NIF OPTICS RECYCLE LOOP

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The National Ignition Facility (NIF) at Lawrence Livermore National Laboratory is the world's largest laser system which focuses high fluence 351 nm laser light from a 192 individual beams of ~40 cm square aperture on a target. The NIF optics recycle loop enables routine operation of the NIF laser at 9 J/cm^2 (3 ns equivalent), which is roughly 2x the laser damage threshold of the fused silica optics[1]. During the recycle loop process, damage sites on the final optics are identified, sized, and blocked in-situ during laser use and then individually repaired after removal of the optic. The key technological advances enabling the recycle loop are reviewed which include: 1) highly damage resistant fused silica optics which enable practical and economic operation of the recycle loop; 2) the Final Optics Damage Inspection (FODI) system which provides the ability to identify the location & size of damage sites on the optics in-situ; 3) the Programmable Spatial Shaper (PSS) which provides the ability to locally shadow block a growing damage site during laser use preventing it from growing too large; and 4) CO_2 laser mitigation, called Rapid Ablation Mitigation (RAM), which provides the ability for off-line optic recovery by repairing the individual growing damage sites. The performance and economic impact of the recycle loop since the start of operation in 2010 is summarized. The recycle loop has reached a level of 40 recycled optics and ~2000 damage site mitigations per week. Finally, the current and future capabilities being implemented to operate the recycle loop with even higher efficiency, enabling higher NIF shot rate and/or even more economic operation, are reviewed.

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[1]M. L. Spaeth, P. J. Wegner,T. I. Suratwala,M. C. Nostrand,J. D. Bude,A. D. Conder, J.A. Folta, J. E. Heebner, L.M. Kegelmeyer, B. J. MacGowan, D. C. Mason, M. J. Matthews, and P. K. Whitman, "Optics Recycle Loop Strategy for NIF Operations above the UV Laser-induced Damage Threshold" *Journal of Fusion Science & Technology* (to be published) (2015)