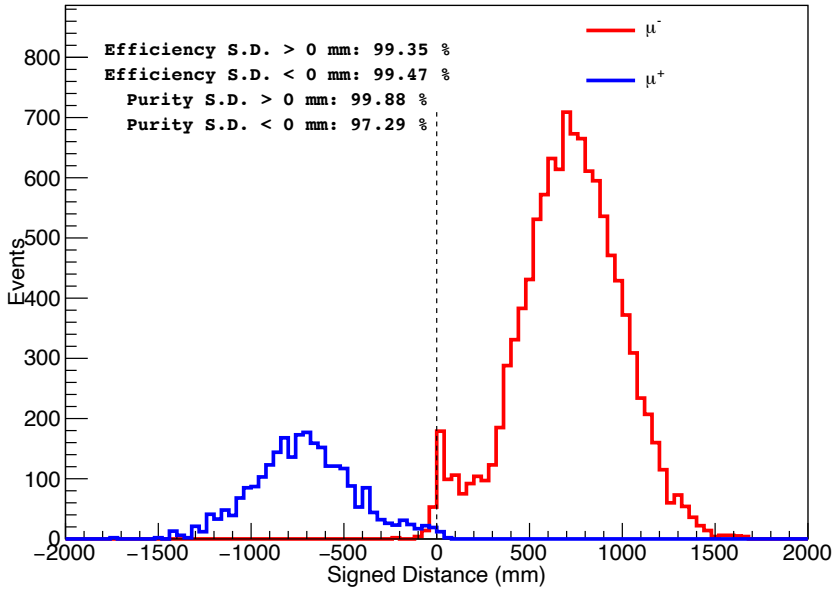
1000.0 < KE$_{\mu}$ < 2000.0 MeV



2000.0 < KE$_{\mu}$ < 3000.0 MeV



3000.0 < KE$_{\mu}$ < 4000.0 MeV



Signed distance

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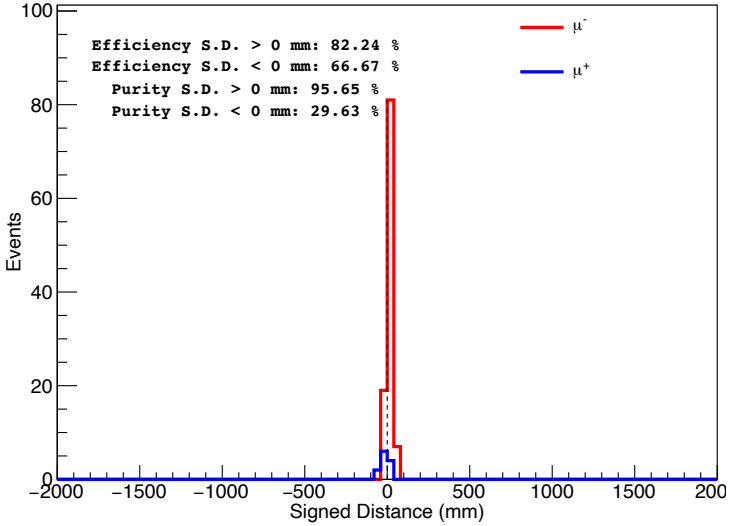
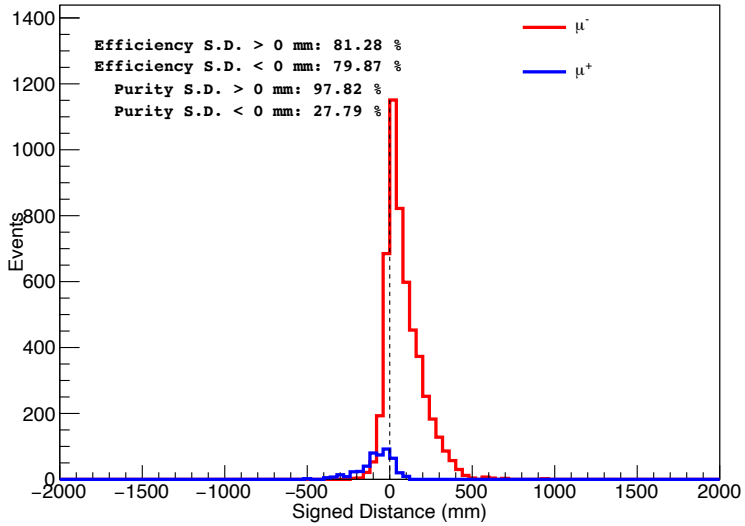
- Took Sushil's code slightly further:
  - made an attempt at an efficiency and purity metric.
  - broke down the muon KE into finer binning at the low and high KE ranges.

