

PRIDE's System for Engineering-scale Pyroprocessing Development

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Outline

- I PRIDE facility's Systems**
- II Performance test (Leakage test)**
- III Ar Charging and Seal Pot Modeling**
- IV Summary**

PRIDE (PyRoprocess Integrated inactive Demonstration facility)

◆ PRIDE Missions

- Test facility to evaluate performance (cold-run) and scale-up issues of full-spectrum pyroprocessing technology

◆ Construction and Operation Plans

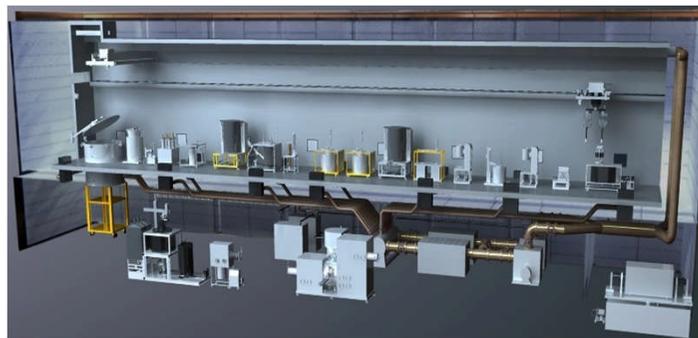
- Design : 2007 ~ 2008 (2 years), Construction : 2009 ~ 2011 (3 years)
- Operations : 2012 ~

◆ Main Features

- Pyroprocess Test & Demonstration with Depleted Uranium or Surrogate up to Engineering Scale
- Argon Gas-filled Cell for Pyroprocessing Work (Impurity Level below 50ppm)
- Full Remote Operation and Maintenance Concepts
- Argon Cell Size: 40m(L) × 4.8m(W) × 6.4m(H)



PRIDE



Bird's-eye view of argon cell



PRIDE (PyRoprocess Integrated inactive Demonstration facility)

Air Environment Hot Cell

$\beta - \gamma$ type Hot Cell

- Hot cell for examination irradiated materials emitting $\beta - \gamma$ (Irradiated Materials Examination Facility)
- Only negative pressure control to minimize radioactive materials contamination
- One-through HVAC system (Air environment)

$\alpha - \gamma$ type Hot Cell

- Hot cell for examination actinide elements (Post Irradiation Examination Facility)
- Negative pressure control and sealing partially to prevent spreading contamination
- Sealing adapted
- One-through HVAC system (Air environment)

Inert(Argon) environment Cell

Pyroprocessing Cell

- Handling active metal and deliquescence molten salts materials
- Inert atmosphere environments
- Closed argon re-circulation system
- Negative pressure control and leak tightness to minimize air ingress into argon cell
- Prevent air ingress when transfer material into cell
- Remote operation and maintenance

Challenges

- ◆ Development for cell equipments with leakless and remote operation and maintenance
- ◆ Argon atmosphere control of large inert cell with impurity level (oxygen and moisture) below 50ppm

Operation Equipments of PRIDE Ar Cell

◆ PRIDE Cell Equipments

- ✓ Large & small transfer lock systems, 2 gravity tubes
- ✓ In-cell crane & In-cell crane trolley hoist
- ✓ Utilities: 34 Cell lights, 17 Windows, Feed-throughs

◆ Functions

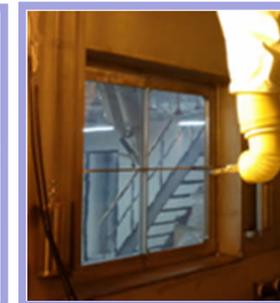
- ✓ Support of pyroprocess equipment operation in the Ar cell
- ✓ Provision of required utilities for the process

◆ Main Features

- ✓ Interlocked control for keeping Ar atmosphere
- ✓ Remotely operable and maintainable design



