Meeting Themes:

Pilot Plants vs. Demos

Pilot Plant Goals and Features

U.S. and International Perspectives and Plans

Concept Scientific Readiness

Concept Technological Readiness

Status of Conceptual Designs

Costs and Schedules

Workforce Development

The Laboratory for Laser Energetics

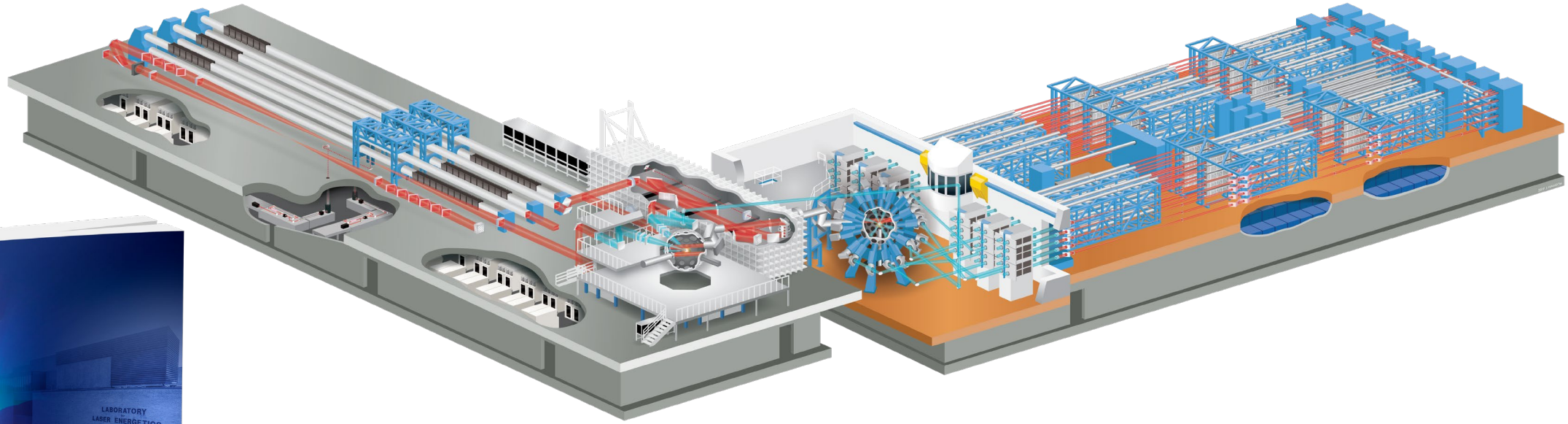
Dr. Chris Deeney, Director, and the LLE Team
University of Rochester
Laboratory for Laser Energetics

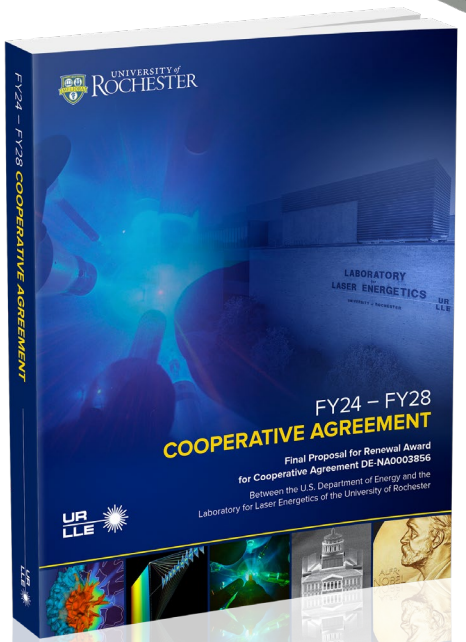
Fusion Power Associates
December 2023

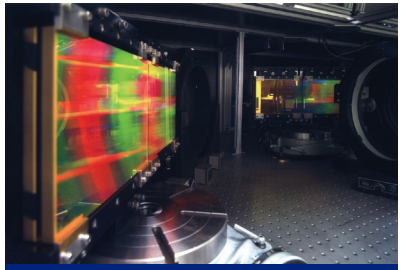
The vision for the University of Rochester's Laboratory for Laser Energetics:

The leading academic institution advancing laser technologies, fusion, and high-energy-density science at scale

National Nuclear Security Administration







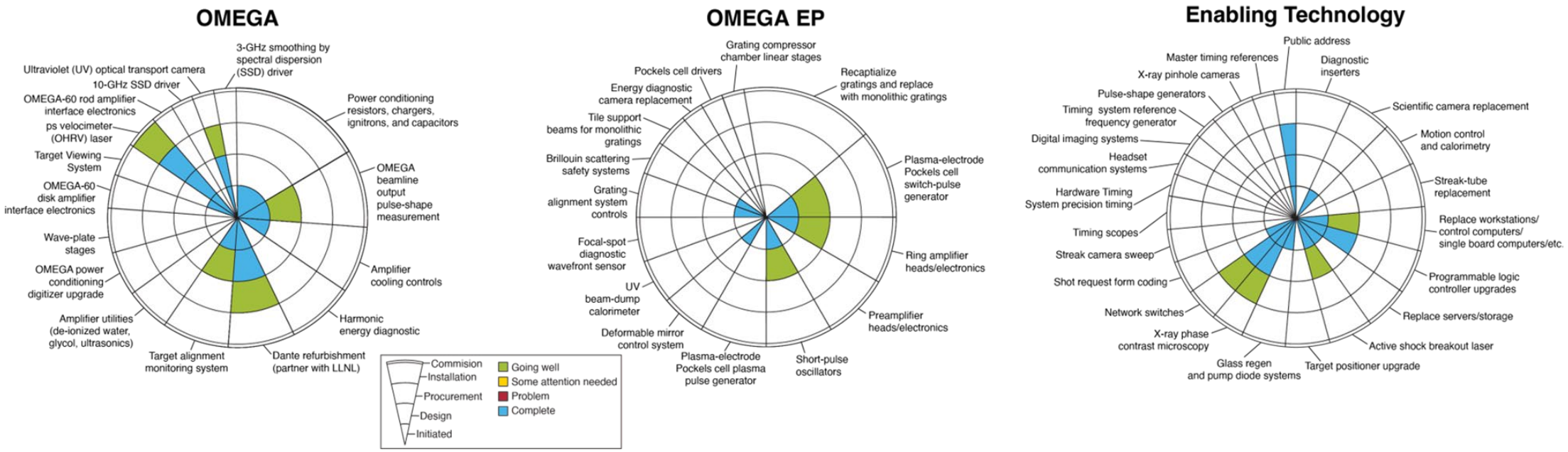
Innovation

Leadership in S&T

Education

Building S&T and future scientists for the national and energy security.

