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Robust and accurate 3D measurement capabilities for laser treatment

InfiniteFocus in Dentistry

Currently the technology of laser pulses for the treatment of hard tooth structure is in progress. R&D put high emphasize on the development of a sophisticated laser-scanning system to drill. InfiniteFocus achieves measurement results that lead to a yet unknown optimisation of the present technology.

The technology of laser pulses: pros & cons

Due to its thermic effect the use of laser pulses is an appropriate technology for the treatment of biological tissue. So, amongst a wide spectrum of possible applications it is used for the treatment of hard tooth structure as well. However, there are certain aspects that have to be taken into account. Firstly, the dental rooth must not be heated up more than 5° Celsius. Otherwise the tooth would get damaged irreversibly. Secondly, the laser pulses need to be focussed enormously. As a matter of fact, these circumstances don´t allow a hands-free treatment at the dentist.

At present the Austrian family-held company W&H Dentalwerk Bürmoos GmbH is one of the leading suppliers of dental precision equipment globally. The R&D staff has tested the unique topomicroscopy measurement system InfiniteFocus. Topomicroscopy unites the functionalities of metrology and microscopy. Non-tactile profile, area and volume measurements are feasible.

Figure 1. Holes in the specimen, drilled throughout laser scanning for the treatment of hard tooth structure. The volume measurement of the holes lead to the ideal energy distribution for an optimised laser scanning system.

The problem: The measurement of the cavity to determine the ideal energy distribution for laser scanning

Currently the laser beam is steered, so it automatically scans a large area of the tooth (d=ca. 0,5 - 2mm). This works similar to the TVs´ electron beam. Next a scan-algorithm has to be found that guarantees the ideal energy distribution over the scanned area. During that process the cavity, its correlation with the proper energy distribution as well as the extracted volume has to be determined. So, special measurement performance is required.

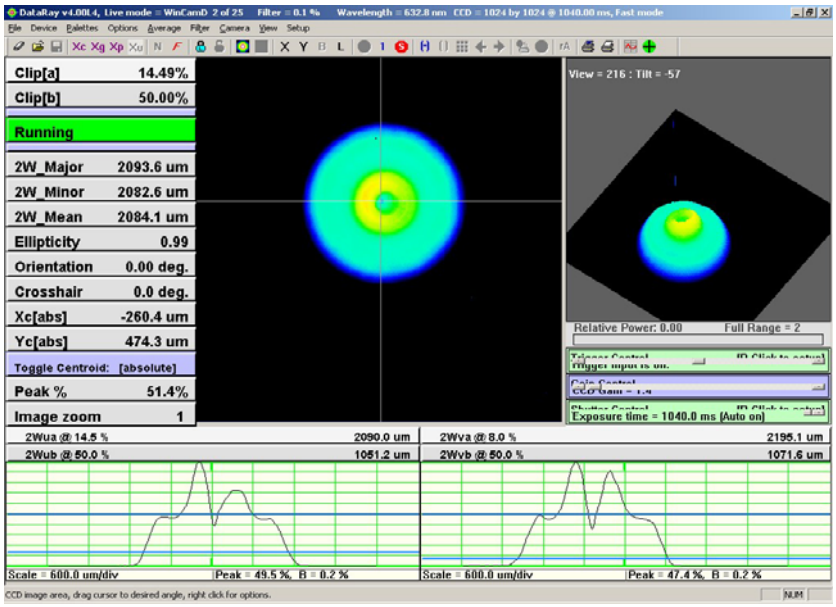


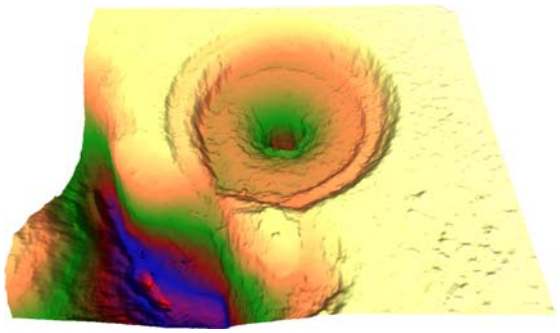
Figure 2. Laser intensity – In combination with the IFM a correlation between laser intensity and 3D measurement results can be established.

