Iterative motif analysis of ZNF343

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Contents

Importing ChIP-exo raw reads of ZNF343 protein

The raw ChIP-exo reads are stored in ZNF343.bed, and peaks calling positions data are stored in ZNF343_peaks.bed. Both are directly downloaded from https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi? acc=GSM2466539

Importing ChIP-exo peaks called from MACS calling of ZNF343 data

```
ZNF343_peaks <- rtracklayer::import("ZNF343_peaks.bed",format="BED")
as.data.frame(ZNF343_peaks)</pre>
```

| ## | seqnames | start | end | width | strand | name | score |
|-------|----------|----------|----------|-------|--------|---------------|--------|
| ## 1 | chr1 | 29097 | 29378 | 282 | + | MACS_peak_1 | 279.22 |
| ## 2 | chr1 | 714213 | 714415 | 203 | + | MACS_peak_3 | 209.95 |
| ## 3 | chr1 | 740257 | 740389 | 133 | + | MACS_peak_4 | 172.36 |
| ## 4 | chr1 | 762406 | 762630 | 225 | + | MACS_peak_5 | 82.07 |
| ## 5 | chr1 | 1014790 | 1015127 | 338 | + | MACS_peak_8 | 154.40 |
| ## 6 | chr1 | 1166749 | 1167195 | 447 | + | MACS_peak_10 | 223.02 |
| ## 7 | chr1 | 1310535 | 1310733 | 199 | + | MACS_peak_11 | 114.28 |
| ## 8 | chr1 | 2144371 | 2144548 | 178 | + | MACS_peak_14 | 156.92 |
| ## 9 | chr1 | 2323282 | 2323536 | 255 | + | MACS_peak_16 | 173.55 |
| ## 10 | chr1 | 3371199 | 3371504 | 306 | + | MACS_peak_20 | 124.01 |
| ## 11 | chr1 | 6305249 | 6305609 | 361 | + | MACS_peak_24 | 85.73 |
| ## 12 | chr1 | 6844443 | 6844830 | 388 | + | MACS_peak_26 | 106.54 |
| ## 13 | chr1 | 7963131 | 7963382 | 252 | + | MACS_peak_30 | 377.01 |
| ## 14 | chr1 | 8484177 | 8484475 | 299 | + | MACS_peak_33 | 221.36 |
| ## 15 | chr1 | 8763278 | 8763471 | 194 | + | MACS_peak_34 | 86.77 |
| ## 16 | chr1 | 9352999 | 9353153 | 155 | + | MACS_peak_38 | 171.51 |
| ## 17 | chr1 | 9599628 | 9600021 | 394 | + | MACS_peak_41 | 101.83 |
| ## 18 | chr1 | 10854949 | 10855279 | 331 | + | MACS_peak_46 | 107.95 |
| ## 19 | chr1 | 11539211 | 11539482 | 272 | + | MACS_peak_52 | 111.74 |
| ## 20 | chr1 | 11968781 | 11969002 | 222 | + | MACS_peak_54 | 97.66 |
| ## 21 | chr1 | 16011146 | 16011385 | 240 | + | MACS_peak_65 | 218.42 |
| ## 22 | chr1 | 16481310 | 16481504 | 195 | + | MACS_peak_68 | 232.02 |
| ## 23 | chr1 | 16767022 | 16767140 | 119 | + | MACS_peak_71 | 101.73 |
| ## 24 | chr1 | 16872092 | 16872274 | 183 | + | MACS_peak_73 | 103.89 |
| ## 25 | chr1 | 16939942 | 16940490 | 549 | + | MACS_peak_74 | 94.71 |
| ## 26 | chr1 | 16971131 | 16971439 | 309 | + | MACS_peak_75 | 173.58 |
| ## 27 | chr1 | 16993105 | 16993822 | 718 | + | MACS_peak_76 | 180.67 |
| ## 28 | chr1 | 17222246 | 17223011 | 766 | + | MACS_peak_79 | 120.11 |
| ## 29 | chr1 | 17287281 | 17287515 | 235 | + | MACS_peak_80 | 100.65 |
| ## 30 | chr1 | 19282115 | 19282467 | 353 | + | MACS_peak_83 | 151.53 |
| ## 31 | chr1 | 21995415 | 21995859 | 445 | + | MACS_peak_89 | 148.13 |
| ## 32 | chr1 | 22264001 | 22264280 | 280 | + | MACS_peak_90 | 177.37 |
| ## 33 | chr1 | 22379120 | 22379444 | 325 | + | MACS_peak_91 | 341.09 |
| ## 34 | chr1 | 23345883 | 23346241 | 359 | + | MACS_peak_92 | 186.20 |
| ## 35 | chr1 | 23670226 | 23670480 | 255 | + | MACS_peak_94 | 621.08 |
| ## 36 | chr1 | 23886096 | 23886513 | 418 | + | MACS_peak_96 | 414.67 |
| ## 37 | chr1 | 24069635 | 24070039 | 405 | + | MACS_peak_97 | 88.10 |
| ## 38 | chr1 | 24194248 | 24194567 | 320 | + | MACS_peak_100 | 114.18 |
| ## 39 | chr1 | 24742605 | 24742846 | 242 | + | MACS_peak_102 | 369.71 |
| ## 40 | chr1 | 25256224 | 25256525 | 302 | + | MACS_peak_107 | 130.97 |
| ## 41 | chr1 | 26202122 | 26202474 | 353 | + | MACS_peak_111 | 149.72 |
| ## 42 | chr1 | 26438334 | 26438680 | 347 | + | MACS_peak_113 | 85.45 |
| ## 43 | chr1 | 26471659 | 26471865 | 207 | + | MACS_peak_114 | 244.53 |
| ## 44 | chr1 | 26947567 | 26947883 | 317 | + | MACS_peak_118 | 107.68 |
| ## 45 | chr1 | 27098555 | 27098713 | 159 | + | MACS_peak_120 | 158.78 |
| ## 46 | chr1 | 27481531 | 27481631 | 101 | + | MACS_peak_123 | 487.42 |

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                                                                        320.91
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                                         149
## 48
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                                                   +
                                                                        109.30
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                                                       MACS_peak_130
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                                                                        87.56
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                                         274
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                                                                        158.64
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                              28586202
                                         886
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                              28969601
                                         437
                                                       MACS_peak_141 1292.81
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                                                                        92.45
                                                       MACS_peak_147
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                                                       MACS_peak_149
                                                                        128.00
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                                                       MACS_peak_155
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                                                                        194.18
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                                         319
                                                                        113.20
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                                                       MACS_peak_160
            chr1
                                                                        87.02
##
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                              32801992
                                         635
                                                       MACS_peak_162
                                                                        88.56
##
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            chr1
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                              33116444
                                         496
                                                       MACS_peak_165
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## 68
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                                                                        143.93
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                              33178125
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                                                       MACS_peak_194
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                                                       MACS_peak_219
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                              45097845
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                             45806085
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## 102
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                             53193021
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## 910
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## 911
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                                                      MACS_peak_2199 1550.18
## 939
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                                                      MACS_peak_2200
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                               3982310
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## 947
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## 948
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                               4381983
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## 952
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##
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## 959
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                               8543200
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                                                      MACS_peak_2254
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##
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                               9800714
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                              10875970
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                                                      MACS_peak_2261
## 963
                   12419775
                              12420122
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## 964
           chr12
                   12502946
                              12503358
                                         413
                                                      MACS_peak_2264
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## 965
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                              13154372
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## 968
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##
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##
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##
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##
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                                                       MACS_peak_2300
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                              26278725
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                                                       MACS_peak_2301
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##
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                                                                         152.12
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##
  983
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                              26986048
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##
  984
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                              26986428
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                                                       MACS_peak_2306
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##
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                                                       MACS_peak_2311
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                                                       MACS_peak_2318
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                              31743976
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## 995
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                              32552776
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                              39837411
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            chr12
                              42488314
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                                                                         211.28
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                                                                         108.27
## 1000
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                              43946148
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                                                       MACS_peak_2342
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## 1001
            chr12
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## 1002
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                              44200012
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## 1003
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                              44230083
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## 1004
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## 1005
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                                                       MACS_peak_2350
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## 1006
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##
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                                                       MACS_peak_2357
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## 1010
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##
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## 1251
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## 1252
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## 1253
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                                                                        141.66
            chr13
##
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                              93880960
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## 1255
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## 1256
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                              95863982
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## 1257
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## 1258
           chr13
                   96348025
                              96348161
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                                                                        205.12
## 1259
            chr13
                   96743213
                              96743791
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                                                       MACS_peak_2989 1537.94
## 1260
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                              98398746
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                                                       MACS_peak_2998
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##
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                              24505723
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## 1289
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                              61115612
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## 1341
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## 1342
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## 1343
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## 1344
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                                                       MACS_peak_3233 2376.01
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  1346
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                                                       MACS peak 3243
## 1348
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## 1388
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## 1419
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##
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## 2260
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##
             chr2
                              61848132
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                                                                         312.62
##
  2404
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                   62132606
                              62132785
                                          180
                                                       MACS_peak_5776 1215.61
  2405
             chr2
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                              64069870
                                          219
                                                       MACS peak 5782
## 2406
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             chr2
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  2407
##
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                              64371155
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##
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##
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##
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##
                                                       MACS_peak_5796
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## 2415
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##
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##
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## 2420
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                              70351462
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                                                       MACS peak 5820
                                                       MACS_peak_5822
## 2421
                   70484990
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             chr2
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             chr2
## 2422
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## 2423
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                              70781545
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                              71454267
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##
  2427
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## 2435
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## 2436
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## 2437
                   74776421
             chr2
                              74776684
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## 2438
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## 2439
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                              75937743
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## 2440
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## 2441
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                              85839100
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                                                                         87.02
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##
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## 2444
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##
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                              95401543
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## 2452
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## 2454
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                              96782552
                                                       MACS_peak_5898
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## 2455
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                                                       MACS_peak_5902
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                                                       MACS_peak_5905
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                                          164
                                                                        183.19
## 2458
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                              97760589
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## 2459
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## 2460
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## 2461
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                                                       MACS_peak_5917
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             chr2
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##
  2465
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                                                                        119.25
##
   2466
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## 2469
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## 2476
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## 2479
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## 2480
                                                      MACS_peak_5957
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## 2481
            chr2 113190914 113191121
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## 2482
            chr2 114647161 114647383
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                                                      MACS peak 5968
                                                                       200.39
## 2483
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## 2484
            chr2 119532066 119532277
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## 2485
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## 2486
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## 2487
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## 2489
            chr2 121102705 121103104
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## 2490
            chr2 121494189 121494527
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## 2491
            chr2 122042713 122042942
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                                                      MACS_peak_5989
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## 2493
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            chr2 128459158 128459865
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## 2494
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                                                      MACS_peak_6001
            chr2 128615502 128615898
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            chr2 128643056 128643587
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## 2497
            chr2 132121483 132121825
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## 2498
            chr2 133173859 133174287
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## 2499
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            chr2 135875072 135875341
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## 2500
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                                                      MACS_peak_6022
## 2501
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## 2502
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## 2503
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## 2504
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## 2520
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## 2530
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## 2531
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##
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##
  2914
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                                           478
                                                                         171.14
##
  2915
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##
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## 2961
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                              54156958
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## 2962
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                              56502505
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             chr3
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## 2963
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                              57542502
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                                                       MACS_peak_7242
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## 2964
             chr3
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                                                       MACS_peak_7253 1324.13
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                              63849496
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                                                       MACS peak 7258
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                                                      MACS_peak_7262
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##
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                              75629381
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## 2996
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## 3004
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##
  3006
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## 3008
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  3013
##
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## 3014
             chr3 126702841 126702955
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                                                      MACS peak 7419
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                                                      MACS_peak_7422
## 3015
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## 3016
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                                                       MACS peak 7424
                                                                        136.05
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## 3017
            chr3 127391338 127391601
                                         264
                                                      MACS_peak_7425
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                                                      MACS_peak_7426
## 3018
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                                                                        97.02
## 3019
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                                                      MACS peak 7428 1185.58
## 3020
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                                         130
                                                                       154.87
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  3021
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## 3034
            chr3 138313209 138313571
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## 3038
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## 3058
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                                                       MACS_peak_7560
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  3185
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##
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                                                      MACS_peak_8082 2268.08
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                               6633732
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## 3340
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             chr5
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## 3378
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```

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                              95159895
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## 3453
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## 3506
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                                                                        400.01
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##
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                    2634817
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  3554
            chr6
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##
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                               3069216
                                                      MACS_peak_8705
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## 3556
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3557
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                                                        MACS_peak_8717
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##
   3562
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                                6687197
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##
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             chr6
                                                                          128.93
```

