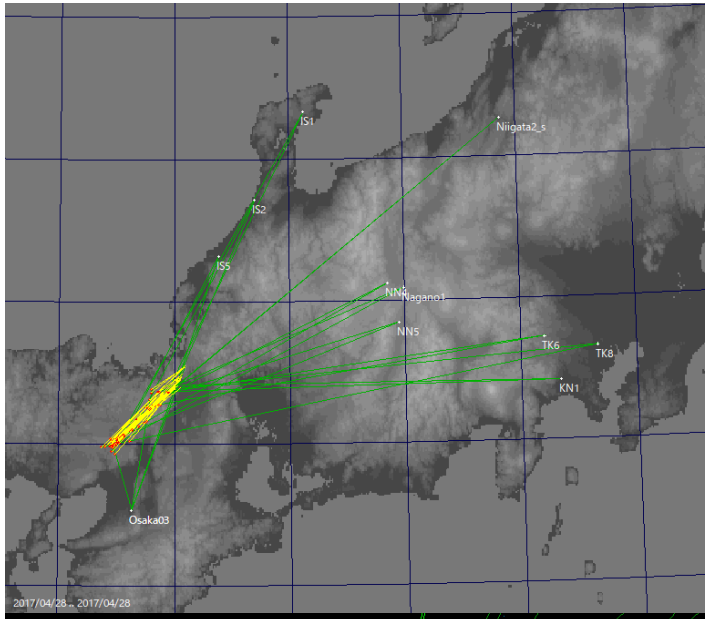
Epochs on UFOOrbit

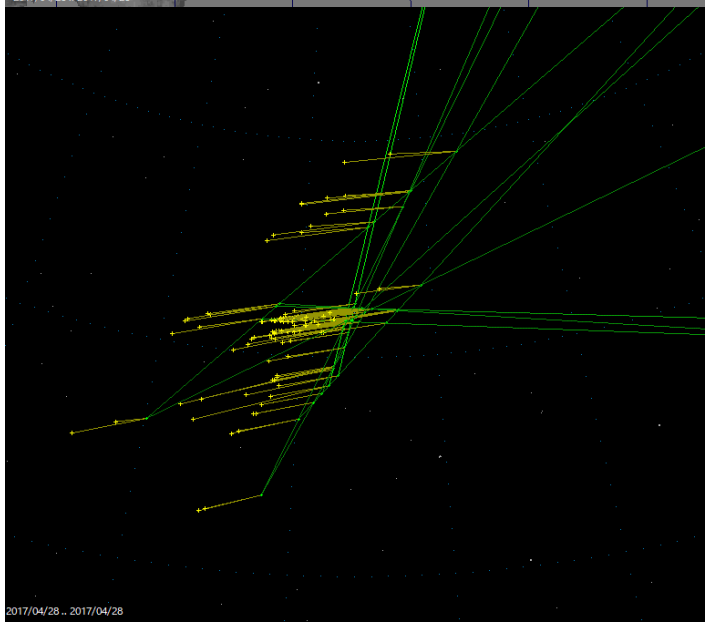
2017 v2.60 update

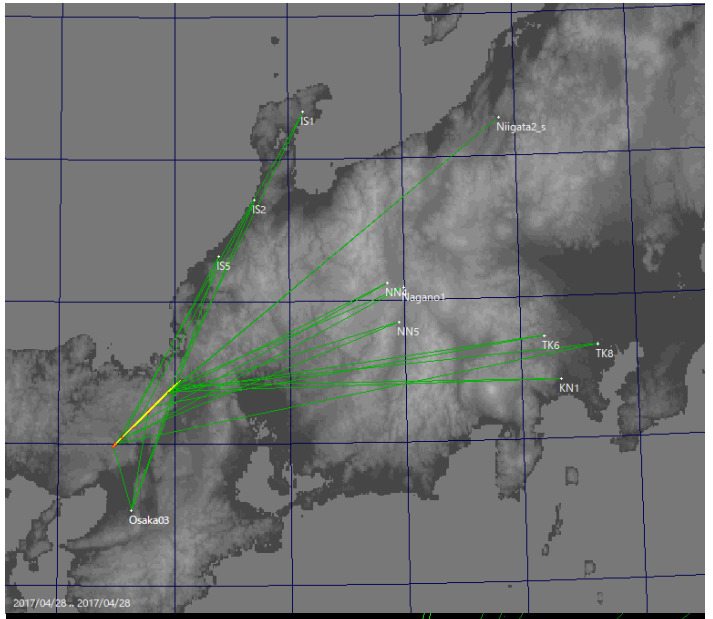
Break Through

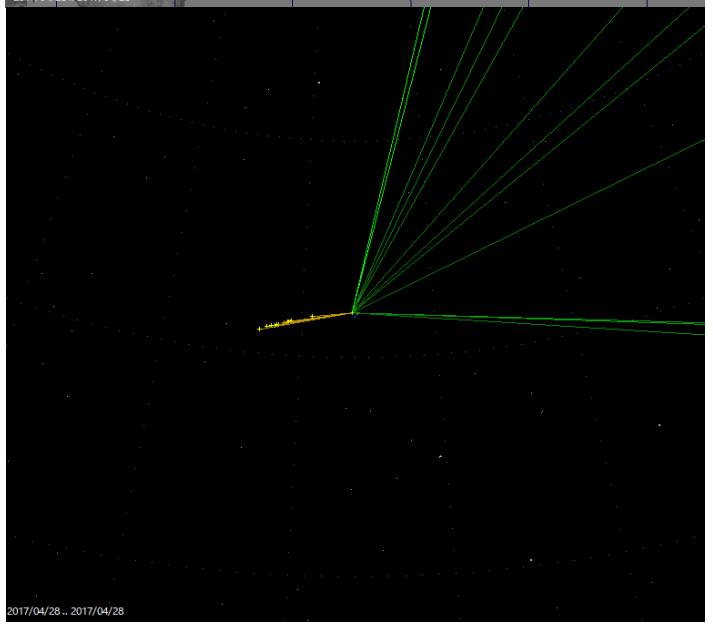
- 2005/1 v1.0 UFOOrbit
- 2007/4 v2.01 UFOOrbitV2
- 2008/2 v2.10 Unified radiant computation
  - Least square method on radiant computation utilizes all simultaneous observation more than 2
- 2014/5 v2.40 Error propagation by Monte Carlo method
  - 2000 trials on one orbit shows possible error distribution
    - A new accuracy scale : Er
    - Er enables orbit selection, that sharpens the concentration of shower radiants
- 2017/5 A new epoch using Er

