

QST Activities towards Japanese DEMO

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- 1. Introduction**
- 2. ITER Project**
- 3. Blanket Development**
- 4. JT-60SA**
- 5. Fusion Neutron Source**
- 6. DEMO R&D (DEMO Design Activity)**
- 7. New JA Fusion Strategy**

Japanese Steps towards Fusion DEMO

Fusion Plasma Production

JT-60

Corresponding Fusion Power of ~10MW



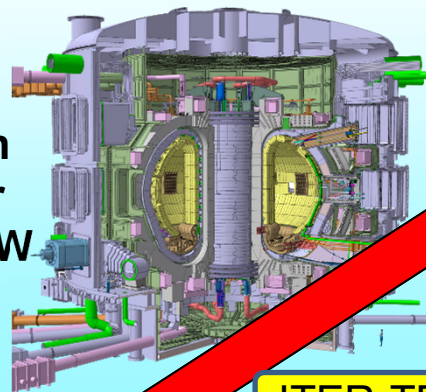
Fusion Energy Production

ITER

7 Members



Fusion Power of 0.5GW



at France

ITER-TBM

Support ITER

Electricity Production

Fusion DEMO



Electric Power of ~0.6 GW

Establish Engineering Basis for DEMO

Broader Approach (BA)

For early realization of DEMO

JA-EU

Collaboration

Naka
Satellite Tokamak; JT-60SA

Rokkasho
IFERC, IFMIF/EVEDA

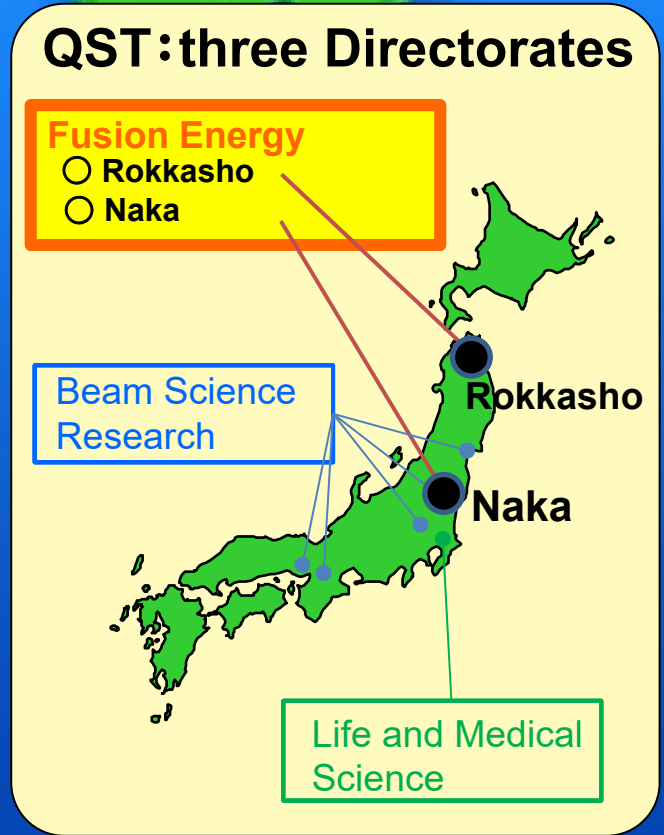
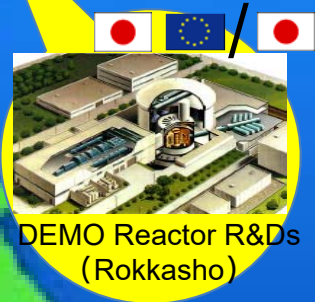
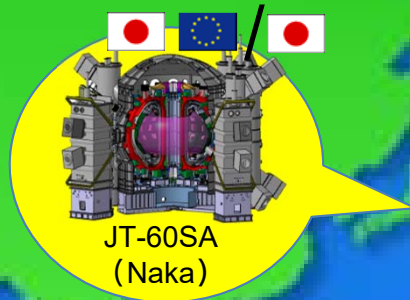
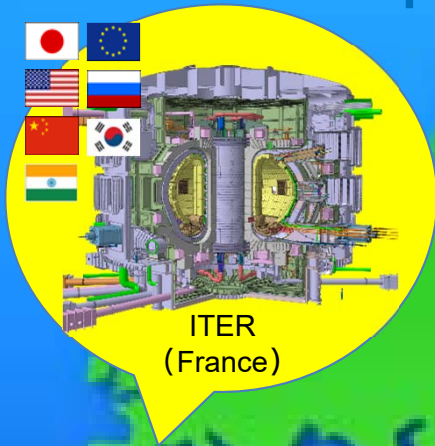


