

High Energy Pulsed Laser Amplification Using Optical Enhancement Cavities



Caltech

2024-2025 DOE INFUSE Award

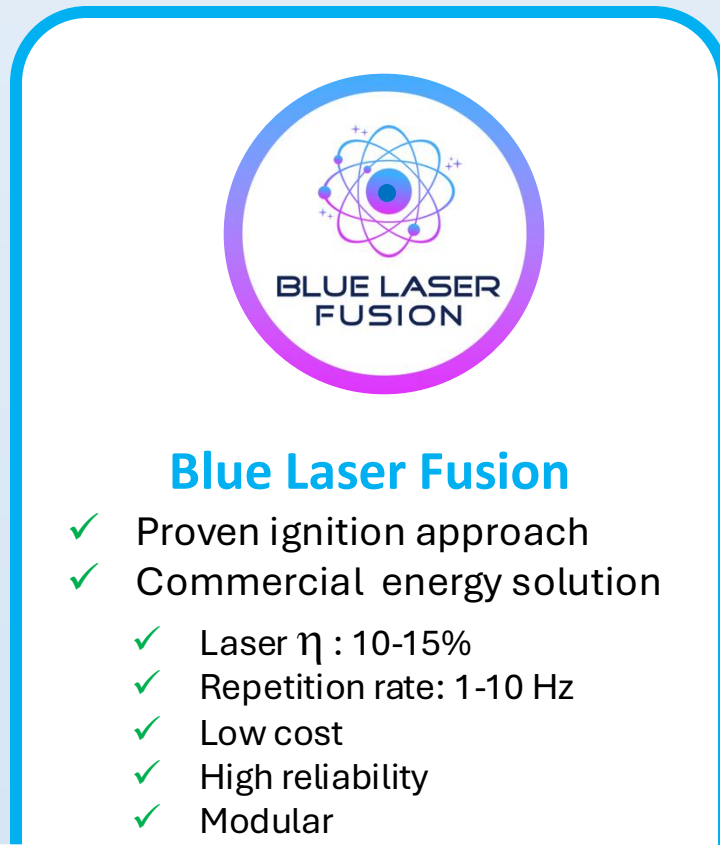
Caltech PI: Rana Adhikari; BLF: Trevor Cohen (PI), Morgan Pattison



