1. Summary of hollow beam tracking

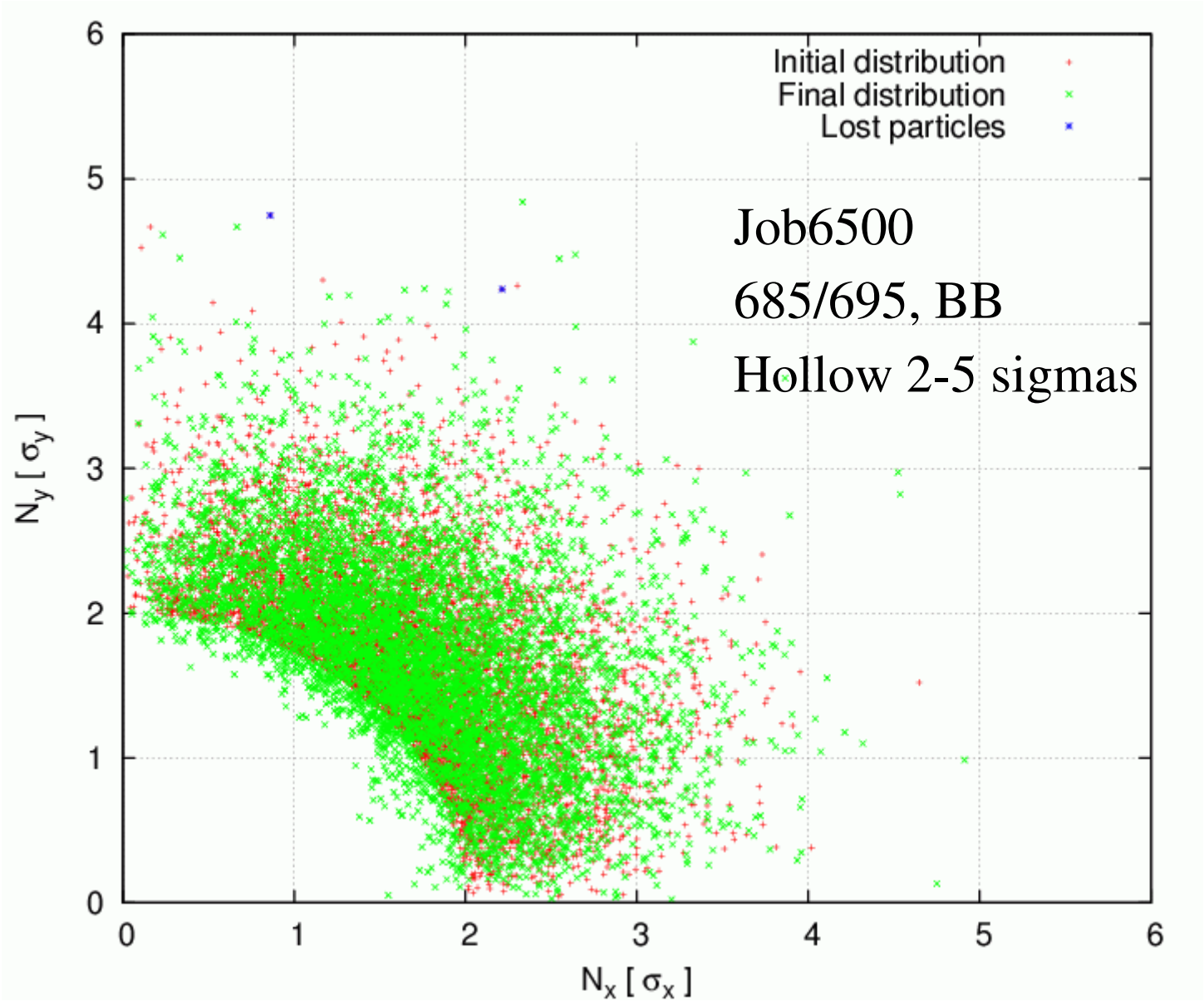
sigma range	macro-particles	representing
0-5	12800	12800
2-5	6400	15497
2.5-5	6400	35630
3-5	6400	105634
4-5	6400	2156698

