



中国科学院上海高等研究院

SHANGHAI ADVANCED RESEARCH INSTITUTE, CHINESE ACADEMY OF SCIENCES

Status of SuperKEKB Accelerator

宗占国

中国科学院上海高等研究院 上海光源科学中心

2026年5月17日 (日)

- 1 SuperKEKB运行状况**
- 2 Challenges**
- 3 SuperKEKB IR**

- All the information from recent reports related to SuperKEKB (from 2025 Dec.)

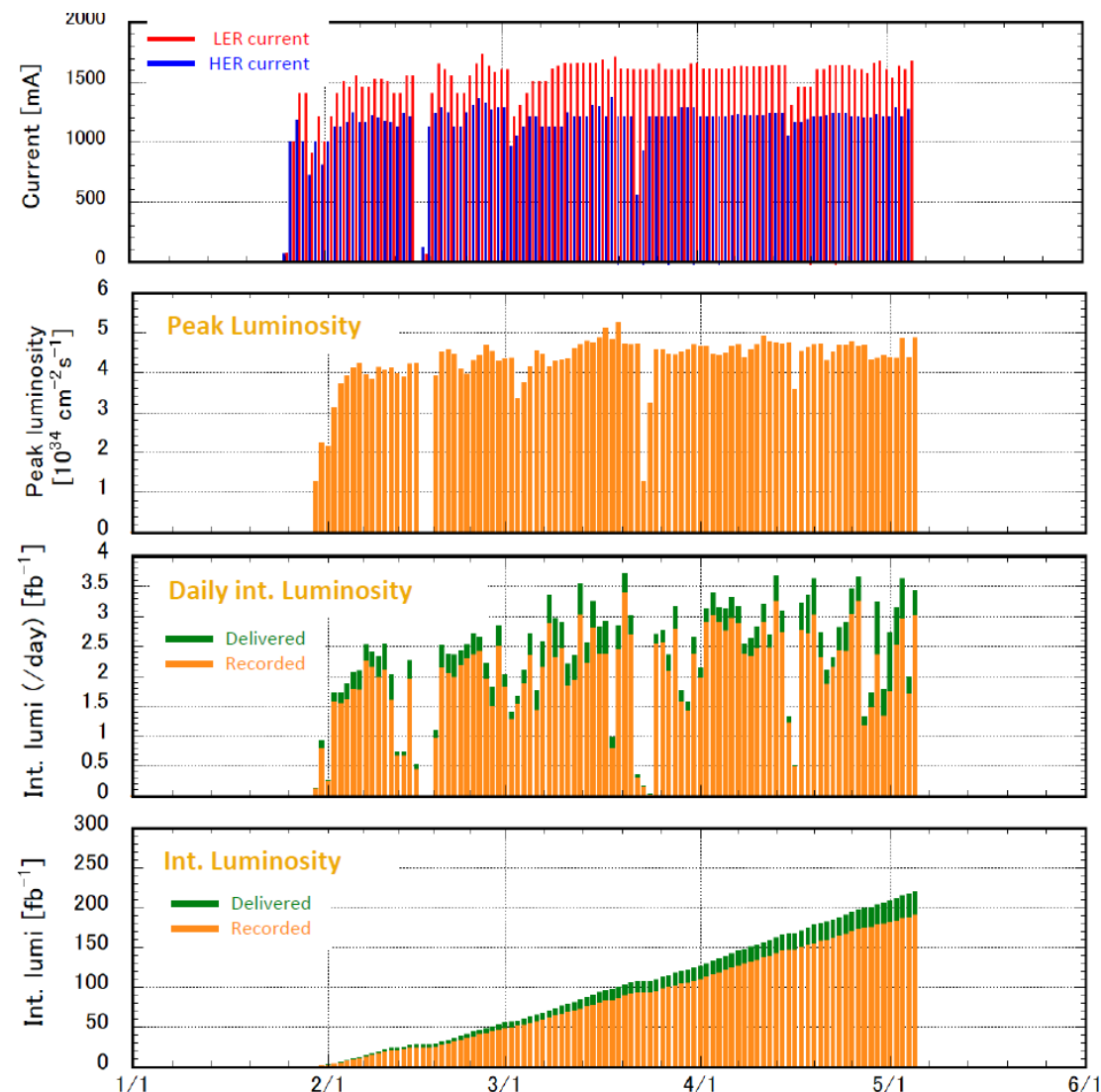
Machine status of SuperKEKB 2026ab

• Luminosity

- Peak luminosity with Belle II HV ON was updated to $5.24 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ on March 19.
- Maximum daily integrated luminosity (recorded) is 3.375 fb^{-1} .
 - Maximum delivered luminosity : 3.706 fb^{-1} (March 21)
 - Shift record (8-hour record) : 1.199 fb^{-1} (recorded) / 1.359 fb^{-1} (delivered)
 - 7-days record : 19.7 fb^{-1} (recorded) / 21.8 fb^{-1} (delivered)
- Integrated luminosity (recorded) is 190.3 fb^{-1} by May 5.
 - Delivered luminosity : 219.9 fb^{-1}
 - ~ 86 % of the planned value (256.8 fb^{-1})
 - Total integrated luminosity : 790 (recorded)/ 902 (delivered) fb^{-1}

• Current

- LER : 1.72 A / HER : 1.36 A



Plans for higher luminosity

	Plan A	Plan B	Plan C	
Peak luminosity	$1 \times 10^{35} \text{ cm}^{-2} \text{ s}^{-1}$	$6 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$	$1 \times 10^{35} \text{ cm}^{-2} \text{ s}^{-1}$	
HER beam current	1.8 A	1.3 A	2.1 A	1.36A done / 2.6A LER current x 0.7
HER bunch current	0.8 mA	0.6 mA	0.9 mA	for 2346 bunches
LER beam current	2.6 A	1.9 A	2.6 A	1.72A done / 3.6 A
LER bunch current	1.1 mA	0.8 mA	1.1 mA	for 2346 bunches
Specific luminosity $\times 10^{31} \text{ cm}^{-2} \text{ s}^{-1} \text{ mA}^{-2}$	5.0	5.9	4.8	
Operation efficiency	> 60%	> 85%	> 75%	
Physics run period	150 days	150 days	100 days	

