TOSHIBA

Total engineering project "Assembly of JT-60SA", the secret of success and technical challenges

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Toshiba Energy Systems & Solutions Corporation
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Efforts toward fusion of Toshiba Energy Systems & Solutions Corporation

From the dawn of fusion research to the construction of large devise In recent years, Toshiba Energy Systems & Solutions Corporation is working on the manufacture of various nuclear fusion facilities.
The field ranges from the main body of the device Superconducting coil , power supply , heating equipment and so on.

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Contents

1. Overview of JT-60SA project
2. Progress of Assembly of JT-60SA
3. Result of Assembly of JT-60SA
4. Secret of success
5. Summary

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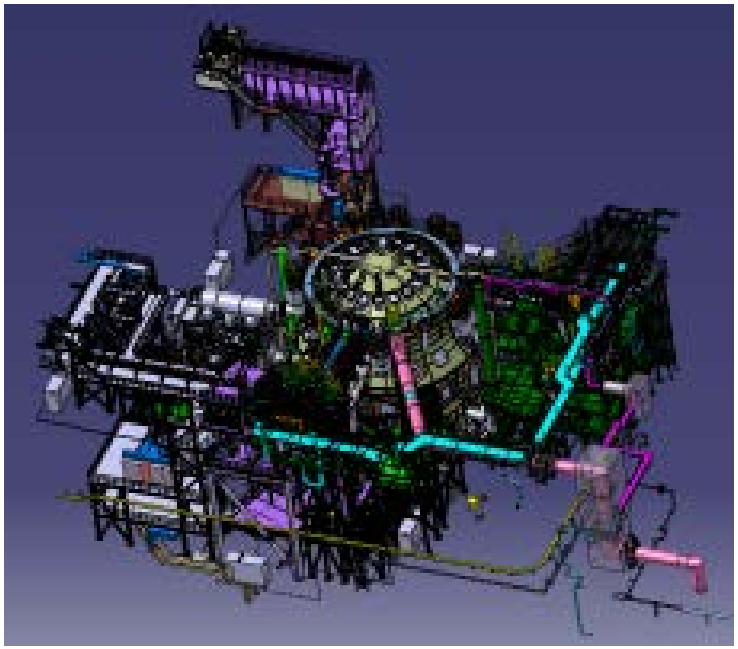
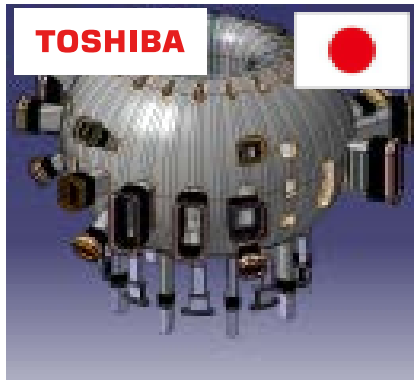
1. Overview of JT-60SA project

JT-60SA project is a joint project between Japan and Europe, and equipment is supplied from multiple manufacturers in multiple countries.
Comprehensive engineering is necessary to assure the overall coordination to assemble the whole device.
Toshiba ESS made the vacuum vessel as the center of tokamak ,part of the Thermal shield and carried out the assembly work of tokamak facilities.

