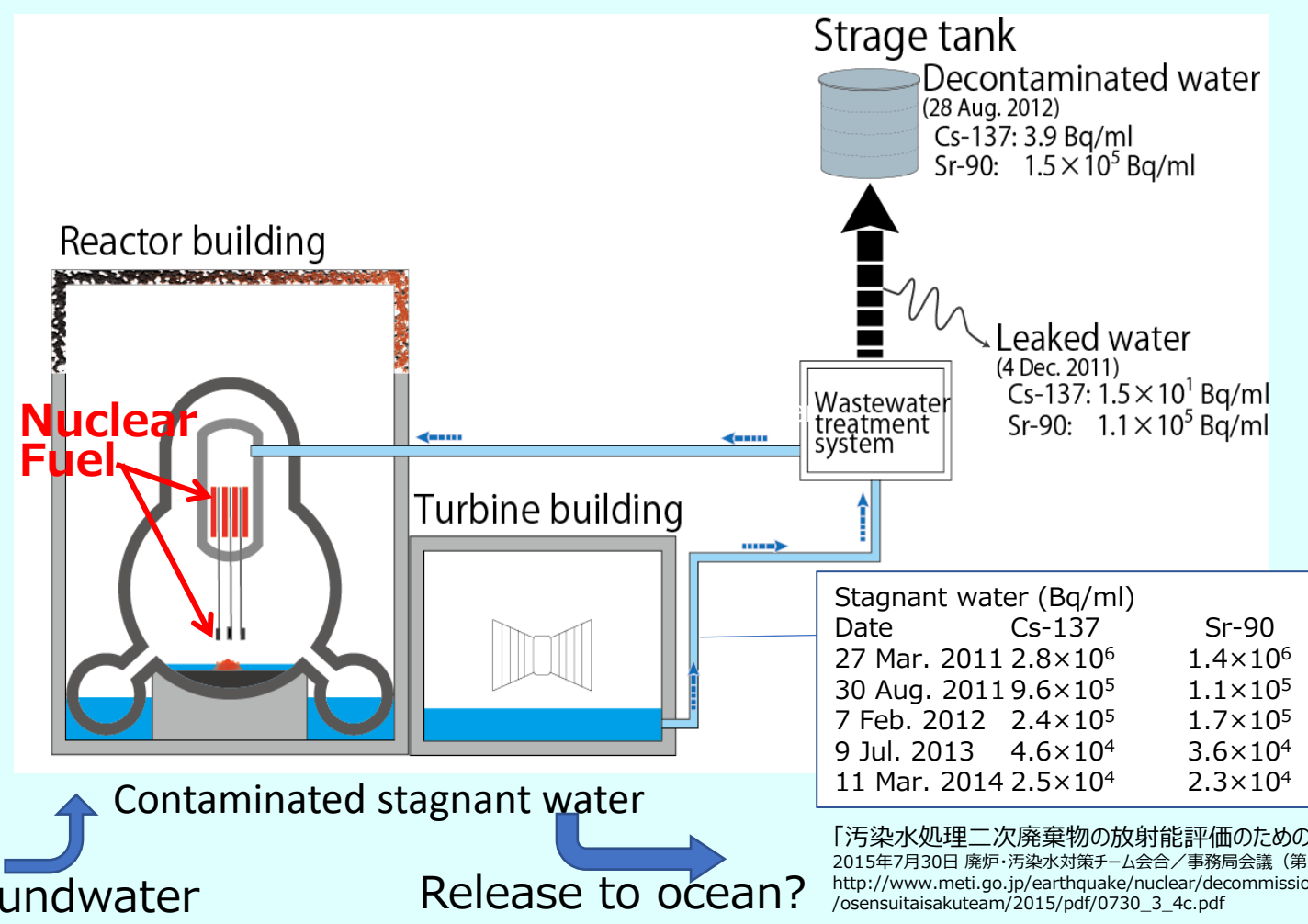


Released strontium-90 from the Fukushima Daiichi Nuclear Power Plant to the Sea

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Sr-90 and Cs-137 activity in the reactor



The contaminated stagnant water exists in the reactor and turbine buildings. Cs-137 and Sr-90 concentrations were more than 1 MBq/mL in March 2011. Decontamination system focused on Cs removal before ALPS system working. Treated water enriched Sr-90. These processes generated possible contamination source with different Sr-90/Cs-137 ratio.