In Japan

Domestic Activities

Blanket Development
Fusion Plasma (JT-60SA)
Fusion Neutron Source
DEMO R&D

Fusion Energy Directorate of QST



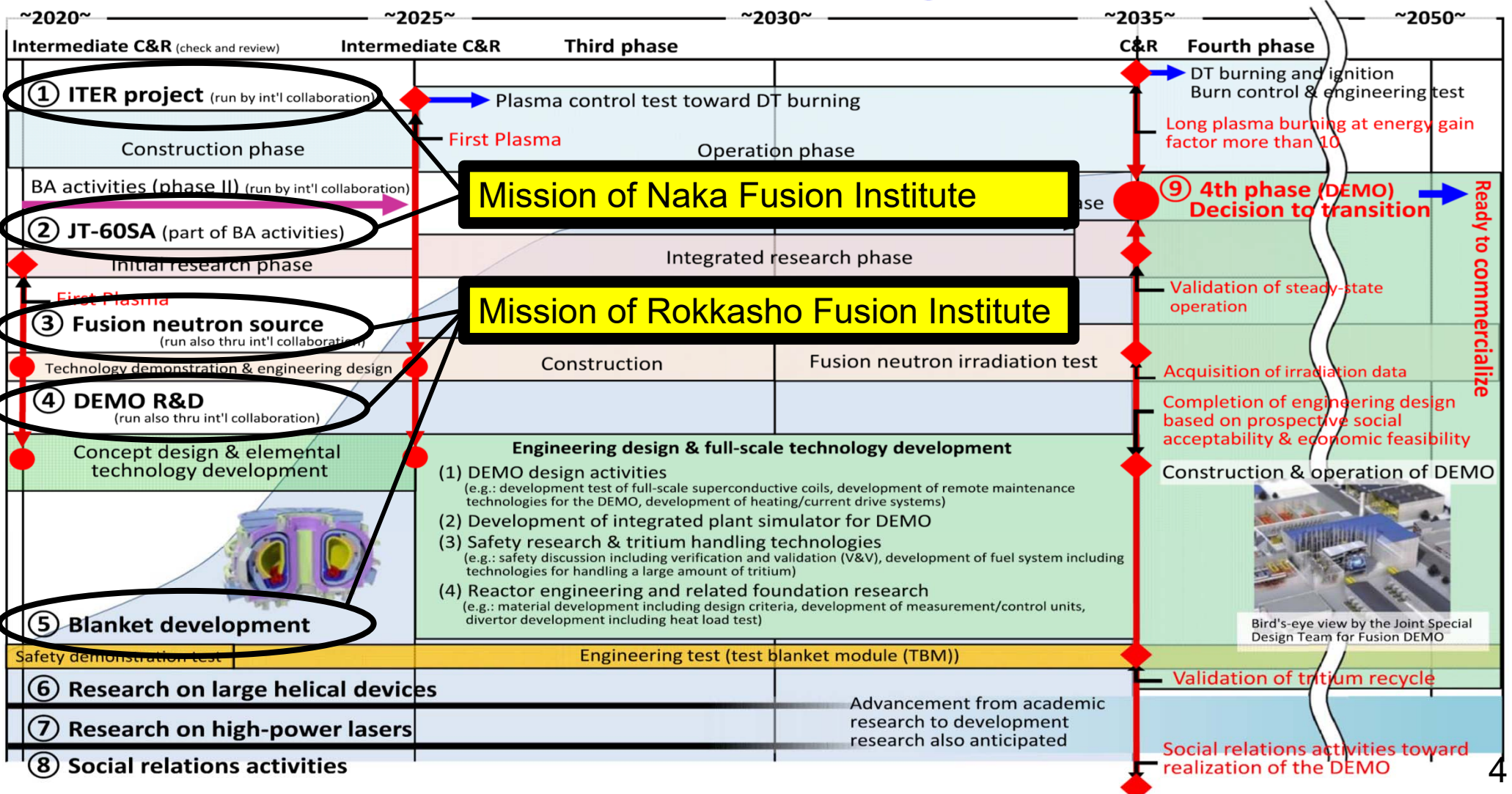
QST is the ITER Domestic Agency of Japan and the BA Implementing Agency of Japan to promote fusion R&Ds towards the realization of “Fusion Energy” by utilizing international collaborations at three locations: ITER (Experimental reactor), Naka Fusion Institute (JT-60SA), and Rokkasho Fusion Institute (DEMO reactor R&Ds) .

Japanese Roadmap toward Fusion DEMO Reactor



- In Japanese Fusion Strategy, three C&Rs are set to decide the transition to Demo Phase just after a successful DT operation in ITER (2035~).
- BA activities is the key framework for Japanese DEMO.
- In 2022, 1st C&R was conducted to confirm the progress.

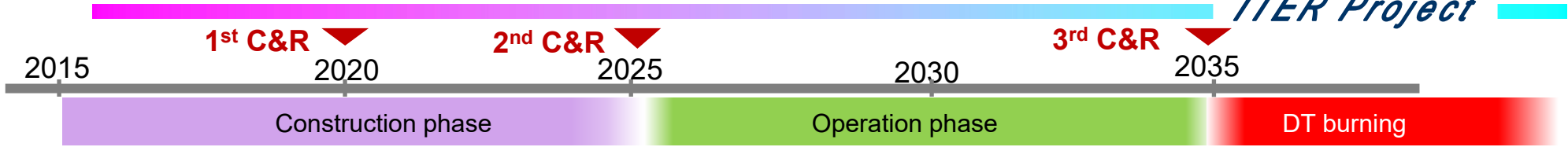
July 24, 2018
 Science and Technology Committee on Fusion Energy
 Subdivision on R&D Planning and Evaluation
 Council for Science and Technology



