

SuperKEKB MR Status

Akio Morita
2021/06/21

New Achievements

- Peak Luminosity

- $2.95668 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ @ 2021/05/17 21:26

- $\beta_y^*=1\text{mm}$ $I = 837.4 / 676.5 \text{ mA}$ (LER/HER) $n_b = 1174$

- Integrated Luminosity

- $1964.22 \text{ pb}^{-1}/\text{day}$ @ 2021/05/18

- $747.19 \text{ pb}^{-1}/\text{shift}$ @ 2021/05/19 swing shift

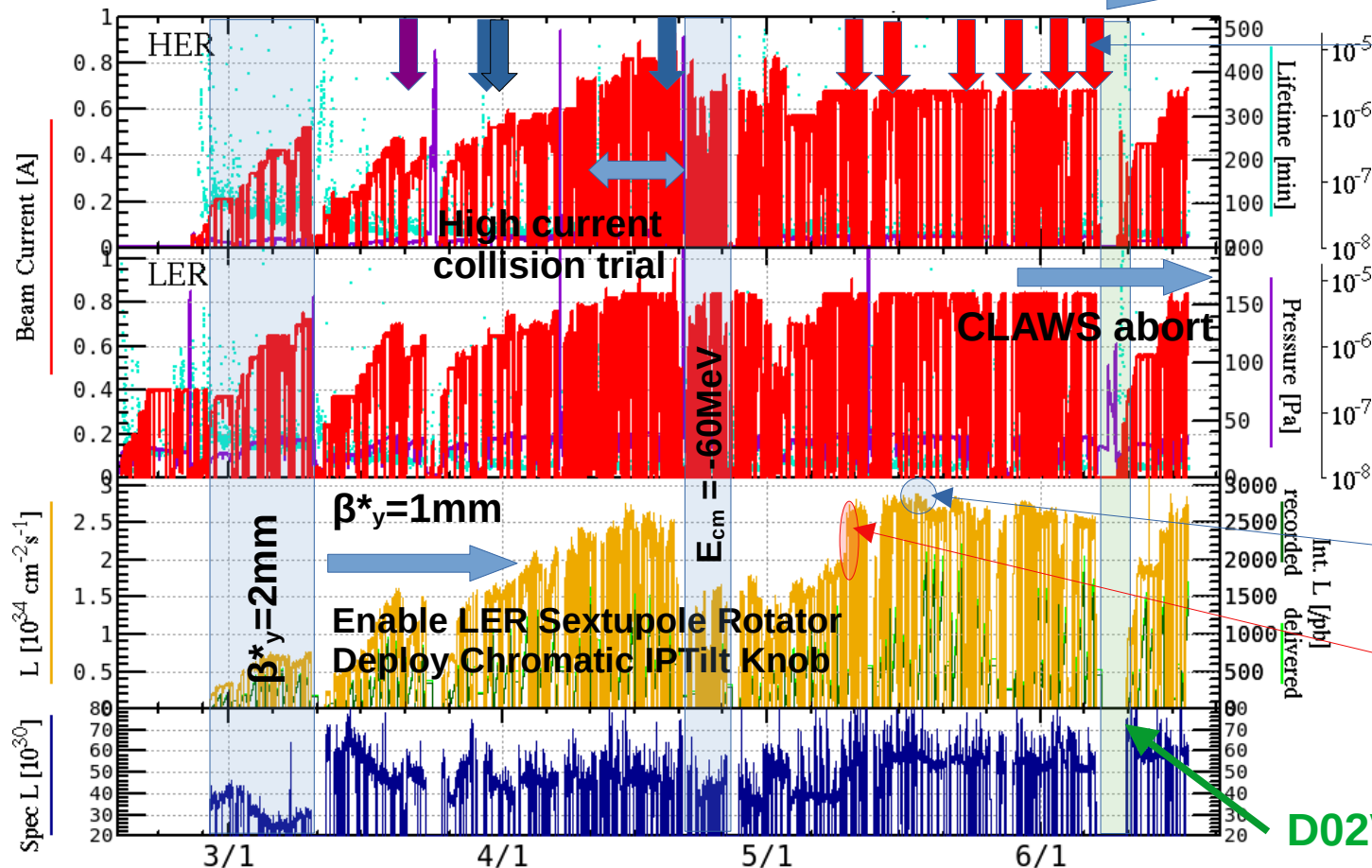
- $\beta_y^*=1\text{mm}$ $I_{\text{max}} = 840 / 680 \text{ mA}$ (LER/HER) $n_b = 1174$