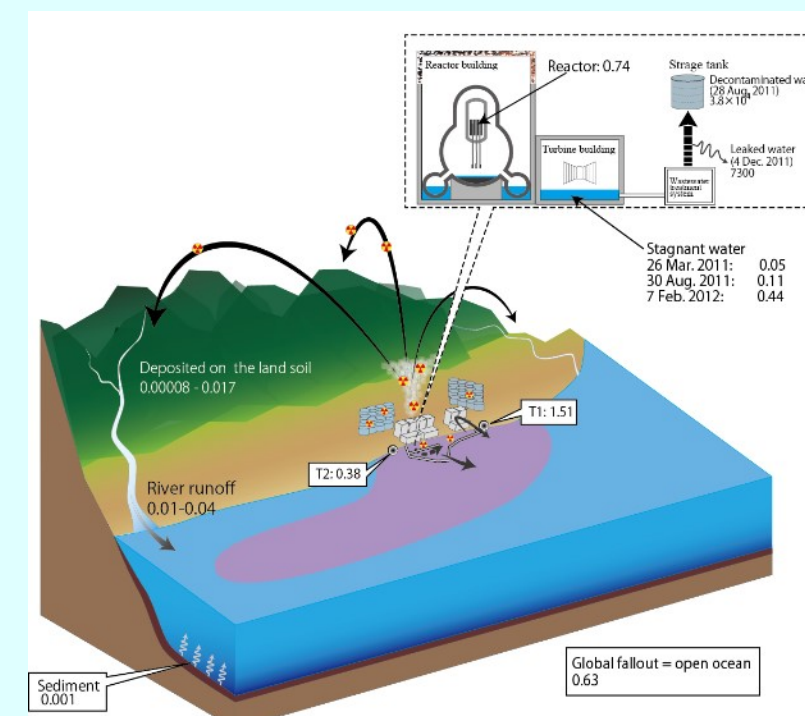
- Risk of leakage to the ocean
 - Is melted fuel in the bottom of reactor as a source?
 - Inflow of groundwater
 - Continuous release to the ocean
- 8.1 GBq Cs-137/day at Aug. 2012 (Kanda, 2013)

Why is Sr-90 analysis necessary?

- Update environmental data
- Evaluation an influence on human and wild animals

$^{90}\text{Sr}/^{137}\text{Cs}$ activity ratio provide the information about source and release process.

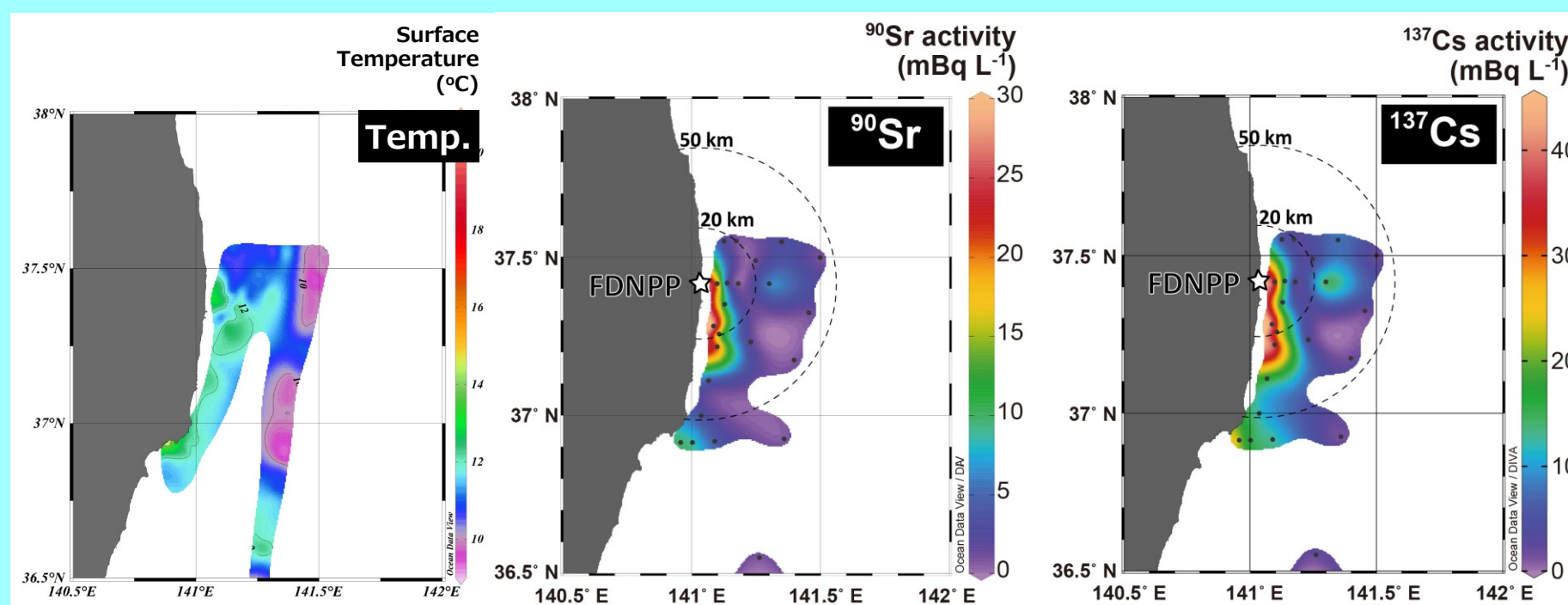
Monitoring for the status of the reactor and leakage from the contaminated water tank