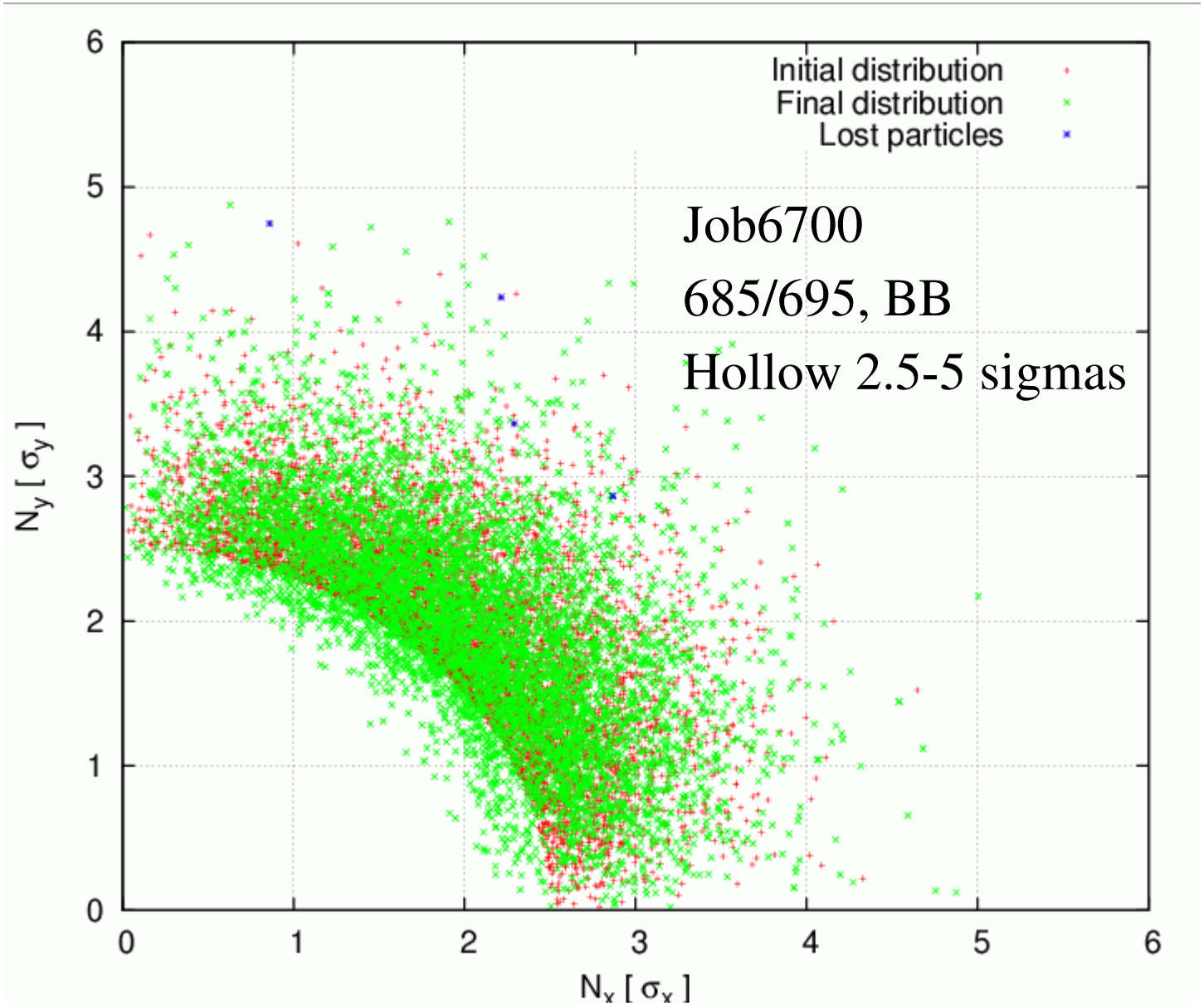
- No much gain with 2-5 sigma hollow beam tracking

