Driving and characterizing strongly magnetized hot dense plasmas in magneto-inertial fusion experiments

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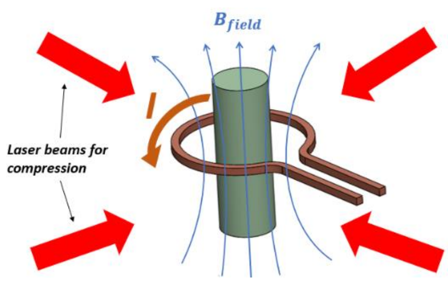
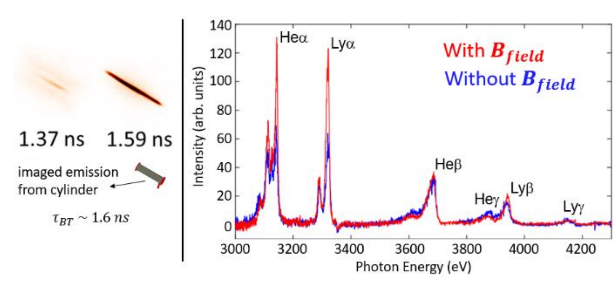
The quest for controlled fusion energy is ongoing for over a half century. Ignition of thermonuclear fuel and energy gain is still to be demonstrated in the laboratory. Fuel implosion by laser irradiation is one of the possible ways, as merely a few months ago a yield of 1.3 MJ fusion energy was delivered out of 1.9 MJ laser drive at the NIF laboratory in USA, the American counterpart of the French LMJ. In such experiments the energy is transported by electrons from the laser absorption region into the ablation front in the target, driving converging shocks that compress the fuel to thermonuclear temperatures (10.000 degrees) at 1000 times the typical solid-state densities: an environment comparable to a star in the laboratory. Electron energy transport and implosion hydrodynamics are complex and often instable. Pre-magnetization of fuel capsules may bring improvements as electron magnetization would mitigate energy losses and instabilities. A seed magnetic-field advected with the fuel implosion would be compressed by 1000s times, becoming enough strong to even confine fusion-issued ions and further enhance the reactions rate. I will present the simulation and experimental work that we are carrying out to understand laser-driven plasma implosion hydrodynamics and magnetic-field compression, along with the generation of tens of Tesla magnetic-fields out of laser-plasma interaction mechanisms to seed the implosions. I will discuss the characterization of the seed magnetic-field out of proton beam probing and of the imploded hot and dense plasmas out of X-ray line spectroscopy.



Setup skecth for a magnetized cylindrical implosion



Typical X-ray emission images and spectra