

Tagging Tridents and Recoils

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Tagging generated trident events

- All generated trident events (tritrig, RAD, BH) are given a 622 parent before SLIC propagates them
 - This allows them to be identified after recon, even after BG mixing
- “hps-mc/stdhep/bin/add_mother” does this

Stdhep	→	read event 8: nevhep = 8, nhep = 4	
RAD		isthep = 3 idhep = 622 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 2 jdahep[1] = 4	
event		phep[0] = 0.000000 phep[1] = 0.000000 phep[2] = 0.100000 phep[3] = 0.100000 phep[4] = 0.000000	
		vhep[0] = 0.000000 vhep[1] = 0.000000 vhep[2] = 0.000000 vhep[3] = 0.000000	
Recoil	→	isthep = 1 idhep = 11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0	
e-	→	phep[0] = 0.001202 phep[1] = 0.002934 phep[2] = 0.008717 phep[3] = 0.009290 phep[4] = 0.000511	
e+	→	vhep[0] = 0.000025 vhep[1] = 0.000061 vhep[2] = 0.004062 vhep[3] = 0.000000	
	→	isthep = 1 idhep = 11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0	
	→	phep[0] = 0.002453 phep[1] = -0.009034 phep[2] = 0.677385 phep[3] = 0.677450 phep[4] = 0.000511	
	→	vhep[0] = 0.000001 vhep[1] = -0.000002 vhep[2] = 0.004062 vhep[3] = 0.000000	
	→	isthep = 1 idhep = -11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0	
	→	phep[0] = -0.003280 phep[1] = 0.008088 phep[2] = 1.613236 phep[3] = 1.613260 phep[4] = 0.000511	
	→	vhep[0] = -0.000000 vhep[1] = 0.000001 vhep[2] = 0.004062 vhep[3] = 0.000000	

Before/After SLIC

Stdhep	read event 8: nevhep = 8, nhep = 4				
trident	isthep = 3 idhep = 622 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 2 jdahep[1] = 4				
event	phep[0] = 0.000000 phep[1] = 0.000000 phep[2] = 0.100000 phep[3] = 0.100000 phep[4] = 0.000000				
	vhep[0] = 0.000000 vhep[1] = 0.000000 vhep[2] = 0.000000 vhep[3] = 0.000000				
	isthep = 1 idhep = 11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0				
	phep[0] = 0.001202 phep[1] = 0.002934 phep[2] = 0.008717 phep[3] = 0.009290 phep[4] = 0.000511				
	vhep[0] = 0.000025 vhep[1] = 0.000061 vhep[2] = 0.004062 vhep[3] = 0.000000				
	isthep = 1 idhep = 11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0				
	phep[0] = 0.002453 phep[1] = -0.009034 phep[2] = 0.677385 phep[3] = 0.677450 phep[4] = 0.000511				
	vhep[0] = 0.000001 vhep[1] = -0.000002 vhep[2] = 0.004062 vhep[3] = 0.000000				
	isthep = 1 idhep = -11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0				
	phep[0] = -0.003280 phep[1] = 0.008088 phep[2] = 1.613236 phep[3] = 1.613260 phep[4] = 0.000511				
	vhep[0] = -0.000000 vhep[1] = 0.000001 vhep[2] = 0.004062 vhep[3] = 0.000000				

SLIC event

Collection Name : MCParticle

Collection Type : MCParticle

Number of Elements : 4

Flag Word: 0xe0000000

Collection Parameters :

