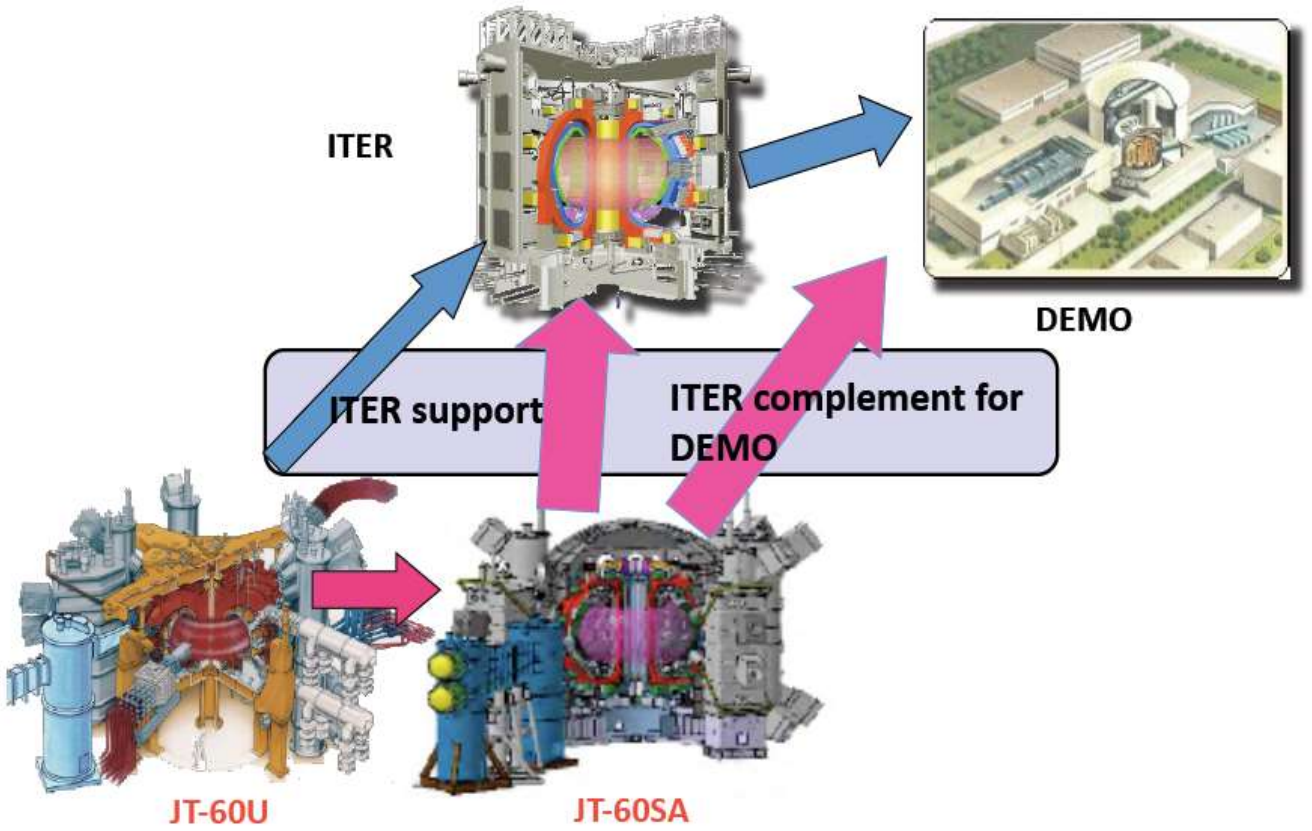
JT-60SA Experiment Team

J. Garcia

JT-60SA Experiment leader from Europe

JT-60SA Mission



- JT-60SA is the evolution of JT-60U within the Broader Approach
- Double mission: Support ITER and DEMO