```
## 3611
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##
   3612
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                                                        MACS_peak_8838
                                                                          291.39
                   27598745
                               27598872
   3613
             chr6
                   27661939
                               27662239
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                                                        MACS peak 8841
                                                                          104.33
   3614
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##
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##
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                               27806781
                                           453
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##
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##
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                                                                           84.63
##
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                                           255
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                                                                           97.02
##
   3620
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                               28778393
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                                                        MACS_peak_8858
                                                                           81.39
             chr6
##
   3622
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                               28782458
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                                                        MACS_peak_8859
                                                                           86.77
##
   3623
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                                                        MACS_peak_8860
                                                                           96.33
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                               28805444
                                                        MACS_peak_8861
##
   3624
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##
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                                           397
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                                                                          125.42
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##
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##
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##
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##
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                                           231
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##
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   3639
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##
   3640
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##
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##
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                                                                           92.38
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##
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##
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                                                                          124.16
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                                                        MACS peak 8904
                                                                          144.36
  3648
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##
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   3649
                                                        MACS_peak_8912
##
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                                           235
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##
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                                                        MACS_peak_8916
##
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##
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                                                        MACS_peak_8919
                                                                          105.48
##
   3654
                                                        MACS_peak_8922
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                                           194
                                                                          151.11
##
   3655
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                               35049586
                                                        MACS_peak_8923
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                                           409
                                                                          117.16
##
   3656
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##
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                               35286329
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##
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                               35877685
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                                                        MACS_peak_8928
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                                           188
                                                        MACS_peak_8935
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                               36842730
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                                                        MACS_peak_8942
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                                                        MACS peak 8943
                                                                          239.16
                                                        MACS_peak_8946
##
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             chr6
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```

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                                           319
                                                        MACS peak 8955
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                                                        MACS_peak_8964
##
                   41747402
                              41747599
                                           198
                                                                         115.90
##
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                                                        MACS_peak_8967
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##
   3670
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                                                        MACS peak 8968
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##
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                              42897952
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                              42952043
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##
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                                                        MACS_peak_8974
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                                                        MACS_peak_8982
                                                                           95.77
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##
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                                                        MACS_peak_9004
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##
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                              53213715
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                                                        MACS_peak_9009
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                              53409950
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##
  3687
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                              53413057
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##
   3688
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                              53516728
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##
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                              54712109
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                              55443850
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                                                        MACS_peak_9018
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                                                        MACS_peak_9021
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##
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##
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##
   3695
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                              58142696
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##
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                                                        MACS_peak_9033
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##
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                                                        MACS_peak_9035
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##
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                                          256
                                                                         123.87
##
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                              70577625
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                                                        MACS_peak_9039
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             chr6
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                              71276940
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                                                        MACS peak 9041
                                                                           94.98
## 3702
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                                                                         139.87
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                              71665837
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                                                                           81.39
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                                                        MACS_peak_9051
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                                                        MACS_peak_9057
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##
                                                        MACS_peak_9063
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                                           228
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##
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##
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                              86353608
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                                                        MACS peak 9087
                                                        MACS_peak_9088
## 3717
                   86388368
                              86388532
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## 3718
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                              88032453
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             chr6
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```

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## 3719
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                             90062699
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                                                      MACS_peak_9096
                                                                       109.09
            chr6
## 3720
            chr6
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                             94127001
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## 3721
                                                      MACS peak 9106
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                             94128429
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## 3722
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            chr6
                             99292905
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                                                                       118.03
## 3723
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                             99293415
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            chr6 116989753 116989894
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## 3772
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## 3773
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## 3778
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                                                      MACS_peak_9347
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                                                       MACS_peak_9380
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                                                       MACS_peak_9478
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                                                      MACS peak 9491
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                                                        MACS peak 9500
                                                                          381.99
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##
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                                                        MACS_peak_9684
                                                                          103.95
   3952
                    73512307
                               73512460
                                                        MACS_peak_9693
             chr7
                                           154
                                                                          230.45
##
   3953
                    74072185
                               74072654
                                           470
                                                        MACS_peak_9696
             chr7
                                                                          334.59
##
   3954
             chr7
                    74203357
                               74203637
                                           281
                                                        MACS_peak_9697
                                                                          160.01
##
   3955
             chr7
                   74489268
                               74489546
                                           279
                                                        MACS_peak_9699
                                                                           96.96
   3956
##
             chr7
                    74572531
                               74572711
                                           181
                                                        MACS_peak_9701
                                                                          183.66
                                                        MACS_peak_9703
##
  3957
                                                                           91.92
             chr7
                    75157018
                               75157258
                                           241
##
   3958
             chr7
                    75268829
                               75268890
                                            62
                                                        MACS_peak_9704
                                                                          102.85
                                                        MACS_peak_9706
##
   3959
             chr7
                    75449276
                               75449475
                                           200
                                                                           90.84
   3960
             chr7
                    75947288
                               75947400
                                           113
                                                        MACS_peak_9709
                                                                          133.28
   3961
##
             chr7
                    77326205
                               77326521
                                           317
                                                        MACS_peak_9713
                                                                          119.59
##
   3962
             chr7
                   79764355
                               79764821
                                           467
                                                        MACS_peak_9717
                                                                          132.32
   3963
##
             chr7
                    80548248
                               80548642
                                           395
                                                        MACS_peak_9719
                                                                          114.28
##
   3964
                    82791733
                               82792213
                                                        MACS_peak_9722
             chr7
                                           481
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##
   3965
             chr7
                    83779682
                               83780035
                                           354
                                                        MACS_peak_9724
                                                                          127.27
##
   3966
                               83824366
                                           195
                                                        MACS_peak_9725
                                                                          132.78
             chr7
                    83824172
##
   3967
                    84320270
                               84320653
                                           384
                                                        MACS_peak_9726
             chr7
                                                                          337.18
##
   3968
                                           539
                                                        MACS_peak_9727
                                                                          142.95
             chr7
                   84815972
                               84816510
   3969
                   86974536
                                                        MACS_peak_9733
##
             chr7
                               86974841
                                           306
                                                                          120.94
                   87104027
                               87104174
##
   3970
             chr7
                                           148
                                                        MACS_peak_9734
                                                                           90.48
   3971
             chr7
                    87230037
                               87230254
                                           218
                                                        MACS peak 9735
                                                                          372.75
  3972
                                                        MACS_peak_9737
##
                   87505593
                               87506003
                                                                          119.79
             chr7
                                           411
  3973
##
             chr7
                   90225551
                               90226108
                                           558
                                                        MACS_peak_9741
                                                                           89.99
##
  3974
                                                        MACS_peak_9742
                                                                          150.58
             chr7
                   90558136
                               90558296
                                           161
   3975
             chr7
                   90893468
                               90893962
                                           495
                                                        MACS_peak_9743
                                                                          108.27
   3976
                                           424
                                                        MACS_peak_9746
##
             chr7
                   91570227
                               91570650
                                                                          152.99
             chr7
##
   3977
                   91875570
                               91875778
                                           209
                                                        MACS_peak_9749
                                                                          299.80
##
   3978
             chr7
                   92219495
                               92219844
                                           350
                                                        MACS_peak_9753
                                                                          112.96
##
   3979
                    92462510
                               92462973
                                                        MACS_peak_9755
             chr7
                                           464
                                                                          142.70
  3980
##
             chr7
                    92750433
                               92750577
                                           145
                                                        MACS_peak_9757
                                                                          173.31
##
   3981
             chr7
                   93551104
                               93551487
                                           384
                                                        MACS_peak_9759
                                                                          170.29
##
   3982
             chr7
                    95950803
                               95951028
                                           226
                                                        MACS_peak_9763
                                                                          240.03
##
   3983
                    96635813
                               96636063
                                           251
                                                        MACS_peak_9764
                                                                          161.16
             chr7
##
   3984
             chr7
                   97501450
                               97501577
                                           128
                                                        MACS_peak_9768
                                                                           94.68
##
   3985
             chr7
                                           251
                                                        MACS_peak_9774
                                                                          390.04
                   98030233
                               98030483
##
   3986
             chr7
                    98252861
                               98253095
                                           235
                                                        MACS peak 9775
                                                                          330.64
##
  3987
                    99006267
                               99006620
                                                        MACS_peak_9781
             chr7
                                           354
                                                                          539.25
## 3988
                   99156289
                               99156619
                                           331
                                                        MACS peak 9786
                                                                          114.81
             chr7
```

```
## 3989
            chr7 99516851 99517096
                                                      MACS_peak_9789
                                         246
                                                                       250.12
## 3990
            chr7 100034243 100034536
                                         294
                                                      MACS_peak_9797
                                                                       356.89
## 3991
            chr7 100048202 100048431
                                         230
                                                      MACS peak 9799
                                                                       316.86
## 3992
                                                      MACS_peak_9801
            chr7 100202416 100202553
                                         138
                                                                        90.27
## 3993
            chr7 100272206 100272403
                                         198
                                                      MACS_peak_9803
                                                                       101.05
## 3994
            chr7 100493144 100493458
                                                      MACS peak 9805
                                                                        82.19
                                         315
## 3995
            chr7 101499831 101500122
                                         292
                                                      MACS_peak_9813
                                                                       336.14
## 3996
            chr7 102152299 102152631
                                         333
                                                      MACS_peak_9816
                                                                        90.53
## 3997
            chr7 102715284 102715516
                                         233
                                                      MACS_peak_9819
                                                                       314.99
## 3998
            chr7 102789511 102790039
                                         529
                                                      MACS_peak_9820
                                                                       174.48
## 3999
            chr7 104653622 104653938
                                         317
                                                      MACS_peak_9827
                                                                       247.99
## 4000
            chr7 105029111 105029365
                                         255
                                                      MACS_peak_9830
                                                                       186.60
                                                      MACS_peak_9831
## 4001
            chr7 105162422 105162691
                                         270
                                                                       226.51
## 4002
            chr7 105172518 105172727
                                         210
                                                      MACS_peak_9832
                                                                       165.68
## 4003
            chr7 105752869 105753108
                                         240
                                                      MACS_peak_9833
                                                                       196.59
## 4004
            chr7 105925037 105925709
                                         673
                                                      MACS_peak_9834
                                                                       413.18
## 4005
                                        1150
                                                      MACS_peak_9835 1675.09
            chr7 106271734 106272883
## 4006
            chr7 106300453 106300854
                                                      MACS_peak_9836
                                         402
                                                                       168.35
## 4007
            chr7 106685263 106685555
                                         293
                                                      MACS_peak_9837
                                                                       287.30
## 4008
            chr7 106808764 106808981
                                         218
                                                      MACS_peak_9838
                                                                        99.41
## 4009
            chr7 107220801 107221048
                                         248
                                                      MACS_peak_9839
                                                                       490.80
## 4010
                                                      MACS_peak_9842
            chr7 108096773 108096865
                                          93
                                                                       136.76
                                                      MACS_peak_9843
## 4011
            chr7 108150754 108151010
                                                                       199.22
                                         257
## 4012
            chr7 111714646 111714887
                                         242
                                                      MACS_peak_9845
                                                                       147.85
## 4013
            chr7 112089941 112090253
                                         313
                                                      MACS_peak_9847
                                                                       160.33
## 4014
            chr7 113725675 113726098
                                         424
                                                      MACS_peak_9851
                                                                        86.49
## 4015
            chr7 113726259 113726513
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                                                      MACS_peak_9852
                                                                       144.97
## 4016
            chr7 115850622 115851027
                                         406
                                                      MACS_peak_9859
                                                                       154.72
## 4017
            chr7 116082349 116082629
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                                                      MACS_peak_9861
                                                                       109.41
## 4018
                                                      MACS_peak_9862
            chr7 116139549 116140090
                                         542
                                                                       231.38
## 4019
            chr7 116346974 116347271
                                         298
                                                      MACS_peak_9866
                                                                       191.89
## 4020
            chr7 116593465 116593731
                                         267
                                                      MACS_peak_9868
                                                                        91.83
## 4021
            chr7 116654900 116654993
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                                                      MACS_peak_9869
                                                                       223.92
## 4022
            chr7 120496792 120497060
                                         269
                                                      MACS_peak_9872
                                                                       104.85
## 4023
            chr7 120497668 120498273
                                                      MACS_peak_9873
                                         606
                                                                       135.09
## 4024
            chr7 121036193 121036425
                                         233
                                                      MACS_peak_9875
                                                                       383.46
## 4025
            chr7 121513090 121513283
                                         194
                                                      MACS peak 9877
                                                                       131.11
## 4026
                                                      MACS_peak_9879
            chr7 121928011 121928401
                                         391
                                                                       674.12
## 4027
            chr7 123389288 123389539
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                                                      MACS_peak_9882
                                                                        98.75
## 4028
            chr7 123672739 123673053
                                                      MACS_peak_9883
                                                                       135.56
                                         315
## 4029
            chr7 124405574 124405895
                                         322
                                                      MACS_peak_9884 1248.51
## 4030
            chr7 124570130 124570260
                                                      MACS_peak_9885
                                         131
                                                                       795.46
## 4031
            chr7 126892882 126893382
                                         501
                                                      MACS peak 9887
                                                                       299.58
## 4032
                                                      MACS_peak_9895
            chr7 127983612 127983867
                                         256
                                                                       160.87
## 4033
                                                                       152.12
            chr7 128001383 128001819
                                         437
                                                      MACS_peak_9896
## 4034
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                                         445
                                                      MACS_peak_9897
                                                                       141.26
                                                                       185.50
## 4035
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                                         342
                                                      MACS_peak_9898
## 4036
            chr7 128694805 128695121
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                                                      MACS_peak_9904
                                                                       250.90
## 4037
            chr7 128828046 128828280
                                         235
                                                      MACS_peak_9905
                                                                        95.48
## 4038
            chr7 128864316 128864512
                                         197
                                                      MACS_peak_9906
                                                                       204.74
## 4039
            chr7 128865005 128865217
                                         213
                                                      MACS_peak_9907
                                                                        80.44
## 4040
            chr7 129074279 129074582
                                         304
                                                     MACS_peak_9908
                                                                       738.88
                                                     MACS_peak_9910
## 4041
            chr7 129251232 129251607
                                         376
                                                                       113.21
## 4042
            chr7 130418506 130418901
                                         396
                                                      MACS peak 9915
                                                                        80.77
```

