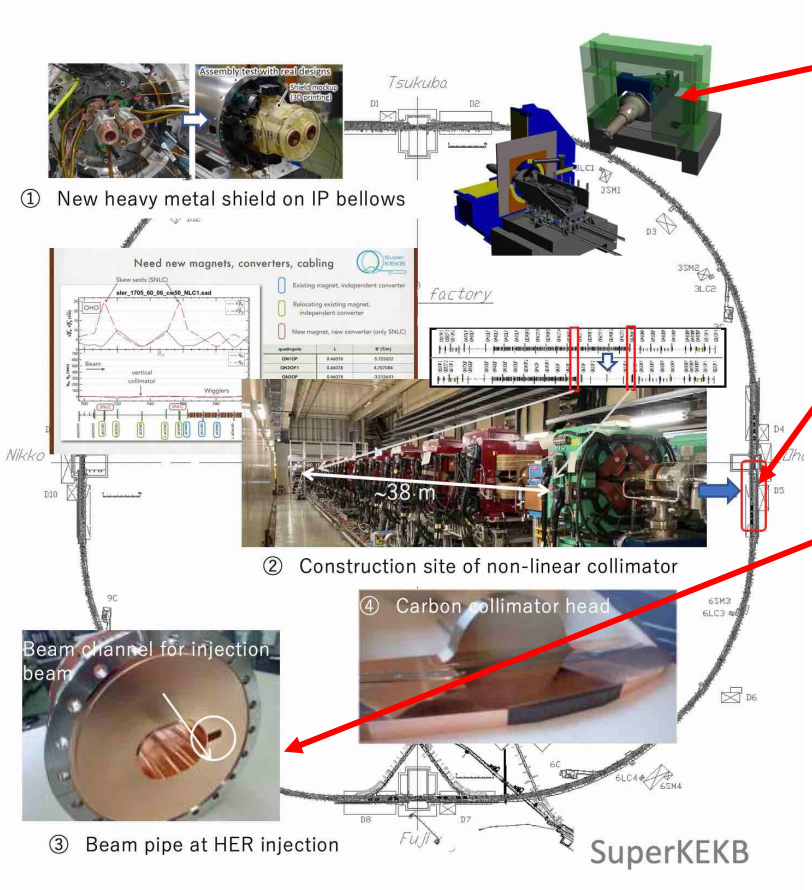
SuperKEKB commissioning

1. LS1 work
2. Commissioning plan
   - 2-1 Vacuum scrubbing
   - 2-2 Tentative weekly schedule
   - 2-3 Current, luminosity

1. LS1 work



(1) Reinforcement of radiation shielding around the IP, replacement of the cap at the head of the QCS cryostat
→ Background reduction

(2) Installation of a new type of collimator (Non-Linear Collimator) in the Oho straight section
→ reduction of beam instability caused by the collimator, collimator protection, and etc.

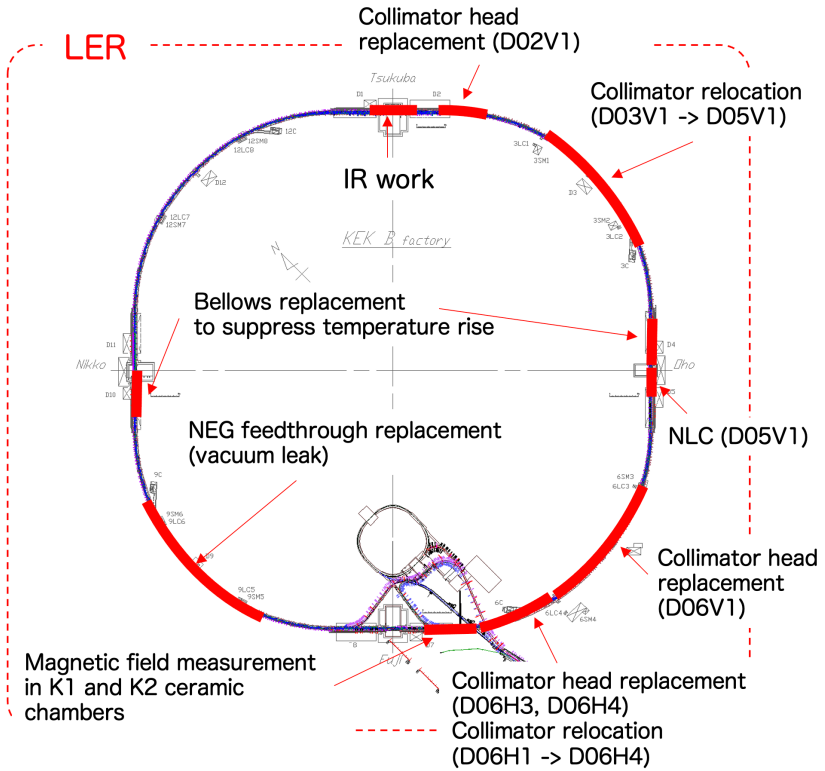
(3)Chamber modification of the HER injection section
→ injection injection efficiency improvement

