

First CRONOS simulation of JT60-SA

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- Input data
- Preliminary results
- Prospects

Input data

JT60-SA reference scenario 2:

Table 2-3: Plasma Parameters for JT-60SA, DEMO (Slim-CS) and ITER

Parameters	JT-60SA					DEMO	ITER		
	#1 Full Ip Inductive DN 41MW	#2 Full Ip Inductive SN 41MW	#3 Full Ip Inductive SN 30MW High density	#4 ITER like Inductive SN 34MW	#5 High βN Full CD SN 37MW	Slim CS	scenario 2, Inductive II	Steady- State (IAEA Lyon)	
Size & Configuration	Plasma current, I_p (MA)	5.5	5.5	5.5	4.6	2.3	16.7	15.0	9.0
	Toroidal magnetic field, B_T (T)	2.25	2.25	2.25	2.28	1.71	6	5.3	5.17
	Major radius, R_p (m)	2.96	2.96	2.96	2.93	2.97	5.5	6.2	6.35
	Minor radius, a (m)	1.18	1.18	1.18	1.14	1.11	2.1	2.0	1.85
	Aspect ratio, A	2.5	2.5	2.5	2.6	2.7	2.6	3.1	3.4
	Elongation, κ_x, κ_{95}	1.95, 1.77	1.87, 1.72	1.86, 1.73	1.81, 1.70	1.92, 1.83	*, 2.0	*, 1.70	*, 1.84
	Triangularity, δ_x, δ_{95}	0.53, 0.42	0.50, 0.40	0.50, 0.40	0.41, 0.33	0.51, 0.41	*, ~0.4	*, 0.33	*, 0.41
	Safety factor, q_{95}	3.2	3	3	3.2	5.7	5.4	3.0	5.13
	Shape Factor ($=q_{95}I_p/aB_T$)	6.7	6.3	6.2	5.7	6.9	7.2	4.3	4.8
Plasma Volume (m ³)	132	131	131	122	124	941	831	793	
Absolute Performance	Fusion output, P_{fus} (MW)	-	-	-	-	-	3000	400	338
	Fusion gain, Q (SA: QDT equivalent)	~0.6	~0.5	~0.4	~0.3	~0.2	52	10	5
	Heating Power (α + external), P_{heat} (MW)	41	41	30	34	37	678	120	136
	Current drive power, P_{CD} (MW)	10	10	10	10	17	59	40	67.7
	Ion Temperature, Vol-ave., Central (keV)	6.3, 13.5	6.3, 13.5	3.7, 7.9	3.7, 8.0	3.3, 6.2	17, 28	8.0, 19	11, 25
	Electron Temp., Vol-ave., Central (keV)	6.3, 13.5	6.3, 13.5	3.7, 9	3.7, 8.0	3.1, 5.9	17, 28	8.8, 23	10.5, 24
	Electron Density, line-average, Vol-ave., Central (E20/m ³)	0.63, 0.56, 0.77	0.63, 0.56, 0.77	1.0, 0.9, 1.2	0.91, 0.9	0.5, 0.5	*, *	*, *	*, *
	Stored Energy (Thermal, Fast ion) (MJ)	22.4, 4.0	22.2, 4.0	21.1, 1.1	21.1, 1.1	21.1, 1.1	*, *	*, *	*, *
	Energy Confinement Time τ_E (s) thermal, total	0.54, 0.64	0.54, 0.64	0.68, 0.7	0.68, 0.7	0.68, 0.7	*, *	*, *	*, *
Normalized Performance	Confinement improvement, HHy2	1.3	1.3	1.1	1.1	1.1	*, *	*, *	*, *
	Normalized beta, β_N	3.1	3.1	2.6	2.6	2.6	*, *	*, *	*, *
	Bootstrap current fraction, f_{BS}	0.29	0.28	0.25	0.25	0.25	*, *	*, *	*, *
	Non inductive CD fraction, f_{CD}	0.51	0.5	0.36	0.36	0.36	*, *	*, *	*, *
	Normalized density, n_e/n_{GW}	0.5	0.5	0.8	0.8	0.8	*, *	*, *	*, *
	Radiation Power Fraction (P_{rad}/P_{heat})	0.8	0.8	0.8	0.8	0.8	*, *	*, *	*, *
Non Dimensional Parameters	Fuel Purity, n_{DT}/n_e	0.8	0.8	0.8	0.8	0.8	*, *	*, *	*, *
	Toroidal beta, β_t (%)	6.5	6.5	5.4	5.4	5.4	*, *	*, *	*, *
	Poloidal beta, β_p	0.85	0.81	0.67	0.67	0.67	*, *	*, *	*, *
	Fast ion beta, β_{fast} (%)	0.98	0.98	0.31	0.31	0.31	*, *	*, *	*, *
	Normalized Gyro radius, ρ^* (poloidal)	0.020	0.019	0.015	0.018	0.035	0.013	0.009	0.018
Normalized Collisionality, ν^*	0.014	0.014	0.063	0.059	0.051	0.008	0.034	0.019	