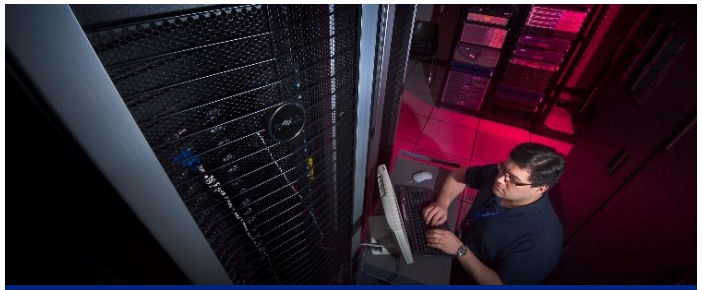
LLE has already started some of the sustainment activities because we cannot wait – we have slowed up new capabilities for mission research



A Dynamic Plan – we are re-assessing the schedule and scope as new information appears

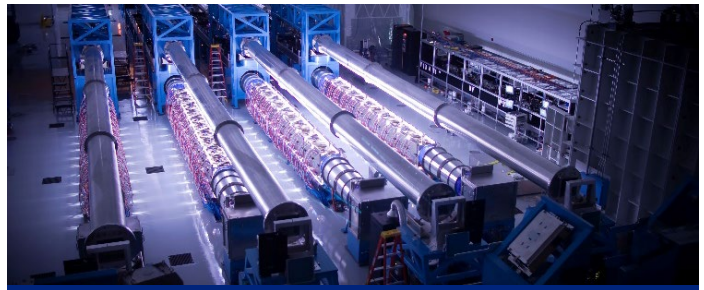
Our robust and vertically integrated program is essential to a “user facility”

National Nuclear Security Administration

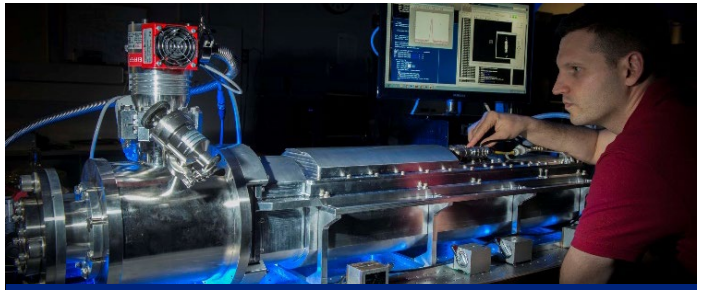


Multi-Dimensional Simulations

Precision Target Fabrication

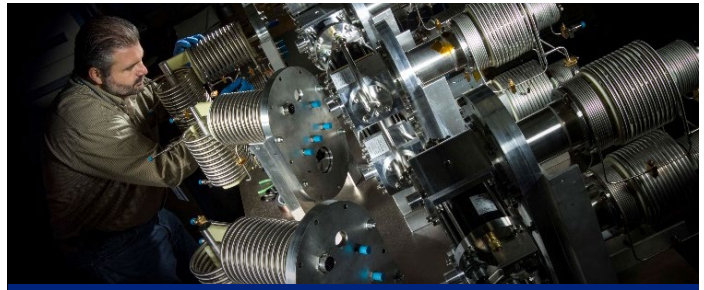


Advanced Laser Technologies



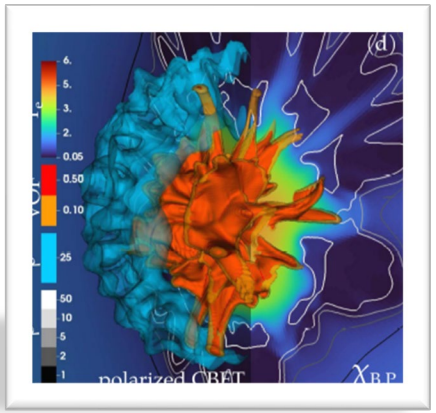
Pioneering Diagnostics

Rigorous Operations

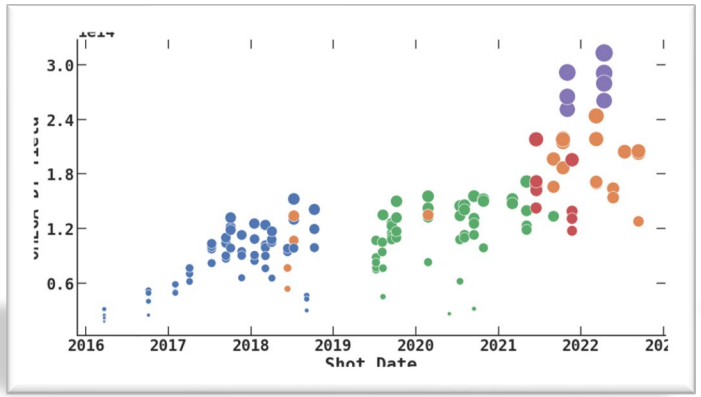


Complex Engineering

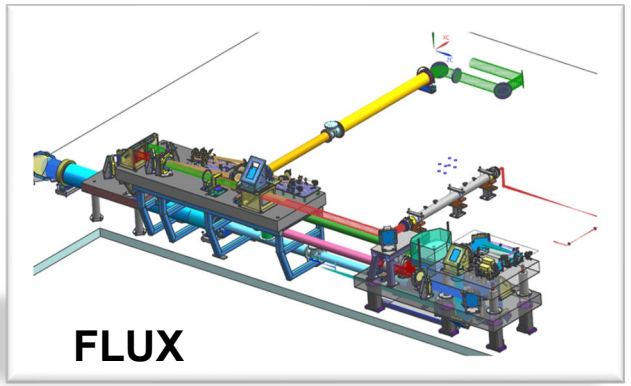
Significant Progress on Direct-Drive Inertial Confinement Fusion



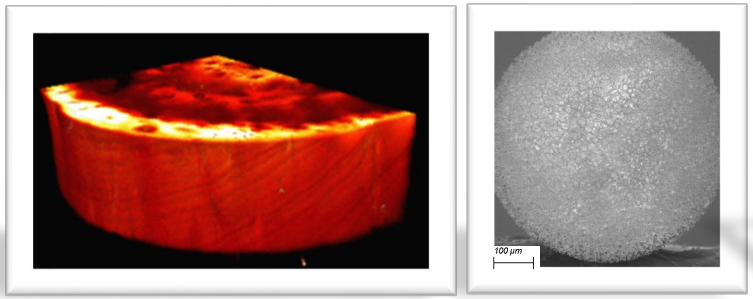
Detailed calculations to enhance understanding



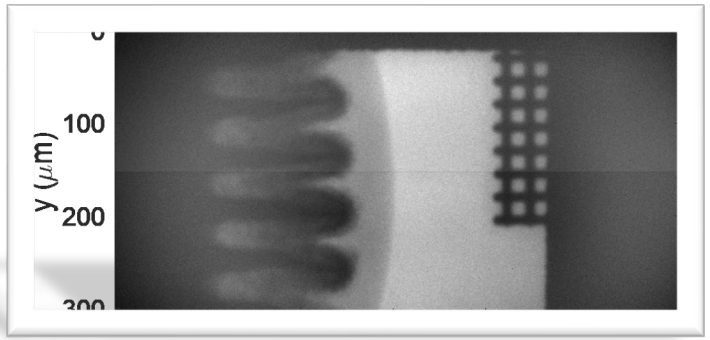
Significant progress on direct drive fusion



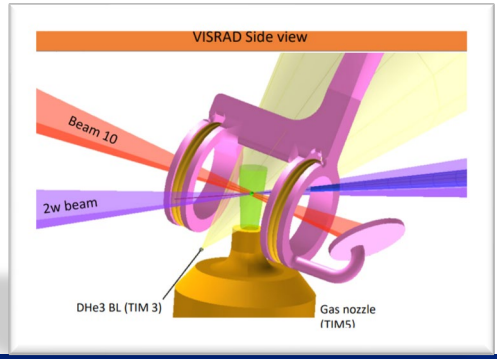
Prototype laser for enabling LPI control in future systems



