

First results and perspectives of the PROTO-SPHERA experiment

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PROTO-SPHERA aims at replacing the metal centerpost of a Spherical Tokamak (ST) with a plasma centerpost (SP), fed by an annular electrodes. It is therefore necessary to: build up the combined ST+SP configuration (calculated stable in ideal MHD) by destabilizing the plasma centerpost (its current I_e will be raised from 8.5kA to 60kA in 1ms) and "tunneling" through a non-linear unstable kink phase; compress the ST to the lowest possible aspect ratio $A=R/a$ at an elongation $\kappa>2$ by a fast rise (1ms) of the current in the PF compression coils, producing then a Flux Core Spherical Tokamak, rather than a Flux Core Spheromak as in the precursor experiment TS-3; sustain the configuration by Helicity Injection from the SP to the ST (ST current $I_p\leq 240\text{kA}$) for at least one resistive time ($\sim 70\text{ms}$); compare the ST performances with the ones of a conventional Spherical Tokamak of similar size (e.g. START). The first phase of PROTO-SPHERA produces the centerpost plasma only: the maximum current achieved up to now is 3.4kA (8.5kA are due). The current is limited by spurious plasma discharges near the Vacuum Vessel: to cure that problem 4 PF coils external to the VV have been added and 2 Polycarbonate insulating flanges (containing the electrodes feed-throughs) are being built. The first results have already removed the major concern that the plasma centerpost could attach itself on a restricted portion of the annular anode. The $\mathbf{E}$ field due to the PF coil casing polarizations inside the machine produces an $\mathbf{E}\wedge\mathbf{B}$ drift that distributes the plasma smoothly upon the annular anode. To complete PROTO-SPHERA we have to built: 1) an extension from 54 to 324 of the cathode filaments in order to allow them to emit $I_e=60\text{kA}$; 2) the fast current rise PF compression coils and their power supply; 3) the upgrading of the plasma centerpost power supply for a fast raise of the current to $I_e=60\text{kA}$. Supercapacitors allow to design in a robust and simple way the last two demanding power supplies.