

Improvement in the beam lifetime by means of an rf phase modulation at the Photon Factory storage ring

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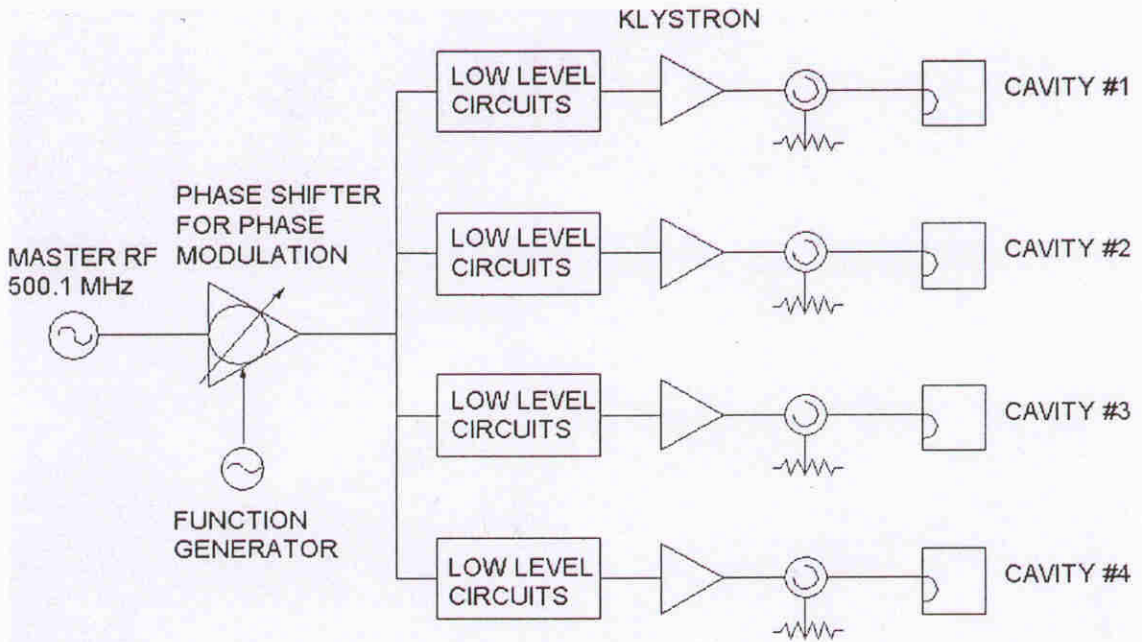
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Summary

In the 2.5-GeV Photon Factory storage ring at KEK, we have found that the beam lifetime can be improved by modulating the phase of an rf accelerating voltage at the frequency of two times the synchrotron oscillation frequency. By applying this phase modulation with a peak-to-peak amplitude of 3.2 degrees, the beam lifetime could be improved, typically, from 22 to 36 hours under the beam current of about 360 mA. At the same time, longitudinal coupled bunch instability could be considerably suppressed. The improvement in the beam lifetime can be explained as the improved Touschek lifetime which is caused by a quadrupole-mode longitudinal oscillation of the stored bunches.

1. rf-phase modulation

Very simple equipment. Only a function generator and a phase shifter !!