2021a/b Operation

Baking Run @ 2021/04/21

$I_{max}=1000/920\text{mA(LER/HER)}$ $n_b=1370$

Stable collision on $I_{max}=840/680\text{mA(LER/HER)}$ $n_b=1174$



QCS Quench

- QCSL/ESL x1
- QC1LE x3
- QC1*P x6

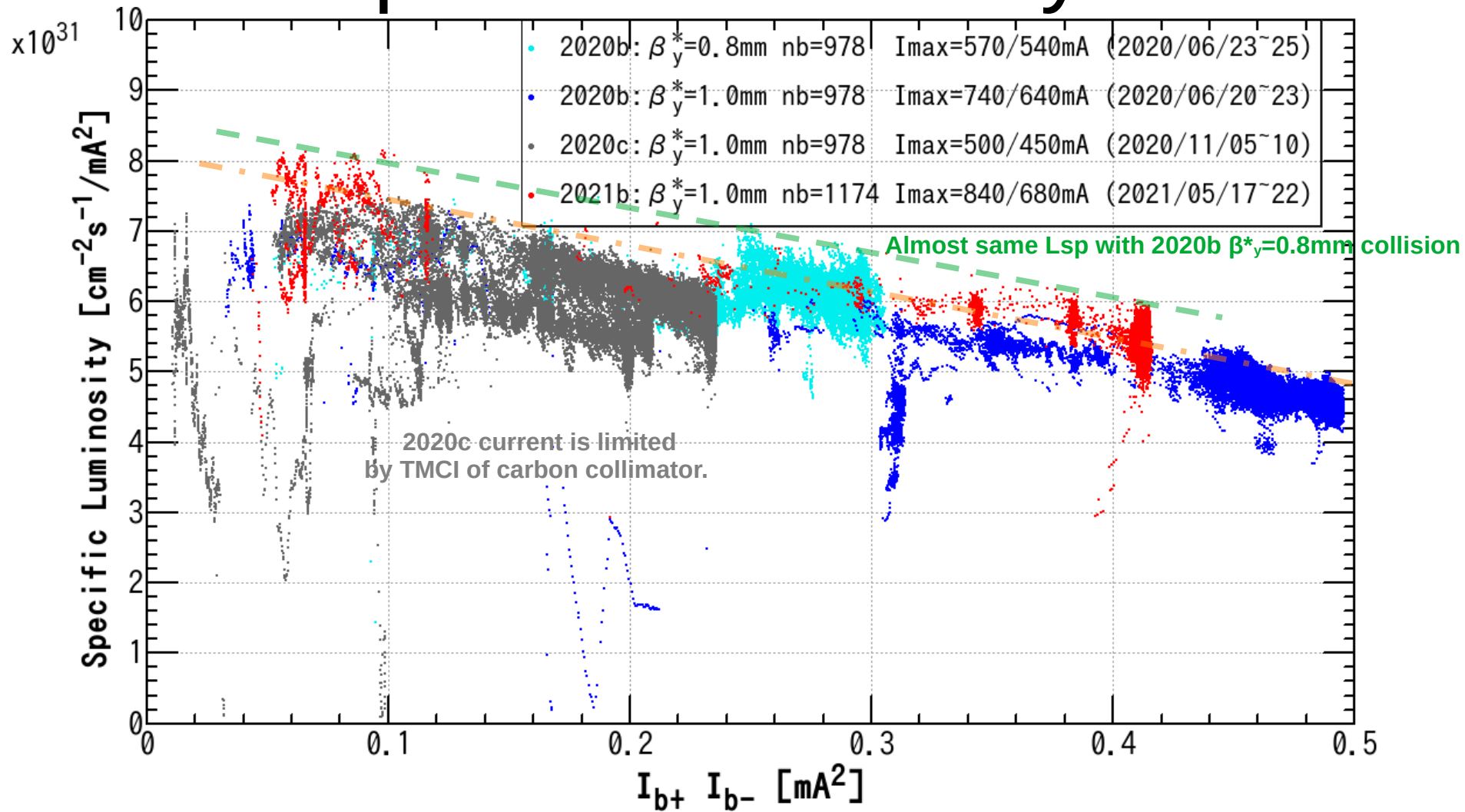
Maximum Current @ PhysicsRun
 $I_{max}=840/820\text{mA(LER/HER)}$ $n_b=1272$
 2021/04/14~19