ITER Project

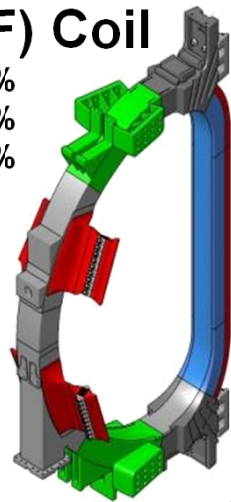
In-Kind Procurement by Japan (QST)

ITER Project



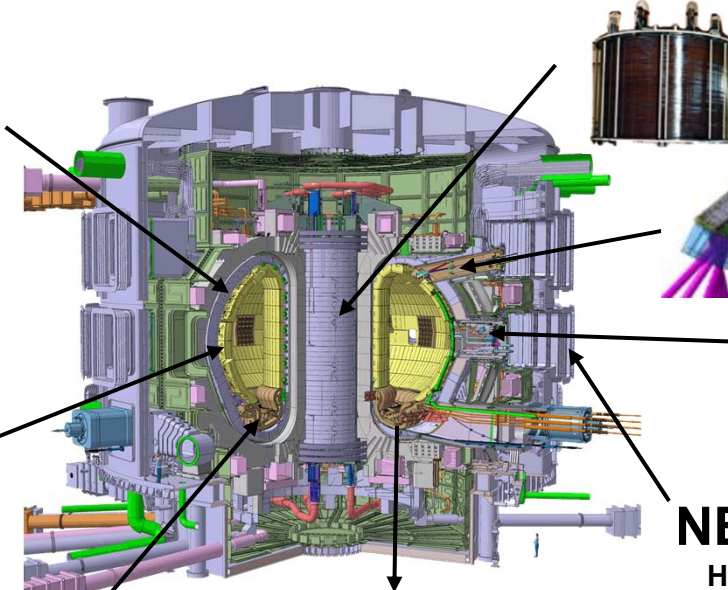
Toroidal Field (TF) Coil

TF Conductors: 25%
TF winding, assembly: 47%
TF Structures: 100%



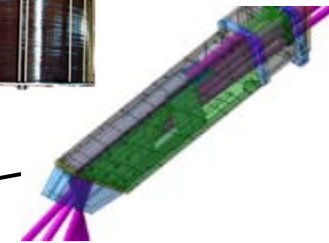
Center Solenoid (CS)

CS conductors: 100%

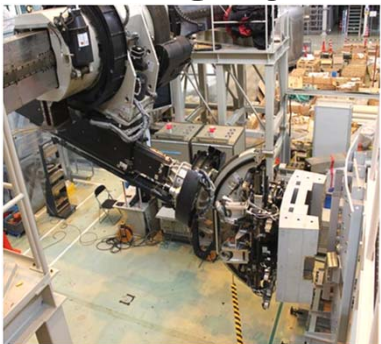


Diagnostics

Micro Fission Chamber
Poloidal Polarimeter
Edge Thomson Scattering
Divertor Impurity Monitor
IR Thermography
Lower Port Integration

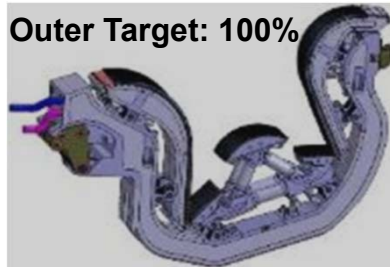


Blanket Remote Handling System



Divertor

Outer Target: 100%



Atmosphere Detritiation



NB heating

HV Bushing: 100%
1 MV Power Supply HV part: 100%
1 MeV Accelerator: 33%



RF heating

Gyrotron
Equatorial Launcher

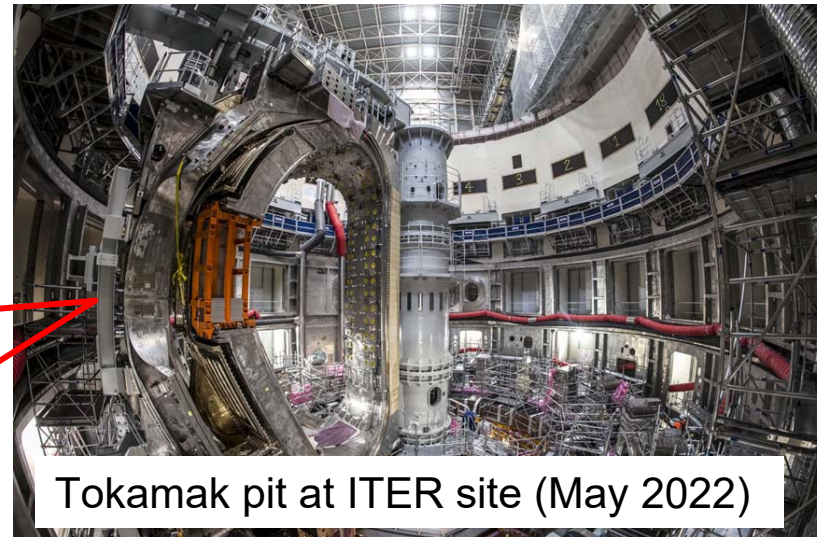


TF coils

- JA has the procurement responsibility of 9 coils. (#9 coils is spare one.)
- Six TF coils have been completed and already delivered to ITER site.



First coil completion (Jan. 2020)



Tokamak pit at ITER site (May 2022)

Gyrotron

- Manufacturing of All eight gyrotrons were completed.



