CesrTA and SuperKEKB

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SuperKEKB meeting

Sideband instability

- Fast head-tail instability
- $\Delta\nu$=3kHz=0.0077

$$\Delta\nu_x + \Delta\nu_y = \frac{r_e}{\gamma}\oint \rho_e \beta ds$$

- ρ_e=1.4x10^{12} m^{-3}, where β=10m.
- K=$\omega_e\sigma_z/c$ and Q=min(Q_{nl}, $\omega_e\sigma_z/c$), Q_{nl}=7 .

$$\rho_{e,th} = \frac{2\gamma\nu_s\,\omega_e\sigma_z/c}{\sqrt{3}KQr_0\beta L} \qquad \omega_e = \sqrt{\frac{\lambda_p r_e c^2}{\sigma_y(\sigma_x+\sigma_y)}}$$

- $\omega_e\sigma_z/c$ characterize instability. High $\omega_e\sigma_z/c$ for low ε rings
- $\omega_e\sigma_z/c$=3~5 for KEKB, $\omega_e\sigma_z/c$>10 for CesrTA and SuperKEKB

Parameters for CesrTA

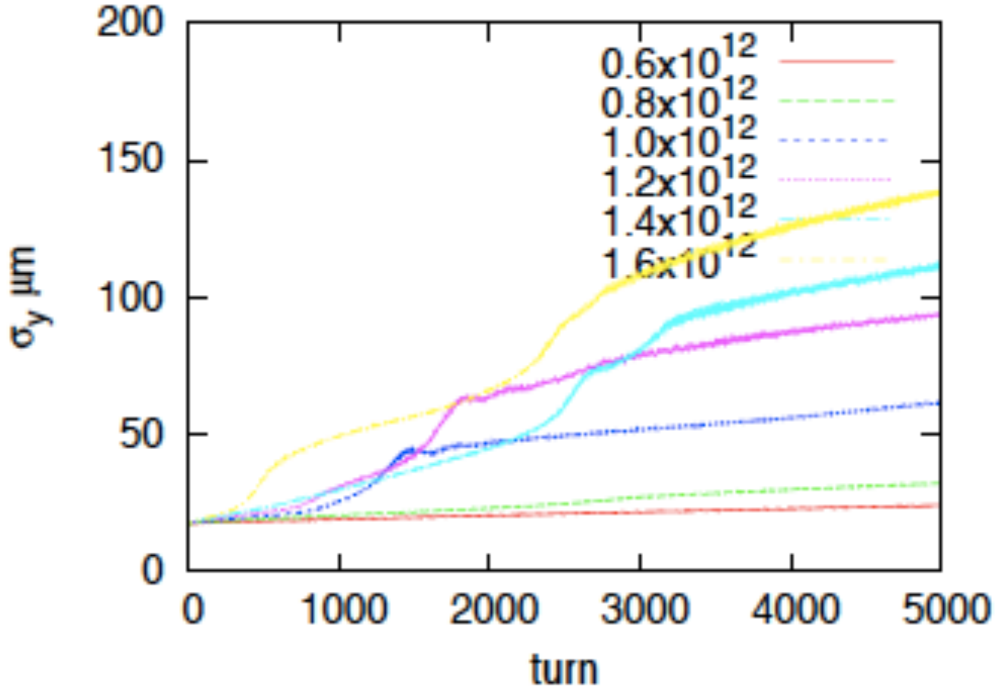
Table 1: Basic parameters of existing positron rings and ILC damping ring

		KEKB	PEP-II	Cesr-TA/5	Cesr-TA/2	ILC-DR
Circumference	L(m)	3,016	2,200	768	768	6,414
Energy	E	3.5	3.1	5.0	2.1	5.0
Bunch population	$N_+(10^{10})$	8	8	2	2	2
Beam current	I_+ (A)	1.7	3.0	-	-	0.4
Emittance	ε_x(nm)	18	48	40	2.6	0.5
Momentum compaction	$\alpha(10^{-4})$	3.4		62.0	67.6	4.2
Bunch length	σ_z(mm)	6	12	15.7	12.2	6
RMS energy spread	$\sigma_E/E(10^{-3})$	0.73		0.94	0.80	1.28
Synchrotron tune	ν_s	0.025	0.025	0.0454	0.055	0.067
Damping time	τ_x	40	40		56.4	26

