

JMO GmbH; Gauting, Germany

Designing the World's First Fully Digital 3D Surgical Microscope with LightTools

“ARRI Medical asked me to design a very challenging illumination system for their ARRISCOPE® digital 3D surgical microscope. It was an off-axis, multi-spectral illumination system with space constraints. LightTools’ advanced design, analysis and optimization tools were critical to delivering a successful design under a tight deadline. As of today, thousands of patients have successfully undergone surgery with the ARRISCOPE and, from what I hear, the surgeons are quite satisfied with the illumination.”

~Julius Muschaweck, founder of JMO GmbH



Images courtesy of JMO GmbH and ARRI Medical.

JMO GmbH Overview

Founded in 2018 by Julius Muschaweck, JMO GmbH provides optical engineering services to a wide range of companies. Specializing in illumination design and drawing on Julius Muschaweck's 25 years of experience designing illumination optics, JMO helps companies get the illumination right in their products, from feasibility studies to fully executed optical designs.

The Design Challenge: Perfect Color Mixing in a Compact Package

When ARRI Medical wanted to make the ARRISCOPE, the world's first, high-definition, fully digital 3D surgical microscope, they turned to Julius Muschaweck for the illumination system design. With this microscope, the surgeon sees a digital, 3D stereo image on a display rather than seeing the light directly through the microscope optics.

The illumination system design was challenging. ARRI Medical wanted to make a polychromatic system with warm white, cool white, green, and red illumination. This would allow the ARRISCOPE to make use of the multispectral information to better differentiate tissue types in the computed image displayed to the surgeon. This provides many advantages, but it also requires an illumination system with perfect color mixing and homogeneity. The illumination system should create a uniform, brightly illuminated rectangular patch in the object plane of the microscope.

The system's packaging is small—about the size of a thumb—and is mounted to the microscope head, off-axis from the imaging system. Space constraints, heat budget, and tolerances were all tight, but the design turnaround was tighter.

The Solution: LightTools Design and Tolerancing Capabilities

Muschaweck used LightTools to get the job done on schedule. He chose the OSRAM OSTAR Medical LED, in which the four LED colors are combined in a single, compact, tunable package. OSRAM, like many other vendors, provides ray data and CAD package models for their LEDs that can be downloaded from their website and integrated directly into LightTools, greatly simplifying the creation of an accurate source model.

The initial design work included extensive use of LightTools' integrated Parametric Controls system. Muschaweck was able to control the model layout using a small collection of numeric parameters, all displayed in a single, convenient location. He completed the initial concept development by hand, using LightTools' non-sequential rays to get instant feedback on the light path. Once a promising design emerged, Muschaweck used LightTools' Parameter Analyzer to scan the parameter space and then launched the integrated optimization engine to find the best solution. He could easily visualize the energy flow from surface to surface throughout the system and make additional design adjustments as needed.

As a final step, Muschaweck performed a tolerance analysis to ensure that the manufactured system would be within specification. With LightTools' built-in tolerance capability, the numeric parameters used to design and optimize the system were available as tolerance parameters, making the analysis easier to set up.

The system was designed on time and within performance and tolerance specifications. The optics were manufactured with a single, injection-molded part combining several optical functions, and one off-the-shelf glass lens. Making things simple is sometimes very hard; but with LightTools, Muschaweck was able to complete the design phase—excluding the detailed tolerance analysis—in one week. As of today, thousands of successful surgeries have been conducted using the ARRISCOPE.

To Learn More

For more information about ARRI Medical GmbH and their ARRISCOPE 3D surgical microscope, visit arrimedical.com.

For more information about JMO GmbH and their professional optical design services, visit jmoptics.de.

For more information about LightTools, visit synopsys.com/optical-solutions/lighttools.html