```
## 4043
            chr7 132676855 132677068
                                                      MACS_peak_9922
                                         214
                                                                       190.01
## 4044
            chr7 134001455 134001725
                                         271
                                                                       398.20
                                                      MACS_peak_9925
            chr7 134117205 134117810
## 4045
                                         606
                                                      MACS peak 9926
                                                                       325.29
## 4046
                                                     MACS_peak_9930
            chr7 134671419 134671680
                                         262
                                                                       205.43
## 4047
            chr7 134854981 134855702
                                         722
                                                      MACS_peak_9931
                                                                       117.98
## 4048
                                                                       107.15
            chr7 134896085 134896694
                                                      MACS peak 9932
                                         610
## 4049
            chr7 135399406 135399687
                                         282
                                                      MACS_peak_9934
                                                                        84.30
## 4050
            chr7 135661796 135662149
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                                                      MACS_peak_9935
                                                                       308.41
## 4051
            chr7 138144965 138145405
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                                                      MACS_peak_9937
                                                                       308.23
## 4052
            chr7 138348449 138348621
                                         173
                                                      MACS_peak_9938
                                                                       171.29
## 4053
            chr7 138794479 138794782
                                         304
                                                      MACS_peak_9940
                                                                        82.53
## 4054
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                                                      MACS_peak_9942
                                                                       114.79
                                                      MACS_peak_9945
## 4055
            chr7 139025735 139025946
                                                                       147.64
                                         212
## 4056
                                                                       363.50
            chr7 139043826 139044132
                                         307
                                                      MACS_peak_9946
## 4057
            chr7 139167754 139168131
                                         378
                                                      MACS_peak_9948
                                                                        81.38
## 4058
            chr7 139877091 139877340
                                         250
                                                      MACS_peak_9949
                                                                       768.00
## 4059
            chr7 139931006 139931280
                                         275
                                                      MACS_peak_9950
                                                                       258.65
## 4060
            chr7 140178621 140178784
                                                      MACS_peak_9951
                                         164
                                                                       104.08
## 4061
            chr7 140372978 140373415
                                         438
                                                      MACS_peak_9956
                                                                       114.90
## 4062
            chr7 140732713 140732956
                                         244
                                                      MACS_peak_9959
                                                                        80.86
## 4063
            chr7 142552451 142552765
                                         315
                                                     MACS_peak_9963
                                                                       150.27
## 4064
                                                      MACS_peak_9964
            chr7 142983530 142983824
                                         295
                                                                        88.60
                                                      MACS_peak_9965
## 4065
            chr7 142985096 142985319
                                                                        89.03
                                         224
## 4066
            chr7 145813253 145813585
                                         333
                                                      MACS_peak_9973
                                                                       363.44
                                                      MACS_peak_9977
## 4067
            chr7 148302533 148302719
                                                                       523.19
## 4068
            chr7 148395610 148396336
                                         727
                                                      MACS_peak_9978
                                                                       129.17
## 4069
            chr7 148581551 148581872
                                         322
                                                      MACS_peak_9980
                                                                        95.43
## 4070
            chr7 148726014 148726267
                                         254
                                                      MACS_peak_9984
                                                                       101.07
## 4071
            chr7 148762438 148762823
                                         386
                                                      MACS_peak_9985
                                                                        93.70
                                                      MACS_peak_9986
## 4072
            chr7 148787464 148787901
                                                                       100.45
                                         438
## 4073
            chr7 148892570 148892705
                                         136
                                                      MACS_peak_9988
                                                                       103.55
## 4074
            chr7 148959319 148959507
                                         189
                                                      MACS_peak_9990
                                                                       143.70
## 4075
            chr7 149194645 149194977
                                         333
                                                      MACS_peak_9992
                                                                       223.34
## 4076
            chr7 149321831 149322046
                                         216
                                                     MACS_peak_9993
                                                                       193.78
## 4077
            chr7 149388018 149388515
                                                      MACS_peak_9994
                                         498
                                                                       230.71
## 4078
            chr7 149439379 149439753
                                         375
                                                     MACS_peak_9995
                                                                       147.74
## 4079
            chr7 150672209 150672386
                                         178
                                                    MACS peak 10001
                                                                        98.75
## 4080
            chr7 150948762 150948955
                                         194
                                                   + MACS_peak_10004
                                                                        89.13
## 4081
            chr7 151215479 151215762
                                                                        80.04
                                         284
                                                   + MACS_peak_10011
## 4082
            chr7 151329115 151329295
                                         181
                                                   + MACS_peak_10012
                                                                        85.73
## 4083
            chr7 151574572 151574803
                                         232
                                                   + MACS_peak_10016
                                                                        87.44
## 4084
                                                   + MACS_peak_10018
            chr7 152160358 152160739
                                         382
                                                                       329.36
## 4085
            chr7 152161295 152161775
                                         481
                                                   + MACS_peak_10019
                                                                       141.29
## 4086
            chr7 154795382 154795589
                                         208
                                                   + MACS_peak_10027
                                                                       159.92
## 4087
            chr7 154997189 154997354
                                                   + MACS_peak_10028
                                                                        97.06
                                         166
## 4088
            chr7 154998166 154998502
                                         337
                                                   + MACS_peak_10029
                                                                       236.38
## 4089
            chr7 155302658 155303081
                                         424
                                                   + MACS_peak_10032
                                                                       171.97
## 4090
            chr7 155437070 155437580
                                         511
                                                   + MACS_peak_10033
                                                                        88.50
## 4091
            chr7 155601092 155601512
                                         421
                                                   + MACS_peak_10034
                                                                       231.77
## 4092
            chr7 156684810 156685122
                                         313
                                                   + MACS_peak_10037
                                                                       128.87
## 4093
            chr7 156686217 156686538
                                         322
                                                   + MACS_peak_10038
                                                                        83.49
## 4094
            chr7 156804232 156804507
                                         276
                                                   + MACS peak 10042
                                                                       254.75
## 4095
            chr7 157091237 157091481
                                                   + MACS_peak_10046
                                                                       154.57
                                         245
## 4096
            chr7 157667999 157668220
                                         222
                                                   + MACS peak 10047
                                                                        85.66
```

```
## 4097
             chr7 158509676 158510239
                                          564
                                                    + MACS_peak_10050
                                                                         86.55
## 4098
             chr7 158621180 158621992
                                          813
                                                                        554.49
                                                    + MACS_peak_10051
                     182855
## 4099
             chr8
                                183142
                                          288
                                                    + MACS_peak_10055
                                                                         150.03
## 4100
             chr8
                     638373
                                638516
                                          144
                                                    + MACS_peak_10058
                                                                         455.54
## 4101
             chr8
                    6566459
                               6566642
                                          184
                                                    + MACS_peak_10062
                                                                         123.67
## 4102
             chr8
                    7468880
                               7469155
                                                    + MACS_peak_10064
                                                                         121.92
                                          276
## 4103
             chr8
                    7923108
                               7923354
                                          247
                                                    + MACS_peak_10067
                                                                         129.72
## 4104
             chr8
                    9911592
                               9911934
                                          343
                                                    + MACS_peak_10071
                                                                         144.61
## 4105
             chr8
                   11142107
                              11142350
                                          244
                                                    + MACS_peak_10072
                                                                         199.43
## 4106
             chr8
                   11550126
                              11550349
                                          224
                                                    + MACS_peak_10073
                                                                        875.93
## 4107
                   11665786
                              11665928
                                          143
                                                    + MACS_peak_10075
                                                                         84.60
             chr8
## 4108
             chr8
                   11872368
                              11872634
                                          267
                                                    + MACS_peak_10076
                                                                         149.87
## 4109
                   12051449
                              12051655
                                                    + MACS_peak_10077
                                                                         124.41
             chr8
                                          207
                   13133907
## 4110
                              13134094
                                                    + MACS_peak_10084
                                                                         210.42
## 4111
             chr8
                   19797118
                              19797259
                                          142
                                                    + MACS_peak_10091
                                                                         122.06
## 4112
                   21946951
                              21947037
                                           87
                                                    + MACS_peak_10094
                                                                         202.83
             chr8
## 4113
                   22022883
                              22023040
                                                    + MACS_peak_10095
                                                                         148.76
             chr8
                                          158
## 4114
                   22102428
                              22102718
                                                    + MACS_peak_10096
             chr8
                                          291
                                                                         198.51
## 4115
                   22298264
                              22298598
                                          335
                                                    + MACS_peak_10097
             chr8
                                                                         98.11
## 4116
             chr8
                   23314922
                              23315275
                                          354
                                                    + MACS_peak_10099
                                                                         124.04
## 4117
             chr8
                   23386921
                              23387298
                                          378
                                                    + MACS_peak_10101
                                                                          92.86
## 4118
                   24774881
             chr8
                              24775111
                                          231
                                                    + MACS_peak_10102
                                                                         151.15
## 4119
             chr8
                   24813024
                              24813815
                                                    + MACS_peak_10103
                                                                        747.81
                                          792
## 4120
             chr8
                   26371372
                              26371691
                                          320
                                                    + MACS_peak_10107
                                                                         85.45
## 4121
             chr8
                   26519377
                              26519501
                                          125
                                                    + MACS_peak_10109
                                                                         250.99
## 4122
             chr8
                   27630033
                              27630153
                                          121
                                                    + MACS_peak_10113
                                                                         229.40
                   28480239
## 4123
             chr8
                              28480506
                                          268
                                                    + MACS_peak_10120
                                                                         360.68
## 4124
             chr8
                   37217115
                              37217500
                                          386
                                                    + MACS_peak_10134
                                                                         89.36
## 4125
             chr8
                   37552647
                              37552847
                                          201
                                                    + MACS_peak_10139
                                                                         144.14
                                                    + MACS_peak_10141
## 4126
                   37553924
                              37554741
                                                                         156.49
             chr8
                                          818
## 4127
             chr8
                   37739521
                              37739641
                                          121
                                                    + MACS_peak_10143
                                                                         136.78
## 4128
             chr8
                   37888226
                              37888553
                                          328
                                                    + MACS_peak_10145
                                                                         104.72
## 4129
             chr8
                   37962589
                              37963199
                                                    + MACS_peak_10147
                                                                         217.20
                                          611
## 4130
                   38126436
                              38126699
                                                    + MACS_peak_10149
                                                                         109.24
             chr8
                                          264
## 4131
                   38244229
                              38244508
                                                    + MACS_peak_10151
                                                                         88.68
             chr8
                                          280
## 4132
             chr8
                   38385462
                              38385711
                                          250
                                                    + MACS_peak_10153
                                                                         169.38
## 4133
             chr8
                   38414029
                              38414426
                                          398
                                                    + MACS_peak_10154
                                                                         342.83
## 4134
                   41908641
                              41908963
                                                    + MACS_peak_10162
             chr8
                                          323
                                                                         155.97
## 4135
                   42381174
                              42381283
             chr8
                                          110
                                                    + MACS_peak_10167
                                                                         331.06
## 4136
             chr8
                   42396746
                              42397214
                                          469
                                                    + MACS_peak_10168
                                                                         181.55
## 4137
             chr8
                   42698340
                              42698717
                                          378
                                                    + MACS_peak_10169
                                                                         318.12
## 4138
                   42911764
                              42911918
                                                    + MACS_peak_10170
             chr8
                                          155
                                                                         83.83
## 4139
             chr8
                   43066697
                              43066847
                                          151
                                                    + MACS_peak_10173
                                                                         269.86
## 4140
             chr8
                   48100975
                              48101253
                                          279
                                                    + MACS_peak_10177
                                                                         80.63
## 4141
                   48173206
                              48173711
                                          506
                                                    + MACS_peak_10178
                                                                         169.95
             chr8
## 4142
             chr8
                   48873247
                              48873411
                                          165
                                                    + MACS_peak_10179
                                                                         118.19
## 4143
             chr8
                   49834406
                              49834619
                                          214
                                                    + MACS_peak_10183
                                                                         172.08
## 4144
             chr8
                   52783327
                              52783473
                                          147
                                                    + MACS_peak_10184
                                                                         192.40
## 4145
             chr8
                   53499494
                              53499650
                                          157
                                                    + MACS_peak_10185
                                                                         127.43
## 4146
             chr8
                   53626080
                              53626371
                                          292
                                                    + MACS_peak_10187
                                                                         107.35
## 4147
             chr8
                   53854311
                              53854487
                                          177
                                                    + MACS_peak_10188
                                                                         160.53
## 4148
             chr8
                   54792495
                              54793570
                                         1076
                                                    + MACS_peak_10195
                                                                         271.89
## 4149
                   54793839
                              54794103
                                                    + MACS_peak_10196
                                                                         80.86
             chr8
                                          265
## 4150
             chr8
                   54934555
                              54934911
                                          357
                                                    + MACS peak 10198
                                                                          96.35
```

