



IAEA FEC 201

Contribution ID: 6

Type: Oral

## Observations of residual bulk-fluid motion and low-mode areal-density asymmetries at peak convergence in NIF implosions through spectral measurements of DD and DT neutrons

*Thursday, 20 October 2016 14:40 (20 minutes)*

Hot-spot ignition planned at the National Ignition Facility (NIF) requires proper assembly of the DT fuel, as manifested by the evolution of areal density ( $\rho R$ ) symmetry and hot-spot ion temperature ( $T_i$ ). Ideally, a spherically symmetric layer of cold and dense fuel with a  $\rho R$  exceeding  $1 \text{ g/cm}^2$  surrounding a  $\sim 5 \text{ keV}$  lower-density hot spot is obtained at peak convergence. To reach these conditions, the implosion must be 1D in nature and efficient conversion of the implosion kinetic energy to hot-spot thermal energy must be obtained. If substantial 3D non-uniformities in the implosion exist, the conversion efficiency is degraded and significant fraction of the implosion kinetic energy, in the form of bulk-fluid motion, remains at peak convergence. Experimentally, the residual bulk-fluid motion is assessed from directional measurements of the primary DT and DD neutron spectrum. The width of the primary spectrum is characteristic of  $T_i$  as well as the variance of the bulk-fluid motion in the burning region. Energy shifts beyond  $T_i$ -induced shifts are also an indication of bulk-fluid motion. Additionally,  $\rho R$  asymmetries are determined from directional yield measurements of scattered neutrons or un-scattered neutrons. In recent high-foot-implosion experiments, directional measurements of the neutron spectrum illustrate the existence of substantial bulk-fluid motion and low-mode  $\rho R$  asymmetries at peak convergence, which degrade the implosion performance. The measured DT-weighted apparent  $T_i$  is also consistently higher than the apparent DD-weighted  $T_i$ , a discrepancy that increases with increasing implosion drive. From a 1D perspective, the DD yields are also too high relative to DT yields. Effects due to profiles, reactivity differences, and bulk-fluid motion partly explain these observations, but none of them appear sufficient to explain the data. The observables are most likely caused by significant  $\rho R$  asymmetries ( $>500 \text{ mg/cm}^2$ ) and substantial bulk-fluid motion of about  $50\text{-}100 \text{ km/s}$ . The hypothesis is that these observations are driven by radiation drive asymmetry, and instabilities seeded by the fill tube and thin tent holding the capsule in the Hohlraum. These issues are currently being addressed by new engineering solutions, more refined implosion modeling, and implementation of new diagnostics. This work was supported by the US DOE (contract DE-AC52-07NA27344).

### Paper Number

IFE/1-3

### Country or International Organization

U.S. A.

**Primary author:** Dr FRENJE, Johan (Massachusetts Institute of Technology)

**Co-authors:** Dr KRITCHER, Andrea (Lawrence Livermore National Laboratory); Dr MACKINNON, Andrew (SLAC National Accelerator Laboratory); Dr APPELBE, Brian (Imperial College London); Dr SPEARS, Brian (Lawrence Livermore National Laboratory); Dr CERJAN, Charles (Lawrence Livermore National Laboratory); Dr YEAMANS, Charles (Lawrence Livermore National Laboratory); Dr CASEY, Daniel (Lawrence Livermore National Laboratory); Dr SAYRE, Daniel (Lawrence Livermore National Laboratory); Dr BRADLEY, David (Lawrence Livermore National Laboratory); Dr MUNRO, David (Lawrence Livermore National Laboratory); Dr CALLAHAN, Debra (Lawrence Livermore National Laboratory); Dr HINKEL, Denise (Lawrence Livermore National Laboratory); Dr HARTOUNI, Edward (Lawrence Livermore National Laboratory); Dr BOND, Essex (Lawrence Livermore National Laboratory); Dr GRIM, Gary (Lawrence Livermore National Laboratory); Dr CAGGIANO, Jac (Lawrence Livermore National Laboratory); Dr KNAUER, James (Laboratory for Laser Energetics, University of Rochester); Prof. CHITTENDEN, Jeremy (Imperial College London); Dr EDWARDS, John (Lawrence Livermore National Laboratory); Dr KILKENNY, Joseph (General Atomics); Dr GATU JOHNSON, Maria (Massachusetts Institute of Technology); Dr ECKART, Mark (Lawrence Livermore National Laboratory); Dr MEEZAN, Nathan (Lawrence Livermore National Laboratory); Dr HURRICANE, Omar (Lawrence Livermore National Laboratory); Dr LANDEN, Otto (Lawrence Livermore National Laboratory); Dr SPRINGER, Paul (Lawrence Livermore National Laboratory); Dr PATEL, Prav (Lawrence Livermore National Laboratory); Dr BIONTA, Richard (Lawrence Livermore National Laboratory); Dr PETRASSO, Richard (Massachusetts Institute of Technology); Dr HATARIK, Robert (Lawrence Livermore National Laboratory); Dr LEPAPE, Sebastien (Lawrence Livermore National Laboratory); Dr MA, Tammy (Lawrence Livermore National Laboratory); Dr SANGSTER, Thomas (Laboratory for Laser Energetics, University of Rochester); Dr DÖPPNER, Tilo (Lawrence Livermore National Laboratory); Dr MURPHY, Tomas (Los Alamos National Laboratory); Dr GLEBOV, Vladimir (Laboratory for Laser Energetics, University of Rochester.); Dr HSING, Warren (Lawrence Livermore National Laboratory)

**Presenter:** Dr FRENJE, Johan (Massachusetts Institute of Technology)

**Session Classification:** Inertial Fusion Experiments & Theory

**Track Classification:** IFE - Inertial Fusion Experiments and Theory