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Laser accelerated ion bunches as a unique tool for high energy density physics

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One of the most universal methods to create the matter at high energy density is the use of energetic ions slowing down in the substance. Contemporary sources of heavy ions are not able, however, to heat the matter to a temperatures above several tens eV. An alternative approach to ion acceleration is based on high intensity laser-matter interaction. Recently, it has been shown that a kJ laser pulse may convert up to 5~\% of its energy to ion bunch in the interaction with thin plastic targets. Estimations show that given the properties of this bunch the resulting energy deposition in the raget will be of the order of 10 MJ/g.

This number is not only almost two orders higher than that planned at FAIR, but it also gives more than 10 keV energy deposition per atom. It means that the matter will be highly ionized and heated to hundreds eV. The problem of ion stopping in such conditions is fundamentally new. The ion bunch slowing down in the matter will be changing it stopping properties so the dynamics become highly non-linear. Recently, it has been also shown that in this regime the ion beam-plasma instabilities may arise which change the interaction picture competely.

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