Effect of Mode-1 Perturbations on OMEGA Areal-Density Measurements



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Summary

A model that adds 3-D corrections to the statistical model illustrates the effects of a mode-1 asymmetries

- The 3-D hydrodynamic simulation *ASTER* and 3-D neutron transport code *IRIS3D* show the effect of mode-1 asymmetries on OMEGA cryogenic implosions
 - ion temperature variations
 - bulk fusing plasma flow
 - density distribution
- OMEGA measurements of ion temperature distribution and bulk flow are correlated
- The 1-D statistical model with a 3-D correction is in better agreement with the backscatter data





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* K. M. Woo et al., ZO04.00006, this conference. ** A. J. Crilly et al., Kl02.00004, this conference.



The neutron spectrum emitted from an ICF target contains information on the hotspot velocity, apparent ion temperature, and the compressed fuel areal density

ASTER* radiation-hydrodynamic Synthetic neutron energy simulation at peak neutron production spectrum** emitted from target Mass density 100 (g/cm³) Primary d_2 300 **DT** neutrons 250 d*N*/d*E* (#/1 keV) Primary 200 **DD** neutrons 60 µm 150 Synthetic neutron 10-2 Scattered neutrons diagnostics 100 50 0 a_2 10-4 10 14 6 E29286 Energy (MeV) E29288c

* I. V. Igumenshchev et al., Phys. Plasmas 23, 052702 (2016).

** F. Weilacher, P.B. Radha, and C. Forrest, Phys. Plasmas 25, 042704 (2018).



ICF: inertial confinement fusion

Mode-1 asymmetry signatures are encoded in the first and second moments of the DT peak neutron spectrum





The OMEGA nTOF suite measures yield, ion temperature, Doppler energy shift, and scattered neutrons along several lines of sight



- Three-dimensional nTOF suite detectors (black circles) form a nearly orthogonal measurement system
- DT ion temperature and yield are measured by detectors along six lines of sight
- Backscatter neutrons are measured by liquid scintillator detectors (red dashed circles) with collimated lines of sight

nTOF: neutron time of flight



Mode-1 asymmetry signatures of the ion temperature variation and bulk flow speed are correlated







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A mode-1 asymmetry results in a nonuniform density distribution that is sampled by the diagnostics

ASTER* radiation-hydrodynamic simulation at peak neutron production





* I. V. Igumenshchev et al., Phys. Plasmas 23, 052702 (2016).

** F. Weilacher, P.B. Radha, and C. Forrest, Phys. Plasmas 25, 042704 (2018).

J. A. Frenje, Plasma Phys. Control. Fusion 62, 023001 (2020).



The statistical model (1-D kernel) with a correction for mode-1 asymmetry (3-D kernel) is in better agreement with the areal-density data





Summary/Conclusions

A model that adds 3-D corrections to the statistical model illustrates the effects of a mode-1 asymmetries

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