

# SPS results | 20 GeV

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# simulation parameters

*SPS, 120 GeV, coldex location,  $R1=4\sigma$*

*vertical case (larger beta), primary coll @6.5 sigma*

*particles generated between 4 and 6 sigma,  $10^5$  turns*

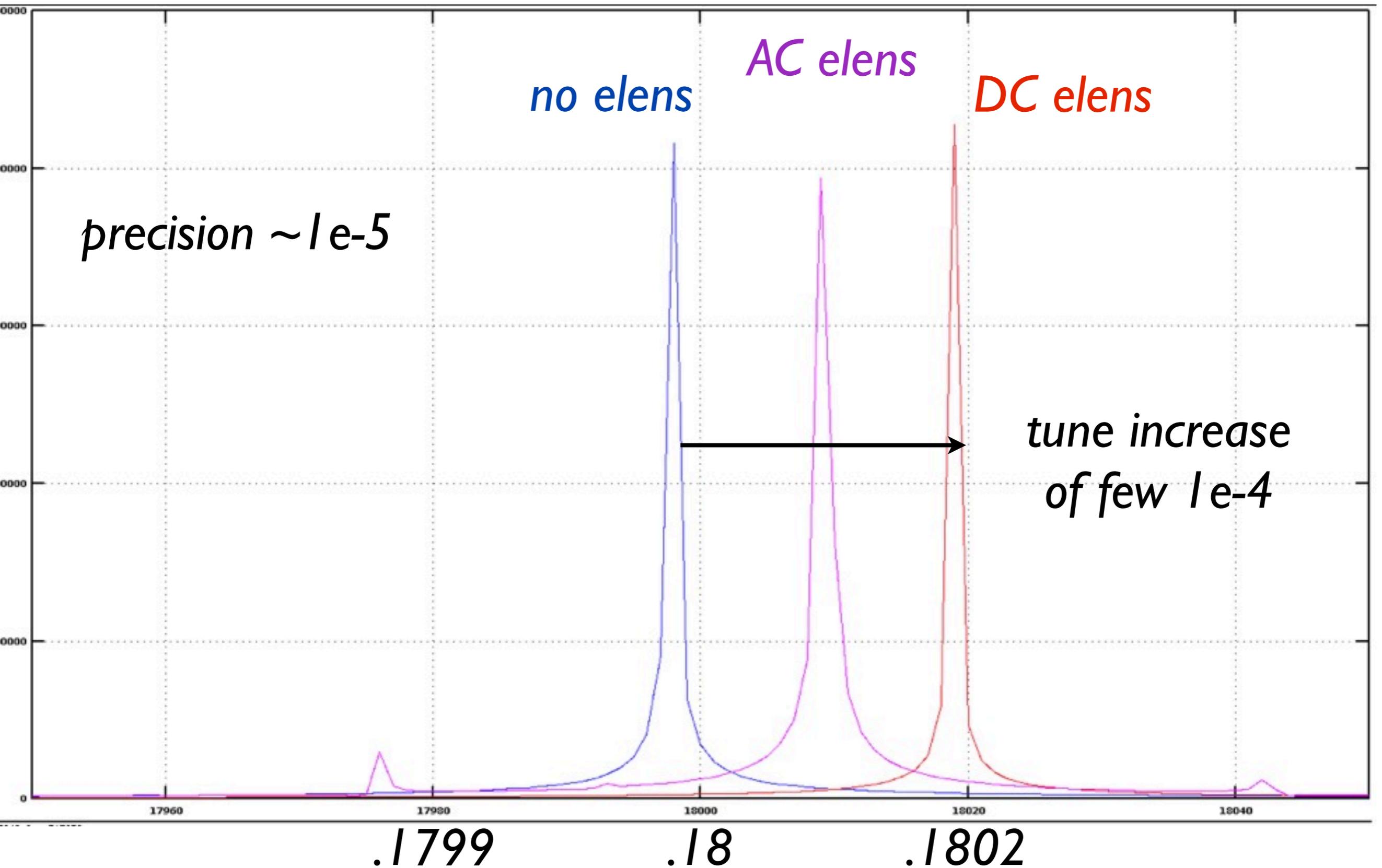
$$\theta(r) = \frac{2L f(r) I_T (1 \pm \beta_e \beta_p)}{4\pi\epsilon_0 r (B\rho)_p \beta_e \beta_p c^2} \quad f(r) = \begin{cases} 0 & r < R_1 \\ \frac{r^2 - R_1^2}{R_2^2 - R_1^2} & R_1 < r < R_2 \\ 1 & r > R_2 \end{cases}$$

- kick prop  $1/\rho c$  (through the magnetic rigidity)
- wrt 7 TeV, we expect a kick  $\sim 50x$  larger
- max kick is also proportional to  $1/r$
- $1\sigma$  is a factor 5 larger, so we expect a factor 5 smaller kicks
- **maximum kick for SPS case  $\sim 1 \mu\text{rad}$  (10x the LHC case)**

