Beaming in on Warm Dense Matter (w/ Video)

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(PhysOrg.com) -- The Neutralized Drift Compression Experiment II (NDCX-II) now under construction at Berkeley Lab will deliver a high-current pulse of lithium ions to a foil target almost simultaneously, momentarily heating it to a state known as warm dense matter. Designing the accelerator to meet these exacting specifications required extensive computer modeling, including the simulations shown here.

The Neutralized Drift Compression Experiment II (NDCX-II) now under construction at Berkeley Lab is an accelerator custom-made to study warm dense matter, a state of matter that's warm indeed - typically around 10,000 degrees Kelvin - and at the same time so dense it's almost solid. Found throughout the Universe in places like the cores of giant planets, warm dense matter interests scientists not just for its own sake but also because it's one of the stages matter passes through on its way to nuclear fusion, notably in the fuel capsules of proposed inertial-fusion power reactors.

To create warm dense matter takes a machine that can deliver a high current (large number) of charged particles to the target almost simultaneously. NDCX-II is designed to do just that. A project of the Heavy Ion Fusion Science Virtual National Laboratory (HIFS-VNL), a collaboration of Berkeley Lab, Lawrence Livermore National Laboratory, and the Princeton Plasma Physics Laboratory, NDCX-II will accelerate bunches of about 200 billion lithium ions (atoms lacking one or more electrons) to moderate energies of about three and a half million electron volts (3.5 MeV), then compress the pulse so that the entire bunch hits the foil target within a billionth of a second, heating it to warm dense matter.

Each movie shows the beam emerging from the injector, accelerating, then exiting the accelerator, entering the drift line, and striking the target. The red shapes are the solenoid magnets. The beam tail is accelerated by the last several induction cores, all shown in blue, so that the beam will be compressed in the plasma-neutralized drift line.

Different colors in the beam indicate the kinetic energies of the ions, according to the color bar. For example, the higher energy of the tail of the beam is indicated by color changing from green to yellow to red as the tail overtakes the head. A final eight-tesla solenoid focuses the beam onto the target at the time of minimum pulse duration, heating the target to create warm dense matter.

NDCX-II has received $11 million in funding from the American Recovery and Reinvestment Act. Construction began in July 2009, and completion of the first phase, an initial configuration with 15 induction cells, is anticipated by March 2012.

More information: More about the Warp simulation program

Provided by Lawrence Berkeley National Laboratory

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