Facility and Safety

27 Oct 2026

K. Watanabe (Acc 3rd)

The 29th KEKB Accelerator Review Committee

Topic

Introduction
- Infrastructure Status focused on SKEKB

Facility
(1) Replacement for Electrical Facility
Concerns for operation
Voltage fluctuations dependent on automatic power factor setting

(2) Replacement for Mechanical Facility
Status of power machinery replacement

(3) Regarding the aging of the buildings
Problems caused by roof leaks

Radiation Safety
(1) Reinforcing radiation shield for NLC and BT
(2) Status of radiation-related applications for next run
Increase the storage beam current (LER/HER)
Increase the injection bunch charge in BT (e-/e+)

Summary

Infrastructure Status focused on SKEKB

Electrical Facilities (Campus-wide configuration)

- Three transformer-rectifier units, each with a power capacity of 50 MW, are installed in central power receiving facilities (AC 154 kV, ~100 MW). (Two units are in constant operation, with one unit serving as a backup.)

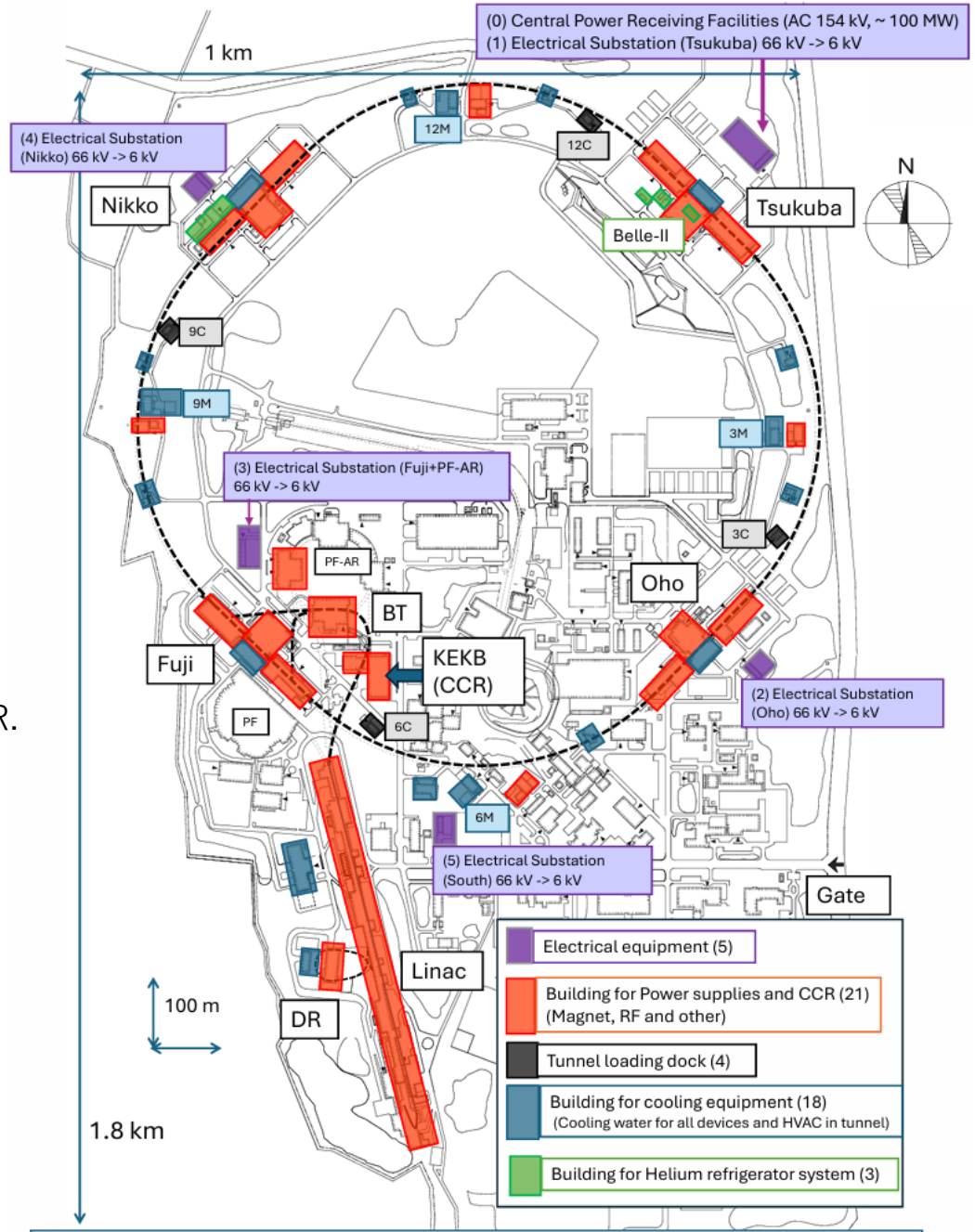
- Power is distributed from a central point to five electrical substations. (extra-high-voltage).

- Finally, it is distributed to multiple low-voltage substations located throughout the campus.

Mechanical Facilities (Focus on SKEKB-MR and BT)

- Mechanical facilities distributed across 16 locations is used for the cooling of MR. A total cooling water flow rate in MR -> ~ 80,000 l/min to cool all devices.

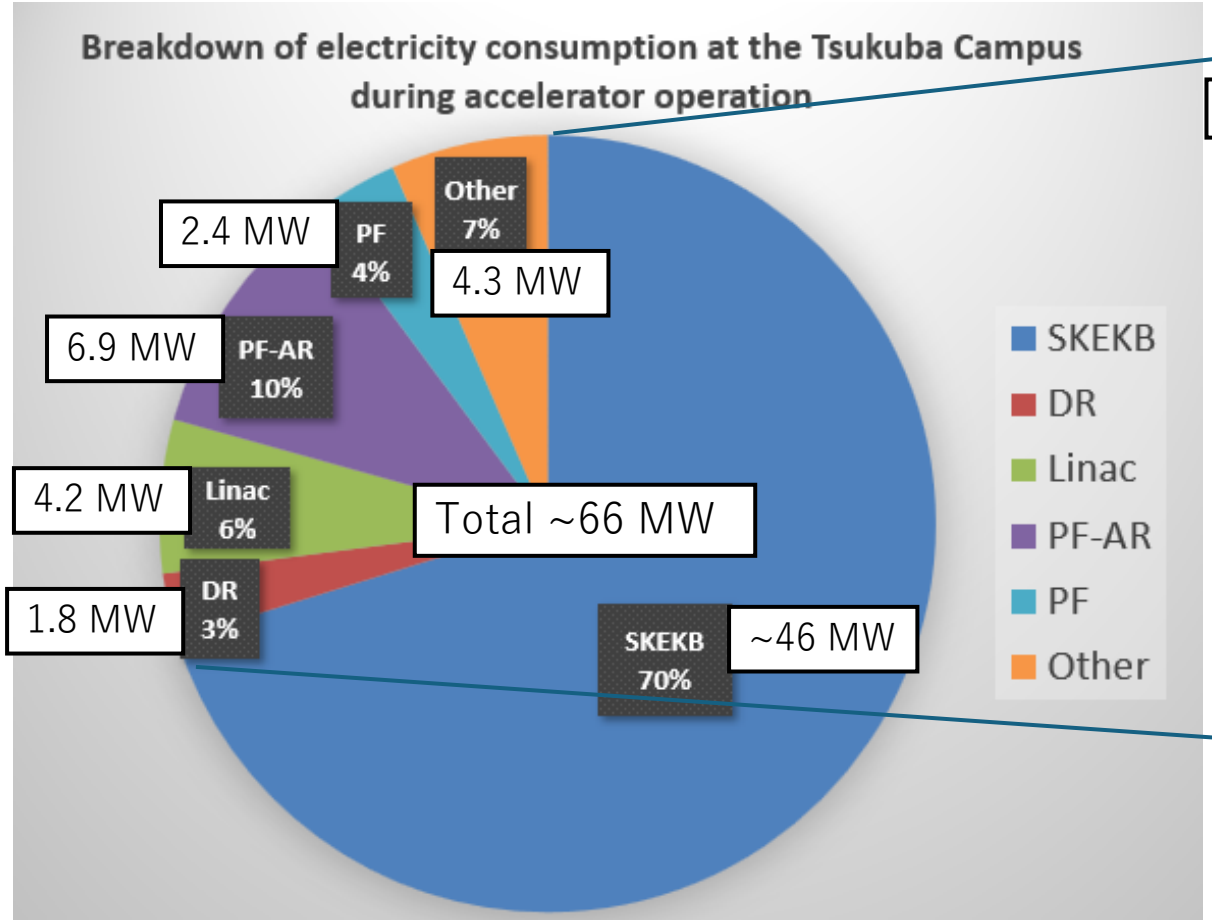
	Total flow (l/min)	Heat load (MW)	Other
Magnet	~20,000	~5.4	Bending, wigger etc.
RF cavity (ARES)	~8,000	~6.4	Normal conducting cavity
Vacuum chamber	~14,000	~11 (Max)	LER 1600 mA/HER 1280mA: ~5.6 MW * Sheared for HVAC in tunnel.
Power supplies	~14,000	****	For magnet and RF power source in MR
Other (HPRF etc.)	~24,000	****	Primary cooling for some devices
BT	~1,100	~0.9	To cooling the magnets



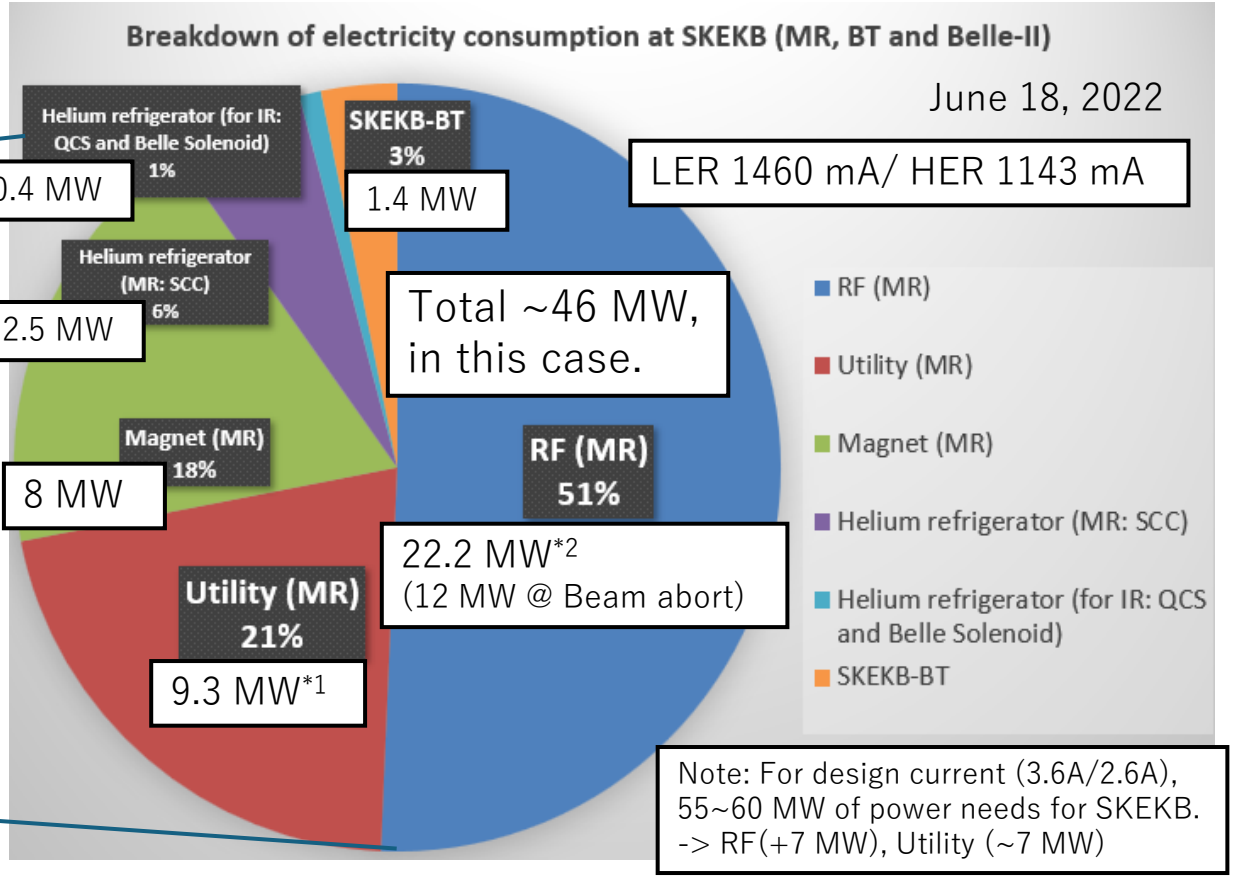
Layout of the buildings used at SKEKB (Tsukuba campus at KEK)

Example of the Regarding electricity consumption at the Tsukuba Campus

An example of a specific operating scenario is provided below.



SKEKB accounts for 70% of the total power consumption on campus. When a beam abort occurs, the supply of RF power to the beam is cut off, resulting in a load reduction of approximately 10 MW. This represents a fluctuation of about 15% of the total.



*1: Utility: Power is used for the operation of the cooling system, with the screw chillers, the water pumps and the fan-motors etc. (Vacuum chamber and Air conditioning within the tunnel.) The required power depends on the stored beam current and outside temperature.

*2: RF: From Power supplies to the Klystrons (to drive ACC cavity) The required power depends on the stored beam current.

Electrical Facility

Replacement handled by the Facilities Department (1)

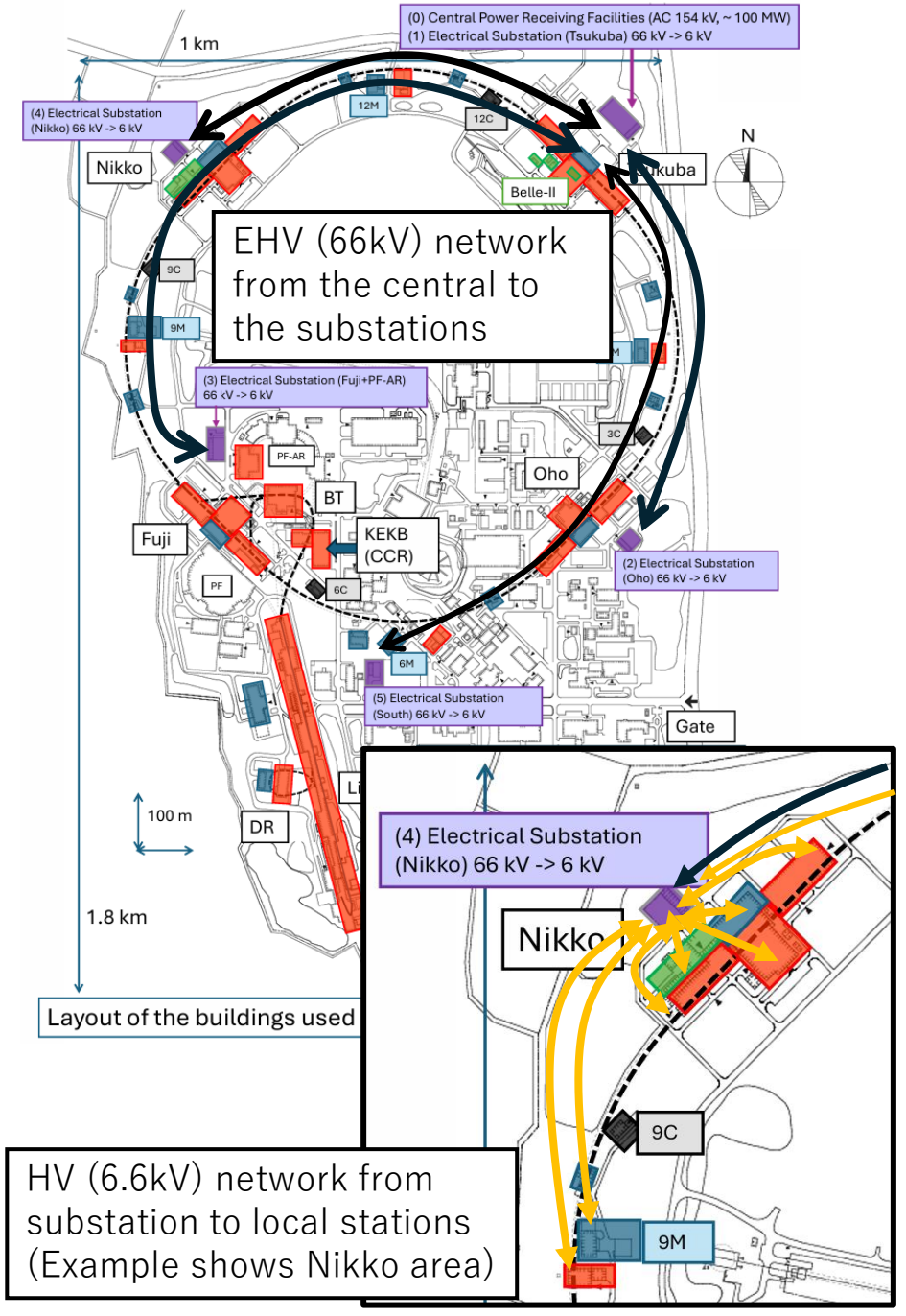
The electrical infrastructure that serves as the current foundation was built in 1982 (for TRISTAN project).
As of 2026, the following equipment has been replaced.

- Central power facilities (154 kV/66 kV): Power receiving capacity of ~100 MW
  - Upgraded in 2024, along with the central monitoring system.
  - Transformer configuration was also changed as followings,
    Old: 100 MW (main)+50 MW (sub) -> New: 50 MW x 3 (main=2, sub=1)

- Filters for substations
  - Replaced the high Voltage Phase Advance Capacitor until 2020 (Completed)
  - Replaced the High-voltage harmonic filter until 2020 (Completed)
  - The capacitor configuration has been adjusted to an optimal capacity for the power supply setup used at SKEKB.

- High voltage cables (66 kV and 6.6 kV)
  - Replaced the EHV (Extra-High-Voltage: 66 kV) cables in 2021 (Completed)
  - Replaced the HV (6.6 kV) cable in 2025 and 2026 (90% completed)

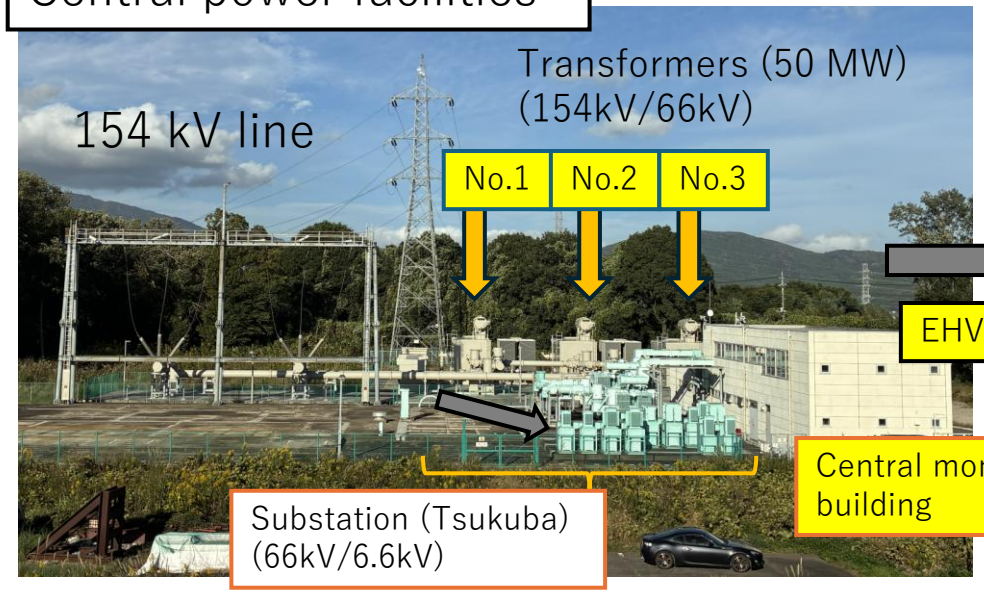
- Next step
  - Replacement of VCB (6.6 kV) in substations (2027–2035): ~100 units in total.
  - The replacement schedule for high-voltage transformers and low-voltage systems has not yet been determined.
  - However, progress is dependent on the available budget.



Replaced item

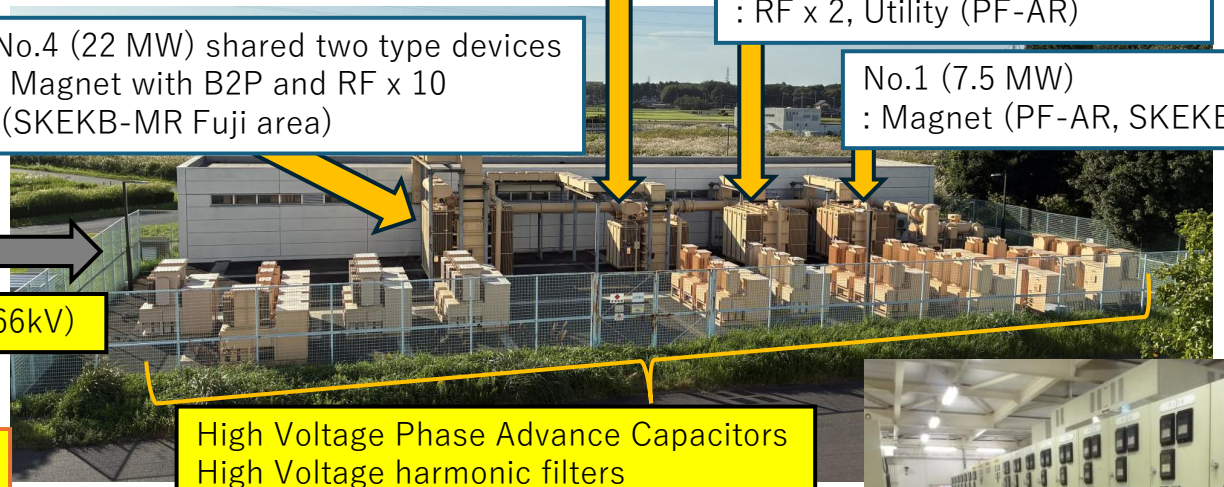
Site photographs of Electrical facilities

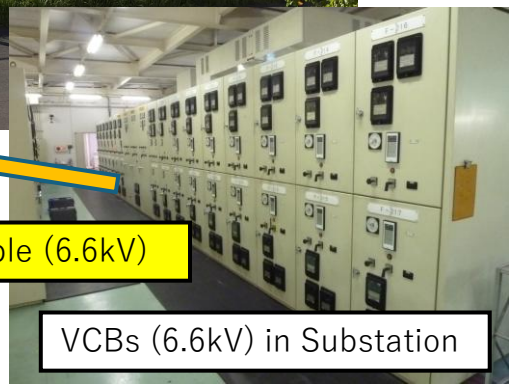
Central power facilities



EHV Substation (Fuji and PF-AR)
(66kV/6.6kV)

EHV cable (66kV)

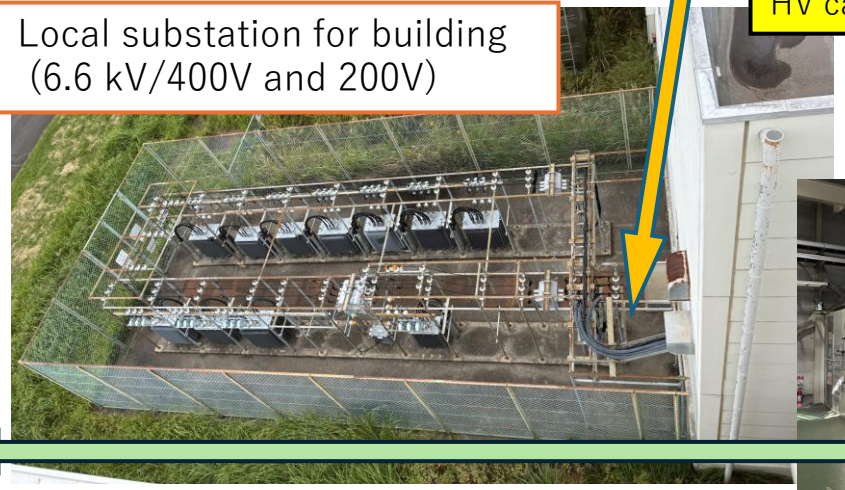




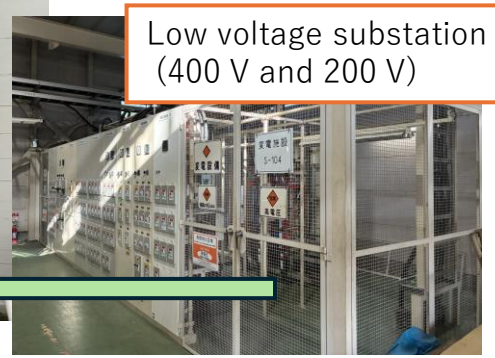
HV cable (6.6kV)

VCBs (6.6kV) in Substation

Local substation for building
(6.6 kV/400V and 200V)



Low voltage substation
(400 V and 200 V)









Circuit breaker
(20~200A)

Low-voltage
distribution panels

Supplying power to all control and cooling devices for accelerator

Concerns for operation

- Concerns
  - A point of concern is the potential for circuit breaker failures within low-voltage distribution panels. There are “exceed 1,000 such circuit breakers in use, **and there is almost no inventory of spares for circuits with a current capacity exceeding 50A.**
  - **Establishing backup circuits is an urgent priority to prepare for unexpected failures (Under proposal).**

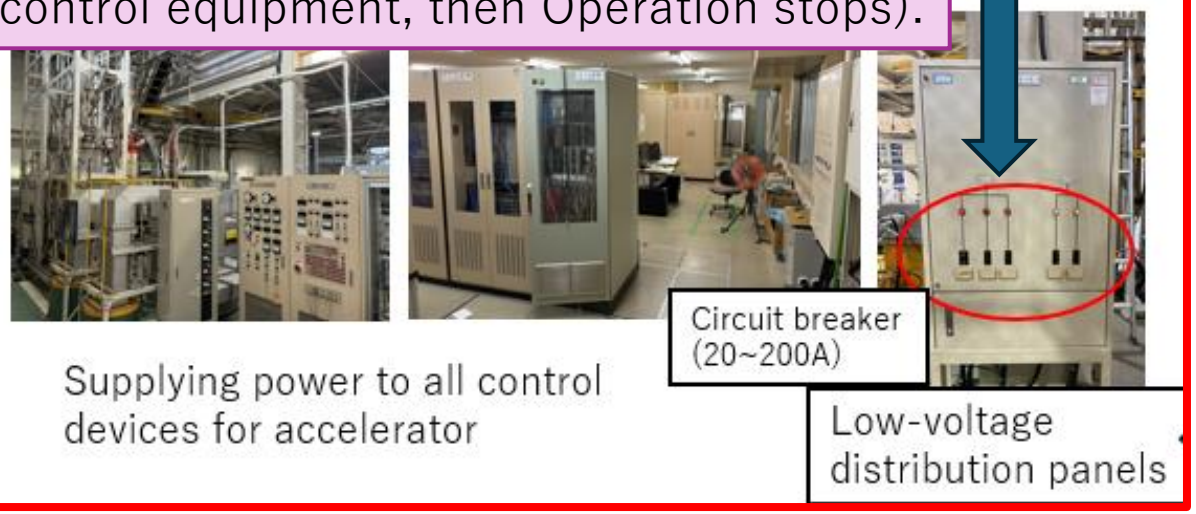
Circuit beakers for distribution panels (1982) -> not replaced.

