Short tracking

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Belle II TRG/DAQ workshop 2019

August 27, 2019

Outline

- 3 SL result
- 5 SL result
- Debug and upgrade on 5 SL ST

End of phase3

- New 5 SL result
- New features: matching with ECL cluster in endcap
- Summary & To do

Performance check

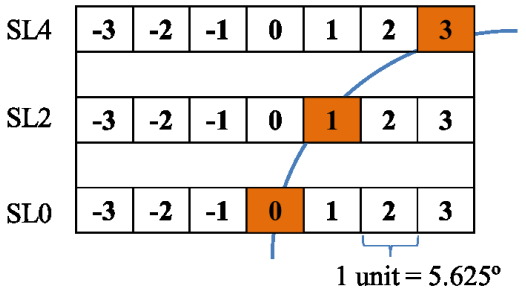
- How to judge the performance of ST in different stages?

- **Correctness** = (# of matched TRG ST)/(# of TRG ST)
  - Highly depends on the noise or background CDC hits.

- **Tracking rate** = (# of matched TRG ST)/(# of CDC tracks)
  - # of CDC tracks: with requirements.
  - Depends on the completeness of the algorithm.

3 SL: exp7 cosmic run 2103 and 2104

- First look of the ST logic (3 SL) with cosmic run
- Correctness: ~88%.



Pattern (1,3)

SL0	SL2	SL4	GRL ST
O			11491 (87.9%)
O	O	O	10612 (81.2%)
X			1577 (12.1%)
X	X	X	297 (2.3%)
X	at least 1 matched		1280 (9.8%)
X	both matched		782 (6.0%)

3 SL: exp7 beam run 3870

- Exp7 run 3870.

- Correctness:
  - CDC tracks: All CDC tracks not found by TRG 2D.
  - SL0: 20.5%
  - SL2: 27.1%
  - All 3 SL: 13.0%

- Lots of wrong ST are found due to background and noise (beam condition).

SL0	SL2	SL4	GRL ST
O			20.5%
	O		27.1%
O	O	O	10.3%
X			79.5%
	X		72.9%
X	X	X	57.9%

3 SL: Cross-check with different beam conditions

- The background on CDC depends on the beam condition. The situation is worse right after beam injection is done.

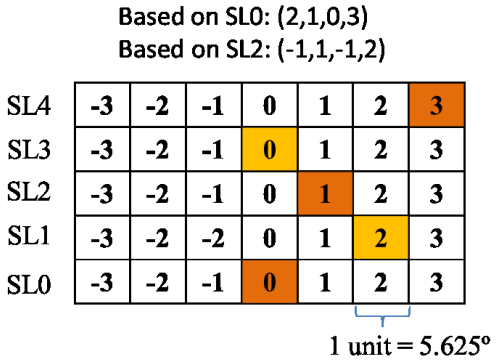
- Here I pick up some of the long runs and check the result for the first and the last output files.
  - 3924: debug run with higher CDC threshold

r03924 head	r03877 head	r03878 head	r03879 head	r03886 head	r03903 head
Tracking rate: 26.9%	Tracking rate: 27.3%	Tracking rate: 28.6%	Tracking rate: 26.2%	Tracking rate: 28.6%	Tracking rate: 28.9%
Correctness: 25.0%	Correctness: 12.5%	Correctness: 9.5%	Correctness: 23.9%	Correctness: 9.9%	Correctness: 8.9%
r03924 tail	r03877 tail	r03878 tail	r03879 tail	r03886 tail	r03903 tail
Tracking rate: 23.7%	Tracking rate: 22.3%	Tracking rate: 26.5%	Tracking rate: 24.1%	Tracking rate: 22.0%	Tracking rate: 23.2%
Correctness: 50%	Correctness: 44.7%	Correctness: 16.3%	Correctness: 45.2%	Correctness: 41.1%	Correctness: 43.0%

5 SL: exp8 beam run 2165

- Part of exp8 run 2165.
- ~40 patterns from TSIM.
- Tracking rate:

Match	Requirement	Tracking rate (%)
SL2	All 5 SL hit && !veto	44.7
SL2 && 4 SL matched	All 5 SL hit && !veto	44.3
SL2 && 5 SL matched	All 5 SL hit && !veto	42.2



- Correctness = $\frac{N(matched\ with\ CDC)}{N(TRG\ ST)}$ = 63.2%
  - "Matched": At least SL2 hit is matched.
  - 60%~70%: improved from 3 SL ST.

