Update on muon Signed Distance

Aug. 16, 2024

TMS

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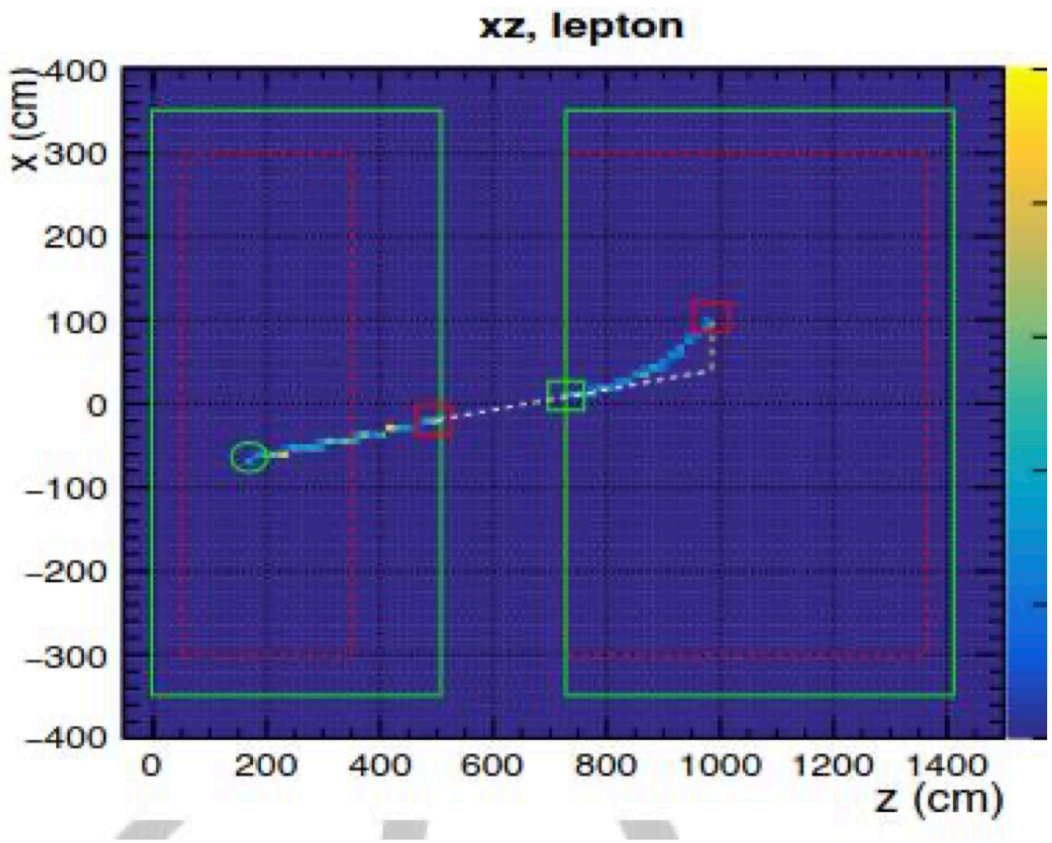
TMS muon signed distance

- Sushil did great work relating to the sign distance.
- Last time showed plots of the signed distance in slices of muon KE.
  - Finer binned at low and high KE.
- The muon KE last time was the “birth” KE.
- This time also have plots using the muon KE **entering TMS**.



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

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

Inputs & Outputs

- 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.
- Also have 0 T and 2 T plots in the back up.
  - All of the plots can be found in my data area.

```
/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

/exp/dune/data/users/mdolce/dune-tms/dune-tms_hists/signed_distance_momentum_slices/fhc+rhc/
```

Signed distance

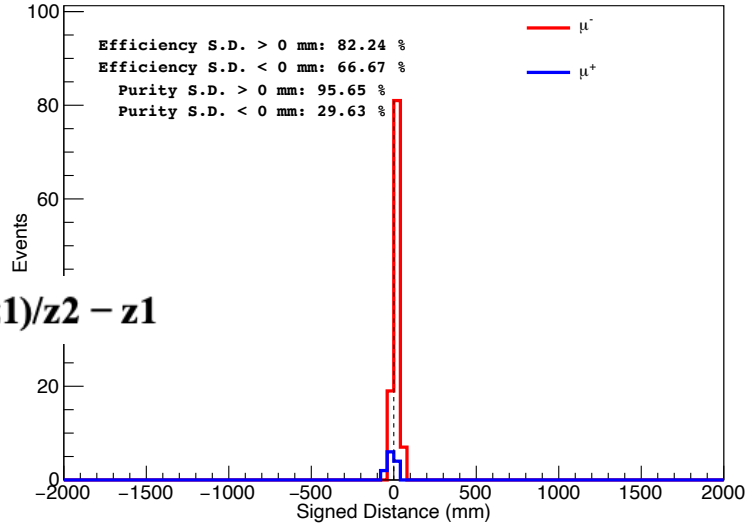
efficiency $_{\mu}$ = events of SD > 0 / all μ events