※ Quantity of circuit breakers identified as requiring replacement

	20~30 A	50~100 A	125~200 A	Other
3ϕ 3W 200V	44	83	43	Motors Heaters
1ϕ 3W 200/100V	170	84	4	Controls
Priority for Replace	Low	High	Very High	
Spares located within the building	A lot	Very small quantity	None	

-> Exact figures are currently under investigation.

Risk of losing power supply to essential control equipment, then Operation stops).



Grid Voltage fluctuations dependent on automatic power factor setting

An automatic power factor correction mechanism is in place to maintain grid voltage and improve the power factor for the entire campus.

- Setting the power factor to be slightly “**leading**” allows for **a discount on electricity costs from the utility provider.** However, a drawback is that a sudden drop in power consumption can cause the grid voltage to spike.

- Setting the power factor to be slightly **"lagging"** (inductive) helps mitigate grid voltage spikes during sudden drops in power consumption. Conversely, if the lagging component becomes too large, the grid voltage may drop excessively, potentially leading to the shutdown of power-driven equipment and machinery. (furthermore, an excessively lagging power factor may incur financial penalties).

Automatic Power Factor Controller (APFC)





High Voltage Phase Advance Capacitors
High Voltage harmonic filters
* Linked to the control of the APFC.

LEAD(進み)





1.0 (100%)



LAG(遅れ)

power-factor meter

Tipped B2P in synchronization with both ring beam aborts

- Initially, the B2P (Bending magnet in LER) tripped in synchronization with a beam abort (Dec 7, 2025).
- This is the first time such an event has occurred since operations began.

- The triggered interlock was an “overvoltage”, resulting from a spike in the grid voltage.

- Further investigation revealed that the excessive grid voltage spike was caused by the automatic power factor regulator being set to a **"leading"** state during the shutdown period (from Jan 2025).

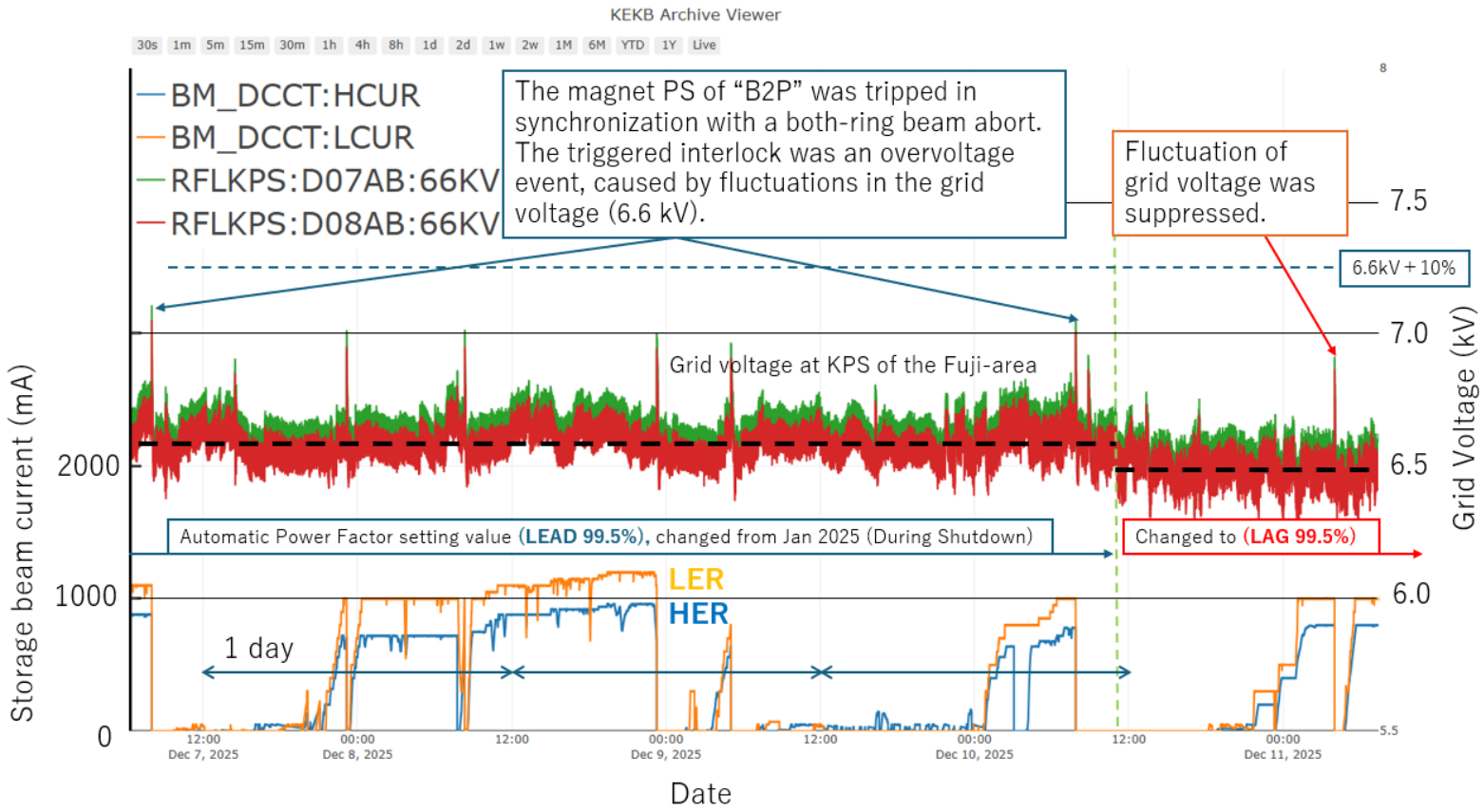
- The setting was not returned to a **"lagging"** state in preparation for the 2025c operational run. The cause was a lack of communication with the facilities department.

- The only circuit that experienced an extremely large spike in grid voltage was this bank (EHV substation in Fuji-area, No. 4), where RF (10 MW) and magnet (1.4 MW) coexist.

07:59:03	HER Beam Abort (880.0mA) LER Beam Abort (1050.5mA) ※同時刻にLinac Magnet（SX_27_1） Down HER Abort High THR VXD diamond LER Abort High THR VXD diamond

Delay ~1 sec

07:59:04	LER Abort MG Power OFF D8 HER Abort MG Power OFF D8 LER Abort MG Software Abort HER Abort MG Software Abort Magnet PS B2P_100 NA or IL



Mechanical Facility

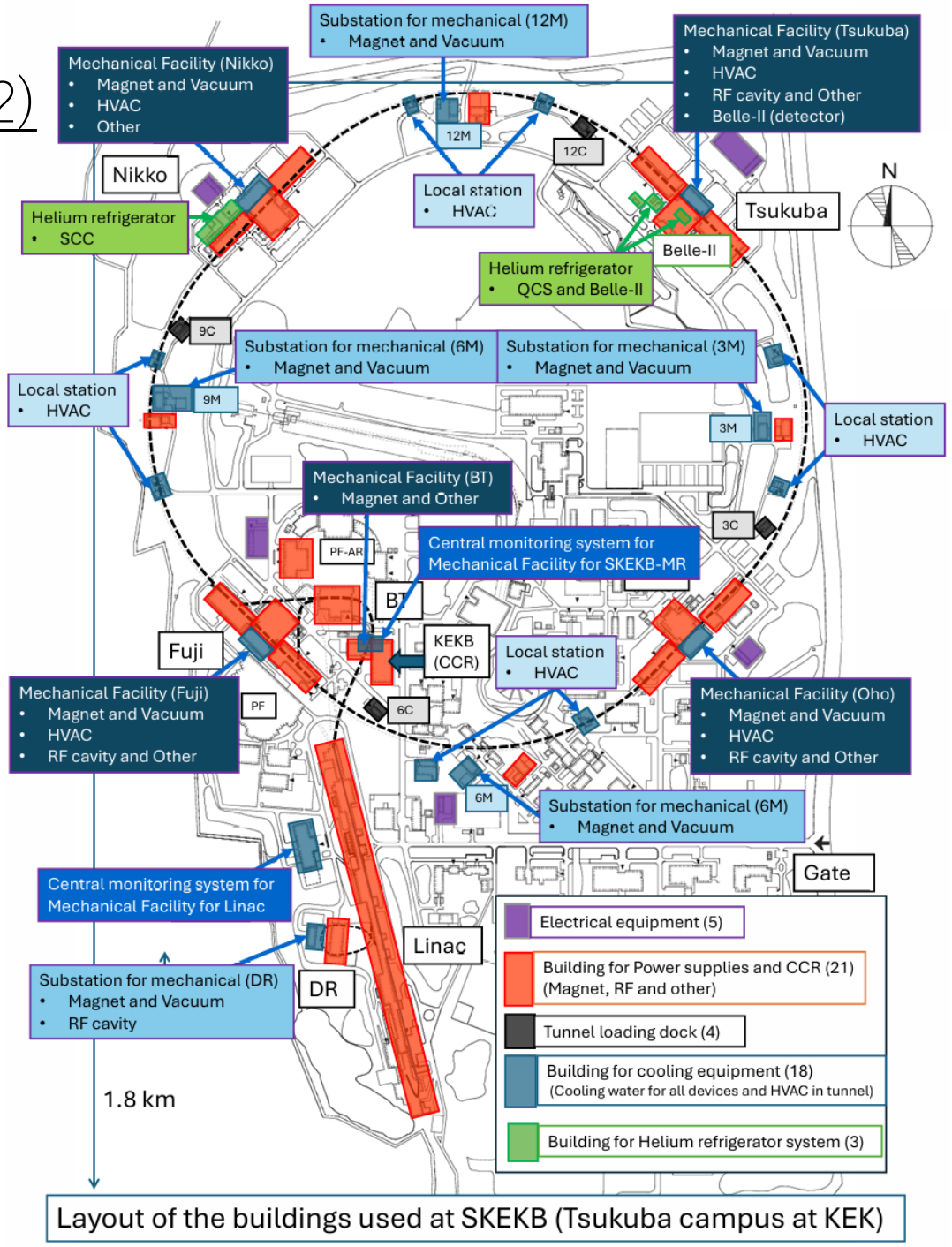
Replacement handled by the Facilities Department (2)

The central monitoring system, the four mechanical facilities and the local stations constructed in 1984 (for TRISTAN project).
The substation was constructed in 2012 to support SKEKB (for increases the storage beam current).

- Central monitoring system: No replacement.
  - Mostly unchanged from 1984.
  - Remote control is limited to start/stop operations only. Parameter settings must be adjusted on-site.
  - Budget requests for these replacements have been submitted since the construction phase of SKEKB (**Under proposal**).

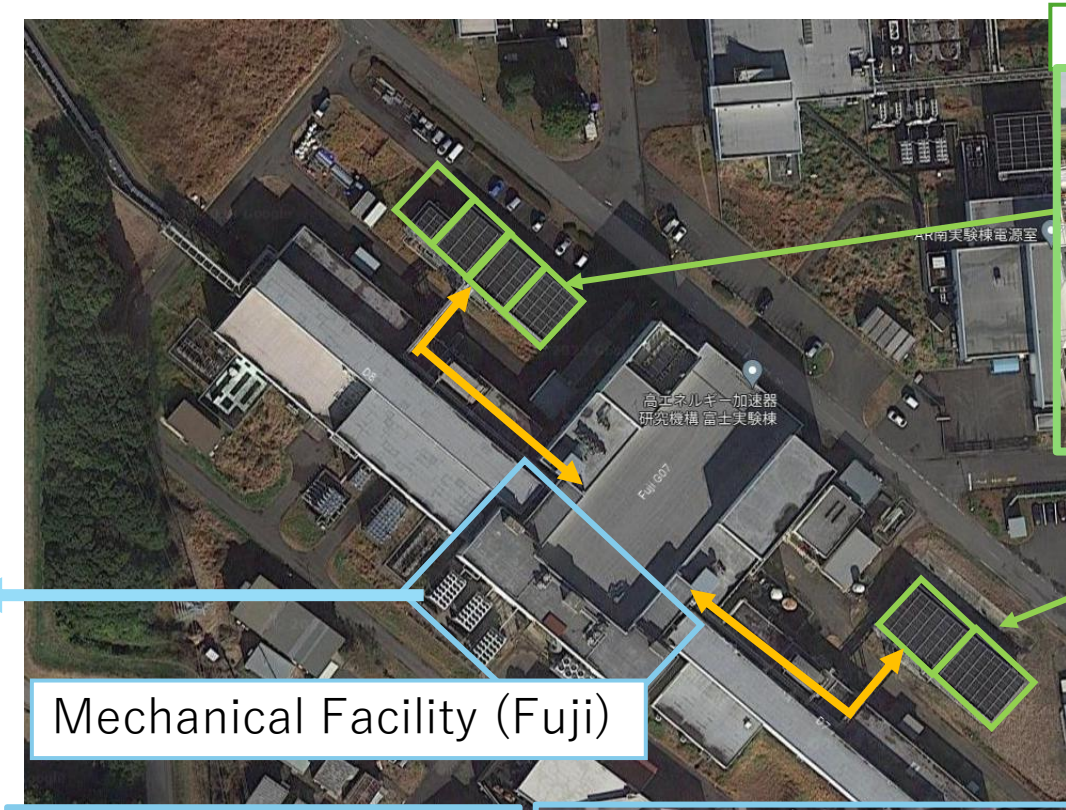
- Air-cooled Cooling water system (Magnet, RF and Other)
  - Replacement has not progressed; most units date back to 1984.
  - Over the past few years of operation, about 10 times ground faults have occurred in the electric motors.
  - Occasional malfunctions in flow rate and water temperature control have occurred, caused by failures in inverter units or control units.

- Screw chillers (Vacuum chamber: which also serves to HVAC)
  - All units (16) for Mechanical Facilities were replaced in 2013.
  - 12 units were prepared for use at substations (3M, 6M, 9M and 12M) during the same period. These units cover only the vacuum chamber.
  - The number of malfunctions related to the compressors is showing an upward trend.



Layout of the buildings used at SKEKB (Tsukuba campus at KEK)

Structure of Mechanical facility (Example shows the Fuji area)

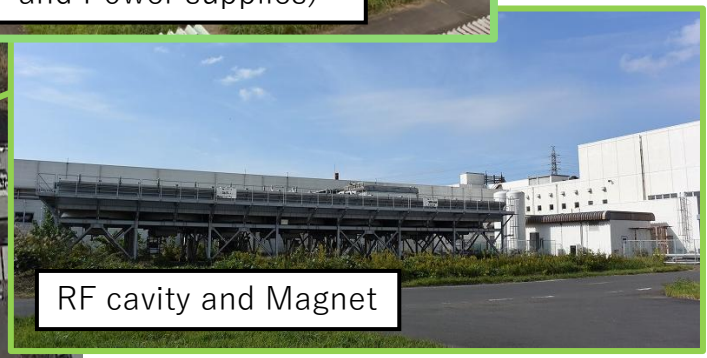


Mechanical Facility (Fuji)

Air-cooled heat exchangers for the various devices



Other (HPRF and Power supplies)



RF cavity and Magnet



Air-cooled cooling towers for refrigerant cooling



Screw Chiller (~400 kW)
* Vacuum chamber and HVAC



Air conditioner in tunnel



Various cooling pumps (primary and backup) and heat exchangers



Three-way valve



Control panel located on-site

Status of cooling water pump replacement focused on MR and BT

To supply ~ 80,000 l/min of cooling water, following pumps are used (Includes the number of backup pumps).

Pump Power	Number of cooling water pumps, sorted by installation year			Other
	1985~1997 (TRISTAN)	1998~2017 (KEKB and SKEKB)	2018~	
Low < 20 kW	HVAC (29)	HVAC (59) BT (2)	HVAC (6)	HVAC: Heating, Ventilation, and Air Conditioning
Middle 20~50kW (Head: 70~90 m)	Mag (5) VAC (6) PS (12)	Mag (12) VAC (8)	VAC (2)	
High 50 ~90kW (Head: 70~90 m)	Mag (6) RF Cav (6) Other (11)	Other (1)		
Total	73	80	8	Total: 161 units

- All pumps operate controlled by inverter unit. The inverter units were installed in conjunction with the pumps.
- The replacement rate for these inverter units is approximately 20%.
- In recent years, there has been an increase in failures among the pumps that were installed during the TRISTAN era. (specifically motor ground faults and "**inverter unit malfunctions**")

Status of cooling tower and fan-unit for HVAC replacement focused on MR and BT

Cooling towers serve to dissipate waste heat generated by the accelerator.



	Number of cooling tower, sorted by installation year			Other
	1985~1997 (TRISTAN)	1998~2010 (KEKB)	2011~2015 (SKEKB)	
Screw chiller (Number of Air-cooled cooling tower for refrigerant cooling)	***	9 (72)	19 (152)	Total: 28 units (Malfunctioning chillers: 4 units) For cooling the vacuum chamber and HVAC in tunnel.
Air-cooled cooling tower (Number of fan-motor)	16 (~100)		8 (64)	Total: 24 units For Cooling for the Magnet, RF cavity and Power supplies and Other.
Water-cooled cooling tower		BT (2)		Total: 2 units (For cooling BT magnets)
Fan unit for HVAC to tunnel			28	Blowers for air conditioning within the tunnel.

- Recently, there has been a series of ground faults in the electric motors used for cooling fans.
- The fan-motor of cooling towers require replacement.
- Four malfunctioning chillers: repairs in progress



Prioritization of mechanical facility

- The current policy is to replace components only when they fail.
  - Maintaining cooling for all devices is critical.

- The priority for replaces is as follows.

  - Central monitoring system
    - Implementation of remote control for operating parameters.
  - “Inverter units” including their control panels.
    - Ensuring an appropriate cooling water flow rate.
  - Cooling water pump units
    - Maintain a continuous supply of cooling water.
  - Three-way valves
    - Prevent the loss of water temperature control.
  - Air-cooling fans (including electric motors)
    - Ensure that heat exchange capacity is maintained.

Buildings for SKEKB

Replacement handled by the Facilities Department (3)

The buildings for SKEKB, these were also constructed in 1982 (for TRISTAN project).

- Issues related to the aging of the building(s)
  - Unsurprisingly, roof leaks rank first.

- Run stop events occurred caused by roof leaks in 2026ab (2 times)

  - March 4, 2026 (02:02:35) -> Injection stopped by I/L of BT magnet.
    It was determined that the interlock trigger was caused by a ground fault in a circuit breaker on the distribution board (BT PS building).
    Fortunately, we were able to resume operations after spending four hours drying out the breaker.

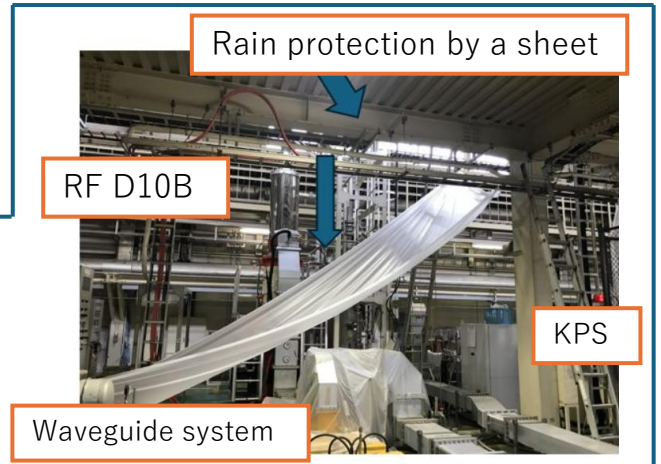
    -> Injection restarted (07:03:30) with initialized BT magnet
    (1 abort happened and 5 hour stopped)

  - May 1, 2026 (10:54:00) -> HER beam aborted by I/L of MR-RF.
    It was determined that the interlock trigger was caused by a ground fault in an arc sensor on waveguide system at RF-D10B.
    We implemented measures to prevent water ingress and disabled this interlock.

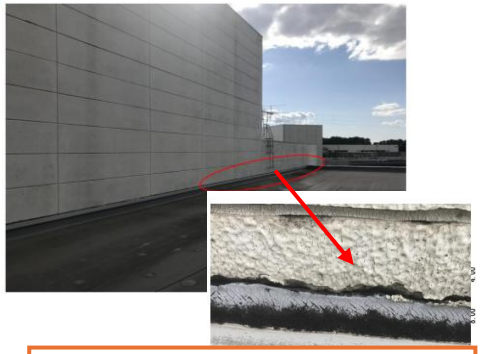
    -> Injection restarted (11:49:19) (1 abort happened and 1 hour stopped)













Repair of roof leaks

Currently, we are carrying out repairs to the exterior walls of two buildings—the same buildings that previously caused operational shutdowns.

- BT power supply building: Completed in Oct 2026
- D10 building: Work is scheduled to begin sometime between January and March.