$L_{peak} \sim 2.95668 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

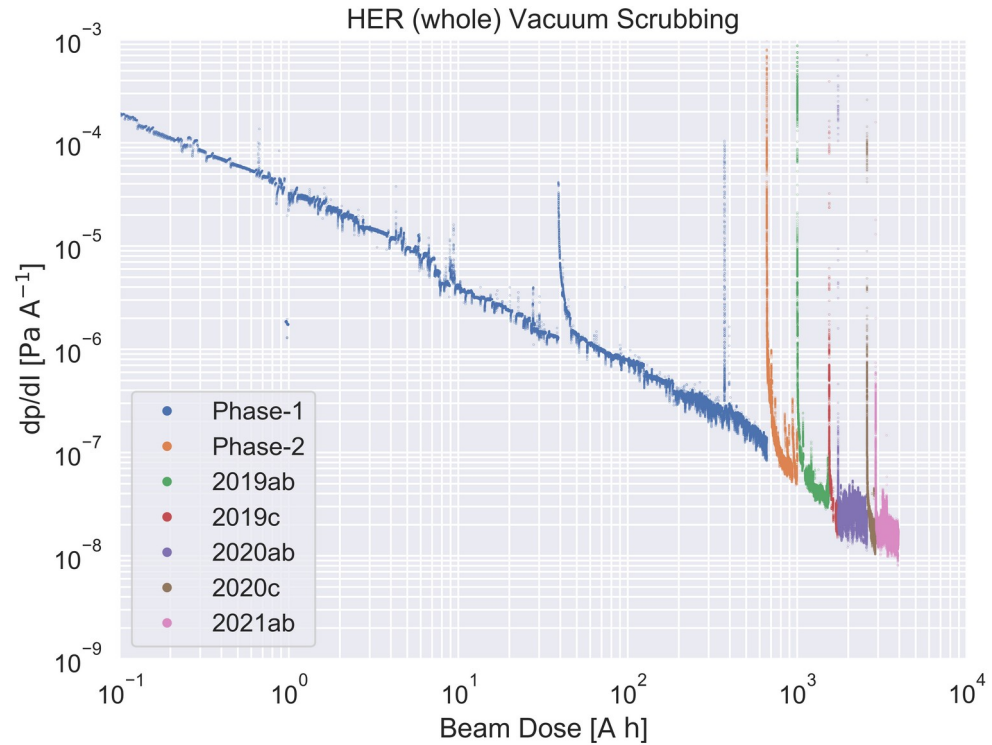
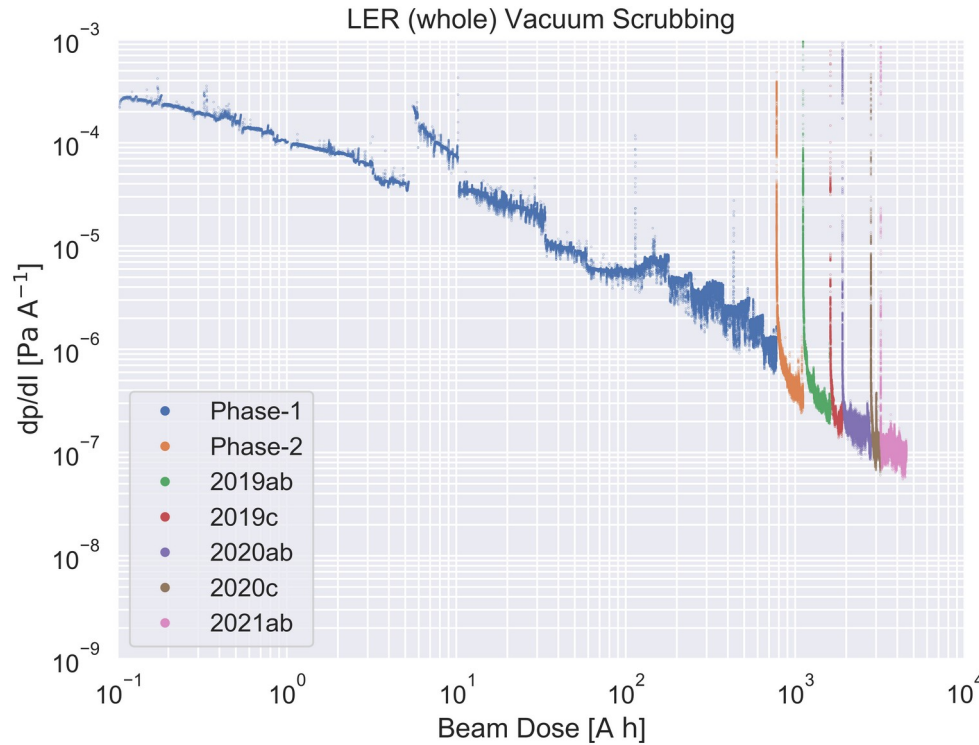
~25% L_{sp} gain by reducing
 HER Vert. BxB FB gain(-6dB)
 LER FB gain is not affected.