JT60-SA scenario 2:

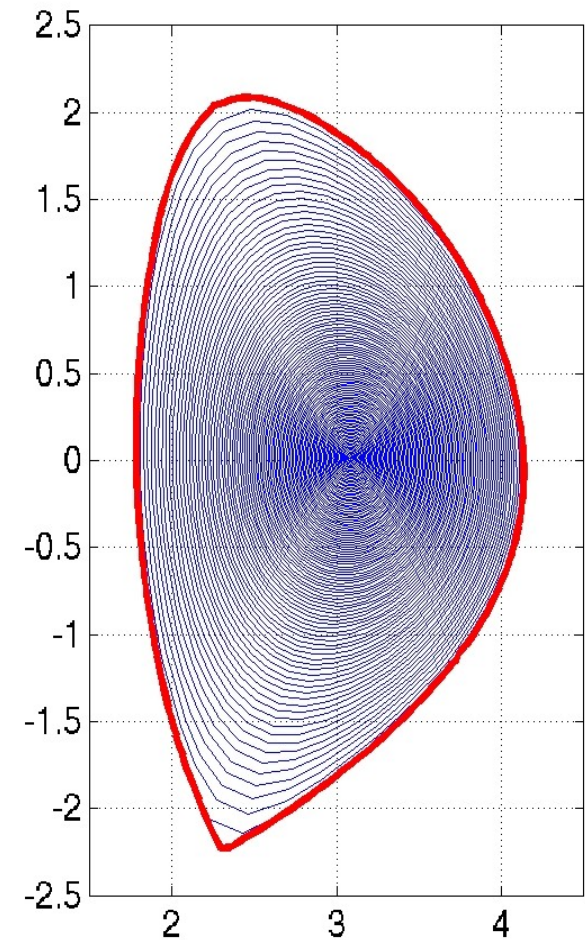
