Overview of Research and Development Conducted by IRID

ICRP International Conference on Recovery after Nuclear Accidents Radiological Protection Lessons from Fukushima and Beyond
Session1.2 Fukushima NPP dismantling

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Introduction : Overview of IRID

【Principles】 IRID commits to R&D for **decommissioning technology of Fukushima Daiichi NPS which is currently an urgent issue** to strengthen the platform for decommissioning technology in future.

- **Name** Technology research associate, International Research Institute for Nuclear Decommissioning (IRID)
- **Establishment** August 1, 2013 (approved)

- **Number of staff: 730 people** (excluding executives, as of July 1, 2020)
  - **National research institutes: 2 Organizations**
    Japan Atomic Energy Agency (JAEA), Advanced Industrial Science and Technology (AIST)
  - **Manufacturers, etc.: 4 Companies**
    TOSHIBA Energy Systems & Solutions Corporation, Hitachi-GE Nuclear Energy, Ltd., Mitsubishi Heavy Industries, Ltd. and ATOX Co., Ltd.
  - **Electric Utilities, etc.: 12 Companies**
    Hokkaido Electric Power Co., Inc., Tohoku Electric Power Co., Inc., Tokyo Electric Power Company (TEPCO) Holdings, Chubu Electric Power Co., Inc., Hokuriku Electric Power Company, Kansai Electric Power Co., Inc., The Chugoku Electric Power Co., Inc., Shikoku Electric Power, Incorporated, Kyushu Electric Power Co., Inc., The Japan Atomic Power Company, Electric Power Development Co., Ltd., Japan Nuclear Fuel Ltd.

- **Total project costs**

Fiscal year	2013 (August-)	2014	2015	2016	2017	2018	2019	2020 (Estimate)
Project costs (100 million yen)	46	122	147	143	148	140	142	188

Introduction : IRID's R&D Projects

1 R&D for fuel removal from spent fuel pool

Evaluation of **Long-term Structural Integrity** of Fuel Assemblies Removed from Spent Fuel Pool
Completed in March 2016

3 R&D for Radioactive Wastes

Technology for **Proceeding Process Methods** of Radioactive Wastes
Completed in March 2019

Treatment and Disposal of Solid Radioactive Wastes

2 R&D for Fuel Debris Retrieval

Technology for Decontamination and Dose Reduction

Remotely Operated Decontamination Technology in R/B
Completed in March 2016

Fuel Debris Retrieval Technology

<Ensuring of Stability>

Corrosion Control Technology in RPV/PCV
Completed in March 2017

Technology for Seismic Resistance /Impact Assessment in RPV/PCV
Completed in March 2018

Criticality Control Technology for Fuel Debris
Completed in March 2019

Fundamental Technologies for Retrieval of Fuel Debris and Internal Structure
Completed in March 2019

<Fuel Debris Retrieval>

Fundamental Technologies **Small Neutron Detector**
Completed in Sep.2018

Retrieval technology for Fuel Debris and Internal Structures

Dust collection System for Retrieval of Fuel debris and Internal structures

Technology for **Collection, Transfer And Storage** of Fuel Debris

Technology for Environmental Improvement

Technology for **Repair and Water Stoppage** For PCV Leak Points
Completed in March 2018

Technology for **Water Circulation** in PCV

Full-scale test for Repair Technology for PCV Leak Points
Completed in March 2018

Full-scale Test for Water Circulation technology in PCV

Investigation and Analysis Technology

<Indirect Investigation>

Fuel debris detection Technology for R/B
Completed in July 2016

Upgrading for **Identifying Conditions Insides the Reactor**
Completed in March 2018

<Direct Investigation>

Investigation Technology Inside the PCV
Completed in March 2018

Technology for **Detailed Investigation Inside PCV**
Completed in March 2019

PCV detailed Investigation: **Demonstration Through X-6 penetration**

PCV Detailed Investigation: **Demonstration of sediments**

Investigation Technology Inside the RPV

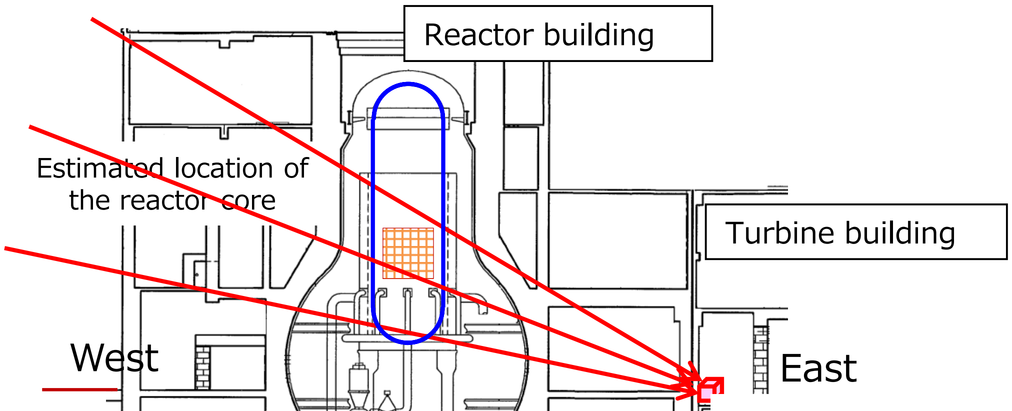
Sampling Technology for Fuel Debris

Fuel Debris Characterization and Analysis

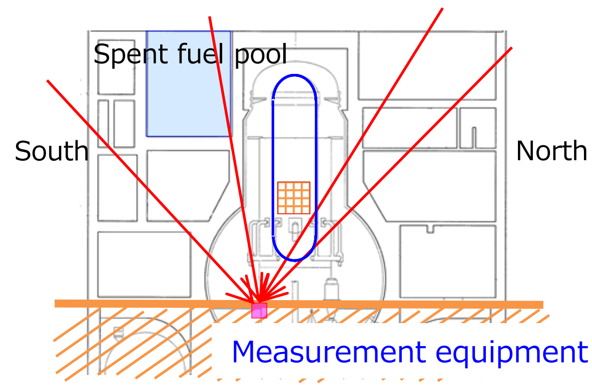
Contents

Measurement of the muon transmission method

- Muon is the secondary cosmic ray generated in the collision of cosmic rays from space with atmosphere. Muon has high energy and characteristics to pass through materials.
- The muon transmission method is to measure muon particles which have passed through the reactor building to capture the images fuel debris distribution inside RPV like X-ray pictures from their transmittance (Higher density materials that less muon can pass through make darker shadow).



