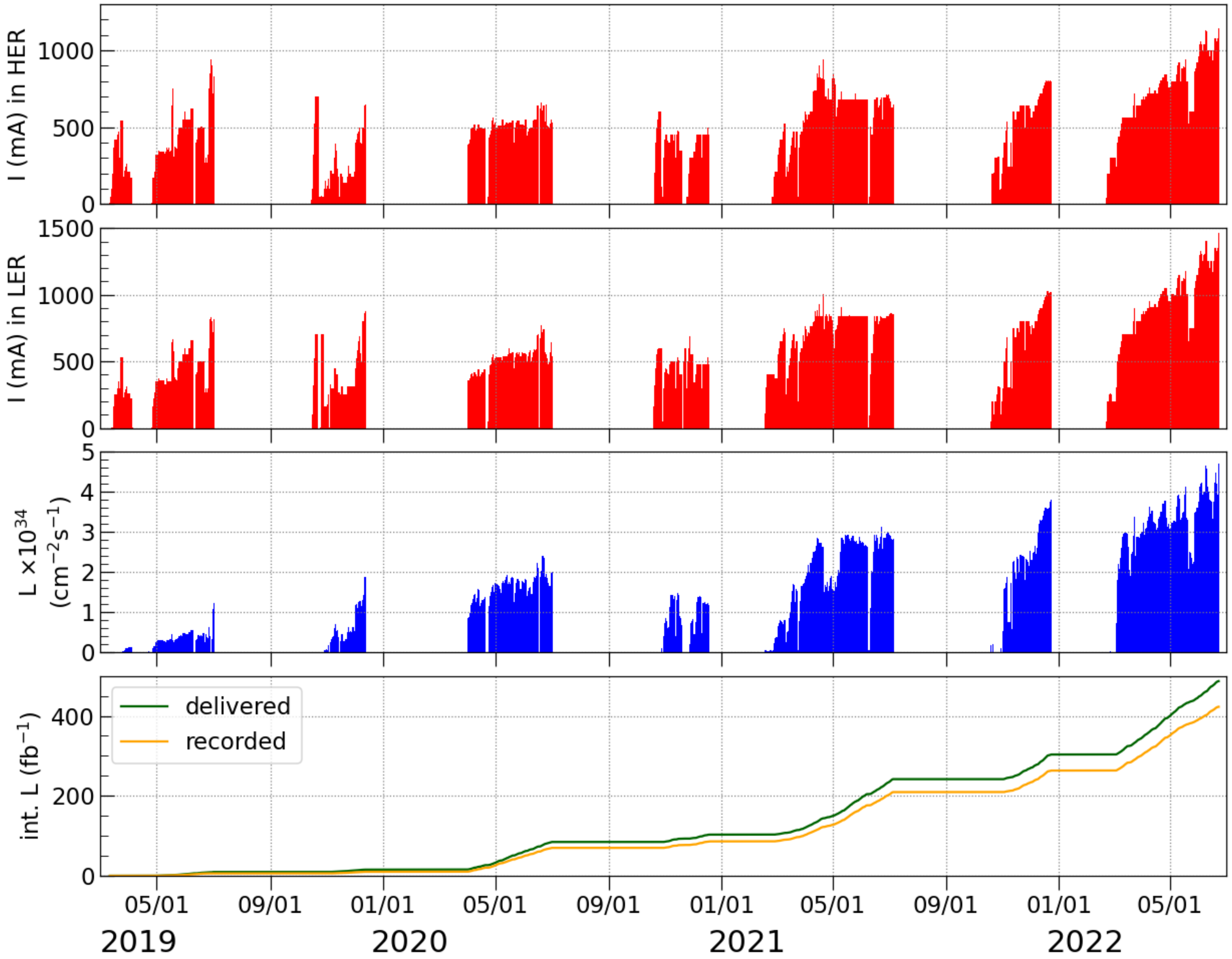
LS2

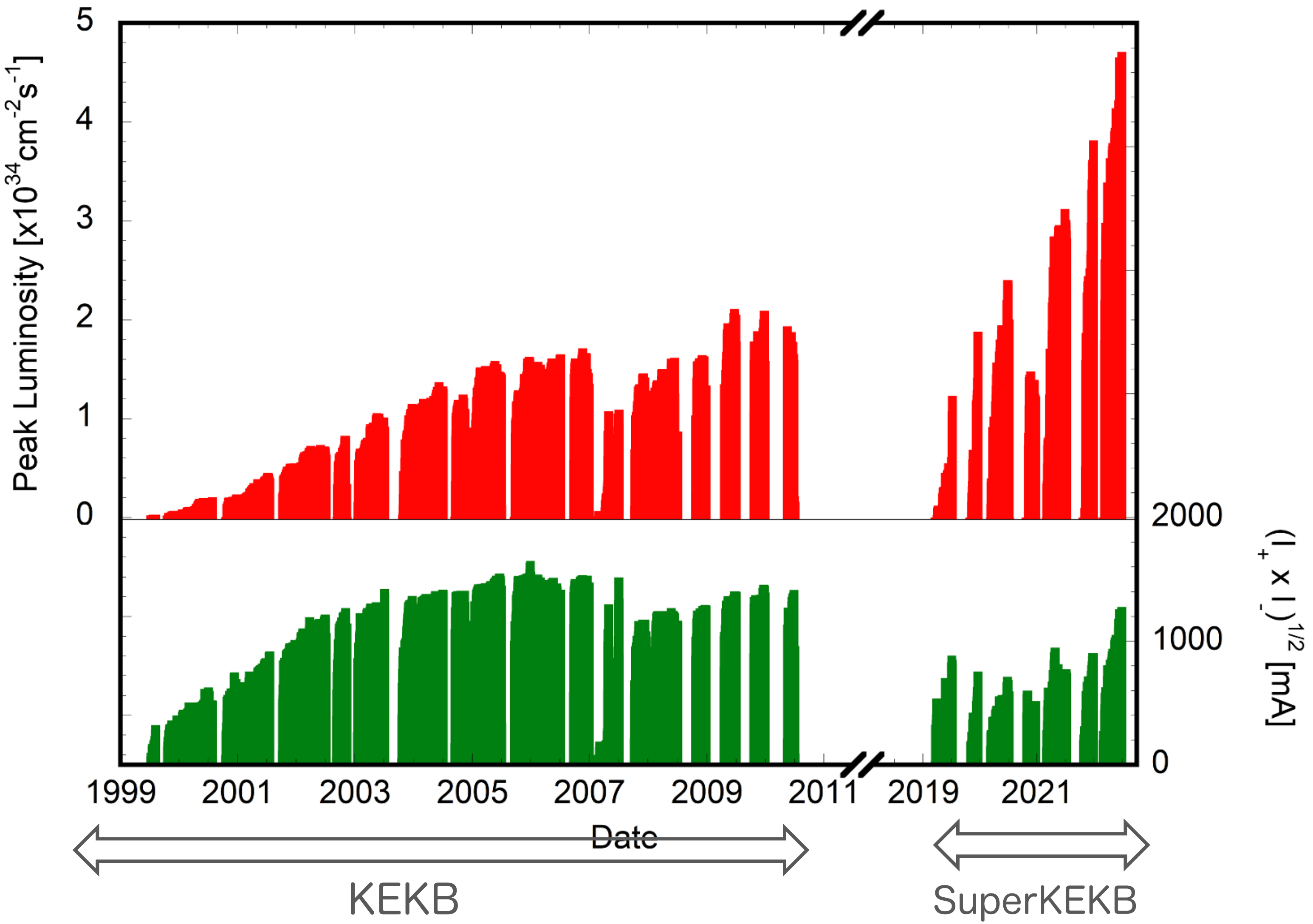
Mika Masuzawa

What we accomplished



What we accomplished

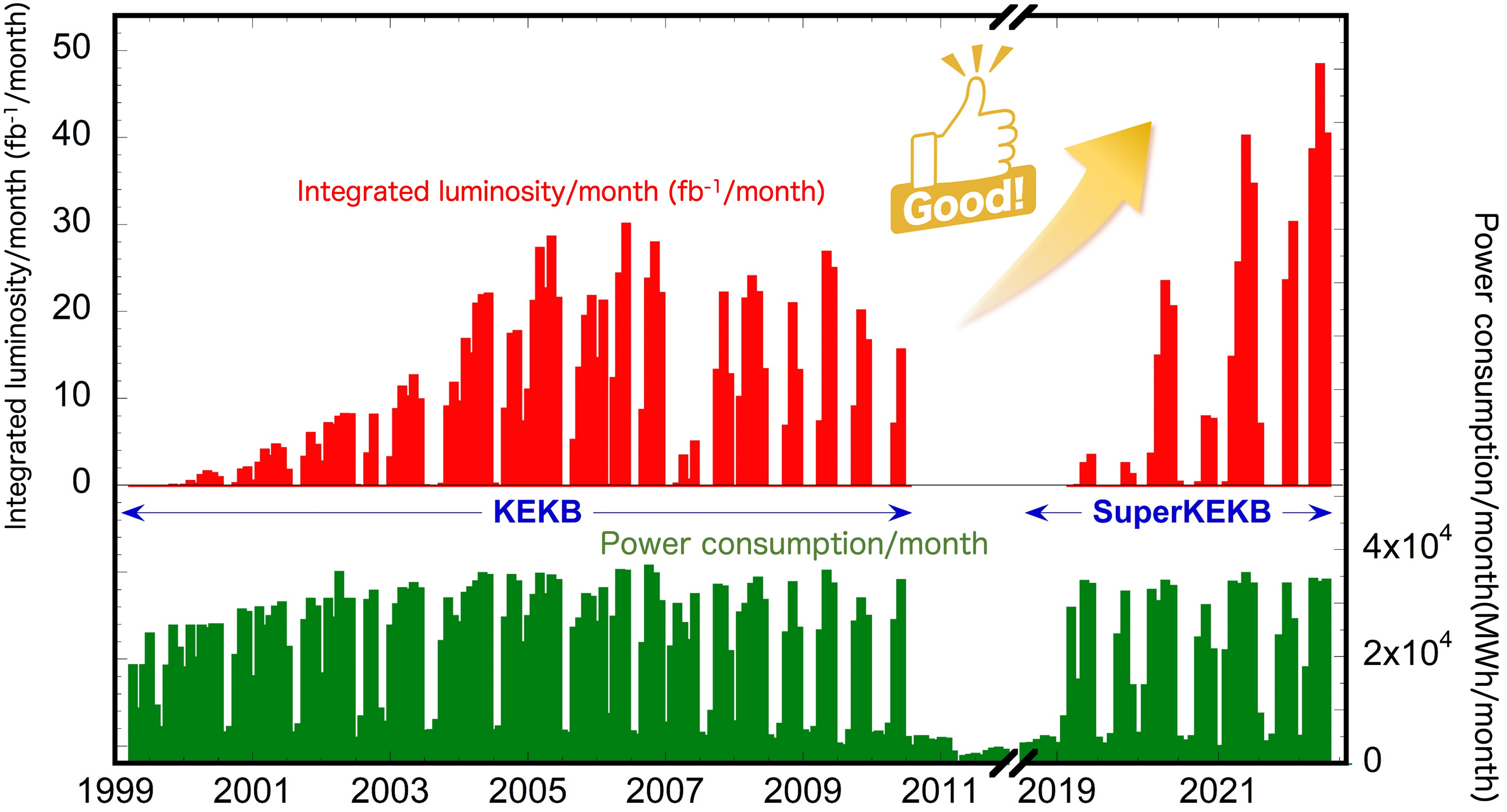
Peak luminosity and Beam currents
(up to June 22, 2022)



By Y. Suetsugu

What we accomplished

Integrated luminosity and Power consumption
(up to Mar. 2022)