Next plan,
Buildings where issues impact for operations caused by roof leaks

- D8 building houses following items:
  - Power supplies for HER Injection system (Septum and Kickers)
  - KPS and Waveguide system for RF D08A, B, C, D, E (5)
  - Room for Monitor system (SRM etc..)
- Mechanical Facility (Fuji)
  - Cooling pump, control panels and HVAC system etc..

Impact:

- Reduction in the number of RF cavity in the LER
- Inability to perform injection to the HER
- Malfunctions in beam monitors (SRM)
- Inability to operate the HER and LER (Cooling water stops)
- Failure of the air conditioning system within the tunnel
- Etc..

BT

Gaps allowing light to enter



Before



Manufactured in 1997



After

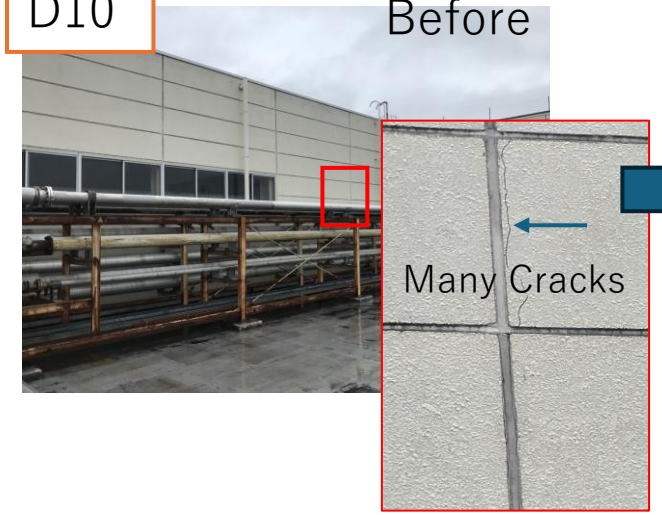




Replaced 4 circuit breakers (2026)

D10

Before



After

Waiting until next year.

D8 building

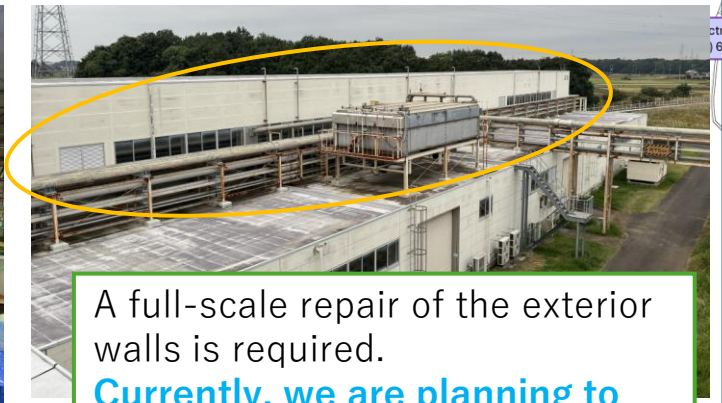




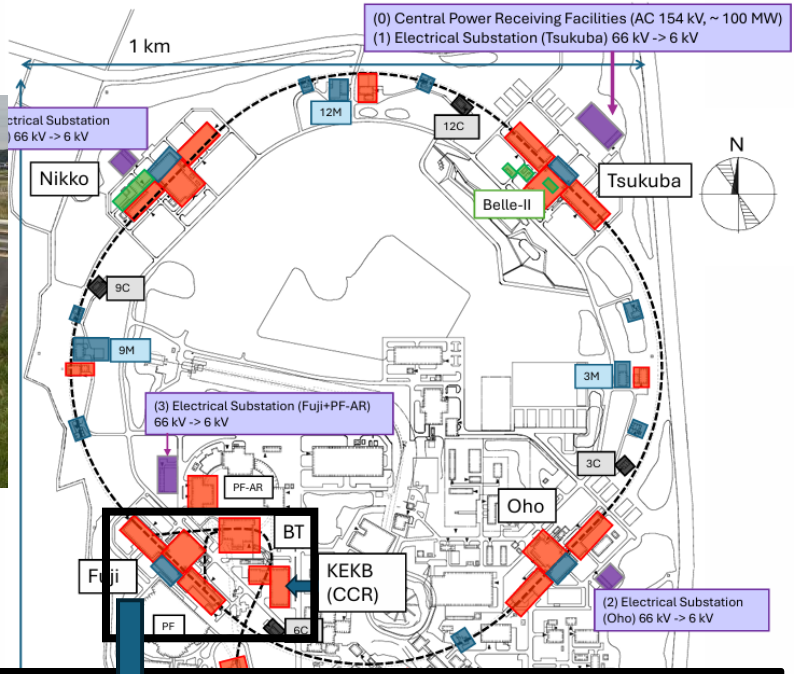
RF D08AB (Waveguide system), KPS for RF D08CD and distribution panels



PS for HER injection

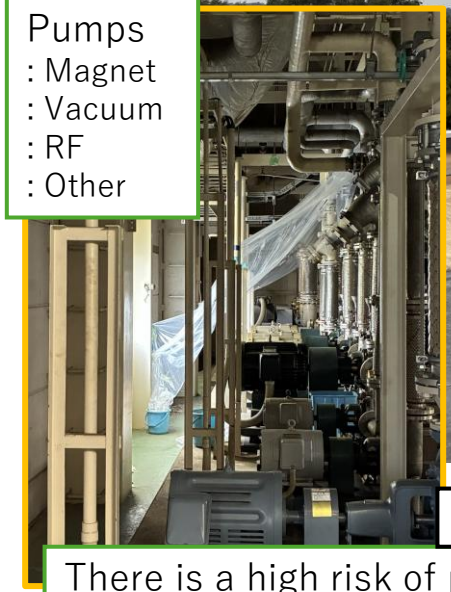


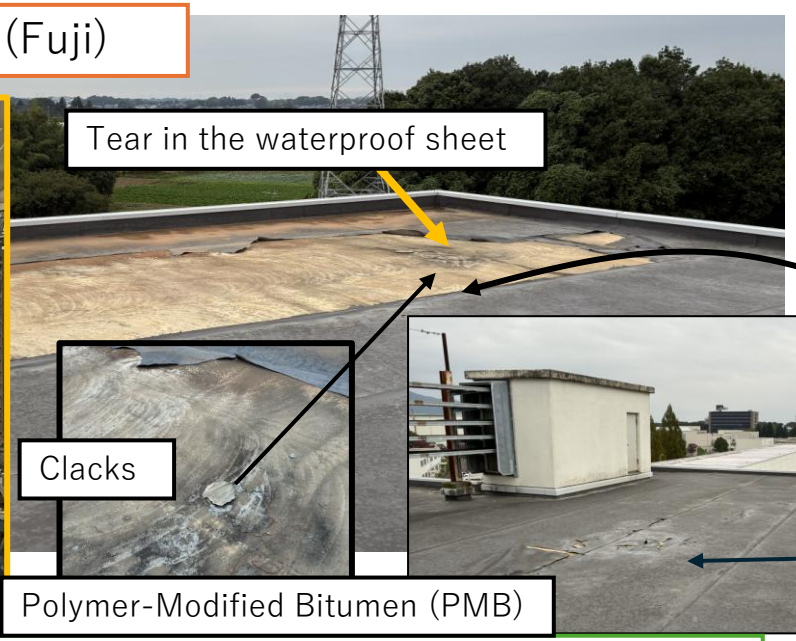
A full-scale repair of the exterior walls is required.
Currently, we are planning to carry out repairs by May 2027.



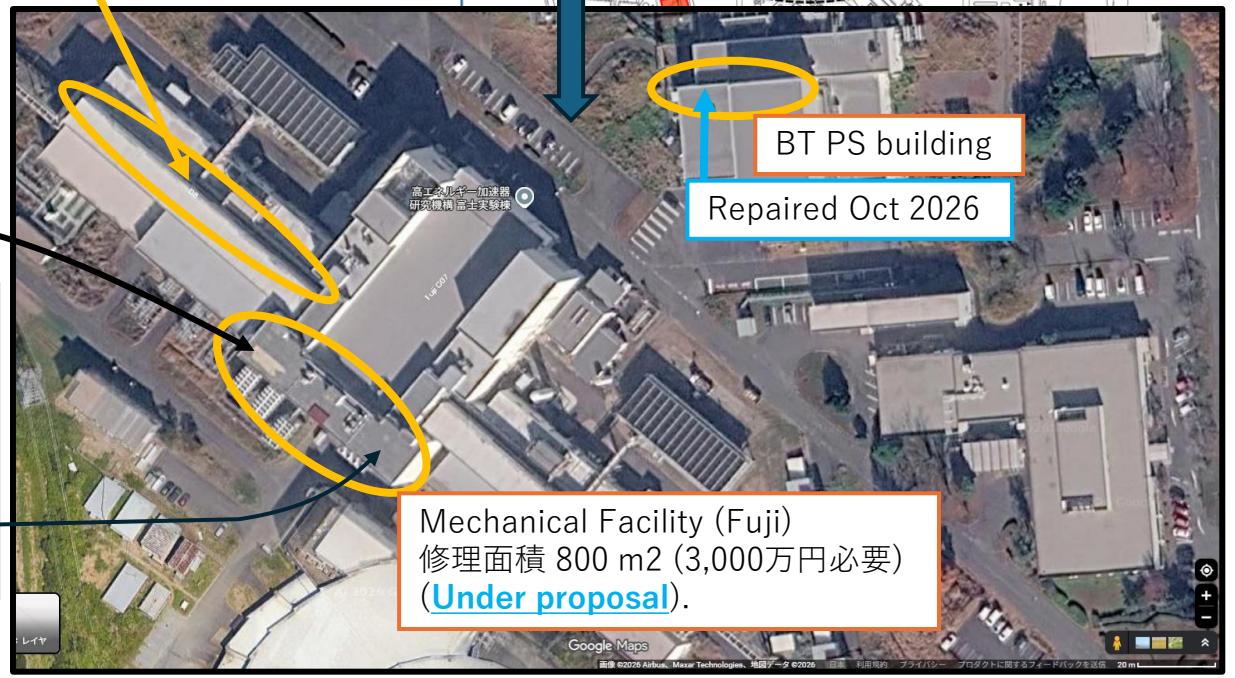
Mechanical Facility (Fuji)

Pumps
: Magnet
: Vacuum
: RF
: Other





There is a high risk of pump failure within the mechanical facility due to roof leaks (ground fault in the electric motor).



D8電源棟SRMハット付近



天井段差のところからかなりの漏水

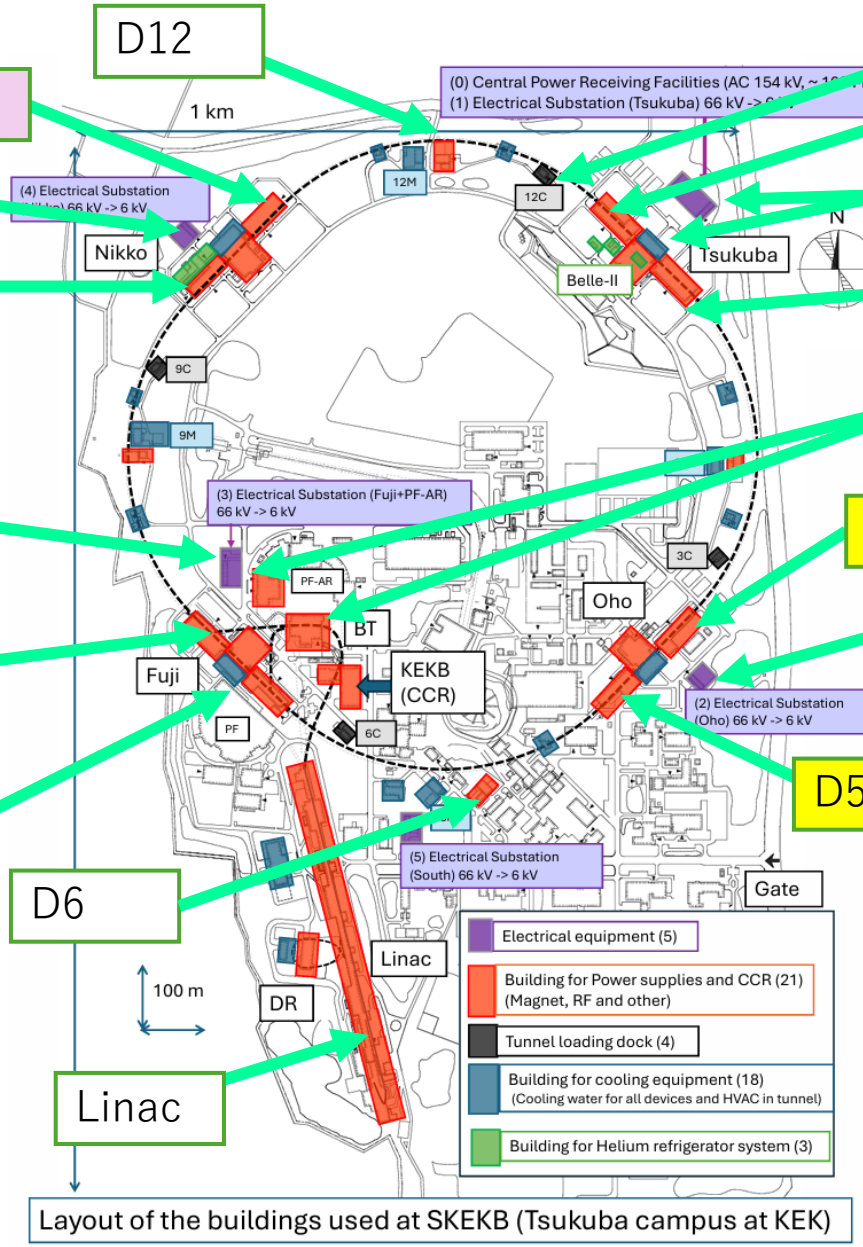
SRMハット内にも浸水



Increased risk of health issues due to mold growth
(**Inhaling mold** can cause health problems.)

Summary of current situation for a roof leak in SKEKB area

Building (51) -> a roof leak appeared more than 17 buildings.



Layout of the buildings used at SKEKB (Tsukuba campus at KEK)

Possibility to occurs:
Electric shock accidents, falls, and hygiene management (**Inhaling mold** can cause health problems.)

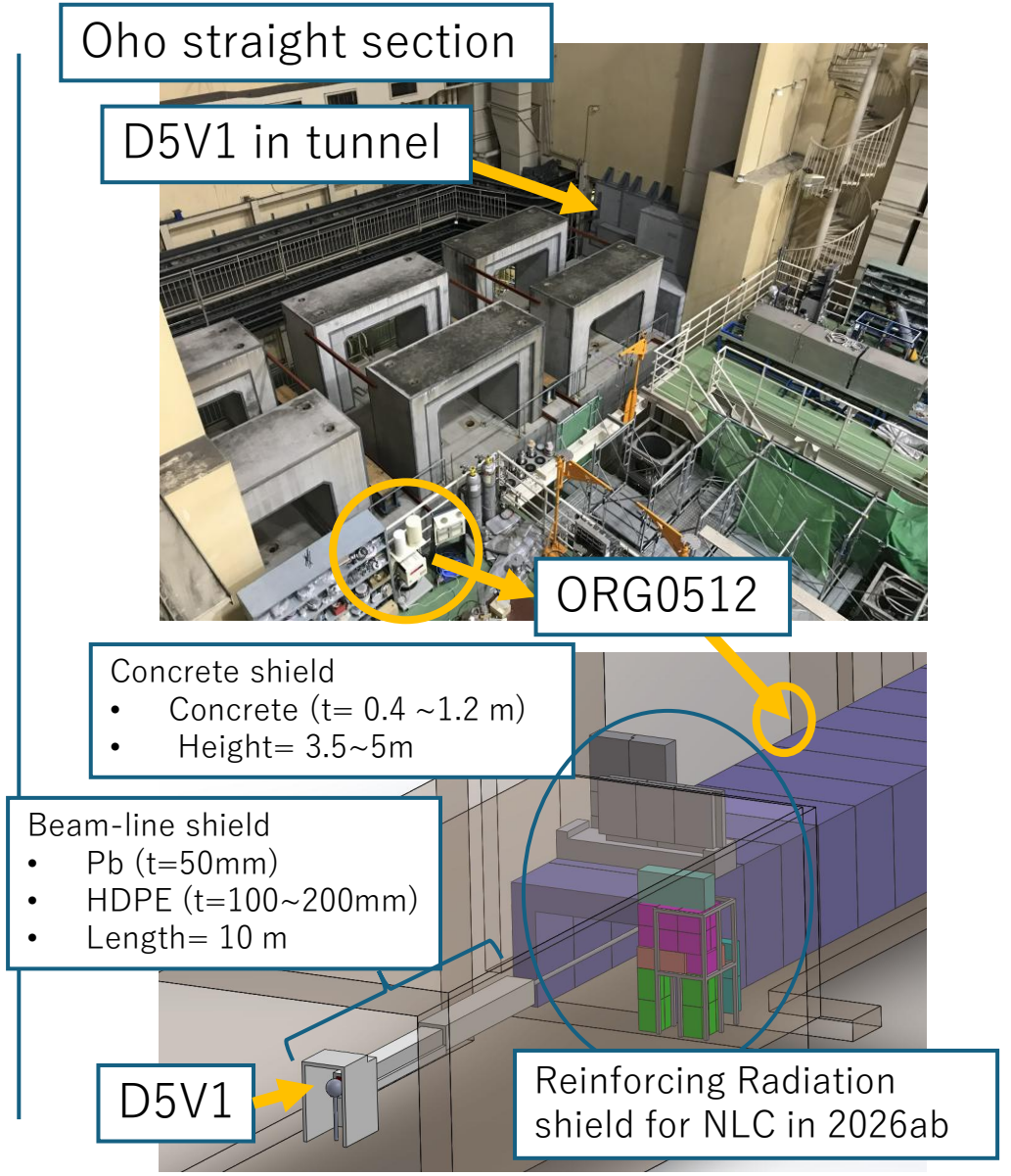
Radiation shielding for NLC and BT

Reinforcing Radiation shield for NLC and BT escape route

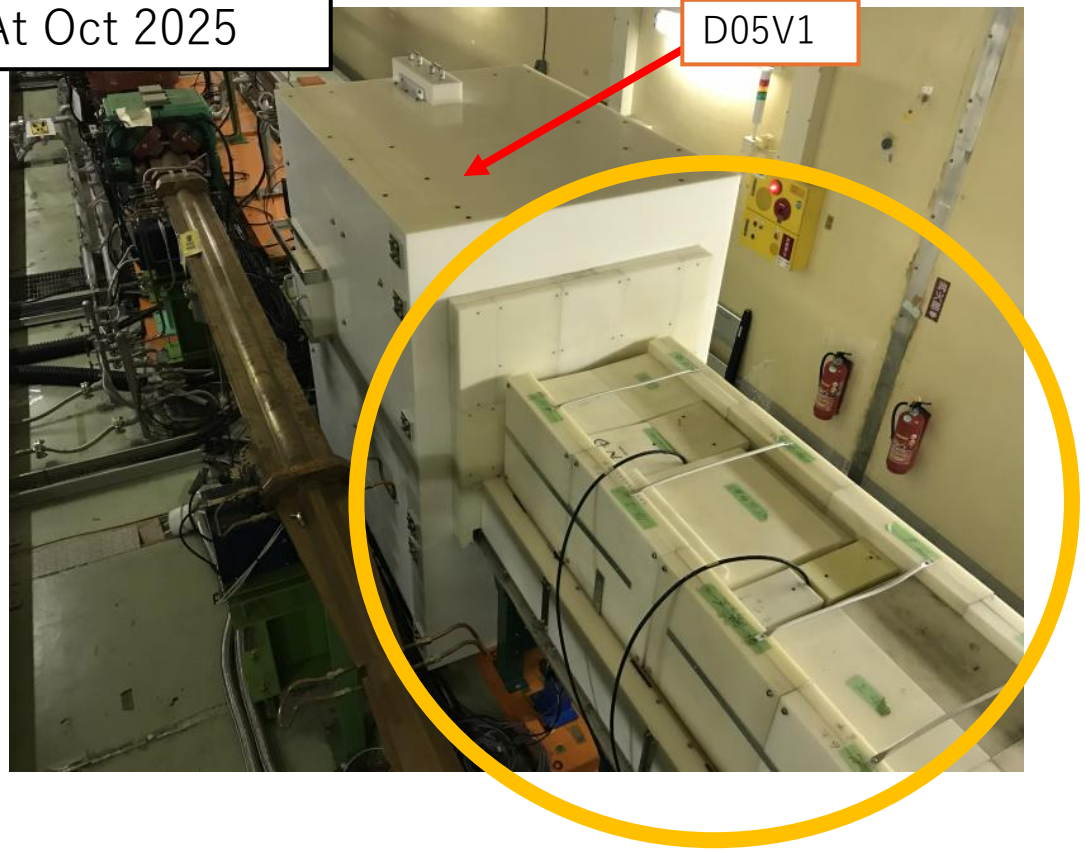
There is no radiation leakage from the shaft on the D5 building.

- Effect of enhancing the radiation shielding for the NLC
  - NLC installed during the LS1 (~2024)
  - Reinforcing radiation shield in stage, starting in 2023
  - Compare the shielding effects at ORG0512 (Radiation monitor), located near the straight section.
    - 2024c: ~260 μSv/h (LER 1600 mA)
    - **2026ab: ~40 μSv/h (LER 1700 mA) -> Conditions that do not impose constraints on operation (Worked well).**
    - Use OSL dosimeters to investigate areas with insufficient shielding (From 26 Jan to 18 Feb 2026).
  - 2027ab: Target of LER= 2.6A and change collimator head (Ti)
    - An increase in the resulting radiation dose is expected.
    - Further enhancement of shielding is required.
      - Reinforcing the shielding directly beneath D5V1.
      - Installing additional shielding in the gaps along the tunnel boundaries.
      - Expected to result in a 1/8 reduction in dose.
      - Completion is scheduled for December 2026.

- Radiation Shielding at surface-level escape route of the SKEKB-BT
  - The objective is to allow for higher radiation limits during beam profile measurements.
  - Installation of the shielding began in 2025.
  - The effectiveness will be evaluated during the SKEKB-BT operation in the 2026c run.

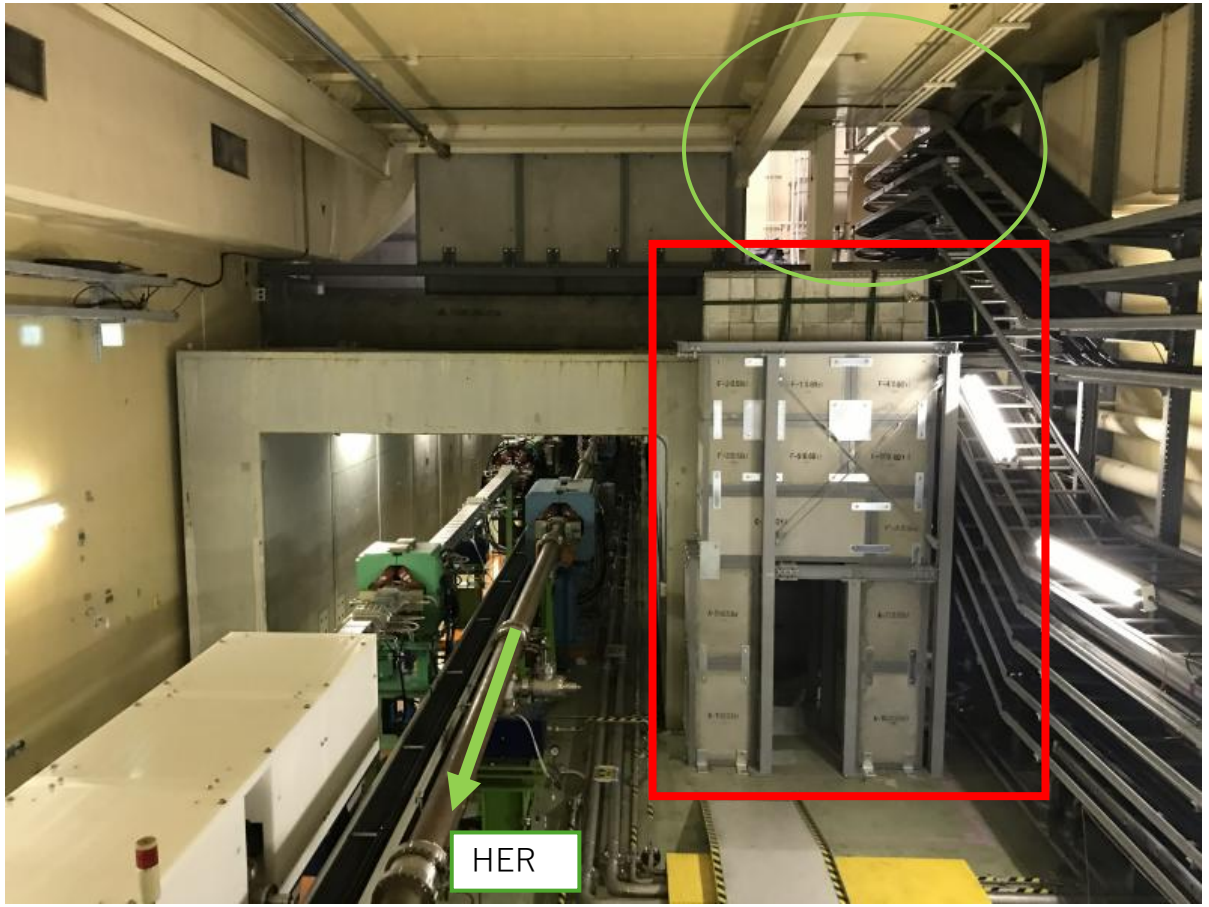


At Oct 2025



The thickness of the high-density polyethylene shielding will be increased from 100-200 mm to 200-400 mm .

