Fast Bunching Experiment at 150MeV FFAG

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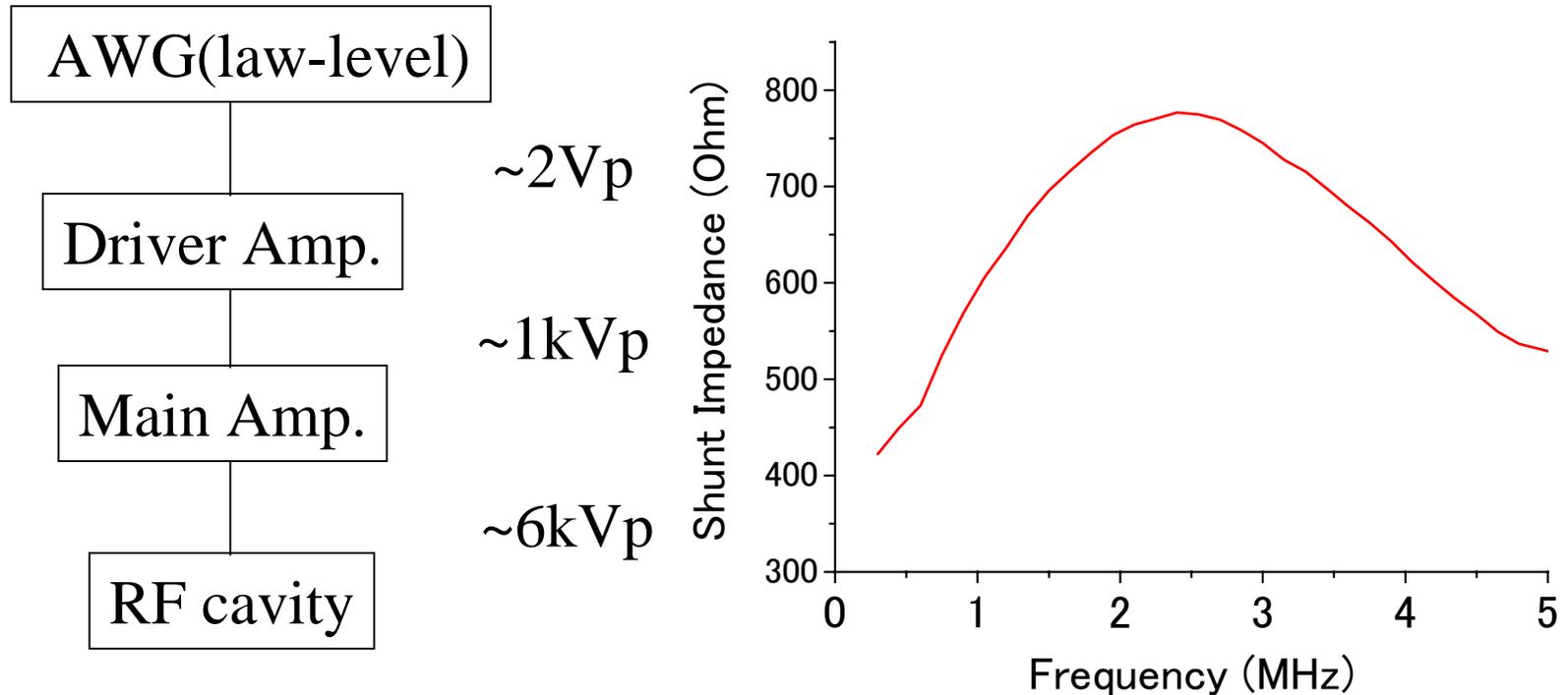
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Motivation for Experiment

- Rapid cycling (100Hz) has been achieved in 150MeV FFAG.

