

# **Japan's Policy on Fusion Research and Development**

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**September 2023**  
**Secretariat of Science, Technology and Innovation Policy**  
**Cabinet Office, JAPAN**



# **Japan's Fusion Energy Innovation Strategy**

**Secretariat of Science, Technology and Innovation Policy  
Cabinet Office, JAPAN**

- **Motivation** of the national strategy for fusion energy.

Fusion energy solving energy, environmental problems



Fusion energy as a new industry

- Carbon neutrality by 2050,
- Global energy situation,
- Ensuring energy security.

- **Benefits of fusion energy:**
  - 1) carbon neutral,
  - 2) abundant fuel supply,
  - 3) inherent safety,
  - 4) environmental protection



• Paradigm shift of energy hegemony from countries with resource to those with technology.

- Increased private-sector investment in fusion energy development
- US, UK have national strategies aiming at commercialization/industrialization of fusion energy
- Japan has technological advantages and reliability, and Japan is a strong partner for the like-minded countries.

- **Vision** of Japan's Fusion Energy Innovation strategy (decided this April).

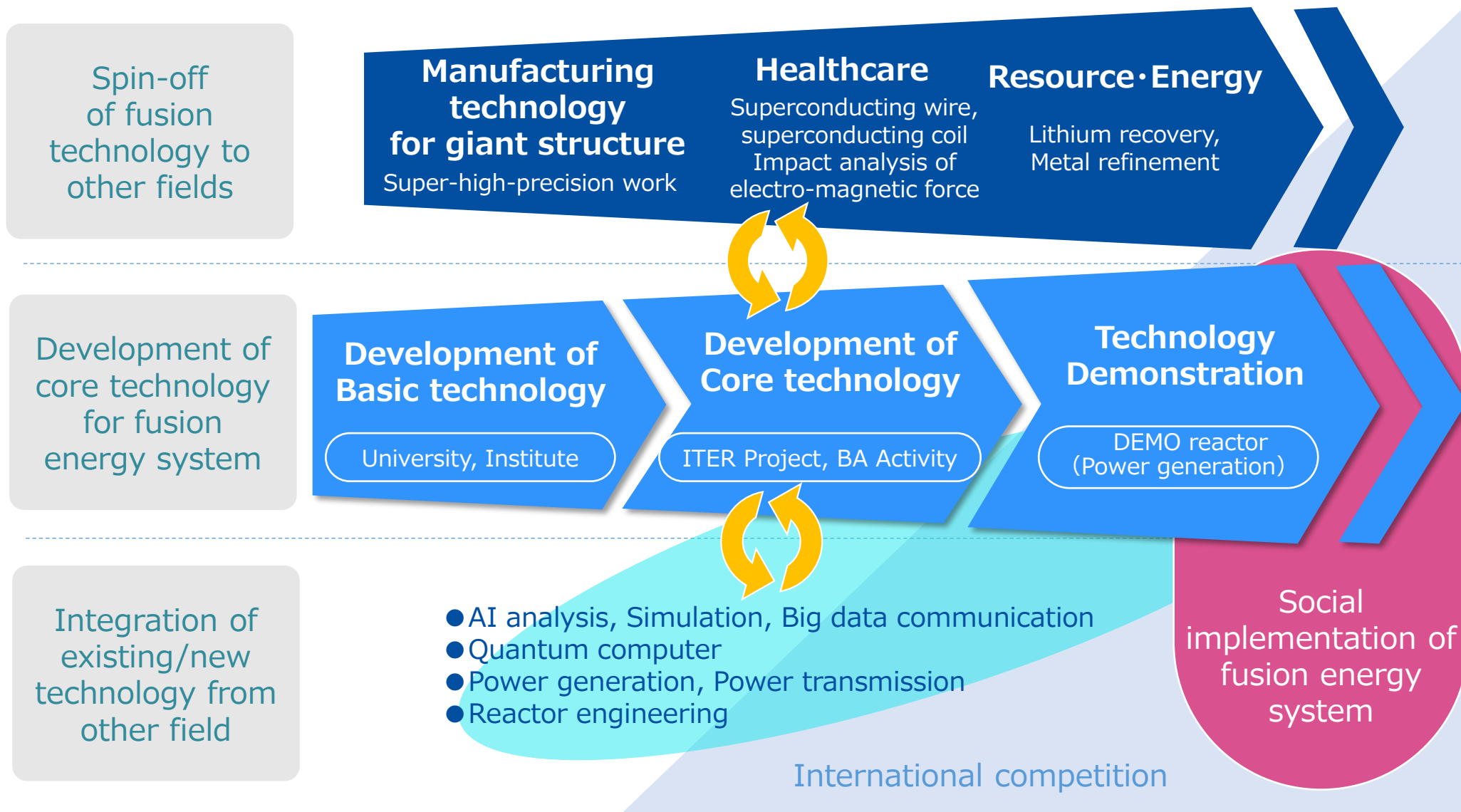
Toward realization of fusion energy, the world's next-generation energy  
**"Commercialization of fusion energy"**  
**seizing the winning market edge with technological superiority**

