Running plan

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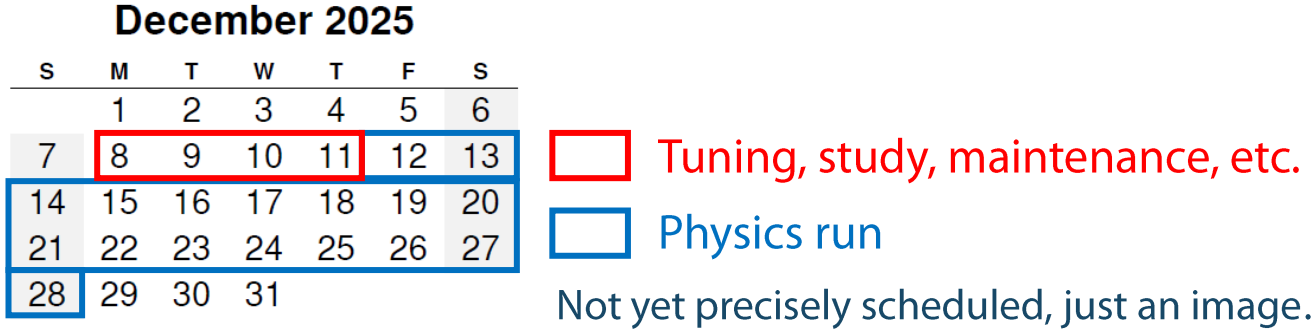
Operational Plan for 2025c-2026b

- **Highest priority in 2025c-2026b is integrated luminosity > 425 fb^{-1}.**
- 2025c–2026b run: 5 Nov. 2025 – 1 Jun. 2026
  - Vacuum scrubbing: 5 Nov. 2025 – 17 Nov. 2025 = 13 days
  - Collision run in 2025c: 19 Nov. 2025 – 24 Dec. 2025 = 36 days
  - (Winter shutdown: 24 Dec. 2025 – 7 Jan. 2026 = 15 days)
  - Collision run in 2026a/b: 9 Jan. 2026 – 1 Jun. 2026 = 144 days
  - **Collision run total: 36 days + 144 days = 180 days**
- Physics runs account for 80% of the full collision operation, ~150 days.
  - 4 days per 3-week cycle are allocated to machine tuning, study, maintenance, etc.



Not yet precisely scheduled, just an image…

Plan A: basic plan

Target

Peak luminosity = 1×10^{35} cm^{-2}s^{-1}

Integrated luminosity > 425 fb^{-1}

Key parameters

Specific luminosity = 5.0×10^{31} cm^{-2}s^{-1}mA^{-2} at 0.86 mA^{2}

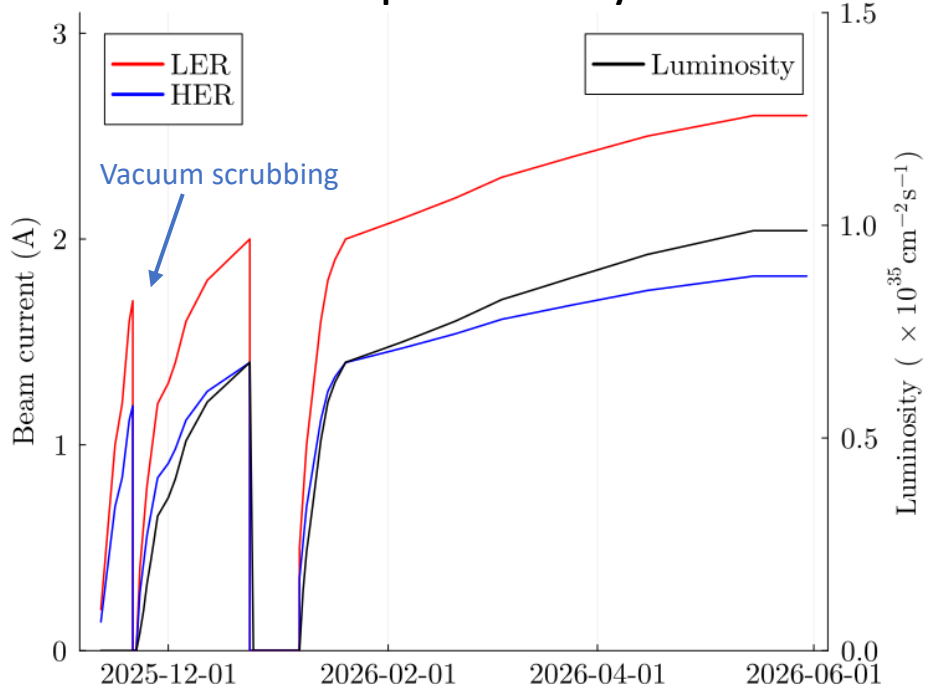
Accelerator efficiency > 60% (N.B., ~67% at 1.7 A & 1.3A in 2024c)