D02V1 collimator works

Specific Luminosity



Vacuum Scrubbing



Vacuum pressures are gradually improved by integral beam dose.

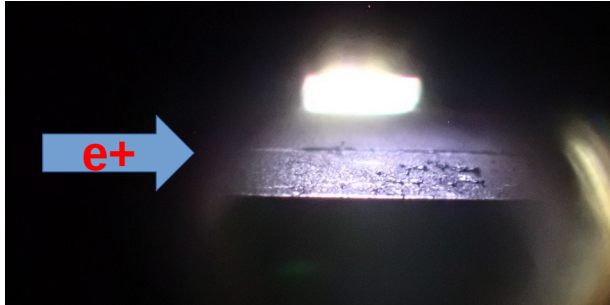
QCS Quenches

- 03/20 – QCSL/ESL Quench (Lv.4 Earthquake)
- 03/28 – QC1LE Quench due to QC1LE PS trouble
- 03/39 – QC1LE Quench due to QC1LE PS trouble
- 04/19 – QC1LE Quench (20msec after VxD abort)
- 05/10 – QC1[LR]P Quench with D2V1 CCG raise
- 05/14 – QC1RP Quench with D06H3 CCG raise
- 05/23 – QC1[LR]P Quench with D06V1 CCG raise
- 05/28 – QC1RP Quench with D06V1 GGC raise
- 06/02 – QC1[LR]P Quench with D02V1 CCG raise
- 06/06 – QC1[LR]P Quench

QC1P quench frequency is big issue for stable collision operation.