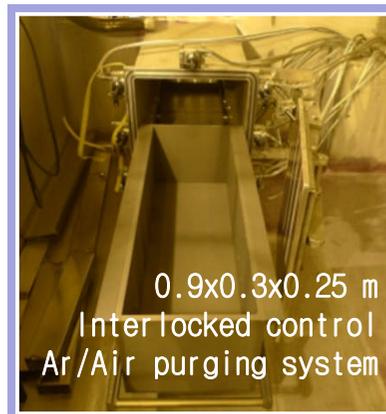
Cell Light



Window



Large Transfer Lock System



Small Transfer Lock System



Gravity Tube



In-cell crane & In-cell crane trolley hoist

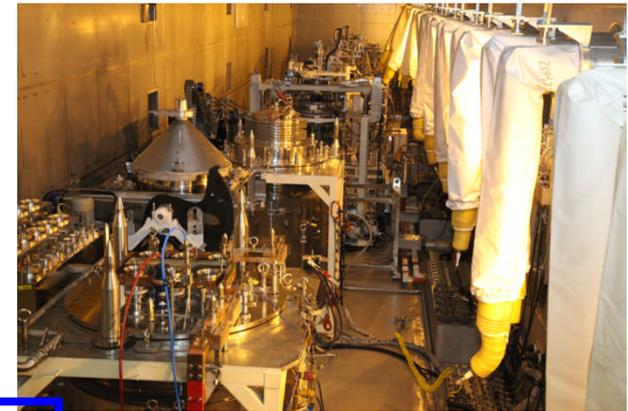
Operation Equipments of PRIDE Ar Cell



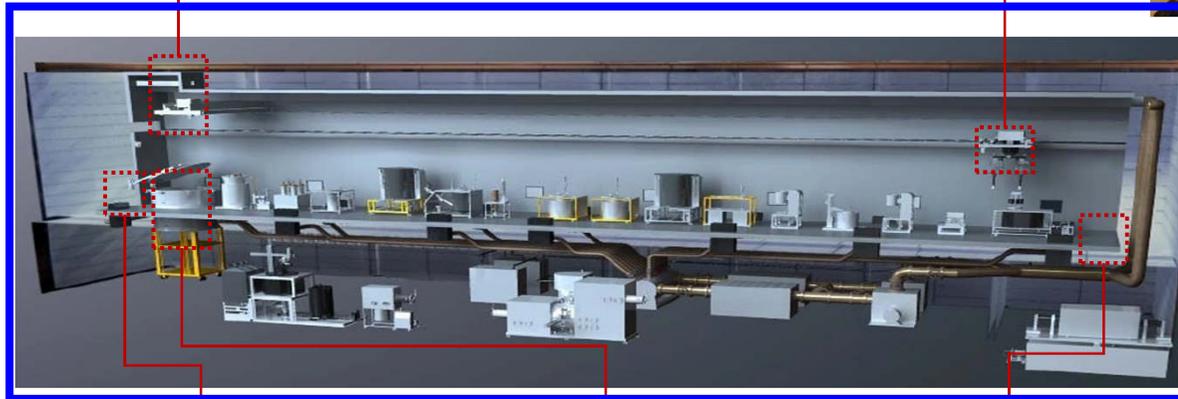
Crane & Crane Trolley Hoist



BDSM & MSM



Inside of the PRIDE Ar Cell



Small & Large Transfer Lock System



Gravity Tube



Operation area

Operation Equipments of PRIDE Ar Cell – Large Transfer Lock



Argon System of PRIDE



PRIDE Argon System Requirements

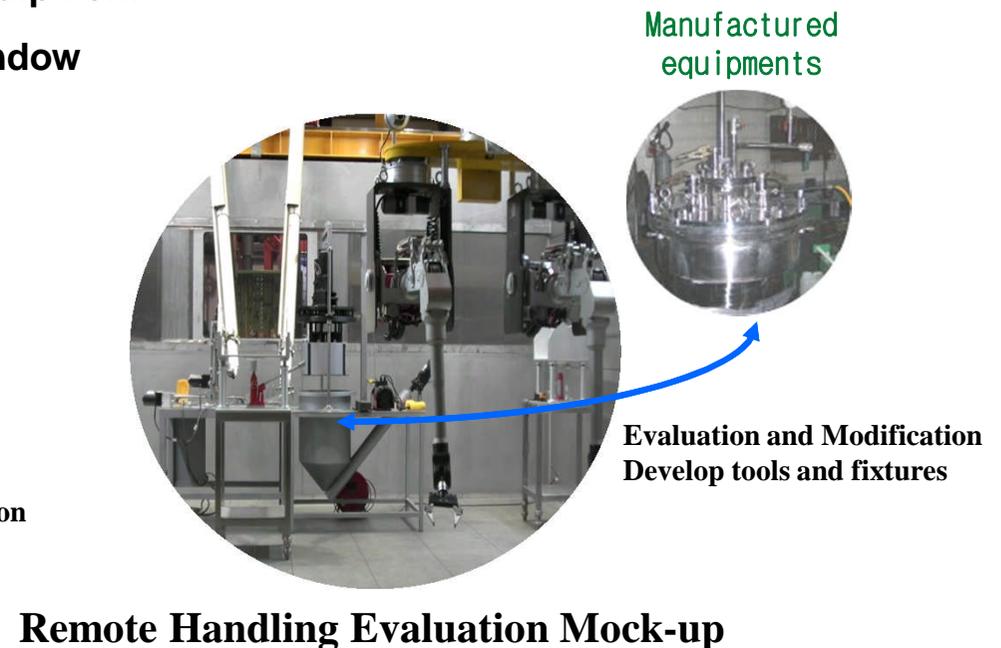
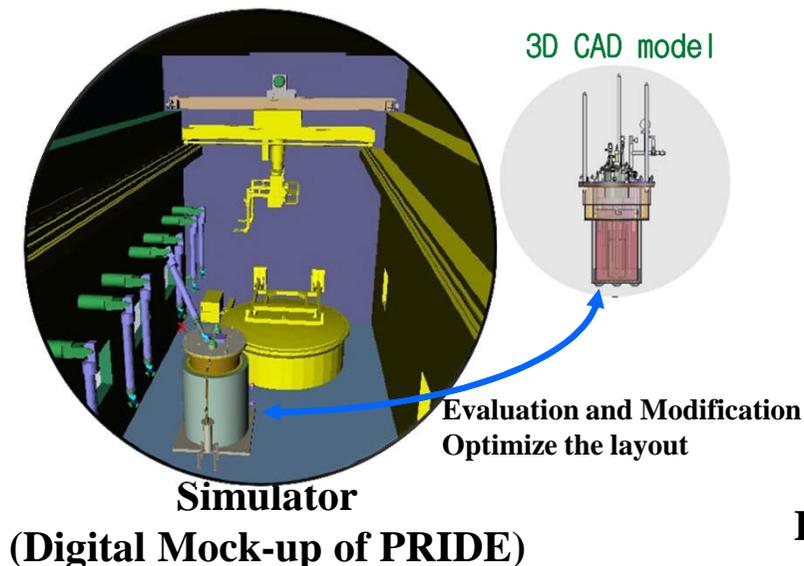
- ◆ **Argon supply system**
 - Argon cell : 1,200 m³
 - Initial charging rate : 300m³/h (4 hours to fill argon cell full)
- ◆ **Argon re-circulation and cooling system**
 - Argon circulation blower : 12,000 m³/h capacity (10 times/h circulation rate)
 - Cooling rate : 80 kW
- ◆ **Argon purification system**
 - Purifier requirements : 48 hours (impurity level 200 ppm -> below 50 ppm O₂, H₂O)
 - Purifier capacity : 200m³/h x 2 unit
- ◆ **Argon exhaust system**
 - Pressure relief requirements: -280mmAq(lower limit), +75mmAq(higher limit)
 - High volume vent system for initial argon charging
 - Low volume vent system for normal operation
 - Seal pot for pressure relief and prevent from backward flowing