(4) Replacement of collimator head
→ installation of more robust collimator, replacement of damaged collimators, Cu coating on the collimator head (against SBL from “fireball,” etc.)

Monitors added, acoustic sensors around the collimators (SBL)

2-1 Vacuum scrubbing

Vacuum scrubbing needed for LER (Vacuum work area indicated by ▬)

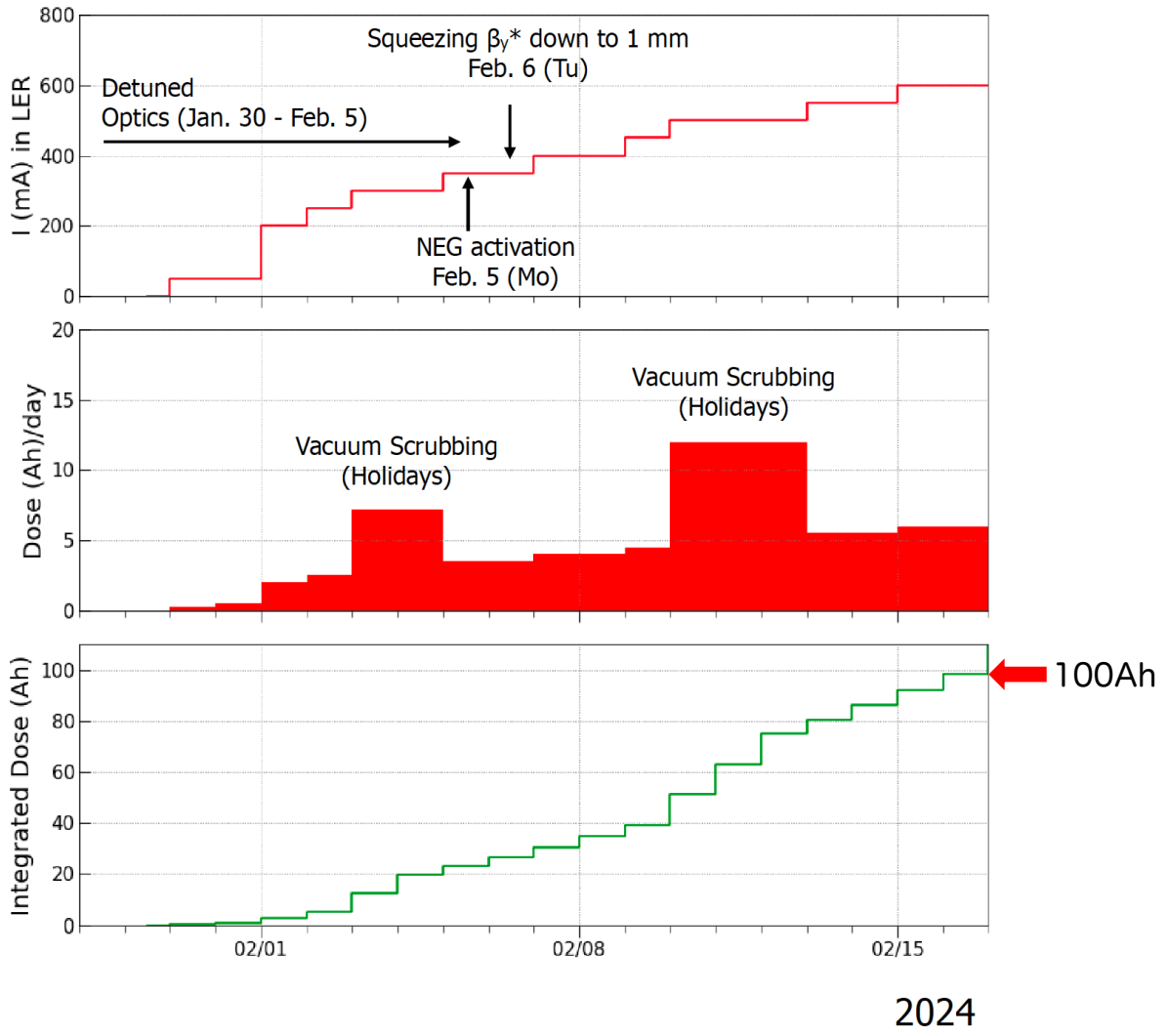


- IR Work
- Beam pipe and other installation work for NLC construction
- Collimator related
  - Head replacement: D02V1, D06V1, D06H3 (carbon), D06H4
  - Collimator relocation: D03V1 to D05V1, D06H1 to D06H4
  - Chamber with HOM absorber installed near D06V1
- Replacement of bellows in Nikko-Oho Wiggler section (to prevent temperature rise)
- Magnetic field measurement in K1 and K2 ceramics chambers
- Vacuum leak due to broken feedthrough for strip-type NEG pump (D09 arc section)

- Beam dose required for vacuum scrubbing (approx.): 100 Ah