```
## 4151
                   56685469
                              56685973
                                          505
                                                    + MACS_peak_10201
             chr8
                                                                         622.51
## 4152
             chr8
                   56793006
                              56793197
                                          192
                                                    + MACS_peak_10202
                                                                         146.39
                                                    + MACS peak 10204
## 4153
             chr8
                   57124313
                              57124541
                                          229
                                                                         166.13
## 4154
                   59572136
                                                    + MACS_peak_10206
             chr8
                              59572342
                                          207
                                                                         156.59
## 4155
             chr8
                   61193718
                              61194164
                                          447
                                                    + MACS_peak_10207
                                                                         127.17
## 4156
             chr8
                   61566354
                              61566572
                                                    + MACS_peak_10210
                                                                        200.85
                                          219
## 4157
             chr8
                   61590851
                              61591089
                                          239
                                                    + MACS_peak_10211 1048.04
## 4158
             chr8
                   62052207
                              62052373
                                          167
                                                    + MACS_peak_10215
                                                                         259.98
## 4159
             chr8
                   63951994
                              63952112
                                          119
                                                    + MACS_peak_10218
                                                                         104.98
## 4160
             chr8
                   66546128
                              66546370
                                          243
                                                    + MACS_peak_10221
                                                                         270.08
## 4161
                   66754162
                              66754305
                                          144
                                                    + MACS_peak_10224
                                                                          81.23
             chr8
## 4162
             chr8
                   67524694
                              67524909
                                          216
                                                    + MACS_peak_10226
                                                                          82.37
## 4163
                   67525180
                              67525838
                                          659
                                                    + MACS_peak_10227
                                                                         258.01
             chr8
## 4164
             chr8
                   67624734
                              67625192
                                          459
                                                    + MACS_peak_10230
                                                                         114.78
                   67837580
## 4165
             chr8
                              67837796
                                          217
                                                    + MACS_peak_10231
                                                                         137.86
## 4166
                   67841741
                              67841993
                                          253
                                                    + MACS_peak_10232
                                                                         104.79
             chr8
## 4167
                                                    + MACS_peak_10233
                                                                         931.80
             chr8
                   68255868
                              68256164
                                          297
## 4168
                   68864205
                              68864572
                                                    + MACS_peak_10234
                                                                         121.08
             chr8
                                          368
                              70269362
## 4169
                   70269087
                                          276
                                                    + MACS_peak_10236
                                                                         85.07
             chr8
## 4170
             chr8
                   70746444
                              70746884
                                          441
                                                    + MACS_peak_10240
                                                                         178.91
## 4171
             chr8
                   71097040
                              71097213
                                          174
                                                    + MACS_peak_10243
                                                                         104.28
## 4172
                   71314907
                                                    + MACS_peak_10245
             chr8
                              71315706
                                          800
                                                                         353.27
## 4173
             chr8
                   71520542
                              71520852
                                                    + MACS_peak_10246
                                                                         918.05
                                          311
## 4174
             chr8
                   73391769
                              73391983
                                          215
                                                    + MACS_peak_10252
                                                                         108.56
## 4175
             chr8
                   73448817
                              73449273
                                          457
                                                    + MACS_peak_10253
                                                                         124.54
## 4176
             chr8
                   74207694
                              74208237
                                          544
                                                    + MACS_peak_10257
                                                                         121.44
                   75232979
                                          300
                                                    + MACS_peak_10260
## 4177
             chr8
                              75233278
                                                                         606.89
## 4178
             chr8
                   75896401
                              75896732
                                          332
                                                    + MACS_peak_10262
                                                                         165.70
## 4179
             chr8
                   77590399
                              77590542
                                                    + MACS_peak_10266
                                                                         139.59
                                                                         116.92
## 4180
                   79577975
                              79578161
                                                    + MACS_peak_10269
             chr8
                                          187
## 4181
             chr8
                   80679899
                              80680333
                                          435
                                                    + MACS_peak_10271
                                                                          89.48
## 4182
             chr8
                   82023359
                              82023480
                                          122
                                                    + MACS_peak_10277
                                                                         133.84
## 4183
             chr8
                   86089389
                              86090119
                                          731
                                                    + MACS_peak_10280
                                                                         224.93
## 4184
                   87354998
                              87355456
                                          459
                                                    + MACS_peak_10281
                                                                          97.85
             chr8
## 4185
                   87526853
                              87527050
                                          198
                                                    + MACS_peak_10282
                                                                          99.48
             chr8
## 4186
             chr8
                   89339428
                              89339900
                                          473
                                                    + MACS_peak_10283
                                                                         146.08
## 4187
             chr8
                   89340158
                              89340279
                                          122
                                                    + MACS_peak_10284
                                                                          81.68
## 4188
                   89340710
                                                    + MACS_peak_10285
                                                                         264.43
             chr8
                              89341181
                                          472
## 4189
                   90769725
                              90769999
                                                    + MACS_peak_10287
                                                                          80.30
             chr8
                                          275
## 4190
             chr8
                   90914163
                              90914362
                                          200
                                                    + MACS_peak_10288
                                                                         116.45
## 4191
             chr8
                   90996475
                              90996714
                                          240
                                                    + MACS peak 10289
                                                                         113.68
## 4192
                   94712305
                                          273
                                                    + MACS_peak_10295
             chr8
                              94712577
                                                                         176.56
## 4193
             chr8
                   94712930
                              94713261
                                          332
                                                    + MACS_peak_10296
                                                                         102.94
                              94928808
                                                    + MACS_peak_10297
## 4194
             chr8
                   94928591
                                          218
                                                                         117.75
## 4195
                   95003780
                              95004007
                                                    + MACS_peak_10299
                                                                          90.75
             chr8
                                          228
                                                    + MACS_peak_10303
## 4196
             chr8
                   95487105
                              95487323
                                          219
                                                                         384.41
## 4197
             chr8
                   95835606
                              95835926
                                          321
                                                    + MACS_peak_10304
                                                                          92.70
## 4198
             chr8
                   95906841
                              95907033
                                          193
                                                    + MACS_peak_10305
                                                                         483.24
## 4199
             chr8
                   96037263
                              96037494
                                          232
                                                    + MACS_peak_10306
                                                                         101.41
## 4200
             chr8
                   96282147
                              96282447
                                          301
                                                    + MACS_peak_10310
                                                                          93.09
## 4201
             chr8
                   97505877
                              97506208
                                          332
                                                    + MACS_peak_10312
                                                                         118.69
## 4202
             chr8
                   99438946
                              99439156
                                          211
                                                    + MACS_peak_10320
                                                                         177.36
## 4203
                   99837516
                              99837844
                                                    + MACS_peak_10322
             chr8
                                          329
                                                                          85.83
## 4204
             chr8 100025261 100025823
                                          563
                                                    + MACS peak 10323
```

```
## 4205
            chr8 101225243 101225582
                                         340
                                                   + MACS_peak_10325
                                                                       504.39
                                                                       227.95
## 4206
            chr8 101321689 101322268
                                         580
                                                   + MACS_peak_10326
                                                   + MACS_peak_10328 1173.34
## 4207
            chr8 101734262 101734488
                                         227
## 4208
            chr8 101920873 101921051
                                         179
                                                   + MACS_peak_10329
                                                                       158.23
## 4209
            chr8 101962668 101963013
                                         346
                                                   + MACS_peak_10330
                                                                        91.71
## 4210
            chr8 101964654 101965103
                                                   + MACS_peak_10331
                                         450
                                                                       181.72
## 4211
            chr8 103136280 103136486
                                                   + MACS_peak_10333
                                                                       162.80
                                         207
## 4212
            chr8 103422900 103423068
                                         169
                                                   + MACS_peak_10335
                                                                       206.76
## 4213
            chr8 103665947 103666262
                                         316
                                                   + MACS_peak_10337
                                                                        83.02
## 4214
            chr8 103668054 103668197
                                         144
                                                   + MACS_peak_10338
                                                                       243.34
## 4215
            chr8 103818594 103819382
                                         789
                                                   + MACS_peak_10340
                                                                       273.70
## 4216
            chr8 103875350 103875497
                                         148
                                                   + MACS_peak_10344
                                                                       216.77
## 4217
                                         642
                                                                       198.38
            chr8 104512524 104513165
                                                   + MACS_peak_10348
                                                                        96.66
## 4218
            chr8 105601160 105601406
                                         247
                                                   + MACS_peak_10351
## 4219
            chr8 110346055 110346345
                                         291
                                                   + MACS_peak_10353
                                                                       460.11
## 4220
            chr8 121135933 121136079
                                         147
                                                   + MACS_peak_10362
                                                                       133.75
## 4221
                                                                       208.84
            chr8 124169876 124170193
                                         318
                                                   + MACS_peak_10374
                                                   + MACS_peak_10375
## 4222
            chr8 124253337 124253578
                                         242
                                                                       127.08
## 4223
            chr8 125486550 125486789
                                                                        96.85
                                         240
                                                   + MACS_peak_10383
## 4224
            chr8 126010217 126010544
                                         328
                                                   + MACS_peak_10387
                                                                        91.05
## 4225
            chr8 126442208 126442736
                                         529
                                                   + MACS_peak_10391
                                                                        83.35
## 4226
            chr8 128748503 128748817
                                         315
                                                   + MACS_peak_10393
                                                                        85.60
## 4227
            chr8 131028668 131028952
                                                   + MACS_peak_10396
                                                                       256.76
                                         285
## 4228
            chr8 131370331 131370731
                                         401
                                                   + MACS_peak_10398
                                                                       152.50
## 4229
            chr8 131531221 131531453
                                         233
                                                   + MACS_peak_10401
                                                                       195.63
## 4230
            chr8 134309274 134309499
                                         226
                                                   + MACS_peak_10406
                                                                        86.43
## 4231
            chr8 135844931 135845095
                                         165
                                                   + MACS_peak_10412
                                                                       229.99
## 4232
            chr8 140718055 140718370
                                         316
                                                   + MACS_peak_10415
                                                                       175.94
## 4233
            chr8 141803963 141804180
                                         218
                                                   + MACS_peak_10420
                                                                       151.88
## 4234
            chr8 142006283 142006590
                                         308
                                                   + MACS_peak_10421
                                                                       110.55
## 4235
            chr8 142010313 142010512
                                         200
                                                   + MACS_peak_10422
                                                                       190.07
## 4236
            chr8 142011095 142011345
                                         251
                                                   + MACS_peak_10423
                                                                       122.57
                                                   + MACS_peak_10425
## 4237
            chr8 142138187 142138365
                                                                        86.58
## 4238
            chr8 142377207 142377369
                                                                       138.70
                                         163
                                                   + MACS_peak_10426
## 4239
            chr8 143807968 143808137
                                         170
                                                   + MACS_peak_10428
                                                                       118.86
## 4240
            chr8 144360806 144361120
                                         315
                                                   + MACS_peak_10431
                                                                       160.01
## 4241
            chr8 144363658 144363835
                                         178
                                                   + MACS_peak_10432 3041.72
## 4242
            chr8 144512654 144513309
                                                   + MACS_peak_10435
                                                                       269.97
                                         656
## 4243
            chr8 144679457 144679719
                                         263
                                                   + MACS_peak_10438
                                                                       587.82
## 4244
            chr8 144717738 144718055
                                                   + MACS_peak_10440
                                                                       221.86
                                         318
## 4245
            chr8 144843316 144843560
                                         245
                                                   + MACS_peak_10442
                                                                       152.91
## 4246
            chr8 145149915 145150206
                                         292
                                                   + MACS_peak_10446
                                                                        91.92
## 4247
            chr8 145582474 145582824
                                         351
                                                   + MACS_peak_10450
                                                                       155.20
## 4248
            chr8 145980771 145980892
                                         122
                                                   + MACS_peak_10458
                                                                       134.25
## 4249
            chr8 146127809 146128100
                                                   + MACS_peak_10460
                                                                       158.44
                                         292
## 4250
            chr8 146228030 146228283
                                         254
                                                   + MACS_peak_10461
                                                                       112.17
## 4251
            chr9
                     214929
                                215116
                                         188
                                                   + MACS_peak_10467
                                                                       506.28
## 4252
                     976242
                                976756
                                         515
                                                   + MACS_peak_10470
                                                                       238.92
## 4253
                    2016486
                               2016778
                                         293
                                                   + MACS_peak_10472
                                                                       102.17
            chr9
## 4254
                    2017569
                               2017667
                                          99
                                                   + MACS_peak_10473
                                                                       119.06
            chr9
## 4255
                    4605937
                                         172
                                                                        91.92
            chr9
                               4606108
                                                   + MACS_peak_10477
## 4256
            chr9
                    4662282
                               4662440
                                         159
                                                   + MACS_peak_10478
                                                                       234.59
## 4257
                    4740980
                               4741482
                                                   + MACS_peak_10479
            chr9
                                         503
                                                                       334.69
## 4258
            chr9
                    4984642
                               4985277
                                         636
                                                   + MACS peak 10480
                                                                       831.24
```