New characterization and complex targets



Diagnostics allowing high resolution imaging



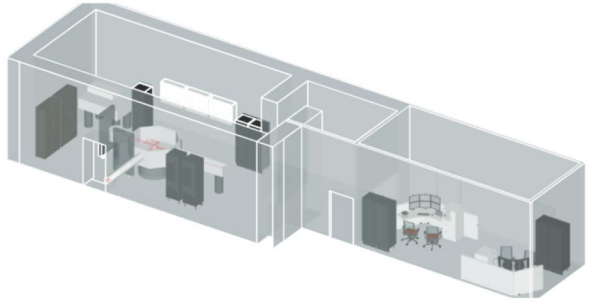
Ever increasingly complex magnetized experiments on Omega

Infrastructure Highlights

TOP 500 Computer System (#349)

New 3D Tomographic System

The new building will enable new laser development and improved target fabrication

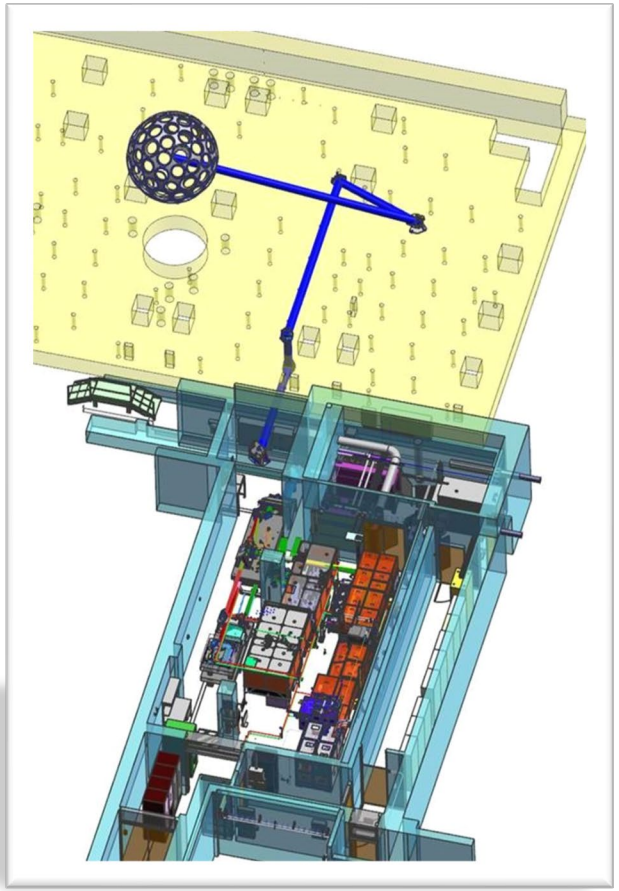


Started design of an MTW-OPAL target area

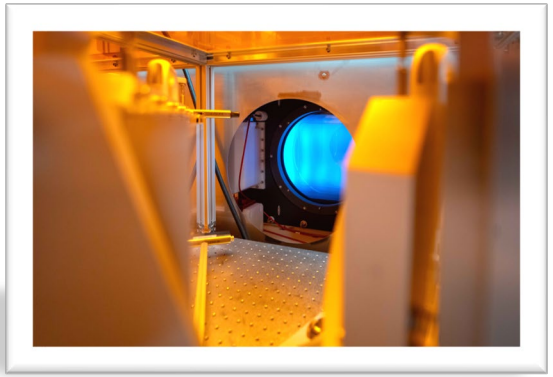
The university continues to enhance our facilities

New capabilities being added to our laser facilities

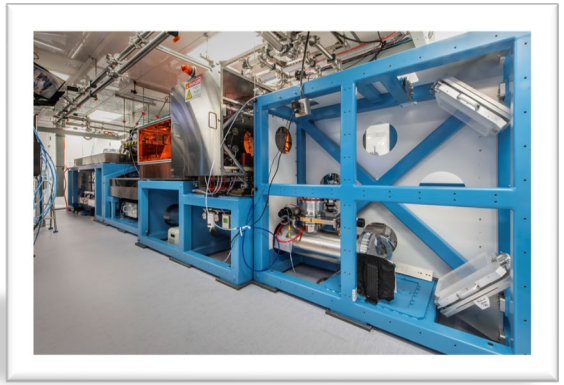
FLUX experiments should begin in 2024



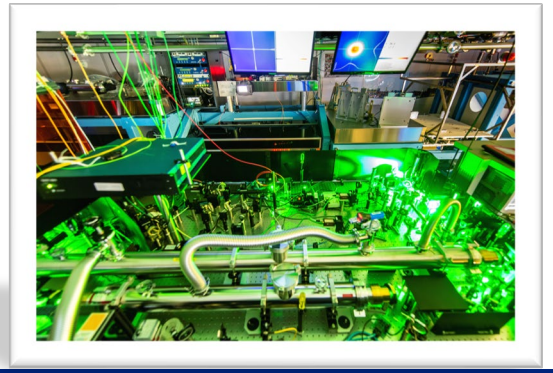
Facility Layout and Beampath to Omega 60



Midscale PEPC is developed and is being tweaked



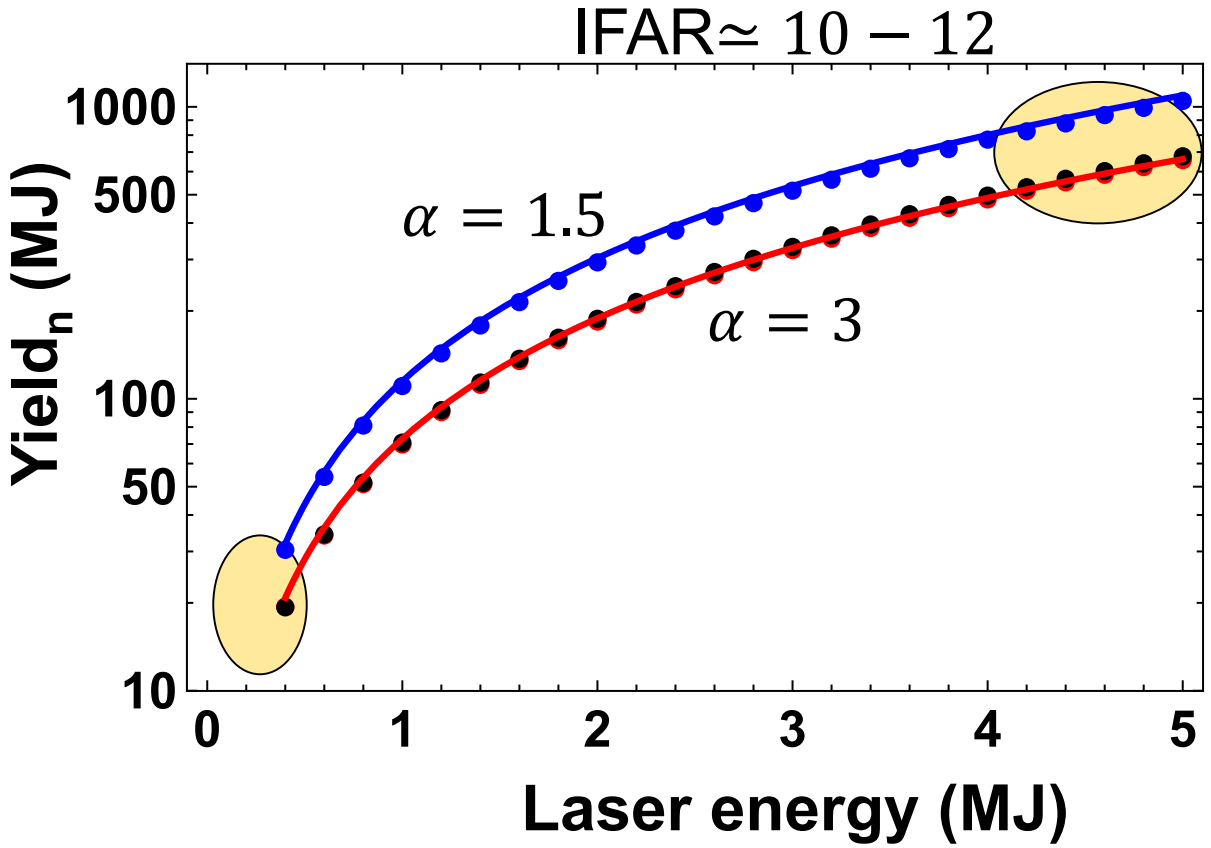
AMICA Pump has been constructed and is being commissioned