By Y. Suetsugu

SuperKEKB (”nano-beam” scheme) is “eco”
economical and ecological

But our goal is luminosity

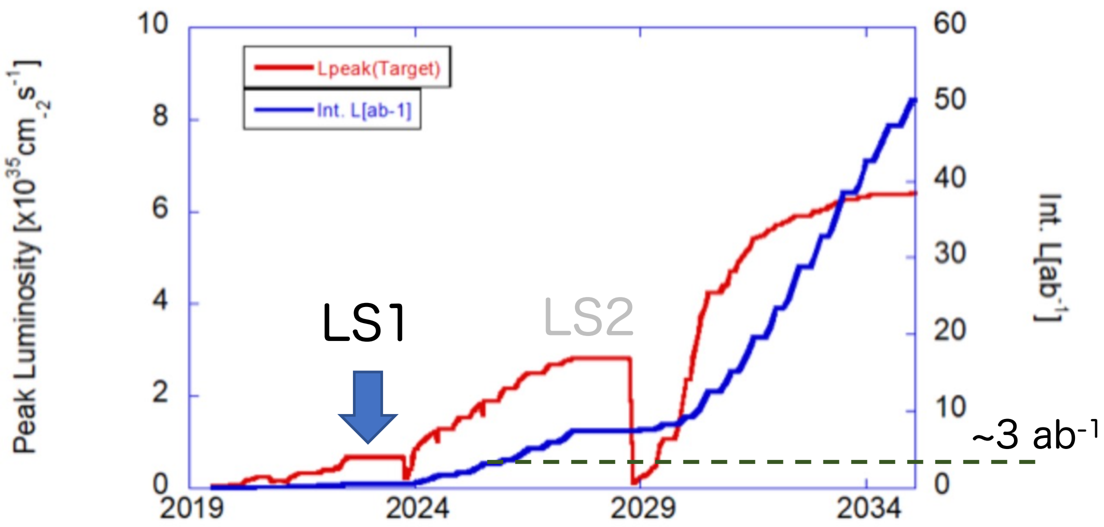
“Next Generation B-factories” @IPAC10

Next Generation B-factories

Q: How many years would we need to accumulate 50 ab^{-1}
(the target given by the physics community)
IF we kept running the present KEKB?