Multi Pair → Unified Radiant

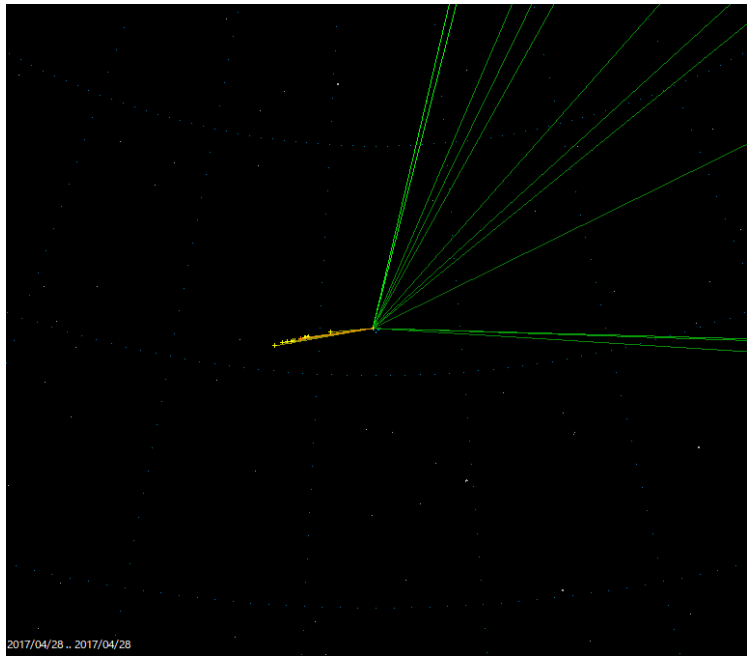


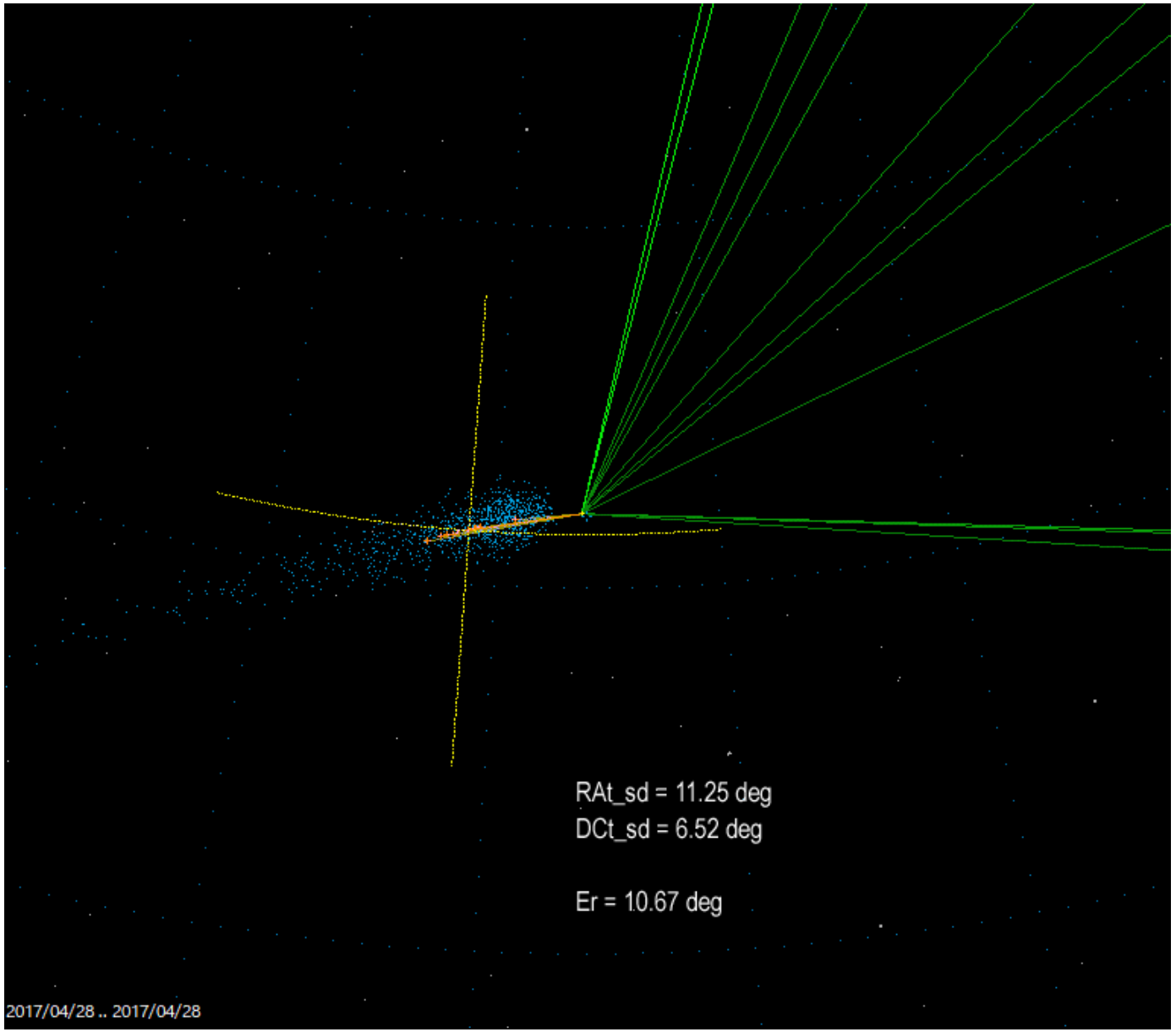






Unified Radiant → Unified Radiant with Error Distribution





An Epoch on May 2017

