

Safety

The 27th KEKB Accelerator Review Committee

2024.3.26

Toshihiro Mimashi

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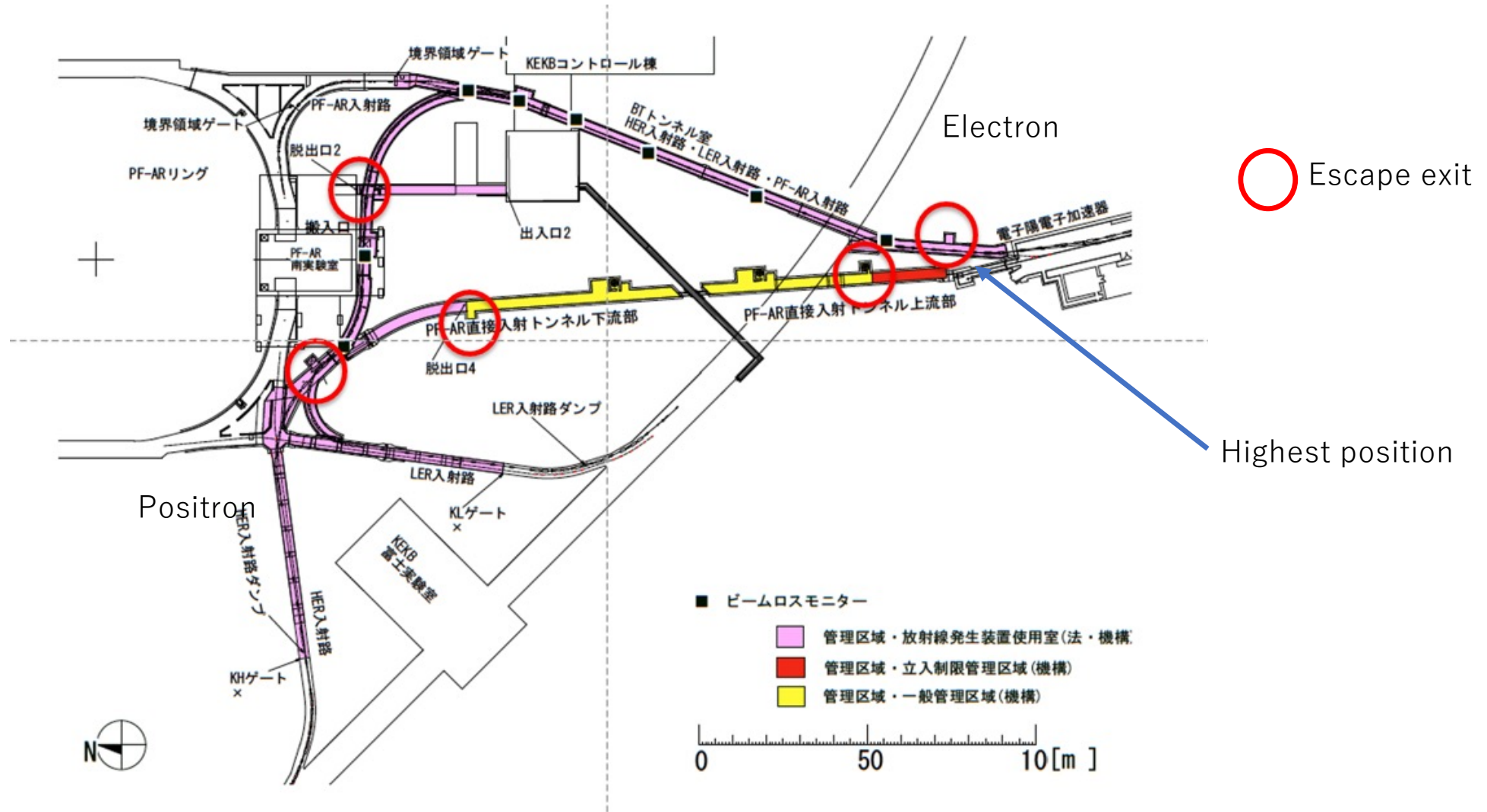
- **Issues of radiation Safety**
 - **Radiation level on the Beam Transfer Line**
 - **Radiation level on Fuji and Tsukuba experimental hall**
 - **Radiation level on Oho experimental hall (NLC in Oho straight section)**
- **ECS Cavity installation on Beam Transfer Line**
- **Fire caused by power supplies**
- **Personnel Protection System modification for tuning of injection beam (Fuji Mode)**

Radiation restriction Level

- General area $< 0.2\mu\text{Sv/h}$
- Radiation monitoring area (KEK) $< 1.5\mu\text{Sv/h}$
- Radiation control area (Nuclear Regulatory Agency) $< 20\mu\text{Sv/h}$

Radiation level measurement @ BT

Radiation level on the Beam Transfer Line



Radiation Level above the Beam Transfer Line

Beam	Repetition Rate	# of Bunches	Beam Charge (1st Bunch)	Beam Charge (2 nd Bunch)
e-	25Hz	2 Bunch	1.47nC	1.05nc
e+	25Hz	2 Bunch	1.26nC	1.2nC

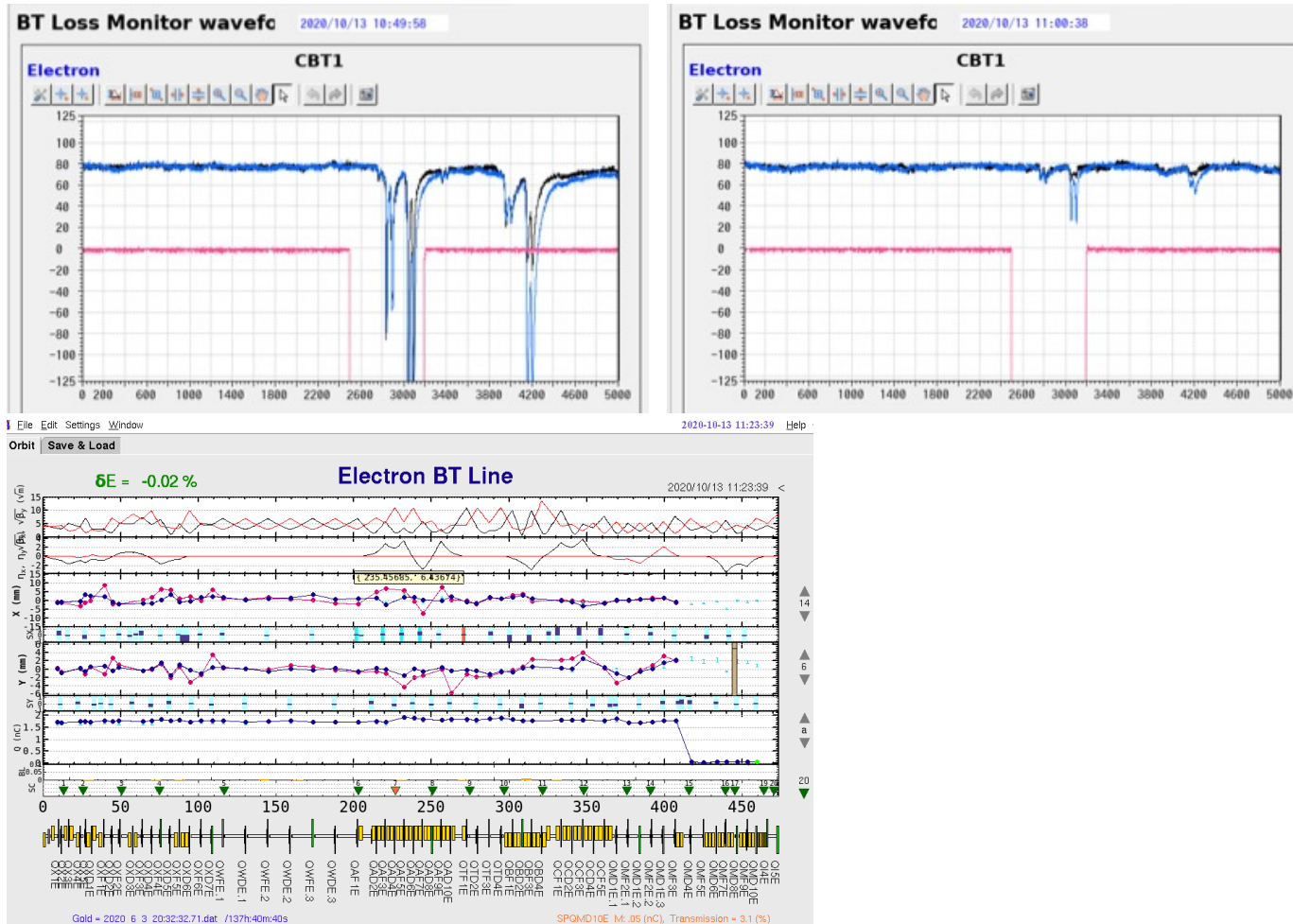
Radiation level in front of the most upstream BT escape exit is high

Before tuning: $0.8\mu\text{Sv/h}$ (must be $0.2\mu\text{Sv/h}$ or less)