- Main reasons for the missing ST in TRG:
  - **Many missing patterns from TSIM study. → Track rate can be further improved after including more patterns.**

5 SL: updated patterns, cosmic runs in the end of phase3

- 137 patterns are included in total.
  - By using exp8 r2165.

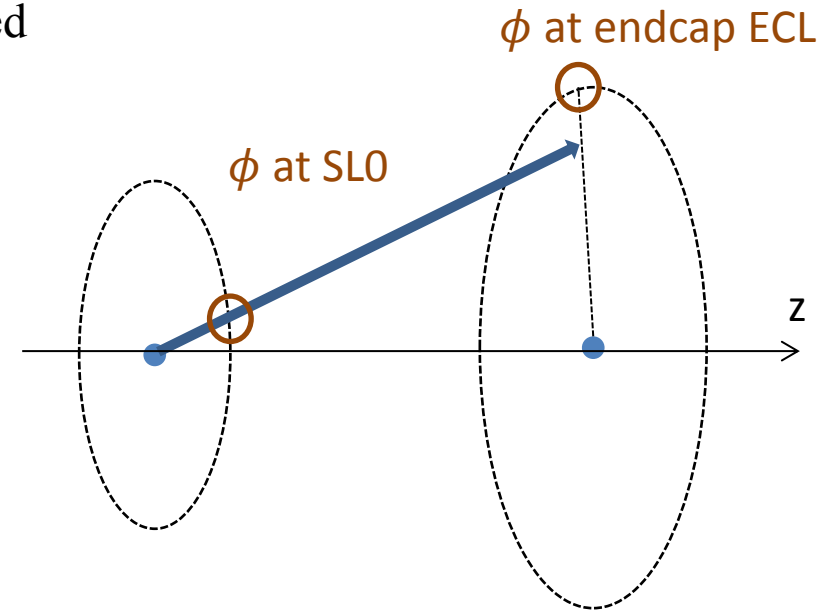
Run	Description, conf	Tracking rate (%)	Correctness (%)
e8 r2165, beam run	Beam run, BEAM conf.	44.7	63.2
e8 r3420~3421	Solenoid+QCS, BEAM conf.	44.8	92.7
e8 r3451	OCS off, BEAM	44.1	91.5
e8 r3467	Both Solenoid QCS off, BEAM	44.9	89.2
e9 r0081	Both Solenoid QCS off, BEAM	83.2	89.7
e9 r0082	Both Solenoid QCS off, COSMIC	86.4	89.7

- By comparing the cosmic runs' results, tracking rate is improved and correctness is the same.

- Waiting for next beam run for further selection.

New features: matching with ECL cluster in endcap

- Investigation on possibility of matching between short track and ECL cluster in endcap region.
- For each short track, we know the ϕ at SL0 and its pattern.
- We can get the extrapolated ϕ of the track at endcap ECL region by using data.
  - If the $\Delta\phi$ distribution for specific patterns is significant, the ϕ of endcap can be obtained in firmware.
- Using the tracks in exp8 run 2165, and the extrapolated track positions on ECL entrance.



Possibility of each pattern reaching each endcaps

- By beam run e8 run2165.
- $|z0| < 10$ cm

				Back	For
0	0	0	0	0.839	0.000
0	-1	0	0	0.680	0.000
0	-1	1	0	0.008	0.000
0	-1	-1	0	1.000	0.000
0	-2	0	0	0.000	0.000
0	-2	1	0	0.000	0.006
0	-2	2	0	0.000	0.923
0	-2	3	0	0.000	1.000
0	-3	1	0	0.000	0.780
0	-3	2	0	0.000	0.997
0	-3	3	0	0.000	1.000
0	-4	2	0	0.000	1.000
0	-4	3	0	0.000	1.000
0	0	0	1	0.895	0.000
0	0	1	1	0.821	0.000
0	-1	0	1	1.000	0.000
0	-1	1	1	0.382	0.000
0	-1	2	1	0.000	0.000
0	-2	2	1	0.000	0.854
0	-2	3	1	0.000	1.000
0	-3	2	1	0.000	0.997
0	-3	3	1	0.000	1.000
0	0	0	-1	0.887	0.000
0	0	-1	-1	0.962	0.000
0	-1	0	-1	0.576	0.000
0	-1	-1	-1	0.888	0.000
0	-2	0	-1	0.000	0.000
0	-2	1	-1	0.000	0.262
0	-3	1	-1	0.000	0.947
0	-3	2	-1	0.000	1.000
-1	-1	0	0	0.786	0.000
-1	-1	1	0	0.000	0.000
-1	-2	0	0	0.200	0.000
-1	-2	1	0	0.000	0.000

