Current Status of ITER Broader Approach Activities within the Framework of Japan-EU Collaboration

- IFMIF/EVEDA & IFERC Projects in Rokkasho and Satellite Tokamak JT-60SA Project in Naka –

The Implementing Teams of IFMIF/EVEDA and IFERC, and the JT-60SA Team

Mission: The Earliest Realization of Fusion Energy

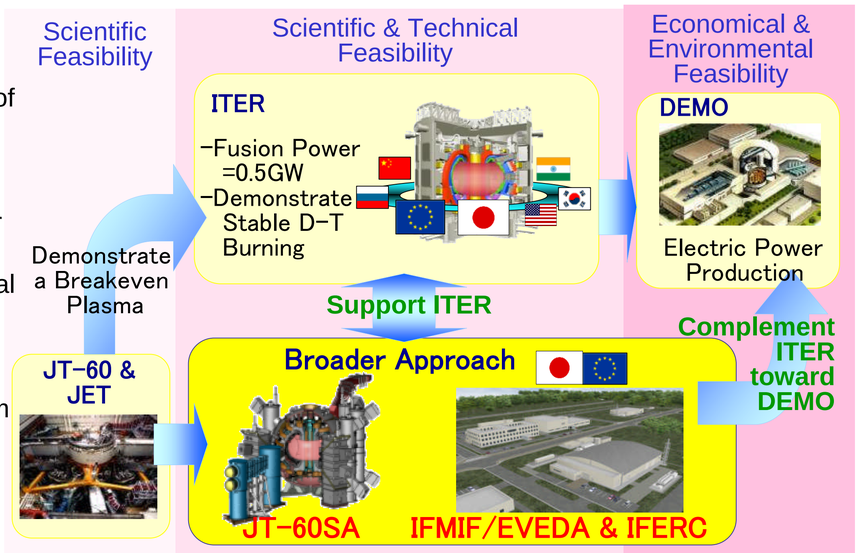
The Broader Approach (BA) is a Japan-EU collaborative project aiming at supporting the ITER Project and complementing developments toward a fusion DEMO reactor on the same period of ITER construction.

The major objective of ITER validate the scientific and engineering feasibility of fusion energy, by demonstrating a stable D-T burning operation. This, however, is considered insufficient for the earliest achievement of fusion energy.

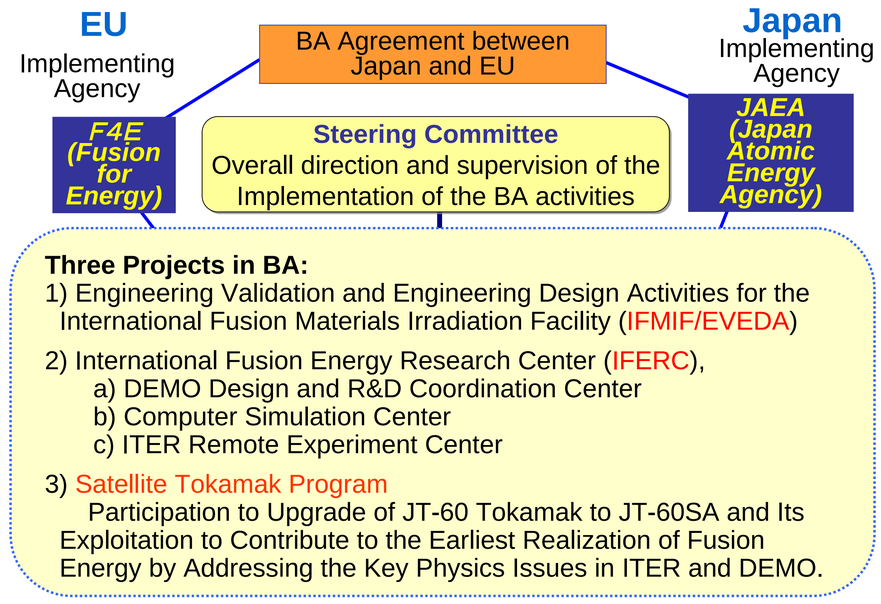
In parallel with the ITER project, additional and supplemental R&Ds are considered necessary as follows: (a) fusion materials development and their irradiation tests, (b) conceptual design and engineering assessments for the DEMO, (c) engineering developments of the breeding blanket including materials for tritium bleeding, neutron multiplier, and also (d) research and developments of plasma to support ITER with exploring advanced tokamak scenarios.

On such a mutual understanding of fusion energy R&D strategy common to both Japan and EU, they agreed to initiate the BA Activities together with the ITER project.