NOPAs are commissioned

Beam paths are being prepared into OMEGA 60

FLUX will open up interesting regimes for future ICF facilities (and fusion energy)

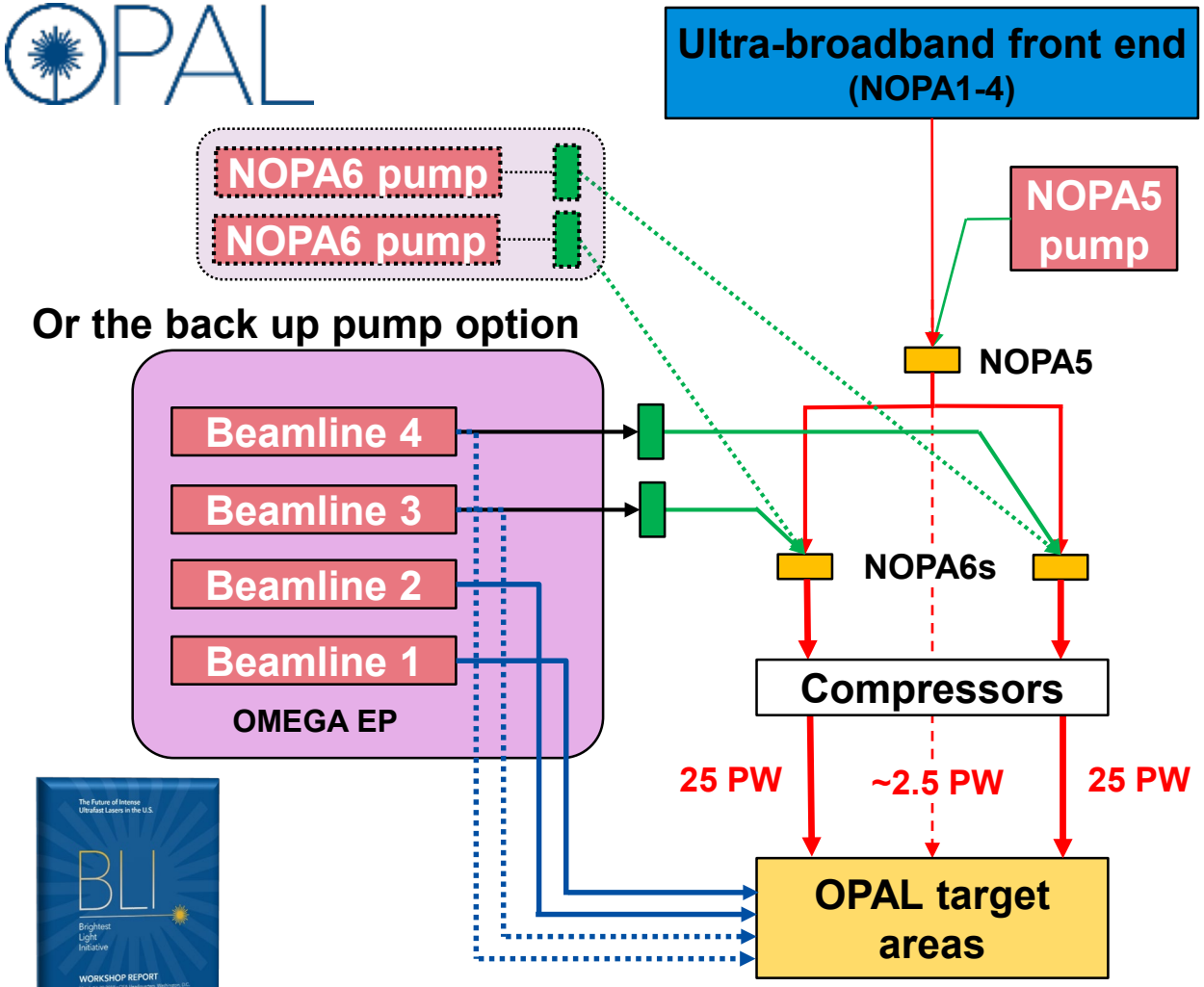


LPI-free broadband laser, beam zooming will be transformative for direct-drive fusion

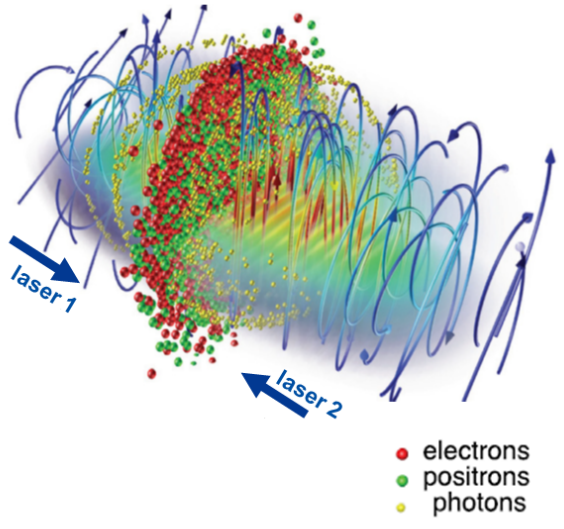
"A Hub for Broadband Laser-Plasma Science Focused on Inertial Fusion Energy" was selected by FES to receive $10M over four years (UR/LLE (lead), UCLA, Univ. Nebraska-Lincoln, Ergodic, LLC, Xcimer Corp.)