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

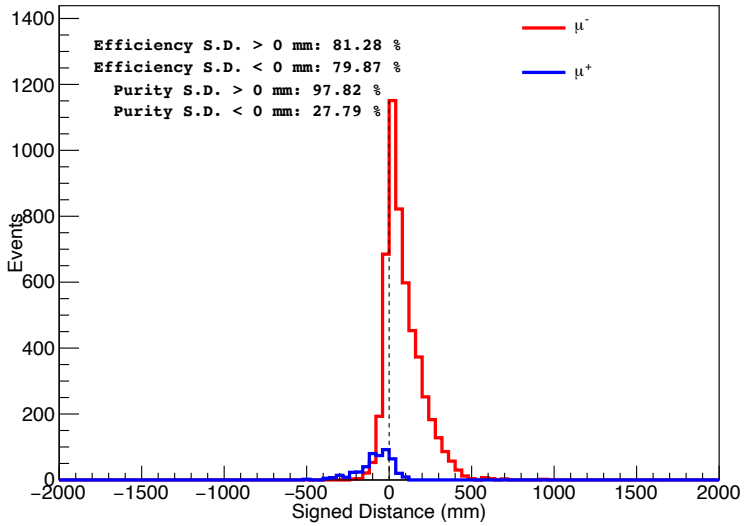
- Previously showed this — KEμ at its "birth".

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

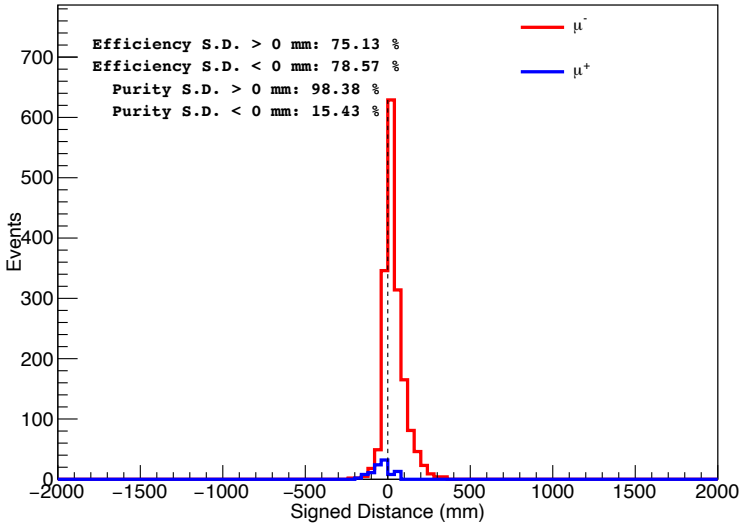
0.0 < KE$_{\mu}$ < 250.0 MeV Inside LAr



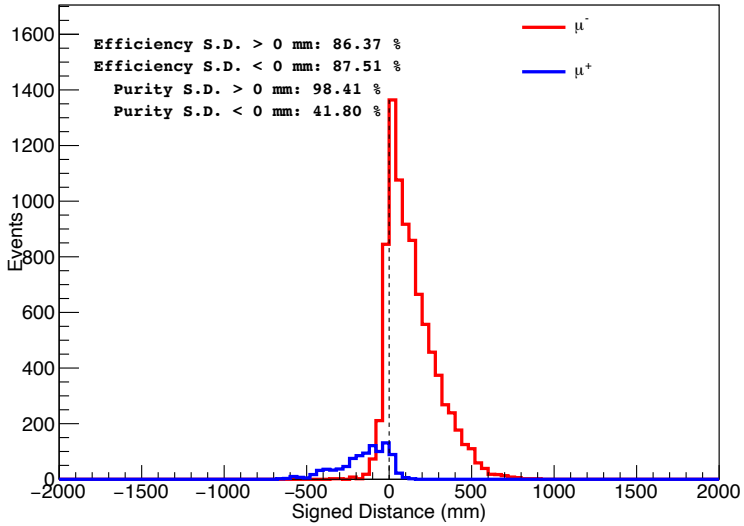
500.0 < KE$_{\mu}$ < 750.0 MeV Inside LAr



