Automatic Alignment of the Advanced Radiographic Capability for the National Ignition Facility

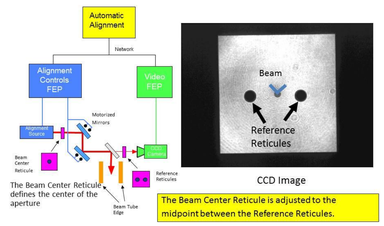
Presented by Karl Wilhelmsen

Abstract

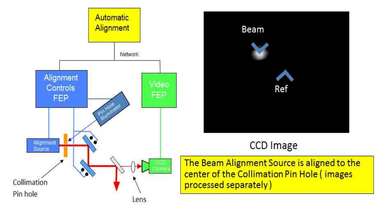
Experiments and operation of the National Ignition Facility (NIF) will soon benefit from a new, high-energy x-ray (60 – 200 keV), radiography diagnostic. To generate these x-rays, in March 2014, NIF will be deploying the Advanced Radiographic Capability (ARC) which is designed to generate precise, high-energy short-pulses, amplified through a NIF beamline, and aimed at backlighter filaments near ignition targets. The alignment precision for ARC is an important element in the success of this enhancement. A key challenge for the ARC automatic alignment (AA) process lies in implementing the new alignment capabilities without disturbing the existing operations of NIF. Any risks that may occur by the addition of the ARC system are mitigated through careful design and control of the ARC/AA interfaces. In this paper, we will describe some of the new ARC alignments, the ARC Split Beam Injector (SBI) and ARC Compressor. The SBI combines two independent ARC beams into a single NIF beam before being aligned and injected into the main NIF amplifier chain. After main amplification, the pulsewidths are compressed in the ARC compressor vessel and aimed at backlighter targets in the NIF target chamber. Alignment verification of the compressor grating will be critical to ensuring the ARC pulses meet their design specifications.

Conceptually, NIF automatic optics alignment can be divided into pointing and centering adjustments

Principle of Centering Alignment

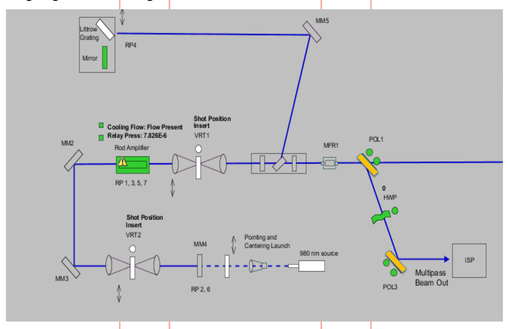


Principle of Pointing Optics

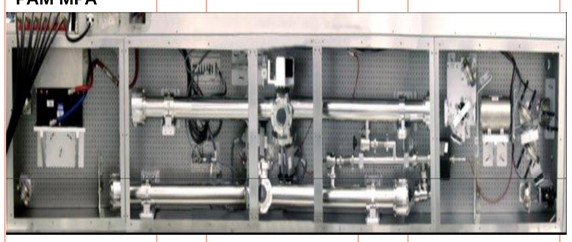


Existing PAM MPA

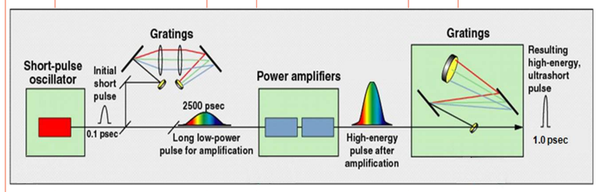
The ARC mirrors planned for Automatic Alignment are highlighted in orange

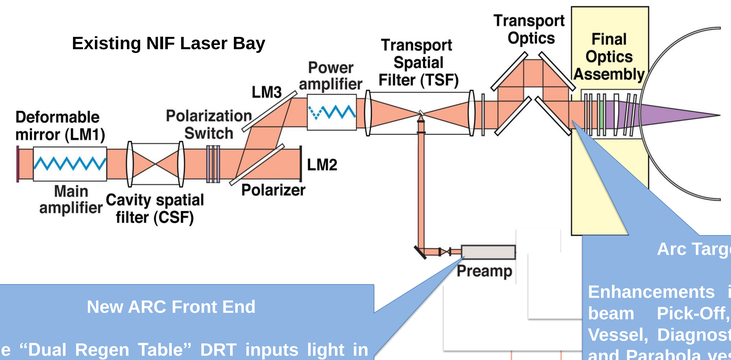


PAM MPA



Conceptually, the addition of ARC involves the insertion of a "New ARC Front End" and a "New ARC Target Area Enhancements". Their alignment uses techniques similar to the NIF Laser Bay alignment





New ARC Front End

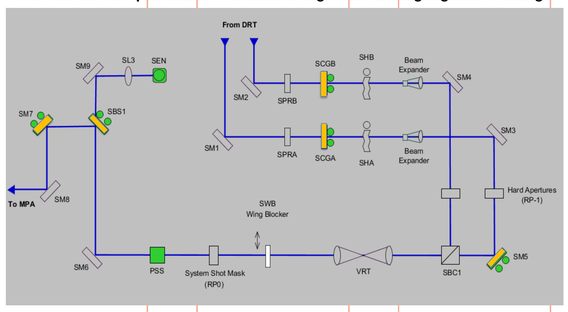
The "Dual Regen Table" DRT inputs light in "Split Beam Injection" SBI. Then, the SBI aligns light for input to existing NIF "Preamplifier Module" "Multi-Pass Amplifier" or PAM MPA are shown below.