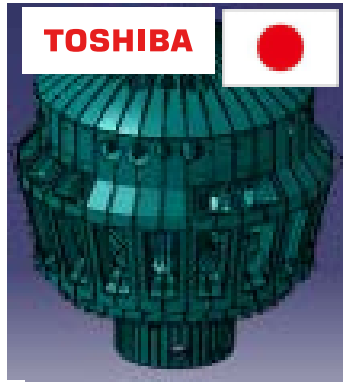


Over view of JT-60SA

Assembly work： TOSHIBA

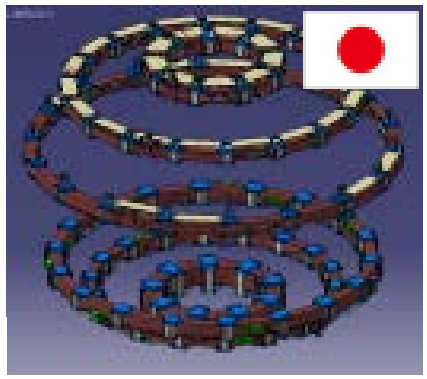


Vacuum Vessel



Thermal Shield

TF Coil



EF Coil

CS Coil

Cryostat

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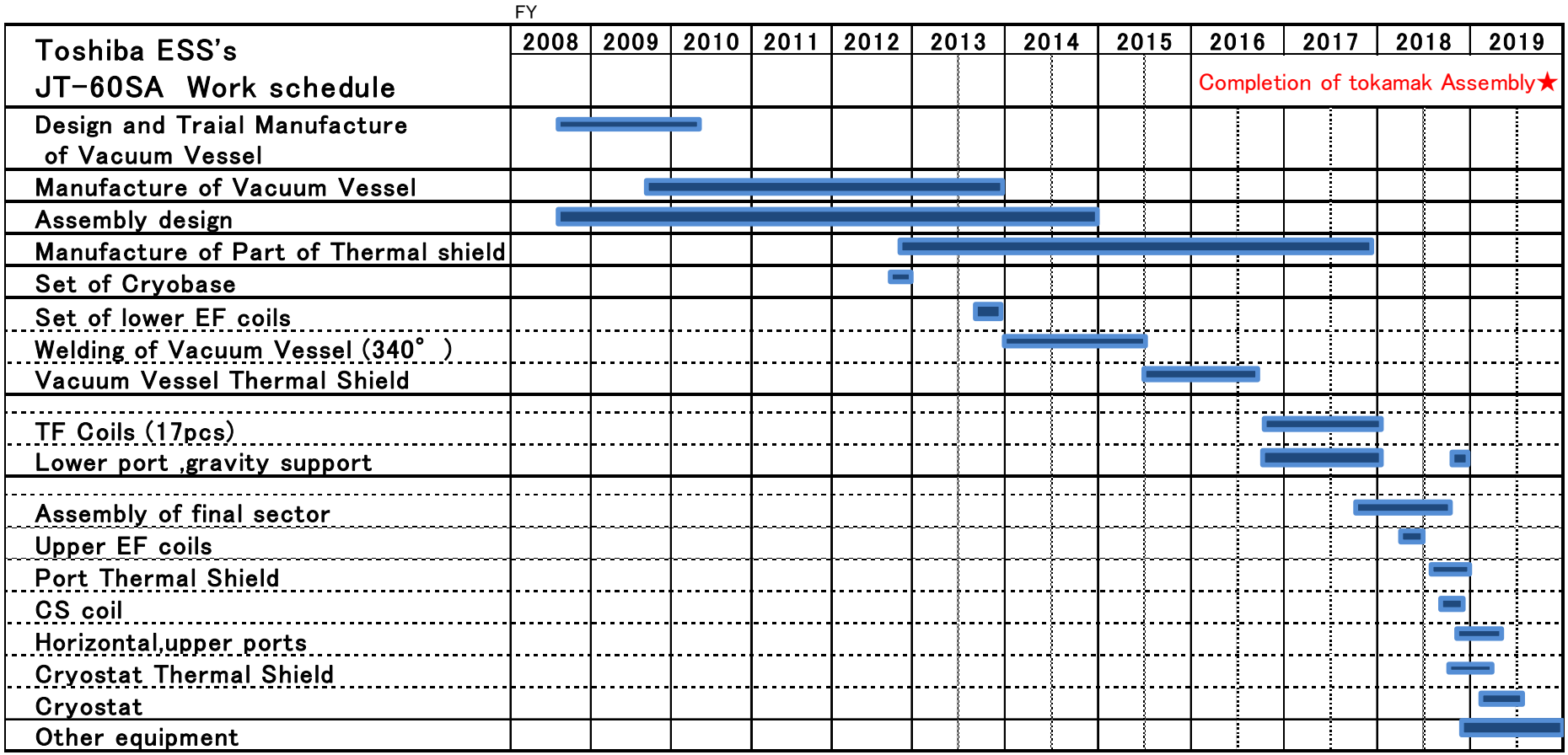
2． Progress of Assembly of JT-60SA

Toshiba ESS is carried out these activities in assembly of JT-60SA

- Manufacture of Vacuum Vessel
- Manufacture of Thermal shield
- Design of assembly work
- Assembly work of Tokamak

Now



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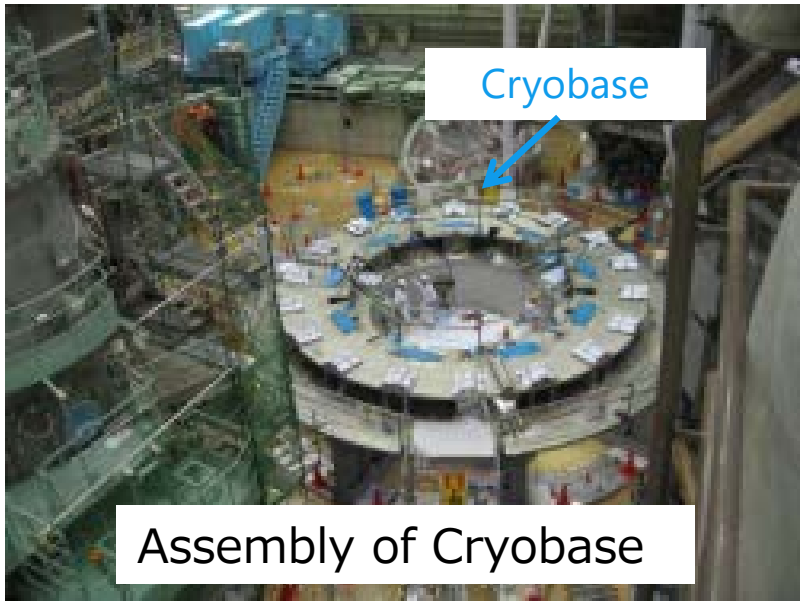
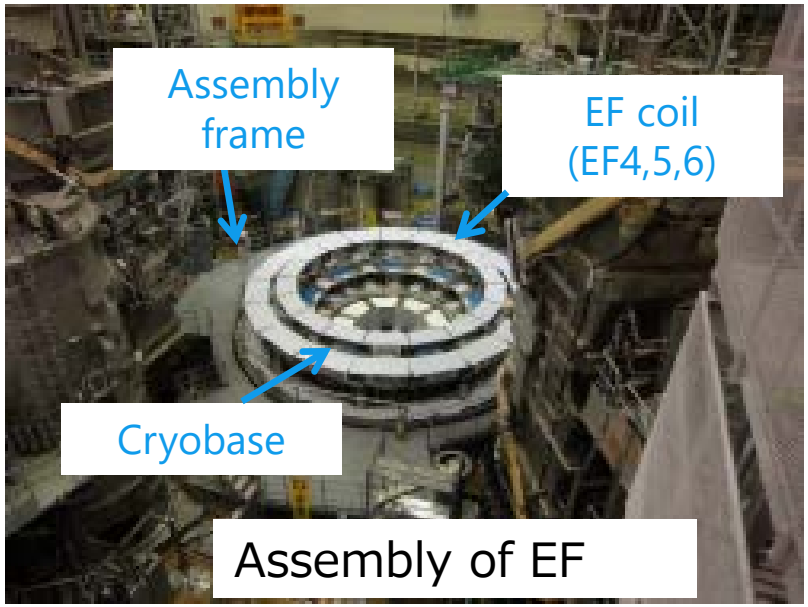
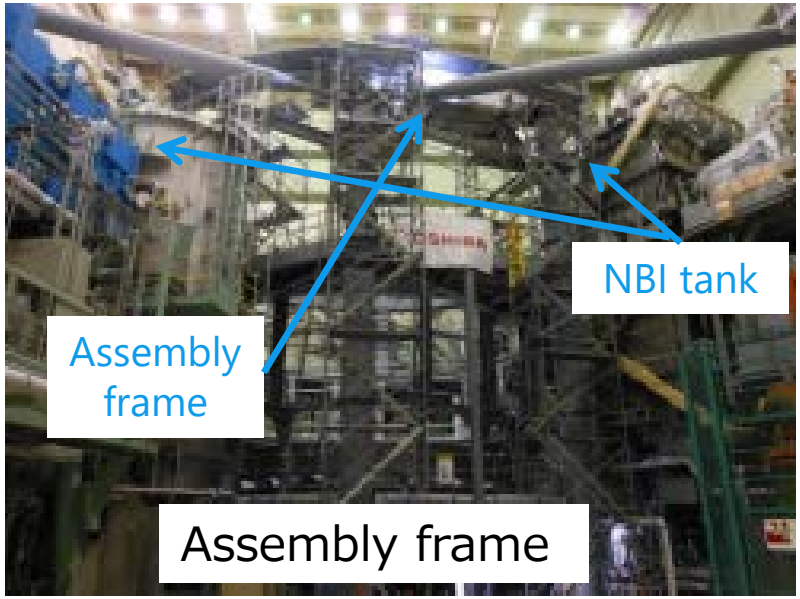
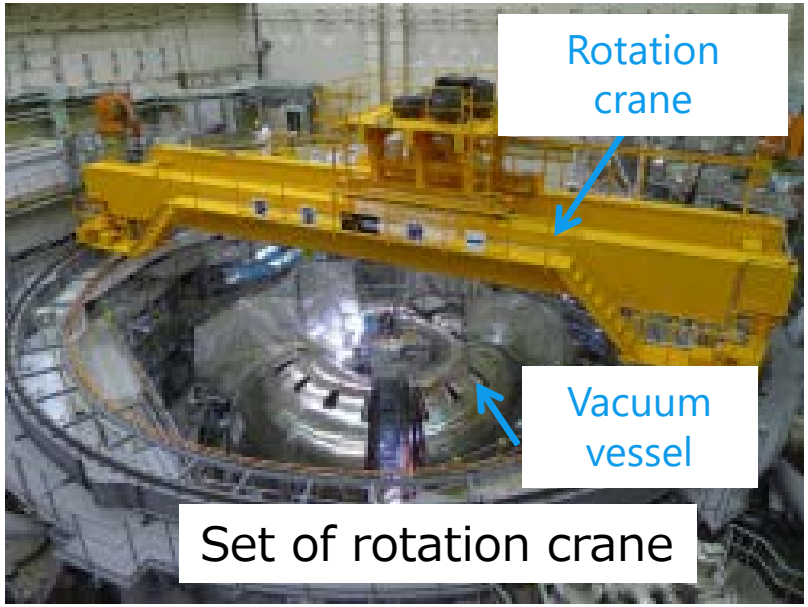
2. Progress of Assembly of JT-60SA- 1　Assembly of Cryobase ～assembly frame