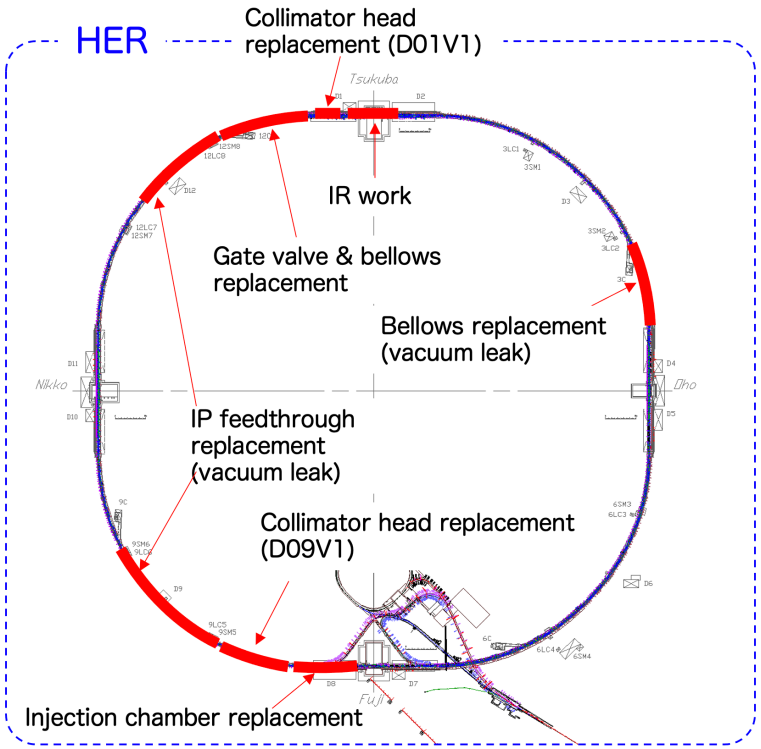
2-1 Vacuum scrubbing

~100Ah scrubbing plan (LER)



2-1 Vacuum scrubbing

Vacuum scrubbing needed for HER (Vacuum work area indicated by ▬)



- IR Work
- Collimator related
  - Head replacement: D01V1, D09V1
- Bellows replacement on the gate valve collision point side (D01 arc section)
  - During beam operation, pressure jumps were frequently occurring in CCG D01_H116 near the gate valve.
  - The bellows on the gate valve collision point side was removed for internal observation, and it was found that the depth of the RF contact groove upstream of the bellows chamber was 1 mm deeper than the design value (the design value of 1.95 mm was actually 2.95 mm).
  - The bellows was replaced with one of the correct dimensions.
- Chamber replacement at injection section
- Vacuum leak at ion pump HV feedthrough (D09, D12 arc section)
- Vacuum leak at bellows chamber weldment (D04 arc section)

