Analysis of the Beam Loss Mechanism During the Energy Ramp-up at the SAGA-LS

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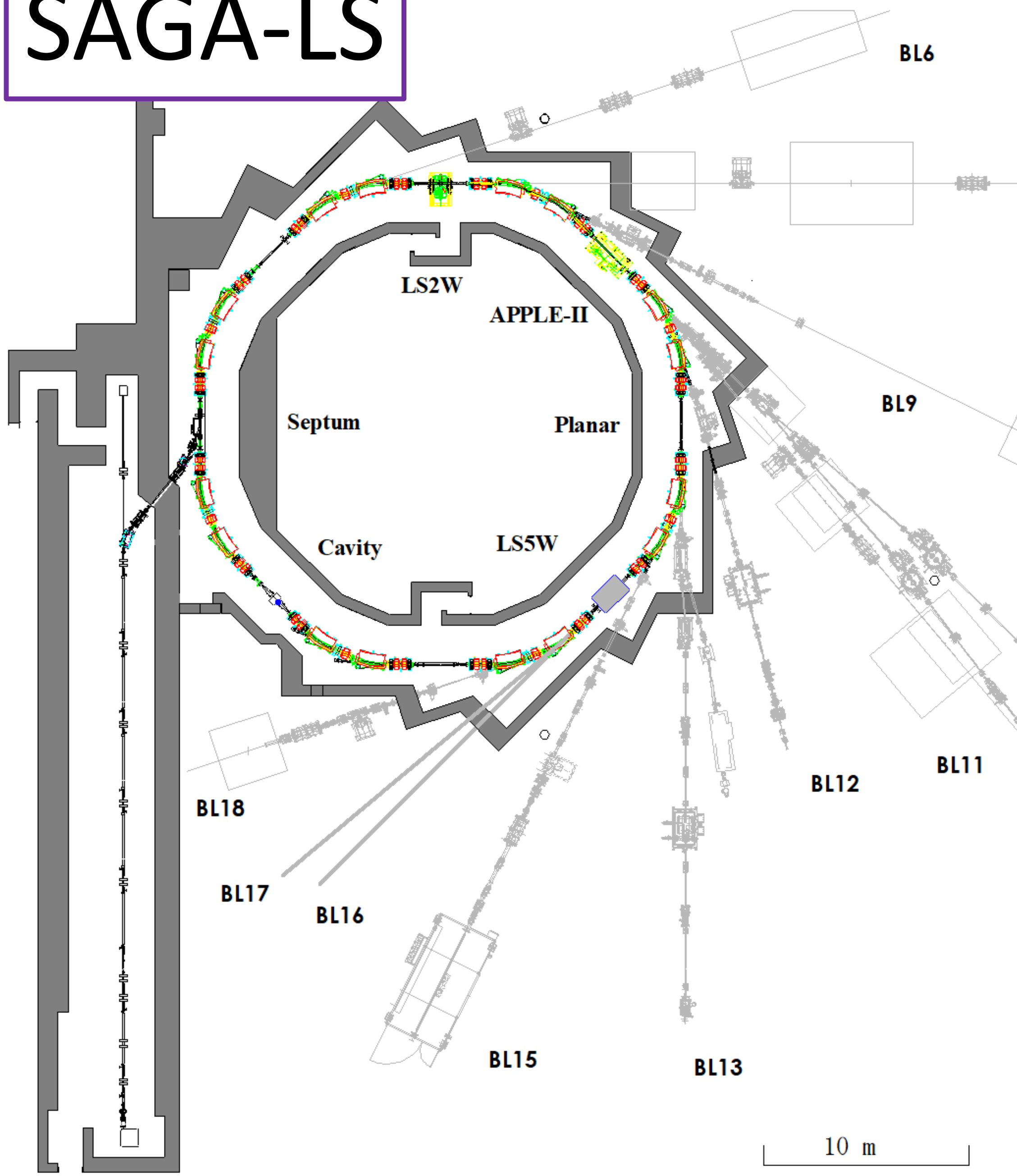
SAGA Light Source

Outline

1. Introduction (about SAGA-LS)
2. Motivation (Beam Loss at the Ramp-up)
3. Problem (Tune shift during the Ramp-up ?)
4. Method
5. Results
6. Summary

Experimental Hall

SAGA-LS



Linac

Length : 30 m

Max Energy : 255 MeV

Storage Ring

Circumference : 75.6 m

Injection Energy: 255 MeV

Max Energy : 1.4 GeV

Beam Current : 300 mA

Lattice : DB（8-hold Symmetry）

Emittance : 25 nm·rad

Insertion Devices:

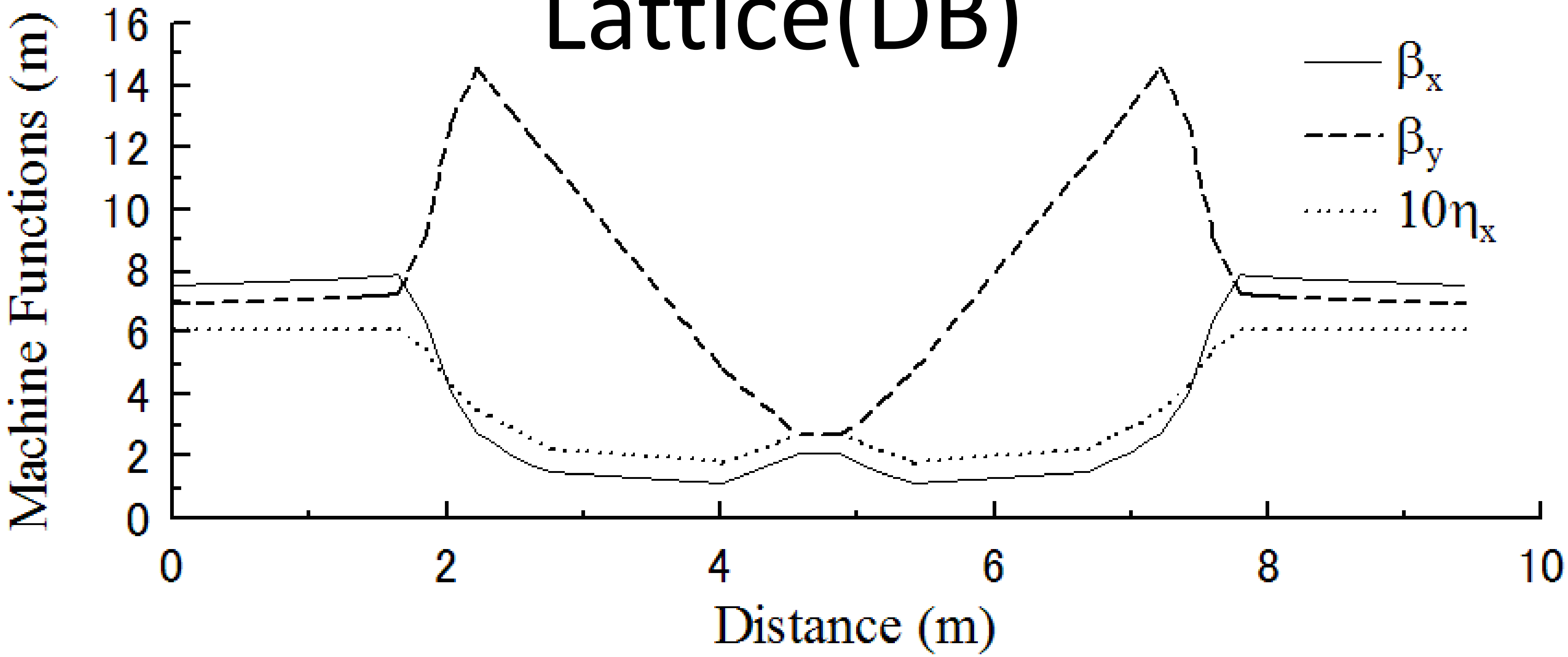
APPLE-II, Planar,

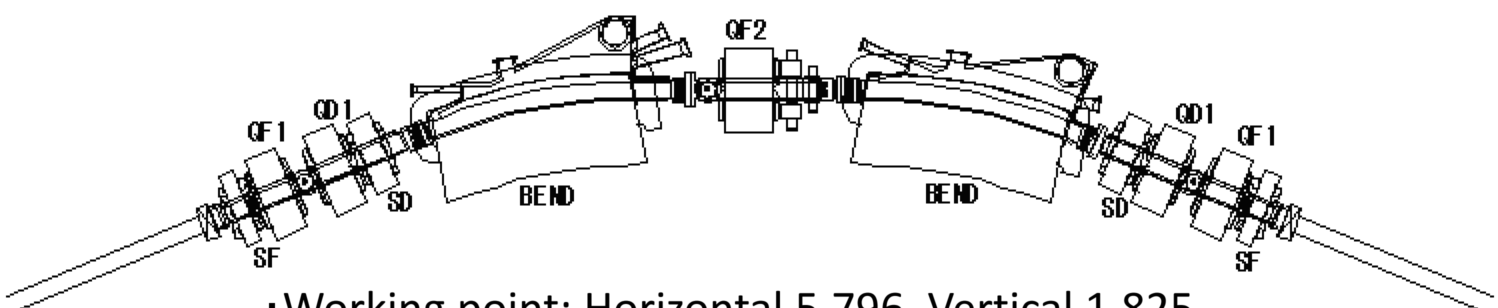
4T Super-Conducting Wiggler×2

Injection Time: 1～4 minutes

<u>Energy Ramp-up: 4 minutes</u>

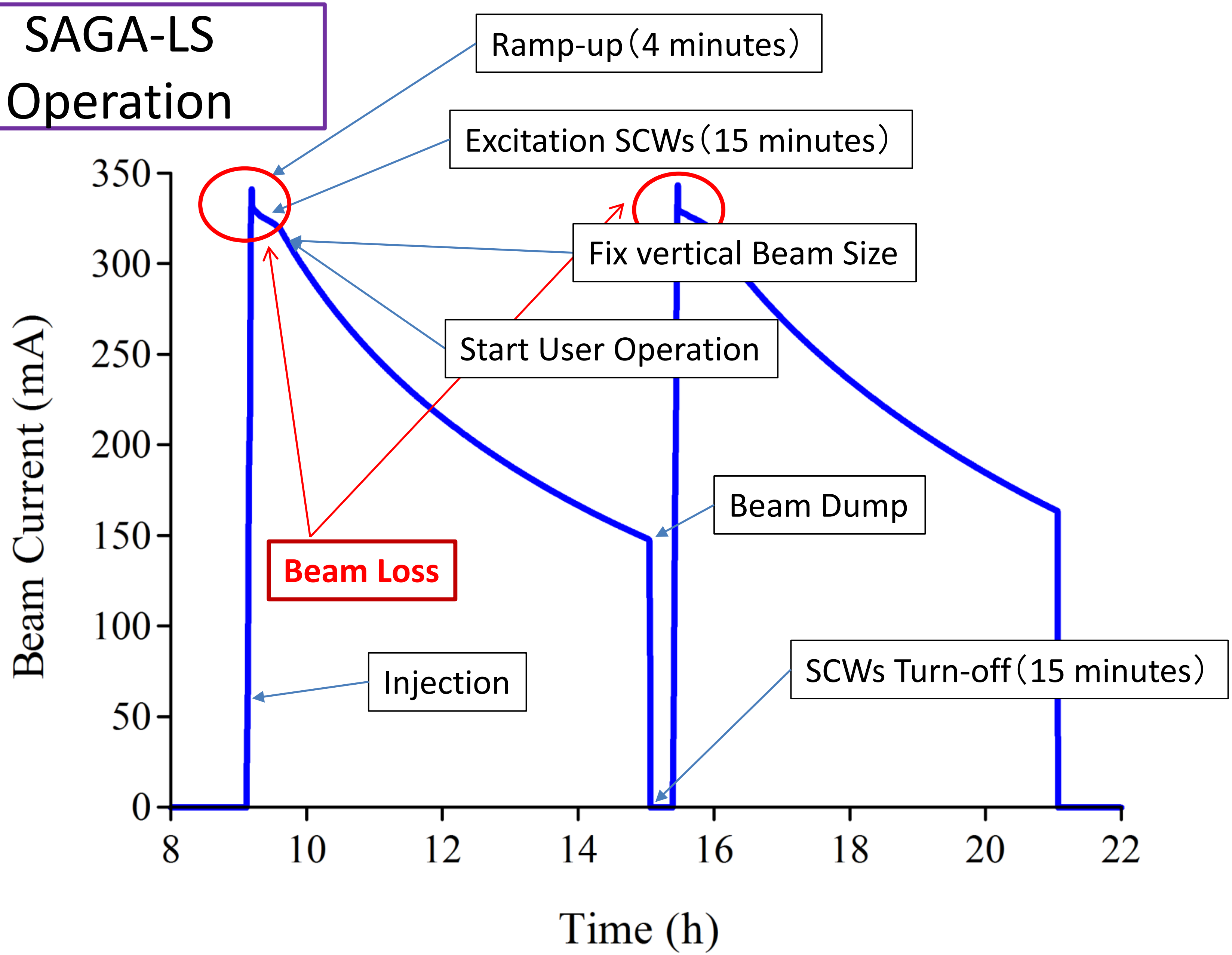
Lattice(DB)