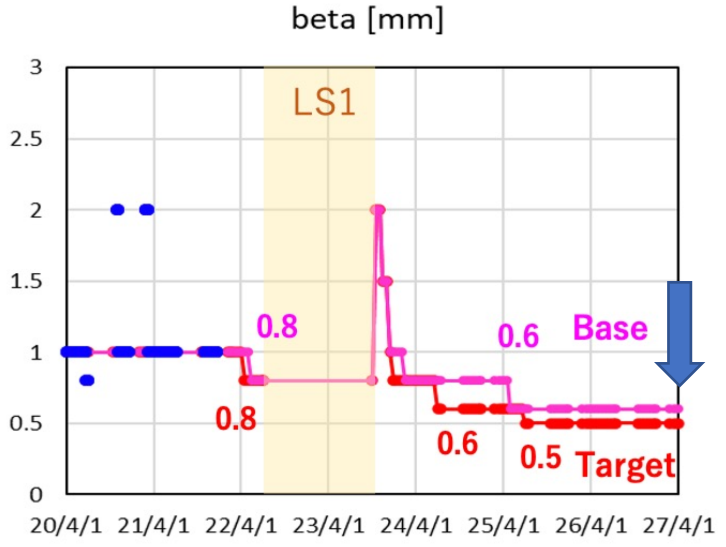
A: With the current peak luminosity of $2 \times 10^{34}\ cm^{-2}s^{-1}$
⇒0.3 ab^{-1}/year (assuming 1.5×10^{7} seconds/year running)
⇒167 years.

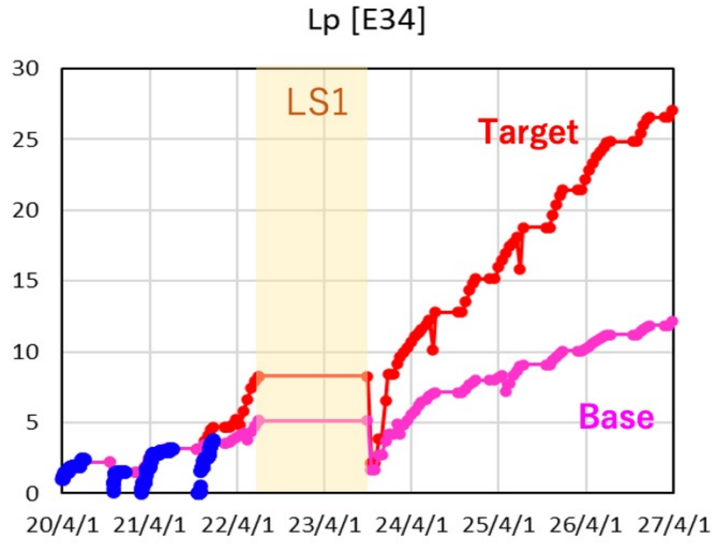
Need for much higher luminosity machines:
Next Generation B-factories



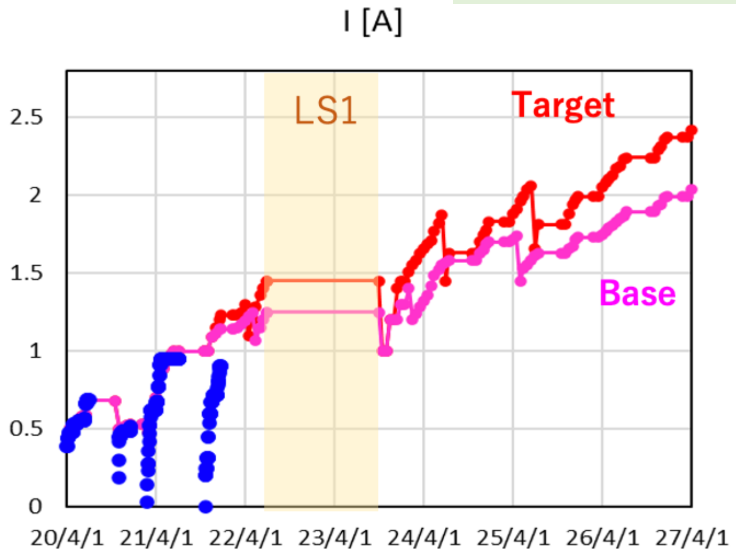
If we had kept running KEKB we would have accumulated ~3 ab^{-1} over 10 years

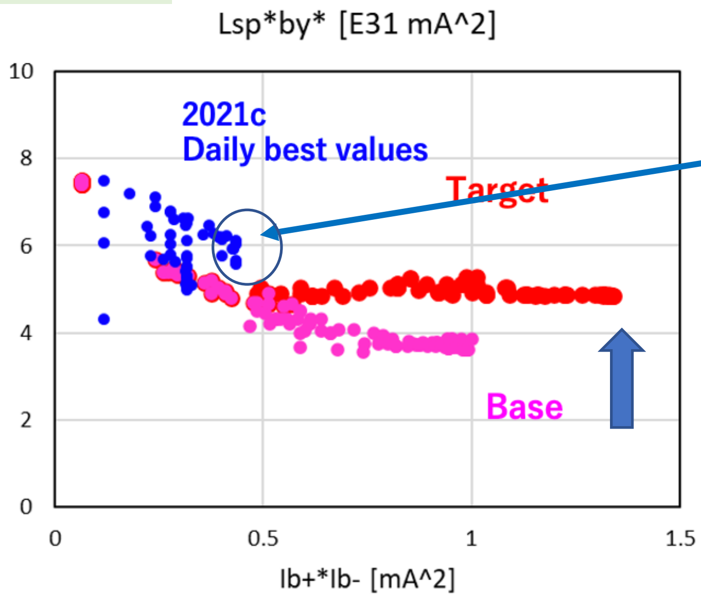
Y. Suetsugu (Feb. 2022)

