Investigation for activation of accelerators at various synchrotron radiation facilities in Japan

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"Clearance of materials from the decommissioning of accelerator facilities"
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Outline

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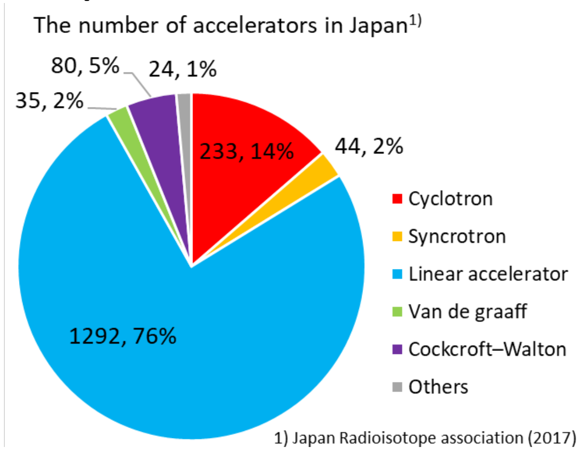
  - ✓ Current status of activation of each facility
  - ✓ Contact dose-rate, Identified nuclides, neutron flux
- Conclusion

Introduction

☐ Problem for decommissioning of accelerator facility

In Japan, there are over 1000 large and small accelerator facilities.



- ✓ They need updating or decommissioning.
- ✓ Guidelines were not prepared (except small scale medical facilities)

☐ investigating the activation of large scale accelerator facilities

Aim of the research	<u>establishment of more reasonable decommissioning process of accelerator facilities</u>

(1) clarification of the target facilities for assessment of activation

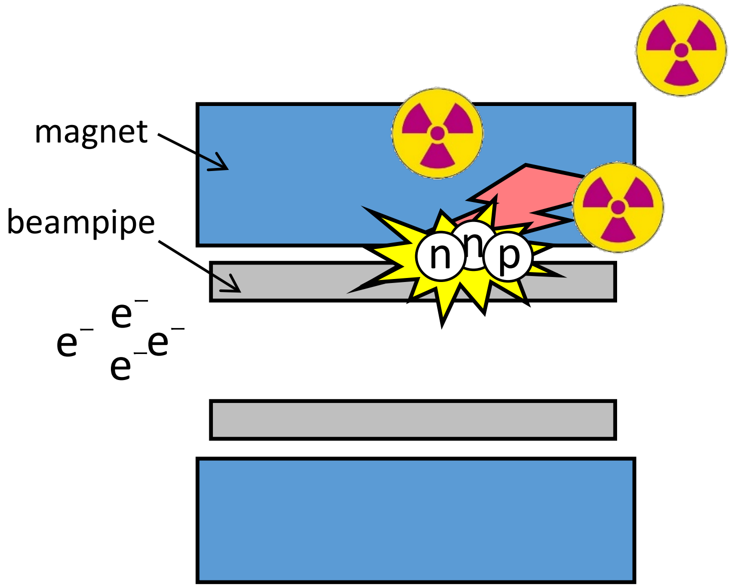
(2) development of novel technique for assessment of activation

(3) provide a guideline for decommissioning as a manual book.

Various type of facilities (synchrotron, cyclotrons,…) were investigated.

Introduction

☐ Activation of accelerator facility



- ✓ Beam loss occurs during operation
- ✓ Bremsstrahlung photon
- ✓ Secondary particles (n, p, e^-, e^+ etc..)
- ✓ Activation

☐ Important things for investigation of activation of accelerator

- Where are the activated areas (beam loss points)?
- How much radionuclides are generated?
- What kind of nuclides are generated?

Focusing on beam-line components and concretes (occupy large volume).

Facilities

☐ Target facilities for activation assessment

We investigated these five facilities, including the largest SPring-8 to the smallest SR center in Japan.

Not only differ in the maximum energy but also differ in the type of pre-accelerator up to the storage ring.

