SuperKEKB status

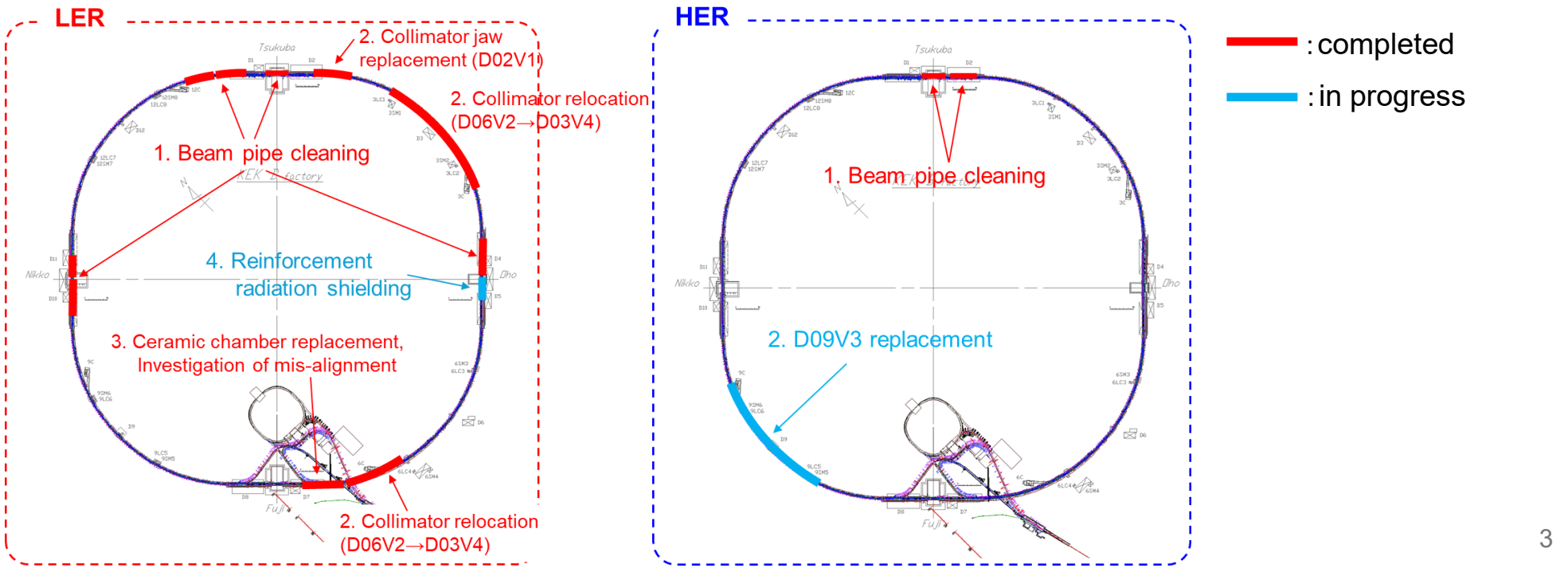
2025/09/29 B2GM
Ryuichi Ueki
on behalf of SuperKEKB

Outline

- Major activities during the shutdown
  - Beam pipe cleaning
  - Alignment of beam pipe at LER injection point
  - Reinforcement of radiation shielding and expansion of the radiation-controlled area (Oho)
  - Installation and conditioning of the new RF gun
- Other activities
- Summary

Current status

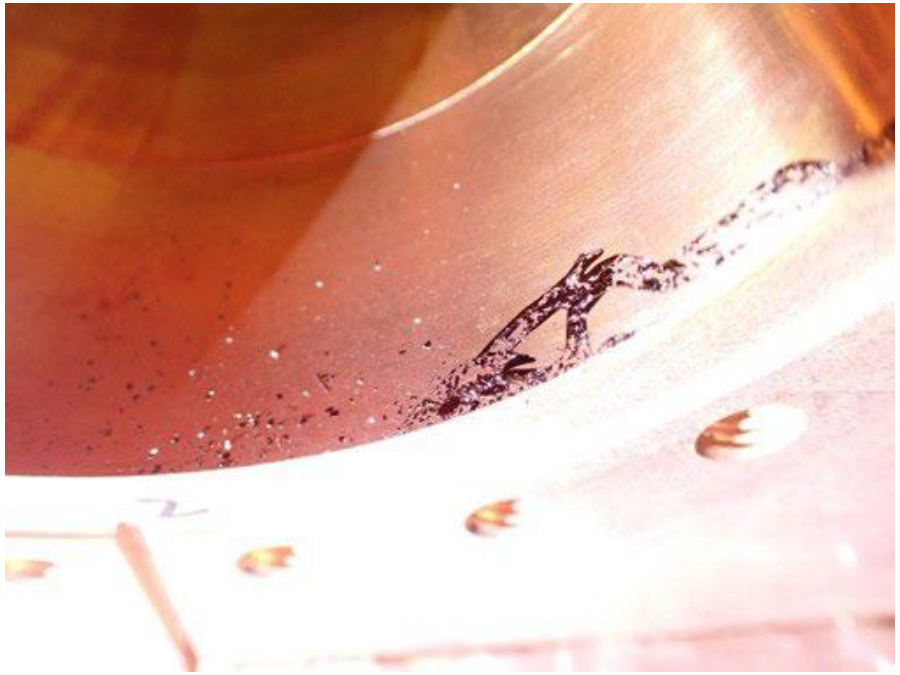
1. Beam pipe cleaning (HER/LER) : completed
2. Remaining collimator works (HER) : In progress
3. Beam pipe realignment at the LER injection point (LER) : completed
4. Reinforcement of radiation shielding at NLC and expansion of radiation-controlled area (LER) : In progress
5. Installation and conditioning of the new RF gun (Linac) : In progress

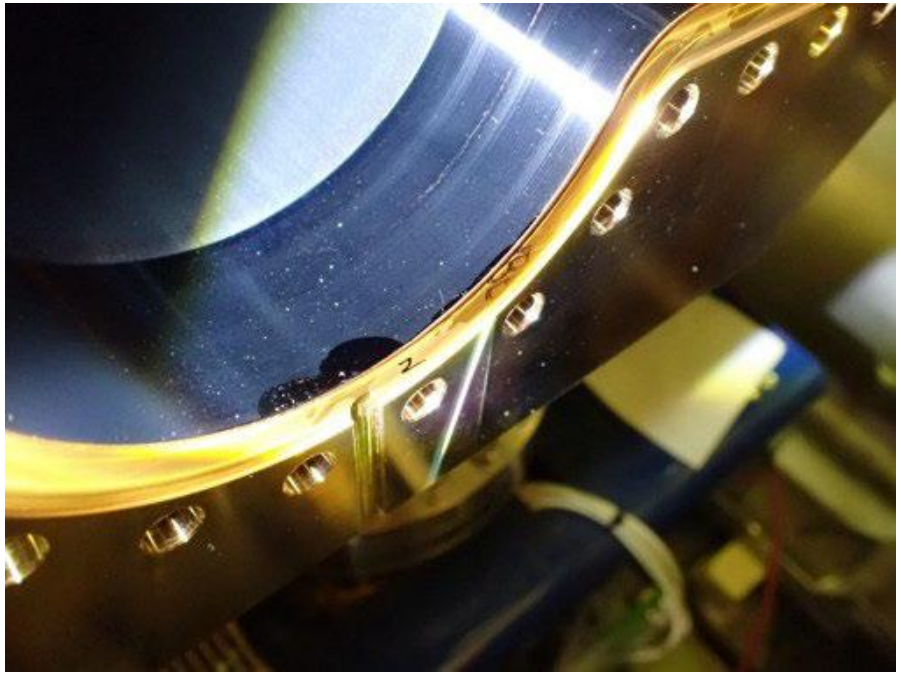


Beam pipe cleaning

Beam pipe cleaning

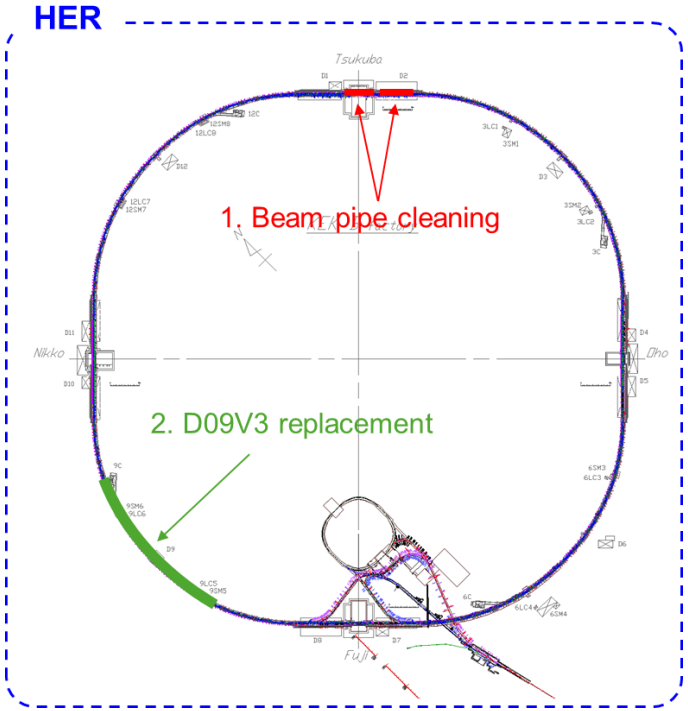
- Internal inspections have been completed, where
  - All MO-type flange connections where VACSEAL was likely used.
  - IR (HER, LER), LER wiggler sections (D04, D10, D11), others
    - Black stains were found on many flange connections and removed.

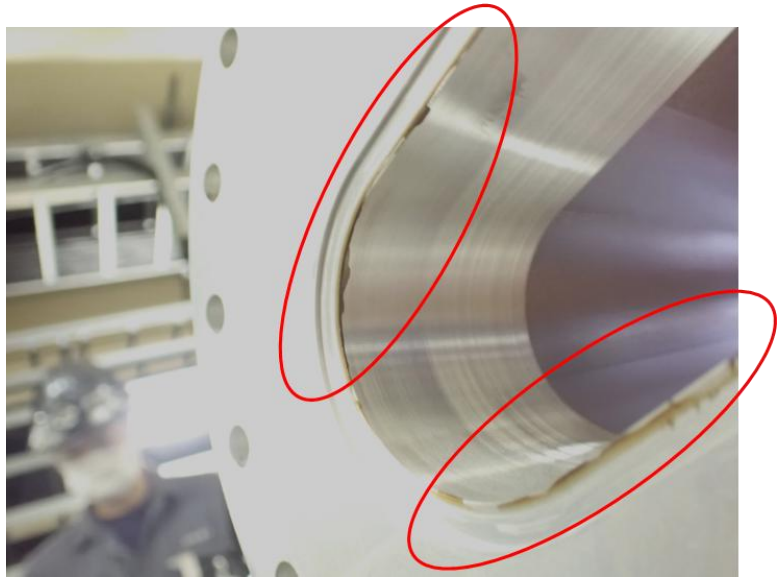




Beam pipe cleaning

- During D9V3 collimator replacement work
  - Black stains were found on HELICOFLEX flange connections.
    - VACSEAL had been used.
    - This is the first time such stains have been found on HELICOFLEX flange.
- Three HELICOFLEX flange connections will be inspected before operation.

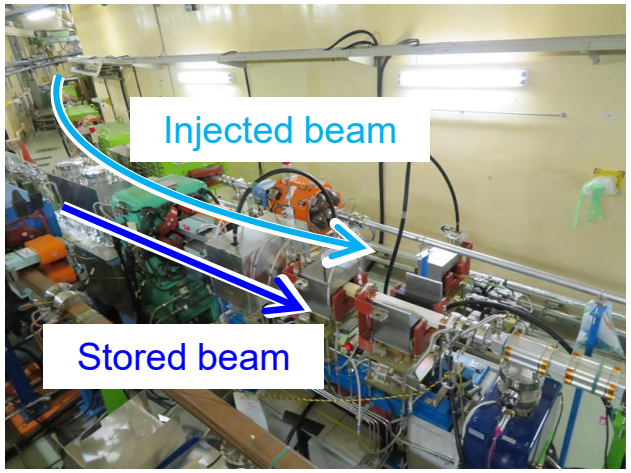


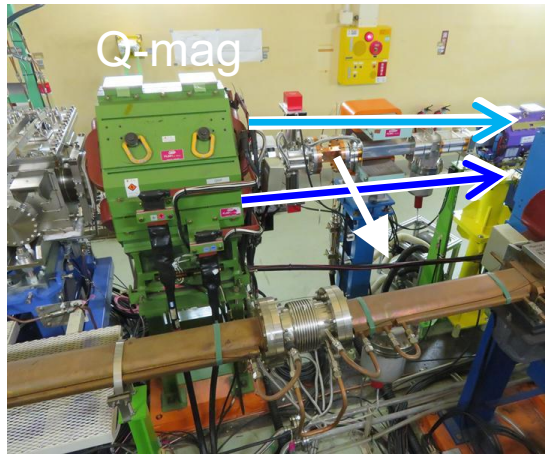


HELICOFLEX flange connection

Alignment of beam pipe at LER injection point

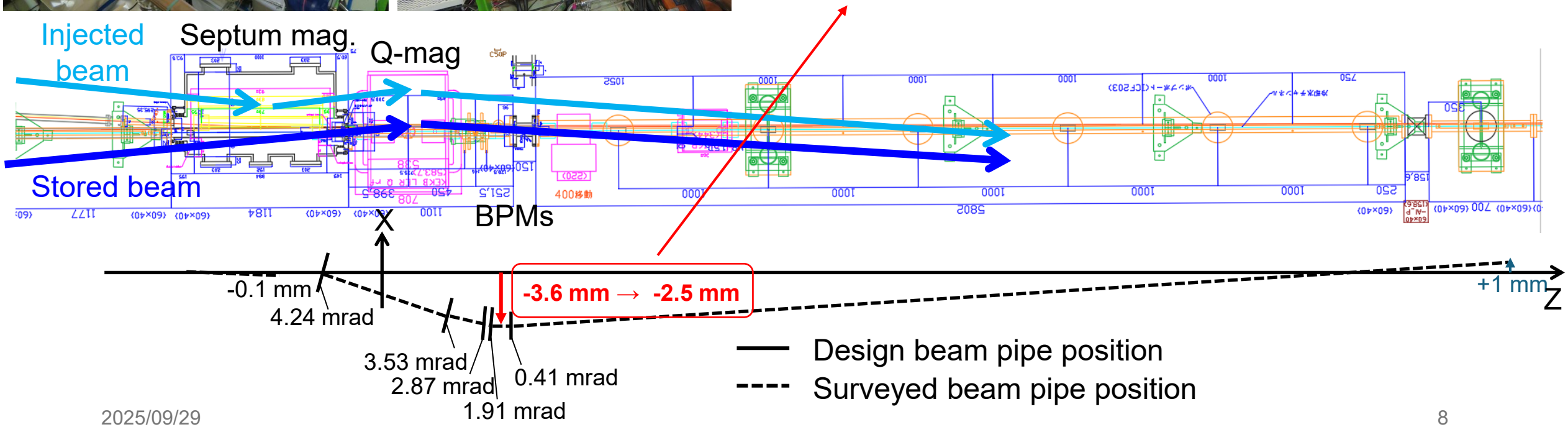
Alignment of beam pipe at LER injection point



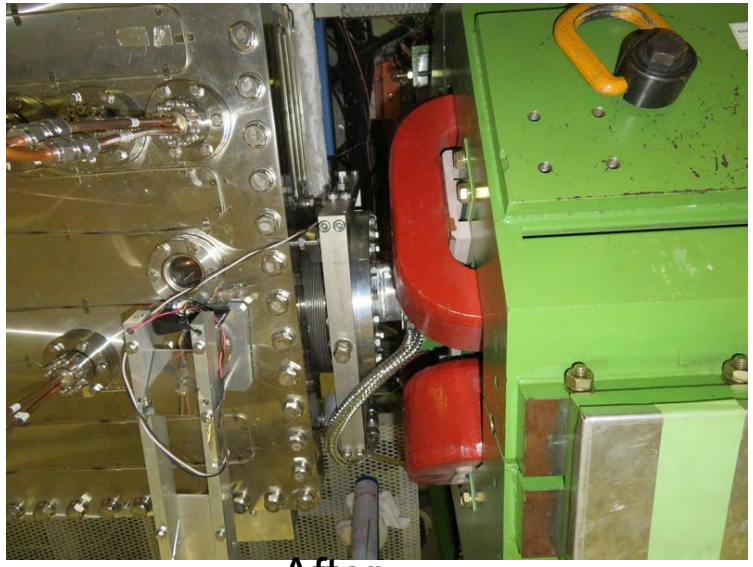


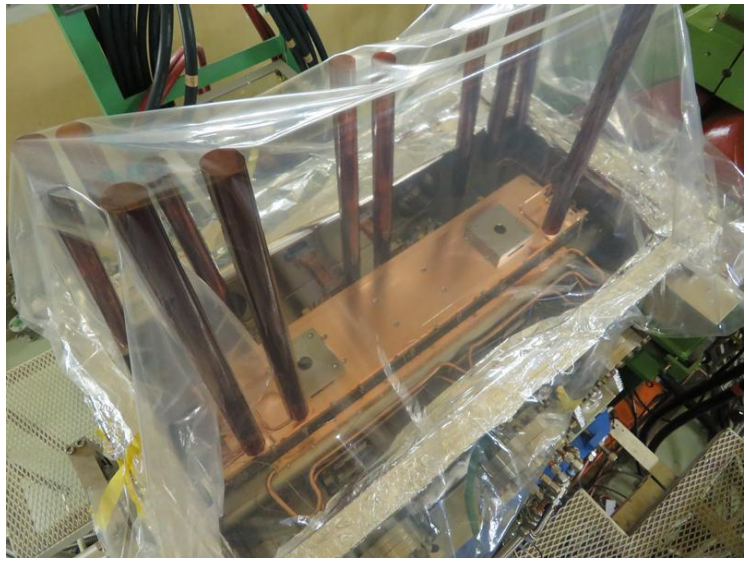
- LER beam pipe position survey was carried out.
- We found out beam pipes were tilted and deformed.