Requirements

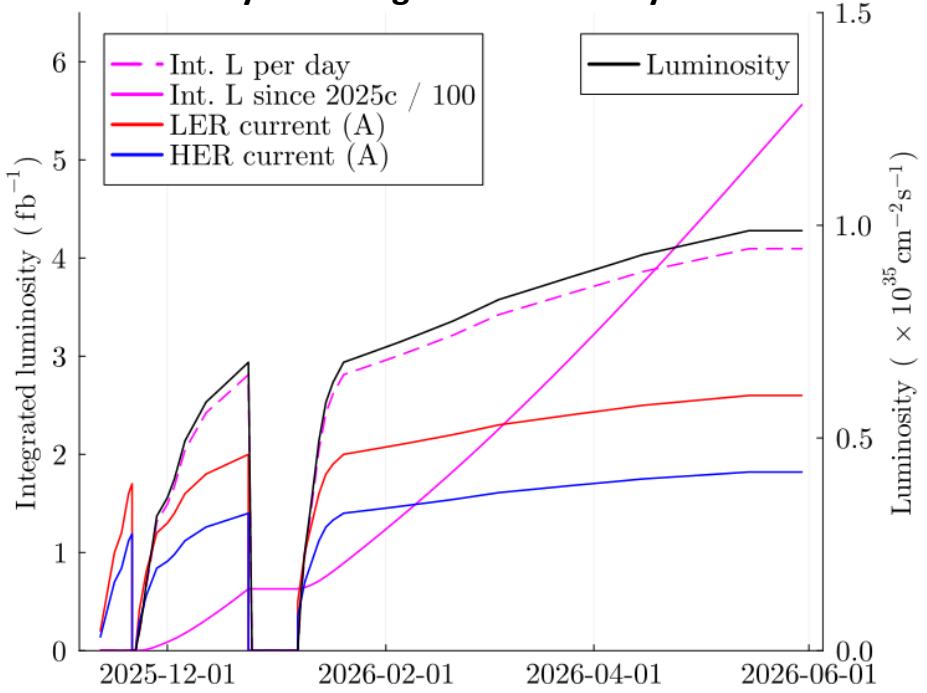
2-bunch injection in HER and LER, β_y* squeezing to 0.9 mm (plus, possibly β_x* squeezing)

Mitigation of beam-beam effects

Beam current and peak luminosity



Luminosity and integrated luminosity



Plan A: basic plan

Detailed explanation

- **Peak luminosity = 5.0 × 10^{31} $cm^{-2}s^{-1}mA^{-2}$ x 0.86 mA^2 x 2346 bunches = 1.0 × 10^{35} $cm^{-2}s^{-1}$**
- **Challenge 1: specific luminosity 5.0 × 10^{31} $cm^{-2}s^{-1}mA^{-2}$** (see p8)
  - Needs to solve the emittance blowup that occurred in HER 2024c
  - Needs squeeze β_y^* to 0.9 mm to lower the beam size at IP
- **Challenge 2: high bunch current 0.86 mA^2 for 2346 bunches** (see p9-11)
  - Corresponds to 1.8 A in HER and 2.6 A in LER
  - Needs to realize 2-bunch injection in LER and HER
  - Needs to mitigate beam-beam effects
  - β_x^* squeezing to 50 mm or lower is planned to avoid σ_x^* blowup harming beam injection.
- **An even relaxed requirement on machine tuning time** (see p12, 13)
  - Accelerator efficiency > 60% is tolerable (N.B., ~67% at 1.6 A & 1.3A in 2024ab.)
  - Namely, machine tuning in the daytime and physics run in the evening and midnight are allowed.

