# Radiation Safety issues for the PF-AR in KEK

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- Management of radiation for PF-AR
- Radiation measurements
- Protection
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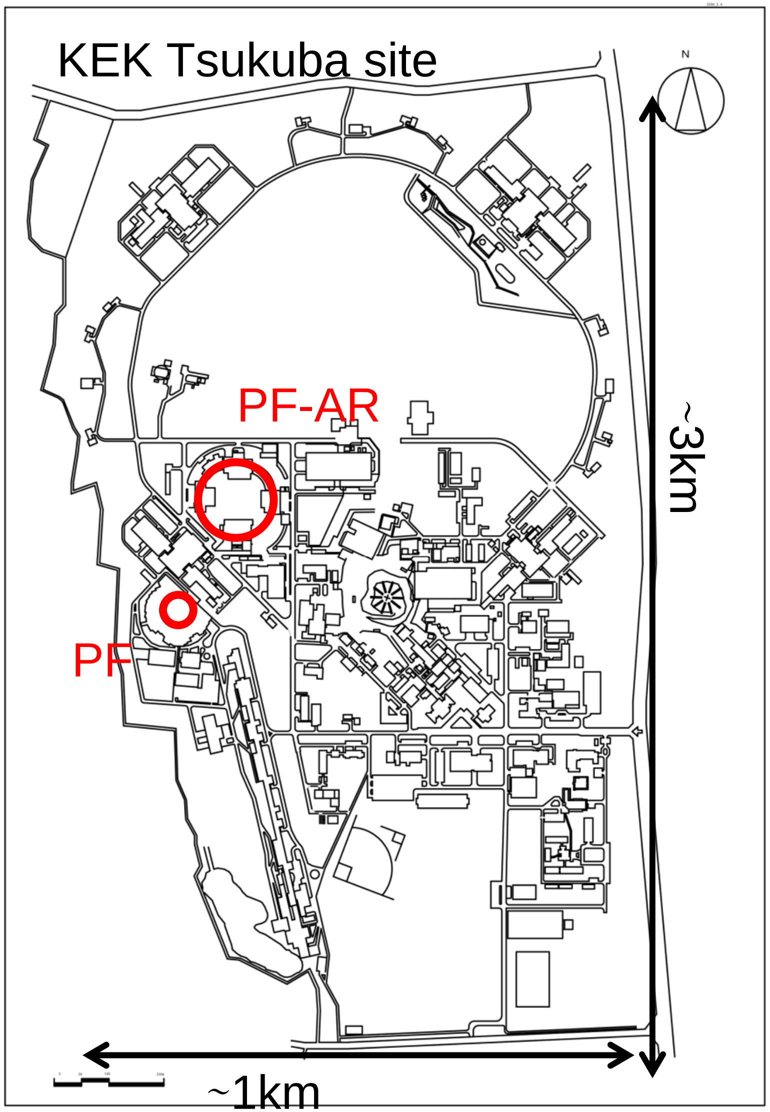
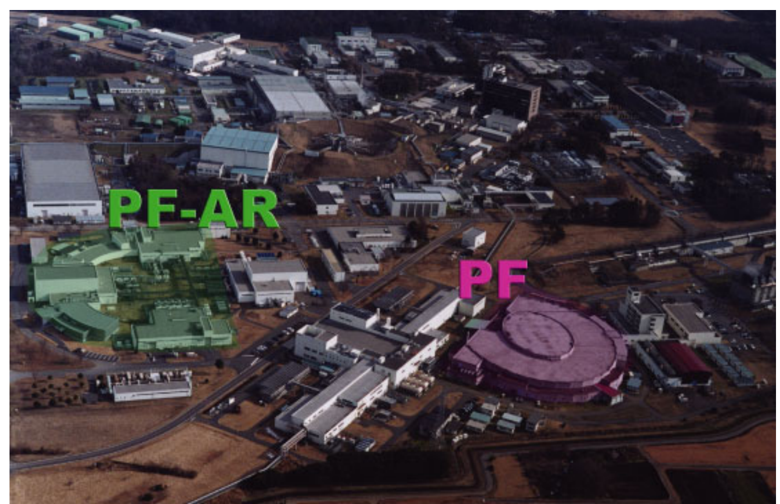
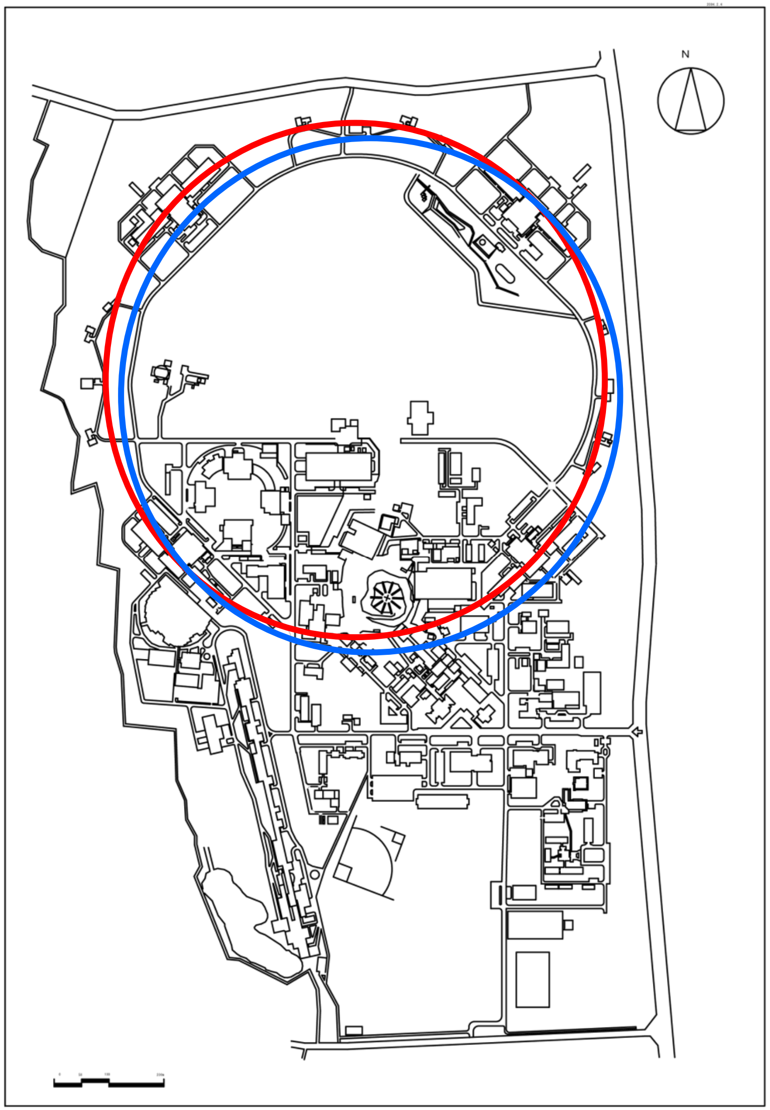
# KEK electron accelerators



