Orbit Fluctuation of Electron Beam due to Vibration of Vacuum Chamber in Quadrupole Magnets

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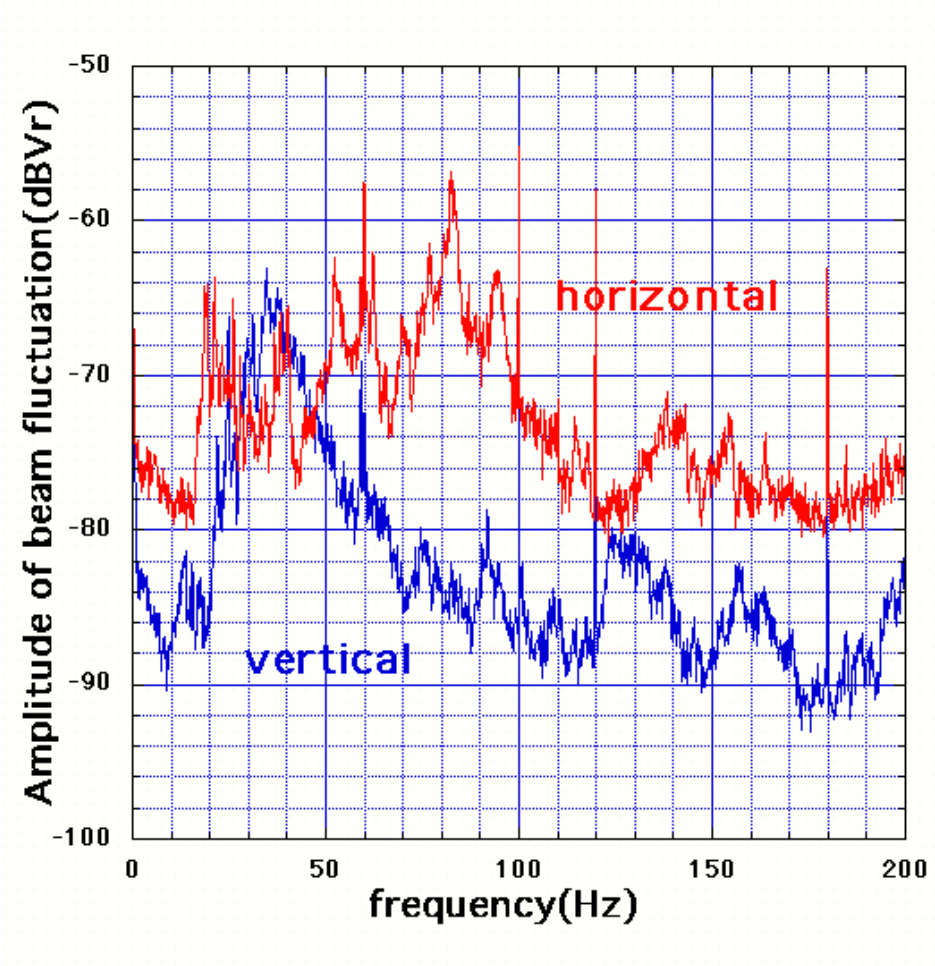
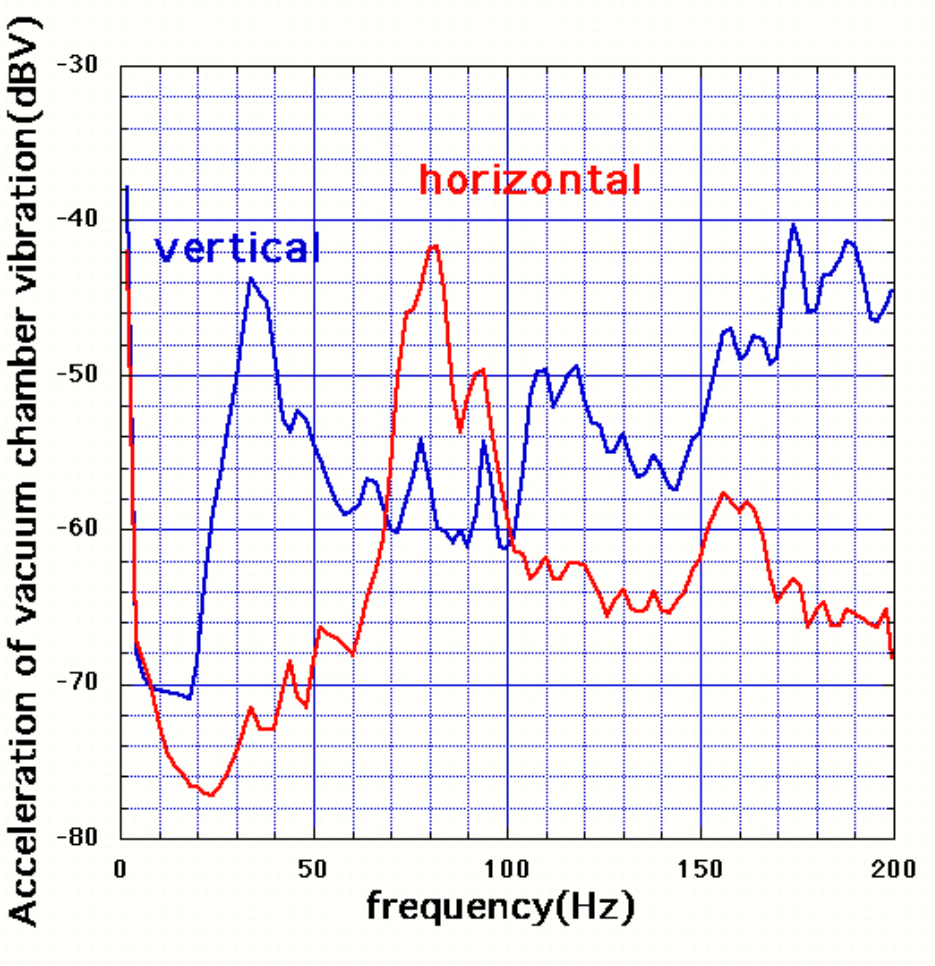
"Reduction of Vibration of SPring-8 Storage Ring Vacuum Chambers"

