**On the injection, wave breaking and filamentation of electrons in LWFA**

R. Iov˘anescu 1, R.P. Daia2, E.I. Slușanschi3, C.M. Ticoș4

*1,2,3,4Engineering and Applications of Lasers and Accelerators Doctoral School (SDIALA), University Politehnica of Bucharest, Bucharest, Romania*

*1,4 Extreme Light Infrastructure – Nuclear Physics, ‘Horia Hulubei’ National Institute for Physics and Nuclear Engineering, M˘ăgurele-Bucharest, Romania*

We study the origin of filamentation of the accelerated electrons in LWFA and their behavior  in dependence to the plasma density. Several 2D PIC simulations  were performed  for different plasma densities, while keeping the other parameters constant.  
A filamentation is observed for lower plasma densities ~9×1017 cm-3 and a0>10 up to a limiting threshold density at around 2.5×1018 cm-3 and then vanishes. Moreover, with the growth of density, at around 4×1018 cm-3 the electrons on the edge of the bubble start to counter propagate and separate from the bubble margin, thus reaching each other behind the rear of the bubble, significantly reducing the self-injection. Depending on the plasma density the bubble has a different dimension and shape, being bigger for  lower densities. The filamentation appears when the bubble closes at its rear and depends on the closure angle of the bubble wall.  
 If the angle of closure of the bubble is less than π (it closes from the beam direction), the filamentation does not set in from the beginning and is limited as the electron bunch is travelling towards the laser pulse. However, if the closure angle of the bubble wall exceeds π (it closes from the rear part), which means that the  wall edges  turn  towards the laser, the electron bunch travels inside the bubble and forms the filaments. This is related to the fact that the constant phase surface of a broken wave in plasma follows such curves that close differently at the rear of the bubble.   
 We present the energy distribution for the different plasma density and the evolution of the filaments in time. Besides, we measure the maximum electron energy for each plasma density at intervals of 250 fs, and obtain lower values in the cases with filamentation.