

Operation Status of PLS-II

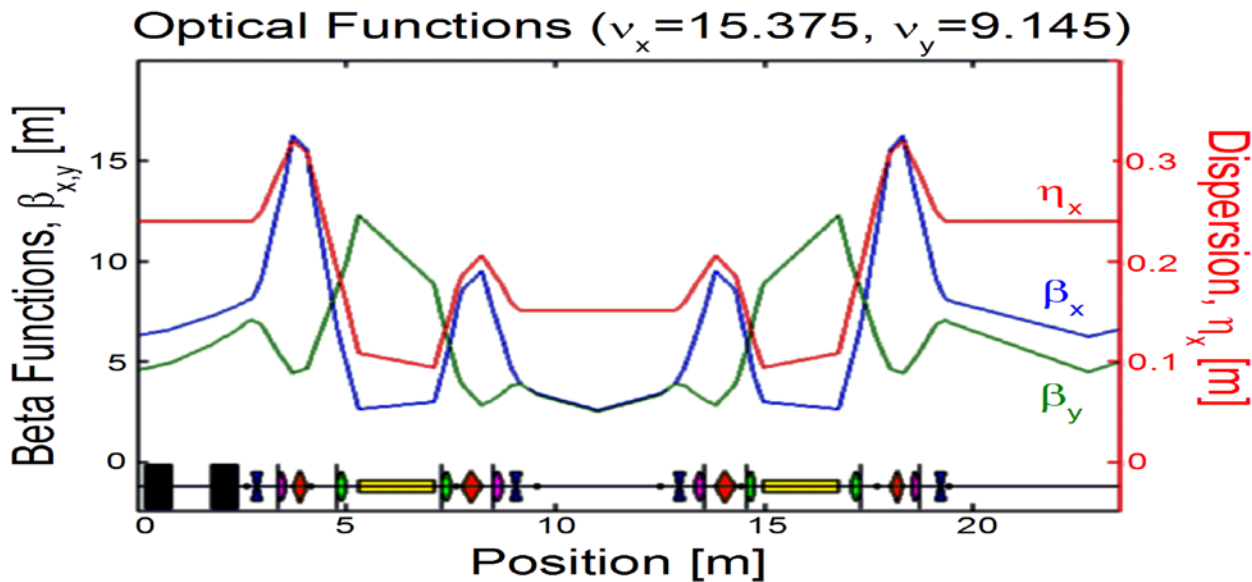
Ilmoon Hwang (Beam operation team)

