

# 2009 Award Winner

## BUILDING FUSION TARGETS WITH PRECISION ROBOTICS

The precision robotic assembly machine can manipulate tiny fusion target components with unprecedented precision in an operating arena the size of a sugar cube. Unlike other machines, innovative use of visual and force feedback allows an operator to drive the machine like a surgical robot and automate the assembly process. Furthermore, the precision robotic assembly machine demonstrates improved and repeatable target quality and a tenfold reduction in manpower needed to assemble laser fusion targets.

### Precision Mechanics and Control

The precision robotic assembly machine can manipulate five target components at once in a 1-cubic-centimeter operating arena. At the heart of the machine is a Livermore-developed reconfigurable manipulator system that assembles millimeter-scale components with micrometer accuracy, 100-nanometer precision (repeatability), and 100-milligram resolution force feedback. A unique attribute of the machine is its ability to stitch together multiple millimeter-scale operating arenas over distances spanning tens of centimeters. The precision robotic assembly machine's manipulator system provides precise and repeatable motions, the force and torque feedback enables deterministic mating of delicate components, and the real-time dimensional metrology enables precise alignment of components and immediate verification of as-built accuracy.

### Fusion in Our Future

Repeatable and consistent production of high-quality, precision ignition targets will play an important role in using the National Ignition Facility to explore high-energy-density regimes relevant for ensuring global security, developing commercial fusion energy and to expand our understanding of the nature and origin of the universe. The precision robotic assembly machine is building the fusion targets that will be at the center of these monumental achievements.



Systems engineer and development team leader Richard Montesanti operates the precision robotic assembly machine. The inset shows an assembled fusion target.



Development team for the precision robotic assembly machine: (front row, from left) Richard Montesanti, Monika Witte, Robert Kent, Manuel Carrillo, Dawn Lord, Elizabeth Dzenitis, and Jeff Atherton; (back row) Robert Bickel, Jack Reynolds, John S. Taylor, Richard Seugling, Jeffrey Klingmann, Ethan Alger (General Atomics), Evan Mapoles, Abbas Nikroo (General Atomics), and Carlos Castro. (Not shown: Livermore retiree George L. Miller.)

#### Additional Contributors



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