We present self-consistent numerical fluid modeling of 2.45 GHz cold non-magnetized plasma along a plasma-dielectric interface at conditions similar to those in cold plasma processing equipment. In such plasmas local electron plasma resonance is known to occur where the local electron density $n_e$ approaches the cut-off density $n_c$. Provided the bulk plasma is overdense ($n_e > n_c$), the electron density $n_e$ first increases away from the interface and then decrease back with the exponentially weakening microwave field in the bulk. There is potential for two $n_e \sim n_c$ resonances: one near and one away from the interface. The second resonance has attracted little attention, although it may be the more important one in processing equipment due to its closeness to the wafers. Our modeling shows that the first resonance is significant only for a few microseconds in the initial transient plasma build-up (Fig. 1).

On the other hand, the second resonance not only exists in steady state, but seems to govern the plasma behavior in this area, sustaining a wide domain of almost uniform plasma with $n_e \sim n_c$, where the microwave is efficiently absorbed. This phenomenon may be partially responsible for increased plasma chemistry reaction rates near the wafer, in agreement with the well-known excellent performance of such plasma sources for chemical dry etching and deposition.

Fig. 1. RF electric field profile evolution with two electron plasma resonances (the plasma-dielectric interface is at $x = 0$).