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



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



Signed distance

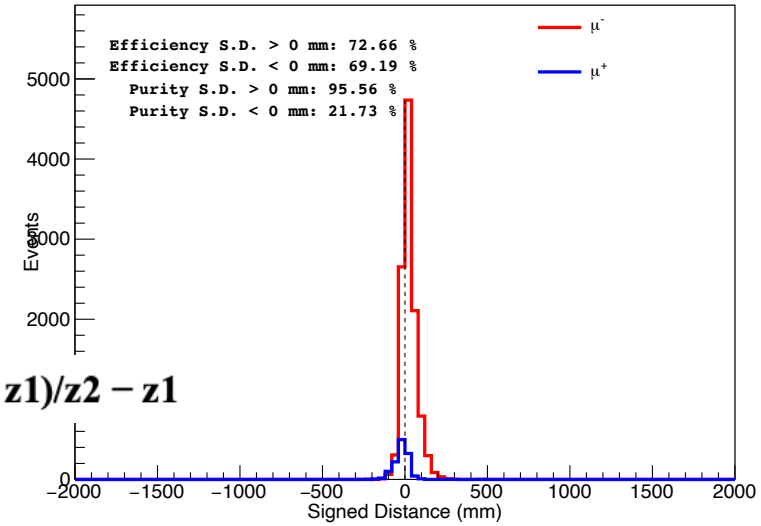
efficiency $_{\mu}$ = events of SD > 0 / all μ events

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

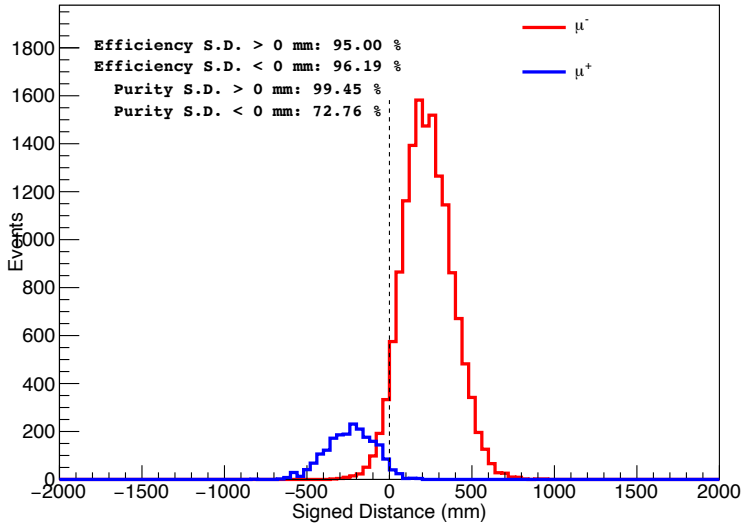
- Now have plots of the KEμ entering TMS.