The solution: Volume measurement with InfiniteFocus

Since the cavities can consist of free-form surfaces a measurement system is necessary that provides a proper resolution of the measured volume even in these depths. InfiniteFocus fulfils all these requests brilliantly. Once the specimen is captured with the IF microscope the system generates a 3D reconstruction. In the following the direct, non-tactile measurement of the holes´ volume can be carried out in the texture image. It is a quick, easy and accurate measurement method that doesn´t require any other additional devices. More than that, InfiniteFocus provides profile, area and roughness measurement capabilities as well.

Figure 3. 3D model a hole throughout laser pulses

Figure 4. 3D pseudo colouring to visualize depths



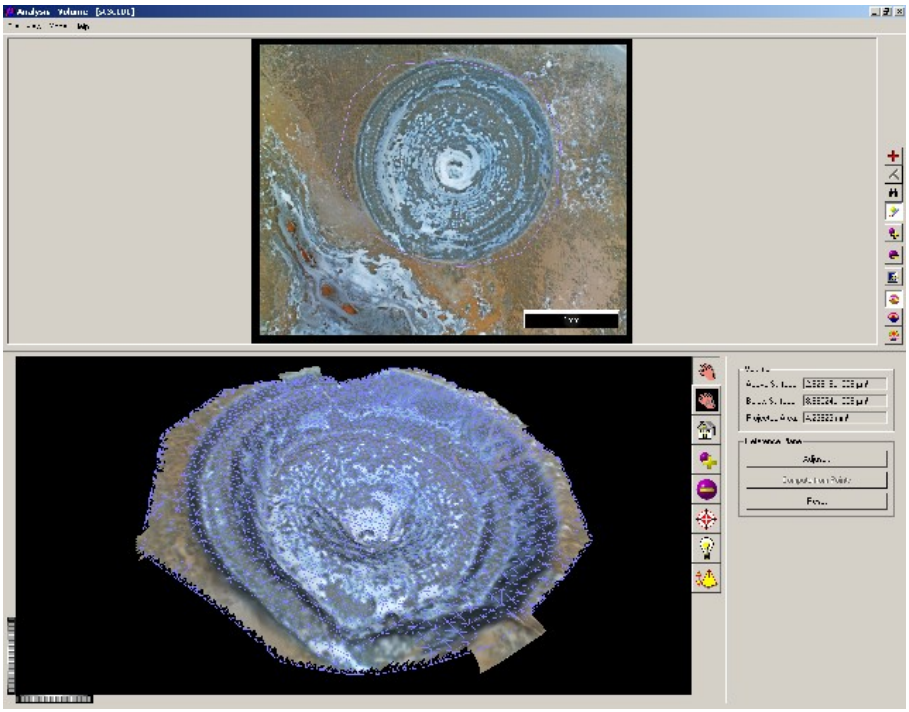


Figure 5. 3D volume measurement of the hole directly in the 2D texture image. The results lead to the development of an optimised laser scanning system since the ideal energy distribution can be determined.

Summary

In order to develop an optimised laser scanning technology to treat hard tooth structure particular measurement performances are necessary. A conventional profilometer doesn´t offer the proper capabilities. It is a tactile device without the visual link between the 3D measurement and the 2D texture whereas InfiniteFocus provides a 3D measurement directly in the image. Due to the results of the unique InfiniteFocus system a massive progress in the development of accurate laser scanning systems to drill holes is prepared. Due to the established correlation with the laser intensity the advantages of IF lead to an optimised, high class treatment of hard tooth structures.

- **IFM enables the exact 3D measurement of drill holes throughout laser pulses**
- **A correlation between the drill and the laser intensity is established**
- **IFM is the only device that enables quick and exact depth measurements over the entire field of view. More than that, the interpretation of the results is eased since the system guarantees brilliant sharpness over the whole field of view in the microscopic image.**

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