
HYDRA radiation hydrodynamics code

**Presented to
Workshop on Accelerator Driven
Warm-Dense-Matter Physics**



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HYDRA is a 2D/3D multiphysics ICF code used to simulate a wide variety of targets

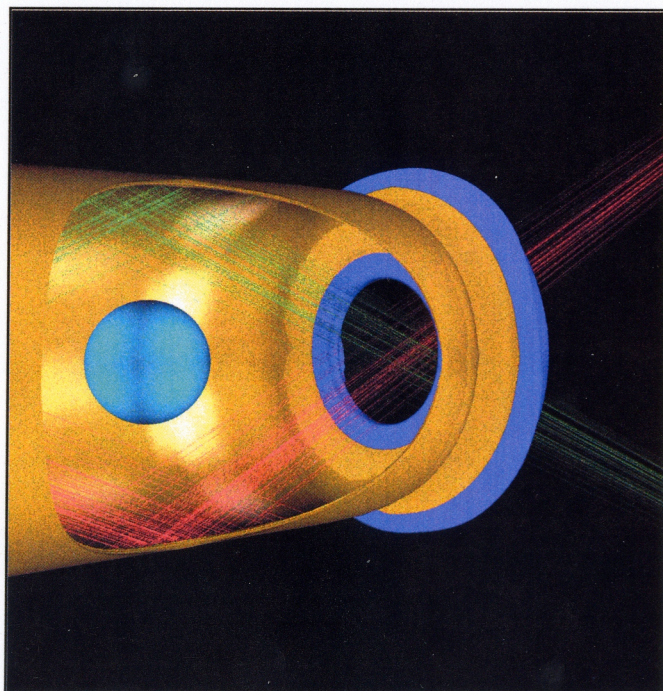


Has been tested against various experiments on Nova and Omega lasers

Applications include:

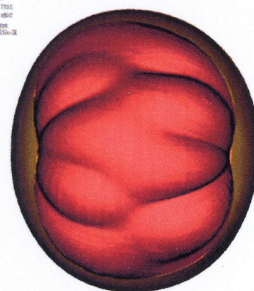
- **Integrated simulations of NIF ignition targets**
- **Effects of beryllium grain microstructure, joints and surface roughness for cryogenic NIF ignition capsules**
- **Fill tubes in NIF ignition targets. Planned experiments to study jet formation due to fill tubes**
- **Effects of surface roughness and engineered features in Omega double shell capsule implosion experiments**
- **Simulations of complex hydrodynamic experiments**
- **Laser propagation experiments through low density gas bags**
- **Implosions in dynamic (current-driven) hohlraums**
- **Studies of analytic models of nonlinear instability growth**

Fully integrated 3D simulations of NIF ignition targets performed with HYDRA are used to optimize target design



Ignition-hohlraum
only perturbations

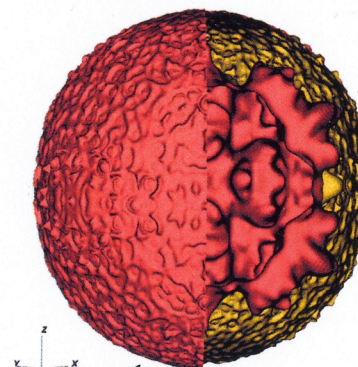
600 g/cc surface



80 μ m

Hohlraum axis (z)