→Mainly it comes from electron beam

After tuning: $0.13\mu\text{Sv/h}$

Optical Fiber loss monitor



2024/3/25

軌道調整前後

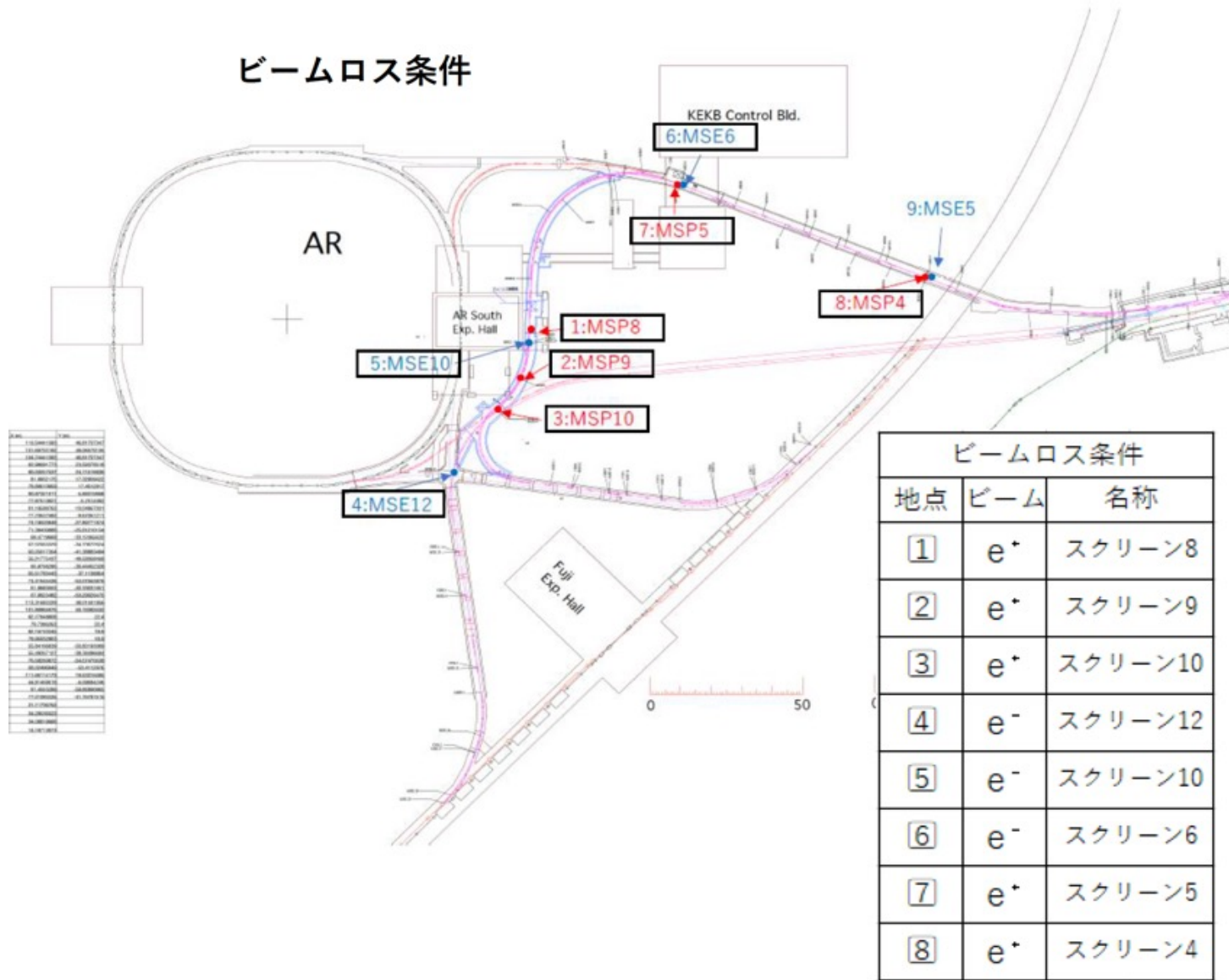
Screen Monitor inserted in the beam line

Radiation Level outside of tunnel becomes high

->Repetition Rate is limited to 1 Hz

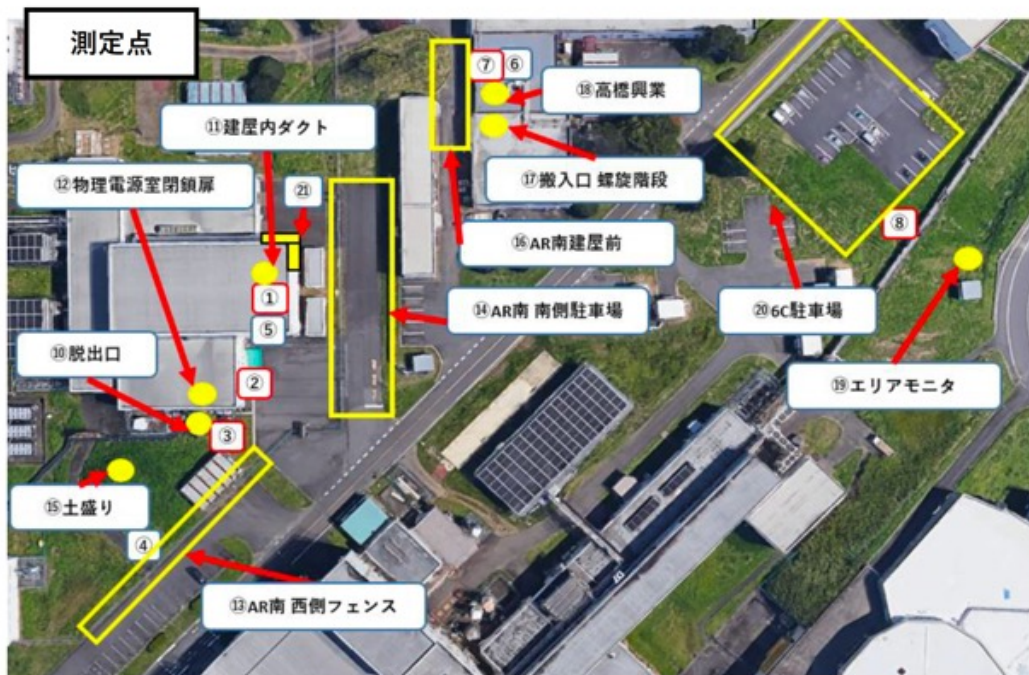
Average Repetition Rate < 0.3 Hz /Hour

ビームロス条件



H.Iwase

12.5Hz Beam Repetition Rate



測定結果

ビームロス条件 ①			
測定点	Nal	IC	レム
①	0.15	0.0	0.000
②	0.20	0.0	0.000
③	0.20	0.0	0.150
⑩	7.50	14	35
⑪	0.40	0.0	0.380
⑫	1.05	1.5	3.0
⑬	0.25	0.0	0.010
⑭	0.20	0.0	0.000
⑰	0.25	0.0	0.000

ビームロス条件 ②			
測定点	Nal	IC	レム
②	0.20	0.0	0.000
⑩	1.50	1.5	5.34
⑫	0.20	0.0	0.200
⑬	0.20	0.0	0.000
⑮	0.20	0.0	0.000

ビームロス条件 ③			
測定点	Nal	IC	レム
③	0.80	0.0	0.000
⑩	1.80	2.5	10
⑫	0.35	0.0	0.550
⑬	0.20	0.0	0.000

ビームロス条件 ④			
測定点	Nal	IC	レム
④	0.15	0.0	0.000
⑩	0.15	0.0	0.000
⑬	0.55	0.8	0.930

ビームロス条件 ⑤			
測定点	Nal	IC	レム
⑩	1.80	3.5	6.55
⑫	0.25	0.0	0.260
⑬	0.10	0.3	0.000

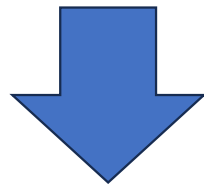
ビームロス条件 ⑥			
測定点	Nal	IC	レム
⑥	0.19	0.5	0.600
⑰	0.13	0.0	0.011
⑱	0.20	0.5	0.860
⑲	0.10	0.0	0.040

ビームロス条件 ⑦			
測定点	Nal	IC	レム
⑦	0.55	1.0	5.2
⑱	0.30	1.0	1.5
⑲	0.12	0.0	0.007

ビームロス条件 ⑧			
測定点	Nal	IC	レム
⑲	0.07	0.0	0.003
⑳	0.20	0.0	0.013

Radiation level on Fuji and Tsukuba experimental hall

General area $< 0.2\mu\text{Sv/h}$



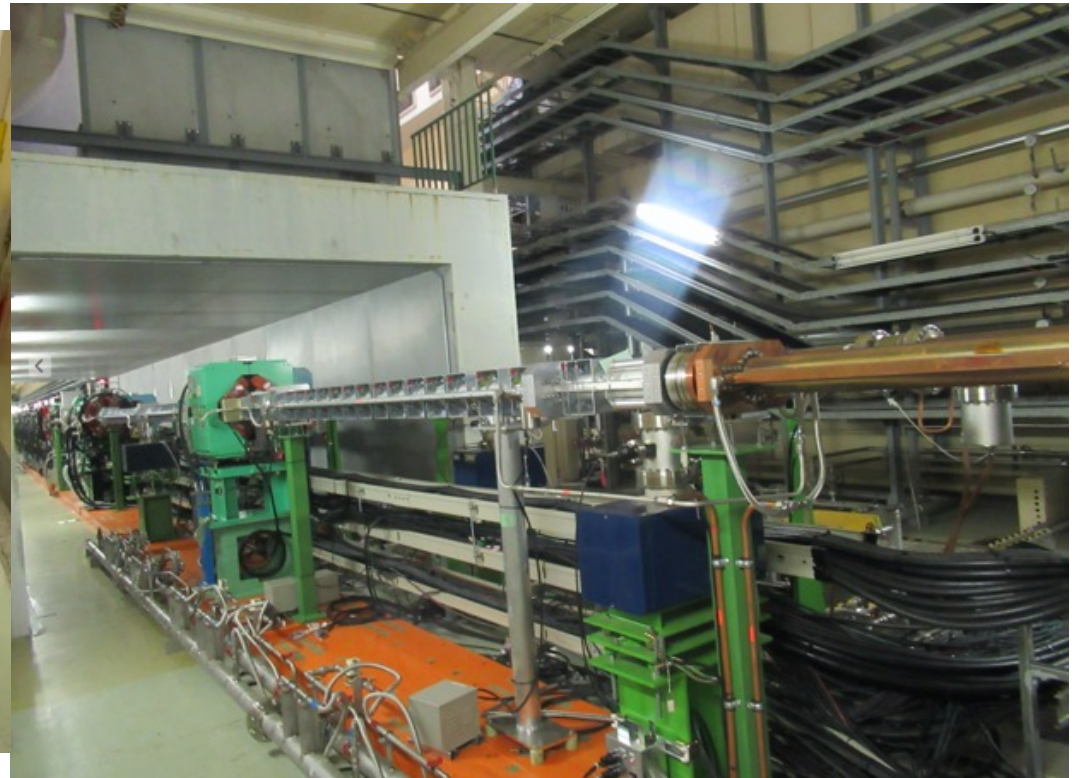
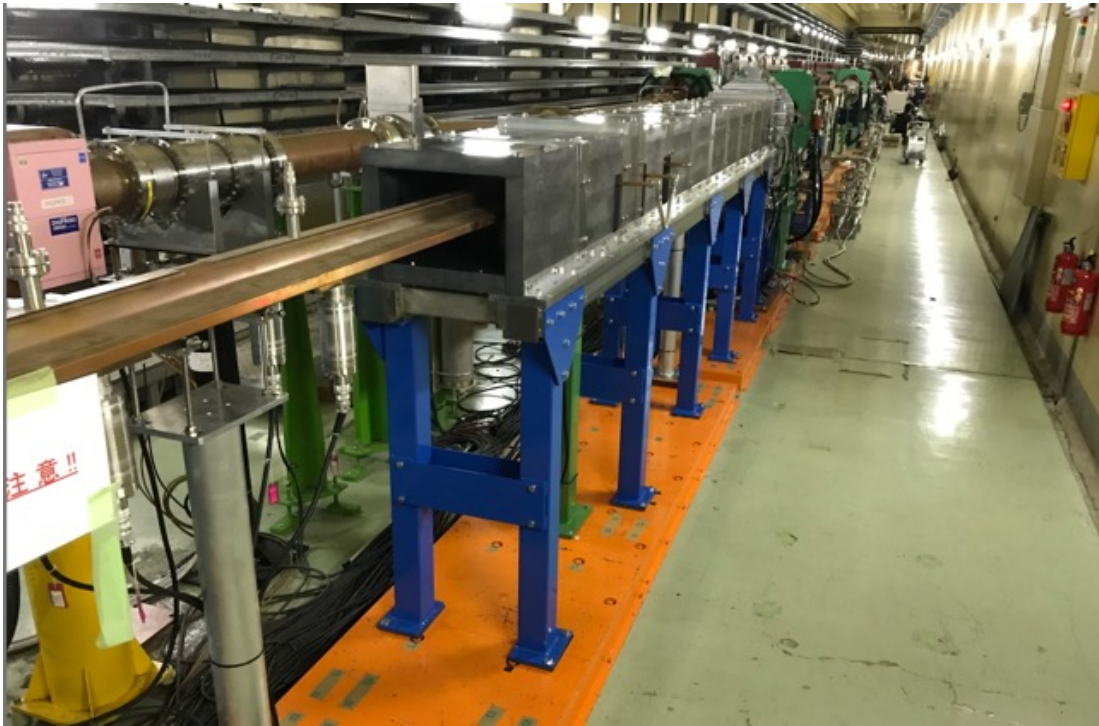
Radiation monitoring area(KEK) $< 1.5\mu\text{Sv/h}$

