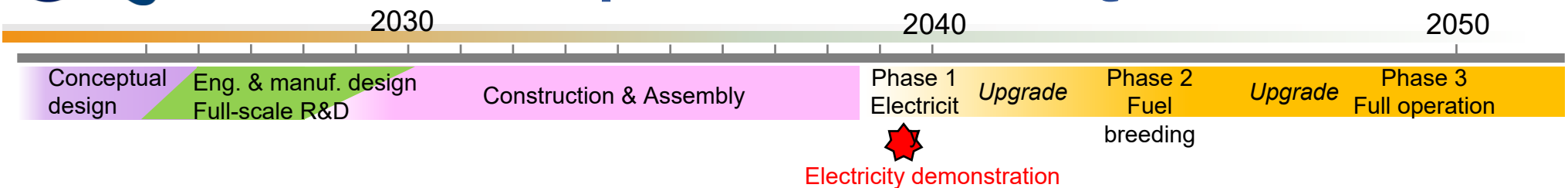


Overview of Q-DEMO Conceptual Design

An aerial perspective rendering of the Q-DEMO conceptual design. The central feature is a large, modern building with a blue roof, housing a complex fusion reactor system. To the left, there are two large rectangular structures with solar panel roofs and yellow internal components. In the foreground, there are several large, dark, cylindrical components arranged in rows. The entire facility is surrounded by greenery, trees, and a parking lot. The background shows a hilly landscape under a bright sky.

NAKAHIRA Masataka
Rokkasho Institute for Fusion Energy,
National Institutes for Quantum Science and Technology (QST), Japan



Demo Plan toward power generation demonstration in 2030's according to Fusion Energy Innovation Strategy

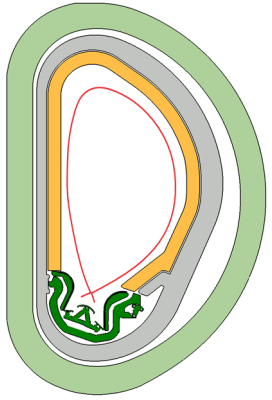
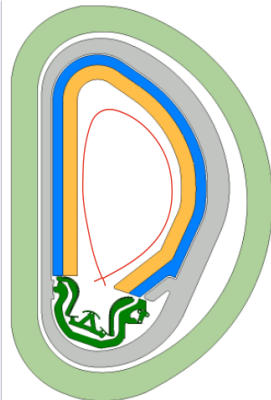
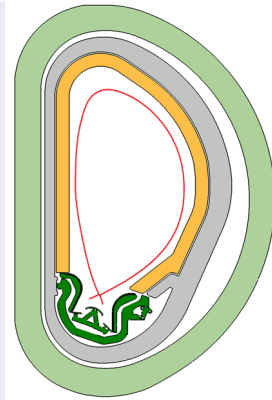
- **Scientifically / Technically meaningful power generation to social implementation**
Self heating dominant, $Q \geq 10$, Net Power ≥ 0
- **Technical basis standing on ITER/BA activities for steady demonstration in 2030's**
Aiming shortest achievement by applying ITER equivalent components as proven technology
- **Phased approach to achieve Demo target (Power Generation, Breeding, Steady state operation)**
Improvement of Plasma and Major component performance in stepwise



Q-DEMO Conceptual Design

- ITER size Demo **"Q-DEMO" conceptual design has been completed**
- Clarifying technical target to be developed for Demo construction and operation. Implemented to infrastructure development plan for fusion technology innovation hub.