- There can be so many possible combination on one meteor

  Ex. 4096 combinations for one simultaneous 12 stations observation

- Different Er on different combination in the simultaneous observation

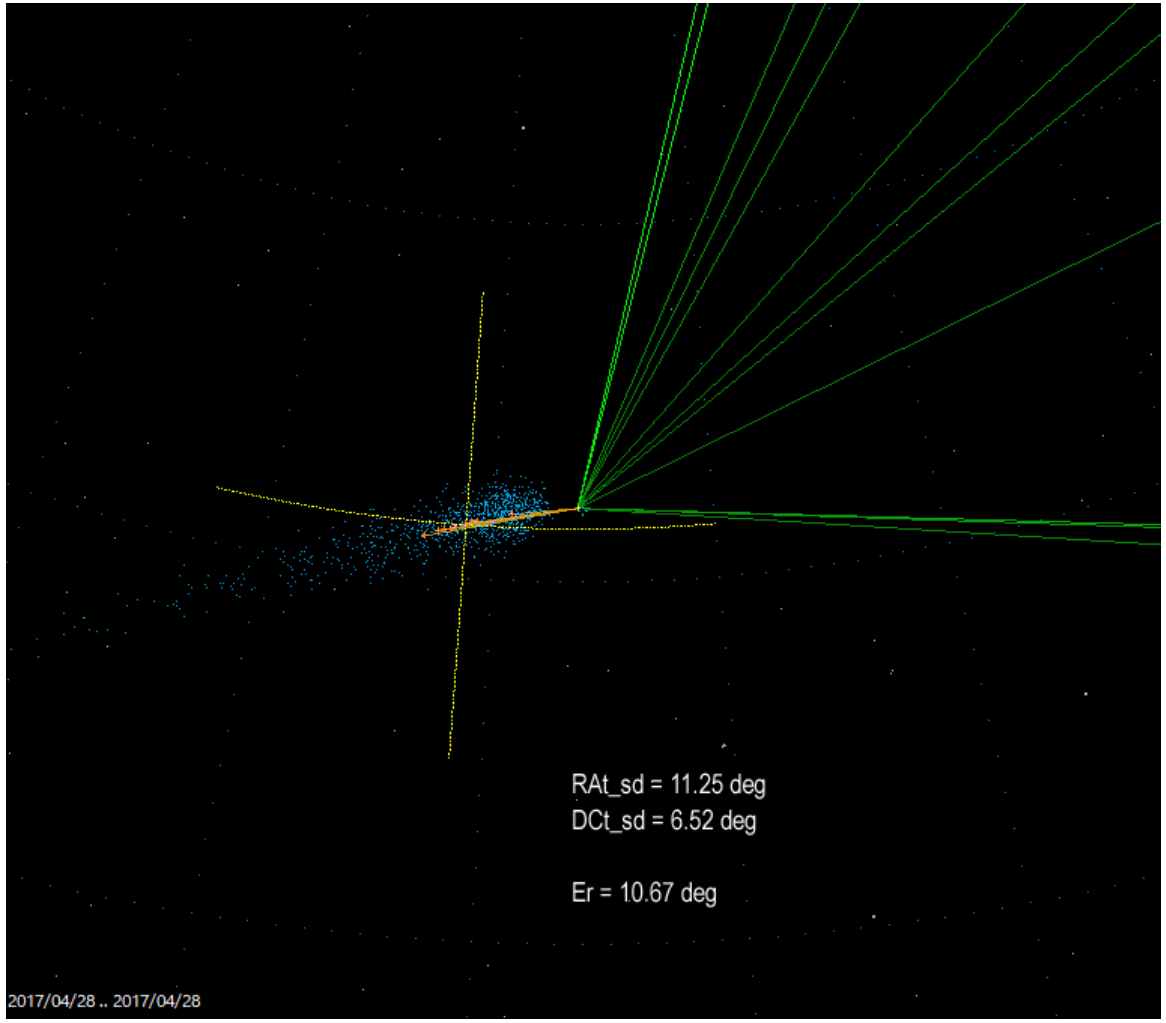