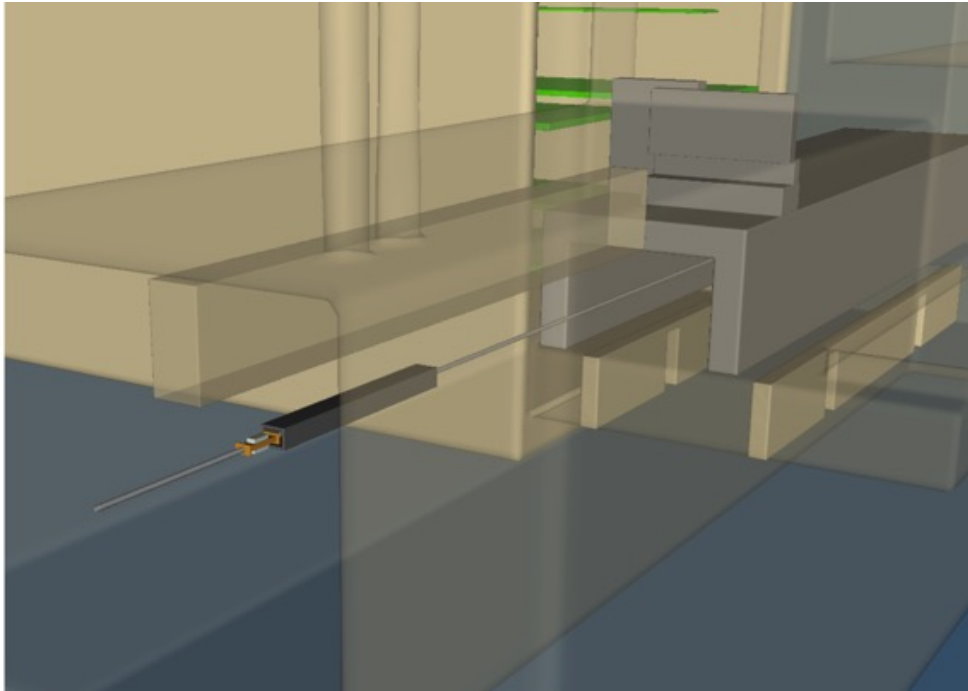
Radiation level on Oho experimental hall

Non-Linear Collimator (NLC) is installed Oho straight section



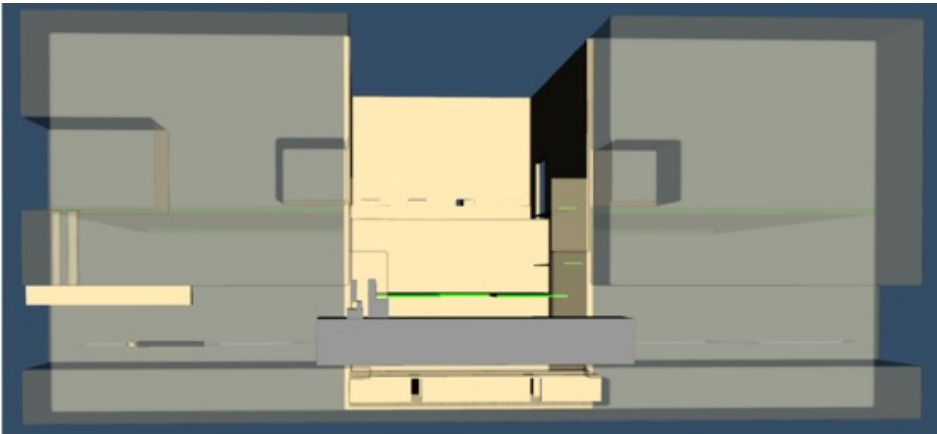
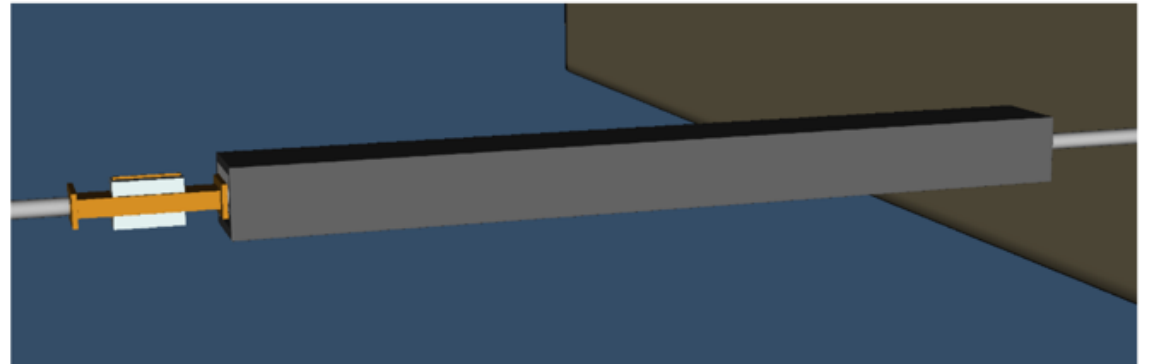
Surround the beam pipe with 5cm of lead. (5m long)

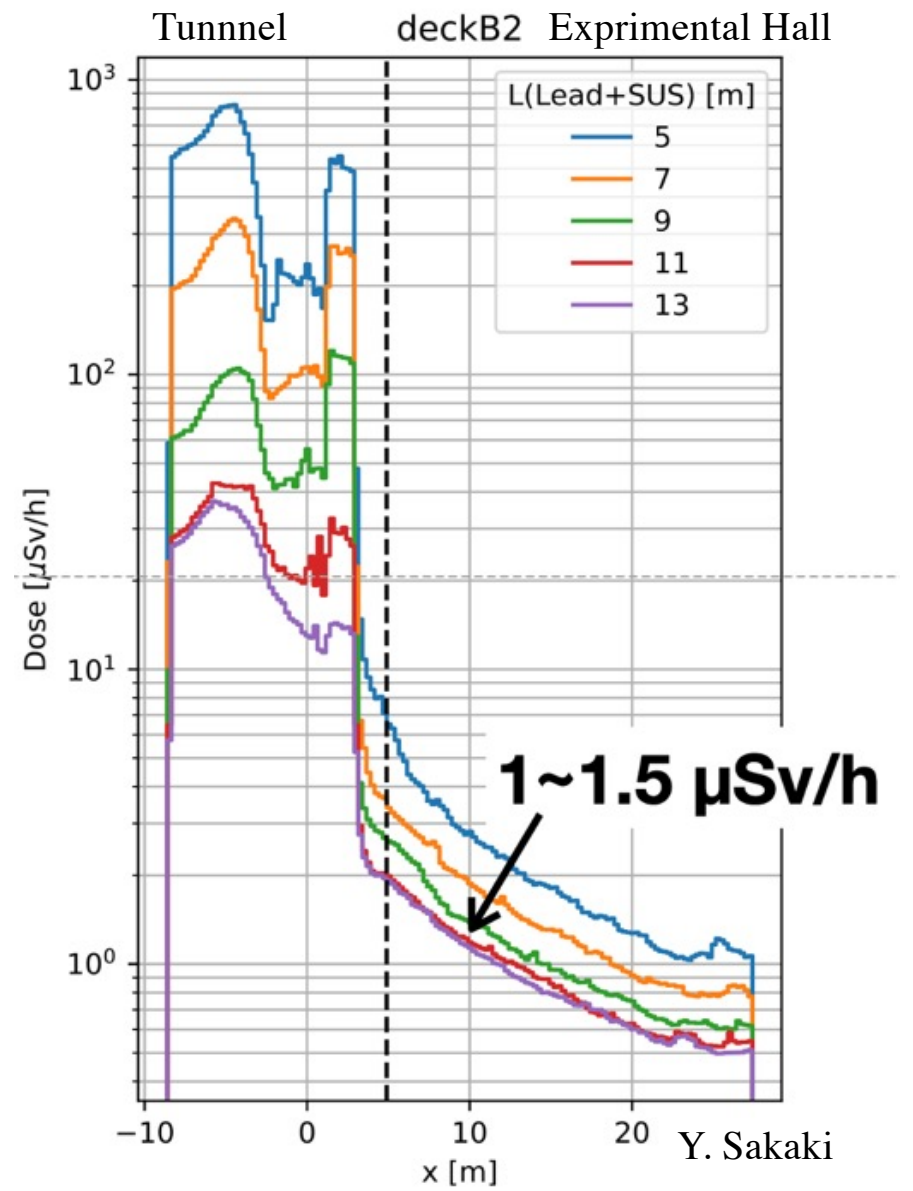
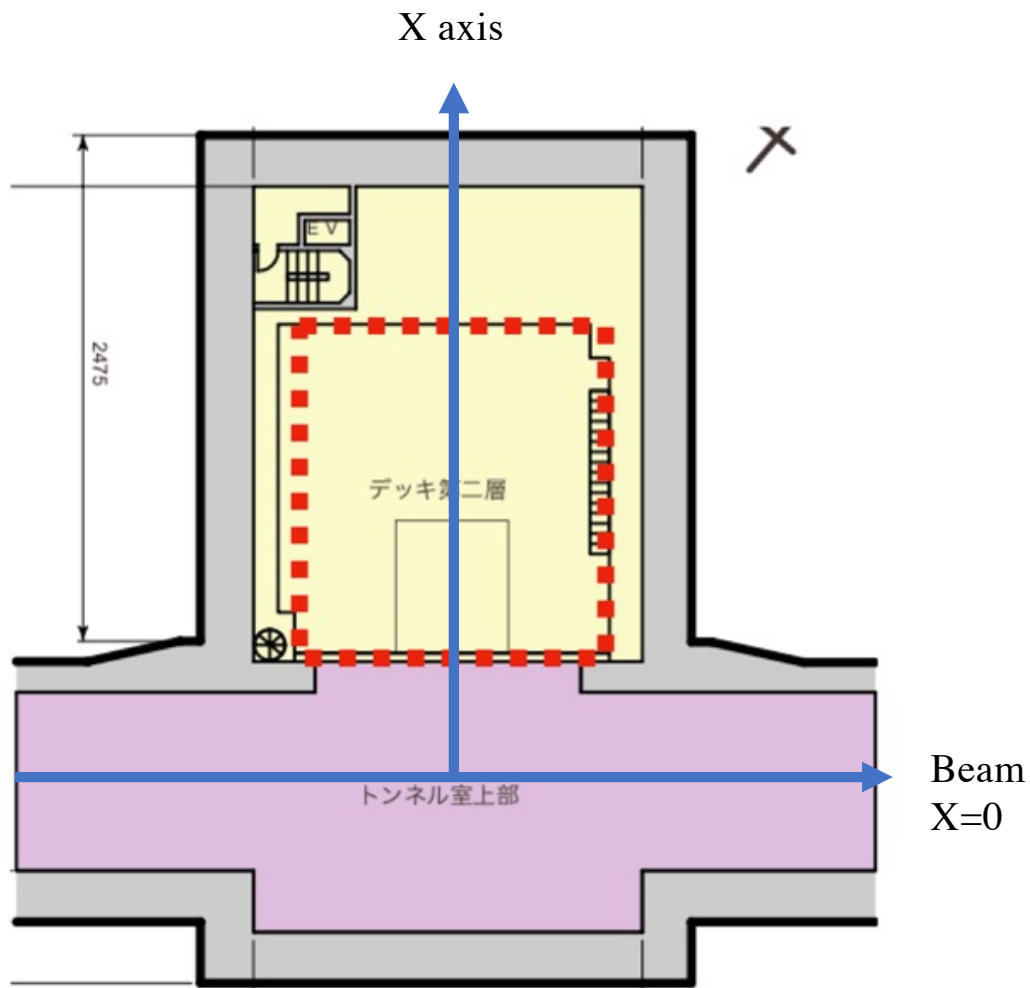




