

Reconstructing K short Using Pi+Pi- Pair in CEPC

Motivation:

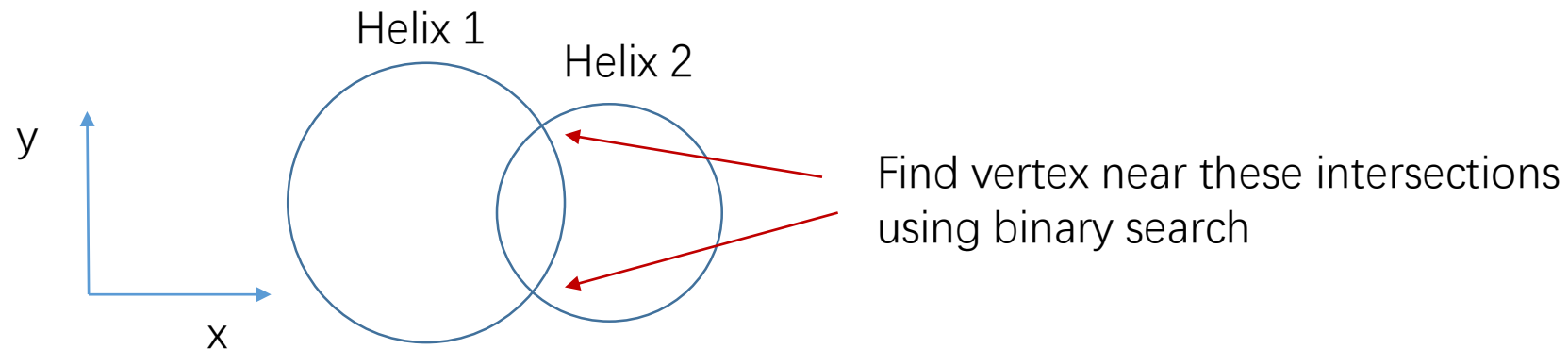
The Z boson plays important role in CEPC, responsible for many physics channels. Therefore it's important to reconstruct its decay product. The current particle reconstruction can only deal with final state particles and cannot reconstruct decayed neutral particles such as K short. The K short has 69% of chance to decay into a pair of pi+ and pi-. In this study, I try to reconstruct K short using a pair of final state pi+ and pi-.

Particles		Effective charge (T_3)		Relative factor	Branching ratio	
Name	Symbols	L	R		Predicted for $x = 0.23$	Experimental measurements ^[11]
Neutrinos (all)	ν_e, ν_μ, ν_τ	$\frac{1}{2}$	0	$3(\frac{1}{2})^2$	20.5%	$20.00 \pm 0.06\%$
Charged leptons (all)	e^-, μ^-, τ^-			$3((-\frac{1}{2} + x)^2 + x^2)$	10.2%	$10.097 \pm 0.003\%$
Electron	e^-	$-\frac{1}{2} + x$	x	$(-\frac{1}{2} + x)^2 + x^2$	3.4%	$3.363 \pm 0.004\%$
Muon	μ^-	$-\frac{1}{2} + x$	x	$(-\frac{1}{2} + x)^2 + x^2$	3.4%	$3.366 \pm 0.007\%$
Tau	τ^-	$-\frac{1}{2} + x$	x	$(-\frac{1}{2} + x)^2 + x^2$	3.4%	$3.367 \pm 0.008\%$
Hadrons (all)					69.2%	$69.91 \pm 0.06\%$
Down-type quarks	d, s, b	$-\frac{1}{2} + \frac{1}{3}x$	$\frac{1}{3}x$	$3(-\frac{1}{2} + \frac{1}{3}x)^2 + 3(\frac{1}{3}x)^2$	15.2%	$15.6 \pm 0.4\%$
Up-type quarks	u, c	$\frac{1}{2} - \frac{2}{3}x$	$-\frac{2}{3}x$	$3(\frac{1}{2} - \frac{2}{3}x)^2 + 3(-\frac{2}{3}x)^2$	11.8%	$11.6 \pm 0.6\%$

Decay of Z

K short Reconstruction Algorithm

1. Find a pair of π^+ and π^- .
2. Determine track helix functions(in theory using track parameters, i.e. $D0$, $Z0$, etc., should give the most accurate results, but surprisingly, just using three tracker hits(innermost, middle and the outermost) to determine track helix function was proven to be more accurate).
3. Apply geometric method to find possible vertex, i.e. the shortest distance between two tracks.
4. Invariant mass at the possible vertex.
5. Whether the shortest distance and the invariant mass are within thresholds.



Sample

5×10^4 $Z \rightarrow qq$ events.