Installing additional shielding in the gaps along the tunnel boundaries.
(high-density polyethylene: t= 100~150mm)



SKEKB-BT
- Layout diagram of the profile monitors.

BTe：5Hz（1.5nC×2-bunch）
BTp：5Hz（2.9nC×2-bunch）
⇒MSE#6、MSP#5
- Personnel in the KEKB control building are exposed to radiation.

MSE#6
MSP#5
MSE#5
BTe：12.5Hz（1.5nC×2-bunch）
BTp：12.5Hz（2.9nC×2-bunch）
⇒MSE#5, MSP#4
MSP#4
Linac
TRISTAN Control Bld.
BT共同溝
(地下)
AR South
Exp. Hall
MSP#8
MSE#10
MSP#9
The use of certain profile monitors leads to an increase in radiation levels at surface-level escape route.
While the repetition rate for measurements was previously capped at **“1 Hz”,** the enhanced shielding is expected to allow for an increase to **“5 Hz”.**
MSP#15
※PFへ
D7
Fuji
Exp. Hall
Beam dump (BTp)
Beam dump (BTe)
0
50
0
50
100
※AR-BT直接入射路建設前のレイアウト（注）

AR (S) buildings
May 2025
2700 x 2700 mm
BT escape route
from Acc tunnel
Sep 2026
Radiation aera
Feb 2026
May 2025



Status of the Application for Change of Radiation Generator

Status of the Application for Change of Radiation Generator for SKEKB-MR and BT

- MR-Ring (HER/LER)
  - The target storage beam current for 2027ab run has been set at 2.0 A (HER) and 2.6 A (LER).
    - Current value (from March 2019): HER 1.9 A / LER 2.6 A
    - Values to be submitted for approval: **HER 2.1 A** / **LER 2.7 A** for 2027ab run
    - Application for Change of Radiation Generator is currently being processed.
      - The approval timeline is yet to be determined.

- SKEKB-BT (electron/positron)
  - The target bunch charge of injection beam for 2027ab run has been set at 2.6 nC (BTe) and 4.0 nC (BTp).
    - Current value (from Jan 2016)
      - 3 nC x 2 bunches x 50 Hz=**[300 nC/s]** (Combined value for BTe and BTp)
    - Actual values recorded during the 2026ab
      - (BTe) 1.5 nC x 2 bunches x 25 Hz + (BTp) 2.9 nC x 2 bunches x 23 Hz = 208.4 nC/s (69.5 %)
    - Values to be submitted for approval
      - **3.0 nC x 2 bunches x 25 Hz + 4.0 nC x 2 bunches x 25 Hz= [350 nC/s] (Up to 117 %)**

    - Preparations have begun for an Application for Change of Radiation Generator.
      - The necessity for additional shielding is currently being evaluated based on an assessment of beam loss along the BT line. The approval timeline is yet to be determined.

Summary

Introduction
- I explained the status of infrastructure facility replace as of 2026.

Electrical Facility
- Replacements beginning from the most upstream equipment.
- A strategy to reduce the risk of prolonged operational shutdowns due to failures in central components.
- Regarding the power factor setting for the campus: During accelerator operation **-> "Lagging (99.5%)"**
  During shut down of SKEKB **-> "Leading (99.5%)"**
  - This configuration helps to moderate the impact of sudden load fluctuations on grid voltage.
- There is significant concern regarding the risk of operational shutdowns caused by the failure of terminal-end circuit breakers.
  - Currently, very few spare circuit breakers with high current capacity.
  - Must need to prepare the backup circuit beakers as quickly as possible.

Mechanical Facility
- Many pieces of equipment, including the central monitoring system, are still from the 1980s.
- Due to budget constraints, we are forced to replace equipment only after a failure occurs.
- The priority for replacing mechanical equipment is as follows: [Central monitoring system], [Inverter units], [Pumps] etc…

Buildings
- The building is intended to protect equipment from external disturbances.
- Currently, however, they are failing to fulfill this function due to leaks caused by aging. Leaky roofs get worse.
- For the time being, we will manage with temporary fixes, while clearly prioritizing and proceeding with repairs.

Radiation Safety
- Currently, we are reinforcing the radiation shielding for the NLC and BT sections.
- We are also proceeding with Application for Change of Radiation Generator .
  - (approval is expected after the start of operations in 2027a).

Backup

17. Radiation Shield for NLC

28th ARC

Findings & comments:

A clear analysis of the radiation issue in the NLC (Non Linear Collimator) region with present mitigations and future plan was presented to the ARC.

In the Oho region, beam losses in the collimator D05V1 are a factor 10-20 larger than the design value. This may limit the SuperKEKB operation due to radiation doses above 1.5 μS/h in the experimental area, machine room and shutter area. Following this year's beam intensity increase and the radiation field analysis, mitigations were put in place. Working areas were declared as radiation-controlled areas with restricted access, 10 cm thick polyethylene was installed along the existing 5 m long lead shielding and concrete blocks were placed in front of the shutter.

Following a detailed analysis of the radiation fields, plans for better radiation shielding to be installed during this shutdown were presented. They consist of extending the existing lead shielding from 5 to 10 m, adding a 10 cm thick polyethylene shield, adding a lead shielding around the collimator and adding a concrete shielding between the so-called "Mongata" concrete shield and the side wall. This would leave the radiation to leak only through the (empty) RF waveguide vertical shaft and the cable trays positioned on the side wall. Doing so, it is expected to reduce the radiation dose in the concerned radiation-controlled areas by about a factor 10. As countermeasures in case beam loss largely exceeds expectations an extension of the radiation-controlled area is considered by placing fences outside the Oho experimental hall.

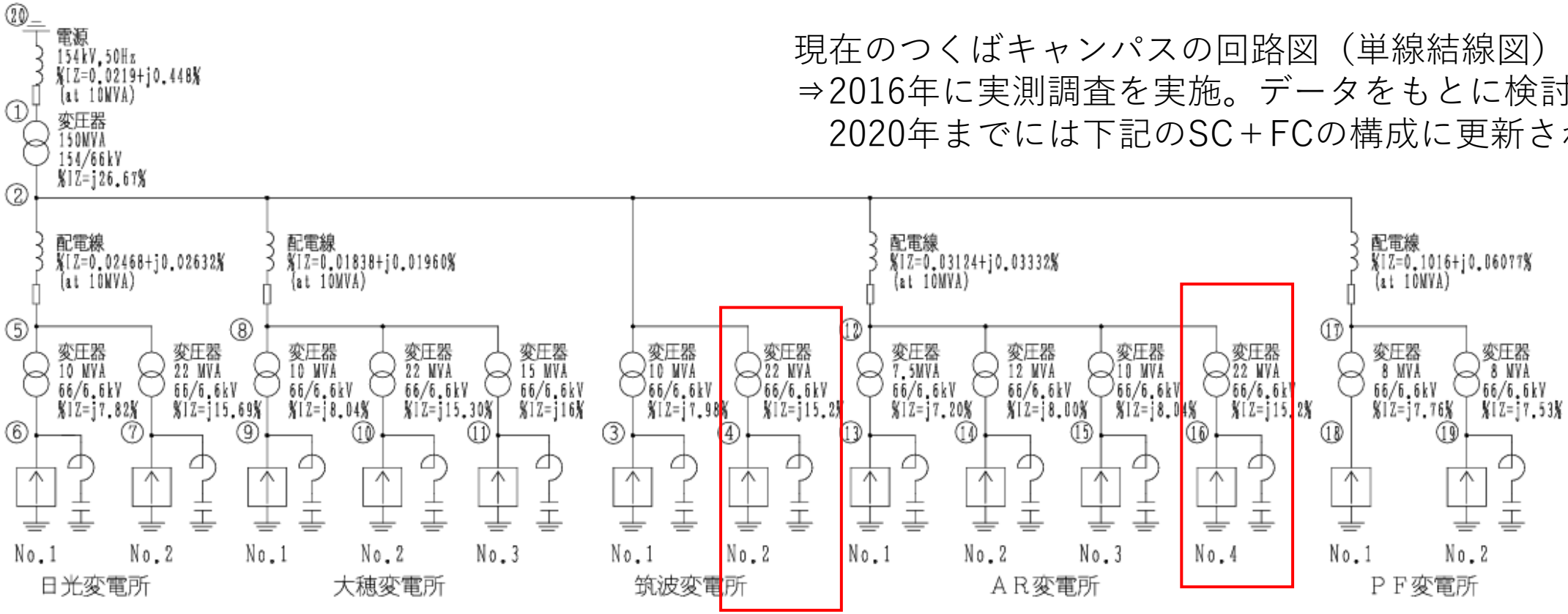
Recommendations:

R17.1: Consider inserting removable shielding stones in the vertical shaft.

R17.2: Consider minimizing the source of radiation by reducing the losses on the collimator by e.g. adapting the material and length of the collimator (while complying with the impedance budget) and placing absorbers close to the radiation source.

Backup (Electrical facility)

現在のつくばキャンパスの回路図（単線結線図）
⇒2016年に実測調査を実施。データをもとに検討。
　2020年までには下記のSC＋FCの構成に更新される。



日光変電所

No. 1
SC 500kvar L=13% (at 6600V)
5次 500kvar (at 6600V)
7次 500kvar (at 6600V)
11次 500kvar (at 6600V)
No. 2
SC 500kvar*3 L=13% (at 6600V)
5次 500kvar (at 6600V)
7次 500kvar (at 6600V)
11次 750kvar (at 6600V)
23次 750kvar (at 6600V)

大穂変電所

No. 1
SC 250kvar L=13% (at 6600V)
5次 250kvar (at 6600V)
7次 250kvar (at 6600V)
11次 250kvar (at 6600V)
No. 2
SC 250kvar L=13% (at 6600V)
5次 250kvar (at 6600V)
7次 250kvar (at 6600V)
11次 250kvar (at 6600V)
No. 3
SC 250kvar L=13% (at 6600V)
5次 250kvar (at 6600V)
7次 250kvar (at 6600V)
11次 250kvar (at 6600V)

筑波変電所

No. 1
5次 500kvar (at 6600V)
7次 500kvar (at 6600V)
11次 500kvar (at 6600V)
No. 2
5次 250kvar (at 6600V)
7次 250kvar (at 6600V)
11次 250kvar (at 6600V)

ＡＲ変電所

No. 1
5次 500kvar (at 6600V)
7次 500kvar (at 6600V)
11次 500kvar (at 6600V)
No. 2
SC 250kvar L=13% (at 6600V)
5次 500kvar (at 6600V)
7次 500kvar (at 6600V)
11次 500kvar (at 6600V)
No. 3
5次 500kvar (at 6600V)
7次 500kvar (at 6600V)
11次 500kvar (at 6600V)
No. 4
SC 500kvar*2 L=13% (at 6600V)
5次 500kvar (at 6600V)
7次 500kvar (at 6600V)
11次 500kvar (at 6600V)

ＰＦ変電所

No. 1
SC 2000kvar L= 6% (at 6600V)
No. 2
SC 6000kvar L= 6% (at 6600V)
5次 500kvar (at 6600V)
7次 500kvar (at 6600V)
11次 500kvar (at 6600V)
ハイパス 500kvar (at 6600V)

SC：進相コンデンサ（力率改善）
5次など：高調波フィルター（FC）
（力率・高調波減衰）

Central power facilities

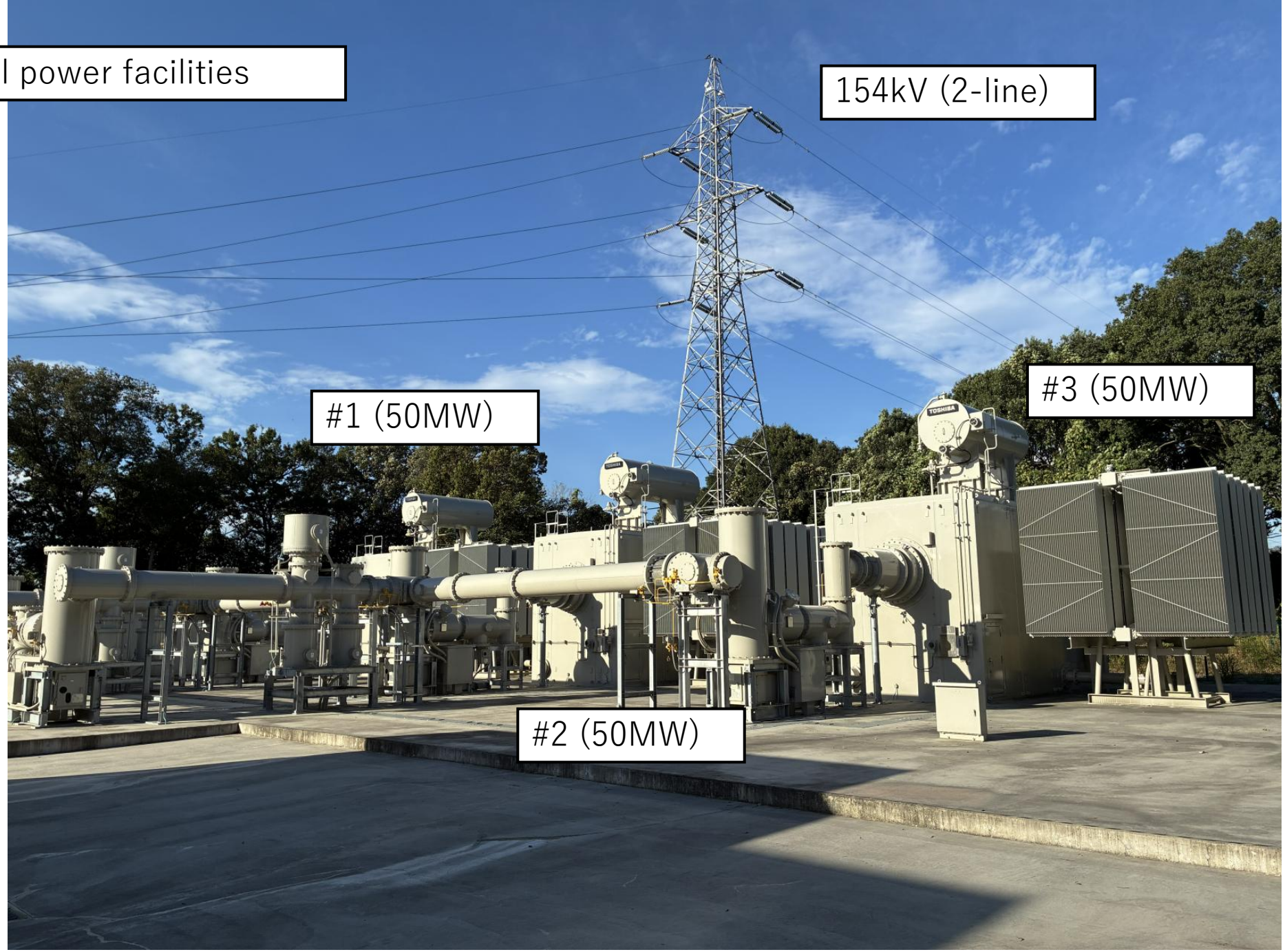


表 2　系統別必要対策設備提案

系統名		Power efficiency	Harmonic filters			
		L=13%	5 次	7 次	11 次	23 次
大穂第 1 バンク		250	250	250	250	—
大穂第 2 バンク		250	250	250	250	—
大穂第 3 バンク		250	250	250	250	—
日光第 1 バンク	※1	500	500	500	500	—
日光第 2 バンク	※1	500*3	500	500	750	750
AR 第 1 バンク	※1※2	—	500	500	500	—
AR 第 2 バンク	※1※2	250	500	500	500	—
AR 第 3 バンク	※1※2	—	500	500	500	—
AR 第 4 バンク		500*2	500	500	500	—
筑波第 1 バンク 1	※1※2	—	500	500	500	—
筑波第 1 バンク 2		—	250	250	250	—

単位：kvar

Oct 15, 2026

Video: KEK Electric Power Information

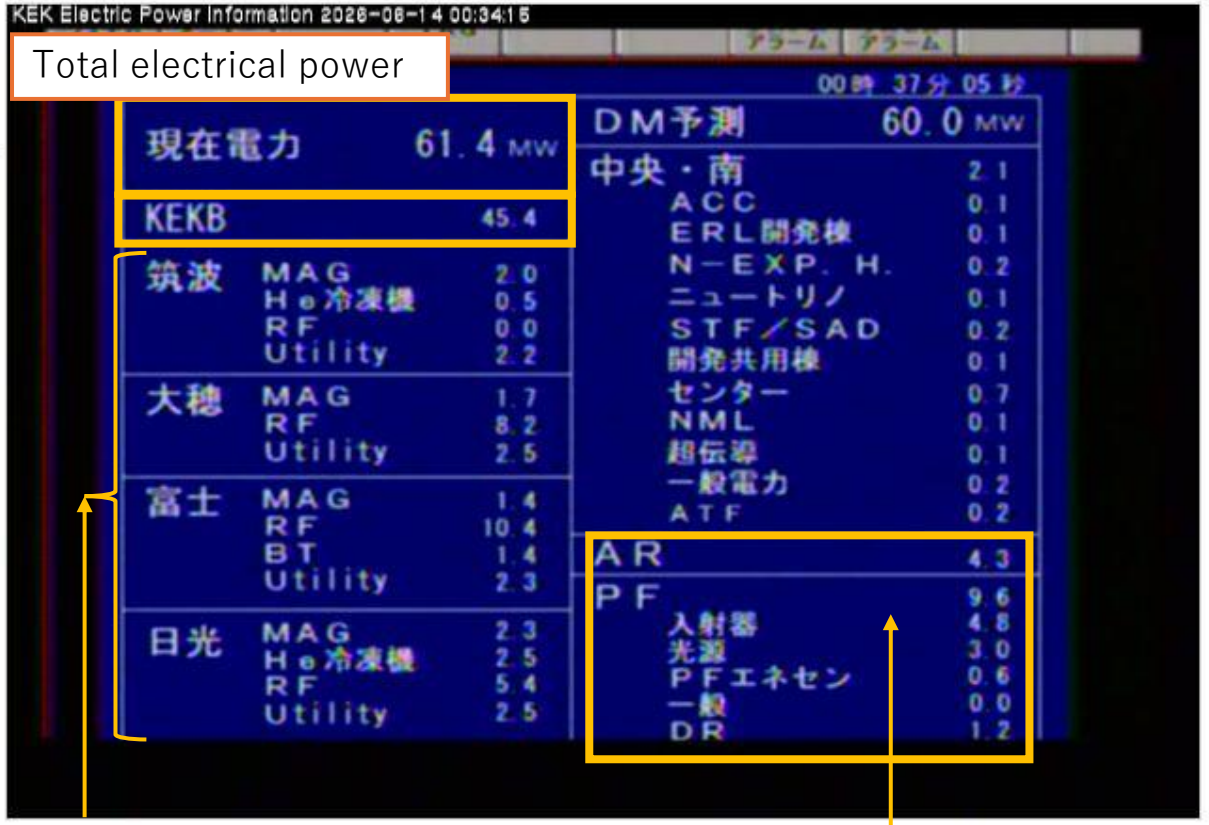


SKEKB-> during Shutdown
(~ 3.2 MW)