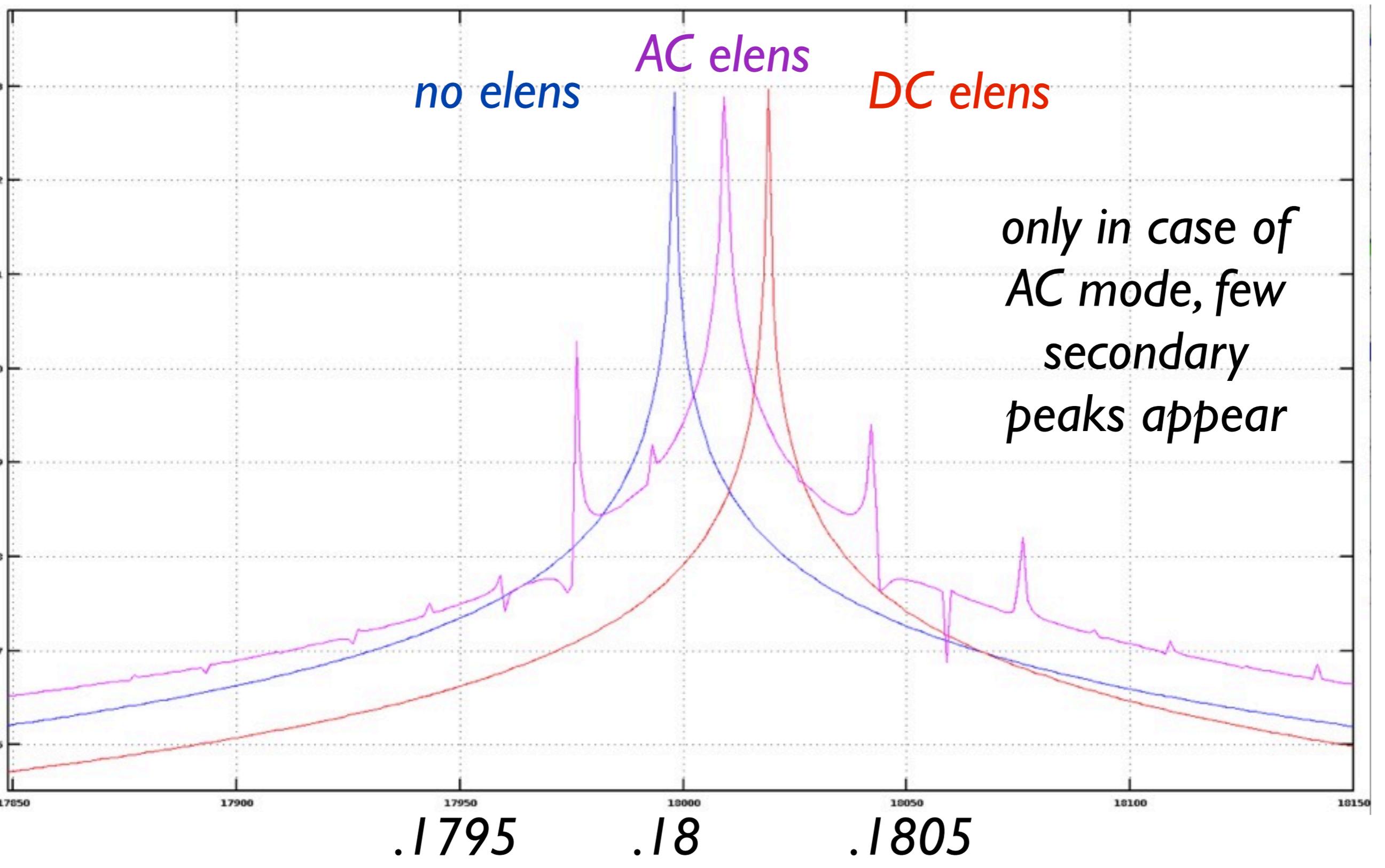
- 4 cases have been simulated:
  - no elens
  - elens always on (DC mode)
  - elens in resonant mode (AC mode)
  - elens in diffusive mode (random)