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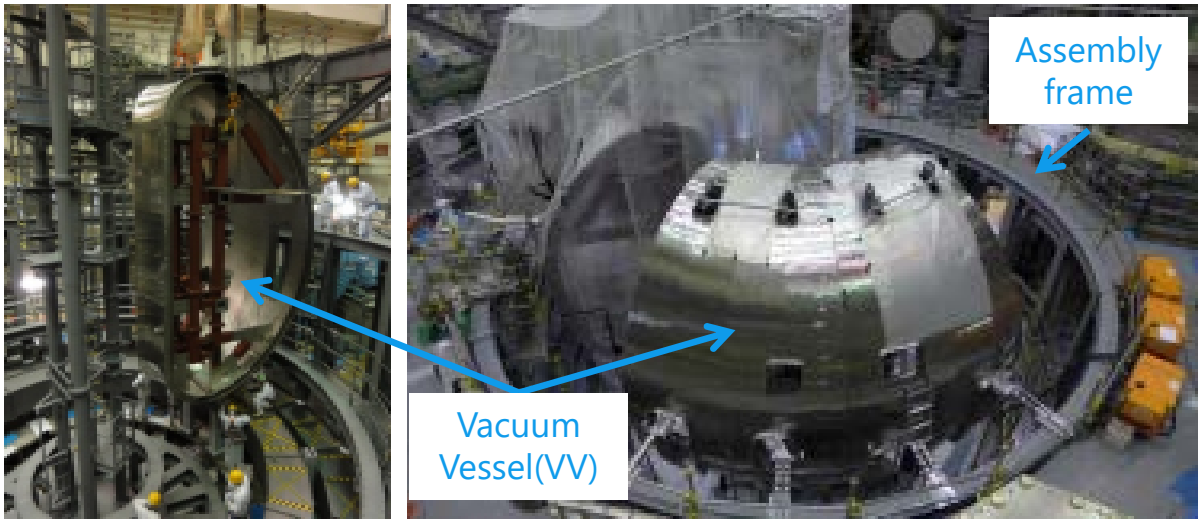
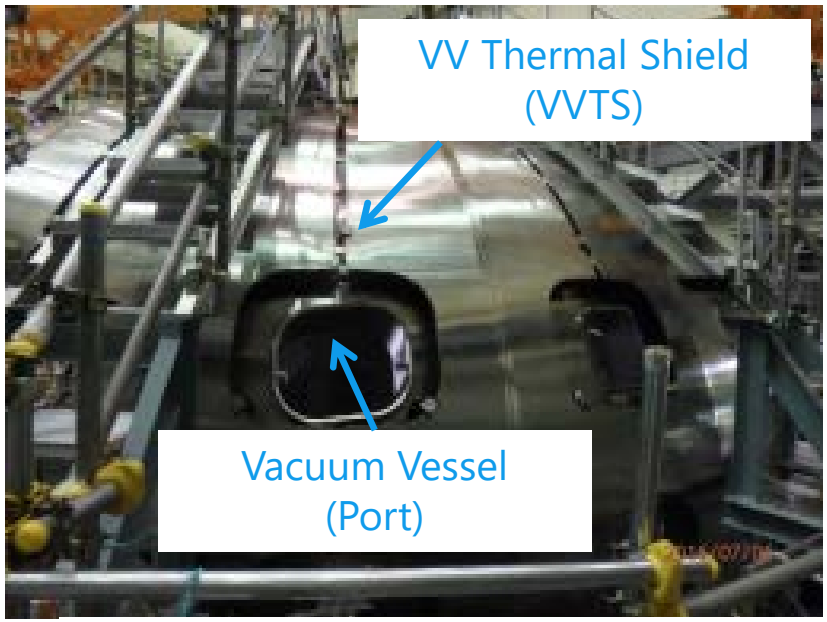
2. Progress of Assembly of JT-60SA Welding of Vacuum Vessel(VV) ～Assembly of Thermal shield



