2016 North American ISOE ALARA Symposium

Restart Status of Japanese NPPs, Filtered Containment Venting System (FCVS), New Regulatory Requirements & Super Engineer Education Project

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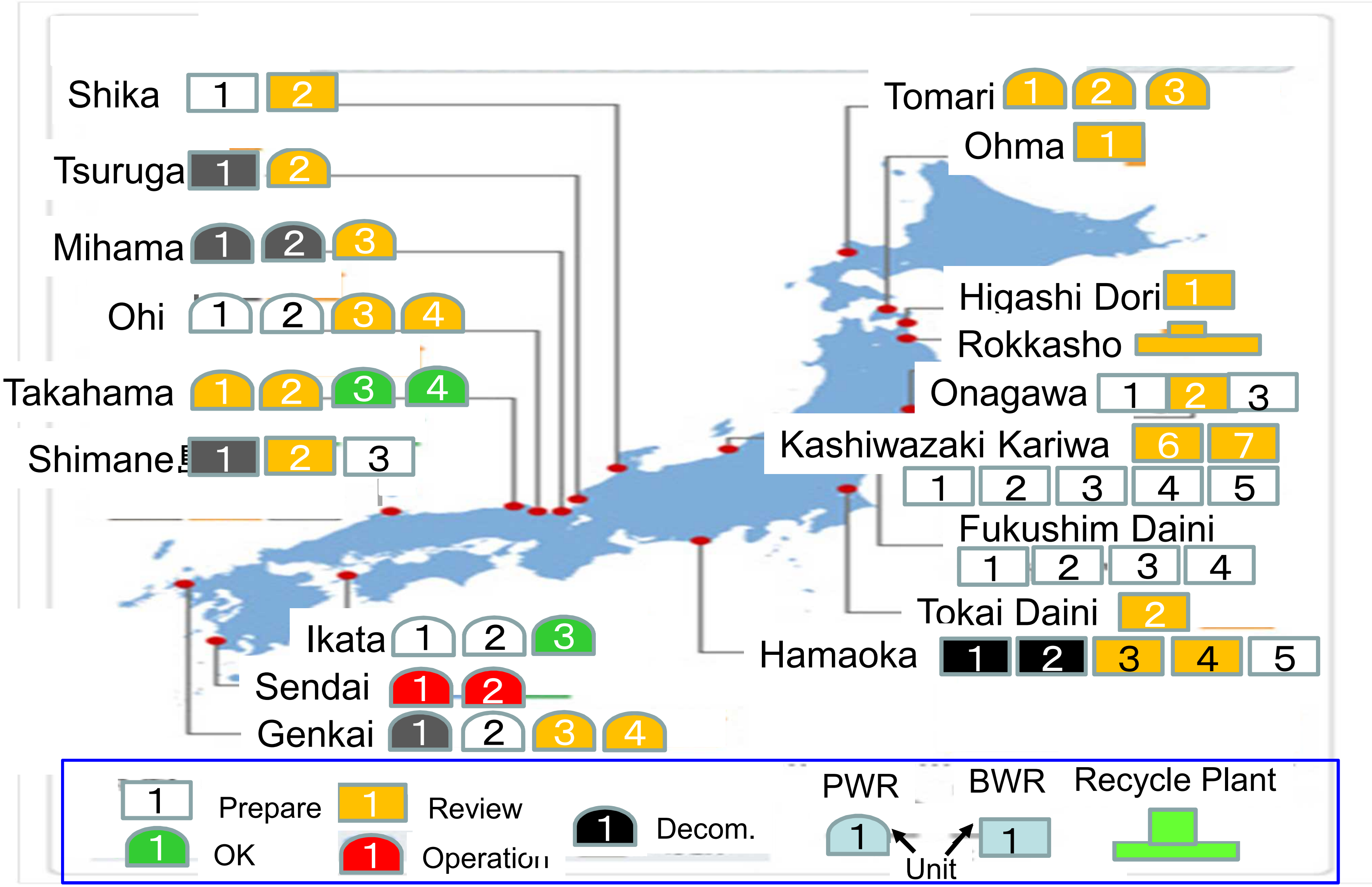
Prestart Status of Japanese NPPs



Sendai 1, 2 restarted in 2015

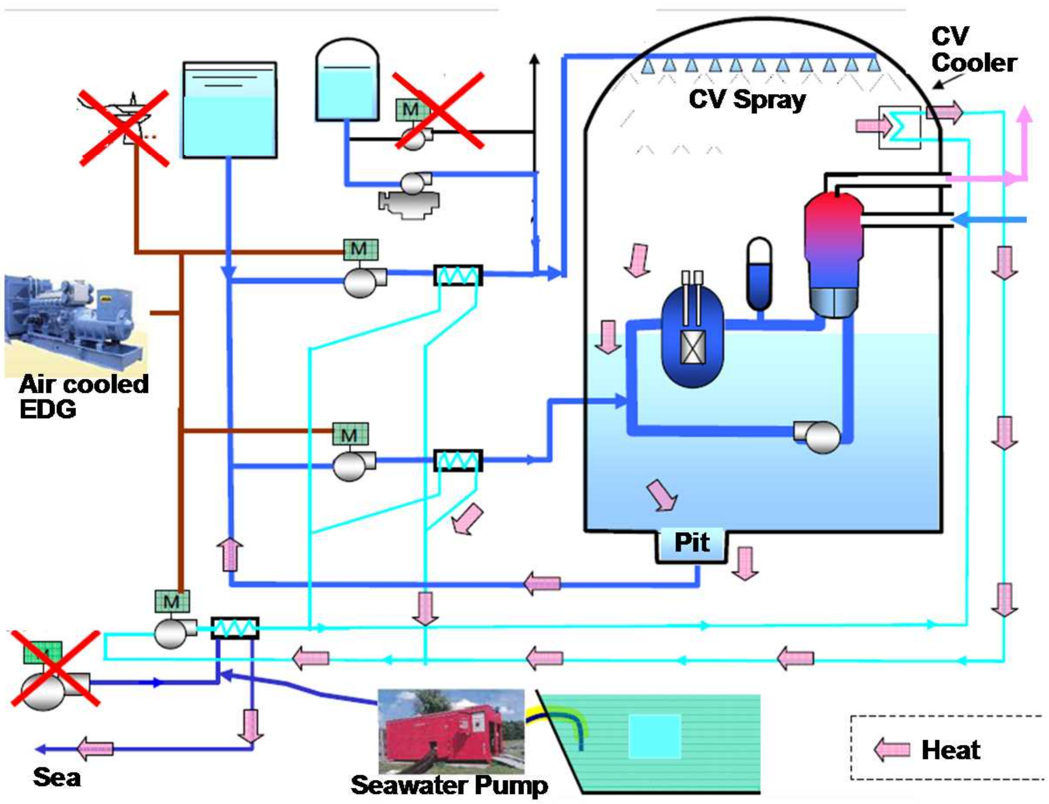
Congratulations for Restart Sendai NPP Unit 1 and 2 (890MWeX2)

