3D MODELING OF LIQUID JETS, USED IN HEAVY ION FUSION FOR BEAM LINE PROTECTION*

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Current designs for thick liquid protection of heavy ion inertial fusion reactors utilize banks of liquid jets to protect sensitive beam line components from neutrons and debris following target explosions. IFE designers must have knowledge of the surface quality of these jets in order to determine the distance between the jets and the ion beams that must propagate through the void spaces between them. Here numerical simulations of such jet flows performed with the customized Flow3D solver are reported. 3-D unsteady flow simulations are qualitatively verified by comparison to several jet flow experiments. These numerical simulations predicted no significant jet breakup in region of interest, but did show surface and shape deformation that may end up determining the minimum standoff distance between jets and driver beams. The simulations also show small droplet ejection that may adversely affect beam propagation characteristics. The intrusion distance of liquid into the beamlines was determined to be below 10% of the original jet thickness throughout computational domain (up to 1 meter downstream from the nozzle). A discussion of the relative effect of turbulence level and direction, and velocity profile is given. Recommendations on how to avoid or minimize unwanted hydrodynamic phenomena (surface rippling and droplet ejection) by upstream conditioning and nozzle design are developed for free surface jets in vacuum in the context of qualitative understanding of the physical mechanisms at play.

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