



Tracking with ML



12th March 2025



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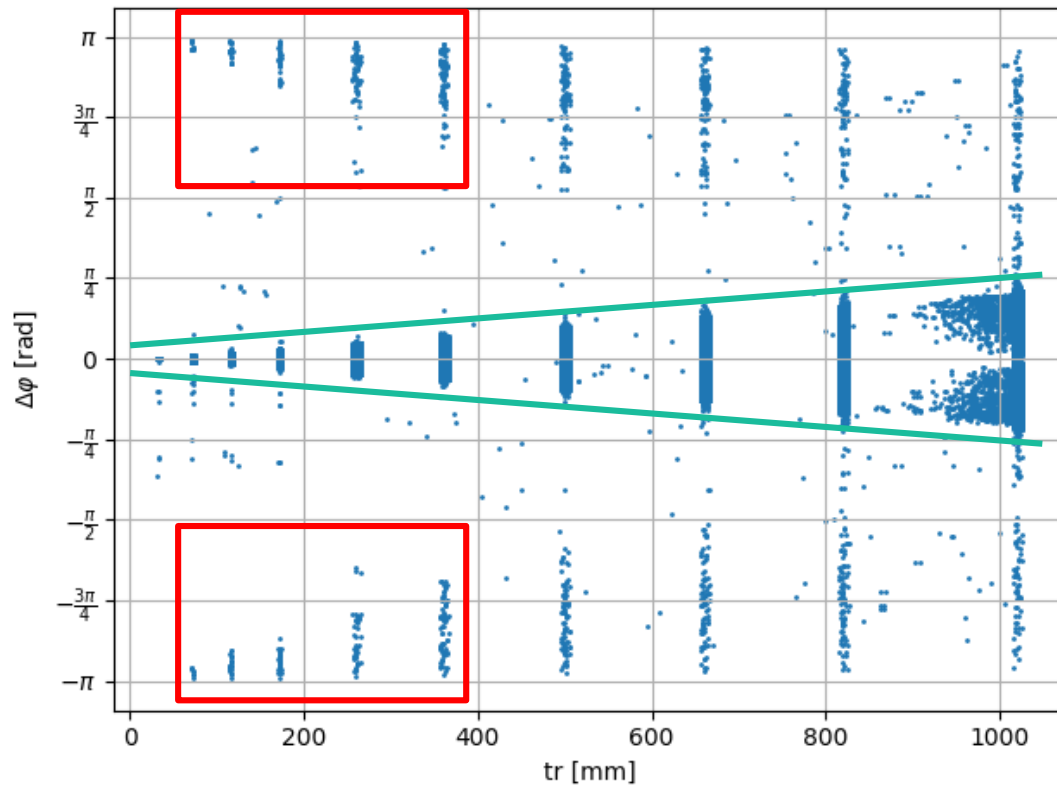


TrackML ordering

- Hits are ordered by hit_id  Now sorted by increasing r

```
hit_id,particle_id,tx,ty,tz,tpx,tpy,tpz,weight
1,238692979273891840,-80.9456,-2.79212,-1502.5,-0.590201,0.00048014,-10.9195,8.87687e-06
2,562952221164044288,-85.8414,-8.60983,-1502.5,-0.748309,-0.0482825,-12.9929,1.22875e-05
3,580971979792711680,-55.6029,-2.71937,-1502.5,-1.31981,-0.0822062,-35.9337,2.36343e-05
4,526926104204673024,-91.9881,-7.60417,-1502.5,-0.215943,-0.0481328,-3.59351,1.02102e-05
5,243194654755913728,-68.1597,-7.73106,-1502.5,-0.64949,-0.0550967,-14.1959,1.08742e-05
6,202663220182253568,-89.0733,-8.16277,-1502.5,-9.33948,-0.832797,-158.115,4.40869e-05
7,0,-34.5591,0.514809,-1502.5,273214,-202257,-940450,0
8,450365047978328064,-46.6731,1.51579,-1502.5,-0.149702,0.0291769,-3.55807,2.71211e-05
9,653022564444012544,-66.7133,-1.54152,-1502.5,-0.816136,-0.0396834,-18.4384,1.33569e-05
10,202665350486032384,-84.8123,-12.3674,-1502.5,-2.29106,-0.360969,-40.7477,3.22125e-05
11,716072821788246016,-90.6612,-12.7967,-1502.5,-0.671139,-0.0655739,-11.107,1.2134e-05
12,513421764953374720,-72.6399,1.76471,-1502.5,-0.766712,0.0356306,-15.7532,1.35032e-05
13,517918904949932032,-136.497,-5.77588,-1502,-0.207892,0.0341211,-2.26381,8.97256e-06
14,0,-167.817,-13.0342,-1502,285499,-33313.5,-957800,0
15,342275633264459776,-152.347,-0.555296,-1502,-0.403204,0.0413873,-3.95018,6.95863e-06
16,441357298967773184,-117.505,1.18236,-1502,-0.264455,0.0390799,-3.37731,1.21215e-05
17,585470356739850240,-149.285,-9.87994,-1502,-3.0065,-0.154082,-30.1249,3.47931e-05
18,504405975764041728,-124.664,-2.30182,-1502,-1.17538,-0.0549401,-14.298,1.66494e-05
19,0,-139.849,-11.1444,-1502,-670351,324178,-667487,0
20,45036408590565376,-105.828,1.00979,-1502,-1.43561,0.0430129,-20.2756,2.20411e-05
21,414332746266050560,-118.636,-9.78046,-1502,-0.216825,-0.0508236,-2.78742,1.11102e-05
22,414332746266050560,-118.324,-9.70817,-1498,-0.21766,-0.0497417,-2.78965,9.62886e-06
23,0,-139.088,-27.7523,-1498,-217577,-117578,-968935,0
```