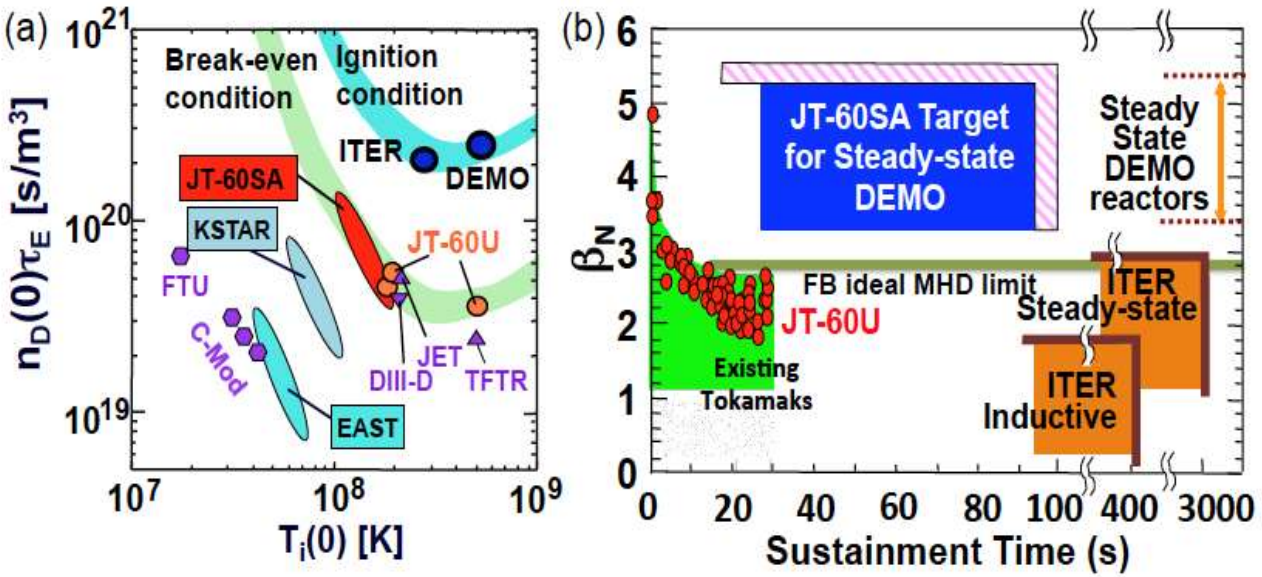
JT-60SA main targets: Research plan a key element

Research plan: 10 years of work!

https://www.jt60sa.org/wp/wp-content/uploads/2021/02/JT-60SA_Res_Plan-5.pdf

- Provide physics answers directly relevant for the DEMO design
- Complement ITER in plasma domains difficult to achieve in such device
- ITER Risk mitigation (disruption: SPI MGI, real time control)
- Provide experience on the operation of a large superconducting tokamak
- Provide essential data to tune models used for ITER and DEMO predictions
- Together with JET or **in replacement of JET,** provide a device for new researchers generations before full ITER scenarios are developed

JT-60SA uniqueness



- JT-60SA can provide unique information in new plasma conditions:
  - Long pulses
  - Very high beta, bootstrap and Greenwald fraction
  - High current
  - Different aspect ratio
  - Highly energetic ions
  - Significant electron heating and low torque