- Er enables combination selection

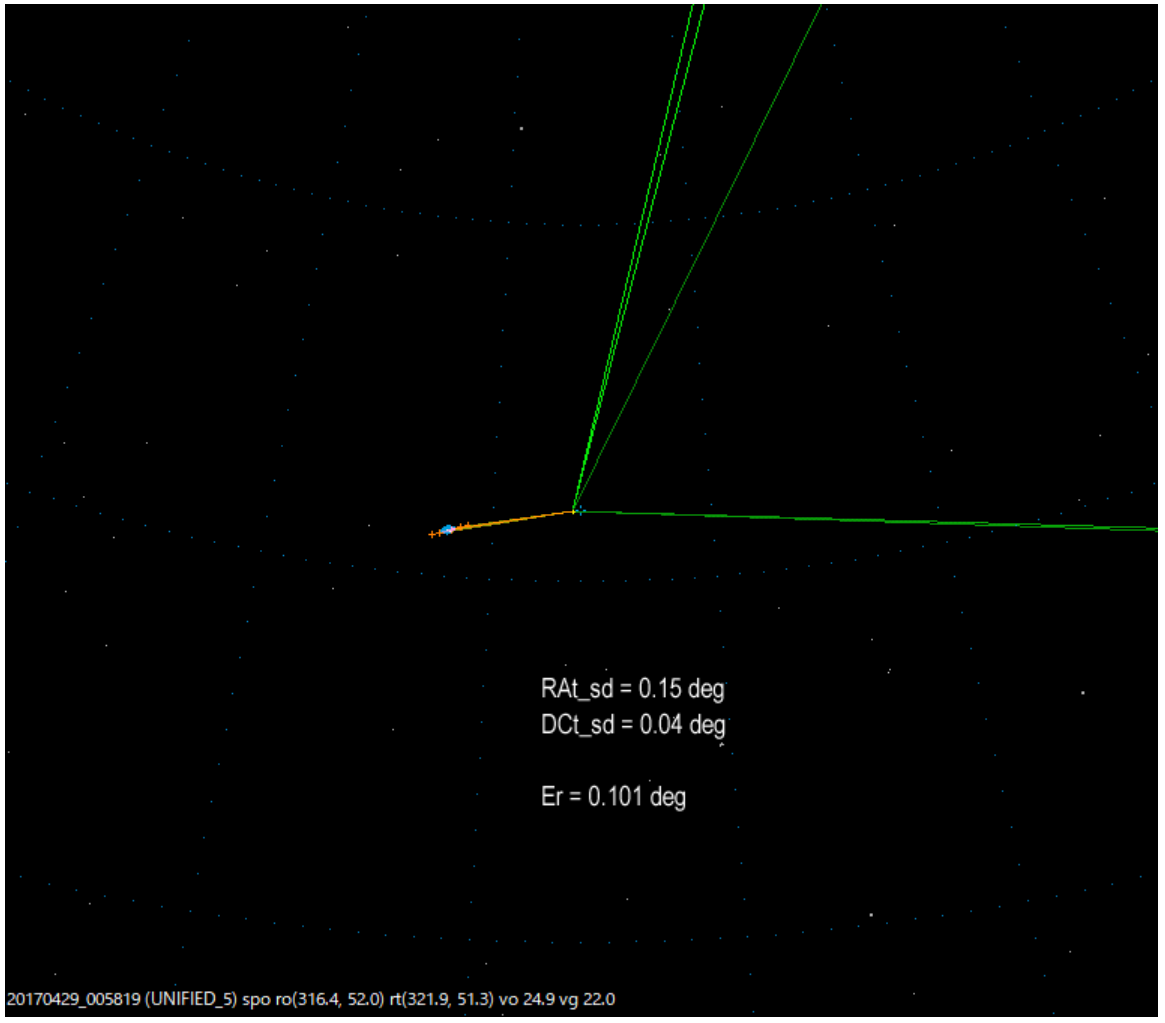
- v2.60 UFOOrbitV2 Select Combination
  - 2000 x 2^n trials for one orbit to select best combination of observation