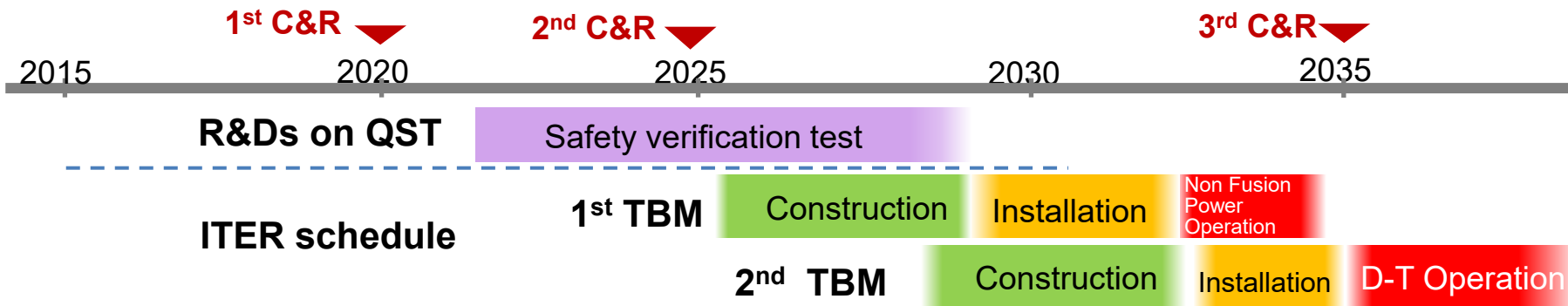
Perform tests of 1st ~ 5th Gyrotron were completed.

- 1MW/300s/~50%,
- 5kHz power modulation.

Blanket Development

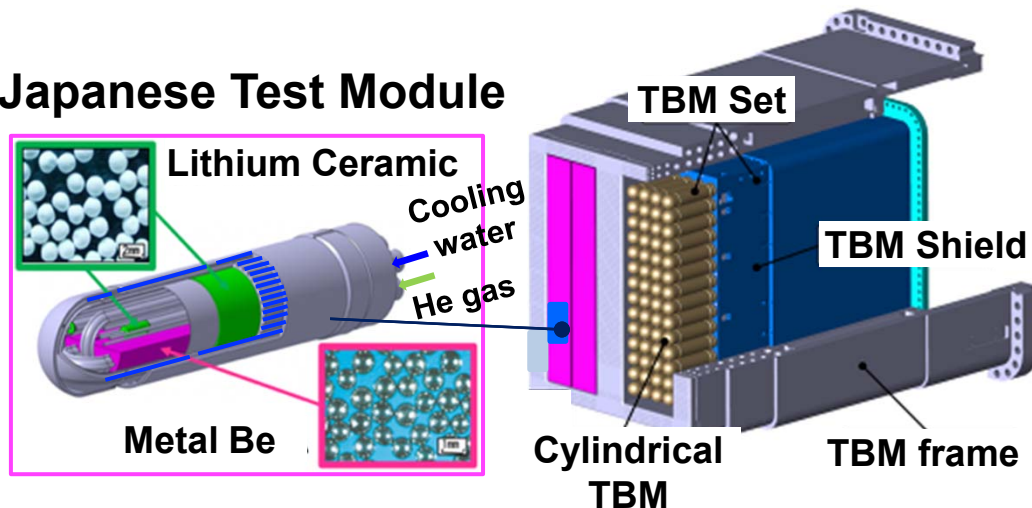
ITER-TBM :

QST is developing the **Water-Cooled Ceramic Breeder (WCCB) Blanket** in ITER-TBM



- Two equatorial ports (#16,18) are allocated to test four Test Blanket Modules (TBMs) simultaneously in ITER-TBM program.
- A **Water-Cooled Ceramic Breeder Test Blanket System (WCCB-TBS)** is proposed by **Japan** and was adopted as the first configuration for the ITER-TBM.
- QST has started to verify the safety specification of the TBM using high pressured & hot cooling water in the Blanket Test Facility Building.