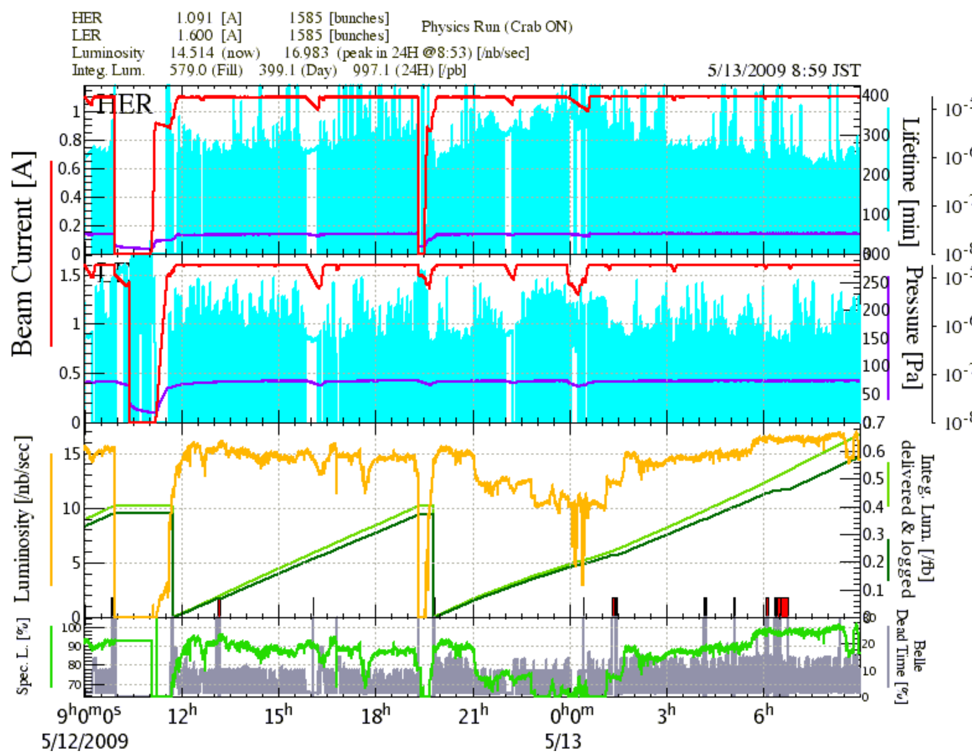

- Synchrotron light sources
  - PF-AR (PF Advanced Ring for pulse X ray)
    - 6.5 GeV electron for pulse X ray
  - **Photon Factory (PF)**
    - 2.5 GeV electron.



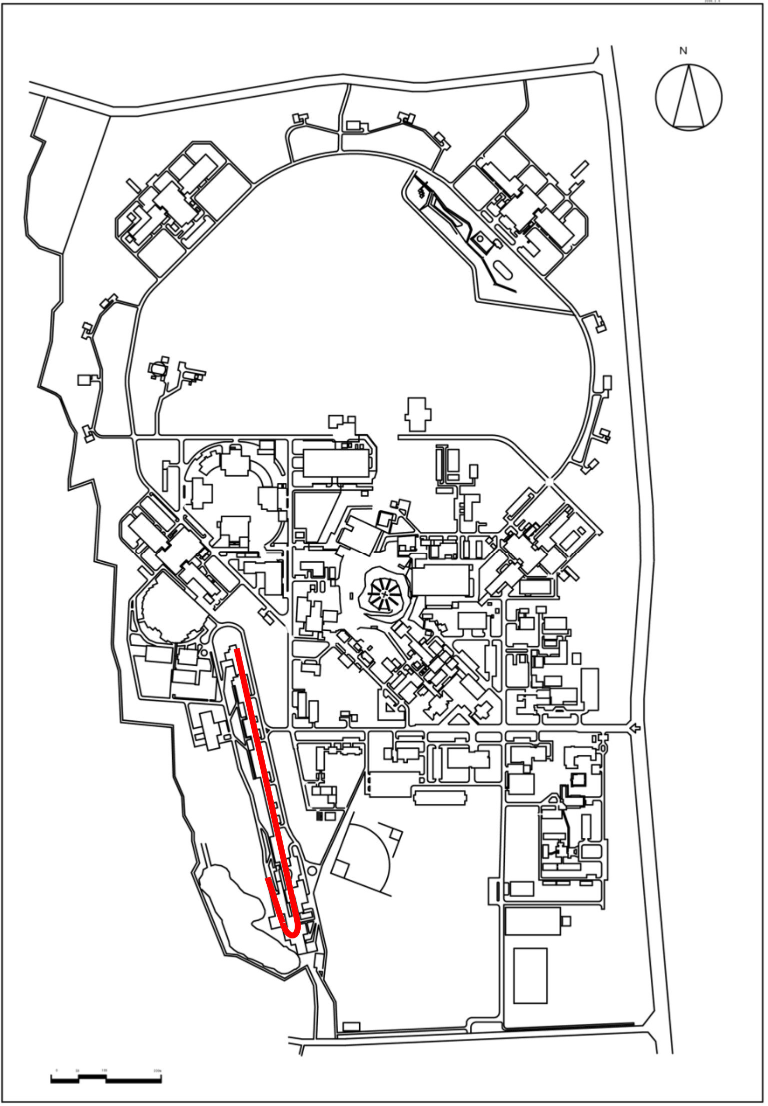
# KEK electron accelerators




- B-Factory (KEKB)
  - To investigate b-meson symmetry
- 8 GeV electron in HER
- 3.5 GeV positron in LER
- Continuous injection



# KEK electron accelerators



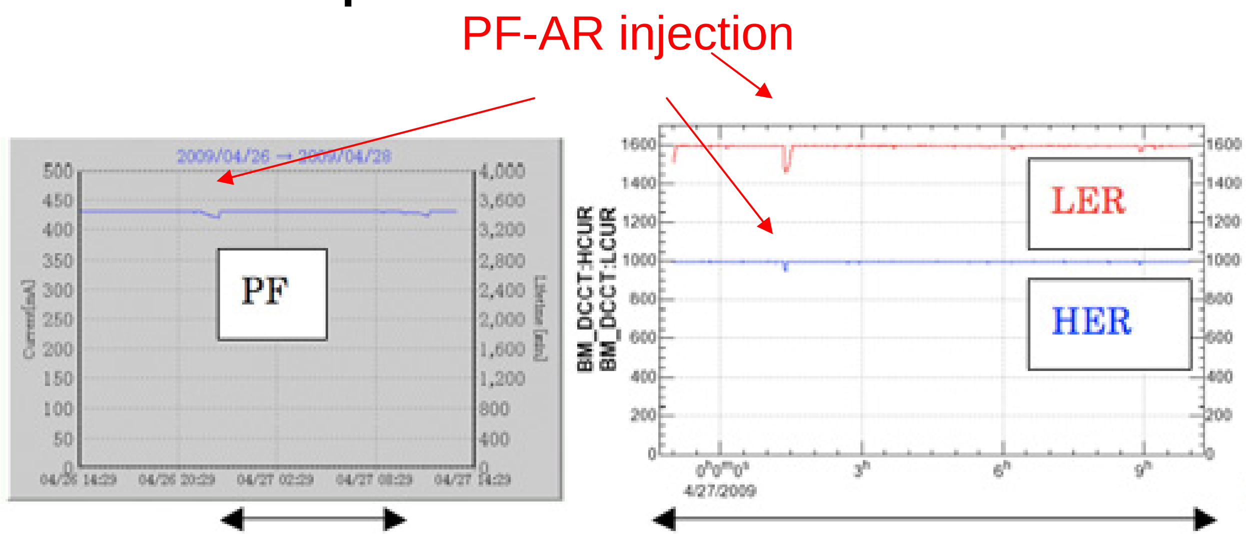

- **Electron and positron LINAC**
  - **8 GeV/2.5 GeV e-, 3.5 GeV e+ typical**
    - **Maximum allowable**