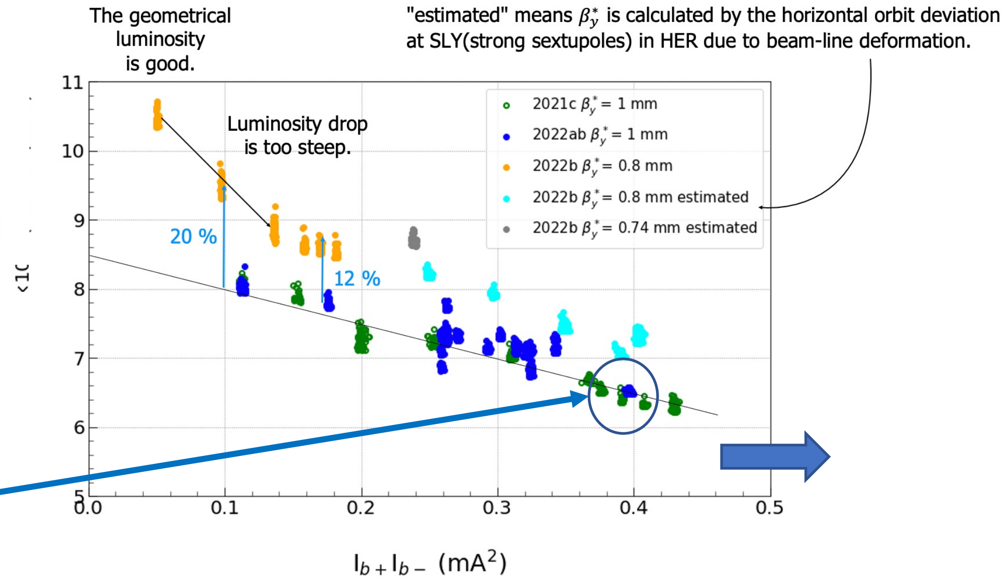




We are closer to the base plan







We need to

increase I_b

squeeze β_y^*

achieve higher L_{sp} at higher I_b

Y. Ohnishi (yesterday's talk)

Obstacles to Luminosity Improvement

- Beam blowup in the LER (single beam, non-collision) : "-1 mode instability" (A1)
- Sudden beam loss (both rings, more serious in the LER) → "fireball hypothesis"
  - Damage of collimator head and/or QCS quench if large beam loss
- Optics degradation due to beam current dependence of beam orbit (A2)
  - Orbit deviation at strong sextupoles is caused by beam line deformation due to intense SR heating.
- Lower beam-beam parameter: 0.035 at 0.7 mA for physics run (0.045 at 1.1 mA) (B)
- Short beam lifetime (dynamic aperture, physical aperture) : LER 8 min(1.25 A) / HER 25 min(1 A) n_b=2346
- Beam related background (optimization of collimators, QCS aperture and IR orbit)
- Beam injection (small physical aperture of injection region, emittance growth in the beam transport line)
- Earthquake : The beam aborts invariably. The ε_y becomes large in the HER. The optics correction is needed.
- Lower online luminosity monitor during LER injection (Beam backgrounds affect the measured value.)

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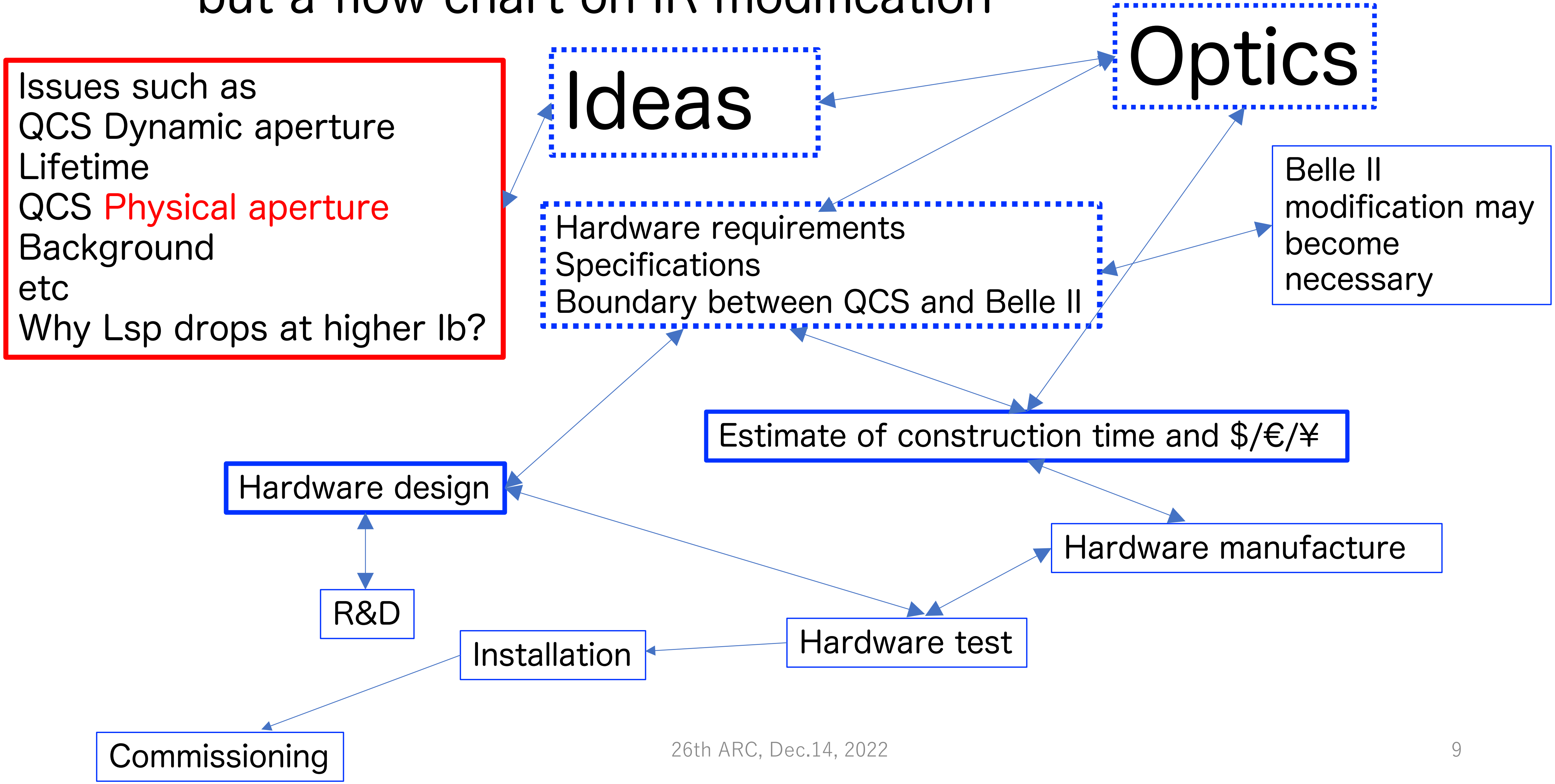
H. Sugimoto (This morning's talk)

There seems to be something more to be understood about our IR.

We should understand our IR first → Modification

We should understand our IR first
but a flow chart on IR modification

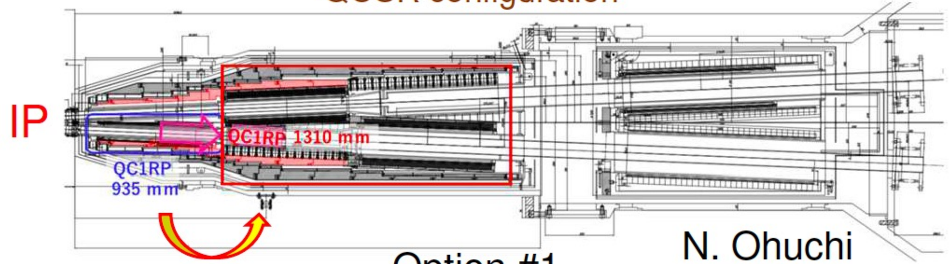


Presented by Y. Suetsugu at the ITF kickoff meeting in July 2021
Among options “option3” seems to be doable.