$$S.D = (x3 - x1) - (x2 - x1)(z3 - z1)/z2 - z1$$

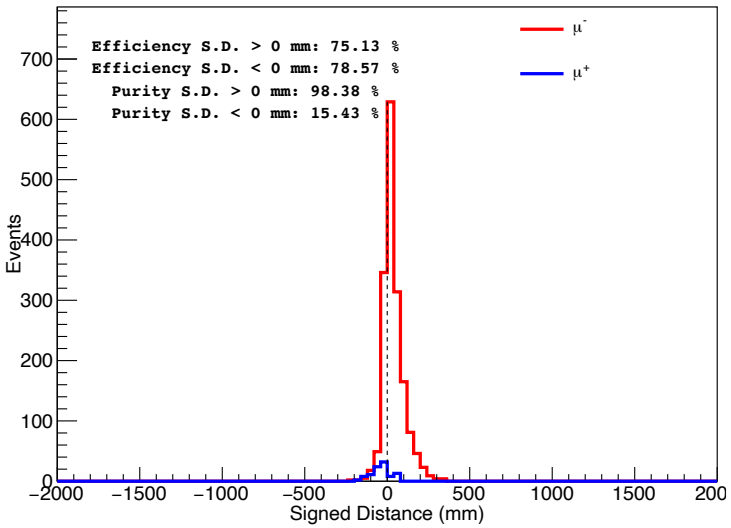
0.0 < KE$_{\mu}$ < 250.0 MeV



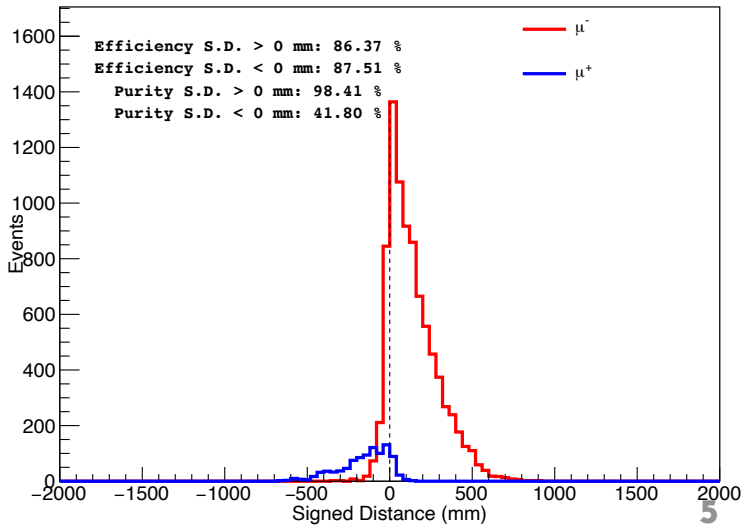
500.0 < KE$_{\mu}$ < 750.0 MeV



250.0 < KE$_{\mu}$ < 500.0 MeV



750.0 < KE$_{\mu}$ < 1000.0 MeV



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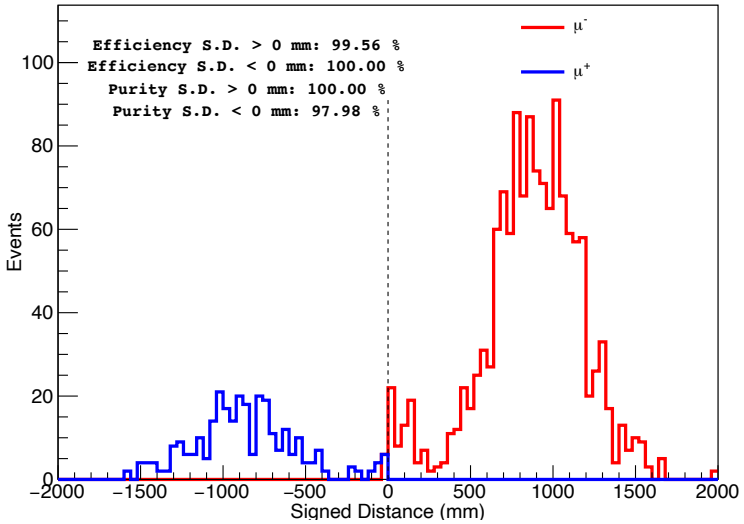
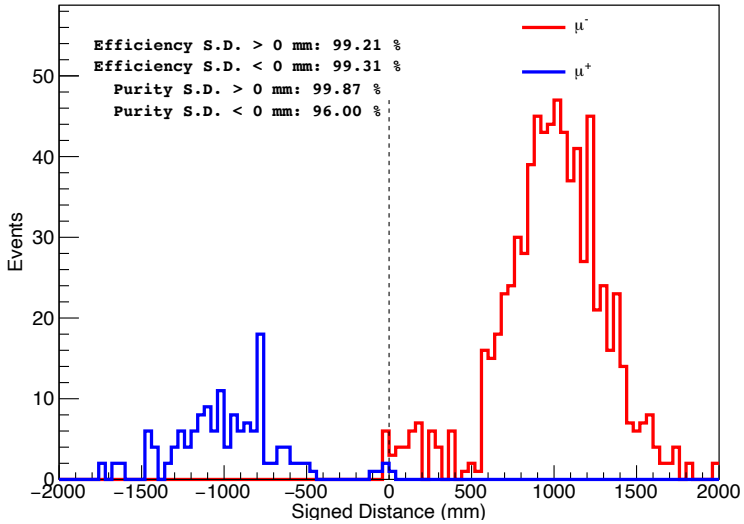
$$S.D = (x3 - x1) - (x2 - x1)(z3 - z1)/z2 - z1$$