- IFE-COLoR (Inertial Fusion Energy—Consortium on LPI Research)
- IFE-Hub will focus on the science of bandwidth effects on laser-plasma interactions for IFE relevant targets
- FLUX will enable experiments to test our models:
  - Ion-acoustic wave instabilities (filamentation, CBET)
  - Electron plasma wave instabilities (TPD, SRS)
    - FLUX f/1 focusing will enable "multibeam physics" to be studied with a single beam (OMEGA LPI Platform)
  - Imprint Physics
- LPSE and OSIRIS (PIC) simulations will be used to design experiments and build confidence in LPI mitigation with bandwidth for IFE

NSF-OPAL will respond to needs of the global research community and lead to regaining U.S. leadership in the field

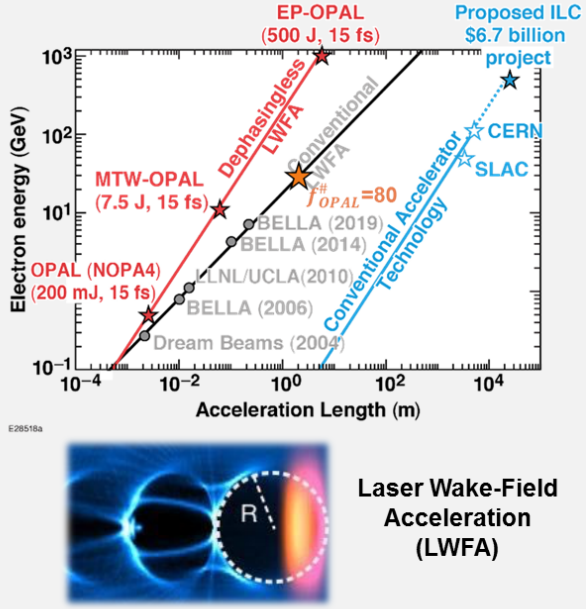


Quantum Science with Extreme Fields



Generating electron-positron plasmas from vacuum and other extreme field effects opens a *Window on the Universe*

Relativistic particle beams

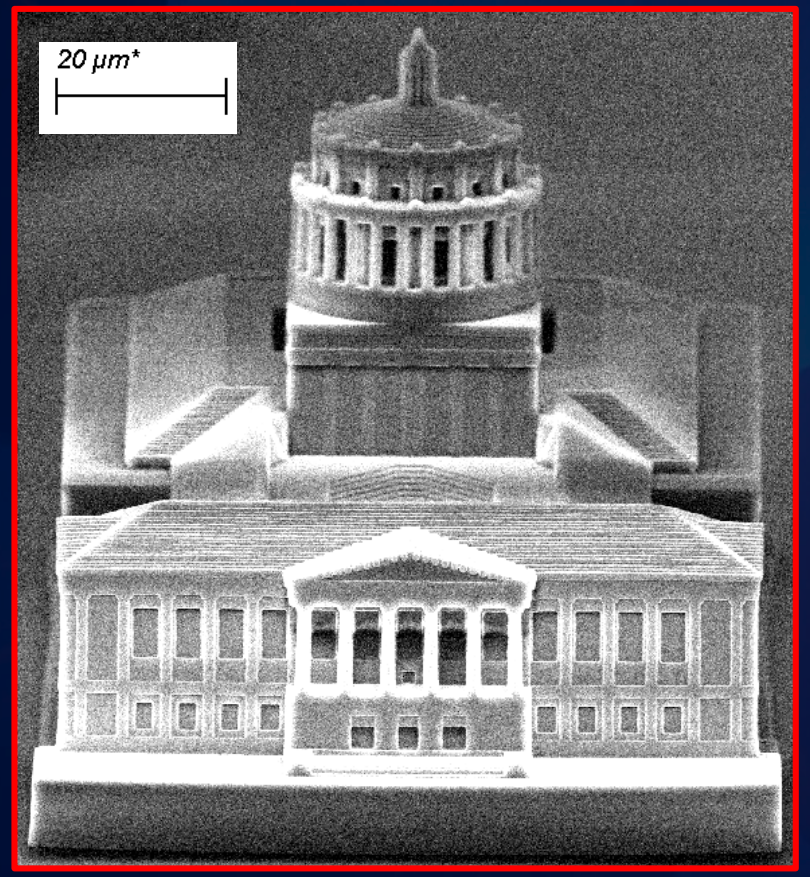


Scaling laser-based particle acceleration enables ~TeV electrons for basic science and applications

It also opens up the opportunity for advanced probes and light sources at NNSA compression facilities

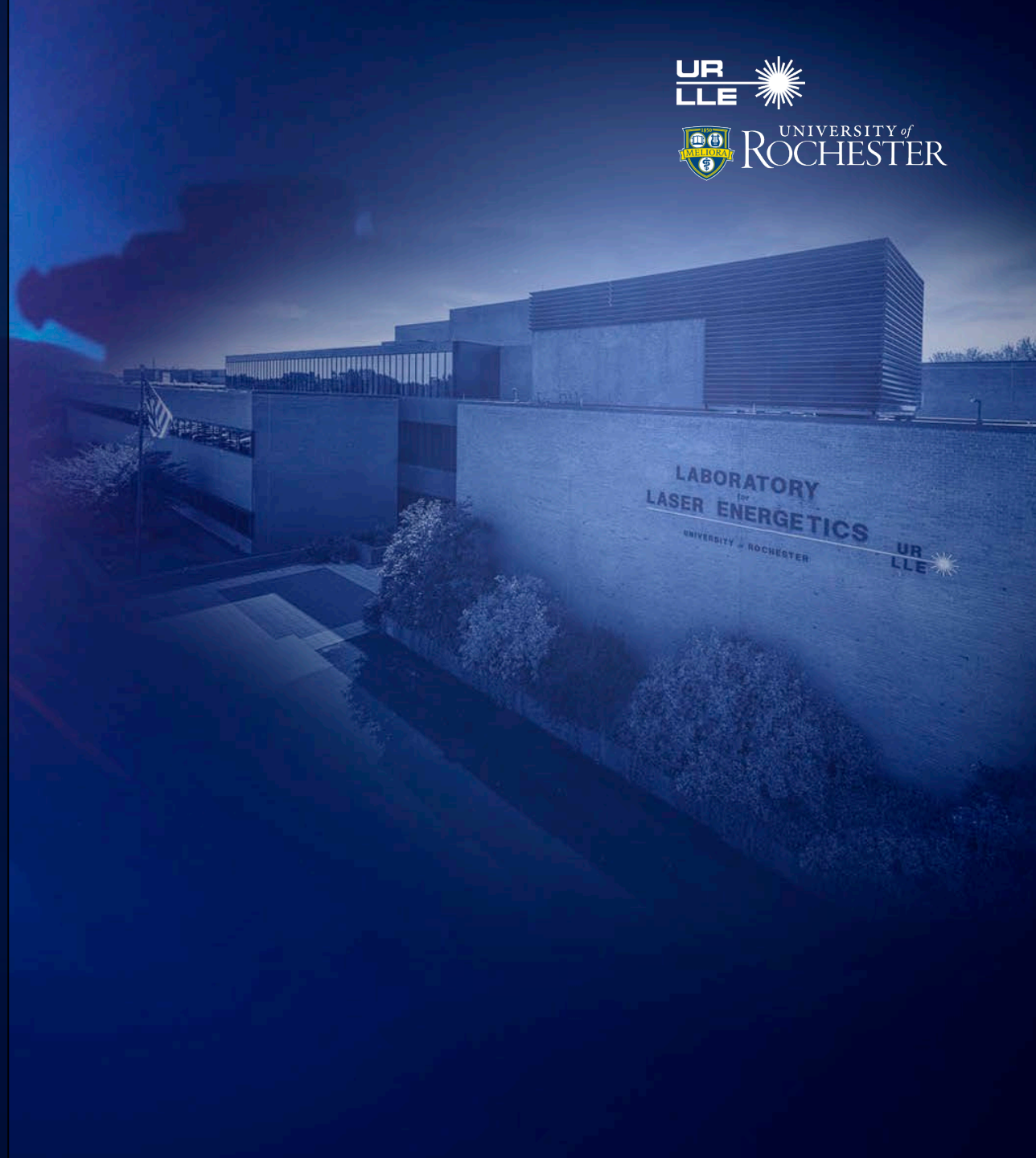
LLE invests in developing the workforce for the community