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

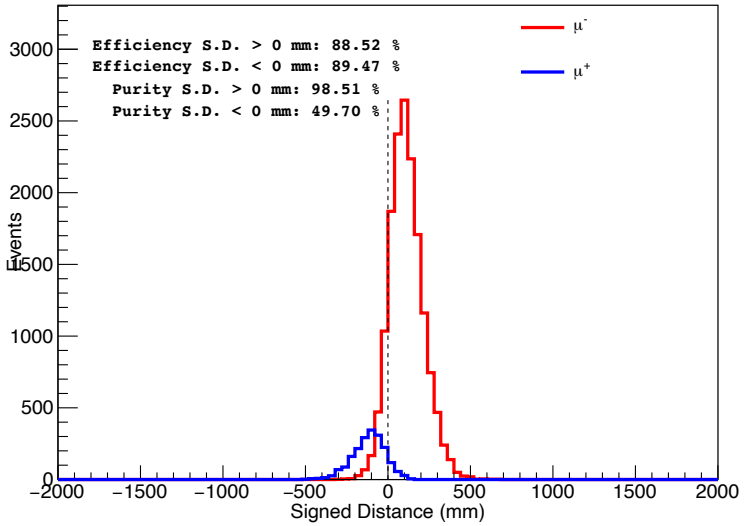
0.0 < KE_{μ} < 250.0 MeV Entering TMS



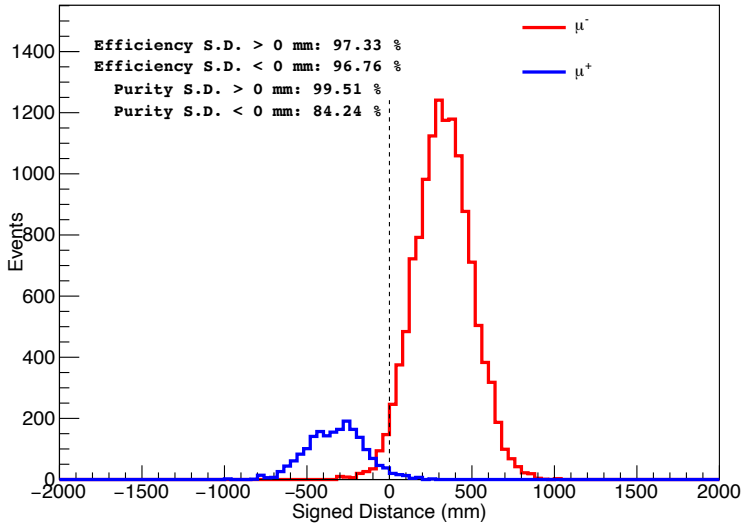
500.0 < KE_{μ} < 750.0 MeV Entering TMS



250.0 < KE_{μ} < 500.0 MeV Entering TMS



750.0 < KE_{μ} < 1000.0 MeV Entering TMS



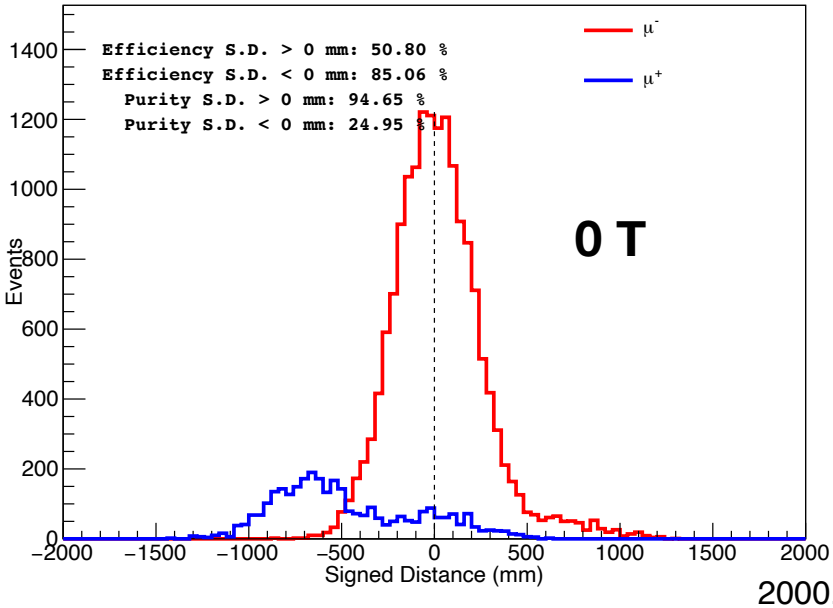
Signed distance

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

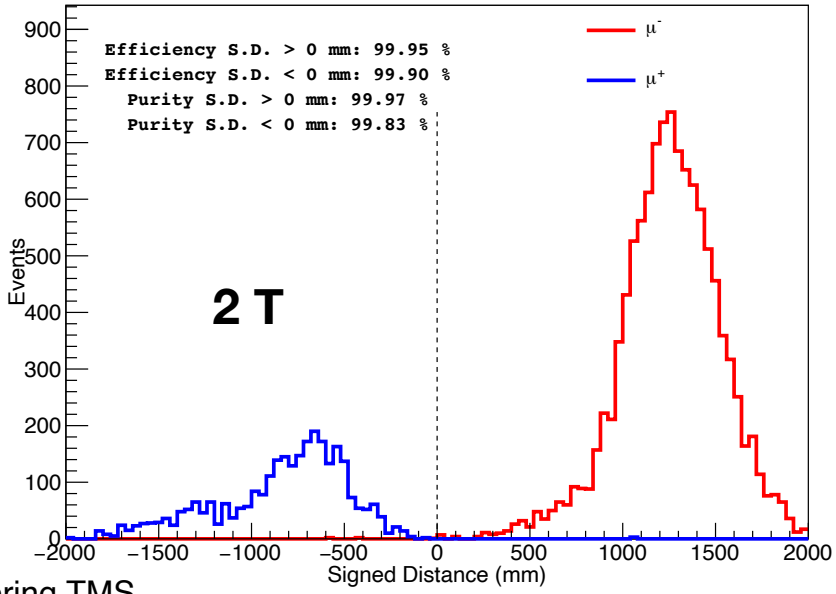
purity $_{\mu}$ = μ events of SD > 0 / all events of SD > 0