      **10GeV (e-), 12.5 GeV·μA**

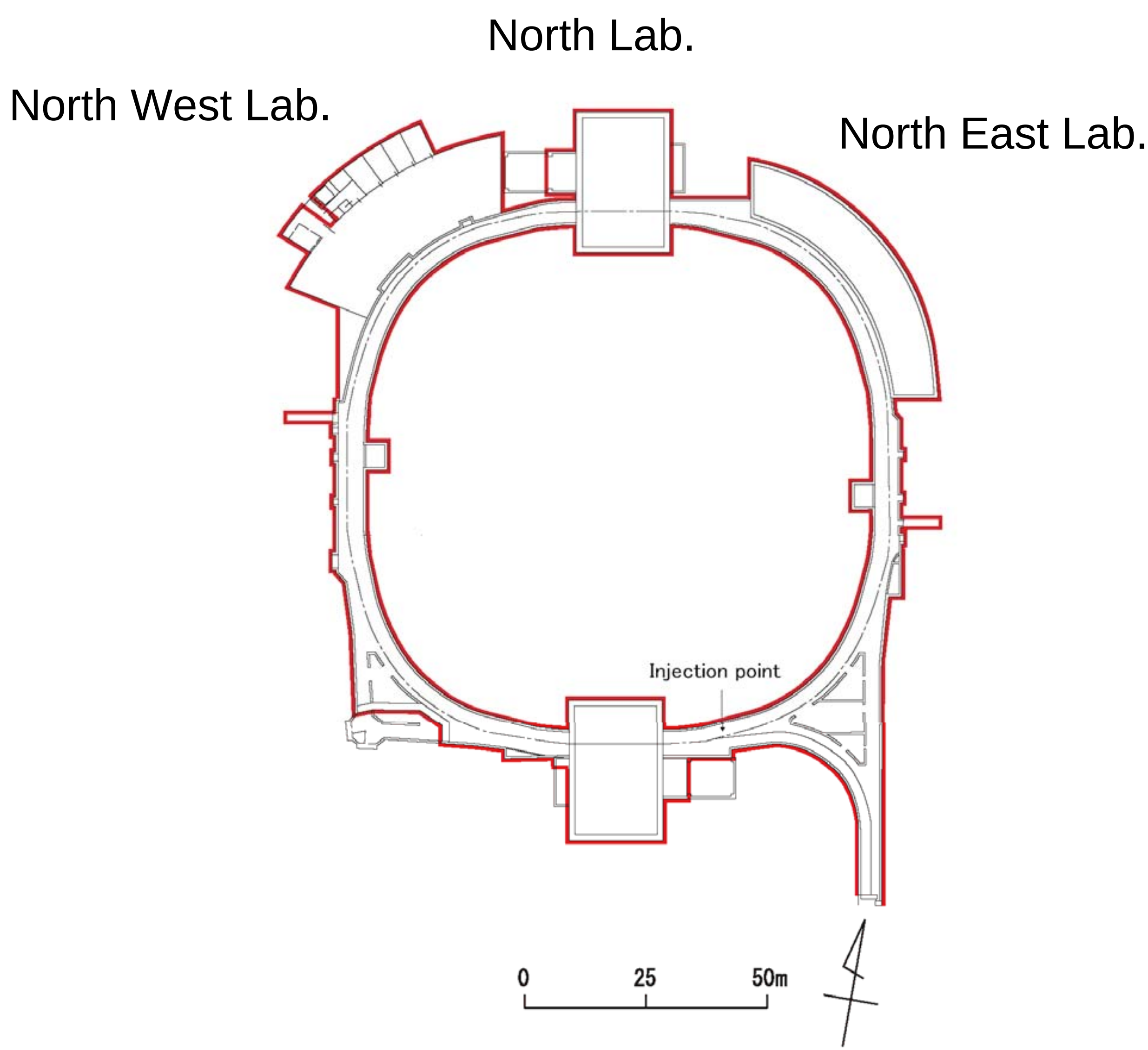
      **5GeV (e+), 6.25GeV·μA**
  - **Provide electron 3 rings**
  - **Provide positron 1 ring**

# Simultaneous injection for 3 rings

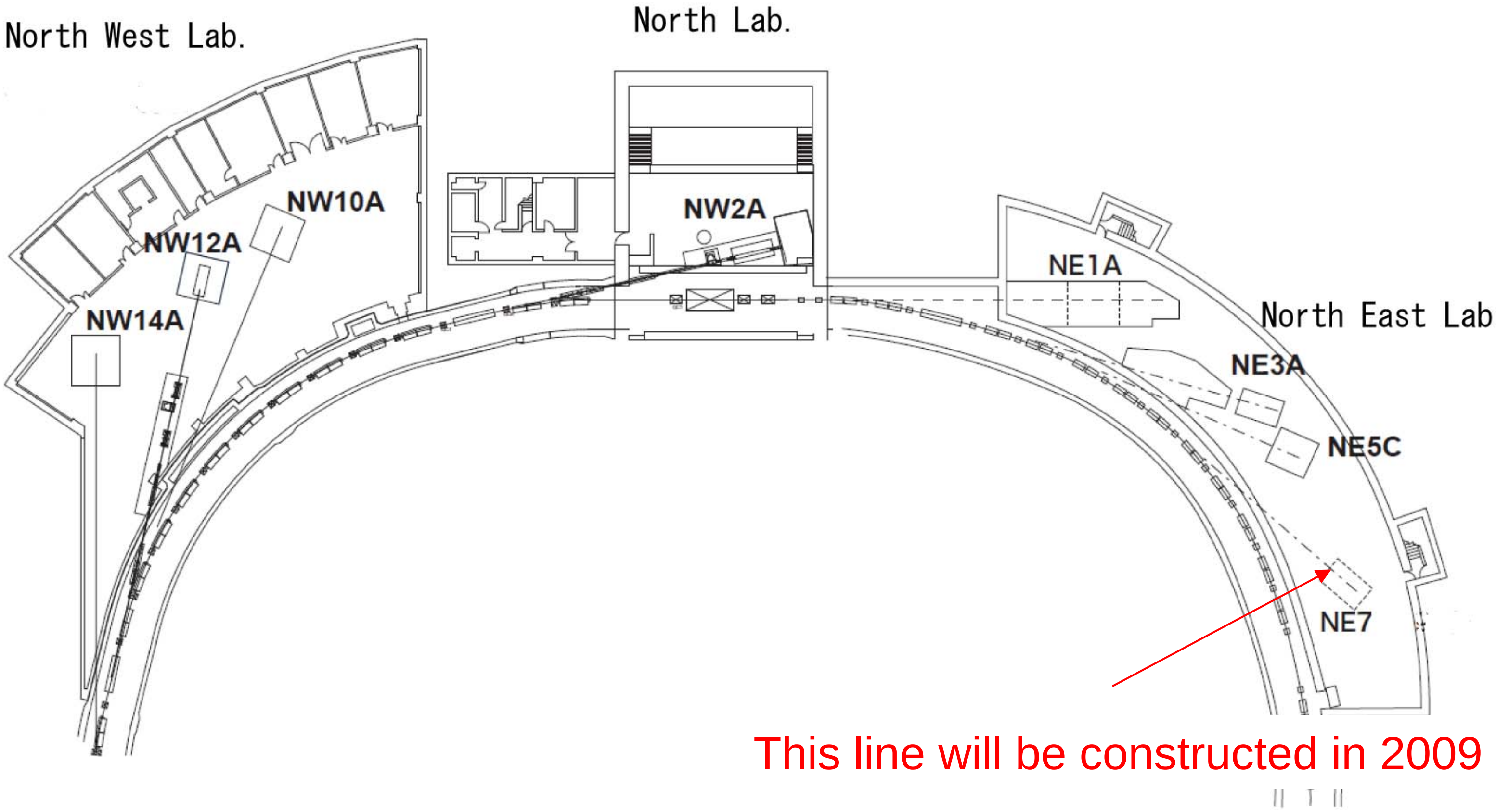
- PF 2.5GeV e-, LER 3.5GeV e+, HER 8GeV e-
- Pulse to pulse switching injection has started since 24th April 2009.( PF 0.5 Hz, HER 12.5 Hz, LER 25 Hz)
- The 3 rings can keep constant current except during PF-AR injection.
- This is a test operation. However it works well.