Plan B: optional plan

Target

Peak luminosity = 6×10^{34} cm^{-2}s^{-1}

Integrated luminosity > 425 fb^{-1}

Key parameters

Specific luminosity = 5.9×10^{31} cm^{-2}s^{-1}mA^{-2} at 0.44 mA^{2}

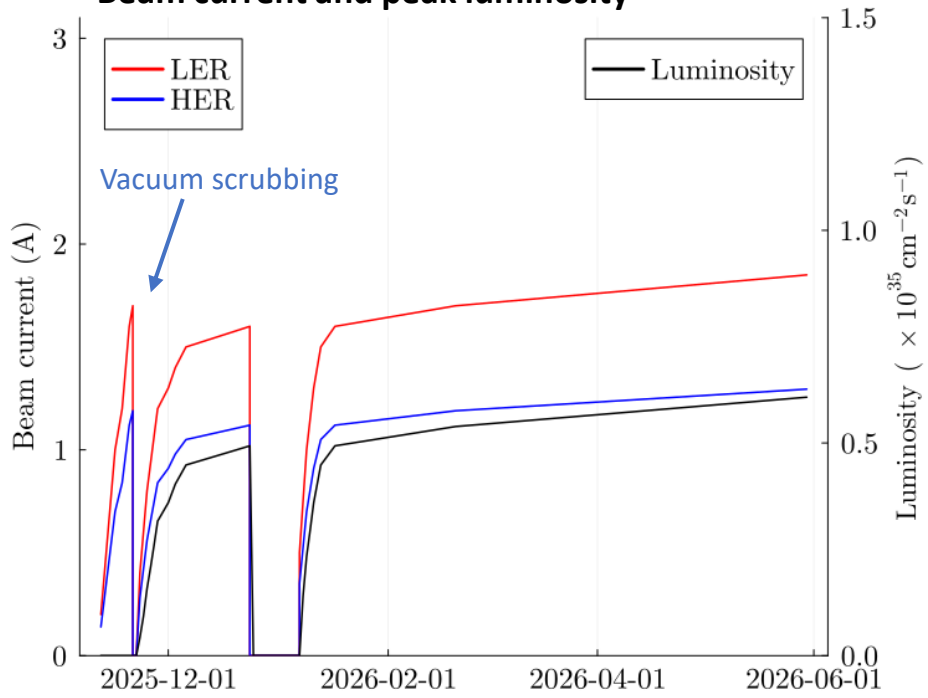
Accelerator efficiency > 85% (N.B., highest record~88% in 2022c)

Requirements

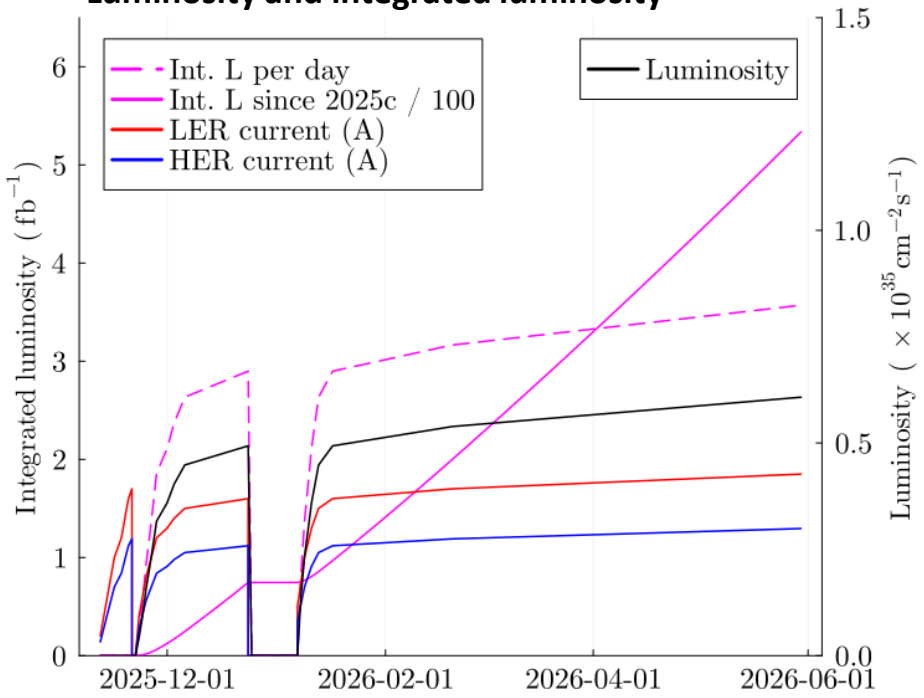
Stable operation (less SBL, less QCS quench, less machine/detector trouble)