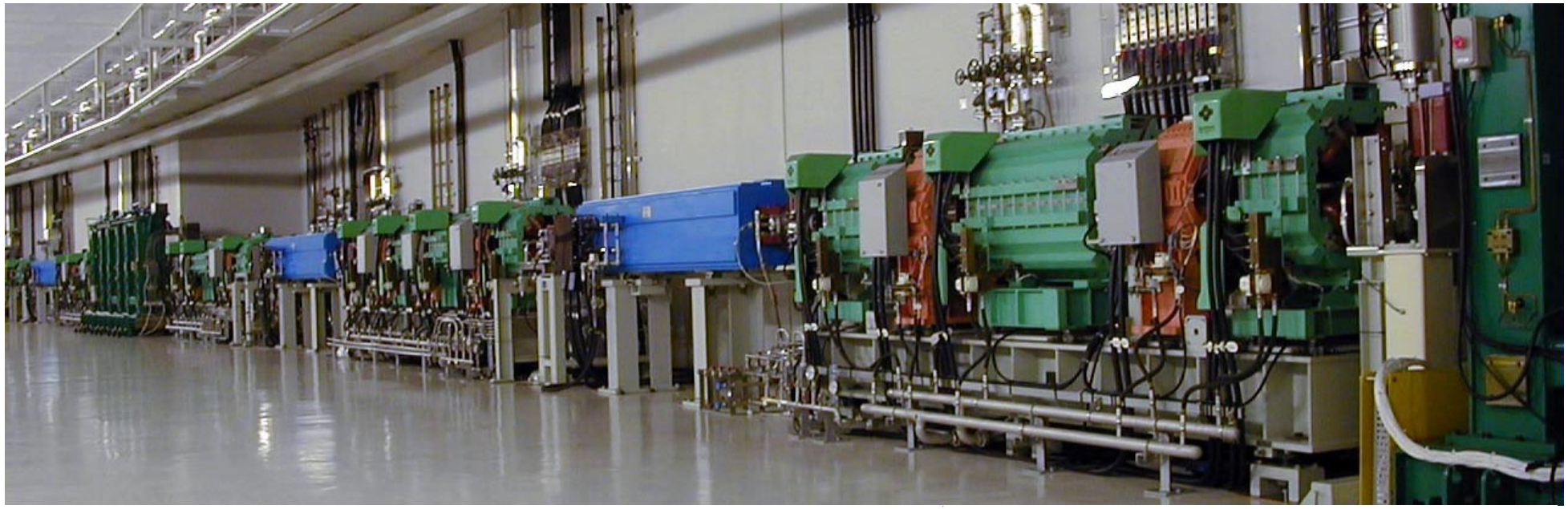
In recent study, we found the correlation between the fluctuation of beam and the vibration of vacuum chambers shaken by the water flow.
The mechanism was shown in previous talk in detail, and in this talk I will show about the source of the vibration and how to reduce them.