November 13, 2023

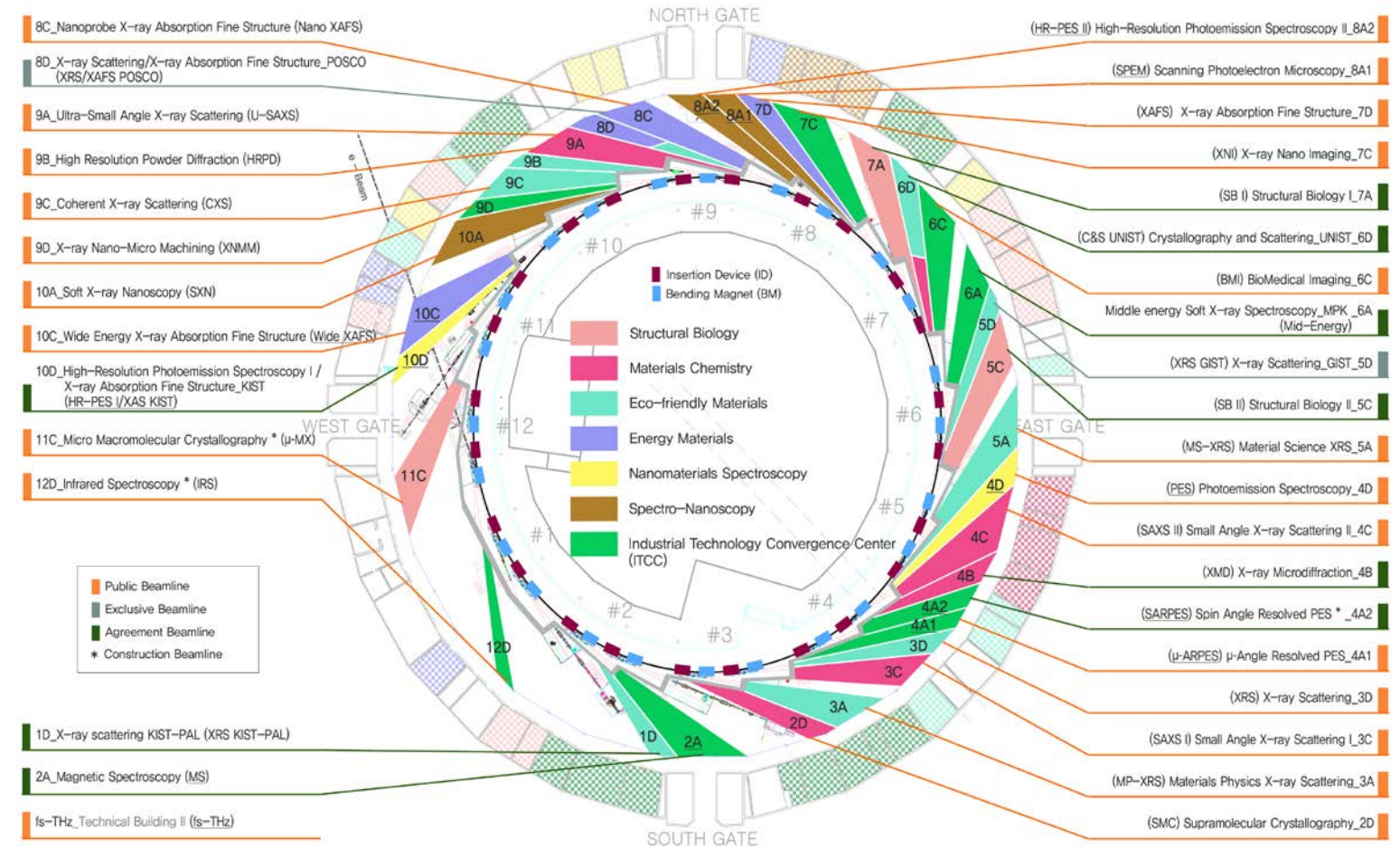


SR parameters

Parameter	Value
Circumference	281.82 m
Super-period	12
Energy	3 GeV
Beam current	250 ~ 400 mA
Emittance	5.8 nmrاد
Emittance coupling	< 1 %
Energy spread	0.1 %
Momentum compaction	0.0013
Bunch length	16 ps
Tune (H/V)	15.375 / 9.145
Chromaticity (H/V)	3 / 3



Beamlines



- 12 Double-bend
- 24 straight – (1 injection, 2 SC-RF, 2 empty) Plan at 2C: MPW
- 19 ID; 21 ID beamlines (A,C)
 - 12 in-vac, 4 EPU, 2 MPW, 1 out-vac planar
- 13 Bending beamlines (B,D)
- 1 IR (in-vac mirror)

Operation Schedule

❖ Operation Goal

Beam service 190 days

Service rate 97%

Beam current 250~400mA

❖ Beam service

136 days with 99.4% (~ 8.2.)

9/27 accident at power plant

Budget problem

27 days left

→ Beam service 163 days

Beam current 250mA

User Beamtime (163 days)							Machine Turn-On & Machine Study (71 days)							Maintenance (121 days)							No Operation (10 days)						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
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29	30	31																									

Service Fault

❖ **Criterion**

- in service period (schedule change excluded)
- no photon beam (closed shutter, injection mode)
- beam loss more than 50mA