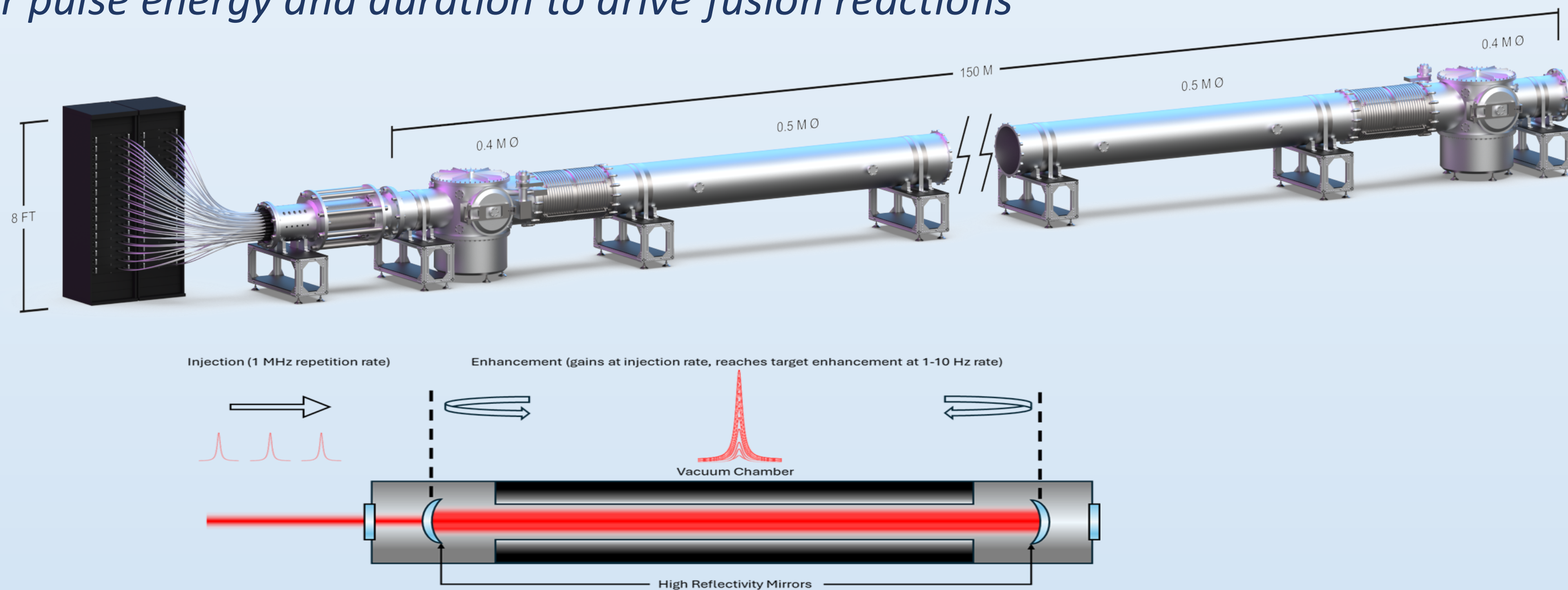
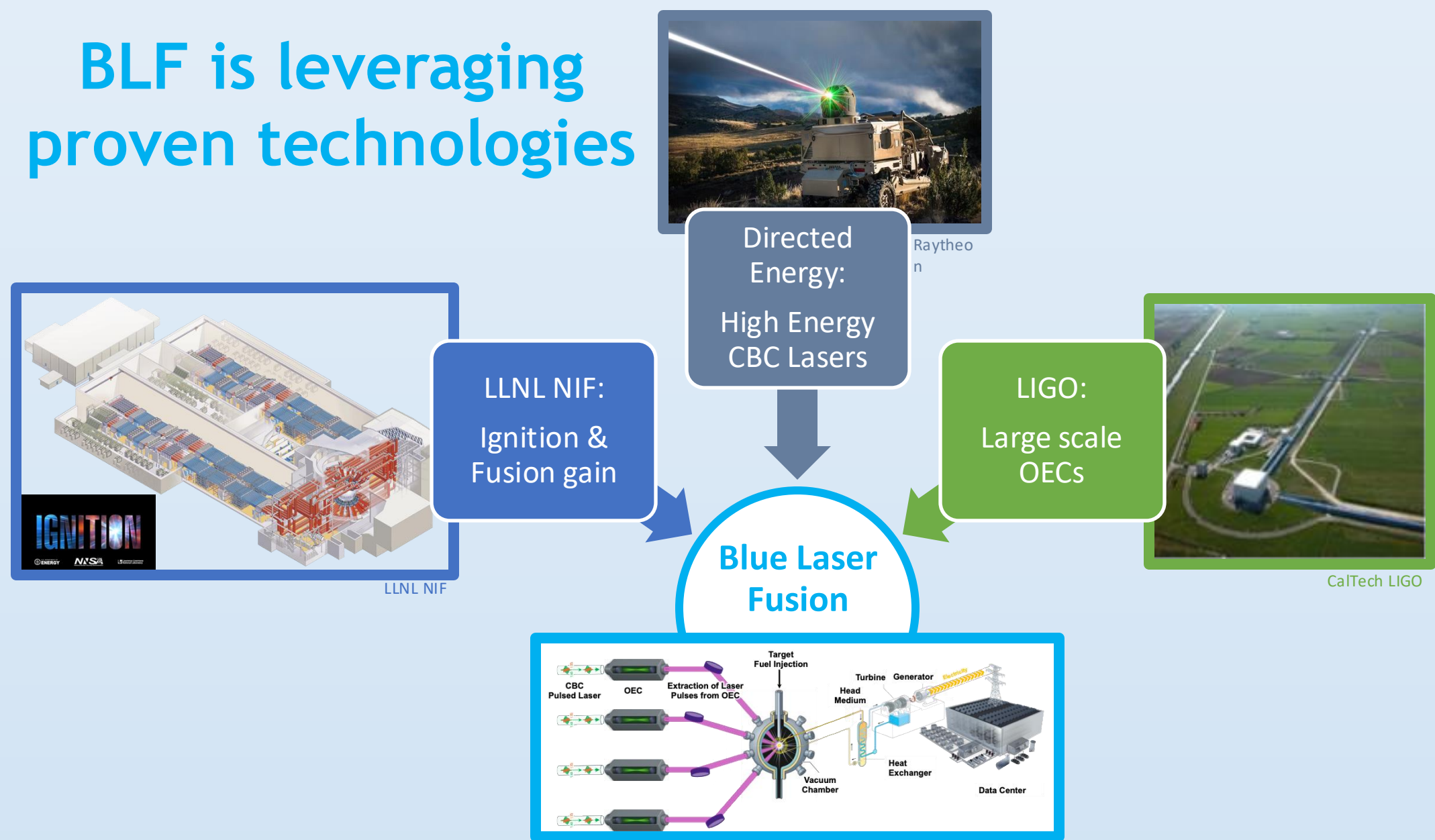
BLF Laser Platform Concept: Implement an optical enhancement cavity (OEC) with CBC injection lasers to generate laser pulse energy and duration to drive fusion reactions