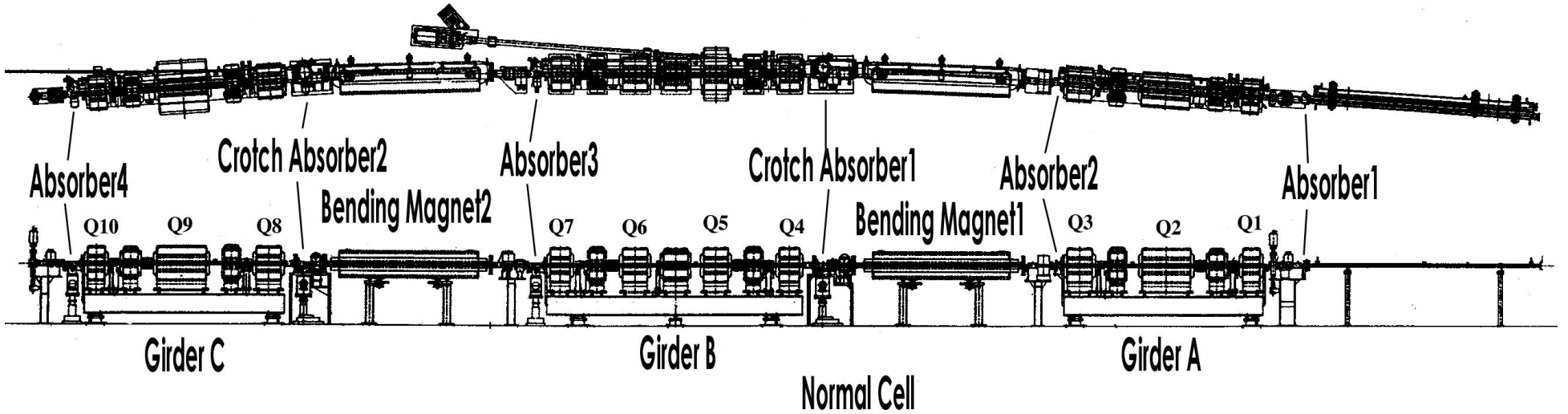


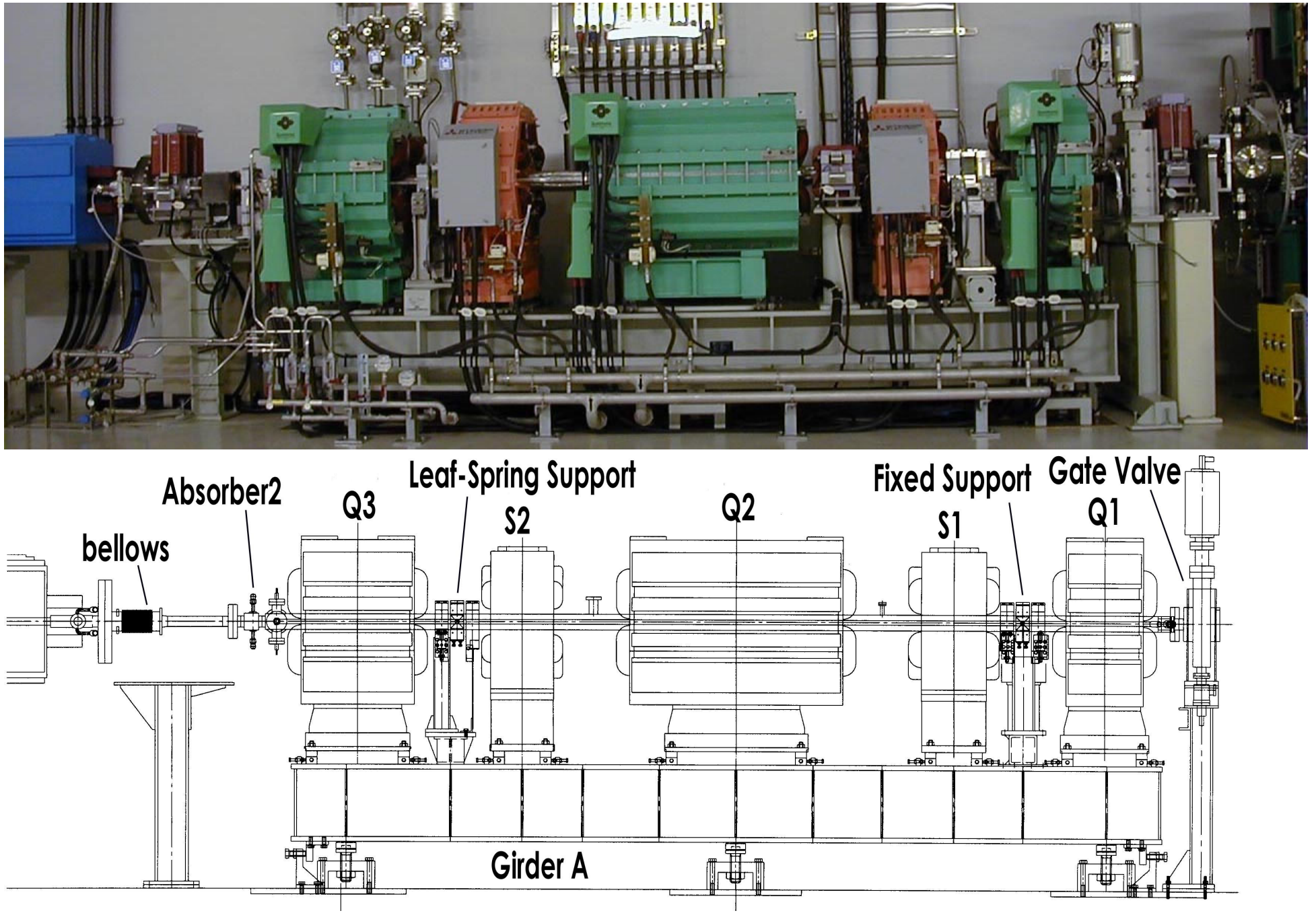


Orbit fluctuation of beam **Vibration of vacuum chambers at AB2**

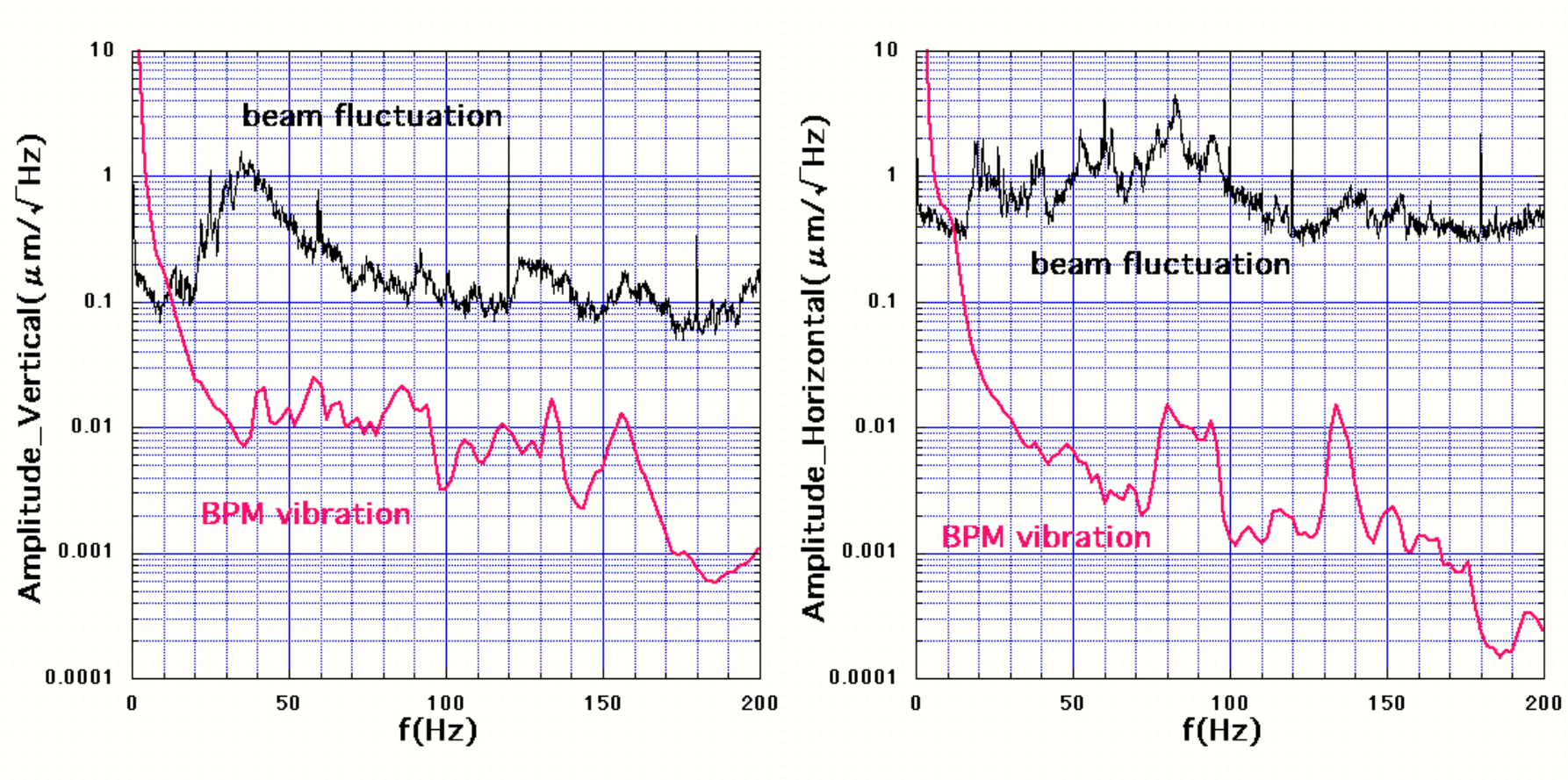
Spectra of vibration of vacuum chambers are similar to the ones of electron beam fluctuation, and there is correlation as shown in previous talk.
In order to reduce the beam fluctuation we investigated how to reduce the vibration of vacuum chambers and improved it.