# Plane figure of PF-AR



# Plane figure of experimental hall




This line will be constructed in 2009

# Main parameter of the PF-AR

| | |
|---|---|
| Beam energy | 6.5 GeV |
| Circumference | 377 m |
| Injection energy | 3.0 GeV |
| Typical num. of bunches | 1 |
| Initial stored current | 60 mA |
| Beam lifetime (at init.cur.) | 20 hours |
| Num. of insertion devices | 6 |

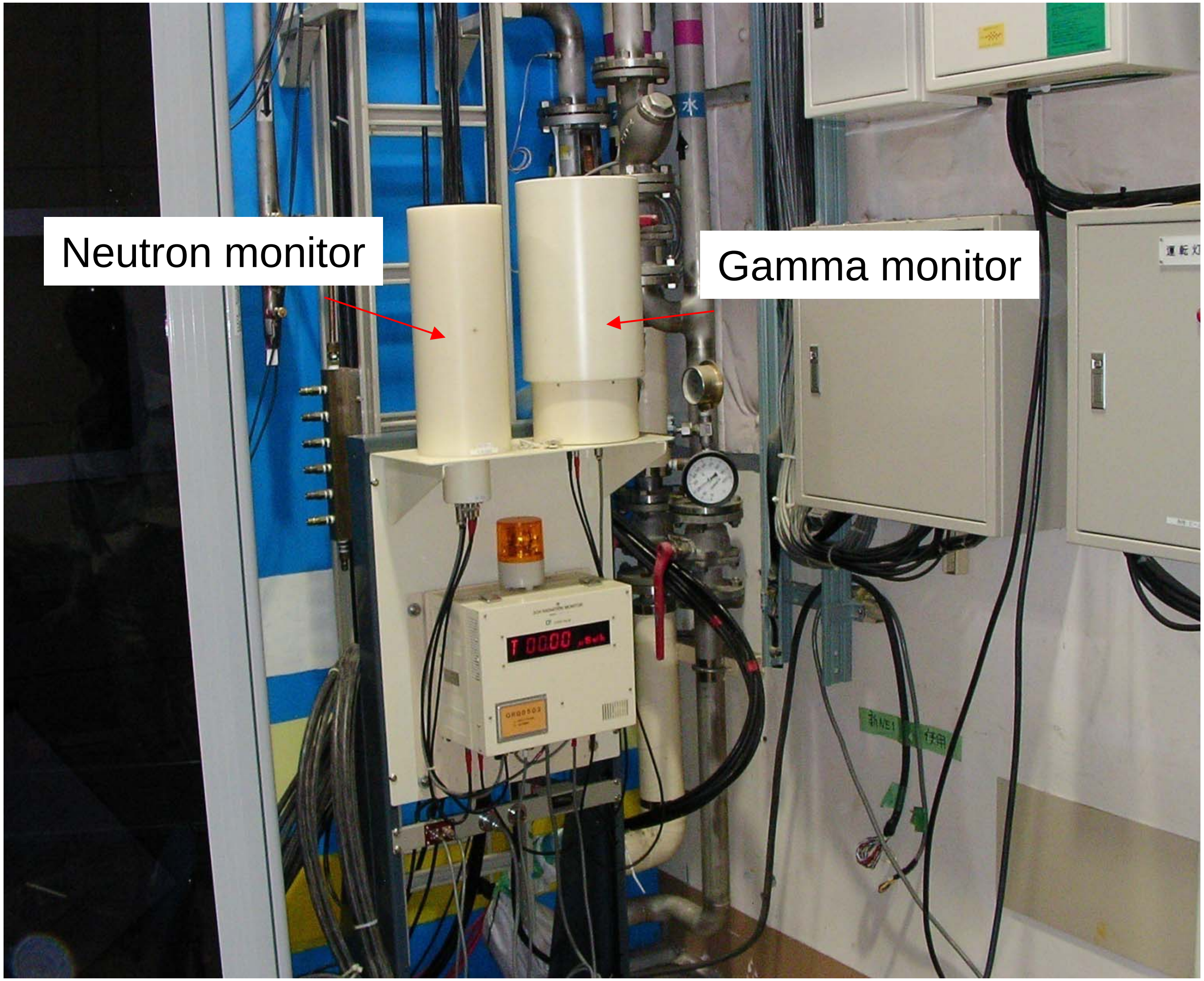
# Management of radiation safety

- Dose rate in the radiation controlled area: $\leqq 20\,\mu Sv/h$
- Personal effective dose limit for the radiation workers: 20 mSv/year for men, 6 mSv/year for women
- Target of personal effective dose: $\leqq$7mSv/year for men, $\leqq$2mSv/year for women

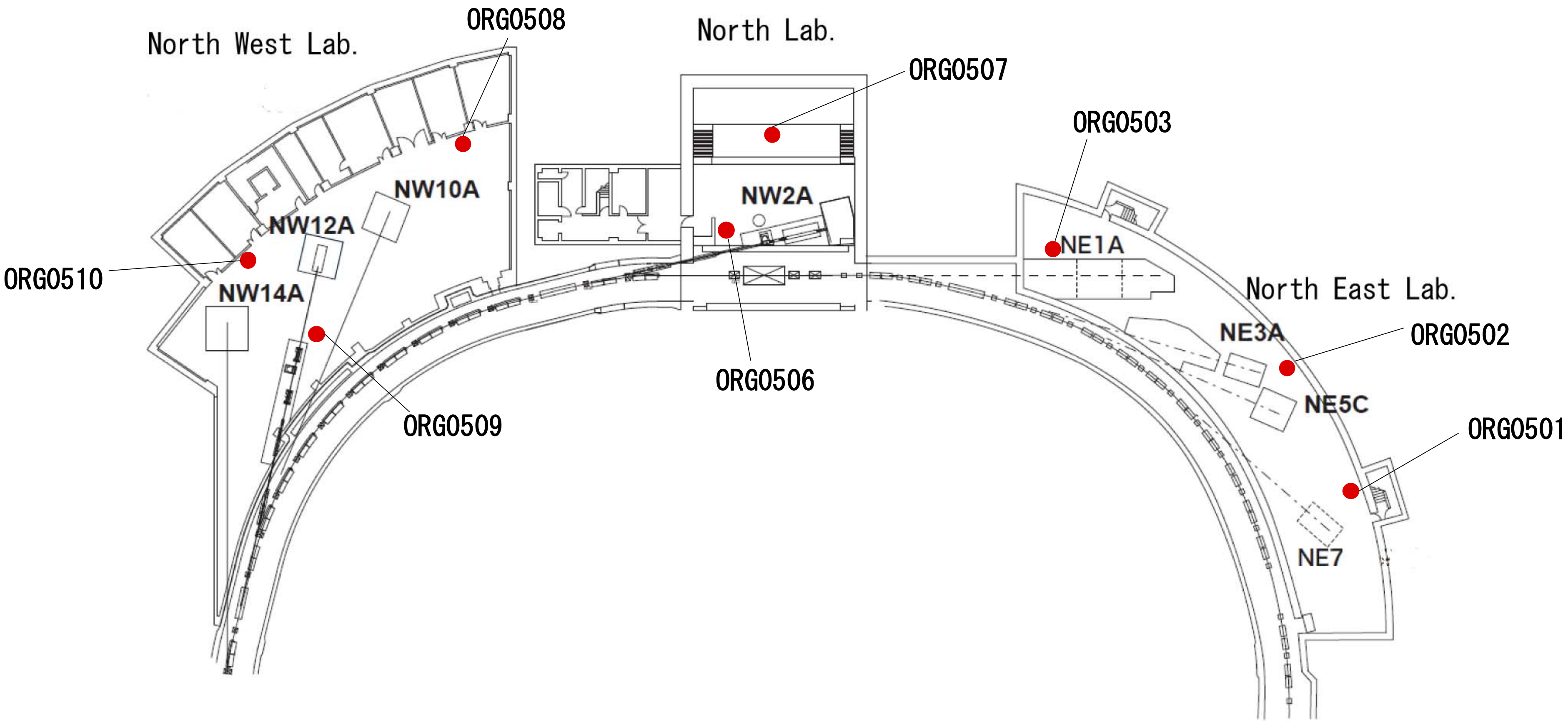
# Measurement of dose rate in the experimental hall

- Dose rates are measured by the area monitors. (We call them ORG monitors.)
- Gamma monitors: Ionization chamber ;10 liters
- Neutron monitors: $BF_3$ proportional counter; 1 inches
- The monitors give an alarm when the dose rate is over 20 $\mu$ Sv/h.