_weight = 0.000e+00

index	[id]	index [parents]	[daughters]	PDG	(px, py, pz)	GenStatus	SimStatus	vertex (x,y,z)	endpoint(x,y,z)	mass	charge	energy
0	[1b0375b3]	[]	[1,2,3]	622	(0.000e+00, 0.000e+00, 1.000e-01)	3	00000000	(0.000e+00, 0.000e+00, 0.000e+00)	(2.470237e-05 6.143595e-05 4.062000e-03)	0.000000e+00	0.000000e+00	1.000000e-01
1	[2f7c7260]	[0]	[]	11	(1.202e-03, 2.934e-03, 8.717e-03)	1	89000000	(2.470e-05, 6.144e-05, 4.062e-03)	(-1.272894e+02 8.910119e+01 3.219673e+01)	5.110000e-04	-1.000000e+00	9.289974e-03
2	[2d209079]	[0]	[]	11	(2.453e-03, -9.034e-03, 6.774e-01)	1	85000000	(2.470e-05, 6.144e-05, 4.062e-03)	(-2.125850e+02 -2.777686e+01 1.415106e+03)	5.110000e-04	-1.000000e+00	6.774495e-01
3	[6bdf28bb]	[0]	[]	-11	(-3.280e-03, 8.088e-03, 1.613e+00)	1	82000000	(2.470e-05, 6.144e-05, 4.062e-03)	(1.945000e+02 5.868497e+00 2.500000e+03)	5.110000e-04	1.000000e+00	1.613260e+00

Tritrig vs. RAD/BH

- Previously, the 622 parent is applied to ALL particles in the stdhep event.
- The RAD/BH generators have distinguishable electrons, so we can do better than this.
- “hps-mc/stdhep/bin/add_mother_toTwins”
 - Adds a ‘622’ documentation particle to be the parent of only the e^+/e^- pair
 - Also adds a ‘99’ documentation particle to be the parent of the recoil electron

Before/After SLIC

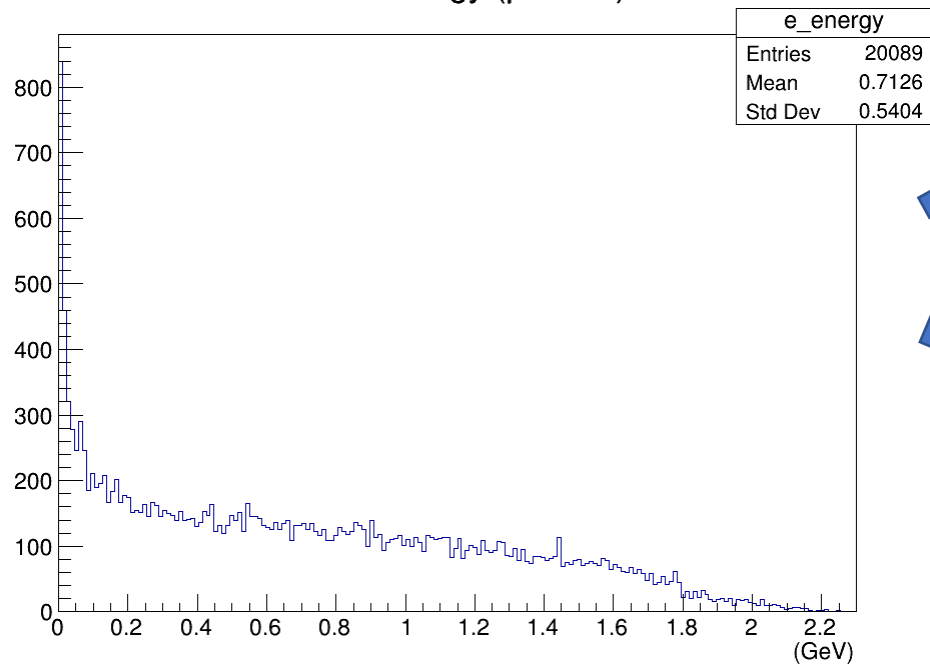
Stdhep trident event	read event 8: nevhep = 8, nhep = 5
	isthep = 3 idhep = 99 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 3 jdahep[1] = 3
	phep[0] = 0.000000 phep[1] = 0.000000 phep[2] = 0.100000 phep[3] = 0.100000 phep[4] = 0.000000 vhep[0] = 0.000000 vhep[1] = 0.000000 vhep[2] = 0.000000 vhep[3] = 0.000000
SLIC event	isthep = 3 idhep = 622 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 4 jdahep[1] = 5
	phep[0] = 0.000000 phep[1] = 0.000000 phep[2] = 0.100000 phep[3] = 0.100000 phep[4] = 0.000000 vhep[0] = 0.000000 vhep[1] = 0.000000 vhep[2] = 0.000000 vhep[3] = 0.000000
	isthep = 1 idhep = 11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0
	phep[0] = 0.001202 phep[1] = 0.002934 phep[2] = 0.008717 phep[3] = 0.009290 phep[4] = 0.000511 vhep[0] = 0.000025 vhep[1] = 0.000061 vhep[2] = 0.004062 vhep[3] = 0.000000
	isthep = 1 idhep = 11 jmohep[0] = 2 jmohep[1] = 2 jdahep[0] = 0 jdahep[1] = 0
	phep[0] = 0.002453 phep[1] = -0.009034 phep[2] = 0.677385 phep[3] = 0.677450 phep[4] = 0.000511 vhep[0] = 0.000001 vhep[1] = -0.000002 vhep[2] = 0.004062 vhep[3] = 0.000000
	isthep = 1 idhep = -11 jmohep[0] = 2 jmohep[1] = 2 jdahep[0] = 0 jdahep[1] = 0
	phep[0] = -0.003280 phep[1] = 0.008088 phep[2] = 1.613236 phep[3] = 1.613260 phep[4] = 0.000511 vhep[0] = -0.000000 vhep[1] = 0.000001 vhep[2] = 0.004062 vhep[3] = 0.000000