$^{90}\text{Sr}/^{137}\text{Cs}$ activity ratio

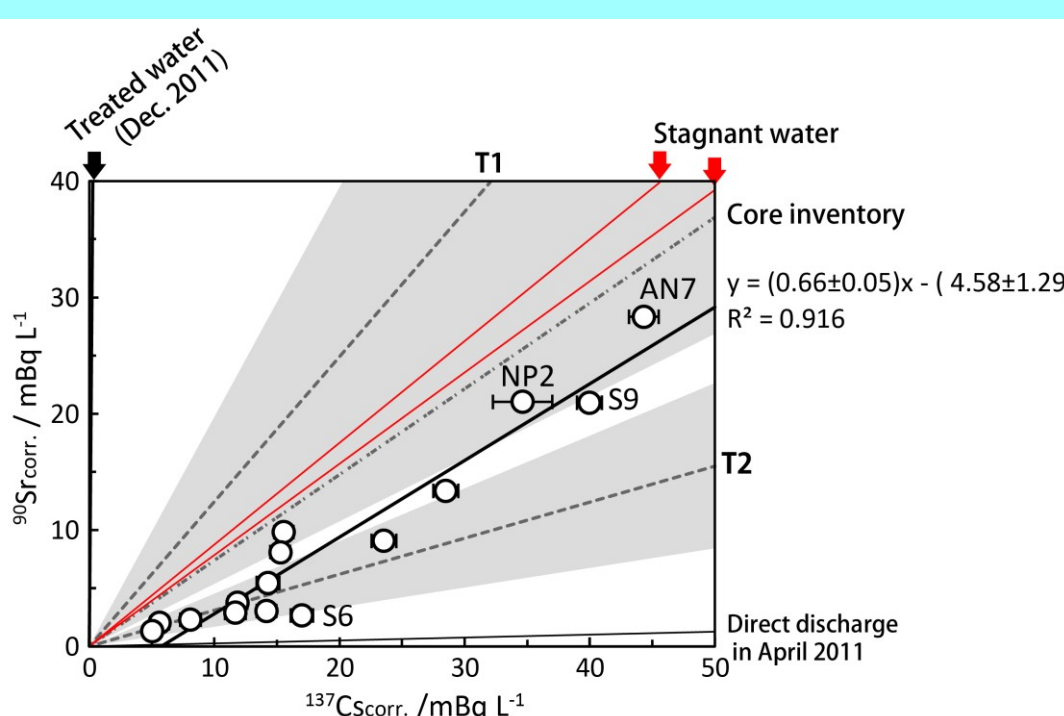
Surface distribution and $^{90}\text{Sr}/^{137}\text{Cs}$ ratio in May 2013

May, 2013



Surface distributions of surface temperature, Sr-90 concentration and Cs-137 concentration in the coastal area along Fukushima Prefecture

High Sr-90 and Cs-137 concentration water moved to south along the Fukushima coast with warm coastal current. However, offshore region in the cold Oyashio Current, Sr-90 concentration were corresponds to the background level. Background was derived from atomic bomb testing. This results indicate that influence from the Fukushima is minor in the open ocean.