Absorber4
Crotch Absorber2
Absorber3
Crotch Absorber1
Absorber2
Absorber1
Bending Magnet2
Bending Magnet1
Q10
Q9
Q8
Q7
Q6
Q5
Q4
Q3
Q2
Q1
Girder C
Girder B
Girder A
Normal Cell


bellows
Absorber2
Q3
Leaf-Spring Support
S2
Q2
Fixed Support
S1
Gate Valve
Q1
Girder A

Fluctuation measurement



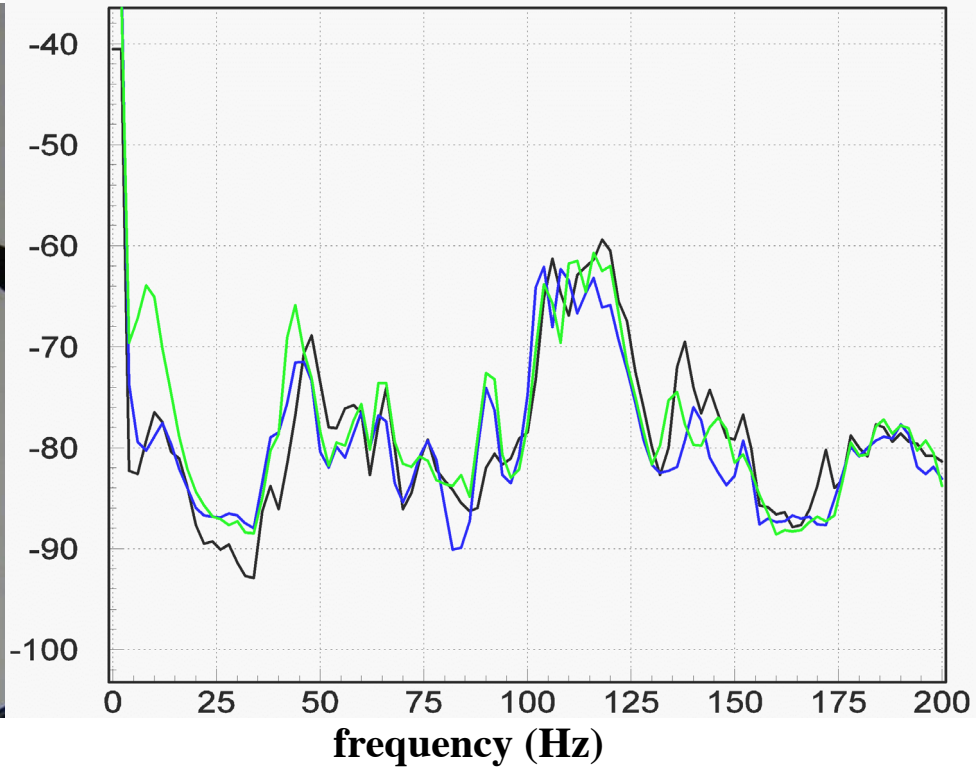
vertical **horizontal**

Comparison between beam fluctuation and RF-BPM vibration

BPM vibrations are low for beam fluctuation enough.
Accordingly vibrations of BPM don't influence the measurement of beam fluctuation.