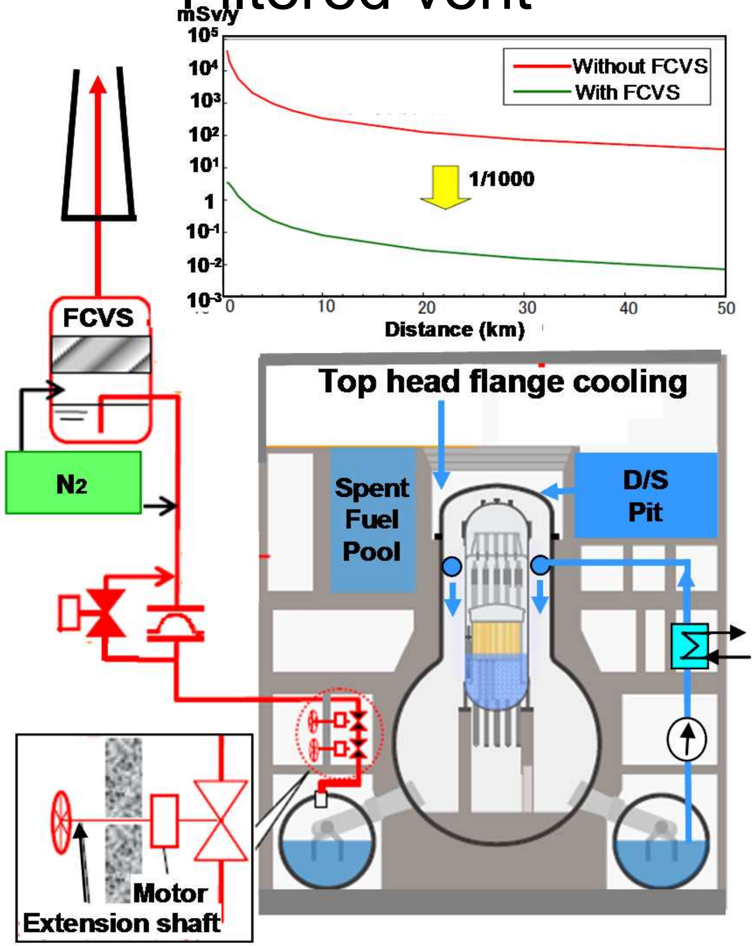
Takahama 3, 4 are ready to restart

Protect CV and PCV cooling

PWR: CV Spray, CV recirculation cooling, PAR

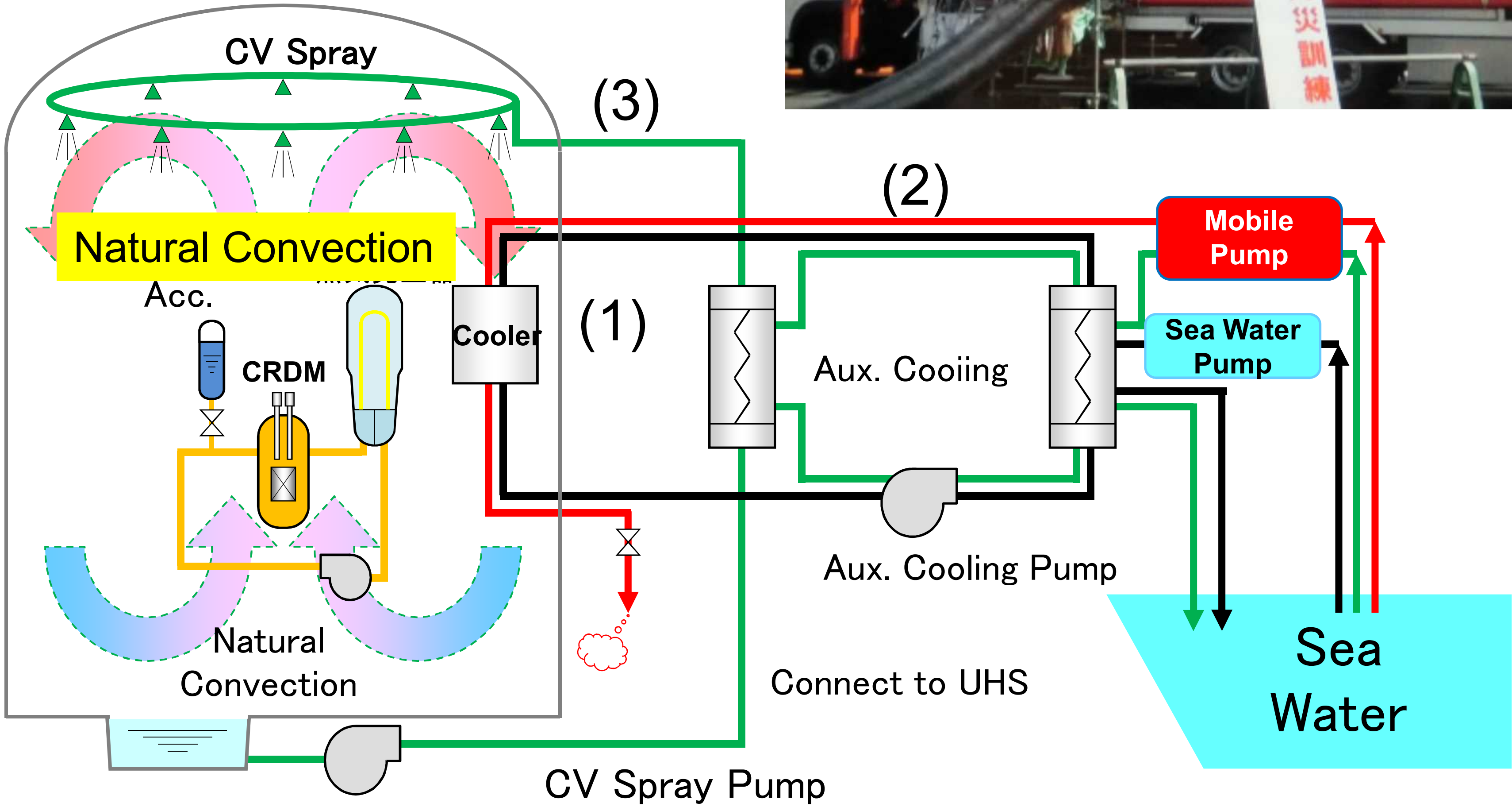
BWR: PCV Spray and RHR, Filtered vent



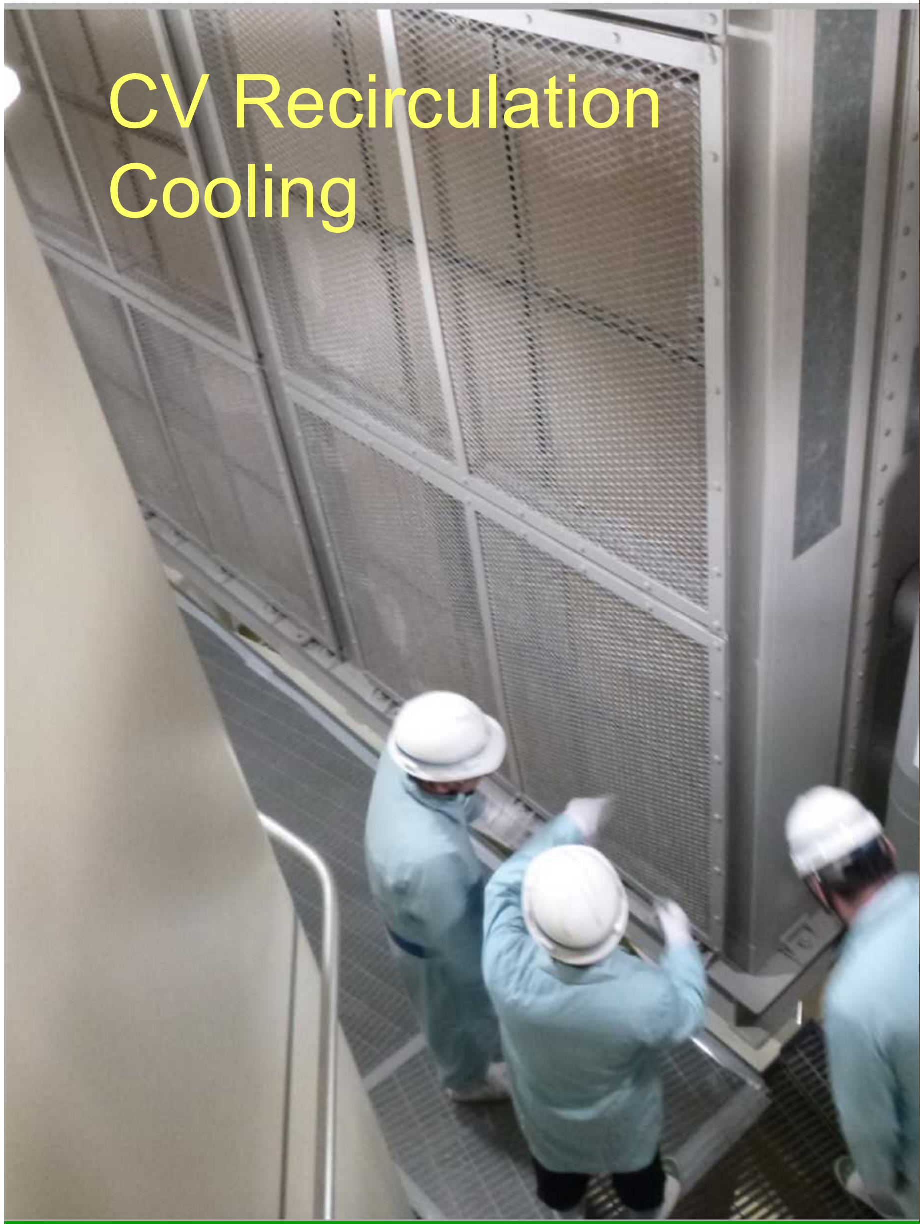


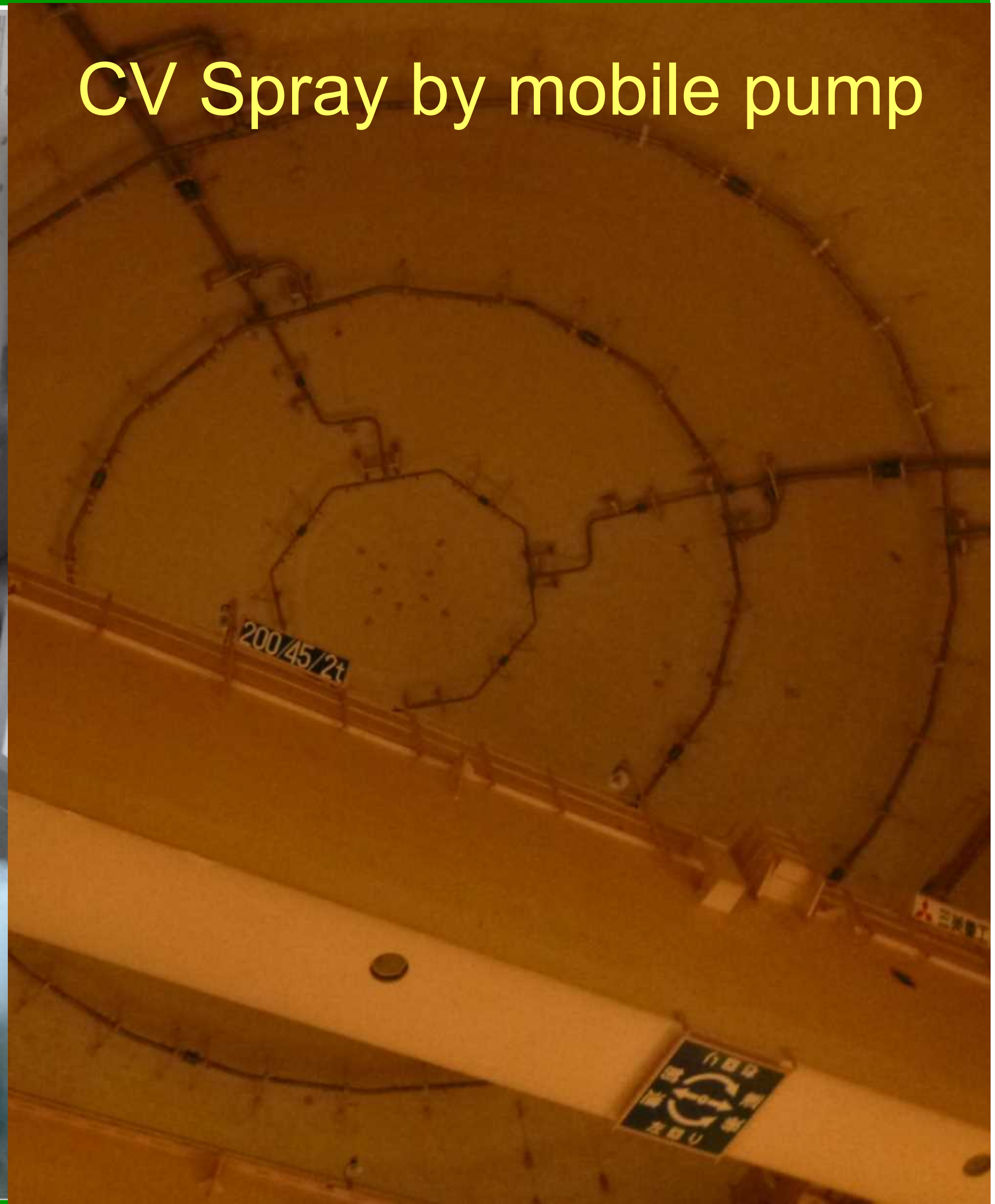
CV Cooling: Mobile pump for cooling (Sendai NPS)

(1)CV Cooling unit
(2)Seawater (3) CV Spray



Resilience for CV Cooling





Resilience for H_2 Accumulation

Tsunami Protection: Water proof door

Mortar Driven Water Injection Pump

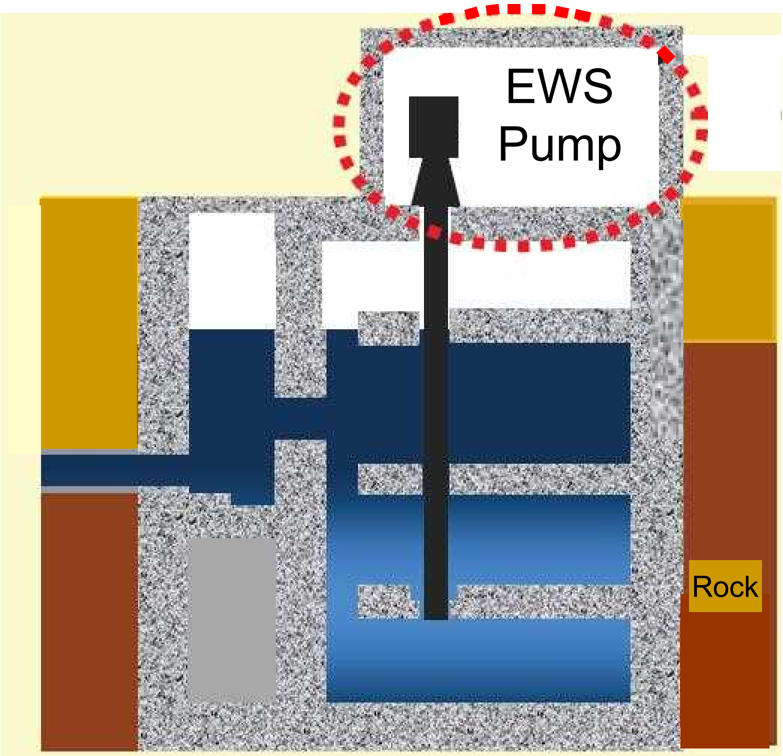
Diesel Engine Driven Water Injection Pump (Diversity is important)

Resilience for Water Injection: Motor Driven Pump (Diversity)

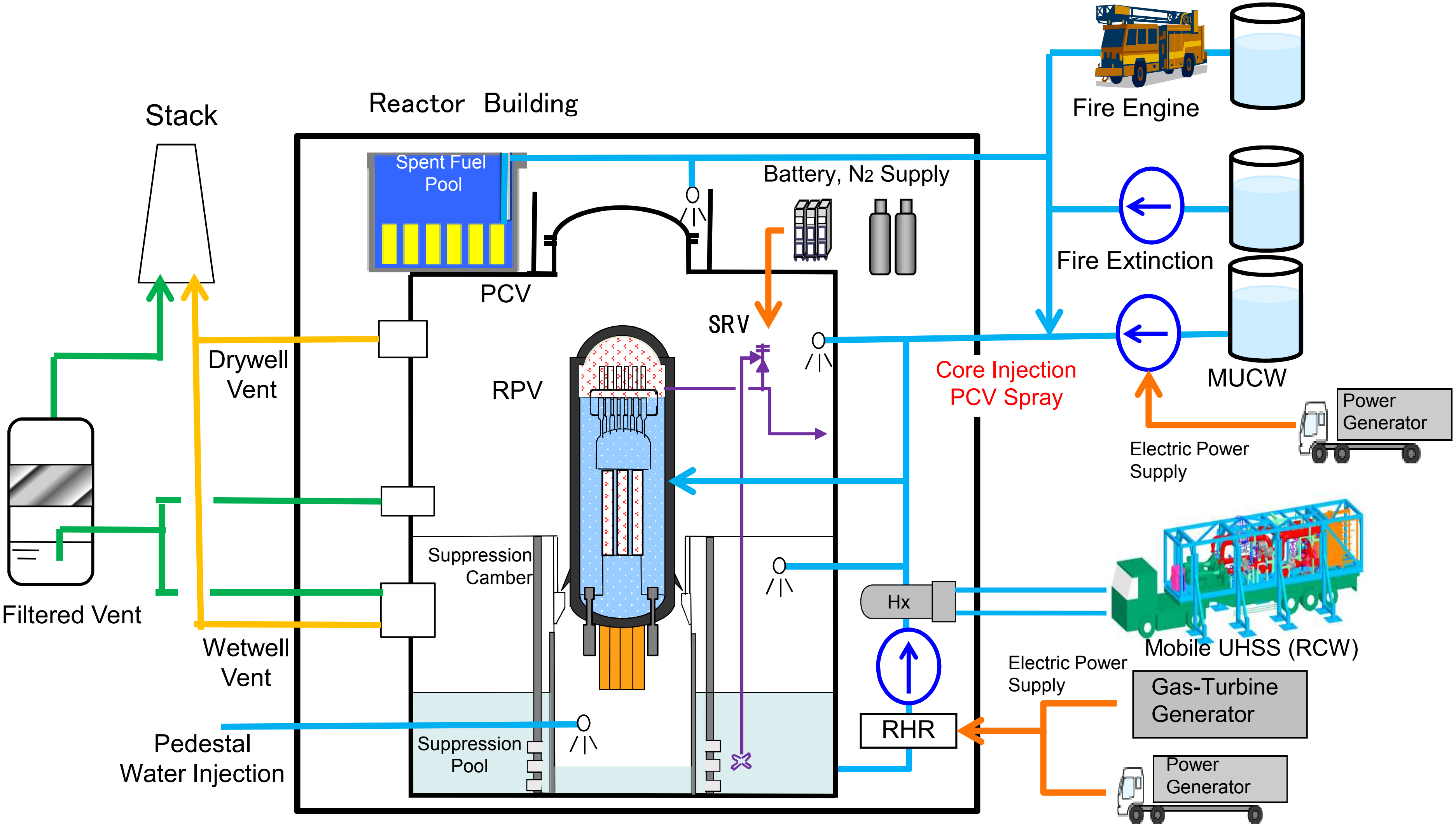
Portable Water Supply Pumps for Resilience Action at Ikata NPS