- Bunching process is necessary for a coasting beam.
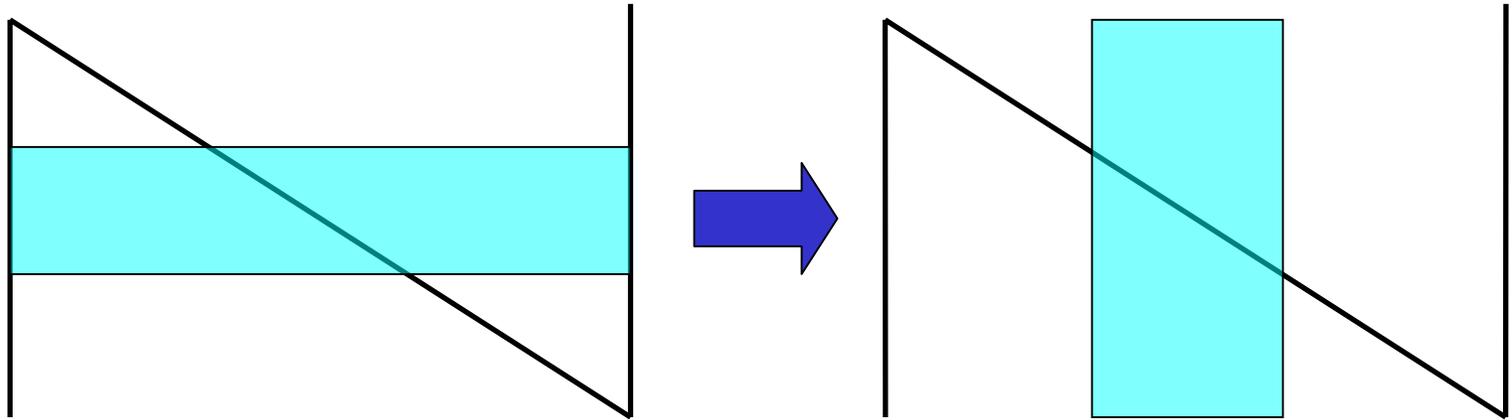
- Adiabatic capture is NOT suitable for rapid cycling.

Technique of fast bunching is needed.

Hardware: RF System

AWG(law-level)

~2Vp

Driver Amp.

~1kVp

Main Amp.

~6kVp

RF cavity

- With Arbitrary Waveform Generator, law-level is flexible.
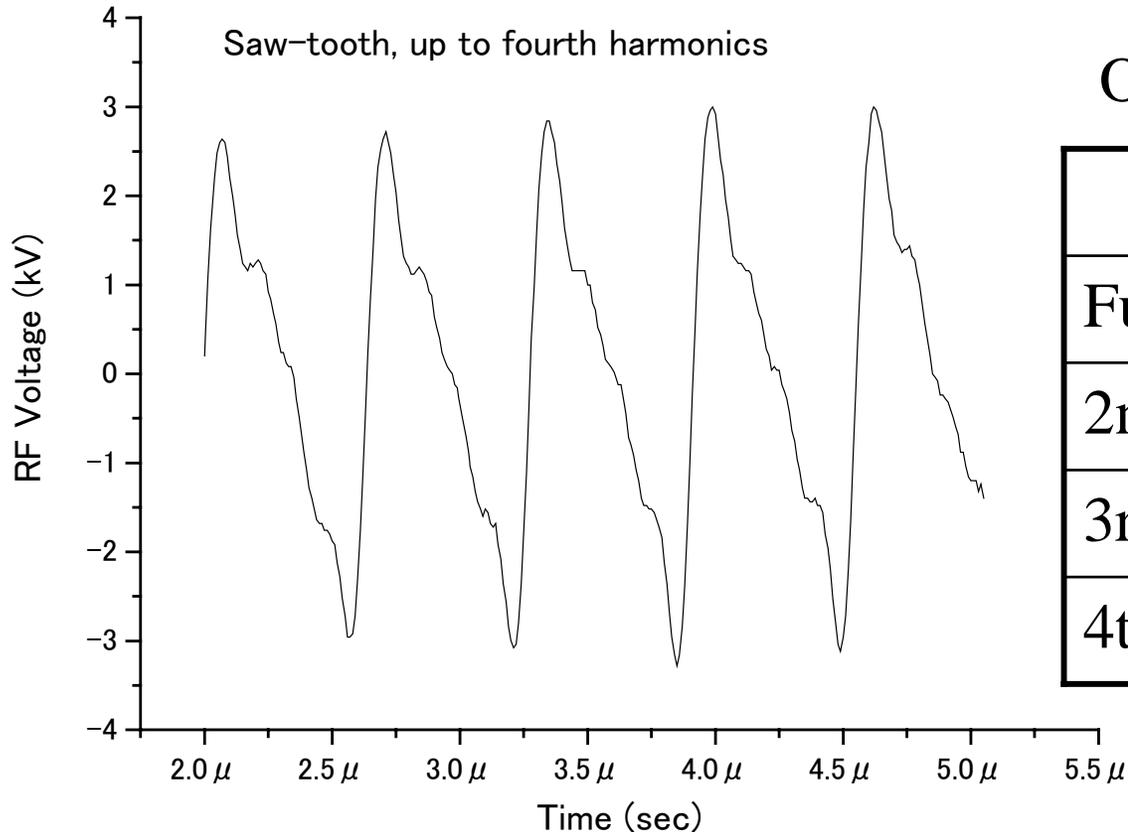- With the broad-band cavity, higher harmonics are available.