Linac and PF: Operating

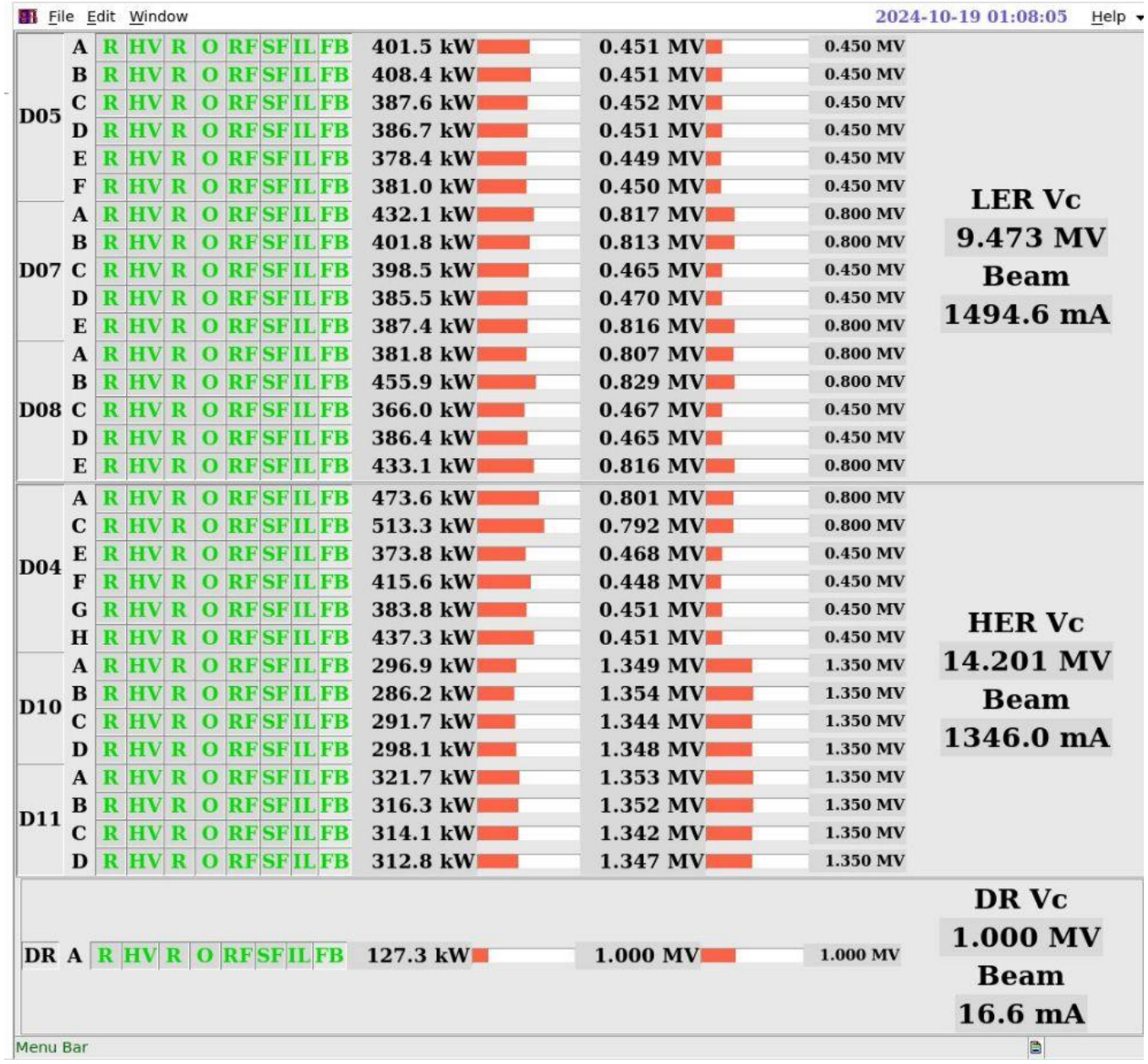
June 14, 2026

Video: KEK Electric Power Information

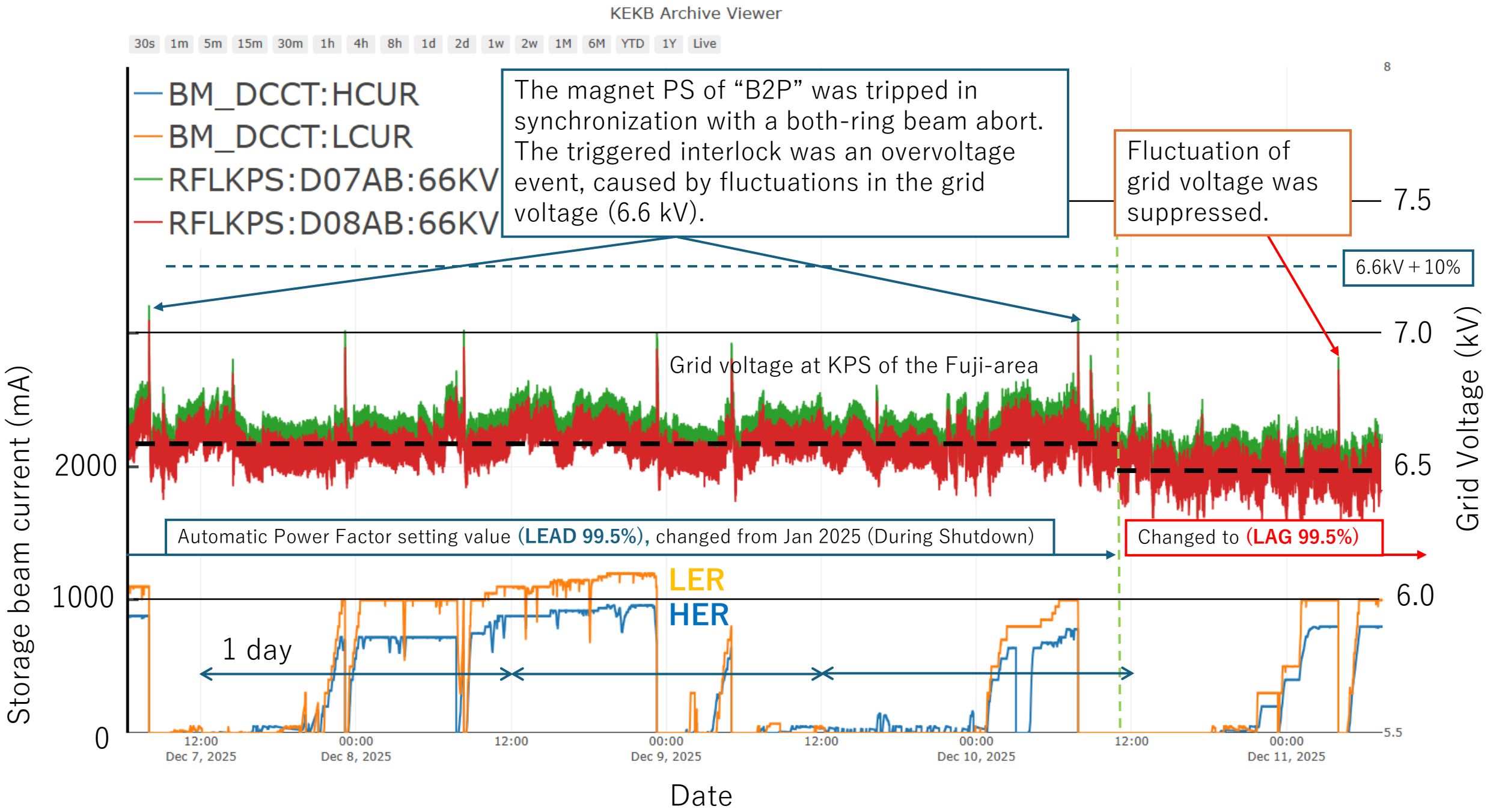


SKEKB: Operating (~46 MW)

Linac, DR, PF and PF-AR: Operating



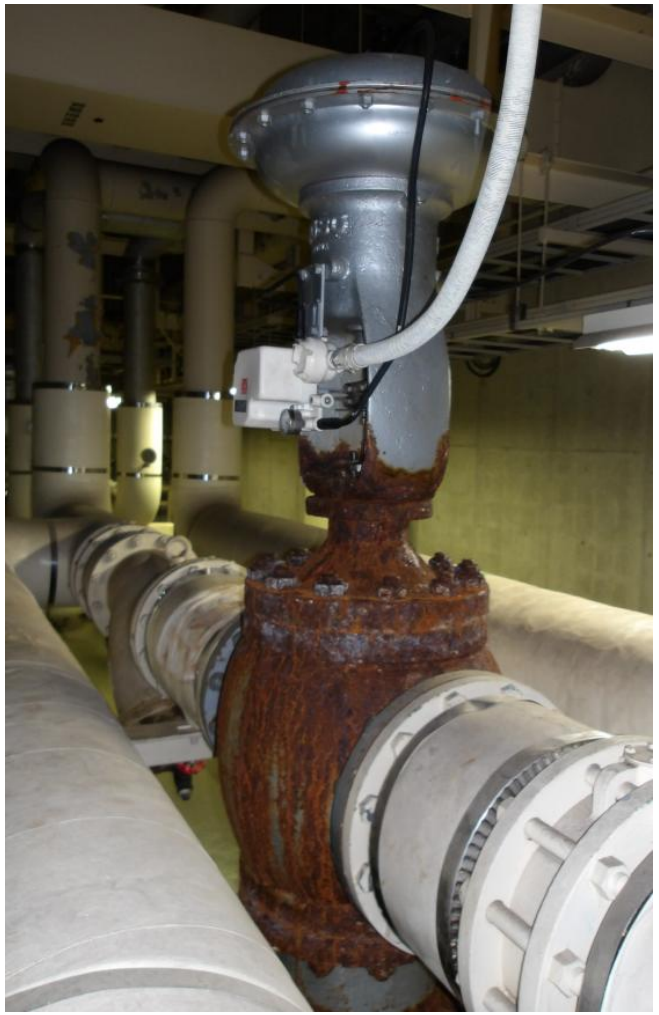
Electrical power -> 22 MW used for MR-RF


KEKB Archive Viewer
30s 1m 5m 15m 30m 1h 4h 8h 1d 2d 1w 2w 1M 6M YTD 1Y Live
BM_DCCT:HCUR
BM_DCCT:LCUR
RFLKPS:D07AB:66KV
RFLKPS:D08AB:66KV
The magnet PS of “B2P” was tripped in synchronization with a both-ring beam abort. The triggered interlock was an overvoltage event, caused by fluctuations in the grid voltage (6.6 kV).
Fluctuation of grid voltage was suppressed.
6.6kV + 10%
Grid voltage at KPS of the Fuji-area
Automatic Power Factor setting value (LEAD 99.5%), changed from Jan 2025 (During Shutdown)
Changed to (LAG 99.5%)
LER
HER
1 day
Storage beam current (mA)
Grid Voltage (kV)
Date
0
1000
2000
5.5
6.0
6.5
7.0
7.5
12:00 Dec 7, 2025
00:00 Dec 8, 2025
12:00
00:00 Dec 9, 2025
12:00
00:00 Dec 10, 2025
12:00
00:00 Dec 11, 2025

Backup (Mechanical facility)

Aigen of three-way-valve, damaged caused by water leak on movable shaft









・1980年代に設置された三方弁：軸受けのシール性が劣化したことによる水漏れが原因で各所が腐食。
軸の固着による動作不良、漏水拡大による冷却系の停止が懸念される状況。

Aigen of water pumps



High power pump (1980s)





Low power pump for HVAC





更新されているポンプはごくわずかな状況である。1~2割ほど。

Aigen of cooling towers: water leak happened a coils in HEX

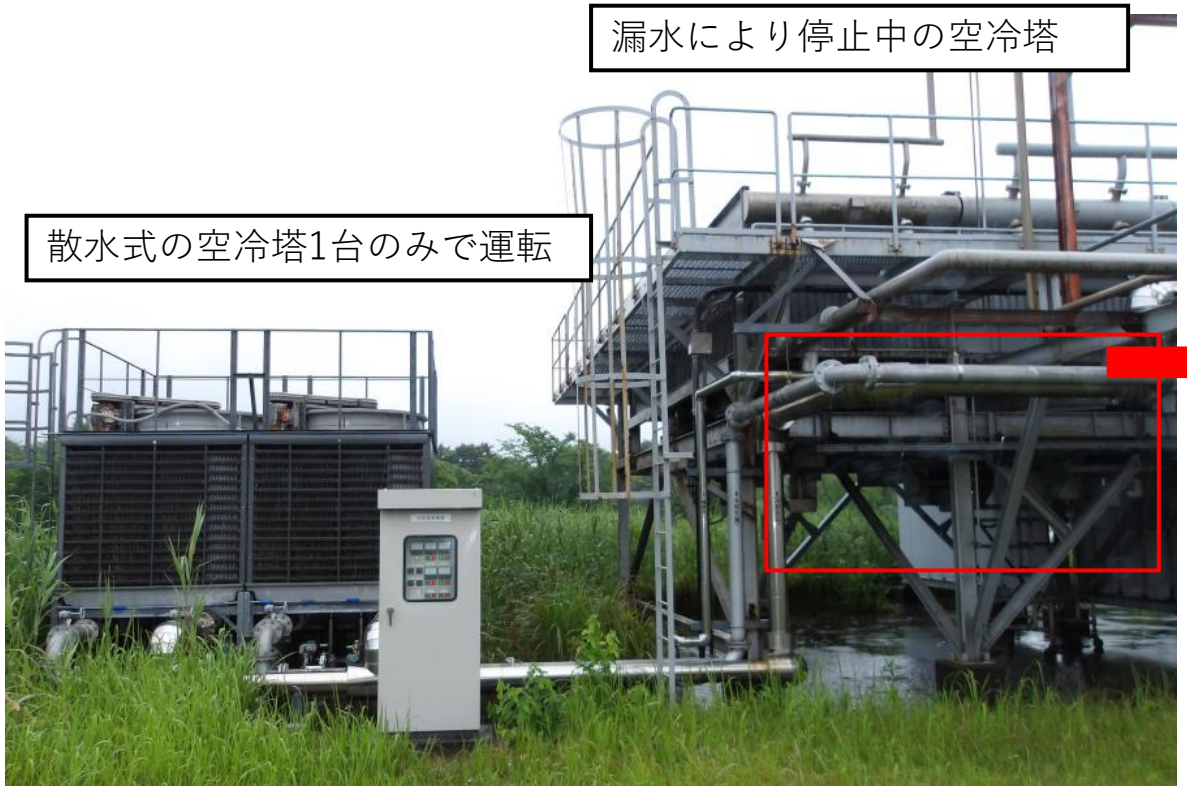
D2電源棟南側屋外 筑波冷却塔TM-CT-6
：Belle-IIのエレキ関係へ冷却水を供給している系統（大型計算機サーバーの冷却も担当している）。

空冷式と散水式を直列に接続して運用していたが、
現在は散水式1台で運転している（予備の系統なし）。

常時運転を要求されるため、計画停電期間（年3日）以外に保守が出来ず、
実験データを保護するためにも、保守性を考慮した冷却系の増強・改造が
必須である。

漏水により停止中の空冷塔

散水式の空冷塔1台のみで運転







・冷却水コイルからの漏水（だいぶ前に故障）
修理不可能と判断。空冷塔自体の更新が必要。

Air cooled fans for the screw chiller

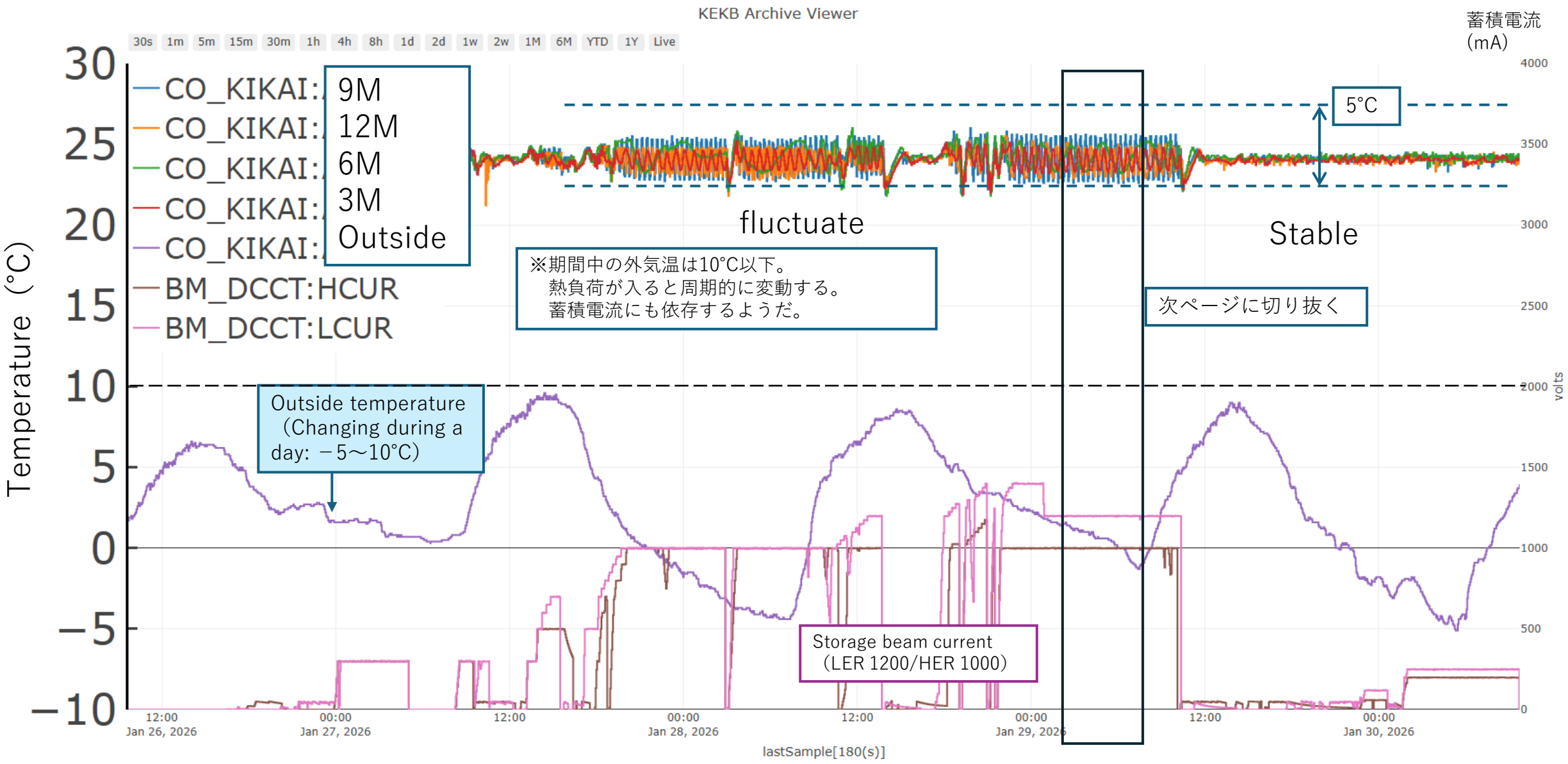


冷媒冷却用の空冷塔（粗熱取り）
老朽化により6台中2台のファンが停止している。
（電動機の地絡が原因）

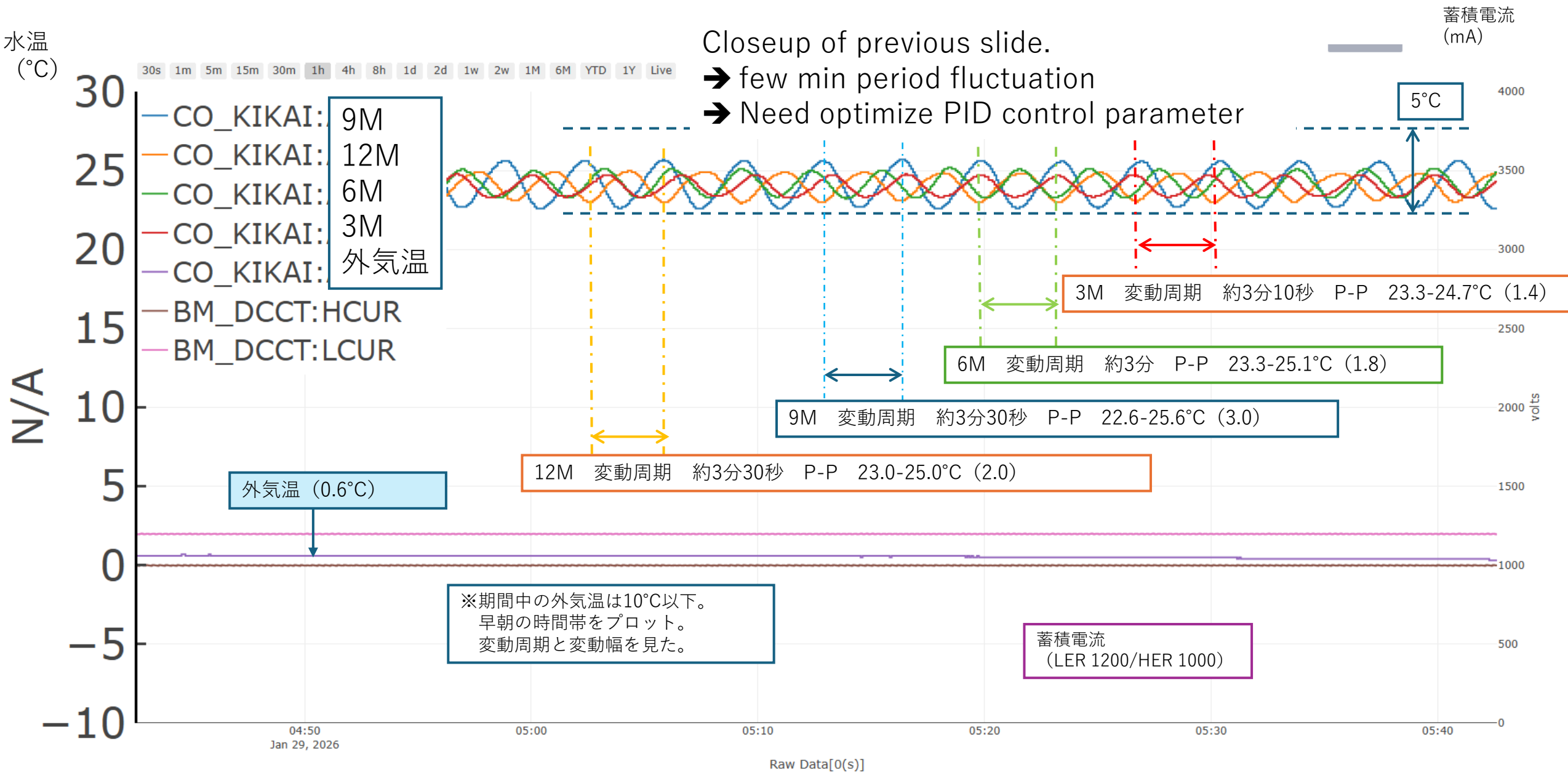


Screw chiller (~400kW)

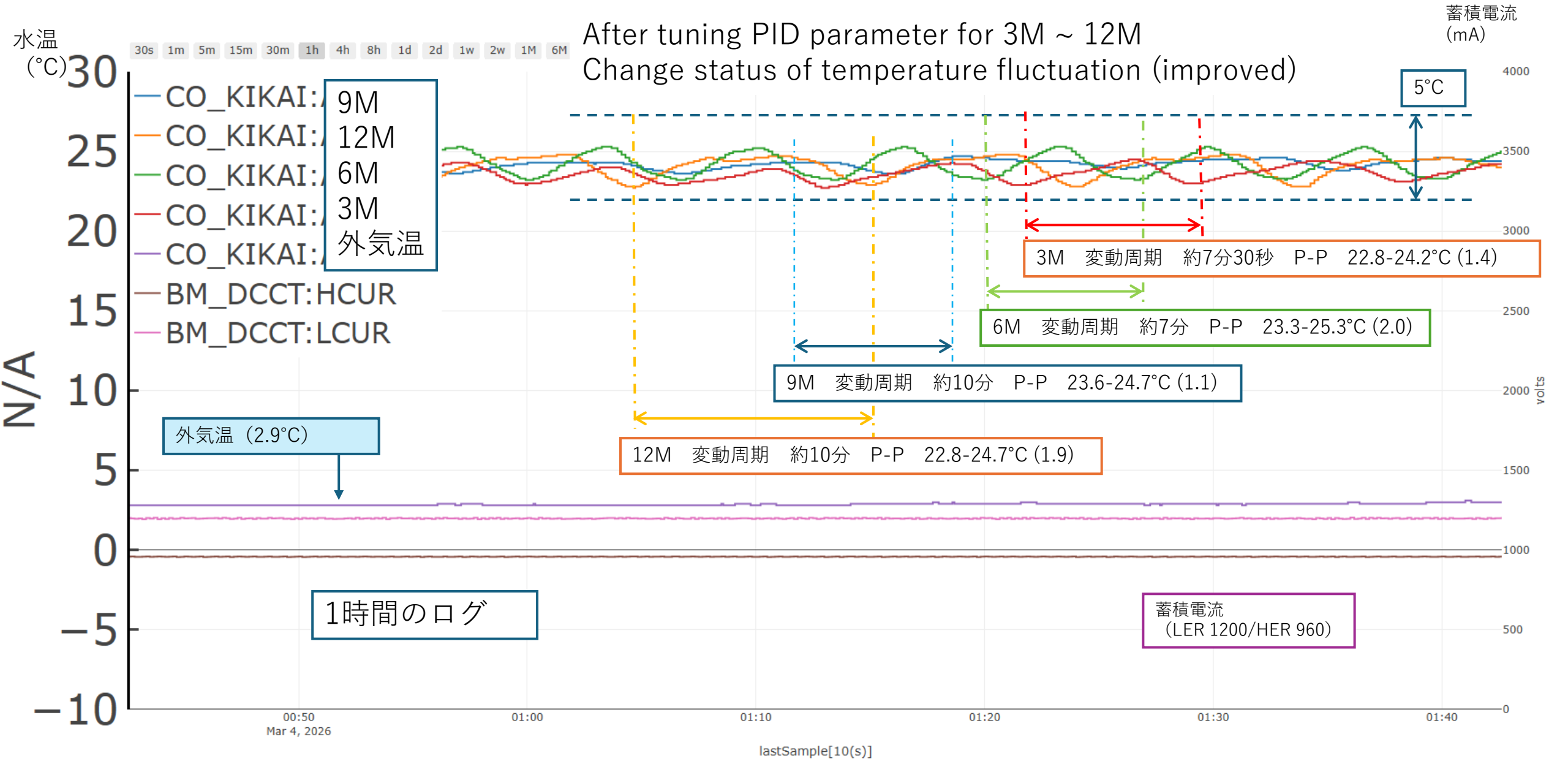
Temperature fluctuations of cooling waters for the MR vacuum chamber, 2026/01/26 9:00~ 1/30 9:00



Temperature fluctuations of cooling waters for the MR vacuum chamber, 2026/01/29 4:40~ 5:50