- Beam dose required for vacuum scrubbing (approx.): 50 Ah

2-2 Tentative weekly schedule

Y. Ohnishi

2024	January					February	
	27 (Sat)	28 (Sun)	29 (Mon)	30 (Tue)	31 (Wed)	1 (Thu)	2 (Fri)
Owl				HER vacuum scrubbing 100 mA	HER vacuum scrubbing 200 mA LER vacuum scrubbing 100 mA	HER vacuum scrubbing 250 mA LER vacuum scrubbing 200 mA	HER vacuum scrubbing 250 mA LER vacuum scrubbing 250 mA
Day			HER β_y^* = 81.0 mm Find COD HER BCM	LER β_y^* = 48.6 mm (without D05V1) Find COD HER BCM LER New beamline	LER/HER TBT BPM study	LER β_y^* = 48.6 mm (with D05V1) LER optics correction D05V1 study	DA measurement
			HER BxB FB tuning	LER BxB FB tuning	HER injection tuning HER kicker jump HER septum tuning	D05V1 study LER impedance meas.	DA measurement
Evening			HER BxB FB tuning	LER BxB FB tuning	LER injection tuning LER kicker jump LER septum tuning	LER/HER QuadBPM	acoustic sensor (SBL)
			HER BPM gain mapping HER optics correction HER injection tuning	LER BPM gain mapping LER optics correction LER injection tuning	LER/HER QuadBPM	LER/HER QuadBPM	acoustic sensor (SBL)

2-2 Tentative weekly schedule

Y. Ohnishi

2024	February						
	3 (Sat)	4 (Sun)	5 (Mon)	6 (Tue)	7 (Wed)	8 (Thu)	9 (Fri)
Owl	HER vacuum scrubbing 300 mA LER vacuum scrubbing 300 mA	HER vacuum scrubbing 300 mA LER vacuum scrubbing 300 mA	HER vacuum scrubbing 350 mA LER vacuum scrubbing 350 mA	HER vacuum scrubbing 350 mA LER vacuum scrubbing 350 mA	HER vacuum scrubbing 400 mA LER vacuum scrubbing 400 mA	HER vacuum scrubbing 400 mA LER vacuum scrubbing 400 mA	HER vacuum scrubbing 450 mA LER vacuum scrubbing 450 mA
Day		Standardize magnets	LER NEG activation	LER β_y^* = 48.6 → 8 mm LER β_y^* = 8 → 3 mm LER β_y^* = 3 → 2 mm LER β_y^* = 2 → 1 mm	HER β_y^* = 81 → 8 mm HER β_y^* = 8 → 3 mm HER β_y^* = 3 → 2 mm HER β_y^* = 2 → 1 mm	collision tuning find collision backet	LER D05V1 study
			LER NEG activation	LER optics correction	HER optics correction	collision tuning	LER D05V1 study
Evening			HER optics correction LER optics correction	LER BxB FB tuning	HER BxB FB tuning	LER TBT BPM study	collimator tuning
				LER injection tuning LER collimator tuning LER impedance meas.	HER injection tuning HER collimator tuning HER impedance meas.	HER TBT BPM study	collimator tuning