Argon System of PRIDE

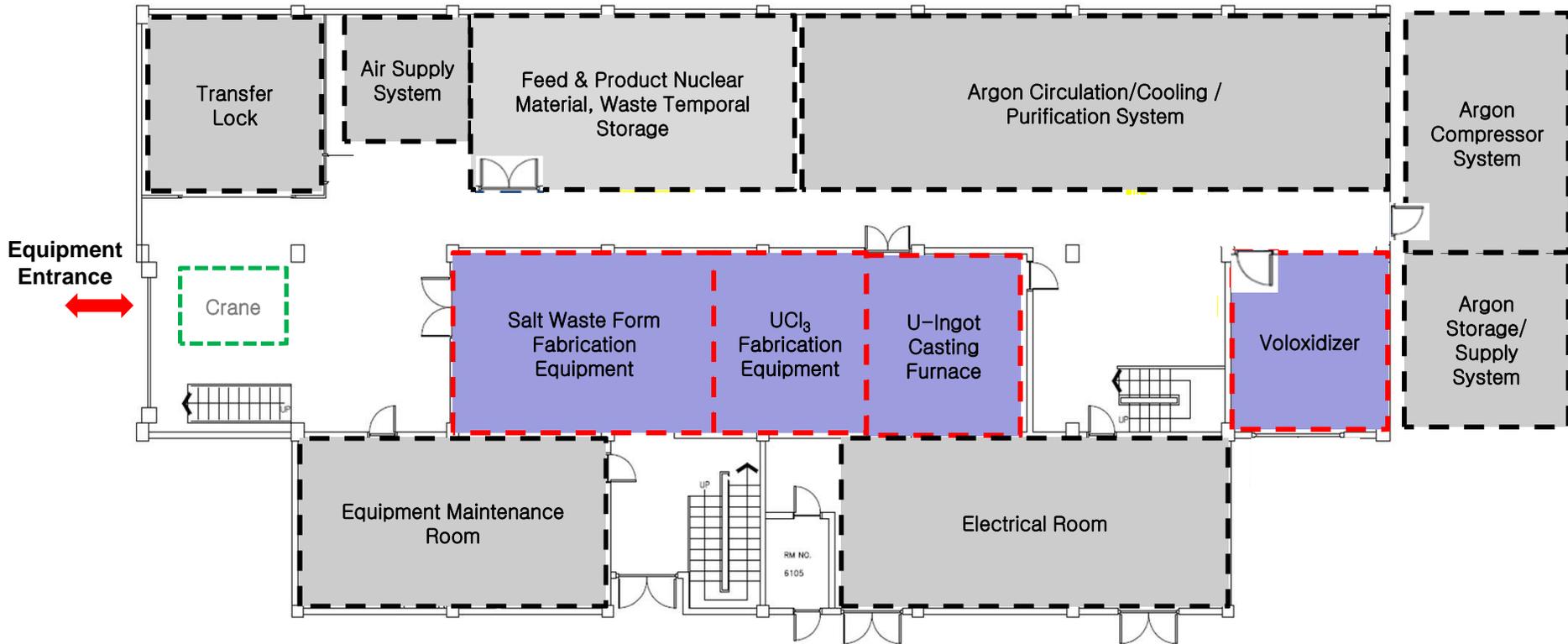


Mock-up for PRIDE

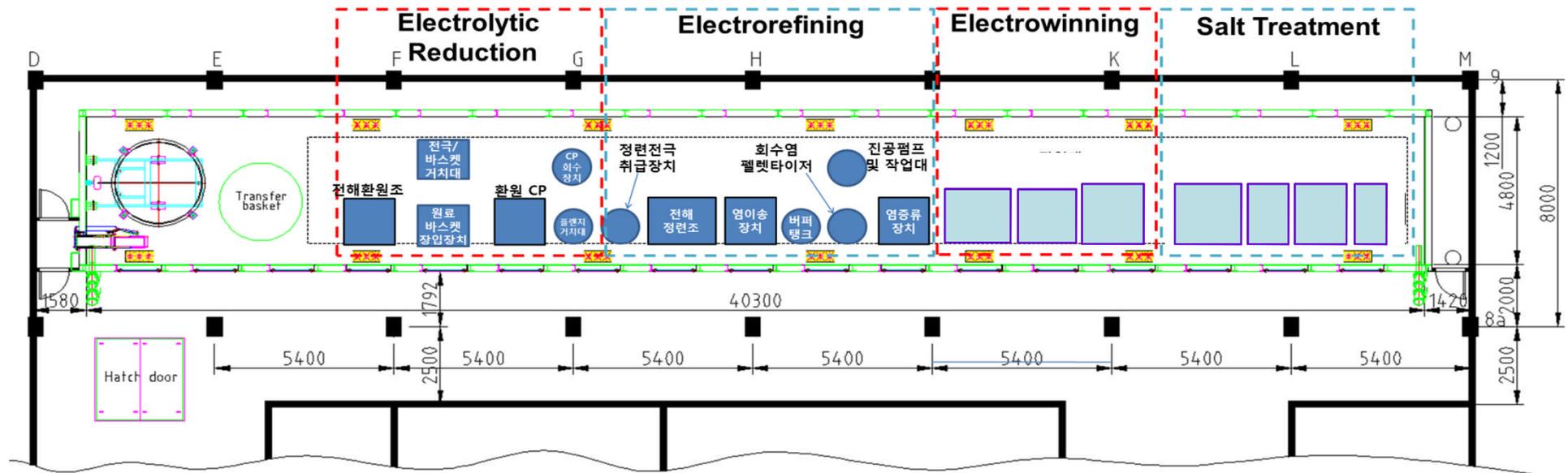
- ◆ Digital Mock-up of PRIDE is used to:
 - ✓ Test **all 3D design model of in-cell equipment prior to manufacturing** for remote operability and maintainability
 - ✓ Optimize the layout of PRIDE
- ◆ Mock-up Area of PRIDE is used to:
 - ✓ Test **all in-cell equipment prior to installation** for remote operability and maintainability
 - ✓ Develop tools and fixtures for unplanned maintenance activities
- ◆ Mock-up Area is equipped with remote-handling equipment
 - ✓ BDSM, Overhead crane, 2 MSM and flexible window