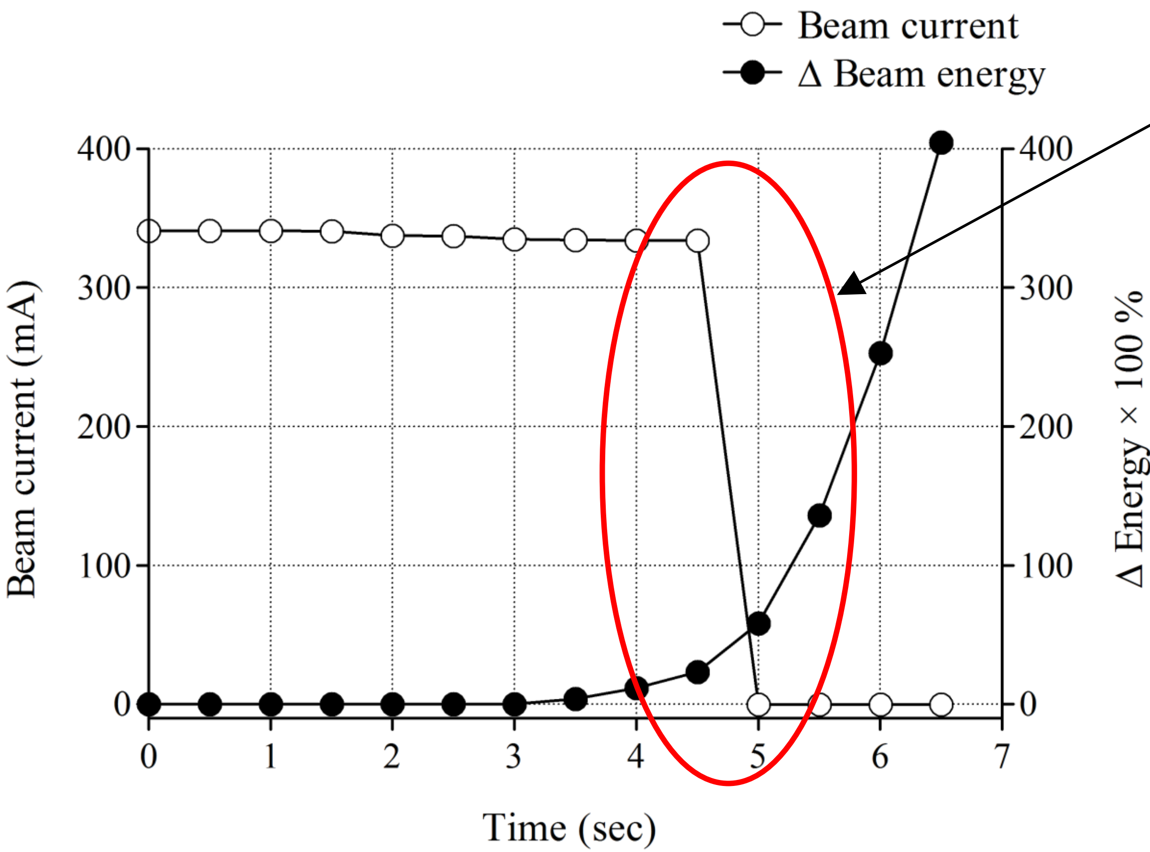
- Working point: Horizontal 5.796, Vertical 1.825
- finite dispersion at straight section: 0.6 m, not achromat

SAGA-LS Operation



1 Injection or 2 Injection , User time: 10:00 to 21:00

Why does beam loss occur?
Due to large Betatron Tune shift?



What happened at this period ?
・large tune shift ?
due to unexpected output of P.S.
・ large beta-beating ?
・non-linear beam dynamics ?
・beam instability ?