2-2 Tentative weekly schedule

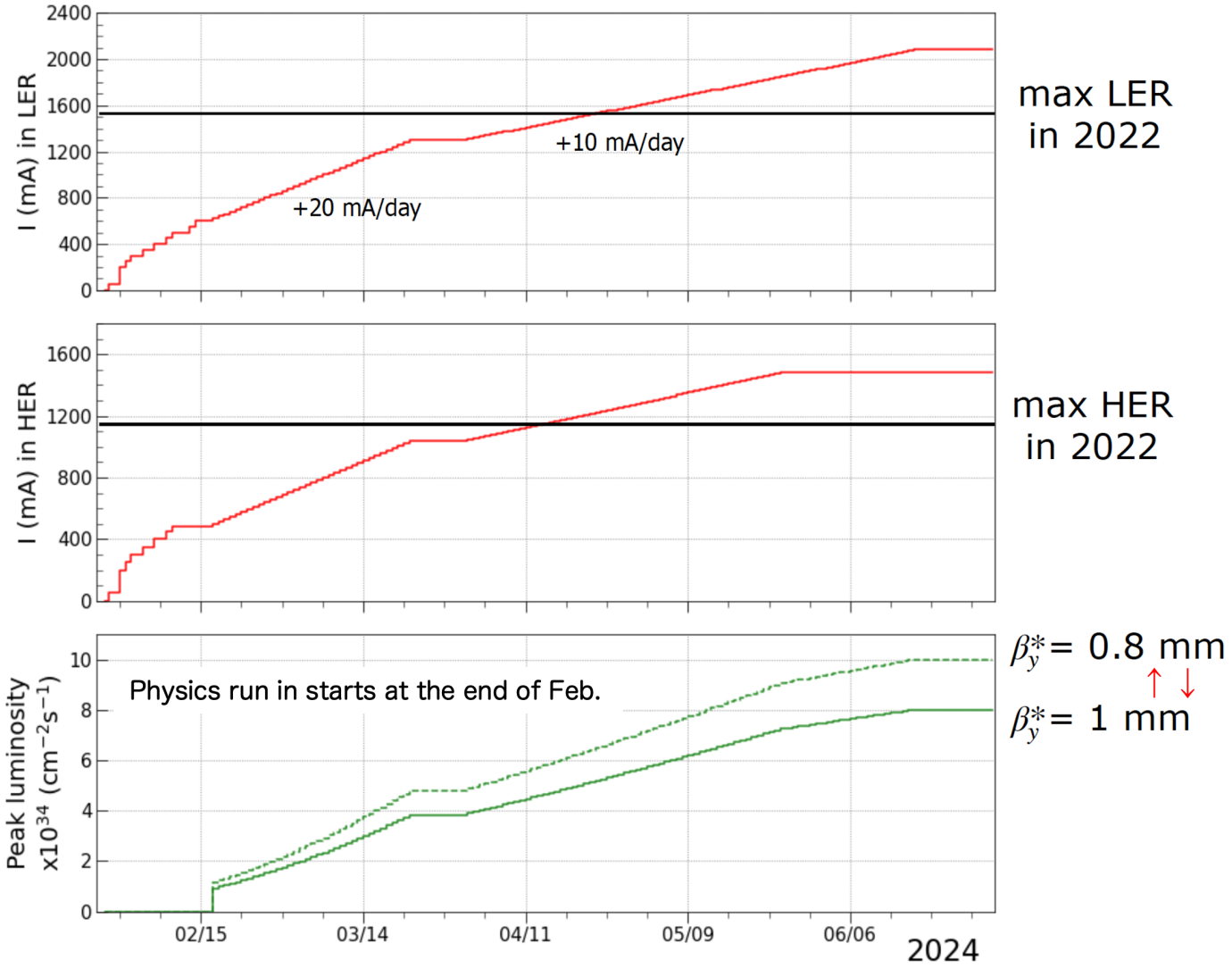
Y. Ohnishi

2024	February						
	10 (Sat)	11 (Sun)	12 (Mon)	13 (Tue)	14 (Wed)	15 (Thu)	16 (Fri)
Owl	HER vacuum scrubbing 500 mA LER vacuum scrubbing 500 mA	HER vacuum scrubbing 500 mA LER vacuum scrubbing 500 mA	HER vacuum scrubbing 500 mA LER vacuum scrubbing 500 mA	HER vacuum scrubbing 550 mA LER vacuum scrubbing 550 mA	HER vacuum scrubbing 600 mA LER vacuum scrubbing 600 mA	HER vacuum scrubbing 600 mA LER vacuum scrubbing 600 mA	HER vacuum scrubbing 600 mA LER vacuum scrubbing 600 mA
Day				HER sextupole study	LER sextupole study	LER rotating sextupole	
				HER sextupole study	LER sextupole study	LER rotating sextupole	
Evening				HER TBT BPM study	LER TBT BPM study		
				HER TBT BPM study	LER TBT BPM study		

2024	February						
	17 (Sat)	18 (Sun)	19 (Mon)	20 (Tue)	21 (Wed)	22 (Thu)	23 (Fri)
Owl	HER vacuum scrubbing 600 mA LER vacuum scrubbing 600 mA	HER vacuum scrubbing 600 mA LER vacuum scrubbing 600 mA	HER vacuum scrubbing 600 mA LER vacuum scrubbing 600 mA	HER vacuum scrubbing 496 mA LER vacuum scrubbing 620 mA			
Day			tuning for physics run		maintenance (regular)		
			tuning for physics run				
Evening							

2-3 Current, luminosity

Y. Ohnishi



Recover the 2022 peak luminosity with $\beta_y^* = 1mm$

↑ ↓

$\beta_y^* = 0.8\,mm$ study

↑ ↓

Aim at Luminosity run with $\beta_y^* = 0.8\,mm$

It is not possible to say at this stage when β_y^* will be changed.