Assumption of Simulation

Hit 10^{10} positron / s hits the collimator head

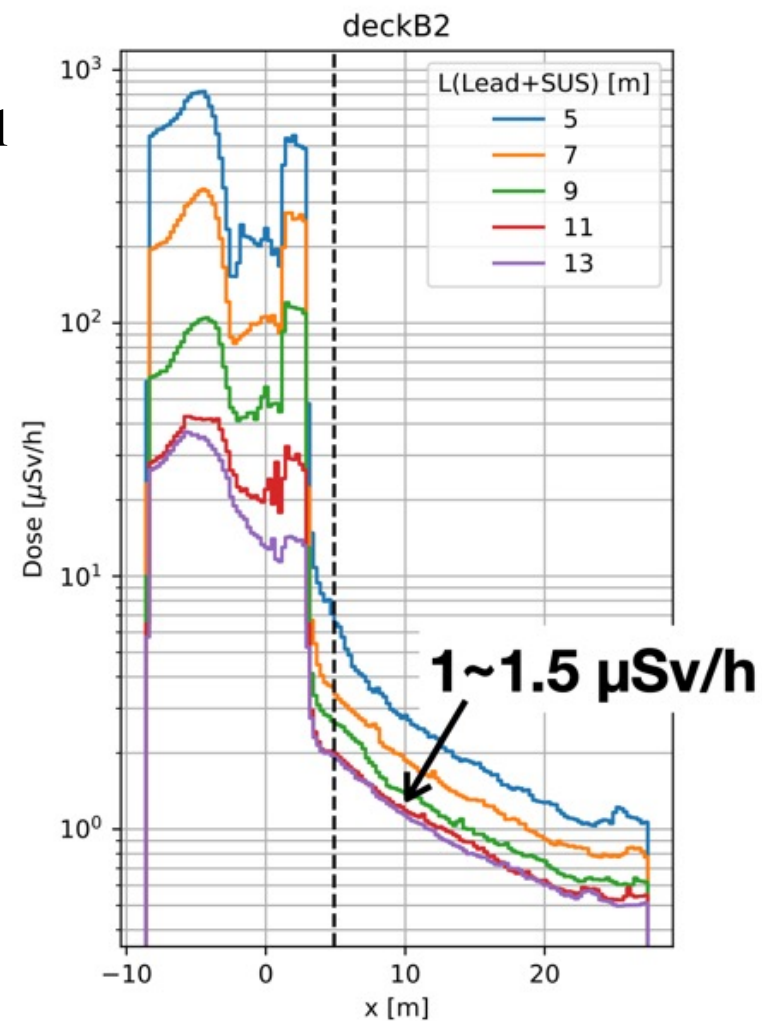
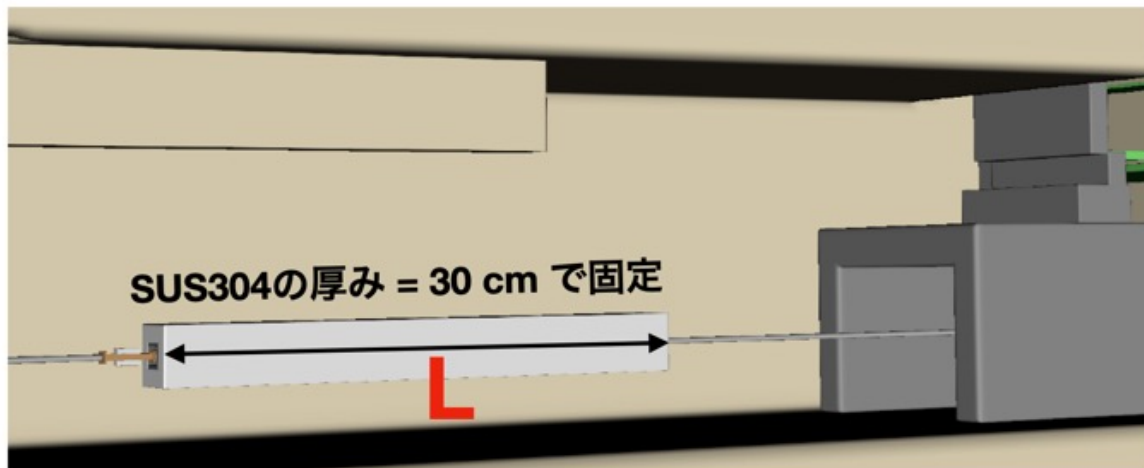