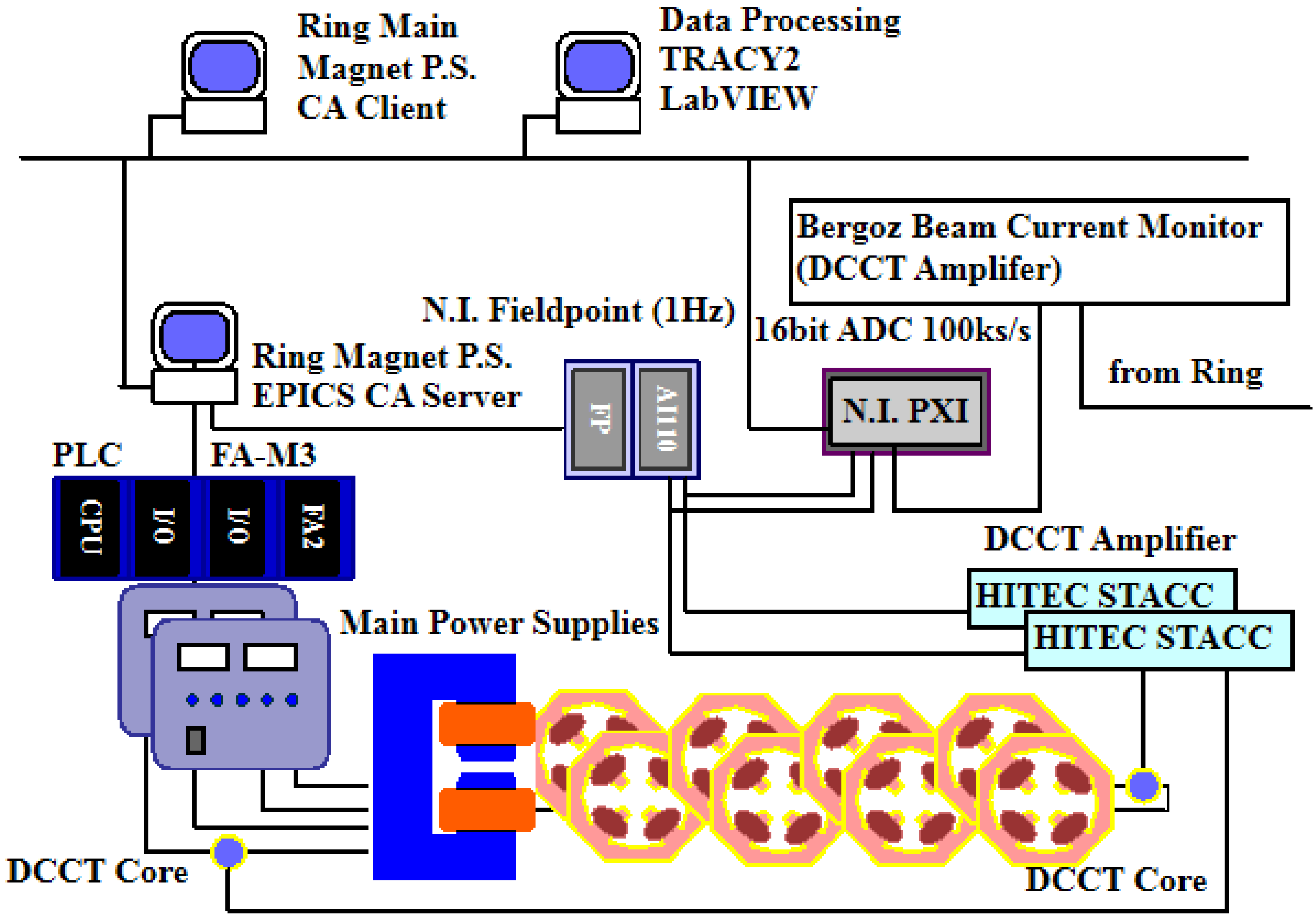
⇩

develop high speed data logging system for monitoring
・ beam current
・ output currents of the P.S.s

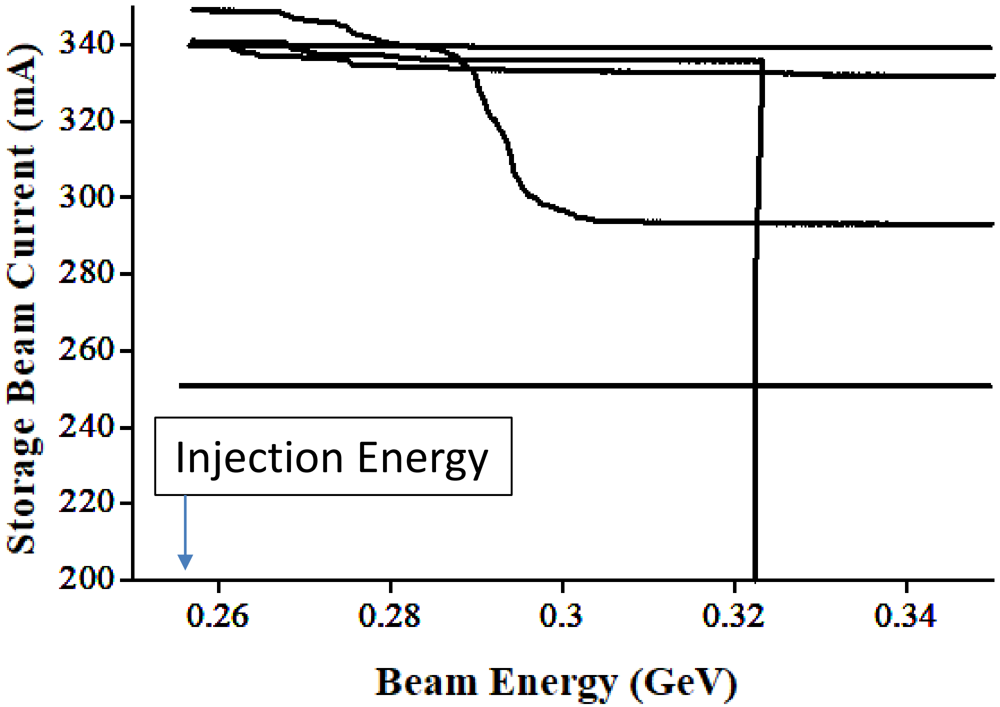
National Instrument PXI
16bit ADC 100ks/sec

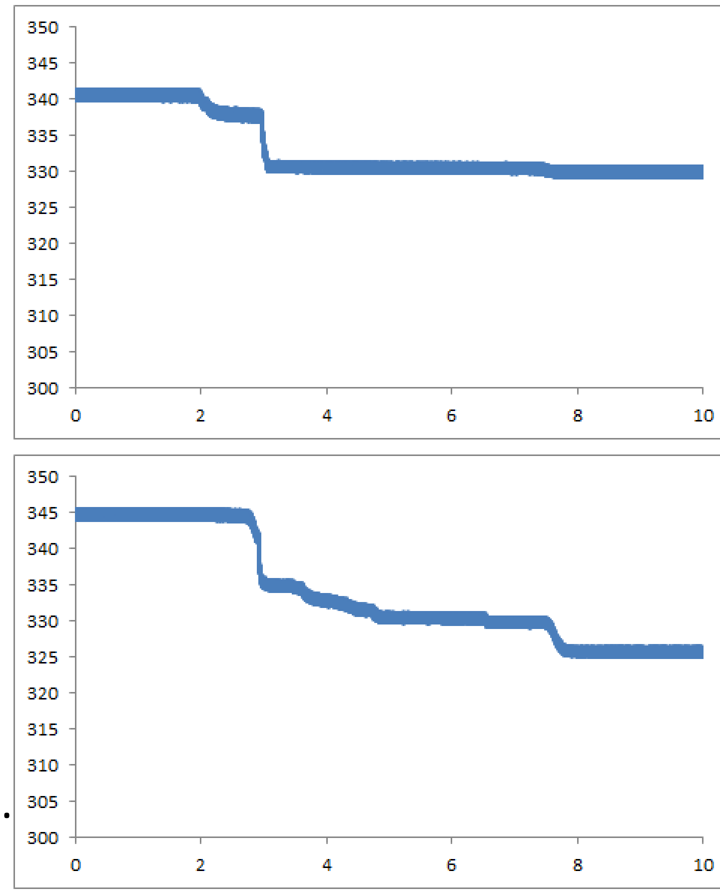
Measured by using common control and monitoring system (1Hz)