Resilience for CV damage:Water Cannon

Snorkel Building at Hamaoka



Measures for SA in BWR

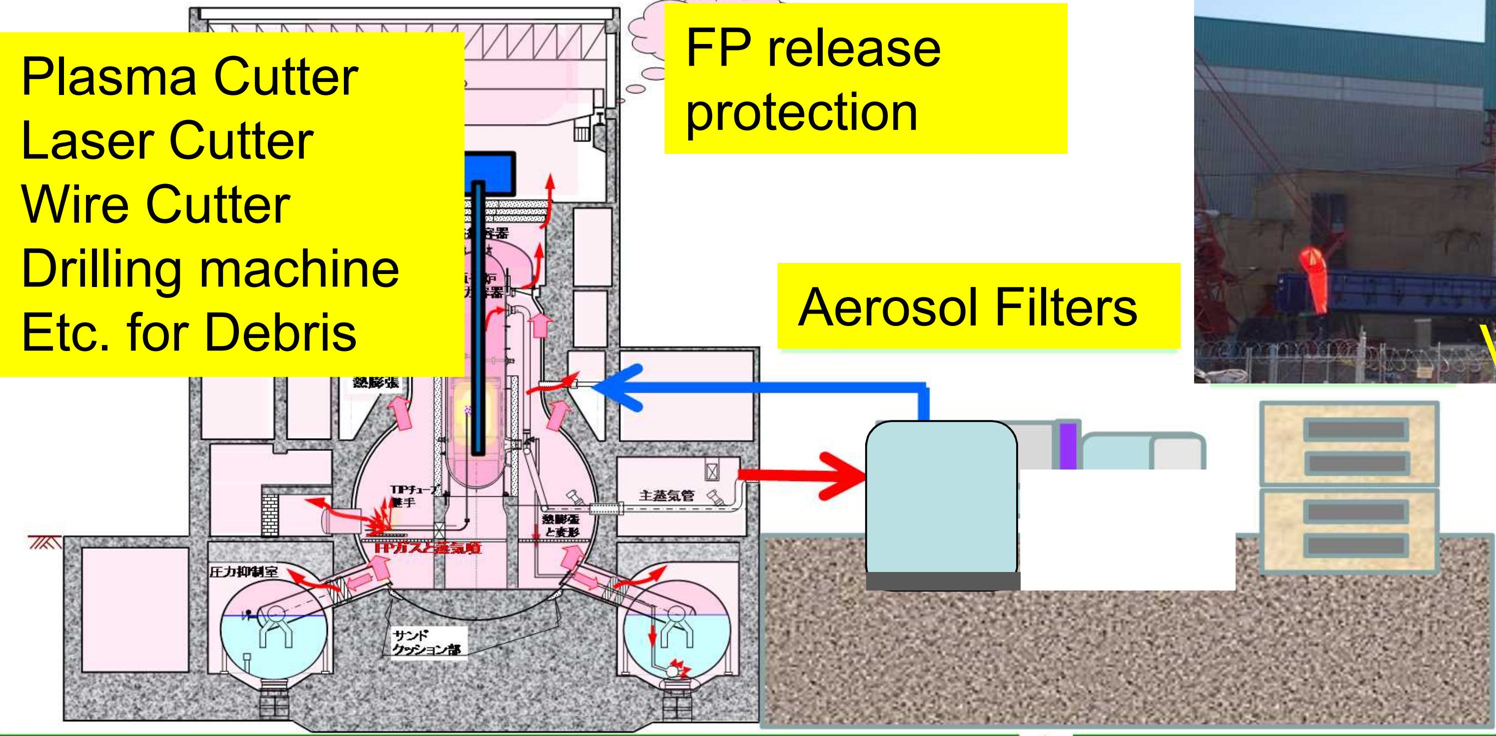


MEXT Project for Nuclear Human Resource Development

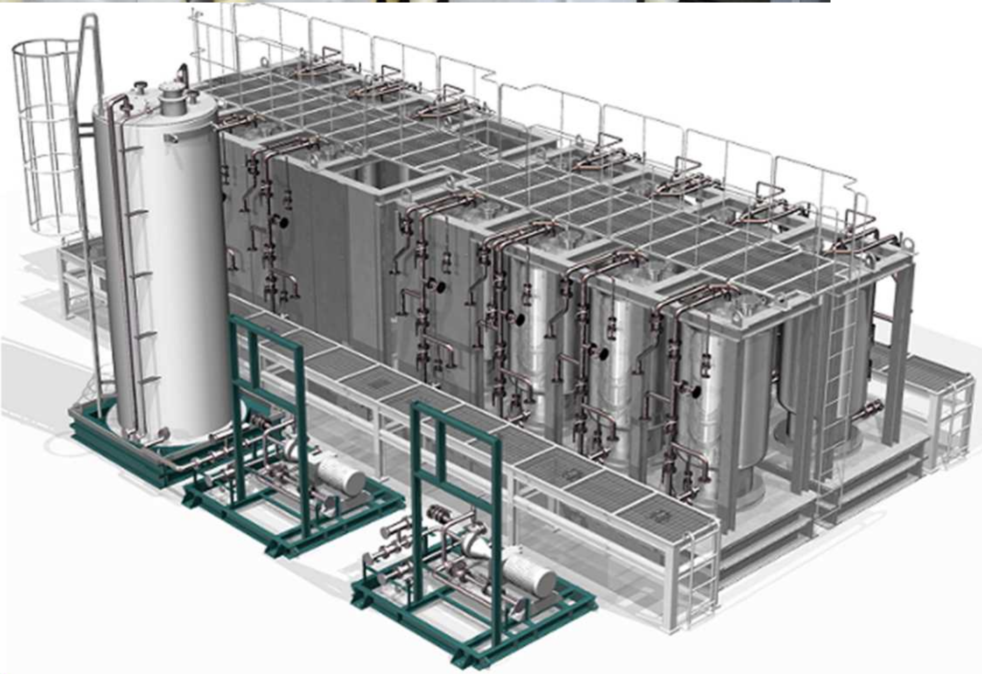
Development of a high efficiency multi-nuclide aerosol filters for radiation protection during a process of cutting core debris at Hokkaido University

For Fukushima-Daiichi Decommissioning Radiation protection during a process of cutting core debris should be needed.

- In order to develop an air clean up system for radiation protection during a cutting core debris of the Fukushima Daiichi NPP as a process of their decommissioning, a high efficiency filters should be developed, such as a wet-type aerosol filter, a metal fiber filter, a silver zeolite



Advanced Liquid Processing System (ALPS)



Treat the contaminated water by removing radionuclides

750
Tons/day in first installed system

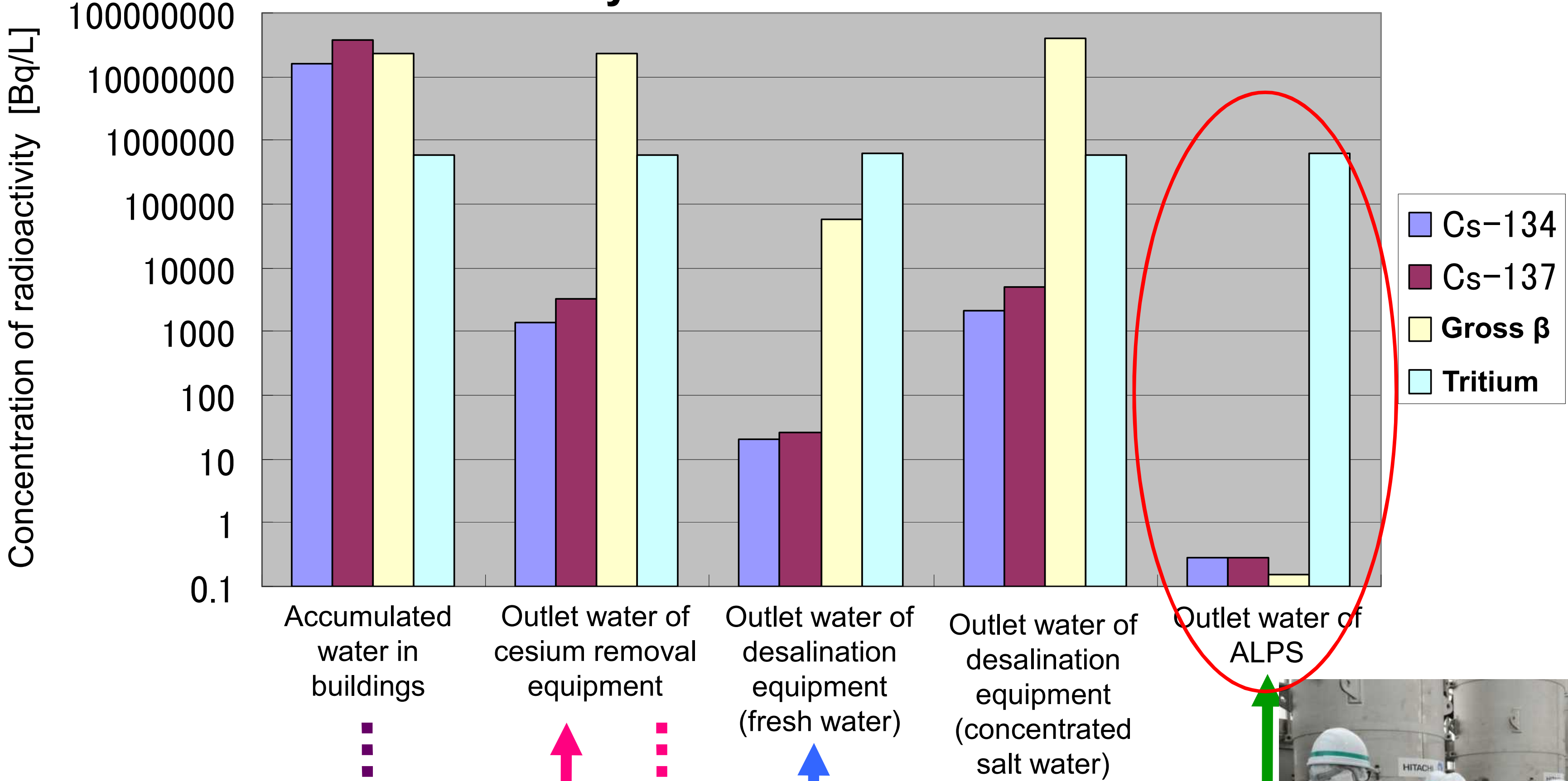
2,000
Tons/day with first installed system
+ additional system
+ high-performance system