Fast Bunching with Saw-tooth

- It takes only 1/4 period of synchrotron oscillation.
- Longitudinal motion is totally adiabatic.
- A shape of bunched beam in phase space can be controlled by varying the saw-tooth voltage.

Saw-tooth

Fourier Expansion: $V(t) = \dfrac{2}{\pi} \displaystyle\sum_{1}^{\infty} (-1)^{n-1} \dfrac{1}{n} \sin(2\pi n f_{rev} t)$

Saw−tooth, up to fourth harmonics

Optimization of law-level

	Amp.	Phase
Fund.	100%	0
2nd.	63%	0
3rd.	63%	-60deg.
4th	100%	-90deg.

Saw-tooth wave is formed well with up to fourth harmonics.
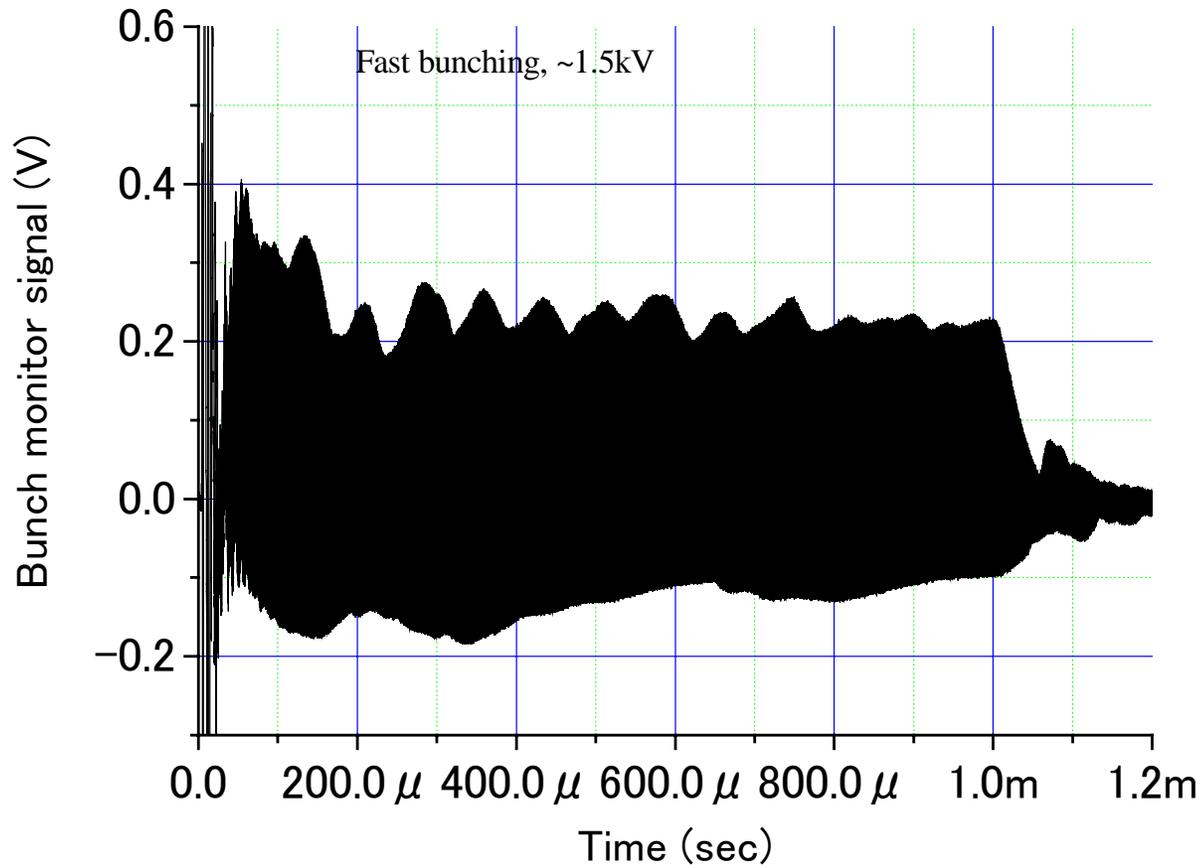
Bunching Experiment
(1) Adiabatic capture