Ignition-capsule
and hohlraum
perturbations



Stagnation
shock

400 g/cc density
isosurface

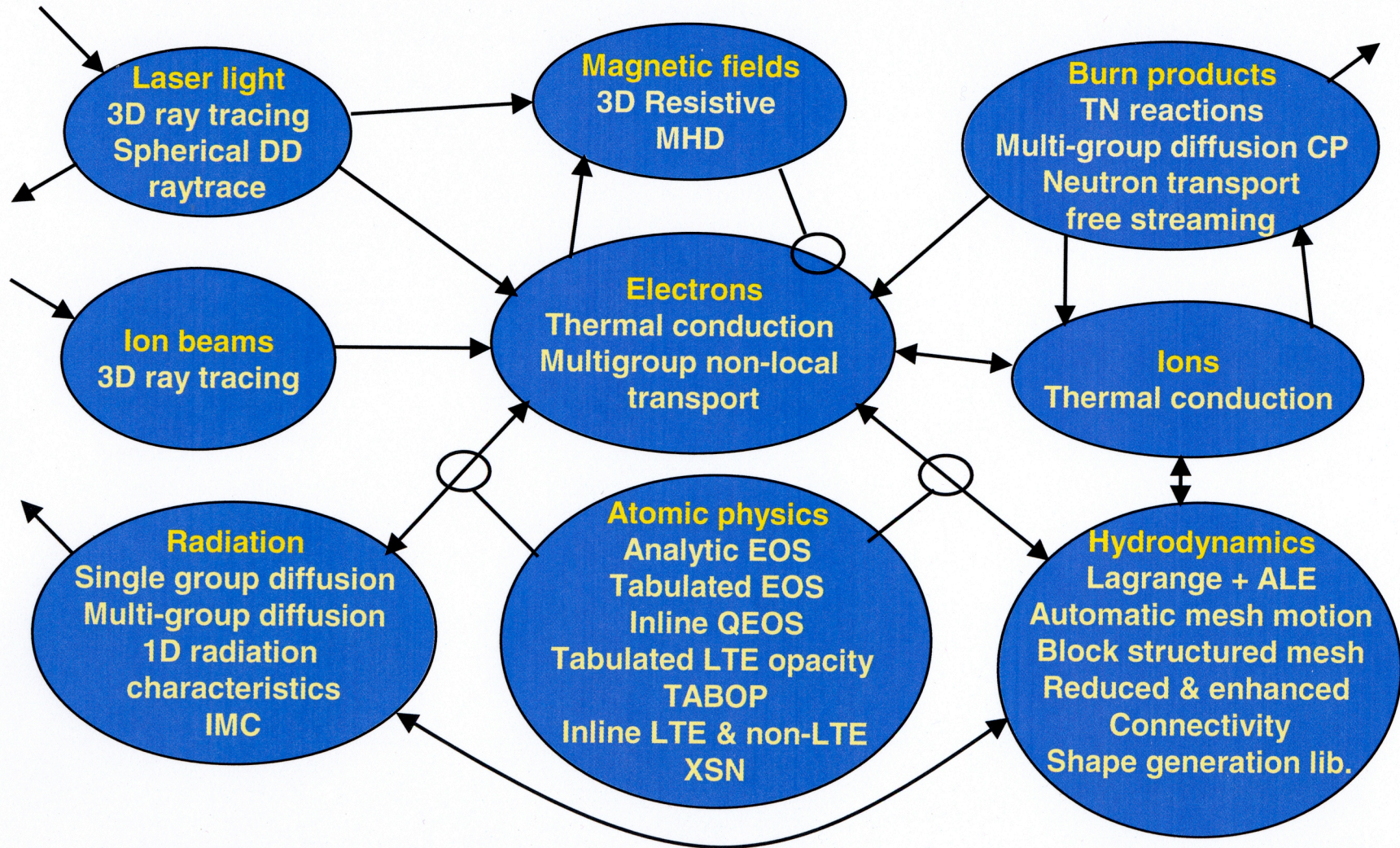
Yields calculated in 3D are near 1D
yields with both Gold and cocktail wall
hohlraums and plastic or Be capsules

HYDRA is being used at several laboratories



- **Users from LANL and SNL model**
 - **Dynamic hohlraums**
 - **Hemishell joints in beryllium ignition capsules**
- **First users from LBNL heavy ion community**
 - **Studying planned EOS experiments with heavy ion beams**
- **HYDRA is being used to simulate direct drive ICF capsule implosions at the University of Rochester Laboratory for Laser Energetics**
- **HYDRA is an export restricted code**

Physical processes modeled by the HYDRA code for ICF simulations



Special requirements for simulations of warm dense matter



- Ion deposition model
 - Formulas for stopping power intended for IFE with higher energy per nucleon
- Electron beam heating
 - Can link deposition profile from ITS Monte Carlo code
- Thermal conductivity
 - Is it important on time scales of interest for a given experiment?
 - Lee and More σ is default, Desjarlais conductivities are to be implemented
- Electron-ion coupling
- Improved equations of state for WDM regime
 - Treat phase changes with sufficient resolution
 - Ensure thermodynamic derivatives from tables well behaved for WDM
- Material strength – isotropic strength being implemented
 - Include temperature dependence
 - Spallation model required?
- Surface tension could be implemented at material interfaces
 - Could model evaporation kinetics in non-equilibrium two phase fluids