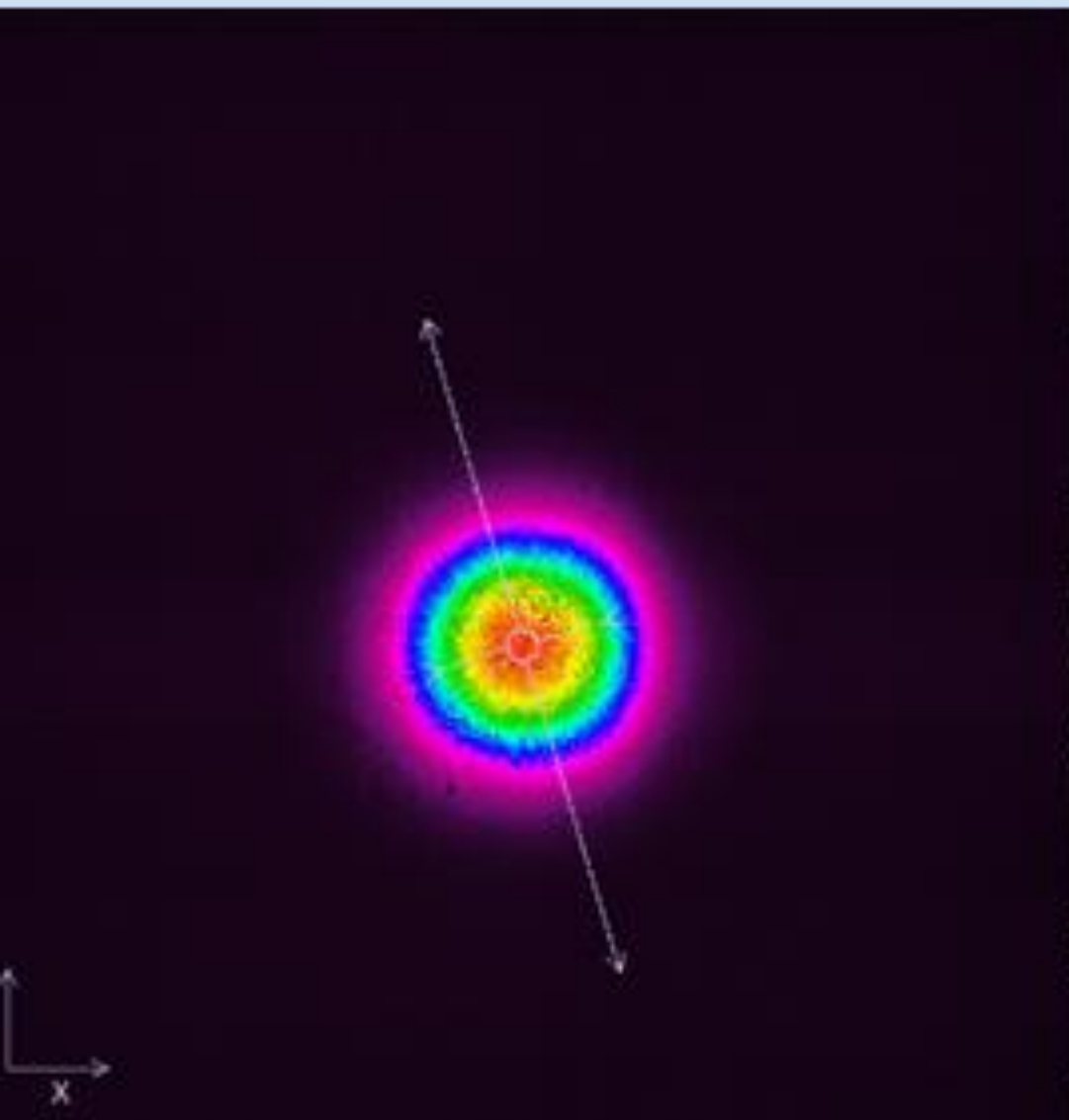
High efficiency OEC laser with a proven IFE approach