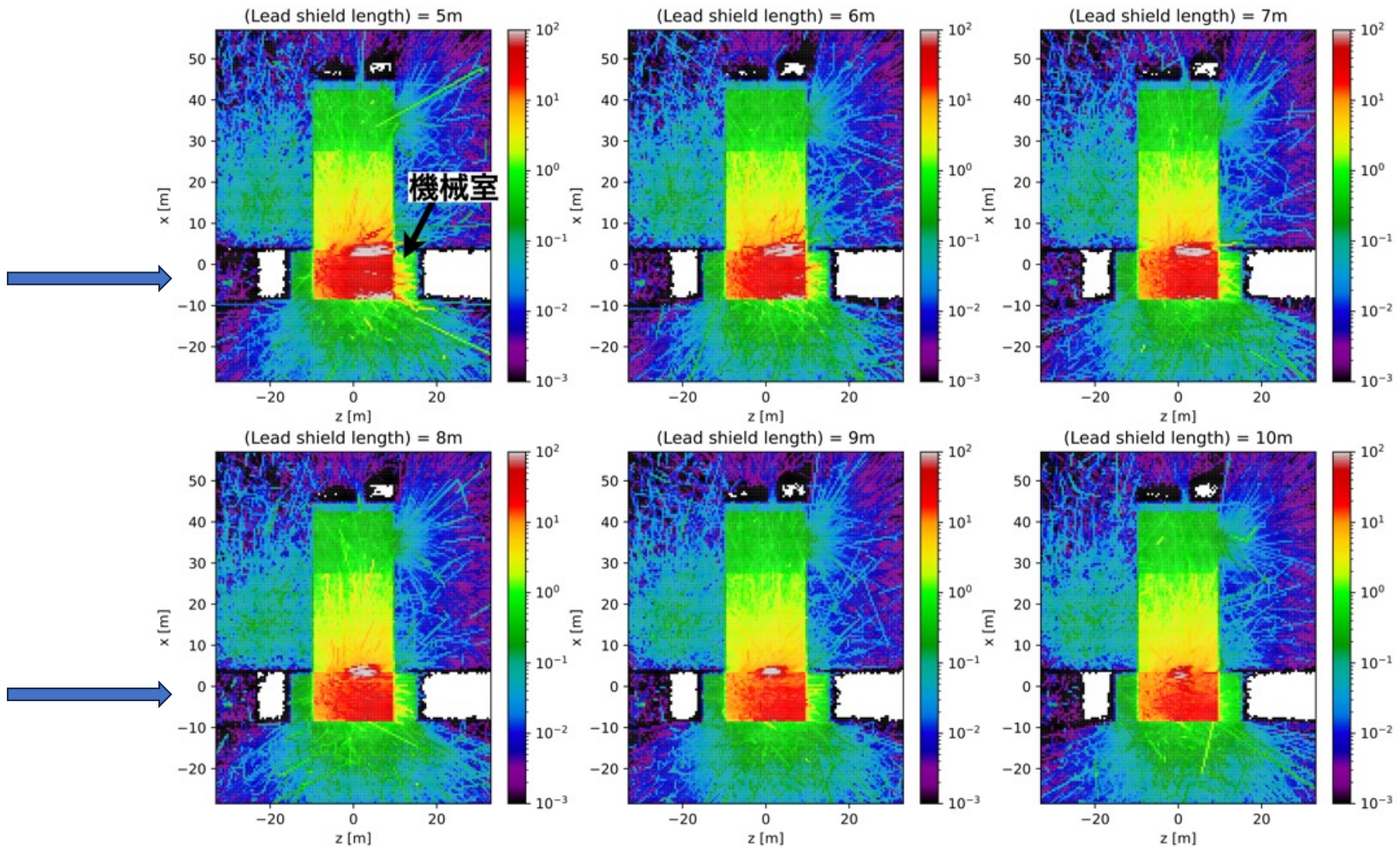


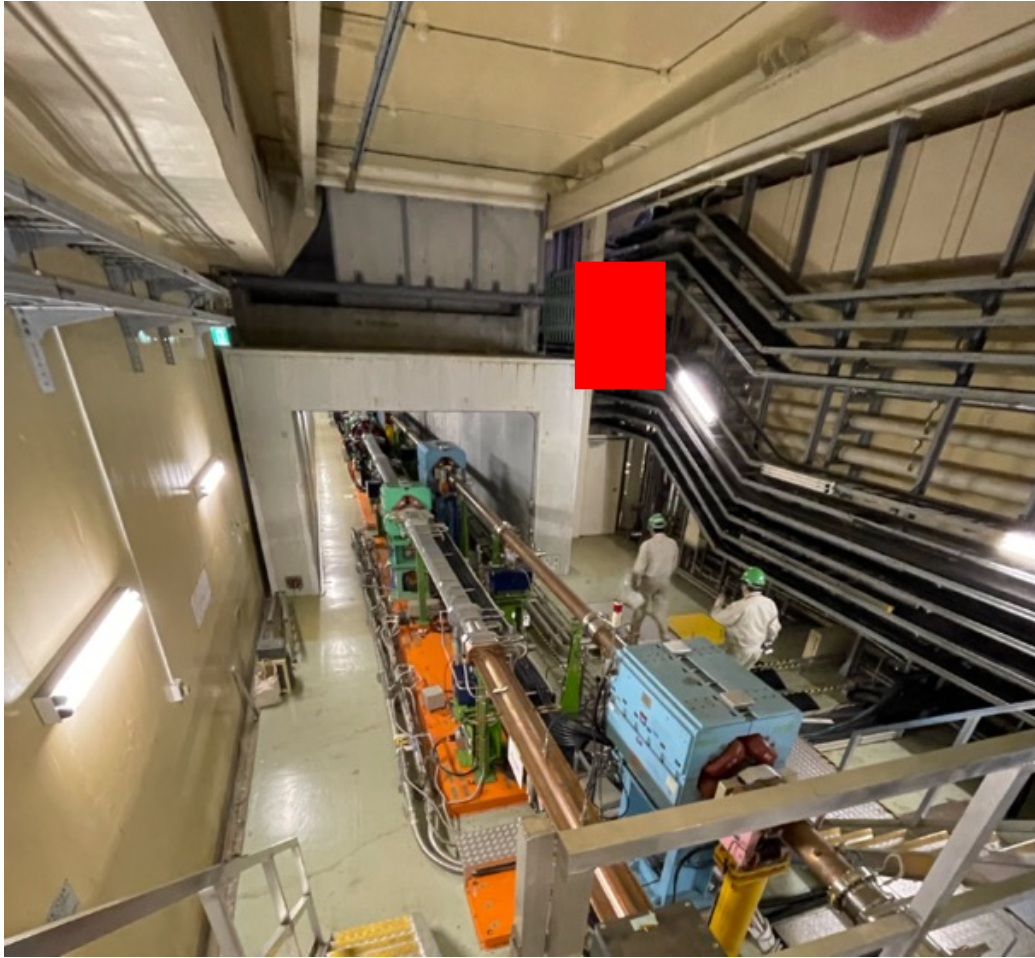
Surround the beam pipe with 5cm of lead 5m.



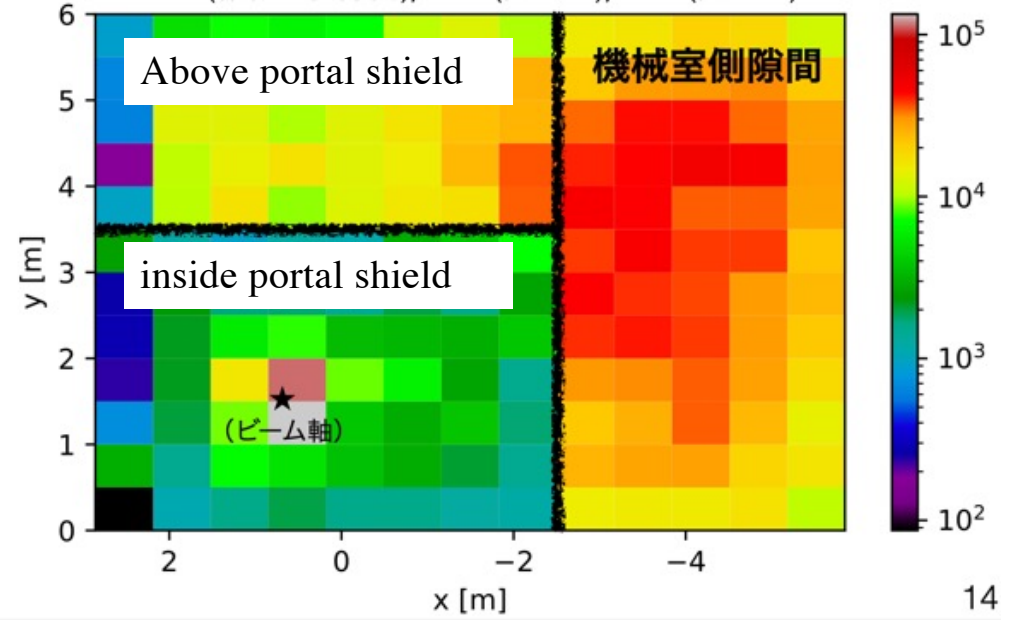
Surround the beam pipe with 5cm of lead + Stainless Steel (or polyethylene) 11-13m.

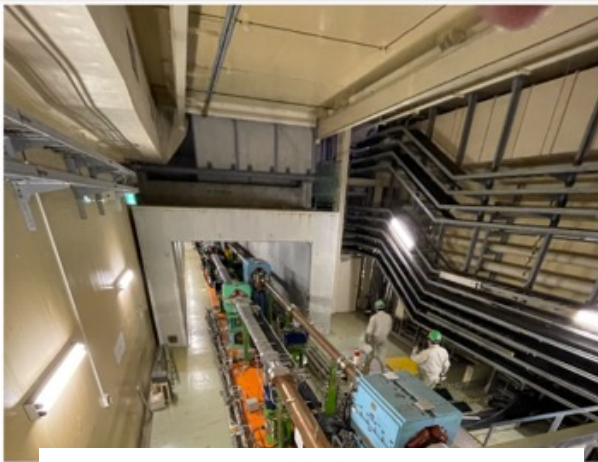




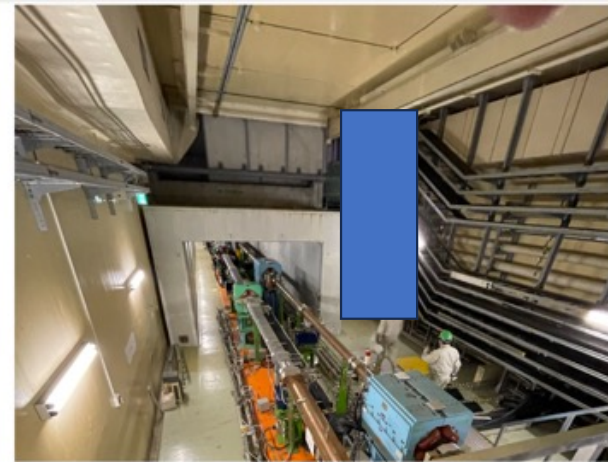
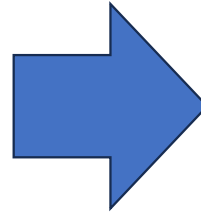


デッキ部到達粒子に起因する粒子が平面を通過した座標とその線量影響度
 66%(機械室側隙間), 15%(門型内), 19%(門型上)

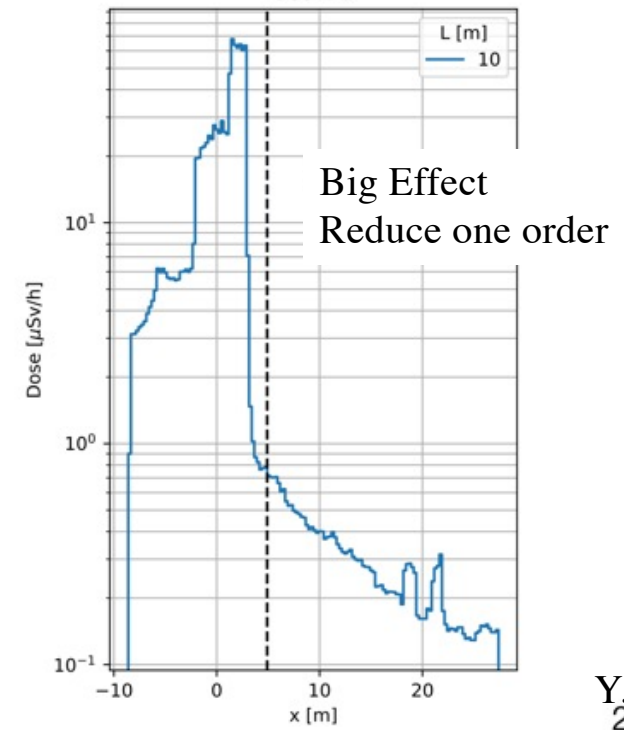
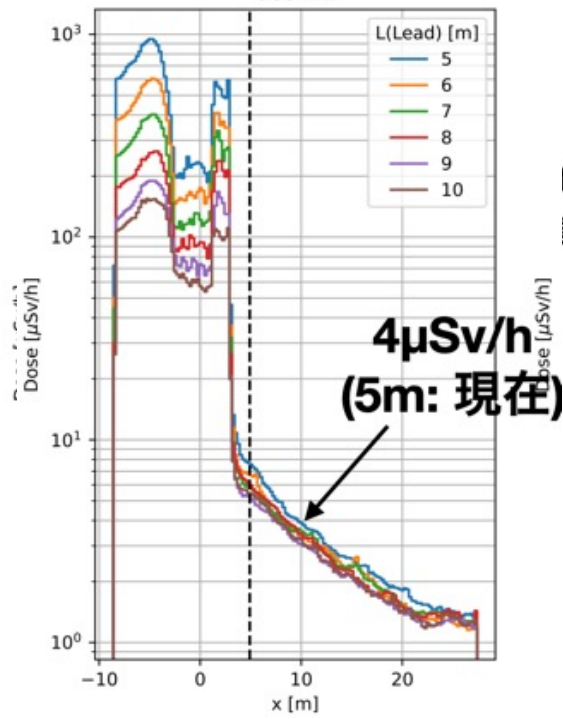