- In 2023, the inaugural program attracted 52 undergraduates from 10 different institutions, with 50% being in engineering. Thirty (approx.) are staying on for year-long engagement.
- In 2024, we expect an increase in students. We are also planning NNSA laboratory visits to network the students with the Labs and to identify internship programs
- Our PhD cadre will grow from 65 this year to about 80 in FY28
  - 11 U of R PhDs graduated this last year
  - 86 U of R PhDs in the last ten years (plus an additional 59 from the user community)
- We will be investing with Monroe Community College to expand their optics 2-year program to include more laser technology

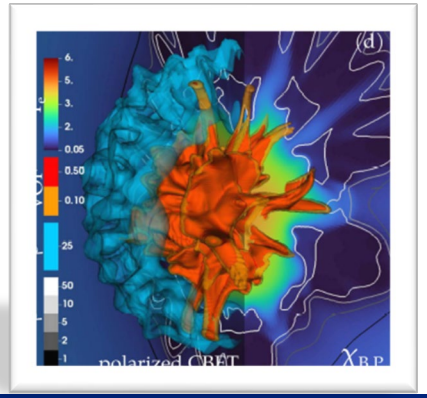


Thank You and Meliora

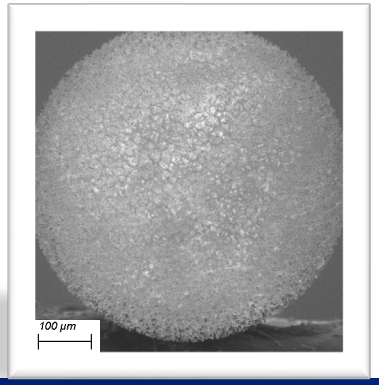
Questions?



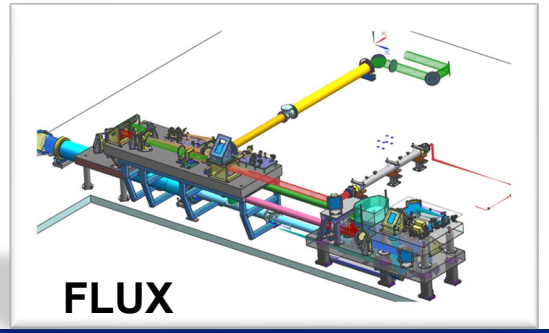
Our ICF and some IFE sponsored research have enabled capabilities and advances of interest to the fusion energy community



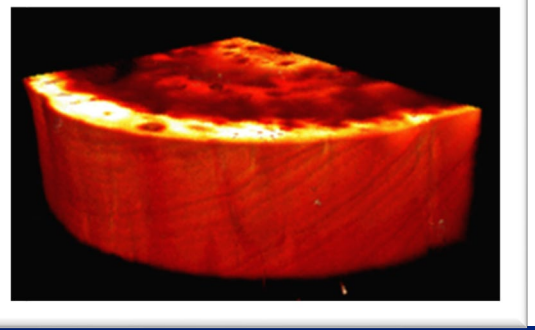
Detailed calculations to improved fusion performance



3D Printing of targets

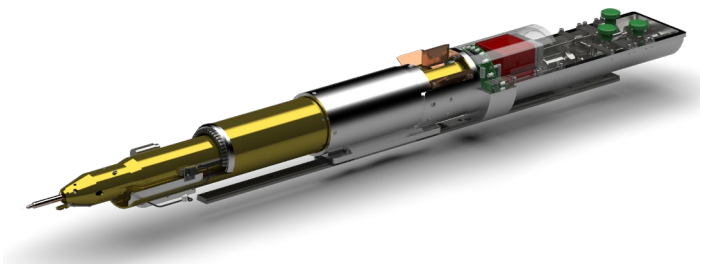


Prototype laser for more efficient fusion



New characterization of fusion targets

Unique tritium handling



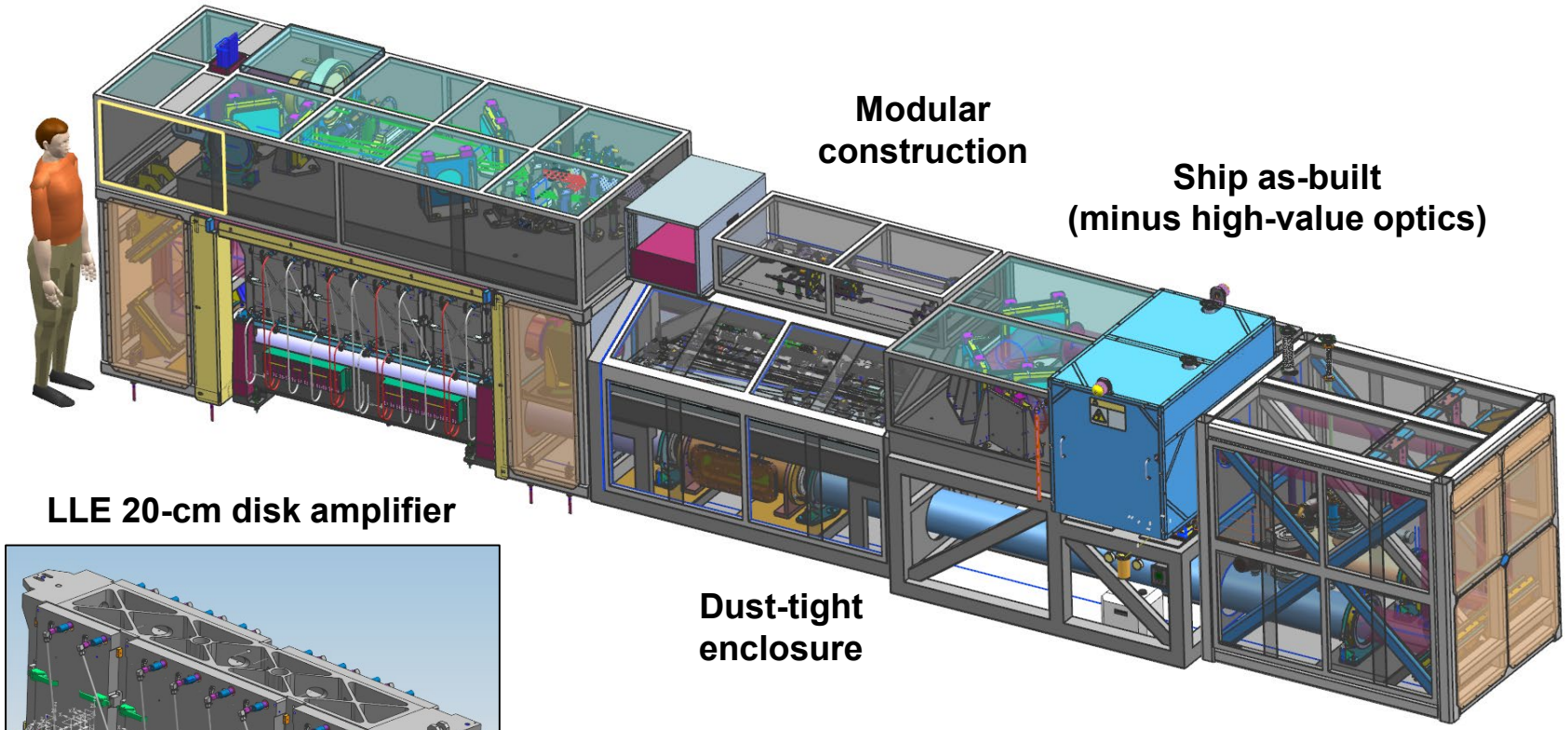
Advanced cryostats for more flexible fusion experiments