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

Beam current and peak luminosity



Luminosity and integrated luminosity



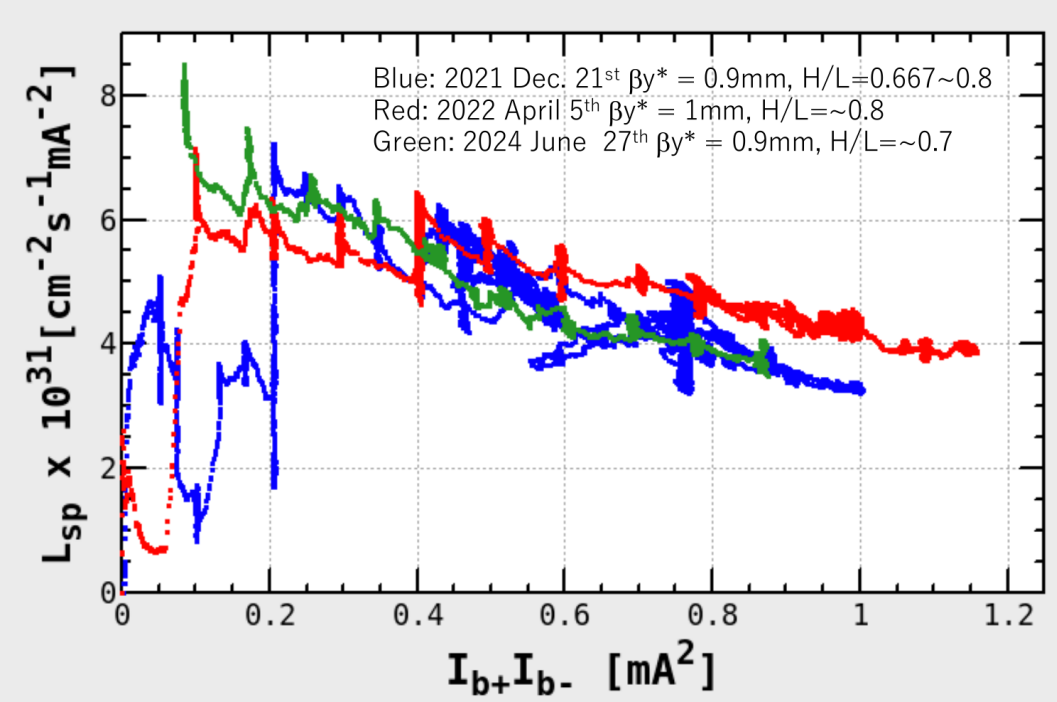
Plan B: optional plan

Detailed explanation

- **Peak luminosity = 5.9×10^{31} $cm^{-2}s^{-1}mA^{-2}$ x 0.44 mA^2 x 2346 bunches = 6.0×10^{35} $cm^{-2}s^{-1}$**
- **Challenge 1: very stable physics run, minimizing machine tuning time** (see p12, 13)
  - Needs to avoid beam abort, QCS quench, and machine/detector troubles as low as possible
  - Needs to minimize machine tuning time as much as possible while securing modest luminosity
- **An even relaxed requirement on the high current operation** (see p11)
  - Target current is 1.3 A in HER, 1.9 A in LER with 2346 bunches.
  - Could achieve 1.3 A in HER even with 1-bunch injection since the end of Nov. 2024

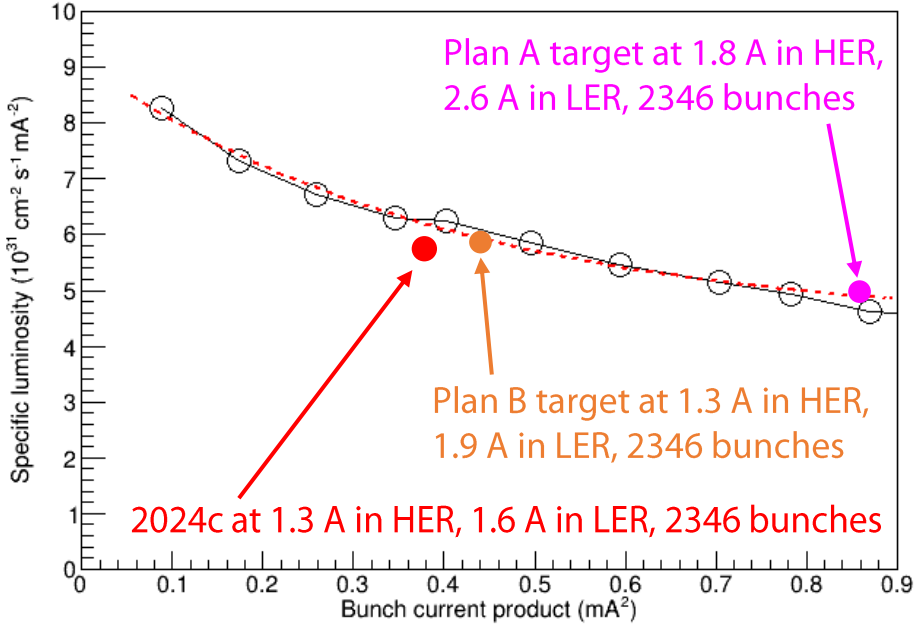
Backup

Specific luminosity



- High specific luminosity could be realized for a small number of bunches, e.g., 393 bunches.
- Challenging to realize it for 2346 bunches due to injection power, chamber-heating induced optics deformation, possibly beam instability, etc.