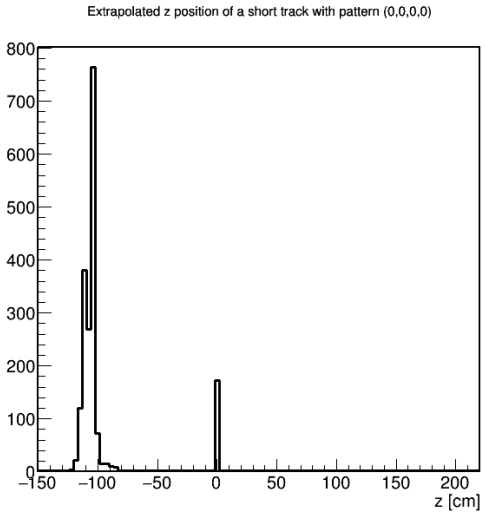
				Back	For
-1	-3	1	0	0.000	0.711
-1	-3	2	0	0.000	0.996
-1	-3	3	0	0.000	1.000
-1	-4	2	0	0.000	1.000
-1	-4	3	0	0.000	1.000
1	0	1	0	0.463	0.000
1	0	0	0	0.877	0.000
1	0	-1	0	1.000	0.000
1	-1	0	0	0.406	0.000
1	-1	1	0	0.007	0.000
1	-2	2	0	0.000	0.974
1	-2	3	0	0.000	1.000
1	-3	2	0	0.000	1.000
1	-3	3	0	0.000	1.000
-1	-1	0	1	0.929	0.000
-1	-1	1	1	0.696	0.000
-1	-2	0	1	0.647	0.000
-1	-2	1	1	0.066	0.000
-1	-2	2	1	0.000	0.000
-1	-3	1	1	0.000	0.000
-1	-3	2	1	0.000	0.926
-1	-3	3	1	0.000	1.000
-1	-4	2	1	0.000	1.000
-1	-4	3	1	0.000	1.000
1	0	-1	-1	0.867	0.000
1	0	0	-1	0.568	0.000
1	-1	-1	-1	0.719	0.000
1	-1	0	-1	0.109	0.004
1	-1	1	-1	0.000	0.092
1	-2	1	-1	0.000	0.766
1	-2	2	-1	0.000	0.990
1	-3	1	-1	0.000	0.989
1	-3	2	-1	0.000	1.000

				Back	For
-1	-1	1	2	0.797	0.000
-1	-1	2	2	0.300	0.000
-1	-2	1	2	0.316	0.000
-1	-2	2	2	0.027	0.016
-1	-2	3	2	0.000	0.467
-1	-3	2	2	0.000	0.396
-1	-3	3	2	0.000	0.969
-1	-3	4	2	0.000	1.000
1	0	-1	-2	0.508	0.000
1	0	0	-2	0.077	0.000
1	-1	1	-2	0.000	0.300
1	-1	0	-2	0.005	0.050
1	-1	-1	-2	0.126	0.000
1	-2	0	-2	0.006	0.326
1	-2	1	-2	0.000	0.874
-2	-2	0	1	0.806	0.000
-2	-2	1	1	0.271	0.000
-2	-3	1	1	0.000	0.015
-2	-3	2	1	0.000	0.341
-2	-4	2	1	0.000	1.000
-2	-4	3	1	0.000	1.000
-2	-5	3	1	0.000	1.000
2	1	0	-1	0.565	0.000
2	0	1	-1	0.000	0.087
2	0	0	-1	0.186	0.005
2	0	-1	-1	0.837	0.000
2	-1	1	-1	0.000	0.418
2	-1	0	-1	0.000	0.015
2	-2	2	-1	0.000	1.000
2	-2	1	-1	0.000	0.918
-2	-2	1	2	0.620	0.000
-2	-2	2	2	0.177	0.040
-2	-3	1	2	0.200	0.020
-2	-3	2	2	0.005	0.481
-2	-3	3	2	0.000	0.988
-2	-4	2	2	0.000	0.928
-2	-4	3	2	0.000	1.000
-2	-4	4	2	0.000	1.000