*for the moment we  
consider the .18  
nominal vertical tune*

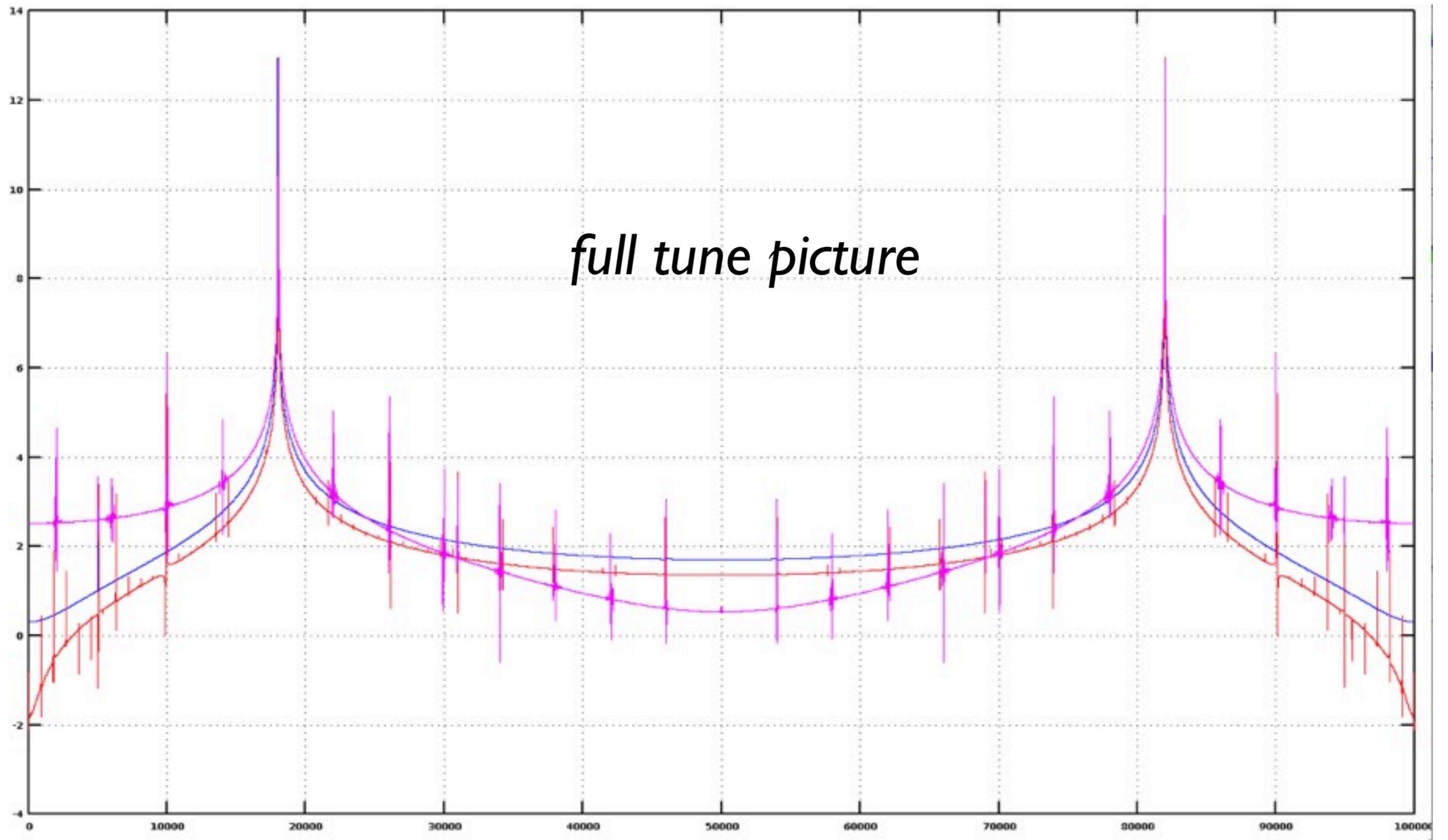
# main tune peak



Log scale



Log scale



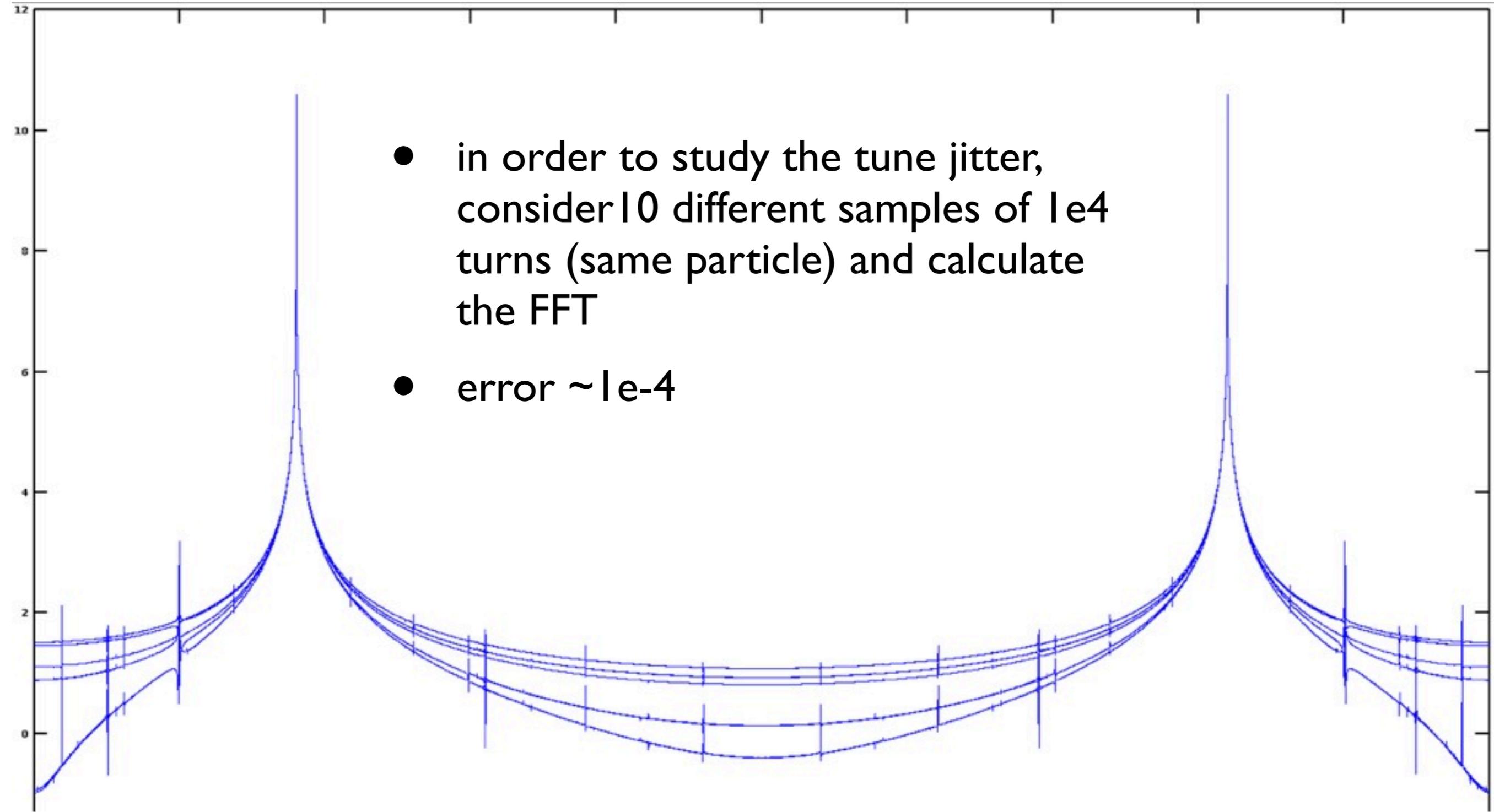
0

1

