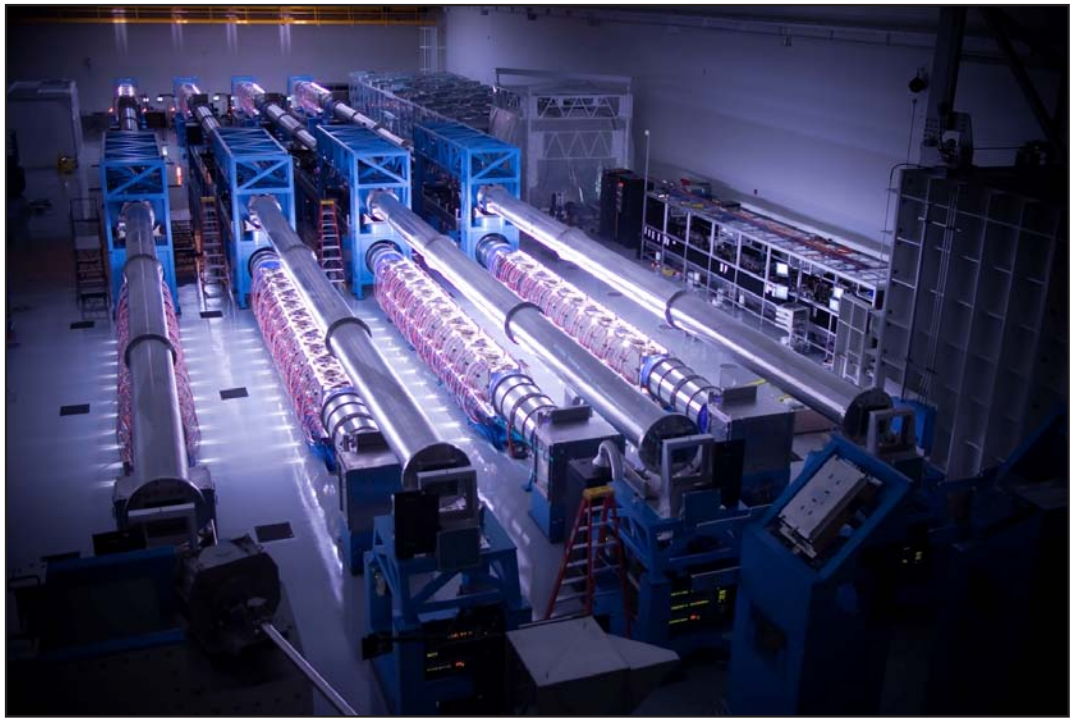
Laser-Driven Inertial Fusion Energy; Direct-Drive Targets Wrap Up



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The ICF community has a common IFE viewpoint (GA, LANL, LLE, LLNL, SNL)

