Ecloud in SPS feedback

K. Ohmi,
June 16, 2011
June 9, June 1

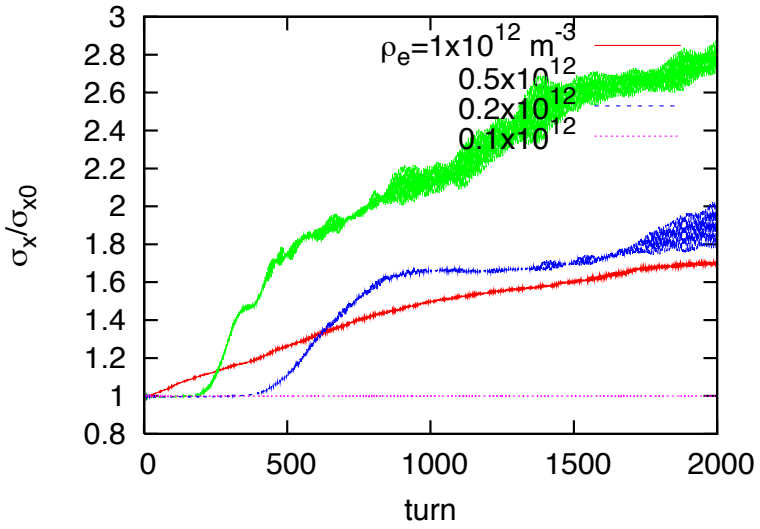
Parameter

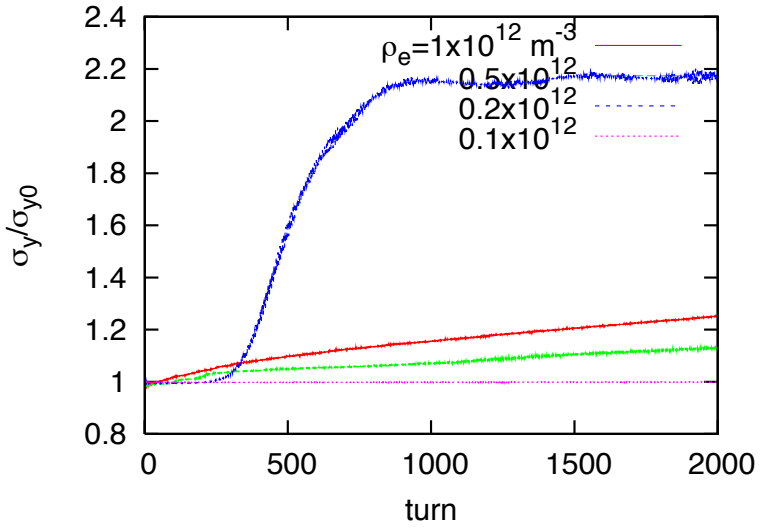
- E=26 GeV, $\varepsilon=1.01\times10^{-7}$, $\beta_x=33.85$m, $\beta_y=71.87$m
- $\sigma_z=0.229$m, $\sigma_E=0.19\%$, $\alpha=1.92\times10^{-3}$, $\nu_s=0.00564$
- $\omega_e/2\pi=355$ MHz, $\omega_e\sigma_z/c=1.7$
- $\rho_{e,th}=1.4\times10^{11}$ m^{-3}.(use the formula)