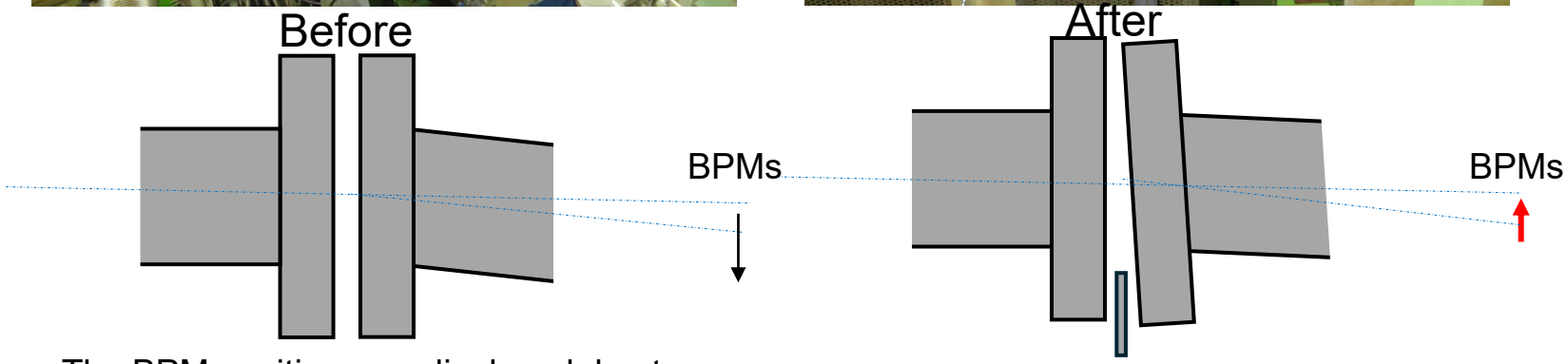
Improvement of physical aperture is expected.



Alignment of beam pipe at LER injection point







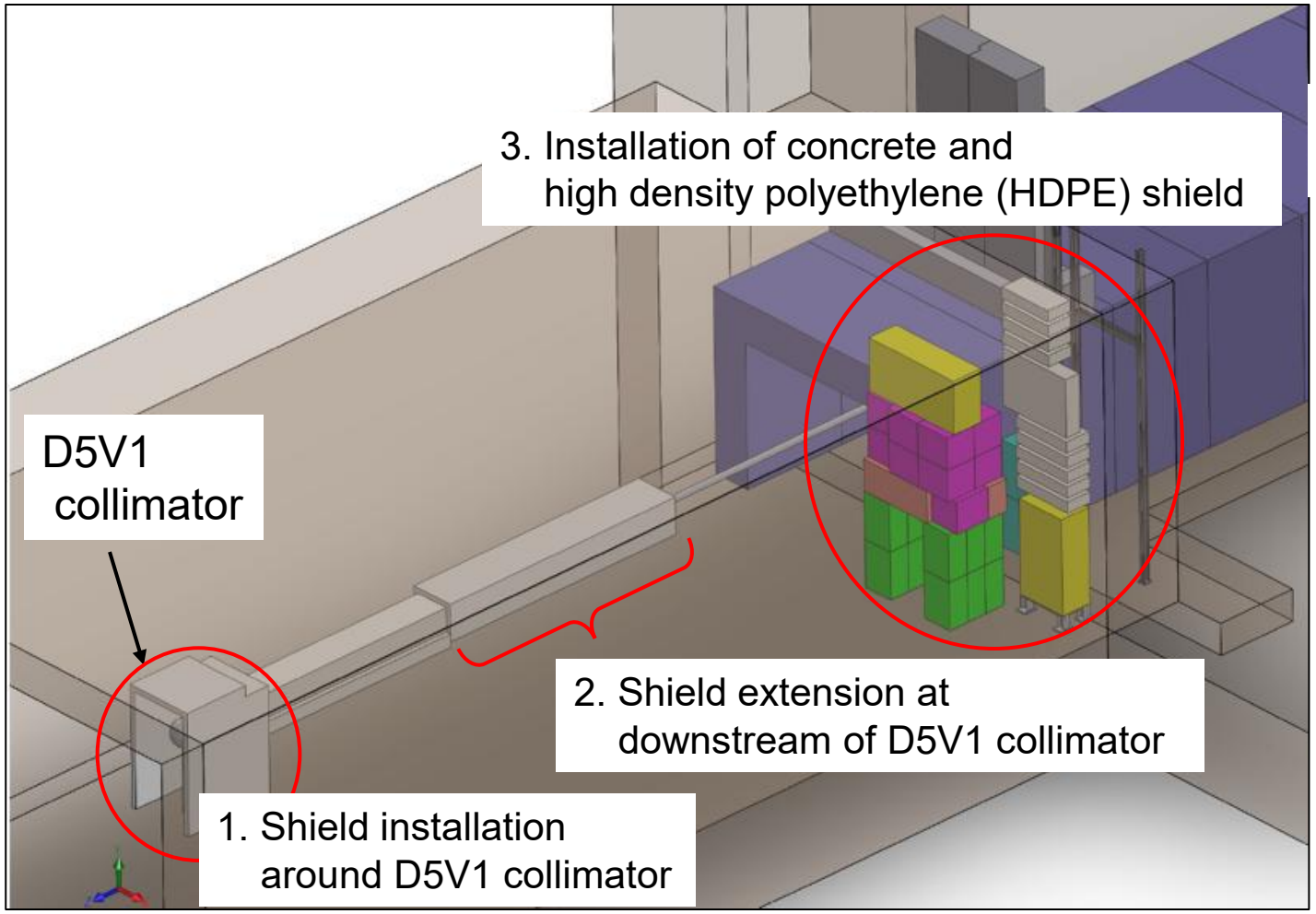
- The BPM position was displaced due to chamber deformation.
- The deformation is believed to have been caused by septum baking.

- The BPM position was adjusted by inserting thin shims between the flanges.

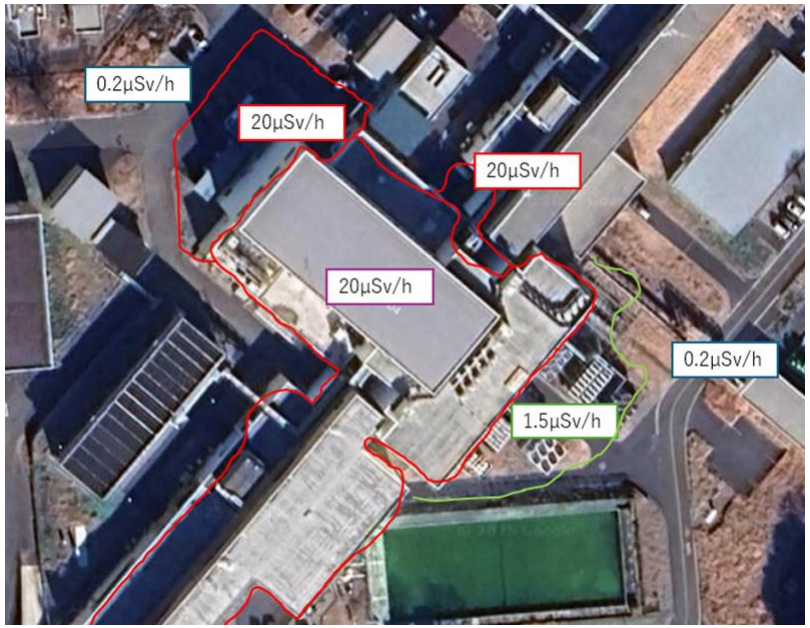
Improvement of physical aperture is expected.

Reinforcement of radiation shielding at NLC

Reinforcement of radiation shielding at NLC



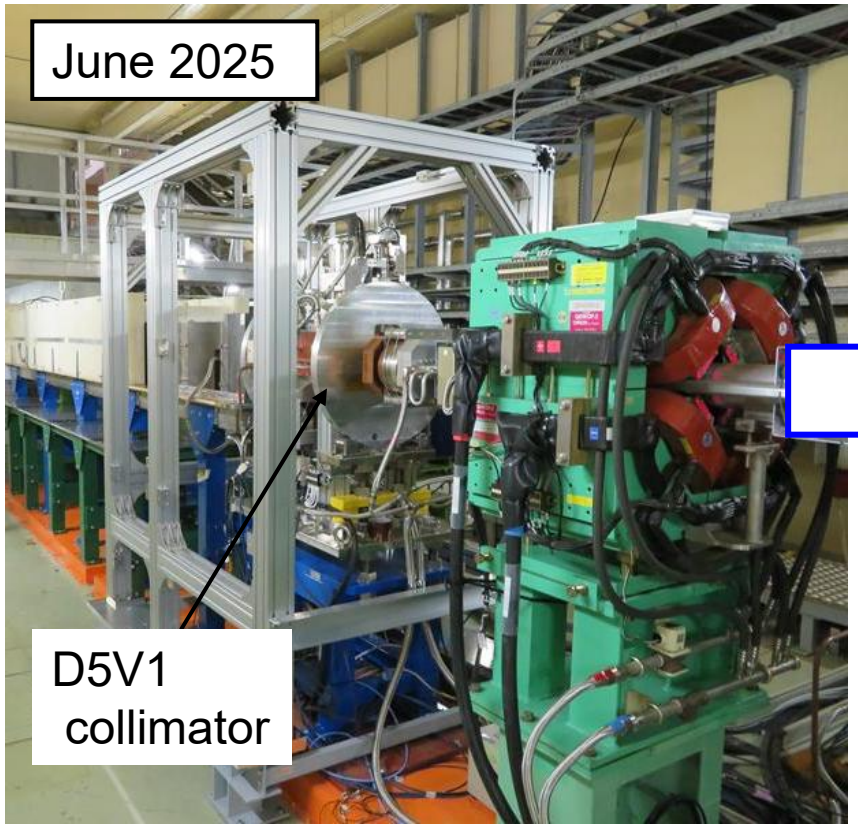
4. Expansion of radiation-Controlled area around Oho experimental building

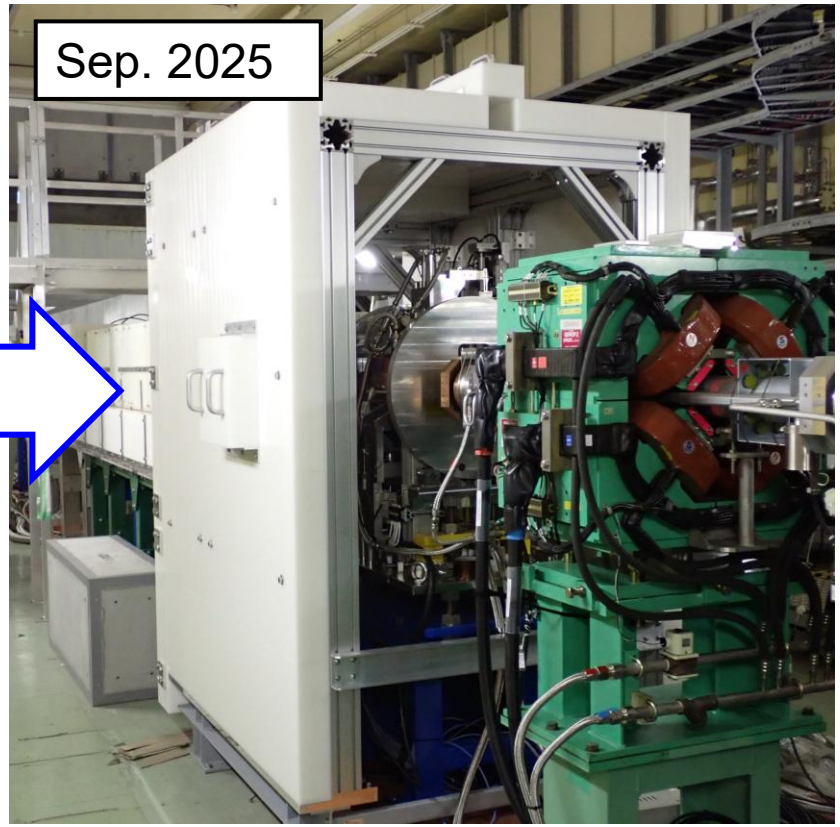


Radiation leakage is expected to be reduced to 1/10

Installation of radiation shield around the collimator

1. Shield installation around D5V1 collimator





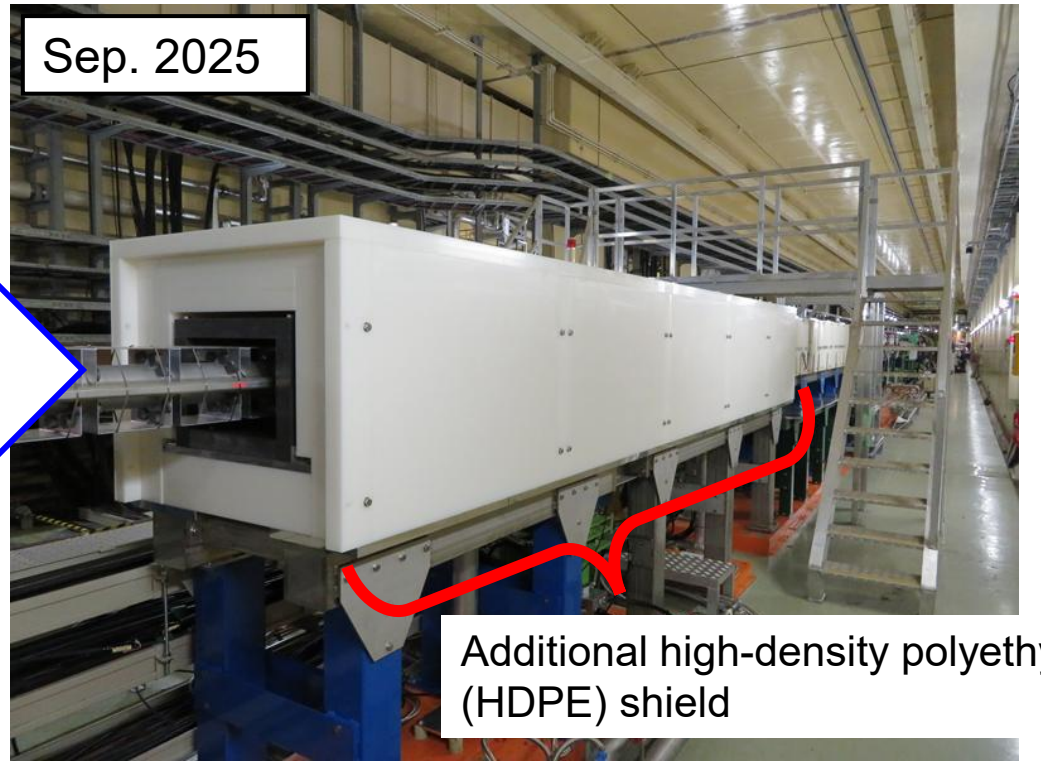
Viewed from e+ upstream

Viewed from e+ downstream

Extension of radiation shielding at downstream of collimator

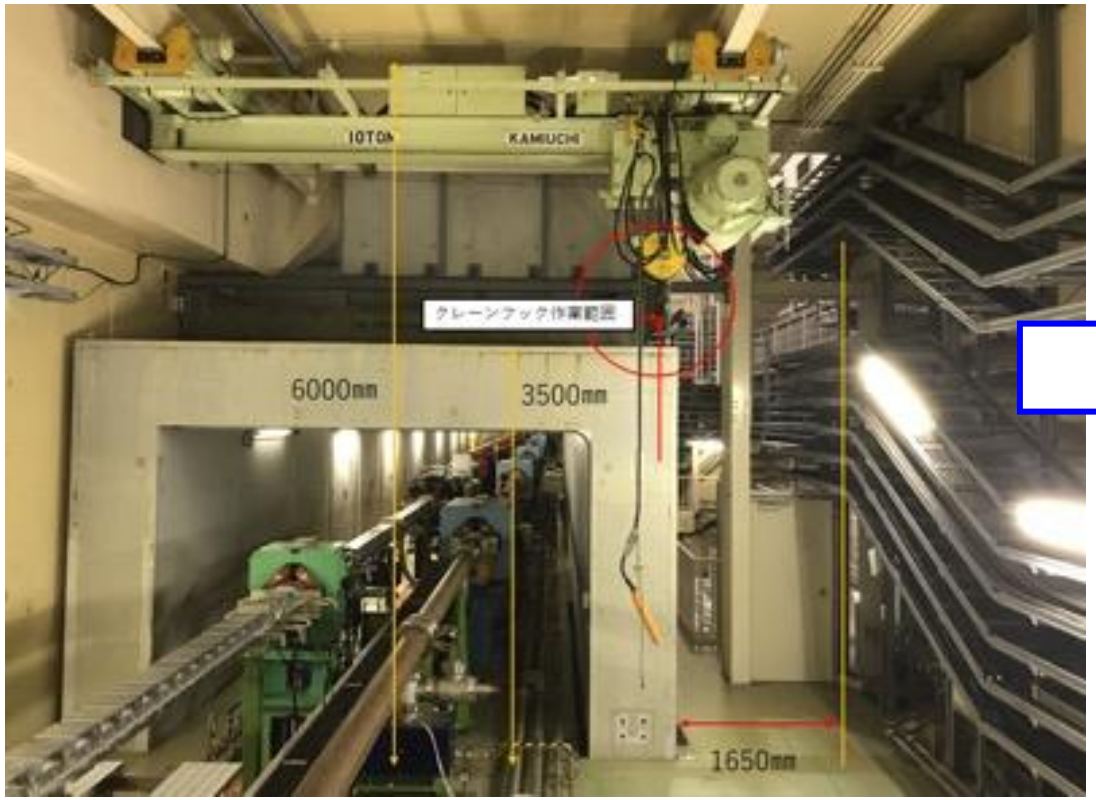
2. Shield extension at downstream of D5V1 collimator