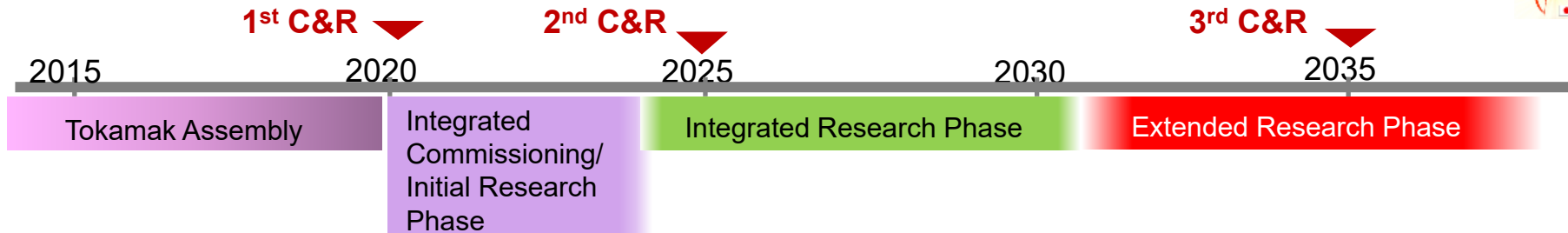
Japanese Test Module



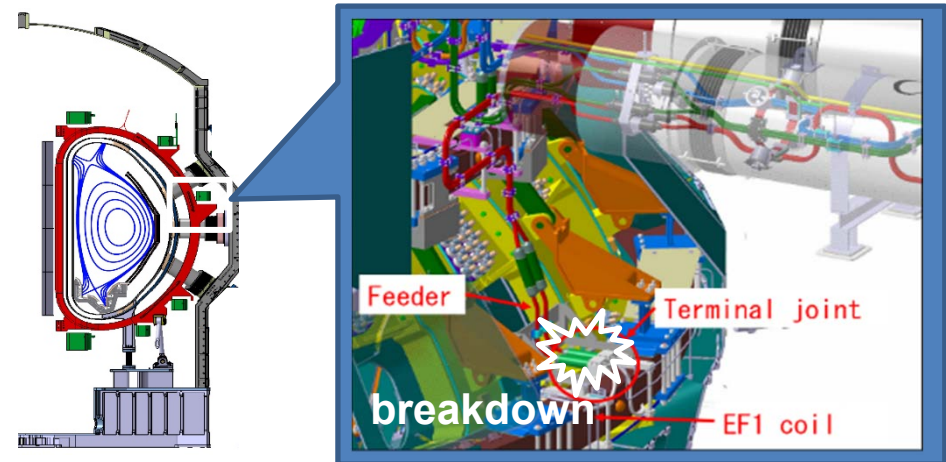
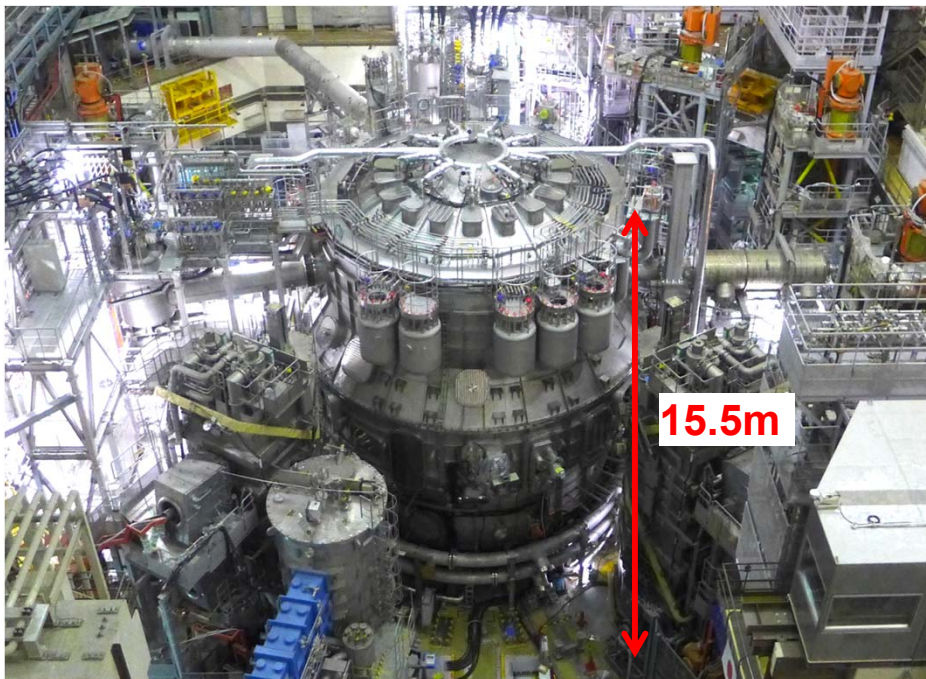
JT-60SA

JT-60SA :

QST is the Implementing Agency of Japan and carries out the integrated commissioning with EU



- JT-60SA Project is implemented under the Broader Approach (BA) agreement between EU and Japan as well as the JA domestic program.
- The integrated commissioning has started since April 2020.
- The integrated commissioning was interrupted due to breakdown at the feeder connection in March 2021.



The Integrated Commissioning will restart in early next year after the countermeasures of the enhancement of electrical insulation at connections.

Fusion Neutron Source

Fusion Neutron Source

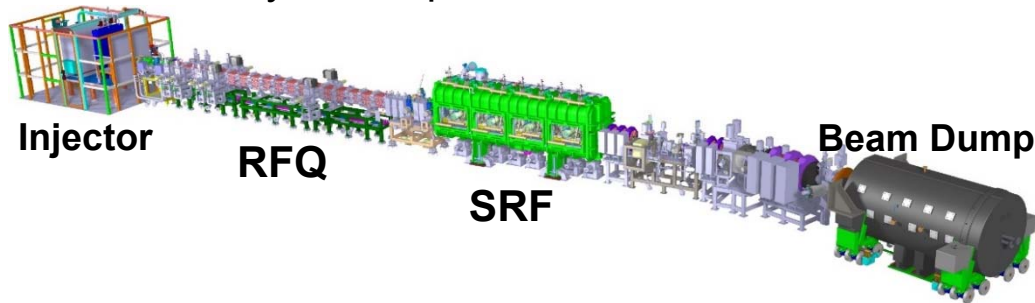
QST considers the construction at the Rokkasho site.