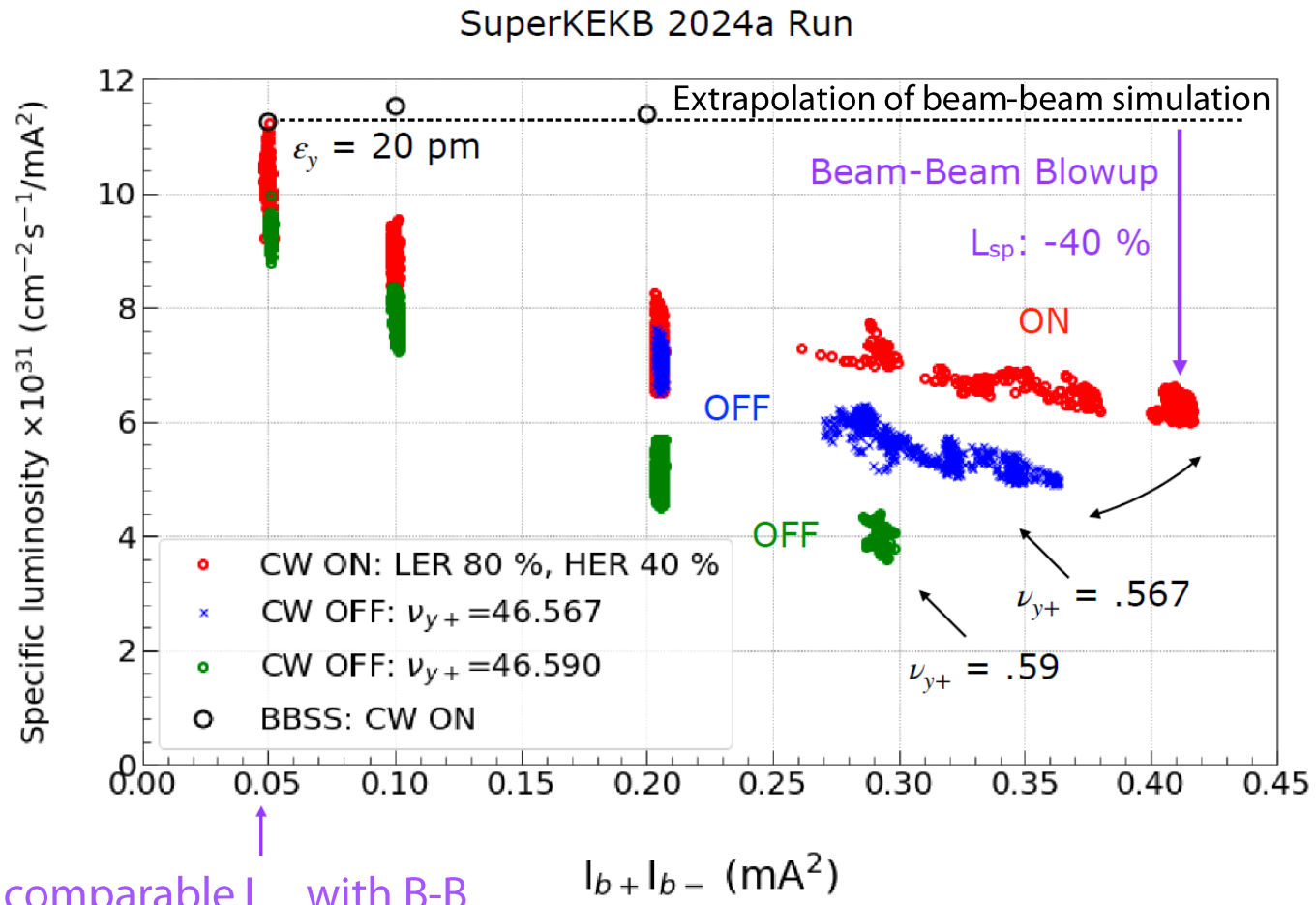
Combined data (red and green in the left panel)



- Specific luminosity lying on the red dashed curve could be realized if HER emittance blowup in 2024c was solved (though not solved.)
- Optics study is planned for early 2025c to address emittance blowup if it reappears.

Beam-beam effects

(Y. Ohnishi, eeFACT2025)