❖ **Fault in 2023**

Service rate 99.4% , total fault time 19h

Beamline - sensors, vacuum pumps

Control - BPM, orbit feedback

Magnet - temperature sensor

Magnet power - Quadrupole, Sextupole

SRF - KSU

Utility - LCW

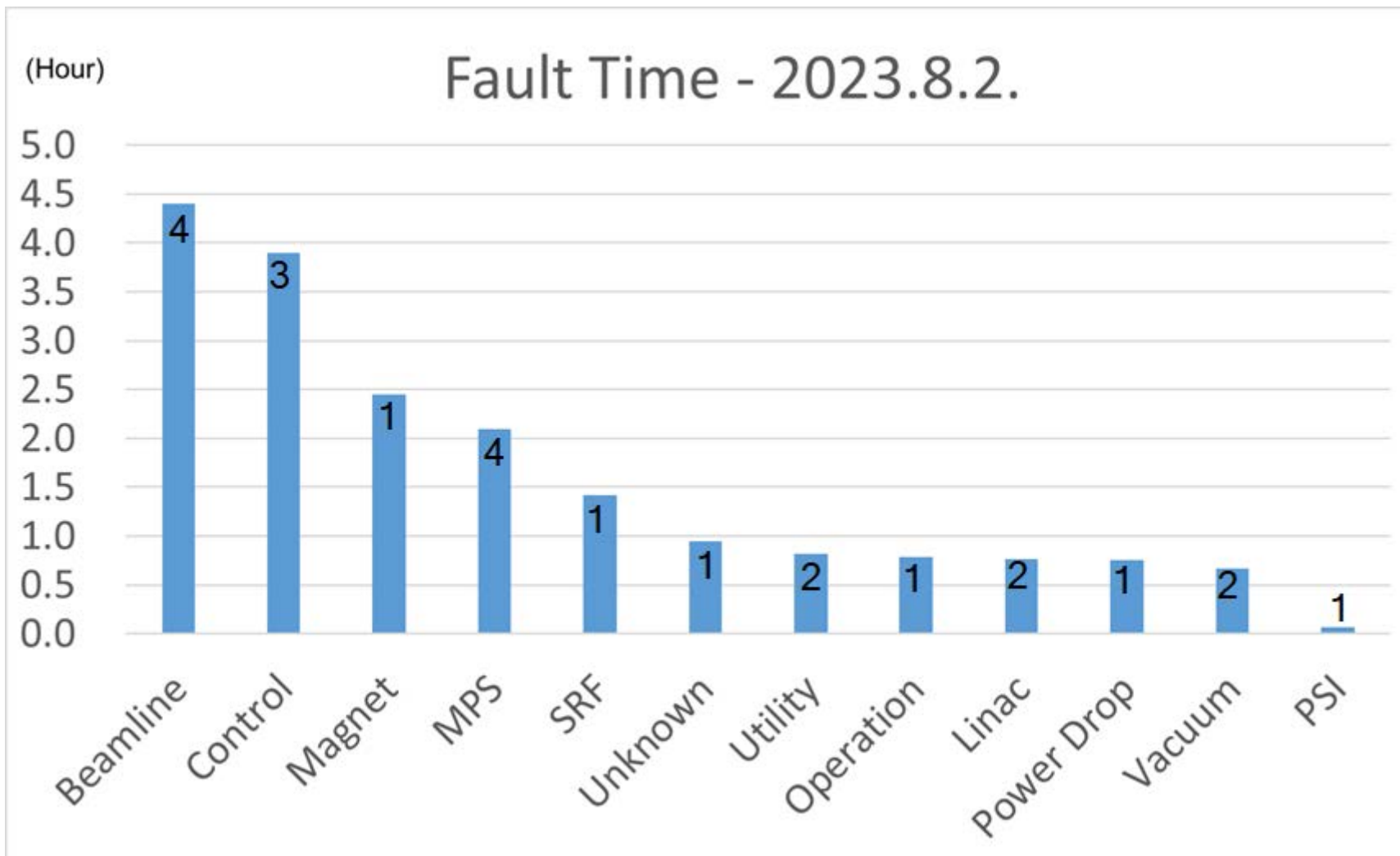
Operation - top-up trip

LINAC - magnet

Power drop

Vacuum - gauge

PSI - detector



LINAC energy

❖ 3 GeV top-up

❖ 2023 summer

Replacement: Accelerating column (2A), Klystron (10B)

New LCW : Individual temperature control

❖ Plan : additional modulator, klystron

a MK for 4 accelerating columns to 2

Orbit interlock

❖ BPM (I-tech brilliance)