Strategy toward Fusion Power



Management Structure for Broader Approach



Three Projects in BA:

1) Engineering Validation and Engineering Design Activities for the International Fusion Materials Irradiation Facility (IFMIF/EVEDA)

2) International Fusion Energy Research Center (IFERC),
   a) DEMO Design and R&D Coordination Center
   b) Computer Simulation Center
   c) ITER Remote Experiment Center

3) Satellite Tokamak Program
   Participation to Upgrade of JT-60 Tokamak to JT-60SA and Its Exploitation to Contribute to the Earliest Realization of Fusion Energy by Addressing the Key Physics Issues in ITER and DEMO.

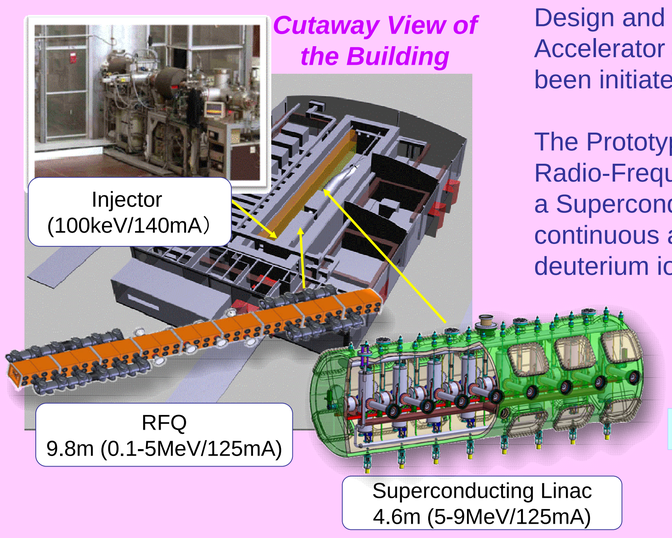
Building Construction Status of International Fusion Energy Research Center in Rokkasho-mura, Aomori Pref.

IFMIF/EVEDA Project

10 Experts

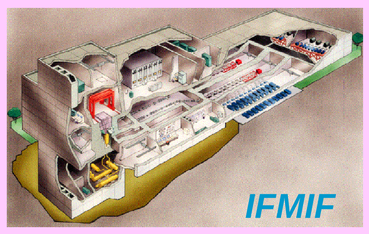
5 Experts and 6 Support Staffs (January, 2010)

Cutaway View of the Building



Design and manufacturing of the IFMIF Prototype Accelerator and the target facility (Li test loop) have been initiated.

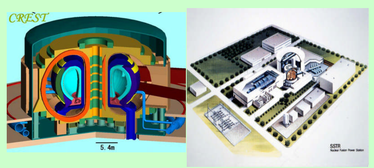
The Prototype Accelerator consists of an injector, a Radio-Frequency Quadrupole (RFQ) Accelerator, and a Superconducting Linac, aiming at demonstrating continuous acceleration of high current (125 mA, CW) deuterium ion beams.



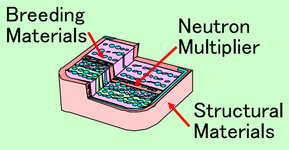
IFERC Project

DEMO Design and R&D Coordination Center

For DEMO design and R&D activities, the first three years of 2007-9 as the first phase have been devoted to workshops and preparation for activities.
The following years will be planned for full-fledged activities in collaborative design and R&D works.
- Establish Common Conceptual DEMO Design (Assumption, Cost, Time Schedule, Safety Concept)
- Physics and Engineering Issues in R&D should be identified, and Preliminary R&D (Low Activated Materials, Breeding Blanket, Tritium Management, etc.)



DEMO Concepts & Safety

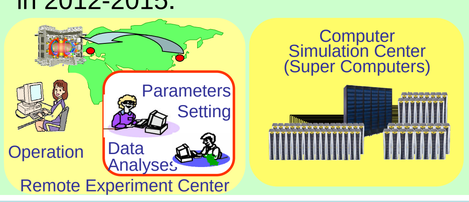


DEMO Breeding Blanket R&D

Computer Simulation Center & ITER Remote Experiment Center

For the Computer Simulation Center, selection of the high performance computer (the next-generation supercomputer) is now going for operation of early in 2012.
- D-T burning plasma simulation for ITER
- Advanced plasma behavior simulation for JT-60SA
- DEMO reactor design
- Advanced material simulation

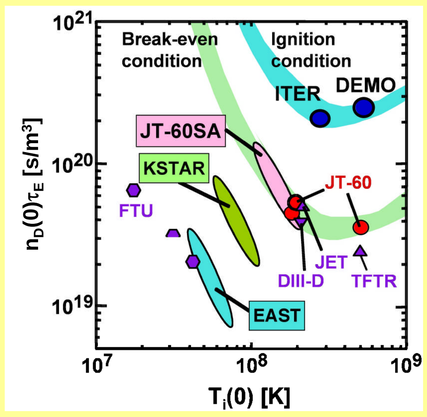
The Remote Experiment Center will be tested in 2015 using JT-60SA, after design, manufacturing, and installation in 2012-2015.