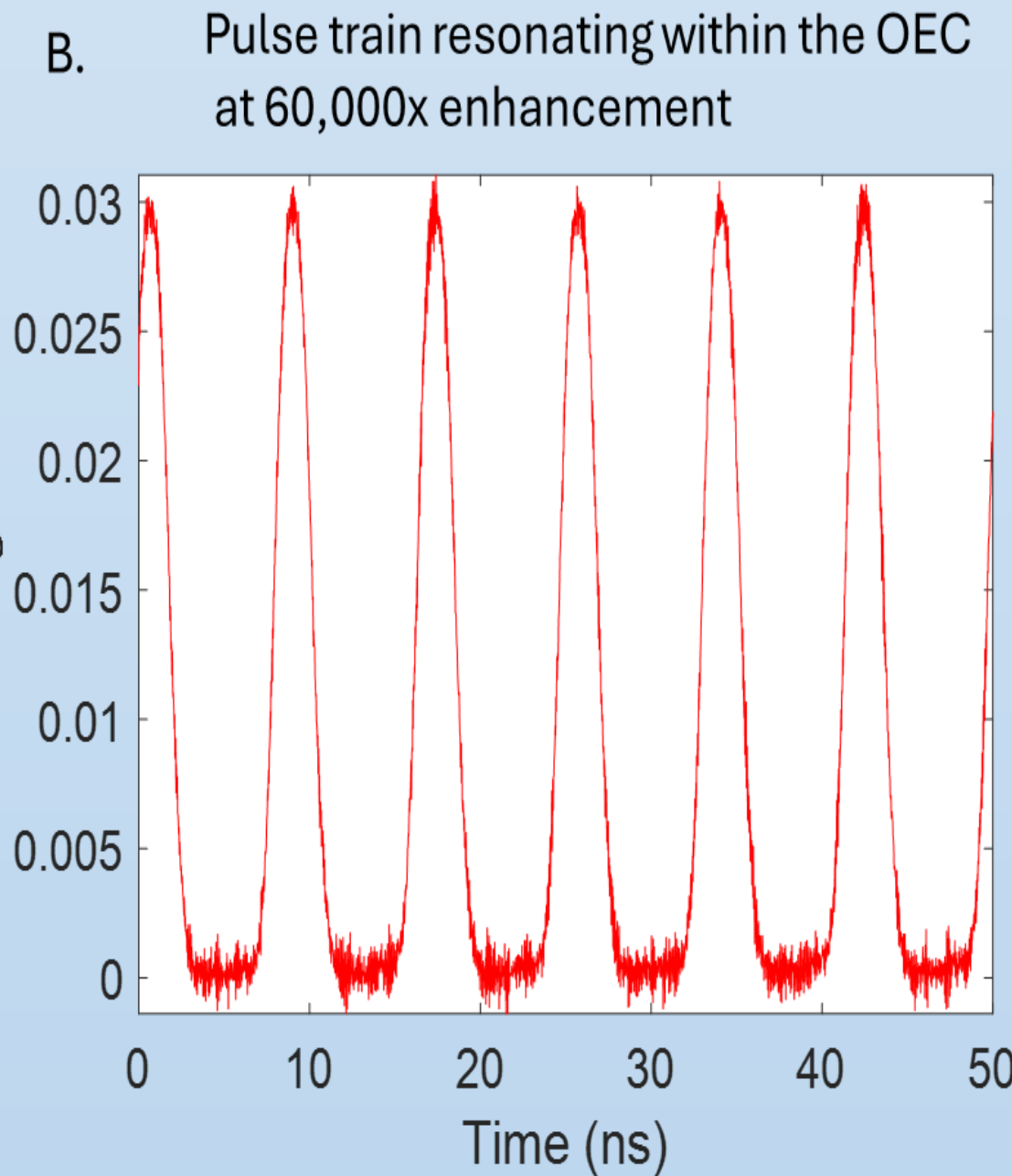
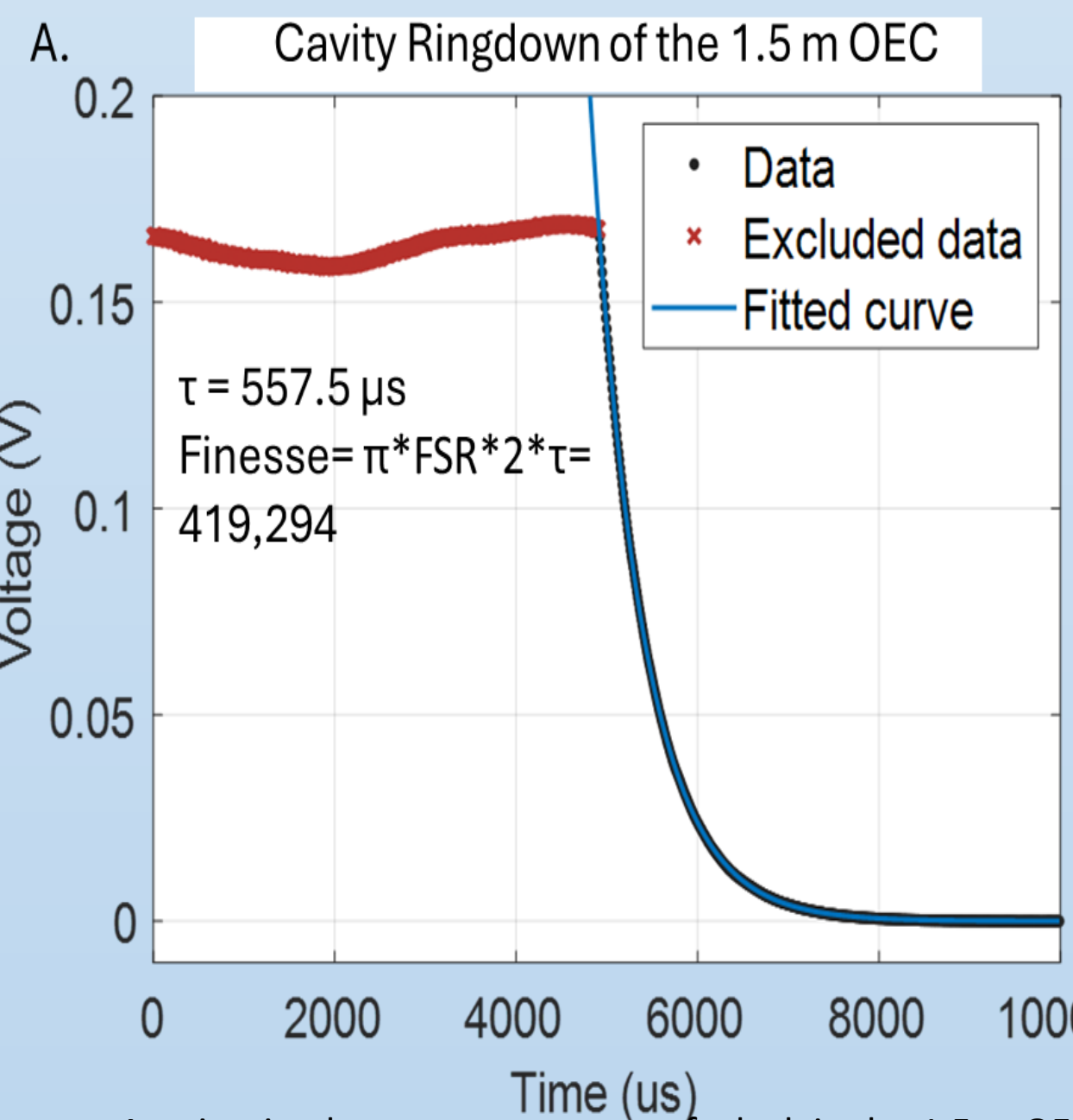