# Area monitor

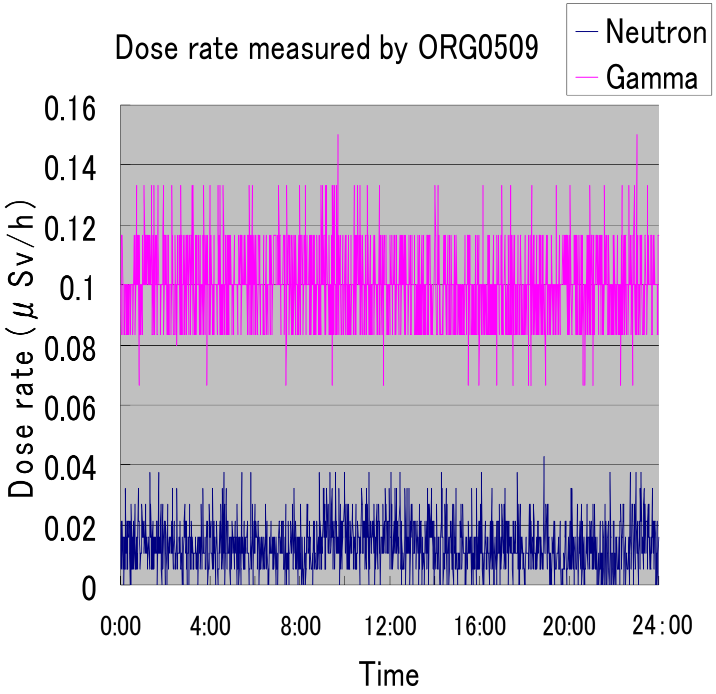


# Location of the area monitors (at present)

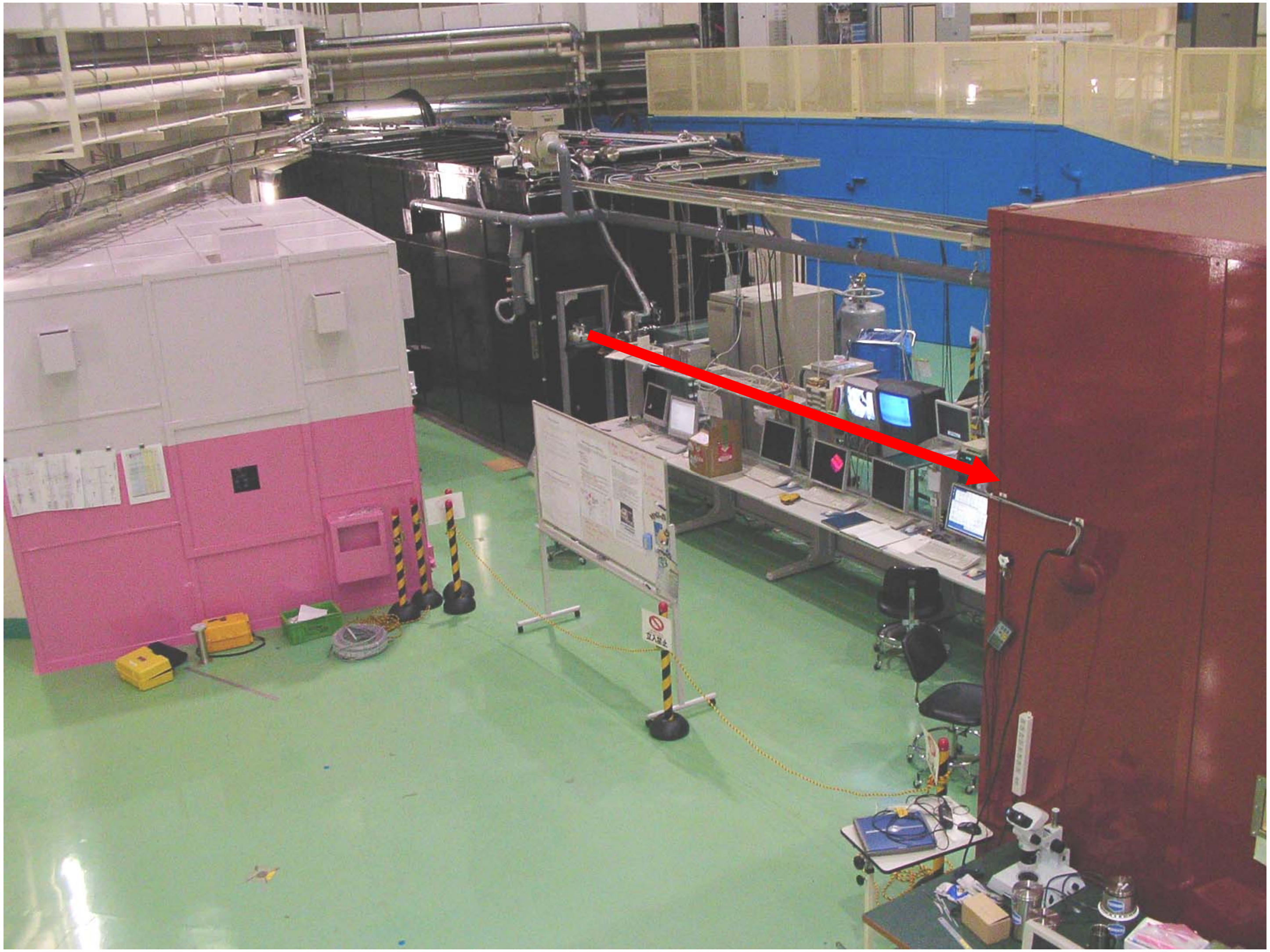


# Measured dose rate in the experimental hall

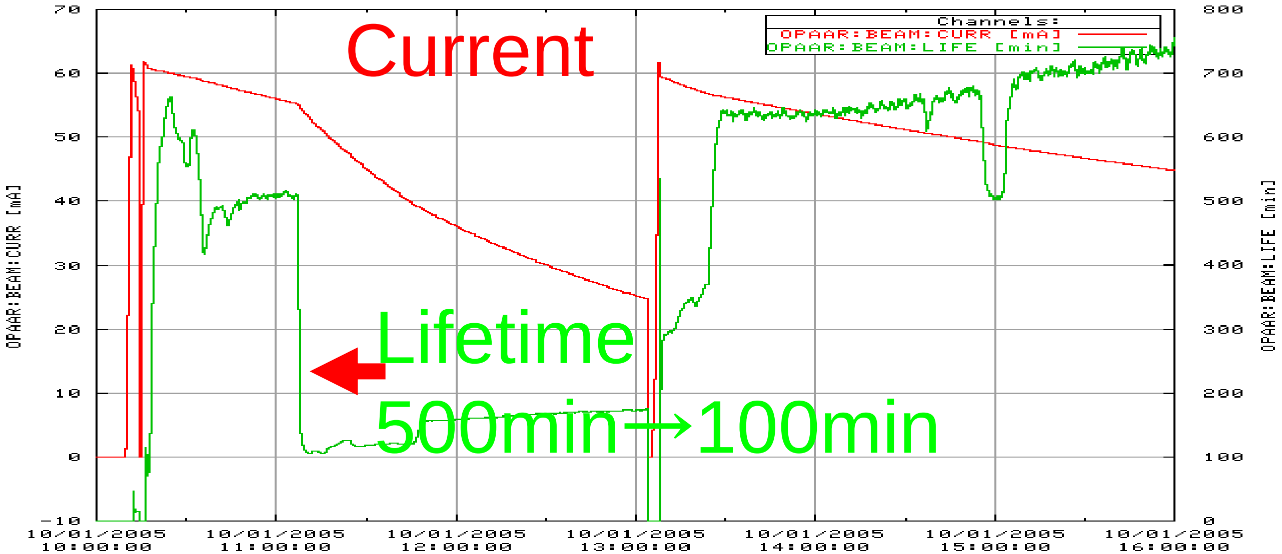
- Usual dose rate ≒ Background level
- Dose rate over the background level occurred when the beam lifetime decreased.
- Next slide shows example of this phenomenon occurred at the beam line NW12.