Plan A for achieving 1 ab^{-1} and $1 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$

Target

Peak luminosity = $1 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$

Integrated luminosity $> 425 \text{ fb}^{-1}$

Key parameters

Specific luminosity = $5.0 \times 10^{31} \text{ cm}^{-2}\text{s}^{-1}\text{mA}^{-2}$ at 0.86 mA²

Operation efficiency $> 60\%$ (N.B., $\sim 67\%$ at 1.7 A & 1.3A in 2024c)

Requirements

2-bunch injection in HER and LER, β_y^* squeezing to 0.9 mm (plus, possibly β_x^* squeezing)

Mitigation of beam-beam effects

Plan for achieving 1 ab^{-1} with $6.7 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$

Target

Peak luminosity = $6.7 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$

Integrated luminosity = 430 fb^{-1}

Key parameters

Specific luminosity = $4.9 \times 10^{31} \text{ cm}^{-2}\text{s}^{-1}\text{mA}^{-2}$ at 0.58 mA²

Fraction of physics run/machine time = 75%

Average operation efficiency $> 80\%$, Belle II DAQ = 90%

Requirements

Stable operation (less SBL, less QCS quench, less machine/detector trouble)

2-bunch injection in LER, Relaxing beam-beam effects

Challenges limiting the performance

- Major Challenge

1. Low machine stability

- Sudden Beam Loss (SBL), etc.

2. Low bunch current limit

- Transverse Mode Coupling Instability (TMCI)

3. Low injection efficiency

- Low stability of injected beam, Large emittance injected beam, Small aperture at injection point

4. Short beam lifetime

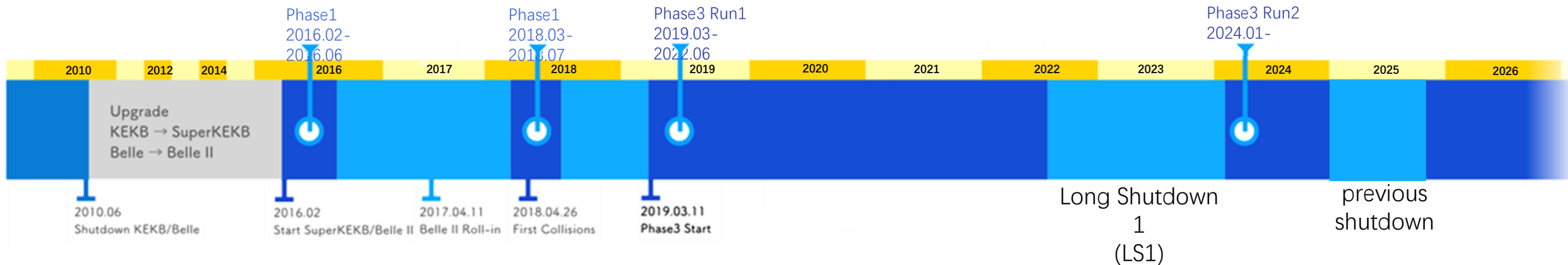
- Strong beam-beam effect, narrow dynamic aperture

5. Severe beam-beam effect

- Large simulation-measurement discrepancy

6. Aging of hardware and facilities

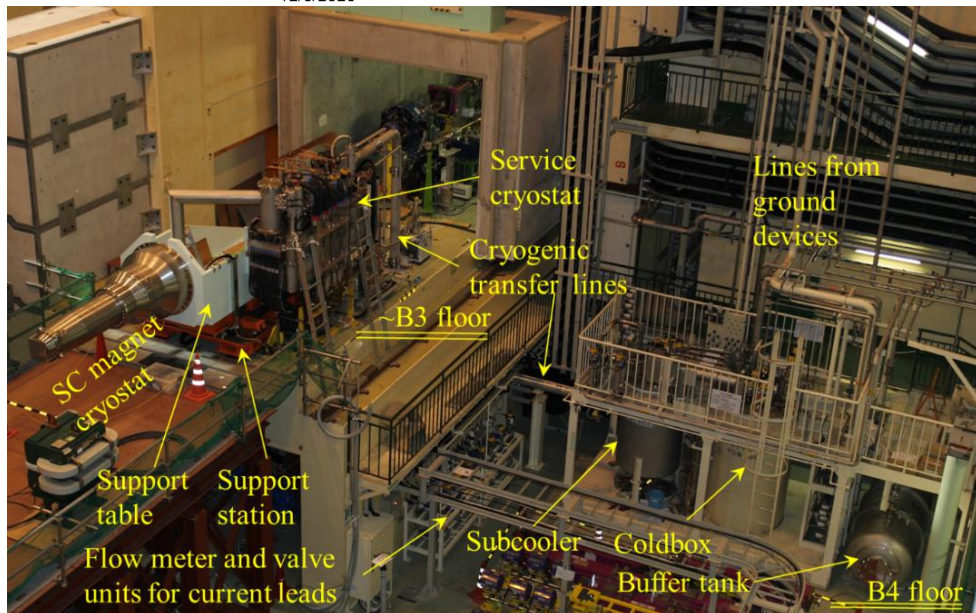
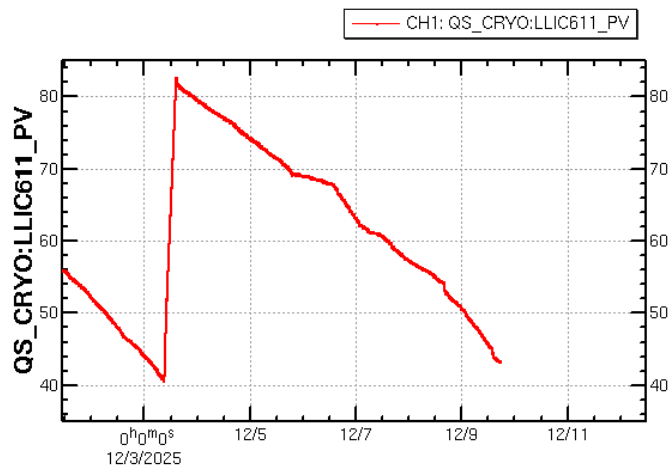
- Mitigation efforts for some of them have already been carried out during the long shutdown 1 (LS1) and the previous shutdown.