BA Activities (IFMIF/EVEDA)

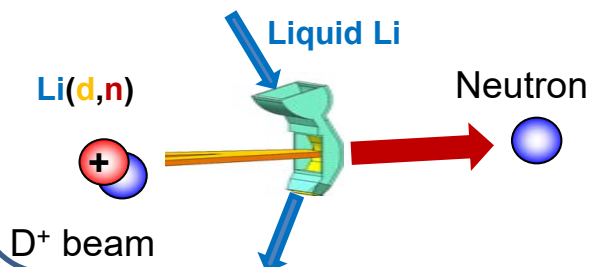
Accelerator R&Ds : LIPAc

- Steady state operation of D^+ , 125mA, 9MeV



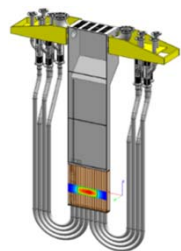
Li target R&Ds

- Control of Liquid Li flow



Test Cell R&Ds

- Prototype components

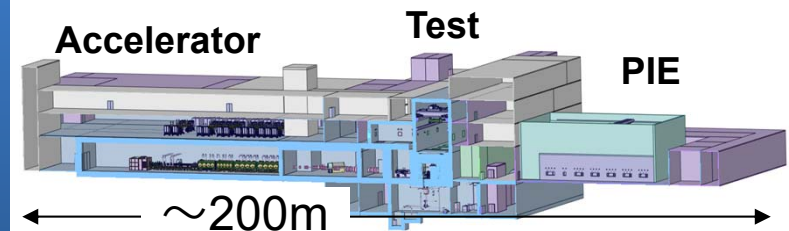


JA Domestic Activity

Site design/ Application



D^+ , 125mA, 40 MeV



~200m

Neutron flux : $\sim 10^{14}/cm^2s$

Design Activity

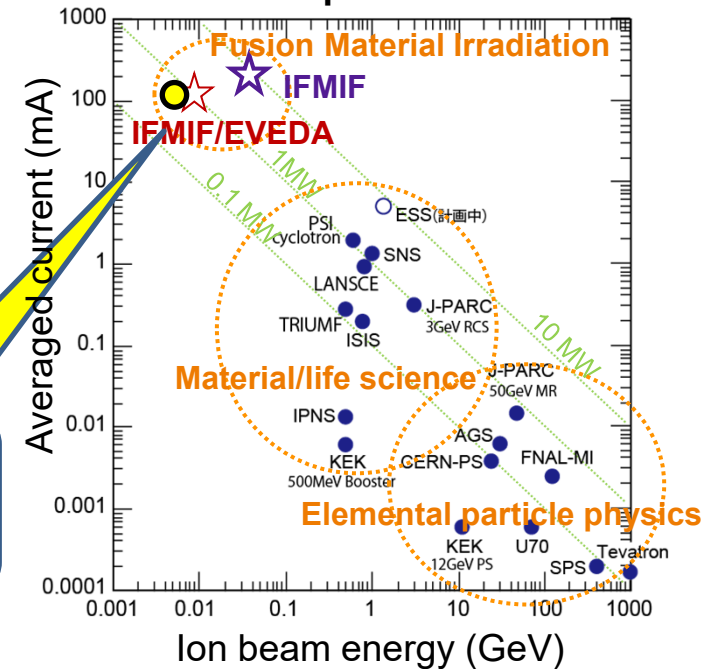
Fusion Neutron Source R&Ds : LIPAc in BA

BA Activities

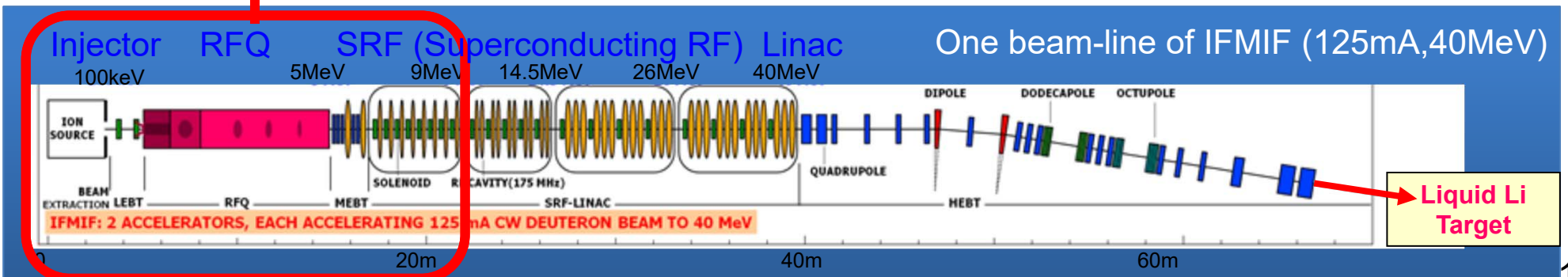


- Engineering Design and Validation of Key Components, such as **Linear IFMIF Prototype Accelerator (LIPAc)** are carried out at the QST Rokkasho Fusion Institute under the BA activities.
- The target of LIPAc is to demonstrate the D+, 125mA, 9 MeV steady state.
- The LIPAc R&Ds is progressing step by step from the Injector, RFQ and to SRF Linac.
- **High beam current of 125mA, 5MeV D+ was achieved for short pulse (~ ms) with the injector and RFQ, and will be performed for long pulse in next year.**