Observation Combination Selection

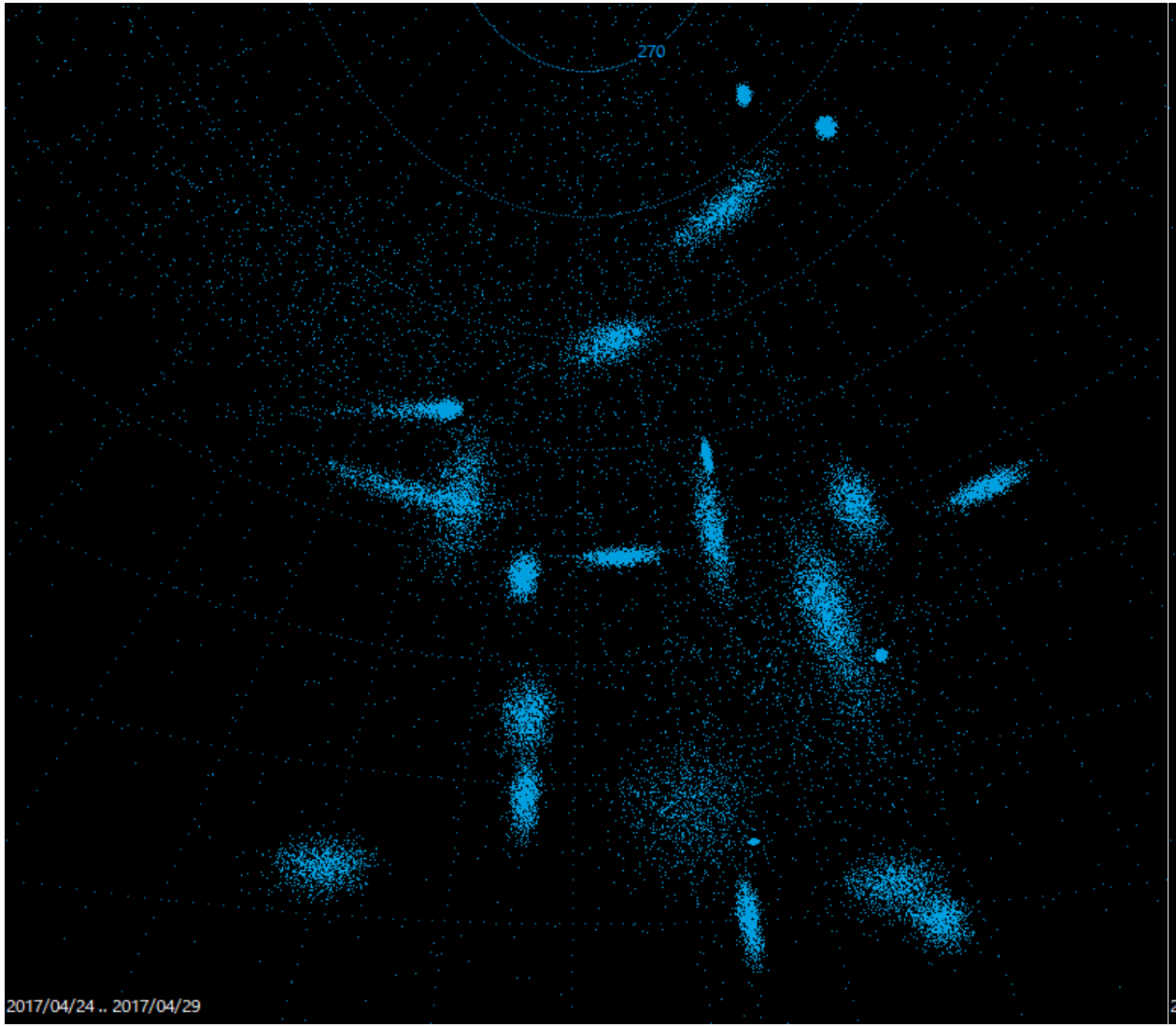
```
metno=1[20170429_005815]------12 simultaneous observations---------↓
#00 20170429_005815 Nagano1_m9 ↓
#01 20170429_005819 Osaka03_06 ↓
#02 20170429_005818 Osaka03_3N ↓
#03 20170429_005819 IS2_S ↓
#04 20170429_005819 IS5_SW ↓
#05 20170429_005819 KN1_W ↓
#06 20170429_005819 TK8_S7 ↓
#07 20170429_005819 TK6_w ↓
#08 20170429_005819 NN5_T1 ↓
#09 20170429_005819 IS1_ ↓
#10 20170429_005819 NN4_FE ↓
#11 20170429_005820 Niigata2_s_4 ↓
-------------------------------------------------------------↓
        1/4096  #00                                          ↓
        2/4096      #01                                      ↓
        3/4096  #00 #01                                       Er=  0.886
        4/4096          #02                                  ↓
        5/4096  #00     #02                                   Er=  0.239
        6/4096      #01 #02                                   Er= -1.#IO
        7/4096  #00 #01 #02                                   Er=  0.246
        8/4096              #03                              ↓
        9/4096  #00         #03                               Er=  1.134
       10/4096      #01     #03                               Er= 10.882
       11/4096  #00 #01     #03                               Er=  5.719
       12/4096          #02 #03                               Er=  5.478
       13/4096  #00     #02 #03                               Er=  2.391
       14/4096      #01 #02 #03                               Er=  8.020
       15/4096  #00 #01 #02 #03                               Er=  3.763
         .........
       93/4096  #00     #02 #03 #04     #06                   Er=  0.226
       94/4096      #01 #02 #03 #04     #06                   Er=  0.101
       95/4096  #00 #01 #02 #03 #04     #06                   Er=  0.143
         .........
     4091/4096  #00 #01     #03 #04 #05 #06 #07 #08 #09 #10 #11 Er= 12.077
     4092/4096          #02 #03 #04 #05 #06 #07 #08 #09 #10 #11 Er= 12.161
     4093/4096  #00     #02 #03 #04 #05 #06 #07 #08 #09 #10 #11 Er= 10.693
     4094/4096      #01 #02 #03 #04 #05 #06 #07 #08 #09 #10 #11 Er= 12.686
     4095/4096  #00 #01 #02 #03 #04 #05 #06 #07 #08 #09 #10 #11 Er= 10.870
--------------------Best combination-----------------------------------
    94/4082/4096  Er=   0.101↓
     #01 #02 #03 #04     #06                    Er=  0.101 Ra=321.853 Dc=
```