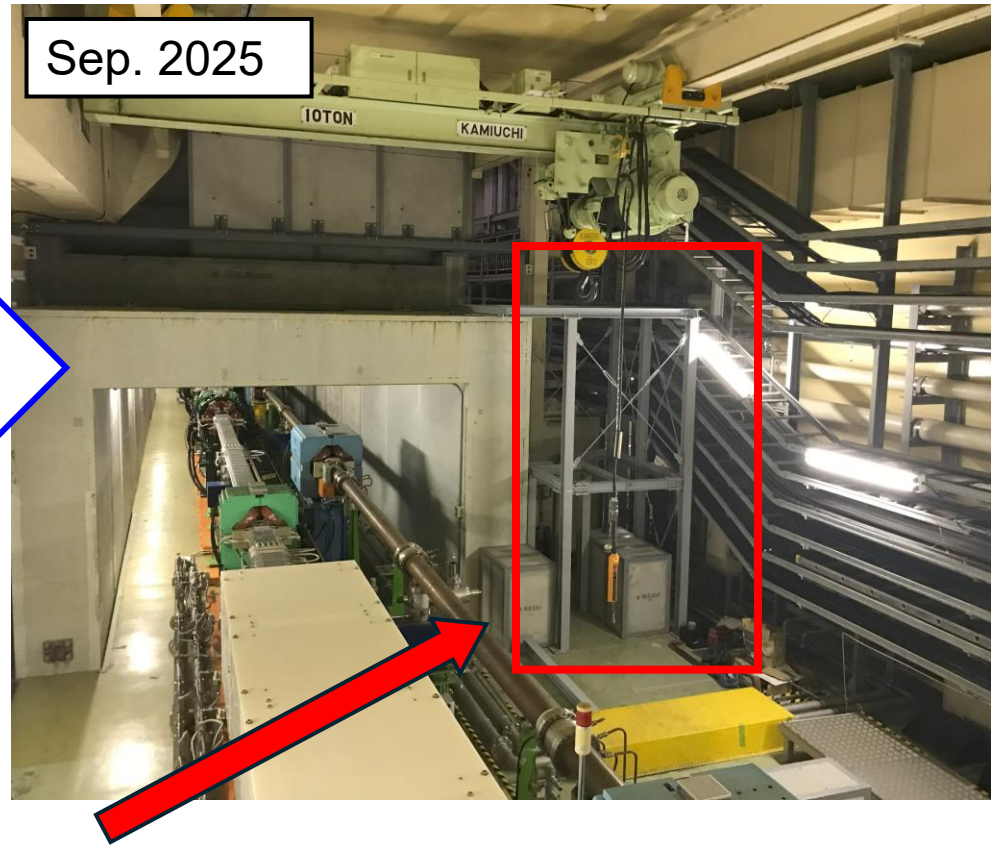
- Radiation shielding at downstream of NLC was extended from 5 m to 10 m.



installation of concrete and polyethylene shield

3. installation of concrete and
   high density polyethylene (HDPE) shield

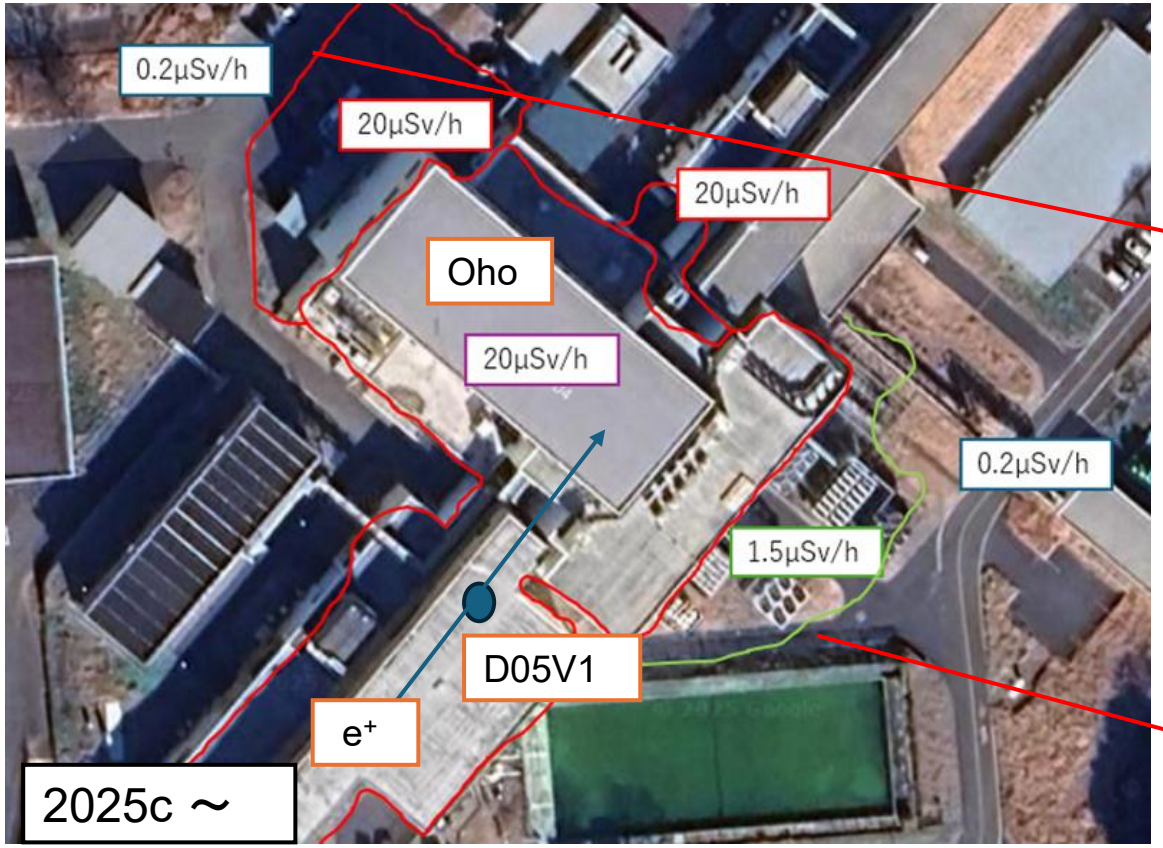


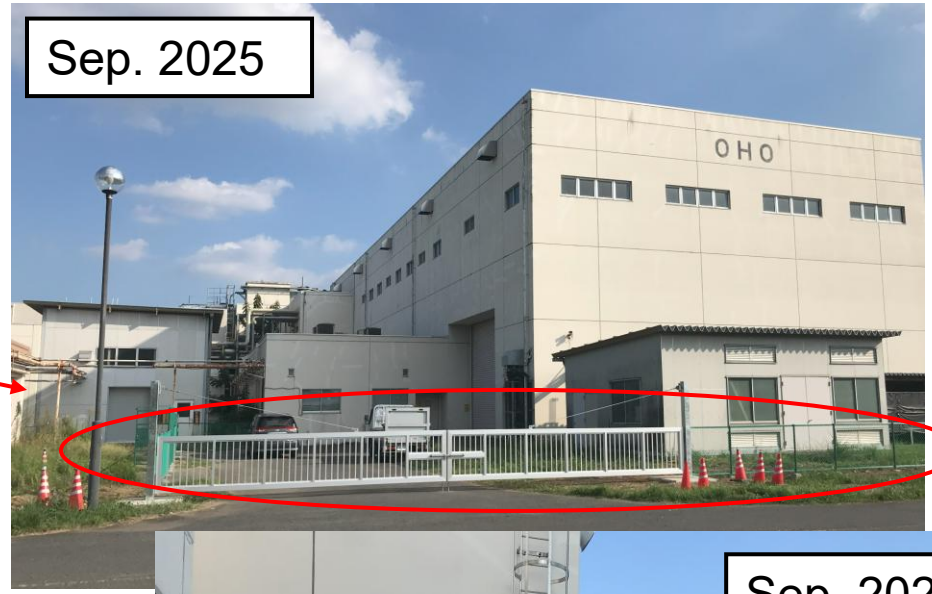


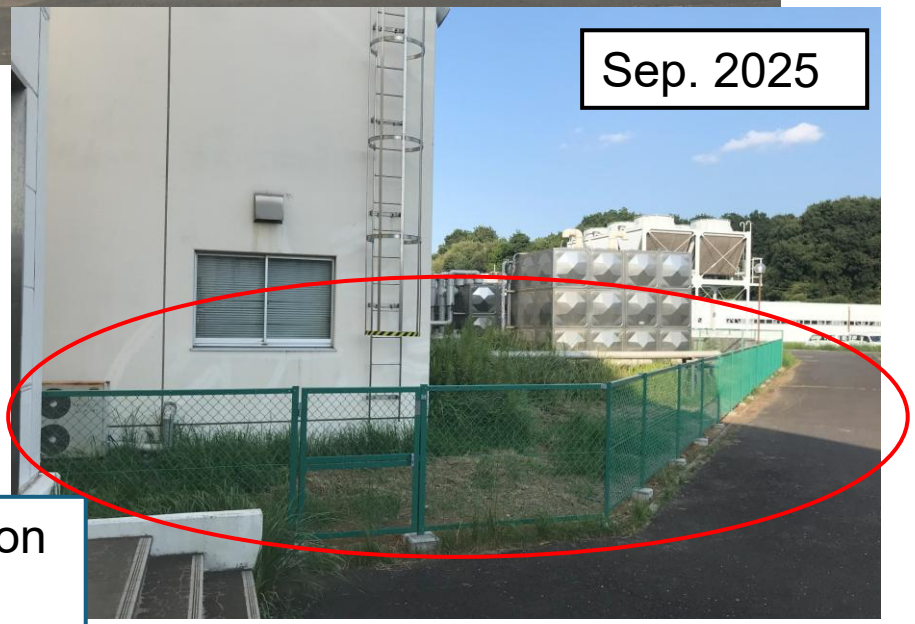
- Frame construction was completed.
- Assembly of the concrete and HDPE shields will be completed by Oct. 24.

Expansion of radiation controlled-area around Oho building

4. Expansion of radiation-Controlled area around Oho experimental building







Construction of the controlled area boundary was completed on September 17th.

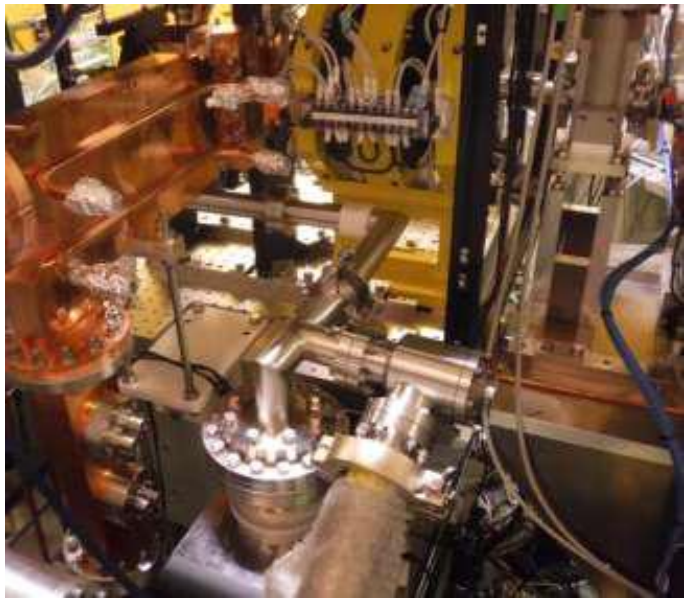
Installation and conditioning of the new RF gun

Installation of the new RF gun (Linac)

New RF gun was installed in the beam line.

- Connection of RF waveguide and vacuum system
- Reconstruction of laser system
- Leak check of vacuum and cooling water

Connection of RF waveguide



Connection of vacuum system

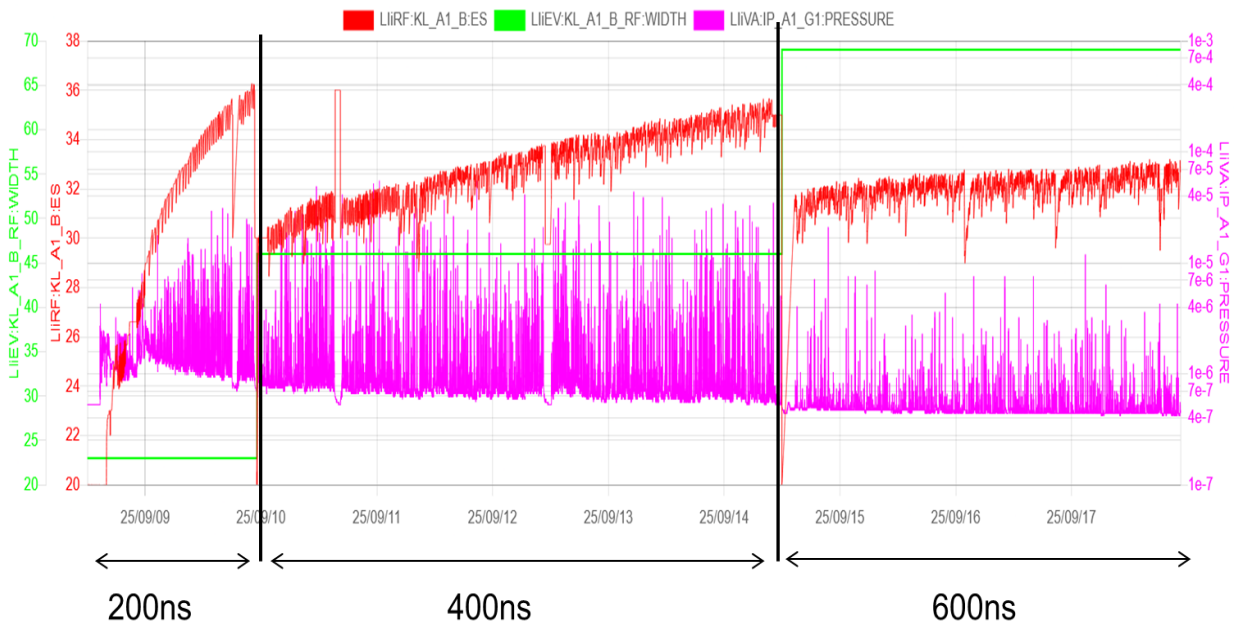
Reconstruction of laser system

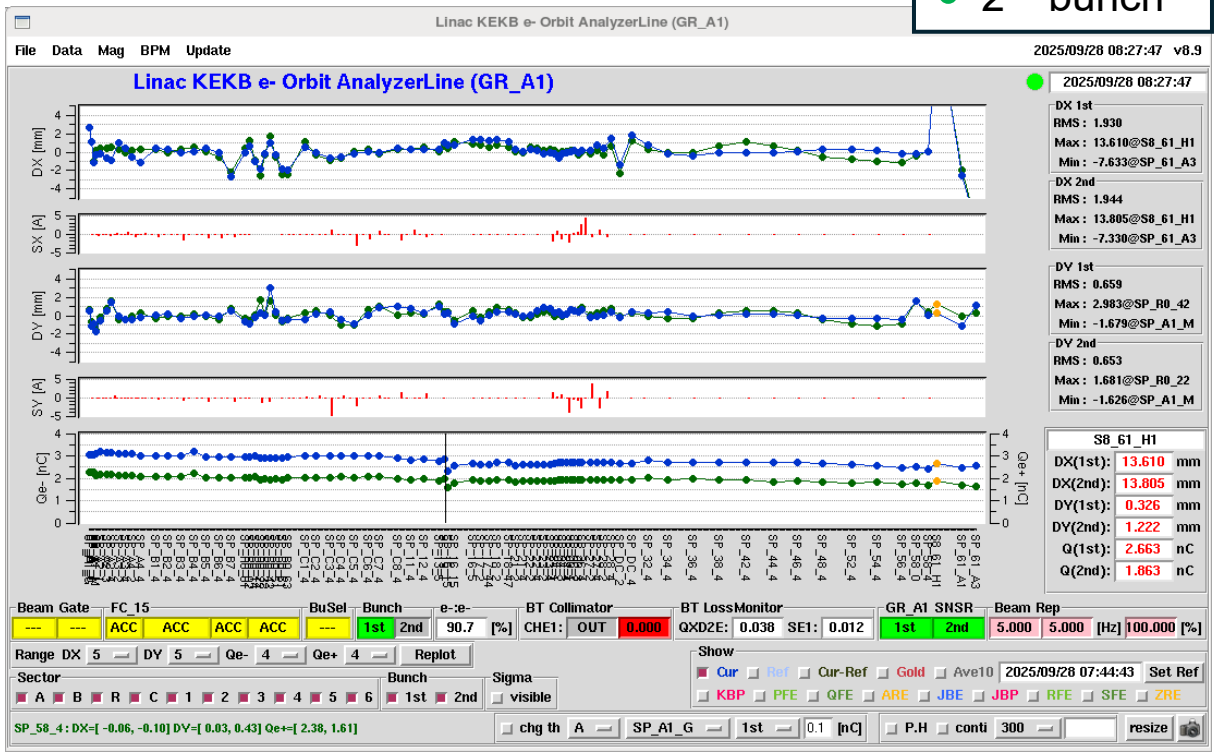
Conditioning of the new RF gun (Linac)

RF gun conditioning at beam line started on 8th September.

- RF power was achieved 19.4 MW (600 ns widths) @9/26 Goal: 20 MW
- Confirmed that two-bunch operation is possible

RF conditioning





Other activities

1. Installation of a bipolar power supply of skew-sextupole magnet for NLC (LER) : Completed

2. Wiggler magnet test at increased power supply current : Completed
   - Reduction in damping time

3. New beam diagnostic line (Linac) : Completed
   - Simultaneous diagnostic with HER injection becomes possible.

4. Fast kicker relocation and new kicker installation (Linac, DR) : In progress

5. ECS installation (BTe) : Completed
   - RF conditioning started from 8th September.
   - Commissioning is scheduled from mid-October.

6. Magnet pole replacement (BTp) : In progress
   - Improvement of the magnetic field quality is expected.

Summary

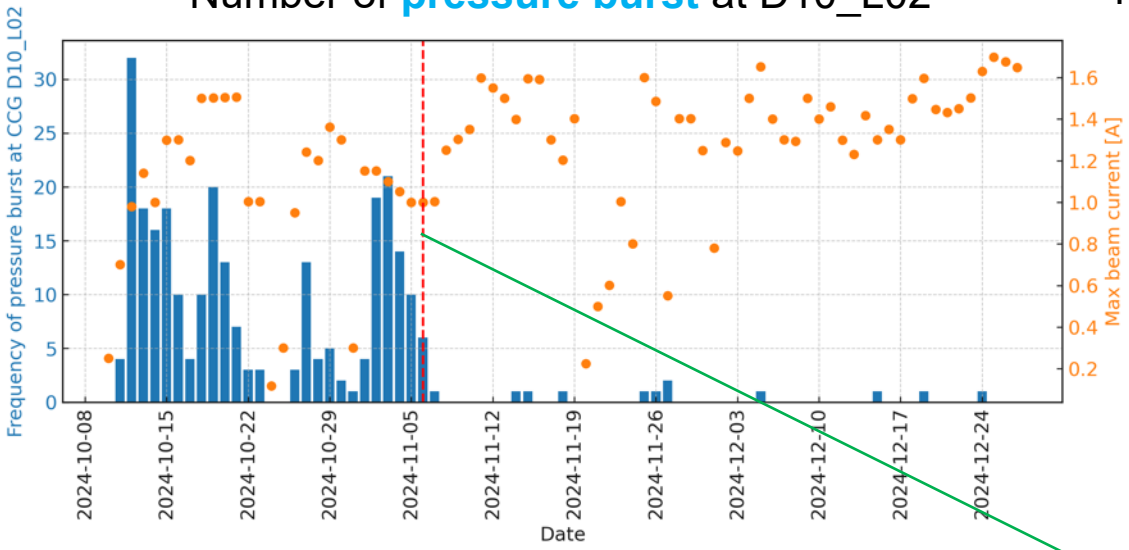
- All work is progressing smoothly and expected to be completed as scheduled.
  1. Beam pipe cleaning (HER/LER) : completed
  2. Remaining collimator works (HER) : In progress
  3. Beam pipe realignment at the LER injection point (LER) : completed
  4. Reinforcement of radiation shielding at NLC and expansion of radiation-controlled area (LER) : In progress
  5. Installation and conditioning of the new RF gun (Linac) : In progress

- Black stains have been observed on the HELICOFLEX flange, and countermeasures are currently under consideration.