Collection Name : MCParticle
Collection Type : MCParticle
Number of Elements : 5
Flag Word: 0xe0000000
Collection Parameters :
_weight = 0.000e+00

index	[id]	index [parents]	[daughters]	PDG	(px, py, pz)	GenStatus	SimStatus	vertex (x,y,z)	endpoint(x,y,z)	mass	charge	energy
0	[3930015a]	[]	[2] 99		(0.000e+00, 0.000e+00, 1.000e-01)	3	00000000	(0.000e+00, 0.000e+00, 0.000e+00)	(2.470237e-05 6.143595e-05 4.062000e-03)	0.000000e+00	0.000000e+00	1.000000e-01
1	[629f0666]	[]	[3,4] 622		(0.000e+00, 0.000e+00, 1.000e-01)	3	00000000	(0.000e+00, 0.000e+00, 0.000e+00)	(-3.751319e-07 8.995271e-07 4.062000e-03)	0.000000e+00	0.000000e+00	1.000000e-01
2	[1bc6a36e]	[0]	[] 11		(1.202e-03, 2.934e-03, 8.717e-03)	1	89000000	(2.470e-05, 6.144e-05, 4.062e-03)	(-1.135590e+02 5.940485e+01 4.187100e+01)	5.110000e-04	-1.000000e+00	9.289974e-03
3	[01ff8b8f]	[1]	[] 11		(2.453e-03, -9.034e-03, 6.774e-01)	1	82000000	(-3.751e-07, 8.995e-07, 4.062e-03)	(-5.867069e+02 -1.055382e+02 2.500000e+03)	5.110000e-04	-1.000000e+00	6.774495e-01
4	[387c703b]	[1]	[] -11		(-3.280e-03, 8.088e-03, 1.613e+00)	1	82000000	(-3.751e-07, 8.995e-07, 4.062e-03)	(1.938995e+02 8.105736e+00 2.500000e+03)	5.110000e-04	1.000000e+00	1.613260e+00

Pre-SLIC Electrons

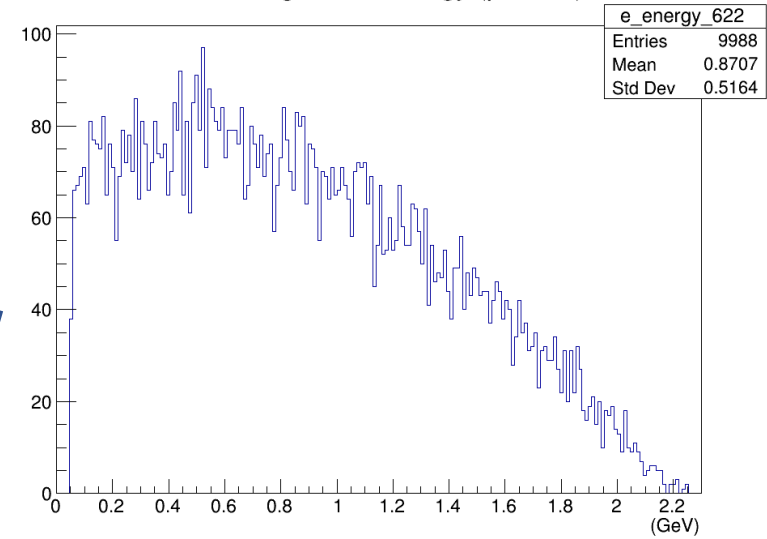
All e- Energy (pre-slic)