$$\rho_{th} = \frac{2\gamma\nu_s\omega_e\sigma_z/c}{\sqrt{3}\,KQr_e\beta_y L};$$

Electron cloud in Free space

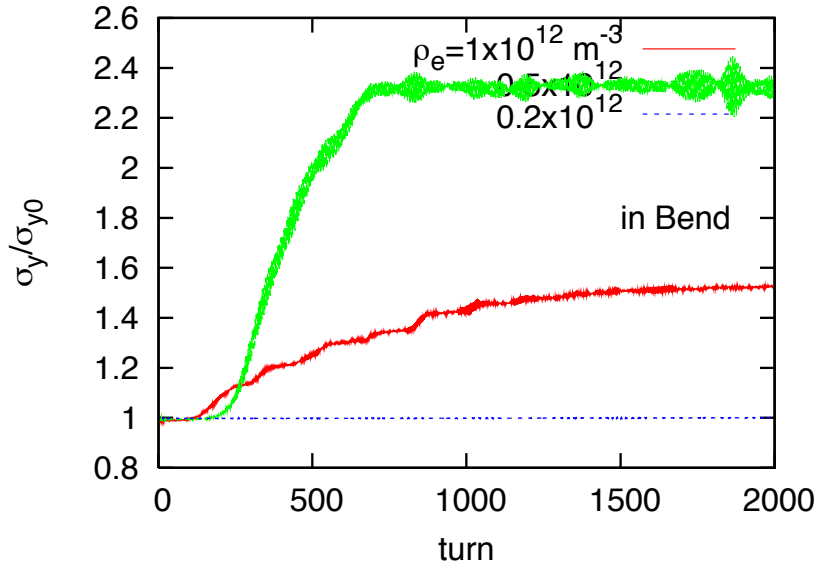
- Note $\sigma_x < \sigma_y$





- Instability signal is clear near the threshold
- Incoherent (artifact) effect is strong in high density.