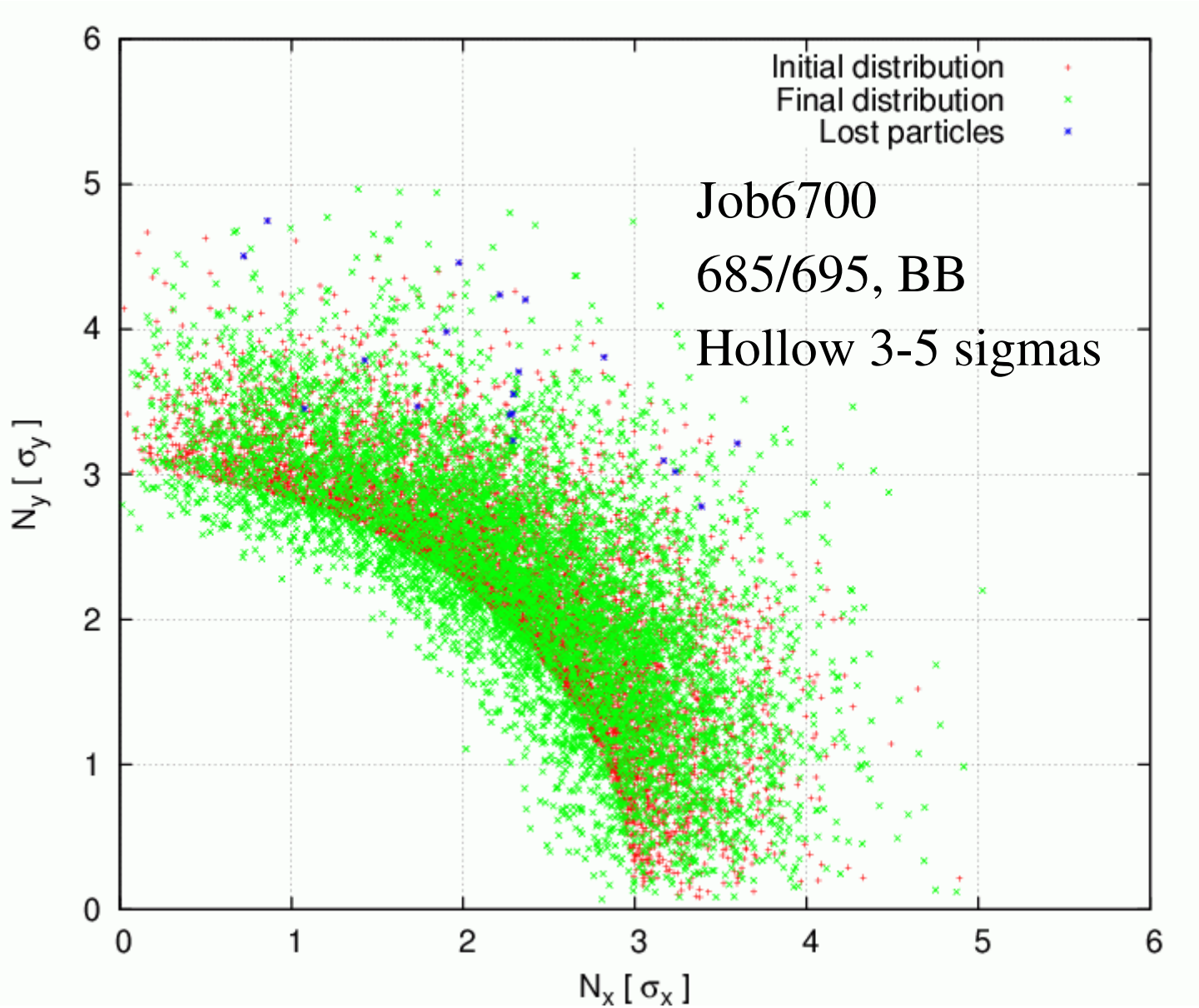
- Acceptable tracking is with 3-5sigma hollow beam.

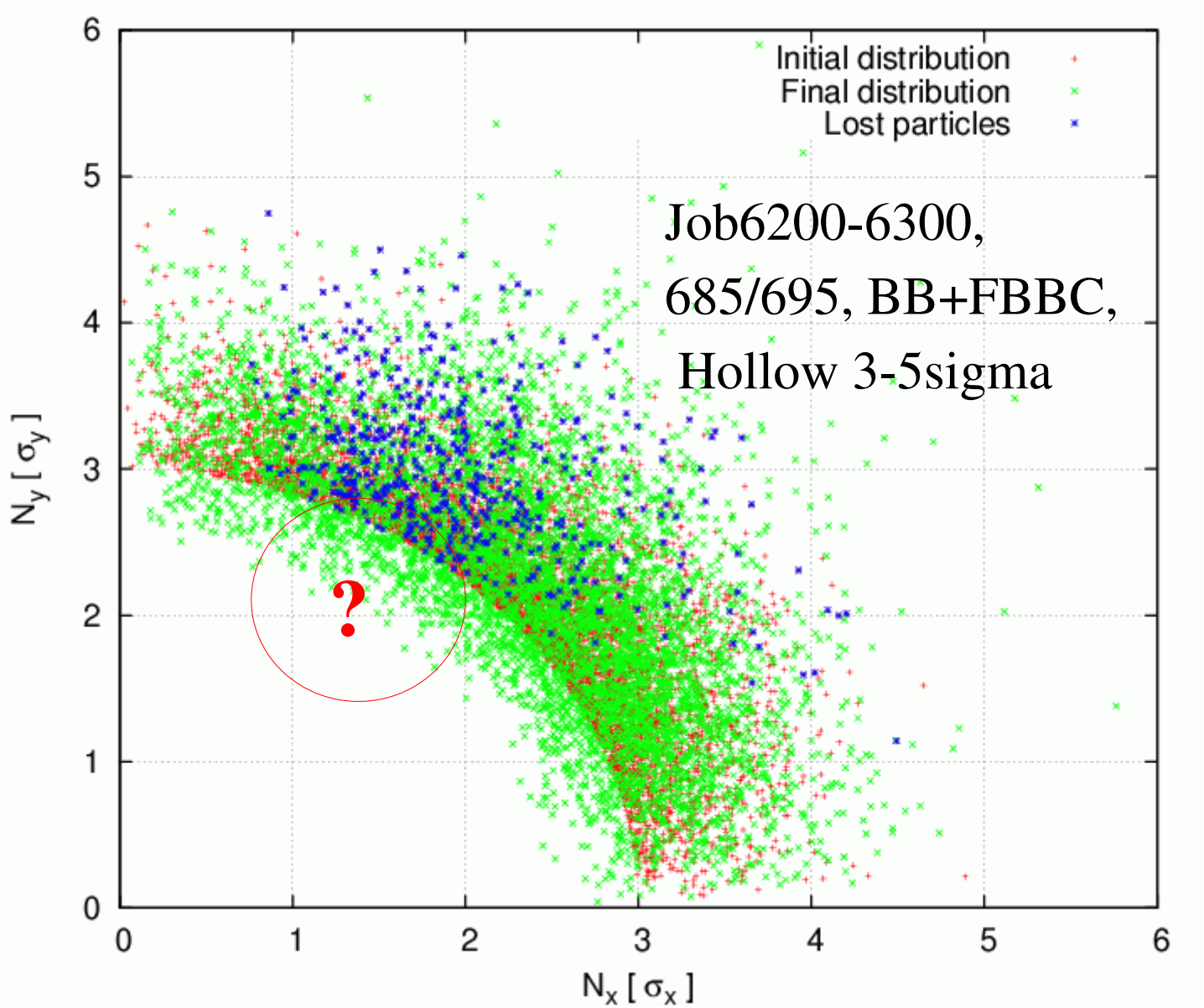
However, this depends on actual dynamic aperture.