Developing the Fusion industry



Developing the Fusion Technology

Framework for Promoting Fusion Energy Innovation Strategy



✓ **Seeing fusion energy as a new industry**, Japan will accelerate the realization of fusion energy through a multifaceted approach,  
 ✓ and not miss the opportunity to **enter the global fusion supply chain competition.**

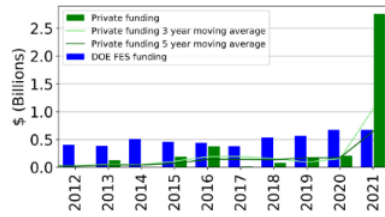
- ✓ **Seeing fusion energy as a new industry**, Japan will not miss the opportunity to **enter the burgeoning global fusion supply chain competition**.
- ✓ In addition to subsequent approach; the ITER Project/BA Activity, and DEMO development, Japan will accelerate the realization of fusion energy through a multifaceted approach such as commercialization.
- ✓ **Japan will establish Fusion Industry Council, support start-up and others' R&D, hold discussions on safety regulations, strengthen its support to emerging technologies, develop educational programs, etc.**

## Fusion energy as a solution for energy and environmental problems

- Carbon neutrality by 2050
- International energy situation greatly impacted by Russia's aggression against Ukraine
- Ensuring energy security
- Benefits of fusion energy:
  - 1) carbon neutral, 2) abundant fuel supply, 3) inherent safety, 4) environmental protection
- Paradigm shift of energy hegemony from countries with resources to those with technology

## Fusion energy as a new industry

- Increased private-sector investment in fusion energy development in other countries
- US, UK have national strategies aiming at commercialization of fusion energy (starting confining technologies to own countries).
- Japan may win in technology but lose in business, although it has technological advantages and reliability.
- Japan is a strong partner for other countries; good chance to get overseas markets.



Reference : <https://science.osti.gov/-/media/fes/pdf/fes-presentations/2022/Wurzel---PPP-Lighning-round-talk.pdf>

### Developing the Fusion industry

**Visualization**

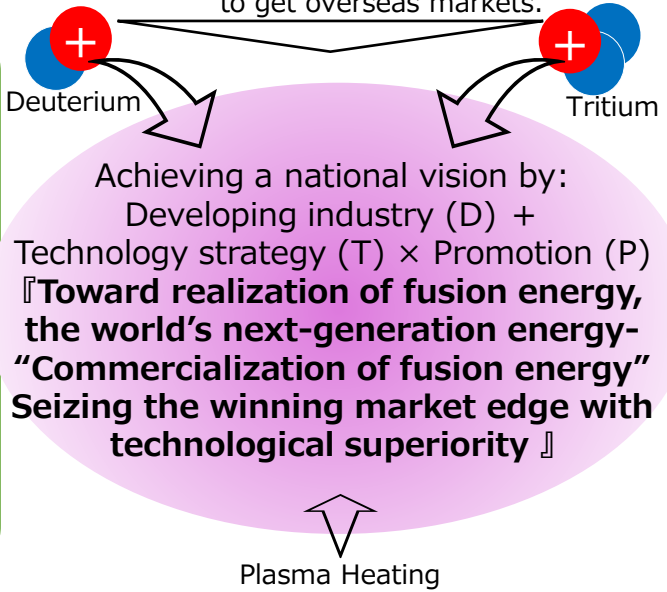
- Early realization of DEMO by accelerated R&D
- Clarification of targets with technology, market opportunity maps