Sr-90/Cs-137 ratio of observed surface seawater. Shaded areas are seawater monitoring data near the FDNPP by Tokyo Electric Power Company.

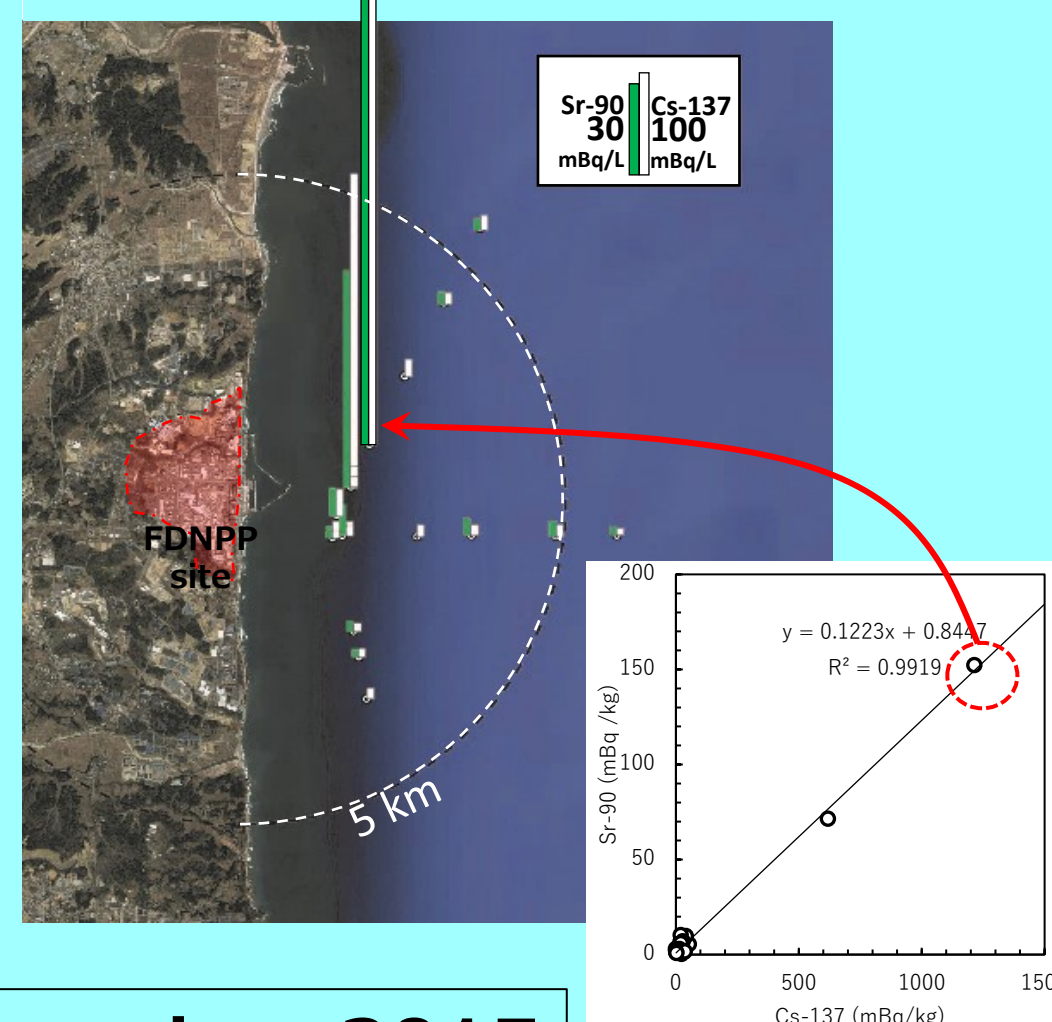
The relationship between Cs-137 and Sr-90 is reflecting the contamination source. The ratio of Sr-90/Cs-137 is 0.66, which is similar to the nuclear fuel and contaminated water in the reactor.

