Engineering and Physics Assessments of Spherical Torus Component Test Facility

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The results of a broadly based study of the engineering and physics characteristics of the Component Test Facility (CTF) [1] using the Spherical Torus or Spherical Tokamak (ST) configuration [2] are presented. The required testing capabilities [3] of the CTF of high fusion neutron fluxes W_L of > 1 MW/m^2, large total testing area of > 10 m^2, and intense testing fluence of > 0.3 MW-yr/m^2 per year are found to set lower bounds on the CTF size (see Figure). Testing of tritium self-sufficiency further pushes the aspect ratio toward 1.4. A typical CTF design is characterized by R = 1.2 m, A = 1.5, elongation = 3, I_p = 10 MA, B_T = 2.5 T, producing a fusion power of 77 MW and W_L of 1 MW/m^2, assuming moderate normalized ST plasma parameters achievable [4] without active feedback control of MHD modes, while using P_{NBI} = 24 MW at E_{NBI} = 120 kV. Assumption of the advanced physics regime with MHD mode stabilization, while using P_{NBI} = 24 MW at E_{NBI} = 330 kV, would enable W_L = 4 MW/m^2 for testing at the level of demonstration power plants. The ST CTF device requires the use of a single-turn normal conducting center leg for the toroidal field coil without the induction solenoid and substantial neutron shielding. A solenoid-free current start-up RF power of 5 – 10 MW, and a ramp-up and sustainment RF and NBI power of 40 MW are estimated, based on latest data. A new systems code that combines the key physics and engineering requirements, limits, and performance of CTF are prepared and utilized as part of this study. The results show a high potential for a family of CTF devices to suit a variety of fusion nuclear testing and R&D missions. *Support by DOE Contract Nos. DE-AC02-76CH03073 & DE-AC05-96OR22464.

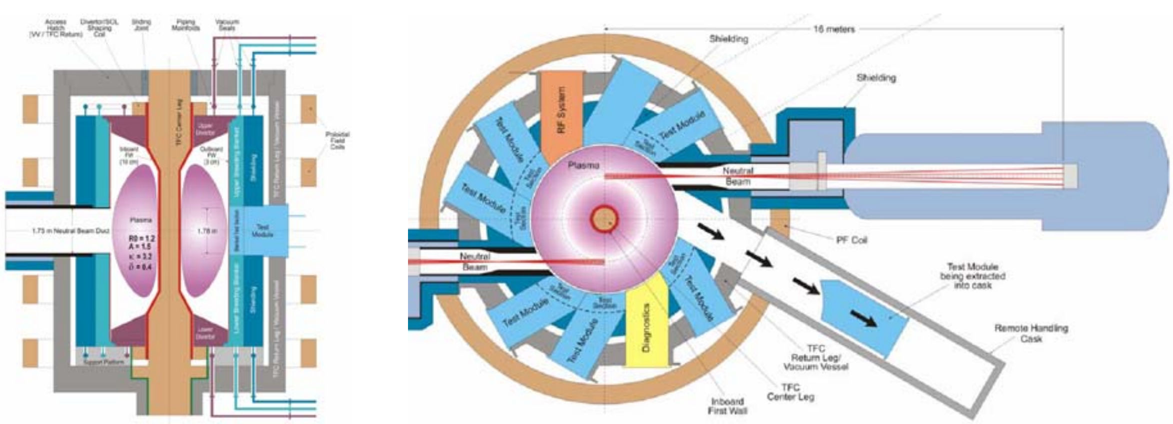

Figure. Elevation and mid-plane views of CTF showing the possible design features dictated by CTF mission.

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