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DIVERTOR HEAT LOAD STUDIES FOR COMPACT STELLARATOR REACTORS*

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The ARIES-CS Advanced Design is a multi-year project to assess the potential of the compact stellarator (CS) concept as a fusion power plant. The present focus is to determine the optimum plasma configuration that meets the physics performance goals and the engineering requirements for an attractive reactor. One of the critical issues is the thermal plasma and alpha-particle heat fluxes that need to be handled by strategically located divertor plates under a set of engineering constraints, most notably a peak heat load of not more than 10 MW/m^2. In this paper, we report initial results of an extensive study of divertor location and size, and the heat load distribution on the target plates for a CS configuration based on NCSX with 3 field periods, 18 modular coils, and a major radius of 8 m. We start with exploring the magnetic field structure outside the last closed magnetic surface (LCMS) using the MFBE code that takes into account the plasma finite beta. Field line tracing is then performed with the GOURDON code to map out the particle trajectories from the LCMS to the divertor plates. The locations of the target plates and baffles are specified in the GEOM code that interfaces with GOURDON. To facilitate assessment of the heat load, both cross-field diffusion along field lines based on measured thermal diffusivity κ_e, and calculation of the inclination of the field lines to the divertor plates are implemented. The alpha heat loss is treated in a different fashion. Presently, we make use of the ORBIT3D code to follow the alpha particles born inside the plasma to their loss past the LCMS. Using these exit points as a start, depending on the particle energy, we either trace field lines or solve for their finite gyro-orbits until they intercept the divertor plates or the first wall. Our initial results indicate the existence of 3/5 magnetic island structures outside the LCMS and the possibility of the application of island divertors. Preliminary plots of field-line footprints on a conformal first wall 10 cm from the LCMS have been obtained. We will report on our initial efforts to characterize the location and geometry of the divertor plates and the corresponding heat loads.

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