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

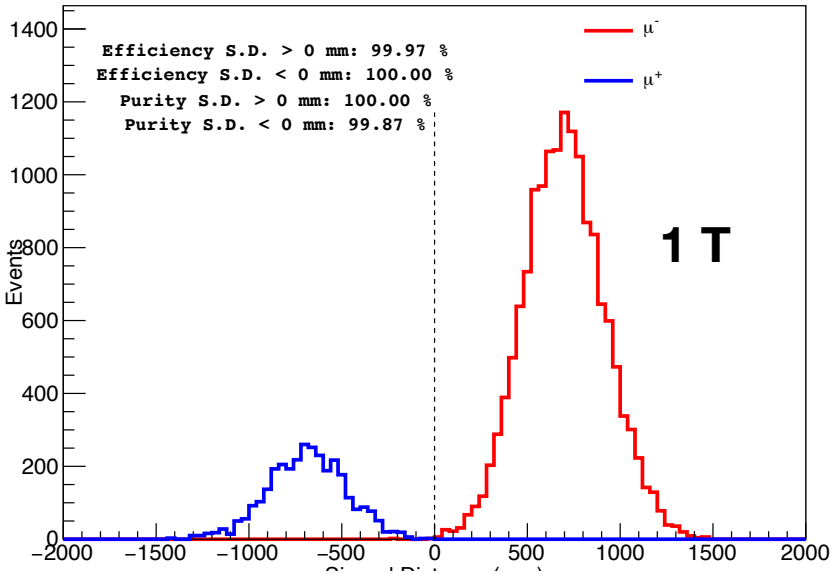
2000.0 < KE_{μ} < 3000.0 MeV Entering TMS



2000.0 < KE_{μ} < 3000.0 MeV Entering TMS



2000.0 < KE_{μ} < 3000.0 MeV Entering TMS



- Also made plots for 0 T and 2 T magnetic fields.

Summary & Next Steps

- Showed the muon sign distance using the muon KE as it enters TMS:
  - Now have complimentary plots — KEμ "birth" **and** KEμ entering TMS.
- Also have plots of 0 T and 2 T magnetic fields in these KE slices.
- Plan to create a PR of this code.
- Was going to move onto reproducing the efficiency plots Sushil had made?
  - And then create a purity plot too.
  - I think the ideal goal is a single plot of all efficiencies & purities for different B fields?
- Would welcome input on **what other metrics** people would like to see.
- Hope to have a "complete" set of plots (sign distance, efficiency, purity) for the collaboration meeting.

Backup

Signed distance

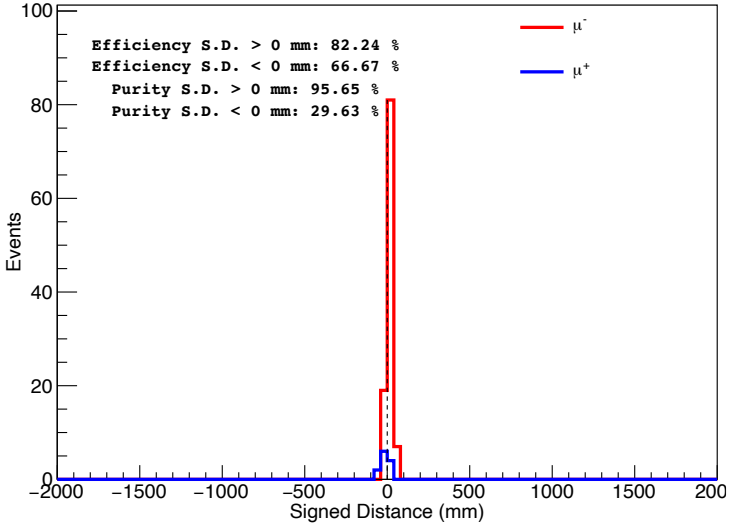
efficiency $_{\mu}$ = events of SD > 0 / all μ events