$\Delta\phi$ distribution



78 602 test particles

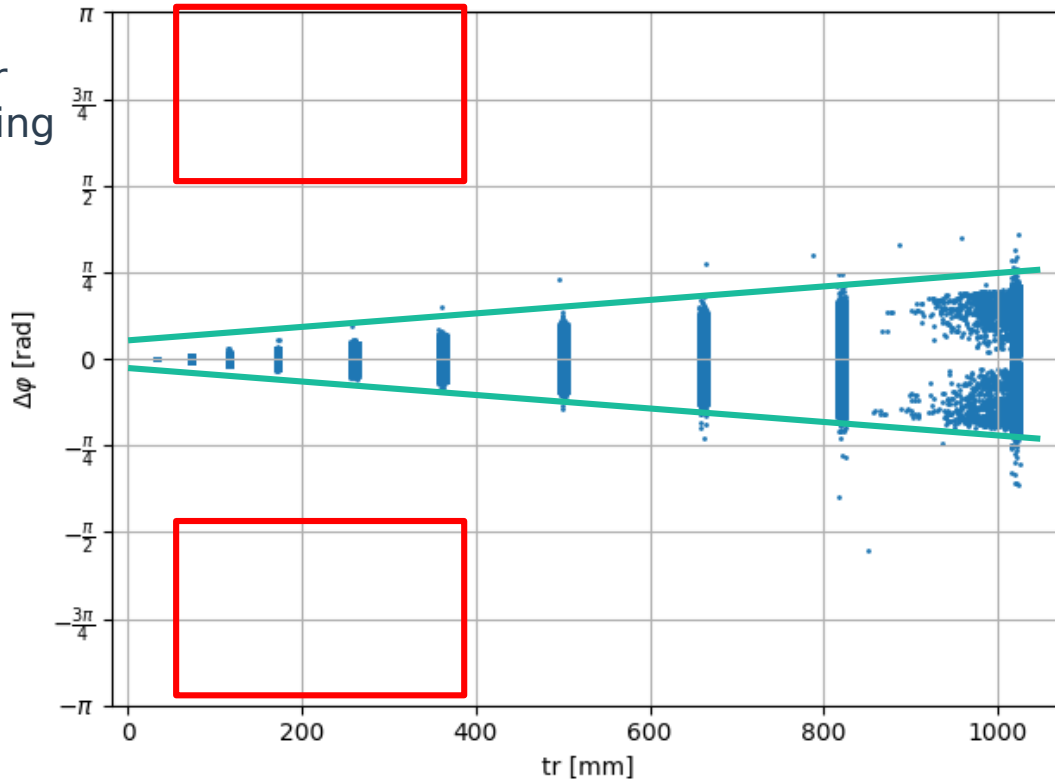
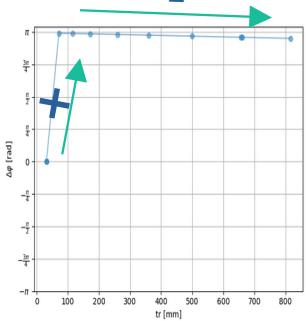
Expected

Not expected

$\Delta\phi$ distribution after scattering cut

Cut any sign change in $d(\Delta\phi)/dr$
→ remove all scattering

~ 0.3 % of the dataset
(257 particles)



78 345 test particles

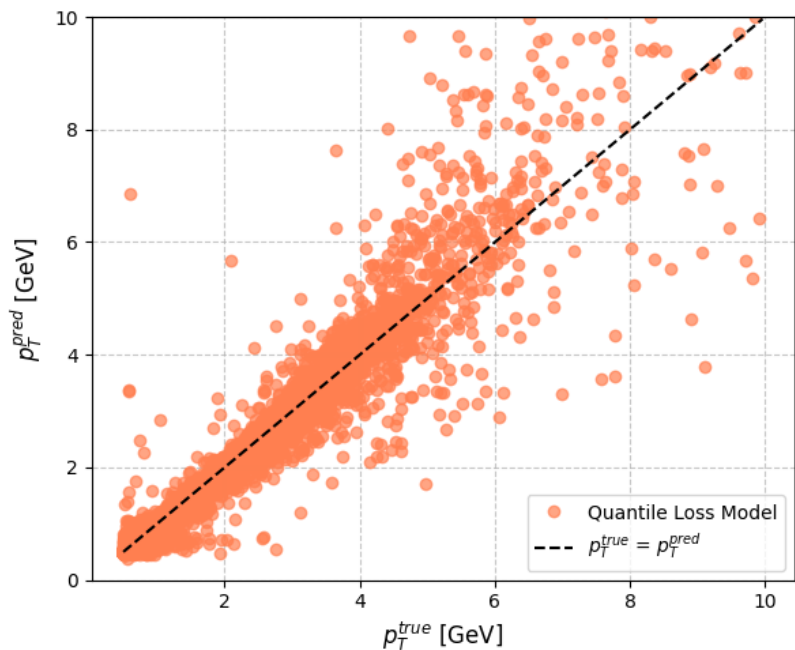
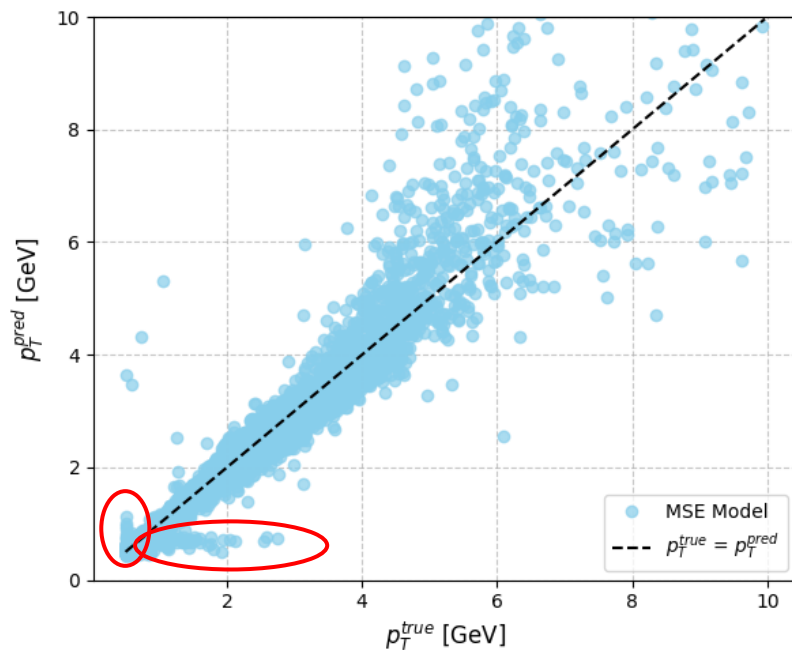
Expected

Not expected

Impact on predictions

p_T^{true} vs p_T^{pred} (($tr, d\phi, tz$) \rightarrow ($q/p_T, p_z$))