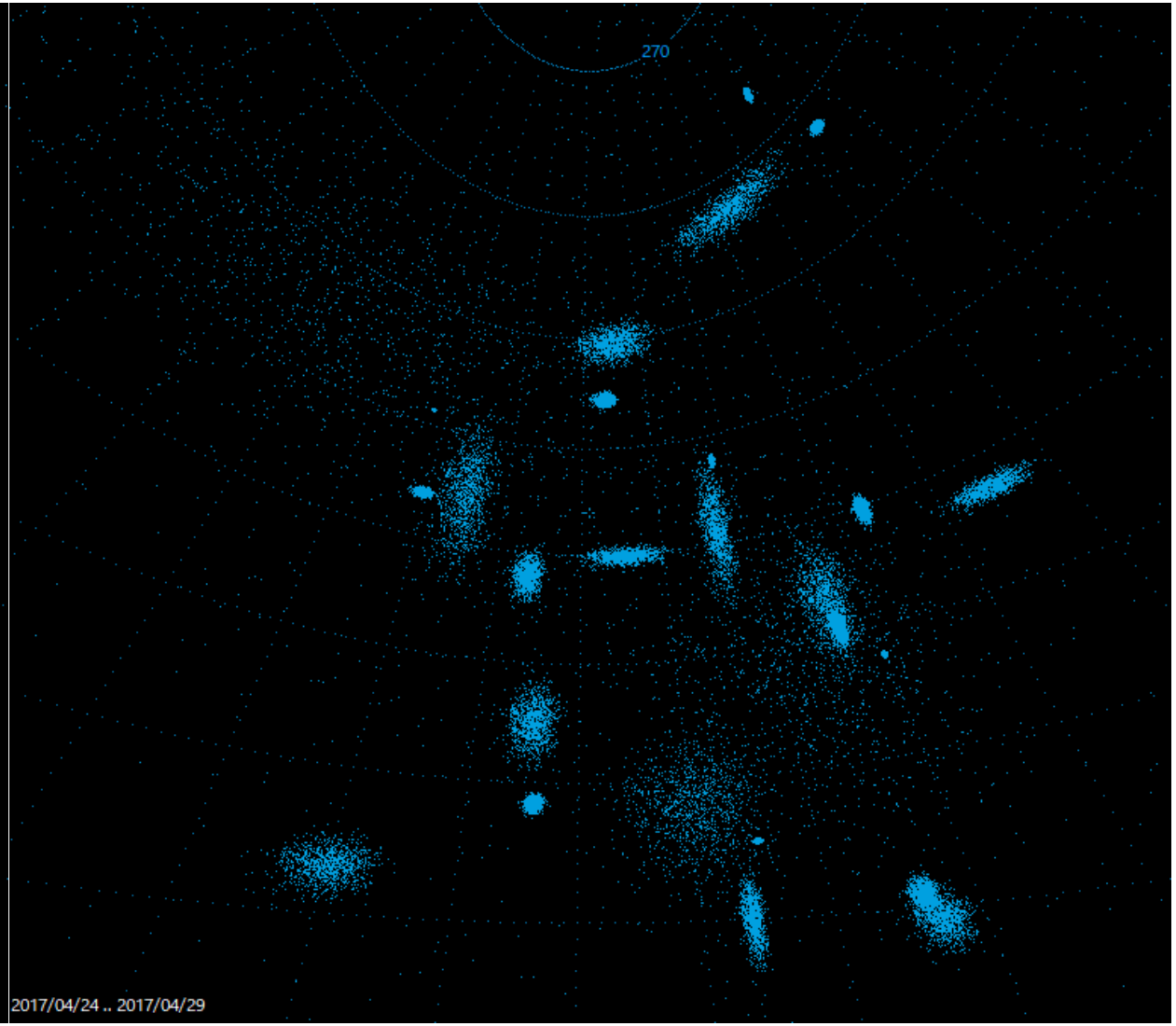
All Observations → Selected Best Combination