Beam Current and P.S. Monitoring System



Beam Loss at the Ramp-up measured by PXI system

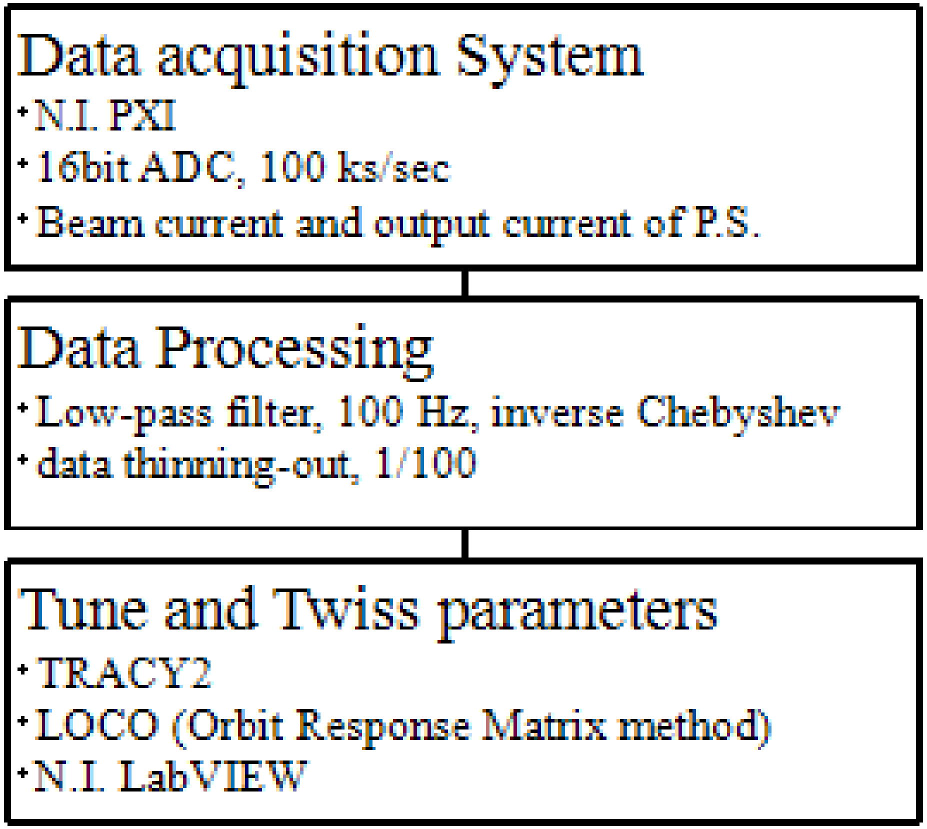


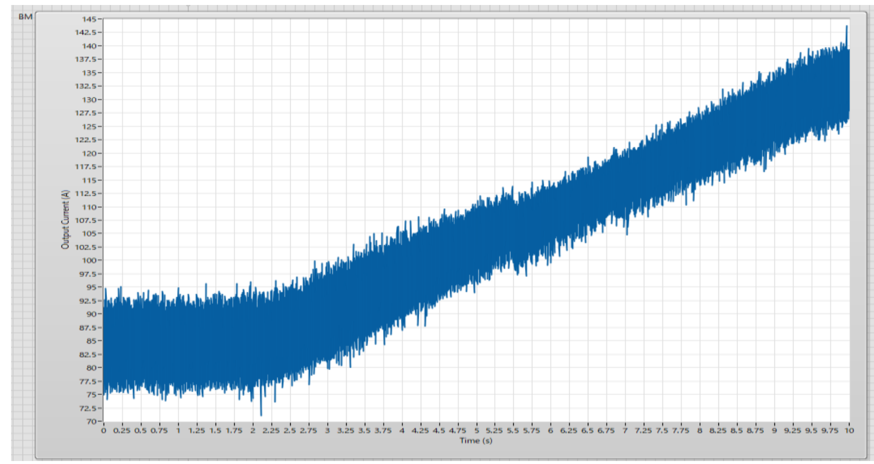


<u>Time structure of the beam loss</u>
(the case of 10mA and 20mA)

・Beam loss occurs at the beginning of the energy ramp-up.
・Normally the amounts of the beam loss is 10 to 40 mA.
・Sometimes all beam lost.
・If the beam current is less than 200 mA, the beam loss doesn't occur at the ramp-up.