Installation of VV on Cryobase

Completion of welding of 340° VV

Inside of VV



Assembly of VV Thermal shield

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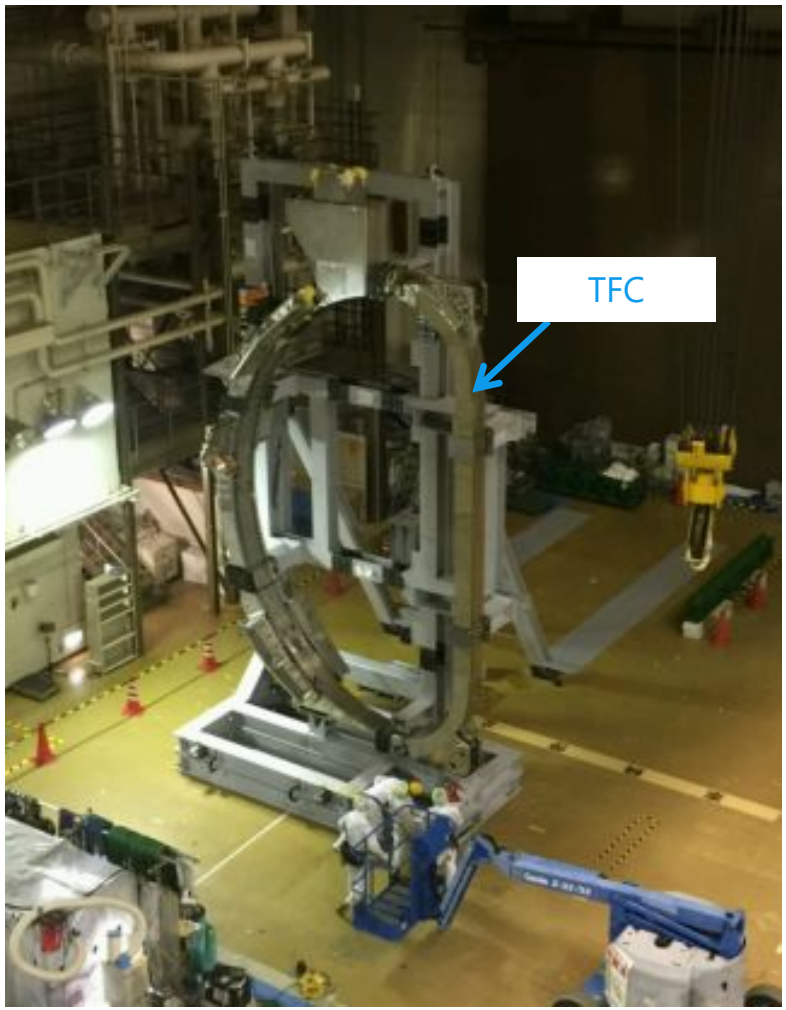
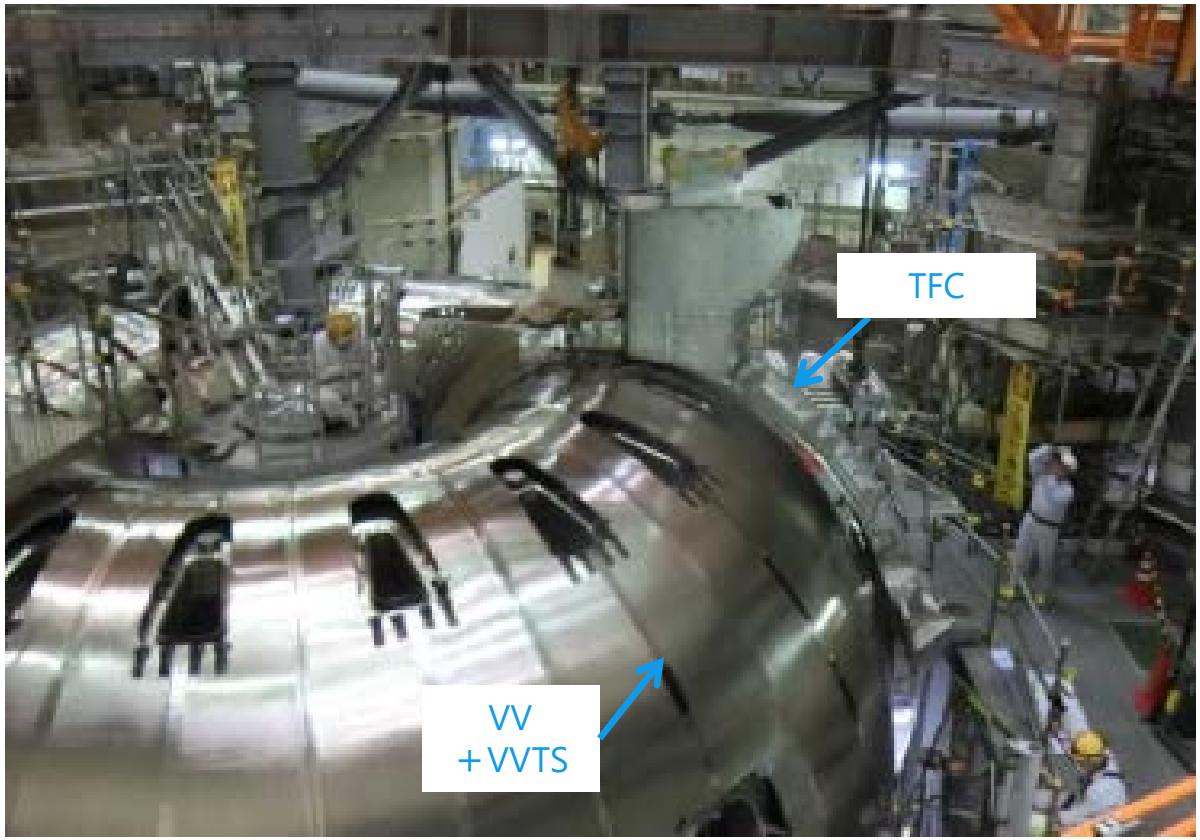
2. Progress of Assembly of JT-60SA　Toroidal Field Coil(TFC)