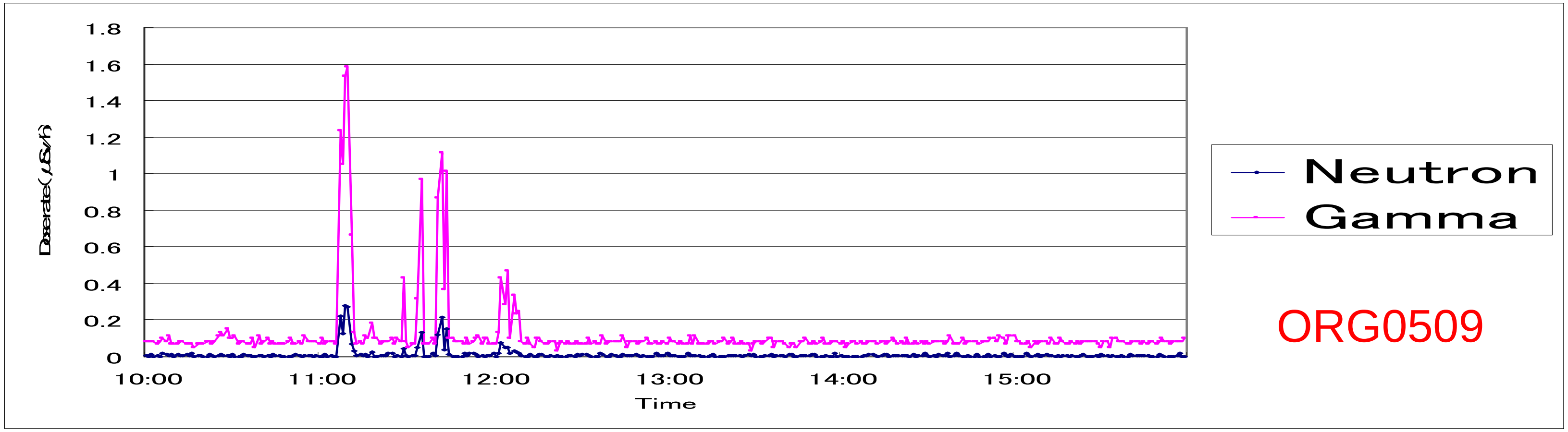


# NW12 beam line



# Sudden drop of the beam lifetime and increase of dose rate

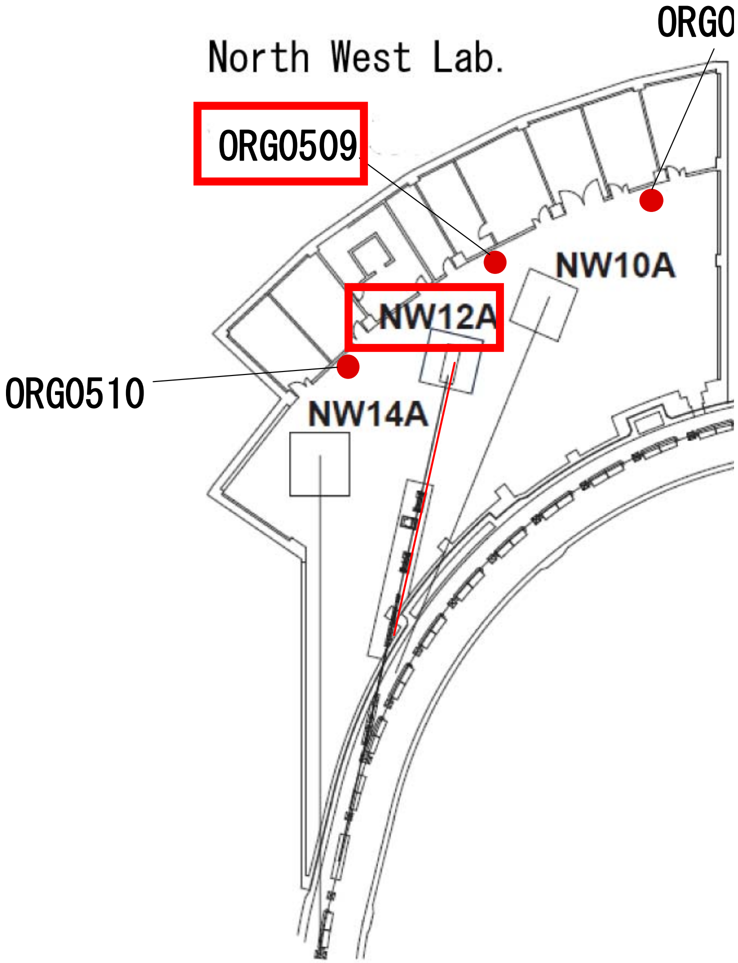


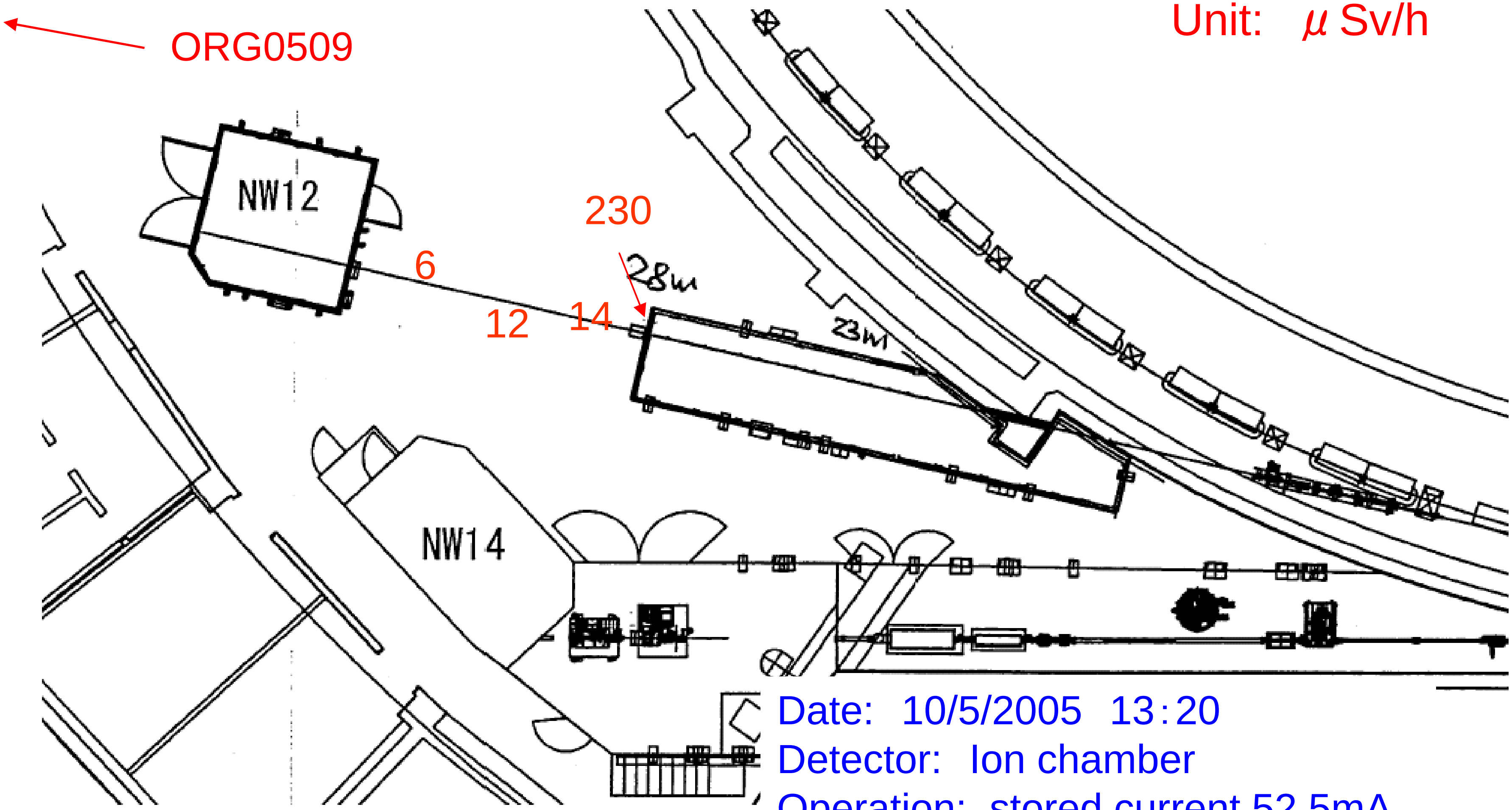

ORG0509

# Positions of beam line NW12 and monitor ORG509

- Radiation source was the upper of NW12.
- Maximum dose rate at ORG509 was 1.6 $\mu$ Sv/h.
- ORG509 was at long distance from the radiation source. We tried to measure near the beam line.