120,000+
Tons of contaminated water processed so far

REMOVE SOURCES OF CONTAMINATION

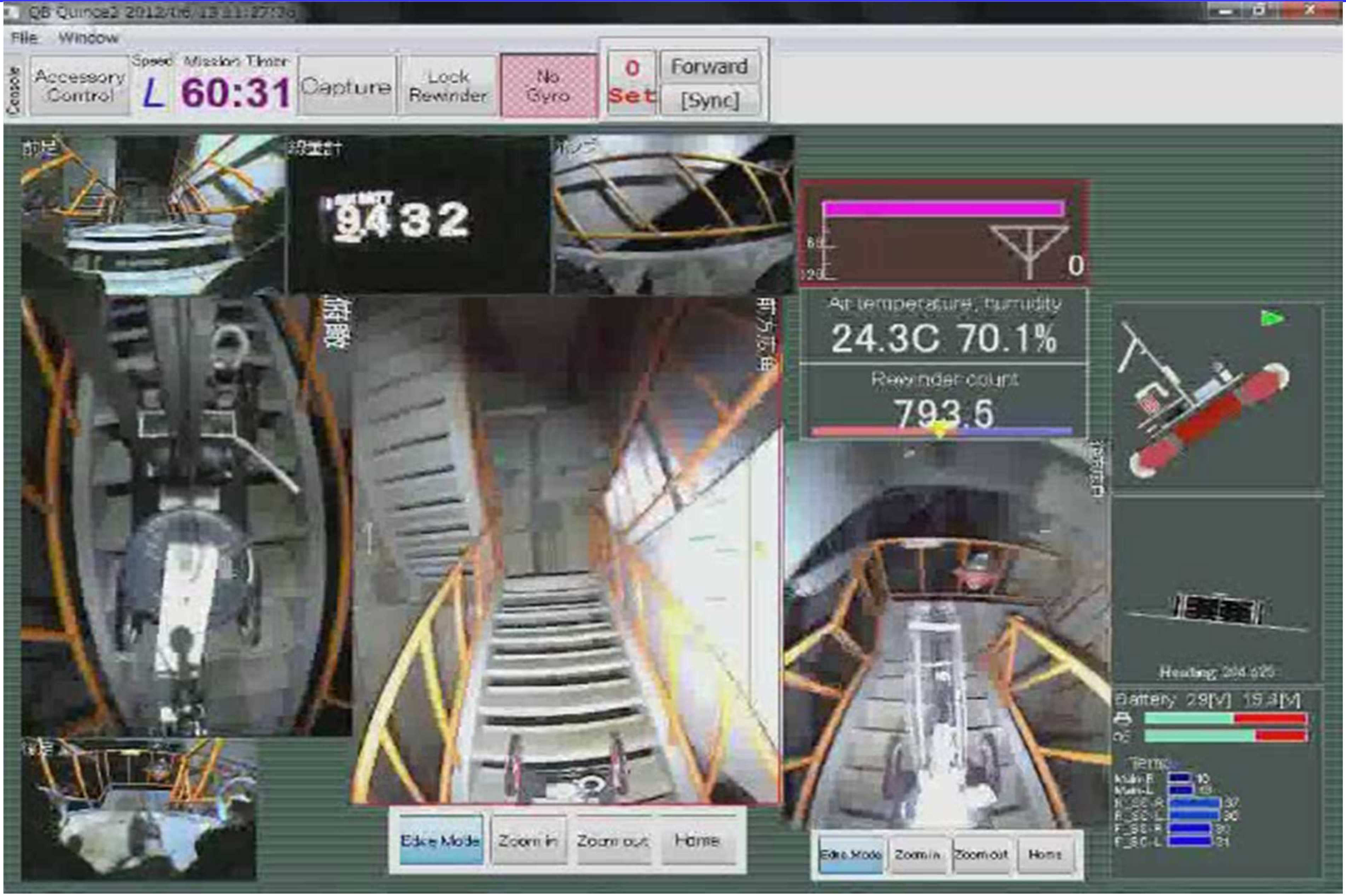
Contaminated Water Status

Radioactivity concentration of main nuclides

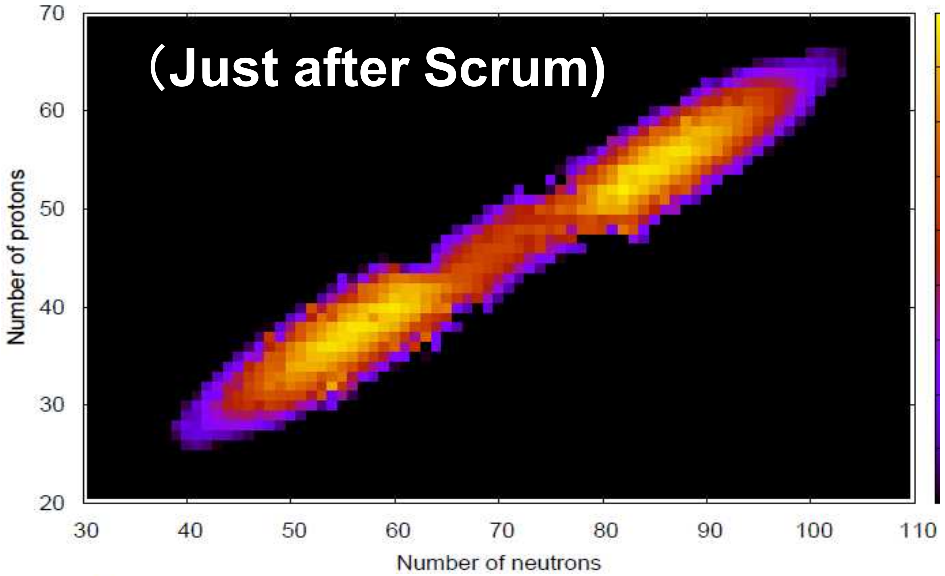


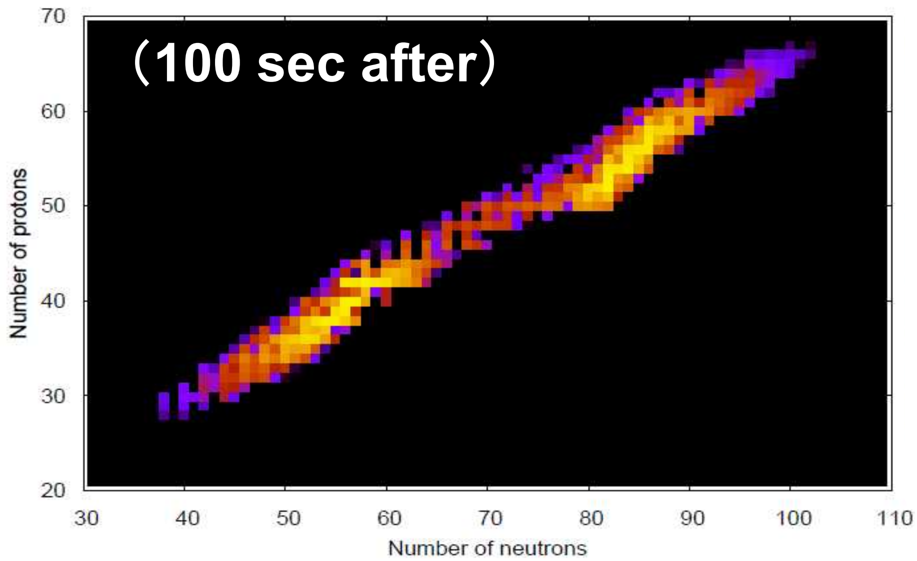
* Sampling was conducted on Nov. 5, 2013 （April 9 to 12, 2013 as for ALPS outlet water）

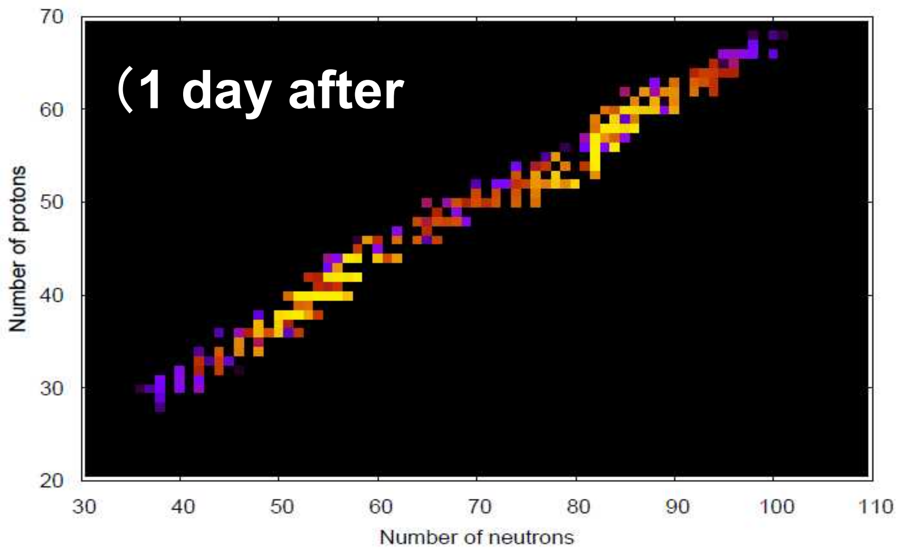
Robotics for Resilience Action at Fukushima Daiichi NPS



Inventory analysis for all the Radio Active Nuclides







Number of Neutron VS.
Number of Proton Mapping
Show decay of unstable
nuclides after scrum

There are many aerosols except agonic Iodine

- I^{129}:Decay constant=16 million years, CH_3I may cause of thyroid cancer

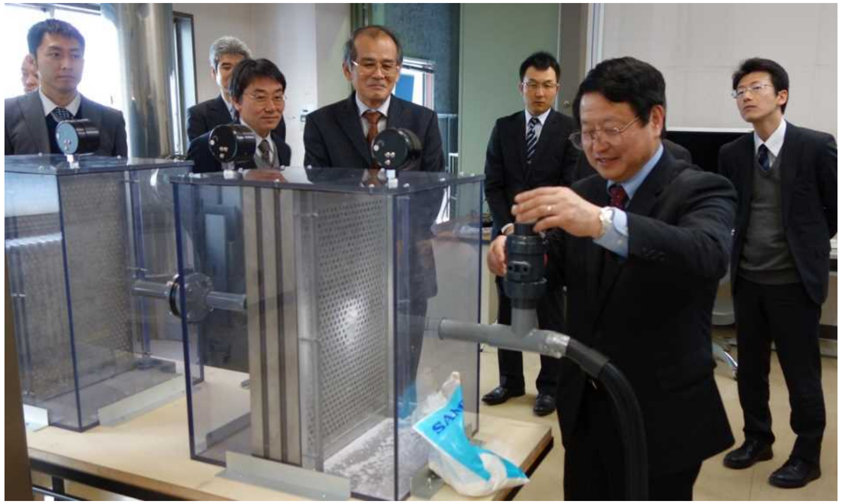
Inventory of nuclide in Fukushima Daiichi Unit 2

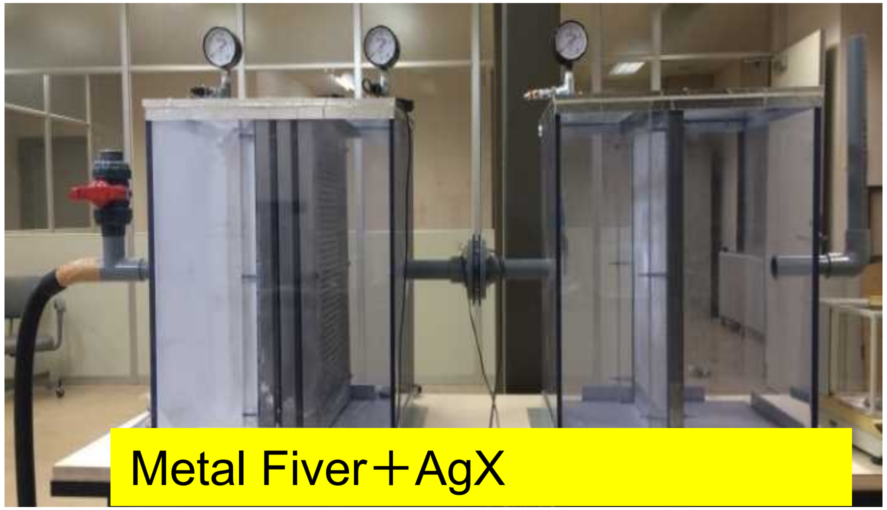
012-018 抜粋

	0h	1h	3h	10h	1d	3d	10d	30d	90d	180d	1y	2y	5y	10y	20y
	Activation														
C13	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2	3.98E+2
O16	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7	1.26E+7
O17	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3	5.12E+3
O18	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4
Cr50	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2	7.84E+2
Cr52	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4	1.60E+4
Cr53	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3	1.83E+3
Cr54	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2	5.13E+2
Fe54	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3	2.79E+3
Fe56	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4	4.56E+4
	Actinide														
U234	1.75E+2	1.75E+2	1.75E+2	1.75E+2	1.75E+2	1.76E+2	1.77E+2	1.80E+2	1.89E+2	2.04E+2	2.34E+2	2.95E+2	4.76E+2	7.69E+2	1.32E+3
U235	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6	1.70E+6
U236	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5	2.99E+5
U237	4.38E+2	4.36E+2	4.32E+2	4.20E+2	3.95E+2	3.22E+2	1.57E+2	2.01E+1	4.46E-2	2.24E-3	2.18E-3	2.07E-3	1.80E-3	1.41E-3	8.72E-4
U238	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7	8.91E+7
Np237	2.40E+4	2.40E+4	2.40E+4	2.40E+4	2.40E+4	2.41E+4	2.43E+4	2.44E+4	2.44E+4	2.44E+4	2.44E+4	2.44E+4	2.45E+4	2.47E+4	2.53E+4
Np239	5.03E+3	4.99E+3	4.88E+3	4.48E+3	3.77E+3	2.09E+3	2.67E+2	7.45E-1	3.46E-3	3.46E-3	3.46E-3	3.46E-3	3.46E-3	3.46E-3	3.46E-3
Pu238	7.22E+3	7.22E+3	7.22E+3	7.23E+3	7.23E+3	7.26E+3	7.29E+3	7.35E+3	7.48E+3	7.62E+3	7.77E+3	7.83E+3	7.68E+3	7.39E+3	6.83E+3
Pu239	3.84E+5	3.84E+5	3.84E+5	3.84E+5	3.85E+5	3.87E+5	3.89E+5	3.89E+5	3.89E+5	3.89E+5	3.89E+5	3.89E+5	3.89E+5	3.89E+5	3.89E+5
Pu240	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5	1.23E+5
Pu241	7.38E+4	7.38E+4	7.38E+4	7.38E+4	7.38E+4	7.38E+4	7.37E+4	7.35E+4	7.29E+4	7.21E+4	7.03E+4	6.70E+4	5.80E+4	4.56E+4	2.82E+4
Pu242	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4	2.42E+4
Am241	3.42E+3	3.42E+3	3.42E+3	3.43E+3	3.43E+3	3.45E+3	3.52E+3	3.71E+3	4.29E+3	5.15E+3	6.88E+3	1.02E+4	1.91E+4	3.13E+4	4.81E+4
Am243	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.03E+3	4.02E+3
Cm242	7.31E+2	7.31E+2	7.31E+2	7.31E+2	7.31E+2	7.26E+2	7.05E+2	6.48E+2	5.02E+2	3.43E+2	1.56E+2	3.32E+1	4.30E-1	1.13E-1	1.08E-1
I129	1.14E+4	1.14E+4	1.14E+4	1.14E+4	1.14E+4	1.14E+4	1.14E+4	1.14E+4	1.15E+4	1.15E+4	1.15E+4	1.15E+4	1.15E+4	1.15E+4	1.15E+4
Te130	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4	2.41E+4
Xe130	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2	3.61E+2
Xe131	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.90E+4	2.91E+4	2.93E+4	2.94E+4	2.95E+4	2.95E+4	2.95E+4	2.95E+4	2.95E+4	2.95E+4	2.95E+4
Xe132	6.86E+4	6.86E+4	6.86E+4	6.87E+4	6.87E+4	6.88E+4	6.89E+4	6.89E+4	6.89E+4	6.89E+4	6.89E+4	6.89E+4	6.89E+4	6.89E+4	6.89E+4

