RFP Key Parameters

Parameter	Present value MST/RFX-mod[a]	ITER-era goal[b]	Reactor Target[c]
Field at magnetic axis (T)	0.6 / 1.8	2.5	9-14
Average field at plasma surface (T)	0.21 / 0.65	1	4-6
Maximum field at a coil (T)	$\le$ 0.21 / 0.65	< 1	~(a/r_{coil}) 4-6
Plasma current (MA)	0.5 / 1.5	4	26-18
Pulse length Δt (sec) and $\Delta t/\tau_E$	0.1&10/0.5&250	5 & 17	>>1
External sustainment/current drive type	Induction	Induction	Induction
Ext. sustainment/current drive power (MW)	2-4 / 12	9	15-30[d]
Current drive efficiency (A/W, Spitzer)	0.2 / 0.13	0.4	1.7-0.6
Major radius, R_0 (m)	1.5 / 2.0	2.4	4.9-3.9
Minor Radius, a (m)	0.51 / 0.46	0.8	1.4-0.6
Elongation, κ	1	1 (optimum?)[e]	1 (optimum?)[e]
Average electron density, $\langle n_e \rangle$ (10^{20} m^{-3})	0.1-0.3 / 0.3	0.4	~3-9
Peak electron T_e (keV)	2-0.7 / 0.9	5	$\langle T_e \rangle \sim 10$
Peak ion T_i (keV)	1.3-0.6 / 0.6[f]	5	$T_i \approx T_e$
Average plasma pressure (MPa)	2.1-3.4$\times 10^{-3}$/n.a.	0.1	1.5-4
Average beta, $2\mu_0<p>/<B_t^2+B_p^2>$ (%)	5-8 (12[g]) / n.a.	10	10.5
Energy confinement time (s)	12×10^{-3} / 3×10^{-3}	0.3	1.1-0.2
Fusion power density (MW/m^3)	< 10^{-6}	< 3×10^{-3}	12-83
Core electron transport[h] (χ_e m^2/s)	~ 5 / ~ 18	0.5	0.3
Core ion transport[h] (χ_i m^2/s)	~ 5 / ~ 18	0.5	χ_e /4
$B(a)\tau_E$ (T-s)	2.5×10^{-3}/2.0×10^{-3}	0.3	1.2-1.8
$\rho^* = \rho_D /a$	20×10^{-3} / 6×10^{-3}	7×10^{-3}	2-3 $\times 10^{-3}$
$S_\alpha = a / \rho_\alpha$	1.1 / 3.1	7.3	35-23
Normalized collisionality, $\nu_i^* \sim \nu_{ii} 2\pi a/v_{th}$	4.4×10^{-3}/17×10^{-3}	0.6×10^{-3}	2-3 $\times 10^{-3}$
Normalized pulse length[i] ($\tau/\tau_{L/R}$)	0.1 / <1	0.3	>>1
Normalized pulse length ($\tau/\tau_{Ti=Te}$)	0.5-5 / 5	16	>>1
Estimated Fusion Power (MW)	~ 10^{-6}	< 0.1	2300
Estimated neutron wall loading (MW/m^2)	Negligible	< 1×10^{-3}	6-18
Average heat load on wall (MW/m^2)	0.1 / 0.3	0.1	4.5-7.5[j]

Notes:

a. Present value data are for the best performing plasmas from MST and RFX-Mod (Italy) near their respective maximum toroidal plasma currents. Where a range of numbers is quoted for MST, this refers to lower-density and higher-density (with pellet injection) results.

b. The numbers in the ITER-era column represent only one possible set of fusion parameter goals. The numbers (e.g., current drive power, electron temperature, and energy confinement time) are roughly consistent with one another.

c. Two reactor parameter sets are provided. The second numbers in the listed ranges are the assumed parameters for the TITAN study. The first numbers in the ranges are for reduced wall load at lower aspect ratio, derived by scaling the TITAN parameters at fixed beta, temperature, and fusion power generation. These are not optimized; rather they illustrate the changes for a larger plasma with reduced wall load.

d. The values listed are for the sustained burn period. The ohmic dissipation is expected to be substantially larger during startup while T_e is lower, e.g., $(4\ \text{keV}/10\ \text{keV})^{-1.5}=4$.

e. An optimum RFP cross sectional shape has not been identified, theoretically or experimentally.

f. RFX-Mod central ion temperature is an estimate. This applies to all subsequent RFX-Mod parameters that depend on T_i.

g. Maximum 12% average beta is achieved in MST at lower $I_p \approx 0.2$ MA.

h. The values listed are $a^2/4\tau_E$. Ion confinement is not yet well determined due anomalous heating effects. For best performance plasmas in MST, global energy confinement for ions appears to be at least as good as for electrons.

i. The current relaxation time is order the toroidal current L/R time ~ $\tau_R/10$, where $\tau_R=\mu_0 a^2/\langle\eta\rangle$.

j. The TITAN study employed a toroidal divertor for particle control, but only a very small fraction of the heat was collected at the divertor. Most of the thermal power was radiated uniformly over the entire first wall surface, by doping the plasma with heavy noble gas. About 70% of the radiated power was assumed from the core plasma. The average heat load at the first wall was 4.6 MW/m^2, and the peak value in the divertor was 7.5 MW/m^2. The P_{wn}=6 MW/m^2 case would presumably have 1/3 lower heat loads, but the larger issue is that boundary control in the RFP is not well developed.