THE COMPACT, MULTIPLE BARREL HIGH SPEED PELLET INJECTOR FOR THE IGNITOR EXPERIMENT

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A four barrel, double stage pellet injector for the Ignitor experiment is under construction in collaboration between the ENEA Laboratory at Frascati and Oak Ridge National Laboratory. The goal is to reach pellet velocities of about 4 km/s, capable of penetrating near the center of the plasma column when injected from the low field side. Ignitor is a compact, high magnetic field device (R_0 = 1.32 m, B_T = 13 T) designed to attain ignition in high density, relatively low temperature plasmas ($n_e \cong n_i \cong 10^{21}$ m^{-3}, $T_e \cong T_i \cong$ 11 keV). The pellet injector is included in the machine design to control the density profile, especially during the crucial phase of the initial current ramp. It is also envisaged as a possible method to fuel the discharge or to provide fast burn control during the ignited phase.

The innovative concepts at the basis of the pellet injector design are the proper shaping of the propulsion gas pressure front and the use of fast valves to considerably reduce the requirements on the expansion volumes necessary to prevent the propulsion gas to reach the plasma chamber. The full four barrels, double stage gun and the gas removal system, with associated controls and diagnostics, have been built and are being tested at CRIOTEC. The propelling system includes four independent relief valves, capable of suitably shaping the rising edge of the pressure pulse to improve pellet acceleration. The shaping valve has been characterized, while the optimization of the gas removal system is under way. The four fast valves (40 mm diameter), located at the end of each guiding tube, have transition (closing) times of about 14 msec and jitters of 1 msec.

ORNL is responsible for the design, construction, and testing of the pellet injector vacuum chamber, the cryogenic systems, the gun barrels, and pellet diagnostics (including light gates/photography stations, microwave cavity mass detector, and a target plate). The new design facilitates change-out of barrels and can accommodate lengths in the range of 0.7 to 1.1 m. In initial testing at ORNL, four barrels with diameters in the range of 1.8 to 4.4 mm will be extensively tested with ORNL single-stage propellant valves and D2 pellets at speeds of ~1 km/s. In the second phase, the ENEA two-stage drivers and support systems will replace the ORNL propellant valves, and integrated testing at high pellet speeds (>3 km/s) will be carried out with a wide range of operating parameters explored.