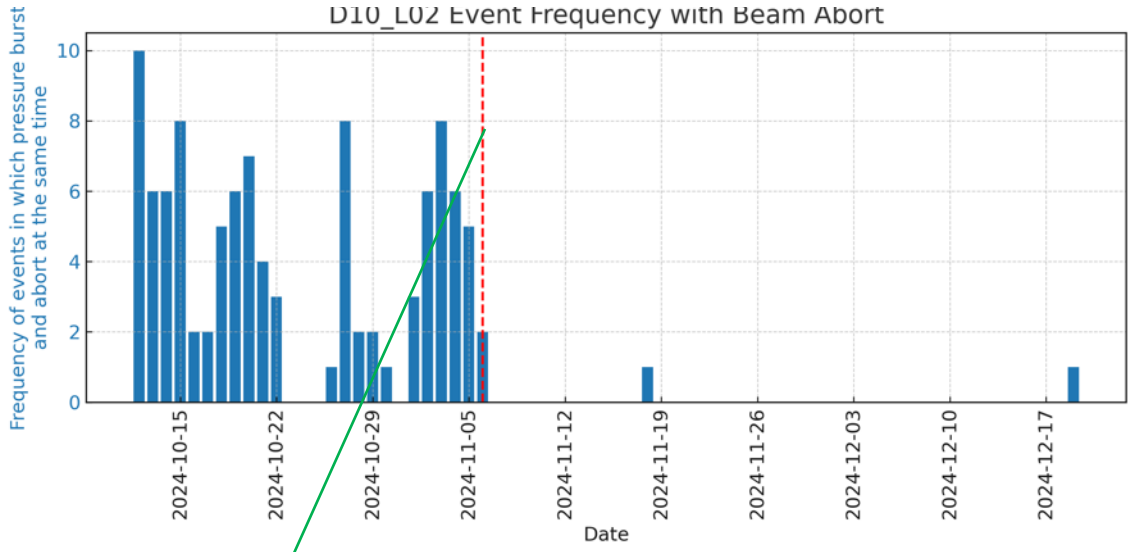
Beam pipe cleaning

- A bellows chamber near CCG D10_L02 was replaced, and VACSEAL was removed from the adjacent beam pipes on Nov. 6 during the 2024c run, using the same cleaning method.
- After this work, the number of pressure bursts in the area has been significantly reduced.

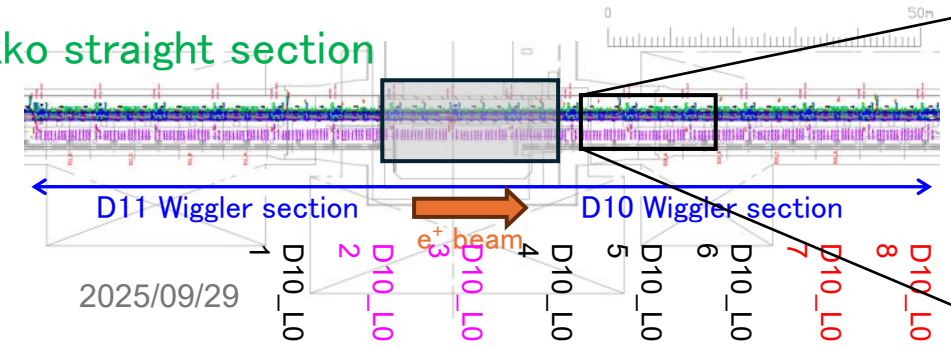
Number of **pressure burst** at D10_L02

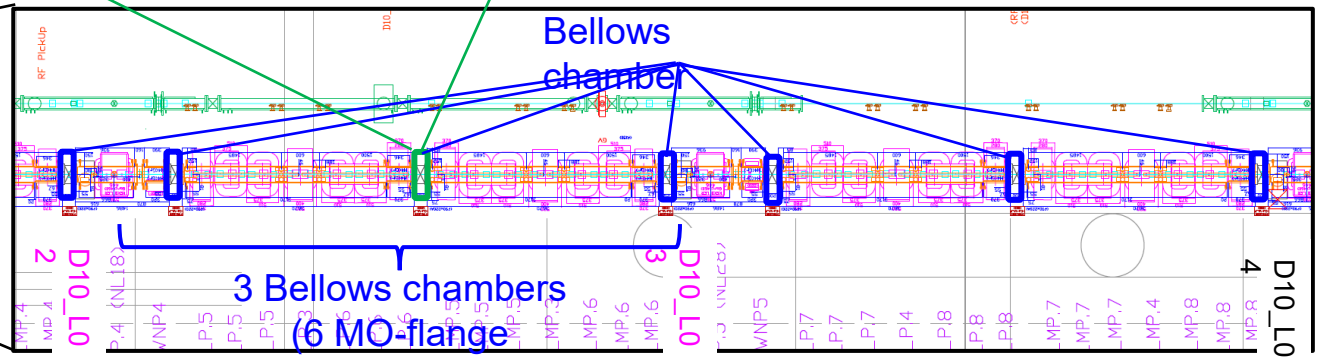


Number of **beam abort accompanied by pressure burst** at D10_L02



Nikko straight section



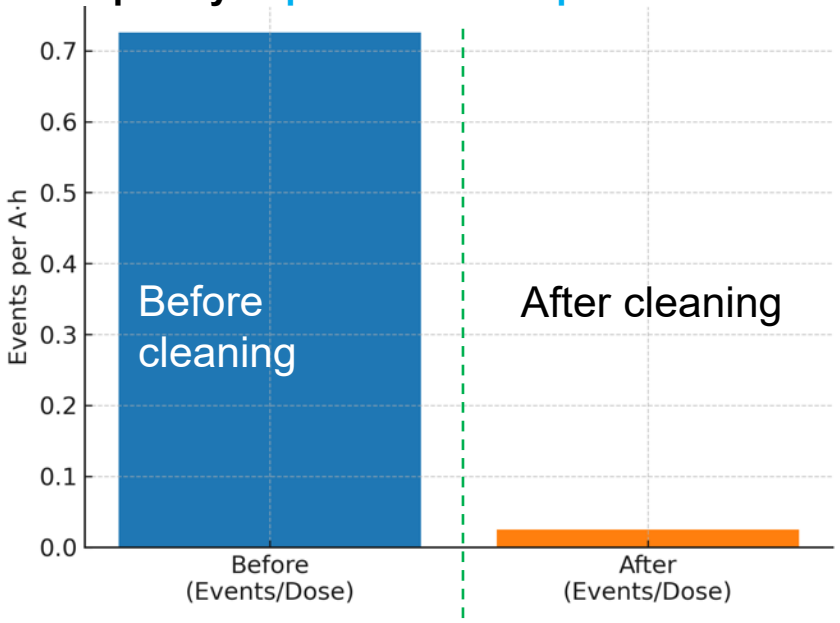


2025/09/29

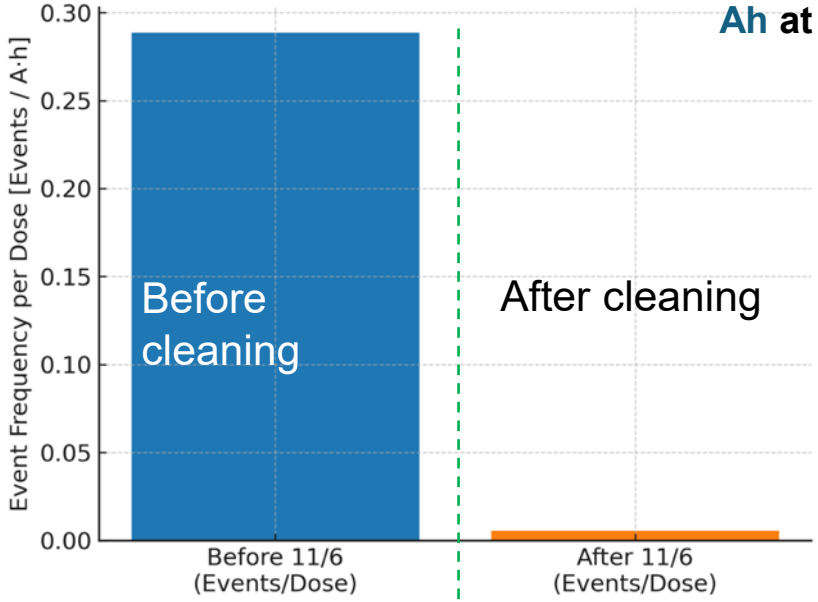
Beam pipe cleaning

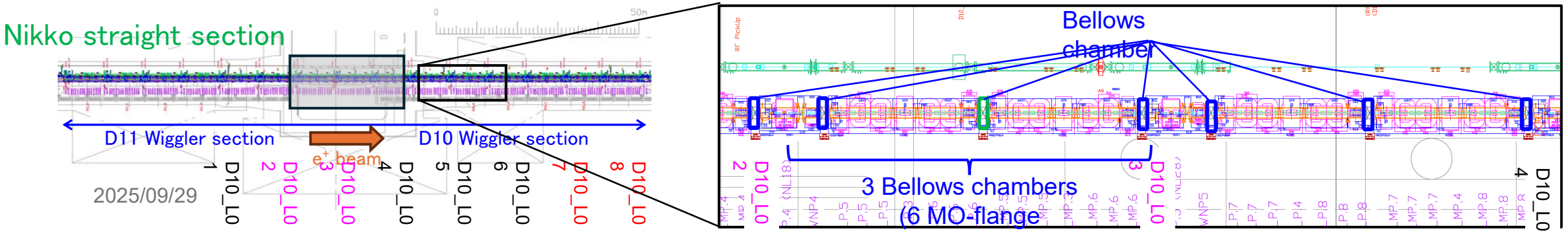
- A bellows chamber near CCG D10_L02 was replaced, and VACSEAL was removed from the adjacent beam pipes on Nov. 6 during the 2024c run, using the same cleaning method.
- After this work, the number of pressure bursts in the area has been significantly reduced.

Frequency of pressure burst per 1 Ah at CCG D10_L02

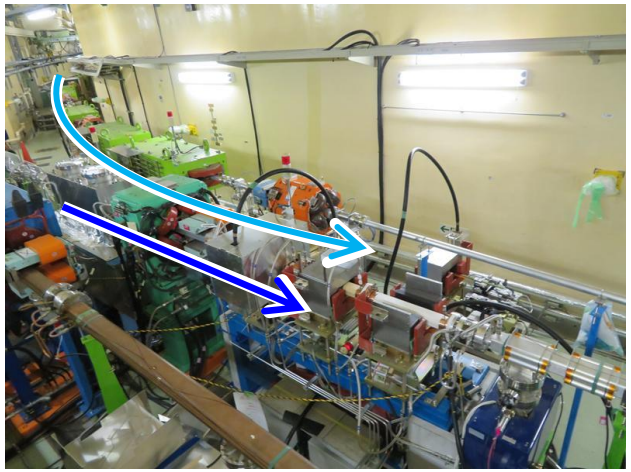


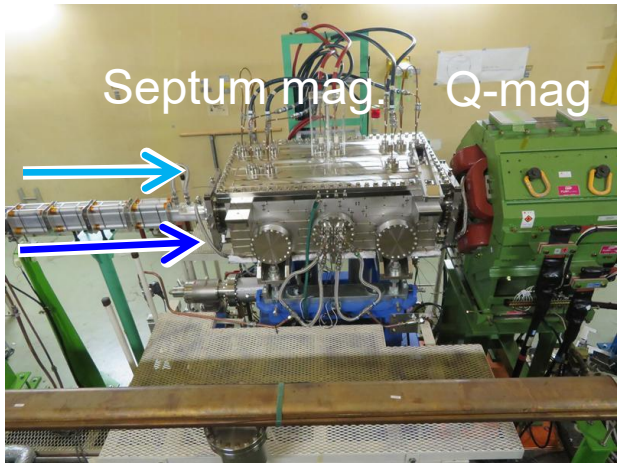
Frequency of beam abort accompanied by pressure burst per 1 Ah at CCG D10_L02

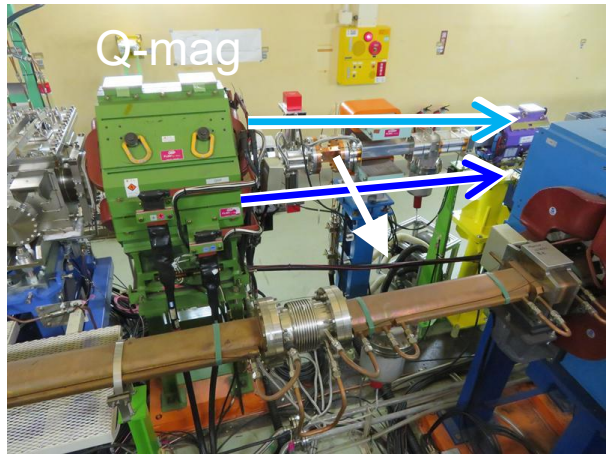


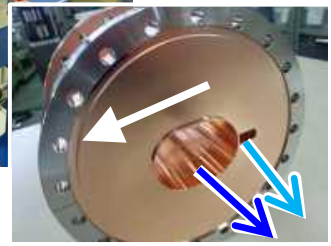


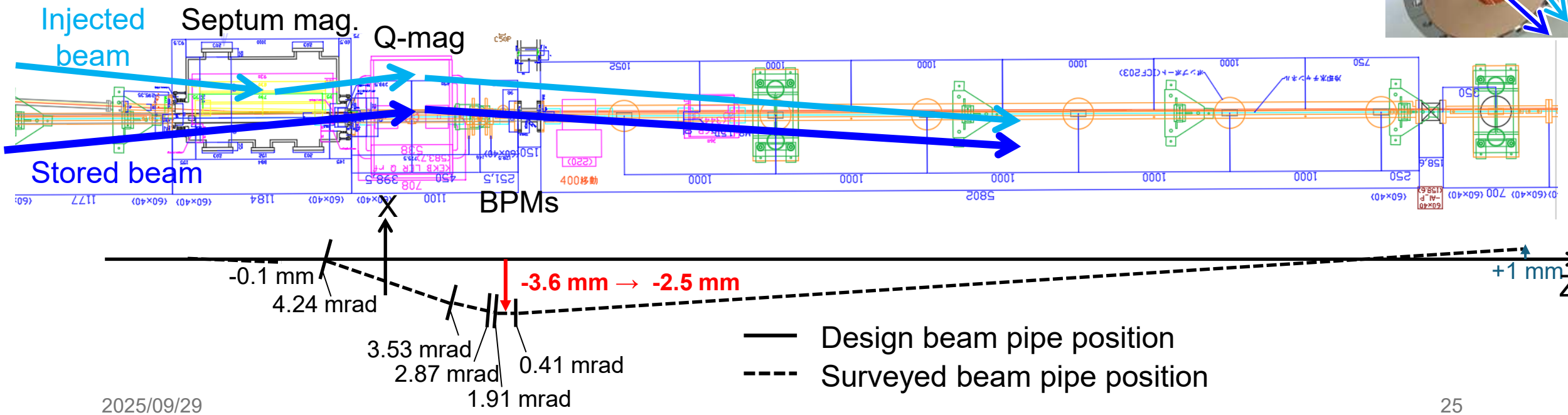
Alignment of beam pipe at LER injection point