PRIDE Layout – 1st Floor



PRIDE Layout – 2nd Floor



Reduction Process

1. Electrolytic reduction equipment
2. Electrolytic reduction cathode processor

Refining Process

3. Electrolytic refiner
4. Molten salt transfer system
5. ER salt distiller (Cathode processor)

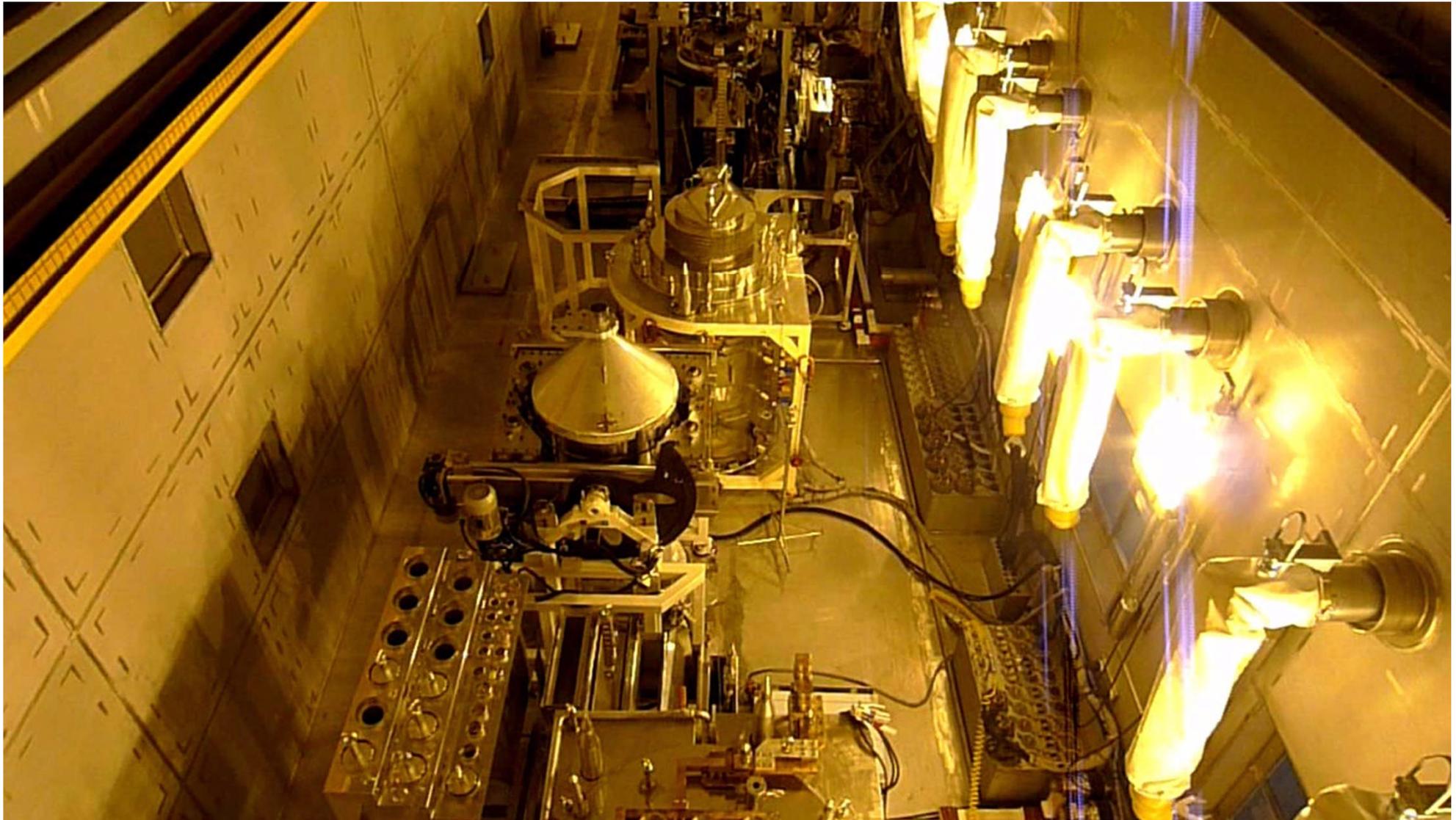
Winning Process

6. LCC Electrowinner
7. RAR process equipment
8. Cadmium distillation equipment

Salt Treatment

9. Oxidative precipitator
10. Melt crystallizer

PRIDE Layout – 2nd Floor



Start-up Test Plans

◆ Construction Schedule

- Installation argon cell structure of PRIDE : '11.07 ~ '11.12
- Installation cell operation and remote equipments : '11.10 ~ '12.02
- Installation of BDSM : ~ '12.03
- Installation argon system and HVAC : '11.10 ~ '12. 02
- Manufacturing process apparatus and installation on PRIDE : ~ '12.05
- PRIDE construction is completed : '12.07

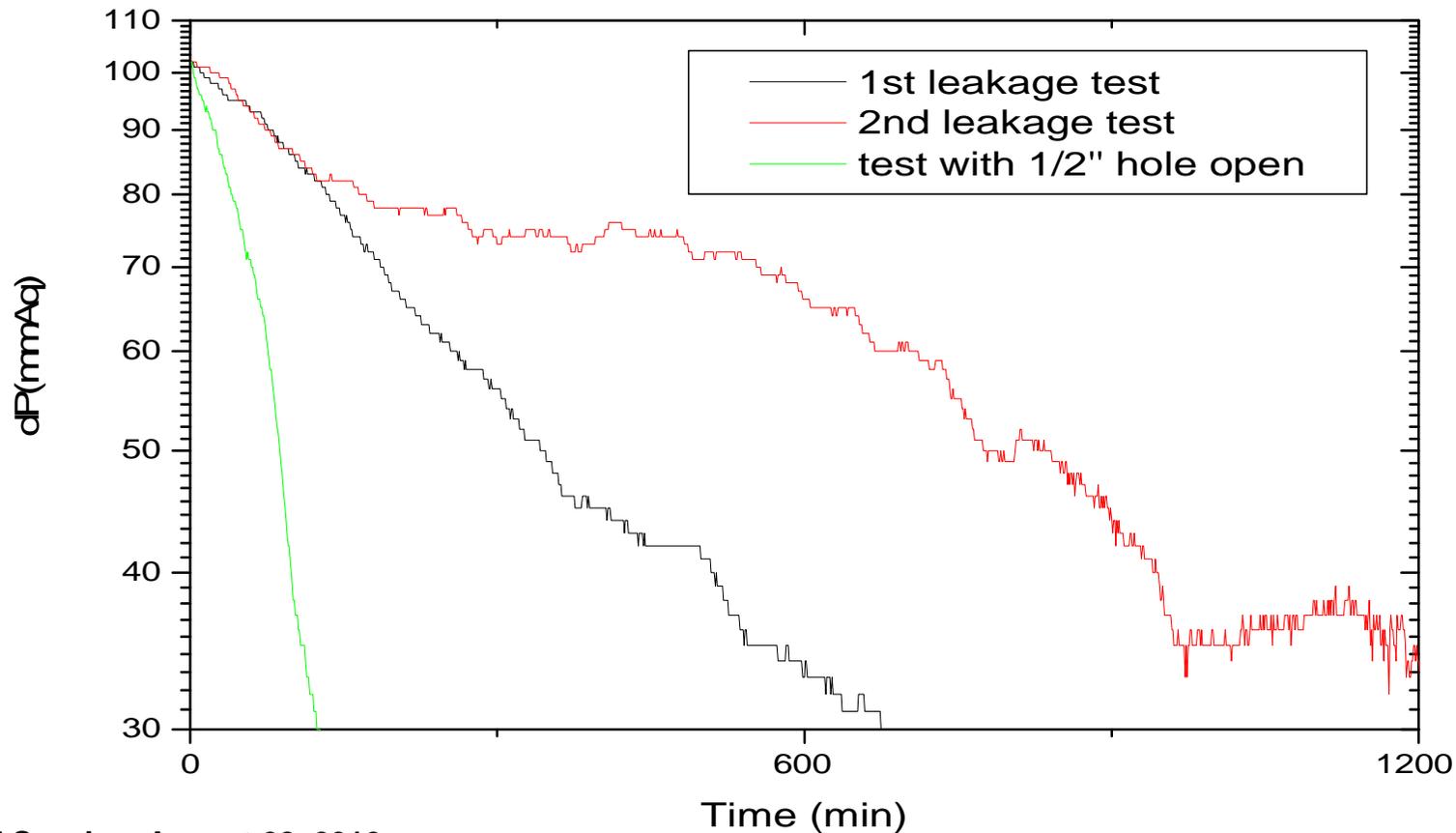
◆ Plans

- PRIDE start-up test in progress(leakage test & Ar charging) : '12.07 ~
- PRIDE operation and utility systems operational and functional performance test : ~ '13.02
- BDSM operational and functional performance test : ~ '13.02
- Process equipment's operational and functional test : ~ '13.02
- Process equipment remote handling test : ~ '13.02
- Process equipment's salt test : '13.03 ~

