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IFE/1-5: Approach to Power Plant Physics and Technology in Laser Fusion Energy Systems under Repetitive Operation

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Different proposals of Laser Fusion Energy have been envisioned in the last years. Those concepts cover Engineering Facility at large scale in Energy, to Power Prototyping and final DEMO Reactors. HiPER (Europe), extended two years as ESFRI Project, LIFE in USA and LIF_T in Japan, and other initiatives, are entering a new phase where is critical the integration of systems (lasers, target manufacturing and injection, chamber and blanket, tritium handling and Power cycles). The decision to start studies for a Engineering Burst (in HiPER) facility with a repetitive laser operation, with realistic burst mode of hundreds to thousands of shots at 5-10 Hz rate, and small gain under continuous (24/7) repetition (Prototype) or final high gain Demo Reactor will be of critical importance. It is very important to consider this difference between Prototype and Demo, because the different target energy gains could have consequences in the first wall and optics. The Engineering Test Bed results will be able to demonstrate with the lowest risk, repetitive laser-injection systems in an already defined model of Chamber. Assuming those conditions, it could be possible to accommodate Experiments in Technology relevant for Prototype and Reactor. This paper shows the differences in designing the chamber for single shot operation (NIF or LMJ Ignition/Gain machines), or repetitive systems, from Laser requirements to Chamber area, activation and damage in optics, wall and structural materials and also dose assessment. A summary of the differences in new designs from Engineering, Prototyping and Demonstration approaches will be the key goal. This paper will presents integration of the various systems needed for an early demonstration of laser-driven power production, including the requirements of tritium and neutron breeding, use of existing reactor-capable materials and considerations of plant safety. Our approach uses two levels: research in each one of the key questions from fundamental to applied physics and technology; and integration of our available answers into a Power Plant System for defining progressive designs from burnup: to thermo-mechanical responses of materials; fluidynamics; tritium generation and cycle; accident analysis after evaluation of activation and radionuclide concentrations, safety and radioprotection.

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