Adiabatic Capture, 1msec

Adiabatic capture, ~2.5kVp
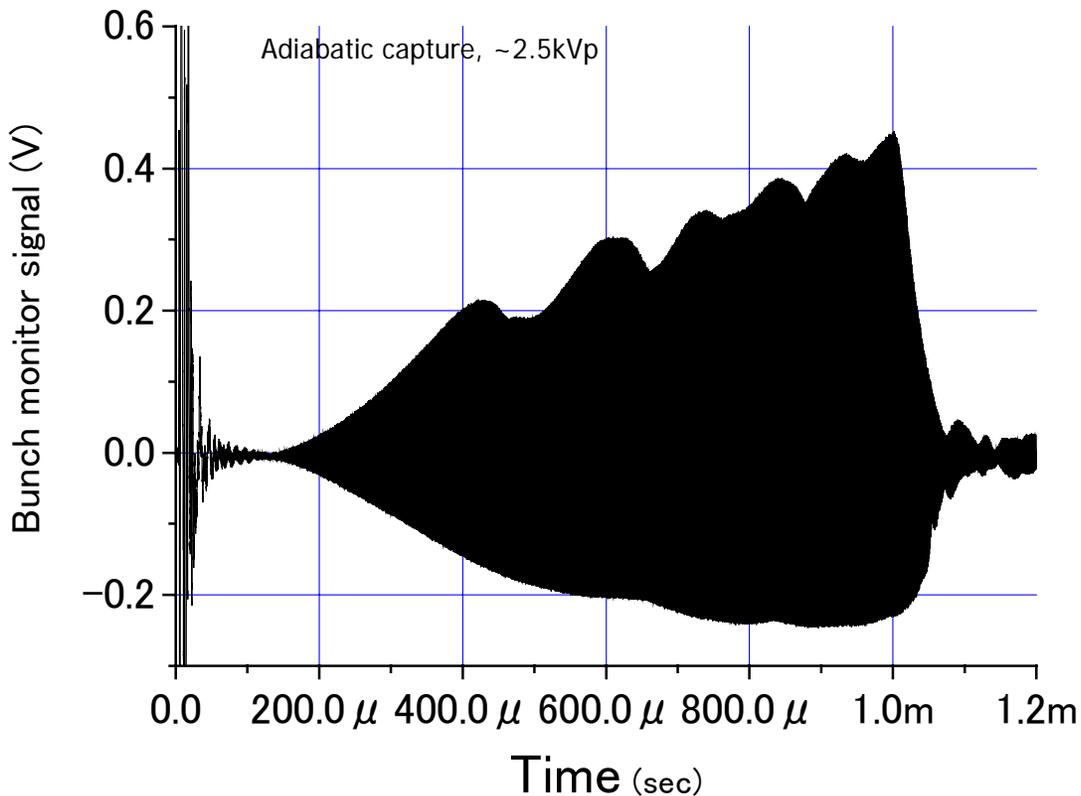
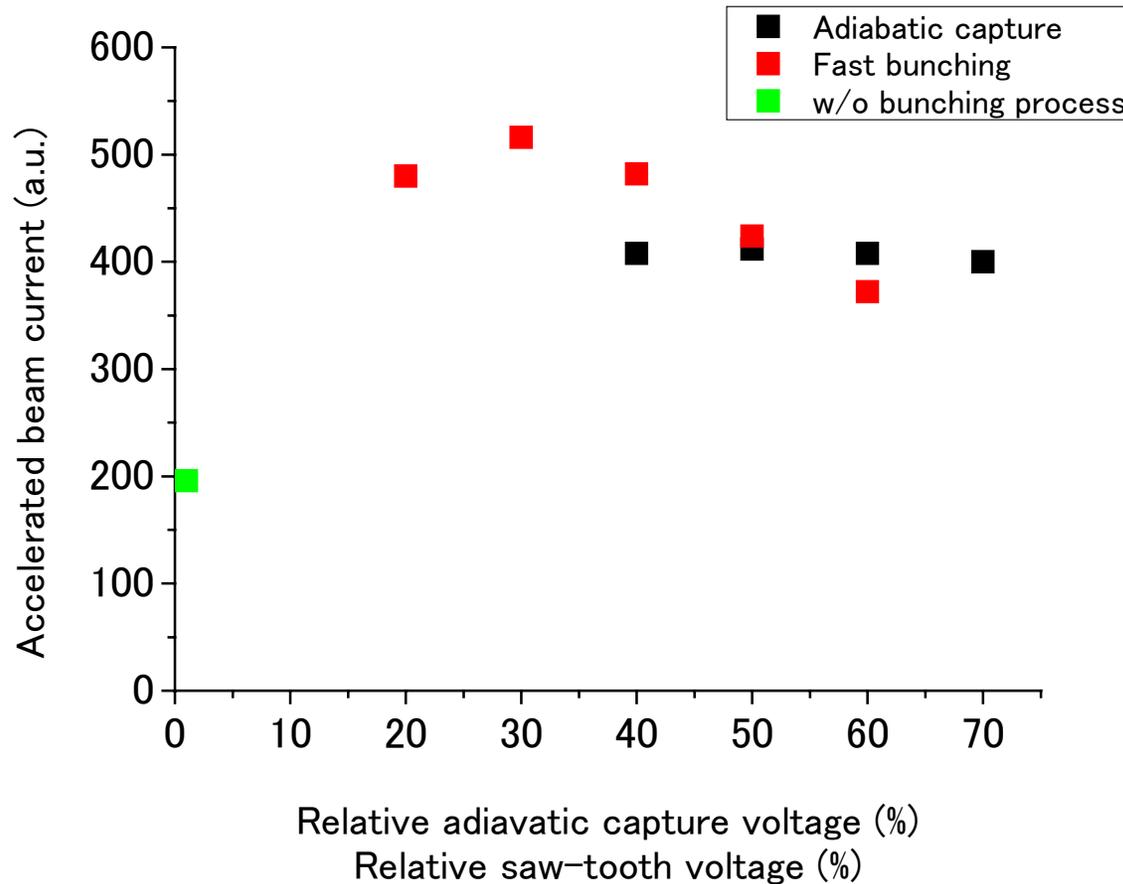1msec seems not enough to keep adiabaticity.

Bunching Experiment
(2) Fast bunching with Saw-tooth

Fast bunching, ~1.5kV

Bunching process finishes less than 100μsec.

Beam Current after Acceleration

Beam current has been increased with the fast bunching.

Summary

- Technique of fast bunching is needed for rapid cycling, when an injected beam is a coasting beam.

- We have applied "saw-tooth" for fast bunching.
  - Bunching process has been shorten less than 100µsec.
  - Beam current has been increased with fast bunching.

- Technique of fast bunching is established with this study.