Table 2: Threshold of the ILC damping ring and other rings

		KEKB[1]	KEKB[2]	PEP-II	CesrTA-5	CesrTA-2	ILC-DR
Bunch population	$N_+(10^{10})$	3	8	8	2	2	2
Beam current	I_+ (A)	0.5	1.7	3.0	-	-	0.4
Bunch spacing	ℓ_{sp}(ns)	8	7	4	4	4	6
Electron frequency	$\omega_e/2\pi$(GHz)	28	40	15	9.6	43	100
Phase angle	$\omega_e\sigma_z/c$	3.6	5.9	3.7	3.2	11.0	12.6
Threshold	ρ_e (10^{12} m^{-3})	0.63	0.38	0.77	7.40	1.70	0.19
Tune shift at ρ_e	$\Delta\nu_{x+y}$	0.0078	0.0047	0.0078	0.0164	0.009	0.011

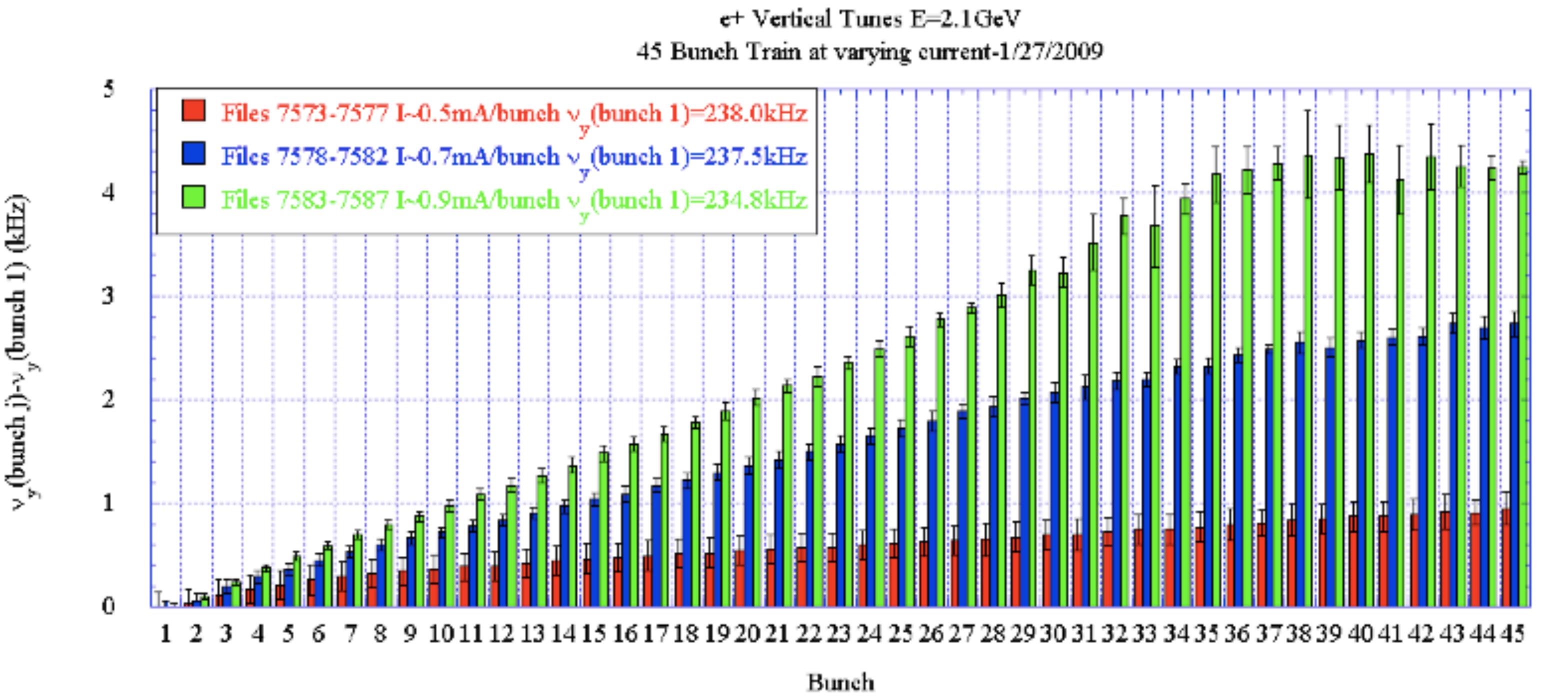
Simulation for CestTA
I=1.3mA, N=2x10^10