Electron cloud in bending magnet

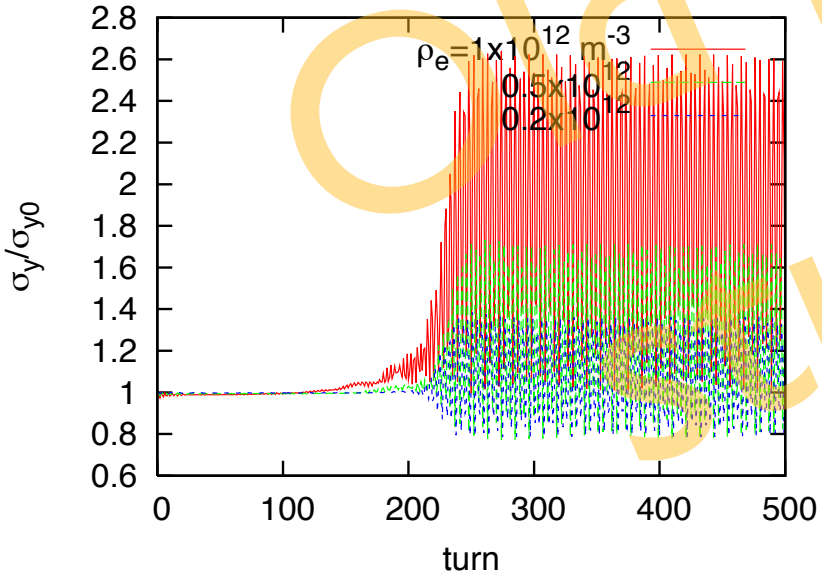


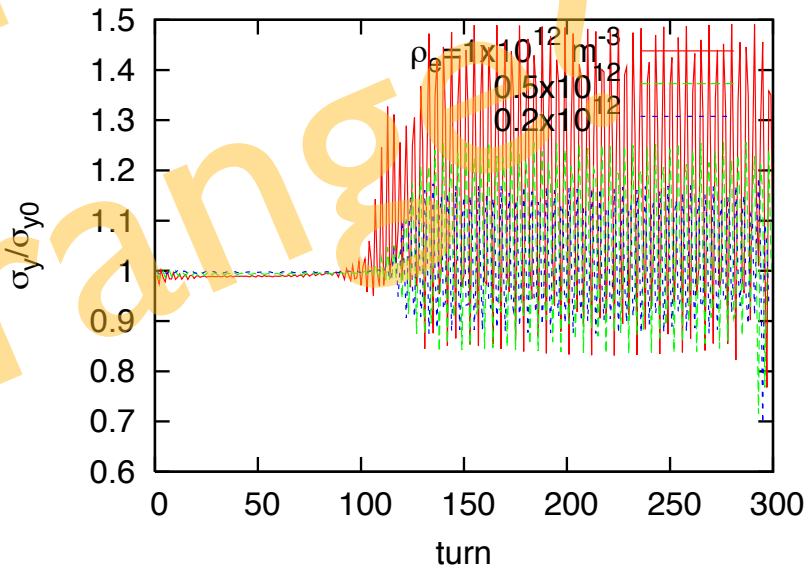
- No x instability

Feedback

- One turn delay, suppress only dipole motion

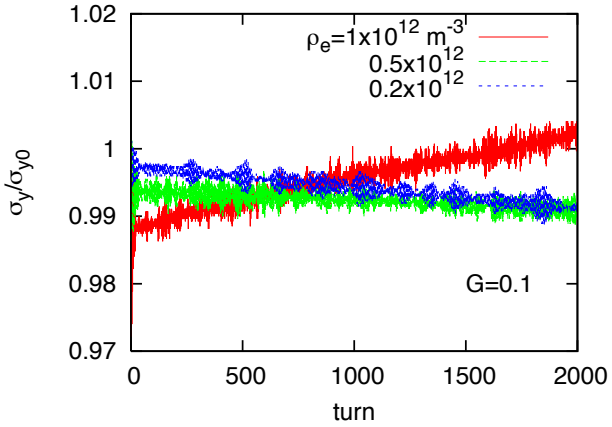
G=0.05 0.1

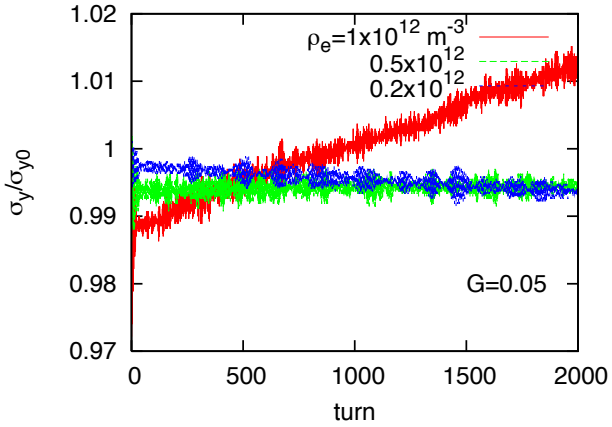


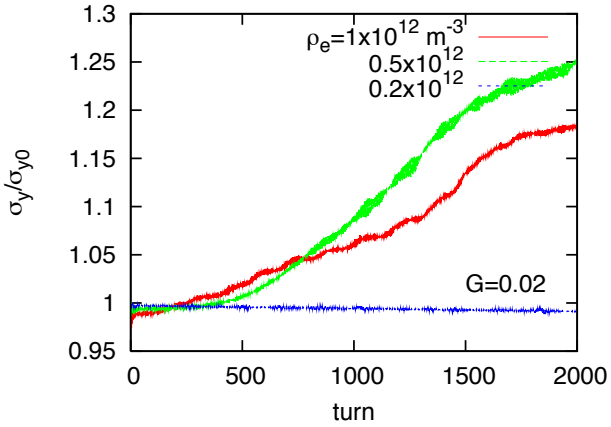


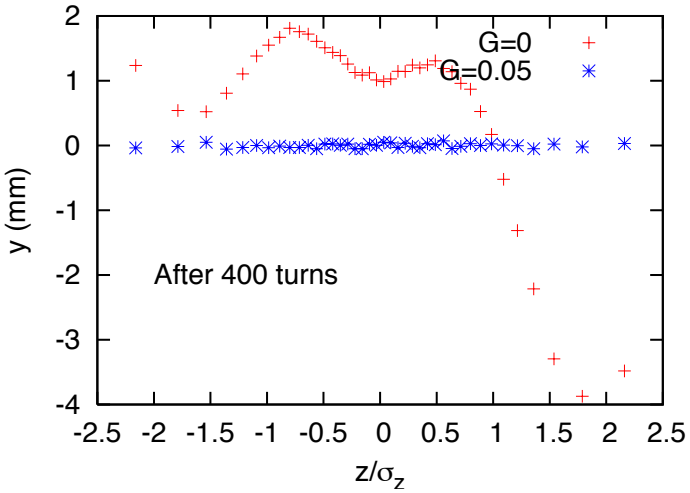
High frequency Feed back

- Feedback slice by slice, nonuniform 40 slices. Max c/Δz=22 GHz.