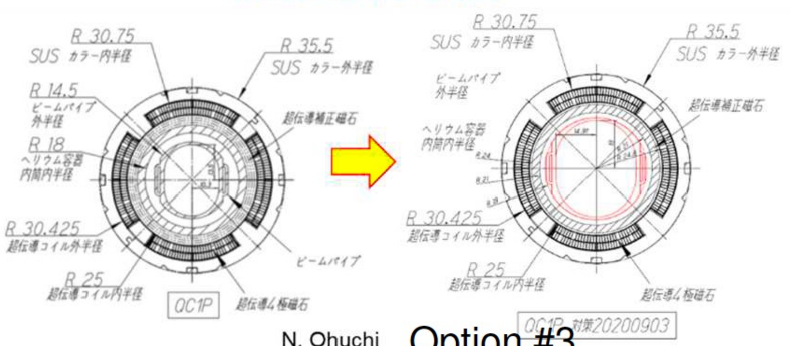
- Possible countermeasures in LS2

Aim	Possible countermeasures	Expected improvement	Ready status	LS1 / LS2 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031~
Widen dynamic aperture	QCS modification (Option#1): Move QC1RP to far side of IP	Found to be no effect.	Will be not adopted	
Expand physical aperture Lower BG	QCSR beam pipe enlargement (Option#3)	13.5 mm -> 15 or 18 mm, b_y^*=0.3 will be possible, **no effect on dynamic aperture, TMCI limit x ~1.5.**	Need design, manufacturing of correction magnets and pipes	

QCSR configuration



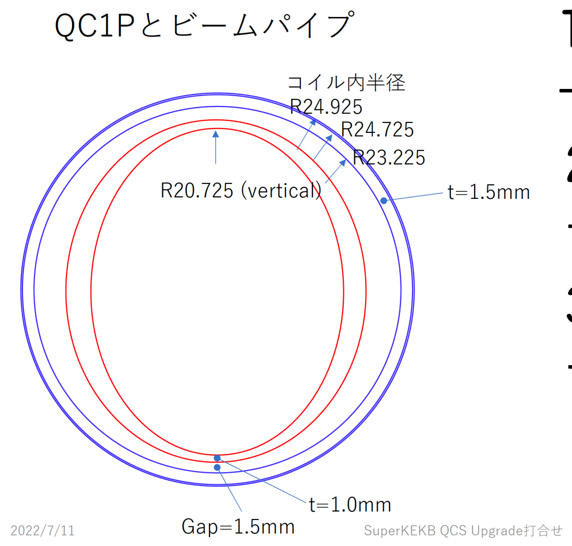
Cross section of QC1RP



We decided to revisit IR upgrade plan(s).

IR/QCS upgrade Progress “ Option 3’ ”

Revisit QC1P modification

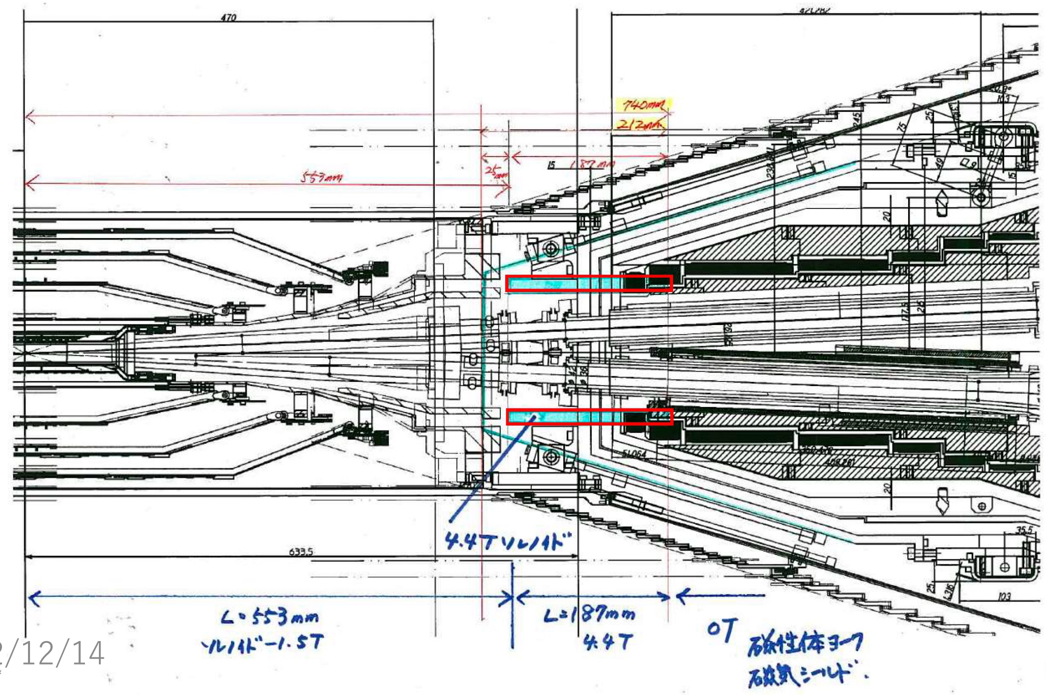


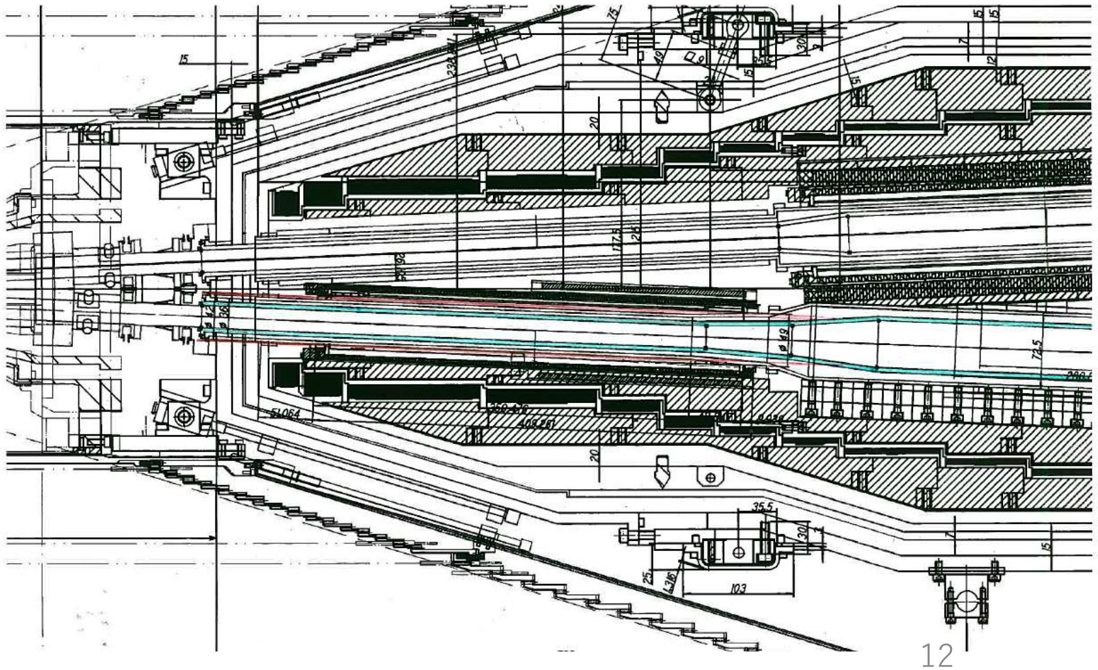
1. Increase QC1P aperture (vertical) from 13mm to (18mm) 20.7 mm
→ Larger physical aperture
2. Fabricate new anti-solenoid coil and move it closer to the IP
→ less x-y coupling might be achieved
3. Cover QC1P by magnetic material
→ magnetic coupling reduction may be achieved

