DEVELOPMENT OF DISASTER PREVENTION APPLICATION FOR ACCELERATOR TUNNEL USING POSITIONING SYSTEM

2019 ITSF meeting @ LUND

Yasuo Kawabata [A)], Hiroaki Matsuda [A)], Kazunobu Matsumoto [A)], Shigeaki Tagashira [B)], **Koji Ishii [C),]** Chihiro Ohmori [C)], Masakazu Yoshioka [D)]

[A)] TOBISHIMA Corp., [B)] Kansai Univ., [C)] KEK/J-PARC Acc., [D)] Tohoku Univ., Iwate Univ.

Joint Research by TOBISHIMA Corp. and KEK/J-PARC Acc.
(Fiscal Year: 2015 – 2018)

1) Motivation of this research
2) Studies
   2-1) Radiation Hardness
   2-2) Application Development
3) Future Plan

2011 EAST JAPAN EARTHQUAKE

You Tube : J-PARC earthquake

Escape Building !!

Working Place

2011.Mar.11
Earthquake disaster while working inside the MR tunnel
⇒ **Evacuated from the C1 entrance**

0 50 100 (m)

~ 400 m

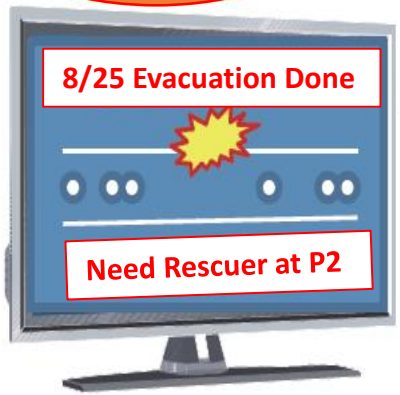
C1 Entrance

Future Accelerator Tunnel (ILC: ~ 20 km)

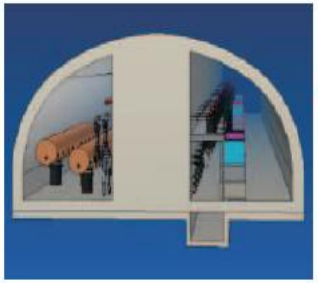
System Image

Monitoring Room

Network ?



- Confirm evacuation situation in real time
- Visibility the rescue target



Worker's Terminal

- Real time information of the accident
- Instruction of evacuation

Technology Choice

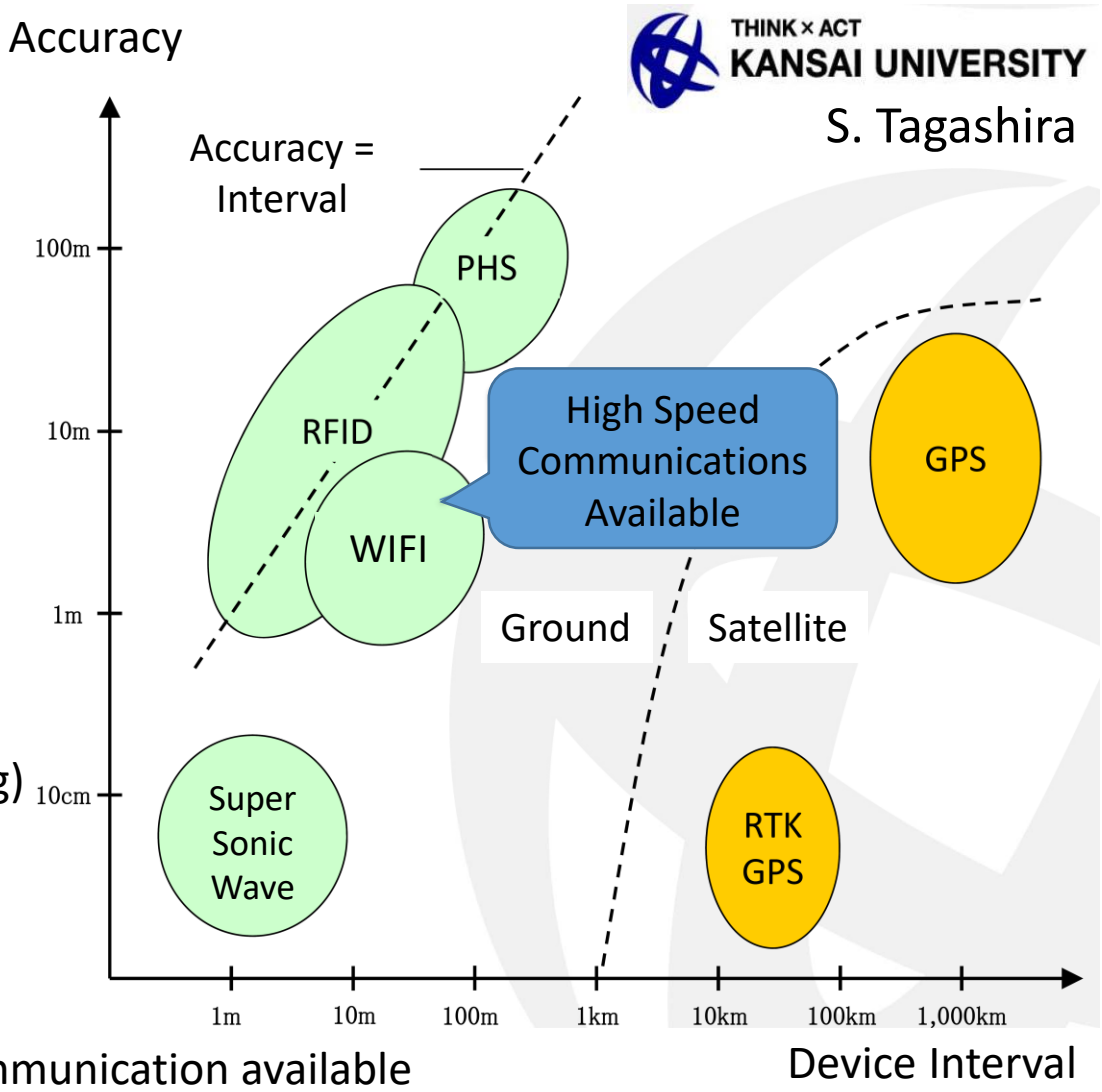
THINK × ACT
KANSAI UNIVERSITY

S. Tagashira

Recent Indoor Positioning System

- Wifi
  a few m accuracy
- BLE (Bluetooth Low Energy)
  ~ 1 m accuracy
- UWB (Ultra Wide Band)
  less than 1 m accuracy
- PDR (Pedestrian Dead Reckoning)
  ~ 1 m accuracy

…

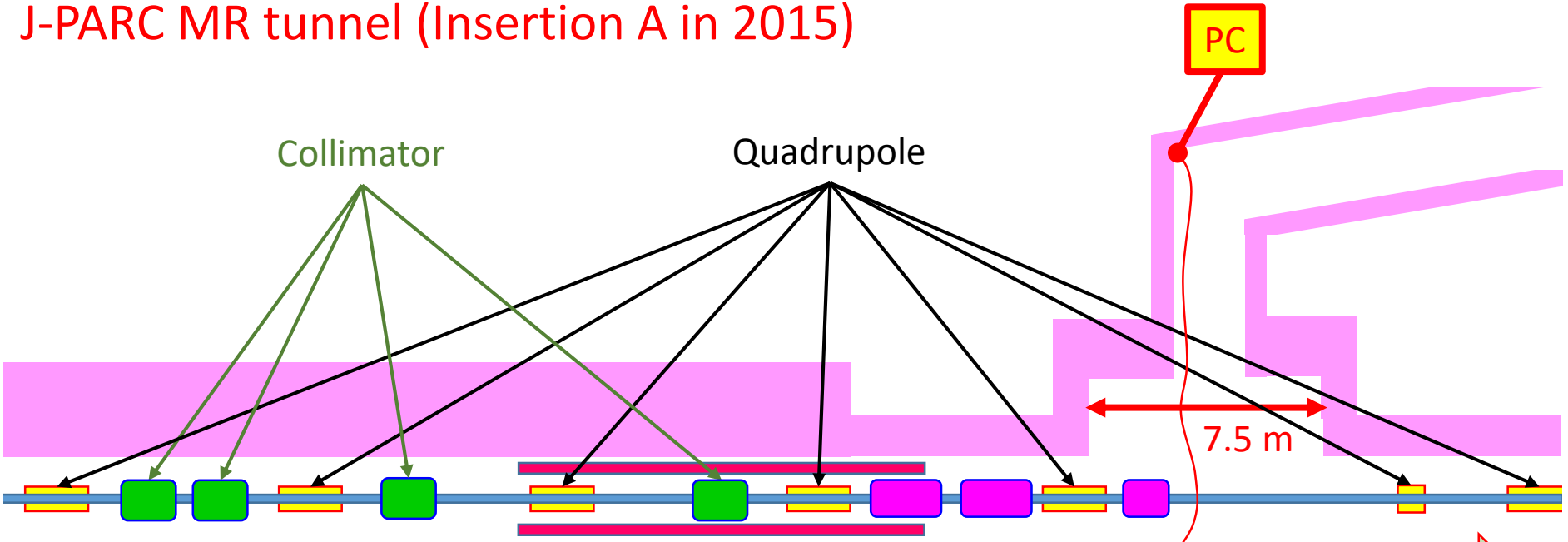


⇒ We choose the Wifi having communication available

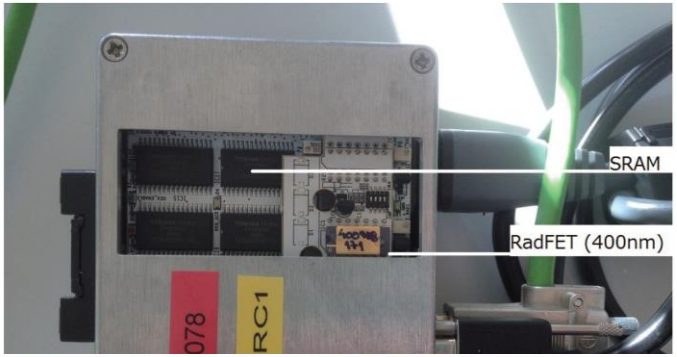
In the J-PARC there is an issue of the radiation
（Even if at the ILC we need to investigate radiation hardness of the system ）