If 10^7 DA smaller than 3sigmas, hollow beam tracking will be abandoned.


Initial distribution
Final distribution
Lost particles
Job6500
685/695, BB
Hollow 2-5 sigmas
N_y [σ_y]
N_x [σ_x]
0
1
2
3
4
5
6


Initial distribution
Final distribution
Lost particles
Job6700
685/695, BB
Hollow 2.5-5 sigmas
N_y [σ_y]
N_x [σ_x]
0
1
2
3
4
5
6


Initial distribution
Final distribution
Lost particles
Job6700
685/695, BB
Hollow 3-5 sigmas
N_y [σ_y]
N_x [σ_x]
0
1
2
3
4
5
6


Initial distribution
Final distribution
Lost particles
Job6200-6300,
685/695, BB+FBBC,
Hollow 3-5sigma
?
N_y [σ_y]
N_x [σ_x]
0
1
2
3
4
5
6

Conclusion:

- Hollow beam 3-5sigmas is very useful if 10^7 turn DA larger than 3 sigmas.

- It can be used, for example,

  1) RHIC BB lifetime tracking
  2) e-lens BB, BB+HBBC tracking

- not very convincing for e-lens BB+FBBC tracking Fortunately there with Guassian 0-5 sigma beam-loss is already detectable.

2. Resonance Driving term calculation

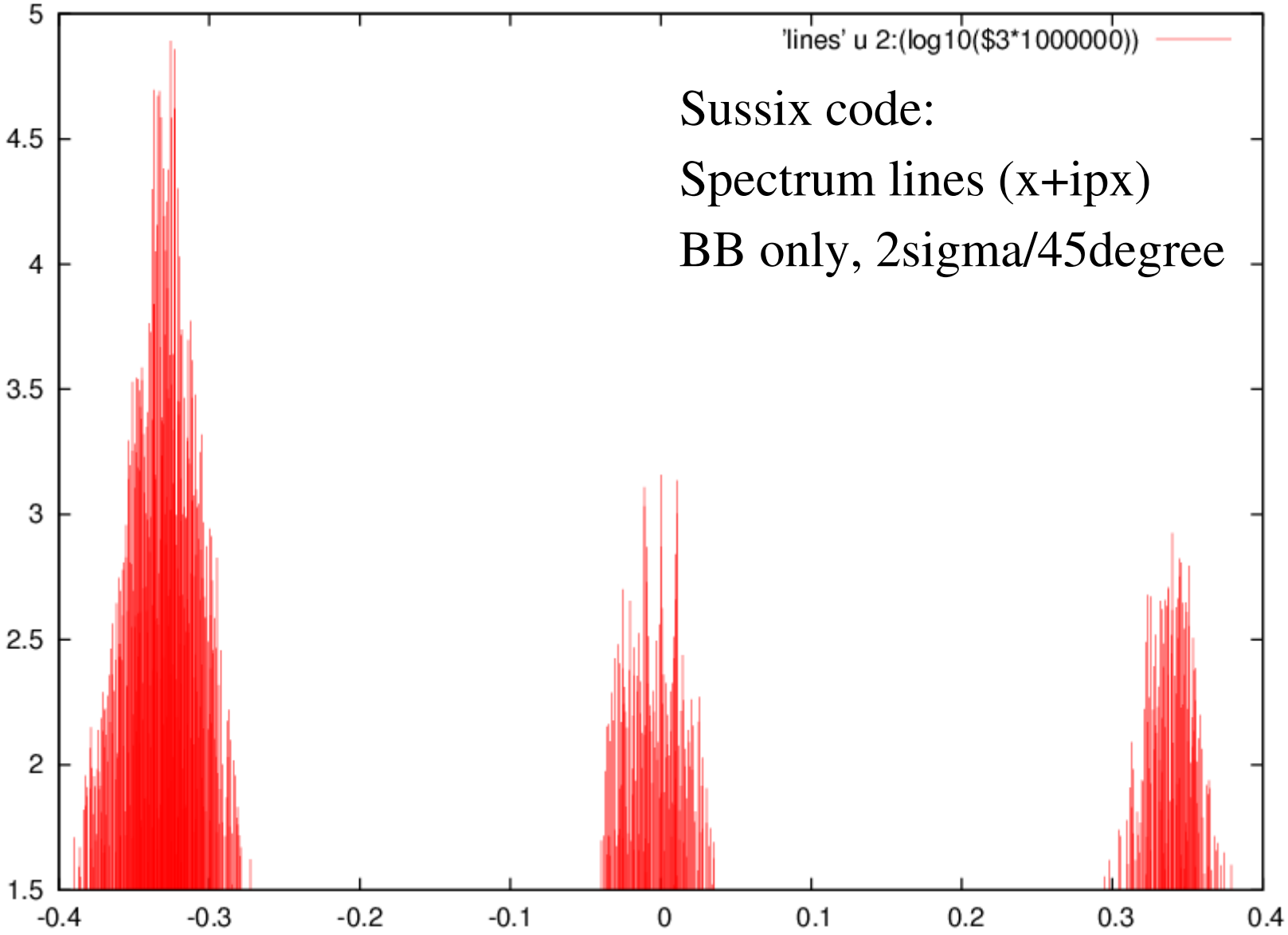
- Nonlinear force produces detunings and RTDs

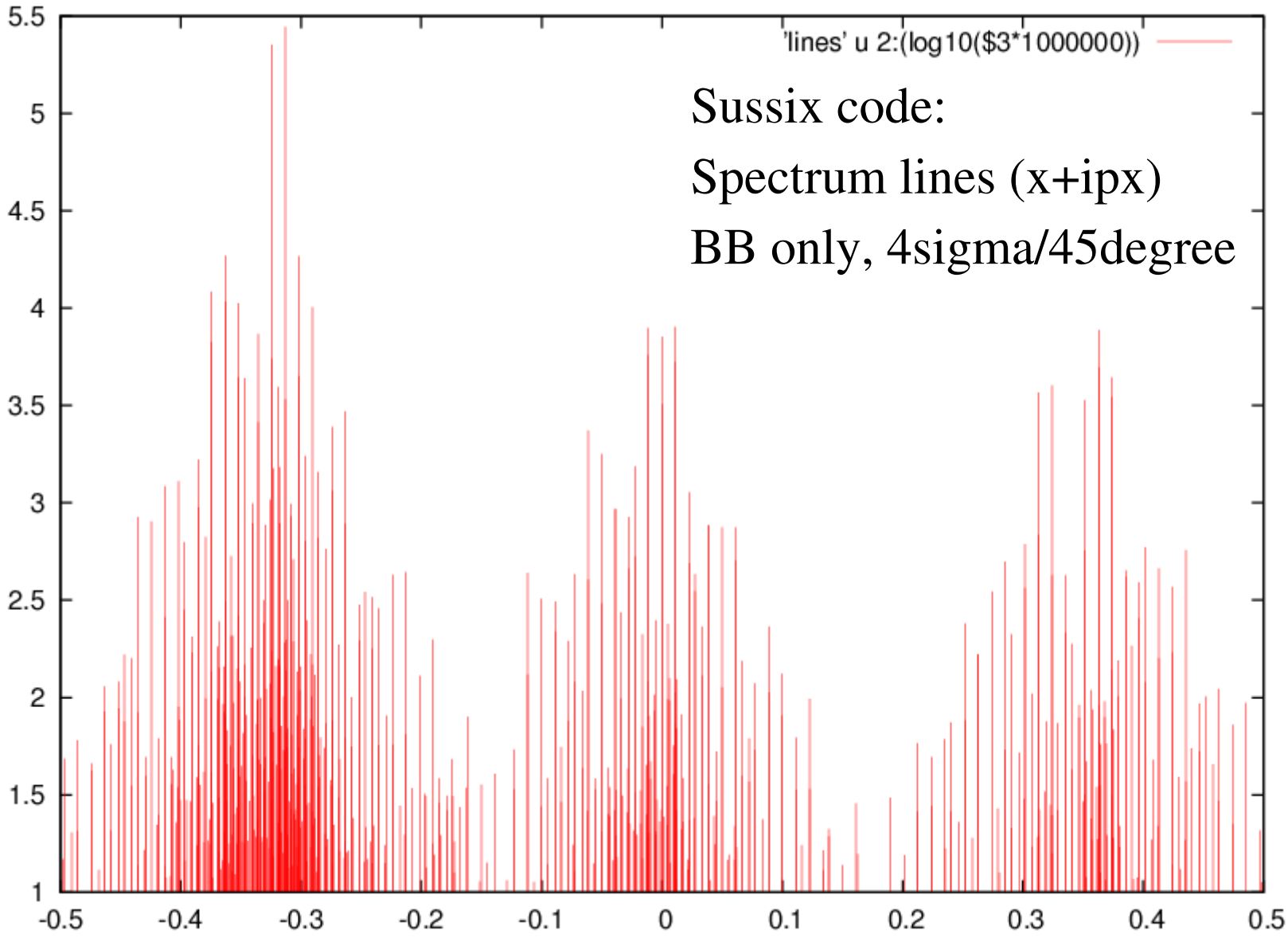
- Detuning had been numerically calculated through tune footprint
  also can be calculated from Norm Form procedure