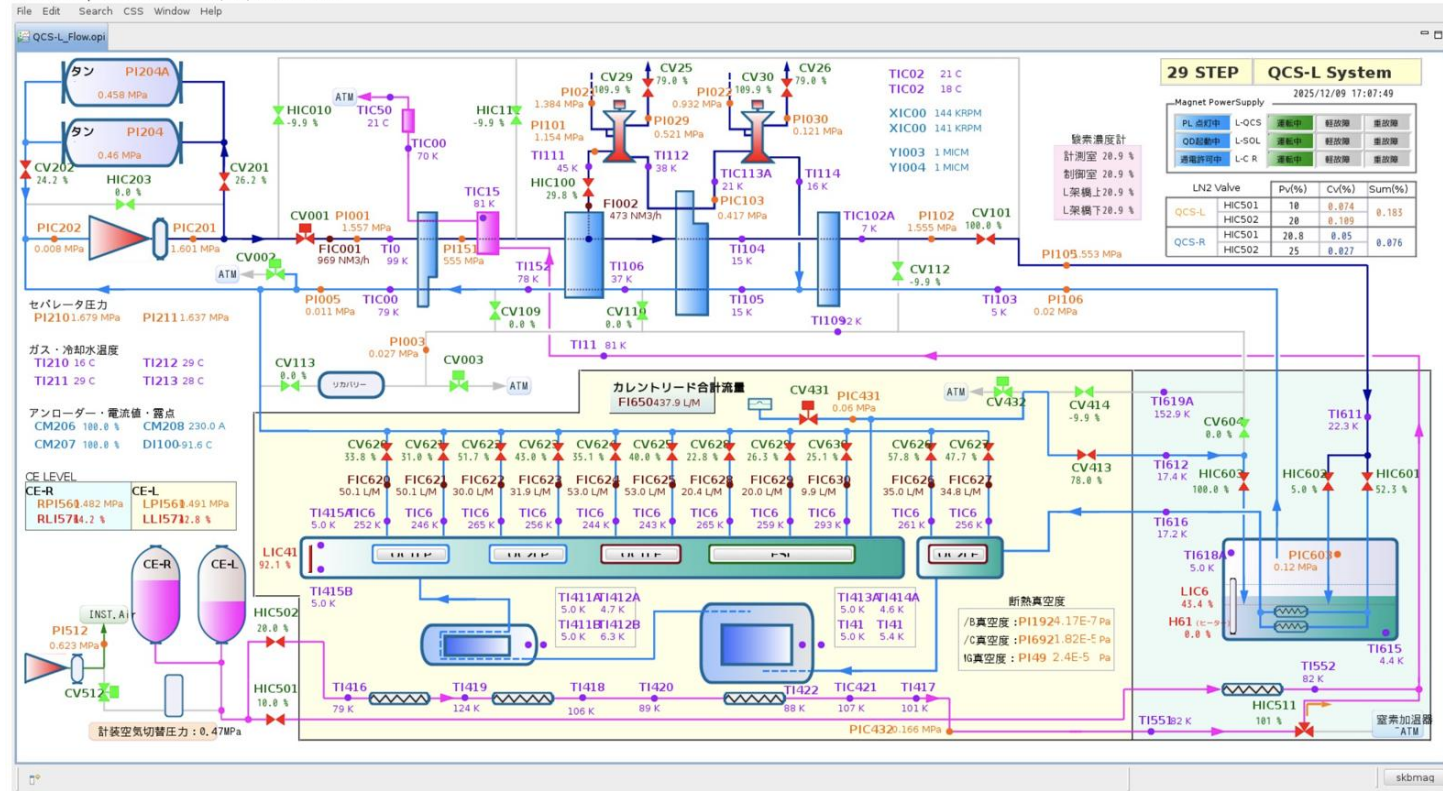
Challenges and countermeasures

Challenge	Countermeasure implemented	Remaining issues
Low machine stability	<ul style="list-style-type: none">• VACSEAL removal, Collimator relocation, Additional loss monitor & acoustic sensors• Robust collimator jaws• Kicker PS optimization• Isolation of BPM block from Q-mag.	<ul style="list-style-type: none">• Investigation of remaining SBL causes• Further robust jaws• Revolver-type collimator
Low bunch current limit	<ul style="list-style-type: none">• Installation of Nonlinear collimator• Reinforced radiation shielding	<ul style="list-style-type: none">• Further reinforcement of radiation shielding
Low injection efficiency	<ul style="list-style-type: none">• Hardware upgrades (Linac, BT, MR)• Injection tuning procedure established• Optics matching and aperture survey	<ul style="list-style-type: none">• Severe beam-beam effect• Energy jitter, orbit drift, poor reproducibility
Severe beam-beam effect	<ul style="list-style-type: none">• Introduction of crab-waist collision scheme• Launch of international simulation collaboration	<ul style="list-style-type: none">• Large simulation-measurement discrepancy
Short beam lifetime	<ul style="list-style-type: none">• Sextupole optimization studies• Water-cooled collimator (D09V3)	<ul style="list-style-type: none">• Still small dynamic aperture• Abnormal pressure rises