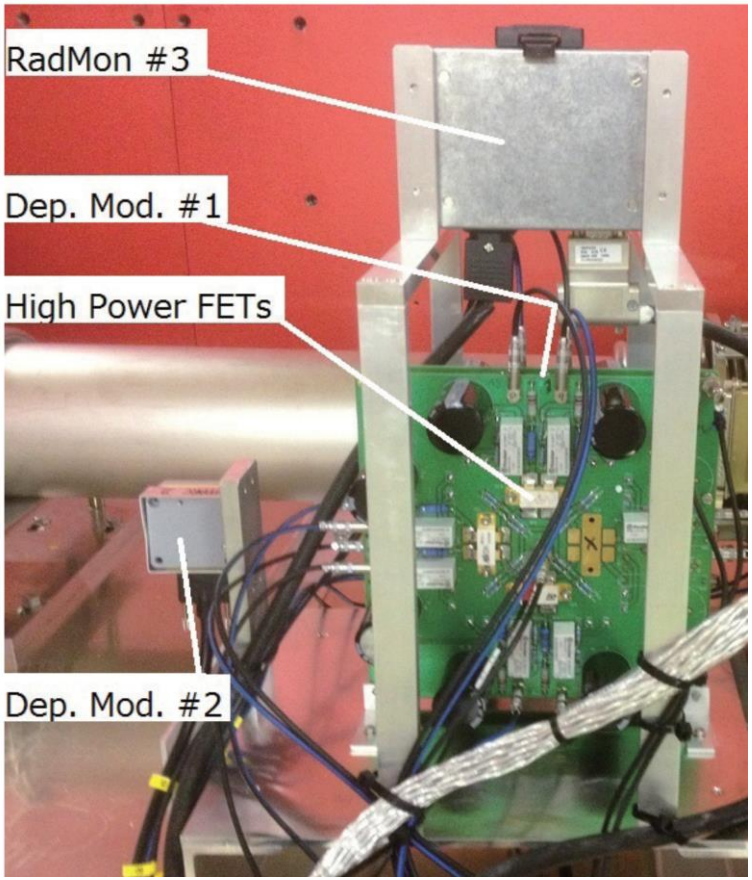
Study of the radiation hardness

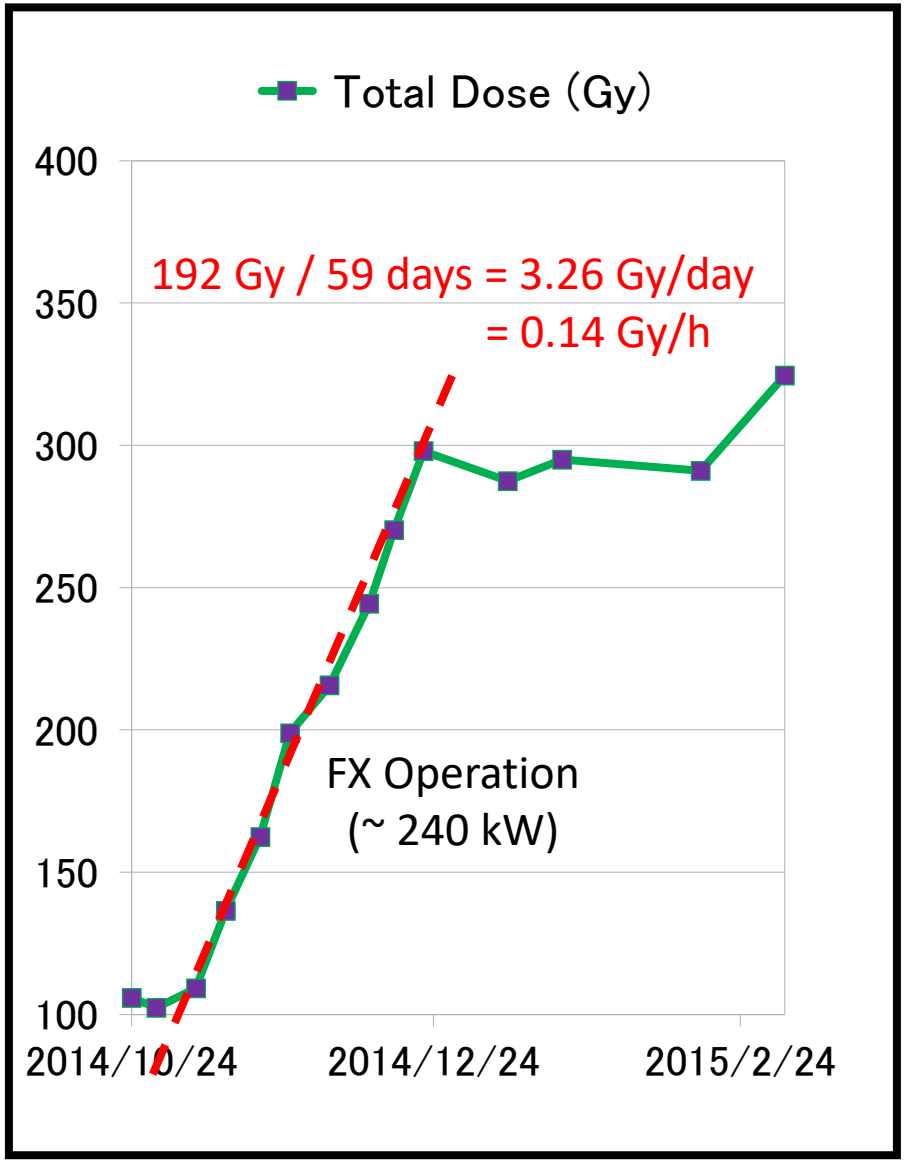
J-PARC MR tunnel (Insertion A in 2015)



Radiation Monitor (provided by CERN)





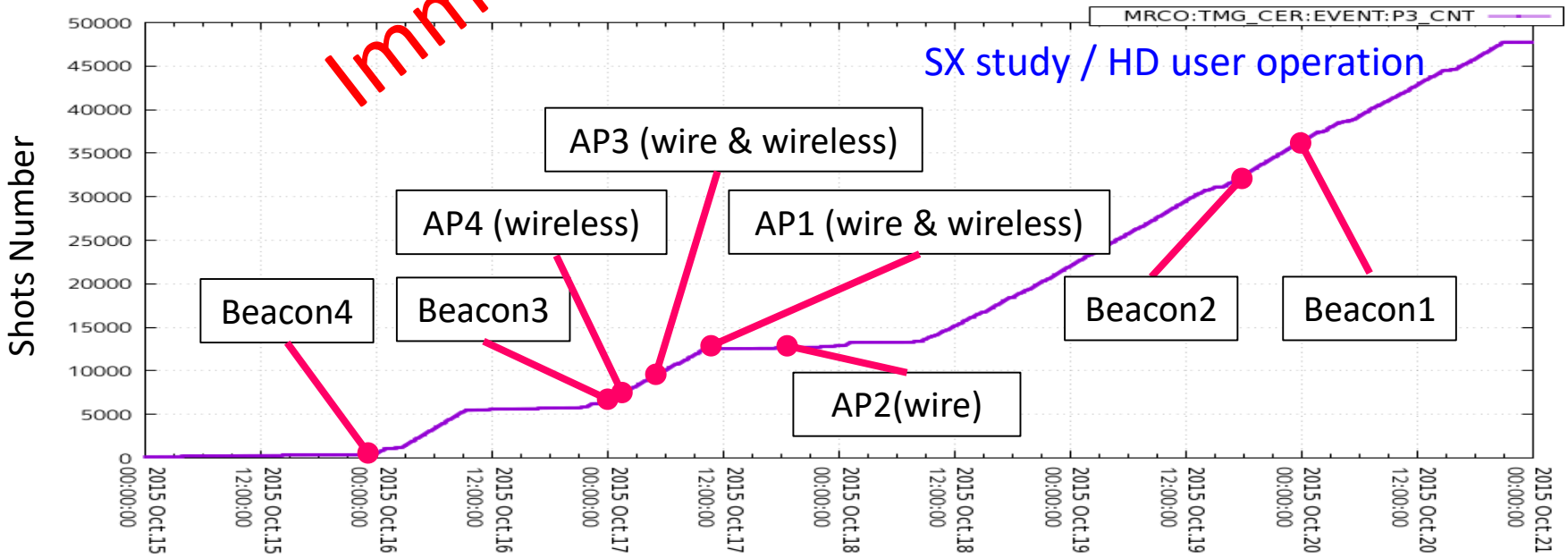


2015.October Irradiation test @ MR tunnel

less than 0.1 Gy

Broken Date/Time	Device	Total number of shots
2015/10/15 22:28	Beacon4	~ 0.5k shots (HD supply)
2015/10/17 0:54	Beacon3	~ 7k shots (HD supply)
2015/10/17 1:55	AP4 (wireless)	~ 8k shots (HD supply)
2015/10/17 5:33	AP3 (wire & wireless)	~ 10k shots (HD supply)
2015/10/17 9:04	AP1 (wire & wireless)	~ 12k shots (HD supply)
2015/10/17 19:53	AP2 (wire) & AP4 (wire)	~ 12k shots (SX study)
2015/10/19 18:05	Beacon2	~ 29k shots (HD supply)
2015/10/20 0:44	Beacon1	~ 32k shots (HD supply)

Immediately BROKEN



2016.February γ-ray irradiation test @ ATOX

ATOX Co. Ltd. Irradiation Facility @ KASHIWA

When γ-ray irradiation is up to the total 1kGy all APs were broken.

If during the irradiation AP's power was off, AP can work up to the excess 1kGy.