# DC elens: tune jitter?

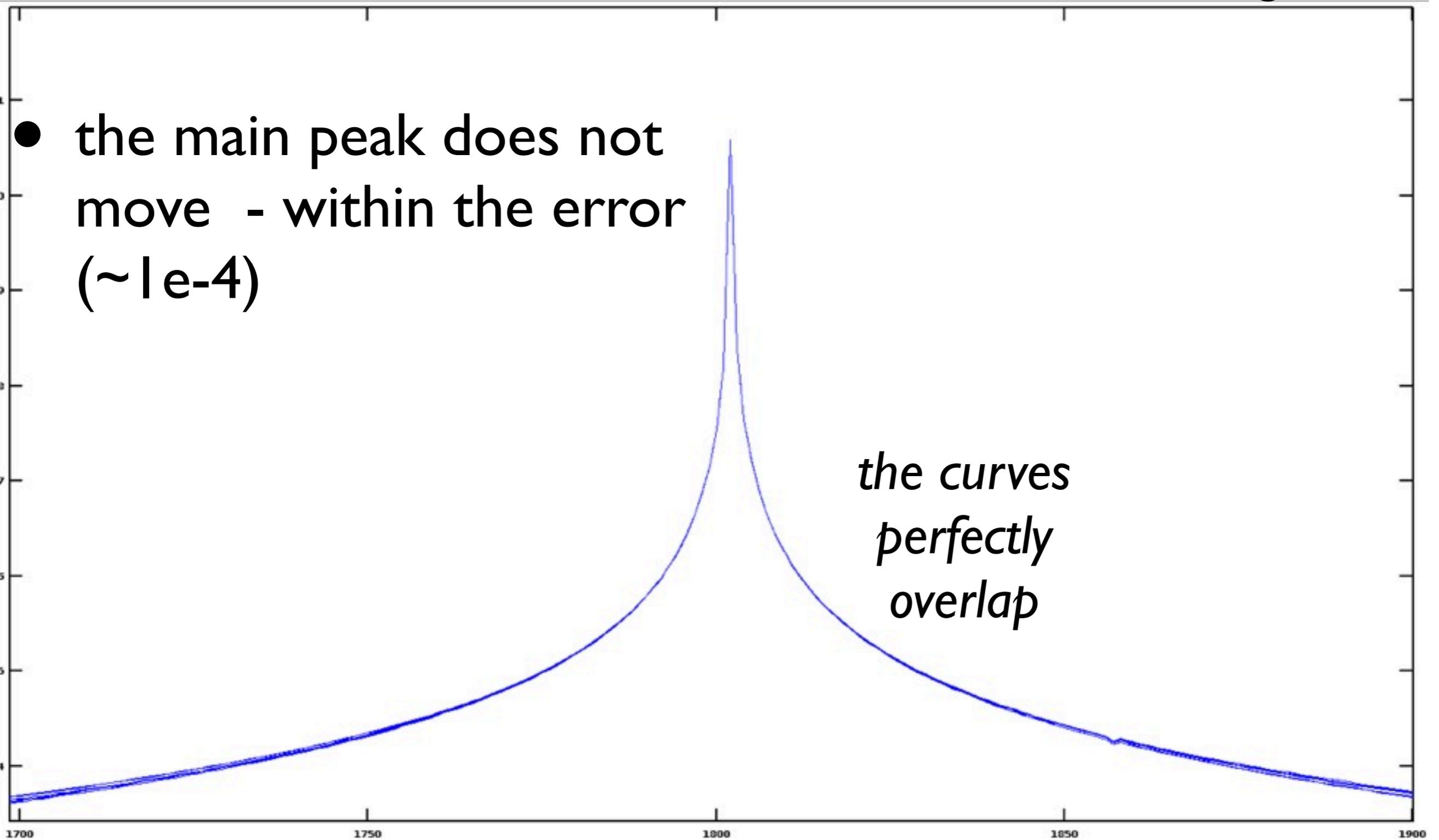
Log scale

- in order to study the tune jitter, consider 10 different samples of  $1e4$  turns (same particle) and calculate the FFT
- error  $\sim 1e-4$