Facility	Energy	Type	Operation mode
Spring-8	8 GeV	L – B – MR	Storage/Top-up
Photon factory	2.5 GeV	L – MR	Storage/Top-up
UVSOR	0.75 GeV	L – B – MR	Storage/Top-up
HiSOR	0.7 GeV	MR	Storage
SR-center	0.575 GeV	MR	Storage

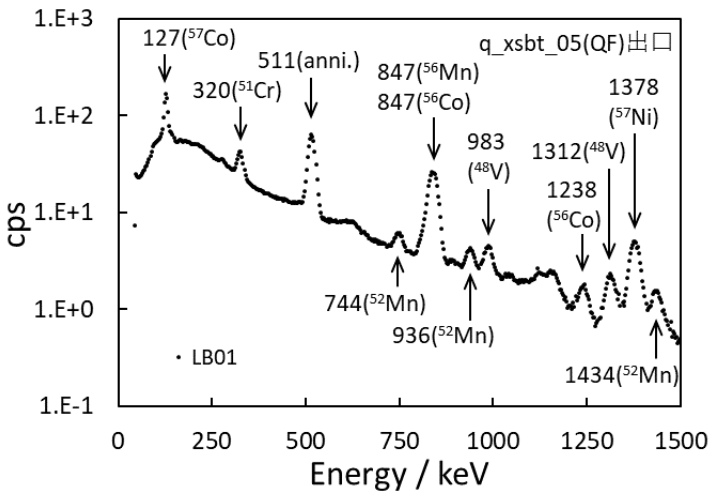
L : Linear accelerator (Linac)
B : Booster synchrotron
MR : Main ring (Storage ring)

Experimental

□ Evaluation for activation of beamline

These were conducted just after the accelerator operation was stopped.

- Where is activated and how much activated?
  → Contact dose-rate measurement with a NaI survey meter
  Scanning the activated area and strength of radiation
- What kind of nuclides are generated in the activated areas?
  → Gamma-ray spectrometry with a $LaBr_3$ scintillation detector
  Nuclide identification at each activated place



Experimental

□ Evaluation for activation of concrete

⇒ Ambient neutron flux measurement

◆ Setting various dosimeters in the whole facility

- Solid track detectors (CR-39)
- Thermo-luminescent dosimeters (TLD)
- Gold foil (bare/covered with Cd plates)

Mapping the thermal and epithermal neutron flux.

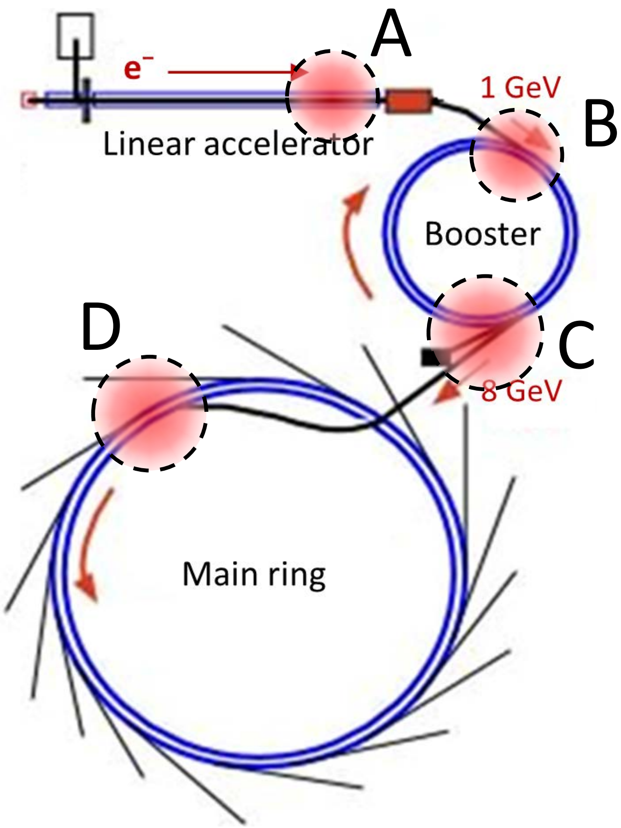
◆ In-situ measurement of ^{24}Na activity

^{24}Na reflects ambient thermal neutron flux. We measured ^{24}Na using a Ge detector with thick radiation shield, just after accelerator operation.