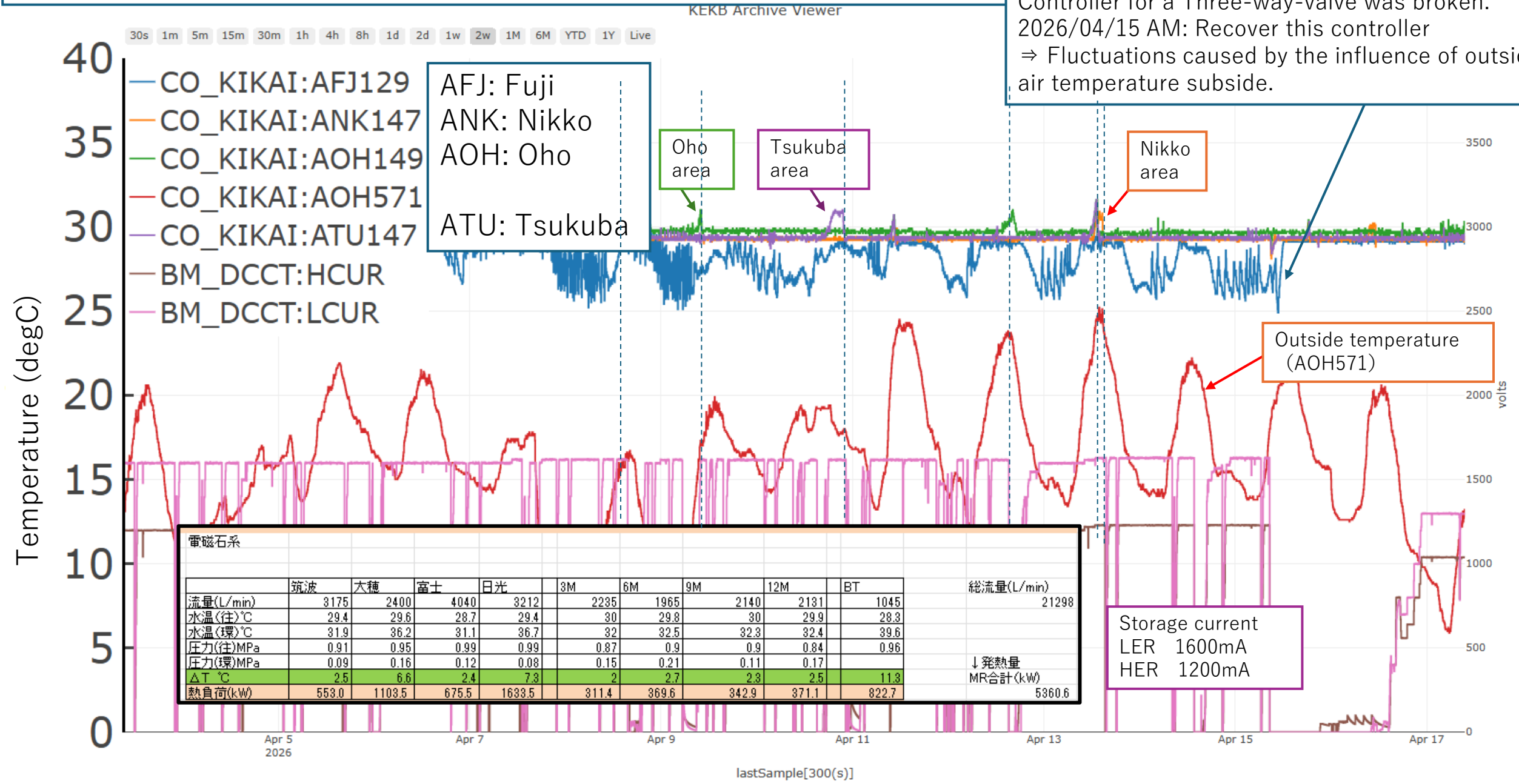


Temperature fluctuations of cooling waters for the MR vacuum chamber, 2026/03/04 00:40~ 01:50



Temperature fluctuations of Magnet cooling waters, 2026/04/03～04/17

Fuji area, Magnet cooling water（Bule: AFJ129）
Controller for a Three-way-valve was broken.
2026/04/15 AM: Recover this controller
⇒ Fluctuations caused by the influence of outside air temperature subside.



電磁石系

	筑波	大穂	富士	日光	3M	6M	9M	12M	BT	
流量(L/min)	3175	2400	4040	3212	2235	1965	2140	2131	1045	総流量(L/min) 21298
水温(往)℃	29.4	29.6	28.7	29.4	30	29.8	30	29.9	28.3	
水温(環)℃	31.9	36.2	31.1	36.7	32	32.5	32.3	32.4	39.6	
圧力(往)MPa	0.91	0.95	0.99	0.99	0.87	0.9	0.9	0.84	0.96	
圧力(環)MPa	0.09	0.16	0.12	0.08	0.15	0.21	0.11	0.17		
ΔT ℃	2.5	6.6	2.4	7.3	2	2.7	2.3	2.5	11.3	↓発熱量
熱負荷(kW)	553.0	1103.5	675.5	1633.5	311.4	369.6	342.9	371.1	822.7	MR合計(kW) 5360.6

Buildings

Problems caused by roof leaks (Instances where driving was - or was likely to be restricted)

・2020年1月29日　10:40~　D11 buildings
Magnet PS（BWDNRP）, Wigger at Nikko



・2020年4月18日　13:40~16:00
D11 building（KPS for RFD11CD）
雨漏り対応（養生）のため、運転停止。

(2) D10 power supply building

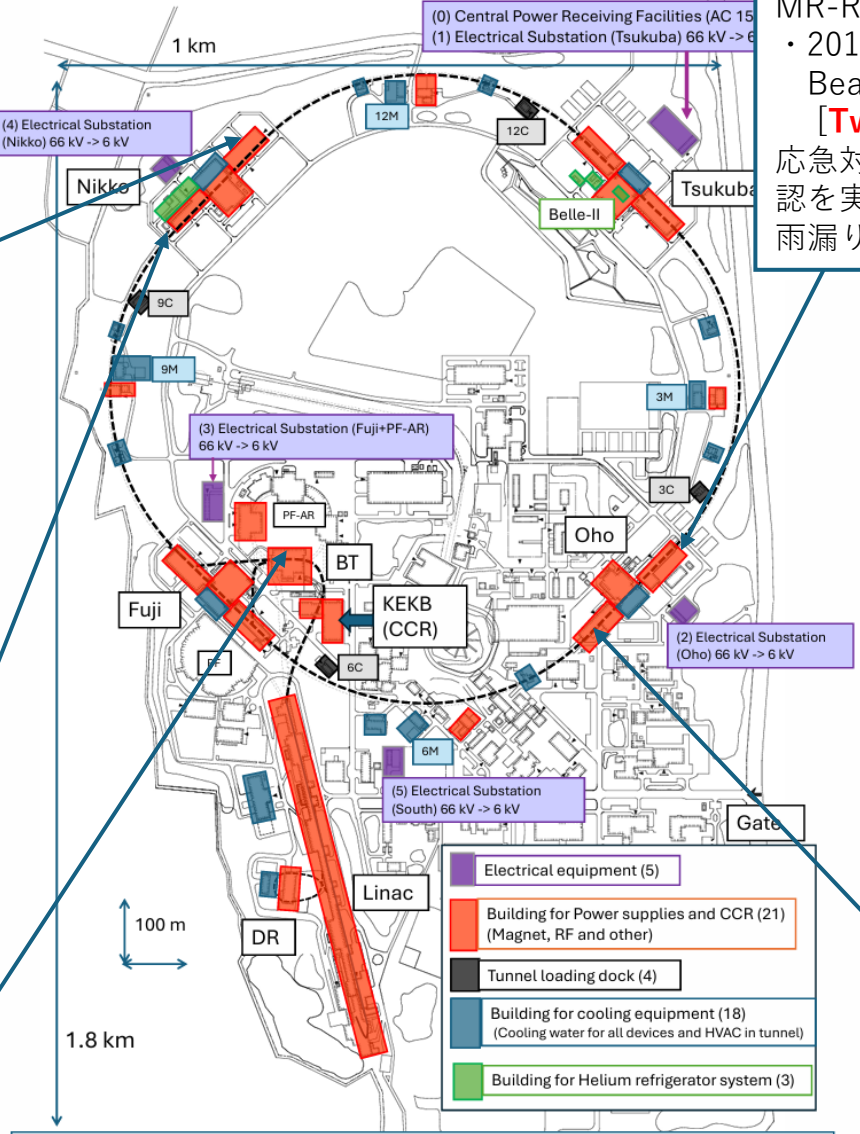
May 4, 2026,　1時間ほど運転停止させた

ARC sensor for protecting waveguide system for Ring RF was broken due to a roof leak.
-> Operation was stopped for few hours.

(1) KEKB-BT power supply building

March 4, 2026, 02:46　7時に復旧, 5時間停止

The circuit beaker tripped due to a roof leak, then BT magnet was downed.
-> Operation was stopped for half day.



Layout of the buildings used at SKEKB (Tsukuba campus at KEK)

MR-RF KPS tripped due to roof leak
・2018年5月13日 19:27:49　D4 building（KPS for RF D04GH）
Beam abort: due to KPS tripped by Anode O.C.
[**Two cavities**] have been taken out of operation.
応急対応として電源上方に雨樋を設置、3日後の5月16日に動作確認を実施、そのあとで運転再開した。
雨漏りによるKPSの耐圧劣化により電源がトリップした例



・2019年10月25日 15:00~ 22:30
D5 building（KPS for RF D05AB, CD, EF）
雨漏り対応（養生）のため、運転停止。

・2020年4月13日　10:10~10:30
D5 building（KPS for RF D05CD）
雨漏り対応（養生）のため、運転停止。
そのあとで雨樋を構築した（保守日を利用）。

Other

施設安全として報告できる内容のリスト、
・NLC周りの放射線シールド増強（D5V1）とその遮蔽効果について
　⇒2026a運転時に中性子検出可能な線量計を配置、その調査結果を元にシールド増強を進めていることを報告。

・インフラ関係
　雨漏り被害について（AR南実験棟、D10電源棟）　実験盤の地絡（BTの電磁石のトリップ）、MR RFの故障（D10-Aのトリップ）
　制御室内の空調設備の故障について（D7電源棟）　RF制御の不安定が引き起こされた。
　冷却水温度制御について（真空チェンバー系、電磁石系）　PID制御パラメーターの調整
　夏期運転時の電力制限について（つくばキャンパス全体における空調の負荷増に起因するビーム電流の縛り）
　DR電源棟　6kV高圧ケーブル損傷（最近の話）
　SKEKB地区における高圧ケーブルの更新（6kV系、1980年代に敷設された高圧ケーブルの更新が進められている話）
　シュリンクバックに関する6kV系の緊急点検について（つくばの加速器側は問題なさそう。施設部所掌で一部発見された話くらい。）
　2026夏期保守期間中に実施した設備修繕のまとめ（機械、電気、建築）
　加速器運転時に発生する放射線が原因の電子機器への影響について（ＰＨＳの不調、監視カメラの短期間運用での故障など）
　電気設備：つくばキャンパス全体における力率設定について（運転中、休止期間中での違い。ビームアボートによる負荷変動が起因の受電系の電圧変動について。）B2Pトリップ。

・放射線申請（変更申請について）
　MR電流増、SKEKB-BT電流増について

Summary

I have outlined the current status of the facility, focusing on the SKEKB-MR and the BT.

Regarding mechanical equipment, half of the cooling water pumps, in particular, are still the original units from the TRISTAN era.

Although infrequent, there have been instances where electric motors have suddenly developed ground faults; consequently, the risk of operational shutdowns or performance limitations due to pump failure is on the rise.

Roof leaks in the buildings have become a serious issue. This has heightened the risk of failures in high-voltage power supply systems, including those for the injection point and the KPS. We will urge the organization to carry out repairs before any personnel-related accidents occur.

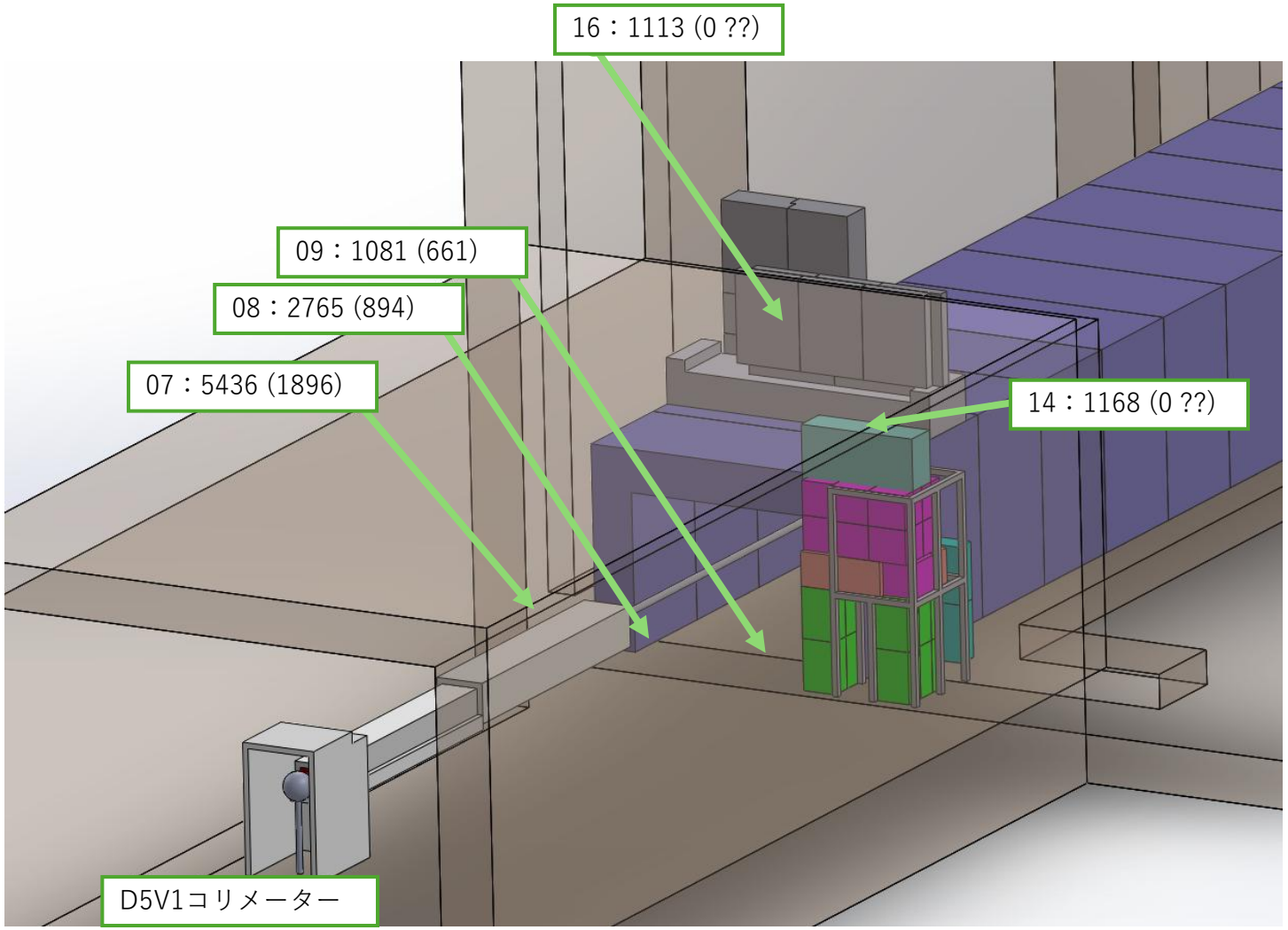
The reinforcement of radiation shielding for the NLC (Non-linear collimetor) is progressing well. At present, radiation leakage is being kept to a level that does not interfere with operations.

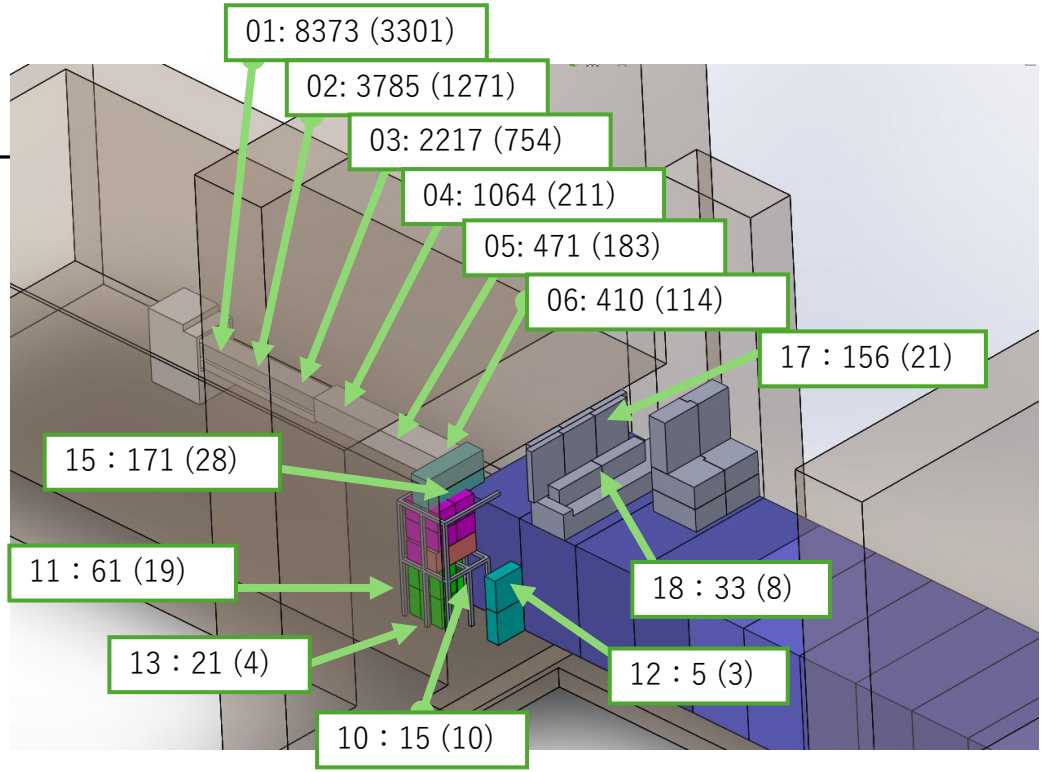
We are currently enhancing the shielding to accommodate the higher stored beam currents targeted for the next operational run, and we anticipate no issues in the foreseeable future.

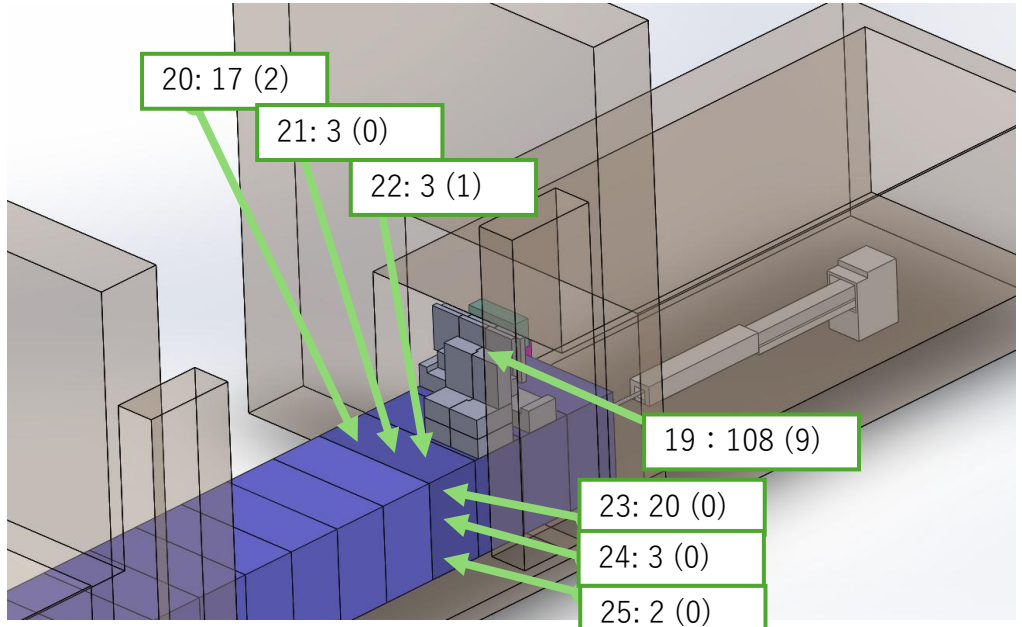
An application to modify the radiation-generating equipment is currently being processed; the timeline for approval remains undecided.