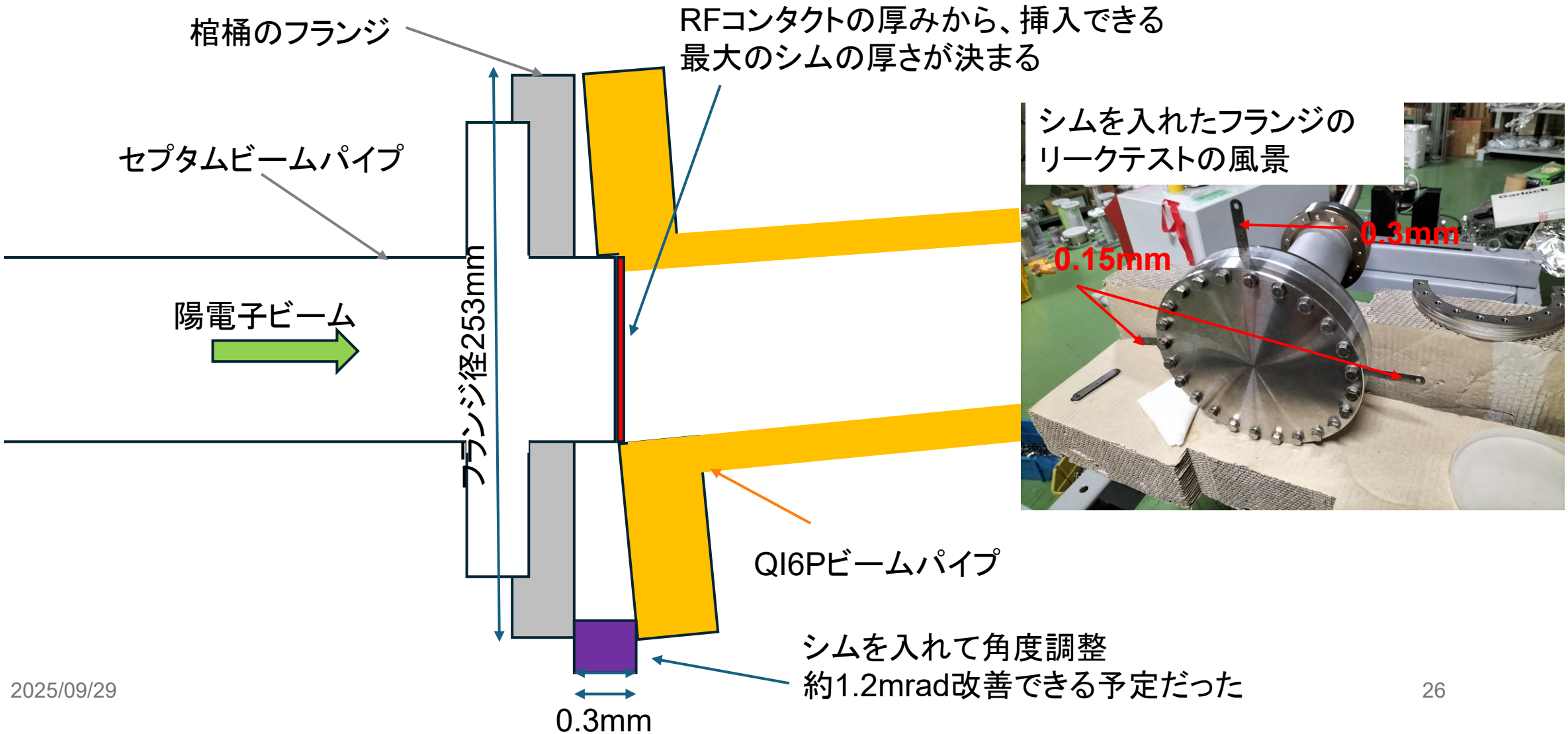








Alignment of beam pipe at LER injection point



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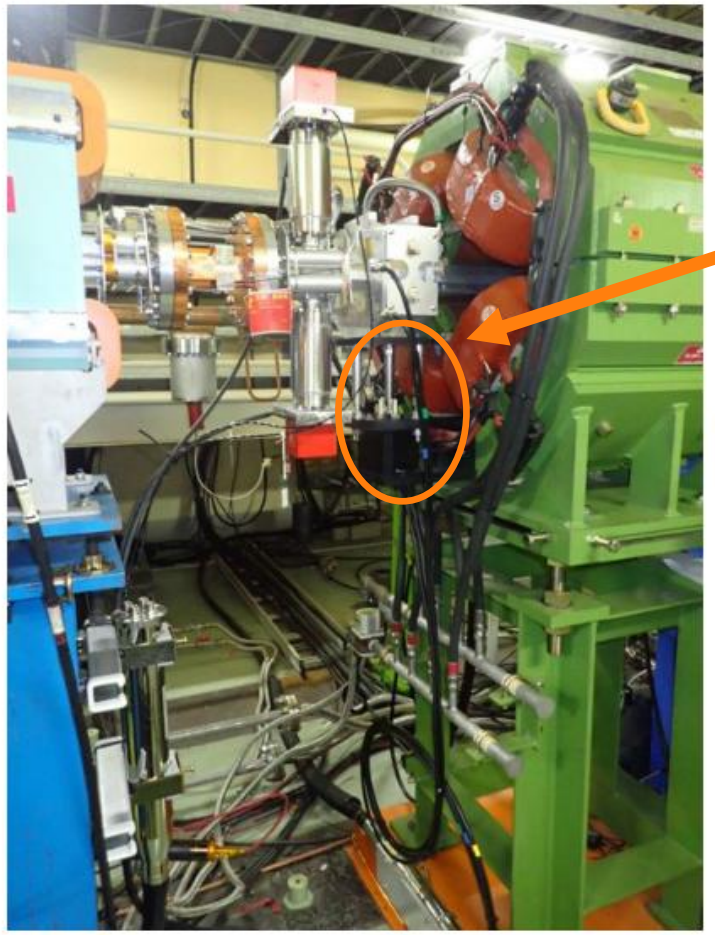
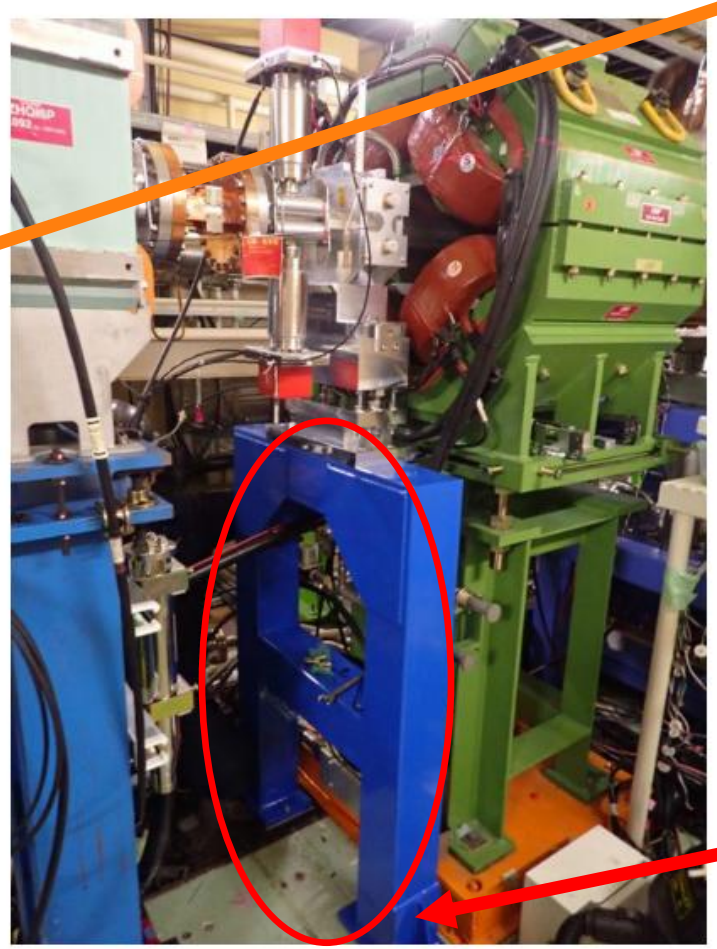




QI6PのBPMサポートは
他の場所とは違いひ弱な構造

リング外側に、QI6PのBPM
サポートが傾ていた

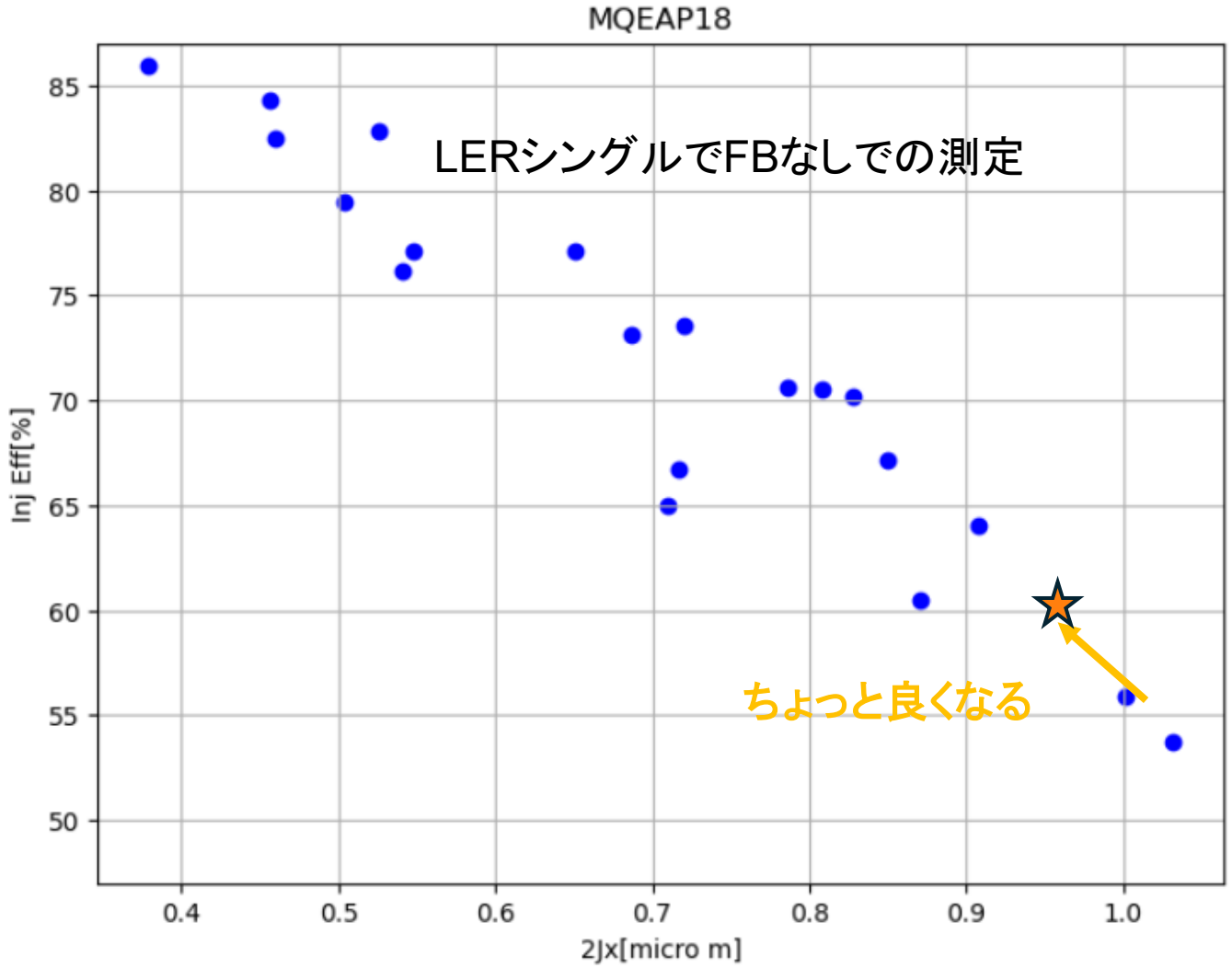
このサポートを緩めるとリング内側に
動きオフセットが緩まると思ったが、
逆でリング外側により動いた

サポートを強化するためと、アライメント調整
ができるように、独立のサポートに
変更した

Alignment of beam pipe at LER injection point

Time	Laser tracker	FARO
2016年7月		0.8mm
2022年	3.6mm	
2025年4月	3.6mm (2024cと同じ状態、真空)	
2025年6月		3.3mm (大気開放した状態)
2025年8月 (シムを入れて、セプタムビームパイプアライメント後、ベーキング前)	2.8mm	2.5mm
2025年9月 (ベーキング後)		2.5mm(速報値)

By*1mmでの2Jxの改善具合の推定



Lifetime 4 min

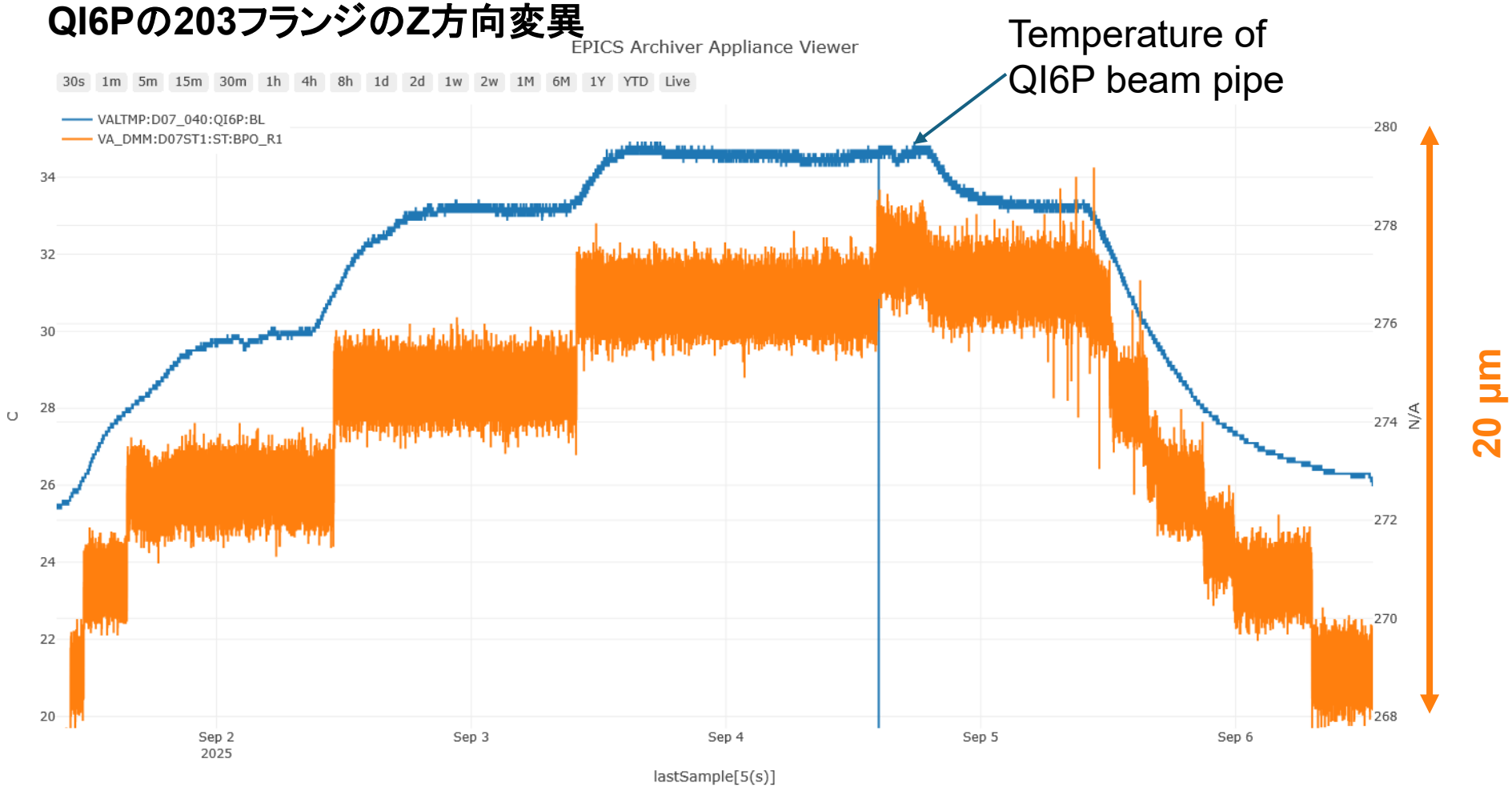
injection charge 6 nC、
injection rate 23 Hz

Circumference 3 000m

Injection efficiency 60%

- **LERシングルなら By*1mm でも 2Aに到達可能！（かも？）**

QI6Pの203フランジのZ方向変異

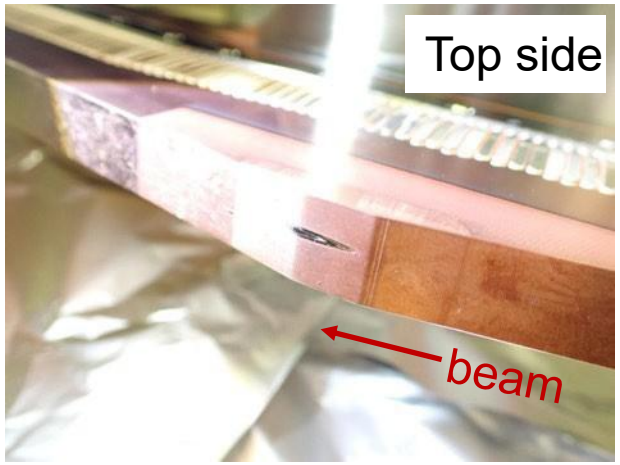


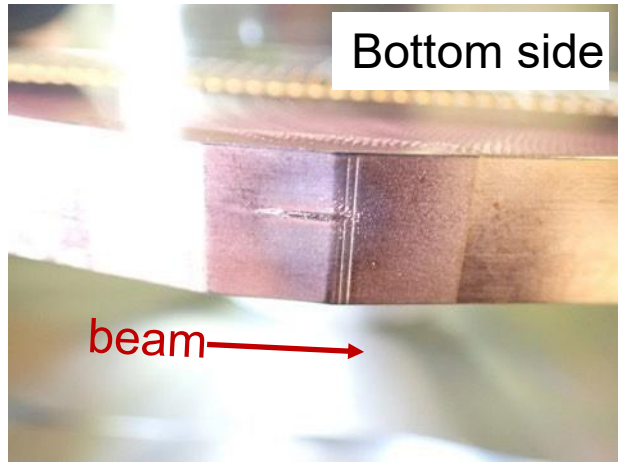
Vacuum Tasks – LER Collimators (Jaw Replacement)

- Damaged jaws in D02V1 and D05V1 were replaced with new ones.
- The top jaw removed from D05V1 was replaced, although its flat area at the tip appeared undamaged and still usable.
- We installed a Ti jaw on the top side of D05V1 to test its durability and evaluate its background reduction performance.