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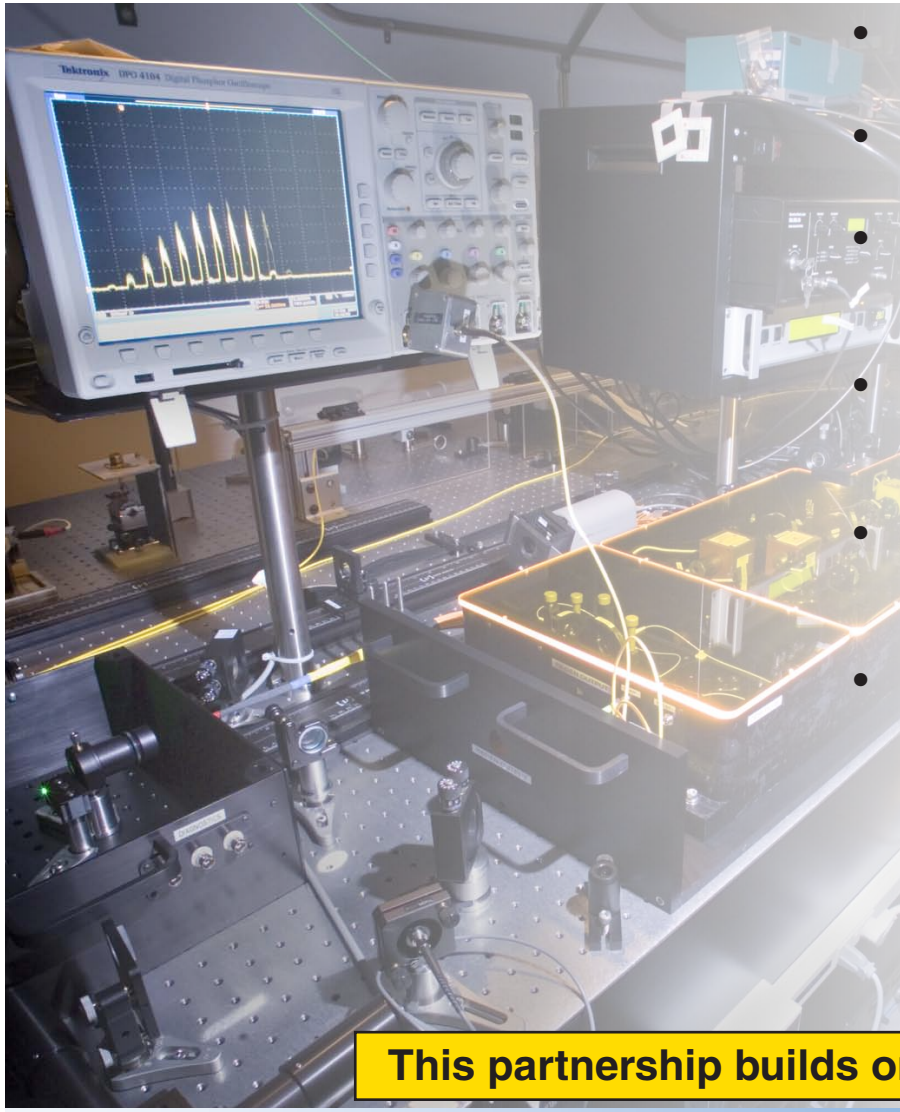
- Demonstration of laboratory ignition will establish that the physics underpinning IFE exploitation is fundamentally sound.
- IFE is a field in which the US is a clear world leader—academically, technologically and industrially.
- We have an opportunity to capitalize on this leadership position over the next few years and leverage prior substantial defense program investment.
- Recent action by the DOE to propose a new IFE development program and secure a stable home for IFE is timely and very welcome.
- Moving forward, the IFE program must focus on the requirements of an operating power plant, with design choices managed at a systems level.
- The inherent modularity and separability of IFE provides significant benefits when considering power plant development, operations, and evolution.
- Taking advantage of significant prior research, future development activities in this program must include IFE-scale science and technology development and demonstration.
- IFE is a national-scale program requiring a coordinated effort by academic, laboratory, and industrial partners.
- A phased program with competition and unambiguous selection criteria is needed.

LLE and LLNL have partnered to develop a diode-pumped solid state laser IFE program