(Needless to say that) luminosity will be lower while tuning the machine with new parameters, such as β_y^*.

2-3 Current, luminosity

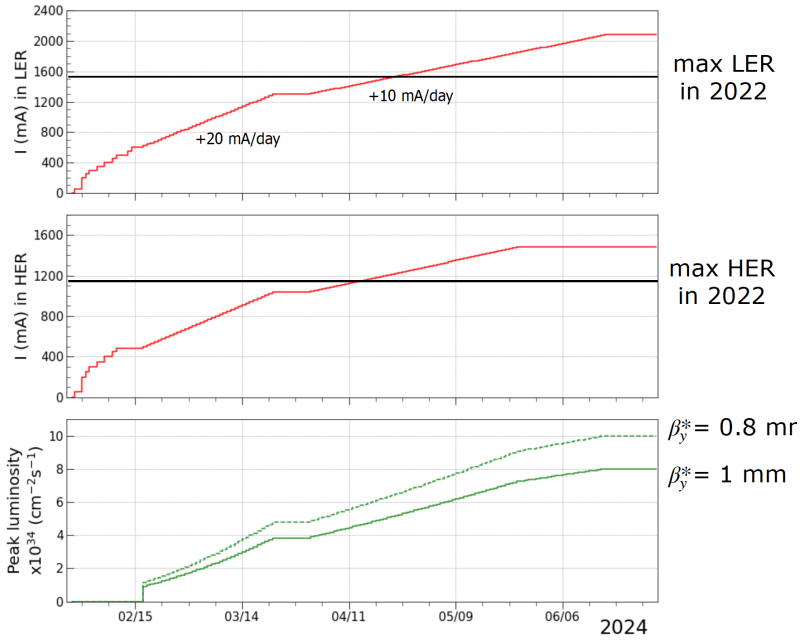
Slide presented at the commissioning meeting on Jan.12, 2024 by Y. Ohnishi.

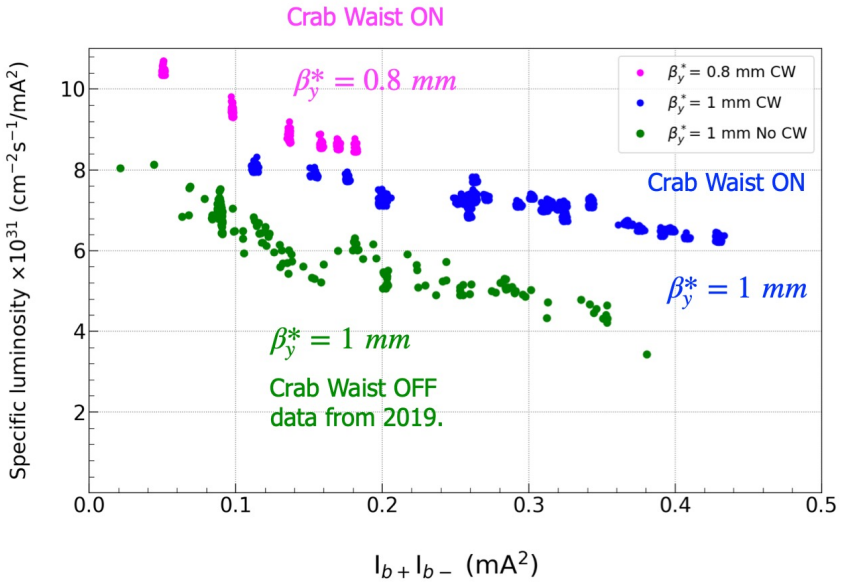
どのようにして、β_y^* を絞っていくか？

10^{35} cm^{-2}s^{-1} を達成するためには、0.8 mmは必要
力学的口径（ビーム寿命）の問題を解決しなければならない。
どこかで、決心する必要がある。（クラブ空洞@KEKBの時のように）

どのようにして、電流を増大していくか？

SBLを封じ込めることができるか？
測定器や加速器に損害を与えずに、安全にビーム電流を増やしていく道筋が必要。





- Increasing the total beam currents (bunch currents)
  ↔ (obstruction) Sudden Beam Loss
- Squeezing β_y^*
  ↔Dynamic aperture, lifetime, background control, injection
  ▶sextupole settings, collimator settings
- Optimizing the Crab waist ratio for both LER and HER.