観測結果：DeepDose [mSv]（NeutronDose [mSv]）

測定期間：2026年1月26～2月18日（24日：576時間）

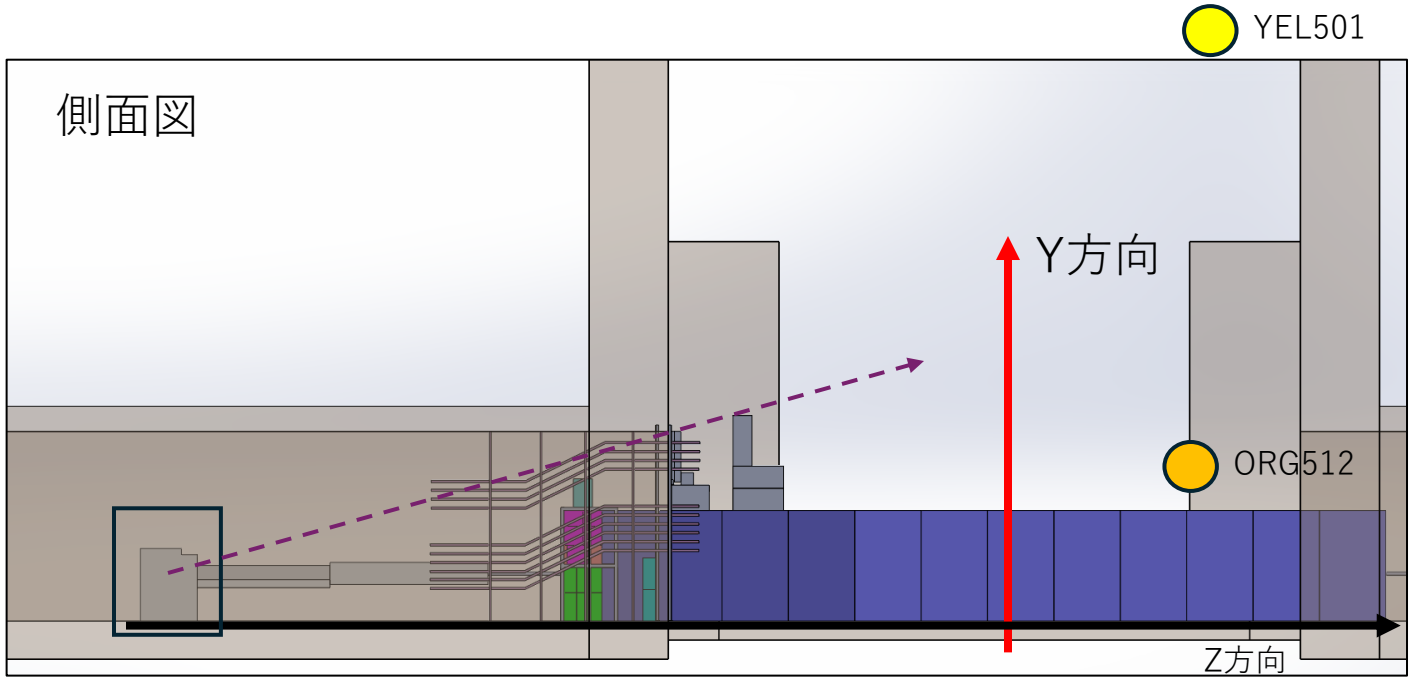




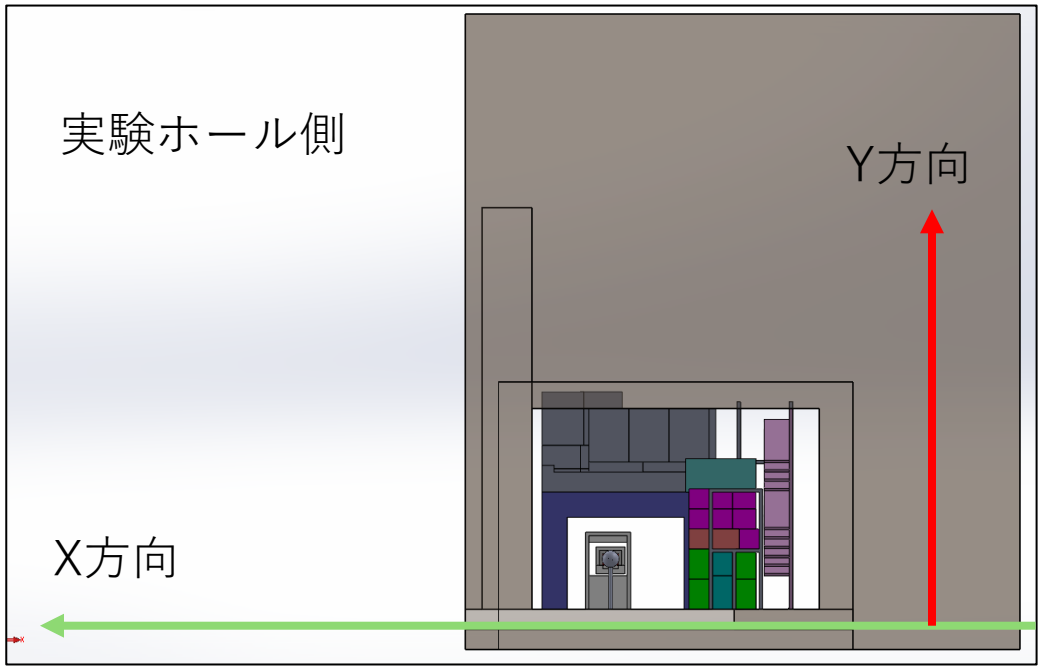


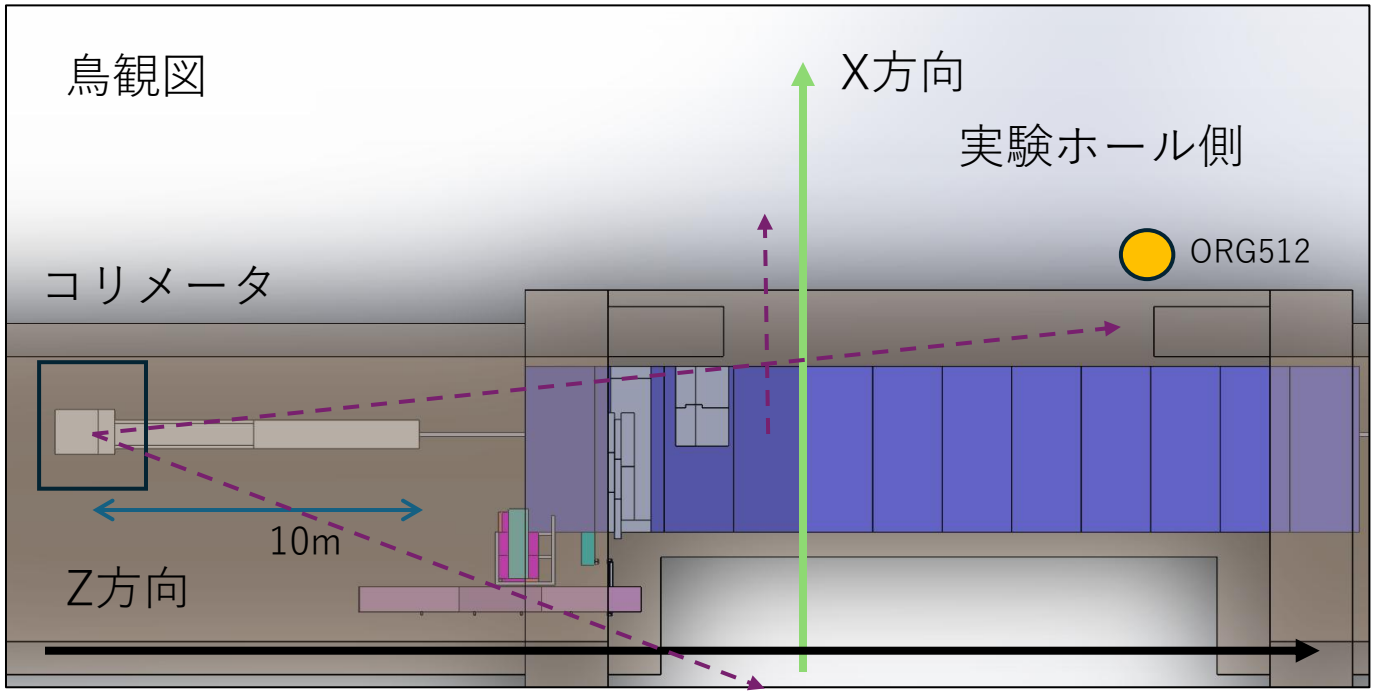
はじめに

大穂直線部に構築した放射線シールドの遮蔽効果と漏洩箇所の探索のため、2026a運転開始前にフィルムバッジ（計25個）を各所に設置した。
1月26日の運転開始から2月18日の保守日までの計24日間の暴露状況をまとめる。
この結果より、今後行うべき遮蔽体増強の方針を検討、必要なビームスタディについて相談する。



コリメータ正面より





遮蔽効果調査のためのバッジ試験（エリアモニターの値）共通：坂木、大山　対応

この期間中の暴露状況を示す。
↑OG0512、YEL501が該当



OSL線量計

放射線を利用される様々なシーンに適応するため２種類の線量計をご用意しています。



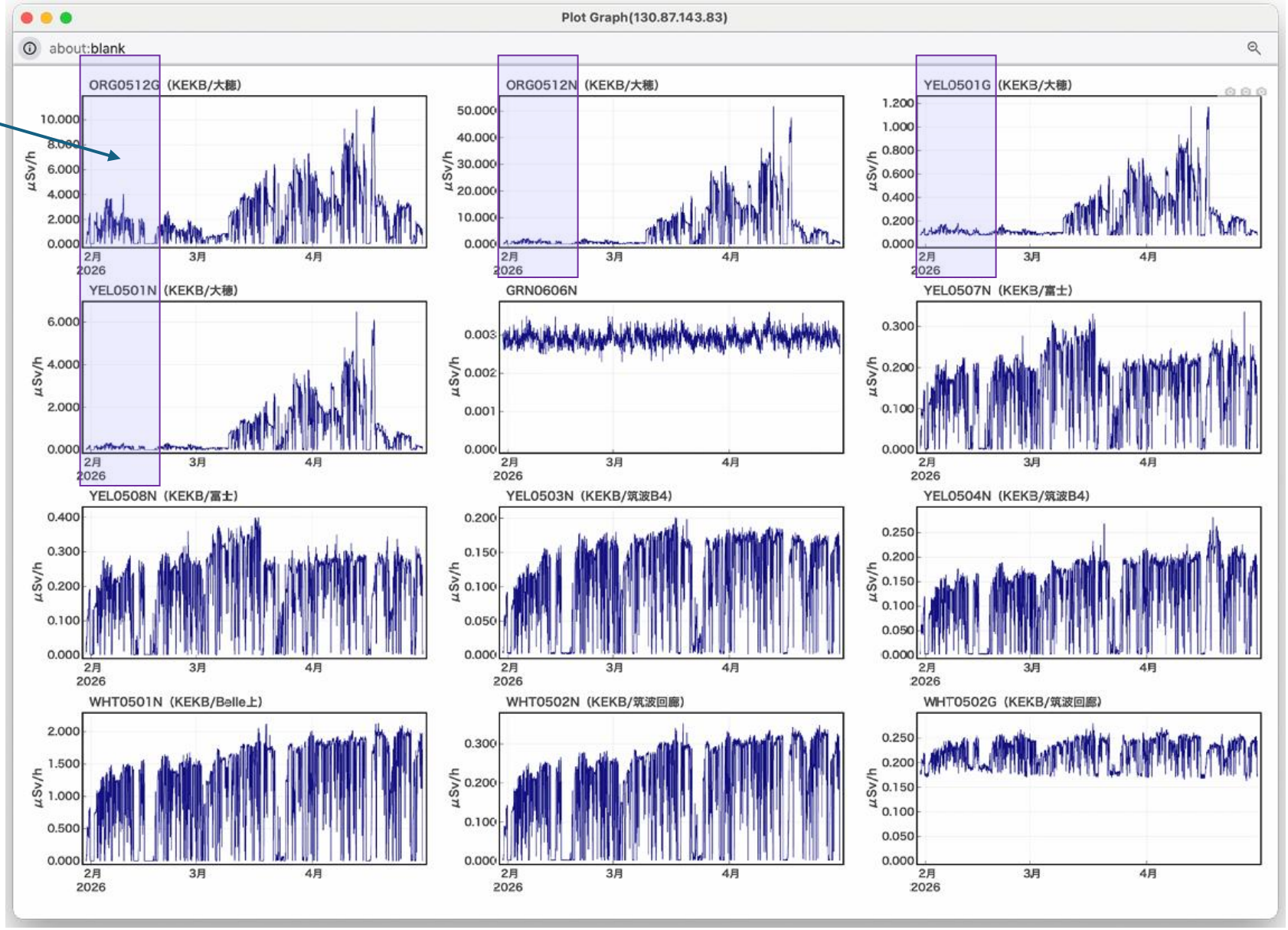
- **InLight（インライト）線量計（XA・EX）**

X・γ線、β線用の線量計です。X・γ線の発生する装置を利用している施設で利用されています。
XAは個人用で、EXは環境用になります。

- **Albedo（アルベド）線量計（中性子用　BA・LA）**

X・γ線、β線および中性子線用の線量計です。サイクロトロンなどを設置されている施設で利用されています。
BA・LAの2つのタイプがあります。

↑使用した線量計



遮蔽効果調査のためのバッジ試験（設置位置の様子）共通：坂木、大山　対応

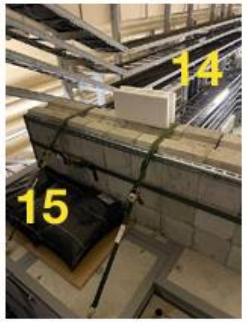
















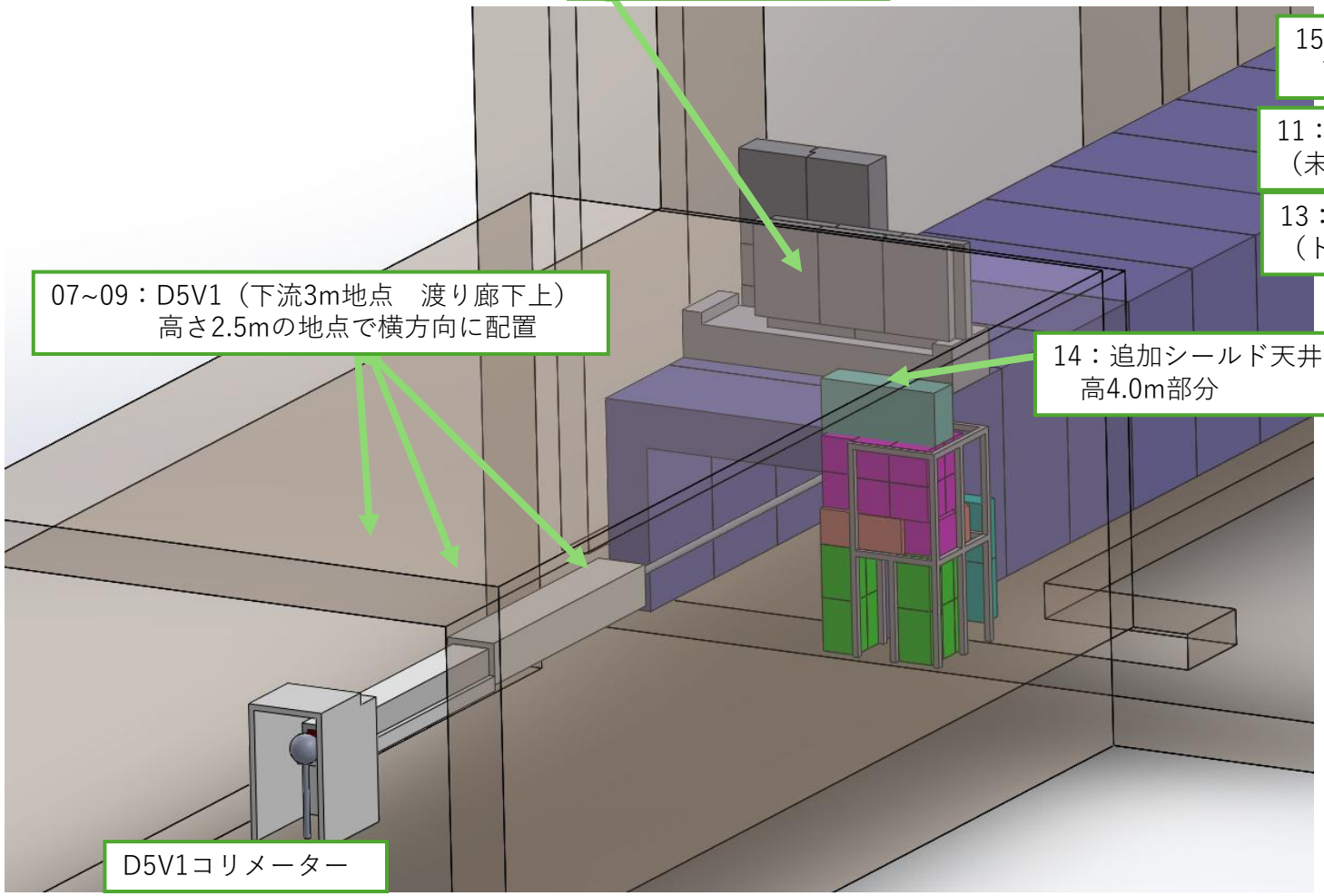


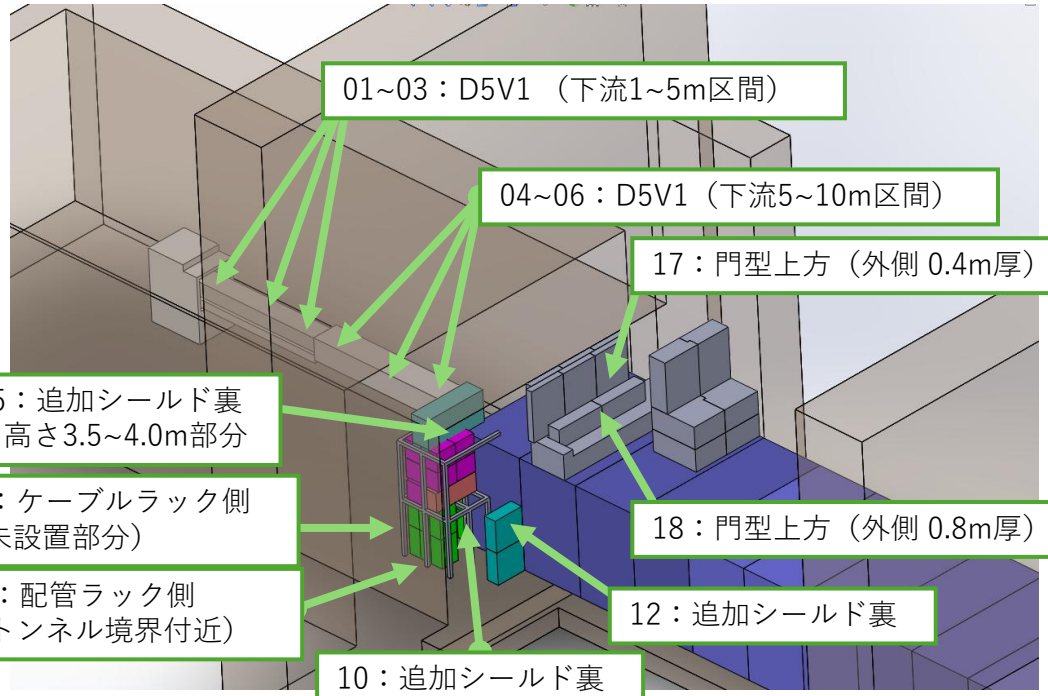


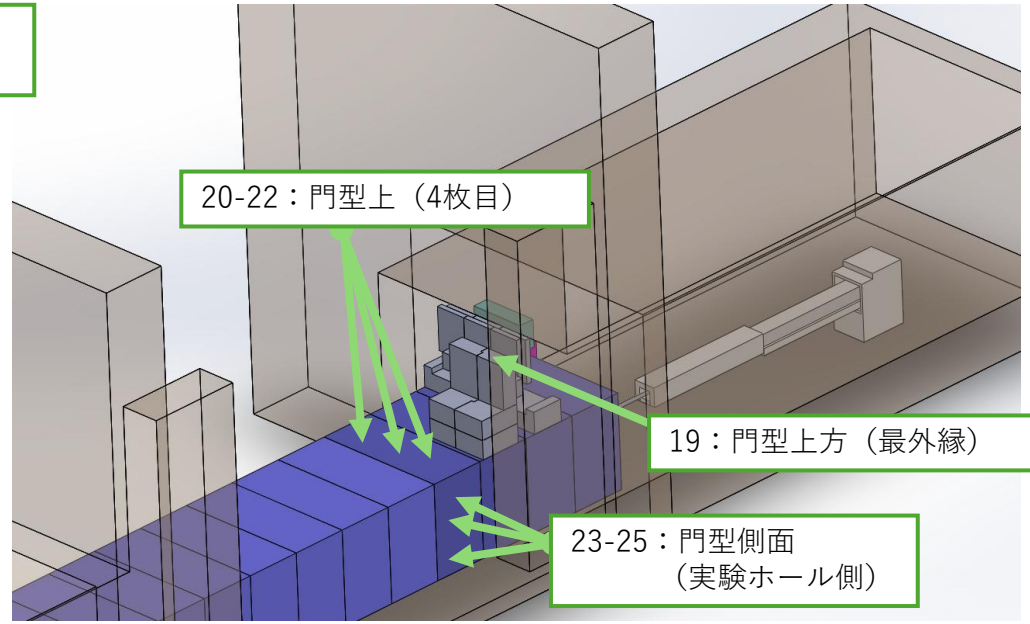




フィルムバッジ設置位置





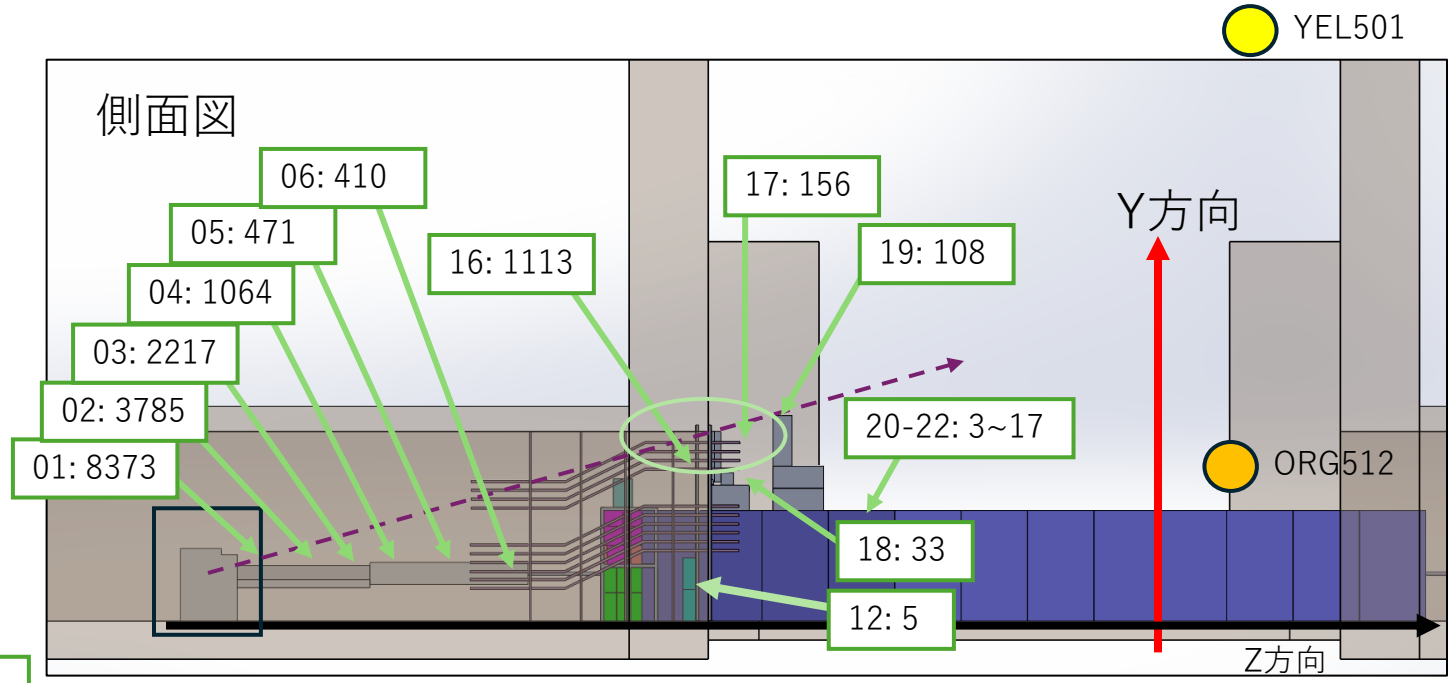


別視点で見てみると

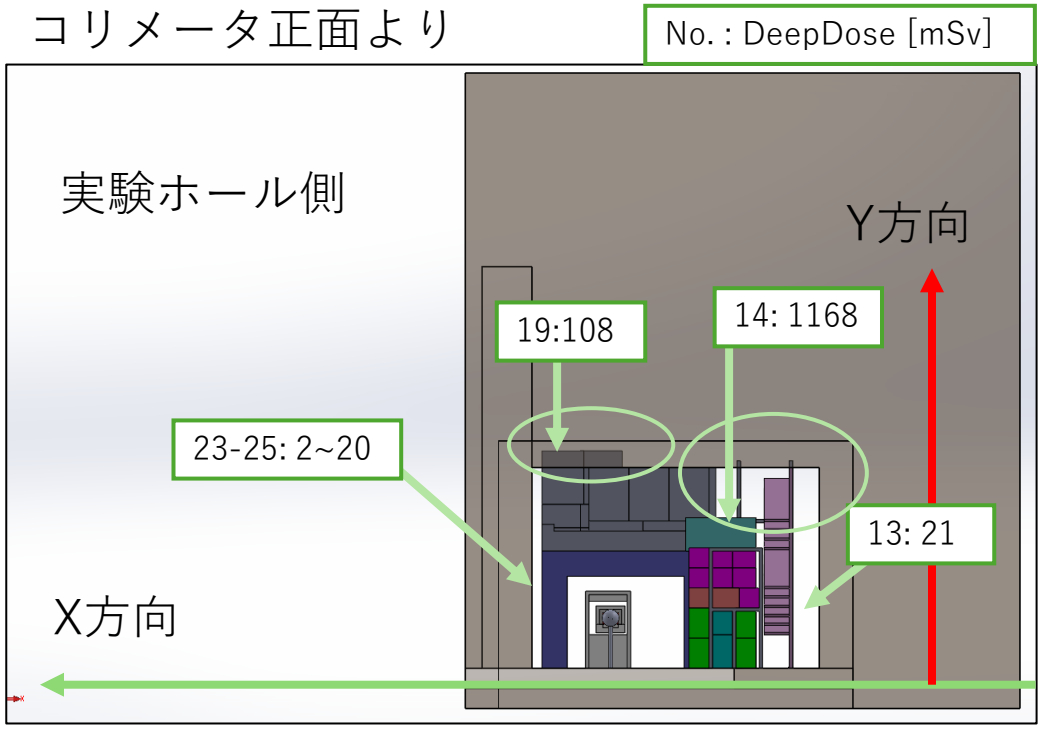
・実験ホールへ漏れ出る線量分布より、
「高さ3.5m以上」のエリアからの漏洩が多い状況であることが確認された。