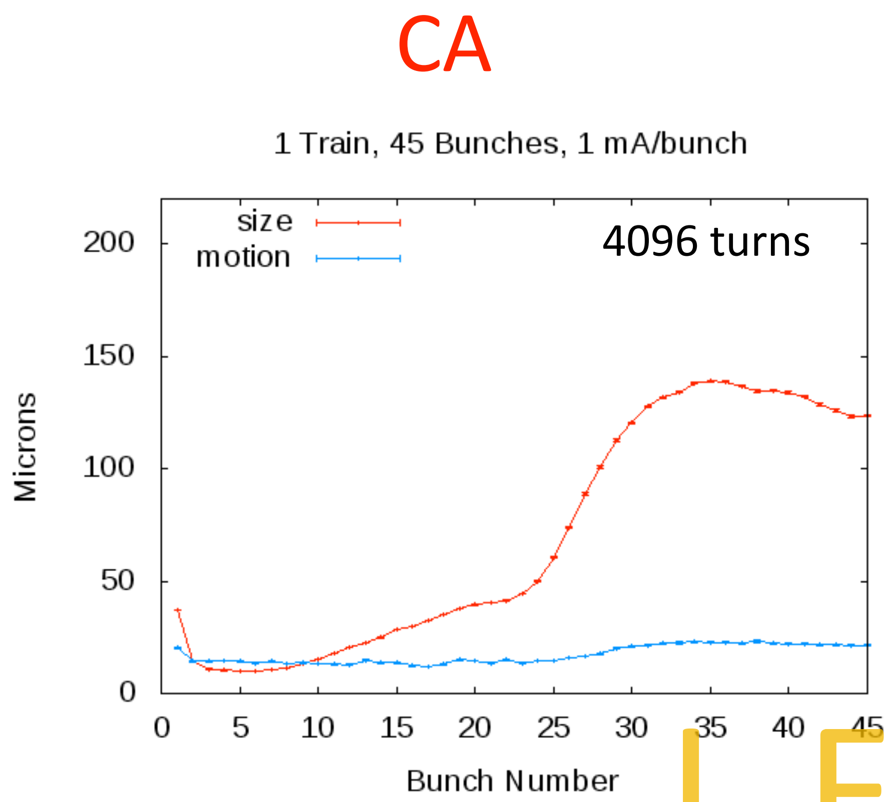
- Simulation ρ_{th}=1x10^{12} m^{-3}.
- Analytic ρ_{th}=1.7x10^{12} m^{-3}.