- Horizontal, Vertical 10 kHz

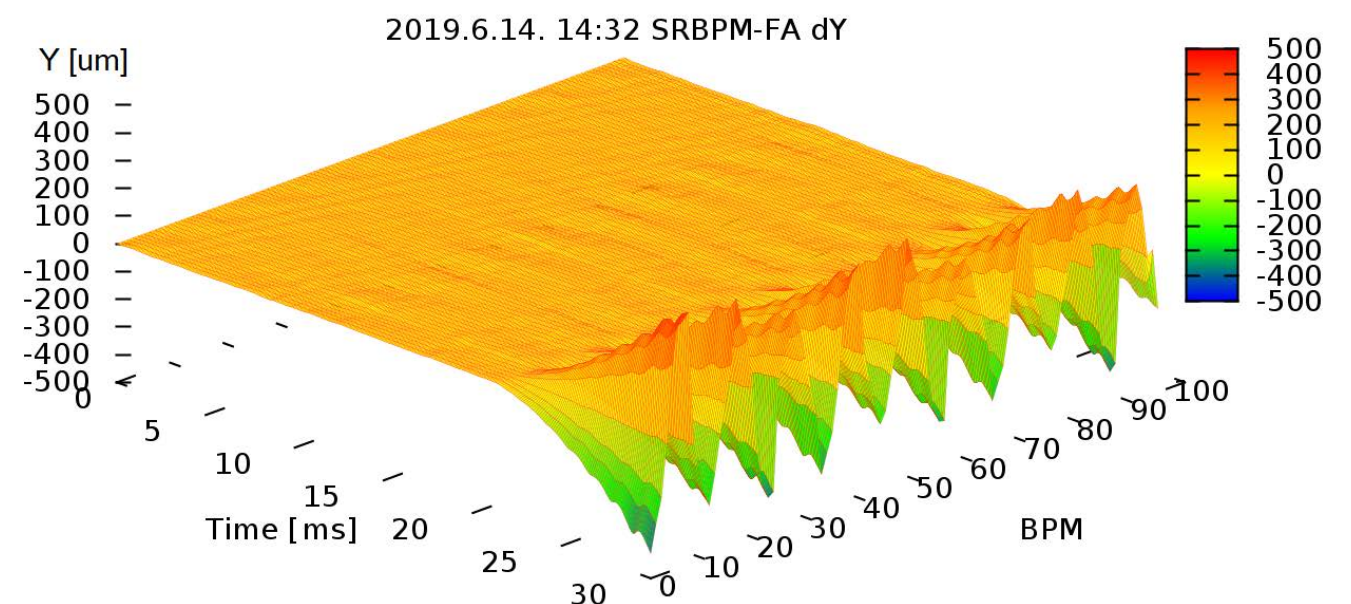
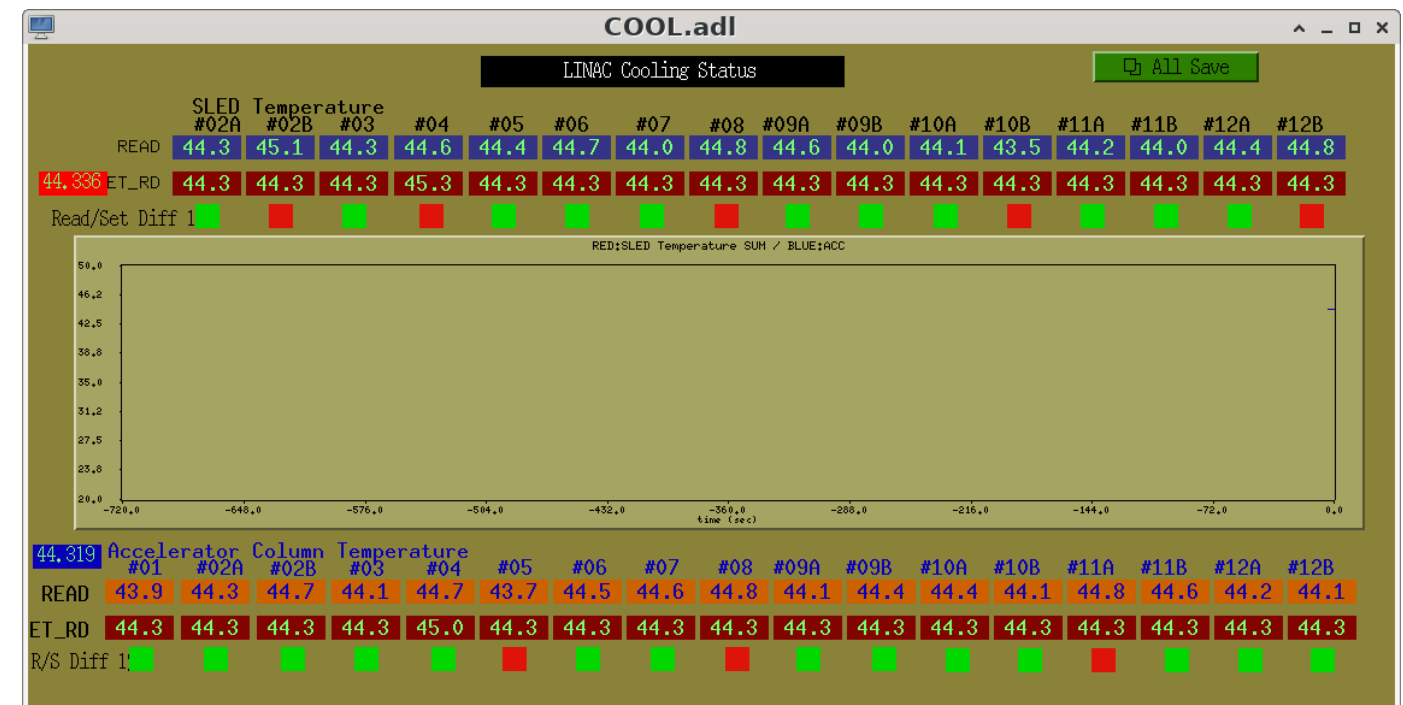
- with/without Machine Interlock system (100 ms/7 ms)