1) 1.0 Gy/h 9:17 start 10:17 stop
2) 10 Gy/h 10:36 start 11:36 stop
3) 100 Gy/h 11:54 start 12:54 stop

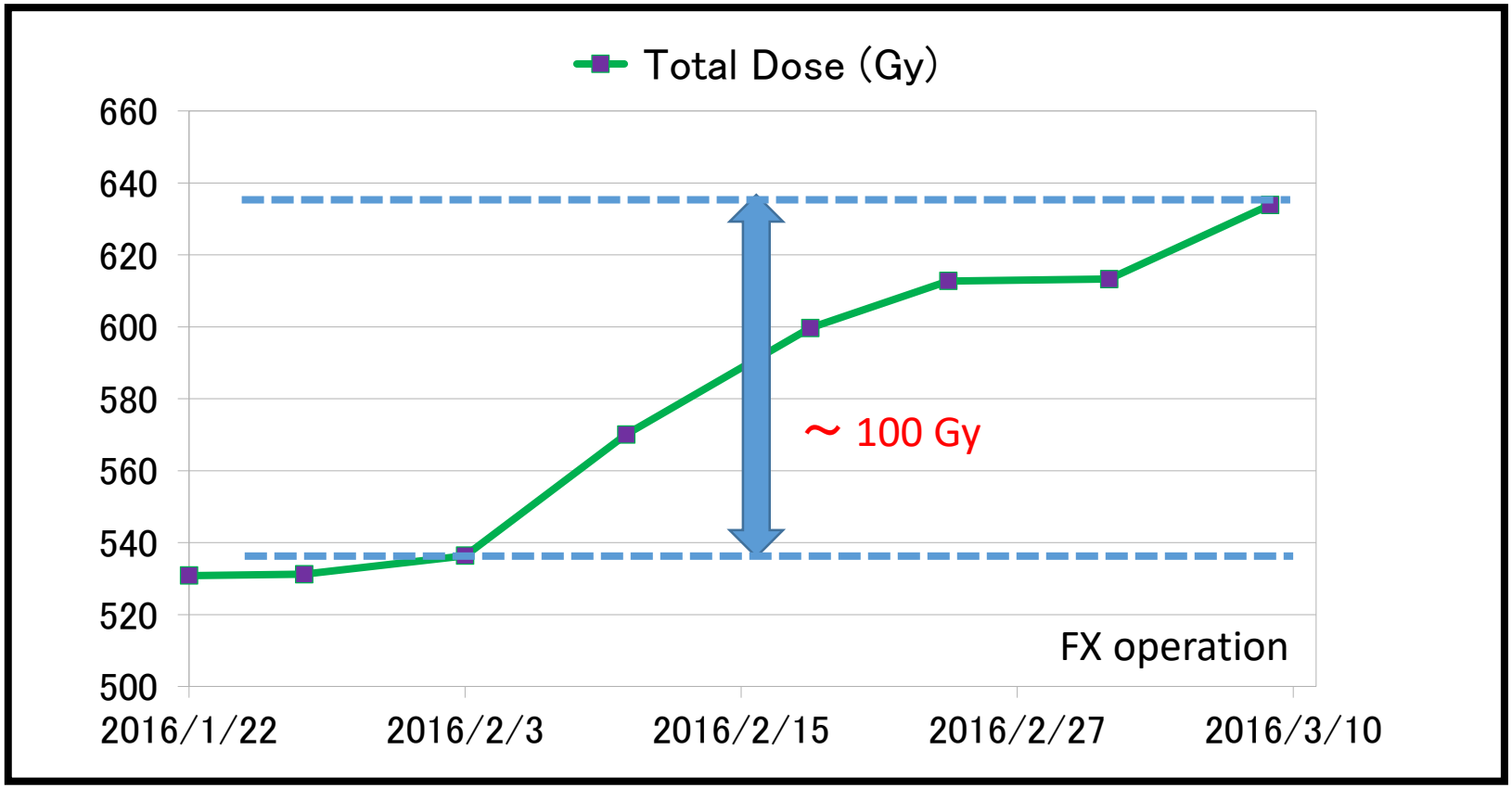
No.	Status	MAC	Power	WiFi	Wired
①	ON	7F18	○	○	○
②	ON	0800	○	○	○
③	ON	84F0	○	○	○
④	OFF	EE70	○	○	○
⑤	OFF	9848	○	○	○
⑥	OFF	9560	○	○	○

4) 1000 Gy/h 13:14 start 14:14 stop

No.	Status	MAC	Power	WiFi	Wired
①	ON	7F18	×	×	×
②	ON	0800	×	×	×
③	ON	84F0	×	×	×
④	OFF	EE70	○	○	○
⑤	OFF	9848	○	○	○
⑥	OFF	9560	○	○	○

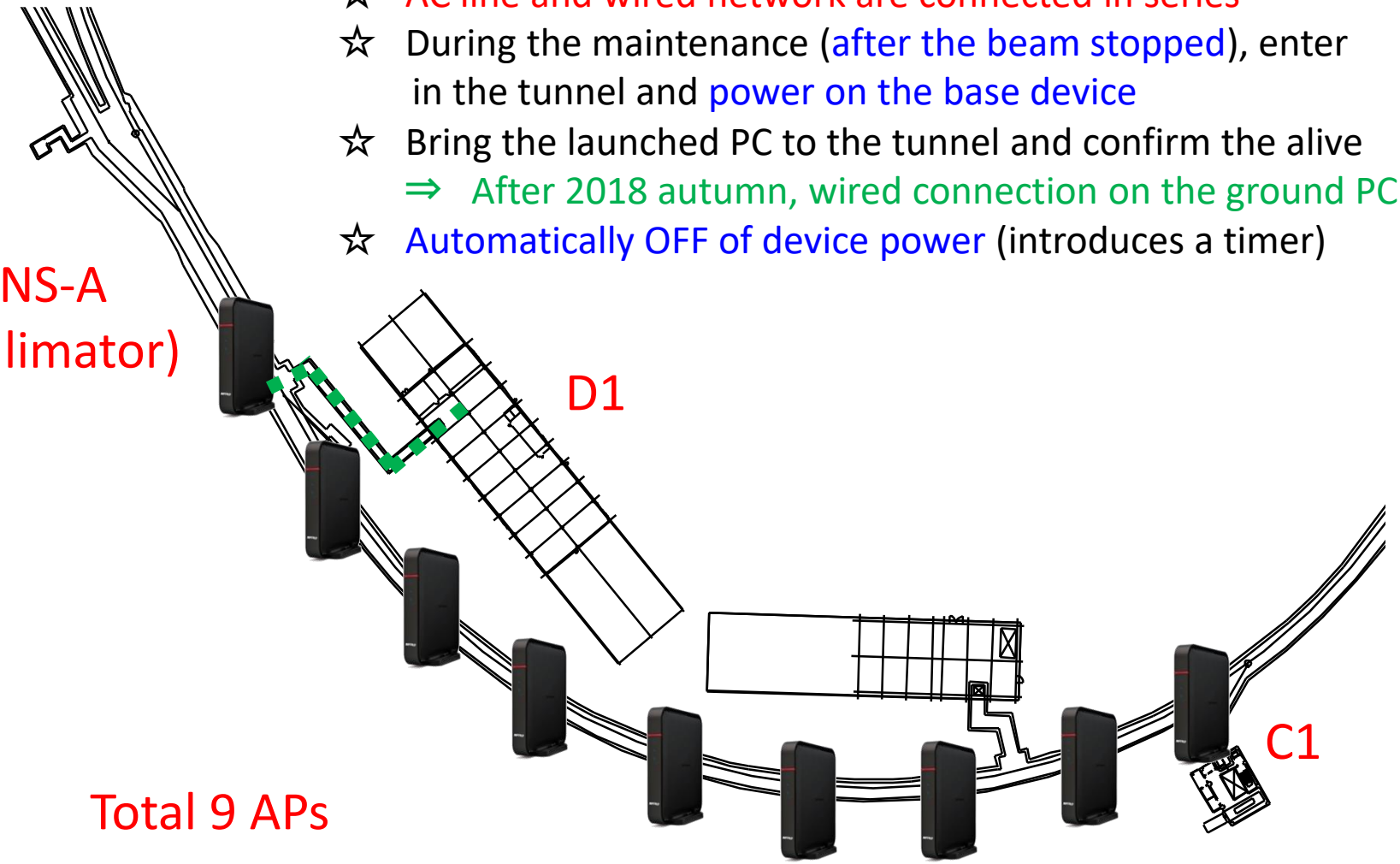
2016.February Irradiation test @ MR tunnel

