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CASE STUDY /

Ansys + University of Jena

"Lens manufacturers provide specifications, but on their own, these were insufficient for our purposes. Our laser applications use different wavelengths from a typical optics project, and we do more complex things like beam shaping. For the work we're doing, we needed ray tracing in OpticStudio to give us the aberration magnitude data so we could compensate for that with our design."

Qingfeng Li
Postdoctoral Researcher / University of Jena

CASE STUDY

Photonics and Applied Physics Labs at University of Jena Use OpticStudio to Gain Precision in Ultrafast Bulk Laser Processing

Experimentation in bulk laser processing — the cutting, drilling, engraving, or other structural modification of dense material using high-powered, high-frequency pulse duration "ultrafast" lasers — is the focus of recent experiments at two schools within the Friedrich Schiller University of Jena in Jena, Germany: The Institute of Applied Physics (IAP) and the Abbe Center of Photonics (ACP). The goal of these experiments was to select or build a lens whose properties offset the aberrations that are unique to a specific optical design. Using an open-source solution, the team was successful in the design and development of high-quality laser systems that can reliably process bulk objects with a minimum of variation error.

Challenges

Successful laser processing depends on accurate prediction of the optical field distribution of the laser's focus. Some laser processing system components can introduce aberrations (distortions) in the laser beam that elongate the focal position of the beam beyond its intended circular presentation. As a result, a reduced level of precision is created by effectively shifting or dispersing the laser's intended path.

Stock lenses often produce aberrations that are within the margin of tolerance for standard optical systems, but not for high-powered lasers. In many optical applications, customizing the light source helps compensate for these aberrations. For laser systems, that isn't an option. During processing, focus material (called the "bulk") can also produce spherical aberrations that affect precision — particularly when processing thick objects.

Ansys Products Used

- OpticStudio Premium

Engineering Solution

To solve these challenges required selecting or building a lens with properties that offset aberrations unique to a specific optical design. Ray tracing analysis was conducted on proposed designs at each step of development to find factors that would yield a system with the precision required to process brittle materials.

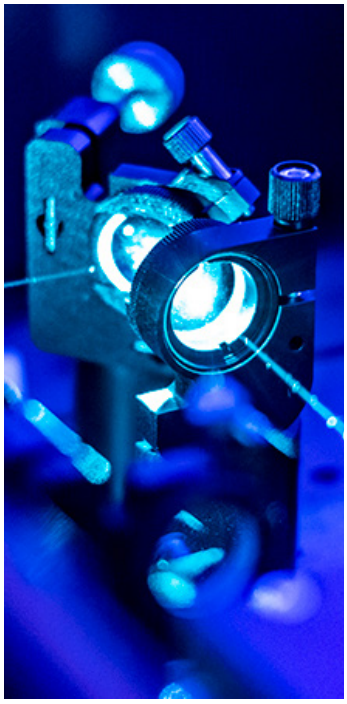
The team used ray tracing algorithms in OpticStudio, then selected the processing condition to test specific system parameters — including lens, processing depth, and spatial light modulator offset — that featured negative aberrations and offset aberrations quantified during OpticStudio analysis.

Benefits

- Using an open-source solution resulted in high-quality laser systems that can quickly and reliably process bulk objects with minimum validation errors.
- Iterating processing conditions with negative aberrations in OpticStudio cleared a path forward to determining the best conditions for enabling the ultrafast laser processing design solution.
- Successful ray tracing in OpticStudio generated data that could be used to inform other system design areas, including requirements critical for processing bulk materials in emerging forms of manufacturing.

Company Description

The Friedrich Schiller University Jena (FSU), founded in 1558, is one of the oldest, most respected public research universities in Germany. Since its opening, the university has put Jena on the map internationally as a center of academia. Today it is the largest higher education institution and the only comprehensive university in the German state of Thuringia, attracting students of all subjects, as well as scientists from all over the globe.



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