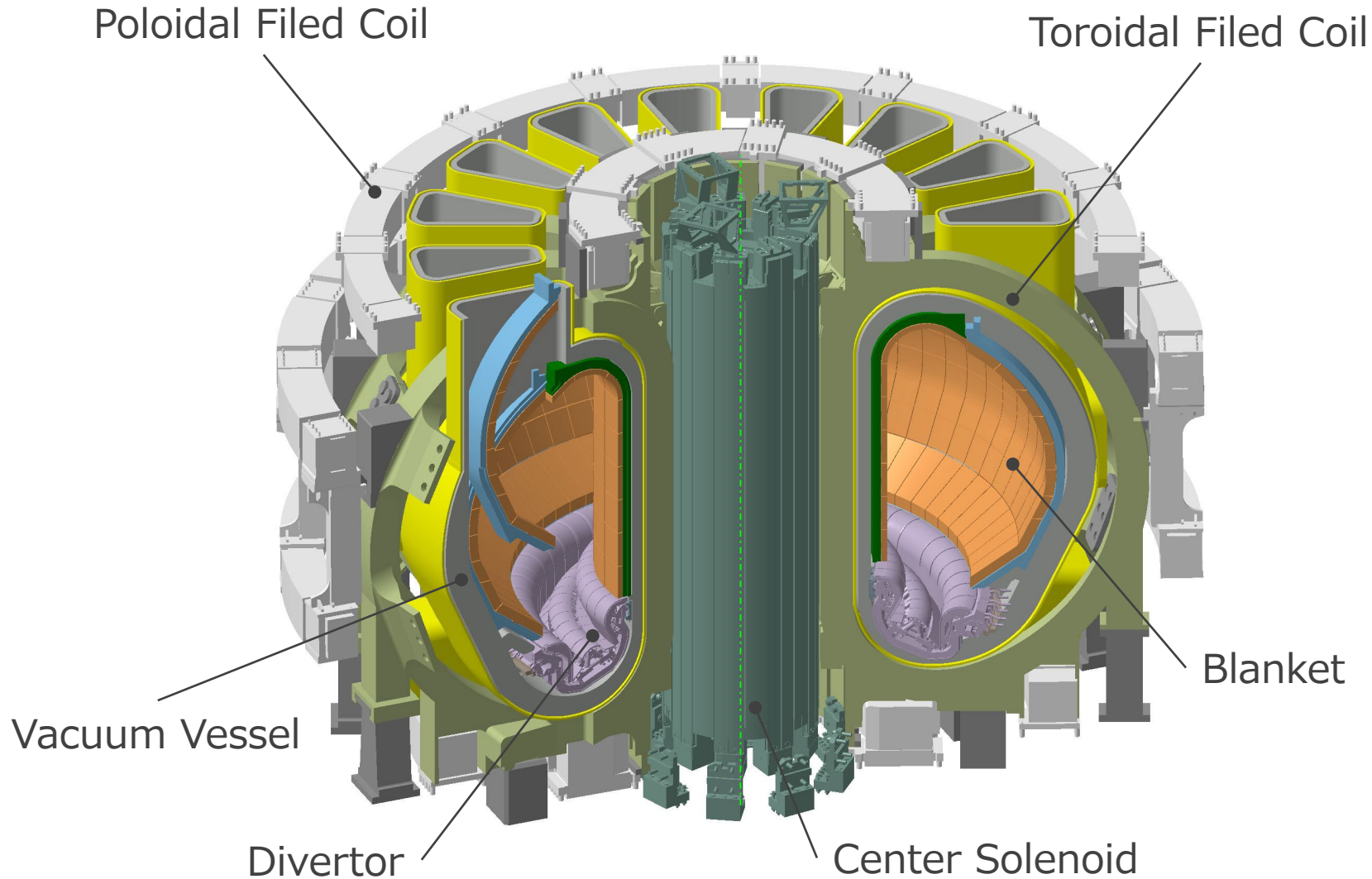
Phased target and Parameters

	Phase1: System Integration Power Generation	Phase2: Blanket Verification PG+T Breeding	Phase3: Enhanced Operation PG+TB+Steady State Op
Target	• Short Pulse (min) • Net Power ≥ 0	• Long Pulse ($\geq 0.5h$) • Net Power ≥ 0 • TBR=1.05	• Steady State • Net Power $\sim 100MW$ • Tritium Breeding • Maintenance Scenario
	 Shield Blanket for power generation Plasma Volume=ITER $\sim 835m^3$	 Breeding Blanket Plasma Volume $\sim 570m^3$	 Breeding Blanket Plasma Volume $\sim 715m^3$
Parameters	ITER Base Operation ✓ Fusion Power : $\sim 500MW$ ✓ Q: 10 ✓ Pulse length : $\sim 400s$ • Heating Device ✓ RF • Shield Blanket ✓ ITER Size	• High Pressure Plasma ✓ Fusion Power : $\sim 500MW$ ✓ Q : ~ 10 • Heating Device ✓ RF / NBI • Breeding Blanket	• Enhanced Plasma based on JT-60SA results ✓ Fusion Power : $> 500MW$ ✓ Higher efficient Heating • Advanced Breeding Blanket • Remote Handling blanket exchange

