

Developments and radiation mitigation studies for the Laser Mégajoule (LMJ) facility instrumentation

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The future LMJ – Laser Mégajoule now under construction in France, is designed to demonstrate ignition and even gain of a DT fusion target. This facility will focus near 2010 up to 1.8 MJ UV laser light energy into a volume of less than 1 cm³ in a few nanoseconds. A successful DT target will produce 10x the initial laser energy by thermonuclear fusion reactions. The high-energy 14 MeV DT neutrons emitted (up to 10¹⁹) will interact with all the facility hardware surrounding the target creating secondary energetic gamma rays. In a few hundreds of nanoseconds the entire facility experimental hall is filled with a mixture of nuclear radiations (DT and downscattered neutrons, gamma rays). Any instrumentation needed to operate or diagnose the target must be set inside the target chamber hall within the biological shield (30 m in diameter) and will be submitted to a moderate dose (up to 10 krad) but in a very fast duration (300 ns) leading to a very high dose rate (up to 10¹² rad(Si)/s). The design of this future instrumentation (plasma and laser diagnostics, facility control-command, cables, fiber-optics, ...) must take into account the large increase of the generated nuclear radiation field compared to present laser facilities (Omega, LIL, NEL). To ensure instrumentation survival, many new studies must be conducted to verify their performances under the new harsh environmental conditions. Simulations and experiments conducted at CEA/DAM since 1999 on the vulnerability of electronic and optoelectronic devices will be presented. Recent results obtained at Omega, the laser facility of the University of Rochester (USA), for radiation effects on CCD readout, streak tubes, fiber optics and coaxial cables, will be useful for the design of the instrumentation of the future LMJ. In addition some new mitigation strategies especially developed to overcome these environmental difficulties for instrumentation design (grounding, shielding, high bandwidth signal transmission, remote imaging devices, new detector studies, ...) will be briefly presented. Synergies with magnetic fusion instrumentation design studies for the next ITER facility are presently considered (common studies on fiber optics vulnerability) and will need to be enhanced.