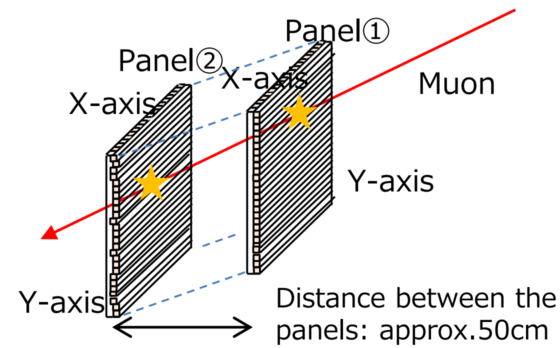
Measurement image of muon particles that pass through the reactor building (East-west cross sectional view)



Measurement image of muon particles that pass through the reactor building (North-south cross sectional view)

<Measurement principle of the muon transmission method (image)>

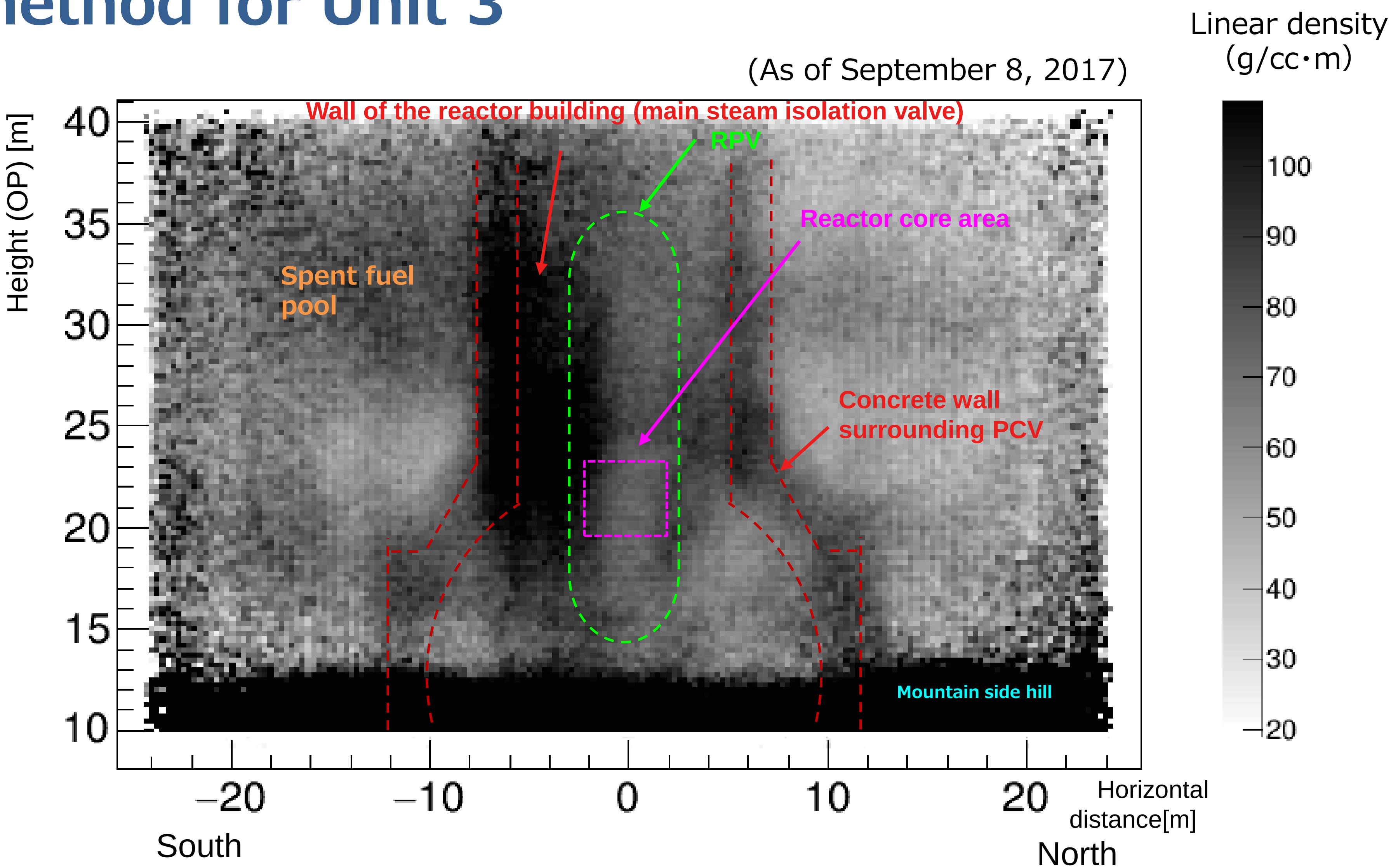
Two panel detectors (plastic scintillators) inside the muon measurement equipment detect incoming cosmic rays muon from the air above and calculate their trace on where they have passed through from the panels.



Quoted from the public data of TEPCO Holdings, Ltd.

Measured results of the muon transmission method for Unit 3

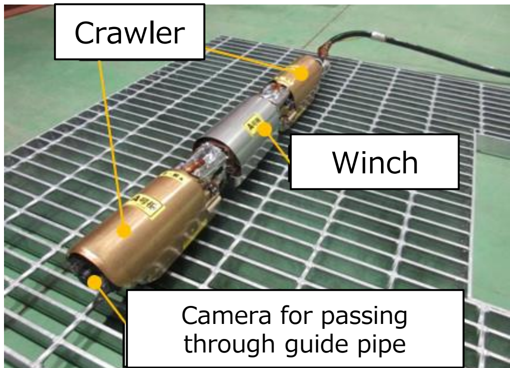
(As of September 8, 2017)



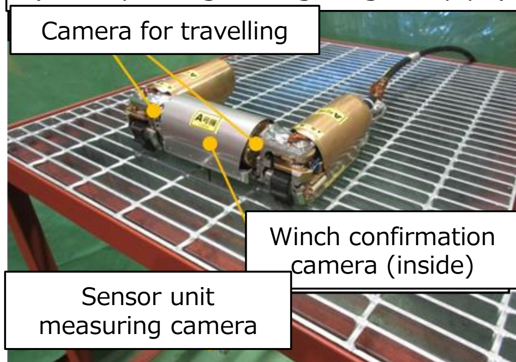
Quoted from the public data of TEPCO Holdings, Ltd.

Robot Investigation of inside PCV

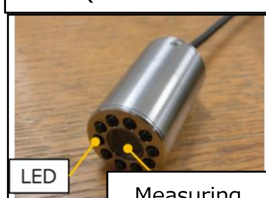
Investigation of outside the pedestal (Unit 1)

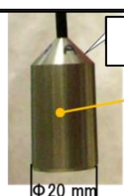


Type Ⅰ
(when passing through a guide pipe)



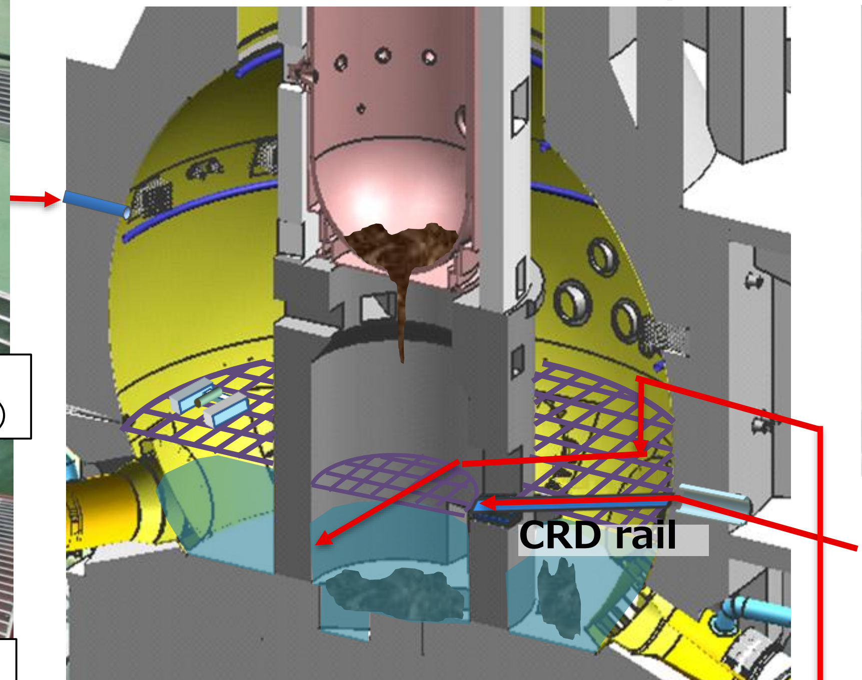
U-shape type
(when travelling on the floor)