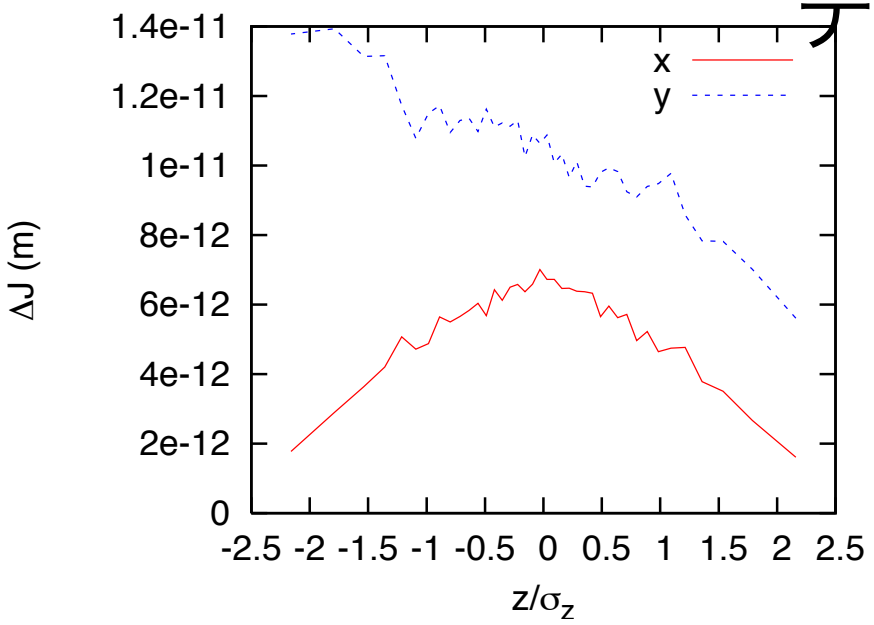


The feedback with <10GHz should give the same result, since high frequency component is not contained.

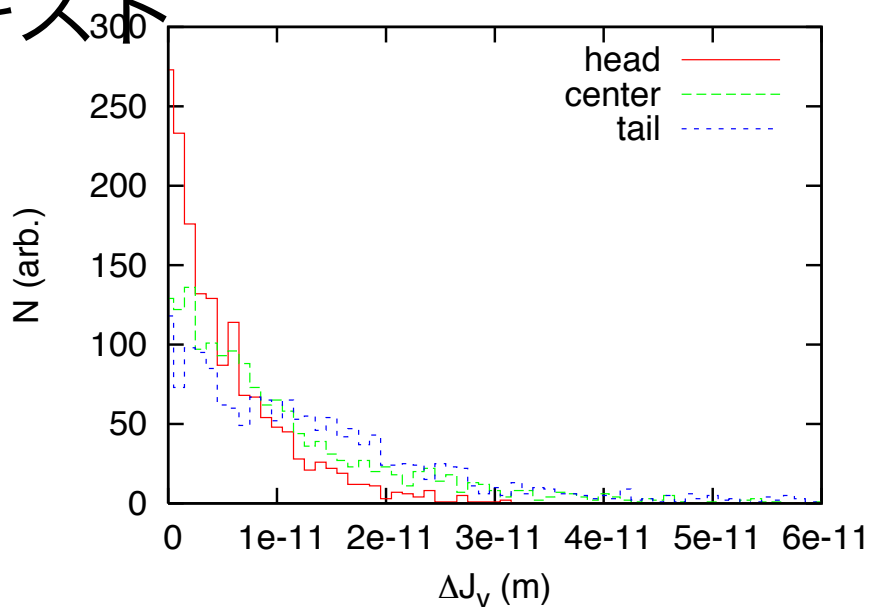
Feedback kick strength

- Plot residual J along z. $J=(\gamma y^2+2\alpha yy'+\beta y'^2)/2$
- Tail amplitude is larger than head.
- Kicker strength = $2G(\Delta J/\beta)^{1/2}$

