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2ND JAPAN-U.S. DECOMISSIONING AND REMEDIATION
FUKUSHIMA RECOVERY FORUM
TOKYO, JAPAN
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Fukushima restoration activities with US collaboration

April 9, 2015

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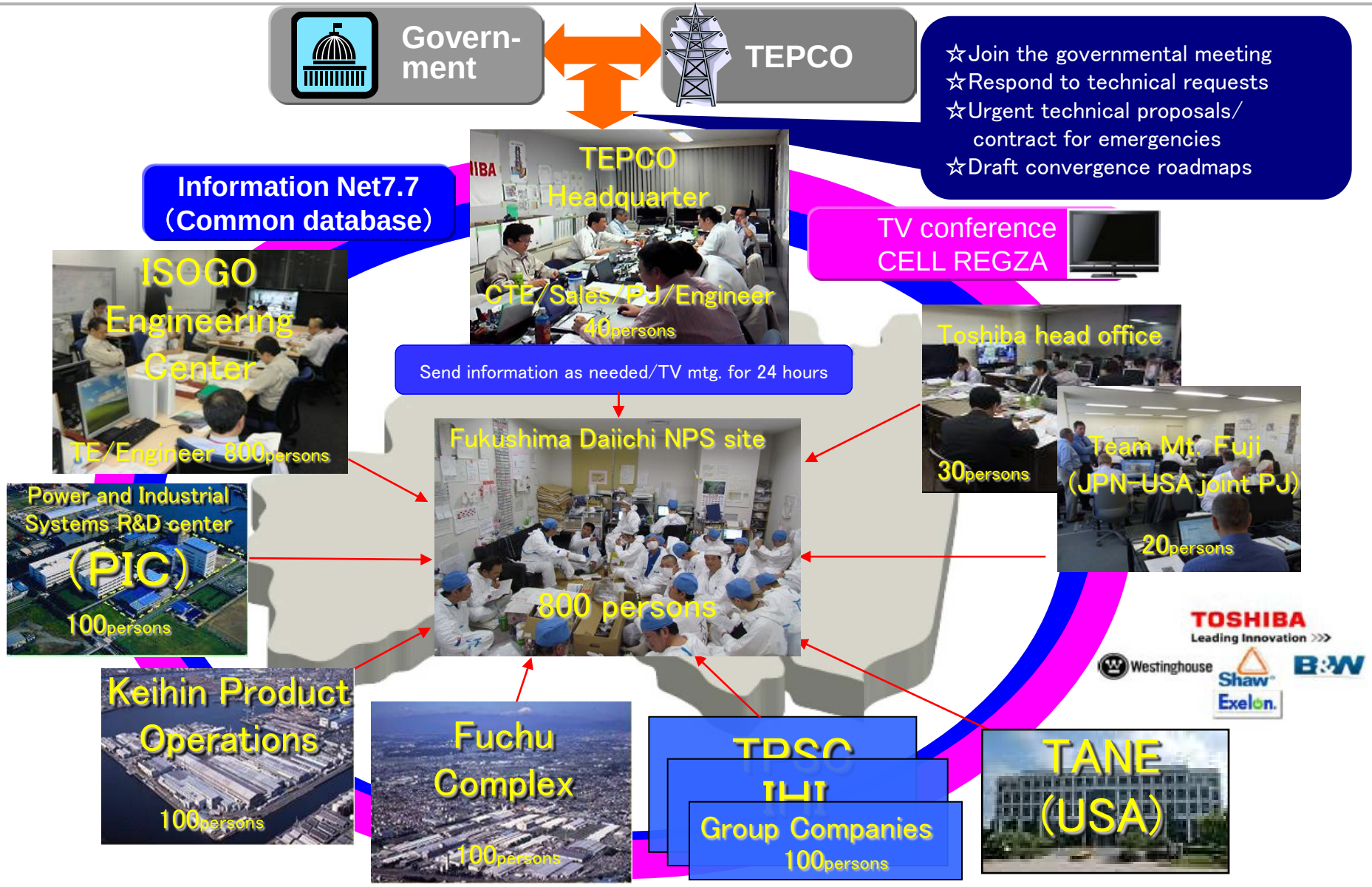
Contents

- Fukushima Restoration Activities
- Emergency Response
- Water Treatment System
- Fuel Removal from SFP
- MAAP5 Enhancement Project
- Muon Imaging
- Conclusion

Global Team for Fukushima Restorations after 3.11



Our Activities for Fukushima Restorations (1/3)

■ Short Term Activities

2011	～	2015	2016～2020	2021～

3/11 ▼

Cold Shutdown Achieved ▼2011/12

Emergency response

Submerged pumps
Hose connection

SFP Cooling Tower

Goal
- Achieve and maintain cold shutdown condition
- Establish recirculation loops of cooling water with minimized risk of leak potential.