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

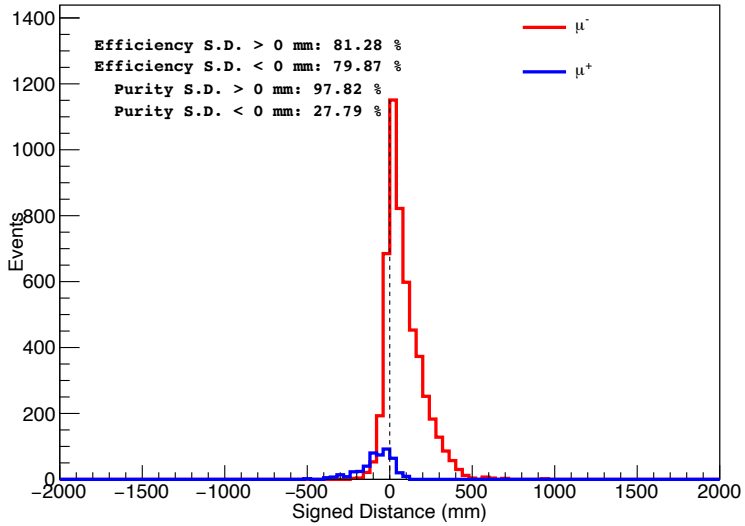
- Took Sushil's code slightly further:
  - made an attempt at an efficiency and purity metric.
  - broke down the muon KE into finer binning at the low and high KE ranges.