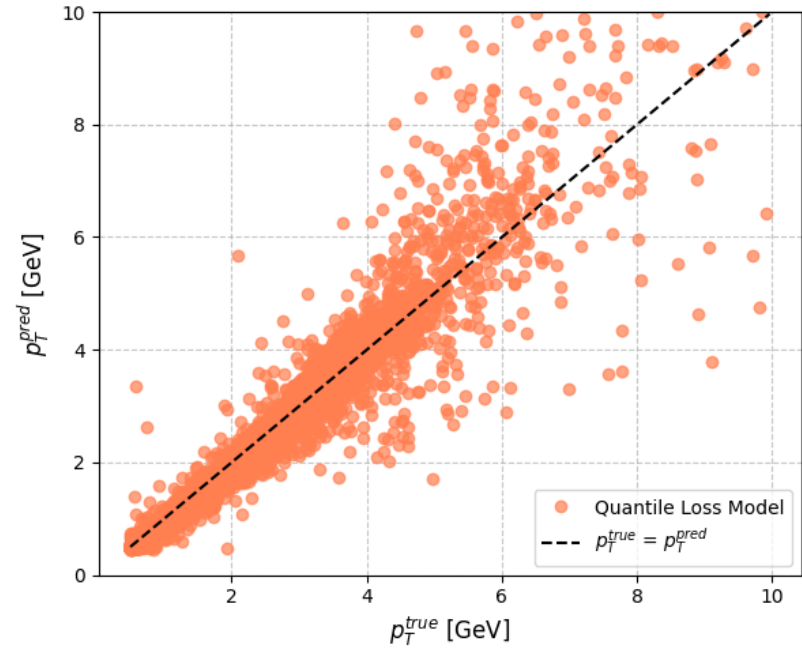
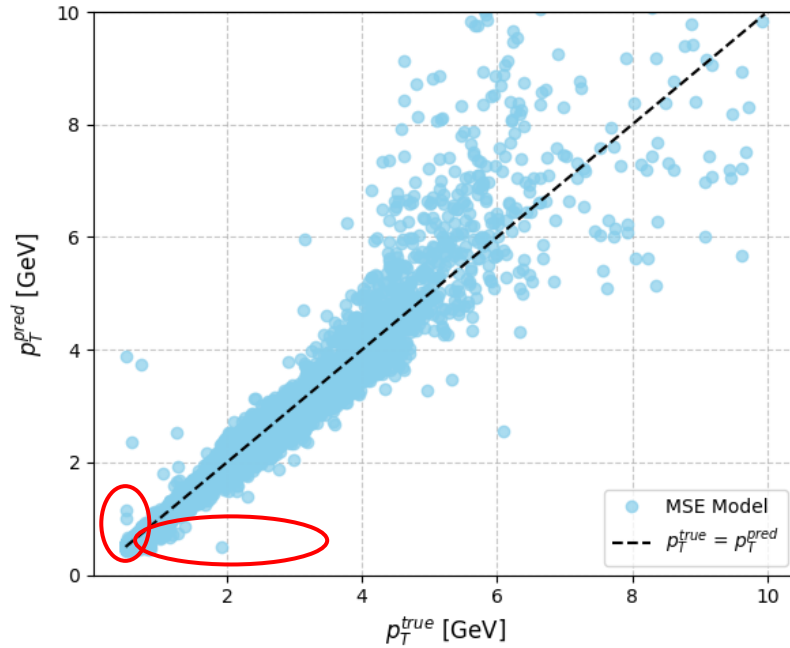
No scattering cut



Impact on predictions

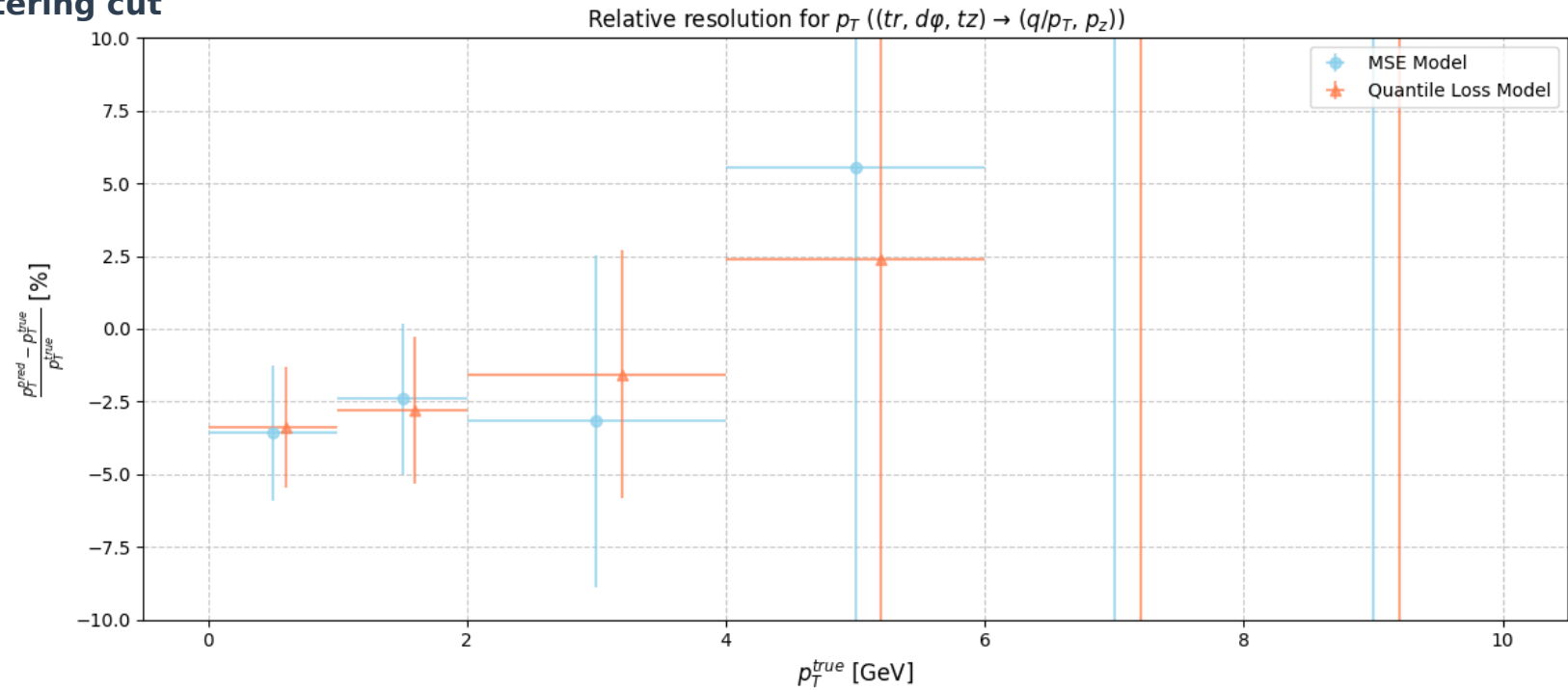
p_T^{true} vs p_T^{pred} (($tr, d\phi, tz$) \rightarrow ($q/p_T, p_z$))

Scattering cut (test only)