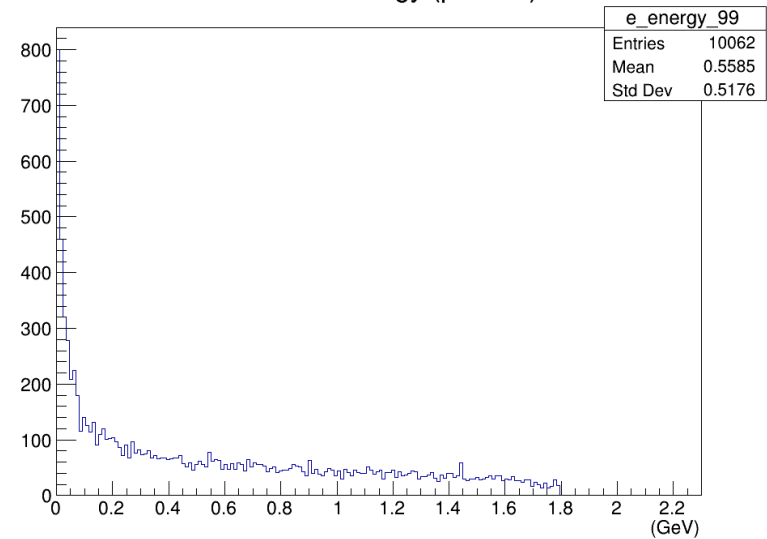
622 parent

99 parent

622 Daughter e- Energy (pre-slic)



Recoil e- Energy (pre-slic)



One worked-around issue...

- Since the tridents are tagged after the target simulation (egs5), new particles (photons, electrons) are sometimes created, throwing off the ordering
 - This happens ~4 out of 100 events.
- The procedure therefore identifies the final two particles passing an energy threshold (50 MeV) as the pair, and assigns the recoil tag to the electron earlier in the list.
 - This is not an issue for most events, but helps eliminate the cases where this happens

Example of such an event

Madgraph5 event

```
6 1 0.6643000E+04 0.1712550E+03 0.7297358E-02 0.1081099E+00
11 -1 0 0 0 0 0.00000000000E+00 0.00000000000E+00 0.22999999432E+01 0.23000000000E+01 0.51100000000E-03 0. 1.
9000002 -1 0 0 0 0 0.00000000000E+00 0.00000000000E+00 -0.20605739337E-12 0.17124000000E+03 0.17124000000E+03 0. 1.
recoil 11 1 1 2 0 0 0.32297226235E-03 -0.18024189689E-04 0.16949030486E-02 0.17995703092E-02 0.51100000000E-03 0. 1.
9000002 1 1 2 0 0 -0.56780343927E-03 -0.77388279450E-04 0.21835412482E-03 0.17124000000E+03 0.17124000000E+03 0. 1.
e- 11 1 1 2 0 0 0.51200308618E-03 0.10421418891E-01 0.16322445797E+01 0.16322780086E+01 0.51100000000E-03 0. 1.
e+ -11 1 1 2 0 0 -0.26717190926E-03 -0.10326006422E-01 0.66584210632E+00 0.66592242001E+00 0.51100000000E-03 0. -1.
```