❖ Slow orbit interlock

- 10 Hz orbit calculation ; 200 ms

❖ Fast orbit interlock

- 10 kHz orbit; 1 ms (achieved by dedicated network to LLRF)



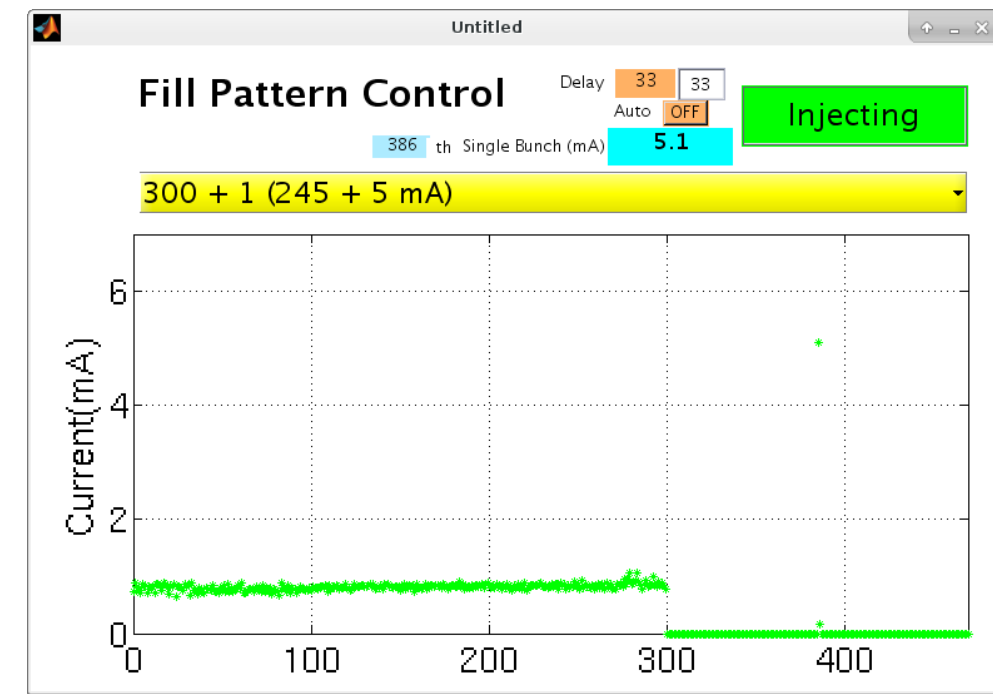
Hybrid fill pattern

❖ Various fill pattern

- Beamline devices were tested with various patterns
harmonic number 470
400, 430, 430+1, 340+3, 250+50, 350+1, 300+1, 60x5, ...

