

## **Ansys + ELI Beamlines**

“Because Zemax is a well-known, well-tested commercial application suite, using OpticStudio gives us high confidence that we can fully understand and predict the phase-to-amplitude modulations of our beam transport.”

**Dr. Stefan Borneis**

Senior Consultant, Laser Beam Transport / ELI Beamlines

# ELI Beamlines Develops a High-power HAPLS Laser Beam Transport System Using OpticStudio

ELI Beamlines focuses on research into developing short-pulse secondary sources of radiation and particles. Its main objective is to become a truly multidisciplinary, user-oriented multi-petawatt ( $10^{15}$  W+, or 1 quadrillion) laser infrastructure to support groundbreaking scientific experiments and applications in a wide variety of fields, including physics and astrophysics, chemistry, biology, medicine, and materials science. ELI Beamlines uses OpticStudio's efficient, reliable system modeling and beam propagation to support these objectives.

## / Challenges

ELI Beamlines' latest advancement is its High-repetition-rate Advanced Petawatt Laser System (HAPLS). HAPLS is the first diode-pumped and highest average power petawatt system (300 W, 10 Hz repetition rate) ever built. HAPLS can achieve focused intensities between  $10^{21}$ - $10^{23}$  watts per square centimeter, the equivalent of all sunlight as it arrives at the earth being focused to the diameter of a human hair. Achieving the extreme high-power, short-pulse features of HAPLS required rigorous design validation and highly nuanced beam propagation capabilities.

## / Ansys Products Used

- OpticStudio (Professional license)

## / Engineering Solution

The success of ELI Beamlines' projects generates ongoing high-funding stability for both the organization and related organizations. This, combined with the precision and unprecedented capabilities its technologies afford to other scientists, make it crucial for ELI Beamlines to build systems efficiently and practically. This ensures collaborators can work together effectively and their discoveries are brought to the rest of the community in timely and impactful ways.

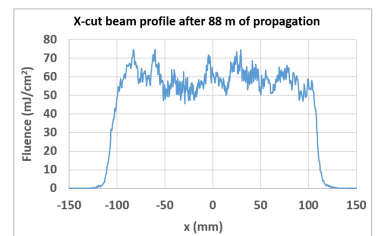
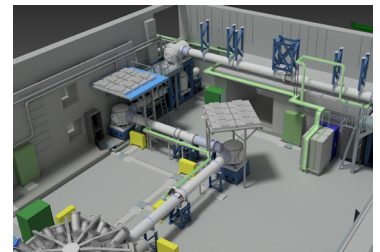
Using OpticStudio, the team modeled phase-to-amplitude modulations during beam propagation to experimental chambers, where the beam is focused up to 100 meters of propagation with off-axis parabolas. OpticStudio was then used to assess intensity modulations, as well as to predict acceptable phase errors as the new HAPLS system was commissioned.

## / Benefits

- OpticStudio enabled sub-system and beam transport system designs for HAPLS, the world's first diode-pumped and highest-repetition-rate petawatt laser system.
- The beam transport model accurately predicted that phase-to-amplitude modulations during free space beam propagation would not lead to intensity spikes that exceeded the laser-induced damage threshold (LIDT) on high-power, dielectrically coated mirrors.
- Project design goals were achieved in far less time using the Zemax software than it would have taken to produce a likely lower-quality result using in-house code development efforts.
- Using OpticStudio saved millions of euros and two to three years of development time due to reduced engineering and coding complexity achieved through beam transport operation predictions.

## / Company Description

Founded in 2011, Prague-based ELI Beamlines is a subsidiary of the pan-European Extreme Light Infrastructure (ELI) project, a member of the European Strategy Forum on Research Infrastructures (ESFRI). ELI began as a shared initiative between the European scientific laser community and Laserlab-Europe. Together, the institutions promote interdisciplinary research development using light and radiation from ELI-hosted laser systems — some of the most intense lasers available worldwide.



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