（▽2015/5 Complete）

Contaminated Water Treatment

▼2011/8～ ▼2013/4～

Simplified Active water Retrieve and Recovery System

Building view

Equipment on site

Multi Radionuclide Removal System

Goal
- Steady purification of stored water without leakage to environment
- Treatment of Tritium to be considered before release to environment

Our Activities for Fukushima Restorations (2/3)

■ Mid Term Activities

2011 ～ 2015	2016 ～ 2020	2021～

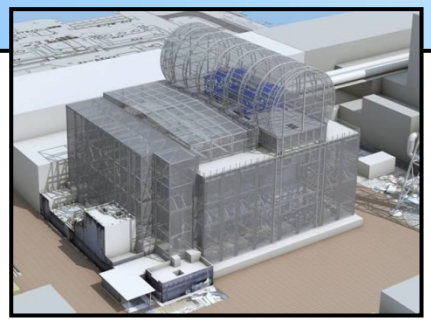
Decontamination / Shielding

Dry Ice Blast Robot

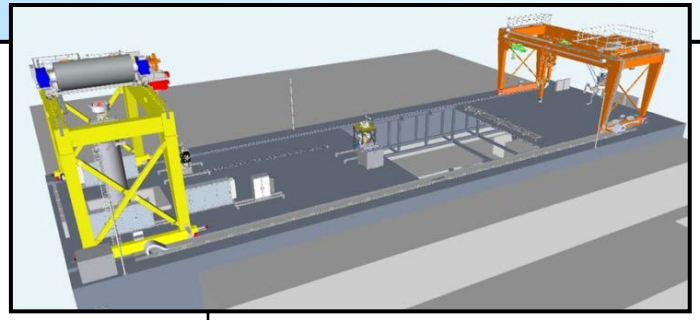
Goal
- Decrease the dose rate in the Reactor Building for personnel access
- Radiation exposure reduction ALAP

1F-4 Complete
▼2014/12

Removal of Fuels from Spent Fuel Pool (SFP)



1F-3 Reactor Building Cover Outline



1F-3 Fuel Removal System

Goal
- Complete fuel removal from SFP before core debris removal

Fuel Removal System for 1F-3 SFP

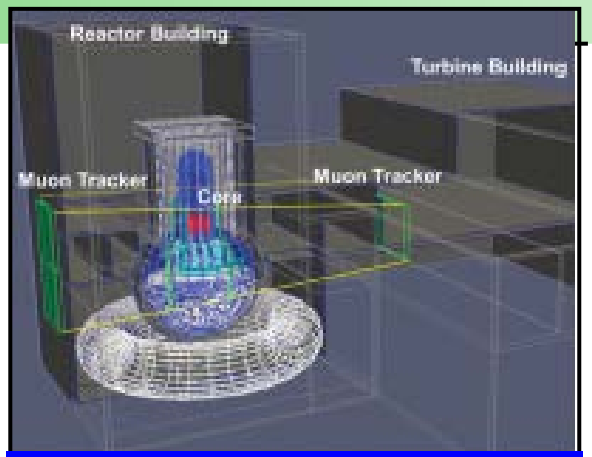
Our Activities for Fukushima Restorations (3/3)

■ Long Term Activities

2011 ～ 2015	2016 ～ 2020	2021～
PCV Vent Pipe Inspection ▼2012	Assessment of debris position ▽2017/3～	1F2 Core debris removal ▽2021/12～
PCV Inspection ▼2014～	Sampling from PCV ▽2017～	Sampling from RPV ▽2019～

R&D, Remote Inspection → **Core Debris Removal**

Quadruped Robot



Imaging of core debris position by Muon (Scattering method)

Goal
- Start removing core debris from 2021

Radioactive Waste Management

Goal
- Establishment of waste management procedure by 2020

Lower part of vent pipe bellows cover by Quadruped Robot

Reference: TEPCO HP
[http://photo.tepco.co.jp/date/2012/201212-j/121211-01j.html]