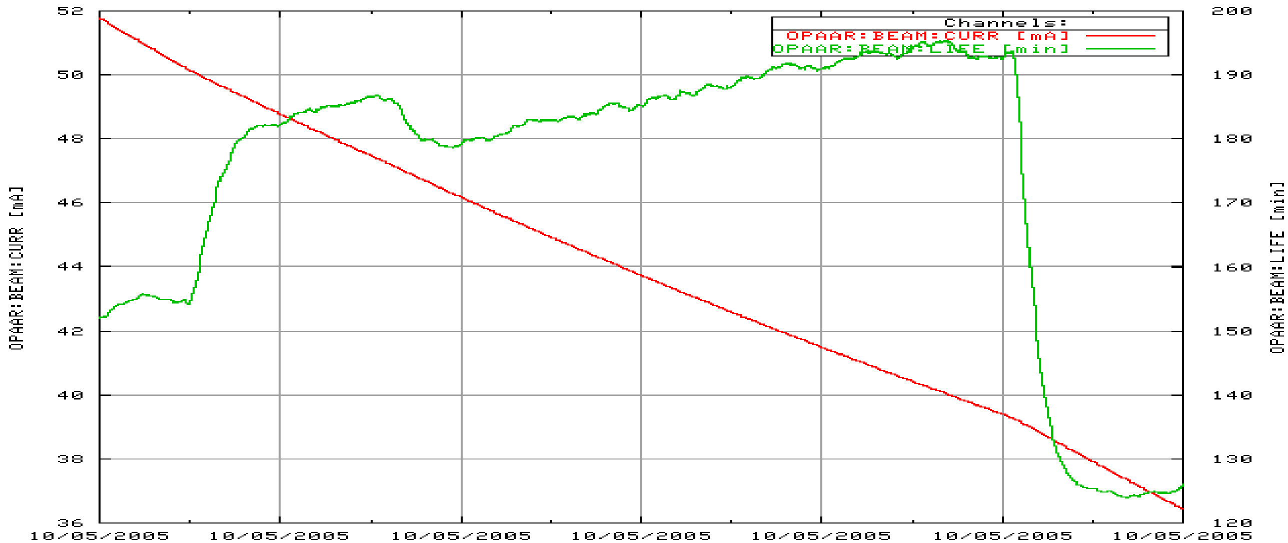


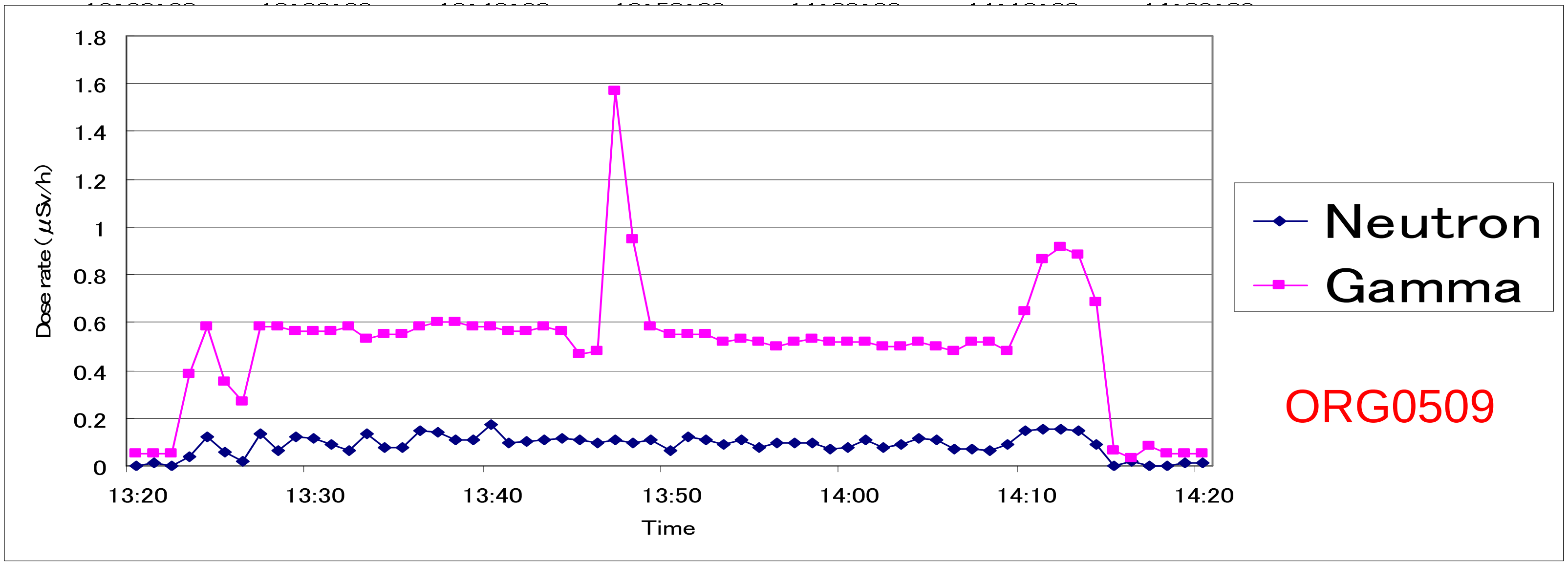
# Radiation measurements around the beam line NW12




Date: 10/5/2005 13:20
Detector: Ion chamber
Operation: stored current 52.5mA
lifetime 186minutes

# Beam lifetime and dose rate at ORG0509 during the measurement



# Condition of the incident

- Changing the gap of NW14 insertion device narrowly often triggered the incident.
- The vacuum level was worse.
- The beam lifetime decreased.
- The dose rate around the beam line increased. NOT around other beam line.
- The dose rate returned to B.G. when the main beam shutter (MBS) was closed.

# The first things what we did for safety

- We set up the area where people were not allowed to enter.
- We changed temporarily the alarm level of the monitors. (20 μ Sv/h → 1 μ Sv/h)