Standup
of TFC



Movement of VV

TFC was set on donut shaped VV
TFC need high accuracy setting, we make measurement point for laser tracker on TFC

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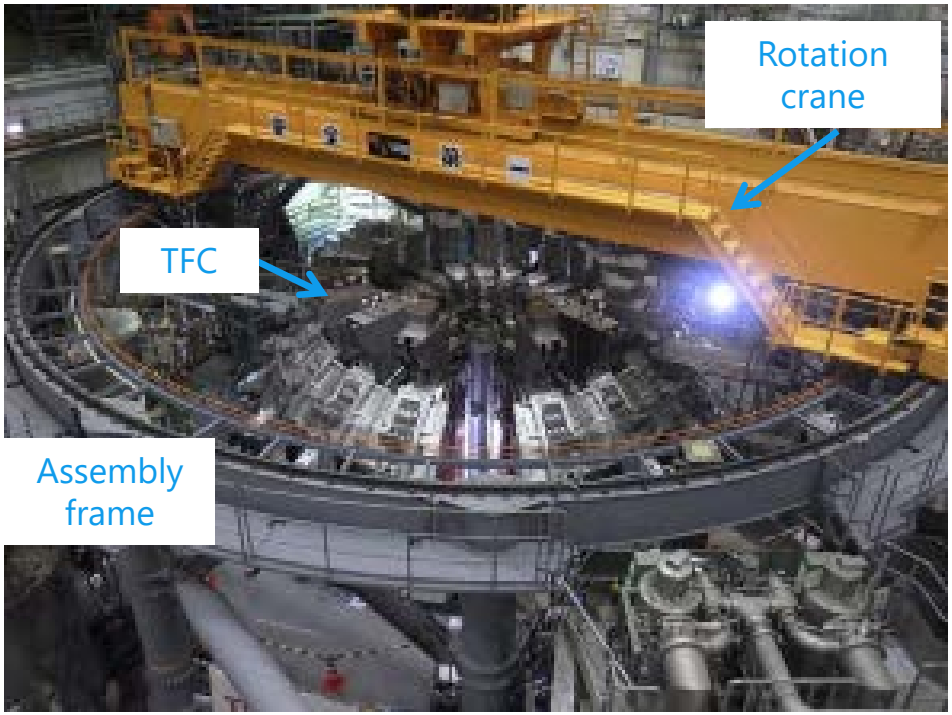
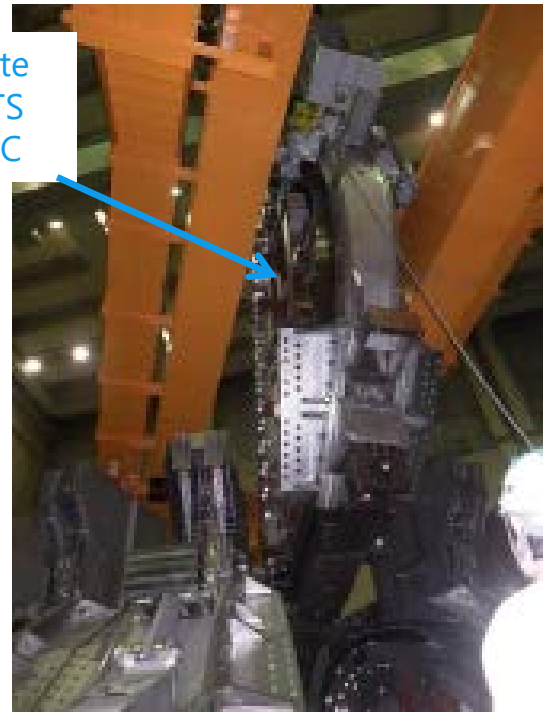
2.Progress of Assembly of JT-60SA-4 Final Sector