❖ Bunch train 300 + Single 5mA

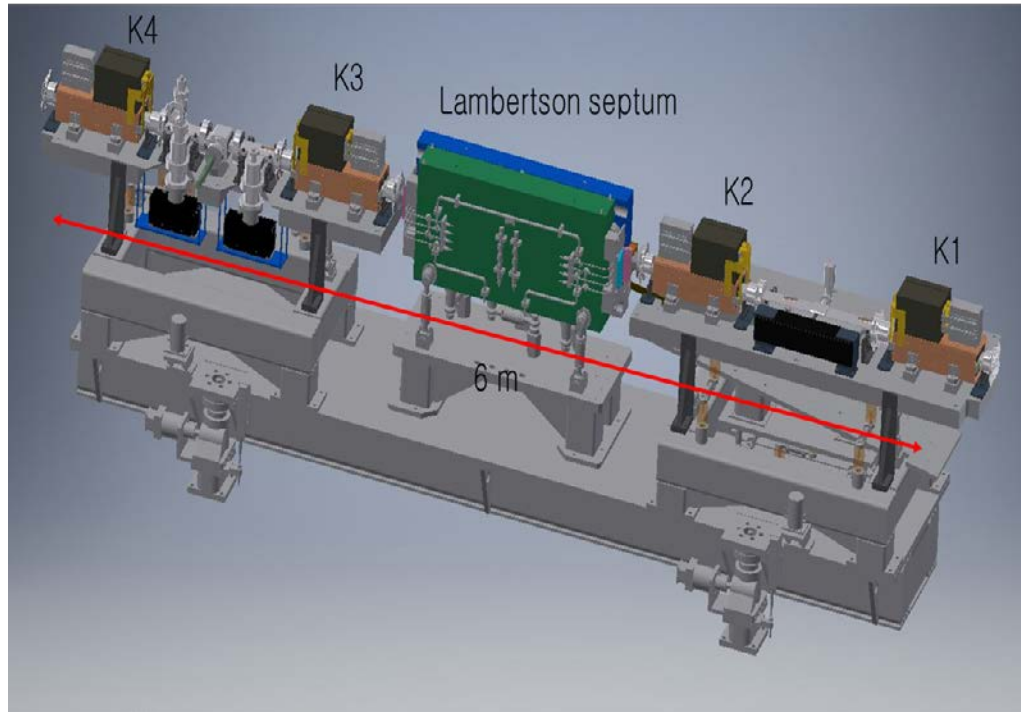
- Coupled-bunch instability by narrow-gap undulators
- 1st Transverse Feedback was designed for equally filled bunches
(single bunch upto 3 mA)
- TFS upgrade to handle unequal bunch
5 mA serviced once in 2021, 2022
- **3 mA** after 2022 summer