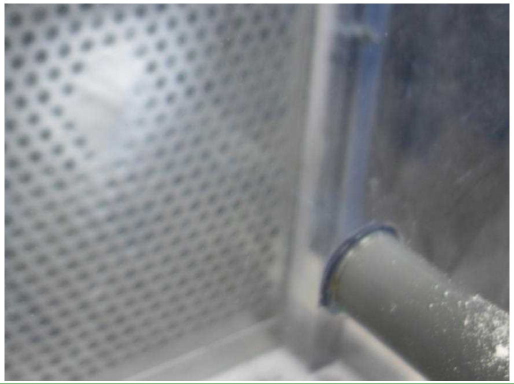
Metal Fiver Filter Test

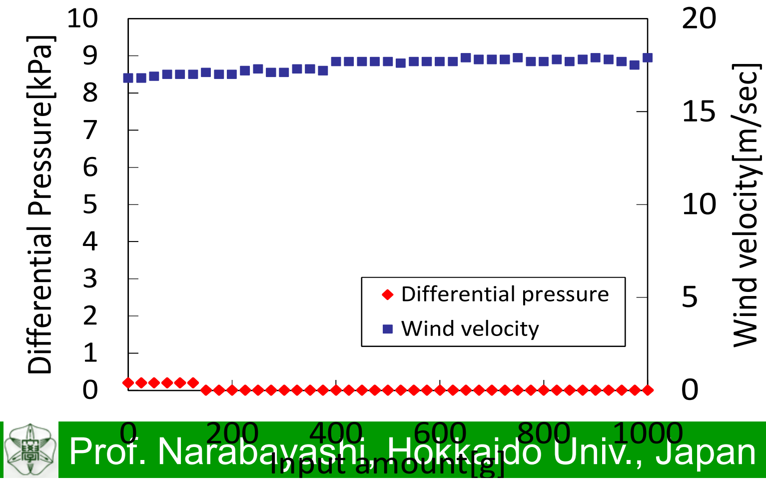
- High performance Metal Fiver Filter with AgX, supplied by RASA



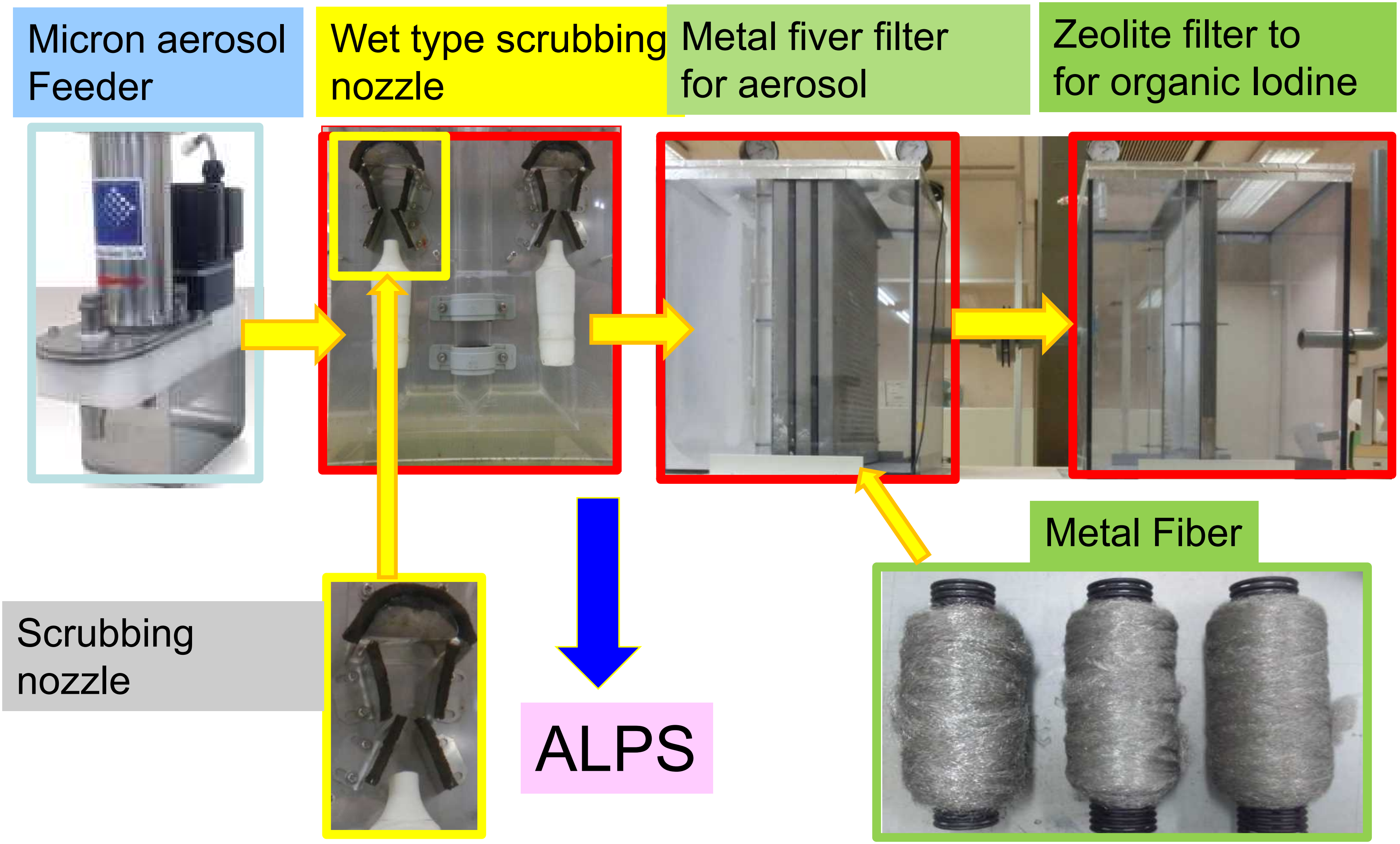


- 0.6μm $BaSO_4$ 25gX40 batches＝1kg
  There are no particle at the down stream of the filter（DF＞10,000）
- Differential Pressure was almost constant