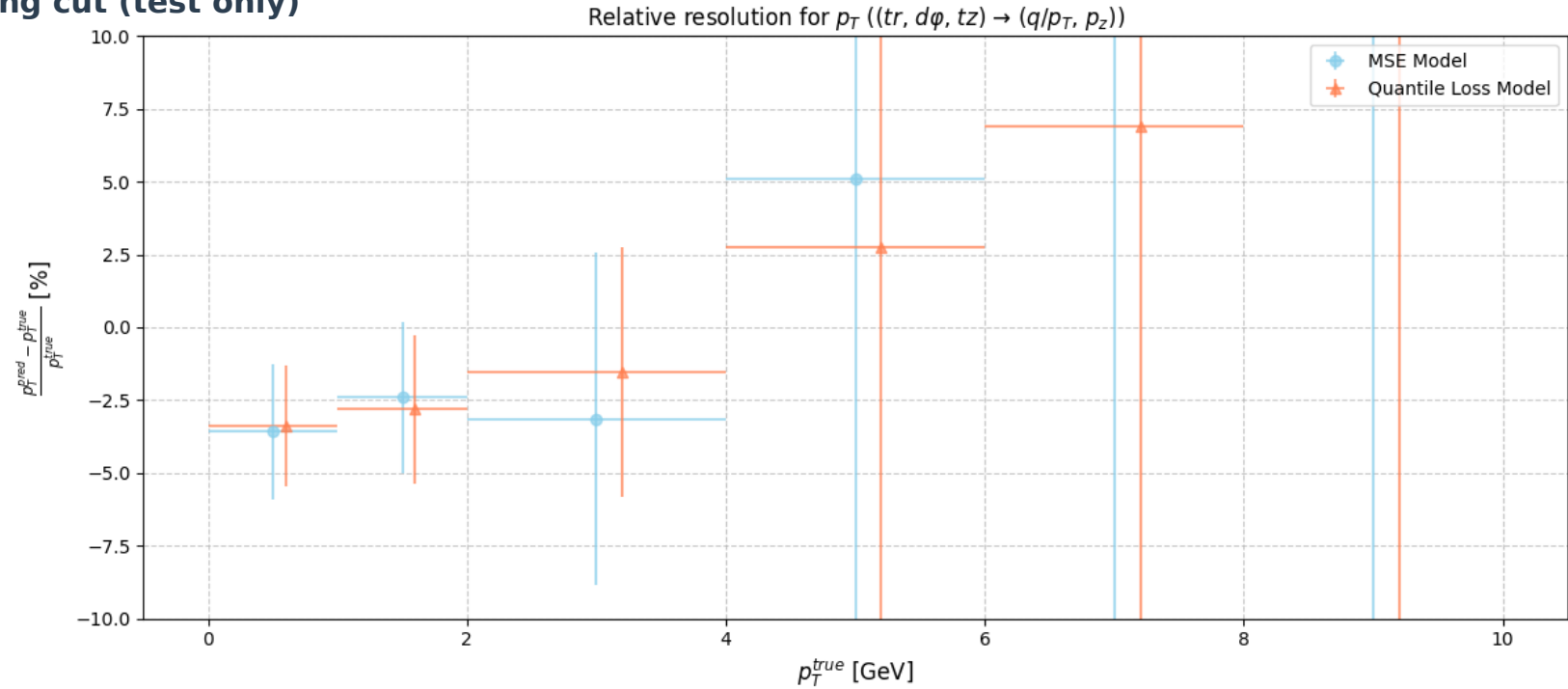
Impact on resolutions

No scattering cut



Impact on resolutions

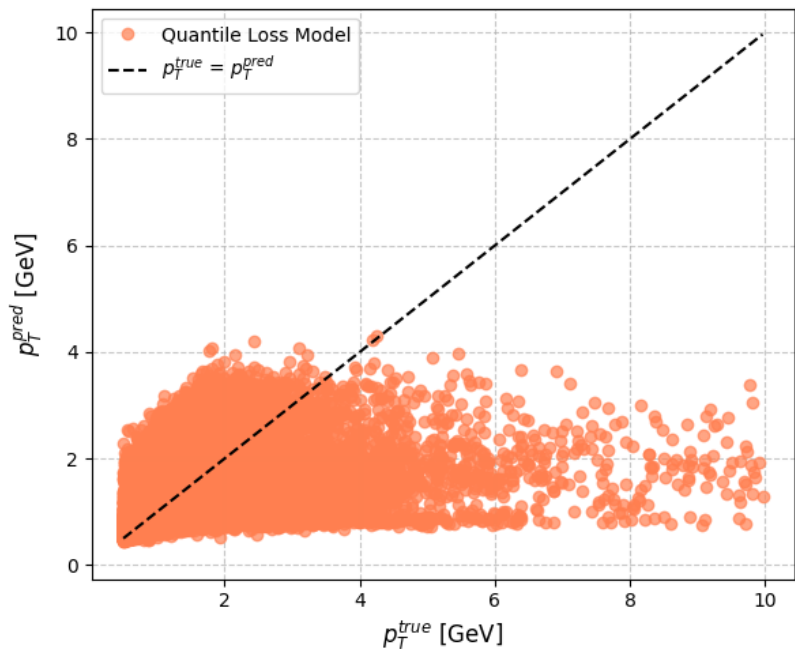
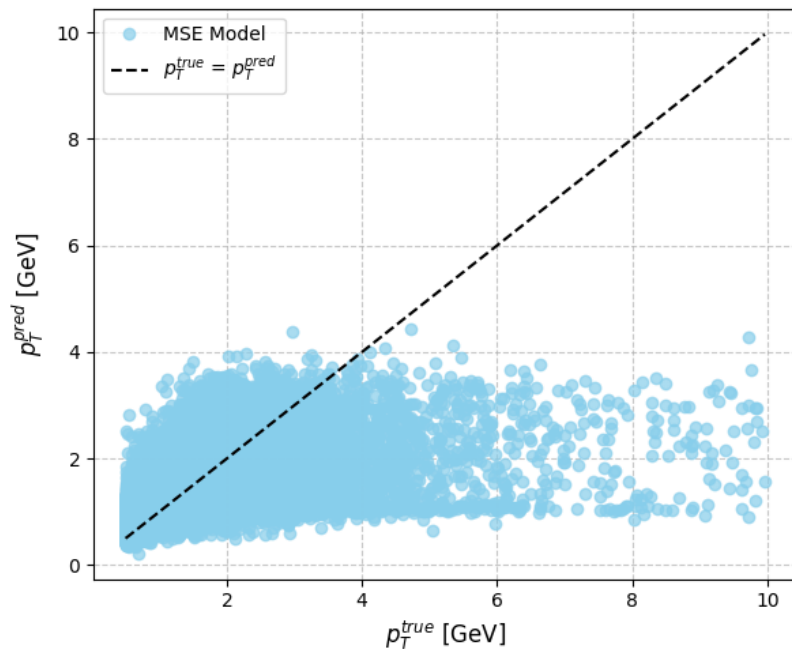
Scattering cut (test only)



Signed p_T vs unsigned

p_T^{true} vs p_T^{pred} ($(tr, d\phi, tz) \rightarrow (p_T, p_z)$)