◆ Direct sampling by core boring and activity analysis (destructive)

Results

- Spring-8 (beamline)



Almost beamline components are not activated!
(dose-rates don't exceed BG)

Activated areas (over 1 μSv/h)

A
Contact dose-rate : **1.30 μSv/h**
Detected nuclides : **^{57}Co, ^{57}Ni**

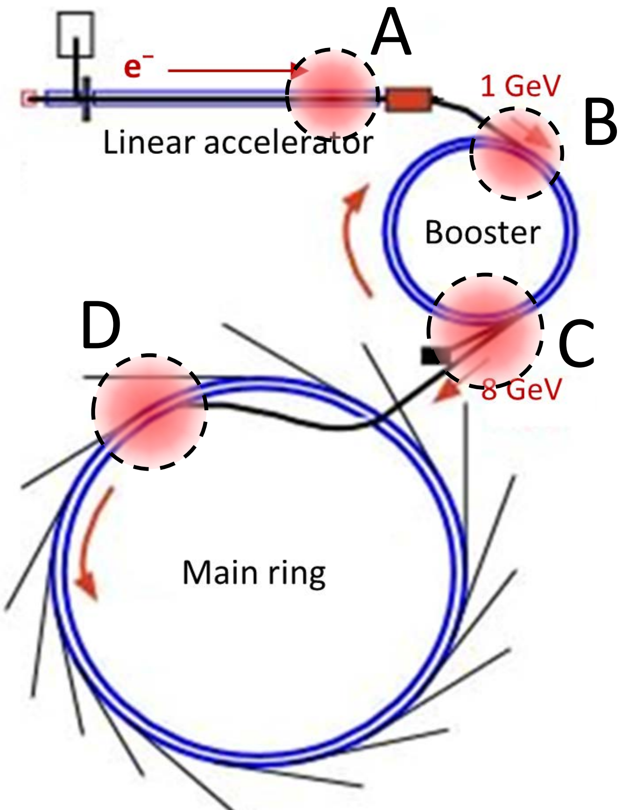
B
dose rate : **2.14 μSv/h** (max.)
nuclides : **^{44}Sc, ^{51}Cr, ^{54}Mn, ^{57}Co, ^{57}Ni**

C
dose rate : **10.0 μSv/h** (max.)
nuclides : **^{44}Sc, ^{48}V, ^{51}Cr, ^{52}Mn, ^{54}Mn, ^{56}Co, ^{57}Co, ^{57}Ni**

D
dose rate : **10.4 μSv/h** (max.)
nuclides : **^{22}Na, ^{54}Mn, ^{57}Co, ^{57}Ni**

Results

- Spring-8 (concrete)



Thermal neutron flux

A	**42.3 n/cm²/s** (beamline) **6.45 n/cm²/s** (wall) **< 3.2 n/cm²/s** (floor)
B	**187 n/cm²/s** (beamline) **63.7 n/cm²/s** (floor)
C	**52.4 n/cm²/s** (floor)
D	**113 n/cm²/s** (beamline) **15.6 n/cm²/s** (floor)

Accumulated activity of ^{60}Co and ^{152}Eu in the concrete floor at 30 years later

B: 8.4×10^{-4} Bq/g (< C.L. : 0.1 Bq/g)

Concrete will not be activated!

Conclusion

- We have been investigating the activation of large scale accelerator facilities to establish more reasonable decommissioning process.

- We conducted investigation of the activation for typical synchrotron radiation facilities.
  - ✓ Activated area is limited, and long lived nuclides such as ^{60}Co and ^{152}Eu were not detected.
  - ✓ It is not necessary to treat almost materials in the Synchrotron radiation facility as radioactive wastes

- These result will be reflected to decommissioning guideline that we editing as the manual book.