```
## 4259
                    5303949
                               5304164
                                                    + MACS_peak_10482
             chr9
                                          216
                                                                         141.76
                    5339063
## 4260
                                          374
                                                                         160.53
             chr9
                               5339436
                                                    + MACS_peak_10483
                               6646000
## 4261
             chr9
                    6645725
                                          276
                                                    + MACS peak 10486
                                                                         773.79
## 4262
                    8857902
             chr9
                               8858161
                                          260
                                                    + MACS_peak_10491
                                                                         107.17
## 4263
             chr9
                   14315168
                              14315497
                                          330
                                                    + MACS_peak_10493
                                                                          87.02
## 4264
             chr9
                   14322434
                              14322944
                                                    + MACS_peak_10494
                                                                         155.64
                                          511
## 4265
             chr9
                   15510507
                              15510929
                                          423
                                                    + MACS_peak_10498
                                                                         185.34
## 4266
             chr9
                   15553003
                              15553189
                                          187
                                                    + MACS_peak_10499
                                                                         210.12
## 4267
             chr9
                   17579308
                              17579733
                                          426
                                                    + MACS_peak_10507
                                                                          88.10
## 4268
             chr9
                   19048996
                              19049313
                                          318
                                                    + MACS_peak_10511
                                                                         121.35
## 4269
             chr9
                   19102741
                              19102925
                                          185
                                                    + MACS_peak_10512
                                                                         190.14
## 4270
             chr9
                   20658242
                              20658374
                                          133
                                                      MACS_peak_10517
                                                                         365.18
## 4271
                   22447176
                                          261
             chr9
                              22447436
                                                    + MACS_peak_10526
                                                                         183.28
                   25716336
                              25716396
## 4272
             chr9
                                                      MACS_peak_10528
                                                                         106.61
## 4273
             chr9
                   26892338
                              26892927
                                          590
                                                    + MACS_peak_10529
                                                                         580.21
## 4274
                   27573182
                              27573419
                                          238
                                                      MACS_peak_10531
                                                                         220.88
             chr9
## 4275
                                                      MACS_peak_10535
                                                                         196.93
             chr9
                   32526340
                              32526438
                                           99
                                                    + MACS_peak_10536
## 4276
                   32550568
                              32550981
             chr9
                                          414
                                                                         192.64
                                                                         115.74
## 4277
                   33167126
                              33167237
                                                    + MACS_peak_10538
             chr9
                                          112
## 4278
             chr9
                   33264418
                              33264774
                                          357
                                                    + MACS_peak_10540
                                                                         103.48
## 4279
             chr9
                   33624080
                              33624333
                                          254
                                                    + MACS_peak_10541
                                                                         160.88
## 4280
                   33676968
             chr9
                              33677349
                                          382
                                                    + MACS_peak_10542
                                                                         673.45
## 4281
             chr9
                   33816987
                              33817548
                                                    + MACS_peak_10543
                                                                         157.12
                                          562
## 4282
             chr9
                   34048564
                              34048842
                                          279
                                                    + MACS_peak_10545
                                                                          83.11
## 4283
             chr9
                   34179380
                              34179483
                                          104
                                                    + MACS_peak_10548
                                                                         100.88
## 4284
             chr9
                   34376683
                              34376920
                                          238
                                                    + MACS_peak_10549
                                                                         251.13
## 4285
             chr9
                   34494129
                              34494329
                                          201
                                                    + MACS_peak_10550
                                                                         229.73
## 4286
             chr9
                   35072285
                              35072684
                                          400
                                                    + MACS_peak_10553
                                                                         223.27
## 4287
             chr9
                   35096221
                              35096459
                                          239
                                                    + MACS_peak_10554
                                                                         152.25
## 4288
                   35489642
                              35489848
             chr9
                                          207
                                                    + MACS_peak_10555
                                                                         141.22
## 4289
             chr9
                   35611213
                              35611487
                                          275
                                                    + MACS_peak_10558
                                                                         369.59
## 4290
             chr9
                   35657794
                                          185
                                                    + MACS_peak_10559
                                                                         462.77
                              35657978
## 4291
             chr9
                   35814799
                              35815079
                                          281
                                                    + MACS_peak_10560
                                                                         363.23
## 4292
                   36136505
                              36137136
                                          632
                                                    + MACS_peak_10561
                                                                          94.95
             chr9
## 4293
                   36487964
                              36488252
                                                    + MACS_peak_10563
             chr9
                                          289
                                                                          80.44
## 4294
             chr9
                   36572713
                              36572995
                                          283
                                                    + MACS_peak_10565
                                                                         127.27
## 4295
             chr9
                   36995833
                              36996043
                                          211
                                                    + MACS_peak_10568
                                                                         112.77
## 4296
             chr9
                   37120528
                              37120775
                                          248
                                                    + MACS_peak_10569
                                                                          83.85
## 4297
                                                                          98.75
             chr9
                   37465903
                              37466093
                                          191
                                                    + MACS_peak_10570
## 4298
             chr9
                   37592663
                              37592803
                                                    + MACS_peak_10572
                                                                         156.42
                                          141
## 4299
             chr9
                   37903943
                              37904344
                                          402
                                                    + MACS_peak_10574
                                                                         120.52
## 4300
                   38227186
                              38227274
                                                    + MACS_peak_10576
                                                                         100.37
             chr9
                                           89
## 4301
             chr9
                   68726199
                              68726694
                                          496
                                                    + MACS_peak_10589
                                                                          95.29
## 4302
             chr9
                   69065499
                              69065629
                                          131
                                                    + MACS_peak_10590
                                                                          84.15
## 4303
                   71319794
                              71320162
                                                    + MACS_peak_10592
                                                                          93.09
             chr9
                                          369
## 4304
             chr9
                   71788621
                              71789009
                                          389
                                                    + MACS_peak_10594
                                                                         118.68
## 4305
             chr9
                   72287794
                              72288024
                                          231
                                                    + MACS_peak_10598
                                                                         320.32
## 4306
             chr9
                   73035732
                              73035925
                                                    + MACS_peak_10601
                                                                          86.24
## 4307
                   74654075
                              74654197
                                          123
                                                      MACS_peak_10605
                                                                         659.76
             chr9
## 4308
             chr9
                   74979667
                              74980151
                                          485
                                                      MACS_peak_10607
                                                                         163.52
## 4309
             chr9
                   74980655
                                          356
                              74981010
                                                      MACS_peak_10608
                                                                         343.19
## 4310
             chr9
                   77502028
                              77502248
                                          221
                                                    + MACS_peak_10610
                                                                          83.02
## 4311
                   77567580
                              77567797
                                                    + MACS_peak_10611
                                                                         219.95
             chr9
                                          218
## 4312
             chr9
                   77703298
                              77703528
                                          231
                                                    + MACS peak 10613
                                                                         195.58
```

```
## 4313
                   79009164
                              79009726
                                                                         80.31
             chr9
                                          563
                                                   + MACS_peak_10614
## 4314
             chr9
                   79433393
                              79433593
                                          201
                                                                        145.31
                                                   + MACS_peak_10616
## 4315
             chr9
                   79626898
                              79627436
                                          539
                                                   + MACS_peak_10618
                                                                        108.27
## 4316
             chr9
                   79714267
                              79714600
                                          334
                                                   + MACS_peak_10620
                                                                         82.07
## 4317
             chr9
                   79792501
                              79792768
                                          268
                                                   + MACS_peak_10621
                                                                         93.03
## 4318
             chr9
                   79793018
                              79793350
                                                   + MACS_peak_10622
                                                                         92.70
                                          333
## 4319
             chr9
                   80851197
                              80851374
                                                   + MACS_peak_10626
                                                                        119.09
                                          178
## 4320
             chr9
                   82206855
                              82207284
                                          430
                                                   + MACS_peak_10630
                                                                        520.68
## 4321
             chr9
                   82259120
                              82259296
                                          177
                                                   + MACS_peak_10631
                                                                        129.02
## 4322
             chr9
                   88714249
                              88714729
                                          481
                                                   + MACS_peak_10644
                                                                        193.08
## 4323
             chr9
                   89562256
                              89562526
                                          271
                                                   + MACS_peak_10650
                                                                        939.75
## 4324
             chr9
                   89563693
                              89563874
                                          182
                                                   + MACS_peak_10651
                                                                        114.92
## 4325
                   89828986
                              89829242
             chr9
                                          257
                                                   + MACS_peak_10653
                                                                        215.49
             chr9
## 4326
                   90341140
                              90341446
                                          307
                                                   + MACS_peak_10655
                                                                        107.24
## 4327
             chr9
                   93405041
                              93405166
                                          126
                                                   + MACS_peak_10666
                                                                        112.74
## 4328
                   93956199
                              93956218
                                           20
                                                   + MACS_peak_10668
                                                                         96.58
             chr9
## 4329
                                                   + MACS_peak_10670
                                                                        161.57
             chr9
                   94277401
                              94277516
                                          116
                                                   + MACS_peak_10673
## 4330
                   94711173
                              94711488
             chr9
                                          316
                                                                        109.24
## 4331
                   95088105
                              95088319
                                                   + MACS_peak_10675
                                                                        309.23
             chr9
                                          215
## 4332
             chr9
                   96213535
                              96213828
                                          294
                                                   + MACS_peak_10679
                                                                        324.31
## 4333
             chr9
                   96929187
                              96929496
                                          310
                                                   + MACS_peak_10682
                                                                        155.97
## 4334
                   97505309
             chr9
                              97505576
                                          268
                                                   + MACS_peak_10684
                                                                        172.18
## 4335
                   98189101
                              98189316
                                                   + MACS peak 10687
                                                                        112.82
             chr9
                                          216
## 4336
             chr9
                   98278099
                              98278285
                                          187
                                                   + MACS_peak_10688
                                                                        224.43
## 4337
             chr9
                   98534789
                              98534969
                                          181
                                                   + MACS_peak_10689
                                                                        111.63
## 4338
             chr9
                   99381457
                              99381697
                                          241
                                                   + MACS_peak_10691
                                                                        220.30
## 4339
                                          220
             chr9
                   99417148
                              99417367
                                                   + MACS_peak_10692
                                                                        163.59
## 4340
             chr9
                   99616579
                              99616769
                                          191
                                                   + MACS_peak_10693
                                                                        511.60
## 4341
             chr9
                   99775617
                              99775855
                                                   + MACS_peak_10694
                                                                         82.80
## 4342
                   99801536
                              99801757
             chr9
                                          222
                                                   + MACS_peak_10695
                                                                        259.88
## 4343
             chr9 100263559 100263816
                                          258
                                                   + MACS_peak_10700
                                                                        290.20
## 4344
             chr9 100395754 100396007
                                          254
                                                   + MACS_peak_10702
                                                                        147.14
                                                   + MACS_peak_10705
## 4345
             chr9 100819087 100819333
                                          247
                                                                         89.78
## 4346
             chr9 100955206 100955473
                                          268
                                                   + MACS_peak_10706
                                                                        253.45
## 4347
             chr9 101469300 101469890
                                                   + MACS_peak_10707
                                          591
                                                                        108.08
## 4348
             chr9 109012056 109012398
                                          343
                                                   + MACS_peak_10717
                                                                        196.60
## 4349
             chr9 109624644 109625029
                                          386
                                                   + MACS_peak_10718
## 4350
             chr9 109625343 109626475
                                         1133
                                                   + MACS_peak_10719
                                                                        189.44
## 4351
             chr9 110187671 110187928
                                          258
                                                   + MACS_peak_10720
                                                                        258.46
## 4352
             chr9 111696264 111696598
                                          335
                                                   + MACS_peak_10725
                                                                        142.45
## 4353
             chr9 111776927 111777222
                                          296
                                                   + MACS_peak_10727
                                                                        984.63
## 4354
                                          228
             chr9 111969138 111969365
                                                   + MACS_peak_10729
                                                                        270.41
## 4355
             chr9 112262153 112262209
                                           57
                                                   + MACS_peak_10730
                                                                         97.37
## 4356
             chr9 113051663 113051916
                                          254
                                                   + MACS_peak_10733
                                                                        150.37
## 4357
             chr9 113341498 113341900
                                                   + MACS_peak_10734
                                                                        120.65
                                          403
## 4358
             chr9 114393600 114393895
                                          296
                                                   + MACS_peak_10736
                                                                        156.42
## 4359
             chr9 114658866 114658988
                                          123
                                                   + MACS_peak_10738
                                                                         98.92
## 4360
             chr9 115095464 115095806
                                          343
                                                   + MACS_peak_10740
                                                                        166.76
## 4361
             chr9 115827542 115827739
                                          198
                                                   + MACS_peak_10745
                                                                        131.82
## 4362
             chr9 115832964 115833216
                                          253
                                                   + MACS_peak_10746
                                                                        145.32
## 4363
                                          227
                                                   + MACS_peak_10748
             chr9 115843840 115844066
                                                                        220.94
## 4364
             chr9 115849313 115849492
                                          180
                                                   + MACS peak 10749
## 4365
             chr9 115873793 115874008
                                                   + MACS_peak_10750
                                          216
                                                                        107.17
## 4366
             chr9 115875178 115875390
                                          213
                                                   + MACS peak 10751
```