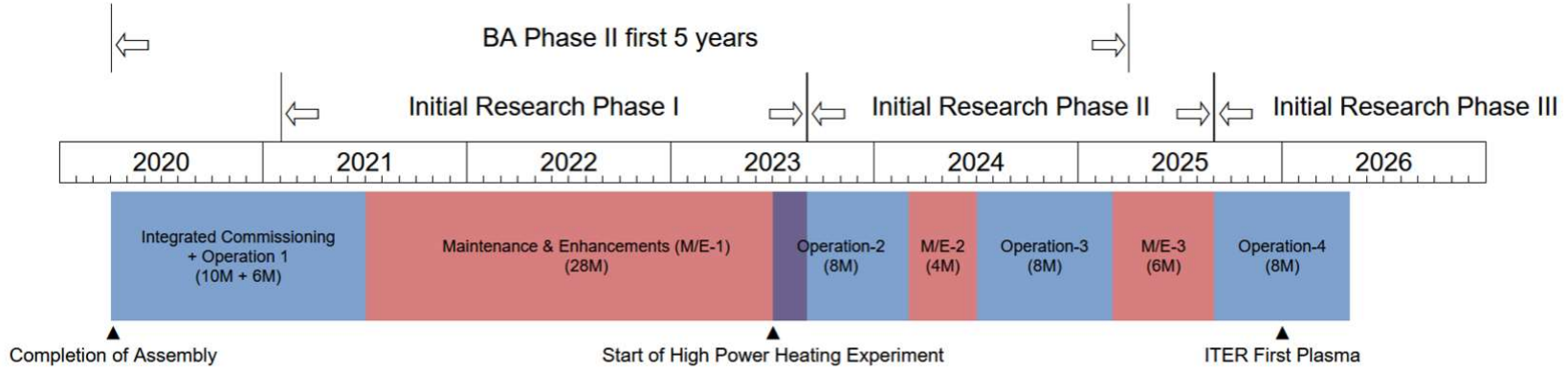
Different phases boundary conditions

	Phase	Expected operation schedule		Annual Neutron Limit	Remote Handling	Divertor	P-NB Perp.	P-NB Tang.	N-NB	NB Energy Limit	ECRF 110 GHz & 138 GHz	Max Power
Initial Research Phase	phase I	2021 (5M)	H	-	R&D	USN Carbon	0	0	0	0	1.5MWx5s	1.5MW
		2023 (2M)				LSN Carbon Div. Pumping	3MW	3MW	10MW	23MW x 14s duty = 1/30	1.5MWx100s + 1.5MWx5s	19MW
	phase II	2023-2024 (6M)	D	3.2E19			6.5MW	7MW				26.5MW
		2024-2025										
	phase III	2025-2027								Real Injection : ~ 26MW x 2-3 sec limited by divertor cooling		
Integrated Research Phase	phase I	2029 - 2031	D	4E20		LSN Actively cooled Carbon Div.Pumping	13MW			20MW x 100s 30MW x 60s duty = 1/30	7MW x 100s	37MW
	phase II	2033 -	D	1E21	Use	LSN Actively cooled Tungsten-coated Carbon Div.Pumping						
Extended Research Phase		>5y	D	1.5E21		DN/SN Actively cooled Tungsten-Coated Carbon Advanced Structure	16MW	8MW		34MW x 100s		41MW

Upper Divertor (open divertor, inertia cooling) is always ready

- JT-60SA phases characterized by different boundary conditions
- Experiments during initial phases are limited in plasma duration and power
- End of initial phase I will further contribute to commissioning

Initial research phase



JT-60SA Project Plan @ December 2020

- Initial phase covers a period of ~5 years
- Critical phase which includes both commissioning and experiments
- Experiments must deal with machine and diagnostic limitations and yet provide interesting operational and scientific results
- Key support of modelling for the preparation and interpretation of experiments

Initial research phase

Initial research phase I
(Includes commisioning)

2020-2021

- **Stable operation at high current in large superconducting machine**
  - Current ramp-up scenario development up to full-current operation
  - Plasma shape and equilibrium control avoiding vertical instability
  - Locked mode and kink mode avoidance during current ramp-up
  - EC Wall conditioning

- **ITER risk mitigation for non-activated phase**
  - Basic disruption studies
  - L-H transition studies in hydrogen / helium plasmas
  - Transport during ramp-up with high electron heating in H vs D
  - q profile tailoring with ECRH/ECCD vs NBI

Initial research phase II-III

2023 2024-2026

- **ITER scenario development**
  - NTM real-time control by ECCD
  - High density H-mode operation
  - Dominant electron heating in H-mode plasmas
  - L-H transition, pedestal physics, ELMs

- **Steady-state high beta scenario development**
  - Simultaneous stabilization of RWM and NTM
  - Real-time kinetic profile control development
  - ITB and intrinsic rotation studies
  - No ITB steady-state scenarios at high beta
  - Fast ion modes effects on turbulence and transport
  - Compatibility of small/no ELM and high β

- **ITER risk mitigation**
  - Disruption avoidance
  - Runaway electron study at high current
  - ELM mitigation/suppression
  - SOL width scaling

Initial research phase I-II: topics

- Research plan collaboration in the past years focused mostly on studies for the flat-top of the main scenarios
- Stronger focus on the initial phase I-II would be important:

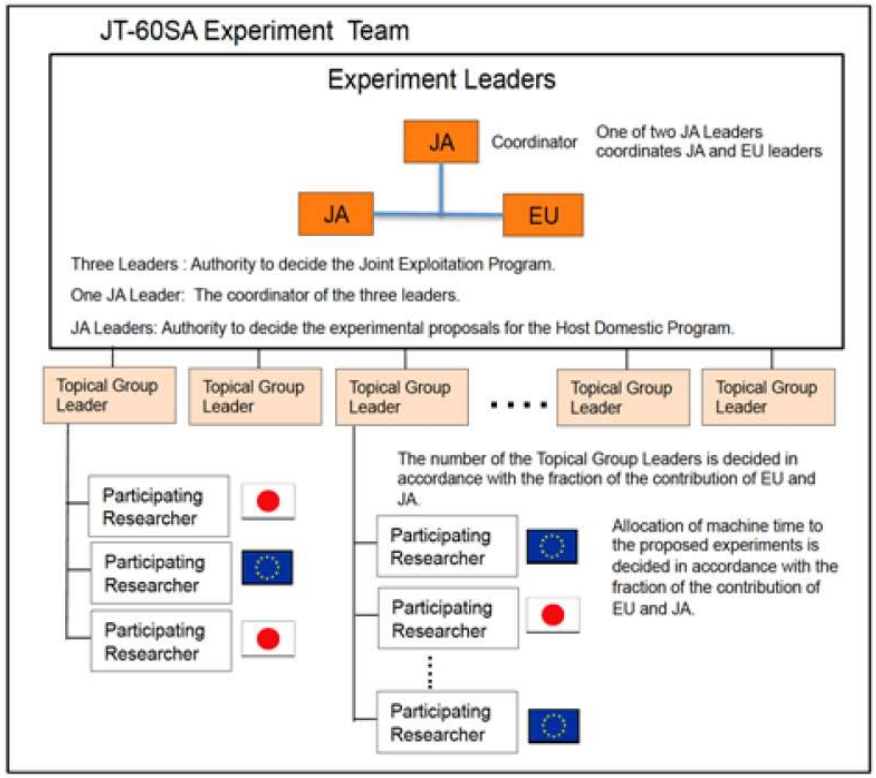
  - Breakdown (EC assisted)
  - Wall conditioning
  - Discharge simulator
  - Plasma vertical stability
  - Ramp-up: q profile evolution with and without current drive → flux pumping?
  - L-mode transport and confinement characterization with electron heating
  - L-H transition studies with different isotopes
  - Initial impurity transport studies
  - Impact of fast ion modes during the ramp-up when including NNBI

Initial research phase I-II: topics

- Research plan collaboration in the past years focused mostly on studies for the flat-top of the main scenarios
- Stronger focus on the initial phase I-II would be important:
  - Breakdown (EC assisted)
  - Wall conditioning
  - Discharge simulator
  - Plasma vertical stability
  - Ramp-up: q profile evolution with and without current drive → flux pumping?
  - L-mode transport and confinement characterization with electron heating
  - L-H transition studies with different isotopes
  - Initial impurity transport studies
  - Impact of fast ion modes during the ramp-up when including NNBI
- Topics with clear on-going activities in the ITPA would be desirable as the they can give stronger impact

Joint JT-60SA Experiment Team

JT-60SA Project leader and EU and JA Project Managers

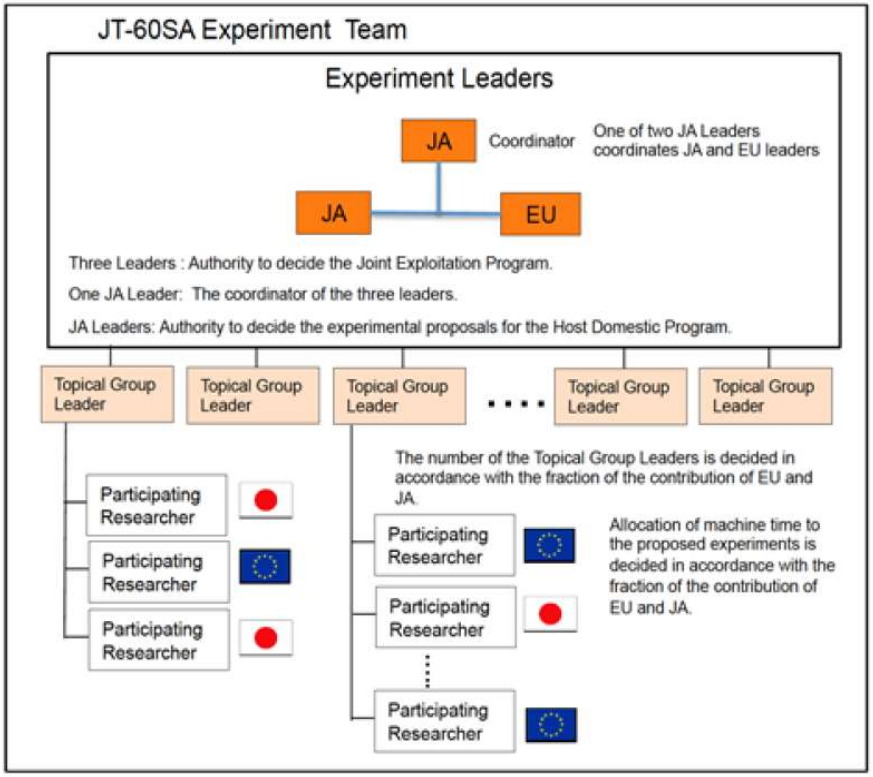


- **The JT-60SA Experiment Team is the unified Experiment Implementation Structure for the JT-60SA experiment**