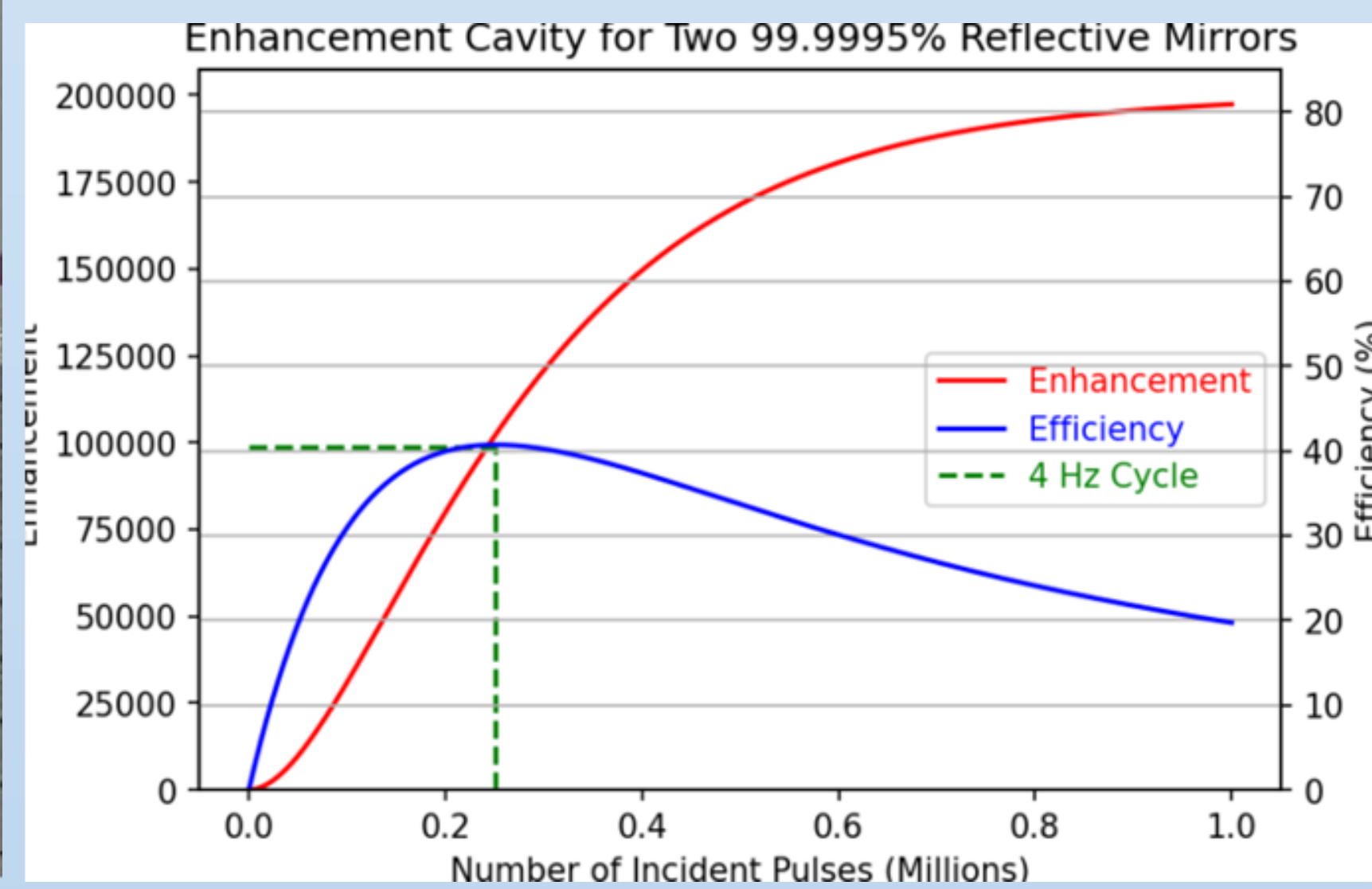