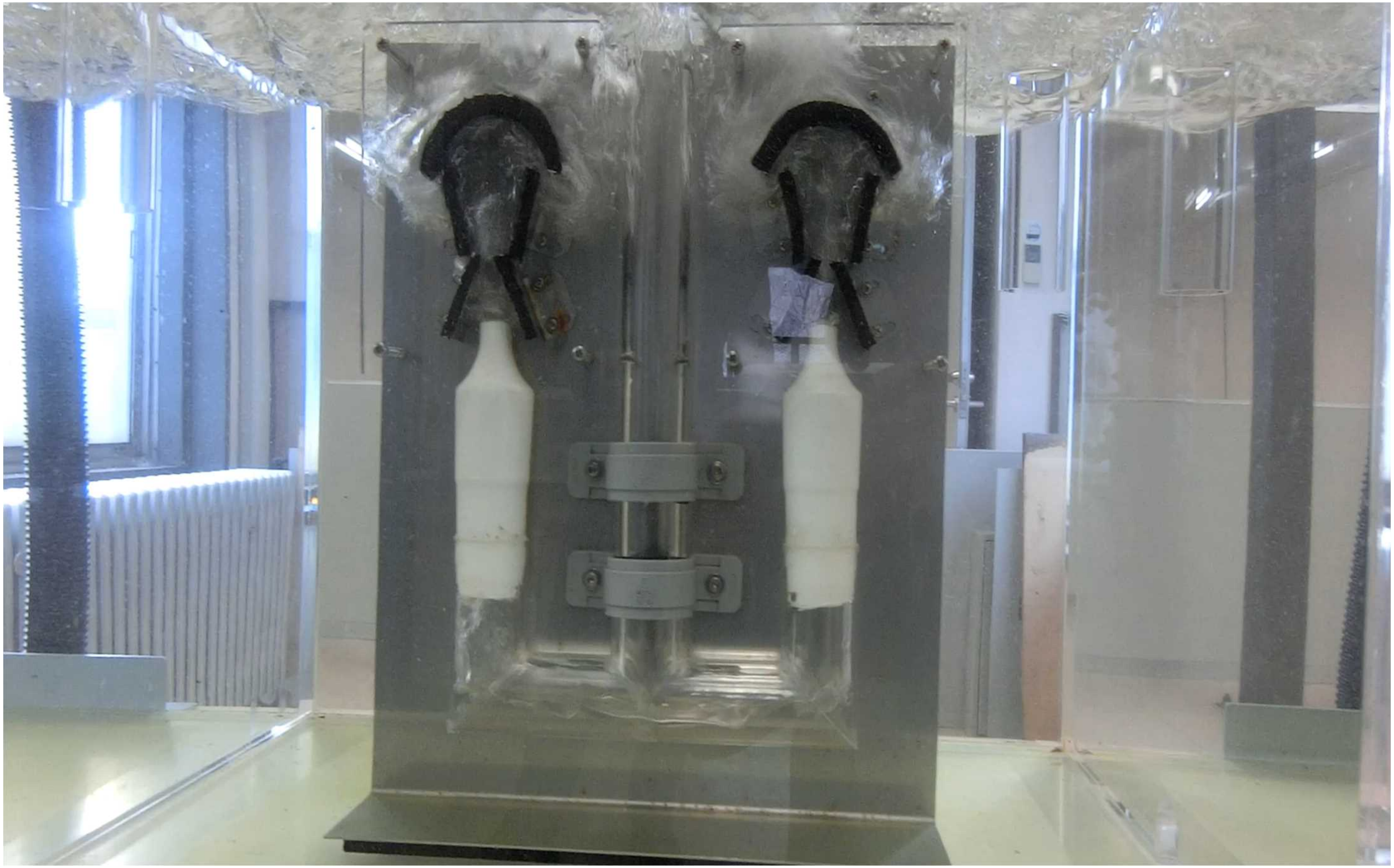




High Performance Filters for Multi-Nuclides

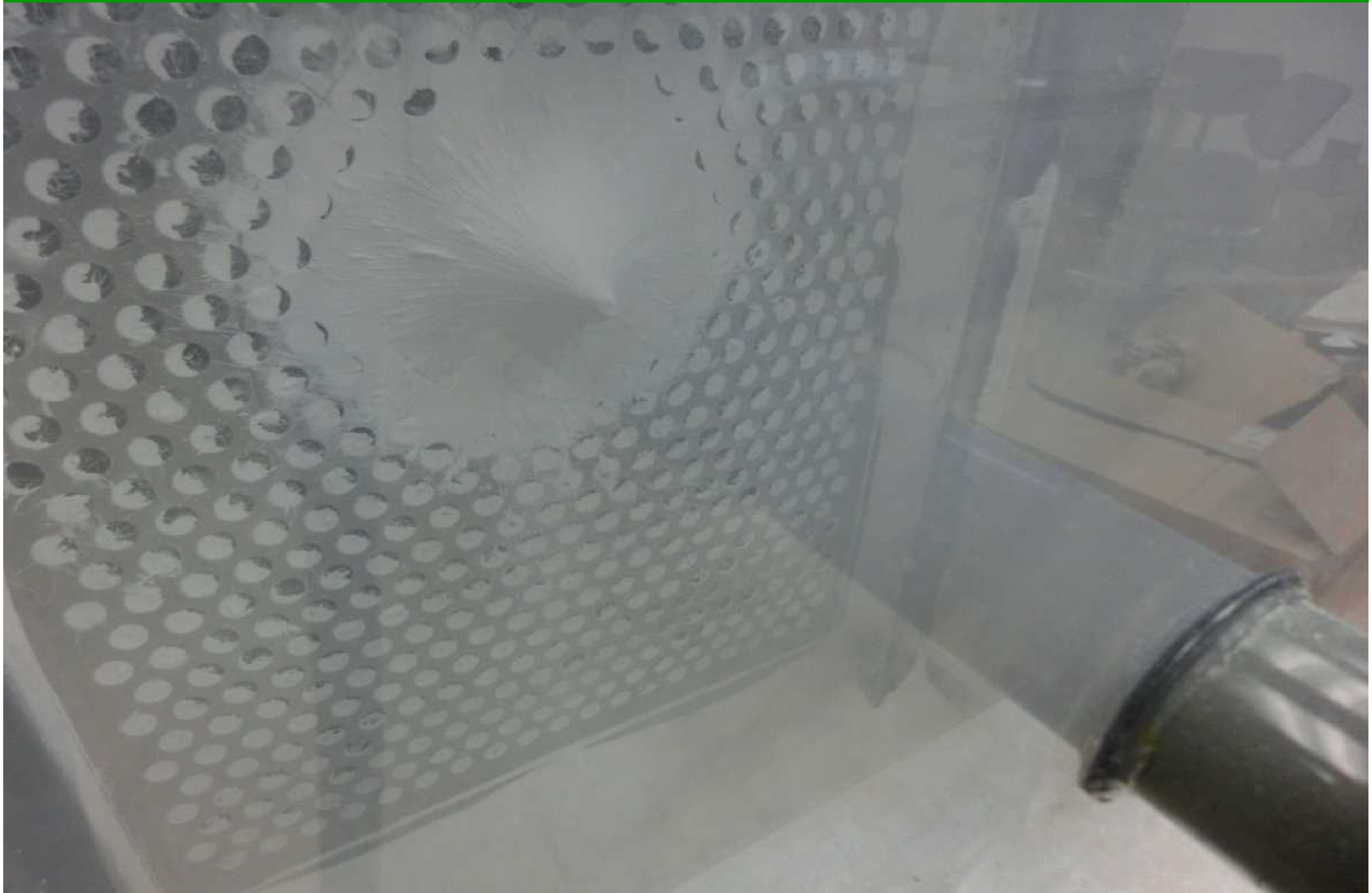


Wet Type Scrubbing Nozzle



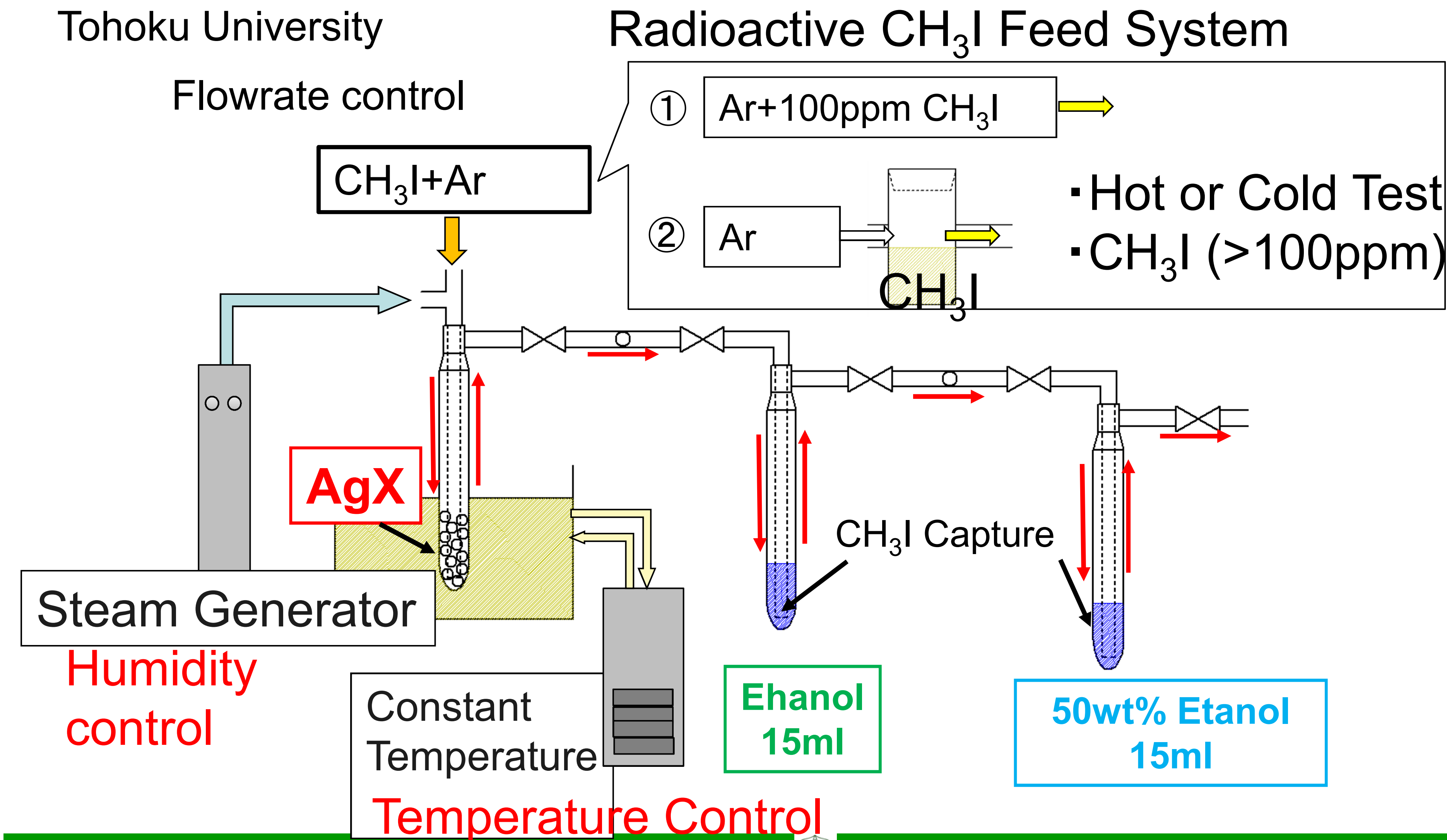
Dry Type: Metal Fiver Filter+AgX

Metal Fiber Filter Test

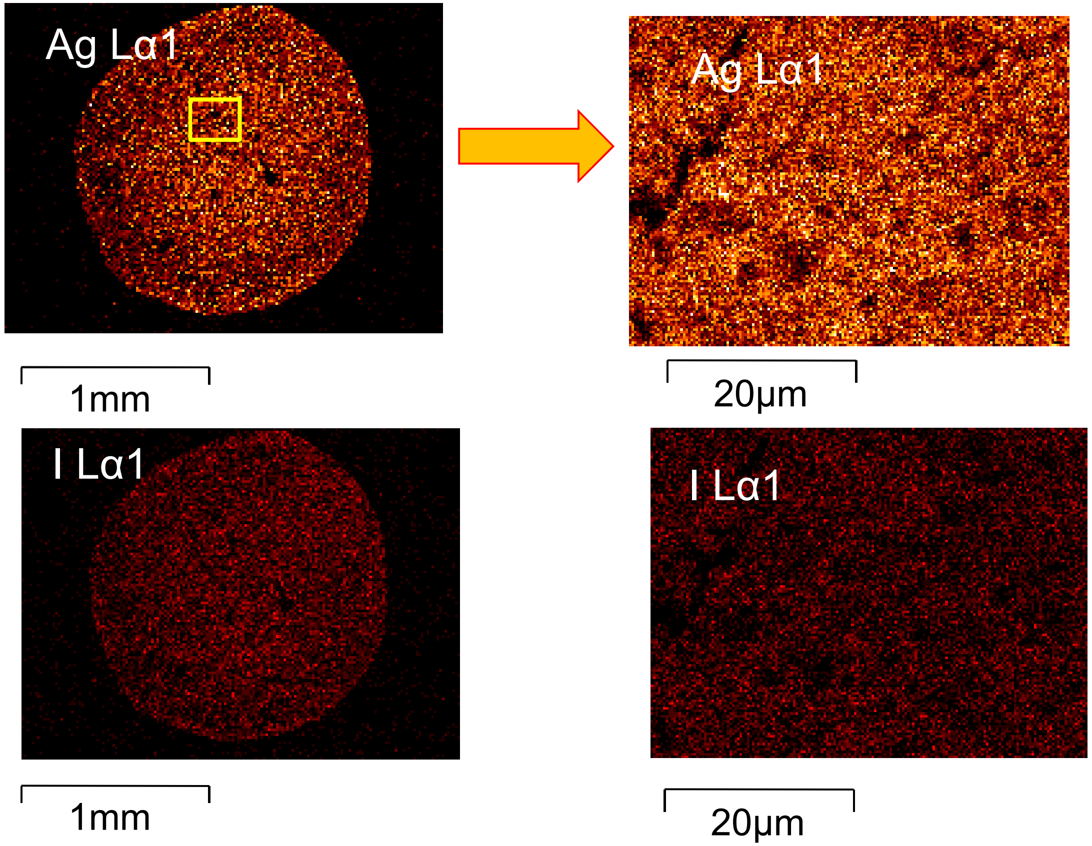


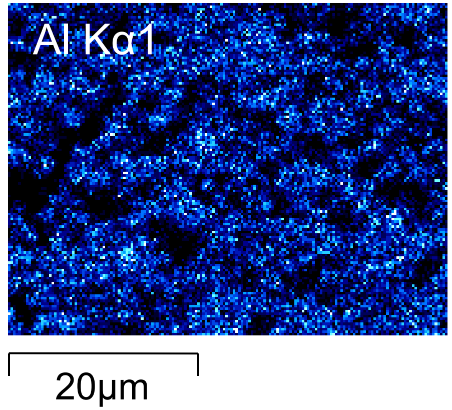
Radioactive Organic Iodine Capture Test

Flow rate,Temerature, Humidity are parameters for the test

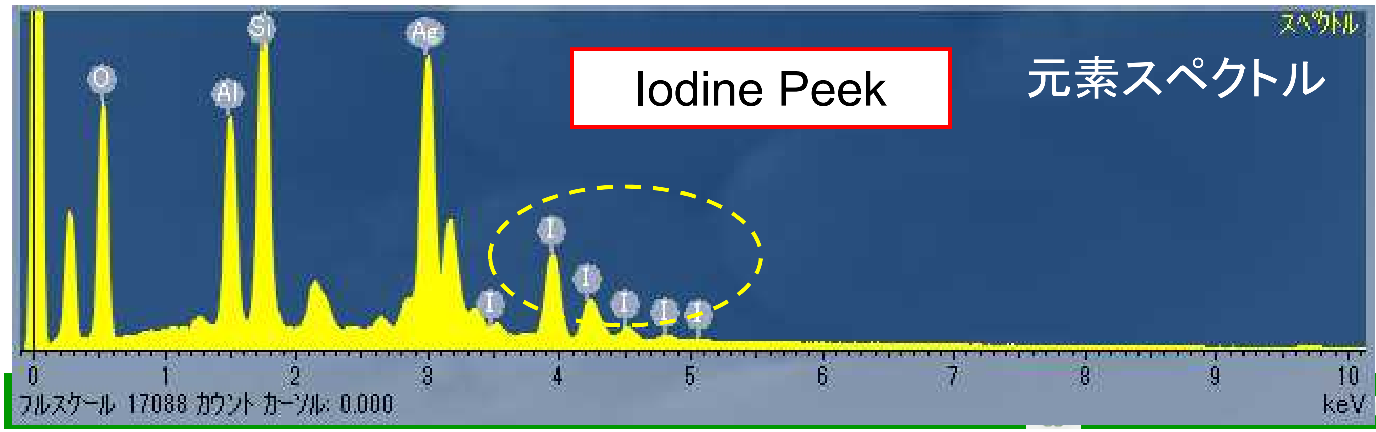


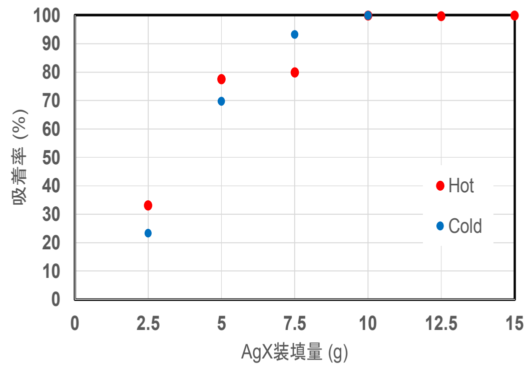
SEM−EDX Analysis Result in a AgX particle





