An Ultra-Short Laser Pulse based Direct Drive Nuclear Fusion Concept

Prof. Dr. Hartmut Ruhl
Marvel Fusion GmbH and Ludwig-Maximilians-University in Munich

Abstract:
While the underlying physics of the ICF approach to nuclear fusion is well understood and a technological implementation of the indirect drive variant of the ICF concept has recently been given at NIF commercially viable ICF concepts are still under investigation. In the present paper we propose core elements of a novel ultra-fast direct drive mixed fuel ICF concept that might be commercially viable. It makes use of ultra-short, ultra-intense laser pulses interacting with nano-structured accelerators embedded into the mixed fuel context. The embedded accelerator technology promises to be highly efficient and capable of ultra-fast fuel heating without fuel pre-compression but is not the focus of the paper. It is the predominant purpose of the mixed fuel concept to avoid cryogenic fuels since specific chemical compounds exist that are capable of chemically binding DT. To which extent mixed fuel concepts can work is investigated in the paper. Under the assumption that the proposed direct drive ultra-fast heating concept is capable of rapidly heating the fuel uniformly to sufficiently high temperatures it is found with the help of MULTI, an ICF community code, that a pBDT mixed fuel reactor design can reach a target yield $QT>1$ with MJ level external isochoric heating. The simulations are used to validate a theoretical scaling model of the mixed fuel reactive hydro flows. The paper does not present a reactor point design.