HP VEE - RF Phase_mod_con_auto3.1.vee

File Edit View Debug Flow Device I/O Data Display Window Help

Main

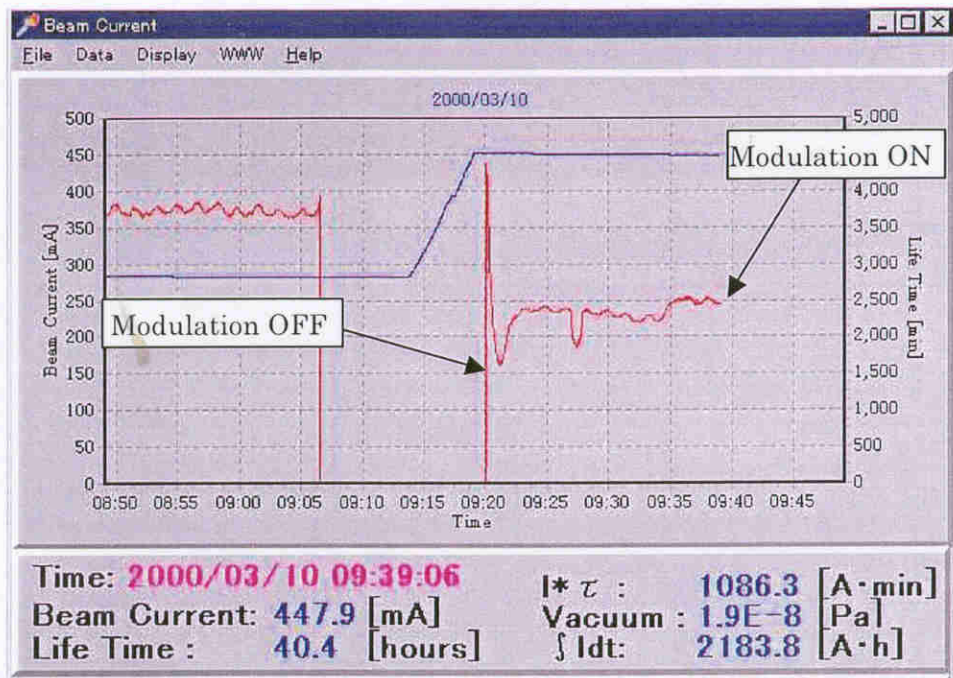
Input Frequency (Hz)	Now Frequency (Hz)	Input FM INT. FREQ. (kHz)	Now FM Int Freq. (Hz)
46.8	46.8k	0.3	300
Change Frequency		Change FM Int FREQ.	
Input Volt (V)	Now voltage (V)	Input FM Dev. (Hz)	Now FM Deviation (Hz)
2.9	2.9	400	400
Change Voltage		Change FM Deviation	
AUTO	Now RF Frequency (Hz)	Now Frequency (Hz)	STOP Break
	500105480	46.8k	

Ready

STD PROF MOD WEB

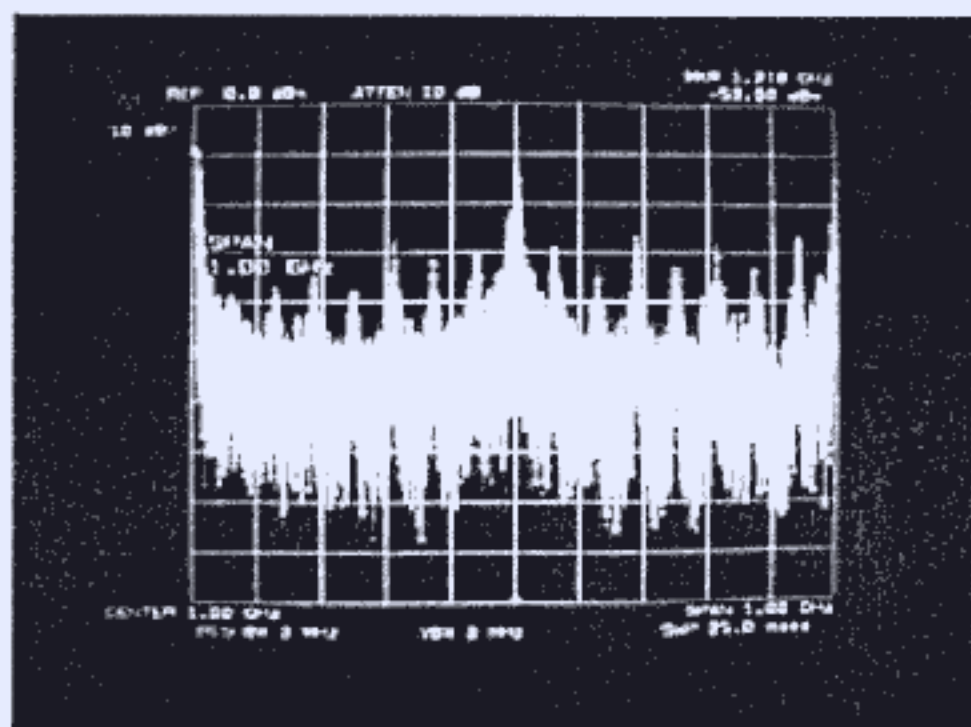
2. Effect of rf-phase modulation

Improvement of beam life time.