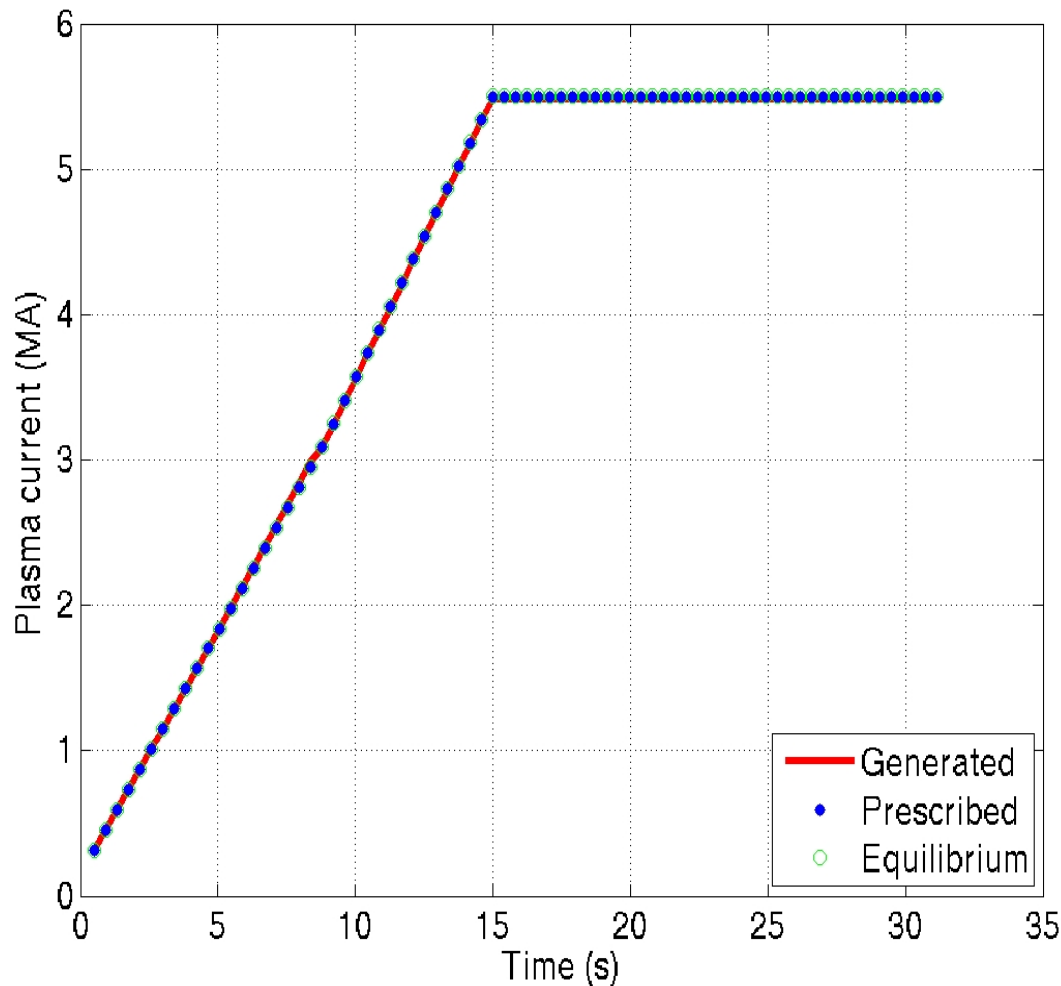
- $I_p = 5.5$ MA
- $B_T = 2.25$ T