Completion of 17 TFC

Standup of final sector



Assembly of final sector

After assembly of 17TFC, Integrated VV, VVTS and TFC was assembled

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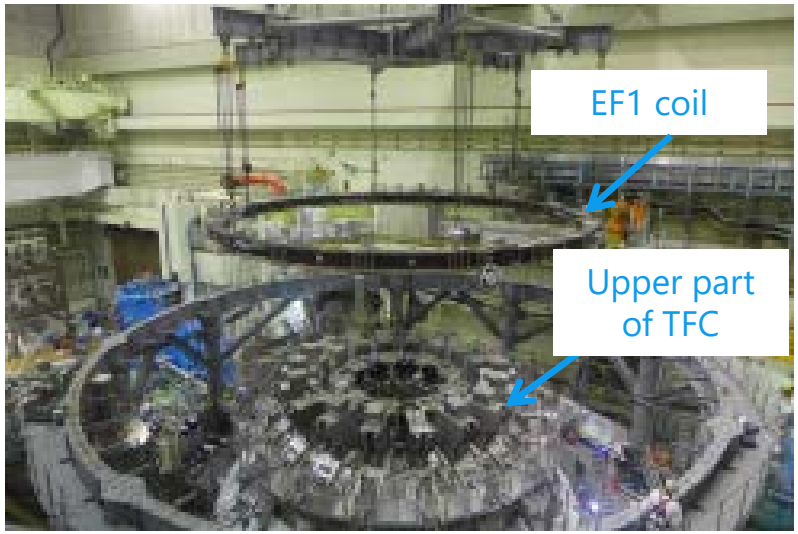
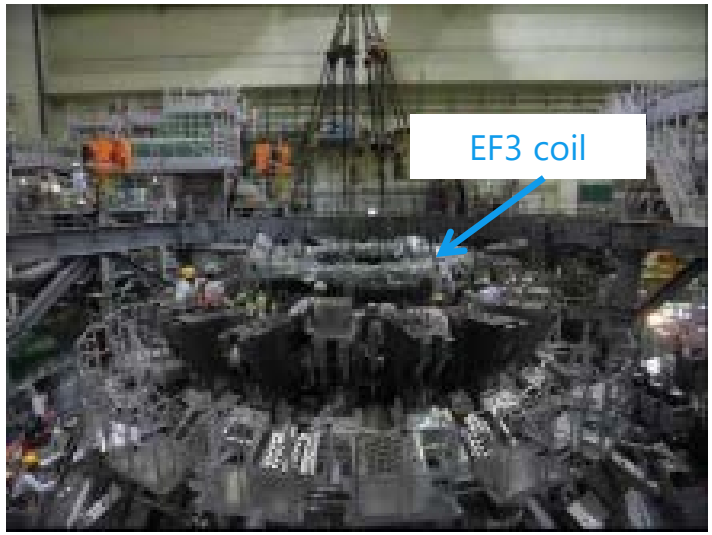
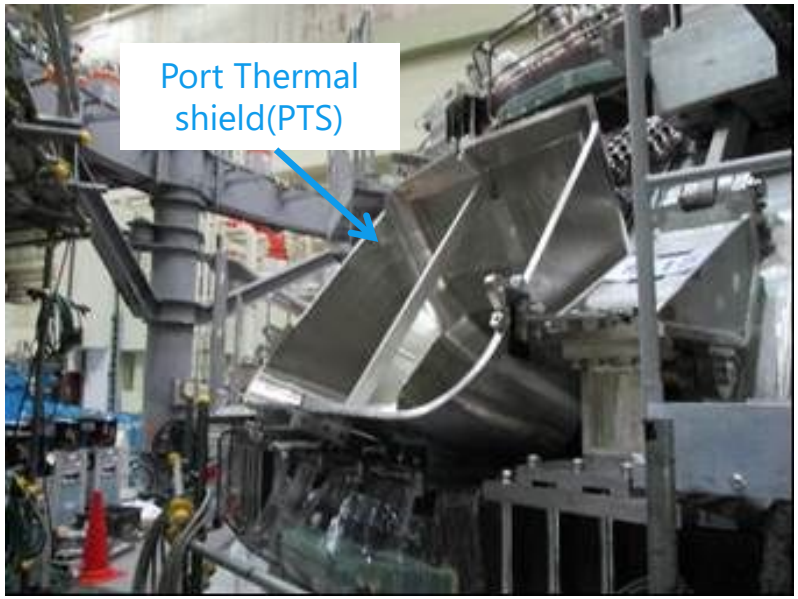
2. Progress of Assembly of JT-60SA 5　EF Coil , Port thermal shield(PTS)