Emergency Response in March 2011

■ Preparation of emergency measures

◆ Recovery of electric power supply

- Car batteries for I&C power supply (2,000 units)
- Installation of cables

  High-voltage cables: 2,000 m

  Low-voltage cables : 23,400 m

Submerged pumps and hoses

◆ Urgent core cooling by seawater injection

- Connection hose and cables
- Submerged pumps (52 sets)

◆ Avoidance of hydrogen explosion

- Drill the roof of reactor building
  (Water jet and core drill)
- Mock up test before explosion of Unit 3

Mock up test for drilling

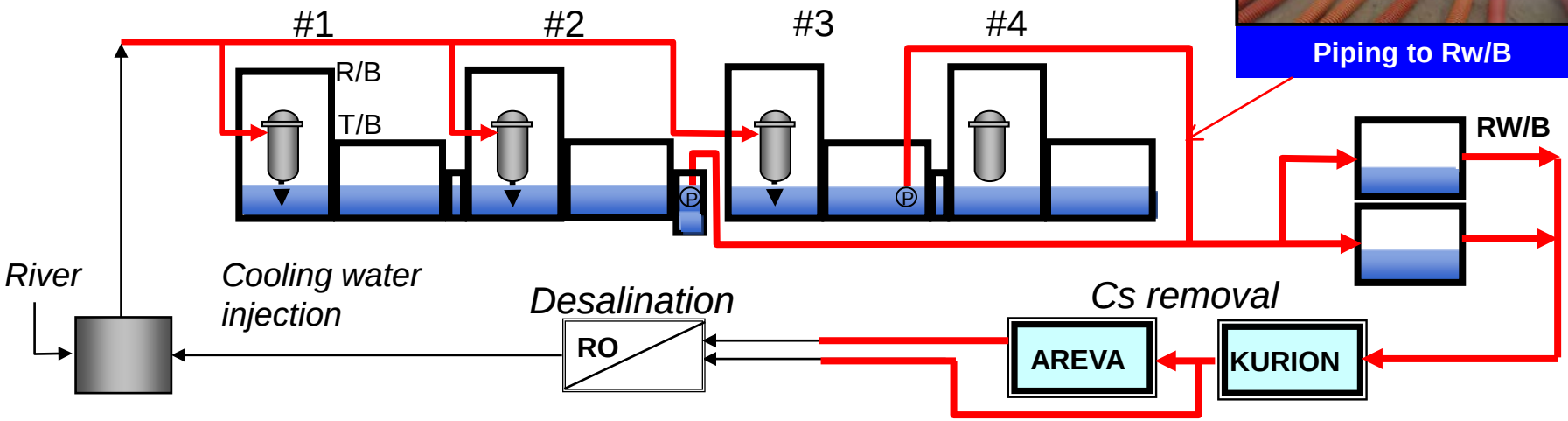
I&C: Instrumentation and Control
HVAC: Heating Ventilation and Air Conditioning and Cooling System

Establish the 1st Water Treatment System

■ Highly contaminated water accumulated in T/B

- ◆ Nearly 70,000 tons of contaminated water as of middle April
- ◆ Urgent water transfer required to Rw/B
- ◆ Established recirculation loop for cooling water treatment system

Piping to Rw/B



■ After equipment supply from overseas companies, piping installation 4,100m with 3,000 welding points

T/B: Turbine Building
Rw/B: Radioactive Waste Building
RO: Reverse Osmosis Cs: Cesium

Installation of the 2nd Water Treatment System

■ Simplified Active water Retrieve and Recovery System

- ◆ Increase stability and redundancy of Cs removal
- ◆ Design and manufacturing collaborated with SHAW* and related companies in U.S.

*: Current CB&I

- ◆ Ready for operation within only 2.5 months from proposal under severe conditions

■ Major characteristics

- ◆ High performance media to achieve high DF
- ◆ Sufficient shielding in vessels for workers
- ◆ Stable operation by simplified system