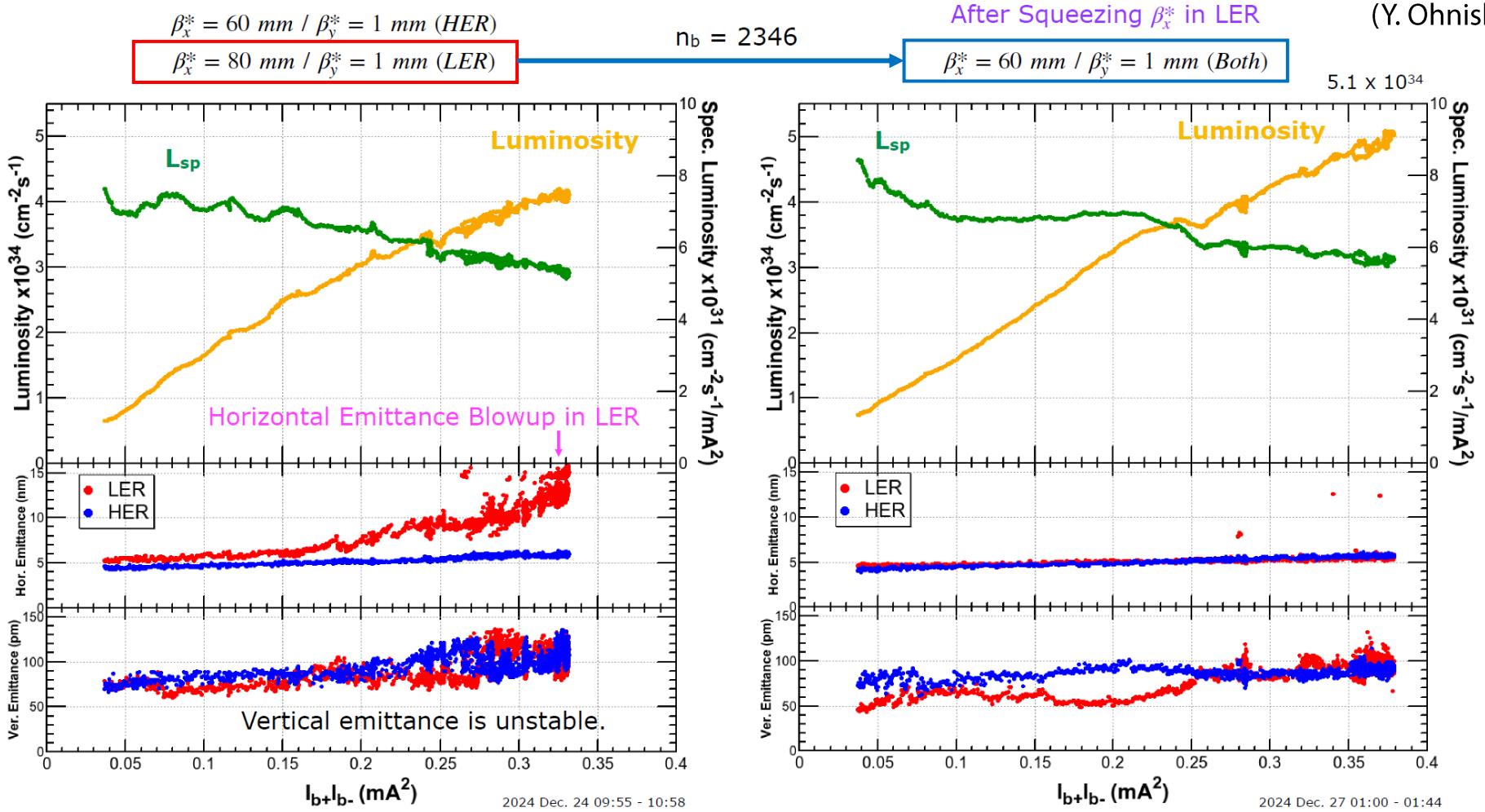


Obtained comparable L_{sp} with B-B simulation at low bunch current

- International collaboration is formed to tackle the beam-beam blowup issue (https://kds.kek.jp/category/1840/).
- Feedback will be applied to machine operation and studies in 2025c.

β_x^* squeezing

(Y. Ohnishi, eeFACT2025)



- β_x^* squeezing to 60 mm in LER was successful in mitigating σ_x^* blowup, then achieving 1.7 A in LER.
- β_x^* squeezing to 50 mm or lower is considered to avoid σ_x^* blowup harming beam injection.

2-bunch injection

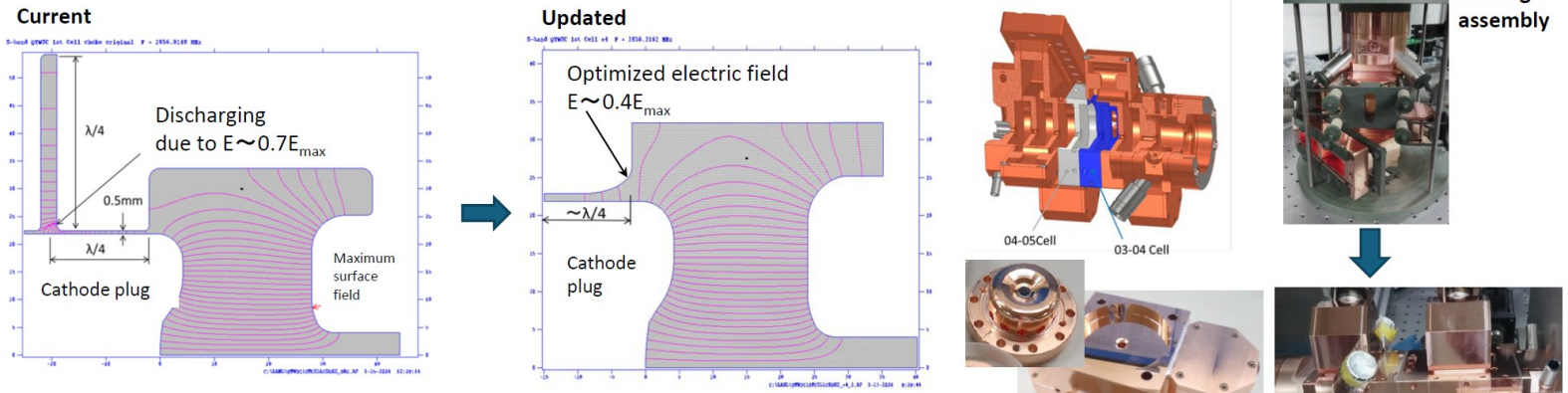
- We could achieve 1.3 A in HER (1-bunch) and 1.7 A in LER (2-bunch) with 2346 bunches in 2024c.
- HER injection started with a 2-bunch scheme. It came to a 1-bunch injection due to the discharge of the RF e- gun.
- Before 2025c, RF e- gun will be replaced with a new type of gun or fixed using a spare cathode plug.
- 2-bunch injection is essential for 1.8 A in HER and 2.6 A in LER in Plan A.

