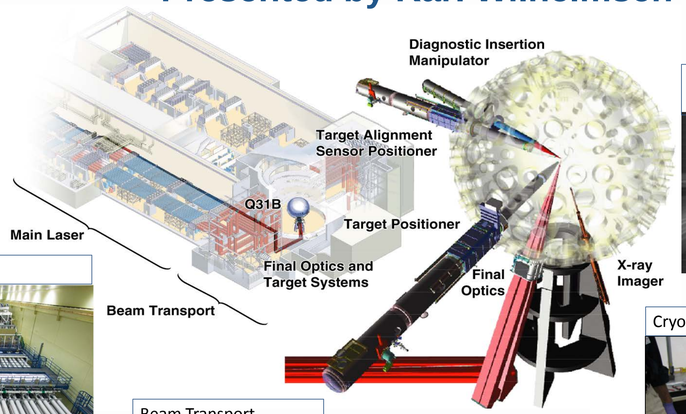
2011 Status of the Automatic Alignment System for the National Ignition Facility

Abstract

Automated alignment for the National Ignition Facility (NIF) is accomplished using a large-scale parallel control system that directs 192 laser beams along the 300-m optical path. The beams are then focused down to a 50-micron spot in the middle of the target chamber. The entire process is completed in less than 50 minutes. The alignment system commands 9,000 stepping motors for highly accurate adjustment of mirrors and other optics. 41 control loops per beamline perform parallel processing services running on a LINUX cluster to analyze high-resolution images of the beams and their references. This poster displays the status the NIF automatic alignment system and the challenges encountered as NIF development has transitioned from building the laser, to becoming a research project supporting a 24 hour, 7 day laser facility. NIF is now a continuously operated system where performance monitoring is increasingly more critical for operation, maintenance, and commissioning tasks. Equipment wear and the effects of high energy neutrons from fusion experiments are issues which alter alignment efficiency and accuracy. New sensors needing automatic alignment assistance are common. System modifications to improve efficiency and accuracy are prevalent. Handling these evolving alignment and maintenance needs while minimizing the impact on NIF experiment schedule is expected to be an on-going challenge for the planned 30 year operational life of NIF.

Increasing Availability by Improving Reliability and Upgrading Target Area Automation

Presented by Karl Wilhelmsen

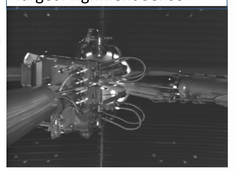


Main Laser

Beam Transport

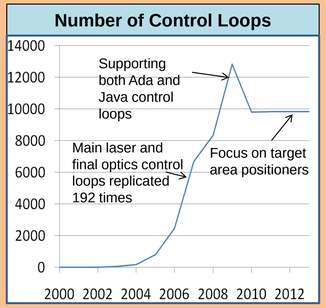
Final Optics

Target Positioner Inside Target Alignment Sensor

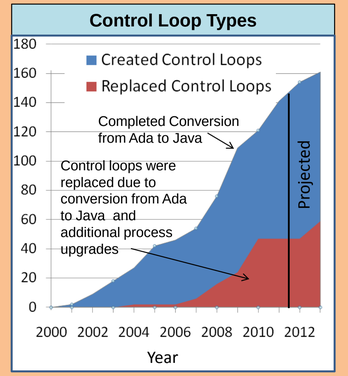


Cryogenic Target Positioner

Automatic Alignment Development



The roll off in the number of control loops at 2009 indicates the completion of the majority of NIF automatic alignment system. Control loops continue to be added, but project increases are small.



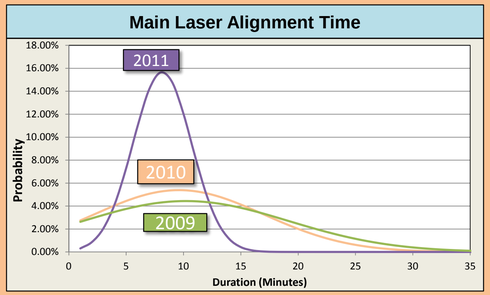
The increase in control loop types illustrates the continuing development of specialty systems such as target area automatic alignment systems.

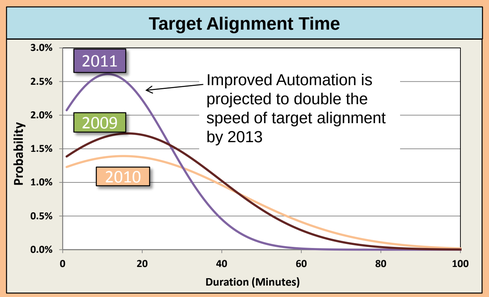
The majority NIF automatic alignment system development is stable. Refinements continue as new systems are built out or upgraded, but changes are small compared to full system.

Improvements in Alignment Speed

Reasons for improved speed:

- Software upgrades for better parallel operations
- Improved procedures to deal with hardware problems
- Operator training
- Hardware preventative maintenance
- Increased automation

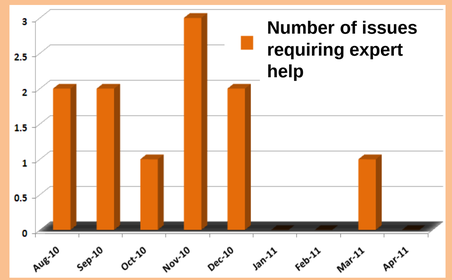


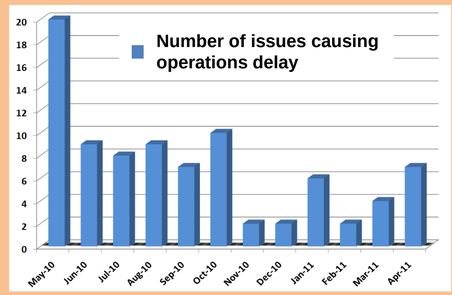


NIF Alignment System Features

- 192 Beamlines
- 50 minute automatic alignment time
- 12,600 stepper motors
- 7,500 Mirror surface actuators
- 2,200 Binary actuators
- 1000 Cameras
- 41 control loops for Shot Operations
- 29 control loops for Maintenance Operations
- 6 control loops for Optics Inspection Alignments

Improvements in Reliability





Increased Reliability Through:

- Operator Training
- Extensive Emulated testing
- Hardware Preventative Maintenance
- Software upgrades for improved error handling
- Increased Automation

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