Fusion energy awards include 3 INFUSE grants and we are teamed with two recipients of DOE's public private partnerships; New IFE award from FES

The New Cooperative Agreement - $503.6M

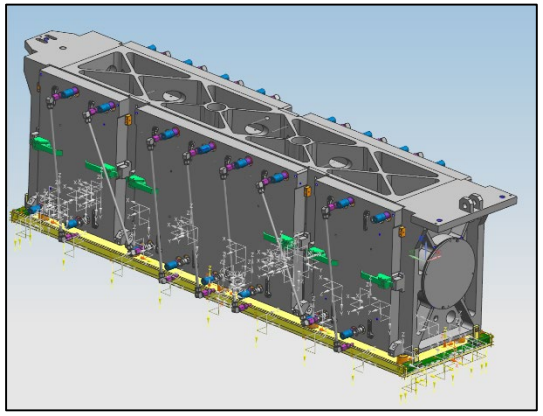
- Most of our activities will be similar to the last cooperative agreement
  - Running our facilities
  - Supporting a national user program
  - Creating a PhD pipeline
  - Lead laboratory for Laser Direct Drive fusion
  - Innovation and basic science for NNSA in HEDP, ICF, and Laser Technologies
- Facility Sustainment
- Expanded undergraduate programs
- Developing the roadmap for Omega Next

The Active Multipass Imaging Cavity Amplifier (AMICA) laser integrates a complete beamline into a flexible package for pumping advanced lasers or for compact dynamic material drivers

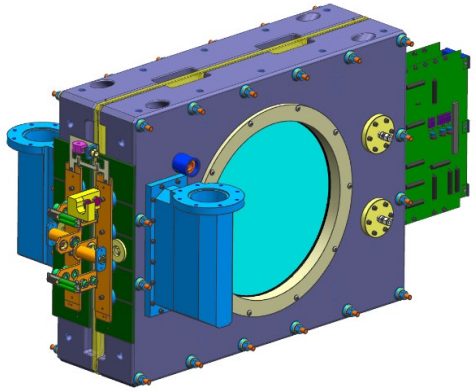


AMICA FLUX Pump laser	AMICA+ laser system *plus* booster amp
600 J (1ω) 400 J (2ω)	~2 kJ (1ω) ~1.5 kJ (2ω)
2× 1.5 ns	30 ns
narrowband	Multi-FM SSD

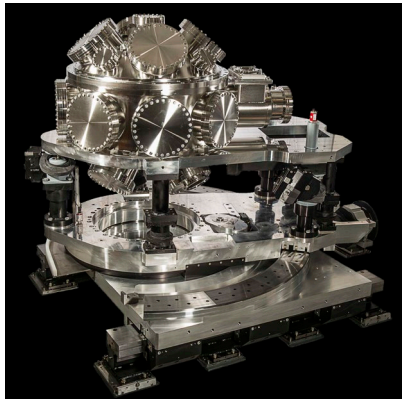
LLE 20-cm disk amplifier

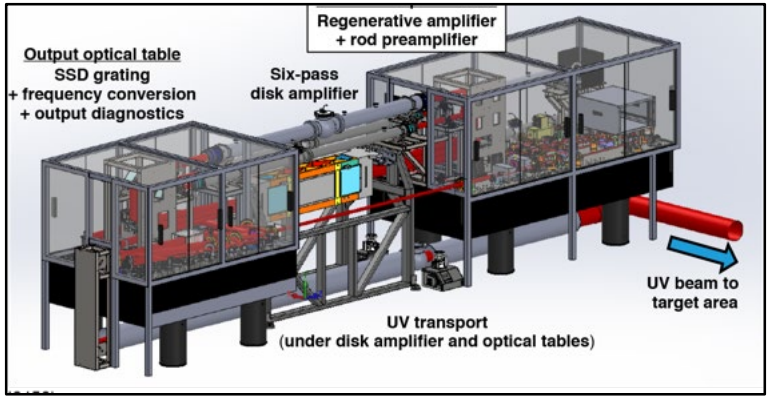


LLE mid-scale PEPC

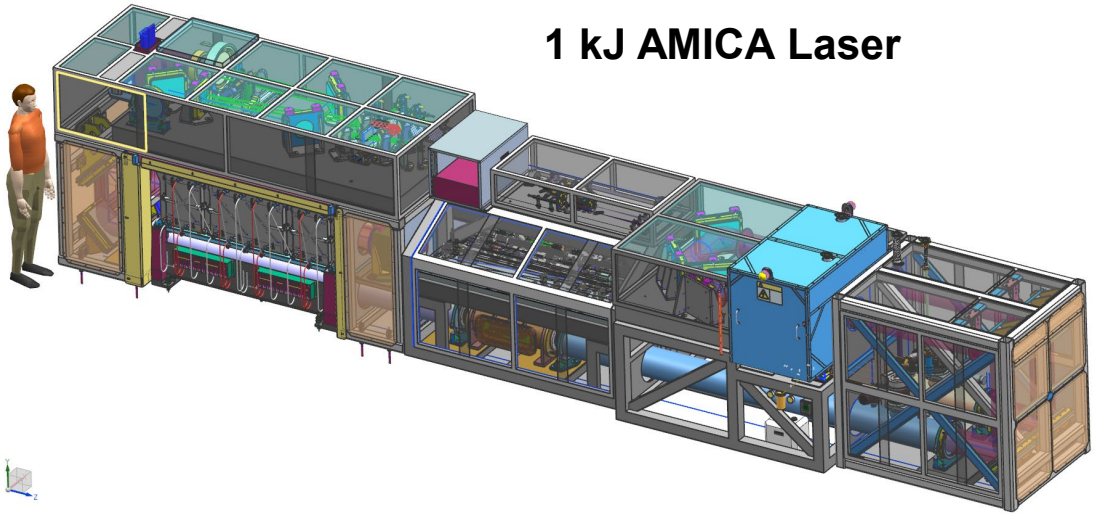


Increased impact beyond classic ICF and HEDP within NNSA – Compression capabilities at Light Sources