Simplified Active water Retrieve and Recovery System

DF: Decontamination Factor

Further Risk Reduction by Water Treatment

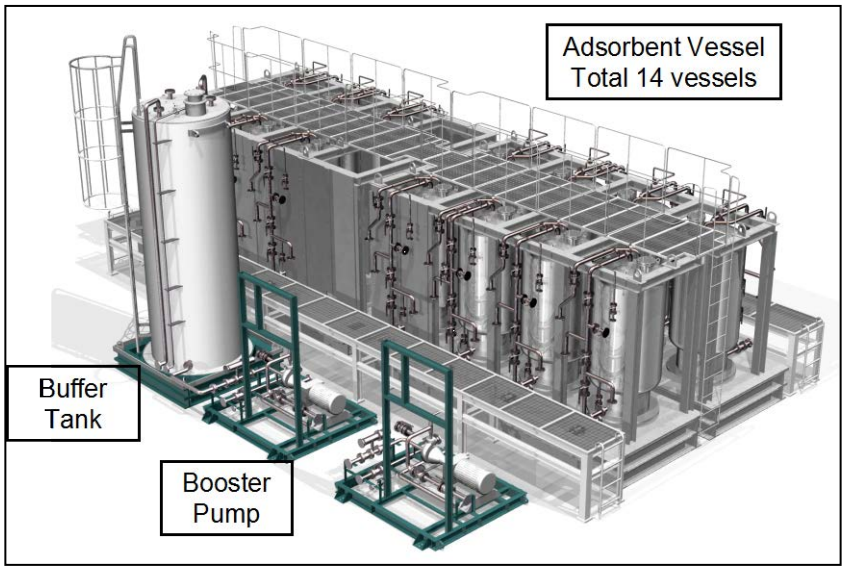
■Multi Radionuclide Removal System

- ◆ Conceptual design by EnergySolutions based on Advanced Liquid Processing System
- ◆ Detailed design and major manufacturing by Toshiba
- ◆ Removal for 62 radionuclides including Strontium from stored contaminated water

Desalination unit (RO apparatus)

Multi Radionuclide Removal System

Tank



Overview of Multi Radionuclide Removal System

- ◆Started hot test operation from April 2013
- ◆Treated more than 300,000 m^3 RO concentrated water up to now

Site installation

Building view

IX (ion exchange) columns

Reference：Tepco web site

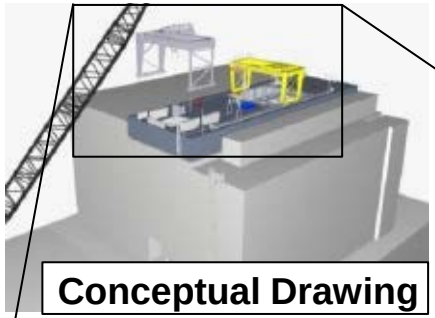
Fuel Removal from 1F-3 SFP

1F-3 Fuel Removal System

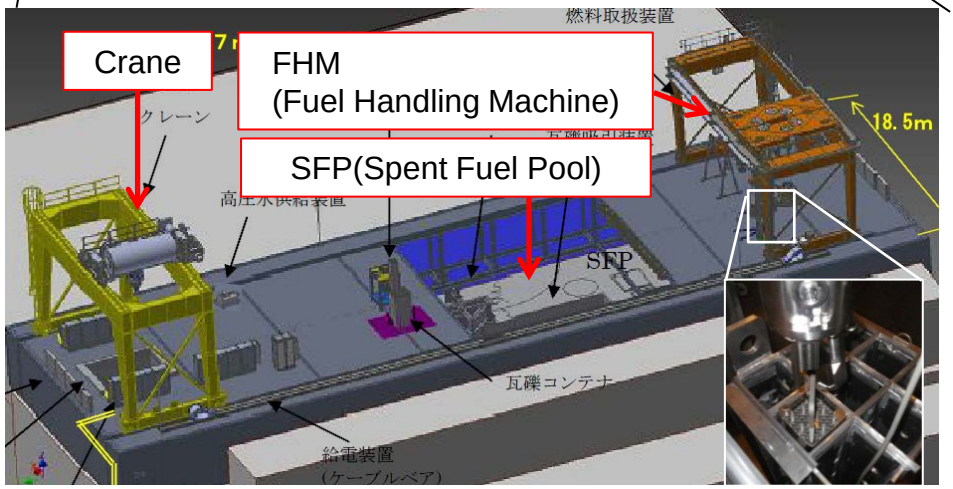
- Conceptual and basic design by Toshiba and WEC
- Detailed Design and fabrication by WEC, PaR Systems, etc.