❖ Plan

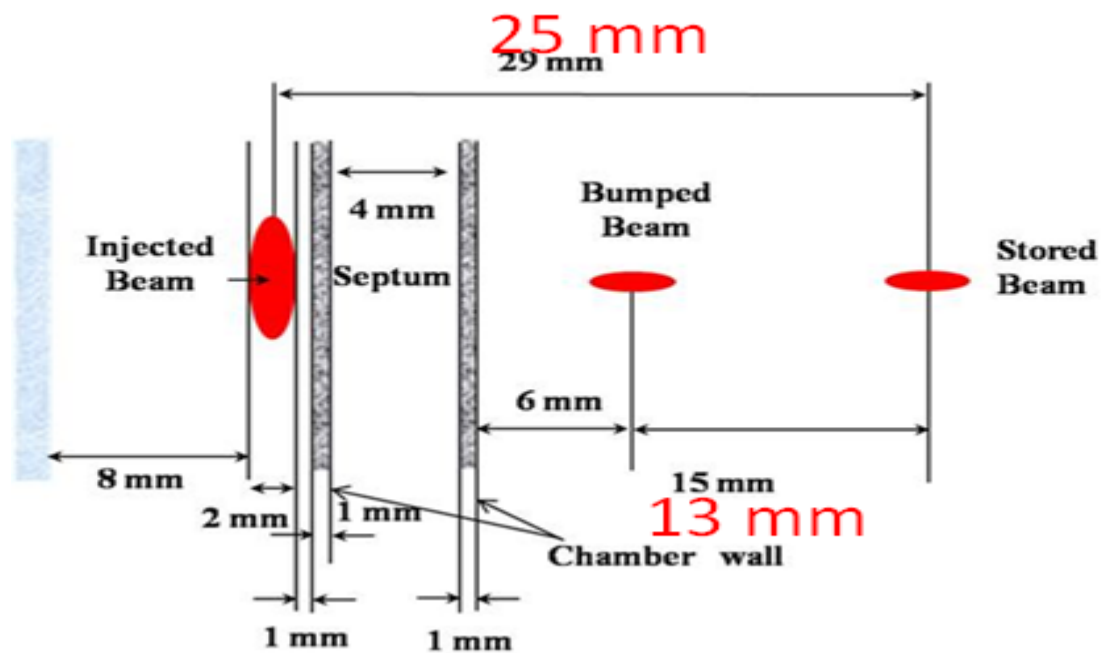
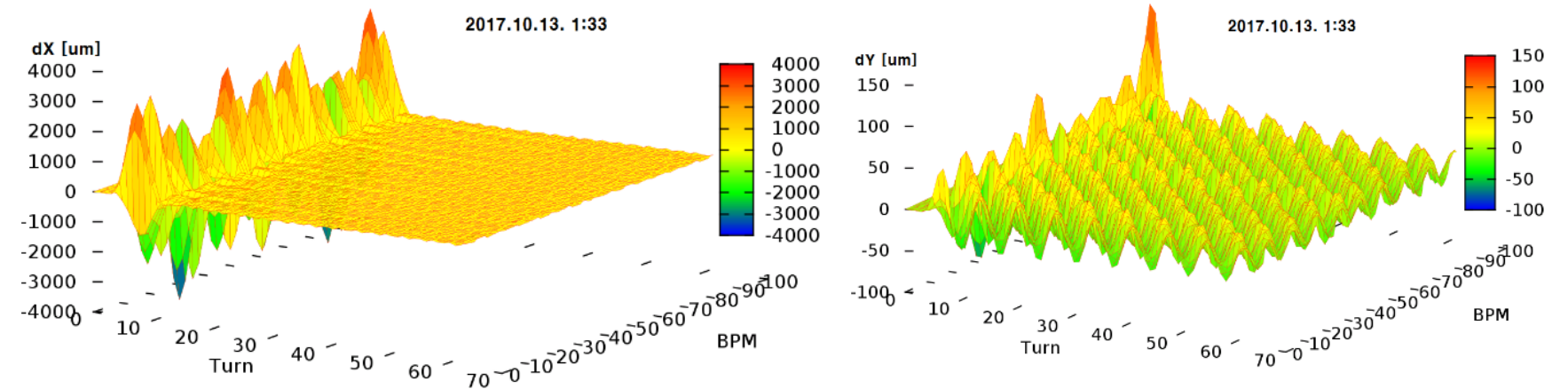
1. TFS study : broken? optimization? other problem?
2. 3rd harmonic cavity : co-work with 4GSR
3. lower RF gap voltage : 4.5MV - loss 1.2MV; waveguide, window
4. New Transverse Feedback
: co-work with 4GSR (member of beam operation team)
5. lattice - alpha

Injection system



❖ Orbit bump by 4 kickers

orbit fluctuation (2017): horizontal 4mm amplitude



❖ Orbit distortion by mismatch

Injection kick 7 us, Damping 4 ms, injection interval 100 ms

BPM 1.0637 MHz 10.13 kHz 9.89 Hz

H 2 mm.rms ~50 um ~1 um

V 0.1 mm .rms ~10 um ~1 um

Typically 5 sec injection every 3 min (10Hz linac)

Injection system

❖ Current issues

- Injection rate is close to 100% but error-sensitive
- In fast imaging, beam missing during injection
- BPM spikes make longer distortion(10sec) through orbit feedback or thermal effect in beamline
- Additional optimization of transvers feedback

❖ Upgrade

- ~~2 pairs control~~: synchronization failure
- ~~Counter kicker~~: tested successfully but no room in injection area
- **New magnet, chamber, tilt (2022)** : horizontal **1mm**, vertical 0.1mm
- **4 individual control** : **installed, test in 2024**
- **Nonlinear kicker** : co-work with 4GSR (member of beam operation team)



Summary

❖ **PLS-II is serving 34 beamlines.**

- MPW beamline (2C) under construction
- Beam service 163 days in 2023 (original plan 190 days, budget problem)
- Beam service rate 99.4% until August

❖ **Beam current will be 400 mA from 250 mA.**

- SRF cavity is repaired and installed.

❖ **Max. current of hybrid fill pattern will be back to 5 mA.**

- repair or upgrade of bunch-by-bunch Transverse Feedback

❖ **Injection system is disturbing orbit, and will be upgraded.**

- 4 individual control of kicker powers, delays

Thank you for your attention