Method for calculating tune from the monitoring value of P.S.s

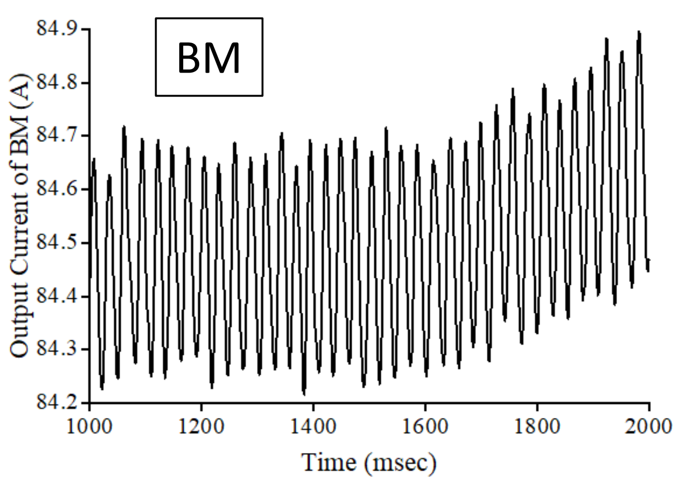


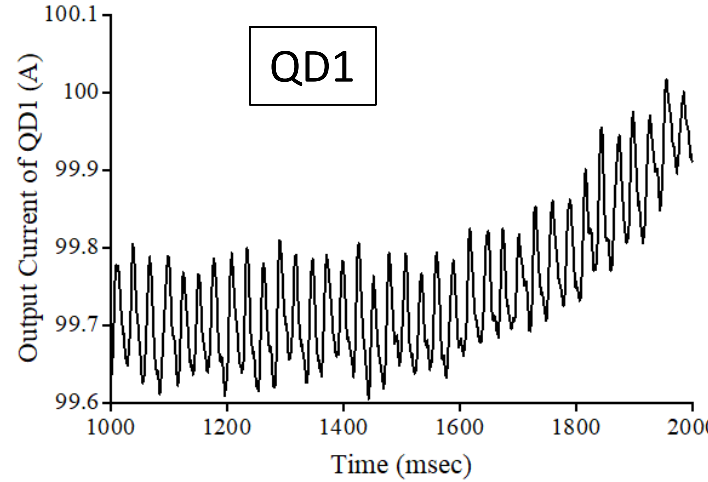


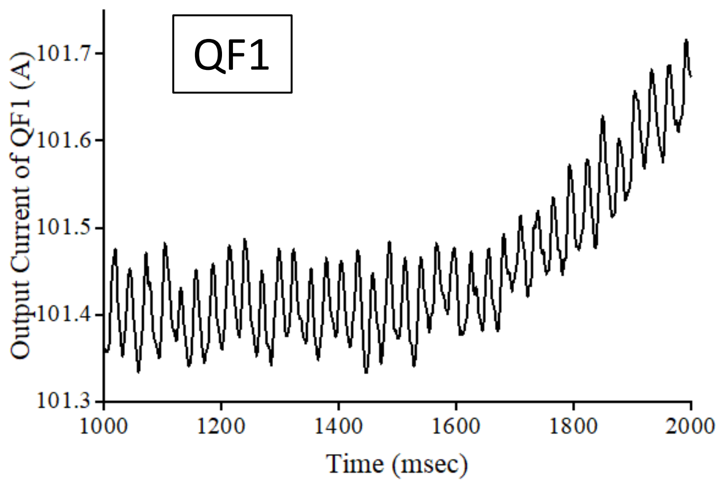
Including high frequency components due to switching noise of the P.S.s.
Low-pass filtered result are shown in next slide

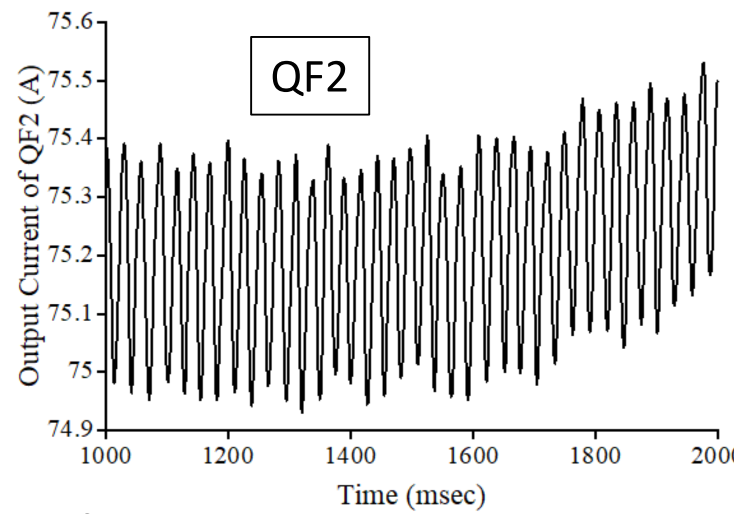
・K-values of the quadrupole magnets were obtained from the monitoring value of the output current of the P.S. by using Response Matrix analysis method (LOCO) .
・Beam energy was estimated by magnetic measurement data.
・Using TRACY2 (beam tracking code) to calculate tune and twiss parameters.