Functions

- Remotely controlled FHM for fuel assemblies and debris removal from SFP
- Remotely controlled crane for transfer vessel handling



Conceptual Drawing

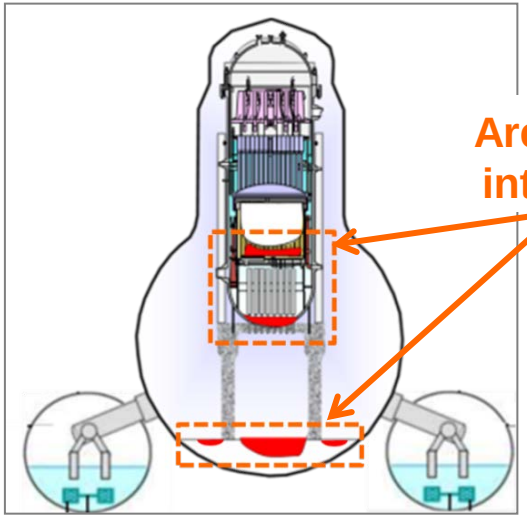


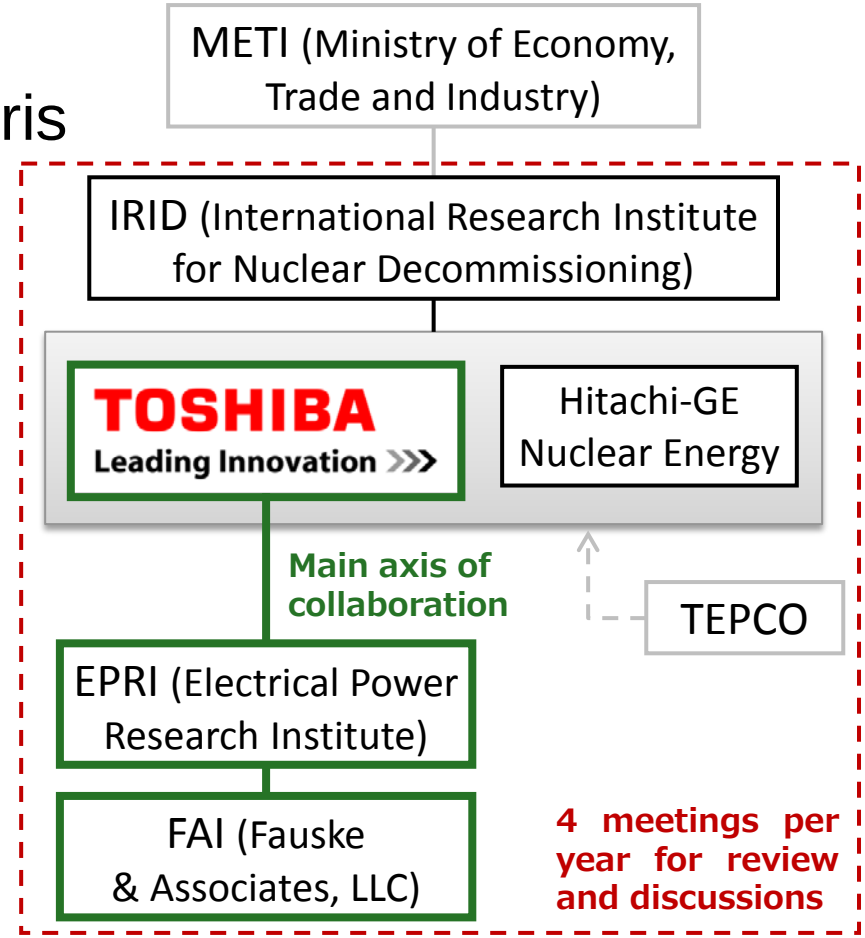
Fuel Handling Grapple

MAAP5 Enhancement Project

■Objective

- ◆Better understanding of accident progression
- ◆Assess the status of core debris inside the reactor vessel and containment, to provide information for concrete procedure of debris removal