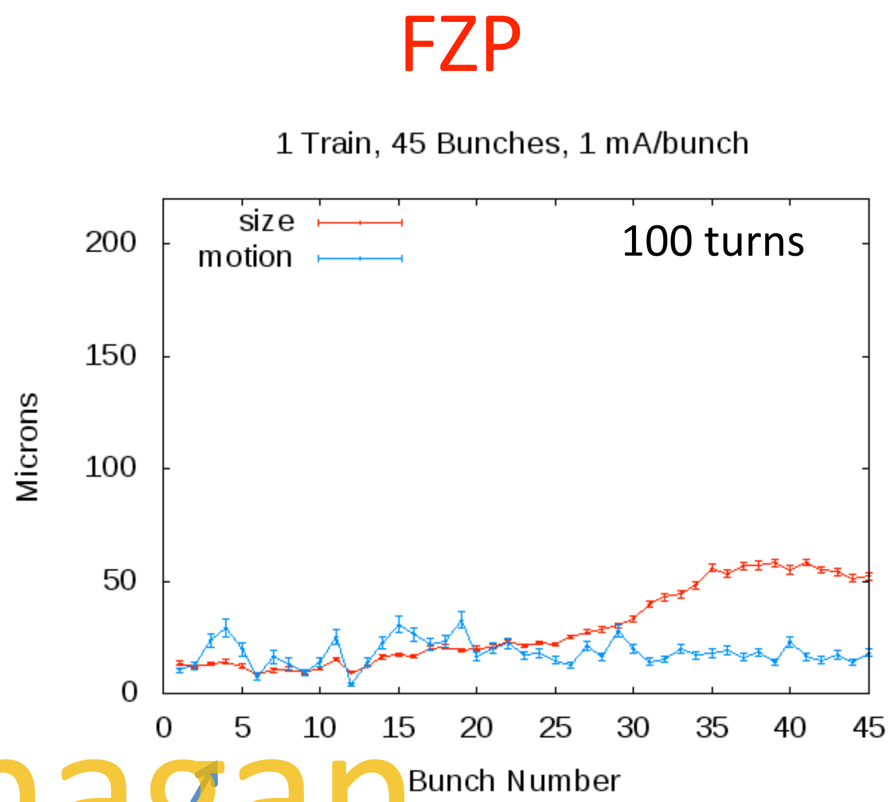
Vertical tune shifts

Positrons, 45 bunch train, currents of 0.5, 0.7, and 0.9 mA/bunch



