CFDWARP — a CFD Code for Plasma & Reactive Flow

THE OBJECTIVES OF OUR RESEARCH are pursued by numerical simulation using the Weakly-ionized Airflow Resolver and Post-processor (CFDWARP) code. Totaling more than 100,000 lines of code, the CFDWARP code is a in-house-developed code for general compressible, turbulent, reacting, and weakly-ionized non-equilibrium flows. It is specifically tailored to solve plasma aerodynamics flowfields where the charged species transport equations and the electromagnetic fields must be solved in coupled form along with the neutrals transport equations. CFDWARP includes a number of unique features that set it apart from other CFD codes used to solve plasma flows, including a plasma model that is 100-1000 times more efficient than alternatives [1], positivity-preserving Roe fluxes [1], convergence acceleration through domain decomposition [1], as well as multidimensional Roe fluxes derived from a modified Cauchy-Kowalevski procedure.

The gains in computational efficiency originating from our in-house-developed plasma model permit CFDWARP to integrate *in coupled form with aerodynamic-scale integration steplengths* the electron and ion transport equations (the "plasma equations") with the equations describing the motion of the neutrals (the "aerodynamics equations"). CFDWARP is the first — and currently only — code with such capability. Because of this unique capability, CFDWARP is capable to yield detailed numerical results of plasma aerodynamics that have so far been out of reach. Such is expected to result in a significant improvement of our understanding of the physics within plasma aerodynamics or plasma-assisted combustion, hence leading to improved designs of DBD plasma actuators and MHD generators.