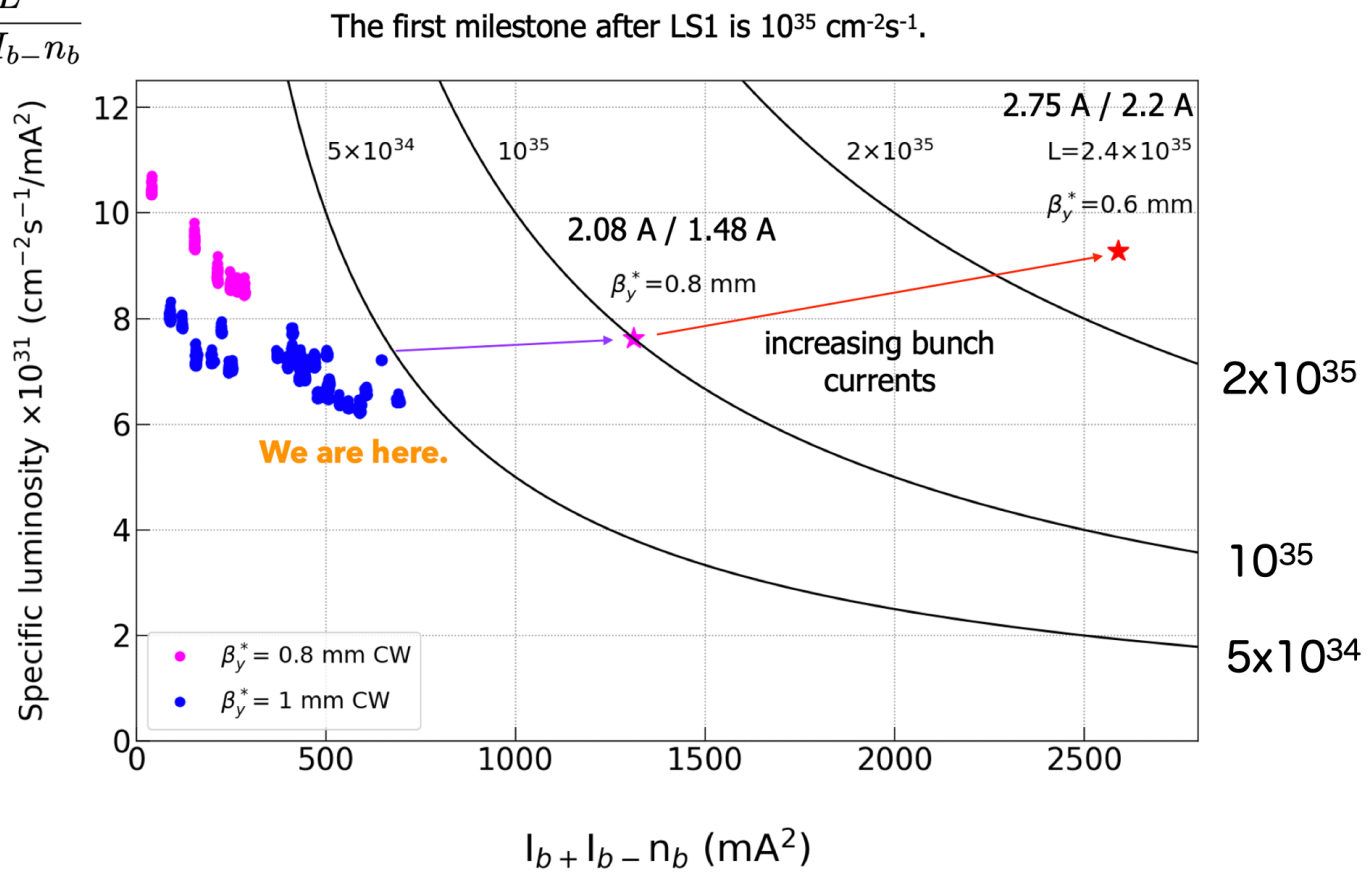
Crab waist (CW)

- Reduces resonance lines and beam-tail due to beam-beam interactions.
- CW seemed to have improved luminosity.
  - We will confirm the luminosity gain.
- The CW ratio (LER 80%, HER 40% in 2022) will be optimized
  - lifetime vs luminosity gain