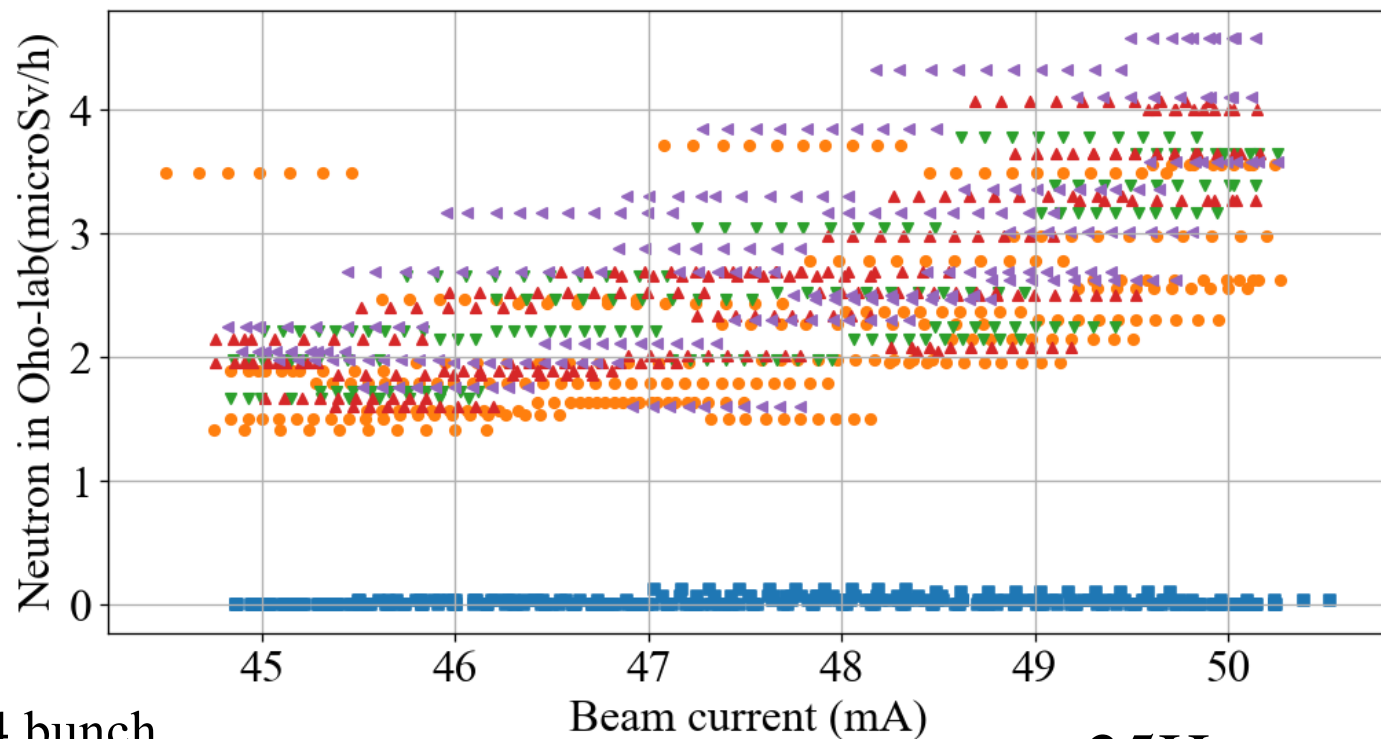


deckB2



deckB2





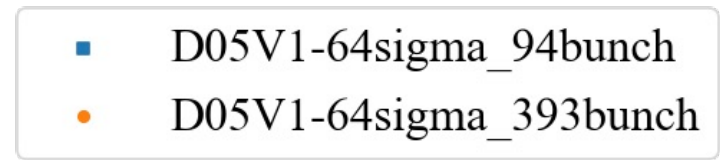
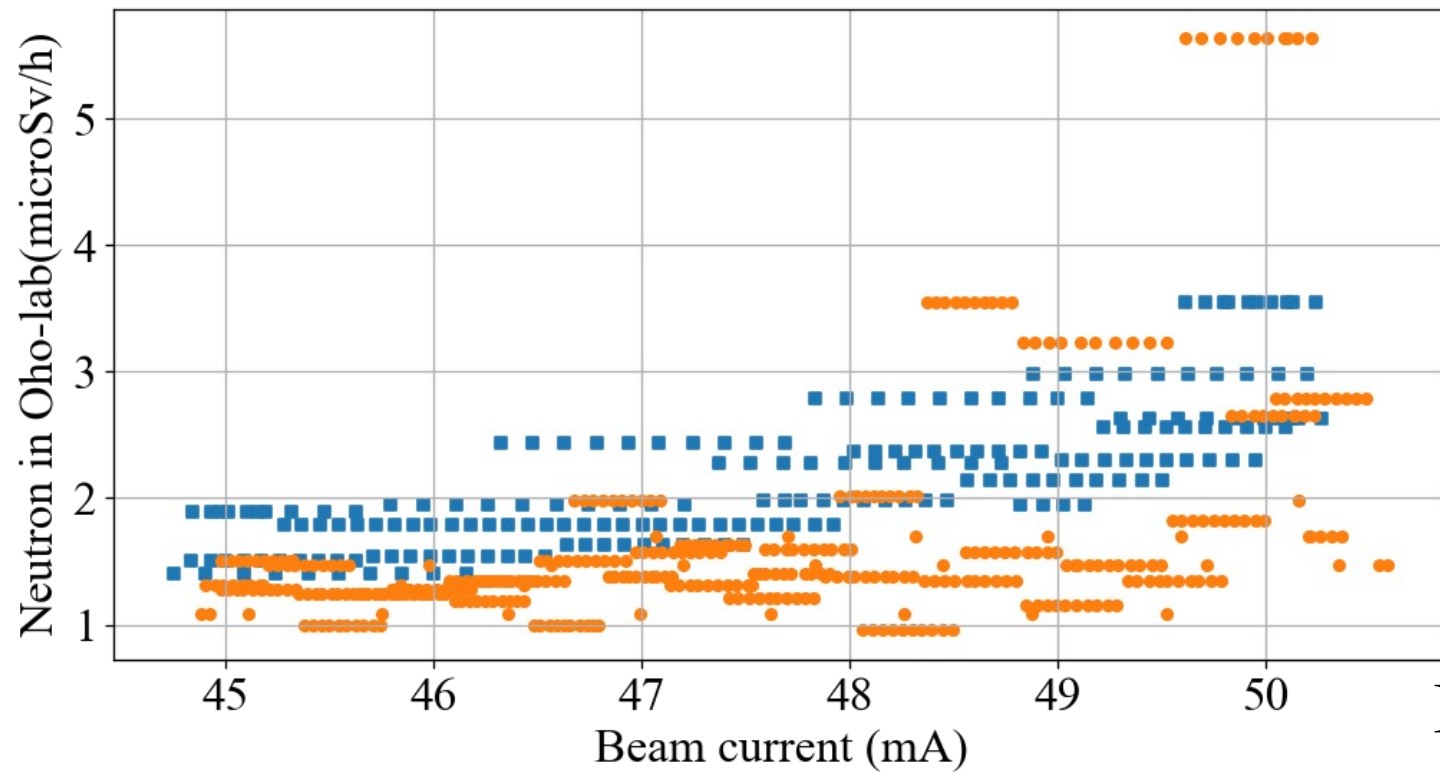
- D06V1-64sigma,Injection
- D05V1-64sigma,Injection
- ▼ D05V1-59sigma,Injection
- ▲ D05V1-57sigma,Injection
- ◄ D05V1-54sigma,Injection

94 bunch
 FC on
 1 Hz
 1 bunch injection



25Hz
 2 Bunch injection
 (x 50 Radiation Level)

S.Terui

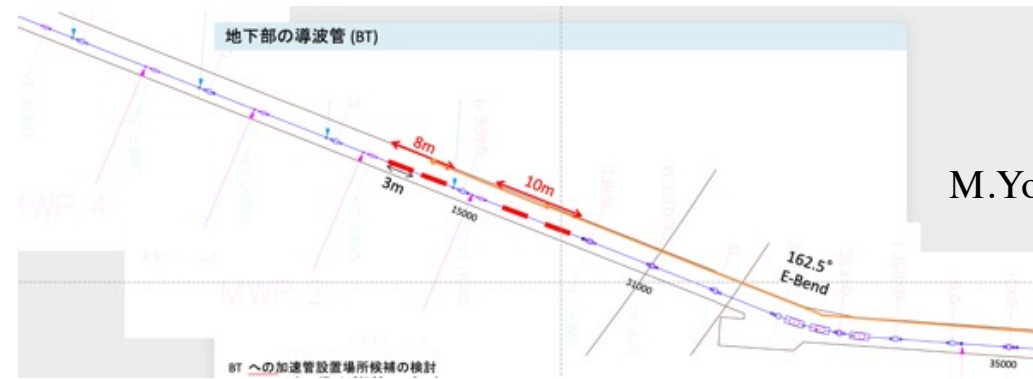


Open D06V1

Beam Current
2.6A

S.Terui

ECS Cavity installation on Beam Transport Line Tunnel

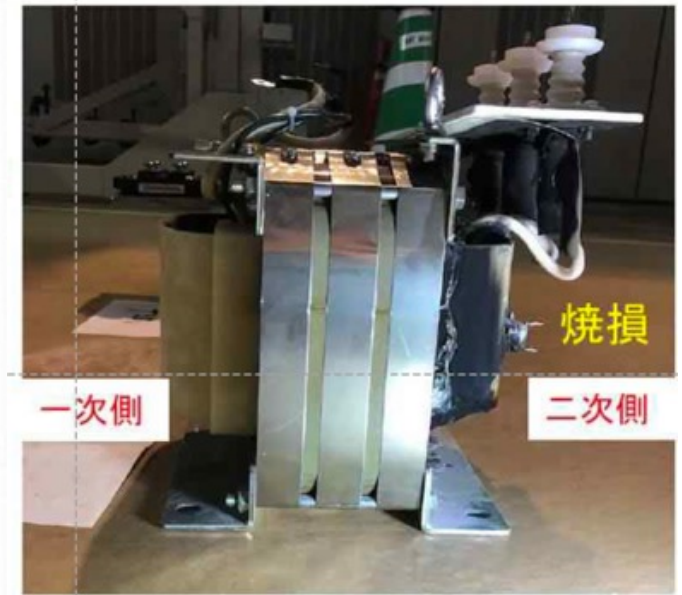


Fire caused by power supply

- MR Power Supply Fire (April 25th):
 - Occurred in a newly developed power supply.
 - Incompatible parts (transformer) in the startup circuit (initial charge).
 - The experience and knowledge that should be shared among J-PARC and KEK accelerator personnel was not sufficiently utilized.
- Hadron Power Supply Fire (June 22nd):
 - The parts have deteriorated due to long-term use (manufactured in 1985).
 - There was a blind spot in the inspection that was neither on the power supply side nor on the load (magnet) side. => Polarity Changer
 - Not enough consideration was given to blind spots in inspection and the possibility of deterioration due to thermal stress due to stable operation over a long period of time.

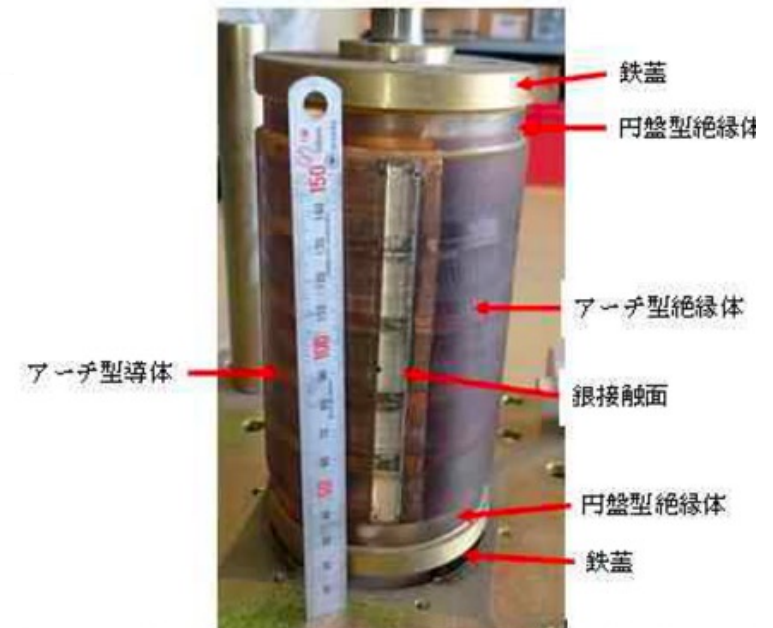
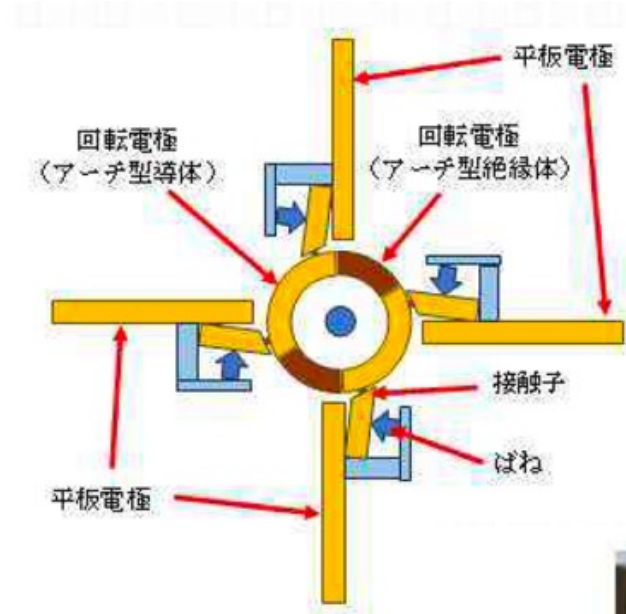
MR Power Supply Fire (April 25th):