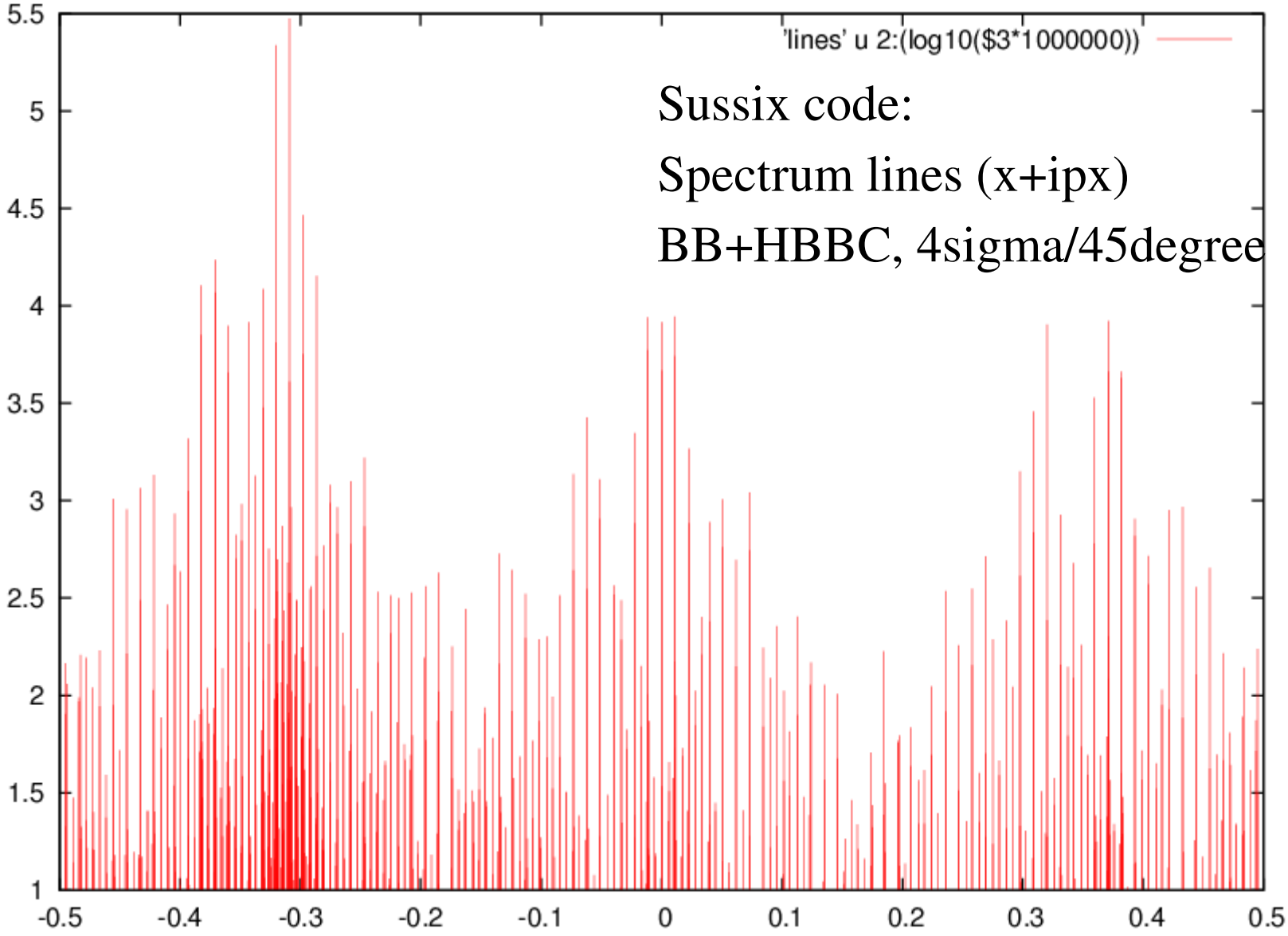
- RTD can be approximately extracted from TBT BPM data
  but analytical calculation is highly recommended