Machine study time
↑ ↓
Physics run

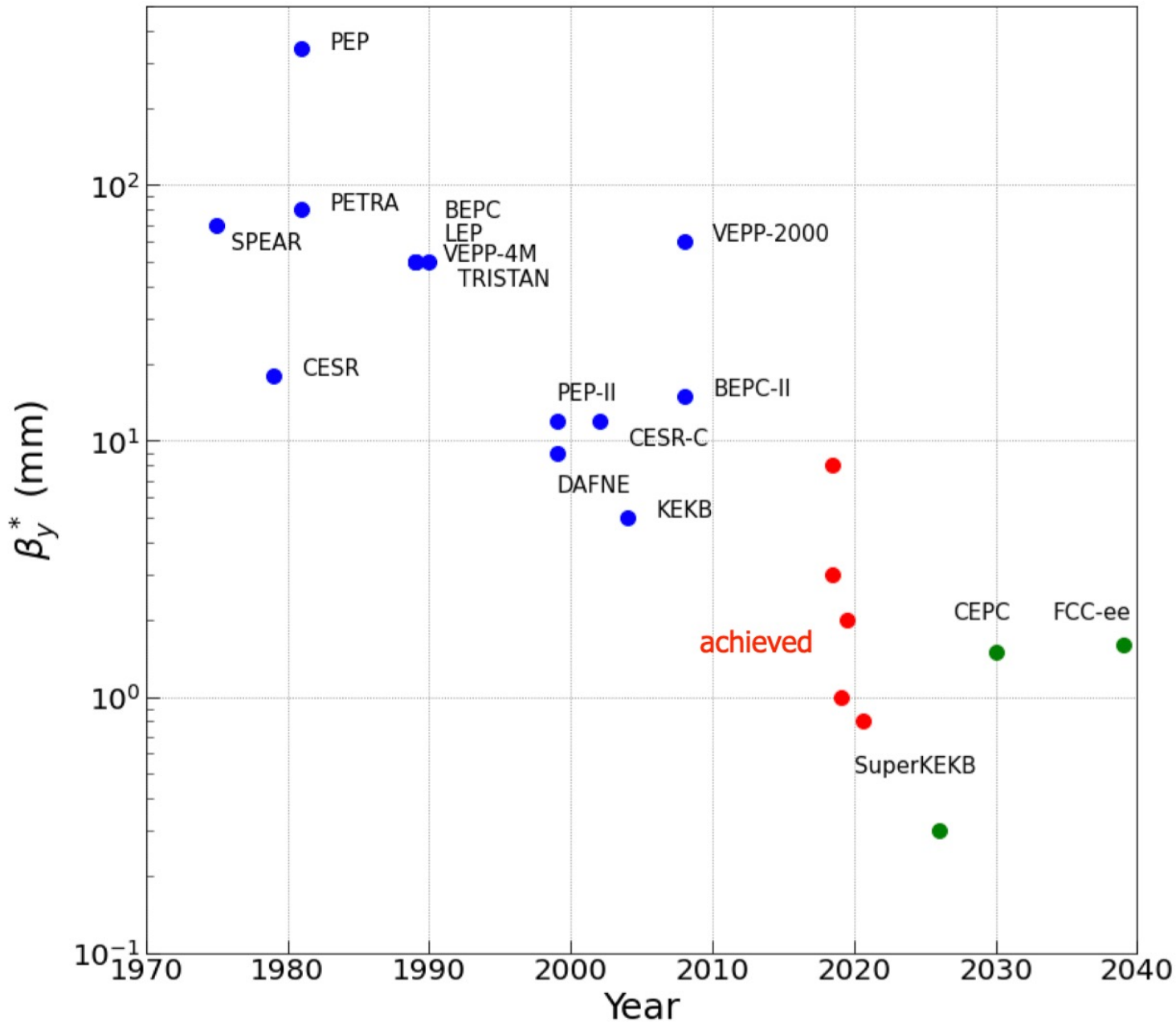
2-3 Current, luminosity

$$L_{sp} = \frac{L}{I_{b+} I_{b-} n_b}$$



Let's continue to work together to achieve our goals.

History of β_y^*



Luminosity degradation

Possible causes

- Machine imperfections: Non-zero linear and chromatic coupling and dispersions at IP, beam-current dependent optics distortion due to orbit change at QCS* and SLY*, etc.
- Imperfect crab waist scheme; Interplay of beam-beam interaction and beam coupling impedance.
- Beam oscillation excited by injection kickers at LER causes luminosity loss by ~10%.

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