Accelerator Operational condition



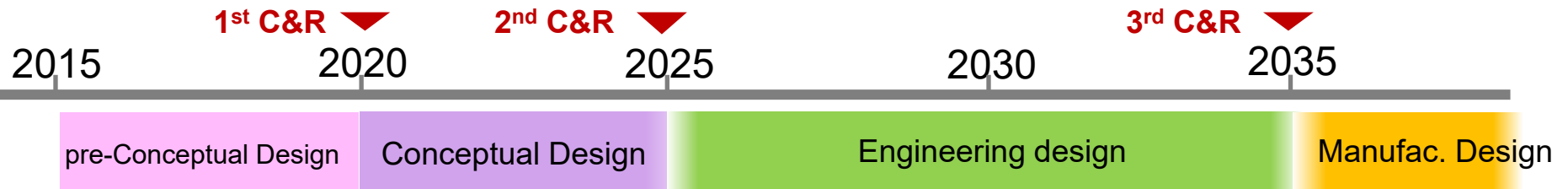
Achieved: High beam current of 125mA, 5MeV, D+



DEMO R&D

- DEMO Design activity -

Demo Design



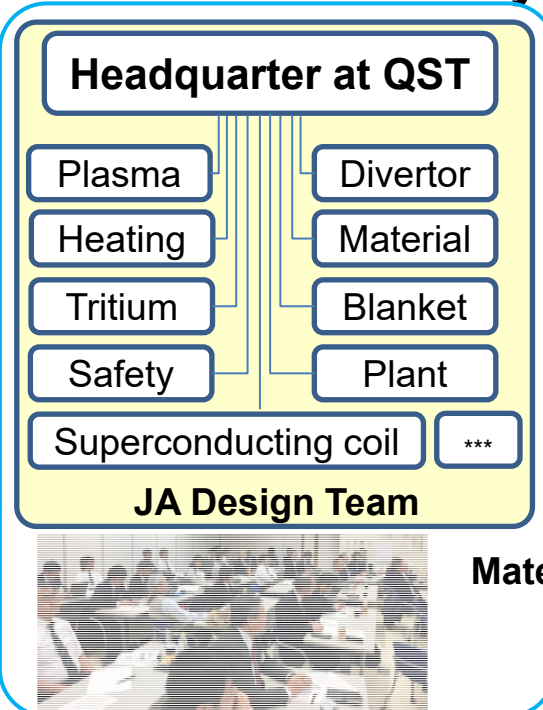
- The design of **Japanese DEMO reactor (JA-DEMO)** is progressing by the JA design team collaborated with the BA activities.
- The total number of the JA design team is ~140 persons of QST, NIFS, universities and industries. Its headquarter is set at QST Rokkasho linked with members by network.

BA Activities

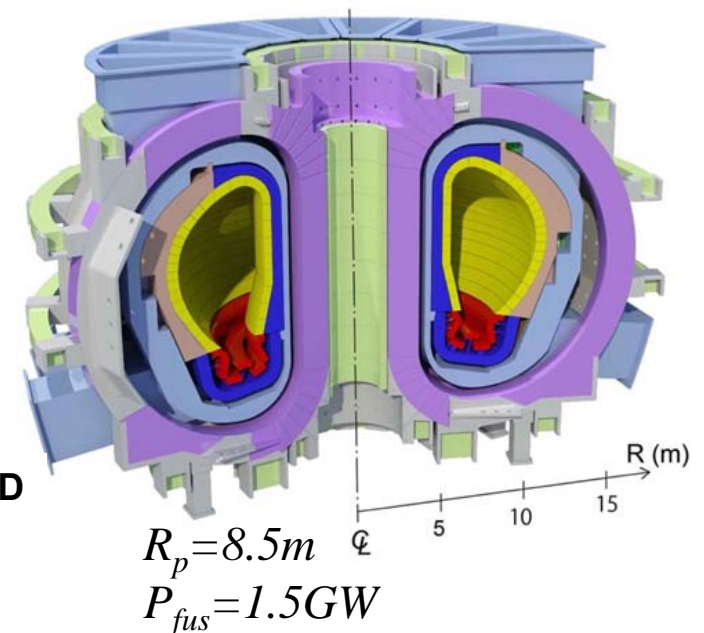


Synergies towards common aim, improved design creativity, benchmark of design & tools, and increased confidence

JA Domestic Activity



JA DEMO “Steady State”