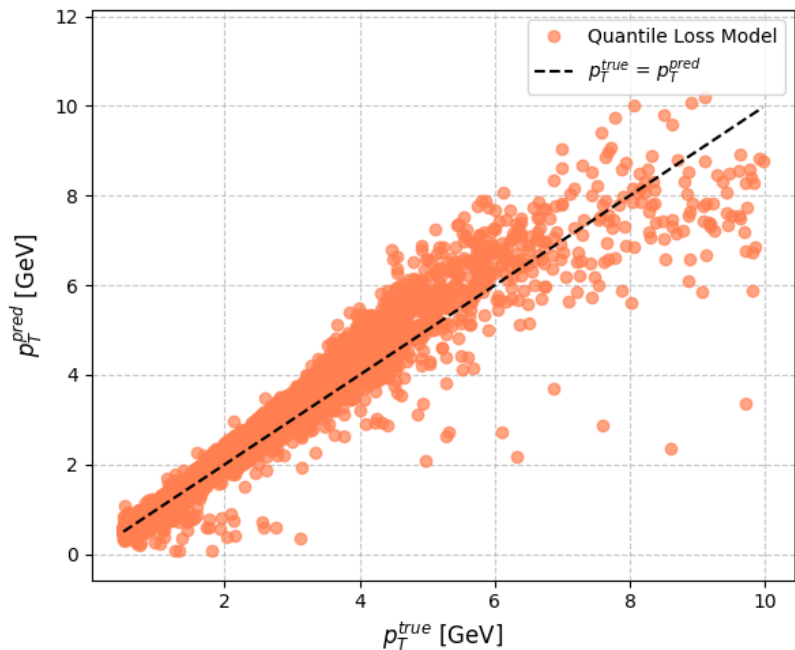
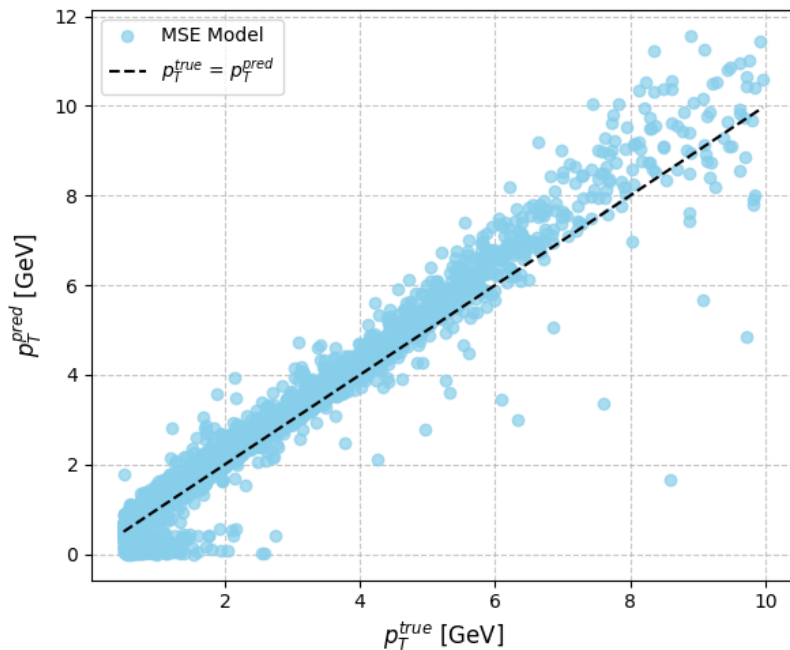
Unsigned
No scattering cut



Signed p_T vs unsigned

p_T^{true} vs p_T^{pred} (($tr, d\phi, tz$) \rightarrow ($q * p_T, p_z$))

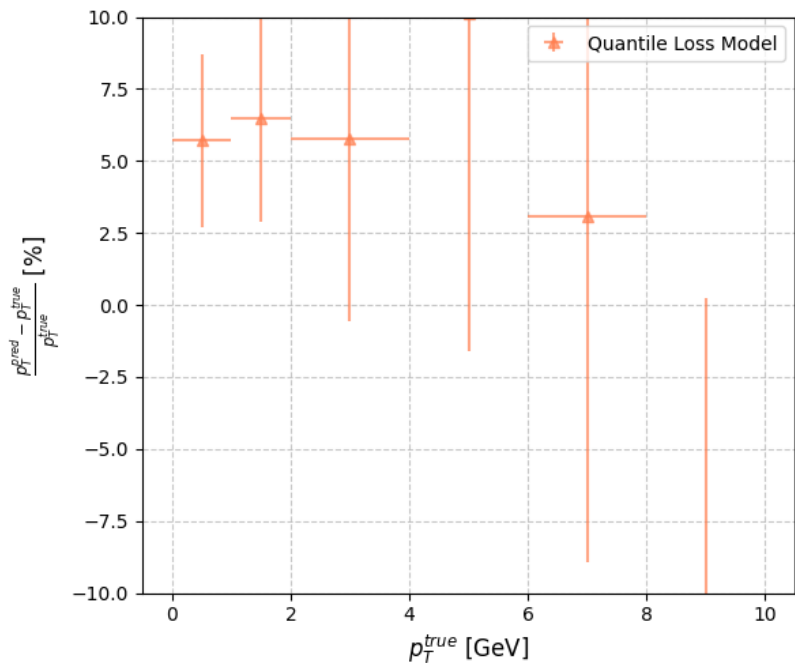
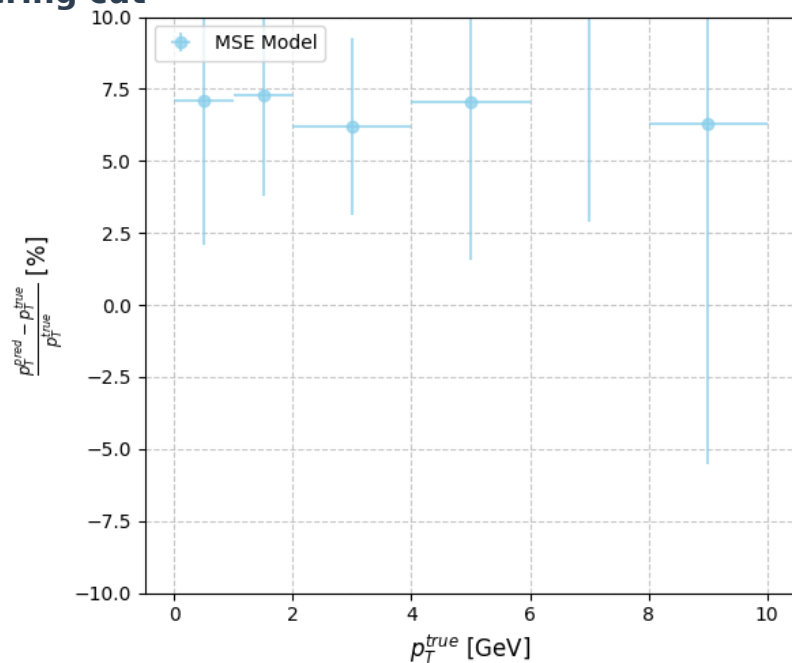
Signed
No scattering cut



Signed p_T vs unsigned

Relative resolution for p_T ($(tr, d\phi, tz) \rightarrow (q * p_T, p_z)$)