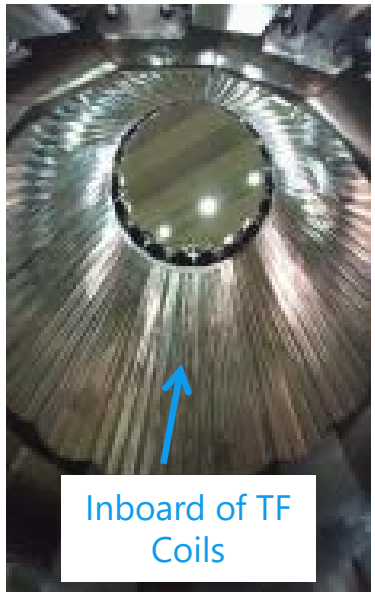
Assembly of EF1 Coil



Assembly of EF3 Coil



Assembly of Port thermal shield



Machine center

Looking up on the center of tokamak CS coil will be assembled

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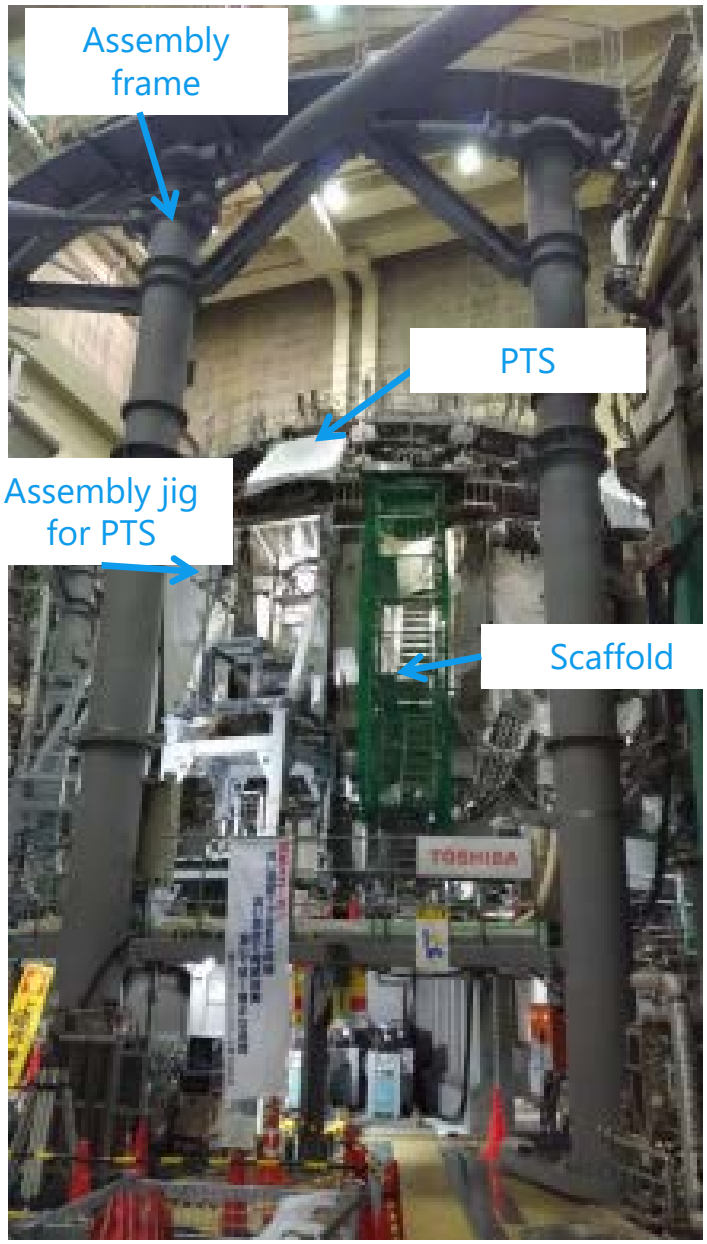
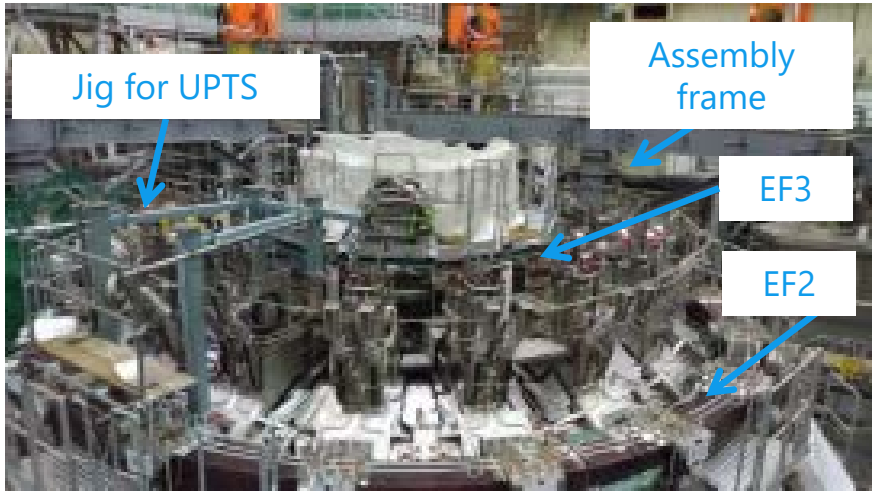
2. Progress of Assembly of JT-60SA -6 Current JT-60SA site



Current site status



Upper part of tokamak

- Completion of assembly of 18-TFCs, and 3-EFCs
- Scaffold was disassembled, for future assembly of Cryostat
- Welding of VV port stub, assembly of PTS are carried out
- Preparation of assembly of CS coil Cryostat and equipment for superconductor is under going

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3. Result of Assembly of JT-60SA

Summary of assembly

Item	Parameter
Assembly of cryobase	Accuracy of center point ±1mm Total weight 250t
Welding of VV	Accuracy of port center ±5mm, Accuracy of vessel wall ±10(IB)/20(OB)mm Total weight 150t, Diameter 10m
Assembly of TFC	Current center of IB±1mm／Coil height 7m
Assembly of EF(1,2,3)	Accuracy of coil center ±2mm／Diameter of coil11m
Port thermal shield(PTS)	32 pcs /54 pcs installed

- Most of the main coils have been installed. Both of them satisfy required installation accuracy.
- Currently there is no big delay in the process. We are progressing with the aim of completing construction in FY2019.
- In the future, we will assemble the CS coil, cryostat and superconducting equipment (feeder, piping). It is currently under preparation.

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4. Secret of success

Important points for progress of project

Project control

- QST[*1]／F4E[*2] judge and take action for problems quickly.
- Upon occurrence of, promptly discussion with the QST, create a recovery plan and minimize the impact
- Preliminary consultation of assembly work ⇒**next sheet**

Technical factor

- Utilization of 3D-CAD and laser tracker
- R&D was conducted in advance on assembly.
- Each devices were designed considering assembly.

Human factor

- Main engineers are continuously engaged in JT-60SA project.

*1 National Institutes for Quantum and Radiological Science and Technology
*2 Fusion For Energy