Major Parameters

	Phase I	Phase II	Phase III
R_p / a_p (m)	6.2 / 2.0	6.2 / 1.65	6.2 / 1.85
A	3.1	3.76	3.35
K_{95}	1.7	1.7	1.7
q_{95}	3.0	3.20	4.29
I_p (MA)	14.96	9.21	9.64
B_t (T)	5.29	5.29	5.79
t_{burn}	347 s	0.55 h	Steady State
P_{fus} (MW)	532	434	908
Q	10	10	15.3
P_{net} (MW)	10.7	2.91	101
P_{gross} (MW)	203	166	339
P_{aux} (MW)	53.2	43.4	59.3
f_{BS} (%)	21.7	36.5	68.1
n_e (10^{19} m^{-3})	9.95	9.93	9.33
H_{98y2}	0.95	1.15	1.50
β_N	1.8	2.5	3.62
f_{GW}	0.85	1.00	1.20
P_{sep} (MW)	105	89.8	150
n_{Ar} / n_e (%)	0.23	0.23	0.5

Major Components

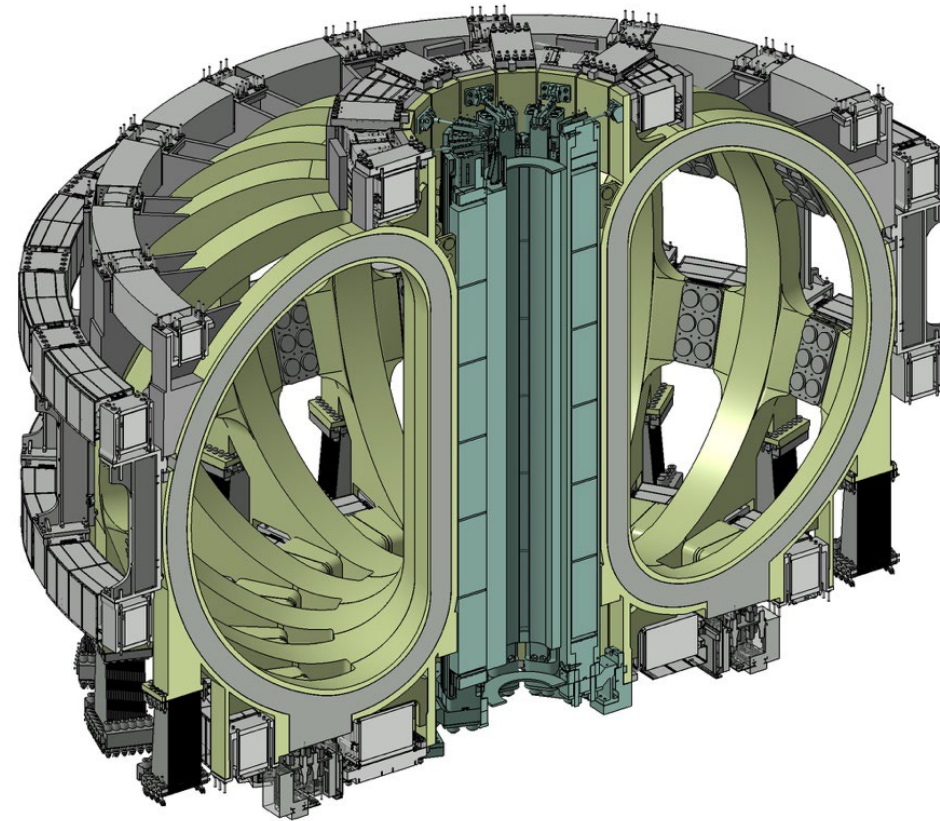


Super Conducting Coil

ITER equivalent configuration and Spec

- TF and CS : Nb_3Sn
- PF : NbTi
- Conductor : Cable-in-Conduit

	Phase 1,2	Phase 3
TF coil number	18	
TF coil magnetic energy	~ 41 GJ	~ 50 GJ
TF coil max field	11.8 T	~ 13.0 T
TF coil max current	68 kA	~ 75 kA
CS max field	13.0 T	
CS nominal current	40 kA at 13 T / 45 kA at 12.7 T	
PF coil max field	~ 6.4 T	
PF coil nominal current	~ 52 kA	
Operation temp	4.5 K	
Weight	≈ 10,000 t	

