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Why we need Integral Concepts to reach the challenges in physics of IFE Reaction Chamber

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Some years ago concepts such as European HiPER gave an opportunity to study in common the physics of the many components for an efficient IFE Reactor. The integral scheme then proposed allows understanding the interconnection among the different components when approaching a realistic design. A common vision for nuclear fusion in general.

The work presented here will remark new research in recent times to get solutions to the plasma facing components (PFC), neutronics assessment, tritium breeding, corrosion, and advanced materials, all of them linked in their responses. In addition, it will include some spin-off from the plasma physics of High Energy Density.

The conditions expected in the PFC materials depend on design and new advanced ones are being designed, manufactured and irradiated based in nanostructures. We have implemented in our laboratory in collaboration with Nano4Energy ® and CIEMAT a set up to cover by sputtering the inner wall of pipes using SiC, and we have optimized the procedure to obtain coating well adhered to the ODS steel (Eurofer). Corrosion and adhesion test are now underway [ref1].

We have proposed [ref2] a novel approach to dynamically manage the efficient tritium breeding ratio (TBR) based on a ceramic breeder (Li2TiO3) with a Be multiplier and a neutron reflector consisting in a water tank (or heavy water) which is responsible through a simple system or filling/emptying such tank to tune the TBR.

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The irradiation of spherical gold nanoparticles with nanosecond laser pulses induces shape transformations yielding nanocrystals with an inner cavity. The concentration of the stabilizing surfactant, the use of moderate pulse fluences, and the size of the irradiated particles determine the efficiency of the process and the size of the void. Hollow nanocrystals are obtained when molecules from the surrounding medium (e.g., water and organic matter derived from the surfactant) are trapped during laser pulse irradiation. These experimental observations can have very interesting prospects for the development of hollow plasmonic nanoparticles with potential applications in materials [ref3].

A large effort is developed in the assessment and qualification of a sophisticated modelling system for neutronic calculations and the associated responses, which is actually applied successfully to ITER, IFMIF-DONES and DEMO facilities [ref4,ref5]. This is a goal to be applied also to next concepts in Inertial Fusion Energy.

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Suites of codes have developed to model multiphysics experiments related to such fields as laboratory astrophysics and plasma based soft X-ray lasers among others. The hydrodynamic behaviour of laser created plasmas for these purposes is modelled using ARWEN code. The amplification of XUV radiation through plasmas is modelled using our codes 1D-DeepOne and 3D Dagon that solve the Maxwell-Bloch equations in time domain, obtaining the resulting wavefront and temporal structure of the amplified radiation. Finally, EMcLAW is a 3D Maxwell solver with adaptive mesh refinement, which is perfectly suited to model the propagation of short pulses through long distances.

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