Arc Target Area

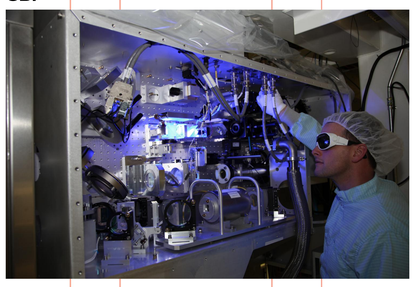
Enhancements including ARC beam Pick-Off, Compressor Vessel, Diagnostic Beam Path, and Parabola vessel are shown below.

New SBI

The ARC mirrors planned for Automatic Alignment are highlighted in orange

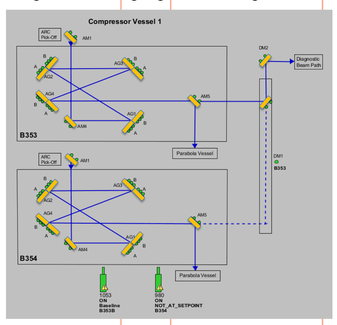


SBI

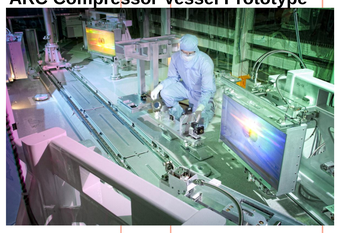


New Compressor Vessel

The ARC mirrors planned for Automatic Alignment are highlighted in orange

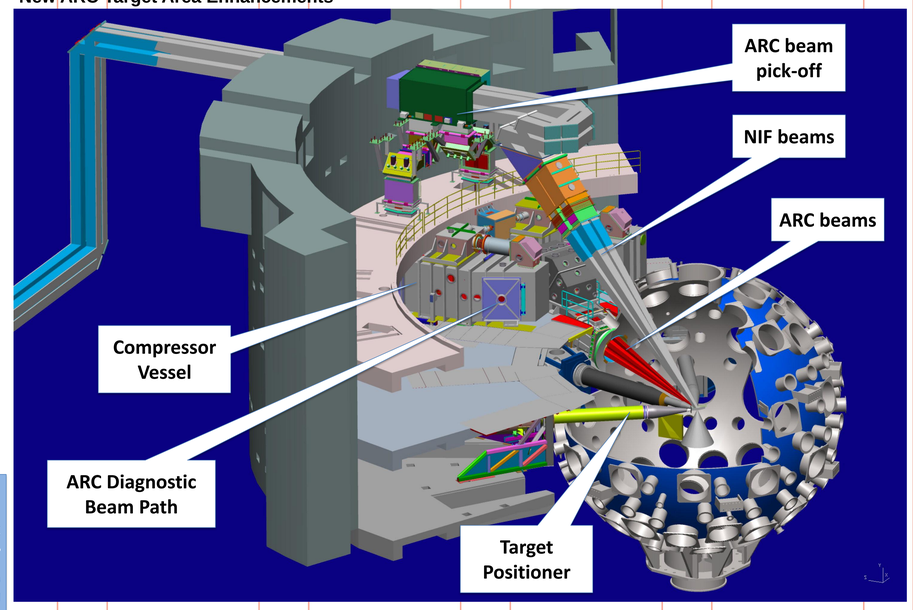


ARC Compressor Vessel Prototype



ARC Diagnostic Table

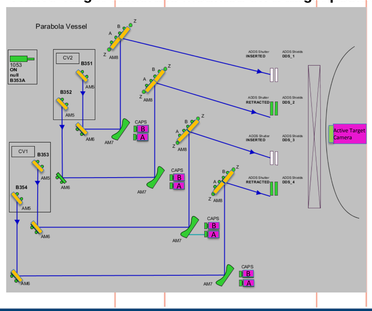
New ARC Target Area Enhancements



ARC Target Area Enhancements,
enclosure for compressor vessel and Target Chamber

New Parabola Vessel

The ARC mirrors planned for Automatic Alignment are highlighted in orange, and the sensor cameras are highlighted in violet. The Active Target camera is mounted on a target positioner.



SUMMARY

Experiments and operation of the NIF will soon utilize the ARC system. The addition of ARC continues to be a complex process, necessitating the addition of 42 new alignment and verification steps per beamline. The alignment precision for ARC is an important element in the success of the added capability. The new alignment capability must be implemented without disturbing the existing operations of NIF. Based on the current schedule, a single ARC beam will be available for experimentation the summer of 2014.

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NIF