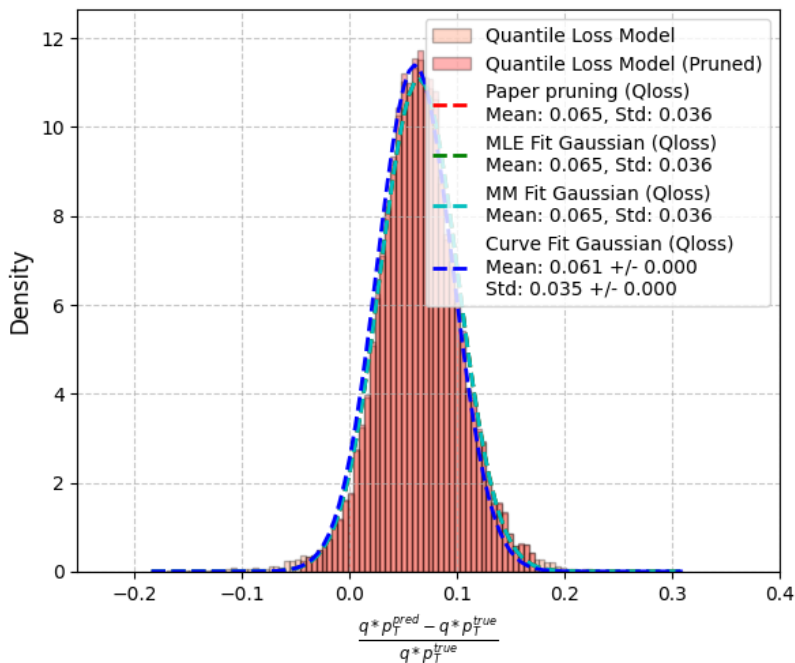
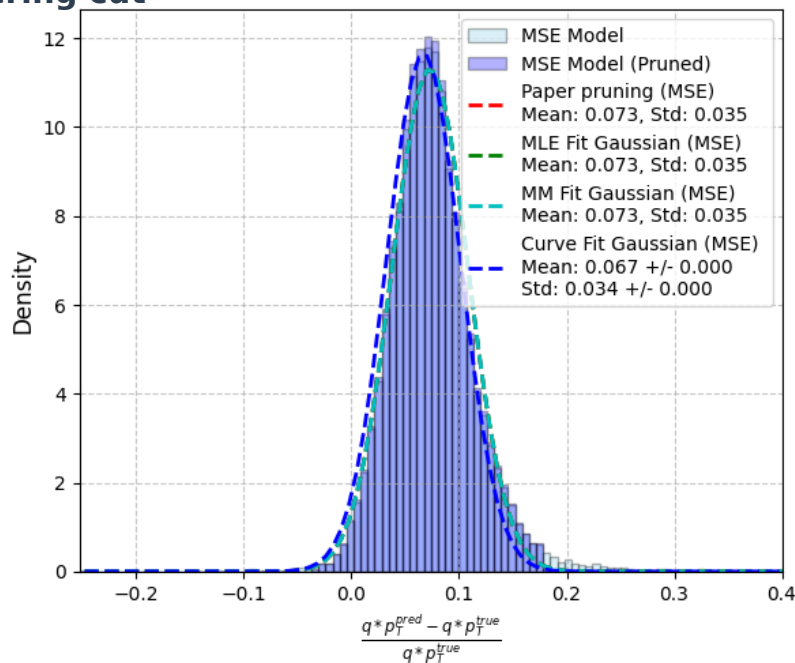
Signed
No scattering cut



Signed p_T vs unsigned

Relative Error Distributions for $q^* p_T$ ($1 \text{ GeV} < p_T < 2 \text{ GeV}$) ($(tr, d\phi, tz) \rightarrow (q^* p_T, p_z)$)

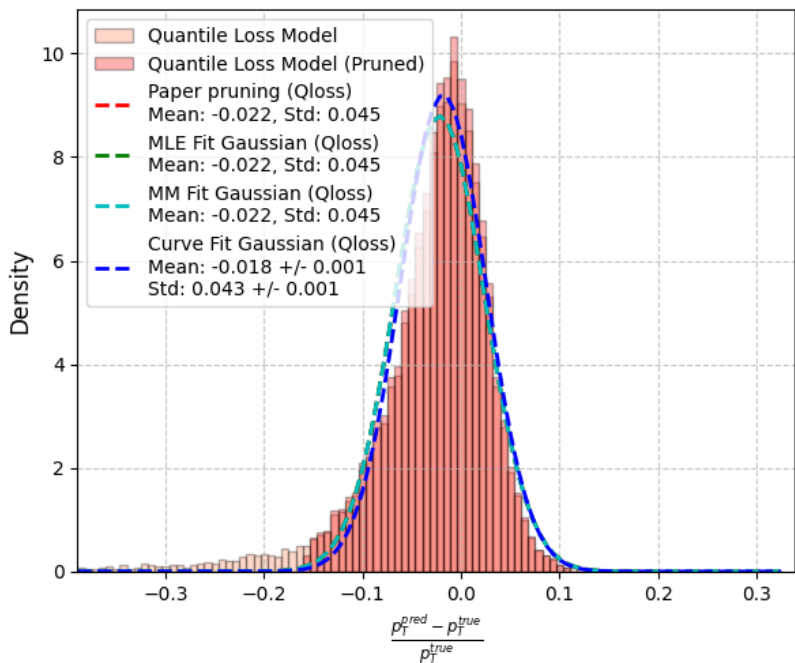
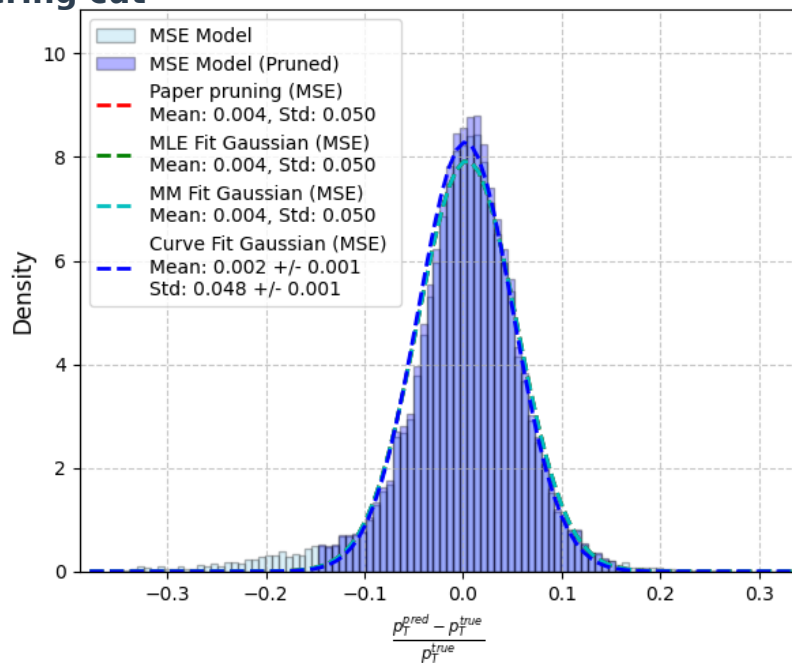
Signed
No scattering cut



Signed p_T vs unsigned

Relative Error Distributions for p_T ($1 \text{ GeV} < p_T < 2 \text{ GeV}$) ($(tx, ty, tz) \rightarrow (p_T, p_z)$)