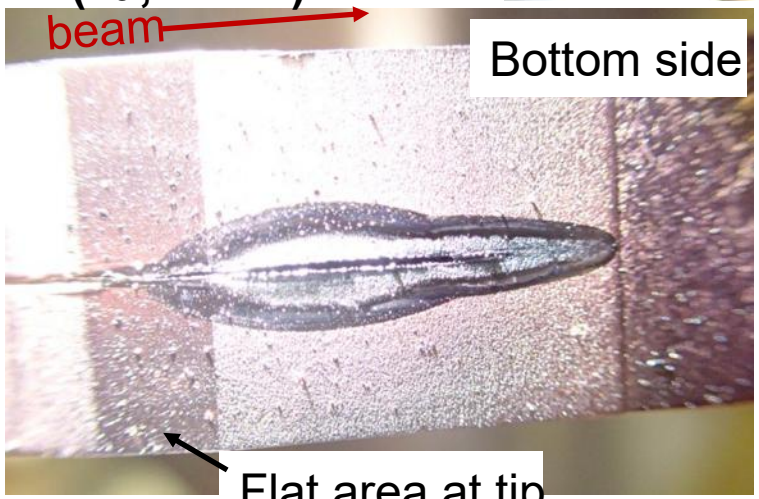
  Installed jaws
  - D02V1: Ta, 10 mm (both side)
  - D05V1: Ti, 10 mm (top side)
    Ta, 10 mm (bottom side)

Damaged jaws removed from D02V1 (Ta, 10 mm)





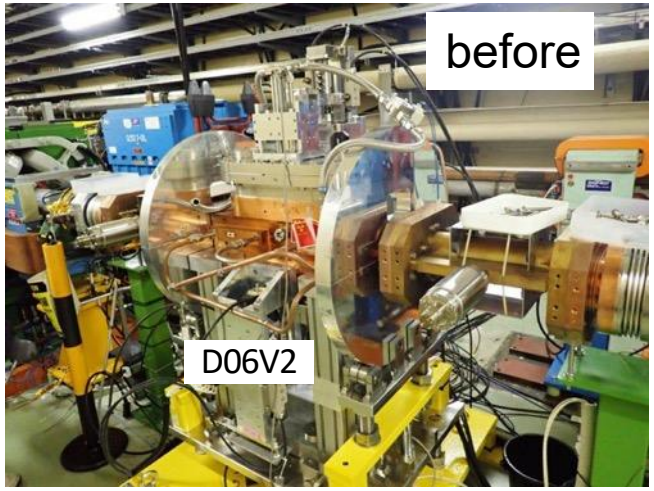
Damaged jaws removed from D05V1 (Ta, 4 mm)

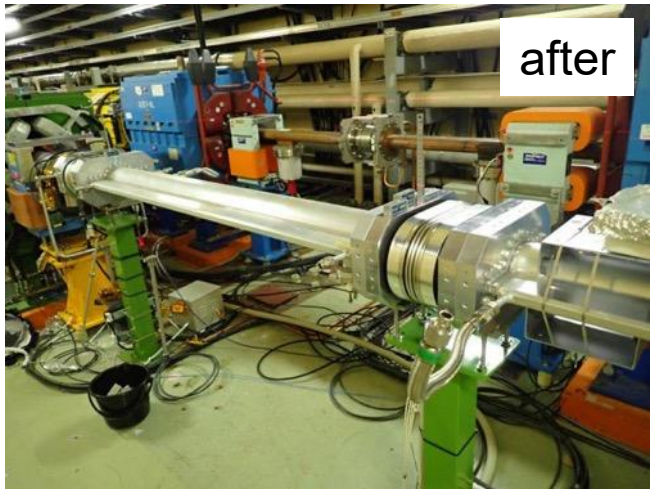


Vacuum Tasks – LER Collimators (D03V4 Relocation)

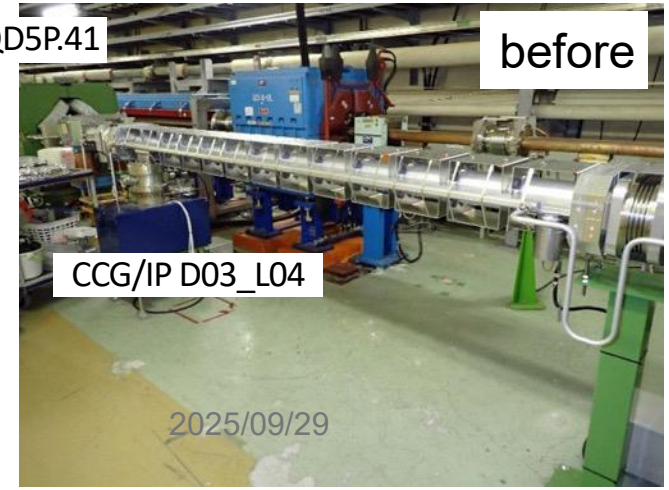
- The D06V2 collimator was relocated to D03V4 as a countermeasure against SBLs to reduce losses at the IR and D02V1 regions.

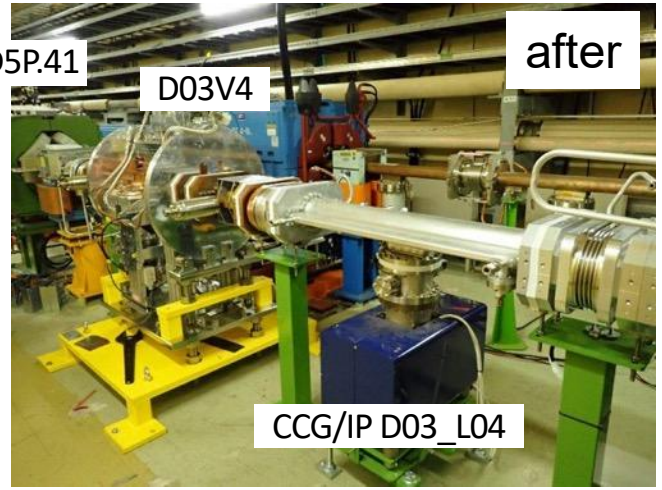
Location of D06V2



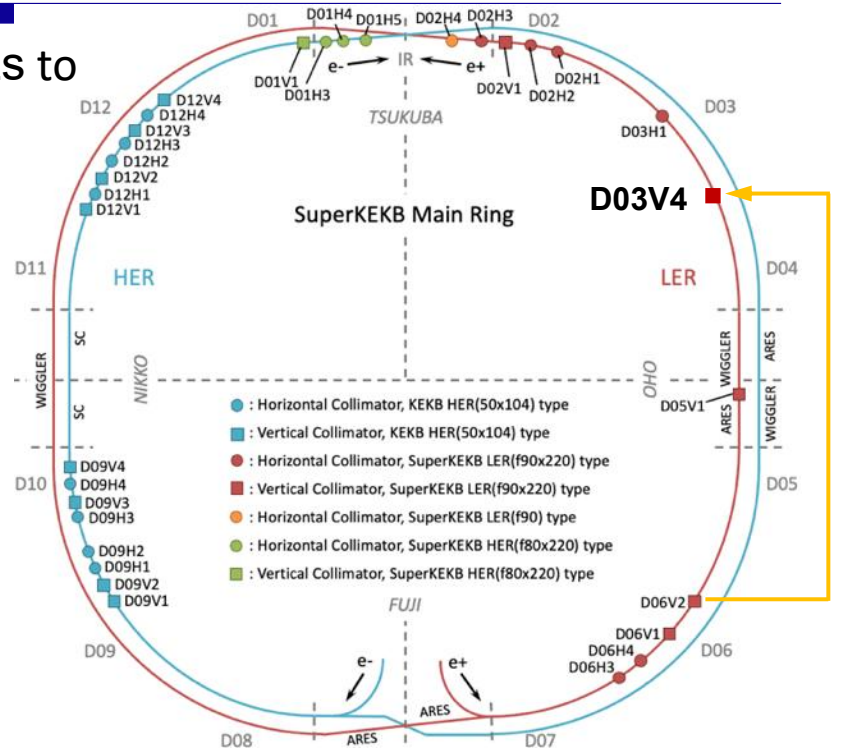


Location of D03V4





Location of collimators

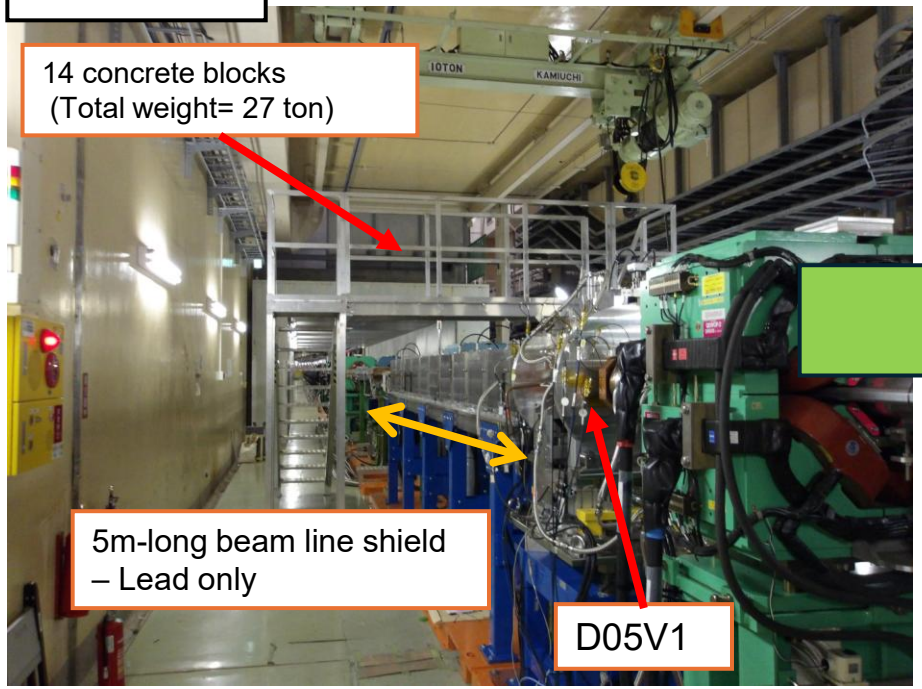


LER vertical collimators and jaws

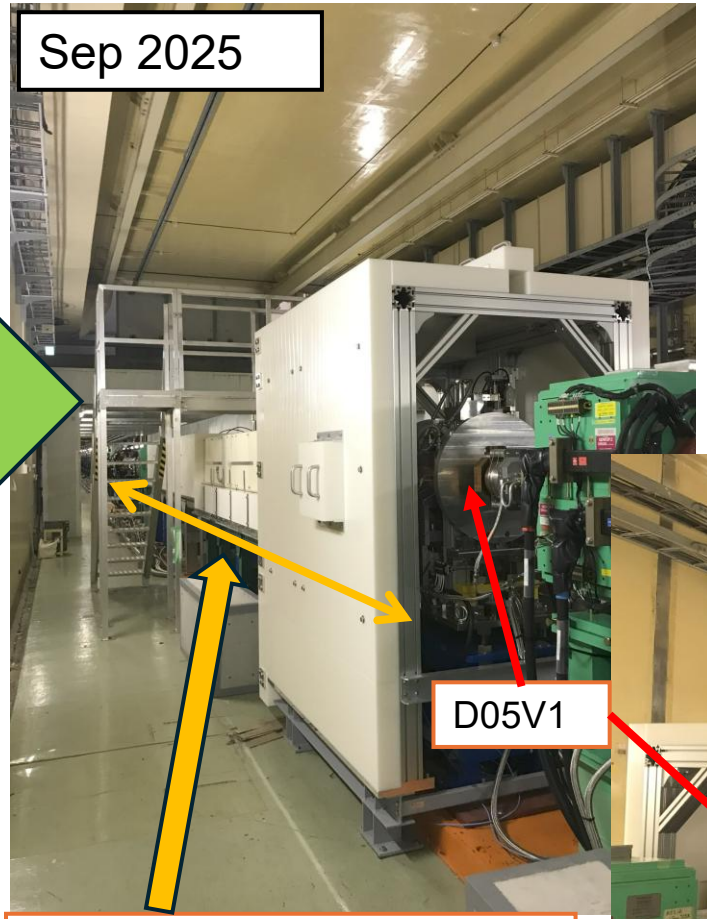
Name	Tip Material (): longitudinal length in mm	Tip Condition
D06V1	Ti (10)	Healthy
D05V1	Top: Ti (10) Bottom: Ta (10)	Healthy
D03V4	Hybrid: Ta (3) + C (7)	Healthy
D02V1	Ta (10)	Healthy

Reinforce the radiation shields around the D05V1 collimator

Oct 2024



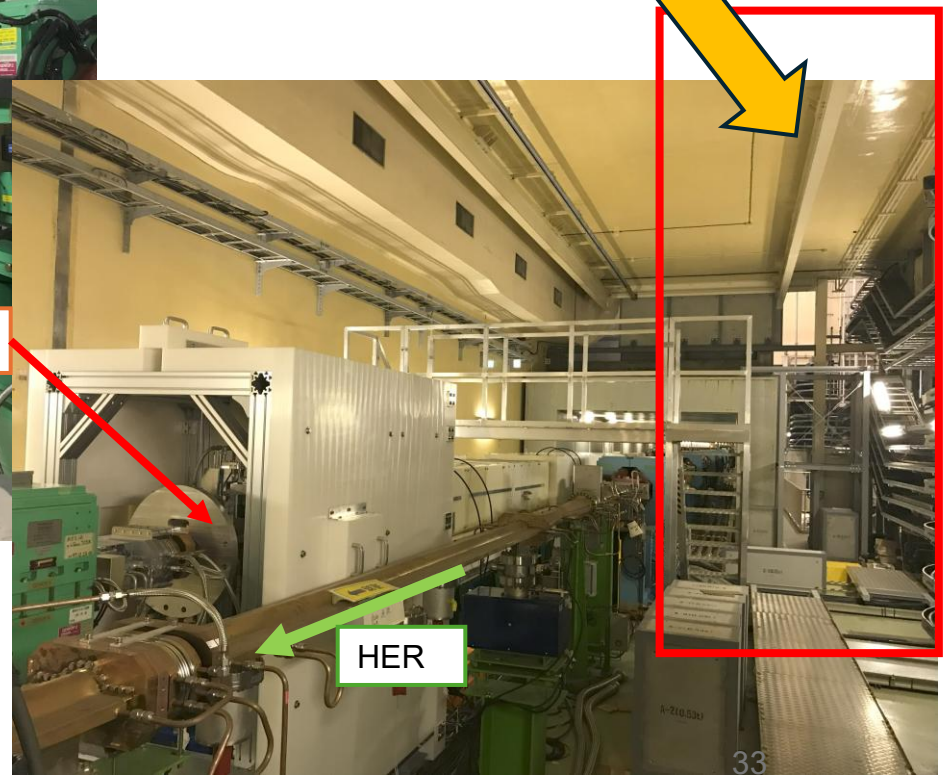
Sep 2025



On the beam line,
* 10m-long beam line shield
  - Lead (50mm thickness)
  - HDPE (100~200mm thickness)
* Shield room around D5V1
  - HDPE (100~200mm thickness)

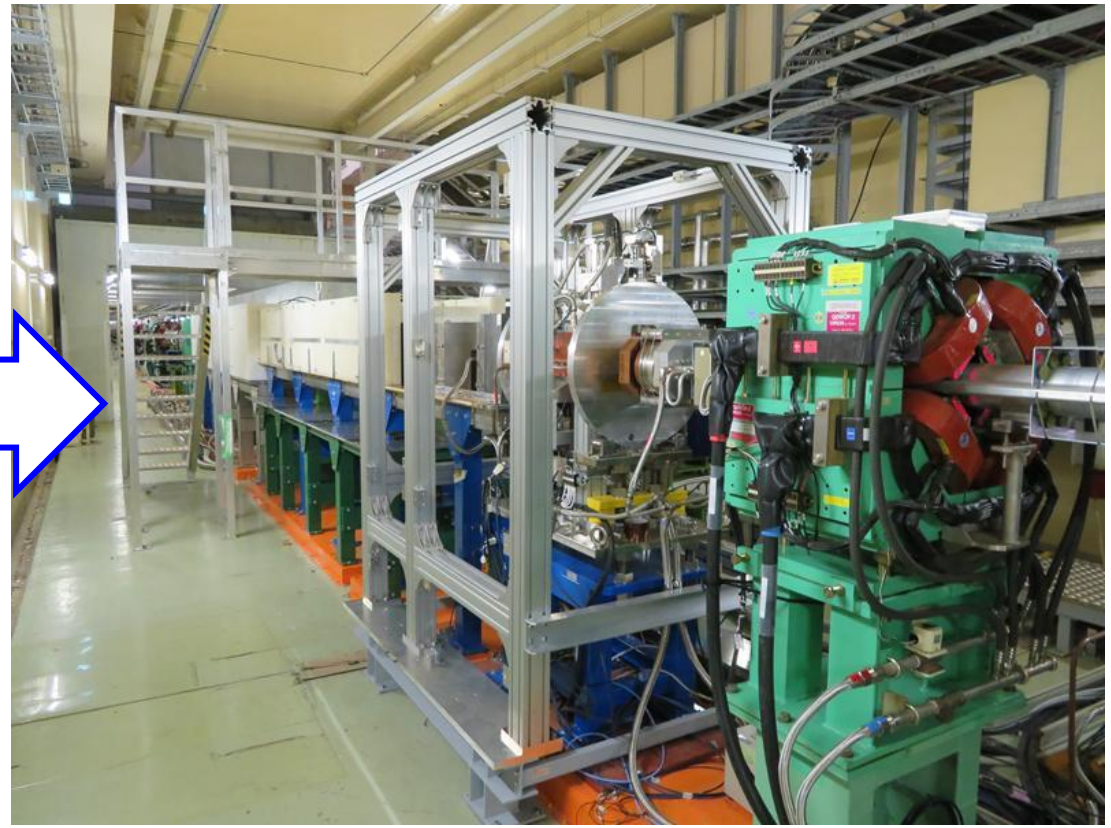
Currently, additional concrete shield is being constructed at the boundary between the tunnel and the laboratory.

And, the high-density polyethylene (HDPE) shield is also constructed on the cable tray.



Leakage radiation amount expected to be 1/10 by these shields

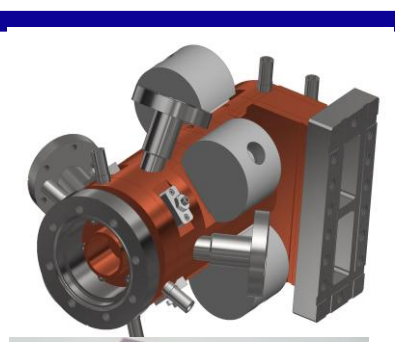
Radiation shielding reinforcement at NLC

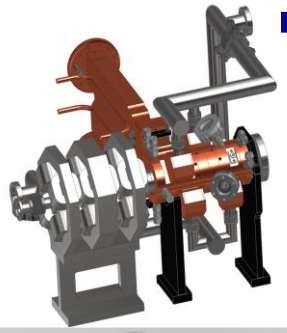


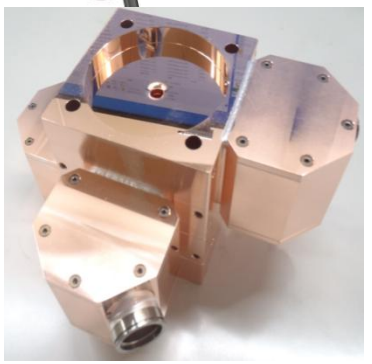
Frame for installing the shielding around D05V1 (NLC) has been completed.