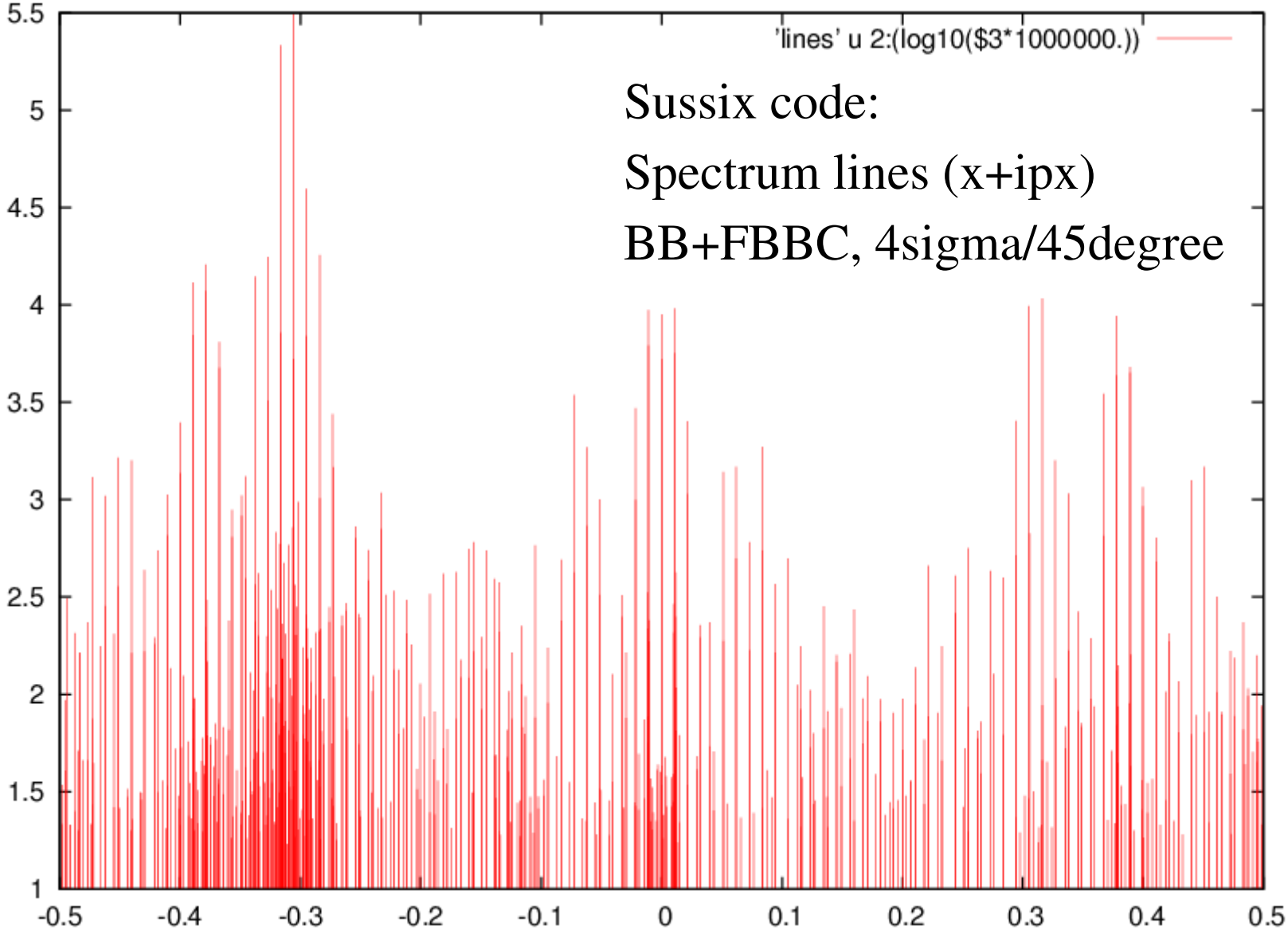
Analytical:
-->independent particle amplitude
-->can go much higher order

Sussix (tune finder):
--> first order approximation
--> link spectrum lines with RTDs


'lines' u 2:(log10($3*1000000))
Sussix code:
Spectrum lines (x+ipx)
BB only, 2sigma/45degree
5
4.5
4
3.5
3
2.5
2
1.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4