**Connections**

- Matching of companies by establishment of Fusion Industry Council of Japan aiming at FY2023

**Fostering**

- Greater support to private companies from FY2023 for reducing gap between industry needs and technology seeds possessed
- Participation in discussion between like-minded countries on safety regulations and standardization
- Formulation of basic ideas on ensuring safety based on inherent safety of fusion energy



### Developing Fusion Technology

- Enhanced support measures for emerging technologies such as miniaturization and high-performance technologies as a game-changer
- Acquisition of key technologies through ITER Project/BA Activity
- Acceleration of R&D anticipating future development of DEMO
- Promotion of academic research on fusion energy
- Promotion of Action Plan for DEMO development by incorporating new technologies

## Framework for Promoting Fusion Energy Innovation Strategy

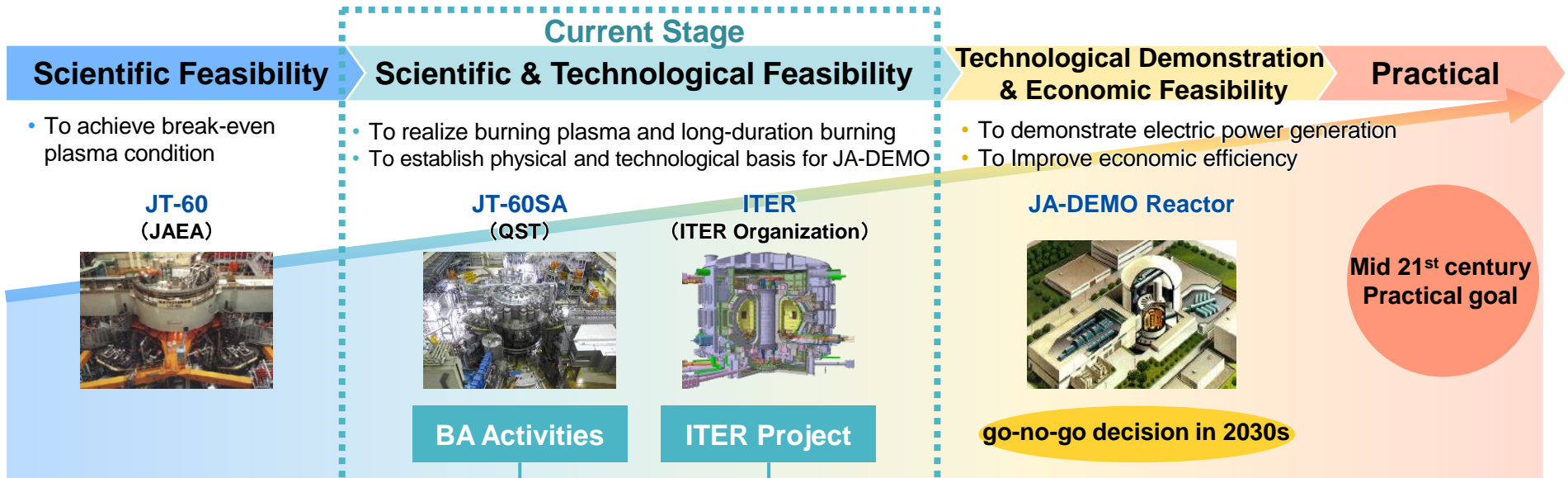
- With Cabinet Office as "control tower," advancing strategy together with relevant ministries, agencies
- Establishing framework for conducting R&D by bringing together, centering on QST, academia and private companies for DEMO development (establishment of fusion technology innovation hub)
- Clarifying future career paths, systematically fostering by industry-academia-government HR engaged in fusion energy
- Strengthening HR development at universities, acquiring excellent HR from other fields, countries (provision of fusion energy educational programs)
- Conducting outreach activities to deepen understanding of citizens