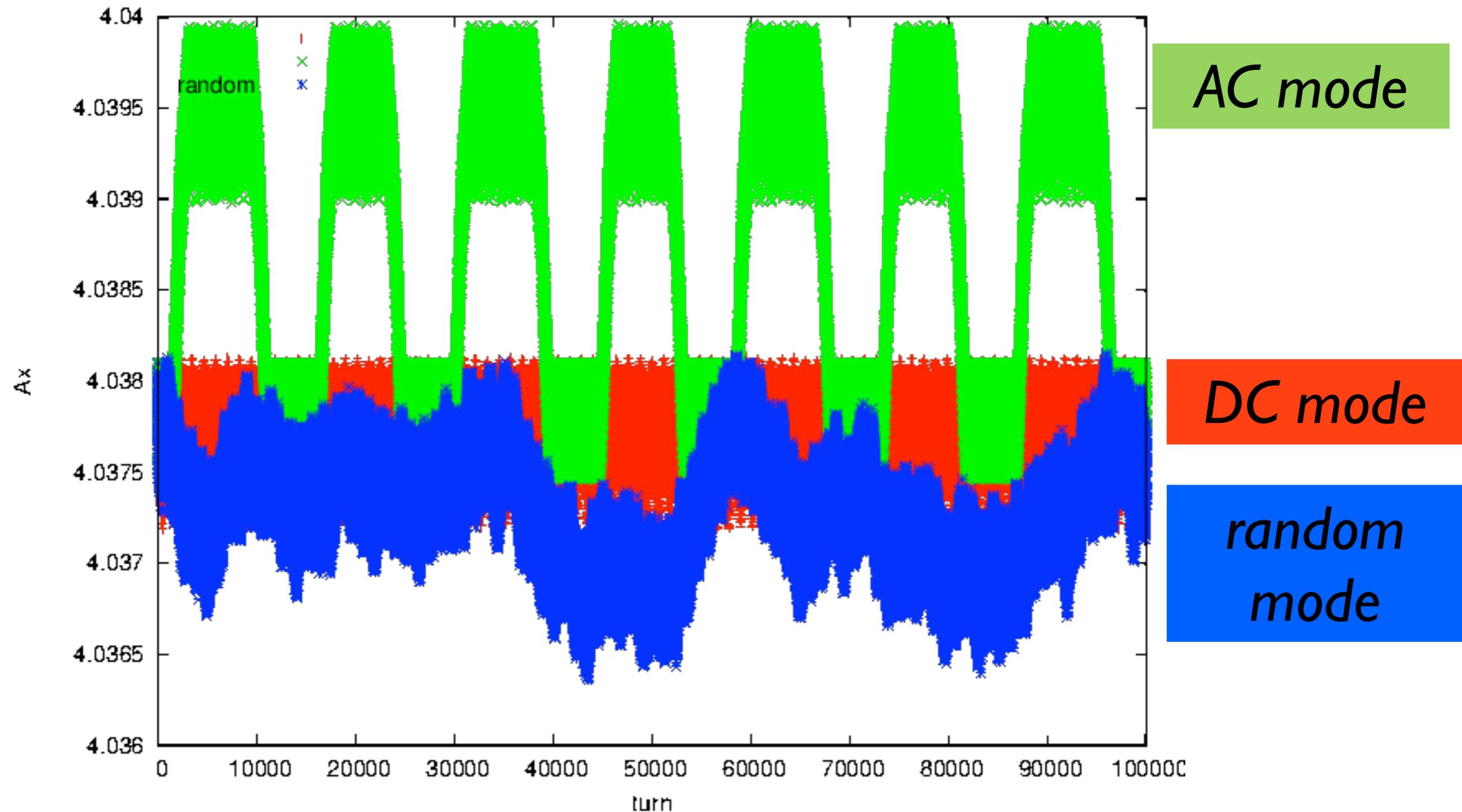
Log scale

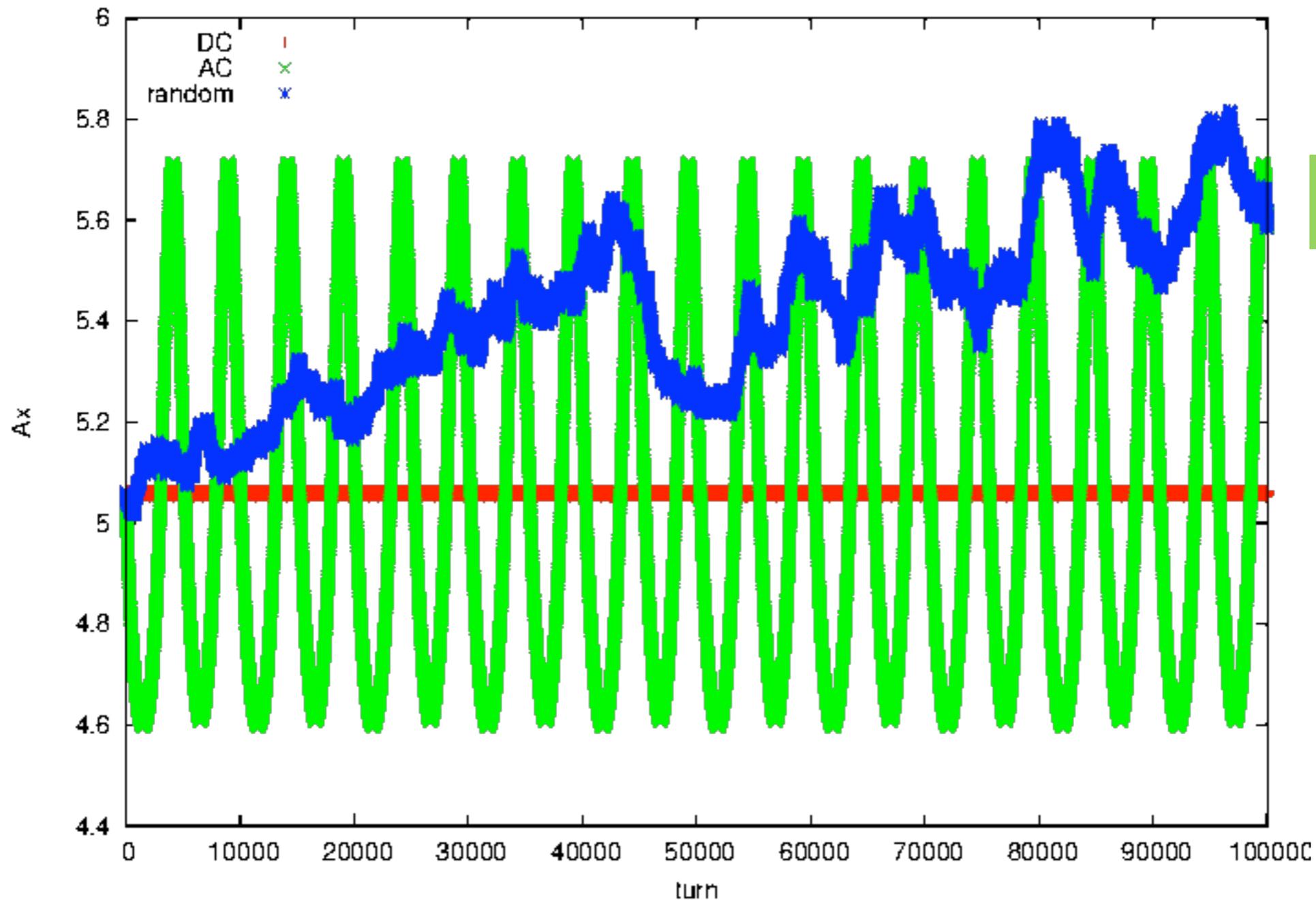
- the main peak does not move - within the error ( $\sim 1e-4$ )