Leakage Test of PRIDE

◆ Leakage Test

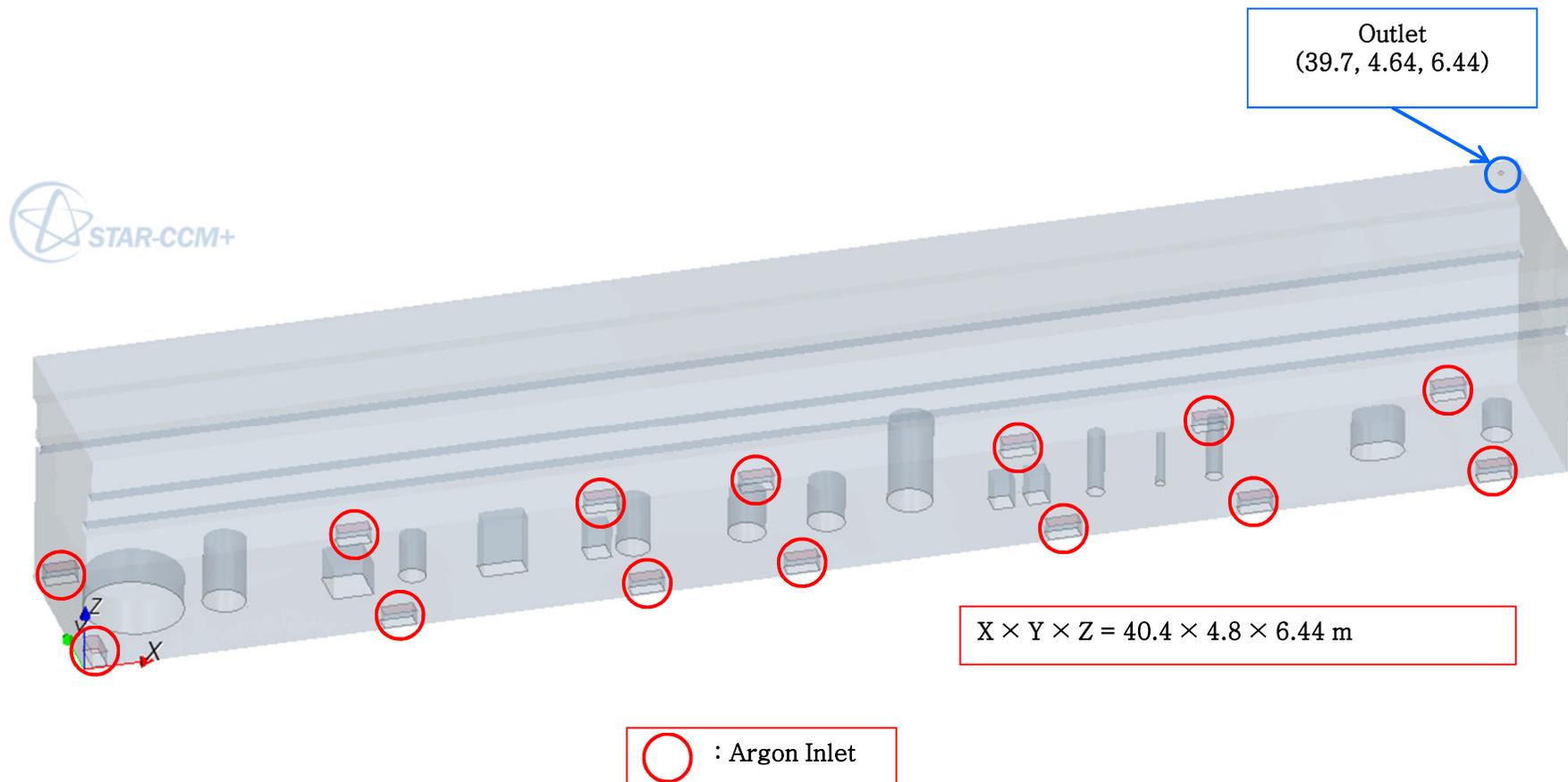
- Method : Pressure decay method
- Test pressure : -100 mmAq ~ -30 mmAq (normal operation conditions)
- Test volume : 1,200 m³
- Leakage check with 10% Ar or 10% He in Air (Snifer test)



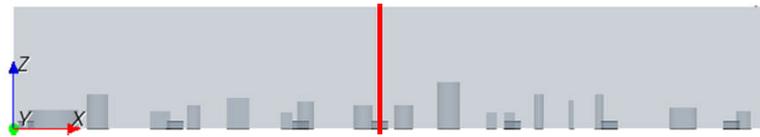
Ar Charging Modeling

◆ Ar charging

- Inlet : Bottom of cell (through 14 filter units)
- Outlet : Upper part of cell (one hole)
- Charging rate : 300 m³