'lines' u 2:(log10($3*1000000))
Sussix code:
Spectrum lines (x+ipx)
BB only, 4sigma/45degree
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5


'lines' u 2:(log10($3*1000000))
Sussix code:
Spectrum lines (x+ipx)
BB+HBBC, 4sigma/45degree
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5


'lines' u 2:(log10($3*1000000.))
Sussix code:
Spectrum lines (x+ipx)
BB+FBBC, 4sigma/45degree
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5

Sussix output (lines):

lines - emacs@rat.pbn.bnl.gov

File Edit Options Buffers Tools Help

```
ANALYSIS OF X SIGNAL, CASE: 91
TUNE X =  -0.3241681689889543

       Line Frequency      Amplitude            Phase            Error         mx  my  ms  p

 1 -.3241681689890E+00 0.225253485444E+00 0.300330623896E+01 0.00000000000E+00   1   0   0   0
 2 -.3016121208196E+00 0.184677375908E-01 -.160276516622E+02 0.21688020470E-05  -1   2   0   0
 3 -.3742203960514E+00 0.121529010881E-01 0.327644773181E+02 0.28546619782E-05   0  -2   0   1
 4 -.3516722968504E+00 0.105931508710E-01 -.244421995876E+02 0.86348282937E-05  -2   0   0   1
 5 -.3629435411220E+00 0.108084559851E-01 -.188571659858E+02 0.29394162518E-05  -1  -1   0   1
 6 0.1880698936940E-06 0.711945747349E-02 0.178788489440E+03 0.18806989369E-06   0   0   0   0
 7 0.3629399779006E+00 0.772883976617E-02 0.106122779923E+01 0.62380516791E-06   1   1   0  -1
 8 0.1128601876279E-01 0.804692769381E-02 0.175625187838E+03 0.90790791188E-05  -1   1   0   0
 9 -.1127829200692E-01 0.790940730458E-02 -.172954016024E+03 0.13523232429E-05   1  -1   0   0
10 -.3467200740031E+00 0.437748714786E-02 0.195924094930E+02 0.20000000000E-02
11 0.3241685898048E+00 0.401268820796E-02 -.325755696275E+02 0.42081585849E-06  -1   0   0   0
12 -.3192442859106E+00 0.393538592142E-02 0.668238642076E+02 0.20000000000E-02
13 0.3742209178634E+00 0.349762778634E-02 -.667257548200E+01 0.33764739212E-05   0   2   0  -1
14 -.3129087818768E+00 0.340180020601E-02 0.135698328162E+02 0.17552571511E-04   0   1   0   0
15 -.2741086689899E+00 0.245581254723E-02 -.309620790082E+02 0.10127598610E-04   2   2   0  -1
16 -.3354247676345E+00 0.260531856520E-02 -.172322177612E+03 0.20341038132E-04   2  -1   0   0
17 -.2966717191085E+00 0.173754830570E-02 0.195060780428E+02 0.20000000000E-02
18 -.5005433565931E-01 0.178102047654E-02 -.969841441440E+02 0.49632588302E-05  -1  -2   0   1
19 -.2853887011781E+00 0.144060934390E-02 0.554188989042E+02 0.20000000000E-02
20 -.3177458954439E+00 0.152646976939E-02 -.984782900224E+02 0.20000000000E-02
21 -.4016750861625E+00 0.129394890439E-02 0.374993589534E+02 0.20000000000E-02
22 -.3227313279894E+00 0.150124207513E-02 -.134009091593E+03 0.14368409996E-02   1   0   0   0
23 -.3855259534139E+00 0.946804851078E-03 -.413525587002E+02 0.20000000000E-02
24 -.2746042022965E-01 0.846298953493E-03 -.109847991485E+03 0.20000000000E-02
25 -.3874354078972E-01 0.935424033969E-03 -.173397113054E+03 0.28891927091E-04  -2  -1   0   1
26 -.3291538153626E+00 0.771783548197E-03 -.502078185610E+02 0.20000000000E-02
27 -.3256036822817E+00 0.103786379701E-02 -.446951333732E+02 0.14355132927E-02   1   0   0   0
28 -.2628565839710E+00 0.780164133397E-03 -.124085996731E+03 0.20000000000E-02
29 -.3403982505973E+00 0.994077569051E-03 -.122260279941E+03 0.20000000000E-02
```

--:-- lines (Fundamental)--L26--Top----------

3. Emittance calculation

- Calculate Sum x^2 for all particle coordinates of all 100000 turns should improve the emittance resolution by one order.
  No further way to improve further.

- Currently waiting for computing time on cluster.bnl.gov
  after we check the actual result

4. Summary

- macro-particle tracking are going on days and nights
- calculating RTD started
- will focus on phase advances between lps