テキスト



Residual J averaged over revolutions

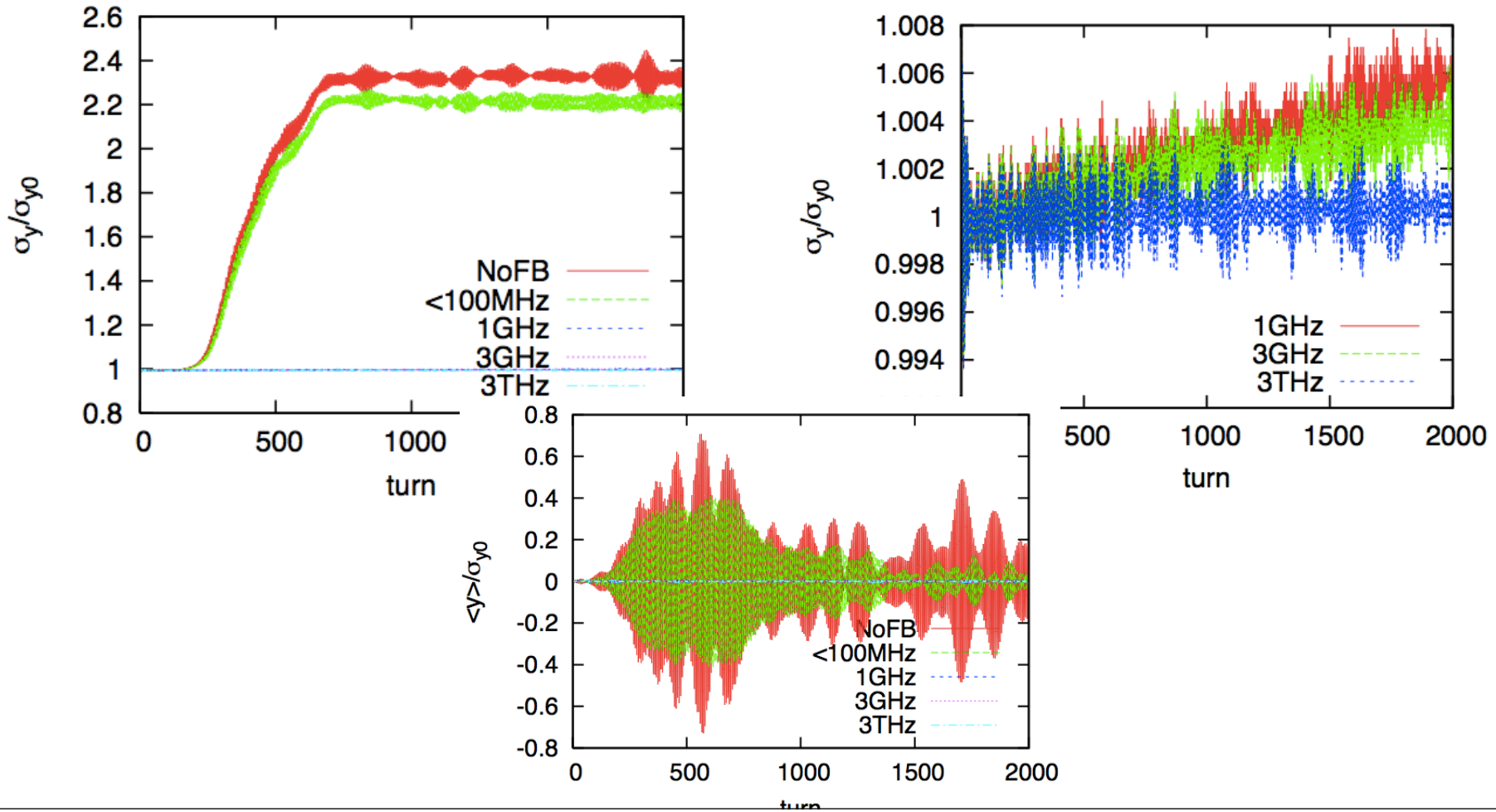


Hist for turn by turn ΔJ.