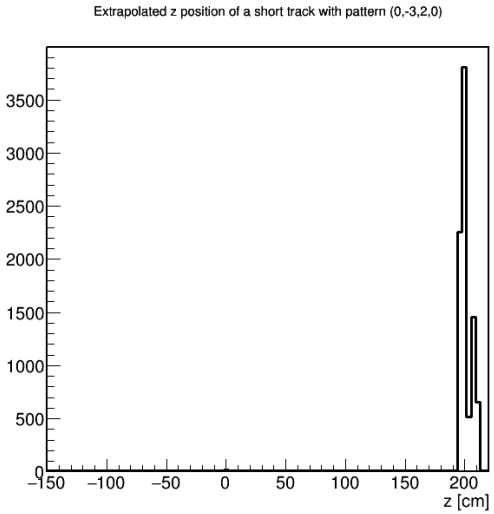
				Back	For
2	1	0	-2	0.613	0.000
2	1	-1	-2	0.818	0.000
2	0	1	-2	0.037	0.481
2	0	0	-2	0.140	0.041
2	0	-1	-2	0.619	0.000
2	0	-2	-2	1.000	0.000
2	-1	2	-2	0.000	1.000
2	-1	1	-2	0.000	0.775
2	-1	0	-2	0.000	0.276
2	-1	-1	-2	0.042	0.000
2	-2	0	-2	0.000	0.846
2	-2	1	-2	0.000	0.981
-2	-2	1	3	0.842	0.000
-2	-2	2	3	0.530	0.012
-2	-3	2	3	0.042	0.292
-2	-3	3	3	0.000	0.870
-2	-3	4	3	0.000	1.000
-2	-4	3	3	0.000	0.900
-2	-4	4	3	0.000	1.000
2	1	-1	-3	0.643	0.000
2	0	-1	-3	0.571	0.000
2	0	-2	-3	1.000	0.000
2	-1	0	-3	0.000	0.790
2	-2	0	-3	0.000	0.981
2	-2	1	-3	0.000	1.000
-2	-2	2	4	0.400	0.000
-2	-3	3	4	0.000	0.563
-2	-3	4	4	0.000	0.889
-2	-4	4	4	0.000	1.000
2	-1	0	-4	0.000	1.000
2	-1	-1	-4	0.000	0.143
2	-2	0	-4	0.000	0.923

Extrapolated z position

- Demonstration plots of the extrapolated z distribution.
  - Peak at 0: doesn't reach ECL.
  - z < -102: Reaching backward endcap.
  - z > 196: Reaching forward endcap.
  - Else: Reaching barrel.



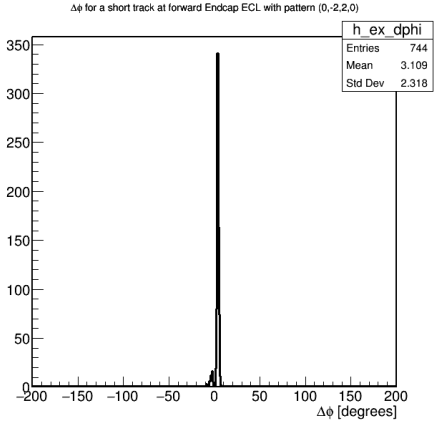
(0,0,0,0):
For most of cases, it reaches backward endcap.

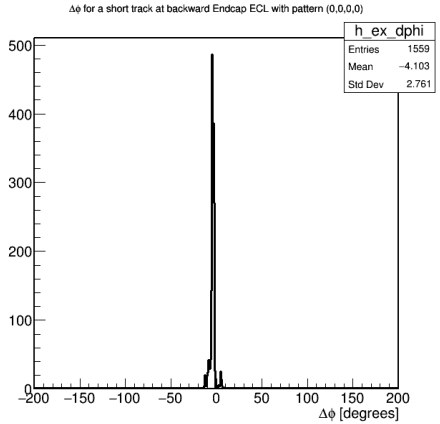


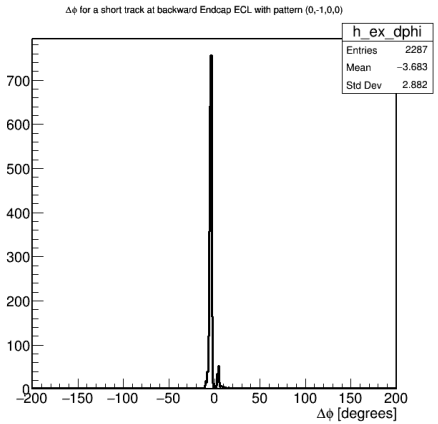
(0,-3,2,0):
For most of cases, it reaches forward endcap.