Vibration measurement

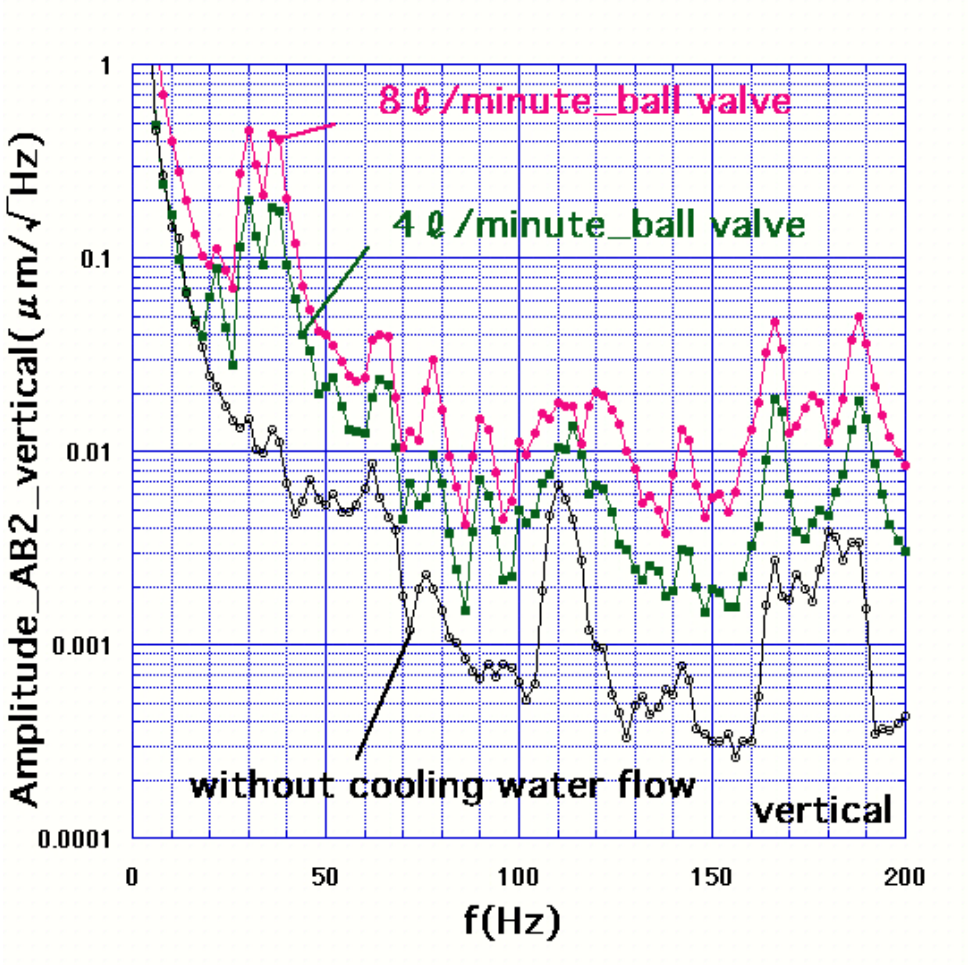
Accelerometer



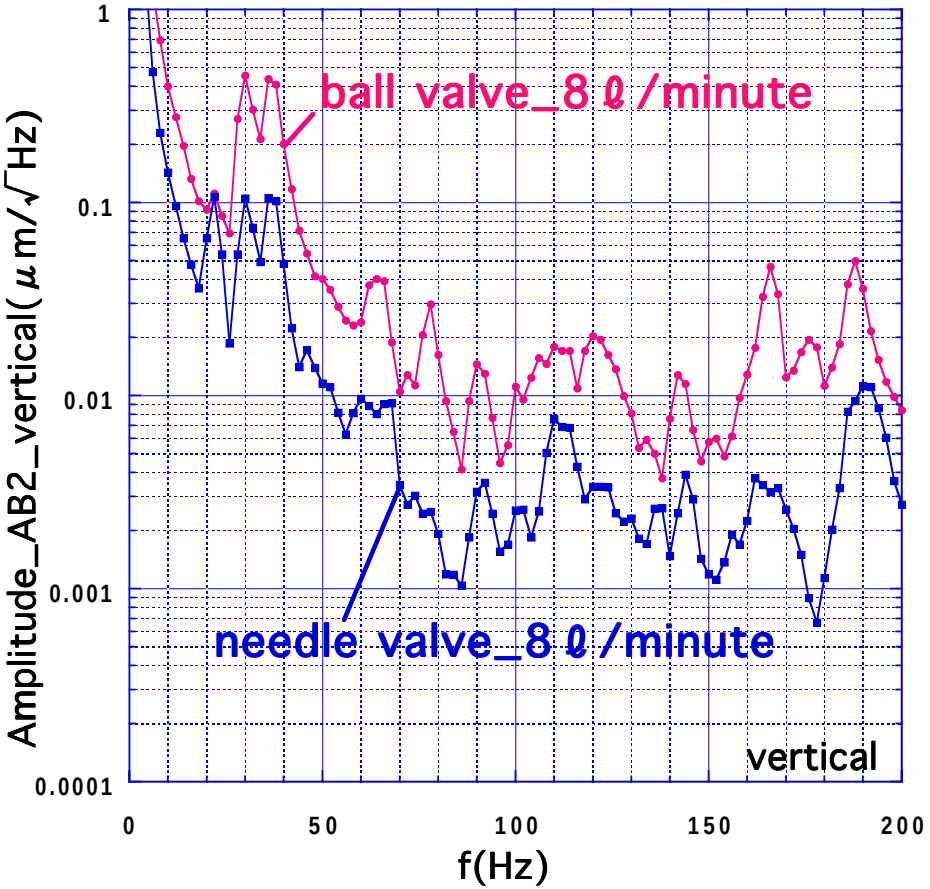
Measurement result of three times with the same conditions

We touched the surface of the vacuum chamber with this by hand and measured the vibration. Measurement result of three times with the same conditions, and error caused by this style is small over 20Hz.