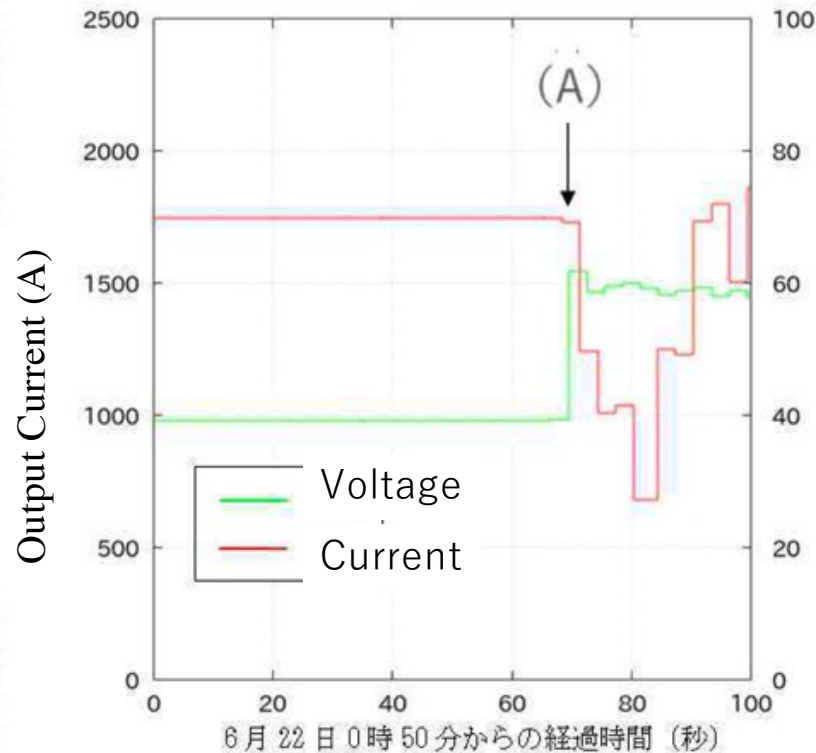
Occurred in transformer of a magnet power supply.



K.Bessho

Polarity Changer





Increased resistance
 Output Current decreased
 Output Voltage increased to Maximum value (60V)

Output Voltage(V)



Contact resistance of Polarity Changer
 $< 0.1\text{m}\Omega \rightarrow 90\text{m}\Omega$
 It caused 100kW power Loss

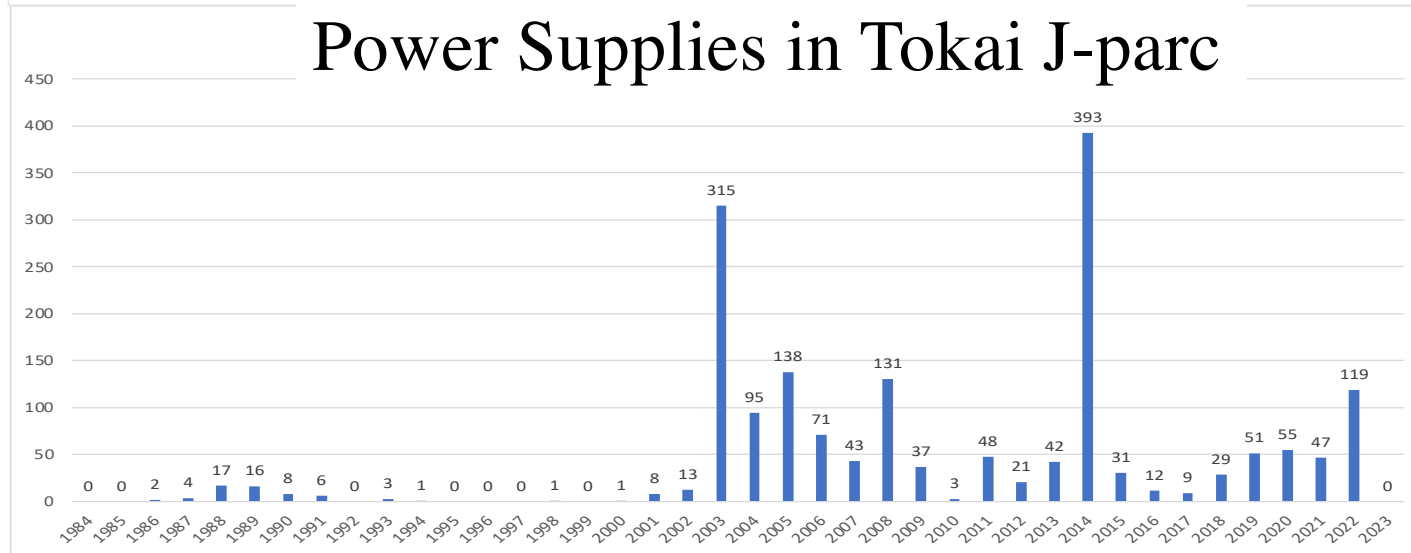
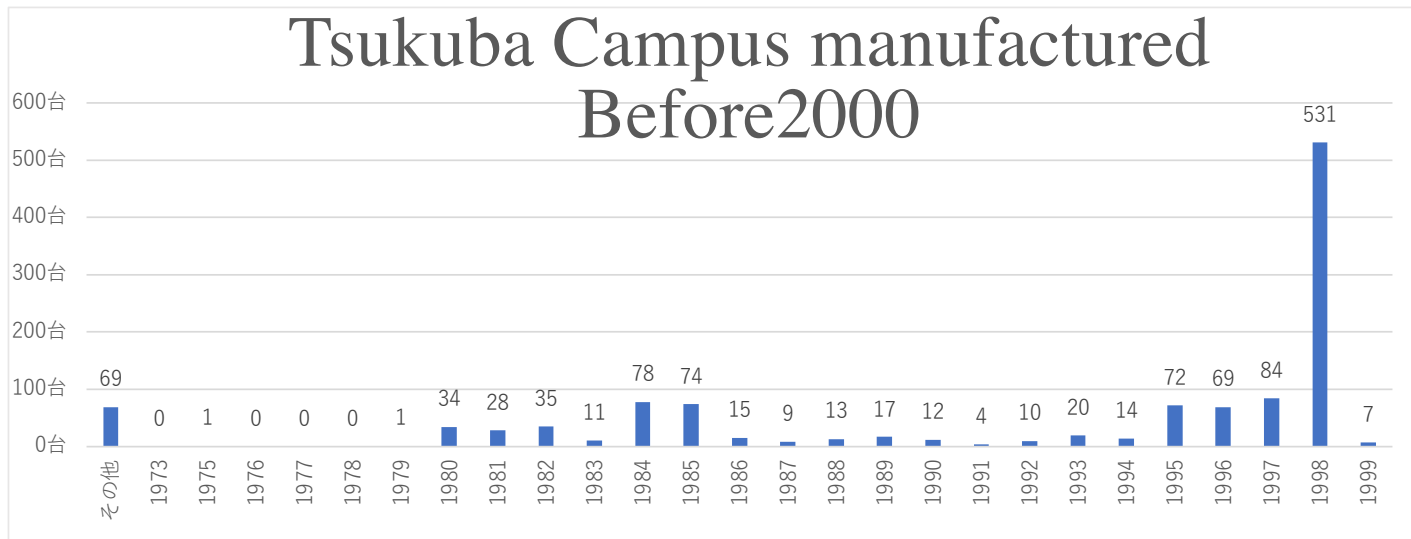
Trouble suddenly Occured
 No signs could be observed

Policy at KEK

- Polarity Changer
 - For power supplies that have the same type of polarizer that caught fire at J-PARC, remove the polarizer or replace it with a more commonly used device.
- Confirm the status of periodic inspections of equipment.
 - Equipment in operation that has not yet been inspected will be inspected immediately and a report will be made to the supervising engineer.
 - Reconfirm that there are no blind spots or deteriorated parts.
 - In areas subject to thermal stress, check for deterioration of components and loosening of bolts.
 - The status of fever will be confirmed using radiation thermometers, thermo-cameras, and pasting of thermo labels.
- When restarting stored old equipment, be sure to conduct a pre-use inspection.

As a continued response in the future

- Power supply equipment related to accelerator operation shall be regularly maintained and inspected by the manufacturer. For power supply units that are approximately 40 years old or older and have not been regularly maintained by the manufacturer, we recommend updating or replacing them so that they are not used for steady, continuous operation.
- Conduct cross-organizational reviews and confirmation work for newly manufactured equipment.
- Consider improving the sophistication of interlocks that operate in the event of a power failure.
- Network cameras will be gradually introduced as they will help detect power failures early and help determine whether or not to enter a room in the event of a fire.