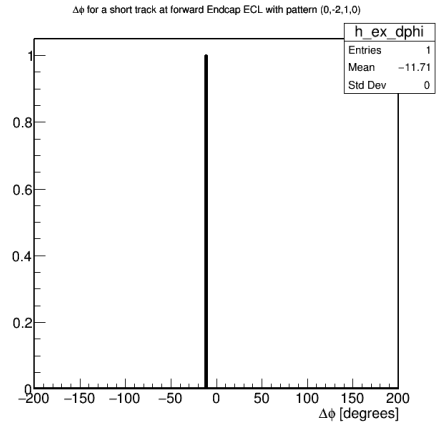
$\Delta\phi$

- $\Delta\phi$ distribution for the patterns with good extrapolated z distribution.
  - Looks good (narrow) enough to utilize.









Summary & To do

- History of the ST logic:
  - 3 SL → 5 SL → updated patterns.

- For now, we expect to have a correctness of 60%~70% and a tracking rate of 90%.
  - Need to check the performance with next beam run.

- To do:
  - Extrapolated the ST up to endcap regions.
  - Investigation has almost been done. Preparation of the logic in GRL firmware is ongoing.

Backup

5 SL: updated patterns

- By beam run e8 run2165. 137 in total.

				eff. (z0)	Ratio
0	0	0	0	93.5%	4.5%
0	-1	0	0	92.4%	8.2%
0	-1	1	0	62.7%	0.6%
0	-1	-1	0	92.9%	0.5%
0	-2	0	0	42.1%	0.1%
0	-2	1	0	27.8%	0.4%
0	-2	2	0	90.7%	2.0%
0	-2	3	0	93.5%	0.1%
0	-3	1	0	34.0%	0.1%
0	-3	2	0	96.9%	21.7%
0	-3	3	0	95.3%	4.6%
0	-4	2	0	94.7%	1.6%
0	-4	3	0	92.3%	0.0%
0	0	0	1	95.0%	0.0%
0	0	1	1	88.1%	0.1%
0	-1	0	1	57.6%	0.0%
0	-1	1	1	55.2%	0.3%
0	-1	2	1	26.5%	0.0%
0	-2	2	1	83.6%	1.4%
0	-2	3	1	96.3%	1.9%
0	-3	2	1	75.2%	0.8%
0	-3	3	1	95.2%	6.9%
0	0	0	-1	20.4%	0.1%
0	0	-1	-1	36.4%	0.0%
0	-1	0	-1	51.0%	2.2%
0	-1	-1	-1	71.4%	1.1%
0	-2	0	-1	3.1%	0.1%
0	-2	1	-1	2.1%	0.1%
0	-3	1	-1	11.6%	0.2%
0	-3	2	-1	64.1%	0.3%
-1	-1	0	0	71.5%	0.3%
-1	-1	1	0	8.2%	0.0%
-1	-2	0	0	27.6%	0.1%
-1	-2	1	0	27.4%	0.1%

				eff. (z0)	Ratio
-1	-3	1	0	47.5%	0.3%
-1	-3	2	0	94.5%	4.9%
-1	-3	3	0	91.9%	0.2%
-1	-4	2	0	92.5%	1.8%
-1	-4	3	0	89.6%	0.2%
1	0	1	0	76.7%	0.7%
1	0	0	0	83.8%	4.6%
1	0	-1	0	50.0%	0.0%
1	-1	0	0	39.5%	0.4%
1	-1	1	0	28.1%	0.3%
1	-2	2	0	54.7%	0.5%
1	-2	3	0	80.0%	0.0%
1	-3	2	0	59.4%	0.1%
1	-3	3	0	80.0%	0.1%
-1	-1	0	1	65.4%	0.1%
-1	-1	1	1	35.6%	0.2%
-1	-2	0	1	24.6%	0.0%
-1	-2	1	1	24.0%	0.3%
-1	-2	2	1	20.7%	0.1%
-1	-3	1	1	4.2%	0.0%
-1	-3	2	1	51.5%	0.9%
-1	-3	3	1	83.5%	1.4%
-1	-4	2	1	53.2%	0.4%
-1	-4	3	1	77.3%	0.5%
1	0	-1	-1	28.7%	0.2%
1	0	0	-1	13.8%	0.4%
1	-1	-1	-1	6.6%	0.1%
1	-1	0	-1	6.6%	0.5%
1	-1	1	-1	6.3%	0.2%
1	-2	1	-1	5.3%	0.2%
1	-2	2	-1	31.9%	0.4%
1	-3	1	-1	32.3%	0.2%
1	-3	2	-1	49.1%	0.2%