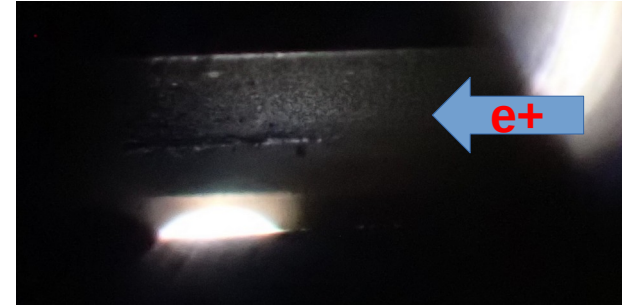
Damaged D02V1 Collimator Head

D02V1 BOTTOM

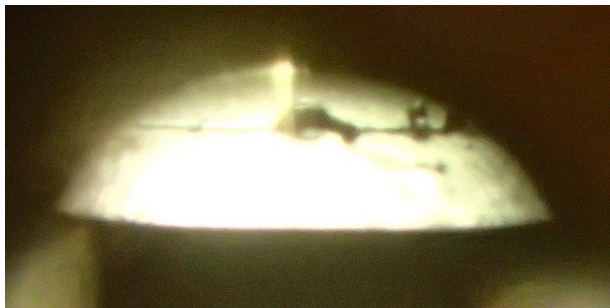


After 05/10 QC1P Quench with D02V1 CCG raise

D02V1 TOP



from 20210510.pptx @ KCG 2021/05/11



After 06/02 QC1P Quench with D02V1 CCG raise

from 20210603D2V1.pptx @ KCG 2021/06/03

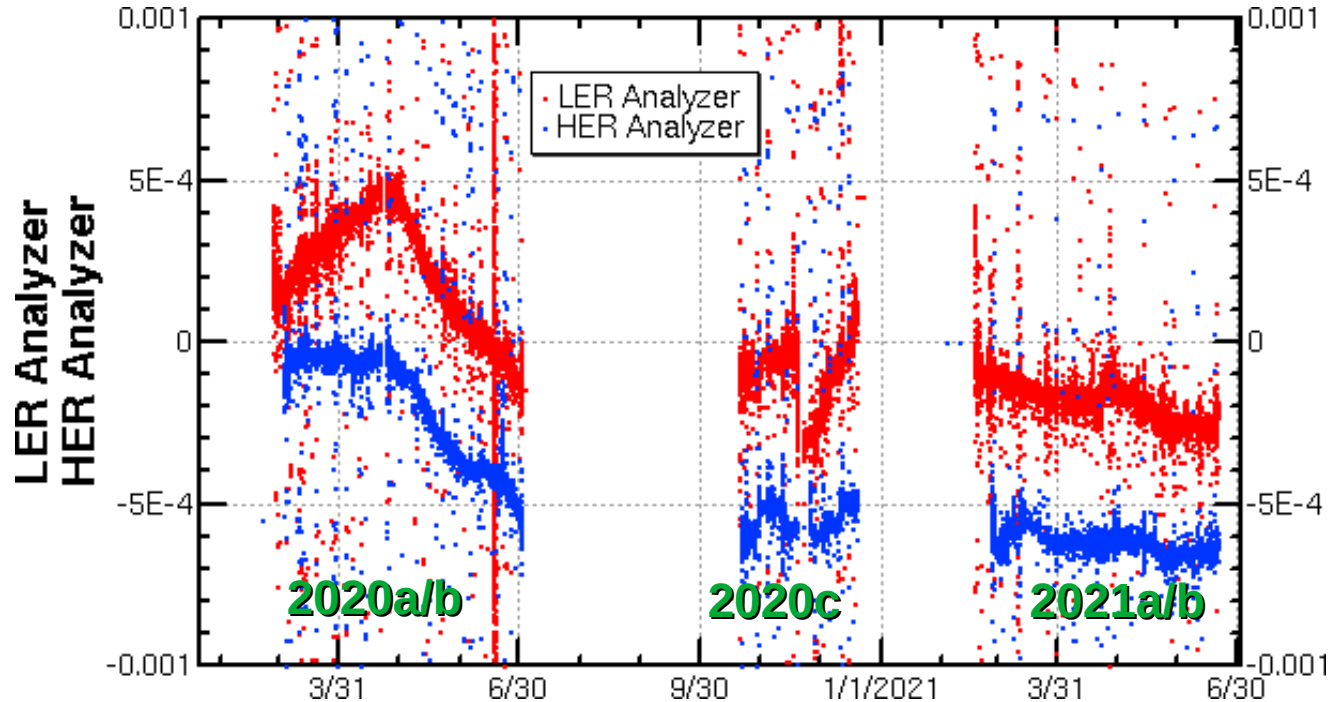
- D02V1 serious damage is suggested by bad detector background after QC1P quench @ 06/02.
- D02V1 surface damage is confirmed by Horizontal Bump Study @ 2021/06/03 11:30~12:00.

D02V1 collimator head was replaced during 2021/06/07~09.