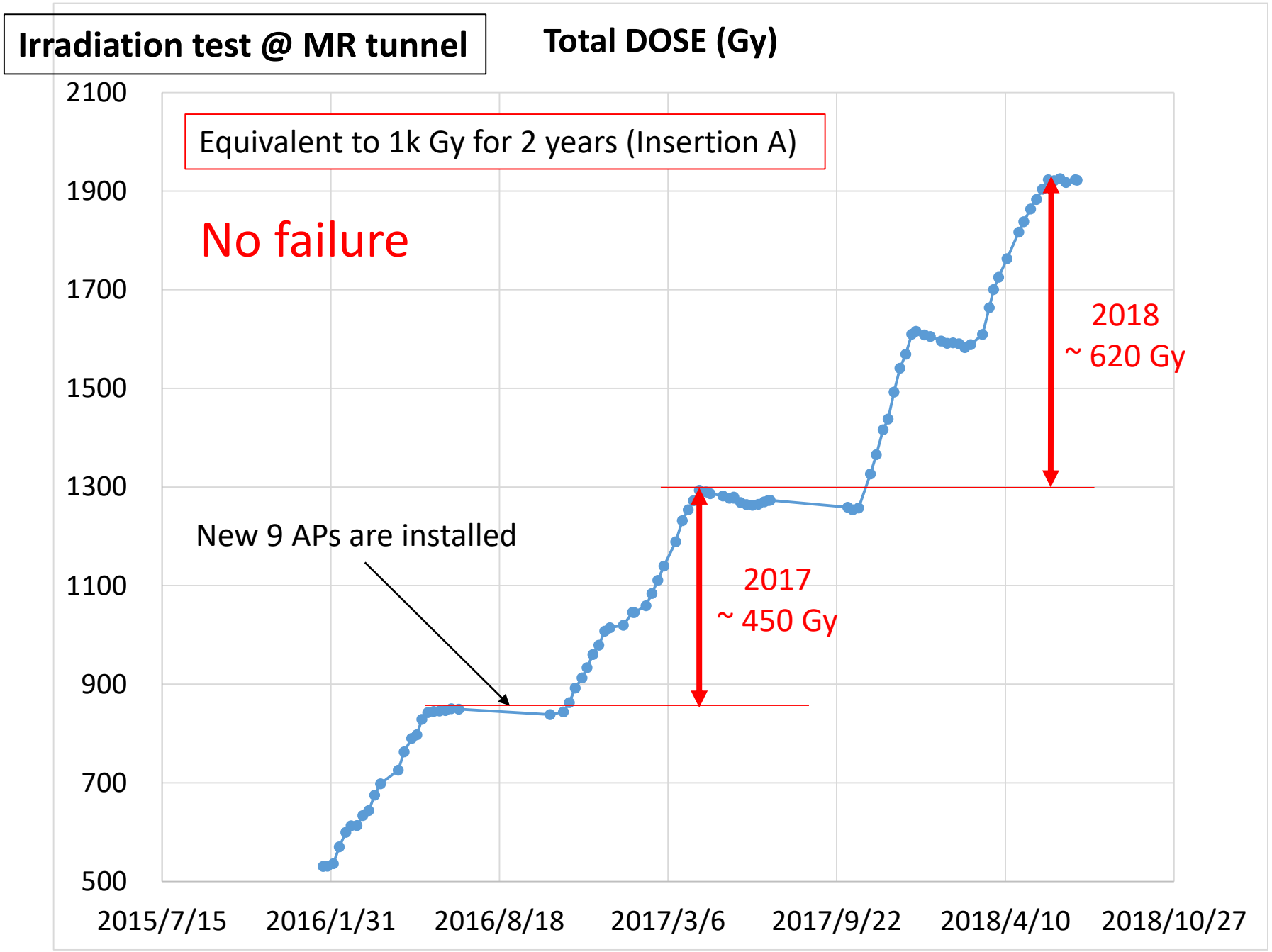
		Power OFF				Far Installed by antenna extension	
		GF04B		GF156		WAPS-AG300H	
		Wired	WiFi	Wired	WiFi	Wired	WiFi
Setup	2016/1/14						
Check	2016/2/3	○	○	○	○	○	○
Check	2016/3/9	○	○	○	○	○	○



2016 Summer ~ 2019 Summer Irradiation test @ MR tunnel

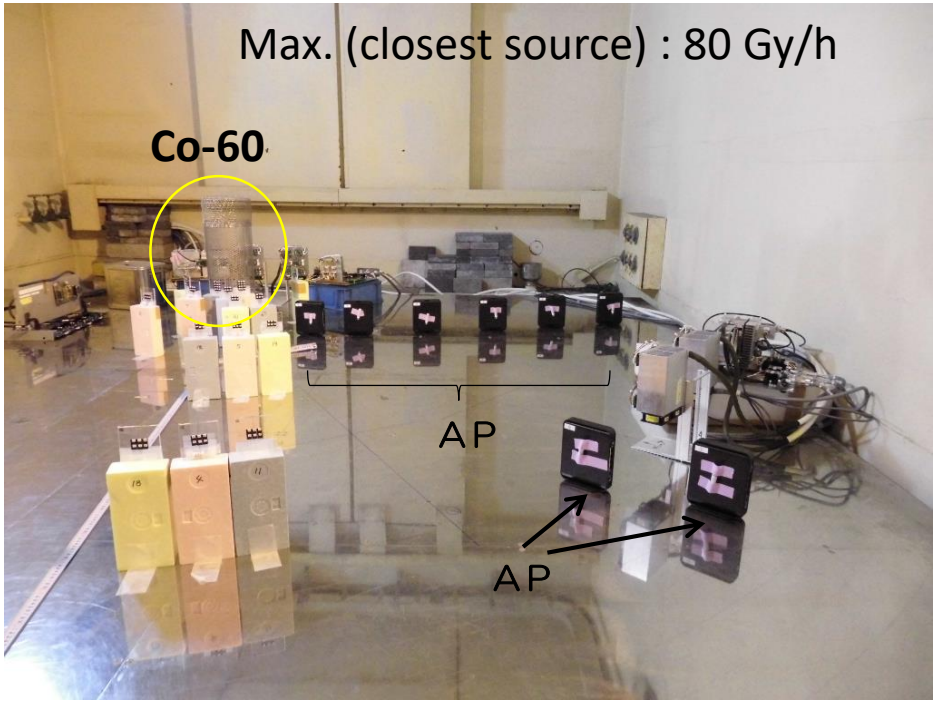
- ☆ Every 50 m from C1 to INS-A a total of 9 APs is installed
- ☆ AC line and wired network are connected in series
- ☆ During the maintenance (after the beam stopped), enter in the tunnel and power on the base device
- ☆ Bring the launched PC to the tunnel and confirm the alive
  - ⇒ After 2018 autumn, wired connection on the ground PC
- ☆ Automatically OFF of device power (introduces a timer)




Irradiation test @ MR tunnel
Total DOSE (Gy)
Equivalent to 1k Gy for 2 years (Insertion A)
No failure
New 9 APs are installed
2017
~ 450 Gy
2018
~ 620 Gy
2100
1900
1700
1500
1300
1100
900
700
500
2015/7/15
2016/1/31
2016/8/18
2017/3/6
2017/9/22
2018/4/10
2018/10/27

2017.June γ-ray irradiation test @ QST

National Institutes for Quantum and Radiological Science and Technology



Experimental result
(Irradiation time /165 hours)

Dose Rate (Gy/h)	Total Dose (Gy)	Power	Wireless (Wifi)	Wired
1.5	247.5	○	○	○
3	495	○	○	○
4.5	742.5	○	○	○
6	990	○	○	○
9	1485	○	○	○
12	1980	○	○	○
18	2970	○	×	×
30	4950	×	×	×

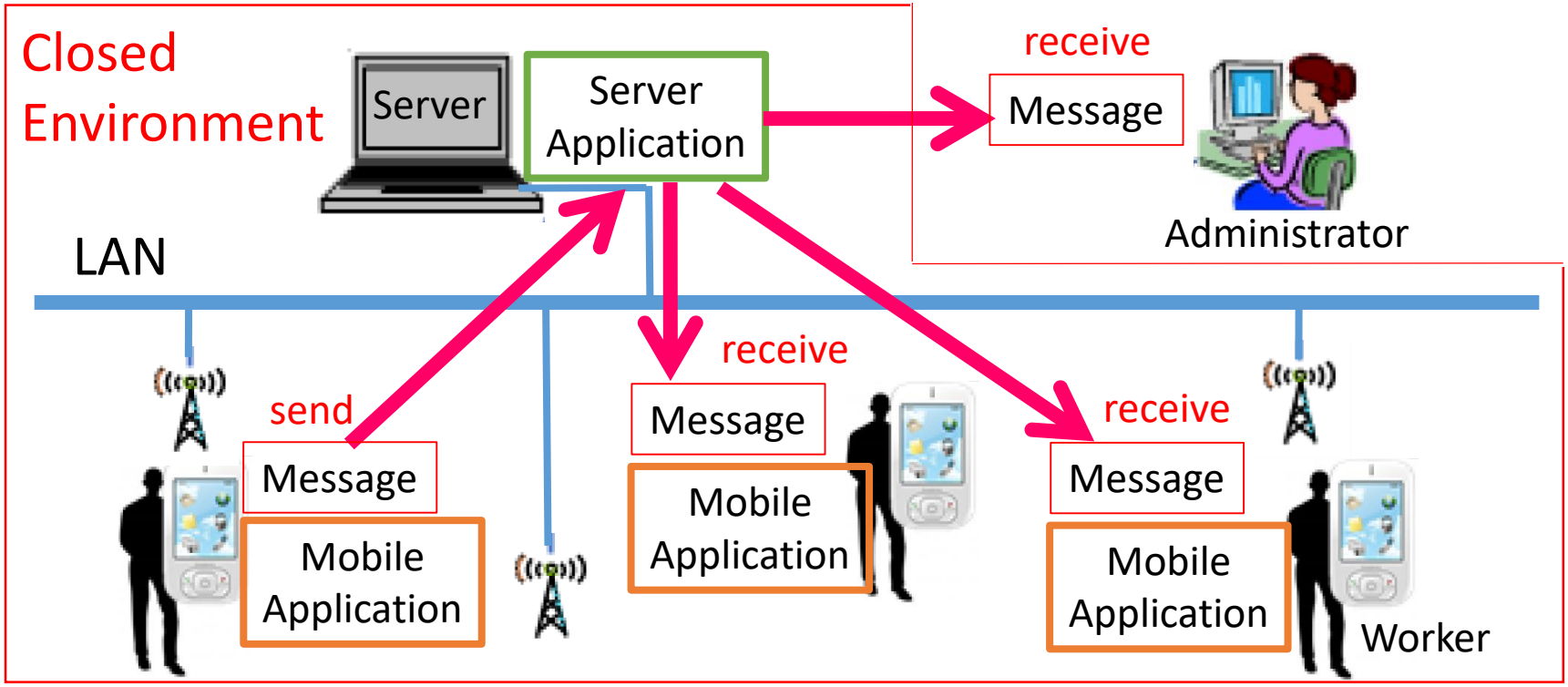
In the environment of total γ-ray irradiation dose is under 2k Gy or less, if power of device is OFF state, it will not be broken even with a commercial one. (ILC: less than 1 mGy/h = million hours are OK)

Development of the prevention application

➢PRTEVENTION Application

Server App. : On the server in closed network, processing requests from the mobile

Mobile App. : On the mobile (smartphone), sending / receiving messages with the server, management of worker position and activities