*the curves  
perfectly  
overlap*

# amplitude change



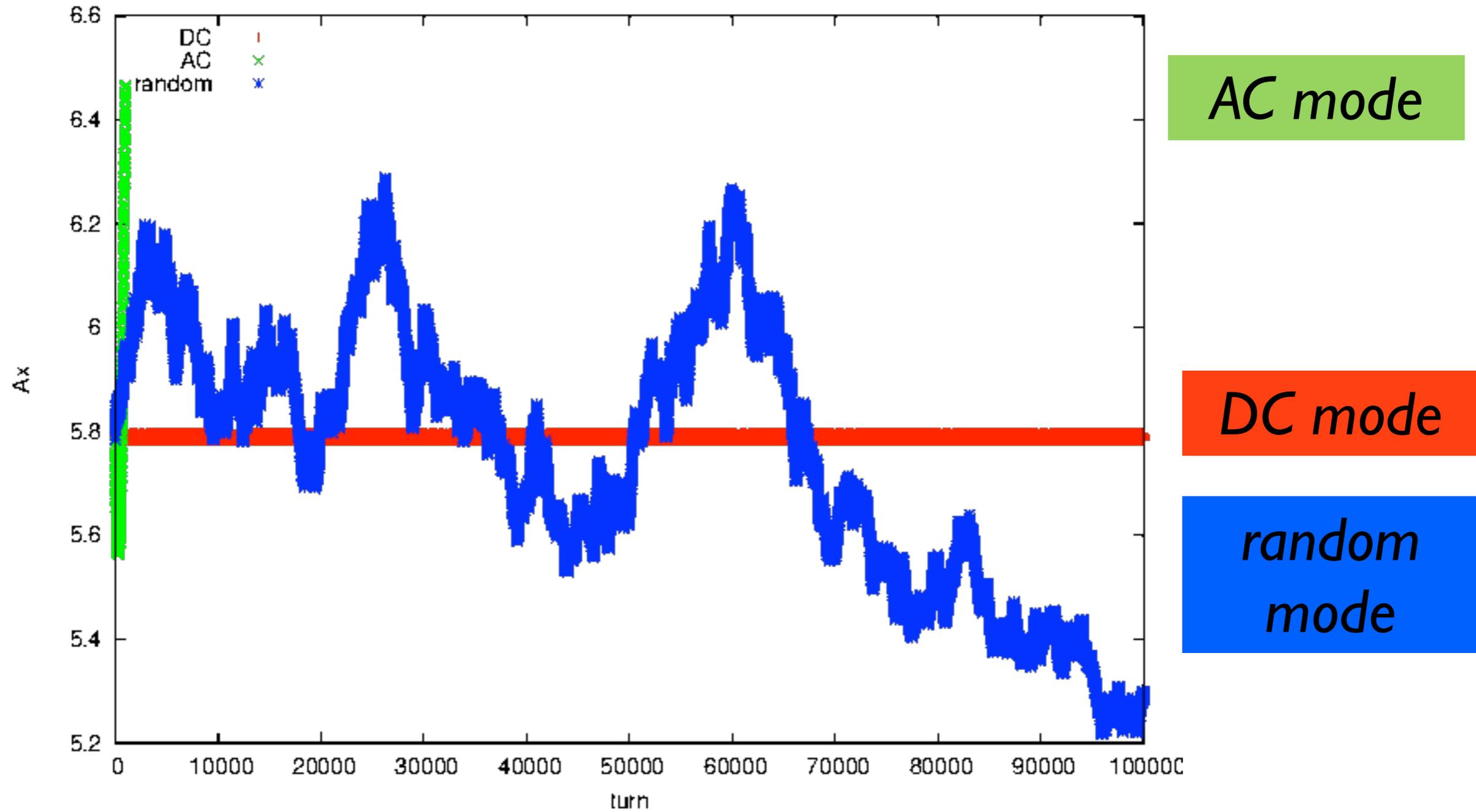


*AC mode*

*DC mode*

*random  
mode*

*\*IF\** you lose a particle in AC mode,  
you lose it extremely fast



# increasing turn number/ particle statistics

- up to  $1e6$  turns, 640 particle
- the coordinates of all the particles are not written anymore -> just the survival particles number is observed