```
## 4367
            chr9 116172500 116172653
                                                   + MACS_peak_10752
                                         154
                                                                       242.21
## 4368
            chr9 123836868 123837113
                                         246
                                                                       100.22
                                                   + MACS_peak_10760
## 4369
                                                   + MACS_peak_10762
            chr9 124261922 124262135
                                         214
                                                                       217.42
## 4370
            chr9 124401434 124401735
                                         302
                                                   + MACS_peak_10763
                                                                       138.50
## 4371
            chr9 124855742 124855872
                                         131
                                                   + MACS_peak_10764
                                                                       106.96
## 4372
            chr9 127014344 127014530
                                                   + MACS_peak_10772
                                                                       277.70
## 4373
            chr9 127242864 127243010
                                         147
                                                   + MACS_peak_10774
                                                                       108.56
## 4374
            chr9 127631436 127631890
                                         455
                                                   + MACS_peak_10778
                                                                       148.79
                                                   + MACS_peak_10779
## 4375
            chr9 127905640 127905915
                                         276
                                                                       107.71
## 4376
            chr9 128469335 128469700
                                         366
                                                   + MACS_peak_10781
                                                                       225.77
## 4377
            chr9 128508539 128509299
                                         761
                                                   + MACS_peak_10782
                                                                       536.07
## 4378
            chr9 128511147 128511357
                                         211
                                                   + MACS_peak_10783
                                                                       125.07
## 4379
            chr9 130159435 130159789
                                         355
                                                                       104.60
                                                   + MACS_peak_10788
## 4380
                                                   + MACS_peak_10789
            chr9 130185867 130186192
                                                                        86.27
## 4381
            chr9 130206336 130206832
                                         497
                                                   + MACS_peak_10790
                                                                       115.99
## 4382
            chr9 130477471 130477894
                                         424
                                                   + MACS_peak_10793
                                                                        88.70
## 4383
                                         506
                                                   + MACS_peak_10794
                                                                       133.49
            chr9 130497121 130497626
                                                   + MACS_peak_10795
## 4384
            chr9 130533754 130534021
                                         268
                                                                       121.52
## 4385
            chr9 130548106 130548526
                                         421
                                                                       226.47
                                                   + MACS_peak_10796
## 4386
            chr9 130742844 130743241
                                         398
                                                   + MACS_peak_10799
                                                                        80.85
## 4387
            chr9 130860812 130861005
                                         194
                                                   + MACS_peak_10801
                                                                       207.50
## 4388
            chr9 131102608 131102818
                                         211
                                                   + MACS_peak_10802
                                                                       204.73
## 4389
            chr9 131465045 131465358
                                                   + MACS peak 10808
                                                                       173.35
                                         314
## 4390
            chr9 131533828 131534294
                                         467
                                                   + MACS_peak_10809
                                                                       113.70
                                                   + MACS_peak_10810
## 4391
            chr9 131549268 131549440
                                         173
                                                                       336.41
## 4392
            chr9 131710041 131710227
                                         187
                                                   + MACS_peak_10811
                                                                       534.71
## 4393
                                         227
            chr9 131843376 131843602
                                                   + MACS_peak_10813
                                                                       382.72
## 4394
            chr9 132175804 132176047
                                         244
                                                   + MACS_peak_10815
                                                                       238.18
## 4395
            chr9 132250753 132251076
                                         324
                                                   + MACS_peak_10816
                                                                       218.76
## 4396
            chr9 132382522 132382730
                                         209
                                                   + MACS_peak_10819
                                                                       113.95
## 4397
            chr9 132565453 132565734
                                         282
                                                   + MACS_peak_10820
                                                                       149.66
## 4398
            chr9 132648176 132648475
                                         300
                                                   + MACS_peak_10822
                                                                       190.23
                                                   + MACS_peak_10823
## 4399
            chr9 132805289 132805478
                                         190
                                                                       142.00
## 4400
            chr9 133319850 133319977
                                         128
                                                                        87.20
                                                   + MACS_peak_10824
## 4401
            chr9 133556590 133556900
                                         311
                                                   + MACS_peak_10827
                                                                       168.71
## 4402
            chr9 133711499 133711665
                                         167
                                                   + MACS_peak_10830
                                                                       214.19
## 4403
            chr9 133971733 133972163
                                         431
                                                   + MACS_peak_10832
                                                                       146.94
## 4404
            chr9 134225374 134225596
                                         223
                                                   + MACS_peak_10833
                                                                       119.27
## 4405
            chr9 134278219 134278432
                                         214
                                                   + MACS_peak_10834
                                                                       295.32
## 4406
            chr9 134614754 134615125
                                                   + MACS_peak_10837
                                                                       340.38
                                         372
## 4407
            chr9 135545281 135545562
                                         282
                                                   + MACS_peak_10840
                                                                       126.41
## 4408
            chr9 136159952 136160198
                                         247
                                                   + MACS_peak_10841
                                                                       102.60
## 4409
            chr9 136857204 136857627
                                         424
                                                   + MACS_peak_10843
                                                                       719.51
## 4410
            chr9 137740867 137741247
                                         381
                                                   + MACS_peak_10846
                                                                        94.98
## 4411
            chr9 137741870 137742384
                                                   + MACS_peak_10847
                                                                       173.33
                                         515
## 4412
            chr9 137797412 137797806
                                         395
                                                   + MACS_peak_10848
                                                                       193.88
## 4413
            chr9 138798435 138798634
                                         200
                                                   + MACS_peak_10853
                                                                        93.72
## 4414
            chr9 139159351 139159659
                                         309
                                                   + MACS_peak_10856
                                                                       237.52
## 4415
            chr9 139334175 139334330
                                         156
                                                   + MACS_peak_10857
                                                                       161.80
## 4416
            chr9 139581535 139581890
                                         356
                                                   + MACS_peak_10859
                                                                       300.69
## 4417
                                         306
                                                   + MACS_peak_10860
            chr9 139606209 139606514
                                                                       162.02
## 4418
            chr9 139622578 139622775
                                                   + MACS peak 10861
## 4419
            chr9 139838850 139839121
                                                   + MACS_peak_10864
                                         272
                                                                       527.52
## 4420
            chr9 139886945 139887120
                                         176
                                                   + MACS peak 10865
```