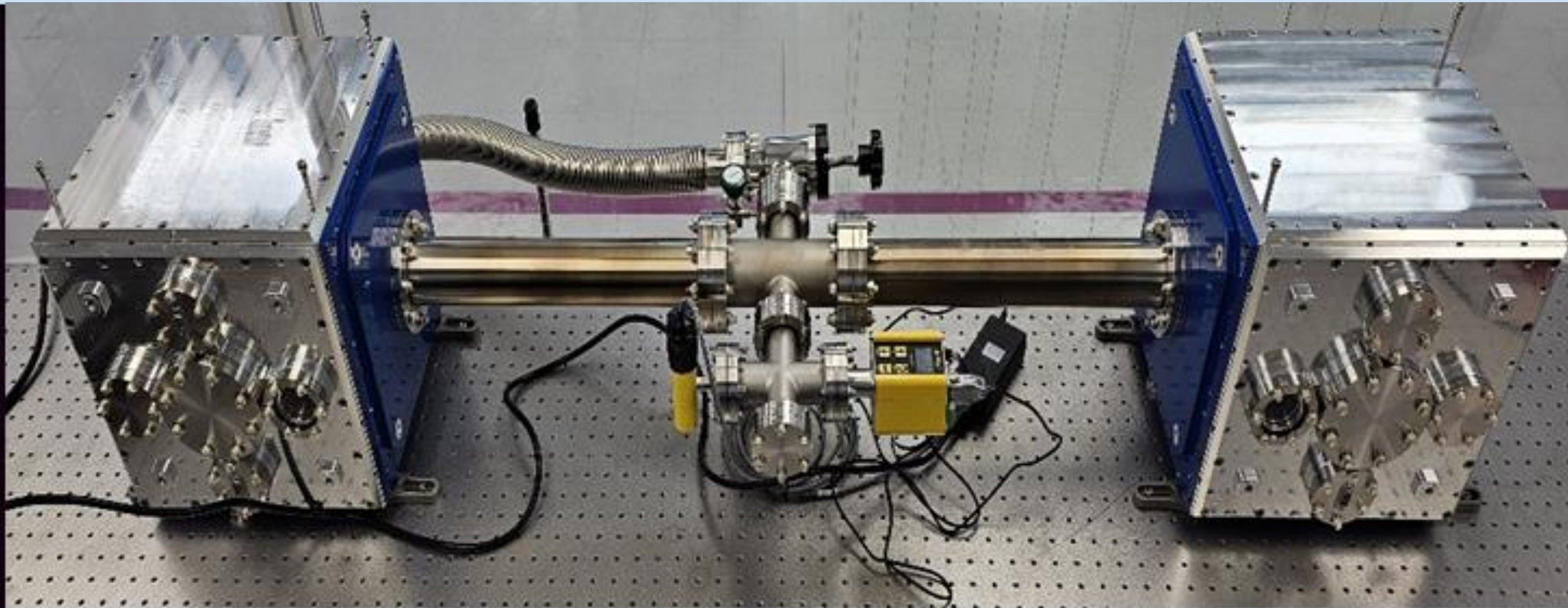
BLF is leveraging proven technologies



