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CURRENT SITUATION AND FUTURE PROSPECTIVES OF THE EUROPEAN IFE PROGRAM, TECHNOLOGY DEVELOPMENT, SCIENCE AND RELATED APPLICATIONS

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Abstract. Inertial Fusion Energy production using lasers represents a key approach to nuclear fusion energy on earth. The concept of laser-driven Inertial Confinement thermonuclear Fusion (ICF) was proposed in 1972 in seminal papers by American and Russian scientists (Basov 1972, Nuckolls 1972), which initiated a worldwide effort to demonstrate inertial fusion in the laboratory. After five decades of continuous progress toward ignition. From December 2022 at the Lawrence Livermore Laboratory the laser-driven inertial fusion principle has been demonstrated several times reaching ignition and burn, with a net Energy Gain (Fusion energy Versus Laser energy) up to 3. The recent results in the US (Kritcher and Ralph 2022, Shawareb 2022, Zylstra et al. 2022, Wilson 2022) have shown clearly that laser-fusion ignition is indeed possible, predictable, and repeatable. Such breakthrough has pushed forward the interest in Laser fusion of many countries, Universities, Research Centres and private companies. The approach pursued by the Livermore scientists is based on the "Indirect drive" scheme where the incoming laser radiation is first converted in soft X-rays in a gold cylinder cavity. Then, these X-rays symmetrically uniformly irradiate a spherical capsule filled with DT fuel and positioned in the center of the cylindrical cavity. The radiation ablates the outer layers of the capsule, compresses the fuel inside more than a thousand times and heats it to a temperature of hundred million degrees. These are conditions where the fusion reactions take place and release a surplus of energy in a form of energetic neutrons, alpha-particles and radiation. The "direct drive" approach consists in the direct laser irradiation of a capsule with a DT fuel (thus bypassing the step of conversion in X-rays in the gold cylinder). It is more efficient and better suited for energy production, but implosion is less stable. Together with magnetic confinement fusion, direct drive ICF is a promising approach for construction of a fusion power plant: an abundant, clean, sustainable, and on-demand energy source for mankind.

References

Kritcher. A. L., et al.: 2022, *Nature Physics* ***18****, 251*

Abu-Shawareb, H. and Indirect Drive ICF Collaboration: 2022, *Phys. Rev. Lett.* **129**, 075001

A. B. Zylstra, O. A. Hurricane, and D. A. C. et al.: 2022, *Nature* ***601****, 542*

T. Wilson: 2022 *Fusion energy breakthrough by US scientists…*, Financial Times, London