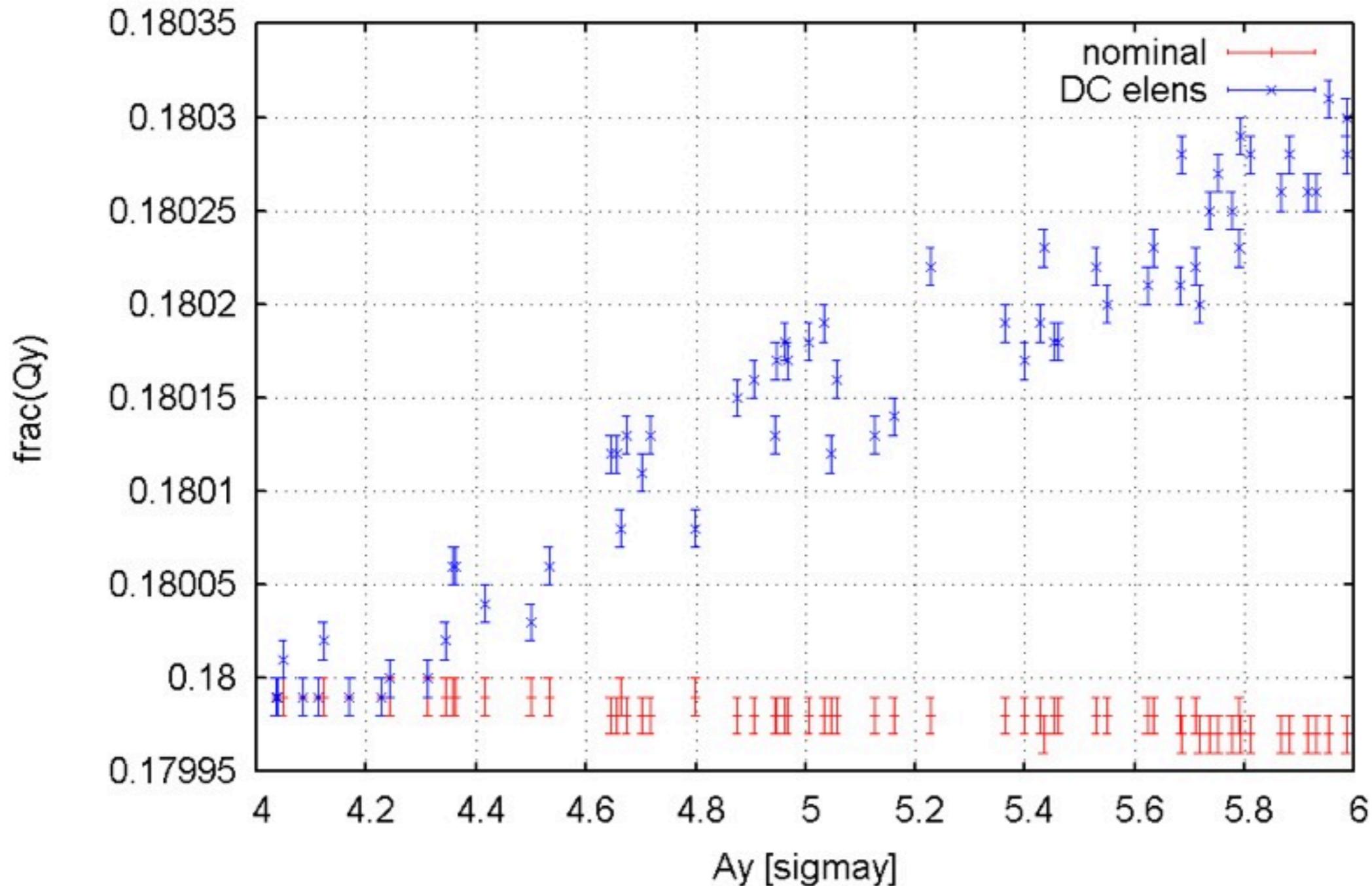
# survival after $1e6$ turns

starting from 640

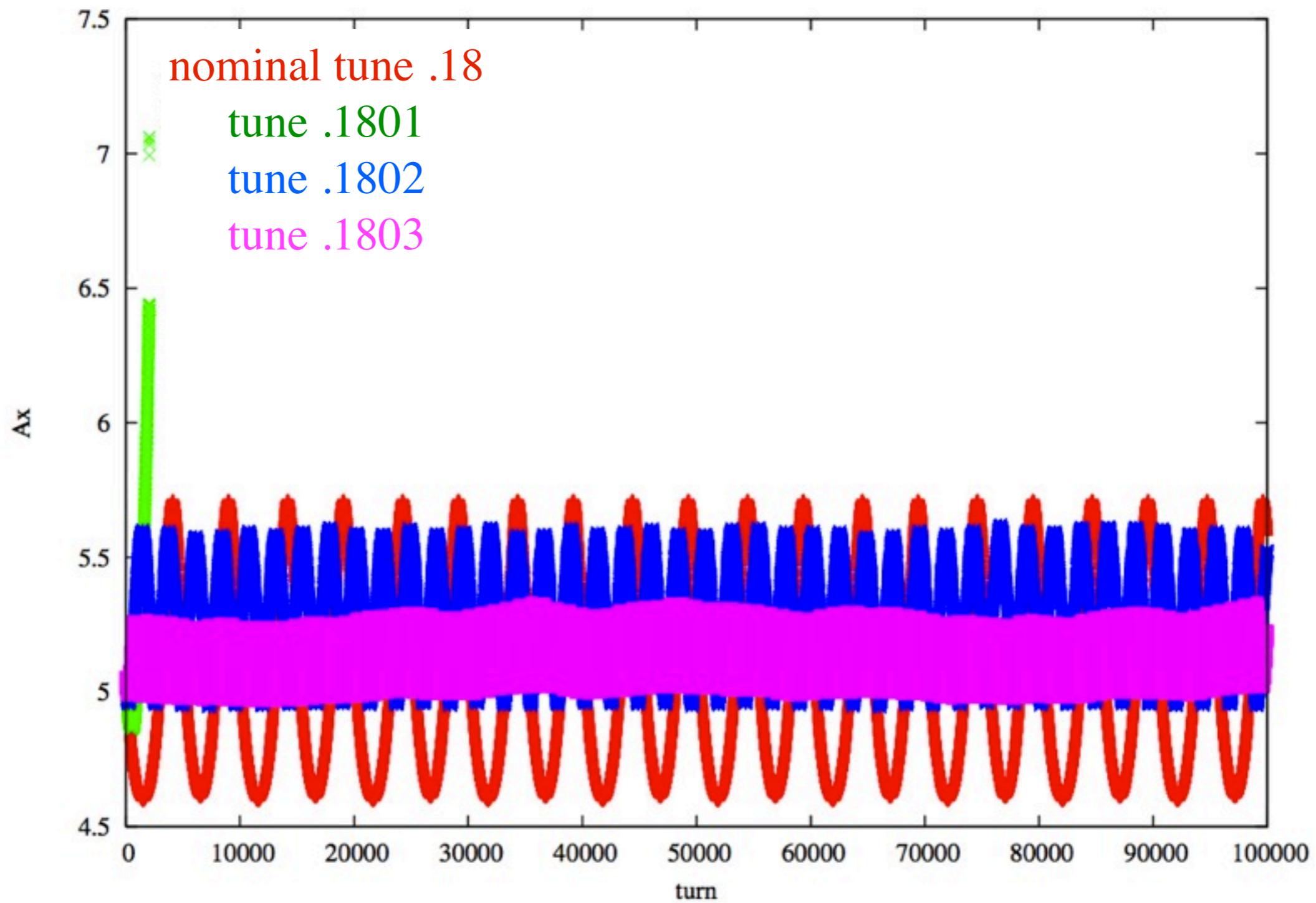
<i>CASE</i>	no el.	DC	AC	random
<i>survival</i>	640	640	538	204
<u><i>survival %</i></u>	1.0	1.0	0.84	0.32