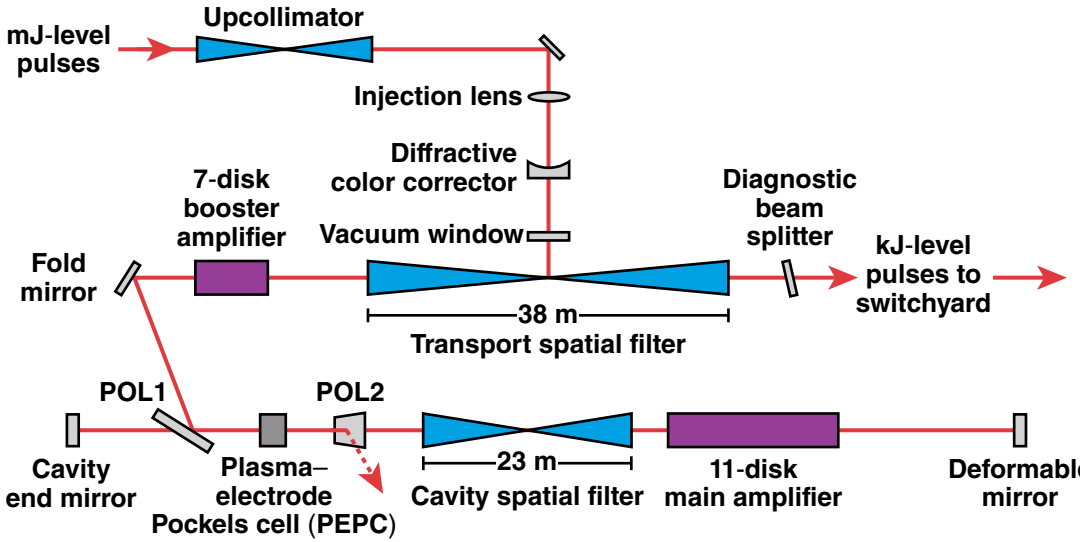


- Ignition should be demonstrated for any concept before progressing to the first plant
- LLE is developing the physics basis for direct-drive ignition
- It is anticipated that polar drive ignition can be demonstrated on NIF before 2020—either hot-spot or shock ignition
- Fast ignition is unlikely to be ready for a pre-2020 ignition demonstration, but the physics basis will be developed on Omega
- A down-select among different solid-state laser-based concepts could be made before the end of the decade
- Most of a diode-pumped IFE power plant system issues are the same for direct- and indirect-drive concepts
  - laser system design, including separability and reliability
  - target fabrication
  - tritium cycle
  - …

This partnership builds on both sites' strengths.

The open architecture of an OMEGA EP beamline could allow it to be converted to diode pumping

- An OMEGA EP beamline is NIF-scale unbundled
- An OMEGA EP beamline could be converted to a full-scale IFE prototype by diode pumping
- Advantages:
  - building and infrastructure exist
  - amplifiers are modular. So, a diode-pumped module could be developed off-line
  - existing OMEGA EP target chamber would allow for full scale-tests of target injection and tracking



LLE and LLNL are working together to resolve the outstanding IFE issues for solid-state laser systems

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- Design, development, and delivery of a fully integrated IFE plant designed to demonstrate all the performance characteristics required for commercial roll out of a fleet of IFE power plants
- Options for the target design will be developed jointly, making use of experiments on NIF and Omega. Options include:
  - 3ω, 2ω indirect drive
  - symmetric direct drive
  - polar driven hot-spot and shock ignition
- Development of a prototype solid-state laser beamline
- Development of "lab-on-a-chip" capsule manufacturing
- Development of an integrated target manufacture, injection and laser-engagement system
- Design and development of closed tritium cycle
- Design and development of final optics
- Development of the fusion engine
- Interactions with the energy industry, vendor supply chain, and others

Summary/Conclusions

LLE is the leader for direct-drive laser-based inertial fusion energy (IFE) concepts

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- Direct-drive based IFE concepts provide a complementary path to IFE relative to indirect-drive—with the potential of higher gains
- The Omega Laser Facility is being used to develop direct-drive IFE concepts—hot spot and shock ignition
- Hot-spot cryogenic implosions have achieved performance comparable to magnetic fusion
- Polar drive was conceived to allow direct-drive concepts to be tested on the NIF without reconfiguration of the beam disposition—current designs predict gains of ~30
- Polar drive could demonstrate ignition on the NIF before 2020
- LLE expertise will be used to develop technologies for glass laser-driven IFE – e.g. "lab-on-a-chip" target manufacture
- LLE and LLNL have partnered to develop the glass laser IFE concept

The solid-state laser concept shows great promise for IFE.