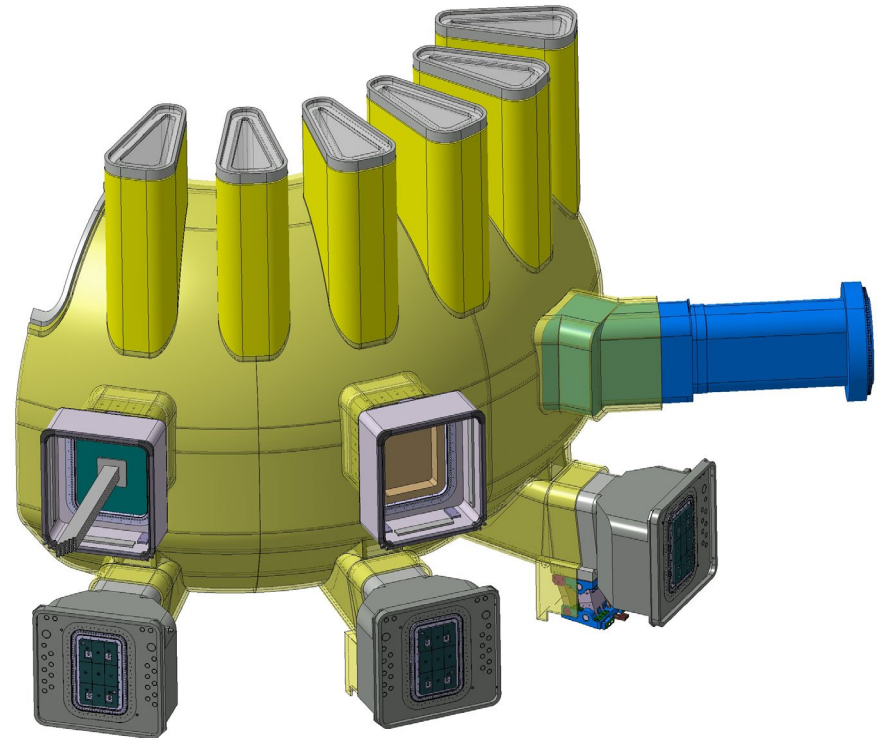


Vacuum Vessel

ITER equivalent configuration and Spec

- D-section Torus configuration
- Outer radius 9.70 m, Height 11.34 m, Section width 6.47 m
- Double wall structure with ribs
- Upper, Equatorial, Lower ports

Port	Number	Section	Inner Size of section (m)
Upper vertical port	18	Trapezoid	0.38 to 1.47 (W) x 3.2 (L)
Equatorial port	6 3	Rectangle	1.78 (W) x 2.2 (H)
• Regular • NB		Trapezoid	0.4 (W) x 0.438 (H)
Lower port	18	Trapezoid	0.728 to 1.39 (W) x 2.175 (H)

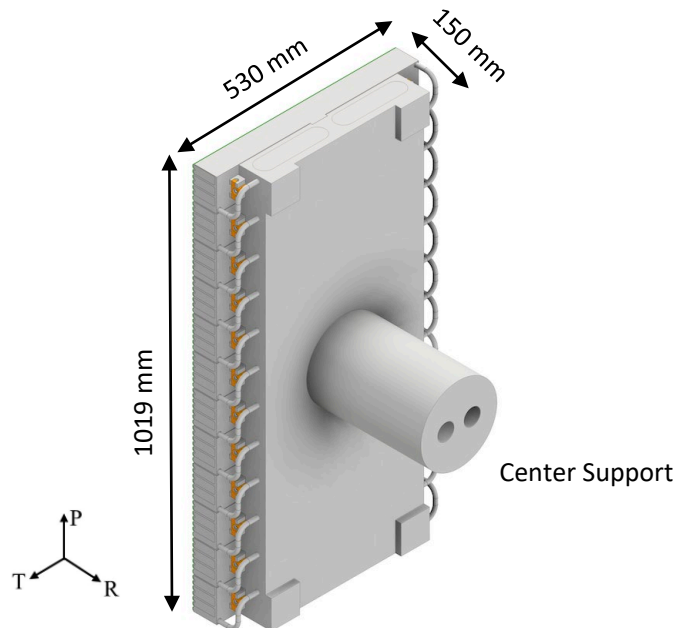


Blanket

Power Generation(Phase 1)

ITER Shield Blanket Design (No tritium breeding)