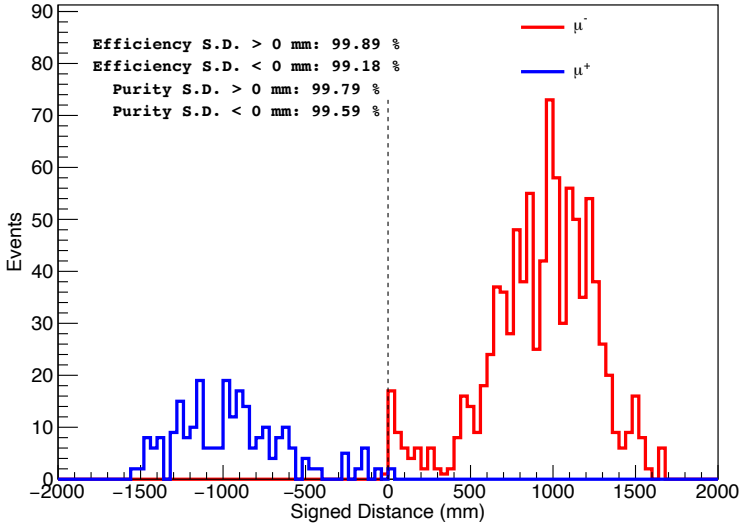
4000.0 < KE$_{\mu}$ < 4250.0 MeV



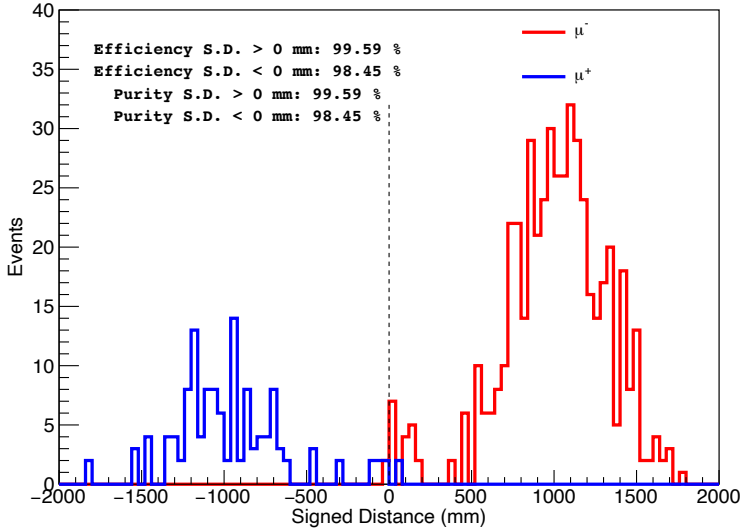
4500.0 < KE$_{\mu}$ < 4750.0 MeV



4250.0 < KE$_{\mu}$ < 4500.0 MeV



4750.0 < KE$_{\mu}$ < 5000.0 MeV



Next Steps

- Showed some metrics of identifying sign of muon using sign distance.
  - These are not *exactly* efficiency and purity metrics.
  - Unsurprisingly, these are more relevant for low KE muons.
  - Insufficient statistics from RHC, would like to have more μ^+ events for these metrics.
  - Planning on using other `tmsreco` files of different B fields and calculate the metrics there — hope to produce a single plot of all sign distance distributions.
- Would welcome input on **what other metrics** people would like to see.