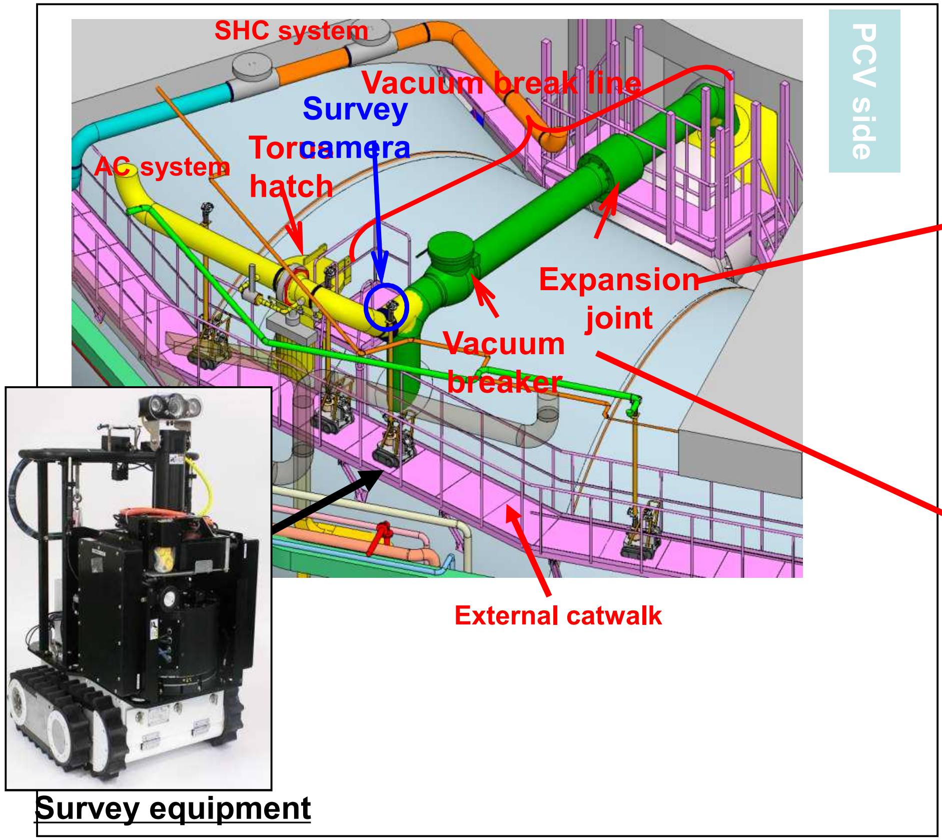
Iodine was captured even at the center of a AgX particle

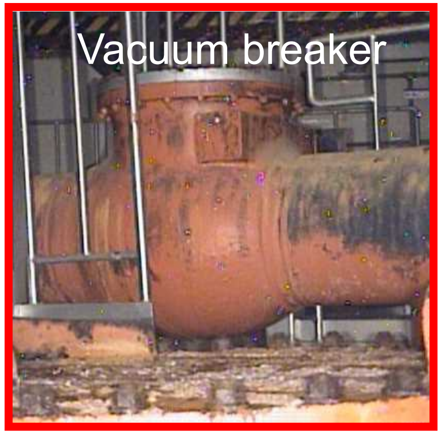




Survey at Basement Floor of Unit 1 Reactor Building

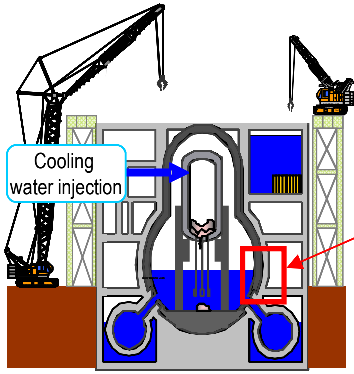
Robots Survey and repair toward filling PCV with water

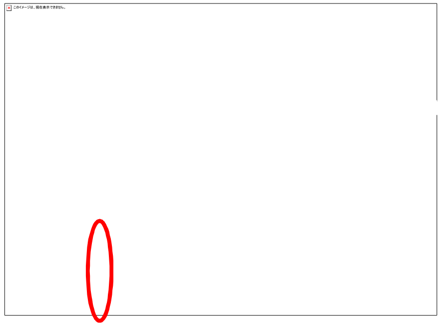




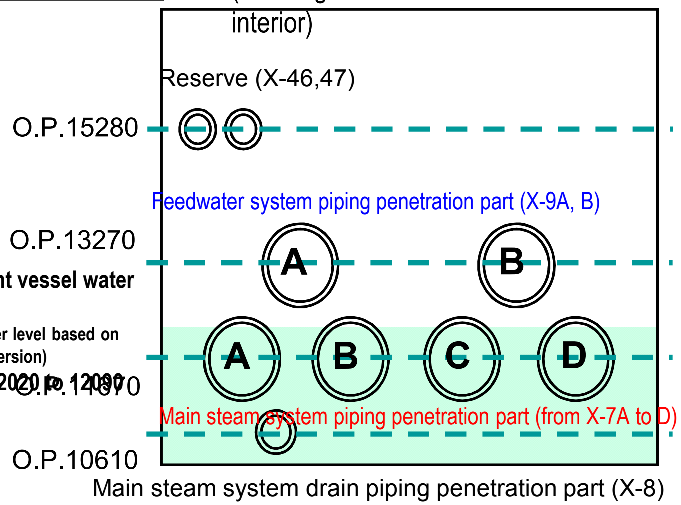
Finding of water leakage

Comprehensive view survey camera (pan tilt camera)

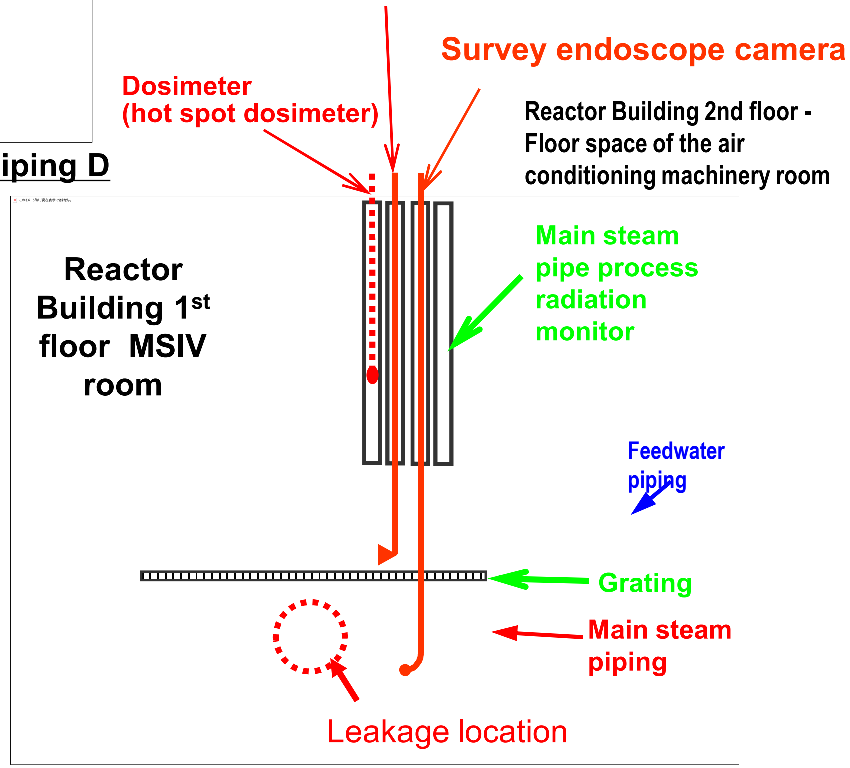




(Drawing seen from the containment vessel's interior)



Main steam isolation valve (MSIV) piping penetration part
Cross-section schematic diagram

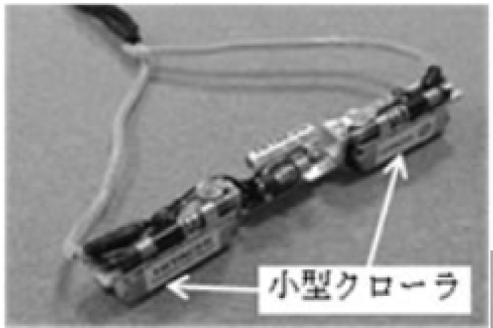


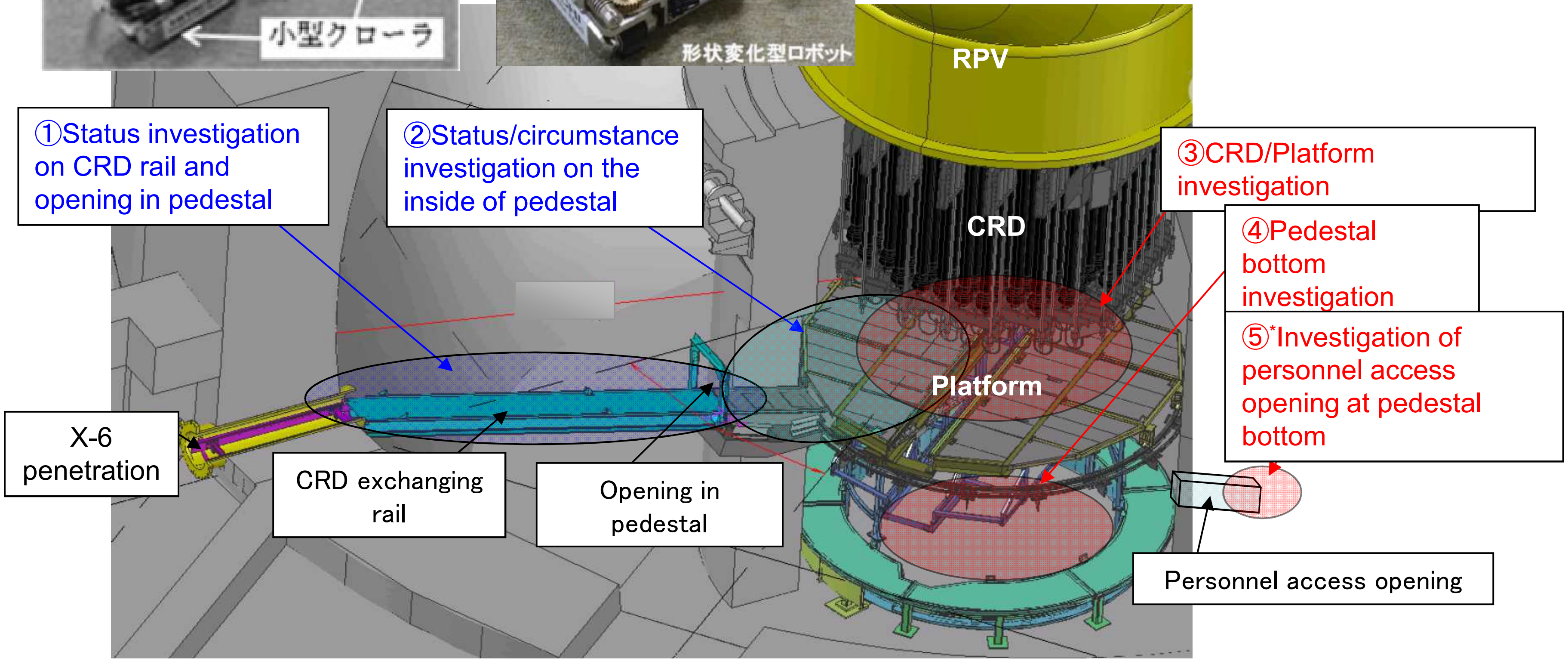
Reactor Building 1st floor MSIV (cross-section)

Note: the radiation monitor for the main steam pipe process is located between water pipes A and B and main steam pipes B ad C.

Investigation into Bottom of Unit 2 RPV (1/2)

Transformer Type Robot for Investigation debris at pedestal



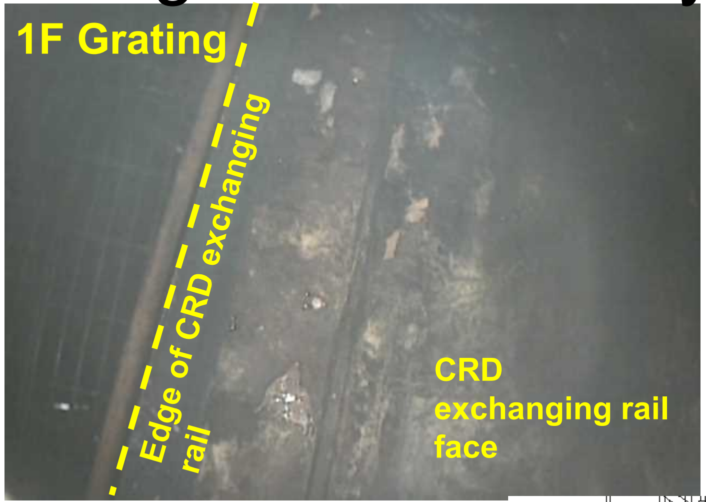


＊As for ⑤, access from the outside of pedestal is also considered.