- Experiment Team Leaders
  - **jointly** select the Topical Group Leaders and organize the work of the Experiment Team;
  - **jointly** develop and implement the Annual Experiment Programme by calling and selecting experimental proposals
  - **jointly** coordinate the experimental campaigns in all its phases (preparation, analysis, publication)
  - **jointly** analyse, document and prioritise proposals for machine enhancements

Joint JT-60SA Experiment Team

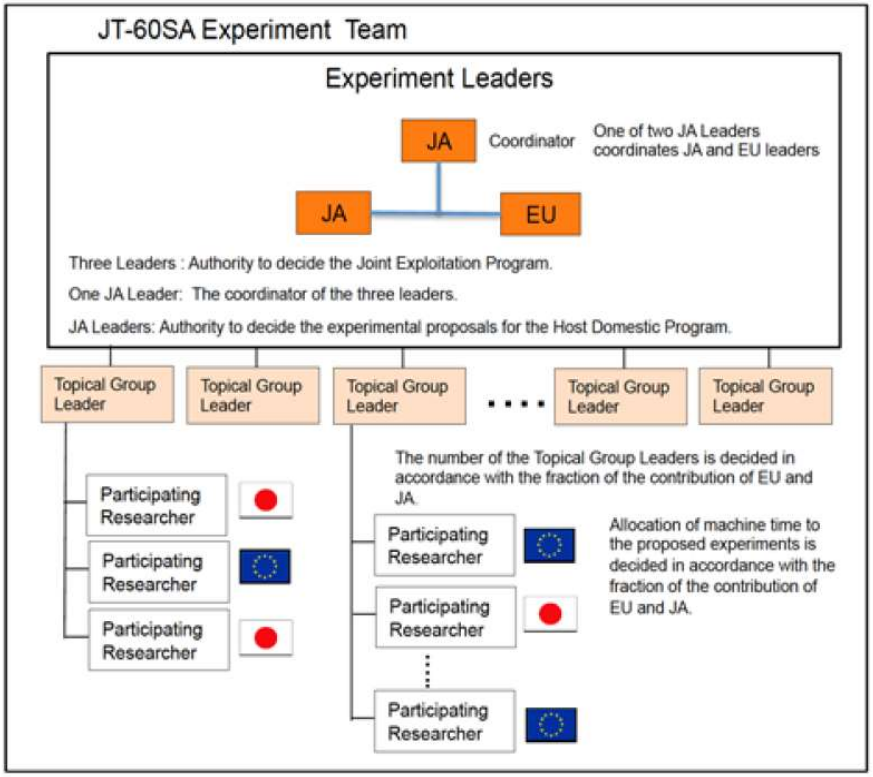
JT-60SA Project leader and EU and JA Project Managers



- Topical Group Leaders (~40% from EU, ~60% from Japan) :
  - coordinate the scientific discussion of experiment proposals and the execution of the experiments assigned to the Topical Group
  - the Experiment Coordinator is assigned by the Topical Group Leader of the topic or by the Experiment Leaders when it is across multiple topics
  - the Topical Leader also summarizes the results and reports to the Experiment Leaders.
- Participating Researchers
  - Experiment proponents or experiment contributors selected within and outside WPSA

Joint JT-60SA Experiment Team

JT-60SA Project leader and EU and JA Project Managers



- The topical groups areas are under discussion
- Need to ensure several aspects:
  - Modelling which covers several topical groups
  - Modelling performed for ITER and DEMO extrapolations
  - Specific work with diagnostics covering several topical groups
- Specific tasks attached to this structure will be added

Creating a team

First RCM: 2011

Latest RCM: 2019

- First duty in the JT-60SA project: create a joint EU-JA experimental team
- In the spirit of the former joint activities in the JT-60SA Research Unit and the research plan definition by the TRO's
- Research Coordination Meeting as an example: from a technical meeting to a broad forum of well known colleagues and new faces

Creating a team

Conclusions

- After many years of construction, JT-60SA is starting the operation!
- Creation of a joint EU-JA experimental team is essential
- Good understanding and communication between all the scientific parties (EUROfusion-QST) is necessary
- Working in isolation from each of the parties will reduce the impact of the scientific activities
- In case help is needed to interact with JA colleagues, do not hesitate to contact me
- The JT-60SA experiment team structure will start after the Integrated commissioning phase finishes
- Focus the activities on the initial research phase from now on is preferable
- Identify where JT-60SA can provide a unique contribution complementing results already obtained from EU or JA tokamak devices
- In Europe, identify how JT-60SA can help DEMO design