Stdhep event (post-egs5)

```
isthep = 3 idhep = 99 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 3 jdahep[1] = 4
phep[0] = 0.000000 phep[1] = 0.000000 phep[2] = 0.100000 phep[3] = 0.100000 phep[4] = 0.000000
vhhep[0] = 0.000000 vhhep[1] = 0.000000 vhhep[2] = 0.000000 vhhep[3] = 0.000000
isthep = 3 idhep = 622 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 5 jdahep[1] = 6
phep[0] = 0.000000 phep[1] = 0.000000 phep[2] = 0.100000 phep[3] = 0.100000 phep[4] = 0.000000
vhhep[0] = 0.000000 vhhep[1] = 0.000000 vhhep[2] = 0.000000 vhhep[3] = 0.000000
isthep = 1 idhep = 11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0
phep[0] = -0.000012 phep[1] = 0.000794 phep[2] = 0.001528 phep[3] = 0.001796 phep[4] = 0.000511
vhhep[0] = -0.000034 vhhep[1] = 0.000561 vhhep[2] = 0.004062 vhhep[3] = 0.000000
isthep = 1 idhep = 11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0
phep[0] = 0.000532 phep[1] = 0.010423 phep[2] = 1.632242 phep[3] = 1.632275 phep[4] = 0.000511
vhhep[0] = 0.000001 vhhep[1] = 0.000012 vhhep[2] = 0.004062 vhhep[3] = 0.000000
isthep = 1 idhep = 11 jmohep[0] = 2 jmohep[1] = 2 jdahep[0] = 0 jdahep[1] = 0
phep[0] = -0.000032 phep[1] = -0.000107 phep[2] = 0.000045 phep[3] = 0.000525 phep[4] = 0.000511
vhhep[0] = 0.000094 vhhep[1] = -0.000309 vhhep[2] = 0.004062 vhhep[3] = 0.000000
isthep = 1 idhep = -11 jmohep[0] = 2 jmohep[1] = 2 jdahep[0] = 0 jdahep[1] = 0
phep[0] = -0.000179 phep[1] = -0.010674 phep[2] = 0.665813 phep[3] = 0.665898 phep[4] = 0.000511
vhhep[0] = -0.000001 vhhep[1] = -0.000030 vhhep[2] = 0.004062 vhhep[3] = 0.000000
```

New
particle

Identified
incorrectly
as a pair electron!

Example of such an event

Madgraph5 event

```
6 1 0.6643000E+04 0.1712550E+03 0.7297358E-02 0.1081099E+00
11 -1 0 0 0 0 0.00000000000E+00 0.00000000000E+00 0.22999999432E+01 0.23000000000E+01 0.51100000000E-03 0. 1.
9000002 -1 0 0 0 0 0.00000000000E+00 0.00000000000E+00 -0.20605739337E-12 0.17124000000E+03 0.17124000000E+03 0. 1.
recoil 11 1 1 2 0 0 0.32297226235E-03 -0.18024189689E-04 0.16949030486E-02 0.17995703092E-02 0.51100000000E-03 0. 1.
9000002 1 1 2 0 0 -0.56780343927E-03 -0.77388279450E-04 0.21835412482E-03 0.17124000000E+03 0.17124000000E+03 0. 1.
e- 11 1 1 2 0 0 0.51200308618E-03 0.10421418891E-01 0.16322445797E+01 0.16322780086E+01 0.51100000000E-03 0. 1.
e+ -11 1 1 2 0 0 -0.26717190926E-03 -0.10326006422E-01 0.66584210632E+00 0.66592242001E+00 0.51100000000E-03 0. -1.
```