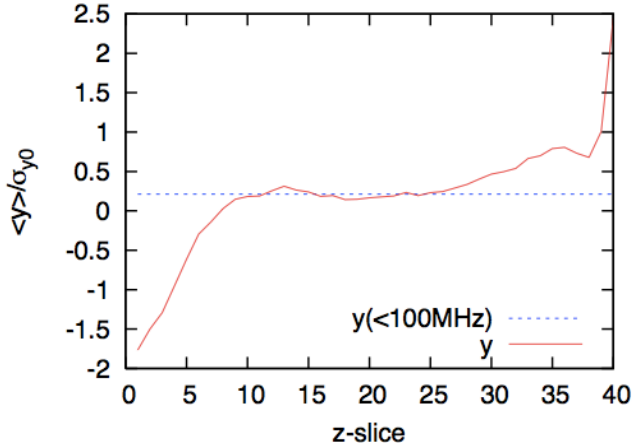
Feedback bandwidth

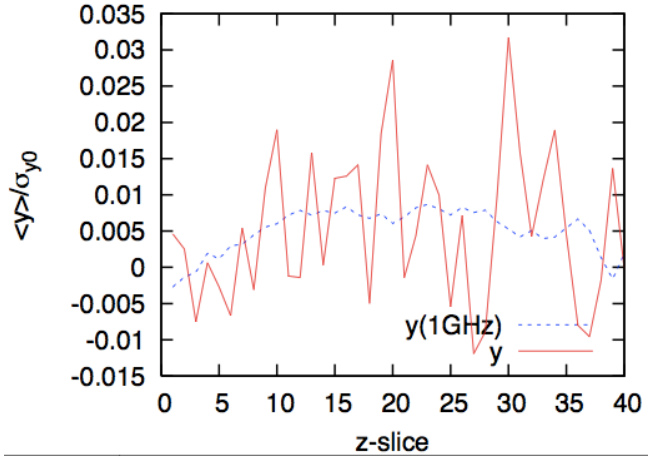
- step function filter, $dz=\pm c/2fr$

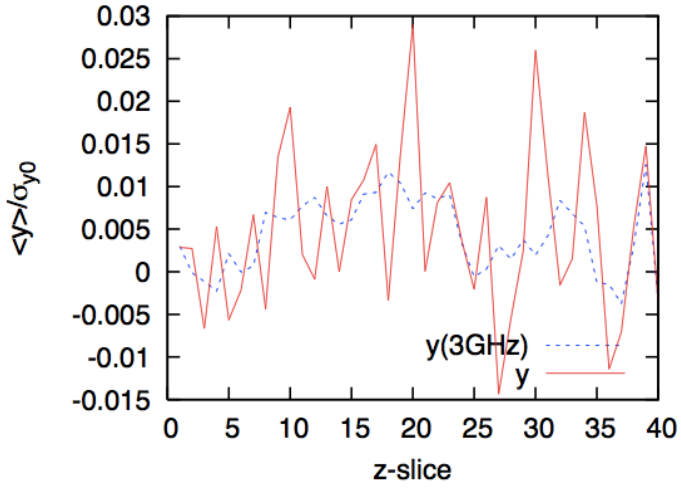
Beam size and dipole amp. for FB bandwidth

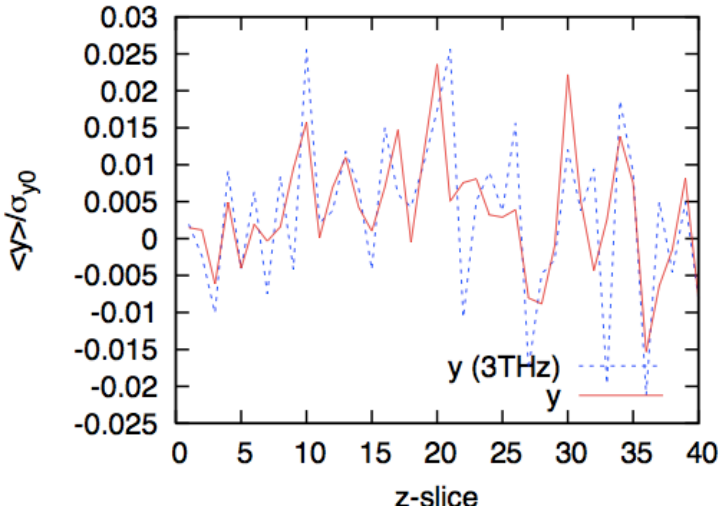


Bunch profile and filter signal one turn before (transferred by linear rev. matrix)