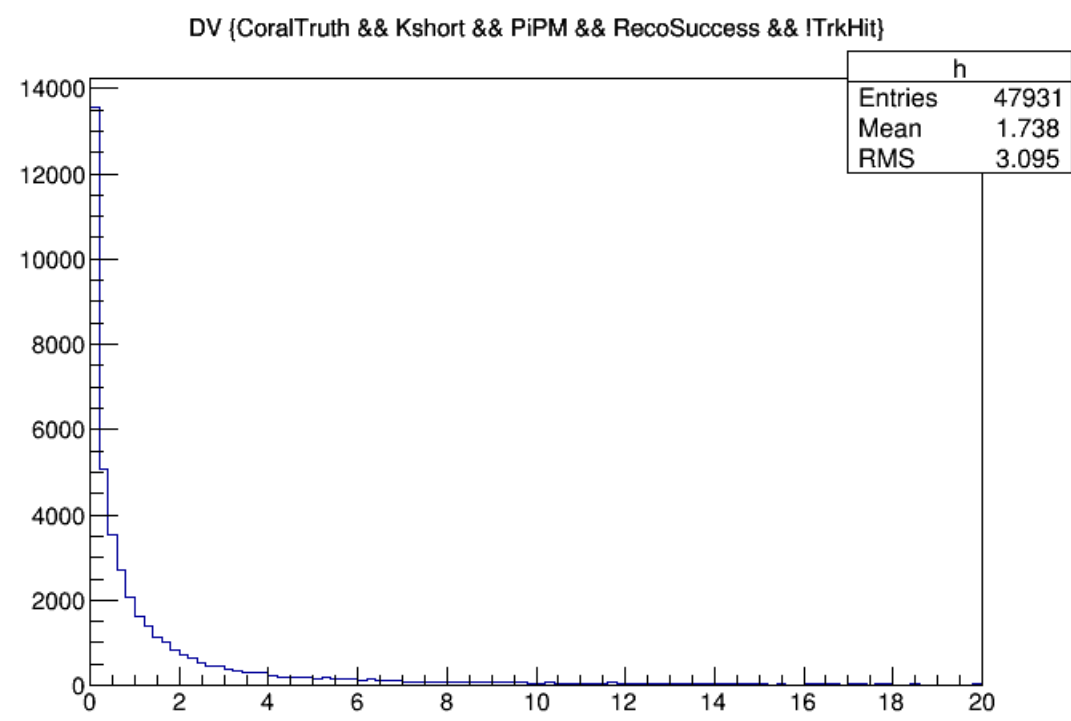
Total K_s truth: 69352

Decayed into $\pi^+\pi^-$: 38388

Both daughters are reconstructed: 15890 → Denominator of efficiency

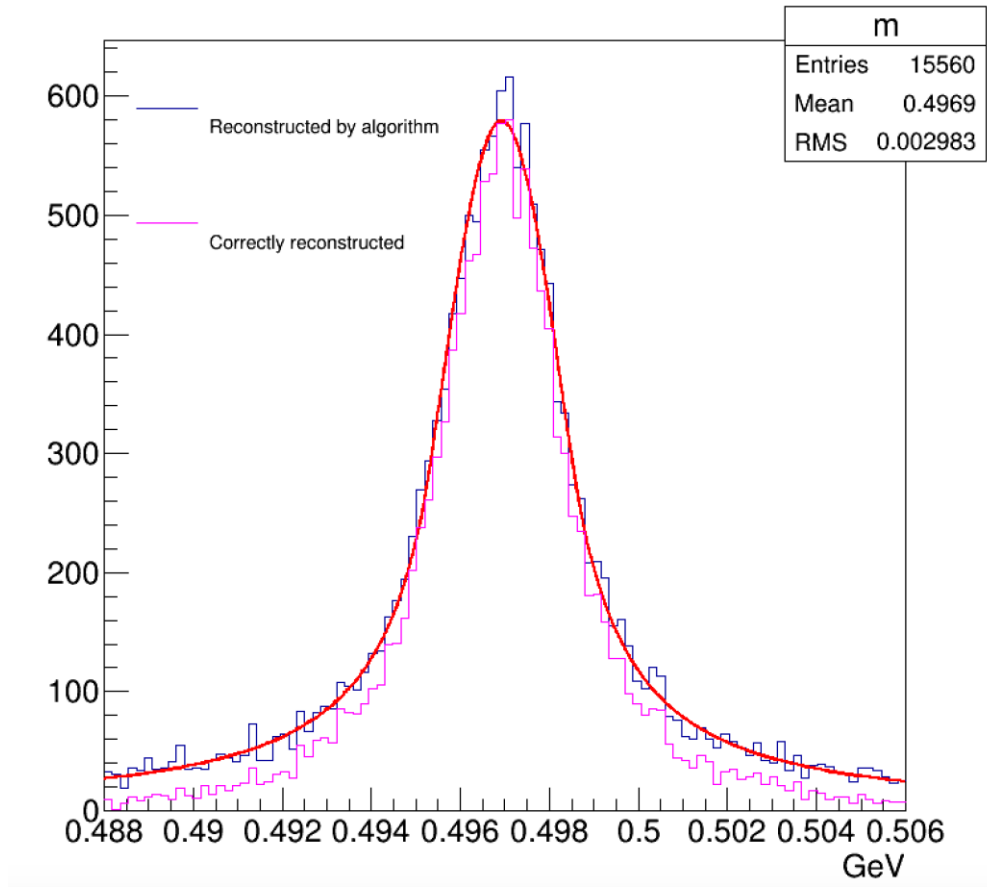
Both PID are correct: 15037

Reconstruction Performance



Distance from reco vtx to real vex/mm

15560 Ks are reconstructed, 12585 are correct
Mass resolution 0.27% , efficiency=79.2%, 纯度=80.1%



Reconstructed Ks mass

Background analysis

In the sample

```
RecoSuccess: 15890
PIDCorrect: 15037
At least one PID is wrong: 853
Info in <TCanvas::MakeDefCanvas>:  created default TCanvas with name c1
Pi+ PID is wrong: 429
    Pi+ identified as PDGID = -13: 274          32.1219 %
    Pi+ identified as PDGID = -11: 118          13.8335 %
    Pi+ identified as PDGID = -211: 35           4.10317 %
    Pi+ identified as PDGID = 13: 2              0.234467 %
Pi- PID is wrong: 441
    Pi- identified as PDGID = 13: 282           33.0598 %
    Pi- identified as PDGID = 11: 119           13.9508 %
    Pi- identified as PDGID = 211: 38            4.45487 %
    Pi- identified as PDGID = -13: 2            0.234467 %
```

Background analysis

Background source of Coral

```
Coral = 15560
CoralSuccess = 12585
Total background = 2975
  ParentType1 == ParentType2: 977      32.8403 %
    Same parent: 881      29.6134 %
      Parent PDGID = 223: 303      10.1849 %
      Parent PDGID = 3122: 152      5.10924 %
      Parent PDGID = -3122: 150      5.04202 %
      Parent PDGID = 310: 73      2.45378 %
      Parent PDGID = 113: 34      1.14286 %