QCSシステム改善：#3について

1. 4極電磁石は、そのまま流用。
   - 補正電磁石は、QC1Pの外周部へ移動。
   - QC1Pは、磁性体ヨークを被る。対抗ビームラインも磁気シールドあり。
2. 補正ソレノイドをQC1Pの前に出す。
3. QC1Pのビームパイプ内径を大きくする。
   - これまでの提案： R13.5mm→R18mm →R20.7mm

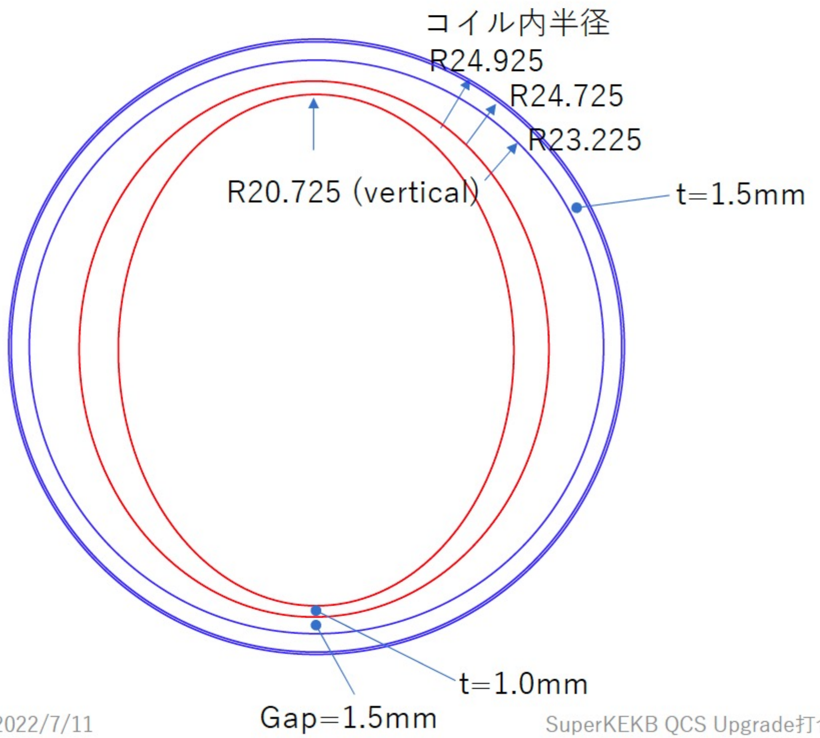
Working with the Optics G

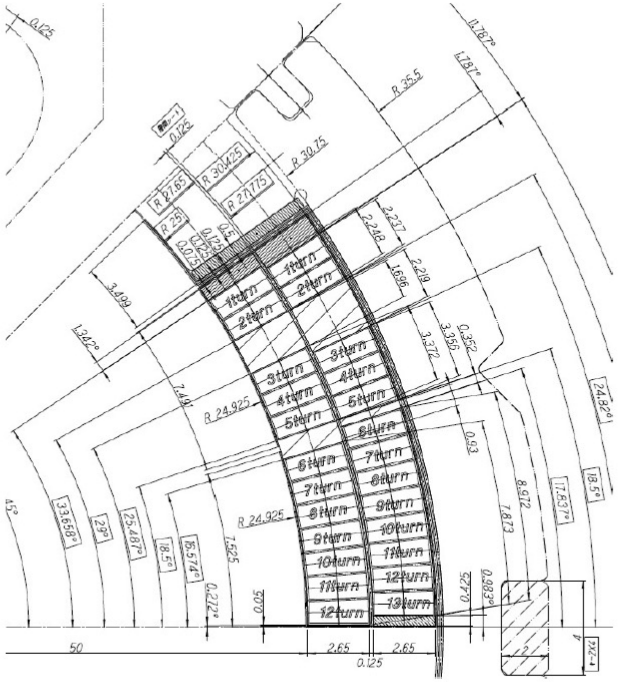




1. Increase QC1P aperture (vertical) from 13mm to (18mm) 20.7 mm

QC1Pとビームパイプ





2022/7/11 SuperKEKB QCS Upgrade打合せ 5

2. Fabricate new anti-solenoid coil and move it closer to the IP

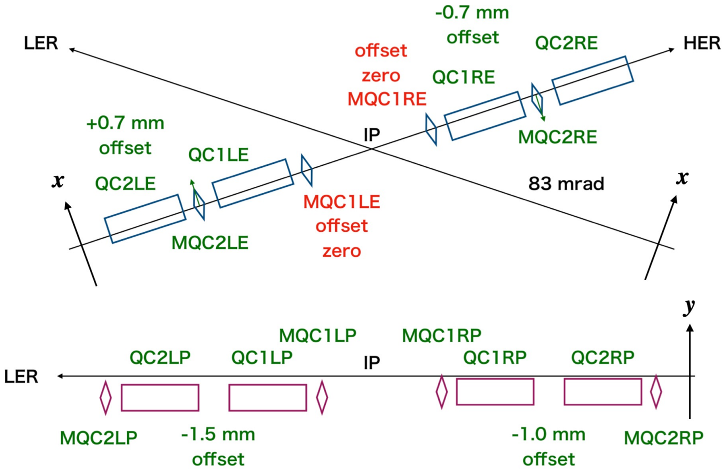
Design concept (A. Morita)

- Beam entering QC1P parallel to QC1P axis → $\int B_x(s)\,ds=0$ $\quad \int \left(\int_0^s B_x(s')\,ds'\right)ds=0$
- Zero coupling/zero chromaticity between IP and QC1P←Cancellation between IP and QC1P → $\int B_s(s)\,ds=0$ $\quad \int \frac{dB_x(s)}{dx}\,ds=0$
- Minimum vertical emittance → ∫ Bx^4 ds

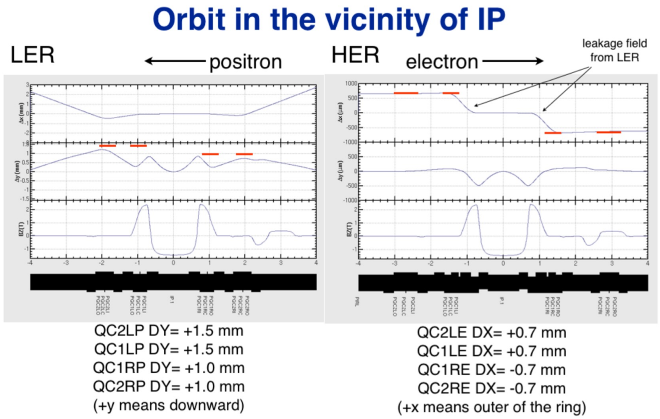
Magnet	Int. field T	Z m	Δx mm	Δy mm	Δθ mrad
QC1LP	22.96	−935	0.0	−1.5	−13.35
QC1RP	22.96	935	0.0	−1.0	7.204
QC2LP	11.48	−1925	0.0	−1.5	−3.725
QC2RP	11.54	1925	0.0	−1.0	−2.114
QC1LE	26.94	−1410	0.7	0.0	0.0
QC1RE	25.39	1410	−0.7	0.0	0.0
QC2LE	15.27	−2700	0.7	0.0	0.0
QC2RE	13.04	2925	−0.7	0.0	0.0