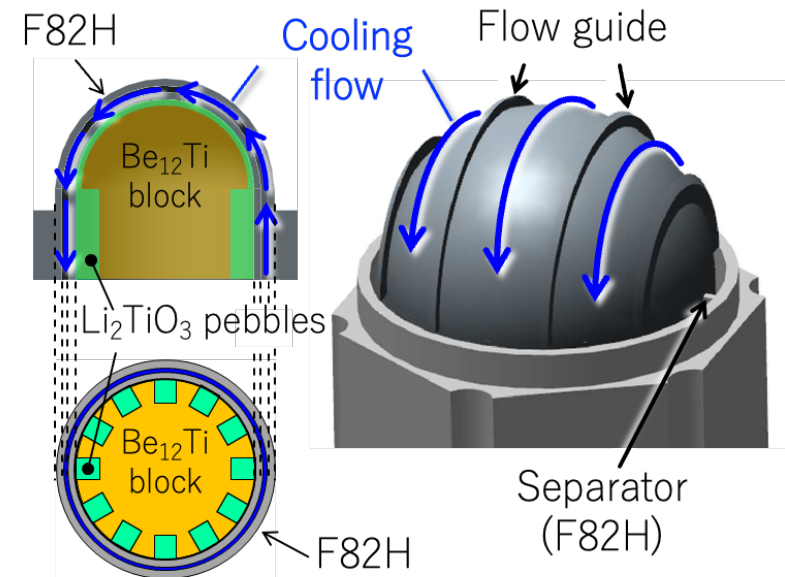
Structure	SUS316L
Neutron multiplier	N/A
Tritium breeder	N/A
Cooling water	$\sim 300^{\circ}\text{C}$, 15.5MPa



Breeding (Phase 2)

JA DEMO Breeding Blanket Design (TBR=1.05)

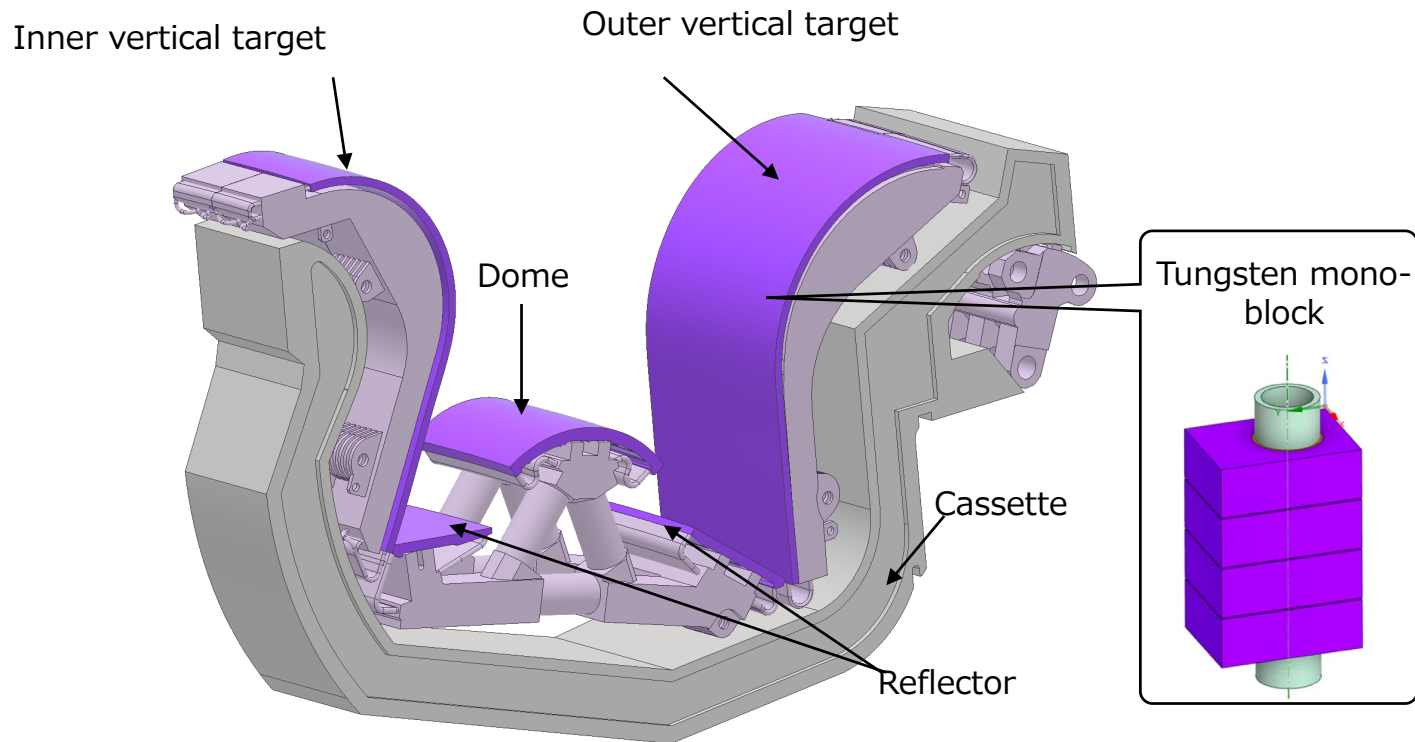
Structure	F82H(RAFM)
Neutron multiplier	Li_2TiO_3
Tritium breeder	Be_{12}Ti
Cooling water	$\sim 300^{\circ}\text{C}$, 15.5MPa