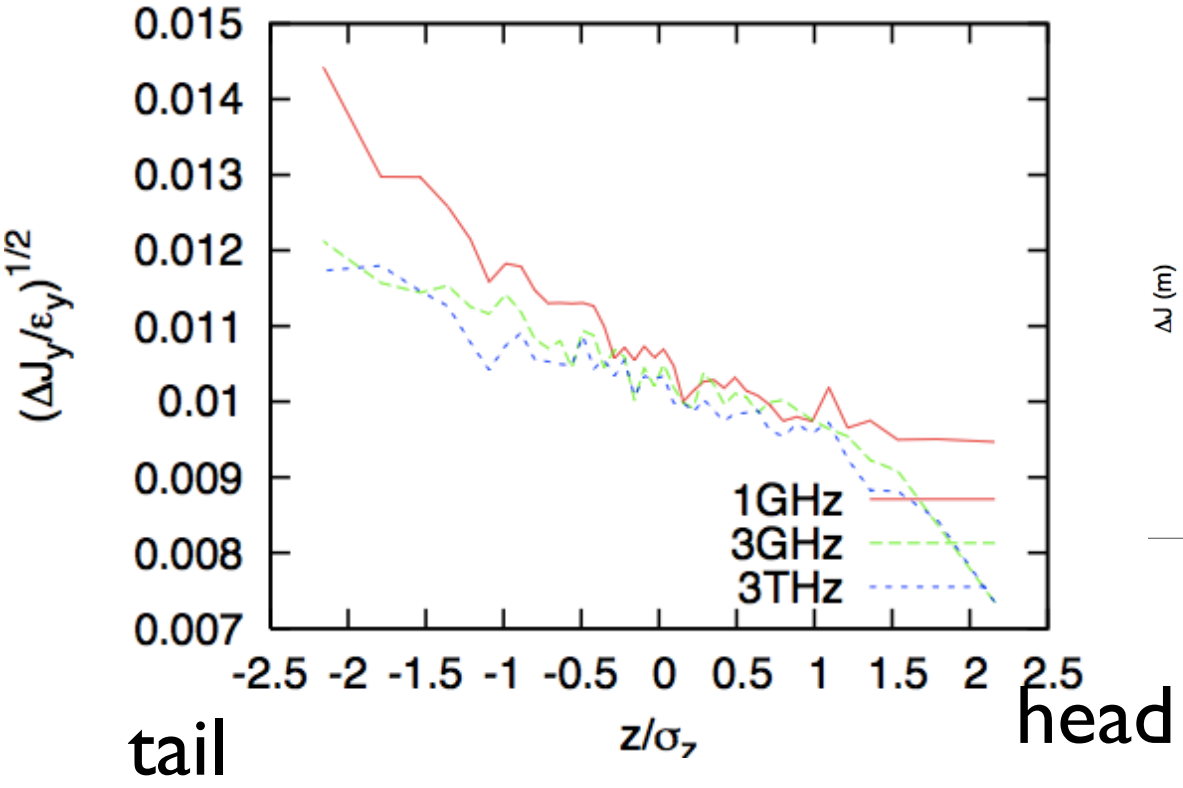


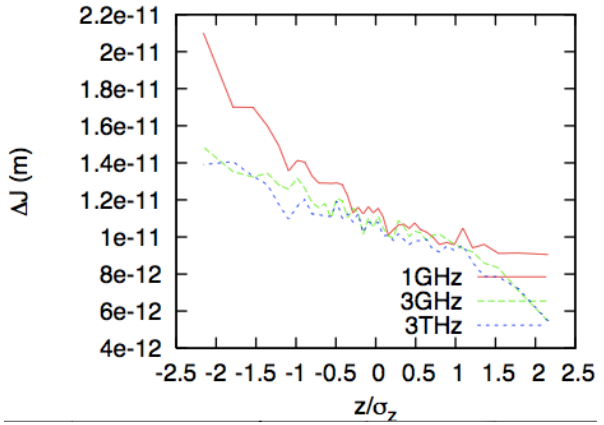




Residual J_y along z

- Residual Jy corresponds to feedback kick strength.
- The absolute values of the strength is determined by noise level.
- In this simulation, the noise level is statistical. Macro-particle in a slice is ~10,000, thus 1% error in each slice.





Summary

- High frequency feedback suppress the head-tail instability induced by electron cloud.
- The gain is G>0.05 (20 turn).
- Feedback with a few GHz is enough.