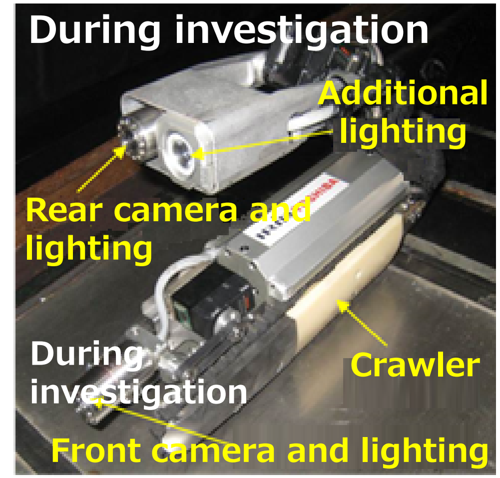




Investigation of inside the pedestal (Unit 2)

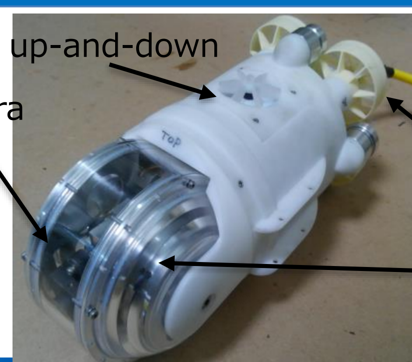
○ Remote-operated crawler robot for investigation





○Suspension type investigation device

Investigation of inside the pedestal (Unit 3)

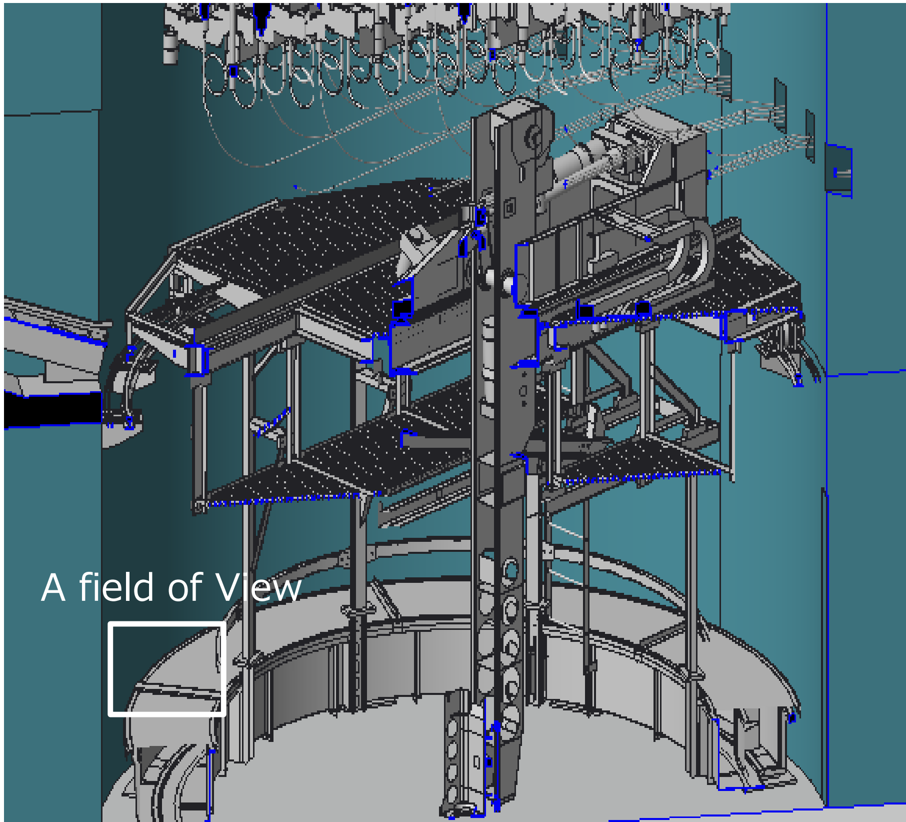


○Submersible Crawling Robot

Investigation inside the Upper Pedestal of Unit 2
(January – February 2017)

Inside the upper pedestal (after processing imaging data)

Investigation inside the Lower Pedestal of Unit 2 (investigation January 2018)

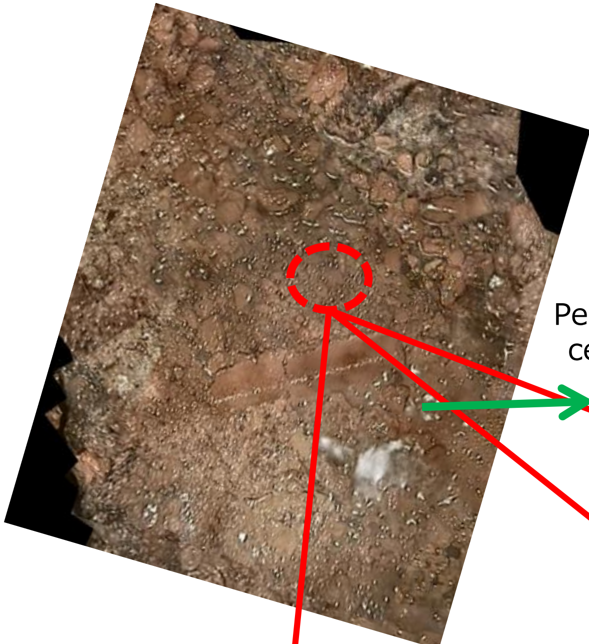


The PCV bottom of Unit 2
(An overhead image)

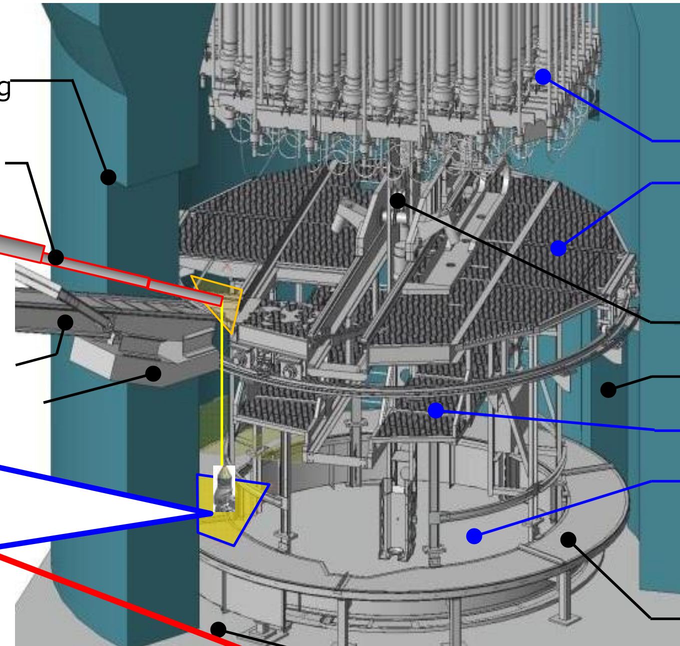
The image data: Near an inner wall of the pedestal at the PCV bottom of Unit 2