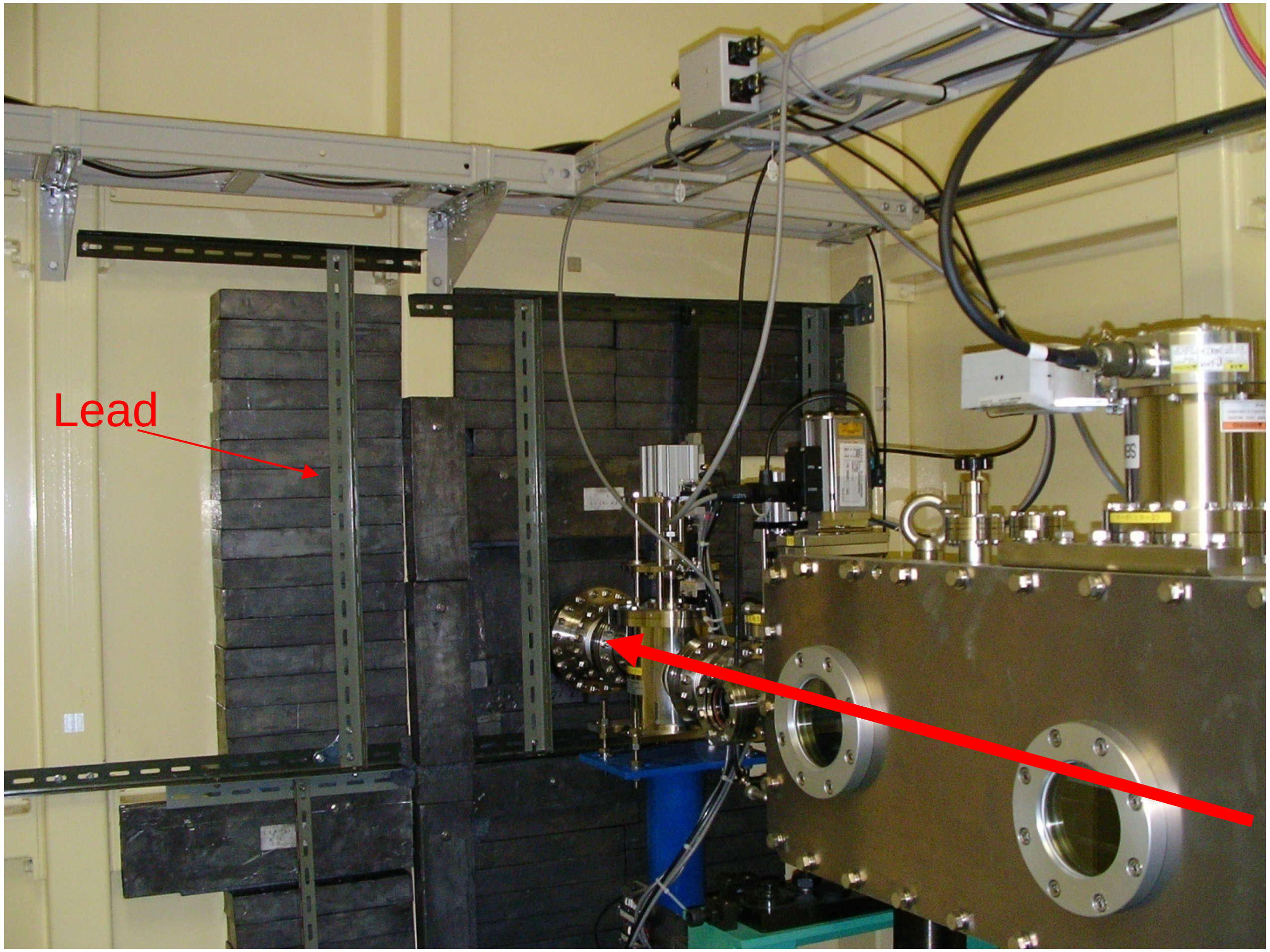
# Study

- The beam orbit was newly arranged for installing new beam line NW14. So it was suspected for the reason. However old beam orbit did not change the situation.
- Measurement of residual radiation from the beam duct of the ring showed the duct near the steering magnet of NW12 was activated. This phenomenon is considered bremsstrahlung due to dust trapping near the duct.
- Checking the log of the monitors showed similar incidents were occurred before. (not so often)

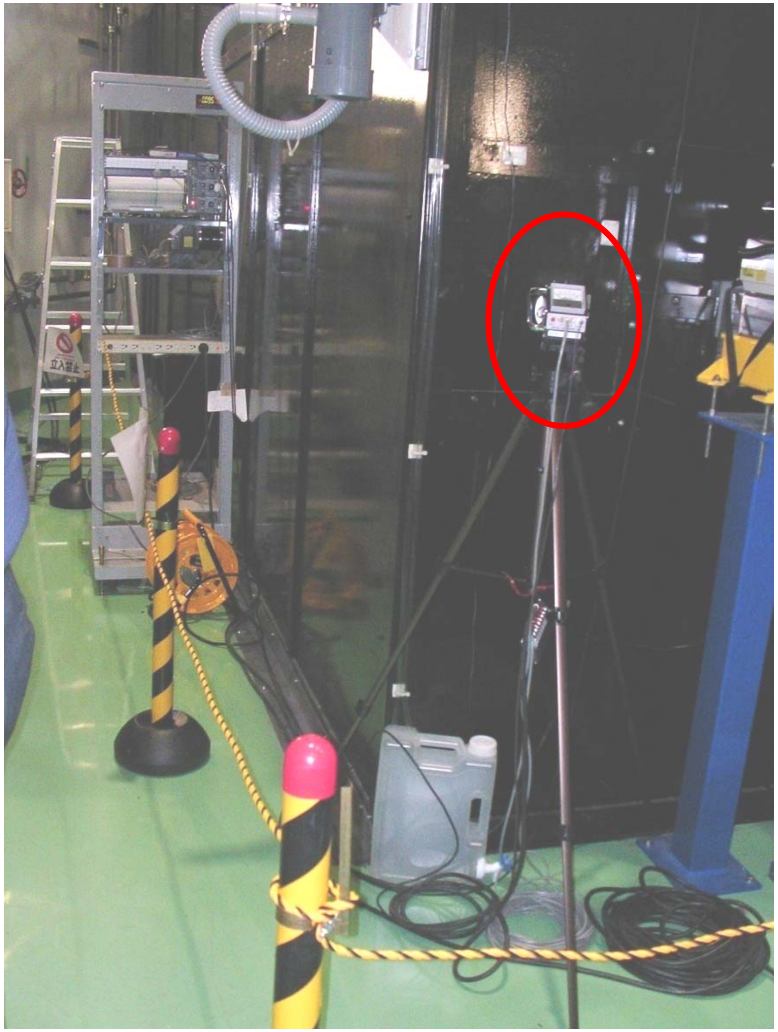
# Protection

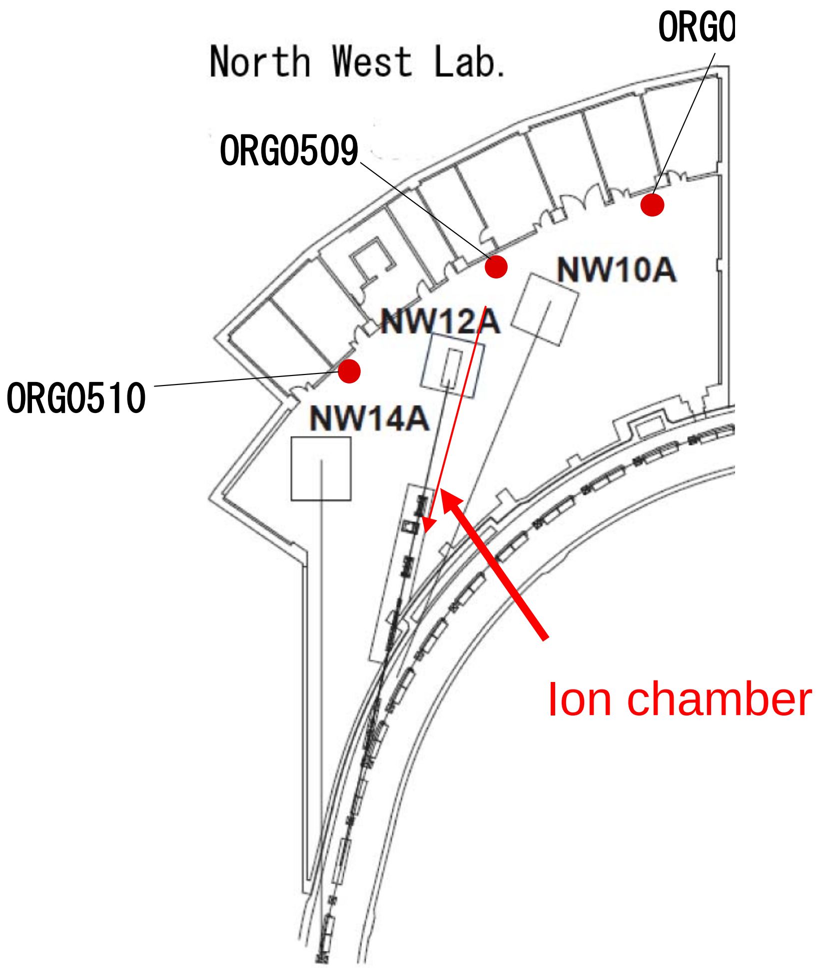
- Lead blocks were installed in the optic hutch of the beam line.
- An ionization chamber for interlock was installed out of the optic hutch. It closes MBS when the dose rate exceeds 5 $\mu$ Sv/h and continues for 3 minutes.
- The area monitor was replaced to detect radiation effectively later.

# Shield in the main hatch



# Ion chamber for interlock and replaced ORG0509






ORG0509 is not seen in this picture.
It replaced later.

# Result

- The frequency of the incident around NW12 decreased. Other beam line (ex. NE3)  had the incident also, but not so often.
- One of sources of the dust is considered distributed ion pump (DIP).The frequency of the incident has decreased since  DIP-OFF operation started.
- More study is needed.