```
## 4421
             chr9 139981419 139981568
                                          150
                                                    + MACS_peak_10867
                                                                         571.97
## 4422
             chr9 140135743 140135838
                                           96
                                                                         249.89
                                                    + MACS_peak_10869
## 4423
             chr9 140345428 140346644
                                         1217
                                                    + MACS_peak_10870
                                                                         964.30
## 4424
             chr9 140398223 140398634
                                          412
                                                    + MACS_peak_10871
                                                                         704.98
## 4425
             chr9 140500201 140500485
                                          285
                                                    + MACS_peak_10873
                                                                          82.40
## 4426
             chr9 140634839 140635082
                                                    + MACS_peak_10874
                                                                         171.33
                                          244
## 4427
             chr9 141044686 141044998
                                          313
                                                    + MACS_peak_10875
                                                                          96.57
## 4428
             chrX
                    1846481
                               1846728
                                          248
                                                    + MACS_peak_10899
                                                                         145.84
## 4429
             chrX
                    2006441
                               2007138
                                          698
                                                    + MACS_peak_10903
                                                                         489.49
## 4430
             chrX
                   10588288
                              10588597
                                          310
                                                    + MACS_peak_10911
                                                                         239.95
## 4431
                   12809144
                              12809649
                                          506
                                                    + MACS_peak_10914
                                                                          90.37
             chrX
## 4432
             chrX
                   13665900
                              13666193
                                          294
                                                    + MACS_peak_10915
                                                                          93.22
                   13752872
## 4433
                              13753120
                                          249
                                                    + MACS_peak_10917
                                                                         123.87
             chrX
## 4434
             chrX
                   15872754
                              15873252
                                          499
                                                    + MACS_peak_10919
                                                                         706.67
## 4435
             chrX
                   16804492
                              16804756
                                          265
                                                    + MACS_peak_10923
                                                                         105.67
## 4436
                   16964786
                              16964899
                                                    + MACS_peak_10924
                                                                          96.94
             chrX
                                          114
## 4437
             {\tt chrX}
                                                    + MACS_peak_10929
                                                                         229.35
                   18372350
                              18372813
                                          464
                                                    + MACS_peak_10932
## 4438
                   19002903
                              19003346
             chrX
                                          444
                                                                         168.33
## 4439
             chrX
                   20380409
                              20380554
                                                    + MACS_peak_10936
                                          146
                                                                         154.77
## 4440
             chrX
                   21756768
                              21756954
                                          187
                                                    + MACS_peak_10939
                                                                         151.11
## 4441
             chrX
                   22140776
                              22140980
                                          205
                                                    + MACS_peak_10942
                                                                         127.27
## 4442
             chrX
                   23841180
                              23841440
                                          261
                                                    + MACS_peak_10947
                                                                          89.45
## 4443
             chrX
                   24043289
                              24043485
                                                    + MACS_peak_10948
                                                                         146.01
                                          197
## 4444
             chrX
                   24072941
                              24073283
                                          343
                                                    + MACS_peak_10950
                                                                         169.79
## 4445
             chrX
                   38079990
                              38080172
                                          183
                                                    + MACS_peak_10958
                                                                         201.69
## 4446
             chrX
                   39828288
                              39828716
                                          429
                                                    + MACS_peak_10960
                                                                         154.12
## 4447
             chrX
                   39958374
                              39958634
                                          261
                                                    + MACS_peak_10962
                                                                         207.38
## 4448
             chrX
                   39965827
                              39966051
                                          225
                                                    + MACS_peak_10963
                                                                         468.55
## 4449
             chrX
                   39967319
                              39967531
                                          213
                                                    + MACS_peak_10965
                                                                         129.29
## 4450
                   40594822
                              40595051
                                                                         338.37
             chrX
                                          230
                                                    + MACS_peak_10969
## 4451
             chrX
                   40653197
                              40653375
                                          179
                                                    + MACS_peak_10970
                                                                         116.94
## 4452
                   41135372
                              41135641
                                          270
                                                    + MACS_peak_10971
                                                                         101.83
             chrX
## 4453
                   46404806
                              46405157
                                          352
                                                    + MACS_peak_10978
                                                                         115.40
             chrX
## 4454
                   47050233
                              47050409
                                          177
                                                    + MACS_peak_10980
             chrX
                                                                         293.46
## 4455
                   47518551
                              47518828
                                          278
                                                    + MACS_peak_10985
             chrX
                                                                         123.23
## 4456
             chrX
                   49687282
                              49687590
                                          309
                                                    + MACS_peak_10992
                                                                         147.17
## 4457
             chrX
                   51075435
                              51075859
                                          425
                                                    + MACS_peak_10993
                                                                          89.95
## 4458
                   51238953
                              51239518
                                                    + MACS_peak_10994
                                                                         132.83
             chrX
                                          566
## 4459
                   51364383
                                                                         442.42
             chrX
                              51364516
                                          134
                                                    + MACS_peak_10995
## 4460
             chrX
                   52949962
                              52950047
                                                    + MACS_peak_10997
                                                                         114.92
                                           86
## 4461
             chrX
                   53104289
                              53104545
                                          257
                                                    + MACS_peak_10999
                                                                         133.77
## 4462
                   53449082
                                                    + MACS_peak_11001
             chrX
                              53449227
                                          146
                                                                         340.05
## 4463
             chrX
                   53461211
                              53461425
                                          215
                                                    + MACS_peak_11002
                                                                          95.77
## 4464
                                                                         180.57
             chrX
                   53710964
                              53711114
                                          151
                                                    + MACS_peak_11003
## 4465
                   53713219
                              53713874
                                                    + MACS_peak_11004
                                                                         145.30
             chrX
                                          656
## 4466
             chrX
                   54384596
                              54384798
                                          203
                                                    + MACS_peak_11009
                                                                          99.63
## 4467
             chrX
                   62571035
                              62571251
                                          217
                                                    + MACS_peak_11016
                                                                         211.10
## 4468
             chrX
                   67653305
                              67653679
                                          375
                                                    + MACS_peak_11020
                                                                         115.09
## 4469
             chrX
                   68049428
                              68049677
                                          250
                                                    + MACS_peak_11022
                                                                         399.48
## 4470
             {\tt chrX}
                   71238314
                              71238623
                                          310
                                                    + MACS_peak_11026
                                                                         149.05
## 4471
             {\tt chrX}
                   71401144
                              71401379
                                          236
                                                    + MACS_peak_11027
                                                                         111.76
## 4472
                   71526064
                              71527009
                                          946
                                                    + MACS_peak_11028
## 4473
             chrX 100186407 100186614
                                                    + MACS_peak_11044
                                                                         796.84
                                          208
## 4474
             chrX 102611464 102611621
                                                    + MACS peak 11052
                                                                          83.02
```

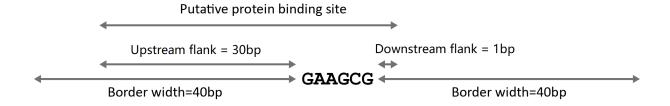
```
## 4475
            chrX 106045974 106046190
                                                   + MACS_peak_11057
                                         217
                                                                       185.80
## 4476
            chrX 107069637 107070296
                                         660
                                                                       100.31
                                                   + MACS_peak_11060
                                                   + MACS_peak_11063
## 4477
            chrX 107979292 107979527
                                         236
                                                                        91.71
## 4478
                                                   + MACS_peak_11072
            chrX 114579984 114580393
                                         410
                                                                       190.98
## 4479
            chrX 118075082 118075292
                                         211
                                                   + MACS_peak_11082
                                                                        93.09
## 4480
            chrX 118370060 118370700
                                                   + MACS_peak_11084
                                                                       133.58
                                         641
## 4481
            chrX 118602644 118603137
                                         494
                                                   + MACS_peak_11085
                                                                       134.89
## 4482
            chrX 118650339 118650584
                                         246
                                                   + MACS_peak_11086
                                                                       146.47
## 4483
            chrX 118708553 118708904
                                         352
                                                   + MACS_peak_11087
                                                                       147.04
## 4484
            chrX 118925493 118925875
                                         383
                                                   + MACS_peak_11090
                                                                       463.51
## 4485
            chrX 118986783 118986969
                                         187
                                                   + MACS_peak_11091
                                                                       490.12
## 4486
                                         477
            chrX 119378704 119379180
                                                   + MACS_peak_11094
                                                                       394.11
## 4487
            chrX 119384677 119384877
                                         201
                                                                       215.16
                                                   + MACS_peak_11095
## 4488
                                                   + MACS_peak_11096
            chrX 119443430 119443608
                                                                        84.30
## 4489
            chrX 119715870 119716071
                                         202
                                                   + MACS_peak_11098
                                                                        81.58
## 4490
            chrX 123095580 123095692
                                         113
                                                   + MACS_peak_11103
                                                                        95.45
## 4491
                                                                        80.77
            chrX 128657141 128657256
                                         116
                                                   + MACS_peak_11110
                                                   + MACS_peak_11112
## 4492
            chrX 128739587 128739698
                                                                        94.56
                                         112
                                         304
## 4493
            chrX 128977121 128977424
                                                   + MACS_peak_11114
                                                                       112.48
## 4494
            chrX 129091104 129091346
                                         243
                                                   + MACS_peak_11115
                                                                       112.81
## 4495
            chrX 129254832 129255093
                                         262
                                                   + MACS_peak_11117
                                                                       115.84
## 4496
            chrX 129473683 129474052
                                         370
                                                   + MACS_peak_11118
                                                                        81.15
## 4497
            chrX 129535959 129536279
                                                   + MACS peak 11119
                                                                       259.57
                                         321
## 4498
            chrX 131157106 131157644
                                         539
                                                   + MACS_peak_11121
                                                                       175.66
## 4499
            chrX 132091452 132091870
                                         419
                                                   + MACS_peak_11124
                                                                       178.38
## 4500
            chrX 133594115 133594390
                                         276
                                                   + MACS_peak_11126
                                                                       538.39
## 4501
                                         355
            chrX 134049153 134049507
                                                   + MACS_peak_11130
                                                                        96.90
## 4502
            chrX 134156439 134156673
                                         235
                                                   + MACS_peak_11133
                                                                       166.76
## 4503
            chrX 134185749 134185979
                                         231
                                                   + MACS_peak_11134
                                                                       116.22
            chrX 134429559 134429915
## 4504
                                         357
                                                   + MACS_peak_11135
                                                                        83.58
## 4505
            chrX 134909209 134909423
                                         215
                                                   + MACS_peak_11140
                                                                       246.41
## 4506
            chrX 135055814 135056170
                                         357
                                                   + MACS_peak_11141
                                                                       114.28
## 4507
            chrX 135992329 135992492
                                         164
                                                   + MACS_peak_11144
                                                                        81.20
## 4508
            chrX 146994012 146994260
                                         249
                                                   + MACS_peak_11152
                                                                       110.61
## 4509
            chrX 149566509 149566705
                                         197
                                                   + MACS_peak_11155
                                                                       169.65
## 4510
            chrX 149993006 149993262
                                         257
                                                   + MACS_peak_11157
                                                                       147.11
## 4511
            chrX 151922278 151922390
                                         113
                                                   + MACS_peak_11163
                                                                       106.61
## 4512
            chrX 152736164 152736300
                                         137
                                                   + MACS_peak_11166
                                                                       167.15
## 4513
            chrX 152864266 152864572
                                         307
                                                   + MACS_peak_11167
                                                                       245.07
## 4514
            chrX 152912600 152912777
                                                   + MACS_peak_11168
                                                                       153.71
                                         178
## 4515
            chrX 152974072 152974216
                                         145
                                                   + MACS_peak_11170
                                                                        96.91
## 4516
            chrX 152989925 152990371
                                         447
                                                   + MACS_peak_11171
                                                                       152.30
## 4517
            chrX 153193609 153193920
                                         312
                                                   + MACS_peak_11173
                                                                       109.43
## 4518
            chrX 153236998 153237638
                                         641
                                                   + MACS_peak_11174
                                                                       213.58
## 4519
            chrX 153438263 153438532
                                         270
                                                   + MACS_peak_11176
                                                                       340.05
## 4520
            chrX 153475433 153475541
                                         109
                                                   + MACS_peak_11177
                                                                       511.87
## 4521
            chrX 153513235 153513359
                                         125
                                                   + MACS_peak_11178
                                                                       368.68
## 4522
            chrX 153570143 153570543
                                         401
                                                   + MACS_peak_11179
                                                                       179.73
## 4523
            chrX 153606613 153606818
                                         206
                                                   + MACS_peak_11180
                                                                       117.04
## 4524
            chrX 153626083 153626485
                                         403
                                                   + MACS_peak_11181
                                                                       365.46
## 4525
            chrX 153639640 153639815
                                         176
                                                                       522.08
                                                   + MACS_peak_11182
## 4526
            chrX 153755348 153755783
                                         436
                                                   + MACS peak 11186
                                                                       162.10
## 4527
            chrX 153979133 153979207
                                          75
                                                   + MACS_peak_11187
                                                                        88.05
## 4528
            chrX 154033826 154034025
                                         200
                                                   + MACS peak 11188
                                                                      140.76
```

```
## 4529
           chrX 154114771 154115057
                                      287
                                               + MACS_peak_11190
                                                                   85.32
## 4530
           chrX 154687889 154688156
                                      268
                                               + MACS_peak_11193
                                                                   85.33
                                               + MACS peak 11195 135.46
## 4531
           chrX 155102983 155103161
                                      179
## 4532
           chrX 155110955 155111525
                                               + MACS_peak_11196
                                      571
                                                                  156.62
```

Searching for all GAAGCG anchor positions within ZNF343 ChIP-exo peaks

```
## # A tibble: 3,231 x 4
##
     seqnames start
                          end strand
##
     <fct>
                <int>
                       <int> <fct>
## 1 chr1
                29353
                       29358 -
## 2 chr1
              762427 762432 +
## 3 chr1
            1166912 1166917 +
## 4 chr1
            1166918 1166923 +
## 5 chr1
            1166934 1166939 +
## 6 chr1
              2144411 2144416 +
## 7 chr1
              2323447 2323452 -
## 8 chr1
              3371244 3371249 +
## 9 chr1
              3371289 3371294 +
## 10 chr1
              3371474 3371479 -
## # ... with 3,221 more rows
```

Counting the ChIP-exo reads adjacent to each anchor site



Ploting the acculamative ChIP-exo reads in forward and reverse direction resectively near the anchor sites.

```
<int [2]>
##
    1 chr1
                 29353
                          29358 -
                                        <int [2]>
##
    2 chr1
                762427 762432 +
                                        <int [7]>
##
    3 chr1
               1166912 1166917 +
                                        <int [6]>
##
    4 chr1
               1166918 1166923 +
##
    5 chr1
               1166934 1166939 +
                                        <int [9]>
##
    6 chr1
               2144411 2144416 +
                                        <int [2]>
##
    7 chr1
               2323447 2323452 -
                                        <int [3]>
                                        <int [3]>
##
    8 chr1
               3371244 3371249 +
   9 chr1
               3371289 3371294 +
                                        <int [2]>
               3371474 3371479 -
                                        <int [2]>
## 10 chr1
## # ... with 3,221 more rows
```

```
ggplot()+
  geom_bar(aes(x=-39:46, weight=plus_count), fill="orange") +
  geom_bar(aes(x=-39:46, weight=-minus_count), fill="green") +
  xlim(-39,46) +
  xlab("Relative position (bp)") +
  ylab("Acculative ChIP-exo Reads")
```



Building binding energy model based on ChIP-exo reads data near anchor sites

For each individual anchor site, the full flanking sequence is extracted based on upstream_flank and down-stream_flank parameters (For ZNF343, it's 30 and 1 respectively).

By taking negative logarithmic ratio of the exo reads, we can estimate the relative binding energy for each site.

```
P_i = \frac{1}{e^{(E_i - \mu)/k_B T} + 1} \approx e^{-(E_i - \mu)/k_B T}
```

where P_i is the occupancy, or binding probability of TF to some particular site i in the genome, which should be porpotional to the exo reads near site i. In an ideal equilibrium-driven system, the occupancy can be defined by above equation, and approximated as $e^{-(E_i - \mu)/k_B T}$ if the protein concentration is sufficiently low. Therefore we can use the negative logarithmic ratio of exo reads near each site to calculate relative binding energy for data regression and motif analysis

```
## # A tibble: 3,159 x 7
##
     seqnames start
                          end strand exo_count Energy Sequence
##
     <fct>
                <dbl>
                        <dbl> <fct>
                                        <int> <dbl> <chr>
                                            3 -1.10 GGGCTAGGACCCAGCGGCTCCGGCAGA...
  1 chr1
                29352 29388 -
##
## 2 chr1
               762397 762433 +
                                            6 -1.79 ACTCAGGGTCCTGTCTGAGGCGGCCAC...
## 3 chr1
              1166882 1166918 +
                                            7 -1.95 CTAACTGGGGATGAGGGTCCACGCGGT...
## 4 chr1
              1166888 1166924 +
                                            4 -1.39 GGGGATGAGGGTCCACGCGGTTCAGAA...
                                            4 -1.39 GCGGTTCAGAAGCGGAAGCGCAGGCGC...
## 5 chr1
              1166904 1166940 +
## 6 chr1
              2144381 2144417 +
                                            7 -1.95 CTGCAGGGACTTTTCCTTCCTCGGAGA...
## 7 chr1
              2323446 2323482 -
                                            3 -1.10 CCGCCCGCCCGCGCCTTGACAGCCCG...
                                                     CAGCCGCCCCCCCAGCCAGACCGCG...
## 8 chr1
              3371214 3371250 +
                                            1
## 9 chr1
              3371259 3371295 +
                                            4 -1.39 CCCCGGGCCGGACCGCGCTGCCGCAGG...
## 10 chr1
              3371473 3371509 -
                                            8 -2.08 CGGGGCTTGCGGGAAAAGCGAGGGGGA...
## # ... with 3,149 more rows
```

TFCookbook is set of functions written in R to analyze and visualize protien-DNA energy model, which can be accessed from https://github.com/zeropin/TFCookbook.