QCS-L status



Browser Update Time : 2025/12/09 17:08:05

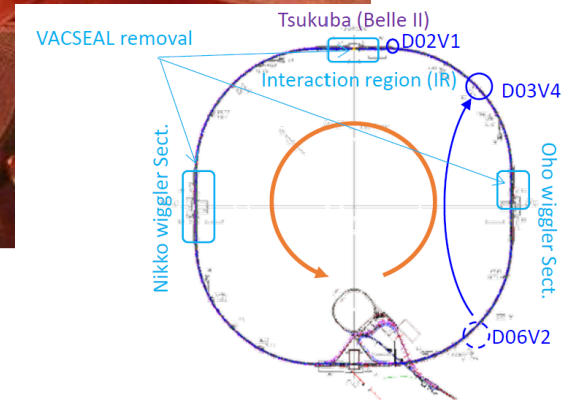
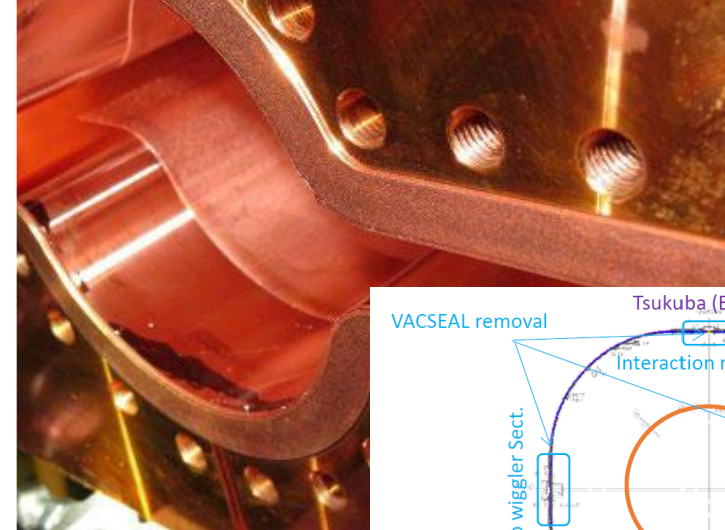
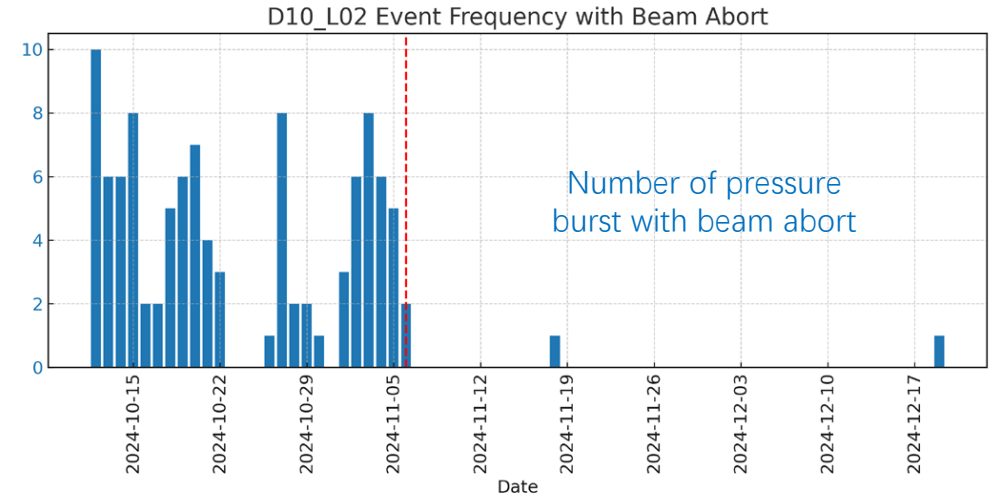


Sudden Beam Loss (SBL)

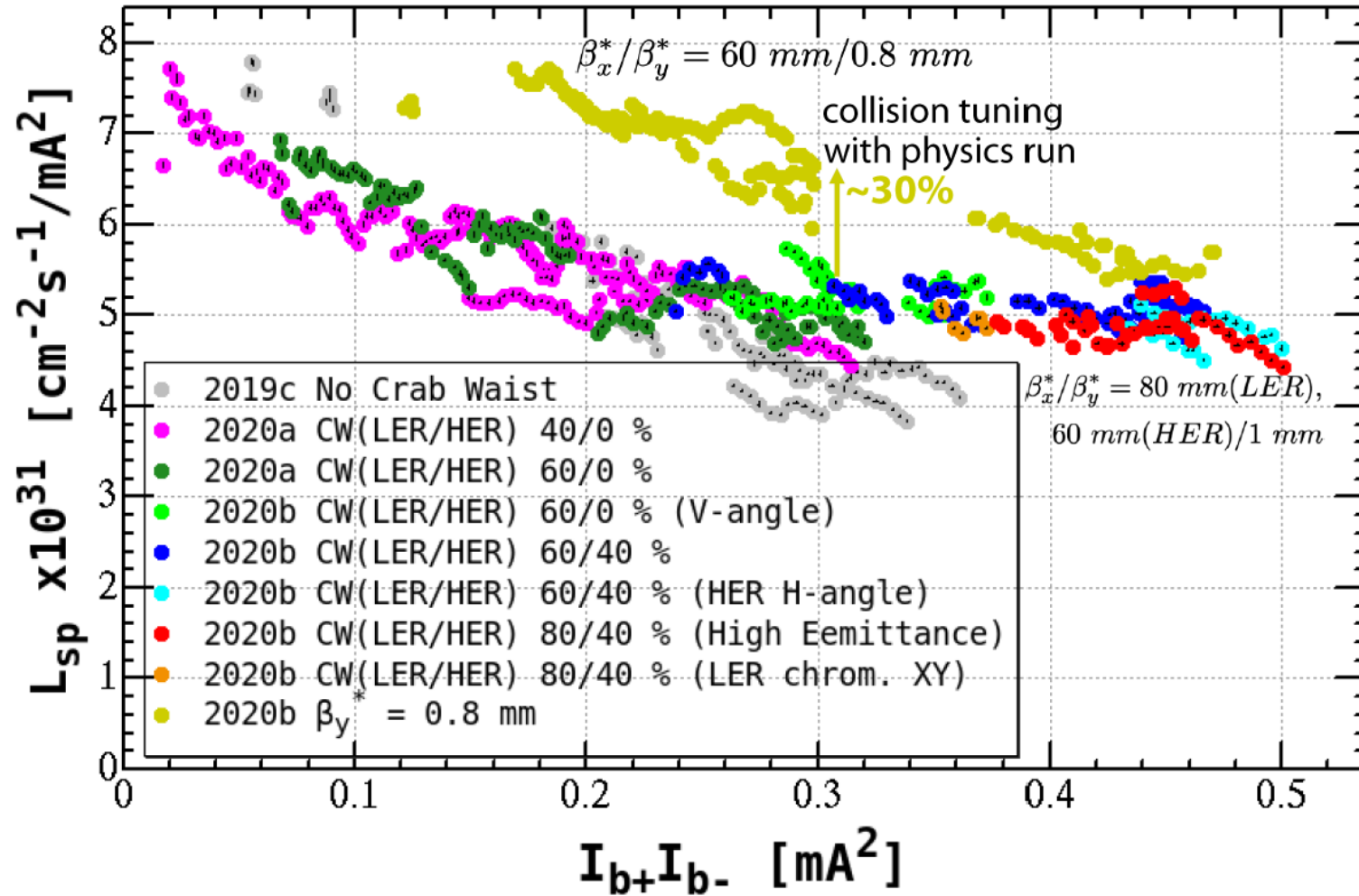
- Sudden Beam Loss (SBL)
 - SBL is the most critical obstacle to achieving stable operation.
 - Part of the beam is suddenly lost within a few turns.
 - It is difficult to prevent uncontrollable beam from damaging Belle II and collimators.
- Countermeasures
 - **Removal of VASCEAL contamination**
 - **All MO-type flange connections likely used VACSEAL were checked and fully cleaned during the previous shutdown.**
 - SBL mitigation effect of VACSEAL removal was confirmed during 2024c run.

