# Absorption of ultra-short and ultra-intense pulses by structured target at solid density. Application to ion acceleration by TNSA

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The Appolon laser which will soon come in operation is capable of providing very intense (> $10^{21}$W/cm2) and very short pulses (FWHM ~18fs) with very little ASE providing very high contrast. Experiments related to ions acceleration are projected. It is the motivation of the present study based on the use of collisionnal 2D PIC simulations.

In order to obtain reliable results we design a system large enough to allow following its time evolution on time scale of the order of 1ps without interaction with boundaries conditions. Given the fact that relativistic particles propagate at c velocity this means a very large system. The target that we used is an Al target with Z=10 and the initial temperature is 50eV. Such parameters imply the use of a small mesh size making the simulation extremely expensive (7000000 hours of CPU time on Blue Gene/Q). In order to reduce the cost and reduce the residual self- heating, we designed a code that handles a system that “grows” in time.

The first simulations that were performed with this code used plane targets and a density jump, exhibit a reflection rate of 90%. Therefore we decided to change the nature of the target and move to structured targets. As the only structures that can be described realistically in 2D are gratings, the following of the study deals with grating targets.

In order to optimize the simulations a set of much smaller simulations was designed using a plasma target with a 1keV initial temperature allowing a much larger grid size and a much larger time step. Moreover, being only interested at this stage by the absorption, the length of the simulation is much shorter, allowing a very systematic study. One of the main results of this study that will be presented is, that contrarily to what is commonly accepted, the excitation of a surface plasma wave does not yield systematically a maximum of absorption. This study showed that using gratings outside of resonance allows absorption of up to 85% of the incoming laser light.

A few characteristic results of this study were chosen to perform the large simulations mentioned at the beginning to study ion acceleration by TNSA. First they showed that the initial temperature of the target has no influence on the absorption, which validate the preceding study. Next they showed a paradoxal result: for the cases that we have studied the maximum of absorption does not correspond to the maximum of acceleration. Study of the corresponding physics is underway. For optimal conditions of acceleration, ions with energy up to 1.2GeV were obtained.