*in this case the random mode seems the more efficient.  
However, the electron lens frequency has been set to the nominal  
tune, while the particles have a tune shift given by the electron  
lens itself!*

# tune variation vs initial amplitude



*for each particle, the tune value is stable. However, it depends on the particle initial conditions*



# survival after 1e6 turns

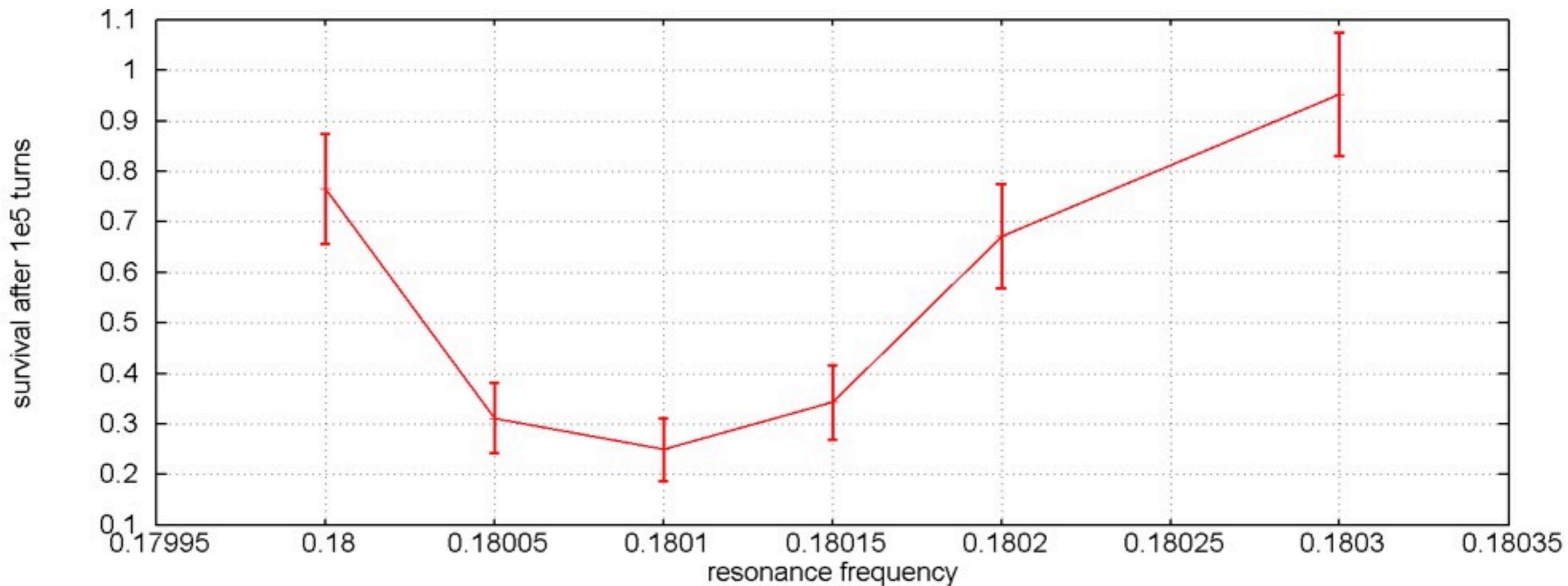
starting from 640

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# survival after 1e5 turns

starting from 64

<u><i>TUNE</i></u>	0.18	0.1805	0.1801	0.18015	0.1802	0.1803
<u><i>survival</i></u>	49	20	16	22	43	61
<u><i>survival%</i></u>	0.76	0.31	0.25	0.34	0.67	0.95



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# conclusion

- Routine is working fine
- Simulated SPS as 120 GeV
- Similar conclusions as for the LHC!
- identified different operation modes of the electron lens (as LHC)
- the DC is not effective (as for the LHC)
- the AC mode is effective only if the resonance frequency is optimized
- the random mode is effective over longer periods at least (10x)
- Implementation of elens as optics element has started - work in progress