➡ Significant reduction in SBL events

- Additional countermeasures
 - Collimator relocation
 - D06V2 -> D03V4 (to protect IR (Belle II, QCS, D02V1 collimator) from uncontrollable beam)
 - Additional beam loss monitors and acoustic sensors
 - Faster beam abort system



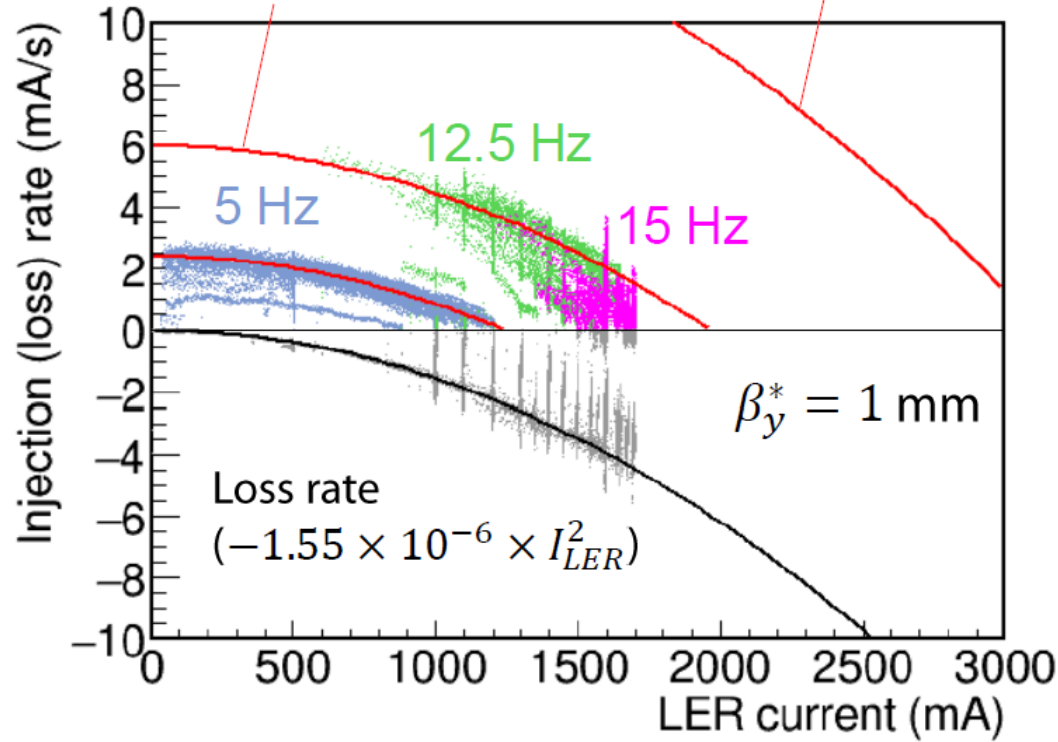
Increase the luminosity



- Until the end of April (i.e., end of the off-resonance run), we will gradually increase the beam current while keeping the abort frequency enough low.
- After the off-resonance run is completed, we plan to reduce β_y^* and increase the luminosity while keeping the current at 1.6A/1.2A.