Results of investigation



Influence of cooling water flow rate of AB2

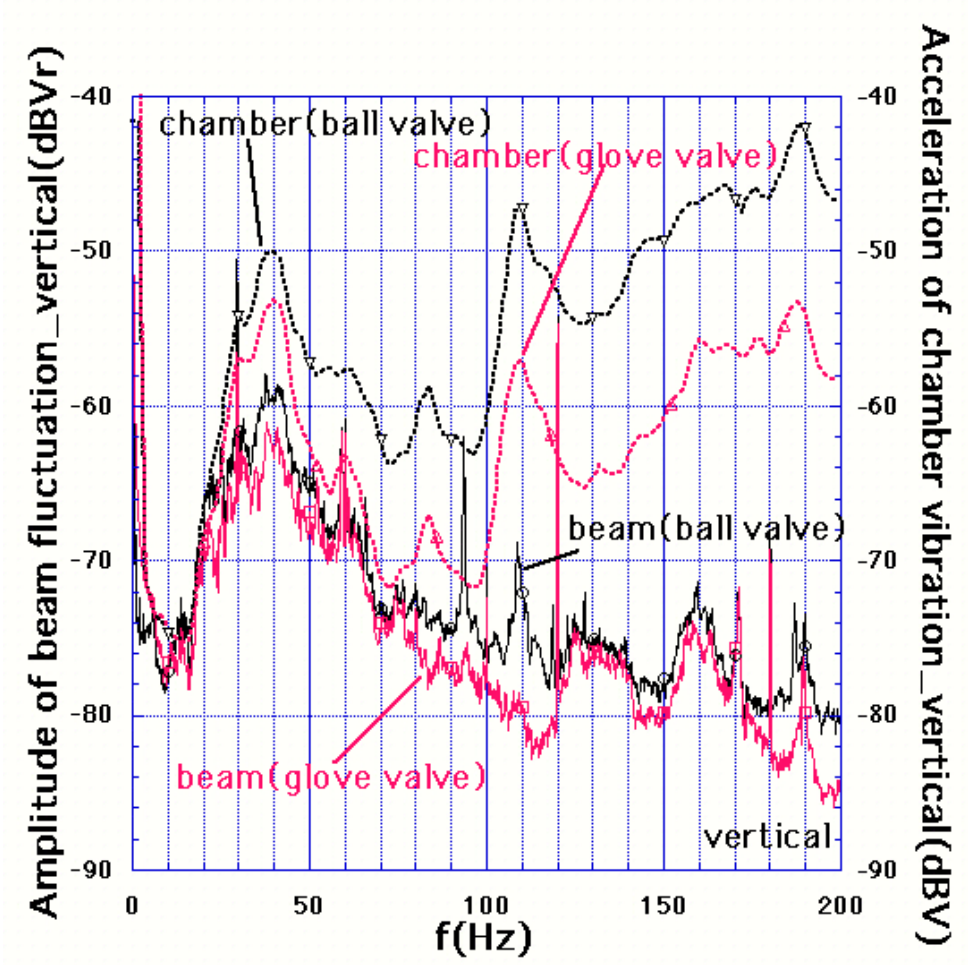


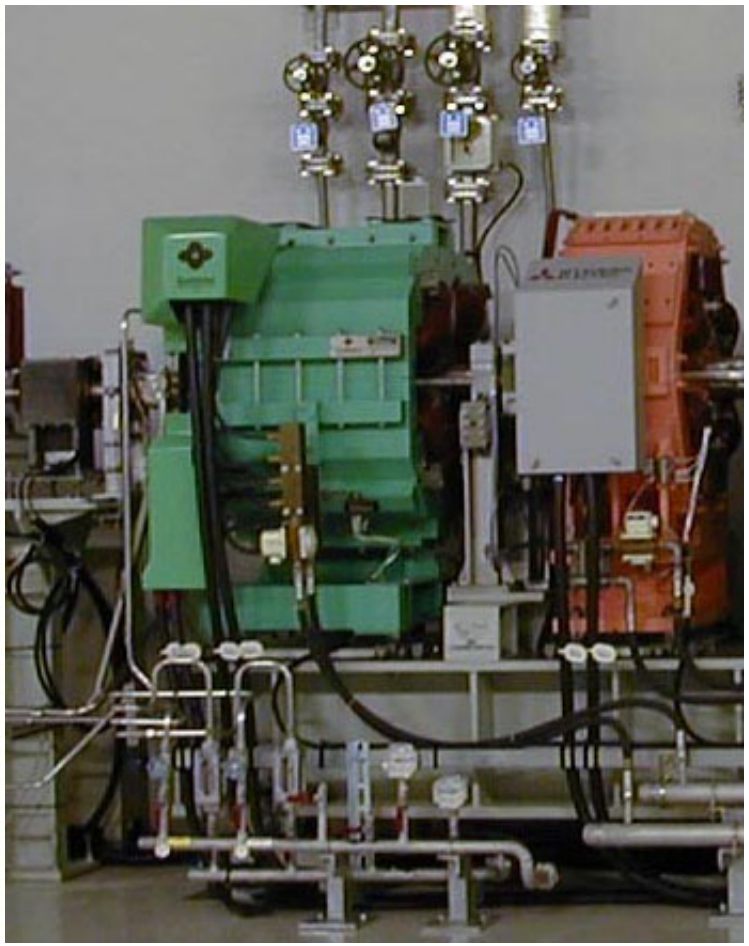
Influence of kind of flow control valve

The cause of vibration of vacuum chambers is cooling water flow of AB2 obviously.

Needle valves are better for vibration

Machine study

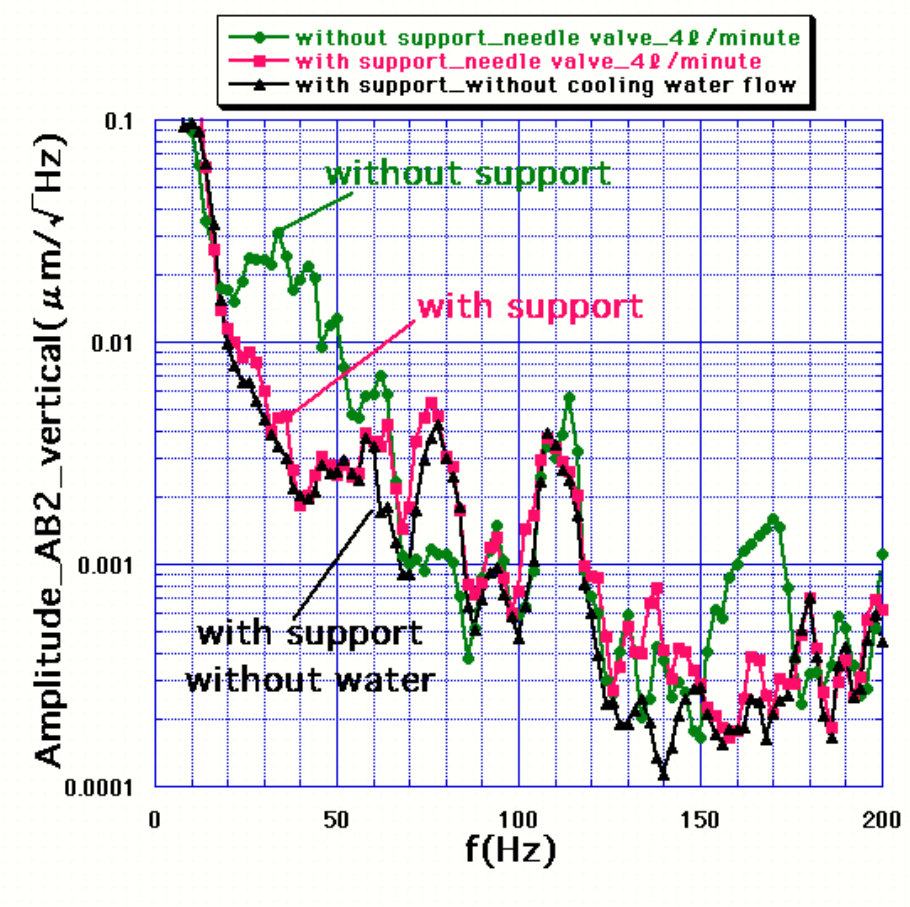




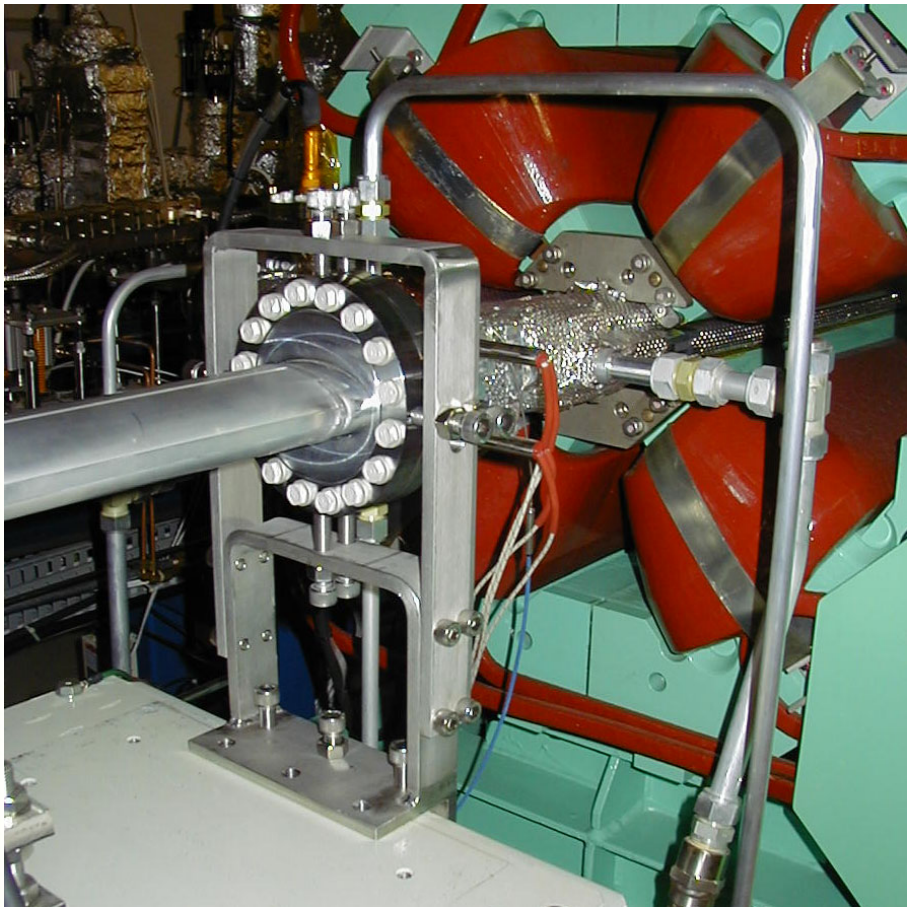
Beam fluctuation and chamber vibration

Before improvement, we confirmed experimentally that vibration of vacuum chambers was the cause of beam fluctuation.

