Debate.txt v 1.4 by Laszlo Csernai; 2021. Feb 2..

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At the end of the Quantum Electronics 2021 Symposium, a debate developed following a comment by István Földes. He has essentially repeated the points published in LPB in 2020 [1], to which Csernai, Kroó, Papp and Strottman had responded in the next issue of LPB [2].

Three issues are brought up:

1) the burning progresses slowly from the first ignited point to the whole target. Földes did not bring up this objection in the debate as he recognized that we aim for starting an ignition in the whole volume, so we do not need a transfer of the light front from one point to another. We plan to verify experimentally this mechanism within a couple of coming months.

2) the nano-plasmonic antennas will not absorb the laser light, because the plasma-mirror on the surface of the nano-antennas will reflect it. He was then confronted with his recent article [3], the content of which was also presented at this conference as a poster that with increasing laser beam energy the light is not reflected but absorbed. After this was brought up, Földes modified his point that the absorbed energy is not reflected but absorbed in a thin layer at the surface of the plasmonic nano-antenna. This view was then countered by pointing out that the target thickness in the envisaged experiments between ~ 0.01-1 mm while the nano-antenna sizes are 1-100 thousand times smaller. These plasmonic surfaces are finely distributed inside the target, so the energy and momentum is absorbed well in the target in any case. This was also presented at the present conference. Laser irradiation led to visible spots indicating structural transition. With the implanted nano-antennas at one mili-Joule beam energy, we got 12 times larger spots (with 600-micron diameter) than without nano-antennas. At lower energies without nano-antennas, one could not see any visible sign of the laser irradiation, while with nano-antennas visible spots appeared already at 0.1 mili-Joule irradiation beam energy.

3) the Laser Wake Field Acceleration will not produce a sufficiently high ion density and ion kinetic energy for a sustainable burning of the target. Regarding the density, it was shown experimentally, that in a linear, colliding beam configuration [4], the same target density is reached as at the National Ignition Facility (NIF). Furthermore, in a recent publication the target compression and acceleration mechanism is described in the Laser Wake Field Acceleration (LWFA) collider configuration [5]. It behaves similar to the one used at NIF, where first with a weak and longer (~20-30.10^{-8} sec.) laser beam was followed by a five times shorter and stronger final pulse. In our model calculation, assuming a similarly weak initial pulse, and a final, much stronger (~ 20 Joule) and million times shorter pulse,-we obtained a compressed and accelerated target fuel before ignition.

This final point was then followed by a vivid discussion weather the LWFA for ions (e.g. protons) could achieve the envisaged kinetic energy before the final collision of the target and projectile parts of the target. Based mainly on fixed, stationary LWFA results, some participants advocated that an ion acceleration sufficient for the final ignition and fusion could not be reached. On the other hand, most of these arguments referred to static and not colliding target sheets, without pre-acceleration. The debate concluded that since the LWFA method is studied for more than two decades by now, one should carefully review the wide literature in this field and continue the disputation via international peer reviewed publications.

[1] I.B. Földes and G.I. Pokol, Laser and Particle Beams, 38 (3), 211-213 (2020).

[2] L.P. Csernai, N. Kroó, I. Papp and D.D. Strottman, Laser and Particle Beams, 38 (4), 285-286 (2020).

[3] Zs. Kovács, K. Bali, B. Gilicze, S. Szatmári and I.B. Földes, Phil. Trans. R. Soc. A 378, 20200043 (2020).

[4] Zhang G., Huan M., Bonasera A. et al., Physics Letters A 383, 2285–2289 (2019).

[5] I. Papp, et al. (NAPLIFE Collaboration), Physics Letters A (2021) in press; arXiv: 2009.0368v4 (2021),