Operating Software Improvements

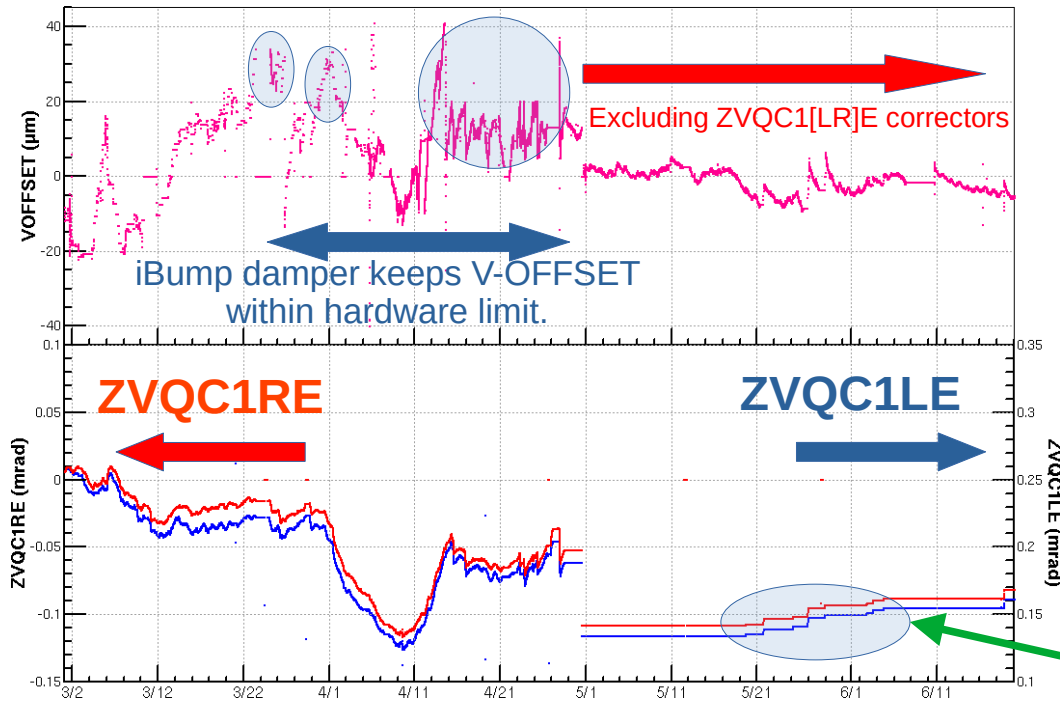
- BT end orbit feedback
 - Feedback stability & reliability are improved by using single waveform EPICS PV containing synchronized BPM data set instead of individual EPICS PVs (x, y position and charge PVs per BPM).
 - Fix data propagation race among individual PVs.
- CCC(slow global orbit feedback)
 - Ring energy analyzer drift is improved by fixing calculation algorithm.
 - Interference with collision feedback (iBump V-OFFSET drift) is improved by reducing degree of corrector freedom.

Ring Energy Analyzer Drift



Energy analyzer drift is reduced by improving conservation of total horizontal steering kick angle.
(Fix kick angle sum drift due to truncating small component in correction vector.)

Collision Feedback V-OFFSET Drift



- Large V-OFFSET drift is observed during 2021/04.
- To keep iBump V-OFFSET within hardware limit, iBump damper is required.
- Overall V-OFFSET drift absorbed by damper is 80µm.
- In order to reduce V-OFFSET drift rate, ZVQC1LE & ZVQC1RE sterrings are excluded from CCC orbit corrector set.

iBump V-OFFSET Drift Mechanism

1. CCC's global orbit correction makes common mode kick between ZVQC1LE and ZVQC1RE.
 - Its mode is hard to observe by BPM system.
2. It makes vertical displacement at the IP and iBump FB is responding to such displacement.
3. iBump V-OFFSET drift is damped via iBump damper by using ZVQC1LE/ZVQC1RE.

IP Chromatic Coupling Issue

- LER sextupole rotator default angle parameter set is changed from “zero” to the angles minimizing **model** IP chromatic coupling since 2021/03/11.
- Chromatic IPTilt knob tool is deployed to control IP chromatic coupling for both LER and HER since 2021/03.
- Now IPTilt(coupling/v-dispersion) and chromatic IPTilt COULD be controlled independently in linear perturbation region.
 - Typical IPTilt knob strength exceeds linear perturbation region.
 - Typical strength of skew quadrupole correctors are increased due to additional constraint.
 - The orbit displacement side effect at changing IPTilt knob becomes more serious.
 - The orbit on some strong skew quadrupole corrector (ex. QKARP) SHOULD be off-centered.
- Chromatic IPTilt knob scan ranges are limited by corrector strength & detector BG.
- The work point reducing beam-beam blow up, which is predicted from beam-beam simulation, is not found at this moment.

Summary

- Achieves better specific luminosity compared with $\beta^*_y=1\text{mm}$ collision in 2020.
 - Achieves almost same I+l. - L_{sp} curve with $\beta^*_y=0.8\text{mm}$ collision in 2020b.
- HER BxB FB side effect to HER beam size & luminosity is found.
 - LER BxB FB looks like OK.
- Adiabatic chromatic IPTilt tuning during PhysicsRun is tried, however, significant luminosity improvement is not found at this moments.
- Collision operation stability is improved by both hardware and operation software improvements.