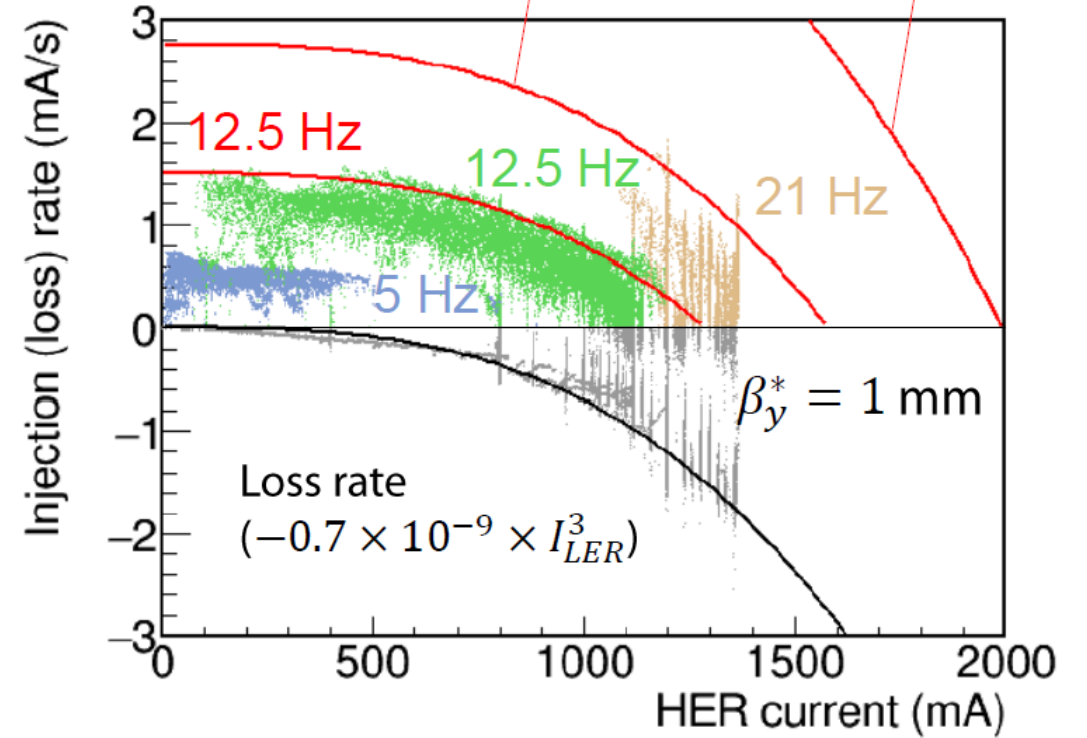
Increase the beam currents

23 Hz, 4 nC x 2 bunch, 95% eff.
12.5 Hz, 2.9 nC x 2 bunch, 95% eff.



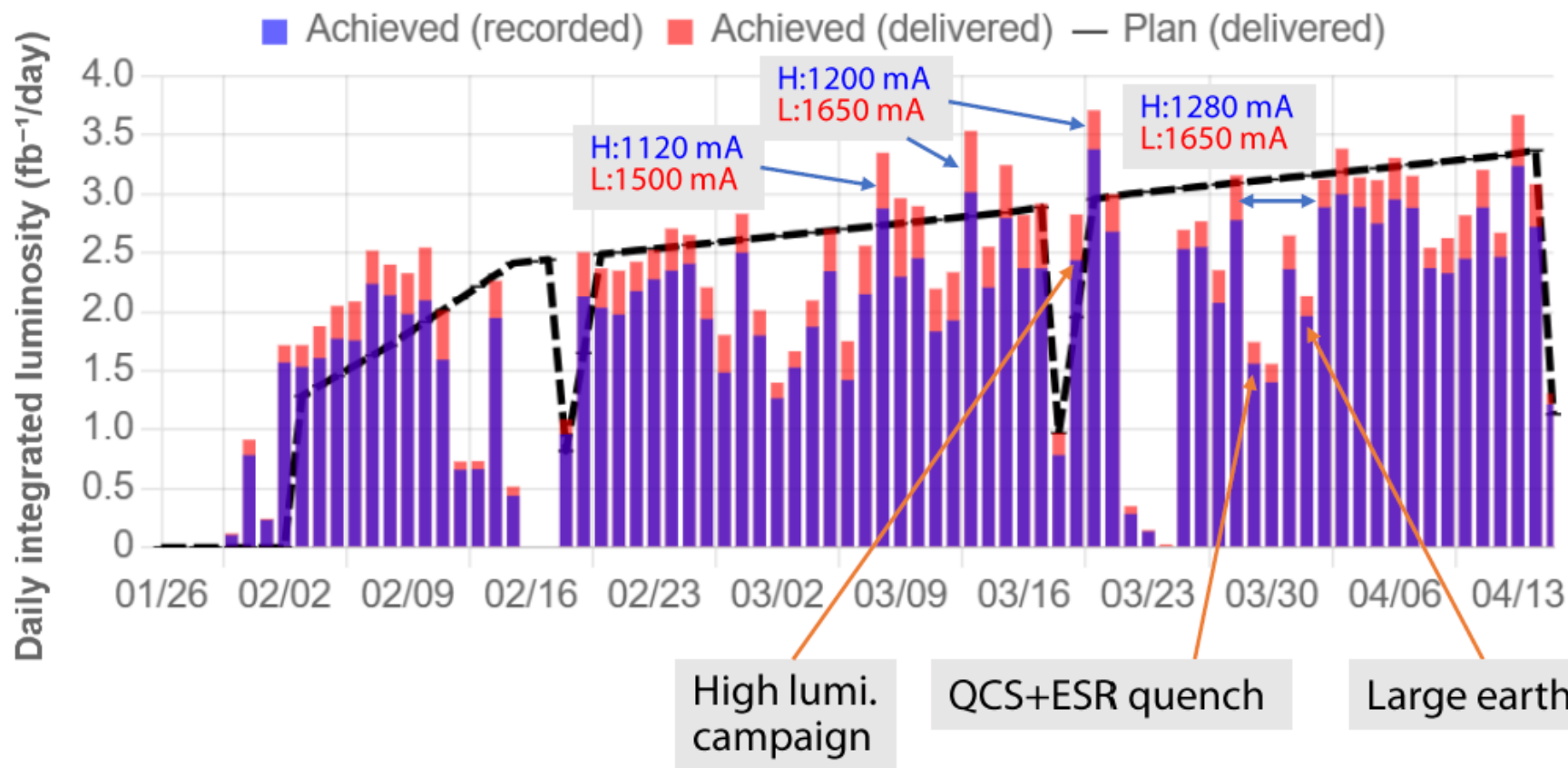
LER current reached 1.70 A with 2 bunch x 15 Hz.
If the repetition rate is increased to 21Hz, it may reach 2.0 A.

