

# **Mini Fission-Fusion-Fission Explosions (Mini-Nukes). A Third Way Towards the Controlled Release of Nuclear Energy by Fission and Fusion**

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Chemically ignited nuclear microexplosions with a fissile core, a DT reflector and U238 (Th232) pusher, offer a promising alternative to magnetic and inertial confinement fusion, not only burning DT, but in addition U238 (or Th232), and not depending on a large expensive laser or electric pulse power supply. The prize to be paid is a gram size amount of fissile material for each microexplosion, but which can be recovered by breeding in U238.

In such a “mini-nuke” the chemical high explosive implodes a spherical metallic shell onto a smaller shell, with the smaller shell upon impact becoming the source of intense black body radiation which vaporizes the ablator of a spherical U238 (Th232) pusher, with the pusher accelerated to a velocity of  $\sim 200$  km/s, sufficient to ignite the DT gas placed in between the pusher and fissile core, resulting in a fast fusion neutron supported fission reaction in the core and pusher. Estimates indicate that a few kg of high explosives are sufficient to ignite such a “mini-nuke”, with a gain of  $\sim 10^3$ , releasing an energy equivalent to a few tons of TNT, still manageable for the microexplosion to be confined in a reactor vessel.

A further reduction in the critical mass is possible by replacing the high explosive with fast moving solid projectiles. For light gas gun driven projectiles with a velocity of  $\sim 10$  km/s, the critical mass is estimated to be 0.25 g, and for magnetically accelerated 25 km/s projectiles it is as small as  $\sim 0.05$  g.

With the much larger implosion velocities, reached by laser- or particle beam bombardment of the outer shell, the critical mass can still be much smaller with the fissile core serving as a fast ignitor.

Increasing the implosion velocity decreases the overall radius of the fission-fusion assembly in inverse proportion to this velocity, for the 10 km/s light gas gun driven projectiles from 10 cm to 5 cm, for the 25 km/s magnetically projectiles down to 2 cm, and still more for higher implosion velocities.

*Key words:* Fusion-Fission; Impact Fusion; Fast Ignition.