Status of RF Gun (Linac) – Updated QTWSC RF Gun

[M. Yoshida *et al.*]

(T. Ishibashi, B2GM, June 2025)

- The current RF gun cathode cell includes a choke structure for thermal cleaning of the cathode.
- The updated cathode cell is designed with:
  - Optimized surface field
  - Additional vacuum pumping
  - A new triplet downstream of the gun
- During brazing, the wrong cavity cell was assembled, resulting in a 10 MHz frequency offset (No tuning required for cathode side cavity chain).
- Tuning of the RF cavity is scheduled this week. RF conditioning will be performed until July.



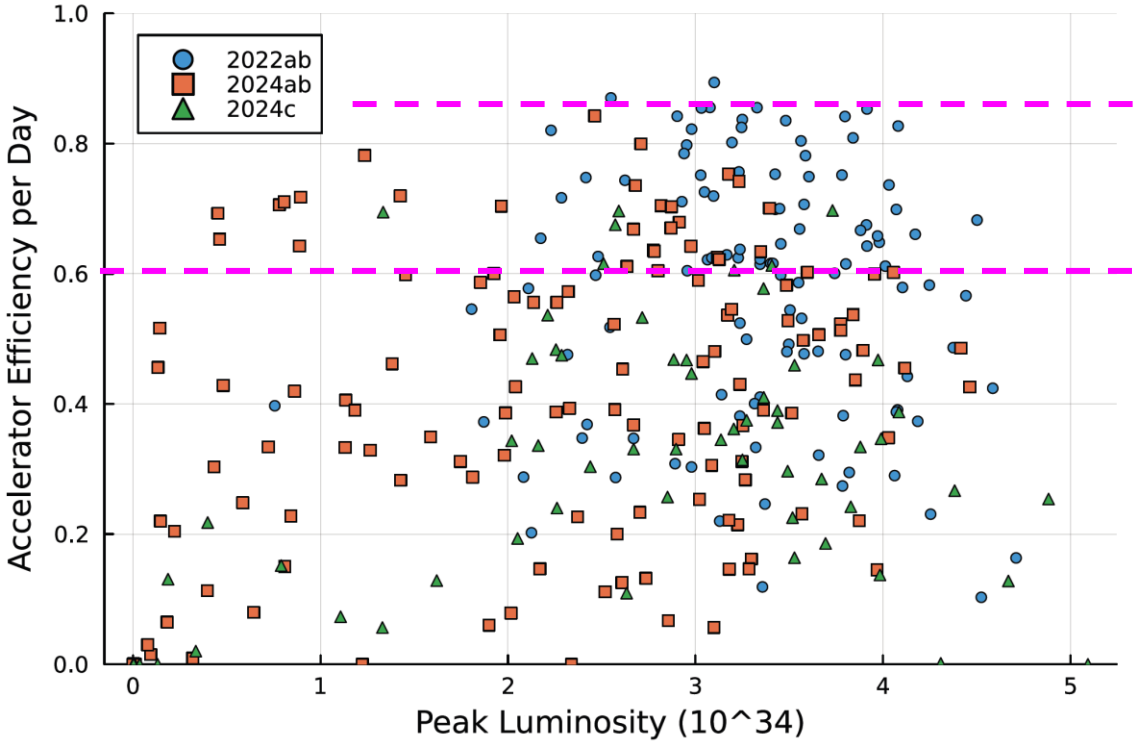
- If tuning cannot sufficiently correct the frequency offset and the schedule is delayed, a new IrCe cathode plug will be installed in the current RF gun.