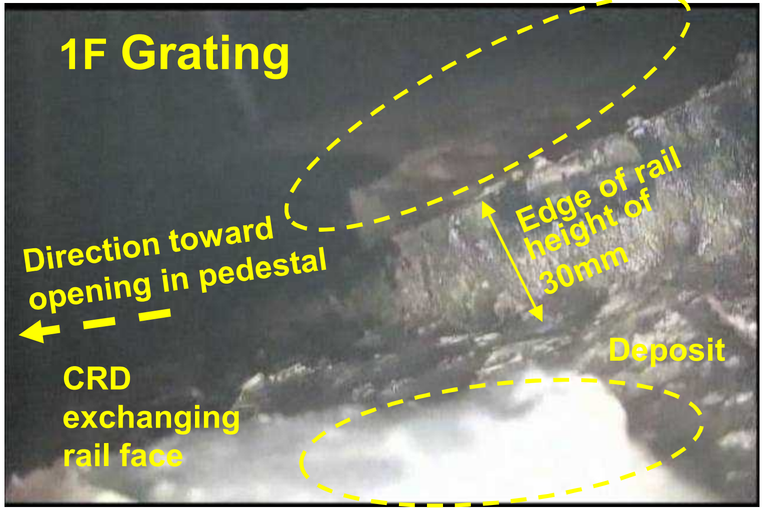
Investigation into Bottom of Unit 2 RPV (2/2)

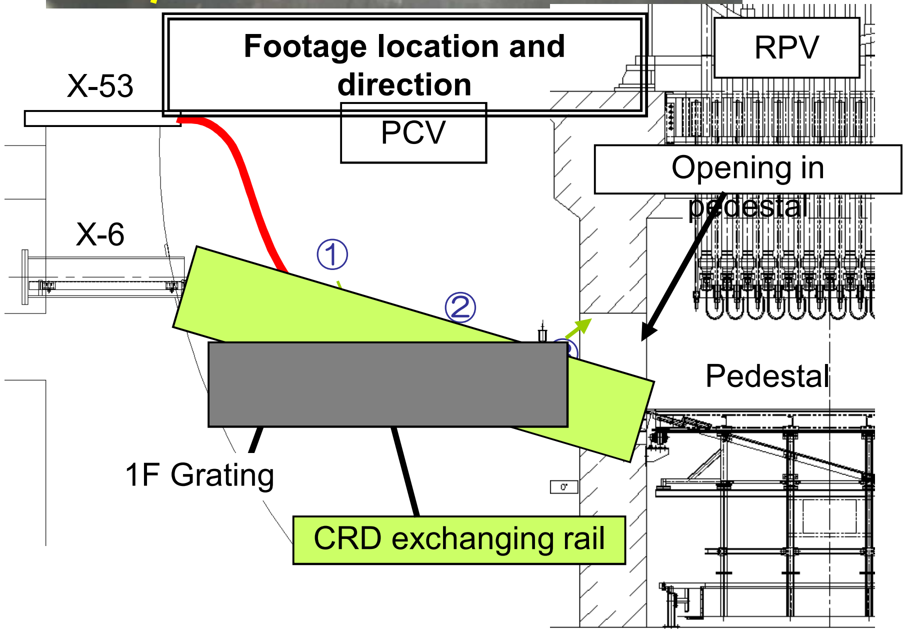
Finding Core Debris by Robotics

①



②





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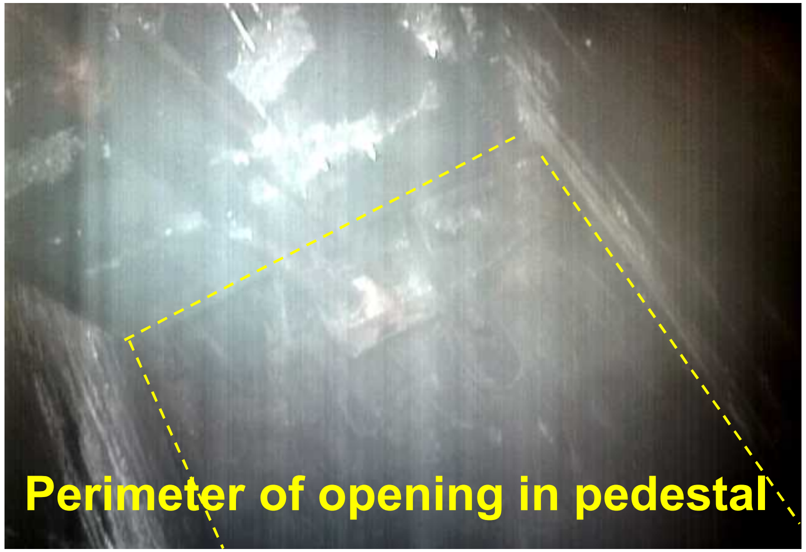


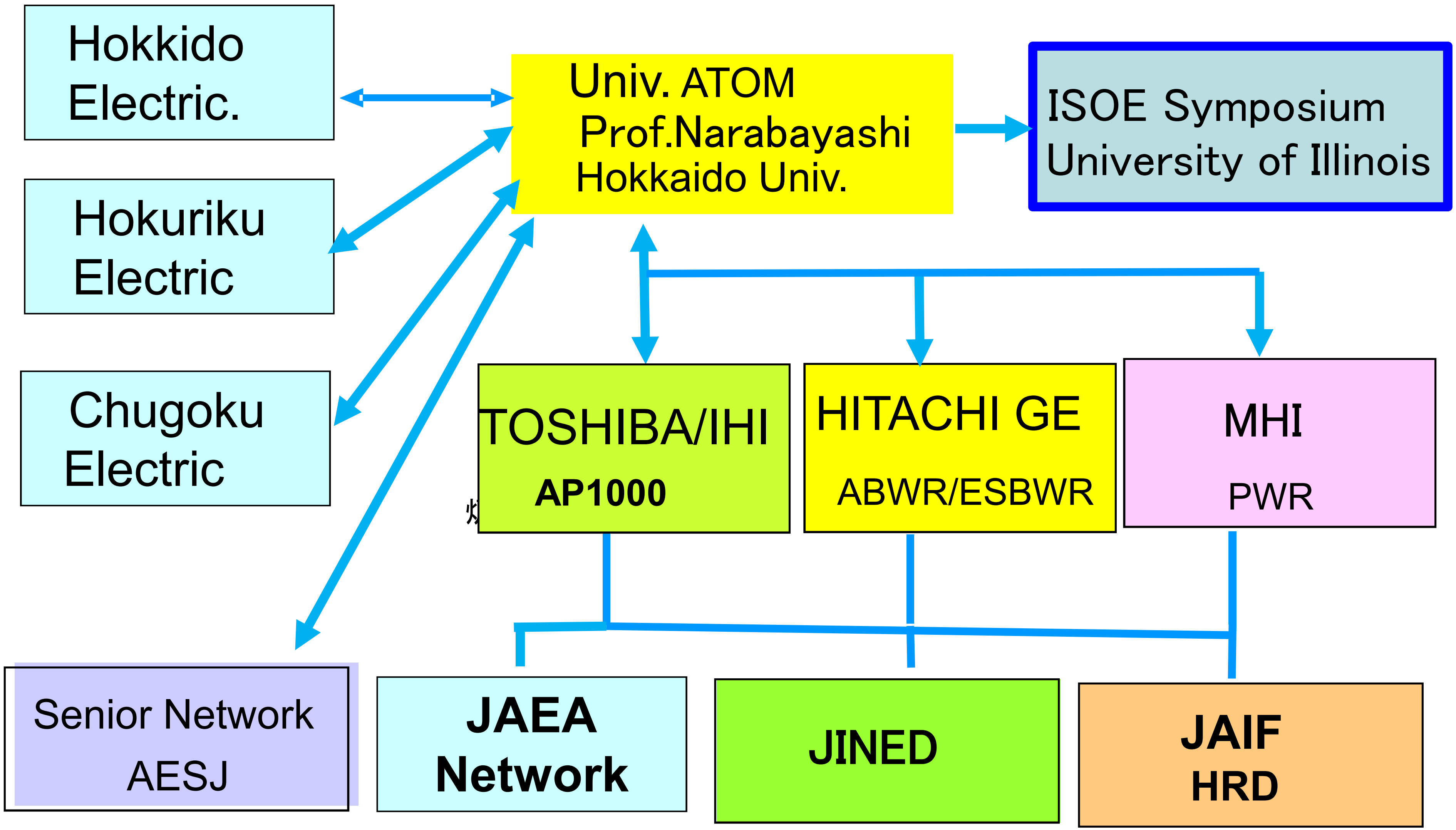
Super Engineer Education Project

MEXT Project for Nuclear Human Resource Development

Super Engineer Education Project
to Achieve Highest Safety
at Hokkaido University

Framework of the Project

■Collaboration of Universities, Electric Po, Co, Vendors



Number of Students Trained in this Project

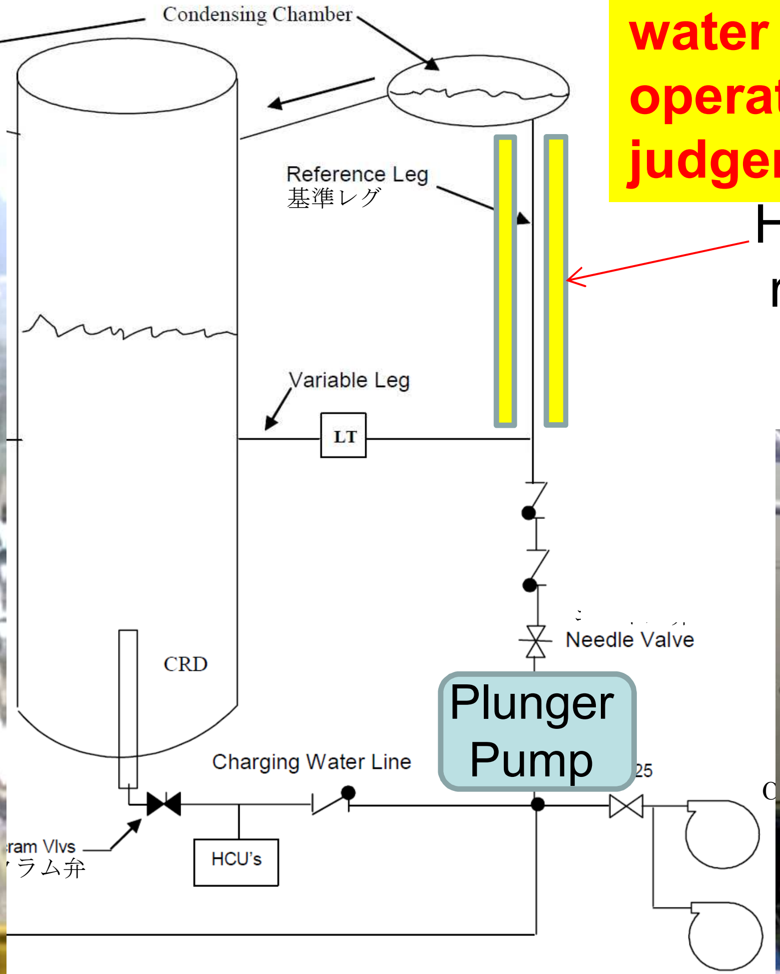
Students	Major	Number of Students			TOTAL
		FY 2015	FY 2016	FY 2017	
BS 1	All students in Hokkaido	–	50	50	100
BS 2	Civil, Natural Resource, Environment, Electronic	100	100	100	300
BS 3	Nuclear, Mechanical Engineering	120	120	120	360
MS 1,2	Nuclear, Plasma, Radiation, Mechanical	0	70	70	140
NPP Training	19 ATOM Universities	13	13	13	39
Vendor R&D	19 ATOM Universities	13	13	13	39
ISOE/Illinois	Excellent Students	5	5	5	15
TOTAL		251	371	371	993

Students Training Programs for Super Engineer

Training course : Filtered vent Test, Water Level Back fill, Water Injection, etc.

FCVS Visualized Facility for training

RWL Reference Leg Backfill



BWR水位計の基準レグ補充水

（IN 2002-06「BWR原子炉水位計のバックフィル改造における設計の脆弱性」、2002年1月）

TMI, Fukushima water level drift cause operator miss judgement

Heat insulated reference leg

Cooperation with University of Illinois from 2015

Mr. Takuma was trained at University of Illinois and he entered TEPCO last April

Conclusion

- From the Lessons of Fukushima-Daiichi Accidents, Japanese NPP has installed safety measures, and Sendai 1 and 2 restarted in 2015. Several PWR will restart and Kashiwazaki-Kariwa(ABWR) will pass to restart, in 2016.
- Development of Filtered Venting System (FCVS) with silver zeolite has finished. Installation has started.

- Development of a high efficiency multi-nuclide aerosol filters for radiation protection during cutting core debris has already started at Hokkaido University as a MEXT project in Japan.
- Nuclear education is very important to improve the resilience technology and safety culture in the world.
- Super Engineer Education Project has started.