Results of investigation



Effect of additional support



Additional support at AB2

We tried to add support device to the vacuum chamber at AB2.
By addition of support, the vibration from 30Hz to 50Hz decreased.
However, the vibration from 70Hz to 80Hz increased
This may be caused by change of eigen frequency.

Improvement

Reduction of cooling water flow rate, from 8 to 4 liter/minute

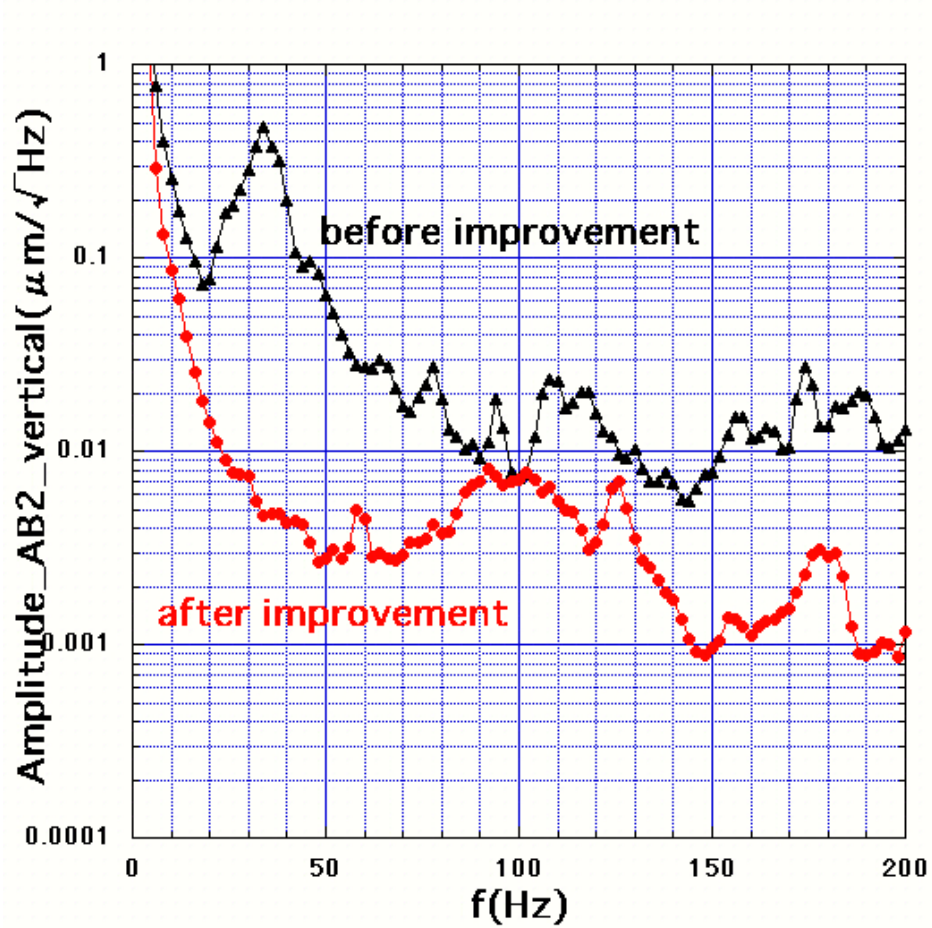
Flow rate of AB2 needed only 4 liter/minute, and AB1 needed 8 liter/minute.

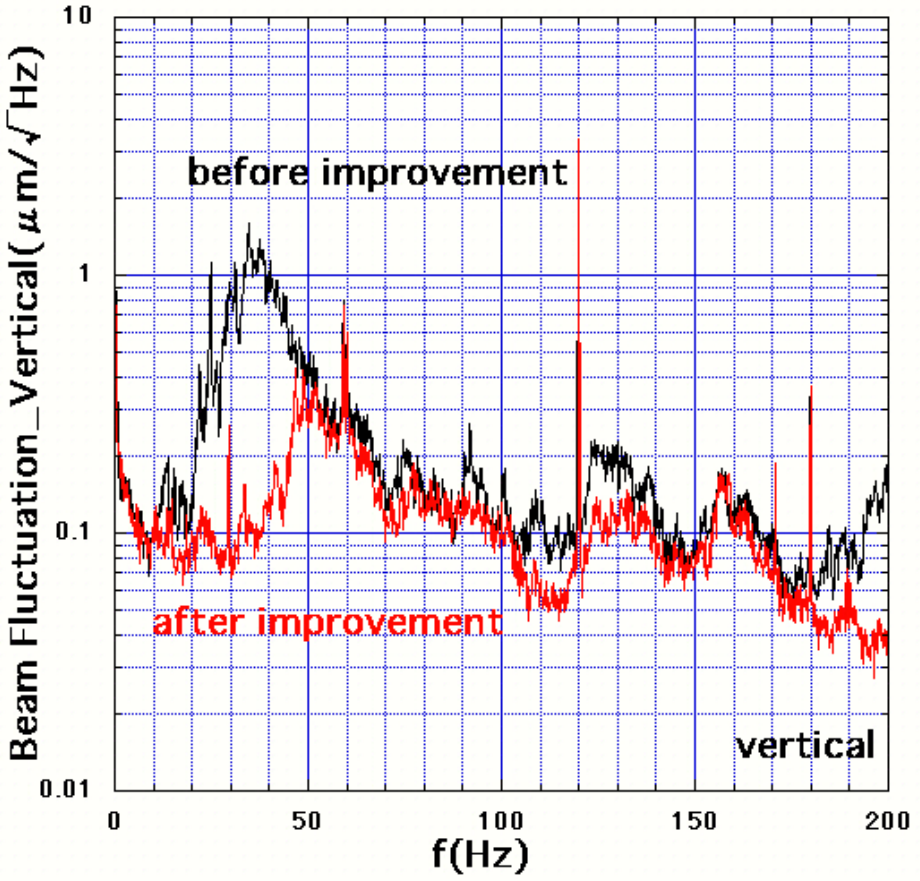
We divided cooling water system of AB1 and AB2, and reduced flow rate of AB2 in half.