```
model <- TFCookbook::buildEnergyModel(Anchor_pos)

## Warning: Expected 111 pieces. Additional pieces discarded in 3159 rows [1, 2, 3,
## 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, ...].</pre>
```

```
##
## Call:
## lm(formula = Energy ~ . - Energy, data = .)
##
## Residuals:
##
        Min
                   1Q
                        Median
                                     3Q
                                              Max
   -2.87648 -0.44403 -0.01204 0.44141
                                         2.22475
##
## Coefficients: (18 not defined because of singularities)
                 Estimate Std. Error t value Pr(>|t|)
## (Intercept) -1.7476872 0.0930043 -18.791 < 2e-16 ***
## `1CG`
                0.0033087
                            0.0327998
                                        0.101 0.919656
## `1CA`
               -0.0381364
                            0.0429586
                                       -0.888 0.374746
## \1CT\
               -0.0375989
                            0.0436493
                                       -0.861 0.389093
## `2CG`
               -0.0204564
                            0.0337145
                                       -0.607 0.544060
## `2CA`
               -0.0825216
                            0.0415990
                                       -1.984 0.047374 *
## `2CT`
                0.0130139
                            0.0430584
                                       0.302 0.762490
## \3CG\
                0.0059615
                            0.0340001
                                        0.175 0.860826
## `3CA`
                                        0.176 0.860207
                0.0073564
                            0.0417679
## `3CT`
               -0.0062896
                            0.0430735
                                       -0.146 0.883914
## \4CG\
               -0.0478368
                            0.0330655
                                       -1.447 0.148075
## '4CA'
               -0.0575759
                            0.0432228
                                       -1.332 0.182935
## \4CT\
               -0.1210951
                            0.0437273
                                       -2.769 0.005651 **
## `5CG`
                            0.0339396
                0.0454724
                                        1.340 0.180409
                            0.0412165
## `5CA`
               -0.0478439
                                       -1.161 0.245815
                            0.0444649
## `5CT`
                0.0053155
                                        0.120 0.904852
## `6CG`
                0.0140595
                            0.0339504
                                        0.414 0.678816
## `6CA`
               -0.0421493
                            0.0418674
                                       -1.007 0.314143
## `6CT`
                0.0036446
                            0.0442155
                                        0.082 0.934312
## `7CG`
                0.0377701
                            0.0334490
                                        1.129 0.258909
## `7CA`
                0.0044352
                            0.0424822
                                        0.104 0.916857
## `7CT`
                0.0118612
                           0.0433707
                                        0.273 0.784499
## `8CG`
               -0.0289418
                            0.0341238
                                       -0.848 0.396426
## `8CA`
                            0.0411057
               -0.0464416
                                       -1.130 0.258645
## `8CT`
                0.0092606
                            0.0433761
                                        0.213 0.830955
## `9CG`
                0.0151335
                            0.0347389
                                        0.436 0.663132
## '9CA'
                0.0035610
                            0.0418195
                                        0.085 0.932147
## `9CT`
                            0.0430284
               -0.0586696
                                       -1.364 0.172823
## \10CG\
                0.0122813
                            0.0335885
                                        0.366 0.714658
## `10CA`
                            0.0437735
               -0.0337085
                                       -0.770 0.441320
## \10CT\
                            0.0438254
                                        0.311 0.755878
                0.0136265
## `11CG`
               -0.0008937
                            0.0343453
                                       -0.026 0.979242
## `11CA`
               -0.0190244
                            0.0413111
                                       -0.461 0.645179
                0.0738764
                            0.0425403
## \11CT\
                                        1.737 0.082555
## `12CG`
                0.0233695
                            0.0338538
                                        0.690 0.490053
                            0.0425917
## \12CA\
                0.0120414
                                        0.283 0.777413
## `12CT`
                0.0293099
                            0.0434639
                                        0.674 0.500138
## \13CG\
                0.0261638
                            0.0332810
                                        0.786 0.431840
## \13CA\
               -0.0078335
                            0.0418508
                                       -0.187 0.851535
## \13CT\
                0.0396439
                            0.0453518
                                        0.874 0.382110
## `14CG`
                0.0089259
                           0.0342230
                                        0.261 0.794252
```

```
## \14CA\
                 0.0215362
                            0.0401317
                                         0.537 0.591557
## \14CT\
                 0.0382229
                            0.0440833
                                         0.867 0.385976
## `15CG`
                -0.0286098
                            0.0340733
                                        -0.840 0.401168
## `15CA`
                -0.0303993
                                        -0.732 0.463956
                            0.0415041
## `15CT`
                 0.0109916
                            0.0439341
                                         0.250 0.802463
                            0.0336162
## `16CG`
                 0.0030196
                                         0.090 0.928432
## `16CA`
                -0.0060318
                            0.0427705
                                        -0.141 0.887858
## `16CT`
                 0.0405341
                            0.0436116
                                         0.929 0.352737
## \17CG\
                 0.0287402
                            0.0341919
                                         0.841 0.400662
## `17CA`
                 0.0455331
                            0.0409783
                                         1.111 0.266591
## \17CT\
                 0.0541645
                            0.0433998
                                         1.248 0.212114
## `18CG`
                -0.0838447
                            0.0339552
                                        -2.469 0.013593
## \18CA\
                -0.0079394
                            0.0419657
                                        -0.189 0.849958
## \18CT\
                -0.0271660
                            0.0423382
                                        -0.642 0.521153
## `19CG`
                            0.0334545
                                         0.334 0.738217
                 0.0111820
## `19CA`
                -0.0398687
                            0.0426520
                                        -0.935 0.349994
## `19CT`
                 0.0108556
                            0.0448633
                                         0.242 0.808820
## `20CG`
                 0.0519942
                            0.0342099
                                         1.520 0.128650
## `20CA`
                 0.0462652
                            0.0403790
                                         1.146 0.251978
## `20CT`
                -0.0017879
                            0.0442948
                                        -0.040 0.967805
## `21CG`
                 0.0566969
                            0.0345088
                                         1.643 0.100492
## `21CA`
                            0.0414897
                                         0.744 0.456888
                 0.0308715
## `21CT`
                            0.0437401
                                         1.087 0.277250
                 0.0475328
## `22CG`
                            0.0342013
                 0.0458140
                                         1.340 0.180494
## `22CA`
                 0.1329299
                            0.0431548
                                         3.080 0.002086 **
## \22CT\
                 0.0116189
                            0.0453476
                                         0.256 0.797800
## `23CG`
                -0.1116000
                            0.0342971
                                        -3.254 0.001151 **
## `23CA`
                -0.0335689
                            0.0417978
                                        -0.803 0.421965
                            0.0453508
## `23CT`
                 0.0891436
                                         1.966 0.049430 *
## `24CG`
                 0.1777555
                            0.0332497
                                         5.346 9.65e-08 ***
## `24CA`
                 0.2290345
                            0.0420945
                                         5.441 5.72e-08 ***
## \24CT\
                 0.2056276
                            0.0447274
                                         4.597 4.45e-06 ***
## `25CG`
                 0.0915212
                            0.0335022
                                         2.732 0.006335 **
## `25CA`
                 0.2226663
                            0.0421933
                                         5.277 1.40e-07 ***
## `25CT`
                 0.1804733
                            0.0446898
                                         4.038 5.51e-05 ***
                            0.0345354
## `26CG`
                -0.0627961
                                        -1.818 0.069114 .
## `26CA`
                -0.0035681
                            0.0418276
                                        -0.085 0.932024
## `26CT`
                            0.0447710
                                         0.592 0.553997
                 0.0264975
## `27CG`
                            0.0338605
                                         2.056 0.039856 *
                 0.0696210
## `27CA`
                 0.0945853
                            0.0418625
                                         2.259 0.023927 *
## `27CT`
                 0.0353317
                            0.0440493
                                         0.802 0.422561
## `28CG`
                            0.0350124
                                        -3.950 7.99e-05 ***
                -0.1383029
## `28CA`
                -0.1124607
                            0.0419759
                                        -2.679 0.007420 **
## `28CT`
                 0.0129820
                            0.0481315
                                         0.270 0.787394
## `29CG`
                -0.2670529
                            0.0366128
                                        -7.294 3.81e-13 ***
## `29CA`
                -0.1456996
                            0.0428055
                                        -3.404 0.000673 ***
## `29CT`
                -0.0274763
                            0.0612705
                                        -0.448 0.653866
## `30CG`
                -0.0182912
                            0.0420218
                                        -0.435 0.663391
## `30CA`
                 0.0547309
                            0.0488523
                                         1.120 0.262659
## `30CT`
                -0.2106104
                            0.0493867
                                        -4.265 2.06e-05 ***
## `31CG`
                        NA
                                    NA
                                            NA
                                                      NA
## `31CA`
                        NA
                                    NA
                                            NA
                                                      NA
## `31CT`
                                                      NA
                        NA
                                    NA
                                            NA
## \32CG\
                        NA
                                    NA
                                            NA
                                                      NA
```

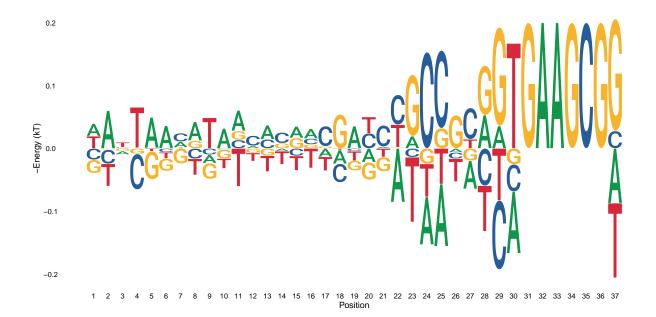
```
## `32CA`
                        NA
                                   NA
                                            NA
                                                      NA
## \32CT\
                        NA
                                   NA
                                            NA
                                                     NA
  `33CG`
                        NA
                                   NA
                                            NA
                                                     NA
  `33CA`
                                            NA
                                                     NA
                        NA
                                   NA
## `33CT`
                        NA
                                   NA
                                            NA
                                                      NA
## `34CG`
                                                     NA
                        NA
                                   NA
                                            NA
## \34CA\
                                            NA
                        NA
                                   NA
                                                     NA
## `34CT`
                        NA
                                   NA
                                            NA
                                                      NA
## \35CG\
                        NA
                                   NA
                                            NA
                                                      NA
                                                      NA
## `35CA`
                        NA
                                   NA
                                            NA
## `35CT`
                        NA
                                   NA
                                            NA
                                                     NA
## `36CG`
                                            NA
                                                      NA
                        NA
                                   NA
## `36CA`
                        NA
                                   NA
                                            NA
                                                      NA
## `36CT`
                                   NA
                                            ΝA
## `37CG`
               -0.1503496
                            0.0318447
                                        -4.721 2.45e-06 ***
## `37CA`
                0.1149191
                            0.0466580
                                         2.463 0.013832 *
## `37CT`
                0.1466307
                            0.0580142
                                         2.527 0.011538 *
##
## Signif. codes: 0 '***' 0.001 '**' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7505 on 3065 degrees of freedom
## Multiple R-squared: 0.1147, Adjusted R-squared: 0.0878
## F-statistic: 4.268 on 93 and 3065 DF, p-value: < 2.2e-16
```

Plotting binding energy logo based on Position Energy Matrix (PEM)

```
matrix <- TFCookbook::getEnergyMatrix(model)

# Anchor positions are added into energy matrix for visualization purposes
matrix[,31:36] <- -0.2*anchorMatrix("GAAGCG")

TFCookbook::plotEnergyLogo(matrix)</pre>
```



Negative control with alternative anchor site(s)

We can perform the same analysis with any alternative anchor site, e.g., tAAGCG, and the resulting motif in the extended region don't match published HT-SELEX and B1H prediction, which lends evidence to our dependent recogition model of ZFPs from another perspective.

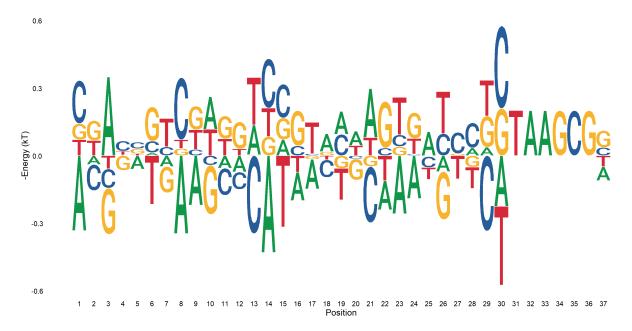


Figure 1: Motif Logo created using alternative anchor site tAAGCG