Stability of Power Supplies found by using PXI System





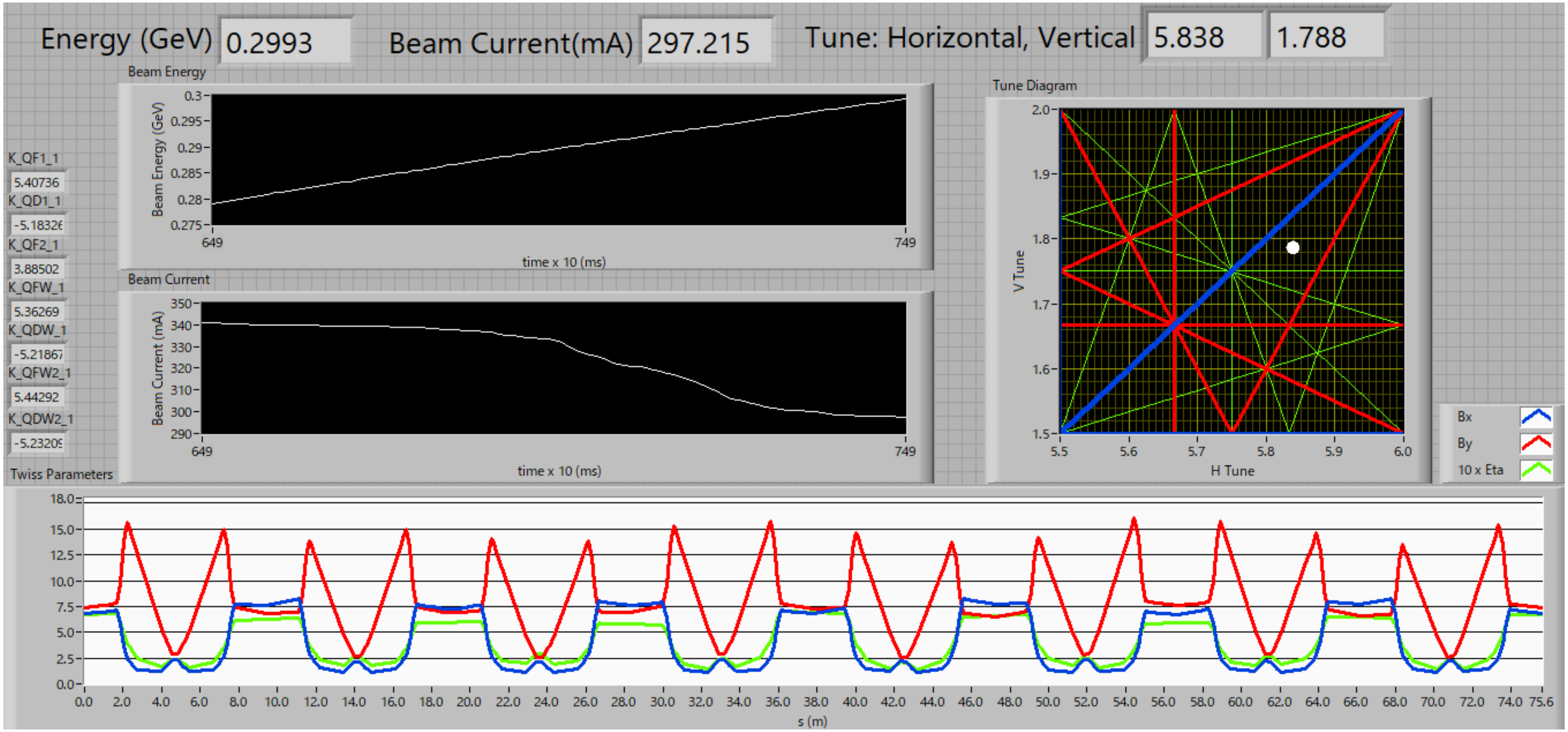




- Stability of the power supplies are less than 1×10^{-3} near injection energy, too wrong. (Specification: 1×10^{-4})

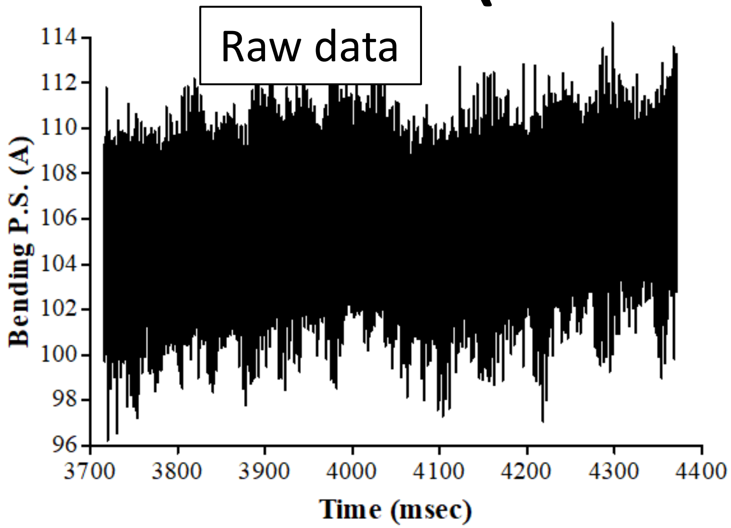
- <u>fluctuating 50 to 100 Hz, this fluctuations couldn't be found in the machine maintenance.</u>

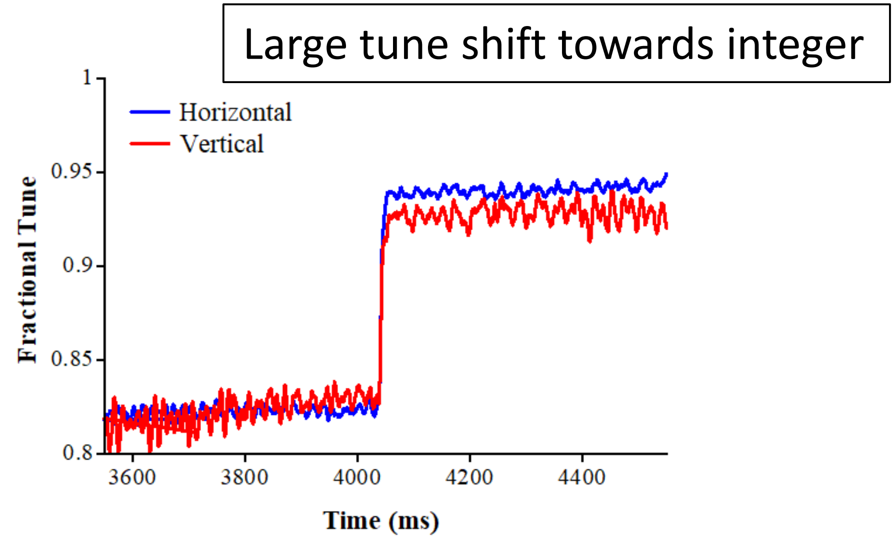
GUI for calculation of tune and twiss parameters

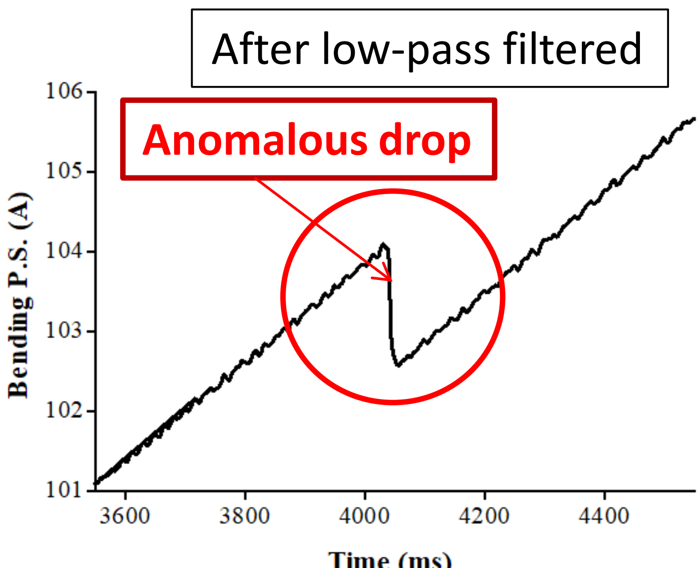


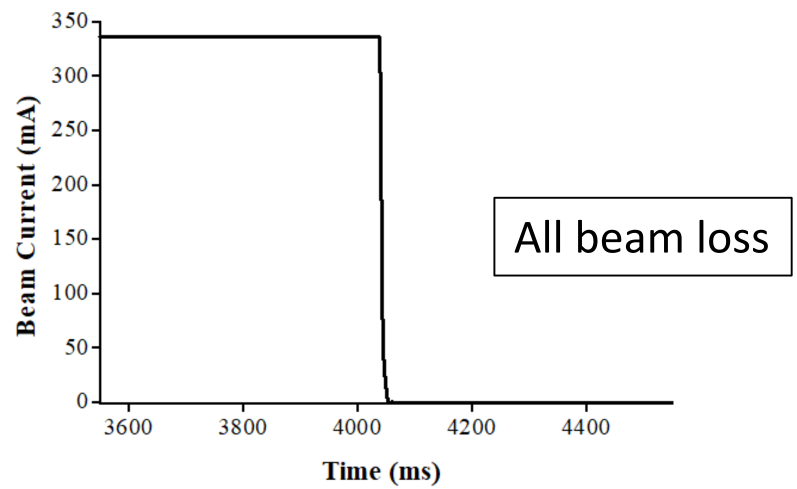
GUI for calculation of the tune and twiss parameters.
TRACY2 is running in background.