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

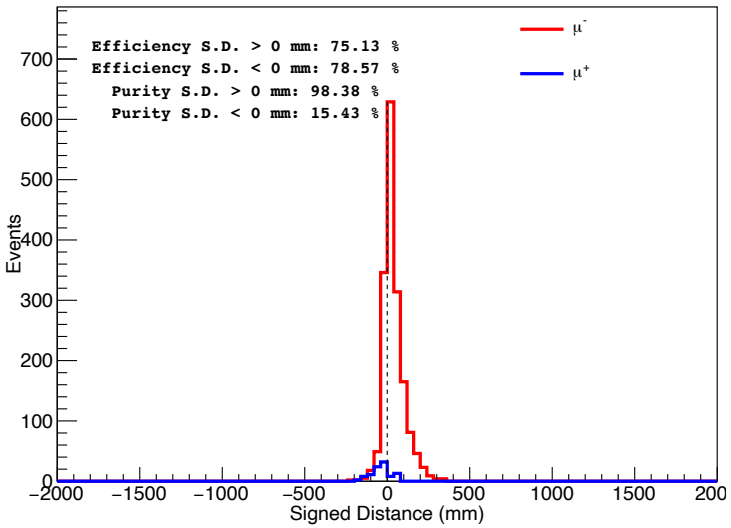
0.0 < KE$_{\mu}$ < 250.0 MeV



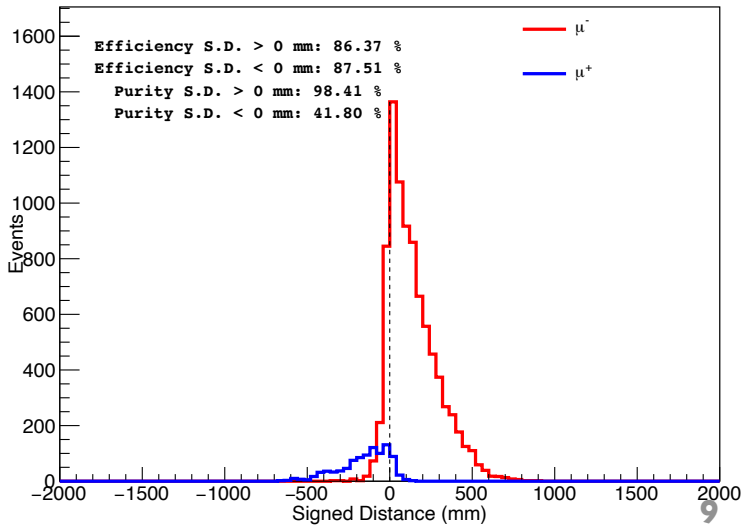
500.0 < KE$_{\mu}$ < 750.0 MeV



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



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



Signed distance

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- Took Sushil's code slightly further:
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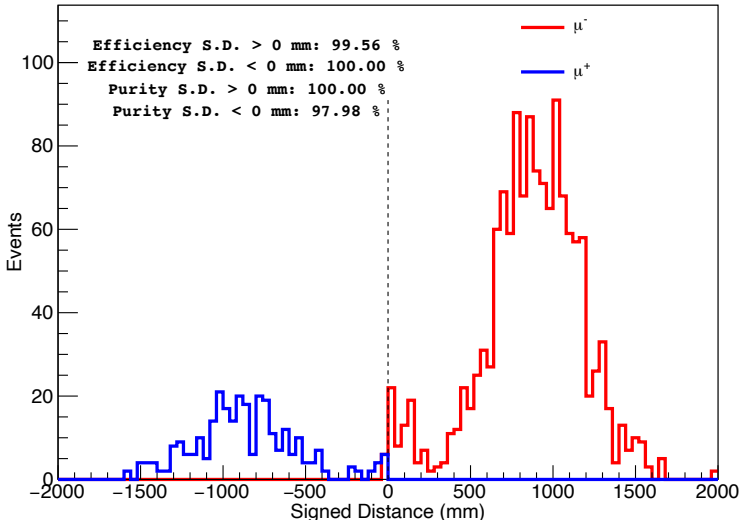
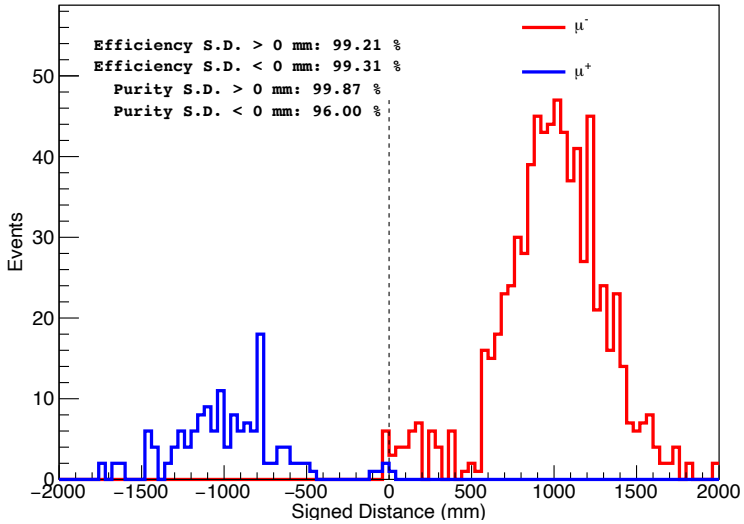
  - broke down the muon KE into finer binning at the low and high KE ranges.

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

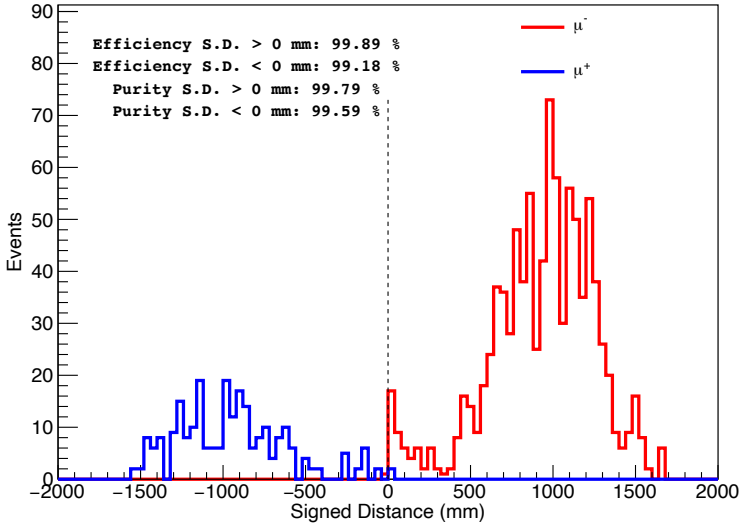
4000.0 < KE$_{\mu}$ < 4250.0 MeV



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



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



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