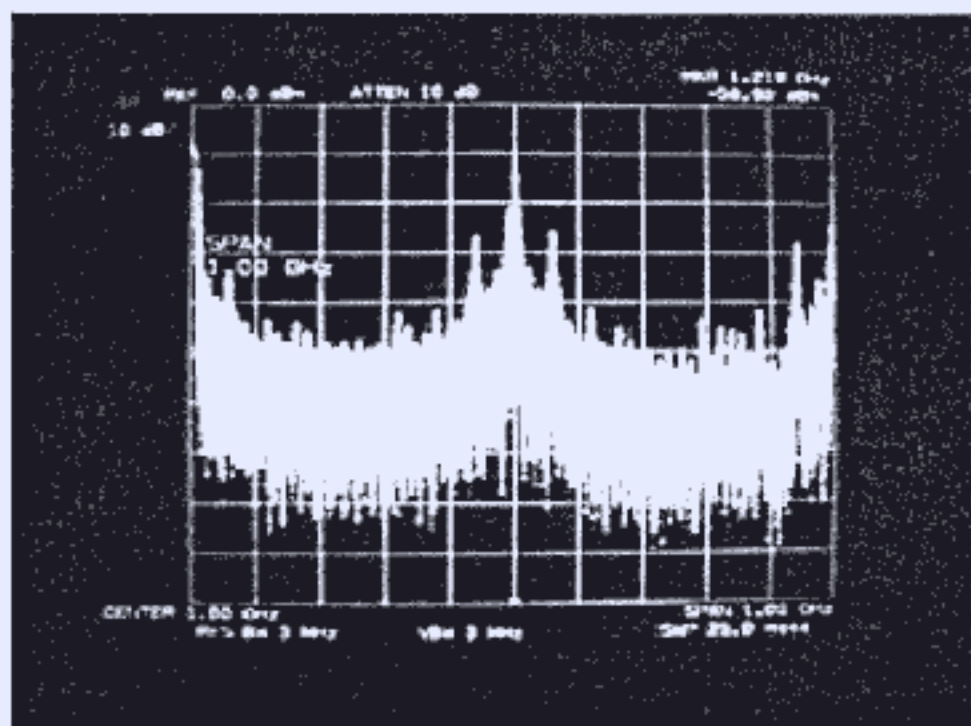


Suppression of the longitudinal coupled-bunch instability.