# **Japan's Fusion Research and Development**

**International Nuclear and Fusion Energy Affairs Division,  
Research and Development Bureau, MEXT, JAPAN**

# Staged Approach toward Fusion Energy of Japan

- Toward the practical application of fusion energy, the decision on the transition to the DEMO reactor will be made after confirming the scientific and technological feasibility through participation in the ITER project, etc.
- R&D will be promoted while periodically checking and reviewing the progress of technological development necessary for the DEMO reactor.



Japan-EU Bilateral Collaboration in Japan supporting ITER and JA-DEMO R&D comprising following activities :IFERC (DEMO design and R&D)

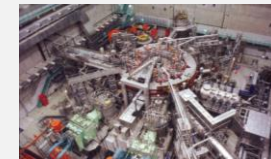
- IFMIF/EVEDA (Engineering Validation for fusion material irradiation facility)
- Satellite Tokamak Programme (JT-60SA)

- 7 Members (EU, US, JA, CN, IN, KO, RF) collaboration
- ITER Organization assembles components as in-kind contribution by 7 Members (JA: Toroidal Field Coils etc.)

## Academic Research



**GEKKO XII, LFEX (Osaka Univ.)**



**Large Helical Device (LHD) (NIFS)**

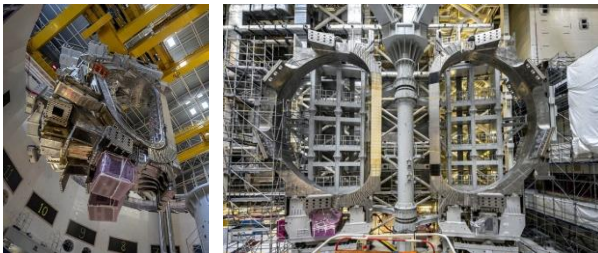
# Progress in ITER Project

- Japan is making its utmost efforts to manufacture very challenging components in cooperation with industry.
- The main components, including TF coils procured by Japan, are being delivered to the ITER site.

## Tokamak Construction

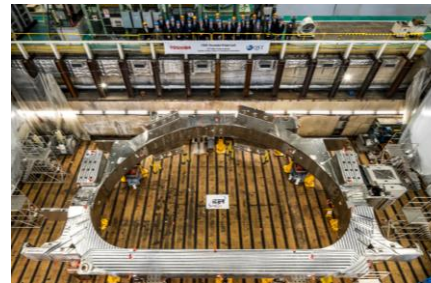


(April 2023)



Vacuum Vessel Sector pulled out from the tokamak pit and repair activities are underway (July 2023)

## Manufacturing of components in Japan



Last regular TF coil to be procured by JA has been completed (Feb 2023) and transported to ITER site (July 2023)



Gyrotron: All production completed (May 2021)  
Factory acceptance test in progress



Diverter Left Outer Vertical Target prototype completed (March 2023)



NBTF: High Voltage Tests for JA components completed (Nov 2019)



# Progress in BA Activities

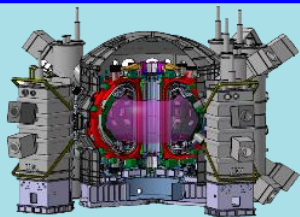
- To support the early realization of fusion energy, JA & EU are jointly implementing 3 projects.
- Phase I (June 2007 - March 2020) : Completed the development of major research environment necessary for the BA activities.
- Phase II (April 2020-) : Produce research results which contribute to and supplement the ITER project by using the research facilities developed in Phase I as well as by improving the performance of the equipment toward the goal.