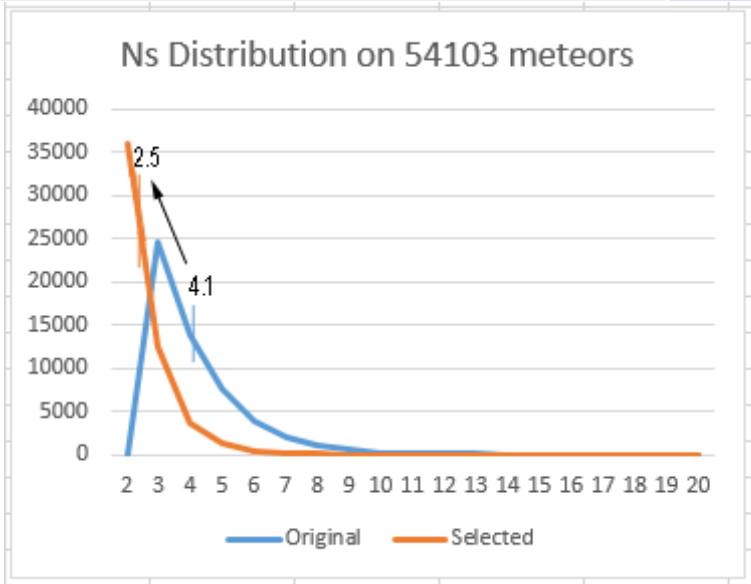
All Observations → Selected Best Combination

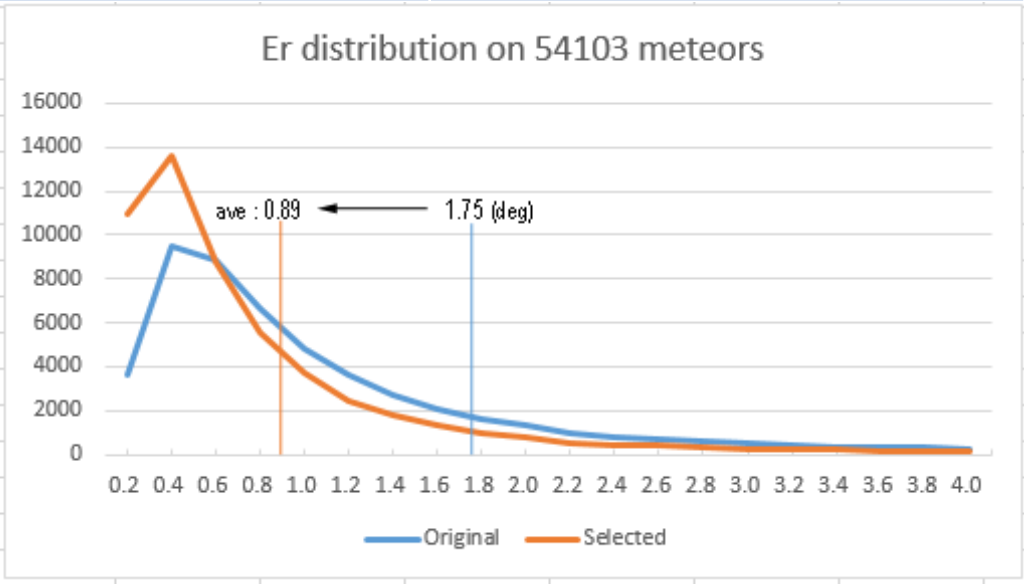




Select Combination on 10years data

Number of Meteors in SonotaCo Network 10 Years observation		
Total 231,872 Meteors		
Single Pair Observation (Ns=2) 158,236 (68%)	Multiple Station (Ns>2) Simultaneous Observation 73,636 (32%)	
	Not Improved by SC 19,533 (27%)	Improved by SC 54,103 (73%)





Number of Highly Accurate (Er < 1.0) Meteors on 10 Years observation		
Ns = 2	Ns > 2	
	Not Improved by SC	Improved by SC88
All :158,236 Er < 1.0 : 42,484 (27%)	All : 19,553 Er < 1.0 : 12,700 (64%)	All : 54,103 Er < 1.0 original : 33,402 (61%) Er < 1.0 selected : 42,634 (79%)
	All : 73,636 Er < 1.0 original : 46,102 (63%) Er < 1.0 selected : 55,436 (75%)	
All : 231,872 Er < 1.0 original : 88,586 (38%) Er < 1.0 selected : 97,816 (42%)		

- Select Combination CPU time
  - UFOOrbit V2.60 CPU time : 31.1hours/4.1GHz for 231872 meteors.
  - Largest Ns = 29 (20161105_182410 earth grazer)
    - 67,108,864 combinations → CPU time = 133days (NOT computed, manually reduced to Ns=5)
  - 2nd Ns = 20 Er = 0.017 (20090515_010724) -> Ns = 5, Er = 0.092
    - 1,048,576 combinations, CPU time = 6.7 hours

- Total rejected single station observations by SC

Number of Improved Meteors	54103
Number of all Single Station Observations of 54103 Meteors	223,482
Number of Single Station Observations Rejected by SC	89,041 (40%)
Number of Single Station Observations Used by SC	134,441 (60%)