INFUSE objective: Implement OEC controls, systems, and models developed by Caltech for LIGO within a platform for laser inertial fusion application



Beam profile of the transmission through the OEC when the laser is locked to the TEM₀₀ mode. The beam diameter is 3.2 mm FWHM. OEC vacuum chamber with 1.5 m cavity length.



A. Cavity ringdown measurement of a lock in the 1.5 m OEC. A fit of the exponential decay yielded a lifetime of 557.5 us corresponding to 419,294 finesse. B. A 2 ns pulse width, 100 MHz, pulse locked to the 1.5 m OEC with 60,000x enhancement.

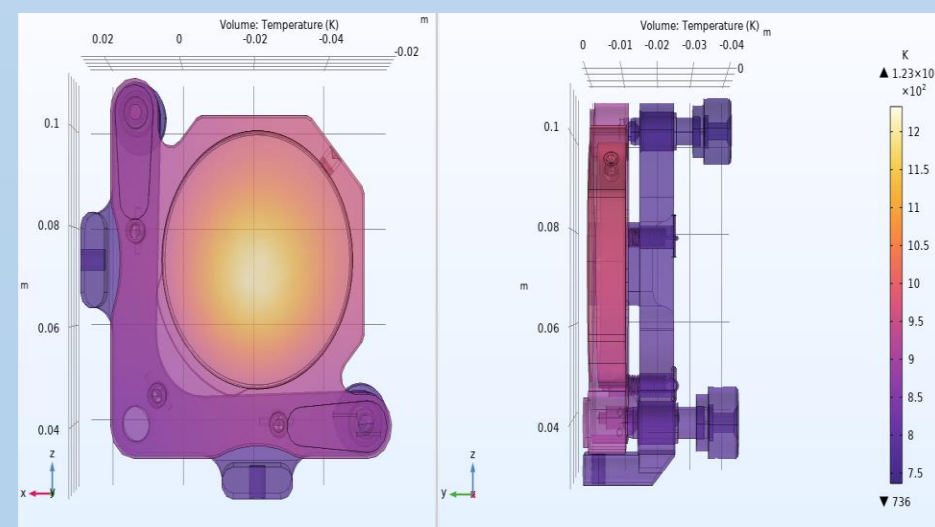
INFUSE Achievements:

- 1.5m OEC laser constructed
- Enhancement >70,000X
- Laser-cavity resonance locking and controls
- Clean vacuum system designed and fabricated
- High reflectivity mirrors specified, procured, installed
- Consistent cavity performance enabling developments to vacuum system, injection lasers, mirror characterization, controls system
- Subsequent design of 15m OECs



Next Steps

- Demonstrate 100,000X cavity enhancement
- Increase injected laser power to cavity
- Improve mirror performance and thermal management
- Improve active cavity alignment controls
- Construct full-scale 150m OEC cavity



Cavity mirror heating in a conventional optic mount

About Blue Laser Fusion, Inc.

Blue Laser Fusion Inc. (BLF) is a leading fusion energy company based in Santa Barbara, CA with offices in Silicon Valley and Tokyo, Japan. The company is commercializing a proprietary and novel laser fusion technology to achieve the world's first carbon-free, on demand, renewable, clean energy generation and to accelerate a transition to an electrified world. BLF aims to commercialize a GW scale reactor to provide power to the grid to meet the acute and increasing demand for clean energy for data centers and to support the AI revolution, for semiconductor chip fabrication facilities and chemical and steel production plants, as well as for electric vehicles and homes. The company has a comprehensive IP portfolio with more than 100 patents and applications internationally. To learn more, please visit: www.bluelaserfusion.com