New IrCe Cathode Plug

Additional machining for tuning

Accelerator efficiency

- A measured quantity of how constantly we can acquire the integrated luminosity while keeping the peak luminosity
- Accelerator efficiency is defined as $\varepsilon_{\mathrm{acc}} \equiv \dfrac{\text{Integrated luminosity}}{\int^{24\ \text{hours}} L_{\mathrm{peak}} dt}$
- Cause of low accelerator efficiency: beam aborts, machine tuning inserted in physics run, unstable luminosity, etc.



Required in Plan B

Required in Plan A

- Accelerator efficiency in the left figure is defined as "per day" so that the inefficiency due to machine tuning in the daytime is included.
- Minimizing machine tuning time as much as possible while maintaining modest luminosity yields high efficiency.

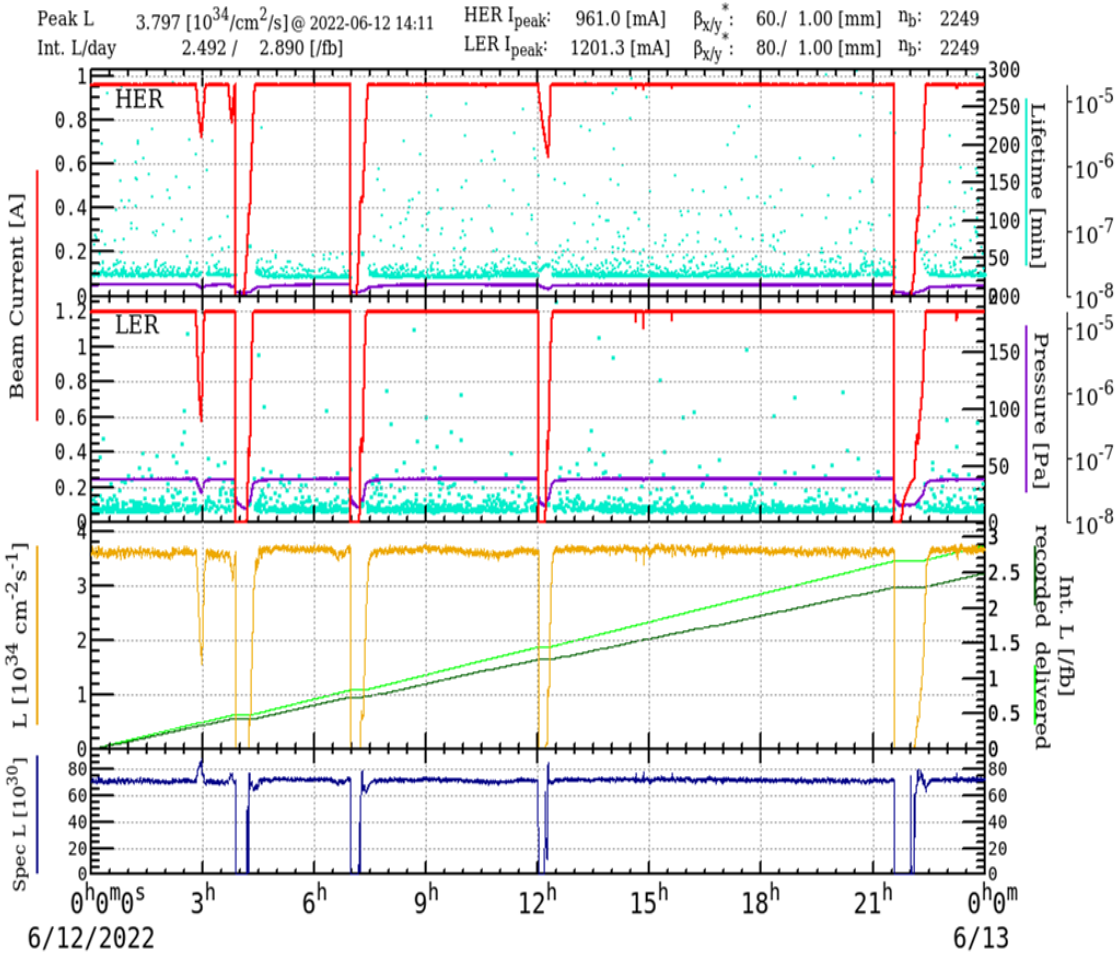
Accelerator efficiency on 12 June 2022

Example of high integrated luminosity/day

- Date: 2022-06-12, with β_y^*=1 mm
- Beam currents: I_{LER}=1.2 A, I_{HER}=0.96 A (2249 bunches)
- Peak luminosity: 3.8×10^{34} $cm^{-2}s^{-1}$
- Integrated luminosity (delivered): 2.89 fb^{-1}
  (2.49 fb^{-1} recorded with the DAQ efficiency: ~86%)

If operated at this luminosity for 24 hours:

- Delivered integrated luminosity = 3.28 fb^{-1}/day
- Accelerator efficiency: (2.89/3.28) × 100 ≈ 88%



Luminosity history