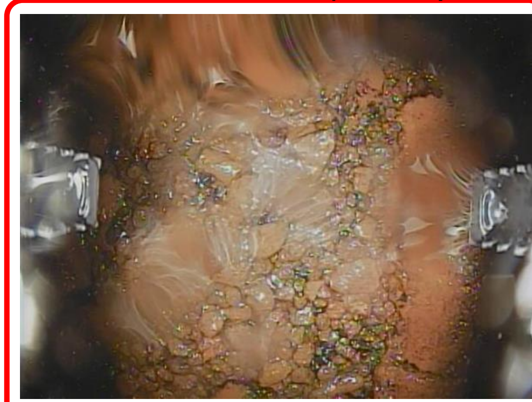
Investigation inside the Lower Pedestal of Unit 2 (February 2019)

TEPCO



Investigation area (A photo taken in January 2018).





Before touching sediment

During contact with sediment

After touching sediment

Source: TEPCO Holdings Inc. website

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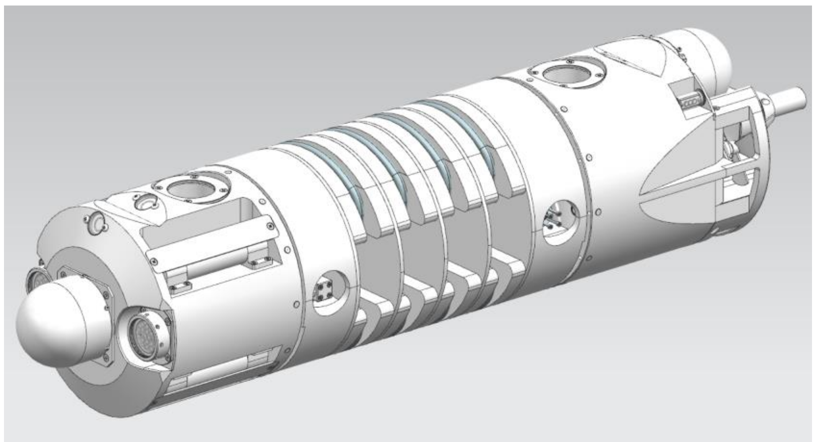
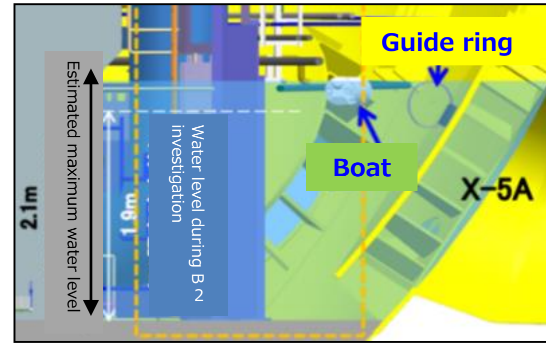
The Boat Type Access Device

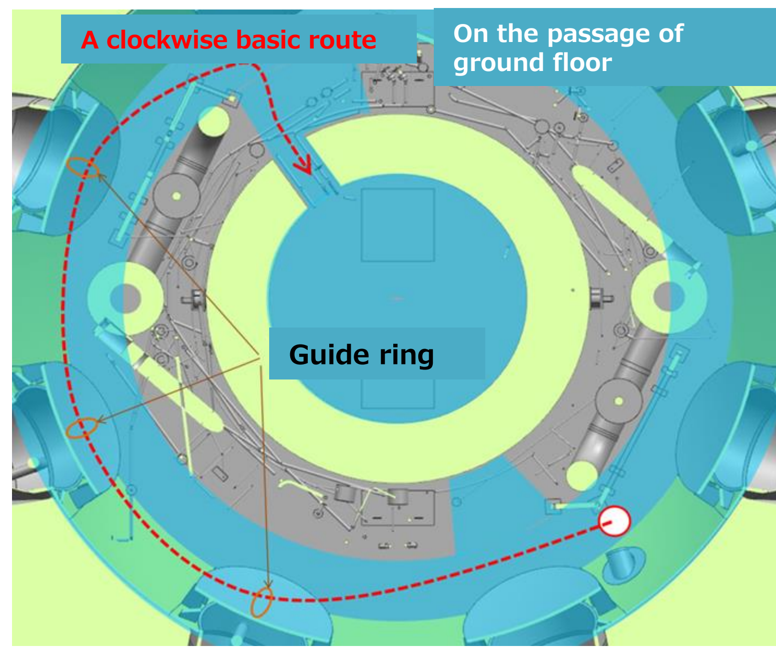
- The boat type access device which can move on a wide range of the water surface in PCV has been developed.



An example of guide ring installation
- Diameter: φ25cm
- Length: Approx. 1.1m
- Thrust: Over 25N

