A laser-driven kiloTesla magnetic bottle for plasma confinement

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The possibility to trigger the proton-boron nuclear fusion reaction (p + 11B → 8.5 MeV + 3a) by using a nsec class laser has been recently demonstrated. This is of high interest since such reaction does not produce any neutrons but just three alpha-particles, which could be used for applications in different fields. The possibility to confine the plasma fuel generated during laser-target interaction through an ultra-intense magnetic field would allow enhancing the rate of the generated alpha-particles.

In last decades it has been experimentally proved that a small coil-target energized with a long pulse (nsec-class), high energy (several hundreds of J) laser can produce a quasi-static (over one nsec) magnetic field of the order of 1 kT.

The combination of several laser beams with the dual purposes of producing a plasma responsible of the fusion reaction and, using a proper synchronization, energizing two multiturn coils would enhance the alpha particle rate by confining ions up to few MeV/u in a small region (less than 1mm^2 in diameter).

We propose the design of an innovative magnetic bottle-like trap made of two multiturn coil targets able to produce a magnitude field of several kT, which is ideal to confine the plasma for a relatively long time (few nsec), thus increasing the number of p-B collisions and, hence, the fusion reaction rate. A complete study of the trap is here reported including magnetic field analysis, electric, thermal and mechanic behavior and also the confinement efficiency using particle tracking code simulations. Preliminary experimental result with low energy laser will also be reported.