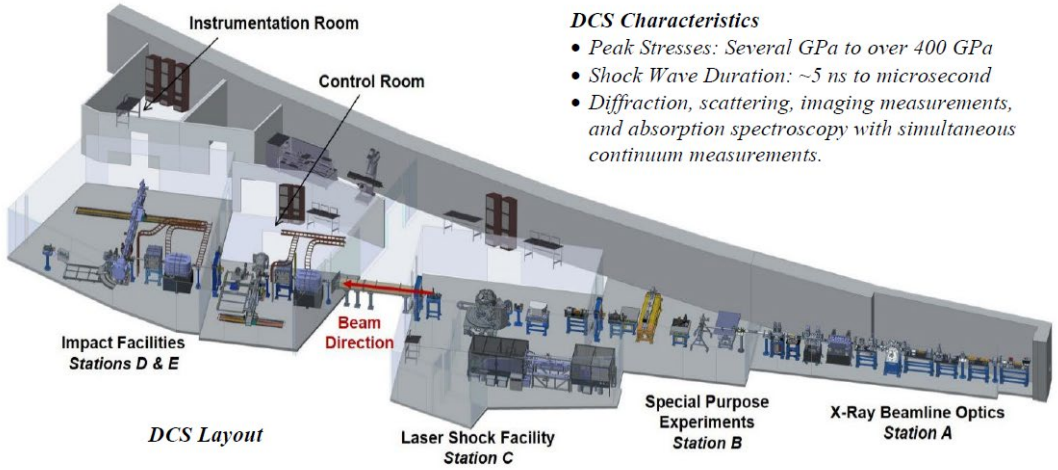


100J Laser for DCS

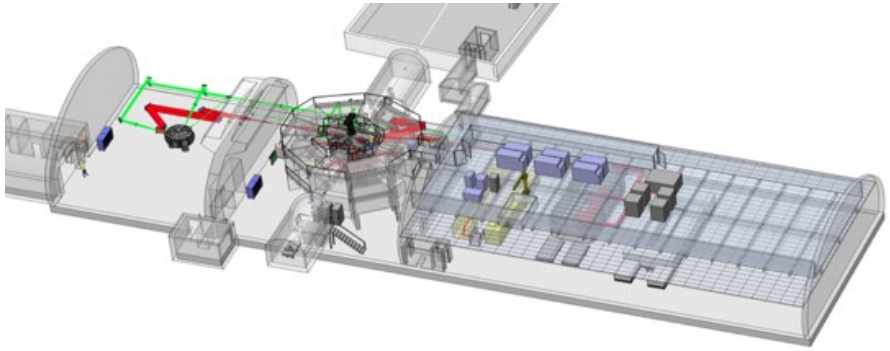


1 kJ AMICA Laser

1 kJ AMICA Laser would fit at DCS to exploit the capabilities APS-U enables



High-energy, long-pulse laser for MEC-U project funded by FES is based on AMICA laser



People Highlights

Sustained growth

U of R, National, and International Awards

Expanded Undergraduate Program

DEI Council Engagement and Guidance

Improving our connection with campus

BEST expanding our outreach

The LLNL panel for announcing "Ignition" on 12/13/22 is comprised of scientists with a long history of research at LLE

UR LLE
UNIVERSITY of ROCHESTER

Mark Herrmann
Program Director for Weapon Physics and Design
LLNL

Alex Zylstra
Lead Experimentalist
MIT PhD 2015 (OMEGA)
615 OMEGA
248 OMEGA EP
863 shots

Annie Kritcher
Principal Designer
85 OMEGA shots

Jean-Michel Di Nicola
Chief Engineer for NIF Laser Systems

Michael Stadermann
Program Manager, Target Fabrication

Art Pak
Team Lead, Stagnation Science
69 OMEGA
151 OMEGA EP
220 shots

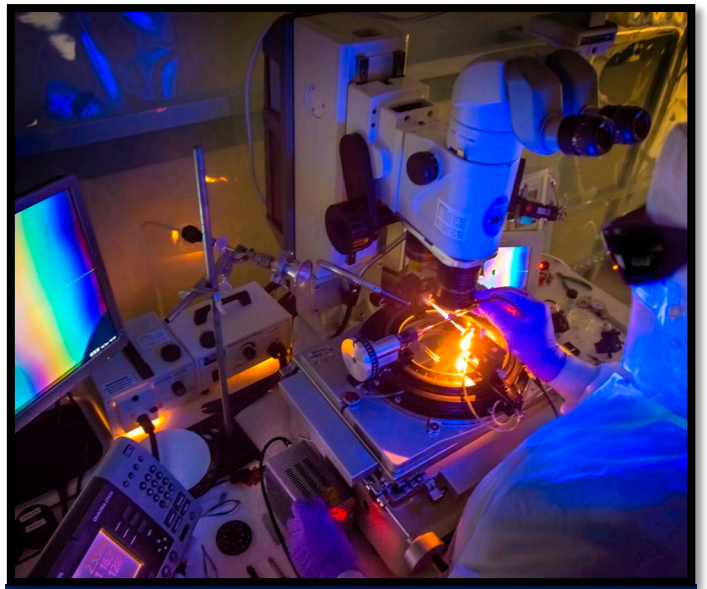
Tammy Ma
Lead Inertial Fusion Energy Institutional Initiative
106 OMEGA
68 OMEGA EP
174 shots

Panel participants were PI or co-PI on 1,342 shots at LLE

LLE has three R&D through production activities

Optical Manufacturing

- 500 components/year
- LLE, national lab, AWE and CEA

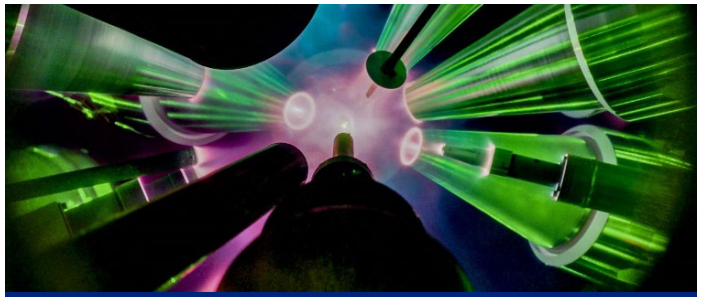


Target Fabrication

- 2500+ precision assemblies/year

Tritium R&D and Target Assembly

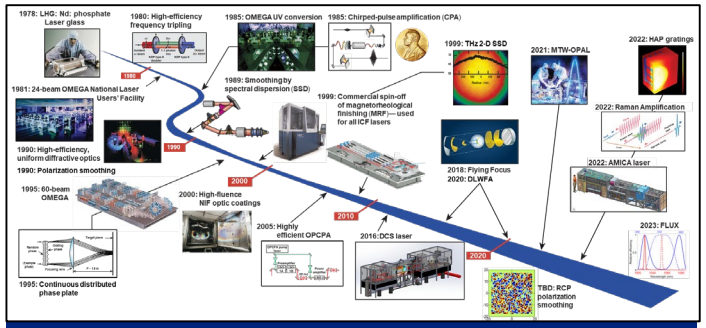
LLE pursues six strategies to realize its vision



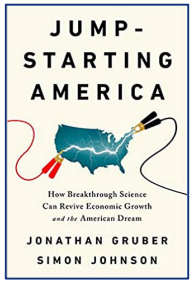
Prepare for a Robust, High-Yield Fusion Facility

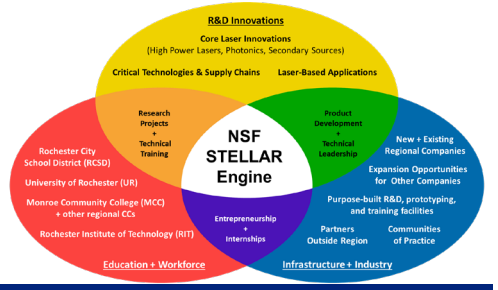
A 10,000+ shot per year "Omega Next"

Next-Generation Workforce



National Innovation Hub





Leader in Regional Development

Modernize Management