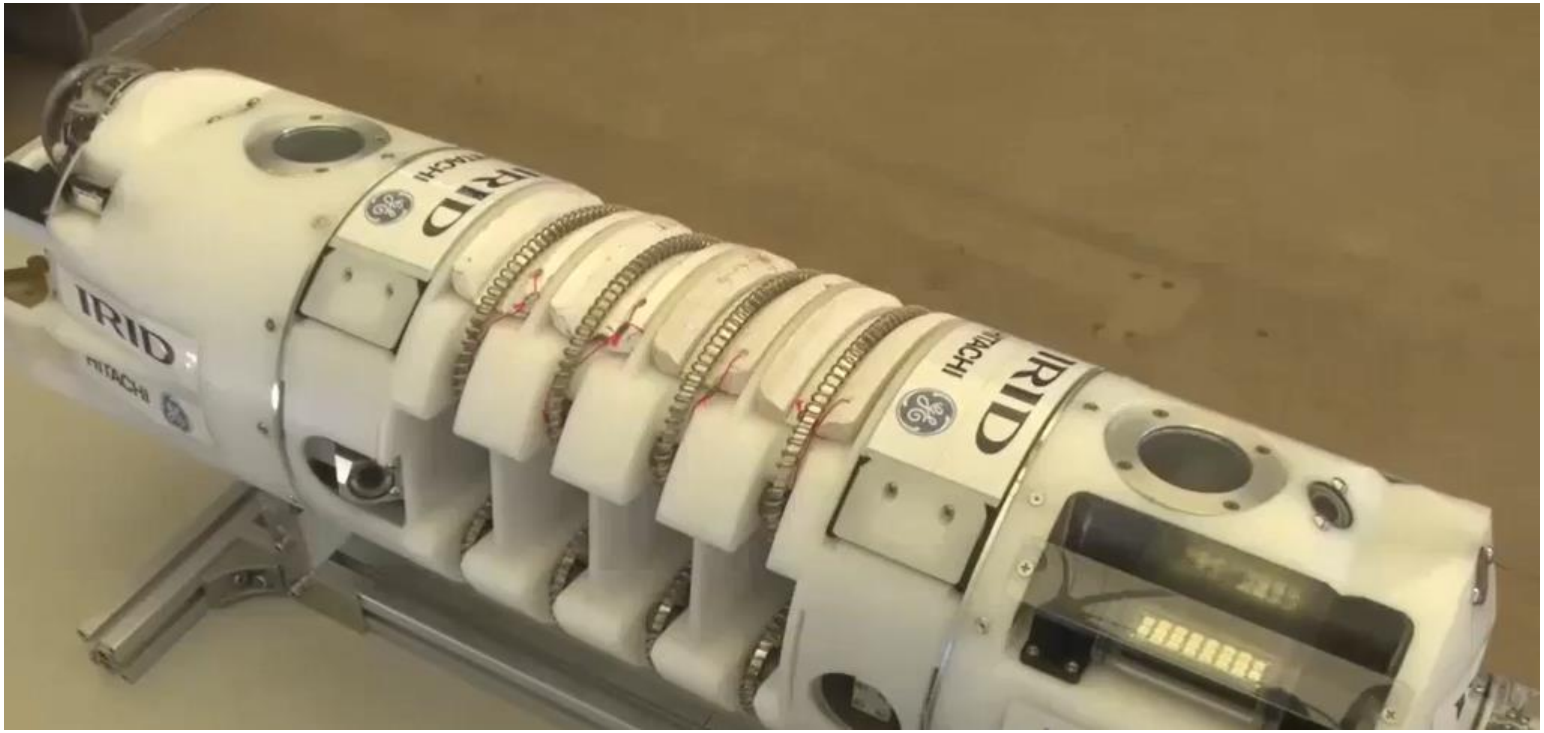
Appearance of the boat type access device





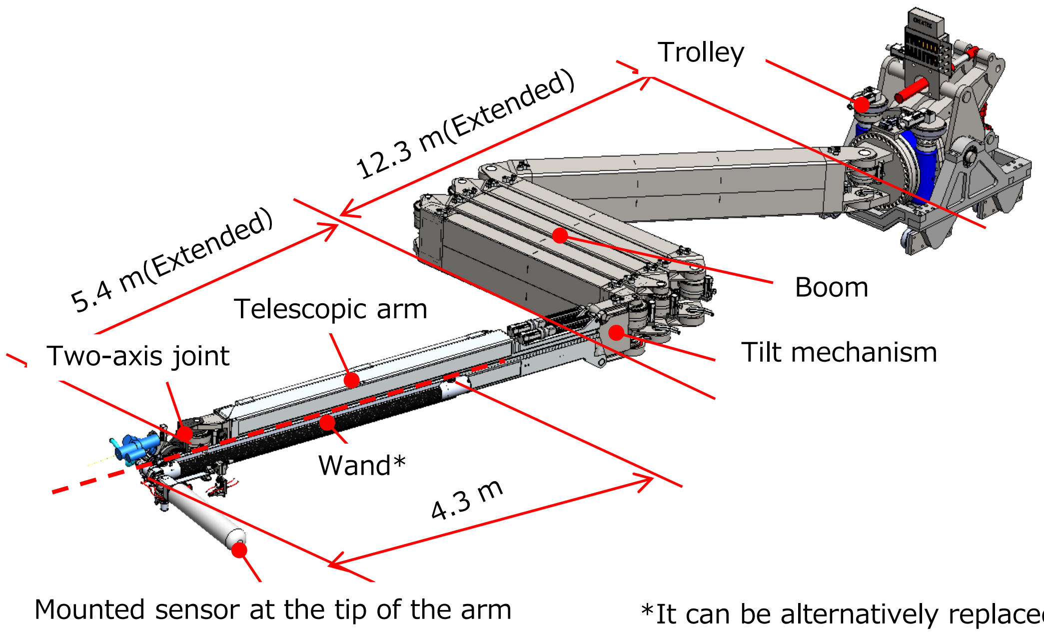
A travelling line of the device

The Boat Type Access Device (video)



The Arm Type Access Device

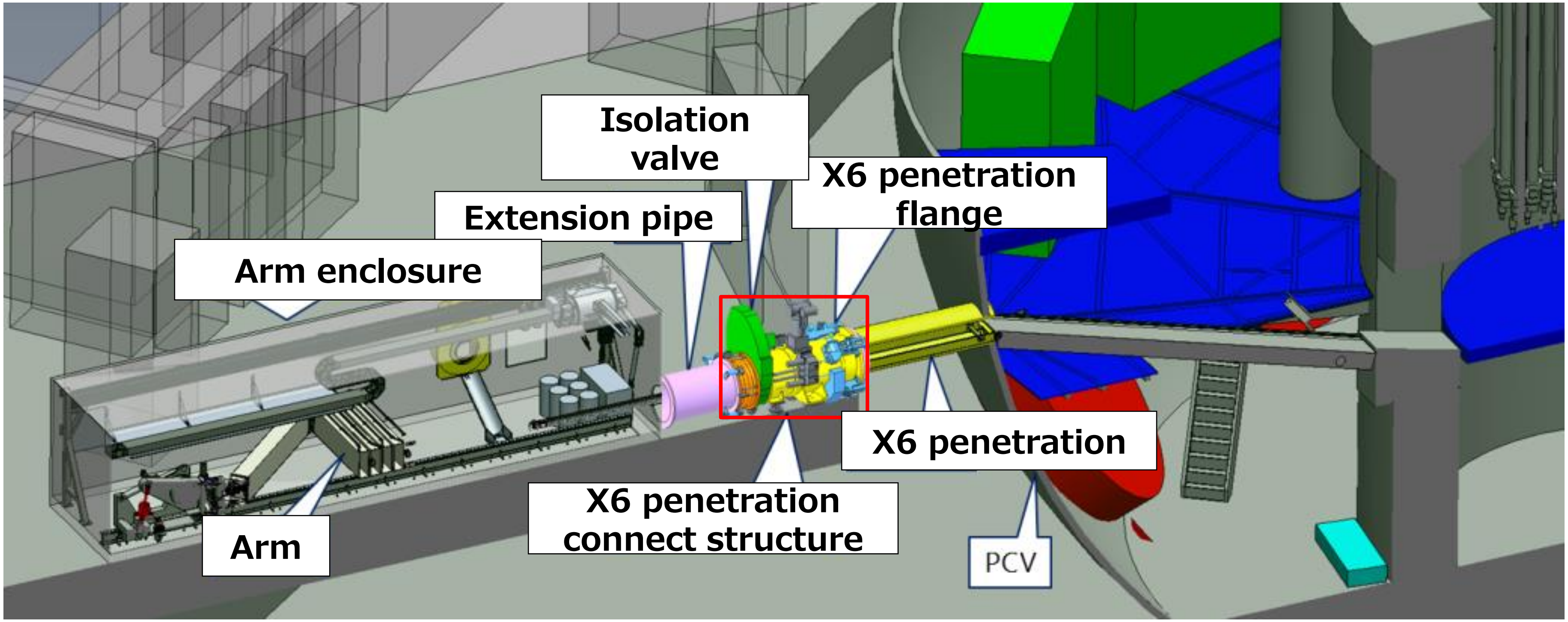
- The arm type access device has been manufactured which can access the wide range through the PCV penetration for maintenance of control rod drive mechanism.
  - Total length of the arm: Approx. 22m
  - The investigation device up to 10kg can be loaded.