Modulation OFF



Modulation ON



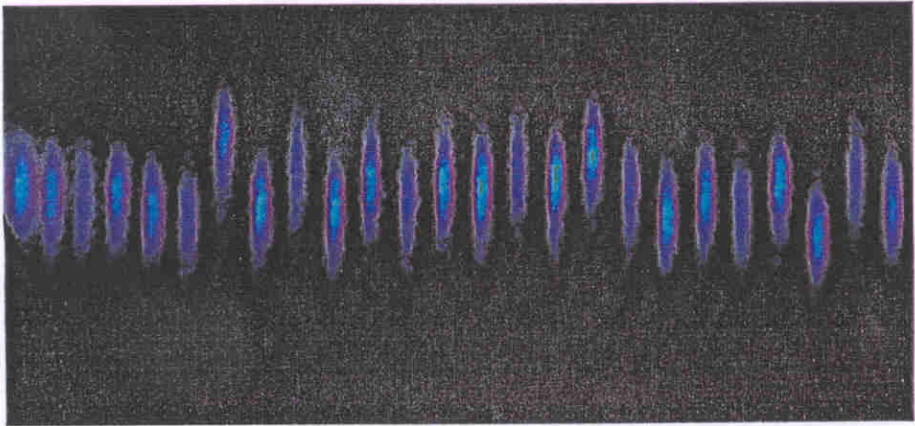
Center Frequency 1GHz

Span 1GHz

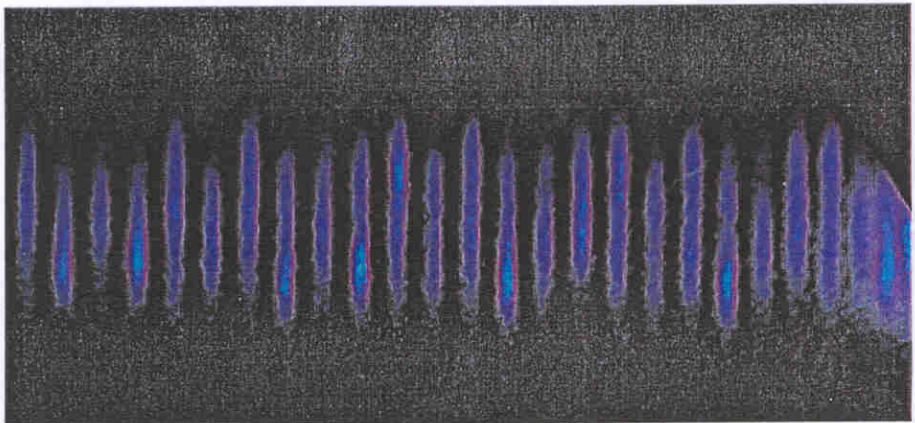
3. Stable quadrupole oscillation

Motion of bunches (streak camera)

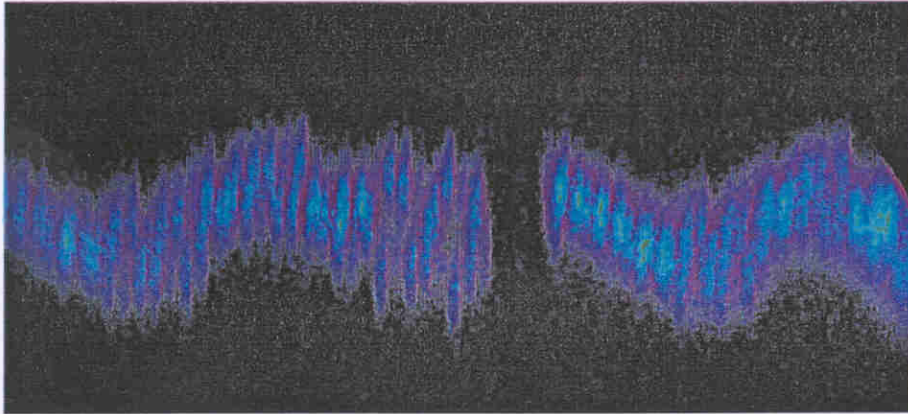
Modulation OFF



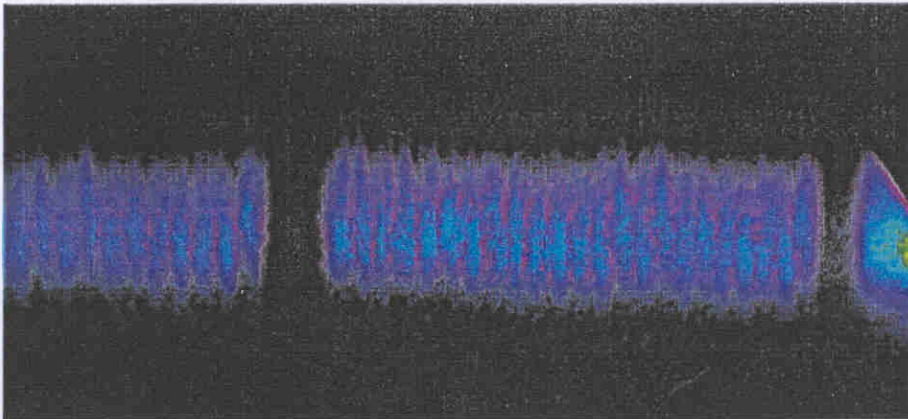
Modulation ON



Modulation OFF



Modulation ON



Stable quadrupole oscillation



Increase of bunch length



Long Touschek lifetime

Suppression of the coupled-bunch instability is not known clearly