Unsigned No scattering cut

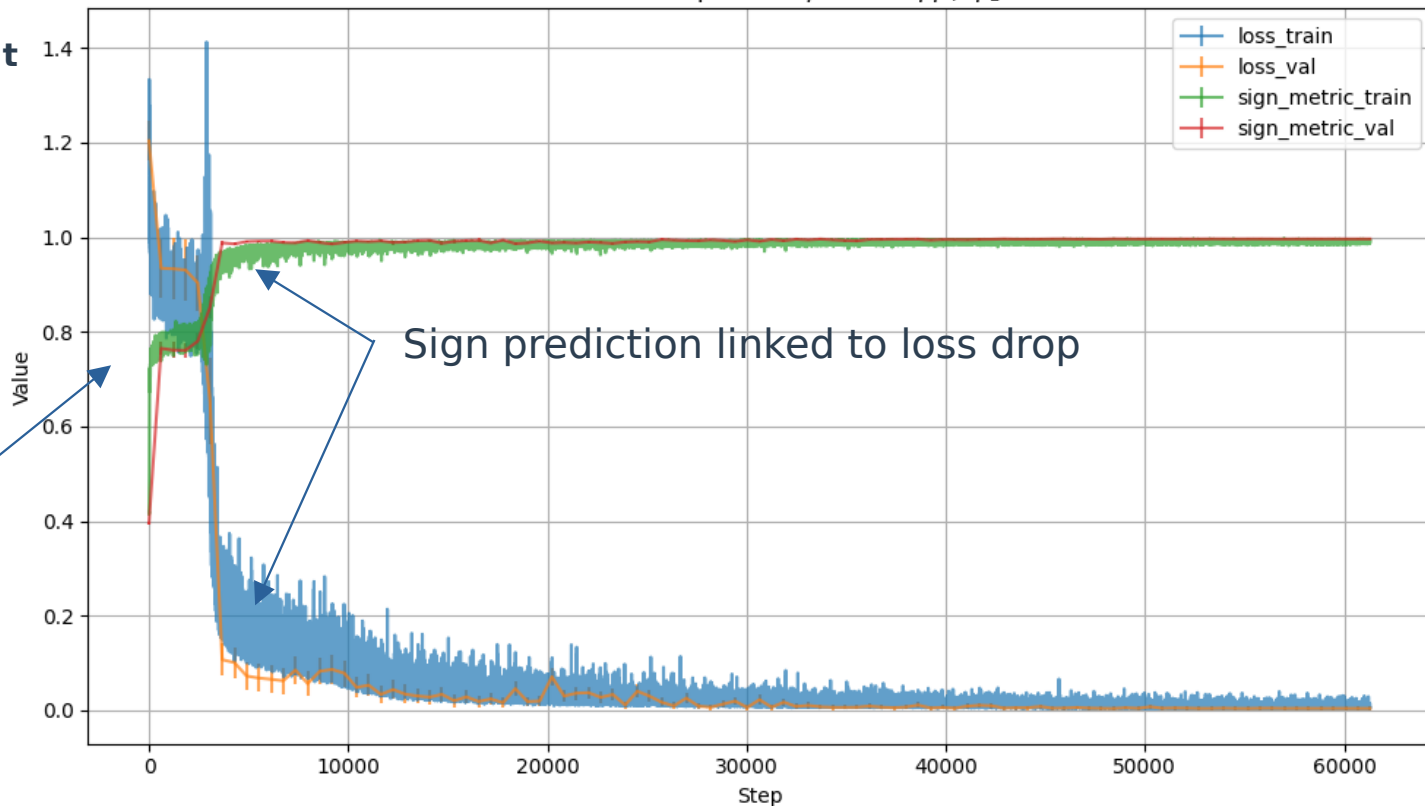


Loss and charge sign

Metrics over Steps ($(tr, d\phi, tz) \rightarrow (q/p_T, p_z)$)

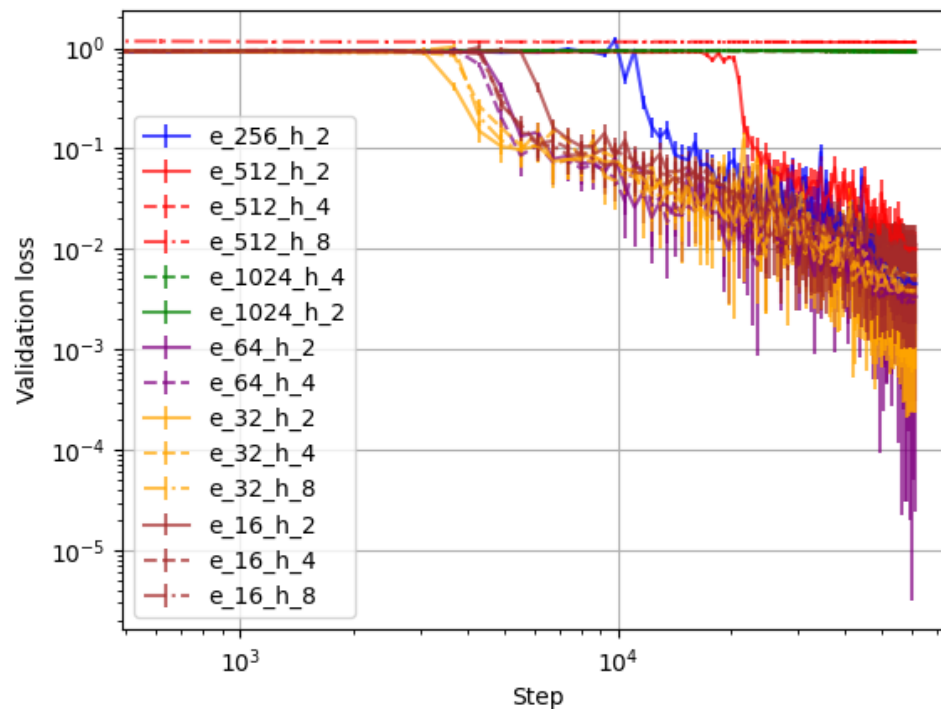
Scattering cut

Why 80%?