## Naka Site

Satellite Tokamak programme (JT-60SA)

Support for the ITER project

Challenging R & D For DEMO

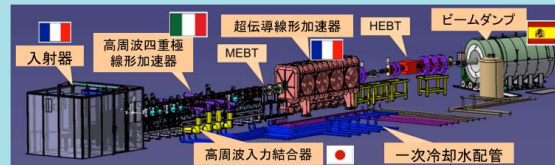


Integrated commissioning restarted in May 2023, aiming for First Plasma in Autumn 2023.

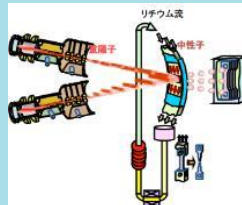
## Rokkasho Site

IFMIF/EVEDA Project

Engineering Validation of Elemental Technologies



Engineering Design of IFMIF



IFERC Project

DEMO Design and R&D Coordination Center



ITER Remote Experimentation

Fusion Computer Simulation Center(CSC)



## National Institute for Fusion Science (NIFS) Large Helical Device (LHD)



machine diameter: 13.5m  
machine height: 9.1m  
net weight: 1,500t  
plasma volume: 30m<sup>3</sup>

## Major Achievements

- ✓ Significant advances in plasma parameters, including the achievement of an ion temperature of 120 million degrees Celsius
- ✓ Outstanding physics results published in prestigious journals
- ✓ High availability of plasma experiments through excellent operation and enhancement of high-precision measurement systems

FY2023- Utilizing LHD as an academic research platform  
to promote interdisciplinary fusion science

Clarification of complex phenomena  
Ex. Fusion Energy / Spontaneous phenomena / Space & Astronomy

The Science and Technology Committee on Fusion Energy of MEXT published the strategies for the development of DEMO reactor.

*December 2017*

➤ **Promotion of R&D for DEMO reactor**

➤ **Action Plan towards DEMO reactor**

*July 2018*

➤ **Roadmap toward DEMO reactor (first report)**

## Phased Approach toward DEMO reactor

- ✓ Current : Pre-conceptual Design Phase
- ✓ **2021 : 1<sup>st</sup> Intermediate Check and Review (C&R)**
- ✓ Conceptual Design Phase
- ✓ Within a few years after 2025 : 2<sup>nd</sup> Intermediate C&R
- ✓ Engineering Design Phase
- ✓ In the 2030s : Final C&R
- ✓ Construction Phase

# All-Japan framework for JA-DEMO

## Science and Technology Committee on Fusion Energy of MEXT

Discuss and decide the policy on fusion R&D, including Roadmap

Draw up/Formulate an Action Plan

### Task Force on JA-DEMO

- Grasp the situation of elemental technologies as a whole
- Optimize the overall strategy

Review

Show the policy

Sharing information etc.

Propose/approve theme of joint research

Joint research toward JA-DEMO

### WG for Joint Research

TF, QST, NIFS, Univ.,  
Joint Special Design Team

- Close relations with universities to strengthen the JA-DEMO R&D framework
- Carry out joint research by universities
- Human resources development through research