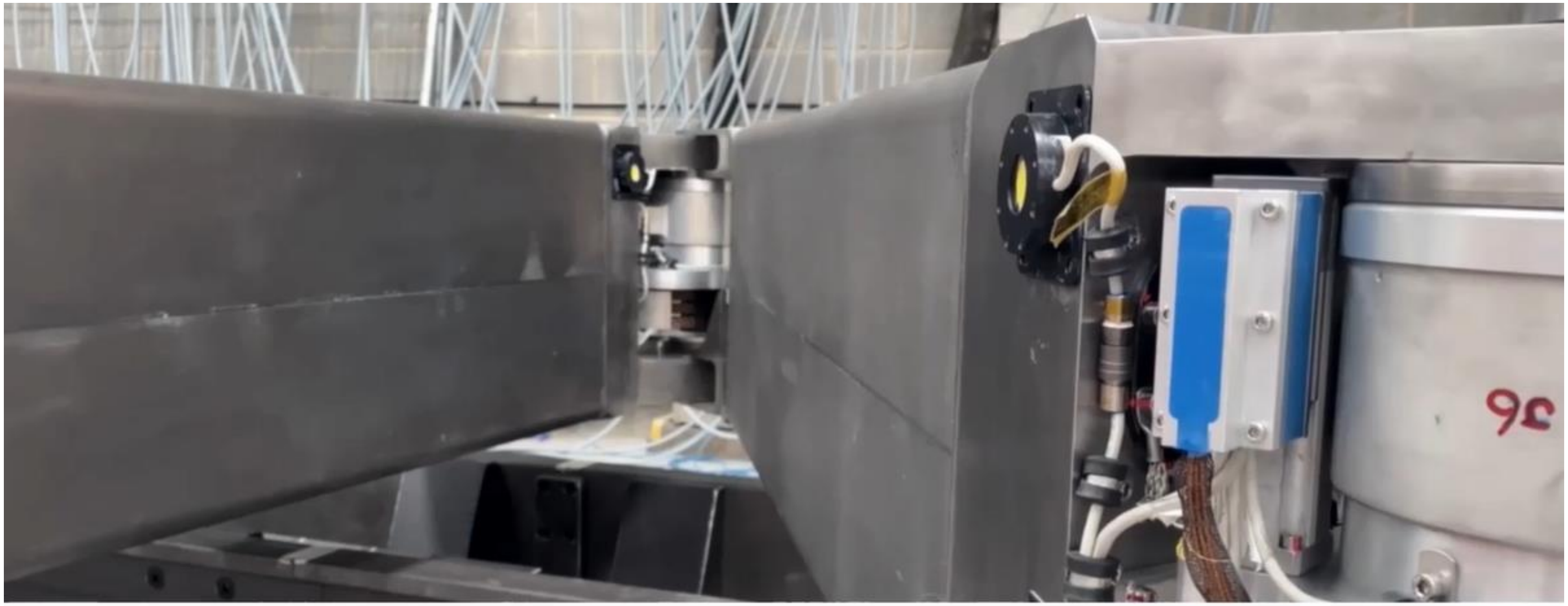
*It can be alternatively replaced a tool.

The arm type access device

Access Route of Arm Type Device



The Arm Type Access Device (Video)



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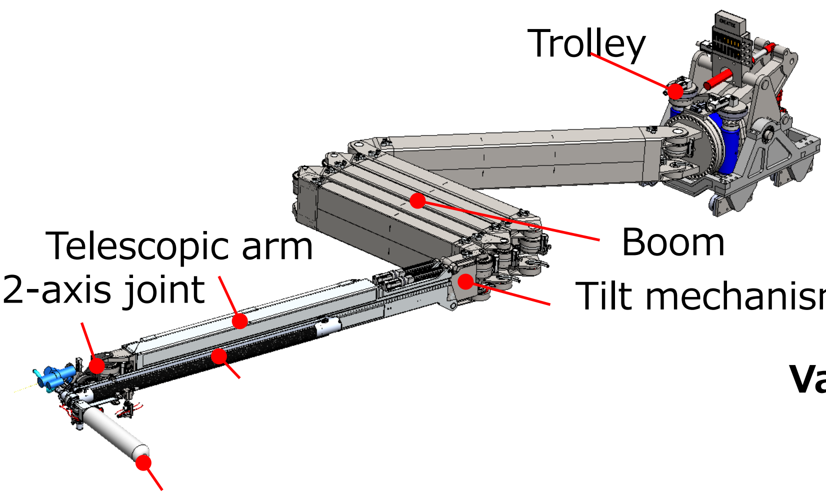
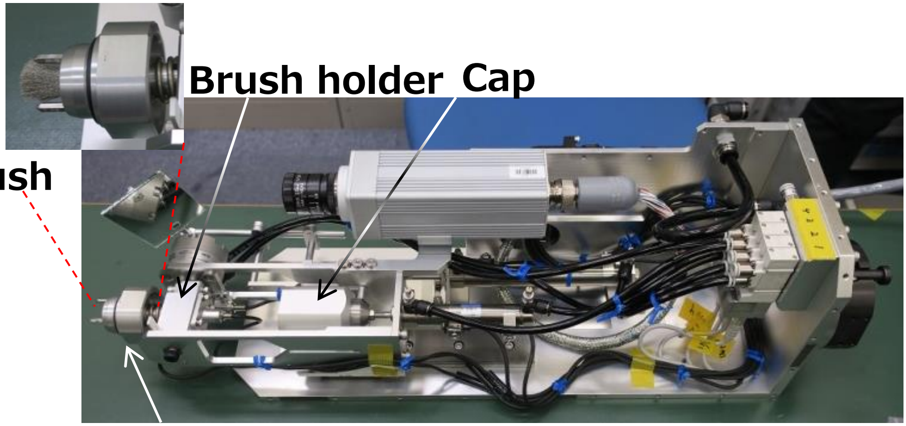
Test Retravel Debris

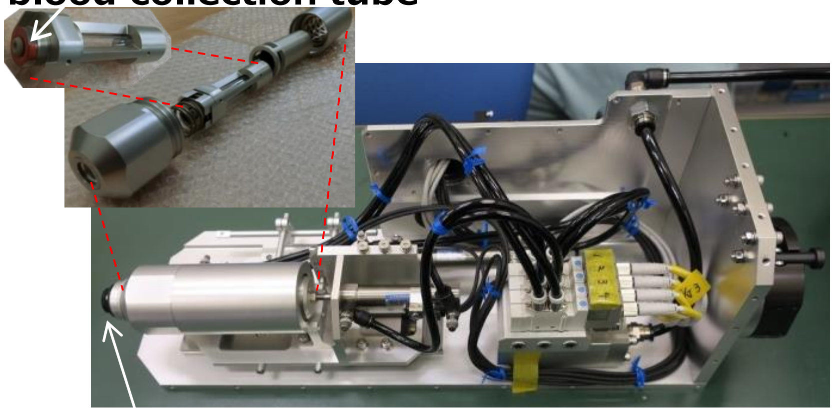
The fuel debris collection device with ultrafine metal wires is equipped with the head of the arm type access device.



