

## Ideal MHD Stability Diagram of Simply Connected Magnetic Configurations with Unitary Beta

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A simply connected magnetic confinement scheme (CKF configurations) can be obtained superposing two axisymmetric homogeneous force-free fields, each with  $\vec{\nabla} \wedge \vec{B} = \mu \vec{B}$ , both having the same value of the relaxation parameter  $\mu = \mu_0 \vec{J} \cdot \vec{B} / B^2$ : the Chandrasekhar-Kendall field of order-1 and the Furth square-toroid field. A variety of unrelaxed ( $\vec{\nabla} \mu \neq 0, \vec{\nabla} p \neq 0$ ) equilibria, similar in shape and topology to the CKF configurations, can be calculated.

Both relaxed and unrelaxed CKF configurations contain a magnetic separatrix and are composed by a "main spherical torus" ST carrying a toroidal current  $I_{ST}$ , two "secondary tori" SC on top and bottom and a "spheromak" discharge P surrounding the three tori, carrying a poloidal current  $I_e$ .

An investigation of the ideal MHD stability has been performed, keeping fixed the total current of the configuration and the shape of the external plasma boundary. Assuming that  $\vec{\nabla} \mu$  and  $\vec{\nabla} p$  are concentrated in the same radial region, the jump of the surface averaged relaxation parameter  $\langle \mu \rangle$  between the edge and the magnetic axis of the configuration controls the ratio  $I_{ST}/I_e$  (roughly proportional to the ST safety factor at the edge  $q_{95}^{ST}$ ), and the radial extension of  $\vec{\nabla} \mu$  and  $\vec{\nabla} p$  controls the safety factor at the ST magnetic axis  $q_0^{ST}$ . It has been found (see Fig. 1) that a wide region exists in the diagram  $q_0^{ST} - q_{95}^{ST}$  in which the unrelaxed CKF configuration are ideally stable with respect to the low-n MHD modes even with an unitary beta in the spherical torus ( $\beta_{ST}=1$ ) and without conducting walls surrounding the plasma (free boundary).

At present there is not yet a clear idea about the methods for injecting the  $I_e$  current, therefore in a preliminary experiment the surrounding discharge will be partially replaced by a force-free screw pinch, fed by electrodes (PROTO-SPHERA).

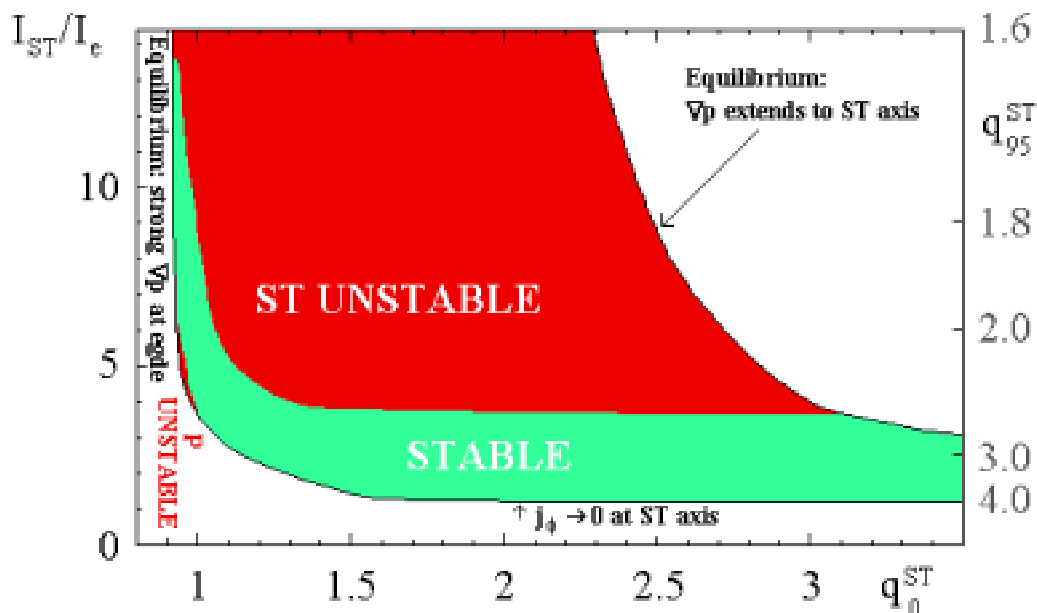


Fig. 1 Stability diagram of an unrelaxed CKF configuration with  $\beta_{ST}=1$ .