Equilibrium and dynamo interplay in ProtoSphera and implications for diagnostics.

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ProtoSphera is a unique plasma configuration consisting of two distinct domains: a plasma column surrounded by a low-aspect ratio torus. The plasma column is a screw pinch formed by a DC discharge (~70 KA) between two ring shaped electrodes; the column shape is reminiscent of a double hourglass, resulting in a central expanded region, where an annular current structure (torus) is allowed to develop as a result of magnetic relaxation. Unlike other self-organized configurations, ProtoSphera lacks a flux conserver and is stabilized thanks to the presence of the central pinch. The torus current is likely sustained through a dynamo mechanism and in particular through an outward helicity flux; helicity conservation typical of Taylor states is expected to hold in weaker form in absence of flux conserver.

The configuration topology and the foreseen equilibria will be discussed addressing in particular the time and spatial scales of dynamo mechanisms and helicity transport. In particular, time dynamics and space scale of MHD activity at the column-torus interface are critical to discriminate between discrete and quasi-stationary contributions for current drive in the torus, where discrete events are more detrimental in term of topology disruption and decrease in overall confinement. Besides, characterization of plasma temperature, density and transport is crucial to identify kinetic contributions to the dynamo field, as a results of particle diffusion or differential trapping.

The onset and permanence of a closed-surface magnetic domain is consistently found in fast camera data, in images as well as in tomographic reconstructions. On the other hand magnetic arrays and optical diagnostics are needed to fully characterize ProtoSphera dynamics and are still under finalization; notably, quantitative data are lacking on current distributions, density and temperature gradients, spectra of MHD perturbations.

Diagnostic design criteria adopted to maximize the achievable information, in particular to discriminate different dynamo mechanisms, are discussed in view of the foreseen step-up in the experiment performances.