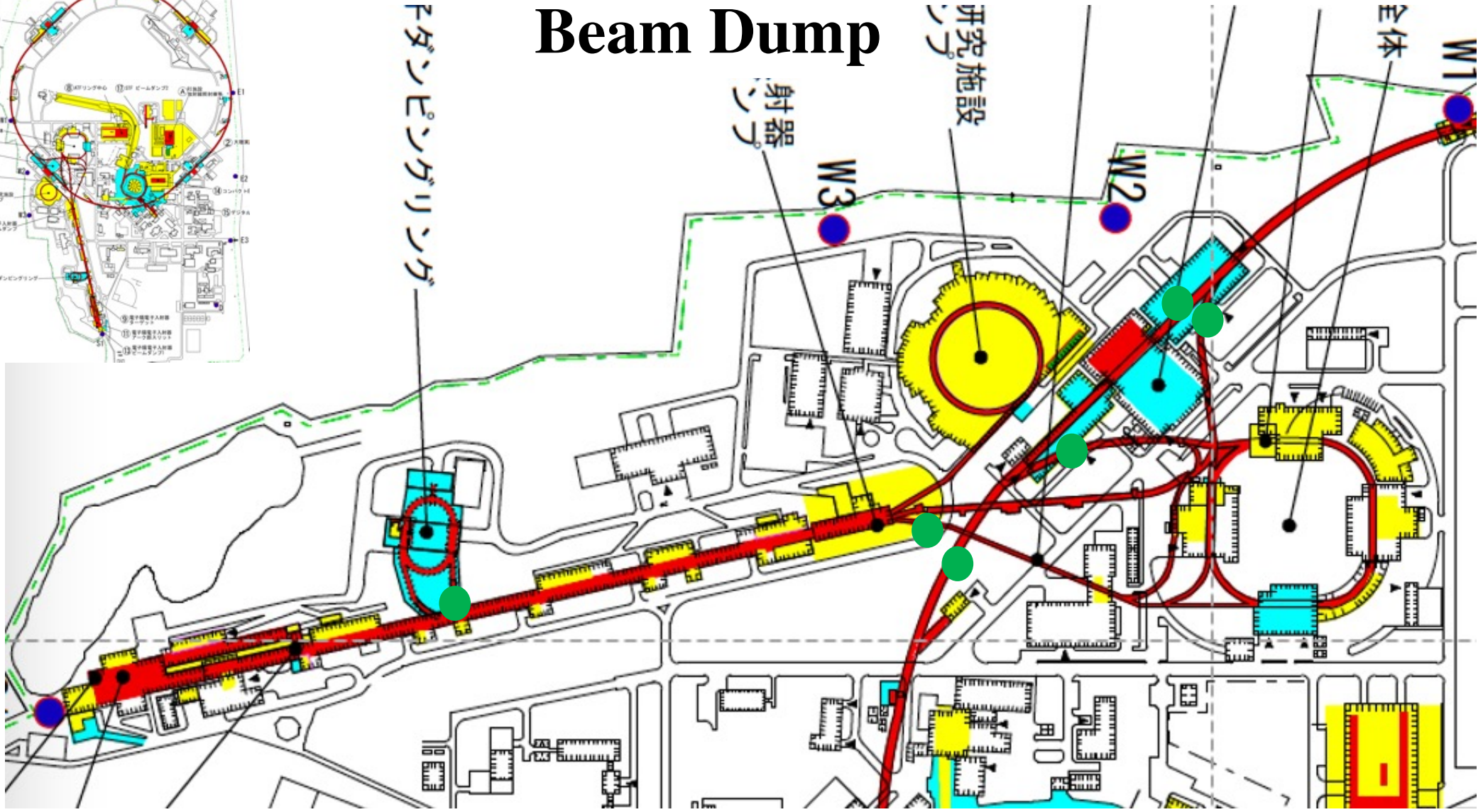
Personnel Protection System modification for tuning of injection beam (Fuji Mode)

- Issues of Injection beam tuning
 - Injection beam tuning with a beam dump inside the injector cannot be performed for the e+ and e- beams at the same time.
 - Requires polarity reversal of the electromagnet at the injector end
 - BT dump mode cannot be used while entering the KEKB main ring.



Personnel Protection System was modified to solve these problems

Beam Dump



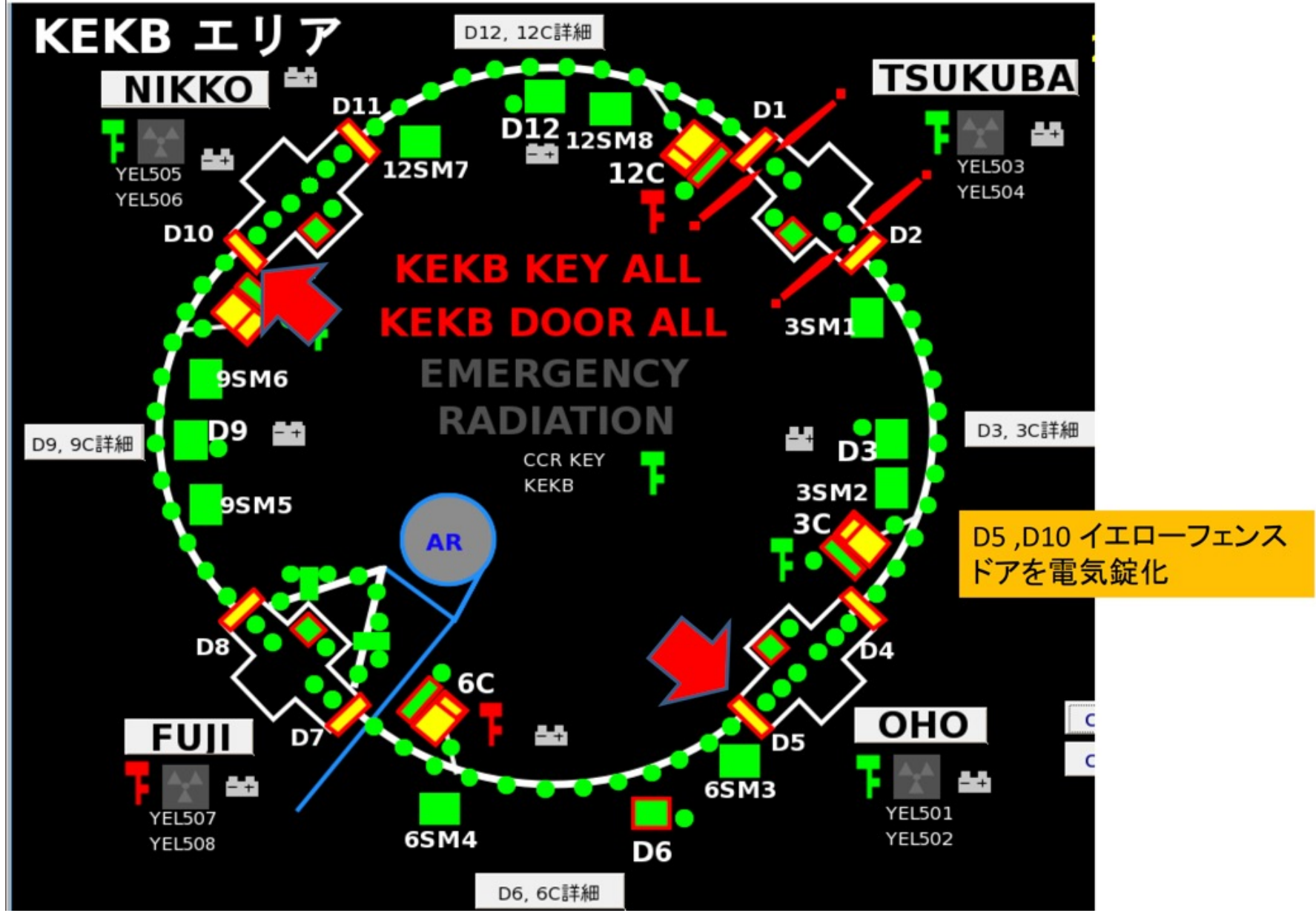
Fuji mode

- The PPS was modified so that even if there are people in the Tsukuba Area, a beam can be transferred all the way to BT End.



- Injection beam tuning is possible even during long-term shutdown of Belle (LS1)
- Even if there is tunnel access for Belle work or work in the accelerator hardware group, the injection beam can be tuned during the day.

KEKB エリア



KEKB KEY ALL
KEKB DOOR ALL
EMERGENCY RADIATION

D5, D10 イエローフェンス
ドアを電気錠化

NIKKO

TSUKUBA

FUJI

OHO

D12, 12C詳細

D9, 9C詳細

D3, 3C詳細

D6, 6C詳細

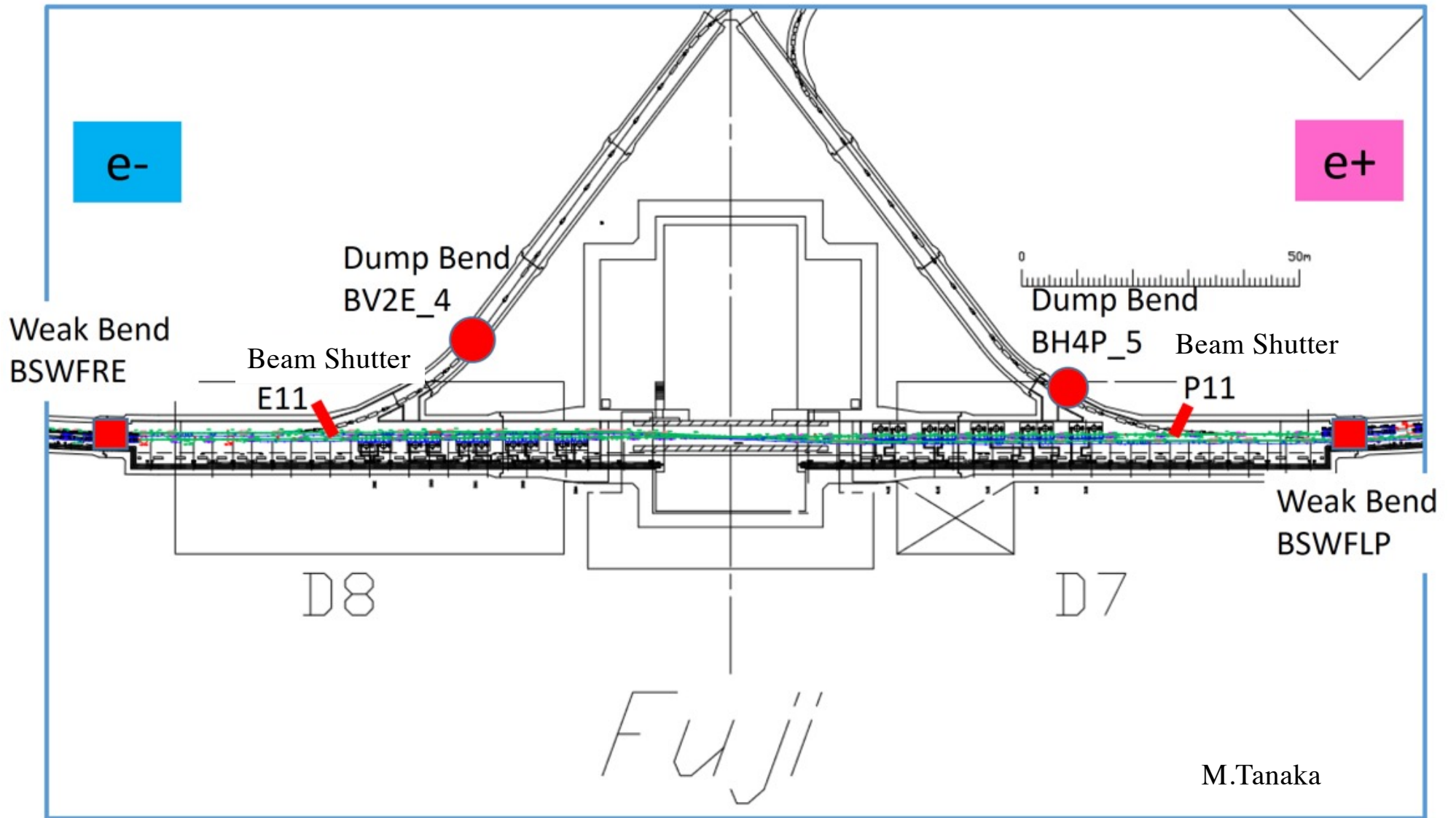
YEL505
YEL506

YEL503
YEL504

YEL507
YEL508

YEL501
YEL502

CCR KEY
KEKB





Fuji Mode Areaの
Personnel Key
(Fuji,6C,9C)