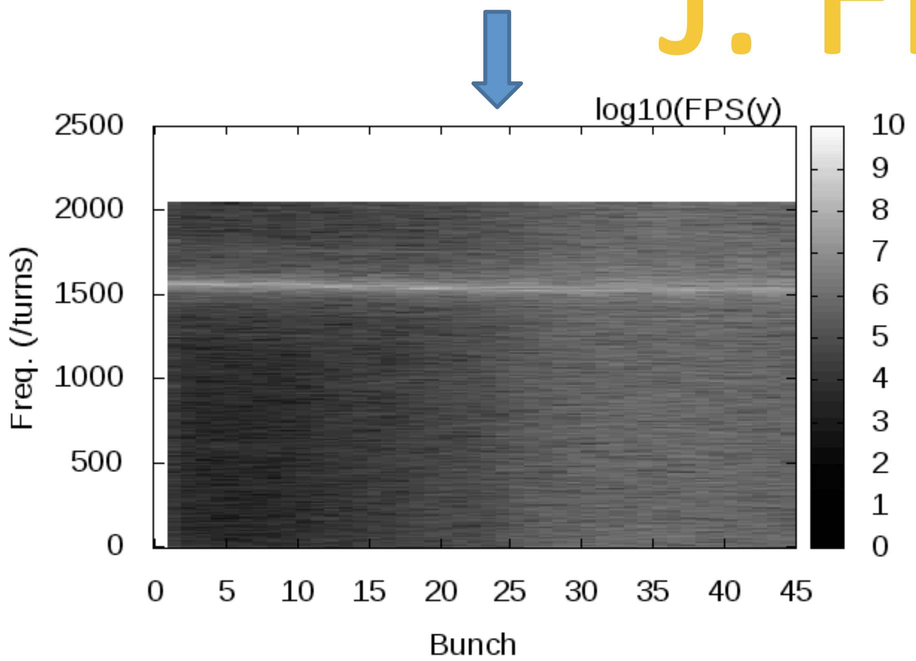
G. Dugan





J. Flanagan

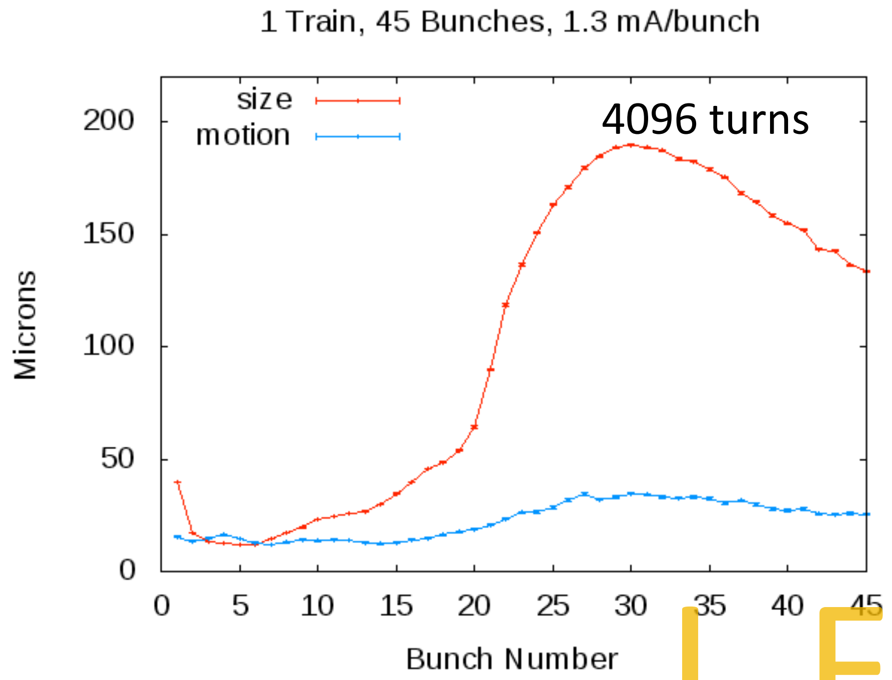
Single-bunch, single-turn fits averaged over turns