Result (the Case of all beam loss)



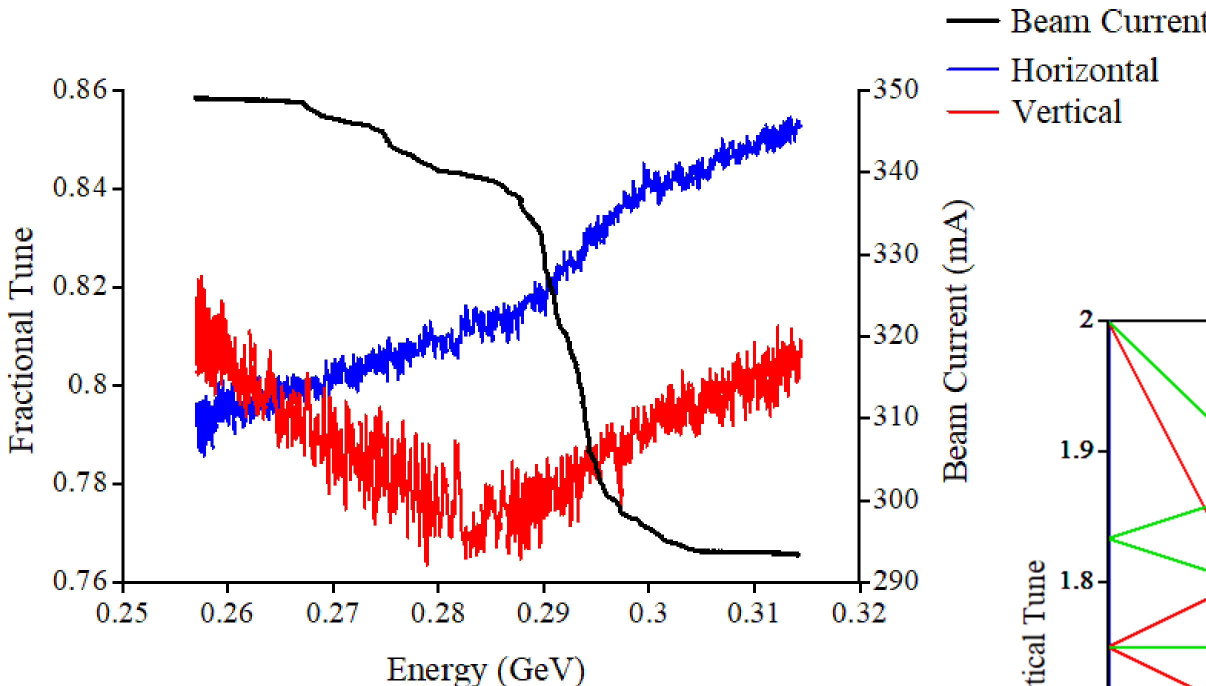






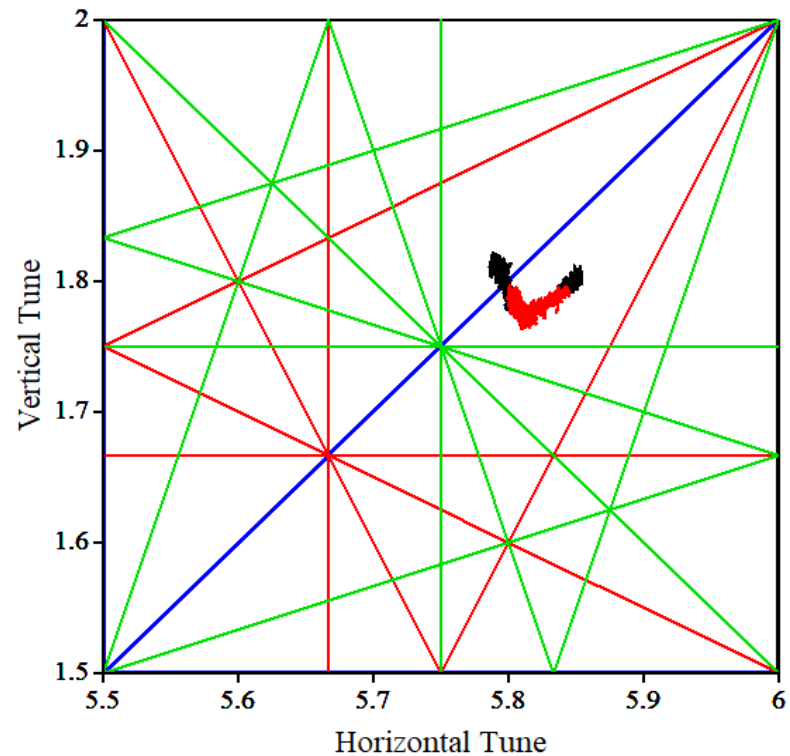
The ramp-up pattern is monotonically increases and fixed, the power down of the power supply during the ramp-up couldn't be expected.

Result (the Case of 60 mA loss)



Tune shift and the beam loss

Tune diagram



・Red region denotes the beam loss points (right Figure)

・Why beam lost ?

・Synchrotron and betatron coupling resonance?
The Cavity is installed in the section of finite dispersion at the SAGA-LS.

・The cause of this beam loss case is unclear.

Summary

- We developed the PXI data logging system for fast monitoring of the beam current and the output current of the power supplies.
- Anomalous output of P.S. of bending magnets was found by processing low-pass filter.
- The anomalous output is one of the causes of the beam loss.
- The mechanism of beam loss is not well understood yet.
- The thing we have to do to accomplish stable ramp-up and to achieve more storage beam current is, first, repairing the power supplies.
- The longitudinal motion will be taken into account to the investigation.

Thank you for attention