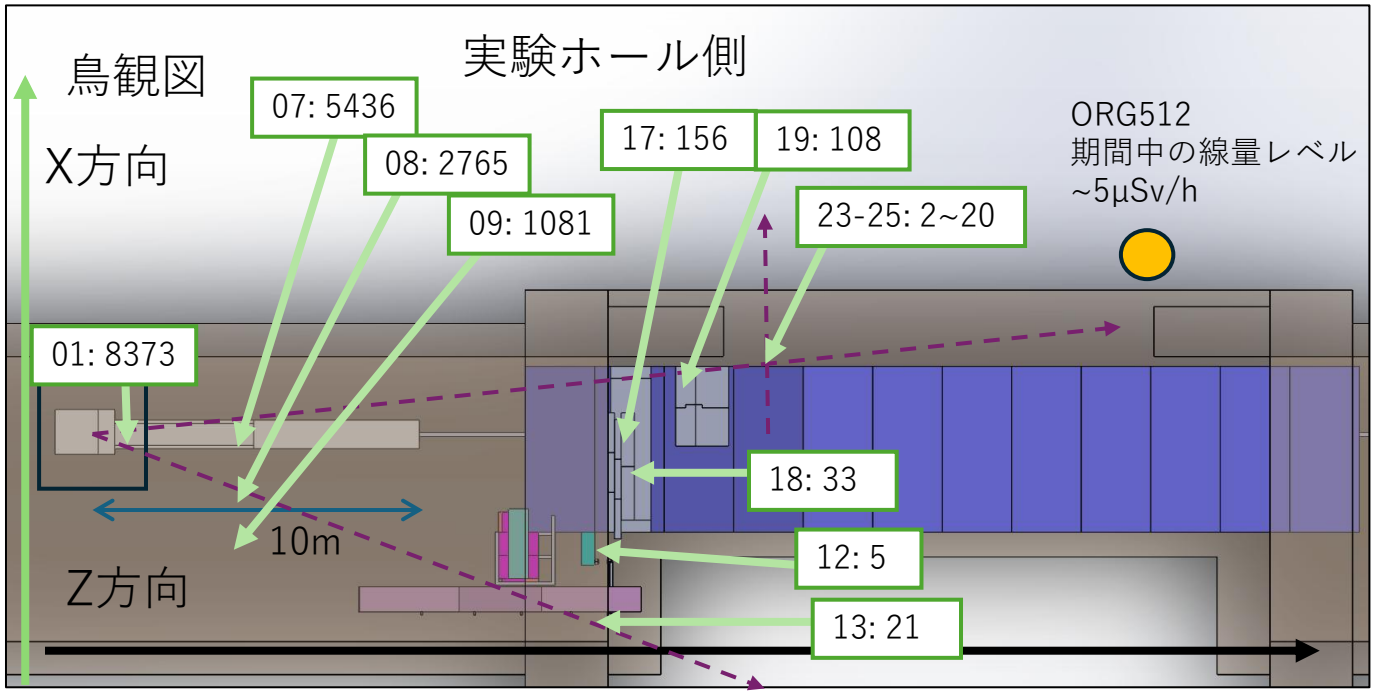
・今後の対策として
①トンネル-実験棟境界の右上方の部分の遮蔽体構築
②既設門型シールド上方の遮蔽強化

③コリメータ直下＋1～5m区間の遮蔽強化を行い、
大元の線量を減らす（1～5mは10cm厚と薄いまま）。

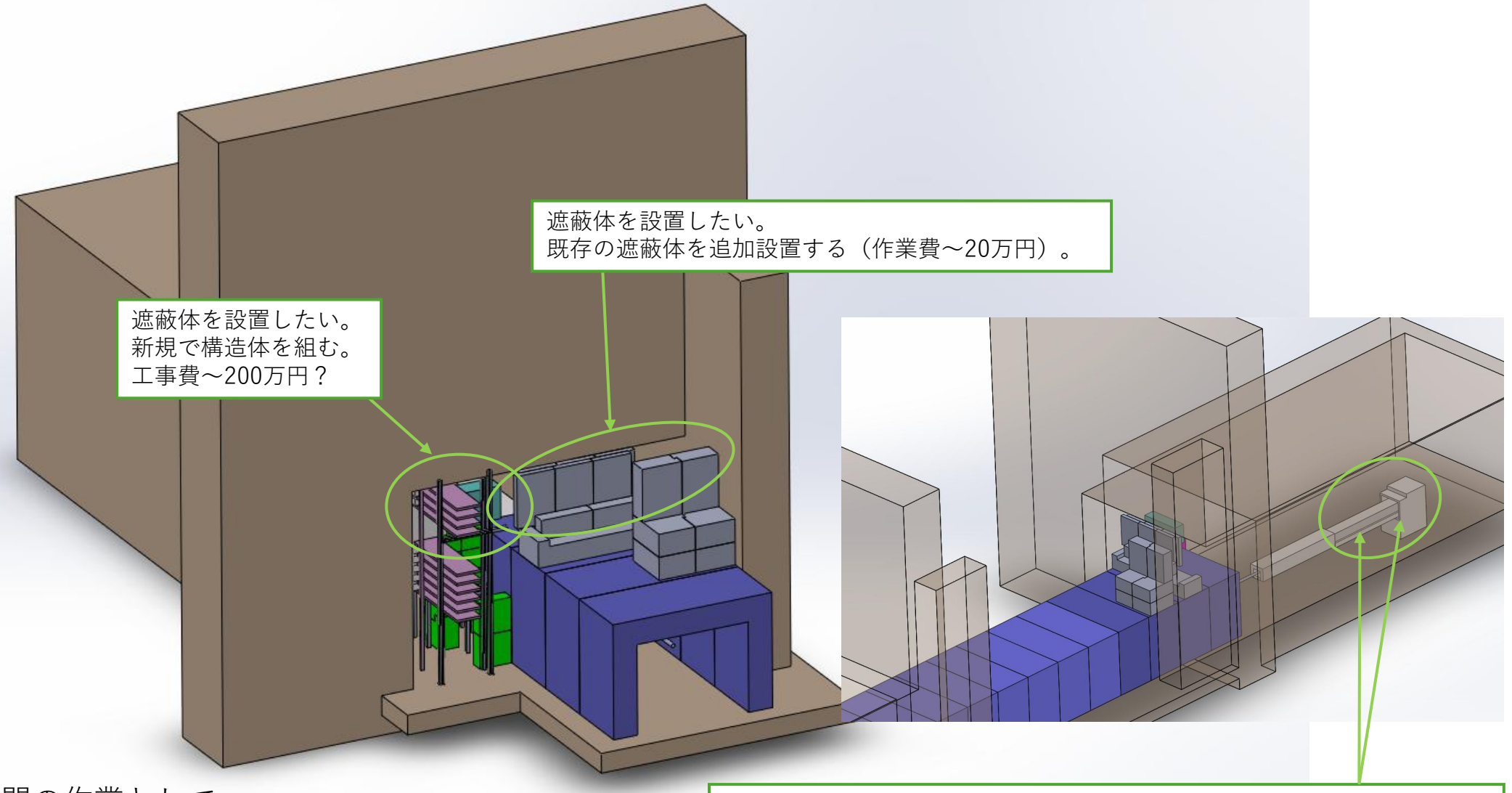


コリメータ正面より





まとめると



・2026年夏期保守期間の作業として、
現時点で漏洩量が多い部分をカバーしたい。
一連の増強で、さらに「~1/8」の減少が見込まれる。

はじめに

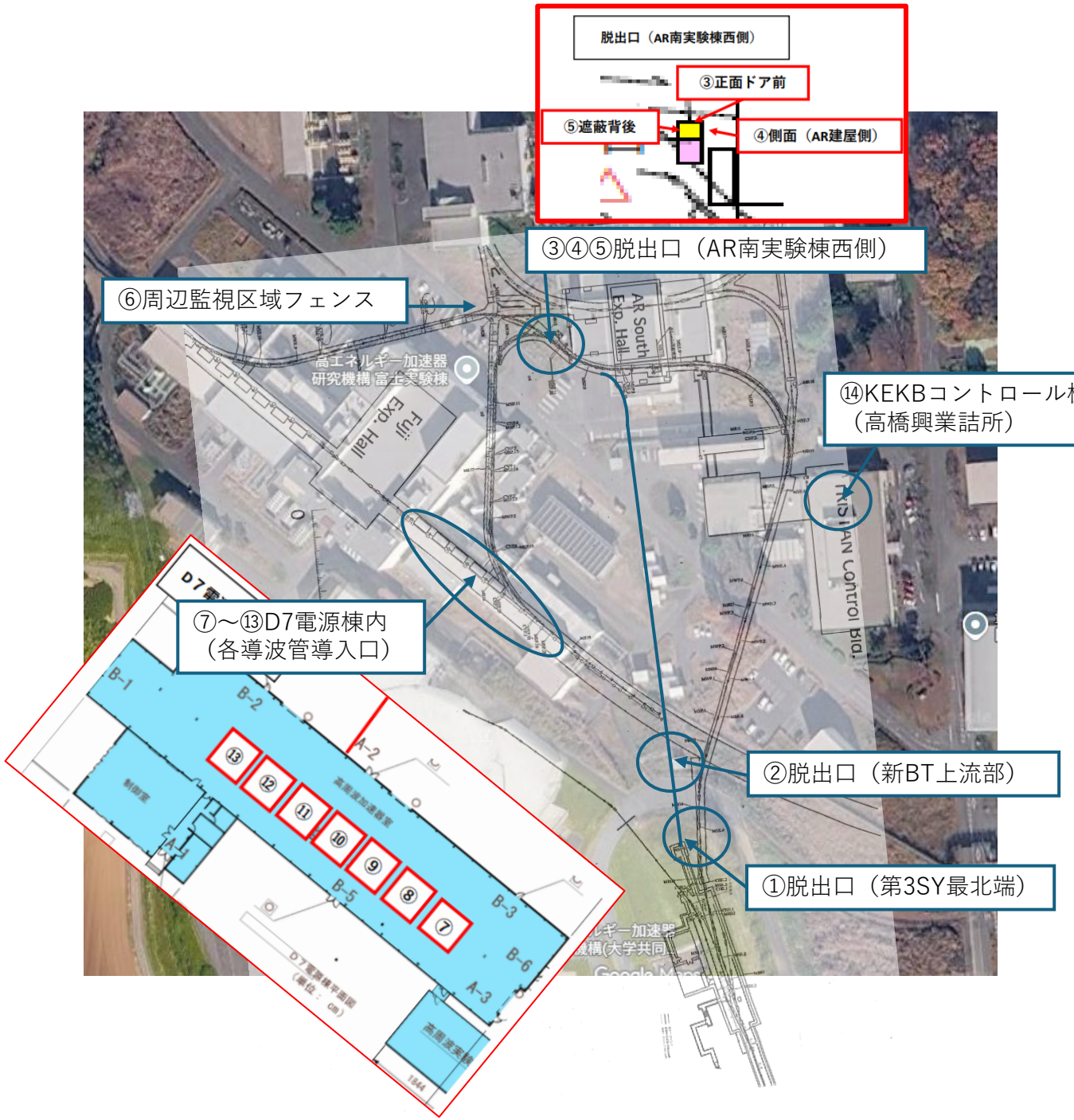
・測定日時　2026年6月30日（火）9:00～10:30

・運転条件
　e-：2バンチ運転（1.5nC、1.5nC）
　e+：2バンチ運転（2.9nC、2.9nC）

⇒この状態で繰り返しを変えつつ、
　各プロファイルモニターを挿入、
　そこから発生する放射線レベルを調査した。

6/30 の放射線測定時の入射ビームより、
　BTe　1.5nC×2バンチ×25Hz
　BTp　2.9nC×2バンチ×23Hz

　合計すると、208.4nC/s（最大出力の69.5%）
※300nC/sが上限



まとめると

BTe：5Hz（1.5nC×2-bunch）
BTp：5Hz（2.9nC×2-bunch）
⇒MSE#6、MSP#5　同時使用可
※12.5Hz⇒「×」抜けてくる中性子で許容値を超える。

BTe：12.5Hz（1.5nC×2-bunch）
BTp：12.5Hz（2.9nC×2-bunch）
⇒MSE#5、MSP#4　同時使用可

SKEKB-BT
プロファイルモニター配置図

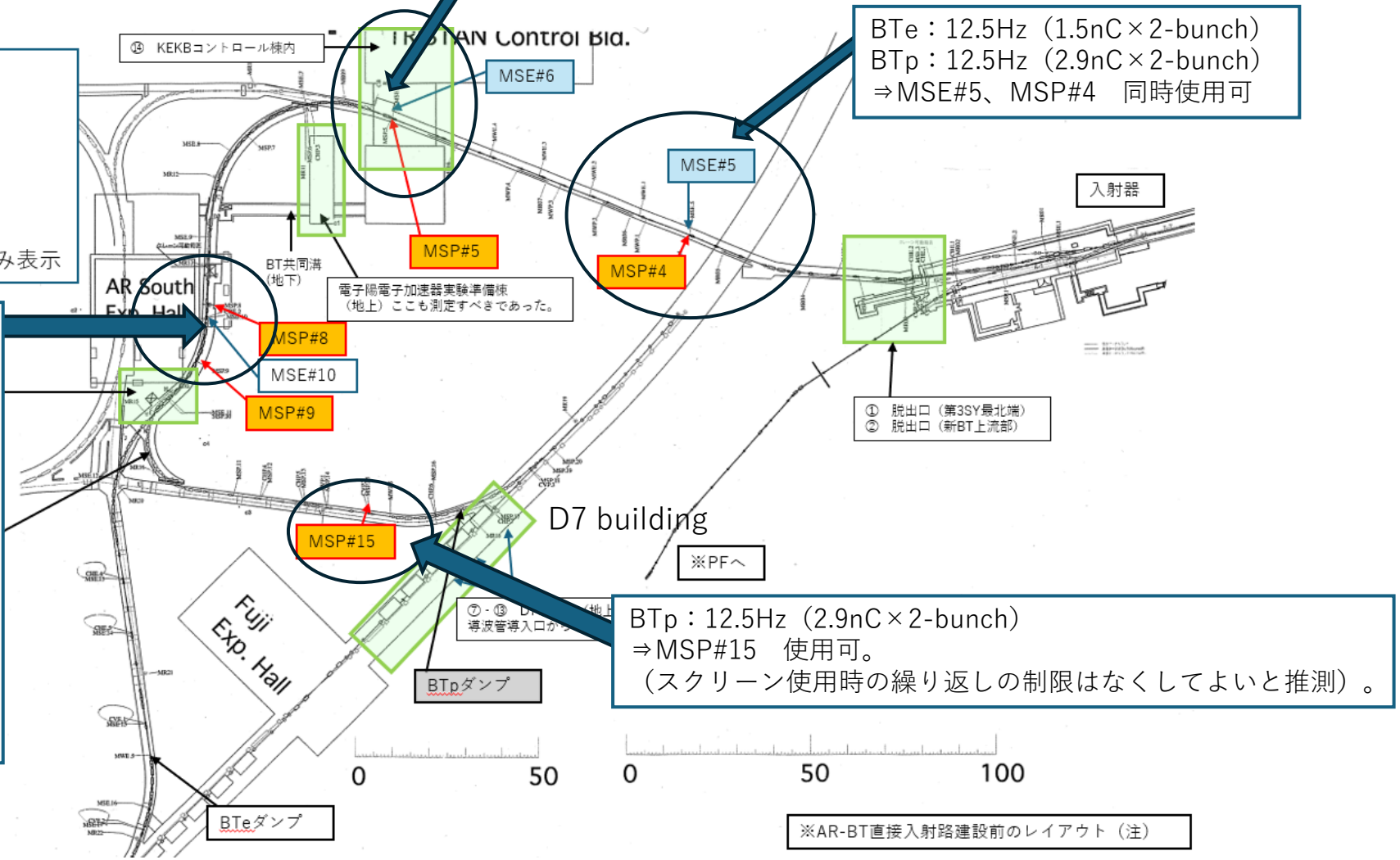
↓プロファイルモニター名称
・MSE（電子）
・MSP（陽電子）

※測定に使用したモニターのみ表示

BTe：1Hz（1.5nC×2-bunch）
BTp：1Hz（2.9nC×2-bunch）
⇒MSP#8、MSE#10　同時使用可

※繰り返しを5Hzに上げると、
片側だけでも厳しい。
更なるシールド増強により、
片側「5Hz」の使用可の可能性が
見えてきた。
※中性子が抜けてくる。
ガンマ、X線は検出されず。

⇒MSP#9　1Hzは問題なし。
5Hzでも問題なしと推測。

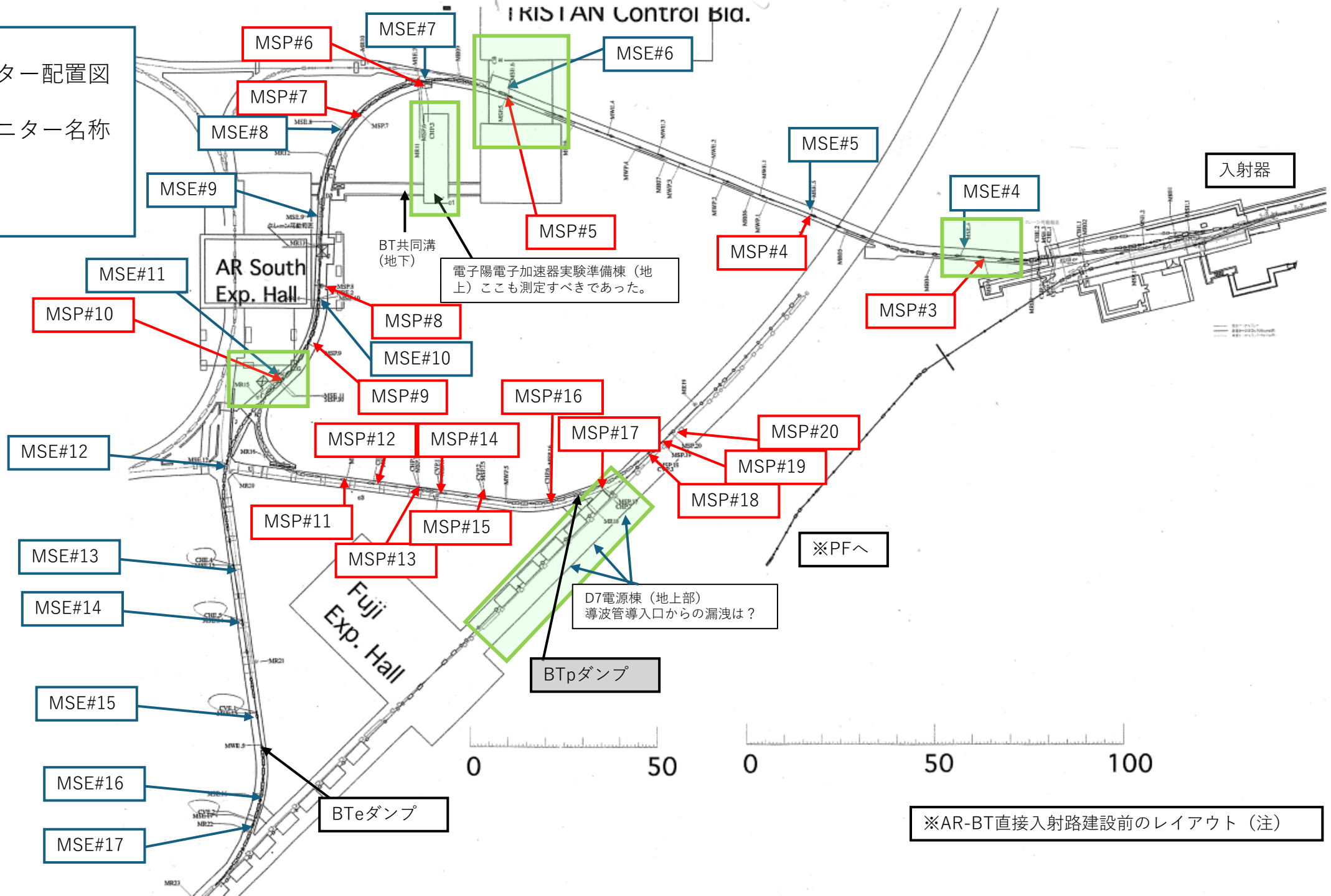


BTp：12.5Hz（2.9nC×2-bunch）
⇒MSP#15　使用可。
（スクリーン使用時の繰り返しの制限はなくしてよいと推測）。

※AR-BT直接入射路建設前のレイアウト（注）

SKEKB-BT
プロファイルモニター配置図

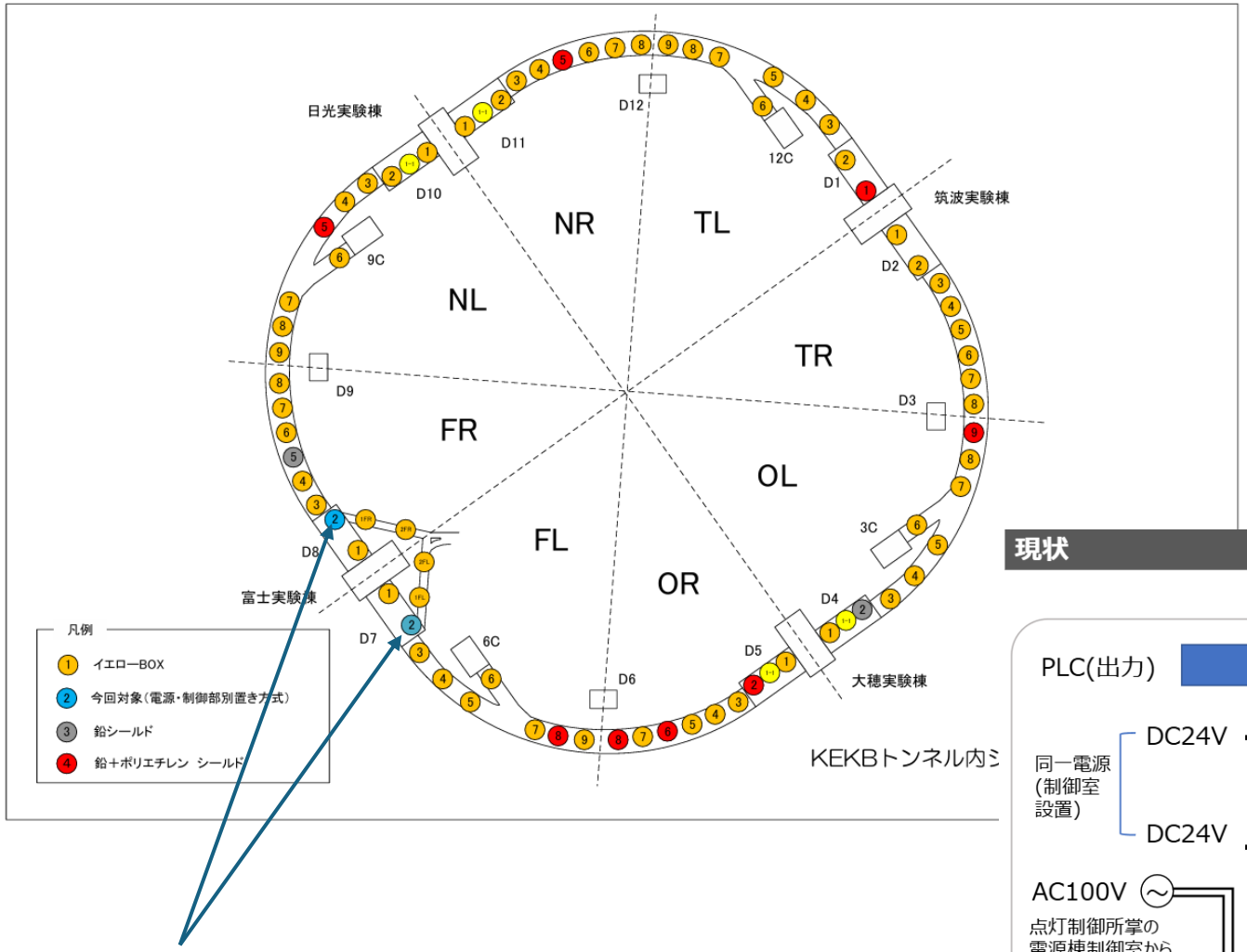
↓プロファイルモニター名称
・MSE（電子）
・MSP（陽電子）



※AR-BT直接入射路建設前のレイアウト（注）

MSC安全担当より

Radiation protection for electronic devices, including LEDs



この2か所に適用

2025c、2026abの運転を経験したが、この2本は無事であった。