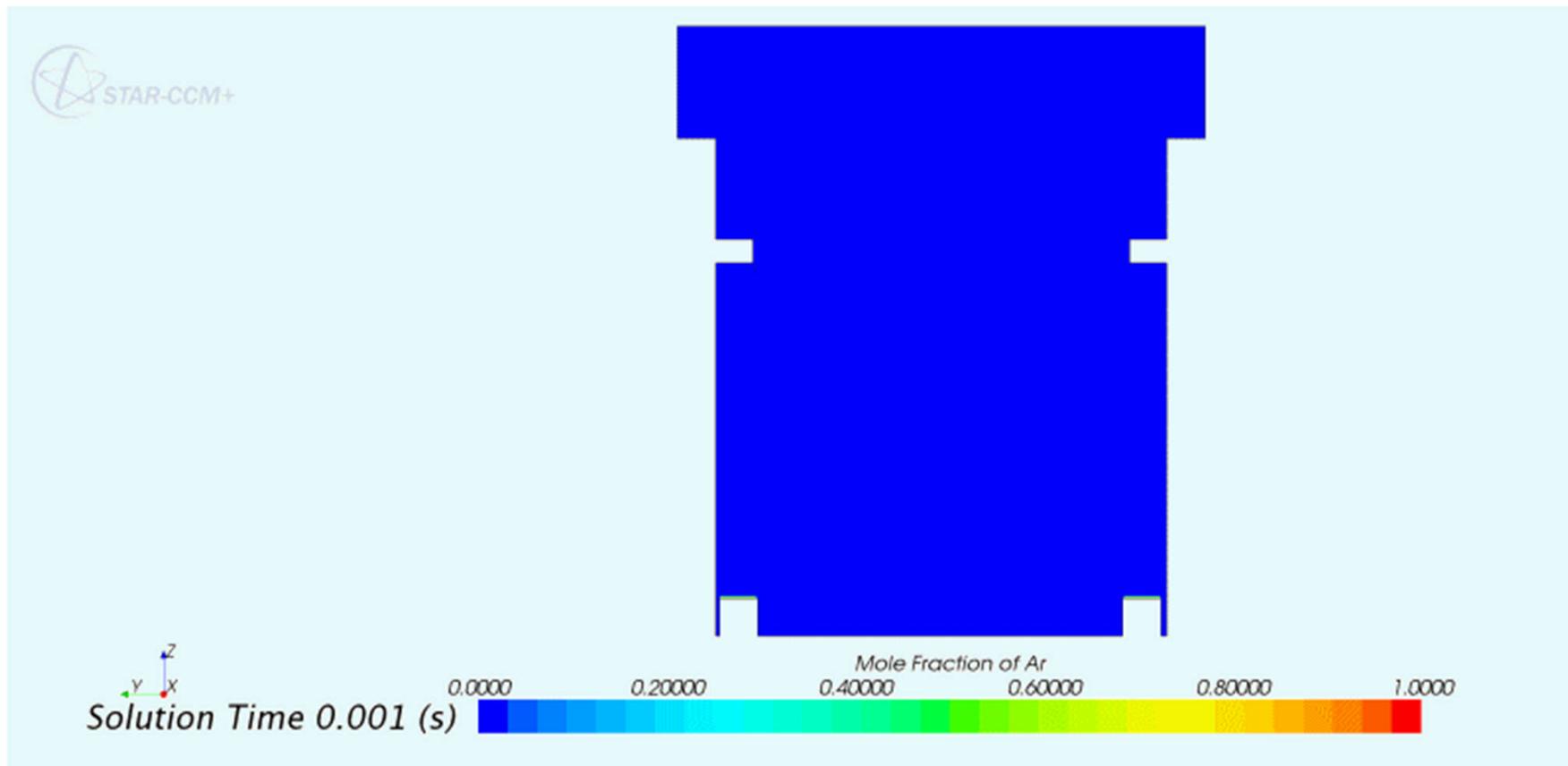


Ar Charging Modeling

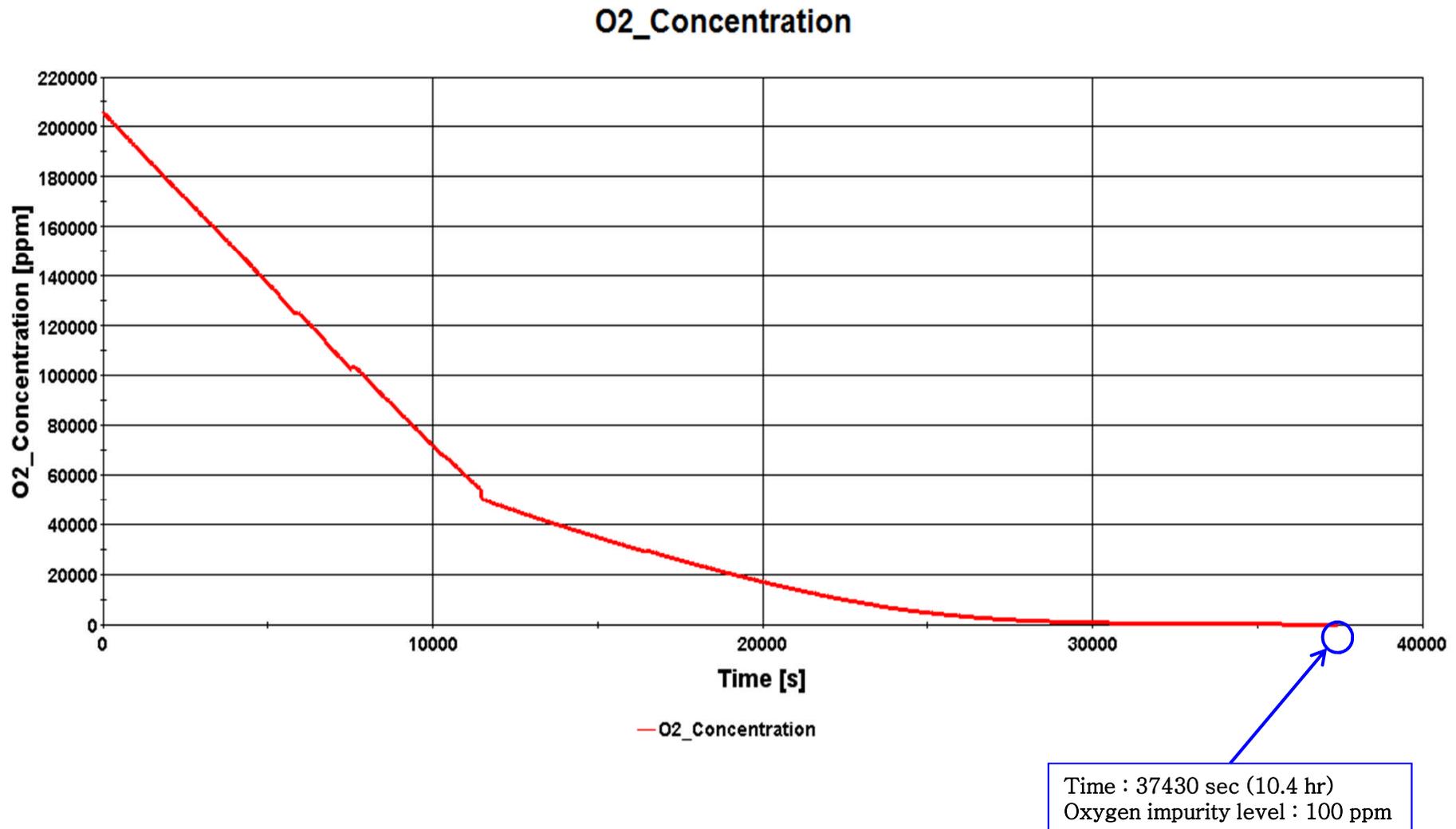


Front View

Animation