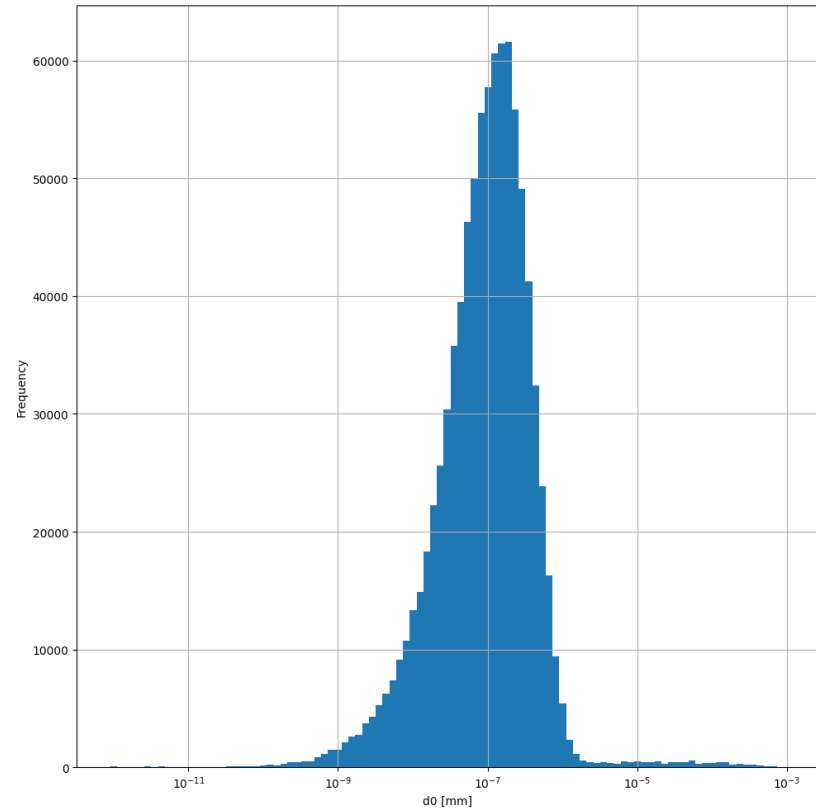
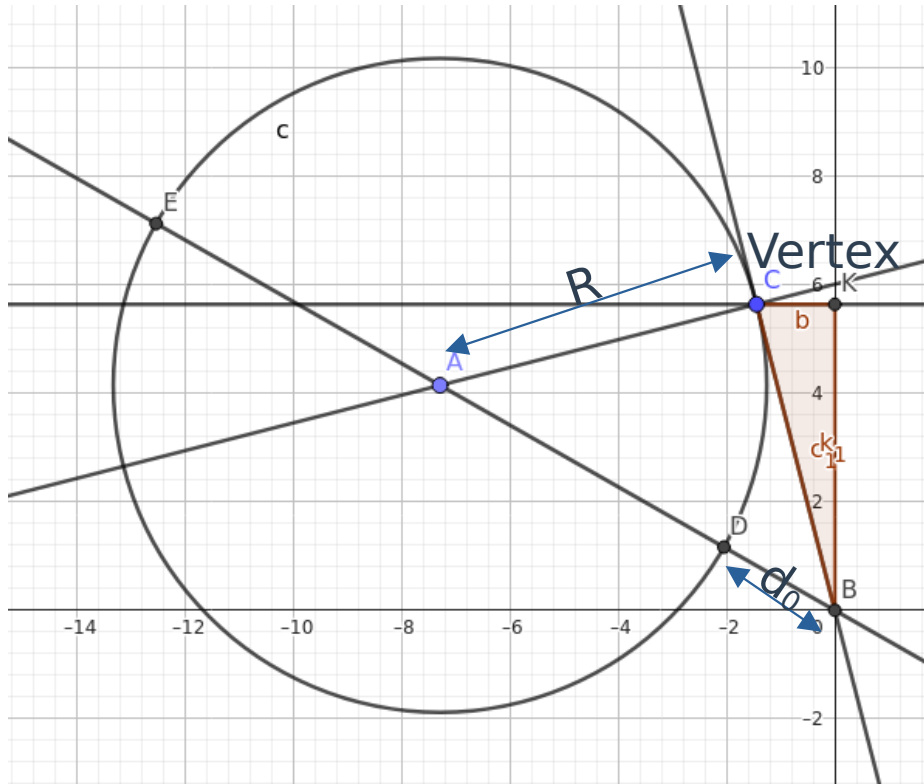


Architecture optimization

No scattering cut
100 epochs

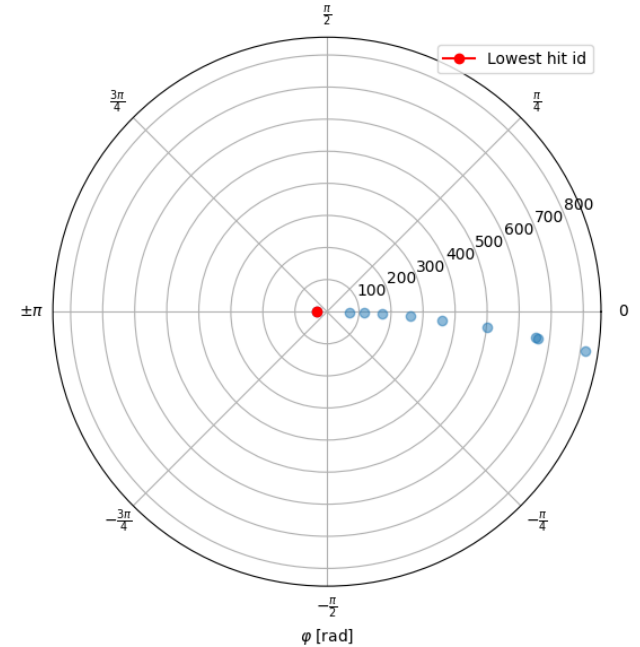
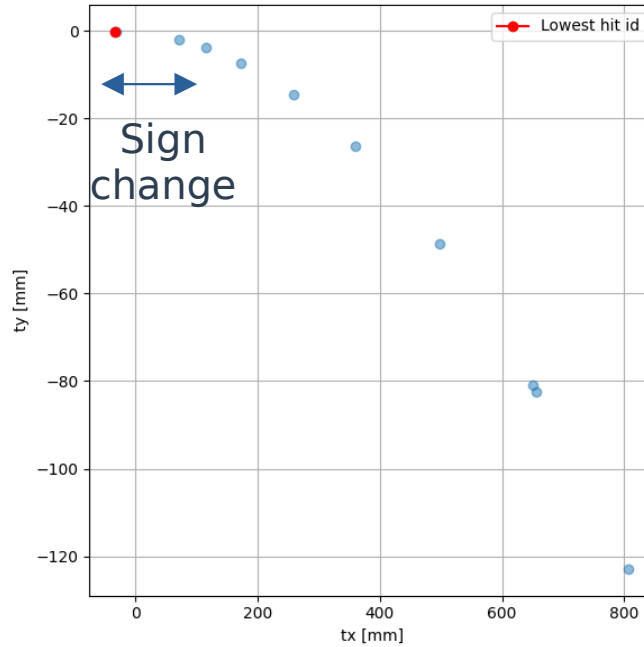
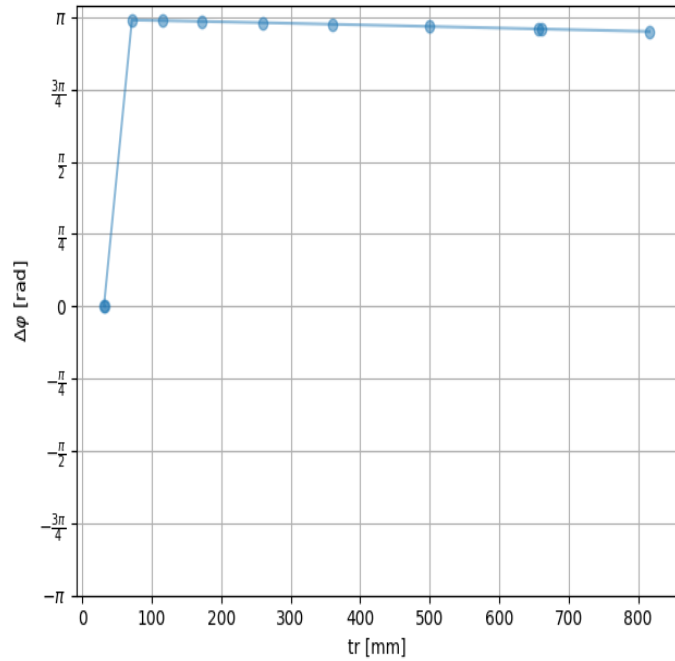


Computation of d_0



BACKUP

Some inspections



Some inspections