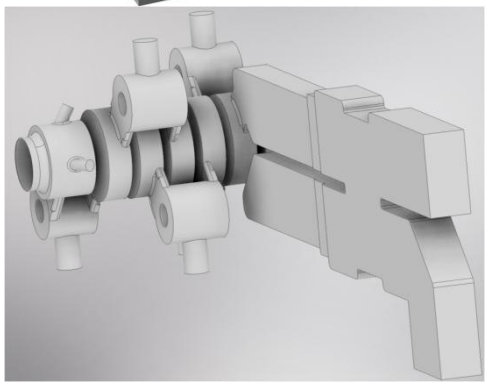
Installation of the new RF gun (Linac)

[Old RF-Gun issue]
- Laser window lifetime
- Dischargement at choke structure
- Dark current
- Energy slope due to lower voltage
- Focusing magnet

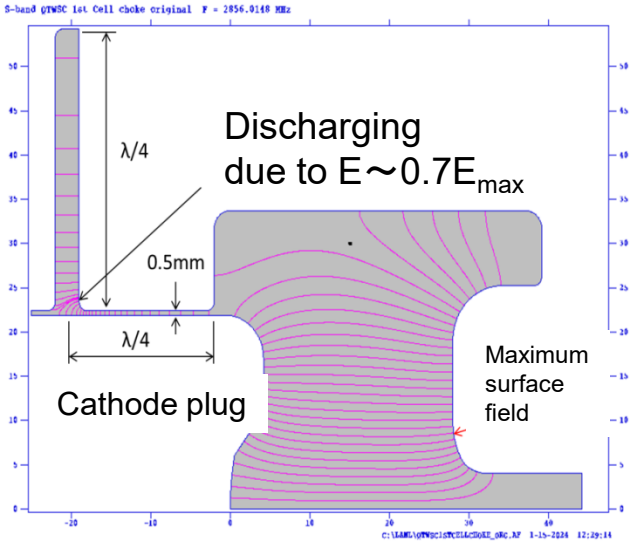




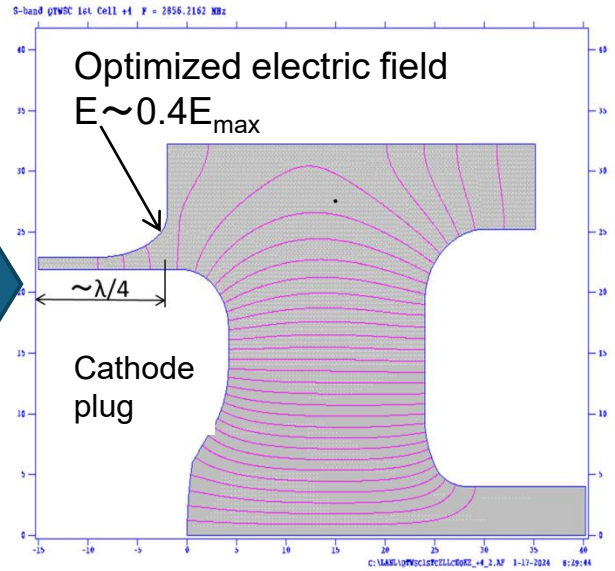


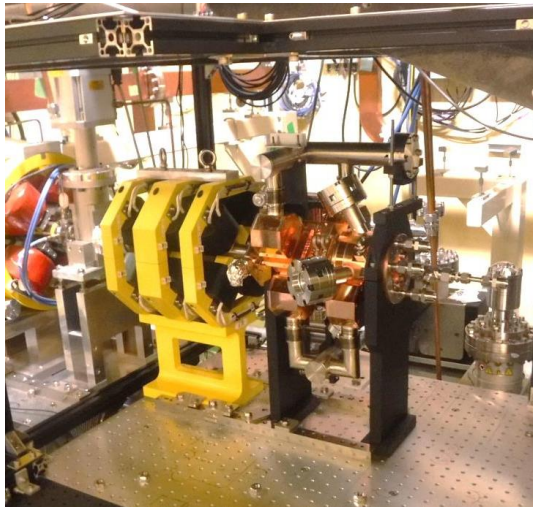


Old RF-Gun cathode cell
with choke structure
for cathode thermal cleaning



New RF-Gun cathode cell
optimized surface field



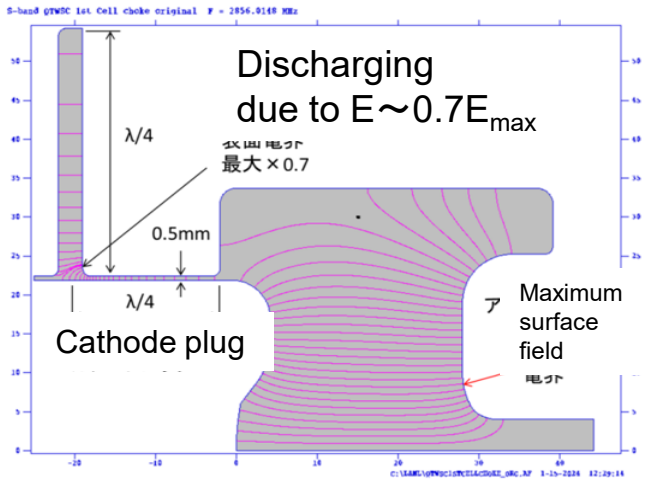


Status of RF Gun (Linac) – Updated QTWSC RF Gun

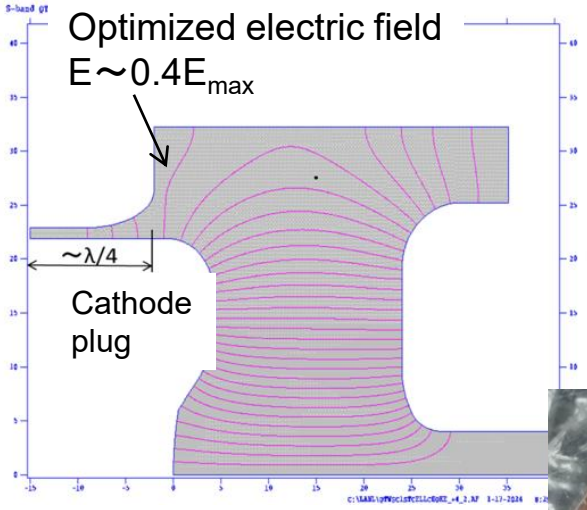
[M. Yoshida *et al.*]

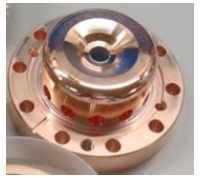
- The current RF gun cathode cell includes a choke structure for thermal cleaning of the cathode.
- The updated cathode cell is designed with:
  - Optimized surface field
  - Additional vacuum pumping
  - A new triplet downstream of the gun
- During brazing, the wrong cavity cell was assembled, resulting 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.

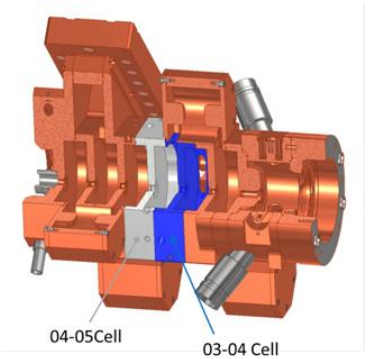
Current

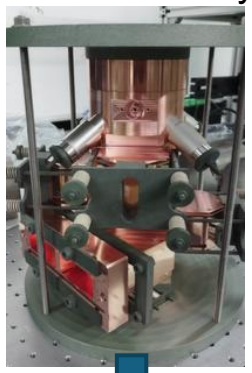


Updated

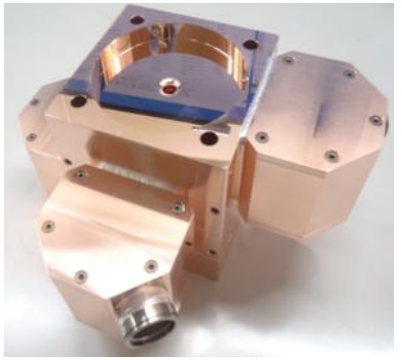


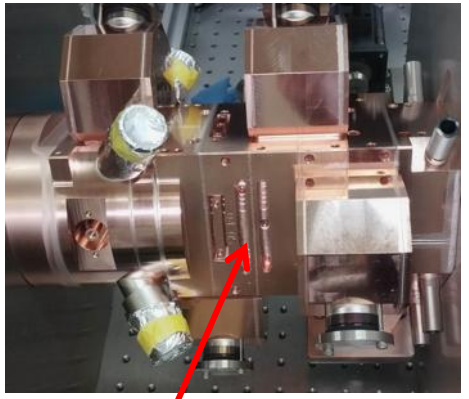






Brazing assembly





New IrCe Cathode Plug

Additional machining for

- 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.

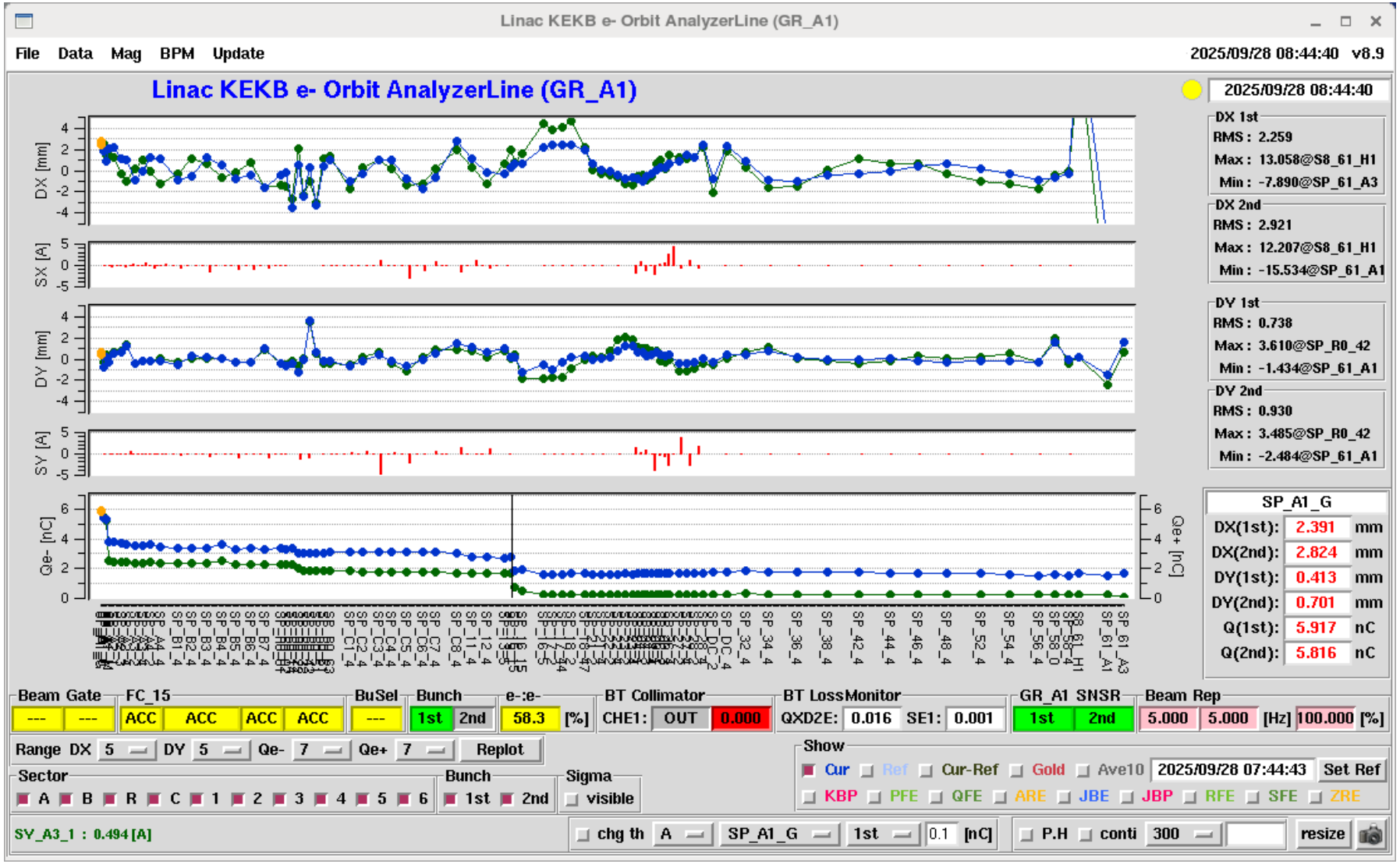
New RF gun installation (Linac)

RF conditioning at test bench

2025/8/4 14:00 ～ 8/18 9:00

RF power was achieved about 5 MW (1 μs width)

New RF gun installation (Linac)



> 6nC was observed at RF-Gun exit.

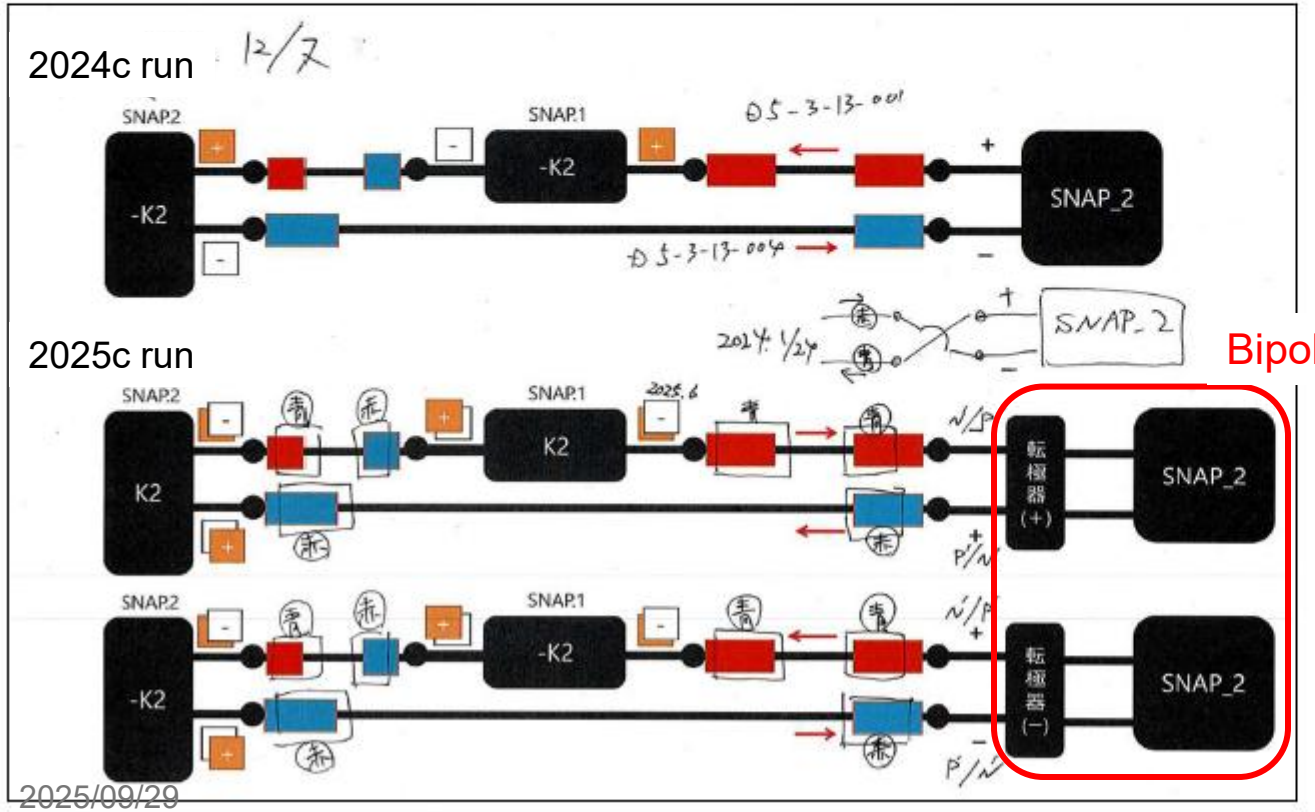
Installation bipolar power supply of Sextupole magnet for NLC

2024c run

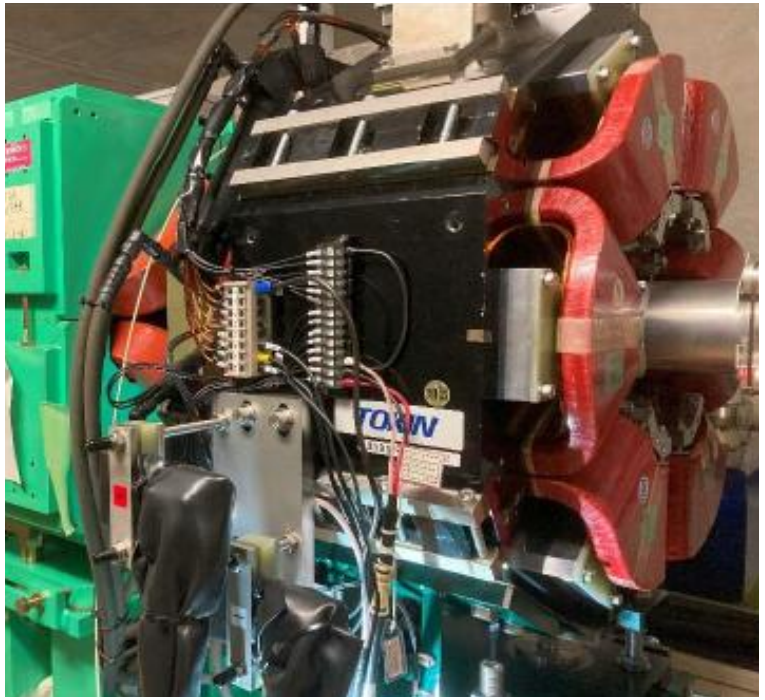
The polarity of the sextupole magnet was reversed by rewiring the power cable. (two or three hours)

2025c run

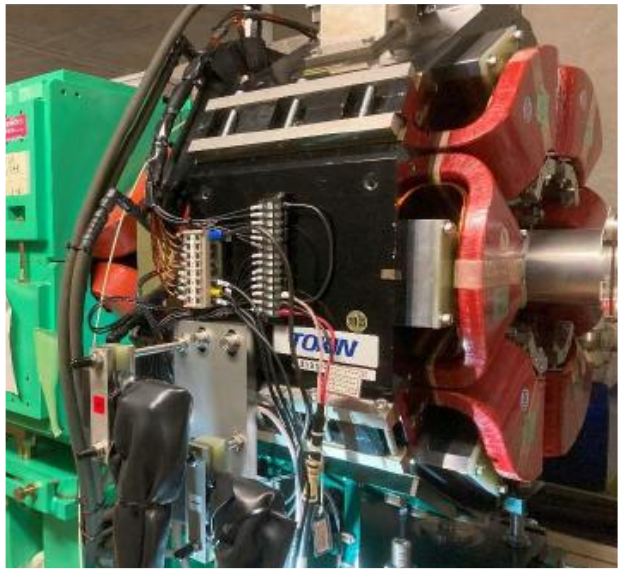
Polarity reversal is possible via remote operation of the polarity reverser.