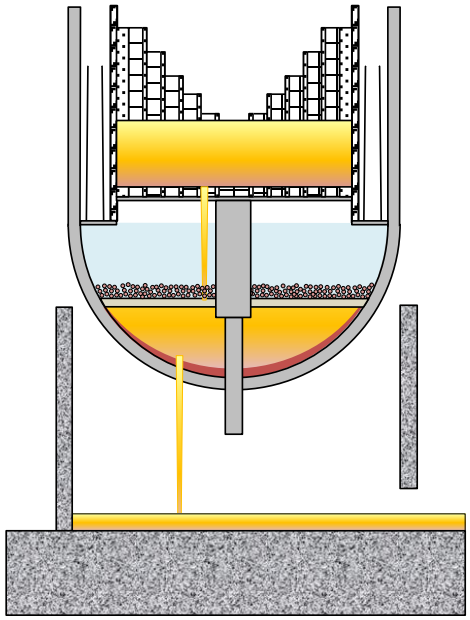


Organization

Process of MAAP5 Code Enhancements

■ Collaborating activities

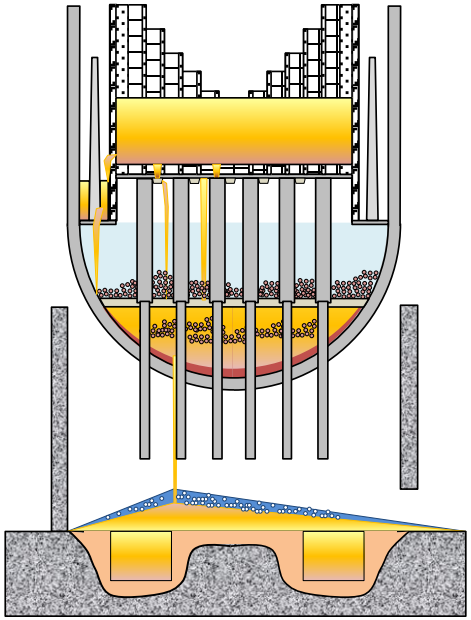
- ◆U.S.: Physical model enhancements, code improvement, verification and validation
- ◆Japan: Code improvement review, Fukushima accident progression analysis.



Before collaboration

(*Simple & Conservative Model*; ~MAAP 5.02)

*The contents of this presentation include the results of "Establishment of basic technology for decommissioning and safety of nuclear reactors for power generation in 2013 (technological study and research concerning forming an idea for processing and disposing of radioactive waste resulting from the accident)", a project commissioned by the Ministry of Economy, Trade and Industry, and the 2013 subsidiary for decommissioning and contaminated water measures (development of technologies for processing and disposing of waste resulting from the accident).



Current state of improvements

(*Realistic Model*; Upcoming MAAP 5.04~)

Outline of Muon Imaging (Scattering Method)

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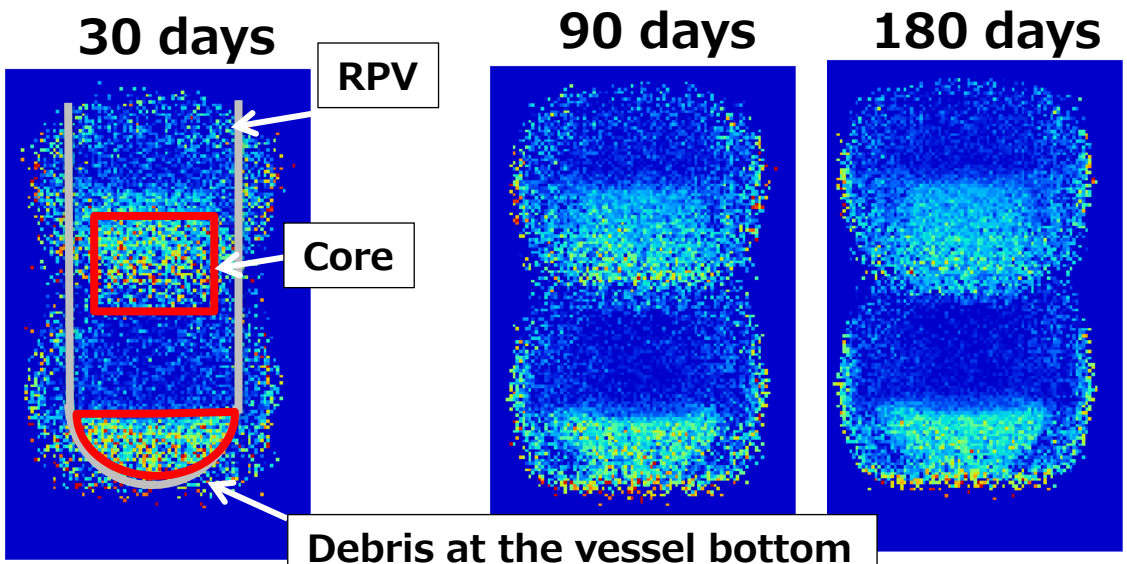
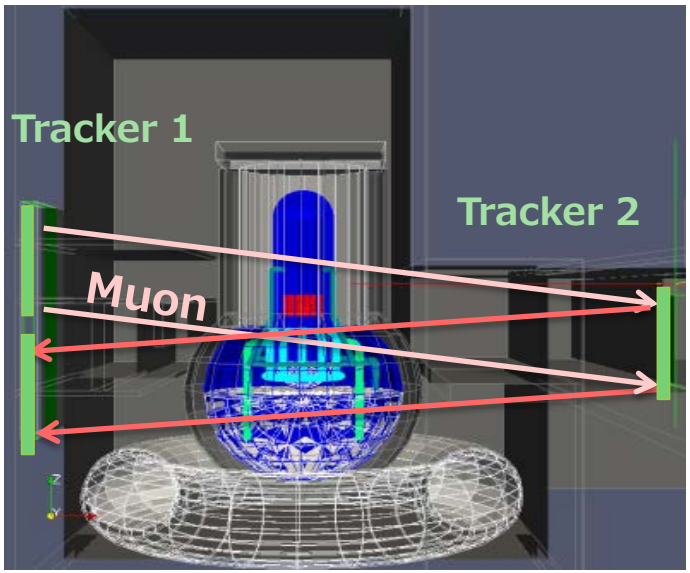
■ Developing sequence