"0.0"

Present magnet position wrt to orbit



BPM coordinate

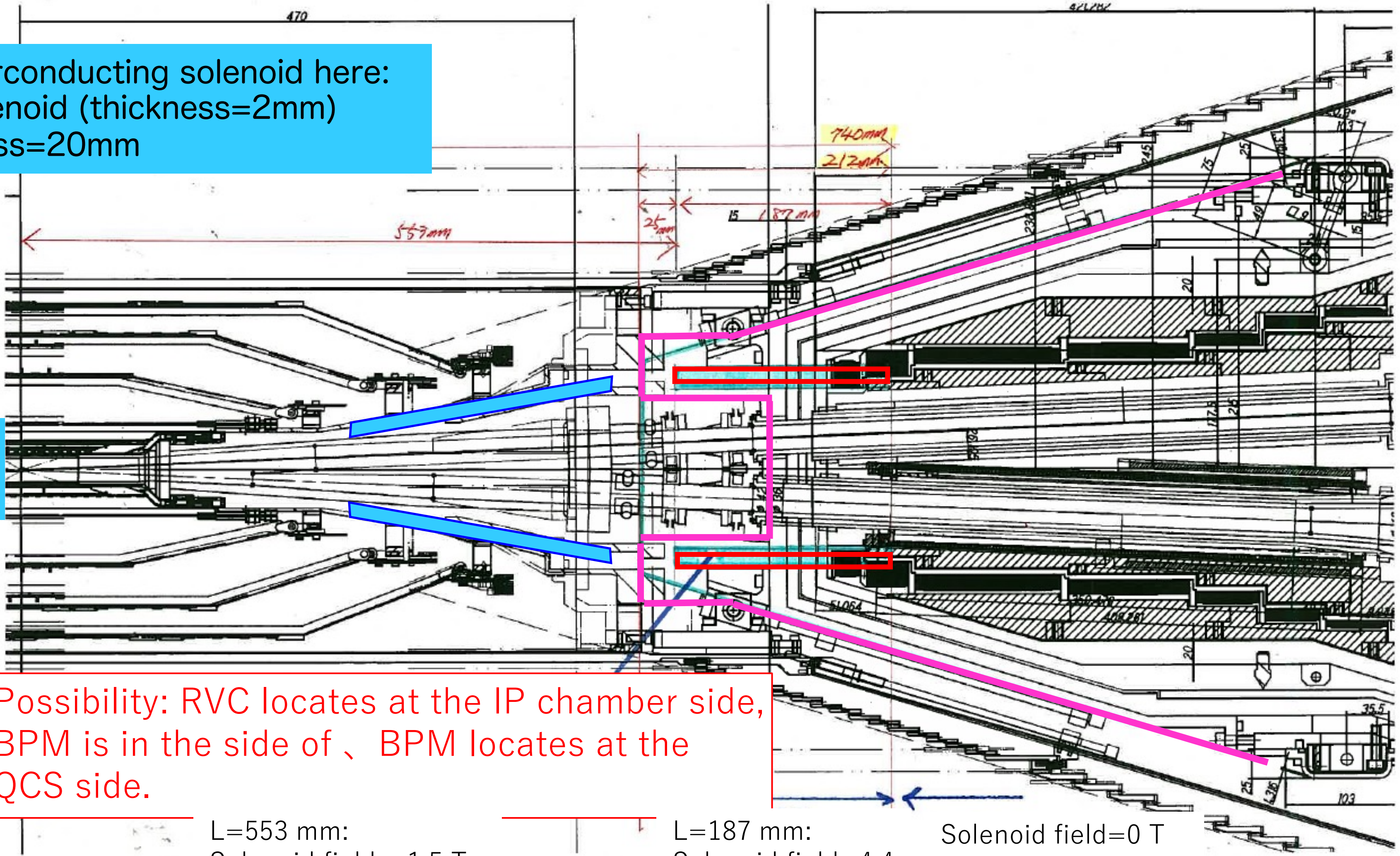


SAD coordinate

QCS upgrade

Adding special superconducting solenoid here:
- Very thin SC solenoid (thickness=2mm)
- Cryostat thickness=20mm

Seek a solution to lower the field



Possibility: RVC locates at the IP chamber side, BPM is in the side of 、BPM locates at the QCS side.