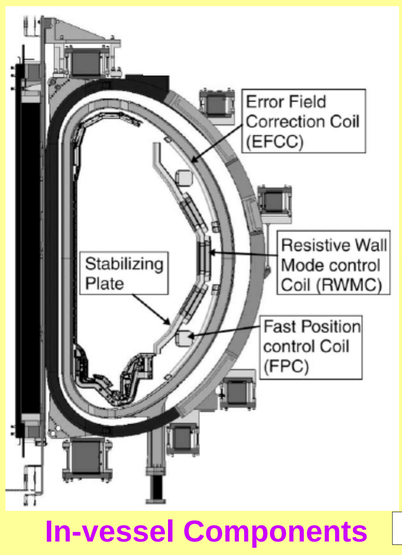
Satellite Tokamak JT-60SA Project

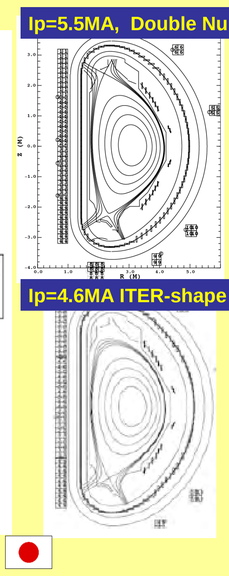
The mission of JT-60SA is capable of confining breakeven-equivalent class, high-pressure deuterium plasmas with the max. plasma current of 5.5 MA, superconducting toroidal (2.26 T) and poloidal field coils. 34 MW of NB and 7 MW of ECRF for up to 100 s.

Complete reconfiguration of the JT-60 by reusing as many existing infrastructure such as the power supplies, heating devices, cooling systems, etc., as possible. In-kind contributions for construction and financial contributions for exploitation are shared by EU and JA.



Plasma Operation Regime

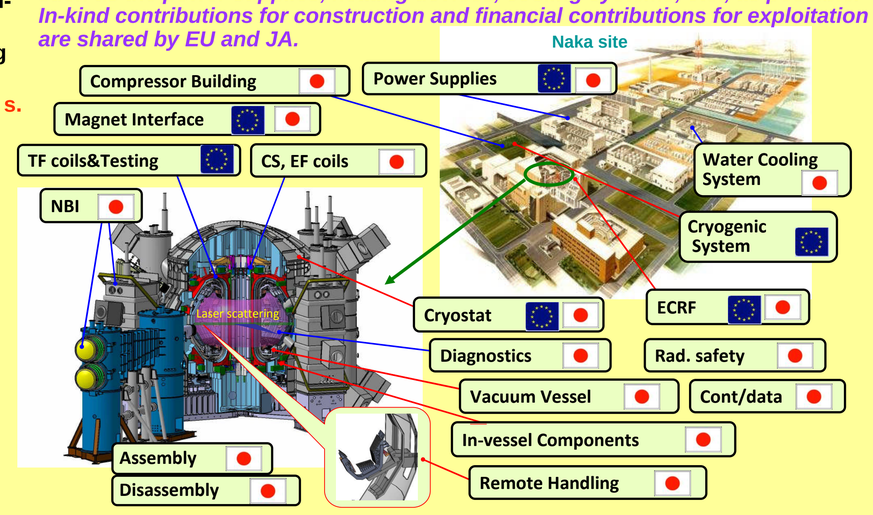




Typical Plasma Parameters

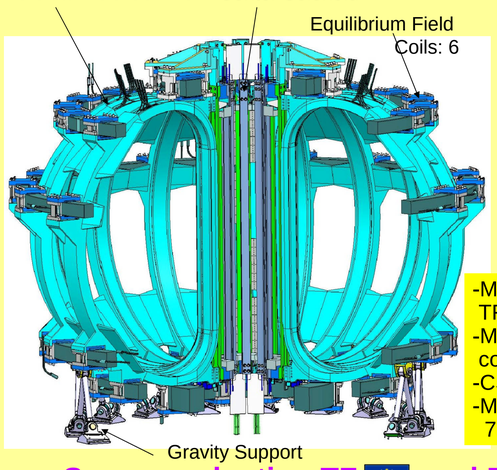
Parameter	DN Low A	ITER-shape	High-β_N full-CD
Plasma Major Radius R (m)	2.96	2.93	2.97
Plasma Minor Radius a (m)	1.18	1.14	1.11
Plasma Current I_p (MA)	5.5	4.6	2.3
Toroidal Field B_o (T)	2.25	2.28	1.71
Plasma Aspect Ratio A	2.5	2.6	2.7
Plasma Elongation κ_x , κ_{95}	1.95, 1.77	1.81, 1.70	1.92, 1.83
Plasma Triangularity δ_x , δ_{95}	0.53, 0.42	0.43, 0.33	0.51, 0.41
Shape Parameter S	6.7	5.7	6.9
Safety Factor q_{95}	3.2	3.2	5.7
Plasma Volume (m^3)	132	122	124
Heating Power (MW)	41	34	37
Assumed HH-factor	1.3	1.1	1.3
Normalized Beta β_N	3.1	2.8	4.3
Thermal Energy Confinement Time τ_E (s)	0.54	0.52	0.26
Electron Density n_e ($10^{20}/m^3$)	0.63	0.91	0.50
Greenwald Density $n_{Greenwald}$ ($10^{20}/m^3$)	1.3	1.1	0.59
Normalized Plasma Density $n_e/n_{Greenwald}$	0.5	0.8	0.86
Flattop Flux (Vs) (li=0.73-0.75)	~9	~17	- (full CD)
Bootstrap current fraction	0.29	0.30	0.66
Discharge flattop duration (s)	100	100	100