- ◆Soon after 3.11, feasibility studies at LANL
- ◆2012, LANL – Toshiba started working together
- ◆August 2013, Demonstration at Toshiba's research reactor
- ◆June 2014, National project started
- ◆March 2015, Muon trackers assembled at Toshiba



Simulation of measurement

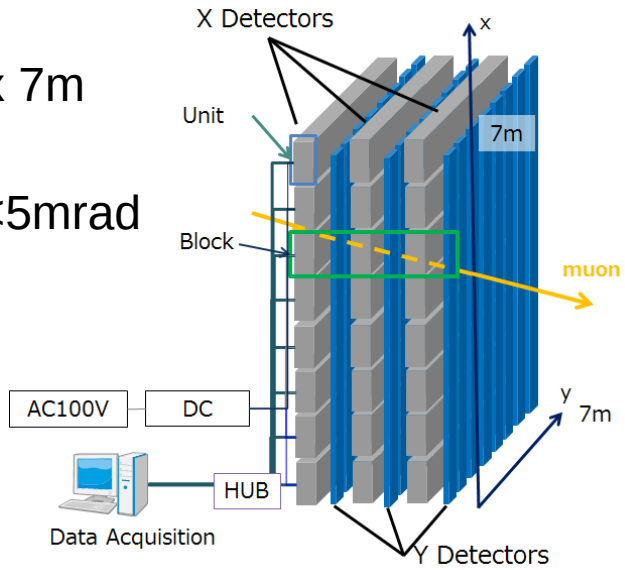


LANL: Los Alamos National Laboratory

Muon Detector for Fukushima Measurement

■ Feature

- ◆Large detector to cover most of the RPV
- ◆Sensors improved for operation under high radiation environment
- ◆Gamma-removal electronics developed
- ◆Specification
  - ➢ Sensor: Drift tube detector (Φ5cm×7m, gas sealed) 1,680 tubes/tracker
  - ➢ Detection area: 7m x 7m
  - ➢ Layer: Six X and Y
  - ➢ Resolution: <1mm, <5mrad



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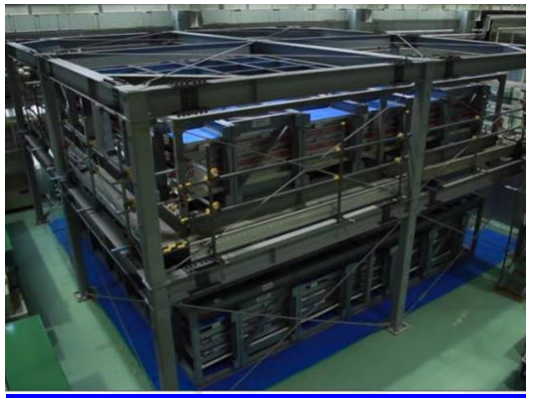

Detector Assembly

Conclusion

- Fukushima restoration activities are essential for Japanese nuclear industry
- We addresses those activities by collaborating with Japanese government and TEPCO
- Prompt proposals of proven technologies for Fukushima restoration from U.S. are welcome
- Clear roles and sufficient bilateral communications between U.S. and Japan are successful key points

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