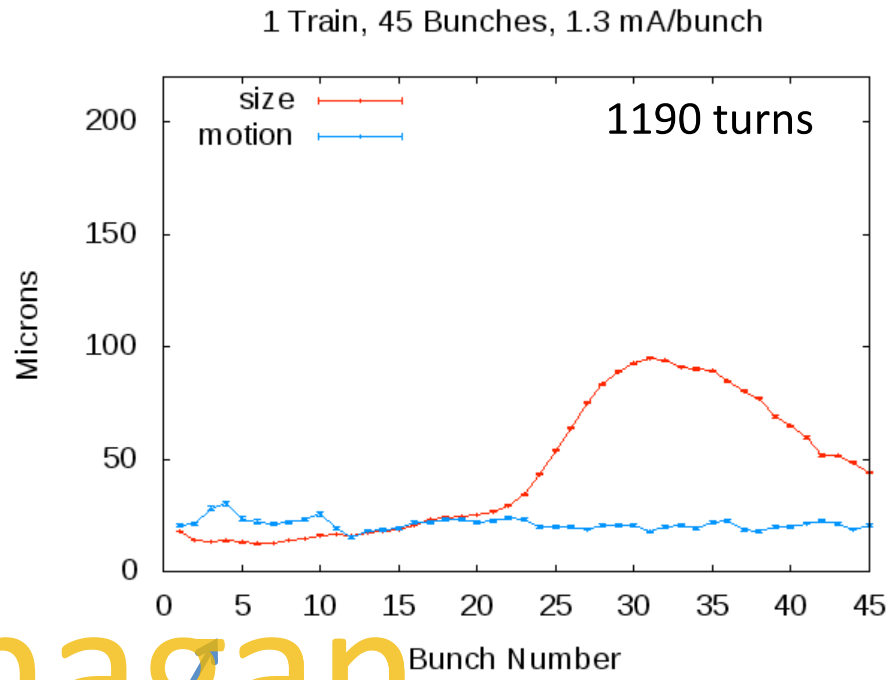
Bunch-by-bunch position spectra

1.0 mA / bunch

CA



FZP



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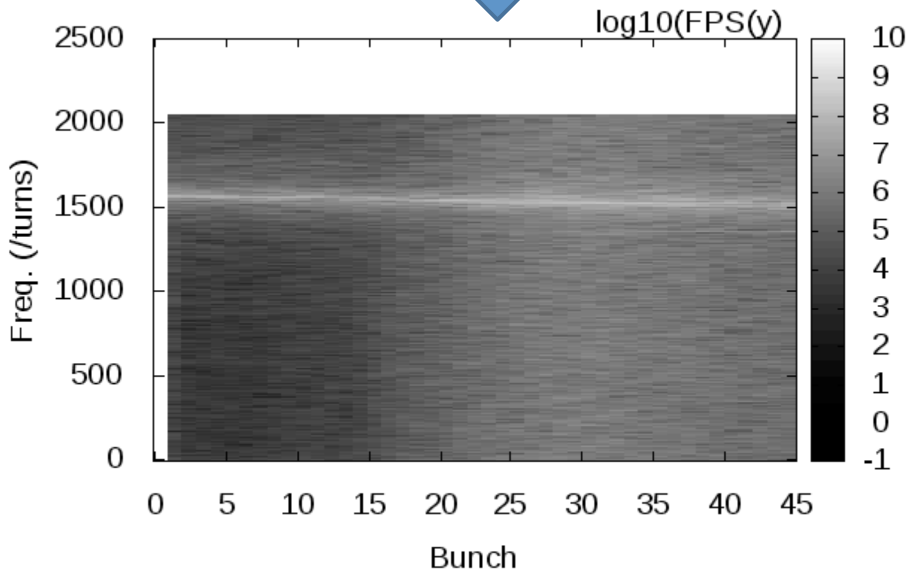


Single-bunch, single-turn fits averaged over turns

Bunch-by-bunch position spectra

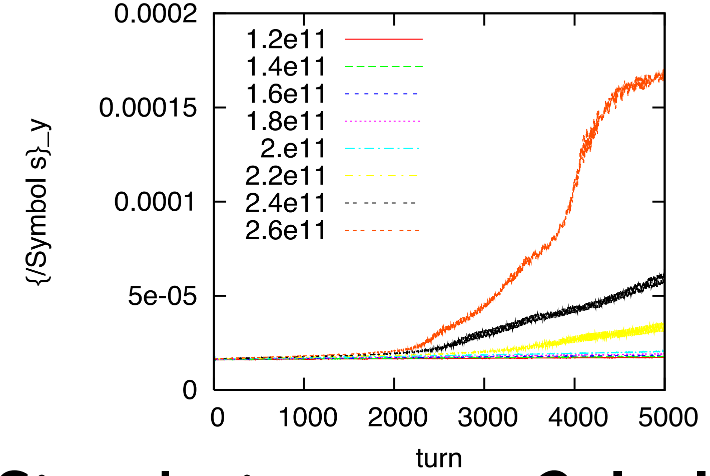
1.3 mA / bunch

CesrTA

- $N=1.6\sim2\times10^{10}$,
- $\rho_{th}=1.4\times10^{12}\ m^{-3}$(experiment)
- $\rho_{th}=1.0\times10^{12}\ m^{-3}$(simulation)
- $\rho_{th}=1.7\times10^{12}\ m^{-3}$(analytic)

- Good agreement

SuperKEKB



Y. Susaki, K. Ohmi, IPAC10

- Simulation $\rho_{th}=2.1\times10^{11}$ m^{-3}.
- Analytic $\rho_{th}=1.1\times10^{11}$ m^{-3}.
- **Target $\rho_e<1\times10^{11}$ m^{-3}**
- Update parameters (both for CesrTA and SuperKEKB).
- Take care of high β section. Effects are enhanced.