JA-DEMO Concept Design

“Joint Special Design Team for Fusion DEMO” of Rokkasho Fusion Institute

- Plan and implement R&D to address issues
- Organize Workshops

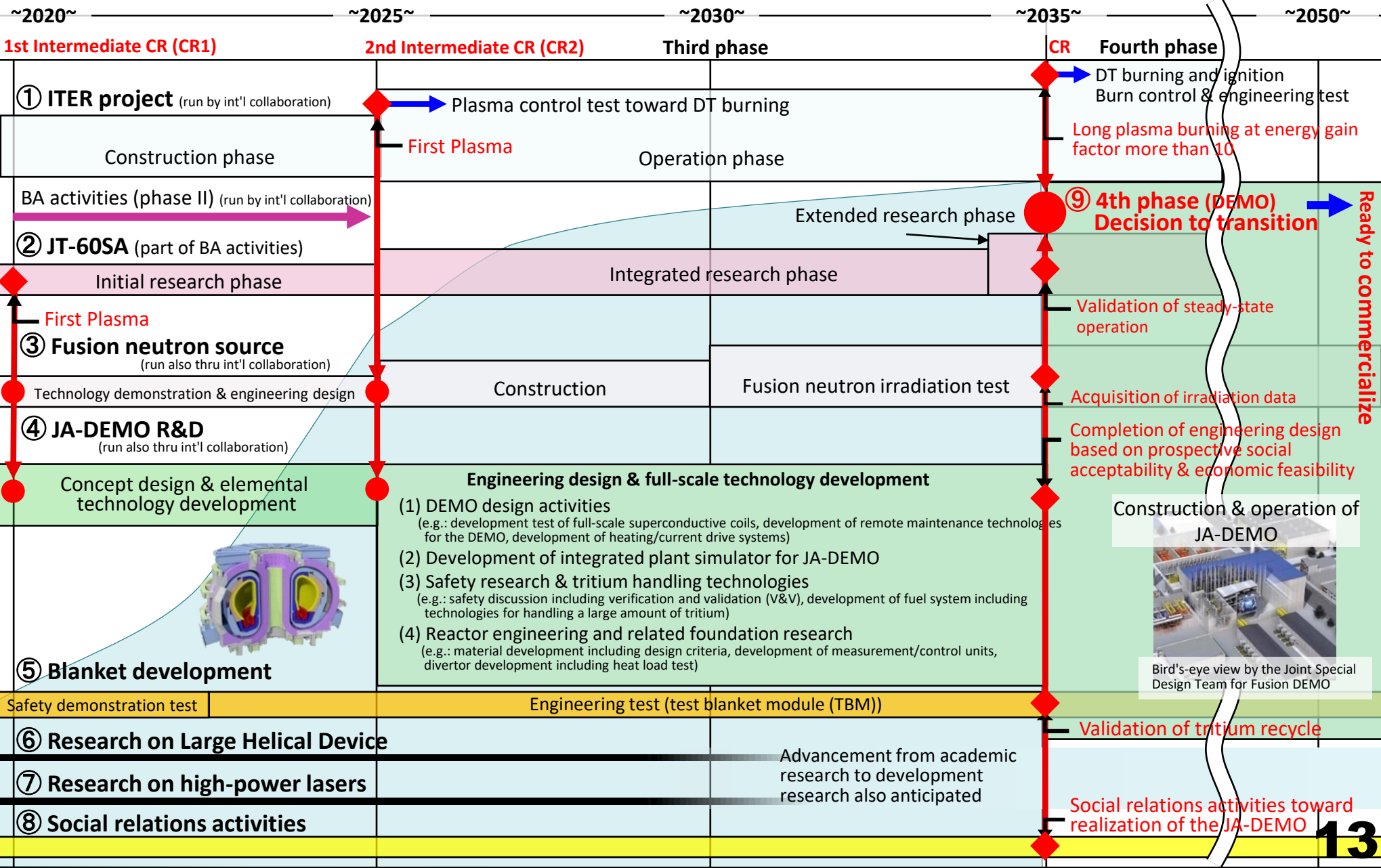
QST, NIFS, Academia, Industry

# Roadmap toward DEMO Reactor



**Legend**

- ◆ When to achieve the target
- ▲ Target to achieve
- When to decide transition to the next phase
- Figure of activities required



# Fusion DEMO Reactor R&D — Main topics for consideration in FY 2023



In response to the report of the First Intermediate Check and Review on Fusion DEMO Reactor R&D(CR1,2022), the Science and Technology Committee on Fusion Energy and the Taskforce on Comprehensive Strategy for DEMO Development will discuss the following issues in FY2023.

- Consideration of budget request and reaction in response to the Fusion Energy Innovation Strategy
- Revision of the Action Plan and R&D Roadmap for DEMO
- Consideration of policy, schedule and method of CR2
- Consideration for the promotion of R&D