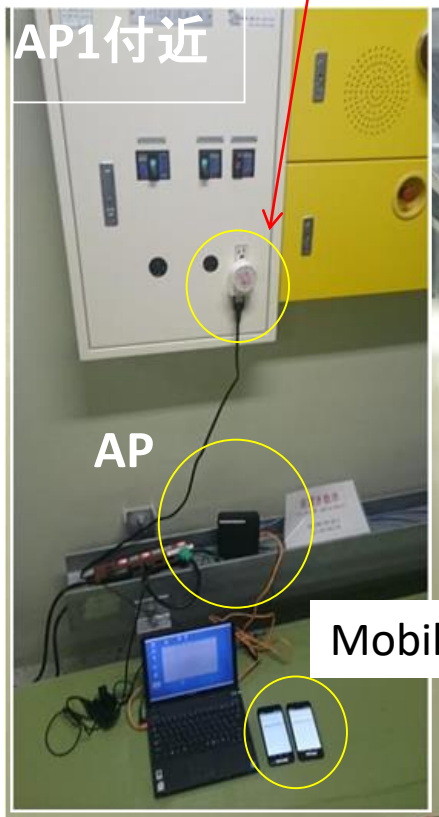
(A) It can be operated in a local closed environment that is disconnected from the outside (from a security point) ⇒ **In the future automatic acquisition of earthquake information etc.**

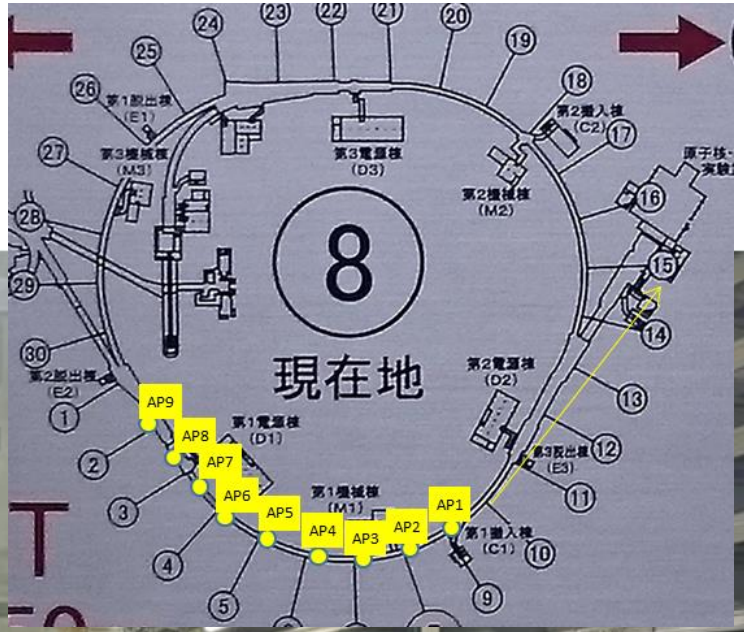
(B) Function to get worker positioning by wireless LAN

(C) 2 ways communication, message recording, and marked as read function

(D) Worker status (abnormality) monitoring function

A timer of the AP device power line
（Automatically OFF）

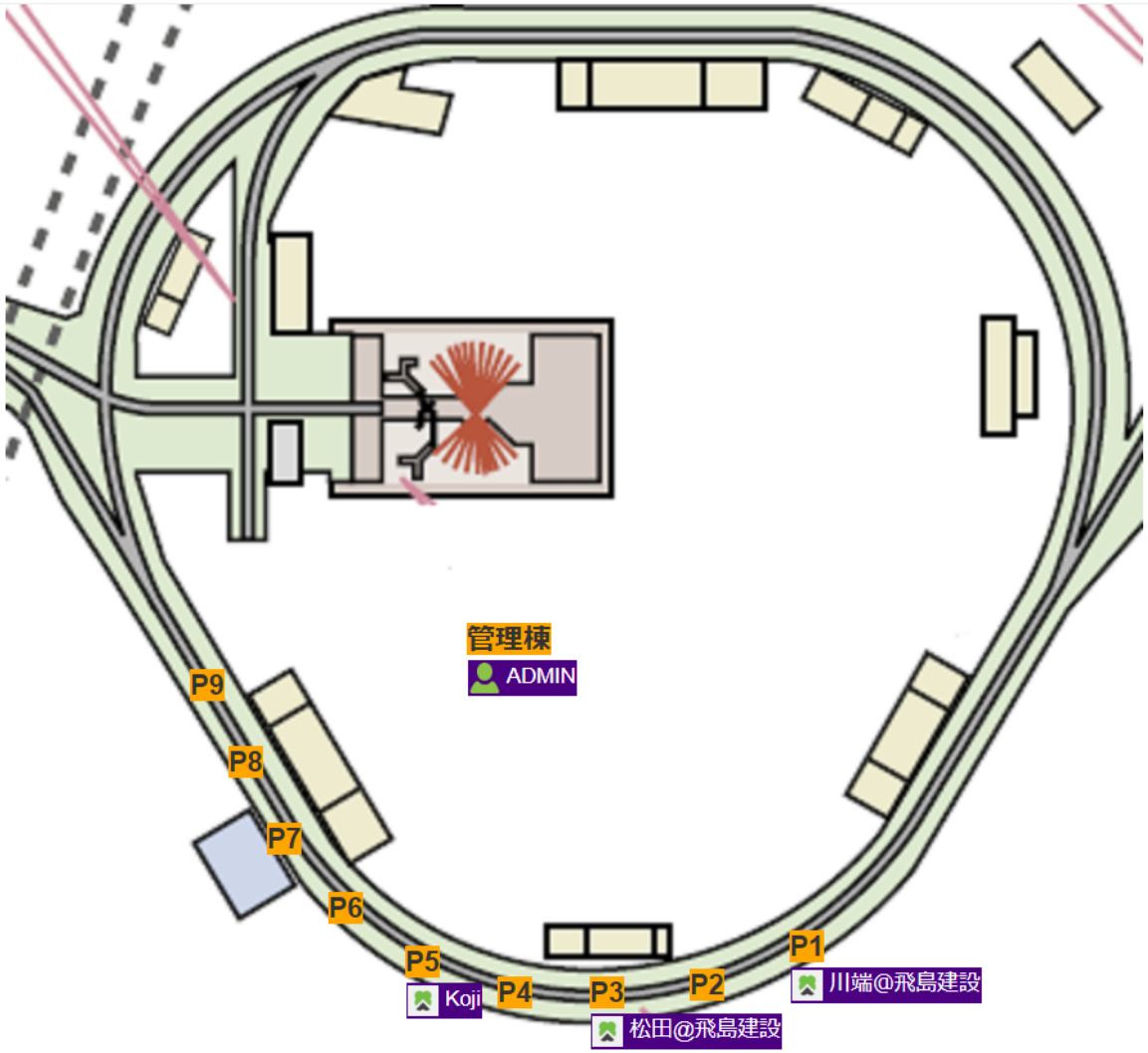




Administrator screen

0/spika/#main

スピカ v2.0



JPARC-MR

ADMIN 16:17 at outside
ADMIN joined to conversation.

ADMIN 16:17 at outside
ADMIN joined to conversation.

川端@飛島建設 34 min ago at P3
川端@飛島建設 joined to conversation.

ADMIN 35 min ago at outside
再起動したらできました

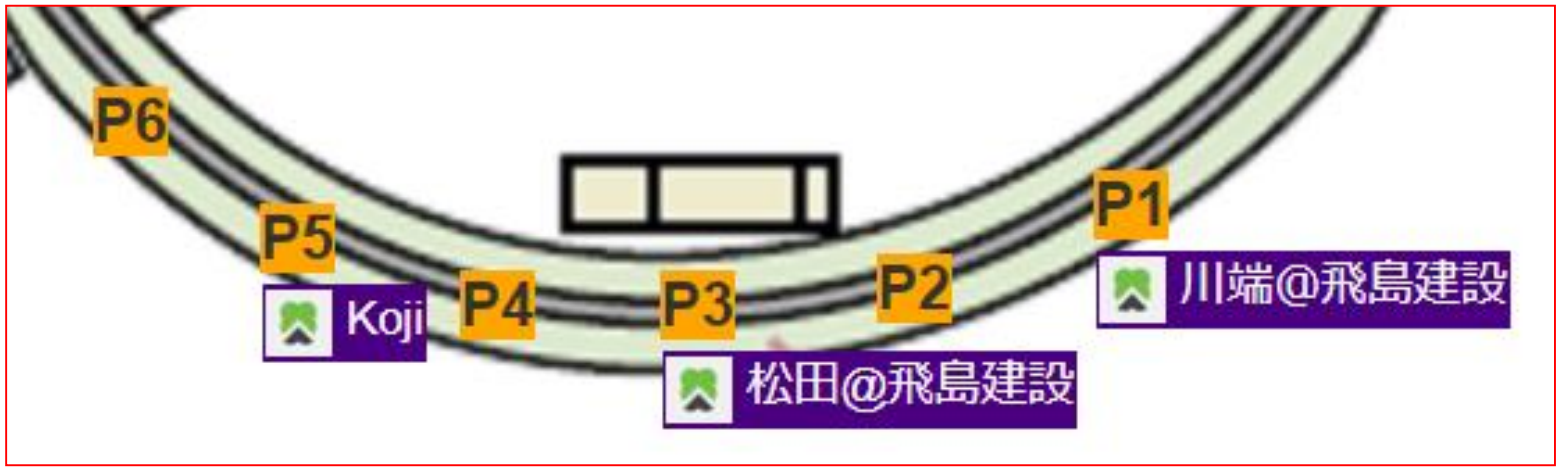
川端@飛島建設 34 min ago at P3
つきました

松田@飛島建設 34 min ago at P3
いまからばらけます

Koji 32 min ago at P4
上流に移動します。

川端@飛島建設 33 min ago at P1
川端は何処にいますか？

ADMIN 32 min ago at outside
P1です



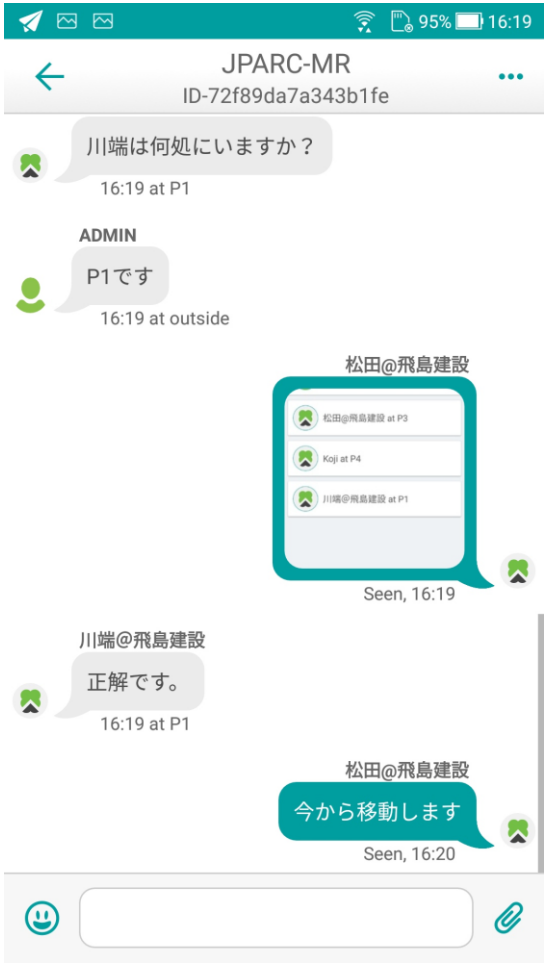
Positioning monitor is a simple method to identify with the closest AP (cell-ID)