Changes from ball valve to needle valve.

Addition of support.

Results of improvement (Vertical)



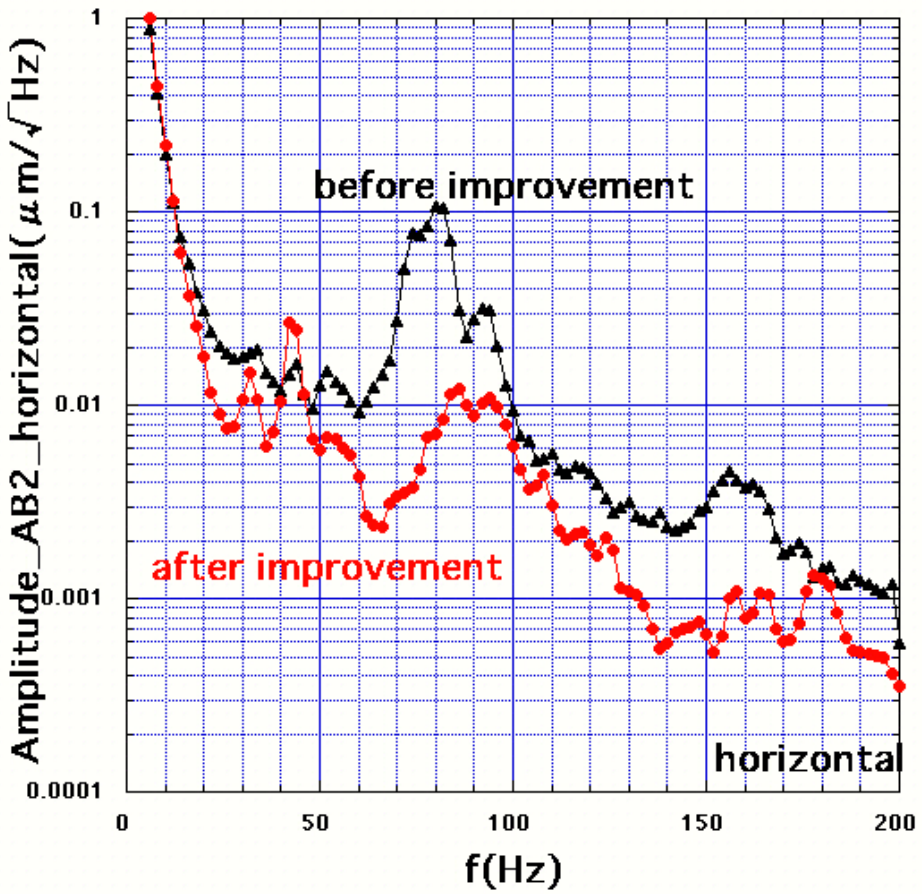


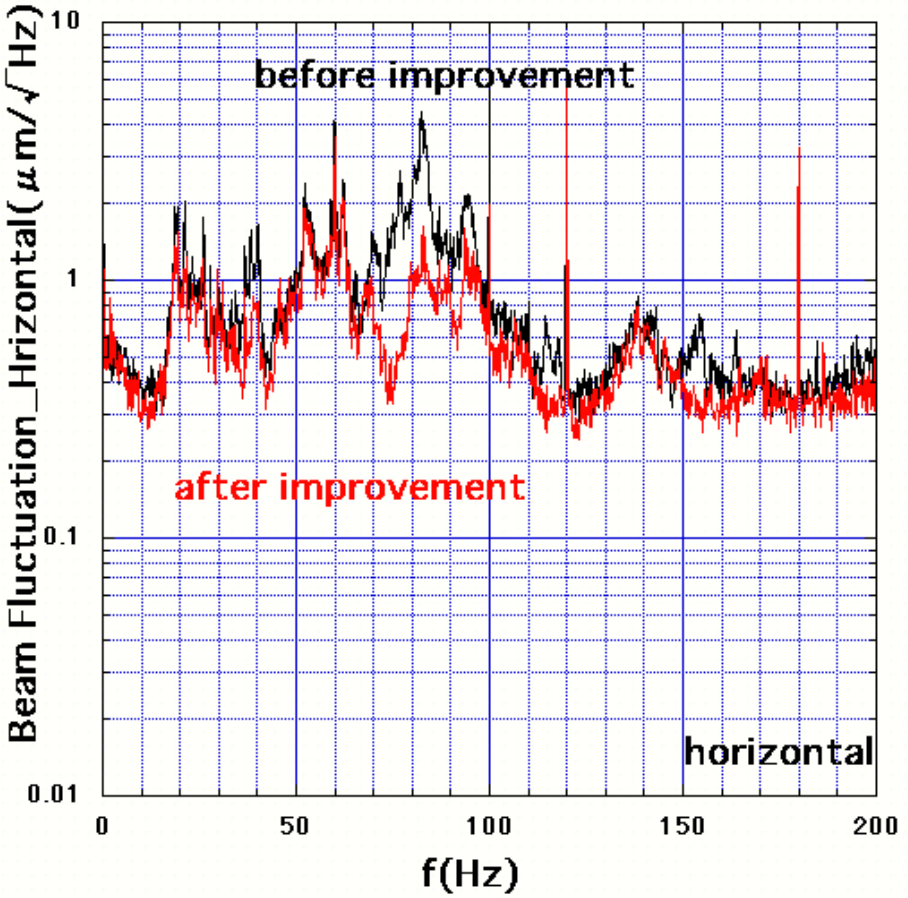
Vibration of vacuum chamber **Fluctuation of electron beam**

Vertical

With both of them, the peak of around 40Hz disappeared

Results of improvement (Horizontal)





Vibration of vacuum chamber **Fluctuation of electron beam**

Horizontal

Vibration and Fluctuation from 70Hz to 100Hz decreased

Summary

We investigated the correlation between vibration of chamber and flow rate or valve shape.

And confirmed experimentally that vibration of vacuum chambers shaken by water flow was the cause of beam fluctuation.

We improved vibration of vacuum chamber,

- **Reduction of cooling water flow rate, from 8 to 4 liter/minute**
- **Change flow control valves from ball valve to needle valve.**
- **Addition of support.**

and reduced orbit fluctuation of electron beam.

- **20~50Hz vertical direction : –20dBVr**
- **70~100Hz horizontal direction : –10dBVr**