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Physics Design Bases of a Spherical Torus with a Plasma Center Column XIANZHU TANG, LANL, ALLEN BOOZER, DAVID LAZANJA, Columbia, SCOTT HSU, LANL — Low aspect ratio toroidal pinches such as the standard ($q > 1$) and the ultra-low-q ($q < 1$) Spherical Tori or Tokamaks (ST), would have a far more robust reactor engineering design if a plasma center column (PCC) can be used in place of a material center post. Biased electrodes across the plasma center column would drive a plasma current to produce the toroidal magnetic field in lieu of the TF coils. Two ongoing efforts are the proto-sphera experiment in Europe and the proposed ST-PCC concept exploration experiment at LANL (see accompanying poster by S. Hsu, et al). The operation of such reactors is naturally divided into two distinct phases: formation by driven-relaxation (helicity injection) and sustainment by auxiliary current drive and heating such as rf and NBI. The design constraints of the ST-PCC are primarily motivated by the formation rather than the sustainment physics. With a Taylor-relaxed plasma as the baseline case, we illustrate both analytically and numerically the three essential factors in guiding the design. First, the flux amplification factor determines the aspect ratio of the ST-PCC. Second, the plasma elongation gives the most freedom in shaping the q profile. Two examples are the standard spherical Tokamak with q>1 throughout the plasma and the ultra-low-q Tokamak with q much less than unity for bulk of the plasma. Third, the vacuum bias magnetic flux plays the second most important role in modifying the q profile.

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