Management by administrators (at the disaster)

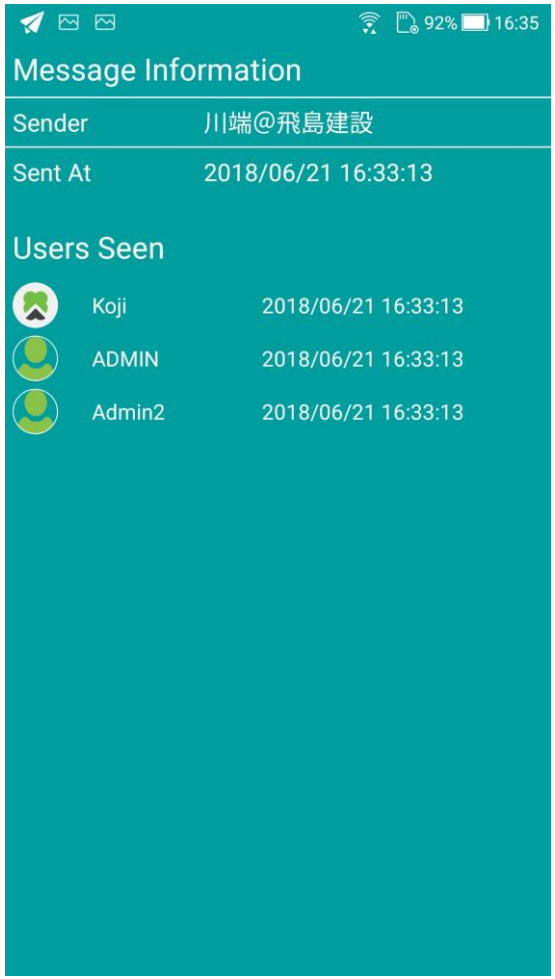
Worker screen (smartphone)

Like LINE app.

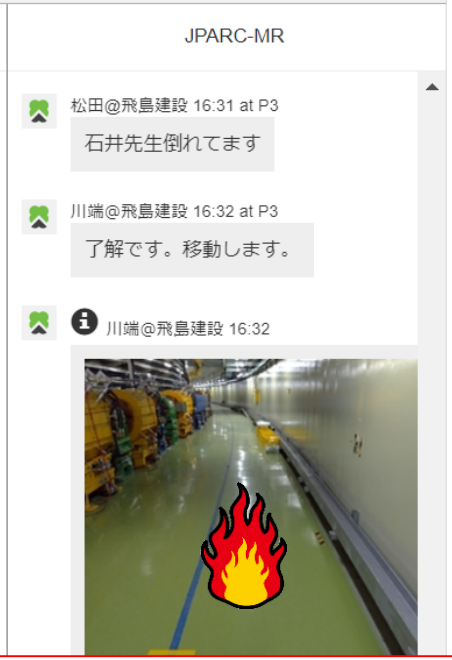
Position Information

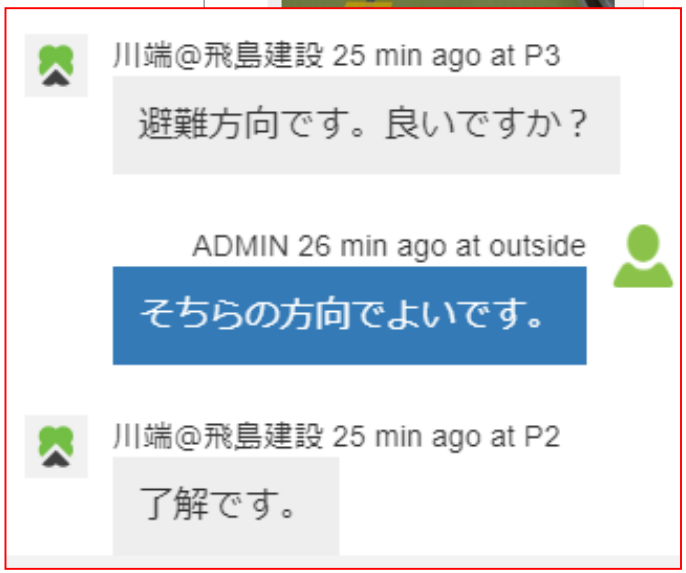


Message browser



Read management





Sharing information in the tunnel (easy taking picture)
Evacuation instruction ⇒ Confirm the direction

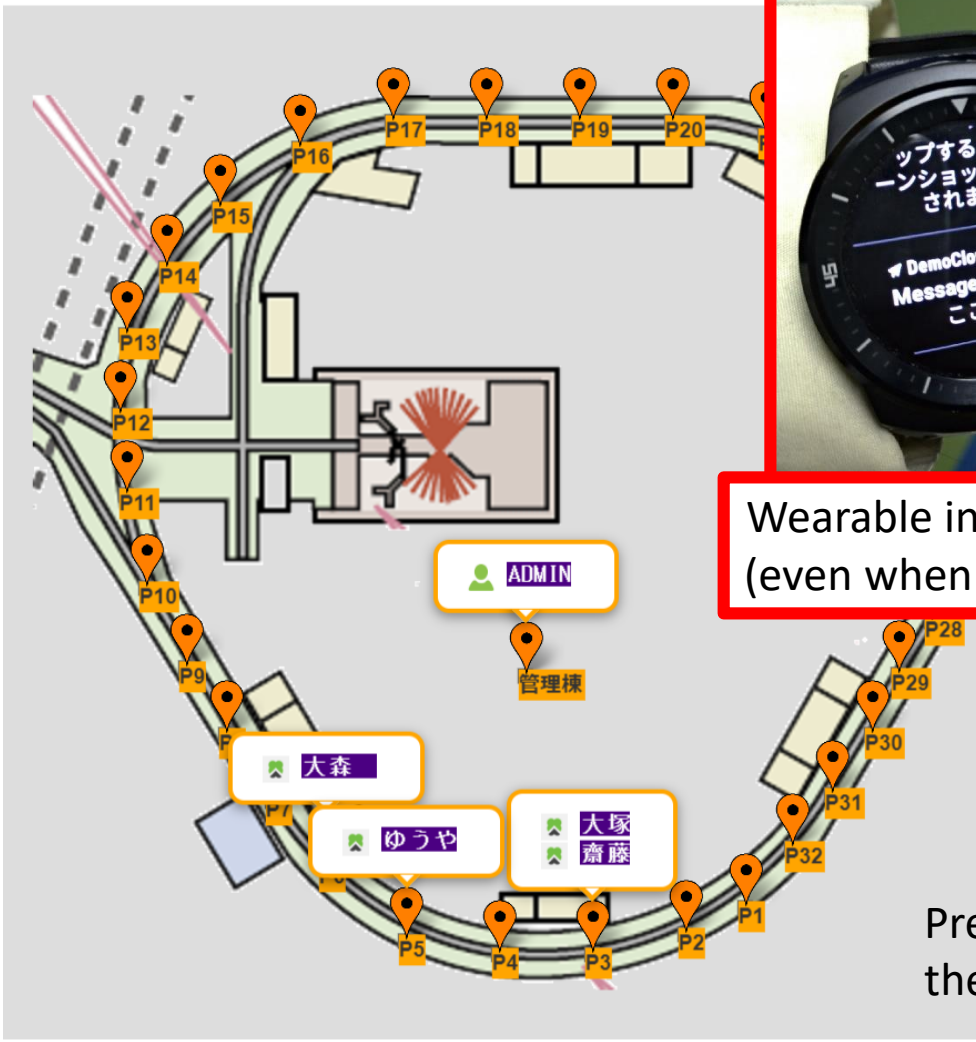
Worker's abnormality (No response with smartphone acceleration sensor)

⇒ Move to other workers for relief / rescue

Latest Progress (2018 Dec.)

