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Journey from Heavy Ion Fusion to High Energy Density Physics over the Past 40 Years

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In 1979 a heavy ion beam driven inertial confinement fusion (ICF) reactor study, named HIBALL was organized by the GSI, in which 50 scientists from different institutions participated. This study included the driver design, the target design and the reactor chamber design. A small group of scientists worked to propose a viable ICF target for the HIBALL reactor system. Suitable target parameters were determined and the target performance was analyzed in detail (Tahir, Long & Mayer-ter-Vehn). This basically was the beginning of the plasma physics at GSI. It was concluded that the very high beam intensities (10^{14} ions / bunch) and short bunch lengths (10 ns) needed for the target implosion, were not possible to achieve with the available technology. Moreover, it was realized that this parameter range could not be accessed even with the technology available in the foreseeable future. For example, today we expect that in 2025, the SIS100 will deliver $5x10^{11}$ uranium ions in a 70 - 100 ns long bunch. However, theoretical work done over the past years has shown that that with such beam parameters, large samples of High Energy Density (HED) matter can generated over a wide range of parameters. Two experiments, namely, HIHEX (Heavy Ion Heating and Expansion) and LAPLAS (Laboratory Planetary Physics), have been proposed for the HED physics research program at FAIR. The former experiment will allow studies of thermophysical properties of HED matter, whereas, the latter will enable to generate the planetary core conditions in the laboratory. In fact these two experiments can also be used to study the equation-of-state of the deuterium-tritium fuel of an ICF target during the irradiation by the pre-pulse. This talk presents an overview of this work.

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