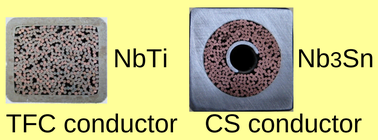
ITER-shape: same κ and δ but lower A than ITER.



Japan-EU Sharing of Tokamak Facilities in Naka

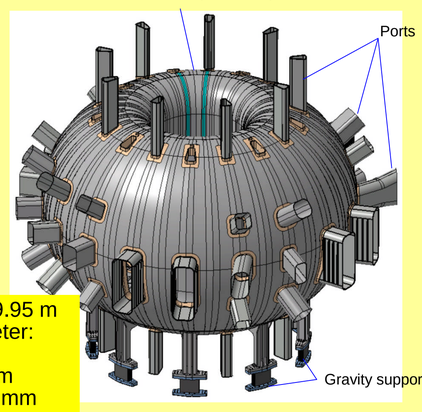
In-vessel Components





-Magnetic Energy in TFC: 1.5 GJ
-Max Field in TFC coils: 5.8 T
-CS Peak Field: 8.9 T
-Magnet Weight 700 tons (4K)

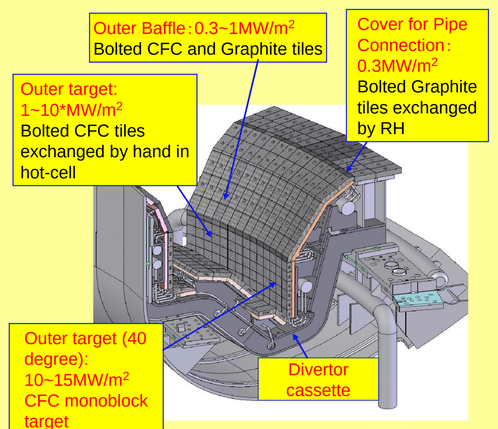
Last insertion part with splice sheet



Outside diameter: 9.95 m
Inboard Side diameter: 2.86 m
Torus height: 6.63 m
Shell thickness 18 mm
Weight~150 ton
One-turn resistance:19 μΩ
Normal operation Temp.:50 degC
(Boric acid water between shells)

Vacuum Vessel (Low Co SUS316L)

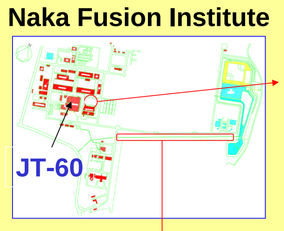
Superconducting TF and PF Coils



Lower Divertor

The divertor target is water-cooled, resistant against the heat flux of 15 MW/m^2.

Naka Fusion Institute



PF Coil Manufacturing Building

PF SC Conductor Manufacturing Building (700m in length)

VV Welding Test

Manufacturing Activities

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
IFMIF/EVEDA	Manufacturing				Installation		Test & Operation				
IFERC: Computer Simulation Center	Selection SuperComp.				Installation		Operation				
IFERC: DEMO Des. R&D Coord.Center	Tech. Discussion				DEMO Design and R&Ds						
IFERC: Remote Experiment Center	System Design								Install. & Ope.		

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Satellite Tokamak JT-60SA	Construction									First Plasma	
Tokamak Device	Assembly									Initial Research phase	
	Start Tokamak Assembly									Complete Tokamak Assembly	
	Integrated Commissioning & Cold Test										
	Commissioning Activities										
	Auxiliary System										

ITER Broader Approach

ITER BA Activities, IFMIF/EVEDA, IFERC, and Satellite Tokamak JT-60SA, are now being implemented within a tight active collaboration between Japan and EU, toward the earliest realization of fusion energy for human beings.