Details of the simulation

- First simulation carried out using the METIS 0D simulation tool.
- Implementation of the official separatrix geometry for scenario 2.
- Creation of a CRONOS simulation file.
- Switch-off all external heating \Rightarrow ohmic simulation, as a start.

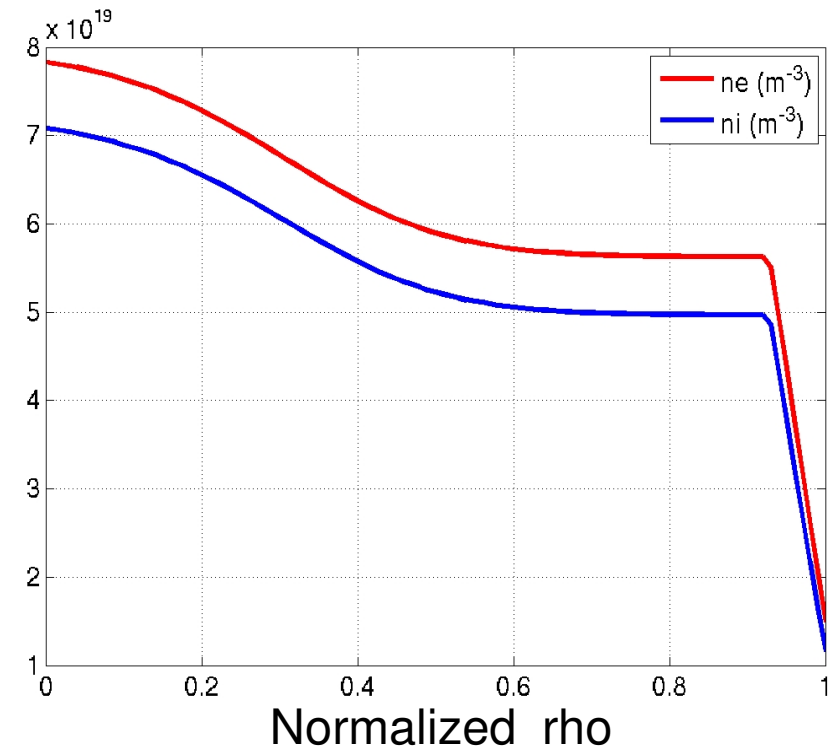
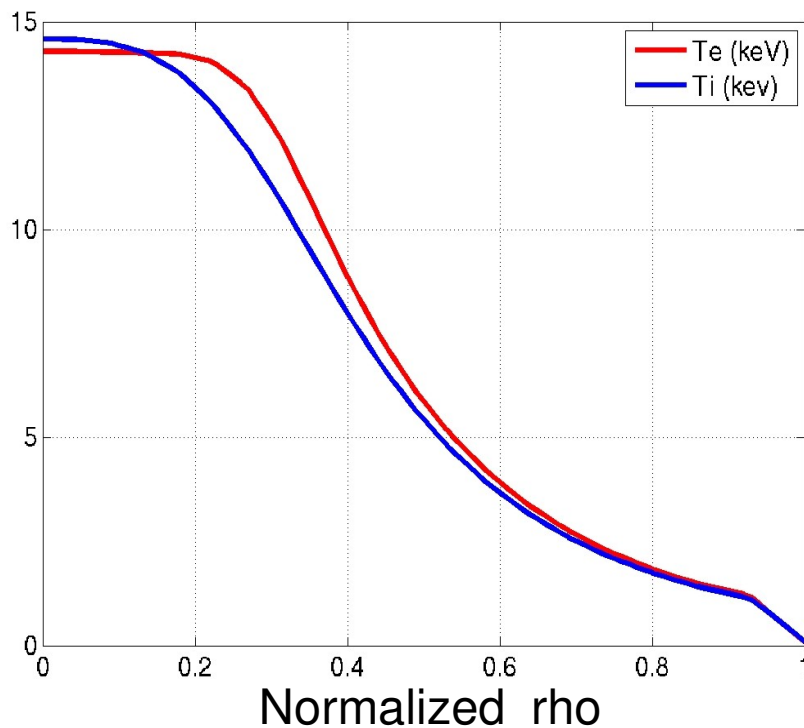
CRONOS preliminary results (1)

Plasma current ramp-up and equilibrium:



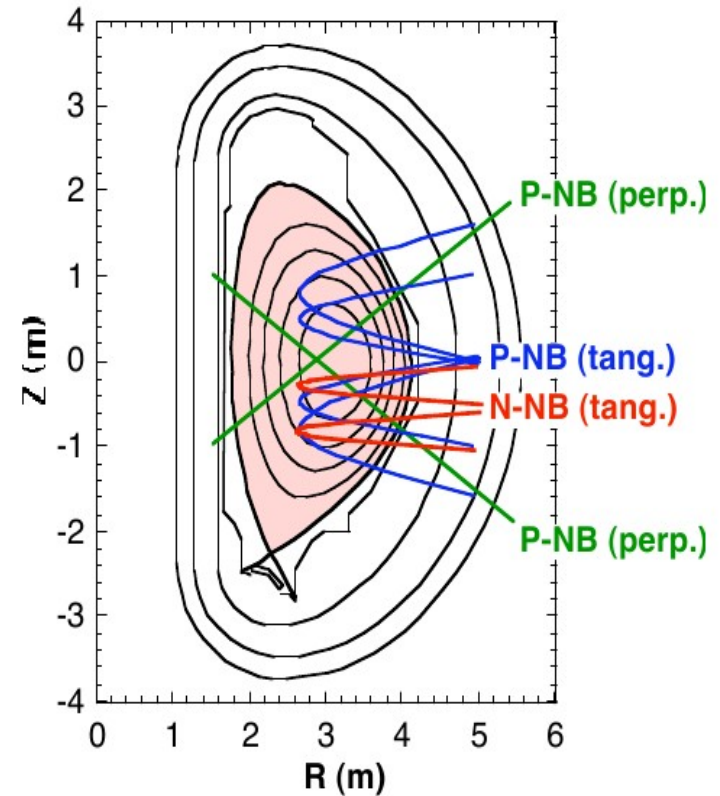
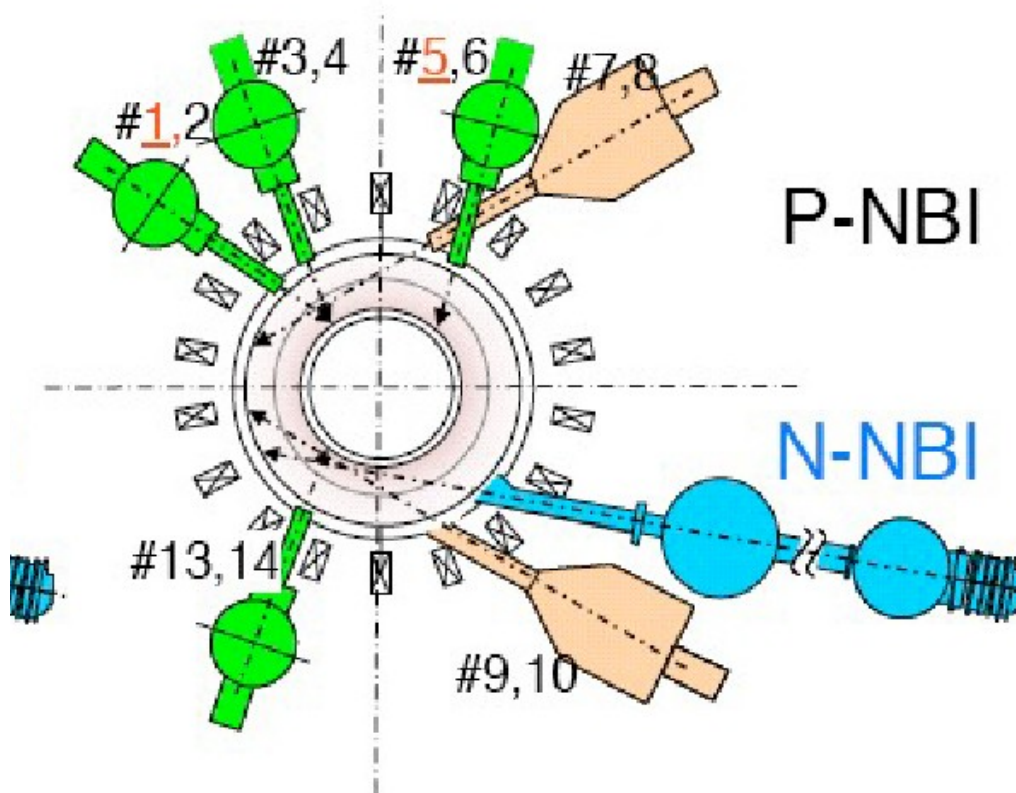
CRONOS preliminary results (1)

Temperature and density profiles on the steady state:



Prospects

Implementation of JT60-SA NBI geometry:



stems in JT-60U and JT-60SA