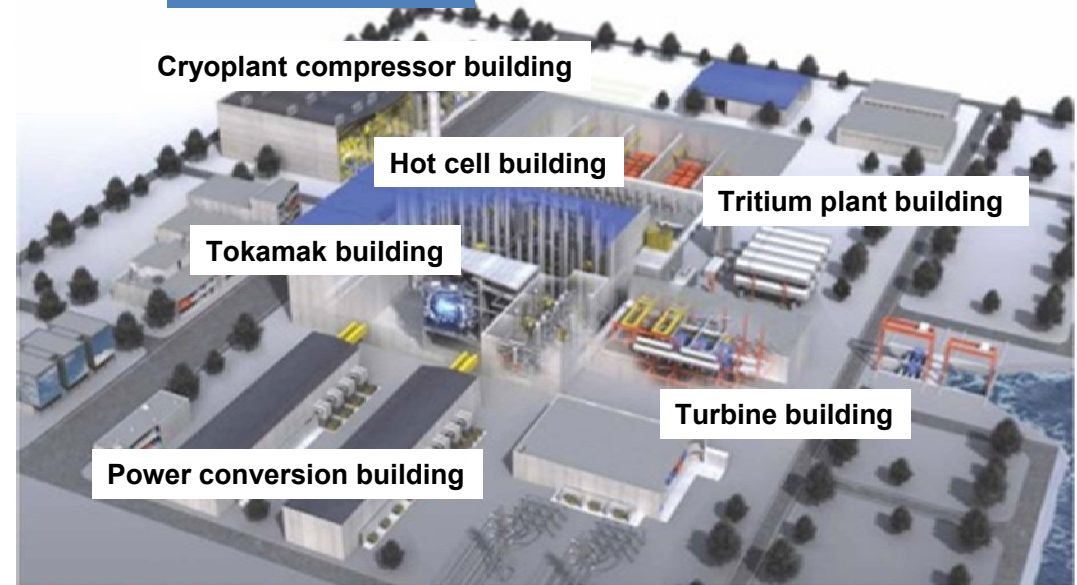
Progress in JA-DEMO Design

Targets of JA DEMO

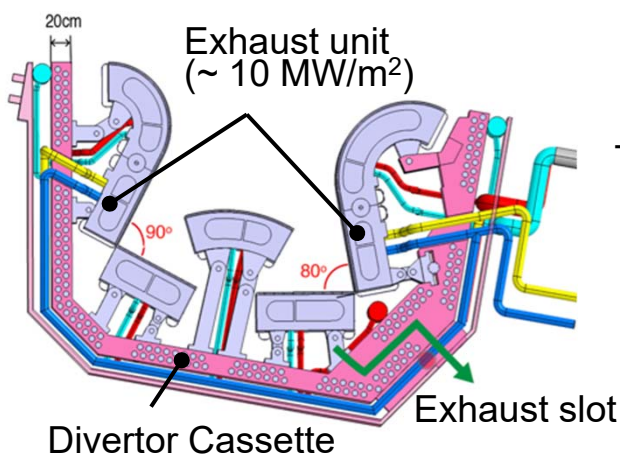
- Steady and stable electric output of over several 100 MW.
- Reasonable availability leading to commercialization.
- Over tritium breeding to fulfil self-sufficiency.

Power Plant

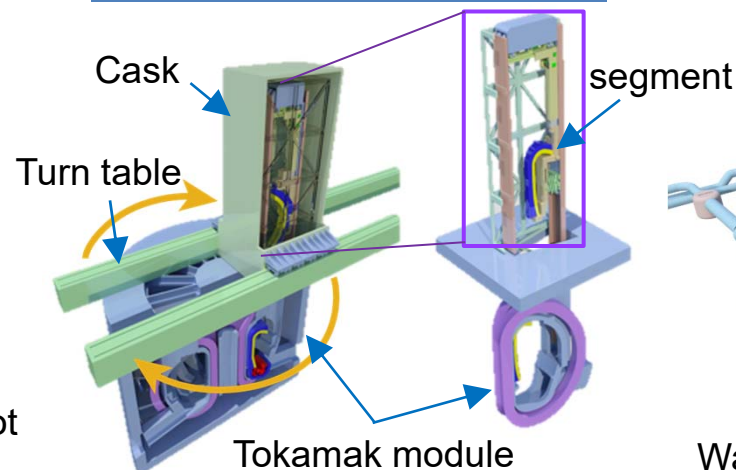
$$P_{Gross\ elec.} = \sim 0.6GW$$



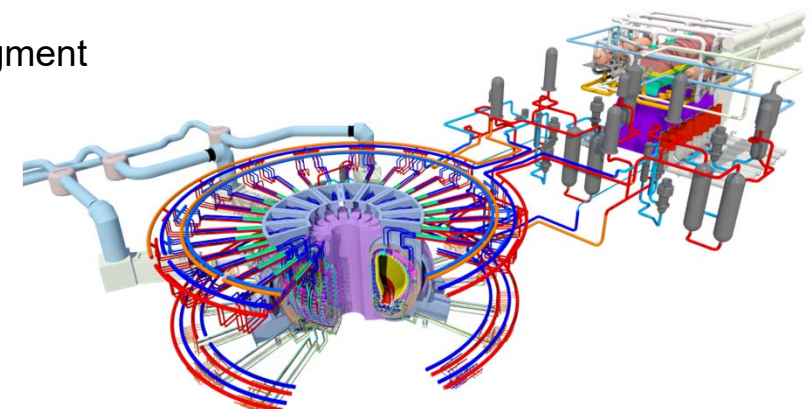
Divertor



Remote Maintenance



Primary heat transfer and turbine systems



Water cool (PWR): 15.5MPa, 290-325°C 17

New JA Fusion Strategy

- **The Japanese Government has established a new Expert Committee on Fusion DEMO Promotion in the Cabinet Office** in September 2022, where the accelerated schedule towards DEMO, the supply chains of DEMO components, and the enhancement of private investments will be discussed.
- A new fusion strategy will be shown in next year.