JPARC-MR

Wearable information terminal
(even when working and noisy)



Prepare to expand
the whole MR ring

JPARC-MR

無事でなりよりです

ゆうや 16:14

V_20181212_161207_OC0.mp4
42.27 MB
Download

ゆうや 16:14 at P9
遅くなりました！

ADMIN 16:14 at outside
動画ありがとうございます！

ADMIN 16:14 at outside
みなさんP4にあつまってください。

ゆうや 16:15 at P8
了解です！

大塚 16:15

Useful stamps

メッセージを入力してください。

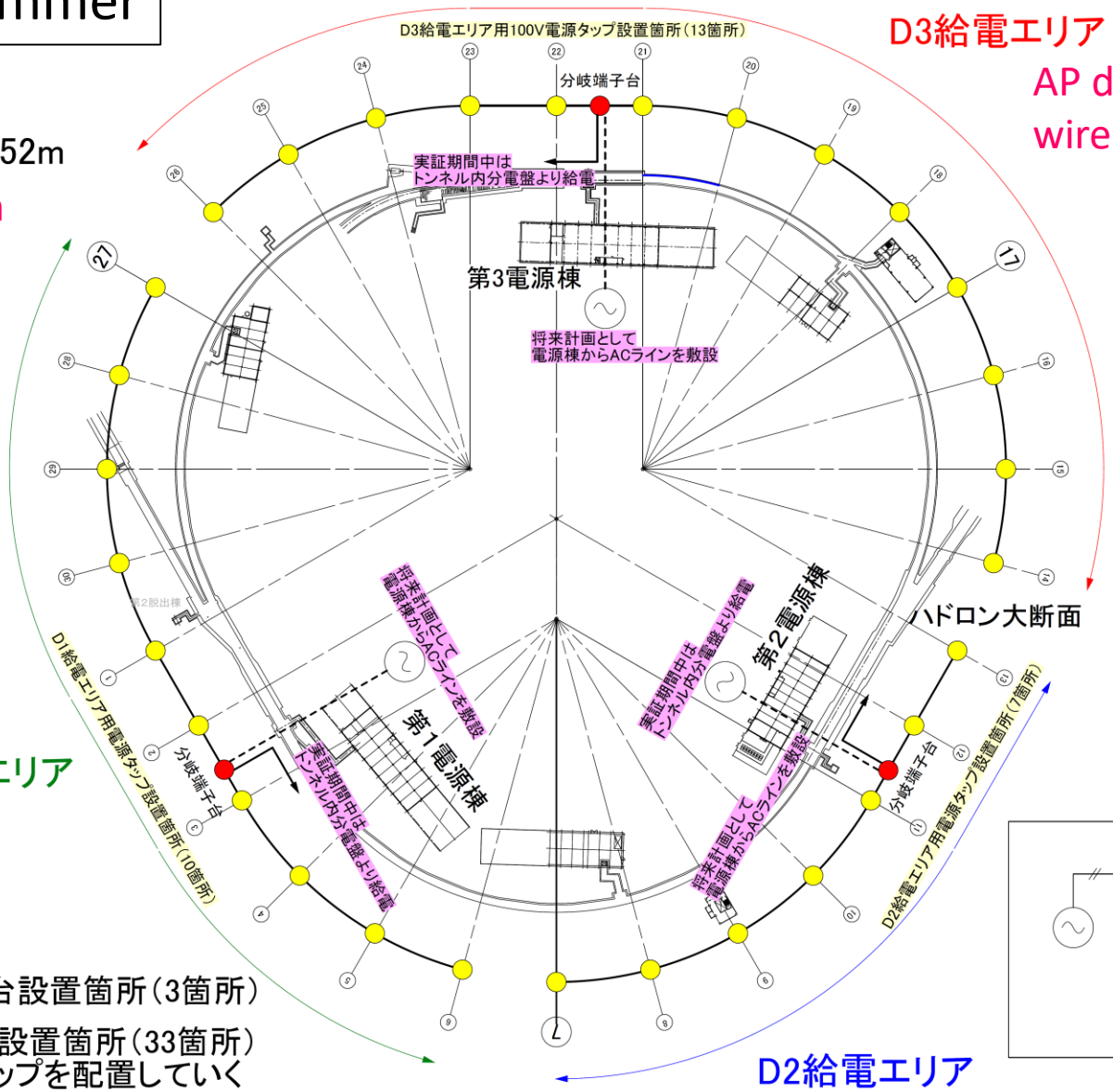
16:16
2018/12/12

In the future

2019 Summer

通芯間隔≒52m

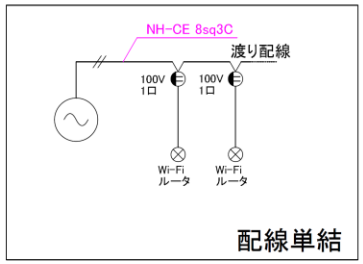
every 52 m



D3給電エリア

AP devices AC lines and wired network lines

D1給電エリア



● 分岐端子台設置箇所（3箇所）

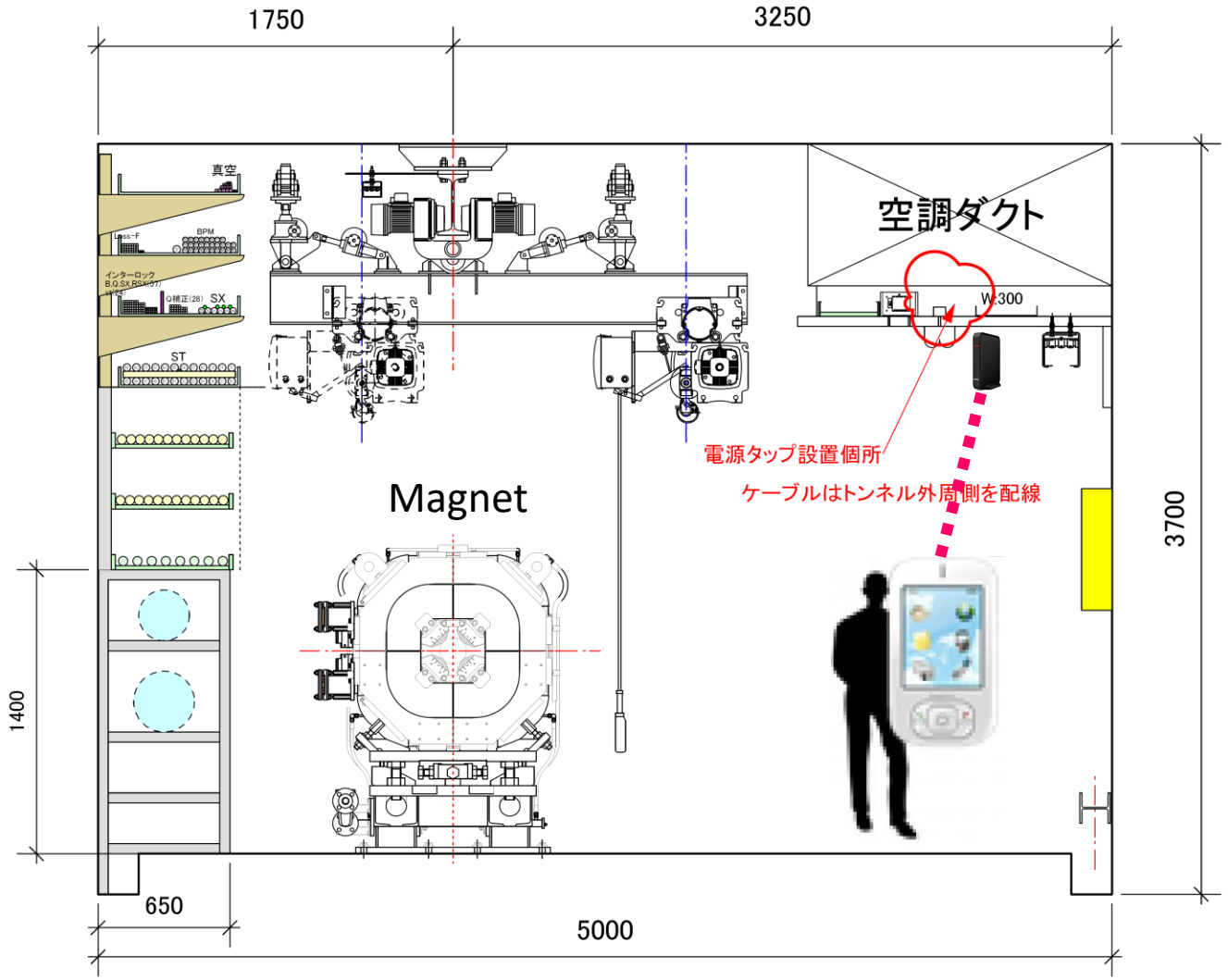
● 電源タップ設置箇所（33箇所）
#通芯にタップを配置していく

Total 33 APs will be installed

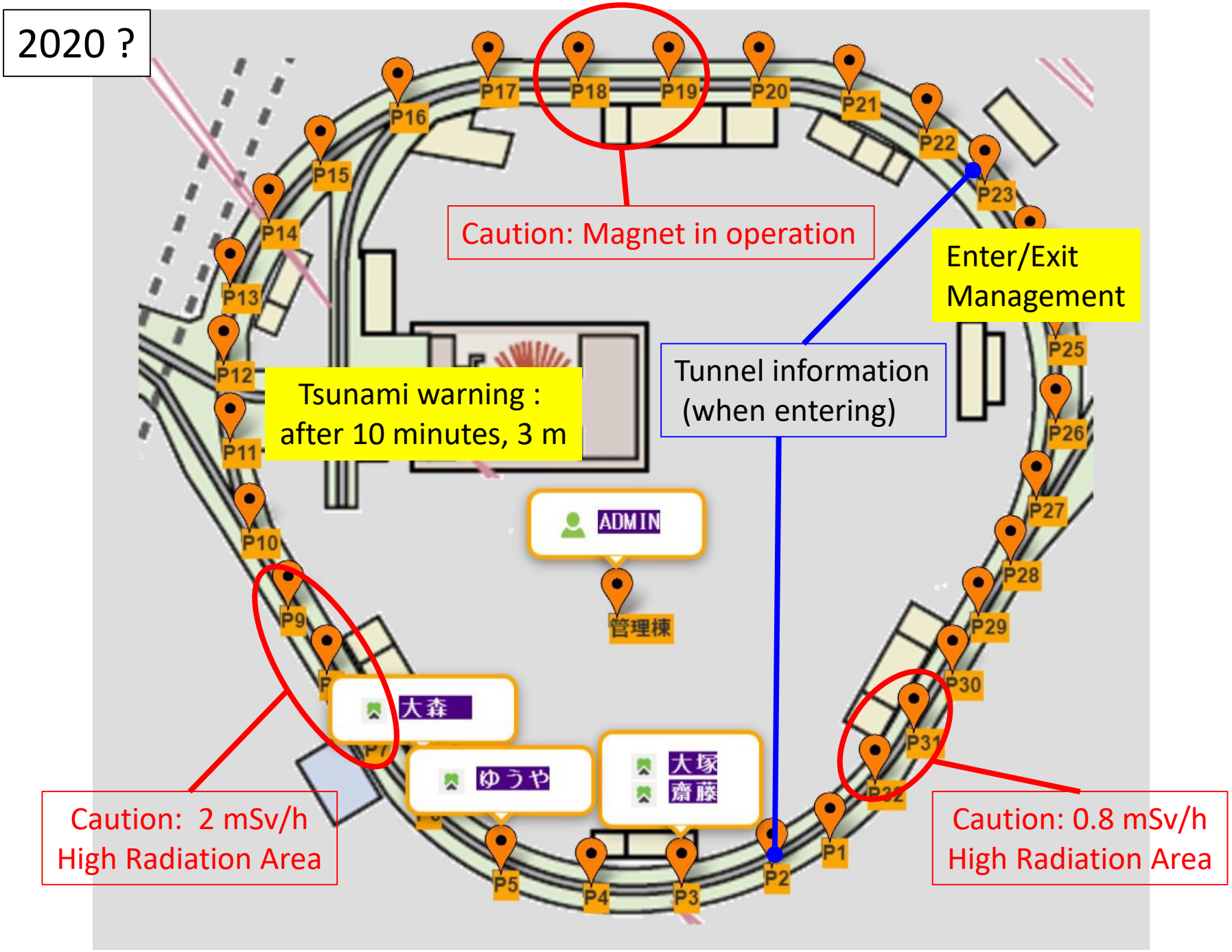
D2給電エリア

Powered by the power supply building (Emergency Generator Line)