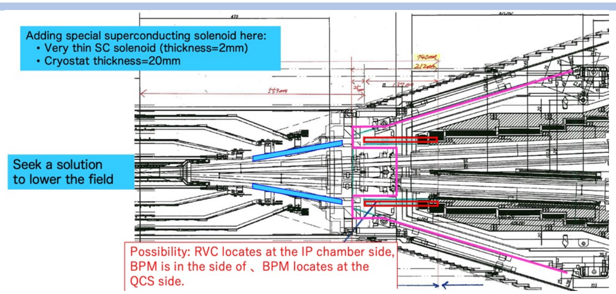
L=553 mm:
Solenoid field=-1.5 T

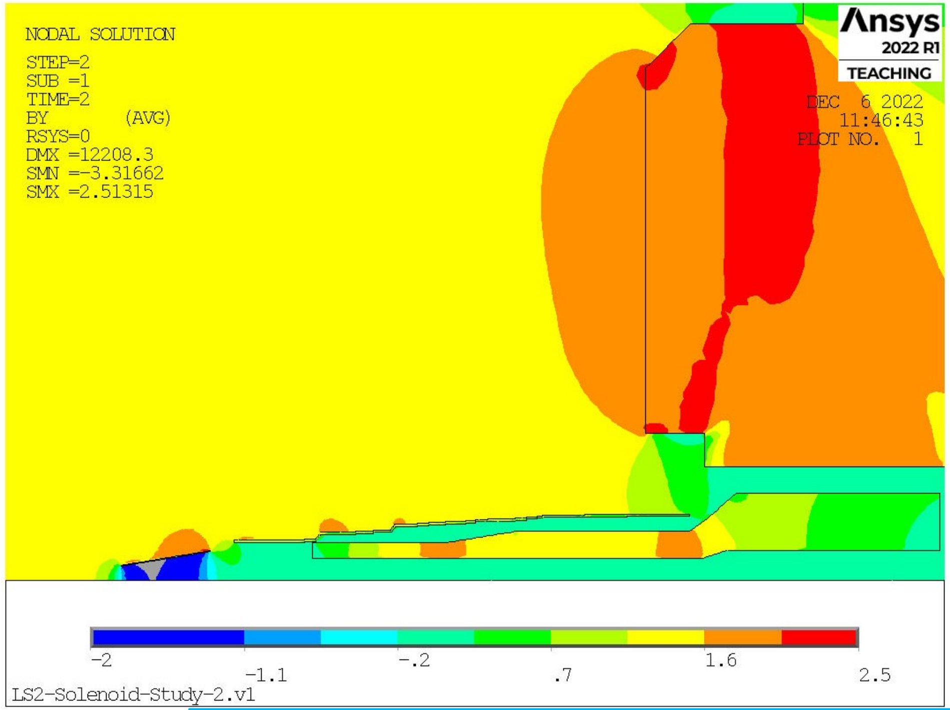
L=187 mm:
Solenoid field=4.4 T

Solenoid field=0 T

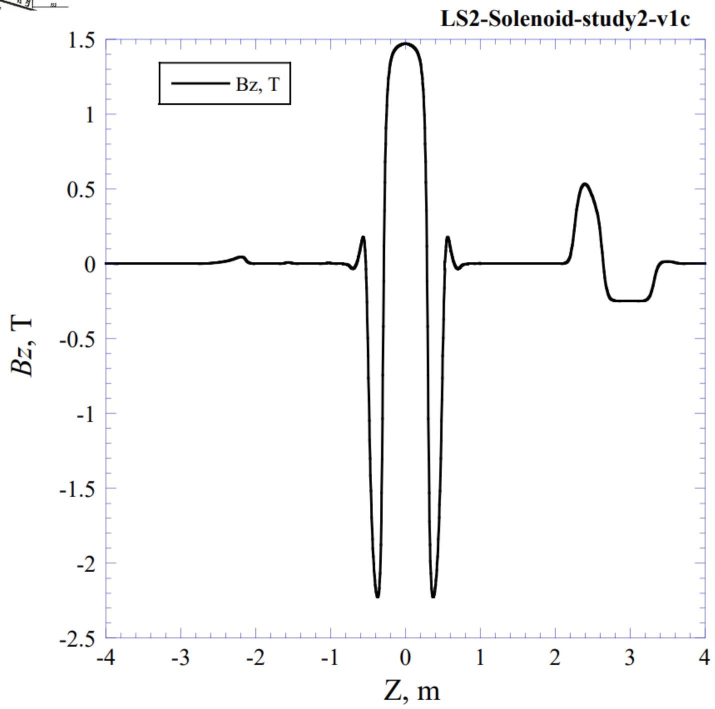
From N. Ohuchi

QCS upgrade



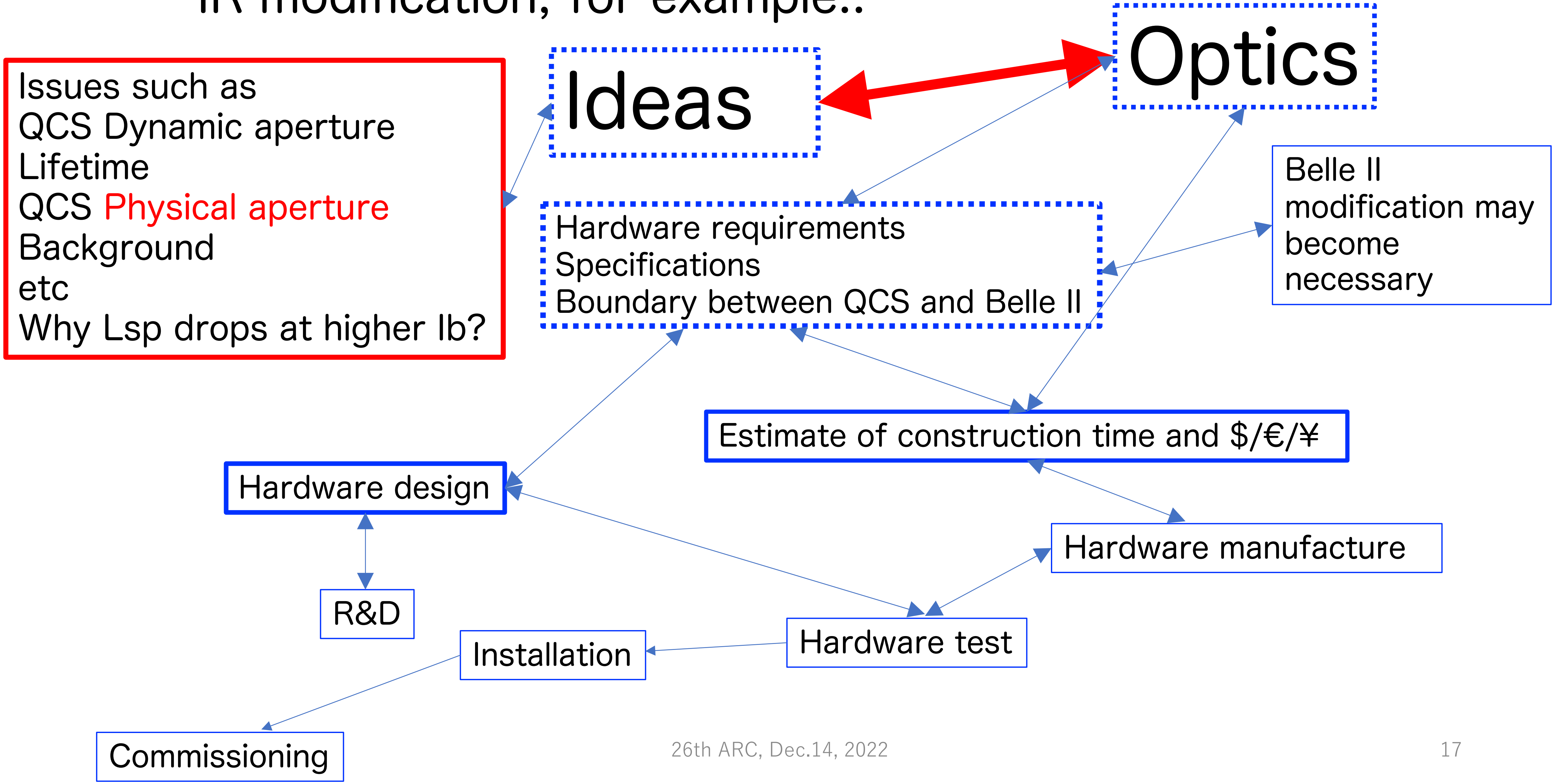


From N. Ohuchi



Bmin & Bmax reasonable
→Optics G will do some quantitative evaluation with a simple model.
If does not work with a simple model, no point spending more time on hardware design.

Something needs to be done
IR modification, for example..



There are other ideas for upgrades other than IR

(New electron BT line, e- ECS, modification of vacuum chamber, and so on)

And some can be done during the summer/winter shutdown periods.

We do not know if/when LS2 takes place.

But we should keep working on the ideas.

And before anything else, we must achieve $1 \times 10^{35} cm^{-2} s^{-1}$