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Ignition at NIF: Where we have been, and where we are going[1]

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This talk reviews results from the past several years in the pursuit of indirect-drive ignition on the National Ignition Facility (NIF), and summarizes ideas and plans for moving forward. We describe the challenging issues encountered by the low-adiabat ("low foot"), "ignition point design" approach, such as: hydrodynamic instability growth and ensuing mix of the CH ablator into the DT hot spot; very high convergence implosions with resultant imperfect symmetry; possible other issues such as hot electron preheat. The complex interplay among these issues is a key theme. We describe the progress that has been made in the understanding and diagnosis of these issues. We present the results from the high-adiabat ("high foot") approach, with its property of relative hydrodynamic stability when compared to the low foot approach, its somewhat reduced convergence ratio, and its achievement of entering the alpha heating regime, an important milestone on the road to ignition. Paths forward towards ignition include excursions from the present approaches in pulse shape, hohlraum, and choice of ablator. Further pulse shaping can lower the adiabat of the high foot approach and lead to higher performance if it continues to retain its hydrodynamic stability properties. Conversely, pulse shaping can provide for "adiabat-shaping" for the low foot approach for it to try to attain better stability. A plethora of hohlraum approaches (size, shape, materials, gas fills) can improve the zero-order drive, as well as the low-mode shape of the implosion. Diagnosing, and then correcting, the time dependence of the symmetry is also a key issue. A variety of ablator materials, along with carefully engineering the drive spectrum, can increase implosion velocity. The high-density carbon ablator has shown promising results in this regard. Some combinations of these developments may allow for an operating space that has a relatively short pulse, in a near vacuum hohlraum. That combination has shown, to date, much better coupling efficiency, and a much lower level of laser plasma instabilities (thus, less electron preheat), than the longer pulse, full gas-fill, ignition hohlraums. Advances in modeling, experimental platforms, and diagnostic techniques developed over the past several years have been key enabling technologies in moving towards ignition, and we anticipate further advances as well. We gratefully acknowledge the dedicated efforts of many hundreds of personnel across the globe who have participated in the laser construction, operation, target fabrication, and all aspects of the target physics program, that have taken us this far towards ignition.

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