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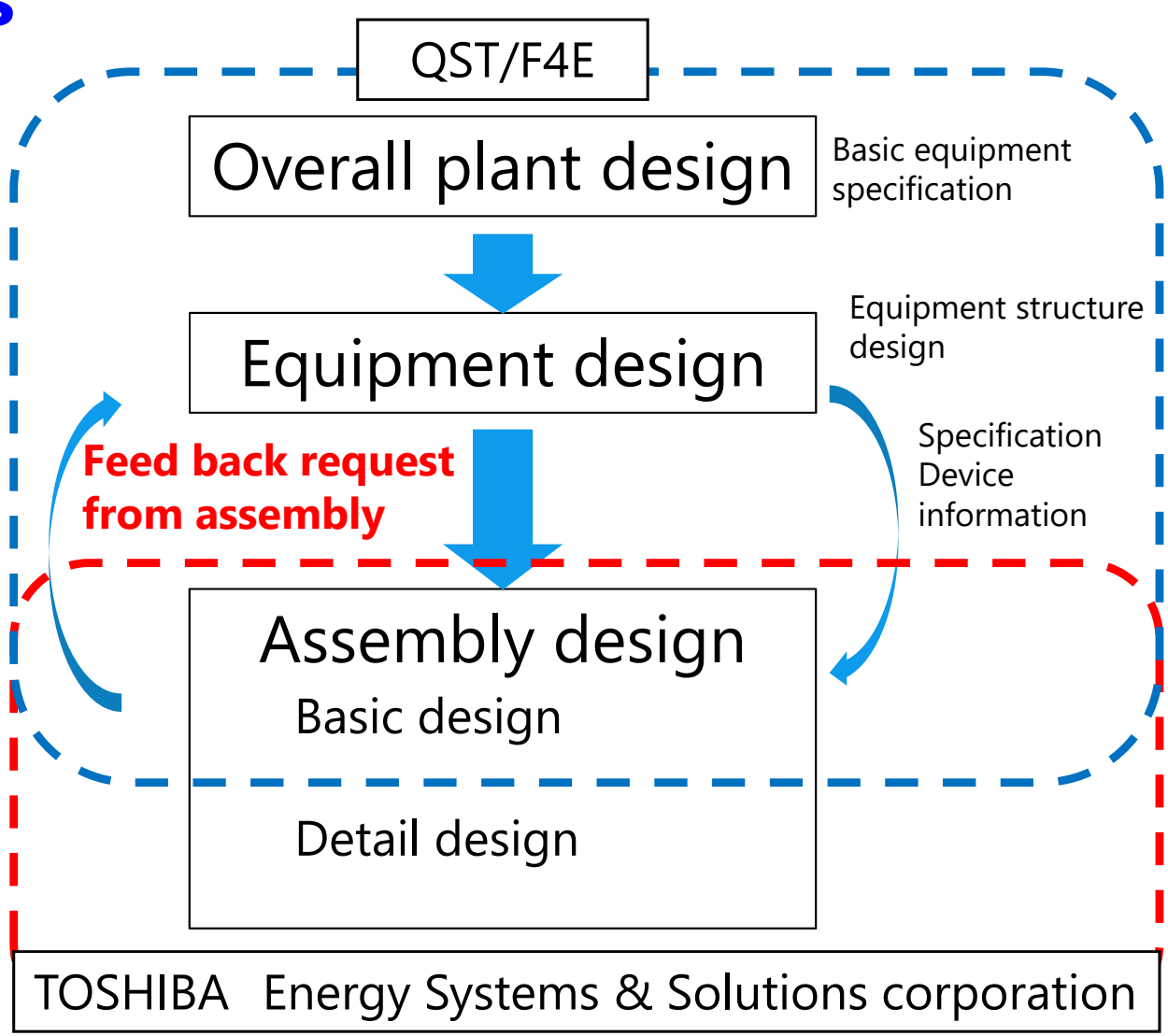
4. Secret of success

- Study on assembly from equipment design and production phases with QST/F4E
- Feedback on assembling requirements centering on device side
- As for TFC in particular, we had technical meetings with the EU team from around 2010 and put together the assembly concept.


TCM-8 2010 Frascati, Italy



Design activities related to assembly

Preliminary consultation and feedback among equipment design ⇔ assembly design were important for Project

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5.Summary

- The JT-60SA assembly work is progressing with the aim of completing construction in FY 2019. So far, assembly of 18 TFCs, and 3 EFCs were completed, and the welding of main part of the vacuum vessel were completed.
- Assembling of each coil which is the main equipment of Tokamak is completed with high accuracy.
- In the future, we will assemble the CS coil, cryostat and superconducting equipment (feeder, piping). It is currently under preparation.
- The assembly design was performed from the time of equipment design, and the requirement from assembly was reflected in the equipment design. For the TFC that needs high precision in particular, we discussed the assembly concept with the EU team and build up it.

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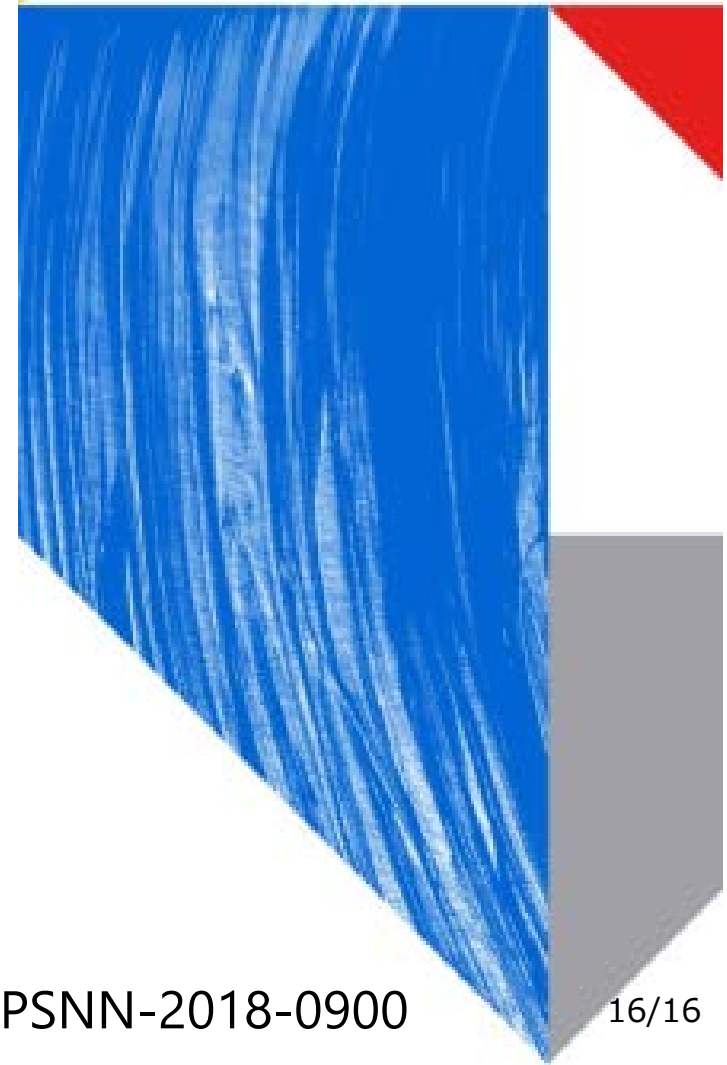

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