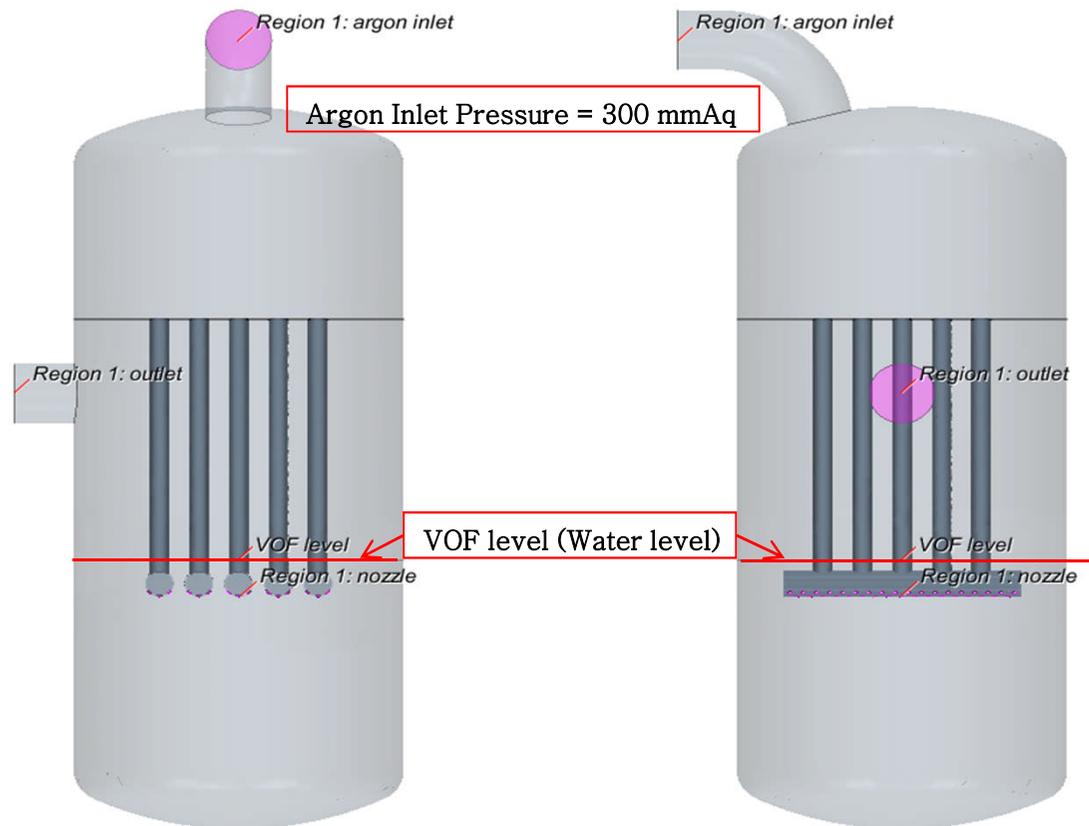


Ar Charging Modeling

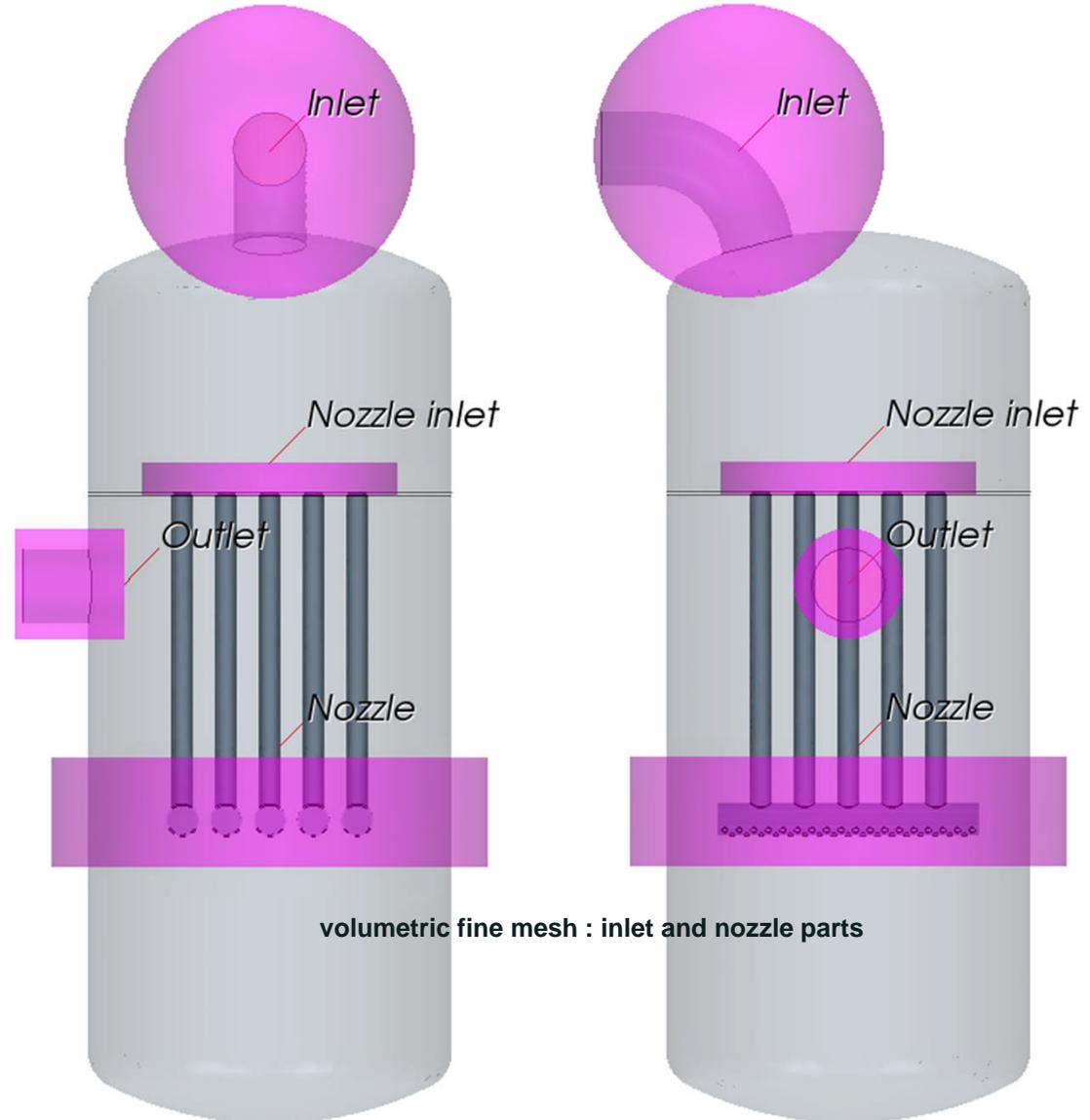
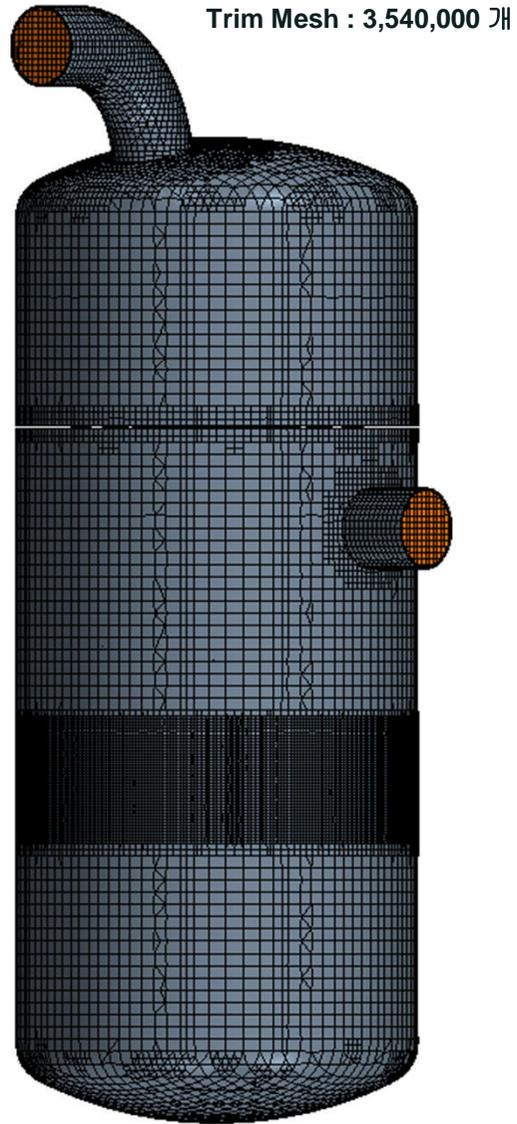