Arm type access device



Ultrafine metal blush type collection device



Vacuum vessel type collection device

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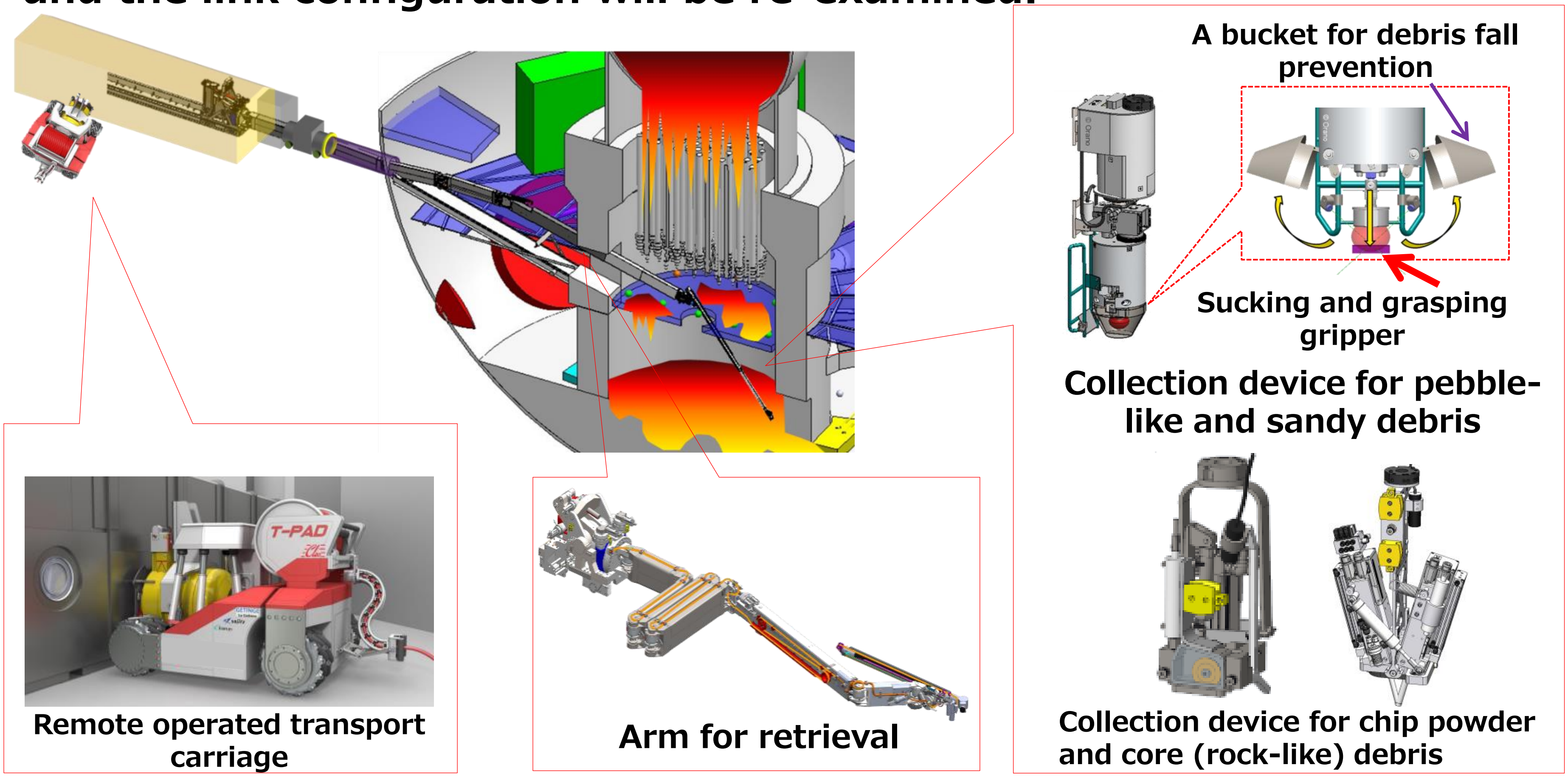
Increasing the Scale of Fuel Debris Retrieval in Stages

Access device for fuel debris retrieval

In order to improve the payload (a maximum loading capacity), a motor for the arm type access device will be improved to strengthen and the link configuration will be re-examined.