Release rate of Sr-90 in 2013 $9.6 \pm 6.1 \text{ GBq day}^{-1}$

Tazoe et al. 2019

Concentrated observation at the vicinity of FDNPP

May, 2014



Most of data are lower than 10 mBq/L. However, extremely high Sr-90 and Cs-137 concentrations were observed at two locations near the power plant. This spike signal clearly indicated that leakage from the power plant was still ongoing in 2014. The plume could be released by tidal pumping and detected before dispersion to the surrounding area.

$^{90}\text{Sr}/^{137}\text{Cs}$ ratio is 0.122. It is much lower than that of the contaminated water in the reactor ranging from 1 to 10. This difference means very serious problem arising. This implied that Cs-137 rich source (unknown) was existing other than contaminated water in the reactor.

Detection of high concentration plume of ^{90}Sr and ^{137}Cs at vicinity of the Fukushima- NPP

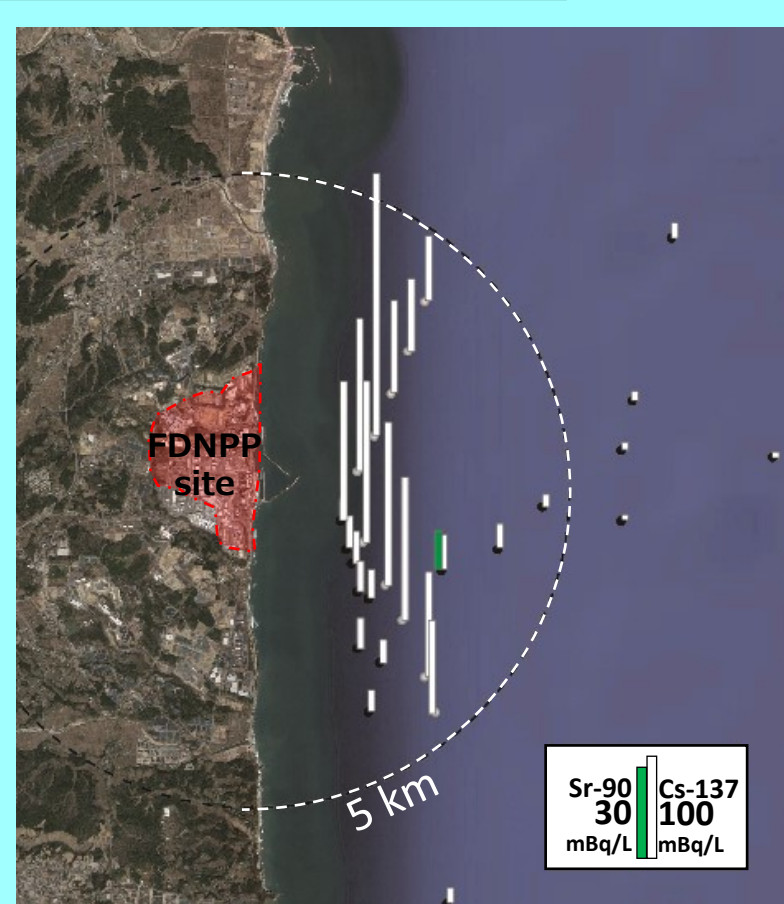
- Leakage from the power plant
- Plume could be released by tidal pumping and detected before dispersion
- $^{90}\text{Sr}/^{137}\text{Cs}$ ratio is 0.122. It is much lower than that of the contaminated water in the reactor ($^{90}\text{Sr}/^{137}\text{Cs} = 1-10$).

Another ^{137}Cs source?

- In 2015, only Cs-137 signals were observed. Cs-137 concentration were more than 100 mBq/L within 5km circle from the plant.
- Sr-90 concentration was observed at only one location. Others were less than detection limit of 3 mBq/L.

Sr-90/Cs-137 ratio were less than 0.03, which is different from expected contamination source!!