Seal Pot Modeling

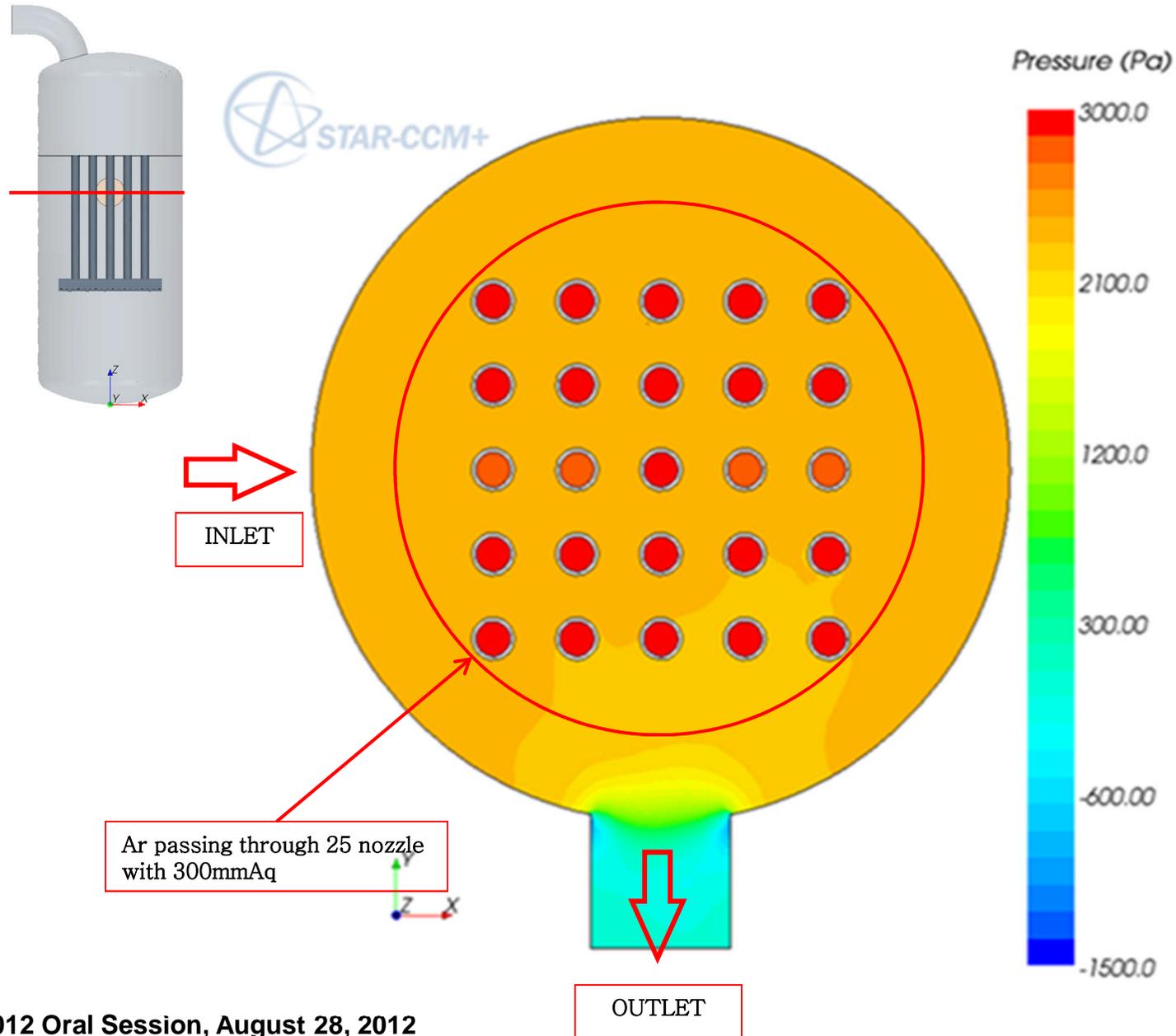
- ◆ Seal pot is safety system for pressure relief of Ar cell
 - Estimate pressure difference between argon inlet and outlet
 - Estimate volumetric flow rates with pressure difference
 - Evaluate and set the optimal parameters of seal pot



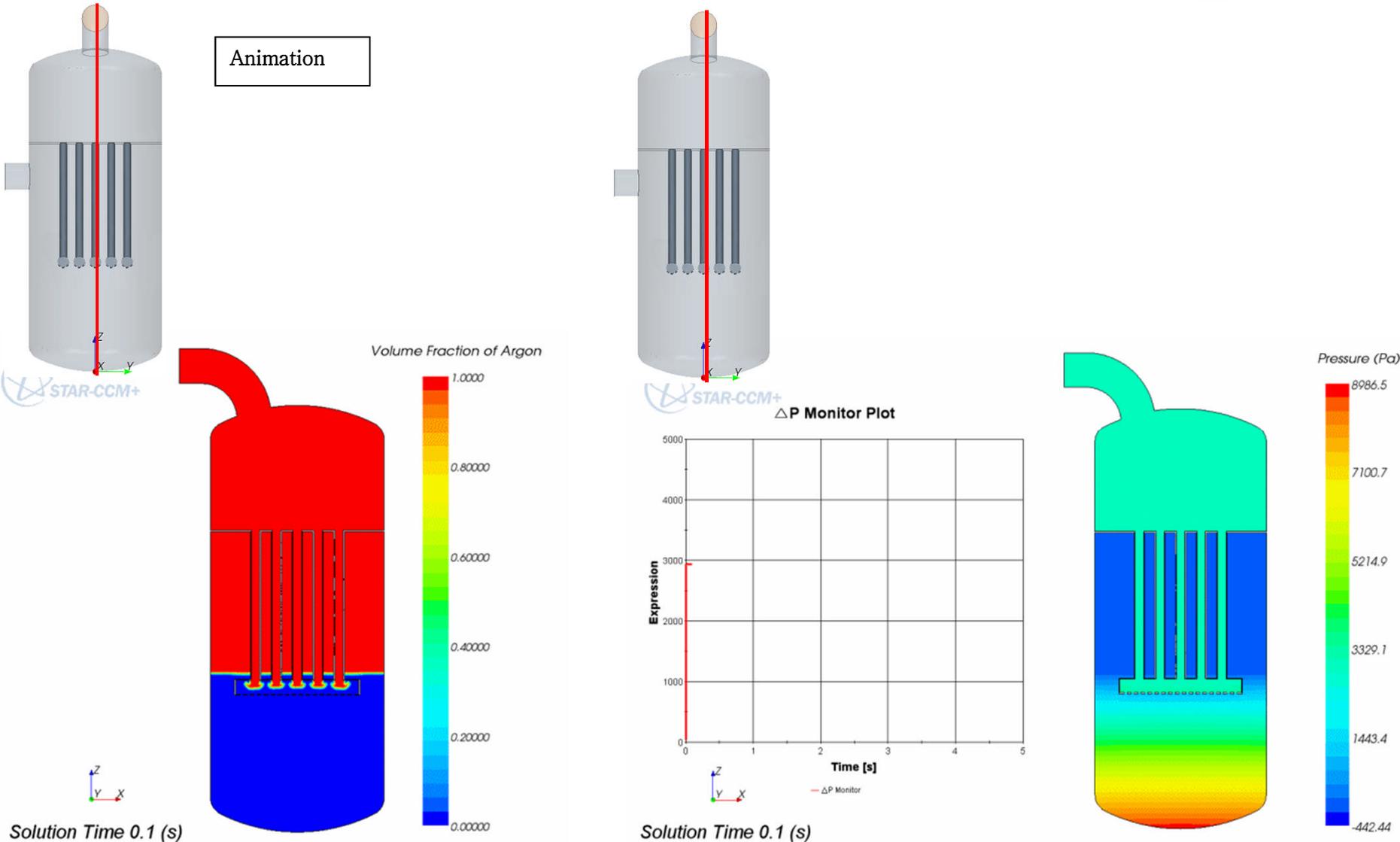
Seal Pot Modeling



Seal Pot Modeling



Seal Pot Modeling



Summary

- ◆ **Development of PRIDE facility is completed in 2012**
 - **Provided with large Ar cell and utilities**
 - **Provided with 17 windows, each window with 2 MSMs**
 - **Provided with one large and small transfer lock, two gravity tube, one 3-ton over-head crane, one 1 ton hoist, and one BDSM in cell**

- ◆ **Performance test is going on to verify the design spec.**
 - **Operational and functional test of operation equipments and utility systems**
 - **Remote operability, maintainability test and develop tools for remote maintenance**
 - **Leakage test of Ar cell and auxiliary systems**
 - **Develop the operation and test procedures**

- ◆ **PRIDE will be used for testing integrity of unit process, adaptability of remote operation, safegaurdability, etc.**

Thank You for Your Attention