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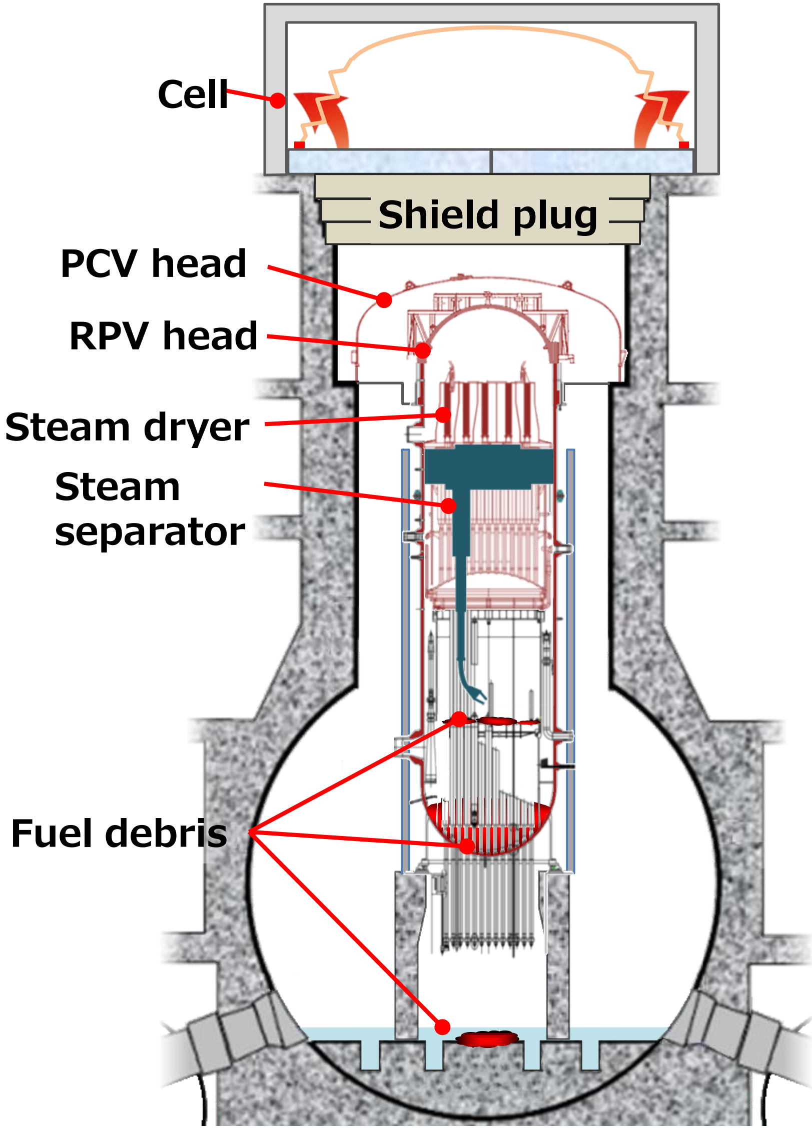
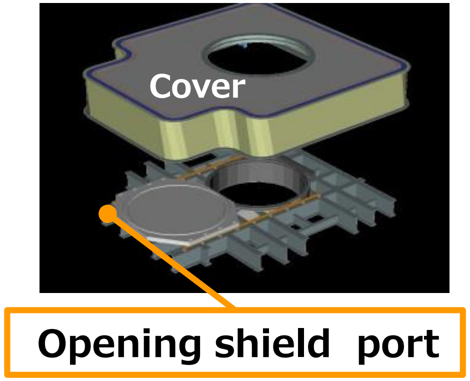
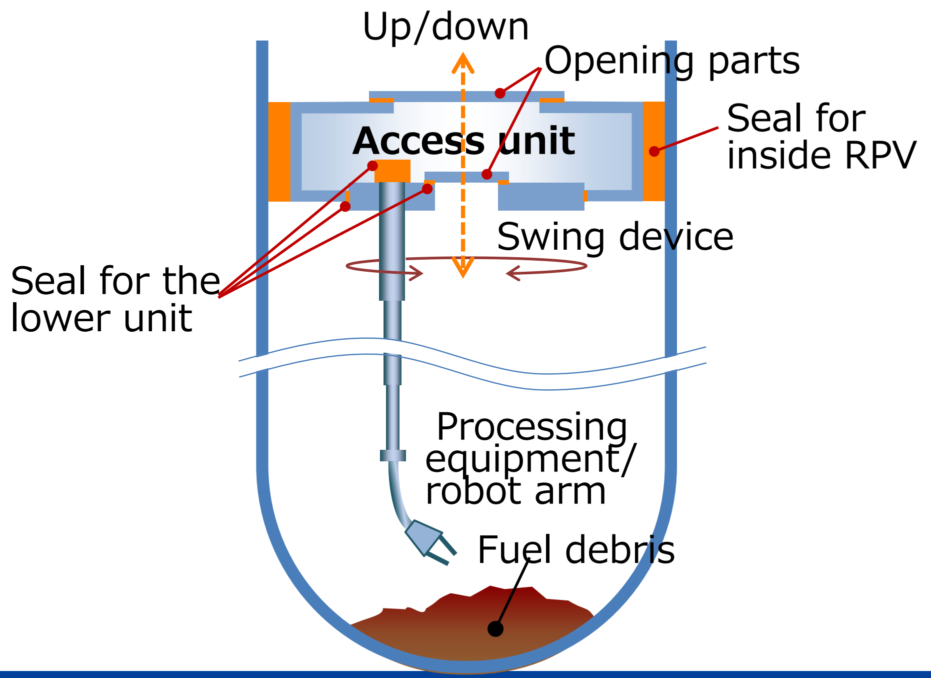
The Top-access Method: Image Drawing of Fuel Debris Retrieval





Access unit for inside RPV (image drawing)

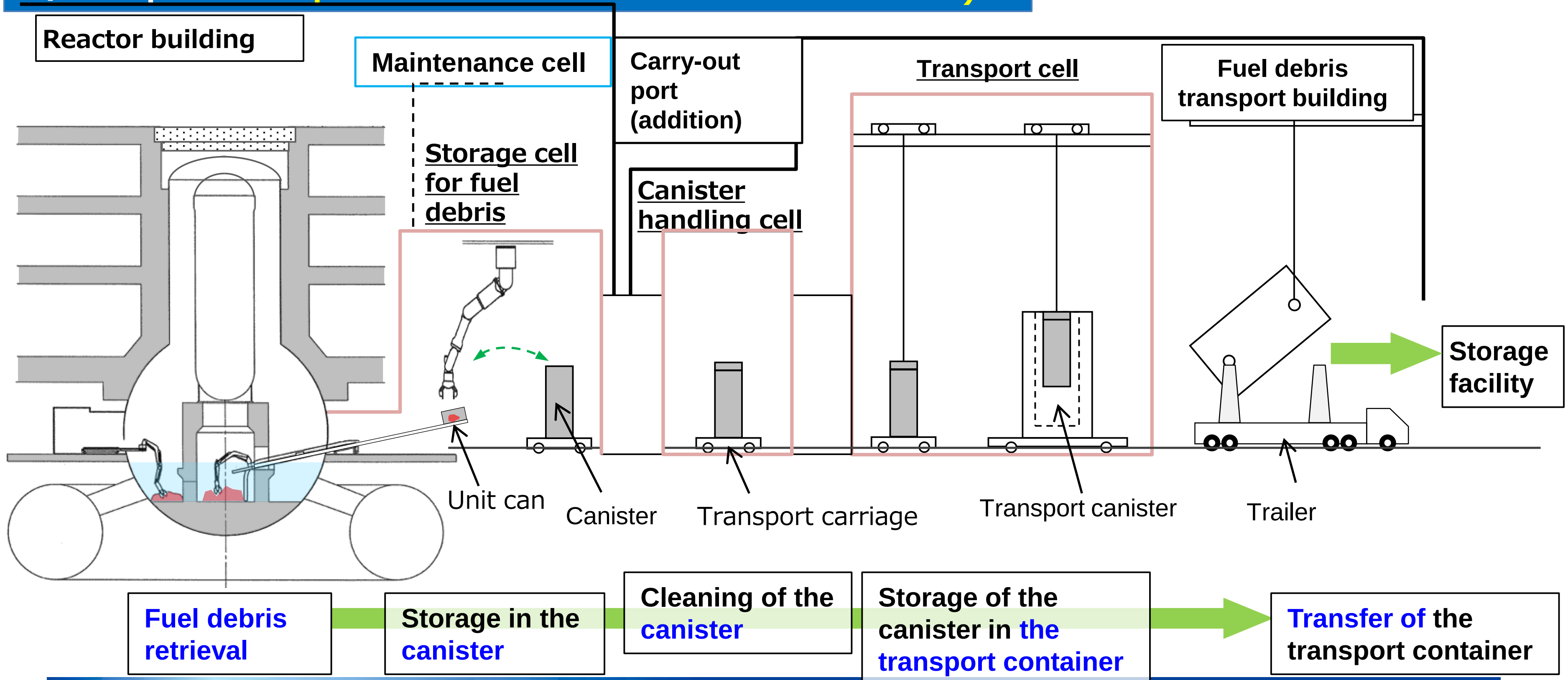


Technology for Containing, Transfer and Storage of Fuel Debris

Canister design ⇒ **Response to specific requirements for Fukushima Daiichi**

- High degrees of burnup and concentrations→**High reactivities**
- The molten core concrete interaction (MCCI) products→ **Hydrogen generation** caused by radiation degradation of water contents in concretes.
- **Sea water injection and melting with instrumental cables → Effects on salt and impurity mixtures**

A transfer method (Dry –side access method)
(example of the partial-submersion side access method)



Ensuring Safety Functions During Fuel Debris Retrieval

Safety Function Requirements

1. Cooling down
2. Confinement (control of negative pressure and water levels in the torus room)
3. Deactivation (protection of fire and explosion)
4. Sub-criticality