December, 2015

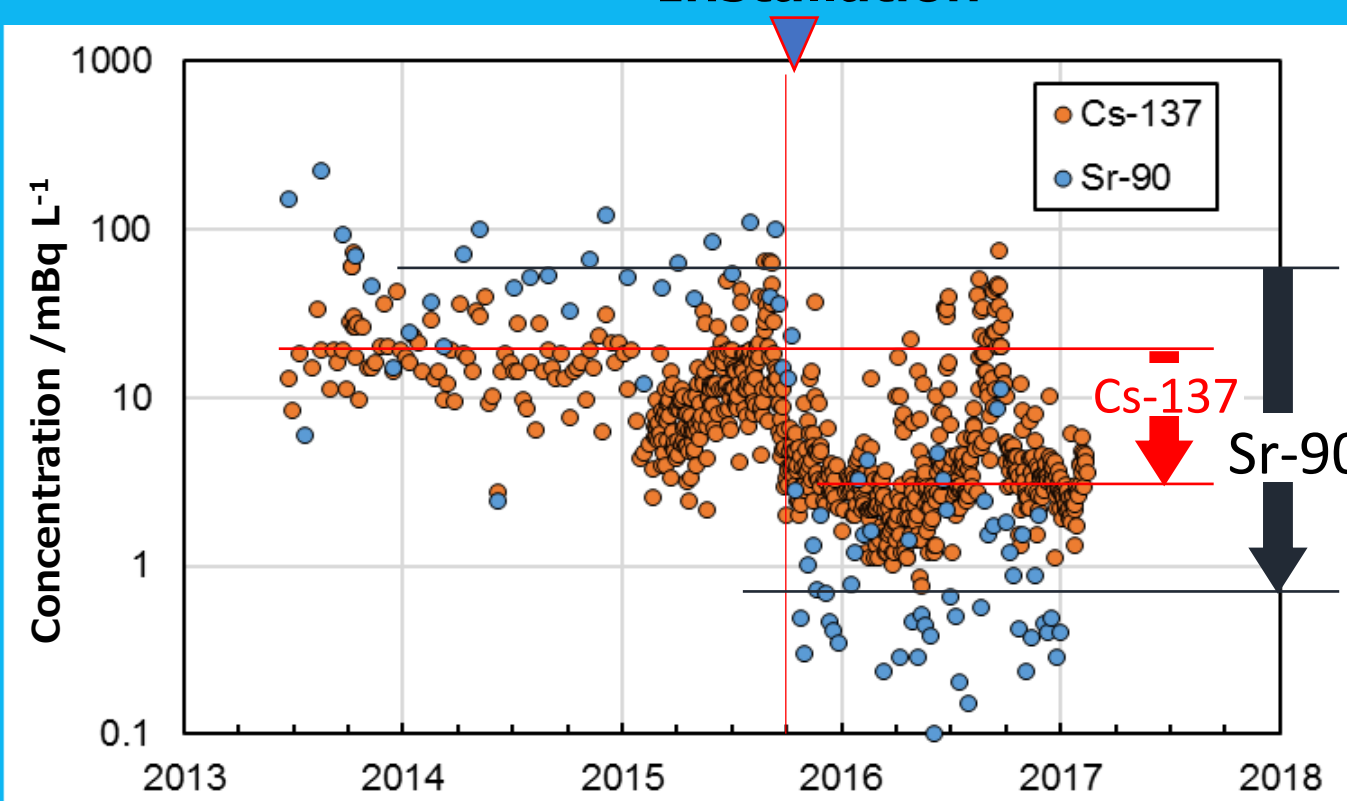


What's happened between 2014 and 2015?

Installation of the seaside water shielding wall (10th Sep. - 26th Oct, 2015)

Temporal variation of concentrations of Sr-90 and Cs-137 in the FDNPP harbor

Installation



In the harbor, Sr-90 concentration suddenly decrease two orders of magnitude after installation of the seaside water shielding wall. Cs-137 concentration is also decrease, but one order of magnitude.

Good news

The leakage from the reactor to the harbor was significantly suppressed (not zero). Release rate of Cs-137 was also decreased.

Bad news

Other Cs-137-rich source and release process existed.