Divertor

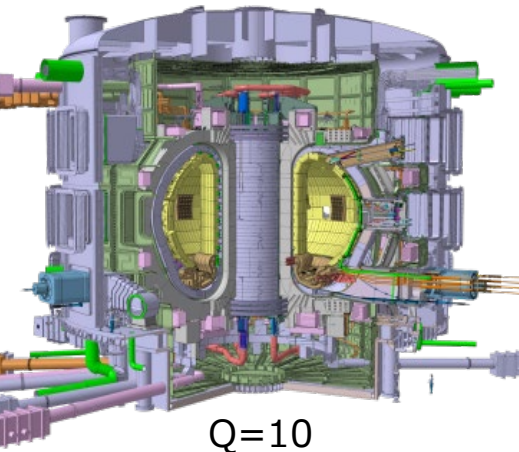
ITER equivalent configuration and Spec

- W-shape (Phase1&2:SUS316L, Phase3:F82H)
- Tungsten mono-block • Cu alloy pipe unit (Phase1&2)
- Tungsten mono-block • F82H pipe unit (phase3)

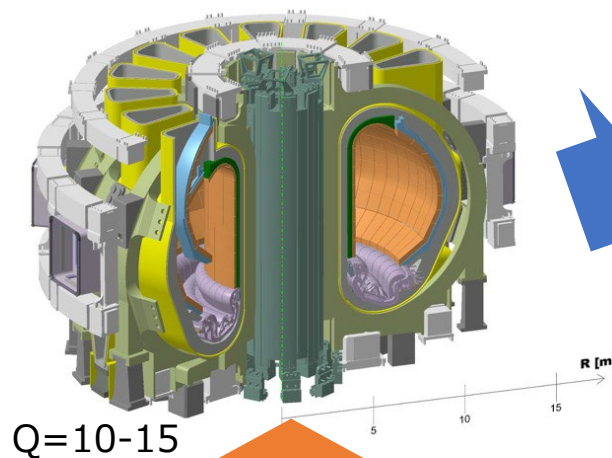




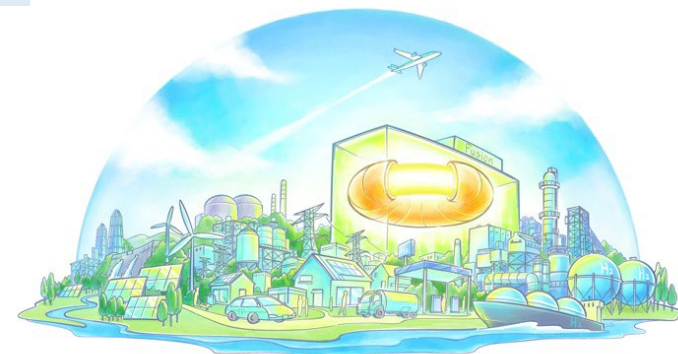
ITER
(Burning
plasma)



Q-DEMO
(Power·Breeding, Steady
state)



**Commercial
(Social
Implementation)**



Q=20-30

Technology Development

- ✓ Fuel system, Blanket, Remote maintenance, etc.
- ✓ Development of Innovation-hub, technology development

Technology Development

- ✓ Compact, Sophistication, Innovative new technology
- ✓ Utilization of Innovation hub

Thank you very much for your attention !!

आपका ध्यान के लिए
धन्यवाद