Stdhep event (post-egs5)

```
isthep = 3 idhep = 99 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 3 jdahep[1] = 3
phep[0] = 0.000000 phep[1] = 0.000000 phep[2] = 0.100000 phep[3] = 0.100000 phep[4] = 0.000000
vhep[0] = 0.000000 vhep[1] = 0.000000 vhep[2] = 0.000000 vhep[3] = 0.000000
isthep = 3 idhep = 622 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 4 jdahep[1] = 6
phep[0] = 0.000000 phep[1] = 0.000000 phep[2] = 0.100000 phep[3] = 0.100000 phep[4] = 0.000000
vhep[0] = 0.000000 vhep[1] = 0.000000 vhep[2] = 0.000000 vhep[3] = 0.000000
isthep = 1 idhep = 11 jmohep[0] = 1 jmohep[1] = 1 jdahep[0] = 0 jdahep[1] = 0
phep[0] = -0.000012 phep[1] = 0.000794 phep[2] = 0.001528 phep[3] = 0.001796 phep[4] = 0.000511
vhep[0] = -0.000034 vhep[1] = 0.000561 vhep[2] = 0.004062 vhep[3] = 0.000000
isthep = 1 idhep = 11 jmohep[0] = 2 jmohep[1] = 2 jdahep[0] = 0 jdahep[1] = 0
phep[0] = 0.000532 phep[1] = 0.010423 phep[2] = 1.632242 phep[3] = 1.632275 phep[4] = 0.000511
vhep[0] = 0.000001 vhep[1] = 0.000012 vhep[2] = 0.004062 vhep[3] = 0.000000
isthep = 1 idhep = 11 jmohep[0] = 0 jmohep[1] = 0 jdahep[0] = 0 jdahep[1] = 0
phep[0] = -0.000032 phep[1] = -0.000107 phep[2] = 0.000045 phep[3] = 0.000525 phep[4] = 0.000511
vhep[0] = 0.000094 vhep[1] = -0.000309 vhep[2] = 0.004062 vhep[3] = 0.000000
isthep = 1 idhep = -11 jmohep[0] = 2 jmohep[1] = 2 jdahep[0] = 0 jdahep[1] = 0
phep[0] = -0.000179 phep[1] = -0.010674 phep[2] = 0.665813 phep[3] = 0.665898 phep[4] = 0.000511
vhep[0] = -0.000001 vhep[1] = -0.000030 vhep[2] = 0.004062 vhep[3] = 0.000000
```

Fixed with a
threshold cut

New
particle



However, the same fixed event after SLIC...

Collection Name : MCParticle
Collection Type : MCParticle
Number of Elements : 7
Flag Word: 0xe0000000
Collection Parameters :
_weight = 0.000e+00

index	[id]	index [parents]	[daughters]	PDG	(px, py, pz)	GenStatus	SimStatus	vertex (x,y,z)	endpoint(x,y,z)	mass	charge	energy
0	[79d8407f]	[]	[2]	99	(0.000e+00, 0.000e+00, 1.000e-01)	3	00000000	(0.000e+00, 0.000e+00, 0.000e+00)	(-3.385830e-05 5.605933e-04 4.062000e-03)	0.000000e+00	0.000000e+00	1.000000e-01
1	[5fbe4146]	[]	[3,4,5]	622	(0.000e+00, 0.000e+00, 1.000e-01)	3	00000000	(0.000e+00, 0.000e+00, 0.000e+00)	(9.373800e-05 -3.087025e-04 4.062000e-03)	0.000000e+00	0.000000e+00	1.000000e-01
2	[1e66f1f5]	[0]	[]	11	(-1.169e-05, 7.936e-04, 1.528e-03)	1	89000000	(-3.386e-05, 5.606e-04, 4.062e-03)	(-1.370160e+01 6.083860e+01 2.591457e+01)	5.110000e-04	-1.000000e+00	1.795934e-03
3	[4e50c791]	[1]	[]	11	(5.319e-04, 1.042e-02, 1.632e+00)	1	82000000	(9.374e-05, -3.087e-04, 4.062e-03)	(-4.513567e+02 -2.019954e+02 2.500000e+03)	5.110000e-04	-1.000000e+00	1.632275e+00
4	[7530ad9c]	[1]	[]	11	(-3.207e-05, -1.066e-04, 4.454e-05)	1	89000000	(9.374e-05, -3.087e-04, 4.062e-03)	(6.458145e+00 -7.924905e+01 -3.645584e+01)	5.110000e-04	-1.000000e+00	5.248729e-04
5	[58a9760d]	[1]	[6]	-11	(-1.789e-04, -1.067e-02, 6.658e-01)	1	85000000	(9.374e-05, -3.087e-04, 4.062e-03)	(1.806047e+02 -3.217572e+01 1.335831e+03)	5.110000e-04	1.000000e+00	6.658984e-01
6	[71e9ddb4]	[5]	[]	22	(3.198e-04, -4.017e-05, 2.684e-03)	0	c2000000	(2.985e+01, -8.014e+00, 5.040e+02)	(2.825040e+02 1.161089e+01 2.500000e+03)	0.000000e+00	0.000000e+00	2.703137e-03