2019 Summer



Version 1.0.0 will be released ⇒ Use for MR workers

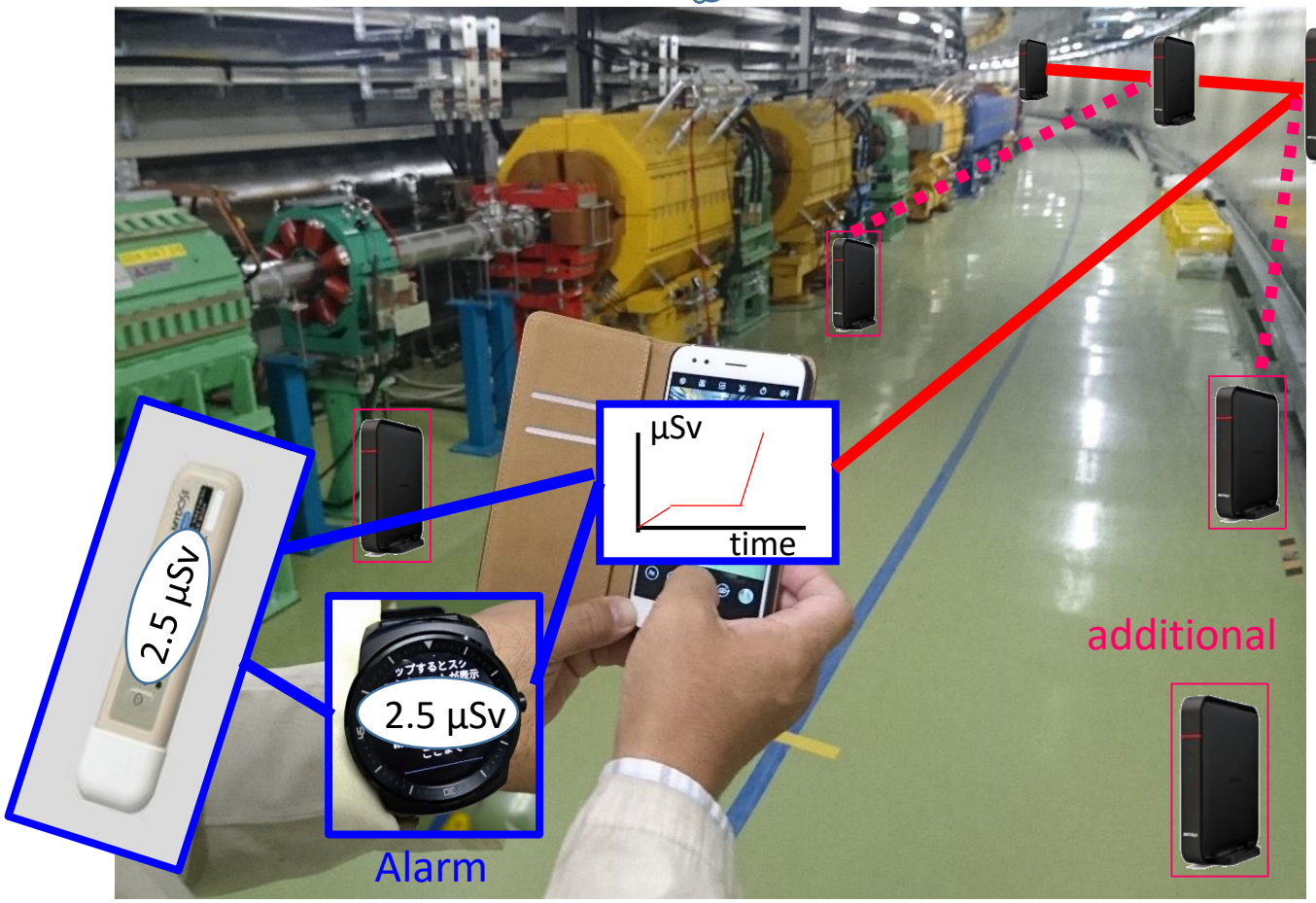

2020 ?
P1
P2
P3
P4
P5
P9
P10
P11
P12
P13
P14
P15
P16
P17
P18
P19
P20
P21
P22
P23
P25
P26
P27
P28
P29
P30
P31
ADMIN
管理棟
大森
ゆうや
大塚
齋藤
Caution: Magnet in operation
Enter/Exit Management
Tunnel information (when entering)
Tsunami warning : after 10 minutes, 3 m
Caution: 2 mSv/h High Radiation Area
Caution: 0.8 mSv/h High Radiation Area

202X ?

Merging with radiation management (who, where, when, how much dose)

Enlargement

For the radiation work in higher environment, additional APs are installed to improve the position accuracy.



Tracking and History

Recoding the time, the position (place), and the radiation dose

Summary

Radiation hardness is studied and found the AP for Wifi is not broken up to 1 k Gy even in the J-PARC MR environment. (Neutron and Gamma)

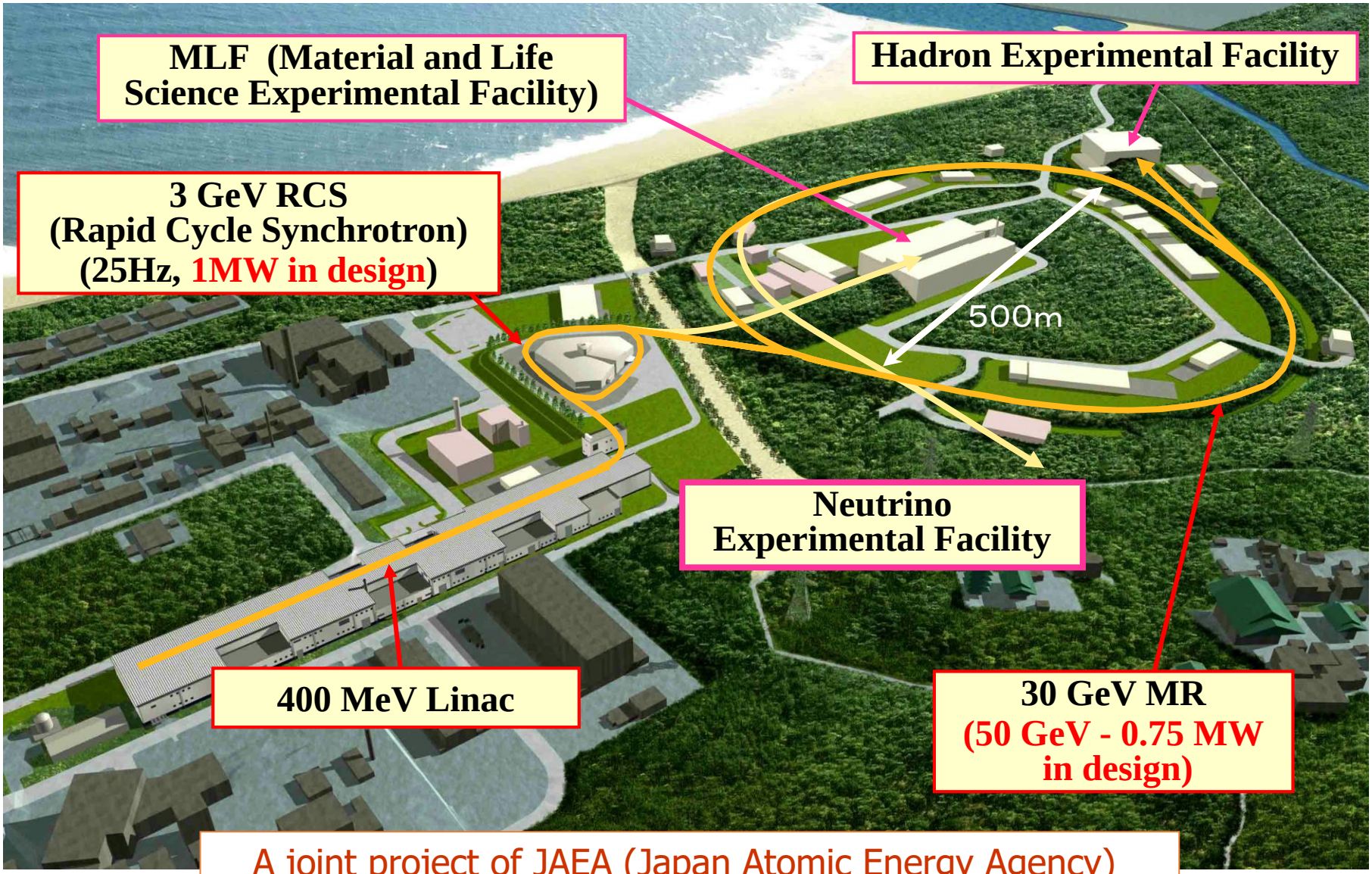
MR disaster prevention application with positioning system is READY.
(During the beam operation AP's power should be OFF)

In 2019 summer we want to release the first version and use it in MR.
(feedback for the application improvement)

For a future prospect, if this system can be developed successfully
it can be expected to be utilized in various facilities.

If you are interested please contact me;
koji.ishii@kek.jp

J-PARC Facilities



A joint project of JAEA (Japan Atomic Energy Agency) and KEK (High Energy Accelerator Research Organization)