

## Publication

### A compact, efficient, and lightweight laser head for CARLO: integration, performance, and benefits

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Ever since the first functional lasers were built about 50 years ago, researchers and doctors dream of a medical use for such systems. Today's technology is finally advanced enough to realize these ambitions in a variety of medical fields. There are well-established laser based systems in ophthalmology, dental applications, treatment of kidney stones, and many more. Using lasers presents more than just an alternative to conventional methods for osteotomies. It offers less tissue damage, faster healing times, comparable intervention duration and in consequence improves postoperative treatment of patients. However, there are a few factors that limit routine applications. These technical drawbacks include missing depth control and safe guiding of the laser beam. This paper presents the engineering and integration of a miniaturized laser head for a computer assisted and robot-guided laser osteotome (CARLO (R)), which can overcome the mentioned drawbacks. The CARLO (R) device ensures a safe and precise guidance of the laser beam. Such guidance also enables new opportunities and methods, e.g. free geometrical functional cuts, which have the potential to revolutionize bone surgery. The laser head is optimized for beam shaping, target conditioning, working distance, compactness and the integration of all other parts needed, e.g. CCD-cameras for monitoring and referencing, a visible laser for cut simulation, etc. The beam coming out of the laser system is conditioned in shape, energy properties and working distance with an optical arrangement to achieve the desired cutting performance. Here also parameters like optical losses, operating mode, optics materials and long-term stability have been taken into account.

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