23 Hz, 1.8 nC x 2 bunch, 70% eff.
23 Hz, 1.8 nC x 1 bunch, 70% eff.



HER current reached 1.36 A with 1 bunch x 21 Hz.
If the efficiency of the 2nd bunch is comparable to that of the 1st bunch, it is possible to reach 1.6A.

2026ab running



- 745.2 fb⁻¹ (recorded) was accumulated as of Apr. 15.
- ~3.4 fb⁻¹ (recorded) is needed to reach 1 ab⁻¹ by Jun. 30. N.B. >3.3 fb⁻¹ was achieved on Mar. 20.

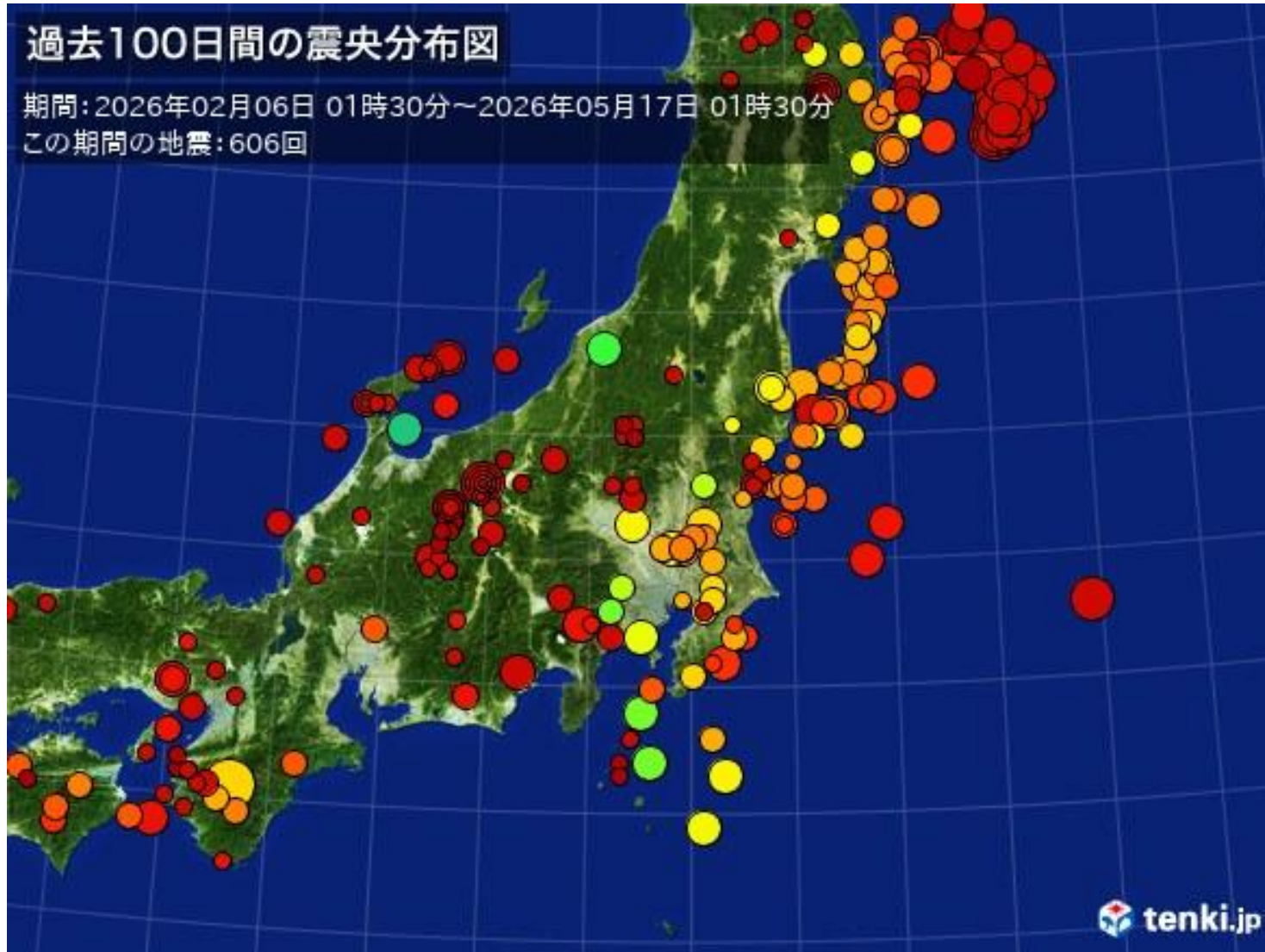
Reasons hindering the increase in integrated luminosity and instantaneous luminosity:

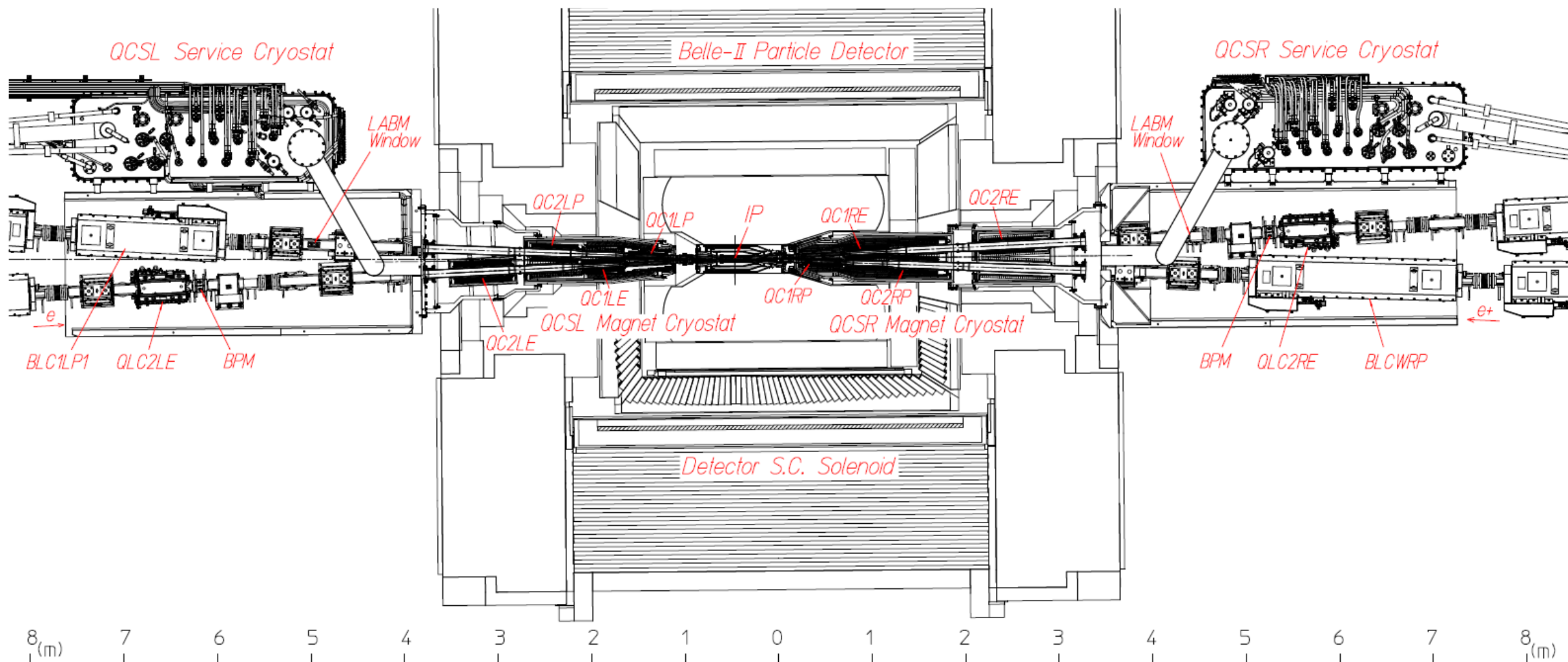
1. The beam current is set lower than the planned value to keep abort frequency low.
2. Specific luminosity is lower than planned.



過去100日間の震央分布図

期間: 2026年02月06日 01時30分～2026年05月17日 01時30分
この期間の地震: 606回

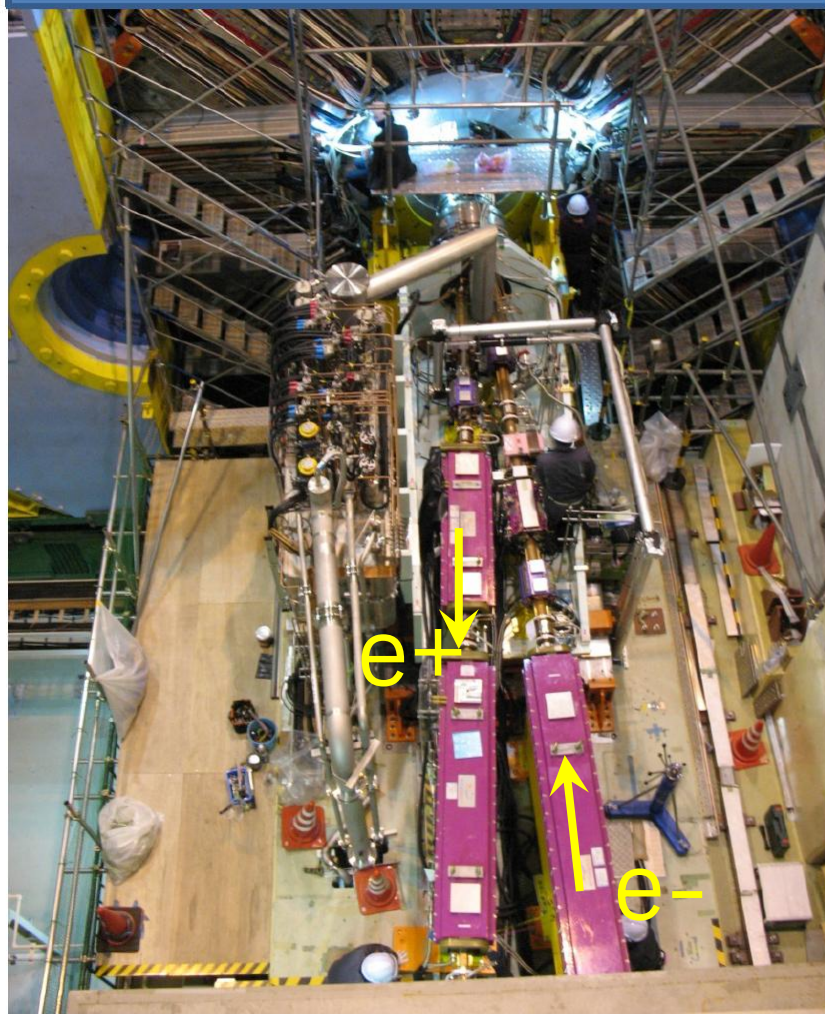




Designation	Half gap or bore radius (mm)	Lam. length (m)	B , $B'(T/m)$, $B''(T/m)$	current \times turns /pole	Number of magnets
Dipole magnets					
BLC1LP1, BLC1RP	112	1.59, 2.13	0.2232	1000A \times 10	2
other BLC type	112	2.13, 3.5	0.117	500A \times 10	4
vertical steering bend					
BC1RP, BC1LP	66	0.2	0.048	10A \times 25	2
BC* E, BC*P, (* = 1 - 4)	133	0.2	0.136	20A \times 720	8
Quadrupole magnets					
QLC2LE, QLC2RE	55	0.5, 0.54	2.04	500A \times 6	2
QK*E, QK*P	134	0.3	2.04	10A \times 20	17

Table 7.5: Summary of new near IR Magnets.

L-side (Nikko-side, D1-side, BWD)



R-side (Oho-side, D2-side, FWD)