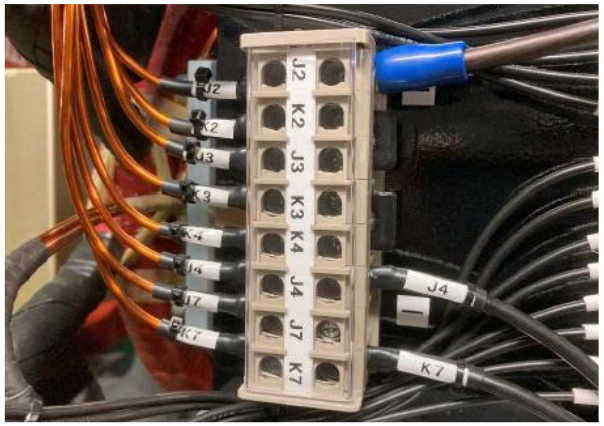


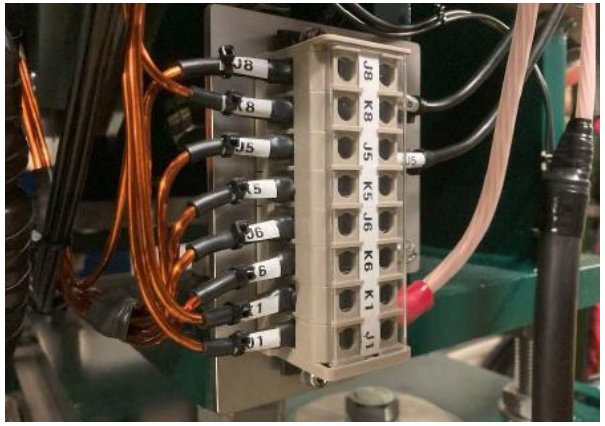
Bipolar PS



Magnet for Non-linear collimator







Re-cabling for normal-Q

Polarity check

Vacuum works - LER

: vented and work completed

: section scheduled for work

LER

1. Internal check and cleaning

4. Collimator jaw replacement (D02V1)

5. Collimator relocation (D06V2→D03V4)

7. Cleaning

1. Beam pipe cleaning

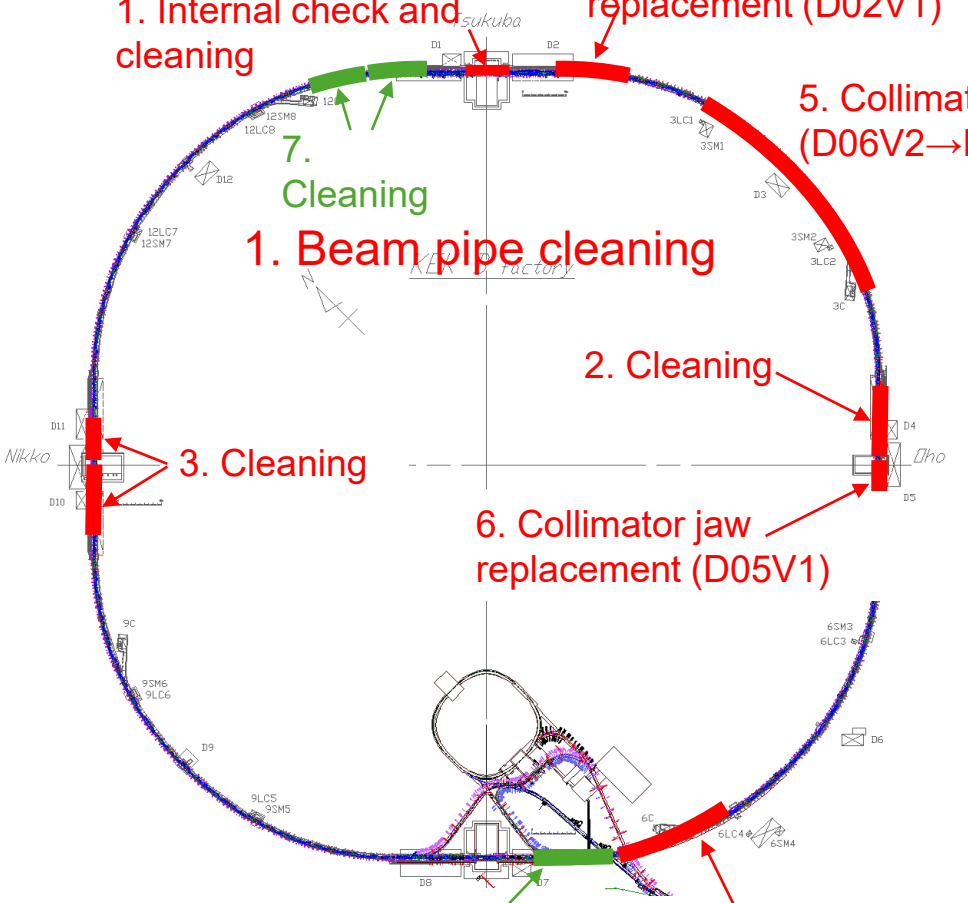
2. Cleaning

3. Cleaning

6. Collimator jaw replacement (D05V1)

8. Ceramic chamber replacement, Investigation of mis-alignment

5. Collimator relocation (D06V2→D03V4)



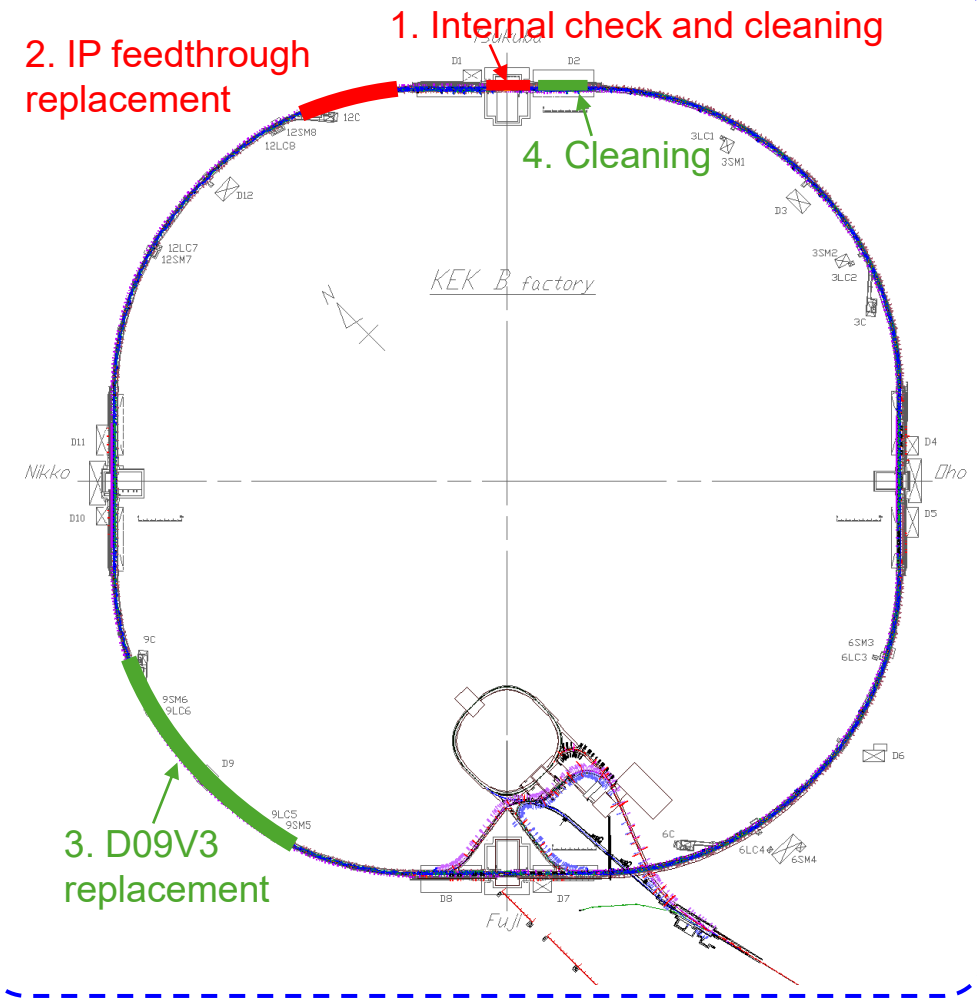
HER

2. IP feedthrough replacement

1. Internal check and cleaning

4. Cleaning

3. D09V3 replacement

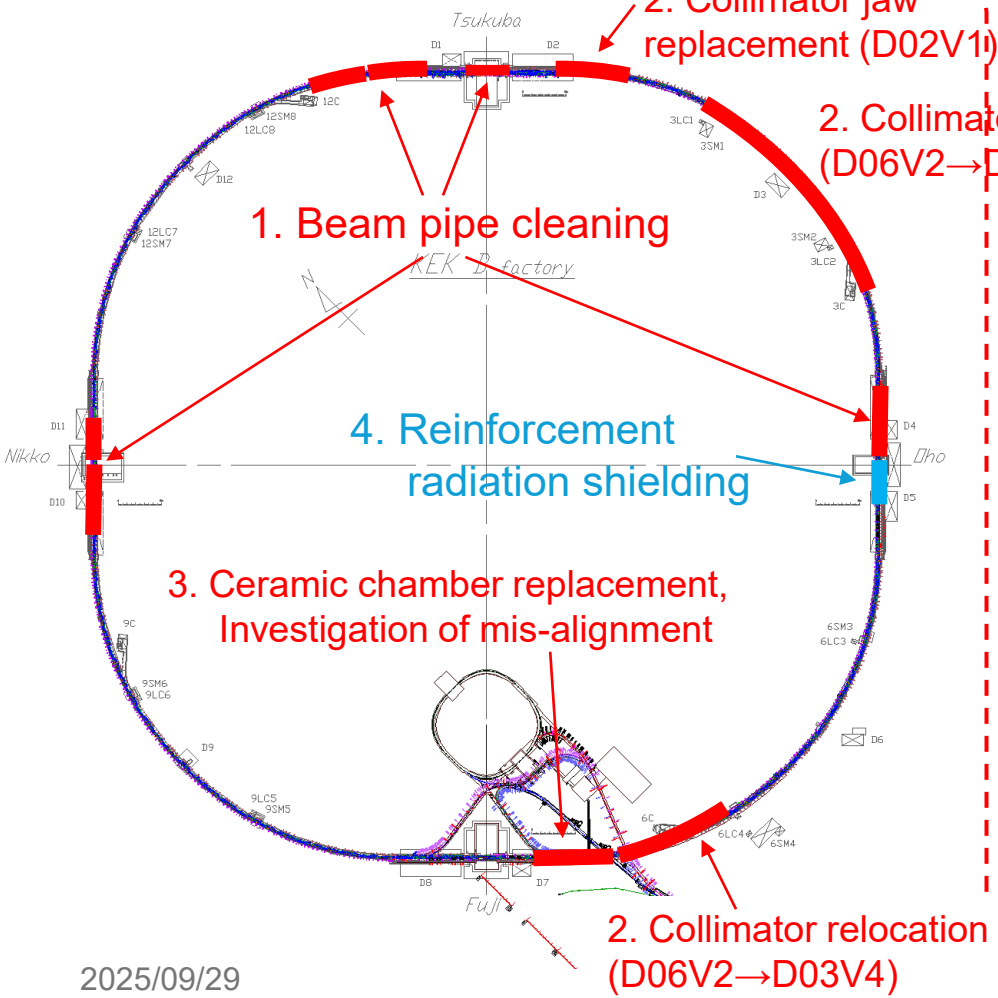


Vacuum works - LER

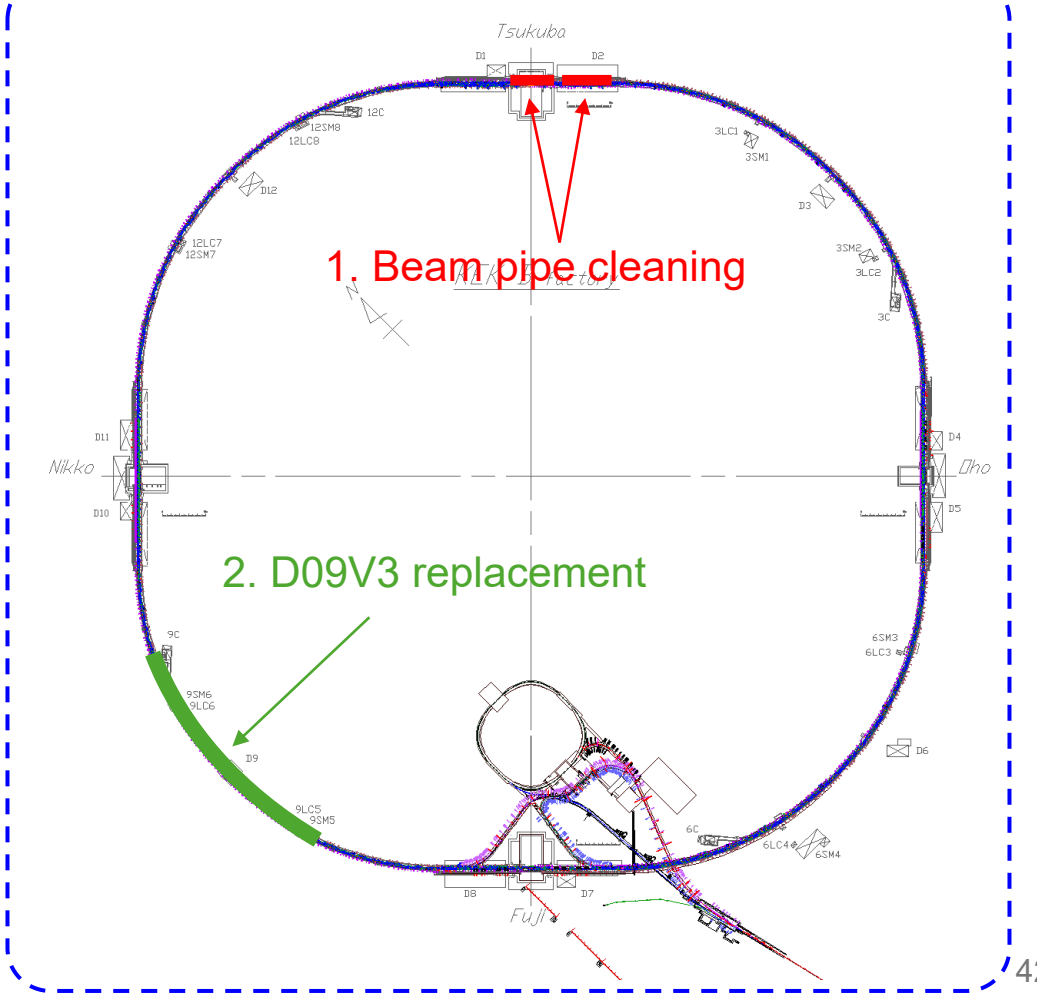
: vented and work completed

: section scheduled for work

LER



HER

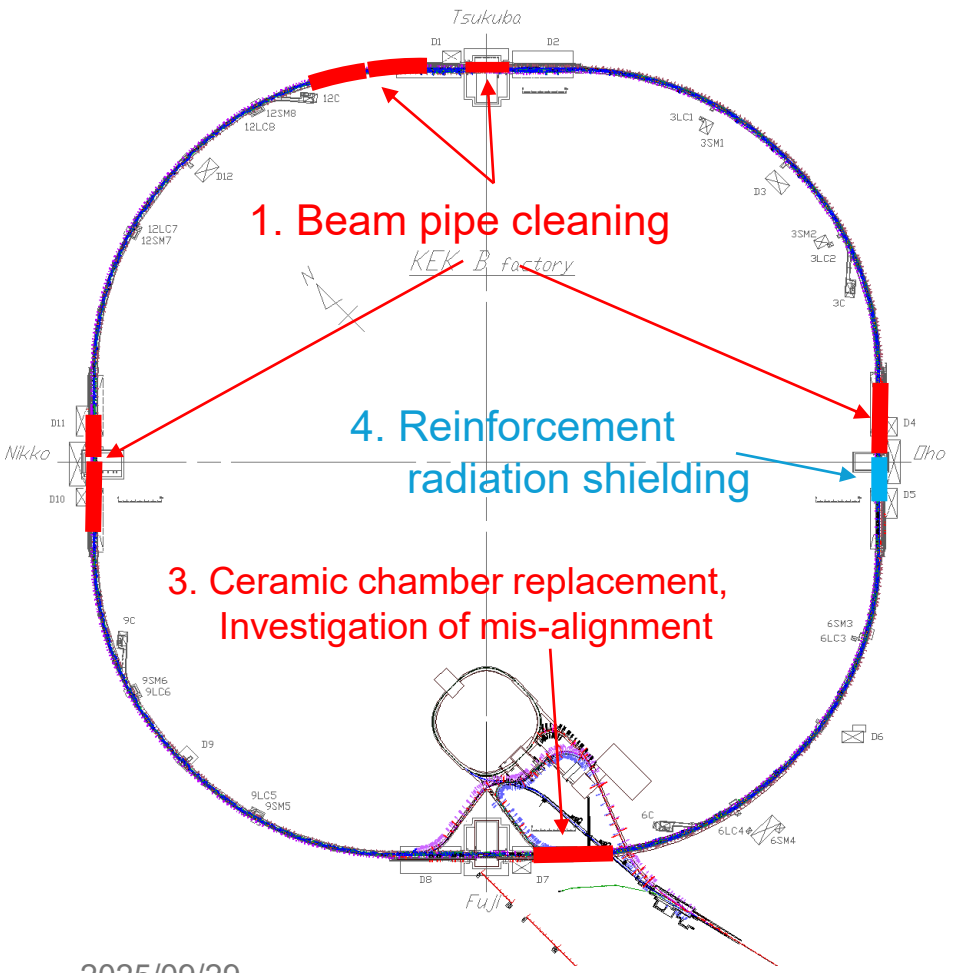


Vacuum works - LER

: vented and work completed

: section scheduled for work

LER



HER