				eff. (z0)	Ratio
-1	-1	1	2	34.1%	0.2%
-1	-1	2	2	10.5%	0.0%
-1	-2	1	2	14.3%	0.1%
-1	-2	2	2	22.0%	0.3%
-1	-2	3	2	14.3%	0.0%
-1	-3	2	2	6.4%	0.1%
-1	-3	3	2	49.0%	0.5%
-1	-3	4	2	44.4%	0.0%
1	0	-1	-2	19.5%	0.3%
1	0	0	-2	7.7%	0.1%
1	-1	1	-2	8.4%	0.1%
1	-1	0	-2	10.9%	0.9%
1	-1	-1	-2	8.3%	0.3%
1	-2	0	-2	4.2%	0.3%
1	-2	1	-2	12.1%	0.3%
-2	-2	0	1	36.1%	0.1%
-2	-2	1	1	22.3%	0.2%
-2	-3	1	1	12.9%	0.1%
-2	-3	2	1	25.5%	0.2%
-2	-4	2	1	20.2%	0.1%
-2	-4	3	1	65.2%	0.2%
-2	-5	3	1	42.9%	0.0%
2	1	0	-1	12.7%	0.1%
2	0	1	-1	11.4%	0.2%
2	0	0	-1	10.9%	0.8%
2	0	-1	-1	9.7%	0.1%
2	-1	1	-1	8.1%	0.5%
2	-1	0	-1	1.7%	0.1%
2	-2	2	-1	25.7%	0.2%
2	-2	1	-1	3.5%	0.1%
-2	-2	1	2	31.9%	0.4%
-2	-2	2	2	18.4%	0.2%
-2	-3	1	2	10.7%	0.1%
-2	-3	2	2	18.5%	0.5%
-2	-3	3	2	35.1%	0.2%
-2	-4	2	2	15.2%	0.1%
-2	-4	3	2	45.5%	0.3%
-2	-4	4	2	54.8%	0.0%

				eff. (z0)	Ratio
2	1	0	-2	20.9%	0.1%
2	1	-1	-2	25.3%	0.0%
2	0	1	-2	8.3%	0.0%
2	0	0	-2	13.4%	0.6%
2	0	-1	-2	20.8%	0.5%
2	0	-2	-2	25.0%	0.0%
2	-1	2	-2	30.4%	0.0%
2	-1	1	-2	18.9%	0.5%
2	-1	0	-2	7.5%	0.7%
2	-1	-1	-2	2.1%	0.0%
2	-2	0	-2	1.9%	0.1%
2	-2	1	-2	13.4%	0.2%
-2	-2	1	3	44.1%	0.0%
-2	-2	2	3	23.4%	0.2%
-2	-3	2	3	6.2%	0.0%
-2	-3	3	3	35.0%	0.2%
-2	-3	4	3	56.5%	0.0%
-2	-4	3	3	28.3%	0.1%
-2	-4	4	3	43.9%	0.0%
2	1	-1	-3	18.8%	0.0%
2	0	-1	-3	21.8%	0.2%
2	0	-2	-3	17.0%	0.0%
2	-1	0	-3	21.8%	0.2%
2	-2	0	-3	16.4%	0.1%
2	-2	1	-3	21.1%	0.0%
-2	-2	2	4	26.0%	0.0%
-2	-3	3	4	14.8%	0.0%
-2	-3	4	4	33.3%	0.0%
-2	-4	4	4	37.5%	0.0%
2	-1	0	-4	25.7%	0.0%
2	-1	-1	-4	8.5%	0.0%
2	-2	0	-4	43.5%	0.0%