      Others: 169      5.68067 %
    Different parent: 96      3.22689 %
      Parent PDGID = 223: 67      2.2521 %
      Others: 29      0.97479 %
```

ParentType1 means parent type of *supposed* Pi+
ParentType2 is for Pi-

```
ParentType1 != ParentType2: 1998      67.1597 %
  ParentType1:
    Parent1 PDGID = 223: 282      9.47899 %
    Parent1 PDGID = 213: 277      9.31092 %
    Parent1 PDGID = 113: 227      7.63025 %
    Parent1 PDGID = 92: 169      5.68067 %
    Parent1 PDGID = 323: 85      2.85714 %
    Parent1 PDGID = 10213: 75      2.52101 %
    Parent1 PDGID = 221: 71      2.38655 %
    Parent1 PDGID = 313: 65      2.18487 %
    Parent1 PDGID = 310: 60      2.01681 %
    Parent1 PDGID = -421: 56      1.88235 %
    Parent1 PDGID = 413: 45      1.51261 %
    Parent1 PDGID = -313: 37      1.2437 %
    Parent1 PDGID = 211: 36      1.21008 %
    Others: 513      17.2437 %
  ParentType2:
    Parent2 PDGID = 223: 293      9.84874 %
    Parent2 PDGID = -213: 254      8.53782 %
    Parent2 PDGID = 113: 187      6.28571 %
    Parent2 PDGID = 92: 177      5.94958 %
    Parent2 PDGID = -323: 83      2.78992 %
    Parent2 PDGID = -10213: 78      2.62185 %
    Parent2 PDGID = 421: 65      2.18487 %
    Parent2 PDGID = 310: 62      2.08403 %
    Parent2 PDGID = 221: 53      1.78151 %
    Parent2 PDGID = -413: 50      1.68067 %
    Parent2 PDGID = -313: 50      1.68067 %
    Parent2 PDGID = 313: 44      1.47899 %
    Parent2 PDGID = -10323: 38      1.27731 %
    Parent2 PDGID = -421: 37      1.2437 %
    Others: 527      17.7143 %
```